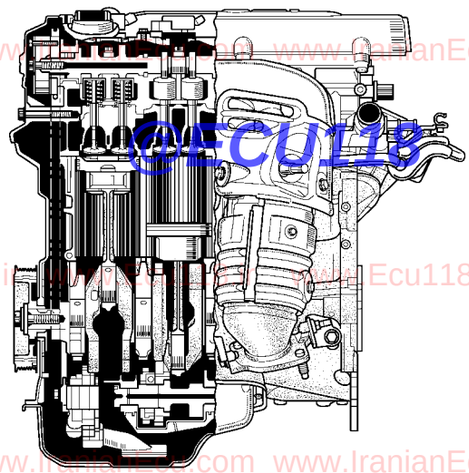
ENGINE

2AZ-FE ENGINE

■DESCRIPTION

- The 2AZ-FE engine, which is an in-line, 4-cylinder, 2.4-liter, 16-valve DOHC engine, based on the 2AZ-FE engine on the ’01 Highlander.
- This engine has following features that have been optimized in order to realize the further improvement of the engine performance, fuel economy and to reduce exhaust emissions.
  - The PS (Planetary reduction Segment conductor motor) starter has been adopted.
  - Meets the ULEV (Ultra Low Emission Vehicle) regulation requirements.
  - ETCS-i (Electronic Throttle Control System-intelligent) has been adopted.
  - VVT-i (Variable Valve Timing-intelligent) system is used.
  - A big bore / long port intake manifold is used.
  - A balance shaft is used.



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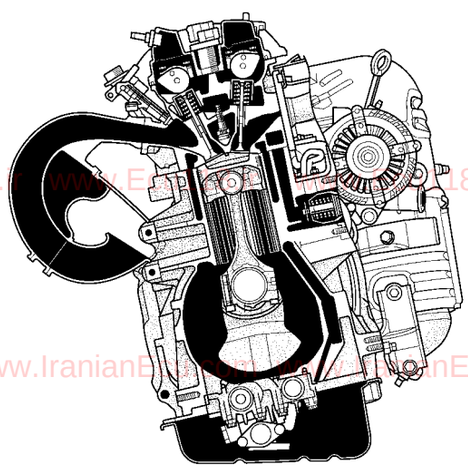
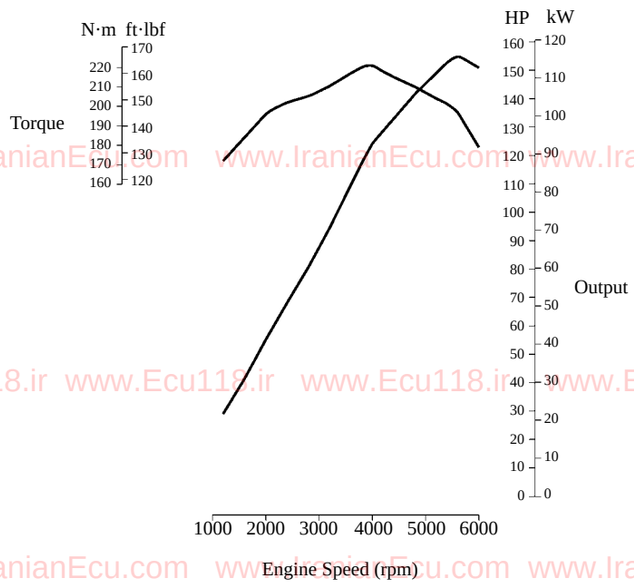


208EG02

▶ Engine Specification ◀

Model		Camry	'01 Highlander
Engine Type		2AZ-FE	←
No. of Cyls. & Arrangement		4-cylinder, In-line	←
Valve Mechanism		16-Valve, DOHC, Chain Drive	←
Combustion Chamber		Pentroof Type	←
Manifolds		Cross-Flow	←
Fuel System		SFI	←
Displacement	cm^3 (cu. in.)	2362 (144.2)	←
Bore × Stroke	mm (in.)	88.5 × 96.0 (3.48 × 3.78)	←
Compression Ratio		9.6 : 1	←
Max. Output	(SAE-NET)	117 kW @ 5600 rpm (157 HP @ 5600 rpm)	115 kW @ 5600 rpm (155 HP @ 5600 rpm)
Max. Torque	(SAE-NET)	220 N·m @ 4000 rpm (162 ft·lbf @ 4000 rpm)	221 N·m @ 4000 rpm (163 ft·lbf @ 4000 rpm)
Firing Order		1-3-4-2	←
Research Octane Number		91 or more	←
Octane Rating		87 or more	←
Dry Weight	kg (lb) M/T	127 (280)	—
	kg (lb) A/T	121 (267)	←
Oil Grade		API SJ, SL, EC or ILSAC	API SH, SJ , EC or ILSAC

▶ Performance Curve ◀



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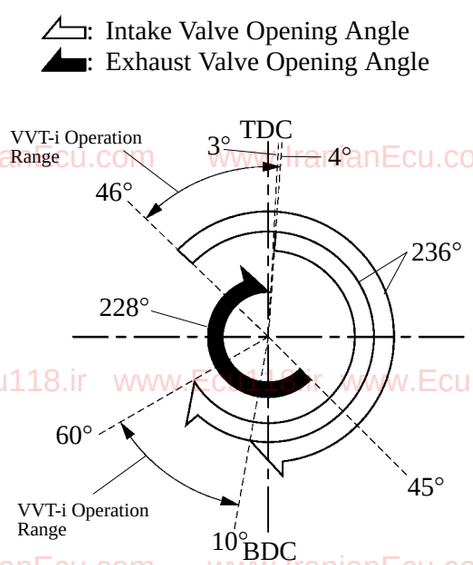
▶ Valve Timing ◀



206EG03

■FEATURES OF 2AZ-FE ENGINE

The 2AZ-FE engine has been able to achieve the following performance through of the adoption of the item listed below.

(1) High performance and fuel economy

(2) Low noise and vibration

(3) Lightweight and compact design

(4) Good serviceability

(5) Clean emission

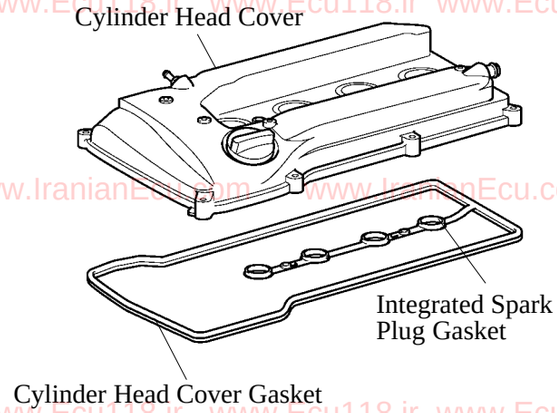
Item	(1)	(2)	(3)	(4)	(5)	Camry	Highlander
The VVT-i system is used.	○				○	○	←
The ETCS-i has been newly adopted.	○					○	—
A cylinder block made of aluminum alloy along with a magnesium head cover has been adopted.			○			○	←
The taper squish shape has been adopted for the piston head.	○				○	○	←
The DIS (Direct Ignition System) makes ignition timing adjustment unnecessary.	○			○	○	○	←
A serpentine belt drive system has been adopted, and the brackets and the engine have been integrated.			○	○		○	←
Timing chain has been used.				○		○	←
The fuel returnless system has been adopted.			○	○	○	○	←
Quick connectors are used to connect the fuel hose with the fuel pipes.				○		○	←
12-hole type fuel injectors with high atomizing performance have been adopted.	○				○	○	←
Iridium-tipped spark plugs have been adopted.	○			○		○	←
Intake manifold made of plastic has been adopted.			○			○	←
A 2-way exhaust control system has been adopted.	○	○				○	←
The use of an air fuel ratio sensor allows precise control.					○	○	←
A resin gear balance shaft has been adopted.		○	○			○	←
The PS (Planetary reduction-Segment conductor motor) starter has been adopted.			○			○	—

Other parts construction are the same as in the '01 Highlander.

■ENGINE PROPER

1. Cylinder Head Cover

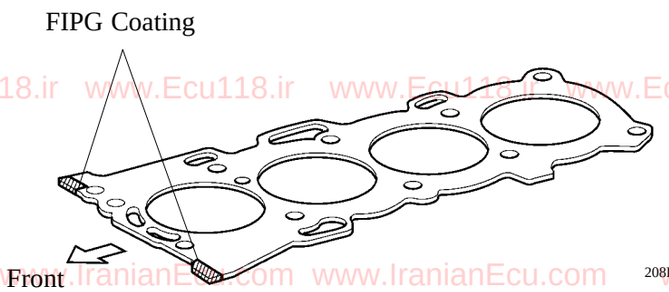
- A lightweight magnesium alloy diecast cylinder head cover is used.
- The cylinder head cover gasket and the spark plug gasket have been integrated to reduce the number of parts.



185EG35

2. Cylinder Head Gasket

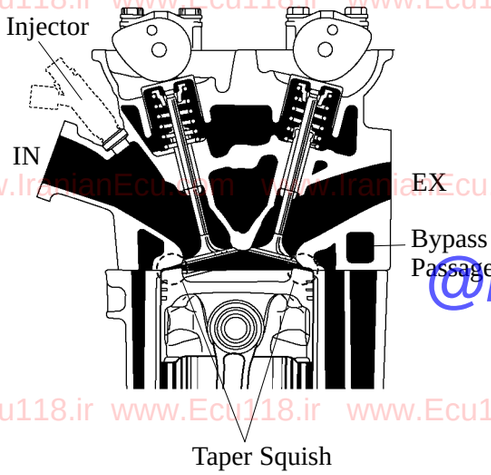
A steel-laminate type cylinder head gasket has been adopted.



208EG05

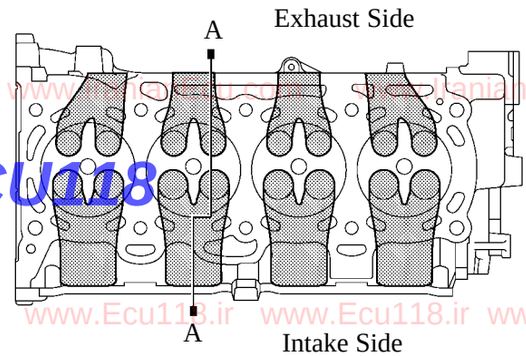
3. Cylinder Head

- The taper squish combustion chamber has been used to realize the highly engine's knocking resistance and fuel efficiency.
- An upright intake port has been used to realize the highly intake efficiency.
- Installing the injectors in the cylinder head enables the injectors inject fuel as close as possible to the combustion chamber. This prevents the fuel from adhering to the intake port walls, which reduces HC exhaust emissions.
- The routing of the water bypass jacket in the cylinder head has been optimized to realize the highly cooling performance. In addition, a water bypass passage has been provided below the exhaust ports to reduce the number of parts and to achieve weight reduction.



208EG67

A - A Cross Section

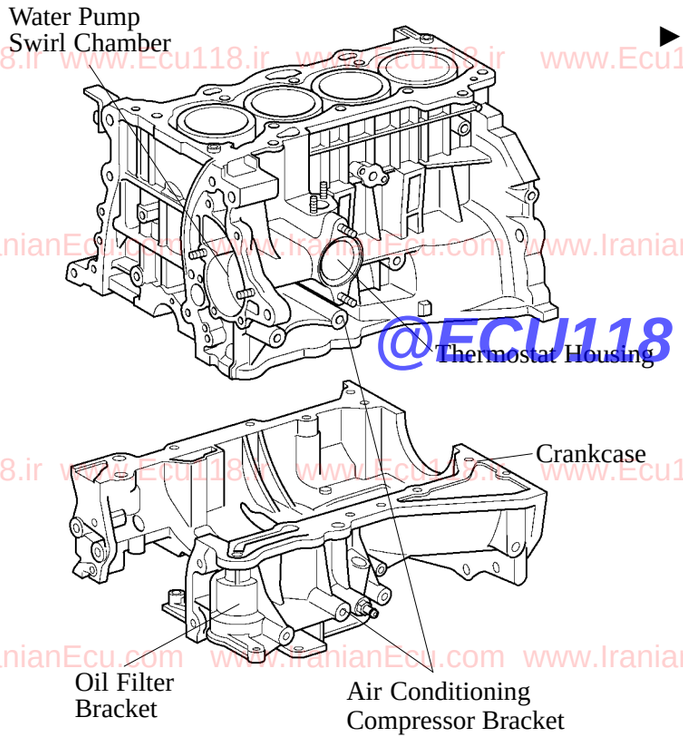


198EG29

View from the Back Side

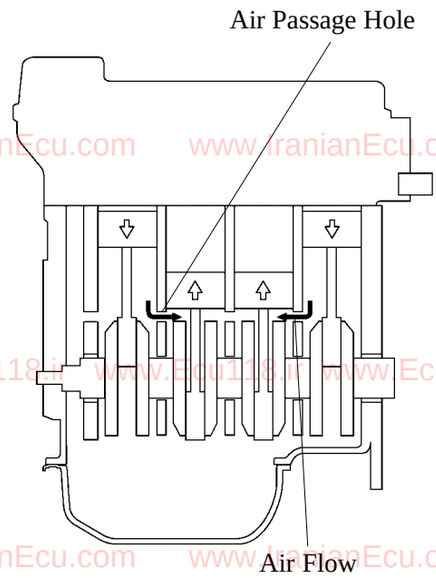
4. Cylinder Block

- Lightweight aluminum alloy is used for the cylinder block.
- By producing the thin cast-iron liners and aluminum alloy cylinder block as a unit to realize the compact design. The liner is thin, so that boring is not possible.
- Passage holes are provided in the bulkhead of the cylinder block. As a result, the air at the bottom of the cylinder flows smoother, and pumping loss (back pressure at the bottom of the piston generated by thepiston's reciprocal movement) is reduced.
- The oil filter and the air conditioning compressor bracket are integrated the crankcase, also the water pump swirl chamber, the thermostat housing and the rear oil seal retainer integrated the cylinder block.



185EG42

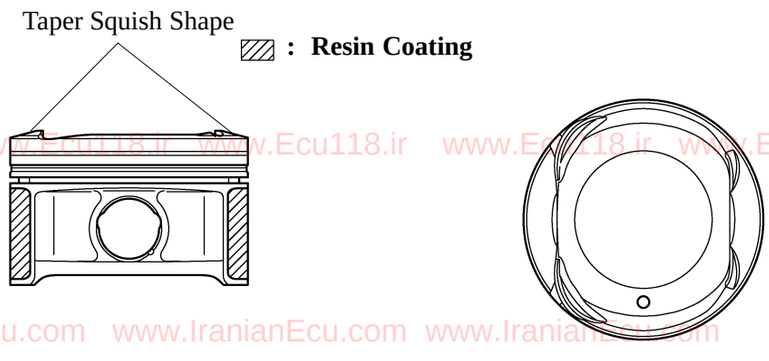
▶ Air Flow During Engine Revolution ◀



179EG04

5. Piston

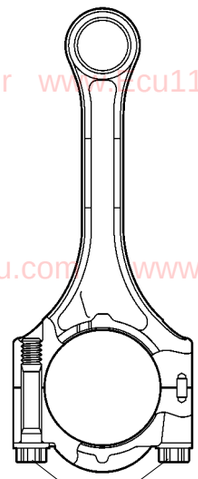
- The piston is made of aluminum alloy and skirt area is made compact and lightweight.
- The piston head portion has adopted a taper squish shape.
- The piston skirt has been coated with resin.
- Full floating type piston pins are used.
- By increasing the machining precision of the cylinder bore diameter, the outer diameter of the piston has been made into one type.



View from the Top Side

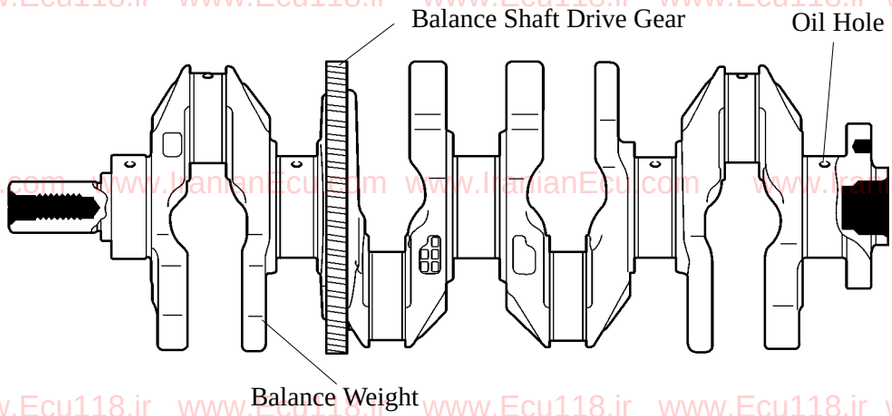
6. Connecting Rod

- The connecting rods and caps are made of high strength steel for weight reduction.
- Nutless-type plastic region tightening bolts of the connecting rod are adopted for a lighter design.



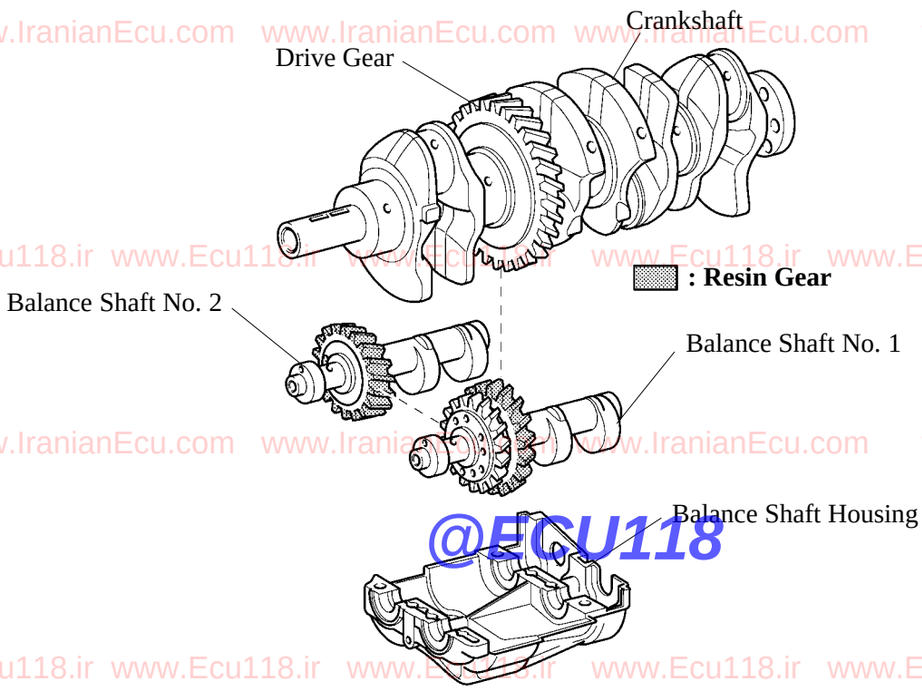
7. Crankshaft

- The crankshaft has 5 journals and 8 balance weights.
- The precision and surface roughness of the pins and journals have been realized to reduce friction.
- The balance shaft drive gear has been installed onto the crankshaft.
- The crankshaft is made of forged steel.



8. Balance Shaft

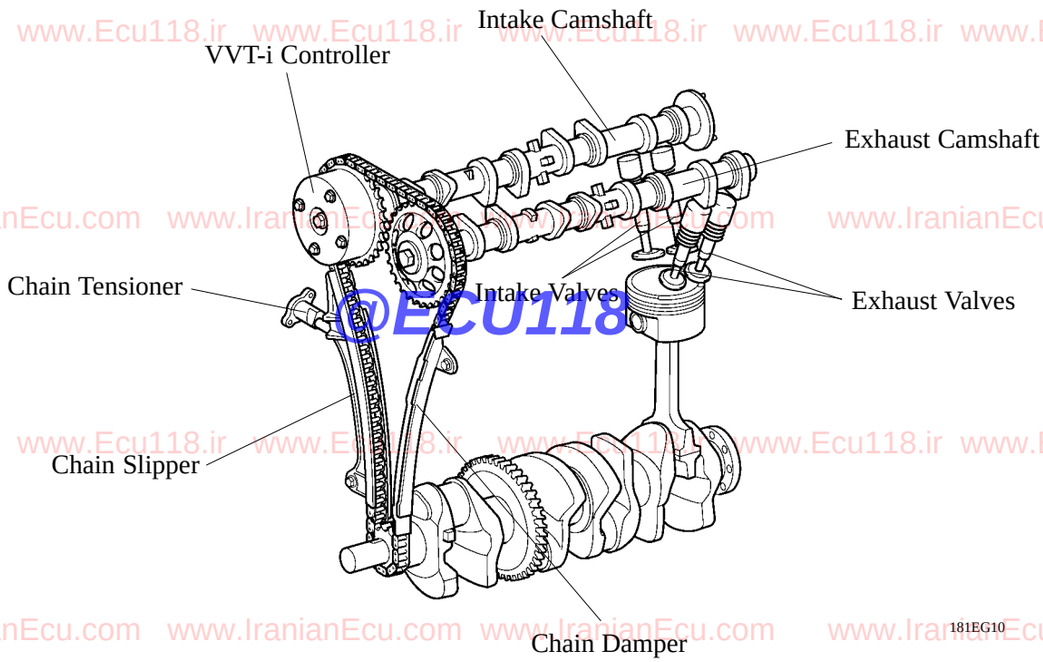
- A balance shaft has been adopted to reduce vibrations.
- A direct-drive system has been adopted which makes use of a gear that is installed onto the counterweight of crankshaft.
- In addition, a resin gear has been adopted on the driven side to suppress noise and offer lightweight design.



■VALVE MECHANISM

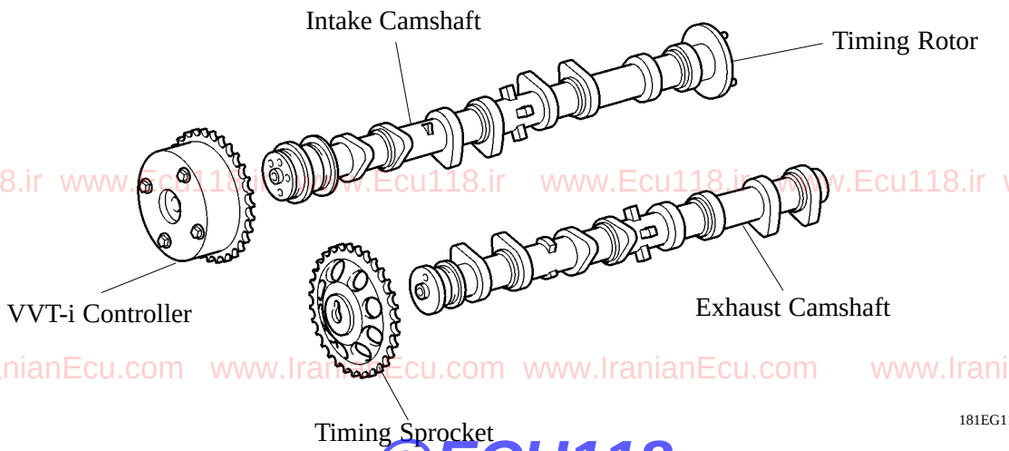
1. General

- Each cylinder is equipped with 2 intake valves and 2 exhaust valves. Intake and exhaust efficiency has been increased due to the larger total port areas.
- The valves are directly opened and closed by 2 camshafts.
- The intake and exhaust camshafts are driven by a chain. The VVT-i system used for the intake camshaft is used to realize highly fuel economy, engine performance and reduce exhaust emissions. For details, see page EG-42 in the VVT-i system section.
- The shimless type valve lifter is used.



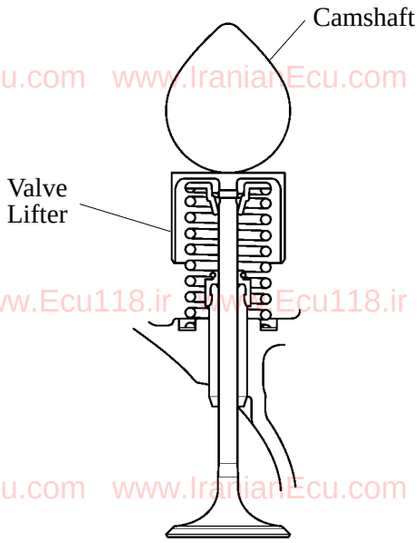
2. Camshaft

- The intake camshaft is provided with timing rotor to trigger the camshaft position sensor.
- In conjunction with the adoption of the VVT-i system, an oil passage is provided in the intake camshaft in order to supply engine oil pressure to the VVT-i system.
- A VVT-i controller has been installed on the front of the intake camshaft to vary the timing of the intake valves.



3. Intake and Exhaust Valves

- Intake and exhaust valves with large-diameter valve face have been adopted to improve the intake air and exhaust gas flow.
- Narrow valve stems have been adopted to reduce the intake and exhaust resistance and for weight reduction.



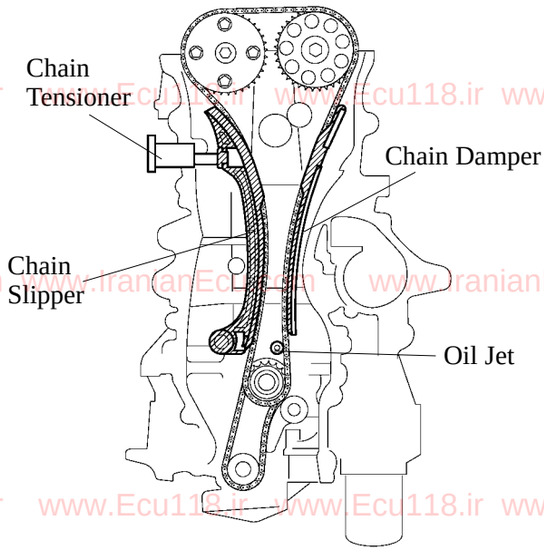
- Along with the increased amount of valve lift, shimless valve lifters that provide a large cam contact surface have been adopted. The adjustment of the valve clearance is accomplished by selecting and replacing the appropriate valve lifters.

Service Tip

The valve lifters are available in 35 size in increment of 0.020 mm (0.008 in.), from 5.060 (0.199 in.) to 5.740 (0.226 in.).
For details, refer to see the 2002 Camry Repair Mnual (Pub. No. RM881U).

4. Timing Chain

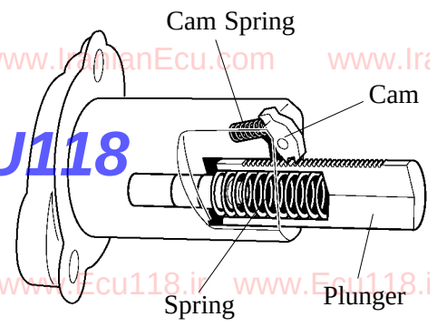
- A roller chain with an 8 mm pitch has been adopted.
- The timing chain is lubricated by an oil jet.



181EG13

5. Chain Tensioner

- The chain tensioner uses a spring and oil pressure to maintain proper chain tension at all times.
  The chain tensioner suppresses noise generated by the chain.
  A ratchet type non-return mechanism is also used.
- To improve serviceability, the chain tensioner is constructed so that it can be removed and installed from the outside of the timing chain cover.

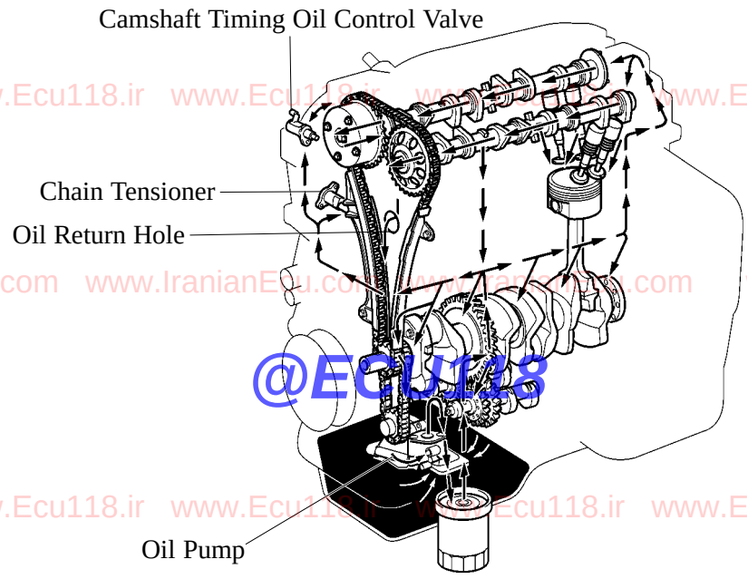


181EG14

■LUBRICATION SYSTEM

1. General

- The lubrication circuit is fully pressurized and oil passes through an oil filter.
- The trochoidal type oil pump is chain-driven by the crankshaft.
- The oil filter is attached downward from the crankcase to improve serviceability.
- Along with the adoption of the VVT-i system, the cylinder head is provided with a VVT-i controller and a camshaft timing oil control valve. This system is operated by the engine oil.



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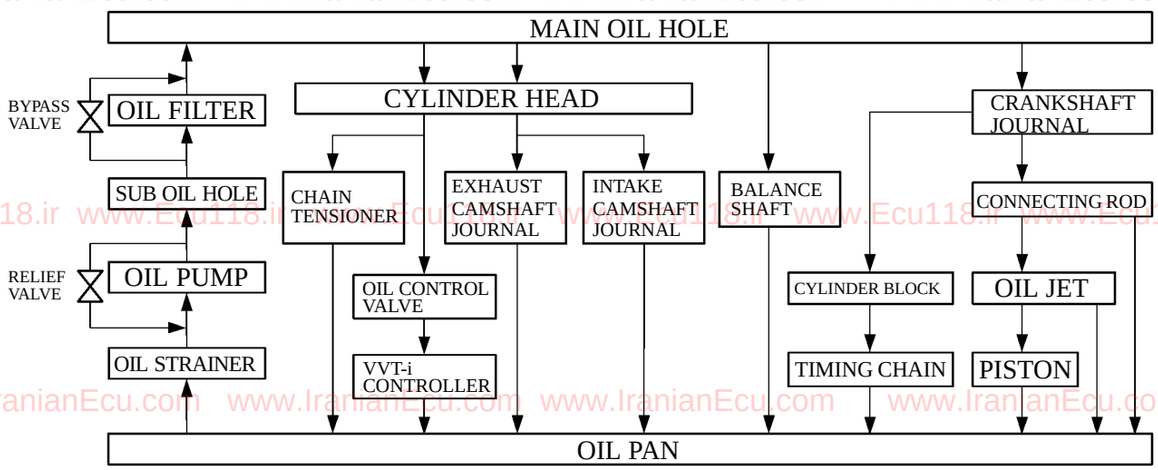


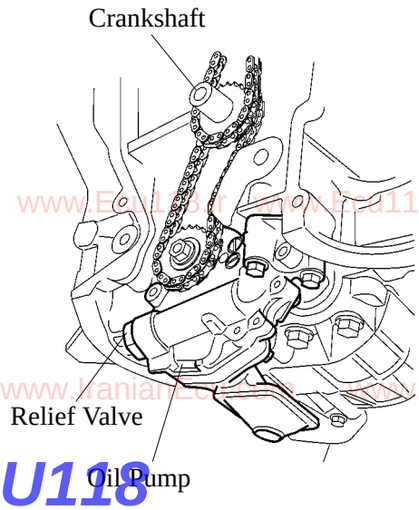
208EG08

▶ **Specifications** ◀

Oil Capacity	Dry	4.5 liters (4.8 US qts, 4.0 Imp. qts)
	with Oil Filter	3.8 liters (4.0 US qts, 3.3 Imp. qts)
	without Oil Filter	3.6 liters (3.8 US qts, 3.2 Imp. qts)

2. Oil Pump

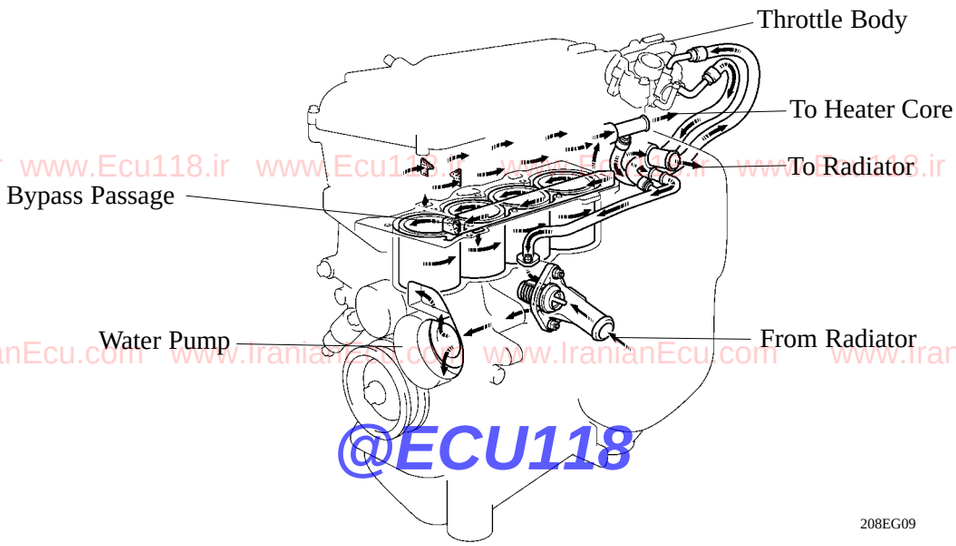
- The trochoidal type oil pump is chain-driven by the crankshaft, and fits compactly inside the timing chain cover.
- Friction has been reduced by means of 2 relief holes in the internal relief system.

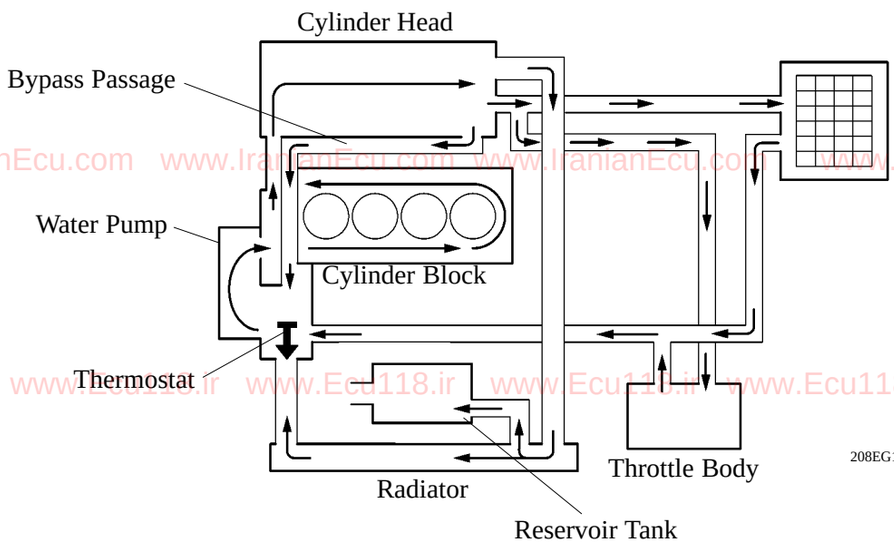


181EG43

■COOLING SYSTEM

- The cooling system is a pressurized, forced-circulation type.
- A thermostat with a bypass valve is located on the water inlet housing to maintain suitable temperature distribution in the cooling system.
  This prevents sudden jumps in temperature while the engine is warming up.
- The flow of the engine coolant makes a U-turn in the cylinder block to ensure a smooth flow of the engine coolant. In addition, a bypass passage is enclosed in the cylinder head and the cylinder block.
- Warm water from the engine is sent to the throttle body to prevent freeze-up.





▶ Specifications ◀

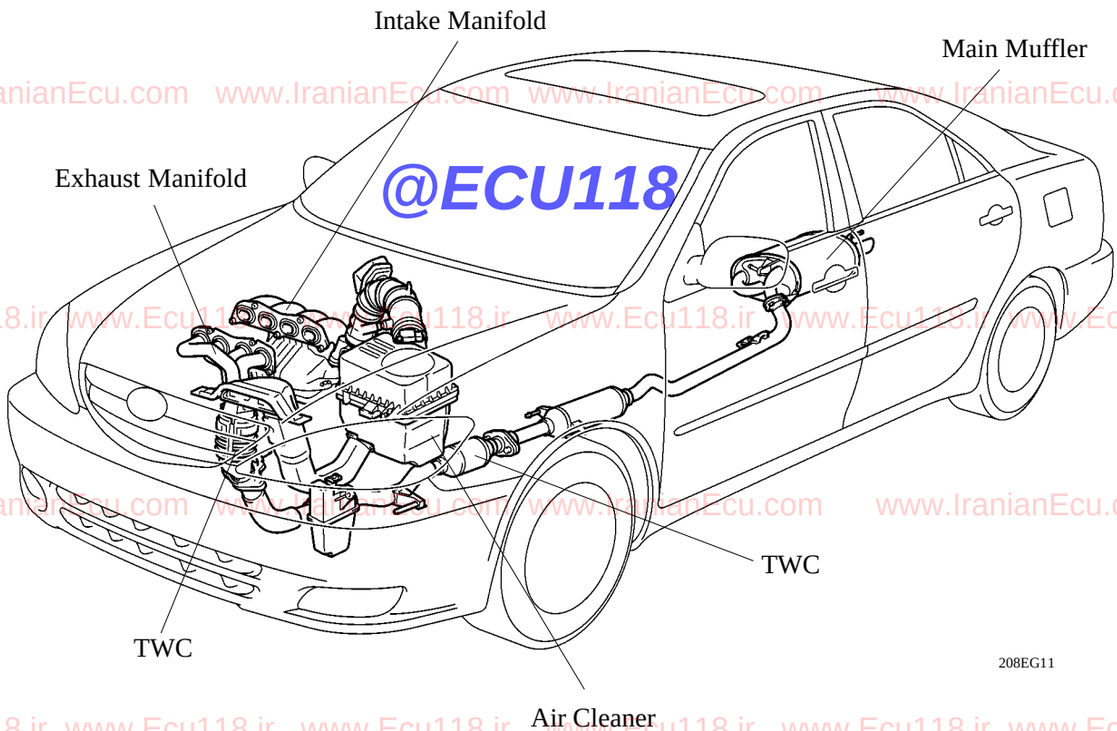
Engine Coolant	Capacity liters (US qts, Imp. qts)	6.2 (6.6, 5.5)
	Type	TOYOTA Long Life Coolant or Equivalent
Thermostat	Opening Temperature °C (°F)	80 - 84 (176 - 183)

■INTAKE AND EXHAUST SYSTEM

1. General

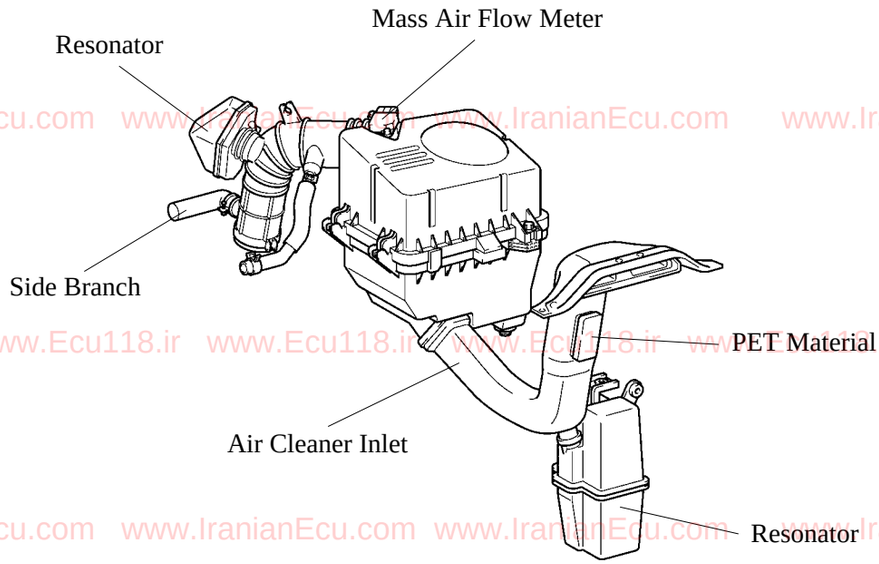
- The two resonators, the side branch and PET* (Polyethylene Terephthalate) material have been newly adopted to air cleaner inlet and air cleaner hose.
- The adoption of ETCS-i (Electronic Throttle Control System-intelligent) has realized excellent throttle control.
- The intake manifold has been made of plastic to reduce the weight and the amount of heat transferred from the cylinder head.
- 2-way exhaust control system is provided to reduce noise and vibration in the main muffler.

*: Using porous material that permits it to breath, air intake pulsating pressure will be let out to the outside of air cleaner inlet.



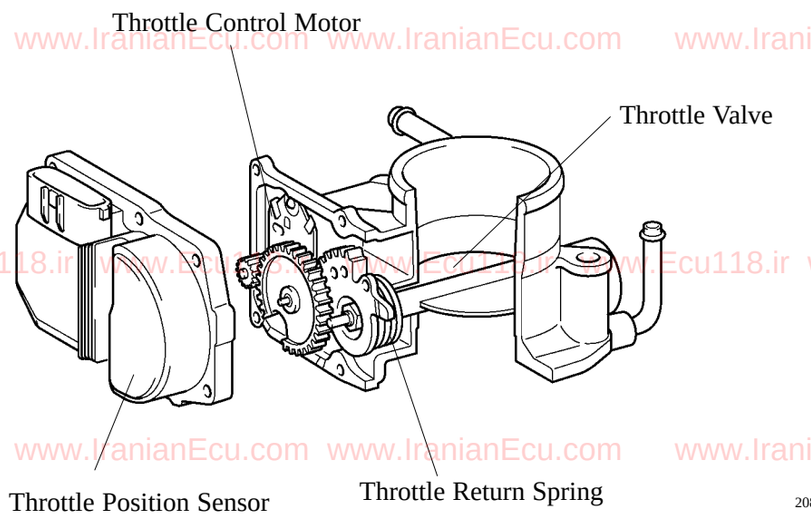
2. Air Cleaner

- A flameless, full-fabric air filter has been adopted to reduce weight and to simplify its disposal.
- The two resonators, the side branch and PET material have been newly adopted to air cleaner inlet and air cleaner hose to reduce the intake air noise.



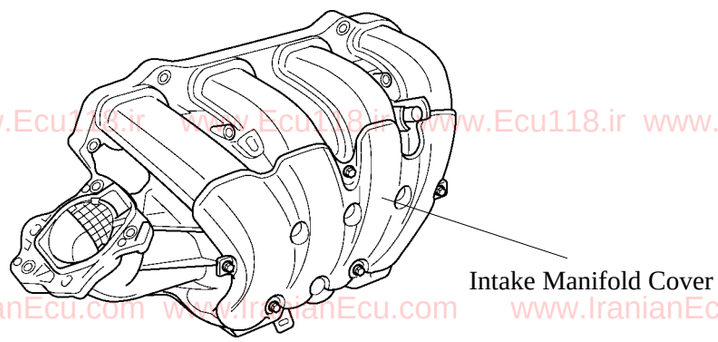
3. Throttle Body

- The adoption of the link-less type ETCS-i has realized excellent throttle control. For details of ETCS-i control, refer to see page EG-40.
- A DC motor with excellent response and minimal power consumption is used for the throttle control motor. The ECM performs the duty ratio control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the opening angle of the throttle valve.



4. Intake Manifold

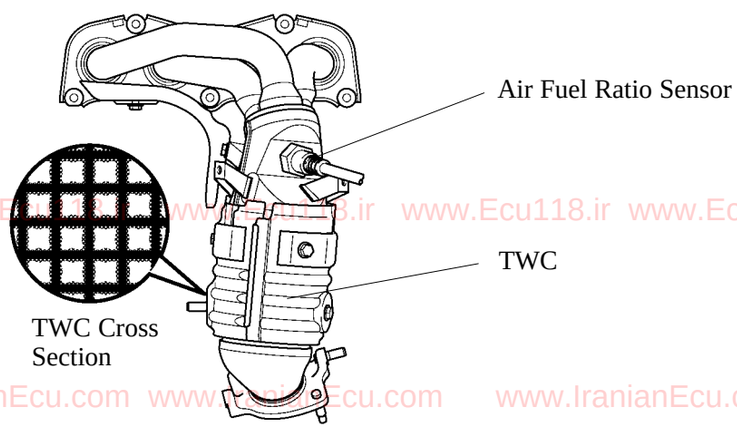
- The intake manifold has been made of plastic to reduce the weight and the amount of heat transferred from the cylinder head. As a result, it has become possible to reduce the intake air temperature and improve the intake volumetric efficiency.
- A resonator is installed inside the air intake chamber which makes use of the intake pulse to improve torque in the mid-speed range.
- The intake manifold cover is used on the intake manifold to reduce intake air noise.



198EG34

5. Exhaust Manifold

- A stainless steel exhaust manifold is used for weight reduction.
- An ultra thin-wall, high-cell ceramic type TWC (Three-Way Catalytic Converter) has been adopted. This TWC enables to improve exhaust emissions by optimizing the cells density.

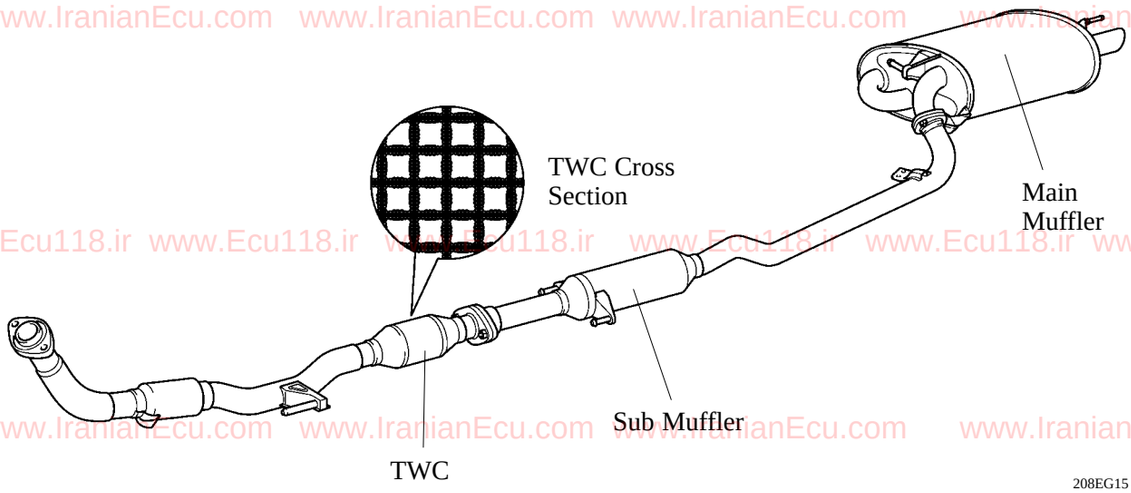


208EG14

6. Exhaust Pipe

General

- An ultra thin-wall, high-cell ceramic type TWC (Three-Way Catalytic Converter) has been adopted. This TWC enables to improve exhaust emissions by optimizing the cells density.
- 2-way exhaust control system is provided to reduce noise and vibration in the main muffler.



2-Way Exhaust Control System

- A 2-way exhaust control system is used. This system reduces the back pressure by opening and closing a variable valve that is enclosed in the main muffler, thus varying the exhaust gas pressure.
- The valve opens steplessly in accordance with the operating condition of the engine, thus enabling a quieter operation at lower engine speeds, and reducing back pressure at higher engine speeds.

1) Construction

The control valve is enclosed in the main-muffler. When the exhaust gas pressure overcomes the spring pressure, the control valve opens steplessly in accordance with the exhaust gas pressure.

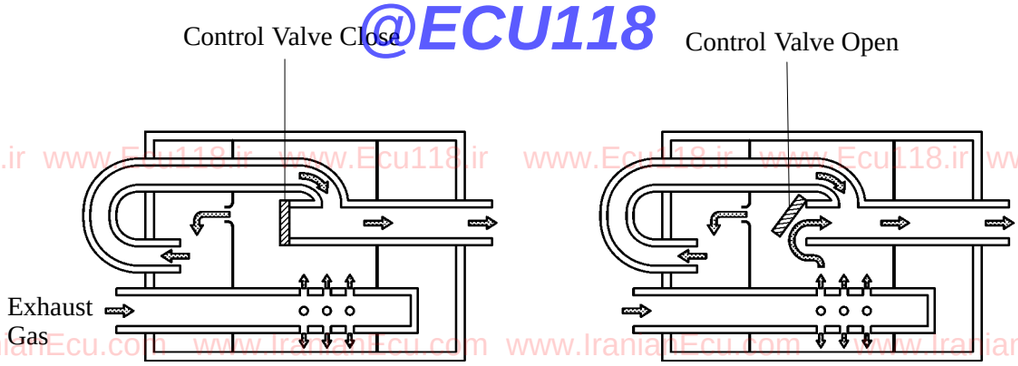
2) Operation

a. When Control Valve is Closed (low engine speed)

Since the pressure in the main muffler is low, the control valve is closed. Hence exhaust gas does not pass the bypass passage, and exhaust noise decreased by the main muffler.

b. When Control Valve is Open (middle to high engine speed)

The valve opens more as the engine speed and the back pressure in the muffler increase. This allows a large volume of exhaust gas to pass the bypass passage, thereby substantially decreasing the back pressure.



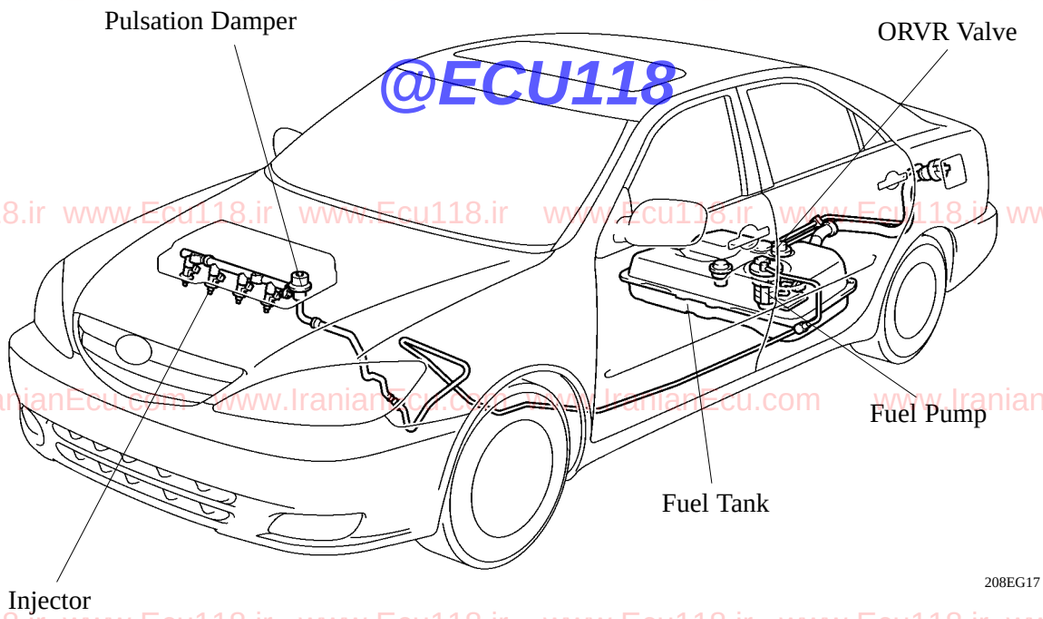
Low Engine Speed **Middle to High Engine Speed**

208EG16

■FUEL SYSTEM

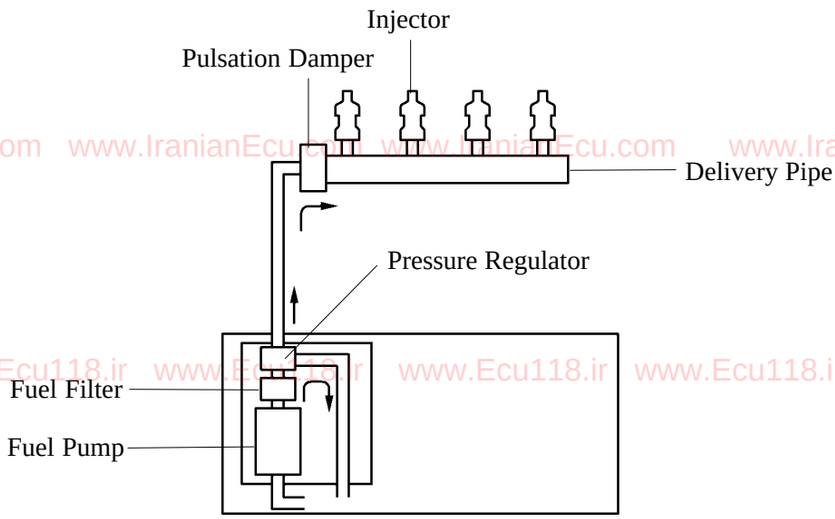
1. General

- A fuel returnless system has been used to reduce evaporative emissions.
- A compact fuel pump in which a fuel filter and pressure regulator are integrated in the module fuel pump assembly has been adopted.
- A quick connector has been adopted to connect the fuel pipe with the fuel hose to improve serviceability.
- The aluminum die-cast delivery pipe has been integrated with the pulsation damper.
- A 12-hole type injector has been adopted.
- A tether has been provided on the fuel filler cap to prevent the cap from being lost, which results in preventing the leakage of fuel or the evaporative gas.
- The quick-turn type fuel tank cap has been adopted to improve usability.
- The ORVR (On-board Refueling Vapor Recovery) system has been used.



2. Fuel Returnless System

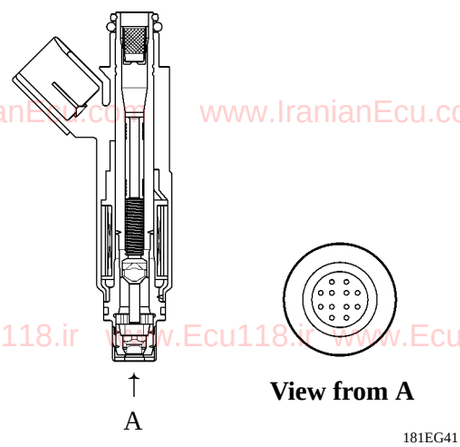
This system has been adopted to reduce the evaporative emission. As shown below, integrating the fuel filter, pressure regulator, and fuel sender gauge with fuel pump assembly it possible to discontinue the return of fuel from the engine area and prevent temperature rise inside the fuel tank.



208EG18

3. Fuel Injector

The compact 12-hole type injector with high atomizing performancehas been adopted.



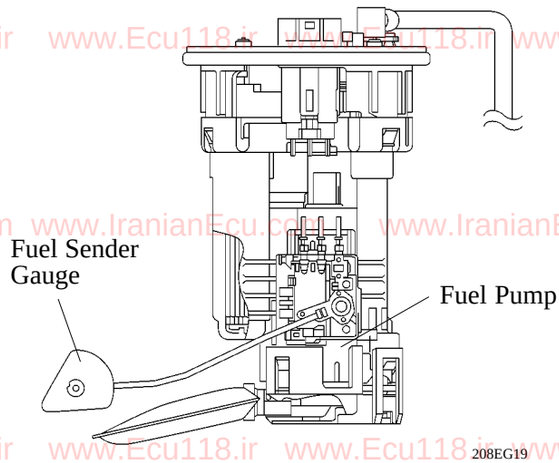
181EG41

4. Fuel Pump

A compact fuel pump in which a fuel filter, pressure regulator, and fuel sender gauge are integrated in the fuel pump assembly has been adopted.

▶ Specification of Pressure Regulator ◀

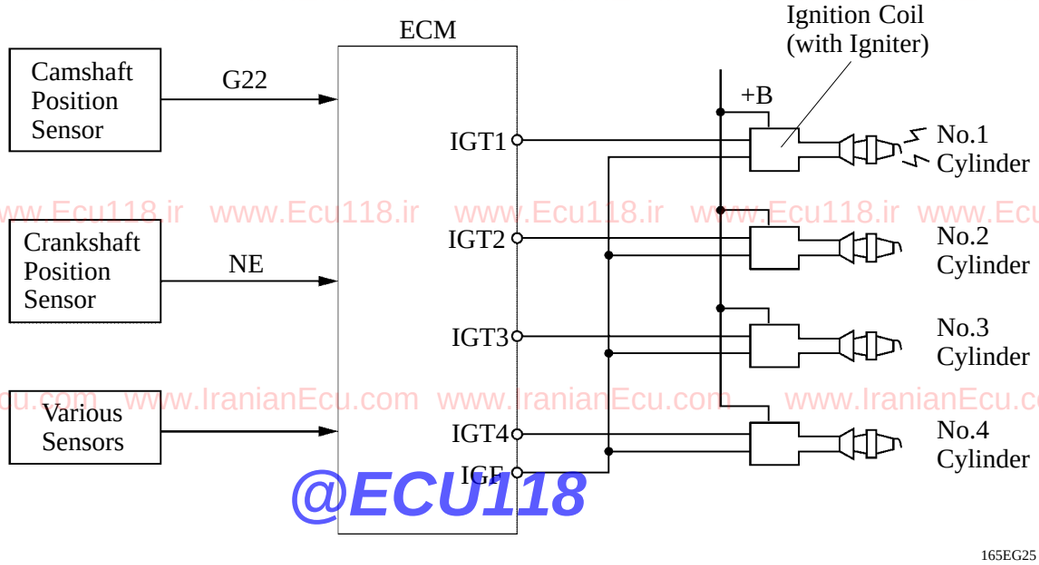
Adjusting Pressure kPa (kgf/cm^2)	324 ± 3.0 (3.3 ± 0.03)



■IGNITION SYSTEM

1. General

- A DIS (Direct Ignition System) has been adopted. The DIS improves the ignition timing accuracy, reduces high-voltage loss, and enhances the overall reliability of the ignition system by eliminating the distributor. The DIS in this engine is an independent ignition system which has one ignition coil (with igniter) for each cylinder.
- Iridium-tipped spark plugs have been adopted.



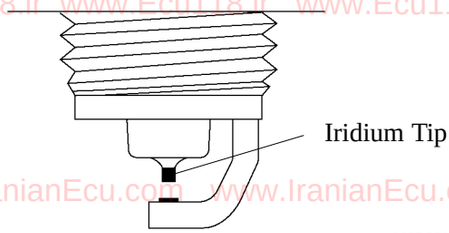
165EG25

2. Ignition Coil

The DIS provides 4 ignition coils, one for each cylinder. The spark plug caps, which provide contact to the spark plugs, are integrated with an ignition coil. Also, an igniter is enclosed to simplify the system.

3. Spark Plug

Iridium-tipped spark plugs have been adopted to realize a 120,000 mile (192,000 km) maintenance-free operation. By making the center electrode of iridium, the same ignition performance as of the platinum-tipped spark plug and further improvement of durability have been realized.



208EG70

▶ **Specifications** ◀

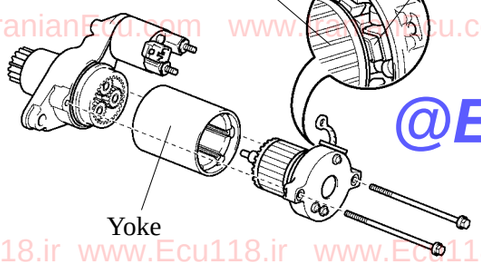
DENSO	SK20R11
NGK	IFR6A11
Plug Gap	1.0 - 1.1 mm (0.0394 - 0.043 in.)

■STARTING SYSTEM

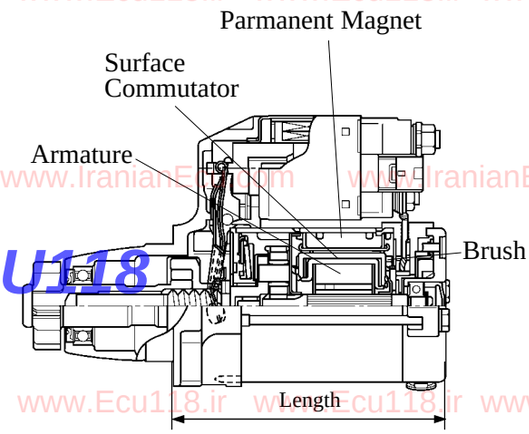
Starter

1) General

- A compact and lightweight PS (Planetary reduction-Segment conductor motor) starter has been adopted on all models.
- Because the PS starter contains an armature that uses square-shaped conductors, and its surface functions as a commutator, it has resulted in both improving its output torque and reducing its overall length.
- In place of the field coil used in the conventional starter, the PS starter uses two types of permanent magnets: main magnets and interpolar magnets. The main magnets and interpolar magnets have been efficiently arranged to increase the magnetic flux and to shorten the length of the yoke.



206EG18



206EG19

▶ **Specifications** ◀

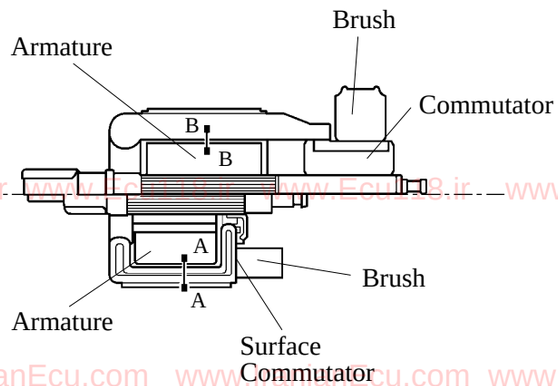
Model	PS Starter	Conventional Type Starter
Length	128 mm (5.04 in.)	145 mm (5.71 in.)
Weight	2950 g	3800 g
Rating Voltage	12 V	12 V
Rating Output	1.6 kW	1.4 kW
Rotating of Direction	Counterclockwise*	←

*: Viewed from Pinion Side

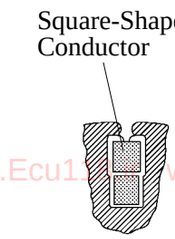
2) Construction

- Instead of the construction of the armature coil of the conventional starter that uses round-shaped conductor wires, the PS starter uses square conductors. With this type of construction, the same conditions that are realized by winding numerous round-shaped conductor wires can be achieved without increasing the mass. As a result, the output torque has been increased, and the armature coil has been made more compact.
- Because the surface of the square-shaped conductors that are used in the armature coil functions as a commutator, the overall length of the PS starter has been shortened.

Conventional Type Starter

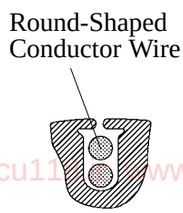


PS Starter



A - A Cross Section

PS Starter

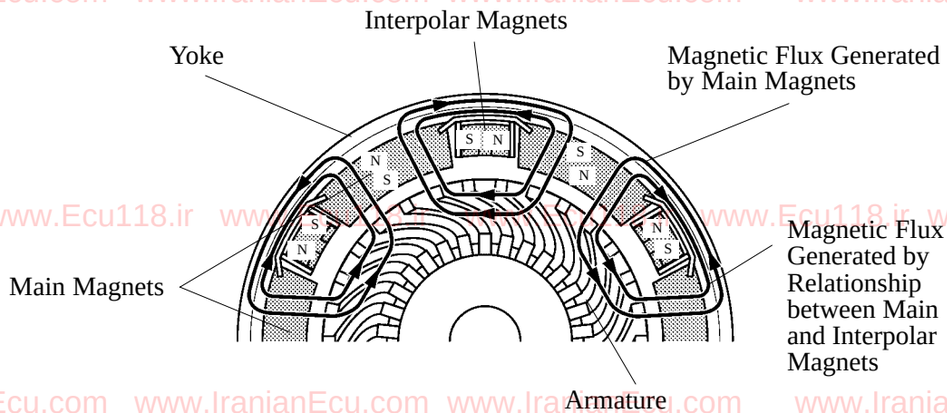


B - B Cross Section

Conventional Type Starter

206EG20

- Instead of the field coils used in the conventional starter, the PS starter has adopted two types of permanent magnets: the main magnets and the interpolar magnets. The main and interpolar magnets are arranged alternately inside the yoke, allowing the magnetic flux that is generated between the main and interpolar magnets to be added to the magnetic flux that is generated by the main magnets. In addition to increasing the amount of magnetic flux, this construction shortens the overall length of the yoke.



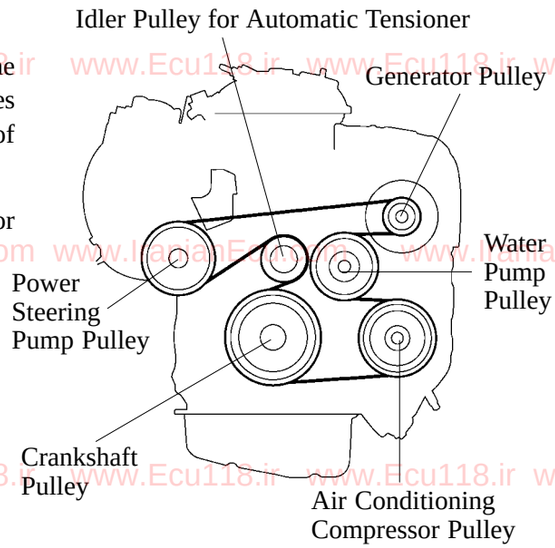
206EG21

Cross Section of Yoke Portion

■SERPENTINE BELT DRIVE SYSTEM

1. General

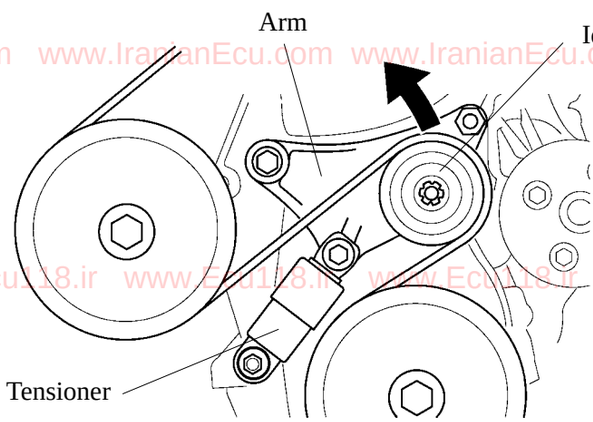
- Accessory components are driven by a serpentine belt consisting of a single V-ribbed belt. It reduces the overall engine length, weight and number of engine parts.
- An automatic tensioner eliminates the need for tension adjustment.



198EG11

2. Automatic Tensioner

- The automatic tensioner consists of an idler pulley, an arm, and a tensioner. The idler pulley maintains belt tension by the force of the spring that is located in the tensioner.
- Due to the different suppliers used, the tensioner comes in two types, although their basic operation remain the same and they are interchangeable.



181EG18

■ENGINE CONTROL SYSTEM

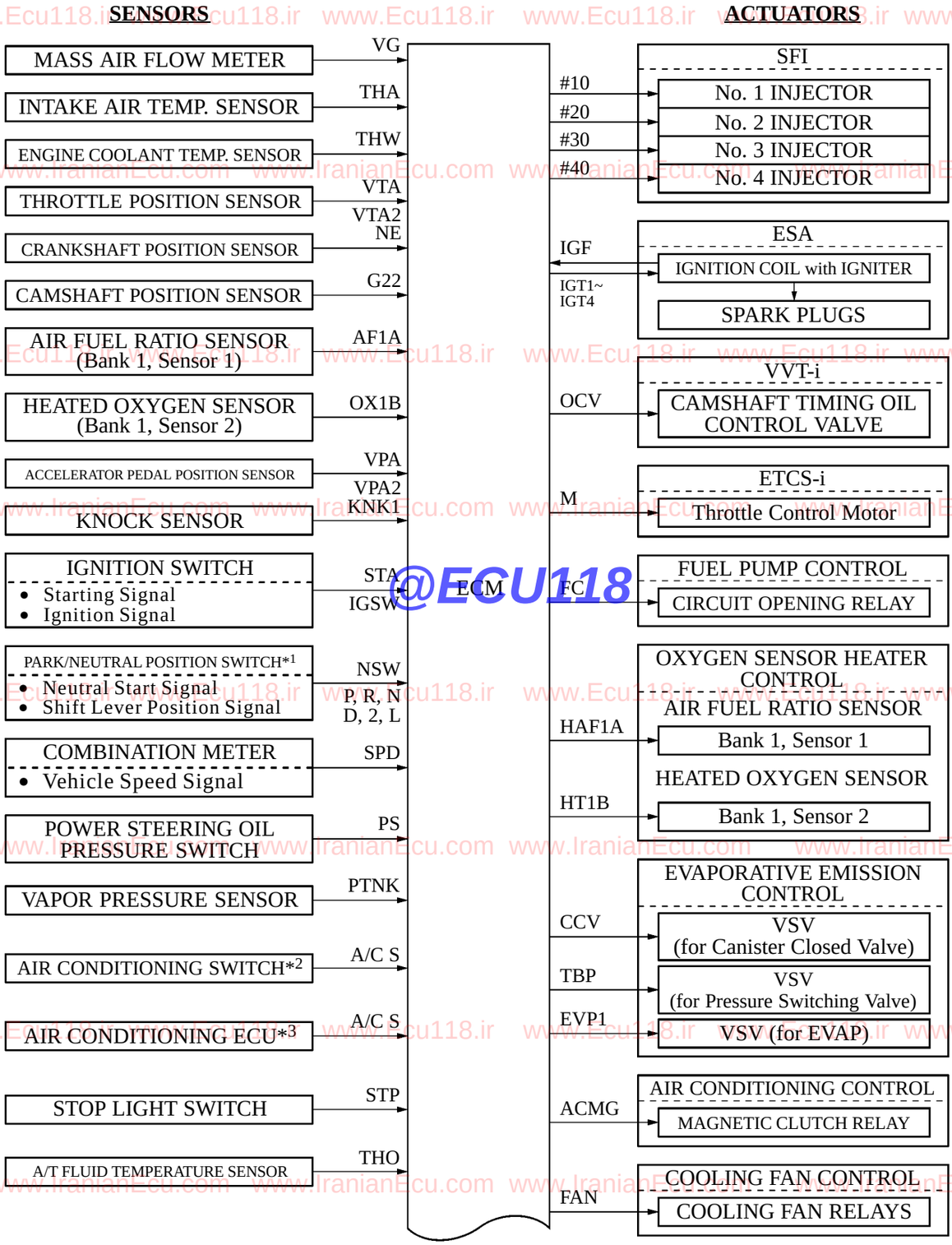
1. General

The engine control system of the 2AZ-FE engine has following system.

System	Outline
SFI (Sequential Multiport Fuel Injection) (For details, see page EG-39)	An L-type SFI system directly detects the intake air mass with a hot wire type mass air flow meter.
ESA (Electronic Spark Advance) (For details, see page EG-39)	Ignition timing is determined by the ECM based on signals from various sensors. The ECM corrects ignition timing in response to engine knocking.
ETCS-i (Electronic Throttle Control System-intelligent) (For details, see page EG-40)	Optimally controls the throttle valve opening in accordance with the amount of accelerator pedal effort and the condition of the engine and the vehicle.
VVT-i (Variable Valve Timing-intelligent) (For details, see page EG-42)	Controls the intake camshaft to an optimal valve timing in accordance with the engine condition.
Fuel Pump Control	Fuel pump operation is controlled by signal from the ECM.
Air Fuel Ratio Sensor, Oxygen Sensor Heater Control	Maintains the temperature of the air fuel ratio sensor or oxygen sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.
Evaporative Emission Control (For details, see page EG-44)	• The ECM controls the purge flow of evaporative emission (HC) in the charcoal canister in accordance with engine conditions. • Using 3 VSVs and a vapor pressure sensor, the ECM detects any evaoprative emission leakage occurring between the fuel tank and the charcoal canister through the changes in the tank pressure.
Air Conditioning Cut-off Control	By turning the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Cooling Fan Control (For details, see page EG-43)	Radiator cooling fan operation is controlled by engine coolant temperature sensor signal (THW) and the condition of the air conditioning operation.
Engine Immobiliser	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.
Diagnosis (For details, see page EG-49)	• When the ECM detects a malfunction, the ECM diagnoses and memorizes the failed section. • To increase the speed for processing the signals, the 32-bit CPU of the ECM has been adopted.
Fail-Safe (For details, see page EG-50)	When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in the memory.

2. Construction

The configuration of the engine control system in the 2AZ-FE engine in the '02 Camry is as shown in the following chart.



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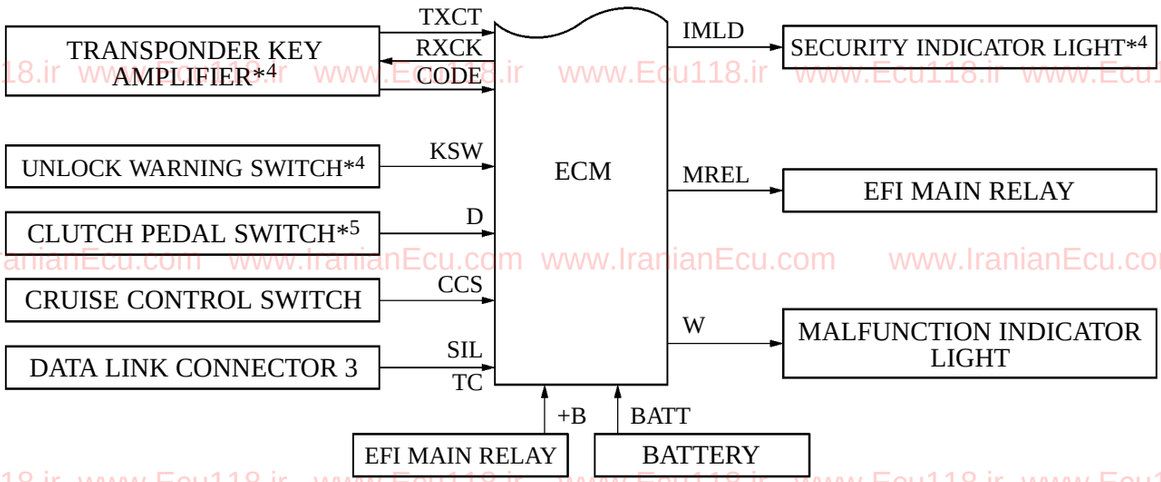
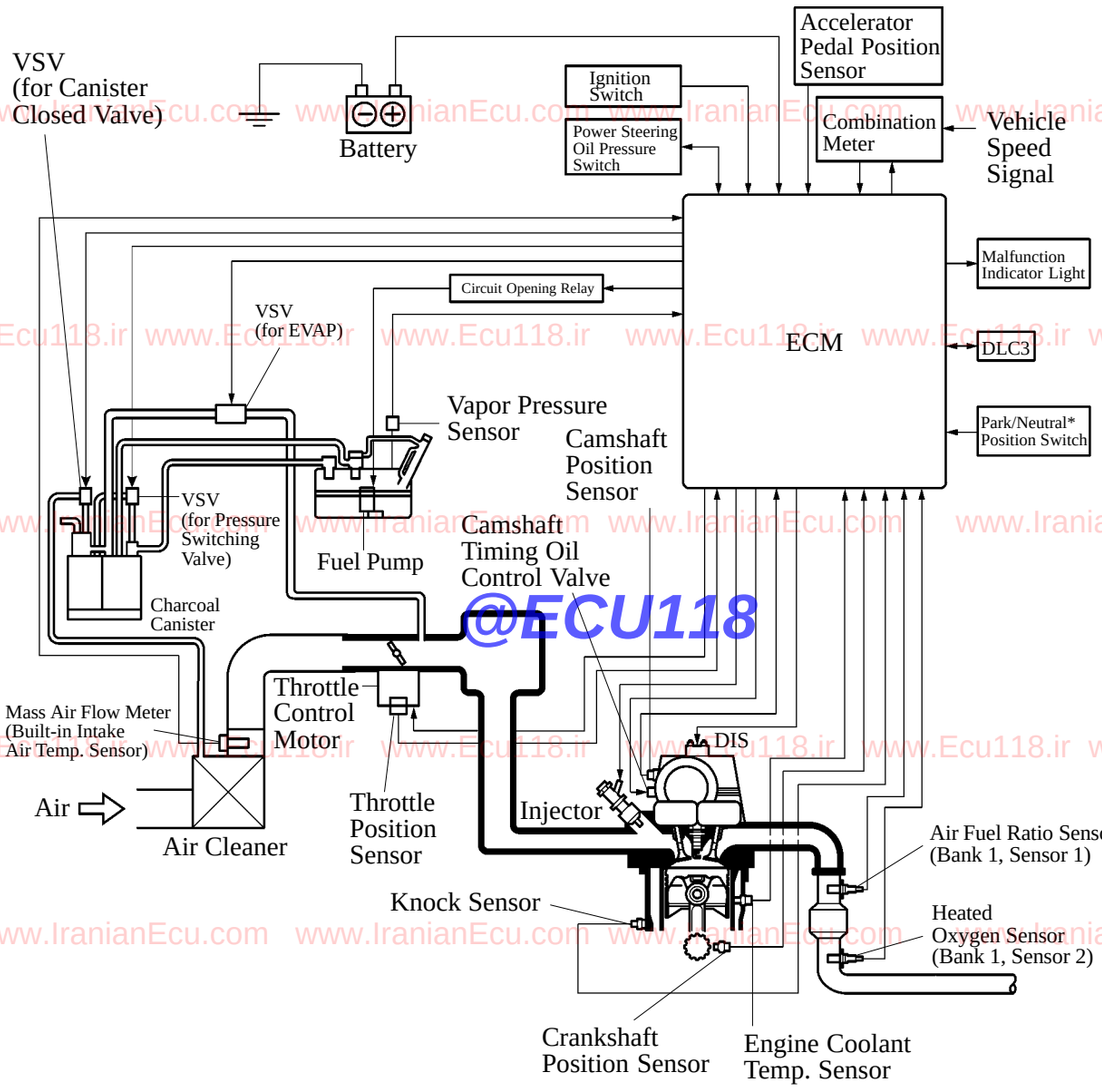
208EG20



*1: Automatic Transaxle Model Only
*2: with Manual Air Conditioning System
*3: with Automatic Air Conditioning System
*4: with Engine Immobiliser System
*5: Manual Transaxle Model Only

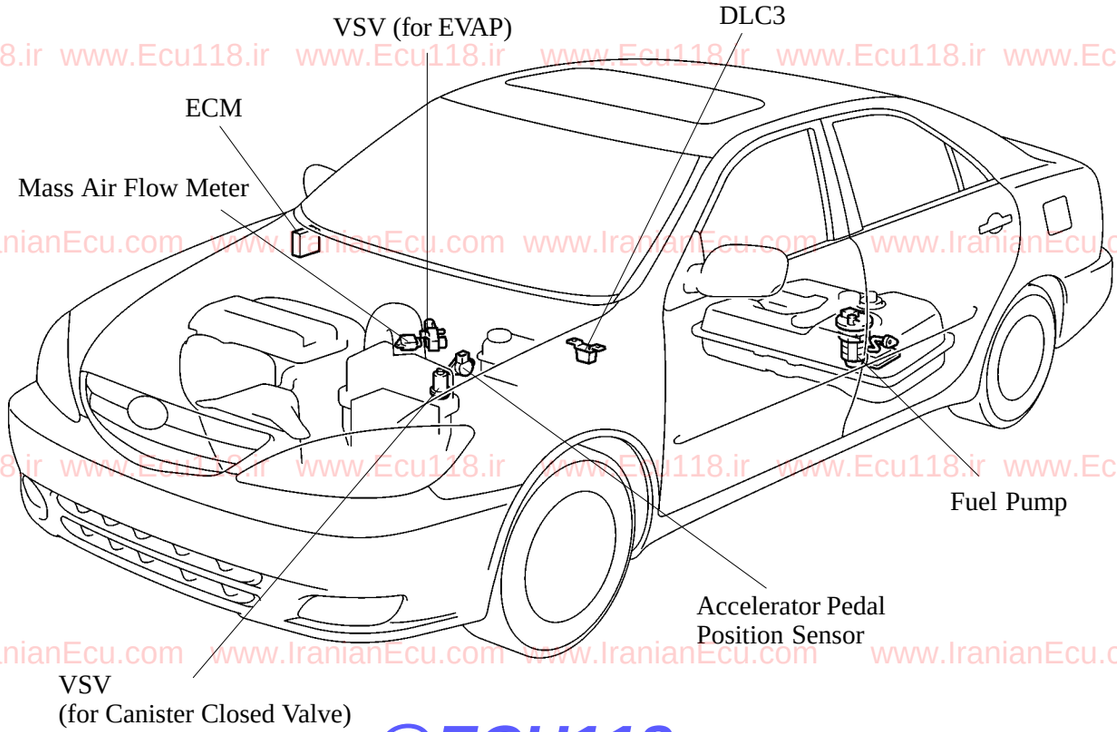
208EG21

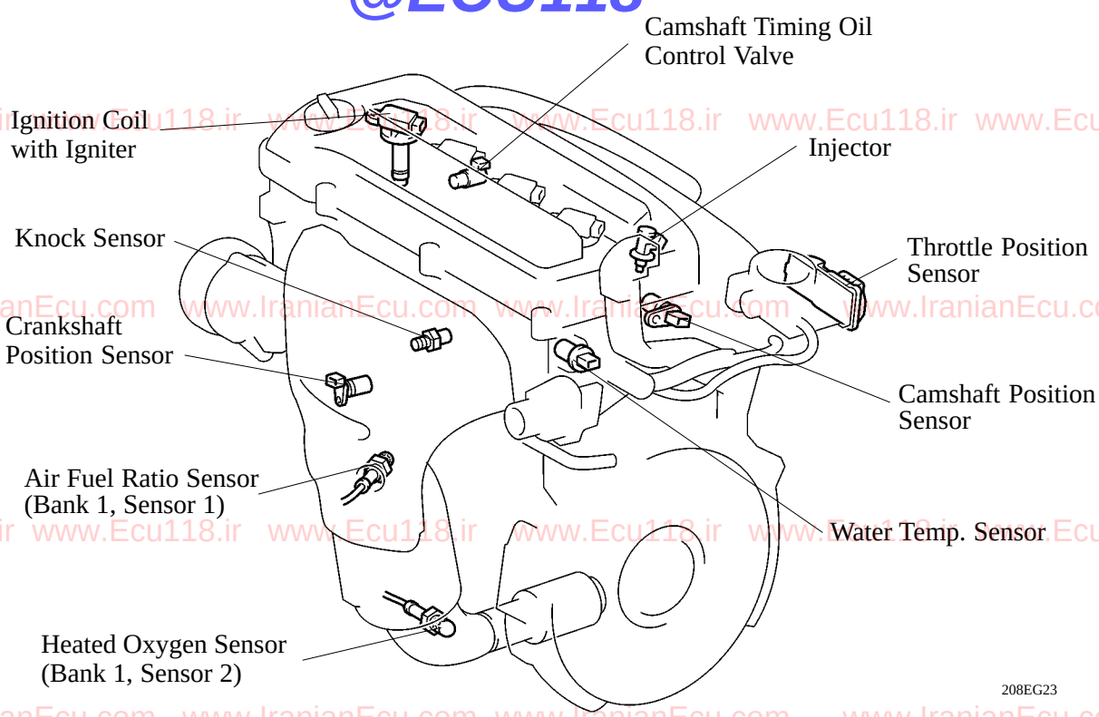
3. Engine Control System Diagram



*: Automatic Transaxle Model Only

4. Layout of Main Components





5. Main Components of Engine Control System

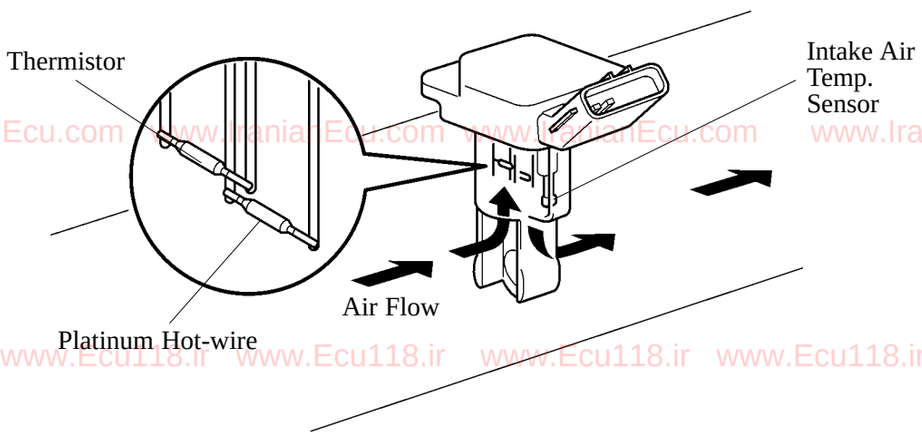
General

The following table compares the main components.

Components	Outline	Quantity
ECM	32-bit ECU	1
Mass Air Flow Meter	Hot-wire Type	1
Crankshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (36-2)	1
Camshaft Position Sensor (Rotor Teeth)	Pick-up Coil Type (3)	1
Throttle Position Sensor	Linear Type	1
Accelerator Pedal Position Sensor	Linear Type	1
Knock Sensor	Built-in Piezoelectric Type	1
Air Fuel Ratio Sensor	with Heater Type	1
Oxygen Sensor	with Heater Type	1
Injector	12-hole Type	4

Mass Air Flow Meter

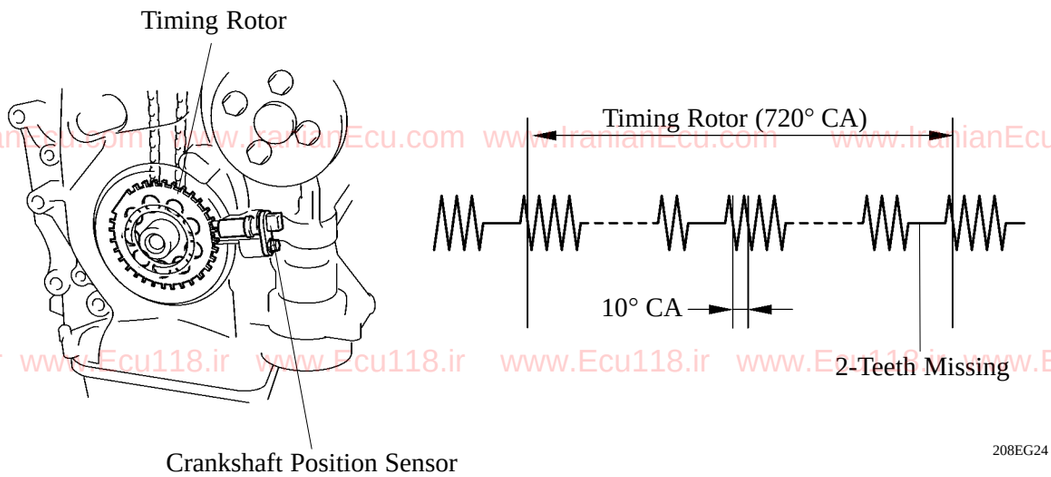
- This mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision has been improved and the intake air resistance has been reduced.
- This mass air flow meter has a built-in intake air temperature sensor.



199EG35

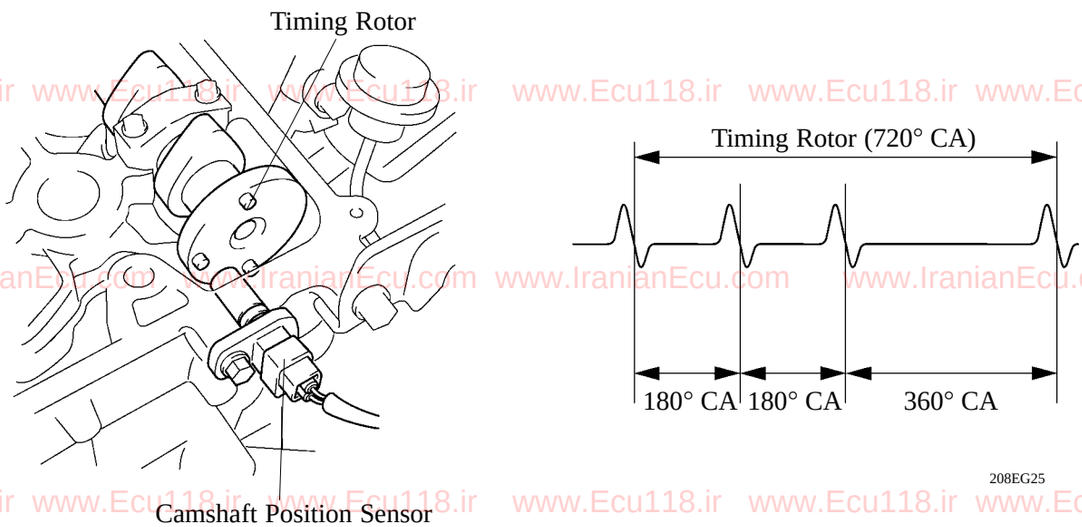
Crankshaft Position Sensor

The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.



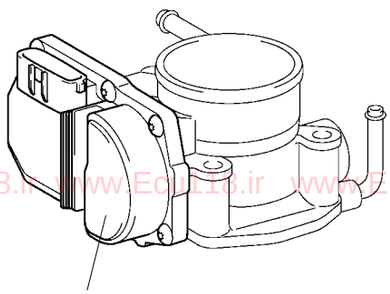
Camshaft Position Sensor

The camshaft position sensor is mounted on the left bank of cylinder head. To detect the camshaft position, a protrusion that is provided on the timing pulley is used to generate 1 pulse for every 2 revolution of the crankshaft.

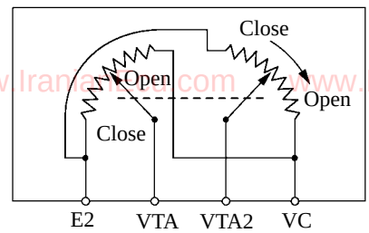


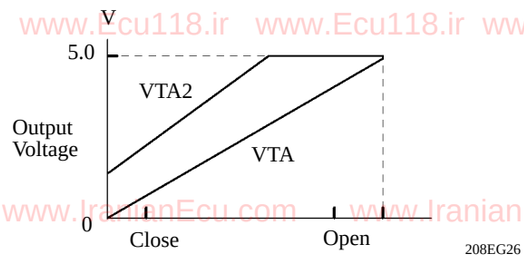
Throttle Position Sensor

This sensor converts the throttle valve opening angles into electronic signals with two differing characteristics and outputs them to the ECM. One is the VTA signal that linearly outputs the voltage along the entire range of the throttle valve opening angle. The other is the VTA2 signal that outputs an offset voltage.



Throttle Position Sensor

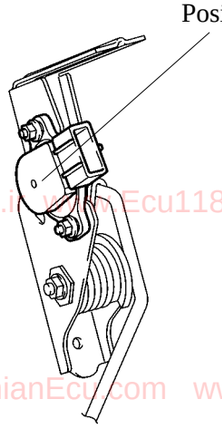




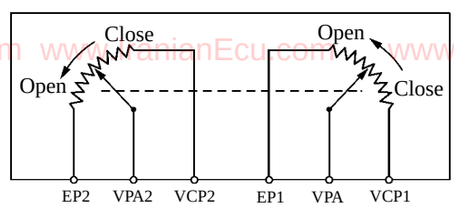
208EG26

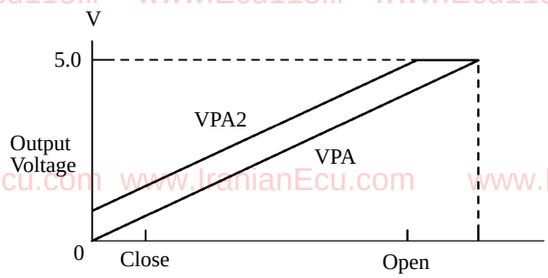
Accelerator Pedal Position Sensor

This sensor converts the accelerator pedal depressed angles into electric signals with two differing characteristics and outputs them to the ECM. One is the VPA signal that linearly outputs the voltage along the entire range of the accelerator pedal depressed angle. The other is the VPA2 signal that outputs on offset voltage.



Accelerator Pedal Position Sensor



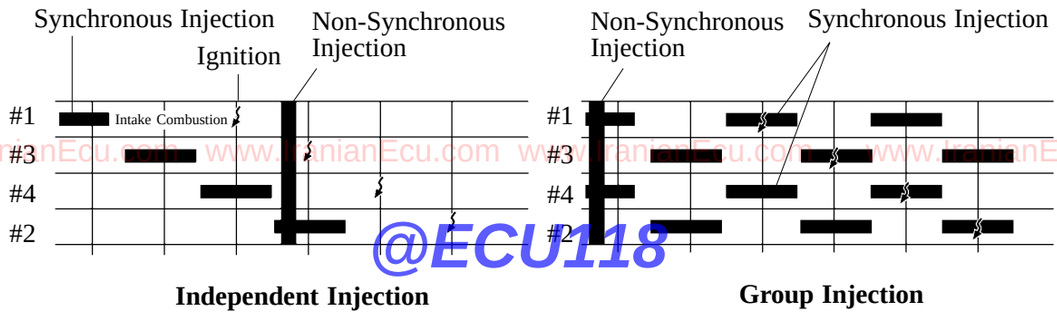


208EG27

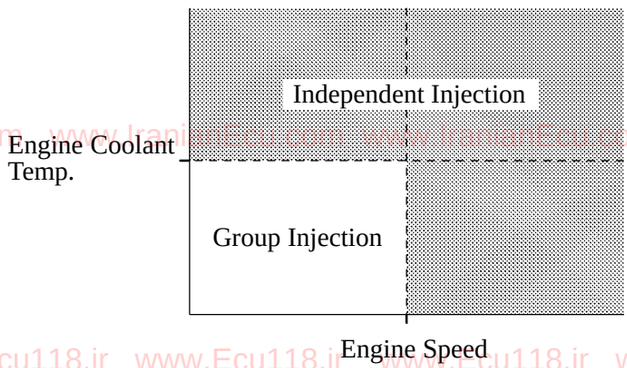
6. SFI (Sequential multiport electronic Fuel Injection) System

- An L-type SFI system directly detects the intake air mass with a hot wire type mass air flow meter.
- An independent injection system (in which fuel is injected once into each cylinder for each two revolution of the crankshaft) has been adopted.
  Also, when the engine is starting, a group injection system (in which fuel is injected once into two cylinders for each one revolution of the crankshaft) has been adopted.
- There are two types of fuel injection:
  a) One is synchronous injection in which corrections based on the signals from the sensors are added to the basic injection time so that injection occurs always at the same timing.
  b) The other is non-synchronous injection in which injection is effected by detecting the requests from the signals of the sensors regardless of the crankshaft angle.

Furthermore, to protect the engine and improve fuel economy, the system effects fuel cutoff in which the injection of fuel is stopped temporarily in accordance with the driving conditions.



208EG28



208EG29

7. ESA (Electronic Spark Advance)

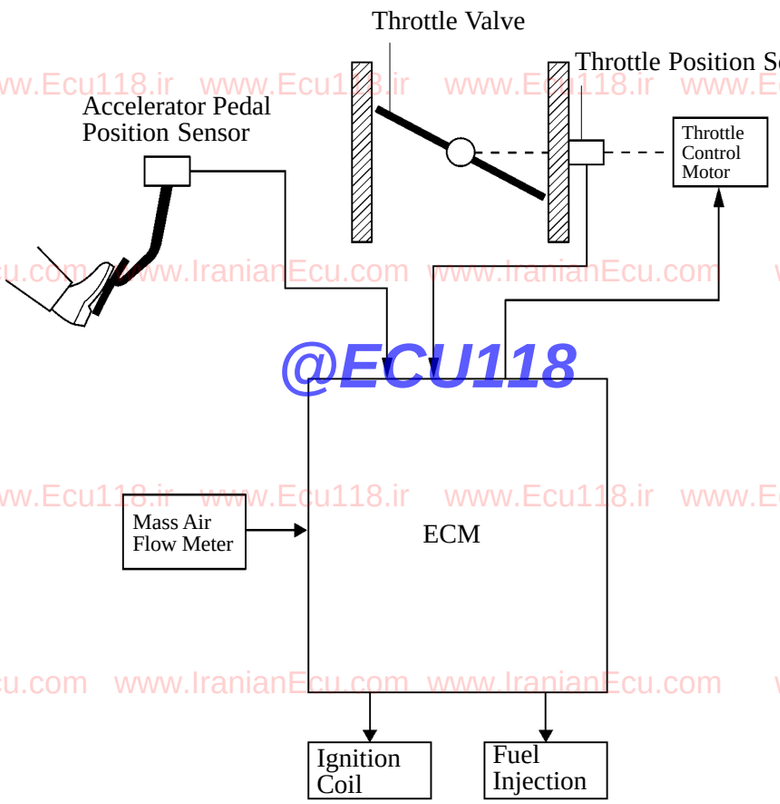
This system selects the optimal ignition timing in accordance with the signals received from the sensors and sends the (IGT) ignition signal to the igniter. The default ignition timing is set to 5° BTDC.

8. ETCS-i (Electronic Throttle Control System-intelligent)

General

- In the conventional throttle body, the throttle valve opening in determined invariably by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the ECM to calculate the optimal throttle valve opening that is appropriate for the respective driving condition and uses a throttle control motor to control the opening.
- The accelerator cable and link have been discontinued, and an a accelerator position sensor has been provided on the accelerator pedal.

▶ System Diagram ◀



Operation

1) General

The ECM drives the throttle control motor by determining the target throttle valve opening in accordance with the respective vehicle operating condition.

- Idle Speed Control
- Shift Shock Reduction Control
- Cruise Control

2) Idle Speed Control

Controls the throttle valve in order to constantly effect ideal idle speed control.

3) Shift Shock Reduction Control

The throttle control is synchronized to the ECT (Electronically Controlled Transmission) control during the shifting of the transmission in order to reduce the shift shock.

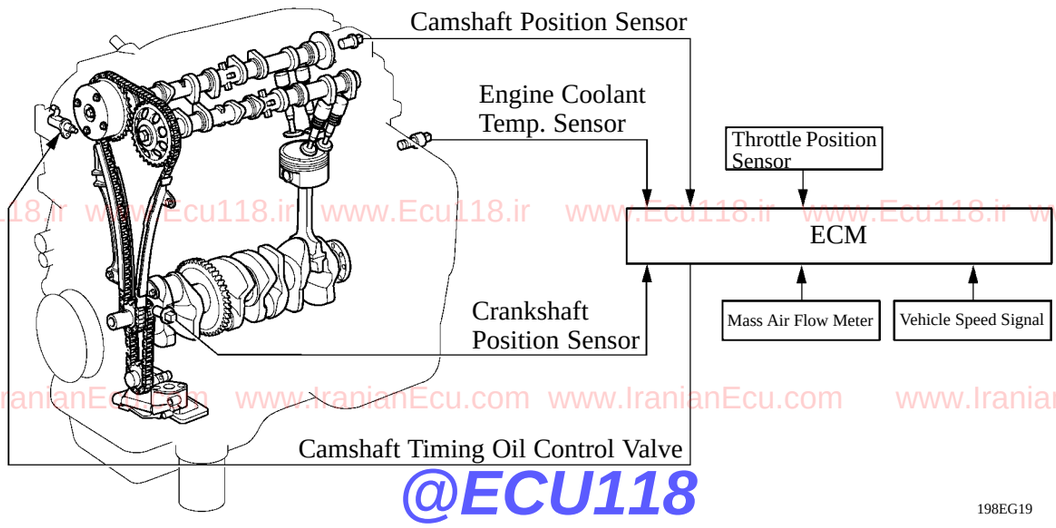
4) Cruise Control

An ECM with an integrated cruise control ECU directly actuates the throttle valve to effect the operation of the cruise control.

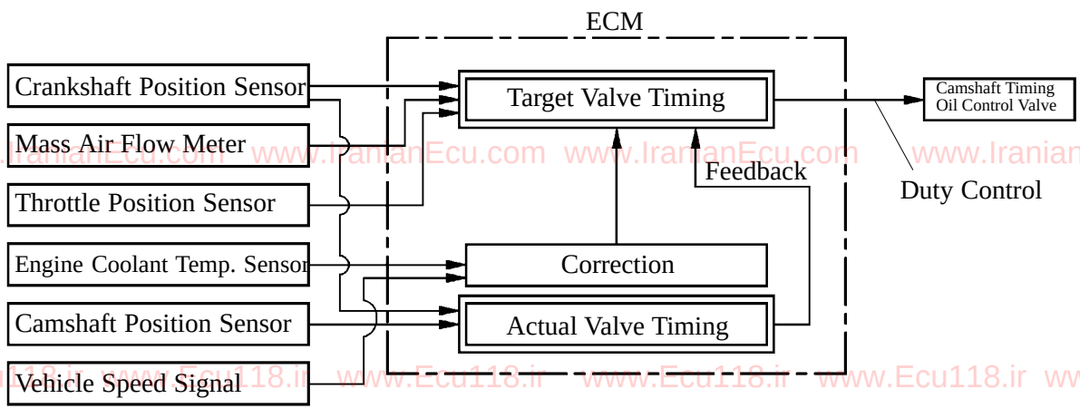
9. VVT-i (Variable Valve Timing-intelligent) System

General

The VVT-i system is designed to control the intake camshaft within a wide range of 50° (of crankshaft angle) to provide a valve timing that is optimally suited to the engine condition, thus realizing improved torque in all the speed ranges and fuel economy, and reduce exhaust emissions. The actual intake valve timing is feedback by means of the camshaft position sensor for constant control to the target valve timing.



198EG19



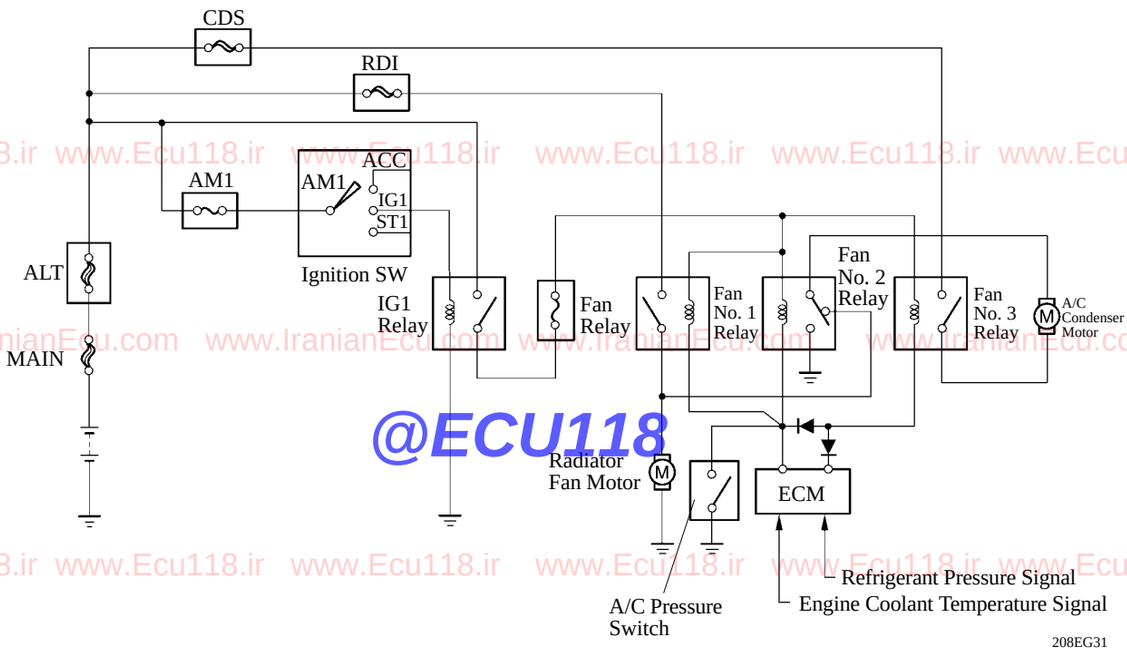
172CR07

10. Cooling Fan Control

In contrast to the previous electric cooling fan system, the water temperature switch has been discontinued. Instead, by sharing the engine coolant temperature sensor to control the fan motor, a simpler system has been realized.

This cooling fan control turns 3 fan relays ON/OFF in accordance with the water temperature and the operating conditions of the air conditioner system. When it is ON, the control is switched to operate the 2 fan motors at Low (serial) or High (parallel).

▶ Wiring Diagram ◀



▶ Cooling Fan Operation ◀

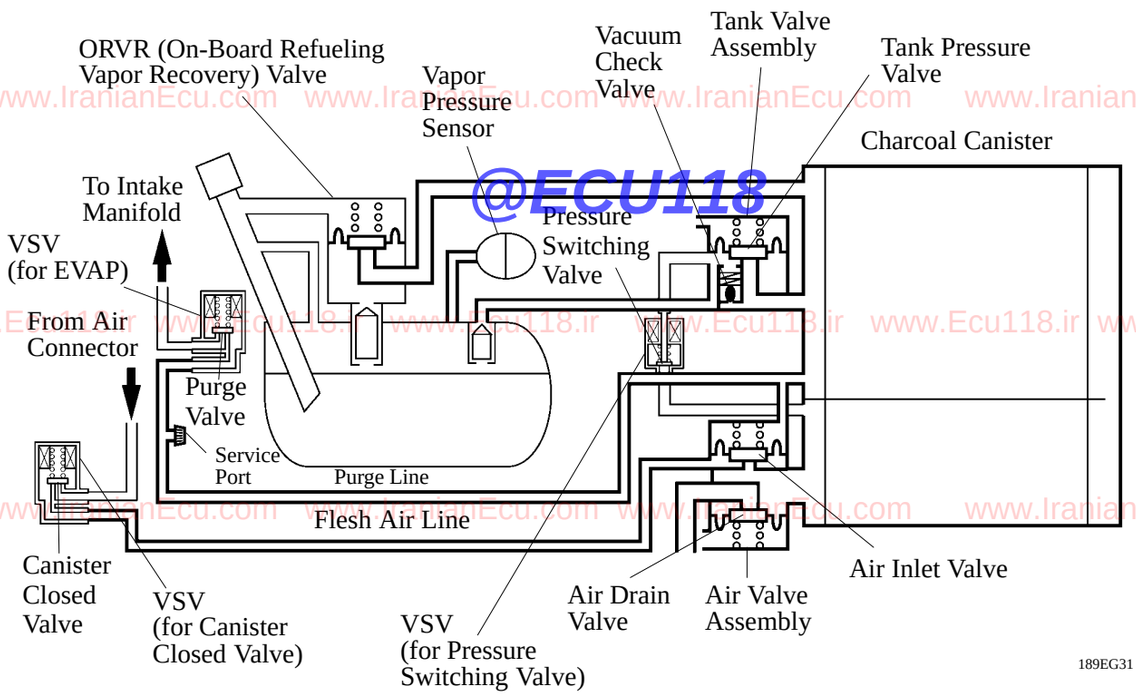
Air Conditioning Condition		Engine Coolant Temperature	
Compressor	Refrigerant Pressure	About 94°C (201°F) or Lower	About 95.5°C (204°F) or Higher
OFF	1.2 MPa (12.5 kgf/cm^2, 177.8 psi) or Lower	OFF	High
ON	1.2 MPa (12.5 kgf/cm^2, 177.8 psi) or Lower	Low	High
	1.5 MPa (15.5 kgf/cm^2, 220.5 psi) or Higher	High	High

11. Evaporative Emission Control System

General

The vacuum type has been adopted on the '02 Camry to detect leaks in the evaporative emission control system. This vacuum type detects leaks by forcefully introducing the purge vacuum into the entire system and monitoring the changes in the pressure. It consists of the following main components:

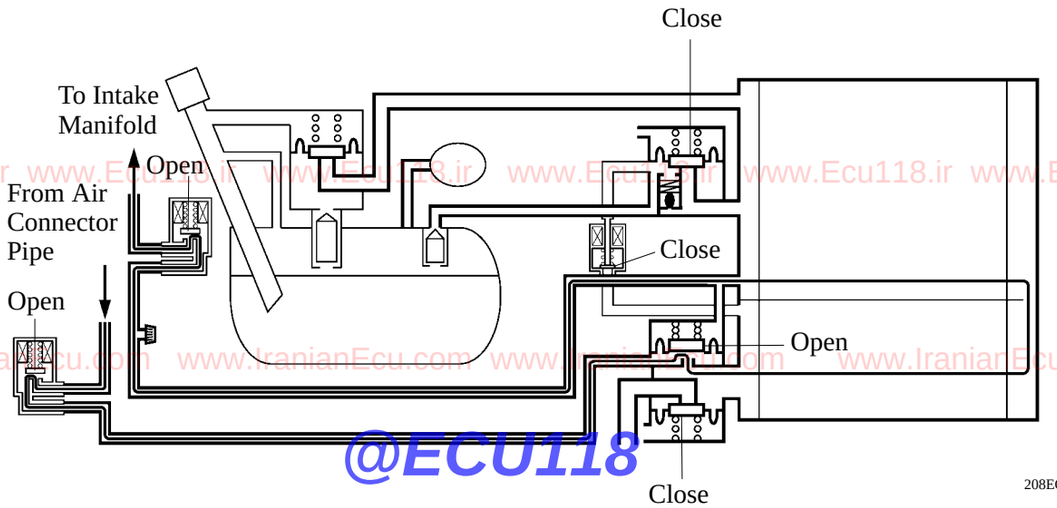
- A VSV (for canister closed valve) that closes the fresh air line from the air cleaner to the charcoal canister has been adopted.
- A VSV (for pressure switching valve) that opens the evaporator line between the fuel tank and the charcoal canister has been adopted.
- Function to close the purge line from the air intake chamber to the charcoal canister for this system is added to the original functions of VSV (for EVAP).
- A vapor pressure sensor that measures the pressure in the fuel tank while checking for evaporative emission leaks and sends signals to the ECM has been adopted.



Operation

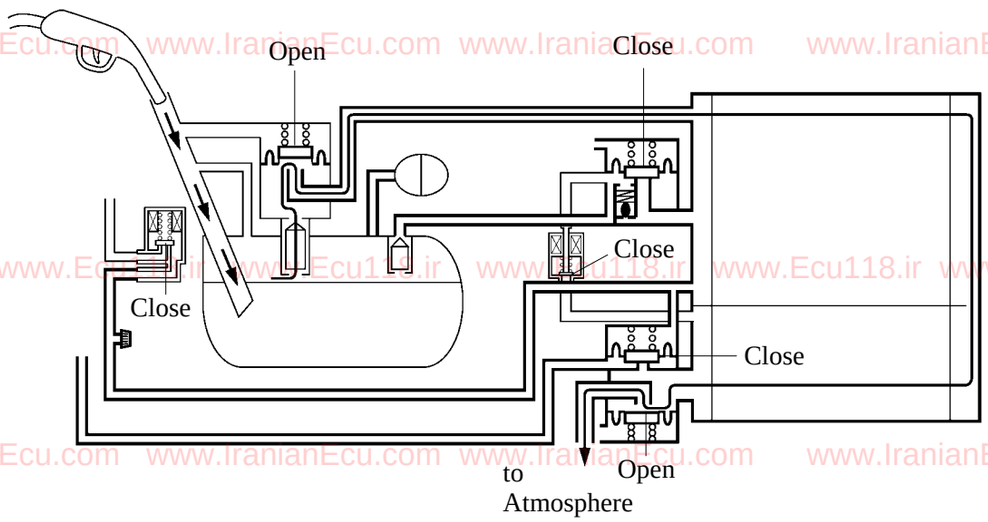
1) Purge Flow

When the engine has reached predetermined parameters (closed loop, engine coolant temp. above 74°C (165°F), etc.), stored fuel vapors are purged from the charcoal canister whenever the purge valve is opened by the ECM. At the appropriate time, the ECM will turn on the VSV (for EVAP).
The ECM will change the duty ratio cycle of the VSV (for EVAP) thus controlling purge flow volume. Purge flow volume is determined by manifold pressure and the duty ratio cycle of the VSV (for EVAP). Atmospheric pressure is allowed into the canister to ensure that purge flow is constantly maintained whenever purge vacuum is applied to the canister.



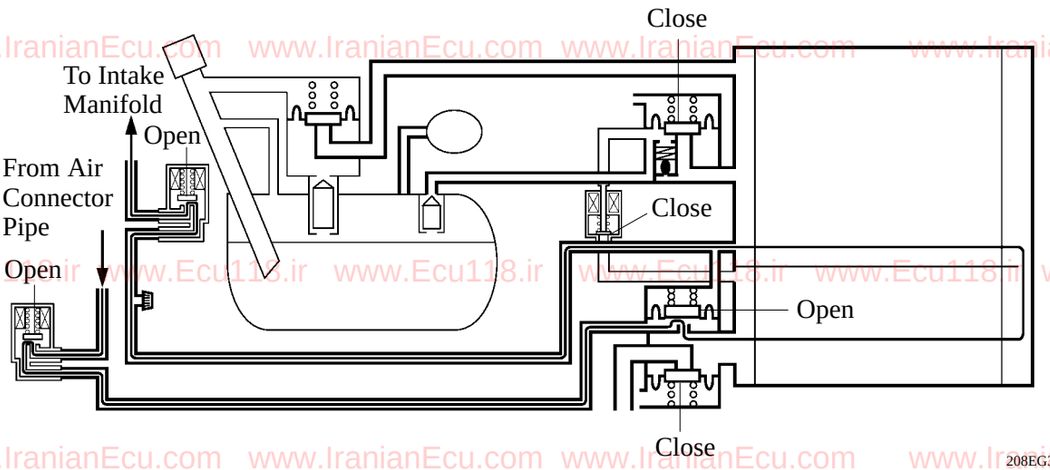
2) ORVR (On-Board Refueling Vapor Recovery)

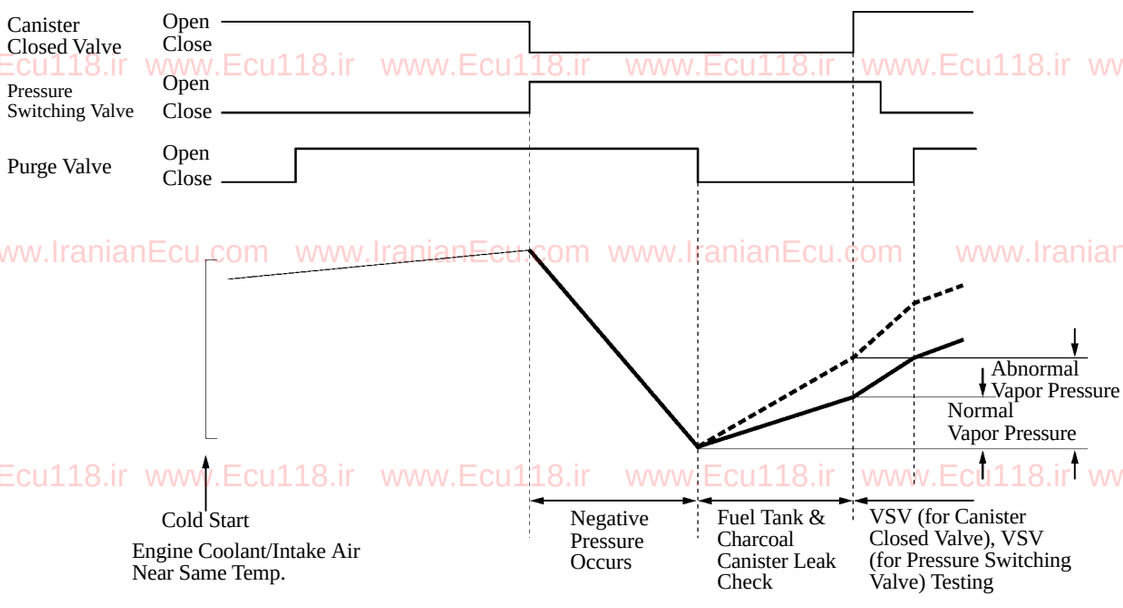
During refueling, low pressure above the diaphragm in the onboard recovery valve lifts allowing fuel vapors into the charcoal canister. At the same time, the air drain valve opens and the charcoal absorbs the fuel vapors.



3) Monitor

The monitor sequence begins with a cold engine start. The intake air temp. and engine coolant temp. sensors must have approximately the same temperature reading. The ECM is constantly monitoring fuel tank pressure. As the temperature of the fuel increases, pressure slowly rises. The ECM will purge the charcoal canister at the appropriate time. With VSV (for pressure switching valve) closed, pressure will continue to rise in fuel tank.



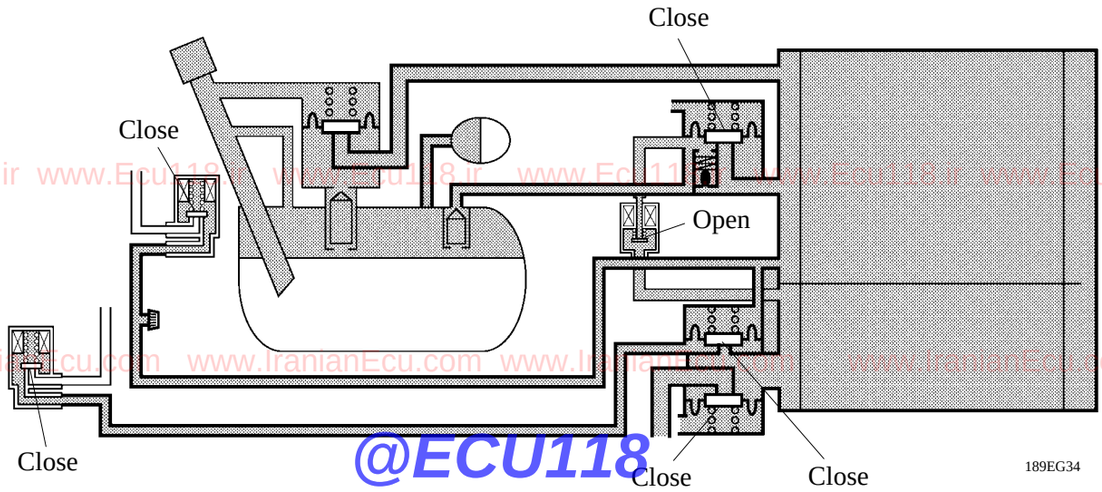


4) DTC P0440 (Evaporative Emission Control System Malfunction)

Initially, when the canister closed valve is closed, and the pressure switching valve and the purge valve are opened, a vacuum is applied to the purge line from the air intake to the charcoal canister and to the evaporator line from the charcoal canister to the fuel tank. Next, the purge valve is closed in order to maintain a vacuum from the VSV (for EVAP) to the inside of the fuel tank. Then, any subsequent changes in the pressure are monitored by the vapor pressure sensor in order to check for evaporative emission leaks.

If a leak is detected, the MIL (Malfunction Indicator Lamp) illuminates to inform the driver. Also, the DTC (Diagnostic Trouble Code) can be accessed through the use of a hand-held tester.

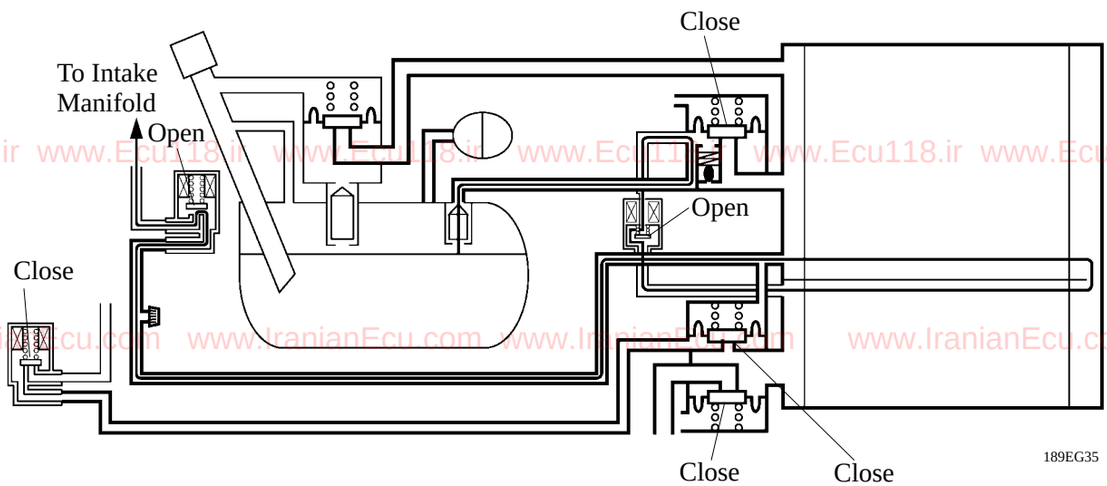
For details on the DTCs, refer to the 2002 Camry Repair Manual (Pub. No. RM881U).



5) DTC P0441 (Evaporative Emission Control System Incorrect Purge Flow)

At a predetermined point, the ECM closed the canister closed valve and opens the pressure switching valve causing a pressure drop in the entire EVAP system. The ECM continues to operate the VSV (for EVAP) until the pressure is lowered to a specified point at which time the ECM closed the purge valve. If the pressure did not drop, or if the drop in pressure increase beyond the specified limit, the ECM judges the VSV (for EVAP) and related components to be faulty and the MIL illuminates to inform the driver. Also, the DTC can be accessed through the use of a hand-held tester.

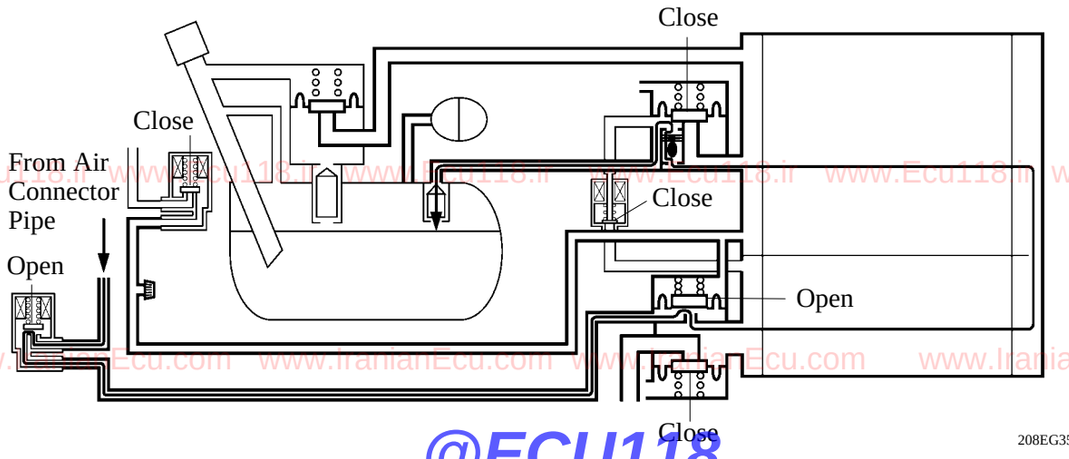
For details on the DTCs, refer to the 2002 Camry Repair Manual (Pub. No. RM881U).



6) DTC P0446 (Evaporative Emission Control System Vent Control Malfunction)

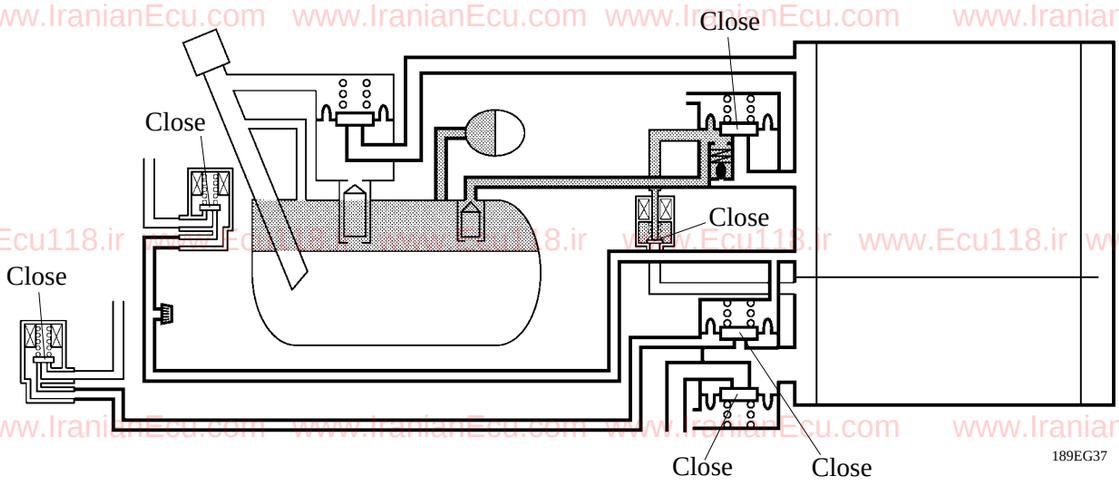
a. Canister Closed Valve

This stage checks the VSV (for canister closed valve) and vent (air inlet side) operation. When the vapor pressure rises to a specified point, the ECM opens the canister closed valve. Pressure will increase rapidly because of the air allowed into the system. No increase or an increase below specifiedrate of pressure increase indicates a restriction on the air inlet side. If a malfunction is detected, the MIL illuminates to inform the driver. Also, the DTC can be accessed through the use of a hand-held tester.
For details on the DTCs, refer to the 2002 Camry Repair Manual (Pub. No. RM881U).



b. Pressure Switching Valve

The ECM closes the pressure switching valve. This action blocks air entire the tank side of the system. The pressure rise is no longer as great. If there was no change in pressure, the ECM will conclude the pressure switching valve did not close. If a malfunction is detected, the MIL illuminates to inform the driver. Also, the DTC can be accessed through the use of a hand-held tester.
For details on the DTCs, refer to the 2002 Camry Repair Manual (Pub. No. RM881U).



12. Diagnosis

When the ECM detects a malfunction, the ECM makes a diagnosis and memorizes the failed section. Furthermore, the MIL (Malfunction Indicator Lamp) in the combination meter illuminates or blinks to inform the driver.
The ECM will also store the DTCs of the malfunctions.
The DTCs can be accessed the use of the hand-held tester.

Service Tip

The length of time to clear the DTC via the battery terminal has been changed from the previous 10 seconds to 1 minute.

13. Fail-Safe

General

When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in the memory.

▶ Fail-Safe Control List ◀

Location on Malfunction	Description Control
Mass Air Flow Meter	In case of a signal malfunction, the engine could operate poorly or the catalyst could overheat if the engine continues to be controlled with the signals from the sensors. Therefore, the ECM effects control by using the values in the ECM or stops the engine.
Accelerator Pedal Position Sensor (For details, see page EG-89)	In case of a signal malfunction, the ECM calculates the accelerator pedal opening angle that is limited by the dual system sensor value and continues effecting throttle valve control. If both system malfunction, the ECM considers that the accelerator pedal is fully closed.
Throttle Position Sensor (For details, see page EG-90)	In case of a signal malfunction, the ECM cuts off the current to the throttle control motor. The throttle valve returns to the prescribed opening by the force of the return spring. The ECM then adjusts the engine output by controlling the fuel injection and ignition timing in accordance with the accelerator pedal opening angle to enable the vehicle to continue driving.
Engine Coolant Temp. Sensor and Intake Air Temp. Sensor	In case of a signal malfunction, the use of the values from the sensors will make the air-fuel ratio become too rich or too lean, which could causes the engine to stall or to run poorly during cold operation. Therefore, the ECM fixes the air-fuel ratio to the stoichiometric ratio and uses the constant values of 80°C engine coolant temperature and 20°C intake air temperature to perform the calculation.
Knock Sensor	In case of a malfunction in the knock sensor or in the knocking signal system (open or short circuit), the engine could become damaged if the timing is advanced despite the presence of knocking. Therefore, if a malfunction is detected in the knock sensor system, the ECM turns the timing retard correction of the knock sensor into the maximum retard value.
Ignition Coil (with Igniter)	In case of a malfunction in the ignition system, such as an open circuit in the ignition coil, the catalyst could be become overheated due to engine misfire. Therefore, if the (IGf) ignition signal is not input twice or more in a row, the ECM determines that a malfunction occurred in the ignition system and stops only the injection of fuel into the cylinder with the malfunction.
Camshaft Position Sensor	In case of a signal malfunction (open or short circuit) or a mechanical malfunction, the ECM stops the VVT-i control.