RAV4

OUTLINE OF NEW FEATURES

The following changes are made for the 2009 model year.

1. Model Line-up

- The following models with the 2AZ-FE engine have been discontinued:

Model Code	Engine	Transaxle	Drive Type	Grade
ACA33L-ANPXKA	2AZ-FE	U140F 4-speed Automatic	4WD	— (Standard)
ACA33L-ANPGKA				Limited
ACA33L-ANPSKA				Sport
ACA38L-ANPXKA		U241E 4-speed Automatic	2WD	— (Standard)
ACA38L-ANPGKA				Limited
ACA38L-ANPSKA				Sport
ACA33L-ANPXKK		U140F 4-speed Automatic	4WD	— (Standard)
ACA33L-ANPGKK				Limited
ACA33L-ANPSKK				Sport

- The following models with the 2AR-FE engine have been introduced:

Model Code	Engine	Transaxle	Drive Type	Grade
ASA33L-A(C)NPXKA	2AR-FE	U140F 4-speed Automatic	4WD	— (Standard)
ASA33L-A(C)NPGKA				Limited
ASA33L-A(C)NPSKA				Sport
ASA38L-A(C)NPXKA		U241E 4-speed Automatic	2WD	— (Standard)
ASA38L-A(C)NPGKA				Limited
ASA38L-A(C)NPSKA				Sport
ASA33L-A(C)NPXKK		U140F 4-speed Automatic	4WD	— (Standard)
ASA33L-A(C)NPGKK				Limited
ASA33L-A(C)NPSKK				Sport

2. Exterior

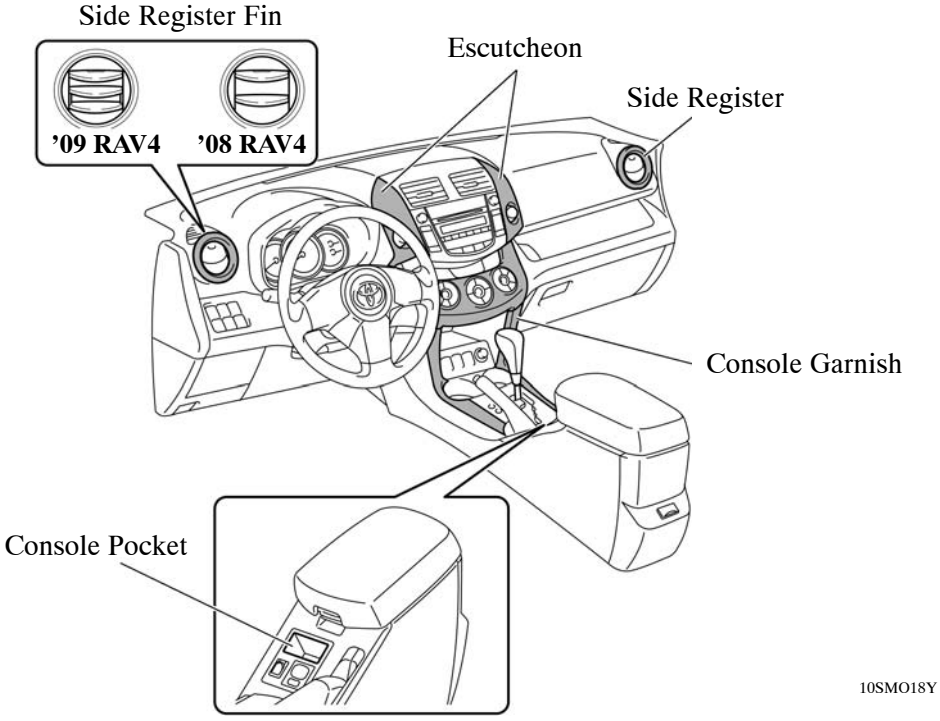
- The design of the headlights, radiator grille, and front bumper has been changed. For details, see page 9.
- The design of the rear combination lights and rear bumper has been changed. For details, see page 11.
- Models with run-flat tires, on which the back door has no spare tire, are optional on the Sport grade of the 4WD models with the 2GR-FE engine. For details, see page 11.
- A large rear spoiler is provided on the Sport grade. For details, see page 12.
- The antenna has been relocated from the front fender to the rear area of the roof. For details, see page 12.
- Outside rear view mirrors with attached side turn signal lights are provided. For details, see page 12.
- The design of the 17-inch aluminum disc wheel has been changed. For details, see page 13.
- The offset of the 18-inch aluminum disc wheel has been changed. For details, see page 13.

- The following exterior colors are available, including 4 new colors:

Color No.	Color Name	Note
040	Super White II	Carryover
070	White Pearl Crystal Shine	Carryover
1F7	Silver Metallic	Carryover
1G3	Gray Metallic	New
202	Black	Carryover
3R3	Red Mica Metallic	Carryover
4T3	Bronze Mica Metallic	New
4T8	Beige Metallic	New
6T3	Dark Green Mica	Carryover
8R3	Grayish Blue Metallic	Carryover
9AF	Dark Violet Mica Metallic	New

3. Interior

- The fawn interior color has been changed to sand beige.
- The ornament color of the door trim has been changed to gray metallic paint color.
- Plated knobs are provided on the models with run-flat tires to give a luxurious impression.
- The number of fins in the side register has been changed from 2 to 3.
- The side registers, escutcheons, and console garnish have been changed from a light gray metallic color to a dark gray metallic color.
- The capacity of the console pocket has been increased in order to provide a space for storing a music player or similar.
- The ornament of the leather type shift knob has been changed to gray metallic paint and hairline grain.



4. 2AR-FE Engine

A newly developed 2AR-FE engine has been added instead of the 2AZ-FE engine. For details, see page 14.

5. 2GR-FE Engine

A permanent DTC is used for the DTCs associated with the illumination of the MIL. The permanent DTCs can not be cleared by using the Techstream, disconnecting the battery terminal, or removing the EFI fuse. For details of the method to clear the DTCs, refer to the 2009 RAV4 Repair Manual (Pub No. RM10S0U).

6. U140F and U241E Automatic Transaxles

- U140F and U241E automatic transaxles are used on models with the 2AR-FE engine.
- A compact and lightweight ATF warmer is used.
- A permanent DTC is used for the DTCs associated with the illumination of the MIL. The permanent DTCs can not be cleared by using the Techstream, disconnecting the battery terminal, or removing the EFI fuse. For details of the method to clear the DTCs, refer to the 2009 RAV4 Repair Manual (Pub No. RM10S0U).

7. U151E and U151F Automatic Transaxles

A permanent DTC is used for the DTCs associated with the illumination of the MIL. The permanent DTCs can not be cleared by using the Techstream, disconnecting the battery terminal, or removing the EFI fuse. For details of the method to clear the DTCs, refer to the 2009 RAV4 Repair Manual (Pub No. RM10SU).

8. Suspension and Axle

A separate input construction type upper support is used in the front suspension of all models. For details of the separate input construction type upper support, refer to the 2006 RAV4 New Car Features (NM01M0U).

9. Brake Control System

- A compact and lightweight brake actuator is used.
- A VSC OFF switch is used.

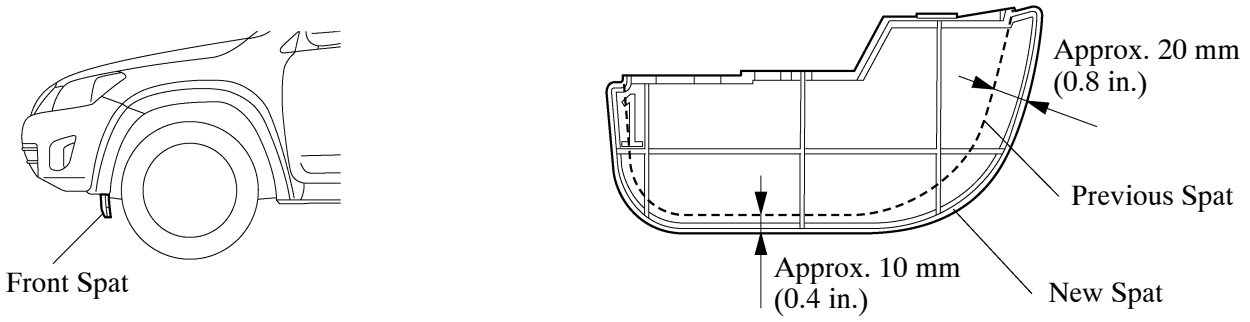
For details, see page 103.

10. EPS (Electric Power Steering)

Battery voltage drop suppression control is used in the EPS (Electric Power Steering) system. For details, see page 106.

11. Body Structure

- A sound absorption structure is used for the dash inner insulator. Thus, it achieves a high level of sound insulation and damping performance in terms of engine noise, combustion sound, gear noise, and road noise.
- In the dash inner insulator, the diameter of the passage hole for the heater pipe has been decreased to reduce the noise entering from the engine compartment.
- The steering column hole cover has been pressed against the dash panel. This improves sealing performance and sound insulation.
- The size of the front spat has been increased to attain favorable aerodynamic performance and fuel economy.



- An active headrest mechanism is used. For details, see page 107.

12. Lighting

An automatic light control system is provided as standard equipment for the Limited grade, and is available as optional equipment for the Sport grade. For details, see page 108.

13. Meter

The following changes have been made to the ’09 RAV4.

- The design of the combination meter has been changed.
- Instant fuel consumption and average fuel consumption are now shown on the multi-information display.
- The indication size of the shift position indicator has been increased.
- A parking brake unreleased warning function has been added.
- The design of the indicator lights has been partially changed.

For details, see page 110.

14. Air Conditioning

- A TSE17 type A/C compressor is used for models with 2AR-FE engine.
- The design of the switches on the automatic control type heater control panel has been changed.

For details, see page 113.

15. Navigation System with AV System

A navigation system with AV system is available as optional equipment for the Limited and Sport grades. For details, see page 114.

16. Rear View Monitor System

A rear view monitor system is available as optional equipment for the Limited and Sport grades. For details, see page 120.

17. Wireless Door Lock Control System

In the customized body electronics system, the setting of the automatic lock time function has been changed as follows:

System	Techstream Display Content	Content	Model	Default Setting	Available Setting
Wireless Door Lock Control System	Auto Lock Time	Function to change the time until relocking after unlocking with the wireless door lock.	’09 RAV4	60	30, 60, 120 or OFF
			’08 RAV4	30	30 or 60

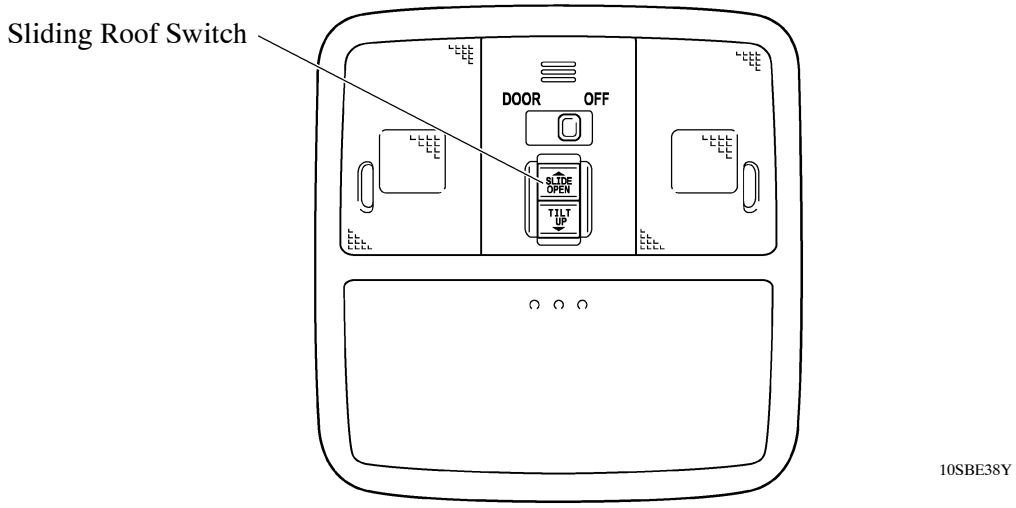
For details, refer to the 2009 RAV4 Repair Manual (Pub. No. RM10S0U).

18. Smart Key System

A smart key system is used for the Limited grade. For details, see page 123.

19. Sliding Roof System

The shape of the sliding roof switch on the overhead console has been changed.



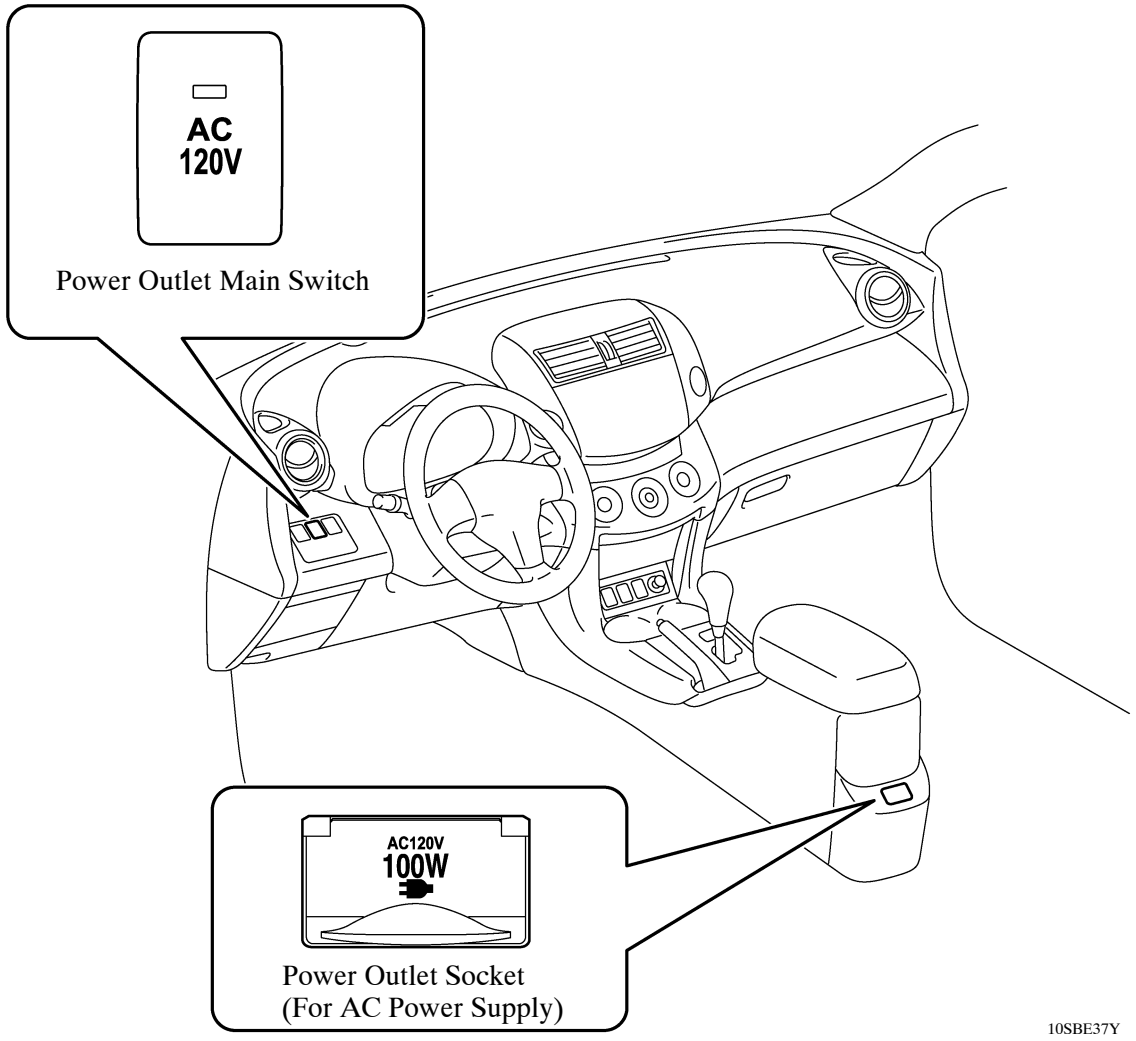
20. Audio System

- New audio head units are used.
- An SDARS (Satellite Digital Audio Radio Service) antenna is used for all models.
- The AUX adapter has been relocated.
- A DISP switch has been added for the steering pad switch. The DISP switch is provided as standard equipment for all models.

For details, see page 159.

21. Power Outlet

- The design of the power outlet main switch and power outlet socket (for AC power supply) has been changed.
- The power outlet socket (for AC power supply) is available as optional equipment for the Limited grade.



MODEL CODE

ASA33 L – A N P X K A

1 2 3 4 5 6 7 8

1	BASIC MODEL CODE		
	CODE	DRIVE TYPE	ENGINE
	ASA33	4WD	2AR-FE
	ASA38	2WD	
	GSA33	4WD	2GR-FE
	GSA38	2WD	

2	STEERING WHEEL POSITION
	L: Left-hand Drive

3	MODEL NAME
	A: RAV4 (Produced by TMC*1) C: RAV4 (Produced by TMMC*2)

4	BODY TYPE
	N: 5-door Wagon

5	GEAR SHIFT TYPE
	P: 4-speed Automatic, Floor A: 5-speed Automatic, Floor

6	GRADE
	X: — (Standard) G: Limited S: Sport

7	ENGINE SPECIFICATION
	K: DOHC and SFI

8	DESTINATION
	A: U.S.A. K: Canada

*1: TMC: Toyota Motor Corporation

*2: TMMC: Toyota Motor Manufacturing Canada, Inc.

MODEL LINE-UP

: New

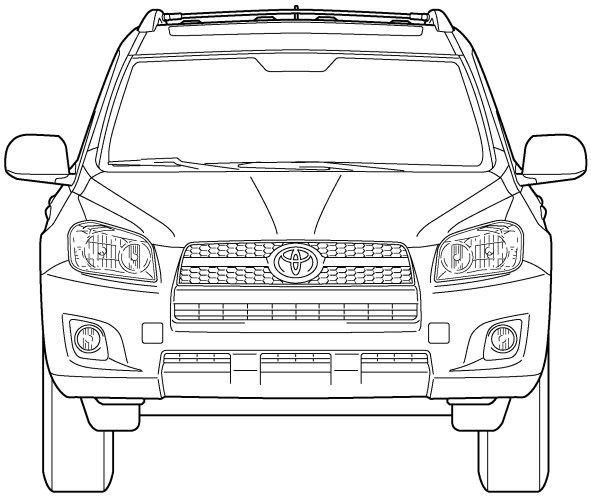
DESTI-NATION	ENGINE	BODY TYPE	GRADE	TRANSAXLE			
				4-speed Automatic		5-speed Automatic	
				2WD	4WD	2WD	4WD
				U241E	U140F	U151E	U151F
U.S.A.	2AR-FE	5-door Wagon	—	ASA38L-A(C)NPXKA	ASA33L-A(C)NPXKA	—	—
			Limited	ASA38L-A(C)NPGKA	ASA33L-A(C)NPGKA	—	—
			Sport	ASA38L-A(C)NPSKA	ASA33L-A(C)NPSKA	—	—
	2GR-FE		—	—	—	GSA38L-A(C)NAXKA	GSA33L-A(C)NAXKA
			Limited	—	—	GSA38L-A(C)NAGKA	GSA33L-A(C)NAGKA
			Sport	—	—	GSA38L-A(C)NASKA	GSA33L-A(C)NASKA
Canada	2AR-FE		—	—	ASA33L-A(C)NPXKK	—	—
			Limited	—	ASA33L-A(C)NPGKK	—	—
			Sport	—	ASA33L-A(C)NPSKK	—	—
	2GR-FE		—	—	—	—	GSA33L-A(C)NAXKK
			Limited	—	—	—	GSA33L-A(C)NAGKK
			Sport	—	—	—	GSA33L-A(C)NASKK

NEW FEATURES

■ EXTERIOR

1. Front Design

- 2 types of design are provided for the front bumper and radiator grille. The front design of the Limited grade consists of a large-size radiator grille and an underguard in order to differentiate it from the standard and Sport grades.
- A newly designed headlight incorporating a front side turn signal light and a side marker within the same lens is used.
- The models with fog lights use plated rings for a luxurious look.



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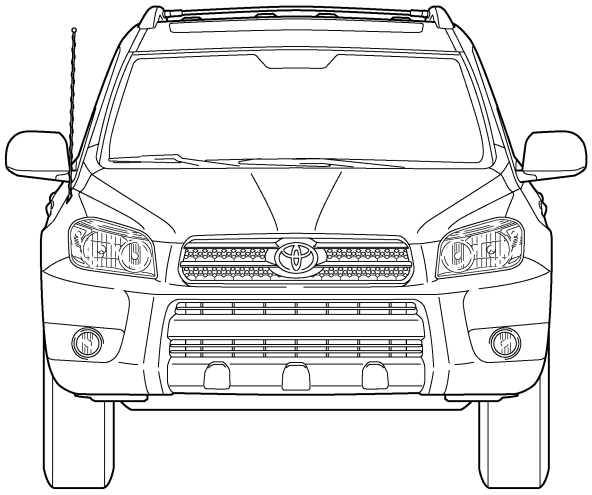
’09 RAV4
Standard and Sport Grades



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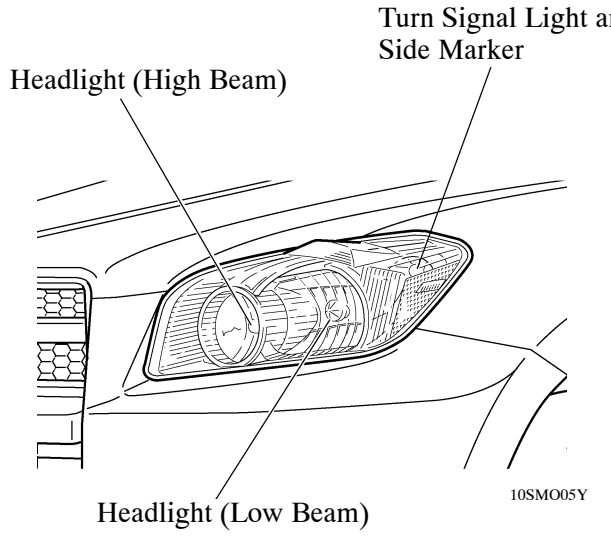
’08 RAV4

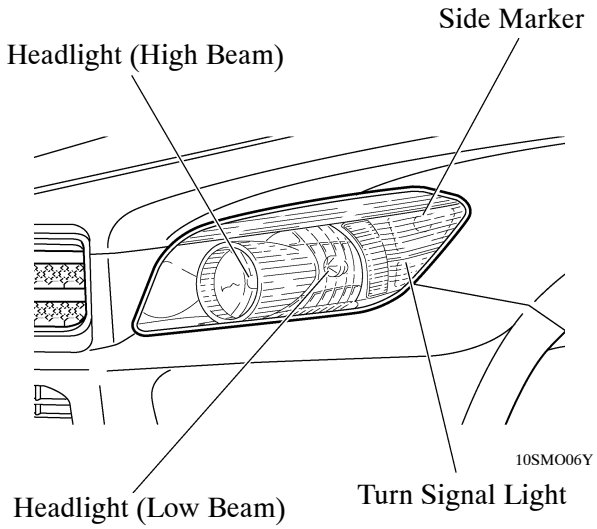
10SMO03Y

’09 RAV4 Limited Grade

▶ Headlight ◀

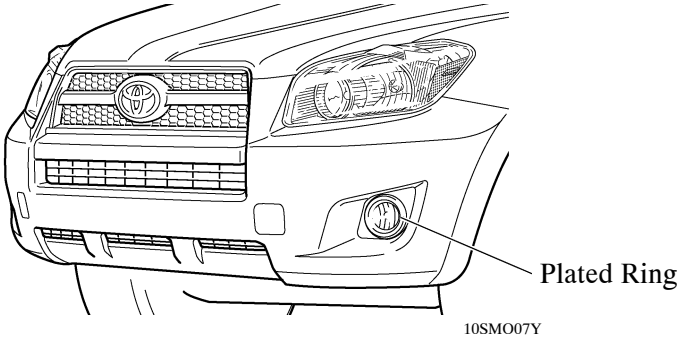


'09 RAV4

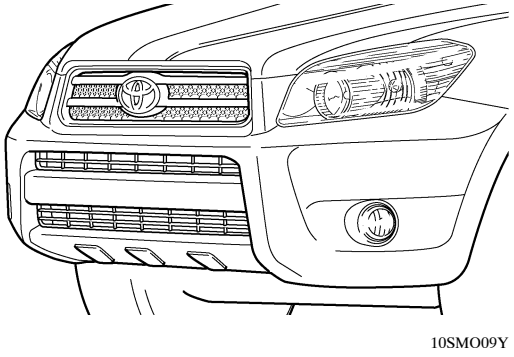


'08 RAV4

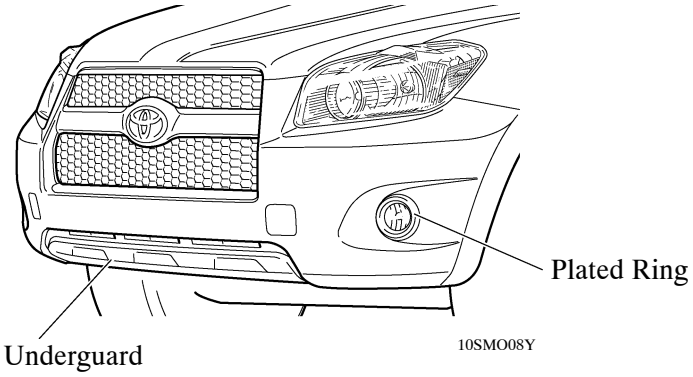
▶ Radiator Grille and Front Bumper ◀



'09 RAV4
Standard and Sport Grades



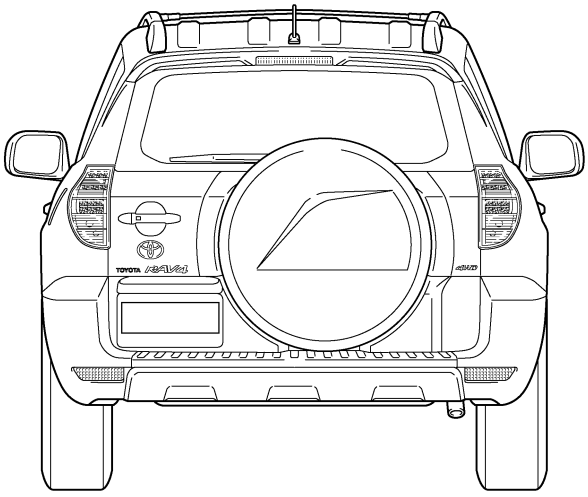
'08 RAV4



'09 RAV4 Limited Grade

2. Rear Design

- The shape of the rear bumper has been changed. In addition, it is provided with a material portion to withstand abrasion during loading and unloading of cargo.
- On the models with the run-flat tires, the back door is designed without a spare tire. A license garnish is provided on the models with the run-flat tires. The license garnish uses plating at the bottom for a luxurious look.
- Newly designed rear combination lights are provided with 12 LEDs (Light Emitting Diodes) in the taillights and stop lights.



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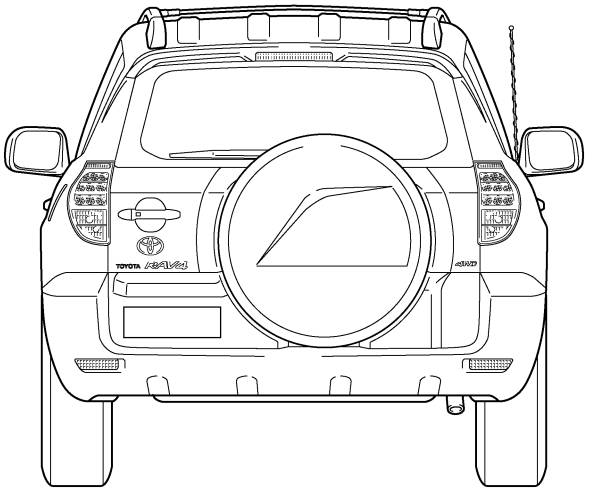
’09 RAV4



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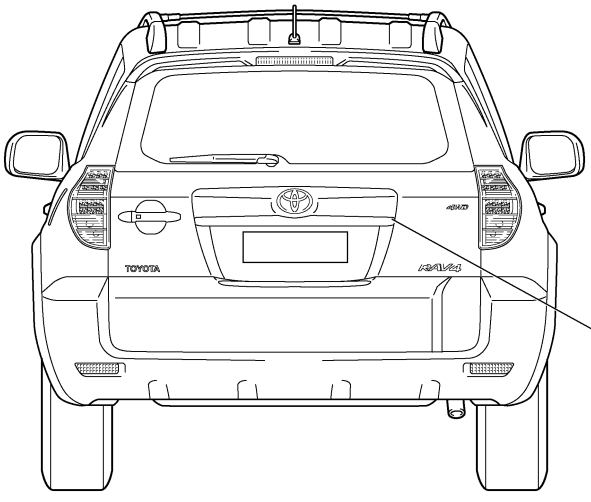
’08 RAV4



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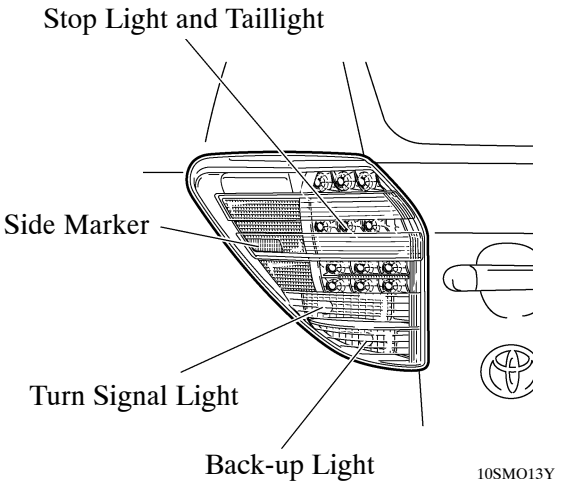
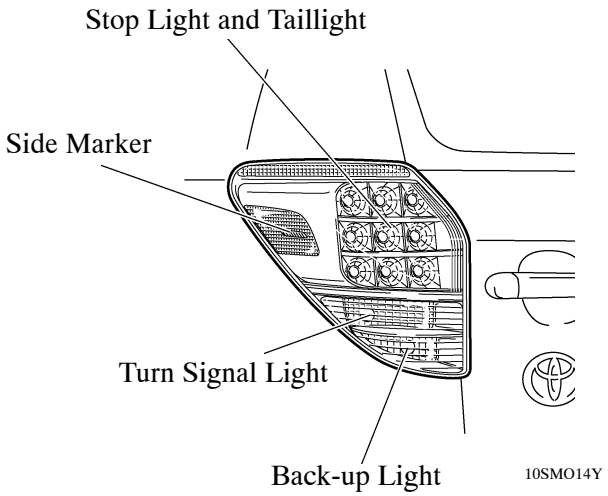
’09 RAV4 with Run-flat Tire

▶ Rear Combination Light ◀



'09 RAV4

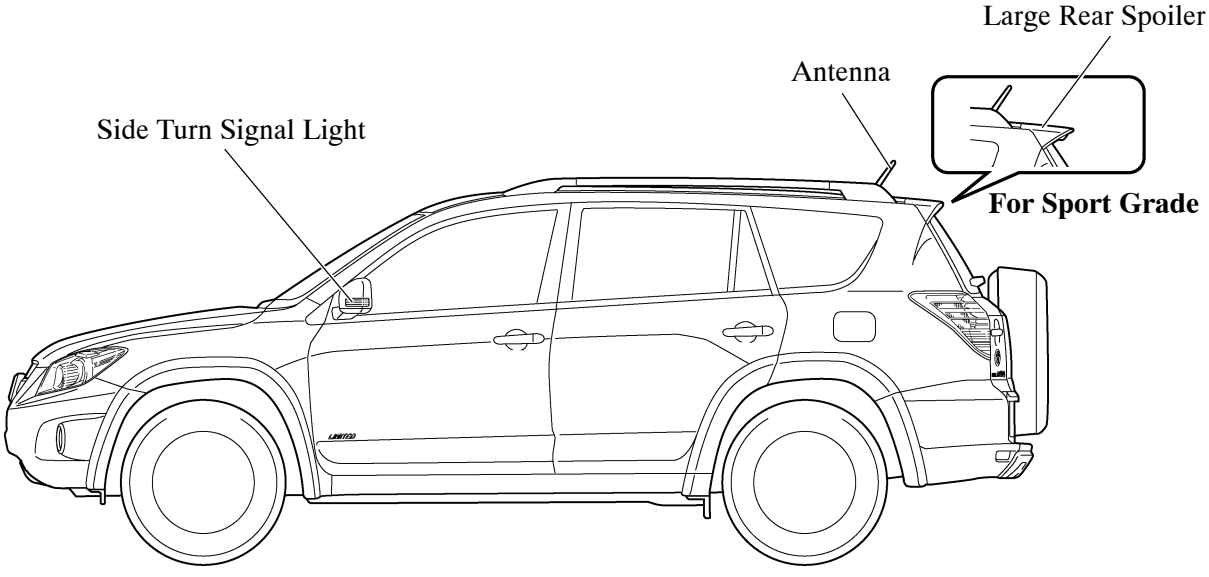


'08 RAV4

3. Side Design

- A large rear spoiler is provided on the Sport grade for a sporty look.
- The antenna has been relocated from the front fender to the rear area of the roof.
- Outside rear view mirrors with attached side turn signal lights are provided as follows:

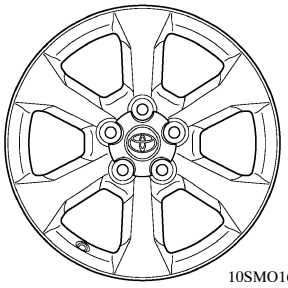
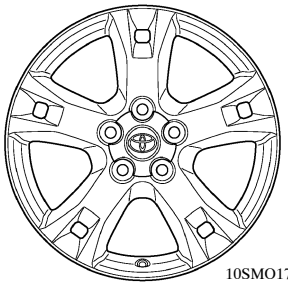
Destination	Grade	Provision	Note
U.S.A.	Standard	—	
	Limited	Standard	
	Sport	Option	Among the TMC made models, this feature is provided only on 4WD models with the 2GR-FE engine.
Canada	Standard	Standard	
	Limited	Standard	
	Sport	Standard	

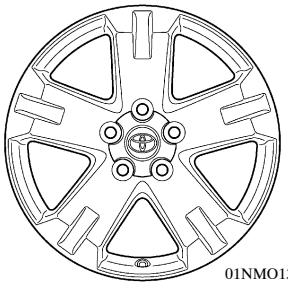
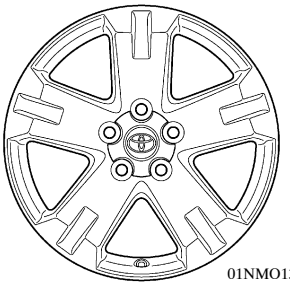


'09 RAV4 Limited Grade

4. Tire and Disc Wheel

- The run-flat tire is provided as optional equipment on the TMC made Sport grade of 4WD models with the 2GR-FE engine. The tire size is P235/55R18.
- The design of the 17-inch aluminum disc wheel has been changed.
- The offset of the 18-inch aluminum disc wheel has been changed from 45 mm (1.8 in.) to 39 mm (1.5 in.) to achieve a powerful appearance.

Grade	Limited	Standard or Sport
Provision	Standard	Option
Tire Size	225/65R17	225/65R17
Disc Wheel Size	17 × 7J	17 × 7J
Disc Wheel Material	Aluminum	Aluminum
P.C.D.*1	114.3 mm (4.5 in.)	114.3 mm (4.5 in.)
Offset	45 mm (1.8 in.)	45 mm (1.8 in.)
Wheel Design	 10SMO16Y	 10SMO17Y

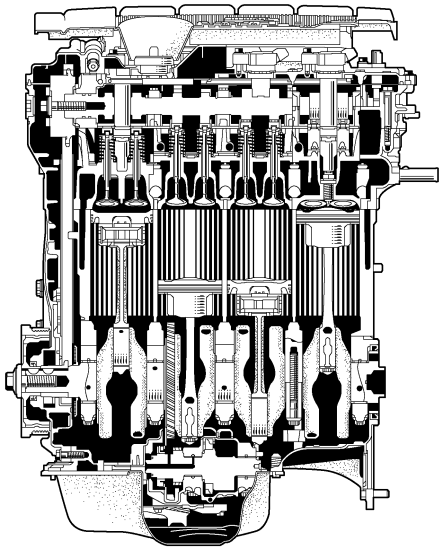
Grade	Sport	Sport
Provision	Standard	Option*2
Tire Size	235/55R18	P235/55R18*2
Disc Wheel Size	18 × 7 1/2J	18 × 7 1/2J
Disc Wheel Material	Aluminum	Aluminum
P.C.D.*1	114.3 mm (4.5 in.)	114.3 mm (4.5 in.)
Offset	39 mm (1.5 in.)	39 mm (1.5 in.)
Wheel Design	 01NMO13Y	 01NMO13Y

*1: Pitch Circle Diameter
*2: Models with run-flat tire

■2AR-FE ENGINE

1. General

The 2AR-FE engine is an in-line, 4-cylinder, 2.5-liter, 16-valve DOHC engine. This engine uses the Dual VVT-i (Variable Valve Timing-intelligent) system, DIS (Direct Ignition System), ACIS (Acoustic Control Induction System) and ETCS-i (Electronic Throttle Control System-intelligent). It has been developed to achieve high performance, quietness, fuel economy and clean emission.



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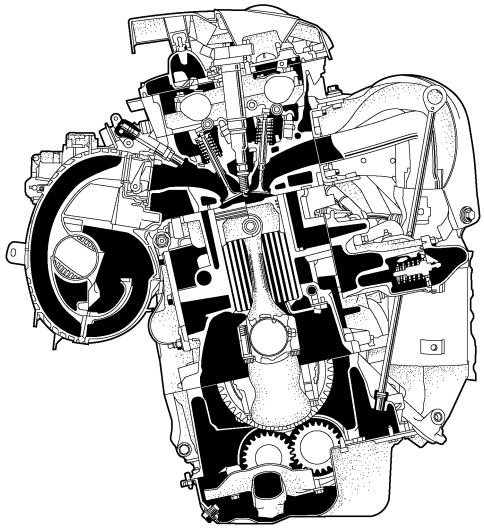


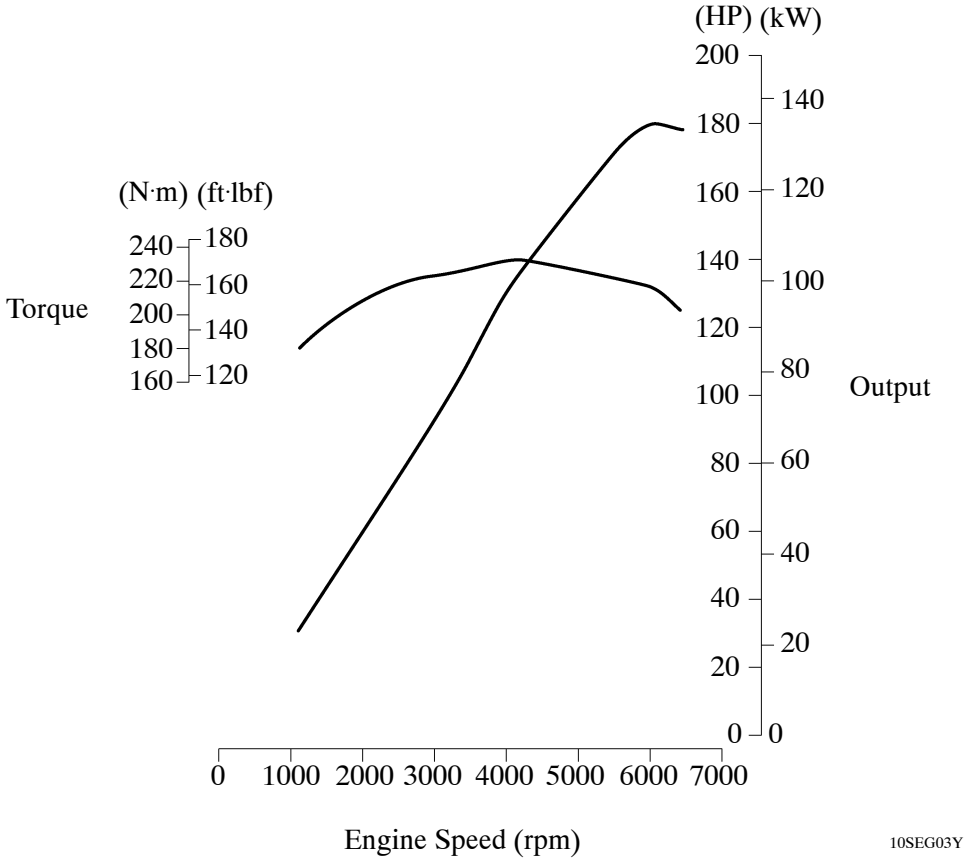
10SEG02Y

▶ Engine Specifications ◀

Model			’09 RAV 4	’08 RAV4
Engine			2AR-FE	2AZ-FE
No. of Cyls. & Arrangement			4-cylinder, In-line	←
Valve Mechanism			16-valve DOHC, Chain Drive (with Dual VVT-i)	16-valve DOHC, Chain Drive (with VVT-i)
Combustion Chamber			Pentroof Type	←
Manifolds			Cross-flow	←
Fuel System			SFI	←
Ignition System			DIS	←
Displacement			2494 cm^3 (152.2 cu.in.)	2362 cm^3 (144.1 cu. in.)
Bore × Stroke			90.0 × 98.0 mm (3.54 × 3.86 in.)	88.5 × 96.0 mm (3.48 × 3.78 in.)
Compression Ratio			10.4 : 1	9.8 : 1
Max. Output*1		(SAE-NET)	134 kW @ 6000 rpm (180 HP @ 6000 rpm)	124 kW @ 6000 rpm (166 HP @ 6000 rpm)
Max. Torque*1		(SAE-NET)	235 N·m @ 4100 rpm (173 ft·lbf @ 4100 rpm)	224 N·m @ 4000 rpm (165 ft·lbf @ 4000 rpm)
Valve Timing	Intake	Open	3° – 53° BTDC	3° – 43° BTDC
		Closed	61° – 11° ABDC	65° – 25° ABDC
	Exhaust	Open	60° – 20° BBDC	45° BBDC
		Closed	4° – 44° ATDC	3° ATDC
Firing Order			1 – 3 – 4 – 2	←
Research Octane Number			91 or higher	←
Octane Rating			87 or higher	←
Tailpipe Emission Regulation			ULEV-II, SFTP	←
Evaporative Emission Regulation			LEV-II, ORVR	←
Engine Service Mass (Reference) *2			147 kg (324.0 lb)	138 kg (304.2 lb)

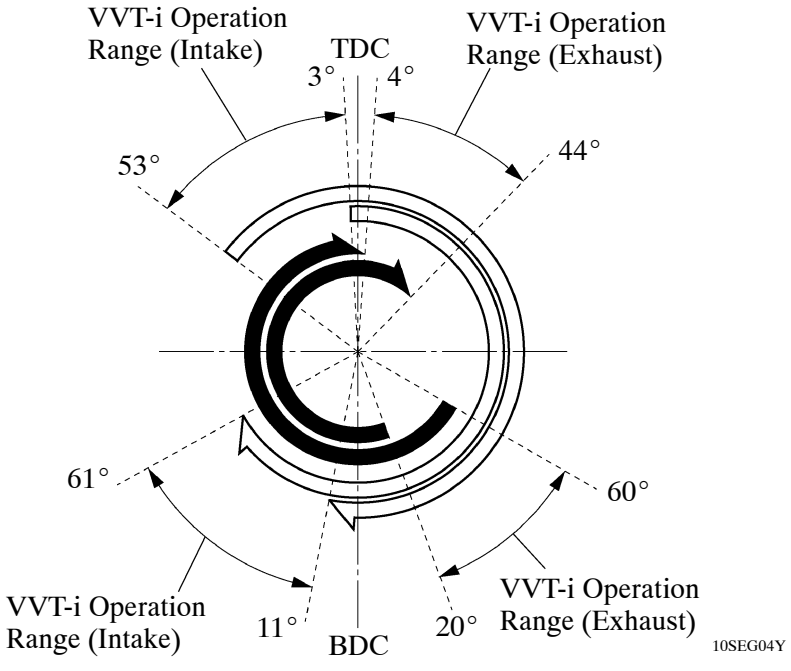
*1: Maximum output and torque rating is determined by revised SAE J1349 standard.
*2: Weight shows the figure with oil and engine coolant fully filled.

▶ Performance Curve ◀



▶ Valve Timing ◀

: Intake Valve Opening Angle
: Exhaust Valve Opening Angle



2. Features of 2AR-FE Engine

The 2AR-FE engine has achieved the following performance features through the use of the items listed below:

(1) High performance and reliability

(2) Low noise and vibration

(3) Lightweight and compact design

(4) Good serviceability

(5) Clean emission and fuel economy

Section	Item	(1)	(2)	(3)	(4)	(5)
Engine Proper	A cylinder head cover made of magnesium alloy is used.			○		
	A taper squish shape is used for the combustion chamber.	○				○
	Spiny-type liners are used in the cylinder bores.	○		○		○
	A water jacket spacer is used.	○				○
	The piston skirt is coated with resin.	○	○			○
	Low tension piston rings are used.	○				○
	A resin gear balance shaft is used.		○	○		
Valve Mechanism	A timing chain and chain tensioner are used.		○		○	
	Hydraulic lash adjusters are used.		○		○	
	Roller rocker arms are used.	○				○
Lubrication System	An oil filter with a replaceable element is used.				○	
Cooling System	TOYOTA Genuine SLLC (Super Long Life Coolant) is used.				○	
Intake and Exhaust System	A charcoal filter is used in the air cleaner cap.					○
	An intake manifold made of plastic is used.			○		
	A linkless-type throttle body is used.			○	○	○
	A thin-wall ceramic TWC (Three-Way Catalytic converter) is used.					○
Fuel System	A fuel returnless system is used.			○	○	○
	Quick connectors are used to connect the fuel hose with the fuel pipe.			○	○	○
	12-hole type fuel injectors with high atomizing performance are used.	○				○
Ignition System	Long-reach type iridium-tipped spark plugs are used.	○			○	○
Charging System	A segment conductor type generator is used.	○	○	○		
Starting System	A PS (Planetary reduction-Segment conductor motor) type starter is used.	○		○		
Serpentine Belt Drive System	A serpentine belt drive system is used.			○	○	

(Continued)

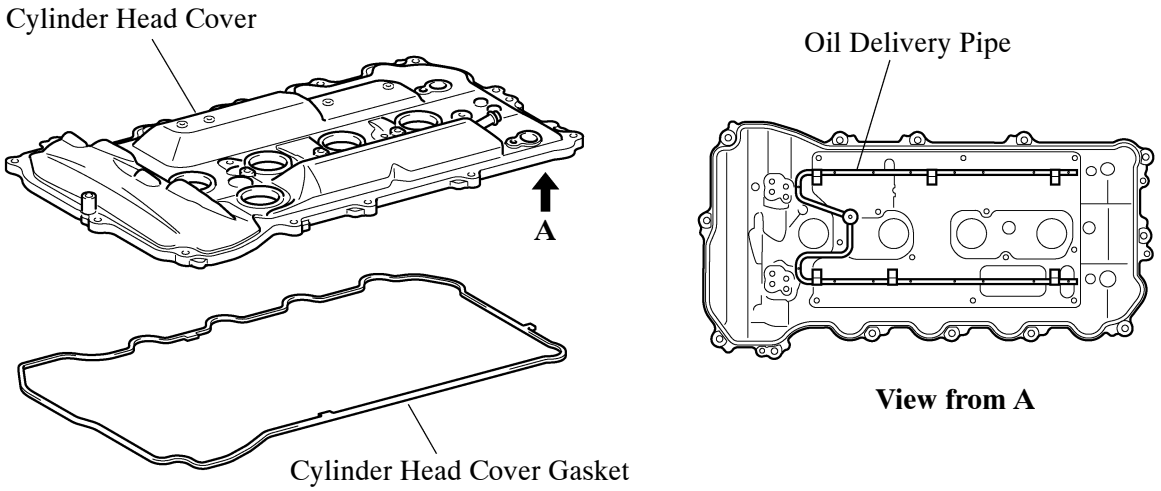
Section	Item	(1)	(2)	(3)	(4)	(5)
Engine Control System	The DIS (Direct Ignition System) makes ignition timing adjustment unnecessary.	○			○	○
	An ETCS-i (Electronic Throttle Control System-intelligent) is used.	○				○
	A Dual VVT-i (Variable Valve Timing-intelligent) system is used.	○				○
	An ACIS (Acoustic Control Induction System) is used.	○				○
	A tumble control system is used.	○				○
	A starter control (cranking hold function) is used.*	○				

*: Models with smart key system

3. Engine Proper

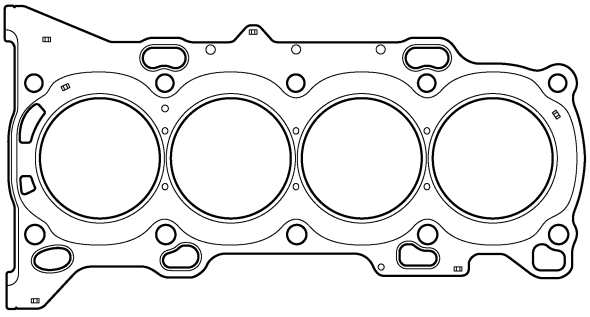
Cylinder Head Cover

- A lightweight magnesium alloy die-cast cylinder head cover is used.
- An oil delivery pipe is installed inside the cylinder head cover. This ensures lubrication to the sliding parts of the roller rocker arm, improving reliability.



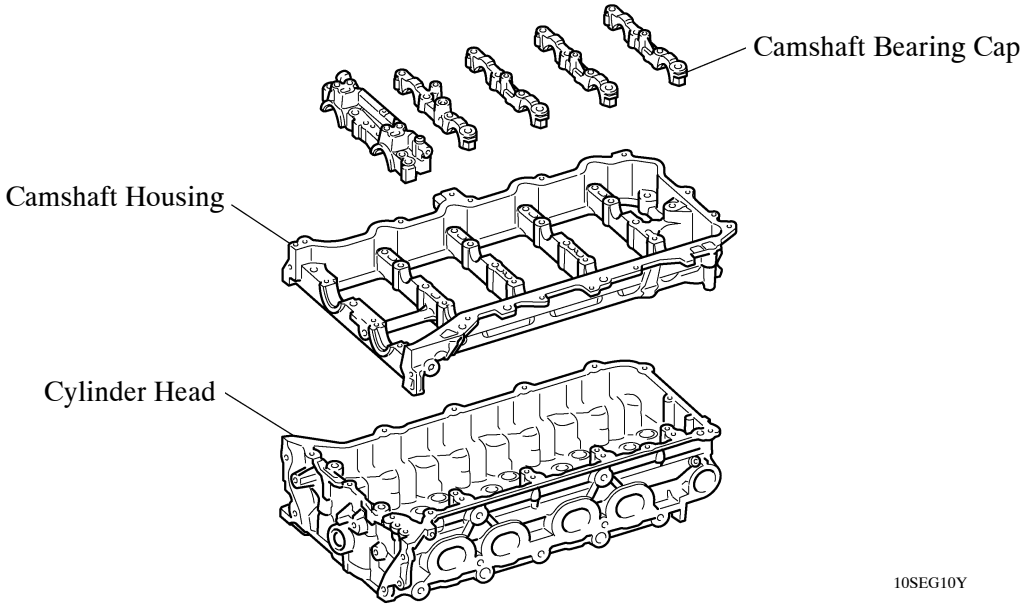
Cylinder Head Gasket

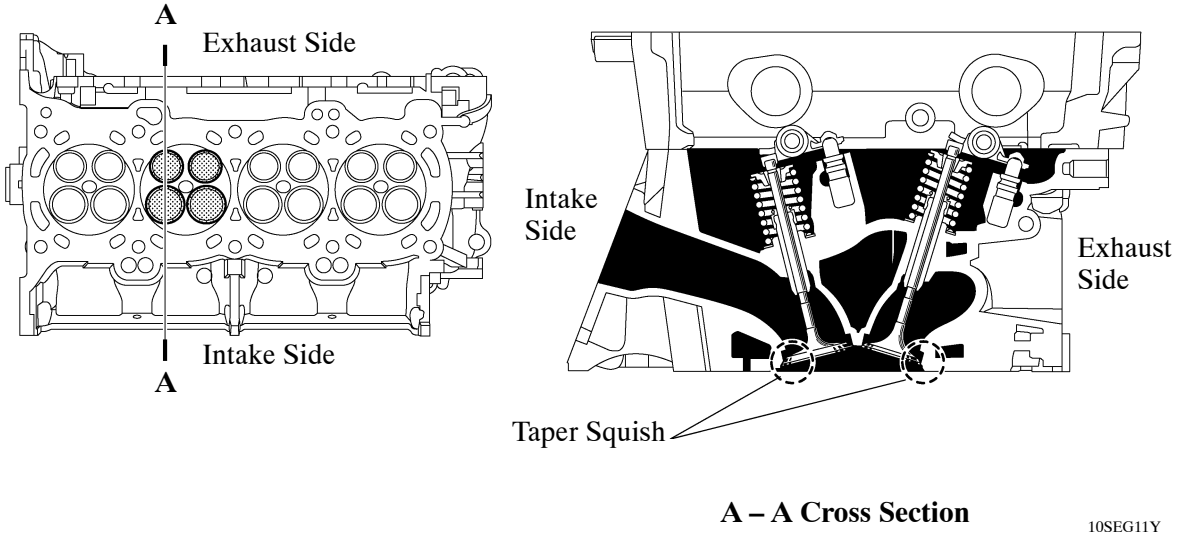
- A triple-layer metal type cylinder head gasket is used.
- The surface of the cylinder head gasket is coated with fluoro rubber to ensure a high level of reliability.



Cylinder Head

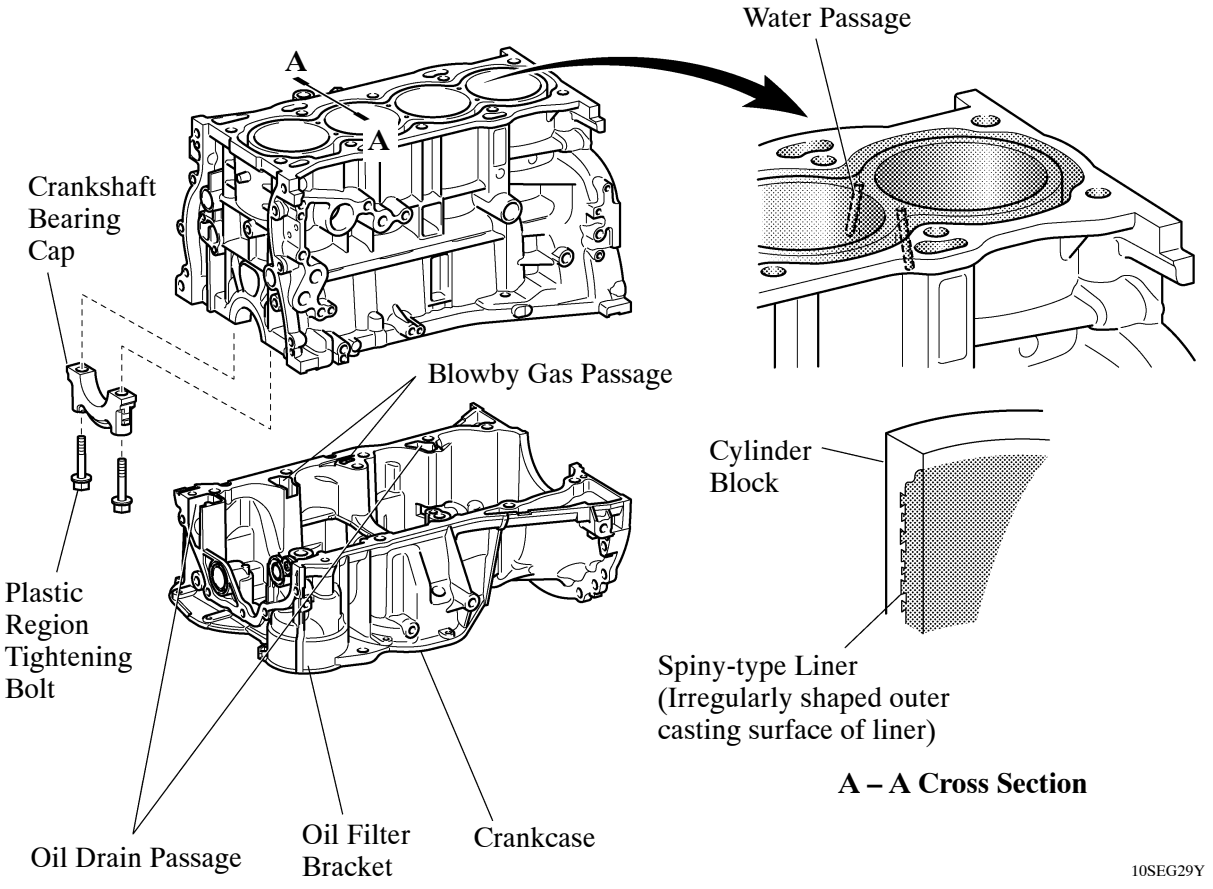
- The cylinder head structure has been simplified by separating the camshaft housing (cam journal portion) from the cylinder head.
- The cylinder head, which is made of aluminum, contains a pentroof-type combustion chamber. The spark plug is located in the center of the combustion chamber in order to improve the engine's anti-knocking performance.
- A taper squish combustion chamber is used to improve anti-knocking performance. In addition, engine performance and fuel economy have been improved.
- Long nozzle type fuel injectors are installed in the cylinder head to reduce the distance from injector to intake valve, thus preventing the fuel from adhering to the intake port walls, and reducing HC exhaust emissions.



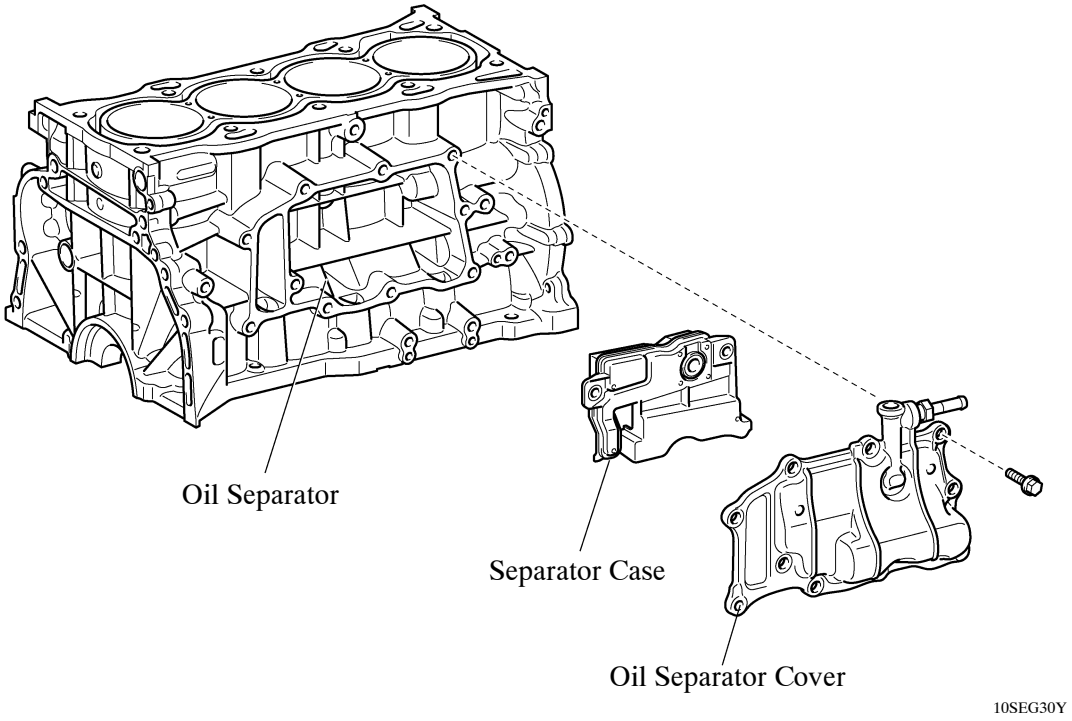


Cylinder Block

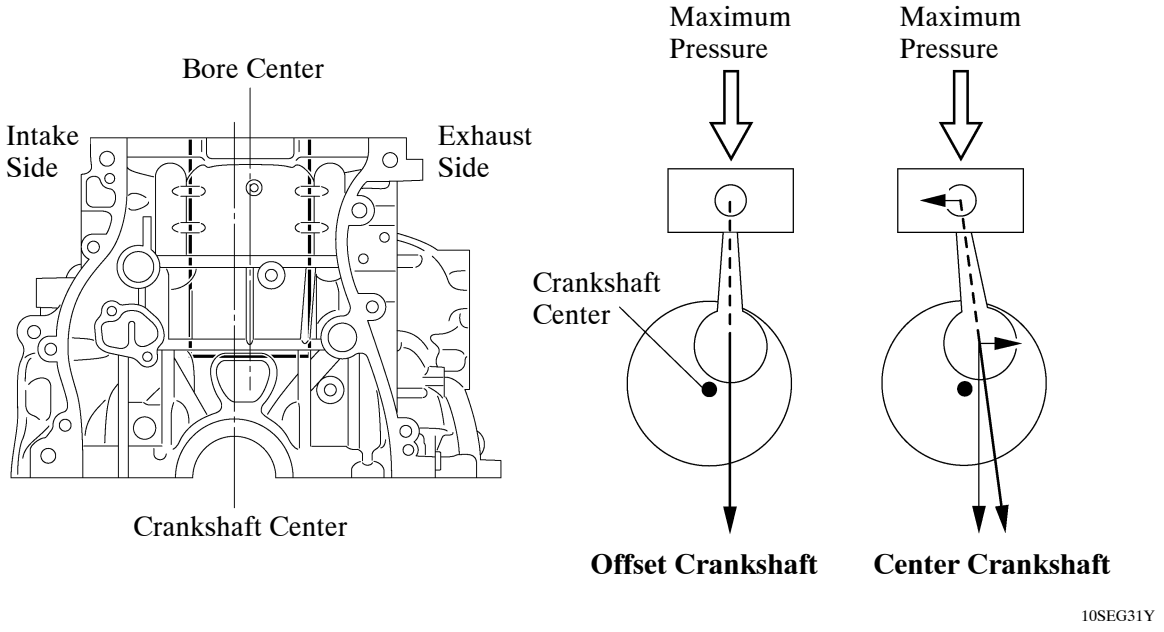
- Water passages have been provided between the cylinder bores. By allowing the engine coolant to flow between the cylinder bores, this construction enables the temperature of the cylinder walls to be kept uniform.
- The liners are the spiny-type, which have been manufactured so that their casting exteriors form large irregular surfaces in order to enhance the adhesion between the liners and the aluminum cylinder block. The enhanced adhesion helps heat dissipation, resulting in a lower overall temperature and heat deformation of the cylinder bores.
- Blowby gas passages are provided in the crankcase.
- Oil drain passages are provided in the crankcase. This prevents the crankshaft from mixing the engine oil, which reduces rotational resistance.
- The oil filter bracket is integrated into the crankcase.



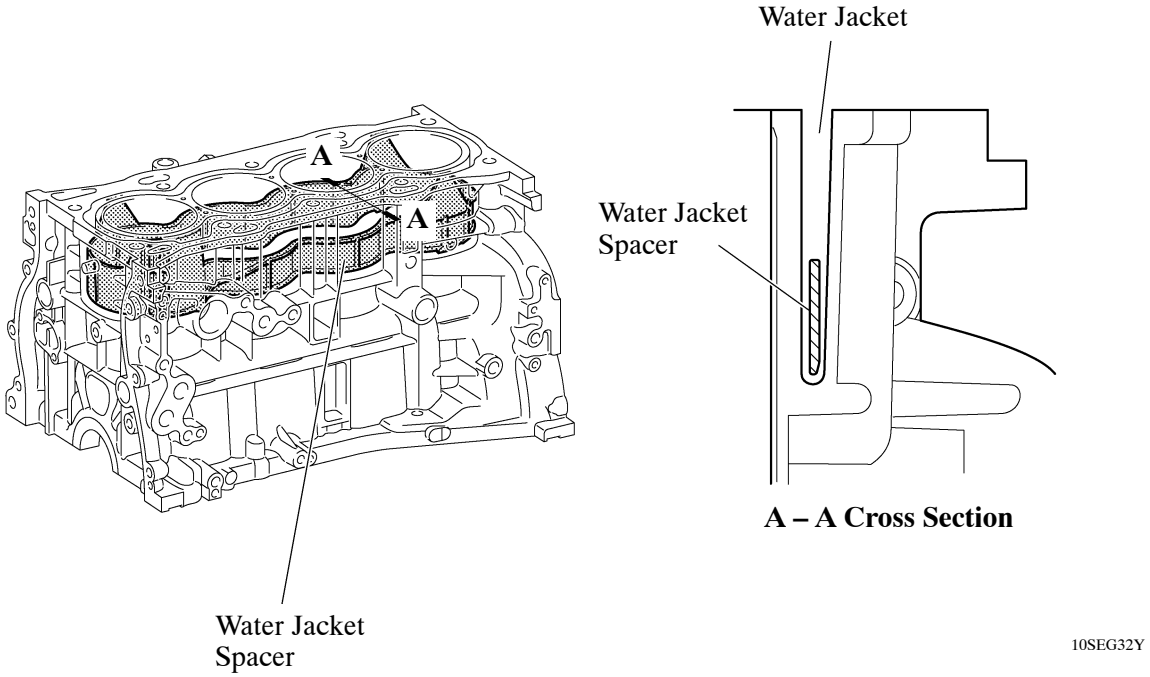
- An oil separator is provided in the blowby gas passage inside the cylinder block. This separates the engine oil from the blowby gas in order to reduce the degradation and consumption of volume of the engine oil.



- Through the use of the offset crankshaft, the bore center is shifted 10 mm (0.39 in.) towards the exhaust, in relation to the crankshaft center. Thus, the side force to the cylinder wall is reduced when the maximum pressure is applied, which contributes to fuel economy.

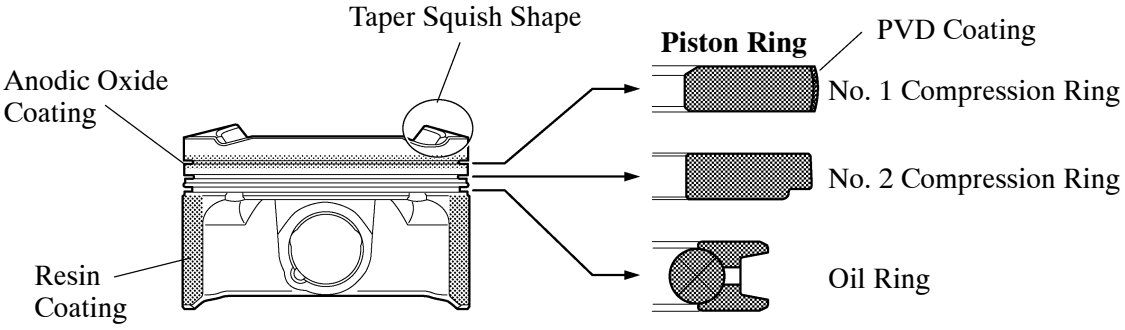


- A shallow bottom water jacket is used. The resulting reduction in the volume of the engine coolant improves warm-up performance, which contributes to improved fuel economy.
- The water jacket spacer is provided in the water jacket of the cylinder block.
- The water jacket spacer suppresses the water flow in the bottom of the water jackets, guides the coolant in the upper area of the water jacket, and ensures uniform temperature distribution. As a result, the viscosity of the engine oil that acts as a lubricant between the bore walls and the pistons can be lowered, thus reducing friction.



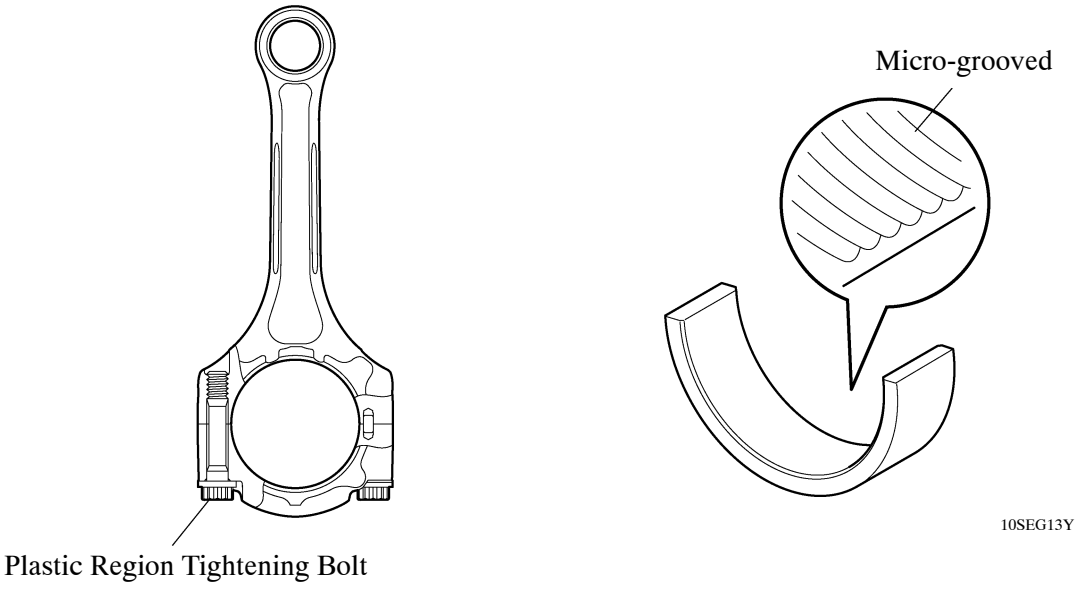
Piston

- The piston is made of aluminum alloy and the skirt area is made compact and lightweight.
- The piston head portion uses a taper squish shape to improve the fuel combustion efficiency.
- The piston skirt has been coated with resin to reduce the friction loss.
- The groove of the top ring is coated with anodic oxide to improve wear resistance and corrosion resistance.
- Low-tension piston rings are used to reduce friction and achieve excellent fuel economy.
- Narrow-width piston rings are used to reduce weight and friction.
- A No. 1 compression ring with an inside bevel shape is used.
- A PVD (Physical Vapor Deposition) coating has been applied to the surface of the No. 1 compression ring, in order to improve its wear resistance.



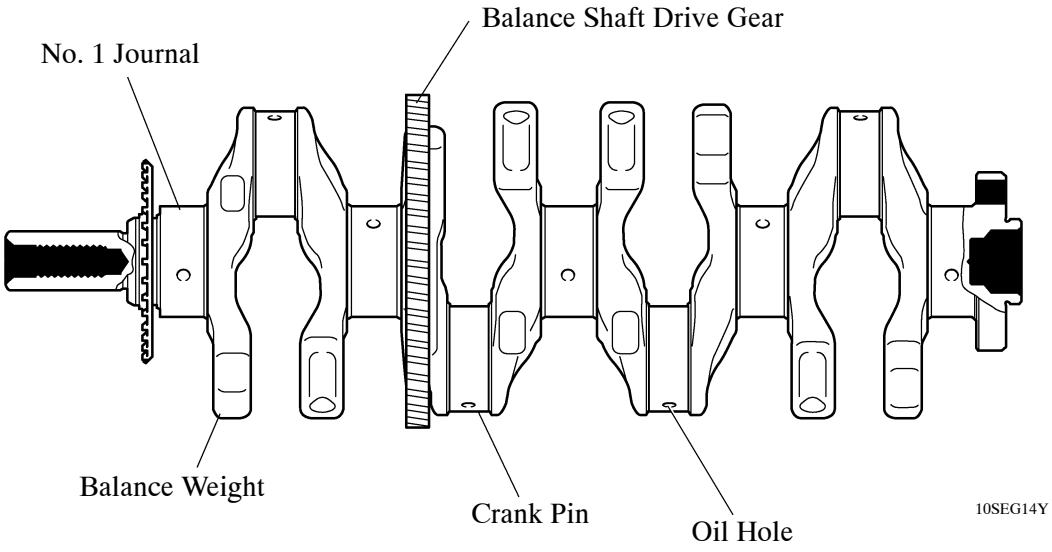
Connecting Rod

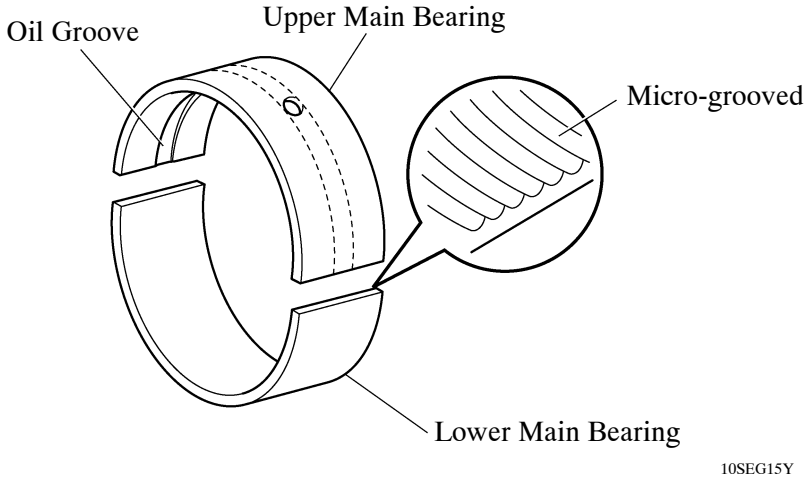
- The connecting rods and caps are made of microalloyed steel.
- Plastic region tightening bolts are used on the connecting rod.
- The connecting rod bearings are reduced in width to reduce friction.
- The lining surface of the connecting rod bearing has been micro-grooved to achieve an optimal amount of oil clearance. As a result, cold-engine cranking performance has been improved and engine vibrations have been reduced.



Crankshaft

- The crankshaft is made of microalloyed steel. It has 5 journals and 8 balance weights.
- A balance shaft drive gear is provided for the crankshaft.
- The crankshaft bearings are reduced in width to reduce friction.
- The lining surface of the crankshaft bearing has been micro-grooved to achieve an optimal amount of oil clearance. As a result, cold-engine cranking performance has been improved and engine vibrations have been reduced.
- The oil groove on the crankshaft bearing is made eccentric to reduce the amount of oil leakage from the bearing. This enables the capacity of the oil pump to be reduced in order to achieve a low friction operation.

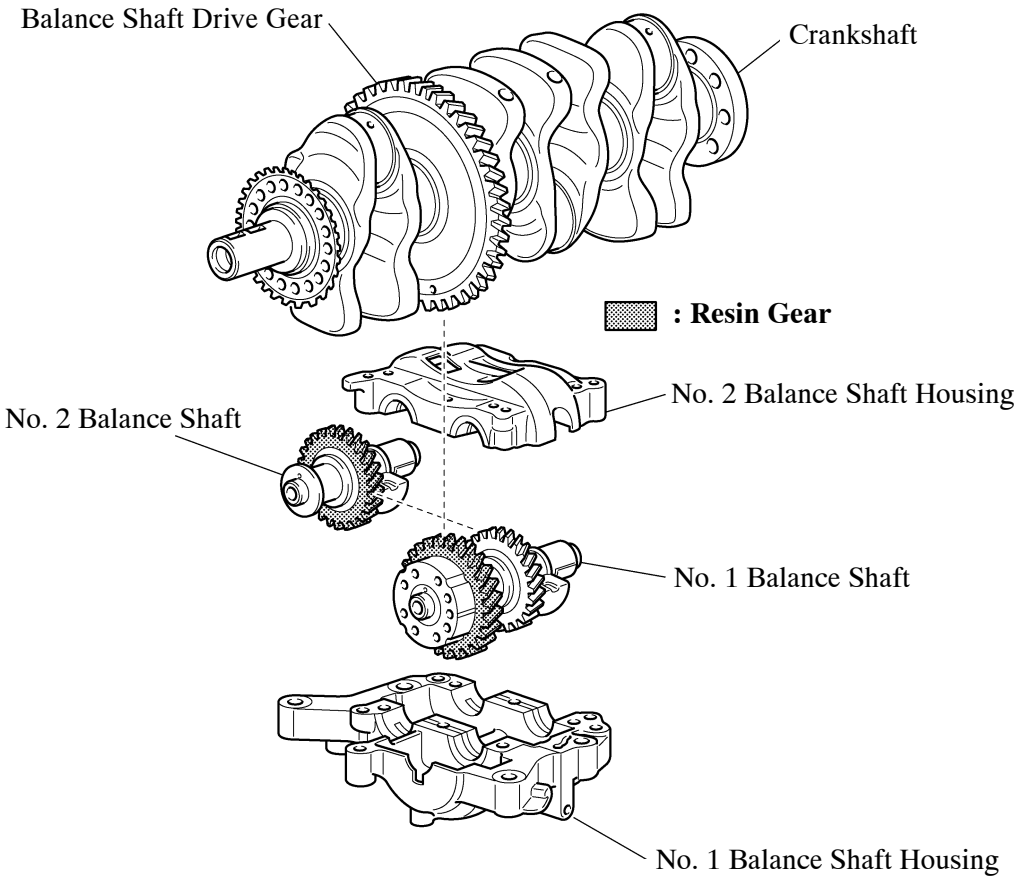




Balance Shaft

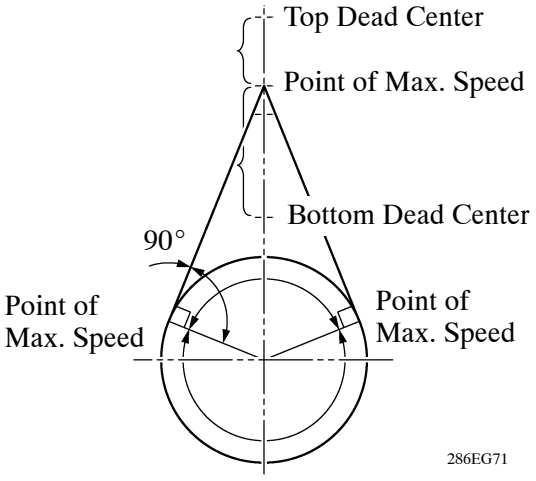
1) General

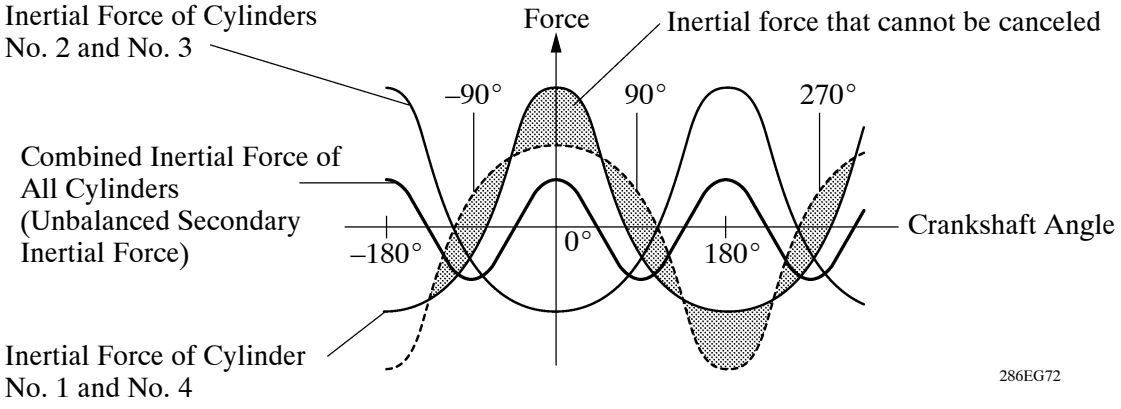
- A balance shaft is used to reduce vibrations.
- The crankshaft directly drives the No. 1 balance shaft.
- In addition, a resin gear is used on the driven side to suppress noise and offer lightweight design.



2) Operation

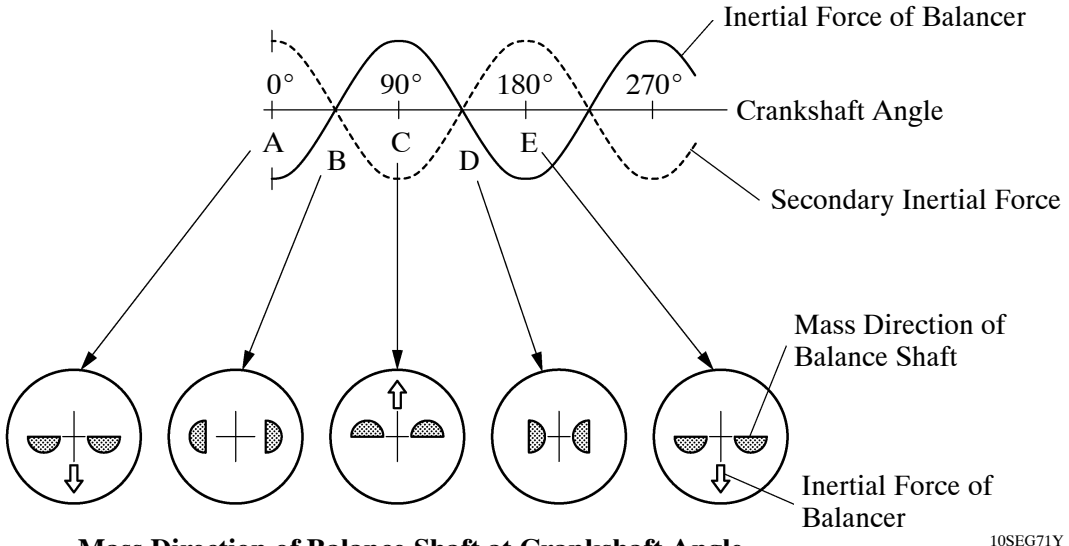
In the in-line 4-cylinder engine, the crankshaft angle for cylinders No. 1 and No. 4 are at exactly the opposite (180°) position of cylinders No. 2 and No. 3. Therefore, the inertial force of the pistons and the connecting rods of the former 2 cylinders and of the latter 2 cylinders almost cancel each other out. However, because the position at which the piston reaches its maximum speed is located toward the top dead center from the center of the stroke, the upward inertial force is greater than the downward inertial force. This unbalanced secondary inertial force is generated twice for each rotation of the crankshaft.





Inertial Force Generated by the In-line 4 Cylinders

To cancel the unbalanced secondary inertial force, 2 balance shafts are rotated twice for each rotation of the crankshaft and generate inertial force in the opposite direction. Also, in order to cancel the inertial force generated by the balance shaft itself, the balance shaft actually consists of 2 shafts rotating in opposite directions.

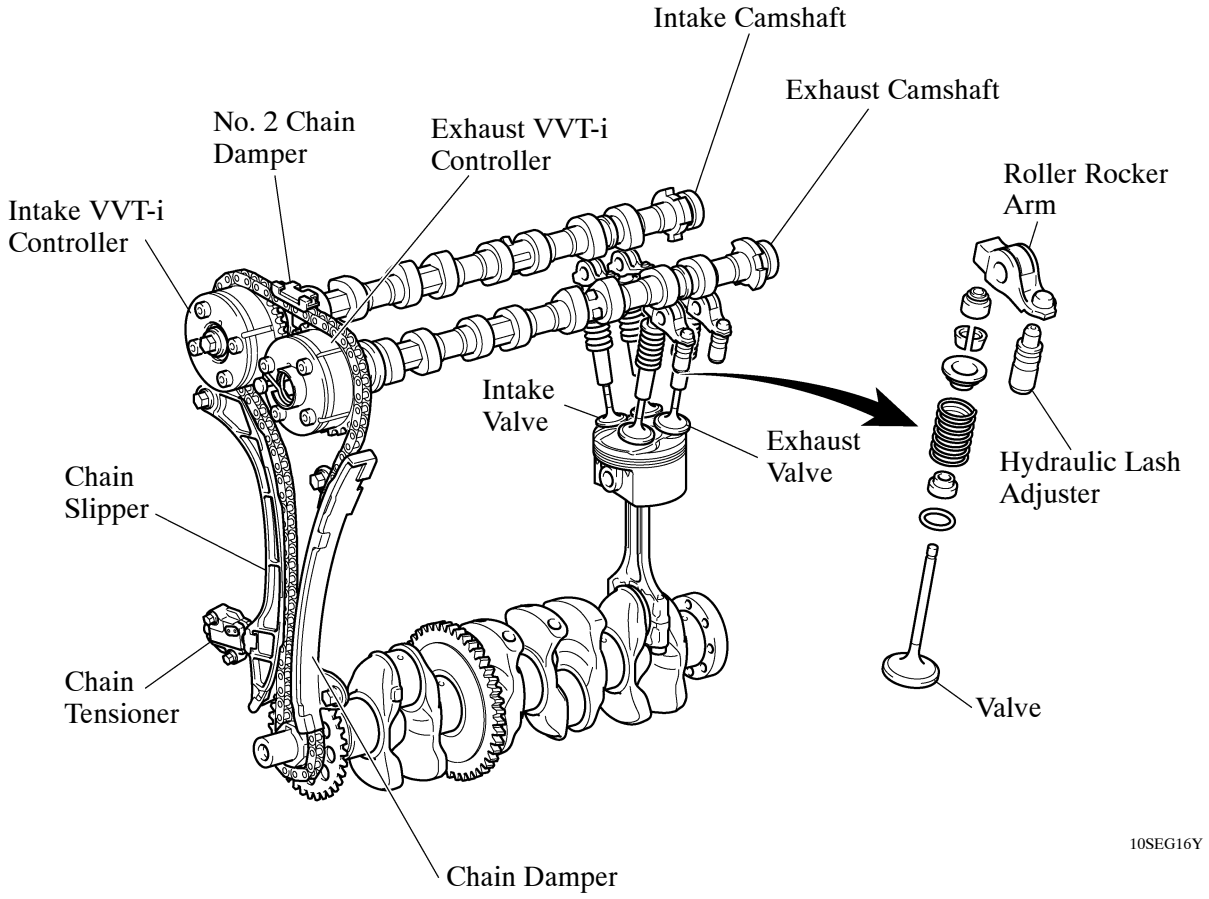


Mass Direction of Balance Shaft at Crankshaft Angle

4. Valve Mechanism

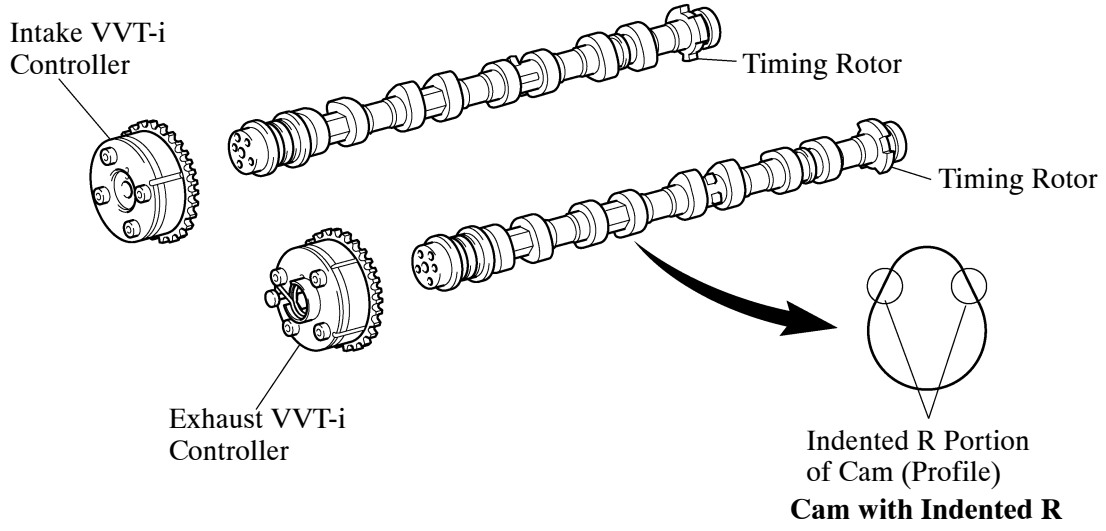
General

- The Dual VVT-i system is used to improve fuel economy and engine performance and reduce exhaust emissions. For details of Dual VVT-i system, see page 72.
- The intake and exhaust camshafts are driven by a timing chain.
- The roller rocker arms with built-in needle bearings are used. This reduces the friction that occurs between the cams and the areas (roller rocker arms) that push the valves down, thus improving fuel economy.
- The hydraulic lash adjusters, which maintain a constant zero valve clearance through the use of oil pressure and spring force, are used.



Camshaft

- An oil passage is provided in the intake and exhaust camshafts in order to supply engine oil to the Dual VVT-i system.
- A VVT-i controller has been installed on each front of the intake and exhaust camshafts to vary the timing of the intake and exhaust valves.
- Together with the use of the roller rocker arm, the cam profile has been designed with an indented R (radius). This results in increased valve lift when the valve begins to open and finishes closing, helping to achieve enhanced output performance.
- A timing rotor for the camshaft position sensor is provided at each back end of the intake and exhaust camshafts.

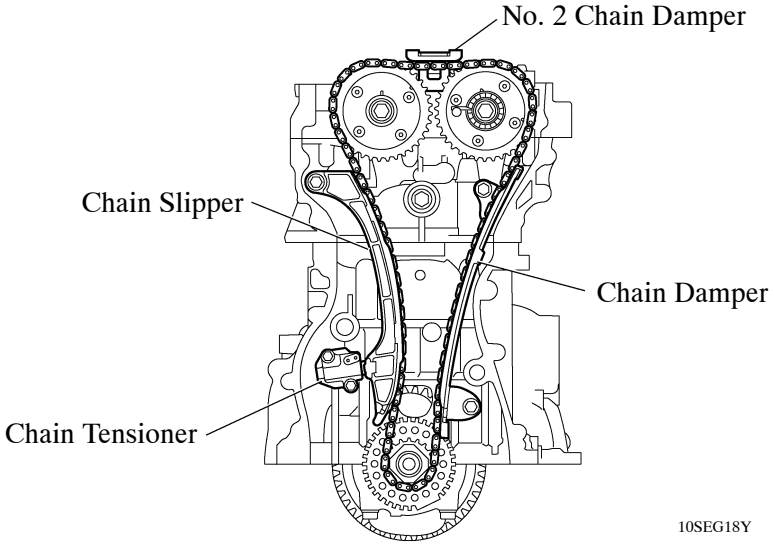


Cam with Indented R

10SEG17Y

Timing Chain

- A roller chain with a 9.525 mm (0.375 in.) pitch is used.
- The timing chain is lubricated by a timing chain oil jet. See page 30 for the location of the timing chain oil jet.
- The chain tensioner uses a spring and oil pressure to maintain proper chain tension at all times. The chain tensioner suppresses noise generated by the timing chain.
- The chain tensioner is ratchet type with a non-return mechanism.
- To achieve excellent serviceability, the chain tensioner is constructed so that it can be removed and installed from the outside of the timing chain cover.



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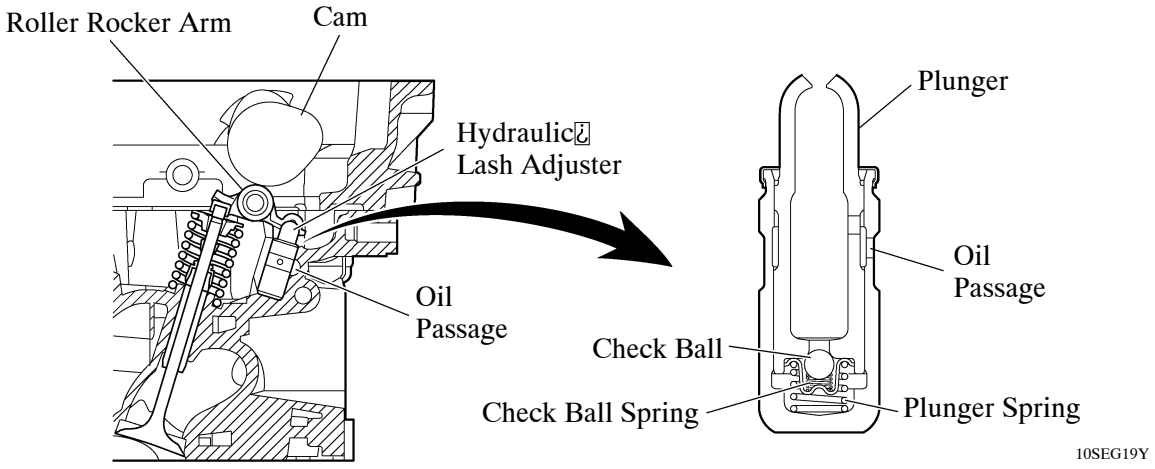
Hydraulic Lash Adjuster

- The hydraulic lash adjuster, which is located at the fulcrum of the roller rocker arm, consists primarily of a plunger, plunger spring, check ball, and check ball spring.
- The engine oil supplied by the cylinder head and the built-in spring actuates the hydraulic lash adjuster. The oil pressure and the spring force that act on the plunger push the roller rocker arm against the cam, in order to adjust the valve clearance that is created during the opening and closing of the valve. As a result, engine noise has been reduced.

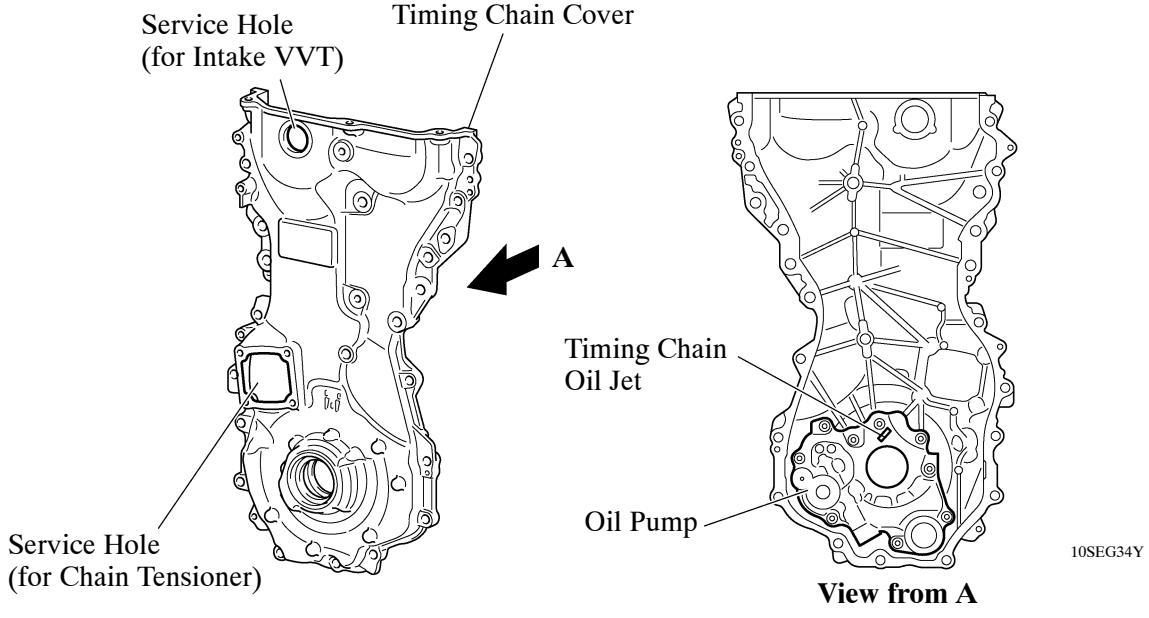


Service Tip

Valve clearance adjustment is not necessary because a hydraulic lash adjuster is used.

Timing Chain Cover

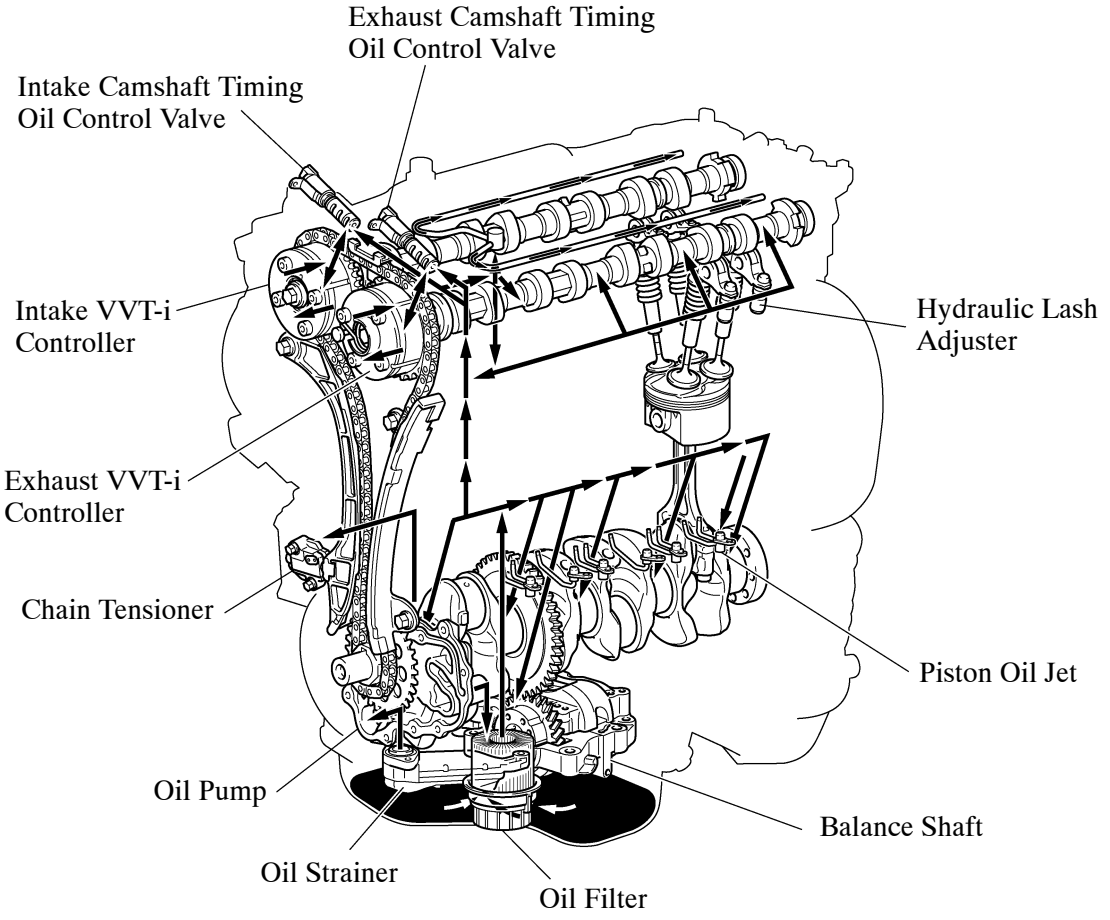
- An aluminum die-cast timing chain cover is used.
- The timing chain cover has an integrated construction consisting of the oil pump and timing chain oil jet. Thus, the number of parts has been reduced, resulting in a weight reduction.
- To achieve excellent serviceability, service holes for the chain tensioner and intake VVT are provided on the timing chain cover.



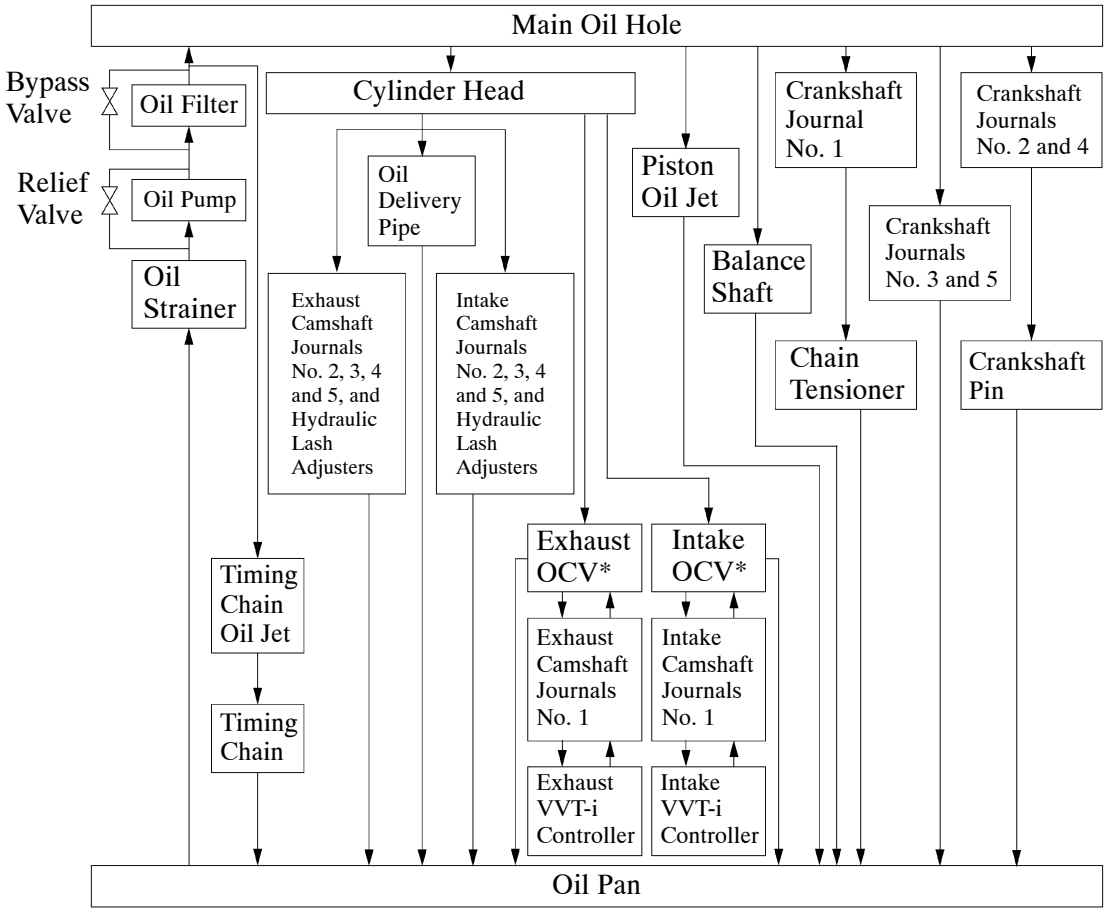
5. Lubrication System

General

- The lubrication circuit is fully pressurized and oil passes through an oil filter.
- This engine has an oil return system in which the oil is force-fed to the upper cylinder head and returns to the oil pan through the oil return hole in the cylinder head.
- A cycloid rotor type oil pump is used. The oil pump is directly driven by the crankshaft.
- The Dual VVT-i system is used. This system is operated by the engine oil.



▶ Oil Circuit ◀

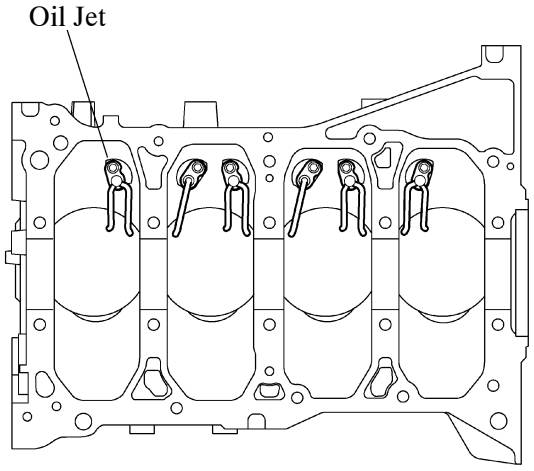


*: OCV (Oil Control Valve)

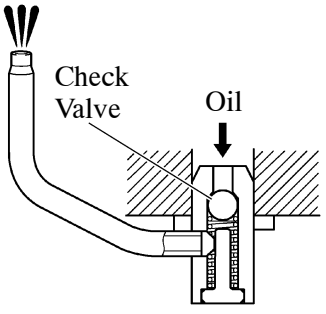
10SEG64I

Oil Jet

- Piston oil jets for cooling and lubricating the pistons and bores are used in the cylinder block.
- These oil jets contain a check valve to prevent oil from being fed when the oil pressure is low. This prevents the overall oil pressure in the engine from dropping.



Bottom Side View

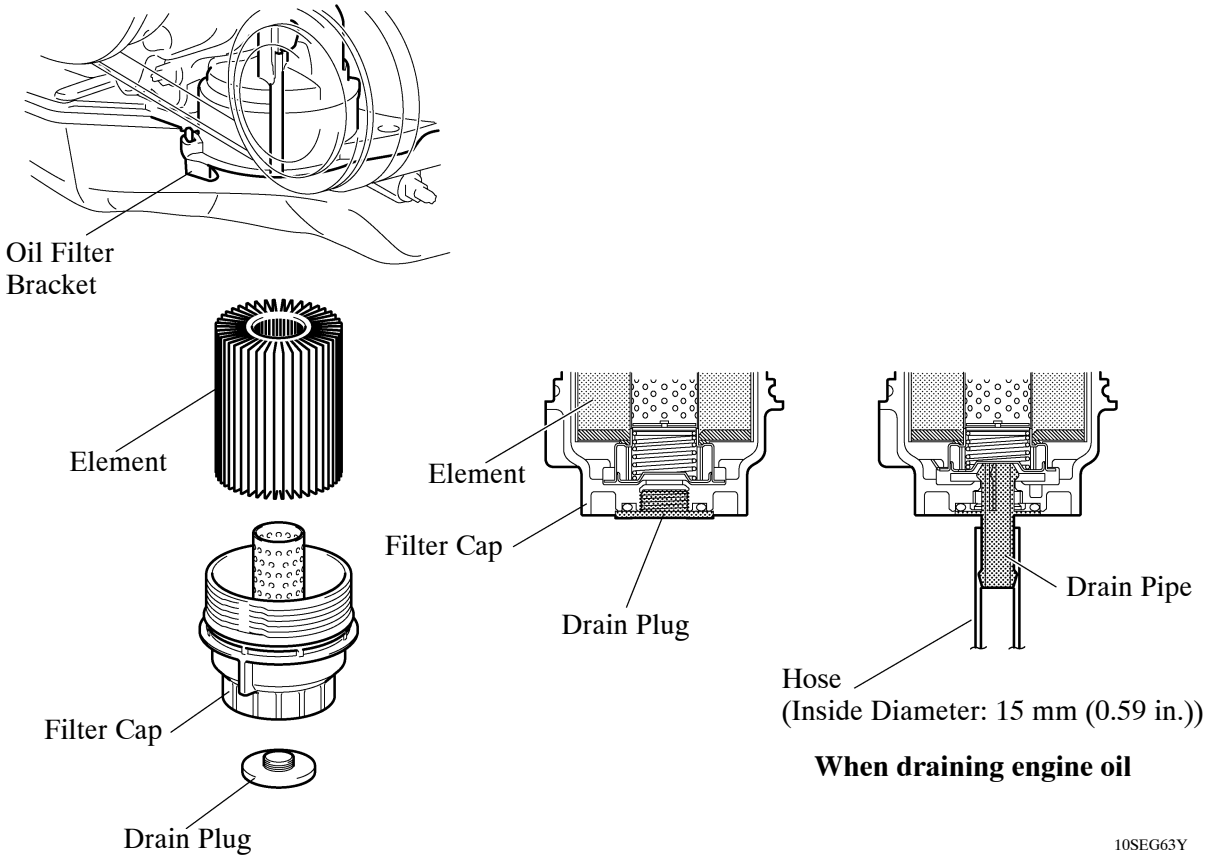


Oil Jet Cross Section

10SEG20Y

Oil Filter

- An oil filter with a replaceable element is used. The element uses a high-performance filter paper to improve filtration performance. It is also combustible for environmental protection.
- A plastic filter cap is used for weight reduction.
- This oil filter has a structure which can drain the engine oil remaining in the oil filter. This prevents engine oil from spattering when replacing the element and allows the technician to work without touching hot engine oil.

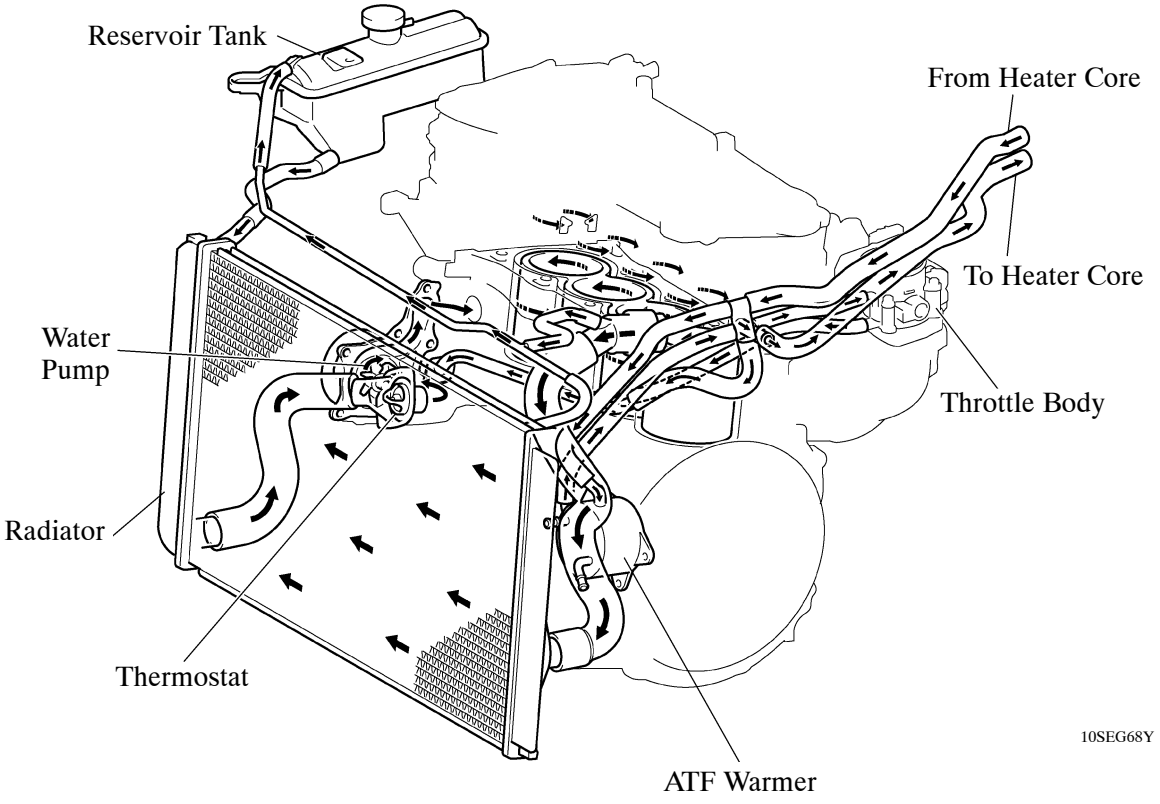


Service Tip

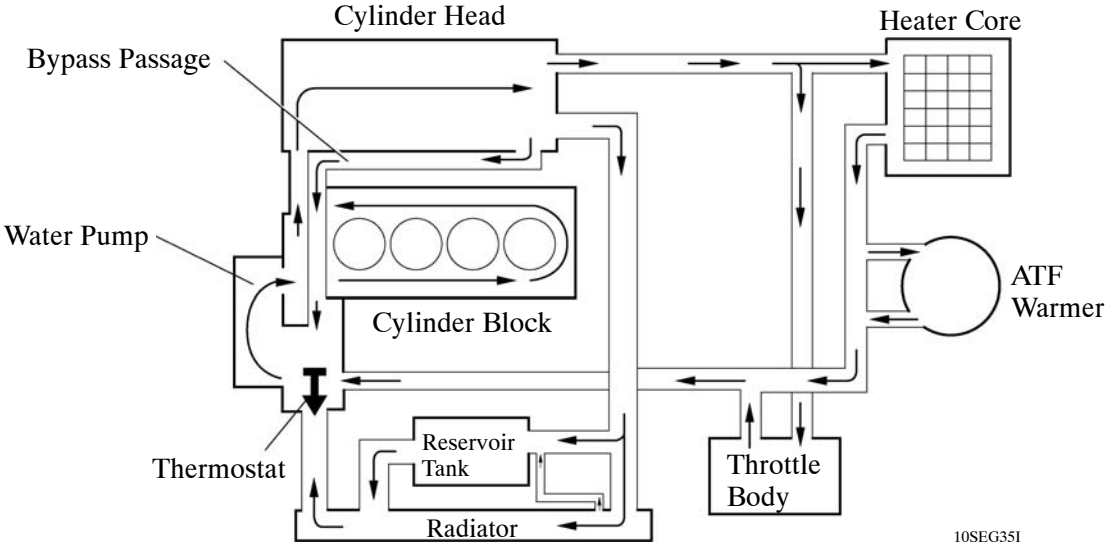
- The engine oil in the oil filter can be drained by removing the drain plug and inserting the drain pipe supplied with the element into the oil filter. For details, refer to the 2009 RAV4 Repair Manual (Pub. No. RM10S0U).
- The engine oil maintenance interval for a model that has an oil filter with a replaceable element is the same as that for the conventional model.

6. Cooling System

- The cooling system uses a pressurized forced-circulation system with a pressurized reservoir tank.
- A thermostat with a bypass valve is located on the water inlet housing to maintain suitable temperature distribution in the cooling system.
- An aluminum radiator core is used for weight reduction.
- The flow of the engine coolant makes a U-turn in the cylinder block to ensure a smooth flow of the engine coolant. In addition, a bypass passage is enclosed in the cylinder head and the cylinder block.
- Warm engine coolant from the engine is sent to the throttle body to prevent freeze-up.
- TOYOTA Genuine SLLC (Super Long Life Coolant) is used.



▶ System Diagram ◀



▶ Specifications ◀

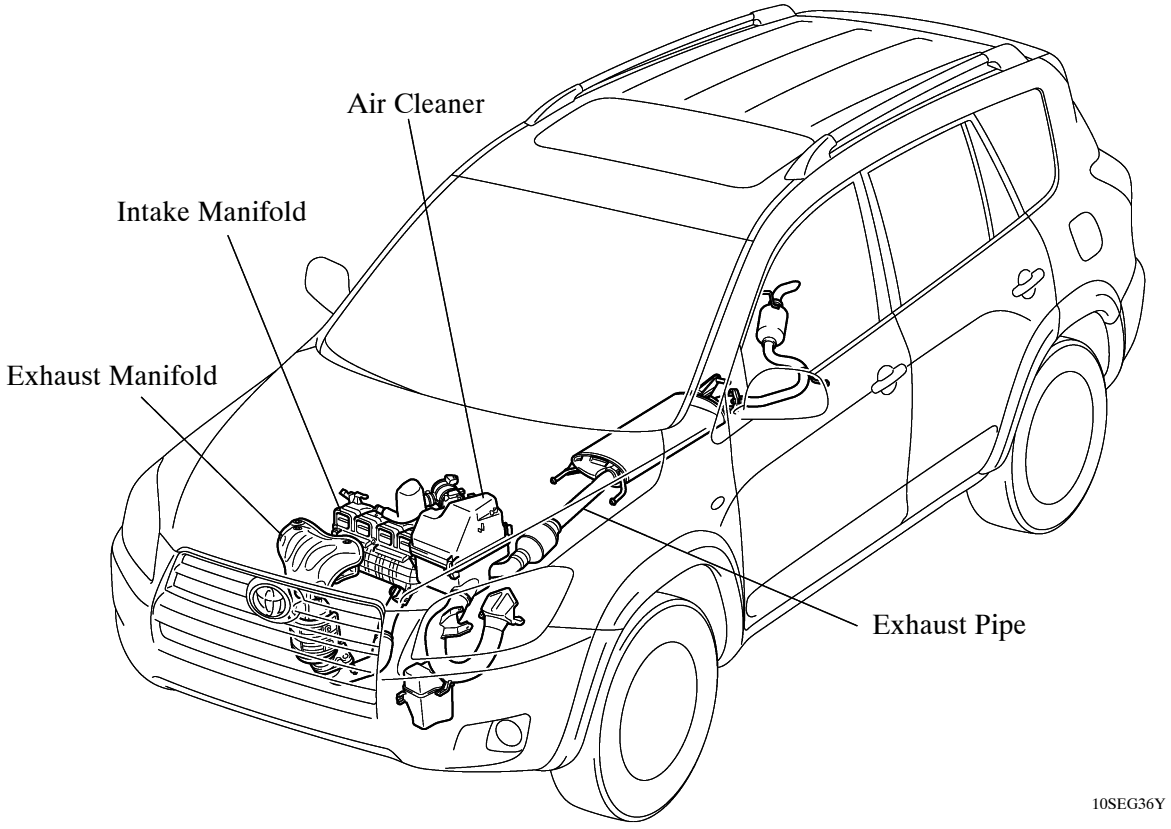
Engine Coolant	Type		TOYOTA genuine SLLC or similar high quality ethylene glycol based non-silicate, non-amine, non-nitrite and non-borate coolant with long-life hybrid organic acid technology (coolant with long-life hybrid organic acid technology is a combination of low phosphates and organic acids). Do not use plain water alone.
	Color		Pink
	Maintenance Intervals	First Time	100000 mile (160000 km)
		Subsequent	Every 50000 mile (80000 km)
Thermostat	Opening Temperature		80 – 84°C (176 – 183°F)

- SLLC is pre-mixed (models for U.S.A.: 50% coolant and 50% deionized water, models for Canada: 55% coolant and 45% deionized water). Therefore, no dilution is needed when SLLC in the vehicle is added or replaced.
- If LLC (red-colored) is mixed with SLLC (pink-colored), the interval for LLC (every 25000 miles (models for U.S.A.), 32000 km (models for Canada) or 24 months whichever comes first) should be used.

7. Intake and Exhaust System

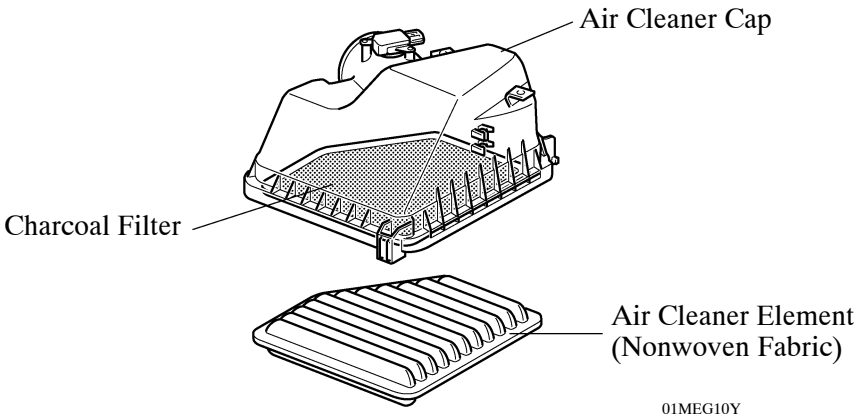
General

- The linkless-type throttle body is used to achieve excellent throttle control.
- ETCS-i (Electronic Throttle Control System-intelligent) is used to provide excellent throttle control. For details, see page 67.
- A plastic intake manifold is used for weight reduction.
- A stainless steel exhaust manifold is used for weight reduction.
- The ACIS (Acoustic Control Induction System) is used to improve the engine performance. For details, see page 78.
- The tumble control system is used to improve the engine performance and reduce exhaust emissions. For details, see page 81.



Air Cleaner

- A nonwoven, full-fabric type air cleaner element is used.
- A charcoal filter, which absorbs the HC that accumulates in the intake system when the engine is stopped, is used in the air cleaner cap in order to reduce evaporative emissions.

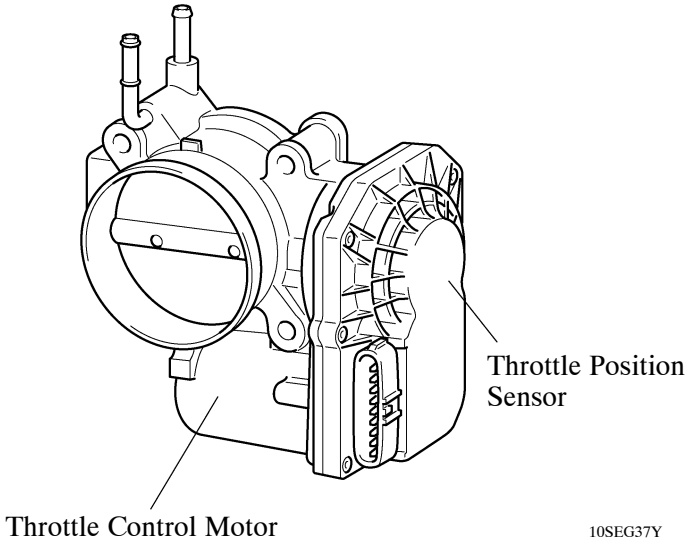


Service Tip

The charcoal filter, which is maintenance-free, cannot be removed from the air cleaner cap.

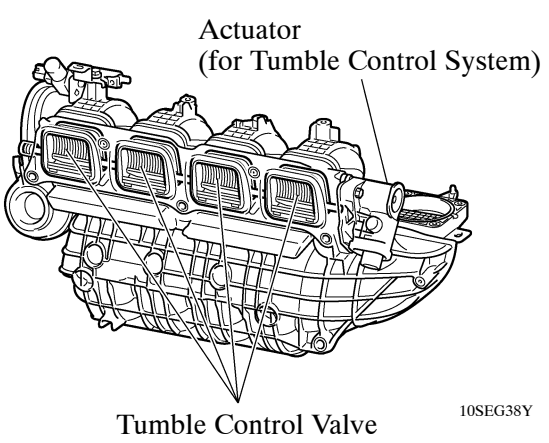
Throttle Body

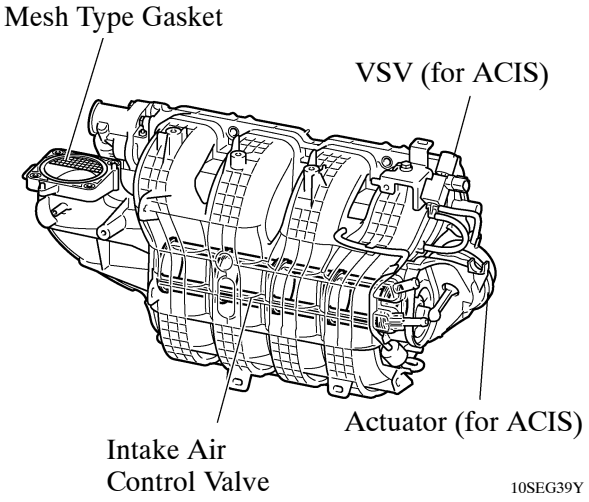
- The linkless-type throttle body is used and it achieves excellent throttle control.
- A DC motor with excellent response and minimal power consumption is used for the throttle control motor. The ECM performs the duty cycle control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the opening angle of the throttle valve.

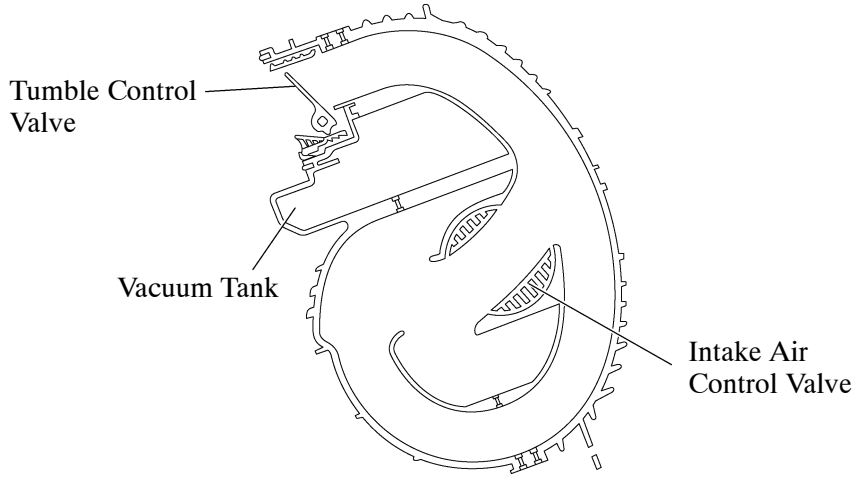


Intake Manifold

- The intake manifold is made of lightweight plastic.
- A rotary type intake air control valve, which has less intake air resistance, is provided in the intake manifold. The intake air control valve is activated by the ACIS (Acoustic Control Induction System). For details, see page 78.
- The tumble control valve is provided in the intake manifold. The tumble control valve is activated by the tumble control system. For details, see page 81.
- A DC motor type actuator for the tumble control system, the vacuum type actuator for the ACIS and VSV for ACIS are provided to the intake manifold. The ACIS actuator is laser-welded onto the intake air chamber.
- A mesh type gasket is used between the throttle body and the intake manifold to improve the flow of air within the intake manifold.
- To achieve a compact configuration, the vacuum tank for the ACIS is located in the dead space of the intake manifold.







Intake Manifold Cross Section

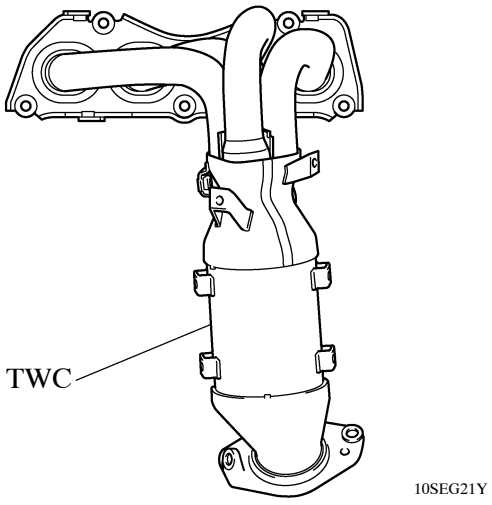
— REFERENCE —

Laser-welding:

In laser-welding, a laser-absorbing material (for the intake manifold) is joined to a laser-transmitting material (for the ACIS actuator). Laser beams are then irradiated from the laser-transmitting side. The beams penetrate the laser-transmitting material to heat and melt the surface of the laser-absorbing material. Then, the heat of the laser-absorbing material melts the laser-transmitting material and causes both materials to become welded.

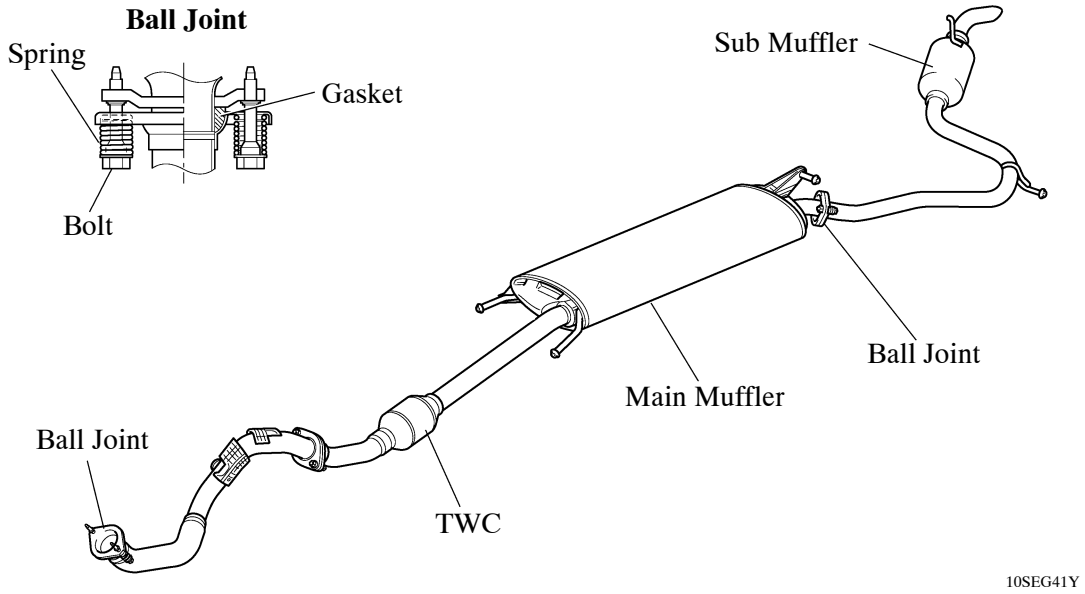
Exhaust Manifold

A stainless steel exhaust manifold is used for improving the warm-up of the TWC (Three-Way Catalytic converter) and for weight reduction.



Exhaust Pipe

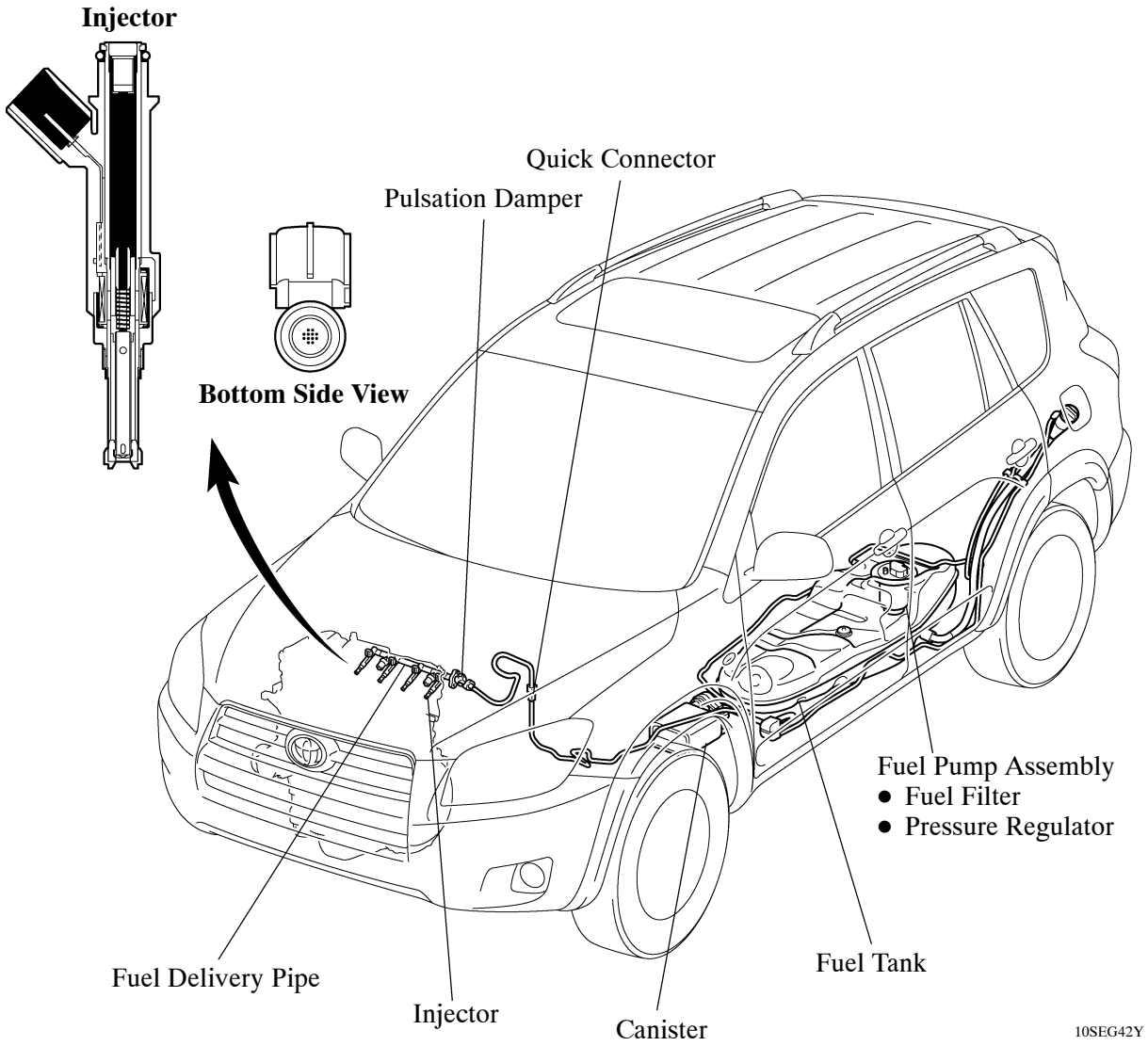
- The exhaust pipe uses two ball joints in order to achieve a simple construction and ensured reliability.
- The TWC is used to reduce exhaust emissions.



8. Fuel System

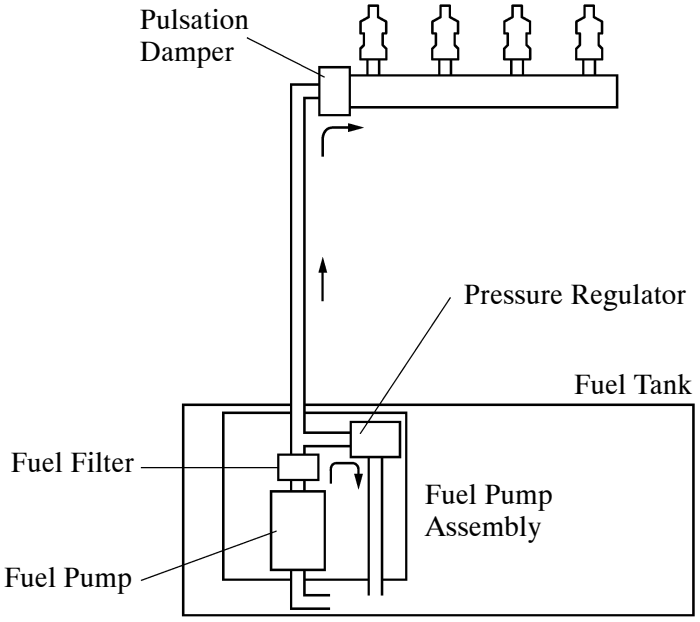
General

- The fuel returnless system is used to reduce evaporative emissions.
- A fuel cut control is used to stop the fuel pump when the SRS airbag is deployed in a front or side collision. For details, see page 84.
- A quick connector is used in the fuel main pipe to improve serviceability.
- The long nozzle type fuel injector is used. This injector has 12 injection holes.
- The ORVR (On-board Refueling Vapor Recovery) system is used. For details, see page 87.



Fuel Returnless System

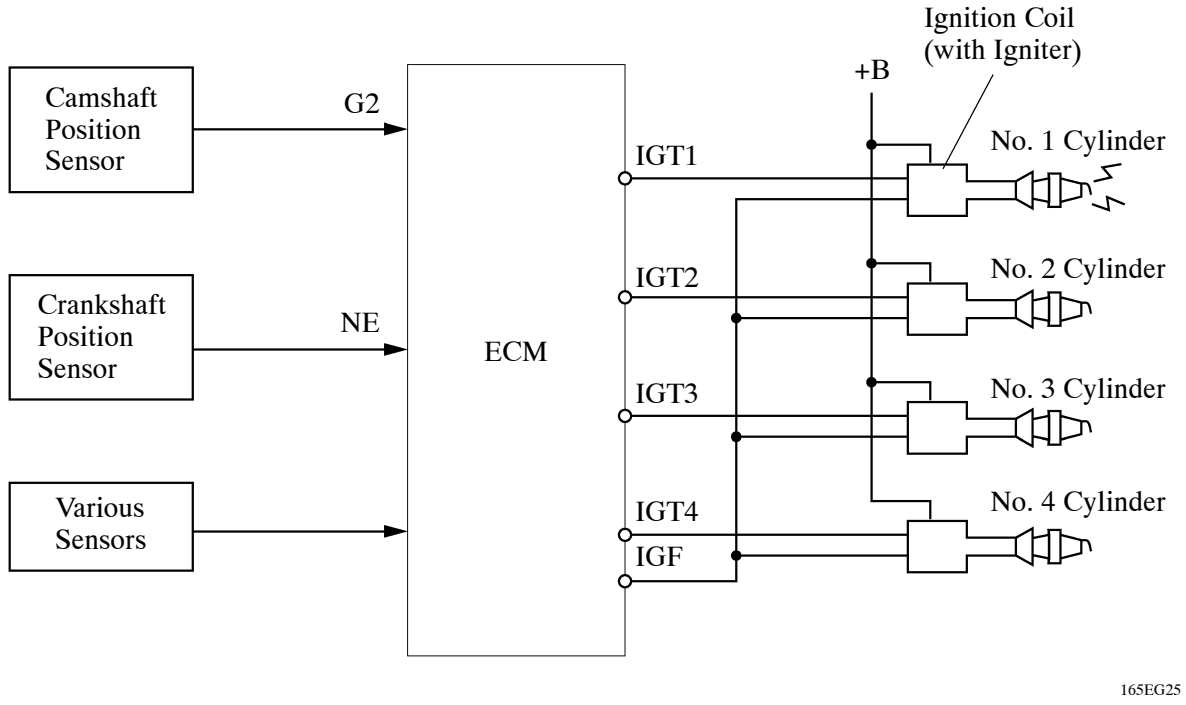
The fuel returnless system is used to reduce the evaporative emission. As shown below, by integrating the fuel filter and pressure regulator with the fuel pump assembly, the fuel return system in which the fuel returns from the engine area has been discontinued and temperature rise inside the fuel tank is prevented.



9. Ignition System

General

- A DIS (Direct Ignition System) is used. The DIS improves the ignition timing accuracy, reduces high-voltage loss, and enhances the overall reliability of the ignition system by eliminating the distributor.
- The DIS in this engine is an independent ignition system which has one ignition coil (with igniter) for each cylinder.
- Long-reach type iridium-tipped spark plugs are used.



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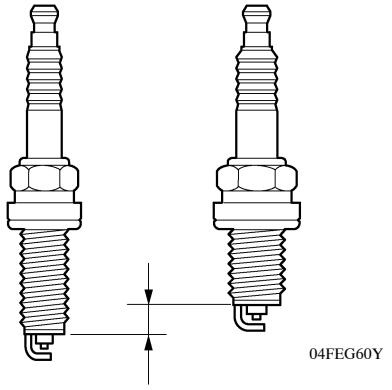
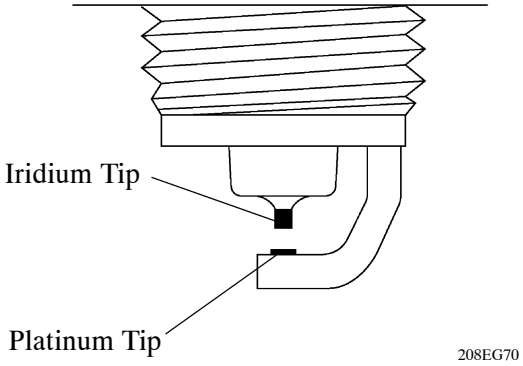
Spark Plug

Long-reach type iridium-tipped spark plugs are used to improve ignition performance while maintaining the same durability as platinum-tipped spark plugs.



Long-reach Type **Conventional Type**



▶ Specifications ◀

Manufacture	Spark Plug Type	Plug Gap
DENSO	SK16HR11	1.0 – 1.1 mm (0.039 – 0.043 in.)

10. Charging System

General

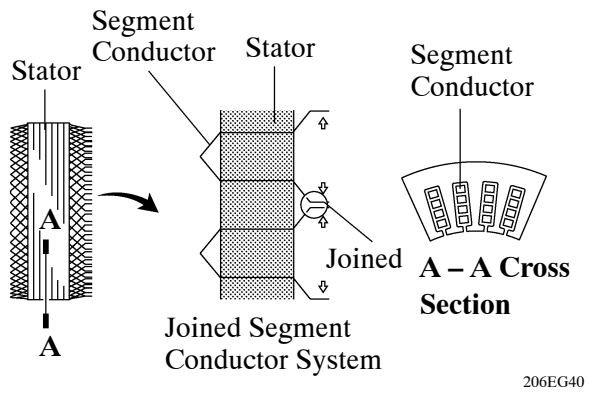
A compact and lightweight segment conductor type generator is used.

▶ Specifications ◀

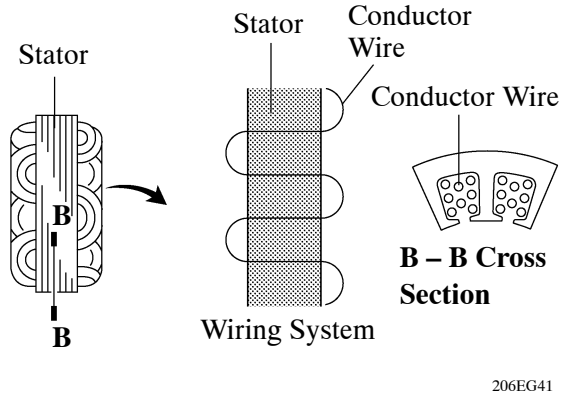
Type	SE0
Rated Voltage	12 V
Rated Output	100 A

Segment Conductor Type Generator

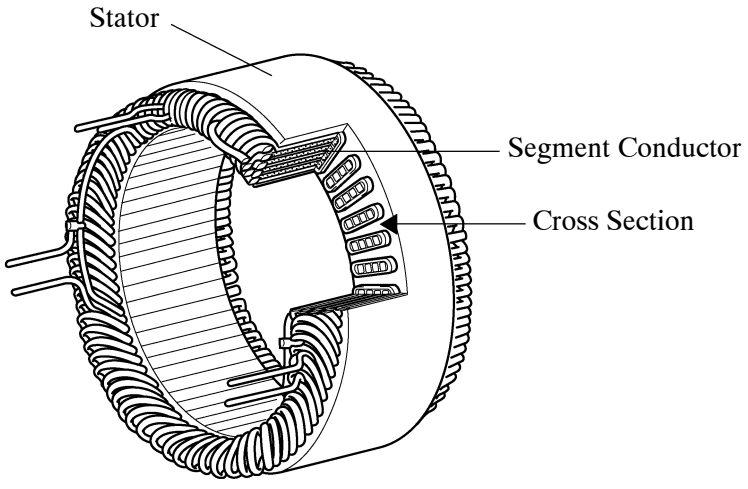
- The segment conductor type generator generates a high amperage output in a highly efficient manner.
- This generator uses a joined segment conductor system, in which multiple segment conductors are welded together to the stator. Compared to the conventional winding system, the electrical resistance has been reduced due to the shape of the segment conductors, and their arrangement helps to make the generator more compact.



Segment Conductor Type Generator

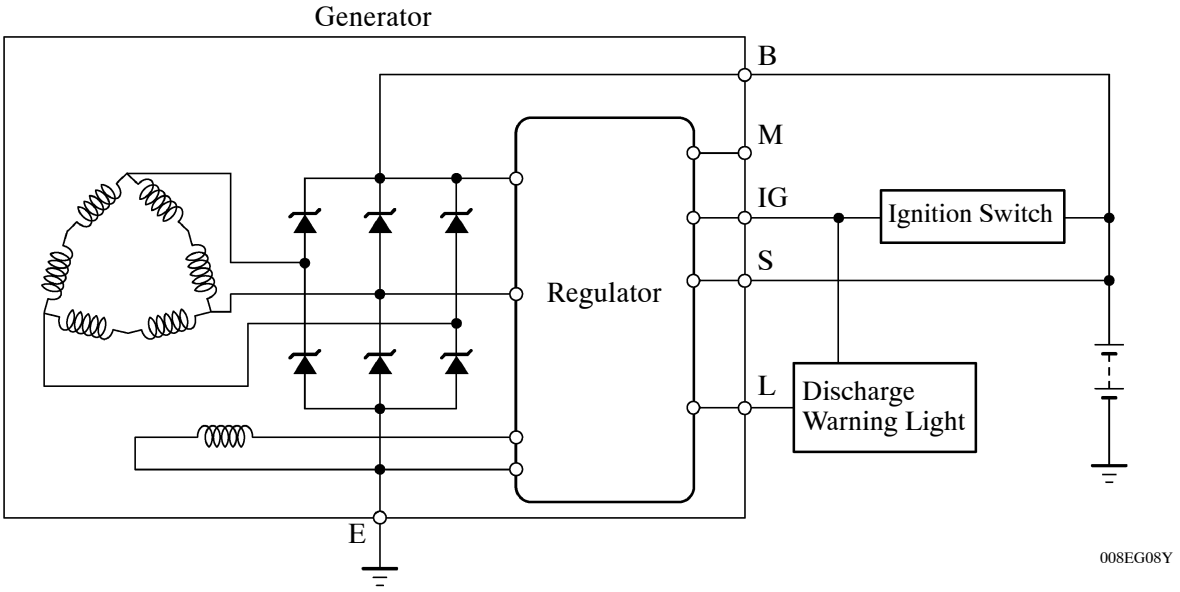


Conventional Type Generator



Stator of Segment Conductor Type Generator 206EG42

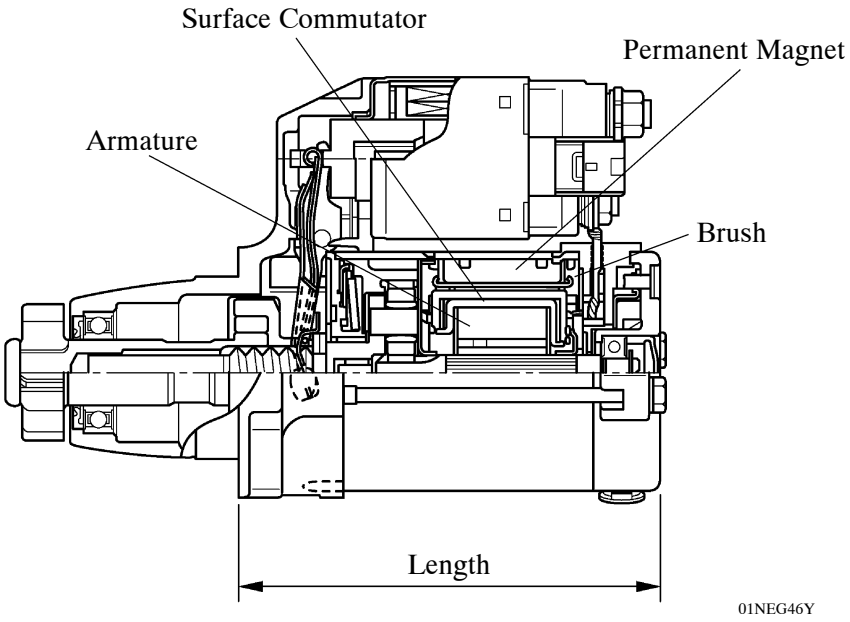
▶ Wiring Diagram ◀



11. Starting System

General

- A compact and lightweight PS (Planetary reduction-Segment conductor motor) type starter is used.
- Because the PS type starter contains an armature that uses square-shaped conductors, and its surface functions as a commutator, its output torque has been improved and its overall length has been reduced.
- In place of the field coil used in the conventional type starter, the PS type starter uses two types of permanent magnets: main magnets and interpolar magnets. The main magnets and interpolar magnets have been efficiently arranged to increase the magnetic flux and to shorten the length of the yoke.



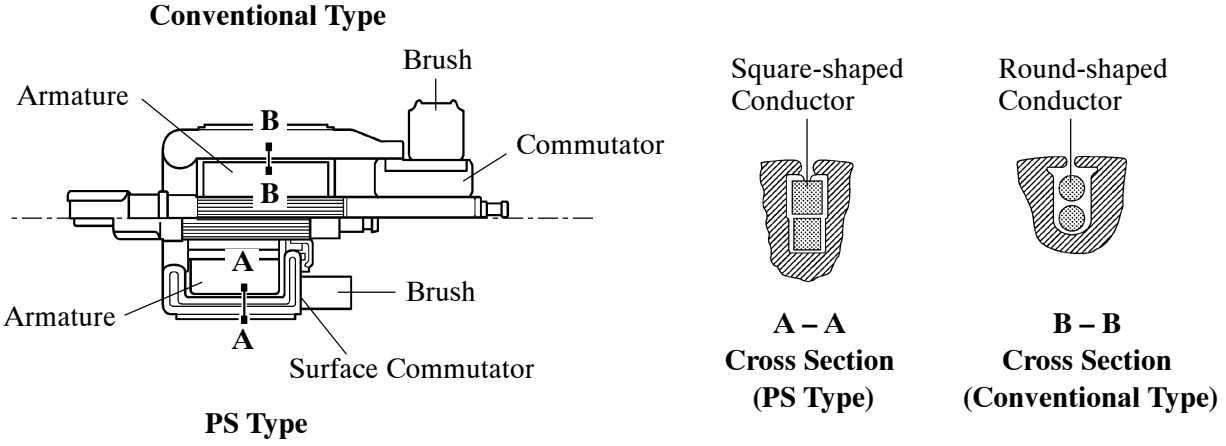
▶ Specifications ◀

Starter Type	PS Type
Rating Output	1.7 kW
Rating Voltage	12 V
Length*1	128.1 mm (5.04 in.)
Weight	2930 g (6.46 lb)
Rotational Direction*2	Counterclockwise

*1: Length from the mounted area to the rear end of the starter
*2: Viewed from pinion side

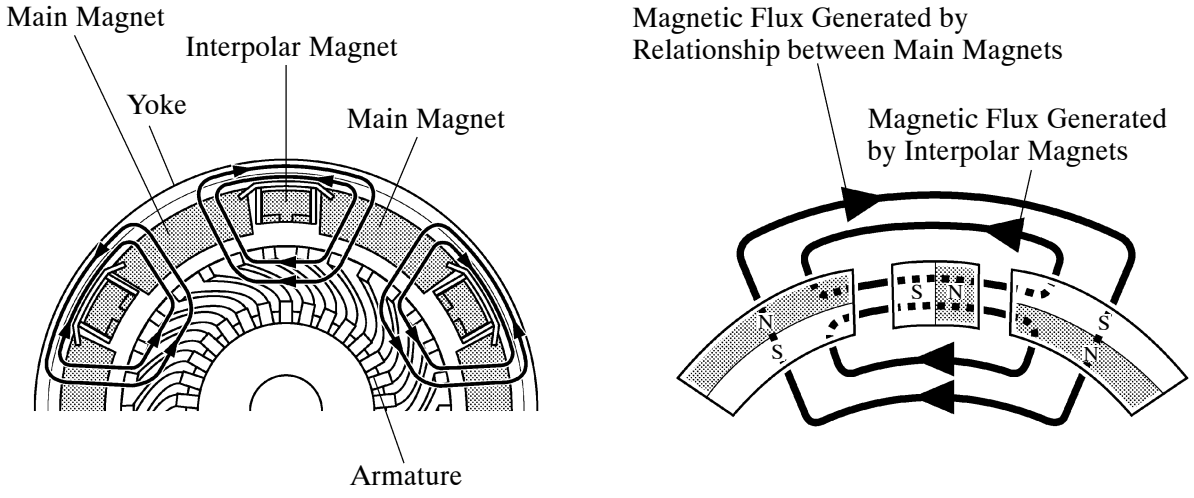
Construction

- Instead of constructing the armature coil with conventional type round-shaped conductor wires, the PS type starter uses square-shaped conductors. With this type of construction, the same conditions achieved by winding numerous round-shaped conductor wires can be achieved without increasing the mass. As a result, the output torque has been increased, and the armature coil has been made more compact.
- Because the surface of the square-shaped conductors used in the armature coil functions as a commutator, the overall length of the PS type starter has been shortened.



206EG20

- Instead of the field coils used in the conventional type starter, the PS type starter uses two types of permanent magnets: the main magnets and the interpolar magnets. The main and interpolar magnets are arranged alternately inside the yoke, allowing the magnetic flux generated between the main and interpolar magnets to be added to the magnetic flux generated by the main magnets. In addition to increasing the amount of magnetic flux, this construction shortens the overall length of the yoke.



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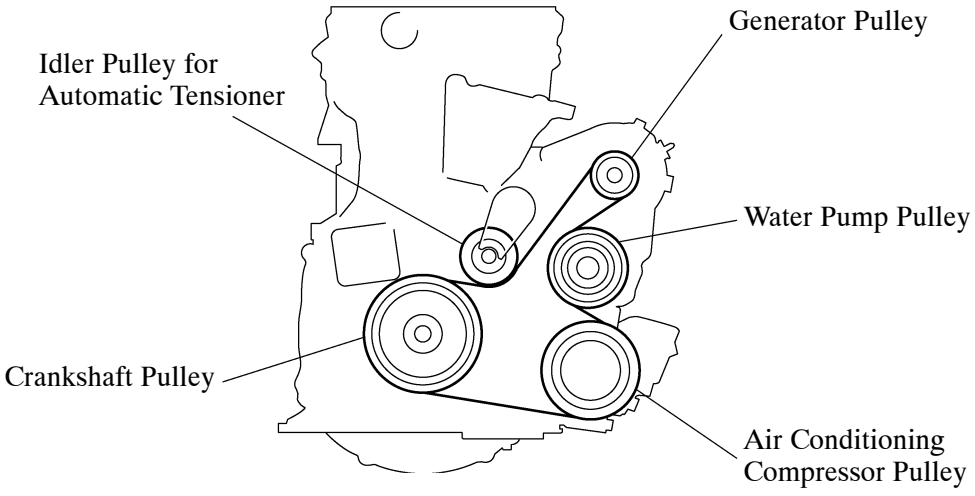
12. Serpentine Belt Drive System

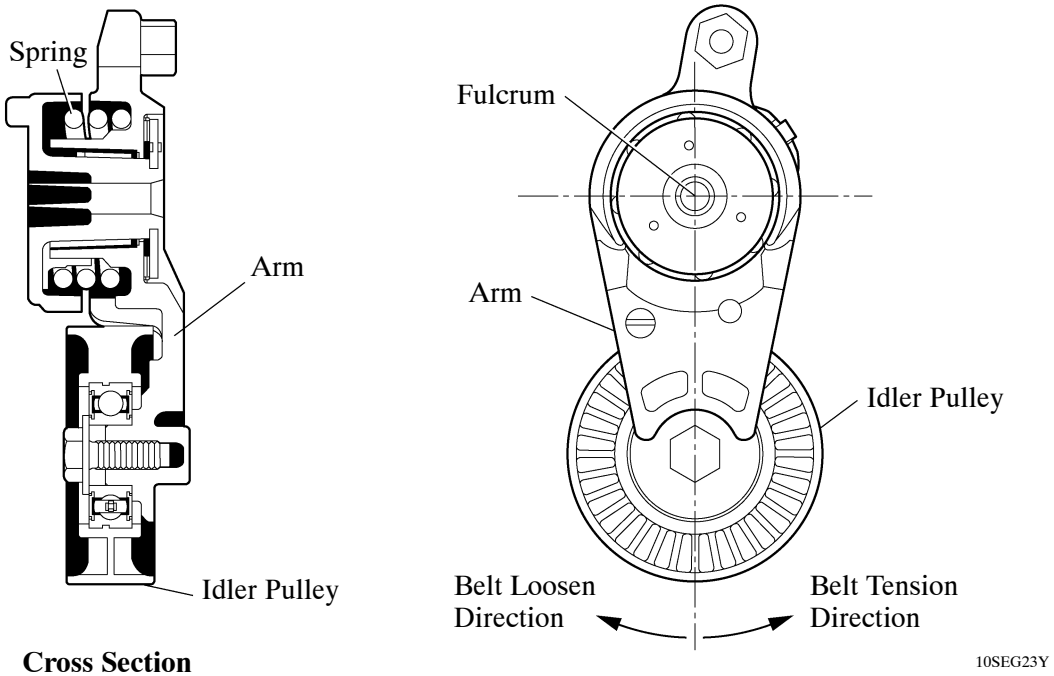
General

- Accessory components are driven by a serpentine belt consisting of a single V-ribbed belt. It reduces the overall engine length, weight and the number of engine parts.
- An automatic tensioner eliminates the need for tension adjustment.



Automatic Tensioner

The tension of the V-ribbed belt is properly maintained by the tension spring enclosed in the automatic tensioner.



Cross Section

13. Engine Control System

General

The engine control system for the 2AR-FE engine has the following systems:

System	Outline
SFI (Sequential Multiport Fuel Injection)	● An L-type SFI system 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.
ESA (Electronic Spark Advance)	Ignition timing is determined by the ECM based on signals from various sensors. The ECM corrects ignition timing in response to engine knocking.
ETCS-i (Electronic Throttle Control System-intelligent) [See page 67]	Optimally controls the throttle valve opening in accordance with the amount of accelerator pedal effort and the condition of the engine and the vehicle.
	● A linkless-type is used, without an accelerator cable. ● An accelerator pedal position sensor is provided on the accelerator pedal. ● A non-contact type throttle position sensor and the accelerator pedal position sensor are used.
Dual VVT-i (Variable Valve Timing-intelligent) System [See page 72]	Controls the intake and exhaust camshafts to an optimal valve timing in accordance with the engine condition.
ACIS (Acoustic Control Induction System) [See page 78]	The intake air passages are switched according to the engine speed and throttle valve opening angle to provide high performance in all speed ranges.
Tumble Control System [See page 81]	Controls fully closes the tumble control valve during cold start and cold running conditions to improve exhaust emissions while the engine is running cold.
Air-fuel Ratio Sensor and Oxygen Sensor Heater Control	Maintains the temperature of the air-fuel ratio sensor or oxygen sensor at an appropriate level to achieve accuracy of detection of the oxygen concentration in the exhaust gas.
Air Conditioning Cut-off Control	Maintains drivability by turning the air conditioning compressor ON or OFF in accordance with the engine condition.
Cooling Fan Control [See page 83]	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.
Fuel Pump Control [See page 84]	● Fuel pump operation is controlled by a signal from the ECM. ● The fuel pump is stopped when the SRS airbags are deployed.

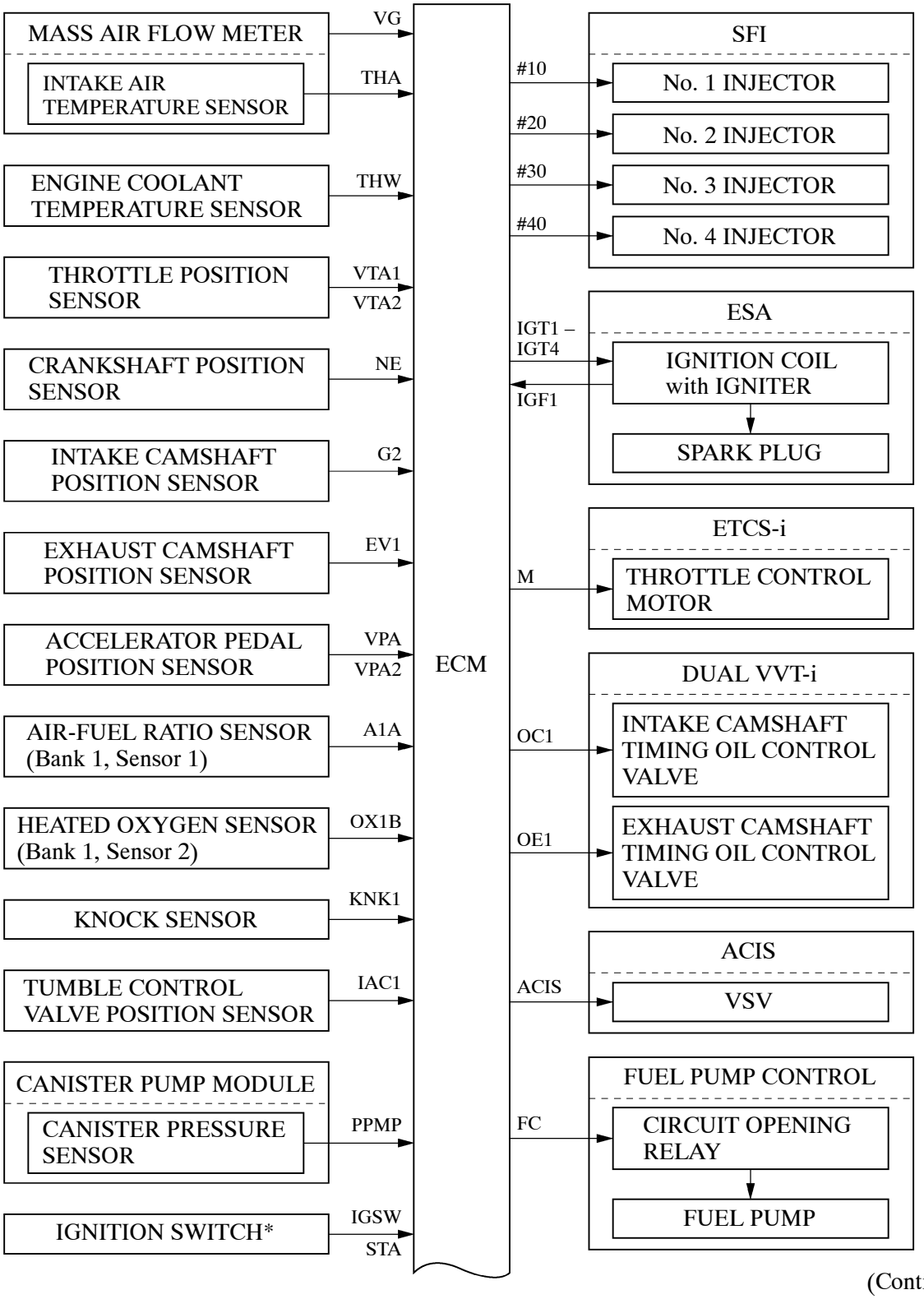
(Continued)

System	Outline
Starter Control (Cranking Hold Function)* [See page 85]	Once the engine switch is pushed, this control continues to operate the starter until the engine is started.
Evaporative Emission Control [See page 87]	The ECM controls the purge flow of evaporative emissions (HC) in the canister in accordance with engine conditions.
	Approximately five hours after the ignition switch has been turned OFF, the ECM operates the canister pump module to detect any evaporative emission leakage occurring in the EVAP (evaporative emission) control system through changes in the 0.02 in. leak pressure.
Engine Immobilizer	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.
Diagnosis [See page 100]	When the ECM detects a malfunction, it diagnoses and memorizes the failed section.
Fail-safe [See page 100]	When the ECM detects a malfunction, it stops or controls the engine according to the data already stored in memory.

*: Models with smart key system

Construction

The configuration of the engine control system in the 2AR-FE engine is shown in the following chart:



(Continued)

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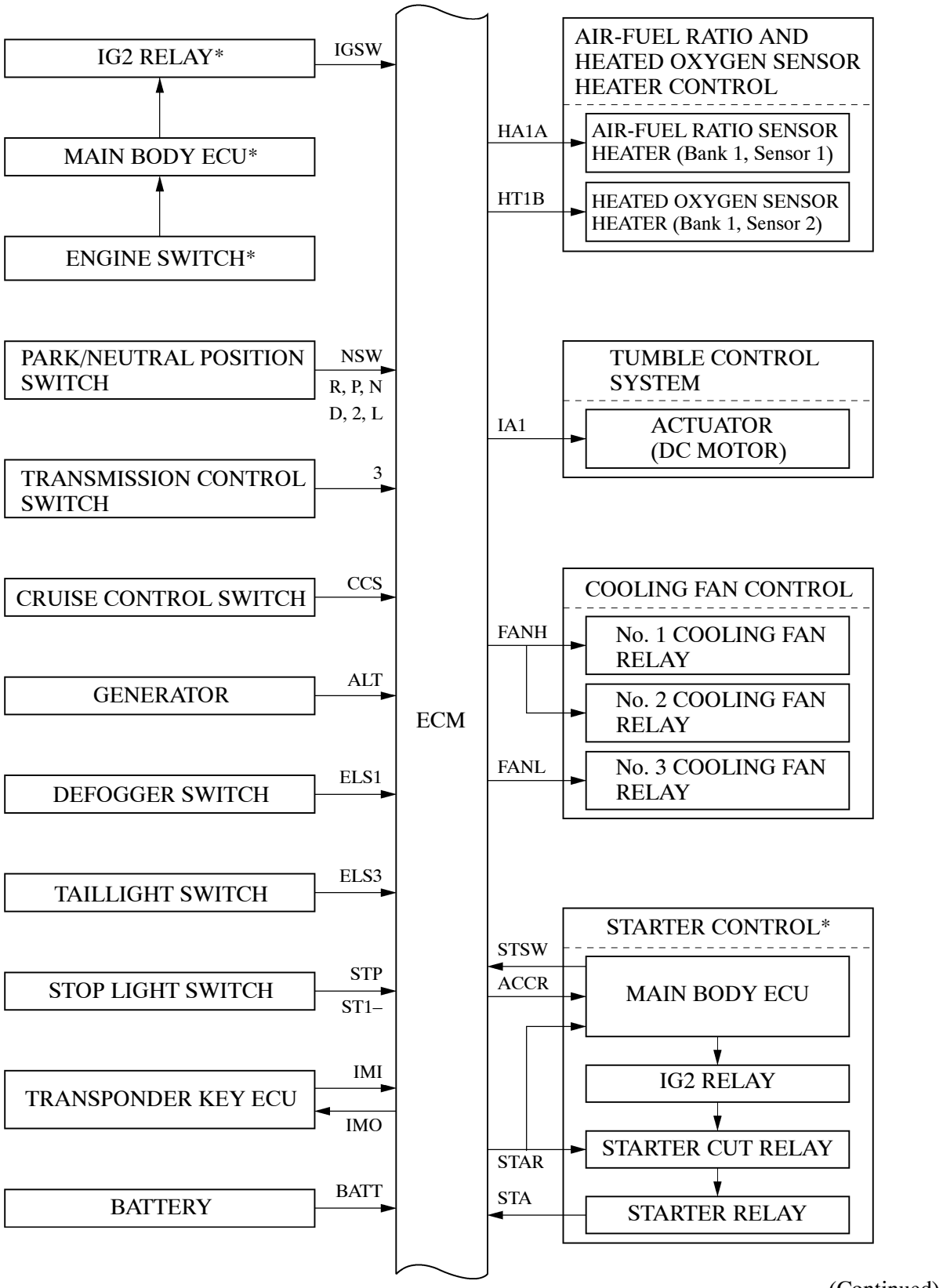
*: Except models with smart key system



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*: Models with smart key system

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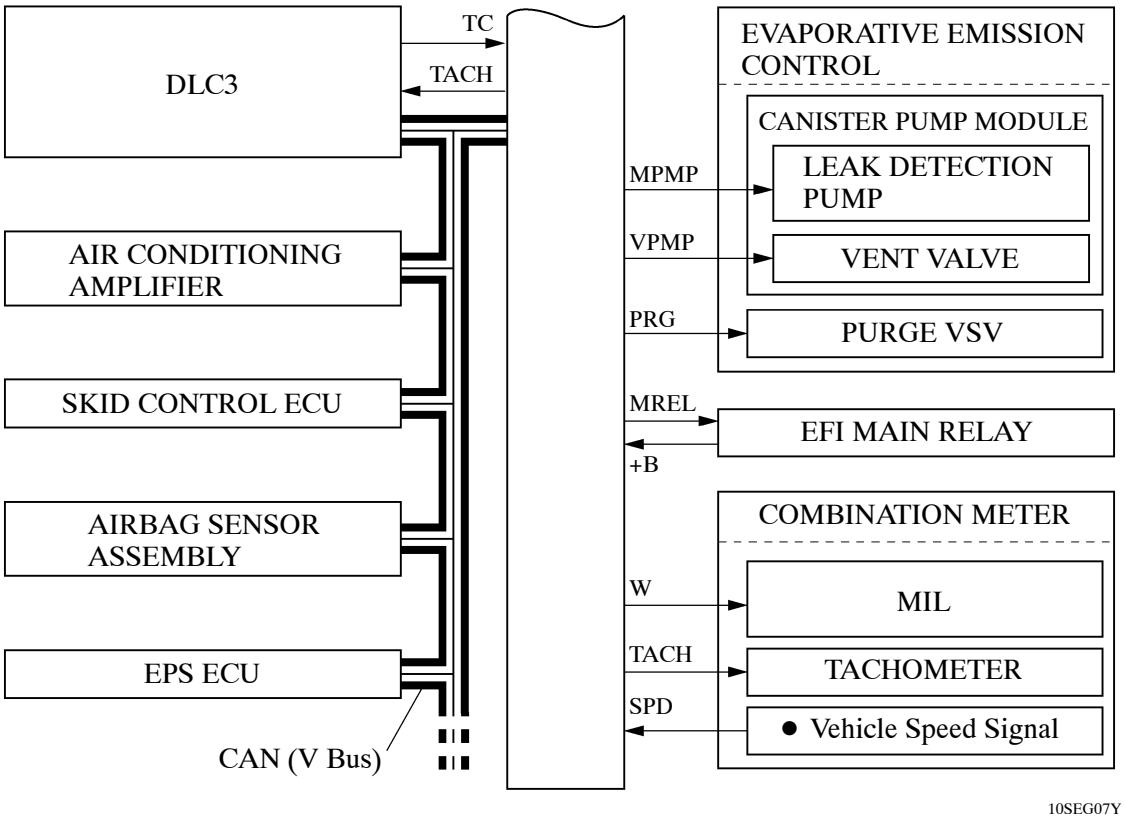
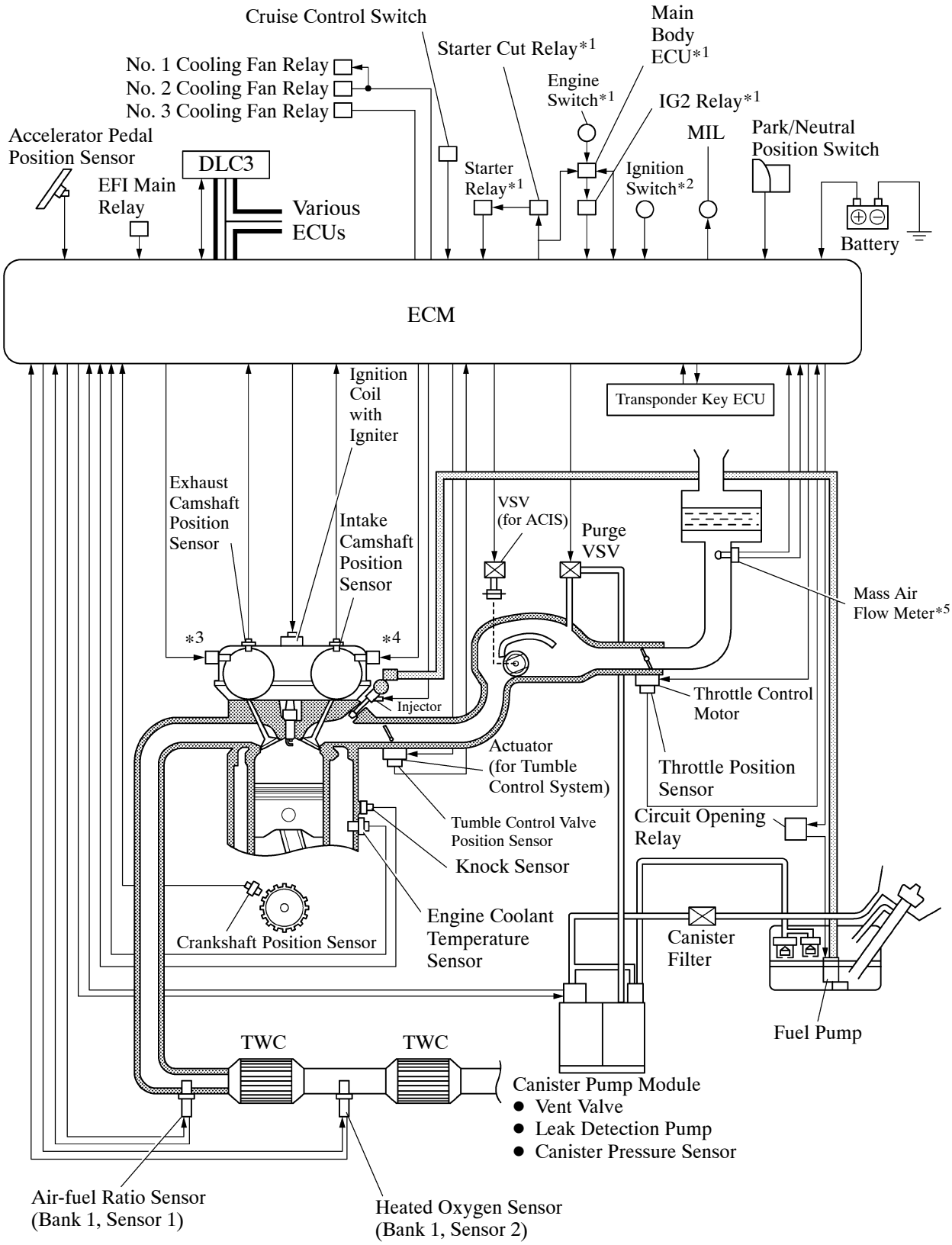

DLC3
TC
TACH
AIR CONDITIONING AMPLIFIER
SKID CONTROL ECU
AIRBAG SENSOR ASSEMBLY
EPS ECU
CAN (V Bus)
EVAPORATIVE EMISSION CONTROL
CANISTER PUMP MODULE
LEAK DETECTION PUMP
VENT VALVE
PURGE VSV
MPMP
VPMP
PRG
MREL
+B
EFI MAIN RELAY
COMBINATION METER
MIL
TACHOMETER
Vehicle Speed Signal
W
TACH
SPD
10SEG07Y

Engine Control System Diagram



*1: Models with smart key system
*2: Except models with smart key system
*3: Exhaust Camshaft Timing Oil Control Valve
*4: Intake Camshaft Timing Oil Control Valve
*5: Built-in intake air temperature sensor

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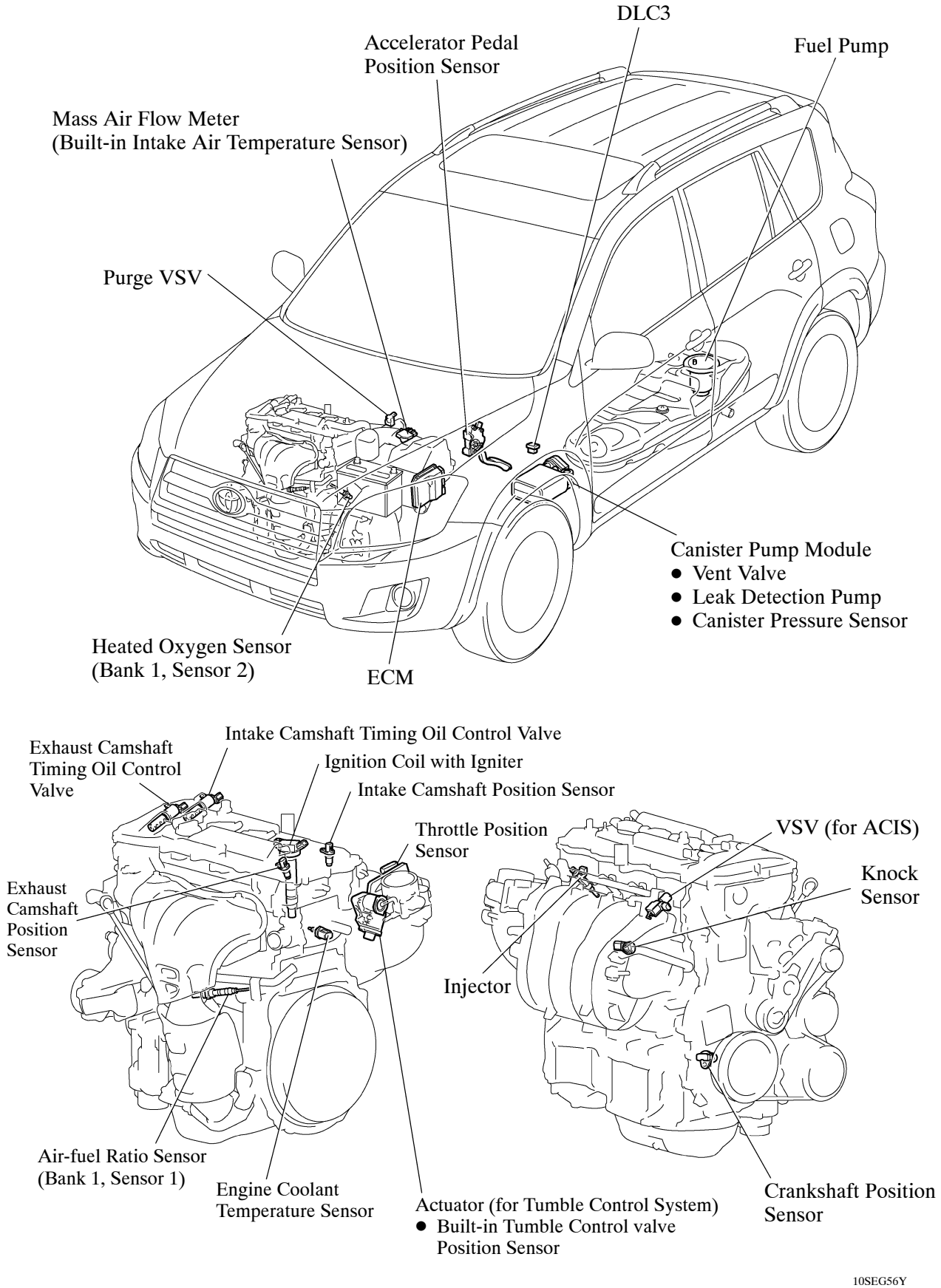
Layout of Main Components



Main Components of Engine Control System

1) General

The main components of the 2AR-FE engine control system are as follows:

Components	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.
Air-fuel Ratio Sensor (Bank 1, Sensor 1) [See page 58]	Type with Heater (Planar Type)	1	This sensor detects the oxygen concentration in the exhaust emission by measuring the electromotive force generated in the sensor itself.
Heated Oxygen Sensor (Bank 1, Sensor 2) [See page 58]	Type with Heater (Cup Type)	1	
Mass Air Flow Meter [See page 59]	Hot-wire Type	1	This sensor has a built-in hot-wire to directly detect the intake air mass.
Intake Air Temperature Sensor [See page 59]	Thermistor Type	1	● This sensor detects the intake air temperature by means of an internal thermistor. ● This sensor is integrated in the mass air flow meter.
Crankshaft Position Sensor [See page 60]	Pick-up Coil Type (Rotor Teeth/36 - 2)	1	This sensor detects the engine speed and performs the cylinder identification.
Camshaft Position Sensor [See page 60]	MRE (Magnetic Resistance Element) Type (Rotor Teeth/3)	2	This sensor performs the cylinder identification.
Throttle Position Sensor [See page 62]	Non-contact Type	1	This sensor detects the throttle valve opening angle.
Accelerator Pedal Position Sensor [See page 63]	Non-contact Type	1	This sensor detects the amount of pedal effort applied to the accelerator pedal.
Tumble Control Valve Position Sensor [See page 64]	Non-contact Type	1	This sensor detects the tumble control valve opening angle.
Knock Sensor [See page 65]	Built-in Piezoelectric Element Type (Flat Type)	1	This sensor detects an occurrence of the engine knocking indirectly from the vibration of the cylinder block caused by the occurrence of engine knocking.

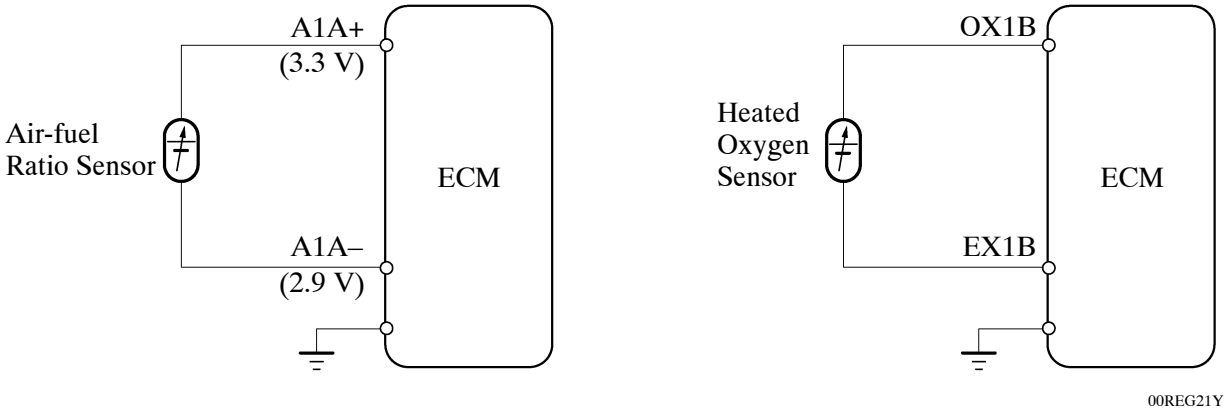
(Continued)

Components	Outline	Quantity	Function
Engine Coolant Temperature Sensor	Thermistor Type	1	This sensor detects the engine coolant temperature by means of an internal thermistor.
Injector	12-hole Type	4	The injector is an electromagnetically-operated nozzle which injects fuel in accordance with the signals from the ECM.

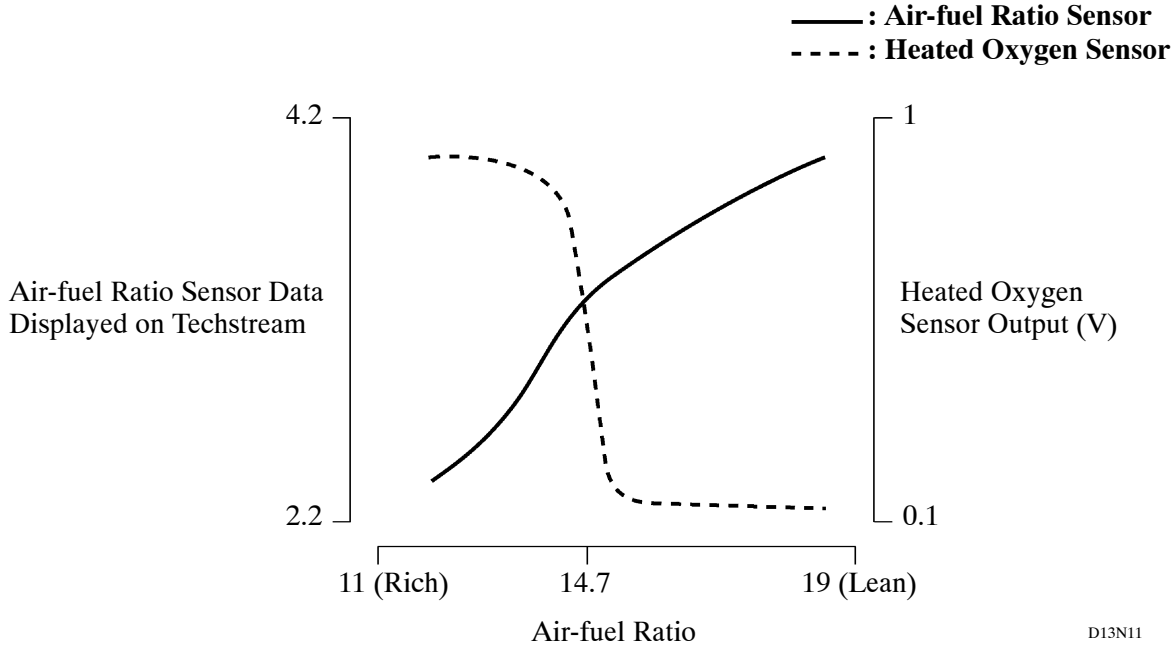
2) Air-fuel Ratio Sensor and Heated Oxygen Sensor

a. General

- The air-fuel ratio sensor and heated oxygen sensor differ in output characteristics.
- Approximately 0.4 V is constantly applied to the air-fuel ratio sensor, which outputs an amperage that varies in accordance with the oxygen concentration in the exhaust emission. The ECM converts the changes in the output amperage into voltage in order to linearly detect the present air-fuel ratio. The air-fuel ratio sensor data is read out by the Techstream.
- The output voltage of the heated oxygen sensor changes in accordance with the oxygen concentration in the exhaust emission. The ECM uses this output voltage to determine whether the present air-fuel ratio is richer or leaner than the stoichiometric air-fuel ratio.

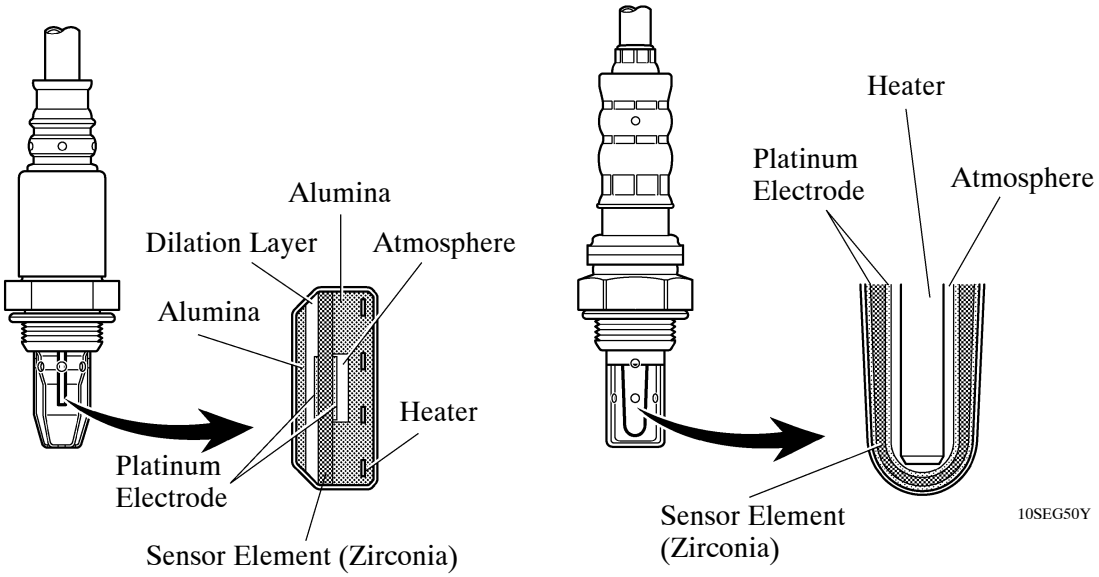


Air-fuel Ratio Sensor Circuit **Heated Oxygen Sensor**



b. Construction

- The basic construction of the air-fuel ratio sensor and heated oxygen sensor is the same. However, they are divided into the cup type and the planar type, according to the different types of heater construction that are used.
- The cup type heated oxygen sensor contains a sensor element that surrounds the heater.
- The planar type air-fuel ratio sensor uses alumina, which excels in heat conductivity and insulation, to integrate a sensor element with the heater, thus achieving the excellent warm-up performance of the sensor.



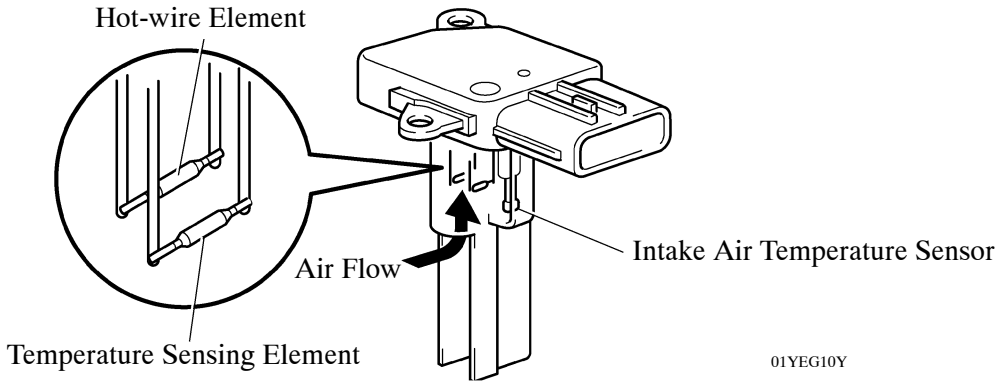
Planar Type Air-fuel Ratio Sensor **Cup Type Heated Oxygen Sensor**

▶ Warm-up Specification ◀

Sensor Type	Planar Type	Cup Type
Warm-up Time	Approx. 10 sec.	Approx. 30 sec.

3) Mass Air Flow Meter

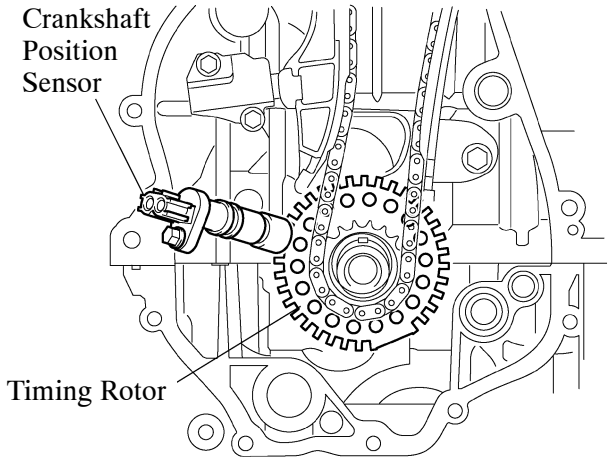
- The compact and lightweight mass air flow meter, which is a plug-in type, allows a portion of the intake air to flow through the detection area. By directly measuring the mass and the flow rate of the intake air, detection precision is ensured and intake air resistance is reduced.
- This mass air flow meter has a built-in intake air temperature sensor.



4) Crankshaft and Camshaft Position Sensors

a. General

- The pick-up coil type crankshaft position sensor is used. 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 missing teeth are used to determine the top dead center.
- The MRE (Magnetic Resistance Element) type intake and exhaust camshaft position sensors are used. To detect the camshaft position, each timing rotor on the intake and exhaust camshafts is used to generate 3 (3 high output, 3 low output) pulses for every 2 revolutions of the crankshaft.



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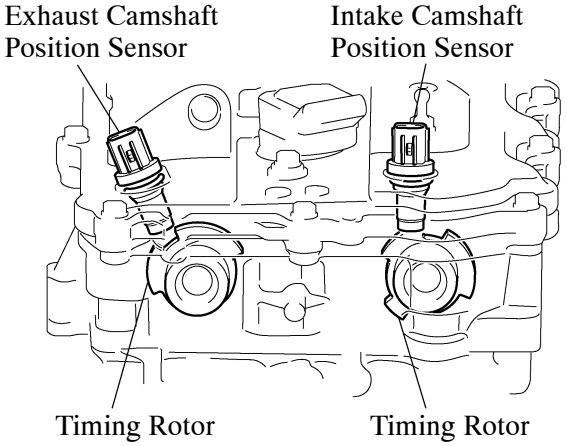

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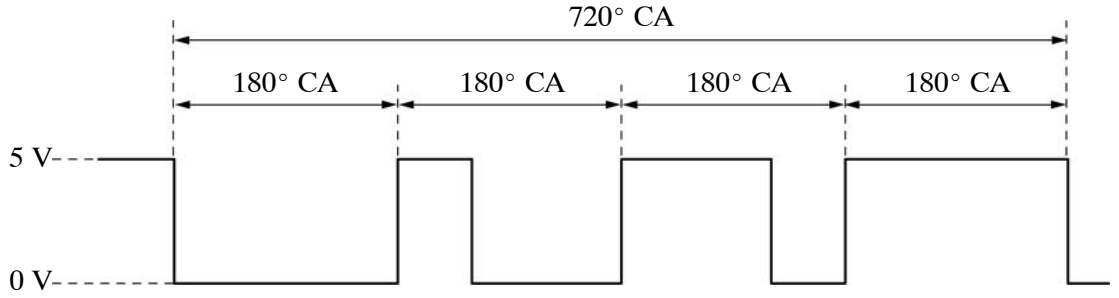
▶ Sensor Output Waveforms ◀



Camshaft Position Sensor Output Waveform

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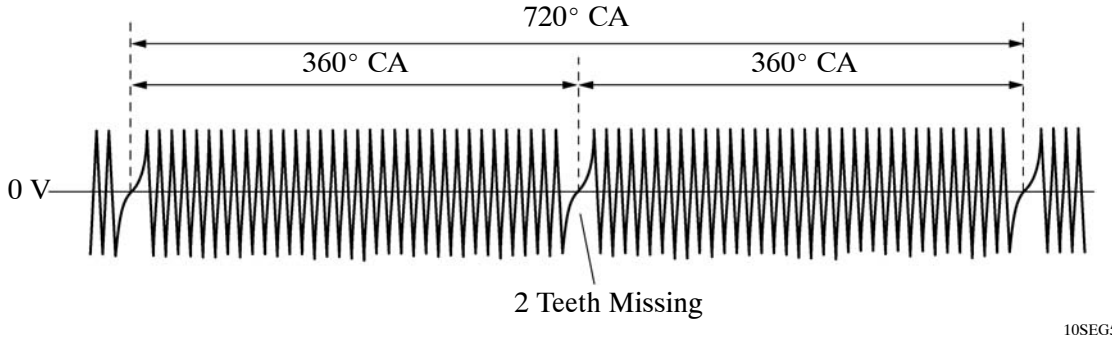


10SEG58I

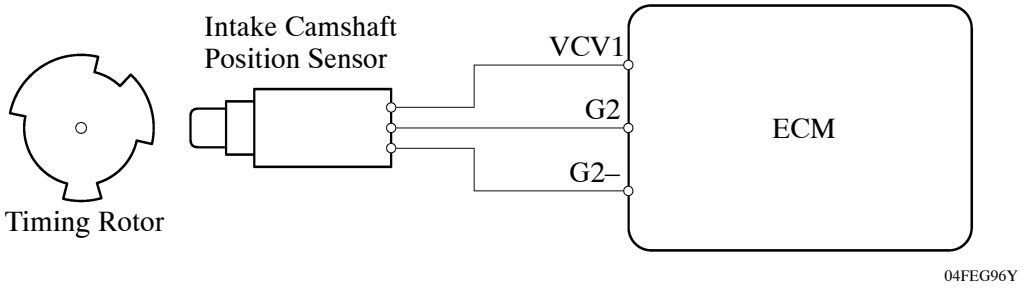
Crankshaft Position Sensor Output Waveform

b. MRE Type Camshaft Position Sensor

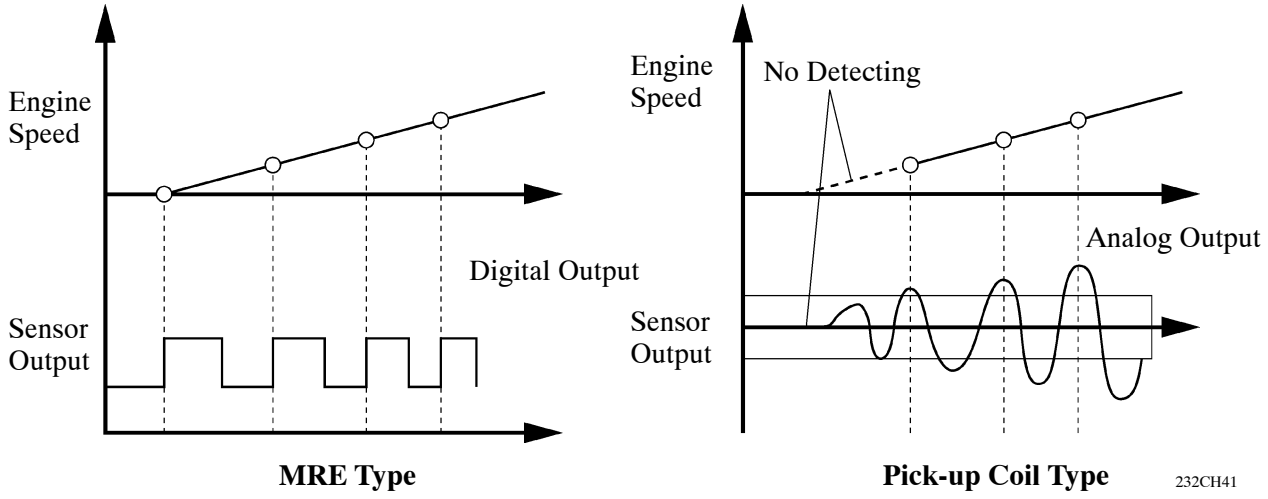
- The MRE type camshaft position sensor consists of an MRE, a magnet and a sensor. The direction of the magnetic field changes due to the different shapes (protruded and non-protruded portions) of the timing rotor, which passes by the sensor. As a result, the resistance of the MRE changes, and the output voltage to the ECM changes to high or low. The ECM detects the camshaft position based on this output voltage.
- The differences between the MRE type camshaft position sensor and the pick-up coil camshaft position sensor used on the conventional model are as follows:

Item	Sensor Type	
	MRE	Pick-up Coil
Signal Output	Constant digital output starts from low engine speeds.	Analog output changes with the engine speed.
Camshaft Position Detection	Detection is made by comparing the NE signals with the Hi/Lo output switch timing due to the protruded/non-protruded portions of the timing rotor, or made based on the number of the input NE signals during Hi/Lo outputs.	Detection is made by comparing the NE signals with the change of waveform that is output when the protruded portion of the timing rotor passes.

▶ Wiring Diagram ◀

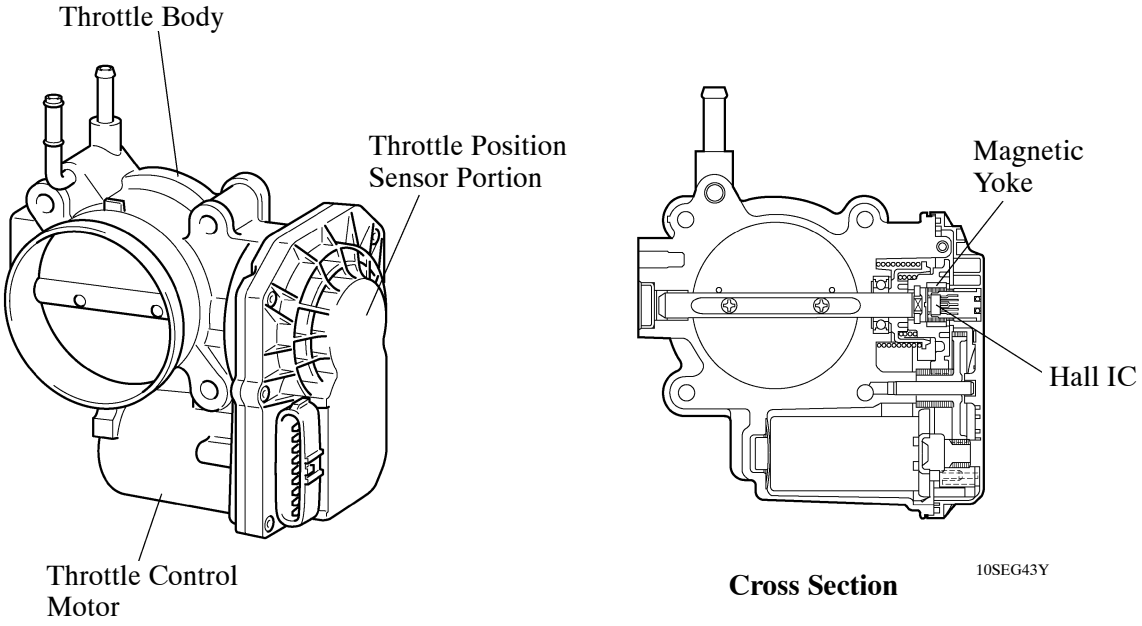


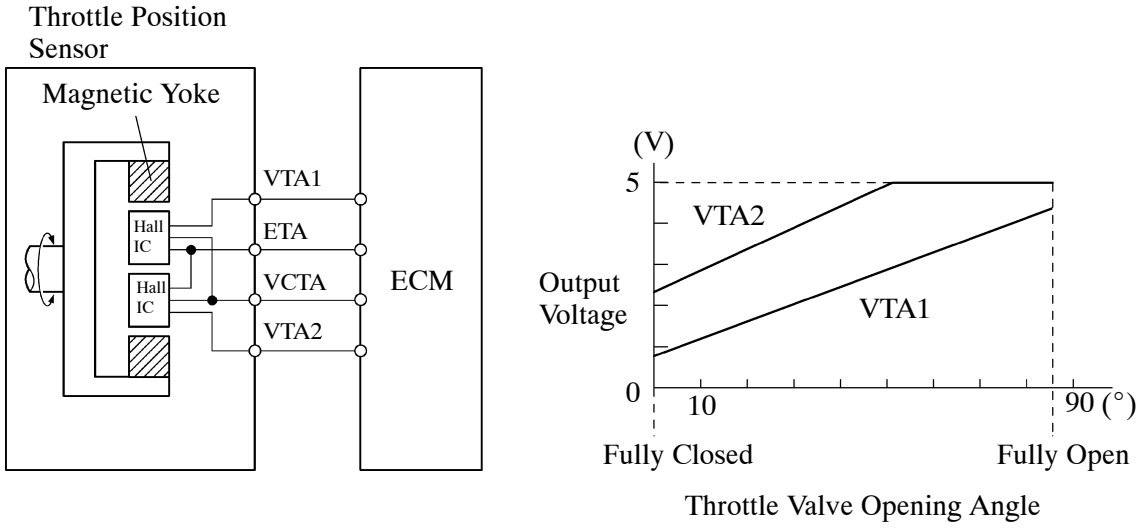
▶ MRE Type and Pick-up Coil Type Output Waveform Image Comparison ◀



5) Throttle Position Sensor

The throttle position sensor is mounted on the throttle body to detect the opening angle of the throttle valve. The throttle position sensor converts the magnetic flux density that changes when the magnetic yoke (located on the same axis as the throttle shaft) rotates around the Hall IC into electric signals to operate the throttle control motor.





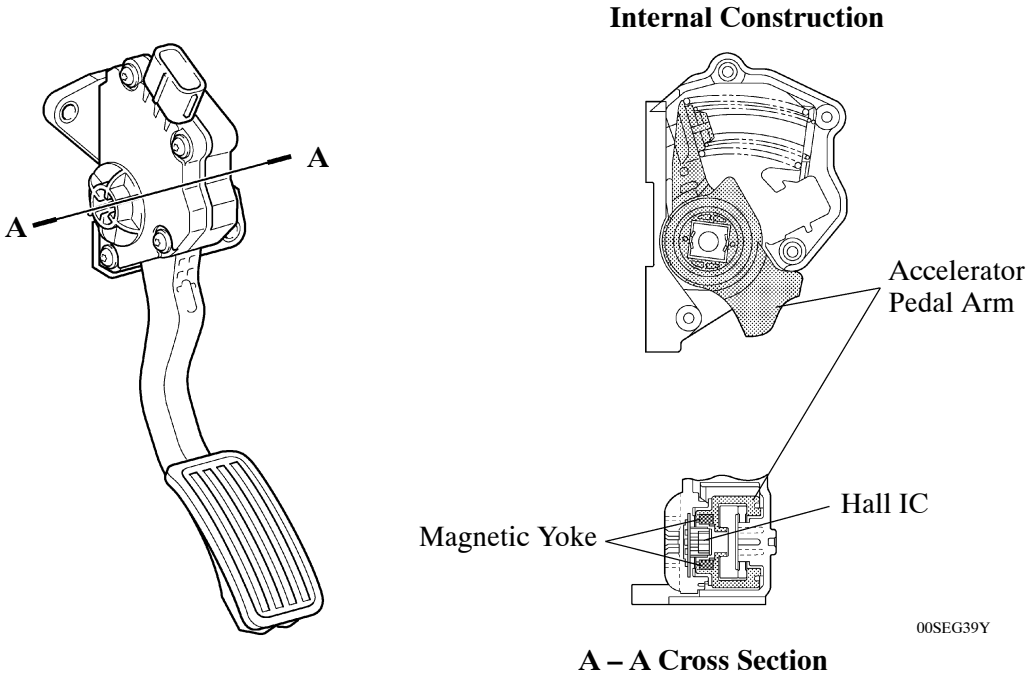
Service Tip

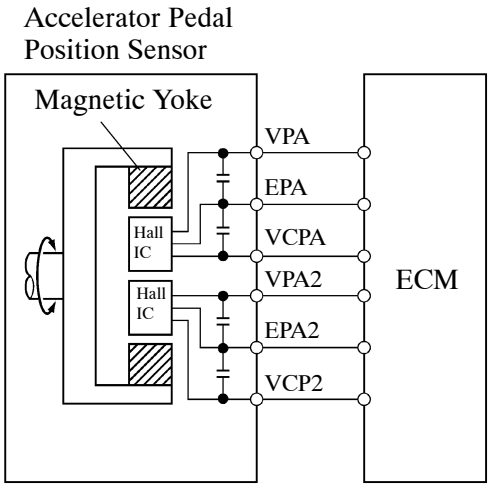
The inspection method differs from the conventional contact type throttle position sensor because this non-contact type sensor uses a Hall IC.
For details, refer to the 2009 RAV4 Repair Manual (Pub. No. RM10S0U).

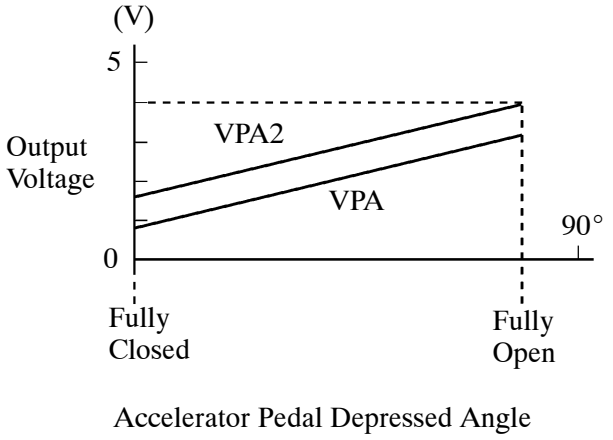
6) Accelerator Pedal Position Sensor

The non-contact type accelerator pedal position sensor uses a Hall IC.

- The magnetic yoke that is mounted at the accelerator pedal arm 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 at that time into electrical signals, and outputs them as accelerator pedal effort to the ECM.
- The Hall IC contains circuits for the main and sub signals. It converts the accelerator pedal depressed angles into electric signals with two differing characteristics and outputs them to the ECM.





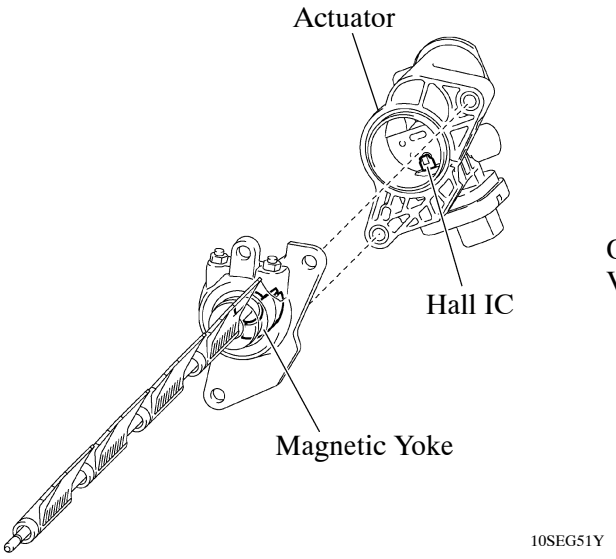


Service Tip

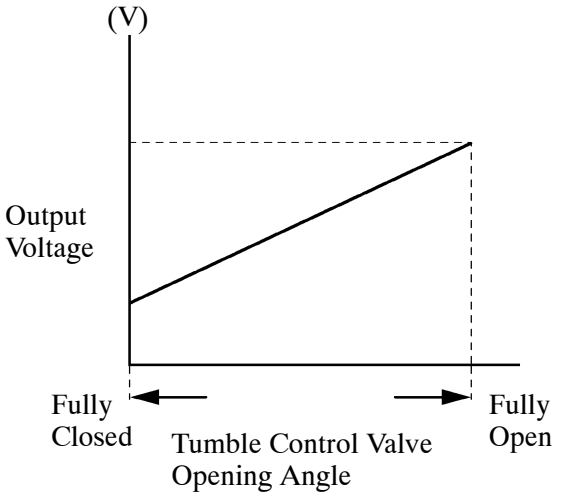
The inspection method differs from the conventional contact type accelerator pedal position sensor because this non-contact type sensor uses a Hall IC.
For details, refer to the 2009 RAV4 Repair Manual (Pub. No. RM10S0U).

7) Tumble Control Valve Position Sensor

The non-contact type tumble control valve position sensor uses a Hall IC.
It detects the tumble control valve opening angle.
The sensor converts the magnetic flux density that changes when the magnetic yoke (located on the same axis as the tumble control valve shaft) rotates around the Hall IC into electric signals and sends them to ECM.

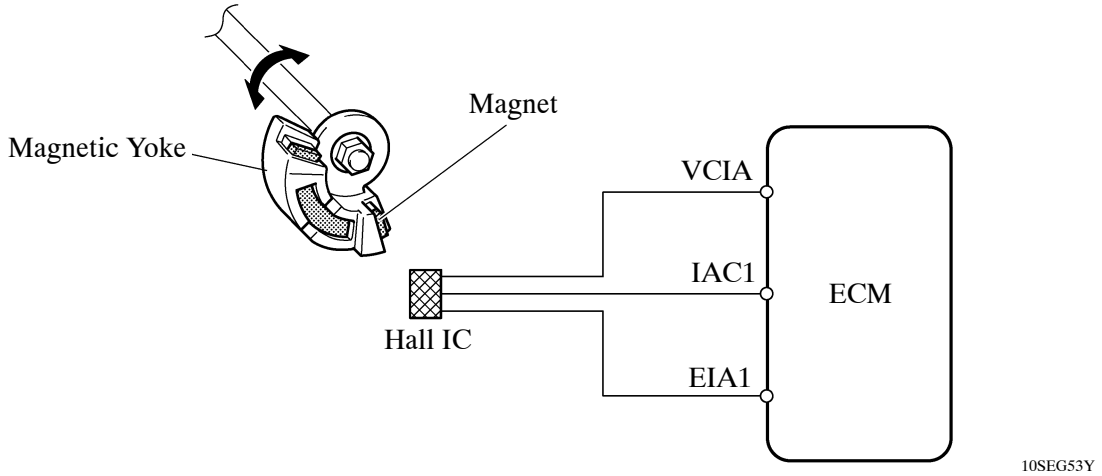


10SEG51Y



10SEG52Y

▶ System Diagram ◀



10SEG53Y

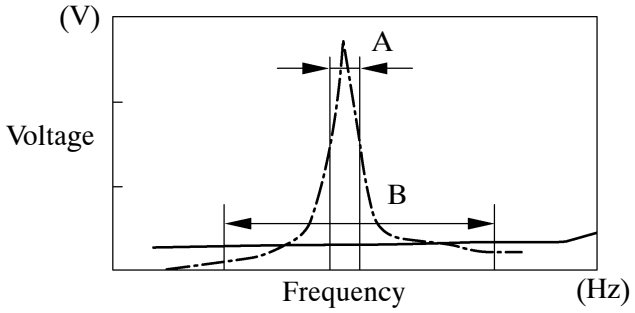
8) Knock Sensor (Flat Type)

a. General

In the conventional type knock sensor (resonant type), a vibration plate which has the same resonance point as the knocking frequency of the engine is built in and can detect the vibration in this frequency band. On the other hand, a flat type knock sensor (non-resonant type) has the ability to detect vibration in a wider frequency band from about 6 kHz to 15 kHz, and has the following features:

- The engine knocking frequency will change a bit depending on the engine speed. The flat type knock sensor can detect the vibration even when the engine knocking frequency is changed. Thus the vibration detection ability is increased compared to the conventional type knock sensor, and a more precise ignition timing control is possible.

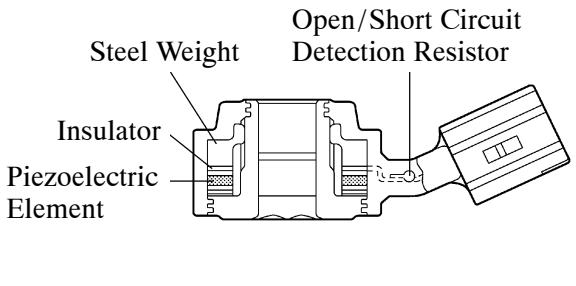
— - — : Conventional Type
——— : Flat Type



Characteristic of Knock Sensor 214CE04

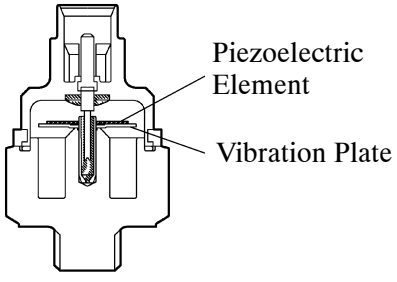
b. Construction

- The flat type knock sensor is installed on the engine through the stud bolt installed on the cylinder block. For this reason, a hole for the stud bolt runs through the center of the sensor.
- Inside the sensor, a steel weight is located on the upper portion and a piezoelectric element is located under the weight through the insulator.
- The open/short circuit detection resistor is integrated.



214CE01

Flat Type Knock Sensor (Non-resonant Type)

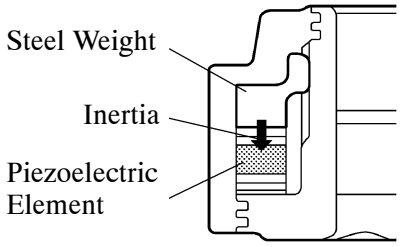


214CE02

Conventional Type Knock Sensor (Resonant Type)

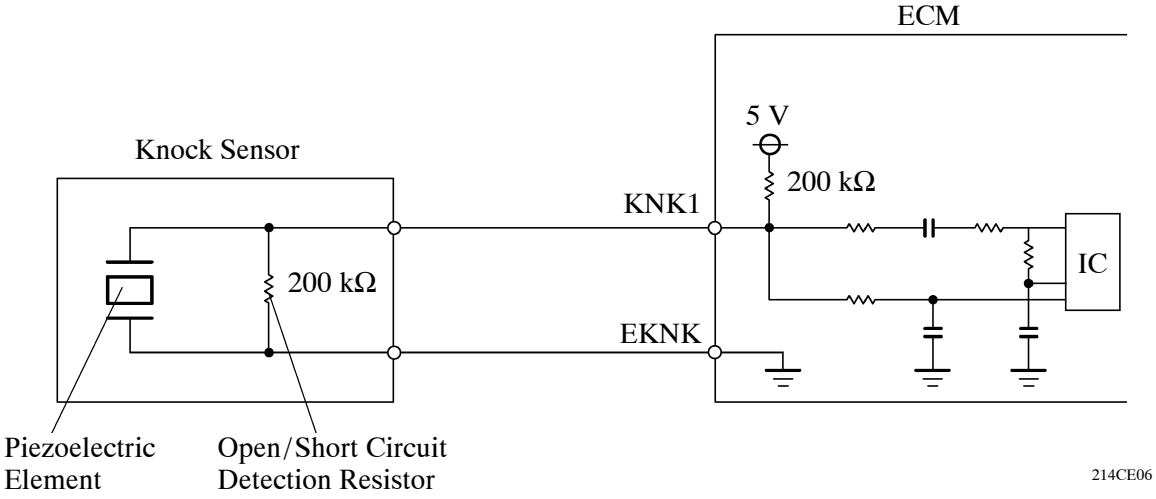
c. Operation

The knocking vibration is transmitted to the steel weight and its inertia applies pressure to the piezoelectric element. The action generates electromotive force.



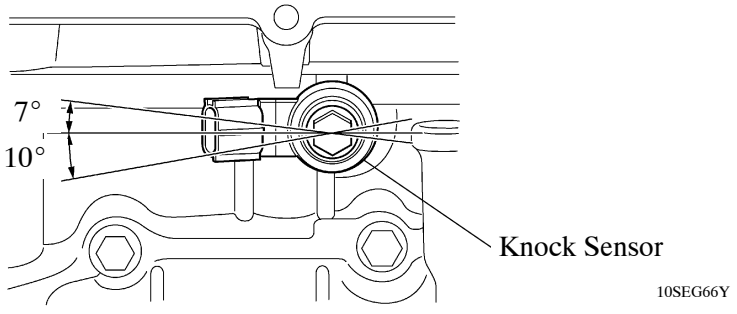
d. Open/Short Circuit Detection Resistor

While the ignition is ON, the open/short circuit detection resistor in the knock sensor and the resistor in the ECM keep constant the voltage at the terminal KNK1 of engine.
An IC (Integrated Circuit) in the ECM is always monitoring the voltage of the terminal KNK1. If the open/short circuit occurs between the knock sensor and the ECM, the voltage of the terminal KNK1 will change and the ECM detects the open/short circuit and stores DTC (Diagnostic Trouble Code).



Service Tip

- In accordance with the use of an open/short circuit detection resistor, the inspection method for the sensor has been changed. For details, refer to the 2009 RAV4 Repair Manual (Pub. No. RM10S0U).
- To prevent water accumulation in the connecter, make sure to install the flat type knock sensor in the position shown in the following illustration:

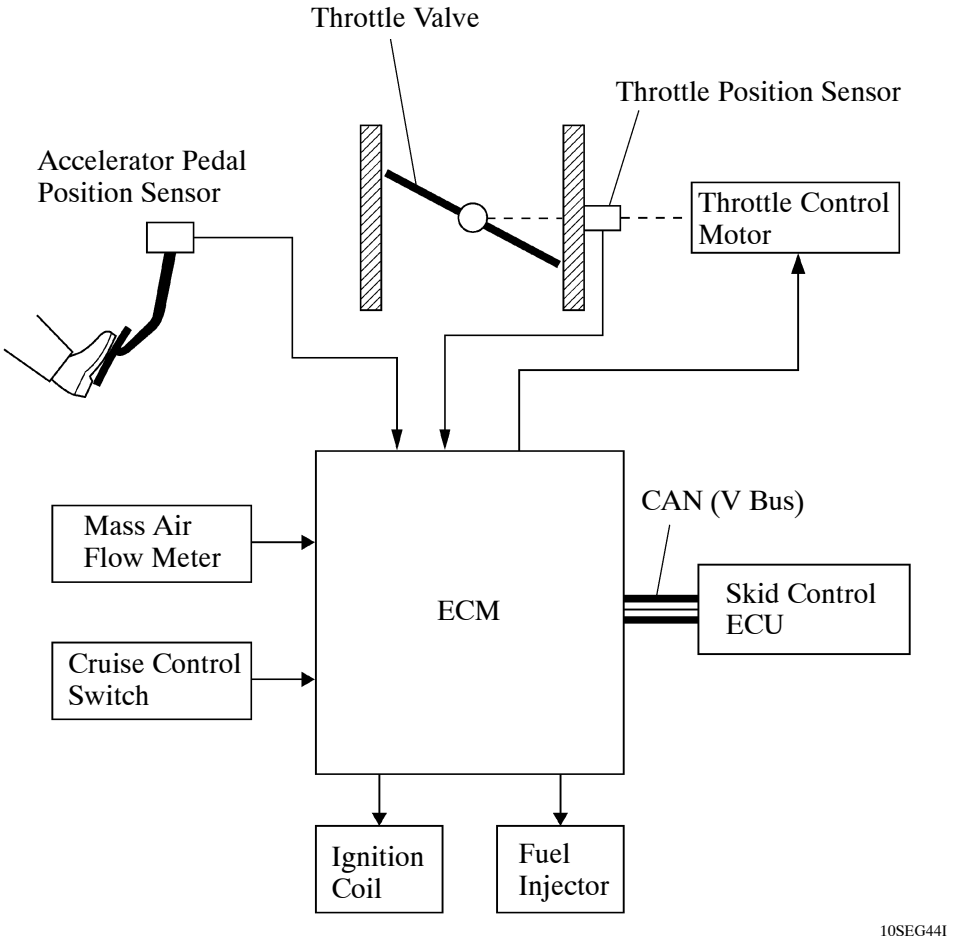


ETCS-i (Electronic Throttle Control System-intelligent)

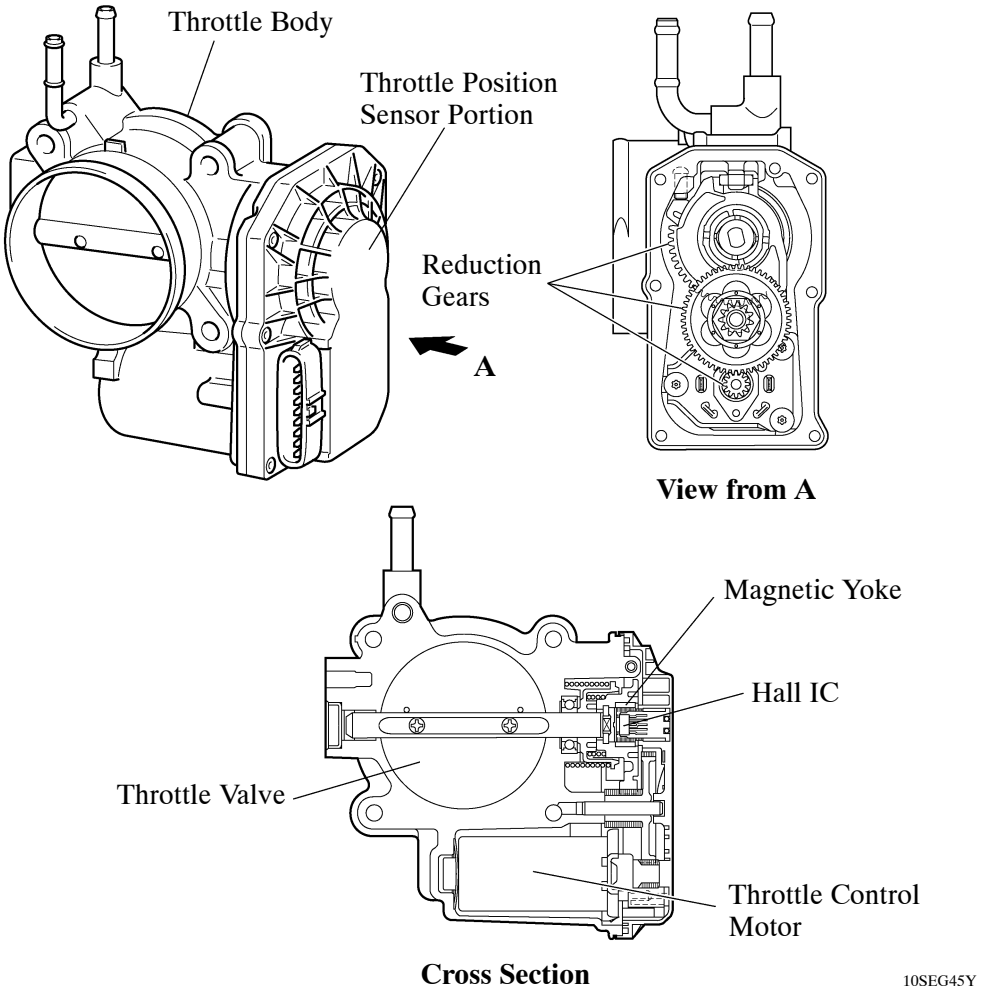
1) General

- The ETCS-i is used, providing excellent throttle control in all the operating ranges. In the 2AR-FE engine, the accelerator cable has been discontinued, and an accelerator pedal position sensor has been provided on the accelerator pedal.
- In the conventional throttle body, the throttle valve opening is determined 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 ETCS-i controls the IAC (Idle Air Control) system, TRAC (Traction Control), VSC (Vehicle Stability Control) system and cruise control system.
- In case of an abnormal condition, this system switches to the limp mode.

▶ System Diagram ◀



2) Construction



a. Throttle Position Sensor

The throttle position sensor is mounted on the throttle body, to detect the opening angle of the throttle valve.

b. Throttle Control Motor

A DC motor with excellent response and minimal power consumption is used for the throttle control motor. The ECM performs the duty cycle control of the direction and the amperage of the current that flows to the throttle control motor in order to regulate the opening of the throttle valve.

3) Operation

a. General

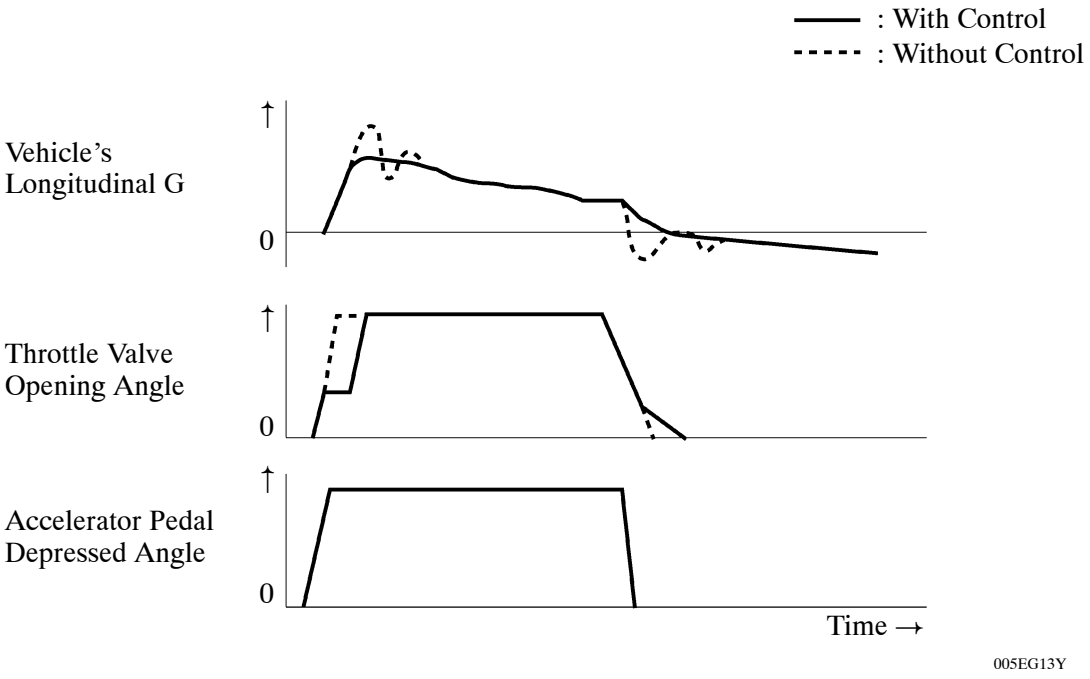
The ECM drives the throttle control motor by determining the target throttle valve opening in accordance with the respective operating condition.

- Non-linear Control
- Idle Air Control
- TRAC Throttle Control
- VSC Coordination Control
- Cruise Control

b. Normal Throttle Control (Non-linear Control)

This 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 speed in order to achieve excellent throttle control and comfort in all operating ranges.

▶ Control Examples During Acceleration and Deceleration ◀



c. Idle Air Control

The ECM controls the throttle valve in order to constantly maintain an ideal idle speed.

d. TRAC Throttle Control

As part of the TRAC system, the throttle valve is closed by a demand signal from the skid control ECU if an excessive amount of slippage is created at a driving wheel, thus facilitating the vehicle in providing excellent stability and driving force.

e. VSC Coordination Control

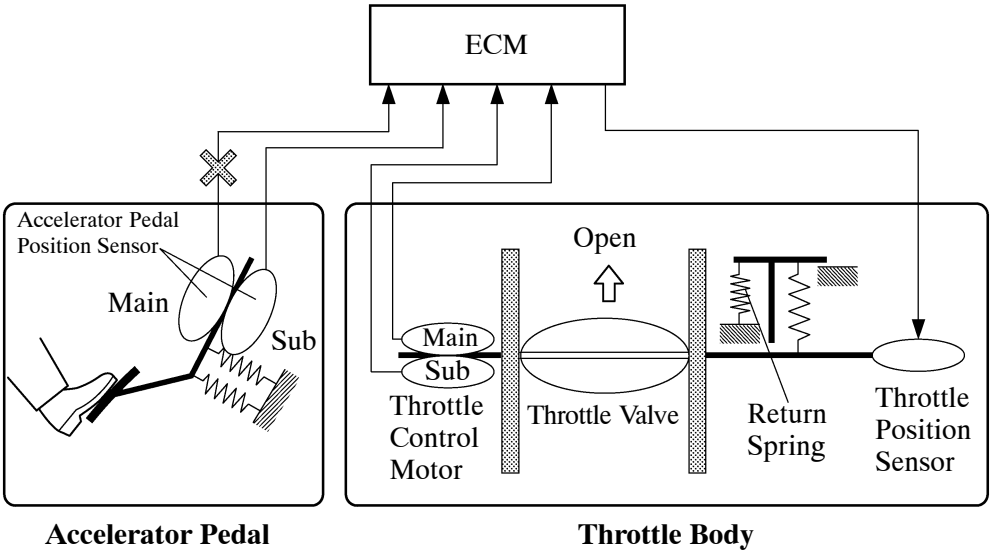
In order to bring the effectiveness of the VSC system control into full play, the throttle valve opening angle is controlled by effecting a coordination control with the skid control ECU.

f. Cruise Control

An ECM with an integrated cruise control ECU directly actuates the throttle valve for operation of the cruise control.

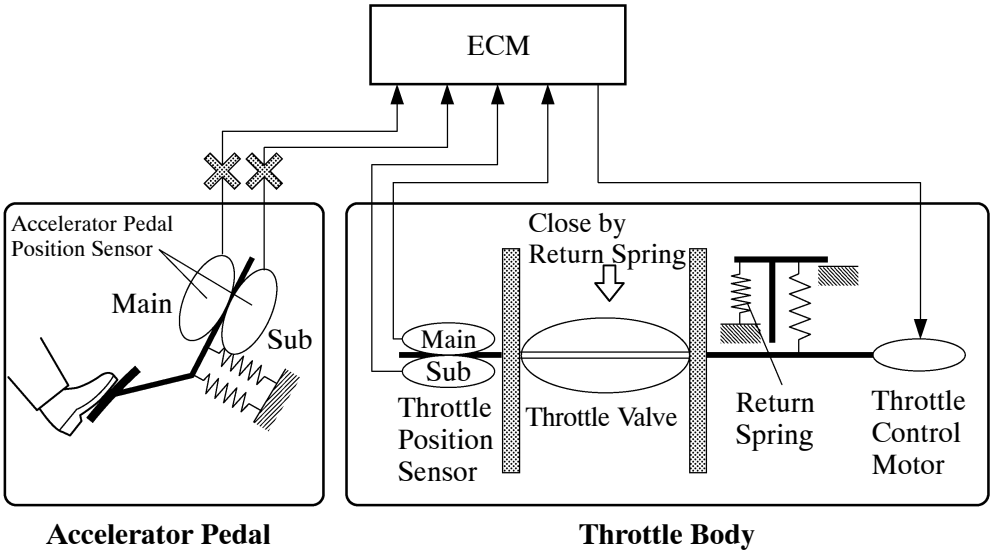
4) Fail-safe of Accelerator Pedal Position Sensor

- The accelerator pedal position sensor is comprised of 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 depressed angle, in order to operate the vehicle under the limp mode control.



199EG45

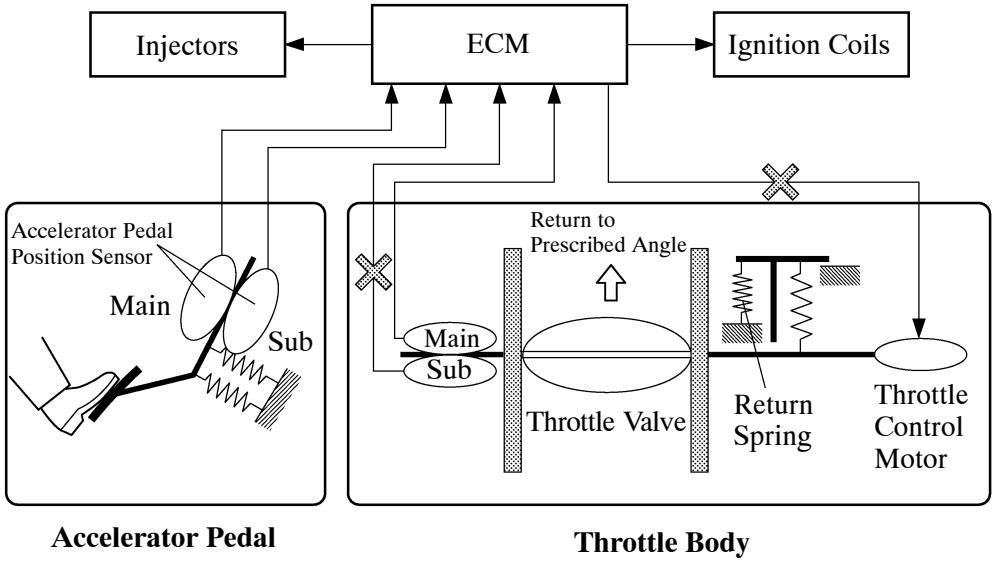
- If both circuits have malfunctions, the ECM detects the abnormal signal voltage from these two sensor circuits and stops the throttle control. At this time, the vehicle can be driven within its idling range.



199EG46

5) Fail-safe of Throttle Position Sensor

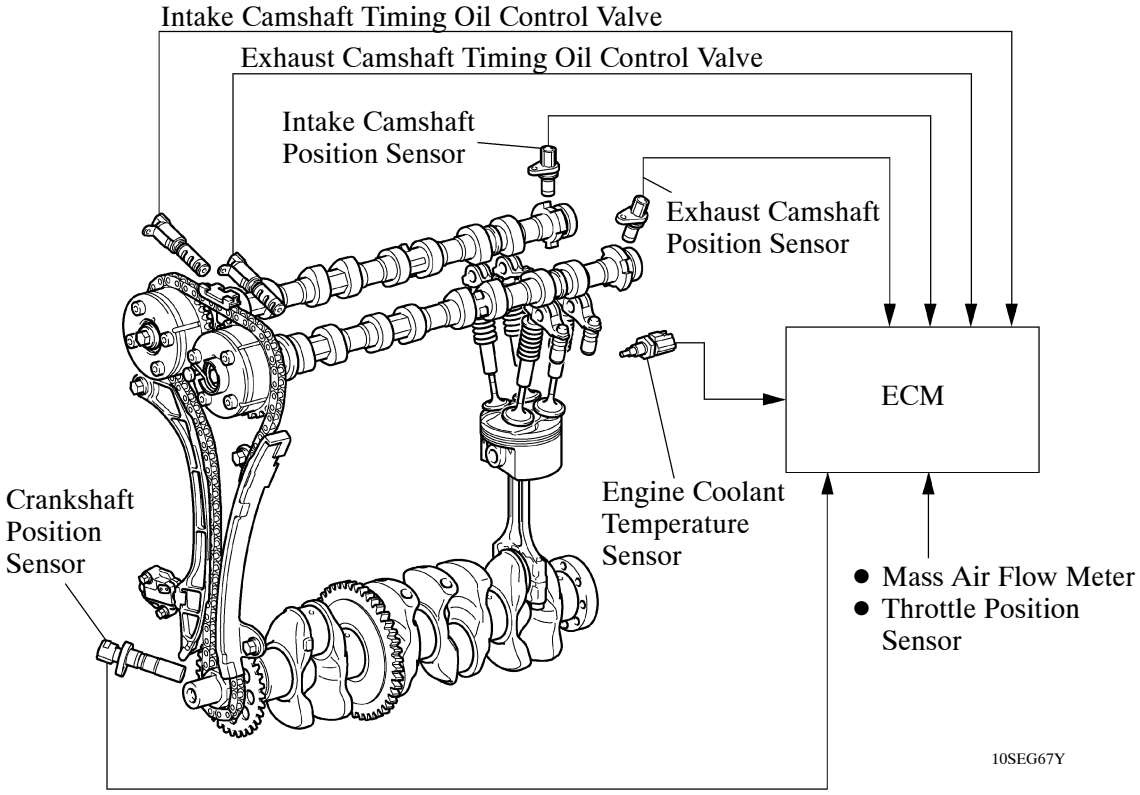
- The throttle position sensor is comprised of two (main, sub) sensor circuits. If a malfunction occurs in either one or both of the sensor circuits, the ECM detects the abnormal signal voltage difference between these two sensor circuits, cuts off the current to the throttle control motor, and switches to the limp mode. Then, the force of the return spring causes the throttle valve to return and stay at the prescribed opening angle. 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 (intermittent fuel-cut) and ignition timing in accordance with the accelerator opening.
- The same control as above is effected if the ECM detects a malfunction in the throttle control motor system.



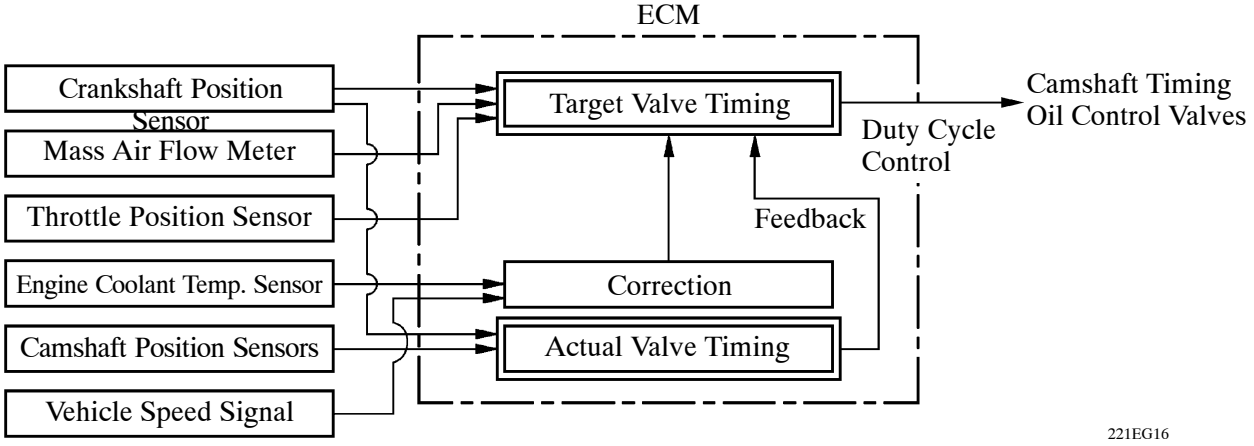
Dual VVT-i (Variable Valve Timing-intelligent) System

1) General

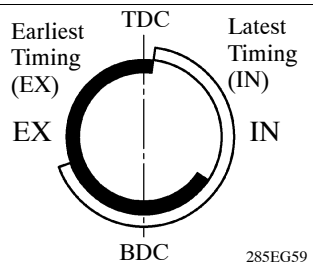
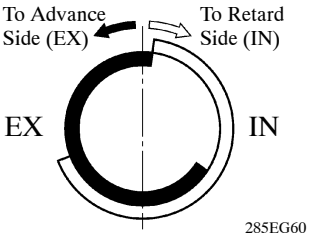
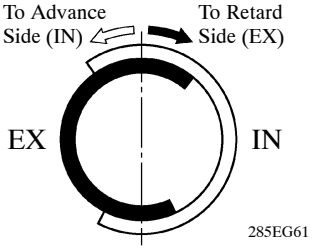
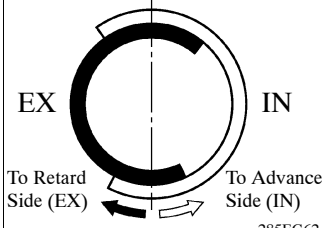
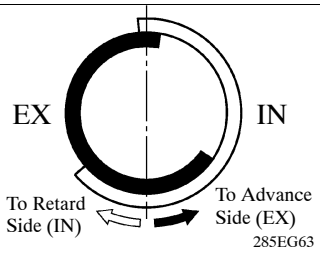
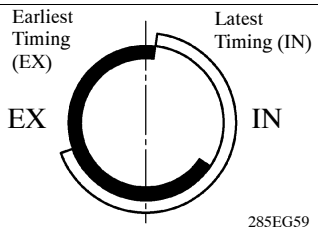
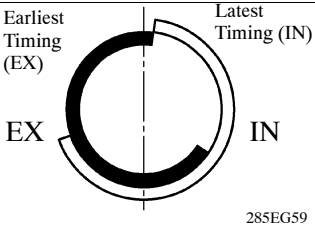
- The Dual VVT-i system is designed to control the intake and exhaust camshafts within a range of 50° and 40° respectively (of Crankshaft Angle) to provide valve timing optimally suited to the engine condition. This improves torque in all the speed ranges as well as increasing fuel economy, and reducing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



- Using the engine speed, intake air mass, throttle position and engine coolant temperature, the ECM can calculate optimal valve timing for each driving condition and controls the camshaft timing oil control valve. In addition, the ECM uses signals from the camshaft position sensor and the crankshaft position sensor to detect the actual valve timing, thus providing feedback control to achieve the target valve timing.



2) Effectiveness of the Dual VVT-i System

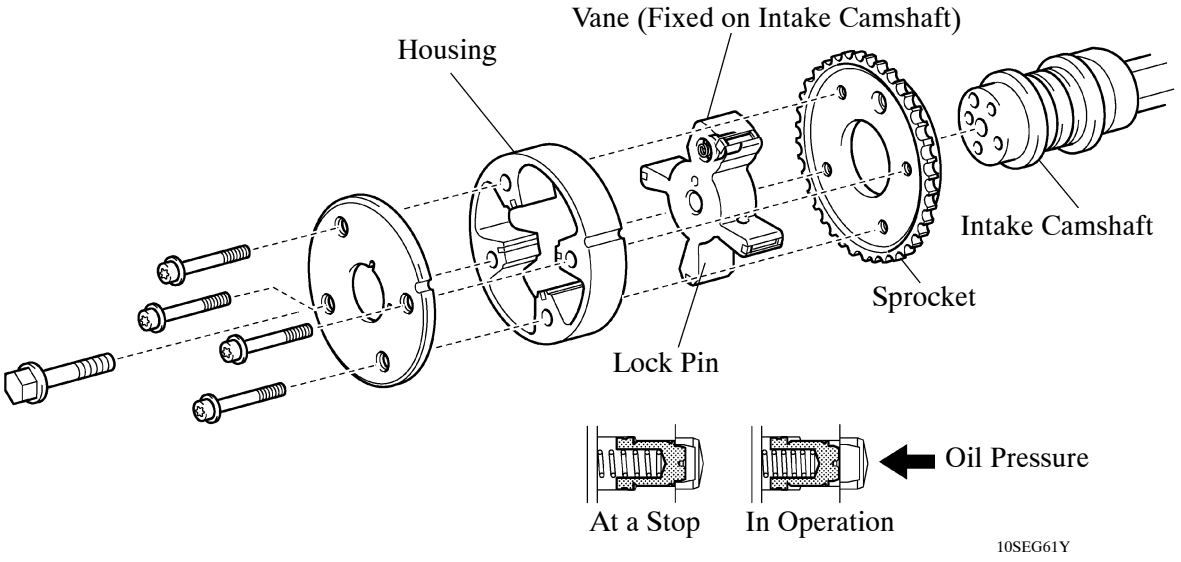
Operation State	Objective		Effect
During Idling		Eliminating overlap to reduce blow back to the intake side	● Stabilized idling speed ● Better fuel economy
At Light Load		Eliminating overlap to reduce blow back to the intake side	Ensured engine stability
At Medium Load		Increasing overlap to increase 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 close timing for volumetric efficiency improvement	Improved torque in low to medium speed range
In High Speed Range with Heavy Load		Retarding the intake valve close timing for volumetric efficiency improvement	Improved output
At Low Temperatures		Eliminating overlap to reduce blow back to the intake side leads to the lean burning condition, and stabilizes the idling speed at fast idle	● Stabilized fast idle speed ● Better fuel economy
● Upon Starting ● Stopping the Engine		Eliminating overlap to minimize blow back to the intake side	Improved startability

3) Construction

a. VVT-i Controller

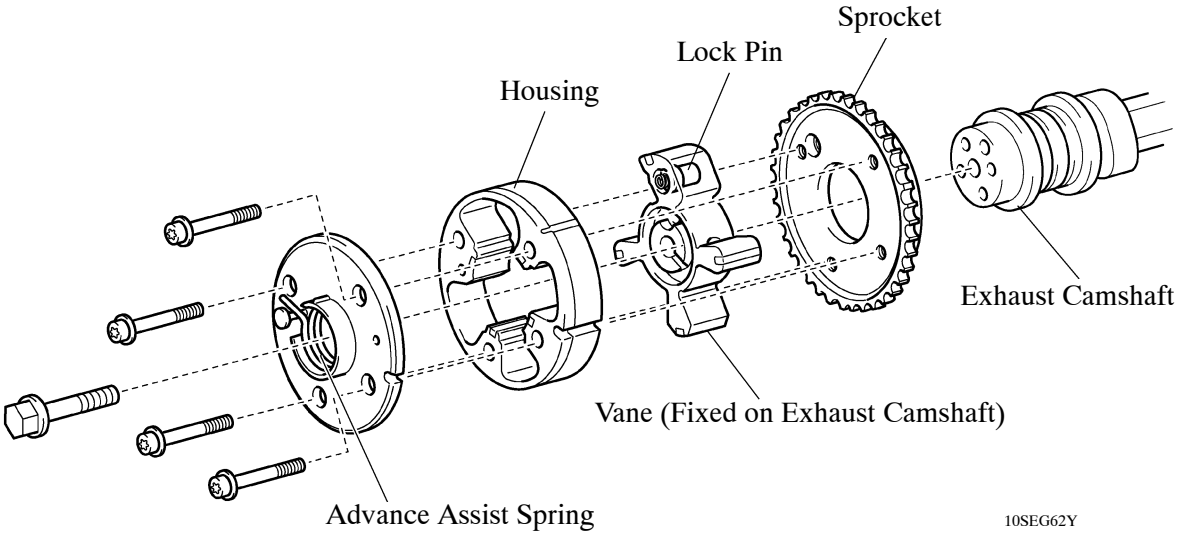
- Each controller consists of a housing driven by the timing chain and a vane coupled with the intake or exhaust camshaft.
- Both the intake and exhaust sides have a four-blade vane.
- The oil pressure sent from the advanced or retarded side path at the intake and exhaust camshafts causes rotation in the VVT-i controller vane circumferential direction to vary the intake and exhaust valve timing continuously.
- When the engine is stopped, a lock pin locks the intake camshaft at the most retarded end and the exhaust camshaft at the most advanced end, to ensure that the engine starts properly.
- An advance assist spring is provided on the exhaust side VVT-i controller. This spring applies torque in the advance direction when the engine is stopped, thus ensuring the engagement of the lock pin.

▶ Intake Side VVT-i Controller ◀



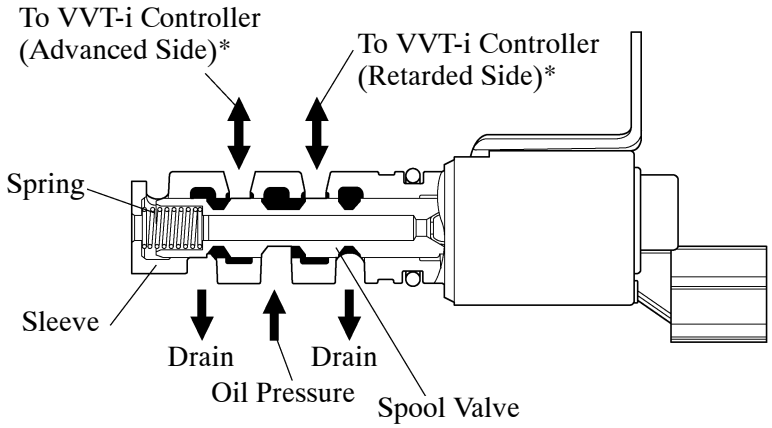
Lock Pin

▶ Exhaust Side VVT-i Controller ◀



b. Camshaft Timing Oil Control Valve

This camshaft timing oil control valve controls the spool valve using duty cycle control from the ECM. This allows hydraulic pressure to be applied to the VVT-i controller advanced or retarded side. When the engine is stopped, the camshaft timing oil control valve is in the most retarded position.



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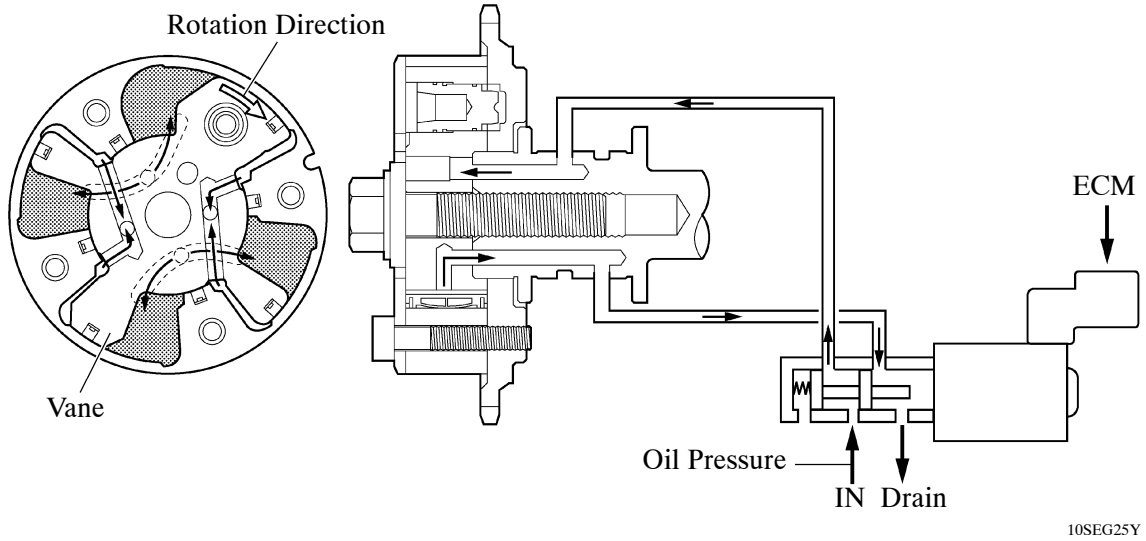
*: On the exhaust side oil control valve, the advance and retard sides are reversed.

4) Operation

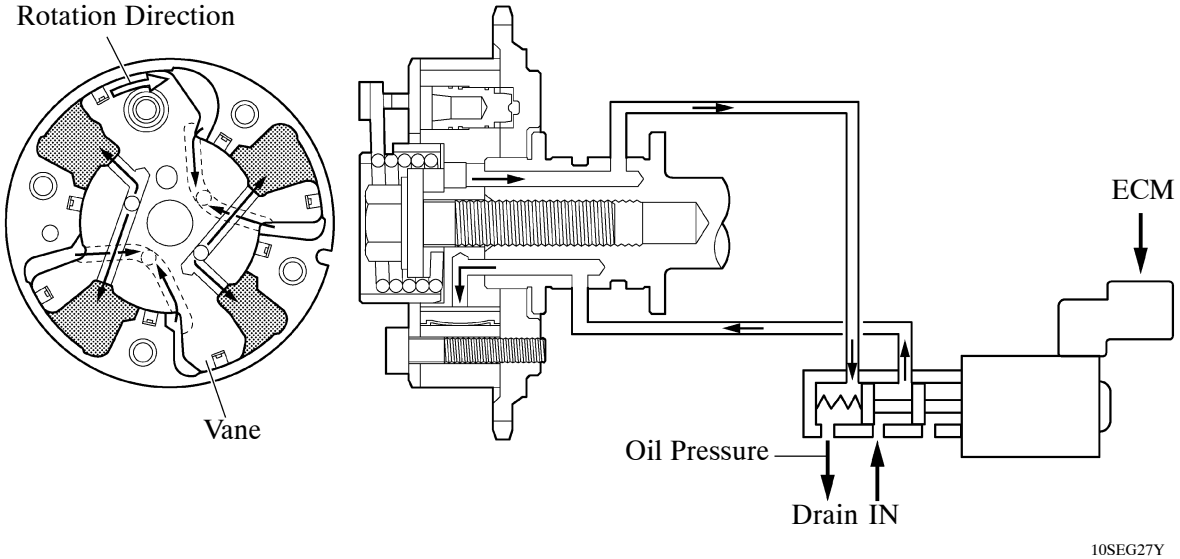
a. Advance

When the camshaft timing oil control valve 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.

▶ Intake Side ◀



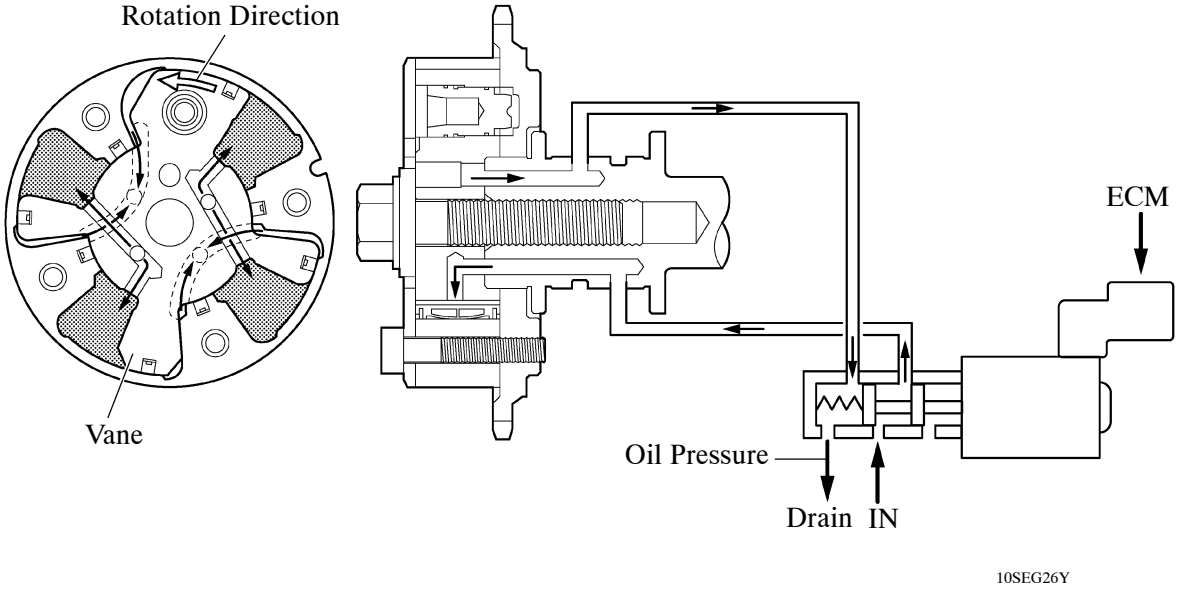
▶ Exhaust Side ◀



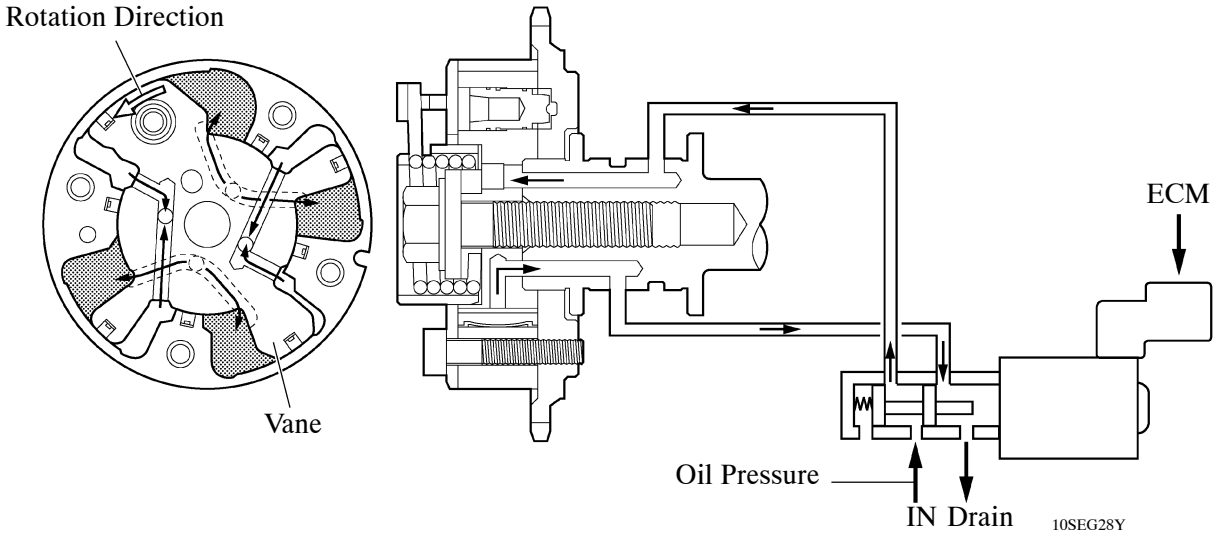
b. Retard

When the camshaft timing oil control valve 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.

▶ Intake Side ◀



▶ Exhaust Side ◀



c. Hold

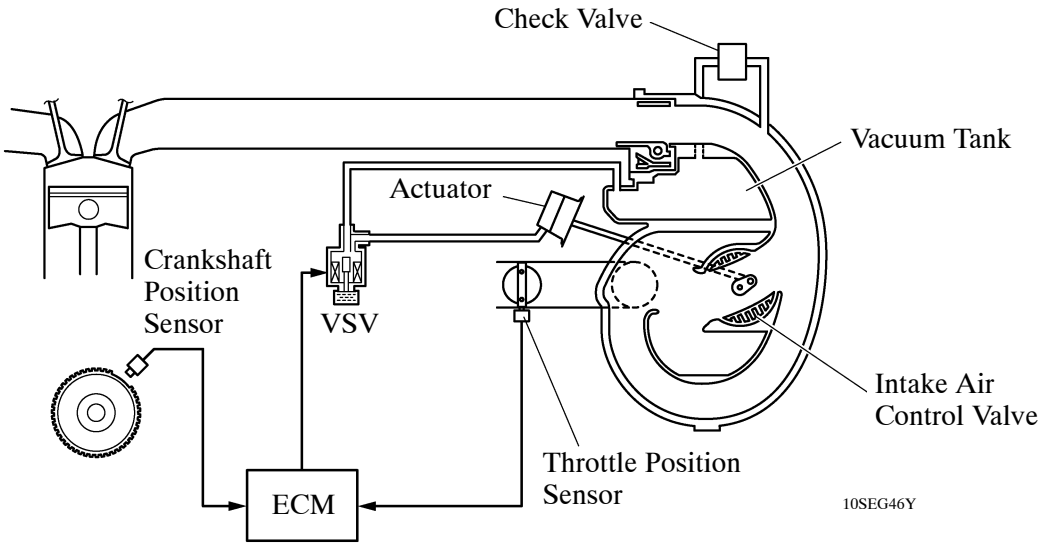
After reaching the target timing, the valve timing is held by keeping the camshaft timing oil control valve in the neutral position unless the traveling state changes.
This adjusts the valve timing at the desired target position and prevents the engine oil from running out when it is unnecessary.

ACIS (Acoustic Control Induction System)

1) General

The ACIS is implemented by using a bulkhead to divide the intake manifold into 2 stages, with an intake air control valve in the bulkhead being opened and 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.

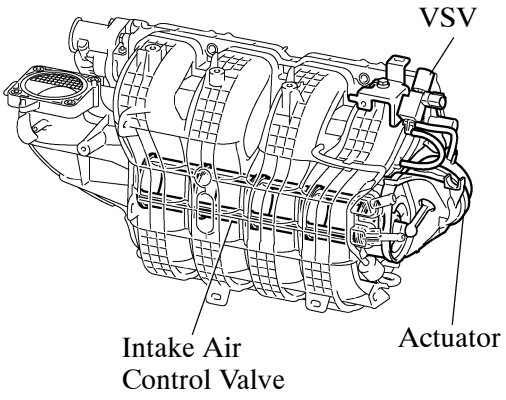
▶ System Diagram ◀



2) Construction

a. Intake Air Control Valve

The intake air control valve is integrated in the intake manifold. It opens and closes to change the effective length of the intake manifold in two stages.



10SEG70Y

b. Actuator

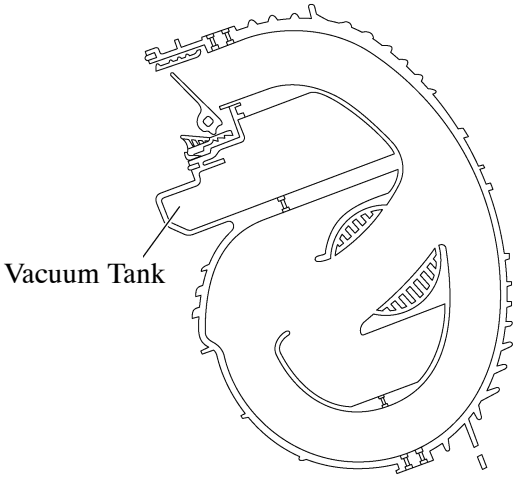
The actuator opens and closes the intake air control valve by the vacuum pressure controlled by the VSV.

c. VSV (Vacuum Switching Valve)

The VSV controls the vacuum applied to the actuator by way of the signal (ACIS) output by the ECM.

d. Vacuum Tank

The vacuum tank is integrated in the intake manifold. Equipped with a check valve, the vacuum tank stores the vacuum applied to the actuator in order to keep the intake air control valve fully closed even during low-vacuum conditions.



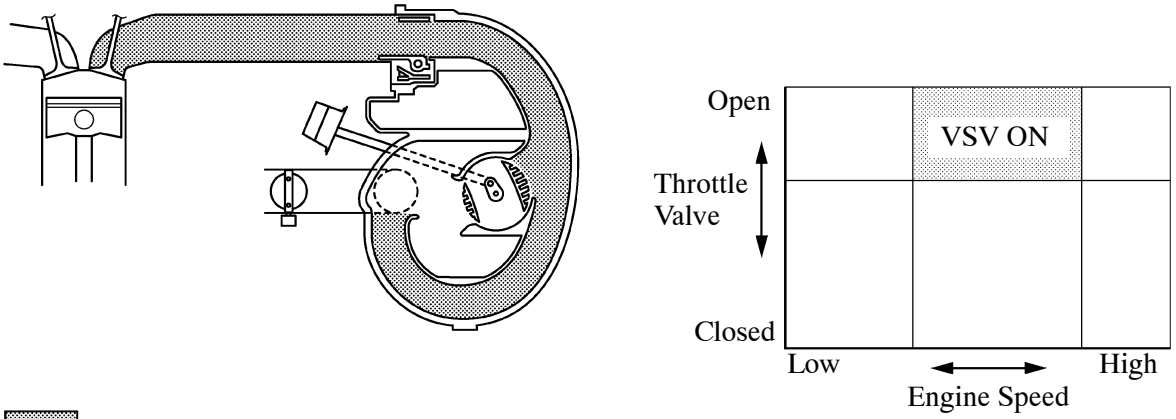
Intake Manifold Cross Section

10SEG40Y

3) Operation

a. When the Intake Control Valve Closes (VSV ON)

The ECM activates the VSV to match the longer pulsation cycle so that the negative pressure 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.

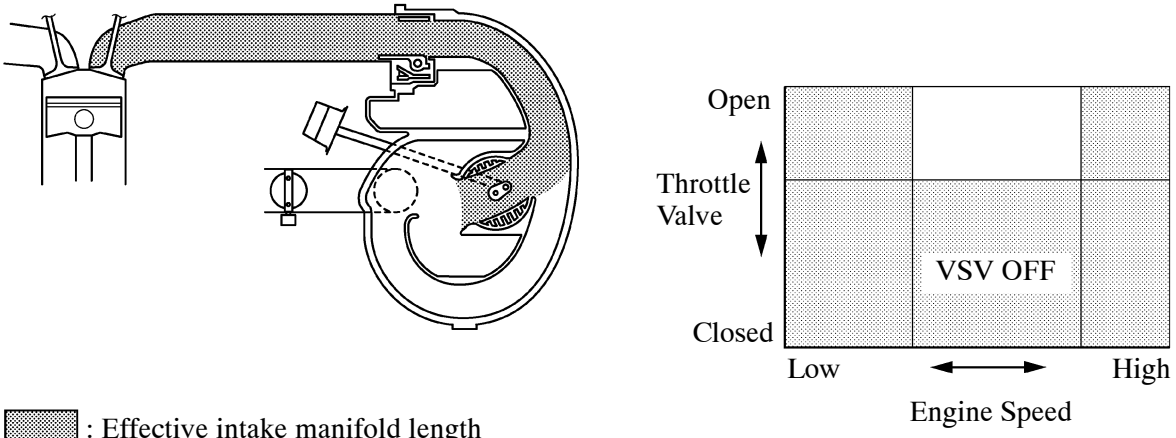


: Effective intake manifold length

10SEG47Y

b. When the Intake Control Valve Opens (VSV OFF)

The ECM deactivates the VSV to match the shorter pulsation cycle so that atmospheric air is led into the diaphragm chamber of the actuator and opens the control valve. When the control valve is open, the effective length of the intake air chamber 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.



: Effective intake manifold length

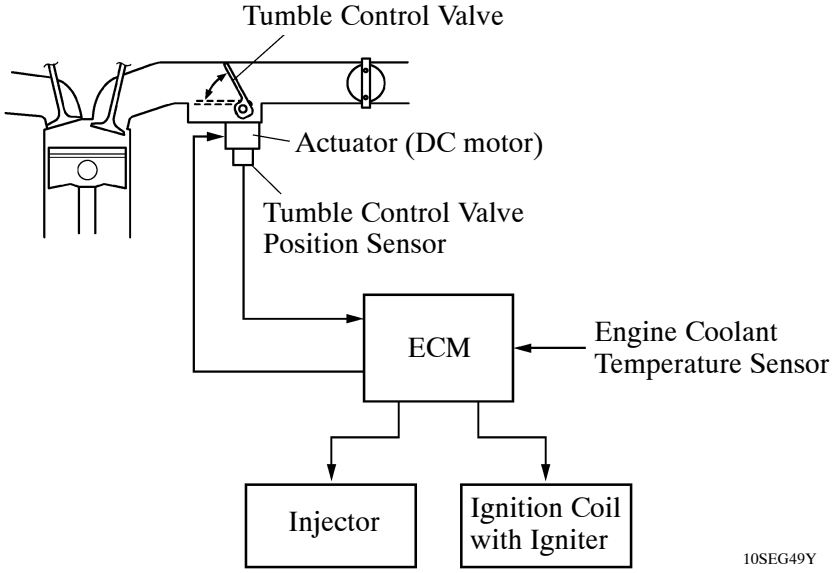
10SEG48Y

Tumble Control System

1) General

In the tumble control system, the tumble control valve remains fully closed during cold start and cold running conditions, in order to create a strong tumble current in the combustion chamber. In addition, this system optimally controls the ignition timing and the fuel injection volume in accordance with the opening and closing of the valve. As a result, it improves combustion while the engine is running cold.

▶ System Diagram ◀



2) Construction

a. Tumble Control Valve

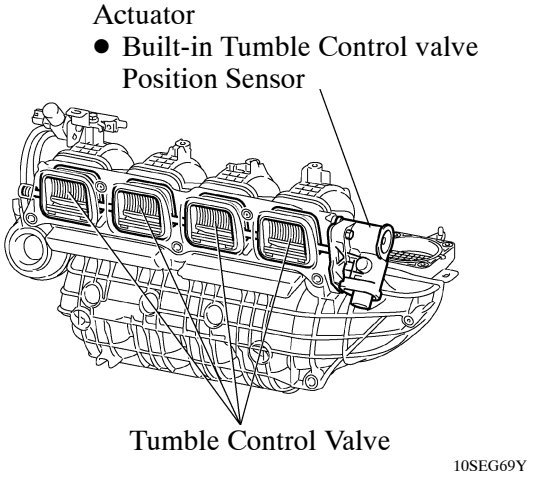
The tumble control valve is provided in the intake manifold. This valve closes in order to create a tumble current in the combustion chamber.

b. Actuator

A DC motor type actuator is provided in the intake manifold. Based on the signals provided by the ECM, the actuator opens and closes the tumble control valve.

c. Tumble Control Valve Position Sensor

For details of the tumble control valve position sensor, see page 64.



3) Operation

a. Engine Running Cold

To improve combustion, the ECM operates the actuator to fully close the tumble control valve, in order to create a strong tumble current in the combustion chamber. This enables the engine to operate at a lean air-fuel ratio immediately after a cold start.
Based on the signals from the various sensors, the ECM retards the ignition timing in order to reduce the amount of unburned gas and promote the warming up of the TWC. In addition, the ECM optimizes the fuel injection volume.
The vacuum pressure created downstream of the valve promotes the atomization of the fuel and prevents the fuel from adhering to the ports.
These measures help reduce exhaust gas emissions while the engine is running cold.

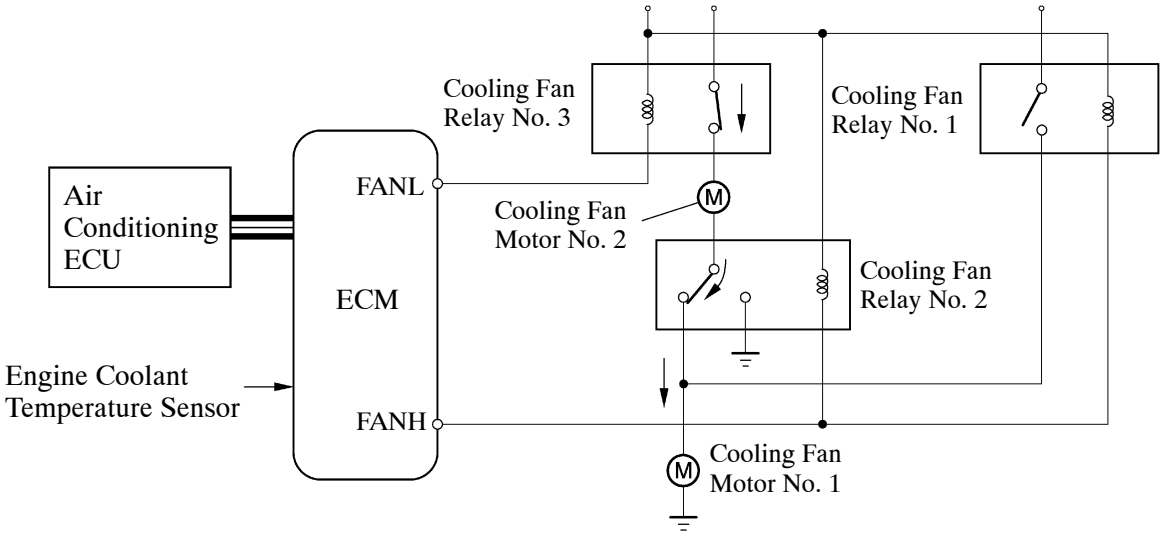
b. Engine Warmed Up

The ECM operates the actuator to fully open the tumble control valve. When the valve is fully open, the passage has minimal intake resistance in order to improve engine performance.

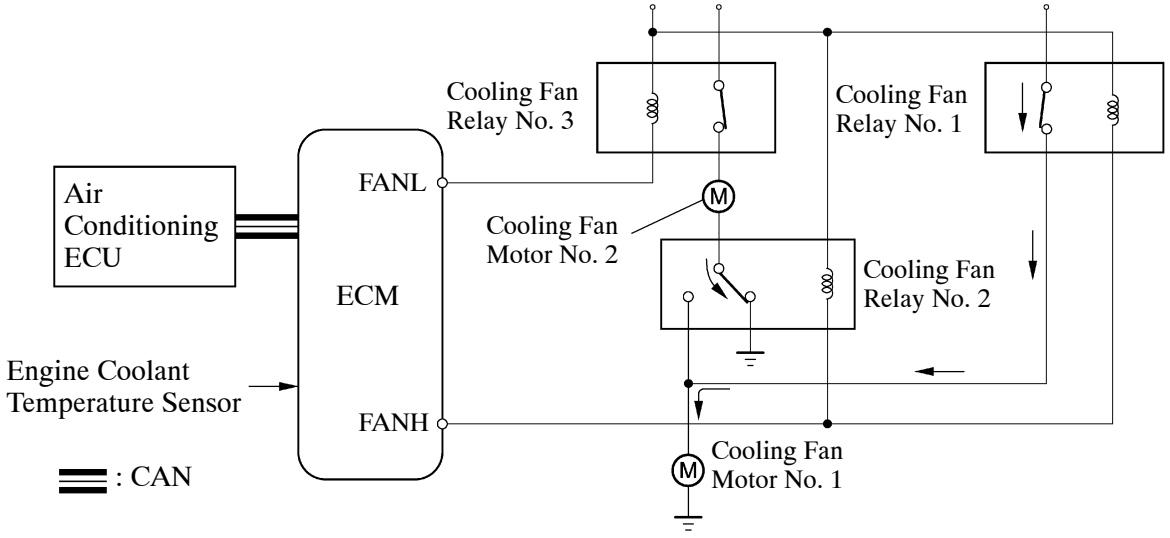
Cooling Fan Control

The ECM controls the operation of the cooling fan in two speeds (low and high) based on the engine coolant temperature sensor signal and the air conditioning ECU signal. This control is accomplished by operating the 2 fan motors in 2 stages through low speed (series connection) and high speed (parallel connection).

▶ Wiring Diagram ◀



Low Speed (Series Connection) 01NEG09Y

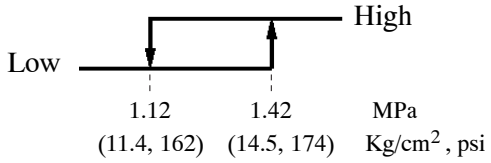


High Speed (Parallel Connection) 01NEG10Y

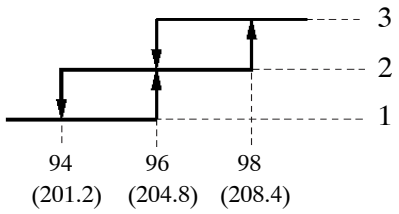
▶ Cooling Fan Operation ◀

Cooling Fan	OFF	Low		High	
A/C Compressor	OFF	OFF	ON	ON	ON
Refrigerant Pressure	–	–	Low	Low	High
Engine Coolant Temperature Level	1	2	1, 2	3	1, 2, 3

Refrigerant Pressure

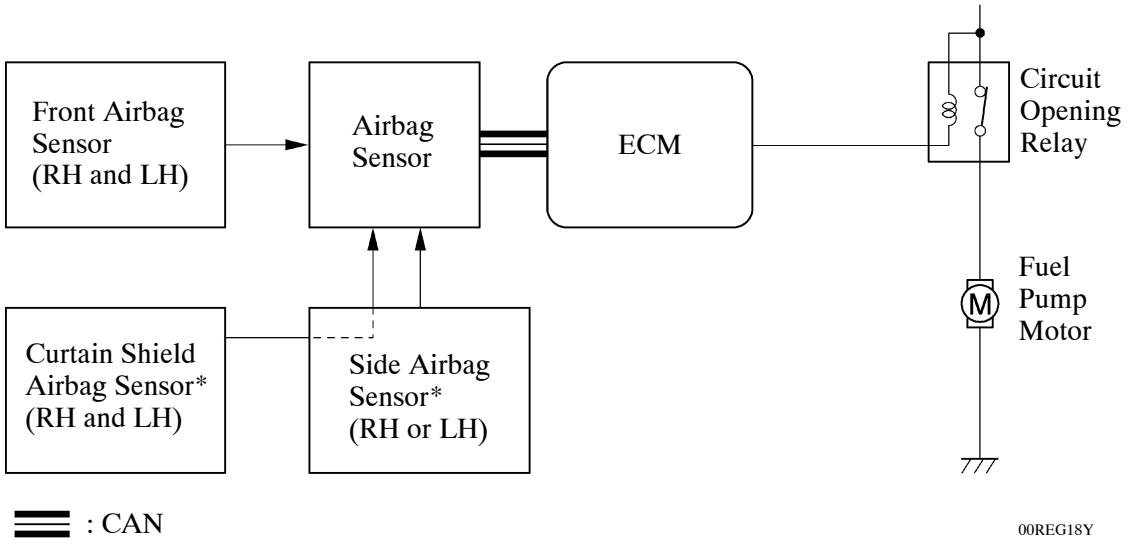


Engine Coolant Temperature Level



Fuel Pump Control

A fuel cut control is used to stop the fuel pump when the SRS airbag is deployed at the front collision. In this system, the airbag deployment signal from the airbag sensor is detected by the ECM, which turns OFF the circuit opening relay.
After the fuel cut control has been activated, turning the ignition switch from OFF to ON cancels the fuel cut control, and the engine can be restarted.



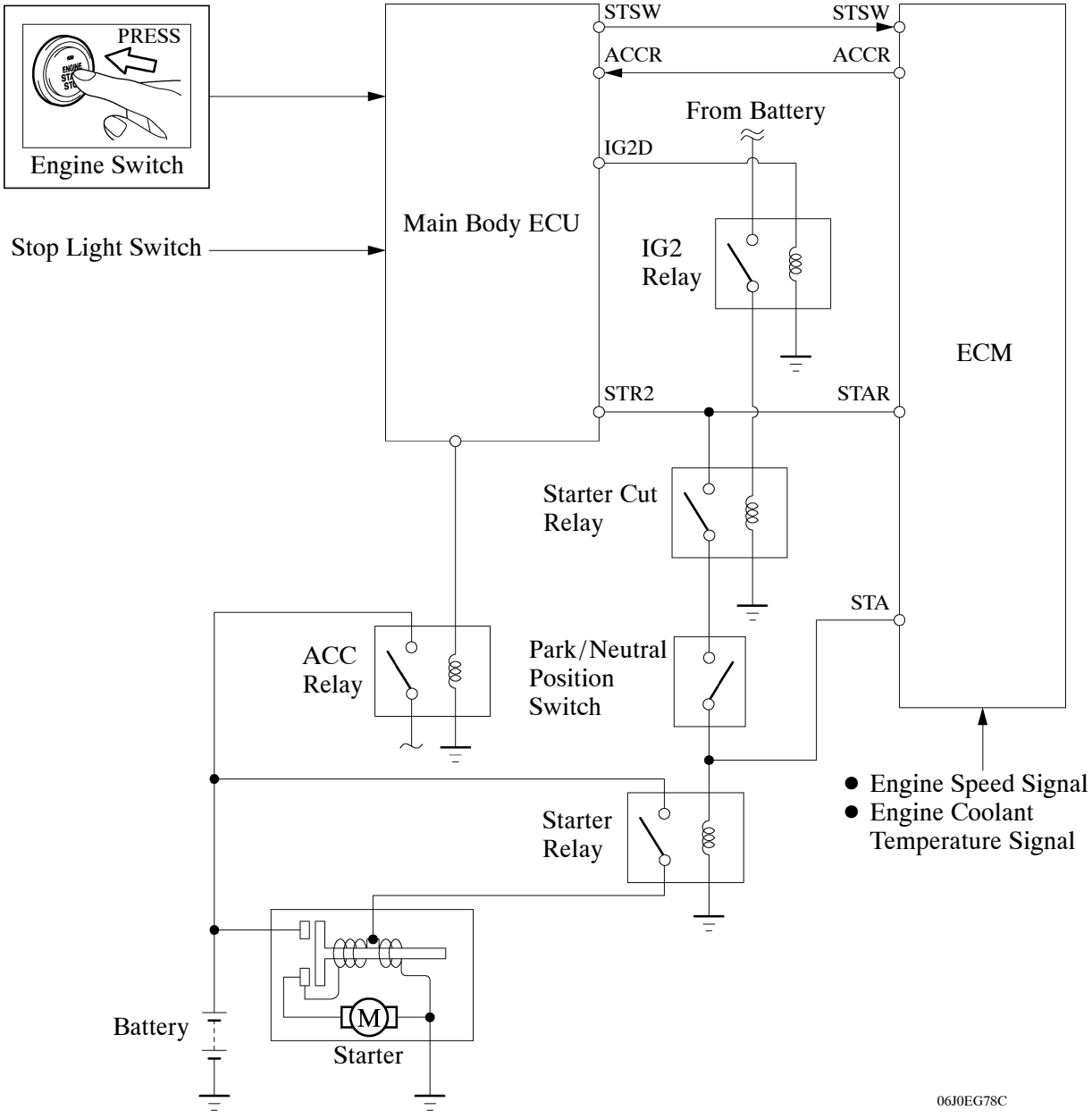
*: Models with SRS side and curtain shield airbags

Starter Control (Models with Smart Key System)

1) General

- 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 the P or N position. This prevents application of the starter for an inadequate length of time and it also prevents the engine from being cranked after it has started.
- When the ECM detects a start signal (STSW) from the main body ECU, it monitors engine speed (NE) and operates the starter until it determines that the engine has started. If the engine has already started, the ECM will not operate the starter, even if the ECM receives the start signal (STSW).

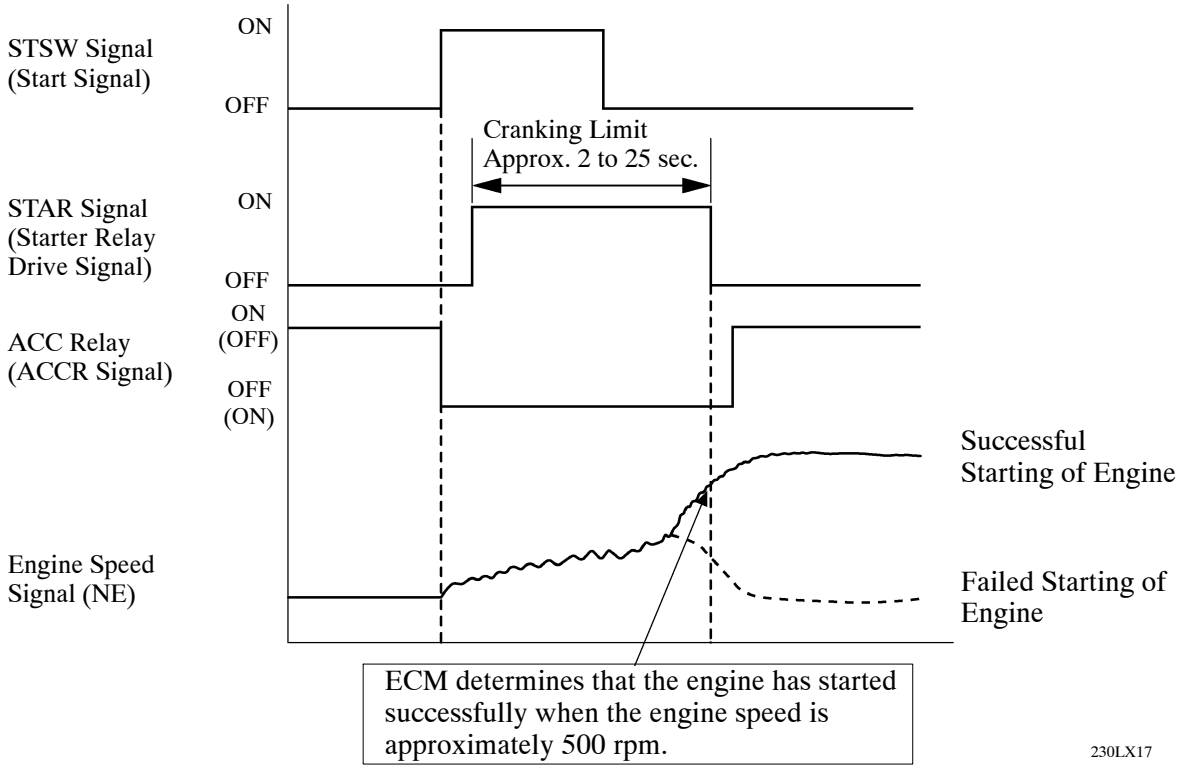
▶ System Diagram ◀



2) Operation

- Before starting occurs, the main body ECU sends power from its IG2D terminal to the IG2 relay, causing the IG2 relay to close. After the IG2 relay closes, it provides power to the coil of the starter cut relay, causing the contacts of the starter cut relay to close, enabling the circuit that operates the starter relay.
- When the ECM detects a start signal (STSW) from the main body ECU, the ECM outputs a starter relay drive signal (STAR). The signal goes through the starter cut relay and the park/neutral position switch to the starter relay. The starter relay activates the starter when it receives this signal.
- If the starter relay drive signal (STAR) cannot be output because the power supplied to the ECM is low, the main body ECU outputs the starter relay drive signal (STR2) instead to help actuate the starter.
- When the ECM detects a start signal (STSW) from the main body ECU, the ECM also outputs an ACC-cut request signal (ACCR) to the main body ECU.
- The ACCR signal instructs the main body ECU to turn off the ACC relay, in order to prevent accessory light flickering from occurring while cranking.
- After the engine speed rises above approximately 500 rpm, the ECM determines that the engine has started and stops the output of the STAR signal. This causes starter operation to stop and the main body ECU to turn on the ACC relay.
- If the engine does not start, the starter operates for a length of time that is based on coolant temperature. This can range from 25 seconds at lower temperatures to 2 seconds when the engine is at operating temperature.
- This system has the following safety features:
  - While the engine is running, the starter cannot operate.
  - The starter will stop operating once the engine has started, even if the start switch remains depressed.
  - Starter operation is limited to a maximum of 30 seconds to protect the starter motor.
  - The starter will stop if the ECM cannot detect an engine speed signal (NE) while the starter is operating.

▶ Timing Chart ◀



EVAP (Evaporative Emission) Control System

1) General

The EVAP (evaporative emission) control system prevents the vapor gas 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 with the canister pump module.
- The canister filter has been provided on the fresh air line. This canister filter is maintenance-free.
- The following are the typical conditions for enabling an EVAP leak check:

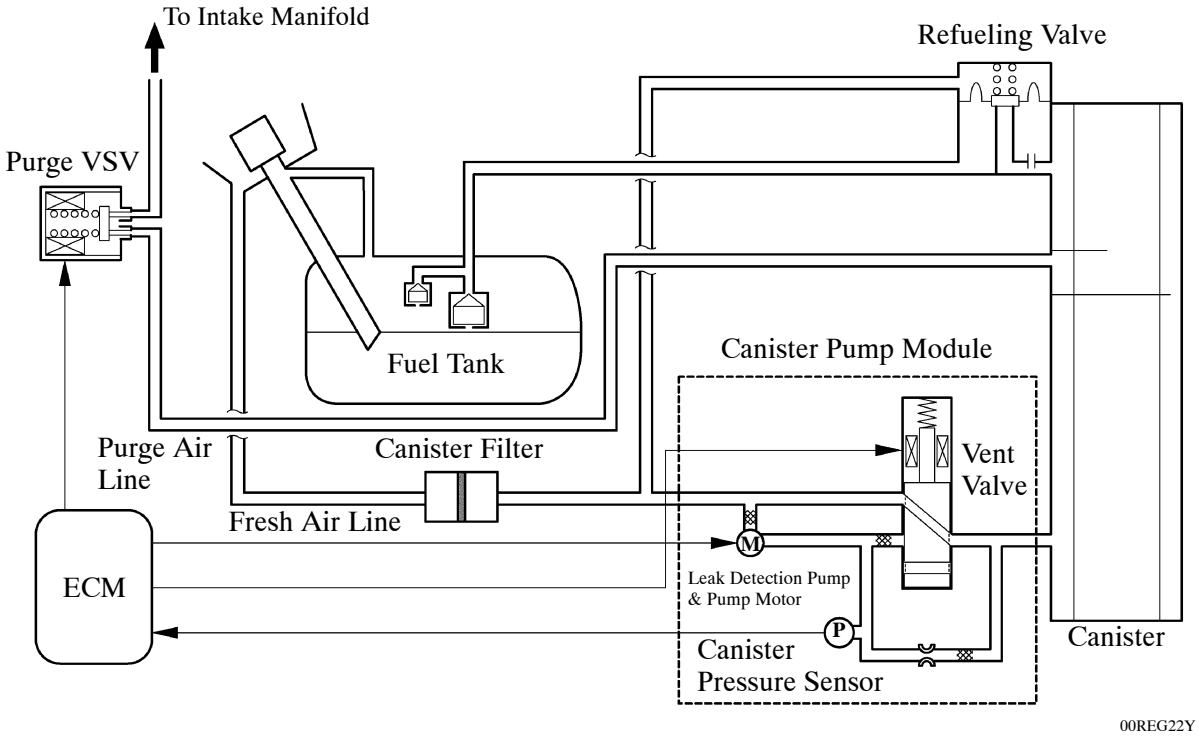
Typical Enabling Condition	● Five hours have elapsed after the engine has been turned OFF*. ● Altitude: Below 2400 m (8000 feet) ● Battery voltage: 10.5 V or more ● Ignition switch: OFF ● Engine coolant temperature: 4.4 to 35°C (40 to 95°F) ● Intake air temperature: 4.4 to 35°C (40 to 95°F)

*: 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.

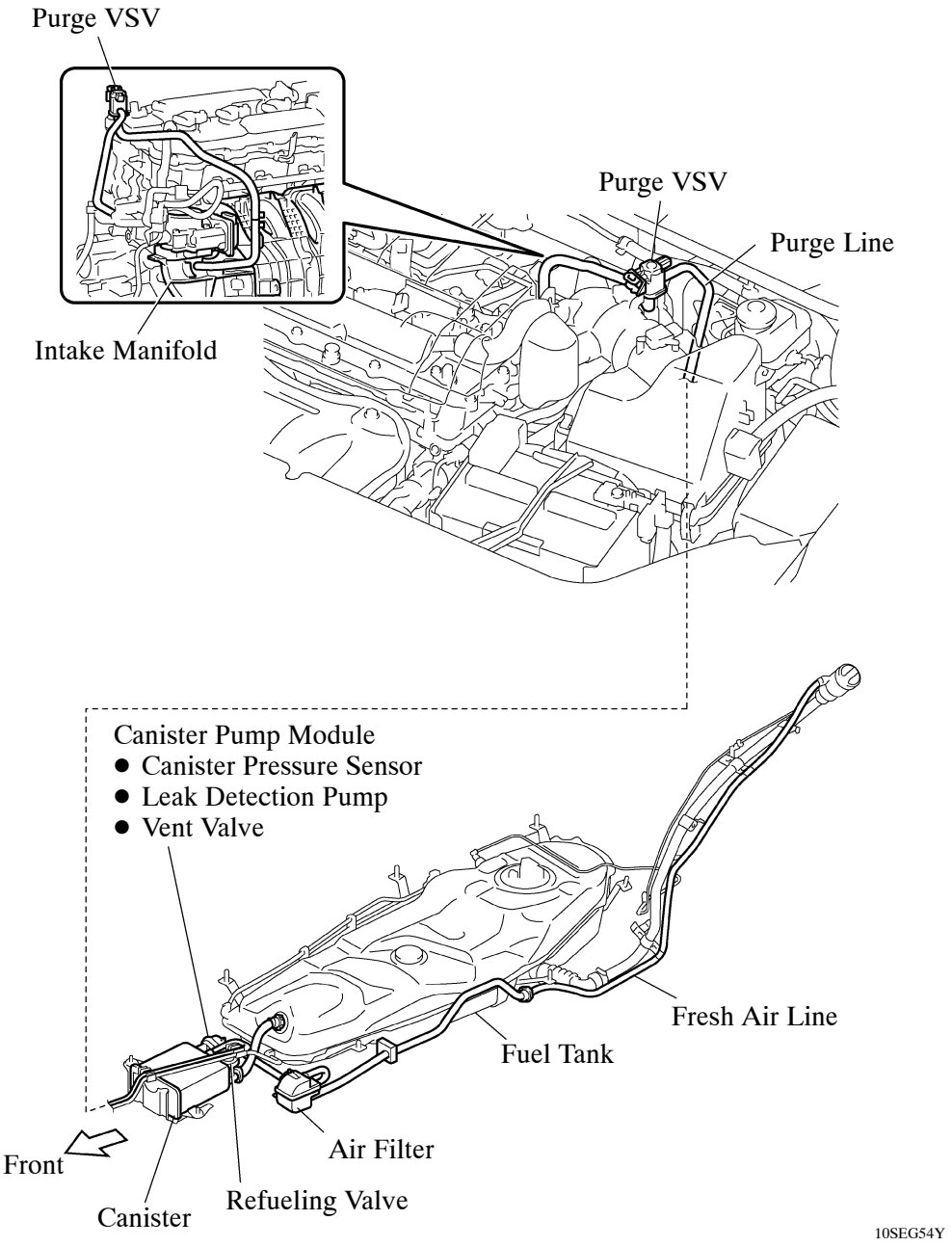
Service Tip

- 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 RAV4 Repair Manual (Pub. No. RM10S0U).

2) System Diagram



3) Layout of Main Components



4) Function of Main Components

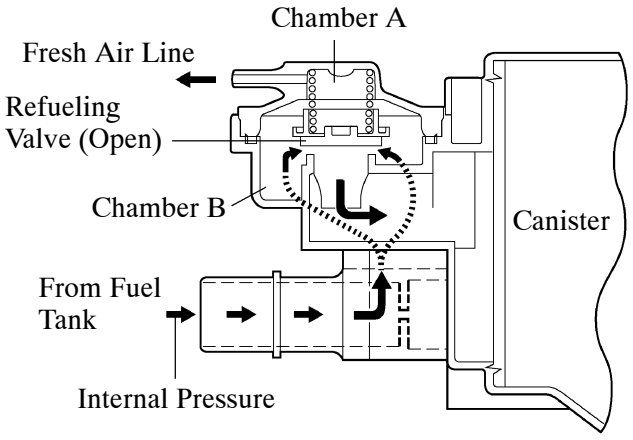
Component		Function
Canister		Contains activated charcoal to absorb the vapor gas created in the fuel tank.
Refueling Valve		Controls the flow rate of the vapor gas from the fuel tank to the canister when the system is purging or during refueling.
	Restrictor Passage	Prevents a large amount of vacuum during purge operation or system monitoring operation from affecting the pressure in the fuel tank.
Fresh Air Line		Fresh air goes into the canister and the cleaned drain air goes out into the atmosphere.
Canister Pump Module	Vent Valve	Opens and closes the fresh air line in accordance with the signals from the ECM.
	Leak Detection Pump	Applies vacuum pressure to the EVAP control system in accordance with the signals from the ECM.
	Canister Pressure Sensor	Detects the pressure in the EVAP control system and sends the signals to the ECM.
Purge VSV		Opens in accordance with the signals from the ECM when the system is purging, in order to send the vapor gas that has been absorbed by the canister into the intake manifold. In system monitoring mode, this valve controls the introduction of the vacuum into the fuel tank.
Canister Filter		Prevents dust and debris in the fresh air from entering the system.
ECM		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.

5) Construction and Operation

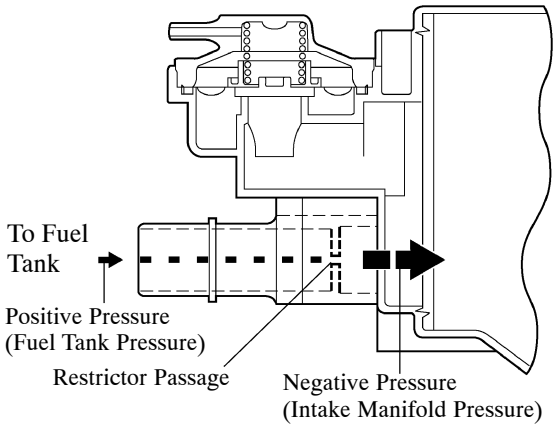
a. Refueling Valve

The refueling valve consists of chamber A, chamber B, and a 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 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.



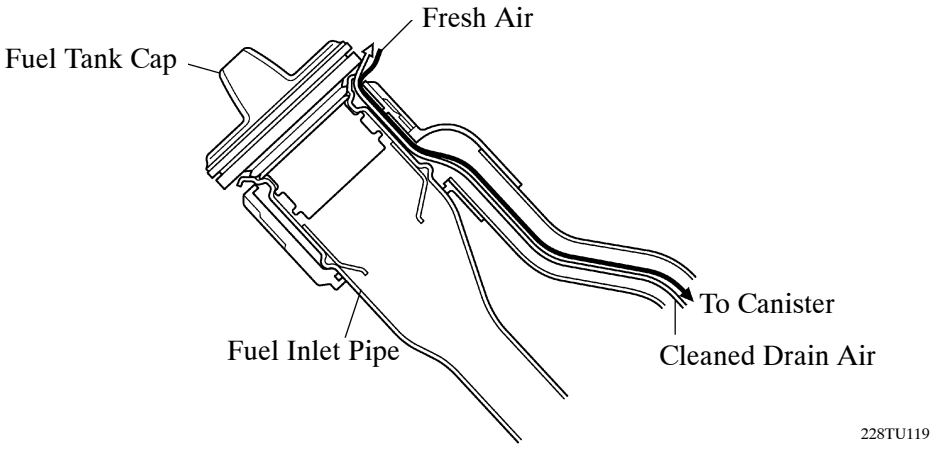
During Refueling 285EG76



During Purge Operation or System Monitoring Operation D13N07

b. Fuel Inlet (Fresh Air Line)

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



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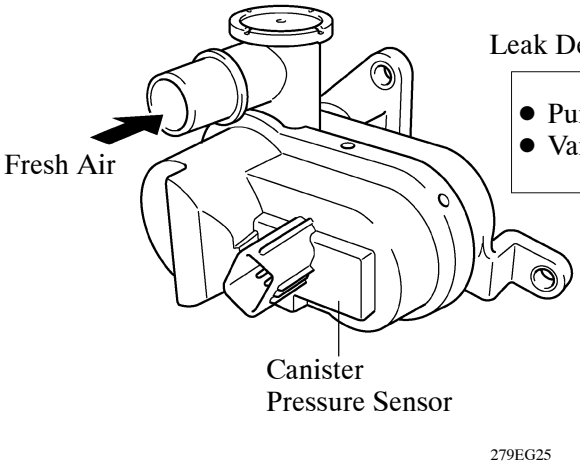
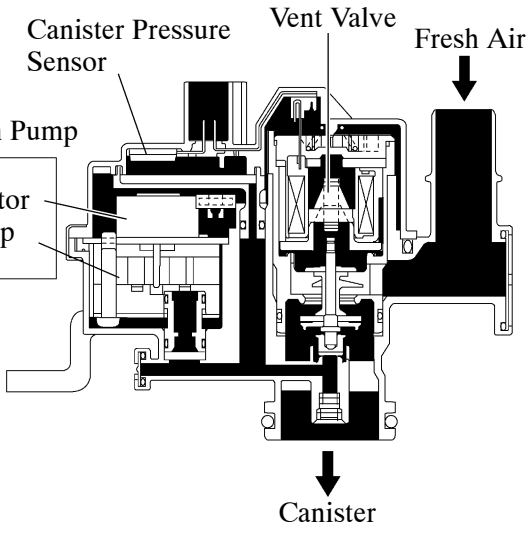
c. Canister Pump Module

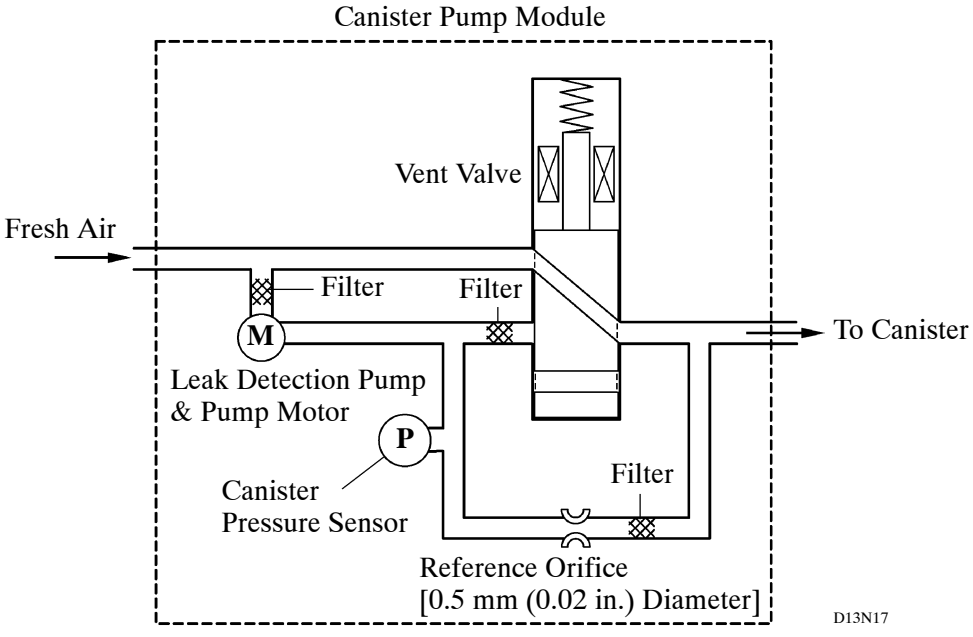
Canister pump module consists of the vent valve, leak detection pump, and canister pressure sensor.

- 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.





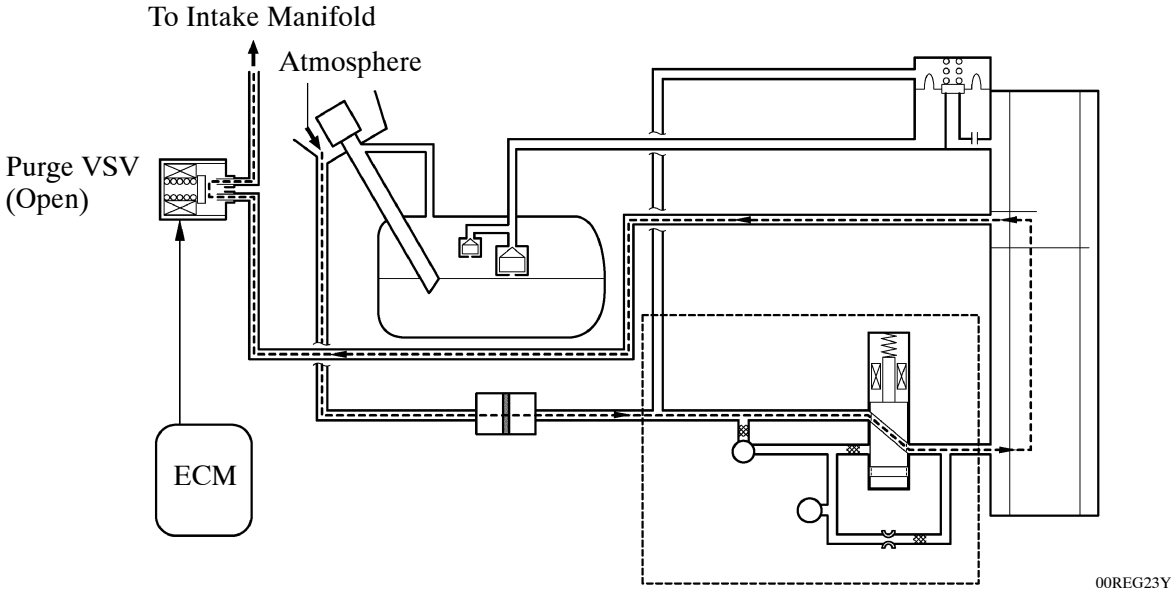
▶ Simple Diagram ◀



6) System Operation

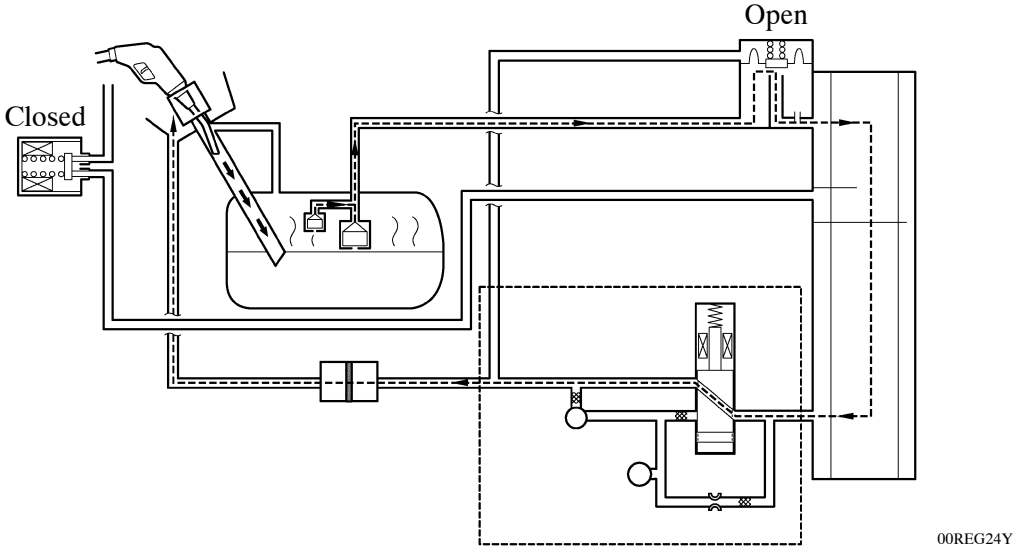
a. Purge Flow Control

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 cycle control of the purge VSV, thus controlling purge flow volume. The purge flow volume is determined by intake manifold pressure and the duty cycle control 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.



b. 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.

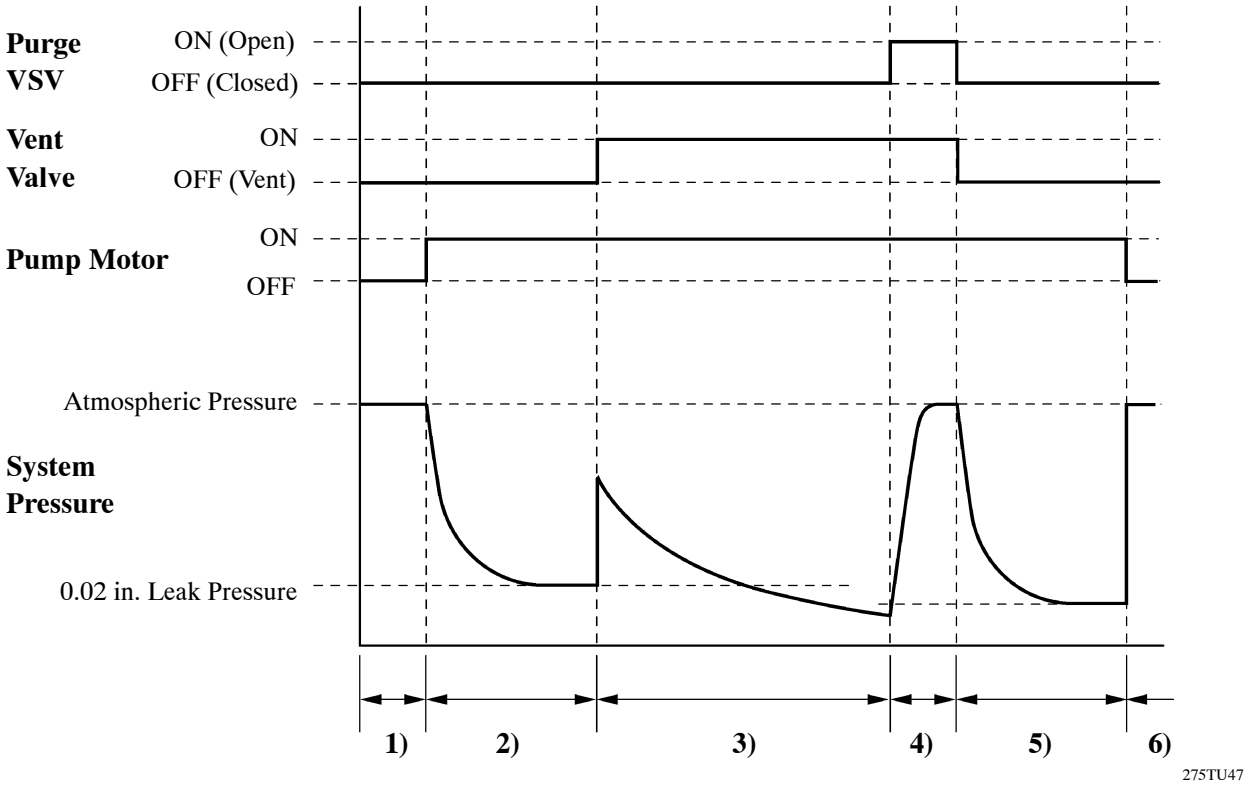


c. EVAP Leak Check

i) General

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

▶ Timing Chart ◀



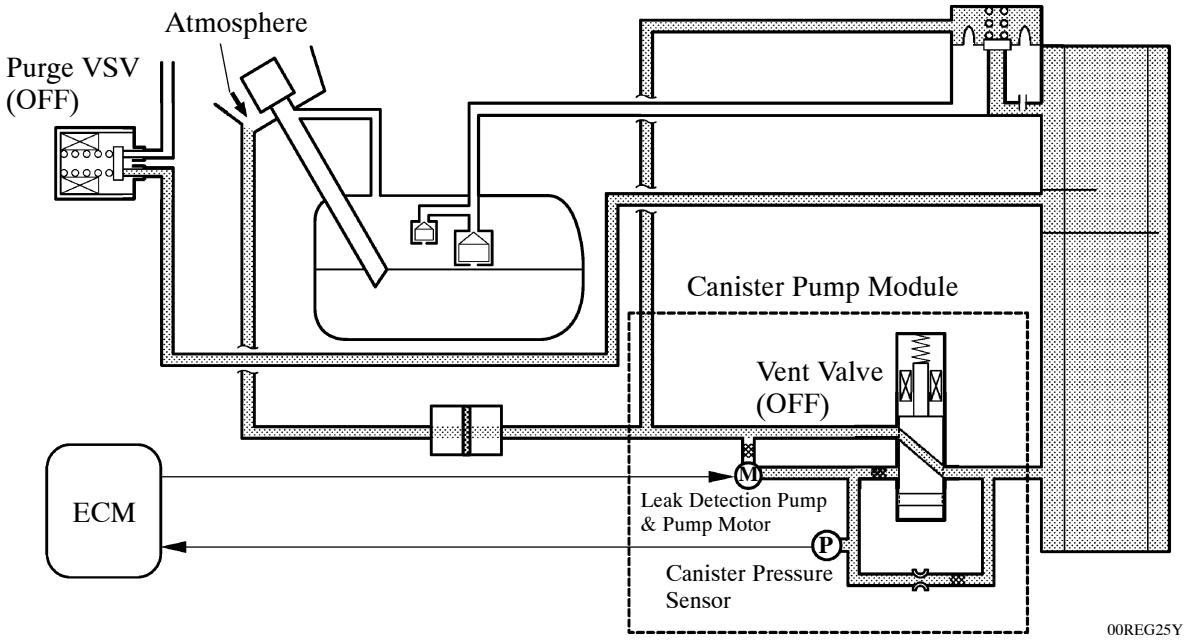
Order	Operation	Description	Time
1)	Atmospheric Pressure Measurement	The ECM turns the vent valve OFF (vent) and measures the EVAP control system pressure to memorize atmospheric pressure.	10 sec.
2)	0.02 in. Leak Pressure Measurement	The leak detection pump creates negative pressure (vacuum) through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

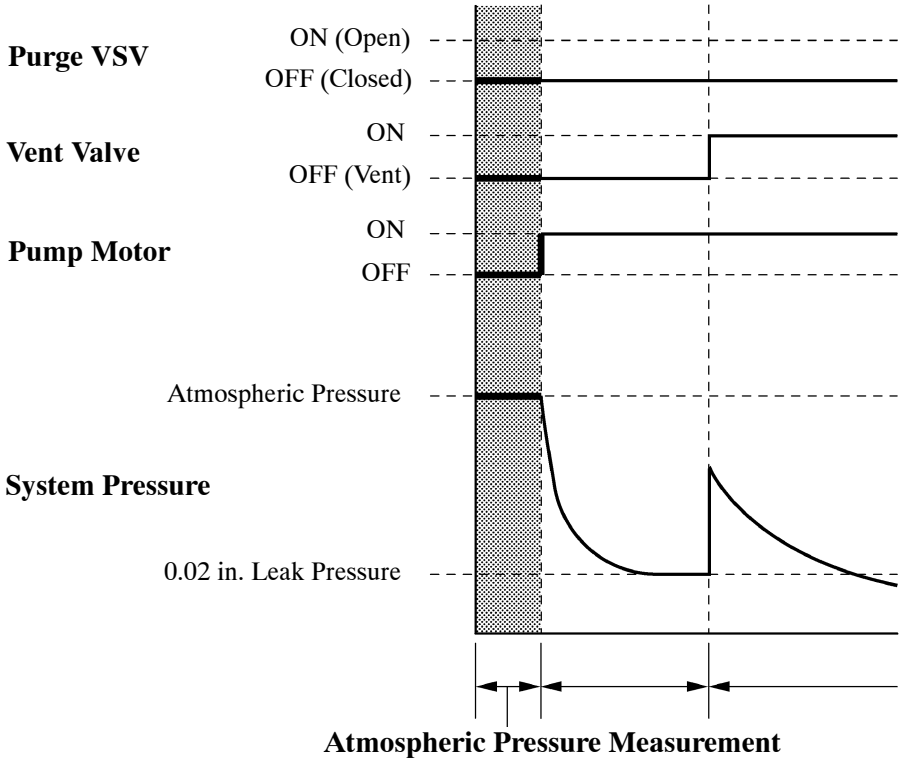
ii) Atmospheric Pressure Measurement

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.

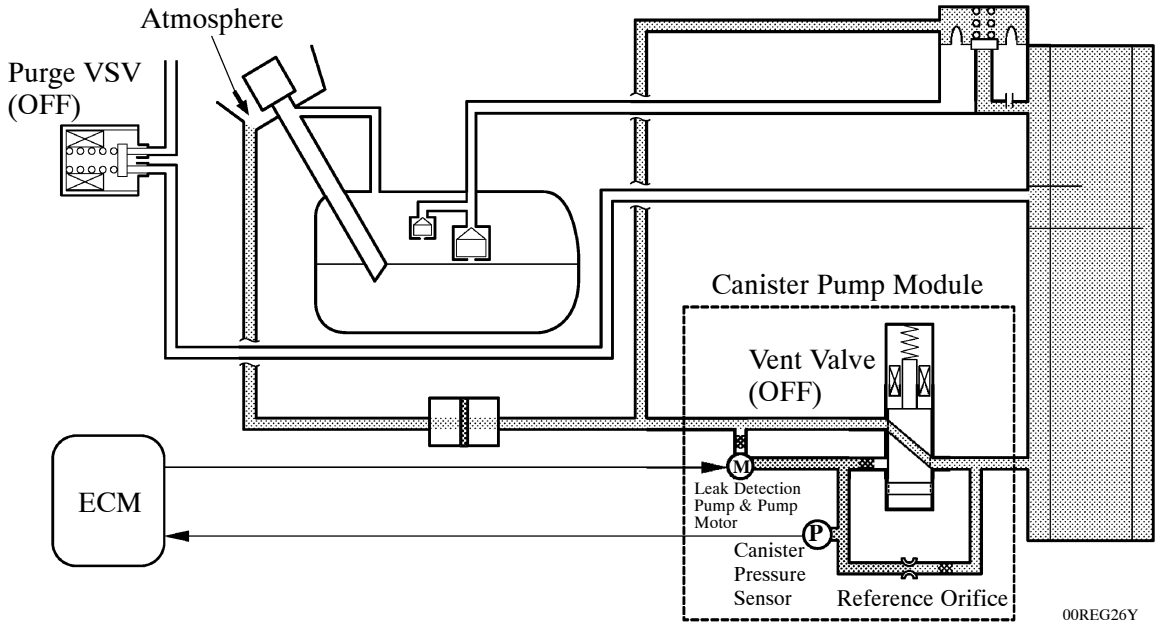


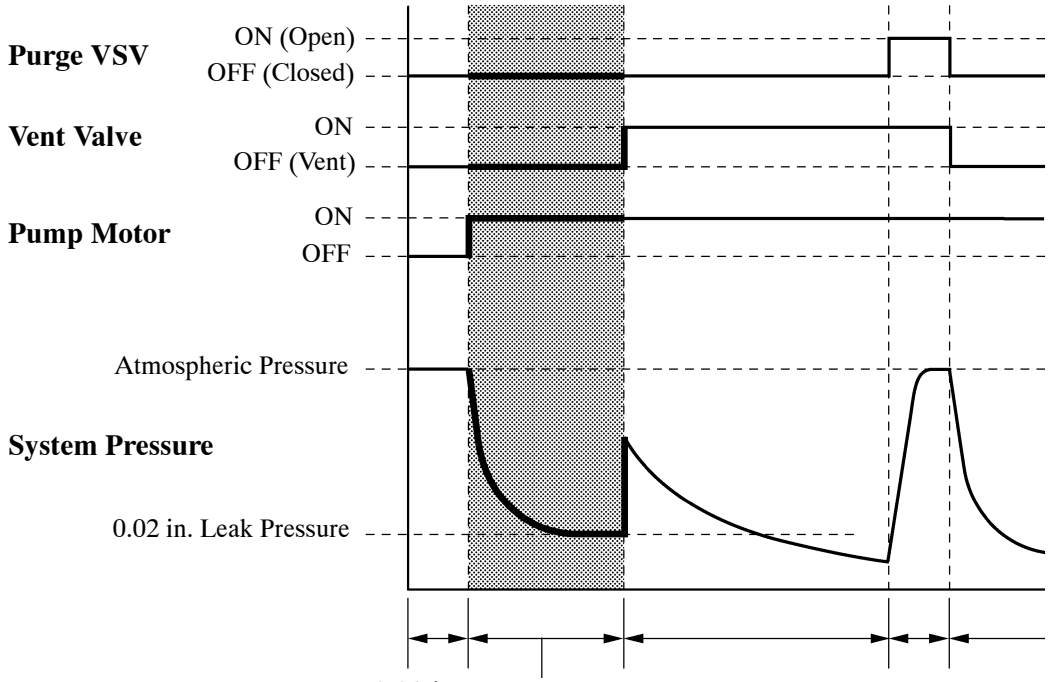


Atmospheric Pressure Measurement D13N22

iii) 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 the 0.02 in. leak pressure due to the atmospheric pressure that enters through the 0.02 in. diameter reference orifice.
3) The ECM compares the logic value with this pressure, and stores it as 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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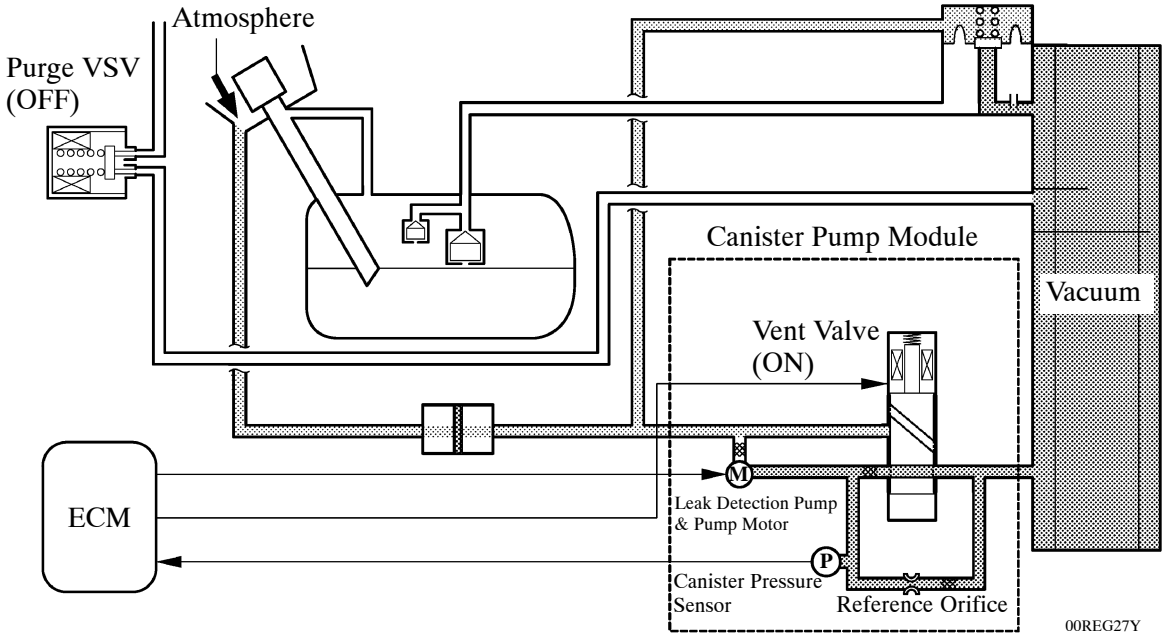
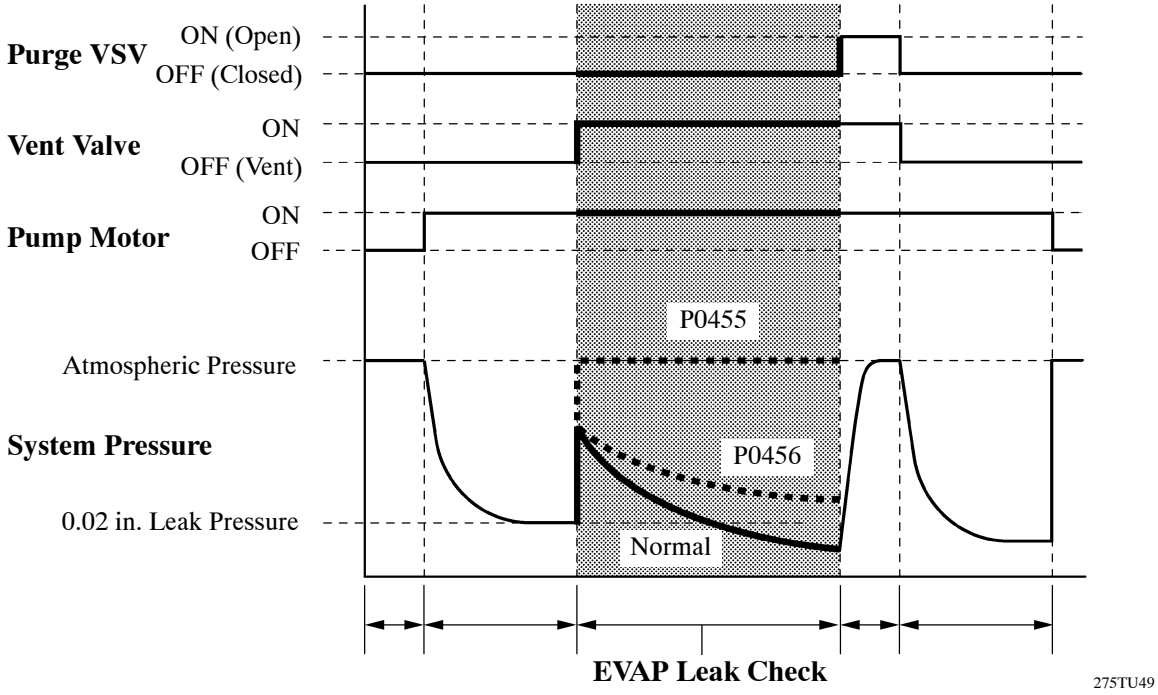
iv) EVAP Leak Check

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.



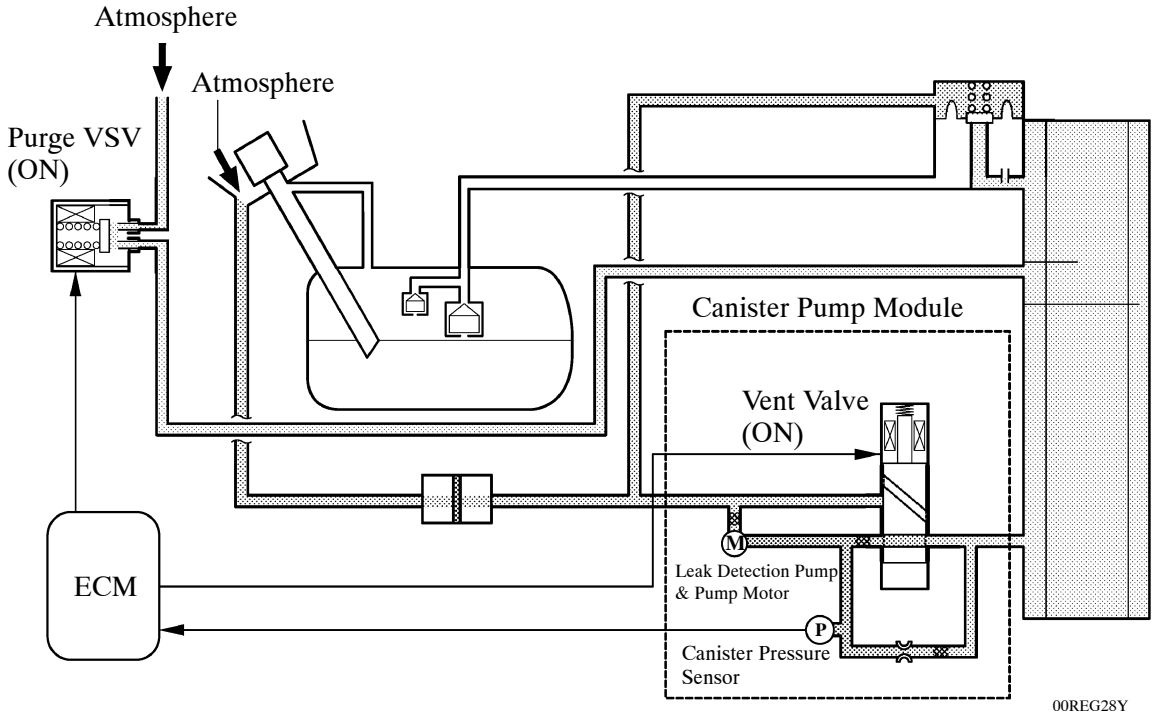


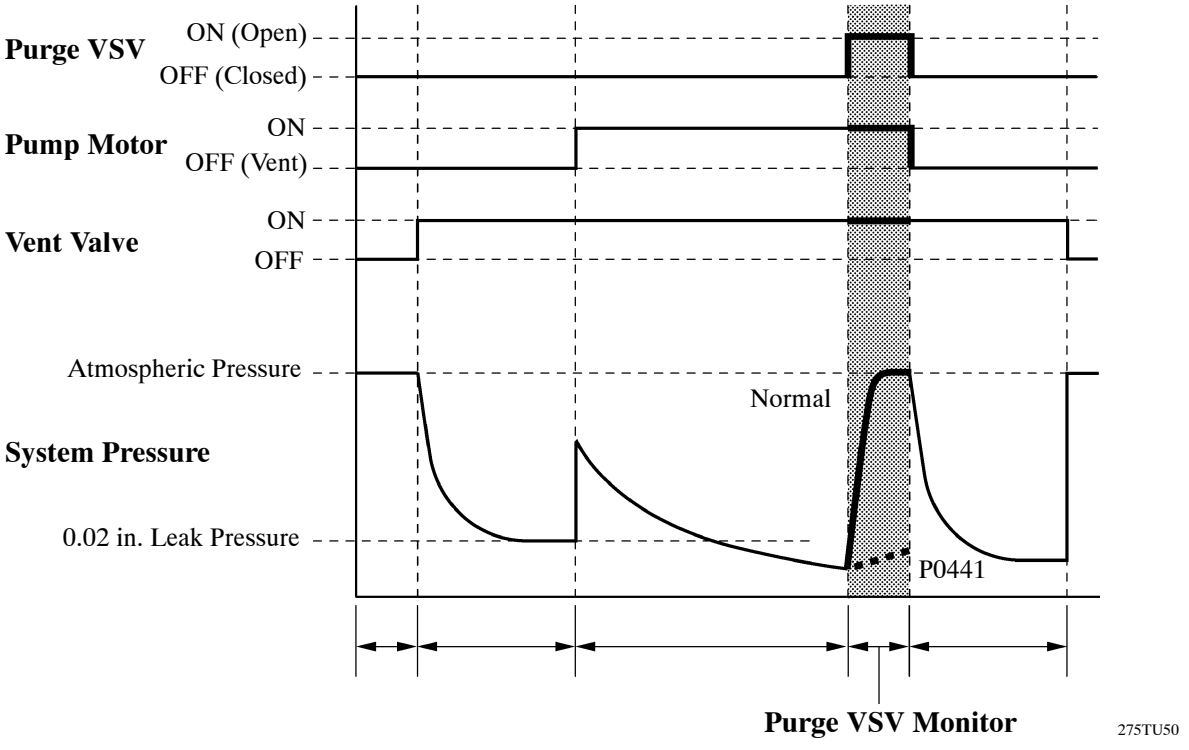
v) Purge VSV Monitor

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.

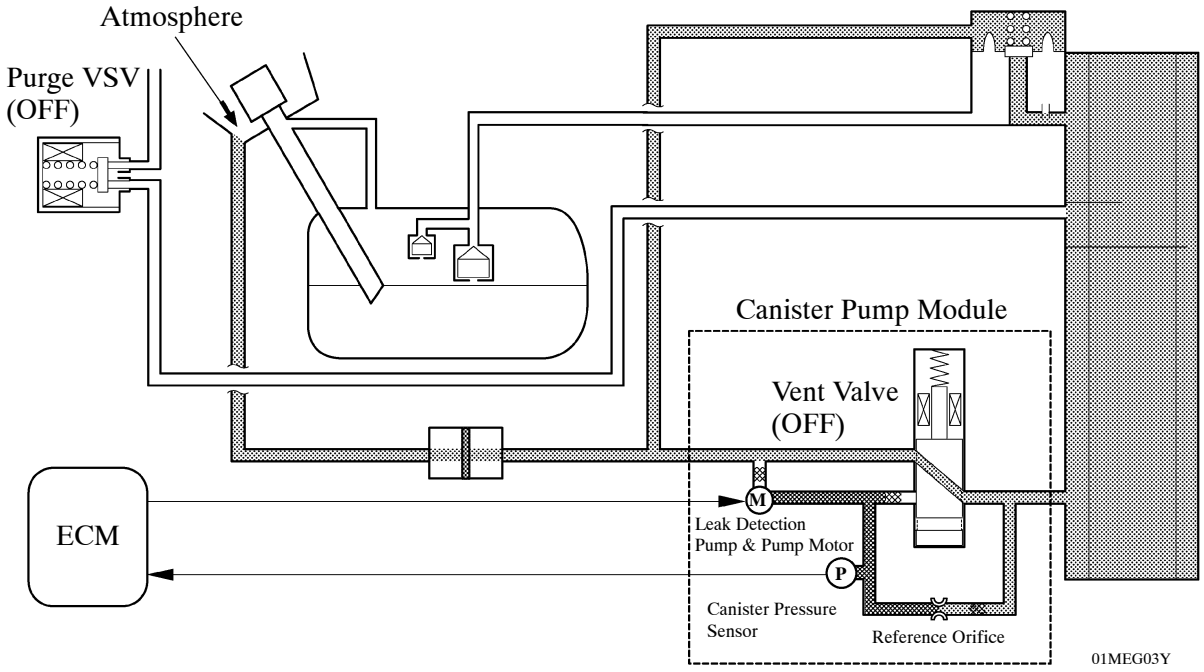
3) If the pressure is out of the normal range, the ECM will stop the purge VSV monitor and store DTC P0441 in its memory.

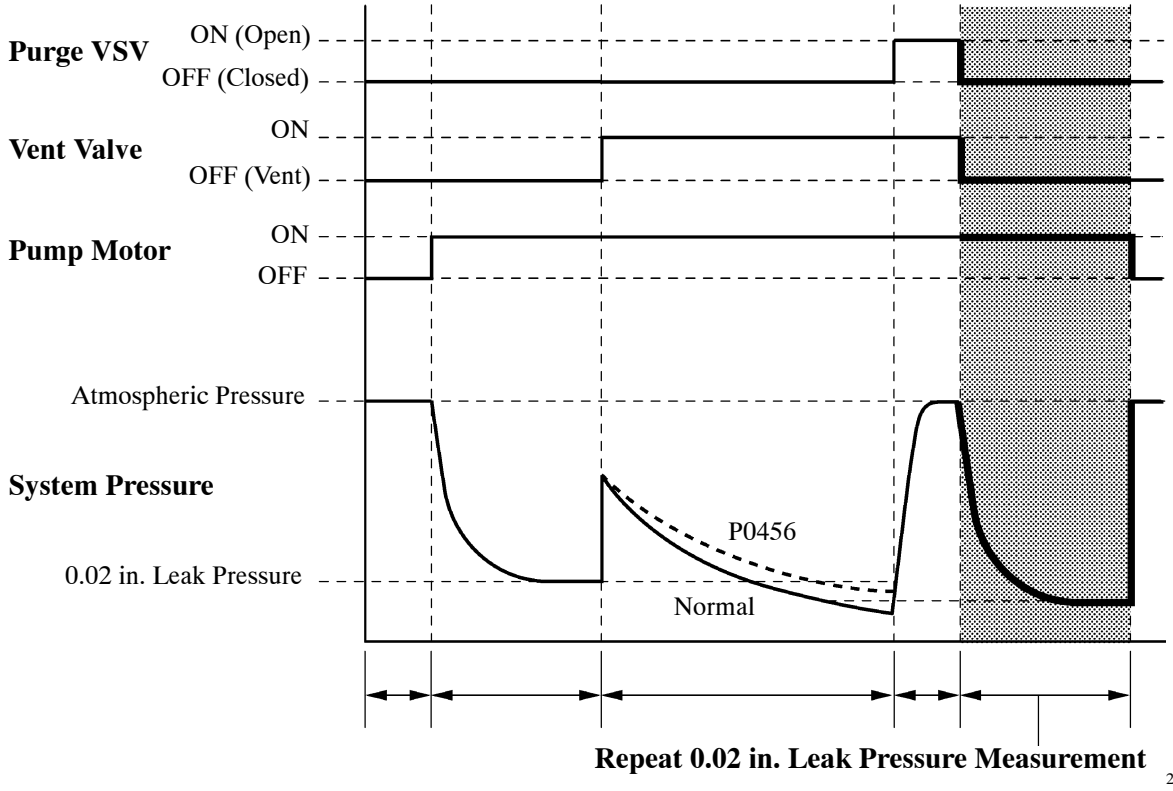




vi) Repeat 0.02 in. Leak Pressure Measurement

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.





Diagnosis

- When the ECM detects a malfunction, it 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.
- A permanent DTC is used for the DTCs associated with the illumination of the MIL. The permanent DTCs can not be cleared by using the Techstream, disconnecting the battery terminal, or removing the EFI fuse.
- For details of the diagnosis and method to clear the DTCs, refer to the 2009 RAV4 Repair Manual (Pub No. RM10S0U).

Fail-safe

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 2009 RAV4 Repair Manual (Pub. No. RM10S0U).

■U140F AND U241E AUTOMATIC TRANSAXLES

1. General

- The U140F and U241E 4-speed automatic transaxles are carried over on the models with the 2AR-FE engine. The basic construction and operation are the same as that of the previous models.
- The differential gear ratio has been changed.

▶ Specifications (U140F Automatic Transaxle) ◀

Model		’09 RAV4	’08 RAV4
Transaxle Type		U140F	←
Engine Type		2AR-FE	2AZ-FE
Drive Type		4WD	←
Gear Ratio*1	1st	3.938	←
	2nd	2.194	←
	3rd	1.411	←
	4th	1.019	←
	Reverse	3.141	←
Differential Gear Ratio		2.814	3.080
Fluid Capacity	Liters (US qts, Imp. qts)	8.1 (8.56, 7.13)	←
Fluid Type		Toyota Genuine ATF WS	←
Weight (Reference)*2	kg (lb)	94.9 (208.8)	98.0 (215.6)

*1: Counter gear ratio included
*2: Weight shows the figure with the fluid fully filled.

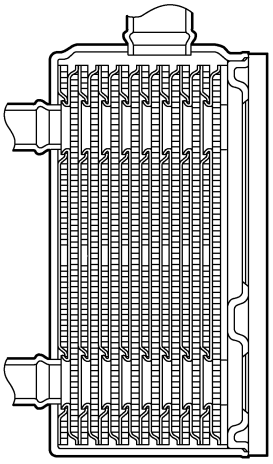
▶ Specifications (U241E Automatic Transaxle) ◀

Model		’09 RAV4	’08 RAV4
Transaxle Type		U241E	←
Engine Type		2AR-FE	2AZ-FE
Drive Type		2WD	←
Gear Ratio*1	1st	3.943	←
	2nd	2.197	←
	3rd	1.413	←
	4th	1.020	←
	Reverse	3.145	←
Differential Gear Ratio		2.740	2.923
Fluid Capacity	Liters (US qts, Imp. qts)	8.1 (8.56, 7.13)	←
Fluid Type		Toyota Genuine ATF WS	←
Weight (Reference)*2	kg (lb)	89.1 (196.0)	89.0 (195.8)

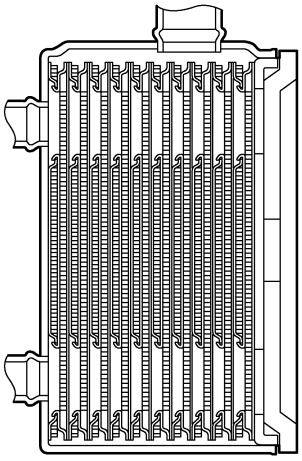
*1: Counter gear ratio included
*2: Weight shows the figure with the fluid fully filled.

2. ATF Warmer

A compact and lightweight ATF warmer with superior cooling performance is used.


10SCH001Y

’09 RAV4


10SCH002Y

’08 RAV4

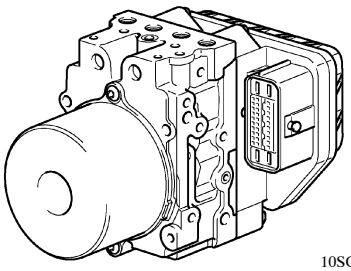
▶ Specifications ◀

Model		’09 RAV4	’08 RAV4
Core Type		Multi Plate Water Cooling	←
Core Size	mm (in.)	90.0 (3.54) × 8	90.0 (3.54) × 10
Fluid Capacity	Liters (US qts, Imp. qts)	0.07 (0.07, 0.06)	0.1 (0.11, 0.09)
Weight (Dry)	kg (lb)	0.44 (0.97)	0.52 (1.14)

■ BRAKE CONTROL SYSTEM

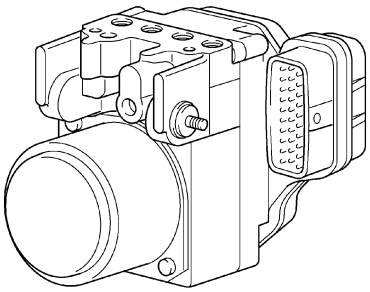
1. Brake Actuator

- A compact and lightweight brake actuator is used. The basic construction and operation are the same as that of the previous models.
- The motor relay and motor cut relay are integrated in the skid control ECU.



10SCH004Y

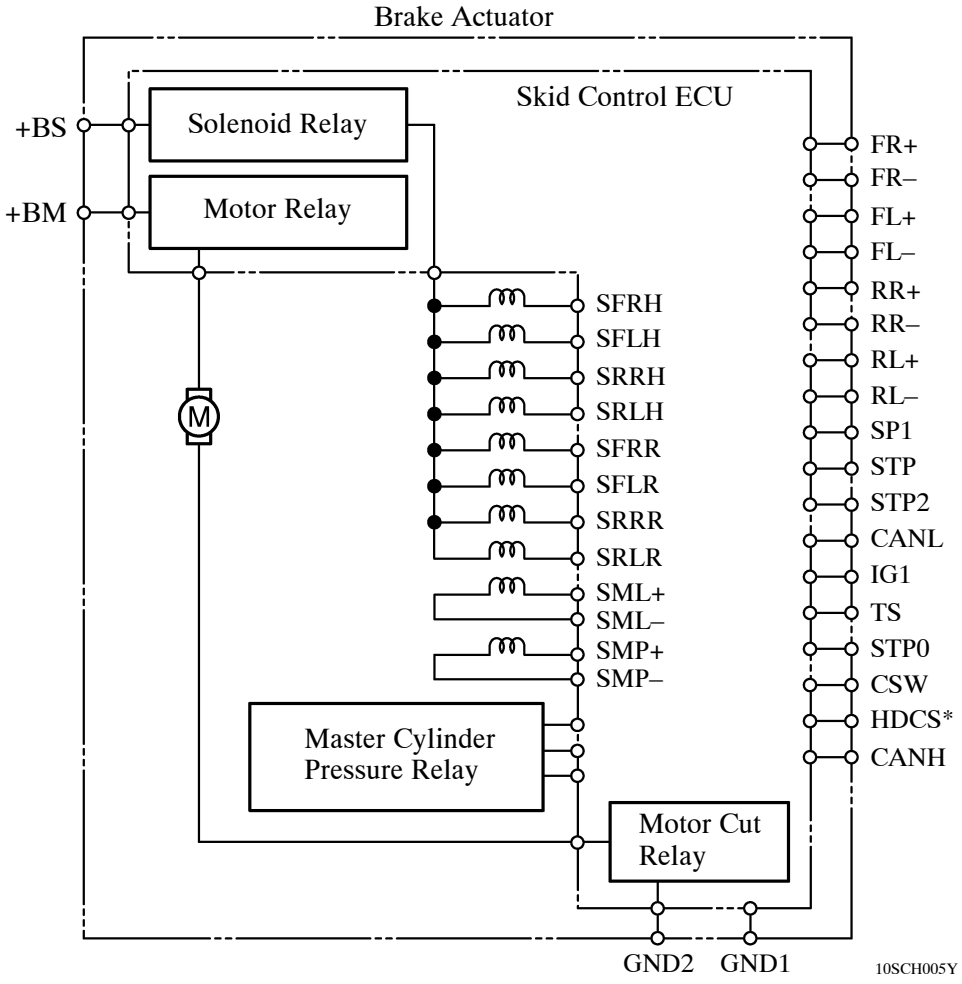
'09 RAV4



01MCH29Y

'08 RAV4

▶ Electric Circuit Diagram ◀

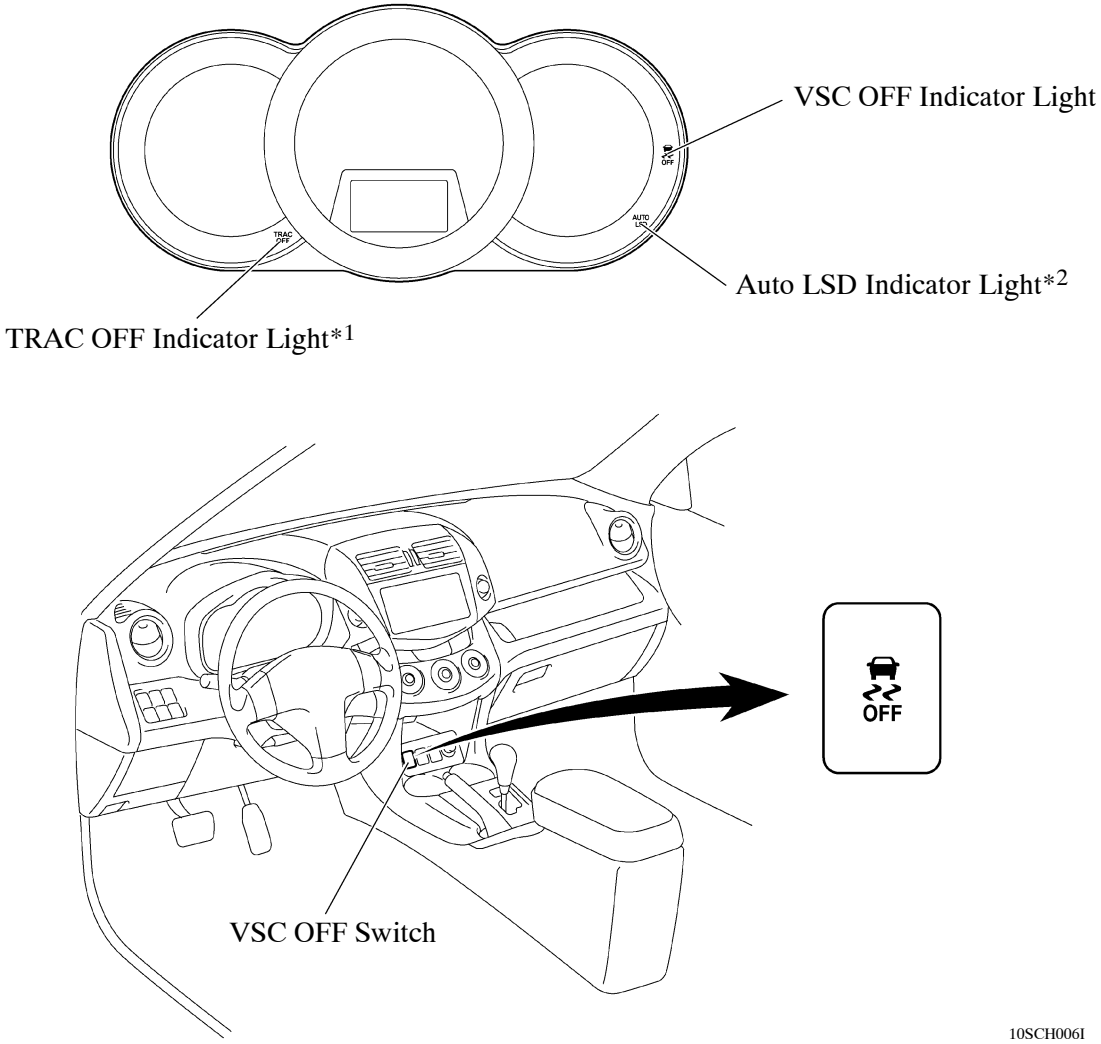


*: Models with downhill assist control

2. VSC OFF Switch

General

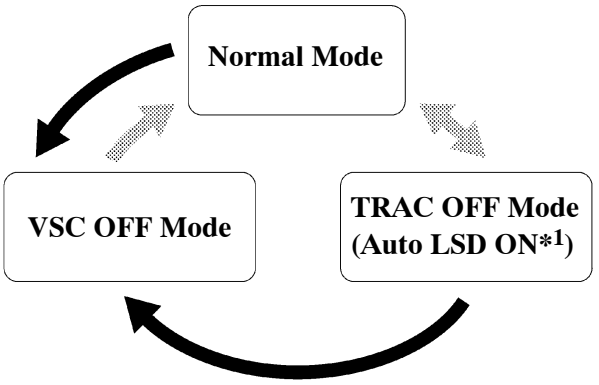
A VSC OFF switch is used. This switch can stop the operation of the VSC and TRAC functions. While the vehicle is running off the shoulder of a road or running on a dirt road, the switch stops the engine output control in order to maintain drive torque. On the 2WD models, the Auto LSD switch has been discontinued. The driver can select the TRAC OFF mode by operating the VSC OFF switch. At the same time, the Auto LSD turns ON, thus enabling the operation of the Auto LSD function.



*1: 4WD models
*2: 2WD models

Function of VSC OFF Switch

- 3 modes can be selected using the VSC OFF switch [Normal mode, TRAC OFF mode (Auto LSD ON*1), VSC OFF mode].
- Briefly pressing the VSC OFF switch in Normal mode selects TRAC OFF mode (Auto LSD ON*1).
- Pressing and holding the VSC OFF switch for 3 seconds or more with the vehicle stopped selects VSC OFF mode, disabling the TRAC, Auto LSD*1 and VSC functions.
- Briefly pressing the VSC OFF switch in TRAC OFF mode (Auto LSD ON*1) or VSC OFF mode or turning the ignition switch (engine switch*2) off returns to Normal mode.



08LCH164Y

: VSC OFF Switch Operation (Briefly press)

: VSC OFF Switch Operation (Press and hold for 3 seconds or more)

*1: 2WD models
*2: Models with smart key system

- The operations of the brake control functions and the illumination states of the respective indicator lights in each mode are as follows:

○: Controllable ×: Not Controllable

Item	Brake Control Function			TRAC OFF Indicator Light*1	Auto LSD Indicator Light*2	VSC OFF Indicator Light
	TRAC	Auto LSD*2	VSC	TRAC OFF 10SCH007Y	AUTO LSD 10SCH008Y	OFF 10SCH009Y
Normal Mode	○	×	○	—	—	—
TRAC OFF Mode (Auto LSD ON)	×	○	○	Light ON	Light ON	Light ON*3
VSC OFF Mode	×	×	×*4	Light ON	—	Light ON

*1: 4WD models
*2: 2WD models
*3: Models with Auto LSD driving at 50 km/h (31 mph) or below
*4: When the vehicle is braking or the yaw rate is large, the VSC will operate even in the VSC OFF mode.

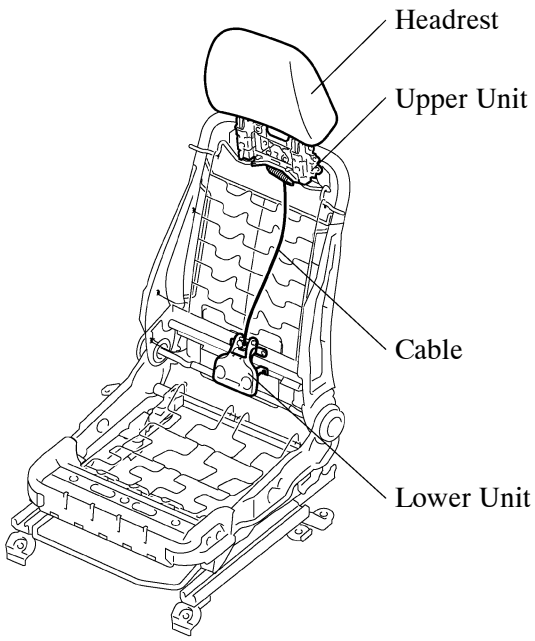
■ EPS (ELECTRIC POWER STEERING)

The EPS ECU of the ’09 RAV4 has the following functions:

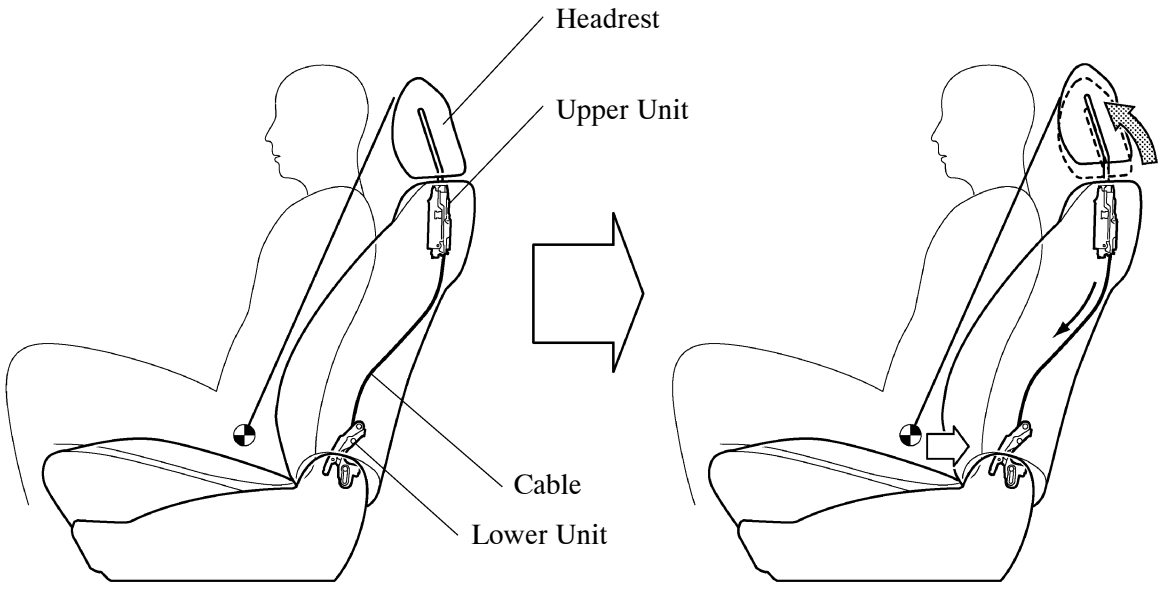
Item	Function	’09 RAV4	’08 RAV4
Basic Control	Calculates the assist current from the steering torque value and the vehicle speed, and actuates the power steering motor.	○	○
Inertia Compensation Control	Ensures the starting movement of the power steering motor when the driver starts to turn the steering wheel.	○	○
Recovery Control	During the short interval between the time the driver fully turns the steering wheel and the time the wheels try to recover, this control assists the recovery force.	○	○
Damper Control	Regulates the amount of assist when the driver turns the steering wheel while driving at high speeds, thus damping the changes in the yaw rate of the vehicle body.	○	○
Battery Voltage Drop Suppression Control	If the battery voltage drops due to a worn battery, this control limits the amperage consumption of the EPS system, thus suppressing the battery voltage drop. This ensures the electric power required for operating the EPS system and prevents the steering assist from stopping.	○	—
System Overheat Protection Control	Estimates the power steering motor temperature based on the amperage and the current duration. If the temperature exceeds the standard, the system limits the amperage to prevent the power steering motor from overheating.	○	○

■ FRONT SEAT

- The active headrest mechanism is used in the front seat headrest.
- Active headrests are provided, which move up and forward almost instantly in the event of a rear-end collision when the force of the occupant body is applied to the seat back and reduce the distance between the occupant's head and the headrest.
- The active headrest consists of the lower unit, cable and upper unit.
  When the lower unit built into the seat back is pressed by the occupant's lumbar as the occupant's body slides down during a rear-end collision, the cable is pulled and the headrest is moved up and forward by the upper unit, reducing the distance between the occupant's head and the headrest.



10SBO002Y



10SBO003Y

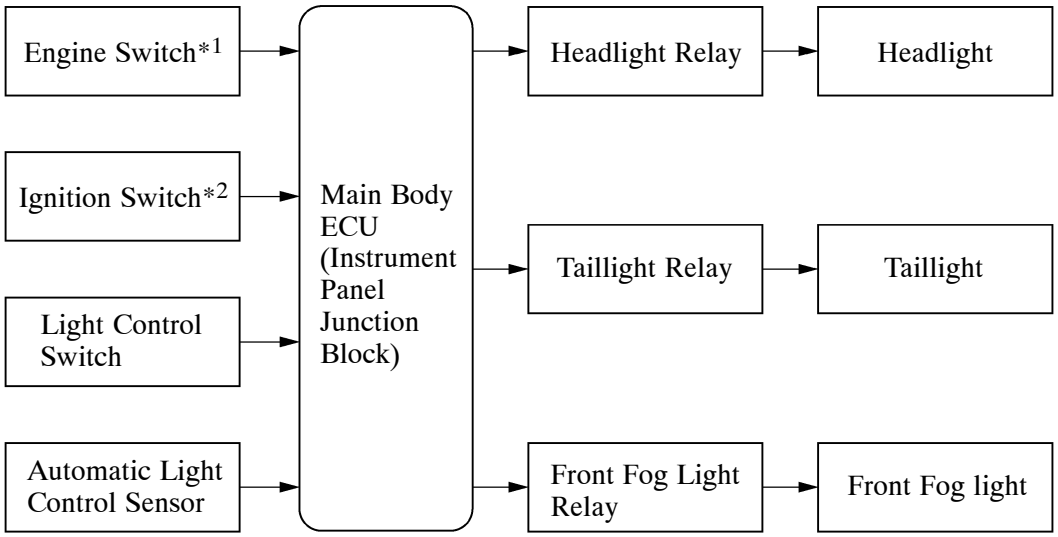
■ LIGHTING

Automatic Light Control System

1) General

- The automatic light control system is used.
- When the light control switch is in the AUTO position, the automatic light control sensor detects the ambient light and automatically turns the headlights, taillights and front fog lights ON or OFF accordingly.
- The automatic light control sensor is integrated with the solar sensor that is used in the automatic air conditioning system.
- This system is controlled by the main body ECU.

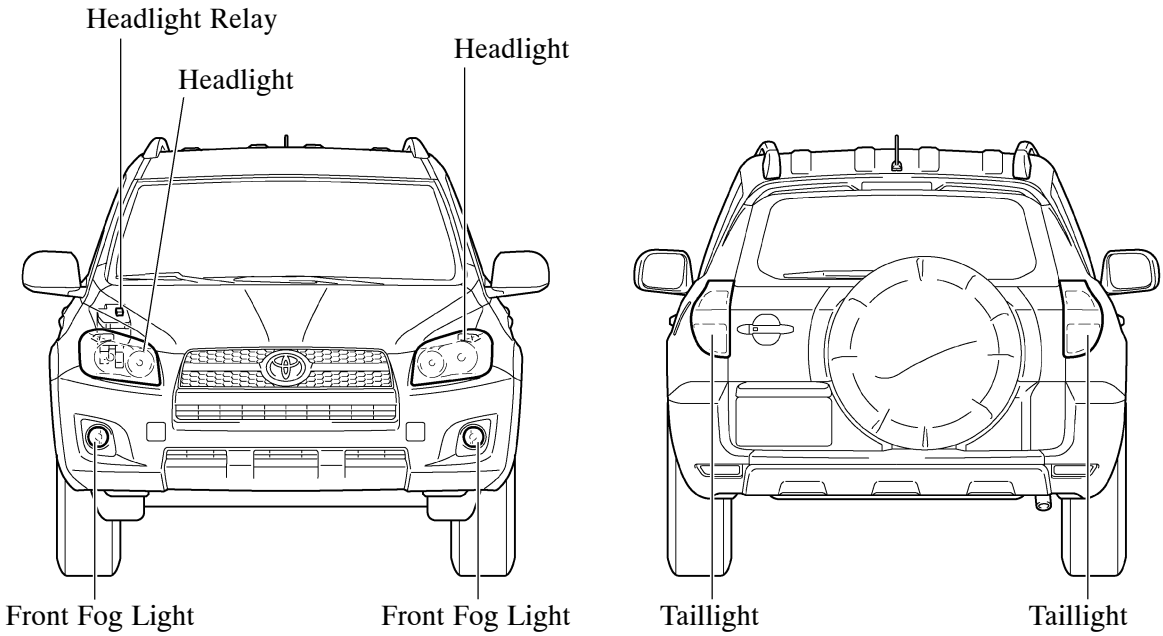
▶ System Diagram ◀

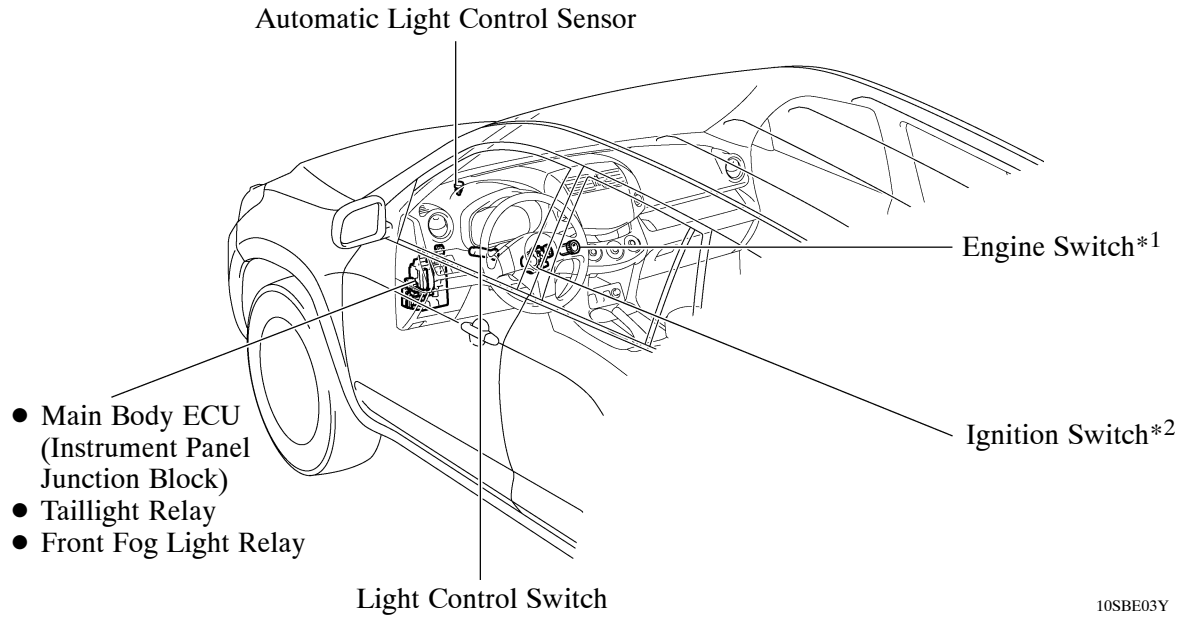


10SBE01Y

*1: Models with smart key system
*2: Models without smart key system

2) Layout of Main Components





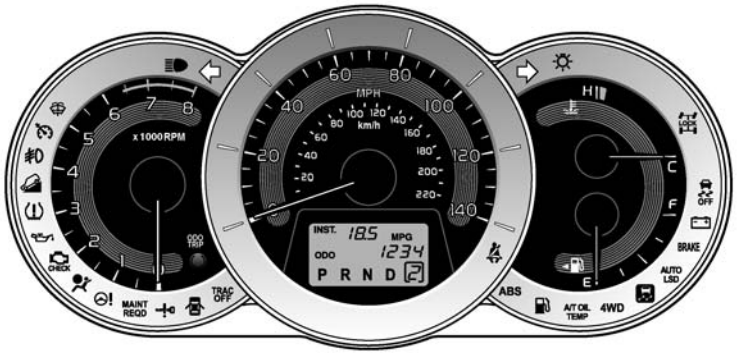
*1: Models with smart key system
*2: Models without smart key system

■METER

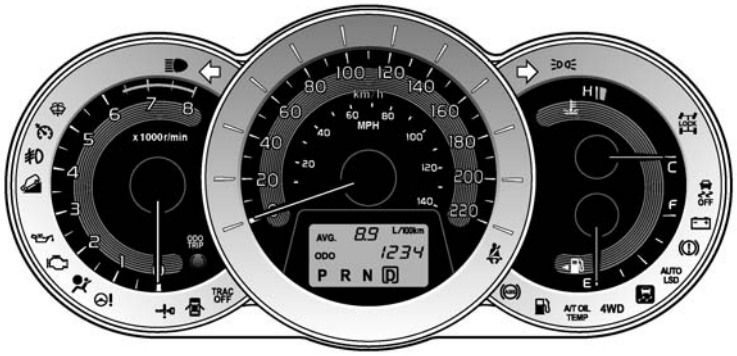
1. General

- The design of the combination meter has been changed.
- The indications for instant fuel consumption and average fuel consumption have been added to the multi-information display.
- The indication size of the shift position indicator has been increased.
- A parking brake unreleased warning function, which sounds the buzzer if the vehicle is driven with the parking brake applied, has been added.
- The following indicator lights have been changed:

Indicator Light \ Model	'09 RAV4	'08 RAV4
Power Steering Warning	 10SBE41Y	P/S 10SBE46Y
Slip	 10SBE42Y	 10SBE47Y
Cruise Main	 10SBE43Y	CRUISE 10SBE48Y
TRAC OFF	 10SBE44Y	—
VSC OFF	 10SBE45Y	—
VSC Warning	—	VSC 10SBE49Y



Models for U.S.A. 10SBE04Y



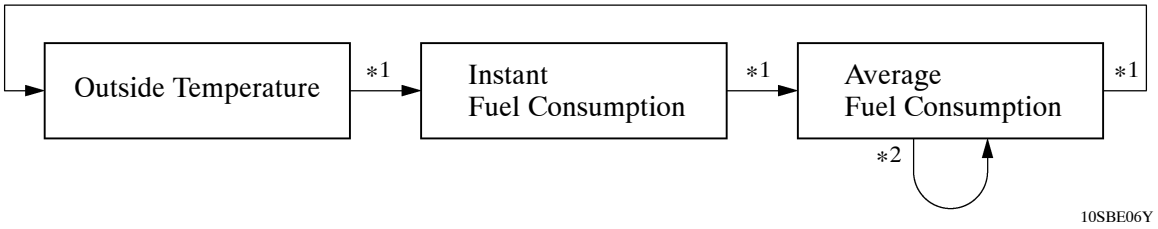
Models for Canada 10SBE05Y

2. Multi-information Display

- Instant fuel consumption and average fuel consumption displays have been added. They appear on the multi-information display.

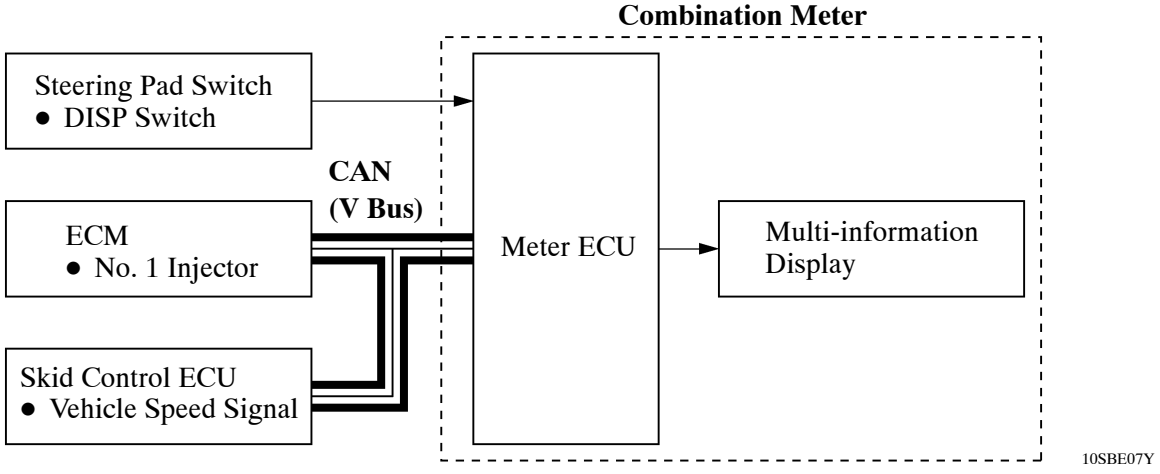
Multi-information Display 10SBE50Y

- The display shown on the multi-information display can be changed with the DISP switch on the steering pad. Each time the driver pushes the DISP switch, the display changes in the following order: outside temperature → instant fuel consumption → average fuel consumption.

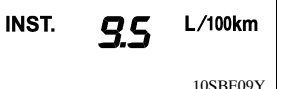
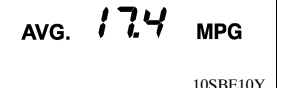


*1: Short press (less than 0.8 seconds)
*2: Long press to reset (0.8 seconds or more)

▶ System Diagram ◀



- The multi-information display has the following features:

Item	Unit	Display Content	Outline
Instant Fuel Consumption	MPG	 10SBE08Y	• Displays the value that has been calculated by the meter ECU, which is based on the driven distance and the fuel consumption volume (fuel injection signal from No. 1 injector), provided that the ignition switch (engine switch*) is changed to ON (IG). • The display updates every time a fuel injection volume is received.
	L/Km	 10SBE09Y	
Average Fuel Consumption	MPG	 10SBE10Y	• Displays the value that has been calculated by the meter ECU, which is based on the driven distance and the fuel consumption volume (fuel injection signal from No. 1 injector). • The value is also reset by pushing the display switch for 0.8 seconds or more. • The display updates every 10 seconds.
	L/Km	 10SBE11Y	

*: Models with smart key system

3. Buzzer

Parking Brake Unreleased Warning Function

When the vehicle reaches a speed of approximately 3 mph (5 km/h) or more while the parking brake is applied, the meter ECU sounds the buzzer to warn the driver that the parking brake is engaged.

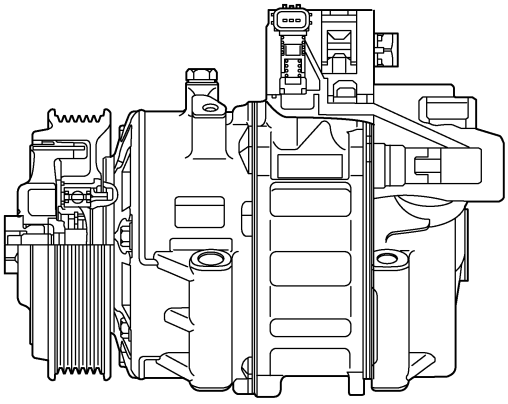
■AIR CONDITIONING

1. General

- A TSE17 type A/C compressor is used for models with the 2AR-FE engine.
- The design of the switches on the automatic control type heater control panel has been changed.

2. A/C Compressor

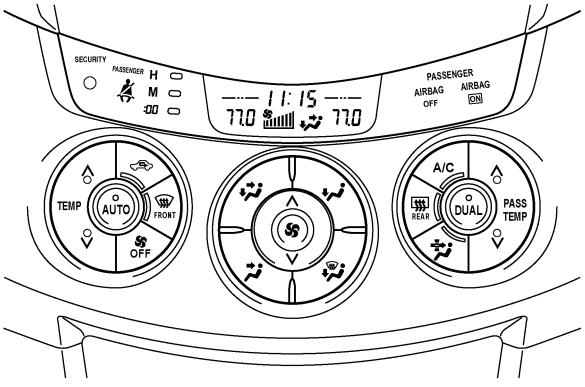
- The TSE17 type A/C compressor has the following features:
  - A refrigerant flow volume sensor is used for calculating the torque of the A/C compressor.
  - A signal from the refrigerant flow volume sensor to the air conditioning amplifier has been added.
  - An oil separator is used in order to reduce the volume of compressor oil that circulates in the system.
  - A variable suction side throtole, which adjusts the size of the refrigerant passage, is used to reduce the noise created during operation.
  - A CS valve is integrated in the control valve in order to quickly discharge the liquid refrigerant that accumulates in the A/C compressor. This suppresses the performance drop during the initial stages of operation even after the vehicle is left parked for a long time.
  - A new, plastic DL type A/C pulley, which is lighter than the previous type, is used.



TSE17 Type A/C Compressor 10SBE12Y

3. Automatic Control Type Heater Control Panel

The design of the switches on the automatic control type heater control panel has been changed.



10SBE13Y

■NAVIGATION SYSTEM WITH AV SYSTEM

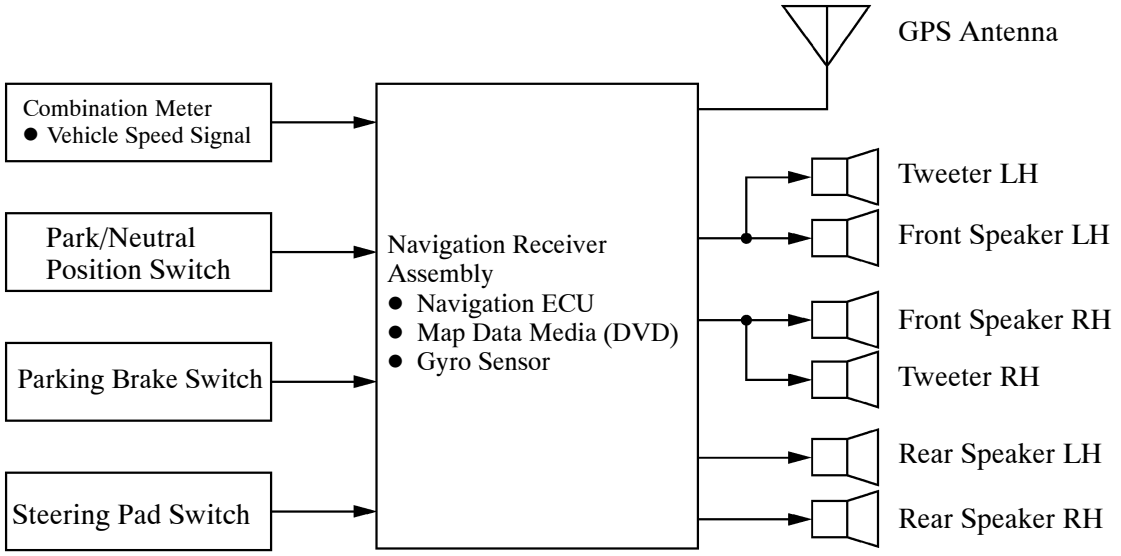
1. General

- A navigation system with AV system is used.
- It uses a wide, 6.5-inch LCD (Liquid Crystal Display) screen with a pressure sensitive touch panel for improved ease of use.
- GPS (Global Positioning System) voice navigation is used.

▶ Specifications ◀

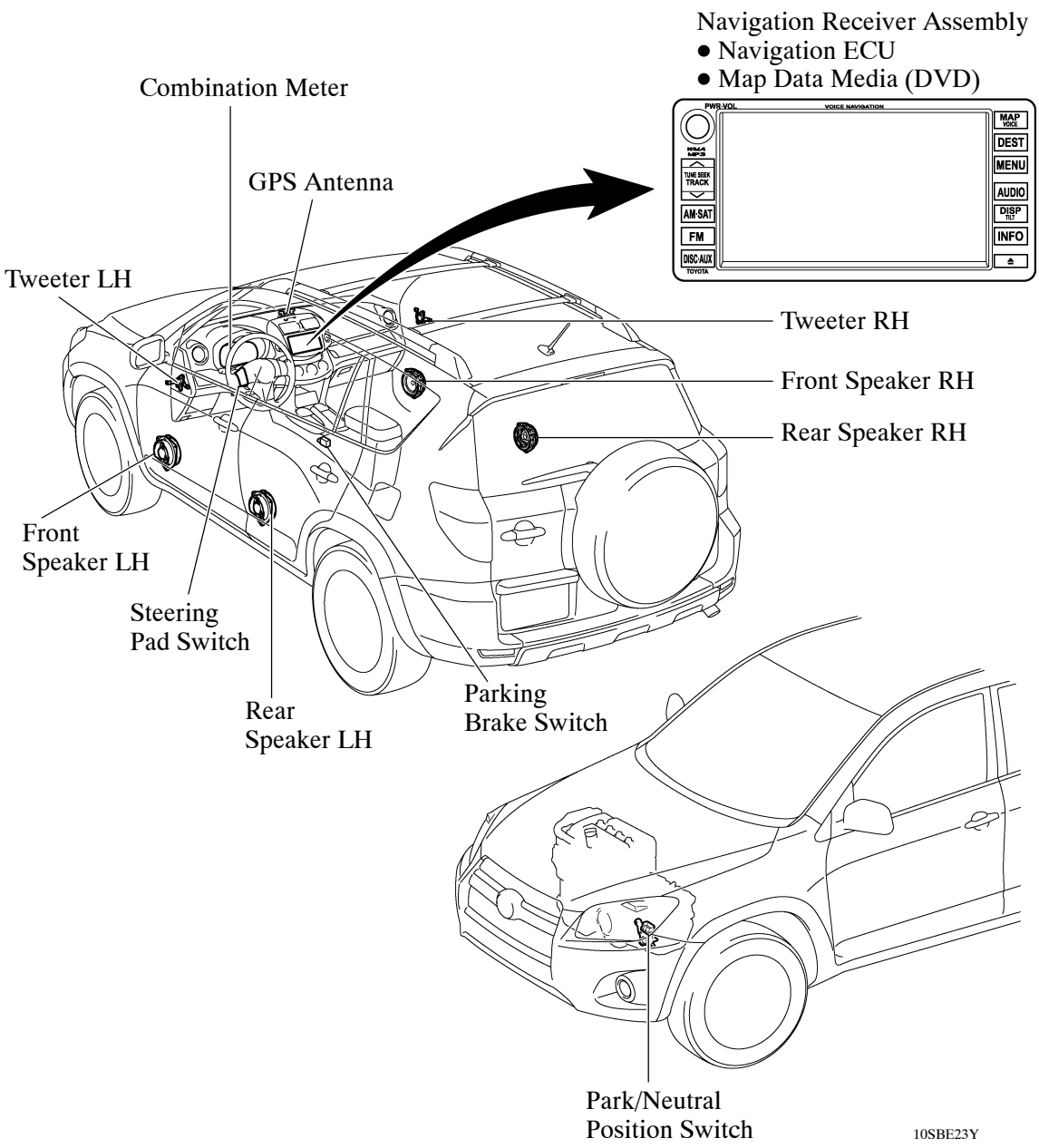
Display	Wide 6.5-inch LCD	
	Pressure Sensitive Touch Panel	
	Manufactured by DENSO	
Navigation System	GPS	
Supported Languages	Voice Guidance	English, French and Spanish
Map Data Media	DVD	
Navigation ECU	Manufactured by DENSO	
	Gyro Sensor	Piezoelectric Ceramic Piece

▶ System Diagram ◀



10SBE52Y

2. Layout of Main Components



3. Construction and Operation

General

The main functions of navigation system are listed below:

Function	Outline
Navigation Screen Display	● Enlargement/Reduction, Rotation and Movement of Map ● Indication of Current Position and Direction of Travel ● Correction of Current Position ● Setting Change and Indication of Route ● Voice Guidance There are many additional functions.
Audio System	Displays the following operations: ● Radio Operation ● CD Operation ● AUX Operation
Maintenance Information	Can be used to inform the driver of inspection or replacement timing of the following items based on the calendar function and vehicle speed signal. Engine Oil: Replace Engine Oil Oil Filter: Replace Engine Oil Filter Rotation: Rotate Tires Tires: Replace Tires Battery: Replace Battery Brake Pad: Replace Brake Linings Wipers: Replace Wiper Blades LLC: Replace Engine Coolant Brake Oil: Replace Brake Fluid ATF: Replace ATF Service: Scheduled Maintenance Air Filter: Replace Air Filter Personal: New information items can be created
Calendar with Memo	It is possible to enter memos for particular dates on the calendar.
Help Screen	Can show the command list and operation guide.
Screen Adjustment	The brightness or contrast of the screen can be adjusted to suit the brightness of surroundings.
Screen Setting	The following screen settings are available: Automatic Transition: Enables automatic return to the navigation screen from the audio screen. Switch Color: Color of touch-screen button can be selected.

(Continued)

Function	Outline
Delete Personal Data	The following personal data can be deleted or returned to their default settings: ● Maintenance Conditions ● Maintenance Information “off” Setting ● Memory Points ● Areas to Avoid ● Previous Points ● Route Trace ● User Selection Settings ● Security Code
Beep Setting	Beep Sound Off
Select Language	The language of the touch-screen buttons, pop-up messages and the voice guidance can be changed. English, French and Spanish are available.
Diagnosis Screen Display	● Service Check ● Display Check ● Navigation Check

Navigation Screen Display

- Based on the map data on the DVD, signals from the GPS satellites, signals from the built-in gyro sensor, and signals from the vehicle speed sensor, the vehicle present position, direction of travel, and driven distance are calculated and displayed on the navigation screen display.
- The functions of the navigation screen display are shown below:

Item		Function
Map Display	Linear Touch Scroll	Enables smooth scrolling by connecting the touch points on the screen.
	On-route Scroll	Scrolls the center of the cursor forward and reverse constantly along the route.
	Heading Up	Displays the map so that the direction of the route progression heads up during route guidance.
	Map Color Change	Depending on the position of the headlight switch, the screen changes between day mode and night mode.
	Front Wide	Displays a map in the direction of travel in an enlarged form. (Heading up only)
	Stepless Scale Display	Changes the scale of the map from the basic 13 steps to an even finer display.
	Direct Scale Change	Directly selects and displays the map scale.
	Multi-step Scale Display	Changes and displays the map scale in 13 stages.
	Split-view Display	Displays different modes on a screen that is split into two views.
	Points-of-interest Display	Displays selected types of marks on the map.
	Taillight-interlocked Map Color Change	Changes the displayed color on the map screen when the taillights are turned ON.
	Road Number Sign Board Display	Displays the road number on the map.
	Compass Mode Screen	Displays the direction of travel and detailed data of the present location.
	Map Coverage Info Screen	Displays the map area that is recorded on DVD.
	Street Name Indication on Scrolled Map	Displays the street name and the city name even when the map screen is being scrolled.
	Foot Print Map	Displays the city maps of Chicago, Detroit, Los Angeles, and New York.
	Building Tenant Information (for foot print map areas)	Displays information on the tenants in the building.
	Arrival Time	Displays the expected time of arrival at the destination.
	Route Trace	Displays the route on the map.
Destination Search	Last Destination Memory	Stores 20 locations of coordinates, names and times that have been set as destinations in the past.
	Hybrid Points-of-interest Search	Narrows the search by names of points-of-interest, category, and areas.
	Points-of-interest Pinpoint Display	Pinpoints and displays the position of points-of-interest.
	House Number Search	Searches for a house number.
	Special Memory Point	Sets a pre-registered point as a destination point while driving.
	Nearest Points-of-interest Search List Display	Searches for nearest points-of-interest and displays a list.
	Intersection Search	By specifying two streets, the point at which they intersect is set as the destination point.
	Emergency Search	Performs a specific search for hospitals, police stations and dealers.

(Continued)

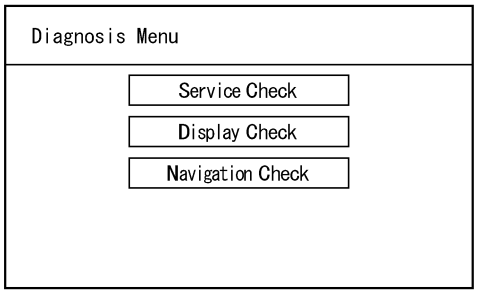
Item		Function
Search	Freeway Entrance/ Exit Search	Searches for the destination by the name of the street that connects to a freeway entrance/exit.
	Coordinate Search	User can input a destination such as an oasis in the desert etc.
	Telephone Number Search	Searches for a facility by its telephone number.
	POI, Brand Icon Indication	Displays icons for points-of-interest.
Route Search	Multiple Destination Setting	Sets multiple destinations. It can also rearrange the sequence of the destinations.
	Route Search	Searches for multiple routes.
	Search Condition Designation	Searches for other recommended shortest routes.
	Regulated Road Consideration	Performs a search taking regulated roads into consideration.
	Avoidance Area	Avoids a designated area and searches a route.
	Freeway Mode Screen	Displays information on facilities in the vicinity of the freeway exits and entrances.
	National Border Conscious Search	As far as possible, searches for a route that does not cross the border between the U.S.A. and Canada.
Guidance	Destination Direction Arrow Display	Uses arrows along the road to display the direction of the destination during route guidance.
	Off-route Arrow Display	Uses arrows to display the direction of the destination during off-route.
	Rotary Guidance	Guidance that renders the entry and exit into a rotary as a single branching point.
	Right or Left Turn Guidance	Voice guidance to instruct the direction of travel to be taken.
	Freeway Direction of Travel Guidance	Voice guidance to instruct the direction of travel to take on the freeway.
	Distance Display Destination	Displays the distance from the present location to the destination.
	Freeway Branch Type Specimen Guidance	Type specimen for guidance to a freeway branch.
	Intersection Zoom-in Display	Zoom-in display when approaching an intersection.
	Turn List Display	Displays a turn list on the right side of the two-screen display.
	Calendar	Anniversary or appointment dates can be input and displayed.
	Function Help	Explains the functions of the switches on the main screens, such as the destination and menu.

Diagnosis Screen Display

The navigation system is equipped with a self-diagnosis function and can display the diagnosis menus shown on the right.
The diagnosis menu contains the following items:

a) Service Check
b) Display Check
c) Navigation Check

For details on the procedure required to enter the diagnosis menu screen, refer to the 2009 RAV4 Repair Manual (Pub. No. RM10S0U).



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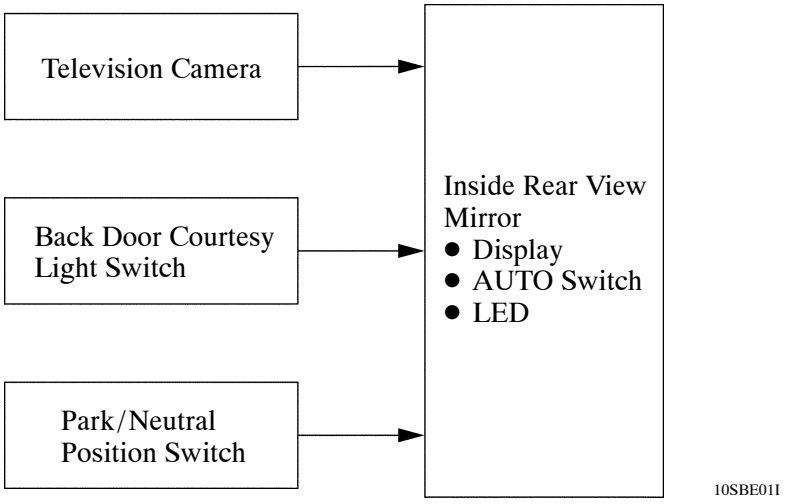
■REAR VIEW MONITOR SYSTEM

1. General

- The rear view monitor system is used.
- To assist the driver in parking the vehicle by monitoring the rear view, the rear view monitor system has a television camera mounted on the back door to display a view of the area behind the vehicle on the display.
- The rear view monitor system consists of the television camera, back door courtesy light switch, park/neutral position switch and display.
- The display is integrated in the inside rear view mirror.
- The rear view monitor system operates when all the conditions given below have been met. At this time, the LED (Light Emitting Diode) on the inside rear view mirror illuminates in green.
  - The ignition switch (engine switch*) is ON (IG).
  - The shift lever is shifted to R.
  - The back door is closed.
- Pushing the AUTO switch on the inside rear view mirror while the rear view monitor system is active will cause the display to disappear and illuminate an amber LED. Pushing the AUTO switch again will cause the display to appear and illuminate a green LED.

*: Models with smart key system

▶ System Diagram ◀

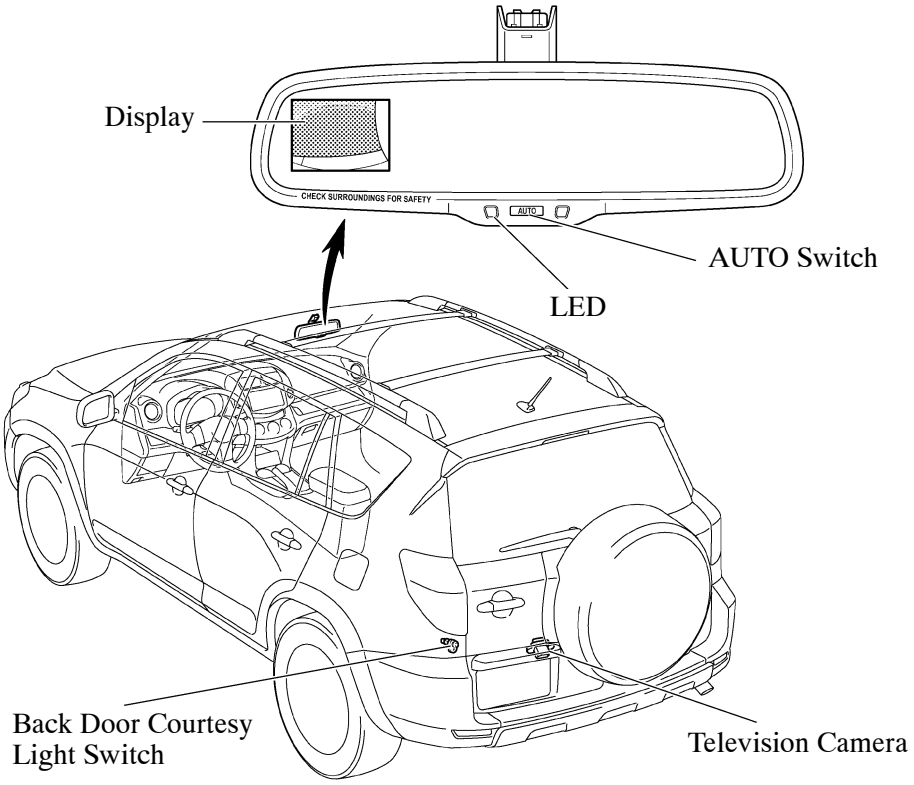


CAUTION

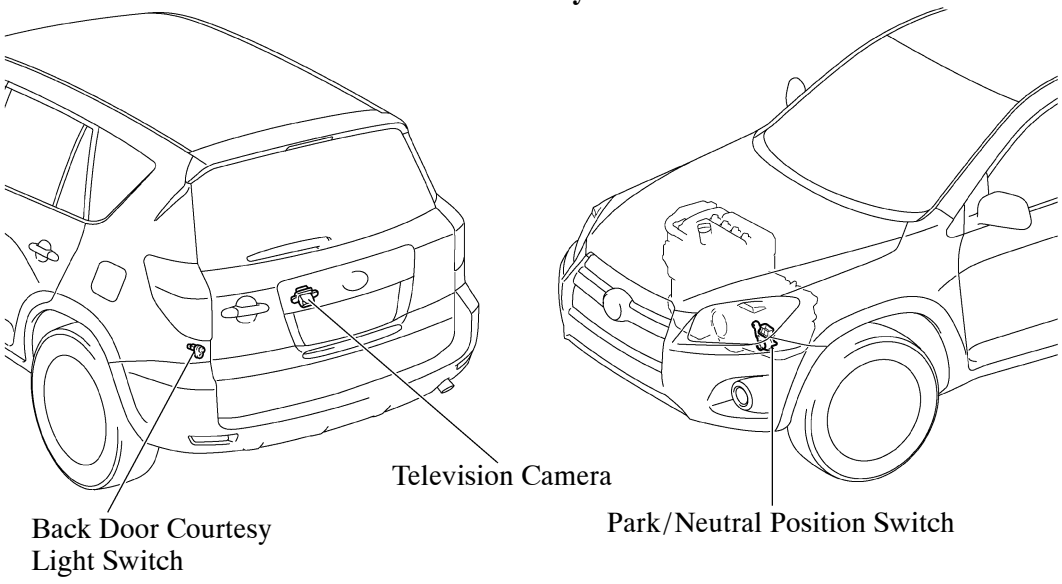
- Do not rely entirely on the rear view monitor system. Use caution, just as you would when backing up any vehicle.
- Never back up while looking only at the screen. The image on the screen may differ from the actual conditions. If you back up while looking only at the screen, you may hit an object or have an accident. When backing up, be sure to check by looking behind and all around the vehicle, both directly and using the mirrors, before proceeding.

2. Layout of Main Components

Inside Rear View Mirror



Models with Tyre Carrier



Models without Tyre Carrier

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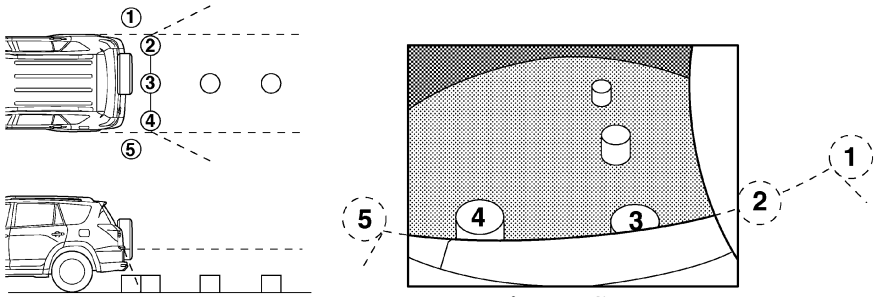
Area Displayed on Screen

- On the display, objects on the right of the vehicle appear on the right side of the display panel, and objects on the left of the vehicle appear on the left side of the display panel.
- The television camera uses a wide-angle lens. The perceived distance from the image that appears on the screen differs from the actual distance.



Display State 10SBE15Y

NOTE: The area displayed on screen may vary according to vehicle state or road conditions.
The area detected by the television camera is limited. The television camera does not detect objects close to either corner of the bumper or under the bumper.

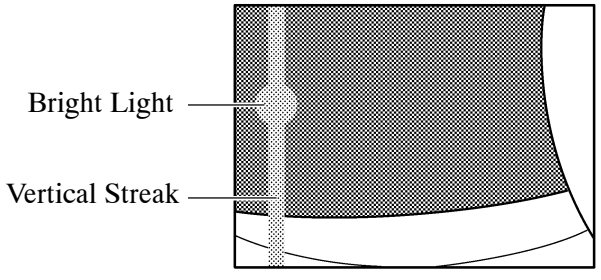
Fail-safe

The table below indicates the conditions of detecting malfunctions in this system:

Malfunctioning Part	Detection Item	Function
Television Camera	Transmission of television camera malfunction signal	Stops signal reception and displays a dark screen

3. Handling Precaution

- In the following cases, it may become difficult to see the images on the screen, even when the system is functioning:
  - When it is dark (for example, at night)
  - When the temperature near the lens is high or low
  - When water droplets are adhering to the television camera, or when humidity is high (for example, when it rains)
  - When foreign matter (for example, snow or mud) is adhering to the television camera
  - When the sun or the headlights of other vehicles are shining directly into the television camera lens
- If a bright light (for example, sunlight reflected off the vehicle body) is picked up by the television camera, the smear effect*, peculiar to the camera, may occur.



Smear Effect 10SBE51Y

— REFERENCE —

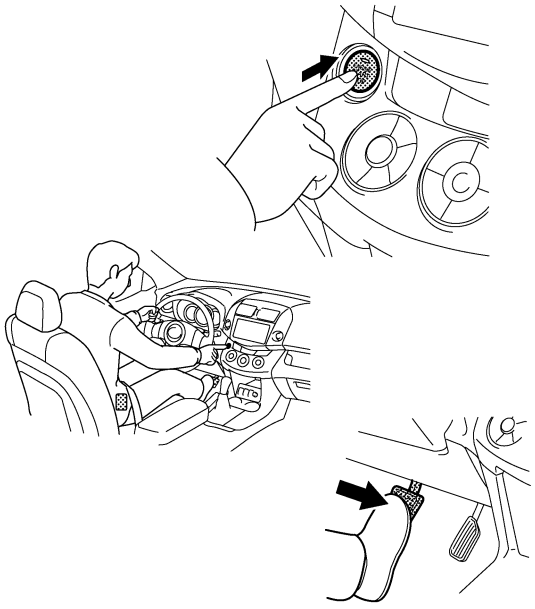
*: Smear effect
A phenomenon that occurs when a bright light is picked up by the television camera; when transmitted by the television camera, the light source appears to have a vertical streak above and below it.

■SMART KEY SYSTEM

1. General

- The smart key system is used.
- The smart key system has a wireless door lock control function and an engine immobilizer function. Furthermore, in this system, the following functions (entry function and start function) are also possible simply by carrying the key in the driver's possession without using a key or transmitter button.
  - All the doors and back door unlock/lock. (Entry unlock/entry lock functions)
  - Engine starts simply by pressing the engine switch while depressing the brake pedal. (Start function)

Entry Unlock/Entry Lock Functions



Start Function

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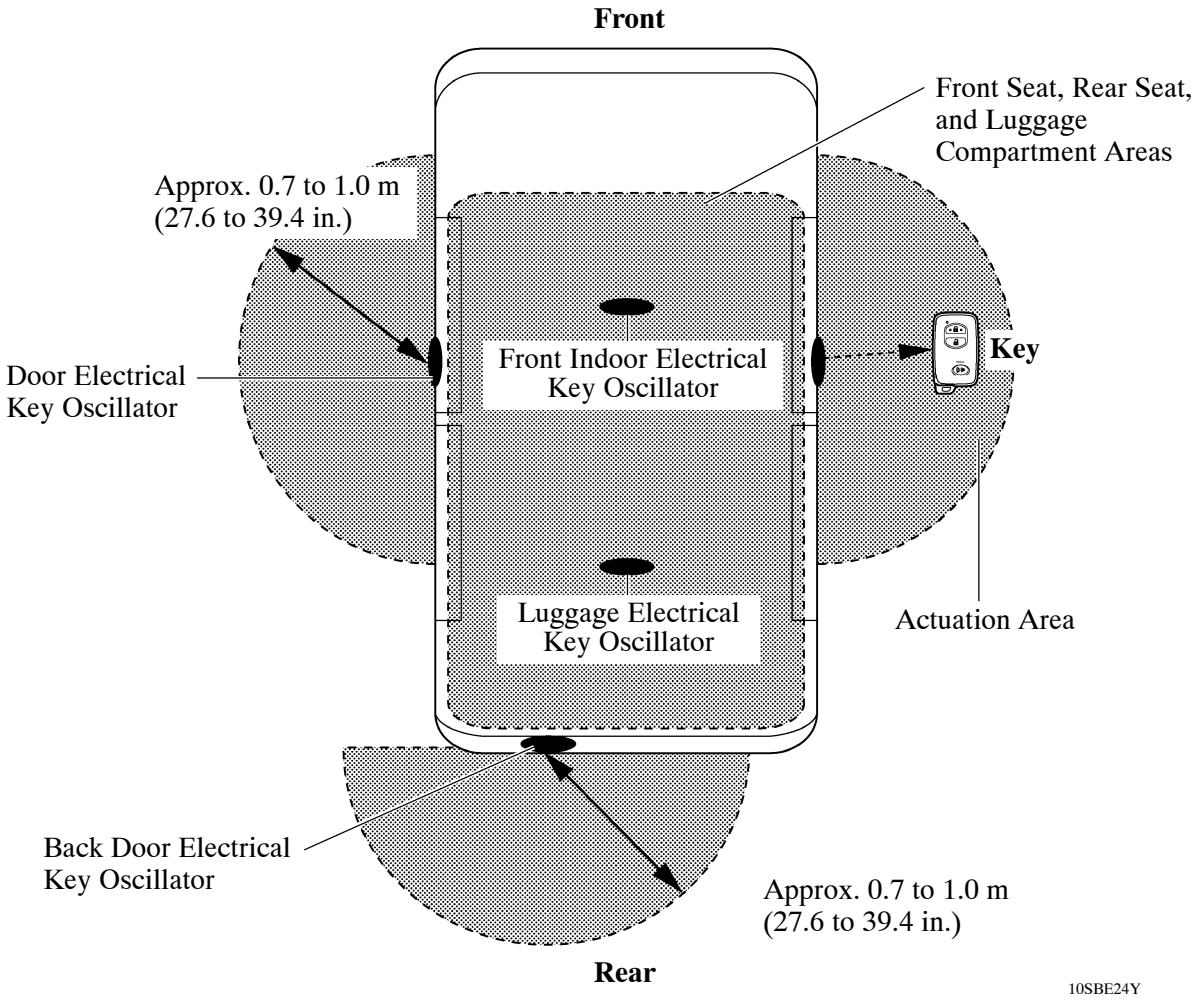
2. Actuation Area

The functions of the smart key system only work when the key is in the actuation area formed by the oscillators.

- The front indoor electrical key oscillator and luggage electrical key oscillator form the actuation area of the start function.
- The door electrical key oscillators and back door electrical key oscillator form the actuation area of the entry function.

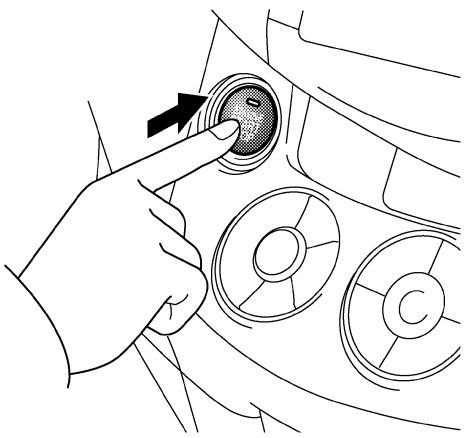


- The front indoor electrical key oscillator forms the actuation area in the upper sections of the driver seat and front passenger seat.
- The luggage electrical key oscillator forms the actuation area in the upper section of the rear seat and in the luggage compartment.

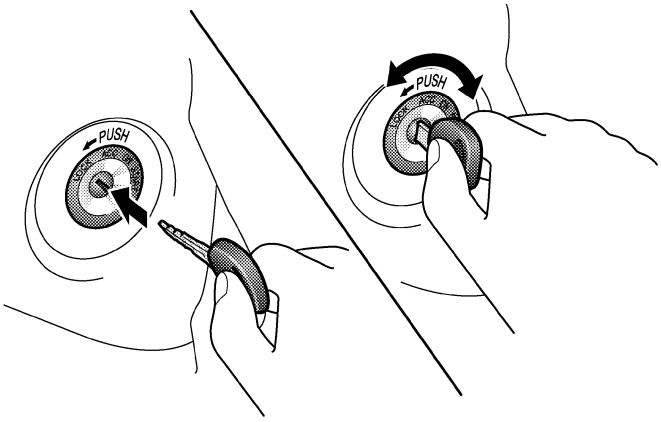
3. Start Function

General

- On the models without the smart key system, the ignition key is inserted into the key cylinder and the ignition switch is turned from the OFF to the ACC, ON or START.
- On the models with the smart key system, the system is operated simply by pressing the push-type engine switch while carrying the key. The main body ECU turns OFF and ON the ACC, IG1, IG2 or ST CUT relays to switch the power source mode.
- This function has different power source mode patterns to suit the brake pedal condition and shift lever position. For details, see page 134.
- Along with the use of the start function, an engine cranking hold function is used.



With Smart Key System



Without Smart Key System

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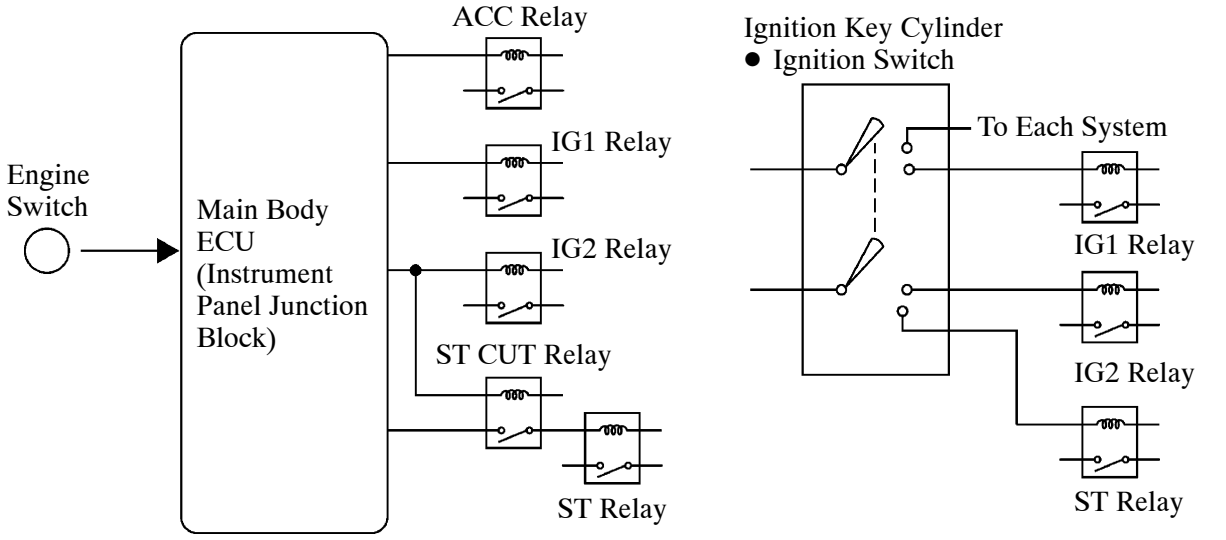
Major Difference

The major differences between the start function and conventional ignition key function are as follows:

Function / Item	Start (Push Button)	Conventional Ignition Key
Switch	Engine Switch	Ignition Switch
Key Cylinder	—	Ignition Key Cylinder
Key	With a built-in transmitter for the smart key system	● With a built-in transponder chip for the engine immobilizer system ● With a built-in transmitter for the wireless door lock control system
Relay	Five Relays (ACC, IG1, IG2, ST CUT and ST Relays)	Three Relays (IG1, IG2, and ST Relays)
Power Relay Control	Main Body ECU	Contact Type Ignition Switch
Security	Restricts the operation of the engine switch unless the certification ECU recognizes the ID code of the key.	Restricts the starting of the engine unless the transponder key ECU recognizes the ID code of the key.
	Restricts the unlocking of the steering lock unless the steering lock ECU receives permissive signals from the certification ECU.	A steering lock mechanism mechanically restricts the movement of the steering in unison with the movement of the key cylinder.

▶ Power Source Circuit ◀



With Smart Key System **Without Smart Key System**

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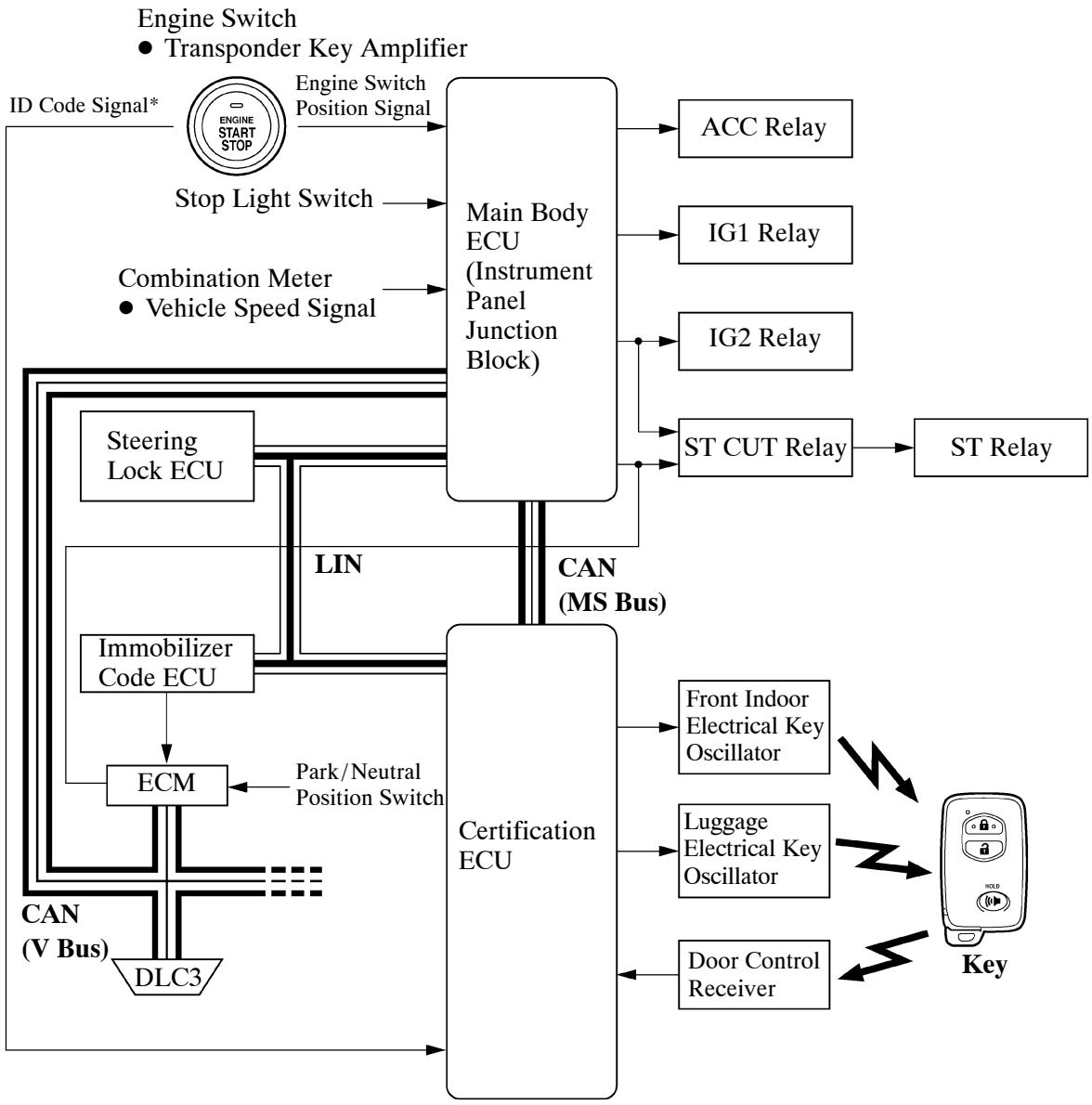
System Diagram

The main body ECU controls the start function. The system diagram below shows the components of the function:



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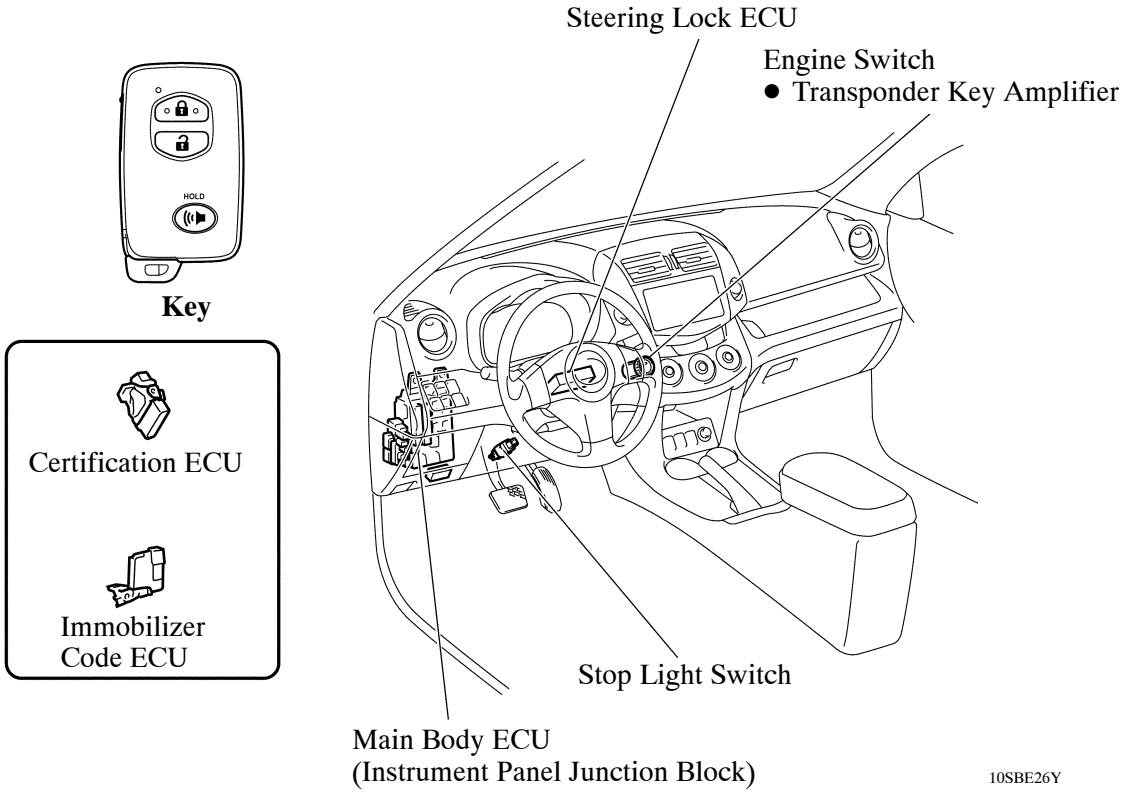
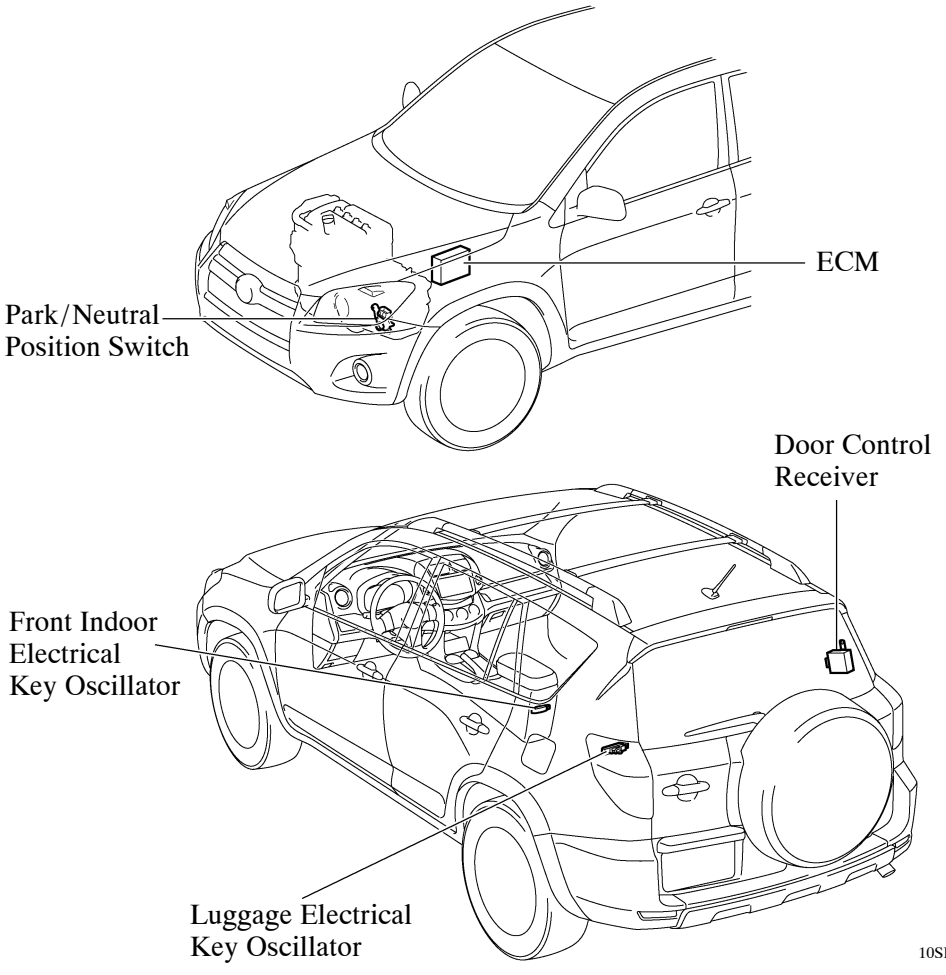
*: Only when the key battery is low.

Layout of Main Components





Function of Main Components

Component	Function
Engine Switch ● Transponder Key Amplifier	● Transmits the engine switch signal to the main body ECU. ● Informs the driver of a power source mode or system abnormality using the indicator light. ● Receives the ID code and transmits it to the certification ECU when the key battery is low.
Key	Receives the signals from oscillators and returns the ID code to the door control receiver.
Front Indoor/Luggage Electrical Key Oscillator	Receives a request signal from the certification ECU and forms the actuation area in the cabin.
Door Control Receiver	Receives the ID code from the key and transmits it to the certification ECU.
Main Body ECU	● Switches the power source modes in four modes (OFF, ON [ACC], ON [IG], START) in accordance with the shift position and the state of the stop light switch. ● Controls the start function in accordance with the signals received from the switches and each ECU.
Certification ECU	Certifies the ID code received from the door control receiver and transmits the certification results to the immobilizer code ECU and steering lock ECU.
Stop Light Switch	Outputs the state of the brake pedal to the main body ECU.
Immobilizer Code ECU	Receives the steering unlock or engine immobilizer unset request signal from the certification ECU, certifies them, and transmits each unset signal to the steering lock ECU or ECM.
ECM	● Receives the engine start request signal from the main body ECU, turns on the ST relay, and starts the engine. ● Receives the signal from the immobilizer code ECU and performs engine ignition and injection.

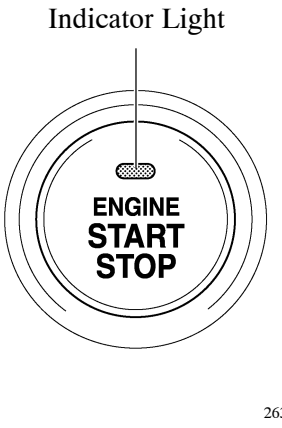
Construction and Operation

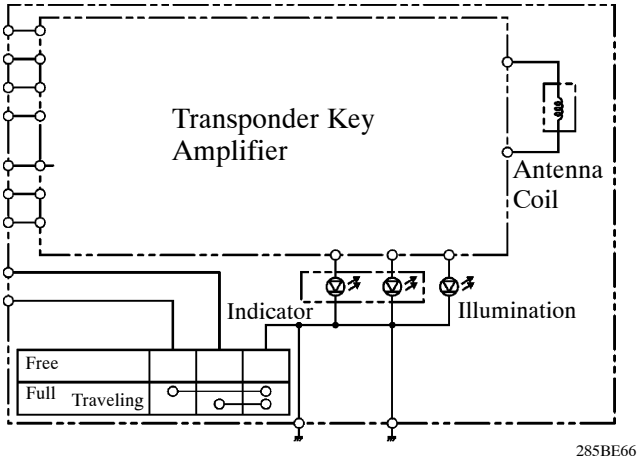
1) Engine Switch

The engine switch consists of a momentary type switch, two color (amber, green) LEDs, and a transponder key amplifier.

- The amber and green LEDs are for the indicator light.
- The driver can check the present power source mode and whether the engine can start or not in accordance with the illumination state of the indicator light.
- When the main body ECU detects an abnormality in the start system while the engine is running, it makes the amber indicator light flash. If the engine is stopped in this state, it might not be possible to restart it.

▶ Circuit Diagram ◀





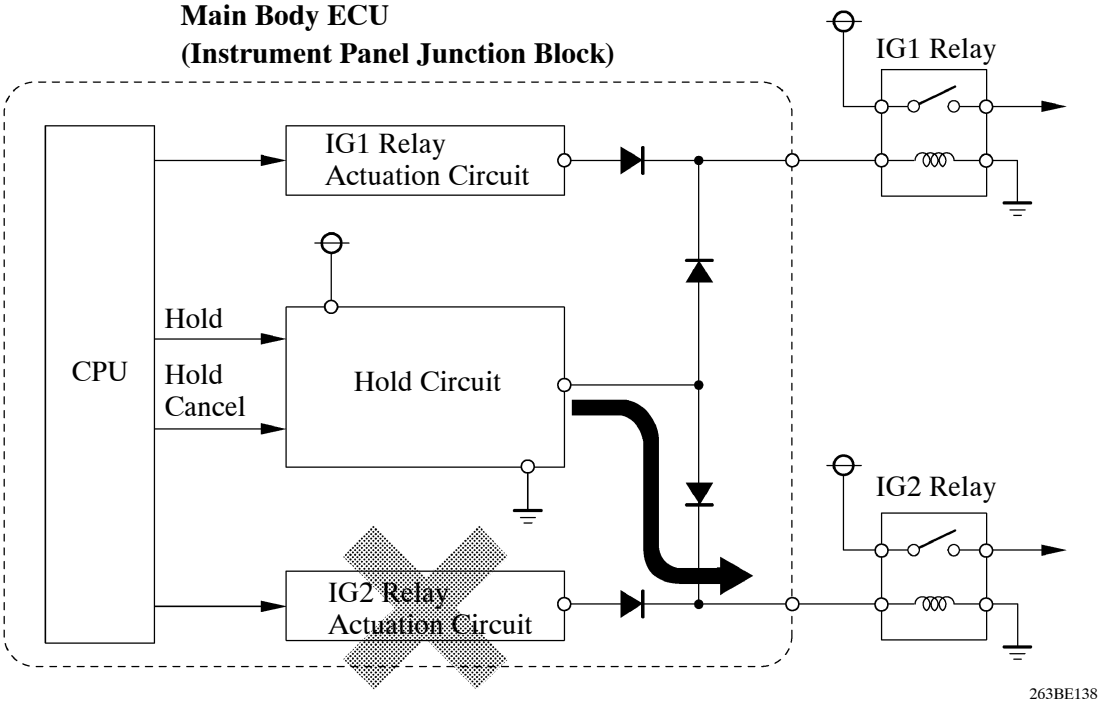
▶ Indicator Light Condition ◀

Power Source Mode/ Condition	Indicator Light Condition	
	Brake pedal not depressed	Brake pedal depressed with shift lever in “P” or “N”
OFF	Turn OFF	Turn ON (Green)
ON (ACC), ON (IG)	Turn ON (Amber)	Turn ON (Green)
Engine Running	Turn OFF	Turn OFF
Steering Lock Not Unlocked	Flash (Green) for 15 seconds	Flash (Green) for 15 seconds
Start System Malfunction	Flash (Amber) for 15 seconds	Flash (Amber) for 15 seconds

2) Main Body ECU

The main body ECU consists of the IG1 and IG2 relay actuation circuits, CPU, and hold circuit.

- The hold circuit is installed to prevent the power supply to the relays from being cut off when an abnormality occurs in the IG1 and/or IG2 relay actuation circuits during driving.



Service Tip

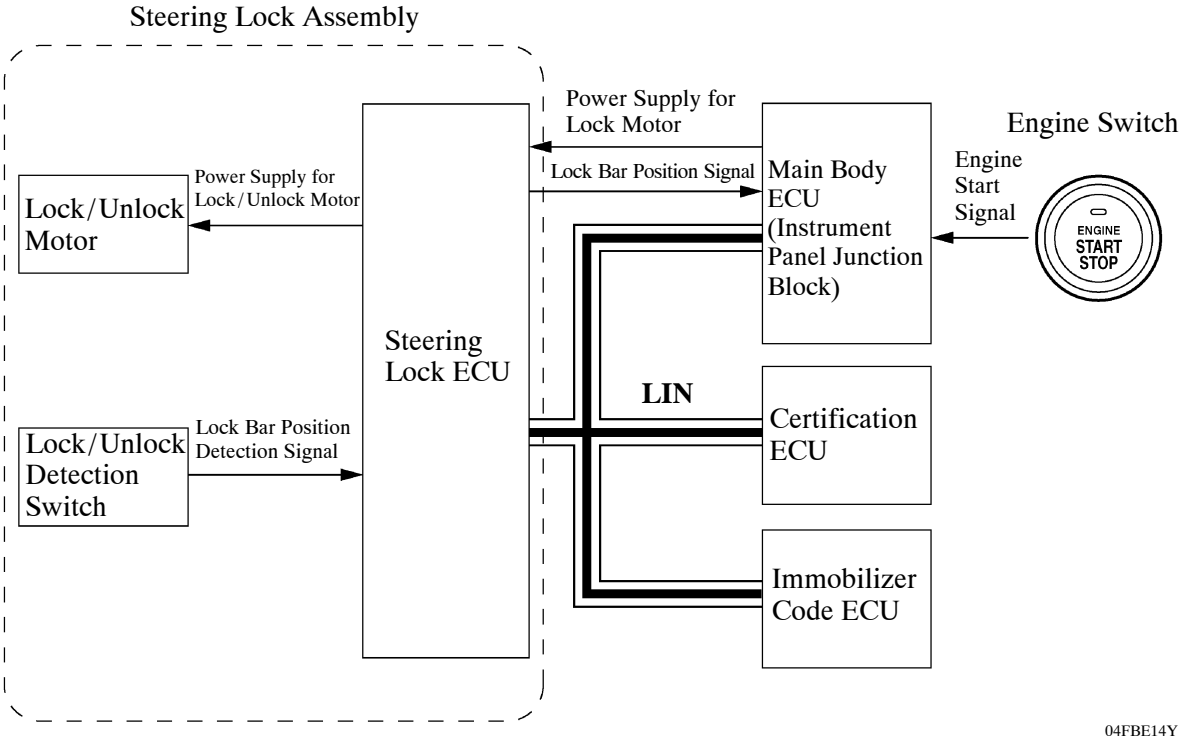
The main body ECU constantly stores the present power source mode in its memory. Therefore, if the power to the main body ECU is interrupted due to the removal of the battery, the main body ECU restores the power source mode after the battery is reconnected.
For this reason, if the battery is removed when the power source mode is anything other than OFF, the power source mode will be restored to the vehicle at the same time the power source mode is restored to the main body ECU (by reconnecting the battery).
Therefore, before removing or disconnecting the battery, make sure to set the power source mode to OFF.

3) Steering Lock System

Along with the use of the smart key system, a steering lock system which uses a lock/unlock motor to lock and unlock the steering wheel is used. This system mainly consists of the steering lock assembly, main body ECU, certification ECU and immobilizer code ECU.

- The steering lock ECU is integrated in the steering lock assembly, and it controls the lock bar operation in the steering lock assembly through the control of the lock/unlock motor.
- The steering lock ECU detects the position (lock/unlock) of the lock bar and transmits this information to the main body ECU and certification ECU.
- In this system, the certification ECU determines whether to lock or unlock the steering wheel based on communication with the main body ECU. Then, the certification ECU sends the lock or unlock request signal to the steering lock ECU through the immobilizer code ECU. Upon receiving the signal, the steering lock ECU operates the lock/unlock motor to lock or unlock the steering wheel.

▶ System Diagram ◀



Service Tip

It is not possible to replace only the steering lock ECU in the steering lock assembly. Therefore, if a malfunction occurs in the ECU, the entire steering lock assembly must be replaced.

Service Tip

After a depleted battery is recharged, the engine may not start at first because the steering lock ECU does not correctly detect the lock bar position.
When this happens, turn off all vehicle power supplies (ON [ACC]=OFF, ON [IG]=OFF), open and close the doors, and then start the engine again.

Start Function Operation

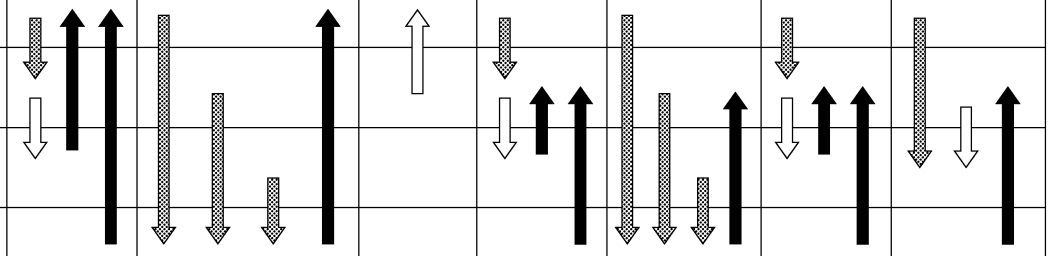
1) General

- When the driver enters the vehicle with the key carried in the driver's possession and the certification ECU recognizes the ID code of the key, the main body ECU authorizes the operation of the engine switch. As a result, the power source mode changes to the mode selected by the engine switch.
- The start function has different power source mode patterns to suit the brake pedal condition and shift lever position.

Pattern	Brake Pedal	Shift Lever	Power Source Mode Pattern
A [See page 135]	Depressed	P or N Position	When the engine switch is pushed once. ● OFF → START
B [See page 138]	Not Depressed	P Position	Each time the engine switch is pushed. ● OFF → ON (ACC) → ON (IG) → OFF
C [See page 140]		Except P Position	Each time the engine switch is pushed. ● OFF → ON (ACC) → ON (IG) → ON (ACC)
D [See page 140]	—	Except P Position	When the engine switch is pushed in the ON (IG) or START. ● ON (IG) or START → ON (ACC)
E [See page 140]	—	P Position	When the engine switch is pushed in the ON (IG) or START. ● ON (IG) or START → OFF

- After approximately 1 hour has elapsed with the power source mode in ON (ACC), the power source control ECU will automatically turn off the power.
- When the key battery is low, the start function can be made to operate by holding the TOYOTA mark of the key against the engine switch. For details, see page 141.
- The table on the next page shows the transition of the power source modes.

▶ Transition of Power Source Mode ◀

Power Source Mode	P Position			N Position		Except P and N Positions	
	Engine Switch Pushed	Engine Switch Pushed with Brake Pedal Depressed	After 1 hour	Engine Switch Pushed	Engine Switch Pushed with Brake Pedal Depressed	Engine Switch Pushed	Engine Switch Pushed with Brake Pedal Depressed
OFF							
ON (ACC)							
ON (IG)							
START							

⇨ : Transition

⇛ : Only when the key certification has been approved

➡ : Only when the vehicle is stopped

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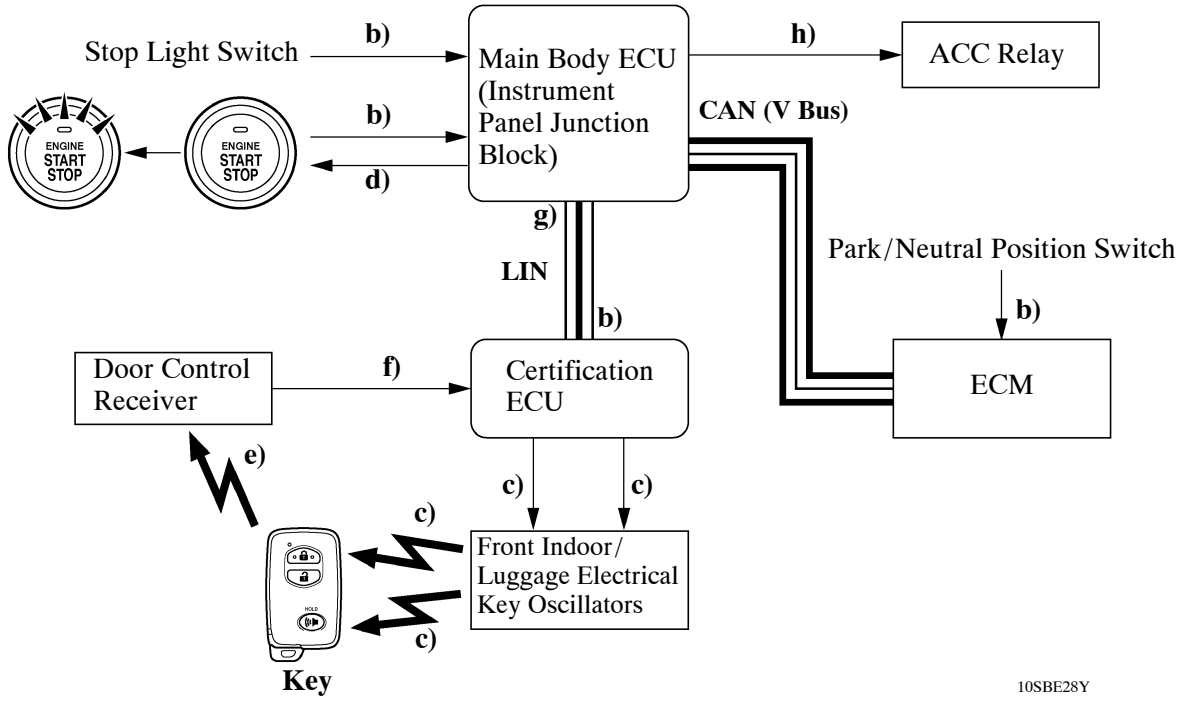
NOTE:

- Normally, the operation of the engine switch is disabled while the vehicle is being driven. However, if the engine must be stopped in an emergency while the vehicle is in motion, the driver can press the engine switch for approximately 3 seconds or more to stop the engine.
- If no signals are transmitted to the main body ECU due to a malfunction in the stop light switch system, the engine will not start even if the driver presses the engine switch while depressing the brake pedal. In this case, the driver can start the engine by the following operations:
  1) Press the engine switch to turn the power source mode from OFF to ON (ACC), and 2) press the engine switch again and hold it for 15 seconds or more.
- Above two operations must be applied only in emergency situations. Under normal conditions, the engine must not be stopped by pressing the engine switch during driving or started without depressing the brake pedal when the shift lever is in any position other than P or N.

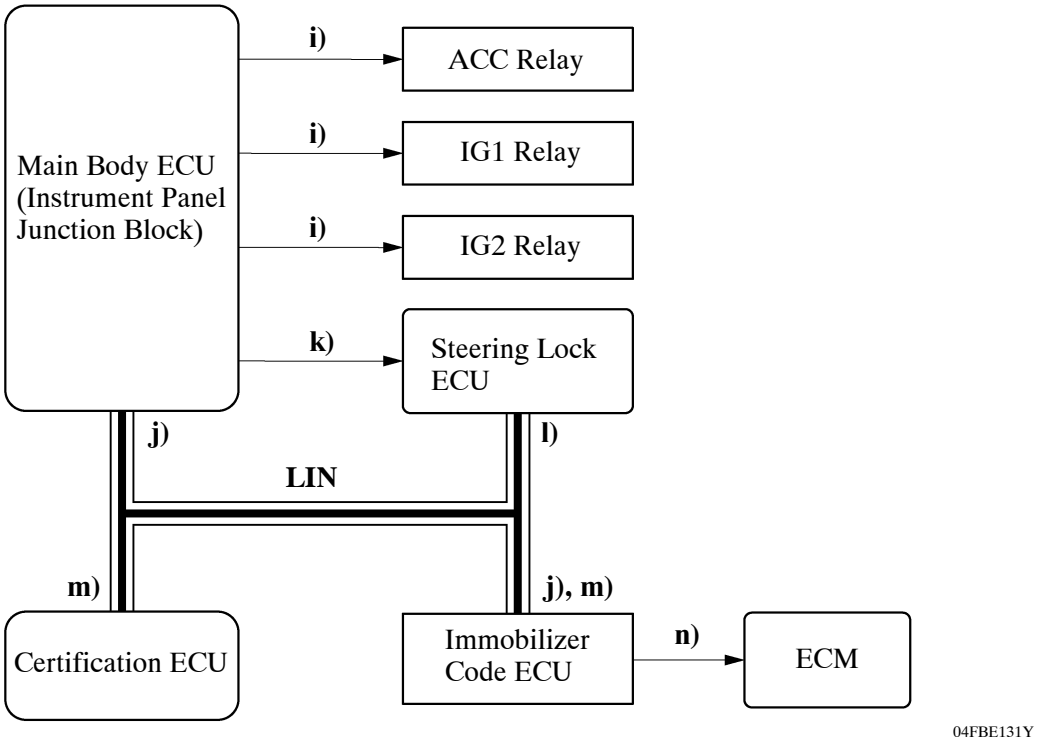
2) Pattern A: OFF → START

Step	System Operation
a)	The driver enters the vehicle with the key carried in the driver's possession.
b)	When the driver presses the engine switch once with the following conditions satisfied, the main body ECU recognizes the engine switch signal and transmits the key certification request signal to the certification ECU. ● Shift position is "P" or "N". ● Brake pedal is depressed. ● Power source mode is in "OFF".
c)	The certification ECU receives the key certification request signal and transmits a request signal to the front indoor/luggage electrical key oscillators. These oscillators then transmit the request signal.
d)	The main body ECU turns on the green indicator light of the engine switch.
e)	The moment the key receives the request signal, it returns to the door control receiver an ID code that includes the response code.
f)	The door control receiver receives this code and transmits it to the certification ECU.
g)	The certification ECU judges and certifies the ID code, and transmits a key certification OK signal to the main body ECU.
h)	After receiving the key certification OK signal, the main body ECU turns on the ACC relay.



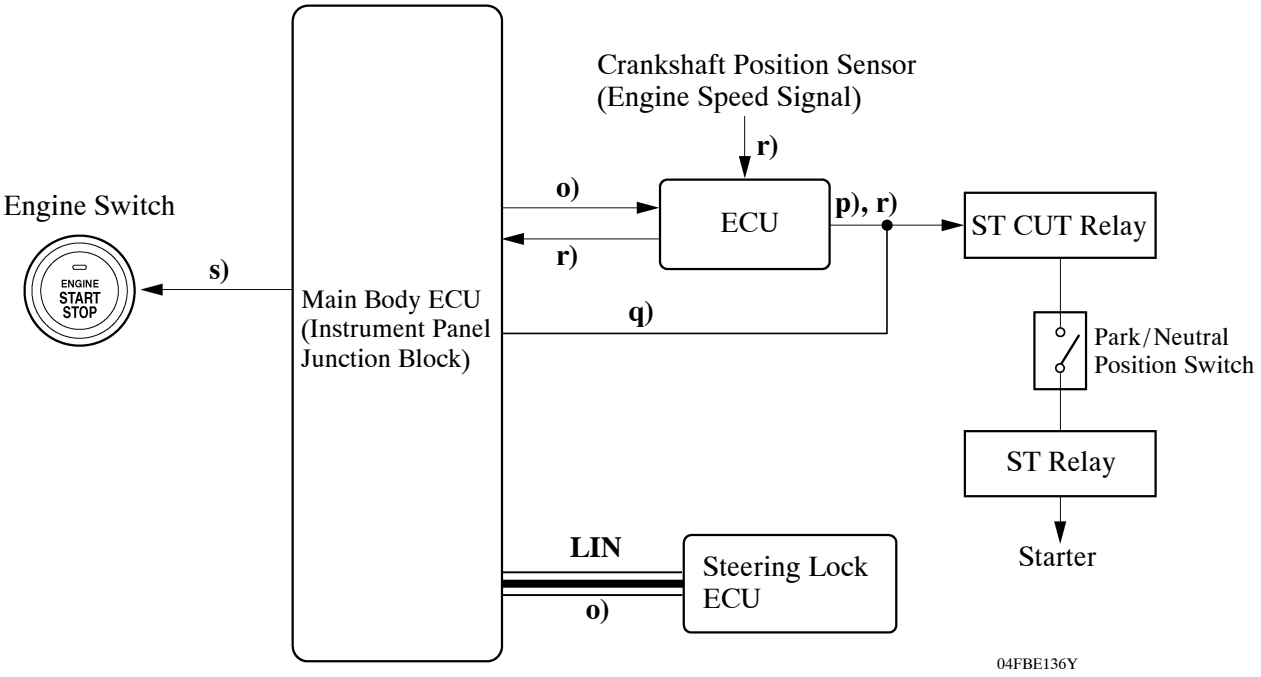
(Continued)

Step	System Operation
i)	The main body ECU turns on the ACC relay, and then turns on the IG1 and IG2 relays.
j)	The certification ECU checks that the power source mode has switched from OFF to ON (IG), and transmits a steering unlock request signal to the main body ECU and immobilizer code ECU.
k)	The main body ECU receives this signal and supplies power to the steering lock ECU.
l)	The steering lock ECU receives the steering unlock request signal via the immobilizer code ECU, and releases the steering lock.
m)	After checking the steering unlock condition, the certification ECU transmits an engine immobilizer unset request signal to the immobilizer code ECU.
n)	The immobilizer code ECU certifies the engine immobilizer unset signal of the certification ECU, transmits the engine immobilizer unset request signal to the ECM, and unsets the engine immobilizer.



(Continued)

Step	System Operation
o)	After checking that the steering is in the unlock condition, the main body ECU transmits a starter request (STSW) signal to the ECM.
p)	The ECM outputs an ST relay (STAR) signal, and actuates the starter.
q)	If the ST relay (STAR) signal cannot be output because the power supplied to the ECM is low, the main body ECU outputs the ST relay (STAR) signal instead, to help actuate the starter.
r)	When the ECM judges from the engine speed signal that engine start has been completed, it stops the ST relay (STAR) signal, and stops the starter.
s)	The main body ECU checks that the engine start has been completed, and turns off the indicator light of the engine switch.



3) Pattern B: OFF → ON (ACC) → ON (IG) → OFF

a. OFF → ON (ACC)

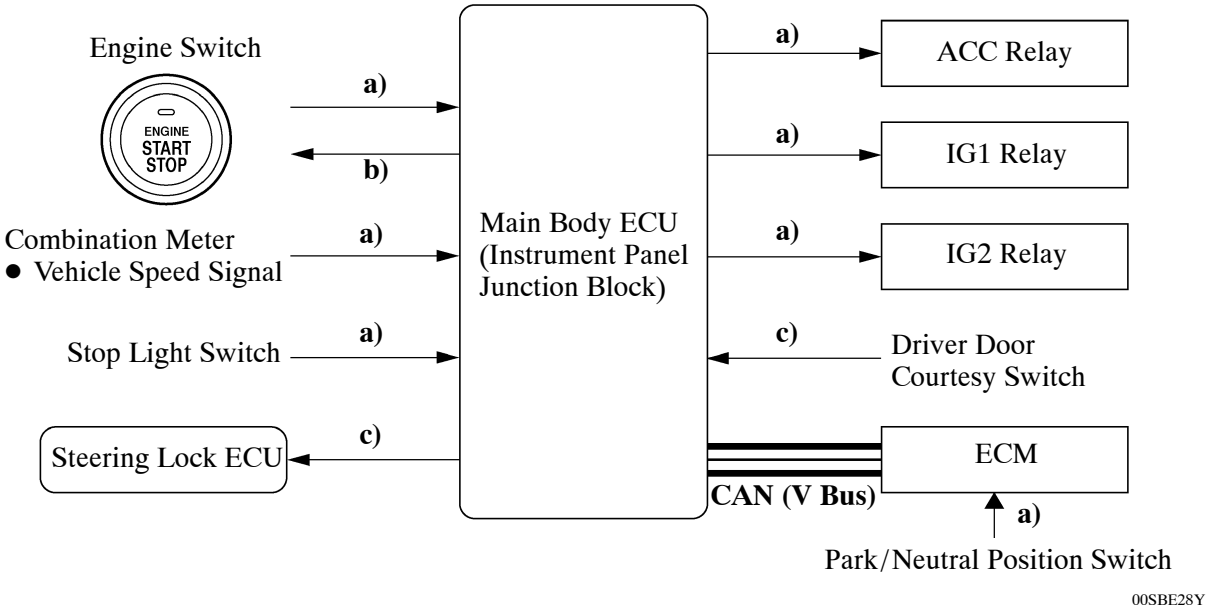
Step	System Operation
a)	The driver enters the vehicle with the key carried in the driver's possession.
b)	When the driver presses the engine switch once with the following conditions satisfied, the main body ECU recognizes the engine switch signal and transmits the key certification request signal to the certification ECU. ● Shift position is "P" or "N". ● Brake pedal is not depressed. ● Power source mode is in "OFF".
c)	When the brake pedal is not depressed, the main body ECU turns on the amber indicator light of the engine switch.
d)	The subsequent system operation is the same as **d) to h) in pattern "A"**. For details, see page 135.

b. ON (ACC) → ON (IG)

Step	System Operation
a)	When the power source mode is "ON (ACC)" and the driver presses the engine switch again, the main body ECU recognizes the engine switch signal and turns on the IG1 and IG2 relays.
b)	The subsequent system operation is the same as **j) to n) in pattern "A"**. For details, see page 135.

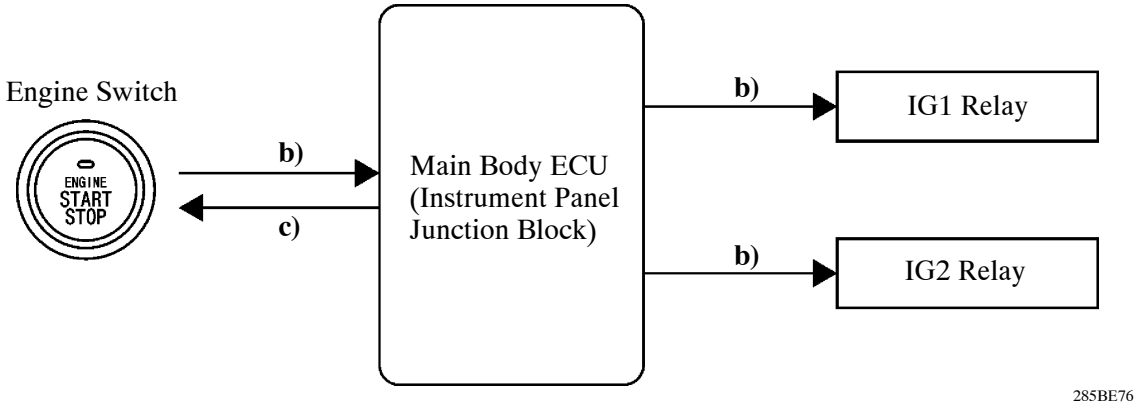
c. ON (IG) → OFF

Step	System Operation
a)	When the engine switch is pressed once with the following conditions satisfied, the main body ECU recognizes the engine switch signal and turns off the ACC, IG1 and IG2 relays. ● Shift position is “P”. ● Brake pedal is not depressed. ● Vehicle speed is 0 mph (0 km/h). ● Power source mode is in “ON (IG)”.
b)	When the power source mode is switched from ON (IG) to OFF, the main body ECU turns off the indicator light of the engine switch.
c)	If the driver door is opened, the main body ECU receives a signal from the driver door courtesy switch. Then, the power supply to the steering lock ECU is stopped to lock the steering.



4) Pattern C: OFF → ON (ACC) → ON (IG) → ON (ACC)

Step	System Operation
a)	The system operations for the power source mode "OFF → ON (ACC) → ON (IG)" are the same as **those in pattern B**. For details, see page 138.
b)	When the engine switch is pressed once with the following conditions satisfied, the main body ECU recognizes the engine switch signal and turns off the IG1 and IG2 relays. ● Shift position is except "P". ● Brake pedal is not depressed. ● Vehicle speed is 0 mph (0 km/h). ● Power source mode is in "ON (IG)".
c)	Even after the power source mode switches from ON (IG) to ON (ACC), the indicator light of the engine switch remains illuminated in amber.



5) Pattern D: ON (IG) or START → ON (ACC)

This system operation is the same as **pattern "C"**. For details, see above. However, the indicator light of the engine switch illuminates as follows:

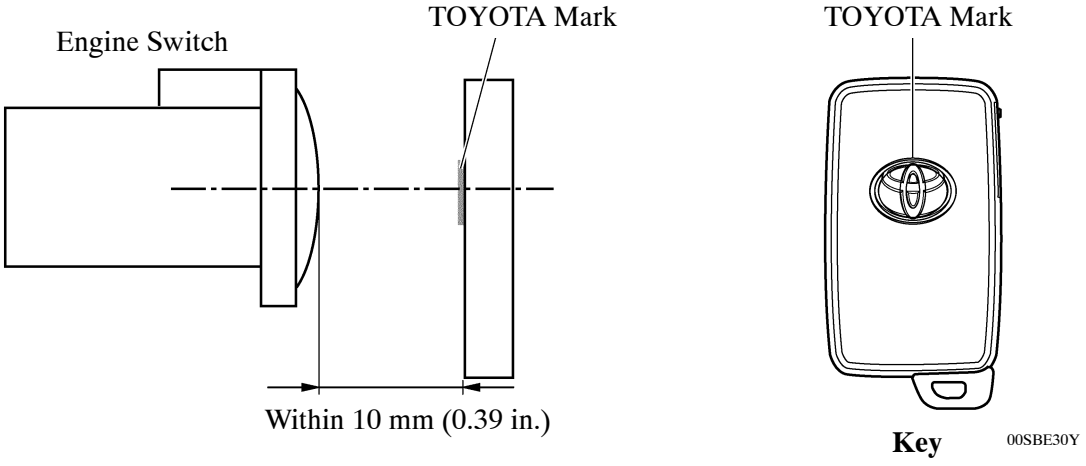
- When the power source mode is switched from ON (IG) to ON (ACC), the main body ECU makes the amber indicator light of the engine switch stay on.
- When the power source mode is switched from engine running to OFF, the main body ECU turns off the indicator light of the engine switch.

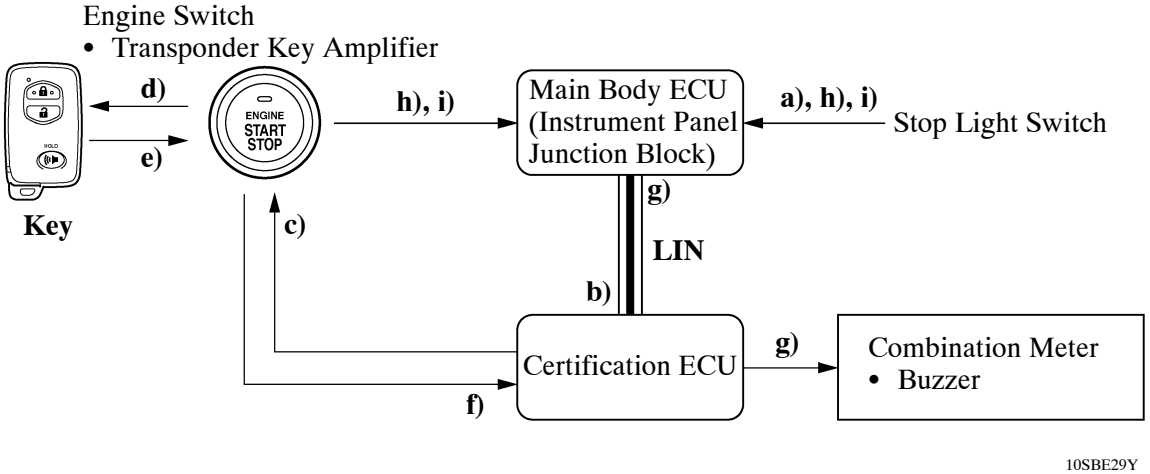
6) Pattern E: ON (IG) or START → OFF

This system operation is the same as **ON (IG) → OFF for pattern "B"**. For details, see page 138.

7) When key battery is low

Step	System Operation
a)	To operate the start system when the key battery is low, hold the TOYOTA mark of the key against the engine switch while depressing the brake pedal.
b)	The main body ECU transmits a key certification request signal to the certification ECU.
c)	The certification ECU does not receive an ID code response from the door control receiver, so it actuates the transponder key amplifier built into the engine switch.
d)	The transponder key amplifier outputs an engine immobilizer radio wave to the key.
e)	The key receives the radio wave, and returns a radio wave response to the transponder key amplifier.
f)	The transponder key amplifier combines the key ID codes with the radio wave response, and transmits it to the certification ECU.
g)	The certification ECU judges and verifies the ID code, and transmits a key certification OK signal to the main body ECU. The buzzer in the combination meter sounds at the same time.
h)	After the buzzer sounds, if the engine switch is pressed within 5 seconds while the brake pedal is depressed, the power source mode switches to START as in the normal condition.
i)	After the buzzer sounds, if the engine switch is pressed within 5 seconds while the brake pedal is not depressed, the power source mode switches to ON (ACC) or ON (IG) as in the normal condition.





Diagnosis

The main body ECU can detect malfunctions in the start function when the power source mode is ON (IG). When the ECU detects a malfunction, the amber indicator light of the engine switch flashes to warn the driver. At the same time, the ECU stores the 5-digit DTC (Diagnostic Trouble Code) in the memory.

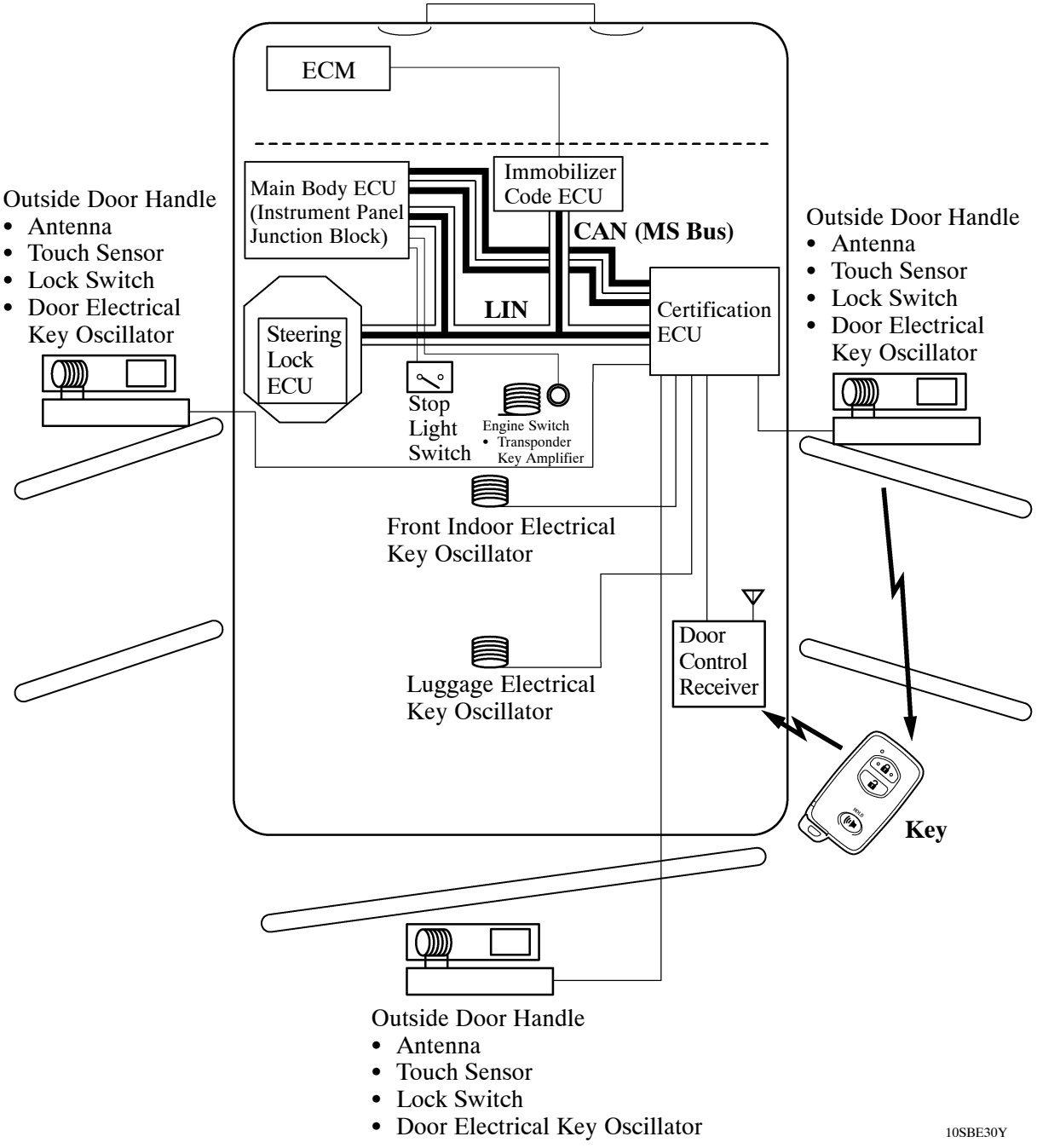
- The indicator light warning continues for 15 seconds even when the power source mode is switched to OFF.
- The DTC can be read by connecting a Techstream to the DLC3.
- The start function cannot be operated again if a malfunction occurs.

For details, refer to the RAV4 Repair Manual (Pub. No. RM10S0U).

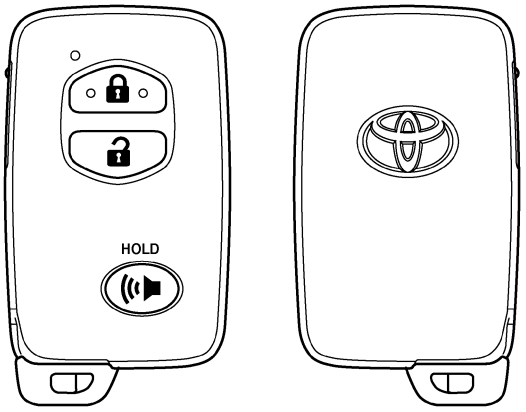
4. Entry Function

System Diagram

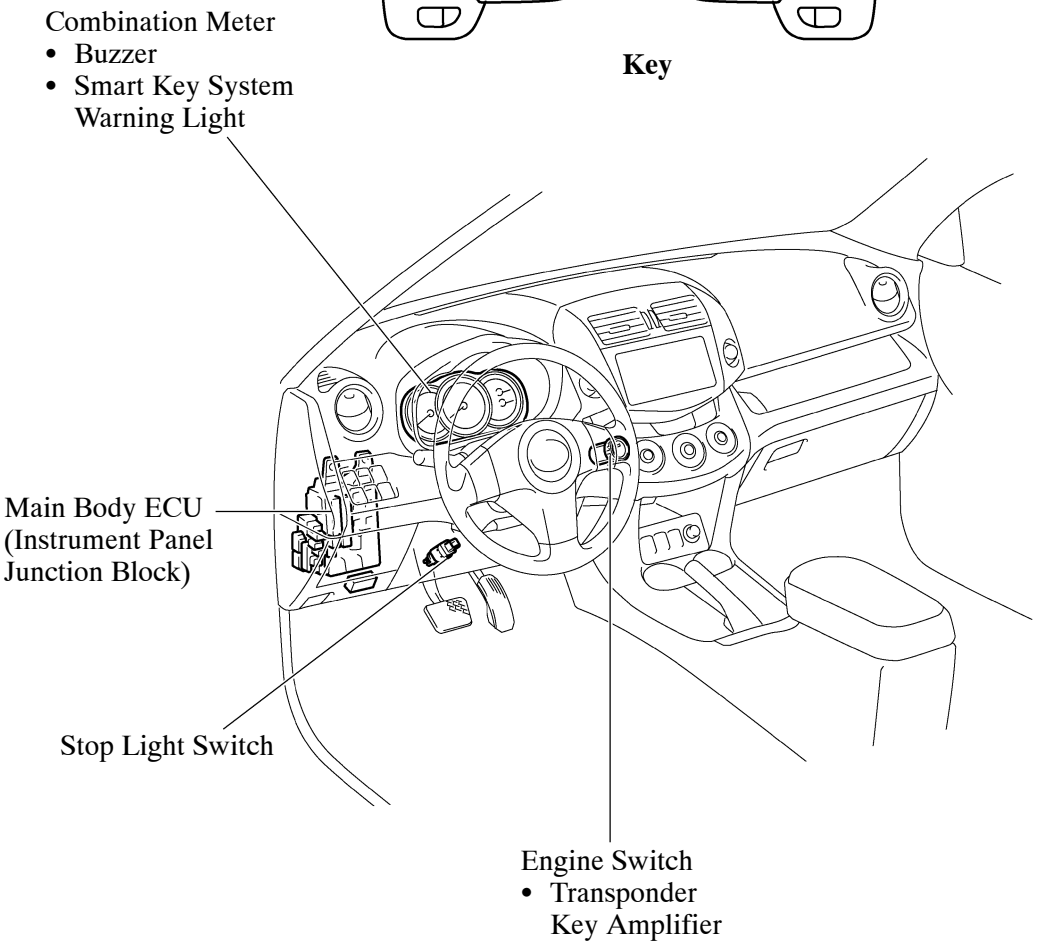
The certification ECU controls the entry function. The system diagram below shows the main components of the function:



Layout of Main Components



Key



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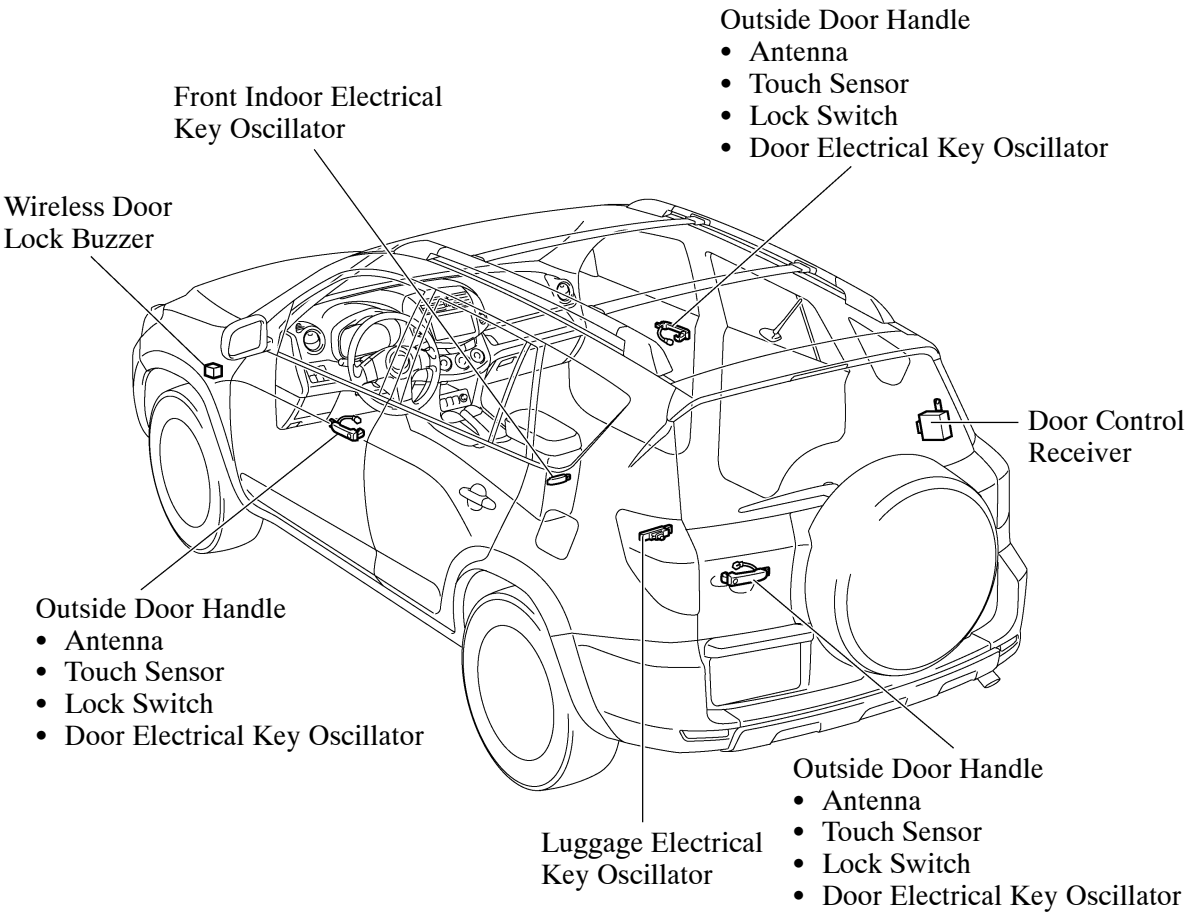
Outside Door Handle
• Antenna
• Touch Sensor
• Lock Switch
• Door Electrical Key Oscillator
Front Indoor Electrical
Key Oscillator
Wireless Door
Lock Buzzer
Door Control
Receiver
Outside Door Handle
• Antenna
• Touch Sensor
• Lock Switch
• Door Electrical Key Oscillator
Outside Door Handle
• Antenna
• Touch Sensor
• Lock Switch
• Door Electrical Key Oscillator
Luggage Electrical
Key Oscillator

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Function of Main Components

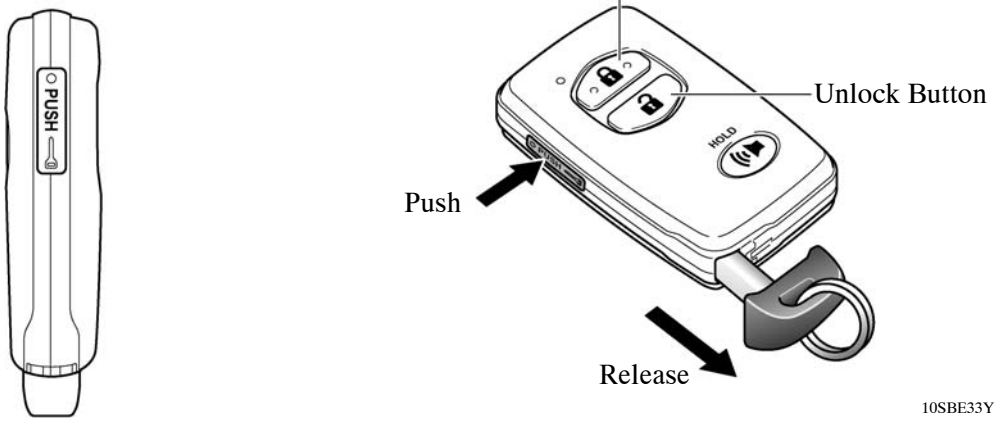
Component		Function
Key		● Outputs information such as the key ID and vehicle ID when the request signals that are output by the front indoor/luggage electrical key oscillators and door electrical key oscillators have been received. ● Outputs the request signal when the driver pushes the lock or unlock button on the key. ● Outputs information such as the key ID and vehicle ID when the radio wave that is output by the transponder key amplifier in the engine switch has been received. ● Integrates the mechanical key in order to unlock the doors when the key battery is low.
Certification ECU		Controls the smart access system with push-button start in accordance with the signals from each oscillator, various switches, ECUs and the key. ● Judges and certifies the ID code from the door control receiver. ● Transmits the engine immobilizer deactivation signal to the immobilizer code ECU. ● Transmits steering unlock signals to the steering lock ECU.
Main Body ECU		Controls the push button start system in accordance with the signals from the various switches, ECUs and combination meter. ● Transmits the key certification request signal to the certification ECU in accordance with the engine switch signal, and turns the relays on and off. ● Receives the request signal from the certification ECU and actuates the door lock motor to lock or unlock all the doors and back door. ● Transmits each door condition to the certification ECU.
Immobilizer Code ECU		Receives the steering unlock or engine immobilizer unset request signals from the certification ECU, certifies them, and transmits each signal to the steering lock ECU or ECM.
Outside Door Handle	Antenna	Transmits the request signals.
	Touch Sensor	Transmits the door unlock request signal to the certification ECU.
	Lock Switch	Transmits the door lock request signal to the certification ECU.
	Door Electrical Key Oscillator	Receives the request signal from the certification ECU, and forms the actuation area around each door.
Front Indoor/Luggage Electrical Key Oscillator		Receives the request signal from the certification ECU, and forms the actuation area in the cabin and luggage compartment.
Door Control Receiver		Receives the ID code from the key in the actuation area and transmits it to the certification ECU.
Stop Light Switch		Outputs the state of the brake pedal to the main body ECU.
Wireless Door Lock Buzzer		When the certification ECU detects human error, it warns the driver by sounding the wireless door lock buzzer, illuminating the smart key system warning light and sounding the buzzer in the combination meter in accordance with the request signal from the ECU.
Combination Meter	Smart Key System Warning Light	
	Buzzer	

Construction and Operation

1) Key

The key consists of a mechanical key, a transmitter for the wireless door lock control and a transceiver for the smart key system.

- The transceiver for the smart key system receives the signals from the oscillators and returns the ID code to the door control receiver.
- The transmitter for the wireless door lock control has a lock button, an unlock button and a panic button.
- When the key battery is low, the key returns the radio wave response received from the engine switch to the engine switch.
- This mechanical key works for the driver door and glove box, but it cannot start the engine.



2) Electrical Key Oscillator

Each electrical key oscillator transmits the request signal received from the certification ECU, and forms a key actuation area to detect the presence of a key.
The actuation area formed by door electrical key oscillators is approximately 0.7 to 1.0 m (27.6 to 39.4 in.) from the outside door handle.

- The actuation area of the door electrical key oscillators is formed by transmitting a request signal every 250 ms while the power source mode is OFF and each door is locked. In this way it detects the proximity of a key. During entry lock, the actuation area is formed with the lock switch on.
- The actuation area of the front indoor/luggage electrical key oscillators is formed when the driver door is opened or closed, during start ignition, when a warning is activated, or when the lock switch is on.

Entry Function Operation

1) General

The entry function has the following functions:

Function	Outline
Wireless Door Lock Control	This function is a convenient system for locking and unlocking all the doors and back door at a distance. The operation of this function in the smart key system is the same as that in the wireless door lock control system. However, the receiver in the certification ECU uses a door control receiver to perform the control.
Entry Unlock [See page 149]	When a key is located in any actuation area of the door electrical key oscillators, all the doors and back door will be unlocked with the touch of an outside door handle.
Entry Illumination [See page 149]	When a key enters any actuation area of the door electrical key oscillators, the room light, foot light and engine switch illumination are turned on.
Entry Lock [See page 150]	When a key is located in any actuation area of the door electrical key oscillators and the power source mode is OFF, all the doors and back door will be locked by merely pressing the lock switch on the outside door handle.
Prevention of Key Confinement [See page 151]	Prevents the doors and back door from being locked by the outside door handle while the key is still inside the vehicle.
Warning [See page 152]	The smart key system causes the certification ECU to sound the buzzer in the combination meter and the wireless door lock buzzer, and illuminates the smart key system warning light in order to alert the driver.
Battery Saving [See page 158]	This function extends the signal transmission (between the system and key) interval from 250 ms to 750 ms, or automatically deactivates the smart key system in order to prevent the vehicle and/or key battery from being drained.

2) Wireless Door Lock Control Function

The wireless door lock control function has the following functions:

Function	Outline
Lock All Doors	Pressing the lock button of the key locks all doors.
Unlock All Doors (2-step Unlock)	Pressing the unlock button of the key once unlocks the driver door, and pressing it again within 3 seconds unlocks all the doors.
Answer Back	The hazard light flashes once when locking, and flashes twice when unlocking, to inform that the operation has been completed.
	The wireless door lock buzzer sounds once when locking, and the wireless door lock buzzer sounds twice when unlocking, to inform that the operation has been completed.
Automatic Lock	If none of the doors are opened within 60 seconds after they are unlocked by the wireless door lock control, all the doors will be locked again automatically.
Panic Alarm	Pressing and holding the panic button on the transmitter for approximately 0.8 seconds activates alarms. Pushing any button on the transmitter during the alarms cancels the alarms.
Door Ajar Warning	If any door is open or ajar, pressing the lock button of the key will cause the wireless door lock buzzer to sound for about 10 seconds.
Illuminated Entry	When all the doors are locked, pressing the unlock button causes the room light, foot light and engine switch illumination to illuminate simultaneously with the unlock operation.

3) Entry Unlock

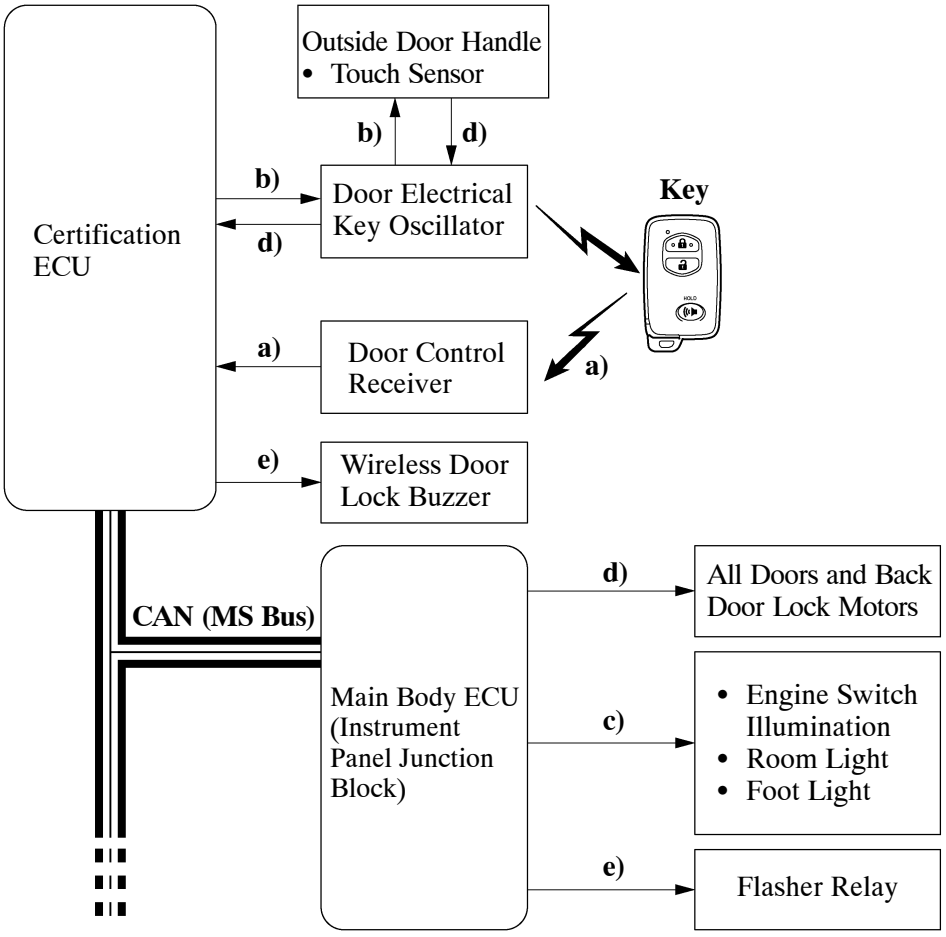
a) When a key enters any actuation area of the door electrical key oscillators, the certification ECU judges and certifies the key ID code received from the door control receiver.

b) After the key ID has been certified, the certification ECU transmits an unlock standby signal to the touch sensor of the relevant door.

c) At the same time, the certification ECU transmits a lighting signal for each illumination (room light, foot light and engine switch illumination) via the main body ECU, and turns on these illuminations. (Entry Illumination Function)

d) If the touch sensor is touched in this condition, the certification ECU transmits a door unlock request signal to the main body ECU, and unlocks all the doors and back door.

e) After all the doors and back door are unlocked, the hazard light flashes twice and the wireless door lock buzzer sounds twice as an answer back.



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4) Entry Lock

a) The lock signal is transmitted to the certification ECU when the driver exits the vehicle with the key carried in the driver's possession and presses the lock switch.

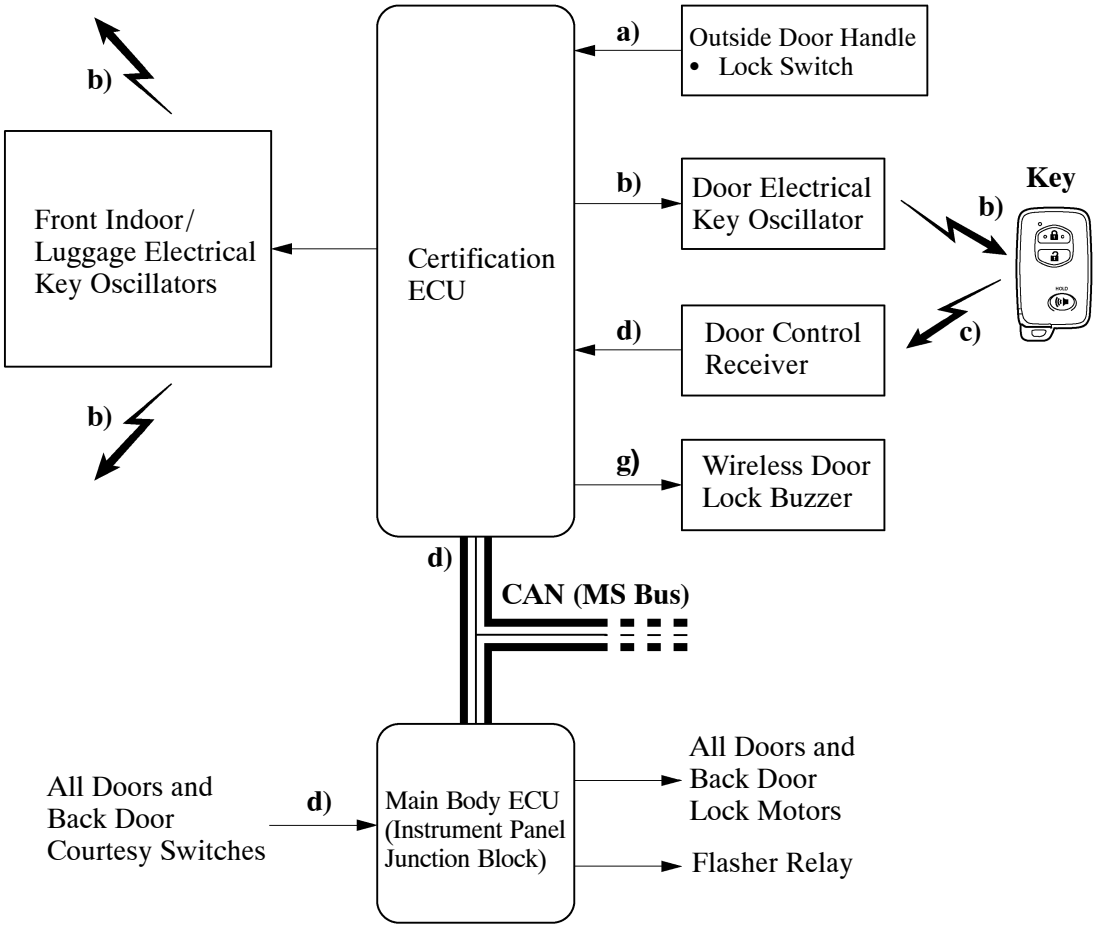
b) The certification ECU transmits a request signal for the door electrical key oscillators and the front indoor/luggage electrical key oscillators to form actuation areas.

c) The key transmits the ID code to the door control receiver.

d) The certification ECU judges and certifies the ID code from the door control receiver. It then checks the location of the key, and when all the doors and back door are closed, the ECU transmits a door lock request signal to the main body ECU.

e) The main body ECU actuates the door lock motors to lock all the doors and back door.

f) After all the doors and back door are locked, the hazard light flashes once and the wireless door lock buzzer sounds once as an answer back.



5) Prevention of Key Confinement

a. General

This function prevents the door from being locked when the key has been left inside the cabin or luggage compartment.

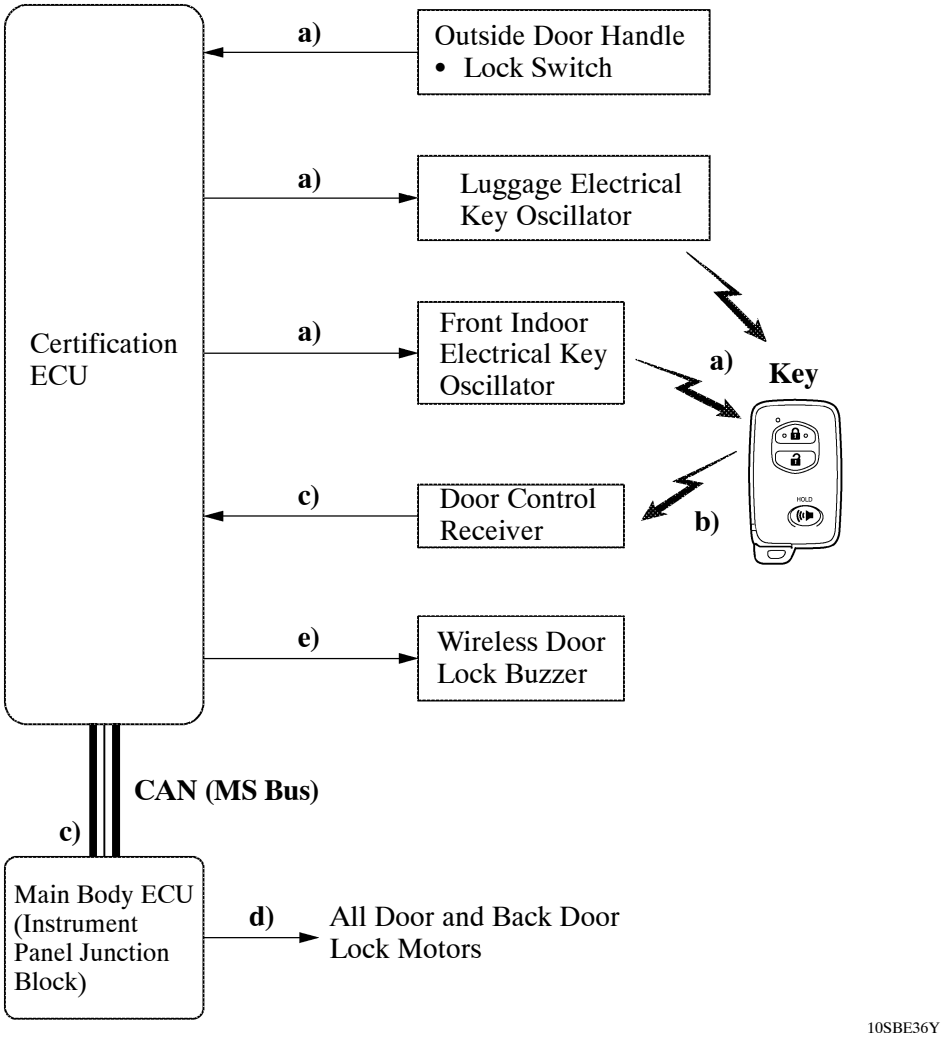
a) When the door is locked from the lock switch while the key is still inside the cabin or luggage compartment, the certification ECU transmits a request signal for the front indoor/luggage electrical key oscillators to form an actuation area.

b) The key transmits the ID code to the door control receiver.

c) The certification ECU judges and certifies the ID code, and checks the location of the key. The ECU transmits a door unlock request signal to the main body ECU.

d) The main body ECU receives the signal and operates each door lock motor to unlock all the doors and back door.

e) The certification ECU sounds the wireless door lock buzzer for 2 seconds as a response to unlock.



6) Warning

General

When any of the situations below occurs, the smart key system causes the certification ECU to sound a buzzer in the combination meter and the wireless door lock buzzer, and illuminate the smart key system warning light in order to alert the driver.

Situation	Condition
A	The shift lever is in a position other than “P” and the power source mode is in other than “OFF”.
B	The driver door is opened while the steering is unlocked.
C	The shift lever is in “P” and the power source mode is not “OFF”.
D	The entry lock is operated while any of the doors are open.
E	The occupant leaves with the key.
F	The engine switch is operated while the key is outside the actuation area.
G	The entry lock is operated while the key is inside the vehicle.
H	The key battery is low.
I	The steering lock cannot be released.
J	A steering lock ECU malfunction has been detected.
K	A main body ECU malfunction has been detected.

Situation: A

There are two patterns for situation A.
Pattern 1: The door is opened and the user tries to leave the vehicle.
Pattern 2: In addition to pattern 1, the user holds the key and tries to move away from the vehicle.
In these situations the following control is performed:

Pattern 1

Possible Effects without Warning		Sudden vehicle start, vehicle theft, vehicle roll-away
Warning Condition		The certification ECU gives a warning when all the following conditions are satisfied: ● Shift lever is not in “P”. ● Power source mode is not “OFF”. ● Driver door is opened. ● Vehicle speed is 0 mph (0 km/h).
Warning Stop Condition		The warning is stopped when one of the following conditions is met: ● Power source mode is “OFF”. ● Shift lever is in “P”. ● Driver door is closed. ● Vehicle speed is above 0 mph (0 km/h).
Combination Meter	Buzzer	Continuously sounds

Pattern 2

Possible Effects without Warning		Sudden vehicle start, vehicle theft, vehicle roll-away
Warning Condition		The certification ECU gives a warning when all the following conditions are satisfied: ● Shift lever is not in "P". ● Power source mode is not "OFF". ● The state of the driver door is changed from open to close. ● Vehicle speed is 0 mph (0 km/h). ● There is no key in the vehicle.
Warning Stop Condition		The warning is stopped when one of the following conditions is met: **Key is in the vehicle:** ● Buzzer and wireless door lock buzzer stop sounding. ● Smart key system warning light turns off. **Vehicle speed is available:** ● Buzzer and wireless door lock buzzer stop sounding. ● Smart key system warning light turns off. **Power source mode is not "ON":** ● All warnings stop.
Combination Meter	Buzzer	Continuously sounds
	Smart Key System Warning Light	Illuminates
Wireless Door Lock Buzzer		Continuously sounds

Situation: B

In this situation the following control is performed:

Possible Effects without Warning		Vehicle theft
Warning Condition		The certification ECU gives a warning when one of the following conditions is met: ● Power source mode is "ON (ACC)" or "OFF" and driver door is opened. ● Power source mode is "ON (ACC)" or "OFF", steering is unlocked and driver door is opened.
Warning Stop Condition		The warning is stopped when one of the following conditions is met: ● Power source mode is "IG (ON)" or driver door is closed. ● Power source mode is "ON (ACC)" or "OFF" and steering is locked.
Combination Meter	Buzzer	Intermittently sounds

Situation: C

There are two patterns for situation C.
Pattern 1: When the shift lever is in “P”, the door is closed and the user holds the key and tries to move away from the vehicle.
Pattern 2: In addition to pattern 1, the user tries to use the entry lock and presses the lock switch.
In these situations the following control is performed:

Pattern 1.

Possible Effects without Warning		Vehicle theft, engine cannot be restarted, auxiliary battery is depleted
Warning Condition		The certification ECU gives a warning when all the following conditions are satisfied: ● Shift lever is in “P”. ● Power source mode is not “OFF”. ● The state of the driver door changed from open to close. ● There is no key in the vehicle.
Warning Stop Condition		The warning is stopped when one of the following conditions is met: ● Power source mode is “OFF” ● There is a key in the vehicle.
Combination Meter	Buzzer	Sounds once
	Smart Key System Warning Light	Illuminates
Wireless Door Lock Buzzer		Sounds 3 times

Pattern 2.

Possible Effects without Warning	Vehicle theft, auxiliary battery is depleted
Warning Condition	The certification ECU gives a warning when all the following conditions are satisfied: ● Shift lever is in “P”. ● Power source mode is not “OFF”. ● All doors are closed. ● There is no key in the vehicle. ● Lock switch is pushed.
Warning Stop Condition	The warning is stopped when one of the following conditions is met: ● Power source mode is “ON (ACC)” or “OFF” and key is not in the vehicle’s exterior actuation area. (Certification result for the outside of the vehicle is NG.) ● There is a key in the vehicle. (Certification result for the inside of the vehicle is OK and that for the outside of the vehicle is NG.)
Wireless Door Lock Buzzer	Sounds for 60 seconds

Situation: D

In this situation the following control is performed:

Possible Effects without Warning	Vehicle theft
Warning Condition	The certification ECU gives a warning when all the following conditions are satisfied: ● Power source mode is “OFF”. ● Any door is opened. ● The entry lock is operated.
Warning Stop Condition	The warning is stopped when one of the following conditions is met: ● Power source mode is “ON (ACC)” or “ON (IG)”. ● All doors are closed. ● Doors are unlocked by the wireless door lock control function. ● 10 seconds has elapsed.
Wireless Door Lock Buzzer	Continuously sounds

Situation: E

In this situation the following control is performed.

Possible Effects without Warning		Engine cannot be restarted
Warning Condition		The certification ECU gives a warning when all the following conditions are satisfied: ● Power source mode is not “OFF”. ● The state of any door other than the driver door changed from open to close. ● Vehicle speed is 0 mph (0 km/h). ● There is no key in the vehicle.
Warning Stop Condition		The warning is stopped when one of the following conditions is met: ● Power source mode is “OFF”. ● There is a key in the vehicle.
Combination Meter	Buzzer	Sounds once
	Smart Key System Warning Light	Illuminates
Wireless Door Lock Buzzer		Sounds 3 times

Situation: F

In this situation the following control is performed:

Possible Effects without Warning		Confuses the driver
Warning Condition		The certification ECU gives a warning when all the following conditions are satisfied: ● Engine switch is pushed. ● There is no key in the vehicle.
Combination Meter	Buzzer	Sounds once
	Smart Key System Warning Light	Illuminates for 8 seconds

Situation: G

In this situation the following control is performed:

Possible Effects without Warning	Vehicle theft
Warning Condition	The certification ECU gives a warning when all the following conditions are satisfied: ● Power source mode is “OFF”. ● All doors are closed. ● Lock switch is pushed. ● There is a key in the vehicle.
Wireless Door Lock Buzzer	Sounds for 2 seconds

Situation: H

In this situation the following control is performed:

Possible Effects without Warning		Smart key system does not function
Warning Condition		The certification ECU gives a warning when all the following conditions are satisfied: ● Power source mode is switched to “OFF” after being left in “ON (IG)” for over 20 minutes. ● Key battery voltage is low. ● There is a key in the vehicle.
Combination Meter	Buzzer	Sounds once

Situation: I

In this situation the following control is performed:

Possible Effects without Warning	Smart key system does not function
Warning Condition	The steering lock does not release when performing the release operation, preventing the engine from starting.
Engine Switch Indicator Light	Green color blinks in 1-second cycles. (Stops blinking after 15 seconds have elapsed.)

Situation: J

In this situation the following control is performed:

Possible Effects without Warning	Engine cannot be started
Warning Condition	An internal malfunction in the steering lock ECU has been detected.
Warning Stop Condition	The internal malfunction in the steering lock ECU has been cleared.
Engine Switch Indicator Light	Amber light blinks in 2-second cycles.

Situation: K

In this situation the following control is performed:

Possible Effects without Warning	Engine cannot be started
Warning Condition	An internal malfunction in the main body ECU has been detected.
Warning Stop Condition	The internal malfunction in the main body ECU has been cleared.
Engine Switch Indicator Light	Amber light blinks in 2-second cycles.

7) Battery Saving

a. Vehicle Battery Saving Function

In the smart key system, signals are emitted outside of the vehicle at a prescribed interval (250 ms) when the doors are locked. Therefore, the vehicle battery could be drained if the vehicle remains parked for a long time. For this reason, the controls listed below are effected:

Condition	Control
No response from key for more than 5 days	Signal transmission interval is extended from 250 ms to 750 ms.
No response from key for more than 14 days	Automatically deactivates the smart key system.

▶ Reinstatement Conditions ◀

- A wireless door lock control signal (lock, unlock) is input and the key ID matches.
- A driver carries the key and pushes the lock switch of the outside door handle.
- A door is locked or unlocked by the mechanical key.

b. Key Battery and Vehicle Battery Saving Function

In the smart key system, if the key is constantly located within the vehicle's exterior actuation area of the door electrical key oscillators, the system maintains periodic communication with the key. Therefore, if the vehicle remains parked in that state for a long time, the key battery and the vehicle battery could be drained.
For this reason, if this state continues for longer than 10 minutes, the smart key system automatically deactivates.

▶ Reinstatement Conditions ◀

- A wireless door lock control signal (lock, unlock) is input and the key ID matches.
- The driver and pushes the lock switch of the outside door handle while carrying the key.
- A door is locked or unlocked by the mechanical key.

Service Tip

Leaving the key close to electrical appliances that emit radio waves could cause the key to accidentally respond, which could cause the key battery to become quickly depleted.

■AUDIO SYSTEM

1. General

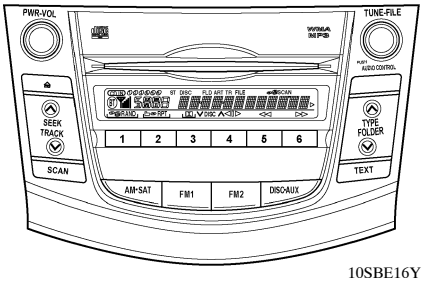
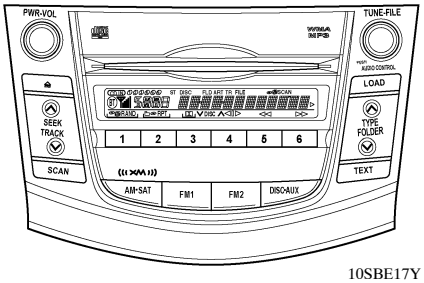
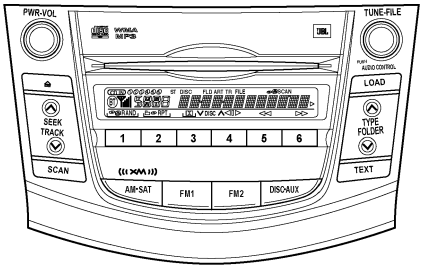
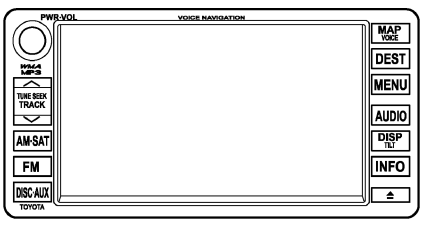
- The audio head units have been changed to support SDARS (Satellite Digital Audio Radio Service).
- The SDARS antenna is provided as standard equipment for all models.
- The AUX adapter has been relocated.
- A DISP switch is used for the steering pad switch.

2. Audio Head Unit

The audio head units have the following features:

▶ Specifications ◀

●: Standard OP: Option —: None

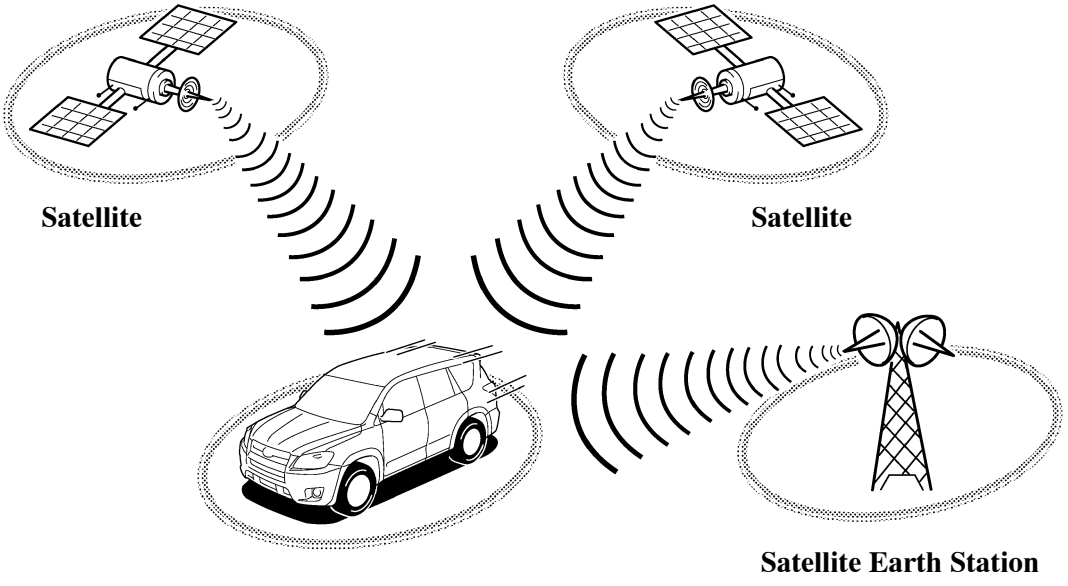
Design	Specification	Provided		
		Standard	Limited	Sport
 10SBE16Y	● AM/FM Tuner ● SDARS Ready ● CD Player ● CD-TEXT Display Function ● MP3 and WMA Playback Function ● 6-speaker System Manufacturer: Fujitsu TEN	●	—	●
 10SBE17Y	● AM/FM Tuner ● SDARS Tuner ● In-dash-6-CD Changer ● CD-TEXT Display Function ● MP3 and WMA Playback Function ● 6-speaker System Manufacturer: Matsushita Electric Industrial	OP	●	OP
 10SBE18Y	● AM/FM Tuner ● SDARS Tuner ● In-dash-6-CD Changer ● CD-TEXT Display Function ● MP3 and WMA Playback Function ● Bluetooth Hands-free Function ● JBL 9-speaker System Manufacturer: Matsushita Electric Industrial	—	OP	—
 10SBE19Y	● 6.5-inch LCD Type Display ● AM/FM Tuner ● SDARS Ready ● CD Player ● CD-TEXT Display Function ● MP3 and WMA Playback Function ● 6-speaker System Manufacturer: DENSO	—	OP	OP

3. SDARS (Satellite Digital Audio Radio Service)

General

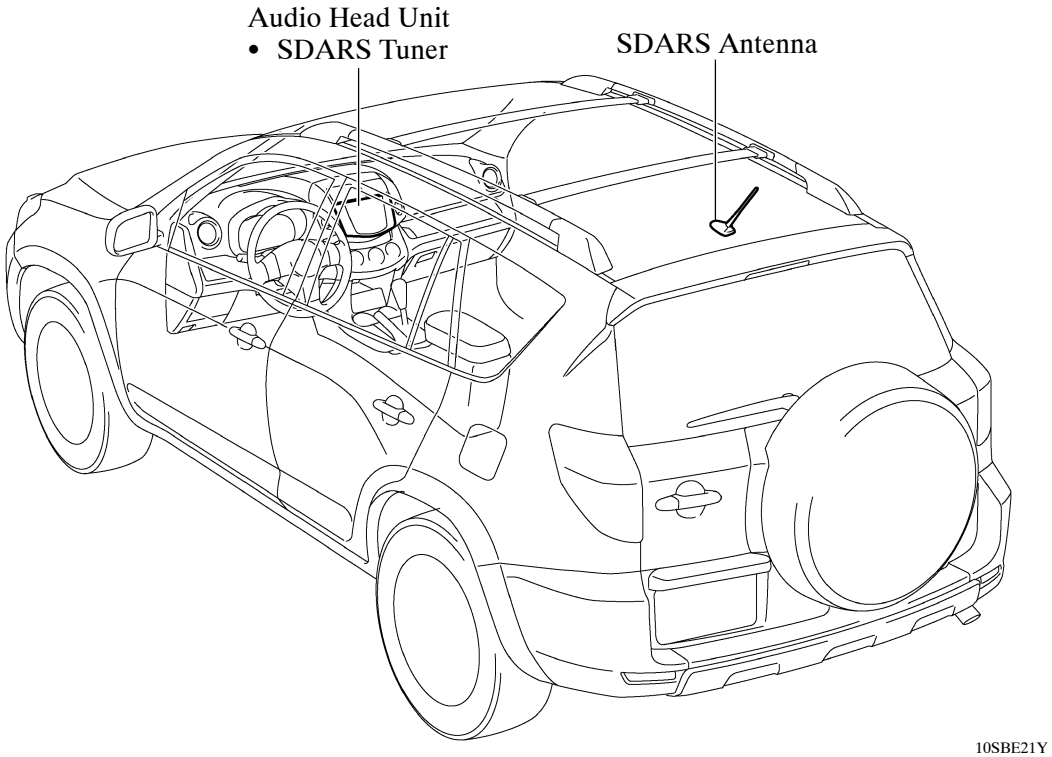
- The SDARS (Satellite Digital Audio Radio Seavice) uses digital radio broadcasts (XM satellite radio).
- The XM satellite radio is a type of pay digital broadcast service.
- The SDARS uses 2 stationary satellites to capture digital radio broadcasts (XM satellite radio) from over 170 channels. The XM satellite radio enables the users to constantly receive their favorite programs in any location in the U.S.A. (except Hawaii and Alaska) and Canada.
- Because it is digital broadcast, XM satellite radio produces high-quality sounds similar to CD. Because it uses satellites, its reception range is very wide. In addition to being able to receive broadcasts throughout the U.S.A. (except Hawaii and Alaska) and Canada, it can receive broadcasts even in Mexico along the border. Thus, users can listen to the same station anywhere in these areas. It is particularly convenient for long-distance drivers because it is not necessary to tune to different stations.
- In addition to the 2 satellites, the XM satellite radio is supported by 800 satellite earth stations. If the signals from the satellites are disrupted by a tunnel, a gulch, or high-rise buildings, a simultaneous broadcast (called “gap filler”) through ground waves helps achieve excellent reception that is free of interruptions.

▶ System Image ◀



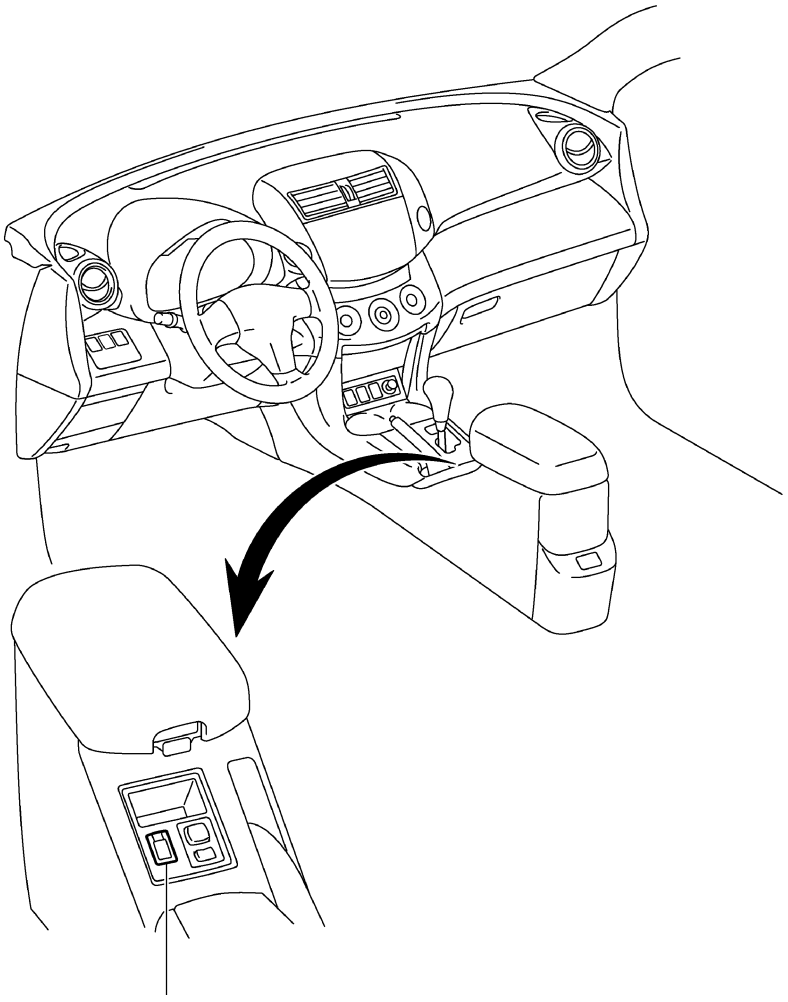
10SBE20Y

Layout of Main Components



4. AUX Adapter

The AUX adapter has been relocated to the console.

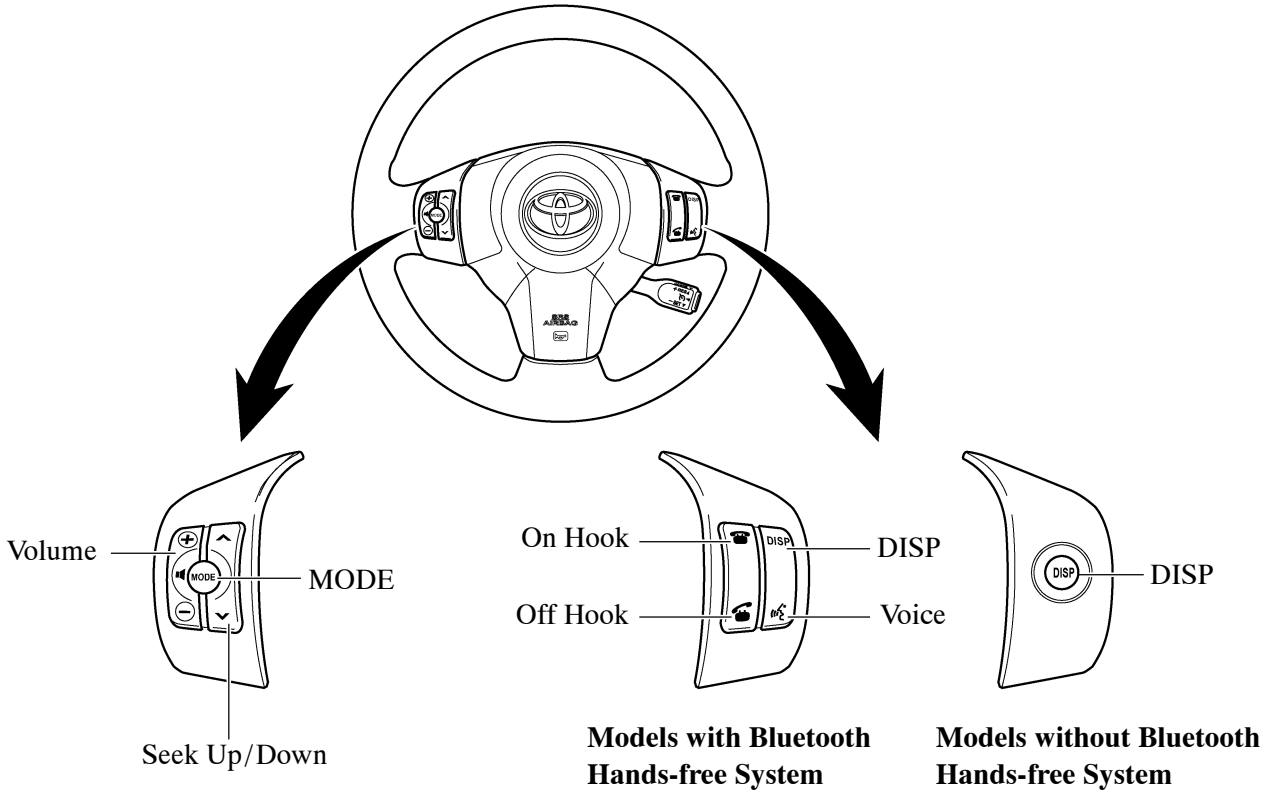


5. Steering Pad Switch

- A DISP switch has been added.
- The steering pad switches that are provided on the steering pad may vary depending on optional equipment, as indicated in the table below:

: New

System	Switch	Equipment		
		Standard Grade	Limited Grade	Sport Grade
Audio	● Volume ● MODE ● Seek Up/Down	—	Standard	Option
Voice Recogning	Voice	—	Option	Option
Telephone	● On Hook ● Off Hook	—	Option	Option
Multi-information Display	DISP	Standard	Standard	Standard



10SBE40Y

MAJOR TECHNICAL SPECIFICATIONS

Item \ Area				U.S.A.			
Body Type				5-door Wagon			
Vehicle Grade				Standard (4WD)	Limited (4WD)	Sport (4WD)	Standard (2WD)
Model Code				ASA33L-A(C)NPXKA	ASA33L-A(C)NPGKA	ASA33L-A(C)NPSKA	ASA38L-A(C)NPXKA
Major Dimensions & Vehicle Weights	Overall	Length	mm (in.)	4570 (180.0)*2, 4575 (180.1)*3	4600 (181.1)	4580 (180.3)	4570 (180.0)*2, 4575 (180.1)*3
		Width	mm (in.)	1815 (71.5)	1815 (71.5), 1855 (73.0)*4	1855 (73.0)	1815 (71.5)
		Height*1	mm (in.)	1685 (66.3), 1745 (68.7)*5 1690 (66.5)*6, 1755 (69.1)*5, 6	1745 (68.7), 1755 (69.1)*6	1745 (68.7)	1685 (66.3), 1745 (68.7)*5 1690 (66.5)*6, 1755 (69.1)*5, 6
	Wheel Base		mm (in.)	2660 (104.7)	2660 (104.7)	2660 (104.7)	2660 (104.7)
	Tread	Front	mm (in.)	1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)
		Rear	mm (in.)	1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)
	Effective Head Room	Front	mm (in.)	1037 (40.8)	1037 (40.8), 1002 (39.4)*7	1037 (40.8), 1002 (39.4)*7	1037 (40.8)
		Rear	mm (in.)	1009 (39.7)	1009 (39.7)	1009 (39.7)	1009 (39.7)
	Effective Leg Room	Front	mm (in.)	1075 (42.3)	1075 (42.3)	1075 (42.3)	1075 (42.3)
		Rear	mm (in.)	940 (37.0)	940 (37.0)	940 (37.0)	940 (37.0)
	Shoulder Room	Front	mm (in.)	1450 (57.1)	1450 (57.1)	1450 (57.1)	1450 (57.1)
		Rear	mm (in.)	1405 (55.3)	1405 (55.3)	1405 (55.3)	1405 (55.3)
	Overhang	Front	mm (in.)	855 (33.7)	855 (33.7)	855 (33.7)	855 (33.7)
		Rear	mm (in.)	1085 (42.7)	1085 (42.7)	1085 (42.7)	1085 (42.7)
	Min. Running Ground Clearance		mm (in.)	190 (7.5)	190 (7.5)	190 (7.5)	190 (7.5)
	Angle of Approach		degrees	29	29	29	29
	Angle of Departure		degrees	25	25	25	25
	Curb Weight	Front	kg (lb)	917 (2022)	925 (2039)	928 (2046)	892 (1967)
		Rear	kg (lb)	668 (1473)	697 (1537)	691 (1523)	632 (1393)
		Total	kg (lb)	1585 (3494)	1622 (3576)	1619 (3569)	1524 (3360)
	Gross Vehicle Weight	Front	kg (lb)	—	—	—	—
		Rear	kg (lb)	—	—	—	—
		Total (2nd / 3rd)	kg (lb)	2055 (4535) / 2205 (4865)	2055 (4535) / 2205 (4865)	2055 (4535) / —	2005 (4430) / 2145 (4730)
	Fuel Tank Capacity		ℓ (US.gal., Imp.gal.)	60 (13.2)	60 (13.2)	60 (13.2)	60 (13.2)
	Luggage Compartment Capacity		m^3 (cu.ft.)	—	—	—	—
Performance	Max. Speed		km / h (mph)	—	—	—	—
	Max. Cruising Speed		km / h (mph)	—	—	—	—
	Acceleration	0 to 60 mph	sec.	—	—	—	—
		0 to 400m	sec.	—	—	—	—
	Max. Permissible Speed	1st Gear	km / h (mph)	—	—	—	—
		2nd Gear	km / h (mph)	—	—	—	—
		3rd Gear	km / h (mph)	—	—	—	—
		4th Gear	km / h (mph)	—	—	—	—
	Turning Diameter (Outside Front)	Wall to Wall	m (ft.)	5.7 (18.7)	5.7 (18.7)	6.0 (19.7)	5.7 (18.7)
		Curb to Curb	m (ft.)	5.3 (17.4)	5.3 (17.4)	5.6 (18.4)	5.3 (17.4)
Engine	Engine Type			2AR-FE	2AR-FE	2AR-FE	2AR-FE
	Valve Mechanism			16-valve DOHC with Dual VVT-i	16-valve DOHC with Dual VVT-i	16-valve DOHC with Dual VVT-i	16-valve DOHC with Dual VVT-i
	Bore × Stroke		mm (in.)	90.0 × 98.0 (3.54 × 3.86)	90.0 × 98.0 (3.54 × 3.86)	90.0 × 98.0 (3.54 × 3.86)	90.0 × 98.0 (3.54 × 3.86)
	Displacement		cm^3 (cu.in.)	2494 (152.2)	2494 (152.2)	2494 (152.2)	2494 (152.2)
	Compression Ratio			10.4 : 1	10.4 : 1	10.4 : 1	10.4 : 1
	Fuel System			SFI	SFI	SFI	SFI
	Octane Rating			87 or higher	87 or higher	87 or higher	87 or higher
	Max. Output (SAE-NET)		kW / rpm (HP / rpm)	134 / 6000 (180 / 6000)	134 / 6000 (180 / 6000)	134 / 6000 (180 / 6000)	134 / 6000 (180 / 6000)
	Max. Torque (SAE-NET)		N·m / rpm (ft-lb / rpm)	235 / 4100 (173 / 4100)	235 / 4100 (173 / 4100)	235 / 4100 (173 / 4100)	235 / 4100 (173 / 4100)
Engine Electrical	Battery Capacity (5HR)		Voltage & Amp. hr.	12 - 55	12 - 55	12 - 55	12 - 55
	Generator Output		Watts	1200	1200	1200	1200
	Starter Output		kW	1.7	1.7	1.7	1.7
Chassis	Clutch Type			—	—	—	—
	Transmission Type			U140F	U140F	U140F	U241E
	Gear Ratio (Counter Gear Ratio Included)	In First		3.938	3.938	3.938	3.943
		In Second		2.194	2.194	2.194	2.197
		In Third		1.411	1.411	1.411	1.413
		In Fourth		1.019	1.019	1.019	1.020
		In Fifth		—	—	—	—
		In Reverse		3.141	3.141	3.141	3.145
	Differential Gear Ratio (Final)			3.080	3.080	3.080	2.923
	Transfer / Differential Gear Ratio			0.439 / 2.277	0.439 / 2.277	0.439 / 2.277	—
	Rear Differential Gear Size		mm (in.)	135 (5.3)	135 (5.3)	135 (5.3)	—
	Brake Type	Front		Ventilated Disc	Ventilated Disc	Ventilated Disc	Ventilated Disc
		Rear		Solid Disc	Solid Disc	Solid Disc	Solid Disc
	Parking Brake Type			Duo-servo Drum	Duo-servo Drum	Duo-servo Drum	Duo-servo Drum
	Brake Booster Type and Size		in.	Single, 10	Single, 10	Single, 10	Single, 10
	Proportioning Valve Type			—	—	—	—
	Suspension Type	Front		MacPherson Strut	MacPherson Strut	MacPherson Strut	MacPherson Strut
		Rear		Double-wishbone	Double-wishbone	Double-wishbone	Double-wishbone
	Stabilizer Bar	Front		Standard	Standard	Standard	Standard
		Rear		Standard	Standard	Standard	—, Option*6
	Steering Gear Type			Rack and Pinion	Rack and Pinion	Rack and Pinion	Rack and Pinion
	Steering Gear Ratio (Overall)			14.4	14.4	14.6	14.4
	Power Steering Type			Electric Motor	Electric Motor	Electric Motor	Electric Motor

*1: Unladen vehicle
*2: With 215 / 70R16 tire
*3: With 225 / 65R17 tire
*4: With over-fender
*5: With roof rail
*6: With rear No. 2 seat
*7: With sliding roof
*8: Option
*9: With run-flat tire

U.S.A.					
5-door Wagon					
Limited (2WD)	Sport (2WD)	Standard (4WD)	Limited (4WD)	Sport (4WD)	Standard (2WD)
ASA38L-A(C)NPGKA	ASA38L-A(C)NPSKA	GSA33L-A(C)NAXKA	GSA33L-A(C)NAGKA	GSA33L-A(C)NASKA	GSA38L-A(C)NAXKA
4600 (181.1)	4580 (180.3)	4570 (180.0)*2, 4575 (180.1)*3	4600 (181.1)	4580 (180.3), 4500 (177.2)*9	4570 (180.0)*2, 4575 (180.1)*3
1815 (71.5), 1855 (73.0)*4	1855 (73.0)	1815 (71.5)	1815 (71.5), 1855 (73.0)*4	1855 (73.0)	1815 (71.5)
1745 (68.7), 1755 (69.1)*6	1745 (68.7)	1685 (66.3), 1745 (68.7)*5 1690 (66.5)*6, 1755 (69.1)*5, 6	1745 (68.7), 1755 (69.1)*6	1745 (68.7)	1685 (66.3), 1745 (68.7)*5 1690 (66.5)*6, 1755 (69.1)*5, 6
2660 (104.7)	2660 (104.7)	2660 (104.7)	2660 (104.7)	2660 (104.7)	2660 (104.7)
1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)
1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)
1037 (40.8), 1002 (39.4)*7	1037 (40.8), 1002 (39.4)*7	1037 (40.8)	1037 (40.8), 1002 (39.4)*7	1037 (40.8), 1002 (39.4)*7	1037 (40.8)
1009 (39.7)	1009 (39.7)	1009 (39.7)	1009 (39.7)	1009 (39.7)	1009 (39.7)
1075 (42.3)	1075 (42.3)	1075 (42.3)	1075 (42.3)	1075 (42.3)	1075 (42.3)
940 (37.0)	940 (37.0)	940 (37.0)	940 (37.0)	940 (37.0)	940 (37.0)
1450 (57.1)	1450 (57.1)	1450 (57.1)	1450 (57.1)	1450 (57.1)	1450 (57.1)
1405 (55.3)	1405 (55.3)	1405 (55.3)	1405 (55.3)	1405 (55.3)	1405 (55.3)
855 (33.7)	855 (33.7)	855 (33.7)	855 (33.7)	855 (33.7)	855 (33.7)
1085 (42.7)	1085 (42.7)	1085 (42.7)	1085 (42.7)	1085 (42.7)	1085 (42.7)
190 (7.5)	190 (7.5)	190 (7.5)	190 (7.5)	190 (7.5)	190 (7.5)
29	29	29	29	29	29
25	25	25	25	25	25
900 (1984)	903 (1991)	975 (2150)	975 (2150)	979 (2158)	950 (2094)
660 (1455)	655 (1444)	690 (1521)	703 (1550)	699 (1541)	651 (1435)
1560 (3439)	1558 (3435)	1665 (3671)	1678 (3699)	1678 (3699)	1601 (3530)
—	—	—	—	—	—
—	—	—	—	—	—
2005 (4430) / 2145 (4730)	2005 (4430) / —	2140 (4720) / 2270 (5015)	2140 (4720) / 2270 (5015)	2140 (4720) / —	2085 (4600) / 2220 (4895)
60 (13.2)	60 (13.2)	60 (13.2)	60 (13.2)	60 (13.2)	60 (13.2)
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
5.7 (18.7)	6.0 (19.7)	6.0 (19.7)	6.0 (19.7)	6.0 (19.7)	6.0 (19.7)
5.3 (17.4)	5.6 (18.4)	5.6 (18.4)	5.6 (18.4)	5.6 (18.4)	5.6 (18.4)
2AR-FE	2AR-FE	2GR-FE	2GR-FE	2GR-FE	2GR-FE
16-valve DOHC with Dual VVT-i	16-valve DOHC with Dual VVT-i	24-valve, DOHC	24-valve, DOHC	24-valve, DOHC	24-valve, DOHC
90.0 × 98.0 (3.54 × 3.86)	90.0 × 98.0 (3.54 × 3.86)	94.0 × 83.0 (3.70 × 3.27)	94.0 × 83.0 (3.70 × 3.27)	94.0 × 83.0 (3.70 × 3.27)	94.0 × 83.0 (3.70 × 3.27)
2494 (152.2)	2494 (152.2)	3456 (210.9)	3456 (210.9)	3456 (210.9)	3456 (210.9)
10.4 : 1	10.4 : 1	10.8 : 1	10.8 : 1	10.8 : 1	10.8 : 1
SFI	SFI	SFI	SFI	SFI	SFI
87 or higher	87 or higher	91 or higher	91 or higher	91 or higher	91 or higher
134 / 6000 (180 / 6000)	134 / 6000 (180 / 6000)	200 / 6200 (268 / 6200)	200 / 6200 (268 / 6200)	200 / 6200 (268 / 6200)	200 / 6200 (268 / 6200)
235 / 4100 (173 / 4100)	235 / 4100 (173 / 4100)	336 / 4700 (248 / 4700)	336 / 4700 (248 / 4700)	336 / 4700 (248 / 4700)	336 / 4700 (248 / 4700)
12 - 55	12 - 55	12 - 55	12 - 55	12 - 55	12 - 55
1200	1200	1200, 1800*8	1200, 1800*8	1200, 1800*8	1200, 1800*8
1.7	1.7	1.7	1.7	1.7	1.7
—	—	—	—	—	—
U241E	U241E	U151F	U151F	U151F	U151E
3.943	3.943	4.235	4.235	4.235	4.235
2.197	2.197	2.360	2.360	2.360	2.360
1.413	1.413	1.517	1.517	1.517	1.517
1.020	1.020	1.047	1.047	1.047	1.047
—	—	0.756	0.756	0.756	0.756
3.145	3.145	3.378	3.378	3.378	3.378
2.923	2.923	3.080	3.080	3.080	3.080
—	—	0.439 / 2.277	0.439 / 2.277	0.439 / 2.277	—
—	—	135 (5.3)	135 (5.3)	135 (5.3)	—
Ventilated Disc	Ventilated Disc	Ventilated Disc	Ventilated Disc	Ventilated Disc	Ventilated Disc
Solid Disc	Solid Disc	Solid Disc	Solid Disc	Solid Disc	Solid Disc
Duo-servo Drum	Duo-servo Drum	Duo-servo Drum	Duo-servo Drum	Duo-servo Drum	Duo-servo Drum
Single, 10	Single, 10	Single, 10	Single, 10	Single, 10	Single, 10
—	—	—	—	—	—
MacPherson Strut	MacPherson Strut	MacPherson Strut	MacPherson Strut	MacPherson Strut	MacPherson Strut
Double-wishbone	Double-wishbone	Double-wishbone	Double-wishbone	Double-wishbone	Double-wishbone
Standard	Standard	Standard	Standard	Standard	Standard
—, Option*6	—	Standard	Standard	Standard	Standard
Rack and Pinion	Rack and Pinion	Rack and Pinion	Rack and Pinion	Rack and Pinion	Rack and Pinion
14.4	14.6	14.4	14.4	14.6	14.4
Electric Motor	Electric Motor	Electric Motor	Electric Motor	Electric Motor	Electric Motor

Item \ Area				U.S.A.		Canada	
Body Type				5-door Wagon			
Vehicle Grade				Limited (2WD)	Sport (2WD)	Standard (4WD)	Limited (4WD)
Model Code				GSA38L-A(C)NAGKA	GSA38L-A(C)NASKA	ASA33L-A(C)NPXKK	ASA33L-A(C)NPGKK
Major Dimensions & Vehicle Weights	Overall	Length	mm (in.)	4600 (181.1)	4580 (180.3)	4570 (180.0)*2, 4575 (180.1)*3	4600 (181.1)
		Width	mm (in.)	1815 (71.5), 1855 (73.0)*4	1855 (73.0)	1815 (71.5)	1815 (71.5), 1855 (73.0)*4
		Height*1	mm (in.)	1745 (68.7), 1755 (69.1)*6	1745 (68.7)	1685 (66.3), 1745 (68.7)*5 1690 (66.5)*6, 1755 (69.1)*5, 6	1745 (68.7), 1755 (69.1)*6
	Wheel Base		mm (in.)	2660 (104.7)	2660 (104.7)	2660 (104.7)	2660 (104.7)
	Tread	Front	mm (in.)	1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)
		Rear	mm (in.)	1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)
	Effective Head Room	Front	mm (in.)	1037 (40.8), 1002 (39.4)*7	1037 (40.8), 1002 (39.4)*7	1037 (40.8)	1037 (40.8), 1002 (39.4)*7
		Rear	mm (in.)	1009 (39.7)	1009 (39.7)	1009 (39.7)	1009 (39.7)
	Effective Leg Room	Front	mm (in.)	1075 (42.3)	1075 (42.3)	1075 (42.3)	1075 (42.3)
		Rear	mm (in.)	940 (37.0)	940 (37.0)	940 (37.0)	940 (37.0)
	Shoulder Room	Front	mm (in.)	1450 (57.1)	1450 (57.1)	1450 (57.1)	1450 (57.1)
		Rear	mm (in.)	1405 (55.3)	1405 (55.3)	1405 (55.3)	1405 (55.3)
	Overhang	Front	mm (in.)	855 (33.7)	855 (33.7)	855 (33.7)	855 (33.7)
		Rear	mm (in.)	1085 (42.7)	1085 (42.7)	1085 (42.7)	1085 (42.7)
	Min. Running Ground Clearance		mm (in.)	190 (7.5)	190 (7.5)	190 (7.5)	190 (7.5)
	Angle of Approach		degrees	29	29	29	29
	Angle of Departure		degrees	25	25	25	25
	Curb Weight	Front	kg (lb)	950 (2094)	954 (2103)	912 (2011)	923 (2035)
		Rear	kg (lb)	665 (1466)	661 (1457)	667 (1470)	692 (1526)
		Total	kg (lb)	1615 (3560)	1615 (3560)	1579 (3481)	1615 (3560)
	Gross Vehicle Weight	Front	kg (lb)	—	—	—	—
		Rear	kg (lb)	—	—	—	—
		Total (2nd / 3rd)	kg (lb)	2085 (4600) / 2220 (4895)	2085 (4600) / —	2055 (4535) / 2205 (4865)	2055 (4535) / 2205 (4865)
	Fuel Tank Capacity		ℓ (US.gal., Imp.gal.)	60 (13.2)	60 (13.2)	60 (13.2)	60 (13.2)
	Luggage Compartment Capacity		m^3 (cu.ft.)	—	—	—	—
Performance	Max. Speed		km / h (mph)	—	—	—	—
	Max. Cruising Speed		km / h (mph)	—	—	—	—
	Acceleration	0 to 60 mph	sec.	—	—	—	—
		0 to 400m	sec.	—	—	—	—
	Max. Permissible Speed	1st Gear	km / h (mph)	—	—	—	—
		2nd Gear	km / h (mph)	—	—	—	—
		3rd Gear	km / h (mph)	—	—	—	—
		4th Gear	km / h (mph)	—	—	—	—
	Turning Diameter (Outside Front)	Wall to Wall	m (ft.)	6.0 (19.7)	6.0 (19.7)	5.7 (18.7)	5.7 (18.7)
		Curb to Curb	m (ft.)	5.6 (18.4)	5.6 (18.4)	5.3 (17.4)	5.3 (17.4)
Engine	Engine Type			2GR-FE	2GR-FE	2AR-FE	2AR-FE
	Valve Mechanism			24-valve, DOHC	24-valve, DOHC	16-valve DOHC with Dual VVT-i	16-valve DOHC with Dual VVT-i
	Bore × Stroke		mm (in.)	94.0 × 83.0 (3.70 × 3.27)	94.0 × 83.0 (3.70 × 3.27)	90.0 × 98.0 (3.54 × 3.86)	90.0 × 98.0 (3.54 × 3.86)
	Displacement		cm^3 (cu.in.)	3456 (210.9)	3456 (210.9)	2494 (152.2)	2494 (152.2)
	Compression Ratio			10.8 : 1	10.8 : 1	10.4 : 1	10.4 : 1
	Fuel System			SFI	SFI	SFI	SFI
	Octane Rating			91 or higher	91 or higher	87 or higher	87 or higher
	Max. Output (SAE-NET)		kW / rpm (HP / rpm)	200 / 6200 (268 / 6200)	200 / 6200 (268 / 6200)	134 / 6000 (180 / 6000)	134 / 6000 (180 / 6000)
	Max. Torque (SAE-NET)		N·m / rpm (ft-lb / rpm)	336 / 4700 (248 / 4700)	336 / 4700 (248 / 4700)	235 / 4100 (173 / 4100)	235 / 4100 (173 / 4100)
Engine Electrical	Battery Capacity (5HR)		Voltage & Amp. hr.	12 - 55	12 - 55	12 - 55	12 - 55
	Generator Output		Watts	1200, 1800*8	1200, 1800*8	1200	1200
	Starter Output		kW	1.7	1.7	1.7	1.7
Chassis	Clutch Type			—	—	—	—
	Transmission Type			U151E	U151E	U140F	U140F
	Gear Ratio (Counter Gear Ratio Included)	In First		4.235	4.235	3.938	3.938
		In Second		2.360	2.360	2.194	2.194
		In Third		1.517	1.517	1.411	1.411
		In Fourth		1.047	1.047	1.019	1.019
		In Fifth		0.576	0.576	—	—
		In Reverse		3.378	3.378	3.141	3.141
	Differential Gear Ratio (Final)			3.080	3.080	3.080	3.080
	Transfer / Differential Gear Ratio			—	—	0.439 / 2.227	0.439 / 2.227
	Rear Differential Gear Size		mm (in.)	—	—	135 (5.3)	135 (5.3)
	Brake Type	Front		Ventilated Disc	Ventilated Disc	Ventilated Disc	Ventilated Disc
		Rear		Solid Disc	Solid Disc	Solid Disc	Solid Disc
	Parking Brake Type			Duo-servo Drum	Duo-servo Drum	Duo-servo Drum	Duo-servo Drum
	Brake Booster Type and Size		in.	Single, 10	Single, 10	Single, 10	Single, 10
	Proportioning Valve Type			—	—	—	—
	Suspension Type	Front		MacPherson Strut	MacPherson Strut	MacPherson Strut	MacPherson Strut
		Rear		Double-wishbone	Double-wishbone	Double-wishbone	Double-wishbone
	Stabilizer Bar	Front		Standard	Standard	Standard	Standard
		Rear		Standard	Standard	Standard	Standard
	Steering Gear Type			Rack and Pinion	Rack and Pinion	Rack and Pinion	Rack and Pinion
	Steering Gear Ratio (Overall)			14.4	14.6	14.4	14.4
	Power Steering Type			Electric Motor	Electric Motor	Electric Motor	Electric Motor

*1: Unladen vehicle
*2: With 215 / 70R16 tire
*3: With 225 / 65R17 tire
*4: With over-fender
*5: With roof rail
*6: With rear No. 2 seat
*7: With sliding roof
*8: Option
*9: With run-flat tire

Canada			
5-door Wagon			
Sport (4WD)	Standard (4WD)	Limited (4WD)	Sport (4WD)
ASA33L-A(C)NPSKK	GSA33L-A(C)NAXKK	GSA33L-A(C)NAGKK	GSA33L-A(C)NASKK
4580 (180.3)	4570 (180.0)*2, 4575 (180.1)*3	4600 (181.1)	4580 (180.3), 4500 (177.2)*9
1855 (73.0)	1815 (71.5)	1815 (71.5), 1855 (73.0)*4	1855 (73.0)
1745 (68.7)	1685 (66.3), 1745 (68.7)*5 1690 (66.5)*6, 1755 (69.1)*5, 6	1745 (68.7), 1755 (69.1)*6	1745 (68.7)
2660 (104.7)	2660 (104.7)	2660 (104.7)	2660 (104.7)
1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)
1560 (61.4)	1560 (61.4)	1560 (61.4)	1560 (61.4)
1037 (40.8), 1002 (39.4)*7	1037 (40.8)	1037 (40.8), 1002 (39.4)*7	1037 (40.8), 1002 (39.4)*7
1009 (39.7)	1009 (39.7)	1009 (39.7)	1009 (39.7)
1075 (42.3)	1075 (42.3)	1075 (42.3)	1075 (42.3)
940 (37.0)	940 (37.0)	940 (37.0)	940 (37.0)
1450 (57.1)	1450 (57.1)	1450 (57.1)	1450 (57.1)
1405 (55.3)	1405 (55.3)	1405 (55.3)	1405 (55.3)
855 (33.7)	855 (33.7)	855 (33.7)	855 (33.7)
1085 (42.7)	1085 (42.7)	1085 (42.7)	1085 (42.7)
190 (7.5)	190 (7.5)	190 (7.5)	190 (7.5)
29	29	29	29
25	25	25	25
923 (2035)	971 (2141)	973 (2145)	975 (2150)
690 (1521)	687 (1515)	699 (1541)	697 (1537)
1613 (3556)	1658 (3655)	1672 (3686)	1672 (3686)
—	—	—	—
—	—	—	—
2055 (4535) / —	2140 (4720) / 2270 (5015)	2140 (4720) / 2270 (5015)	2140 (4720) / —
60 (13.2)	60 (13.2)	60 (13.2)	60 (13.2)
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
6.0 (19.7)	6.0 (19.7)	6.0 (19.7)	6.0 (19.7)
5.6 (18.4)	5.6 (18.4)	5.6 (18.4)	5.6 (18.4)
2AR-FE	2GR-FE	2GR-FE	2GR-FE
16-valve DOHC with Dual VVT-i	24-valve, DOHC	24-valve, DOHC	24-valve, DOHC
90.0 × 98.0 (3.54 × 3.86)	94.0 × 83.0 (3.70 × 3.27)	94.0 × 83.0 (3.70 × 3.27)	94.0 × 83.0 (3.70 × 3.27)
2494 (152.2)	3456 (210.9)	3456 (210.9)	3456 (210.9)
10.4 : 1	10.8 : 1	10.8 : 1	10.8 : 1
SFI	SFI	SFI	SFI
87 or higher	91 or higher	91 or higher	91 or higher
134 / 6000 (180 / 6000)	200 / 6200 (268 / 6200)	200 / 6200 (268 / 6200)	200 / 6200 (268 / 6200)
235 / 4100 (173 / 4100)	336 / 4700 (248 / 4700)	336 / 4700 (248 / 4700)	336 / 4700 (248 / 4700)
12 - 55	12 - 55	12 - 55	12 - 55
1200	1200, 1800*8	1200, 1800*8	1200, 1800*8
1.7	1.7	1.7	1.7
—	—	—	—
U140F	U151F	U151F	U151F
3.938	4.235	4.235	4.235
2.194	2.360	2.360	2.360
1.411	1.517	1.517	1.517
1.019	1.047	1.047	1.047
—	0.576	0.576	0.576
3.141	3.378	3.378	3.378
3.080	3.080	3.080	3.080
0.439 / 2.227	0.439 / 2.227	0.439 / 2.227	0.439 / 2.227
135 (5.3)	135 (5.3)	135 (5.3)	135 (5.3)
Ventilated Disc	Ventilated Disc	Ventilated Disc	Ventilated Disc
Solid Disc	Solid Disc	Solid Disc	Solid Disc
Duo-servo Drum	Duo-servo Drum	Duo-servo Drum	Duo-servo Drum
Single, 10	Single, 10	Single, 10	Single, 10
—	—	—	—
MacPherson Strut	MacPherson Strut	MacPherson Strut	MacPherson Strut
Double-wishbone	Double-wishbone	Double-wishbone	Double-wishbone
Standard	Standard	Standard	Standard
Standard	Standard	Standard	Standard
Rack and Pinion	Rack and Pinion	Rack and Pinion	Rack and Pinion
14.6	14.4	14.4	14.6
Electric Motor	Electric Motor	Electric Motor	Electric Motor

– MEMO –