EMISSION CONTROL SYSTEM

CONTENTS

Vehicles equipped with a gasoline engine present three potential sources of air pollution: engine crankcase emissions, fuel system evaporative emissions and engine exhaust emissions.

Emission Control System Specifications

1. Crankcase Emission Control System	
Type of system	Closed
PCV valve	×
Oil separater	×
2. Evaporative Emission Control System	
Canister	Single
Carbon element	×
Purge control valve	×
Fuel filler cap	With relief valve
Vapor separator tank	Vapor-liquid
Overfill limiter (two-way valve)	×
Fuel check valve	×
Thermo valve	×
3. Exhaust Emission Control System	
Jet valve	×
Catalytic converter (c/c)	Dual (three way type)
Secondary air supply system	Reed valve
Exhaust gas recirculation system	
EGR valve	Single
Fuel control system (ECI system)	×
Idle speed control system	× (for A/C unit only)
High altitude compensation system	×

× : available

FUEL USAGE STATEMENT

All cars except those with turbocharged engines:
Use unleaded gasoline having a minimum octane rating of 87, (R + M)/2.

Cars equipped with a turbocharged engine:
Your car will operate satisfactorily on unleaded gasoline having a minimum octane rating of 87 (R + M)/2, the use of premium unleaded gasoline having an octane rating higher than 87 may help to obtain better performance.
If prolonged heavy engine knocking (audible pinging) occurs on your car, consult your dealer.

Gasolines Containing Alcohol

Some gasolines sold at service stations contain alcohol, although they may not be so identified. Use of fuels containing alcohol is not recommended unless the nature of the blend can be determined as being satisfactory.

Gasohol – A mixture of 10% ethanol (grain alcohol) and 90% unleaded gasoline may be used in your car. If driveability problems are experienced as a result of using gasohol, it is recommended that the car be operated on gasoline.

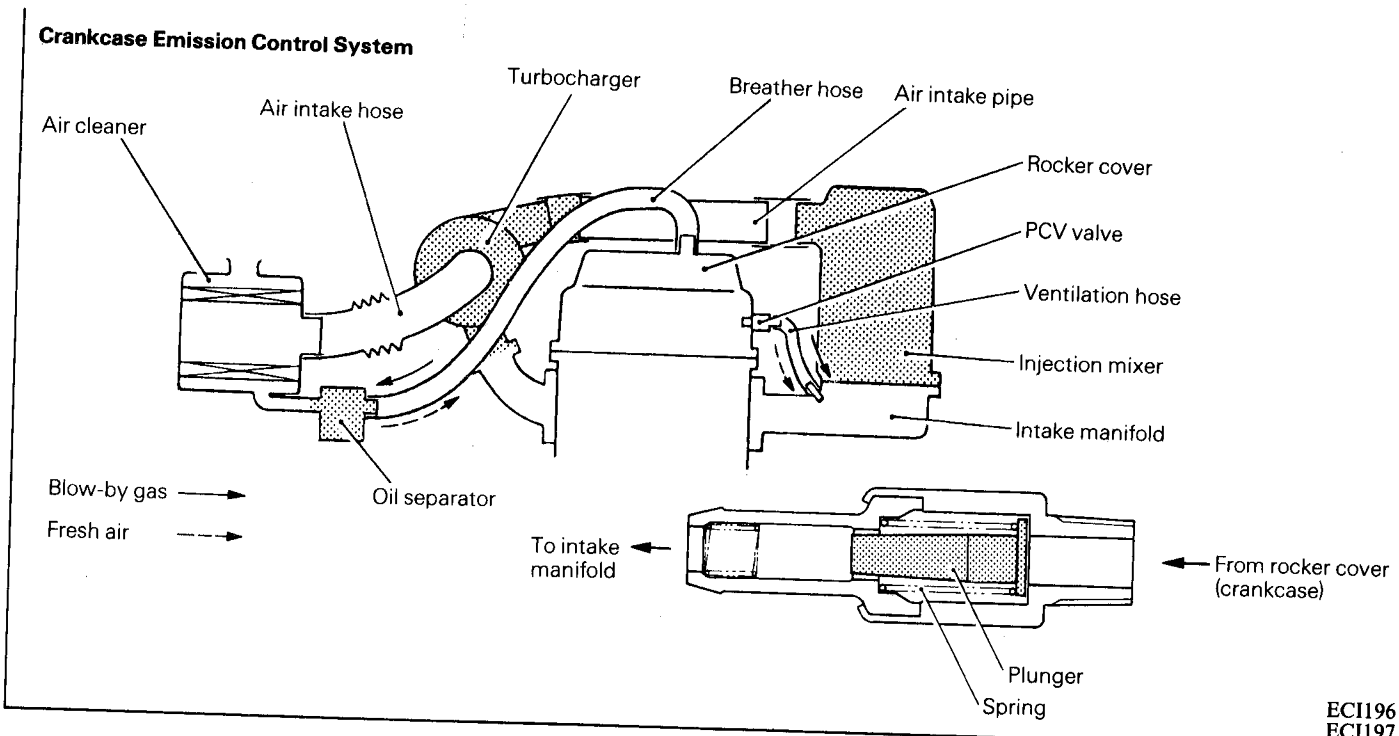
Methanol – Do not use gasolines containing methanol (wood alcohol). Use of this type of alcohol can result in vehicle performance deterioration and damage critical parts in the fuel system components. Fuel system damage and performance problems, resulting from the use of gasolines containing methanol, may not be covered by the new vehicle warranty.

A closed-type crankcase ventilation is utilized to prevent the blow-by gases from escaping into the atmosphere. This system has a positive crankcase vent valve (PCV valve) at the rocker cover.

This system supplies fresh air into the crankcase through the air cleaner. Inside the crankcase, the fresh air is mixed with the blow-by gases, and this mixture passes through the PCV valve into the induction system.

The PCV valve has a metered orifice throught which the mixture of fresh air and blow-by gases is drawn into the intake manifold in response to the intake manifold vacuum.

The valve capacity is adequate for all normal driving conditions. Under heavy acceleration or high-speed driving, there is less intake manifold vacuum available, and the blow-by gases exceed the PCV valve capacity. In this case the blow-by gases back up into the air cleaner through the breather hose.

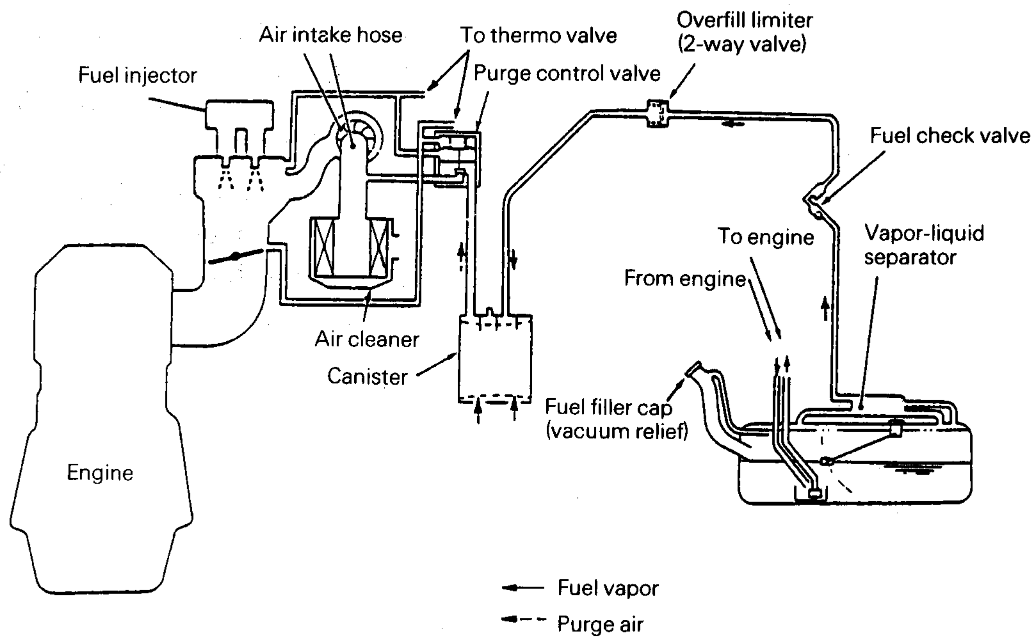


INSPECTION

1. Check PCV valve for operation. Refer to "GROUP 0, Lubrication and Maintenance."
2. Check oil separator and oil return pipe for clogging and leaks.

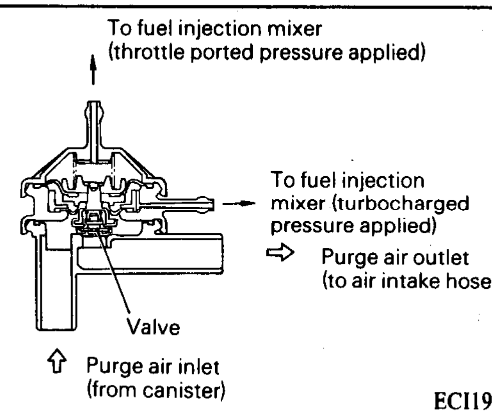
The evaporative emission control system for preventing the loss of fuel vapor from the fuel system to the atmosphere consists of a charcoal canister, a purge control valve, a thermo valve, and so on.
While the engine is inoperative, fuel vapor generated inside the fuel tank is absorbed and stored in the charcoal canister.
When the engine is running, the fuel vapor absorbed in the canister is drawn into the air intake hose through the purge control valve.

Evaporative Emission Control System



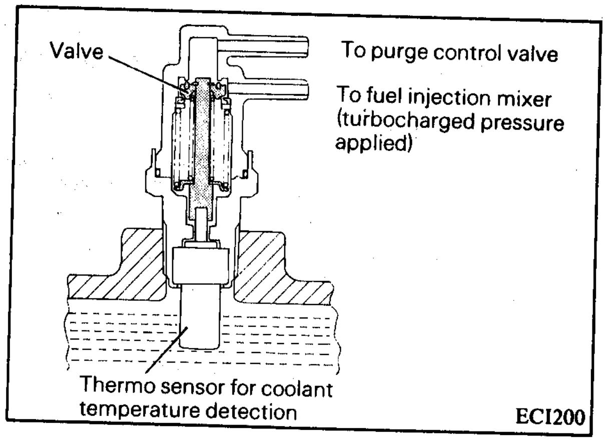
ECI198

The purge control valve is kept being closed at idling to prevent vaporized fuel from entering into the air intake hose for positive control of high idle CO emissions which is particularly a problem under high ambient temperature condition. And once the pressure difference between the turbocharged and the throttle ported-pressures exceeds the pre-set value, the purge control valve is opened.



ECI199

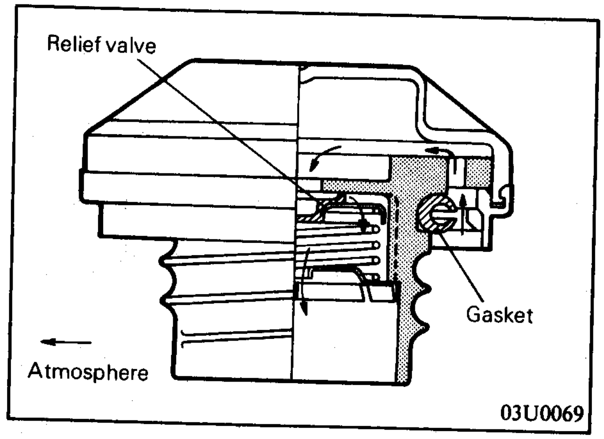
The thermo valve, for sensing the coolant temperature at the intake manifold closes the purge control valve when the coolant temperature is lower than the pre-set value in order to reduce CO and HC emissions under engine warm-up conditions, and opens the purge control valve when the coolant temperature above the pre-set temperature.



SEE 14-31 FOR VACUUM DIAGRAM

FUEL FILLER CAP

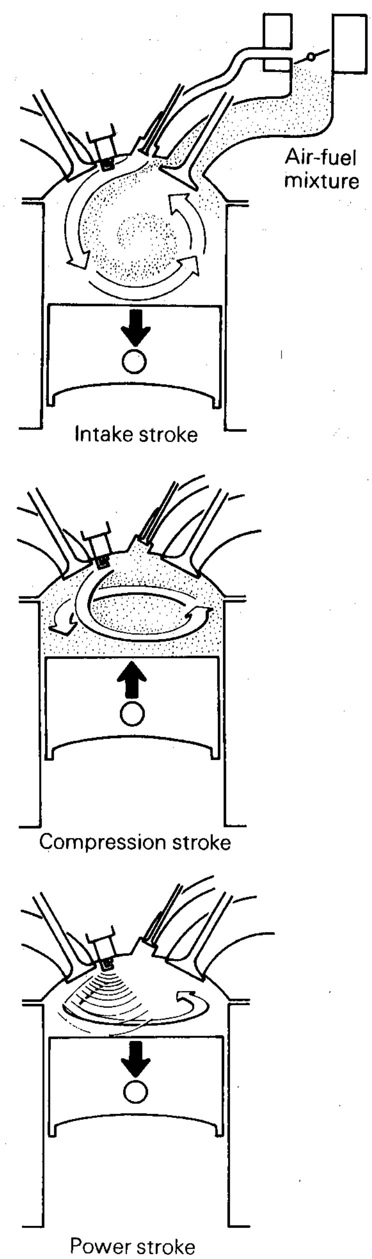
Fuel filler cap is equipped with relief valve to prevent the escape of fuel vapor into the atmosphere.



Exhaust emissions (carbon monoxide, hydrocarbons and oxides of nitrogen) are controlled by a combination of engine modifications and the addition of special control components.
Modifications to the engine include combustion chamber, intake manifold and camshaft.
Additional control devices include an exhaust gas recirculation (EGR) system, dual catalytic converters, secondary air supply system and fuel control system.
These systems have been integrated into a highly effective system which controls exhaust emissions while maintaining good vehicle performance.

JET AIR SYSTEM

The combustion chamber is the same cross-flow type hemispherical combustion chamber as the conventional one. In addition to the intake valve and exhaust valve, a jet valve has been provided to draw jet air (super lean mixture or air) into the combustion chamber. The jet valve assembly consists of the jet valve, jet body and spring and is screwed into the jet piece which is press-fitted in the cylinder head with its jet opening toward the spark plug.
A jet air passage is provided in the carburetor, intake manifold and cylinder head. Air flows through the two intake openings provided near the primary throttle valve of the carburetor, goes through the passage in the intake manifold and cylinder head, and flows through the jet valve and the jet opening into the combustion chamber.
The jet valve is actuated by the same cam as the intake valve and by a common rocker arm so that the jet valve and intake valve open and close simultaneously.
On the intake stroke, the air-fuel mixture flows through the intake valve port into the combustion chamber. At the same time, jet air is forced into the combustion chamber because of the pressure difference produced between the two ends of the jet air passage (between the jet air intake openings in the carburetor throttle bore and the jet opening of the jet piece) as the piston moves down.
When the throttle valve opening is small during idling or light load, a large pressure difference is produced as the piston goes down, causing jet air to flow into the combustion chamber rapidly. The jet air flowing out of the jet opening scavenges the residual gases around the spark plug and creates a good ignition condition. It also produces a strong swirl in the combustion chamber which continues throughout the compression stroke and improves flame propagation after ignition, assuring high combustion efficiency.
When the throttle valve opening is increased, more air-fuel mixture is drawn in from the intake valve port so that the pressure difference is reduced and less jet air forced in.
The jet air swirl dwindles with increase of the throttle valve opening, but the intensified inflow of normal intake air-fuel mixture can satisfactorily promote combustion.



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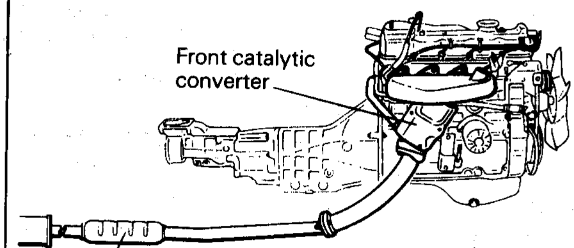
CATALYTIC CONVERTER



The catalytic converters require the use of unleaded gasoline only. Leaded gasoline will destroy the effectiveness of the catalysts as an emission control device.
Under normal operating conditions, the catalytic converters will not require maintenance. However, it is important to keep the engine properly tuned. If the engine is not kept properly tuned, engine misfiring may cause overheating of the catalysts. This may cause heat damage to the converters or vehicle components. This situation can also occur during diagnostic testing if any spark plug cables are removed and the engine is allowed to idle for a prolonged period of time.

Cautions

1. **Operation of any type, including idling, should be avoided if engine misfiring occurs. Under this condition the exhaust system will operate at abnormally high temperature, which may cause damage to the catalyst or under-body parts of the vehicle.**
2. **Alteration or deterioration of ignition or fuel system, or any type of operating condition which results in engine misfiring must be corrected to avoid overheating the catalytic converters.**
3. **Proper maintenance and tuneup according to manufacturer's specifications should be made to correct the conditions as soon as possible. Interrupting the ignition at high speeds with the transmission in gear may result in an overheated catalyst.**

Removal

Caution

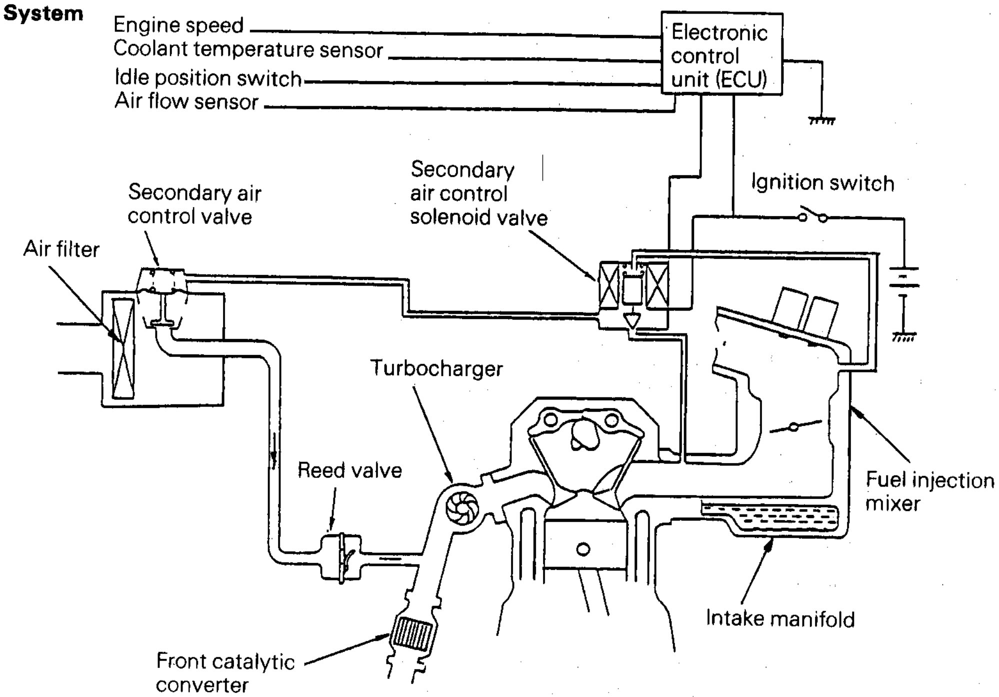
Before removing or inspecting the exhaust system, ensure that the exhaust system is cool enough.

1. Remove heat cowl and heat protector.
2. Remove oxygen sensor and secondary air pipe from front catalytic converter.
3. Disconnect front exhaust pipe at front catalytic converter.
4. Remove stud nuts attaching front catalytic converter to turbocharger, slide catalytic converter off studs and away from turbocharger.

SECONDARY AIR SUPPLY SYSTEM

The air injection system consists of a reed valve, a secondary air control valve and a solenoid valve, ECU and some sensors.

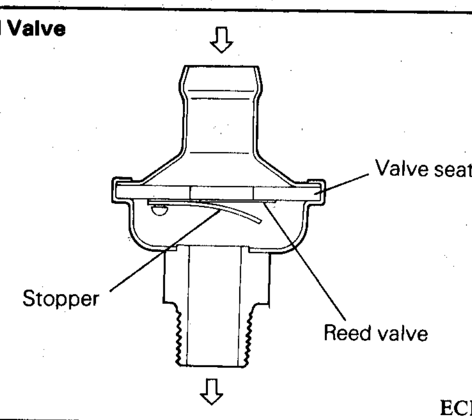
Secondary Air Supply System



ECI202

The reed valve supplies secondary air into the front catalytic converter for the purpose of promoting oxidation of exhaust emissions during the engine warm-up operation, the engine-hot-start operation and the vehicle deceleration.
The reed valve is actuated by exhaust vacuum being generated from pulsation in the exhaust manifold, and extra air is supplied into the exhaust manifold through the secondary air control valve.

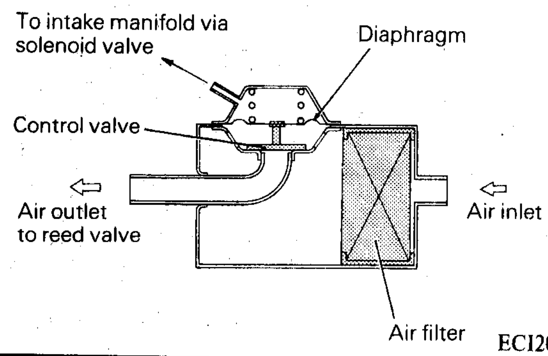
Reed Valve



ECI203

The secondary air control valve is opened by the intake manifold pressure when the solenoid valve is energized by the ECU based on the information on coolant temperature, intake air flow, engine speed, ignition switch START, and idle position.

Secondary Air Control Valve



ECI204

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

An Exhaust Gas Recirculation (EGR) system is utilized for reducing oxides of nitrogen in the vehicle exhaust.

In this system, the exhaust gas is partially recirculated from an exhaust port of cylinder head into a port located at the intake manifold below the fuel injection mixer, while the EGR flow is controlled by an EGR control valve and a solenoid valve.

The pressure applied to the EGR control valve is controlled by the solenoid valve motion which mixes the throttle ported pressure with the turbo-charged pressure.

The solenoid valve motion is controlled by the ECU based on the information on coolant temperature, and engine speed.

EGR Control Valve

The EGR control valve is controlled by throttle ported pressure in response to the throttle valve opening, while the EGR flow is suspended at idle for retaining idle quality, and within the other engine operating range including WOT specified by engine speed to protect EGR control valve diaphragm from being heated to extreme high temperature due to recirculated exhaust gas from the turbocharged engine.

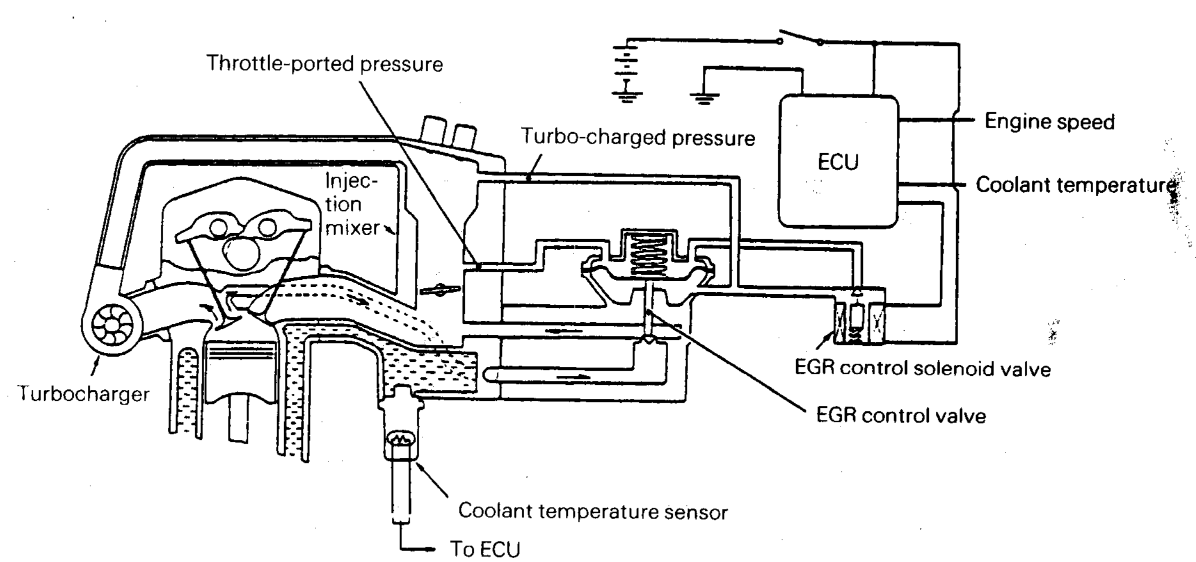
The pressure to be applied on the EGR control valve is controlled by the solenoid valve.

Solenoid Valve

When the solenoid valve incorporated in the EGR system is energized by the ECU, the EGR control valve is closed due to the throttle ported pressure mixed with the turbocharged pressure, and is opened with the aid of the throttle ported vacuum applied to its diaphragm when the solenoid valve is de-energized by the ECU.

The solenoid valve motion is controlled by the ECU based on the information on coolant temperature and engine speed.

EGR System

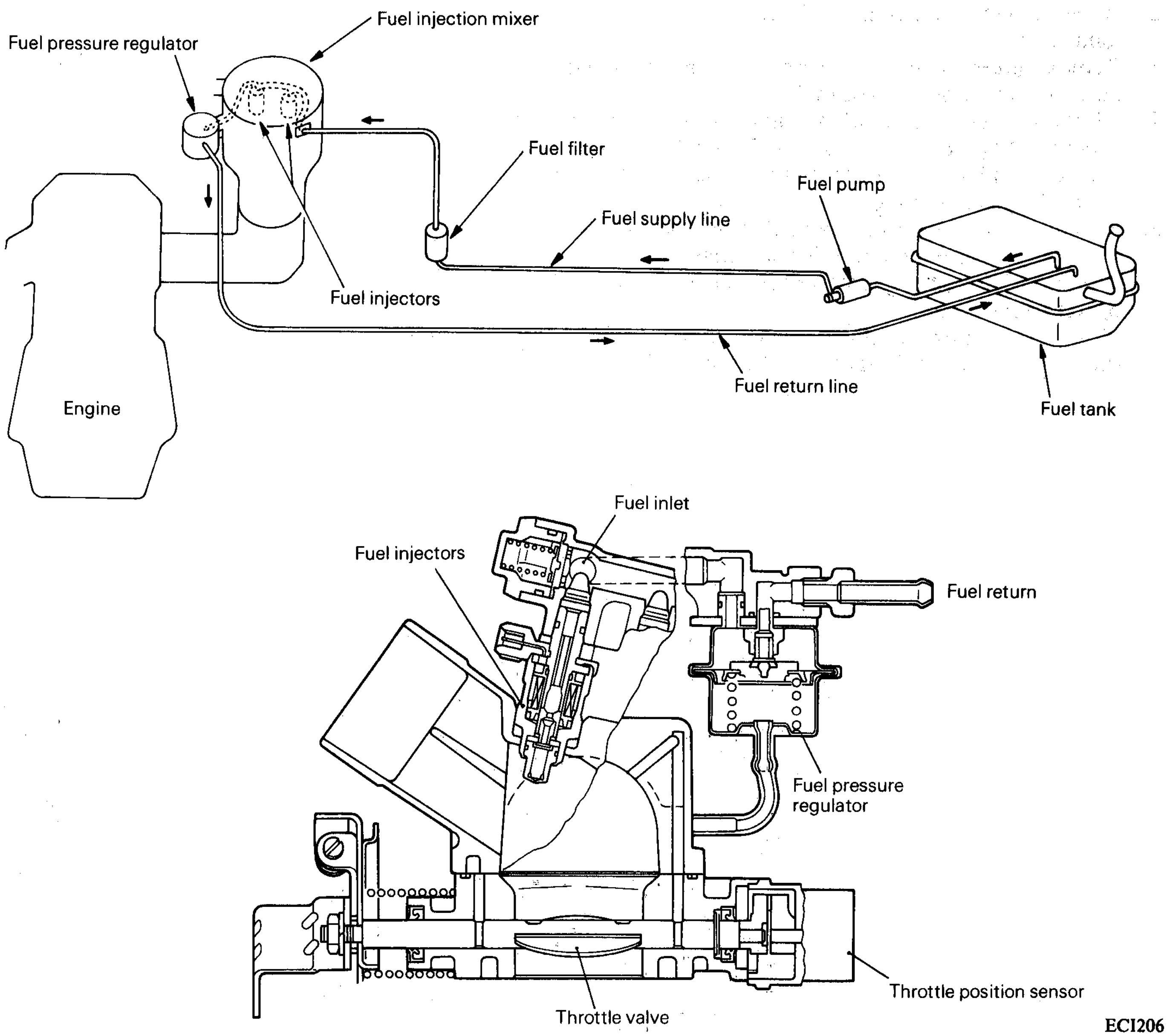


EC1205

Inspection for EGR Control Solenoid Valve

1. Start engine and let it run at idle.
2. Allow engine to warm up until it reaches normal operating temperature.
3. Remove green stripe hose from injection mixer and connect vacuum pump to hose end.
4. Disconnect connector of solenoid valve and apply a vacuum of approx. –33.3 kPa (–250 mmHg, –9.8 in.Hg). If unstable idling occurs or engine stalls at the moment, the EGR system is good.
5. Reconnect connector of solenoid valve and perform test as under previous step. In this case, engine should remain unaffected, as negative pressure chamber of EGR valve is open to atmosphere.
   If unstable idling occurs, it means that solenoid valve stays closed. Solenoid valve must be replaced.

Fuel System



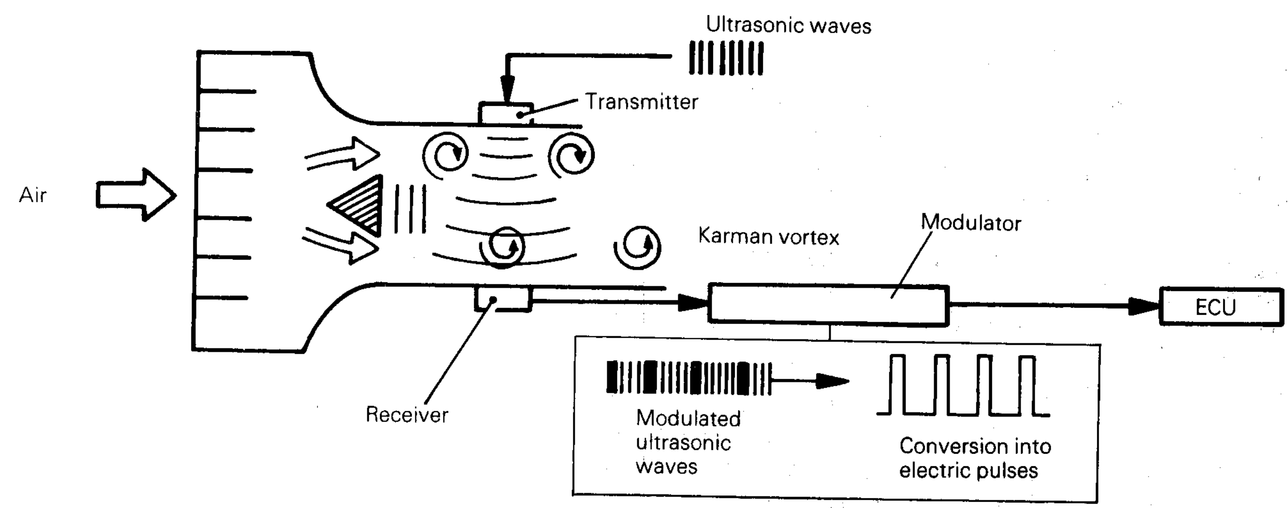
ECI206
03K539

CONTROL OF AIR FUEL RATIO

The fuel control system is the Electronically Controlled Injection (ECI) system which consists of an Electronic Control Unit (ECU), two fuel injectors, an air flow sensor and other components.
The amount of fuel metered by the two fuel injectors is determined by an electric signal supplied by the ECU.
The ECU monitors various engine and vehicle parameters needed to calculate the fuel delivery time (the frequency and duration of injection) of the fuel injectors.
The fuel delivery time is modified by the ECU according to such operating conditions as cranking, cold starting, altitude, acceleration, deceleration and so on.

The fuel is drawn from the fuel tank and forced by the electrically driven fuel pump to the pressure line through a fuel filter. At the end of fuel line, the fuel pressure regulator controls the fuel pressure at the pre-set value so as for the pressure difference between fuel pressure and turbocharged intake air pressure above the throttle valve to be constant, and thus the amount of fuel injected is only dependent on the fuel delivery time controlled by ECU.
The two fuel injectors installed in the fuel injection mixer assembly are alternately energized by the ECU, once every specified electric pulses from the air flow sensor almost all over the operation zone and at the other specified intervals in the remaining zones. Each injector features its swirl nozzle that atomizes fuel at higher efficiency, and facilitates the combustion of fuel.
The air flow sensor installed in the air cleaner assembly detects air flow rate, with utilizing the Karman vortex phenomenon, in the form of electric pulses converted by the modulator from the counted Karman vortexes.

Air Flow Sensor



ECI208

Enrichment

STARTING ENRICHMENT

To ensure the starting performance, the fuel delivery time is determined by the ECU which takes account of information on coolant temperature and others except electric pulses from the air flow sensor because the air flow rate is unstable under the starting conditions.
The starting enrichment control is over when the ignition switch is released from the START position and the engine speed gets over the specified one.

AFTER STARTING ENRICHMENT

For a very short time period just after engine starting, another enrichment is provided to obtain stable combustion. To get proper enrichment for that time period, the ECU processes information on the coolant temperature as a parameter to determine the enrichment characteristic.

WARM-UP ENRICHMENT

The warm-up enrichment is provided for proper vehicle operation by a signal from the ECU which processes information on the coolant temperature, until the coolant temperature rises to the pre-set level. This enrichment is provided during the engine warm-up period, the open loop operation, and part of the closed loop operation.

ACCELERATION ENRICHMENT

The acceleration enrichment is provided for ensuring vehicle driveability during acceleration during both in the open and the closed loop operation, by a signal from the ECU which processes information from the throttle position sensor.

Fast Idle

Fast idle is controlled by one of functions of Idle Speed Control System.

Fuel Cut-off

DECELERATION FUEL CUT-OFF

In order to decrease HC emissions emitted during vehicle deceleration, the fuel delivery time is remarkably decreased by the ECU changing the injection interval determined by the specified pulses from the air flow sensor with the specified duration of injection.

During vehicle deceleration while the idle position switch is not yet turned to ON position, the fuel delivery time is determined by the ECU responding to throttle valve closing speeds.

OVER PRESSURE FUEL CUT-OFF

In order to protect the turbo charged engine from over loading, the fuel injectors are energized by the ECU only every ignition spark timing when the pressure sensor detects higher intake manifold pressure than the pre-set value.

ECI SYSTEM

The ECI system is a pulse time system that injects fuel into the fuel injection mixer above the throttle valve. Fuel is metered to the engine via the two electronically controlled fuel injectors.
The basic functions of this system are tabulated below. Input signals from a variety of sensors are fed to the ECU, and then, the ECU generates output signals for all of the controlled functions.

Parameters Sensed

(1) Intake air flow
(2) Intake air temperature
(3) Intake manifold pressure (and barometric pressure)
(4) Coolant temperature
(5) Engine speed
(6) Exhaust oxygen concentration
(7) Throttle position
(8) Idle position
(9) Battery voltage
(10) Engine cranking
(11) Park/Neutral mode
(12) Vehicle speed
(13) A/C system switch "ON"
(14) Motor position switch

Parameters Controlled

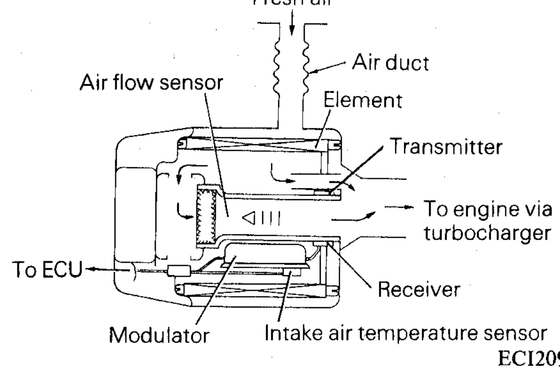
(1) Fuel injection control signal
(2) Secondary air control valve signal
(3) EGR control signal
(4) Solenoid valve (for pressure sensor) control signal
(5) Idle speed control signal

Data Sensor and Parameters Sensed

AIR FLOW SENSOR

The air flow sensor installed in the air cleaner assembly consists of the device for generating Karman vortexes, the ultrasonic wave transmitter, the receiver and the modulator. Ultrasonic waves with a constant frequency are transmitted across the air flow containing Karman vortexes which are generated proportionally to air flow rate, and then, the ultrasonic frequency is modulated by the vortexes.
The receiver detects the modulated waves, and the modulator converts them into electric pulses. The electric pulse information is transmitted to the ECU for use in controlling the fuel delivery time and secondary air management.

Air Cleaner Assembly



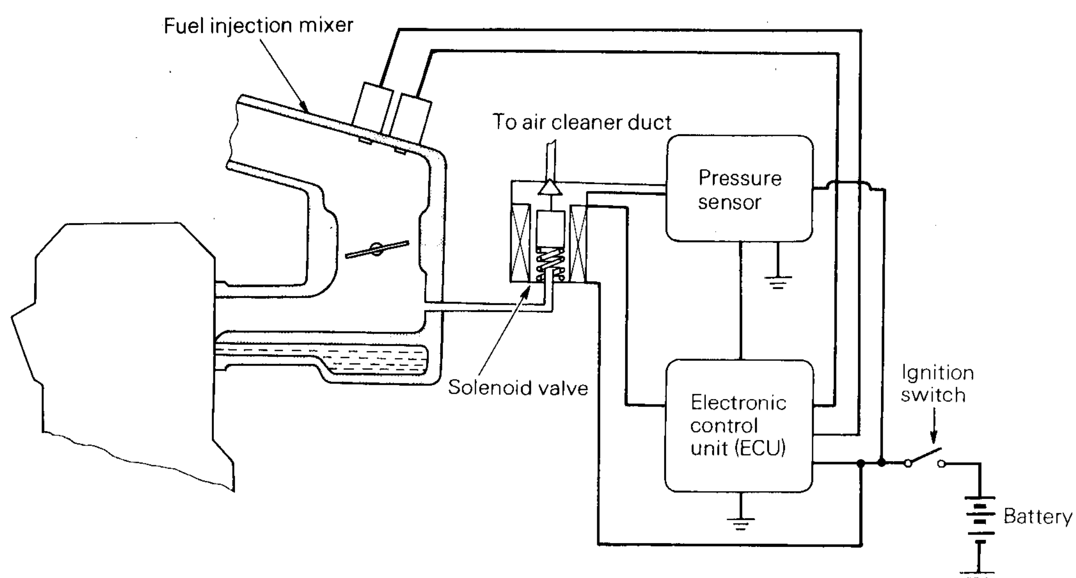
INTAKE AIR TEMPERATURE SENSOR

The intake air temperature sensor is installed on the modulator located in the air cleaner. This sensor measures the temperature of intake air in the air cleaner, and this temperature is used to supply air density information to the ECU for fuel requirements.

PRESSURE SENSOR

This sensor installed on the firewall senses ambient barometric pressure and absolute pressure in the intake manifold.
Ambient barometric pressure is sensed by the sensor energizing the solenoid valve by the ECU for the specified period immediately after engine starting and thereafter once every specified period. Information on ambient pressure changes due to weather and/or altitude is provided to the ECU for controlling the fuel delivery time.
During the remaining period, other than the above specified periods, the solenoid valve is deenergized and this sensor detects intake manifold pressure (absolute pressure), and the information is provided to the ECU for controlling the fuel delivery time, and idle speed.

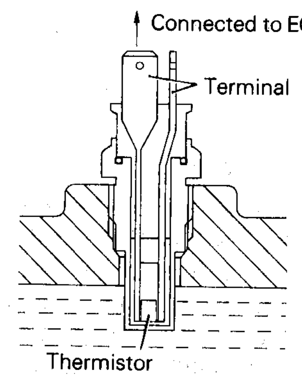
Pressure Sensor



COOLANT TEMPERATURE SENSOR

The coolant temperature sensor is installed in the intake manifold. This sensor provides data to the ECU for controlling fuel delivery time, EGR, secondary air management and idle speed.

Coolant Temperature Sensor



ECI211

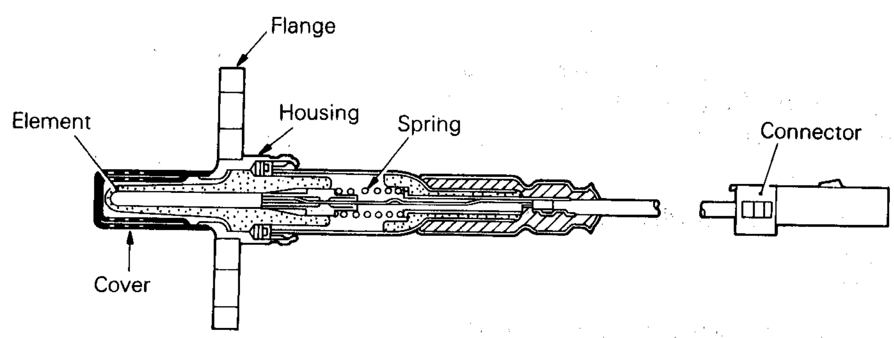
ENGINE SPEED SENSOR

The engine speed signal comes from the ignition coil.
Electric signals from the ignition coil are sent to the ECU where the time between these pulses is used to calculate engine speed, which is used in controlling fuel delivery time, EGR, secondary air management and idle speed.

OXYGEN SENSOR (O_2 SENSOR)

The oxygen sensor which consists of a closed end zirconia sensor is placed in the exhaust gas stream between the turbocharger and the front three-way catalyst.
The output voltage signal from this sensor, which varies with oxygen content in the exhaust gas stream, is provided to the ECU for use in controlling closed loop operation of the fuel delivery time.

Oxygen Sensor



ECI212

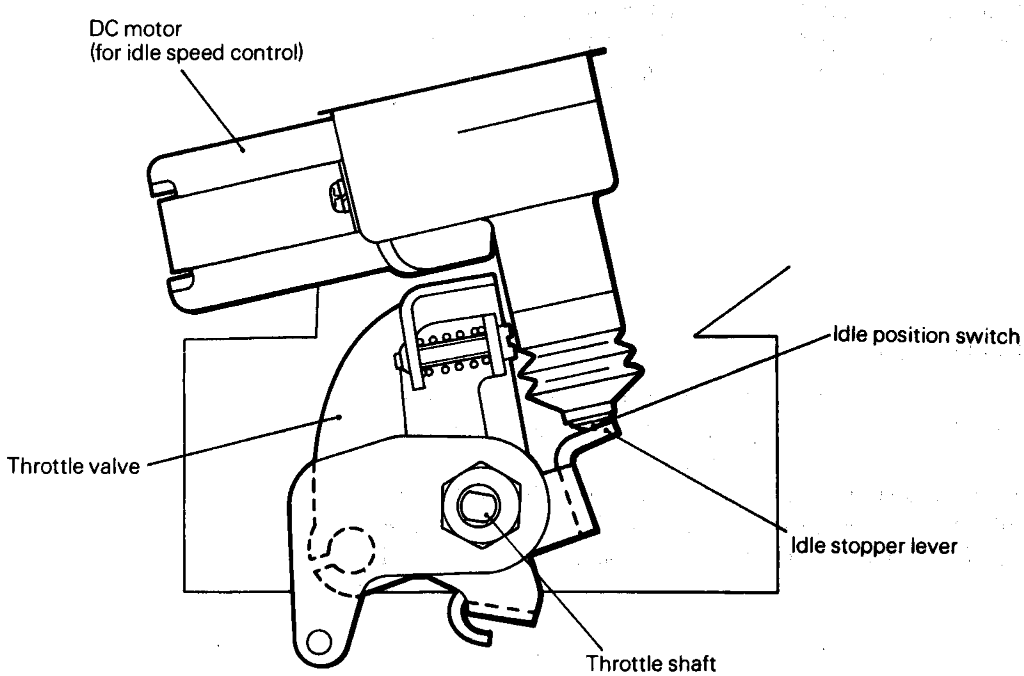
THROTTLE POSITION SENSOR

This is a rotary potentiometer mounted on the fuel injection mixer body. This sensor provides throttle angle information to the ECU to be used for the fuel delivery time and idle speed control.

IDLE POSITION SWITCH

This switch is installed on the fuel injection mixer assembly and turned ON when the throttle valve is at the closed (idling) position. Information from this switch is provided to the ECU for use in controlling fuel delivery time (during vehicle deceleration), idle speed and secondary air management. This switch is also used as an idle speed adjusting device.

Idle Speed Control System



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BATTERY VOLTAGE

Battery voltage is detected by the ECU. The battery voltage signal provides information to the ECU to allow for voltage compensation of the controlled functions.

A/C SYSTEM SWITCH

The A/C system switch signal indicates when the A/C mode switch is in the "A/C on" position.

ENGINE CRANK SWITCH

The engine crank switch provides a signal to the ECU when the engine is cranked.

PARK/NEUTRAL SWITCH

The park/neutral switch signal indicates when the automatic transmission gear selector is in the park or neutral position.

TIME

Time is generated by the ECU internal microprocessor clock.

VEHICLE SPEED SENSOR

The vehicle speed signal comes from the reed switch which senses speedometer cable speed. Pulses from this switch are sent to the ECU where the time between these pulses is used to calculate vehicle speed, which is used in controlling idle speed.

ELECTRONIC CONTROL UNIT (ECU)

The ECU is mounted in the passenger compartment and consists of a printed circuit board mounted in a protective metal box. It receives various signals from the sensors and switches. These various discrete inputs are processed and used by the ECU in controlling fuel delivery time, EGR, solenoid valve for pressure sensor, idle speed and secondary air management.

Parameters controlled

FUEL INJECTION CONTROL

There are two ways to control the fuel injection. One is the open loop control and the other is the closed loop control, which are switched each other by the ECU based on information on coolant temperature, exhaust oxygen concentration, air flow, and engine speed.
Under open loop control, the air fuel ratio is determined by the fuel delivery time (the frequency and duration of injection) which is controlled by the ECU.
Under the closed loop control, the air fuel ratio is feedback controlled by the ECI system including the exhaust oxygen sensor.

EGR CONTROL

The pressure applied to the EGR control valve is controlled by the solenoid valve motion which mixes the throttle ported pressure with the turbocharged pressure.
The solenoid valve motion is controlled by the ECU based on the information on coolant temperature and engine speed.

SECONDARY AIR CONTROL

The pressure applied to the secondary air control valve is switched by the solenoid valve from the intake manifold pressure to the turbocharged pressure or vice versa.
The solenoid valve motion is determined by the ECU based on the information on coolant temperature, air flow, engine speed and idle position.

IDLE SPEED CONTROL (ISC) SYSTEM

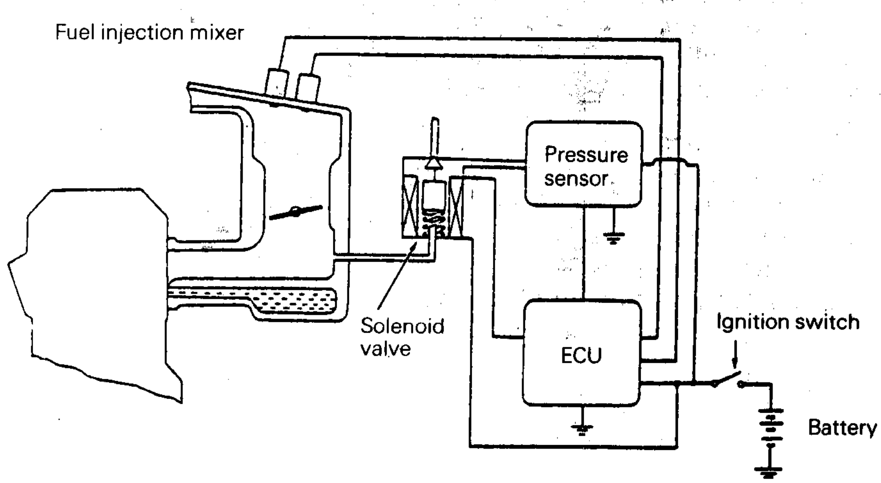
Engine idle speed, crank throttle angle and deceleration throttle angle are controlled by an electric motor driven actuator which changes the throttle angle by acting as a movable idle stop. The ECU controls the ISC actuator by providing the appropriate outputs to yield the idle speed or throttle angle required for the particular operating condition. The electronic components for the ISC system are integral with the ECU.

Adaptive memory control

During closed loop operation, the ECU monitors the output voltage signal from the exhaust oxygen sensor, and stores in a RAM (Random Access Memory) the mean values of feedback gain (proportional and integral gains).
The last mean values are always stored.
During open loop operation, the fixed pre-programmed fuel delivery time is modified by the ECU with the mean values of feedback gain to improve emission performance.
RAM is always powered from a standby power source.

HIGH-ALTITUDE COMPENSATION SYSTEM

In order to comply with Federal requirements, at all the fuel injection vehicles are equipped with a pressure sensor and a solenoid valve which are utilized as a high altitude compensator.
When the ignition switch is turned to ON position and thereafter once every specified period, the solenoid valve is energized by the ECU for the specified time, which in turn allows the pressure sensor to detect the ambient barometric pressure. Then, the fuel delivery time is determined by the ECU in response to the ambient barometric pressure so that the air/fuel ratios at high-altitudes can be maintained to the same degree as those at sea level.



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