9. EVAP (Evaporative Emission) Control System

General

The EVAP (evaporative emission) control system prevents the vapor gas that is created in the fuel tank from being released directly into the atmosphere.

- The canister stores the vapor gas that has been created in the fuel tank.
- The ECM controls the purge VSV in accordance with the driving conditions in order to direct the vapor gas into the engine, where it is burned.
- In this system, the ECM checks the evaporative emission leak and outputs DTC (Diagnostic Trouble Code) in the event of a malfunction. An EVAP (evaporative emission) leak check consists of an application of a vacuum pressure to the system and monitoring the changes in the system pressure in order to detect a leakage.
- This system consists of the purge VSV, canister, refueling valve, canister pump module, and ECM.
- The ORVR (Onboard Refueling Vapor Recovery) function is provided in the refueling valve.
- The canister pressure sensor has been included to the canister pump module.
- The canister filter has been provided on the fresh air line. This canister filter is maintenance-free.
- The followings are the typical conditions for enabling an EVAP leak check:

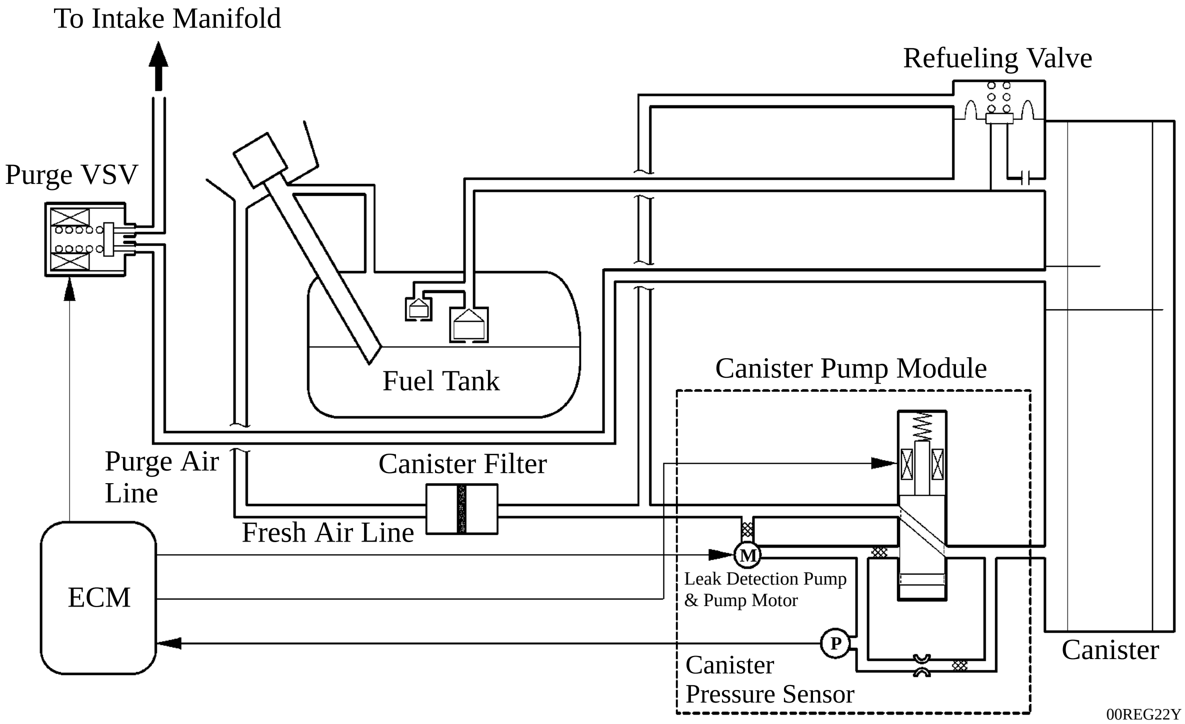
Typical Enabling Condition	● Five hours have elapsed after the engine has been turned OFF*. ● Altitude: Below 2400 m (8000 feet) ● Battery voltage: 10.5 V or more ● Ignition switch: OFF ● Engine coolant temperature: 4.4 to 35°C (40 to 95°F) ● Intake air temperature: 4.4 to 35°C (40 to 95°F)

*: If engine coolant temperature does not drop below 35°C (95°F), this time should be extended to 7 hours. Even after that, if the temperature is not less than 35°C (95°F), the time should be extended to 9.5 hours.

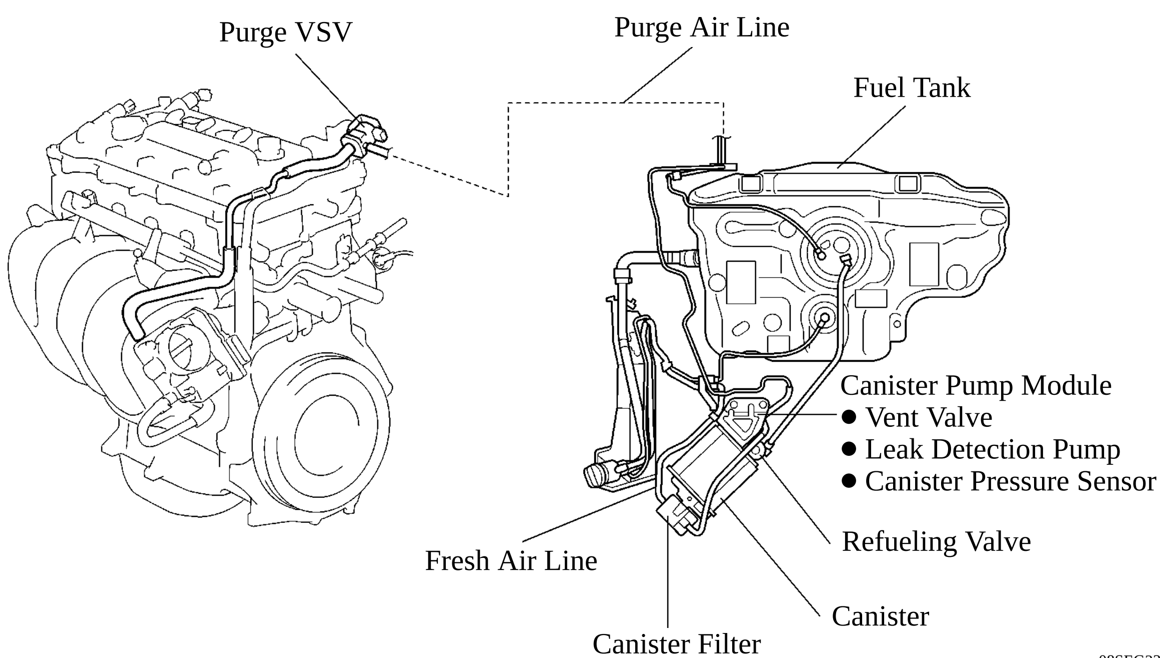
Service Tip

- The canister pump module performs the EVAP leak check. This check is done approximately five hours after the engine is turned off. So you may hear sound coming from underneath the luggage compartment for several minutes. It does not indicate a malfunction.
- The pinpoint pressure test procedure is carried out by pressurizing the fresh air line that runs from the pump module to the air filler neck. For details, refer to the 2009 Corolla Repair Manual (Pub. No. RM08M0U).

System Diagram



Layout of Main Components



Function of Main Components

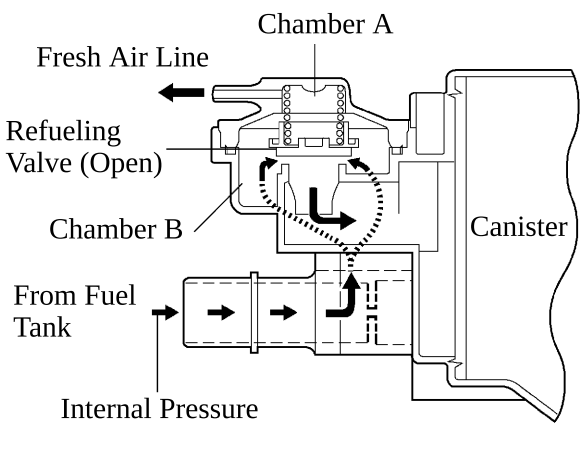
<table>
<tr><th colspan="2">Component</th><th>Function</th></tr>
<tr><td colspan="2">Canister</td><td>Contains activated charcoal to absorb the vapor gas that is created in the fuel tank.</td></tr>
<tr><td colspan="2" rowspan="1">Refueling Valve</td><td>Controls the flow rate of the vapor gas from the fuel tank to the canister when the system is purging or during refueling.</td></tr>
<tr><td></td><td>Restrictor Passage</td><td>Prevents a large amount of vacuum during purge operation or system monitoring operation from affecting the pressure in the fuel tank.</td></tr>
<tr><td colspan="2">Fresh Air Line</td><td>Fresh air goes into the canister and the cleaned drain air goes out into the atmosphere.</td></tr>
<tr><td rowspan="3">Canister Pump Module</td><td>Vent Valve</td><td>Opens and closes the fresh air line in accordance with the signals from the ECM.</td></tr>
<tr><td>Leak Detection Pump</td><td>Applies vacuum pressure to the EVAP control system in accordance with the signals from the ECM.</td></tr>
<tr><td>Canister Pressure Sensor</td><td>Detects the pressure in the EVAP control system and sends the signals to the ECM.</td></tr>
<tr><td colspan="2">Purge VSV</td><td>Opens in accordance with the signals from the ECM when the system is purging, in order to send the vapor gas that was absorbed by the canister into the intake manifold. In system monitoring mode, this valve controls the introduction of the vacuum into the fuel tank.</td></tr>
<tr><td colspan="2">Canister Filter</td><td>Prevents dust and debris in the fresh air from entering the system.</td></tr>
<tr><td colspan="2">ECM</td><td>Controls the canister pump module and purge VSV in accordance with the signals from various sensors, in order to achieve a purge volume that suits the driving conditions. In addition, the ECM monitors the system for any leakage and outputs a DTC if a malfunction is found.</td></tr>
</table>

Construction and Operation

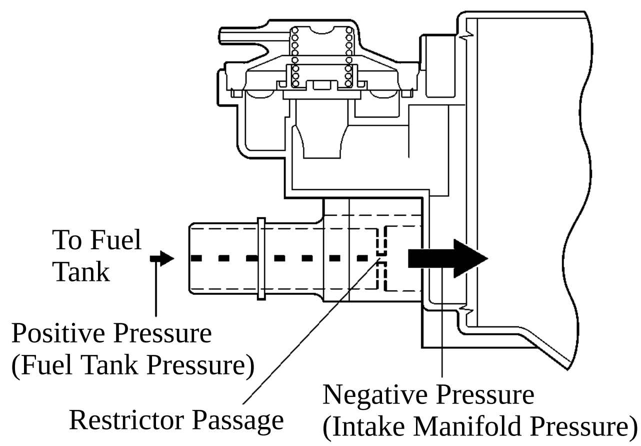
1) Refueling Valve

The refueling valve consists of the chamber A, chamber B, and restrictor passage. A constant atmospheric pressure is applied to the chamber A.

- During refueling, the internal pressure of the fuel tank increases. This pressure causes the refueling valve to lift up, allowing the vapor gas to enter the canister.
- The restrictor passage prevents the large amount of vacuum that is created during purge operation or system monitoring operation from entering the fuel tank, and limits the flow of the vapor gas from the fuel tank to the canister. If a large volume of vapor gas recirculates into the intake manifold, it will affect the air-fuel ratio control of the engine. Therefore, the role of the restrictor passage is to help prevent this from occurring.



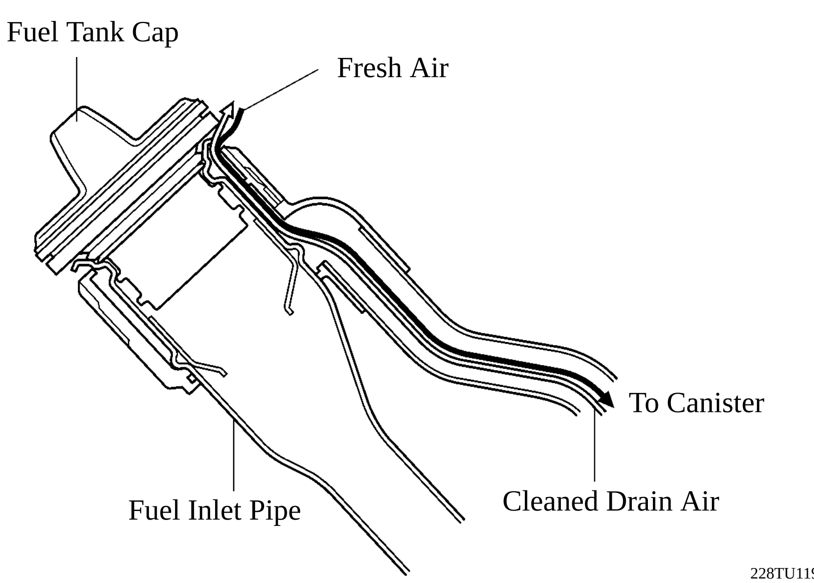
During Refueling



During Purge Operation or System Monitoring Operation

2) Fuel Inlet (Fresh Air Line)

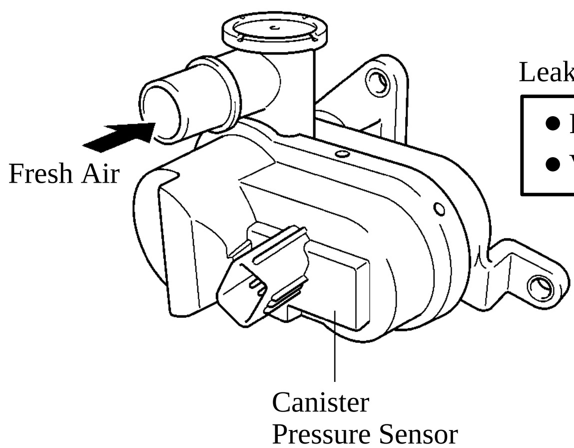
In accordance with the change of structure of the EVAP control system, the location of a fresh air line inlet has been changed from the air cleaner section to the near fuel inlet. The flesh air from the atmosphere and drain air cleaned by the canister will go in and out of the system through the passage shown below.



3) Canister Pump Module

Canister pump module consists of the vent valve, leak detection pump, and canister pressure sensor.

- The vent valve switches the passages in accordance with the signals received from the ECM.
- A DC type brushless motor is used for the pump motor.
- A vane type vacuum pump is used.



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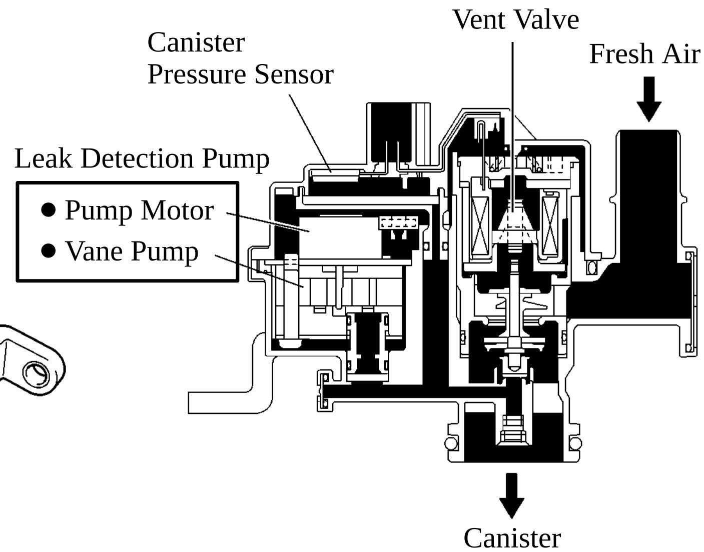

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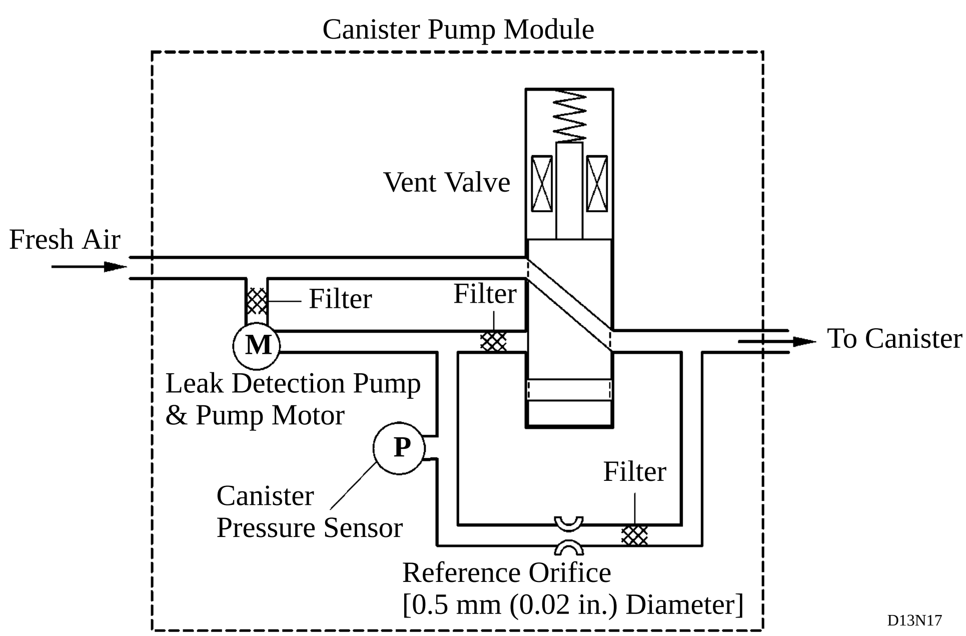
▶ Simple Diagram ◀



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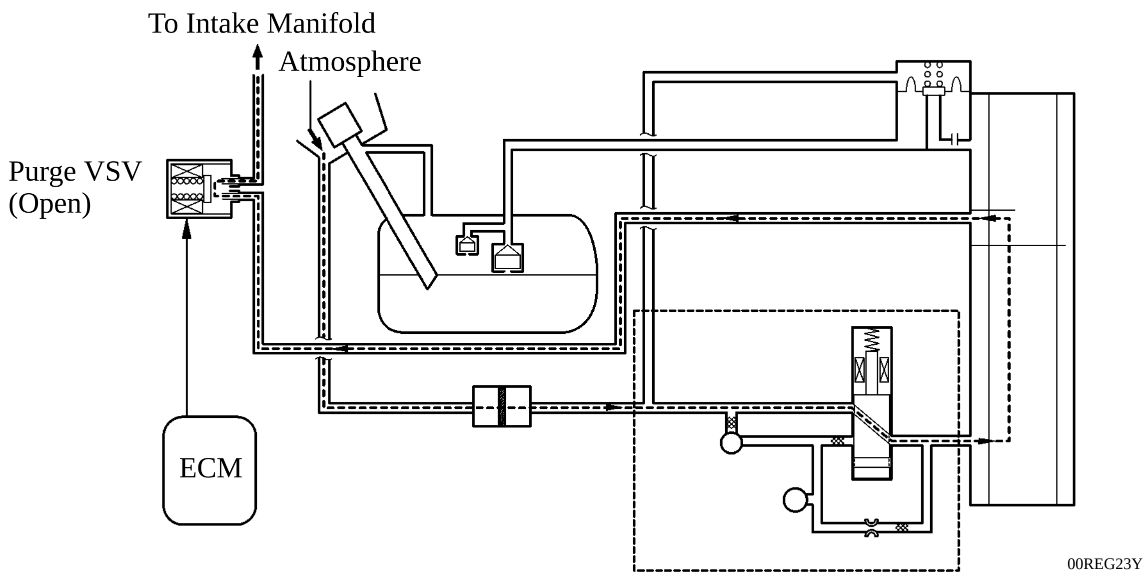
System Operation

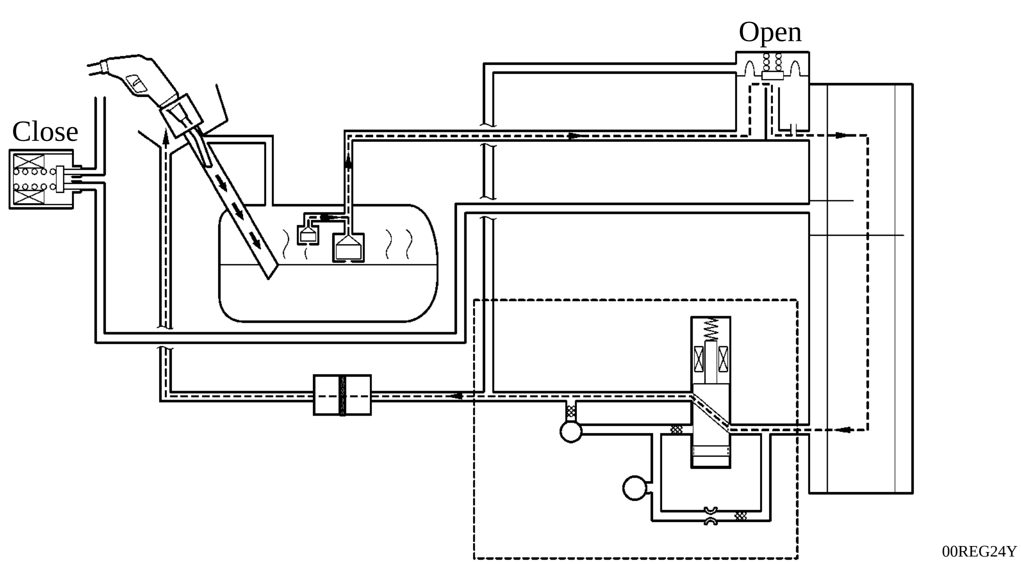
1) Purge Flow Control

When the engine has satisfied the predetermined conditions (closed loop, engine coolant temperature above 74°C (165°F), etc.), the stored vapor gas is purged from the canister whenever the purge VSV is opened by the ECM.
The ECM will change the duty ratio cycle of the purge VSV, thus controlling purge flow volume. Purge flow volume is determined by intake manifold pressure and the duty ratio cycle of the purge VSV. Atmospheric pressure is allowed into the canister to ensure that purge flow is constantly maintained whenever purge vacuum is applied to the canister.



2) ORVR (On-board Refueling Vapor Recovery)

When the internal pressure of the fuel tank increases during refueling, this pressure causes the diaphragm in the refueling valve to lift up, allowing the vapor gas to enter the canister. Because the vent valve is always open (even when the engine is stopped) when the system is in a mode other than the monitoring mode, the air that has been cleaned through the canister is discharged outside the vehicle via the fresh air line. If the vehicle is refueled in the monitoring mode, the ECM will recognize the refueling by way of the canister pressure sensor, which detects the sudden pressure increase in the fuel tank, and will open the vent valve.

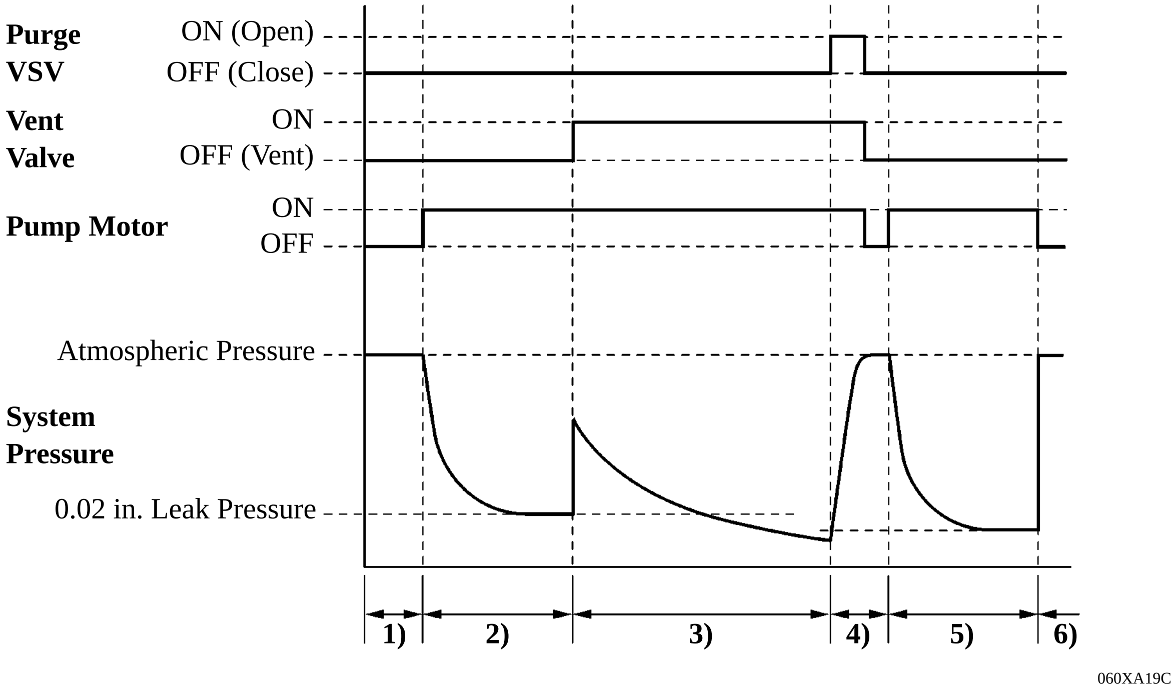


3) EVAP Leak Check

a. General

The EVAP leak check operates in accordance with the following timing chart:

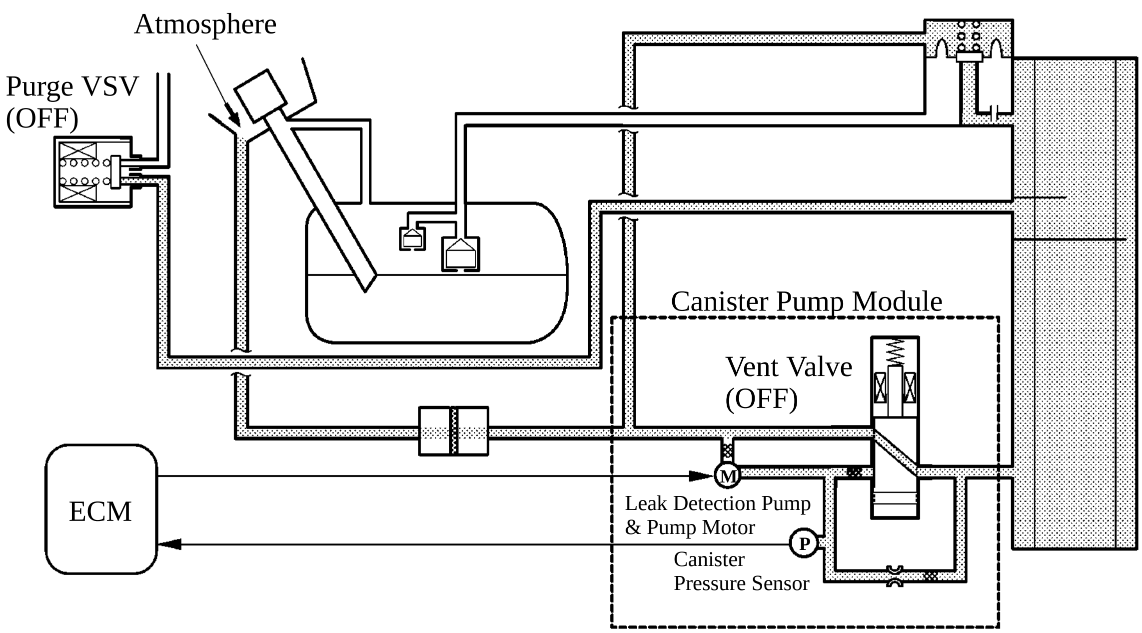
▶ Timing Chart ◀



Order	Operation	Description	Time
1)	Atmospheric Pressure Measurement	ECM turns vent valve OFF (vent) and measures EVAP control system pressure to memorize atmospheric pressure.	10 sec.
2)	0.02 in. Leak Pressure Measurement	Leak detection pump creates negative pressure (vacuum) through 0.02 in. orifice and the pressure is measured. ECM determines this as 0.02 in. leak pressure.	60 sec.
3)	EVAP Leak Check	Leak detection pump creates negative pressure (vacuum) in EVAP control system and EVAP control system pressure is measured. If stabilized pressure is larger than 0.02 in. leak pressure, ECM determines EVAP control system has a leakage. If EVAP control system pressure does not stabilize within 12 minutes, ECM cancels EVAP monitor.	Within 12 min.
4)	Purge VSV Monitor	ECM opens purge VSV and measures EVAP control system pressure increase. If increase is large, ECM interprets this as normal.	10 sec.
5)	Repeat 0.02 in. Leak Pressure Measurement	Leak detection pump creates negative pressure (vacuum) through 0.02 in. orifice and pressure is measured. ECM determines this as 0.02 in. leak pressure.	60 sec.
6)	Final Check	ECM measures atmospheric pressure and records monitor result.	—

b. Atmospheric Pressure Measurement

1) When the ignition switch is turned OFF, the purge VSV and vent valve are turned OFF. Therefore, the atmospheric pressure is introduced into the canister.
2) The ECM measures the atmospheric pressure through the signals provided by the canister pressure sensor.
3) If the measurement value is out of standards, the ECM actuates the leak detection pump in order to monitor the changes in the pressure.



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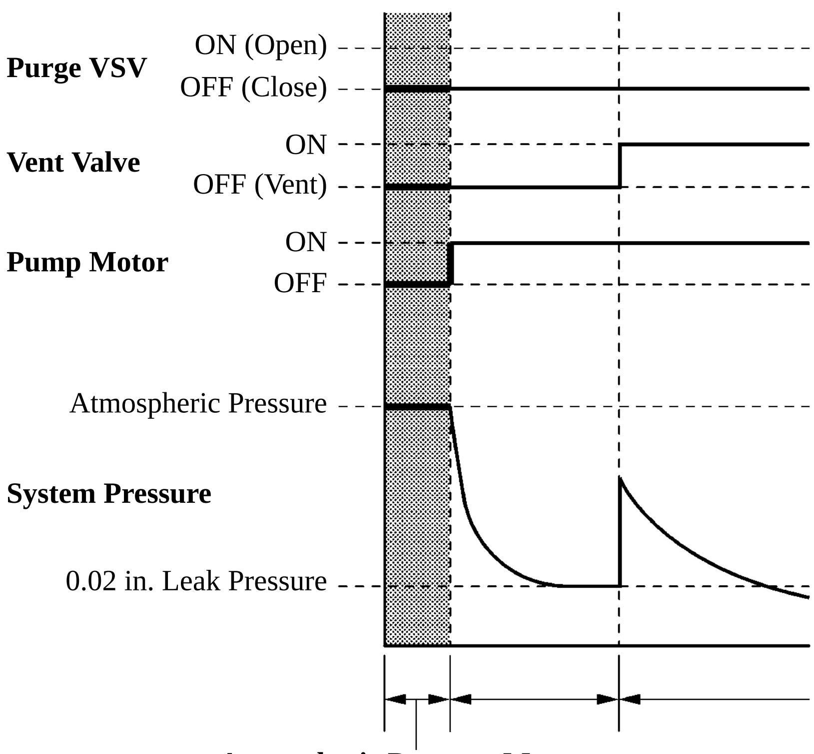
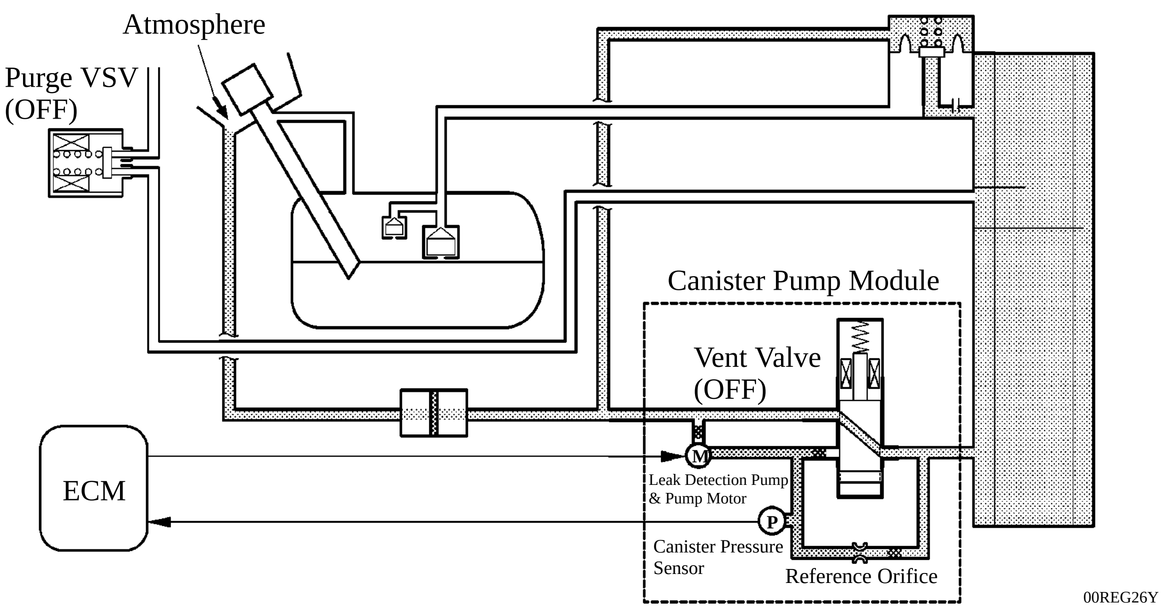


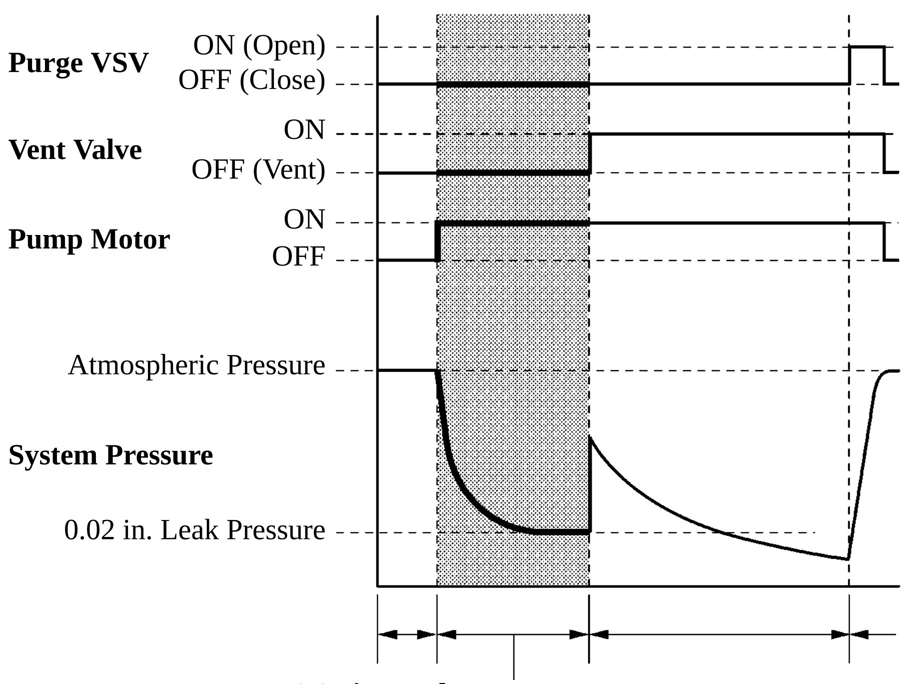
Atmospheric Pressure Measurement

D13N22

c. 0.02 in. Leak Pressure Measurement

1) The vent valve remains OFF, and the ECM introduces atmospheric pressure into the canister and actuates the leak detection pump in order to create a negative pressure.
2) At this time, the pressure will not decrease beyond a 0.02 in. leak pressure due to the atmospheric pressure that enters through a 0.02 in. diameter reference orifice.
3) The ECM compares the logic value with this pressure, and stores it as a 0.02 in. leak pressure in its memory.
4) If the measurement value is below the standard, the ECM will determine that the reference orifice is clogged and store DTC (Diagnostic Trouble Code) P043E in its memory.
5) If the measurement value is above the standard, the ECM will determine that a high flow rate pressure is passing through the reference orifice and store DTCs (Diagnostic Trouble Codes) P043F, P2401 and P2402 in its memory.





0.02 in. Leak Pressure Measurement

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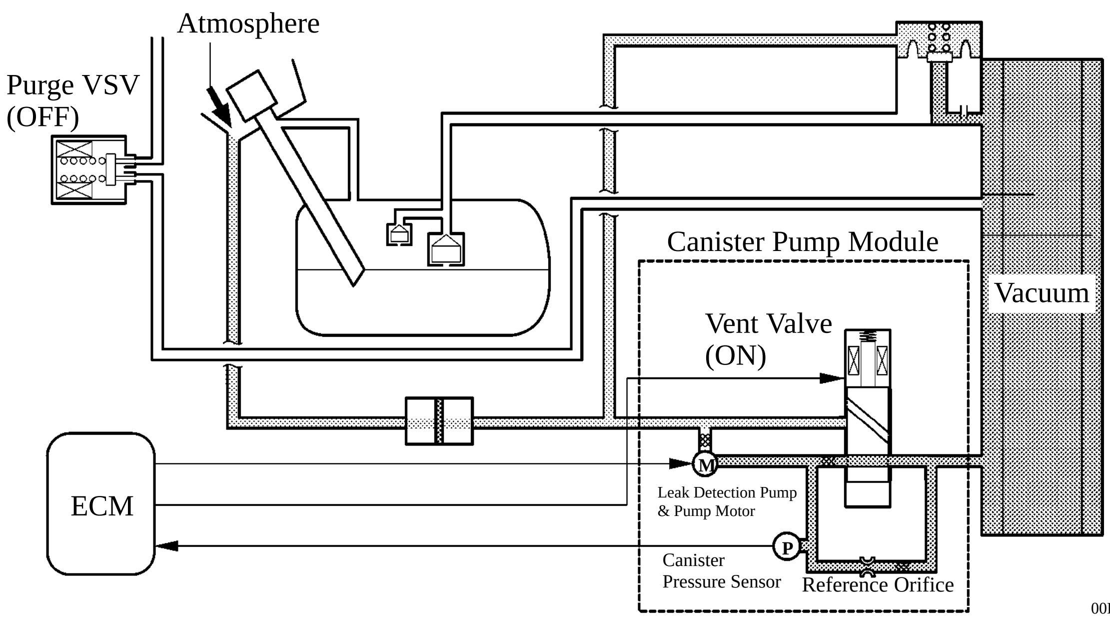
d. EVAP Leak Check

1) While actuating the leak detection pump, the ECM turns ON the vent valve in order to introduce a vacuum into the canister.
2) When the pressure in the system stabilizes, the ECM compares this pressure with the 0.02 in. leak pressure in order to check for a leakage.
3) If the measurement value is below the 0.02 in. leak pressure, the ECM determines that there is no leakage.
4) If the measurement value is above the 0.02 in. leak pressure and near atmospheric pressure, the ECM determines that there is a gross leakage (large hole) and stores DTC P0455 in its memory.
5) If the measurement value is above the 0.02 in. leak pressure, the ECM determines that there is a small leakage and stores DTC P0456 in its memory.



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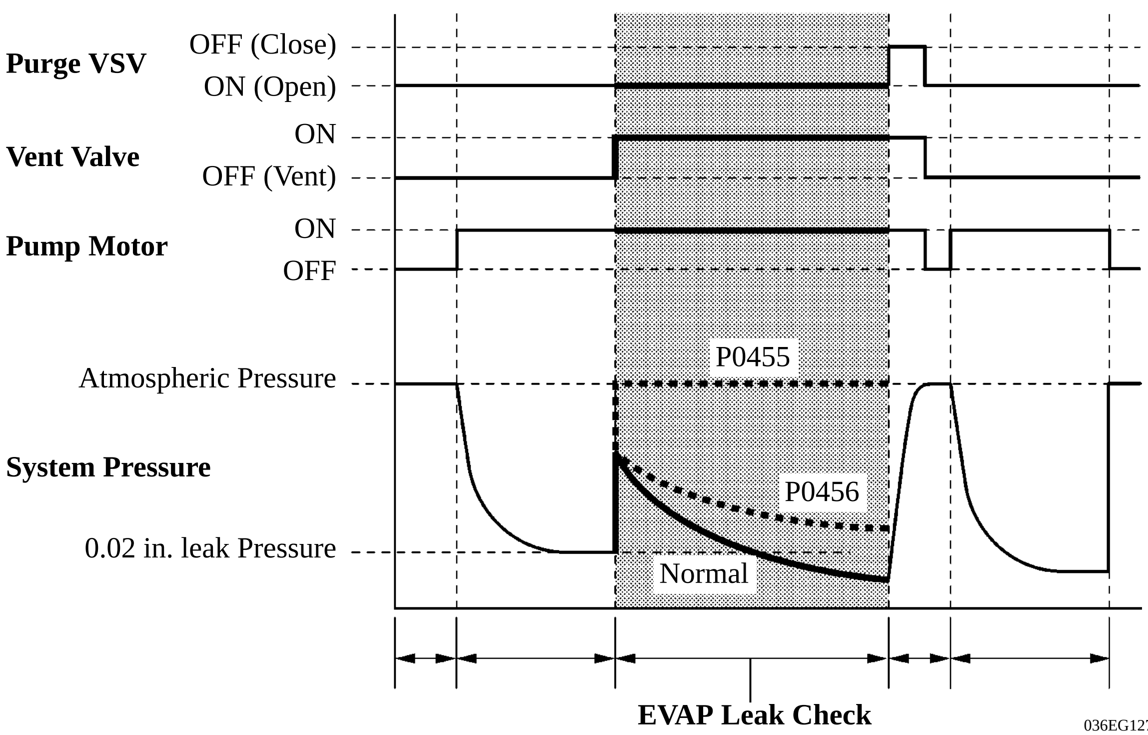

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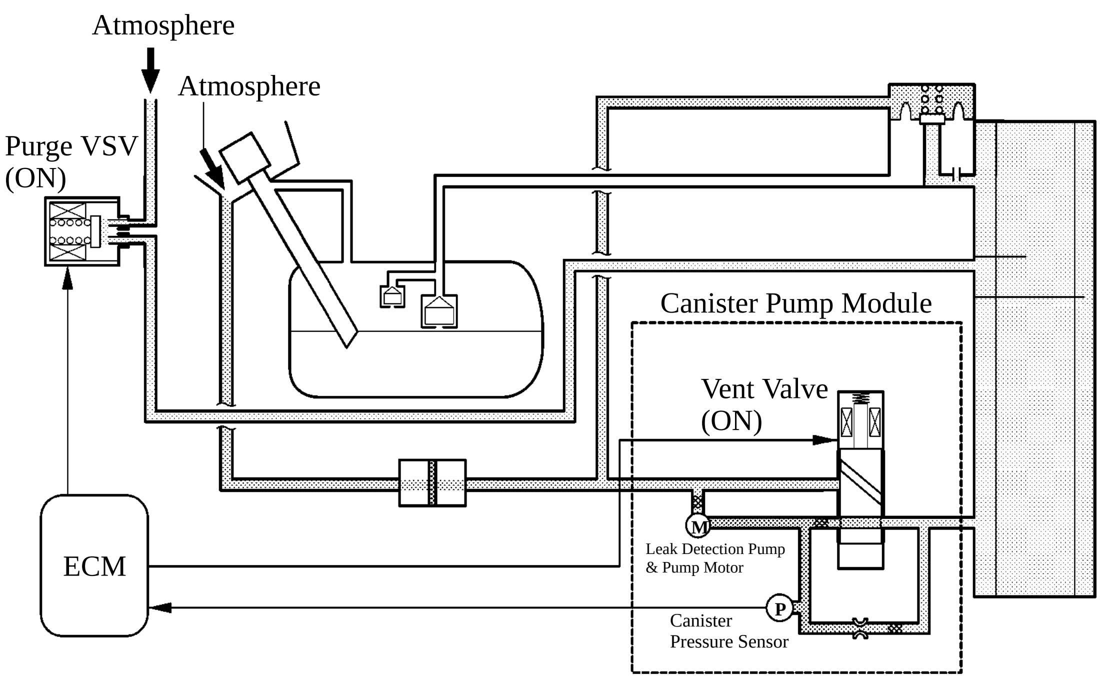
e. Purge VSV Monitor

1) After completing an EVAP leak check, the ECM turns ON (open) the purge VSV with the leak detection pump actuated, and introduces the atmospheric pressure from the intake manifold to the canister.
2) If the pressure change at this time is within the normal range, the ECM determines the condition to be normal.
3) If the pressure is out of the normal range, the ECM will stop the purge VSV monitor and store DTC P0441 in its memory.



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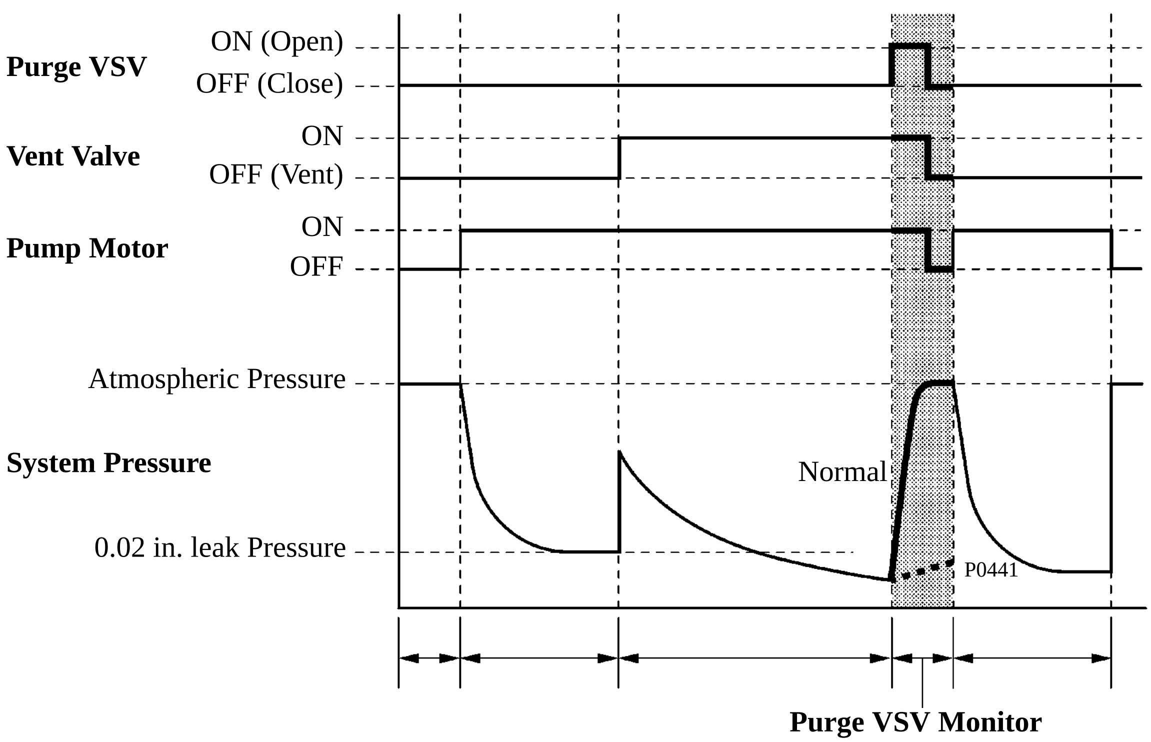

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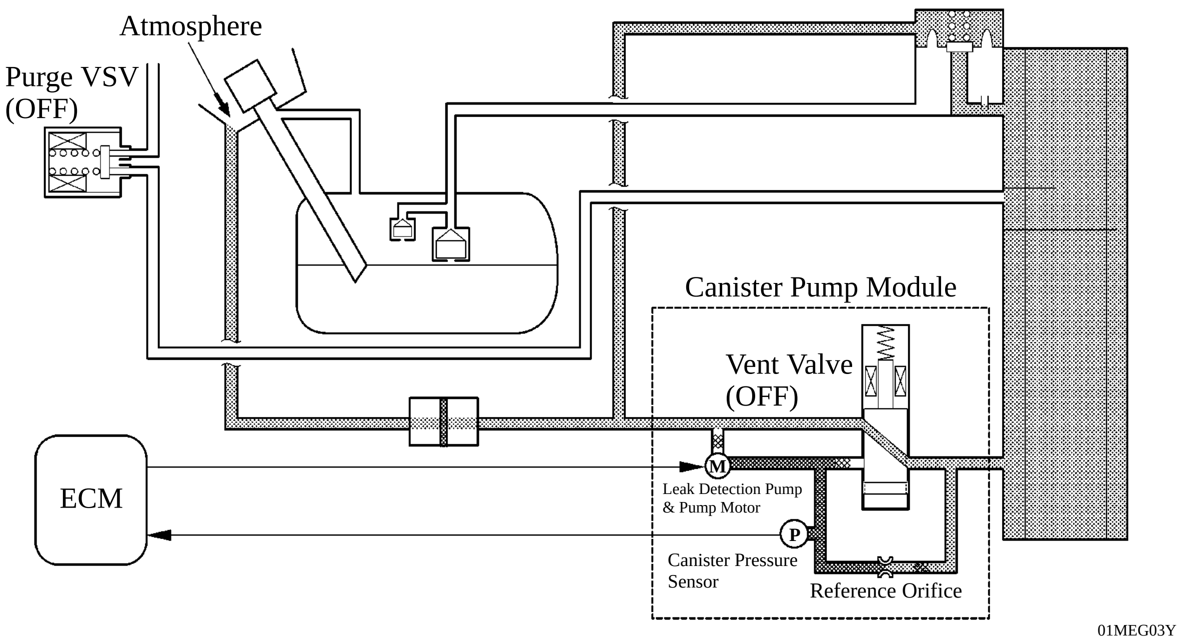
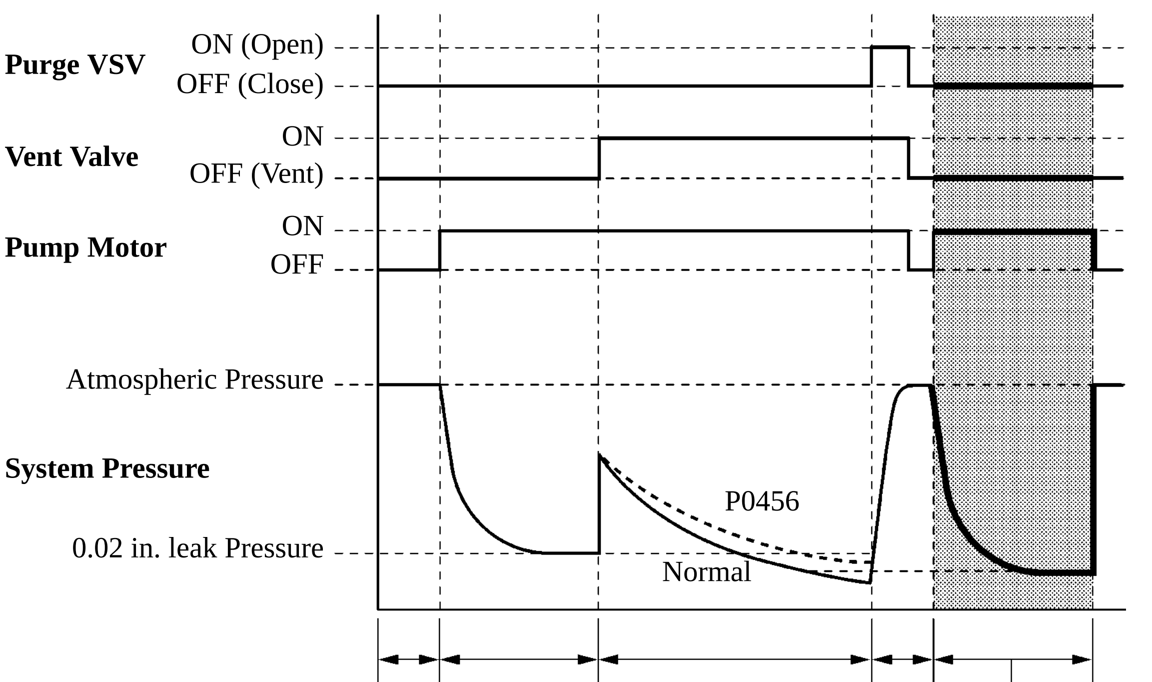
f. Repeat 0.02 in. Leak Pressure Measurement

1) While the ECM operates the vacuum pump, the purge VSV and vent valve turn off and a repeat 0.02 in. leak pressure measurement is performed.
2) The ECM compares the measured pressure with the pressure during EVAP leak check.
3) If the pressure during the EVAP leak check is below the measured value, the ECM determines that there is no leakage.
4) If the pressure during the EVAP leak check is above the measured value, the ECM determines that there is a small leakage and stores DTC P0456 in its memory.





Repeat 0.02 in. Leak Pressure Measurement

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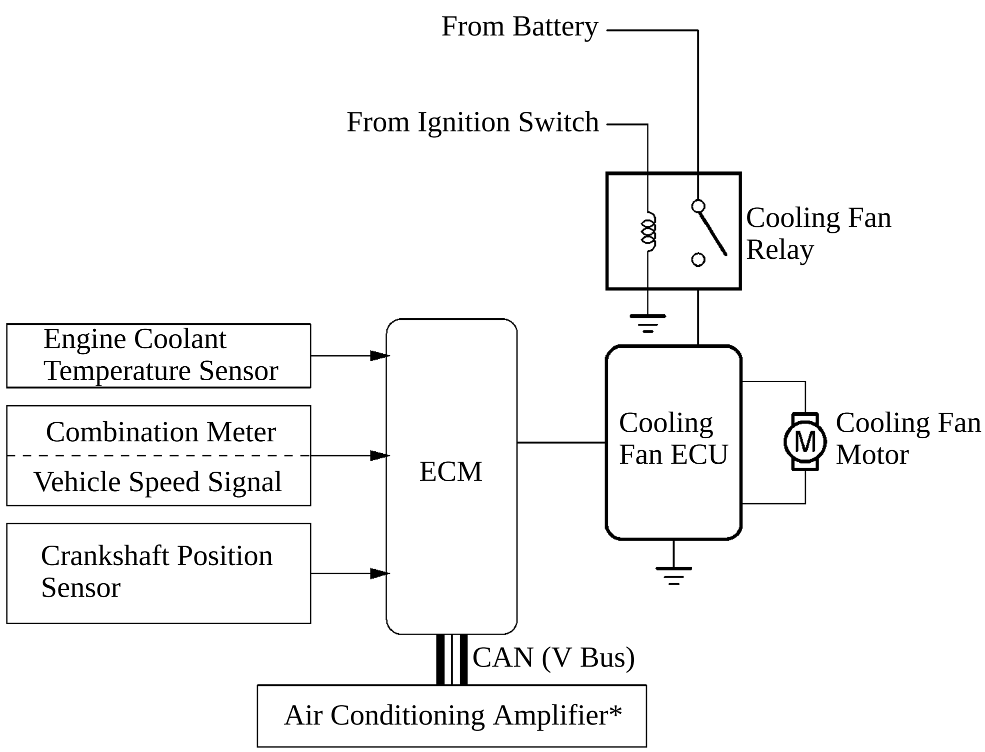
10. Cooling Fan Control System

General

A cooling fan control system is used. To achieve an optimal fan speed in accordance with the engine coolant temperature, vehicle speed, engine speed, and air conditioning operating conditions*, the ECM calculates the proper fan speed and sends the signals to the cooling fan ECU. Upon receiving the signals from the ECM, the cooling fan ECU actuates the fan motors. Also, the fan speed is controlled by the ECUs using the stepless control.

▶ **Wiring Diagram** ◀



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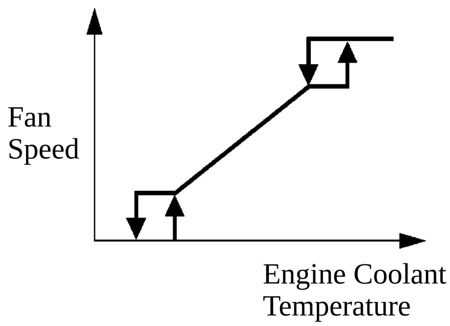
*: Models with Air Conditioning System

Operation

As illustrated below, the ECM determines the required fan speed by selecting the fastest fan speed from among the following:
(A) The fan speed required by the engine coolant temperature, (B) the fan speed required by the air conditioning refrigerant pressure, (C) the fan speed required by the engine speed, and (D) the fan speed required by the vehicle speed.



(A) Fan speed required by engine coolant temperature

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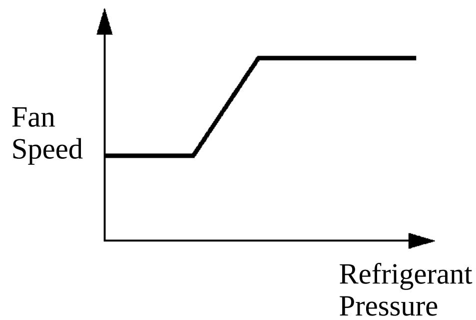
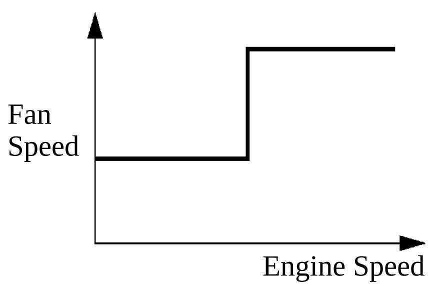


(B) Fan speed required by air conditioning refrigerant pressure

189EG14



(C) Fan speed required by engine speed

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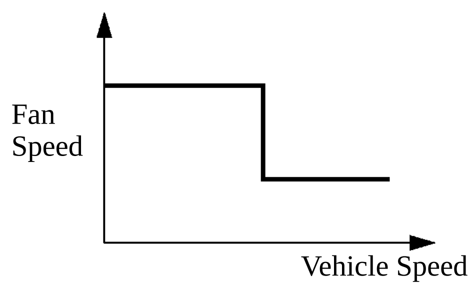

(D) Fan speed required by vehicle speed

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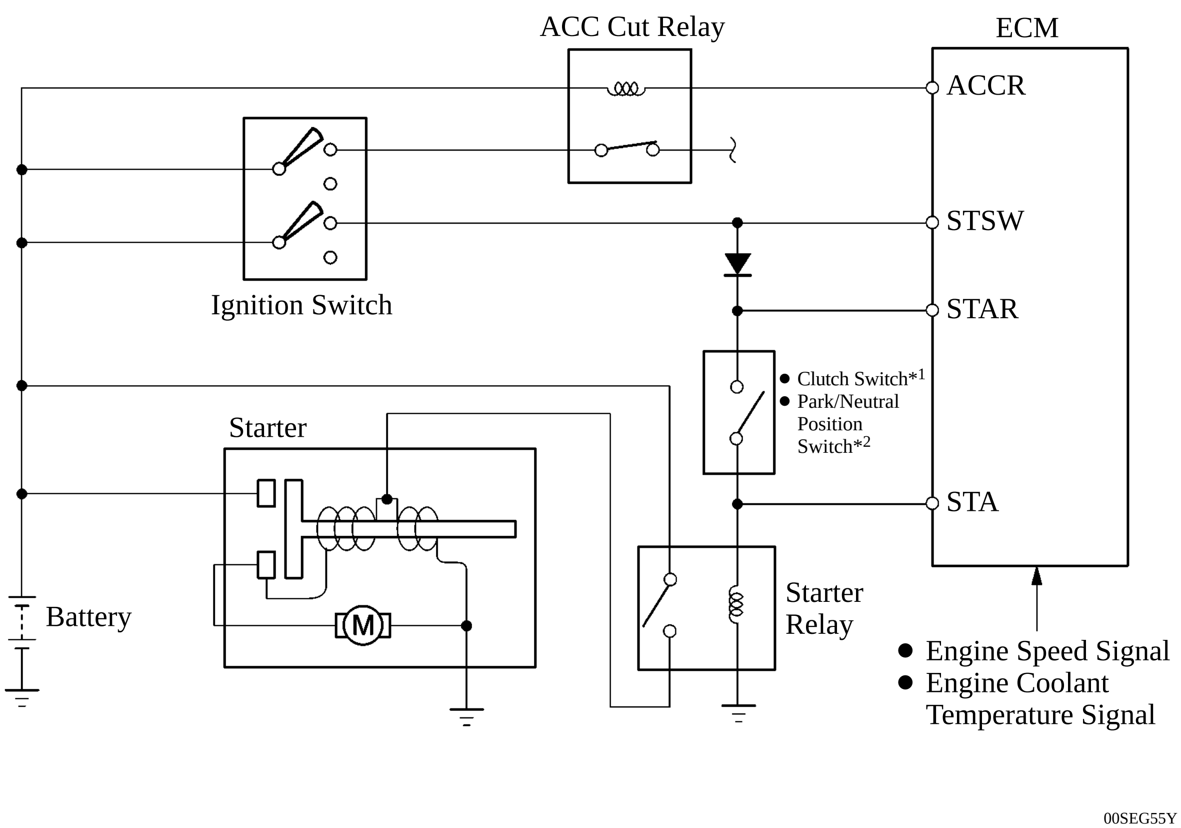
11. Starter Control (Cranking Hold Function)

General

1) For Models without Smart Key System

- Once the ignition switch is turned to the START position, this control continues to operate the starter until the engine starts, without having to hold the ignition switch in the START position. This prevents starting failures.
- When the ECM detects a start signal from the ignition switch, this system monitors the engine speed (NE) signal and continues to operate the starter until it determines that the engine has started.

▶ System Diagram ◀

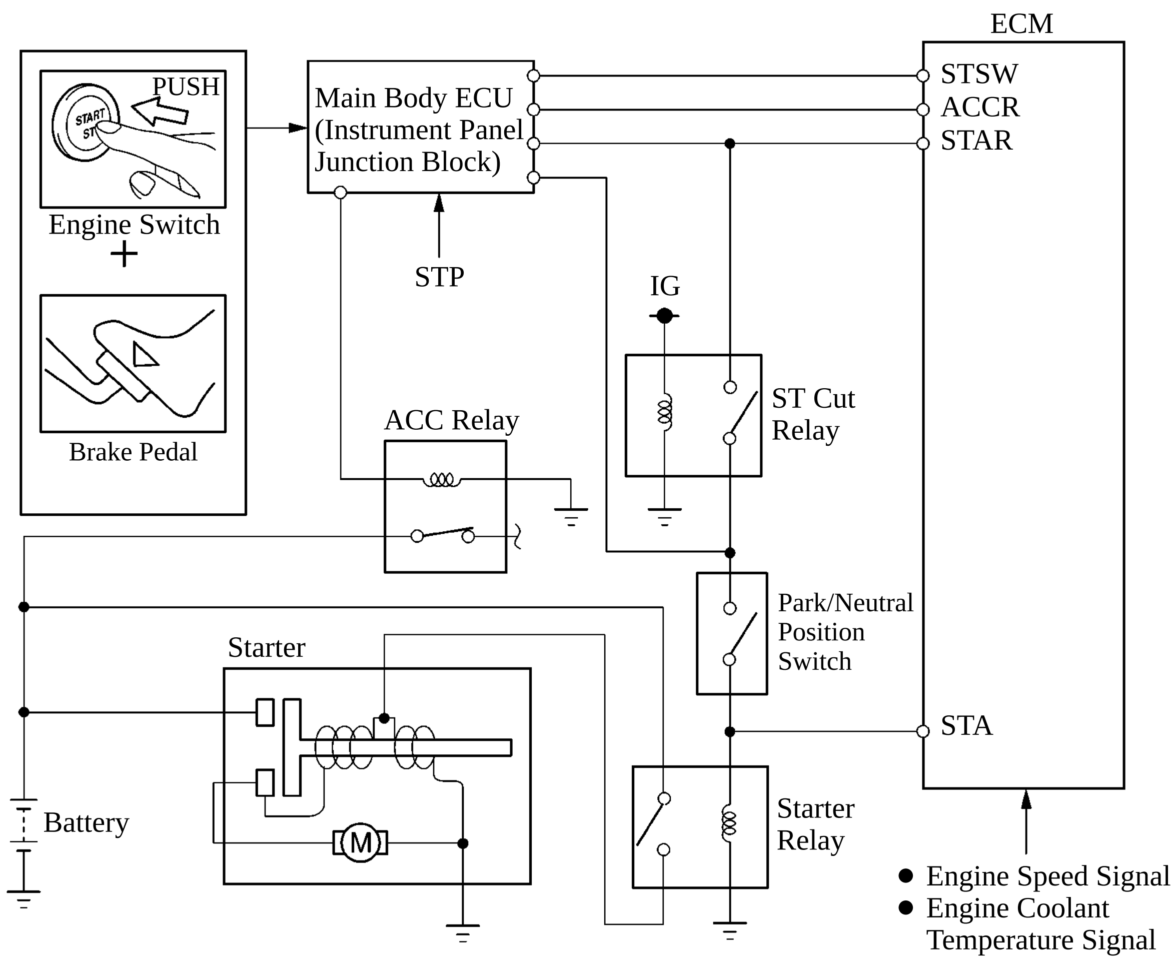


*1: Manual Transaxle Models
*2: Automatic Transaxle Models

2) For Models with Smart Key System

- Once the engine switch is pushed, this function continues to operate the starter until the engine starts, provided that the brake pedal is pressed. This prevents starting failures and the engine from being cranked after the engine has started.
- When the ECM detects a start signal from the main body ECU, this system monitors the engine speed (NE) signal and continues to operate the starter until it determines that the engine has started. Furthermore, even if the ECM detects a start signal from the main body ECU, this system will not operate the starter if the ECM has determined that the engine has already started.
- If the starter relay (STAR) signal cannot be output because the power supplied to the ECM is low, the main body ECU outputs the starter relay (STAR) signal instead to help actuate the starter.

▶ System Diagram ◀



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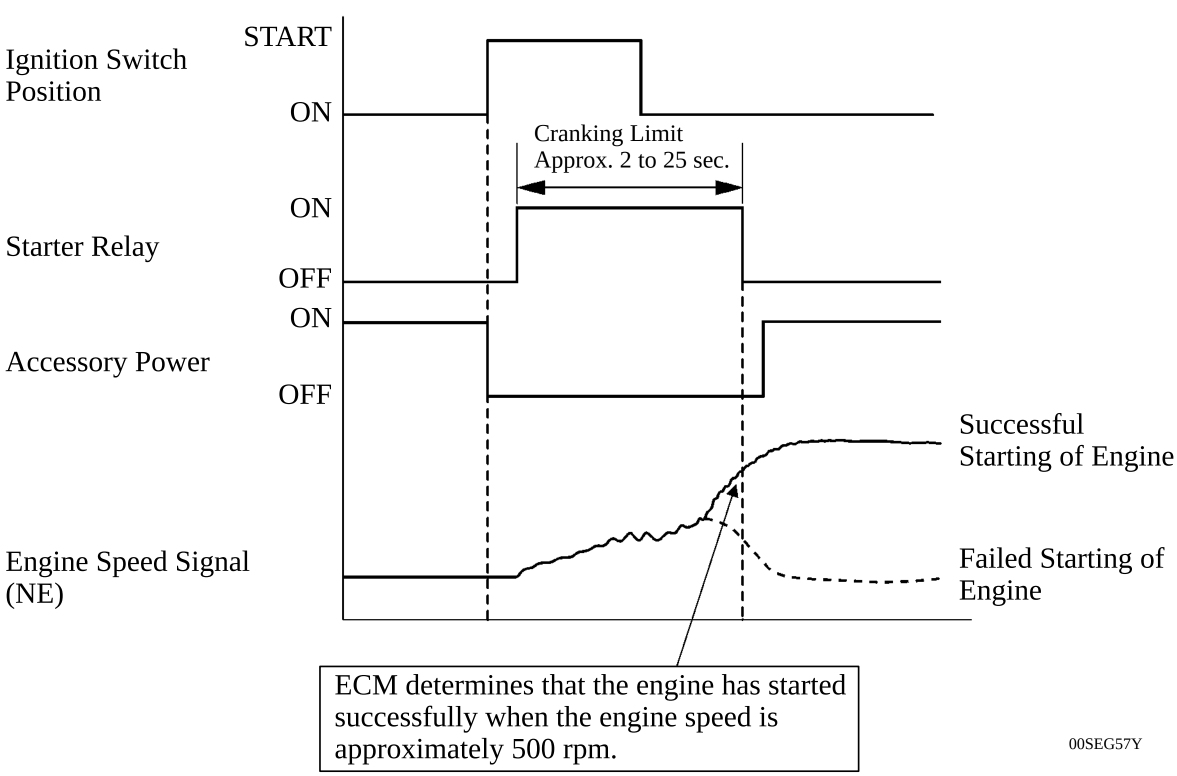
Operation

1) For Models without Smart Key System

- As indicated in the following timing chart, when the ECM detects a start signal from the ignition switch, it energizes the starter relay to operate the starter. If the engine is already running, the ECM will not energize the starter relay.
- After the starter operates and the engine speed becomes higher than approximately 500 rpm, the ECM determines that the engine has started and stops the operation of the starter.
- If the engine has any failure and does not work, the starter operates as long as its maximum continuous operation time and stops automatically. The maximum continuous operation time is approximately 2 seconds through 25 seconds depending on the engine coolant temperature condition. When the engine coolant temperature is extremely low, it is approximately 25 seconds and when the engine is warmed up sufficiently, it is approximately 2 seconds.
- This system cuts off the current that powers the accessories while the engine is cranking to prevent the accessory illumination from operating intermittently due to the unstable voltage that is associated with the cranking of the engine.
- This system has the following protections.
  - In case that the starter begins to operate, but cannot detect the engine speed signal, the ECM will stop the starter operation immediately. However, if the ignition switch is held in the START position, the starter continues to operate.

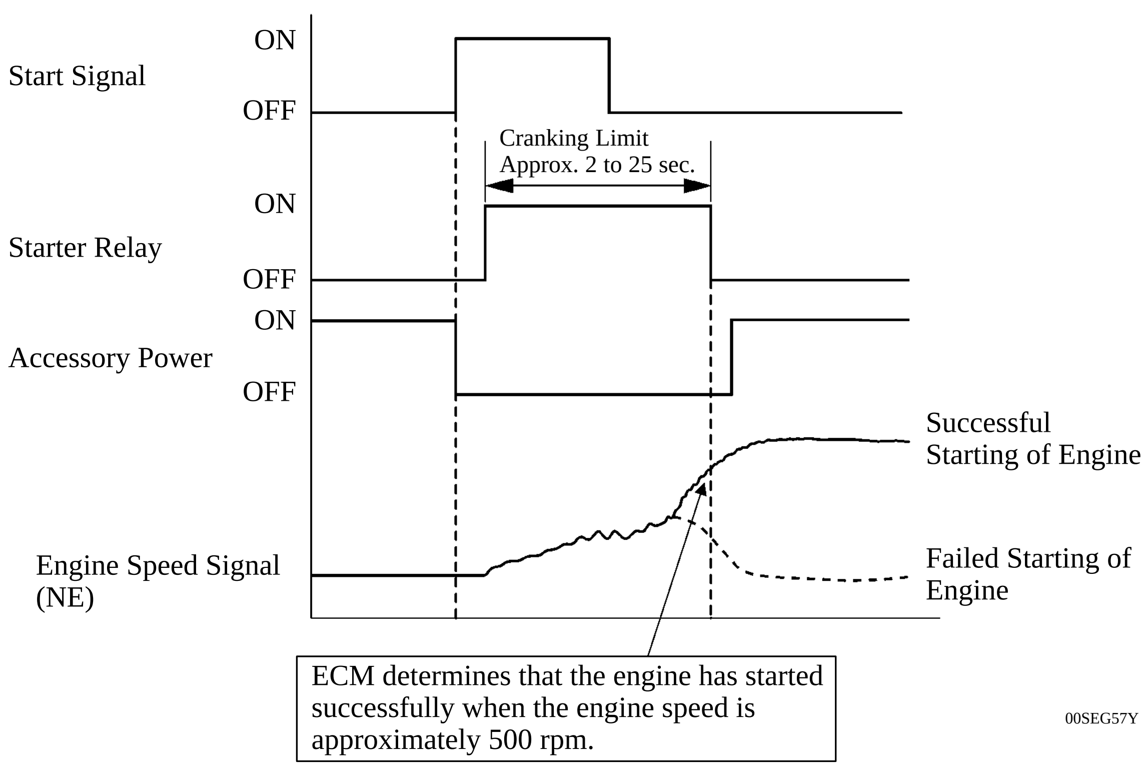
▶ Timing Chart ◀



2) For Models with Smart Key System

- As indicated in the following timing chart, when the ECM detects a start signal (STSW) from the main body ECU, the ECM outputs the STAR and ACCR signals to the main body ECU. Upon detecting the STAR and ACCR signals from the ECM, the main body ECU energizes the starter relay to operate the starter. If the engine is already running, the ECM stops the output of the STAR and ACCR signals to the main body ECU. Thus, the main body ECU will not energize the starter relay.
- After the starter operates and the engine speed becomes higher than approximately 500 rpm, the ECM determines that the engine has started and stops the output of the STAR and ACCR signals to the main body ECU. Thus, the main body ECU will stop the operation of the starter.
- If the engine has any failure and does not work, the starter operates as long as its maximum continuous operation time and stops automatically. The maximum continuous operation time is approximately 2 seconds through 25 seconds depending on the engine coolant temperature condition. When the engine coolant temperature is extremely low, it is approximately 25 seconds and when the engine is warmed up sufficiently, it is approximately 2 seconds.
- This system cuts off the current that powers the accessories while the engine is cranking to prevent the accessory illumination from operating intermittently due to the unstable voltage that is associated with the cranking of the engine.
- This system has the following protections.
  – While the engine is running normally, the starter does not operate.
  – In case the driver keeps pressing the engine switch and the engine successfully started, the ECM stops the output of the STAR and ACCR signals when the engine speed becomes higher than 1,200 rpm. Thus, the main body ECU will stop the operation of the starter.
  – In case the driver keeps pressing the engine switch and the engine does not start, the ECM stops the output of the STAR and ACCR signals after 30 seconds have elapsed. Thus, the main body ECU will stop the operation of the starter.
  – In case the ECM cannot detect an engine speed signal while the starter is operating, the ECM will immediately stop the output of the STAR and ACCR signals. Thus, the main body ECU will stop the operation of the starter.

▶ Timing Chart ◀



12. Diagnosis

- When the ECM detects a malfunction, the ECM makes a diagnosis and memorizes the failed section. Furthermore, the MIL in the combination meter illuminates or blinks to inform the driver.
- The ECM will also store the DTCs of the malfunctions. The DTCs can be accessed by the use of the Techstream.
- For details, refer to the 2009 Corolla Repair Manual (Pub. No. RM08M0U).

Service Tip

To clear the DTC that is stored in the ECM, use a Techstream or disconnect the battery terminal or remove the EFI fuse for 1 minute or longer.

13. Fail-safe

When a malfunction is detected at any of the sensors, there is a possibility of an engine or other malfunction occurring if the ECM were to continue to control the engine control system in the normal way. To prevent such a problem, the fail-safe function of the ECM either relies on the data stored in memory to allow the engine control system to continue operating, or stops the engine if a hazard is anticipated. For details, refer to the 2009 Corolla Repair Manual (Pub. No. RM08M0U).