SFI SYSTEM

GENERAL

1. OUTLINE

(a) The engine control system performs highly accurate, integrated control of the following systems to achieve high performance, high power, high fuel efficiency and reduce emissions

(1) Sequential Multiport Fuel Injection (SFI)
(2) Electronic Spark Advance (ESA)
(3) Electronic Throttle Control System-intelligent (ETCS-i)
(4) Dual Variable Valve Timing-intelligent (VVT-i)
(5) Acoustic Control Induction System (ACIS)
(6) Tumble Control System
(7) Fuel Pump Control
(8) Air Conditioning Cut-off Control
(9) Cooling Fan Control
(10) Starter Control (Cranking Hold Function)*
(11) Air Fuel Ratio Sensor and Oxygen Sensor Heater Control
(12) Engine Immobiliser
(13) Diagnosis
(14) Fail-safe

*: Models with smart key system

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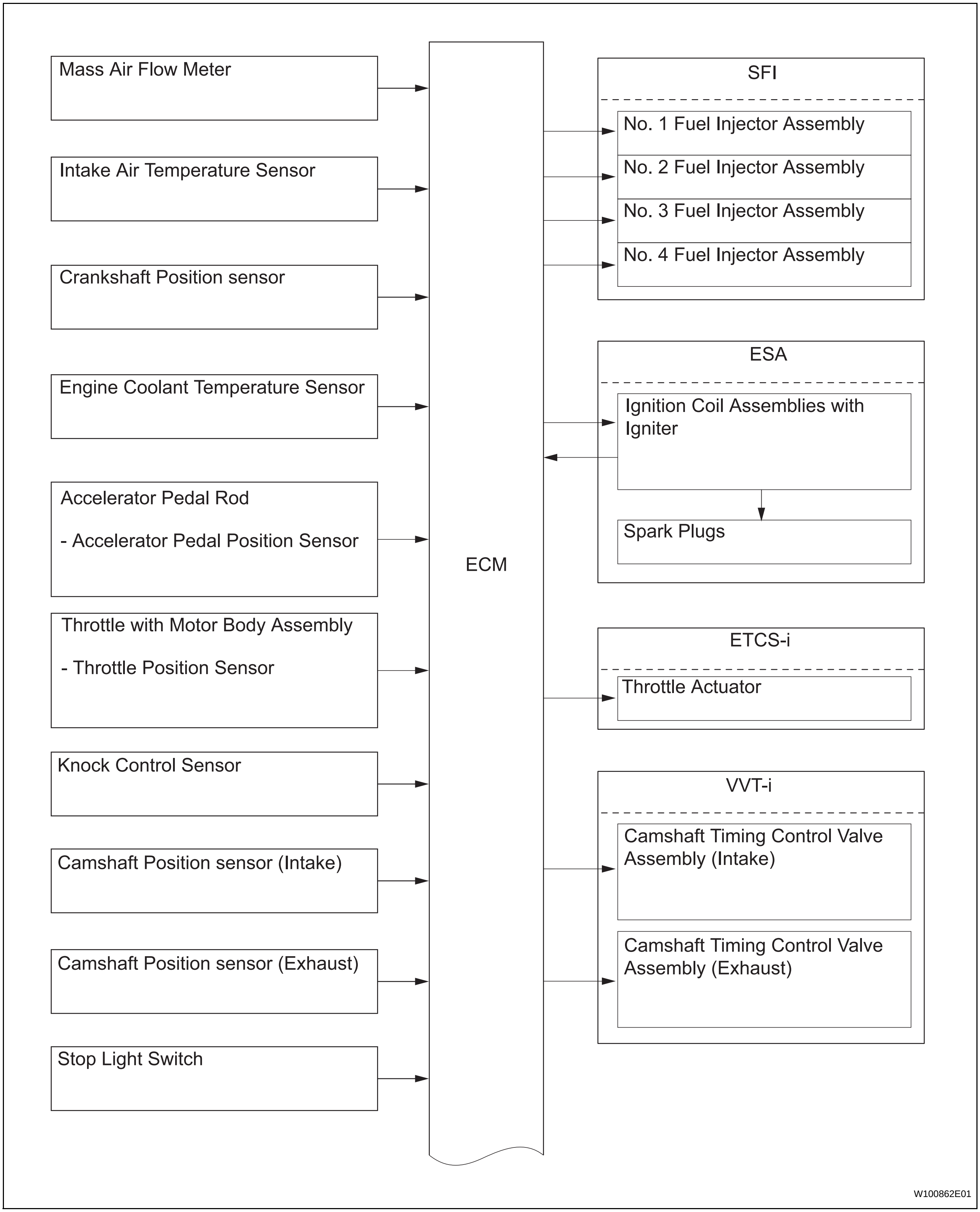
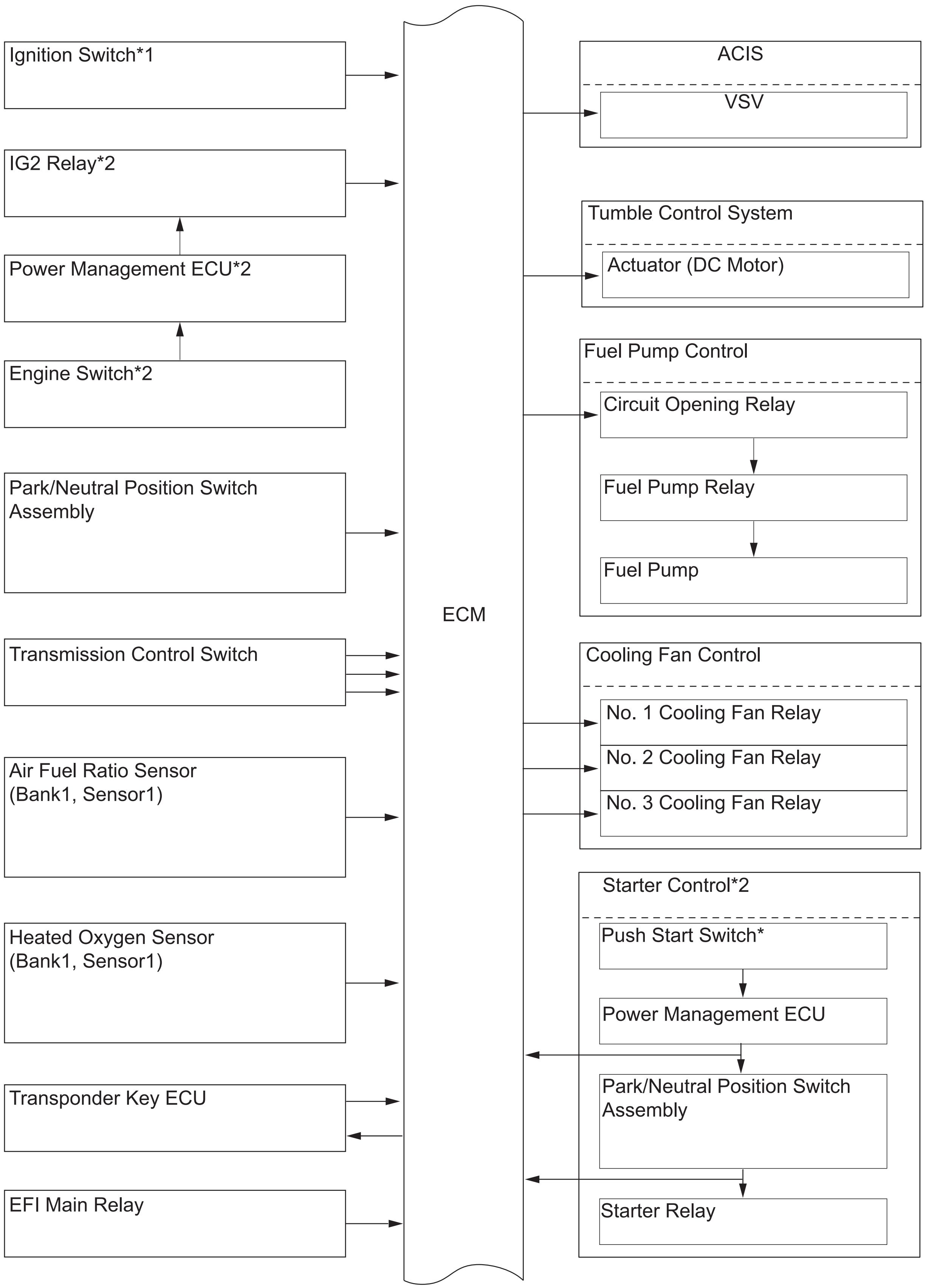
SYSTEM DIAGRAM





*1 Models without Smart Key System

*2 Models with Smart Key System

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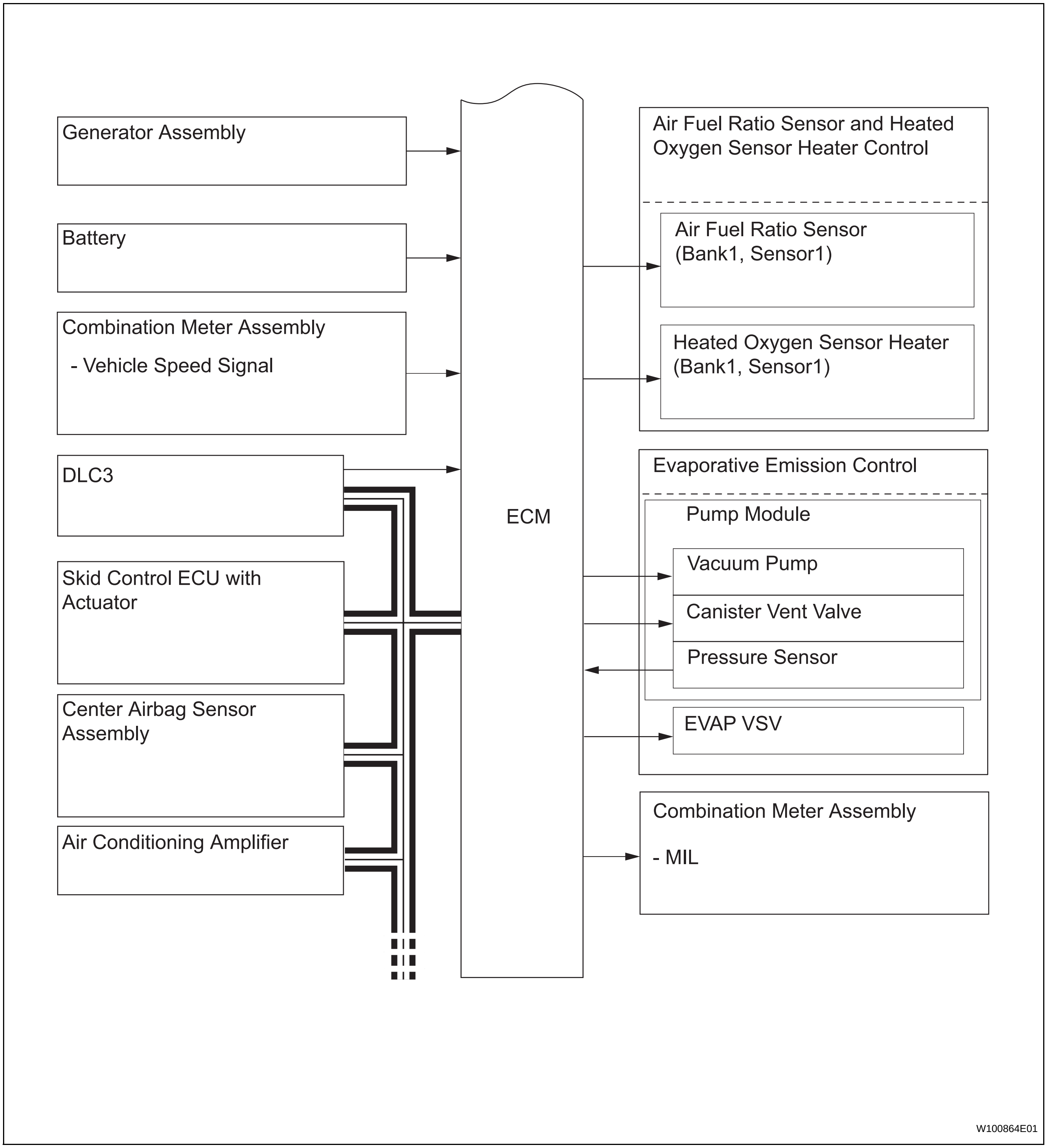
Generator Assembly
Battery
Combination Meter Assembly
- Vehicle Speed Signal
DLC3
Skid Control ECU with Actuator
Center Airbag Sensor Assembly
Air Conditioning Amplifier
ECM
Air Fuel Ratio Sensor and Heated Oxygen Sensor Heater Control
Air Fuel Ratio Sensor (Bank1, Sensor1)
Heated Oxygen Sensor Heater (Bank1, Sensor1)
Evaporative Emission Control
Pump Module
Vacuum Pump
Canister Vent Valve
Pressure Sensor
EVAP VSV
Combination Meter Assembly
- MIL
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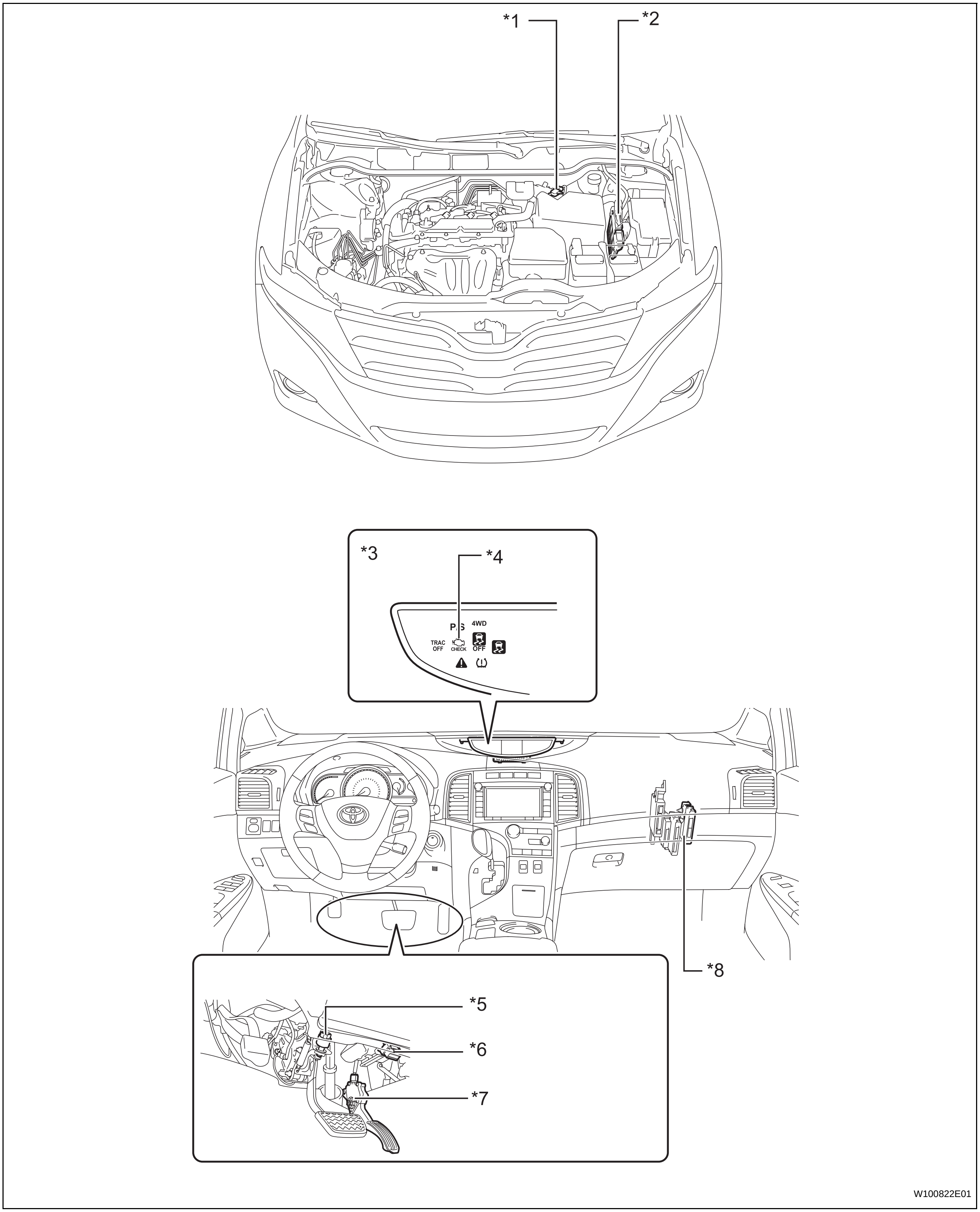
PARTS LOCATION



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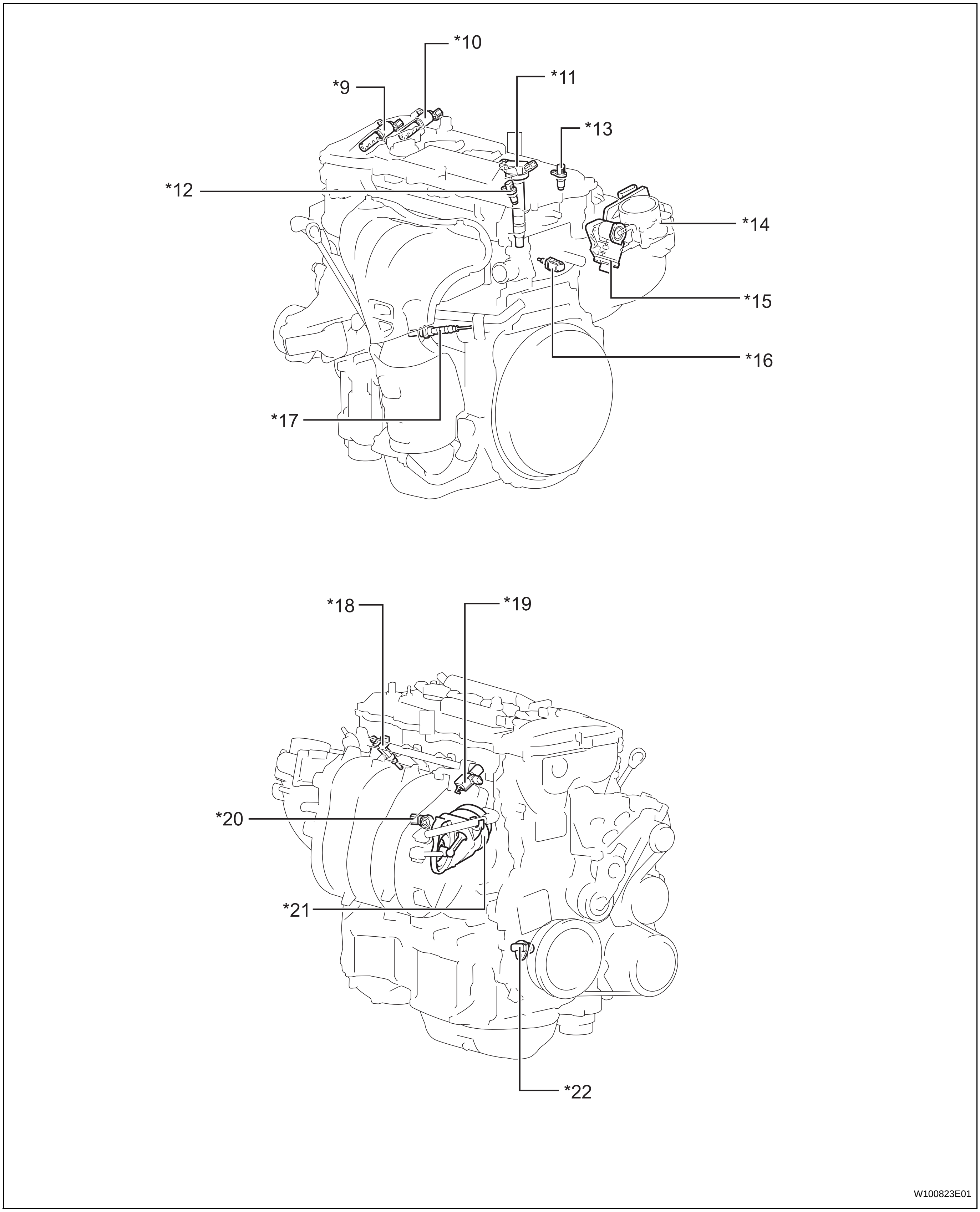

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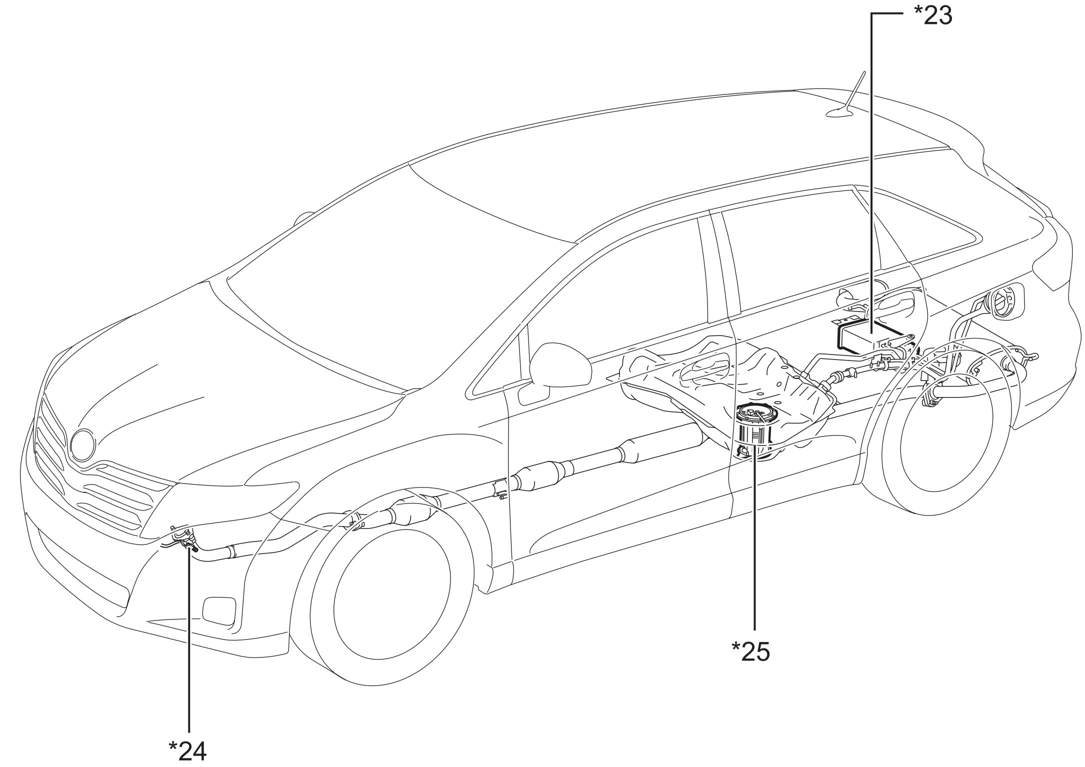

Text in Illustration

*1	Mass Air Flow Meter	*2	ECM
*3	Accessory Meter	*4	MIL
*5	Stop Light Switch	*6	DLC3
*7	Accelerator Pedal Rod - Accelerator Pedal Position Sensor	*8	Power Management Control ECU
*9	Exhaust Camshaft Timing Oil Control Valve Assembly	*10	Intake Camshaft Timing Oil Control Valve Assembly
*11	Ignition Coil Assembly (with Igniter)	*12	Camshaft Position Sensor (Exhaust)
*13	Camshaft Position Sensor (Intake)	*14	Throttle with Motor Body Assembly - Throttle Position Sensor - Throttle Actuator
*15	Tumble Control Valve	*16	Engine Coolant Temperature Sensor
*17	Air Fuel Ratio Sensor	*18	Fuel Injector Assembly
*19	VSV (For ACIS)	*20	Knock Control Sensor
*21	ACIS Valve Actuator	*22	Crankshaft Position Sensor

*23	Canister Pump Module - Vent Valve - Leak Detection Pump - Canister Pressure Sensor	*24	Heated Oxygen Sensor
*25	Fuel Pump Assembly	-	-

DETAILS

1. FUNCTION OF MAIN COMPONENTS

(a) The main components of the engine control system are as follows:

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Component	Outline	Quantity	Function
ECM	32-bit CPU	1	The ECM optimally controls the SFI, ESA and ISC to suit the operating conditions of the engine in accordance with the signals provided by the sensors.
Mass Air Flow Meter	Hot-wire Type	1	This sensor has a built-in hot-wire to directly detect the intake air mass.
Intake Air Temperature Sensor	Thermistor Type	1	This sensor detects the intake air temperature by means of an internal thermistor (built into the mass air flow meter).
Engine Coolant Temperature Sensor	Thermistor Type	1	This sensor detects the engine coolant temperature by means of an internal thermistor.
Crankshaft Position Sensor [No. of Rotor Teeth]	Pick-up Coil Type [36 - 2]	1	This sensor detects the engine speed and performs cylinder identification.
Camshaft Position Sensor for Intake [No. of Rotor Teeth]	Magneto-Resistance Element (MRE) Type [3]	1	This sensor performs cylinder identification.
Camshaft Position Sensor for Exhaust [No. of Rotor Teeth]	Magneto-Resistance Element (MRE) Type Type [3]	1	This sensor performs cylinder identification.
Accelerator Pedal Position Sensor	Linear (Non-contact) Type	1	This sensor detects the amount of pedal effort applied to the accelerator pedal.
Throttle Position Sensor	Linear (Non-contact) Type	1	This sensor detects the throttle valve opening angle.
Knock Control Sensor	Built-in Piezoelectric Type (Non-resonant Type/Flat Type)	1	This sensor detects an occurrence of engine knocking indirectly from the vibration of the cylinder block caused by the occurrence of engine knocking.
Air Fuel Ratio Sensor	Heated Type (Planar Type)	1	As with the oxygen sensor, this sensor detects the oxygen concentration in the exhaust gas. However, it detects the oxygen concentration in the exhaust gas linearly.
Heated Oxygen Sensor	Heated Type (Cup Type)	1	This sensor detects the oxygen concentration in the exhaust gas by measuring the electromotive force which is generated in the sensor itself.
Fuel Injector Assembly	12-hole Type	4	The injector is an electromagnetically-operated nozzle which injects fuel in accordance with signals from the ECM.

2. SYSTEM CONTROL

(a) The engine control system of the 1AR-FE engine has the following features.

System	Outline
Sequential Multiport Fuel Injection (SFI)	• This is an L-type SFI system. It directly detects the intake air mass with a hot wire type mass air flow meter. • The fuel injection system is a sequential multiport fuel injection system. • Fuel injection takes 2 forms: – Synchronous injection, which always takes place with the same timing in accordance with the basic injection duration and an additional correction based on the signals provided by the sensors. – Non-synchronous injection, which takes place at the time an injection request based on the signals provided by the sensors is detected, regardless of the crankshaft position. • Synchronous injection is further divided into group injection during a cold start, and independent injection after the engine is started.

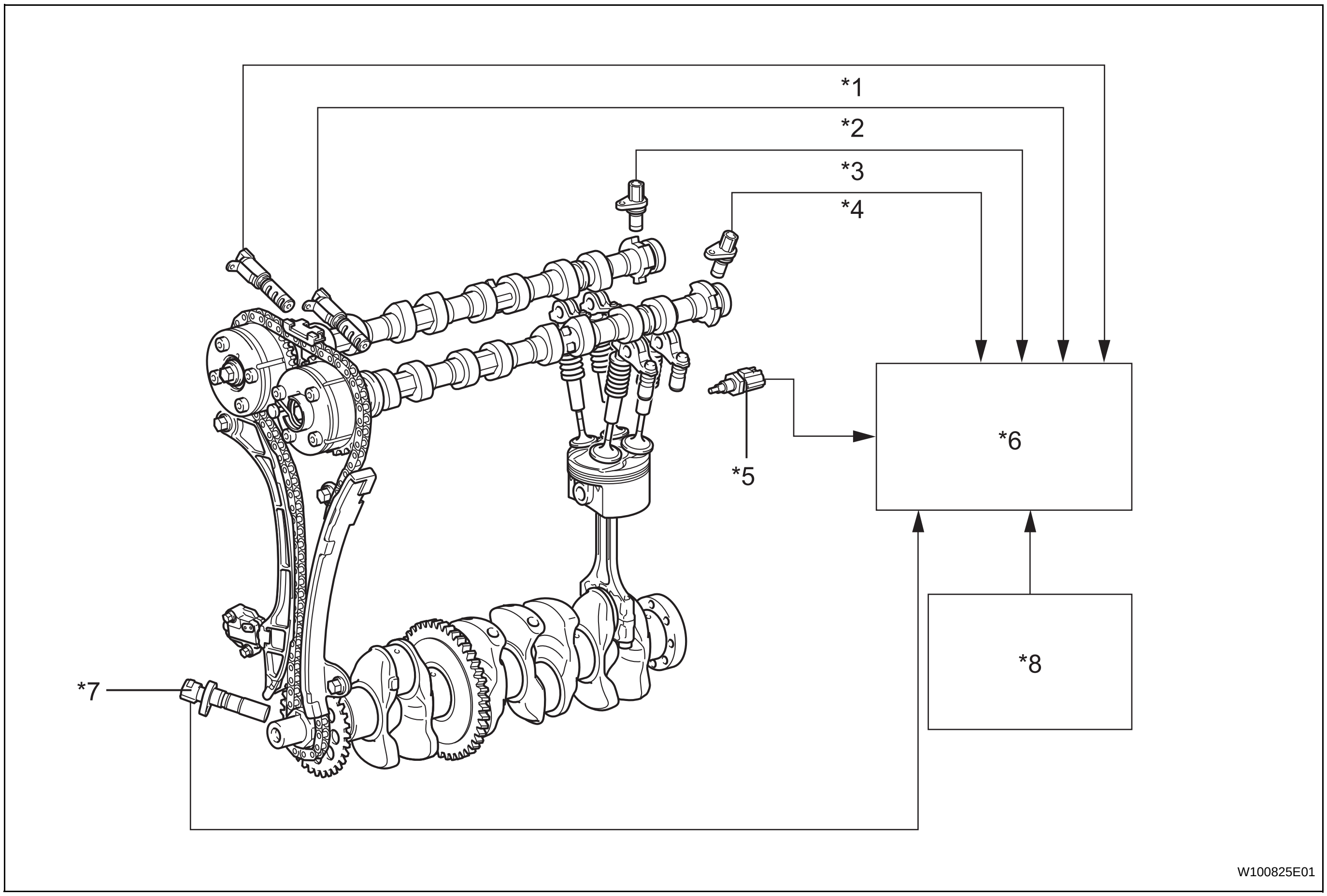
System	Outline
Electronic Spark Advance (ESA)	• Ignition timing is determined by the ECM based on signals from various sensors. The ECM corrects ignition timing in response to engine knocking. • This system selects the optimal ignition timing in accordance with the signals received from the sensors and sends (IGT) ignition signals to the igniters.
Electronic Throttle Control System-intelligent (ETCS-i)	Optimally controls the opening angle of the throttle valve in accordance with the accelerator pedal input and the engine and vehicle conditions.
Variable Valve Timing-intelligent (Dual VVT-i)	Controls the intake and exhaust camshaft to an optimal valve timing in accordance with engine operating conditions.
Acoustic Control Induction System (ACIS)	The intake air passages are switched based on engine speed and throttle valve opening angle to provide high performance in all engine speed ranges.
Tumble Control System	Controls fully closes the tumble control valve during cold start and cold running conditions to improve exhaust emissions while the engine is running cold.
Fuel Pump Control	• Fuel pump operation is controlled by signals from the ECM. • The fuel pump is stopped when an SRS airbag is deployed in a frontal, side, or rear side collision.
Air Conditioning Cut-off Control	By turning the air conditioning compressor on or off in accordance with the engine conditions, drivability is maintained.
Cooling Fan Control	Radiator cooling fan operation is controlled by signals from the ECM based on the engine coolant temperature sensor signal and the operating condition of the air conditioning.
Cranking Hold Function* (Starter Control)	Once the engine switch is pushed, this control operates the starter until the engine starts.
Air fuel Ratio Sensor and Heated Oxygen Sensor Heater Control	Maintains the temperature of the air fuel ratio sensors or heated oxygen sensors at an appropriate level to increase the ability of the sensor to accurately detect the concentration of oxygen.
Evaporative Emission Control	• The ECM controls the purge flow of evaporative emissions (HC) from the charcoal canister assembly in accordance with engine conditions. • Approximately 5 hours after the ignition switch has been turned off, the ECM operates the canister pump module to check for evaporative emission leaks between the fuel tank assembly and the charcoal canister assembly. The ECM can detect leaks by monitoring for changes in the fuel tank pressure.
Active Control Engine Mount	The damping characteristics of the front engine mount are varied to reduce idle vibration.
Engine Immobiliser	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.
Diagnosis	When the ECM detects a malfunction, the ECM records the malfunction and information that relates to the fault.
Fail-safe	When the ECM detects a malfunction, the ECM stops or controls the engine according to the data already stored in memory.

*: Models with smart key system

3. FUNCTION

(a) Dual VVT-i System

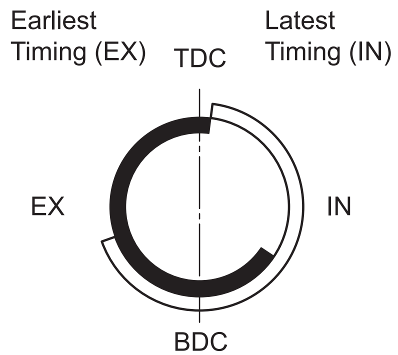
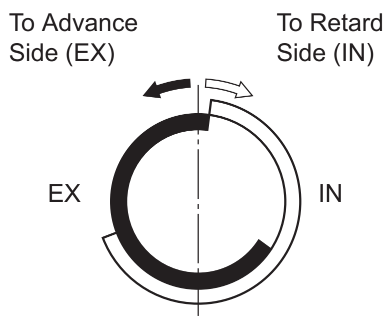
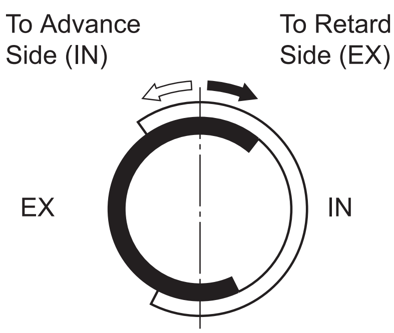
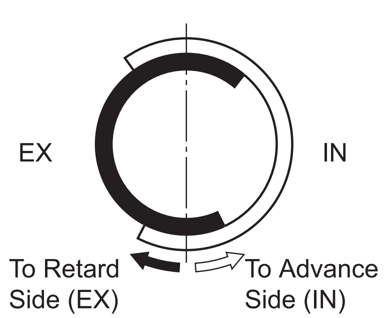
(1) The Dual Variable Valve Timing-intelligent (VVT-i) system is designed to control the intake and exhaust camshafts within a range of 50° and 40° respectively (of Crankshaft Angle) to provide valve timing that is optimally suited to the engine operating conditions. This improves torque in all the speed ranges as well as increasing fuel economy, and reducing exhaust emissions.



Text in Illustration

*1	Intake Camshaft Timing Oil Control Valve Assembly	*2	Exhaust Camshaft Timing Oil Control Valve Assembly
*3	Intake Camshaft Position Sensor	*4	Exhaust Camshaft Position Sensor
*5	Engine Coolant Temperature Sensor	*6	ECM
*7	Crankshaft Position Sensor	*8	• Mass Air Flow Meter • Throttle Position Sensor

(2) The VVT-i system delivers excellent benefits in the different operating conditions as shown in the table below.

Operation State	Objective		Effect
During Idling		Eliminating overlap reduces blow back to the intake side.	- Stabilized idling rpm - Better fuel economy
At Light Load		Eliminating overlap to reduce blow back to the intake side.	Engine stability is ensured
At Medium Load		Increasing overlap to increase internal EGR to reduce pumping loss.	- Better fuel economy - Improved emission control
In Low to Medium Speed Range with Heavy Load		Advancing the intake valve closing timing improves volumetric efficiency.	Improved torque in low to medium speed range

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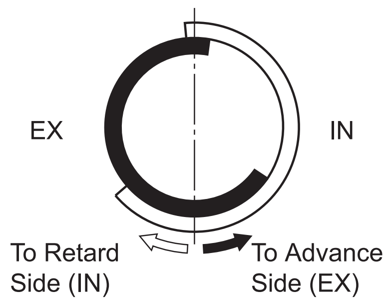
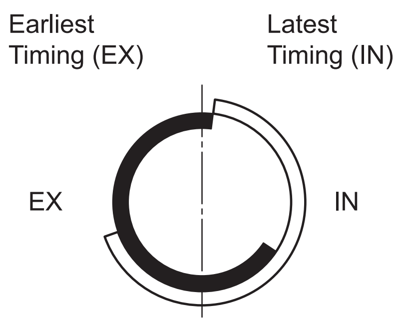
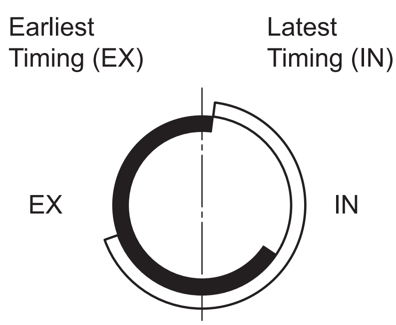
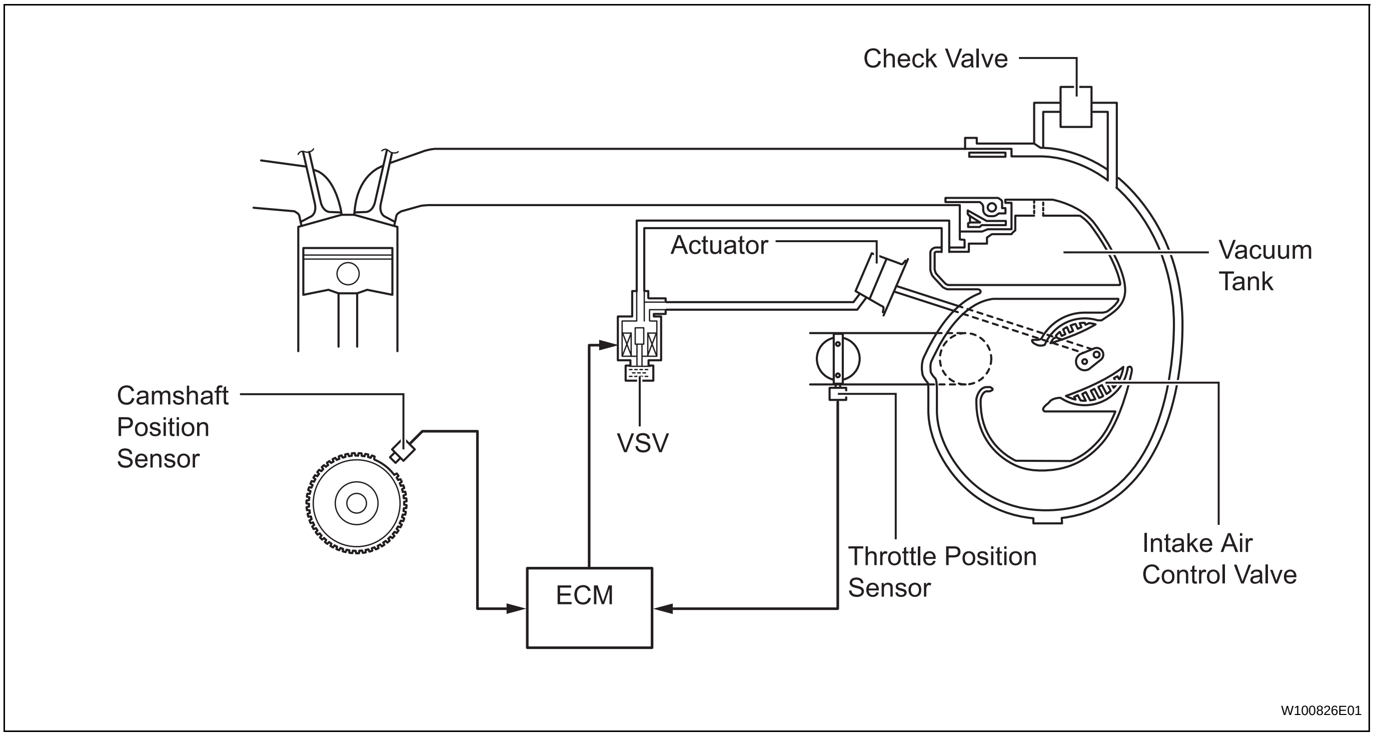
<table>
<tr><th>Operation State</th><th colspan="2">Objective</th><th>Effect</th></tr>
<tr><td>In High Speed Range with Heavy Load</td><td>
</td><td>Advancing the intake valve closing timing improves volumetric efficiency.</td><td>Improved output</td></tr>
<tr><td>At Low Temperatures</td><td>
</td><td>Eliminating overlap to reduce blow back to the intake side stabilizes the idling speed at fast idle.</td><td>- Stabilized fast idle speed
- Better fuel economy</td></tr>
<tr><td>- Upon Starting
- Stopping the Engine</td><td>
</td><td>Eliminating overlap minimize blow back to the intake side.</td><td>Improved startability</td></tr>
</table>

(b) Acoustic Control Induction System (ACIS)

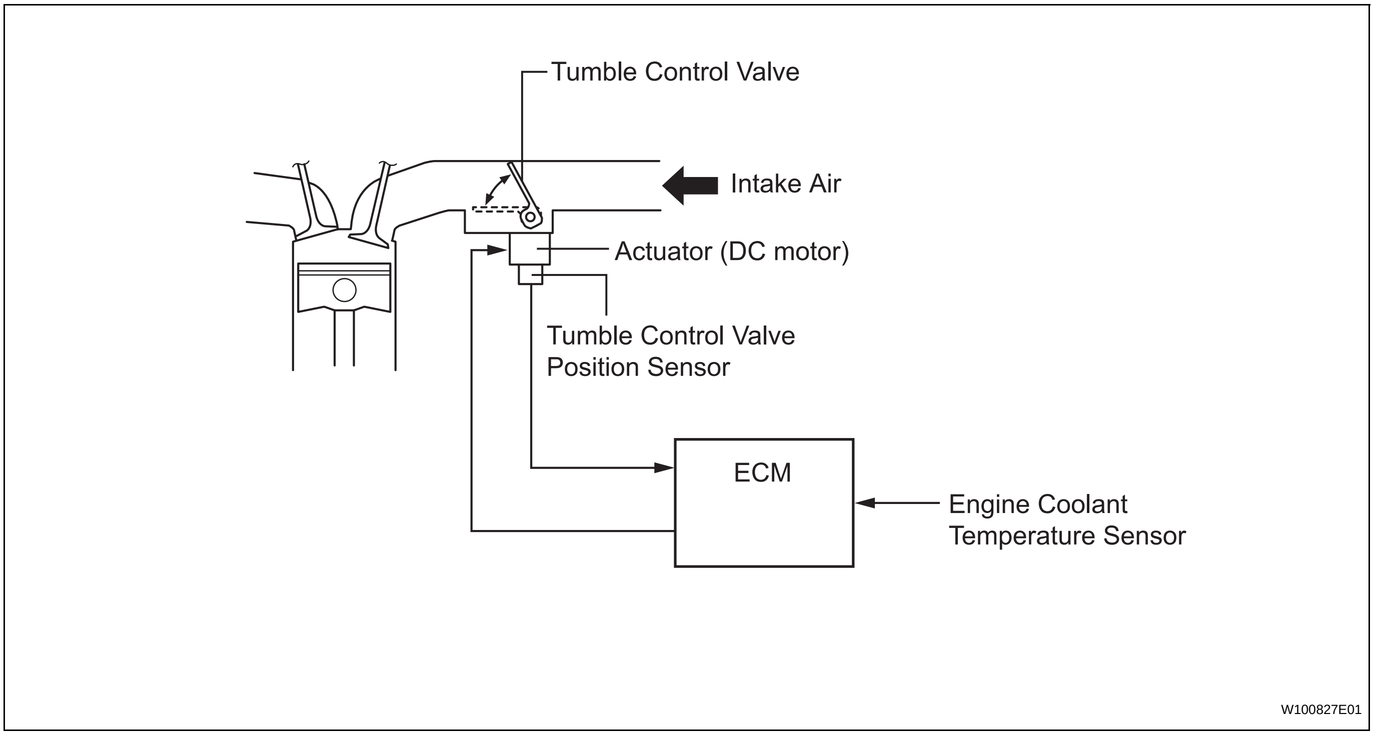
(1) The Acoustic Control Induction System (ACIS) uses a rotary type intake air control valve to divide the intake manifold, creating 2 stages. The intake air control valve is opened or closed to vary the effective length of the intake manifold in accordance with the engine speed and throttle valve opening angle. This increases the power output in all ranges from low to high speed.



(c) Tumble Control System

(1) The tumble control system generates tumble flow using the tumble control valves when the engine is cold. This achieves excellent combustion conditions.

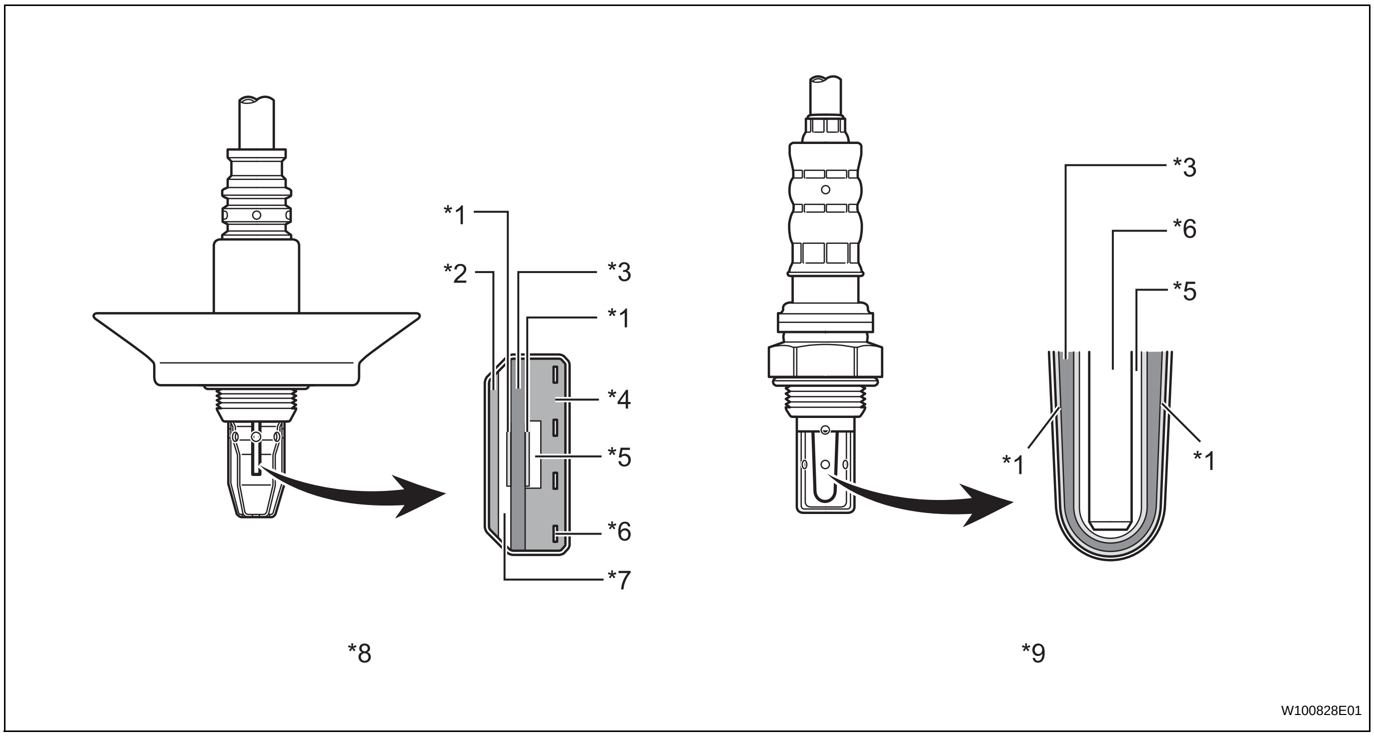
(2) The ECM controls the tumble control valves according to the engine coolant temperature signal.



(d) Fuel Pump Control
   (1) The fuel pump is controlled by the ECM using the fuel pump relay. The fuel pump control has a fuel cut control. Fuel cut control stops the fuel pump when any of the SRS airbags has deployed.
(e) Cooling Fan Control System
   (1) The cooling fan control system achieves an optimal fan speed in accordance with the engine coolant temperature and air conditioning operating conditions.
(f) Cranking Hold Function (Models with smart key system)
   (1) Once the engine switch is pressed, this function operates the starter until the engine starts, provided that the brake pedal is depressed and the shift lever is in P or N. This prevents application of the starter for an inadequate length of time. It also prevents the engine from being cranked after it has started.

4. CONSTRUCTION

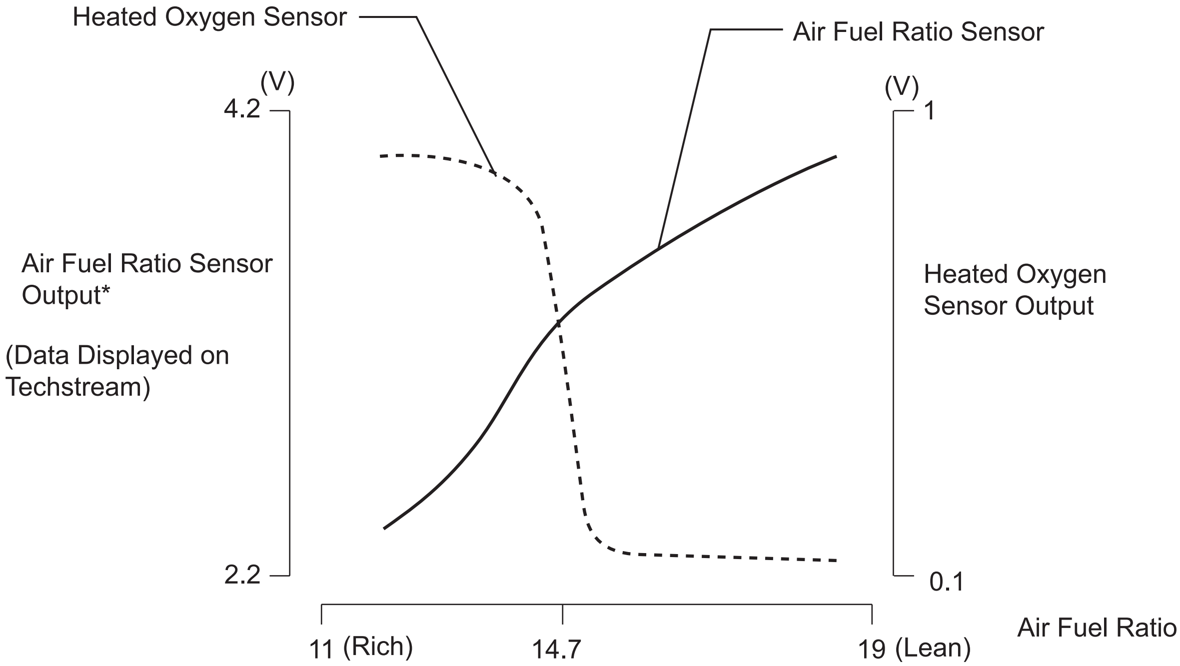
(a) Air Fuel Ratio Sensor and Heated Oxygen Sensor
   (1) A planar type air fuel ratio sensor and a cup type heated oxygen sensor are used. The basic construction of the heated oxygen sensor and the air fuel ratio sensor is the same. However, they are divided into the cup type and the planar type, according to the different types of heater construction used.
   (2) The planar type air fuel ratio sensor uses alumina, which excels in heat conductivity and electrical insulation, to integrate a sensor element with a heater, thus improving the warm-up performance of the sensor.
   (3) The cup type heated oxygen sensor contains a sensor element that surrounds a heater.



Text in Illustration

*1	Platinum Electrode	*2	Alumina
*3	Sensor Element (Zirconia)	*4	Alumina
*5	Atmosphere	*6	Heater
*7	Diffusion Resistant Layer	*8	Air Fuel Ratio Sensor (Planar Type)
*9	Heated Oxygen Sensor (Cup Type)	-	-

(4) As illustrated below, the conventional heated oxygen sensor is characterized by a sudden change in its output voltage at the threshold of the stoichiometric air fuel ratio (14.7:1). In contrast, the air fuel ratio sensor data is approximately proportionate to the existing air fuel ratio. The air fuel ratio sensor converts the oxygen density to current and sends it to the ECM. As a result, the detection precision of the air fuel ratio has been improved. The air fuel ratio sensor data can be viewed using Techstream.



*: This value is calculated internally in the ECM and is not an ECM terminal voltage.

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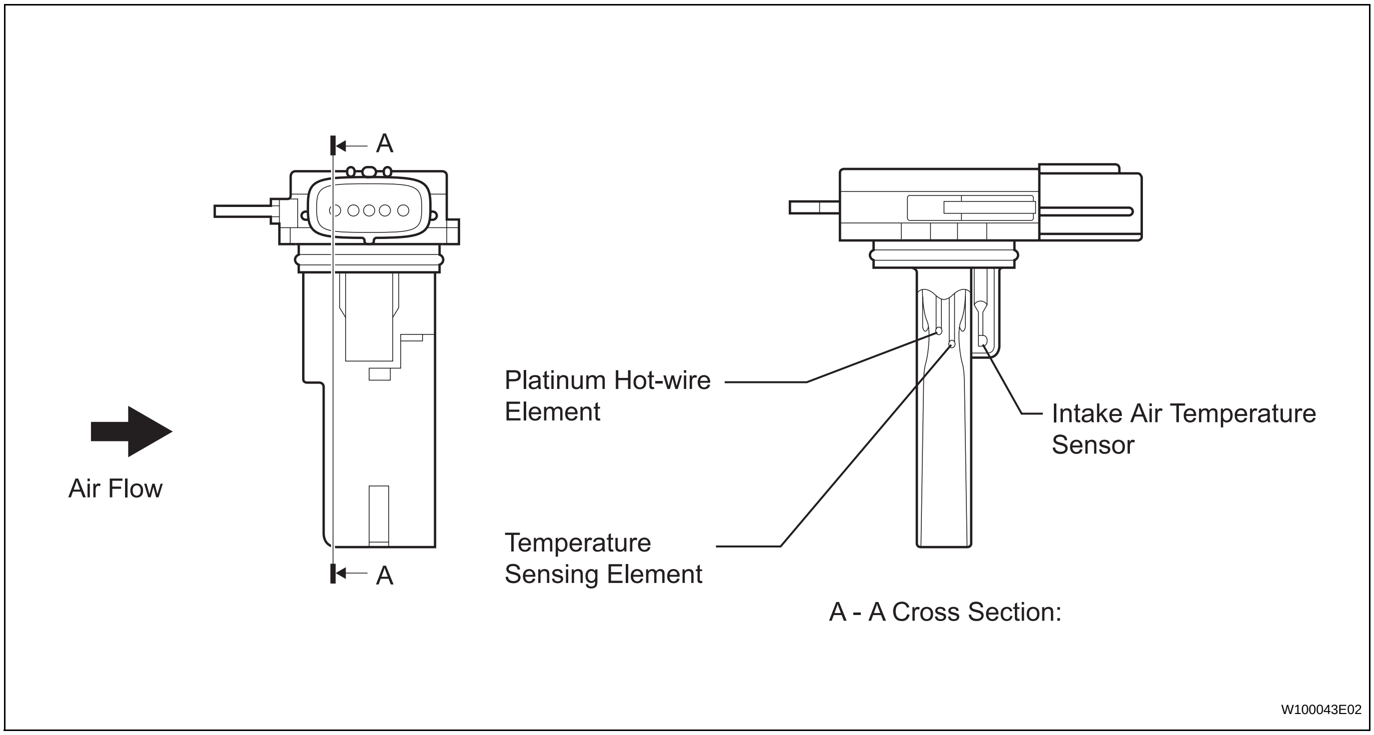
(b) Mass Air Flow Meter

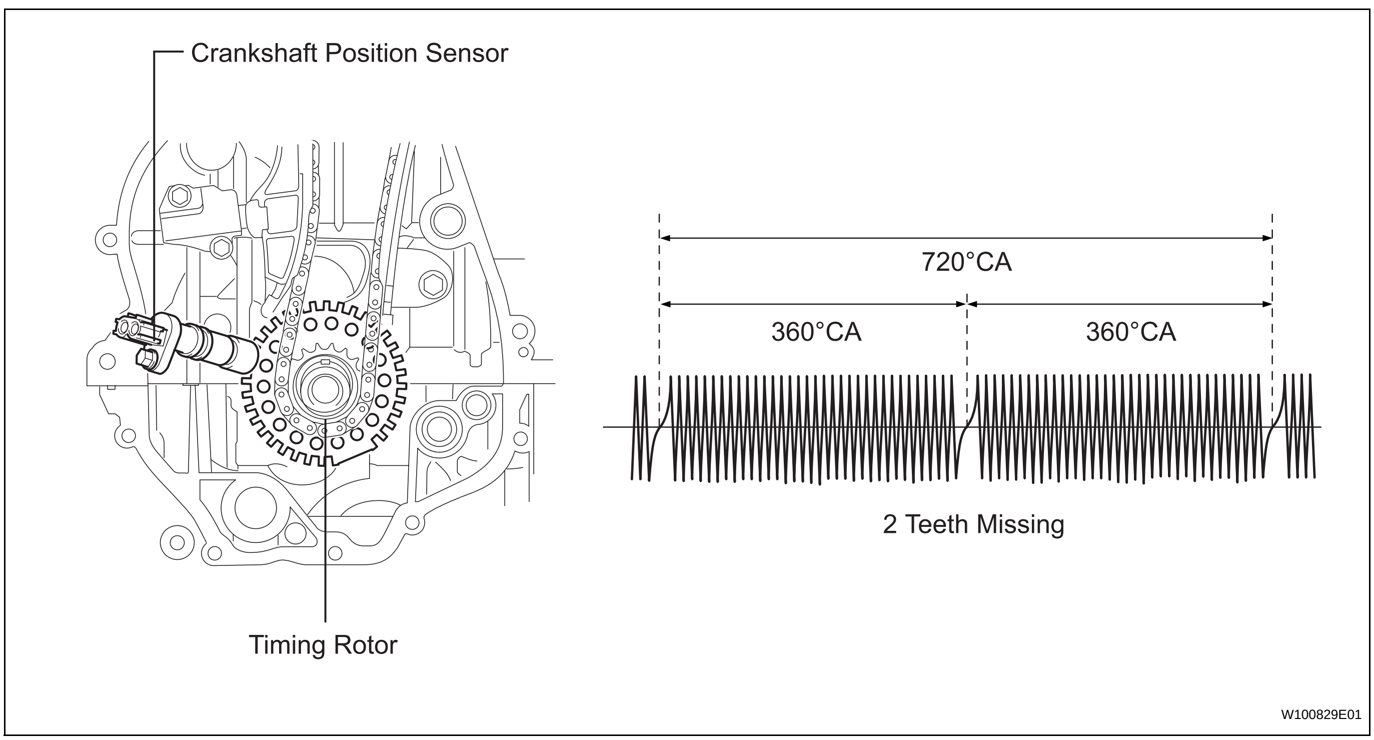
(1) The mass air flow meter, which is a slot-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, the detection precision is improved and the intake air resistance is reduced.

(2) This mass air flow meter has a built-in intake air temperature sensor.



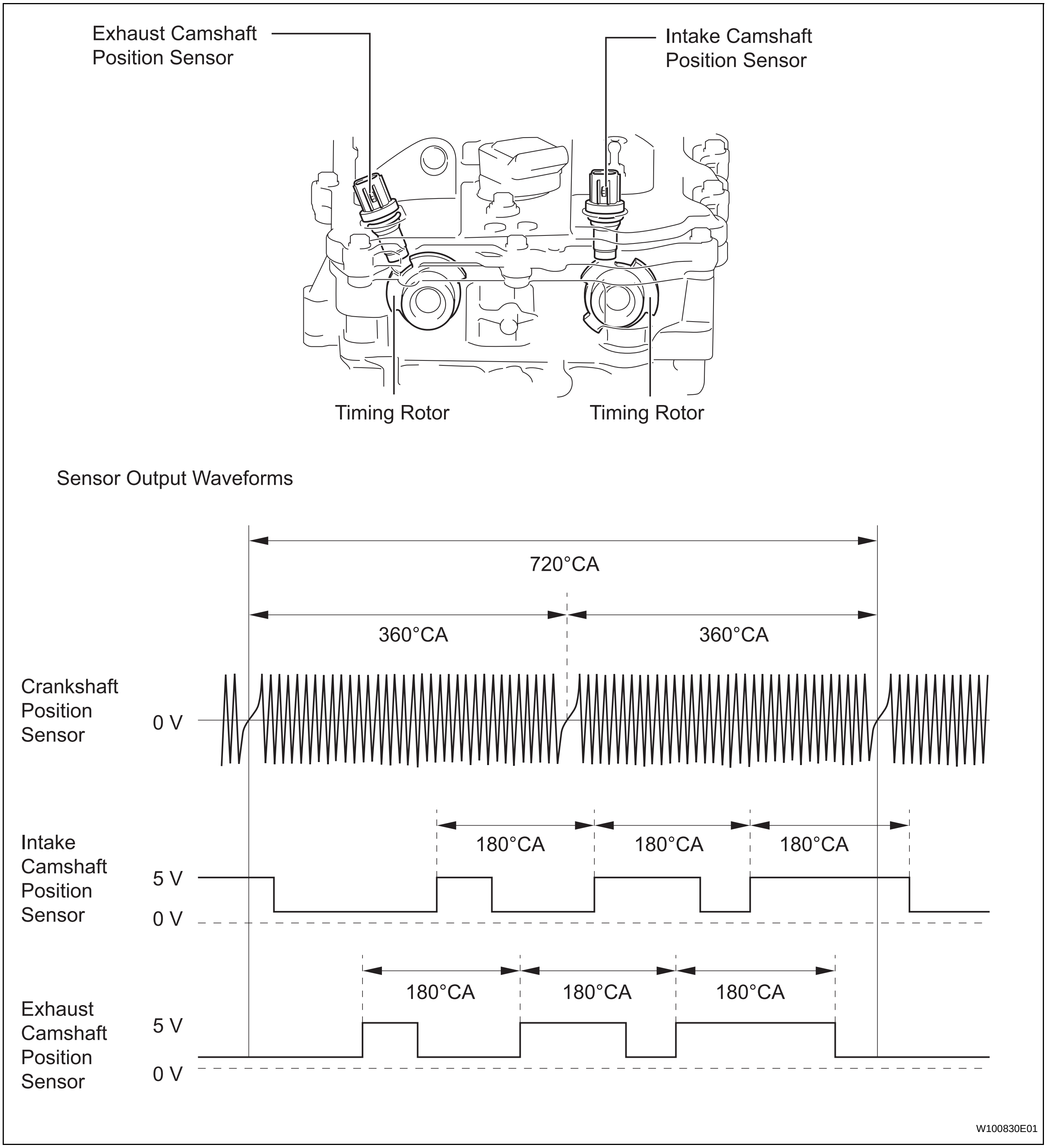
(c) Crankshaft Position Sensor

(1) The timing rotor of the crankshaft consists of 34 teeth with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the change of the signal due to the missing teeth is used to determine top-dead-center.



(d) Camshaft Position Sensor

(1) Magneto-Resistance Element (MRE) type camshaft position sensors (intake and exhaust) are used. To detect each camshaft (intake) position, a timing rotor that is secured to the camshaft (intake) in front of the camshaft timing gear assembly is used to generate 6 (3 Hi Output, 3 Lo Output) pulses for every 2 revolutions of the crankshaft. The timing rotor for each camshaft (exhaust) is part of the respective camshaft.



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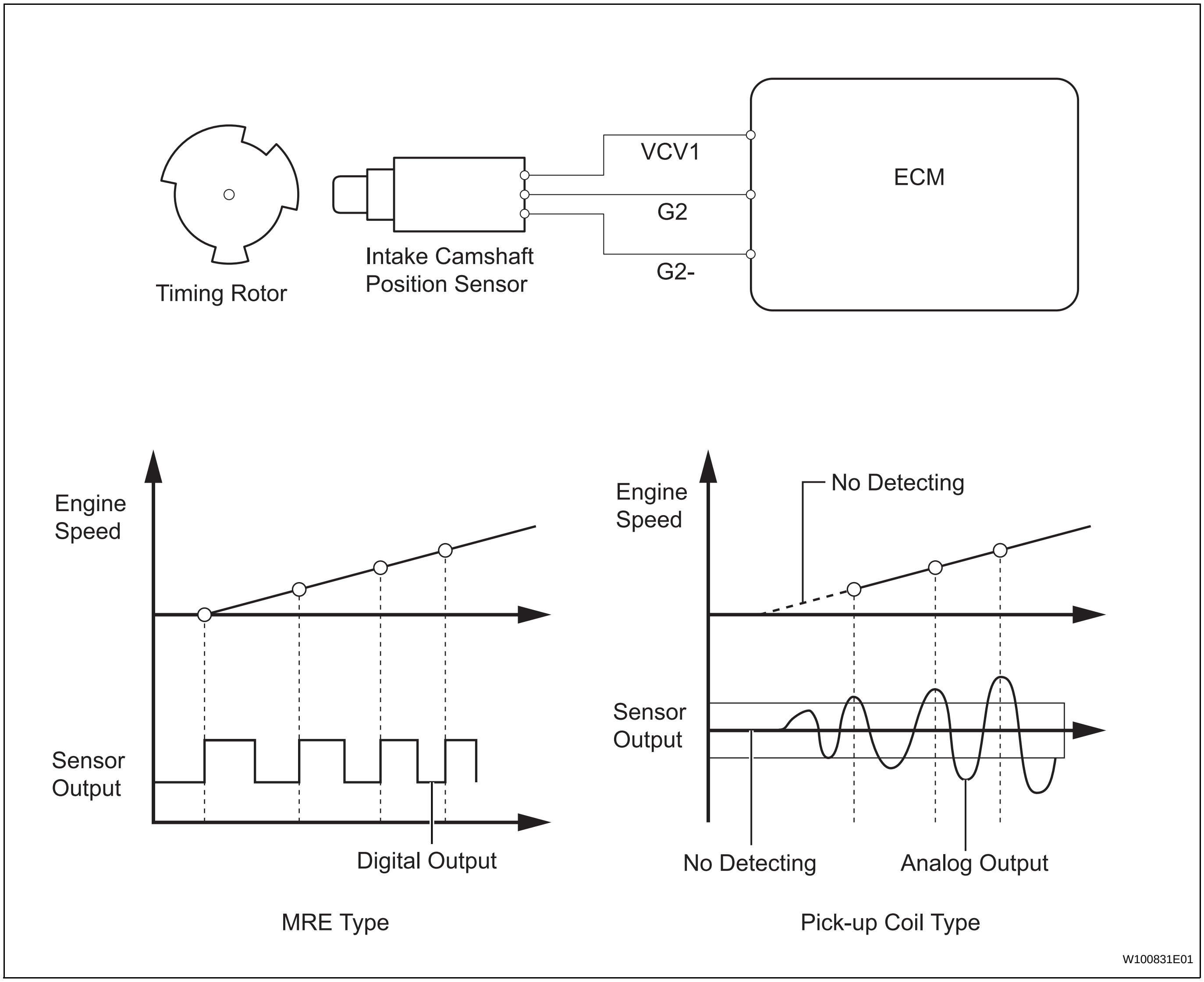
(2) An MRE type camshaft position sensor consists of an MRE, a magnet and a sensor. The direction of the magnetic field changes due to the profile (protruding and non-protruding portions) of the timing rotor, which passes by the sensor. As a result, the resistance of the MRE changes, and the output voltage to the ECM changes to Hi or Lo. The ECM detects the camshaft position based on this output voltage.

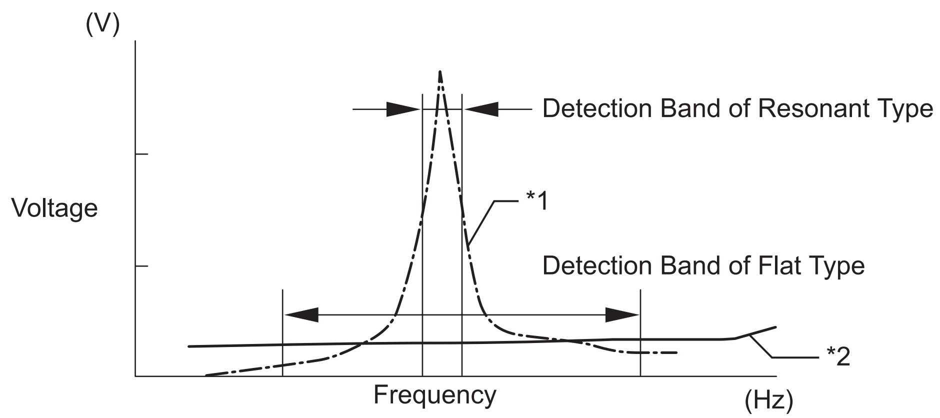


(e) Knock Control Sensor (Flat Type)

(1) In a conventional knock control sensor (resonant type), a vibration plate is built into the sensor. This plate has the same resonance point as the knocking* frequency of the engine block. This sensor can only detect vibration in this frequency band.
*: The term "Knock" or "Knocking" is used in this case to describe either preignition or detonation of the air fuel mixture in the combustion chamber. This preignition or detonation refers to the air fuel mixture being ignited earlier than is advantageous. This use of "Knock" or "Knocking" is not primarily used to refer to a loud mechanical noise that may be produced by an engine. A flat type knock control sensor (non-resonant type) has the ability to detect vibration in a wider frequency band (from about 6 kHz to 15 kHz). It has the following features:

- A flat type knock control sensor is installed to an engine by placing it over the stud bolt installed on the cylinder block sub-assembly. For this reason, a hole for the stud bolt exists in the center of the sensor.
- In the sensor, a steel weight is located in the upper portion. An insulator is located between the weight and a piezoelectric element.
- An open/short circuit detection resistor is integrated in the sensor.

(2) The engine knocking frequency will vary slightly depending on the engine speed. The flat type knock control sensor can detect vibration even when the engine knocking frequency changes. Due to the use of the flat type knock control sensor, the vibration detection ability is increased compared to a conventional type knock control sensor, and more precise ignition timing control is possible.



*1: Resonance Characteristic of Conventional Type (Resonant)

*2: Resonance Characteristic of Flat Type (Non-resonant)

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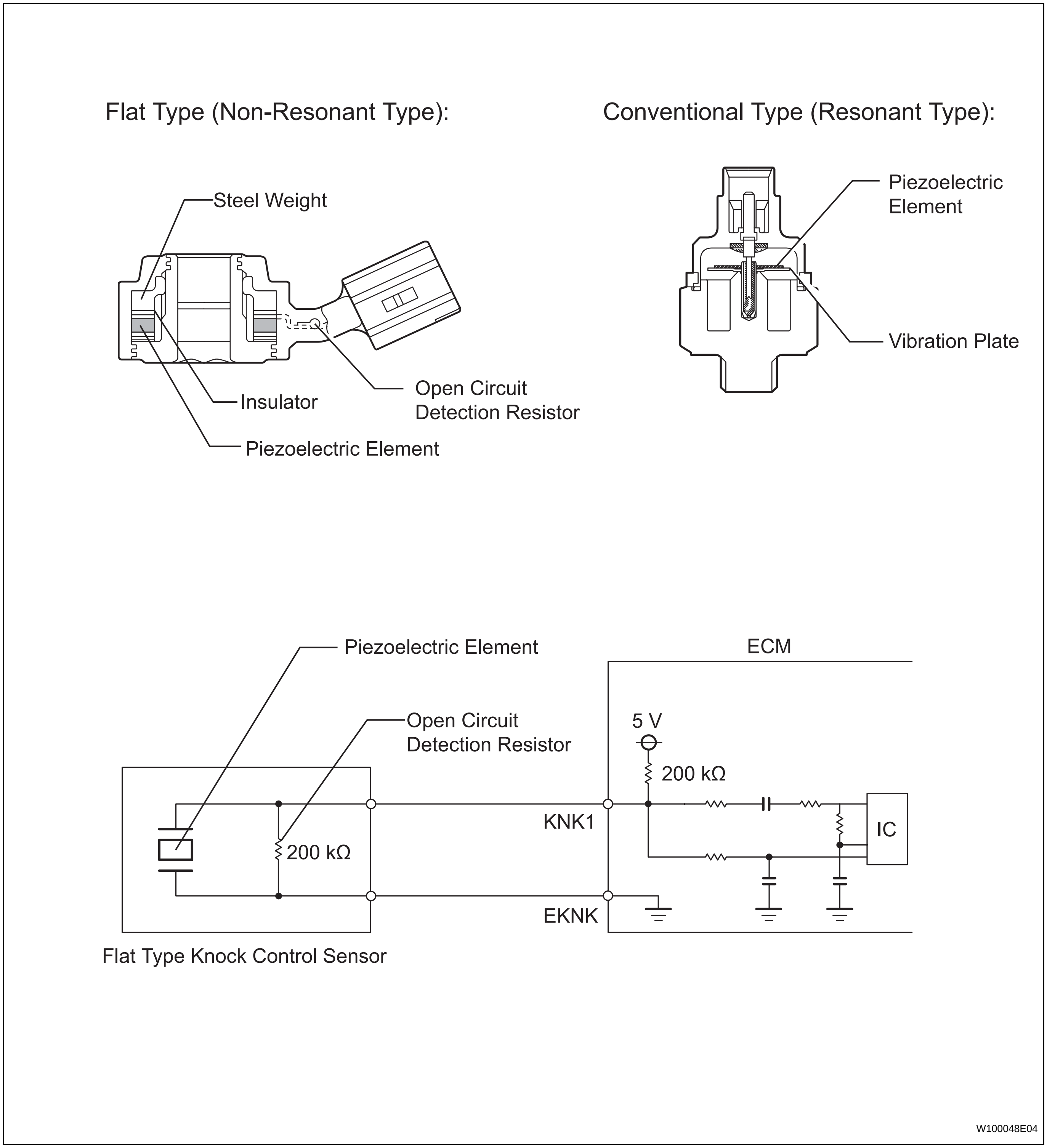
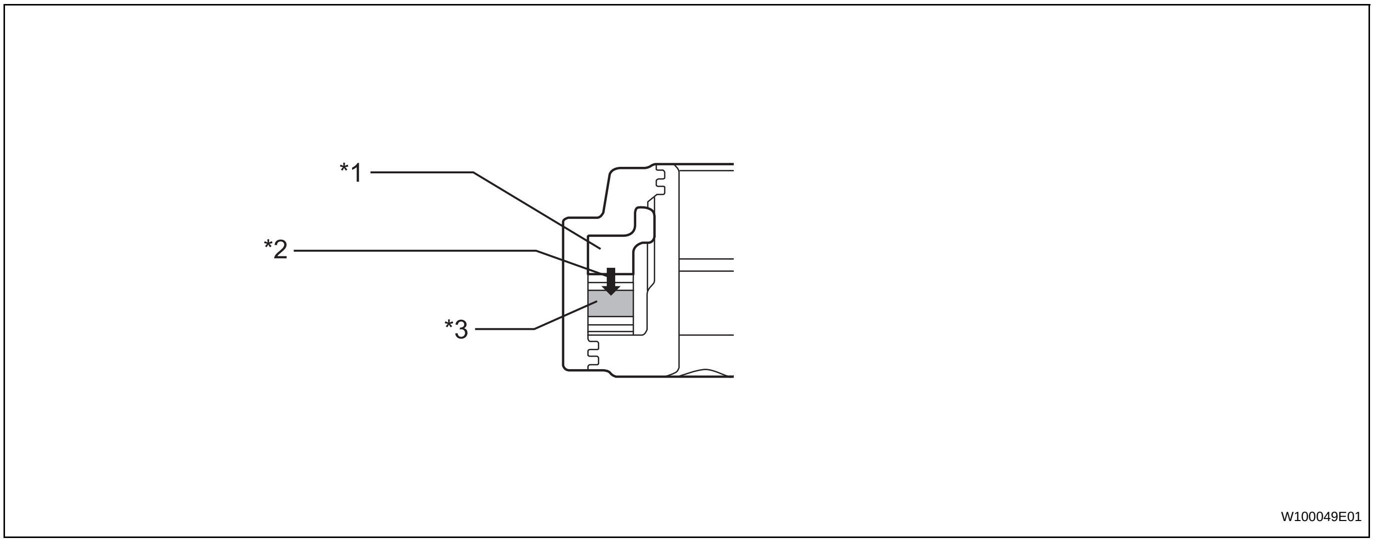
(3) An open/short circuit detection resistor is integrated in the sensor. When the ignition is ON, the open/short circuit detection resistor in the knock control sensor and the resistor in the ECM keep the voltage at terminal KNK1 constant. An Integrated Circuit (IC) in the ECM constantly monitors the voltage of terminal KNK1. If an open or short circuit occurs between the knock control sensor and the ECM, the voltage of terminal KNK1 will change and the ECM will detect this and store a Diagnostic Trouble Code (DTC).



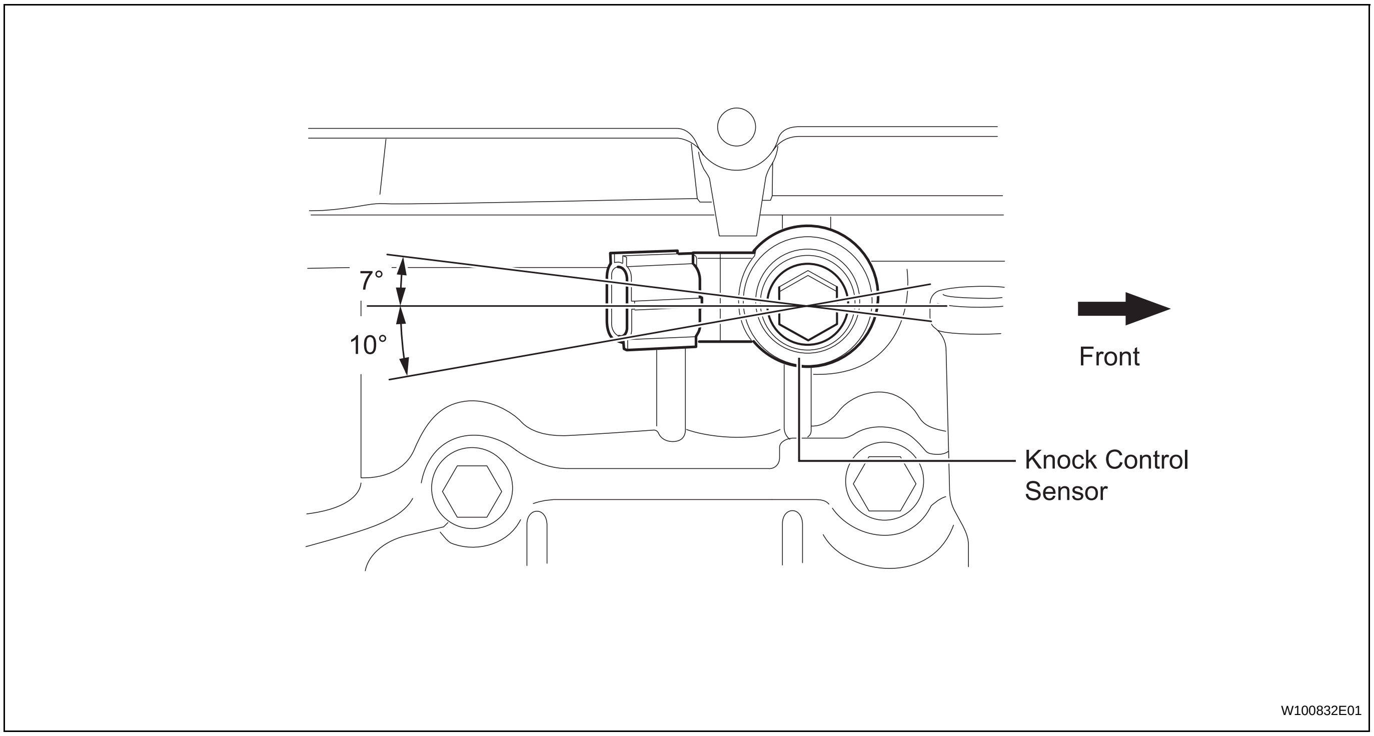
(4) Vibrations caused by knocking are transmitted to the steel weight. The inertia of this weight applies pressure to the piezoelectric element. This action generates electromotive force.



Text in Illustration

*1	Steel Weight	*2	Inertia
*3	Piezoelectric Element	-	-

(5) To prevent water accumulation in the connector, make sure to install the flat type knock control sensor in the position shown in the following illustration:

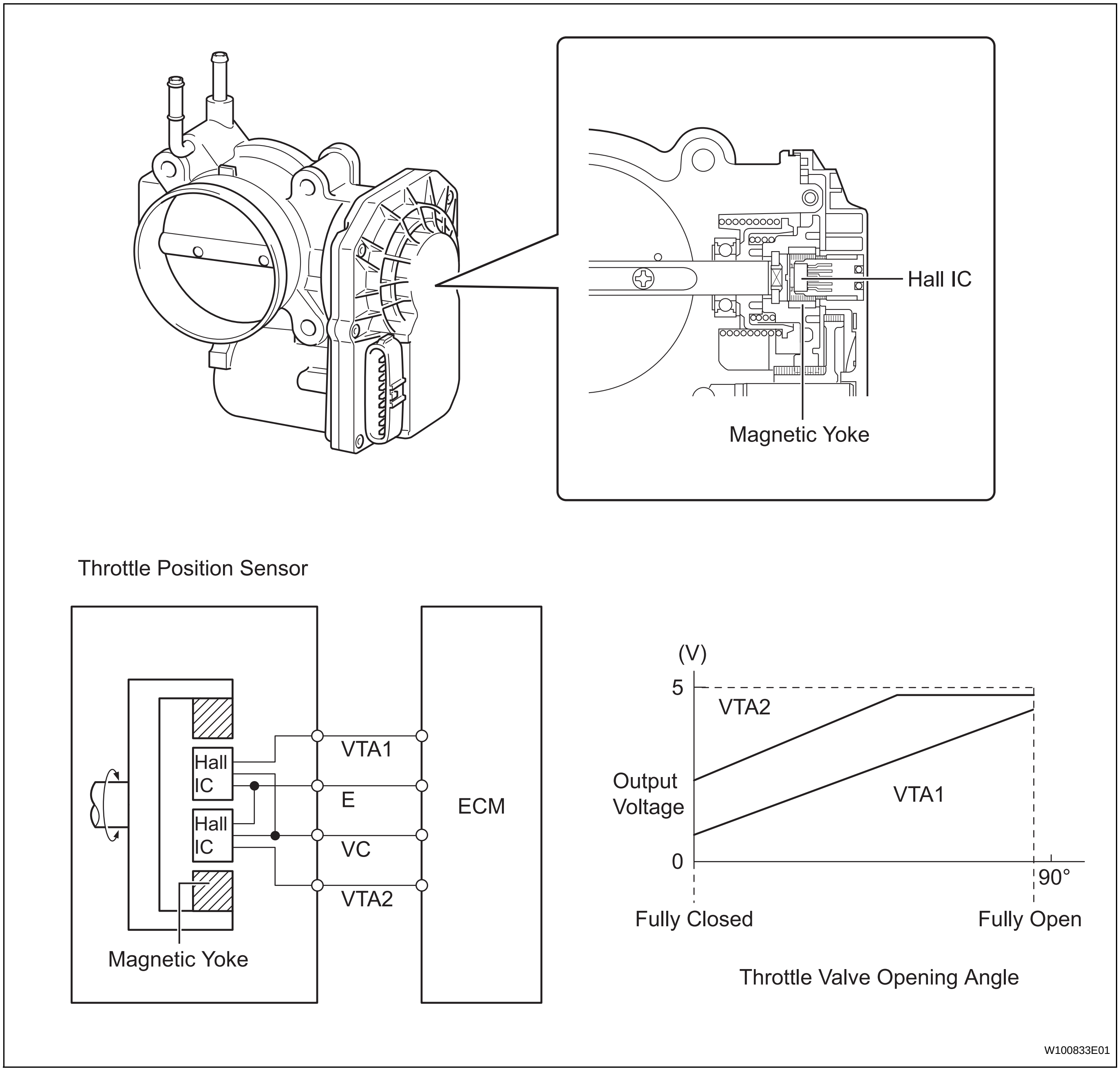


(f) Throttle Position Sensor

(1) This non-contact type throttle position sensor uses a Hall IC, which is mounted on the throttle with motor body assembly.

- The Hall IC is surrounded by a magnetic yoke. The Hall IC converts the changes that occur in the magnetic flux into electrical signals, and outputs them in the form of throttle valve position signals to the ECM.

- The Hall IC contains circuits for the main and sub signals. It converts the throttle valve opening angle into electric signals that have differing characteristics, and outputs them to the ECM.



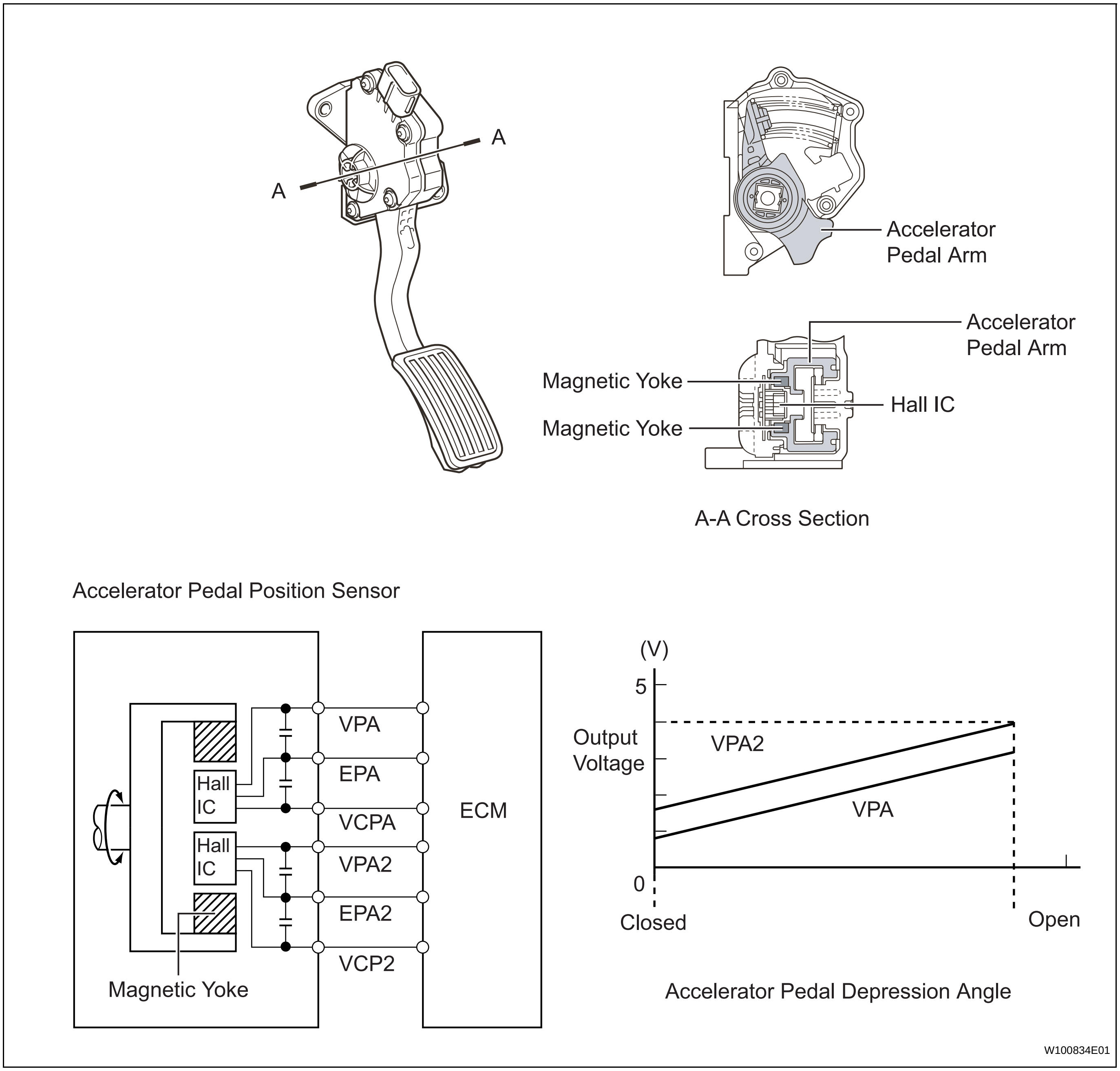
HINT:
The inspection method differs from a contact type throttle position sensor because this non-contact type throttle position sensor uses a Hall IC. For details, refer to the Repair Manual.

(g) Accelerator Pedal Position Sensor

(1) This non-contact type accelerator pedal position sensor uses a Hall IC, which is mounted on the accelerator pedal arm.

- A magnetic yoke is mounted at the base of the accelerator pedal arm. This yoke rotates around the Hall IC in accordance with the amount of effort that is applied to the accelerator pedal. The Hall IC converts the changes in the magnetic flux that occur into electrical signals, and outputs them in the form of accelerator pedal position signals to the ECM.

- The Hall IC contains 2 circuits, 1 for the main signal, and 1 for the sub signal. It converts the accelerator pedal position (angle) into electric signals that have differing characteristics and outputs them to the ECM.



HINT:
The inspection method differs from a contact type accelerator pedal position sensor because this non-contact type accelerator pedal position sensor uses a Hall IC. For details, refer to the Repair Manual.

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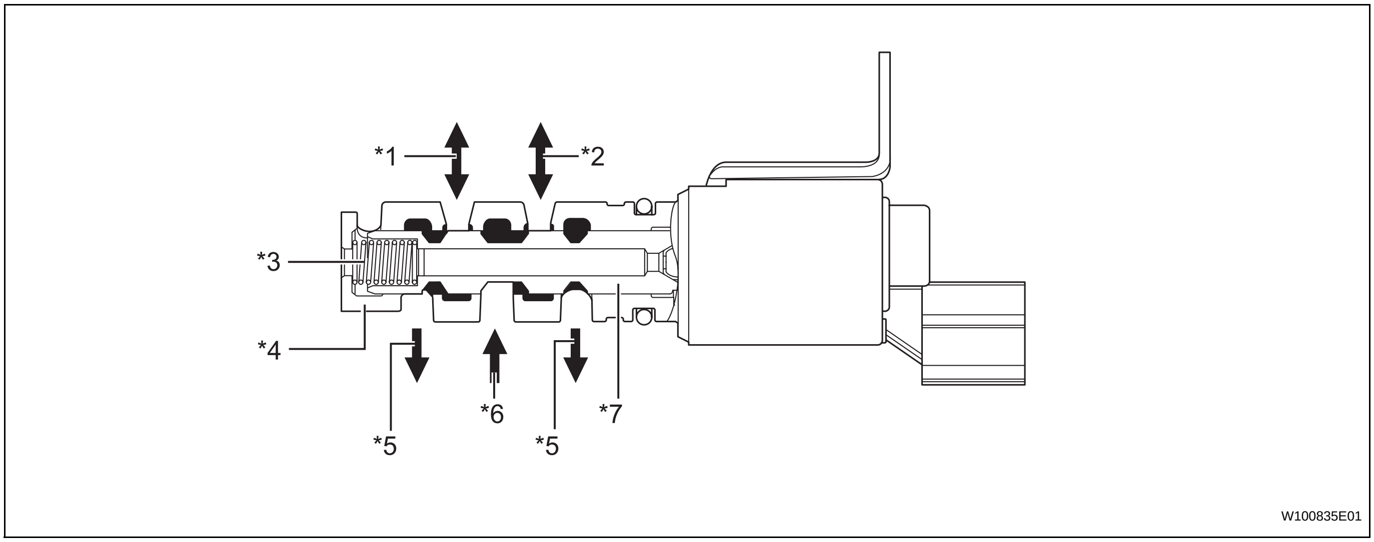
(h) Camshaft Timing Oil Control Valve Assembly

(1) The camshaft timing oil control valve assembly controls its spool valve using duty-cycle control from the ECM. This allows hydraulic pressure to be applied to the camshaft timing gear assembly or camshaft timing exhaust gear assembly advance or retard side. When the engine is stopped, the camshaft timing oil control valve assembly (intake) will move to the retard position, and the camshaft timing oil control valve assembly (exhaust) will move to the advance position.



Text in Illustration

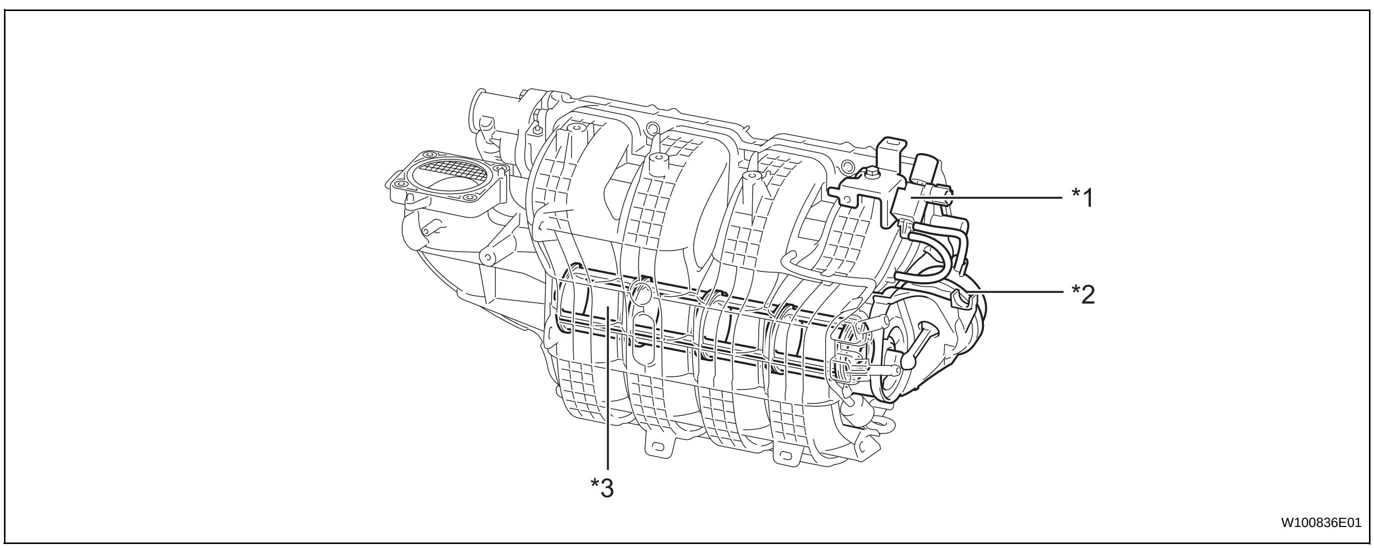
*1	To Camshaft Timing Gear Assembly (VVT-i Controller) (Advance Side)	*2	To Camshaft Timing Gear Assembly (VVT-i Controller) (Retard Side)
*3	Spring	*4	Sleeve
*5	Drain	*6	Oil Pressure
*7	Spool Valve	-	-

*: On the exhaust side oil control valve, the advance and retard sides are reversed.

(i) Intake Air Control Valve

(1) The intake air control valve is installed in the intake manifold. It opens and closes to provide 2 effective lengths of the intake manifold.

(2) The ACIS actuator activates the intake air control valve based on signals from the ECM.



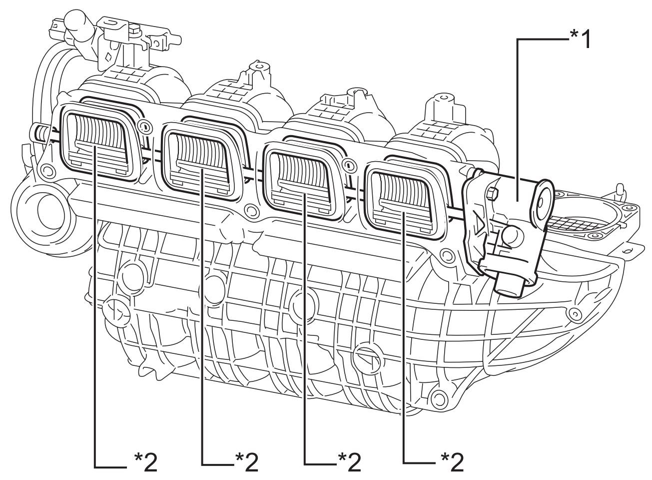
Text in Illustration

*1	VSV	*2	ACIS Actuator
*3	Intake Air Control Valve	-	-

(j) Tumble Control Valve

(1) The tumble control valves are built into the intake manifold. The tumble control valves close when the engine is cold, generating tumble flow in the combustion chamber.

(2) The actuator activates the tumble control valves based on signals from the ECM.



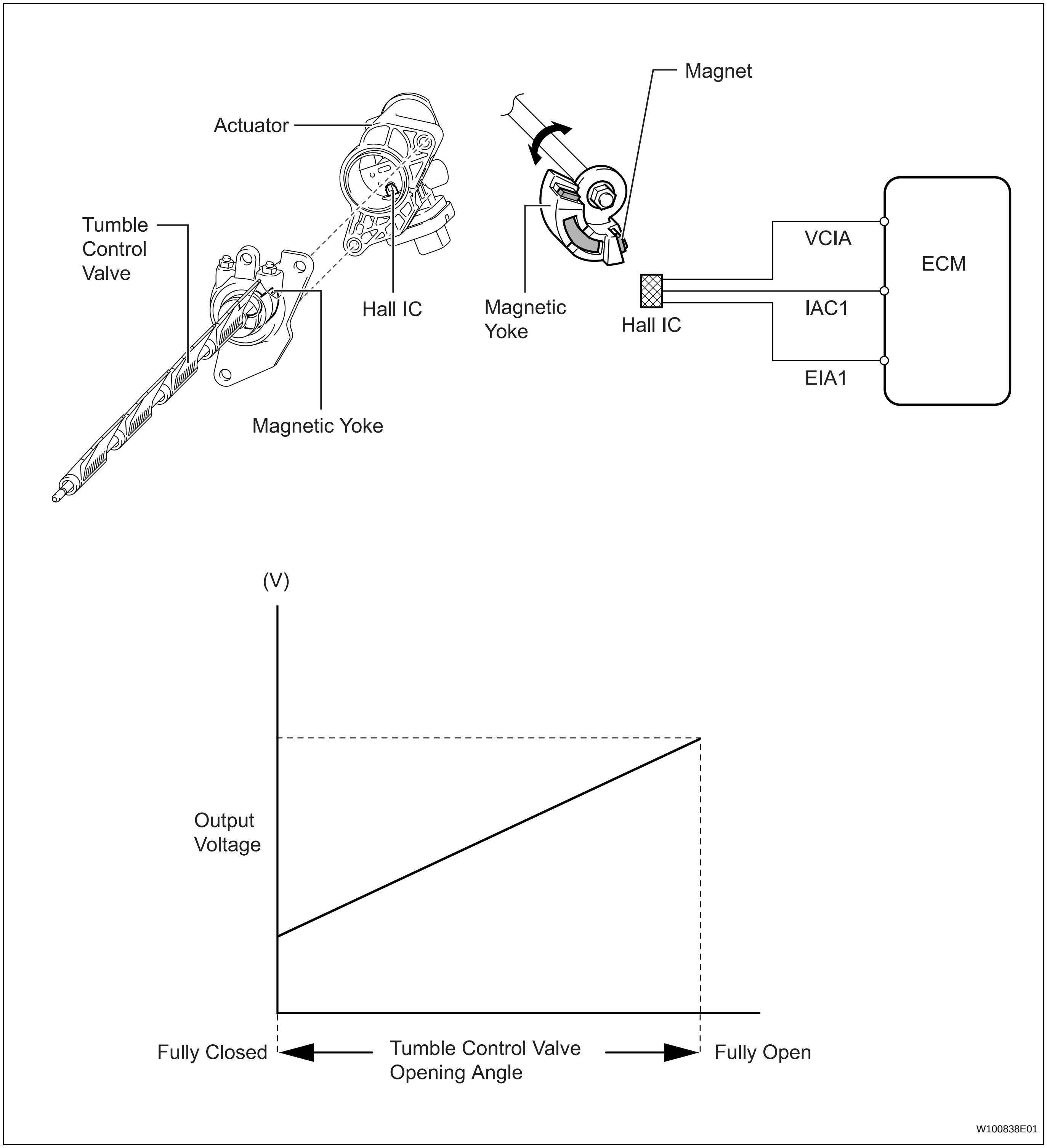
Text in Illustration

*1	Actuator (For Tumble Control Valves) - Built-in Tumble Control Valve Position Sensor	*2	Tumble Control Valve

(k) Actuator (For tumble control valves)

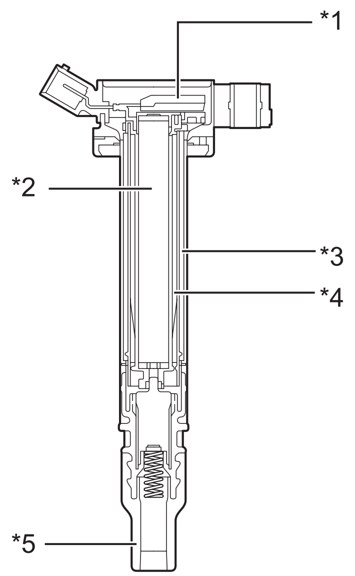
(1) A tumble control valve position sensor that uses a Hall IC is built into the actuator for the tumble control valves.

(2) The tumble control valve position sensor detects the opening amount of the tumble control valves, and sends signals to the ECM.



(l) Ignition Coil Assembly

(1) The Direct Ignition System (DIS) provides 4 ignition coil assemblies, 1 for each cylinder. The spark plug caps, which provide contact to the spark plugs, are integrated with the ignition coil assembly. Also, an igniter is enclosed to simplify the system.



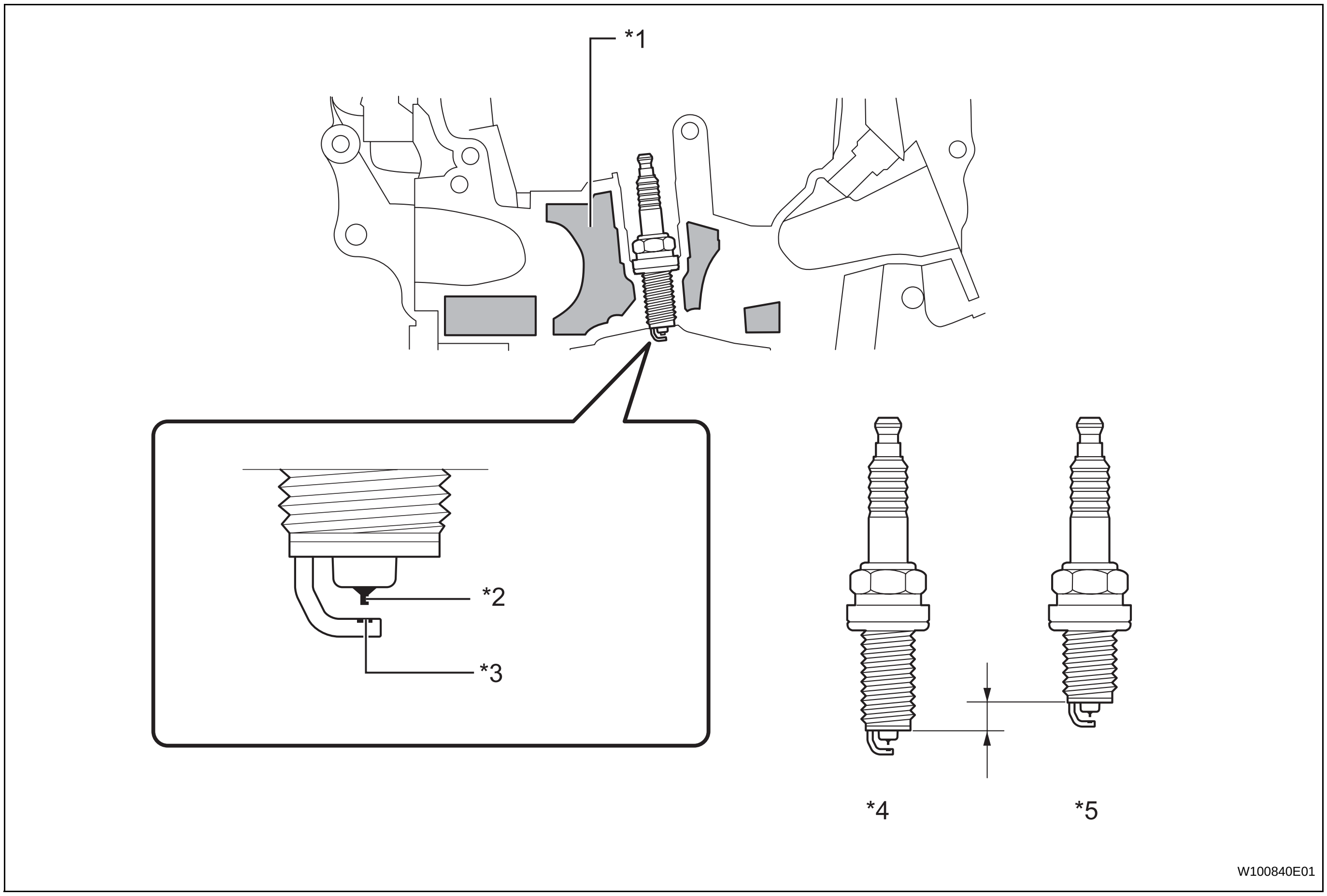
Text in Illustration

*1	Igniter	*2	Iron Core
*3	Primary Coil	*4	Secondary Coil
*5	Plug Cap	-	-

(m) Spark Plug

(1) Long-reach type spark plugs are used. This type of spark plug allows the area of the cylinder head sub-assembly that receives the spark plugs to be made thick. Thus, the water jacket can be extended near the combustion chamber, which contributes to cooling performance.

(2) Iridium-tipped spark plugs are used to achieve a 192000 km (120000 mile) maintenance interval. By making the center electrode of iridium, it is possible to achieve superior ignition performance and durability when compared to platinum-tipped spark plugs.



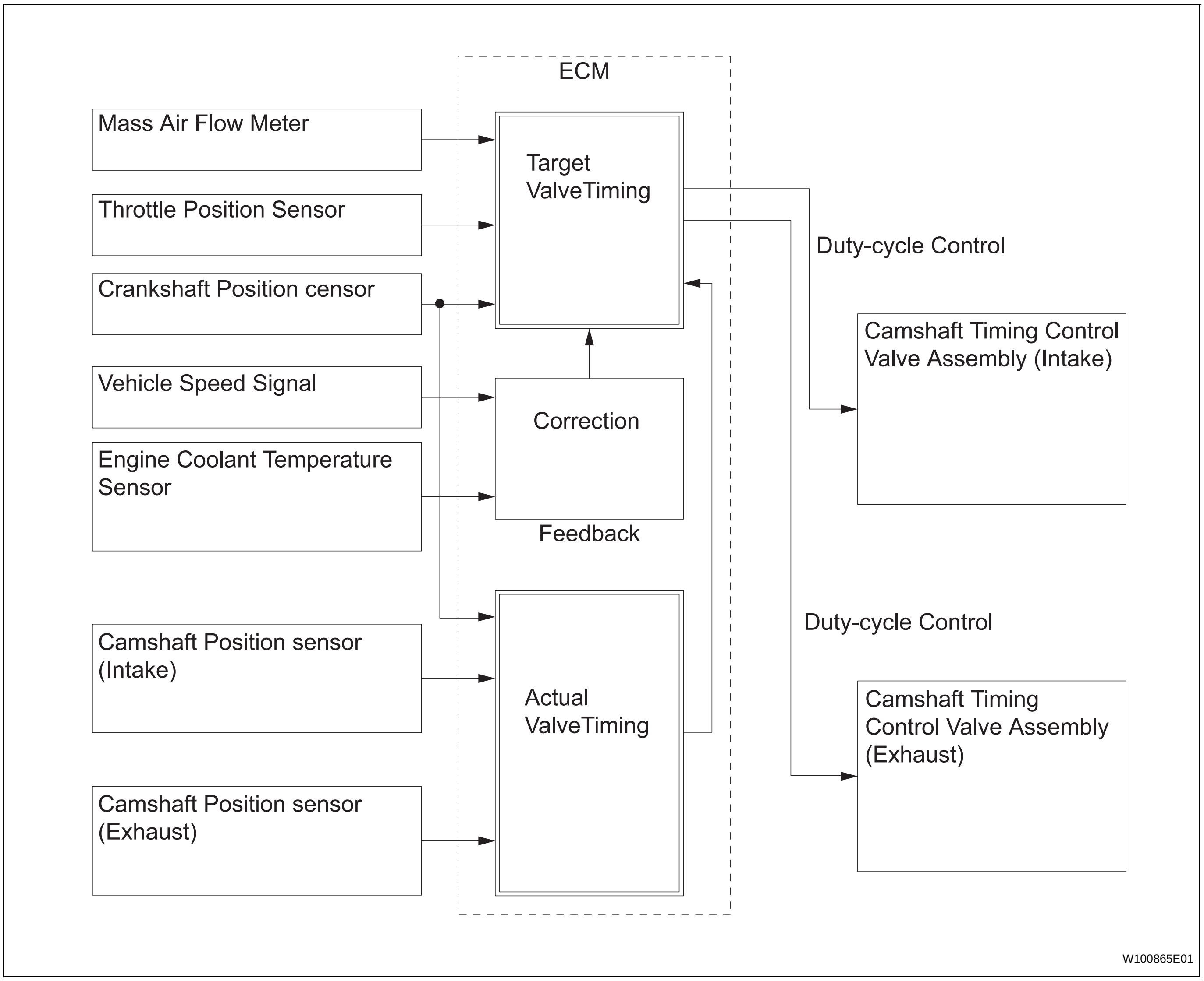
Text in Illustration

*1	Water Jacket	*2	Iridium Tip
*3	Platinum Tip	*4	Long-reach Type
*5	Conventional Type	-	-

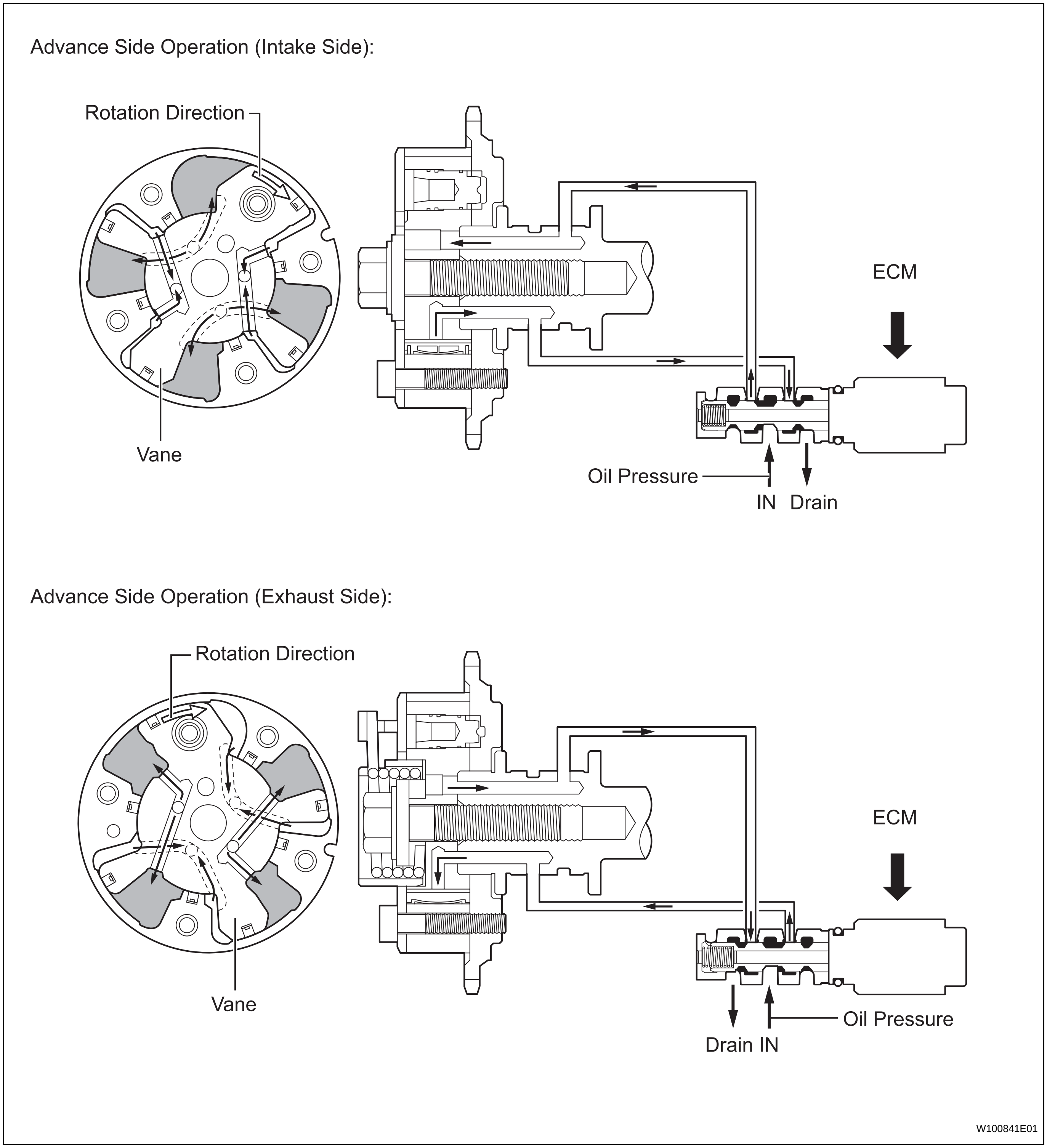
5. OPERATION

(a) Dual VVT-i System

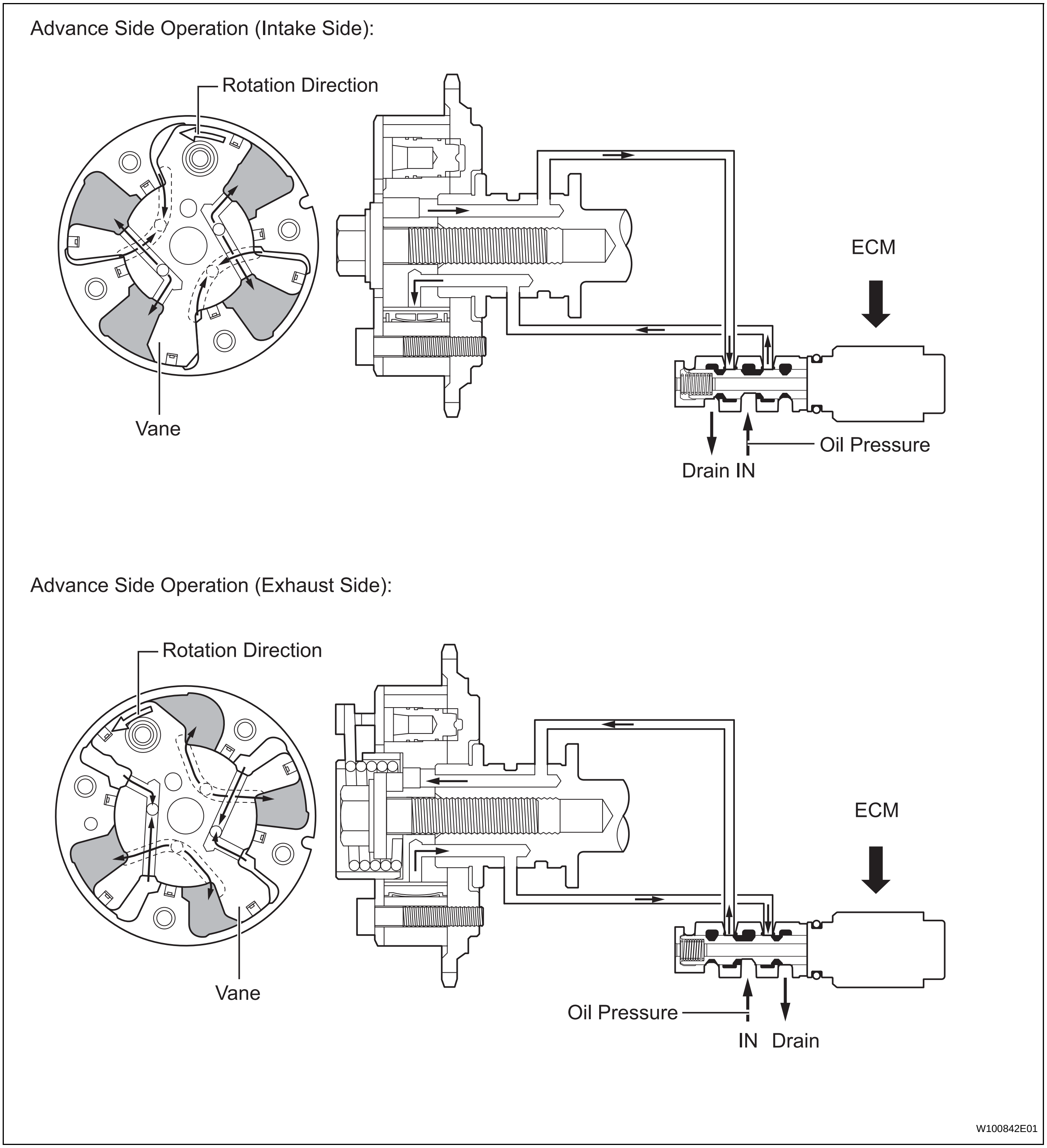
(1) Based on engine speed, intake air volume, throttle position and engine coolant temperature, the ECM calculates optimal valve timing for all driving conditions. The ECM also controls the camshaft timing oil control valve assemblies. In addition, the ECM uses signals from the camshaft position sensors and the crankshaft position sensor to detect the actual valve timing, thus providing feedback control to achieve the target valve timing.



(2) When the camshaft timing oil control valve assembly is positioned as illustrated below by the advance signals from the ECM, the resultant oil pressure is applied to the timing advance side vane chamber to rotate the camshaft in the timing advance direction.



(3) When the camshaft timing oil control valve assembly is positioned as illustrated below by the retard signals from the ECM, the resultant oil pressure is applied to the timing retard side vane chamber to rotate the camshaft in the timing retard direction.



(4) After reaching the target timing, the engine valve timing is maintained by keeping the camshaft timing oil control valve assembly in the neutral position unless the engine operating conditions change. This maintains the engine valve timing at the desired target position by preventing the engine oil from running out of the camshaft timing oil control valve assembly.

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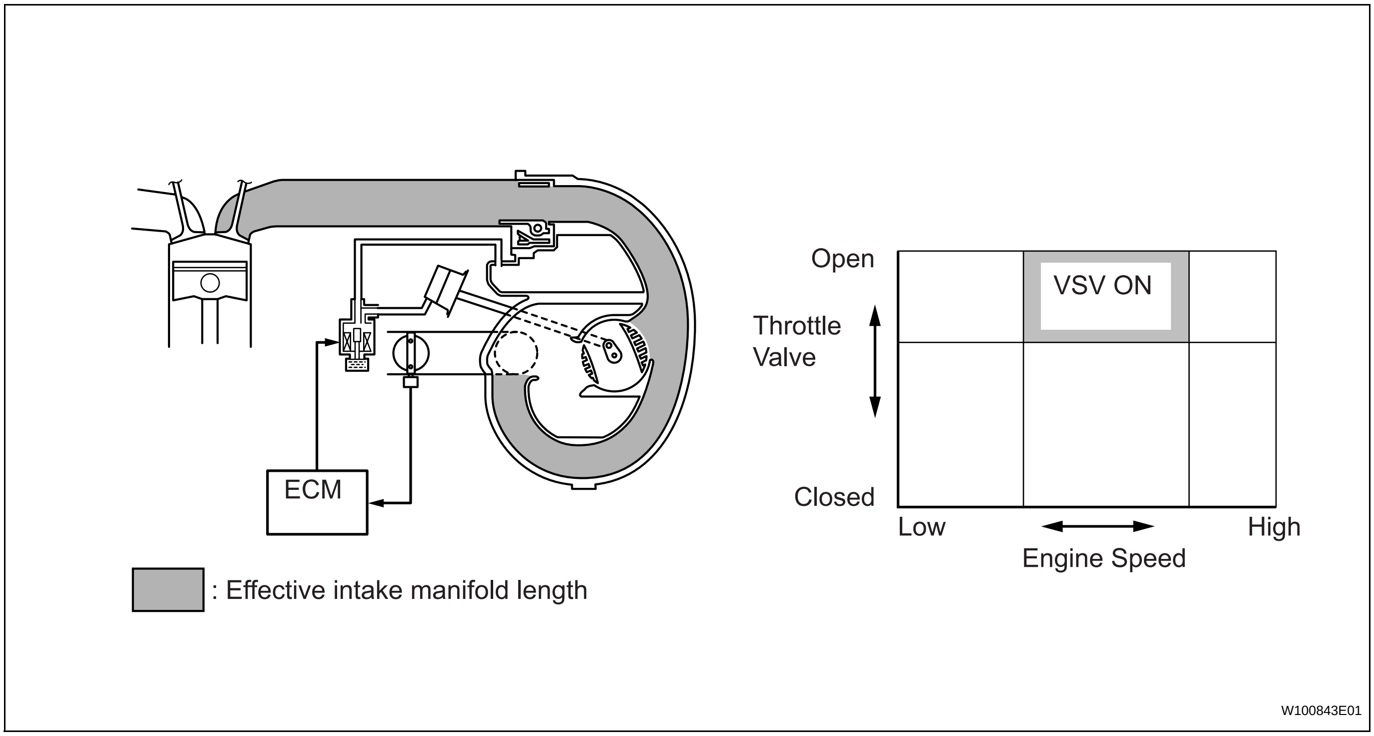
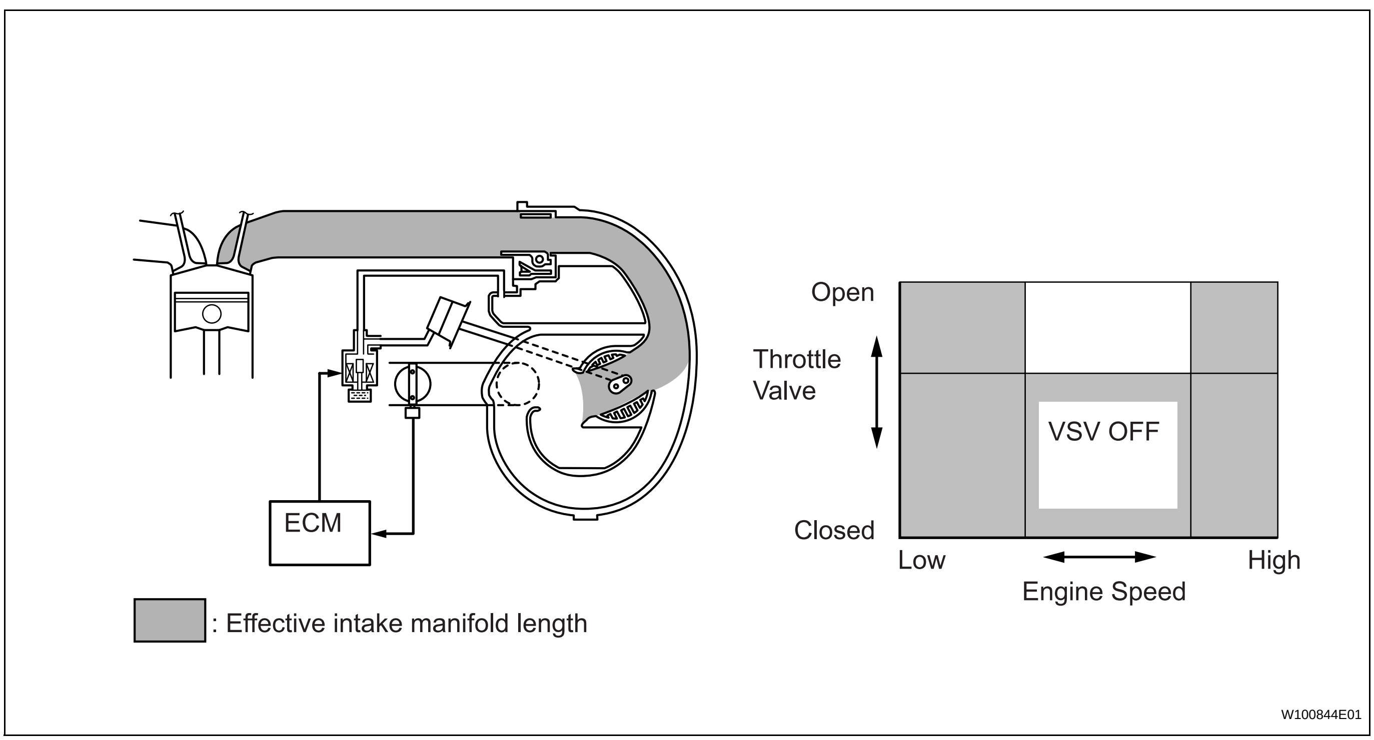
(b) Acoustic Control Induction System (ACIS)

(1) To match the longer pulsation cycle, the ECM activates the VSV so that vacuum acts on the diaphragm chamber of the actuator. This closes the control valve. As a result, the effective length of the intake manifold is lengthened and the intake efficiency in the medium speed range is improved due to the dynamic effect of the intake air, thereby increasing the power output.



(2) Under any condition except when the engine is running at medium speed under high load, the ECM causes the actuator to open the control valve. When the control valve is open, the effective length of the intake air surge tank is shortened and peak intake efficiency is shifted to the low-to-high engine speed range, thus providing greater output at low-to-high engine speeds.



(c) Tumble Control System

(1) When the engine is cold, the ECM controls the DC motor type actuator, closing the tumble control valves to generate a strong tumble flow in the combustion chamber. As a result, even when cold, stable combustion is possible using a leaner air fuel ratio.

(2) The ECU promotes rapid warming of the catalyst by retarding the ignition timing.

(3) The ECM can optimize fuel economy and control exhaust emissions when cold because vacuum is generated downstream of the tumble control valves after they close, controlling the adhesion of fuel to the sides of the intake ports.

(4) When the engine is warm, the ECM controls the DC motor type actuator, opening the tumble control valves completely. As a result, the intake air resistance due to the tumble control valves is minimized.

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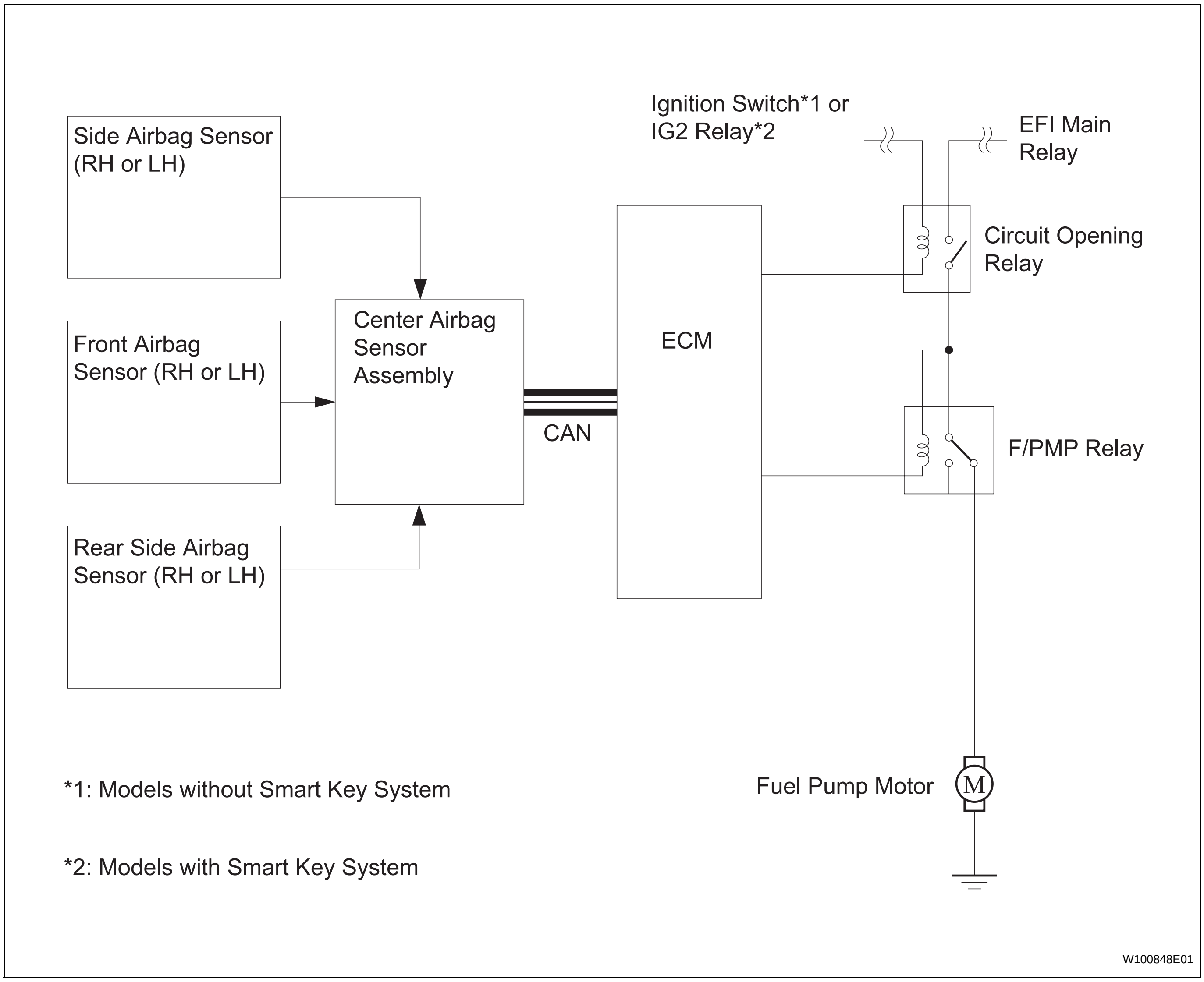
(d) Fuel Pump Control

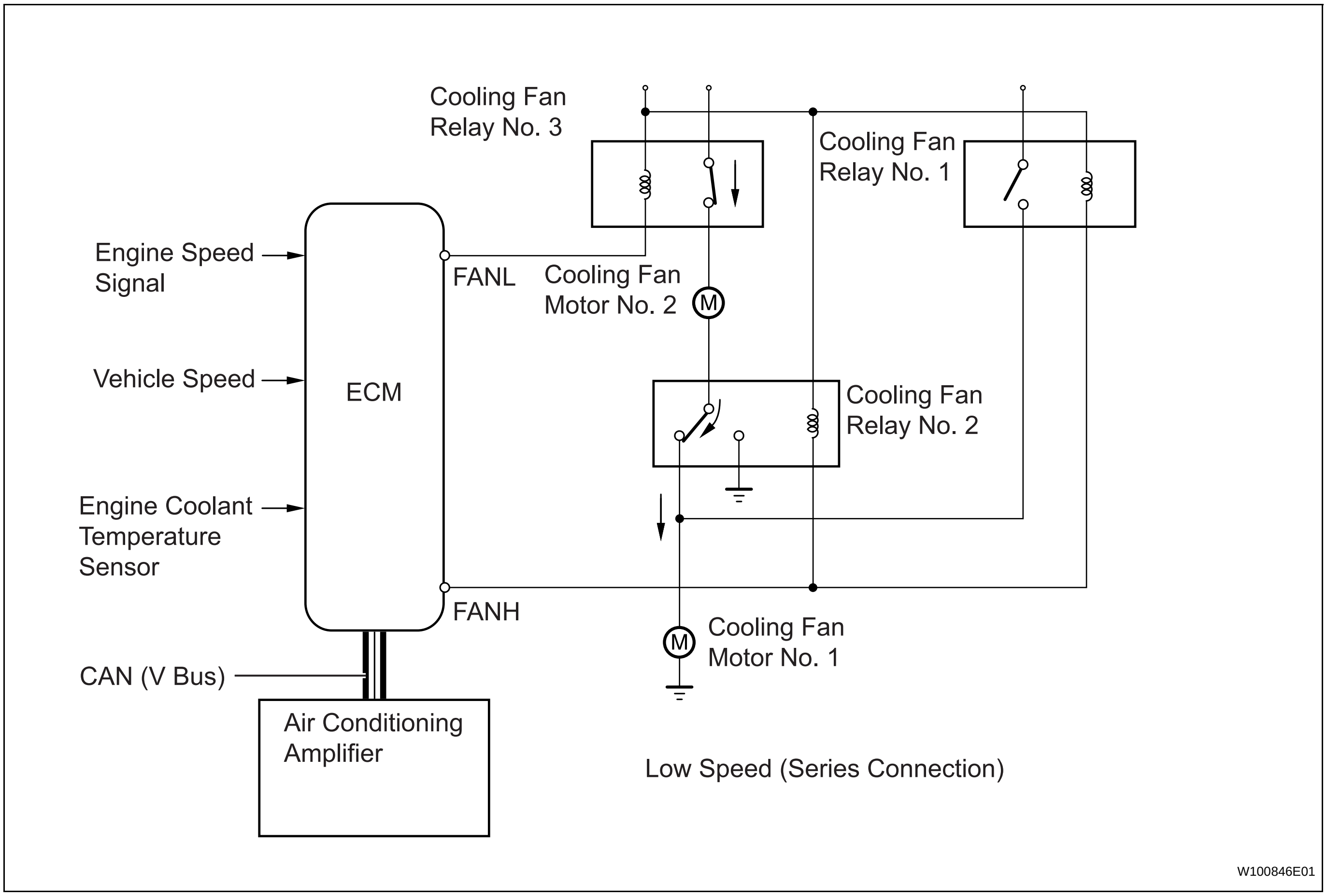
(1) The fuel pump is controlled by the ECM using the fuel pump relay. The fuel pump control has a fuel cut control. Fuel cut control stops the fuel pump when any of the SRS airbags has deployed.

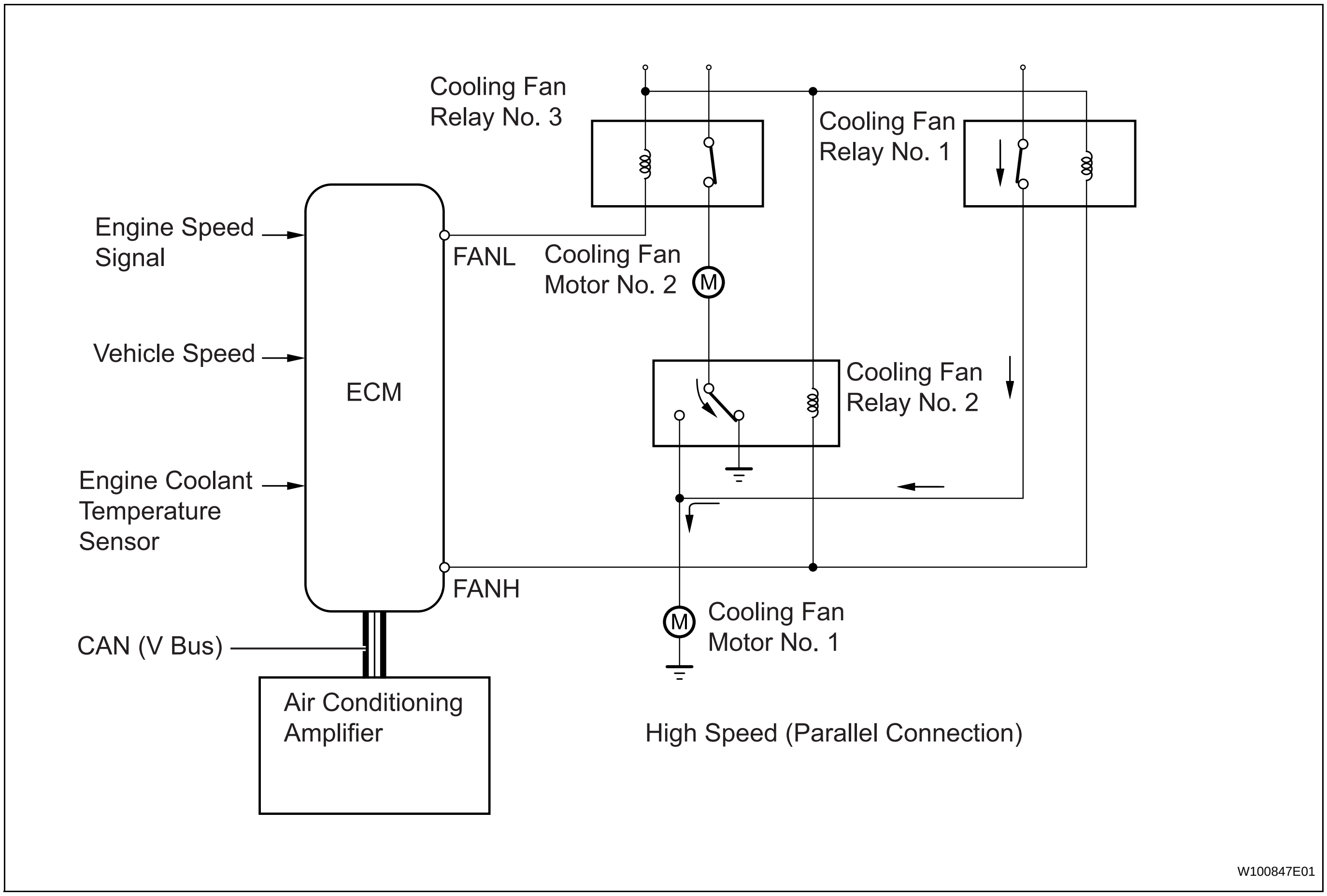
- When the ECM detects the airbag deployment signal from the Center Airbag Sensor Assembly, the ECM will turn the circuit opening relay off. After the fuel cut control has been activated, turning the power source from OFF to the IG-ON position cancels the fuel cut control, and the engine can be restarted.



(e) Cooling Fan Control System

(1) The ECM controls the operation of the cooling fan using 2 speeds (low and high) to achieve an optimal fan speed in accordance with the engine coolant temperature, vehicle speed, engine speed, and air conditioning operating conditions. This control is accomplished by operating the 2 fan motors in series to achieve low speed, and in parallel to achieve high speed.





6. FAIL-SAFE

(a) When a malfunction is detected by any of the sensors, there is a possibility of an engine or other malfunction occurring if the ECM continues 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 Repair Manual.

7. DIAGNOSIS

(a) When the ECM detects a malfunction, it makes a diagnosis and memorizes information related to the fault. Furthermore, the MIL in the combination meter illuminates or blinks to inform the driver.

(b) The ECM will also store DTCs for the malfunctions. The DTCs can be accessed by the use of the Techstream.

(c) A permanent DTC is used for DTCs associated with the illumination of the MIL. Permanent DTCs can not be cleared by using the Techstream, disconnecting the battery terminal, or removing the EFI fuse.

(d) For details of the diagnosis and method to clear DTCs, refer to the Repair Manual.