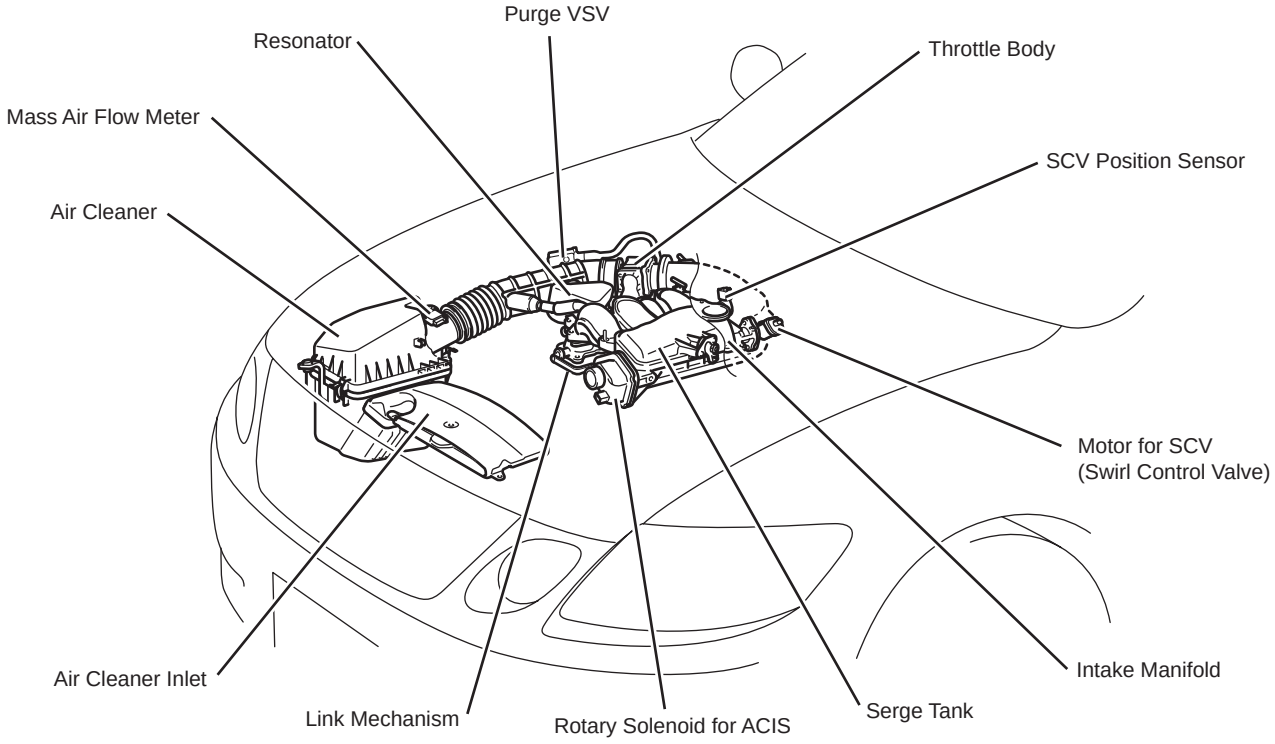
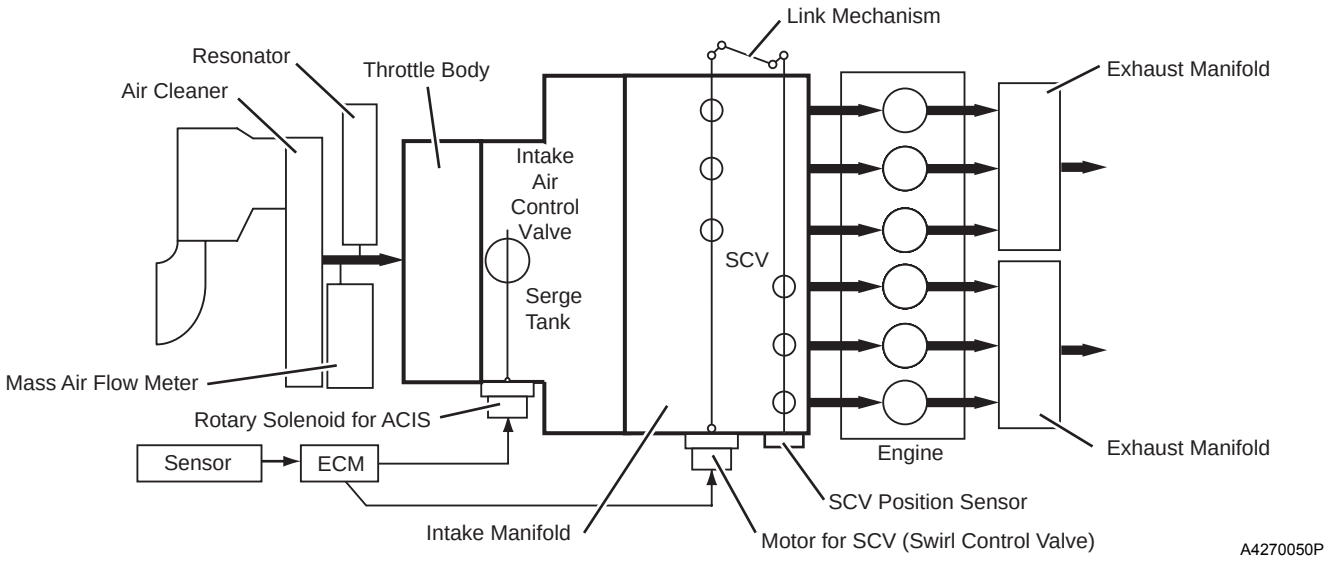
3GR-FSE INTAKE

General

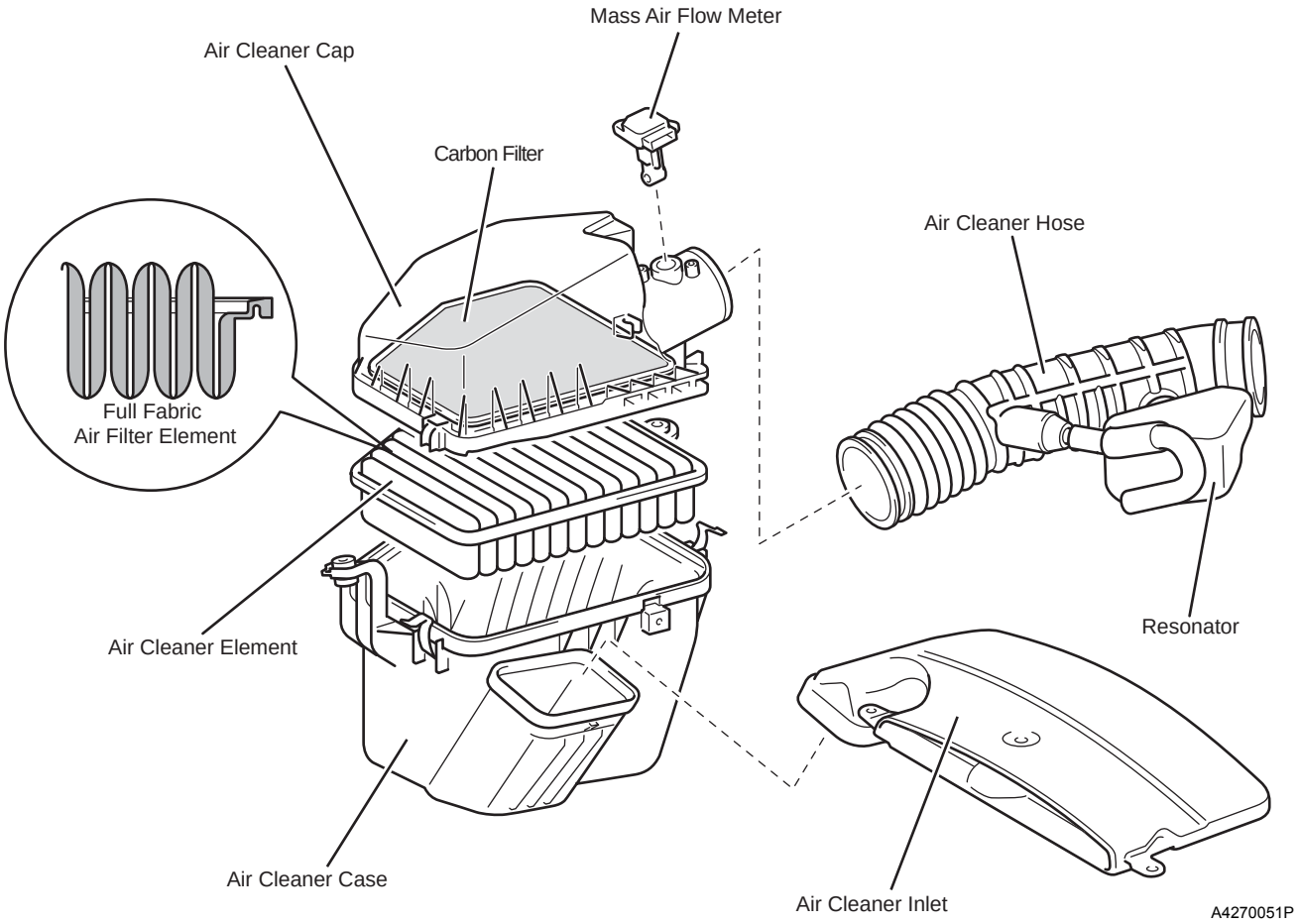
- A surge tank with a built-in ACIS (Acoustic Control Induction System) and an intake manifold with a built-in SCV (Swirl Control Valve) are used.
- A hot-wire type Mass airflow meter (with a built-in intake air temperature sensor) is provided in the air cleaner cap.
- The ETCS-i system is used and a single-valve, electronically controlled throttle body is installed.





Air Cleaner

- A removable cap type air cleaner case is used for enhanced serviceability. Also, an Mass airflow meter (with a built-in intake air temperature sensor) is provided in the air cleaner cap.
- A dry type air cleaner element is used and provided with an ample filtering surface area.
- A compact resonator is provided in the air cleaner hose to reduce intake noise.
- A full fabric air filter element, which does not contain an outer frame or rubber seal, is used. As a result, the case could be made compact, with recyclability in mind.
- A carbon filter,which adsorbs the HC that accumulates in the intake system when the engine is stopped ,has been adopted in the air cleaner cap in order to reduce evaporative emissions.(For U.S.A.,Canada,Koria,Taiwan)

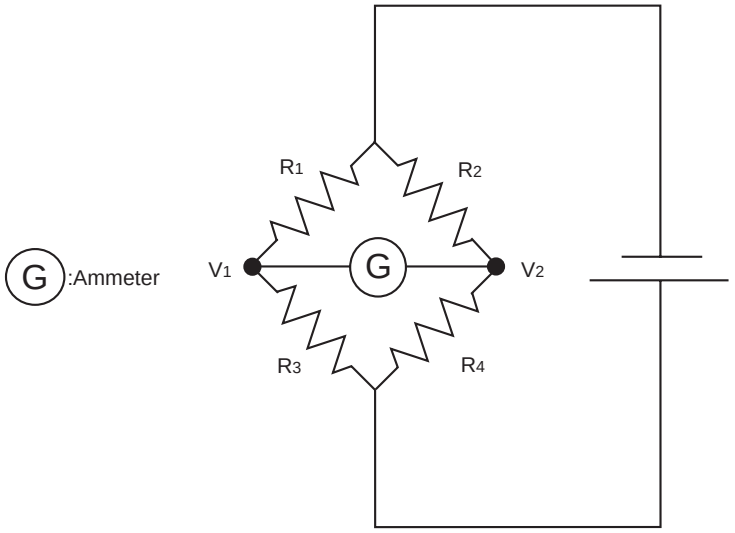


Mass Air Flow Meter

- This mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision has been improved and the intake air resistance has been reduced.
- This mass air flow meter has a built-in intake air temperature sensor.
- This system measures the air flow in the bypass, which is less likely to be affected by the intake pulsations created by the air cleaner. Also, the flow path is constructed to minimize flow resistance, thus reducing flow loss. Therefore, this system can measure small to large airflow in a precise manner.

Hot Wire Type Mass Air flow Meter Operation

- A hot-wire measurement portion measures the volume of the intake air that is partially routed through a bypass. The hot-wire, which uses a platinum filament, measures the intake air volume of the engine by comprising a bridge circuit that consists of an intake temperature measurement resistor and a heating resistor (heater). In principle, this airflow meter can directly measure the mass flow due to the nature of the hot-wire type MAF (Mass Air Flow) meter. Therefore, it does not require a density correction to counter the changes in the intake temperature. However, it does require intake temperature data in order to effect engine control such as in SFI (Sequential Fuel Injection). For this reason, the MAF (Mass Air Flow) meter contains a compact, thermistor type intake temperature sensor that detects the intake temperature.
- The bridge circuit is connected as shown in the diagram below. When R1 x R4 = R2 x R3 is established in this circuit, V1 becomes V2, causing the ammeter G to indicate 0.



Bridge Circuit

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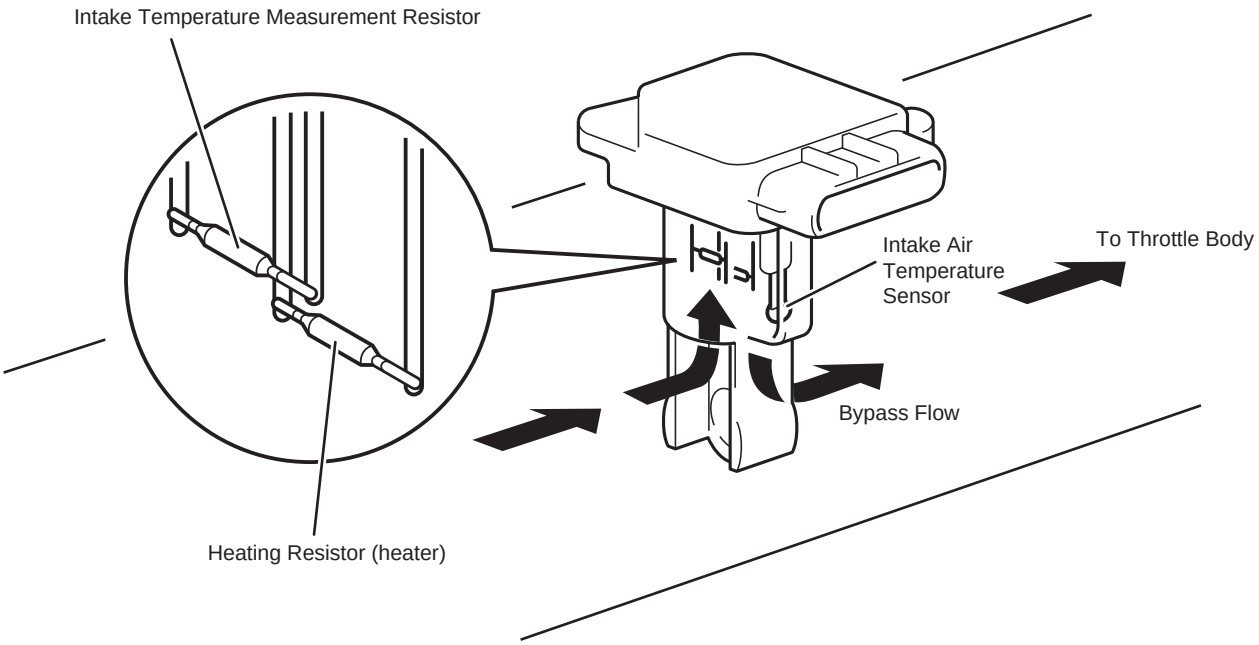
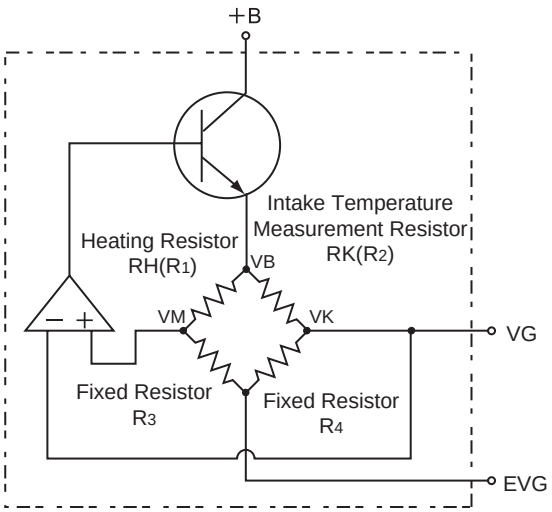
- When the intake air volume changes, the bridge circuit in the hot-wire measurement portion effects feedback control to supply electricity to the heating resistor, in order to maintain a constant difference in temperature between the intake temperature measurement resistor and the heating resistor (heater). Then, it converts the supplied electricity into voltage and outputs it to the ECM. The ECM calculates the engine intake air volume based on a predetermined relationship between the MAF (Mass Air Flow) meter output voltage and the flow volume.
- The diagram below describes the configuration of the bridge circuit of the hot-wire type MAF (Mass Air Flow) meter. For example, if the intake volume that is drawn in increases, it cools the heating resistor and decreases the RH value, thus resulting in RH (R1) x R4 < RK (R2) x R3, VM ≠VK. When the control unit detects this condition, it effects control to increase the amperage that flows from the power supply to VB (to heat RH), in order to result in RH (R1) x R4 = RK (R2) x R3, VM = VK.





Bridge Circuit

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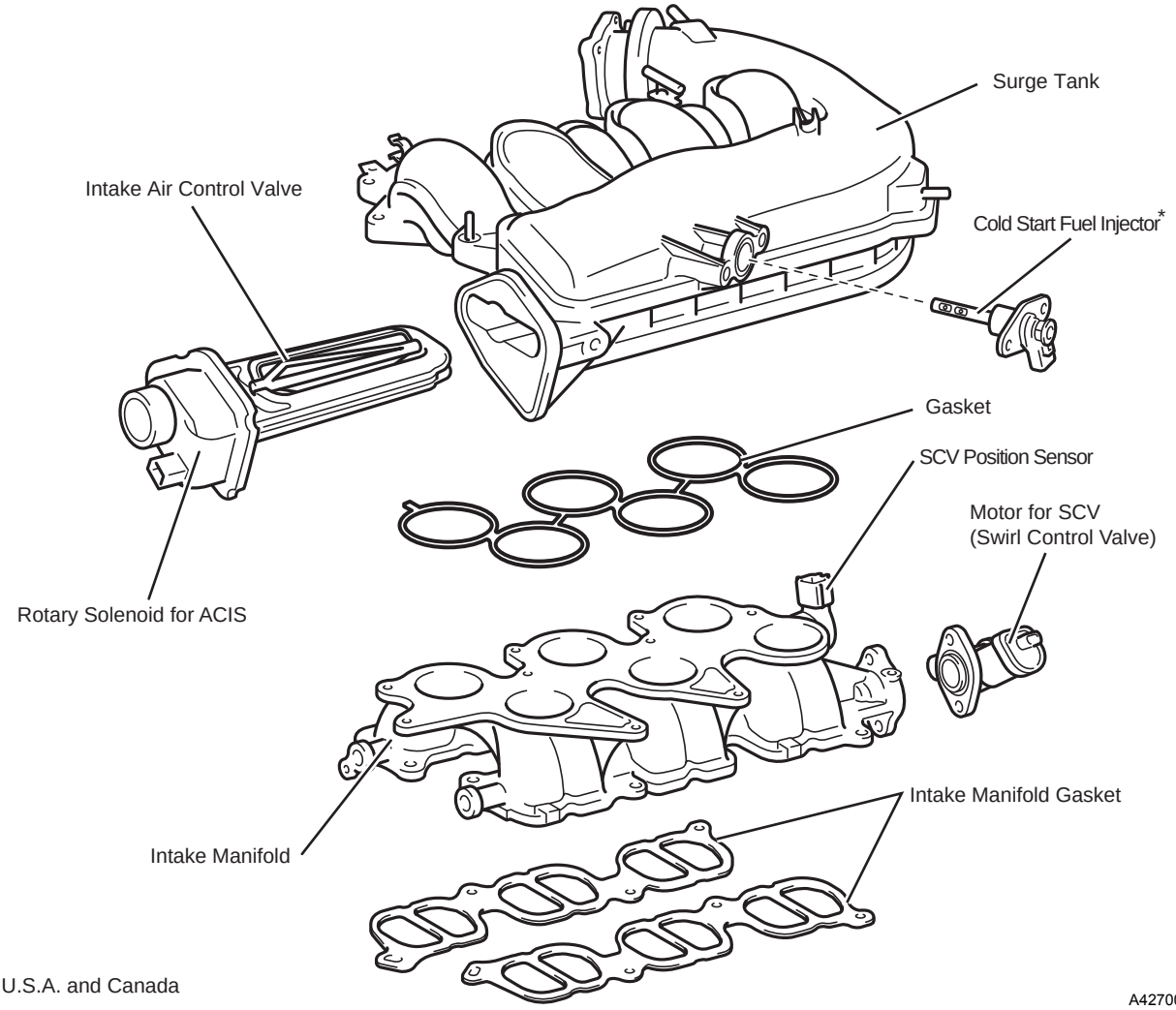
Intake Manifold

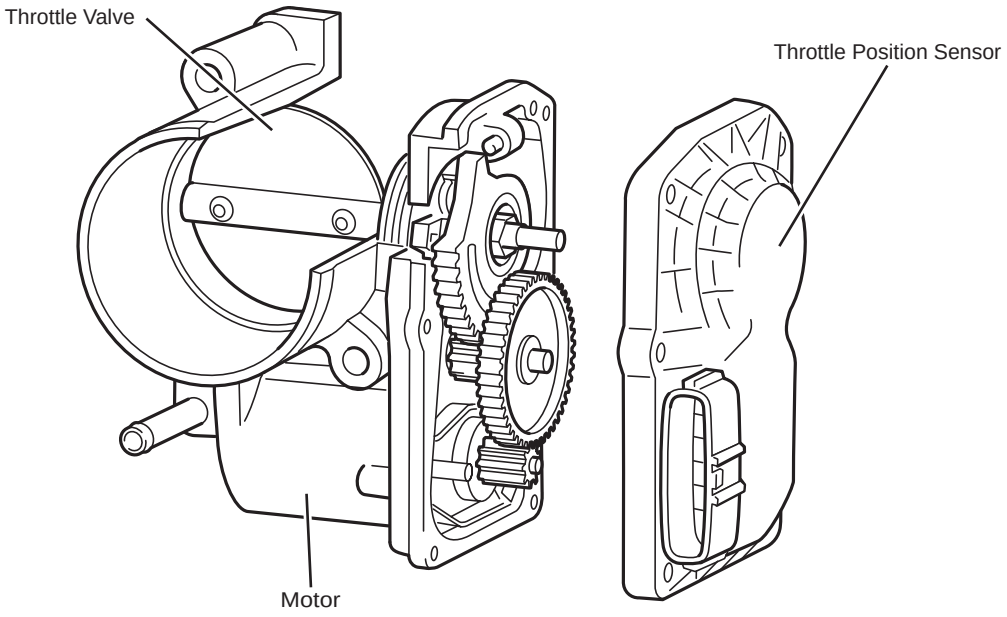
- An ACIS (Acoustic Control Induction System) with independent ports and an intake system with a swirl control valve (SCV) are used. The port diameter and length have been optimized to strike a balance between high torque in all driving ranges and fuel economy performance.
- A swirl control valve (SCV) is provided in the intake manifold to stabilize combustion while the water temperature is low, and open-close control is effected to achieve a higher torque at low engine speeds.
- A plastic surge tank is used for weight reduction. Also, an ACIS (Acoustic Control Induction System) is used, and the intake manifold length has been made variable to increase the torque in all ranges.



Throttle Body

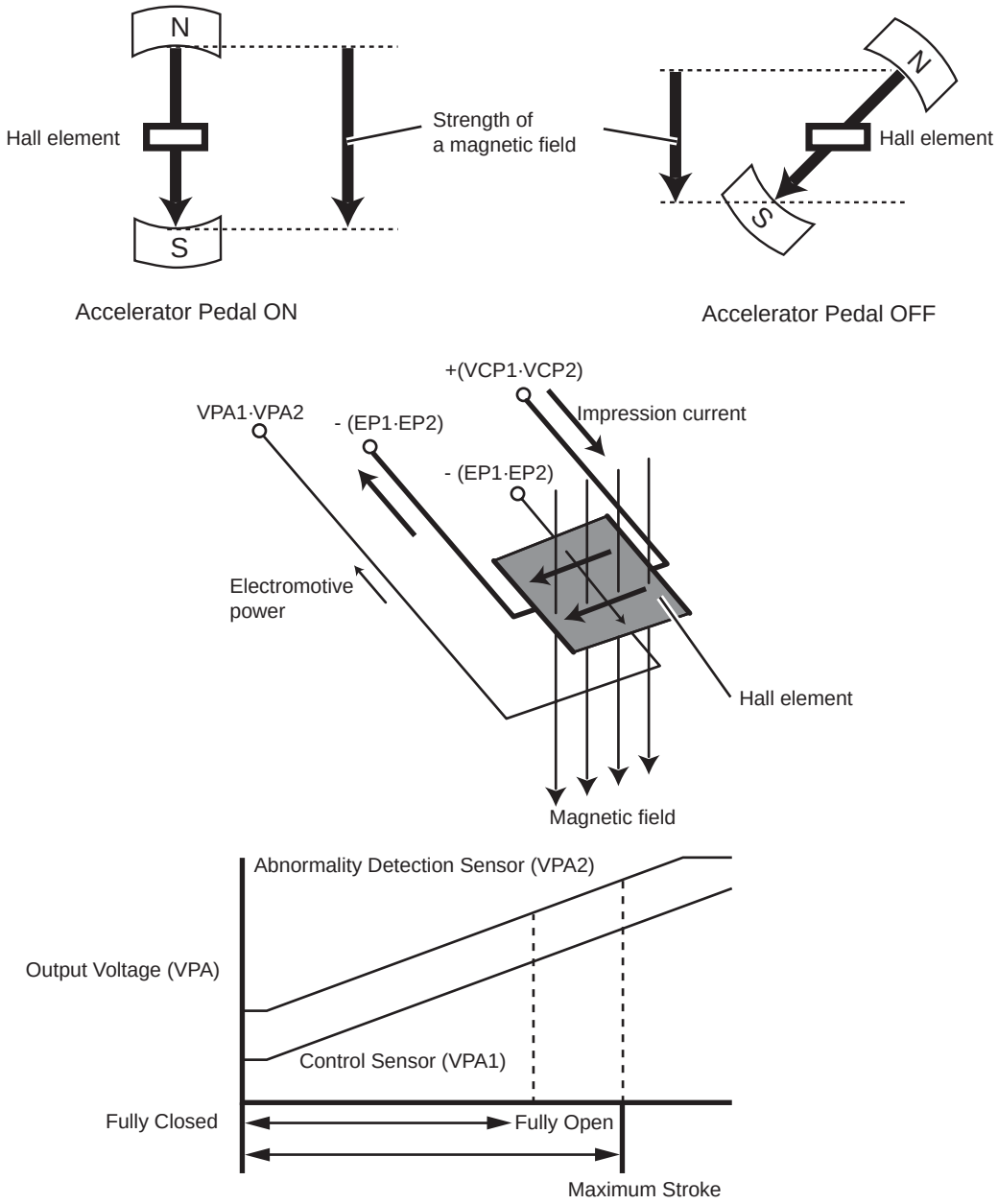
- The adoption of the ETCS-i has realized excellent throttle control.
- The accelerator pedal position sensor is attached to the accelerator pedal.
- A link-less type throttle body has been adopted.
- The accelerator position sensor, which is provided on the accelerator pedal, transmits the operation by the driver (amount of pedal effort on the accelerator) to the ECM. The ECM determines the throttle position that suits the driving conditions and actuates the throttle motor. Then, the throttle position sensor gives feedback regarding the throttle valve position to the ECM.
- A motor with excellent response and minimal power consumption is used for the throttle control motor. The ECM performs the duty ratio control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the opening angle of the throttle valve.
- Both the accelerator position sensor and the throttle position sensor consist of two internal circuits (main, sub), in order to constantly monitor the system for malfunctions.
- If a malfunction is detected, the system illuminates a warning light in the combination meter to alert the driver, and cuts the current to the motor. The throttle valve return spring returns the throttle valve to a predetermined position. Thus, by cutting the fuel injection off and retarding the ignition timing, the system regulates the engine power output in accordance with the accelerator position to enable the vehicle

to continue driving.



Accelerator Pedal Position sensor

- This sensor, which is mounted on the accelerator pedal, detects the amount of pedal effort applied to the accelerator. By using a Hall element, this electronic position sensor enables accurate control and ensures permanent reliability. When the amount of pedal effort applied to the accelerator changes, this sensor sends the angle of the magnetic field in relation to the flow of the applied current in the Hall element (VCP1 -> EP1, VCP2 -> EP2) in the form of an accelerator pedal effort signal to the ECM. In addition, this sensor consists of a dual system having different output characteristics to ensure reliability.

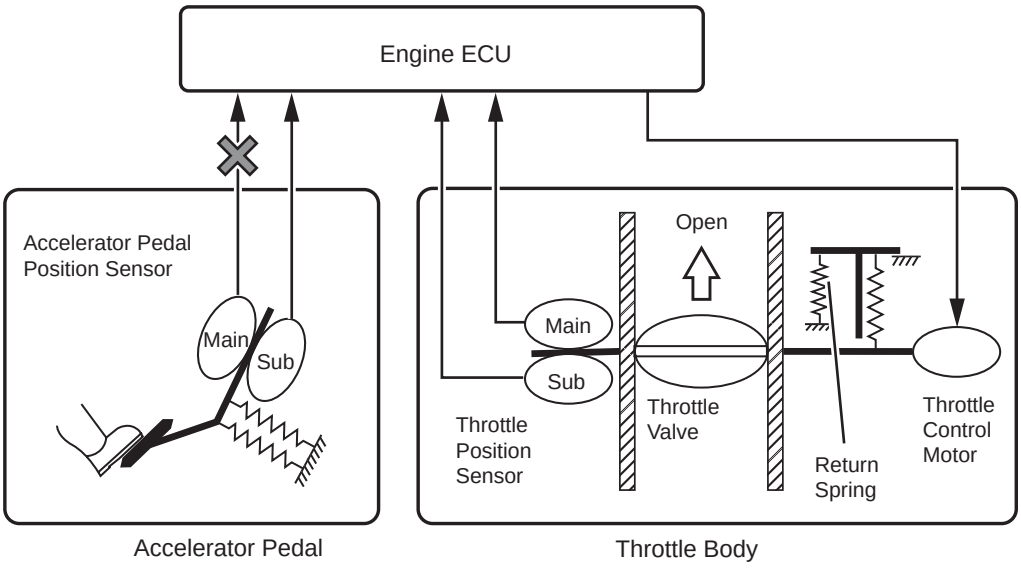


Fail Safe

- The accelerator position sensor comprises two (main, sub) sensor circuits, to detect the pedal position. In case of an abnormal condition in the signal, the ECM switches to the failsafe driving mode.

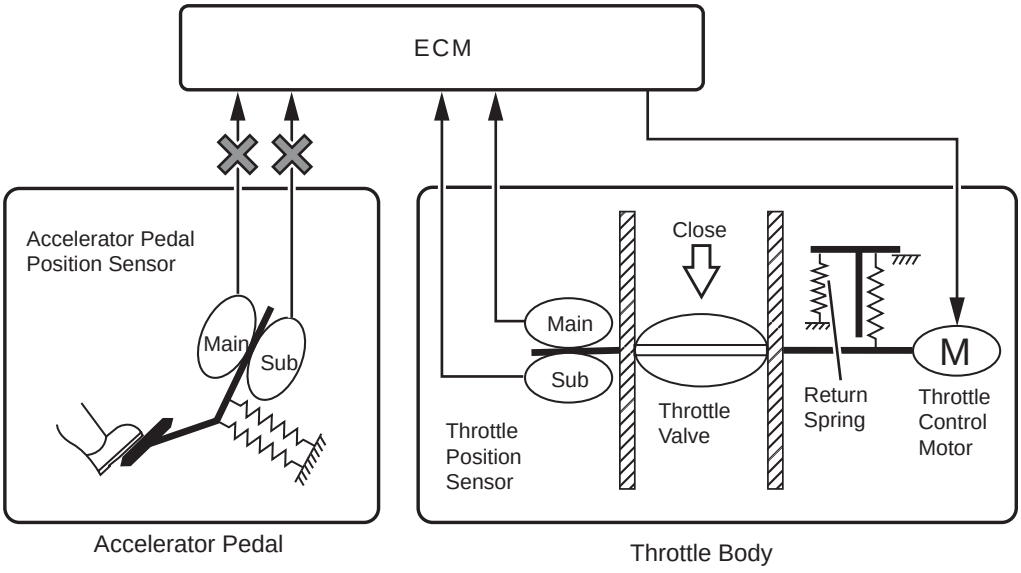
System 1 Failure

The accelerator pedal position sensor comprises two (main, sub) sensor circuits. If a malfunction occurs in either one of the sensor circuits, the ECM detects the abnormal signal voltage difference between these two sensor circuits and switches to the limp mode. In the limp mode, the remaining circuit is used to calculate the accelerator pedal opening, in order to operate the vehicle under limp mode control.



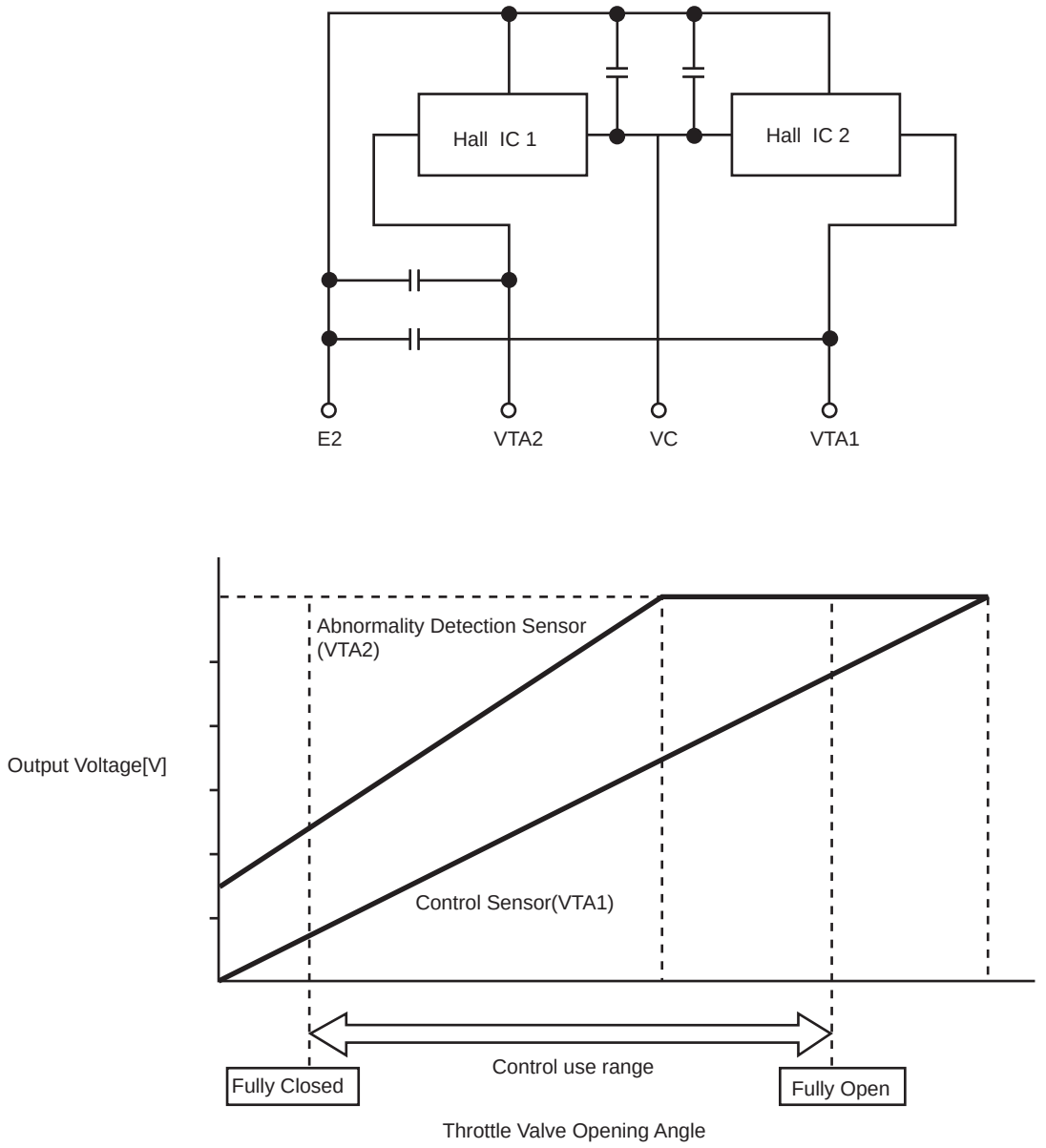
System 2 Failure

If both systems malfunction, the ECM detects the abnormal signal voltage between these two sensor circuits and regards that the opening angle of the accelerator pedal is fully opened and then continues the throttle control. At this time, the vehicle can be driven within its idling range.



Throttle Position Sensor

- This sensor, which is located in the throttle body, detects the position of the throttle valve. By using a Hall element, in the same way as the accelerator position sensor, this electronic position sensor enables accurate control and ensures permanent reliability. In addition, this sensor consists of a dual system having different output characteristics to ensure reliability.



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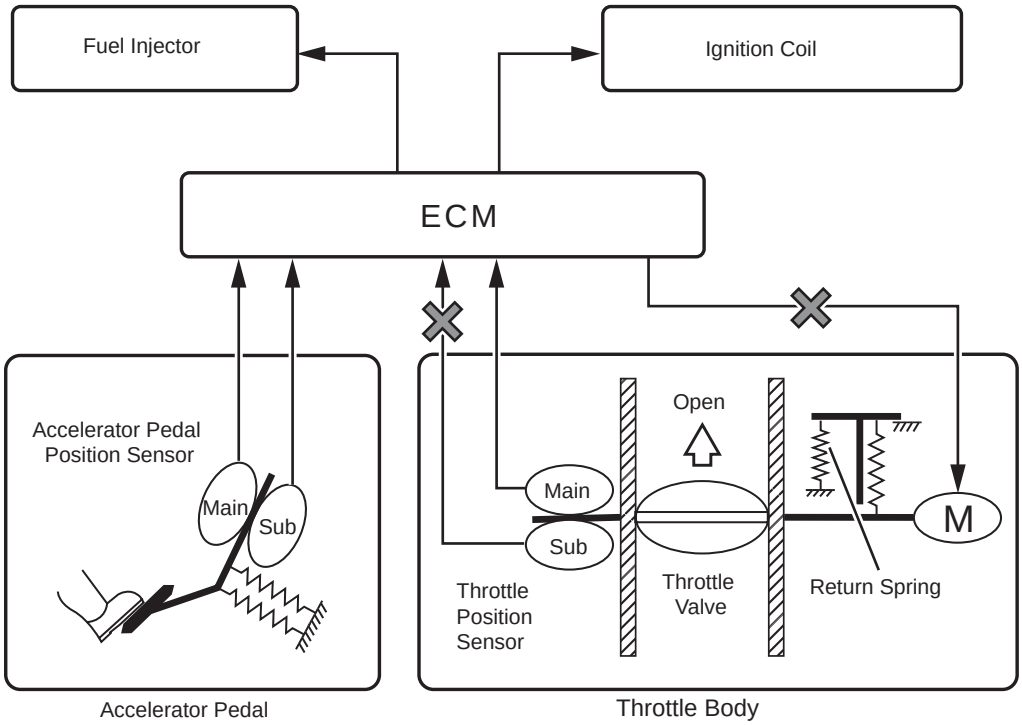
Fail Safe

- The throttle position sensor comprises two (main, sub) sensor circuits, to detect the throttle position. In case of an abnormal condition in the signal, the ECM switches to the failsafe driving mode.

Failure Detection

The throttle position sensor comprises two (main, sub) sensor circuits. If a malfunction occurs in either one of the sensor circuits, the ECM detects the abnormal signal voltage difference between these two sensor circuits, cuts off the current to the throttle control motor, and switches to the limp mode. Then, the force of the return spring causes the throttle valve to return and stay at the prescribed opening. At this time, the vehicle can be driven in the limp mode while the engine output is regulated through the control of the fuel injection and ignition timing in accordance with the accelerator opening.



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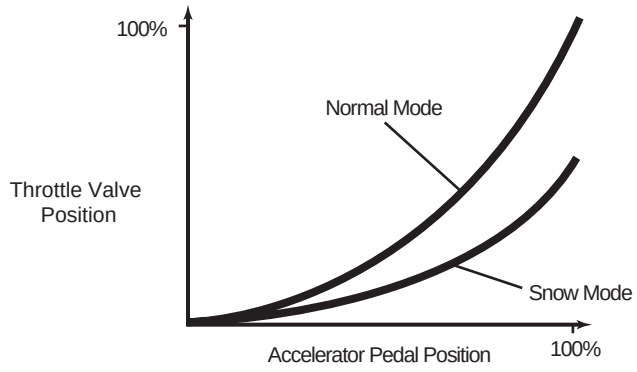
ETCS-i (Electronic Throttle Control System-intelligent)

- In the conventional throttle body, the throttle valve opening is determined invariably by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the ECM to calculate the optimal throttle valve opening that is appropriate for the respective driving condition and uses a throttle control motor to control the opening.
- The functions of the ordinary throttle position control (nonlinear control), idle speed control (ISC), traction control (including VSC), and cruise control have been integrated in the single-valve electronically controlled throttle body.
- Excellent driving stability and comfort have been achieved by effecting integrated control with the power train, and vehicle stability has been ensured through cooperative control with the ECT and VSC systems.
- Two CPUs, one for the ETCS-i, and the other for the SFI control, monitor each other to ensure a reliable system.
- A dual system is used so that the vehicle can continue to operate in the event of a problem, thus ensuring reliability.

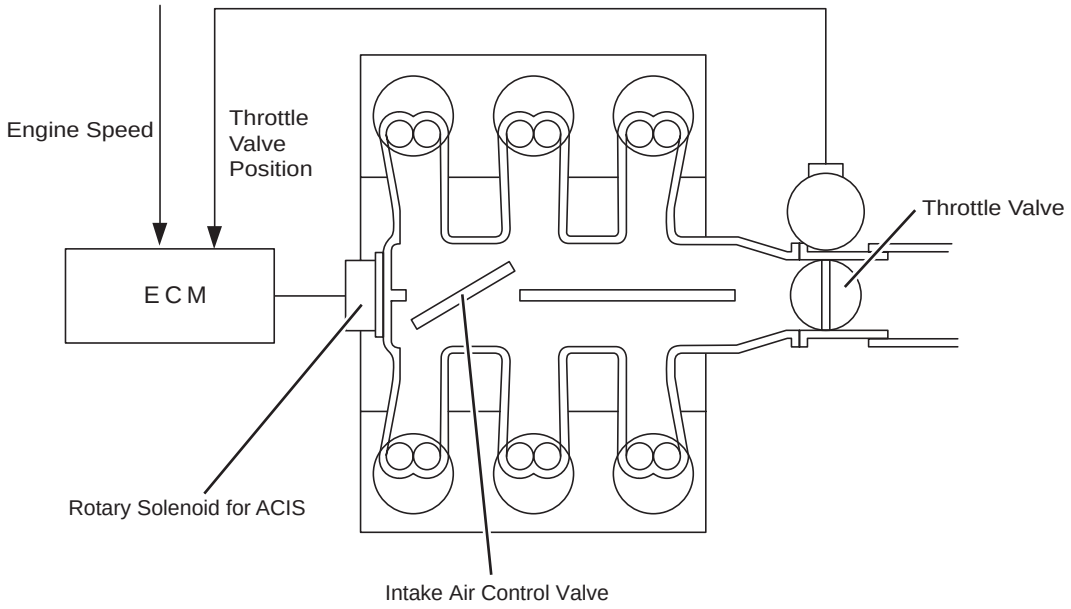
ETCS-i Control

Nonlinear Control	Normal-mode Control	Controls the throttle to an optimal throttle valve opening that is appropriate for the driving condition such as the amount of the accelerator pedal effort and the engine operating condition in order to realize excellent throttle control and comfort in all operating ranges.
	SNOW-mode Control	In situations in which low-μ surface conditions can be anticipated, such as when driving in the snow, the throttle valve can be controlled to help vehicle stability while driving over the slippery surface. This is accomplished by turning on the SNOW switch of the pattern select switch, which, in response to the amount of the accelerator pedal effort that is applied, reduces the engine output from that of the normal driving level.
ECT + SFI + ETCS-i Integrated Control (Shift Shock Reduction Control)		During the shifting of the ECT, this control regulates the throttle valve position in order to reduce the shift shock that occurs during shift up and down, and shorten the shifting duration.
Maximum Speed Control		When the vehicle speed reaches 240 km/h, this control closes the throttle valve to suppress the increase of vehicle speed.
TRC (VSC) + ETCS-i Cooperative Control (models equipped with VSC)		In order to bring the effectiveness of the VSC system control into full play, the throttle valve opening angle is controlled by effecting a coordination control with the skid control ECU.
Idle Speed Control		Controls the fast idle speed in accordance with the engine coolant temperature, and the idle speed after the engine has been warmed up. It controls the idle speed by regulating the fuel injection volume and the throttle position.



Electronic ACIS (Acoustic Control Induction System)

- Pressure fluctuations are indirectly created in the intake manifold by the intake stroke. The influence exerted on the subsequent intake stroke by the pressure fluctuations remaining in the intake manifold, even after the intake valve has closed, is called a pulsation effect. When the pressure fluctuations that remain after the intake valve has closed coincides with the subsequent intake stroke, the pressure increases at the time the valve opens, the intake air volume increases, and the torque increases.
- To proactively utilize this pulsation effect, the Acoustic Control Induction System changes the effective intake manifold length in accordance with the cycle of the pulsation flow that changes with the engine speed, in order to increase the torque in all ranges.

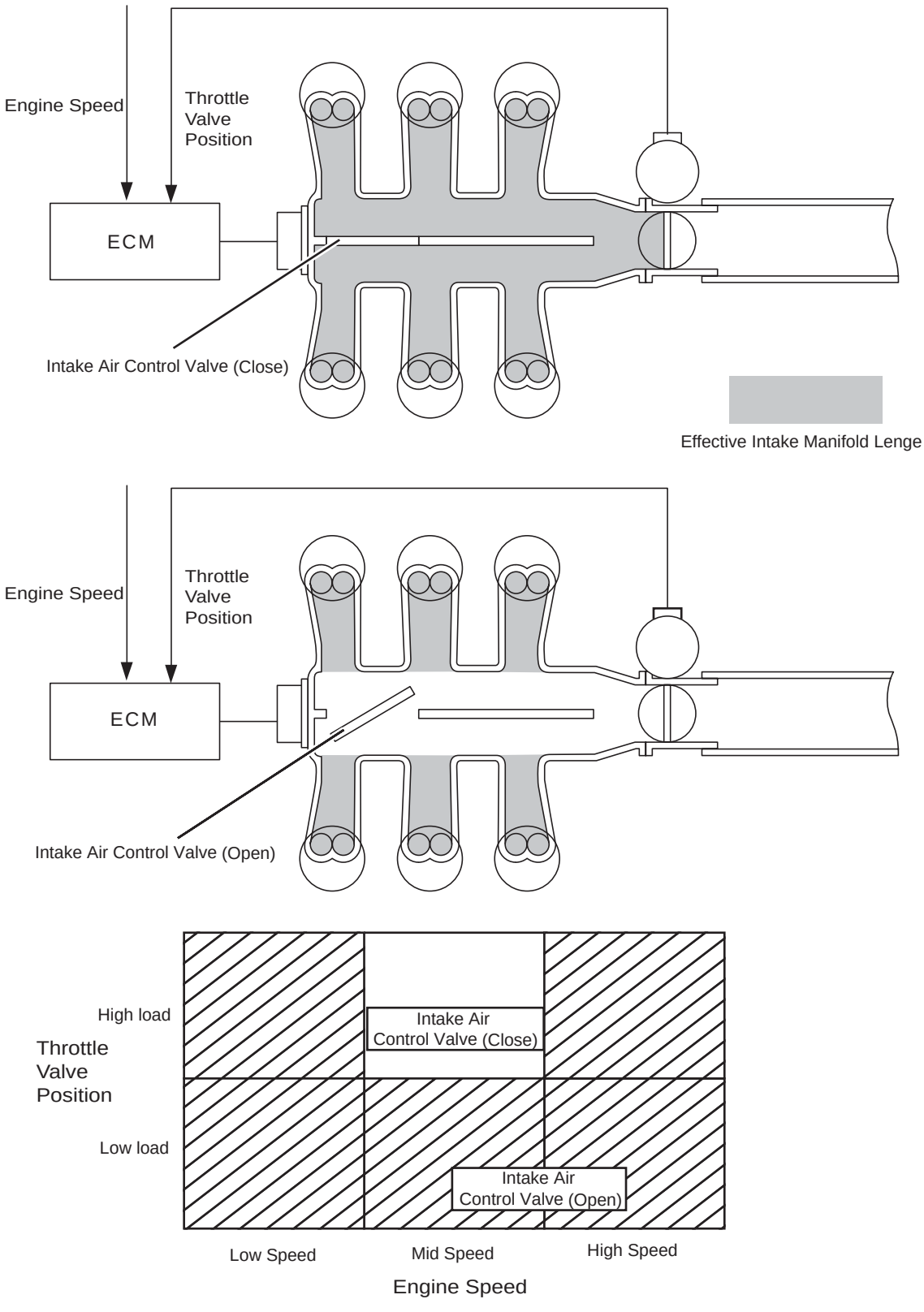


List of Functions

Device Name	Function
Crankshaft Position Sensor	Detects engine speed.
Throttle Position Sensor	Detects throttle valve position.
Intake Air Control Valve	Opens and closes the valve to switch the effective intake manifold length in two stages.
Rotary Solenoid for ACIS	Opens and closes the Intake Air Control valve under the command of the ECM.
ECM	Sends a signal to the ACIS rotary solenoid at an appropriate timing in accordance with the signals received from the sensors.

Electronic ACIS Operation

- The ECM opens and closes the Intake Air Control valve in accordance with the engine speed and the throttle valve position, in order to enhance the torque in all ranges, particularly in the medium-speed range.



Electronic SCV (Swirl Control Valve)

- The SCVs on the right and left banks are connected with a linkage mechanism, enabling both SCVs to be actuated with a single, compact motor, thus realizing a lightweight and compact construction.
- An SCV, which is provided at one of the two independent intake ports, opens and closes under the control signals received from the ECM.
- Closing one of the ports accelerates the speed of the intake air that flows through the other port, and strengthens the lateral turbulence in the combustion chamber. This results in promoting the atomization of fuel when the water temperature is low, thus stabilizing combustion. In addition, this improves combustion efficiency in the low-speed, light load range, resulting in improved fuel economy.
- Based on the engine speed, Engine Coolant temperature, and load signals, the ECM actuates the motor of the SCV in order to open and close the valve.