TO INDEX

B8 ENGINE CONTROL SYSTEM

1KR

1 OUTLINE

1-1 DESCRIPTION

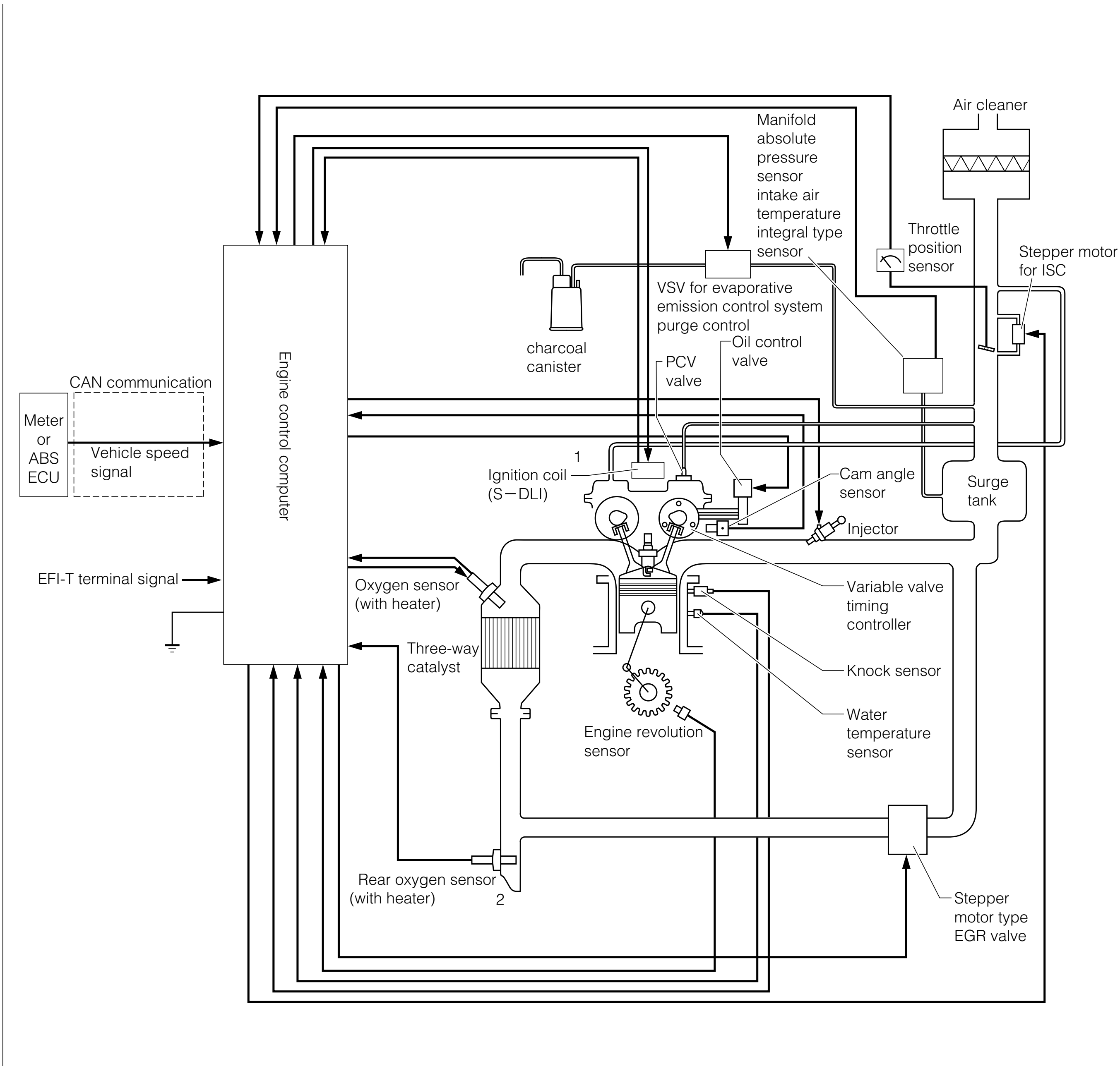
1.Engine control system of the 1KR— FE type engine uses the engine control computer to totally control the electronic fuel injection system (EFI), electronic spark advance (ESA), variable valve timing control, and idol speed control (ISC).

2.The system conducts serial communication with the following ECU's.
  (1) Airbag ECU
  (2) Immobilizer ECU (Immobilizer system-equipped vehicle only)

3.The system conducts CAN communication with the following ECU's.
  (1) Meter ECU
  (2) ABS ECU (ABS-equipped vehicle only)

4.The diagnostic (self-diagnosis) function and fail safe function are provided in the event of failure.

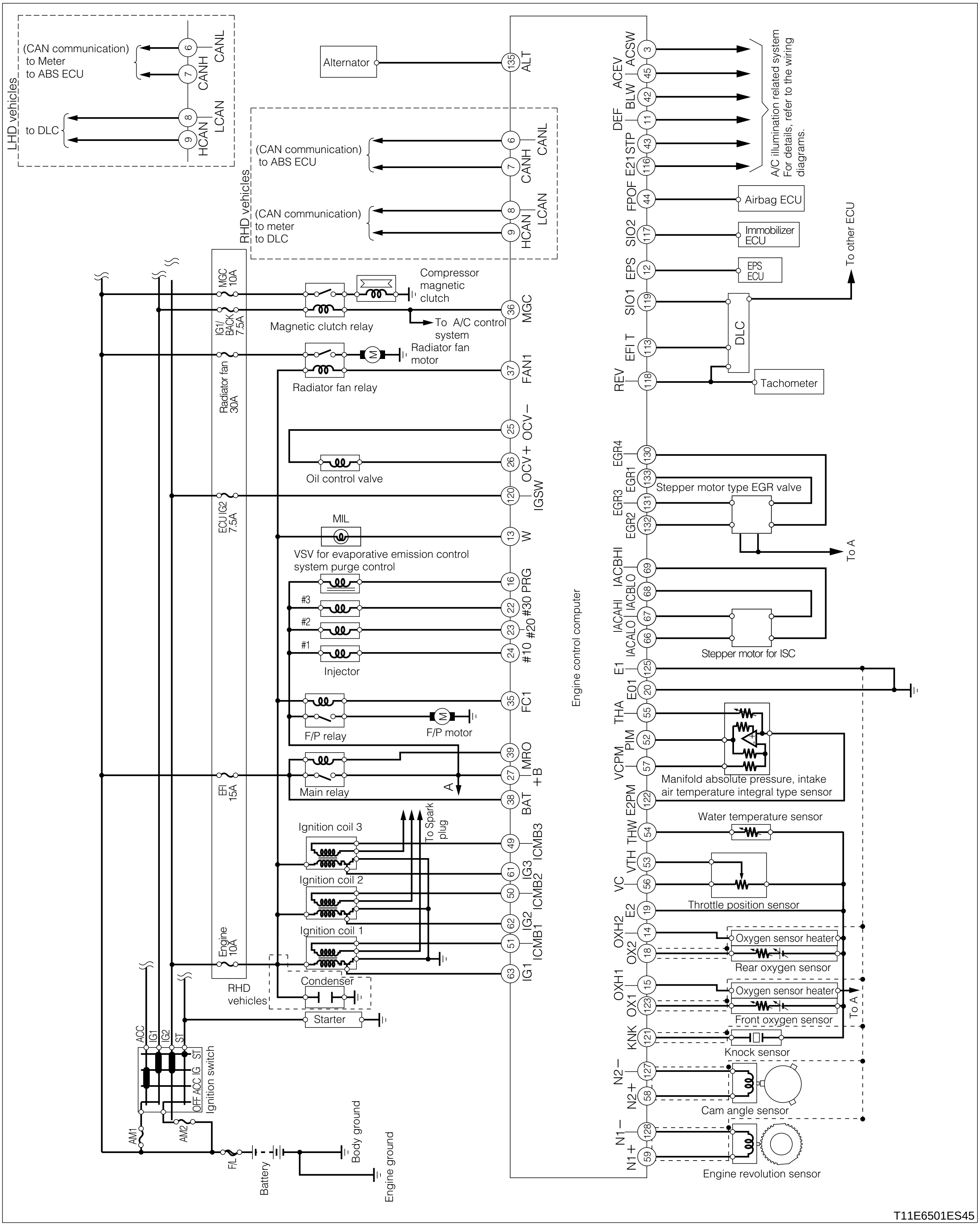
1-2 SYSTEM DRAWING



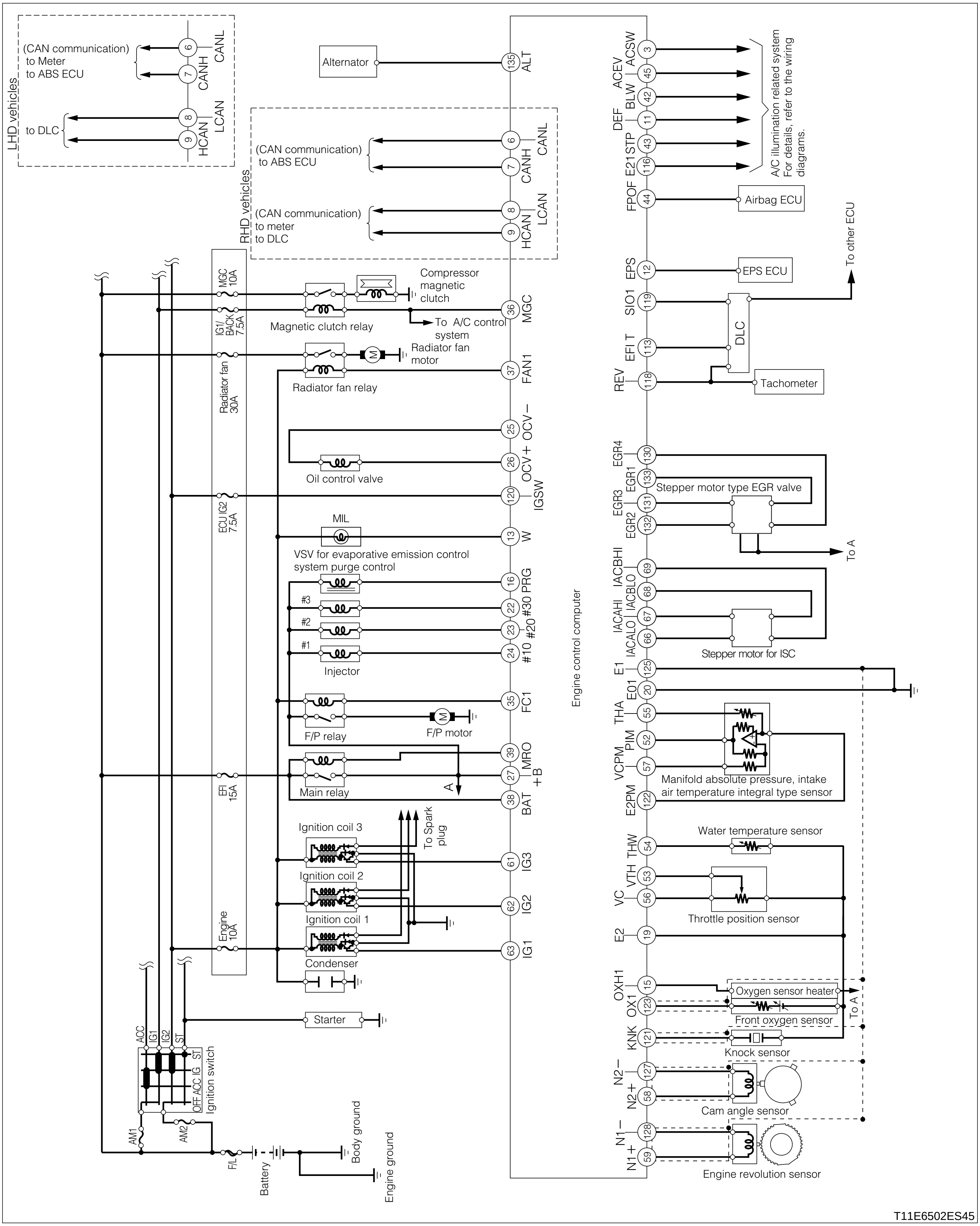
1: Ion current detection device built-in for only EU specifications
2: For only EU specifications

1-3 SYSTEM WIRING DIAGRAM

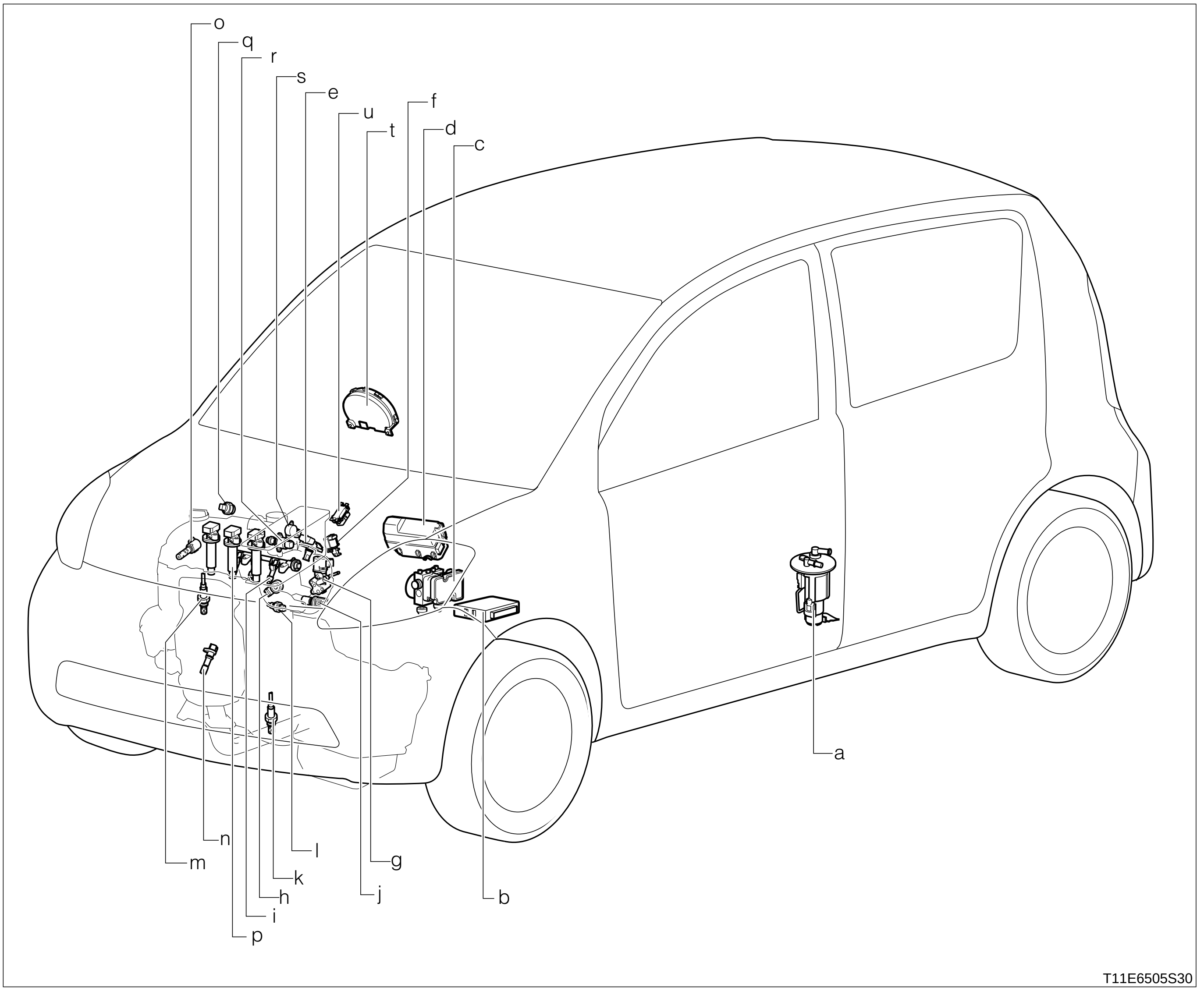
For EU Specifications



For general Specifications



1-4 LOCATION OF COMPONENTS



	Part name
a	Fuel pump
b	Engine control computer
c	ABS actuator (ABS-equipped vehicle only)
d	Relay block
e	Manifold absolute pressure/ intake air temperature integral type sensor
f	VSV for evaporative emission control system purge control
g	Stepper motor type EGR valve
h	Knock sensor
i	Injector
j	Cam angle sensor
k	Rear oxygen sensor (EU-specification vehicle only)
l	Engine water temperature sensor
m	Oxygen sensor
n	Engine revolution sensor
o	Oil control valve
p	Ignition coil
r	Stepper motor for ISC
s	Throttle position sensor
t	Combination meter
u	DLC

2 CONTROL

2-1 EFI SYSTEM

2-1-1 DESCRIPTION

The electronic fuel injection system detects the driving condition through sensor signals from the amount of intake air calculated from the intake manifold pressure and the engine speed. And it controls injection quantity (amount of time that the injector is energized) to ensure proper air-fuel ratio for the driving condition.

The electronic fuel injection system employs an intermittent injection that is synchronized with the engine revolution speed, performing independent injection for each cylinder.

As the fuel injection method, there are synchronous injection and asynchronous injection. The synchronous injection is an injection that is synchronized with the engine revolution signal. On the other hand, the asynchronous injection is an independent injection that is not synchronized with the engine revolution signal. This asynchronous injection takes place, for example, at the time of rapid acceleration.

Also, to protect the engine and catalyst, fuel cutting is performed according to the driving condition.

2-1-2 INJECTION SYSTEM

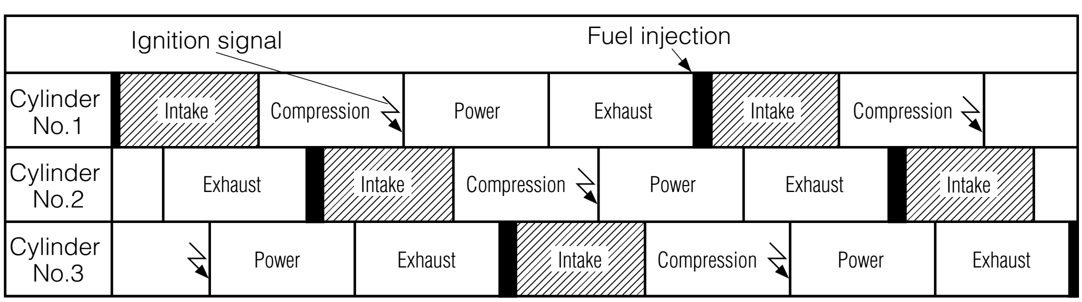
(1) Synchronous injection

The synchronous injection is an injection that is synchronized with the engine revolution signal. There are two methods for synchronous injection: One is the injection during starting period; and the other is the injection after starting period.

The judgment as to whether it is the starting period or after starting period is carried out, based on the engine revolution speed.

① Injection during starting period

A cylinder is identified based on the signal (cylinder identification signal) from the engine speed sensor. After the cylinder is identified, independent injection is performed in each cylinder in accordance with the information obtained from the sensor.



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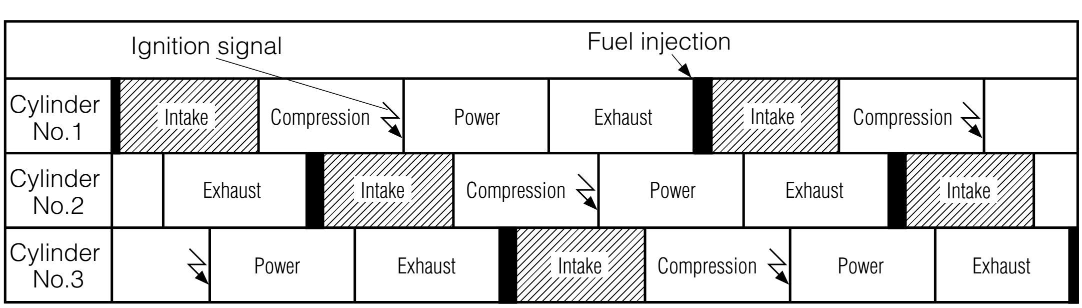
② Injection after starting period

Independent injection is performed, respectively, for each cylinder, based on the cylinder information by the revolution signal (N signal)



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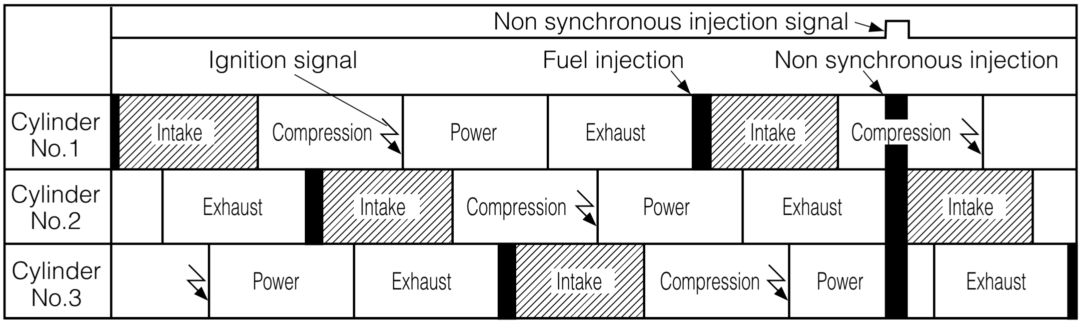
(2) Asynchronous injection

Injection is performed immediately when conditions are satisfied. The injection of this type occurs without synchronizing with the engine revolution signal.



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2-1-3 DETERMINATION OF INJECTION AMOUNT (INJECTION TIME DURING SYNCHRONOUS INJECTION)

(1) Injection time during starting period

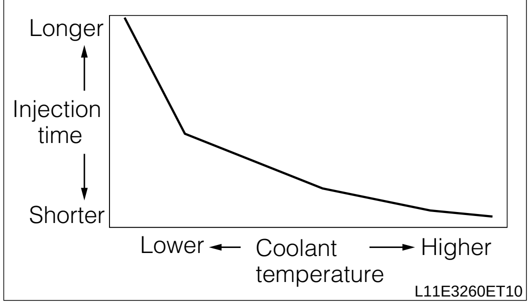
The injection time is determined by the basic injection time during starting period, which is determined by coolant temperatures, various compensation coefficients, and invalid injection time.

Injection time during starting period = Basic injection time during starting period × Various compensation coefficients + Invalid injection time

When the coolant temperature is below the set value, injection is performed into several injections.

① **Basic injection time during starting period**

The basic injection time is determined by the coolant temperature. When the engine is in a cold period, gasoline adhered to the intake valves and inner walls of the intake ports becomes difficult to evaporate. Therefore, the injection amount during cold period has been set to a greater value.



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② **Coefficient of compensation for revolution speed during starting period**

When the coolant temperature is low, compensation suited for the engine speed is performed so that startability may be improved.

③ **Coefficient of compensation for atmospheric pressure during starting period**

Compensation suited for the atmospheric pressure is provided to improve startability.

④ **Coefficient of compensation for the number of injections during starting period**

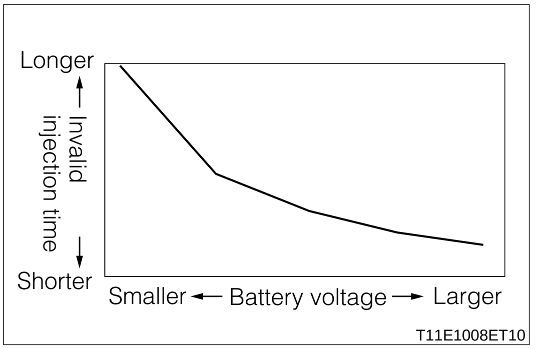
The number of injections during starting period is counted so that the injection time can be properly reduced based on the number of injections.

⑤ **Coefficient of intake air temperature compensation**

This coefficient is used to rectify the difference in the air density, which is caused by the difference in intake air temperatures.

⑥ **Invalid injection time**

The injector valve does not open at the moment of energizing and requires some time period for injection to start. This time period is referred to as invalid injection time. Invalid injection time will vary with the battery voltage, with a higher battery voltage resulting in a shorter invalid time, while a lower battery voltage resulting in a longer invalid time. For this reason, the injector energizing time is calculated by adding the invalid injection time, which is based on the constantly measured battery voltage, to the actual injection time.



(2) Injection time after starting period

The injection time is determined by the basic injection time after starting period, various compensations and invalid injection time.

Injection time after starting period = Various compensation time based on basic injection time after starting period + Invalid injection time

① **Basic injection time after starting period**

This is a time determined by the intake manifold pressure and engine revolution speed.

② **Coefficient of intake air temperature compensation**

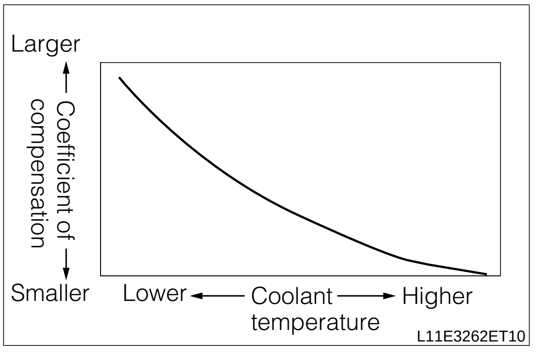
This coefficient rectifies the difference in the air density, caused by the difference in intake air temperatures.

③ **Compensation coefficient during resuming period after fuel cut**

The injection amount is reduced according to the reduced number of rotations during resuming period after fuel cut in order to improve drivability.

④ **Coefficient of compensation for increase of engine warming-up**

This is an increase compensation for the engine cold period determined by the coolant temperature. This compensation is carried out, until the warming-up is completed.



⑤ **Coefficient of increase compensation after starting period**

In order to achieve the stabilization of engine revolution speed immediately after the engine has started, the initial value for the coefficient of increase is determined according to the coolant temperature during the engine starting period. Then, the value is reduced at every time when the injection takes place after the engine starting.

⑥ **Time of compensation for air-to-fuel ratio during transient time**

This is for the compensation of the air-to-fuel ratio during transient time. This time is determined based on the coolant temperature, etc.

⑦ **Coefficient of air-to-fuel ratio feedback compensation**

Rich or lean condition in the air-fuel mixture is detected by the signal from the O_2 sensor and the rear O_2 sensor* during the engine running after warm-up. The injection quantity is adjusted accordingly so that the air-fuel ratio is controlled in the narrow range near the theoretical air-fuel ratio where the three-way catalyst exhibits high performance.

NOTE

- *: Rear O_2 sensor is for the EU-specification vehicle only.

⑧ **Coefficient of power increase compensation**
During a high load driving, the amount of injection is increased according to the intake manifold pressure and engine revolution speed.

⑨ **Coefficient of compensation for increase after re-starting**
The initial value is determined according to the coolant temperature at time of re-starting. The injection amount is reduced for each injection.

⑩ **Coefficient of atmospheric pressure compensation**
Compensation according to the atmospheric pressure is performed.

⑪ **Idling stabilization compensation advance**
During idling, the injection amount is compensated based on the engine revolution signal to stabilizing the revolution speed.

⑫ **Water temperature compensation advance**
During a high load, high revolution driving, the advance value is compensated according to the coolant temperature.

⑬ **Coefficient of low-rotation compensation**
The injection amount is increased during low-rotation period.

⑭ **Compensation coefficient during knock feedback**
Injection quantity is increased when the ignition timing is too retarded during knock feedback.

⑮ **Invalid injection time**
(See the section of the invalid injection time of the injection time during starting period.)

2-1-4 DETERMINATION OF INJECTION AMOUNT (INJECTION TIME DURING ASYNCHRONOUS INJECTION)

(1) Asynchronous injection during change in idle switch
When the throttle valve is changed from the closed state (idling condition) to the opened state, injection occurs once for all cylinders simultaneously for a certain length of time.

(2) Asynchronous injection during change in intake manifold pressure
Injection occurs once for all cylinders simultaneously for a certain length of time according to the increase ratio of the intake manifold pressure.

(3) Asynchronous injection during resuming period after fuel cutting
If the engine revolution speed drops drastically during the resuming period after fuel cutting, injection occurs for a certain length of time.

(4) Asynchronous injection when the air-conditioner is ON
When the air-conditioner is switched from OFF"→"ON"

(5) Asynchronous injection when the power steering is "ON".
When a request signal is sent from EPS ECU during steering wheel operation, injection occurs for a certain length of time.

2-1-5 FUEL CUTTING

(1) Fuel cutting during deceleration
When the engine revolution speed exceeds the specified value and the throttle valve is closed, fuel cut occurs.

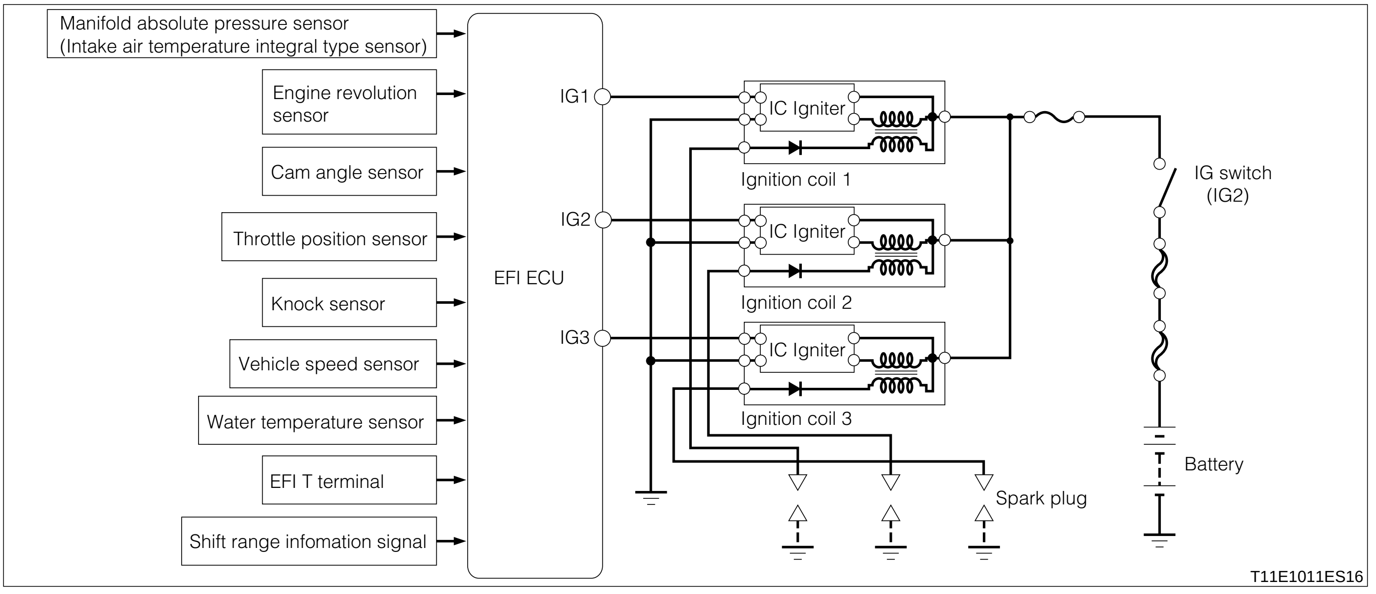
(2) Fuel cutting during catalyst overheated period
Fuel is cut off according to the engine revolution speed and the intake manifold pressure, thus preventing the catalyst from overheating.

(3) Fuel cutting at high engine revolution speed
When the engine revolution speed exceeds the specified value, fuel cut occurs.

2-2 ELECTRONIC SPARK ADVANCE SYSTEM

2-2-1 DESCRIPTION

ESA (electronic spark advance system) uses the engine control computer to calculate and control the optimal ignition timing according to the engine conditions after the cylinder has been identified by the engine speed sensor signal.
In addition, the ion current combustion control system detects the ion current in the combustion chamber and controls ignition timing for optimal combustion.
The electronic spark advance system can be classified into two modes: One is a fixed spark advance synchronized with the engine revolution signal, and the other is a calculation spark advance determined by the engine revolution speed and intake manifold pressure.



2-2-2 DETERMINATION OF IGNITION TIMING

(1) Fixed advance

BTDC10° fixed spark advance synchronized with the engine revolution signal occurs during start-up or short circuit condition at the EFI-T terminal.

(2) Calculation advance

Under conditions other than the fixed advance, the ignition timing is determined by engine conditions, such as the intake manifold pressure and engine revolution speed.
Ignition timing advance = Basic advance ± Various compensation advances

① **Basic advance**

This is the ignition timing determined by the engine revolution speed and intake manifold pressure.

② **Water temperature compensation advance**

The advance value is compensated according to the coolant temperature.

③ **Idling stabilization compensation advance**

In cases where the idling speed drops during the idling period, the timing is advanced. Conversely, in cases where the idling speed rises, the timing is retarded.

④ **Transient compensation advance**

The advance value is compensated in accordance with sharp fluctuations of the intake manifold pressure during running.

⑤ **Control of energizing time**

Energizing time of the ignition coil is controlled in accordance with the engine revolution speed and power supply voltage to the ignition coil.

⑥ **Knock compensation advance**

When knocking is detected by the output signal of the knock sensor, ignition timing will retard immediately. When knocking does not occur for a given length of time, ignition timing will be advanced gradually until knocking occurs again. In this way the optimal ignition timing can be maintained at all times. Compensation value is limited to prevent adverse influence to the engine.

⑦ **Acceleration surging compensation advance**

The ignition timing advance is compensated when the intake manifold pressure changes beyond a set amount during acceleration at a low speed after the engine has warmed up.

⑧ **Inner EGR compensation advance**

The ignition timing advance is compensated according to the variable valve timing..

⑨ **External EGR compensation advance**

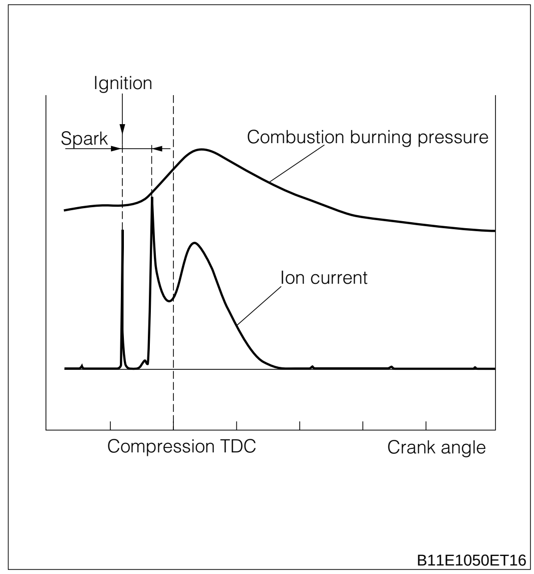
The ignition timing advance is compensated according to the amount of external EGR.

2-2-3 ION CURRENT COMBUSTION CONTROL SYSTEM

(1) DESCRIPTION

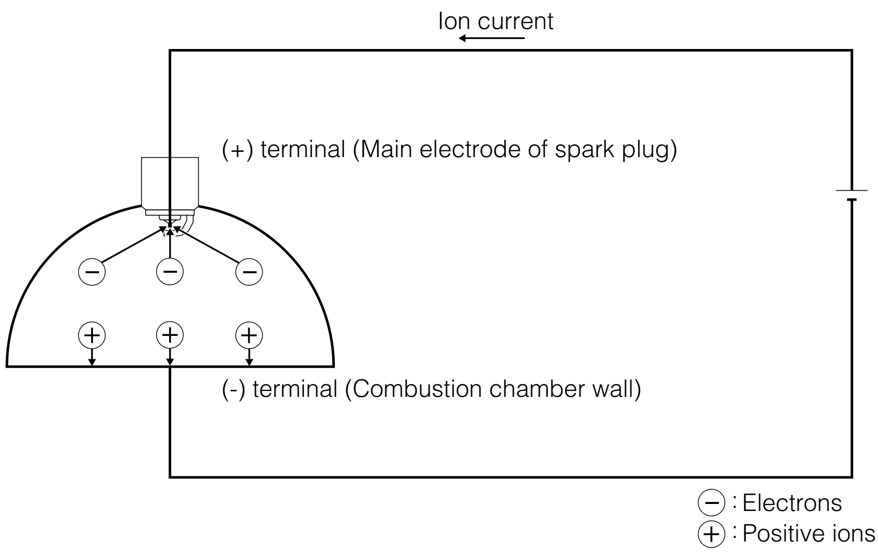
The engine control computer uses the spark plug to detect ion current generated during combustion burning, thereby detecting combustion burning condition in the cylinder.

This allows detection of misfire and combustion limit, thus controlling ignition timing for optimal combustion.



(2) Principle

1. Positive ions and electrons are generated in the flame during combustion.
2. When the charge voltage on the primary side of the ignition coil is applied to the main electrode of the spark plug after the arc discharge ignition, ion current will be produced in the flame.
3. The detected ion current, as being a minute output, is subject to noise. Therefore, ion current waveform is converted into a rectangular wave in the ion current detection circuit, which is built into the ignition coil, and the signal is sent to the engine control computer to determine combustion and misfire.
4. Ion current is not created when engine misfire occurs. Therefore, when the input voltage of the engine control computer falls below the standard value, it determines that misfire has occurred.



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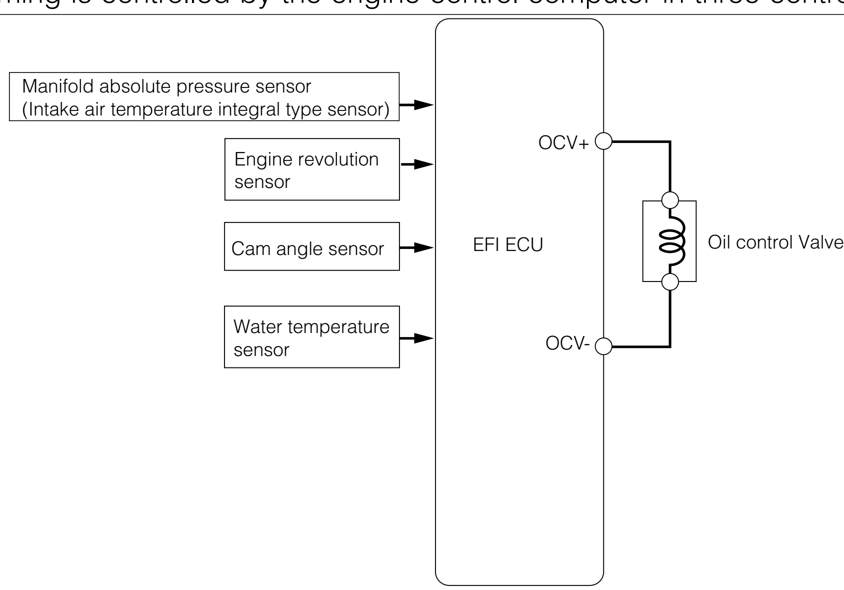
2-3 DYNAMIC VARIABLE VALVE TIMING CONTROL

2-3-1 DESCRIPTION

The engine control computer turns ON and OFF the oil control valve according to the signals from the manifold absolute pressure sensor, coolant temperature sensor and engine revolution speed so as to regulate the hydraulic pressure applied to the variable valve timing controller. This way, the opening/closing timing of the intake air valve can be controlled to the target timing. The opening/closing timing of the intake air valve is detected by the camshaft position sensor. Any deviation, when encountered, will be corrected.

The valve timing is controlled by the engine control computer in three control modes.



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(1) Forced most-retarded angle mode

This is the mode that forces the No. 1 camshaft to rotate till maximum retard in the intake valve open/close timing . This mode is used to regulate the oil control valve when starting and when battery voltage falls below the set value.

(2) 0˚retention mode

The retention mode is used, when a target displacement is 0˚. (Refer to the following section on feedback mode for the target displacement angle.)

(3) Feedback mode

① **Determination of target displacement angle**

The target displacement angle is determined according to the throttle valve opening degree, intake manifold pressure, atmospheric pressure, engine revolution speed, and coolant temperature.

② **Determination of oil control valve driving duty ratio**

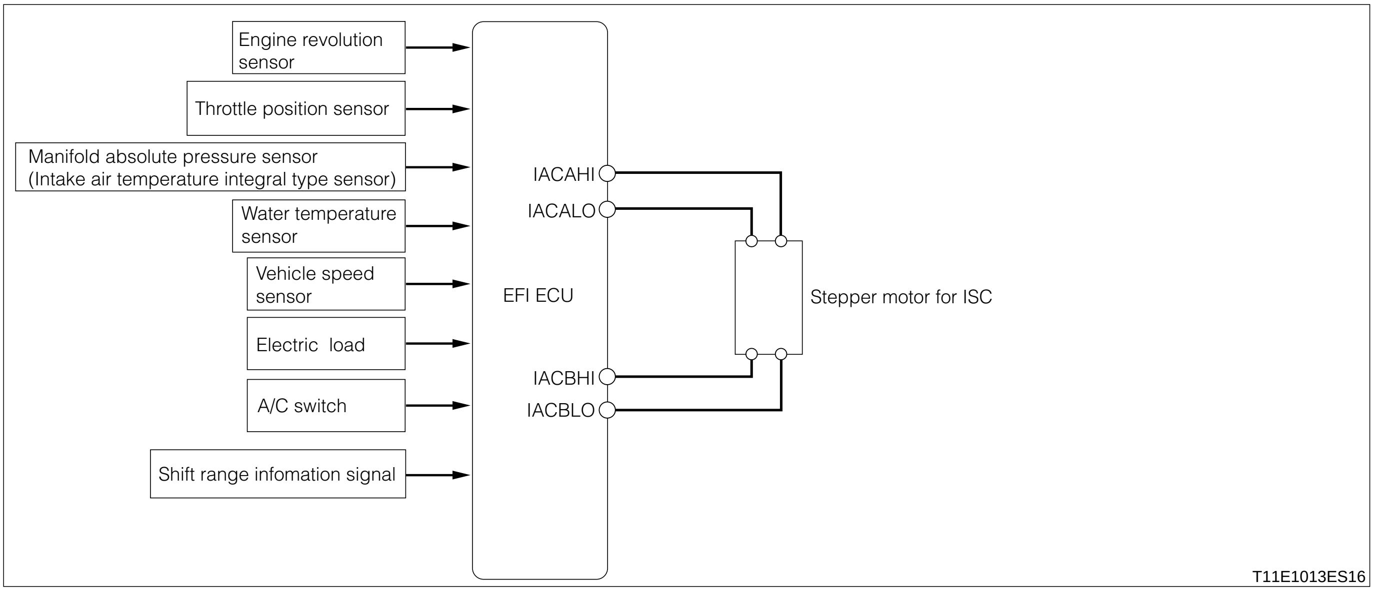
The duty ratio is determined based on the signal from the target displacement angle and camshaft position sensor according to the engine revolution speed and coolant temperatures.

2-4 IDLE SPEED CONTROL SYSTEM (ISC)

2-4-1 DESCRIPTION

The idle speed control (ISC) controls the engine idle speed to prevent engine stall that occurs due to the load applied to the engine during idling.

The engine control computer activates the ISC stepper motor by the signal sent from the sensors, which then controls the pass way area that bypasses the main passage, where the throttle valve is located, in order to control the intake air during idling.



2-4-2 DETERMINING AMOUNT OF DRIVE

The engine control computer determines the opening angle of the ISC valve by the signal from sensors and outputs the amount of drive to the ISC stepper motor based on the valve opening angle.

(1) Water temperature compensation amount

During the period from the engine starting through the end of warming-up, the opening degree of the ISC valve is compensated according to the coolant temperature.

(2) Compensation amount during starting period

During the engine starting period and for several seconds after the starting, the ISC valve is opened to increase intake air in order to improve the engine startability.

(3) Compensation amount for feedback

The opening angle of the ISC valve is changed according to the difference between the idle speed and the target revolution speed to achieve the target revolution speed.

(4) External load compensation amount

1. When changes occur in the air conditioner load, electric load, radiator fan load and so forth, the opening angle of the ISC valve changes according to respective loads, thereby controlling the engine revolution speed.
2. The engine revolution speed is controlled by the power steering load (when the steering wheel is operated with the vehicle in a stationary state) during idling period.

(5) Compensation amount by engine revolution load

The ISC valve opens once, and then gradually closes, in order to obtain better converge into the target revolution speed when the engine revolution speed drops.

(6) EGR compensation amount

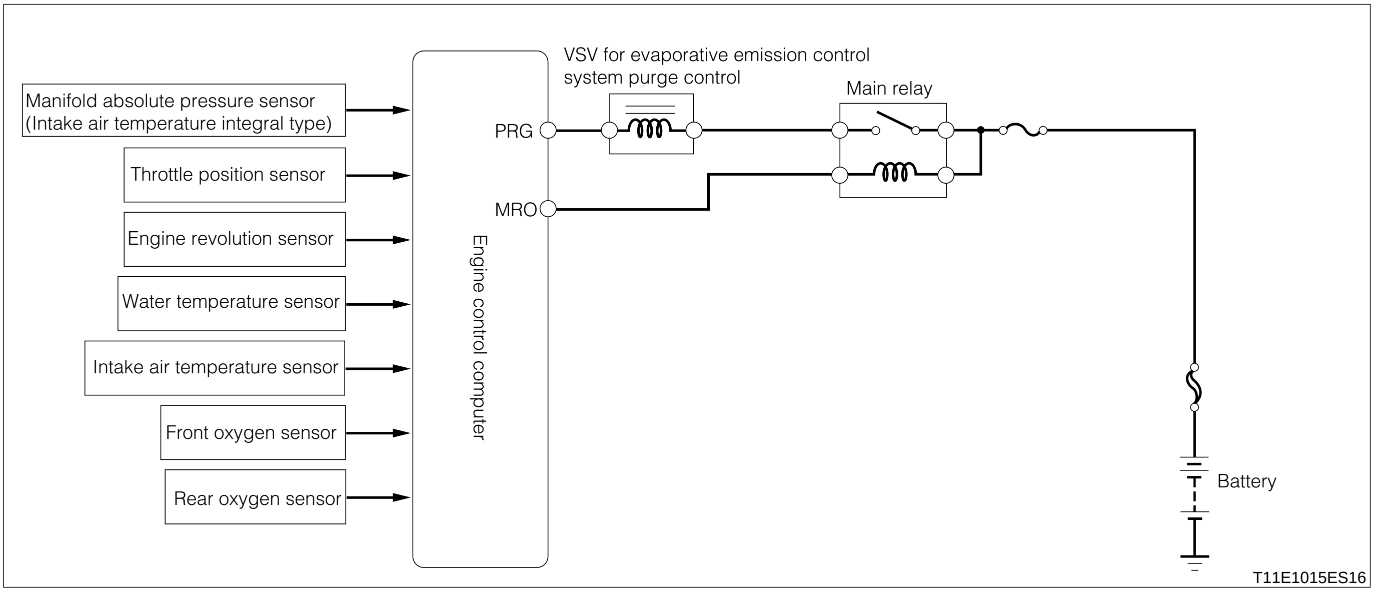
When the throttle valve closes suddenly, the ISC valve opens to allow new charge, thus increasing the quantity of air.

2-5 VSV CONTROL FOR EVAPORATOR PURGE

2-5-1 DESCRIPTION

When all of the following conditions are satisfied, the engine control computer turns ON the VSV for evaporative emission purge (duty control), thus purging the fuel evaporative emissions to the combustion chamber.

1.After engine has warmed up
2.During the air-to-fuel ratio feedback
3.When the accelerator pedal is depressed:
4.When the engine control computer is not in a learning mode:



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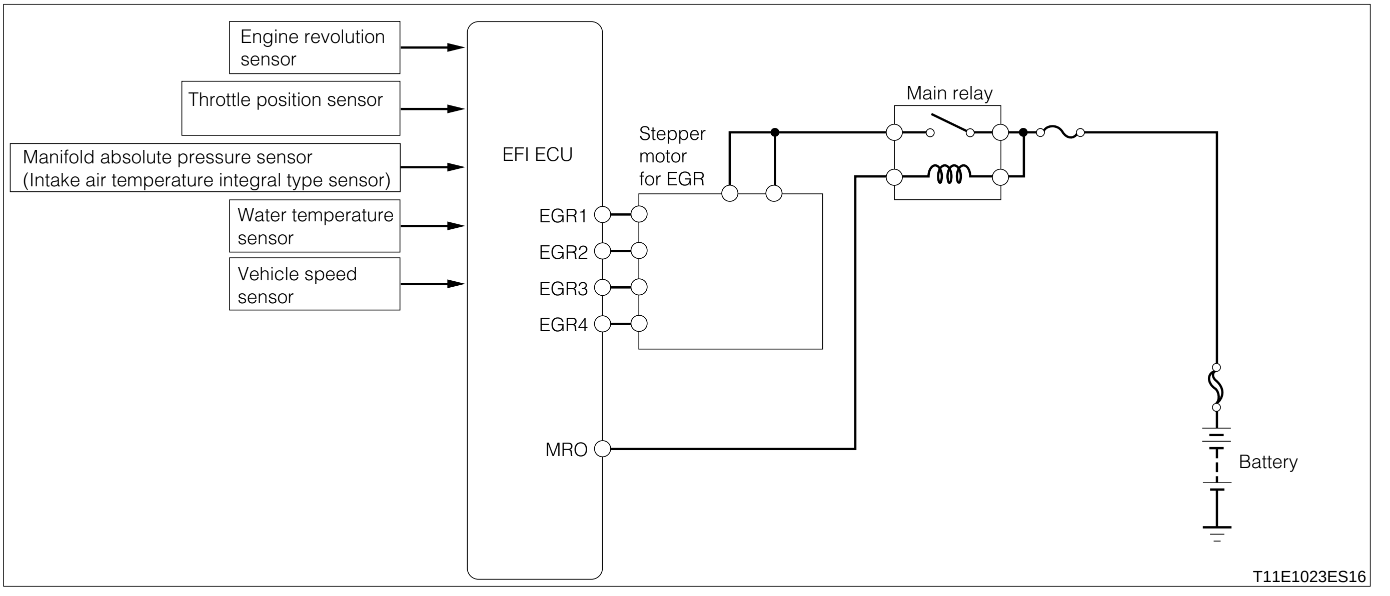
2-6 EGR STEPPER MOTOR CONTROL

The engine control computer activates the EGR stepper motor according to the engine revolution speed, throttle position sensor, manifold absolute pressure sensor (with the intake air temperature sensor), and the coolant temperature sensor, thereby regulating the opening angle of the EGR valve to achieve an optimum amount of EGR.



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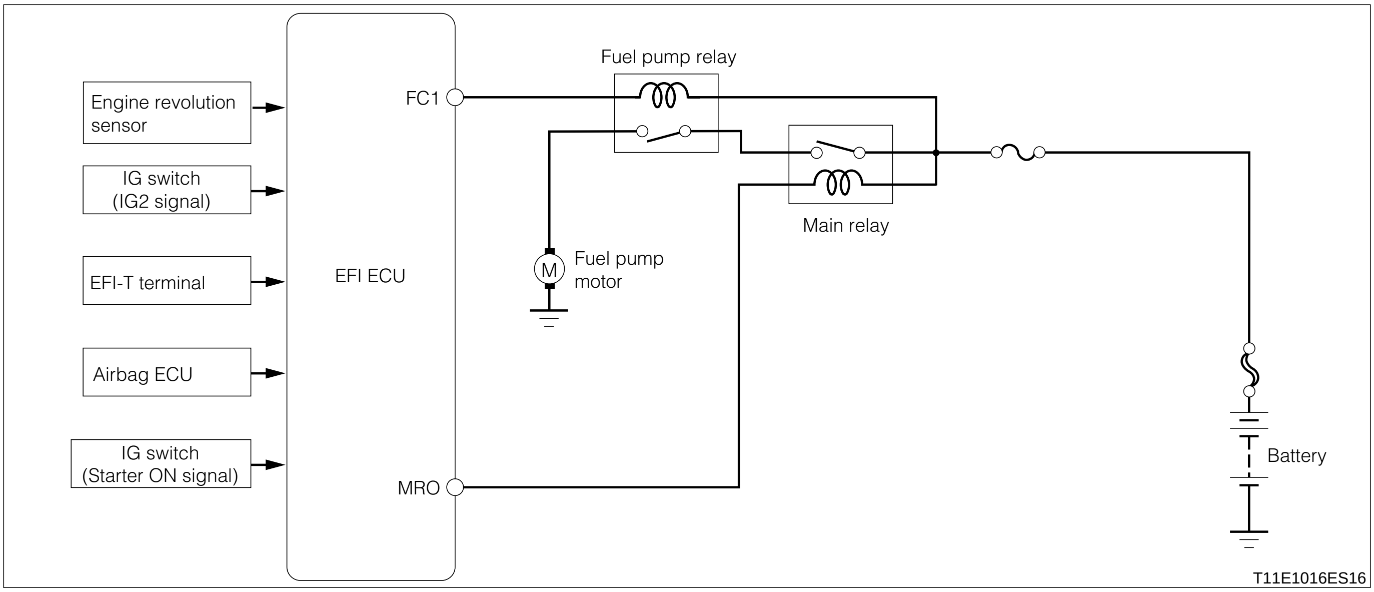
2-7 FUEL PUMP CONTROL

When any of the following 4 conditions is satisfied, and no fuel pump stop signal is sent from the airbag ECU, the engine control computer will turn ON the fuel pump relay to activate the fuel pump.

1. For two seconds after the IG switch ON (with the terminal EFI-T turned OFF):
2. For eight seconds after the IG switch ON (with the terminal EFI-T turned ON):
3. After identifying the cylinder and for two seconds after the revolution signal is inputted (The pump is continued to be driven when the engine revolution speed is more than 20 rpm.):
4. Three seconds after starter is switched from OFF → ON



2-8 AIR CONDITIONER CUT CONTROL

2-8-1 DESCRIPTION

When the following conditions for the air conditioner cutting are satisfied, the engine control computer turns OFF the air conditioner relay and the compressor magnet clutch, thereby cutting the air conditioner.

(1) Air conditioner cut by coolant temperature

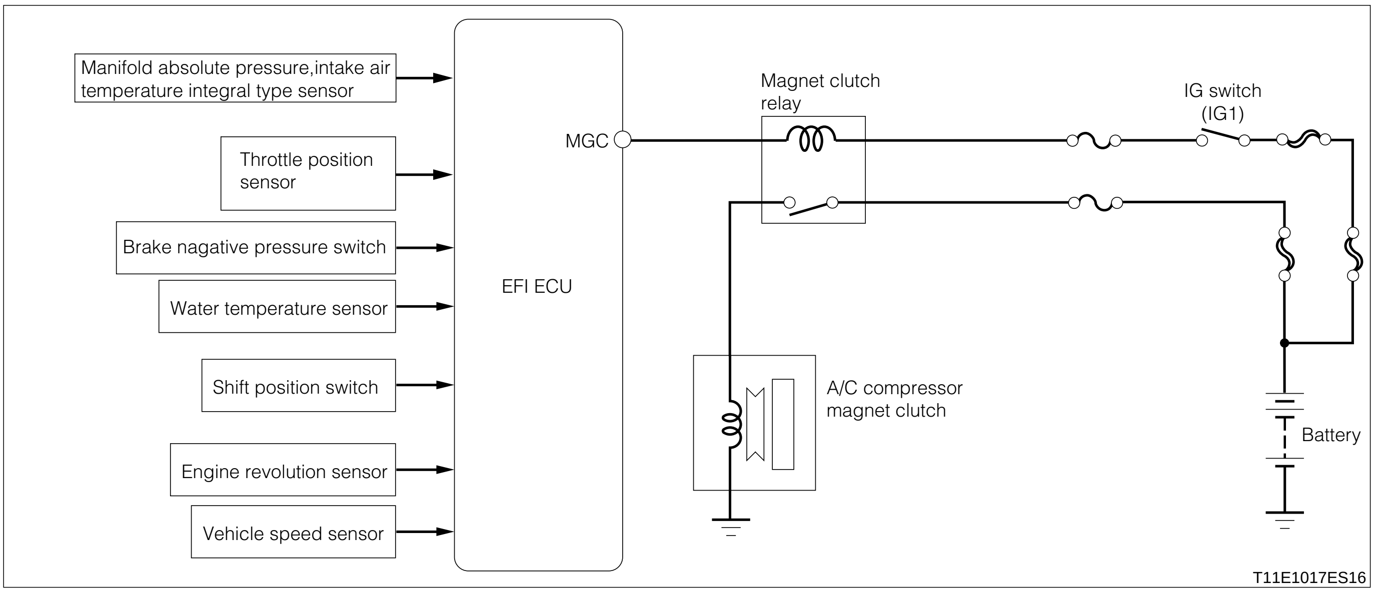
When the following conditions are satisfied, the air conditioner is cut.

1. When the coolant temperature becomes above the set value:

(2) Air conditioner cut in running area

When at least one of the following conditions is satisfied, the air conditioner is cut.

1. When the throttle valve opening degree and the manifold absolute pressure exceed the set value:
2. When the throttle valve opening degree exceeds the set value by the vehicle speed:



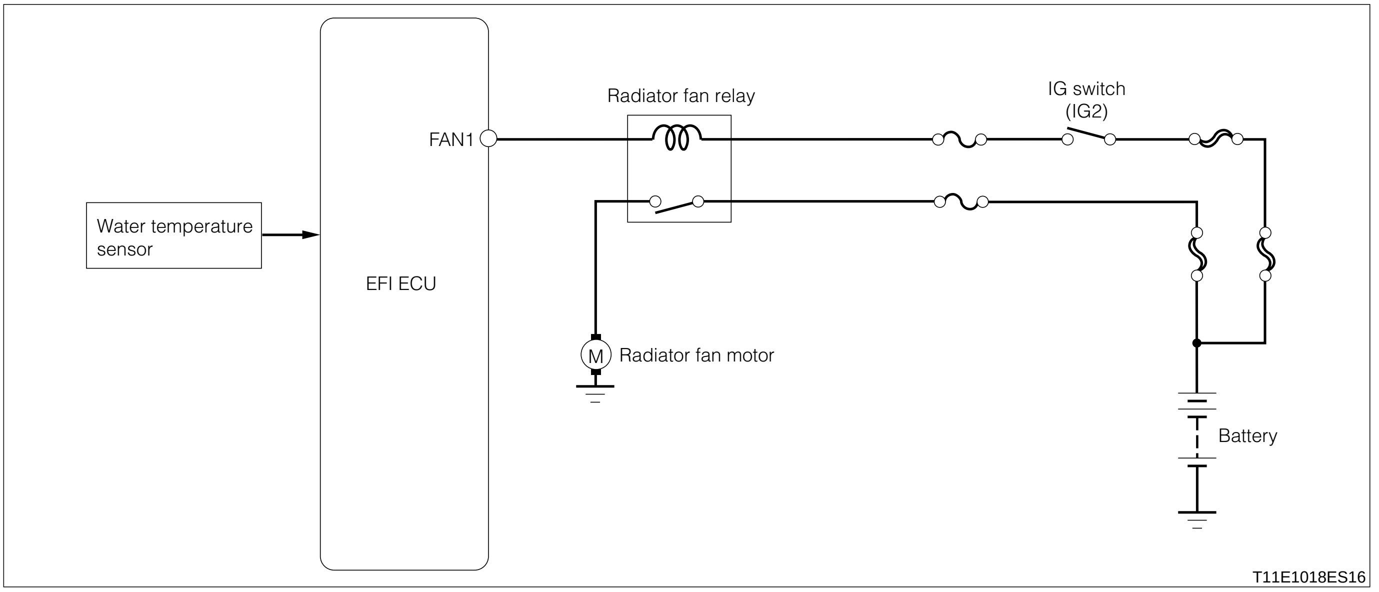
2-9 RADIATOR FAN MOTOR CONTROL

2-9-1 DESCRIPTION

When the preset condition is satisfied, the radiator fan relay is turned ON, and the radiator fan motor is operated. If not satisfied, the radiator fan relay is turned OFF.

NOTE

- When an abnormality occurs in the coolant temperature sensor system, the radiator fan motor rotates all the time by the fail-safe function.



2-10 AIR CONDITIONER IDLE-UP CONTROL

2-10-1 DESCRIPTION

When all of the following conditions are satisfied, the engine idle speed is increased.

1. When the air conditioner switch is ON:
2. When the blower switch is ON:
3. When the air conditioner cutting control is not performed:
4. When the air conditioner evaporator temperature exceeds the set value:

2-11 MAGNET CLUTCH CONTROL

2-11-1 DESCRIPTION

When all of the following conditions are satisfied, the magnet clutch is turned ON.

1. When the air conditioner idle-up control is performed:
2. When the engine revolution speed exceeds a certain value:

2-12 ALTERNATOR CONTROL

2-12-1 DESCRIPTION

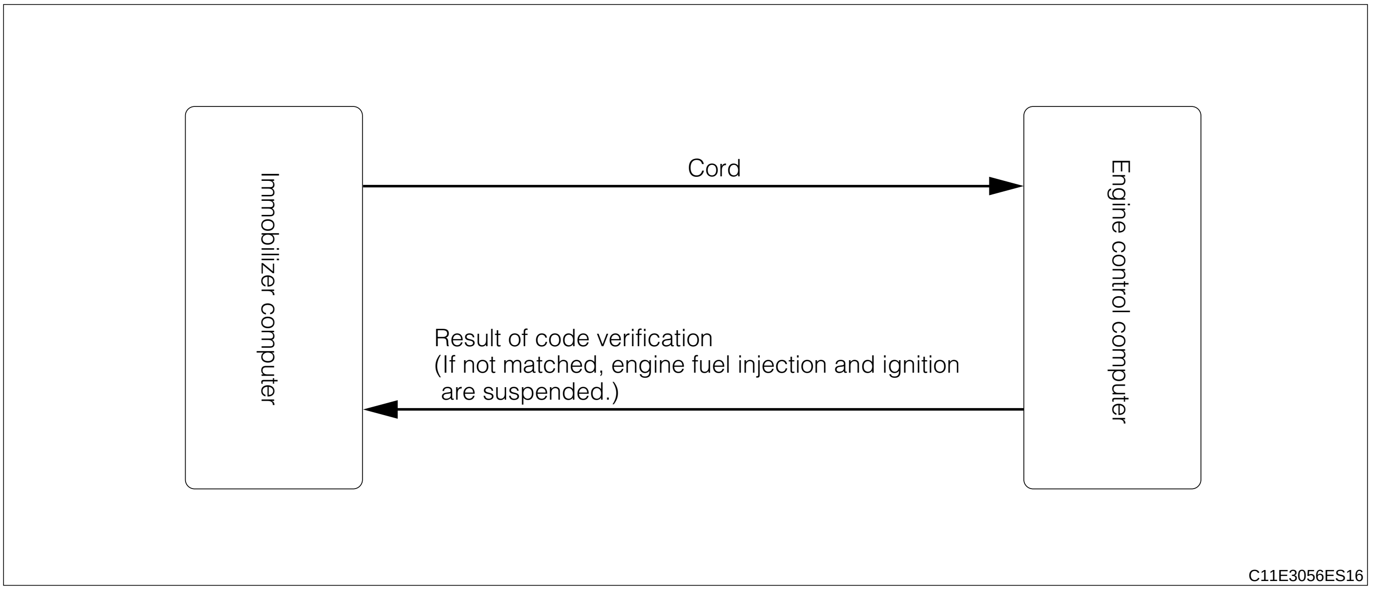
When the preset condition is satisfied, the alternator stops charging .

2-13 AIRBAG ECU COMMUNICATION

When the signal from the airbag ECU is received in the event of a collision, etc., the fuel pump relay is turned OFF, thus stopping the fuel pump.

2-14 IMMOBILIZER SYSTEM COMMUNICATION (IMMOBILIZER SYSTEM-EQUIPPED VEHICLE ONLY)

The engine control computer communicates with the immobilizer ECU for code verification. If the code does not match, fuel injection and ignition are stopped to prevent the engine from starting.



2-15 CAN COMMUNICATION

The engine control computer conducts CAN communication with the meter ECU and ABS ECU (ABS-equipped vehicle only). Multiple pieces of information and data are sent and received through a pair of communication wires (twisted pair wiring).

Refer to the section "CAN communication system" for the details of CAN communication.

Refer to Page L2-1.

2-16 DIAGNOSIS (SELF-DIAGNOSIS) FUNCTION

2-16-1 OUTLINE

(1) DESCRIPTION

In the diagnosis system, a computer memorizes any system which encounters abnormality in its output/input signal systems, and inform the driver of the abnormality by flashing or illuminating the malfunction indicator lamp (MIL, warning lamp) while the engine is running.
Since the memory of the diagnosis content is performed directly by the battery, the diagnosis content is memorized even if the IG switch is turned ACC or LOCK. For detailed information about the assignment of the diagnosis trouble code (DTC), the checking and erasing procedures for the DTC, refer to the EF section of the service manuals. The following shows the DTC the table showing failsafe functions, although these information is posted in the EF section of the service manuals.

(2) Instructions on use of this technical information book

This technical information book covers both the area where type certification is conducted based on the EC exhaust emission approval procedures, and other areas. However, the assignment of the diagnosis trouble codes and their reading are different between these two areas. Hence, observe the following instructions.

1. Use of DS-21 diagnosis tester or OBD II generic scan tool:
   (1) Areas where type certification are performed based on EC exhaust emission approval procedures: Use the 4-digit code (example, P0105) which is assigned according to the ISO standards.
   (2) You can use the 4-digit codes by using the DS-21 diagnosis tester or OBD II generic scan tool. Or you can also use two-digit codes (example, 31) without using such tester or tool. You can employ whichever convenient method.
2. The OBD II generic scan tool refers to a scan tool which complies with the ISO 14230 (KWP2000) format.
3. When the OBD II generic scan tool is used, all trouble codes (4-digit codes) can not be read out. It should be remembered that only trouble codes which have a zero after P, like P0XXX, can be read out.
4. The 2-digit codes are slightly inferior to the 4-digit codes in identifying the trouble sections.
5. The area where type certification is performed based on EC exhaust emission approval procedures is hereinafter referred to as the EU area.

2-16-2 FAIL-SAFE FUNCTION

When abnormality takes place in the signal from sensors, or malfunctions take place in the control of the oil control valve for the variable valve timing, conditions such as engine failure, catalyst overheating may result, if the control is continued as it is. To prevent this, the fail-safe function uses the values stored in the computer in order to control operations.

When the malfunction is remedied to the normal condition after an abnormality was detected, the fail-safe control will be released. However, the diagnosis result remains.

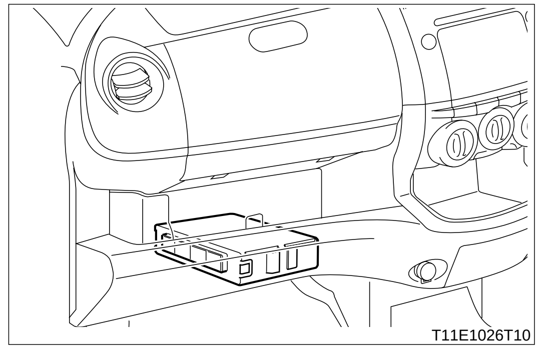
Fail safe specifications

Item	Fail-safe execution conditions	FAIL-SAFE SPECIFICATIONS
Manifold absolute pressure sensor signal system	When abnormality takes place in the signal from the manifold absolute pressure sensor:	The manifold absolute pressure is estimated by the throttle opening angle and the engine revolution speed. When abnormality occurs in the signal from the throttle position sensor, the signal from the manifold absolute pressure sensor is set to the constant value. If both the throttle opening angle and engine speed exceed their set values, the fuel is cut.
Ignition system	When malfunction takes place in the ignition signal:	Fuel injection is cut in the cylinder whose ignition signal is faulty.
Coolant temperature sensor system	When malfunction takes place in the signal from the coolant temperature sensor:	The signal from the coolant temperature sensor is set to a constant value.
Throttle position sensor system	When abnormality takes place in the signal from the throttle position sensor:	The signal from the throttle position sensor is set to a constant value.
A/C evaporator temperature sensor signal system	When malfunction takes place in the signal from the A/C evaporator temperature sensor:	The air conditioner will be cut.
Atmospheric pressure sensor circuit malfunction	When the signals from the atmospheric pressure sensor are not outputted continuously over a certain length of time after starting.	The signal from the atmospheric pressure sensor is set to a constant value.
Knock sensor signal system	When abnormality takes place in the signal from the knock sensor:	The ignition timing is retarded.
Intake air temperature sensor signal system	When malfunction takes place in the signal from the intake air temperature sensor:	The signal from the intake air temperature sensor is set to a constant value.
ISC stepper motor signal system	When malfunction takes place in the detection signal for the ISC stepper motor:	ISC control is stopped. Fuel is cut.
Oil control valve system	When malfunction takes place in the control voltage for the oil control valve:	Oil control valve energizing control is prohibited.
Camshaft position sensor system	When malfunction takes place in the signal from the camshaft position sensor:	The signal from the camshaft position sensor is set to a constant value.
Rear O_2 sensor system (EU-specification vehicle only)	When abnormality takes place in the signal from the rear O_2 sensor:	The feedback control is changed to open control.
Immobilizer communication system (Immobilizer system-equipped vehicle only)	When abnormality takes place in the communicates with the immobilizer ECU, code reference failed due to malfunction in the computer internals.	Fuel injection and ignition are stopped.
Stepper motor type EGR valve system	When abnormalities take place in the EGR gas flow: When open or short circuit occurs in the wiring to the EGR stepper motor:	After the EGR valve is fully closed, control of energizing the EGR stepper motor is stopped.

3 COMPONENTS

3-1 ENGINE CONTROL COMPUTER

The engine control computer is mounted under the glove box on the front passenger seat side, providing fuel injection control, electronic spark advance control, variable valve timing control, idol speed control, evaporator purge control, etc. The engine control computer communicates with other ECU's, outputs the operation status of the engine through EFI ECU, and inputs the signal from ECU's, providing various controls such as idle-up, fuel cut, and ignition stop.

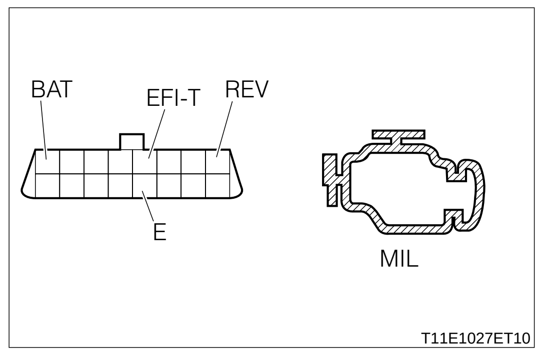


3-2 DLC

3-2-1 DESCRIPTION

The DLC is installed in front of the driver's seat (at the lower end of the instrument panel, on the driver's door side), providing the following checks.

(1) Indication of diagnosis
(2) Indication of O_2 sensor state



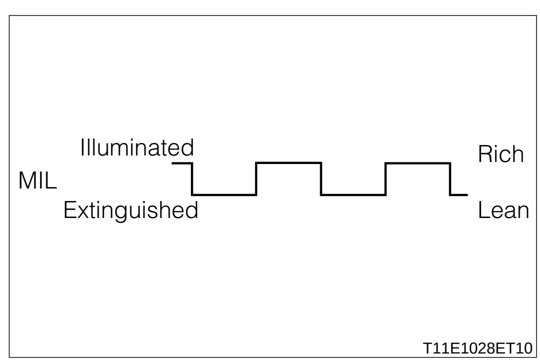
3-2-2 INDICATION OF DIAGNOSIS

When the terminal EFI T and E are shorted while the IG switch is ON, the engine check lamp inside the combination meter flashes to indicate the error code, starting with a smaller code. The error code is identified by the number of flashing, displayed repeatedly.

3-2-3 INDICATION OF O_2 SENSOR STATE

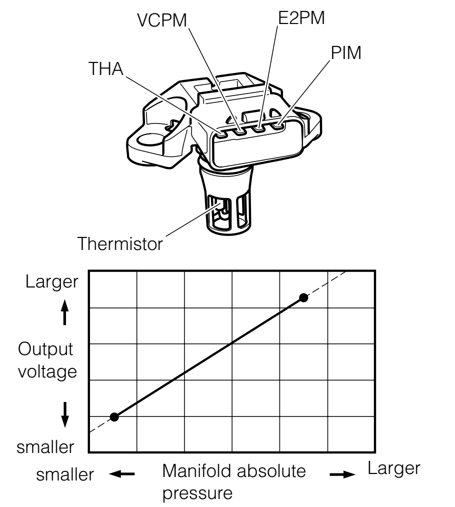
Short-circuit the terminal EFI T and E with the IG switch turned ON, maintain the engine speed above 2000rpm, and keep the brake pedal depressed. In this way, the output status of the O_2 sensor and feedback control can be checked by ON/OFF operations of the engine check lamp.
(No indication of the rear O_2 sensor state)

(1) Rich side: Lamp ON
(2) Lean side: Lamp OFF



3-3 MANIFOLD ABSOLUTE PRESSURE / INTAKE AIR TEMPERATURE INTEGRATED SENSOR

The sensor is an integral type where the manifold absolute pressure sensor and the intake air temperature sensor are integrated.
The sensor is mounted on the intake manifold to detect the manifold absolute pressure in the intake manifold and intake air temperature. The manifold absolute pressure outputs are sent to the PIM terminal, and intake air temperature outputs are sent to the THA terminal through the thermistor, whose resistance changes with temperature.



"Characteristics of manifold absolute pressure sensor"
T11E1029ET16

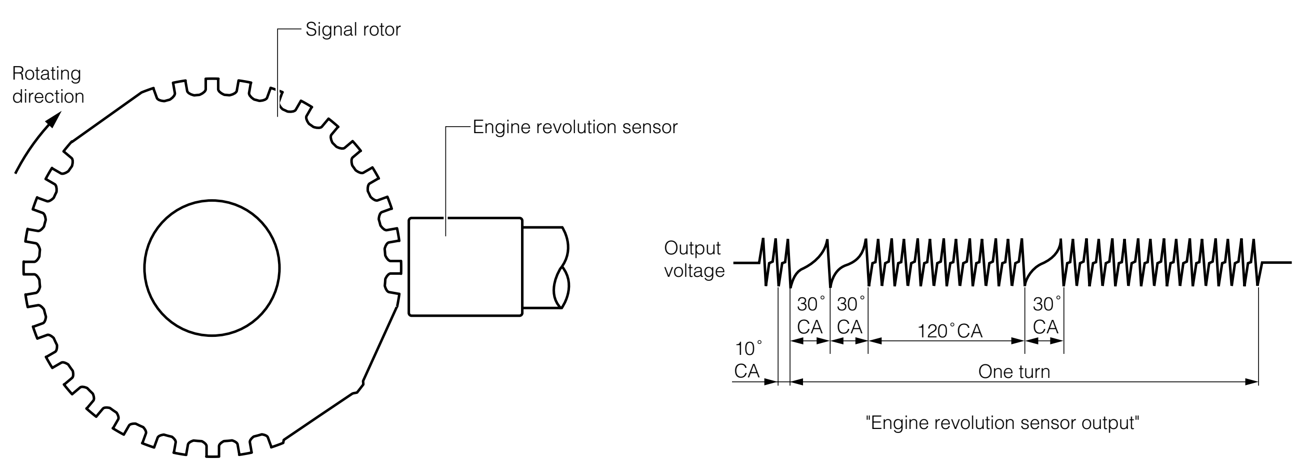
Characteristics of intake air temperature sensor

Temperature [℃]	−30	−20	20	80	120
Resistance [kΩ]	-28.6	16.2	2.45	0.322	-0.117

NOTE
- Figures inside parentheses show reference values.

3-4 ENGINE SPEED SENSOR, SIGNAL ROTOR

The signal rotor is installed at the front of the crankshaft in order to detect the crank angle. The signal rotor has a projection for which the engine speed sensor is installed.
As the crankshaft turns, the air gap changes between the engine revolution sensor and the projection provided on the signal rotor, causing changes in the magnetic flux to generate a pulse.
The engine speed is calculated based on the interval of the pulses generated by this projection.



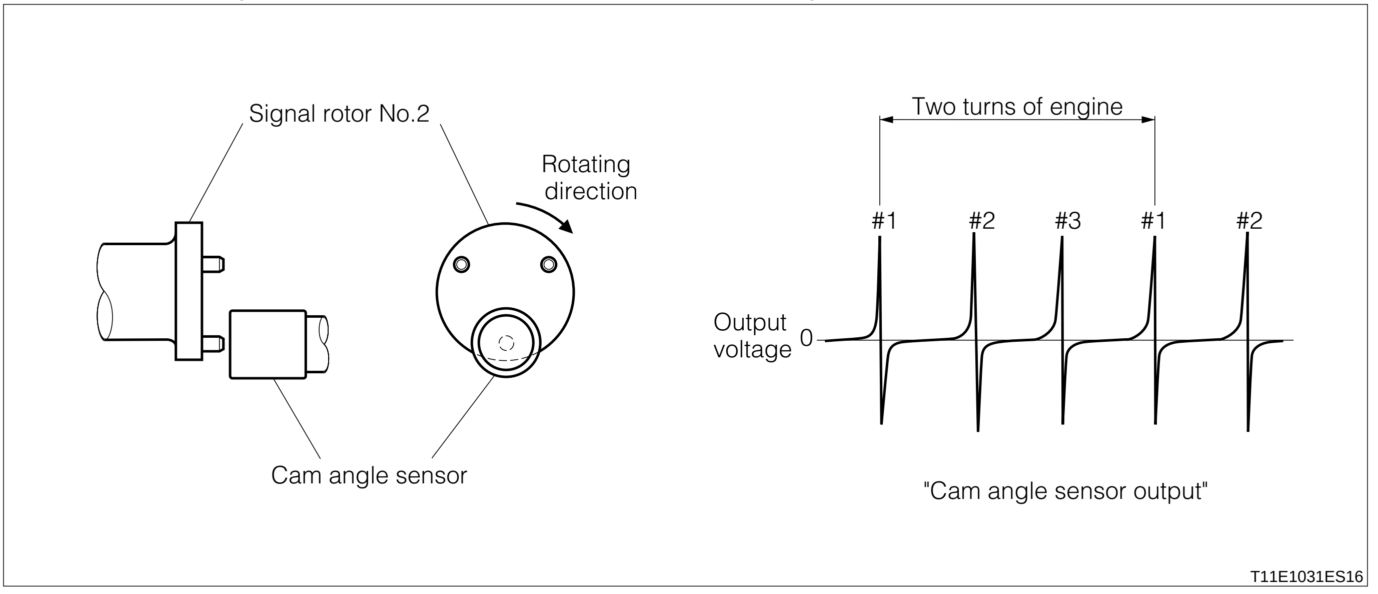
"Engine revolution sensor output"
T11E1030ES16

3-5 CAMSHAFT POSITION SENSOR AND SIGNAL ROTOR NO.2

A projection is provided at the rear of the No.1 camshaft to detect the phase of the No.1 camshaft and the crankshaft. The camshaft position sensor is mounted at the rear of the cylinder head.

When the No.1 camshaft makes a turn, the air gaps change between the camshaft position sensor and each of the three projections on the signal rotor No.2. As a result, the magnetic flux changes, and three pulses per turn are generated at the camshaft position sensor.

The phase of the No.1 camshaft and the crankshaft is detected by the signals from the camshaft position sensor and the engine speed sensor. The variable valve timing control is performed based on this phase.



3-6 COOLANT TEMPERATURE SENSOR

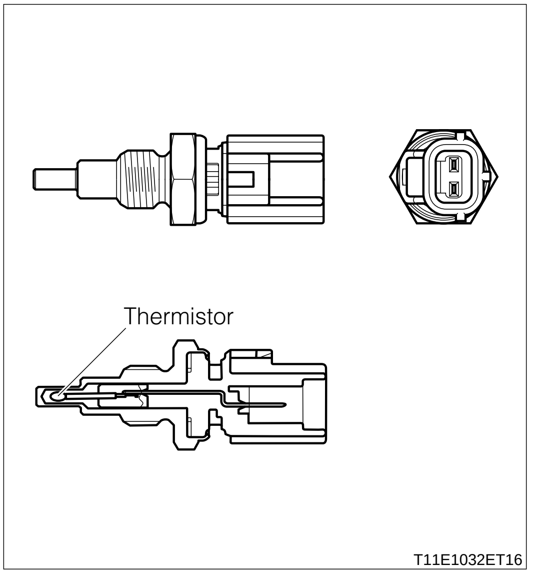
The coolant temperature sensor, mounted on the cylinder head, detects the coolant temperatures.

The sensor has a built-in thermistor, whose resistance changes with temperature. The input signals from the thermistor are sent to the engine control computer.

The coolant temperature gauge in the meter uses coolant temperature signals sent from the engine control computer through CAN communication.

Characteristics of coolant temperature sensor

Temperature [℃]	−20	20	80	110
Resistance [kΩ]	15.04	2.45	0.318	0.142

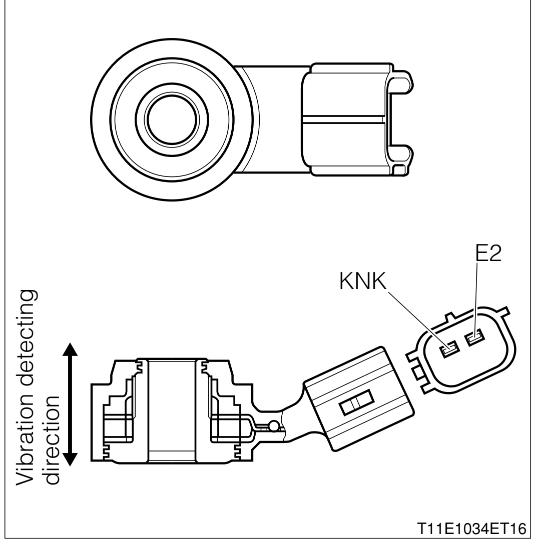


3-7 ATMOSPHERIC PRESSURE SENSOR (EU-SPECIFICATION VEHICLE ONLY)

The atmospheric sensor is incorporated in the engine control computer. This sensor senses the atmospheric pressure, which is used for compensation of the fuel injection amount, etc.

3-8 KNOCK SENSOR

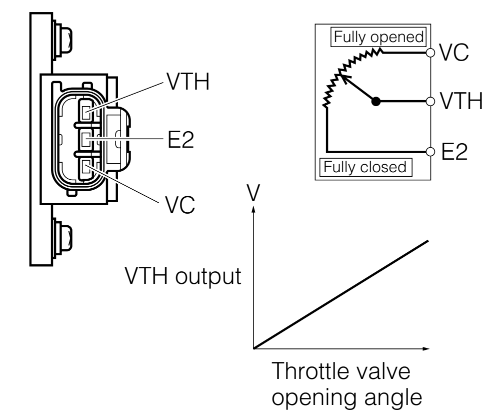
The knock sensor is mounted on the cylinder block and detects knocking indirectly from the vibration of the cylinder block that occurs by knocking.
A piezoelectric element, which is built into the sensor, converts vibrations of the cylinder block into electric signals.
The non-resonance type knock sensor is used to improve accuracy in knock detection.



T11E1034ET16

3-9 THROTTLE POSITION SENSOR

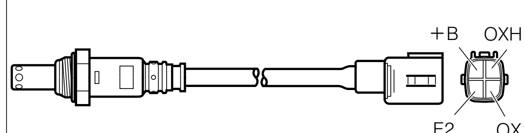
The sensor is installed to the throttle body and has a built-in potentiometer, which detects a throttle opening angle linearly.



L17E3132ET16

3-10 O_2 SENSOR

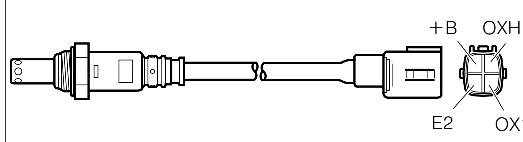
The sensor is installed to the exhaust manifold and detects the oxygen concentration in the exhaust emission by the amount of the electromotive force generated within the sensor. The lower the oxygen concentration, the greater the electromotive force gets, indicating that the air-to-fuel ratio is rich (rich condition).
Based on this voltage, the engine control computer judges whether the current air-to-fuel ratio is greater or smaller than the stoichiometric ratio.
The sensor begins operating at about 300˚C or more. In order to activate the sensor sooner, a heater circuit is provided. This helps improve accuracy of the air-to-fuel ratio feedback control, thus reducing the exhaust emission.



T11E1036ET10

3-11 REAR O_2 SENSOR (EU-SPECIFICATION VEHICLE ONLY)

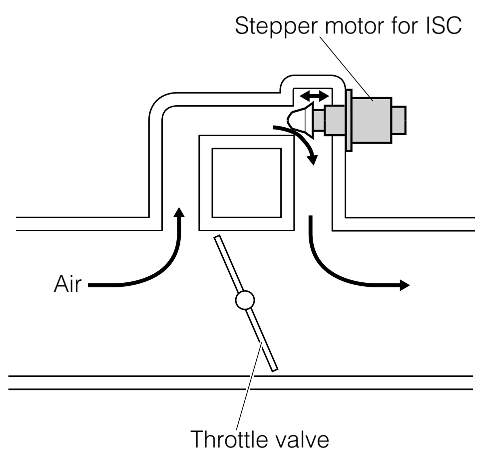
The sensor is installed to the exhaust front pipe. It detects the oxygen concentration in the exhaust emission after passing over the catalyst, by the amount of the electromotive force generated within the sensor. The lower the oxygen concentration, the greater the electromotive force gets.
Based on this voltage, the engine control computer judges whether the current air-to-fuel ratio is the target value or not, thus monitoring the oxygen sensor provided upstream.
The sensor begins operating at about 300˚C or more. In order to make the sensor operate more early, a heater circuit is provided.



T11E1036ET10

3-12 ISC STEPPER MOTOR

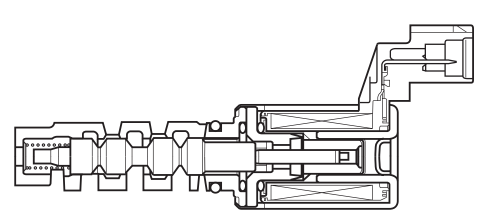
The engine control computer activates the stepper motor and controls the intake air during idling by changing the area of the pass way that bypasses the main passage, where the throttle valve is located.
The stepper motor is driven with 200 steps from the full-close to full-open position of the ISC valve, opening the valve in the reverse direction and closing in the forward direction.



L17E3138ET16

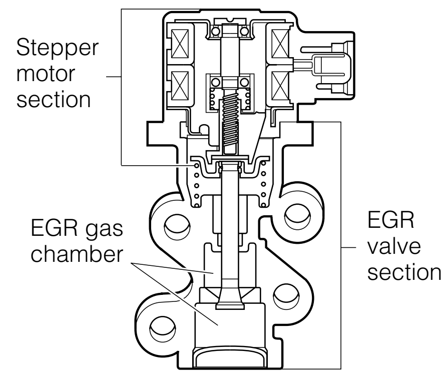
3-13 OIL CONTROL VALVE

The oil control valve turns ON and OFF according to the duty signal from the engine control computer so as to regulate the hydraulic pressure applied to the variable valve timing controller. This way, the opening/closing timing of the intake air valve can be controlled to the target timing.


T11E1045T16

3-14 EGR STEPPER MOTOR

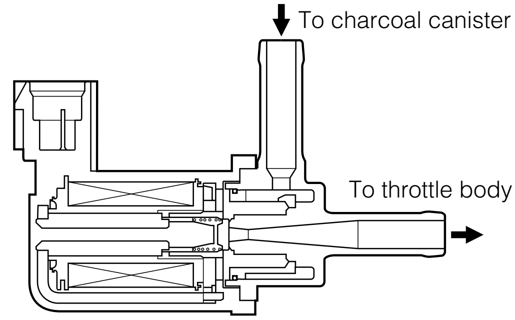
The EGR valve uses the stepper motor to regulate the opening angle of the EGR valve by means of the duty signal from the engine control computer, thereby controlling the amount of exhaust emission mixed with the intake air.



T11E1048ET16

3-15 VSV FOR EVAPORATOR PURGE CONTROL

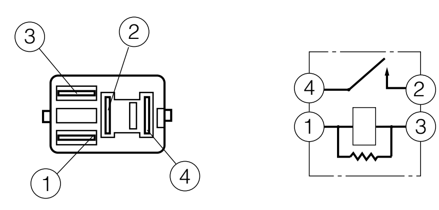
The amount of fuel evaporative emission that flows to the engine combustion chamber is controlled by the duty signal from the engine control computer.



T11E1054ET10

3-16 MAIN RELAY, FUEL PUMP RELAY, RADIATOR FAN RELAY

This is installed in the relay box of the engine compartment.
The main relay supplies power to the engine control computer when the IG switch is ON.
When the IG switch is ON, the fuel pump relay is activated by the signal from the engine control computer to supply power to the fuel pump.
When conditions to activate the radiator fan motor control are satisfied, the radiator fan relay is turned ON by the signal from the engine control compute to supply power to the radiator fan motor.



W11E3059T10

K3

1 OUTLINE

1-1 DESCRIPTION

1.The engine control system of the K3−VE type engine uses the engine control computer to totally control the electronic fuel injection system (EFI), electronic spark advance (ESA), variable valve timing control, and idol speed control (ISC).

2.The system conducts serial communication with the following ECU's.

(1) Airbag ECU

(2) Immobilizer ECU (Immobilizer system-equipped vehicle only)

3.The system conducts CAN communication with the following ECU's.

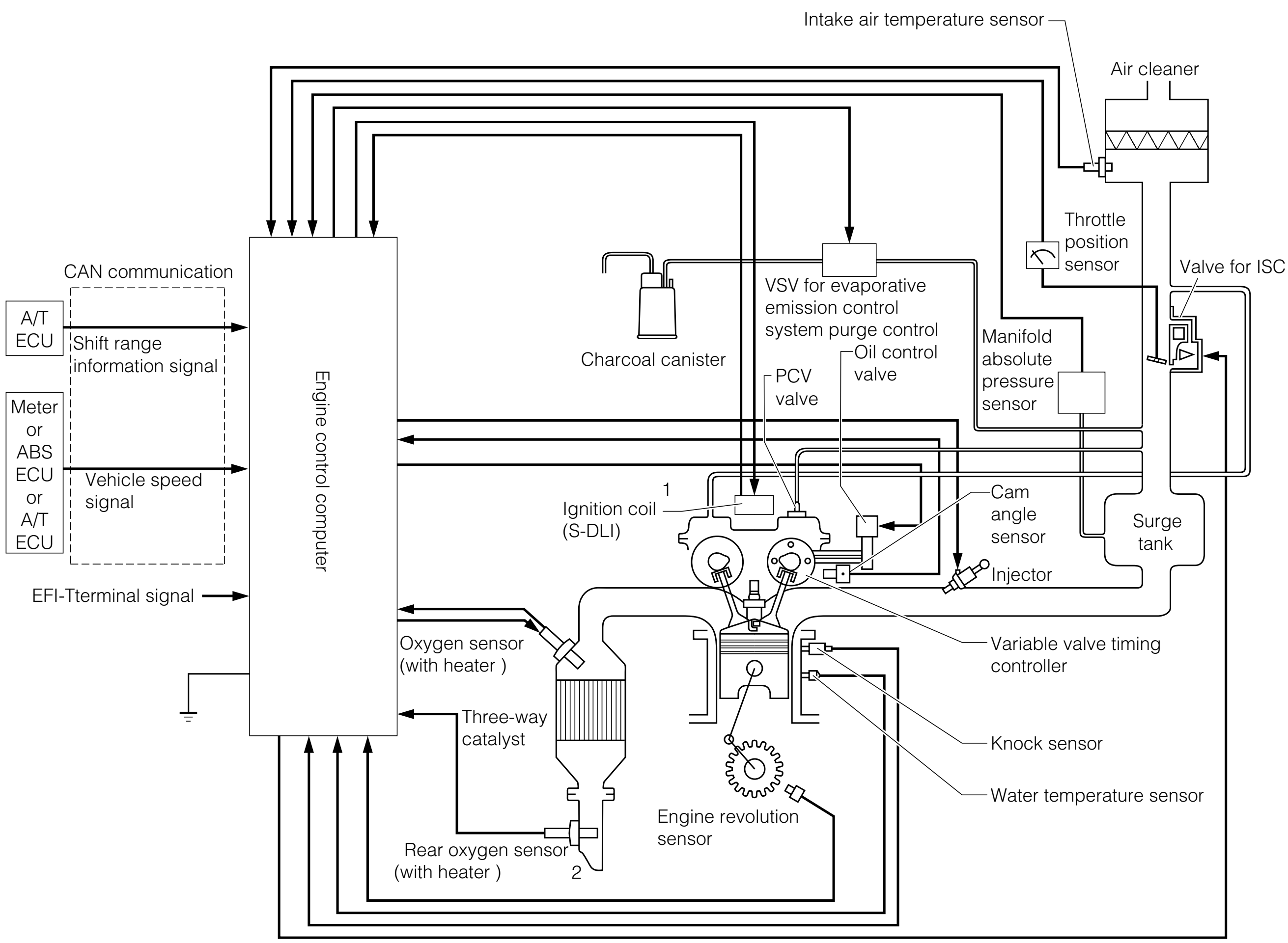
(1) Meter ECU

(2) A/T ECU (A/T vehicle only)

(3) ABS ECU (ABS-equipped vehicle only)

4.The diagnostic (self-diagnosis) function and fail safe function are provided in the event of failure.

1-2 SYSTEM DRAWING

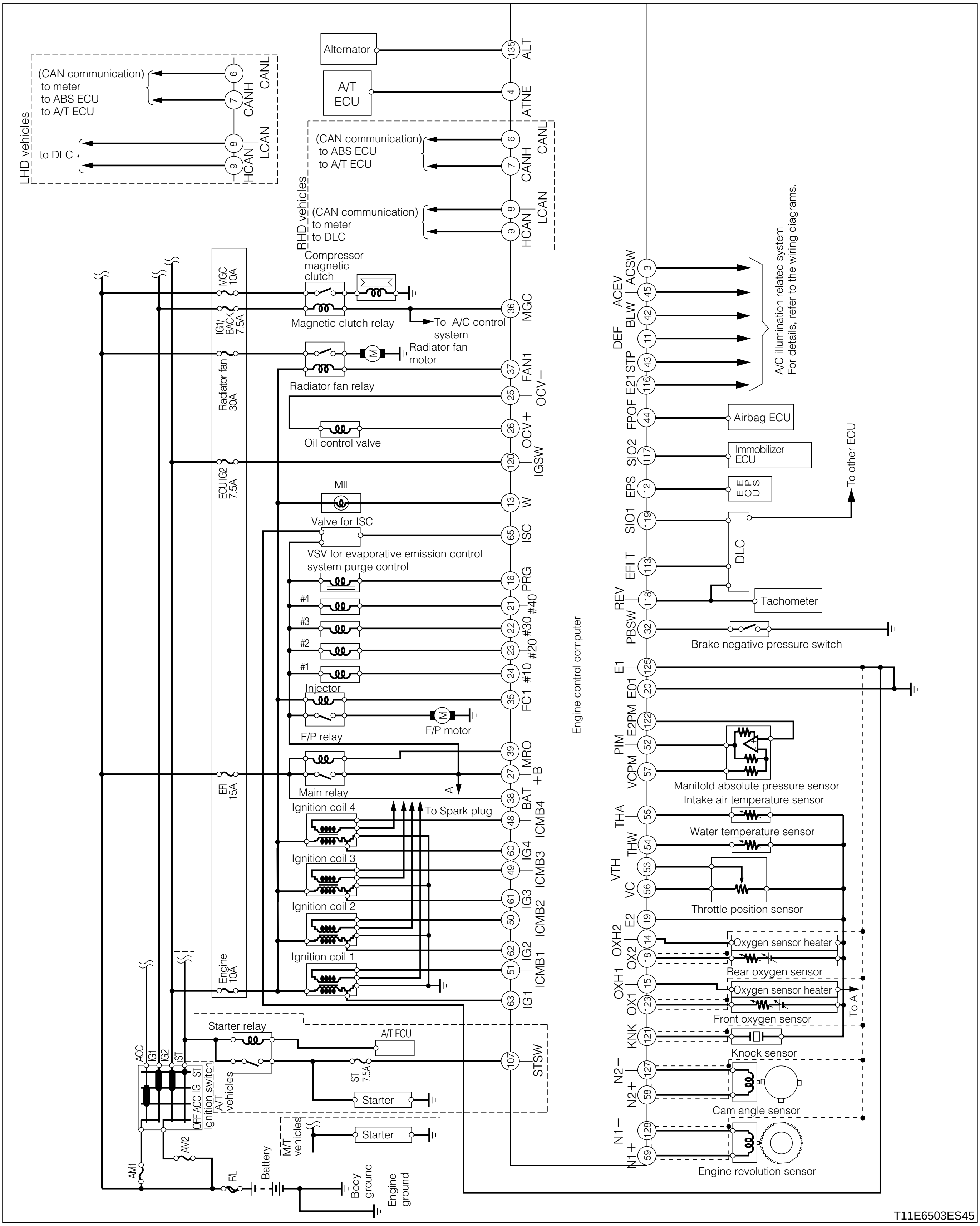


1: Ion current detection device built-in for only EU specifications

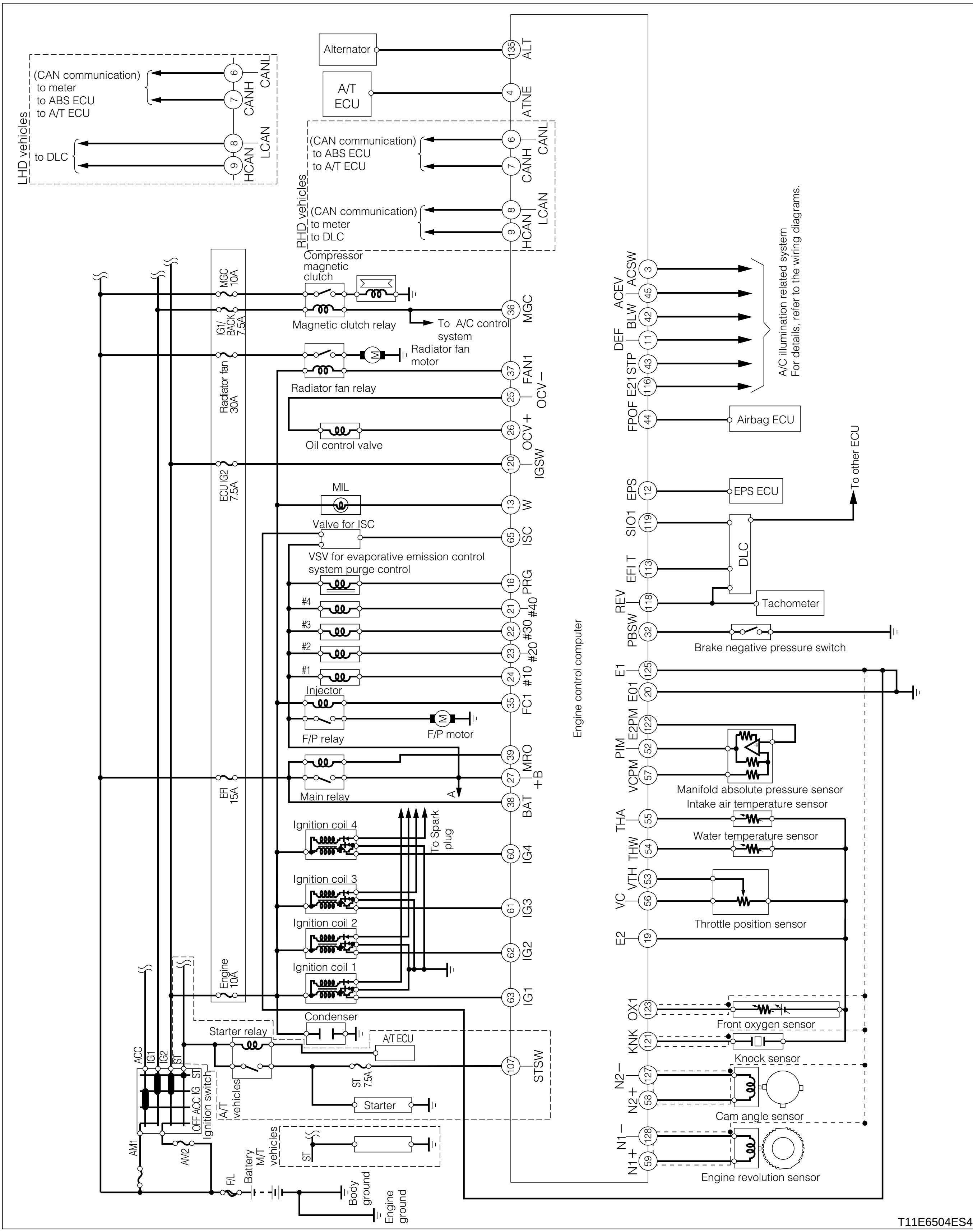
2: For only EU specifications

1-3 SYSTEM WIRING DIAGRAM

For EU Specifications

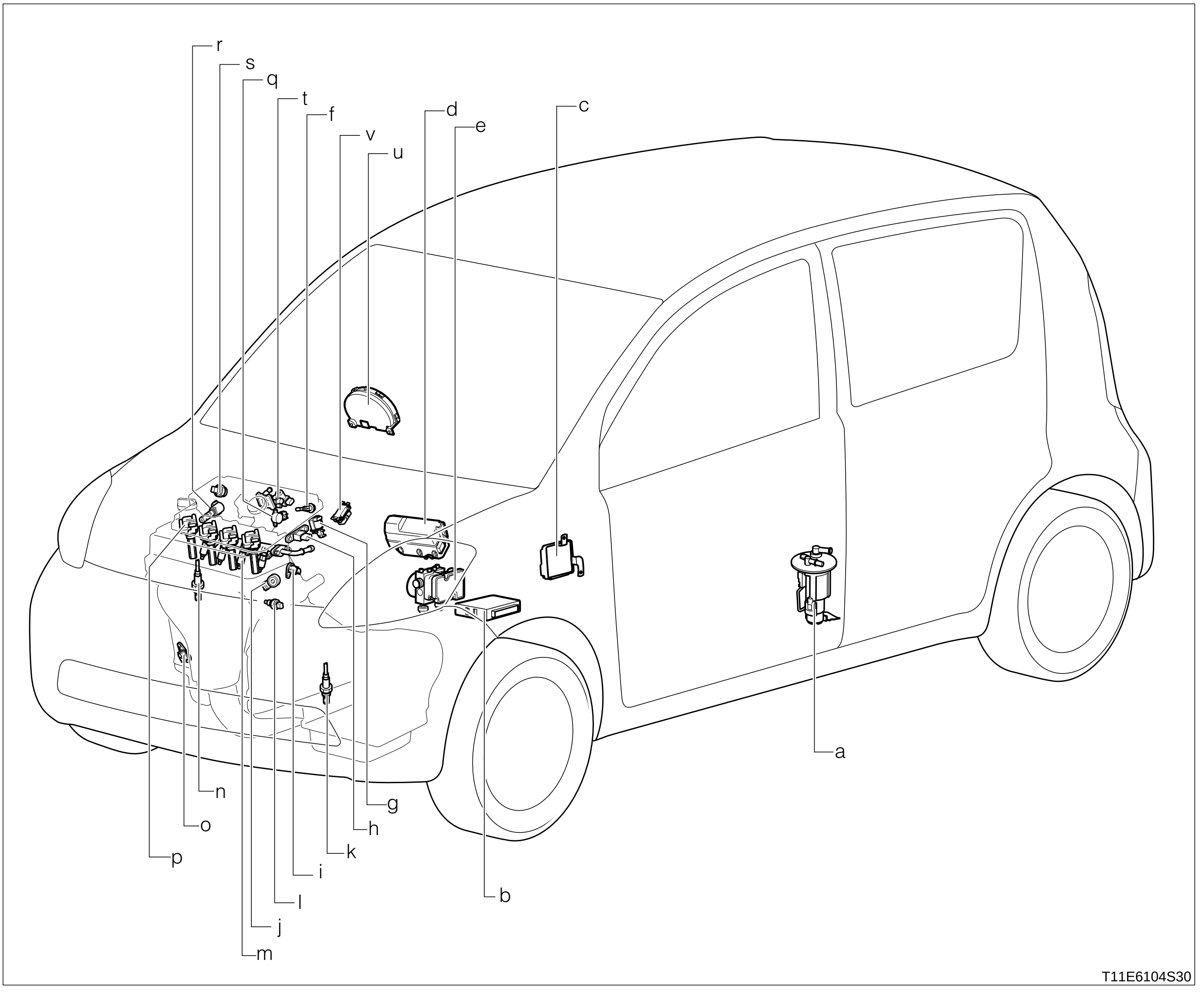


For general Specifications



T11E6504ES45

1-4 LOCATION OF COMPONENTS



	Part name
a	Fuel pump
b	Engine control computer
c	Transmission control computer (A/T vehicle only)
d	Relay block
e	ABS actuator (ABS-equipped vehicles)
f	Intake air temperature sensor
g	VSV for evaporative emission control system purge control
h	Manifold absolute pressure sensor
i	Camshaft position sensor
j	Knock sensor
k	Rear oxygen sensor (EU-specification vehicle only)
l	Water temperature sensor
m	Injector
n	Oxygen sensor
o	Engine revolution sensor
p	Ignition coil
q	Throttle position sensor
r	Oil control valve
s	Brake negative pressure switch (A/T vehicle only)
t	Valve for ISC
u	Combination meter
v	DLC

2 CONTROL

2-1 EFI SYSTEM

2-1-1 DESCRIPTION

The electronic fuel injection system detects the driving condition through sensor signals based on the amount of intake air calculated from the intake manifold pressure and engine revolution speed. It controls injection quantity (amount of time that the injector is energized) to ensure the proper air-fuel ratio for the driving condition.

The electronic fuel injection system employs an intermittent injection that is synchronized with the engine revolution speed, performing independent injection for each cylinder.

As the fuel injection method, there are synchronous injection and asynchronous injection. The synchronous injection is an injection that is synchronized with the engine revolution signal. On the other hand, the asynchronous injection is an independent injection that is not synchronized with the engine revolution signal. This asynchronous injection takes place, for example, at the time of rapid acceleration.

Also, to protect the engine and catalyst, fuel cutting is performed according to the driving condition.

2-1-2 INJECTION SYSTEM

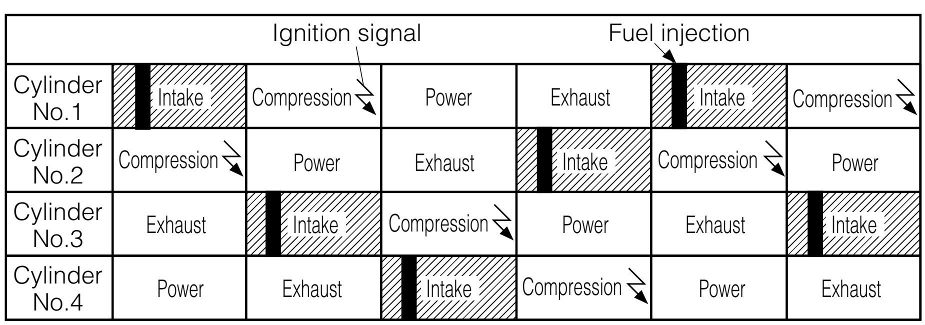
(1) Synchronous injection

The synchronous injection is an injection that is synchronized with the engine revolution signal. There are two methods for synchronous injection: One is the injection during starting period; and the other is the injection after starting period.

The judgment as to whether it is the starting period or after starting period is carried out, based on the engine revolution speed.

① Injection during starting period

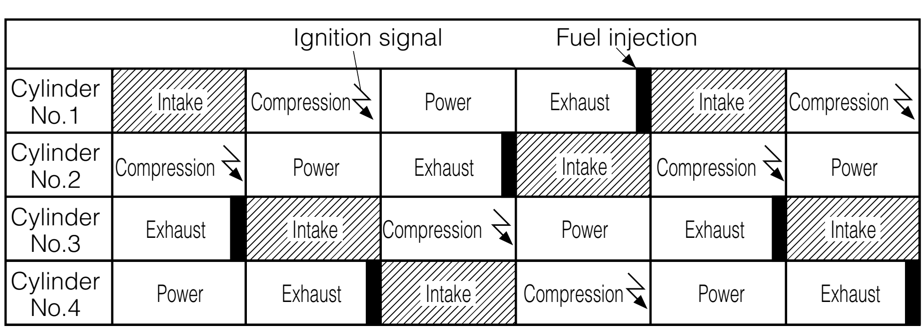
A cylinder is identified based on the signal (cylinder identification signal) from the engine speed sensor. After the cylinder is identified, independent injection is performed in each cylinder in accordance with the information obtained from the sensor.



T11E1104ES10

② Injection after starting period

Independent injection is performed, respectively, for each cylinder, based on the cylinder information by the revolution signal (N signal)



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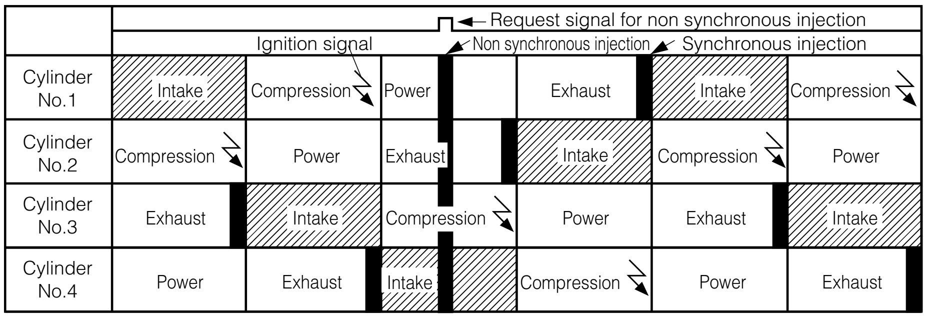
(2) Asynchronous injection

Injection is performed immediately when conditions are satisfied. The injection of this type occurs without synchronizing with the engine revolution signal.



T11E1106ES10

2-1-3 DETERMINATION OF INJECTION AMOUNT (INJECTION TIME DURING SYNCHRONOUS INJECTION)

(1) Injection time during starting period

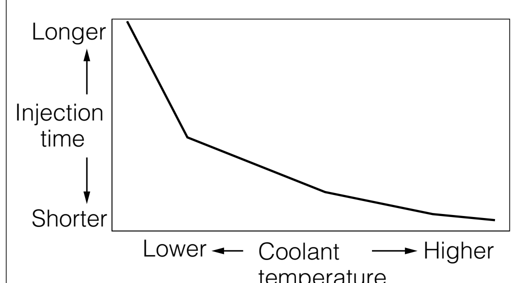
The injection time is determined by the basic injection time during starting period, which is determined by coolant temperatures, various compensation coefficients, and invalid injection time.

Injection time during starting period = Basic injection time during starting period × Various compensation coefficients + Invalid injection time

When the coolant temperature is below the set value, injection is performed into several injections.

① Basic injection time during starting period

The basic injection time is determined by the coolant temperature. When the engine is in a cold period, gasoline adhered to the intake valves and inner walls of the intake ports becomes difficult to evaporate. Therefore, the injection amount during cold period has been set to a greater value.



L11E3260ET10

② Coefficient of compensation for revolution speed during starting period

When the coolant temperature is low, compensation suited for the engine speed is performed so that startability may be improved.

③ Coefficient of compensation for atmospheric pressure during starting period

Compensation suited for the atmospheric pressure is provided to improve startability.

④ Coefficient of compensation for the number of injections during starting period

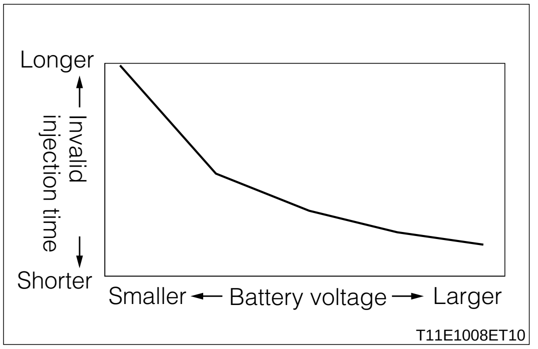
The number of injections during starting period is counted so that the injection time can be properly reduced based on the number of injections.

⑤ Coefficient of intake air temperature compensation

This coefficient is used to rectify the difference in the air density, which is caused by the difference in intake air temperatures.

⑥ **Invalid injection time**

The injector valve does not open at the moment of energizing and requires some time period for injection to start. This time period is referred to as invalid injection time. Invalid injection time will vary with the battery voltage, with a higher battery voltage resulting in a shorter invalid time, while a lower battery voltage resulting in a longer invalid time. For this reason, the injector energizing time is calculated by adding the invalid injection time, which is based on the constantly measured battery voltage, to the actual injection time.



(2) Injection time after starting period

The injection time is determined by the basic injection time after starting period, various compensations and invalid injection time.

Injection time after starting period = Various compensation time based on basic injection time after starting period + Invalid injection time

① **Basic injection time after starting period**

This is a time determined by the intake manifold pressure and engine revolution speed.

② **Coefficient of intake air temperature compensation**

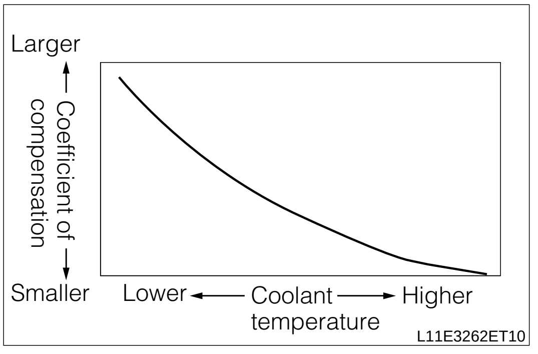
This coefficient rectifies the difference in the air density, caused by the difference in intake air temperatures.

③ **Compensation coefficient during resuming period after fuel cut**

The injection amount is reduced according to the reduced number of rotations during resuming period after fuel cut in order to improve drivability.

④ **Coefficient of compensation for increase of engine warming-up**

This is an increase compensation for the engine cold period determined by the coolant temperature. This compensation is carried out, until the warming-up is completed.



⑤ **Coefficient of increase compensation after starting period**

In order to achieve the stabilization of engine revolution speed immediately after the engine has started, the initial value for the coefficient of increase is determined according to the coolant temperature during the engine starting period. Then, the value is reduced at every time when the injection takes place after the engine starting.

⑥ **Time of compensation for air-to-fuel ratio during transient time**

This is for the compensation of the air-to-fuel ratio during transient time. This time is determined based on the coolant temperature, etc.

⑦ **Coefficient of air-to-fuel ratio feedback compensation**

Rich or lean condition in the air-fuel mixture is detected by the signal from the O_2 sensor and the rear O_2 sensor* during the engine running after warm-up. The injection quantity is adjusted accordingly so that the air-fuel ratio is controlled in the narrow range near the theoretical air-fuel ratio where the three-way catalyst exhibits high performance.

NOTE

- *: Rear O_2 sensor is for the EU-specification vehicle only.

⑧ **Coefficient of power increase compensation**

During a high load driving, the amount of injection is increased according to the intake manifold pressure and engine revolution speed.

⑨ **Coefficient of compensation for increase after re-starting**

The initial value is determined according to the coolant temperature at time of re-starting. The injection amount is reduced for each injection.

⑩ **Coefficient of atmospheric pressure compensation**

Compensation according to the atmospheric pressure is performed.

⑪ **Idling stabilization compensation advance**

During idling, the injection amount is compensated based on the engine revolution signal to stabilizing the revolution speed.

⑫ **Water temperature compensation advance**

During a high load, high revolution driving, the advance value is compensated according to the coolant temperature.

⑬ **Coefficient of low-rotation compensation**

The injection amount is increased during low-rotation period.

⑭ **Compensation coefficient during knock feedback**

Injection quantity is increased when the ignition timing is too retarded during knock feedback.

⑮ **Invalid injection time**

(See the section of the invalid injection time of the injection time during starting period.)

2-1-4 DETERMINATION OF INJECTION AMOUNT (INJECTION TIME DURING ASYNCHRONOUS INJECTION)

(1) Asynchronous injection during change in idle switch

When the throttle valve is changed from the closed state (idling condition) to the opened state, injection occurs once for all cylinders simultaneously for a certain length of time.

(2) Asynchronous injection during change in intake manifold pressure

Injection occurs once for all cylinders simultaneously for a certain length of time according to the increase ratio of the intake manifold pressure.

(3) Asynchronous injection during resuming period after fuel cutting

If the engine revolution speed drops drastically during the resuming period after fuel cutting, injection occurs for a certain length of time.

(4) Asynchronous injection when the air-conditioner is ON

When the air-conditioner is switched from OFF"→"ON"

(5) Asynchronous injection when the power steering is "ON".

When a request signal is sent from EPS ECU during steering wheel operation, injection occurs for a certain length of time.

2-1-5 FUEL CUTTING

(1) Fuel cutting during deceleration

When the engine revolution speed exceeds the specified value and the throttle valve is closed, fuel cut occurs.

(2) Fuel cutting during catalyst overheated period

Fuel is cut off according to the engine revolution speed and the intake manifold pressure, thus preventing the catalyst from overheating.

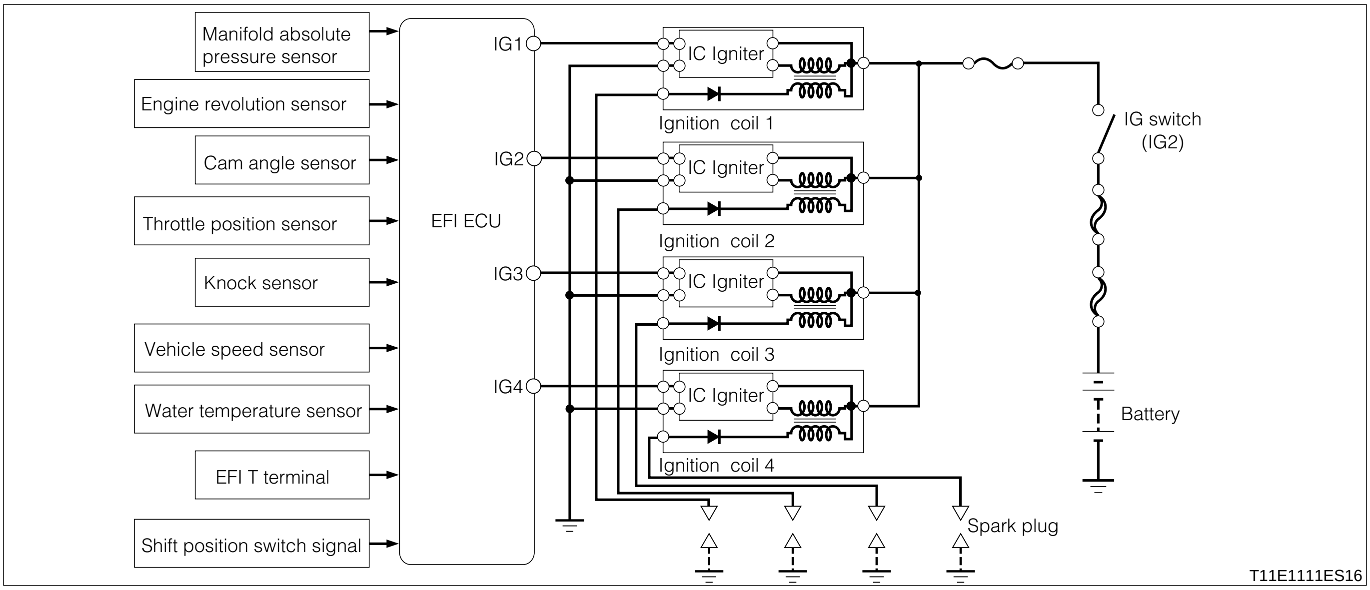
(3) Fuel cutting at high engine revolution speed

When the engine revolution speed exceeds the specified value, fuel cut occurs.

2-2 ELECTRONIC SPARK ADVANCE SYSTEM

2-2-1 DESCRIPTION

ESA (electronic spark advance system) uses the engine control computer to calculate and control the optimal ignition timing according to the engine conditions after the cylinder has been identified by the engine speed sensor signal.
In addition, the ion current combustion control system detects the ion current in the combustion chamber and controls ignition timing for optimal combustion.
The electronic spark advance system can be classified into two modes: One is a fixed spark advance synchronized with the engine revolution signal, and the other is a calculation spark advance determined by the engine revolution speed and intake manifold pressure.



2-2-2 DETERMINATION OF IGNITION TIMING

(1) Fixed advance

BTDC6° fixed spark advance synchronized with the engine revolution signal occurs during start-up or short circuit condition at the EFI-T terminal.

(2) Calculation advance

Under conditions other than the fixed advance, the ignition timing is determined by engine conditions, such as the intake manifold pressure and engine revolution speed.
Ignition timing advance = Basic advance ± Various compensation advances

① **Basic advance**

This is the ignition timing determined by the engine revolution speed and intake manifold pressure.

② **Water temperature compensation advance**

The advance value is compensated according to the coolant temperature.

③ **Idling stabilization compensation advance**

In cases where the idling speed drops during the idling period, the timing is advanced. Conversely, in cases where the idling speed rises, the timing is retarded.

④ **Transient compensation advance**

The advance value is compensated in accordance with sharp fluctuations of the intake manifold pressure during running.

⑤ **Torque reduction compensation advance (A/T vehicles only)**

In order to reduce shifting shocks, the ignition timing is retarded so as to reduce the engine torque when sharp acceleration is made from a low speed or when a shift is made from Ⓟ or Ⓝ range to other ranges.

⑥ **Control of energizing time**

The energizing time of the ignition coil is controlled in accordance with the engine revolution speed and power supply voltage to the ignition coil.

⑦ **Knock compensation advance**

When knocking is detected by the output signal of the knock sensor, ignition timing will retard immediately. When knocking does not occur for a given length of time, ignition timing will be advanced gradually until knocking occurs again. In this way the optimal ignition timing can be maintained at all times. Compensation value is limited to prevent adverse influence to the engine.

⑧ **Acceleration surging compensation advance**

The ignition timing advance is compensated when the intake manifold pressure changes beyond a set amount during acceleration at a low speed after the engine has warmed up.

⑨ **Inner EGR compensation advance**

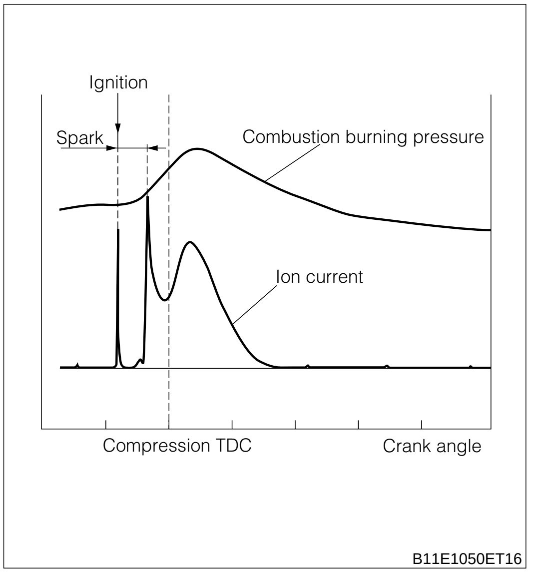
The ignition timing advance is compensated according to the variable valve timing..

2-2-3 ION CURRENT COMBUSTION CONTROL SYSTEM

(1) DESCRIPTION

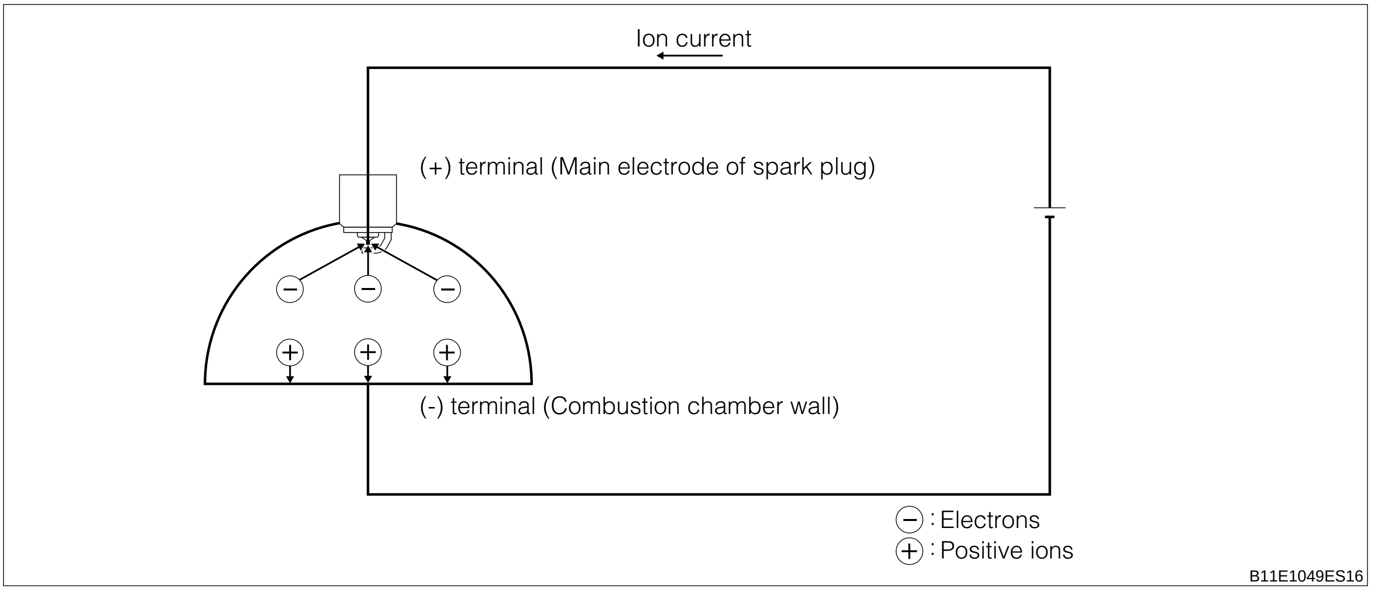
The engine control computer uses the spark plug to detect ion current generated during combustion burning, thereby detecting combustion burning condition in the cylinder.

This allows detection of misfire and combustion limit, thus controlling ignition timing for optimal combustion.



(2) Principle

1. Positive ions and electrons are generated in the flame during combustion.
2. When the charge voltage on the primary side of the ignition coil is applied to the main electrode of the spark plug after the arc discharge ignition, ion current will be produced in the flame.
3. The detected ion current, as being a minute output, is subject to noise. Therefore, ion current waveform is converted into a rectangular wave in the ion current detection circuit, which is built into the ignition coil, and the signal is sent to the engine control computer to determine combustion and misfire.
4. Ion current is not created when engine misfire occurs. Therefore, when the input voltage of the engine control computer falls below the standard value, it determines that misfire has occurred.

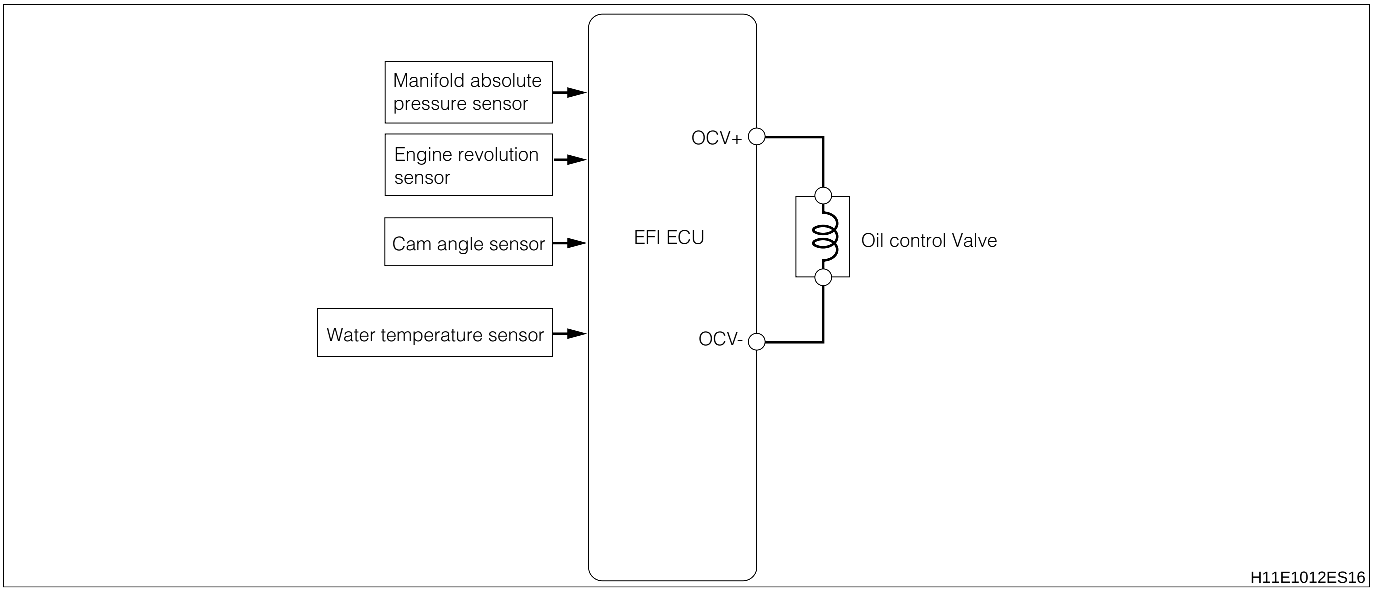


2-3 DYNAMIC VARIABLE VALVE TIMING CONTROL

2-3-1 DESCRIPTION

The engine control computer turns ON and OFF the oil control valve according to the signals from the manifold absolute pressure sensor, coolant temperature sensor and engine revolution speed so as to regulate the hydraulic pressure applied to the variable valve timing controller. This way, the opening/closing timing of the intake air valve can be controlled to the target timing. The opening/closing timing of the intake air valve is detected by the camshaft position sensor. Any deviation, when encountered, will be corrected.

The valve timing is controlled by the engine control computer in three control modes.



(1) Forced most-retarded angle mode

This is the mode that forces the No. 1 camshaft to rotate till maximum retard in the intake valve open/close timing . This mode is used to regulate the oil control valve when starting and when battery voltage falls below the set value.

(2) 0˚retention mode

The retention mode is used, when a target displacement is 0˚. (Refer to the following section on feedback mode for the target displacement angle.)

(3) Feedback mode

① Determination of target displacement angle

The target displacement angle is determined according to the throttle valve opening degree, intake manifold pressure, atmospheric pressure, engine revolution speed, and coolant temperature.

② Determination of oil control valve driving duty ratio

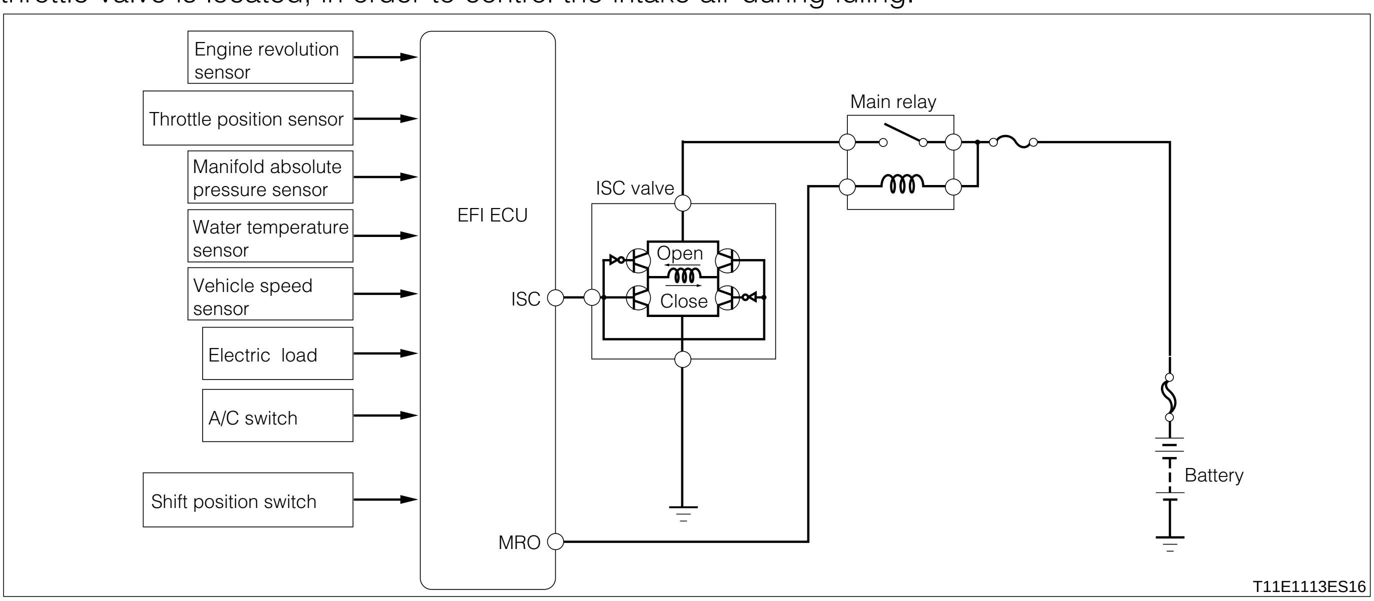
The duty ratio is determined based on the signal from the target displacement angle and camshaft position sensor according to the engine revolution speed and coolant temperatures.

2-4 IDLE SPEED CONTROL SYSTEM (ISC)

2-4-1 DESCRIPTION

The idle speed control (ISC) controls the engine idle speed to prevent engine stall that occurs due to the load applied to the engine during idling.

The engine control computer controls the ON/OFF duty ratio for energizing the ISC valve by the signal sent from the sensors. In this way, it controls the pass way area that bypasses the main passage, where the throttle valve is located, in order to control the intake air during idling.



2-4-2 DETERMINATION OF DRIVING DUTY RATIO

The engine control computer determines the opening angle of the ISC valve by the signal from sensors and outputs the duty ratio according to that opening to the ISC valve.

(1) Water temperature compensation amount

During the period from the engine starting through the end of warming-up, the duty ratio is compensated according to the coolant temperature.

(2) Compensation amount during starting period

During the engine starting period and for several seconds after the starting, the duty ratio is increased to increase intake air in order to improve the engine start ability.

(3) Compensation amount for feedback

The duty ratio changes according to the difference between the idle speed and the target revolution speed to achieve the target revolution speed.

(4) External load compensation amount

1. When changes occur in the air conditioner load, shift range load (A/T vehicle only), electric load, radiator fan load and so forth, the opening angle of the ISC valve changes according to respective loads, thereby controlling the engine revolution speed.
2. The engine revolution speed is controlled by the power steering load (when the steering wheel is operated with the vehicle in a stationary state) during idling period.

(5) Compensation amount by engine revolution load

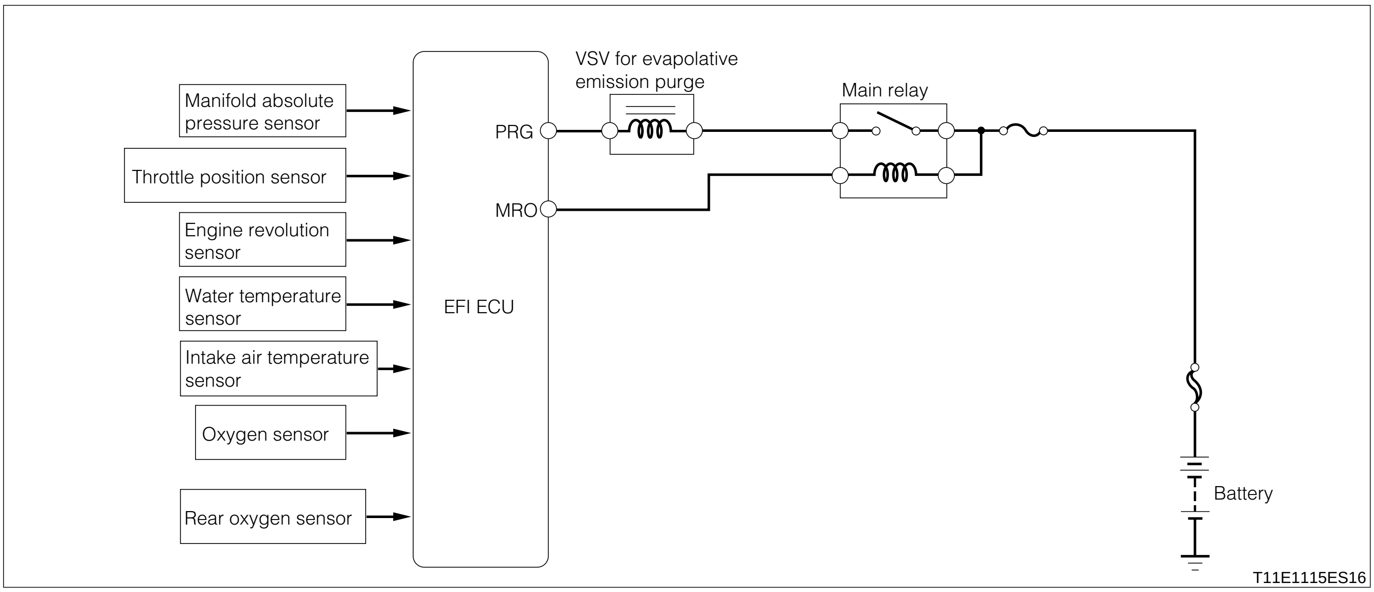
The duty ratio rises once, and then gradually drops, in order to obtain better converge into the target revolution speed when the engine revolution speed drops.

2-5 VSV CONTROL FOR EVAPORATOR PURGE

2-5-1 DESCRIPTION

When all of the following conditions are satisfied, the engine control computer turns ON the VSV for evaporative emission purge (duty control), thus purging the fuel evaporative emissions to the combustion chamber.

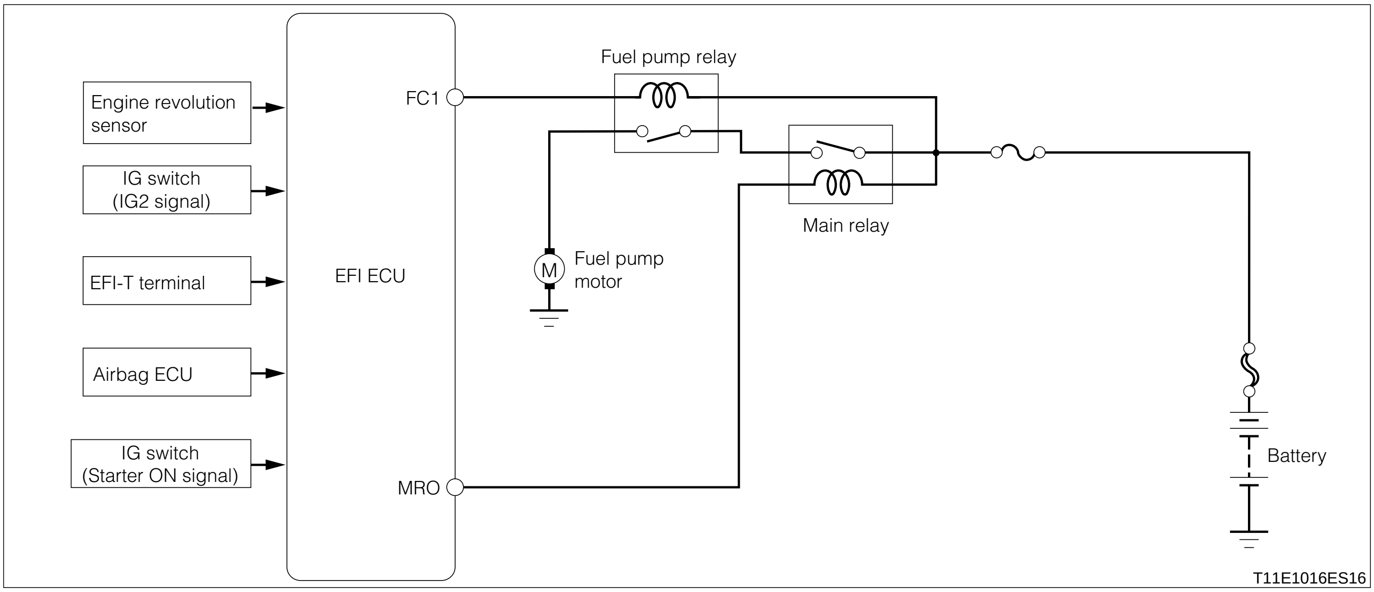
1. After engine has warmed up
2. During the air-to-fuel ratio feedback
3. When the accelerator pedal is depressed:
4. When the engine control computer is not in a learning mode:



2-6 FUEL PUMP CONTROL

When any of the following 4 conditions is satisfied, and no fuel pump stop signal is sent from the airbag ECU, the engine control computer will turn ON the fuel pump relay to activate the fuel pump.

1. For two seconds after the IG switch ON (with the terminal EFI-T turned OFF):
2. For eight seconds after the IG switch ON (with the terminal EFI-T turned ON):
3. After identifying the cylinder and for two seconds after the revolution signal is inputted (The pump is continued to be driven when the engine revolution speed is more than 20 rpm.):
4. Three seconds after starter is switched from OFF → ON



2-7 AIR CONDITIONER CUT CONTROL

2-7-1 DESCRIPTION

When the following conditions for the air conditioner cutting are satisfied, the engine control computer turns OFF the air conditioner relay and the compressor magnet clutch, thereby cutting the air conditioner.

(1) Air conditioner cut by coolant temperature

When the following conditions are satisfied, the air conditioner is cut.

1. When the coolant temperature becomes above the set value:

(2) Air conditioner cut in running area

When at least one of the following conditions is satisfied, the air conditioner is cut.

1. When the throttle valve opening degree and the manifold absolute pressure exceed the set value:
2. When the throttle valve opening degree exceeds the set value by the vehicle speed:

(3) Air conditioner cut when engine revolution speed drops (A/T vehicle only)

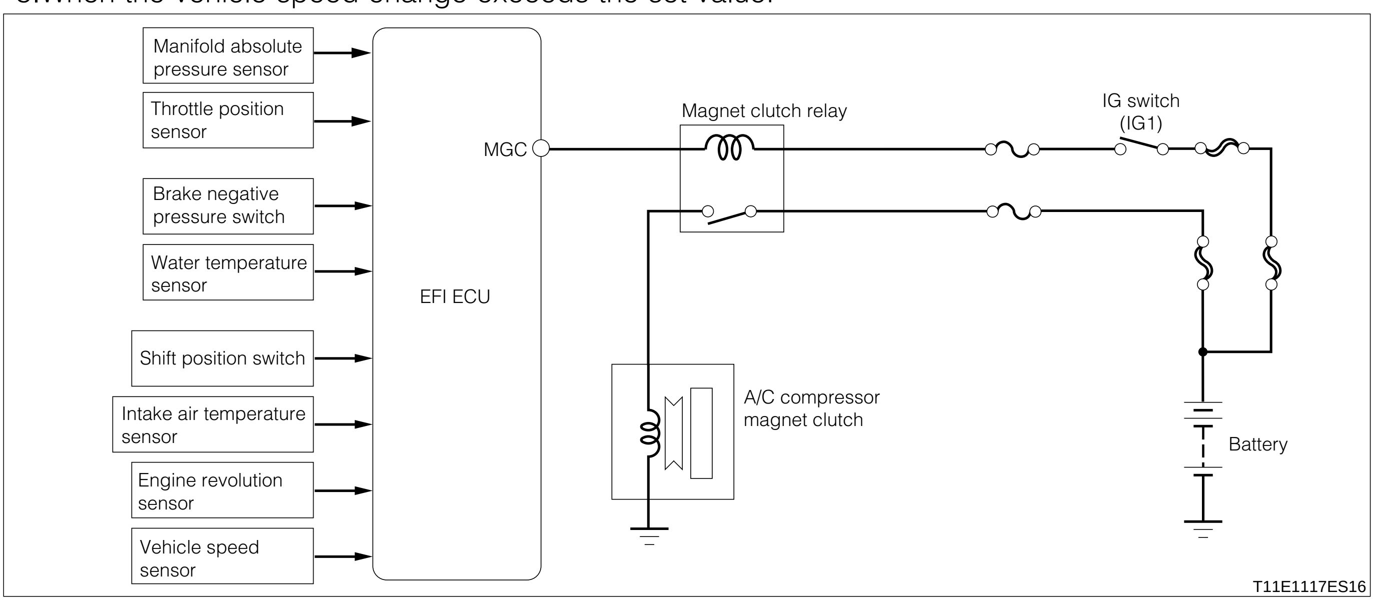
When all of the following conditions are satisfied, the air conditioner is cut.

1. When the engine revolution speed is the set value or less with the shift lever in a range other than P or N:
2. When the drop of the engine revolution speed exceeds the set value:

(4) Air conditioner cut during deceleration (A/T vehicle only)

When all of the following conditions are satisfied, the air conditioner is cut.

1. When the shift lever is in a range other than P, N:
2. When the idle switch is ON:
3. When the manifold absolute pressure due to engine revolution speed exceeds the set value:
4. When the vehicle speed is in the set range:
5. When the vehicle speed change exceeds the set value:



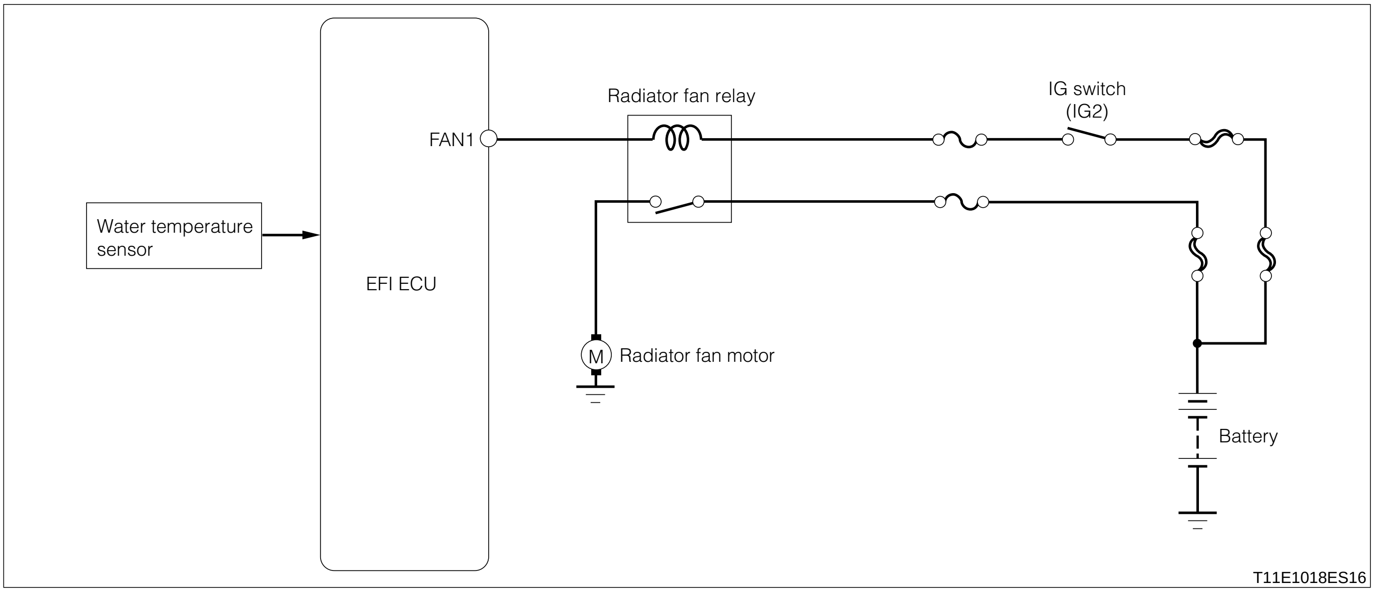
2-8 RADIATOR FAN MOTOR CONTROL

2-8-1 DESCRIPTION

When the preset condition is satisfied, the radiator fan relay is turned ON, and the radiator fan motor is operated. If not satisfied, the radiator fan relay is turned OFF.

NOTE

- When an abnormality occurs in the coolant temperature sensor system, the radiator fan motor rotates all the time by the fail-safe function.



2-9 AIR CONDITIONER IDLE-UP CONTROL

2-9-1 DESCRIPTION

When all of the following conditions are satisfied, the engine idle speed is increased.

1. When the air conditioner switch is ON:
2. When the blower switch is ON:
3. When the air conditioner cutting control is not performed:
4. When the air conditioner evaporator temperature exceeds the set value:

2-10 MAGNET CLUTCH CONTROL

2-10-1 DESCRIPTION

When all of the following conditions are satisfied, the magnet clutch is turned ON.

1. When the air conditioner idle-up control is performed:
2. When the engine revolution speed exceeds a certain value:

2-11 ALTERNATOR CONTROL

2-11-1 DESCRIPTION

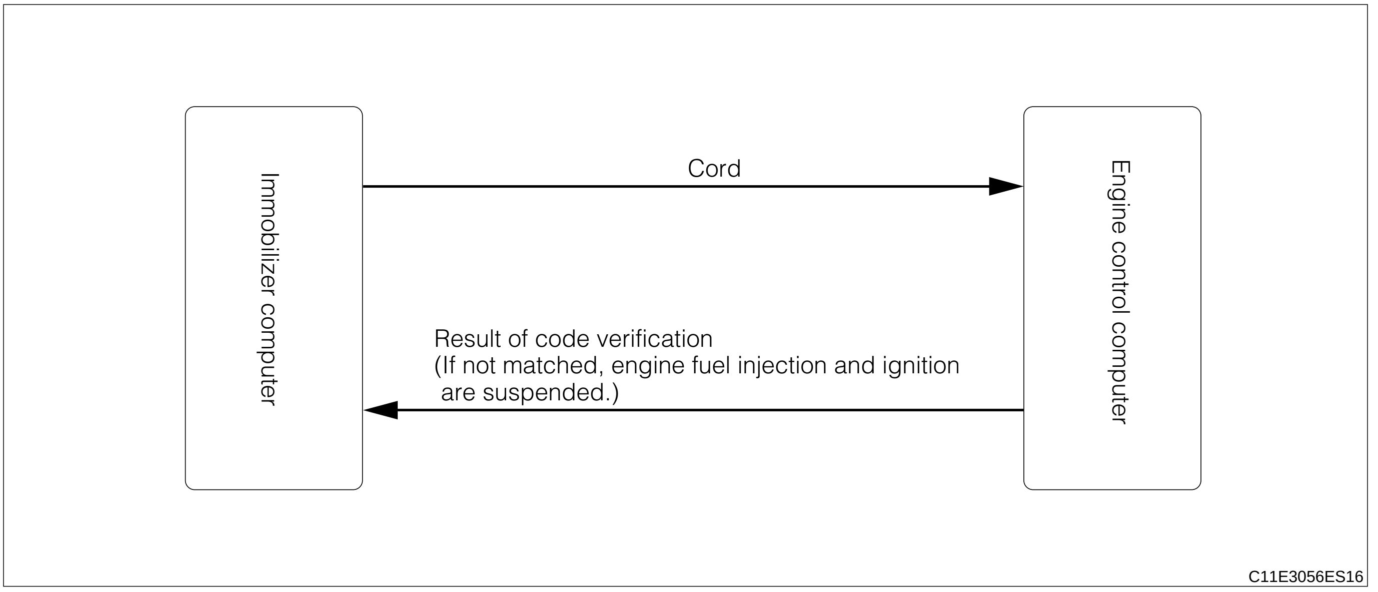
When the preset condition is satisfied, the alternator stops charging.

2-12 AIRBAG ECU COMMUNICATION

When the signal from the airbag ECU is received in the event of a collision, etc., the fuel pump relay is turned OFF, thus stopping the fuel pump.

2-13 IMMOBILIZER SYSTEM COMMUNICATION (IMMOBILIZER SYSTEM-EQUIPPED VEHICLE ONLY)

The engine control computer communicates with the immobilizer ECU for code verification. If the code does not match, fuel injection and ignition are stopped to prevent the engine from starting.



2-14 CAN COMMUNICATION

The engine control computer conducts CAN communication with the meter ECU, A/T ECU (A/T vehicle only) and ABS ECU (ABS-equipped vehicle only). Multiple pieces of information and data are sent and received through a pair of communication wires (twisted pair wiring).

Refer to the section "CAN communication system" for the details of CAN communication.

Refer to Page L2-1.

2-15 DIAGNOSIS (SELF-DIAGNOSIS) FUNCTION

2-15-1 OUTLINE

(1) DESCRIPTION

In the diagnosis system, a computer memorizes any system which encounters abnormality in its output/input signal systems, and inform the driver of the abnormality by flashing or illuminating the malfunction indicator lamp (MIL, warning lamp) while the engine is running.
Since the memory of the diagnosis content is performed directly by the battery, the diagnosis content is memorized even if the IG switch is turned ACC or LOCK. For detailed information about the assignment of the diagnosis trouble code (DTC), the checking and erasing procedures for the DTC, refer to the EF section of the service manuals. The following shows the DTC the table showing failsafe functions, although these information is posted in the EF section of the service manuals.

(2) Instructions on use of this technical information book

This technical information book covers both the area where type certification is conducted based on the EC exhaust emission approval procedures, and other areas. However, the assignment of the diagnosis trouble codes and their reading are different between these two areas. Hence, observe the following instructions.

1. Use of DS-21 diagnosis tester or OBD II generic scan tool:
   (1) Areas where type certification are performed based on EC exhaust emission approval procedures: Use the 4-digit code (example, P0105) which is assigned according to the ISO standards.
   (2) You can use the 4-digit codes by using the DS-21 diagnosis tester or OBD II generic scan tool. Or you can also use two-digit codes (example, 31) without using such tester or tool. You can employ whichever convenient method.
2. The OBD II generic scan tool refers to a scan tool which complies with the ISO 14230 (KWP2000) format.
3. When the OBD II generic scan tool is used, all trouble codes (4-digit codes) can not be read out. It should be remembered that only trouble codes which have a zero after P, like P0XXX, can be read out.
4. The 2-digit codes are slightly inferior to the 4-digit codes in identifying the trouble sections.
5. The area where type certification is performed based on EC exhaust emission approval procedures is hereinafter referred to as the EU area.

2-15-2 FAIL-SAFE FUNCTION

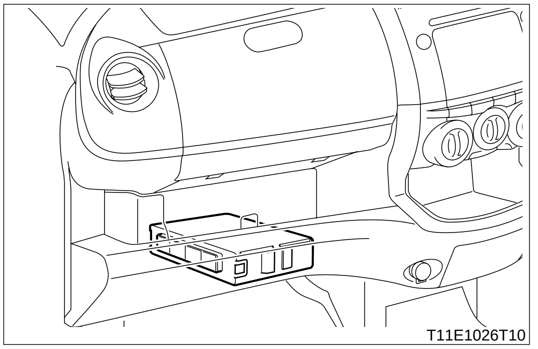
When abnormality takes place in the signal from sensors, or malfunctions take place in the control of the oil control valve for the variable valve timing, conditions such as engine failure, catalyst overheating may result, if the control is continued as it is. To prevent this, the fail-safe function uses the values stored in the computer in order to control operations.
When the malfunction is remedied to the normal condition after an abnormality was detected, the fail-safe control will be released. However, the diagnosis result remains.

Fail safe specifications

Item	Fail-safe execution conditions	FAIL-SAFE SPECIFICATIONS
Manifold absolute pressure sensor signal system	When abnormality takes place in the signal from the manifold absolute pressure sensor:	The manifold absolute pressure is estimated by the throttle opening angle and the engine revolution speed. When abnormality occurs in the signal from the throttle position sensor, the signal from the manifold absolute pressure sensor is set to the constant value. If both the throttle opening angle and engine speed exceed their set values, the fuel is cut.
Ignition system	When malfunction takes place in the ignition signal:	Fuel injection is cut in the cylinder whose ignition signal is faulty.
Coolant temperature sensor system	When malfunction takes place in the signal from the coolant temperature sensor:	The signal from the coolant temperature sensor is set to a constant value.
Throttle position sensor system	When abnormality takes place in the signal from the throttle position sensor:	The signal from the throttle position sensor is set to a constant value.
A/C evaporator temperature sensor signal system	When malfunction takes place in the signal from the A/C evaporator temperature sensor:	The air conditioner will be cut.
Atmospheric pressure sensor circuit malfunction	When the signals from the atmospheric pressure sensor are not outputted continuously over a certain length of time after starting.	The signal from the atmospheric pressure sensor is set to a constant value.
Knock sensor signal system	When abnormality takes place in the signal from the knock sensor:	The ignition timing is retarded.
Intake air temperature sensor signal system	When malfunction takes place in the signal from the intake air temperature sensor:	The signal from the intake air temperature sensor is set to a constant value.
Oil control valve system	When malfunction takes place in the control voltage for the oil control valve:	Oil control valve energizing control is prohibited.
Camshaft position sensor system	When malfunction takes place in the signal from the camshaft position sensor:	The signal from the camshaft position sensor is set to a constant value.
Rear O_2 sensor system (EU-specification vehicle only)	When abnormality takes place in the signal from the rear O_2 sensor:	The feedback control is changed to open control.
Immobilizer communication system (Immobilizer system-equipped vehicle only)	When abnormality takes place in the communicates with the immobilizer ECU, code reference failed due to malfunction in the computer internals.	Fuel injection and ignition are stopped.

3 COMPONENTS

3-1 ENGINE CONTROL COMPUTER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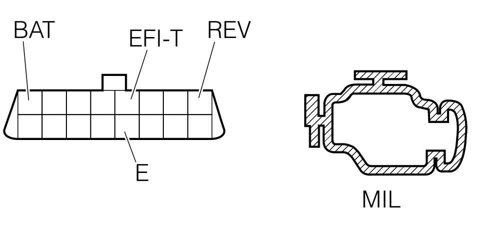
The engine control computer is mounted under the glove box on the front passenger seat side, providing fuel injection control, electronic spark advance control, variable valve timing control, idol speed control, evaporator purge control, etc. The engine control computer communicates with other ECU's, outputs the operation status of the engine through EFI ECU, and inputs the signal from ECU's, providing various controls such as idle-up, fuel cut, and ignition stop.

3-2 DLC

3-2-1 DESCRIPTION

The DLC is installed in front of the driver's seat (at the lower end of the instrument panel, on the driver's door side), providing the following checks.

(1) Indication of diagnosis
(2) Indication of O_2 sensor state



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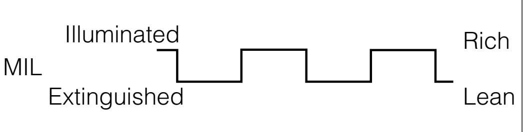
3-2-2 INDICATION OF DIAGNOSIS

When the terminal EFI T and E are shorted while the IG switch is ON, the engine check lamp inside the combination meter flashes to indicate the error code, starting with a smaller code. The error code is identified by the number of flashing, displayed repeatedly.

3-2-3 INDICATION OF O_2 SENSOR STATE

Short-circuit the terminal EFI T and E with the IG switch turned ON, maintain the engine speed above 2000rpm, and keep the brake pedal depressed. In this way, the output status of the O_2 sensor and feedback control can be checked by ON/OFF operations of the engine check lamp.
(No indication of the rear O_2 sensor state)

(1) Rich side: Lamp ON
(2) Lean side: Lamp OFF



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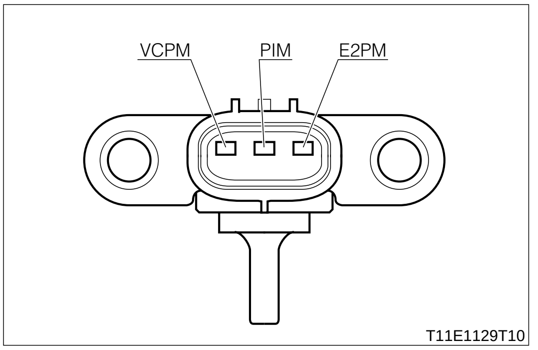
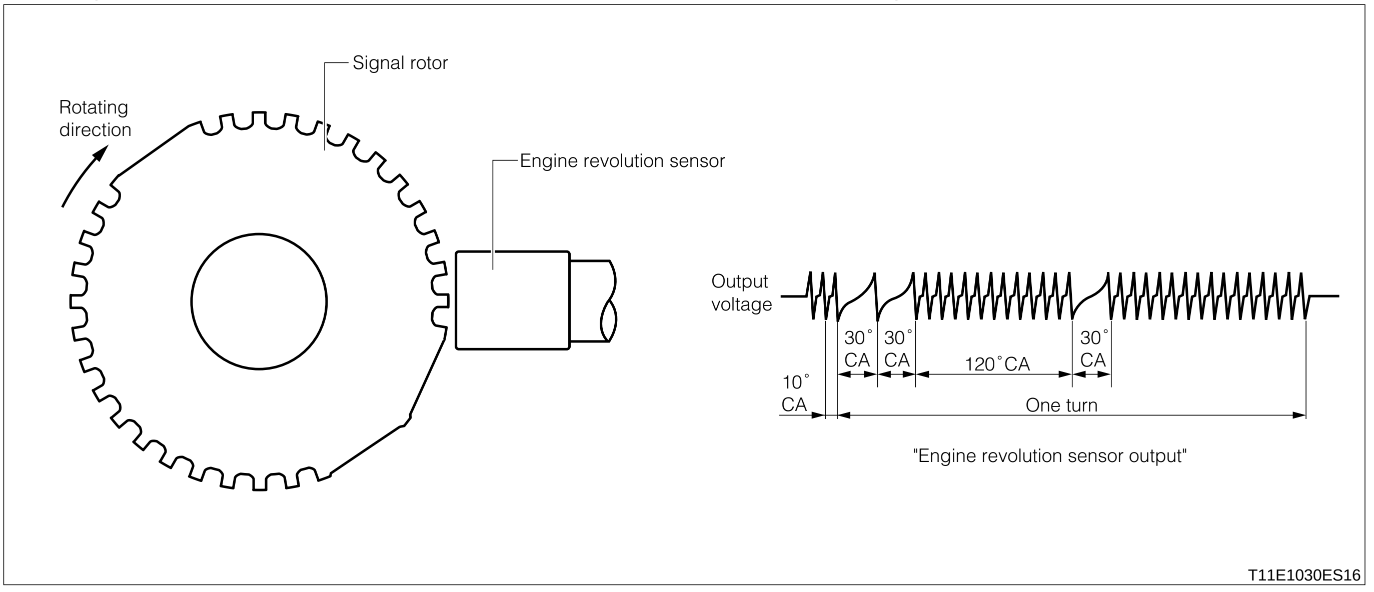
3-3 MANIFOLD ABSOLUTE PRESSURE SENSOR

The manifold absolute pressure sensor is installed to the air cleaner to detect the manifold absolute pressure inside the intake manifold through the hose.



3-4 ENGINE SPEED SENSOR, SIGNAL ROTOR

The signal rotor is installed at the front of the crankshaft in order to detect the crank angle. The signal rotor has a projection for which the engine speed sensor is installed.
As the crankshaft turns, the air gap changes between the engine revolution sensor and the projection provided on the signal rotor, causing changes in the magnetic flux to generate a pulse.
The engine speed is calculated based on the interval of the pulses generated by this projection.

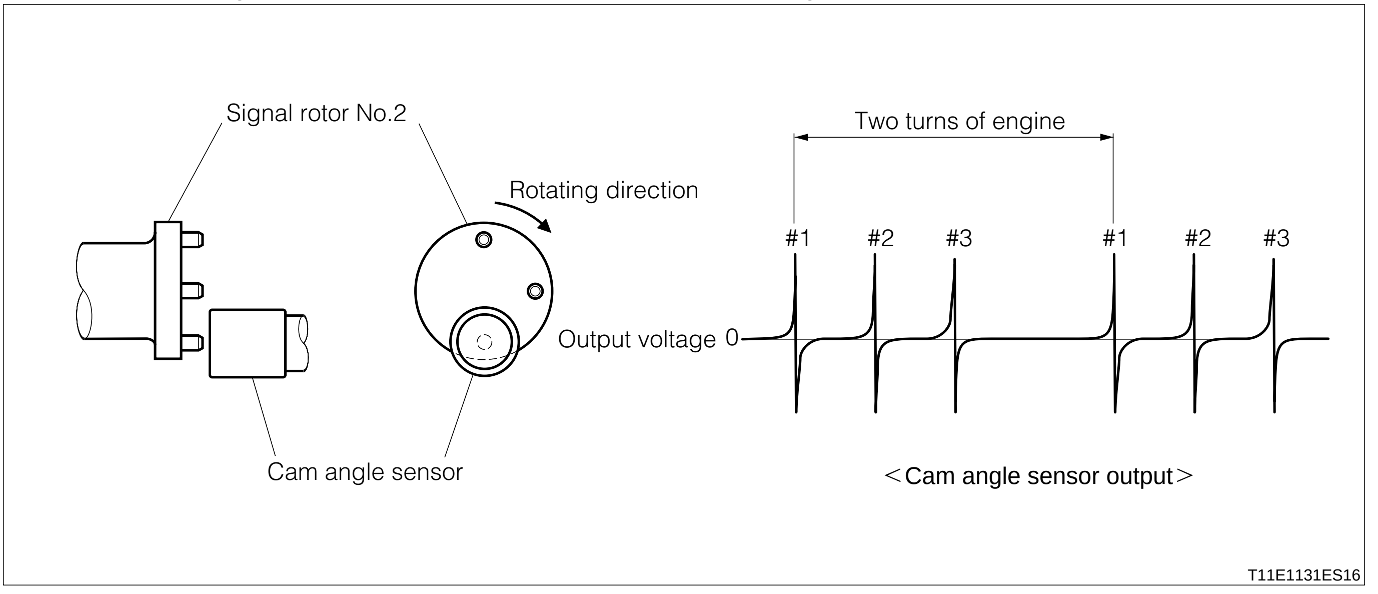


3-5 CAMSHAFT POSITION SENSOR AND SIGNAL ROTOR NO.2

A projection is provided at the rear of the No.1 camshaft to detect the phase of the No.1 camshaft and the crankshaft. The camshaft position sensor is mounted at the rear of the cylinder head.

When the No.1 camshaft makes a turn, the air gaps change between the camshaft position sensor and each of the three projections on the signal rotor No.2. As a result, the magnetic flux changes, and three pulses per turn are generated at the camshaft position sensor.

The phase of the No.1 camshaft and the crankshaft is detected by the signals from the camshaft position sensor and the engine speed sensor. The variable valve timing control is performed based on this phase.



3-6 COOLANT TEMPERATURE SENSOR

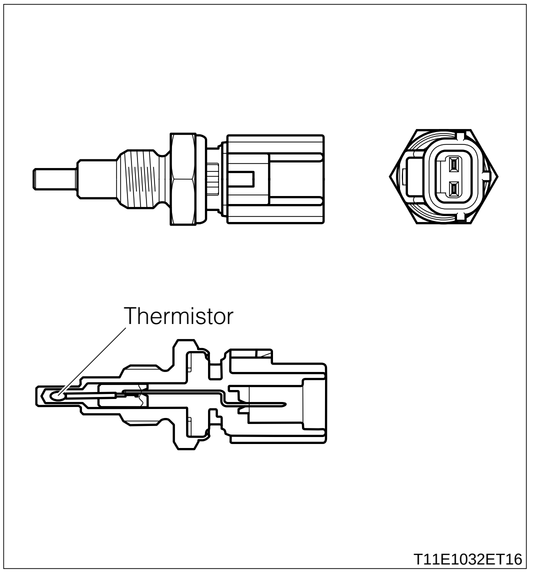
The coolant temperature sensor, mounted on the cylinder head, detects the coolant temperatures.

The sensor has a built-in thermistor, whose resistance changes with temperature. The input signals from the thermistor are sent to the engine control computer.

The coolant temperature gauge in the meter uses coolant temperature signals sent from the engine control computer through CAN communication.

Coolant temperature sensor

Temperature [℃]	−20	20	80	110
Resistance [kΩ]	15.04	2.45	0.318	0.142



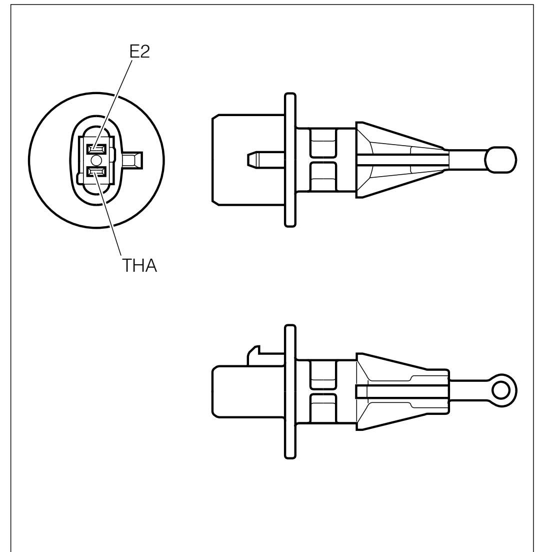
3-7 INTAKE AIR TEMPERATURE SENSOR

The intake air temperature sensor is installed on the clean side of the air cleaner to detect the intake air temperature.

The sensor has a built-in thermistor, whose resistance changes with temperature.

Intake air temperature sensor

Temperature [℃]	−30	−20	20	80	120
Resistance [kΩ]	-28.6	16.2	2.45	0.322	-0.117



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NOTE

- Figures inside parentheses show reference values.

3-8 ATMOSPHERIC PRESSURE SENSOR (EU-SPECIFICATION VEHICLE ONLY)

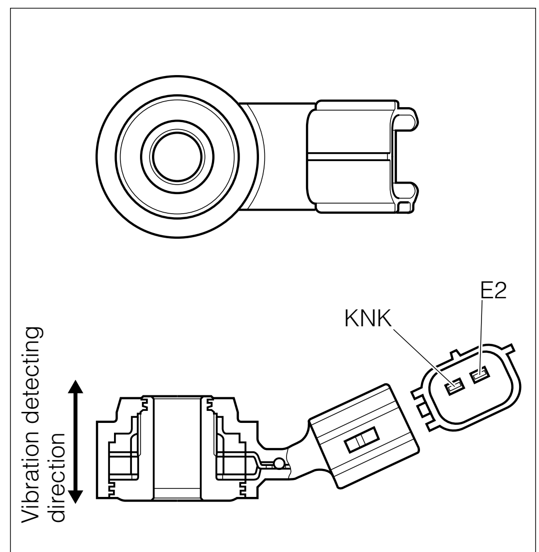
The atmospheric sensor is incorporated in the engine control computer. This sensor senses the atmospheric pressure, which is used for compensation of the fuel injection amount, etc.

3-9 KNOCK SENSOR

The knock sensor is mounted on the cylinder block and detects knocking indirectly from the vibration of the cylinder block that occurs by knocking.

A piezoelectric element, which is built into the sensor, converts vibrations of the cylinder block into electric signals.

The non-resonance type knock sensor is used to improve accuracy in knock detection.



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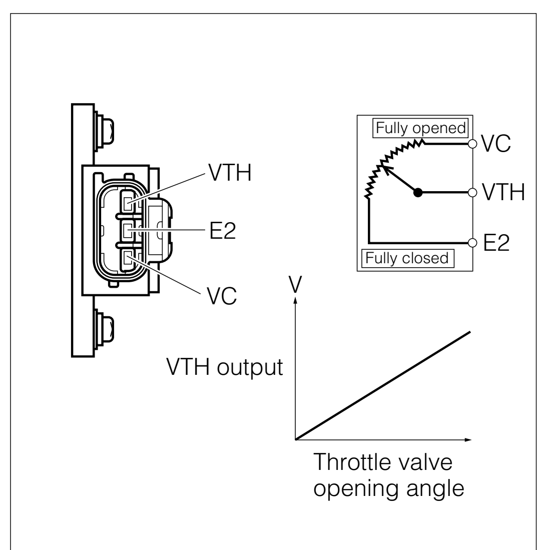
3-10 THROTTLE POSITION SENSOR

The sensor is installed to the throttle body and has a built-in potentiometer, which detects a throttle opening angle linearly.



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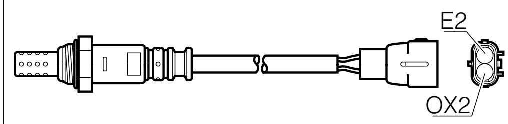
3-11 O_2 SENSOR

The sensor is installed to the exhaust manifold and detects the oxygen concentration in the exhaust emission by the amount of the electromotive force generated within the sensor. The lower the oxygen concentration, the greater the electromotive force gets, indicating that the air-to-fuel ratio is rich (rich condition).
Based on this voltage, the engine control computer judges whether the current air-to-fuel ratio is greater or smaller than the stoichiometric ratio.
The sensor begins operating at about 300˚C or more. In order to activate the sensor sooner, a heater circuit is provided for EU-specification vehicle. This helps improve accuracy of the air-to-fuel ratio feedback control, thus reducing the exhaust emission.



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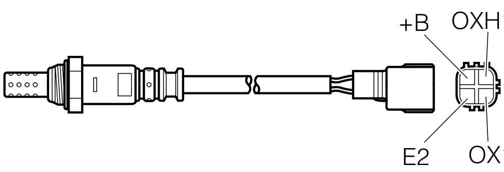

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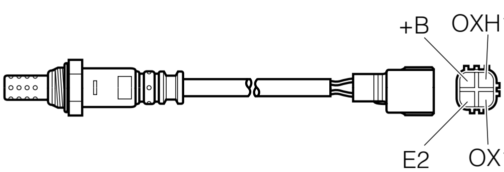
3-12 REAR O_2 SENSOR (EU-SPECIFICATION VEHICLE ONLY)

The sensor is installed to the exhaust front pipe. It detects the oxygen concentration in the exhaust emission after passing over the catalyst, by the amount of the electromotive force generated within the sensor. The lower the oxygen concentration, the greater the electromotive force gets.
Based on this voltage, the engine control computer judges whether the current air-to-fuel ratio is the target value or not, thus monitoring the oxygen sensor provided upstream.
The sensor begins operating at about 300˚C or more. In order to make the sensor operate more early, a heater circuit is provided.



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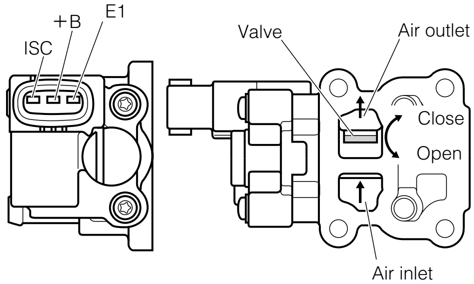
3-13 VALVE FOR ISC

This is a rotary solenoid valve which controls the amount of air which bypasses the throttle valve by using the duty signal from the engine control computer.
The amount of air is determined by the ON/OFF time ratio (duty ratio) of the engine control computer signal.



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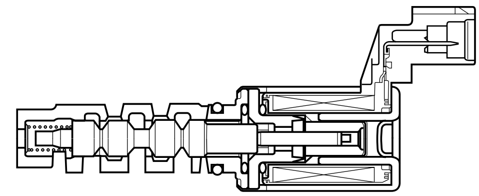
3-14 OIL CONTROL VALVE

The oil control valve turns ON and OFF according to the duty signal from the engine control computer so as to regulate the hydraulic pressure applied to the variable valve timing controller. This way, the opening/closing timing of the intake air valve can be controlled to the target timing.



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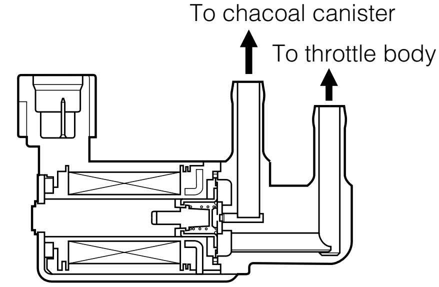
3-15 VSV FOR EVAPORATIVE EMISSION CONTROL SYSTEM PURGE CONTROL

The amount of fuel evaporative emission that flows to the engine combustion chamber is controlled by the duty signal from the engine control computer.



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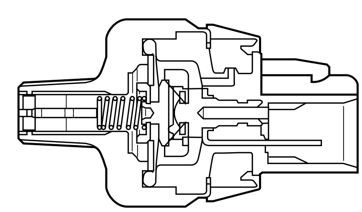
3-16 BRAKE NEGATIVE-PRESSURE SWITCH(A/T VEHICLES ONLY)

The switch is installed to the brake booster and is switched ON when the pressure inside the brake booster exceeds the working pressure (atmospheric pressure side), so that the engine control computer performs the air-conditioner cutting control.

NOTE

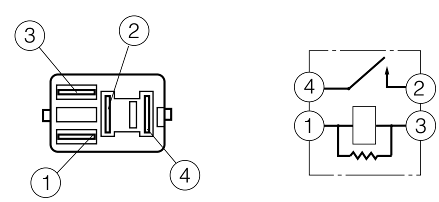
- Working pressure: −34.6kPa{−260mmHg}



M21E3056T10

3-17 MAIN RELAY, FUEL PUMP RELAY, RADIATOR FAN RELAY

This is installed in the relay box of the engine compartment.
The main relay supplies power to the engine control computer when the IG switch is ON.
When the IG switch is ON, the fuel pump relay is activated by the signal from the engine control computer to supply power to the fuel pump.
When conditions to activate the radiator fan motor control are satisfied, the radiator fan relay is turned ON by the signal from the engine control computer to supply power to the radiator fan motor.



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