TO FOREWORD

GENERAL INFORMATION

OUTLINE

VEHICLE IDENTIFICATION

OUTLINE

Model Line-UP

MODEL CODE(GENERAL SPECIFICATIONS)

<table>
<tr><th>Body type</th><th>Drive</th><th>Engine</th><th>Transmission</th><th>Seating Capacity</th><th>Steering position</th><th>Grade</th><th colspan="2">Model code</th></tr>
<tr><td rowspan="6">Station wagon</td><td rowspan="2">4WD</td><td rowspan="6">3SZ-VE</td><td>5M/T(M5S)</td><td rowspan="6">5</td><td rowspan="2">RHD</td><td rowspan="6">DX</td><td rowspan="2">J210RG</td><td>GMDF</td></tr>
<tr><td>Electronic control 4A/T(A4Q-D1)</td><td>GQDF</td></tr>
<tr><td rowspan="2">2WD</td><td>5M/T(M5S)</td><td rowspan="4">LHD</td><td rowspan="2">J200LG</td><td>GMDF</td></tr>
<tr><td>Electronic control 4A/T(A4Q-D1)</td><td>GQDF</td></tr>
<tr><td rowspan="2">4WD</td><td>5M/T(M5S)</td><td rowspan="2">J210LG</td><td>GMDF</td></tr>
<tr><td>Electronic control 4A/T(A4Q-D1)</td><td>GQDF</td></tr>
</table>

MODEL CODE(EUROPE SPECIFICATIONS)

<table>
<tr><th>Body type</th><th>Drive</th><th>Engine</th><th>Transmission</th><th>Seating Capacity</th><th>Steering position</th><th>Grade</th><th colspan="2">Model code</th></tr>
<tr><td rowspan="11">Station wagon</td><td>2WD</td><td rowspan="10">3SZ-VE</td><td>5M/T(M5S)</td><td rowspan="11">5</td><td rowspan="4">RHD</td><td rowspan="2">DX</td><td>J200RG</td><td>GMDFW</td></tr>
<tr><td rowspan="3">4WD</td><td>Electronic control 4A/T(A4Q-D1)</td><td rowspan="3">J210RG</td><td>GQDFW</td></tr>
<tr><td>5M/T(M5S)</td><td rowspan="2">SX</td><td>GMXFW</td></tr>
<tr><td>Electronic control 4A/T(A4Q-D1)</td><td>GQXFW</td></tr>
<tr><td rowspan="2">2WD</td><td>5M/T(M5S)</td><td rowspan="7">LHD</td><td rowspan="4">DX</td><td rowspan="2">J200LG</td><td>GMDFW</td></tr>
<tr><td>Electronic control 4A/T(A4Q-D1)</td><td>GQDFW</td></tr>
<tr><td rowspan="5">4WD</td><td>5M/T(M5S)</td><td rowspan="4">J210LG</td><td>GMDFW</td></tr>
<tr><td>Electronic control 4A/T(A4Q-D1)</td><td>GQDFW</td></tr>
<tr><td>5M/T(M5S)</td><td rowspan="2">SX</td><td>GMXFW</td></tr>
<tr><td>Electronic control 4A/T(A4Q-D1)</td><td>GQXFW</td></tr>
<tr><td>K3-VE</td><td>5M/T(M5S)</td><td>DX</td><td>J211LG</td><td>GMDFW</td></tr>
</table>

Model Code

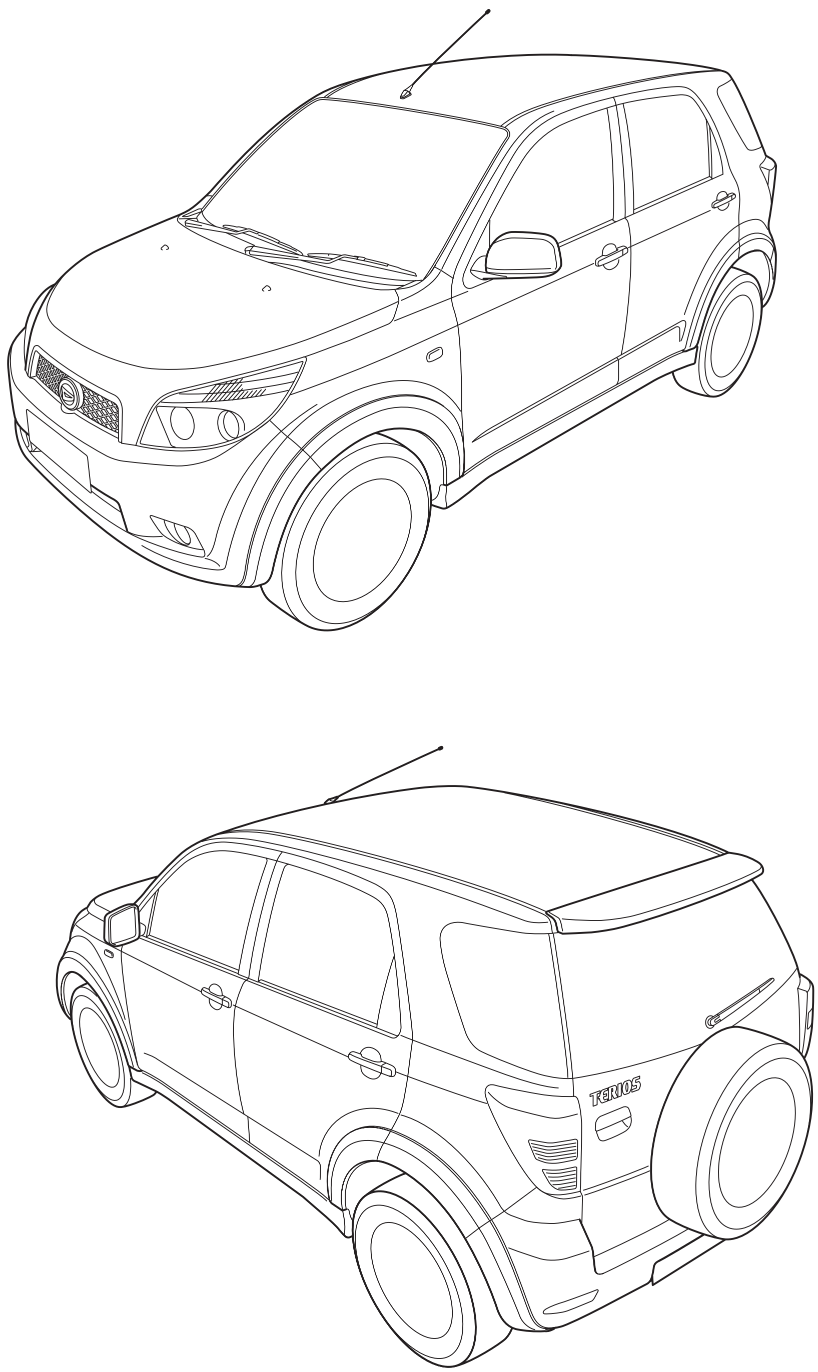
J2	1	0	L	G	—	G	M	X	F	W
1	2	3	4	5		6	7	8	9	10

A1270001S-D

EXPLANATION OF VEHICLE MODEL CODE

1	Model
	J2:TERIOS
2	Drive
	0:2WD
	1:4WD
3	Engine
	0:3SZ-VE
	1:K3-VE
4	Steering
	L:LHD
	R:RHD
5	Body type
	G:Wagon
6	Door
	G:5-door
7	Transmission
	M:5M/T
	Q:Electronic control 4A/T
8	Grade
	D:DX
	X:SX
9	Engine
	F:VVT engine
10	Market
	None:General
	W:EU

Exterior Appearance



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Specifications

SPECIFICATIONS(J200LG/J200RG)

Items				J200LG/J200RG			
				GMDF	GQDF	GMDFW	GQDFW
			Engine	3SZ-VE			
			Market	General		Europe	
			Drive	5M/T	E4A/T	5M/T	E4A/T
Overall length	215/65R16		mm	4055			
	235/60R16		mm	—	—	4075	—
Overall width	215/65R16		mm	1695			
	235/60R16		mm	—	—	1745	—
Overall height	Standard		mm	1690			
	Roof rail		mm	1740			
Interior length			mm	1770			
Interior width			mm	1380			
Interior height			mm	1235			
Wheelbase			mm	2580			
Tread	215/65R16	Front	mm	1450			
		Rear	mm	1460			
	235/60R16 5M/T	Front	mm	—	—	1450	—
		Rear	mm	—	—	1480	—
Minimum road clearance			mm	190			
Min Turning Radius			m	4.9(Tire),5.0(Body)			
Kerb weight			kg	1120	1130	1140	1150
Cross vehicle weight	General,Europe		kg	1720			
Seating capacity			persons	Front:2,Rear:3			
Engine Type				3SZ-VE			
Total displacement			cc	1495			
Bore× stroke			mm	72.0× 91.8			
Max.output			kw/rpm	77[6,000]			
Max.torque			Nm/rpm	140[4,400]			
Compression ratio				10.0			
Fuel system				EFI(Electronic fuel injection)			
Fuel tank capacity			Litres	50			

Items				J200LG/J200RG			
				GMDF	GQDF	GMDFW	GQDFW
		Engine		3SZ-VE			
		Market		General		Europe	
		Drive		5M/T	E4A/T	5M/T	E4A/T
Clutch	5M/T			Dry single plate with diaphragm spring and mechanical actuation			
	4A/T			3-element,1-stage,2phase			
Transmission	5M/T			Forward 5-speed,manual,all syncromesh			
	4A/T			Forward 4-speed full automatic			
Transmission gear ratio	3SZ-VE	5M/T		1st:3.769 2nd:2.045 3rd:1.376 4th:1.000 5th:0.838 Rev:4.128			
		4A/T		1st:2.731 2nd:1.526 3rd:1.000 4th:0.696 Rev:2.290			
Final reduction gear ratio	3SZ-VE	5M/T		4.875			
		4A/T		5.125			
Steering type				Rack & Pinion			
Main brakes	Front			Disc brakes with booster			
	Rear			Drum brakes,leading trading with booster			
Parking brake				Mechanically operating on rear wheels			
Suspension	Front			MacPherson struts with coil springs			
	Rear			Axle type with 5links			
Tires	Standard			215/65R16			
	Flared wheel arch			—	—	235/60R16	—
Trailer towing	with brake	kg		1350			
	without brake	kg		400			

SPECIFICATIONS(J210LG/J210RG)

Items			J210LG/J210RG					
			GMDF	GQDF	GMDF W	GQDF W	GMXF W	GQXF W
		Engine	3SZ-VE					
		Market	General		Europe			
		Drive	5M/T	E4A/T	5M/T	E4A/T	5M/T	E4A/T
Overall length	215/65R16	mm	4055					
	235/60R16	mm	—	—	—	—	4075	—
Overall width	215/65R16	mm	1695					
	235/60R16	mm	—	—	—	—	1745	—
Overall height	Standard	mm	1690					
	Roof rail	mm	1740					

Items				J210LG/J210RG					
				GMDF	GQDF	GMDF W	GQDF W	GMXF W	GQXF W
			Engine	3SZ-VE					
			Market	General		Europe			
			Drive	5M/T	E4A/T	5M/T	E4A/T	5M/T	E4A/T
Interior length			mm	1800					
Interior width			mm	1385					
Interior height			mm	1240					
Wheelbase			mm	2580					
Tread	215/65R16	Front	mm	1450					
		Rear	mm	1460					
	235/60R16 5M/T	Front	mm	—	—	—	—	1450	—
		Rear	mm	—	—	—	—	1480	—
Minimum road clearance			mm	190					
Min Turning Radius			m	4.9(Tire),5.0(Body)					
Kerb weight			kg	1160	1170	1170	1180	1190	1200
Cross vehicle weight	General,Europe		kg	1720					
Seating capacity			persons	Front:2,Rear:3					
Engine Type				3SZ-VE					
Total displacement			cc	1495					
Bore× stroke			mm	72.0× 91.8					
Max.output			kw/rpm	77/6,000					
Max.torque			Nm/rpm	140[4,400]					
Compression ratio				10.0					
Fuel system				EFI(Electronic fuel injection)					
Fuel tank capacity			Litres	50					
Clutch	5M/T			Dry single plate with diaphragm spring and mechanical actuation					
	4A/T			3-element,1-stage,2phase					
Transmission	5M/T			Forward 5-speed,manual,all syncromesh					
	4A/T			Forward 4-speed full automatic					
Transmission gear ratio	3SZ-VE	5M/T		1st:3.769 2nd:2.045 3rd:1.376 4th:1.000 5th:0.838 Rev:4.128					
		4A/T		1st:2.731 2nd:1.526 3rd:1.000 4th:0.696 Rev:2.290					
Final reduction gear ratio	3SZ-VE	5M/T		5.125					
		4A/T		5.571					
Steering type				Rack & Pinion					

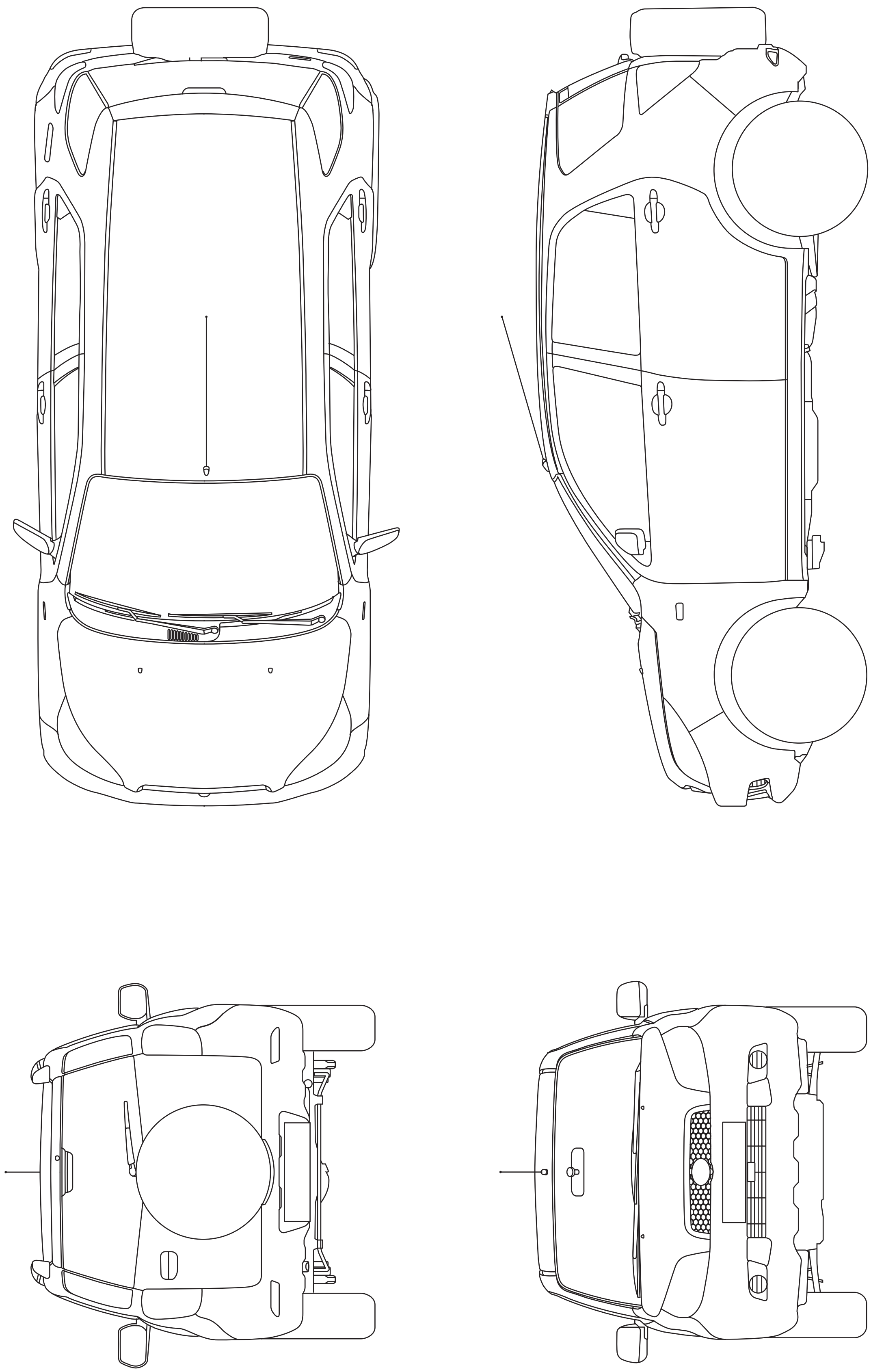
Items				J210LG/J210RG					
				GMDF	GQDF	GMDF W	GQDF W	GMXF W	GQXF W
			Engine	3SZ-VE					
			Market	General		Europe			
			Drive	5M/T	E4A/T	5M/T	E4A/T	5M/T	E4A/T
Main brakes	Front			Disk brakes with booster					
	Rear			Drum brakes,leading trading with booster					
Parking brake				Mechanically operating on rear wheels					
Suspension	Front			MacPherson struts with coil springs					
	Rear			Axle type with 5links					
Tires				215/65R16					
Trailer towing	without brake	kg		1350					
	with brake	kg		400					

SPECIFICATIONS(J211LG)

Items			J211LG
			GMDFW
		Engine	K3-VE
		Market	Europe
		Drive	5M/T
Overall length		mm	4055
Overall width		mm	1695
Overall height	Standard	mm	1690
	Roof rail	mm	1740
Interior length		mm	1770
Interior width		mm	1380
Interior height		mm	1235
Wheelbase		mm	2580
Tread	Front	mm	1450
	Rear	mm	1460
Minimum road clearance		mm	200
Min Turning Radius		m	4.9(Tire),5.0(Body)
Kerb weight		kg	1170
Cross vehicle weight		kg	1720
Seating capacity		persons	Front:2,Rear:3
Engine Type			K3-VE

Items				J211LG
				GMDFW
		Engine		K3-VE
		Market		Europe
		Drive		5M/T
Total displacement			cc	1298
Bore× stroke			mm	72.0× 79.9
Max.output			kw/rpm	63/6,000
Max.torque			Nm/rpm	120/3,200
Compression ratio				10.0
Fuel system				EFI(Electronic fuel injection)
Fuel tank capacity			Litres	50
Clutch	5M/T			Dry single plate with diaphragm spring and mechanical actuation
Transmission	5M/T			Forward 5-speed,manual,all syncromesh
Transmission gear ratio	K3-VE	5M/T		1st:3.769 2nd:2.045 3rd:1.376 4th:1.000 5th:0.838 Rev:4.128
Final reduction gear ratio	K3-VE	5M/T		5.571
Steering type				Rack & Pinion
Main brakes	Front			Disk brakes with booster
	Rear			Drum brakes,leading trading with booster
Parking brake				Mechanically operating on rear wheels
Suspension	Front			MacPherson struts with coil springs
	Rear			Axle type with 5links
Tires				215/65R16
Trailer towing	with brake		kg	1350
	without brake		kg	400

Views of Vehicle



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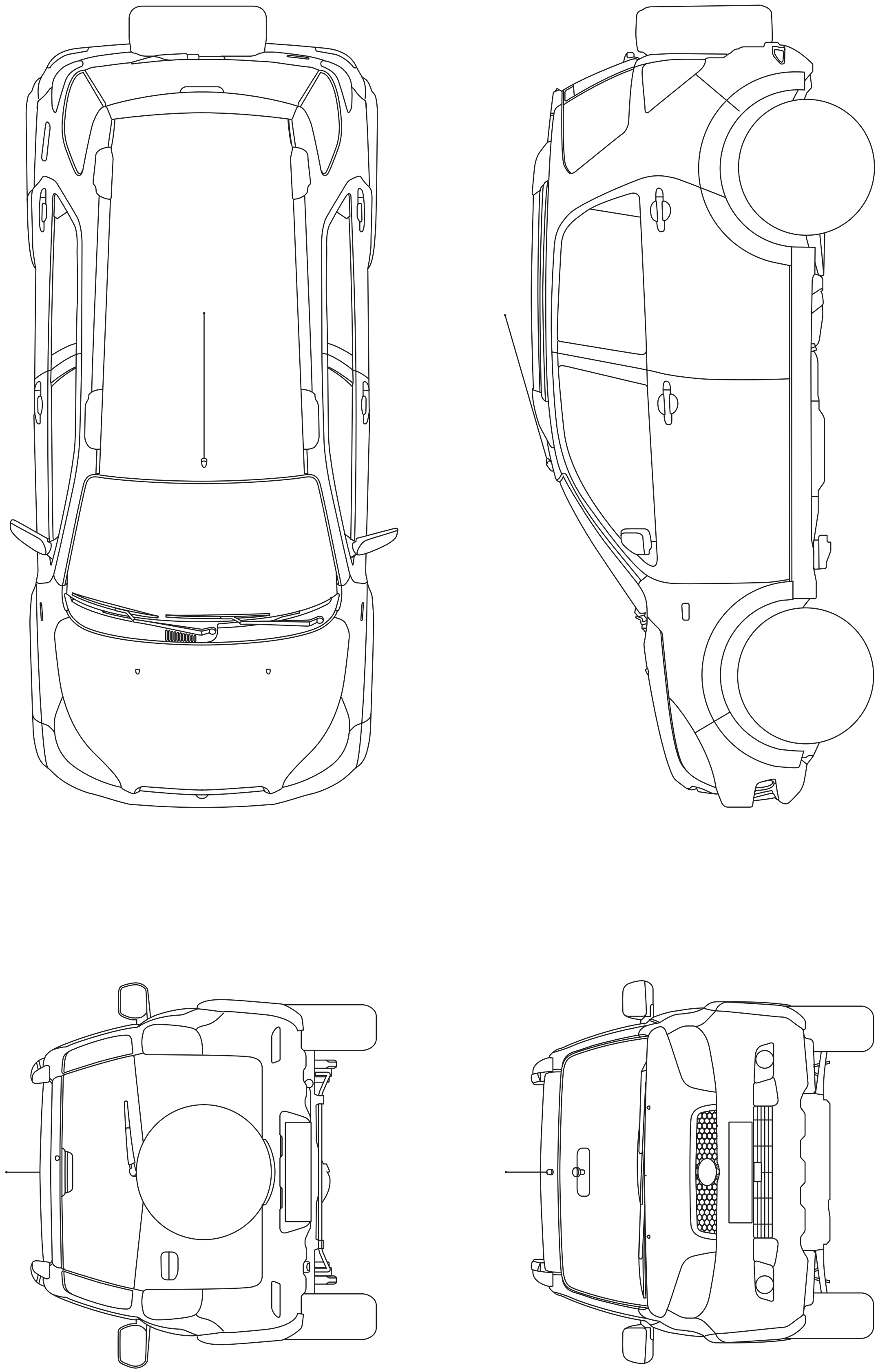

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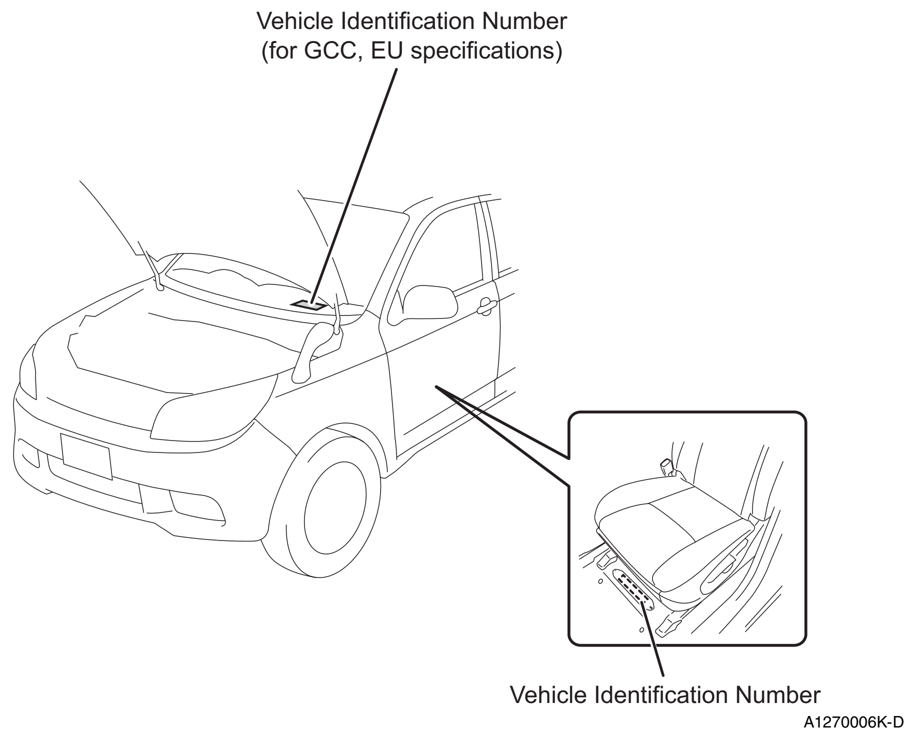
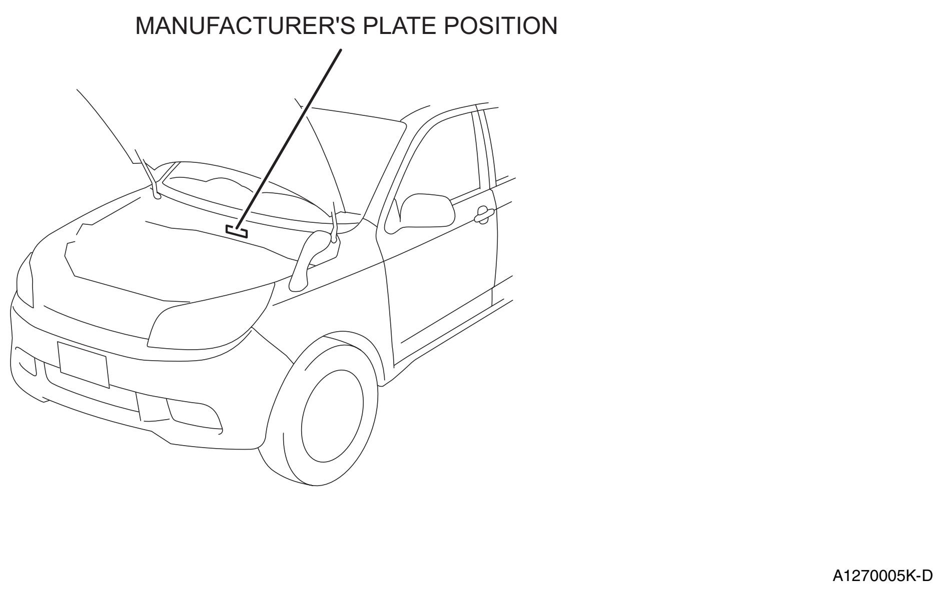
VEHICLE IDENTIFICATION

Vehicle Identification Number & Manufacturer's Plate Position

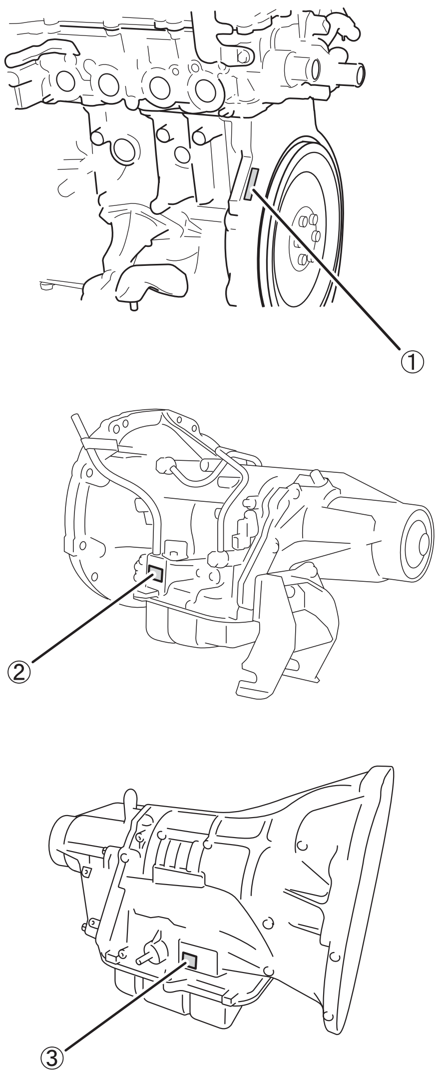
VEHICLE IDENTIFICATION NUMBER



MANUFACTURER'S PLATE POSITION



Engine Number & Transmission Number Position



① 3SZ,K3 Engine Number

② M5S Transmission Number

③ A4Q-D1 Transmission Number

A1270007K-D

TO FOREWORD

ENGINE

ENGINE IN GENERAL

ENGINE CONTROL SYSTEM (3SZ-VE/ K3-VE)

FUEL SYSTEM (3SZ-VE/K3-VE)

INTAKE SYSTEM (3SZ-VE/K3-VE)

ENGINE MECHANICAL COMPONENTS (3SZ-VE/K3-VE)

EXHAUST SYSTEM (3SZ-VE/K3-VE)

CLEANING SYSTEM (3SZ-VE/K3-VE)

LUBRICATION SYSTEM (3SZ-VE/K3-VE)

IGNITION SYSTEM (3SZ-VE/K3-VE)

STARTING AND CHARGING SYSTEM (3SZ-VE/K3-VE)

ENGINE IN GENERAL

Outline of Engine

- The newly developed 3SZ-VE engine (1.5-liter gasoline engine) is employed and mounted fore-and-aft.
- For European models, the K3-VE engine (1.3-liter gasoline engine) is employed and mounted fore-and-aft.
- With the objective of achieving performance exceeding that of a small car engine, the 3SZ-VE engine has been developed as a leading next-generation small car engine.

Features of Engine [3SZ-VE/K3-VE]

- The volumetric efficiency on the intake side and the knocking limit have been increased to achieve an output characteristic required for the engine to produce high torque especially at low- and intermediate-speed ranges. Variable valve timing control by means of an offset crankshaft and a DVVT controller has been employed to improve fuel efficiency.
- The potential of the engine itself has been increased and an exhaust gas cleaning system has been employed to satisfy the new long-term emission regulations (an emission reduction of 50%).
- Serpentine belt drive has been employed to drive the auxiliary equipment. The oil pump and the water pump have been incorporated into the cylinder block to reduce overall engine length and lower weight.
- A high-strength cast iron cylinder block and an aluminum alloy oil pan have been employed to increase the rigidity of the joint with the power plant.
- A steel 8-balance crankshaft has been employed to increase rigidity and reduce the vibrations of the crankshaft due to bending or twisting. Furthermore, a damper pulley and a flexible flywheel have been employed to reduce the vibrations of the crank system.

Features of 3SZ-VE/K3-VE Engine (High Performance and High Fuel Efficiency)

Items contributing to high performance and low fuel consumption	Effects
DOHC 4 narrow-angle valves	Improvement in heat efficiency
Resin axial-flow isometric intake manifold	Improvement in volumetric efficiency in low- and intermediate--speed ranges
Stainless steel exhaust manifold	Improvement in output because of a reduction in exhaust gas pressure
Variable valve timing control device (DVVT)	High output and low fuel consumption
Offset crankshaft	Reduction in friction loss
Weight reduction of dynamic valve components	Reduction in friction loss

Features of 3SZ-VE/K3-VE Engine (Low Emission)

Items contributing to low emission	Effects
Variable valve timing control device	Reduction in NOx by internal EGR system
Exhaust manifold made of stainless steel pipes + exhaust manifold integral with catalytic converter	Improvement in cleaning performance because of early activation of catalyzer

Items contributing to low emission	Effects
Fine particle injector + independent injection method	Reduction in emission
Fuel non-return system	Reduction in amount of fuel evaporating in fuel tank (evaporating gas: HC)

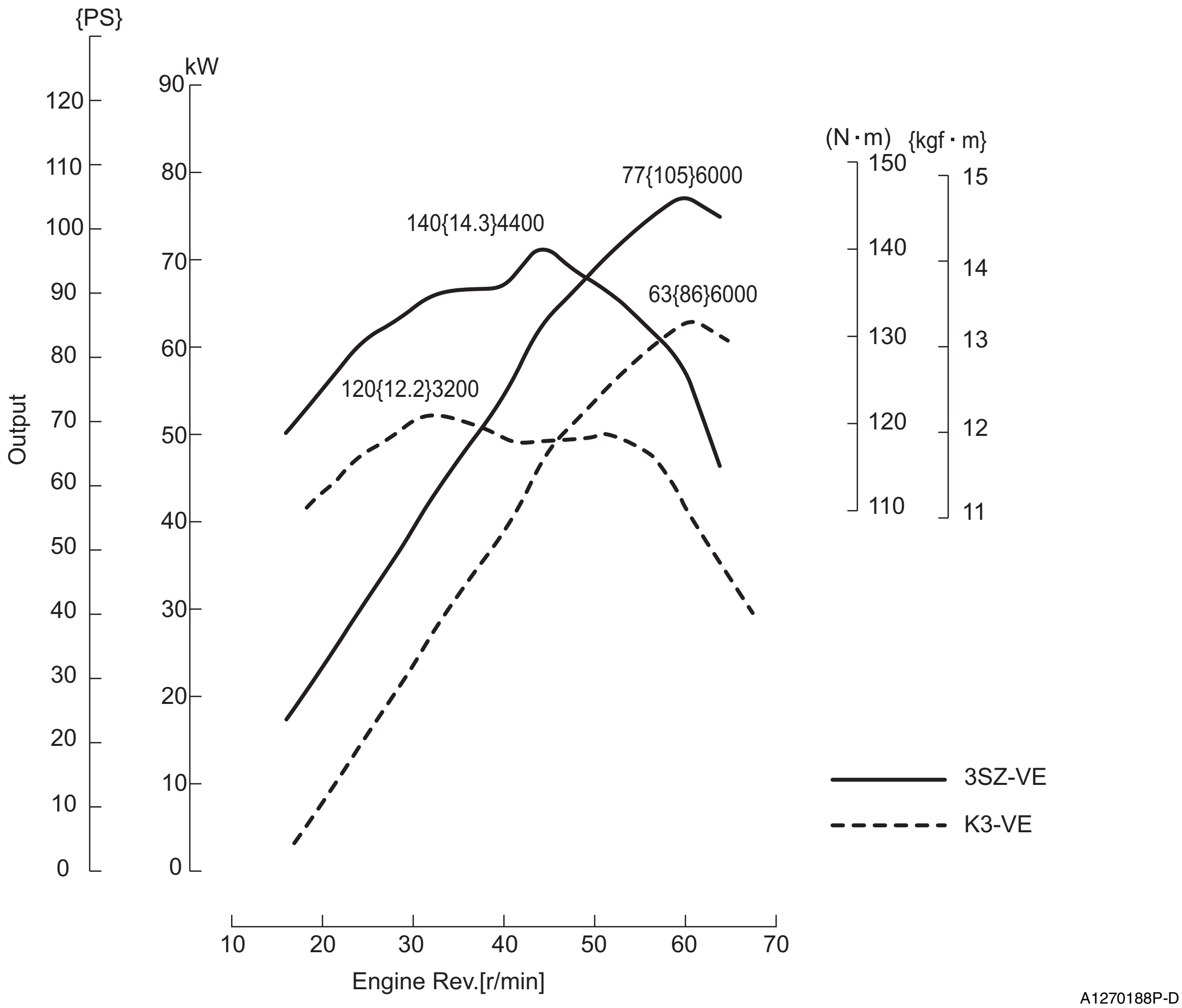
Features of 3SZ-VE/K3-VE Engine (Lightweight and Compact)

Items contributing to light-weight and compactness	Effects
Serpentine belt layout	Reduction in engine overall length
Oil pump (incorporated into the cylinder block)	Reduction in engine overall length
Water pump (incorporated into the cylinder block)	Reduction in engine overall length
Single-stage chain	Reduction in engine overall length and width
Resin axial-flow isometric intake manifold	Weight saving by the use of a resin manifold
Stainless steel exhaust manifold	Weight saving by the use of a steel-plate manifold

Features of 3SZ-VE/K3-VE Engine (Low Vibration, Low Noise and Silence)

Items contributing to low vibrations, low noise and quietness	Effects
Stiff cast iron cylinder block	Reduction in vibrations brought about by improvement in rigidity
Oil pan integral with a stiffener	Vibration reduction brought about by increase in power plant joint rigidity
8-balance steel crankshaft	Reduction in hitting noise and vibrations due to bending and twisting
Flexible flywheel	Reduction in vibrations of crank system
Crankshaft pulley with damper	Reduction in vibrations of crank system
Large-capacity resin air cleaner	Reduction in suction noise

Engine Specifications [3SZ-VE/K3-VE]

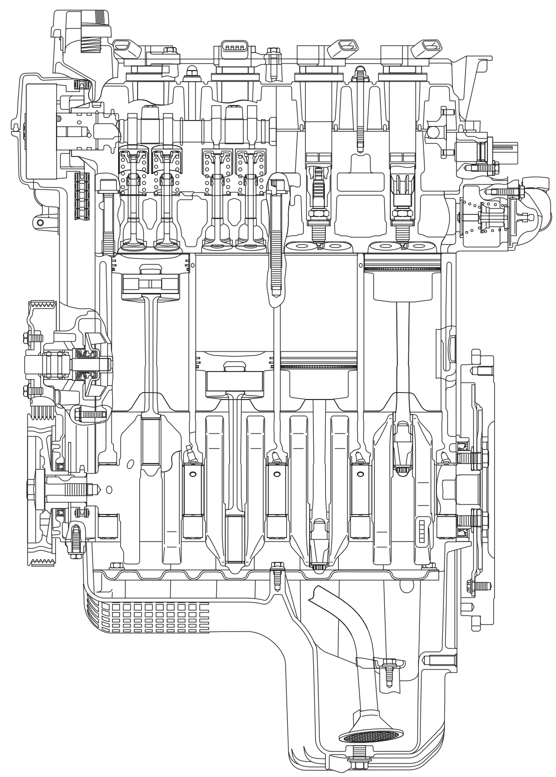


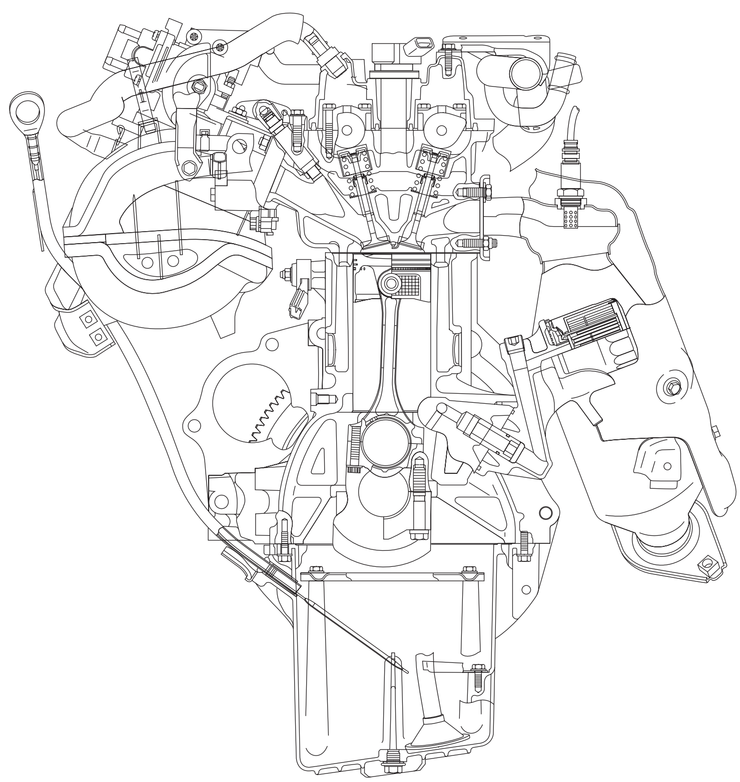
Engine type	3SZ-VE	K3-VE
Type	Water-cooled four-cycle gasoline engine	←
Arrangement and number of cylinders	In-line four-cylinder engine mounted fore-and-aft	←
Dynamic valve mechanism	DOHC chain drive (Intake: 2, exhaust: 2)	←
Combustion chamber shape	Pent roof type	←
Intake and exhaust pipe layout	Cross flow type	←
Total displacement [L]	1.495	1.298
Bore diameter × stroke [mm]	72 × 91.8	72.0 × 79.9
Compression ratio	10.0	←
Maximum output [kW {PS}] (r/min)	[80 {109}] (6000)	[63 {90}] (6000)
Maximum torque [N•m {kgf•m}] (r/min)	[141 {14.4}] (4400)	[120 {12.5}] (3200)

Engine type	3SZ-VE	K3-VE
Valve timing Intake opening	32° to -10° BTDC	30° to -12° BTDC
Valve timing Intake closing	18° to 60° ABDC	10° to 52° ABDC
Valve timing Exhaust opening	30° BBDC	←
Valve timing Exhaust closing	2° ATDC	←
Fuel feed system	Electronically controlled fuel injection system (EFI)	←
Ignition system	Full-transistor DLI battery ignition	←
Idle speed [r/min]	650	700
Oil used	SAE 0W-20 API SJ or higher	←

Sectional View of Engine [3SZ-VE/K3-VE]

3SZ-VE





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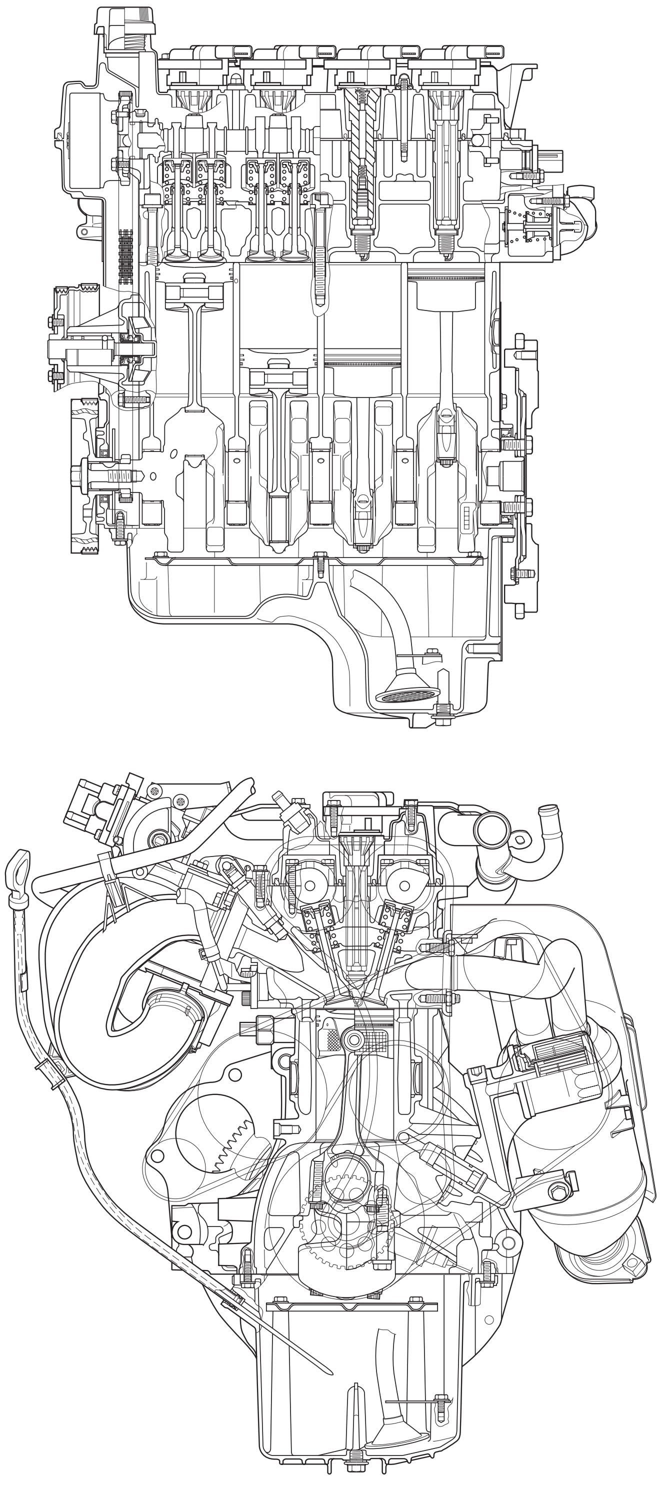
K3-VE



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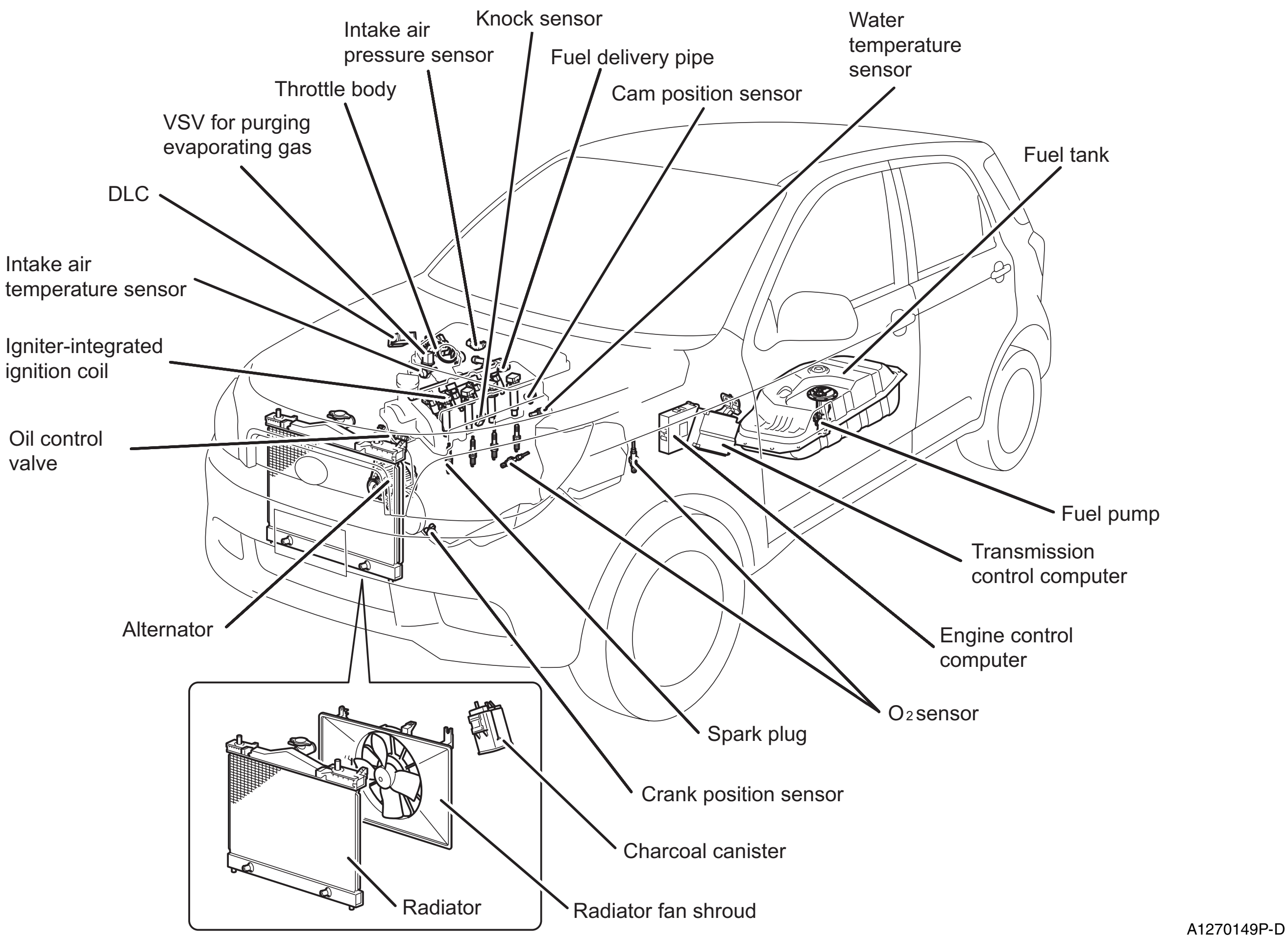
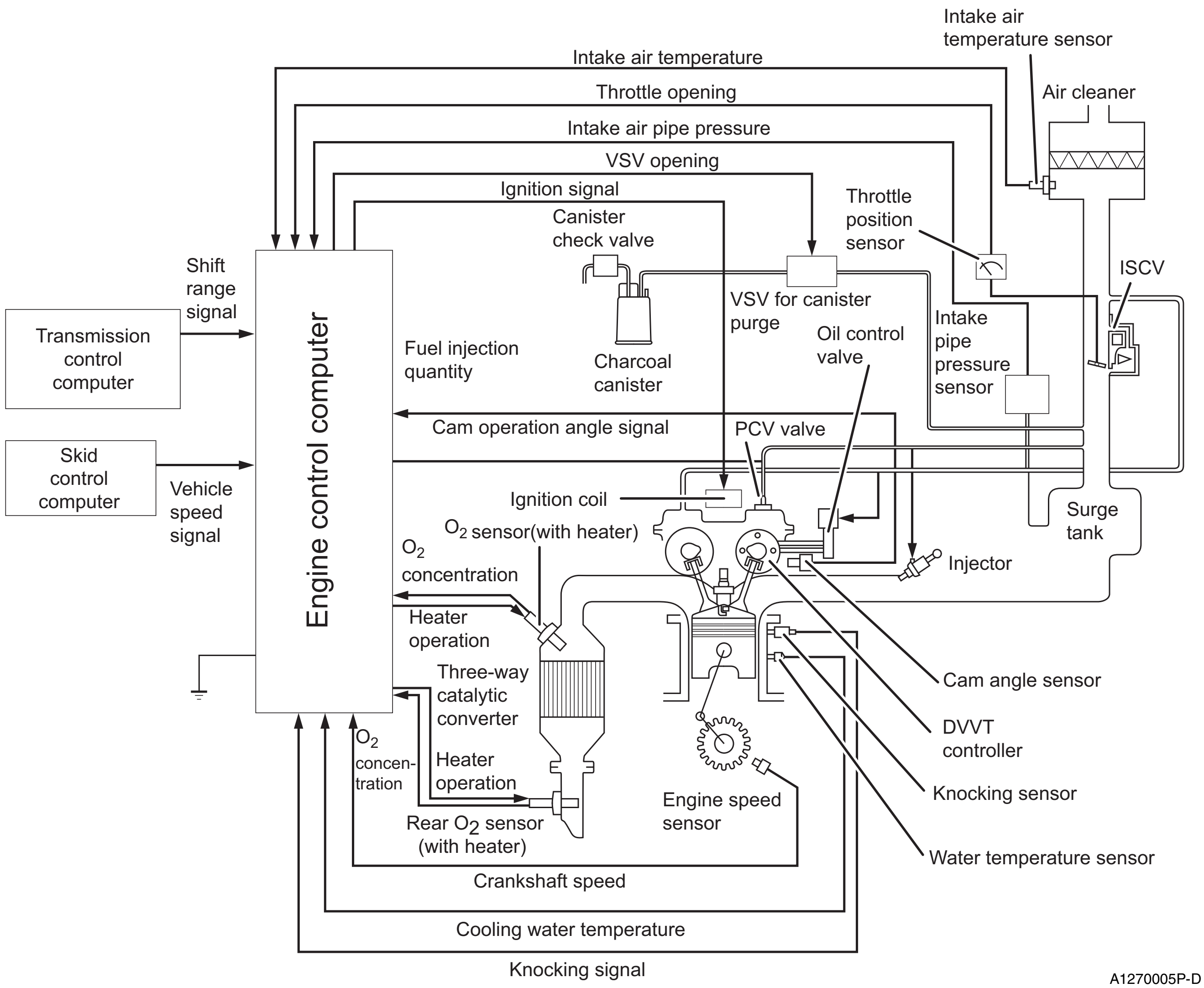
ENGINE CONTROL SYSTEM (3SZ-VE/K3-VE)

Engine Control System in General

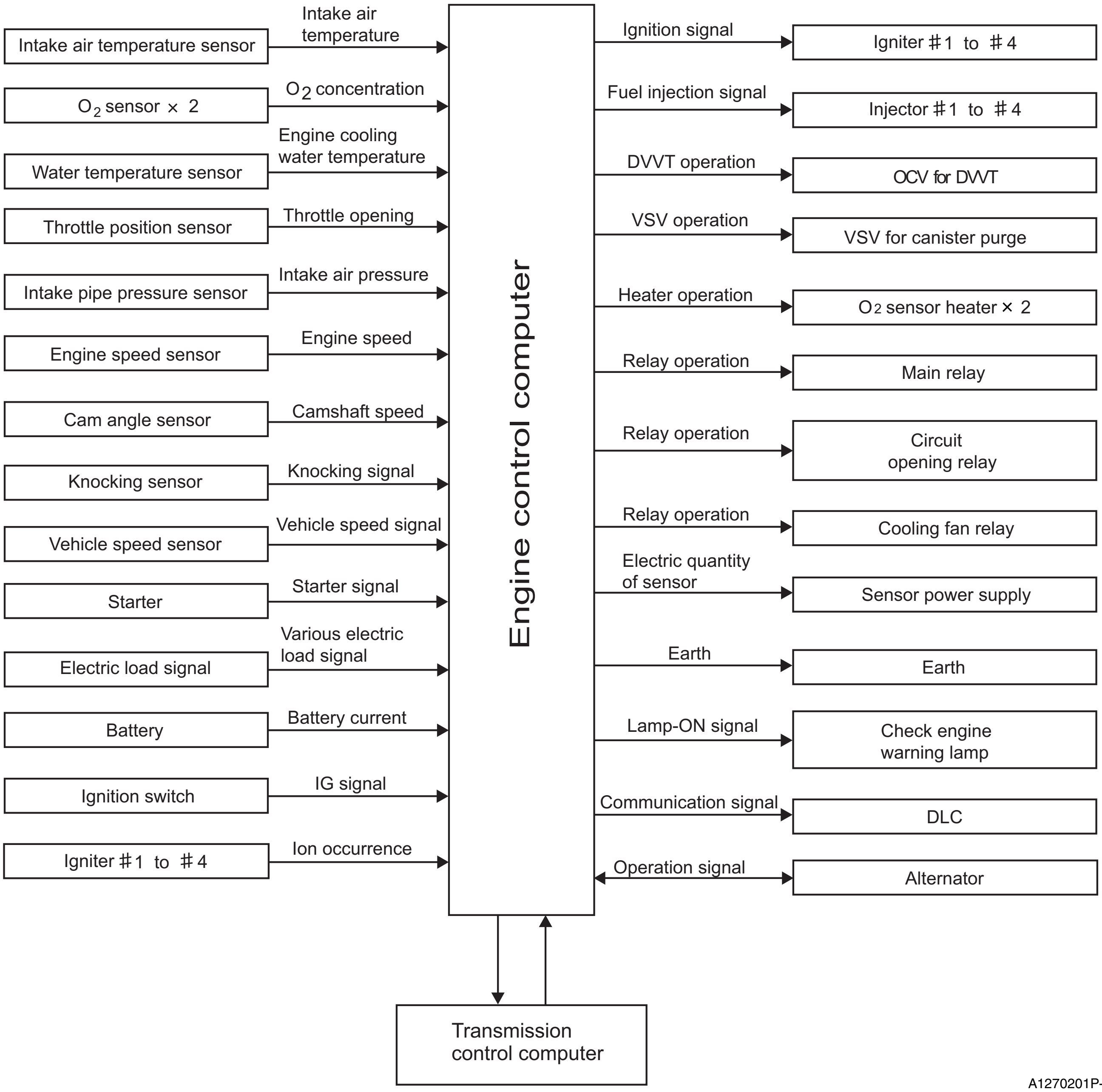
- The engine control system for the 3SZ-VE and the K3-VE uses an engine control computer to centralize EFI control (electronically controlled fuel injection), ESA control (electronically controlled spark advance), DWT control, ISC control (idle speed control), etc.
- A distributor-less ignition system is used to distribute power from each ignition coil directly to the spark plug on the corresponding cylinder.
- A fail-safe function and a diagnosis function (self-diagnosis) are provided for the engine control system in case of a system failure.



Schematic diagram of the system



European models



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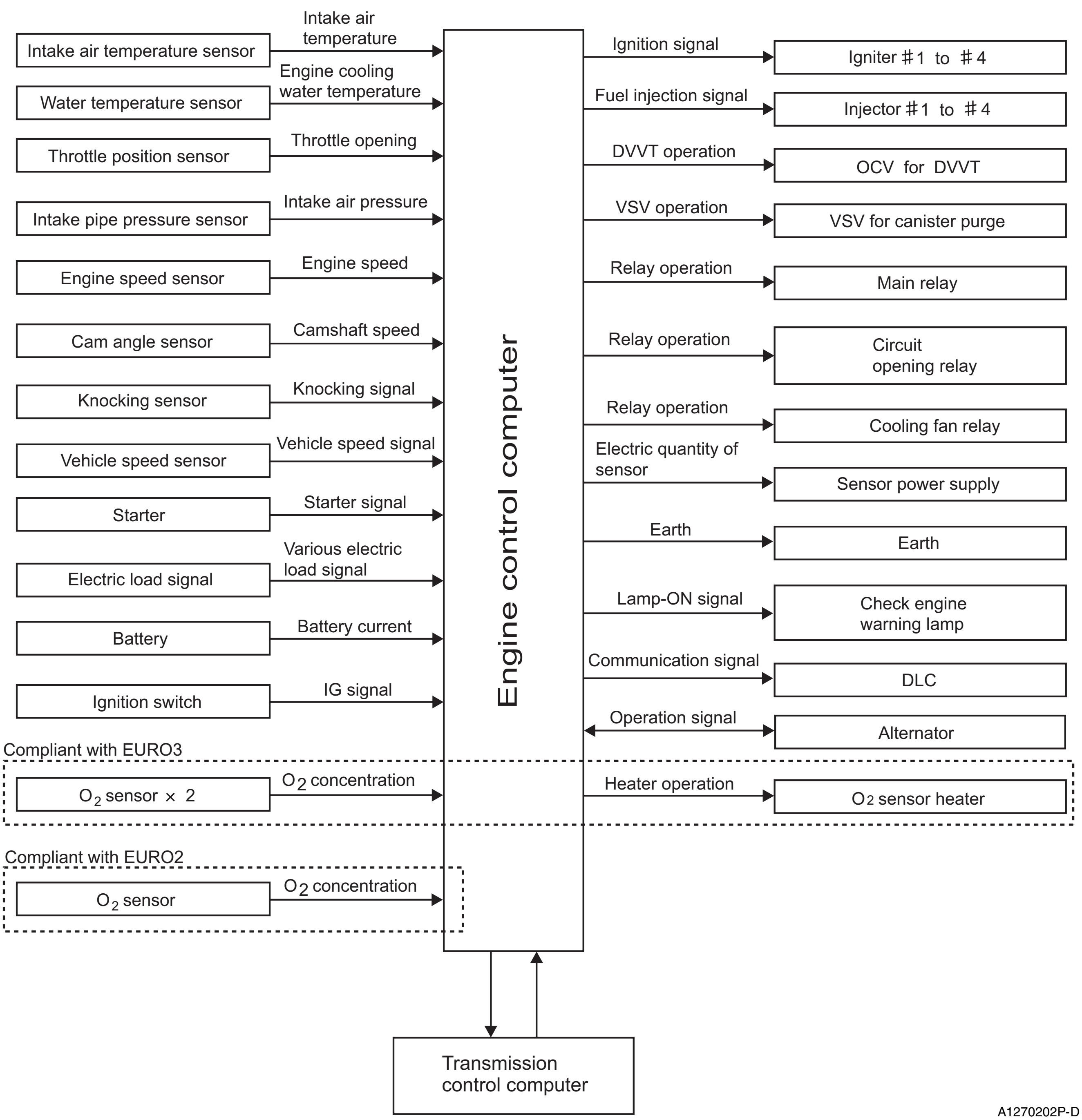
Models other than European models



A1270202P-D

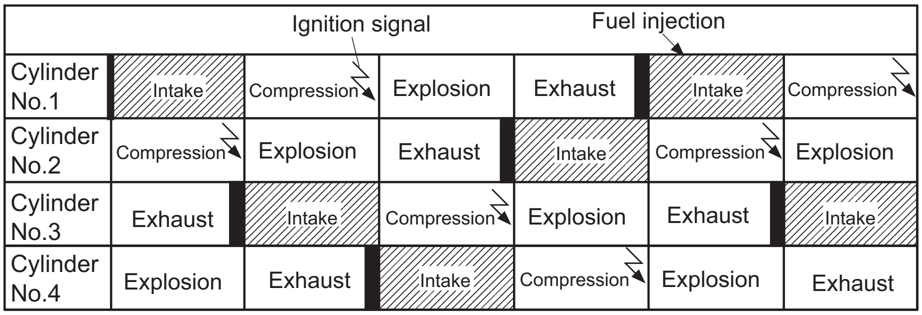
Fuel Injection Control (EFI)

- The electronically controlled fuel injection system determines the operating condition of the engine from signals from each sensor and regulates the quantity of fuel to be injected (injector energizing time) according to the quantity of intake air, which is determined from the engine speed and the intake pipe pressure, in order to achieve an air-fuel ratio that meets the operating condition.
- Fuel is injected into each cylinder individually and intermittently in sync with engine revolution signals.
- There are two types of fuel injection methods: synchronous injection in which fuel is injected in sync with engine revolution signals and asynchronous fuel injection in which fuel is injected irrespective of engine revolution signals in rapid acceleration etc.
- Fuel is cut off occasionally according to operating condition to protect the engine and the catalyzer.

- Synchronous injection, which means that fuel is injected in sync with engine revolution signals, is of two types: ignition at the start and ignition after the start. It depends on the engine speed as to which type of ignition is selected.

Injection at the start

- Cylinders are identified by signals (cylinder identifying signals) from the engine revolution sensor and fuel is injected simultaneously into all the cylinders each time an engine revolution signal (Ne signal) is received.



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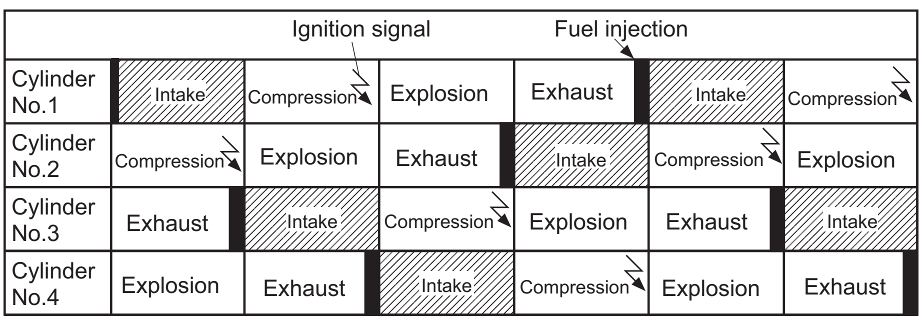
Injection after the start

- Fuel is injected individually to each cylinder according to the cylinder information provided by means of engine revolution signals (Ne signal).



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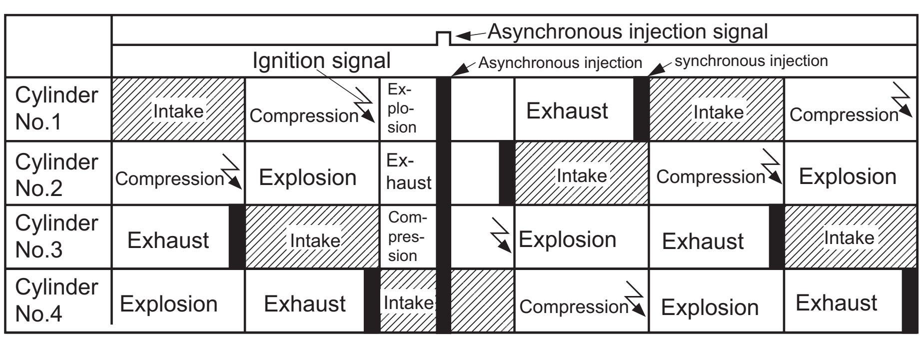
Asynchronous injection

- Fuel is injected as soon as the given conditions are met, irrespective of engine revolution signals.



A1270118P-D

Synchronous Injection

At-start injection time

- The injection time at the start of the engine is determined by the at-start base injection time, which is determined by the cooling water temperature, various correction factors, and the invalid injection time.
- At-start injection time = At-start base injection time × various correction factors + invalid injection time
- When the cooling water temperature is lower than the specified limit, fuel is injected on several occasions.

At-start base injection time	The at-start base injection time is determined by the cooling water temperature. A larger quantity of fuel is injected at a lower temperature, because the lower the engine temperature, the more difficult it is for the fuel on the inner wall of the intake manifold to evaporate.
Starting speed correction factor	When the cooling water is cold, the starting speed is corrected to make it easier to start the engine.
At-start atmospheric pressure correction factor	A correction is made according to the atmospheric pressure to make it easier to start the engine.
At-start injection number-of-times correction factor	The number of times fuel was injected at the start of the engine is counted and the injection time is reduced with increase in this number of times.
Intake air temperature correction factor	This correction factor is used to compensate for the variation in the density of intake air according to air temperature.
Invalid injection time	Invalid injection time refers to the time elapsing before an injector opens its valve to inject fuel after it is turned on. Invalid injection time varies according to the battery voltage: the higher the battery voltage, the shorter the injection time is, and vice versa. For this reason, the actual injection time is determined by adding the invalid injection time that varies according to the battery voltage to the at-start base injection time.

After-start injection time

- The injection time after the start of the engine is determined by the after-start base injection time, various correction factors and the invalid injection time.
- After-start injection time = Time determined by making various corrections to the after-start base injection time + invalid injection time

After-start base injection time	The after-start base injection time is determined by the engine speed and the intake pipe pressure.
Intake air temperature correction factor	This correction factor is used to compensate for the variation in the density of intake air according to air temperature.
Fuel cut recovery correction factor	At the time of recovery from a fuel cut, the quantity of fuel to be injected is reduced according to the reduction in engine speed in order to improve driveability.
Warm-up increase correction factor	This correction factor, which varies with the cooling water temperature, is used to increase the quantity of fuel to be injected for cold start. A correction using this correction factor is made until the completion of engine warm-up.
After-start increase correction factor	At the start of the engine, the initial increase correction factor is determined according to the cooling water temperature to stabilize the engine speed immediately, and after the start, it is reduced gradually.
Transient air-fuel ratio correction factor	This correction factor is used to correct the air-fuel ratio during transition and it is determined by the cooling water temperature, etc.

Air-fuel ratio feedback correction factor	Whether the air-fuel mixture fed into the engine after warm-up is rich or lean is determined based on signals from the O_2 sensor. The quantity of fuel to be injected is regulated by increasing or reducing the quantity of fuel injected in order to keep the air-fuel ratio within a narrow range in the vicinity of the theoretical air-fuel ratio that enables the three-way catalytic converter to clean exhaust gas most efficiently.
Power increase correction factor	Under heavy-load conditions, the quantity of fuel to be injected is increased according to the engine speed and the intake pipe pressure.
After-restart increase correction factor	The initial value is determined based on the cooling water temperature at the restart and it is reduced gradually each time fuel is injected.
Atmospheric pressure correction factor	A correction is made according to the atmospheric temperature.
Idle speed stabilization factor	During idling, the quantity of fuel to be injected is corrected according to the engine speed.
Water temperature correction factor	Under heavy-load and high-speed conditions, the quantity of fuel to be injected is corrected according to the cooling water temperature.
Low engine speed correction factor	The quantity of fuel to be injected is increased when the engine is running at a low speed.
Invalid injection time	Invalid injection time refers to the time elapsing before an injector opens its valve to inject fuel after power is applied to it.

Asynchronous Injection

Asynchronous injection at the time of a change in idle switch position

- When the throttle valve is opened from a closed position (idling position), fuel is injected simultaneously into all the cylinders once for a certain time.

Asynchronous injection at the time of a change in intake pipe pressure

- Fuel is injected simultaneously into all the cylinders for a certain time period according to the rate of increase in the intake pipe pressure.

Asynchronous injection at recovery from a fuel cut

- If the engine speed drops considerably at recovery from a fuel cut, fuel is injected for a certain time.

Asynchronous injection at the time the air conditioner is turned on

- When the air conditioner is turned on, fuel is injected for a certain time.

Asynchronous injection at the time the power steering system is turned on

- When the oil pressure switch (for power steering) is turned on during steering, fuel is injected for a certain time.

Fuel Cutoff

Fuel cutoff during deceleration

- Fuel is cut when the engine speed exceeds the specified limit and the throttle valve is fully closed.

Cut off during catalyzer overheating

- To prevent the catalyzer from overheating, fuel is cut according to the engine speed and the intake pipe pressure.

Fuel cut when the engine speed exceeds the specified limit

- Fuel is cut when the engine speed increases above the specified limit.

Ignition Timing Control (ESA)

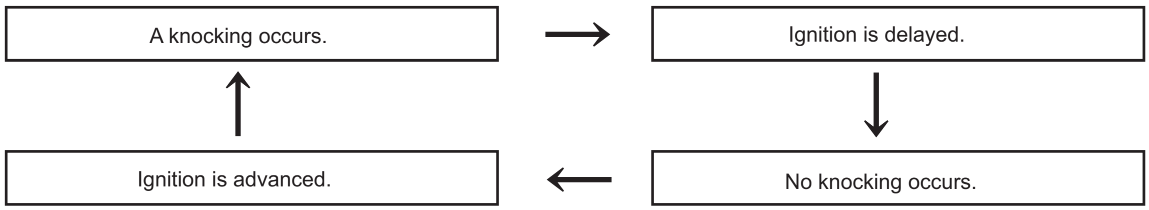
- The engine control computer uses ESA (Electronically Controlled Spark Advance) control to identify cylinders by signals from the engine revolution sensor, and calculate and regulate the ignition timing optimally according to engine operating conditions.
- There are two types of spark advance angles: fixed advance angle that synchronizes with engine revolution signals and calculated spark advance angle that is determined by the engine speed and the intake pipe pressure.
- The fixed advance angle refers to a spark advance angle of 6° (BTDC) that synchronizes with revolution signals at the start.
- When the spark advance angle is not fixed, the ignition timing (calculated advance angle) is determined by the engine speed, the intake pipe pressure, etc. according to engine operating conditions.

Table of calculated advance angles

Base advance angle	Refers to the ignition timing that is determined by the engine speed and the intake pipe pressure.
Water temperature correction advance angle	Corrects the ignition timing according to the cooling water temperature.
Idling stabilization correction advance angle	Advances the ignition timing when the idle speed decreases or delays it when the idle speed increases.
Excess correction advance angle	Corrects the ignition timing if the intake pipe pressure fluctuates excessively during driving.
Torque reduction correction advance angle (only for A/T models)	Delays the ignition timing when the vehicle is accelerated rapidly from low-speed range or when gears are shifted from the P or N position to reduce the shock due to a speed change by reducing the engine torque.
Energizing time control	The energizing time of each ignition coil is regulated according to the engine speed and the voltage applied to the ignition coil.
Knocking correction advance angle	Delays the ignition timing immediately if it is determined from signals from the knock sensor that the engine has knocked, and if the engine does not knock for a certain period of time, advances the ignition timing gradually until the engine knocks again. This control always enables optimum regulation of the ignition timing. To prevent this correction factor from adversely affecting the engine, a limit is placed on it.
Acceleration surging correction advance angle	Corrects the ignition timing if fluctuations of the intake pipe pressure go out of specified limits during acceleration in low-speed range immediately after engine warm-up.
Internal EGR correction advance angle	Corrects the ignition timing according to the variable valve opening speed.

Knock Control System

- If an engine knocking is detected, the ignition timing is delayed gradually in equal steps, which vary according to the size of knocking, until the engine stops knocking.
- After the engine has stopped knocking, the ignition timing is advanced gradually in equal steps. If the engine knocks again during this process, then the ignition timing is delayed again.



Knocking feedback control cycle

A1270251P-D

Maximum and Minimum Advance Angles

- Upper and lower limits are set on advance angles, because advancing or delaying the ignition timing excessively adversely affects the engine.

Maximum and minimum advance angles

Maximum advance angle (BTDC)	50°
Minimum advance angle	0°

Calculation of Ignition Timing

- The engine control computer calculates the ignition timing optimally according to the operating condition from data provided by means of Ne·G2 signals, intake air temperature signals, throttle valve opening signals, cooling water temperature signals, etc. and sends ignition signals to the igniter-integrated ignition coils.

Idle Speed Control (ISC)

- In idle speed control (ISC), the engine control computer regulates the idle speed by adjusting the duty ratio for turning on and off the power to the ISC valve under the control of signals from each sensor. A rotary ISC unit capable of performing control with a high degree of accuracy has been employed this time.
- The engine control computer determines the opening of the ISC valve from signals from each sensor and sends a signal indicating the duty ratio corresponding to the opening to the ISC valve.

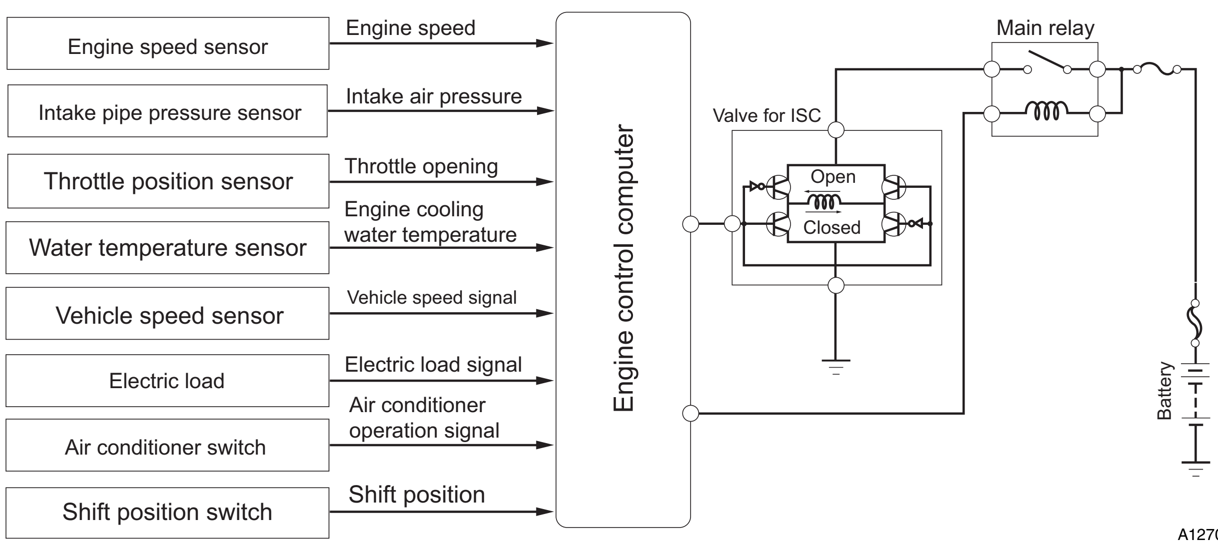


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Table of corrections

Item corrected for water temperature	The duty ratio is corrected according to the cooling water temperature during the period from the start of the engine to the completion of warm-up.
Item corrected at the start	At the start of the engine and for several seconds after the start, the duty ratio is corrected to improve the startability of the engine.
Item corrected for feed-back	The duty ratio is corrected according to the difference between the actual idle speed and the target idle speed in order to achieve the target speed.
Item corrected for external loads	When a load, such as air conditioner load, shift lever position load (A/T), electric load or radiator fan load, changes, the duty ratio is changed accordingly to adjust the engine speed.
	During idling, the engine speed is regulated according to the power steering load.
Item corrected for engine speed	When the engine speed decreases, the duty ratio is increased temporarily and then reduced gradually so that the engine speed converges to the target speed efficiently.

DVVT System

- The engine control computer turns on or off the oil control valve under the control of signals from the pressure sensor and water temperature sensor and according to the engine speed to regulate the hydraulic pressure acting on the DVVT controller, and if the intake valve opening/closing timing sensed by the cam position sensor is off, the engine control computer adjusts the timing.
- The engine control computer adjusts the intake valve opening/closing timing in 3 modes.

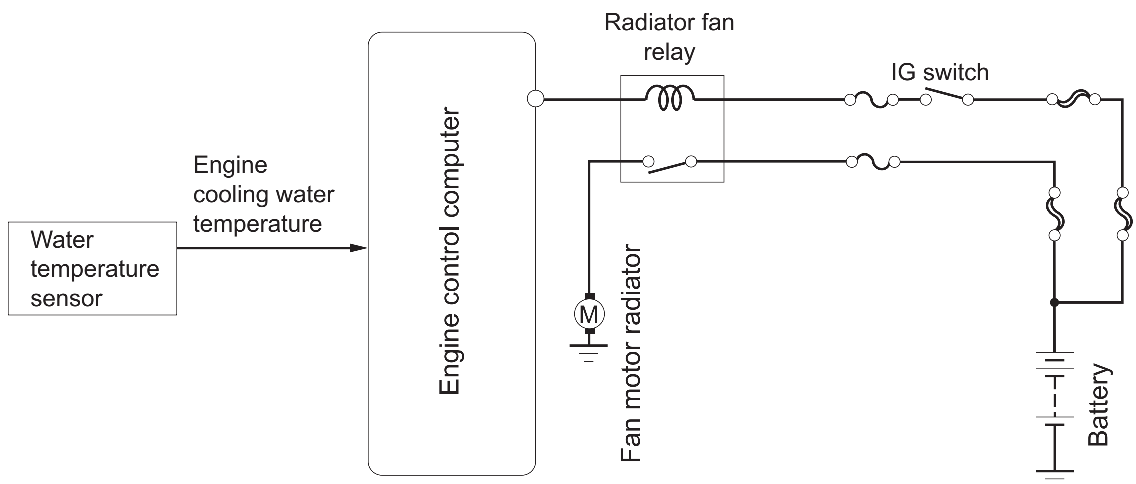
Forced maximum delayed injection mode		In this mode, the intake valve opening/closing timing of intake camshaft No.1 is forcibly delayed to the maximum, and at the start of the engine or if the battery voltages drops below the specified voltage, the oil control valve is regulated in this mode.
0° retention mode		When the target second of arc is 0°, the intake valve opening/closing timing is adjusted in this mode.
Feedback mode	Setting of a target second of arc	A target second of arc is set according to the throttle opening, intake pipe pressure, atmospheric pressure, engine speed and cooling water temperature.
	Setting of an oil control valve drive duty ratio	Based on the target second of arc and data provided by the cam position sensor, a duty ratio is set according to the engine speed and the cooling water temperature.

Cooling Fan System

- The radiator fan relay is turned on to start the radiator fan motor If one of the following conditions is met: the cooling water temperature is above the specified temperature, the air conditioner relay is ON, or the water temperature sensor fails. If none of these conditions is met, the radiator fan relay is turned off.

❖REFERENCE❖

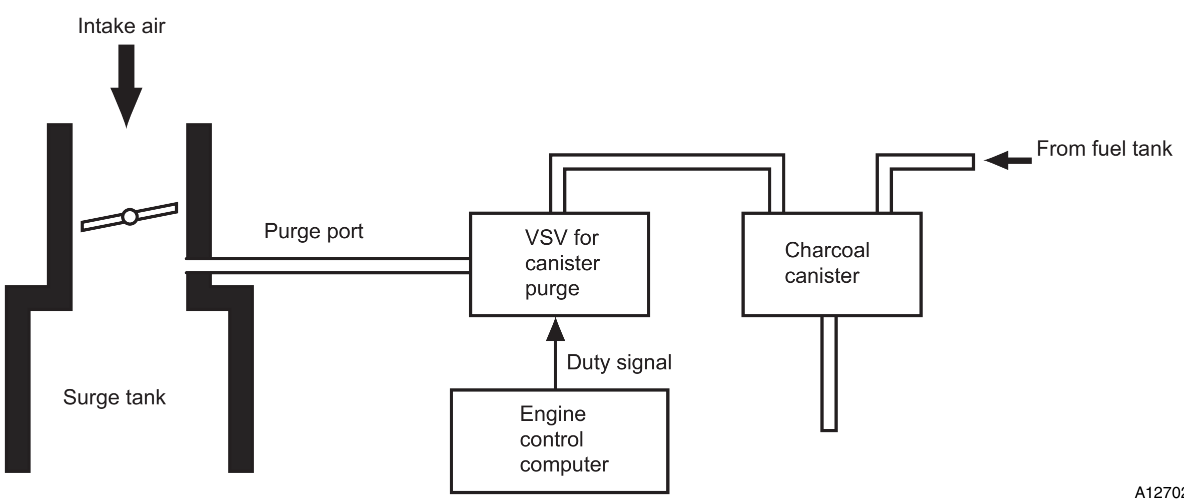
If the water temperature sensor fails, the fail-safe function keeps the fan motor running.



A1270151P-D

Canister Purge Control

- Canister purge control for sucking fuel evaporated in the fuel tank into the intake ports to burn is employed. To regulate the amount of fuel purged from the canister, the engine control computer regulates the opening of the VSV according to the operating condition.
- The charcoal canister is mounted in the engine compartment and the VSV in the air cleaner.



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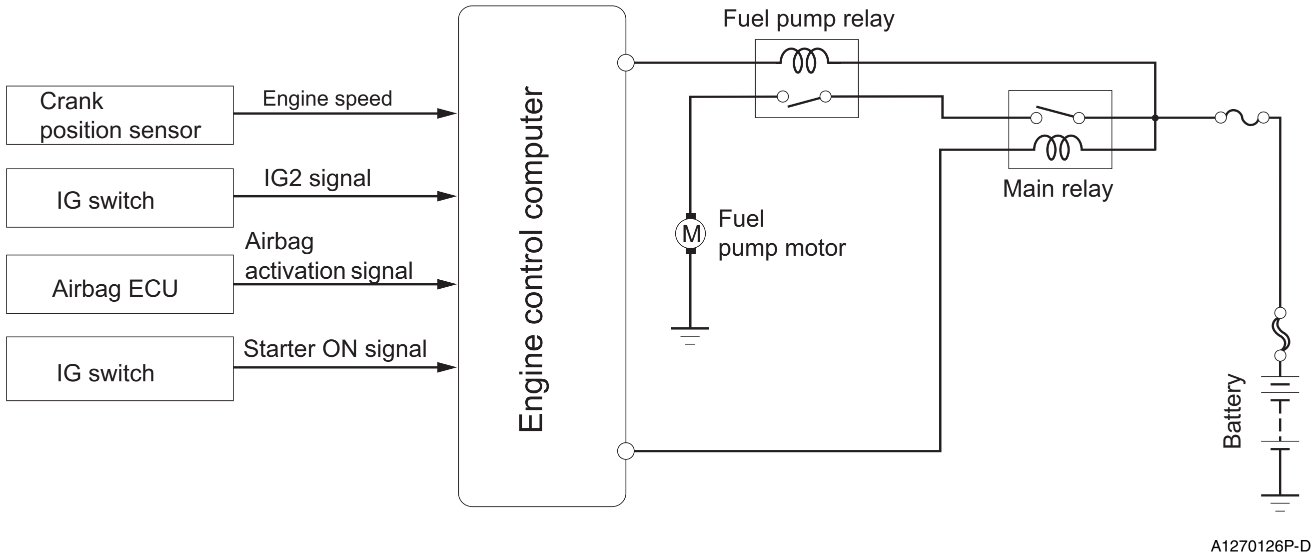
Fuel Pump Control

- If at least one of the following conditions is met and a fuel pump stop signal is not put out by the airbag computer, the engine control computer turns on the fuel pump to start it.
  - 2 seconds after the ignition switch is turned on (when T terminal is OFF)
  - 8 seconds after the ignition switch is turned off (when T terminal is ON)
  - 2 seconds after cylinders are identified and a revolution signal is given (if the engine speed is 20 rpm or more, the pump keeps operating.)
  - 3 seconds after the starter is switched from the OFF to ON position.



Air Conditioner Cutoff Control

- If one of the following conditions is met, the engine control computer turns off the relay and the magnet clutch of the compressor to cut off the air conditioner.

Cutoff of air conditioner because of water temperature rise

- If the following condition is met, the air conditioner is cut off.

The cooling water temperature is above the set temperature.

Cutoff of air conditioner in certain operating ranges

- The air conditioner is cut off if at least one of the following conditions is met.

The throttle valve opening exceeds the opening set based on the vehicle speed.
The throttle valve opening exceeds the set value.

Cutoff of air conditioner because of drop in engine speed (only for A/T models)

- If all the following conditions are met, the air conditioner is cut off.

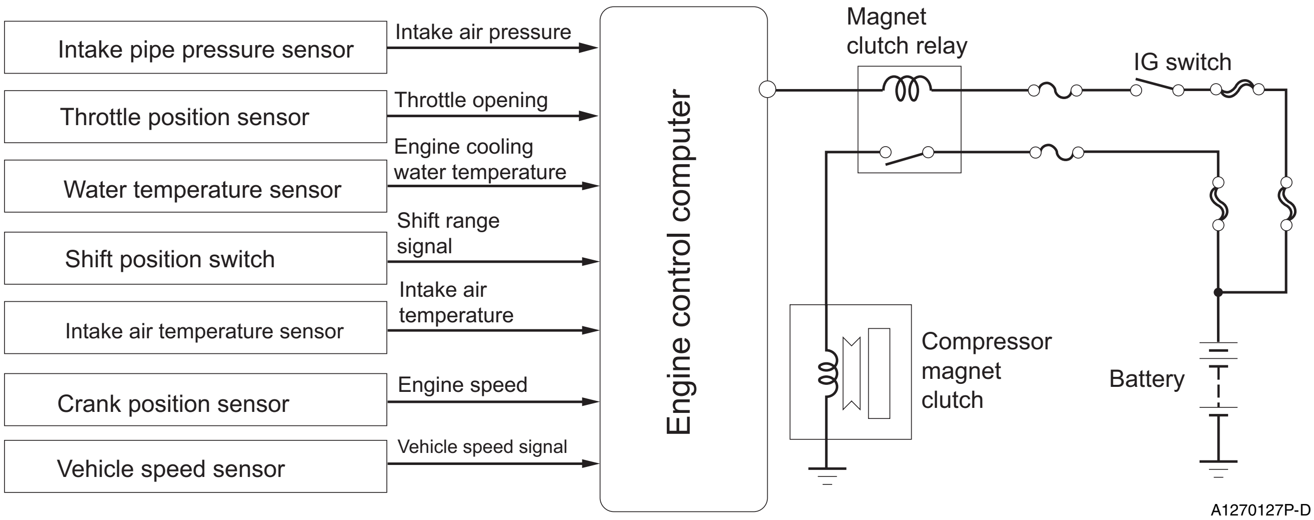
The shift lever is in a position other than P or N and the engine speed is below the set speed.
The engine speed has dropped below the set speed.

Cutoff of air conditioner during deceleration (only for A/T models)

- If all the following conditions are met, the air conditioner is cut off.

The shift lever is in a position other than P or N.
The idling switch is in the ON position.
The intake air pressure set based on the engine speed exceeds the set pressure.
The vehicle speed is within specified limits.

The change in vehicle speed is outside of specified limits.



Air Conditioner Idle Speed Control

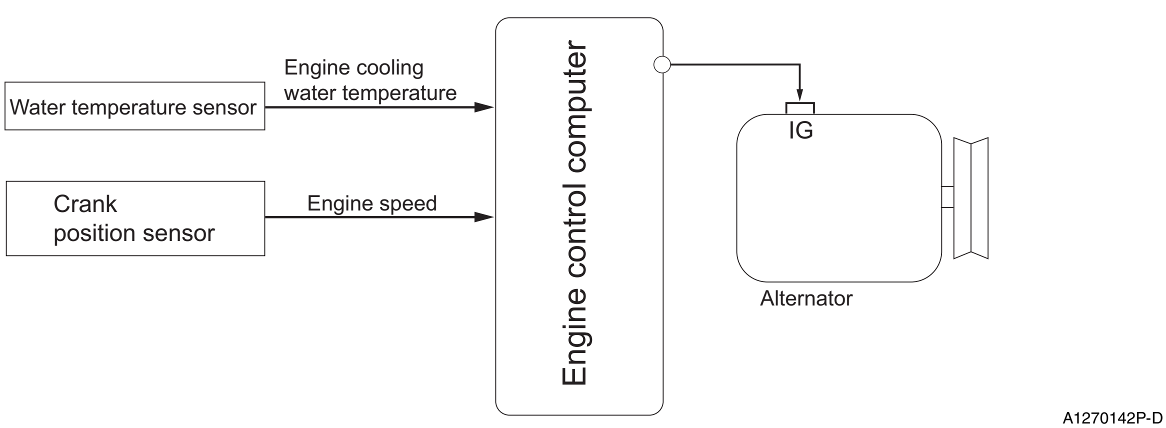
- If all the following conditions are met, the idle speed of the engine increases.
  - The air conditioner switch is in the ON position.
  - The blower switch is in the ON position.
  - The air conditioner is not cut off.
  - Air conditioner evaporator temperature is above the set temperature.

Magnetic Clutch Control

- If both the following conditions are met, the magnet clutch is turned on.
  - The air conditioner is turned on during idling.
  - The engine speed is above the specified temperature.

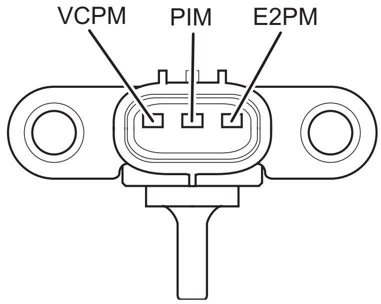
Alternator Charge Control

- The alternator stops charging the battery or reduces the supply voltage at very low temperatures, at the start of the engine, or if the engine speed has decreased below the set speed within a certain period of time after the start.



Intake Air Pressure Sensor

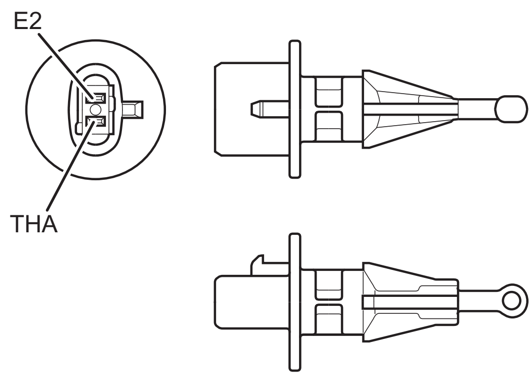
- The intake pressure sensor mounted in the air cleaner senses the intake pressure in the intake manifold.



A1270131P-D

Intake Air Temperature Sensor

- The intake air temperature sensor mounted on the clean side of the air cleaner senses the intake air temperature. It has a built-in thermistor whose resistance varies with temperature.



A1270134P-D

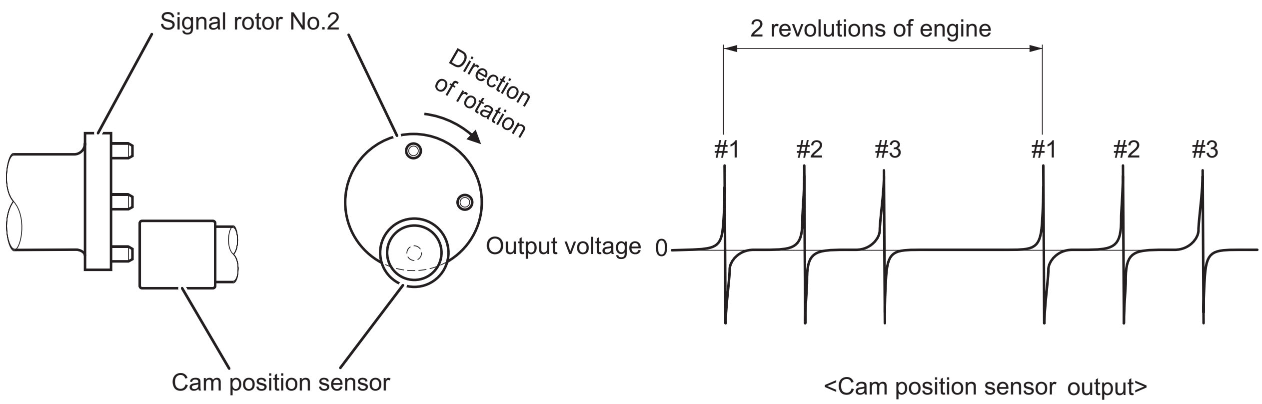
Intake air temperature sensor

Temperature [° C]	-30	-20	20	80	120
Resistance [kΩ]	(28.6)	16.2	2.45	0.322	(0.117)

❖ REFERENCE ❖
The values within parentheses are shown for reference purposes.

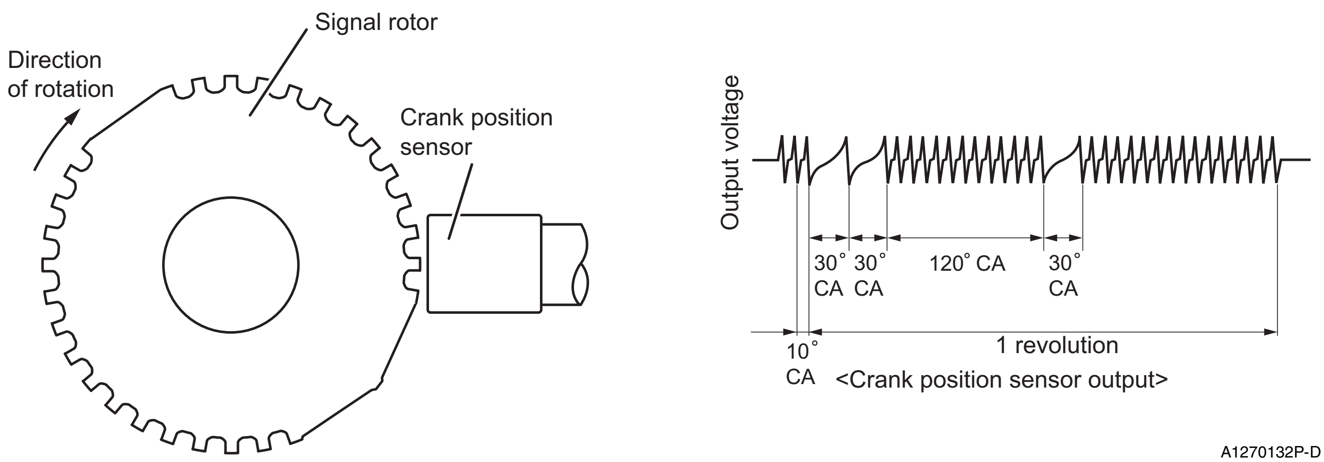
Cam Position Sensor (G2 Signal)

- Three protrusions are provided at the rear of the intake camshaft and a position sensor at the rear of the cylinder head to sense the phase of the intake camshaft and that of the crankshaft.
- When the intake camshaft makes one revolution, the air gap between each protrusion and the cam position sensor changes and the resulting flux changes cause the cam position sensor to produce 3 pulses per revolution.
- The phase of the intake camshaft and that of the crankshaft are sensed with signals from the cam position sensor and the engine speed sensor. DVVT control is performed according to these phases.



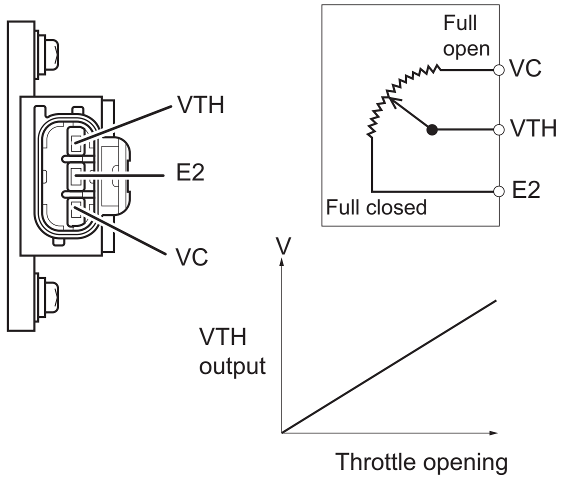
Crank Position Sensor

- To sense the crank angle, a signal rotor is provided at the front of the crankshaft, and a crank position sensor that operates in conjunction with the protrusions on the signal rotor is also provided.
- When the crankshaft rotates, the air gap between the crank position sensor and each protrusion on the signal rotor changes and accordingly flux changes, producing pulses.
- The engine speed is calculated from the interval at which these protrusions produce pulses.



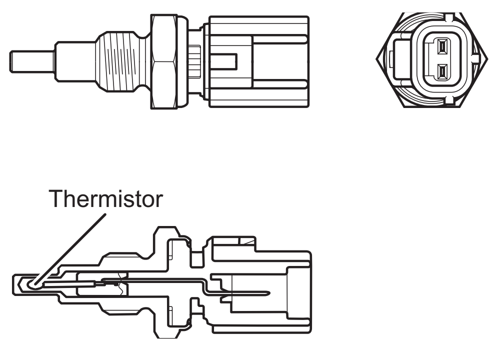
Throttle Position Sensor

- The throttle position sensor is mounted in the throttle body and has a built-in potentiometer that senses the throttle opening linearly.



Water Temperature Sensor

- A sensor for sensing the cooling water temperature is mounted in the cylinder head. The sensor has a built-in thermistor whose resistance varies with temperature and transmits signals from the thermistor to the engine control computer.

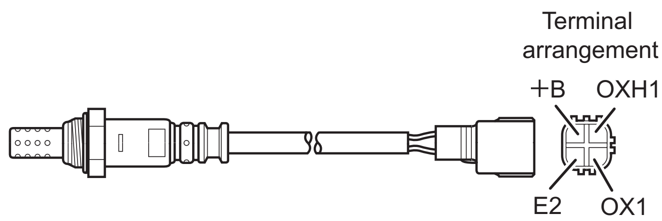


Water temperature sensor

Temperature (°C)	-20	20	80	110
Resistance (kΩ)	15.04	2.45	0.318	0.142

O2 Sensor

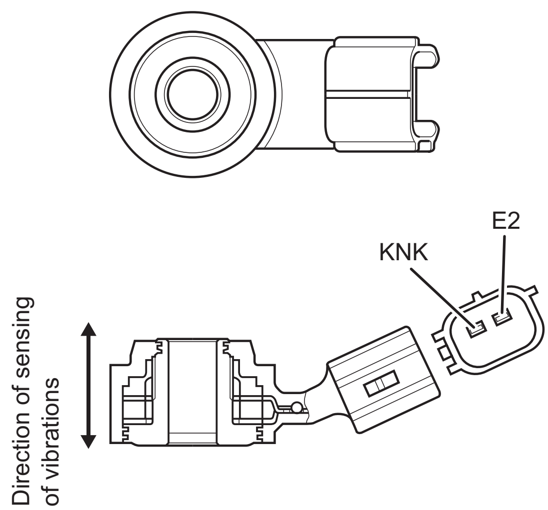
- The exhaust manifold and the exhaust front pipe for European models are provided with O_2 sensors (with heater).
- The O_2 sensor (with heater) determines the concentration of oxygen in exhaust gas from the amount of electromotive force produced by itself. The lower the concentration, the more electromotive force it will produce and the denser (richer) the air-fuel mixture will be. From the voltage applied by the sensor, the engine control computer determines whether the current air-fuel ratio is lower or higher than the theoretical air-fuel ratio. The sensor is designed to work at temperatures of about 300°C and above, so in order to make it start working at a lower temperature, it is provided with a heater circuit. The heater increases the accuracy of air-fuel ratio feedback and therefore helps reduce the amount of exhaust gas.



A1270137P-D

Knock Sensor

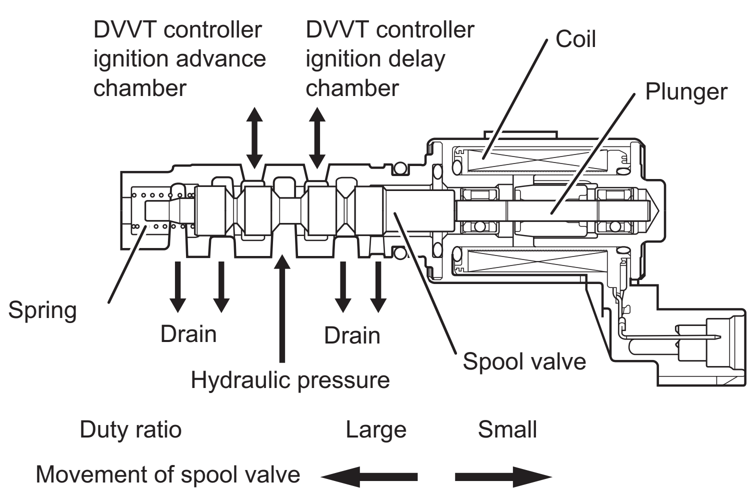
- The knock sensor, which is mounted in the cylinder block, detects the occurrence of knocking indirectly by sensing the vibration of the cylinder block caused by the knocking.
- The sensor has a built-in piezoelectric device that converts the vibration of the cylinder block into an electrical signal.
- To increase the accuracy of detecting a knocking, a non-resonant knock sensor is employed.



A1270135P-D

OCV for DVVT

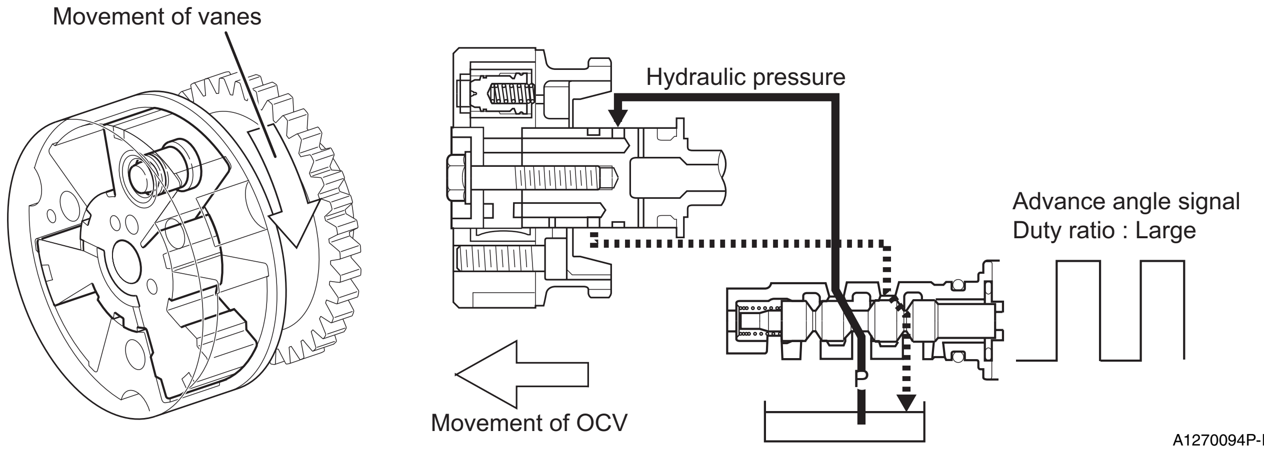
- Under the control of duty signals from the engine control computer, the spool valve is switched to change the oil path to the DVVT controller.



A1270075P-D

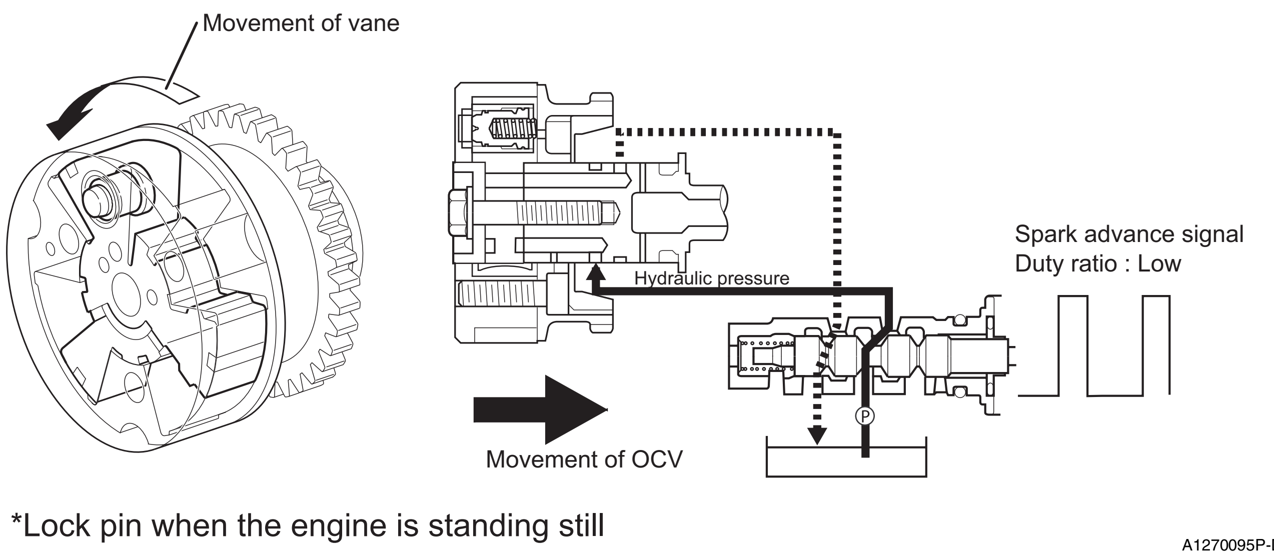
Advanced Injection

- The oil control valve operates under the control of signals from the engine control computer and the engine oil pressure is applied to the vane chamber on the advanced injection side, with the result that the intake camshaft rotates in the direction in which it advances with respect to the housing.



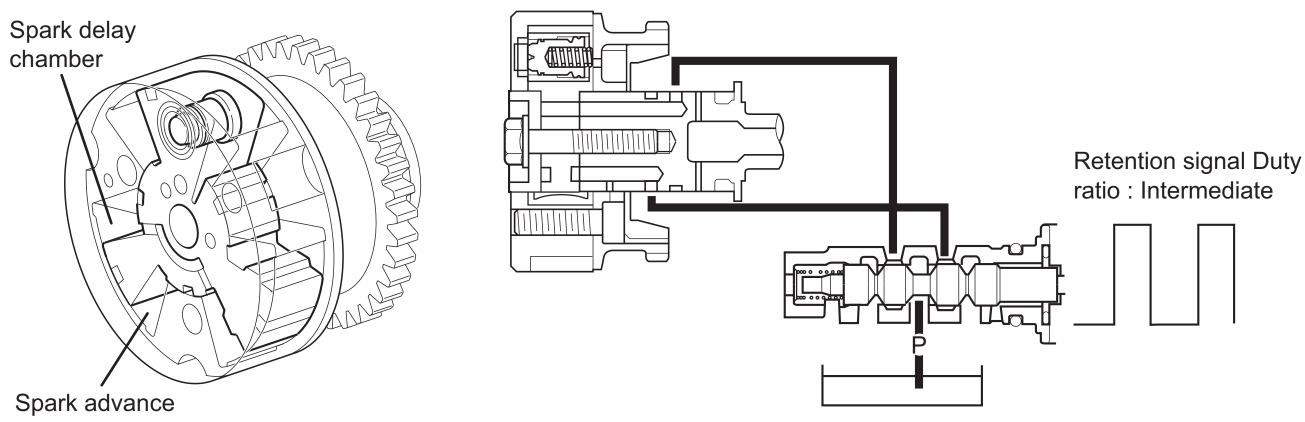
Delayed Injection

- The oil control valve operates under a signal from the engine control computer and the engine oil pressure is applied to the vane chamber on the delayed injection side, with the result that the intake camshaft rotates in the direction in which it delays with respect to the housing.



On Hold

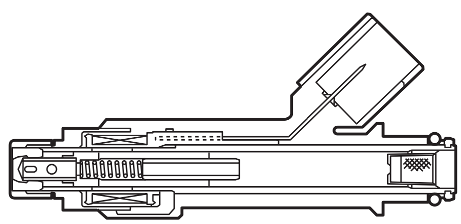
- When the target ignition timing is achieved, the oil control valve blocks the oil path to the DVVT controller to retain the ignition timing.



A1270096P-D

Fuel Injector

- The 3SZ-VE engine uses fine-particle type four-nozzle fuel injectors. These injectors atomizes fuel efficiently and reduces the amount of fuel adhering to the intake ports, and therefore contribute to an increase in fuel efficiency and a reduction in emission.
- The K3-VE engine uses four-nozzle fuel injectors to optimize the fuel injection characteristic.



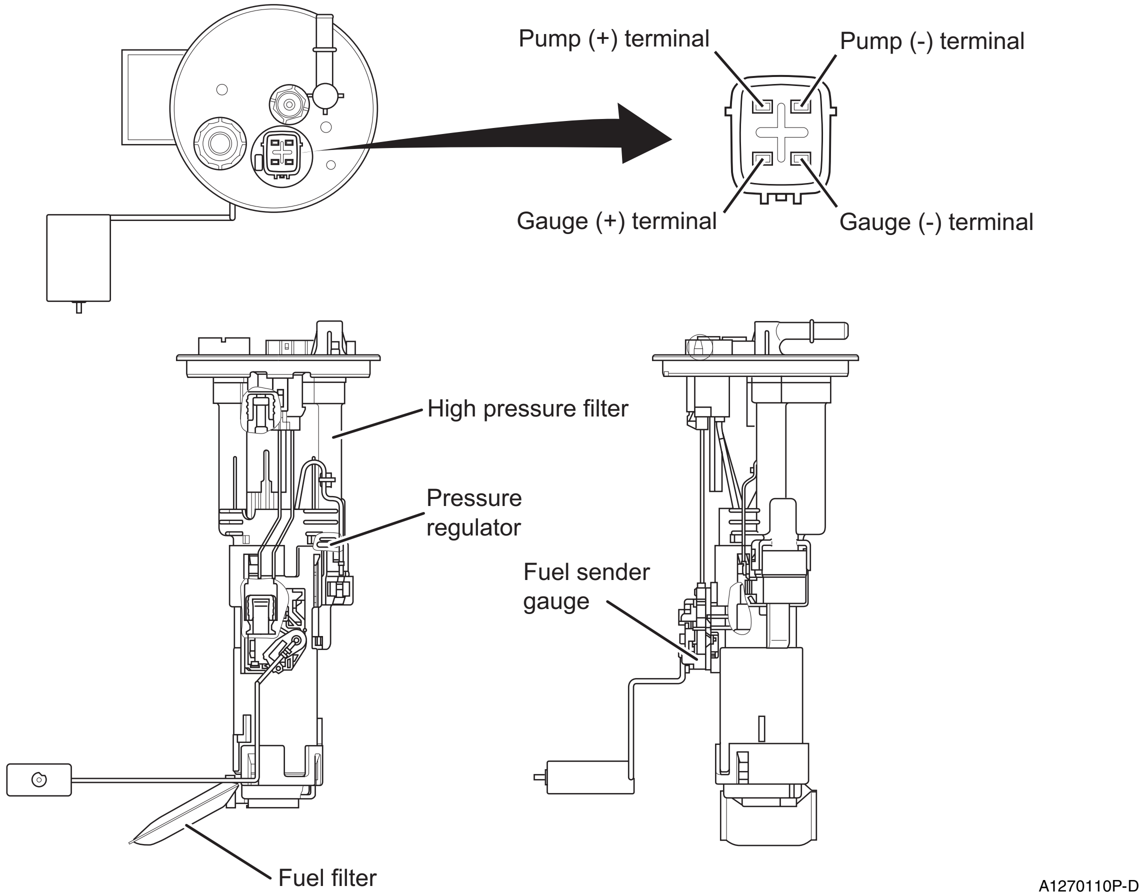
A1270108P-D

Injector specifications

Flow rate [at a fuel pressure of 250 kPa] (L/min)	0.199
Coil resistance [at 20° C] (Ω)	12

Fuel Pump

- The fuel pump is integrated with a fuel pressure regulator and a high-pressure filter and fuel is returned within the fuel tank.
- The fuel center gage is incorporated into the fuel pump.
- The fuel pump is an in-tank type and has quick connectors for connecting fuel tubes.

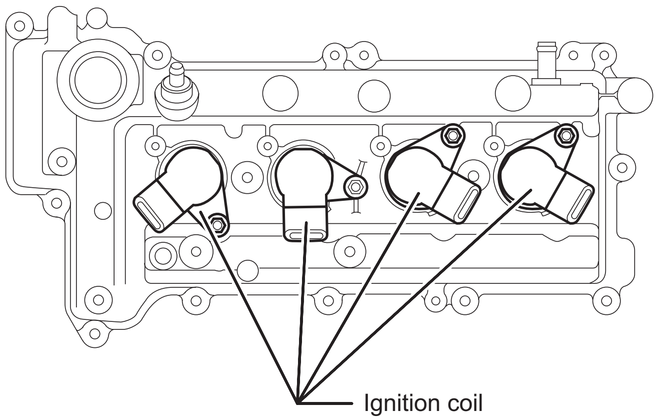


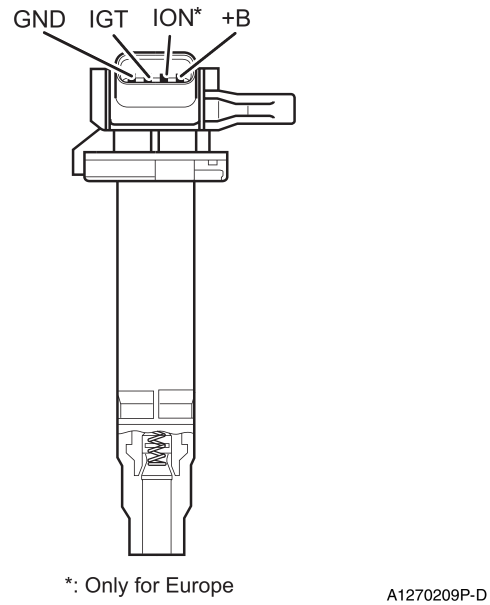
Fuel pump specifications

Discharge (L/h) (at 12 V, 294 kPa)	80 or more
Pressure regulator control pressure (kPa) (400 L/h)	324
Fuel filter filtration area (cm^2)	600

Igniter-Integrated Ignition Coil

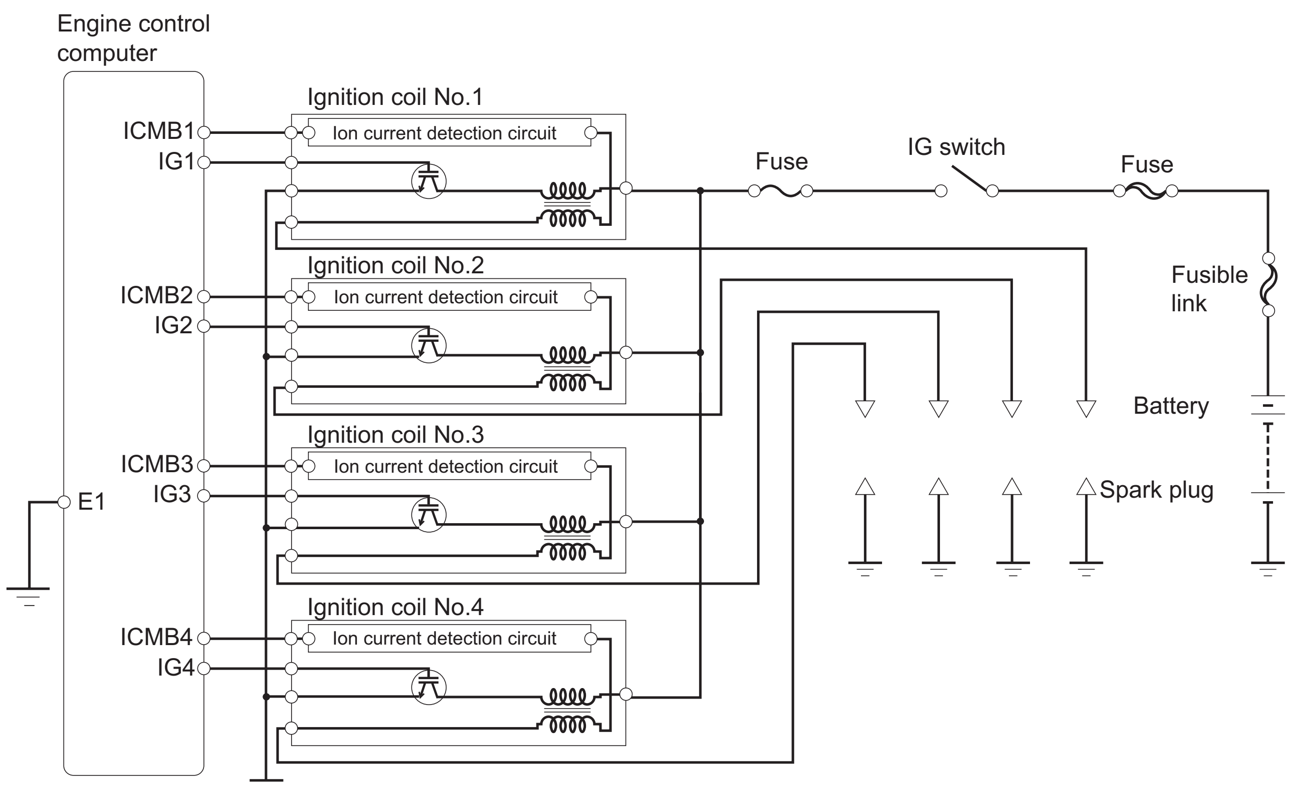
- Ignition coils with a built-in stick type igniter are employed to improve ignition controllability and reliability.
- The ignition coils are mounted in the cylinder head cover, one right above the spark plug of each cylinder.
- An ion current combustion control system that detects ions produced during combustion is employed only for European models.





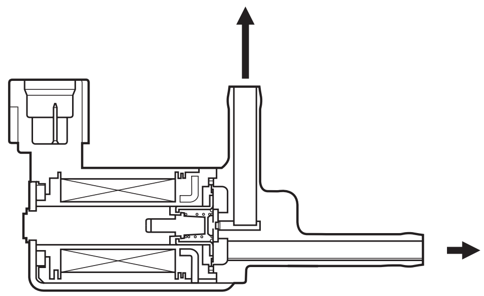
Ion Current Combustion Control System

- The igniter detects the ion current produced during combustion. The ion current detected is converted into an ion voltage and transmitted to the engine control computer. If this voltage is lower than the specified voltage, the engine control computer determines that a misfiring has occurred and increments the number of misfiring by one.
- If the number of misfirings reaches a specified limit, the check engine warning lamp lights to inform the driver that the engine is in bad condition.
- If the number of misfirings reaches the number at which the catalyzer may overheat, the check engine warning lamp blinks.



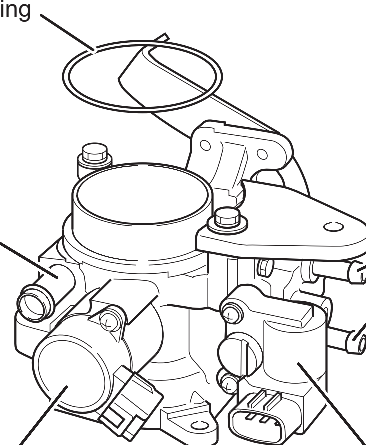
VSV for Canister Purge

- The quantity of evaporated fuel to be fed into the combustion chambers of the engine is regulated under the control of signals from the engine control computer.



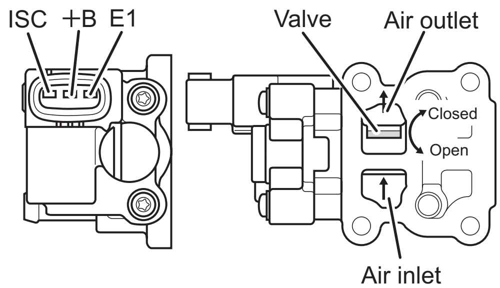
Throttle Valve (Body)

- A down-draft type throttle body is employed. The throttle body is mounted directly on the cylinder head through a bracket to reduce vibrations and improve reliability.
- A resin throttle link, a small R-ISCV, a small throttle position sensor are employed to save weight.
- A nonlinear throttle link is employed to improve the starting acceleration feel.



R-ISCV

- R-ISCV refers to a rotary solenoid valve that regulates the quantity of air bypassing the throttle valve under the control of signals from the engine control computer.
- The quantity of air is determined by the ratio of ON time to OFF time (duty ratio) specified by signals from the engine control computer.



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Actuation of R-ISVC

Assisting the engine in starting	To make it easier for the engine to start, the duty ratio is raised to increase the quantity of air passing through the R-ISCV at the start of the engine and for several seconds after the start. After the engine has started, the duty ratio is adjusted according to the cooling water temperature to regulate the engine speed.
Predictive control	When the electric load changes, for example, as a result of turning on or off the air conditioner, the load applied to the engine changes and the engine speed changes accordingly. When receiving a load change signal, the engine control computer sends a signal responsive to the load change to the R-ISCV, which then regulates the quantity of air passing through it to reduce the change in engine speed.
Feedback control and idle speed control according to electric load	If it is determined by monitoring the engine speed for a certain time that there is a difference between the actual idle speed and the target idle speed, the engine control computer sends a signal to the R-ISCV, which then regulates the quantity of air passing through it to make the idle speed approach the target idle speed. The idle speed is raised according to electric load to stabilize during idling.
Idle speed step-up control when air conditioner is turned on	When the air conditioner is turned on, the engine control computer increases the idle speed in 2 levels according to the load applied by the air conditioner without increasing it more than necessary in order to ensure fuel efficiently and driveability.
Idle speed control when power steering system is activated	When receiving, from the power steering hydraulic sensor, a signal indicating that the power steering system is activated, the engine control computer increases the idle speed to ensure driveability.

Diagnosis Function

- If an error occurs in the signal input line of the system, the diagnosis function makes the computer inform the service person of the part in which the error has occurred.

Clearing by means of a check tool

- An error code detected can be cleared on the screen by the check tool connected to the DLC connector.

Clearing by means of a fuse

- An error code detected can be cleared from memory by turning off the ignition switch and then removing the EFI fuse from the relay box in the engine compartment for 60 seconds or more (at ordinary temperature).
- An error code detected by the diagnosis function can also be cleared by turning off another backup circuit, the grounding circuit, or the power from the battery, in which case, however, it may take longer to clear the error code from memory.

✦ CAUTION ✦

- **The warning lamp remains lit even after the completion of repair of the failed part; it goes out after the engine control computer determines the part is functioning normally.**
- **There are errors that can be detected only during driving, so a driving test is needed.**

Fail-Safe Function

● In the event of an error that may cause the engine to malfunction or the catalytic converter to overheat, for example, an error in a signal from a sensor or an error in the regulation of the DVVT oil control valve, the fail-safe function operates the computer by means of numeric values stored in the computer itself.

● When the system recovers from an error, the fail-safe function is deactivated but the diagnosis results remain stored in memory.

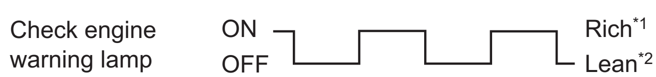
DLC

● The DLC placed in front of the driver's seat (in the lower section of the instrument panel, on the driver's door side) indicates diagnosis results and the status of the O_2 sensor.

- Indication of diagnosis results
- Indication of O_2 sensor

● If EFI-T and E are short-circuited, the check engine warning lamp in the combination meter blinks, indicating error codes sequentially in ascending order by the number of times it blinks.

● As to the status of the O_2 sensor, if EFI-T and E are short-circuited with the ignition switch ON and the engine speed is increased to 2,000 rpm or more by depressing the accelerator pedal, the check engine warning lamps comes on or remains off, indicating the status of the O_2 sensor and whether feedback control is performed normally. (The status of the rear O_2 sensor cannot be indicated.)



A1270130P-D

❖REFERENCE❖

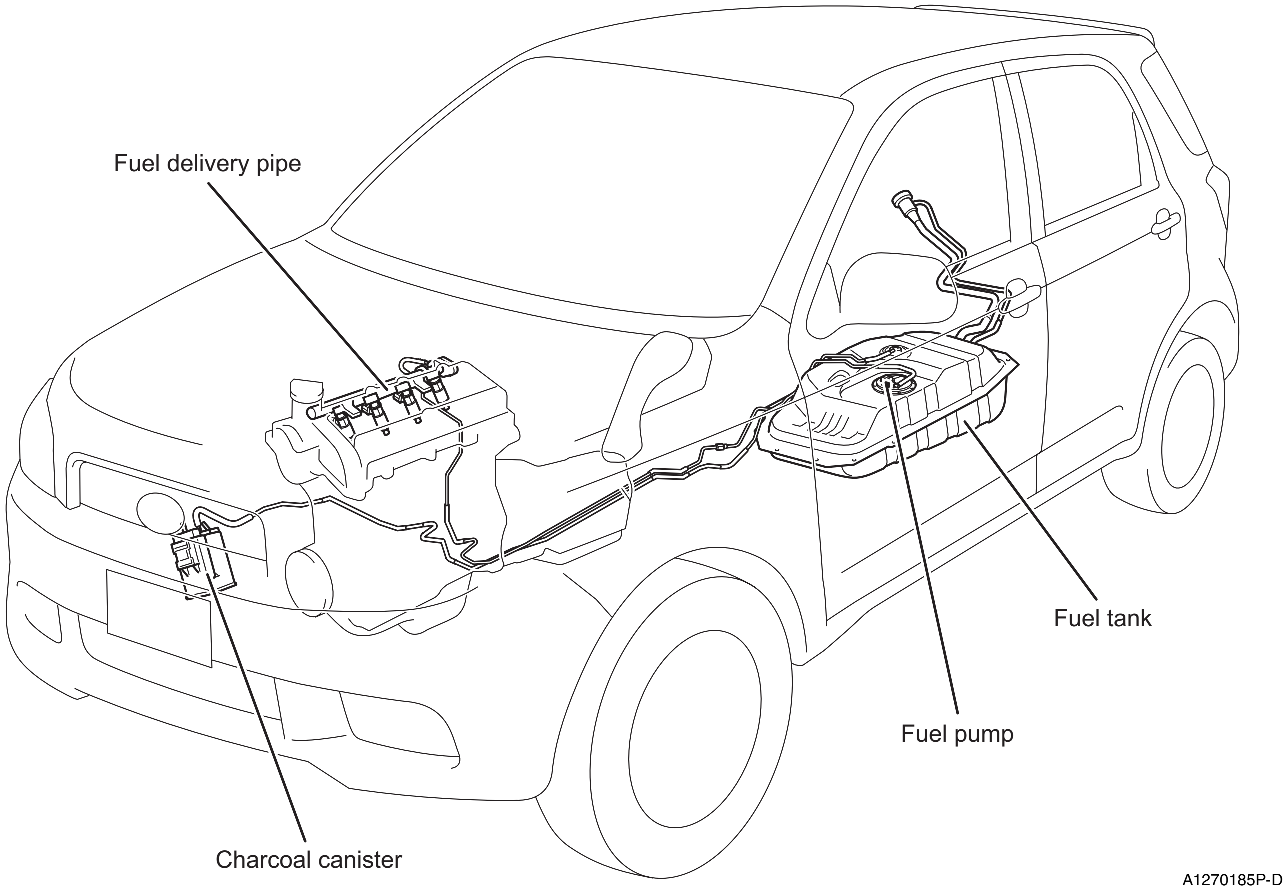
*1 : Rich mixture side: Lamp ON

*2 : Lean mixture side: Lamp OFF

FUEL SYSTEM (3SZ-VE/K3-VE)

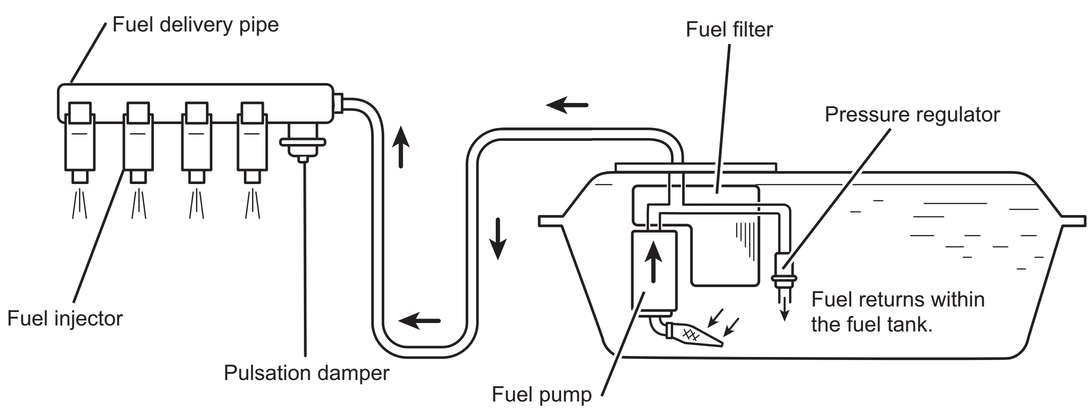
Fuel System in General

- All models are equipped with a fuel no-return EFI fuel feed system.
- All models are also provided with a fuel cut system so designed that when receiving signals from the airbag computer in the event of a vehicle collision, the engine control computer stops the fuel pump forcibly to prevent the leakage and burning of fuel.



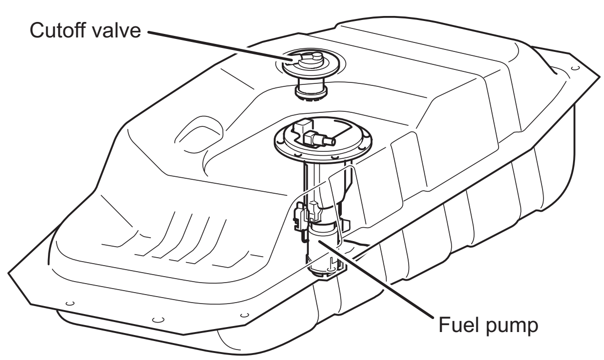
Fuel Non-Return System

- The pressure regulator integral with the fuel tank feeds the smallest quantity of fuel required for the engine at a constant pressure, while returning the excess amount of fuel within the fuel tank. This system prevents fuel from passing through the engine compartment and returning to the fuel tank after heated, and therefore reduces the quantity of fuel evaporating in the fuel tank.



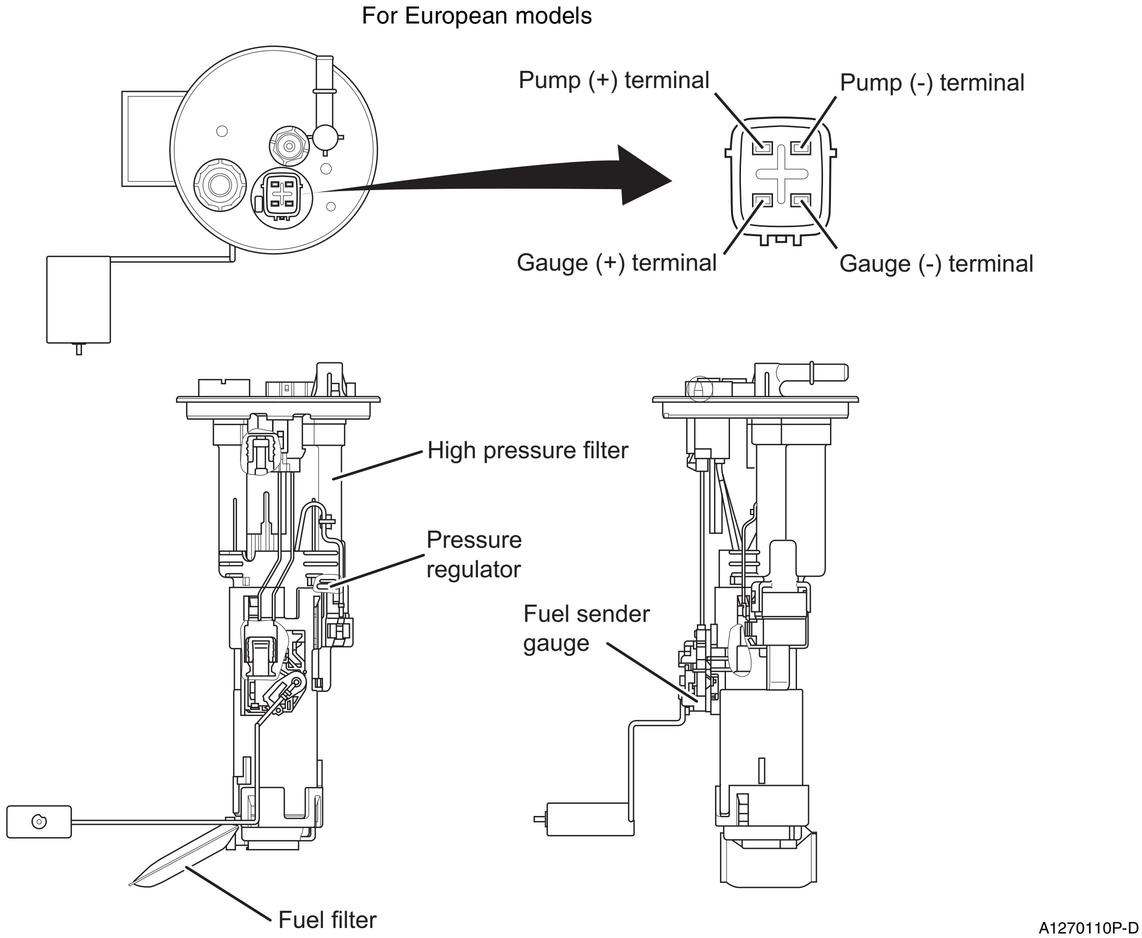
Fuel Tank

- The fuel tank is provided with a cutoff valve and a fuel inlet with a built-in fuel check valve to prevent fuel leaks and ensure safety during refueling and in the event of a rollover of the vehicle.
- A material free of lead and hexavalent chromium is used for the fuel tank to reduce the environmental load. The fuel tank has recycle marks to facilitate disassembly.
- Instead of a drain hole, the fuel tank has a service hole on the vehicle body side as a means of discharging fuel.



Fuel Pump

- The fuel pump is integrated with a fuel pressure regulator and a high-pressure filter and fuel is returned within the fuel tank.
- The fuel center gage is incorporated into the fuel pump.
- The fuel pump is an in-tank type and has quick connectors for connecting fuel tubes.

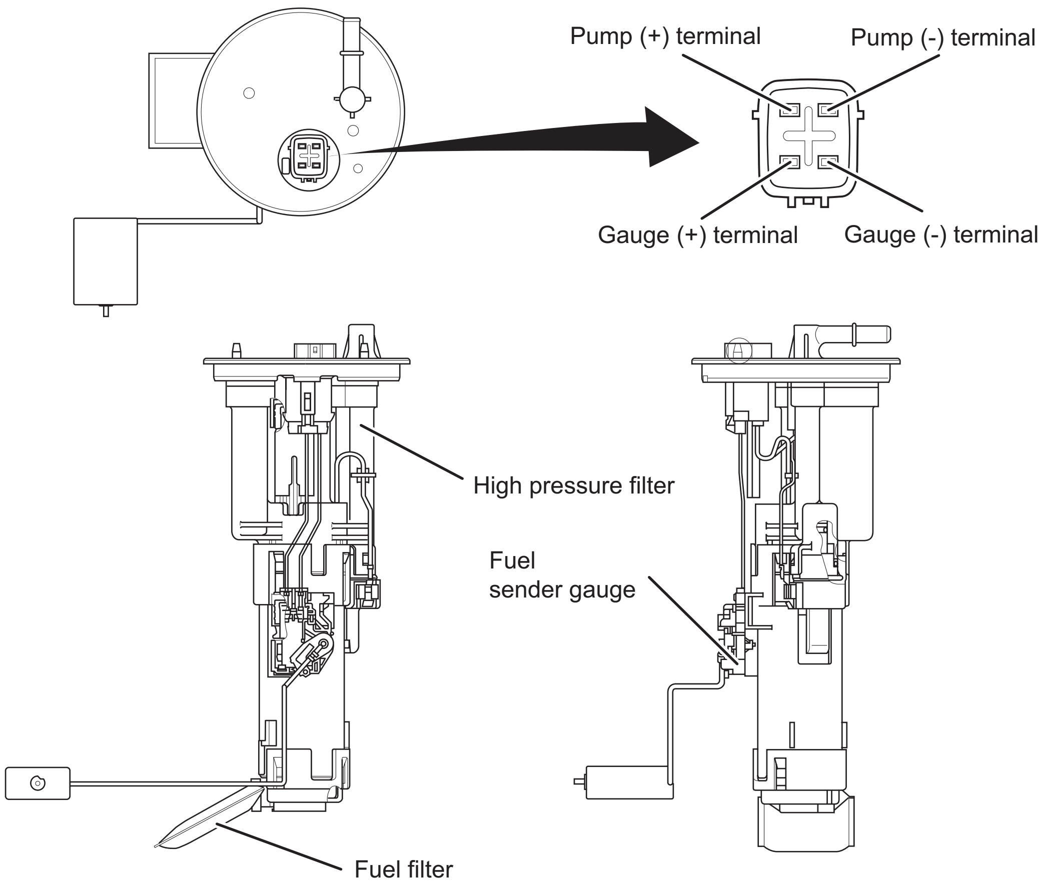


Fuel pump specifications (For European models)

Discharge (L/h) (12 V, 294 kPa)	80 or more
Pressure regulator control pressure (kPa) (400 L/h)	324
Fuel filter filtration area (cm^2)	600

- Models other than European models employ fuel pumps with a large fuel filter.

Models other than European models



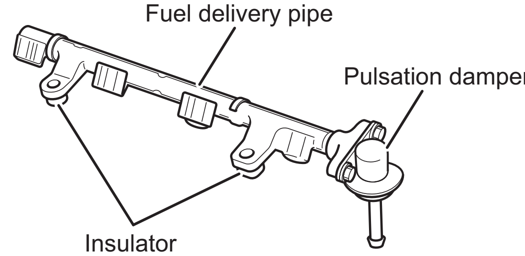
A1270146P-D

Fuel pump specifications (For models other than European models)

Discharge (L/h) (12 V, 294 kPa)	80 or more
Pressure regulator control pressure (kPa) (400 L/h)	324
Fuel filter filtration area (cm^2)	1180

Fuel Delivery Pipe

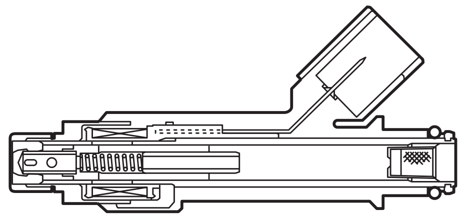
- The fuel delivery pipe is made of aluminum alloy and connected to a fuel hose through an O-ring.
- The fuel hose connector is provided with a pulsation damper to absorb pulsations of fuel and increase the accuracy of injecting fuel.



A1270107P-D

Fuel Injector

- The 3SZ-VE engine uses fine-particle type four-nozzle fuel injectors. These injectors atomizes fuel efficiently and reduces the amount of fuel adhering to the suction ports, and therefore contribute to an increase in fuel efficiency and a reduction in emission.



A1270108P-D

Injector specifications (3SZ-VE/K3-VE)

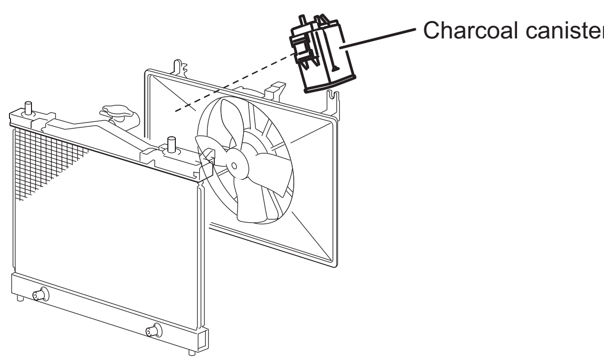
Flow rate [Max. lift, fuel pressure of 300 kPa, 20° C] (cm^3/min)	199.0*
Coil resistance [20° C] (Ω)	12*

❖REFERENCE❖

* : Characteristics determined with test oil (dry solvent)

Charcoal Canister

- Canister purge control has been adopted to suck and burn fuel evaporated in the fuel tank.
- A charcoal canister is mounted on the radiator fan shroud in the engine compartment.

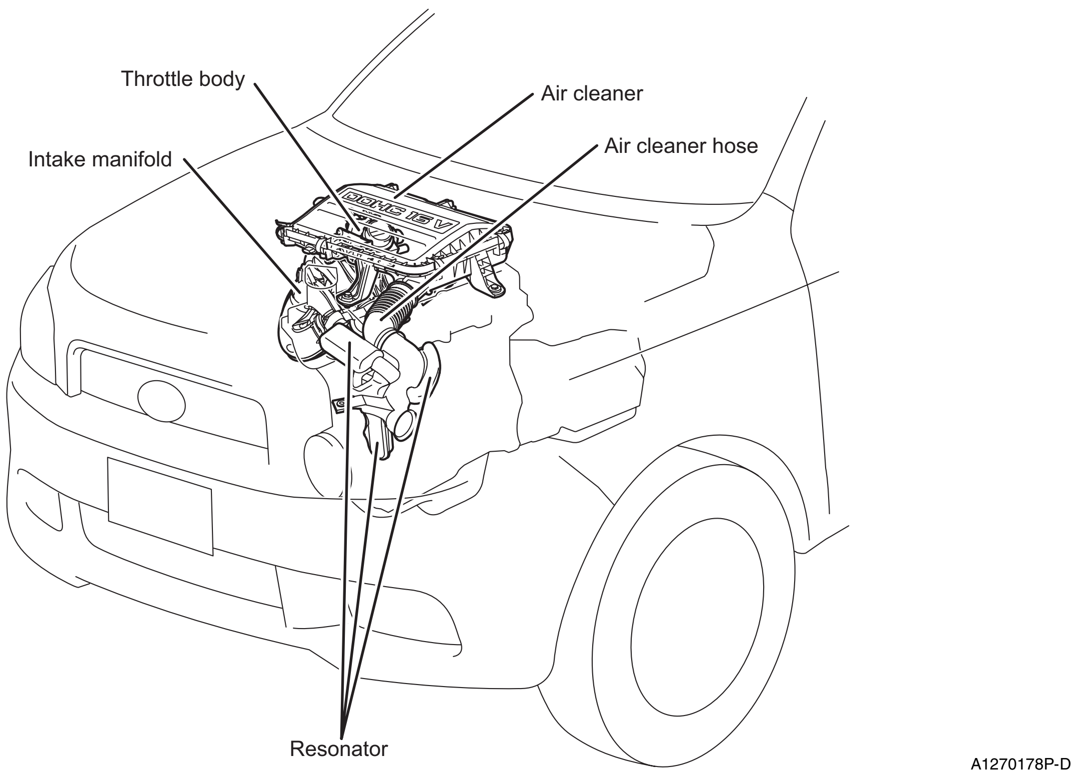


A1270189P-D

INTAKE SYSTEM (3SZ-VE/K3-VE)

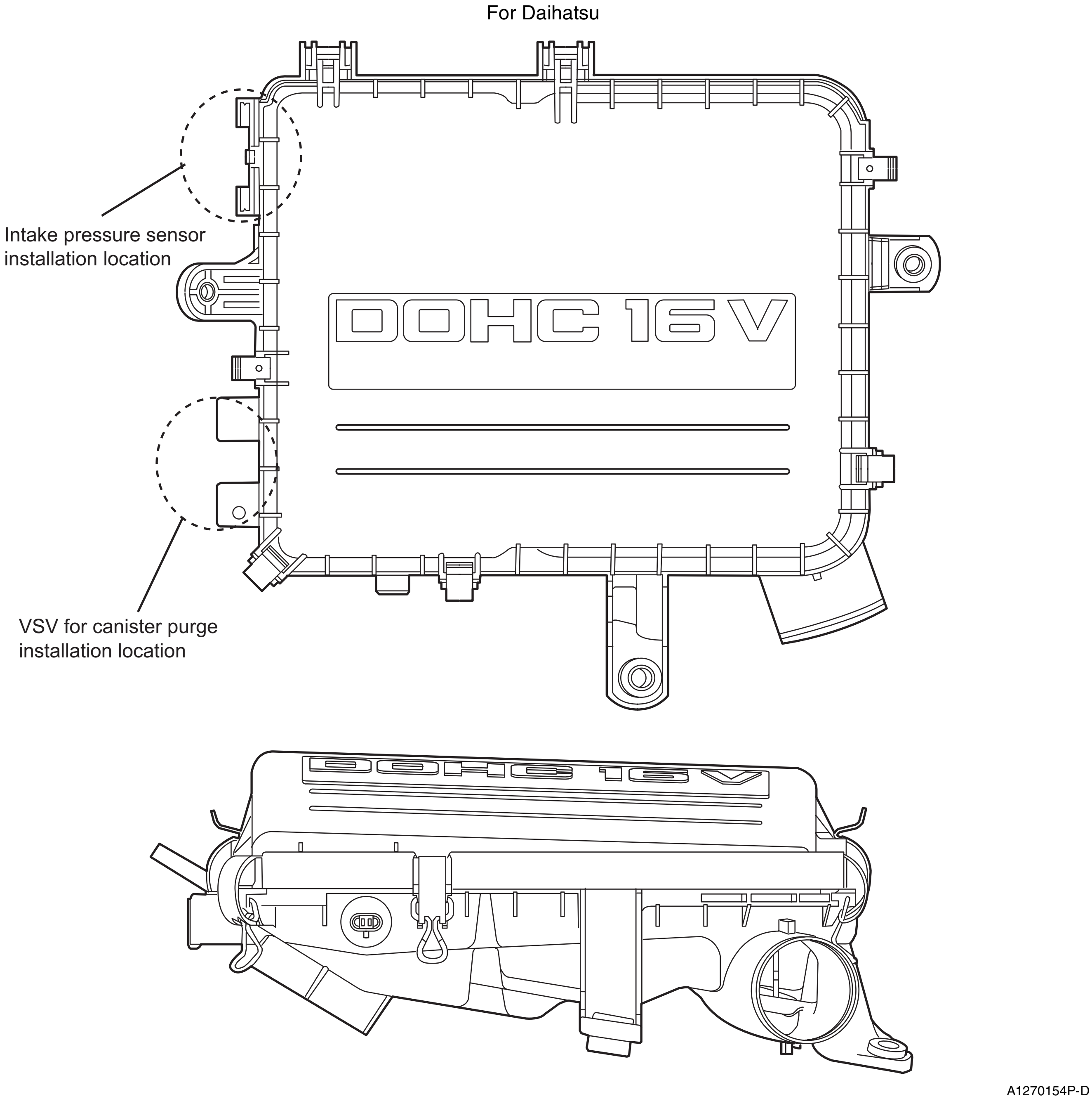
Intake System in General

- The intake system consists of an air cleaner, air cleaner hoses, a throttle body and an intake manifold. The air cleaner is placed right above the engine and directly mounted on the throttle body through an O-ring in order to reduce intake resistance and engine radiation noise.
- A long port type resin intake manifold is employed to improve engine performance at low- and intermediate-speed ranges.



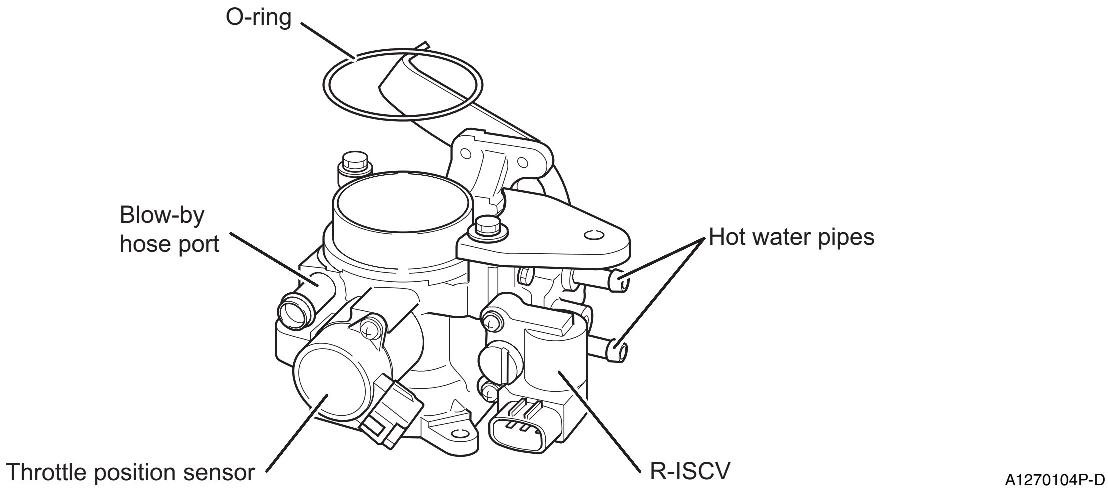
Air Cleaner

- A large-capacity plastic air cleaner (6L) integral with an expansion chamber is employed to reduce the suction noise.
- A suction air temperature sensor is mounted in the air cleaner to regulate the suction air temperature. A canister purge control VSV seat and an intake pressure sensor seat are placed on the side of the case.



Throttle Valve (Body)

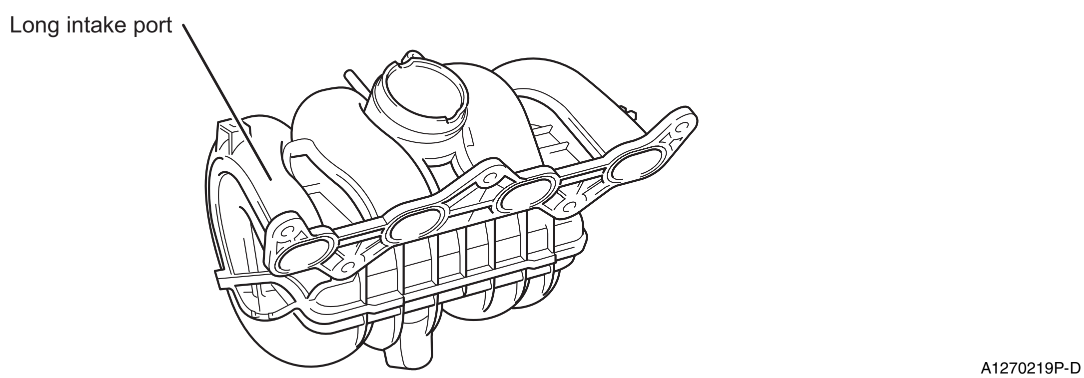
- A down draft type throttle body is employed. It is mounted directly on the cylinder head through a bracket to reduce vibrations and improve reliability.
- A resin throttle link, a small R-ISCV, a small throttle position sensor are employed to save weight.
- A nonlinear throttle link is employed to improve the starting acceleration feel.



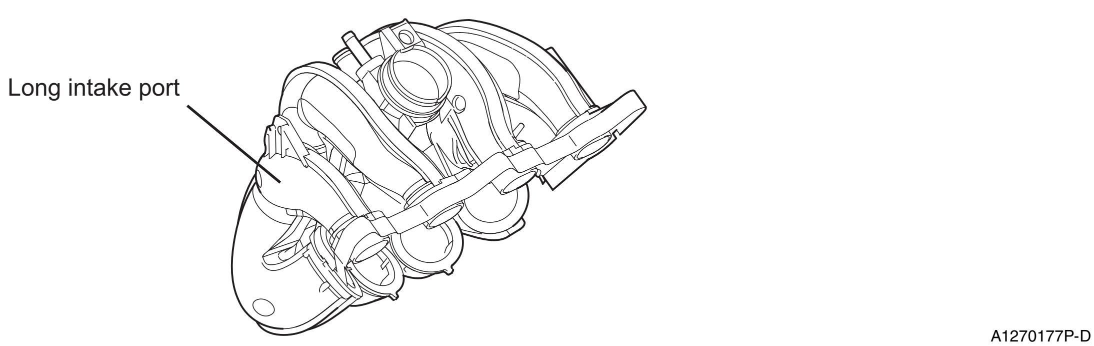
Intake Manifold

- A built-up resin intake manifold (the pipes are molded by the blow molding method (DRI) and branches by the vibration welding method (3SZ-VE) or heat ray welding method (K3-VE)) is employed to improve performance and save weight.
- The axial flow and same lengths are made equal to feed the same amount of air into each cylinder and to reduce the suction rambling noise.
- Tapered long intake ports are provided to make the most of the inertia supercharging effect and to increase torque at intermediate- and high-speed ranges.
- A decrease in suction air temperature achieved by the use of a resin intake manifold and a reduction in suction air resistance by the use of molded resin ports with proper inner surface roughness contribute to an increase in volumetric efficiency.

3SZ-VE



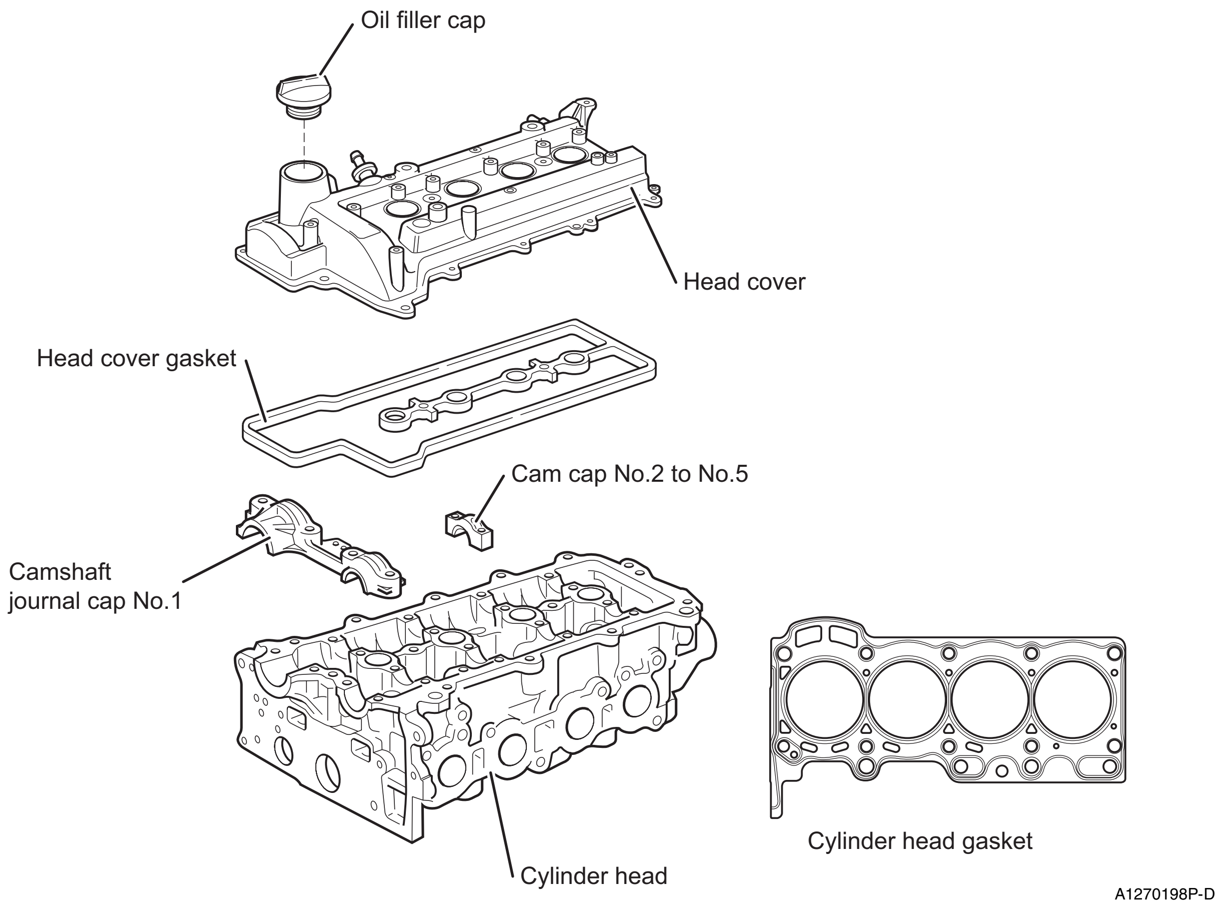
K3-VE



ENGINE MECHANICAL COMPONENTS (3SZ-VE/K3-VE)

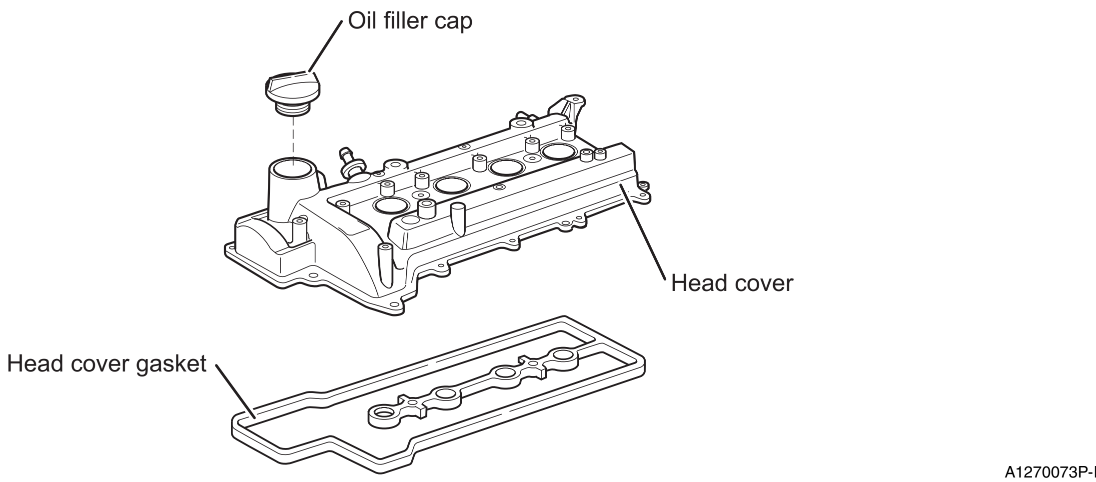
Cylinder Head-Related Items

- The cylinder head cover is made of lightweight rigid aluminum alloy.
- The gasket in the outer section and the gasket in the spark plug tube section that make up the cylinder head gasket are integrated with each other to ensure ease of servicing. The cylinder head gasket is made of heat resistant acrylic rubber.
- The cylinder head is made of lightweight rigid aluminum alloy. A DVVT hydraulic oil passage is installed in it and the wall thickness is optimized to save weight.



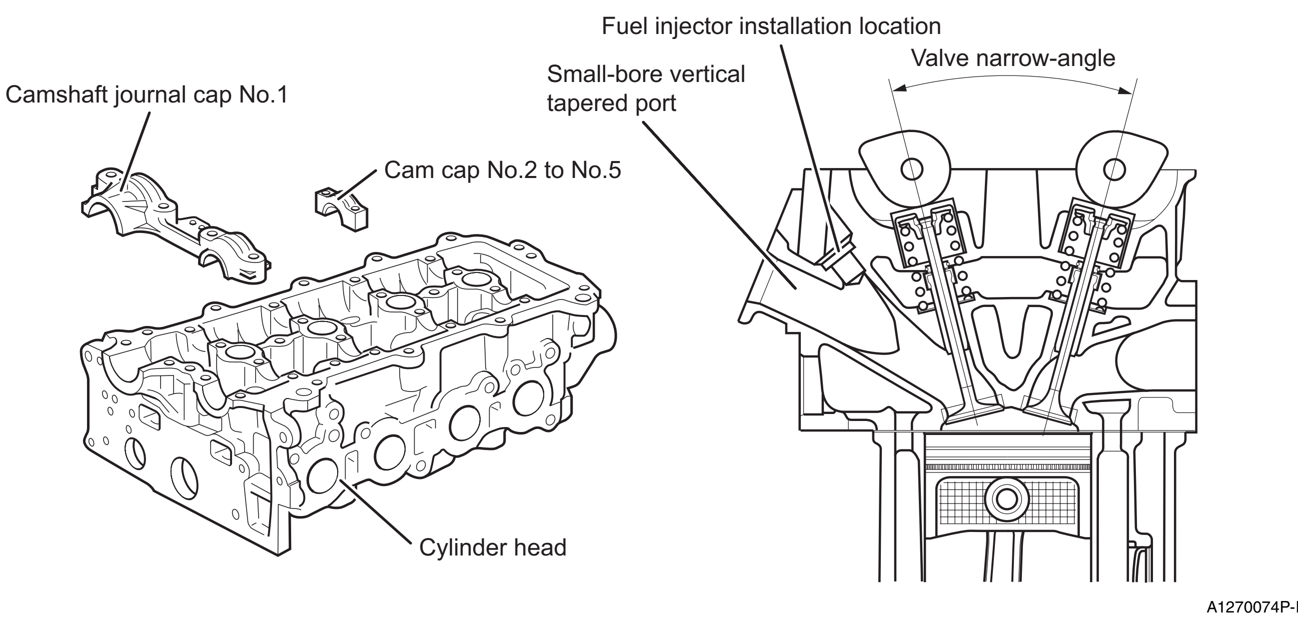
Cylinder Head Cover

- The cylinder head cover is molded integrally with the cover of the spark plug tube section to make the structure simple.
- The cylinder head cover is fastened with bolts around the periphery and at the center, and bolts are arranged at regular intervals around the periphery to improve sealing performance.



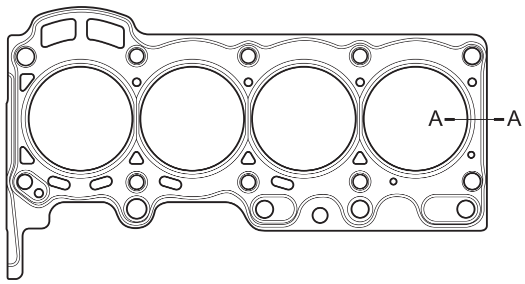
Cylinder Head

- A combustion chamber shape with an excellent surface-to-volume ratio has been adopted to improve knocking resistance and combustion efficiency.
- The suction and exhaust ports are arranged so as to achieve a cross flow, and small-bore vertical tapered ports are employed to improve suction efficiently.
- A fuel injector is mounted in each intake port of the cylinder head to reduce the amount of fuel adhering to the inner wall and the amount of HC emitted.
- An intake first cooling system in which cooling water flows from the intake side to the exhaust side is employed for the cylinder head to lower the intake air temperature and improve charging efficiency and knocking resistance.



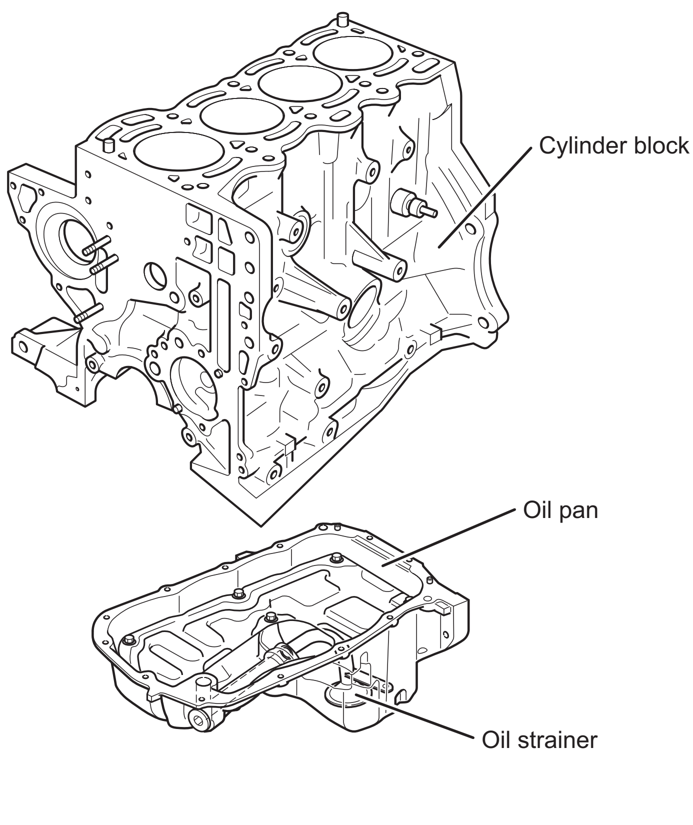
Cylinder Head Gasket

- A single layer metal gasket is employed. A shim with the same width as the sealing surface is laser-welded in each cylinder bore section to make bearing stress uniform and ensure sealing performance and durability.



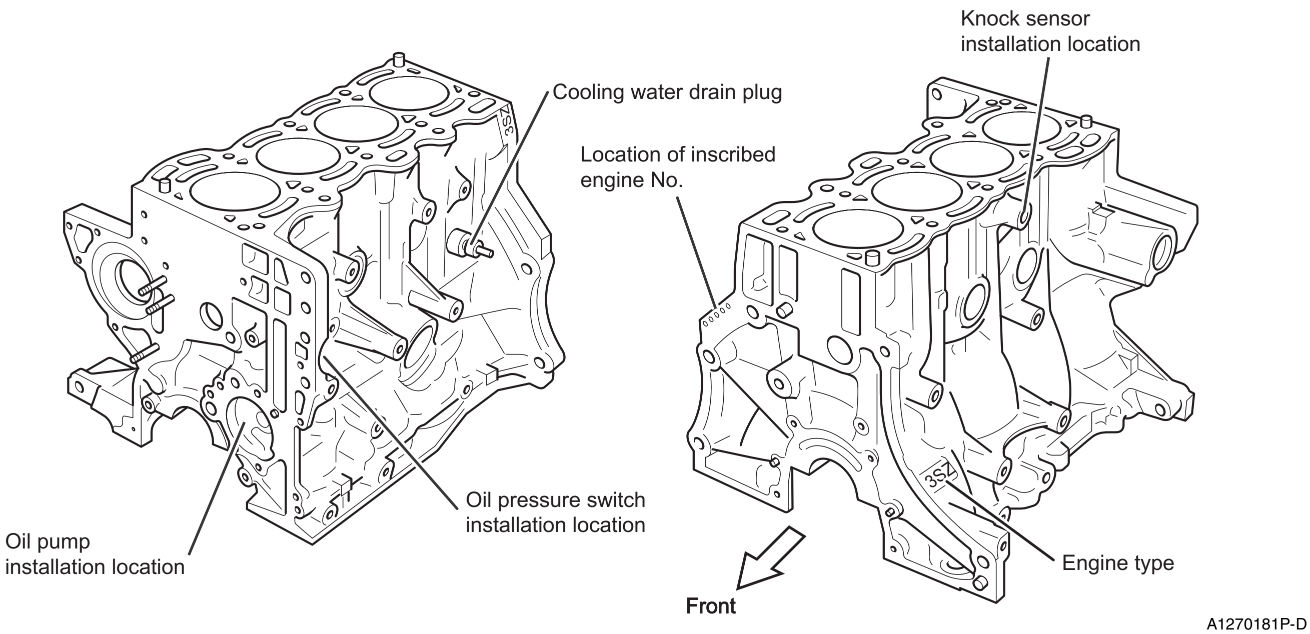
Cylinder Block-Related Items

- The cylinder block is made of rigid cast iron. The spacing between bores is set at 6.0 mm to make the engine compact. The center of each bore is placed 8.0 mm away from the center of the journal to offset the crankshaft.
- The oil pan is made of aluminum alloy and has a baffle plate.



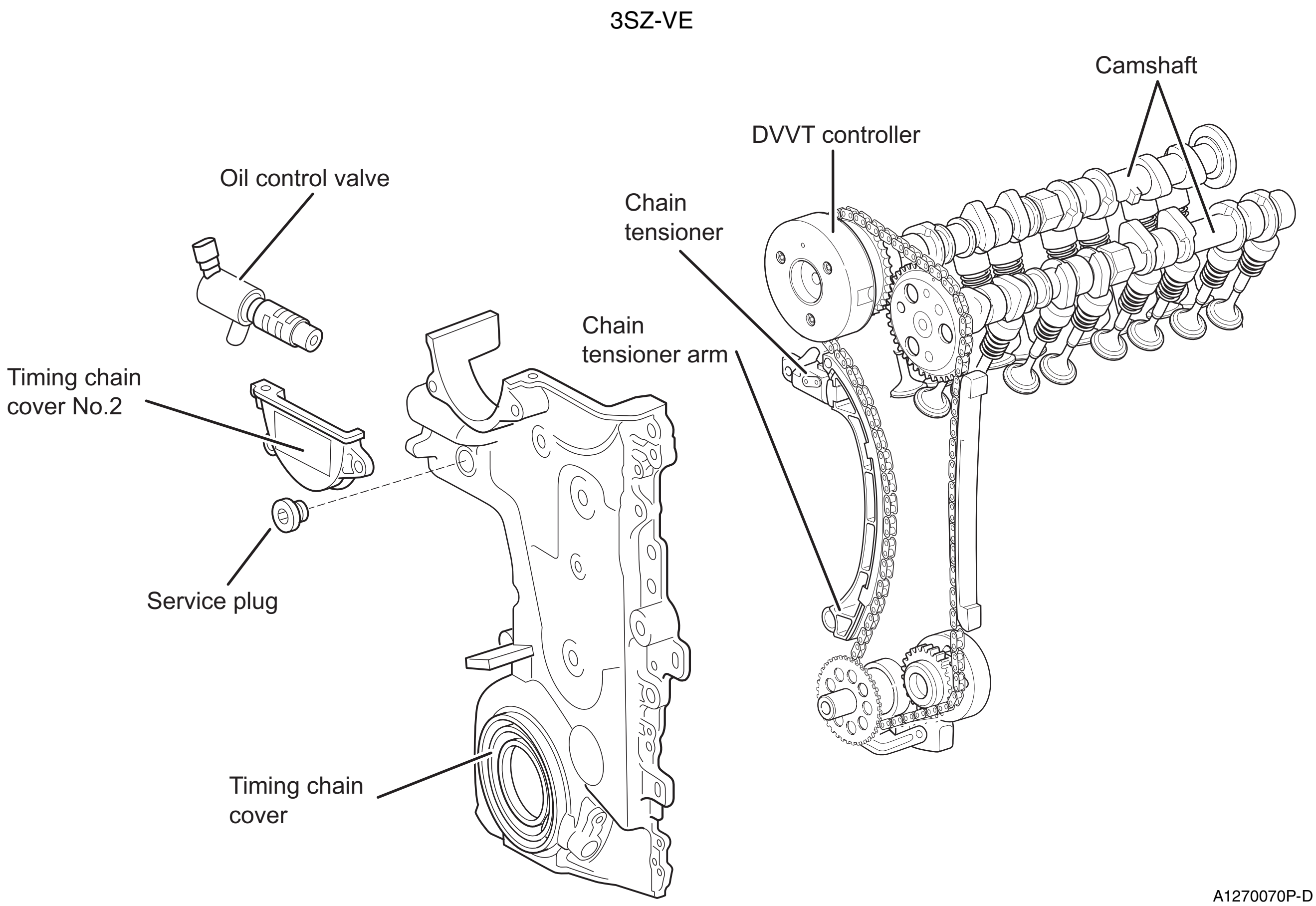
Cylinder Block

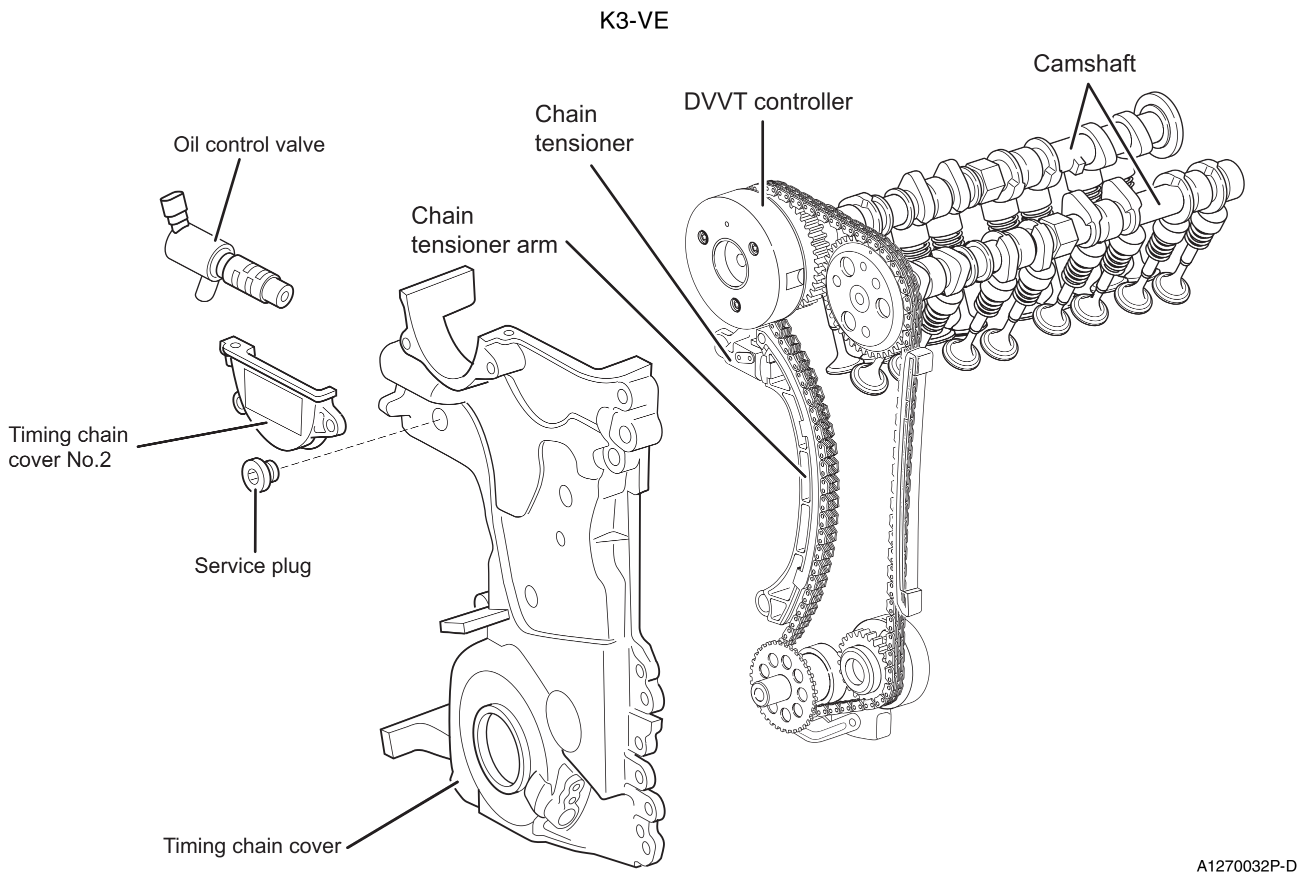
- The water jacket is of Siamese construction and drilled passages are added between bores to ensure durability.
- The center of each bore is shifted toward the exhaust side by 8.0 mm with respect to the center of crankshaft (offset crankshaft) to reduce combustion pressure losses during transmission to each piston.
- The water pump turbulence chamber, the oil pump rotor chamber and the relief valve are combined into one block or incorporated into the cylinder block to make them lighter in weight and smaller in size.



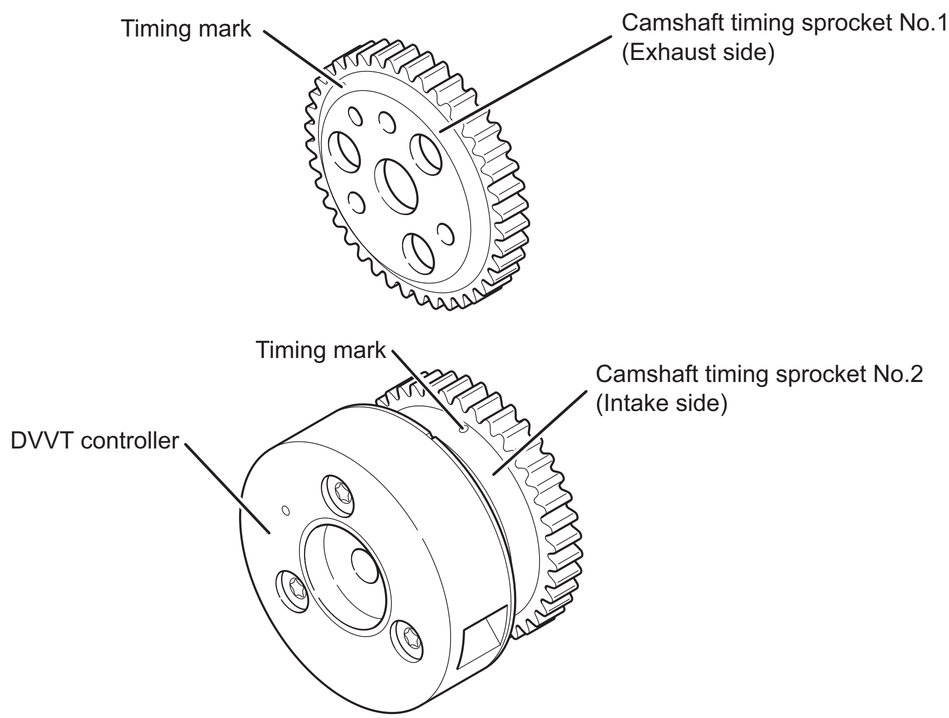
Timing System-Related Items

- The 3SZ-VE engine uses a 8.0 mm-pitch roller chain to drive the camshafts. The overall length of the engine has been reduced by using the same timing chain to drive the oil pump.
- The K3-VE engine uses a 6.35 mm-pitch silent chain to drive the camshafts. The overall length of the engine has been reduced by using the same timing chain to drive the oil pump.
- The use of a timing chain has the advantage of dissipating heat via its cover, and therefore it lowers the oil temperature and improves reliability.


3SZ-VE
Camshaft
DVVT controller
Oil control valve
Chain
tensioner
Chain
tensioner arm
Timing chain
cover No.2
Service plug
Timing chain
cover
A1270070P-D



● Marks are inscribed on camshaft timing sprocket No.1 and camshaft timing sprocket No.2 as match marks for installing a timing chain.



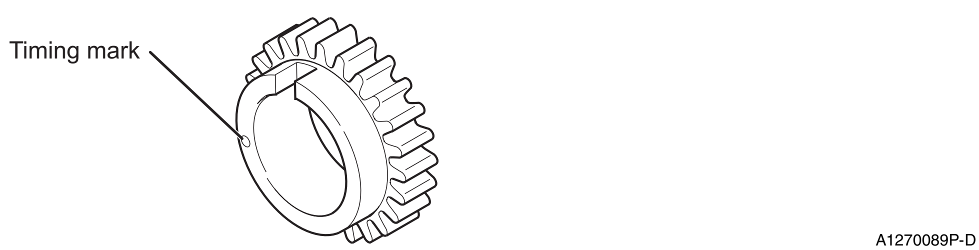
Camshaft sprocket specifications (3SZ-VE)

	Camshaft timing sprocket No.1	Camshaft timing sprocket No.2
Material	Sintered alloy	←
Surface treatment	Induction hardening and tempering	←
Tooth profile	Sprocket shape	←
Number of teeth	34	←
Pitch [mm]	8.00	←
Pitch circle diameter [mm]	ϕ86.70	←
Face width [mm]	4.4	←

Camshaft sprocket specifications (K3-VE)

	Camshaft timing sprocket No.1	Camshaft timing sprocket No.2
Material	Sintered alloy	←
Surface treatment	Induction hardening and tempering	←
Tooth profile	Sprocket shape	←
Number of teeth	42	←
Pitch [mm]	6.35	←
Pitch circle diameter [mm]	ϕ84.97	←
Face width [mm]	8.4	←

- A mark is inscribed on each crankshaft timing sprocket as a matchmark for installing a timing chain.



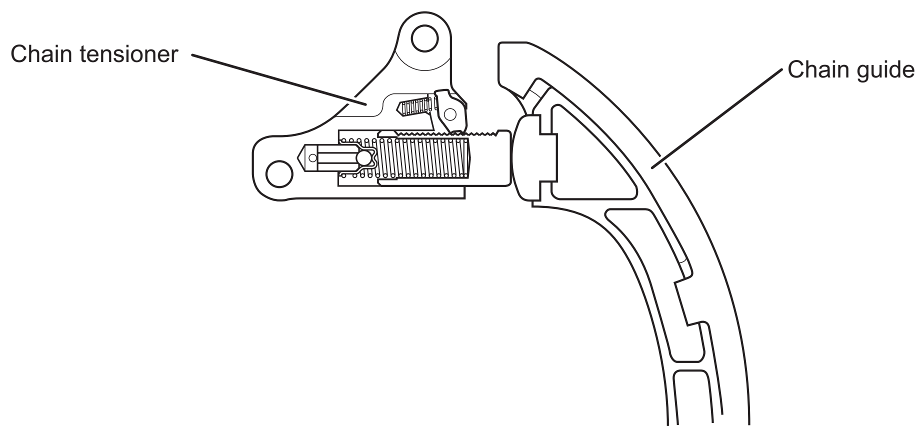
Crankshaft sprocket specifications (3SZ-VE)

Material	Sintered alloy
Surface treatment	Induction hardening and tempering
Tooth profile	Sprocket shape
Number of teeth	17
Pitch [mm]	8.0
Pitch circle diameter [mm]	ϕ43.54
Face width [mm]	4.4

Crankshaft sprocket specifications (K3-VE)

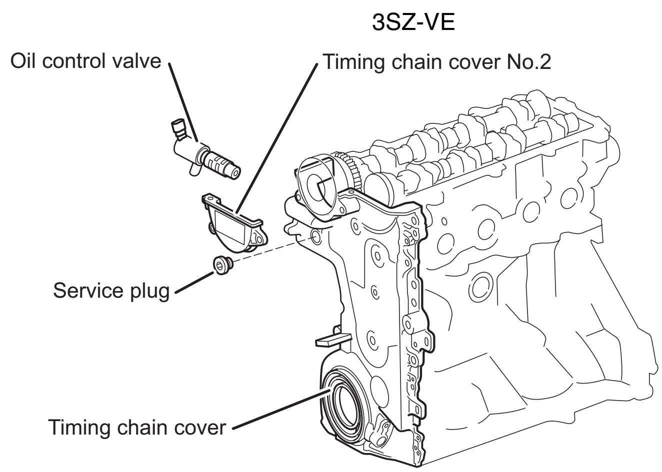
Material	Steel
Surface treatment	Induction hardening and tempering
Tooth profile	Sprocket shape
Number of teeth	21
Pitch [mm]	6.35
Pitch circle diameter [mm]	ϕ42.61
Face width [mm]	8.4

- The chain tensioner plunger maintains proper timing chain tension using both hydraulic pressure and spring force to ensure the durability and quietness of the chain.
- The timing chain cover has a service hole to make it easier to release the ratchet mechanism at the time of servicing.



A1270090P-D

- The chain oil nozzles are aimed at the area where the chain engages each crankshaft sprocket and the contact pressure is the highest and at the area where the chain is engaged with the oil pump sprocket to spray lubricating oil on them to prolong their lives and ensure quietness.
- The mating faces of the cylinder head, cylinder block and timing chain cover are sealed with the cylinder head gasket, and liquid sealant (FIPG) is applied to the upper and lower surfaces of the gasket to absorb the thermal expansion of each part and ensure sealing performance.
- The OCV (Oil Control Valve) on the top regulates the amount of oil from the cylinder head to the DVVT controller.



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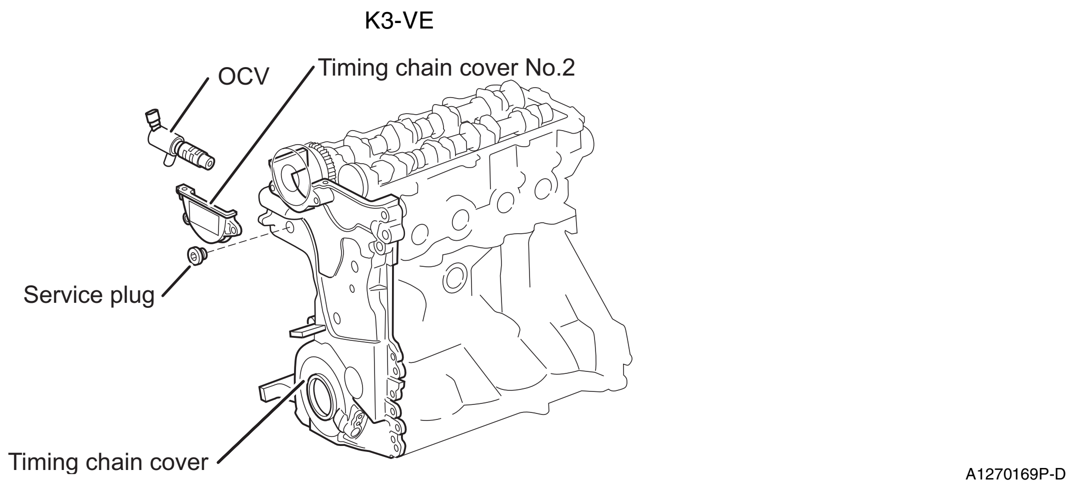
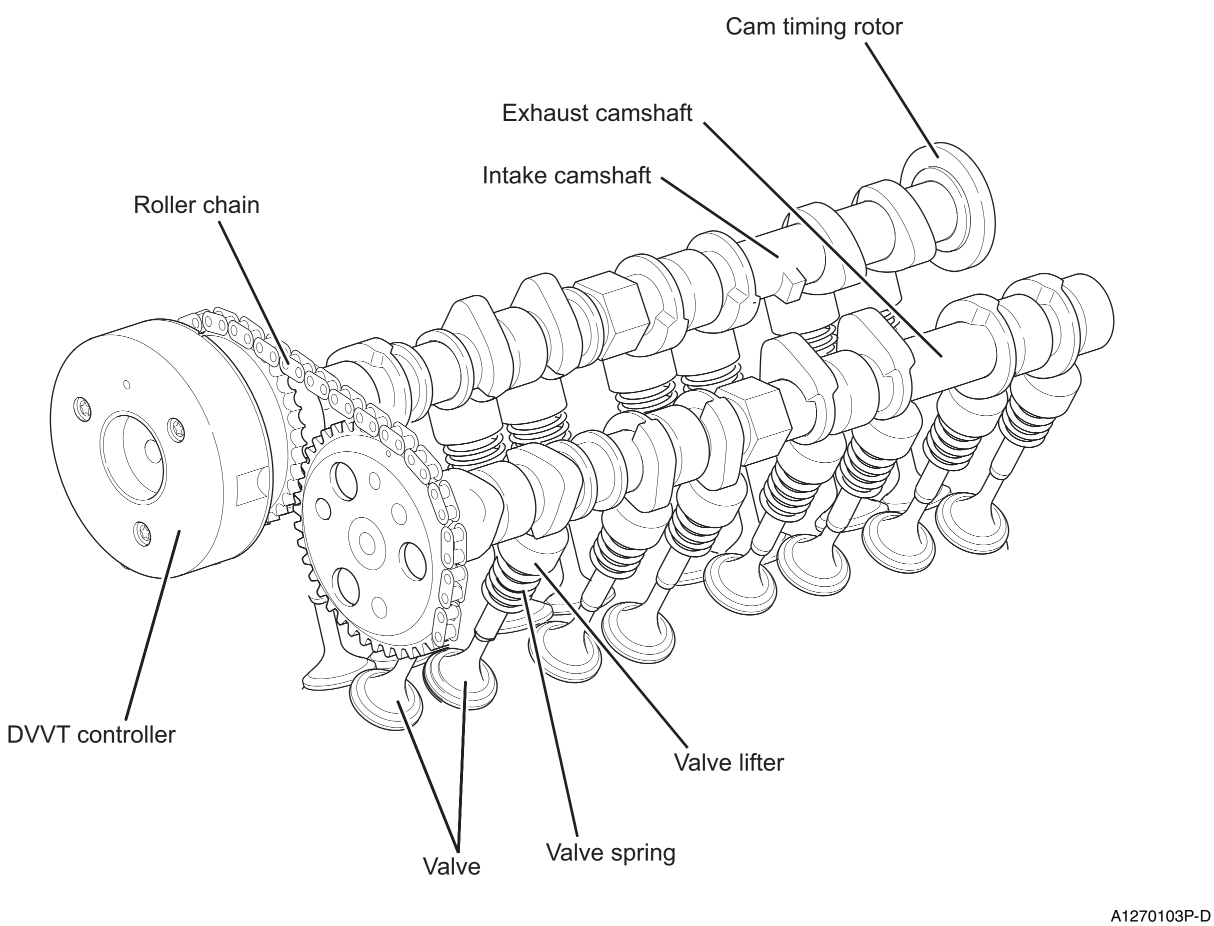
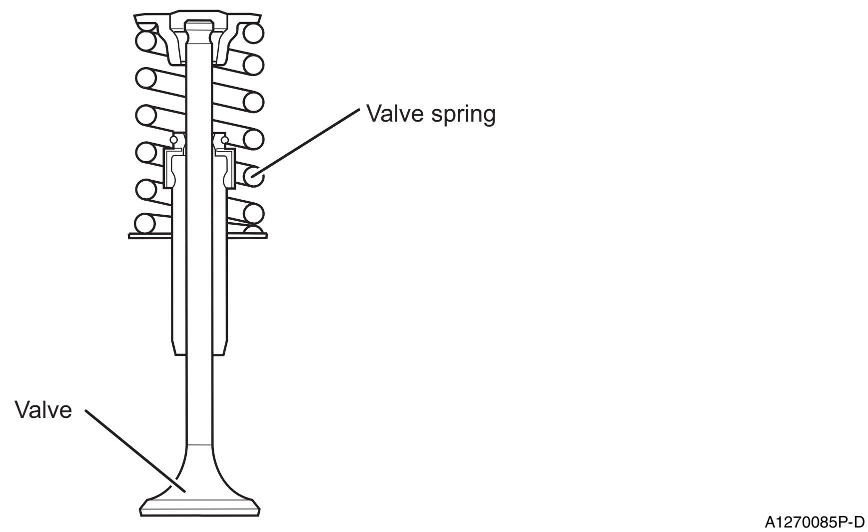


Valve-Related Items

- A single-stage chain that drives the intake camshaft, exhaust camshafts and oil pump is employed to reduce the overall length of the engine. A direct injection DOHC 4-valve system (2 intake valves and 2 exhaust valves) is employed and DVVT which regulates the valve timing properly according to the operating condition of the engine is also provided.
- The intake and exhaust valves are all made of heat resisting steel and nitrided entirely (except the valve faces).
- The 3SZ-VE uses valves with a thin stem to reduce mechanical losses.



- The valve springs are made of carbon steel for special valve springs and treated by shot peening. The springs used for the intake and exhaust valves are the same. They are unequal-pitch springs that quickly respond to the valves. To reduce friction losses, the maximum load is reduced by reducing the equivalent mass of the dynamic valve system.



3SZ-VE

Intake valve No.1	Overall length [mm]	88.15
	Valve head diameter [mm]	ϕ27.8
	Stem diameter [mm]	ϕ5.0
Exhaust valve No.1	Overall length [mm]	89.1
	Valve head diameter [mm]	ϕ23.4
	Stem diameter [mm]	ϕ5.0

K3-VE

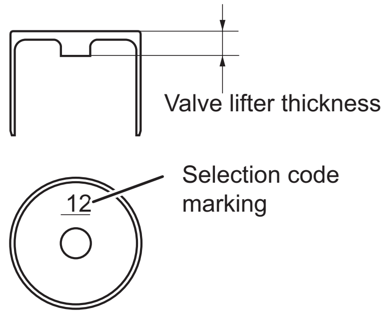
Intake valve No.1	Overall length [mm]	88.15
	Valve head diameter [mm]	ϕ22.6
	Stem diameter [mm]	ϕ5.0
Exhaust valve No.1	Overall length [mm]	89.1
	Valve head diameter [mm]	ϕ22.6
	Stem diameter [mm]	ϕ5.0

Valve spring specifications

Manufacturer	Chuo Spring	Suncall
Coil outside diameter (mm)	ϕ22.9	←
Total number of coils	9.16	←
Free length (mm)	45.55	45.53
Identification mark	None	Orange

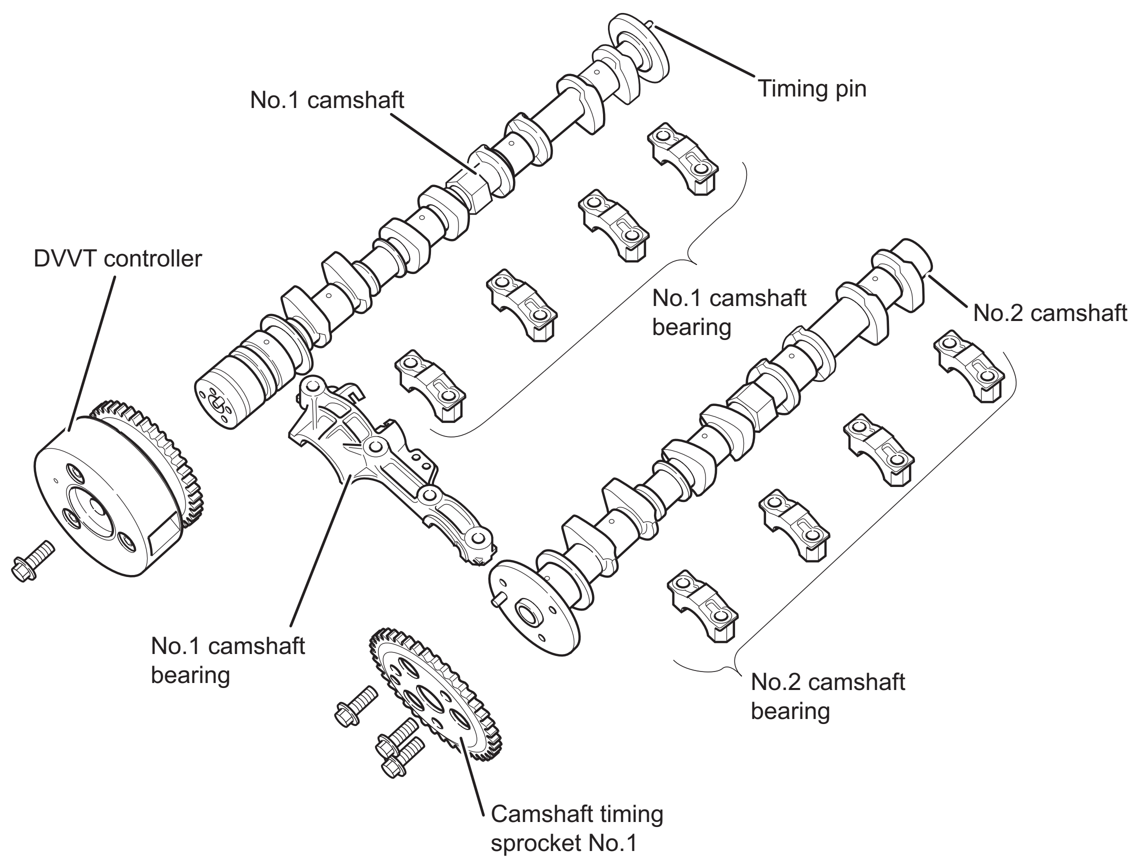
- Valve lifters without shim are employed for weight saving. The valve clearance is adjusted by changing the top face thickness.

- A total of 29 types of valve lifters with different top face thickness ranging from 5.12 to 5.68 mm in steps of 0.02 mm are available. Each of them can be identified by the figure* inscribed on the back (*: represents the decimal fraction of the top face thickness).



A1270086P-D

- Both camshaft No.1 (intake side) and camshaft No.2 (exhaust side) are made of alloy cast iron hollow tubes.
- To make the cylinder head smaller in size, the camshafts are driven by a single-stage chain.
- A DVVT controller integral with a sprocket is mounted at the front end of camshaft No.1, and 3 timing pins for determining the DVVT cam position are placed at the rear end.

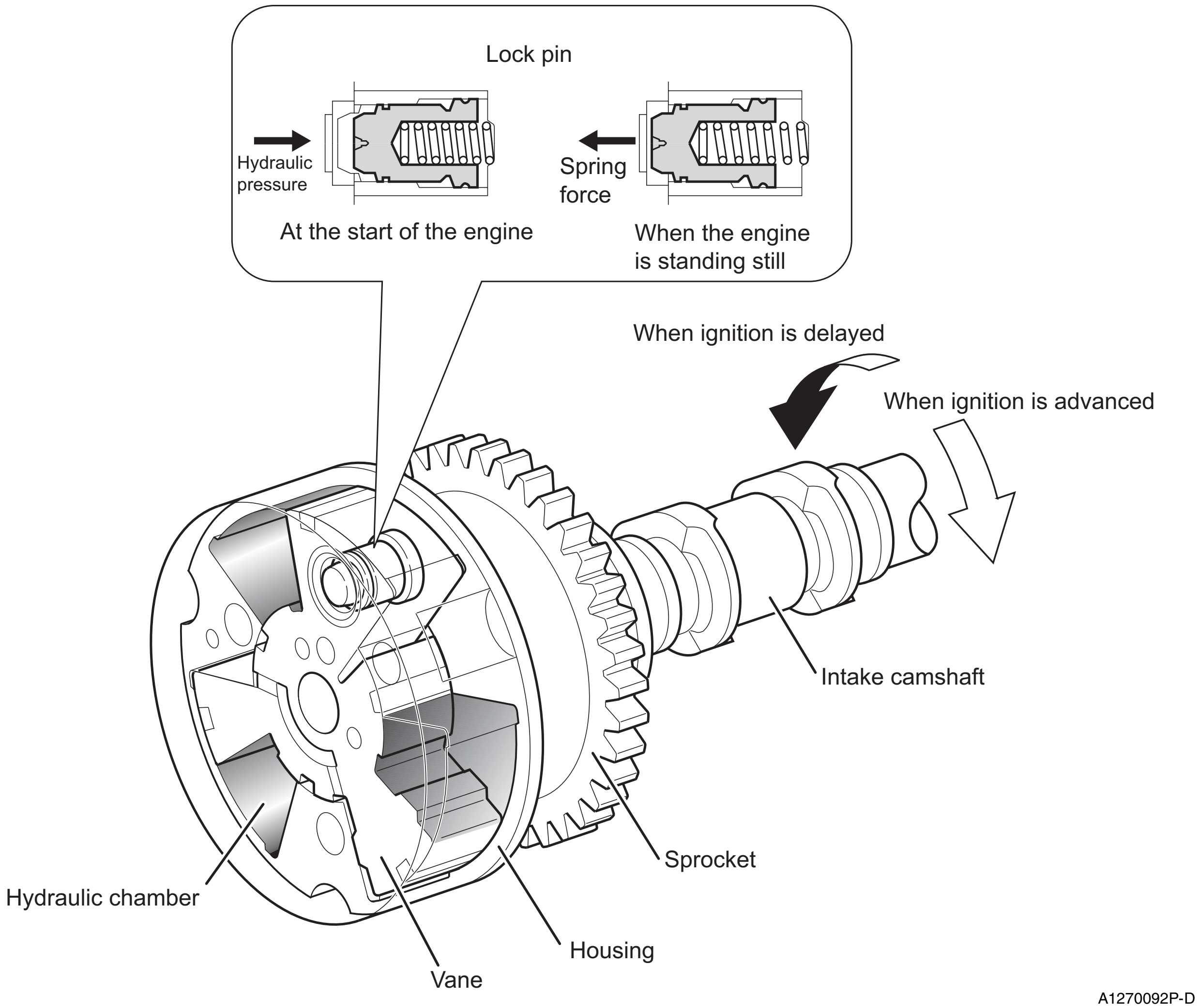


A1270076P-D

DVVT Controller

- The DVVT controller consists of the housing mounted on a sprocket driven by the timing chain and the vane fixed to camshaft No.1 (intake side).

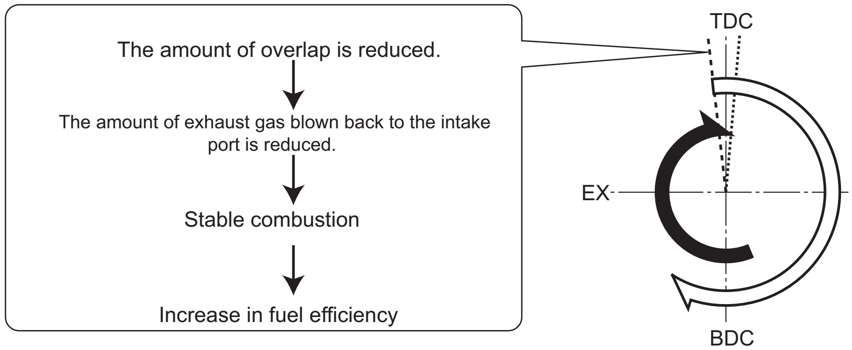
- When the oil pressures in the two hydraulic chambers (advanced ignition chamber and delayed ignition chamber) formed by the housing and the vane are regulated, the vane moves in the circumferential direction of the housing and continuously changes the phase of camshaft No.1. The valve timing is adjusted properly in this way.
- At the start of the engine when the housing rotates, the vane is pushed toward the delayed injection side and locked with a pin. After the engine has started, the lock pin is released automatically by hydraulic pressure.



Effects of DVVT

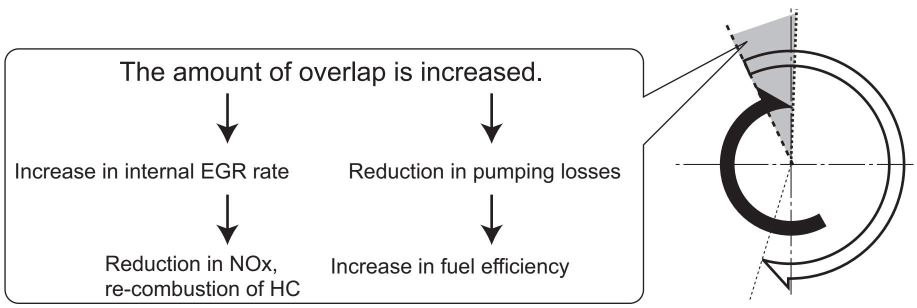
- To strike a balance between low fuel consumption and high output, the DVVT adjusts the valve timing according to the operating condition of the engine by continuously shifting the phase of the camshaft.

At low temperature, at engine start, during idling or under light load



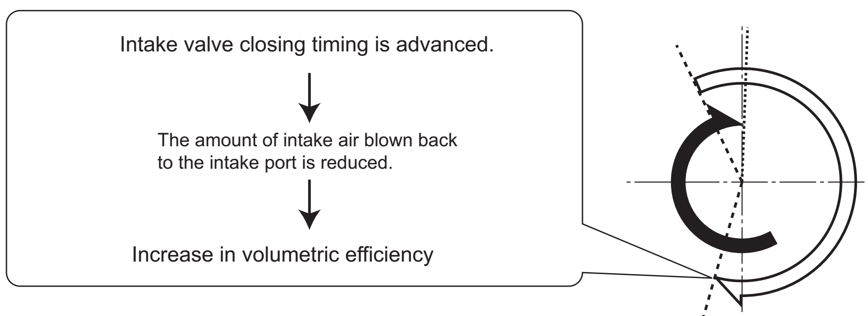
A1270253P-D

Moderate-load speed range



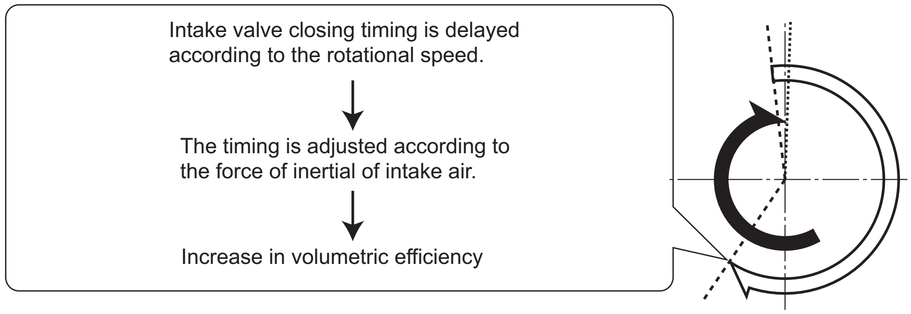
A1270254P-D

Heavy-load, low- and intermediate-speed ranges



A1270255P-D

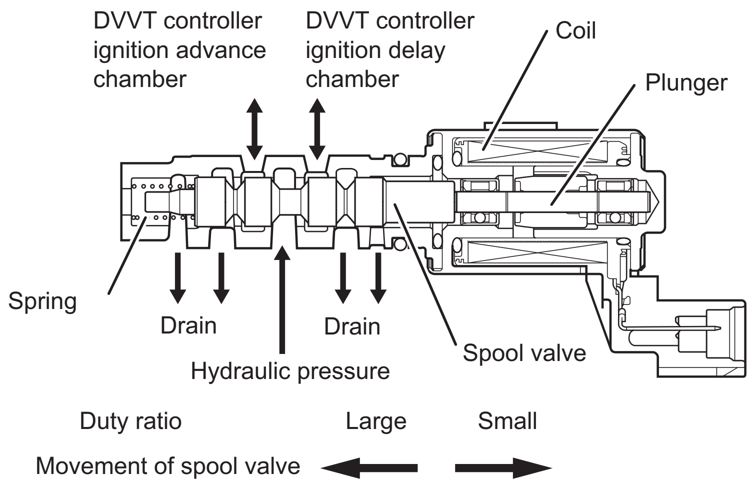
Heavy-load, high-speed range



A1270256P-D

OCV for DVVT

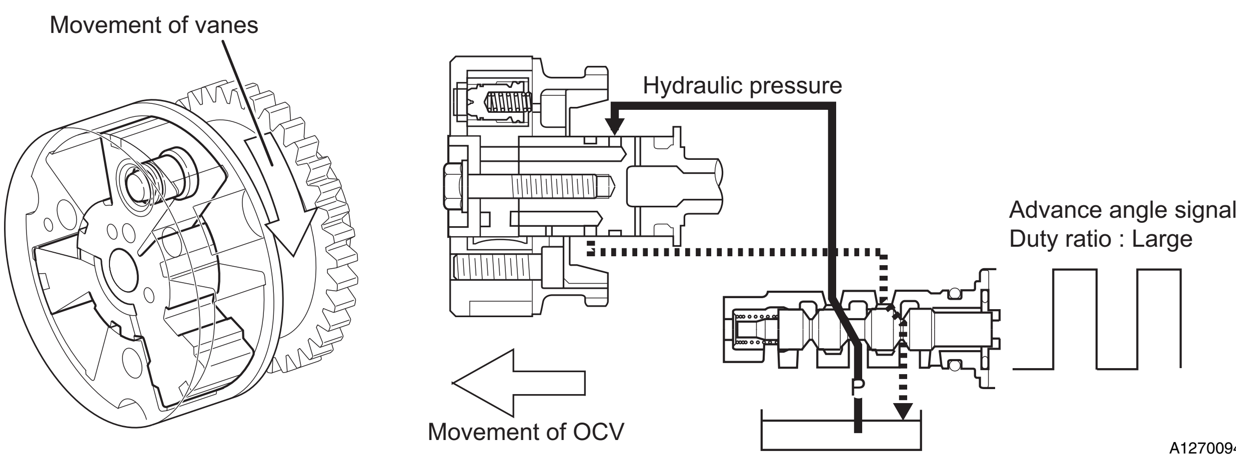
- Under duty signals from the engine control computer, the OCV (Oil Control Valve) regulates the spool valve to switch the oil path to the DVVT controller.



A1270075P-D

Advanced Injection

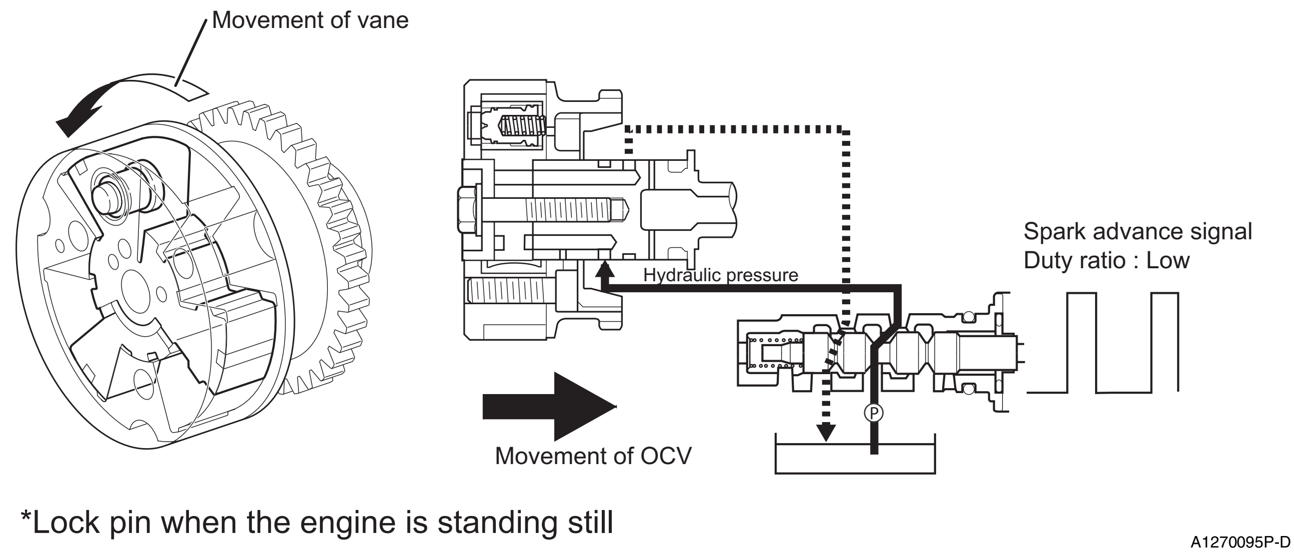
- The oil control valve operates under the control of signals from the engine control computer and the engine oil pressure is applied to the vane chamber on the advanced injection side, with the result that the intake camshaft rotates in the direction in which it advances with respect to the housing.



A1270094P-D

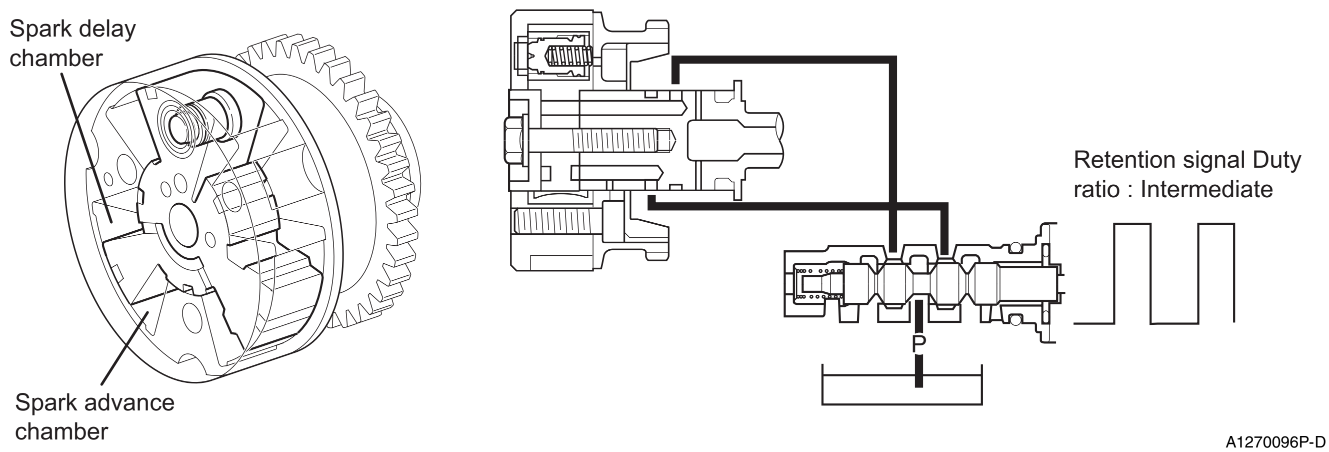
Delayed Injection

- The oil control valve operates under a signal from the engine control computer and the engine oil pressure is applied to the vane chamber on the delayed injection side, with the result that the intake camshaft rotates in the direction in which it delays with respect to the housing.



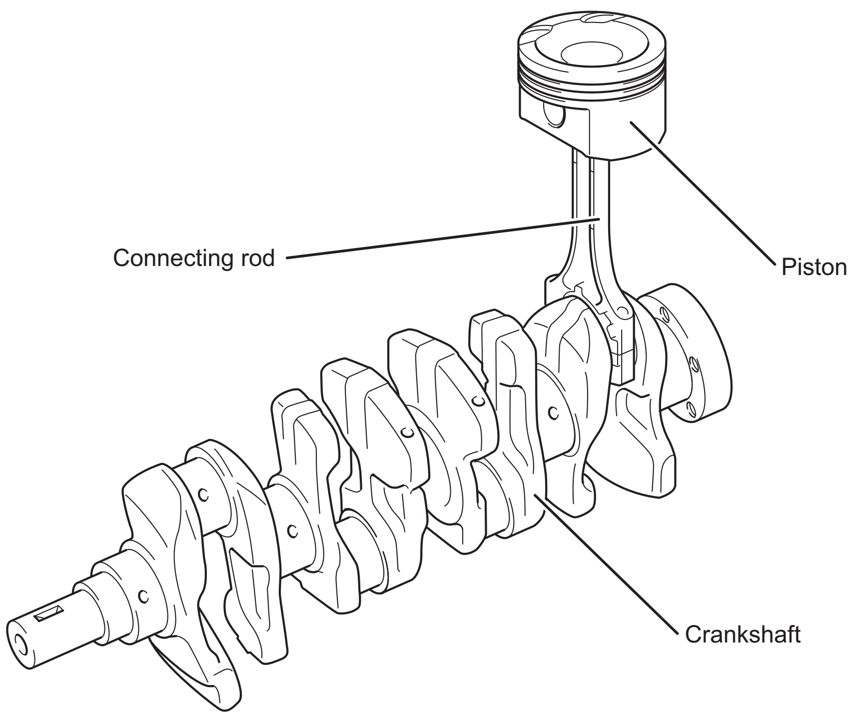
On Hold

• When the target ignition timing is achieved, the oil control valve blocks the oil path to the DVVT controller to retain the ignition timing.



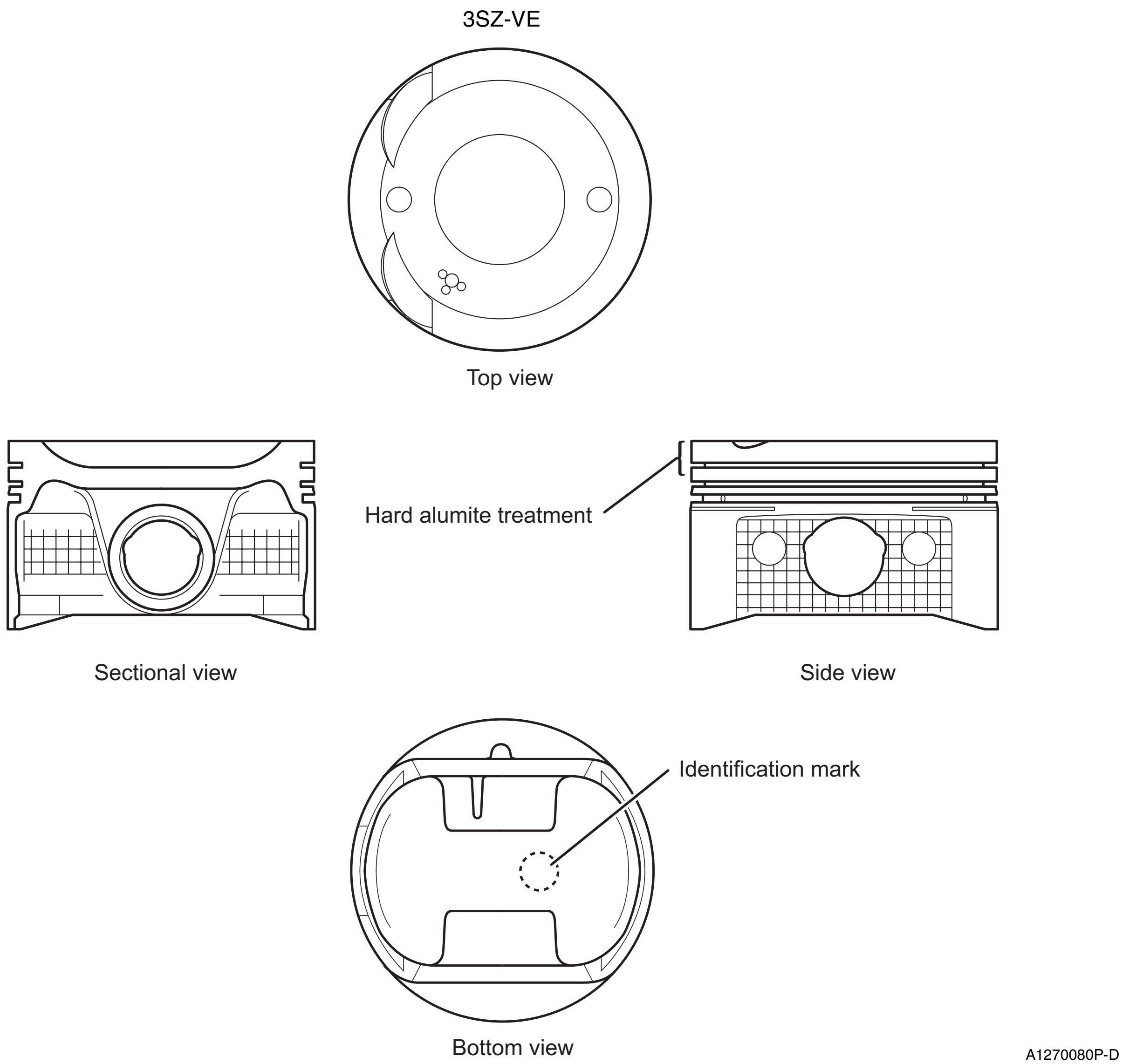
Piston Crank-Related Items

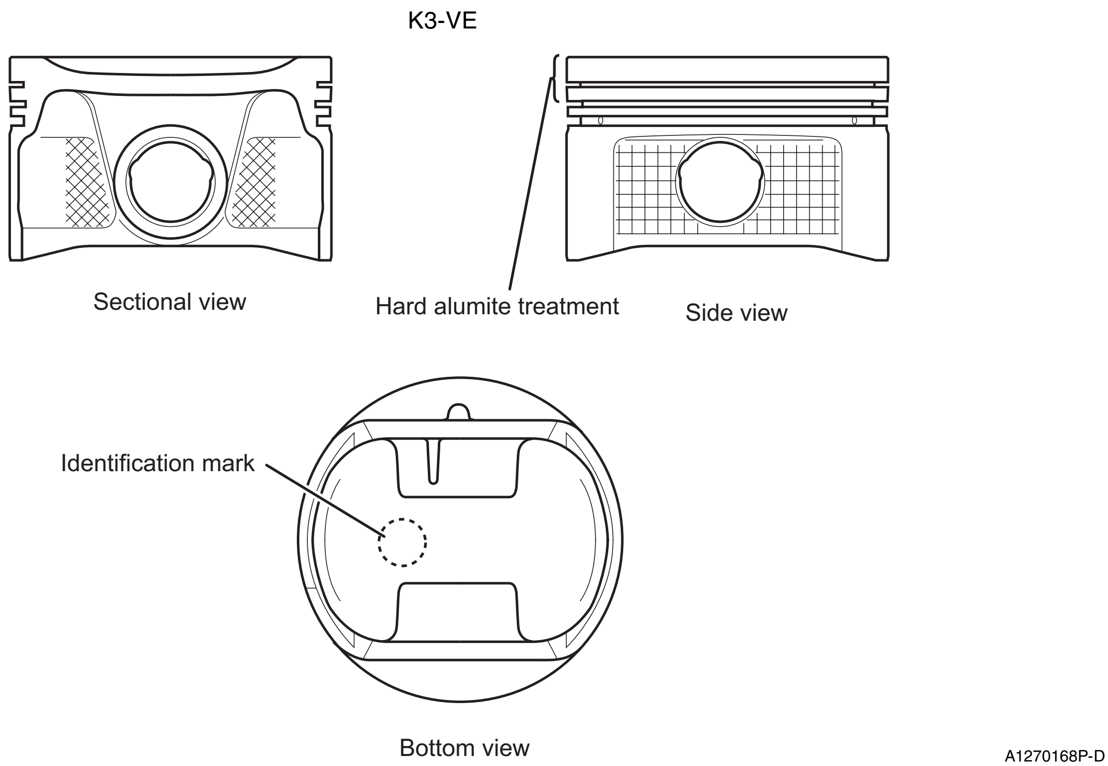
- The pistons are made of lightweight aluminum alloy. A side relief is provided for each piston pin hole to ensure reliability.
- High-strength vanadium steel is employed for the connecting rods. To make the big end smaller, the connecting rod cap is fastened by plastic region fastening method without using nuts.
- Stepped piston pins with a reduced overall length are employed to save weight and ensure rigidity. The piston pins are press-fitted in the connecting rod.
- A steel crankshaft is employed to ensure rigidity To reduce friction losses and achieve low fuel consumption, the crankshaft is so installed that its centerline is not in line with the cylinder bore centerline (offset crankshaft).



Piston

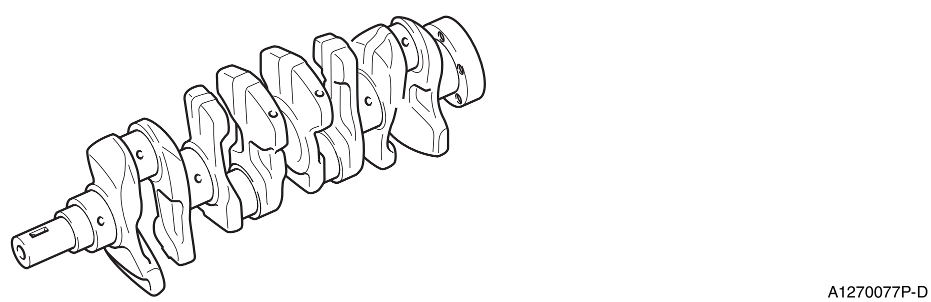
- Pistons with a reduced compression height and a narrow, short skirt are employed to save weight and reduce friction losses. To reduce the oil consumption and ensure reliability, the rigidity of the entire piston has been made uniform by increasing the rigidity of the skirt. Furthermore, the area above the 2nd land is hardened by chemical treatment (hard alumite treatment) to increase abrasion resistance.
- Only one size of piston is provided for reasons of increased accuracy in machining pistons and cylinder bores.
- The pistons for the 3SZ-VE engine are resin-coated and marked with an L for identification.
- The pistons for the K3-VE engine are marked with an L for identification.


3SZ-VE
Top view
Hard alumite treatment
Sectional view
Side view
Identification mark
Bottom view
A1270080P-D



Crankshaft

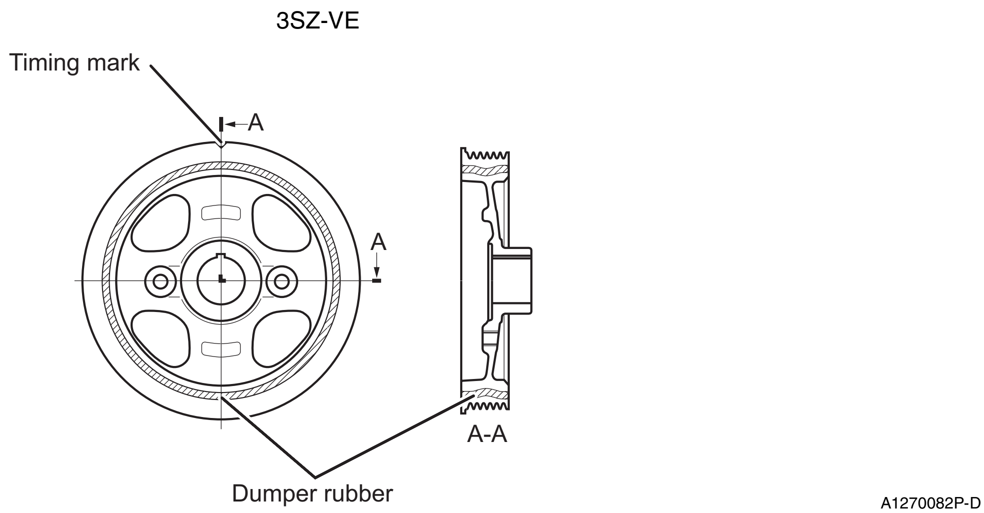
- A steel crankshaft is employed to ensure strength and rigidity. It is an 8-balance-weight type which has an advantage in vibration.

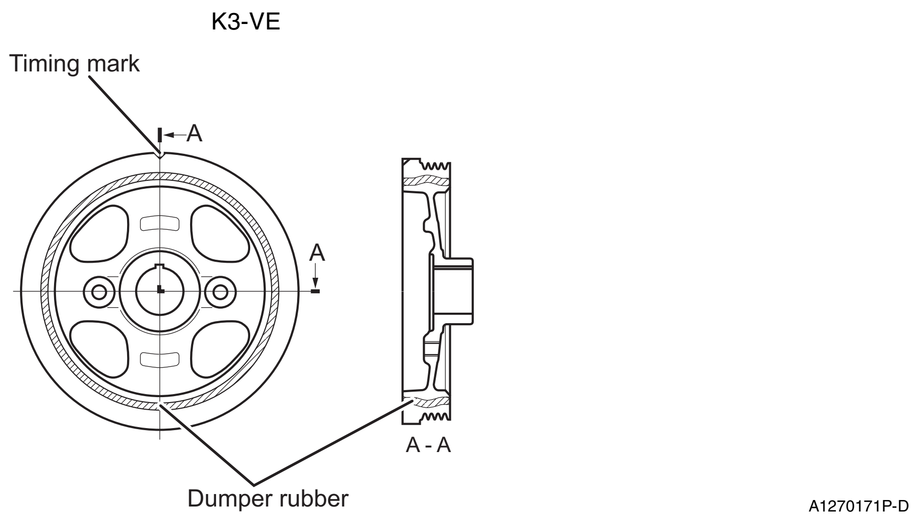


Crankshaft specifications

Engine type	3SZ-VE	K3-VE
Journal diameter [mm]	ϕ46.0	←
Journal width [mm]	21.8	←
Crank pin diameter [mm]	ϕ42.0	ϕ40.0
Crank pin width [mm]	18	←

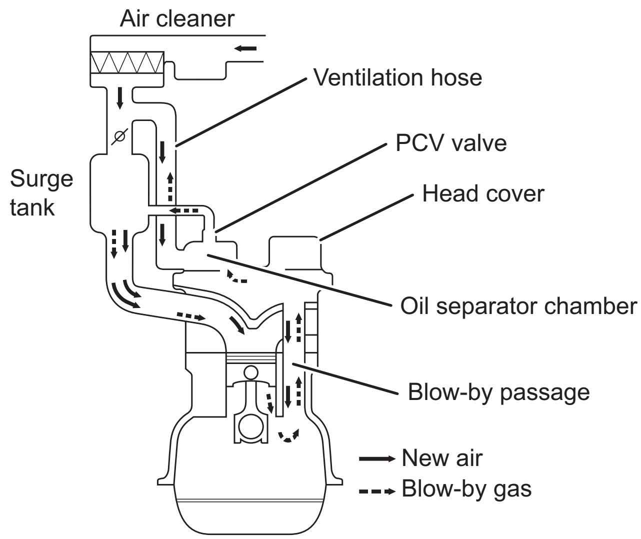
- A cast iron crankshaft pulley with a rubber damper is employed to reduce the vibrations caused by distortion of the crankshaft. An ignition timing check mark is put on the crank pulley side.





Blow-by Gas Reduction System

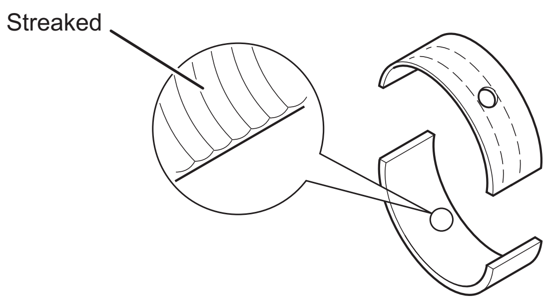
- The blow-by reduction system is a crank case ventilation type which passes blow-by gas from the crank case to the cylinder head cover through the blow-by gas passage in the cylinder block.
- After separation from oil in the oil separator chamber in the cylinder head cover, blow-by gas is sucked into the combustion chambers to re-burn.



A1270152P-D

Crankshaft Bearing

- The lining surface is streaked (streaking of sliding surface of bearing) to improve initial conformability and help the bearing retain oil. The oil clearance has been reduced to reduce the metal hitting noise.



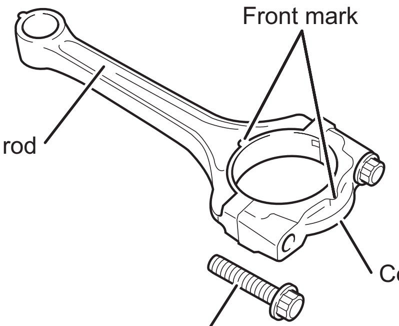
A1270078P-D

Crankshaft bearing specifications

Selection code	Bearing thickness [mm]
2	Over 1.989 to 1.992
3	Over 1.992 to 1.995
4	Over 1.995 to 1.998
5	Over 1.998 to 2.001

Connecting Rod

- The connecting rod is made of high-strength vanadium steel and surface treated twice (corning and shot peening for adding residual strength).
- The width and diameter at the small end of the connecting rod and the diameter at the big end have been reduced to save weight and reduce friction losses.
- The connecting rod bolts are fastened by plastic region fastening method without using nuts in order to save weight and make the shape at the big end stable.



Connecting rod specifications

Engine type	3SZ-VE	K3-VE
Inside diameter at small end [mm]	ϕ18.0	←
Inside diameter at big end [mm]	ϕ45.0	ϕ43.0
Distance between centers at small and big ends [mm]	148.88	129.5

Connecting Rod Bearing

- The lining surface is streaked to improve durability and reliability.
- Only one size of connecting rod bearing is provided for reason of increased accuracy of machining the crankshaft and the crankshaft.

Piston Ring

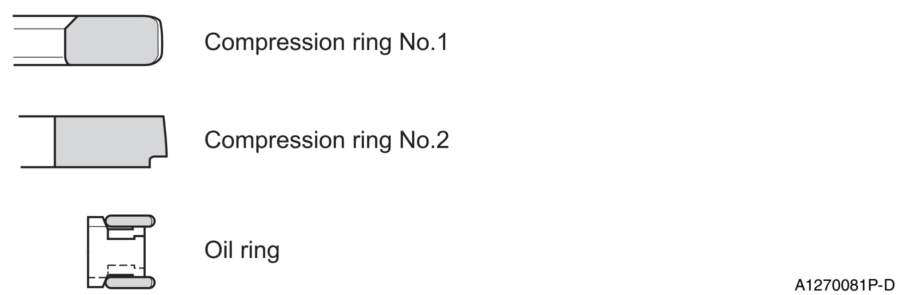
- Thin B-type rings are employed to reduce the oil consumption.

Piston ring specifications (3SZ-VE)

Compression ring No.1	Material	Steel
	Thickness [mm]	2.5
	Width [mm]	1.2
	Upper surface symbol	TT
Compression ring No.2	Material	Cast iron
	Thickness [mm]	2.3
	Width [mm]	1.2
	Upper surface symbol	TT
Oil ring	Material	Steel
	Thickness [mm]	2.25
	Width [mm]	2.0
	Upper surface symbol	—

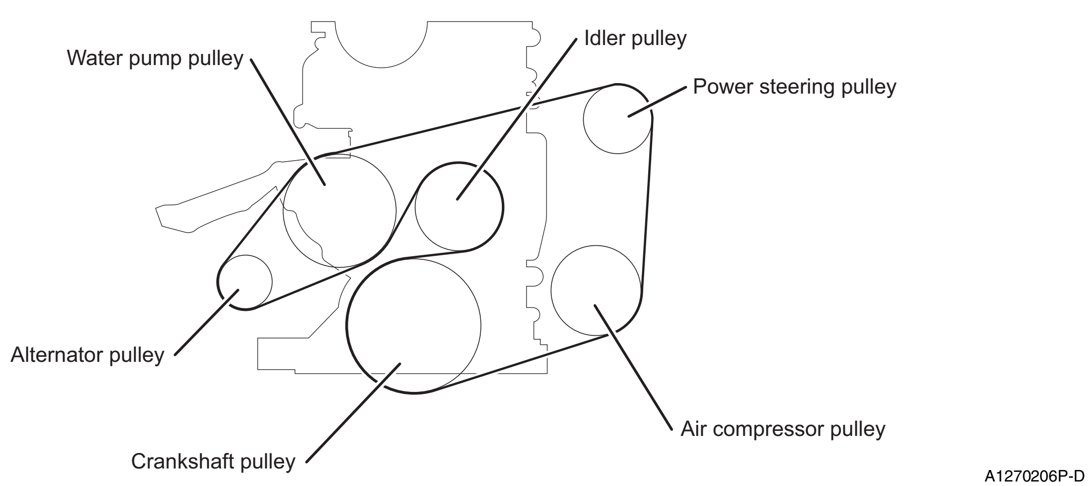
Piston ring specifications (K3-VE)

Compression ring No.1	Material	Steel
	Thickness [mm]	2.6
	Width [mm]	1.2
	Upper surface symbol	T
Compression ring No.2	Material	Cast iron
	Thickness [mm]	2.6
	Width [mm]	1.2
	Upper surface symbol	T
Oil ring	Material	Steel
	Thickness [mm]	2.25
	Width [mm]	2.0
	Upper surface symbol	—



V-belt

- A serpentine drive layout which makes it possible to drive all auxiliary devices with a single belt has been adopted to make it easier to check the belt and adjust its tension.



Pulley specifications

Pulley	Pulley diameter [mm]
Crankshaft	ϕ139
Alternator	ϕ55
Water pump	ϕ116
Air compressor	ϕ93
Power steering pump	ϕ125
Idler pulley	ϕ70
Idler pulley	3SZ: 85 (back) , K3: ϕ88 (back)

Belt length

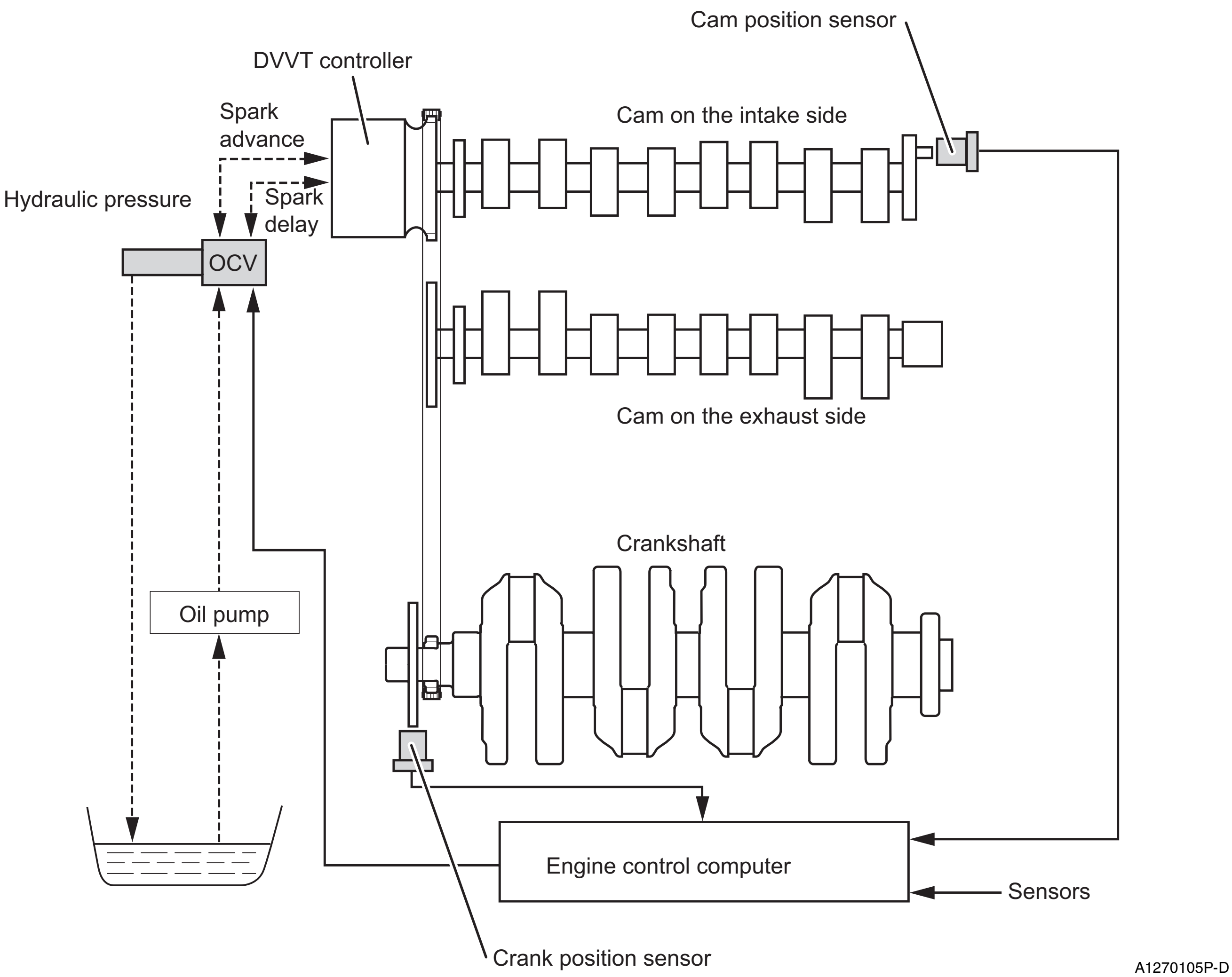
		Belt length [mm]
Serpentine drive	A/C provided	3SZ: 1880, K3: 1850
	A/C not provided	3SZ : 1820, K3: 1790

DVVT System

- DVVT (Dynamic Variable Valve Timing control device) which adjusts the valve timing properly at speeds from idle speed to high speed is employed. DVVT strikes a balance between low fuel consumption and high output.
- During idling, DVVT prevents air-fuel mixture from flowing into the exhaust port by reducing the valve overlap to a minimum, so that fuel efficiency is improved.
- Under moderate-load operating conditions, DVVT increases the valve overlap and accordingly the amount of exhaust gas recirculated (EGR) increases, reducing the vacuum in the intake pipe. As a result, inert gas is fed again to lower the combustion temperature, the amount of NOx decreases, unburned gas is re-burned reducing the amount of HC.
- Under heavy-road operating conditions, DVVT adjusts the valve timing according to the required quantity of air increasing torque output.

Outline of system

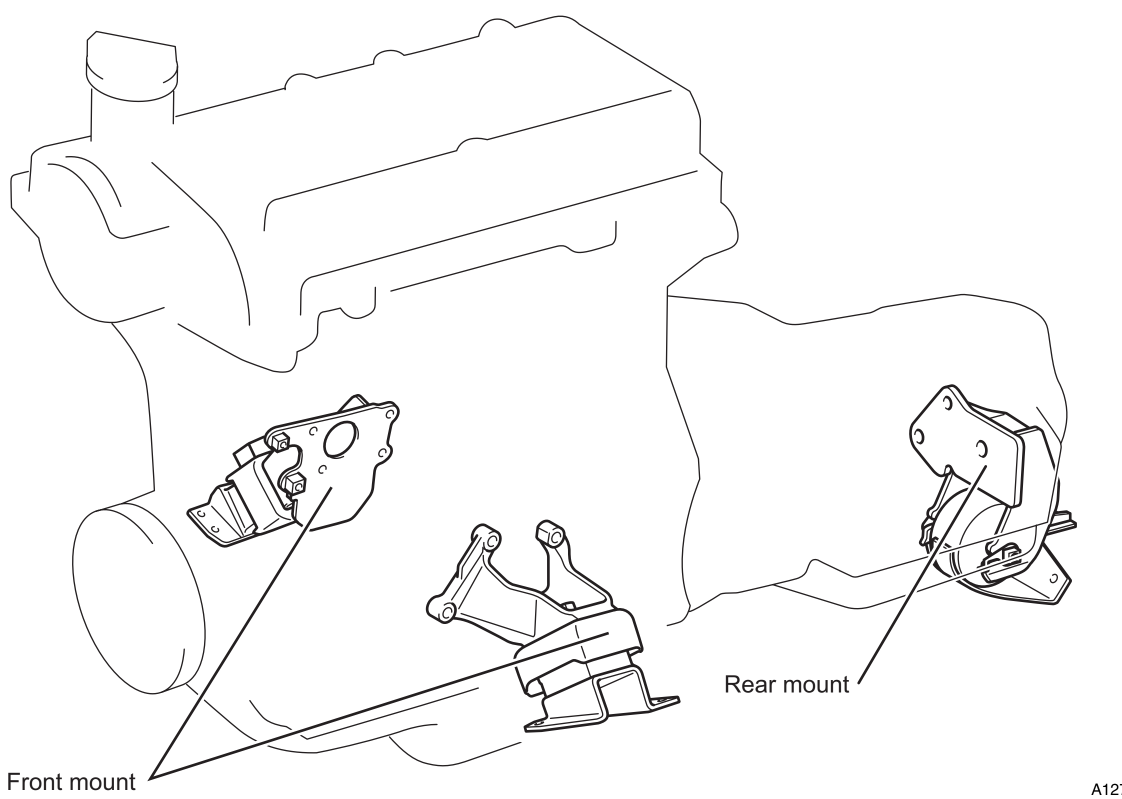
- The engine control computer regulates the oil control valve according to the engine speed, intake pipe pressure, etc, and applies the engine hydraulic pressure to both the inlet and the outlet of the DVVT controller mounted on camshaft No.1 (intake camshaft) in order to adjust the phase of camshaft No.1 properly.



Engine Mount

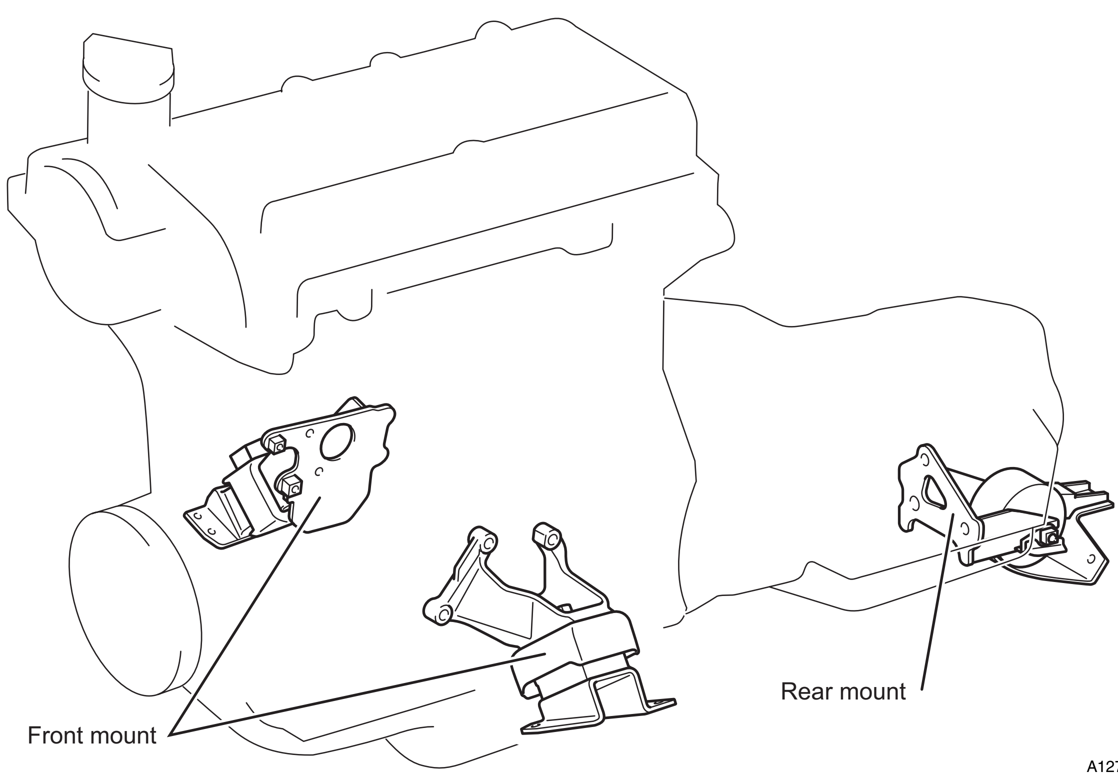
- A total of 3 engine mounts are provided: 2 front mounts on the engine side and 1 rear mount on the transmission side.

A/T model



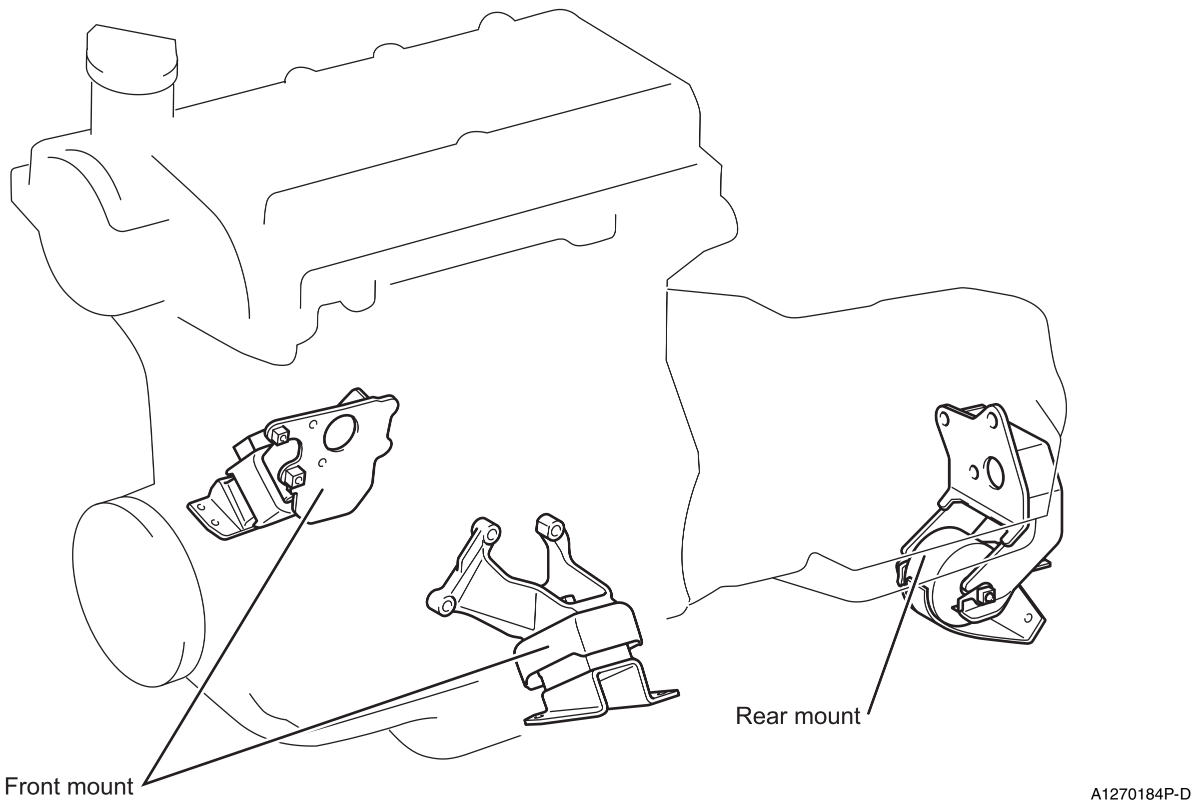
A1270182P-D

M/T model



A1270183P-D

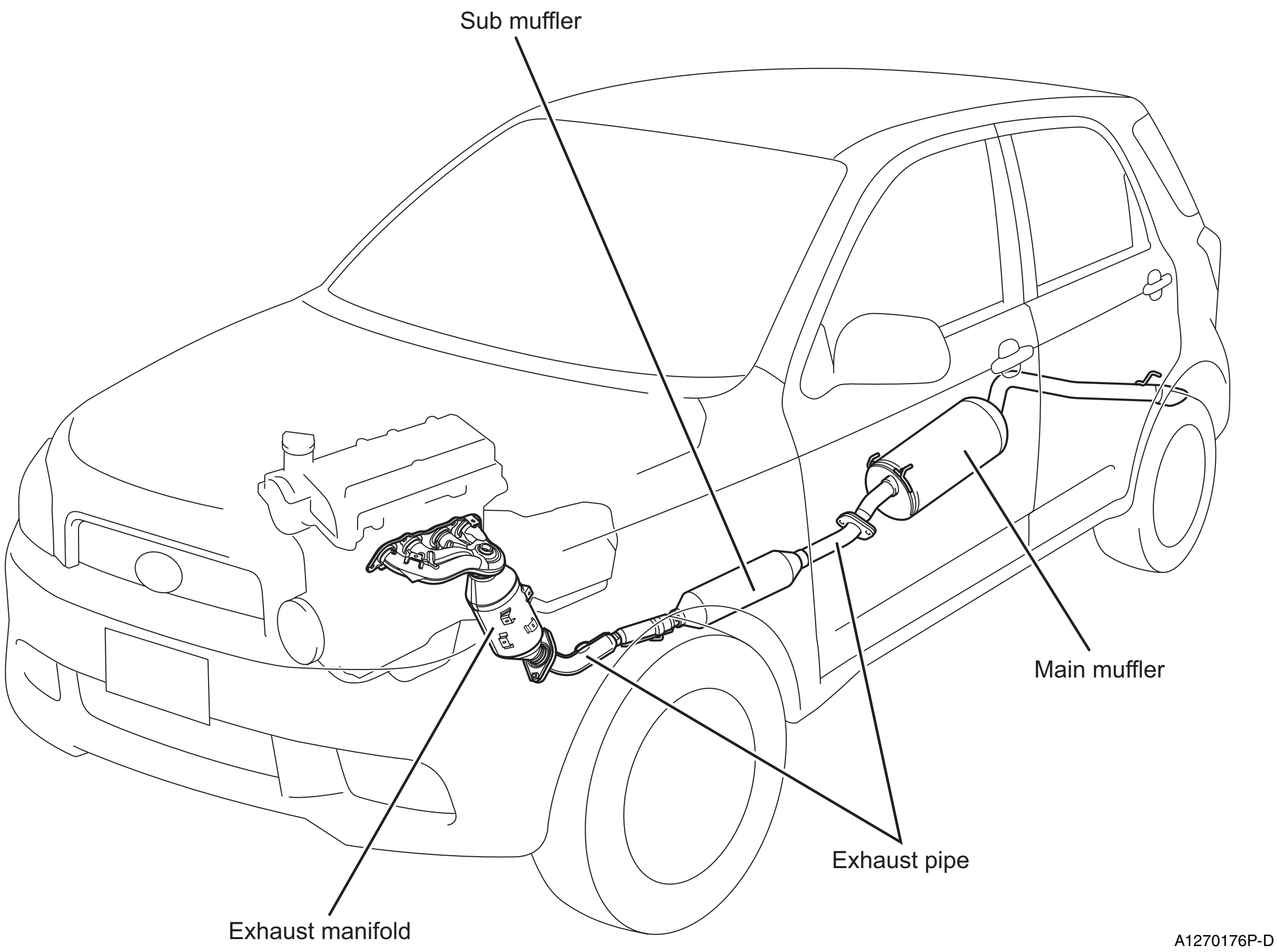
M/T (2WD) model



EXHAUST SYSTEM (3SZ-VE/K3-VE)

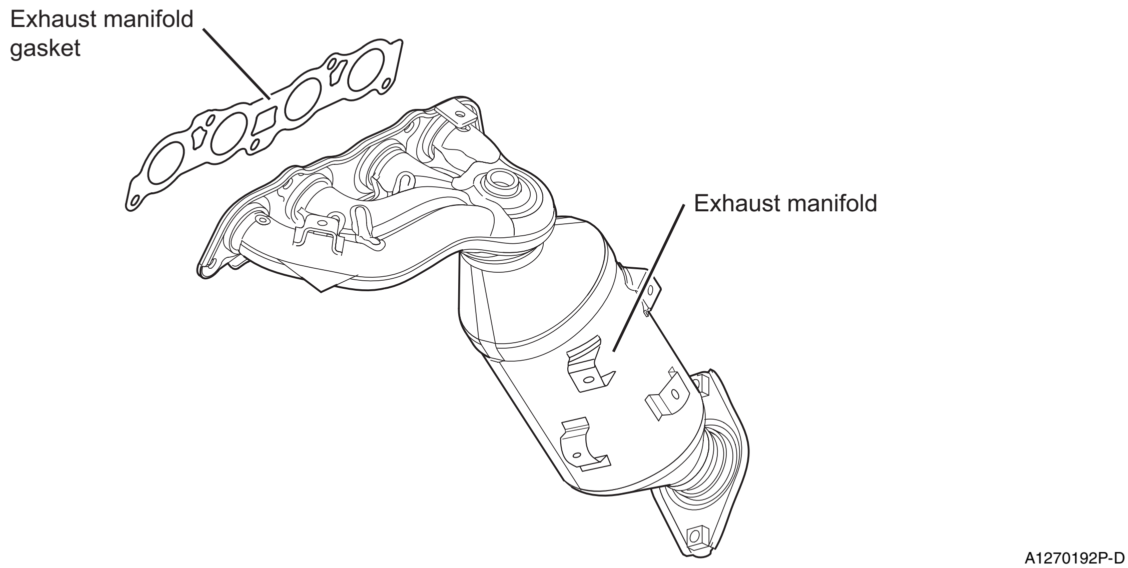
Exhaust System in General

- The exhaust system, which consists of an exhaust manifold, an exhaust pipe and a muffler, uses a metal exhaust manifold integral with a catalytic converter to reduce weight and improve performance.



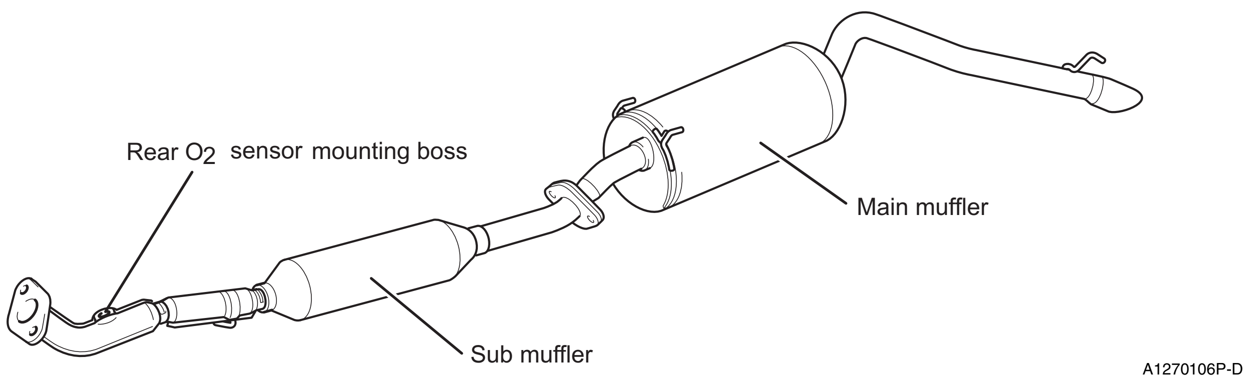
Exhaust Manifold

- A thin-walled stainless steel exhaust manifold integral with a catalytic converter is employed to reduce the quantity of heat, improve engine warm-up performance and thus comply with emission regulations.
- The exhaust manifold is provided with a stainless steel gasket.



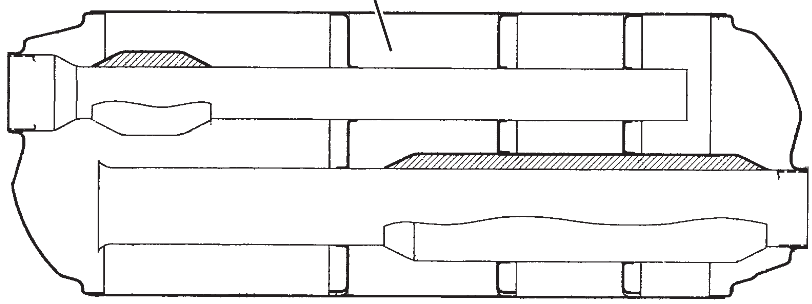
Exhaust Pipe

- The exhaust pipe is provided with a main muffler and a sub-muffler. To optimize the muffler structure and reduce its capacity and weight, the main muffler has been manufactured using laser welding, the first time this technology is used in a muffler.
- The exhaust pipe is entirely made of stainless steel to save weight and increase corrosion resistance.



Muffler

- The main muffler employs a muffler with 4 expansion chambers to reduce the booming noise.
- The main muffler is laser-welded for weight saving.
- To save weight, the sub-muffler uses louver type inner pipes that require no sound insulating material.



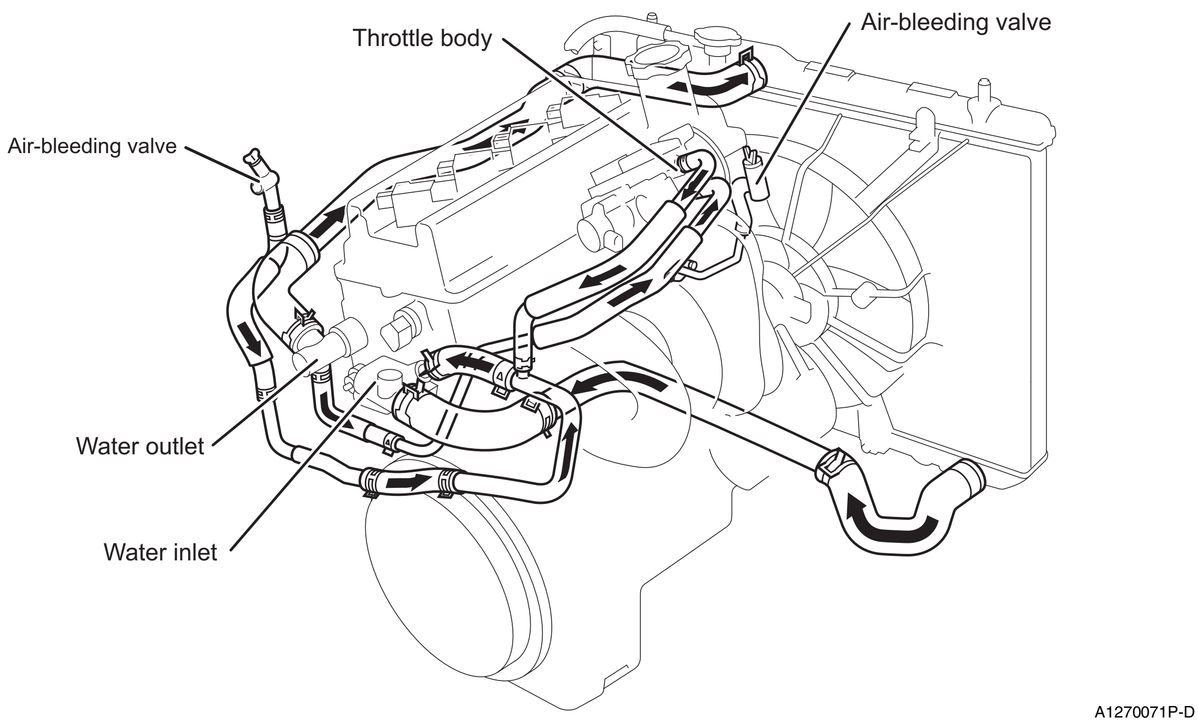
Muffler specifications

	Sub-muffler	Main muffler
Capacity (L)	2.8	14.0

CLEANING SYSTEM (3SZ-VE/K3-VE)

Cooling System in General

- The cooling system is a forced circulation water cooling system and uses a thermostat with a bypass valve.
- To increase the knocking resistance by lowering the combustion chamber temperature and the intake port wall temperature, the cooling system is so designed that cooling water from the radiator is first led to the intake side of the engine (intake first cooling system).



Cooling water specifications

		3SZ-VE				K3-VE			
		M/T model		A/T model		M/T model		A/T model	
Destination		Temperate regions	Tropical regions	Temperate regions	Tropical regions	Temperate regions	Tropical regions	Temperate regions	Tropical regions
Concentration of LLC [%]	Temperate regions (including snowy regions)	30	←	←	←	←	←	←	←
	Cold climate regions	50	←	←	←	←	←	←	←
Diluent		Tap water	←	←	←	←	←	←	←

			3SZ-VE				K3-VE			
			M/T model		A/T model		M/T model		A/T model	
Capac-ity [L]	Total capacity (except reservoir)		4.55	4.65	4.45	4.55	4.30	4.40	4.30	4.30
	Reservoir capacity [L]	Full	0.9	←	←	←	←	←	←	←
		Low	0.15	←	←	←	←	←	←	←

Radiator

- An aluminum-core radiator with upper and lower tanks is employed to save weight.
- The radiator fan motor is regulated under the control of signals from the engine control computer.

Radiator specifications

			M/T	A/T
Radiator	Heat dissipation capacity [kW]	Temperate regions	44.6	←
		Tropical regions	49.5	←
	Core size [W×H×T (mm)]	Temperate regions	553.4 × 425 × 12	←
		Tropical regions	553.4 × 425 × 16	←
	Quantity of cooling water [L]	Temperate regions	1.4	1.3
		Tropical regions	1.5	1.4
Radiator cap opening pressure [kPa]			108	←
Oil cooler	Heat dissipation capacity [kW]		—	2.0
	Quantity of automatic fluid [L]		—	0.06

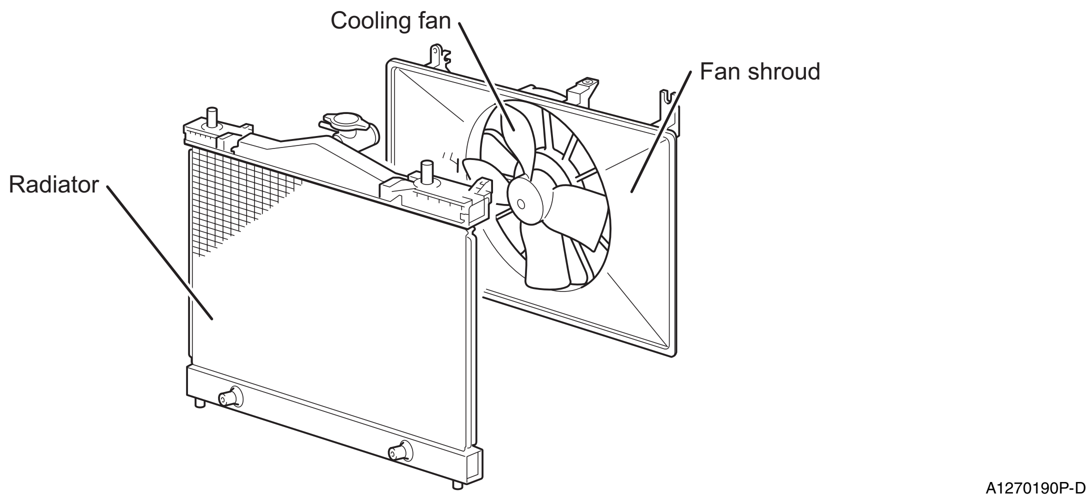
- The radiator fan is a suction type electric fan.

Radiator fan specifications

Motor	Type	DC ferrite		
		Temperate regions	Tropical regions (M/T)	Tropical regions (A/T)
	Rated voltage [V]	12	←	←
	Output [W]	80	120	160
Fan	Outside diameter [mm]	ϕ340	←	←
	Number of blades	4	5	←

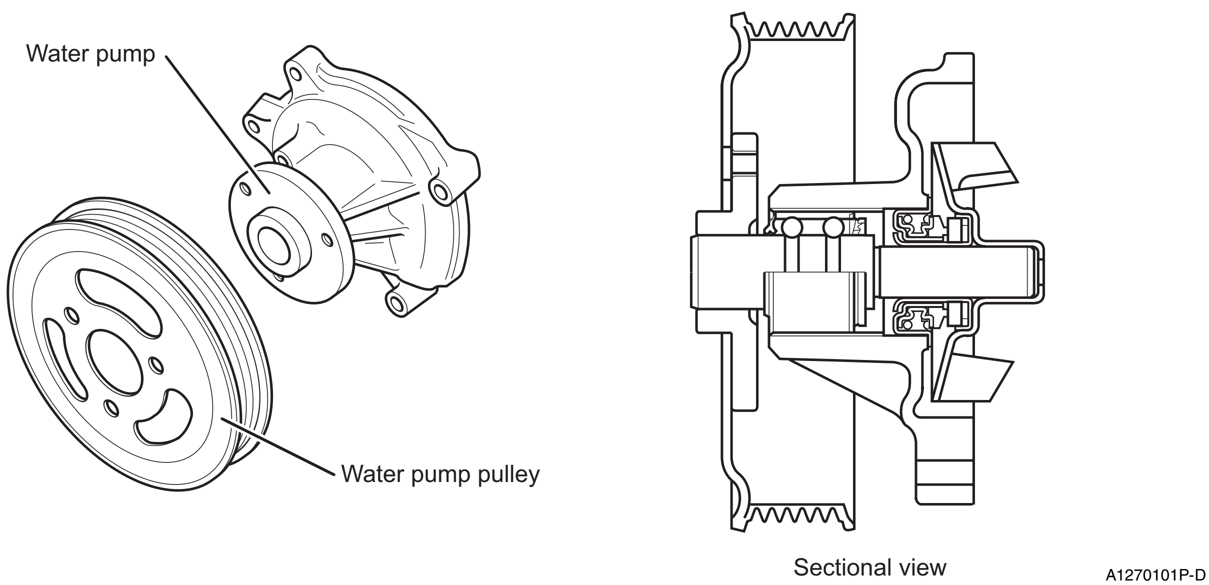
Cooling Fan and Fan Shroud

- To lower the temperature of air let into the air cleaner during low-speed driving and achieve a high output, the cooling fan is so positioned and its shroud is so shaped that hot air that has passed through the radiator does not flow into the air cleaner.
- A large cooling fan is employed to improve cooling performance. Since this single fan does not require a sub fan to provide the required air cooling performance, it helps to reduce the weight of the system.
- A lightweight resin fan shroud is employed.



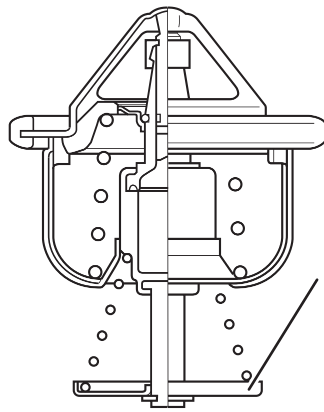
Water Pump

- A centrifugal water pump is used. To reduce the load applied to the bearing when the belt is under an excessive tension, the pulley is so designed that the V-belts come into contact with the top and bottom of the pulley.
- To ensure reliability, the water pump is sealed with an SiC baked carbon gasket and a triple-lip bearing is used.



Thermostat

- The thermostat has a differential pressure regulating valve for bypassing cooling water to the bottom using a differential pressure.
- When the engine is cold, the total quantity of cooling water flows into the heater because both the thermostat and the differential pressure regulating valve are closed. But when the quantity of cooling water has increased due to an engine speed increase, the differential pressure regulating valve opens to bypass cooling water to the intake first cooling water passage. When the engine is warm and the quantity of cooling water has increased, the differential pressure regulating valve opens to decrease cavitation.



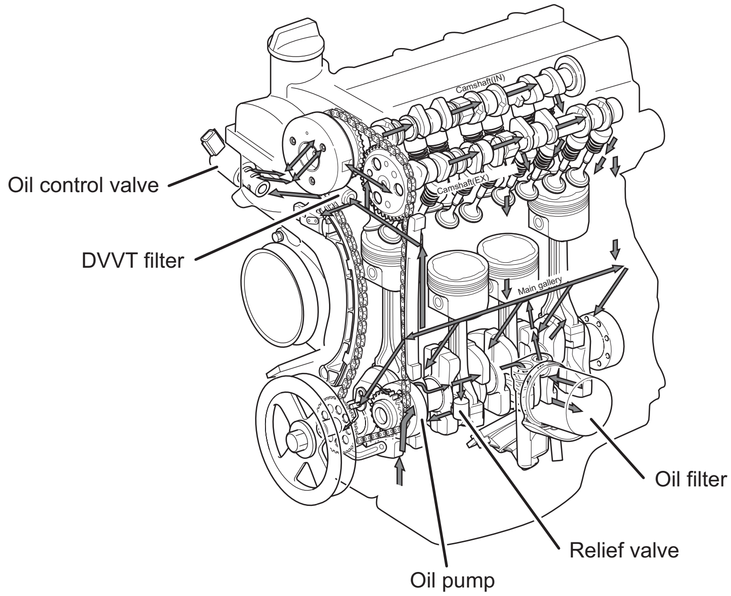
Thermostat specifications

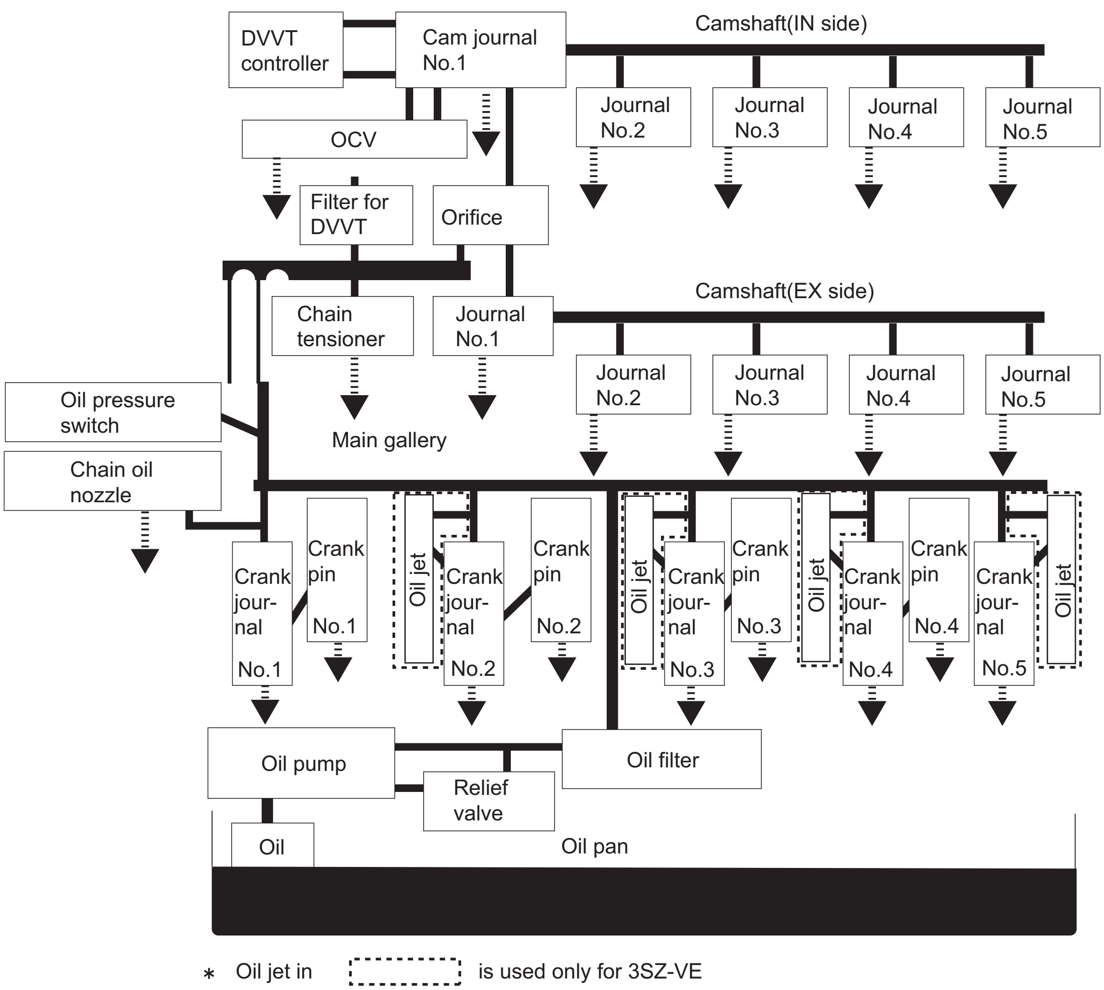
Installation location	Water inlet
Valve opening temperature (°C)	80±2.0
Total lift (mm)	8.5 mm or more (at 93°C)

LUBRICATION SYSTEM (3SZ-VE/K3-VE)

Lubrication System In General

- The lubrication system is a forced circulation and filtration type.
- Oil in the oil pan is sucked up by the oil pump driven by the timing chain and filtered in the oil filter. After this some of the oil is sent through the main gallery to the crankshaft, pistons and timing chain and the rest through an orifice to the cylinder head, chain plunger tensioner, OCV, DVVT controller and camshafts to lubricate them.


Oil control valve
DVVT filter
Oil filter
Relief valve
Oil pump
Camshaft(IN)
Camshaft(EX)
Main gallery


DVVT controller
Cam journal No.1
Camshaft(IN side)
Journal No.2
Journal No.3
Journal No.4
Journal No.5
OCV
Filter for DVVT
Orifice
Chain tensioner
Journal No.1
Camshaft(EX side)
Journal No.2
Journal No.3
Journal No.4
Journal No.5
Oil pressure switch
Chain oil nozzle
Main gallery
Crank journal No.1
Crank pin No.1
Oil jet
Crank journal No.2
Crank pin No.2
Oil jet
Crank journal No.3
Crank pin No.3
Oil jet
Crank journal No.4
Crank pin No.4
Crank journal No.5
Oil jet
Oil pump
Relief valve
Oil filter
Oil
Oil pan
* Oil jet in [dashed box] is used only for 3SZ-VE

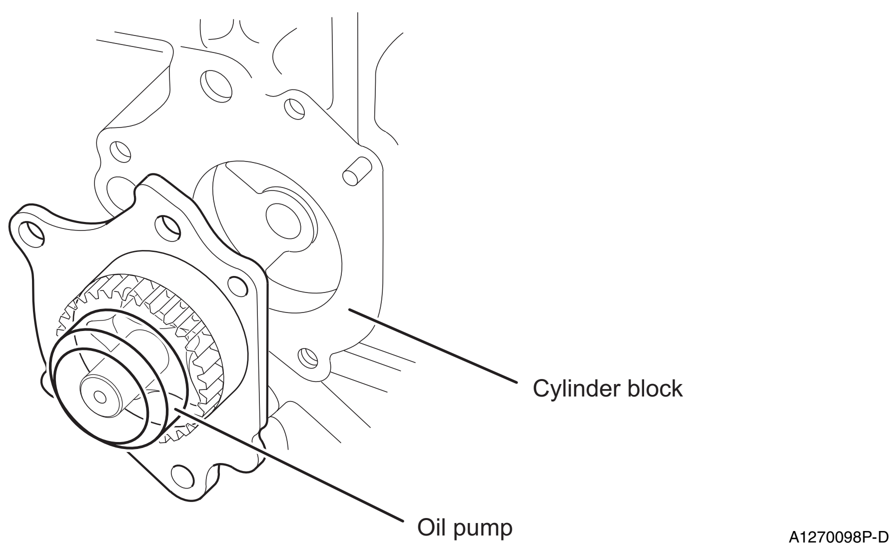
A1270153P-D

Engine oil specifications

			All models
Type	SAE classification		0W-20
	API classification		SJ or more
Capacity	Total capacity (L)		3.6
	Oil pan capacity	Full (L)	3.0
		Low (L)	1.5
	Replaceable quantity [Full]	Except filter (L)	2.9
		Including filter (L)	3.2

Oil Pump

- The rotor chamber and the relief valve are mounted on the cylinder block to make the structure simple and reduce the overall engine length.
- The oil pump is a compact, high-efficiency, 4-lobe, 5-node trochoidal gear pump that is driven by the timing chain at a speed reduced by using a different shaft from the crankshaft.
- An inner relief type is employed to reduce pump running losses by preventing fluctuations in oil level and the sucking of air.



Oil pump specifications (3SZ-VE/K3-VE)

Discharge [at {5,100 rpm/290 kPa}] (liter/min)	37 or more
Relief valve opening pressure [at {2,000 rpm}] (kPa)	490

Oil Filter

- A dedicated oil filter bracket is provided to ensure ease of servicing.

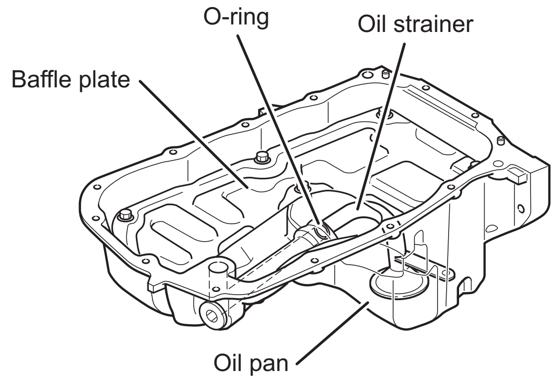
Oil filter specifications

Manufacturer	Denso	Tokyo Roki
Type	Full-flow	←
Filtration area (cm^2)	700	800

Manufacturer	Denso	Tokyo Roki
Bypass valve opening pressure (kPa)	98	←

Oil Pan and Oil Strainer

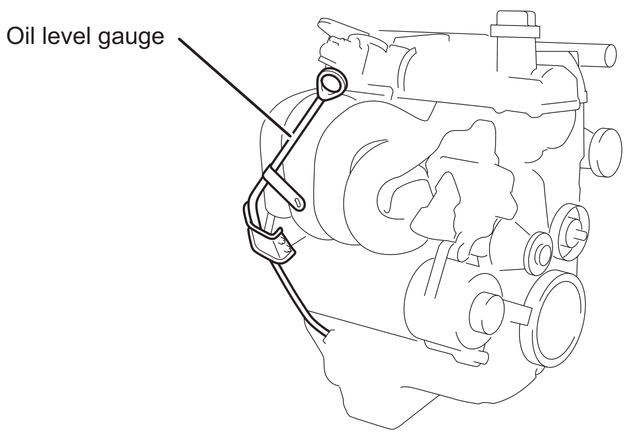
- An aluminum allow oil pan is employed and vibrations and noise have been reduced drastically by stiffening the joint with the transmission.
- Aluminum, a material with a high degree of shaping flexibility, has been used to manufacture an oil pan that can hold a sufficient quantity of oil and thereby retard the deterioration of oil and prevent air from being sucked in during cornering.



A1270099P-D

Oil Level Gauge

- The guide pipe is inserted in the oil pan through a hole and placed on the intake side of the engine. To ensure ease of inspection and servicing, the oil level gauge insertion port is placed at the same level as the cylinder head.

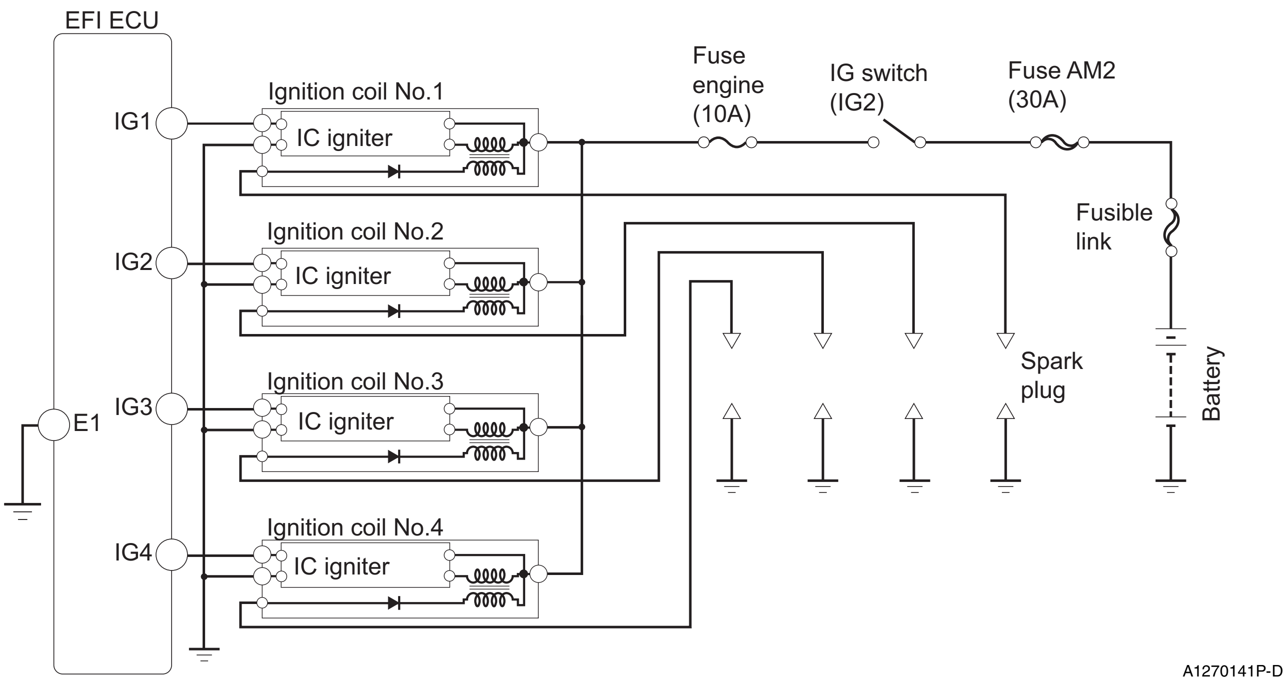


A1270069P-D

IGNITION SYSTEM (3SZ-VE/K3-VE)

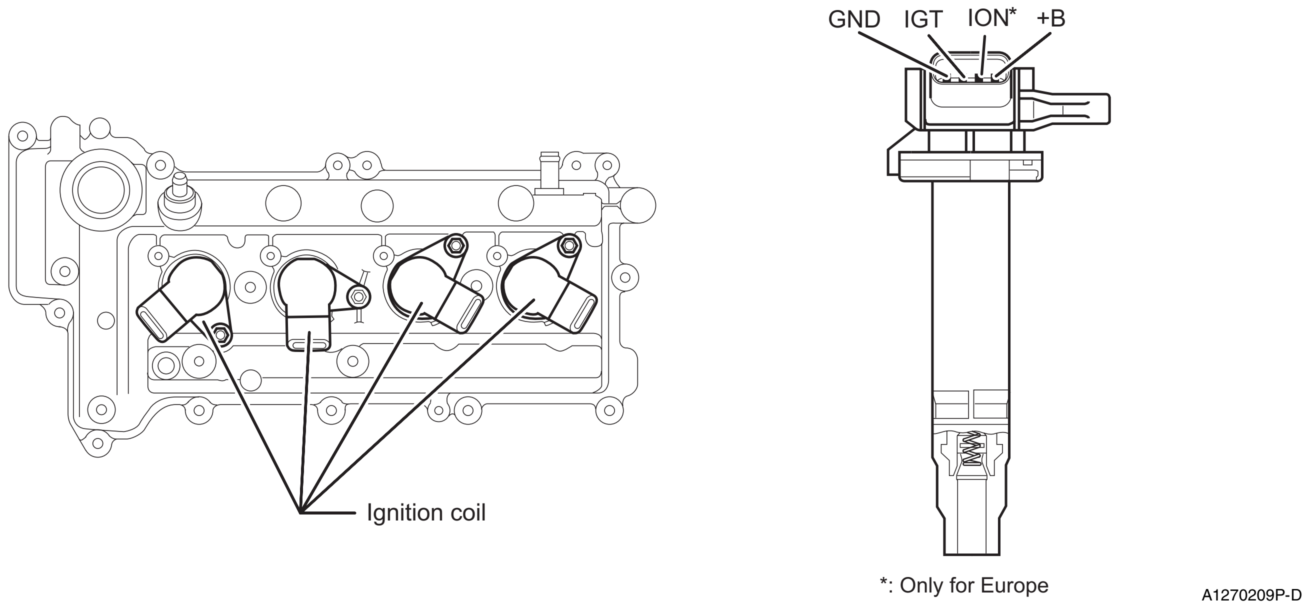
Ignition System in General

- A DLI (Distributor-less Ignition) system is employed to improve ignition performance.
- The DLI system does not require a distributor and ignition coils mounted right above the spark plugs. This eliminates ignition energy losses due to power distribution and supplies electric energy directly to the spark plugs and always turning them on under optimum conditions.



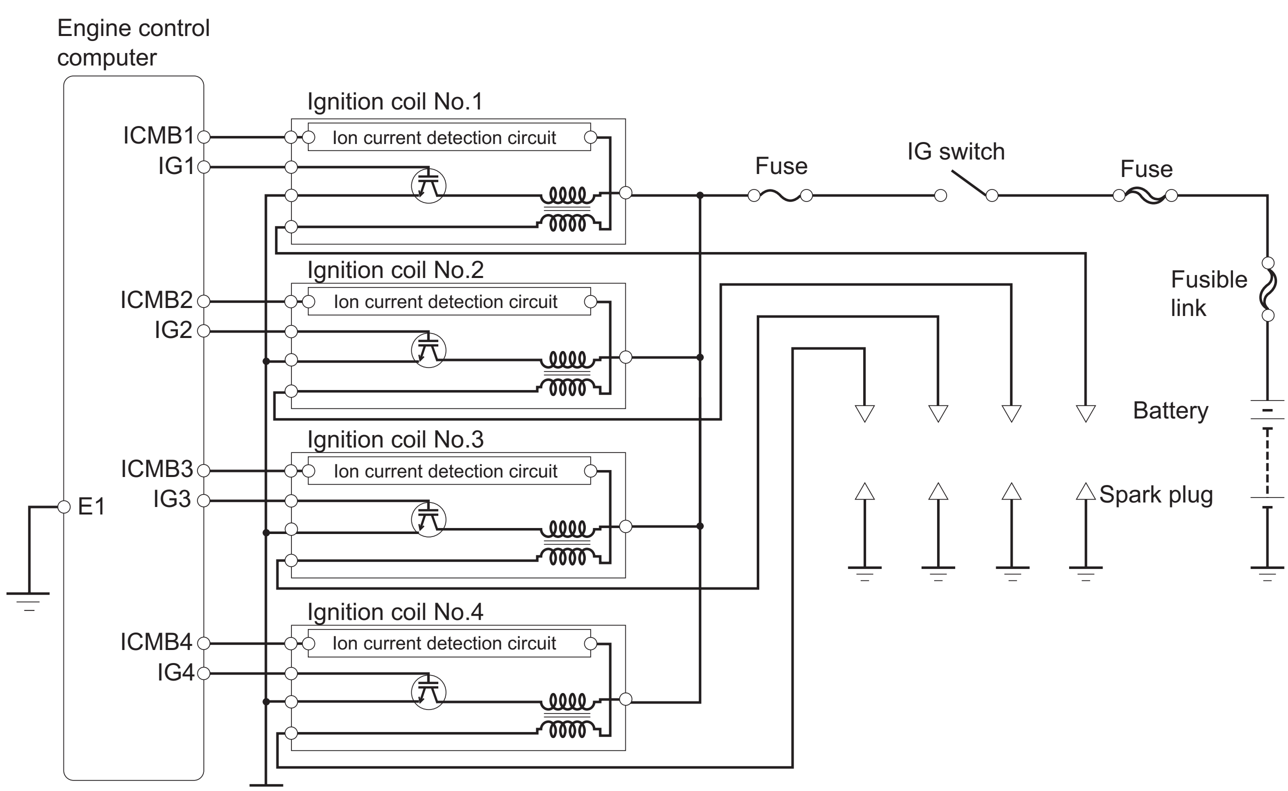
Igniter-Integrated Ignition Coil

- Ignition coils with a built-in stick type igniter are employed to improve ignition controllability and reliability.
- They are mounted in the cylinder head cover right above the spark plug on each cylinder.
- An ion current combustion control system that detects ions produced during combustion is employed only for European models.



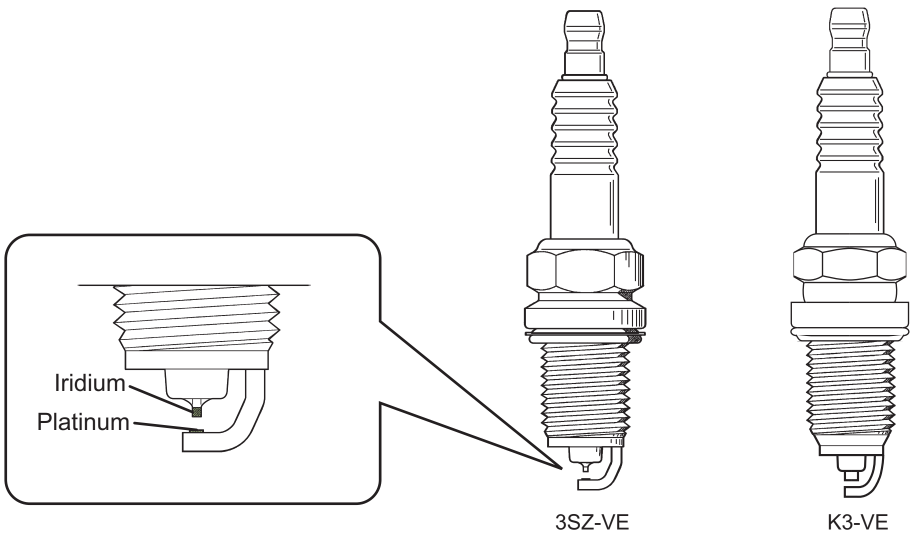
Ion Current Combustion Control System

- The igniter detects the ion current produced during combustion. The ion current detected is converted into an ion voltage and transmitted to the engine control computer. If this voltage is lower than the specified voltage, the engine control computer determines that a misfiring has occurred and increments the number of misfire events by one.
- If the number of misfire events reaches the specified one, the check engine warning lamp lights to inform the driver that the engine is not working well.
- If the number of misfiring events reaches the number at which the catalyzer may overheat, the check engine warning lamp blinks.



Spark Plug

- The 3SZ-VE engine uses spark plugs with a center electrode made of iridium alloy. Thanks to its exceptionally high wear resistance, iridium alloy makes it possible to reduce the diameter of the center electrode and thus to ensure the reliability of ignition.

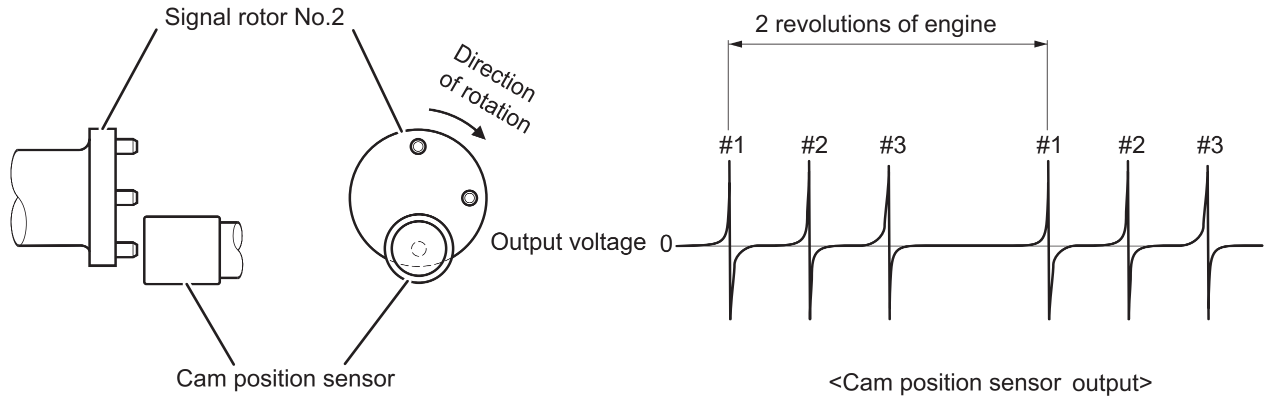


Spark plug specifications

Engine mounted	3SZ-VE	K3-VE	
Manufacturer	NGK	DENSO	NGK
Type	IKR7C	K20RU11	BKR6EY-11
Electrode distance (mm)	0.8 to 0.9	1.0 to 1.1	←
Width across flat (mm)	16	←	←

Cam Position Sensor (G2 Signal)

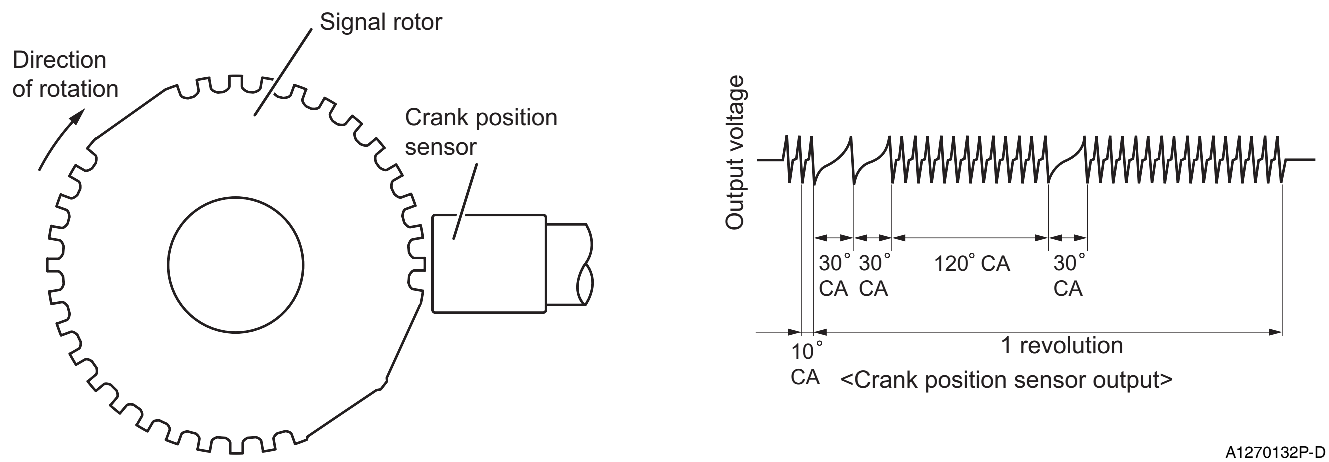
- Three protrusions are provided at the rear of the intake camshaft and a position sensor is located at the rear of the cylinder head to sense the phase of the intake camshaft and that of the crankshaft.
- One revolution in the intake camshaft changes the air gap between each protrusion and the cam position sensor changing the flux and causing the cam position sensor to generate 3 pulses per revolution.
- Signals from each cam position sensor and the engine speed sensor sense the phase of the intake camshaft and the crankshaft. DVVT control is performed according to these phases.



A1270143P-D

Crank Position Sensor

- To determine the crank angle, a signal rotor is placed at the front of the crankshaft, and a crank position sensor responsive to the protrusions on the signal rotor is provided.
- Crankshaft rotation changes the air gap between the crank position sensor and each protrusion on the signal rotor causing flux changes that result in the generation of a pulse.
- The engine speed is determined from the interval at which pulses are produced by these protrusions.

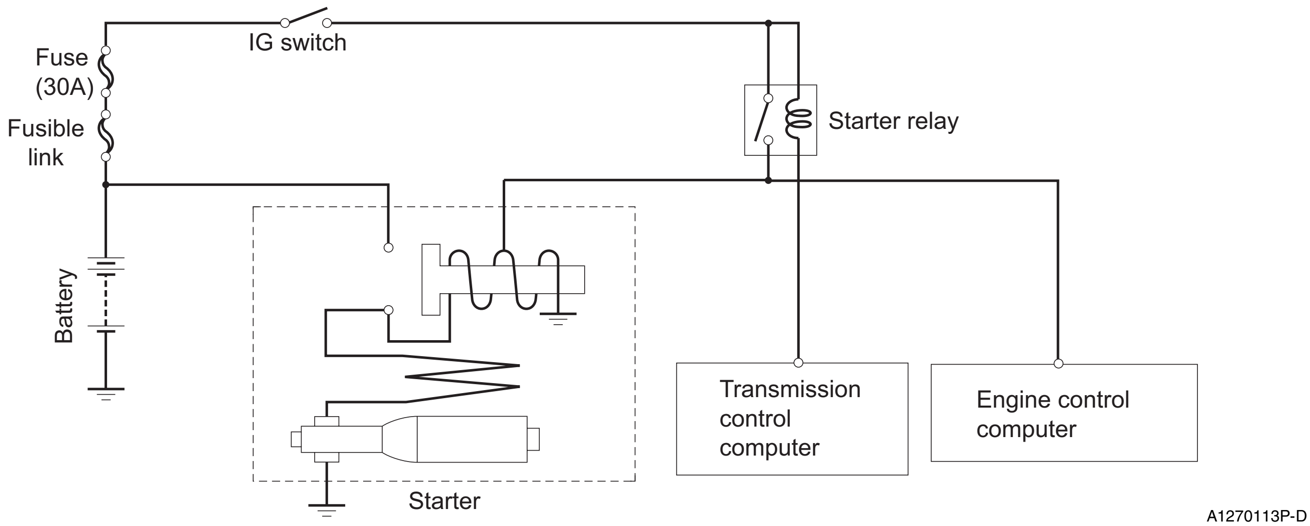


A1270132P-D

STARTING AND CHARGING SYSTEM (3SZ-VE/K3-VE)

Starter

- Two types of starters are available: a temperate region type and a cold climate region type.

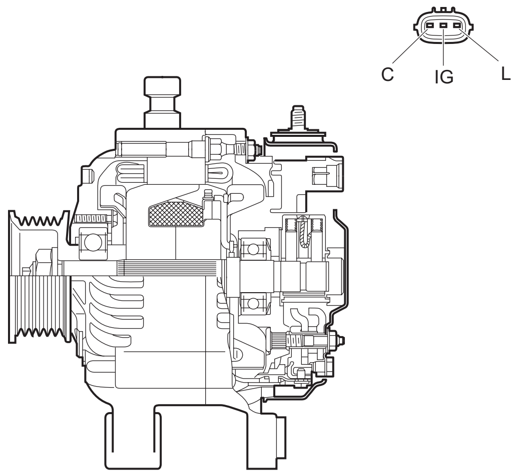


Starter specifications

	Temperate regions	Cold climate regions
Rated output (kW)	0.8	1.0
No-load characteristics	50 A or less [at 11.5 V] 6,000 rpm or more	90 A or less [at 11.5 V] 3,000 rpm or more
Number of pinion teeth	8	←
Direction of rotation	Clockwise when viewed from the pinion side	←
Weight (kg)	3.15	3.10

Alternator

- The alternator is a compact dynamo with a built-in IC regulator.
- The alternator lets its regulator adjust the voltage in 2 levels under signals from the engine control computer.



A1270114P-D

Alternator specifications

Rated voltage and max. output (V-A)	12-80
Output characteristic [at 13.5 V, 5000 rpm] (A)	90.0 or more
Maximum allowable number of revolutions (rpm)	18,000
Voltage regulated by regulator [at 5,000 rpm, 10 A, 25° C] (V)	Hi
	Lo
Direction of rotation	Clockwise when viewed from the pulley side
Pulley diameter (mm)	ϕ55
Weight (kg)	4.50

SUSPENSION

SUSPENSION IN GENERAL

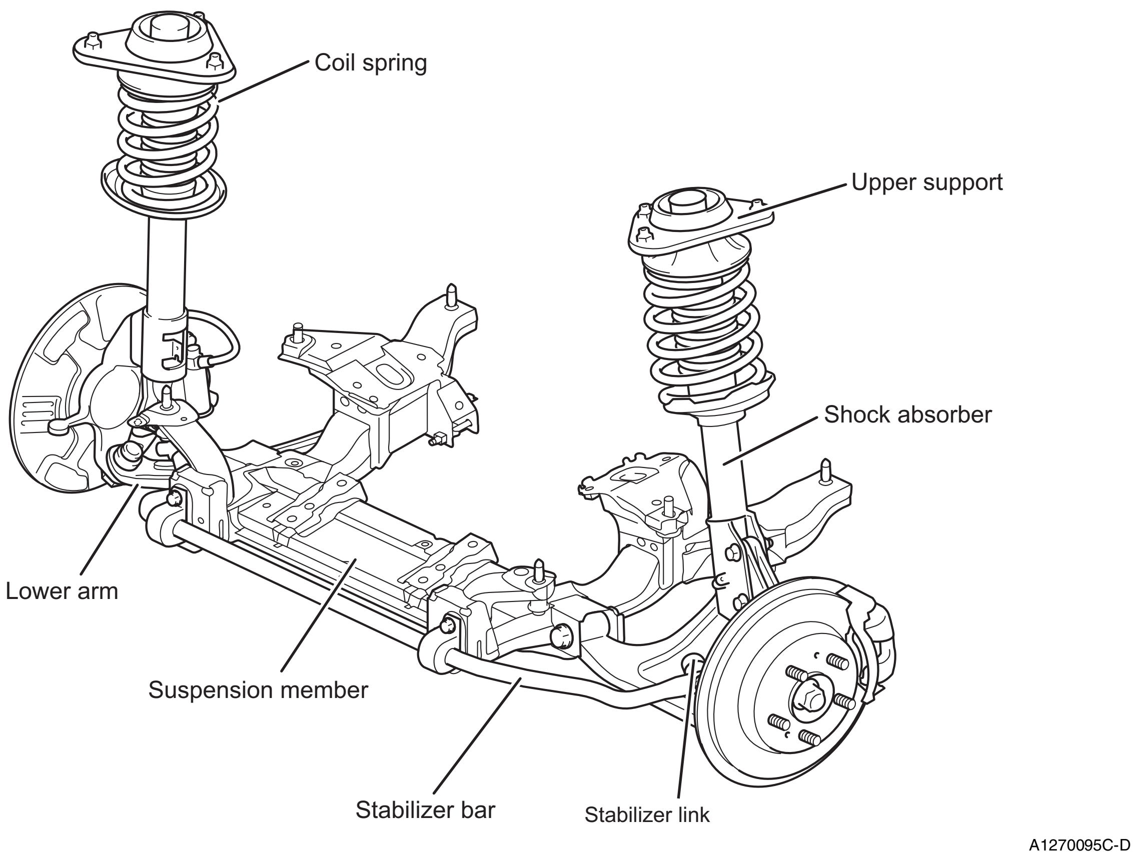
FRONT SUSPENSION

REAR SUSPENSION

SUSPENSION IN GENERAL

Outline of Front Suspensions

- A McPherson strut type suspension with A-shaped lower arms is employed.
- An excellent balance between driving stability and riding comfort has been achieved by optimizing the suspension geometry.
- A stabilizer is provided for the front suspension of every model to ensure sufficient roll rigidity. Ball joint type stabilizer links are also employed.



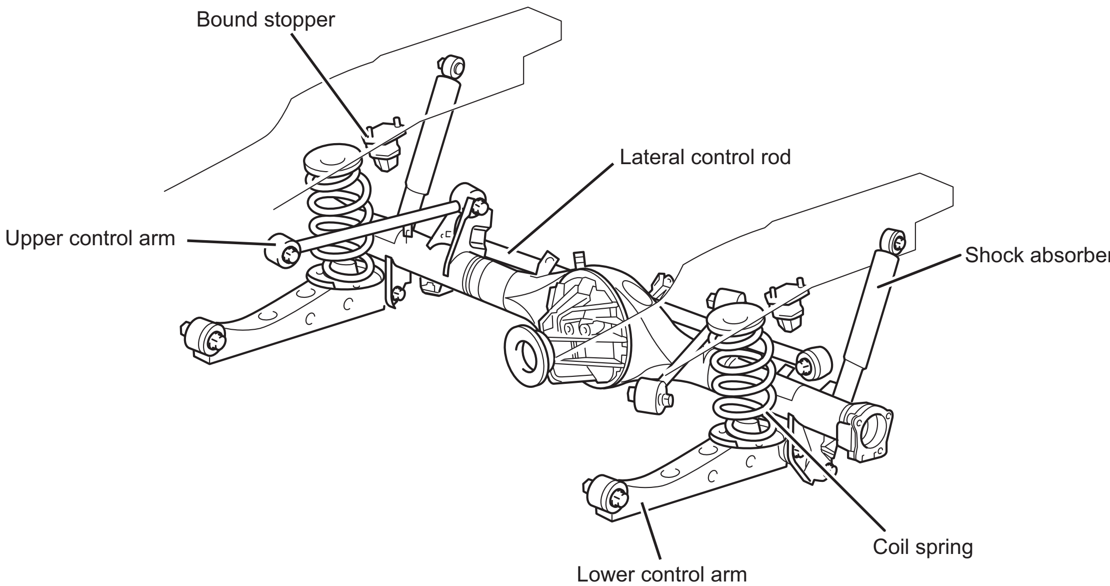
Alignment specifications

	2WD models	4WD models
Camber angle [degree]	0° 30'	←
Caster angle [degree]	4° 50'	←
Kingpin inclination [degree]	12° 25'	←
Toe-in [mm]	0	←

Outline of Rear Suspensions

- The rear axle employs a five-link coil spring suspension, which supports the rear axle with upper control arms, lower control arms and a lateral control rod.

● A weight reduction has been achieved by adopting a hollow pipe construction for the lateral control rod.



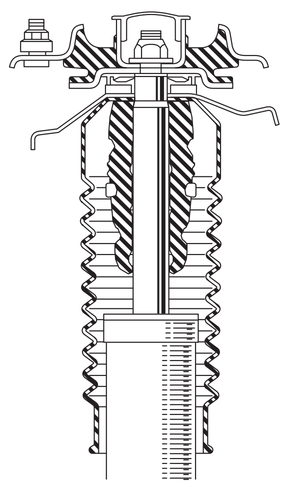
Alignment specifications

	Standard model	Low-down model
Camber angle [degree]	0° 00'	←
Toe-in [mm]	0	←

FRONT SUSPENSION

Upper Support and Coil Spring

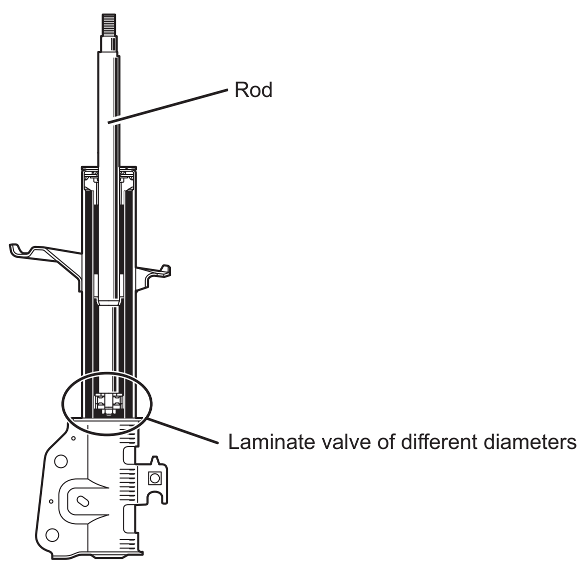
- An offset is provided by inclining the axis of the coil spring with respect to the axle of the strut to reduce the lateral load and frictional force to the shock absorber.



A1270138C-D

Shock Absorber

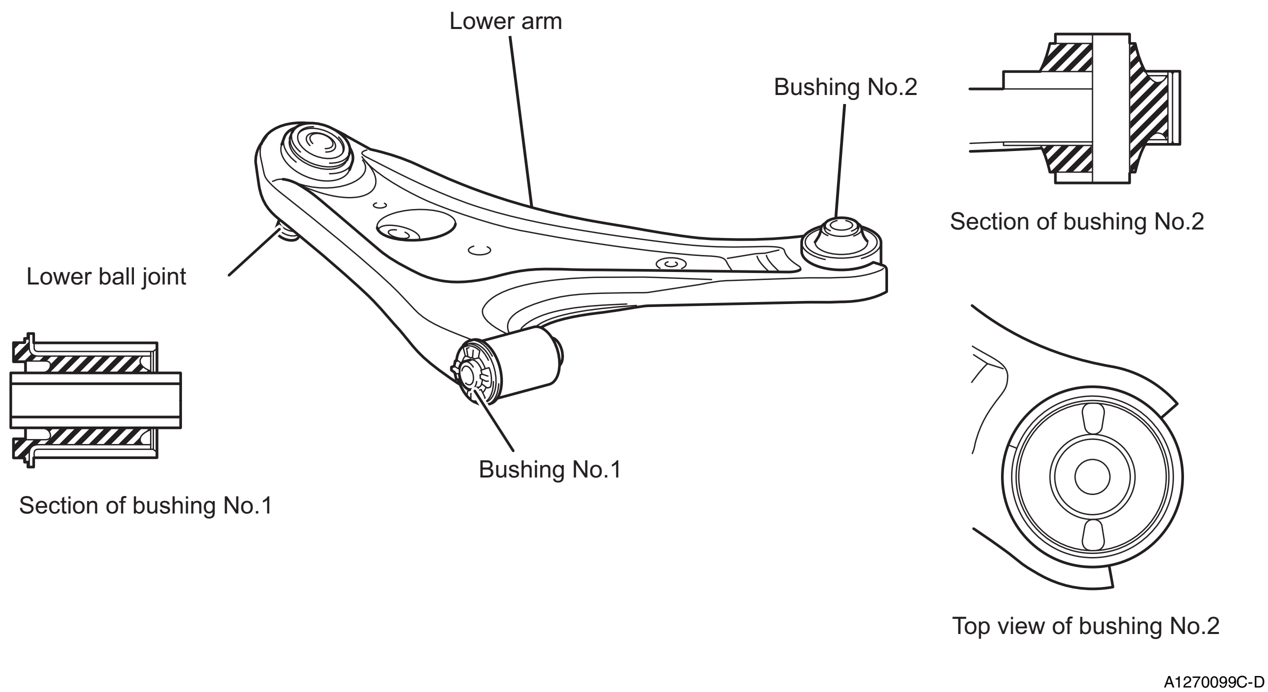
- Shock absorbers filled with low pressure gas are employed to reduce the risk of cavitation and obtain stable damping force. An excellent balance between driving stability and riding comfort has been achieved by employing viscoelastic oil seals and laminate valves of different diameters as they allow the shock absorbers to produce damping force even when the pistons move at extremely low speeds.



A1270098C-D

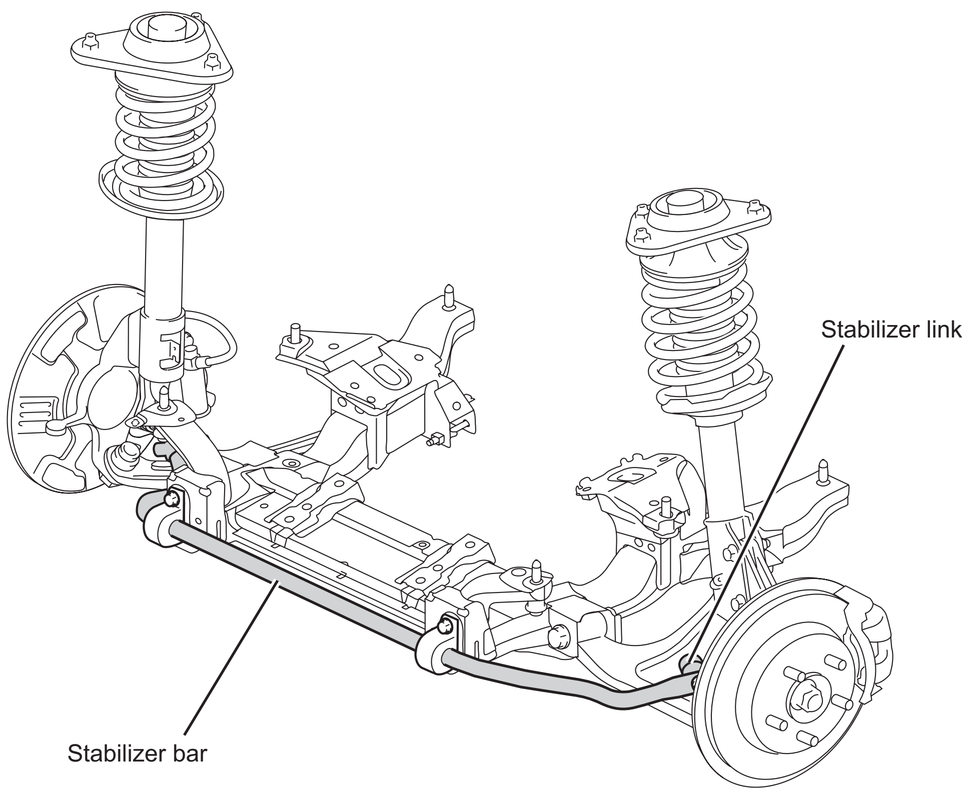
Lower Arm and Bushing

- A-shaped lower arms are employed. To reduce the change in alignment when excessive force is applied to the suspensions, bushings No. 1 and No. 2 are placed horizontally and vertically, respectively, in the joint with the suspension member.
- The positions and characteristics of the lower arm bushings are optimized to optimize compliance and achieve a balance between riding comfort and steering feel.
- Bushing No. 1 employs a longitudinal shaft without outer tube, and bushing No. 2 employs a vertical shaft with an outer tube (bulging inner casing).



Stabilizer

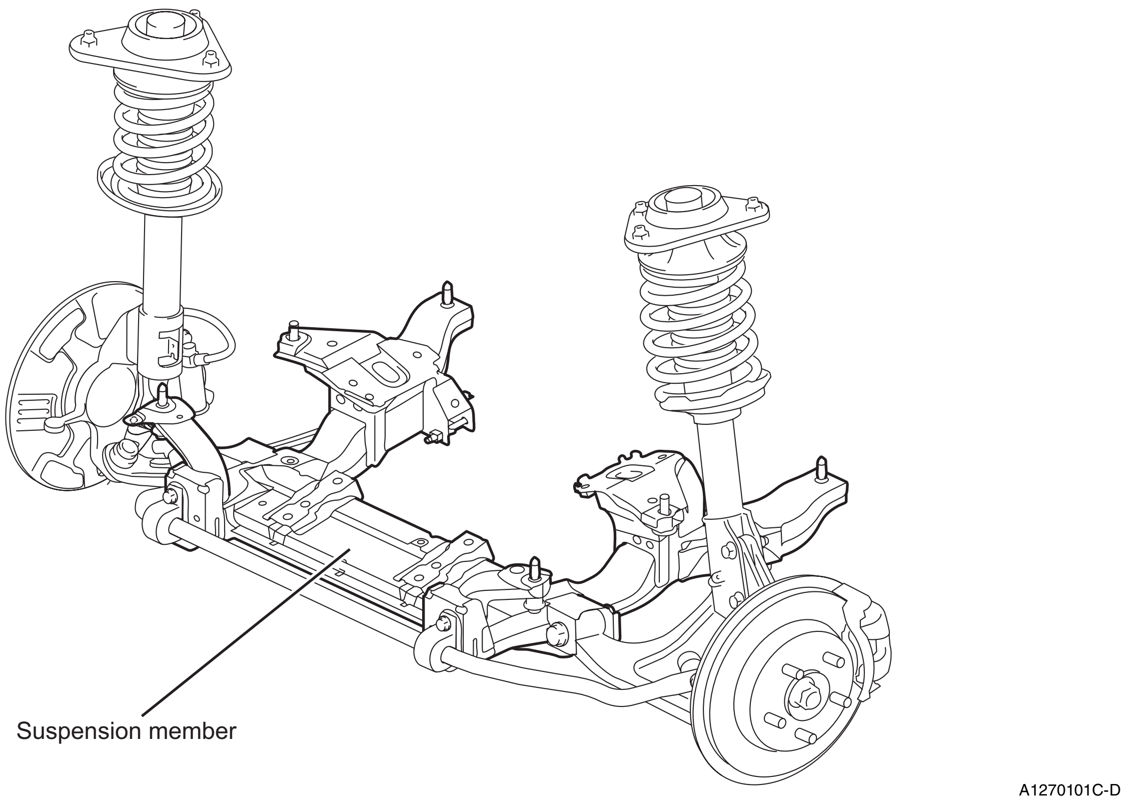
- A front stabilizer is provided for every model as standard equipment.
- Ball joint type stabilizer links are employed and mounted on the lower arms to increase the responsiveness at all stages of rolling, to improve the effectiveness of the stabilizer, and to achieve a balance between driving stability and riding comfort.



A1270100C-D

Suspension Members

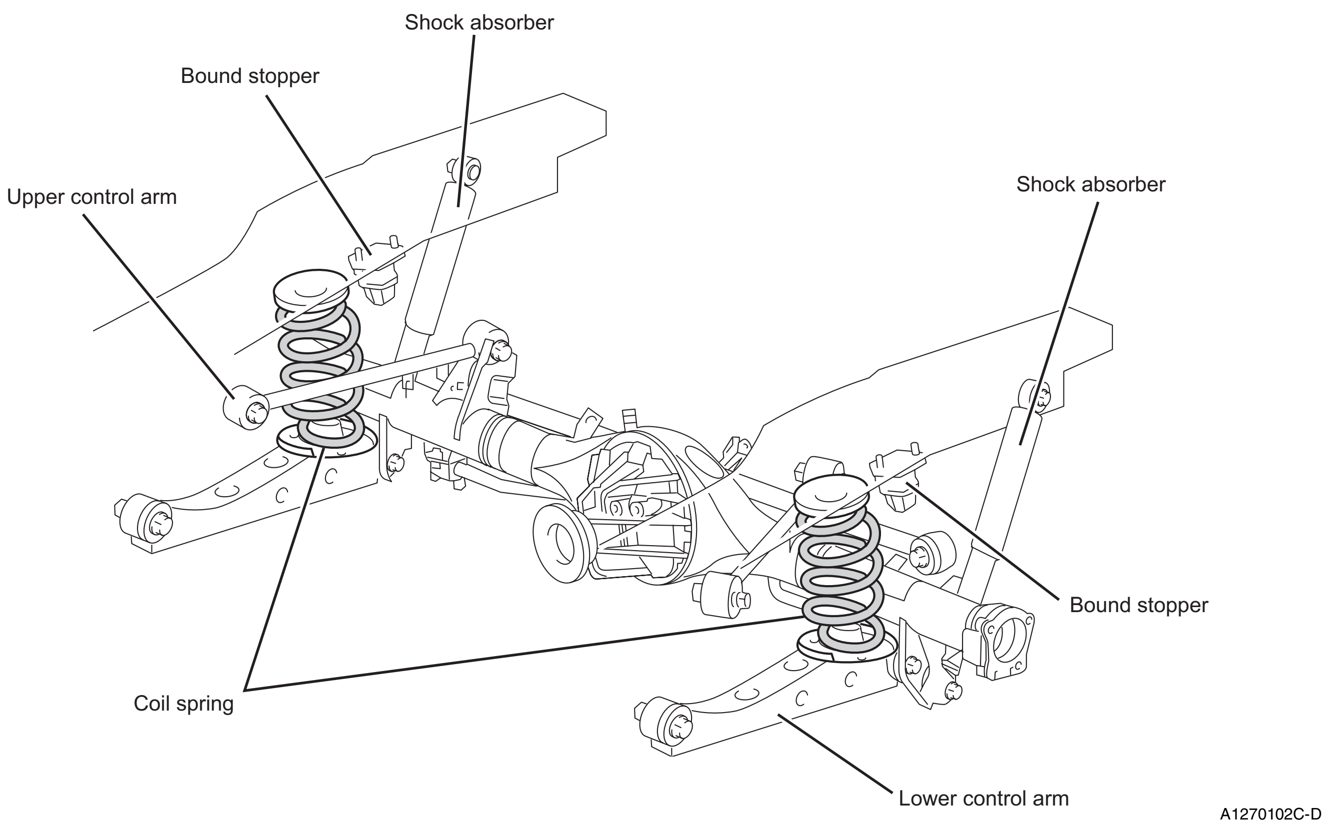
- The suspension member is made of stamped steel.
- The lower arms and the steering gear are mounted on the front suspension member to reduce noise and ensure the rigidity of the suspension and steering gear.


Suspension member
A1270101C-D

REAR SUSPENSION

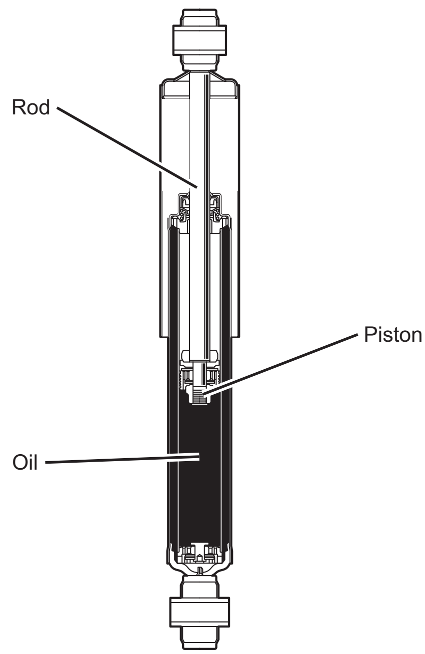
Coil Spring

- A low floor has been achieved by placing a coil spring on each lower control arm and excellent riding comfort has been achieved by optimizing the spring constant.
- The coil spring, the shock absorber and the bound stopper are placed separately to distribute the load from the suspension, and the protrusion into the passenger compartment is limited with consideration given to the low floor.



Shock Absorber

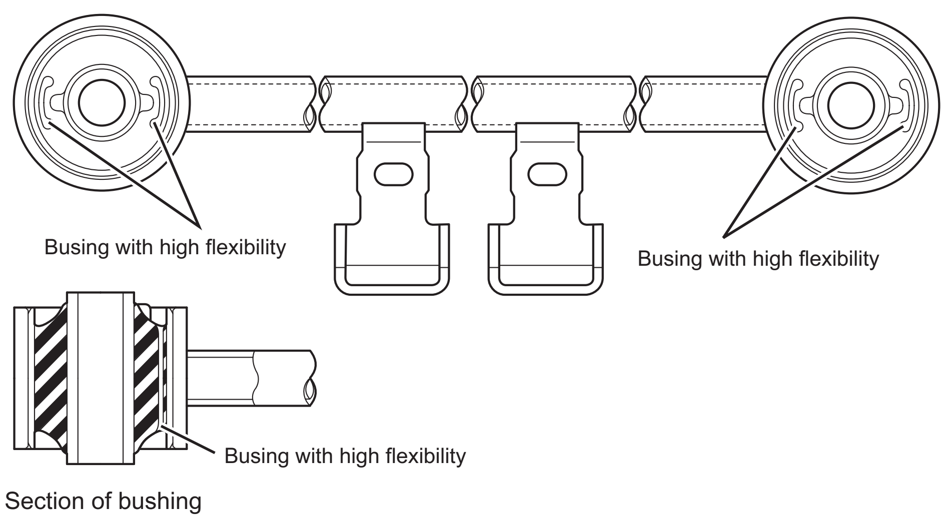
- Tube type double-acting shock absorbers are employed to optimize the damping force and achieve a balance of driving stability and riding comfort.



A1270103C-D

Upper Control Arm and Bushing

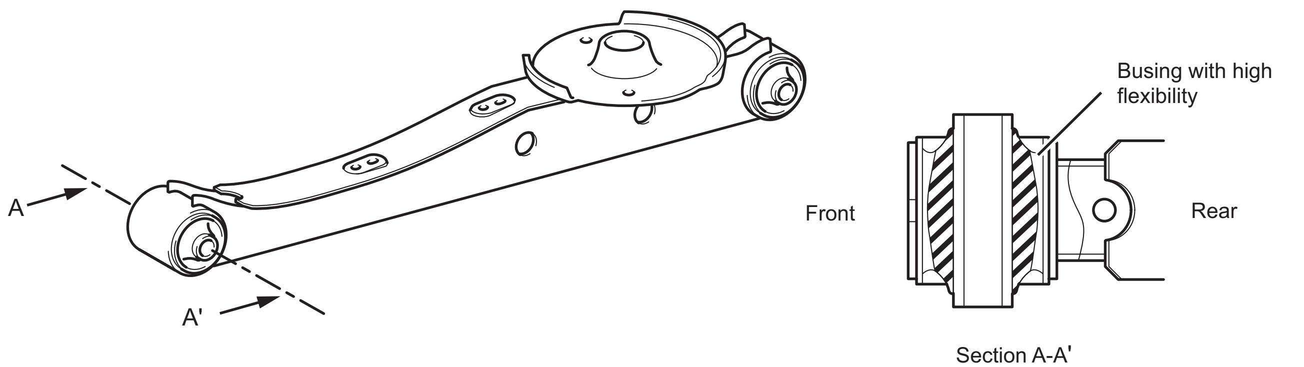
- Upper control arms made of hollow pipes are employed to achieve a weight reduction.
- The upper control arms are placed in a slanting direction to shift the lateral force produced during cornering in the understeer direction while achieving a high degree of stabilizer effectiveness and to achieve a good balance between driving stability and riding comfort. Furthermore, bushings with high longitudinal compliance (flexibility of suspension) are employed on both front and rear sides to ensure driving stability and riding comfort.



A1270104C-D

Lower Control Arm and Bushing

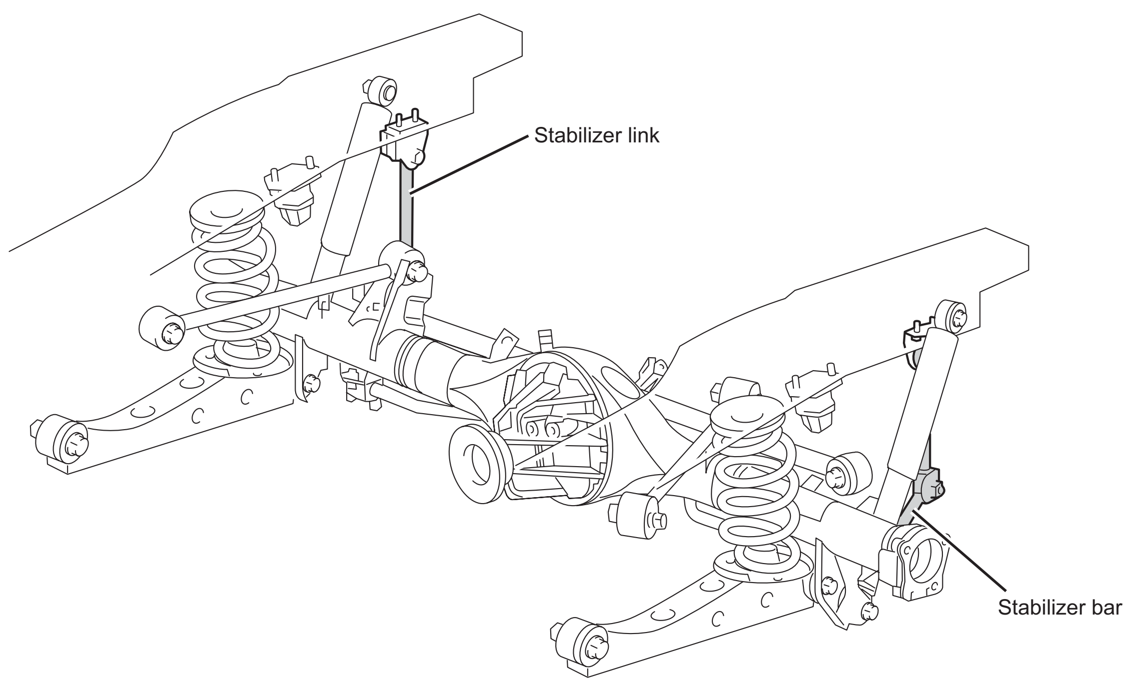
- Bushings with high longitudinal compliance (flexibility of suspension) are employed on both front and rear sides to ensure driving stability and riding comfort.



A1270105C-D

Stabilizer

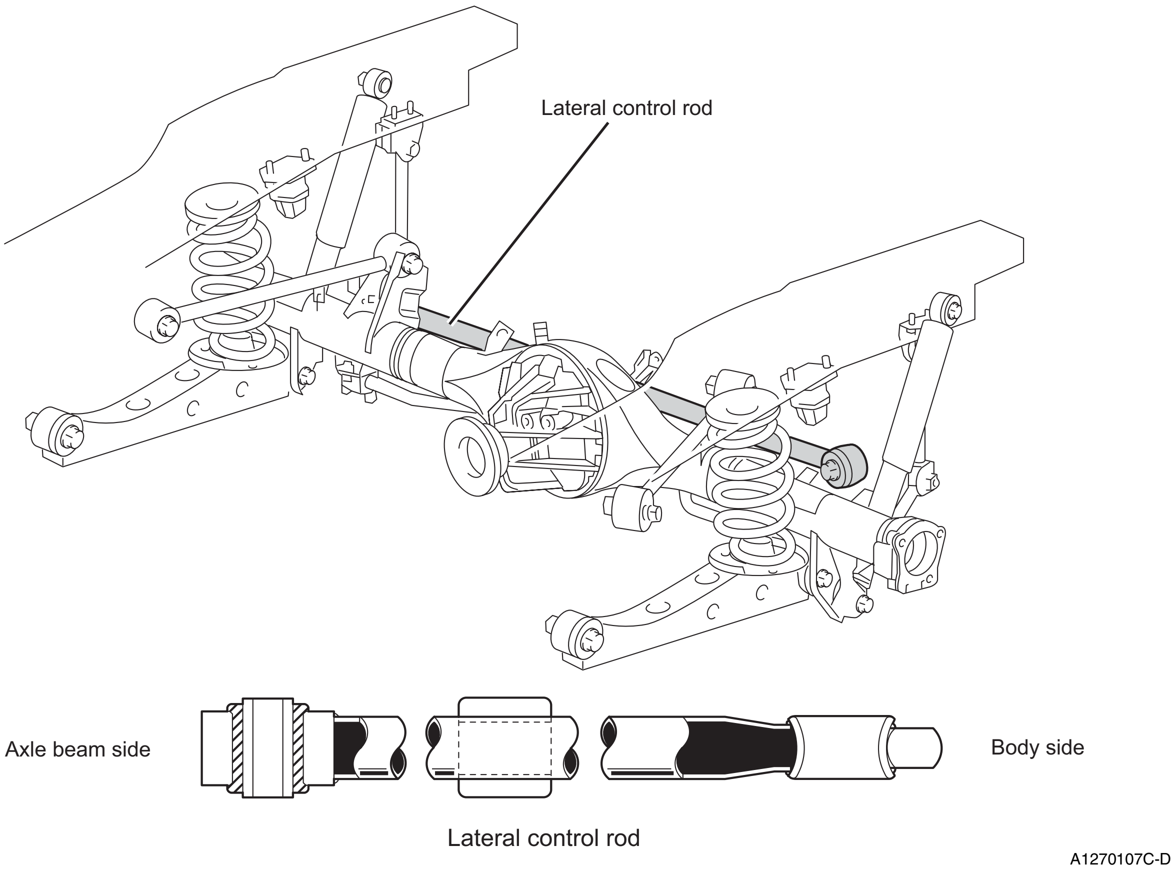
- Rear stabilizers are provided for 4WD high-grade European models as standard equipment. They are also available for models other than European models as options.
- The rear stabilizer is a hollow type which ensures higher rolling rigidity while achieving a balance between driving stability and riding comfort.



A1270106C-D

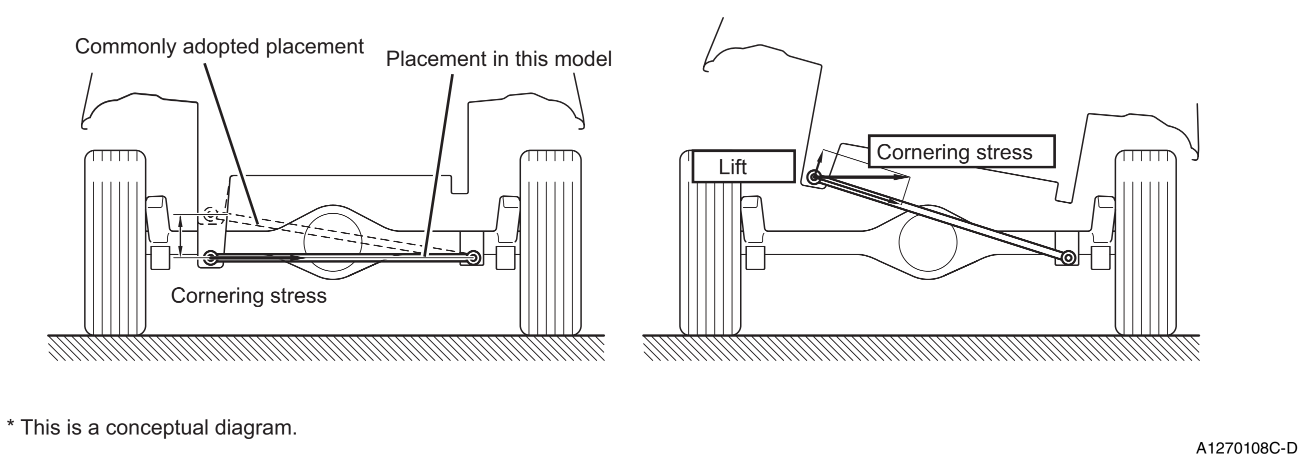
Lateral Control Rod

- A lateral control rod made of a hollow pipe is employed to ensure high stability for the vehicle during cornering.



Optimal Arrangement of Lateral Control Rod

- The lateral control rod is so placed that it will be parallel with the axle when a passenger gets into the vehicle and that it will effectively sustain cornering stress during cornering, and the lift is limited to ensure high cornering ability.
- The lateral control rod is placed behind the axle to turn compliance steer during cornering into understeer.



TO FOREWORD

DRIVE LINE & AXLE

DRIVETRAIN

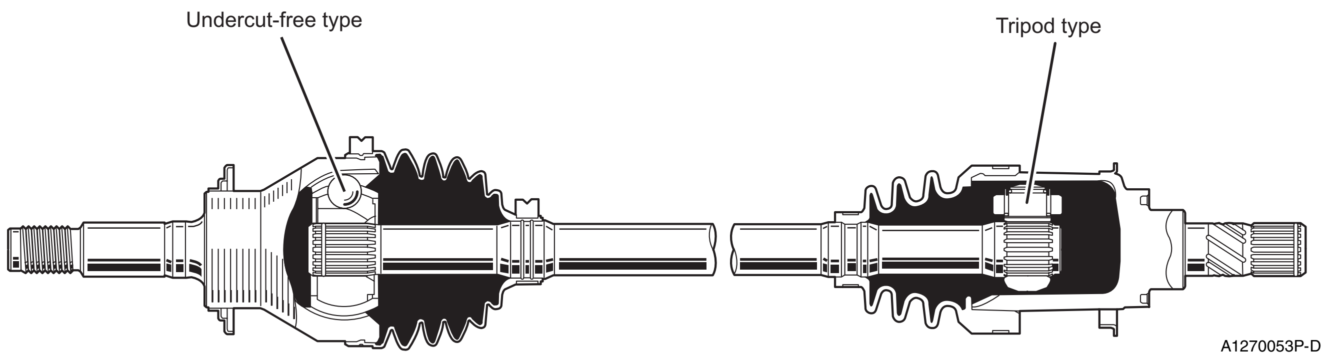
AXLE

DRIVETRAIN

Drive Shaft

● Each drive shaft is provided with an undercut-free joint on the axle side and a tripod universal joint on the differential gear side.

● A resin boot is employed for the joint on the axle side.

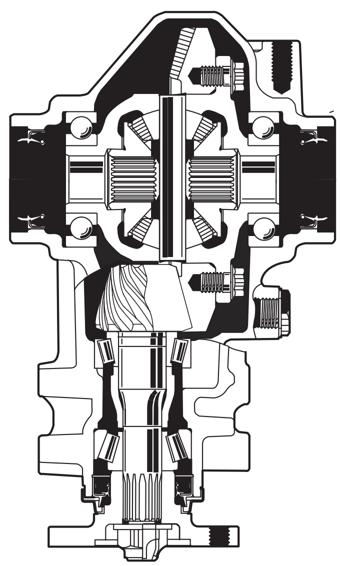


A1270053P-D

Front Differential Gear

● The reduction ratio for 3SZ-VE engine-equipped models is set at 5.125 for M/T vehicles and 5.571 for A/T vehicles.

● K3-VE engine-equipped models have a reduction ratio of 5.571.



A1270160P-D

Front differential gear specifications

Engine mounted	3SZ-VE		K3-VE
Transmission specifications	5M/T	4A/T	5M/T
Reduction ratio	5.125	5.571	←
Identification mark	JAA	JAB	JAC

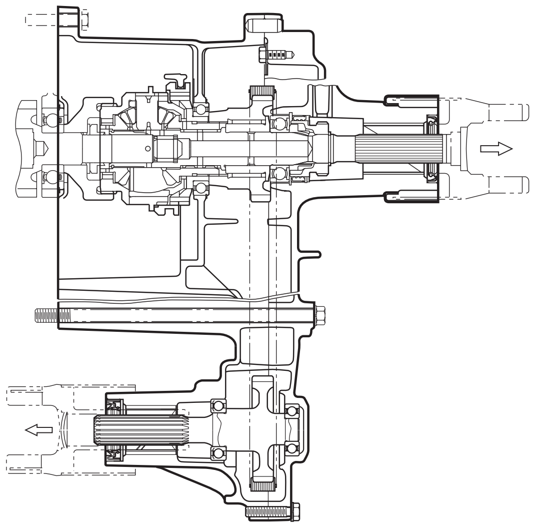
Engine mounted		3SZ-VE		K3-VE
Drive pinion	Number of teeth	8	7	←
	Gear type	Hypoid gear	←	←
Ring gear	Number of teeth	41	39	←
	Outside diameter (mm)	162	←	
	Gear type	Hypoid gear	←	←
Pinion gear	Number of teeth	10	←	←
	Gear type	Straight bevel gear	←	←
Side gear	Number of teeth	16	←	←
	Gear type	Straight bevel gear	←	←
Oil used	Name	Hypoid gear oil SAE80W-90 (API classification: GL-5)	←	←
	Quantity (L)	0.45	←	←

Outline of Full-Time AWD

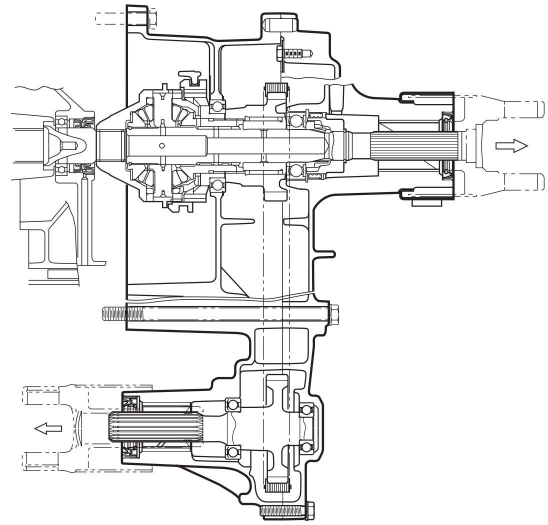
- A full-time 4WD system with a center differential gear lock mechanism has been employed. This 4WD system combines the rough road driving performance of part-time 4WD vehicles with the high driving stability of full-time 4WD vehicles to deliver high tractive ability and steering stability under a wide variety of road conditions.
- The center differential gear lock switch allows the driver to change the driving conditions according to the road condition.

Transfer

- Each portion of the transfer has been reinforced to adapt it to the 3SZ-VE engine.



For M/T model



For A/T model

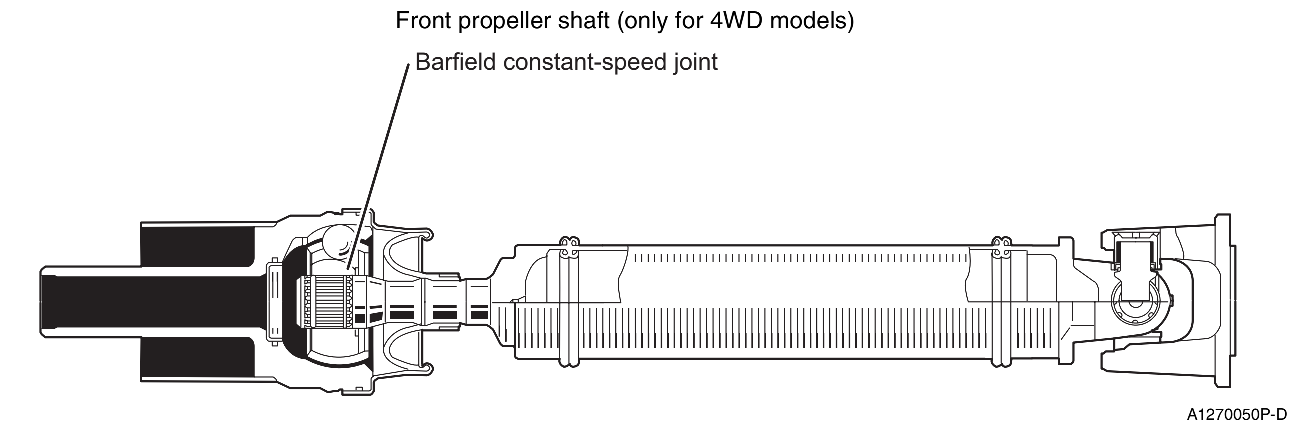
A1270049P-D

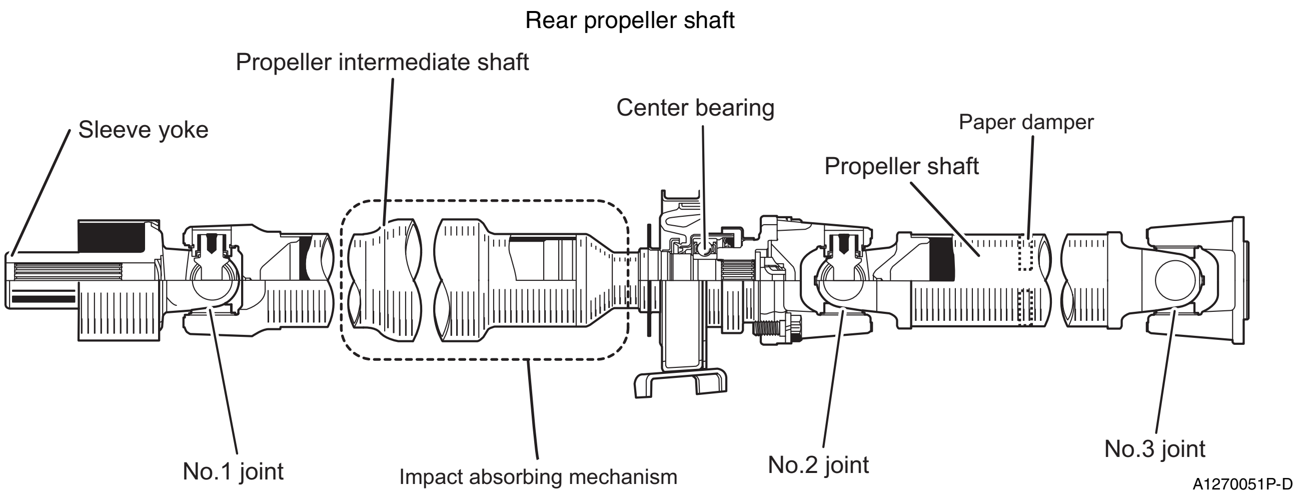
Transfer specifications

Engine		3SZ-VE		K3-VE
Transmission		M/T model	A/T model	M/T model
Specifications		Full-time 4WD with center differential gear lock	←	←
Differential gear ratio		5.125	5.571	←
Number of speedometer drive gear teeth		6	None	None
Number of speedometer driven gear ratio		23 (None for ABS models)	None	None
Transfer oil	Name	Transmisson gear oil SAE75W-80 (API classification: GL4)	←	←
	Quantity of oil	2.21 L (Including transmission oil)	1.6 L	2.21 L (Including transmission oil)

Propeller Shaft

- The front propeller shaft employs a two-joint type and the transfer side uses a Barfield constant-speed joint.
- The rear propeller shaft employs a three-joint type with a center bearing. To improve the ability to reduce noise and vibrations, a paper damper is inserted in propeller tube No.2.
- A newly designed shock absorbing mechanism has been adopted for propeller tube No.1 of the rear propeller shaft.



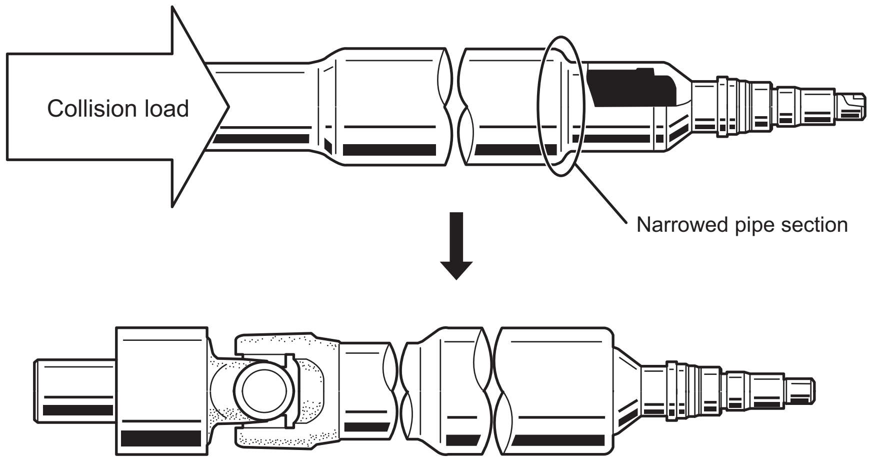


Propeller shaft specifications [mm]

2WD	Rear	Tube outside diameter	Straight pipe section: 57 mm Extended pipe section: 75 mm
		Overall length	1672 mm
		Distance between joint No.1 and joint No.2	715.5 mm
		Distance between joint No.2 and joint No.3	784 mm
4WD	Front	Tube outside diameter	45 mm
		Overall length	490 mm
		Distance between joints	326.5 mm
	Rear	Tube outside diameter	Straight pipe section: 57 mm Extended pipe section: 75 mm
		Overall length	1523.5 mm
		Distance between joint No.1 and joint No.2	567 mm
		Distance between joint No.2 and joint No.3	784 mm

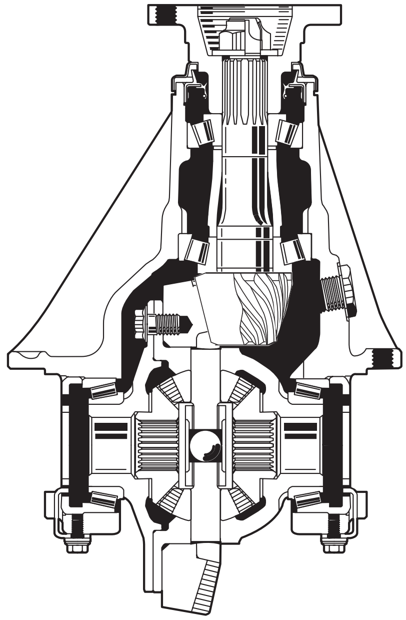
Shock Absorbing Mechanism

- The shock absorbing mechanism reduces the G applied to the vehicle body in the event of a frontal collision by compressing and deforming the narrowed pipe section of the propeller shaft.

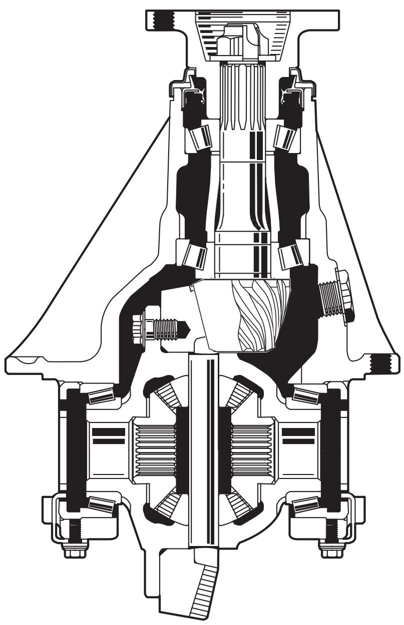


Rear Differential Gear

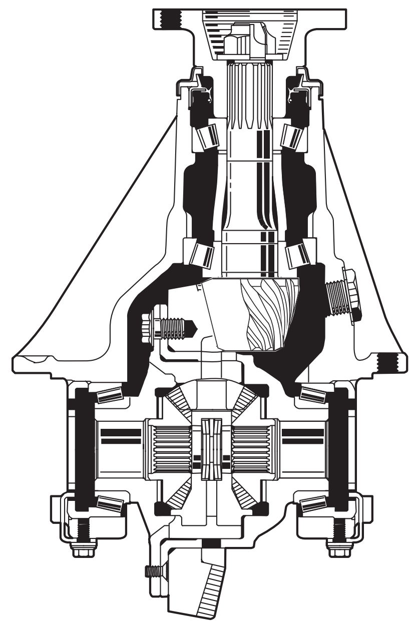
- The reduction ratio of the rear differential gear designed specifically for 2WD models is set at 4.875 for M/T vehicles and at 5.125 for A/T vehicles and a four-pinion type is employed to adapt the differential gear to the 3SZ-VE engine.
- The reduction ratio of the rear differential gear designed specifically for 4WD models is set at 5.571 for A/T vehicles and at 5.125 for M/T vehicles and a two-pinion type is employed to adapt the differential gear to the 3SZ-VE engine. K3-VE engine-equipped models have a reduction ratio of 5.571.
- An LSD (Limited-Slip Differential) mechanism is available as a maker option for 4WD models.



<2WD model>



<4WD model>



<4WD(LSD) model>

A1270156P-D

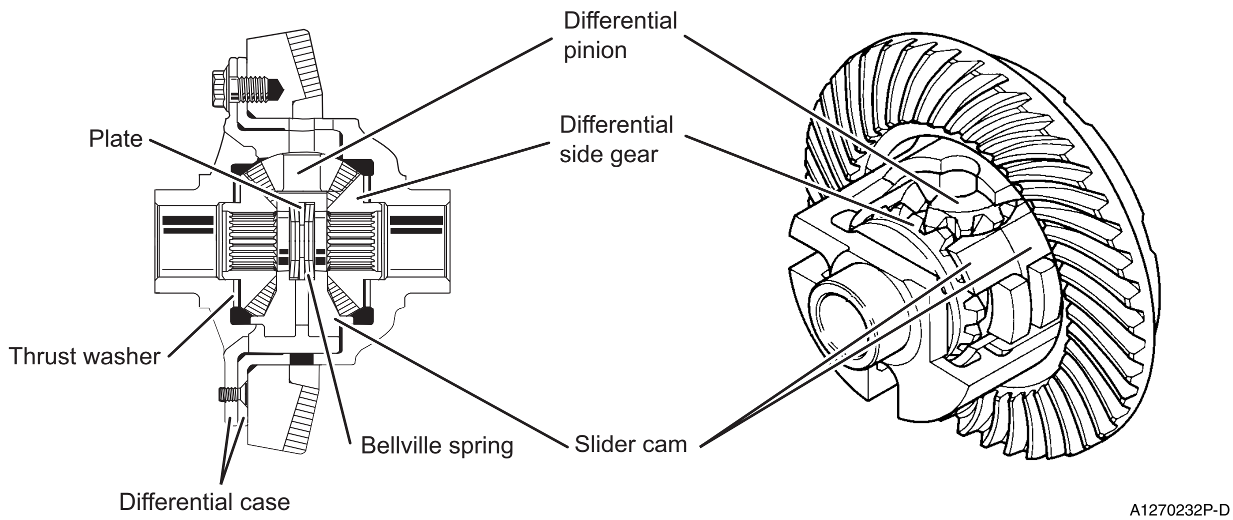
Rear differential gear specifications

Drive system		3SZ-VE				K3-VE
		2WD model		4WD model		4WD model
Transmission		M/T	A/T	M/T	A/T	M/T
Reduction ratio		4.875	5.125	←	5.571	←
Drive pinion	Number of teeth	8	←	←	7	←
	Gear type	Hypoid gear	←	←	←	←

Drive system		3SZ-VE				K3-VE
		2WD model		4WD model		4WD model
Ring gear	Number of teeth	39	41	←	39	←
	Outside diameter (mm)	180	183	←	180	←
	Gear type	Hypoid gear	←	←	←	←
Pinion gear	Number of teeth	10	←	←	←	←
	Gear type	Straight bevel gear	←	←	←	←
	Quantity	4	←	2	←	←
Side gear	Number of teeth	16	←	←	←	←
	Gear type	Straight bevel gear	←	←	←	←
Oil used	Standard model	Hypoid gear oil SAE80W-90 (API classification: GL5)	←	←	←	←
	LSD-equipped models (only for 4WD models)	—	—	Hypoid gear oil SAE80W-90LSD (API classification: GL5)	←	←
Quantity of oil (L)		1.8	←	←	←	←

Structure of LSD

- The direct-traction LSD (Limited-Slip Differential) is a torque-responsive LSD and has the following features.
  - Lightweight and compact
  - High responsiveness, because the differential gear itself has differential restricting capability and mechanical linkages, such as clutch plates, are not used in the driving force transmission route.
  - No change in bias ratio over time, because frictional elements, such as multi-disk clutches, are not used.
- One major feature of the direct-traction LSD is its simple structure, which is achieved by using ordinary bevel gears as differential gears and giving the differential gear the capability to restrict the differential motion of gears on its own.
- The direct-traction LSD has a part called slider cam, which is located inside the two pairs of differential gears (differential pinions and differential side gears), as with ordinary differential gear units, and it uses the friction between this cam and each differential gear as force for restricting the differential motion of gears.



Operation of LSD

Straight running (No difference in rotational speed between right and left wheels)

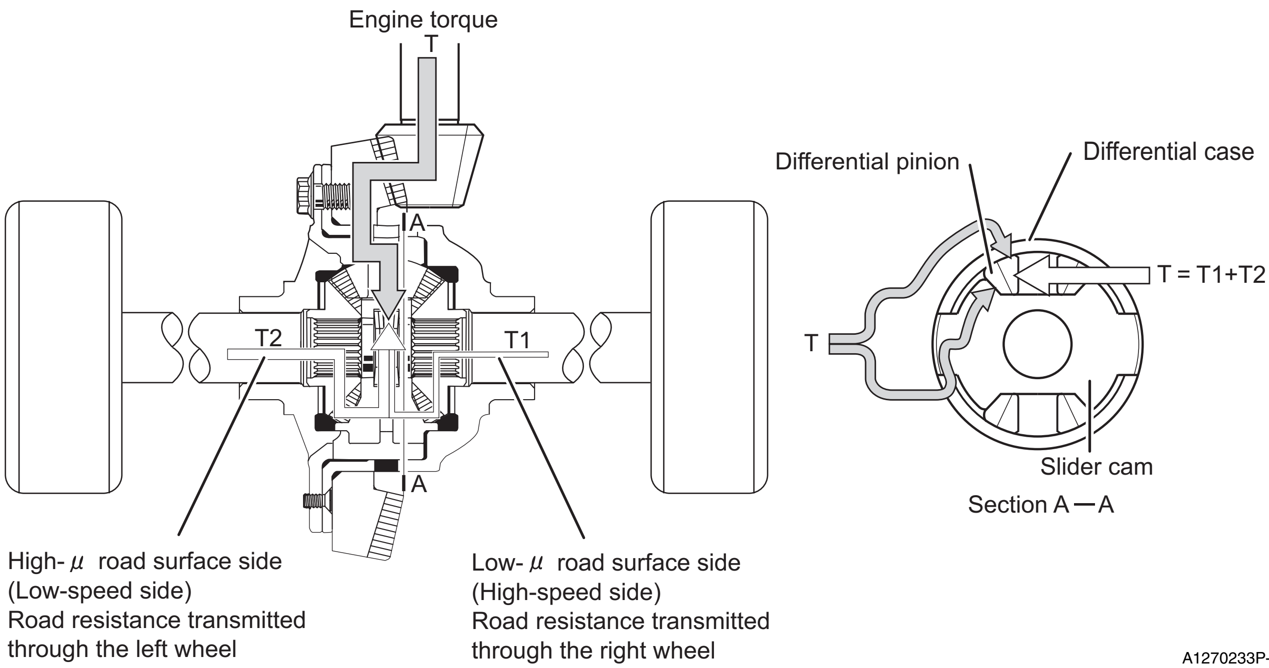
- As the right and left wheels rotate at the same speed, the differential case, two pairs of differential gears, and right and left wheels rotate together as one gear, and driving torque is transmitted from the ring gear to the differential case, slider cam, side gears, and axle shafts in this order.

Differential

- During cornering or when there is a difference in rotational speed between the right and left wheels, for example, when the right and left wheels are on road surfaces with different friction coefficients μ, the LSD regulates the rotational speed of each wheel by rotating the differential pinions on their respective axes, just as with ordinary differential gear units, in order to absorb the difference in rotational speed between the right and left wheels.

Limitation on differential

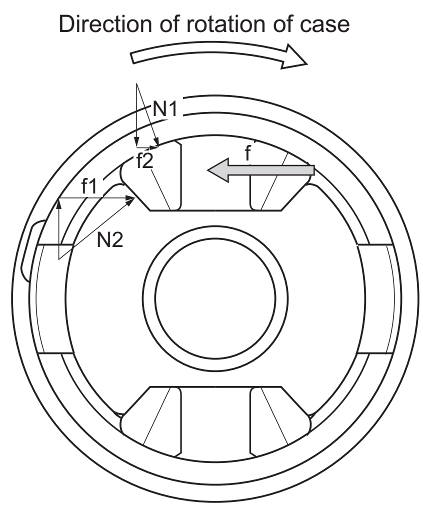
- When driving torque (T) is applied, the road resistance (T = T1 + T2) produces force that pushes the differential case against the slider cam and the differential pinions. When a differential develops, this pushing force acts on the rotating differential pinions as frictional resistance (differential restricting force) and driving force is transmitted to the wheel rotating at a lower speed (wheel on road surface with high μ).



A1270233P-D

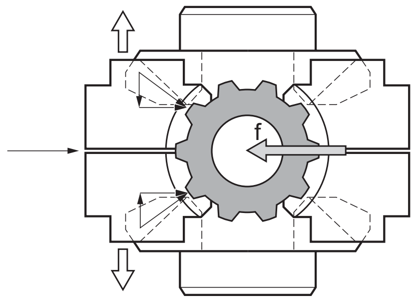
Differential restricting force

- Principal differential restricting forces produced by the pushing force include the following.
- The torque transmitted from the engine to the differential case and the road resistance transmitted through the tires act as force that pushes the differential pinions against the differential case and the slider cam (f). This pushing force produces forces N1 and N2 between each differential pinion and the slider cam, which act on the rotating differential pinions as frictional resistance (differential restricting force), restricting the rotation of the differential pinions.



A1270234P-D

- The slider cam works as a cam, as the name suggests, and attempts to extend outward by pushing force from the differential pinion. By this action, the slider cam pushes the differential side gears, producing frictional resistance between the slider cam and each side gear and between each side gear and the thrust washer, thus restricting the rotation of the side gears.

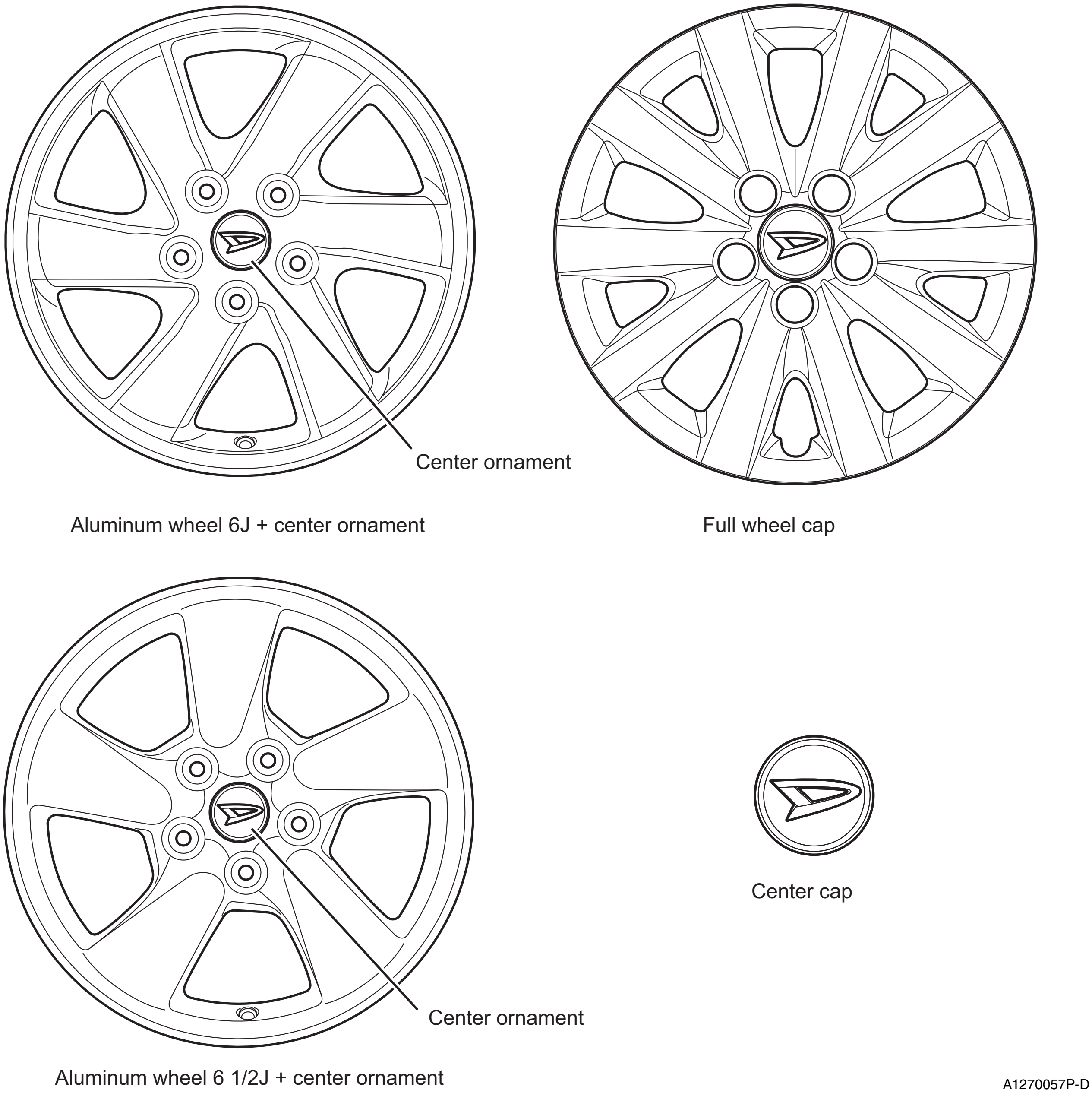


A1270235P-D

Tire and Disk Wheel

- All models are provided with 16 × 6J steel wheels as standard equipment.
- A newly designed aluminum wheel is optionally available for all models.
- A spare tire soft cover is provided as standard equipment for European models, or optionally available for models other than European models.

Tire and disk wheel specifications

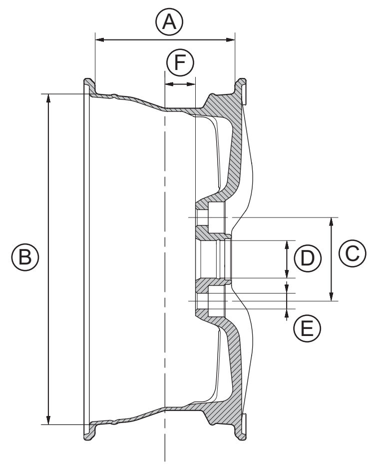


❖REFERENCE❖

●: Standard equipment Δ: Optionally available —: Not available

Destination	Standard tire and spare tire				Spare tire cover
	235/60R 16	215/65R 16			
	16 × 6 1/2J aluminum wheel with center ornament	16 × 6 J aluminum wheel with center ornament	16 × 6J steel wheel with full wheel cap	16 × 6J steel wheel with wheel cap	
Europe	Δ	Δ	Δ	●	●

Destination	Standard tire and spare tire				Spare tire cover
	235/60R 16	215/65R 16			
	16 × 6 1/2J aluminum wheel with center ornament	16 × 6 J aluminum wheel with center ornament	16 × 6J steel wheel with full wheel cap	16 × 6J steel wheel with wheel cap	
Other than Europe	—	Δ	Δ	●	Δ



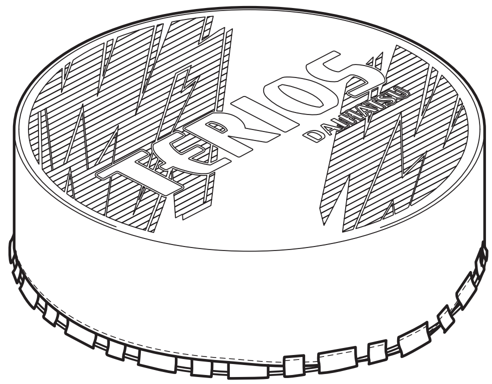
A1270183C-D

Disk wheel dimensions (mm)

	A: Rim width	B: Rim diameter	C: P.C.D.	D: Hub hole diameter	E: Bolthole diameter	F: Amount of offset
16 × 6 1/2J aluminum	165	405.6	114.3	55.6	13	50
16 × 6J aluminum	152	405.6	114.3	55.6	13	50
16 ×6J steel	152	405.6	114.3	66.5	15	50

Spare Tire Cover

- A spare tire cover is provided as standard equipment for European models or optionally available for models other than European models.
- The spare tire cover is a soft type.



Spare tire cover

A1270195P-D

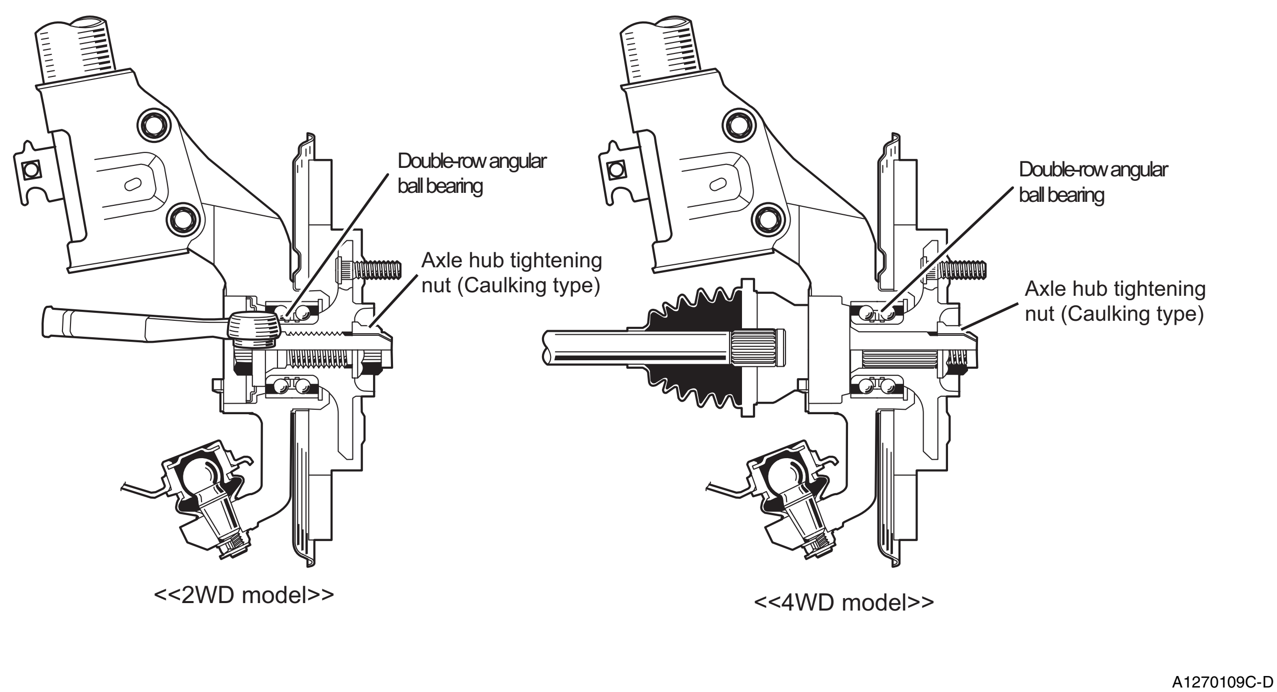
AXLE

Front Axle

- The front axle employs compact double-row angular bearings that are low in rolling resistance and have built-in oil seals.
- The wheel speed sensor uses a semiconductor sensor and a magnet type rotor. The rotor is placed in the axle bearing oil seal.
- Axle hub fastening nuts* are a caulking type. Caulking type nuts are used to reduce the number of parts and increase ease of assembly.

❖REFERENCE❖

* : The axle hub fastening nuts are a caulking type and are not reusable. When removing the nut, release the caulked portion completely before loosening the nut to avoid damage to the threads in the drive shaft.

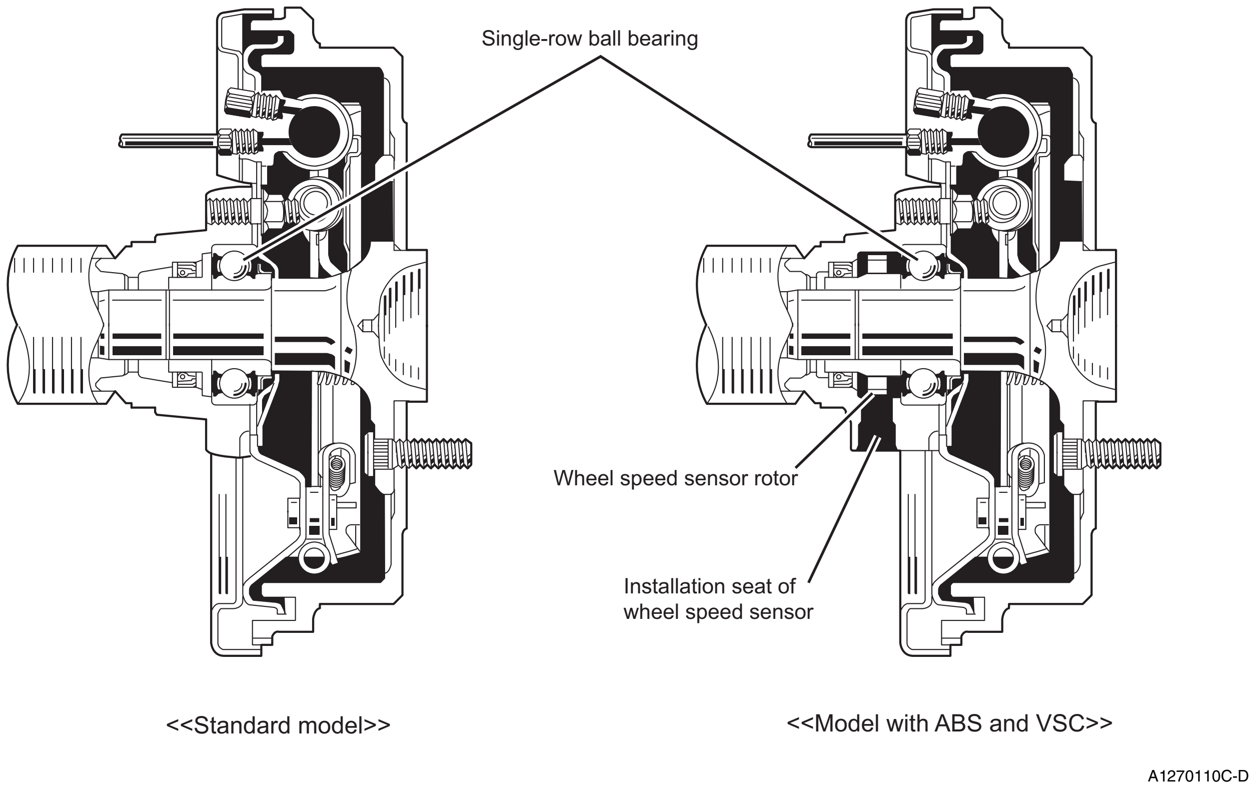


✦ CAUTION ✦

Do not bring any magnetized object in contact with the wheel speed sensor or the rotor, because they use magnets. Also, be careful not to allow foreign objects, including magnetic substances, to adhere to them.

Rear Axle

- Every model employs a semi-floating type axle with double-row ball bearings as wheel bearings.
- The wheel speed sensor rotor is placed in the rear axle shaft. (For ABS-equipped models)


Single-row ball bearing
Wheel speed sensor rotor
Installation seat of
wheel speed sensor
<<Standard model>>
<<Model with ABS and VSC>>
A1270110C-D

TO FOREWORD

BRAKE

BRAKE

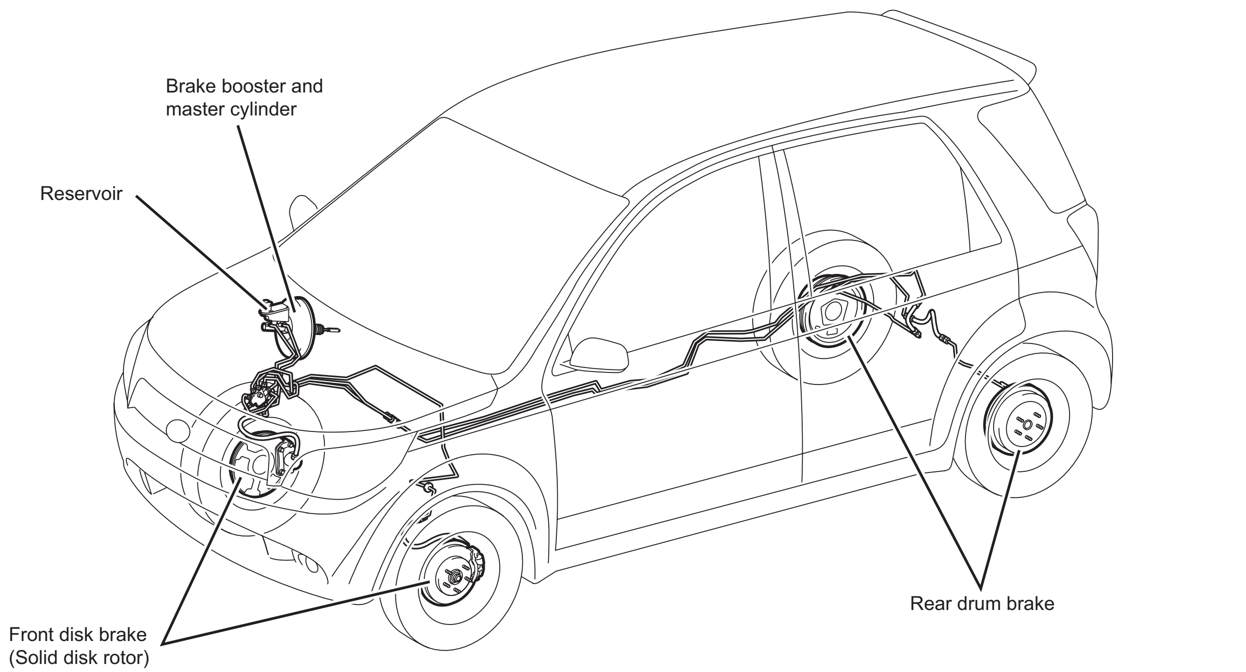
ABS WITH EBD

TRC, VSC AND BRAKE ASSIST DEVICE

BRAKE

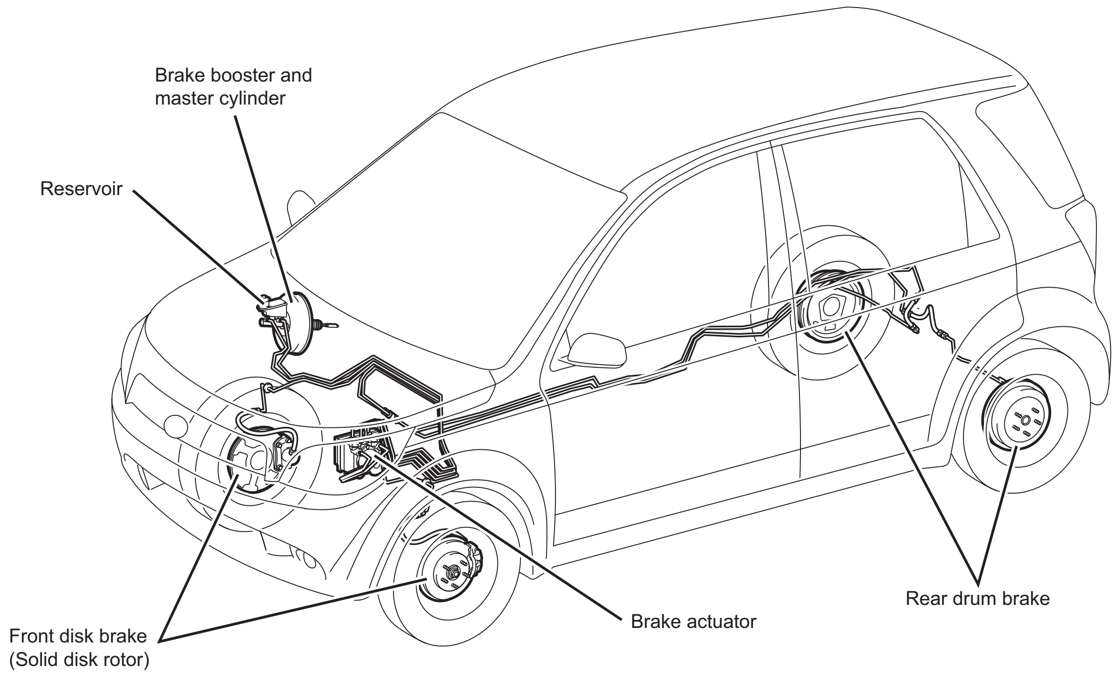
Outline of Brakes

- The brake system employs disk brakes for the front wheels and drum brakes for the rear wheels.
- All European models are equipped with an ABS system with EBD and a mechanical brake assist mechanism using a brake booster. An electronically controlled brake assist system, a TRC system and a VSC system are optionally available for 4WD A/T models.
- Models other than European models are provided with a mechanical brake assist mechanism as standard equipment and an ABS system with EBD as an option.
- All models except TRC- and VSC-equipped ones employ 15-inch disk brakes for the front wheels, and TRC and VSC-equipped models employ 16-inch disk brakes.
- Models equipped with an ABS system with EBD can optionally be provided with 16-inch disk brakes.

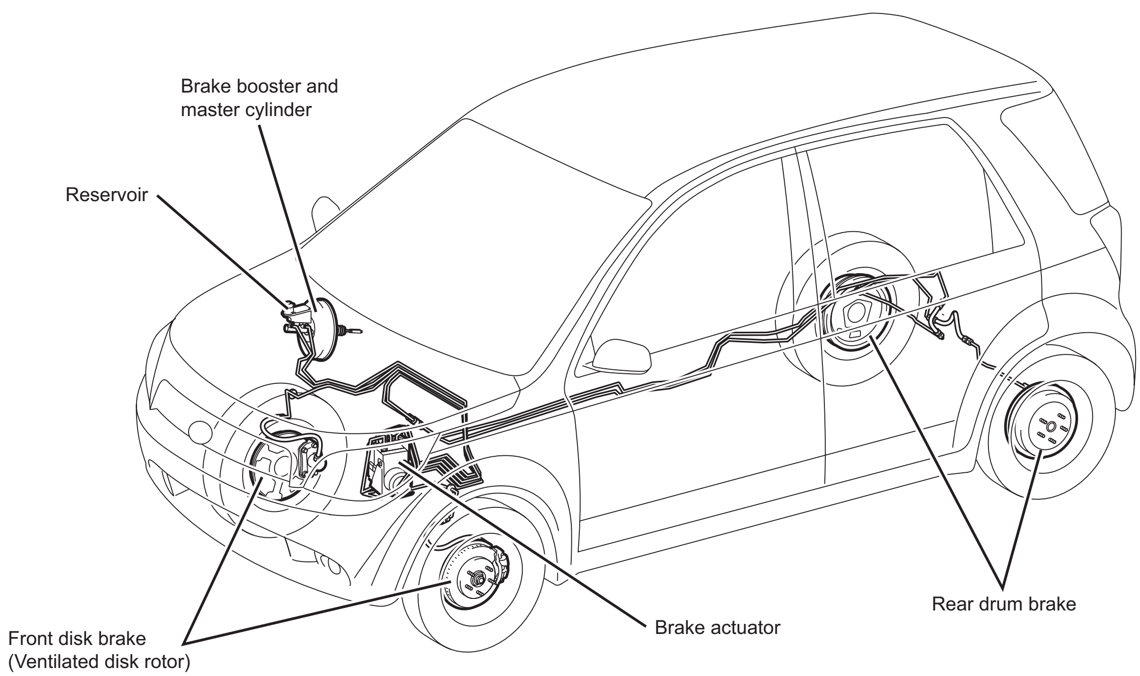


<<Standard Model>>

Brake piping



Model with ABS



Model with VSC and Model with ABS and 16-inch disk brake

A1270086C-D

Brake master cylinder specifications

	Standard model and model with ABS	Model with VSC
Type	P*1 + L*2	P + P
Bore diameter [mm]	22.2	←

	Standard model and model with ABS	Model with VSC
Piston stroke [mm]	15.0 + 17.0	14.6 + 17.0

❖REFERENCE❖
*1 : Port-less
*2 : Conventional

Brake booster specifications

	Standard model and model with ABS	Model with VSC
Type	Vacuum-assisted	←
Size	Single 10"	←

Front brake specifications

	Standard model and model with ABS	Model with VSC
Caliper type	FS16K	FS16U
Cylinder bore diameter [mm]	54.0	←
Disk rotor [mm]	Solid	Ventilated
Rotor size (O.D. × T) [mm]	273.0 × 16.0	287.0 × 22.0
Brake pad size (L × W × T) [mm]	104.0 × 45.5 × 10.0	←
Brake pad surface area [cm^2]	40	←

Rear brake specifications (Common to all models)

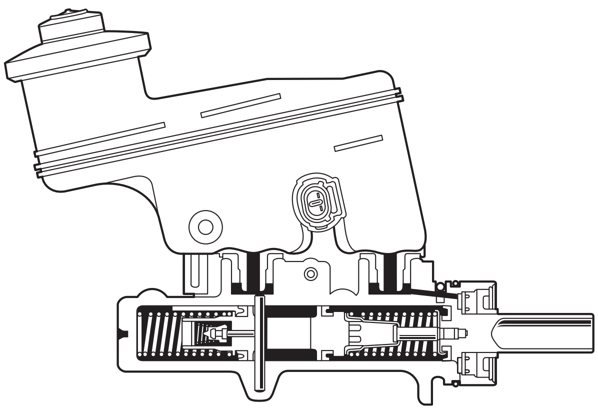
Type	Leading-trailing
Cylinder bore diameter [mm]	19.0
Drum inside diameter [mm]	228
Lining size (L × W × T) [mm]	219.0 × 35.0 × 5.0
Lining surface area [cm^2]	76.0

Parking brake specifications

	M/T model	A/T model (Japanese model)
Type of operation	Hand-operated	Foot-operated
Type [mm]	Mechanical wheel braking	←
Drum inside diameter [mm]	Shared with main brakes	←
Lining size (L × W × T) [mm]	Shared with main brakes	←
Lining surface area [cm^2]	Shared with main brakes	←

Brake Master Cylinder and Reservoir

- All models employ a reservoir-integrated tandem master cylinder 22.2 mm in bore diameter.
- All models except models with VSC employ a P+L type (port-less + conventional) master cylinder, and models with VSC employ a P+P (port-less + port-less) type master cylinder.



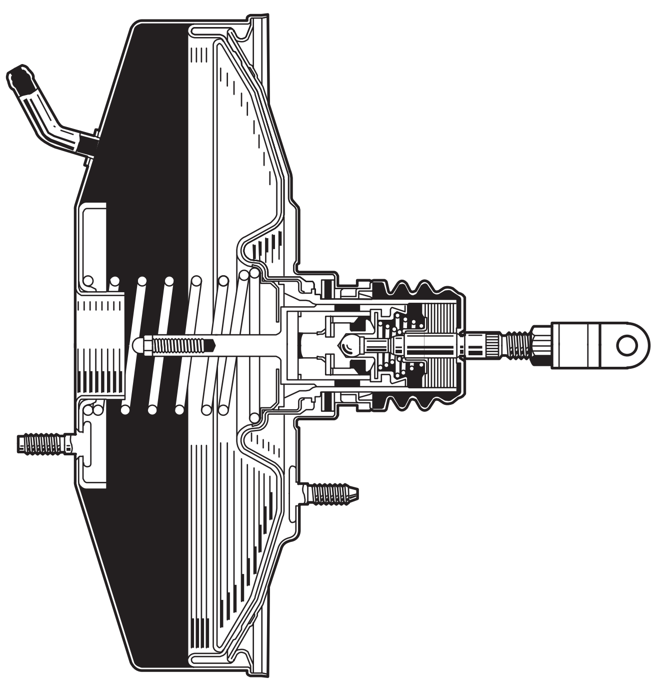
L + L type

P + P type (Model with VSC)

A1270087C-D

Brake Booster

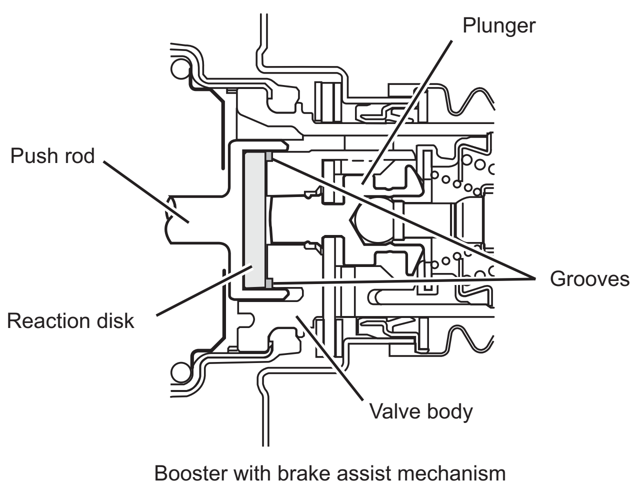
- All models employ a 10-inch single type vacuum-assisted brake booster.
- A brake booster with a mechanical brake assist mechanism is employed. In emergency braking, for example, the panicked driver may not be able to fully slam on the brakes, even though he or she can quickly hit the brakes. There are also cases when the driver cannot hold the brake pedal down, even though he or she can slam on the brakes. In such cases, the brakes of the vehicle cannot fully deliver their performance. If the brake pedal effort exceeds a certain level, however, the brake booster with a brake assist mechanism further increases the extra brake force boosted by the booster itself, in order to enable the brakes, including the ABS system, to deliver higher performance in the event of an emergency.

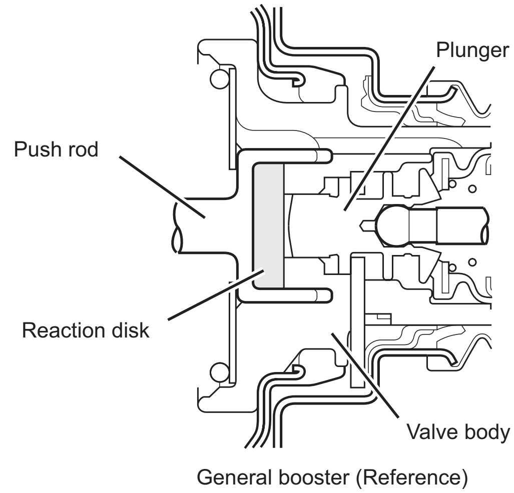


A1270093C-D

Structure of the Brake Booster with Mechanical Brake Assist Mechanism

• In the vacuum-assisted brake booster, the force produced by the difference in pressure between the front and rear chambers in the valve body when the valve body directly pushes the reaction disk is transmitted to the push rod. In conventional brake boosters, the contact surface between the valve body and the reaction disk is flat, except for the section where the plunger is placed. By contrast, a brake booster equipped with a brake assist mechanism has a grooved valve body. Other sections have the same structure as ordinary brake boosters.





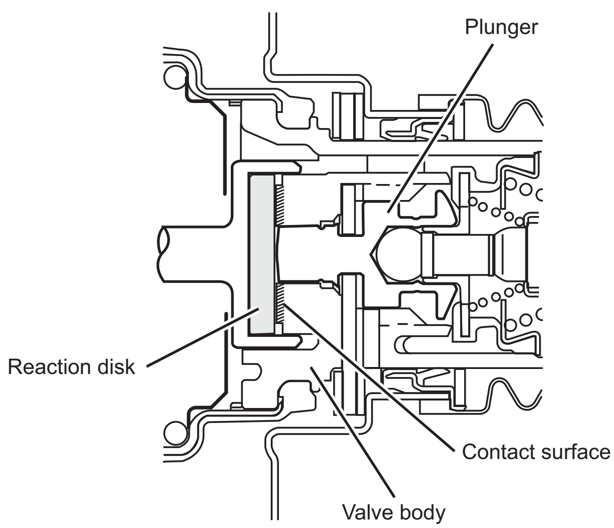
A1270088C-D

Operation of Brake Booster with Mechanical Brake Assist Mechanism

- Servo ratio is a brake booster characteristic. The term servo ratio refers to the ratio of the increase in input to the increase in output, and a brake booster with a higher servo ratio produces a higher output at the same level of input. Servo ratios vary according to the areas of the surface on which the valve body and the reaction disk are in contact with each other and of the surface on which the plunger and the reaction disk are in contact with each other, and therefore the servo ratio increases with increase in the contact area on the valve body side with respect to that on the plunger side. If the brake pedal effort reaches a certain level, the brake assist mechanism adopted this time increases the servo ratio in order to produce more brake force for emergency braking.

Normal braking

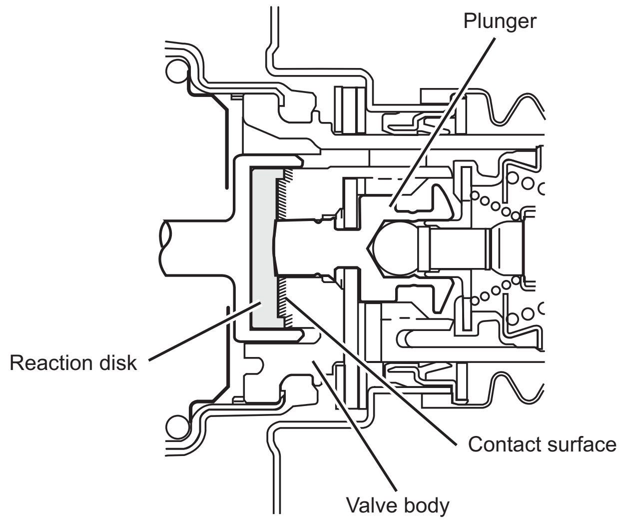
In normal braking, the plunger is in contact with the reaction disk through the end face of the plate, and the valve body through the plane except the grooved portion in the outer region.



A1270089C-D

Assisted braking

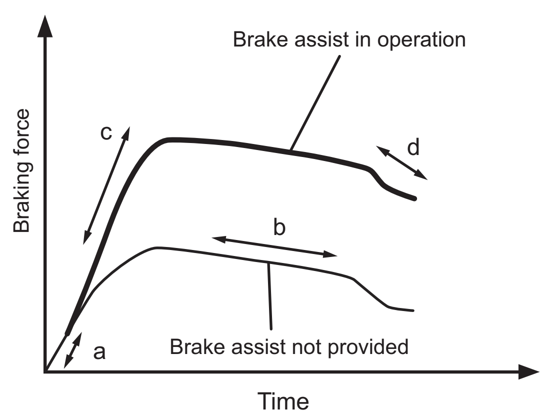
If hitting the brake pedal in an emergency generates more force than that required for normal braking, the reaction disk deforms to block the grooves in the valve body. In contrast with normal braking, this increases only the area of the surface in contact with the valve body, with the result that the ratio of the contact area on the valve body side to the contact area of the plate on the plunger side increases and the servo ratio increases accordingly. For this reason, this brake booster can produce a higher output than a conventional brake booster.



A1270090C-D

Concept of Brake Assist

- In an emergency, a panicked driver may be able to hit the brake pedal quickly enough but not hard enough to generate the required brake force. (a in the figure)
- A driver in such a situation may not be able to hold down the brake pedal long enough to produce the necessary brake force. (b in the figure)
- The brake assist mechanism helps in such situation by assuming that a quick stab at the brake pedal means the driver wishes to stop the vehicle at once and generates sufficient brake force, even if he or she does not fully slam on the brakes. (c in the figure)
- If the driver then eases off the brakes intentionally, the brake assist mechanism reduces the extra brake force produced by the booster so that the driver can do it without feeling something is wrong with the brakes. (d in the figure)



A1270161C-D

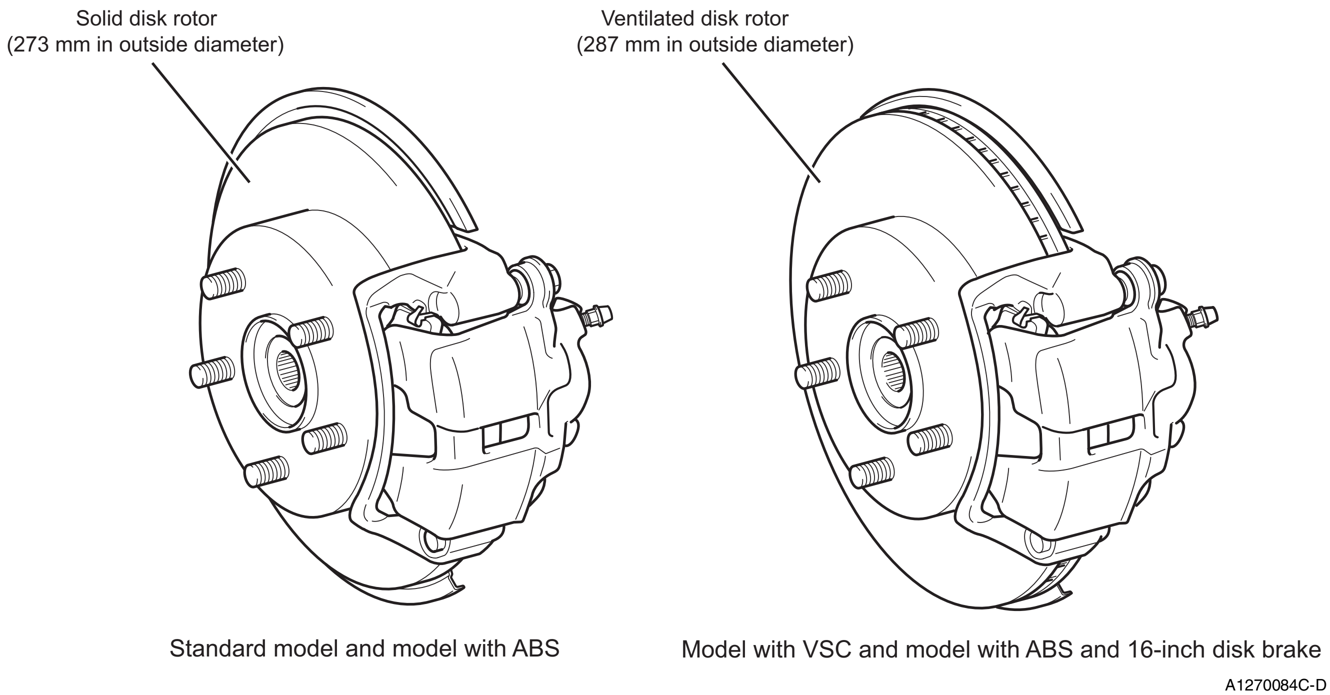
Caution on Brake Assist

- The brake assist mechanism is not a system that enables the brakes to deliver higher performance than they actually possess. For safe driving, therefore, pay careful attention to vehicle speed and the distance between your car and the one ahead.
- The brake assist mechanism operates if the driver slams on the brakes to stop his or her car at once, but does not make its presence known

at other times. conditions.

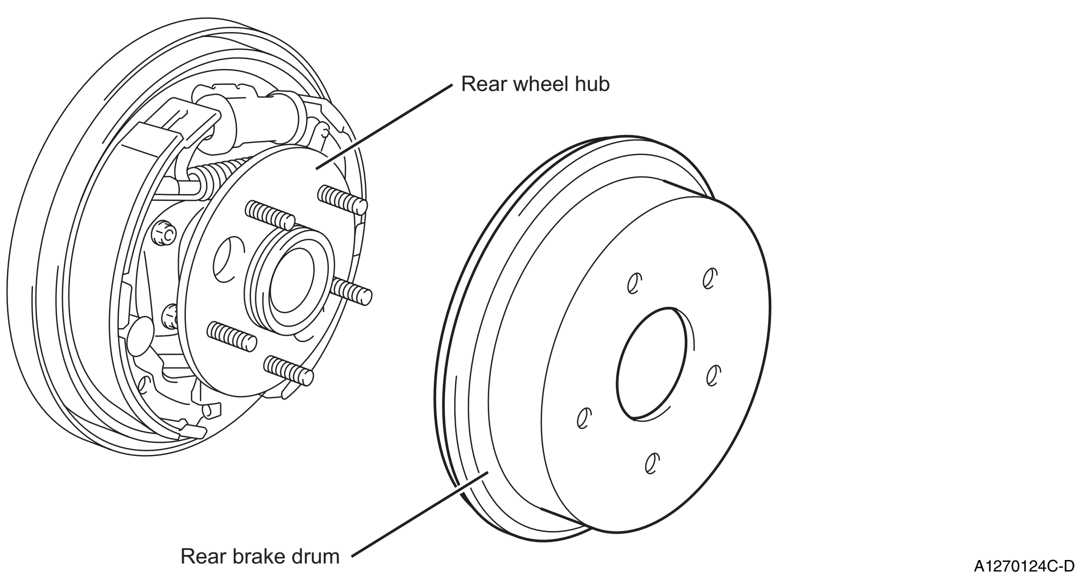
Front Brake

- All models are equipped with disk brakes.
- All models except models with VSC are provided with solid disk rotors 273 mm in outside diameter as standard equipment. Models with VSC employ ventilated disk rotors 287 mm in outside diameter.



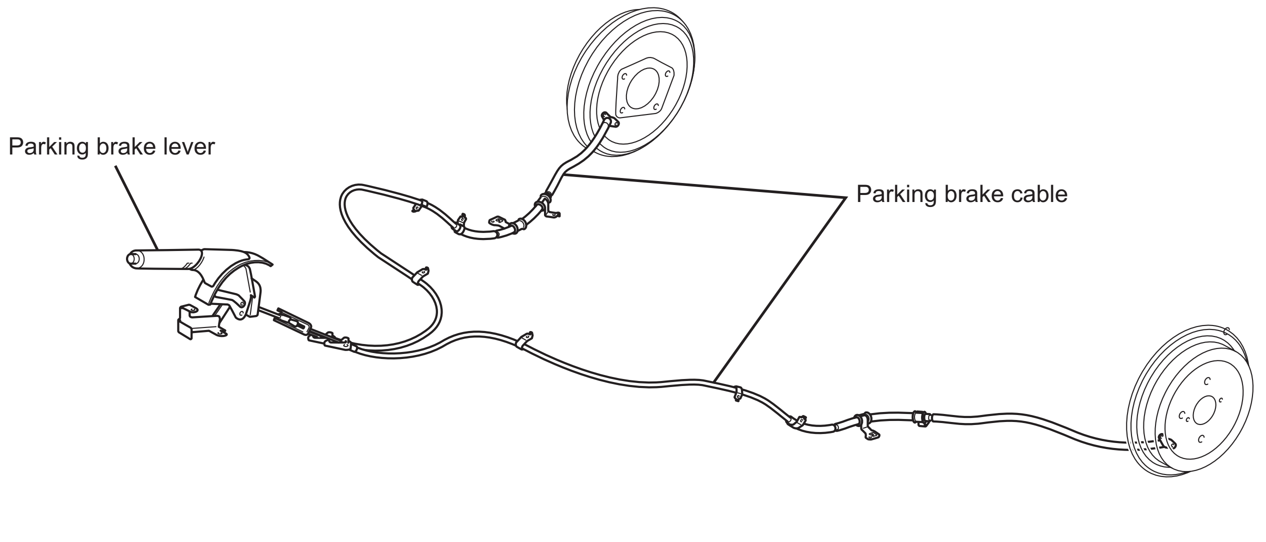
Rear Brake

- All models are equipped with leading-trailing type drum brakes. The brake drum 228 mm in inside diameter is so constructed that it can be separated from the wheel hub.



Parking Brake

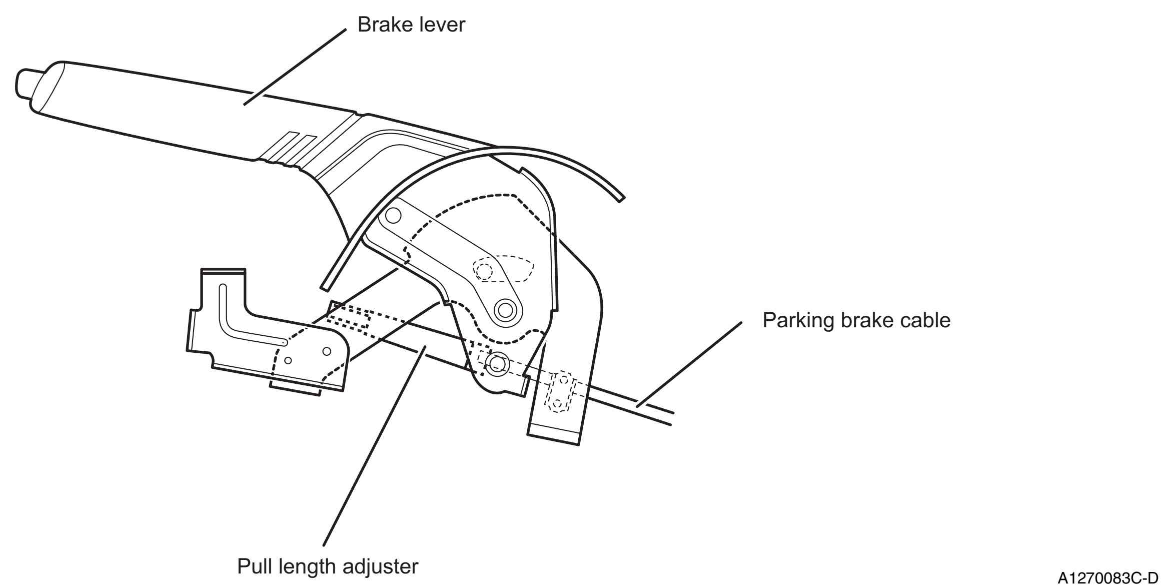
- A center lever-operated parking brake is employed. All models are equipped with a leading-trailing type rear two-wheel braking parking brake, which is also used as a rear brake.



<<Center lever-operated parking brake>>

Structure of Hand-Operated Parking Brake

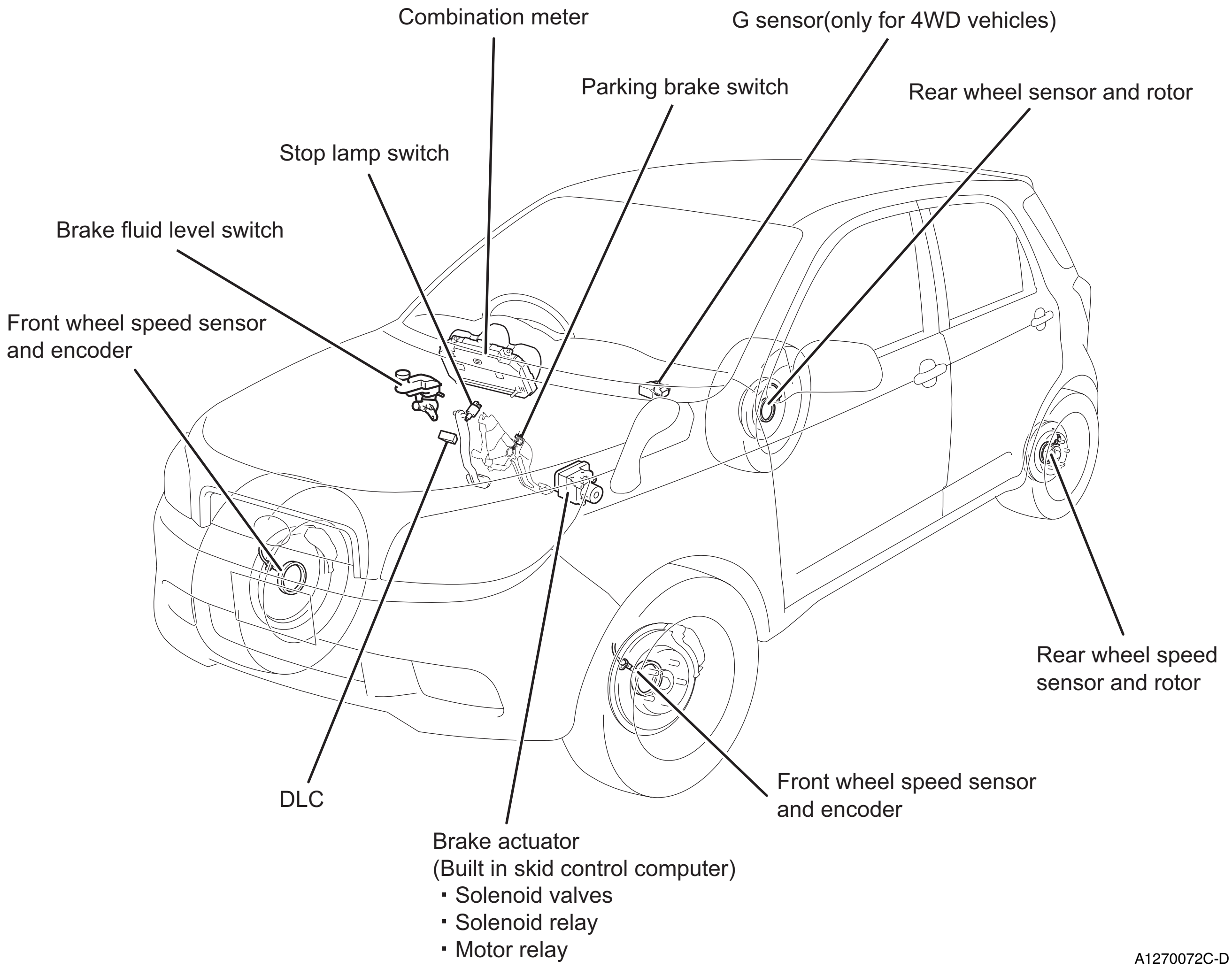
- The center lever-operated parking brake is so constructed that pulling up the parking brake lever activates the parking brake and pressing the release button releases the brake.
- An adjuster for adjusting the travel of the parking brake lever is placed in the lower section of the parking brake lever.



ABS WITH EBD

Outline of ABS with EBD

- EBD(Electronic Brake Force Distribution : An ABS system with EBD (Electronic Brake Force Distribution) is provided for every model. (EC)
- An ABS system with EBD is available as a maker option for every model. (For models other than Japanese and European models)
- In the event of a failure, the fail-safe function turns on the warning lamp to inform the driver, and the diagnosis (self-diagnosis) function shows the service person the location where the failure occurred.



Principal system components and their functions

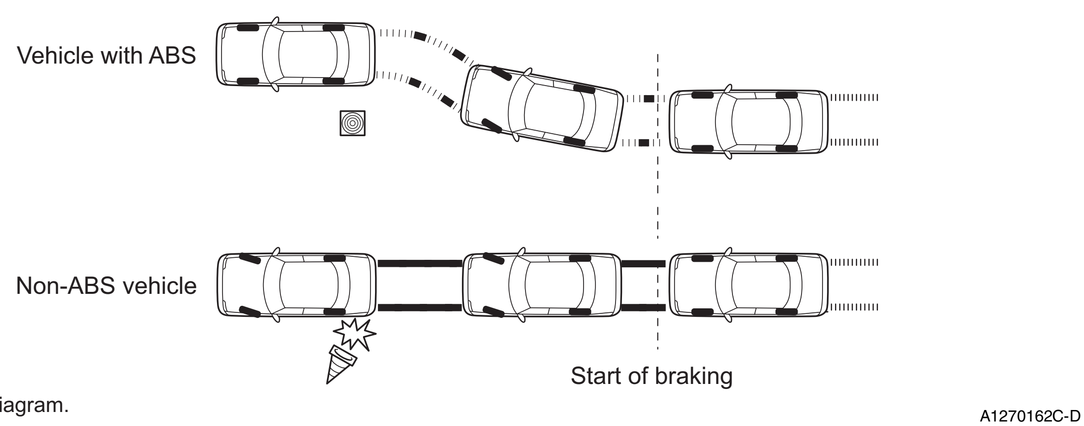
Components	Functions
Wheel speed sensor and encoder	Senses the rotational speed of each of the four wheels and transmits it to the skid control computer.
Stop lamp switch	Checks the operating status of the brakes and transmits it to the skid control computer.
Combination meter	Each warning lamp placed in the combination lamp warns the driver of the occurrence of a system failure.

Components	Functions
Brake actuator	Signals from the skid control computer regulate the hydraulic pressure in each brake cylinder.
Solenoid relay (built into the brake actuator)	Supplies power to the solenoid valves in the brake actuator.
Motor relay (built into the brake actuator)	Supplies power to the pump motors in the brake actuator.
Skid control computer (built into the brake actuator)	The skid control computer processes signals from each sensor and sends control signals to the brake actuator to control the braking operation of the ABS system.
G sensor (provided only for 4WD vehicles)	Senses the longitudinal deceleration of the vehicle and transmits it to the skid control computer.
Parking brake switch	Checks the operating status of the parking brake.
Brake fluid level switch	Checks the brake fluid level.
DLC	With the diagnosis tool connected to this, diagnosis codes and data can be read out of the computer.

ABS with EBD

Description

- In order for a vehicle to run, turn and stop, it is absolutely necessary for the tires to properly perform its function of gripping the road. However, if the brakes are slammed on or they are applied on a slippery road, such as a snowy road or wet road, the wheels may lock while the vehicle is still running, causing the tires to slip. To prevent this, the ABS (Antilock Brake System) determines the wheel speed when the brakes are applied in such a situation, and uses a computer to regulate the brake fluid pressures of all the four wheels. ABS can be defined as a system for keeping the steering system controllable and the vehicle stable by preventing wheel lockup and ensuring high braking performance.
- In addition to conventional ABS system functions, this ABS system also provides an EBD function to enable proper control of the brake forces to the front and rear wheels and to the right and left wheels to ensure excellent braking performance, irrespective of the change in loading condition.

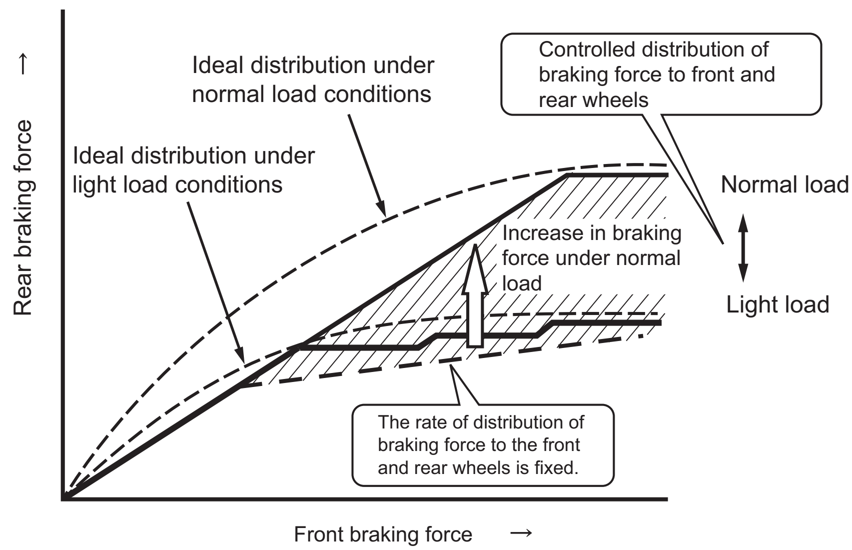


* This is a conceptual diagram.

Front/Rear Braking Force Distribution Control

- Front/rear brake force distribution control aims at redistributing brake force properly between the front and rear wheels according to the driving conditions of the vehicle to ensure that the brakes perform their basic function of bringing the vehicle to a complete stop.

• This control ensures effective use of the brake force to the rear wheels as required by changes in vehicle weight caused by loading or deceleration, and also reduces brake pedal work while ensuring excellent braking performance, especially when the vehicle is heavily loaded.



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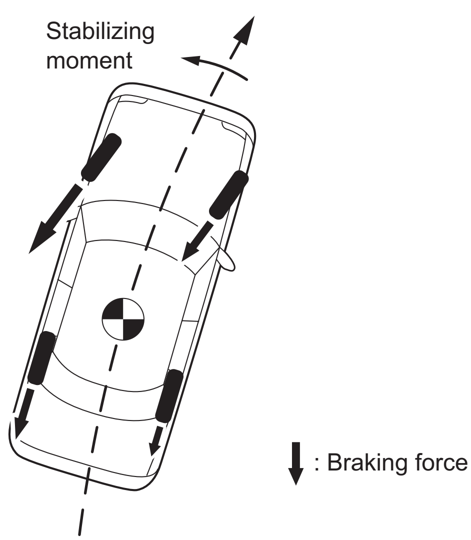
Right/Left Braking Force Distribution Control

• Left/right brake force distribution control ensures vehicle stability during braking and excellent braking performance by controlling the brake forces to the left and right wheels when the brakes are applied during cornering.



* This is a conceptual diagram.

A1270164C-D

Caution on ABS with EBD

• The ABS system is not a system that enables the tires to deliver higher performance than the actual ability of the tires. For safe driving, always pay careful attention to vehicle speed and the distance between your car and the one ahead.
• Mounting tires other than the specified ones, for example, tires of a different size adversely affects ABS control.
• When starting the engine for the first time, you may hear the operating noise of the motor. This noise is produced because of an initial check and does not indicate that something is wrong with your vehicle.
• During the initial check, the brake pedal may feel somewhat heavy, but that does not mean that the brake pedal is faulty.

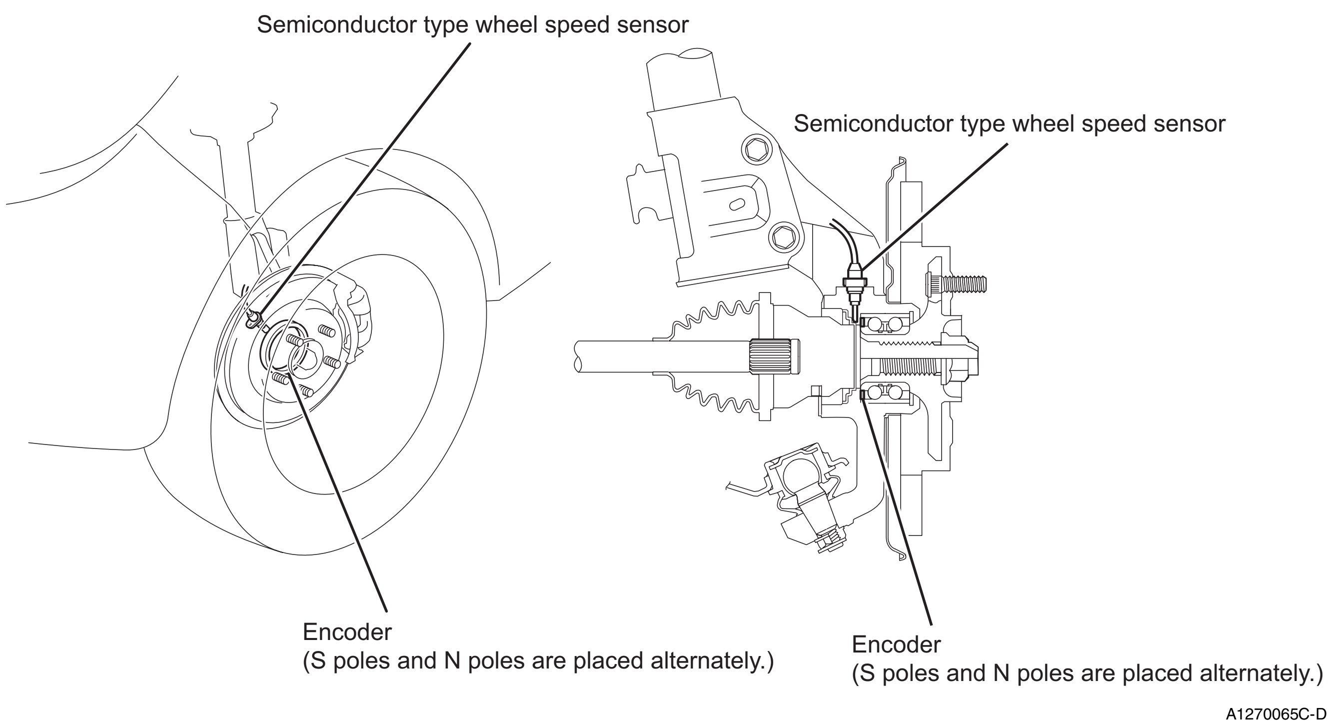
- The braking distance of a vehicle with ABS may be longer than that of a non-ABS vehicle if it is activated under the following conditions.

Conditions

When driving on a gravel road or road covered with fresh snow
When tire chains are put on
When running over a bump, such as a joint in the road
When driving on a rough road, such as an uneven road or stone-paved road

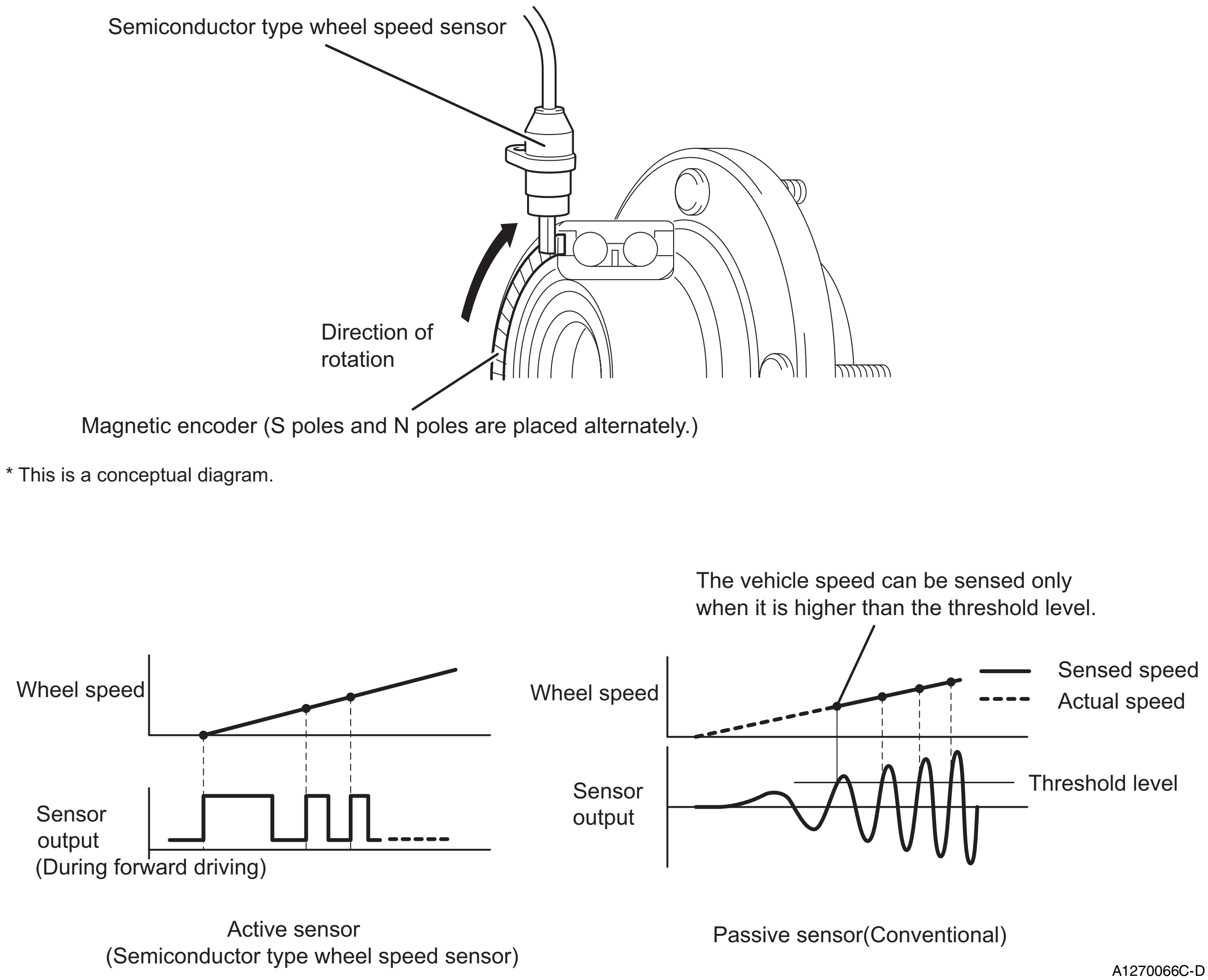
Front Wheel Speed Sensor and Encoder

● A semiconductor wheel speed sensor is mounted in each steering knuckle, and an encoder is mounted in the outer region of the inner lace of each hub bearing.



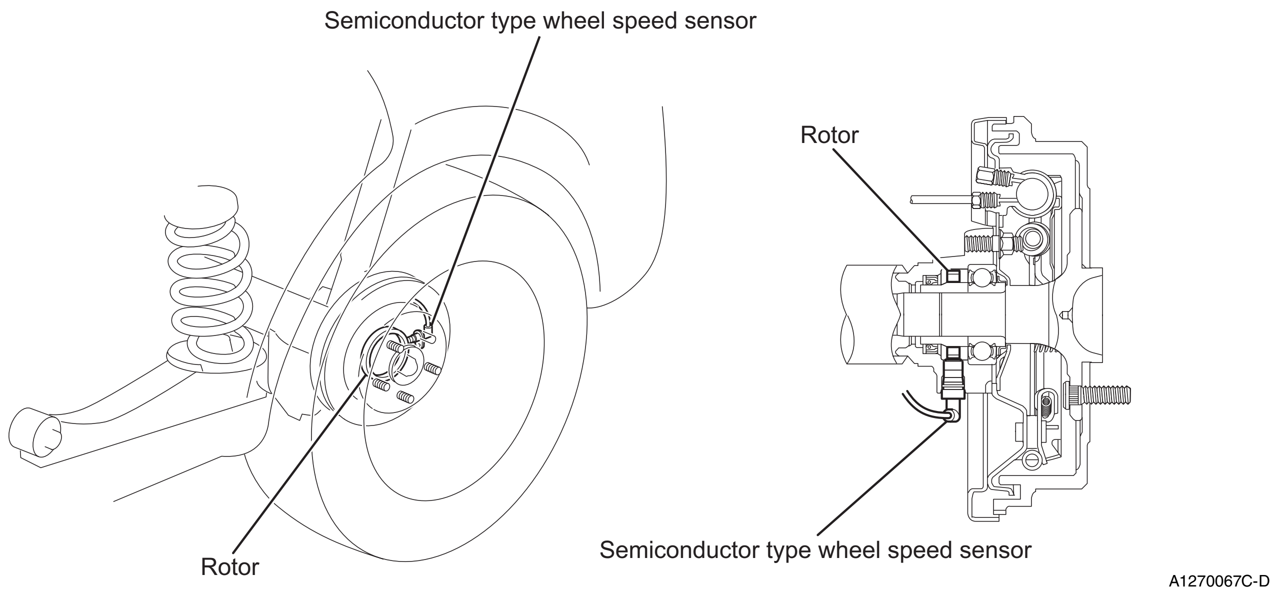
Principle of Sensing

- Made of rubber containing magnetic particles, the magnetic encoder has equally spaced N and S poles (48 each) around the circumference.
- An active sensor senses changes in the magnetic field caused by the rotation of the magnetic encoder and transmitted as a wheel speed pulse.
- Unlike conventional passive sensors, active sensors are cable of sensing magnetic field changes at vehicle speeds from around 0 km/h.



Rear Wheel Speed Sensor and Rotor

- A rear wheel speed sensor and a sensor rotor are press-fitted in each rear axle housing and each rear axle shaft, respectively. The principle of sensing the wheel speed is basically the same as that of the front wheel speed sensor.

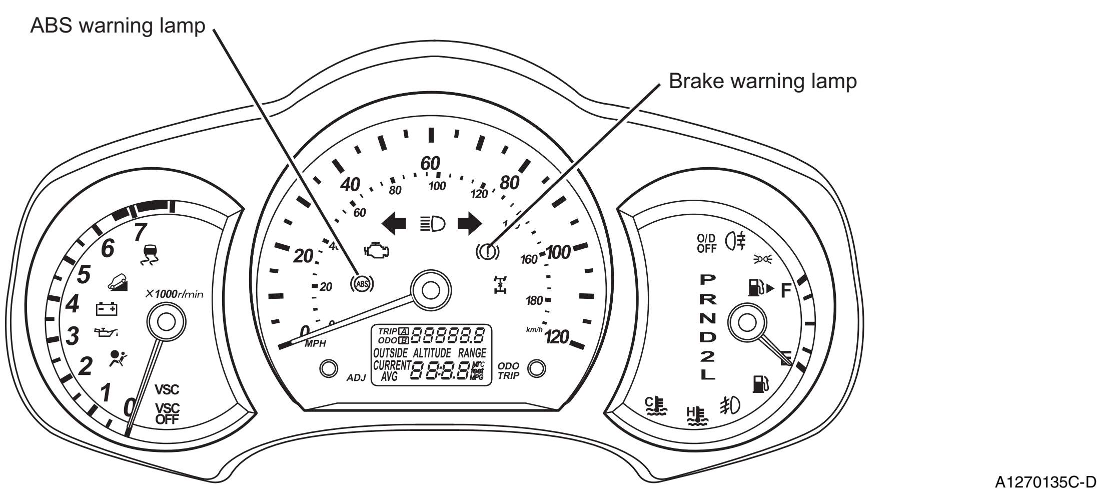


Stop Lamp Switch

- This switch detects brake signals.

Warning Lamp and Indicator

- The warning lamps are placed in the combination meter.
- If a system failure occurs, the warning lamp for the failed system comes on to warn the driver of the failure. When the ignition switch is turned on, the warning lamps come on for an indicator check and go out after 3 seconds.



Functions of warning lamps

Brake warning lamp	Comes on when the parking brake is applied under normal conditions and when the amount of brake fluid has decreased to a certain level. In the event of a failure that prevents not only the ABS but also the EBD from functioning, this warning lamp also comes on along with the ABS warning lamp to warn the driver.
ABS warning lamp	Comes on to warn the driver that the ABS system has failed. In diagnosis mode, this warning lamp indicates a diagnosis code by blinking.

G (Acceleration of Gravity) Sensor

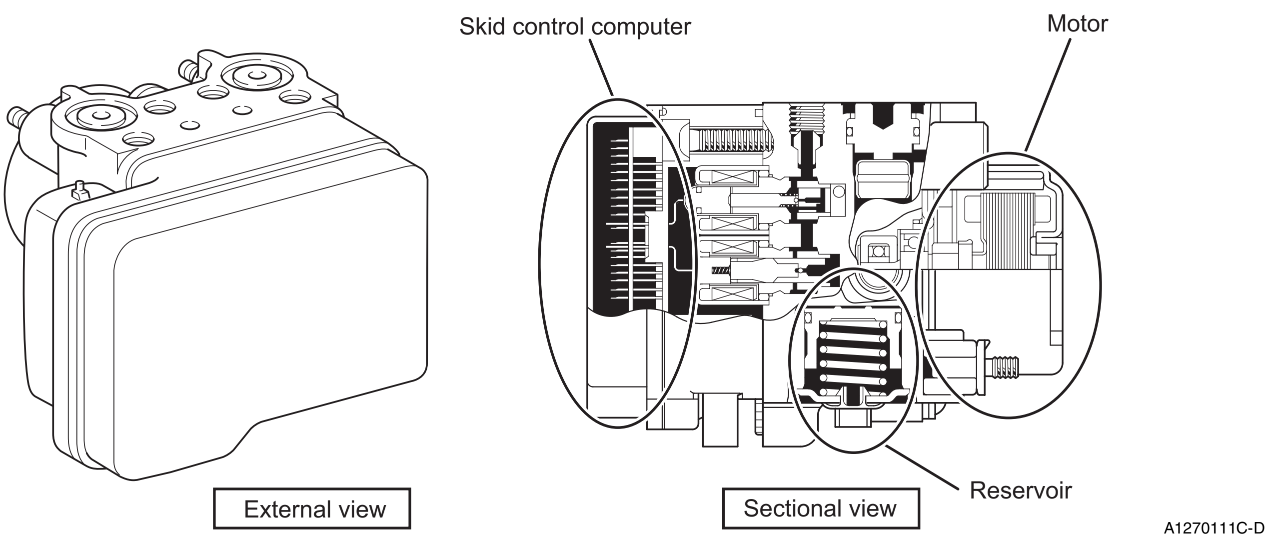
- Since all four wheels are directly driven in a 4WD vehicle, an ABS system based solely on wheel-speed control may not provide stable braking in such a vehicle. To improve stability and ensure optimum braking performance, a G sensor senses deceleration to control the operation of the ABS system properly. The G sensor is mounted under the driver's seat.

Parking Brake Switch

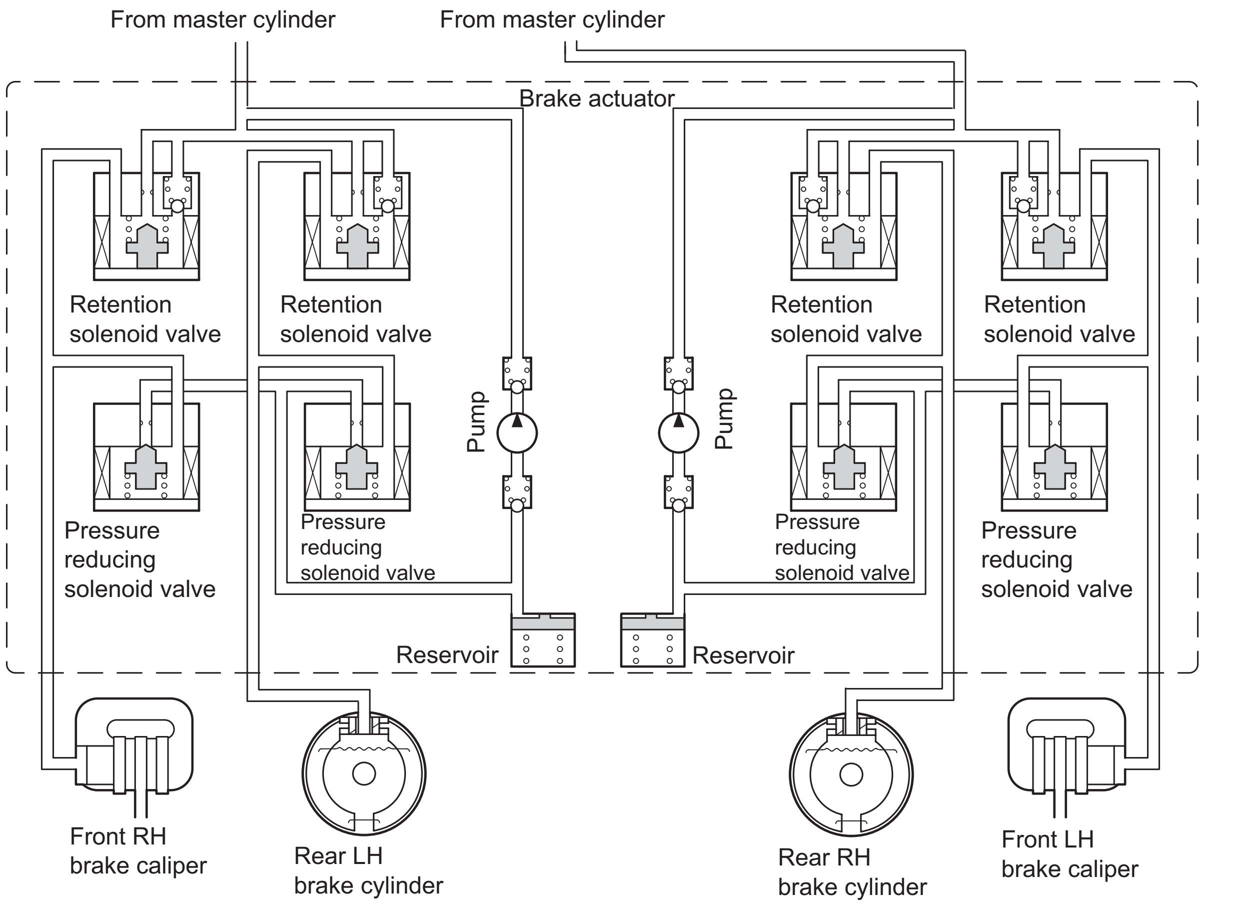
- This switch detects the operating status of the parking brake. When the parking brake is applied, it turns on and sends a signal to the skid control computer, which, in turn switches on the brake warning lamp.

Brake Actuator

- The brake actuator consists of retention solenoid valves, pressure reducing solenoid valves, pumps, reservoirs, etc. and regulates the brake fluid pressure in each brake cylinder.
- The brake actuator and the skid control computer are combined in one unit to make them smaller in size and lighter in weight.



Hydraulic circuit



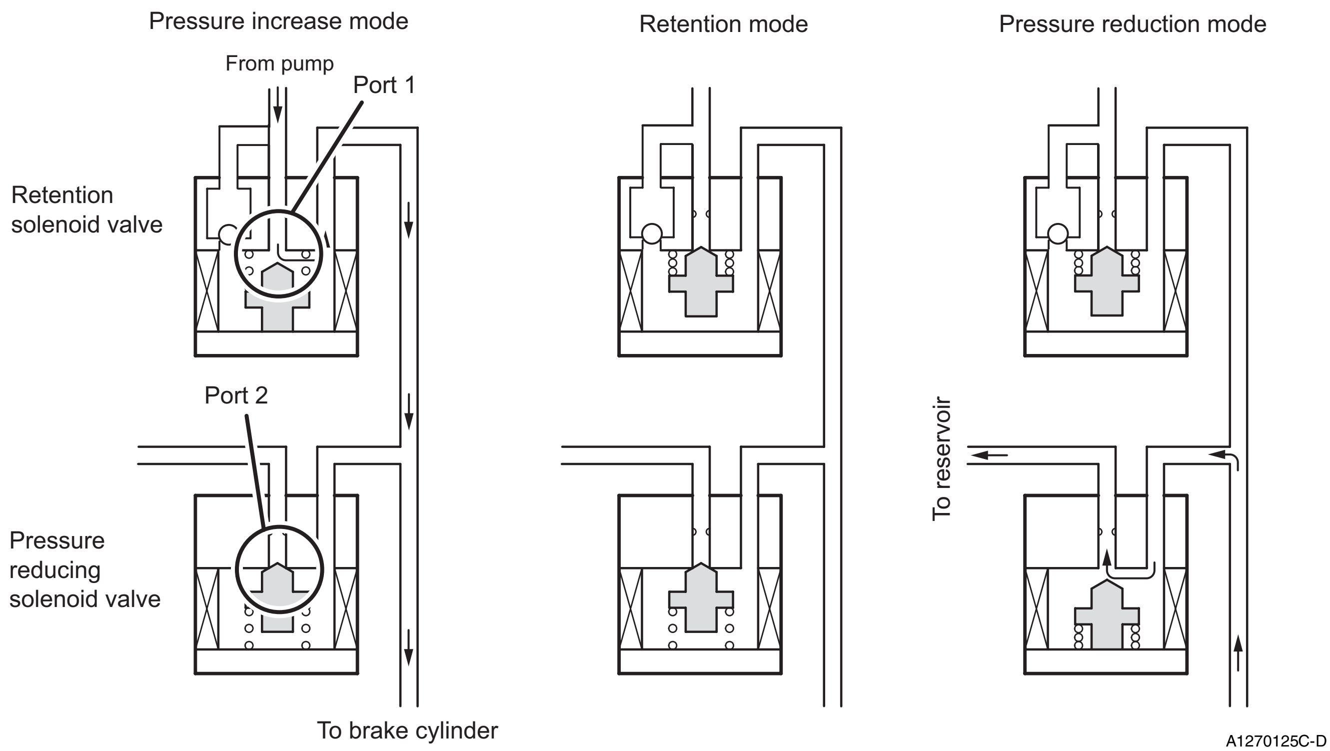
When deactivated (All input signals OFF)

Pressure Retention/Reduction Solenoid Valve

- The brake actuator operates two solenoid valves under the control of signals from the skid control computer to switch the brake hydraulic circuit among 3 modes: pressure reduction, retention and pressure increase modes.

Operation of ABS with EBD

- The brake actuator controls the hydraulic pressure to each of the four wheels using retention solenoid valves, pressure reducing solenoid valves, pumps and reservoirs.



Control operation

When not activated	Normal braking	—	—
When activated	Pressure increase mode	Retention mode	Pressure reduction mode
Retention solenoid valve	OFF	ON	←
Power reducing solenoid valve	OFF	←	ON
Port 1	Open	Closed	←
Port 2	Closed	←	Open
Hydraulic pressure in brake cylinder	Increase the hydraulic pressure	Retain the hydraulic pressure	Reduce the hydraulic pressure

ABS Solenoid Relay

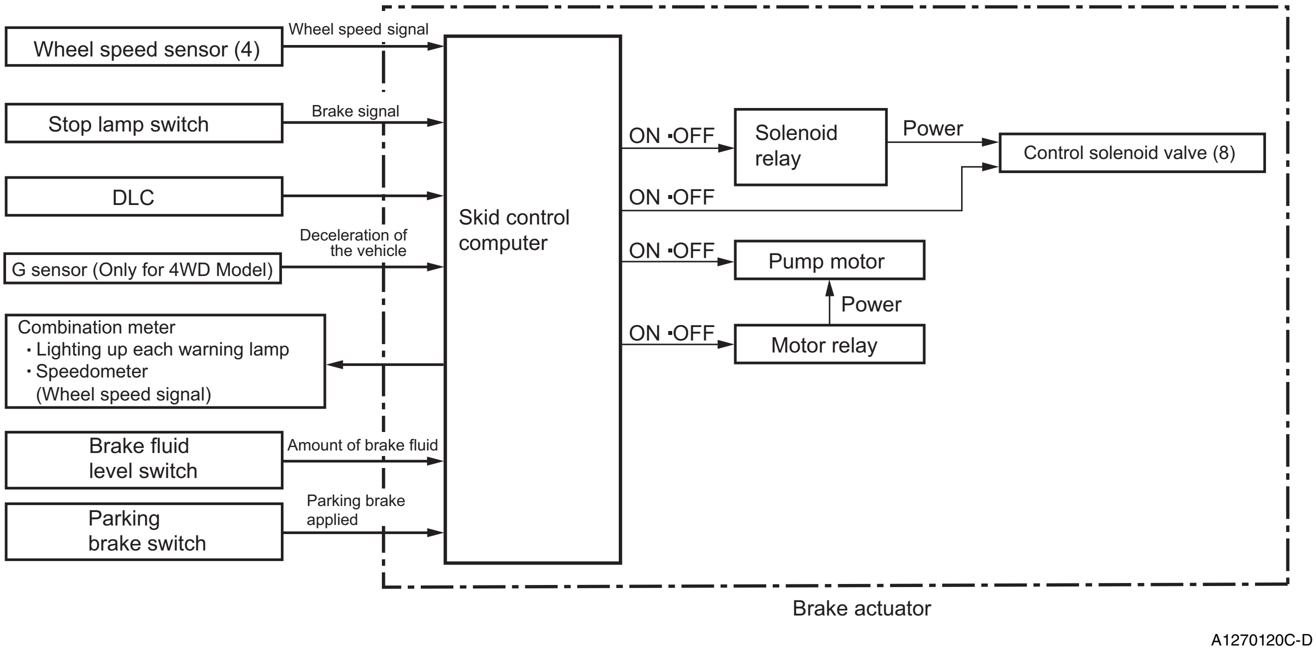
- This relay supplies power to the solenoid valves in the brake actuator.

ABS Motor Relay

- This relay supplies power to the pump motors in the brake actuator.

Skid Control Computer

- The computer processes wheel speed signals from each wheel speed sensor and sends operation signals to the brake actuator to let it control the brakes according to road conditions.



Fail-Safe Function

- If the skid control computer or the brake actuator fails, the fail-safe function turns on the ABS warning lamp and blocks the activation of the ABS system and the brake assist system. In the event of a failure that prevents the EBD from functioning normally, this function also turns on the brake warning lamp and blocks the activation of the EBD.

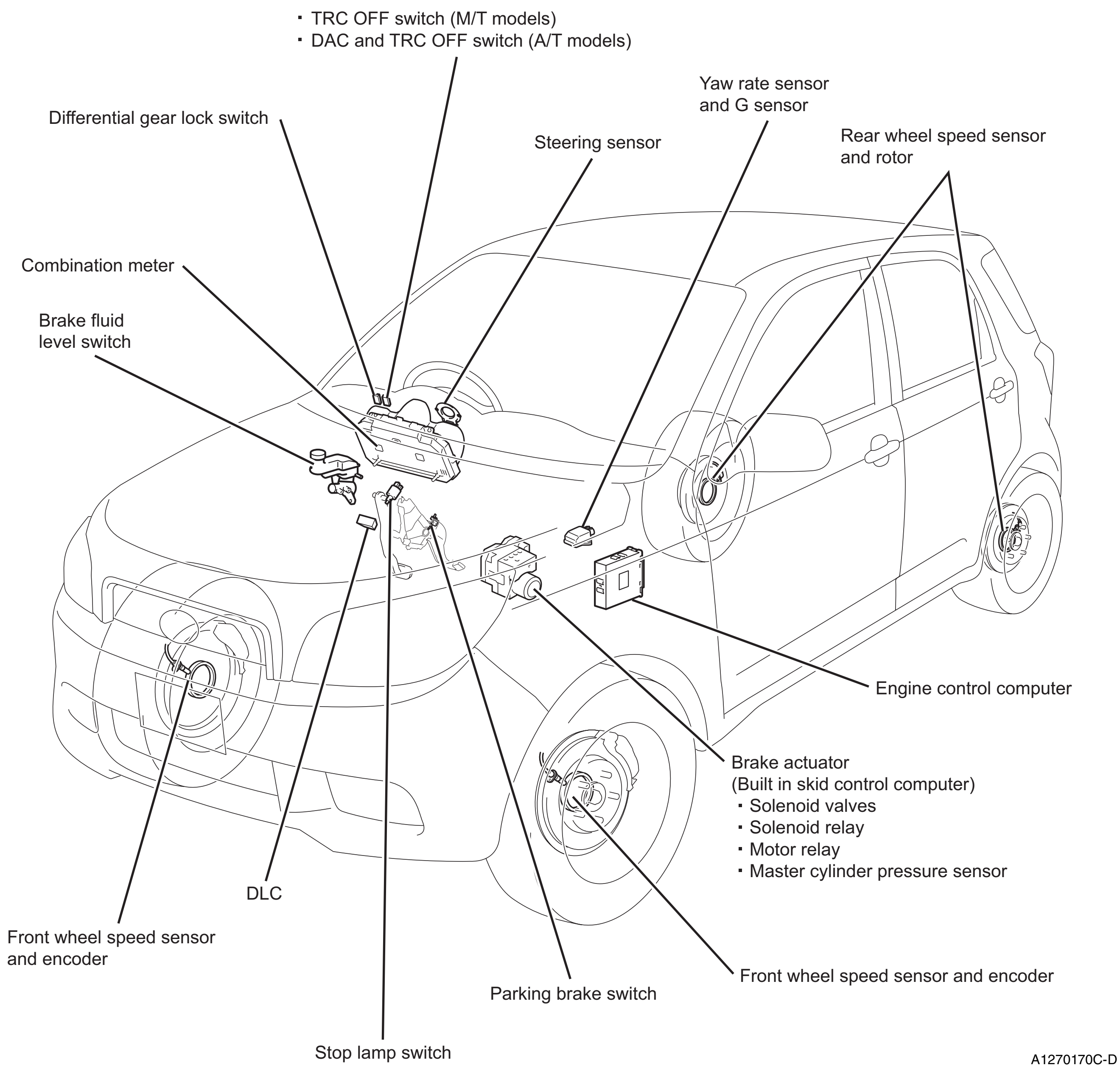
Diagnosis Function

- A diagnosis function has been added to facilitate servicing. For more information about this function, refer to the service manual.

TRC, VSC AND BRAKE ASSIST DEVICE

Outline of TRC, VSC and Brake Assist Device

- The skid control computer processes signals from each sensor and controls the braking operations of the ABS, TRC, VSC and brake assist mechanism.
- The skid control computer, which is incorporated in the CAN communications system, communicates with the engine control computer, steering sensor, yaw rate sensor, G sensor and DLC through the CAN network.
- Every A/T vehicle with VSC is equipped with a hill start assist control system and a downhill assist control system (DAC) so that it can start and roll down stably and smoothly even on a steep hill.



Principal components and their functions

Components	Functions
Wheel speed sensor (semiconductor type)	Senses the wheel speed and transmits it to the skid control computer.
Ignition switch	Supplies power to the skid control computer.
Yaw rate sensor and G sensor	Determines the yaw angle, angular velocity (rotating velocity) and longitudinal and lateral decelerations of the vehicle body and transmits them to the skid control computer.
Parking brake switch	Checks the operating status of the parking brake and transmits it to the skid control computer.
Stop lamp switch	Checks the operating status of the brakes and transmits it to the skid control computer.
Steering sensor	Determines the steering angle and the steering direction and transmits them to the skid control computer through the CAN network.
TRC OFF switch	Turning off this switch stops the operation of the TRC.
Master cylinder pressure sensor	Senses the pressure in the master cylinder and transmits it to the skid control computer.
Combination meter	The slip indicator lamp, brake warning lamp, ABS warning lamp, VSC warning lamp and VSC OFF lamp are placed in the combination meter.
Brake actuator	Regulates the hydraulic pressure in the brake cylinder on each of the four wheels under the control of signals from the skid control computer.
ABS motor relay	Supplies power to the pump motors in the brake actuator.
ABS motor cutoff relay	If the motor relay fails, this relay cuts off the supply of power to the pump motors in the brake actuator.
ABS solenoid relay (built into the brake actuator)	Supplies power to the solenoid valves in the brake actuator.
VSC beeper	Sounds intermittently to inform the driver that the VSC is in operation.
Skid control computer	Processes signals from each sensor and controls the braking operations of the ABS, TRC, VSC, brake assist mechanism, hill start assist control system and downhill assist control system.
Engine control computer	Communicates with the skid control computer through the CAN network.
Brake fluid level switch	Checks the brake fluid level.
DAC switch	Turning on and off this switch activates and stops the operation of the TRC.
DLC	With the diagnosis tool connected to this, diagnosis codes and data can be read out of the computer.

TRC

Description

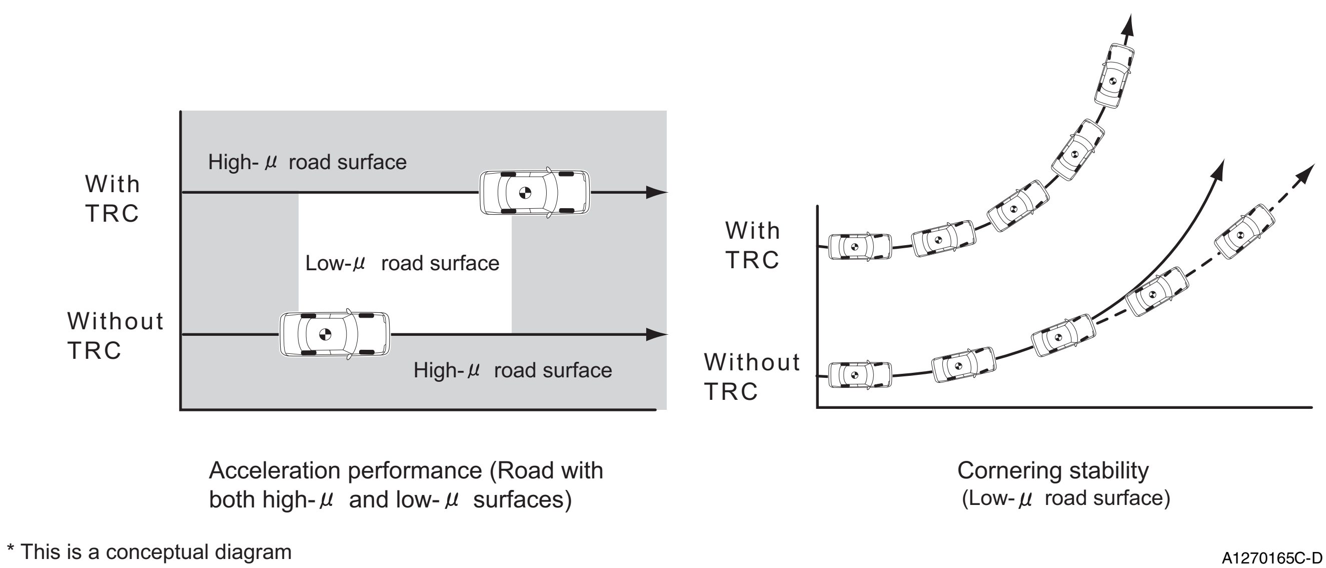
- If the vehicle is started or accelerated on a slippery road by opening the throttle excessively, the driving wheels may slip because of excessive torque produced, impairing starting acceleration performance and steering control. In such a case, the TRC system regulates the brake fluid pressures of the driving wheels to prevent them from slipping, to secure driving force responsive to the road conditions, and to ensure the starting acceleration performance, straight running stability and cornering stability of the vehicle.

Features of TRC

1	TRC eliminates the need to pay excessive attention to accelerator control in starting or accelerating on a slippery road.
2	TRC ensures excellent controllability and stability during acceleration.
3	TRC increases cornering stability even during acceleration.
4	TRC ensures stable acceleration even when the road surfaces under the right and left driving wheels differ.

✦ CAUTION ✦

TRC does not operate when the differential gear is locked.



VSC

● The VSC system is designed to ensure stability in the turning direction of the vehicle, while the TRC system is mainly aimed at ensuring braking stability and accelerating stability. Although a vehicle make turns steadily as the steering wheel is turned under normal conditions, the front or rear wheels may considerably skid sideways, depending on the road conditions, vehicle speed, circumstances, for example, unexpected circumstances under which the vehicle is forced to make a sharp turn, or external factors. In such cases, the VSC system automatically controls the operation of the brake on each wheel to ensure stability and minimize the amount of skidding of the front and rear wheels.

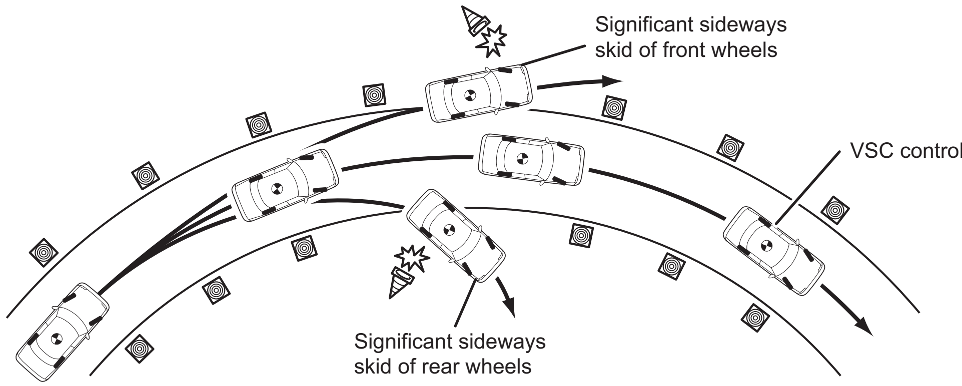
Outline of Control Performance

- The VSC system determines the vehicle condition from signals received from the yaw rate sensor, the G sensor, etc. and regulates the brake fluid pressure accordingly.
- Here are some examples of circumstances under which tires lose their sideways grip.

Examples of circumstances under which tires lose their grip

1 While the front wheels maintain a tight grip, the rear wheels are losing their grip. (significant sideways skid of rear wheels)
2 While the rear wheels maintain a tight grip, the front wheels are losing their grip. (significant sideways skid of front wheels)

- The VSC system operates under the circumstances shown in the figure below to minimize the amount of skidding of the front or rear wheels.



This is a conceptual diagram.

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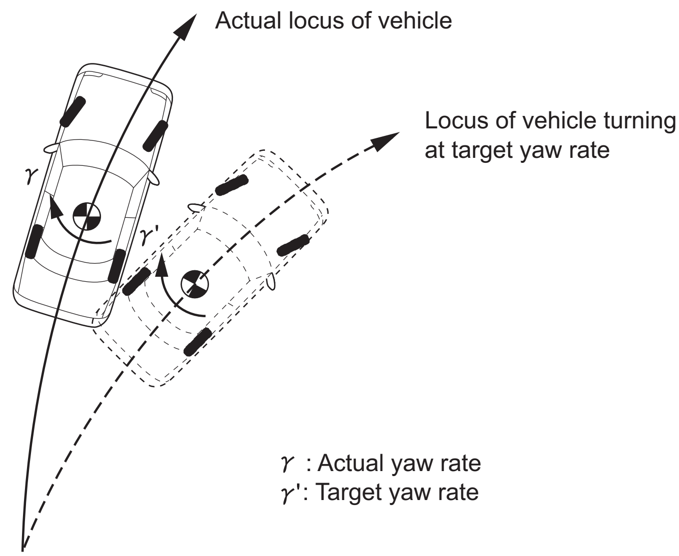
Judgement of Front Wheel Sideslip Tendency

- Whether the front wheels have a tendency to skid sideways or not is determined by the skid control computer from the target yaw rate and the actual yaw rate. Thus an actual yaw rate that is smaller than the target yaw rate, i.e., rate at which the vehicle is designed to yaw when steered (determined by the amount of steering and the vehicle speed) means that the vehicle does not turn easily and that the front wheels have a strong tendency to skid sideways.



* This is a conceptual diagram.

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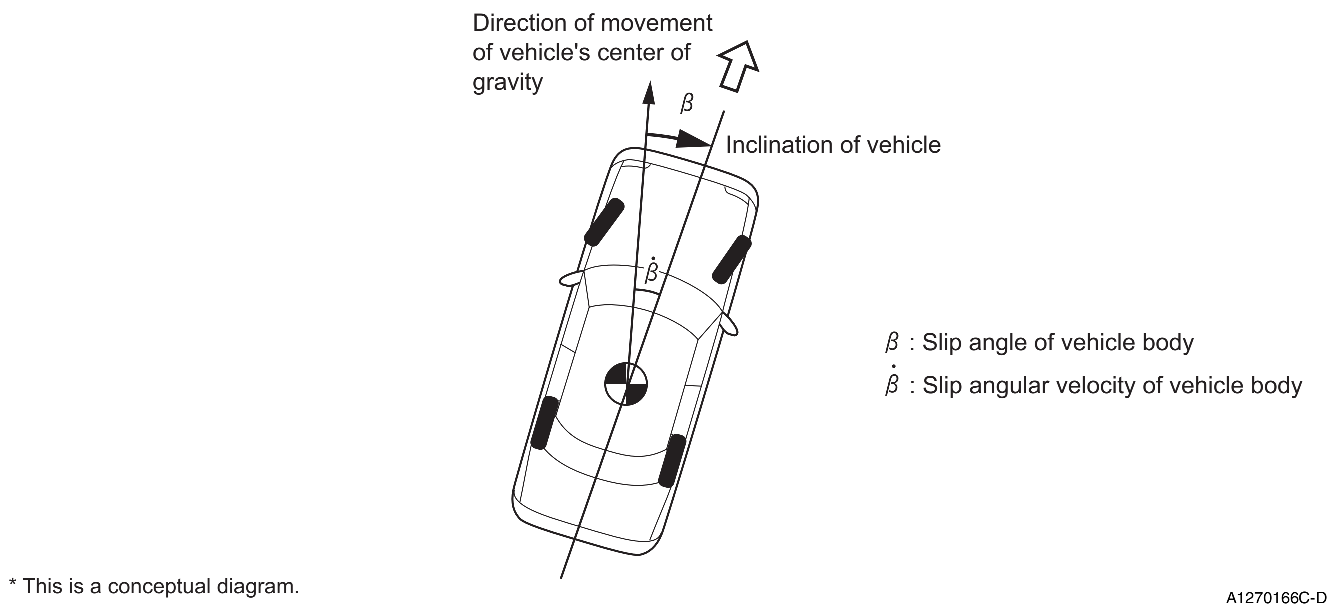
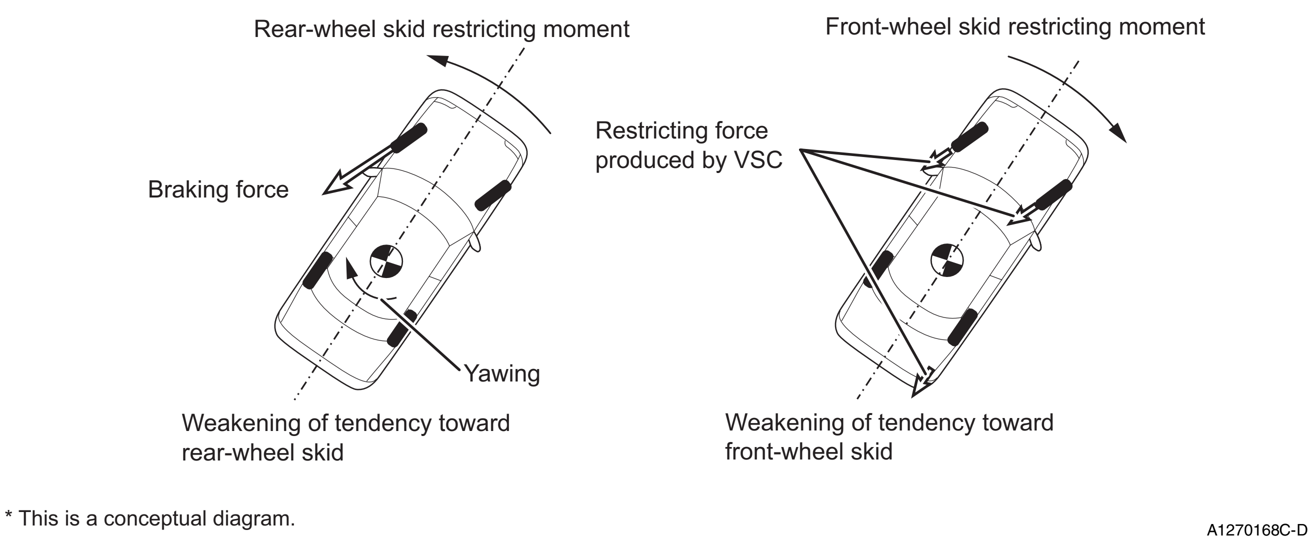
Judgement of Rear Wheel Sideslip Tendency

- Whether the rear wheels have a tendency to skid sideways or not is determined by the skid control computer from the slip angle and slip angular velocity of the vehicle body measured by the yaw rate sensor and the G sensor. If the vehicle body has a wide slip angle and a high slip angular velocity, the vehicle has a tendency toward rear-wheel skid.



Principle of VSC

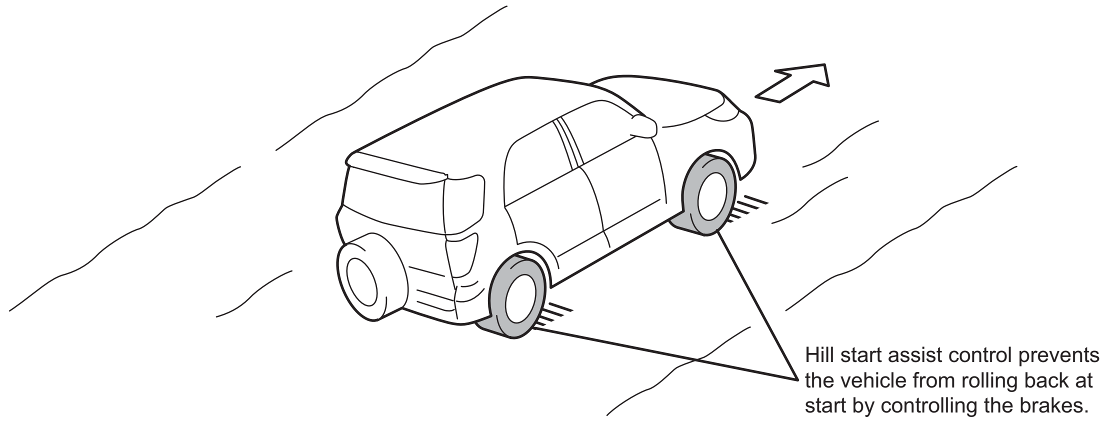
- Reducing the strong tendency of a vehicle toward rear-wheel skid
  If the skid control computer determines that the vehicle has a strong tendency toward rear-wheel skid, the VSC system applies the brakes to the front and rear outside wheels according to the degree of tendency in order to reduce the vehicle's tendency toward rear-wheel skid by making the vehicle produce outward moment. Also, a reduction in vehicle speed helps increase vehicle stability.
- Reducing the strong tendency of a vehicle toward front-wheel skid
  If the skid control computer has determined that the vehicle has a strong tendency toward front-wheel skid, the VSC system applies the brakes to the front and rear wheels according to the degree of tendency in order to decrease the vehicle's tendency toward front-wheel skid by reducing the lateral force.



Uphill Start Assist Control

- A hill start assist control system is provided for every A/T vehicle with VSC.
- The hill start assist control system automatically increases the brake fluid pressures of the four wheels to prevent the vehicle from rolling

back when starting on a slope.



Activation conditions

- The hill start assist control system is activated if the brakes are applied when all the following conditions are met.
- When the system is activated, the beeper sounds a beep (two beeps when deactivated), the VSC slip indictor blinks, and the brake lamp lights.

System activation conditions

1.	The shift lever is in a position other than P.
2.	The vehicle is completely stationary.
3.	The parking brake is not applied.
4.	The accelerator pedal is not depressed.
5.	The brake pedal is further depressed after stopping the vehicle by pressing the brake pedal.

Deactivation conditions

- The system is deactivated if one of the following conditions is satisfied.

Deactivation conditions

1	The shift lever is placed in the P position.
2	The accelerator pedal is depressed.
3	The parking brake is applied.
4	The brake pedal is depressed.
5	Two seconds or more have elapsed since the activation of the system.

✦ CAUTION ✦

- **Unlike the parking brake, the hill start assist control system is not capable of keeping the vehicle stationary for a long time. It cannot hold the vehicle stationary for more than 2 seconds after activation, so perform usual starting operation within this period.**
- **If the system is not activated even though the brake pedal is depressed, release the brake pedal temporarily, and then press it down again. If this does not activate the system, check whether all the activation conditions are satisfied.**

- **The hill start assist control system may not be able to hold the vehicle stationary on a steep slope or a very slippery road.**
- **The hill start assist control system is operational even when the center difflock system is engaged.**

Effect

- The hill start assist control system prevents the vehicle from rolling back while the driver is shifting his or her foot from the brake pedal to the accelerator pedal, so that it helps the driver shift his or her foot to the accelerator pedal in good time.
- The hill start assist control system reduces the amount of wheel spinning during acceleration and thus makes it easier to start the vehicle on a slippery road.

Details of Control

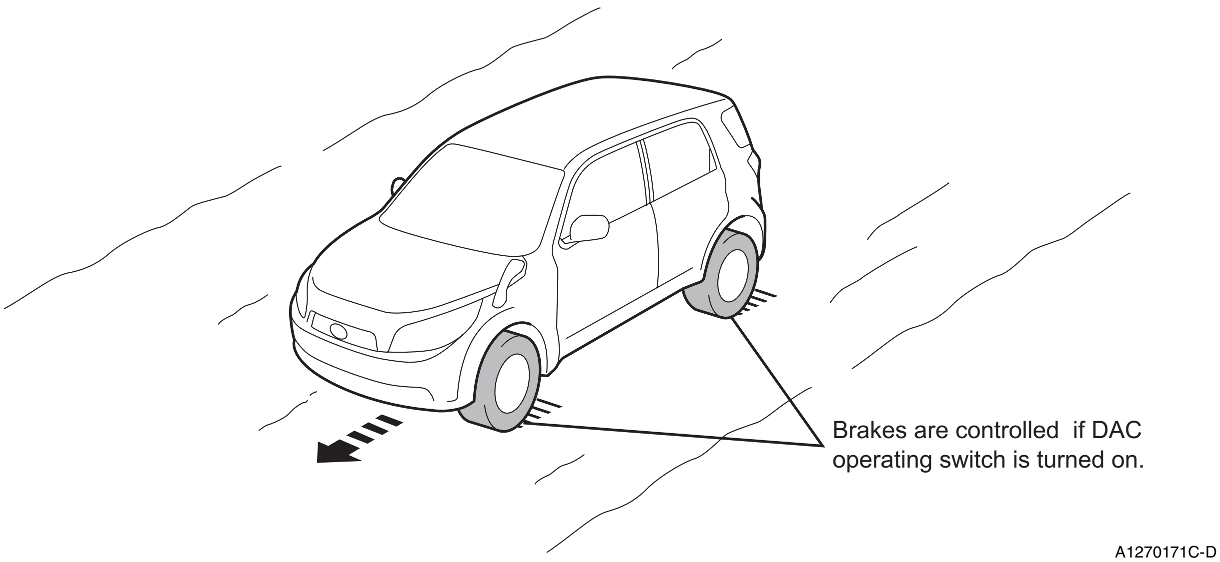
- If all the activation conditions for the hill start assist control system are satisfied, the skid control computer calculates the required amount of control and regulates the brake fluid pressure of each wheel.
- After the vehicle has come to a stop, the hill start assist control system releases the brake fluid pressure and terminates control if the vehicle is running state or 2 seconds has passed after the stop.

Caution

- The hill start assist control system is not designed to hold the vehicle stationary on a slope.
- When the hill start assist control system is activated, the slip indicator lamp in the combination meter blinks and the brake warning lamp lights.
- Although the hill start assist control system is designed to prevent the vehicle from rolling back on a slope by applying the brakes to the four wheels, it may not work properly on an extremely steep slope or slippery road with an extremely low friction coefficient, such a frozen road.
- The operating noise heard when the hill start assist control system is activated indicates that the system is operating normally and not that something is wrong with the system.

Downhill Start Assist Control

- Every A/T vehicle with VSC is equipped with a downhill assist control system (DAC).
- The downhill assist control system automatically regulates the brake fluid pressure of each of the four wheels so that the vehicle can roll down a steep hill stably at a constant low speed without causing the tires to lock.
- It is effective, especially when the vehicle is rolling down a steep hill on which it cannot slow down to a safe speed using only the engine brake.



Activation conditions

Activation position	Only L or R
When DAC operation switch is ON	The DAC operation switch allows the driver to activate and deactivate the DAC.
OFF during acceleration or braking	When the accelerator pedal or brake pedal is depressed, this system is turned off so as not to prevent the driver from accelerating or decelerating the vehicle smoothly.
Low vehicle speed	When going down a slope, slow down the vehicle to a sufficiently low speed. The DAC is operative when the vehicle is rolling down a hill at speeds of 25 km/h or below.

Effect

- The DAC system allows the driver driving down a steep hill to concentrate on steering without having to pay special attention to braking or acceleration pedal work and to hold the vehicle easily at a constant low speed.
- On a slippery slope, it enables the vehicle to roll down at a low speed without causing the tires to lock and it helps increase vehicle stability by reducing vibrations when rolling down uneven slopes.
- Furthermore, the DAC system contributes to an increase in controllability and makes it easy to avoid an obstacle or change direction, because the tires do not lock when the DAC system is activated.

Details of Control

- The DAC system determines whether it is allowed to operate or not from signals received, the ON/OFF state of the DAC switch, the shift lever position, accelerator information, the operating status of the brakes, etc. from each sensor.
- Then, it determines the direction in which the vehicle is headed and the road gradient from signals from the wheel speed sensors and the G sensor, and sets a target speed (forward driving: 6 km/h, reversing: 4 km/h).
- Lastly, it determines the acceleration of the vehicle from the speed of each wheel, and if it has judged that control is necessary, it regulates the brake fluid pressure of each wheel to make each wheel speed to settle to its normal state.

Caution

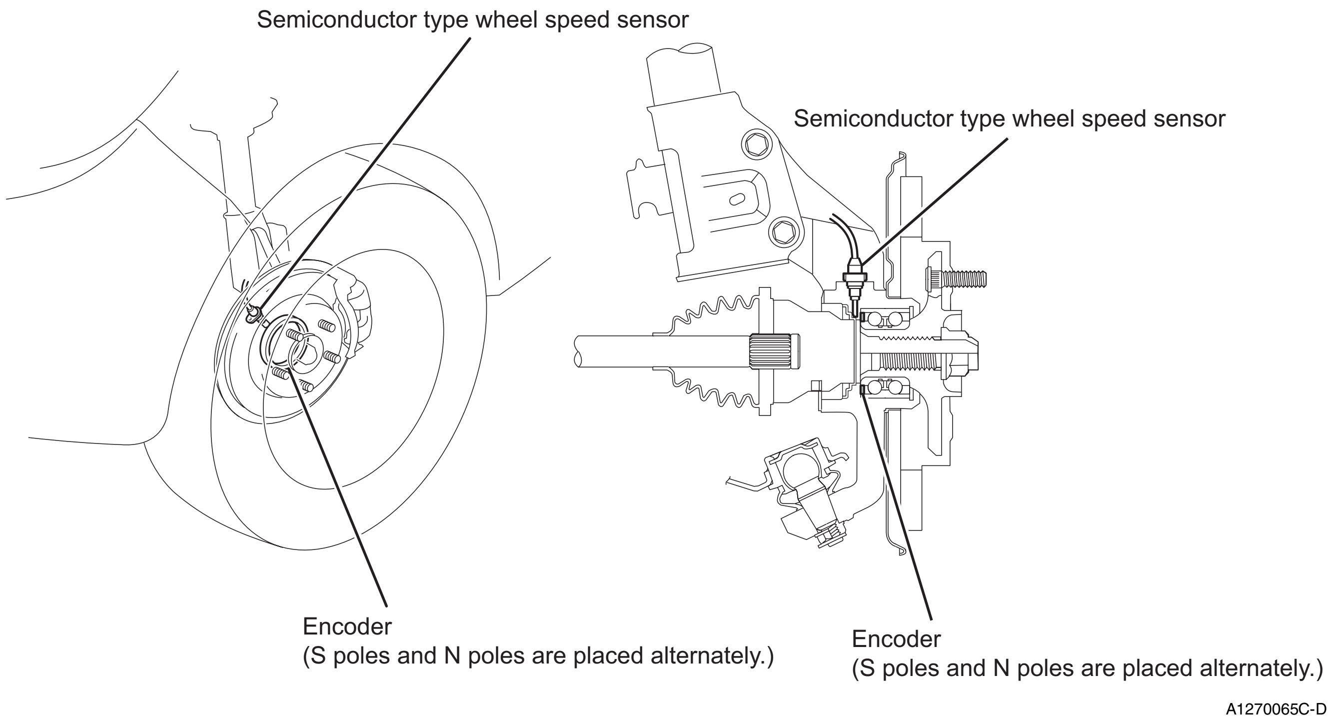
- Before starting the vehicle, make sure the DAC indicator is lit. The DAC system does not operate when the DAC indicator is blinking.
- When the DAC is activated, the slip indicator in the combination meter blinks and the brake warning lamp lights.
- When driving down a steep hill where the DAC may be activated, shift to L or R position to slow down to a safe speed.
- Activating the brake control of the DAC system continuously causes an increase in the temperature of the brake actuator. If the temper-

ature has become very high, the electric beeper sounds intermittently to warn the driver. In such a case, the operation of the DAC system is suspended for system protection.

- Although the DAC system enables the vehicle to roll down a hill at a constant speed using brake control of the four wheels, it may not be able to hold the vehicle speed constant on an unusually steep hill or a road of an extremely low friction coefficient, such as a frozen road.

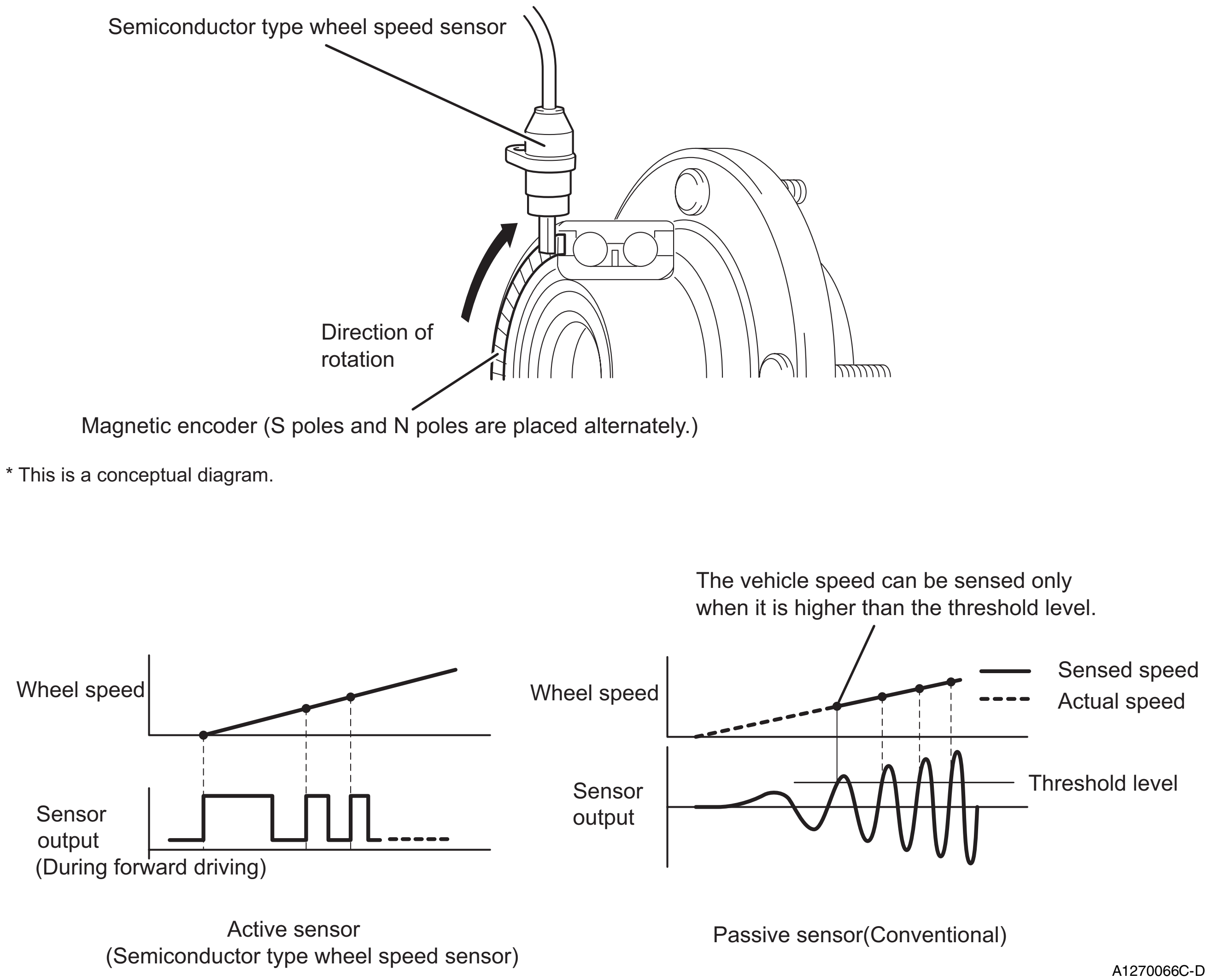
Front Wheel Speed Sensor and Encoder

● A semiconductor type wheel speed sensor is mounted in each steering knuckle, and an encoder in the outer region of the inner lace of each hub bearing.



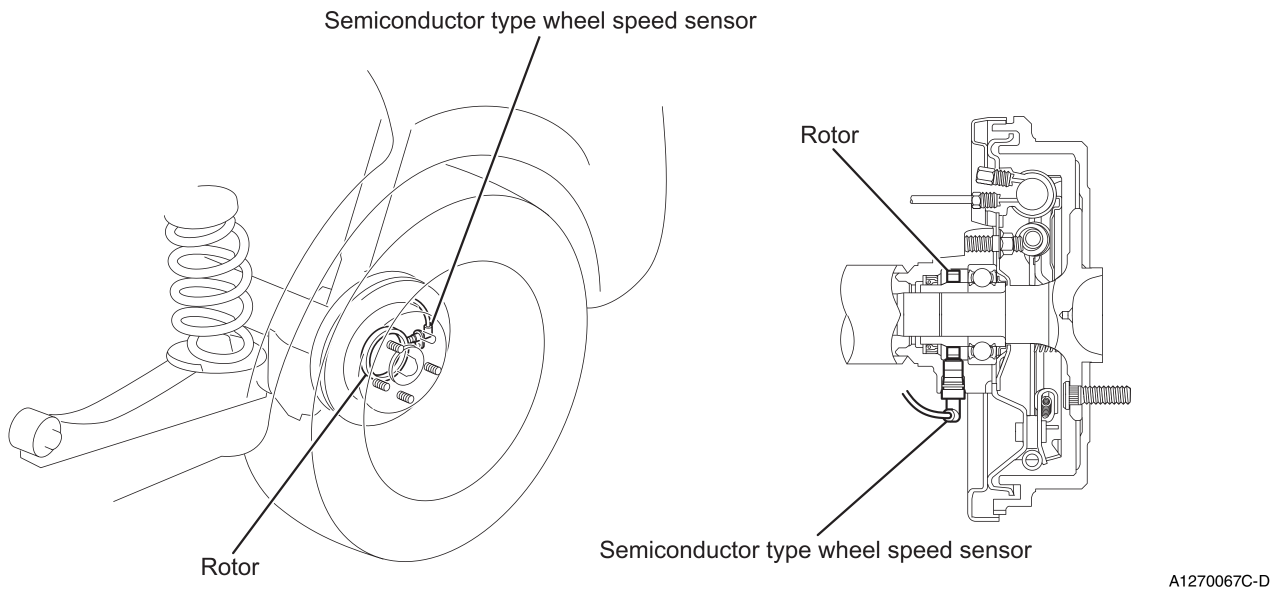
Principle of Sensing

- The magnetic encoder is made of rubber filled with magnetic particles and N and S poles (48 each) that are equally spaced along the circumference.
- The change in magnetic field caused by the rotation of the magnetic encoder is detected by an active sensor and transmitted as a wheel speed pulse.
- Unlike commonly used passive sensors, active sensors are capable of sensing changes in magnetic field at vehicle speeds from around 0 km/h.



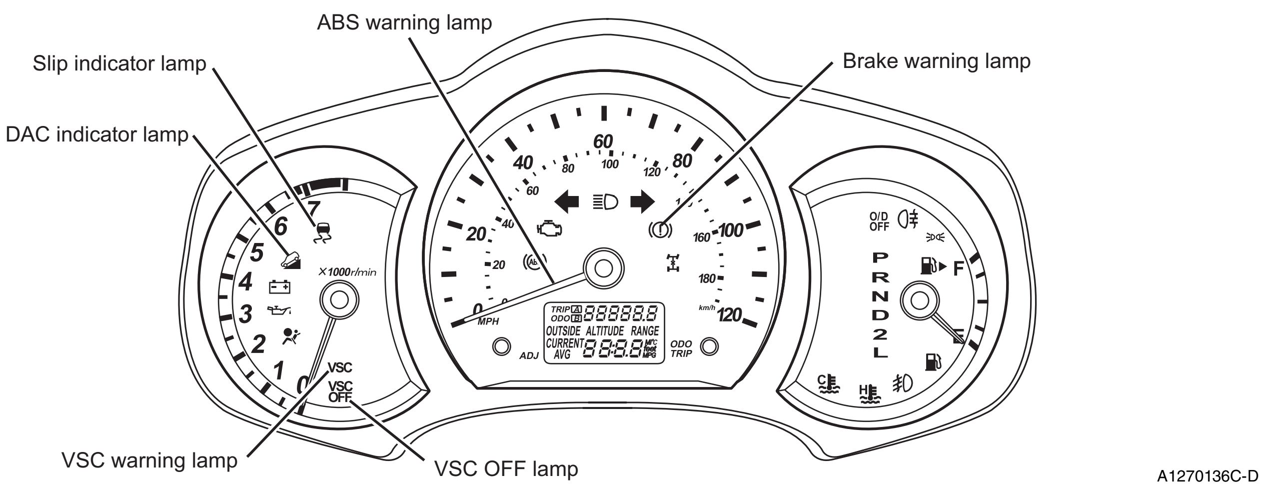
Rear Wheel Speed Sensor and Rotor

- A rear wheel speed sensor and a sensor rotor are press-fitted in each rear axle housing end and each rear axle shaft, respectively. The principle of sensing the wheel speed is basically the same as that of the front wheel speed sensor.



Warning Lamp and Indicator

- The warning lamps are placed in the combination meter.
- If a system failure occurs, the warning lamp for the failed system comes on to warn the driver of the failure. When the ignition switch is turned on, they come on for a lamp bulb check and go out after 3 seconds.



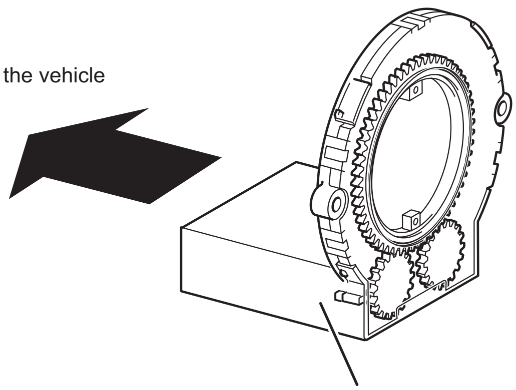
Warning lamps

ABS warning lamp	If the ABS system or the brake assist mechanism fails, this warning lamp comes on to warn the driver of the failure.
VSC warning lamp	If the VSC system fails, this warning lamp comes on to warn the driver of the failure. In diagnosis mode, this warning lamp indicates a diagnosis code by blinking.
VSC OFF lamp	This lamp lights to indicate that the VSC system is deactivated.
Slip indicator lamp	This lamp blinks to indicate that the TRC, VSC, DAC and the uphill start assist control are activated. This lamp lights if TRC is OFF.
Brake warning lamp	If the brake assist mechanism fails, the skid control computer turns on this lamp.

DAC indicator lamp	This lamp lights to indicates that the DAC system is in operation.

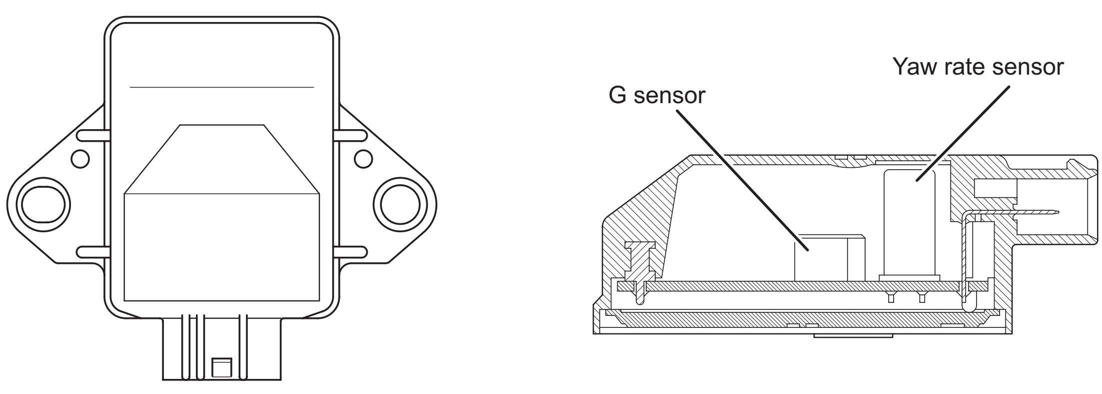
Steering Sensor

- A steering sensor is mounted in the combination switch section. It determines the amount and direction of steering and transmits them to the skid control computer.
- The sensor has 2 sets of magnetic resistor elements that sense the rotation of the magnets built in the sensing gear, and determines the rotation of the steering wheel from changes in magneto-resistance when the sensing gear rotates.



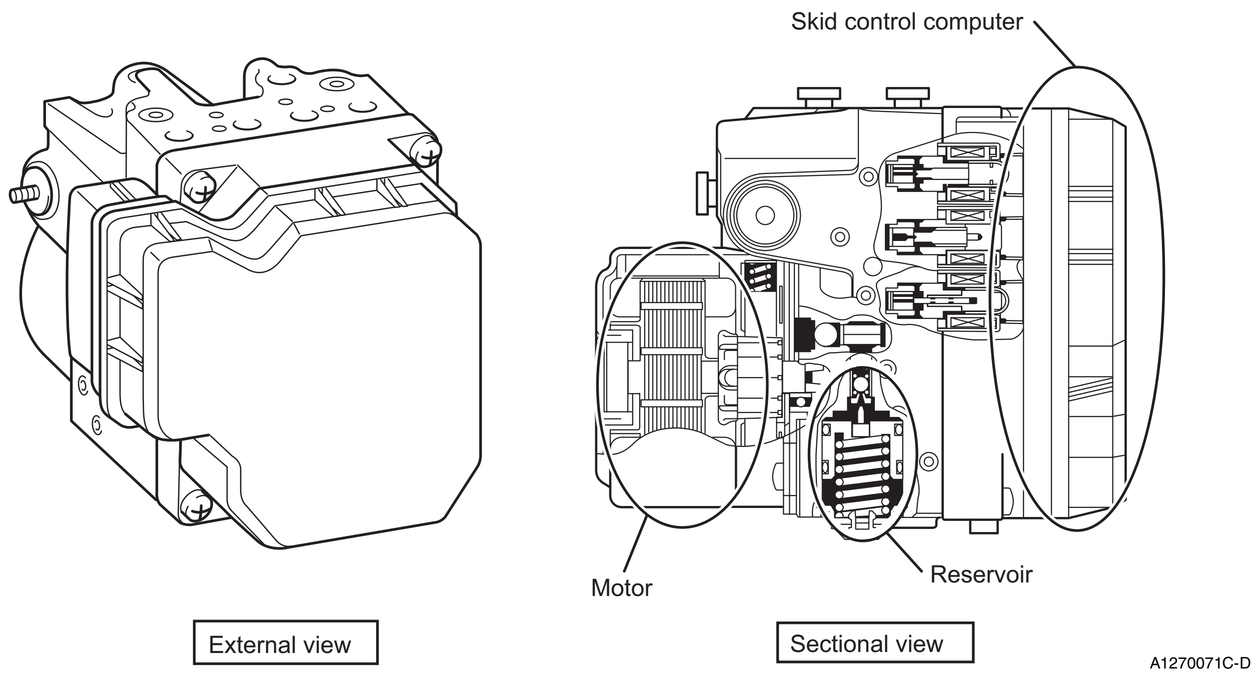
Yaw Rate Sensor and G Sensor

- A semiconductor type yaw rate sensor and a G sensor (composed of a longitudinal G sensor and a lateral G sensor), which are combined in one unit for compactness, are mounted under the driver's seat. The G sensor measures the amounts of strains on its internal beam that is deflected as the vehicle accelerates and converts them into signals. A combination of two G sensors mounted at an angle of 45° with respect to the longitudinal centerline of the vehicle make it possible to determine deceleration in the horizontal direction, and their linear output capability makes it possible to perform fine control according to road conditions.
- The yaw rate sensor determines the angular velocity (yaw rate and rotating velocity) of the vehicle in its vertical direction from the amount and direction of strain on the piezoelectric ceramic. A dedicated IC (integrated circuit) is used for the oscillation of the sensor unit and for signal processing to ensure that the sensor is compact and reliable.

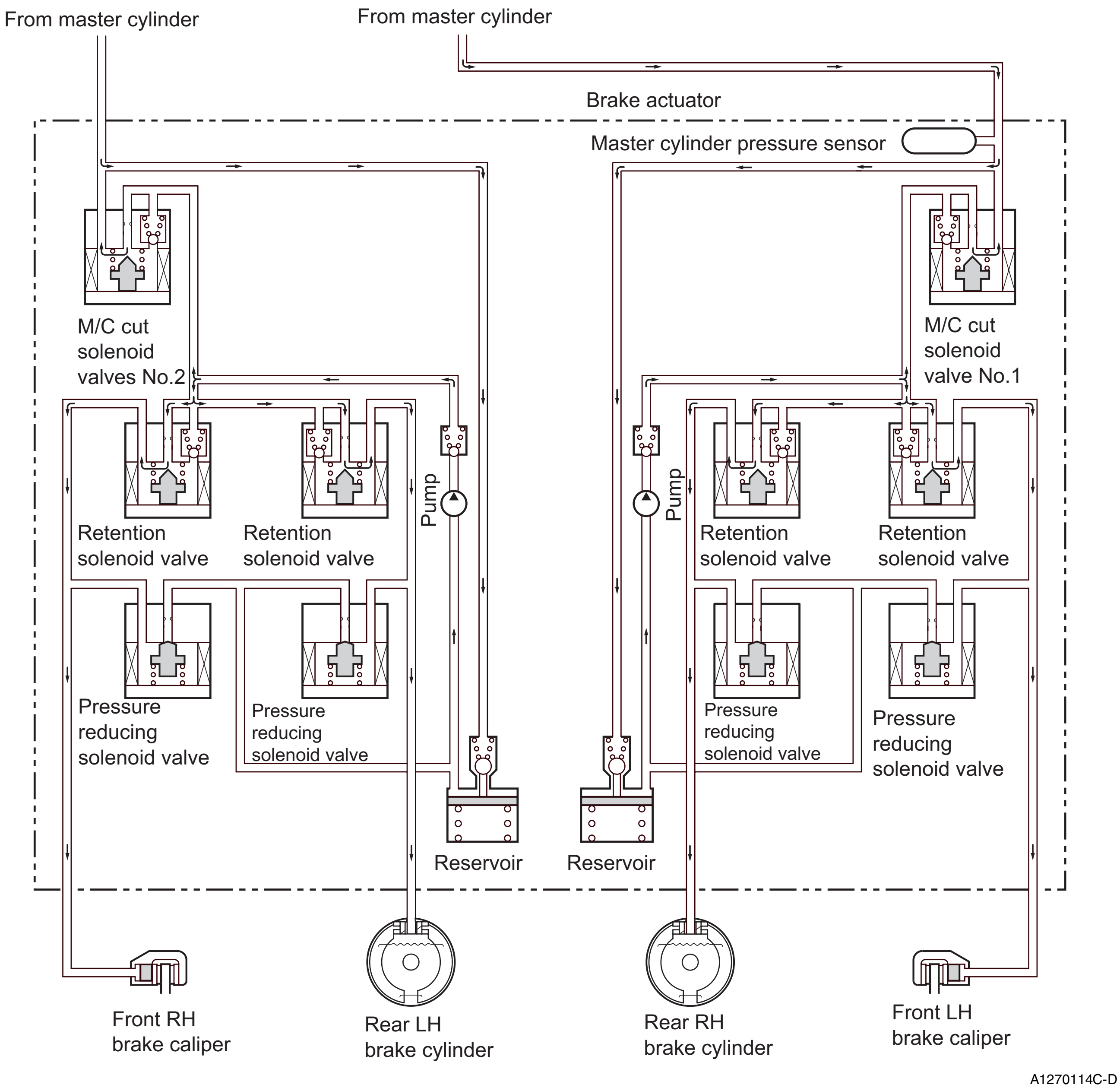


Brake Actuator

- The brake actuator consists of master cylinder cutoff solenoid valves, retention solenoid valves, pressure reducing solenoid valves, pumps, reservoirs, etc. and it regulates the hydraulic pressure in each brake cylinder. The brake actuator is integrated with the skid control computer for size reduction.



Hydraulic circuit diagram

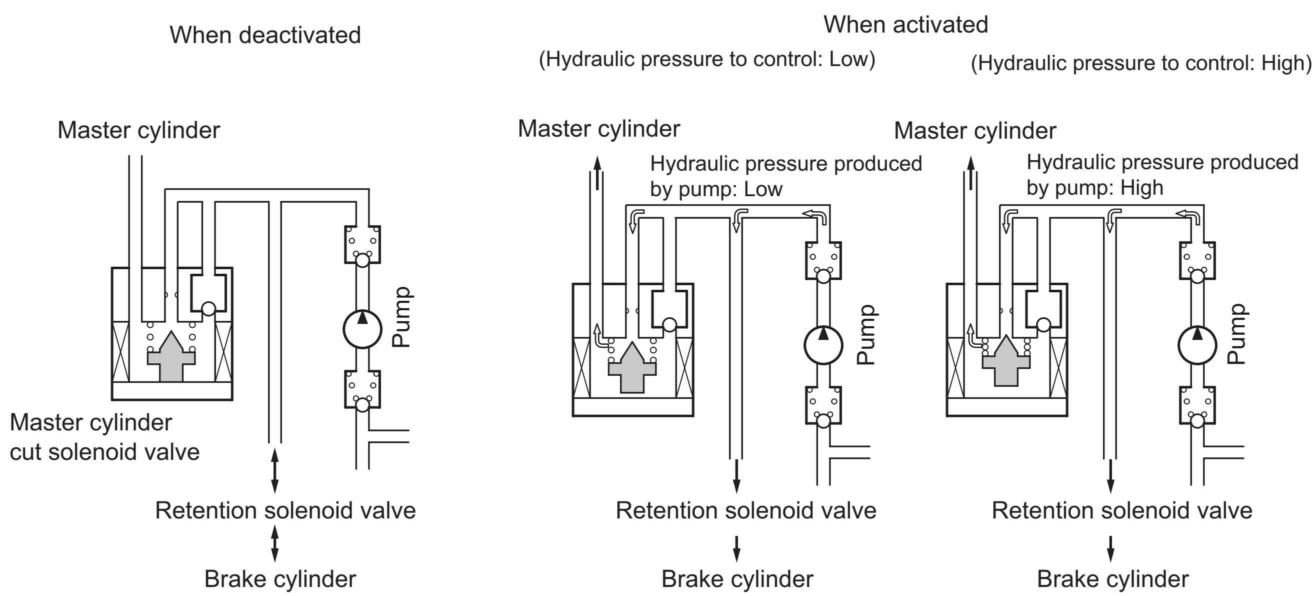


Pressure Retention/Reduction Solenoid Valve

- The two solenoid valves are actuated under the control of signals from the skid control computer to switch the hydraulic circuit among three modes: pressure increase, retention and pressure reduction.

Master Cylinder Cutoff Solenoid Valve

- Linear solenoid valves are employed for the master cylinder cutoff solenoid valves to smoothen changes in hydraulic pressure during control by the brake assist mechanism.
- The hydraulic pressure produced by each pump is regulated by opening or closing the valves to produce control hydraulic pressures responsive to the operating status.



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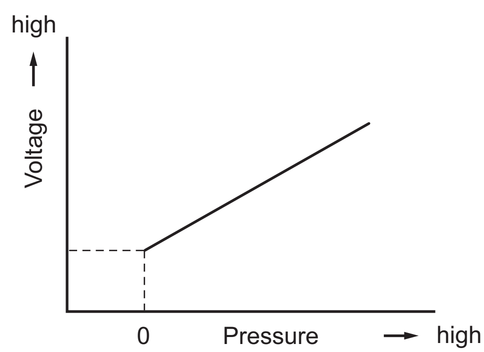
Master Cylinder Pressure Sensor

- The master cylinder pressure sensors are built into the brake actuator. They send master cylinder pressure signals to the skid control computer.



Output characteristic

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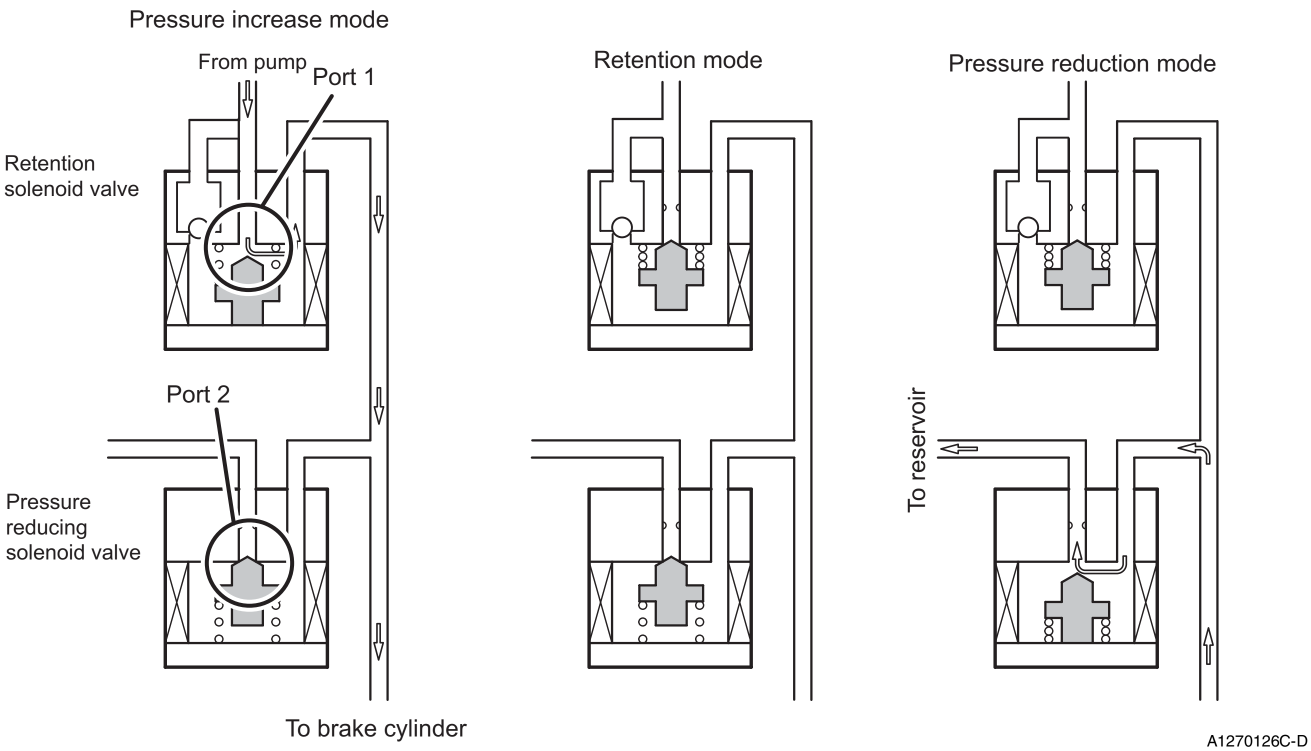
Operation of ABS with EBD

- The ABS system regulates the hydraulic pressures to the four wheels using retention solenoid valves, pressure reducing solenoid valves, pumps and reservoirs.

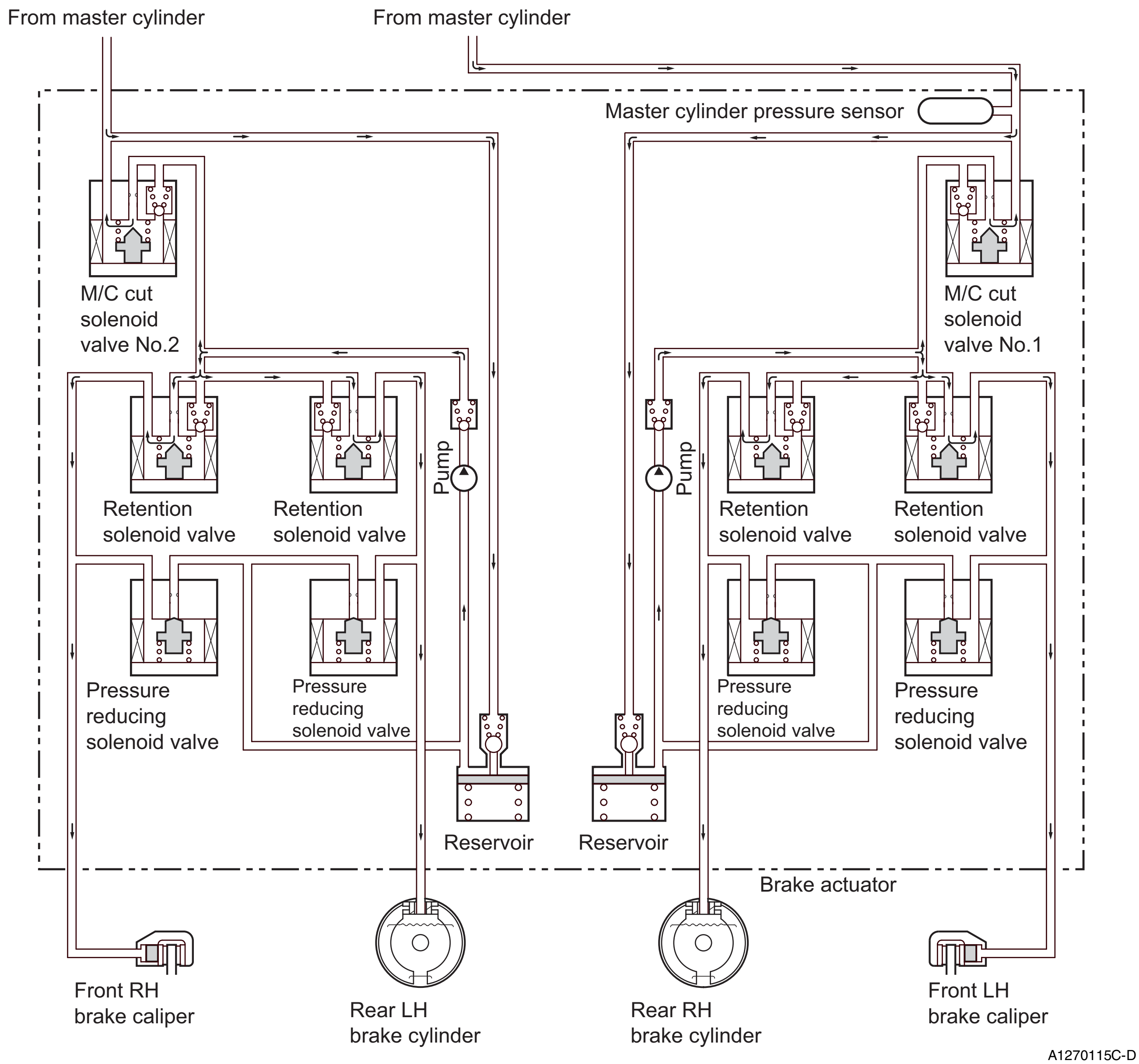


Control operation

When deactivated	Usual braking	—	—
When activated	Pressure increase mode	Retention mode	Pressure reduction mode
Retention solenoid valve	OFF	ON	←
Pressure reducing solenoid valve	OFF	←	ON
Port 1	Open	Closed	←
Port 2	Closed	←	Open
Hydraulic pressure in brake cylinder	Increase the hydraulic pressure.	Retain the hydraulic pressure.	Reduce the hydraulic pressure.

Actuation of Brake Assist Device

- The brake assist mechanism conveys the hydraulic pressure produced by each pump in the brake actuator to each brake cylinder to let it produce a higher hydraulic pressure than that produced by the master cylinder.

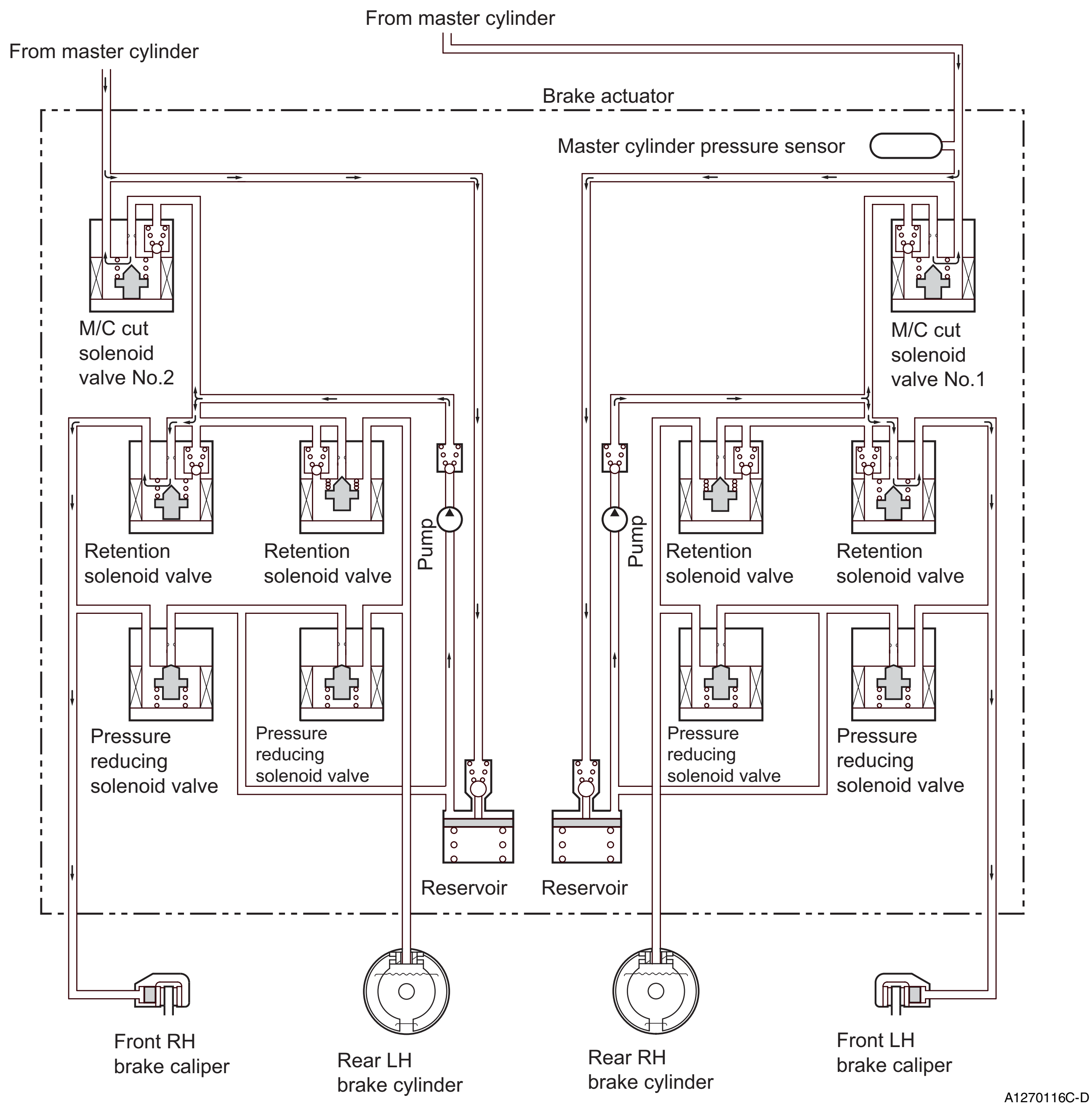


Control operation by brake assist mechanism

Input signal	When not controlled	When controlled by brake assist mechanism
M/C cutoff solenoid valve No.1	OFF (Open)	ON (Pressure regulation)
M/C cutoff solenoid valve No.2	OFF (Open)	ON (Pressure regulation)
Retention solenoid valve	OFF (Open)	←
Pressure reducing solenoid valve	OFF (Closed)	←
Hydraulic pressure in brake cylinder	Same as the hydraulic pressure from the master cylinder	Increase the hydraulic pressure above the pressure from the master cylinder.

Actuation of TRC

- The hydraulic pressure produced by each pump in the brake actuator is conveyed to the brake cylinder on each wheel to prevent the tire to slip because of driving force.



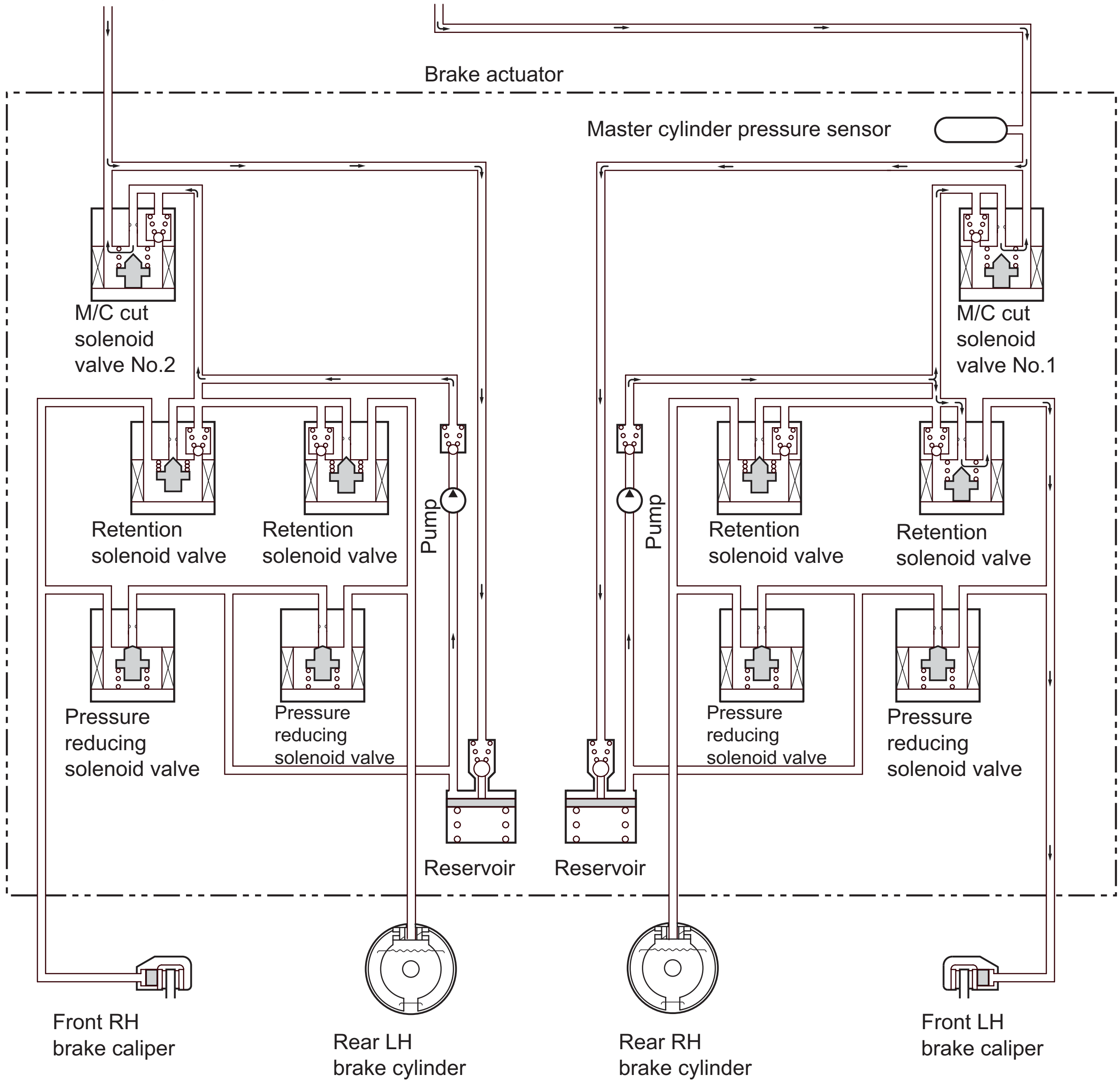
Control operation of TRC

Input signal	When not controlled	When controlled by TRC		
		Pressure increase mode	Retention mode	Pressure reduction mode
M/C cutoff solenoid valve No.1	OFF (Open)	ON (Pressure regulation)	←	←
M/C cutoff solenoid valve No.2	OFF (Open)	ON (Pressure regulation)	←	←

Input signal		When not controlled	When controlled by TRC		
			Pressure increase mode	Retention mode	Pressure reduction mode
Front wheels	Retention solenoid valve	OFF (Open)	←	ON (Closed)	←
	Pressure reducing solenoid valve	OFF (Closed)	←	←	ON (Open)
	Hydraulic pressure in brake cylinder	—	Increase the hydraulic pressure.	Retain the hydraulic pressure.	Reduce the hydraulic pressure.
Rear wheels	Retention solenoid valve	OFF (Open)	←	ON (Closed)	←
	Pressure reducing solenoid valve	OFF (Closed)	←	←	ON (Open)
	Hydraulic pressure in brake cylinder	—	Increase the hydraulic pressure.	Retain the hydraulic pressure.	Reduce the hydraulic pressure.

Rear Wheel Sideslip Control

- The hydraulic pressure produced by each pump in the brake actuator is led into the brake cylinder on each wheel and the brake fluid pressure is regulated to prevent the front or rear wheel to skid sideways.
- In rear wheel sideways skid preventive control, the brake on the front wheel outer of turn is actuated.



* Illustration shows the operation of rear wheel sideways skid preventive control while turning to the right.

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Control operation of VSC (Rear wheel sideways skid preventive control)

Input signal	When not controlled	When controlled by VSC		
		Pressure increase mode	Retention mode	Pressure reduction mode
M/C cutoff solenoid valve No.1	OFF (Open)	ON (Pressure regulation)	←	←
M/C cutoff solenoid valve No.2	OFF (Open)	ON (Pressure regulation)	←	←

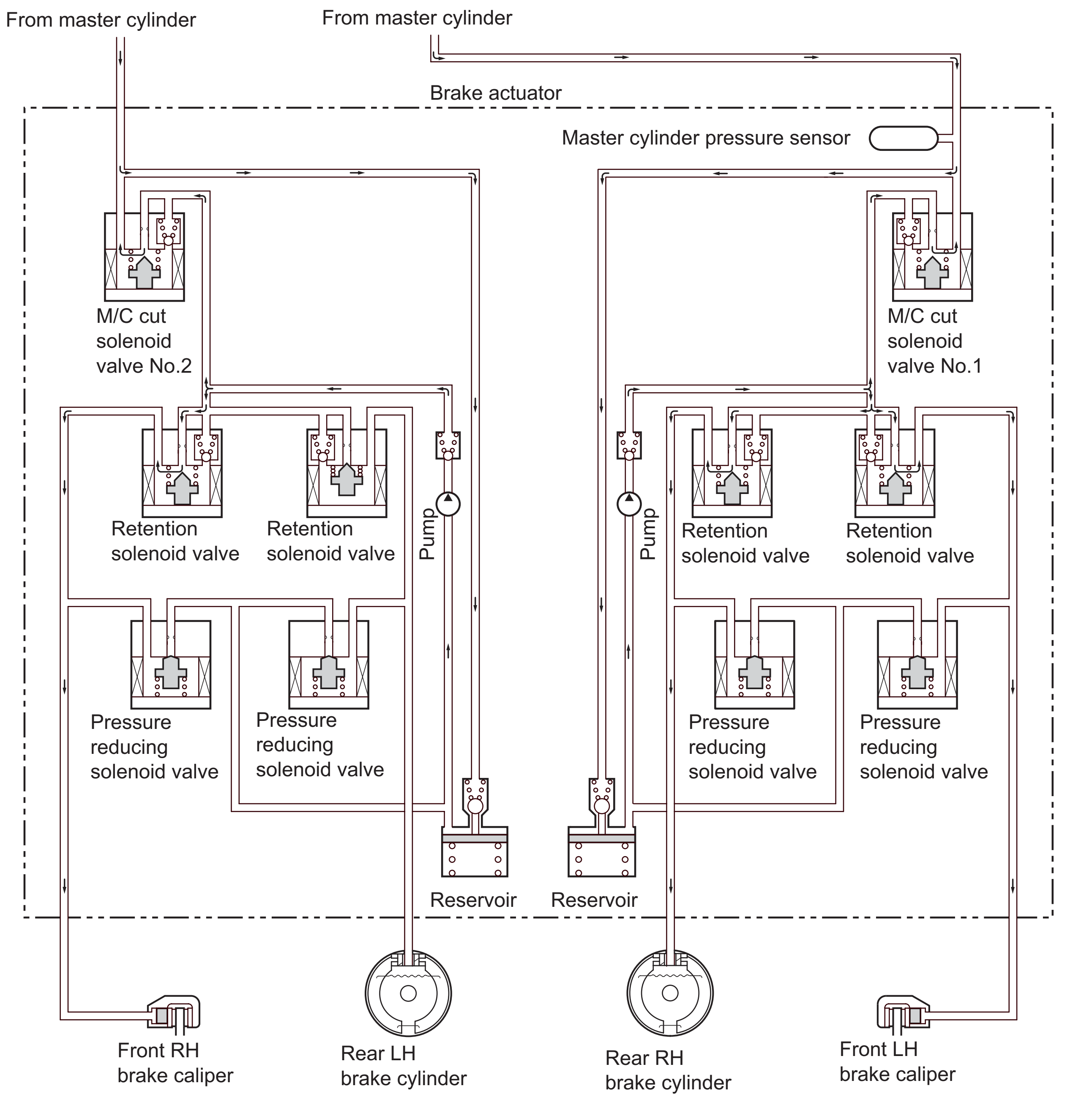
Input signal		When not controlled	When controlled by VSC		
			Pressure increase mode	Retention mode	Pressure reduction mode
Front wheels	Retention solenoid valve	OFF (Open)	←*	ON (Closed)	←
	Pressure reducing solenoid valve	OFF (Closed)	←	←	ON (Open)
	Hydraulic pressure in brake cylinder	—	Increase the hydraulic pressure.	Retain the hydraulic pressure.	Reduce the hydraulic pressure.
Rear wheels	Retention solenoid valve	OFF (Open)	←	←	←
	Pressure reducing solenoid valve	OFF (Closed)	←	←	←
	Hydraulic pressure in brake cylinder	—	—	—	—

❖ REFERENCE ❖

* : For uncontrolled wheels, the retention solenoid valves are ON (closed).

Front Wheel Sideslip Control

- VSC control conveys the hydraulic pressure produced by each pump in the brake actuator into the brake cylinder on each wheel and regulates the brake fluid pressure to prevent the front or rear wheel from skidding sideways.
- In front wheel sideways skid preventive control, the brakes on both rear wheels and if necessary the brake on the outside front wheel are actuated.



* Illustration shows the operation of front wheel sideways skid preventive control while turning to the right.

A1270118C-D

Control operation of VSC (Front wheel sideways skid preventive control)

Input signal	When not controlled	When controlled by VSC		
		Pressure increase mode	Retention mode	Pressure reduction mode
M/C cutoff solenoid valve No.1	OFF (Open)	ON (Pressure regulation)	←	←
M/C cutoff solenoid valve No.2	OFF (Open)	ON (Pressure regulation)	←	←

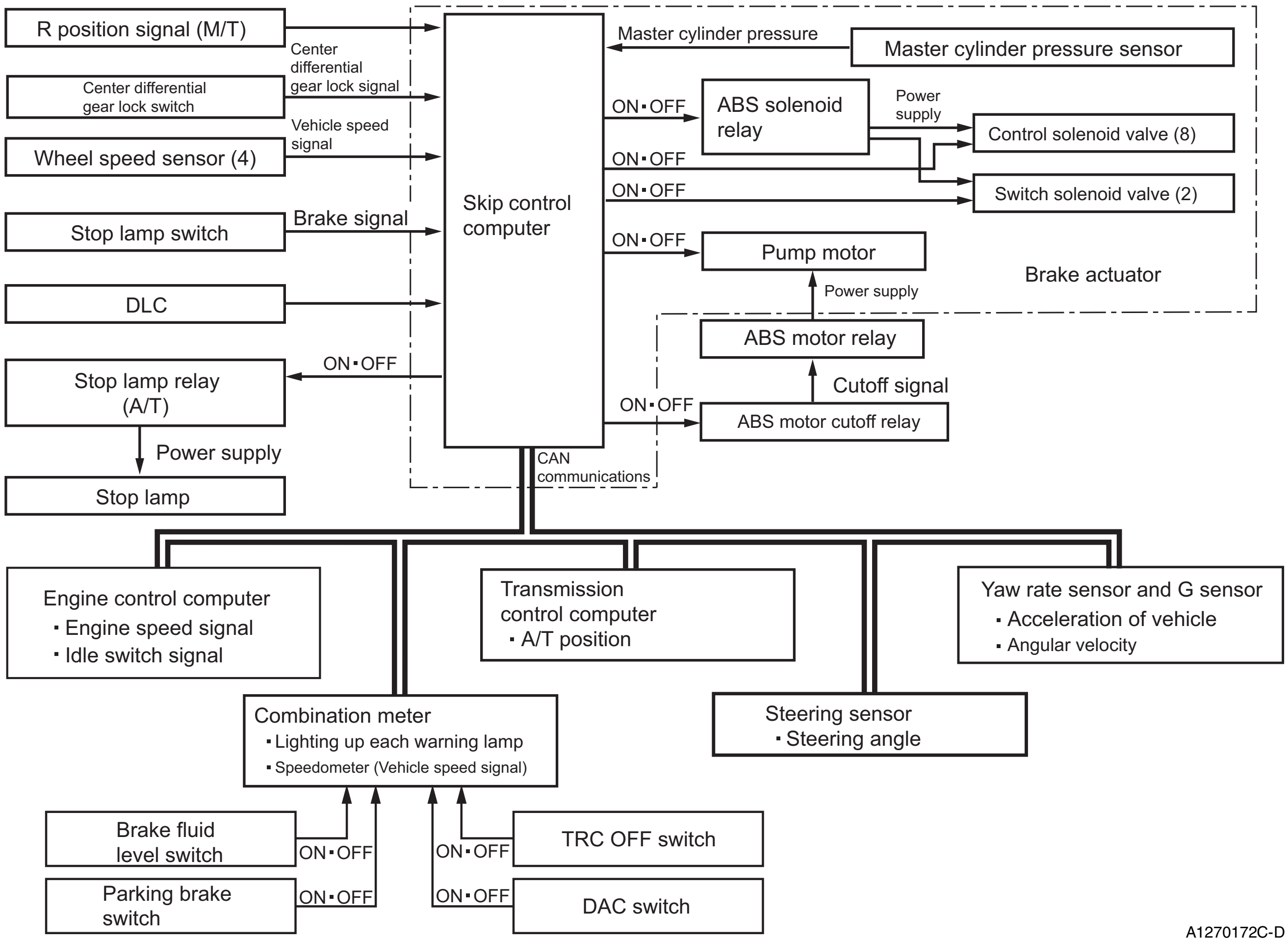
Input signal		When not controlled	When controlled by VSC		
			Pressure increase mode	Retention mode	Pressure reduction mode
Front wheels	Retention solenoid valve	OFF (Open)	←*	ON (Closed)	←
	Pressure reducing solenoid valve	OFF (Closed)	←	←	ON (Open)
	Hydraulic pressure in brake cylinder	—	Increase the hydraulic pressure.	Retain the hydraulic pressure.	Reduce the hydraulic pressure.
Rear wheels	Retention solenoid valve	OFF (Open)	←	ON (Closed)	←
	Pressure reducing solenoid valve	OFF (Closed)	←	←	ON (Open)
	Hydraulic pressure in brake cylinder	—	Increase the hydraulic pressure.	Retain the hydraulic pressure.	Reduce the hydraulic pressure.

❖REFERENCE❖

* : For uncontrolled wheels, the retention valves are ON (closed).

Skid Control Computer

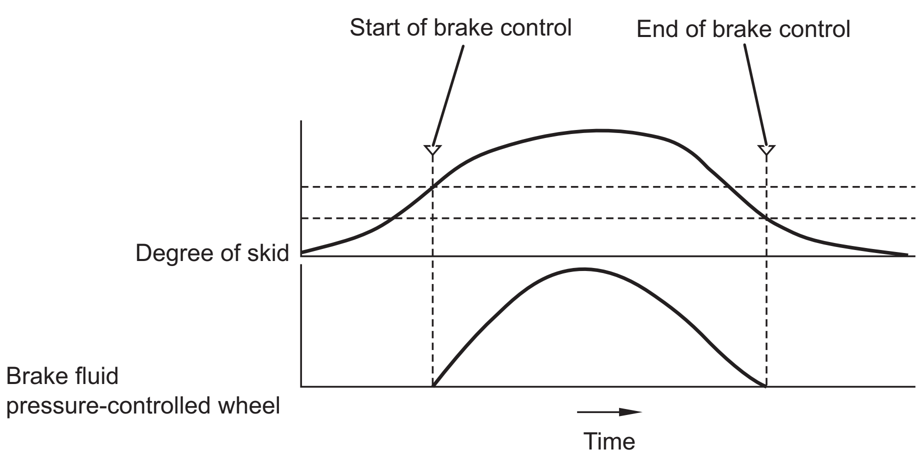
- The skid control computer processes signals from each sensor to control the braking operation of the ABS, TRC, VSC, brake assist mechanism, etc. The skid control computer communicates with the engine control computer and transmits control signals.



A1270172C-D

VSC Control

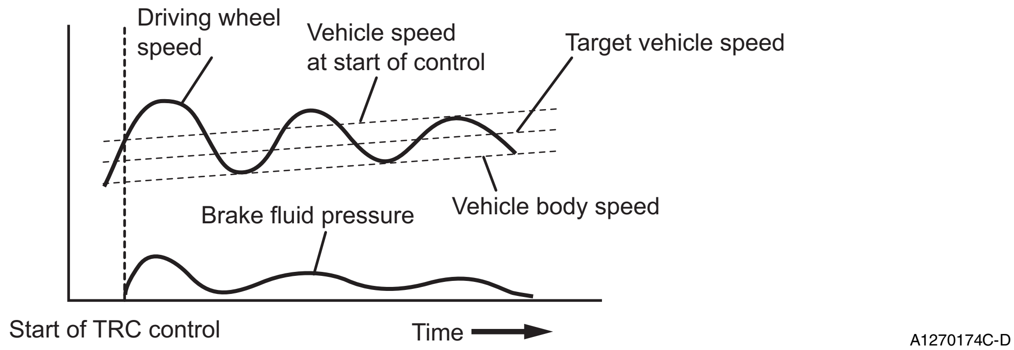
- The VSC system determines the vehicle condition from the information provided by the vehicle speed sensors, yaw rate sensor, linear G sensor and steering sensor, and if it has determined that the vehicle has a tendency to oversteer or understeer, it regulates the brake fluid pressure of each wheel or cuts off the supply of fuel to the engine, depending on the vehicle's steering tendency.



A1270173C-D

TRC Control

- If a driving wheel starts slipping on a slippery road, its speed far exceeds vehicle speed estimated from the speed of the other wheel that is not slipping. In such a case, the TRC system controls the operation of the engine and that of the brakes on both sides independently according to the degree of slippage.



Initial Check Function

- When the vehicle speed reaches approx. 6 km/h for the first time after the ignition switch is turned on, each solenoid valve and motor in the brake actuator are operated one after another for an electrical check. During this initial check, the operating noise of the solenoid valves or motor may be heard from the engine compartment, but this is normal and does not indicate that something is wrong with the brake actuator.

TO FOREWORD

TRANSMISSION / TRANSAXLE

CLUTCH

MANUAL TRANSMISSION (M5S)

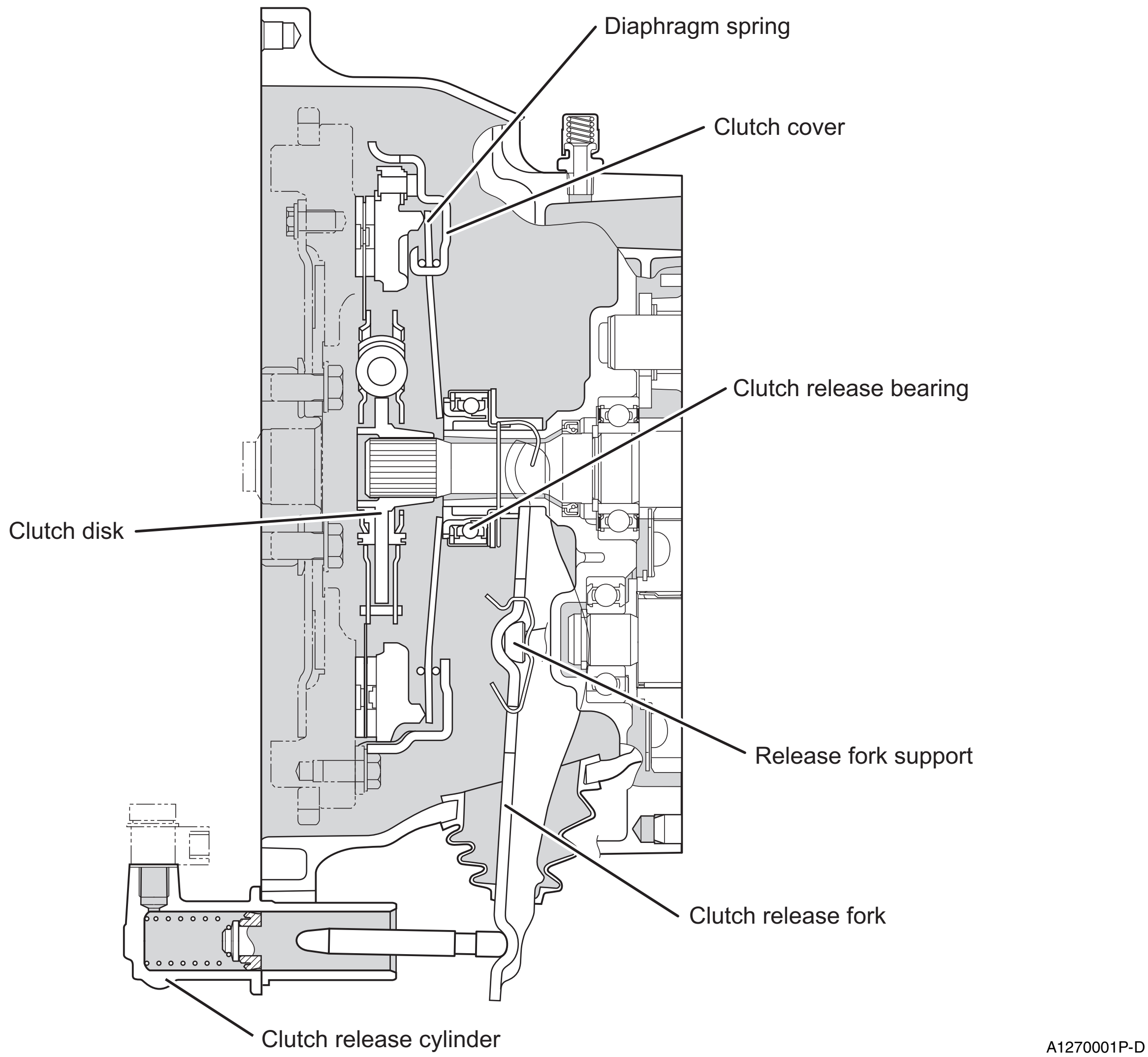
ELECTRONICALLY CONTROLLED AUTOMATIC TRANSMISSION (A4Q)

SHIFT LOCK SYSTEM WITH KEY INTERLOCK

CLUTCH

Clutch System in General

- To respond to the high torque delivered by the 3SZ-VE engine, a clutch cover and a clutch disk have been newly designed. Furthermore, a hydraulic clutch control system has been employed.
- A clutch start system that prevents the engine from starting when the clutch pedal is not depressed has been employed.



Clutch specifications

Engine type		3SZ-VE	K3-VE
Clutch	Type	Dry single-plate diaphragm spring type	←
	Drive system	Hydraulic	←
Clutch cover	Pressure plate size (mm)	$\phi200 \times \phi140$	$\phi190 \times \phi132$
	Identification (color)	Pink	Yellow

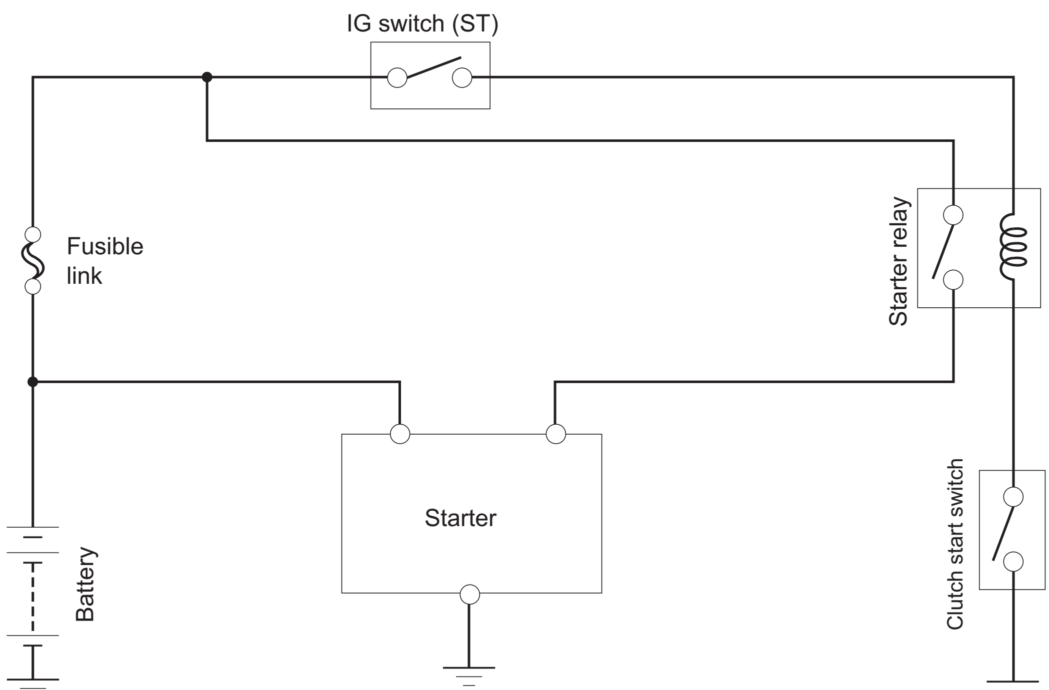
Engine type		3SZ-VE	K3-VE
Clutch disk	Outside diameter × inside diameter × facing thickness (mm)	ϕ200 × ϕ140 × 3.2	ϕ190 × ϕ132 × 3.5
	Material	Semi-mold	←
	Identification (color)	Pink	Yellow
Clutch master cylinder	Type	Conventional	←
Clutch release cylinder	Type	Nonadjustable	←

Clutch Pedal

- The pedal lever ratio and the pedal travel have been optimized to achieve excellent pedal operating feel.
- The clutch switch for the clutch start system is mounted on the clutch pedal bracket.

Clutch Start System

- The clutch start system allows the engine to start only when the clutch pedal is depressed to the floor, and thus it prevents the vehicle from making a jack-rabbit start even if the driver starts the engine with gears engaged without depressing the clutch pedal.



A1270004P-D

Operation of Clutch Start System

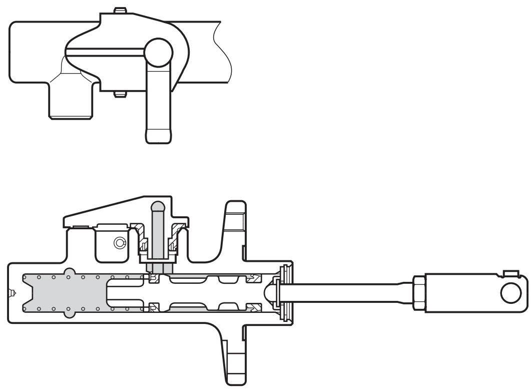
• Depressing the clutch pedal turns on the clutch switch. When the clutch switch is in the ON position, turning the ignition switch to the START position turns on the starter relay and thus actuates the starter.

Clutch Start Switch

- The clutch start switch is mounted on the clutch pedal bracket. When the clutch pedal is depressed, the clutch pedal bracket presses the clutch start switch to turn it on.

Clutch Master Cylinder

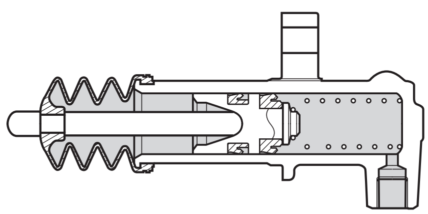
- A conventional master cylinder is provided.
- When the clutch pedal is depressed, the piston pushed by the pushrod blocks the port to the reservoir to send fluid to the clutch release cylinder through a pipe.



A1270002P-D

Clutch Release Cylinder

- A nonadjustable clutch release cylinder is employed.
- The hydraulic pressure produced by the master cylinder pushes the piston, which in turn pushes the clutch release fork through the pushrod.
- The clutch release cylinder is provided with a breather plug to purge air from operating fluid.
- The release fork and the pushrod are always held in contact by a spring. This eliminates the need to adjust the play even when the clutch facing is worn.

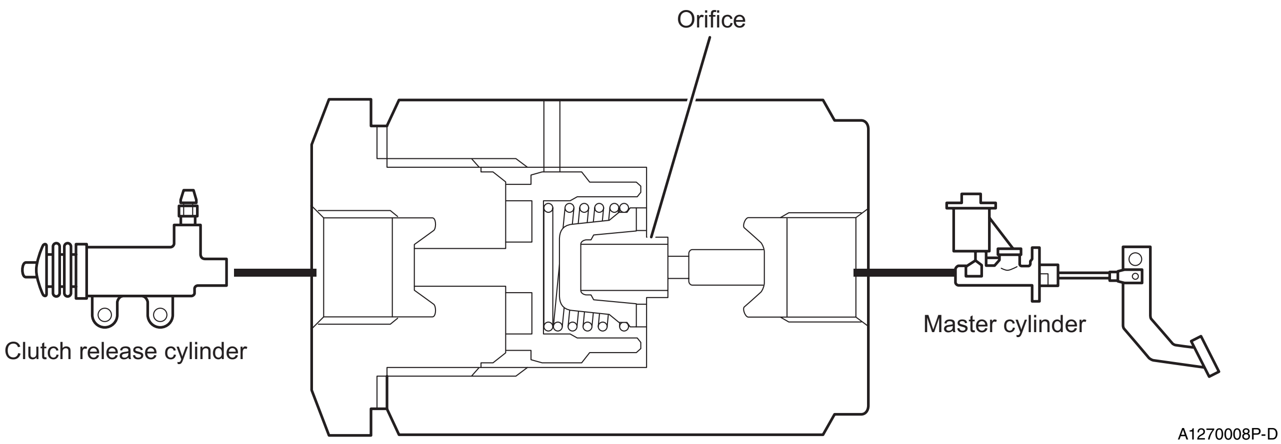


A1270003P-D

Clutch Orifice Valve

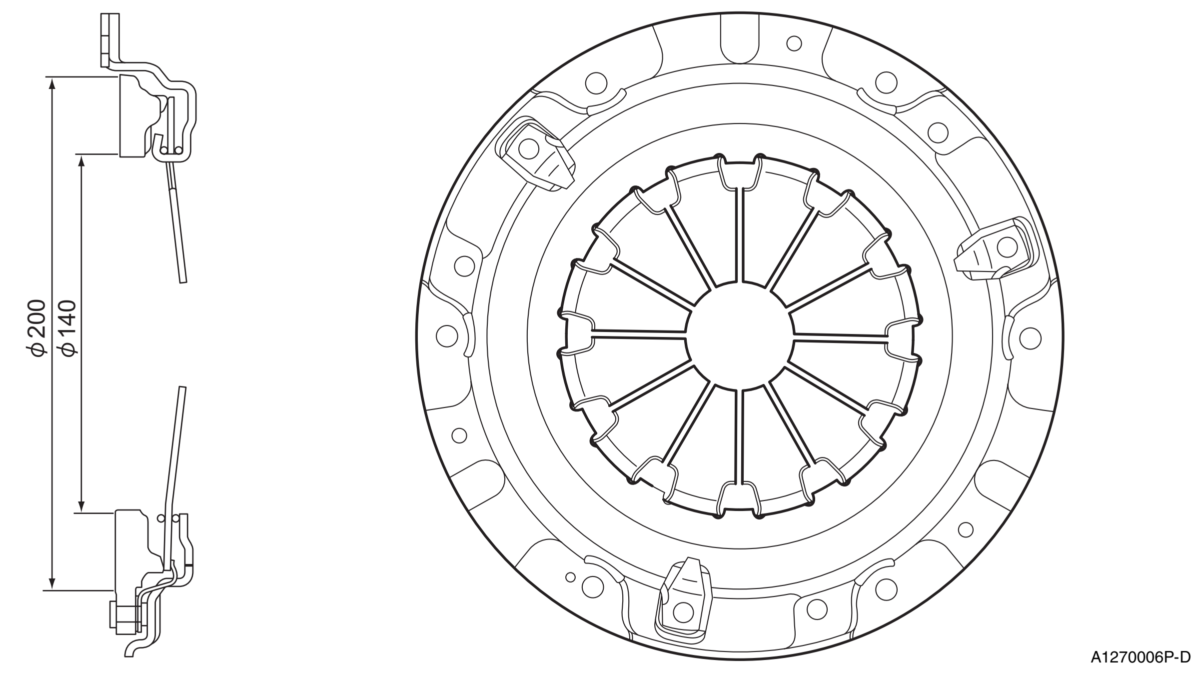
- A clutch orifice valve is employed to prevent excessive driving force from being applied to the drive train because of the rapid engagement of the clutch (incorrect operation).
- To prevent the driver from feeling something is wrong with the clutch when engaging or disengaging it at a low temperature, the orifice valve used to control the engagement of the clutch operates as described below.

When engaging the clutch (When easing up on the clutch pedal)	The orifice in the oil path of the clutch control system is opened to adjust the clutch engagement speed by increasing the resistance in the path.
When disengaging the clutch (When depressing the clutch pedal)	When the clutch is disengaged, the orifice is opened to prevent the driver from feeling something is wrong with the clutch.
When the oil is cold	When the oil is cold and thick, the orifice is opened to prevent an excessive reduction in clutch engagement speed.



Clutch Cover

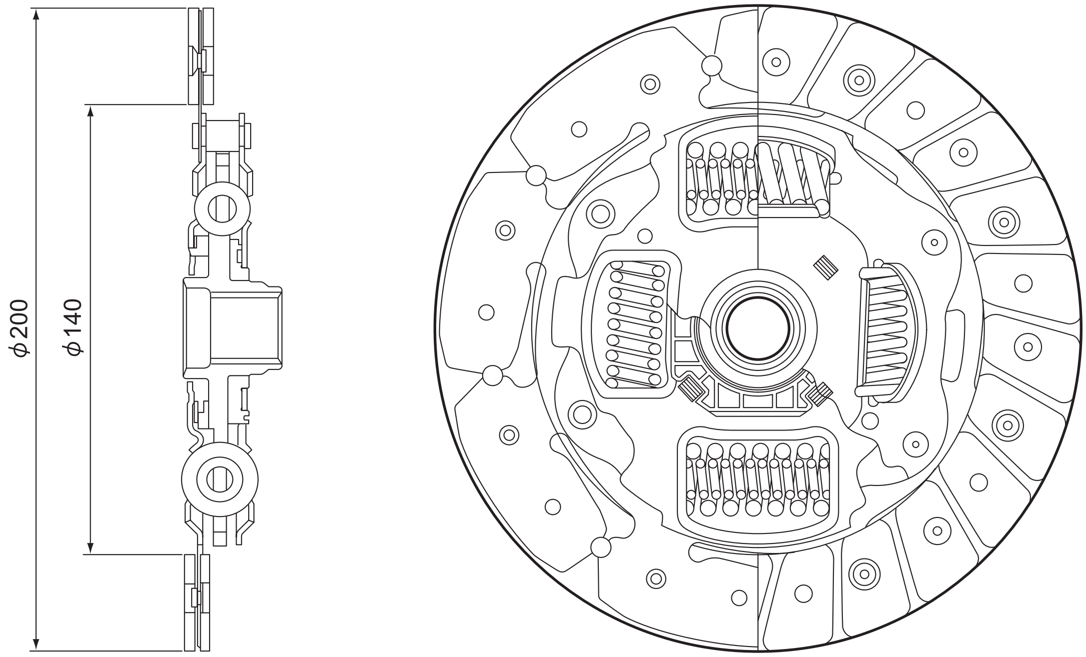
- A diaphragm spring clutch cover is employed.



Clutch Disk

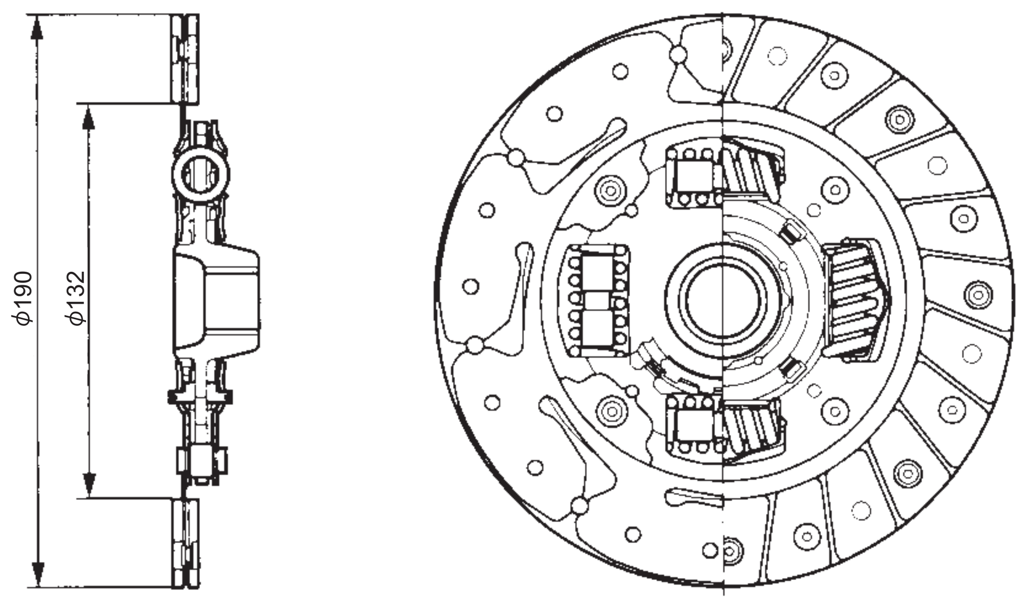
- A dry single-plate clutch disk 200 mm in outside diameter is employed for the 3SZ-VE engine.
- The K3-VE engine employs a dry single-plate clutch disk 190 mm in outside diameter.

3SZ-VE



A1270007P-D

K3-VE



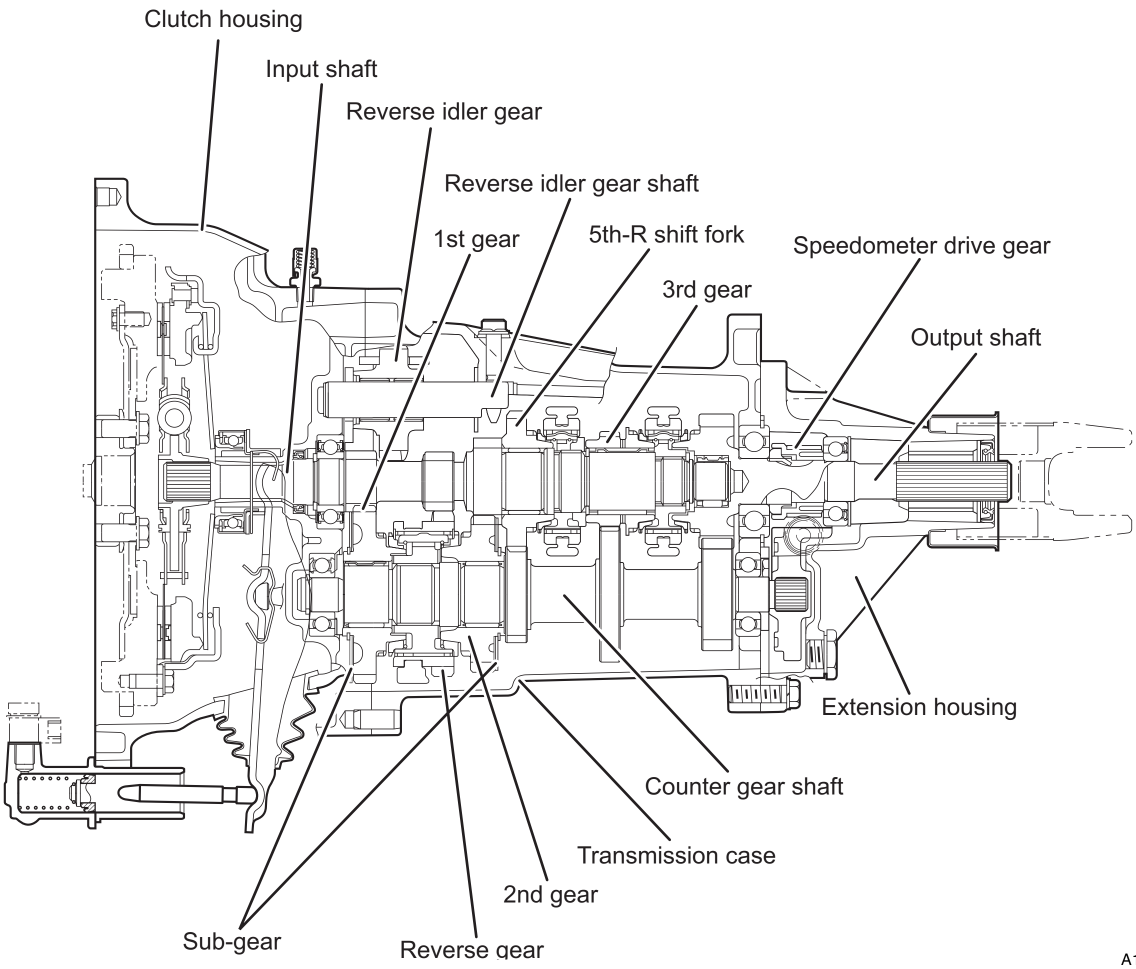
A1270211P-D

MANUAL TRANSMISSION (M5S)

Outline of Manual Transmission

- The vehicle employs an M5S transmission.
- Each portion of the transmission has been reinforced to adapt to the 3SZ-VE engine.

Models equipped with the 3SZ-VE (2WD models)



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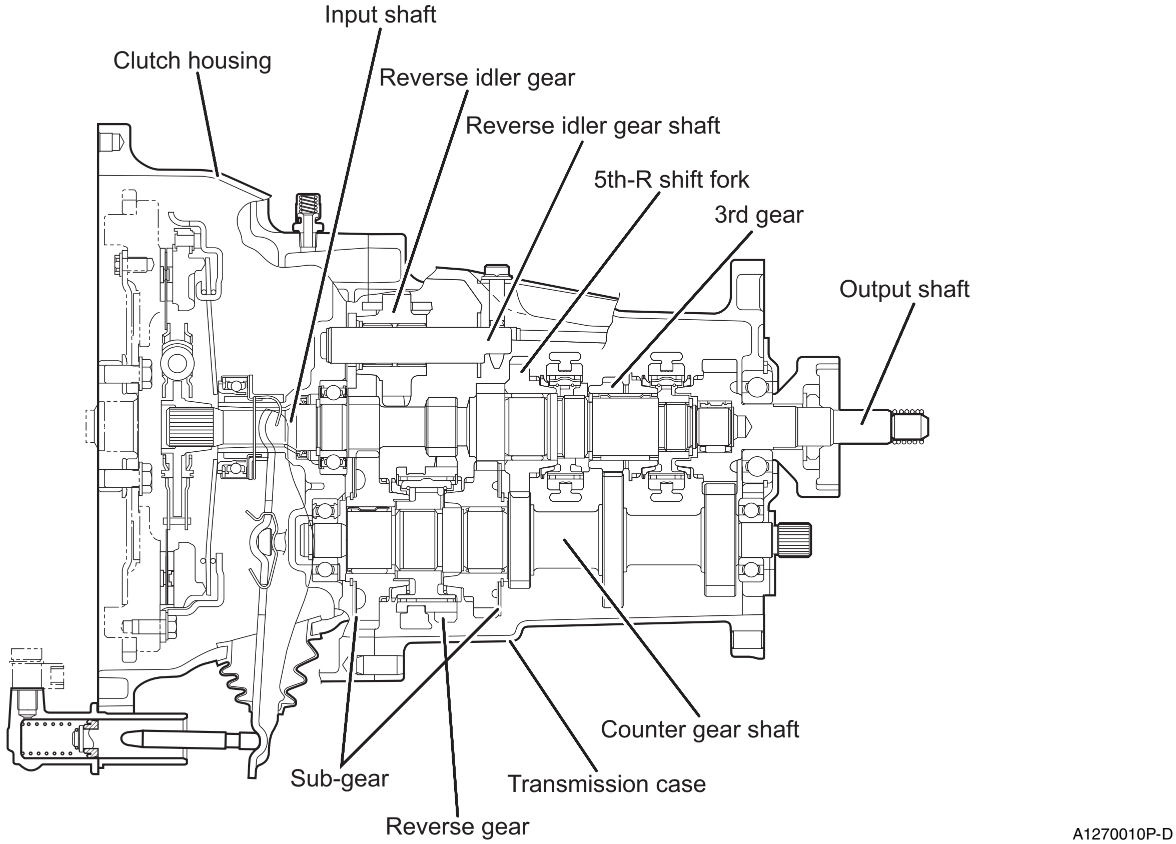
Models equipped with 3SZ-VE (4WD models)

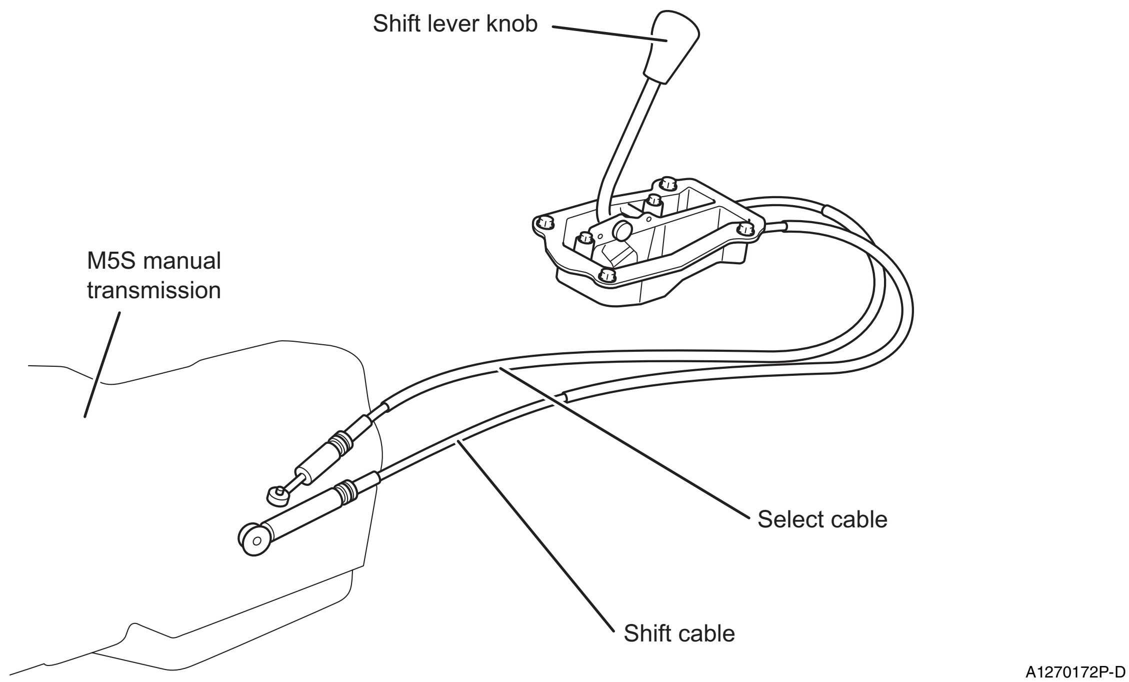


Transmission specifications

Engine		3SZ-VE		K3-VE
Drive system		2WD	4WD	4WD
Transmission type		M5S-CB	M5S-CC	M5S-CA
Number of speeds		5	←	←
Reduction ratio	1st	3.769	←	←
	2nd	2.045	←	←
	3rd	1.376	←	←
	4th	1.000	←	←
	5th	0.838	←	←
	Rev	4.128	←	←
Speedometer gear	Number of drive gear teeth (color code)	6	←	None
	Number of driven gear teeth (color code)	22 (None)	23 (Yellow)	None

Shift Control

- A remote control system using two push-pull cables has been employed for the shift control mechanism. The housing is made of aluminum alloy to improve rigidity and shifting feel.

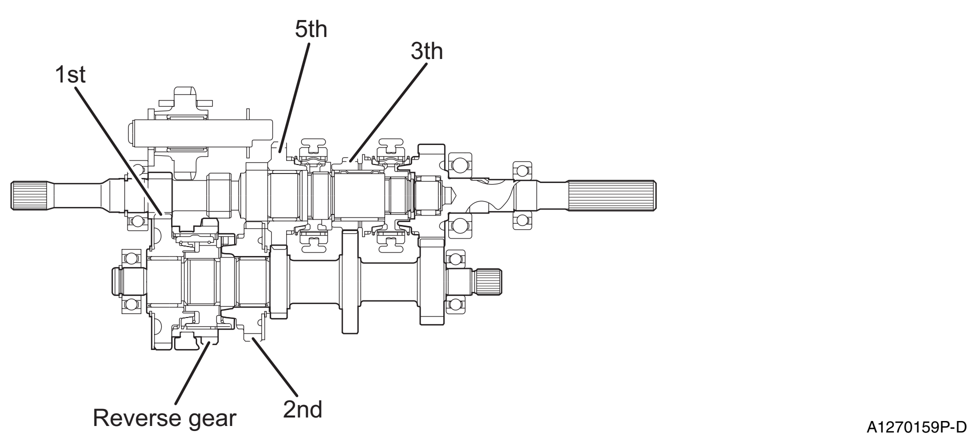


Casing

- A sectional type casing is employed to improve rigidity.
- The casing consists of a clutch housing, a transmission case and an extension housing (2WD models).
- These casings are made of aluminum alloy for weight saving. Ribs are arranged effectively to make the casings smaller in size and lighter in weight.

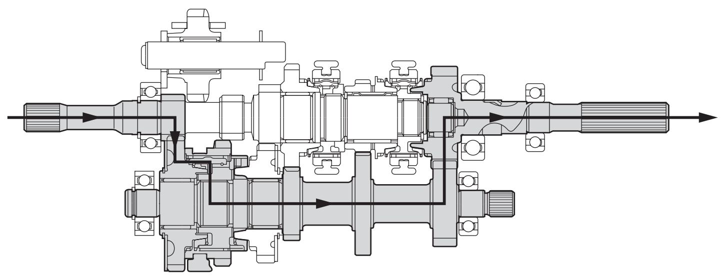
Gear Train

- The gear train uses the 4th gear as the direct gear and the 5th gear as the overdrive gear. The gears are arranged in the order of 1st gear, reverse gear, 2nd gear, 5th gear, 3rd gear and output reduction gear, when viewed from the front side.



Operation of M5S Gear Train

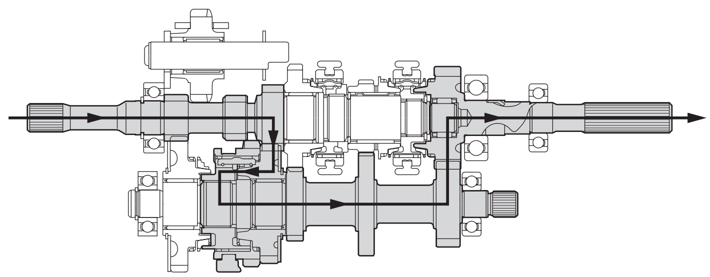
1st



1st

A1270013P-D

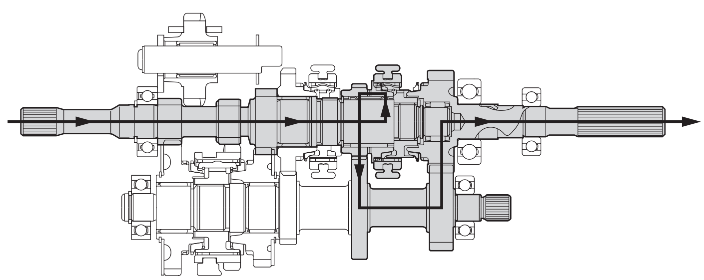
2nd



2nd

A1270014P-D

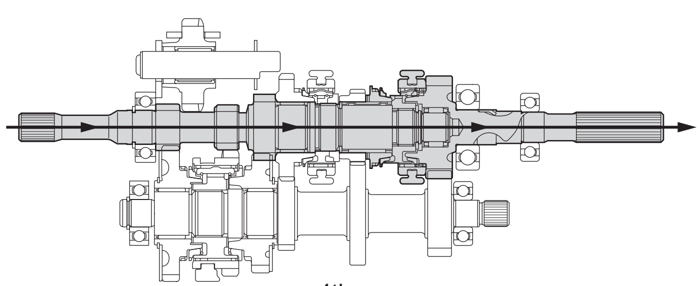
3rd



3rd

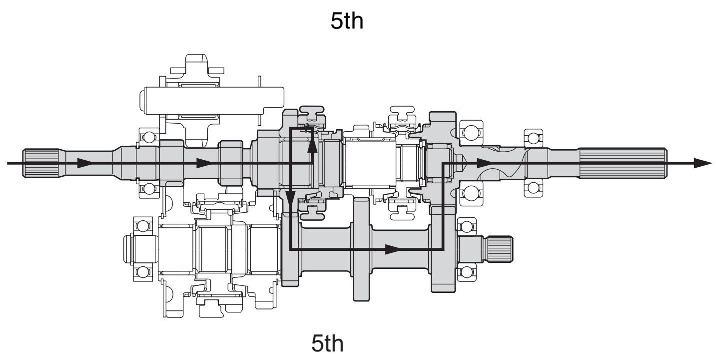
A1270015P-D

4th



4th

A1270016P-D



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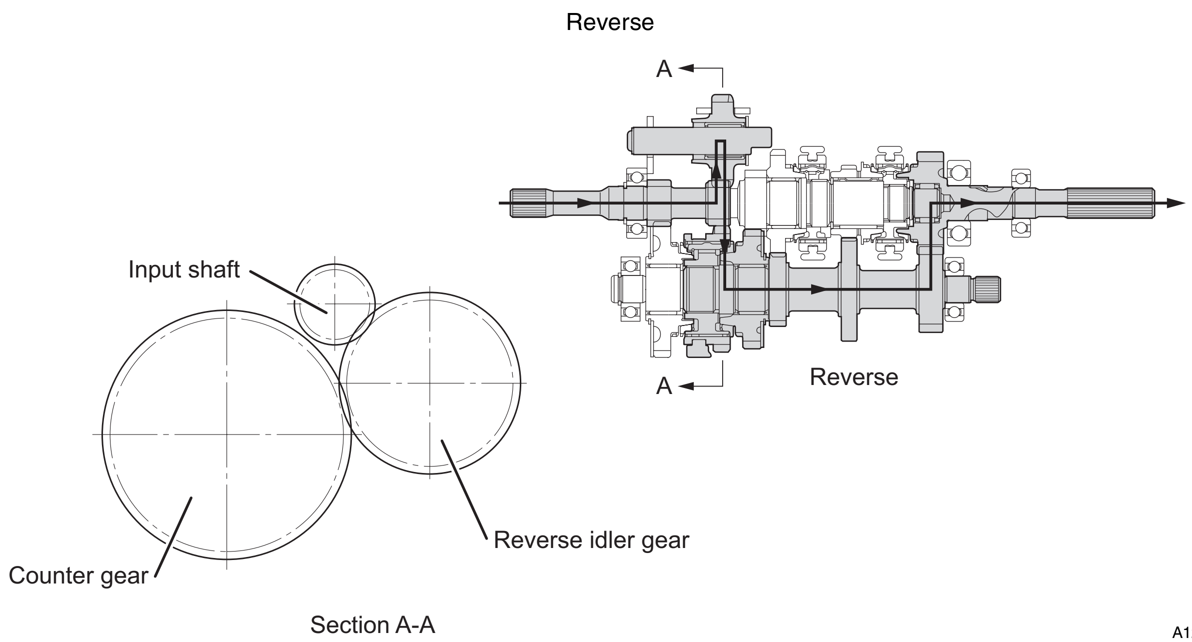
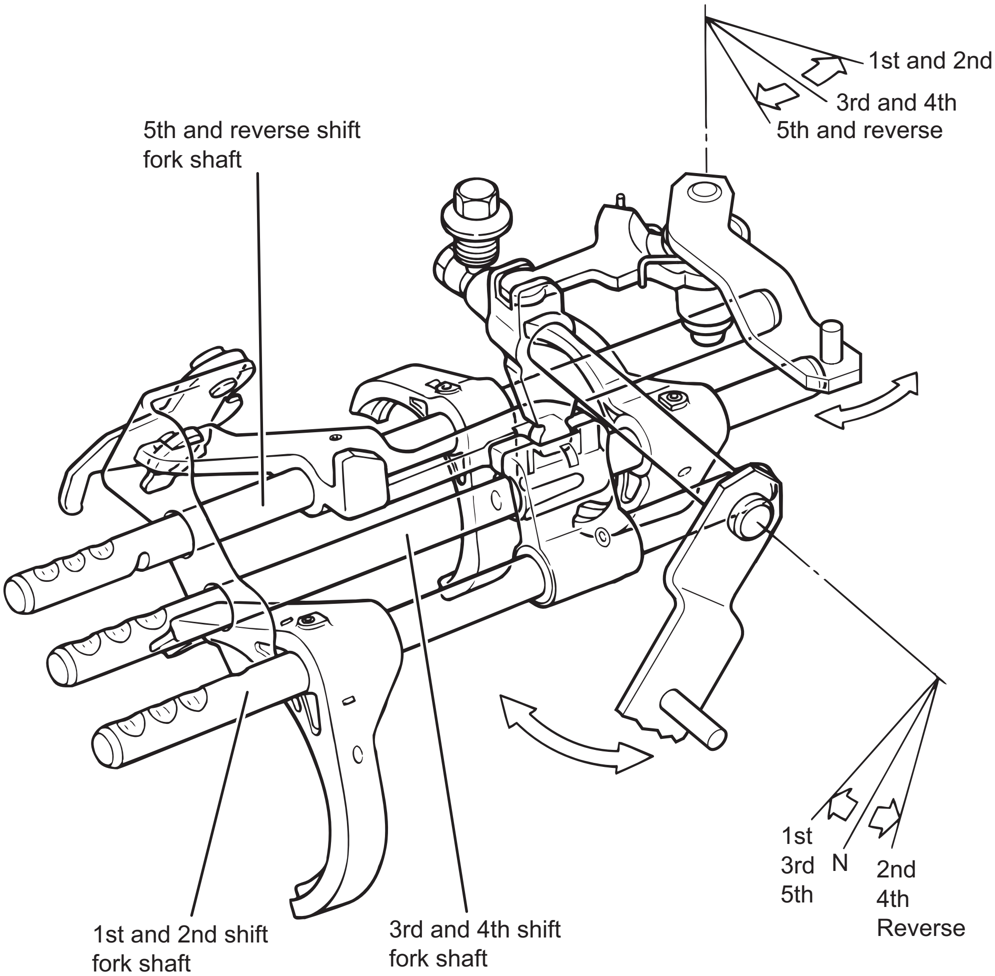


A1270018P-D

Shift and Select Mechanism

- The shift and select mechanism employs a shift and select cable-operated remote control system.
- An inter cam lock type is employed for the double engagement prevention mechanism to make the control system more compact.
- The shift fork is made of aluminum alloy for weight saving.



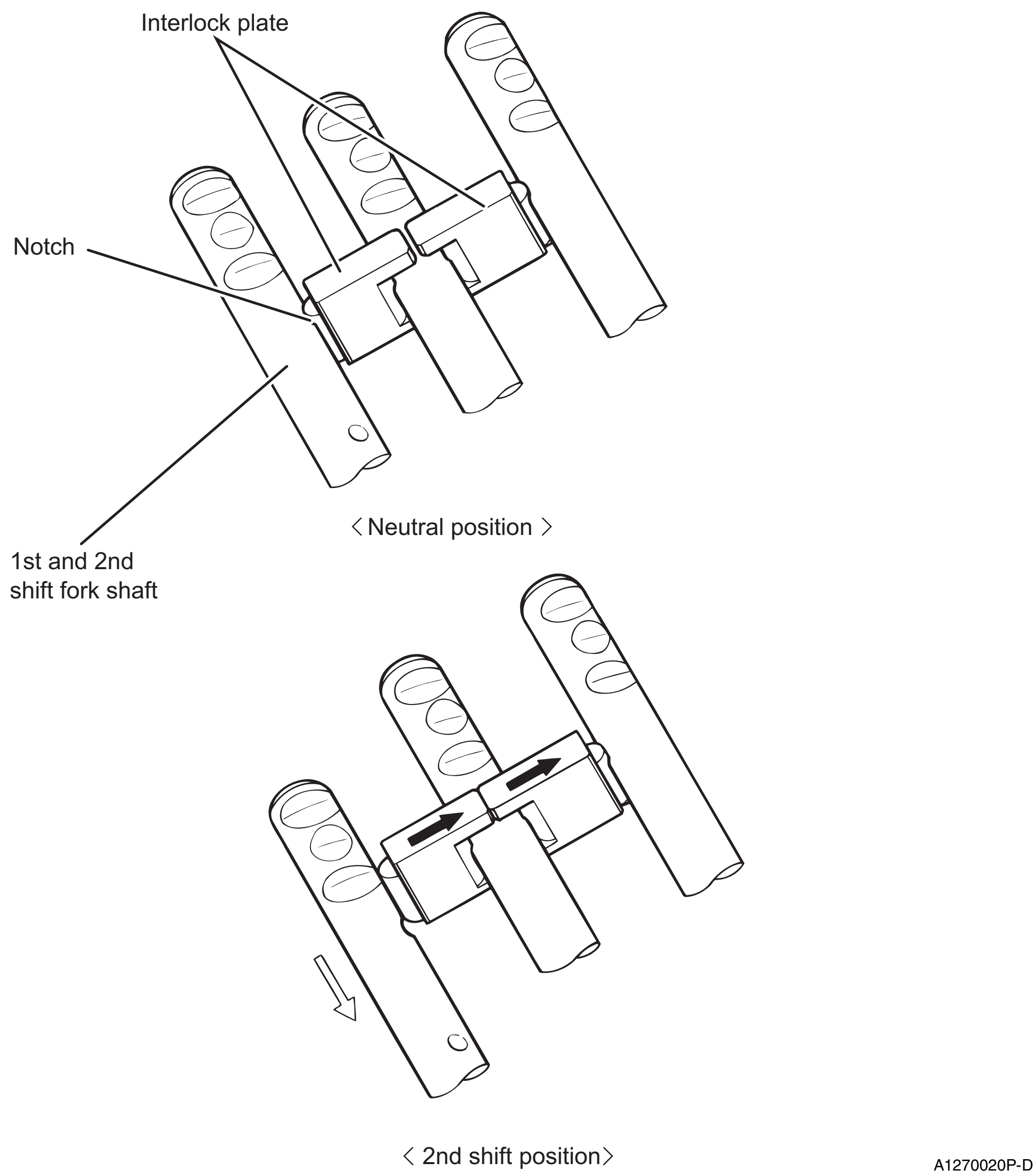
A1270019P-D

Double Engagement Prevention Mechanism

- The double engagement prevention mechanism aimed at preventing two or more gears from being shifted simultaneously is composed of two interlock plates.

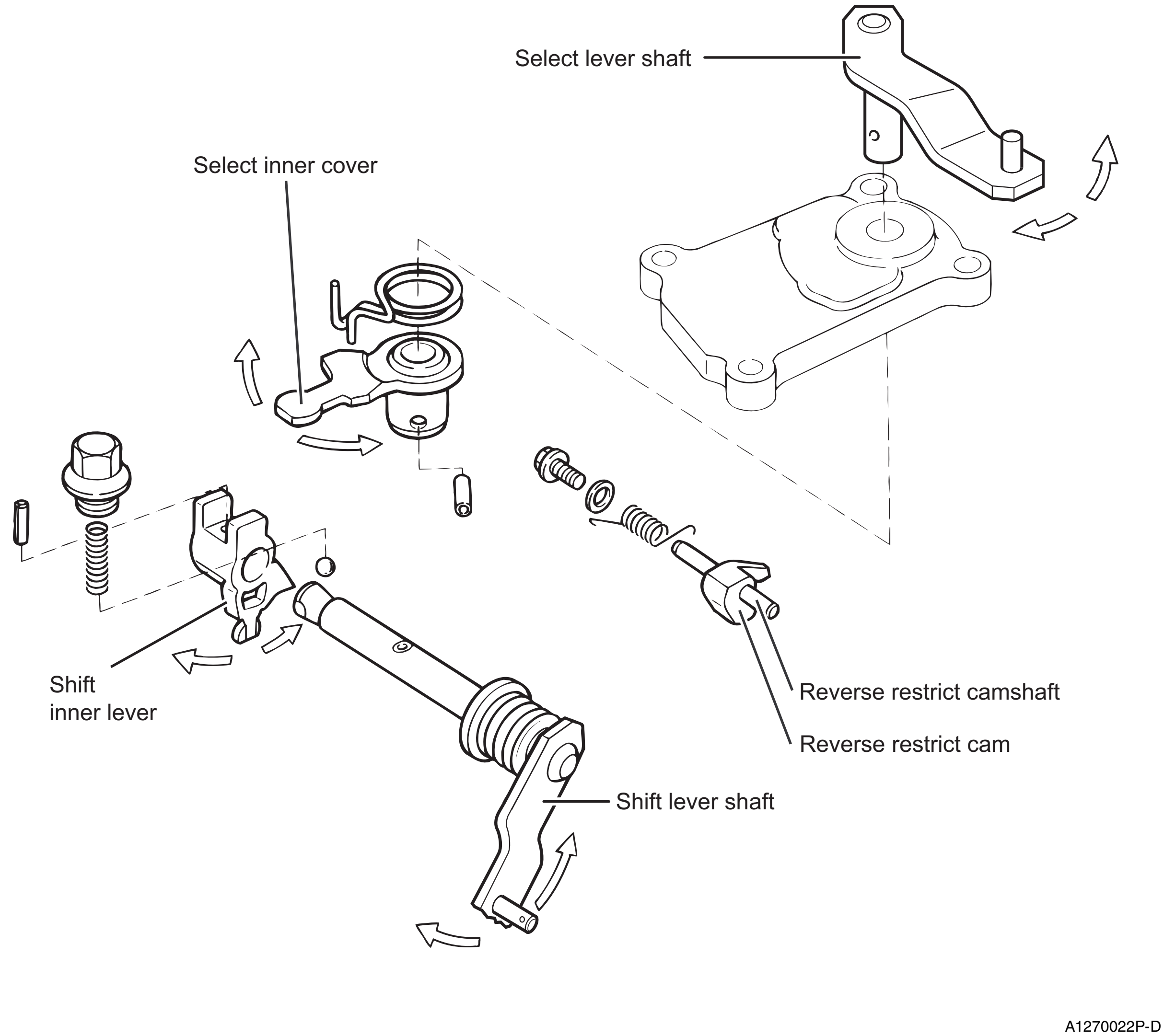
Operation

- When the 1st and 2nd shift fork shaft slides simultaneously in their axial direction from the Neutral position, an interlock plate comes off the notch in the shaft and is pushed to the right-hand side in the figure. As a result, the other interlock plate pushes the notch in the 5th and shift fork shaft, and therefore the 3rd and 4th shift fork shaft and the 5th and reverse shift fork shaft are locked to prevent two or more gears from being engaged simultaneously.



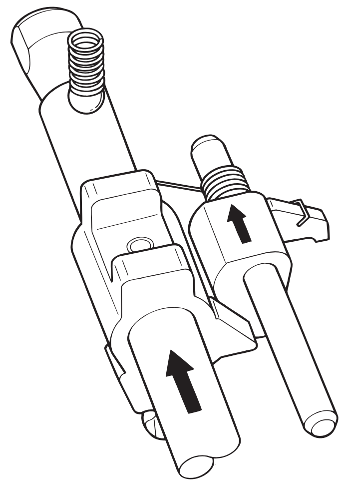
Reverse Shift Error Prevention Mechanism

- The reverse shift error prevention mechanism prevents gear shifting from the 5th gear directly to the reverse gear during driving.
- To shift from the 5th gear to the reverse gear, the shift lever has to be returned to the Neutral position temporarily.



When shifting to 5th or reverse gear

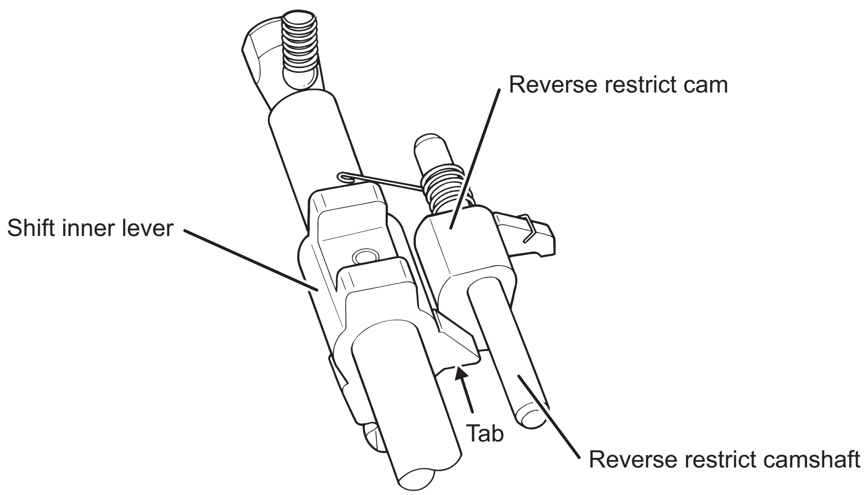
- When the 5th or reverse gear is selected, the lug on the shift inner lever pushes and slides the reverse restrict cam in the direction of the arrow shown in the figure below.



5th and reverse. selected

A1270026P-D

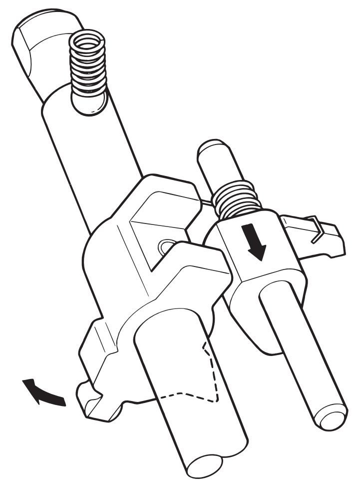
Gears in Neutral position



A1270027P-D

When shifting to 5th gear

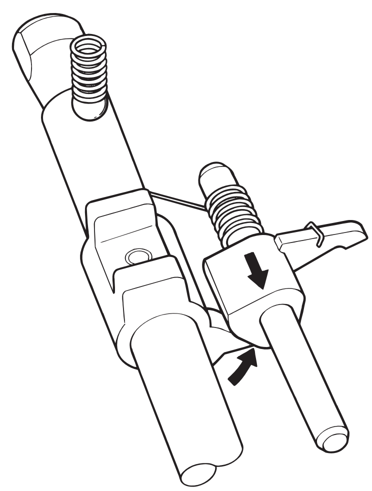
- When gears are shifted to the 5th-speed position after that, the lug on the shift inner lever comes off the reverse restrict cam and returns by spring force to the Neutral position.



A1270024P-D

When shifting from 5th gear directly to reverse gear

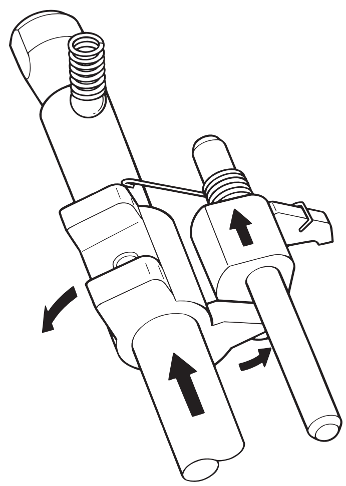
- If an attempt to shift from the 5th gear directly to the reverse gear is made, the lug on the shift inner lever comes into contact with the back of the reverse restrict cam and blocks it from turning further, thus preventing gears from being shifted directly to the Reverse position.



A1270023P-D

When shifting from a gear other than 5th gear to reverse gear

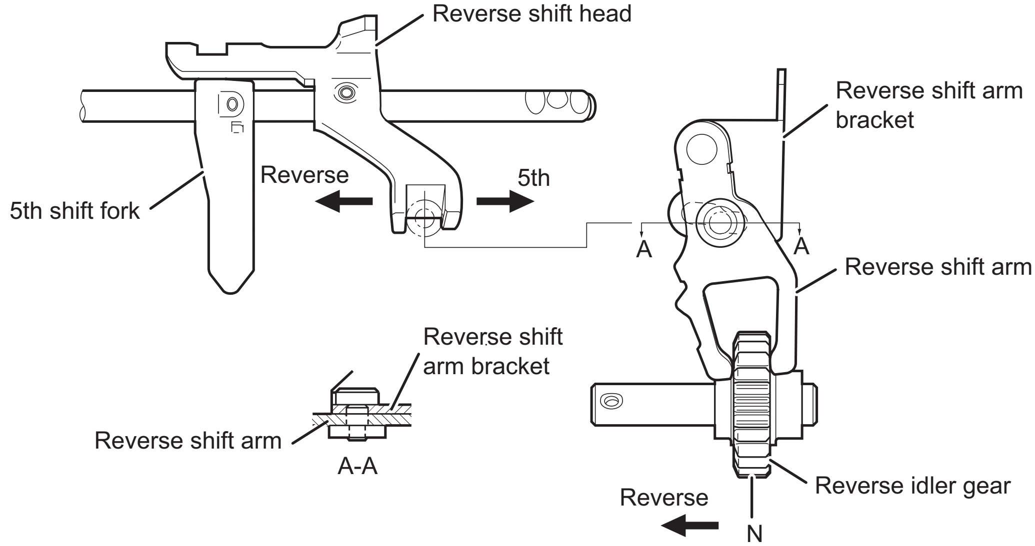
- When the shift lever is placed in the reverse position, the lug on the shift inner lever pushes and slides the reverse restrict cam in the direction of the arrow in the figure below. As a result, the shift inner lever turns until the upper surface of the tab comes into contact with the reverse restrict cam shaft to shift gears to the Reverse position.



A1270025P-D

Reverse Shift Arm Single Movement Mechanism

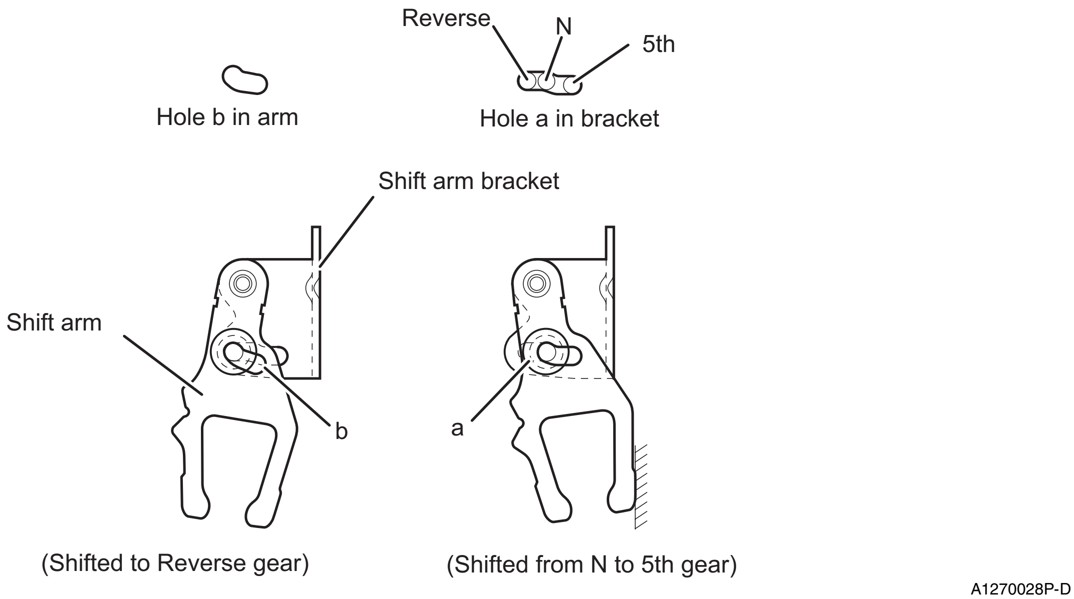
- The reverse shift arm movement restricting mechanism is so constructed that the reverse shift arm functions only when the reverse shift head, which moves toward both the 5th gear and the reverse gear, is shifted to the reverse side.



A1270029P-D

Operation

- When gears are shifted to the reverse position, the pin engaged with the reverse shift head moves along hole (a) in the reverse shift arm bracket and the reverse shift arms moves the reverse idler gear to the position where it engages with the reverse gear.
- In the neutral position, however, the hole (b) in the reverse shift arm is in agreement with the hole (a) in the reverse shift arm bracket, as shown in the figure below. Therefore, shifting the gears to the 5th-speed position moves only the pin but not the reverse shift arm.

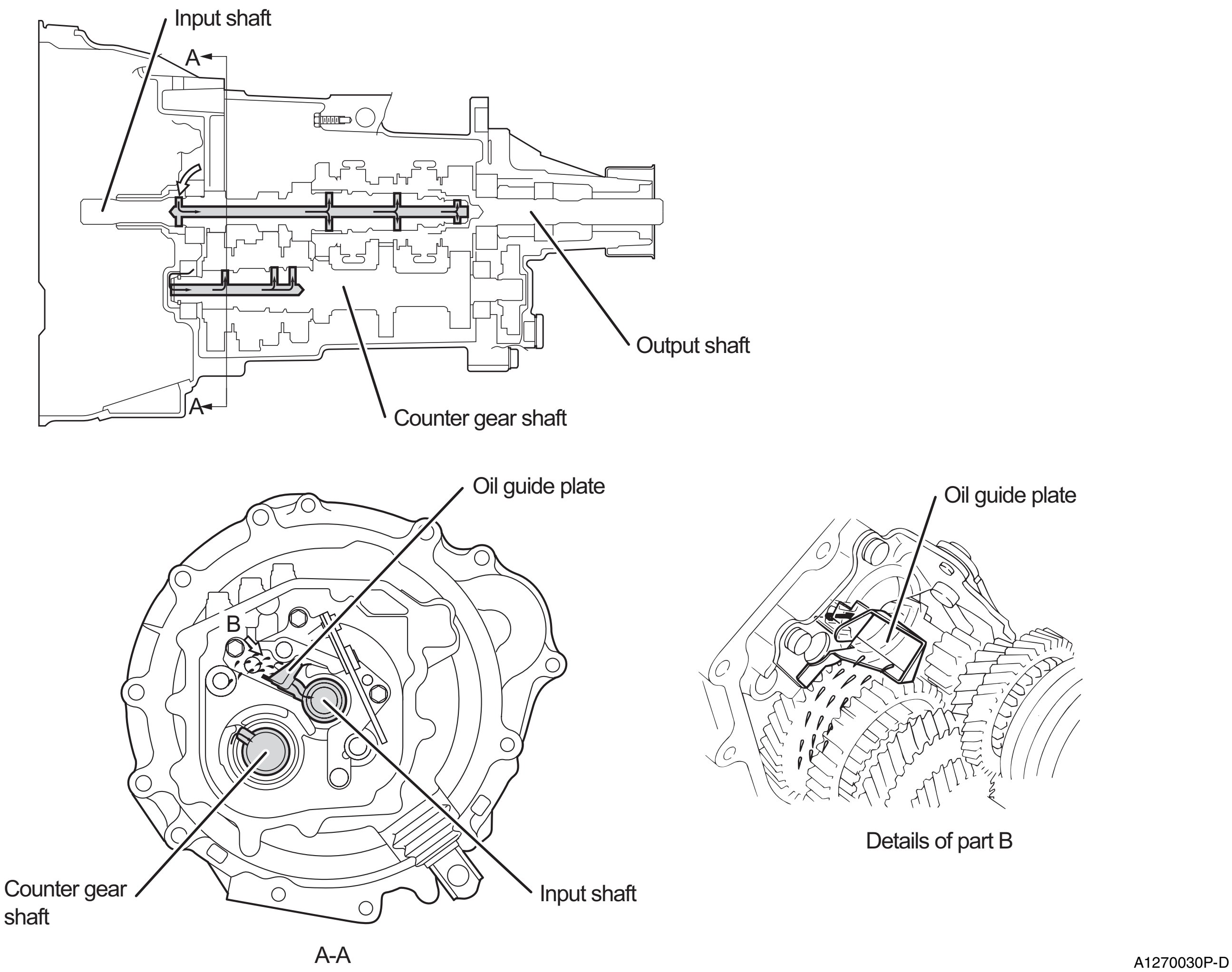


Lubrication Mechanism

- The shaft center lubricating method is used for lubricating the transmission case to improve lubrication efficiency and improve reliability.
- An oil slinger is used for oil sump lubrication of the extension housing to improve lubrication efficiency and reliability.
- A dedicated large metal dust collection magnet is used to improve the ability to collect dust.

Lubrication in Transmission Case

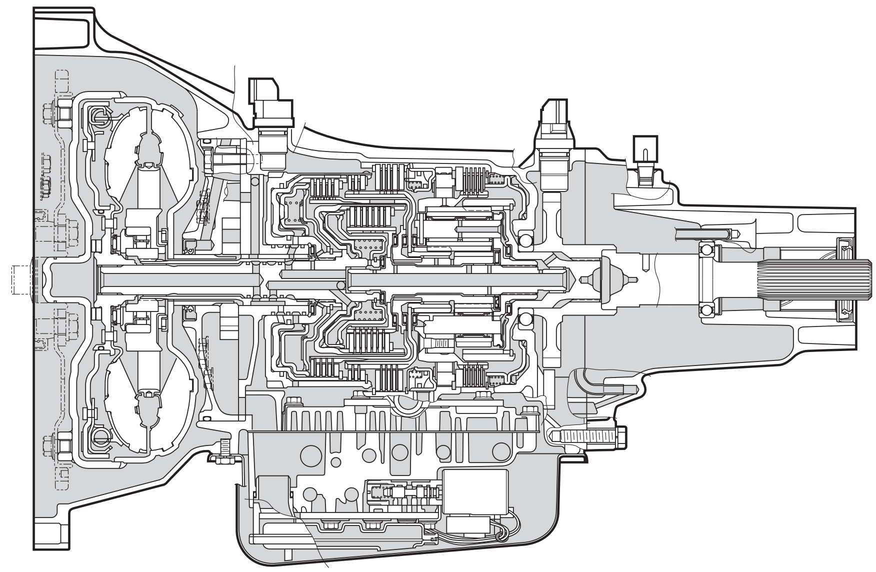
- Oil scooped up mainly by the 1st gear is led into the input shaft center by the guide plate integral with the reverse shift arm bracket. Then, the oil runs along the shaft center to lubricate the 5th gear, the 3rd gear and the needle bearing at the rear end of the input shaft.
- On the counter gear side, oil runs trough the oil groove on the clutch housing side and enters the shaft center from the front end of the shaft. Then, it lubricates the needle bearings of the 1st and 2nd gears.


Input shaft
A
Output shaft
A
Counter gear shaft
Oil guide plate
B
Counter gear shaft
Input shaft
A-A
Oil guide plate
Details of part B
A1270030P-D

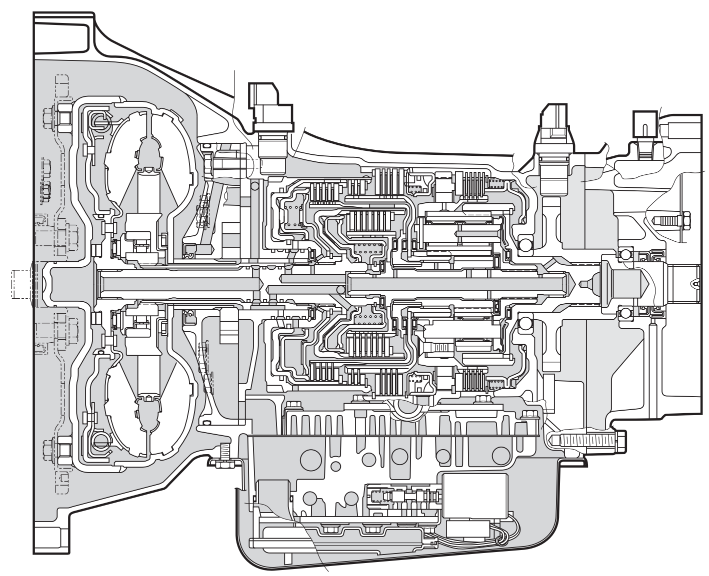
ELECTRONICALLY CONTROLLED AUTOMATIC TRANSMISSION (A4Q)

Automatic Transmission in General

- The newly developed A4Q-D1 automatic transmission is employed.
- This automatic transmission is provided with a means of directly controlling gear shift control elements hydraulically and electronically to improve transmission efficiency and ensure smooth and responsive gear shifting.



<2WD>



<4WD>

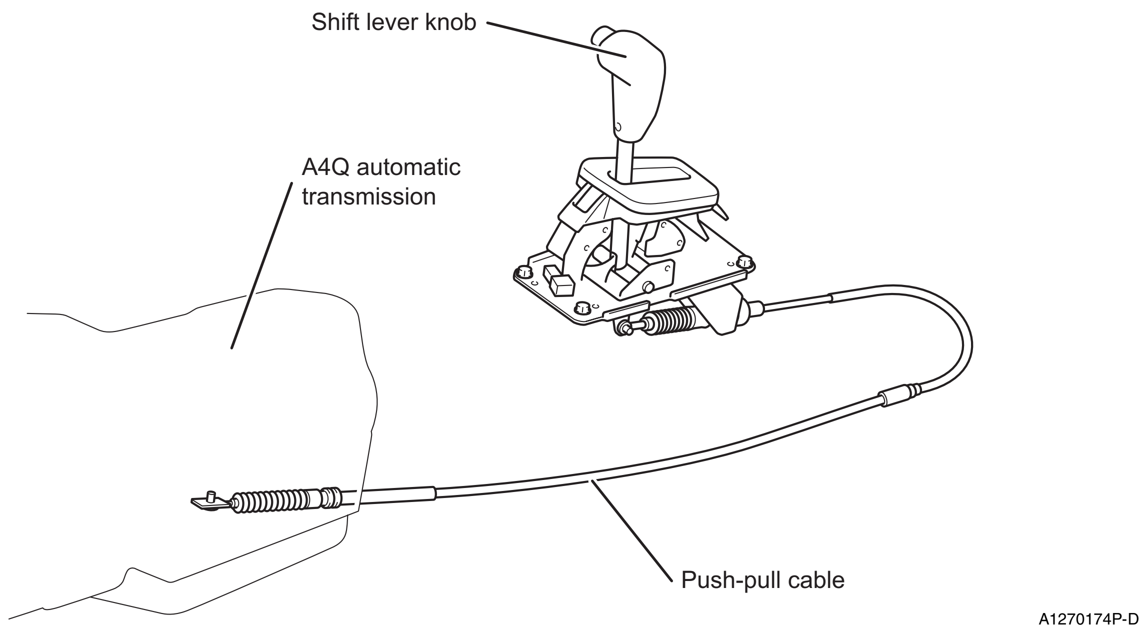
A1270037P-D

Automatic transmission specifications

Transmission type		A4Q-D1	
Engine type		3SZ-VE	
Drive system		2WD	4WD
Torque converter type		Three-control element, one stage, two-phase torque converter with lock-up mechanism	←
Engine stalling torque ratio		1.88	←
Number of speeds		4 forward speeds and 1 reverse speed	←
Reduction ratio	1st	2.730	←
	2nd	1.526	←
	3rd	1.000	←
	4th	0.696	←
	Reverse	2.290	←
Number of planetary gear teeth	Number of front planetary gear teeth	31	←
	Planetary long pinion	20	←
	Rear planetary sun gear	26	←
	Planetary short pinion	19	←
	Planetary ring gear	71	←
Gear shift control system		Electronically and hydraulically controlled planetary gear system	←
Clutches and brakes	C1	2	←
	C2	4	←
	C3	6	←
	B1	4	←
	B2	5	←
Manual control patterns		P-R-N-D-2-L	←
ATF	Name	DEXRON-III	←
	Quantity	Approx. 4.6 L	←
Oil cooling system		Water cooling by means the oil cooler built into the radiator	←

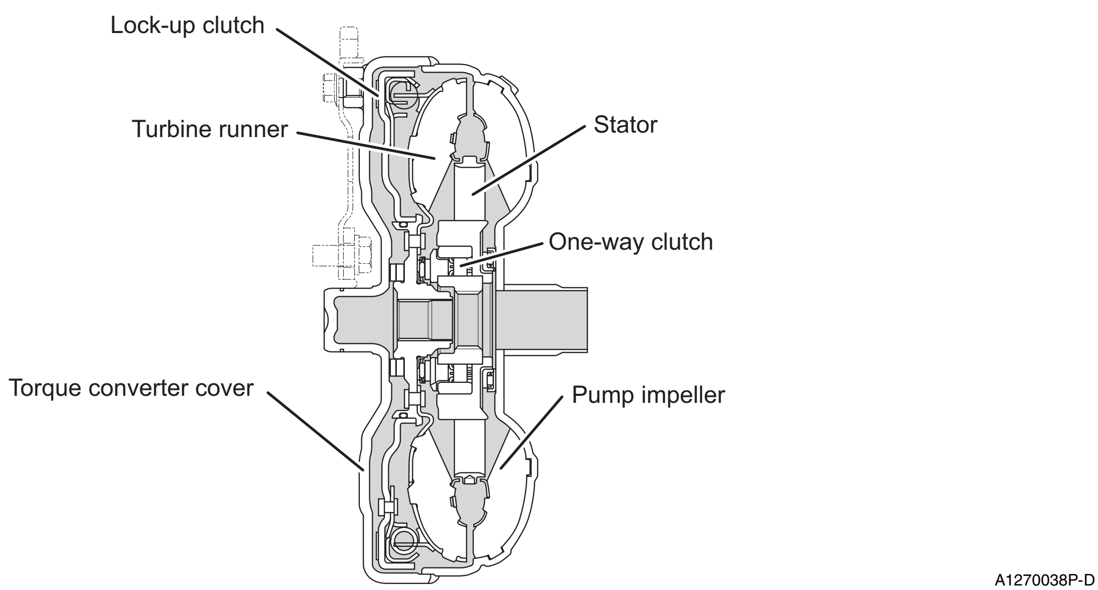
Shift Control

- A push-pull cable-operated remote control system is employed for the shift control system. It is a floor shift system with 6 shift lever positions: P, R, N, D, 2 and L (with an O/D ON-OFF switch).



Torque Converter

- A three-control element, one-stage, two-phase torque converter with a lock-up mechanism is employed.
- The torque converter is composed of a pump impeller integral with a torque converter cover with a drive plate, a turbine runner with a spline fitted in the input shaft on the transmission side, a stator, a one-way clutch that supports the stator, a lock-up clutch, etc.



Gear Train

- In the drive train, driving force transmitted from the engine to the input shaft through the torque converter is transferred to the planetary gears through clutches and brakes to change speed.
- The drive train is a Ravineaux planetary gear train. It has the same structure as a conventional unit but is smaller in size.
- The Ravineaux planetary gear train is composed of a front planetary sun gear, a rear planetary sun gear, a planetary short pinion, a planetary long pinion, a planetary carrier, a planetary ring gear, etc.
- The clutch pistons have clutches with a centrifugal hydraulic canceling mechanism to ensure that the gear shift control elements regulate

hydraulic pressures with a high degree of accuracy.

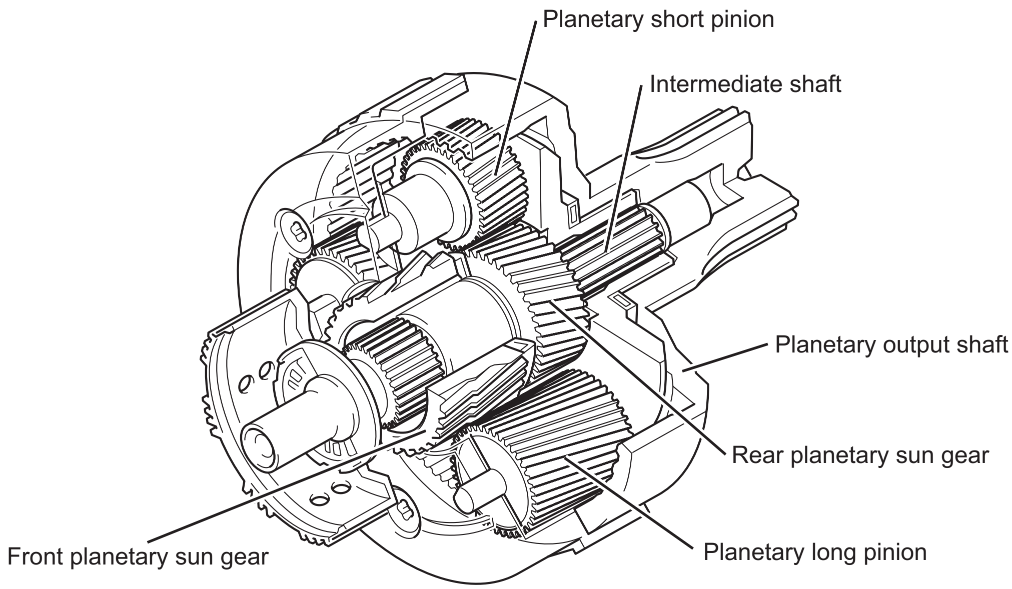
- The gear shift control elements refer to three wet multi-plate clutches and two brakes: reverse clutch (C1), forward clutch (C2), rear clutch (C3), 2nd and 4th brake (B1), and 1st and reverse brake (B2).
- For the pistons of the reverse clutch (C1), forward clutch (C2) and rear clutch (C3), clutches with a centrifugal hydraulic pressure canceling mechanism are provided to achieve fine control of hydraulic pressures and smooth gear shifting.

Functions of gear shift control elements

Gear shift control elements		Functions
C1	Reverse clutch	Couples the input shaft with the front planetary sun gear.
C2	Forward clutch	Couples the input shaft with the rear planetary sun gear.
C3	Rear clutch	Couples the input shaft with the intermediate shaft (→planetary carrier).
B1	2nd and 4th brake	Locks the front planetary sun gear.
B2	1st and reverse brake	Blocks the planetary carrier from rotating.
F	One-way clutch	Blocks the planetary carrier from rotating counterclockwise.

Structure of Ravineaux Planetary Gear

- The Ravineaux planetary gear train is composed of an intermediate shaft, a front planetary sun gear, a rear planetary sun gear, a planetary short pinion, a planetary long pinion and a planetary ring gear.
- Driving force is input to the Ravineaux planetary gear train through three routes: intermediate shaft, front planetary sun gear and rear planetary sun gear.
- Driving force is output through a single route: planetary ring gear, and transmitted to the differential gear through the planetary output shaft.
- To achieve the gear ratio of the four-forward-speed, one-reverse-speed transmission, driving force input routes are changed by switching from one frictional element to another, and the planetary short and long gears that revolve around the planetary sun gears are locked or unlocked.



Structure of A4Q Gear Train

- There are four power transmission routes, three of which are input routes: the route from the input shaft to the front planetary sun gear via clutch C1, the route to the rear planetary sun gear via clutch C2, and the route to the intermediate shaft (→planetary carrier) via clutch C3. On the other hand, one of them is also an output route: route from the planetary ring gear to the output shaft.

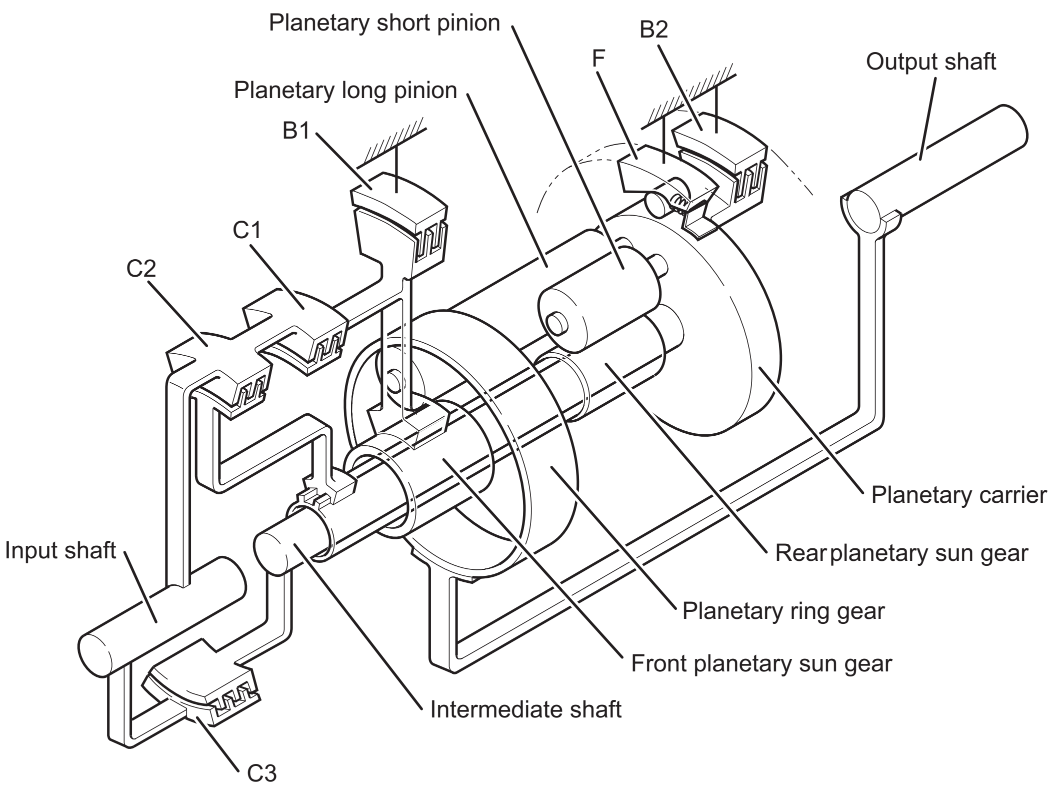


Table of operations of gear shift control elements

Gear position	C1	C2	C3	B1	B2	F
Reverse	❍				❍	

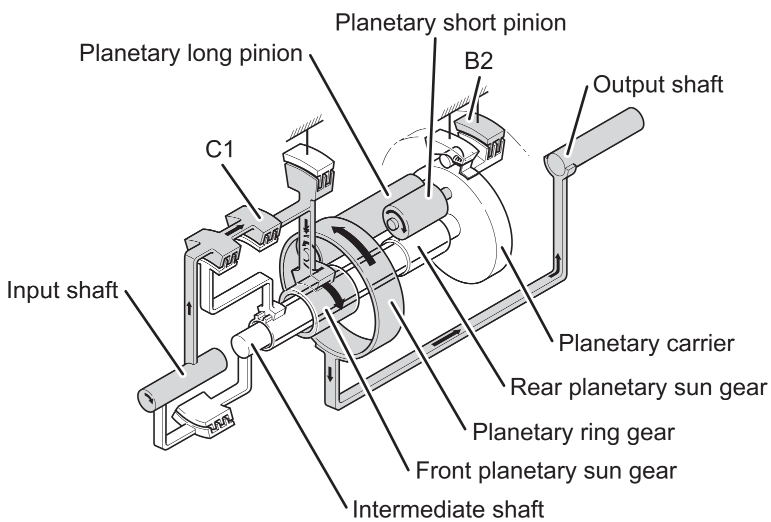
Gear position	C1	C2	C3	B1	B2	F
Neutral						
1st (D•2)		❍				❍
2nd		❍		❍		
3rd		❍	❍			
4th			❍	❍		
1st (L)		❍			❍	❍

Operation of A4Q Gear Train

- The operation of the gear train in each shift lever position is as follows.

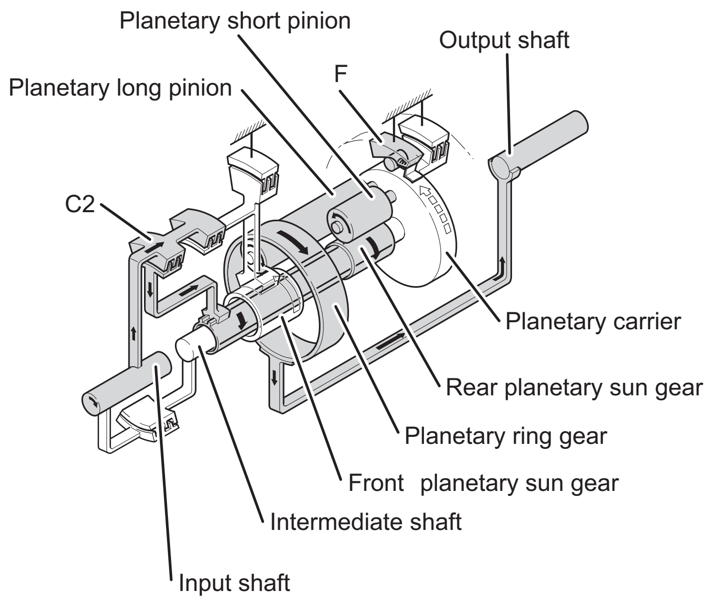
R gear

- In the case of the reverse gear, the reverse clutch (C1) and the 1st and reverse brake work and shift gears to reverse, and therefore the output shaft rotates counterclockwise.
- Since the reverse clutch (C1) is working at that time, as shown in the figure below, the turning force of the input shaft is transmitted directly to the front planetary sun gear.
- On the other hand, the clockwise turning force transmitted by the action of the 1st and reverse brake (B2) rotates the planetary long pinion counterclockwise, as a result of which the output shaft coupled with the planetary ring gear rotates counterclockwise.



D- or 2nd-position 1st gear (engine brake not applied)

- In the case of the 1st gear in the D or 2nd position, the forward one-way clutch (C2) works, allowing the output shaft to rotate clockwise.
- Since the forward clutch (C2) is working at that time, as shown in the figure below, the turning force of the input shaft is transmitted directly to the rear planetary sun gear, which then transmits clockwise turning force to the planetary short pinion.
- On the other hand, the planetary long pinion, which is engaged with the planetary short pinion and receives clockwise turning force, tries to rotate the planetary carrier counterclockwise. However, since the one-way clutch (F) blocks the planetary carrier from rotating, the planetary ring gear receiving clockwise turning force rotates the output shaft clockwise.



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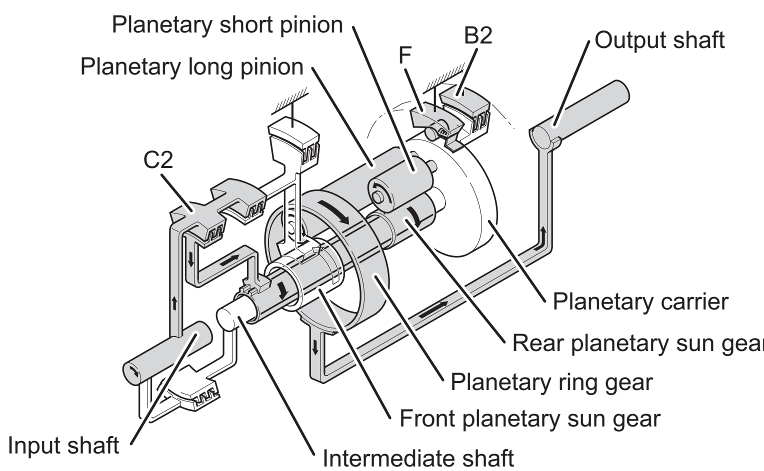
L-position 1st gear (engine brake applied)

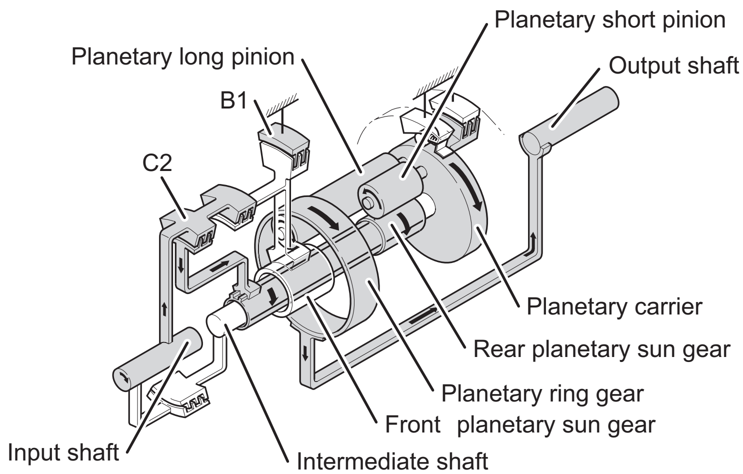
- Although turning force is transmitted in the same way as in the case of the 1st gear (D or 2nd) described above, the 1st and reverse brake (B2) blocks the planetary carrier from rotating clockwise. That is, when the 1st gear (D or 2nd) works, the one-way clutch (F) blocks the planetary carrier from rotating counterclockwise, allowing turning force to be transmitted to the planetary ring gear.
- When the engine brake is applied, however, the one-way clutch does not operate because of force applied in the opposite direction and the planetary carrier idles, so the 1st and reverse brake (B2) locks the planetary carrier to make the engine brake take effect.



A1270046P-D

2nd gear

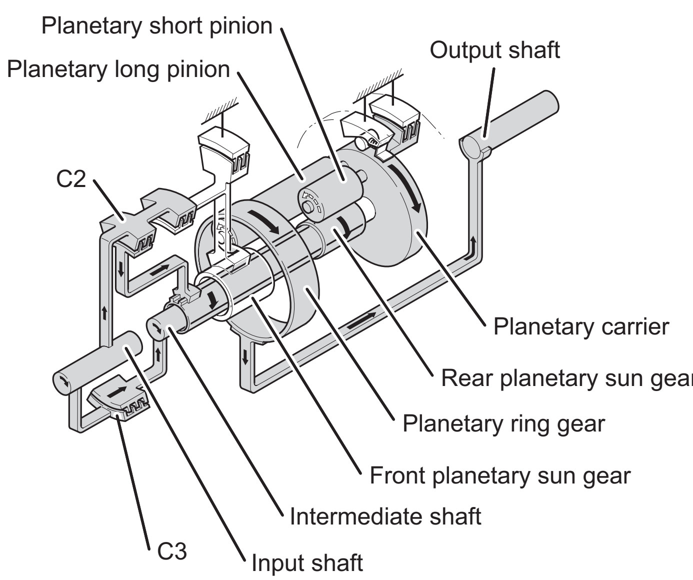
- In the case of the 2nd gear, the forward clutch (C2) and the 2nd and 4th brake (B1) work, allowing the output shaft to operate clockwise.
- Since the forward clutch (C2) is working at that time, as shown in the figure below, turning force is transmitted directly to the rear planetary sun gear, which then transmits counterclockwise turning force to the planetary short pinion.
- On the other hand, since the front planetary sun gear is locked by the 2nd and 4th brake (B1), the planetary long pinion engaged with the planetary short pinion receives clockwise turning force and revolves clockwise around the front planetary sun gear while rotating on its axis, transmitting clockwise turning force to the output shaft. Then the planetary ring gear transmits clockwise turning force to the output shaft.



A1270042P-D

3rd gear

- In the case of the 3rd gear, the forward clutch (C2) and the rear clutch (C3) work, allowing the output shaft to rotate clockwise.
- Since the forward clutch (C2) and the rear clutch (C3) are working at that time, as shown in the figure below, the input shaft, the rear planetary sun gear and the planetary carrier rotate in the same direction. Therefore, the planetary short pinion and the planetary ring gear receive and transfer clockwise turning force to the output shaft.



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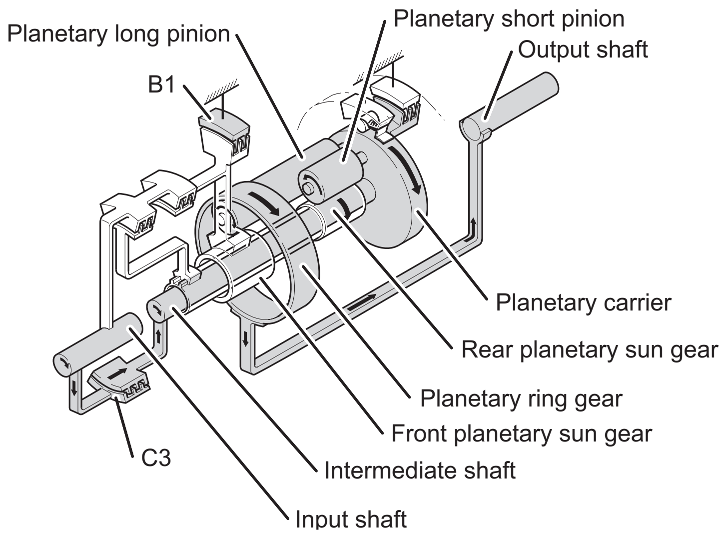
4th gear

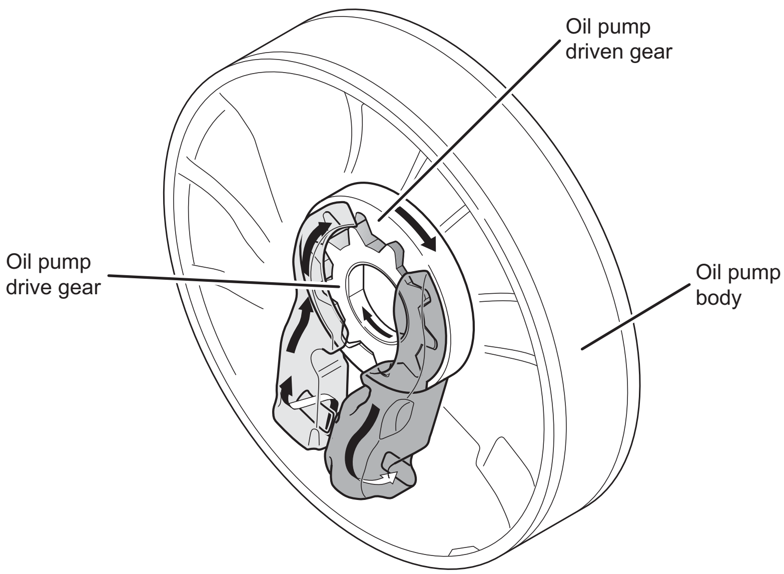
- In the case of the 4th gear, the rear clutch (C3) and the 2nd and 4th brake (B1) work and the output shaft rotates clockwise.
- Since the rear clutch is working at that time, as shown in the figure below, the tuning force of the input shaft is transmitted directly to the intermediate shaft, which then transmits clockwise turning force to the planetary carrier.
- On the other hand, since the front planetary sun gear is locked by the 2nd and 4th brake (B1), the planetary long pinion supported by the planetary carrier revolves around the front planetary sun gear while rotating on its axis, as a result of which the planetary ring gear rotates clockwise.
- Then, the planetary ring gear transmits clockwise turning force to the output shaft.



A1270044P-D

Oil Pump

- A non-crescent oil pump is employed to increase efficiency.
- A pump which has no crescent (non-crescent pump) but has a driven gear smaller in size than those of conventional pumps is used to reduce the load the pump applies when it is operated.
- The oil pump is composed of an oil pump body, an oil pump drive gear and an oil pump driven gear. Using the gear driven by the torque converter, it feeds automatic transmission oil forcibly to the hydraulic control system.



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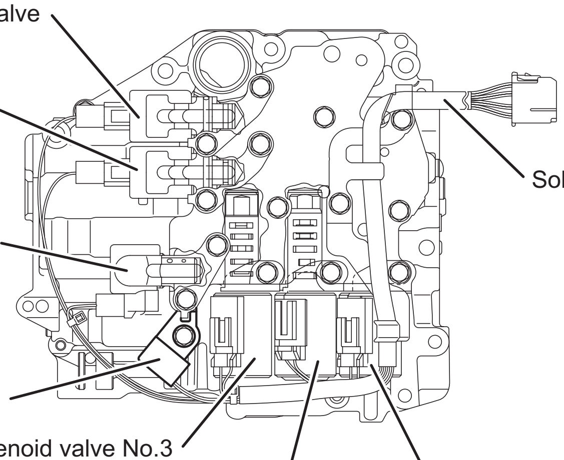
Hydraulic Control Unit

- Using the hydraulic pressure produced by the oil pump, the hydraulic control system regulates and switches hydraulic pressures to operate each gear shift control element of the drive train according to the driving conditions, feeds hydraulic oil into transmission case to lubricate gears, etc.
- The hydraulic control system is composed of an oil pump for producing hydraulic pressure and a valve body for regulating the hydraulic pressure of each gear shift control element.

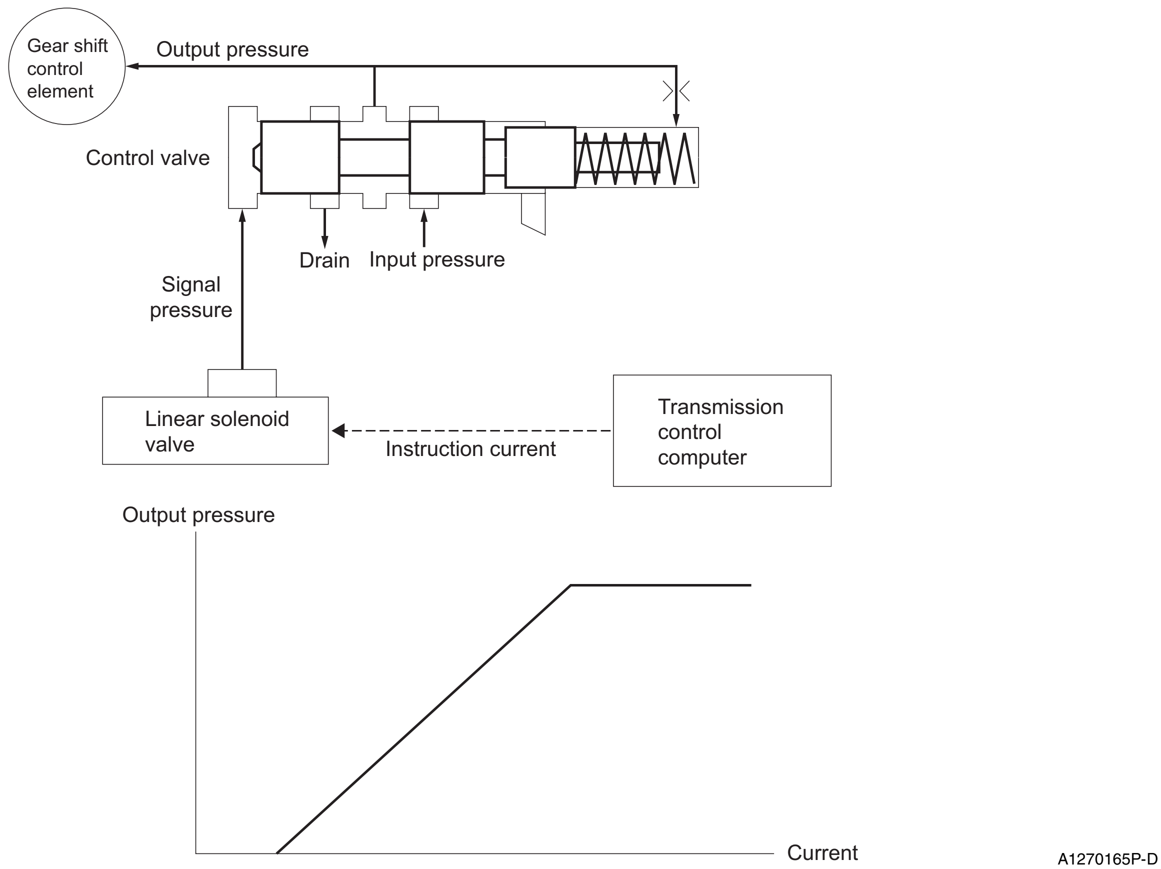
- The hydraulic control system is a direct pressure control type that regulates the hydraulic pressure directly using the solenoid valve provided for each gear shift control element (clutches and brakes) and the control valve. This makes it possible to minutely regulate the pressures on both the release and engagement sides in the middle of gear shifting (clutch-to-clutch control), and thus to achieve quick and smooth gear shifting.
- The valve body is placed at the lower part of the transaxle case. It is composed of a regulator valve for adjusting the hydraulic pressure produced by the oil pump to the line pressure, solenoid valves for regulating and switching oil paths under the control of signals from the gear shift control computer, control valves for regulating the pressure of oil from the solenoid valves to operate each gear shift control element, and other valves for switching oil paths according to the line pressure.



Functions of solenoid valves

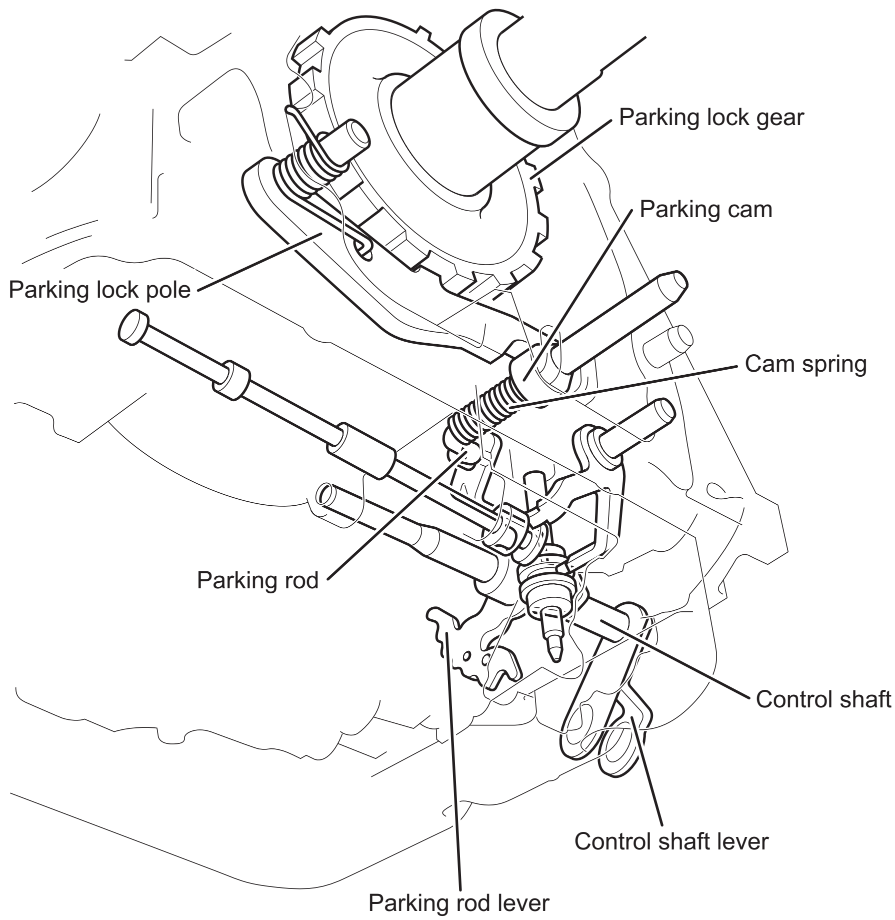
Name	Functions
Solenoid valve No.1	Regulates the hydraulic pressure of brake B1.
Solenoid valve No.2	Regulates the hydraulic pressure of clutch C2.
Solenoid valve No.3	Regulates the hydraulic pressure of clutch C3 and brake B2. Regulate the line pressure.
Duty solenoid valve	Regulates the hydraulic pressure of the lock-up clutch.
Lock-up solenoid valve	Switches lock-up relay valves.
Switch solenoid	Switches solenoid relay valves.

- To change speed, the valve body of this automatic transmission regulates the hydraulic pressures of the gear shift control elements (B1, B2, C2 and C3), using the control valve connected directly to each gear shift control element. The control valve is connected to a linear solenoid valve that sends signal pressures to the control valve.
- To regulate the output hydraulic pressure, each linear solenoid valve regulates the signal pressure according to the current adjusted by the gear shift control computer.



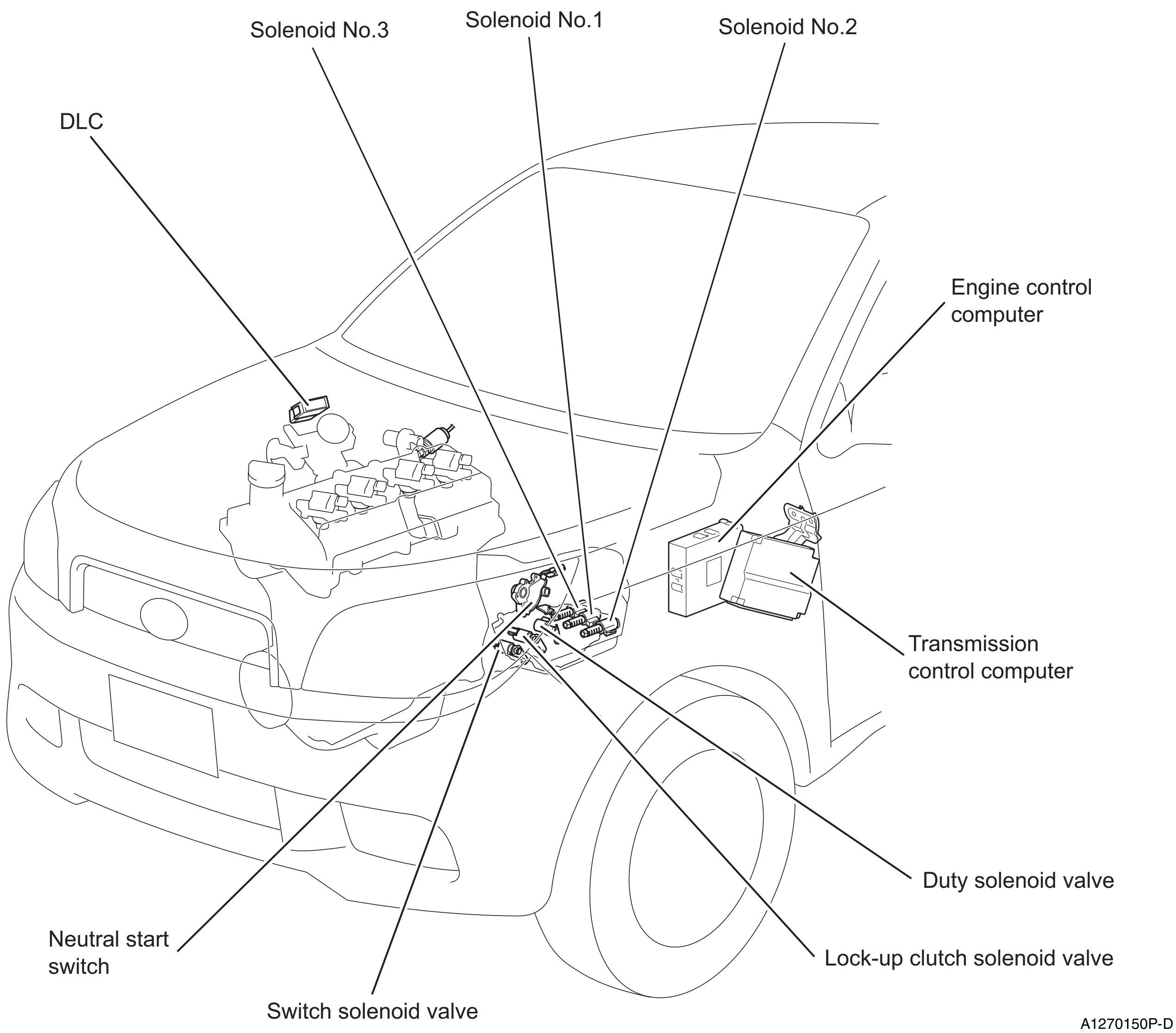
Parking Lock Mechanism

- When gears are shifted to the P position, the parking rod pushes the parking cam out, which in turn pushes up the barking lock pole. Then, the parking lock pole engages with the parking lock gear to lock it.



ECT Control (Computer-Controlled)

- The gear shift control system, which consists of a gear shift control computer, sensors, switches, solenoid valves, etc., perform gear shift control, clutch-to-clutch control, lock-up control, etc.
- It has a diagnosis function to inform the driver or service person that the system has failed and a fail-safe function to ensure the minimum driving ability of the vehicle while protecting the system itself in the even of a system failure. It also supports a diagnosis tool to improve ease of servicing.



Determination of Gear Position and Lock-up ON/OFF

Automatic gear shift mode

- When the shift lever is in the D, 2 or L position, the transmission control computer judges that the transmission is in automatic gear change mode, and it checks the vehicle speed, throttle opening and brake signals against the gear change diagram selected, and determines whether or not to engage the lock-up clutch.

Shift to low-speed gear inhibit control during high-speed driving

- If a shift to a lower gear occurs during high-speed driving, the gears are held in the current position until the vehicle speed decreases to the set speed or below to prevent the engine speed from increasing excessively.

Reverse inhibit control

- If gears are shifted to the R position by mistake during forward driving, the gears are held in the neutral position until the vehicle speed decreases to the set speed or below to avoid the risk of an accident.

Gear change control at low temperatures

- If the transmission oil is cold, for example, immediately after the start of driving at an extremely low temperature, the following restrictions are imposed on gear shifting.

Restrictions on gear shifting at low temperatures

Transmission oil temperature	Restrictions on gear shifting
-10° C or below	Shifting to 3rd gear prohibited
10° C or above	Shifting to 4th gear prohibited

Torque Reduction Control

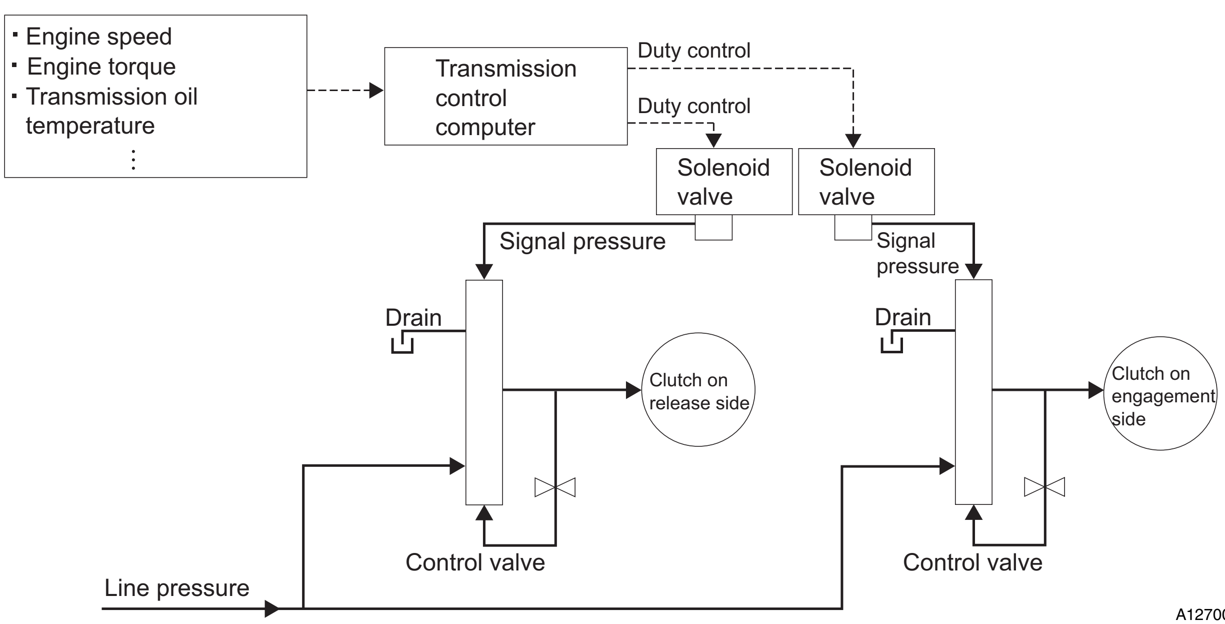
- To reduce fluctuations in output shaft torque in the middle of gear shifting and the shock when gears are engaged, the gear shift control elements (clutches and brakes) in the transmission are engaged smoothly by delaying the engine ignition timing.
- When delaying the engine ignition timing, the transmission control computer sends a signal to the engine control computer.

Electronical Control of Line Pressure

- When gears are in the 3rd, 4th or reverse position (after completion of gear shifting) and when the vehicle is standing still with gears in the D position, the line pressure is regulated to reduce the load on the oil pump and improve fuel efficiency.
- When gears are in the 3rd, 4th or reverse position (after completion of gear shifting), the line pressure is regulated according to the turbine torque. Solenoid valve No.3 is used to regulate the line pressure.
- When the vehicle is standing still with gears in the D position, the line pressure is reduced by turning on the duty solenoid valve (a duty ratio of 100%) and turning off the switch solenoid valve.

Clutch-to-Clutch Transmission Control

- In the course of changing speed, the gear shift control computer minutely regulates the hydraulic pressures of the clutches (brakes) on both the release and engagement sides simultaneously in order to change speed smoothly and quickly while preventing an abrupt increase in engine speed and interlocking between planetary gears.
- According to the information about engine torque, transmission oil temperature, etc. provided by the engine control computer, the gear shift control computer performs the feedback control of the solenoid valves on both the release- and engagement-side clutches (brakes) so as to change the engine speed at the target rate and to ensure ideal torque fluctuations for the output shaft.
- The gear shift control computer learns the changes in hydraulic pressure at the time of engagement caused by secular changes of the engine and transmission, and adjusts hydraulic pressures automatically to prevent gear shifting feel from changing over time.



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Transmission Control

- From information provided by means of signals from each sensor, the transmission control computer determines the optimum gear and whether or not to engage the lock-up clutch according to the driving condition and if necessary, it operates solenoid valves to change gears and perform lock-up control.
- The table below lists gear change patterns by shift lever position.

Gear shift and lock-up patterns

Gear shift mode		Automatic gear shift mode
D	O/D ON	1⇔2⇔[3]⇔[4]
	O/D OFF	1⇔2⇔[3]←(4)
2		1⇔2←(3)←(4)
L		1←(2)←(3)←(4)

❖ REFERENCE ❖
The gears in brackets are gears with which the lock-up clutch is operative, except when the transmission oil is cold. The gears in parentheses apply when “shift to low-speed gear inhibit control during high speed driving” is exercised.

- Considering the current gear and the target gear, the transmission control computer changes gears by operating solenoid valve No.1, solenoid valve No.2, solenoid valve No.3, duty solenoid valve, LUC solenoid valve and switch solenoid valve. Here is the relationship between the operation of each solenoid valve and shift lever position.

Table of operations of solenoid valves

	Solenoid valve No.1	Solenoid valve No.2	Solenoid valve No.3	Duty solenoid valve	Lock-up solenoid valve	Switch solenoid valve
P position Neutral	×	❍	❍	❍	×	❍
Neutral	×	❍	❍	×	×	❍
Reverse	×	❍	×*2	×	×	❍*3
4th	❍	❍	×*2	×*1	×*1	×
3rd	×	×	×*2	×*1	×*1	×
2nd	❍	×	❍	×	×	❍
1st (D·2)	×	×	❍	×*4	×	❍*5
1st (L)	×	×	×	❍	×	❍

❖ REFERENCE ❖
❍=Energized ×=Not energized

*1 : Lock-up control after engagement: ❍
*2 : Line pressure regulation after engagement: ❍
*3 : Line pressure regulation after engagement: ×
*4 : Line pressure regulation during a halt with gears in D position: ❍
*5 : Line pressure regulation during a halt with gears in D position: ×

Lock-up Timing Control

- During driving in high-speed range, direct coupling control (control for engaging the lock-up clutch completely) is performed to increase transmission efficiency.

- The lock-up clutch is engaged or disengaged by operating the lock-up clutch solenoid valve and the duty solenoid valve.
- When engaging the lock-up clutch, first the lock-up solenoid valve is turned on and then the duty solenoid valve is operated to regulate the hydraulic pressure on the release side. The amount of torque transmitted by the lock-up clutch is adjusted in this way at the specified rate for the specified time in order to reduce the shock caused by the engagement of the lock-up clutch.
- When disengaging the lock-up clutch, a hydraulic pressure is applied gradually to the release side by operating the duty solenoid valve. When the lock-up clutch is disengaged, the lock-up clutch solenoid valve is turned off.

Lock-up clutch operative gear

		1st	2nd	3rd	4th
D position	Direct coupling control	×	×	❍	❍
	Speed reduction control	×	×	❍	❍

❖ REFERENCE ❖
❍=Operated ×=Not operated

Operations of solenoid valves

Lock-up clutch	Lock-up clutch solenoid valve	Duty solenoid valve
OFF	×	×
OFF⇔ON (Transient)	❍	∆
ON (Direct coupling)	❍	❍
Speed reduction control	❍	∆

❖ REFERENCE ❖
❍=Energized ∆=Under duty control ×=Not energized

Slip Lock-up Control

- During low-speed driving or deceleration, slip lock-up control is performed by making the clutch slip slightly.
- In flex lock-up control, the hydraulic pressure on the release side is regulated by operating the duty solenoid valve so that the engine speed reaches the target speed.

Slip lock-up operative gears

		1st	2nd	3rd	4th
D position	Slip lock-up control	×	×	❍	❍

Operations of solenoid valves

Lock-up clutch	Lock-up solenoid valve	Duty solenoid valve
Under slip lock-up control	❍	∆

❖ REFERENCE ❖
❍=Energized ∆=Under duty control

Uphill and downhill gear shift control

- Uphill and downhill gear shift control restricts shifting up to 4th gear and locking up gears on a road sloping up and down alternately in order to enable the vehicle to run lightly on sloping roads without sacrificing economical efficiency on level roads. On downhill roads, this control ensures that moderate engine braking force is produced even if gears are shifted down to 3rd gear.

- The condition of an uphill or downhill road is determined by comparing the actual acceleration calculated from the vehicle speed with the vehicle acceleration on a level road calculated from the throttle opening, vehicle speed and gear used.
- If it is determined that the road slopes up, shifting up to 4th gear and locking up gears are restricted.
- When the brakes are applied on a road that is judged to slope down, gears are shifted down to 3rd gear.
- To give priority to the driver's intention, uphill and downhill gear shift control is exercised only when the shift lever is in the D position and the O/D switch is held down (O/D operative).

Squat Control

- If gears are shifted from the P to D (2 or L) position to start the vehicle with the throttle fully opened and the brakes applied, gears are shifted temporarily to the 2nd position (N→2nd→1st) to prevent the vehicle from squatting down because of an abrupt change in torque.

Fail-Safe Function

- If an error occurs in the signal input/output system of the gear shift control computer, the fail-safe function enables the computer to continue control to minimize degradation in driving performance.
- When the system has recovered from an error, the fail safe-safe function is deactivated but the diagnosis results (except certain error codes) remain stored in memory.
- When the fail-safe function is activated, the warning lamp (O/D OFF lamp) blinks. (Except for certain functions)

Diagnosis Function

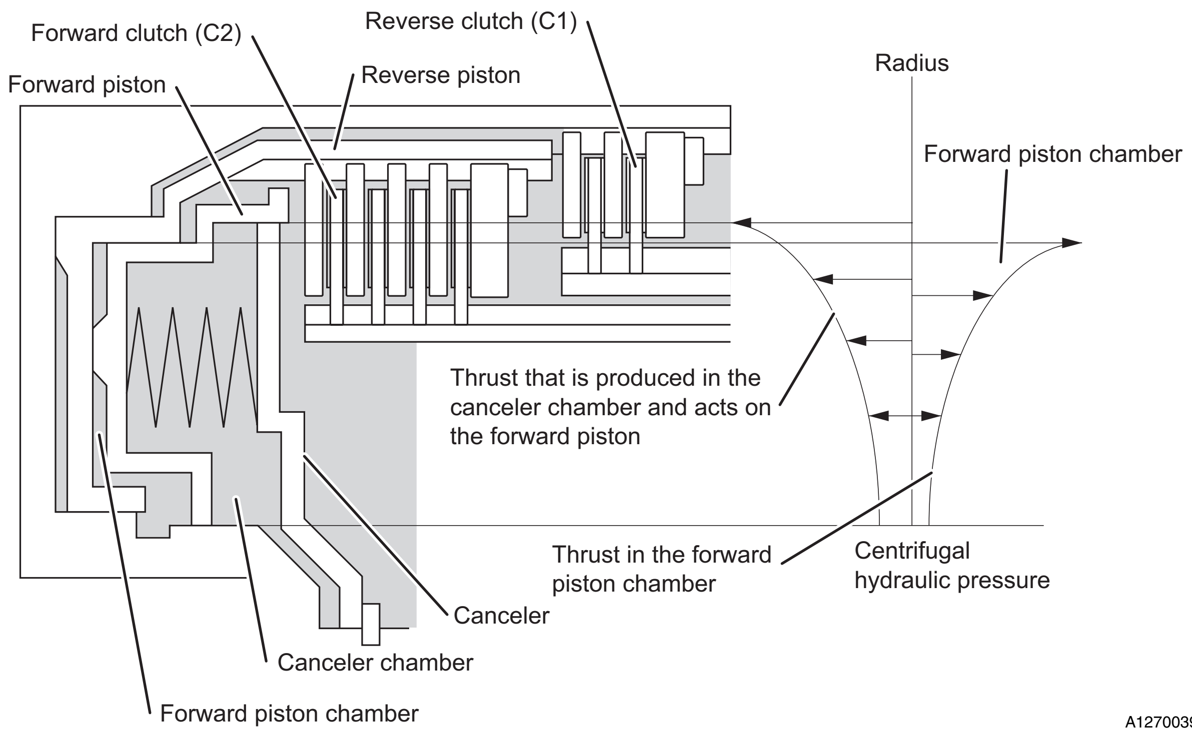
- The diagnosis function refers to a self-diagnosis function provided for the computer as a means of informing the service person of the failed item in the event of a failure in the input/output system. There are a total of 22 diagnosis items, including 6 solenoid valve-related items checked under normal conditions. In the event of a failure, the computer saves information on the failed item into memory. The storage device is powered from the battery, so information stored in memory is not cleared by turning off the ignition switch. In addition to this function, a warning function is provided to inform the driver of the occurrence of a system failure if it occurs during driving.

✦ CAUTION ✦

Some items are not stored in memory.

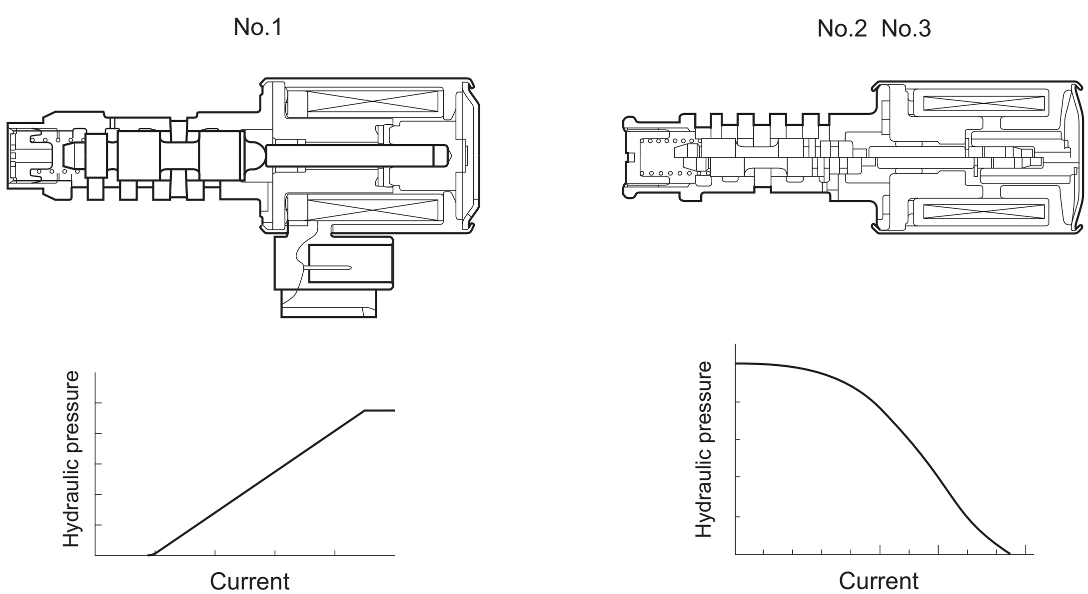
Centrifugal Hydraulic Canceler

- Pistons used to actuate clutches mounted on rotating parts, such as reverse and forward clutches, sometimes operate, causing a gear shift shock, even if no hydraulic pressure is applied to them, because a centrifugal hydraulic pressure produced by rotation acts on them, causing them to develop thrust.
- A centrifugal hydraulic mechanism is provided for the reverse clutch (C1), forward clutch (C2) and rear clutch (C3). In this mechanism, the canceling chamber placed on the opposite side of the clutch hydraulic chamber, as shown in the figure below, cancels the centrifugal hydraulic pressure produced in the clutch hydraulic chamber, using the centrifugal hydraulic pressure produced in the canceling chamber. This mechanism allows the engagement and release timing to be adjusted minutely without being affected by a centrifugal hydraulic pressure, and thus serves to ensure smooth gear shifting at all speed ranges.



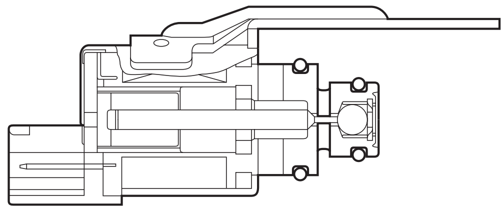
Solenoid Valve

- Solenoid valve No.1 is a linear solenoid valve composed of a solenoid control unit and a pressure regulating valve. The plunger in the solenoid control unit pushes the pressure regulating valve to produce a hydraulic pressure in proportion to the voltage applied. This valve is closed under normal conditions (no hydraulic pressure is produced when no current is applied).



Lock-up Clutch Solenoid and Switch Solenoid

- The lock-up clutch solenoid valve and the switch solenoid valve are three-way ON-OFF switch solenoid valves. When they are ON, they open the oil paths to apply hydraulic pressures, and when they are OFF, they close the oil paths while releasing the hydraulic pressures.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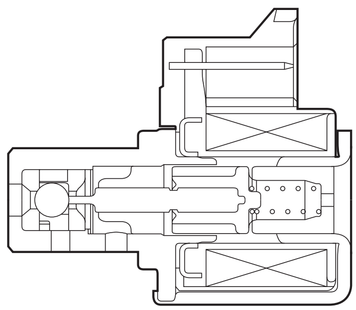
Duty Solenoid

- This duty solenoid valve regulates the line pressure under the control of duty signals.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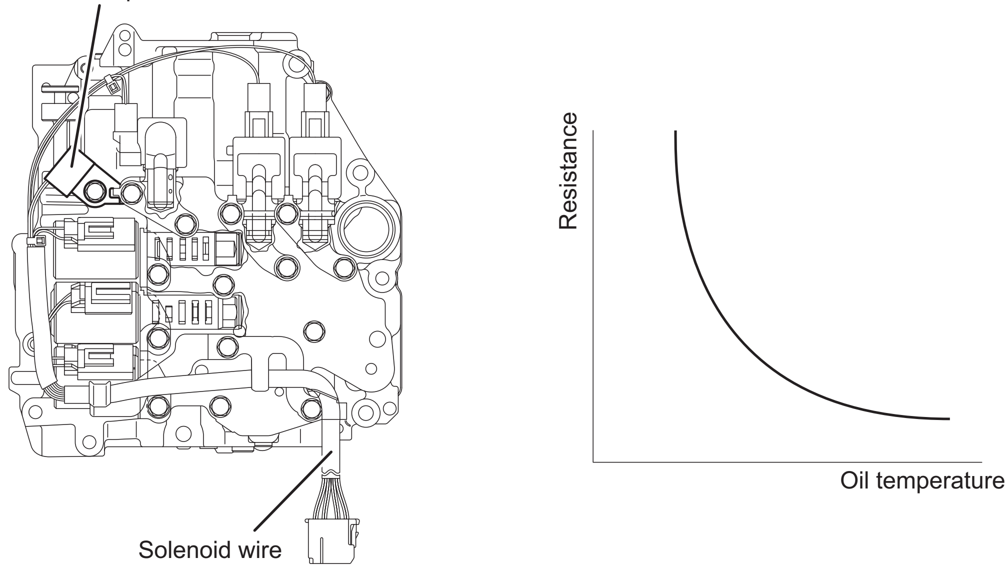
Oil Temperature Sensor

- The oil sensor, which is mounted at the lower part of the valve body, senses the transmission oil temperature. The wire from the oil temperature is integral with solenoid wires.



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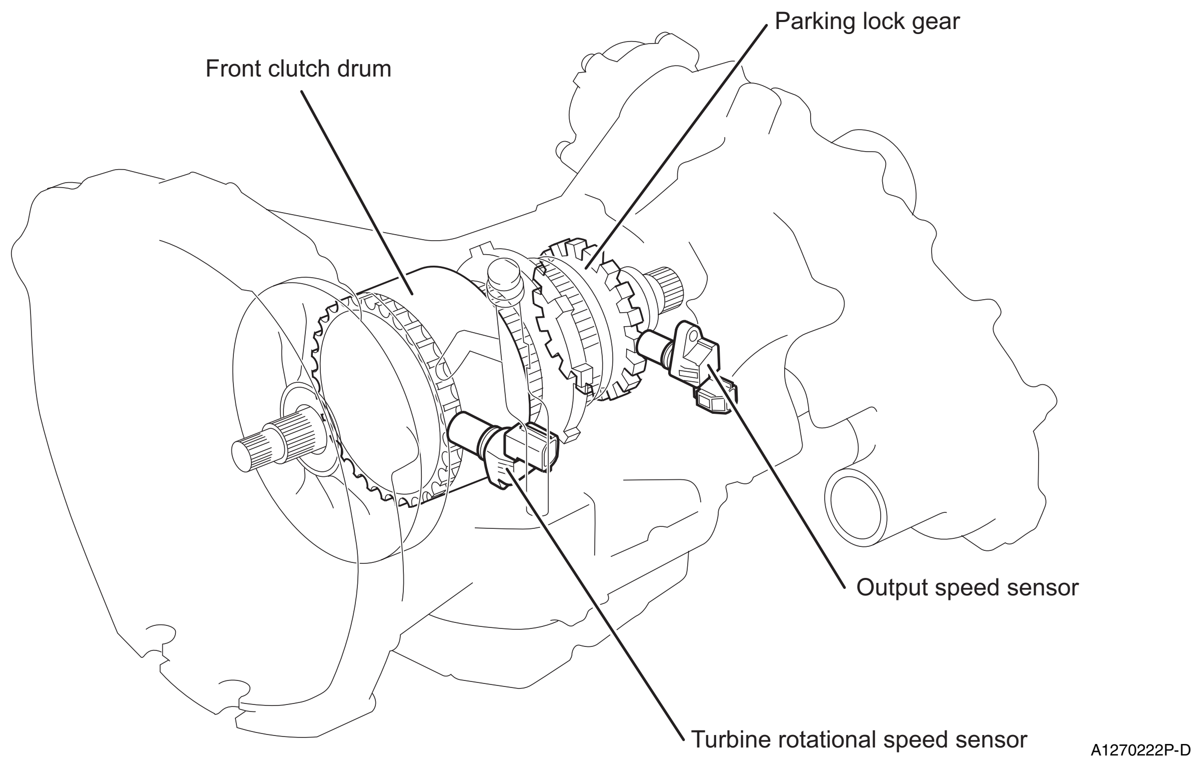
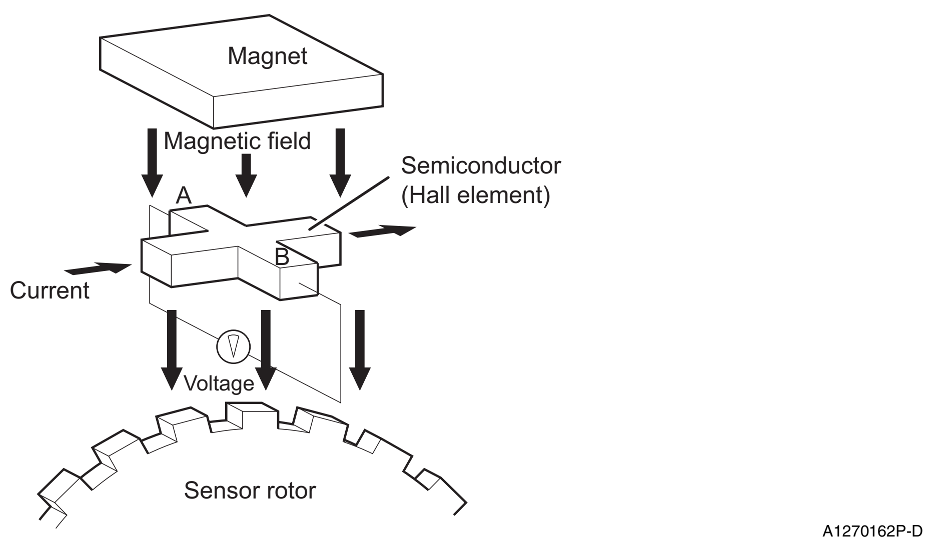
Turbine Rotational Speed Sensor and Output Speed Sensor

- The turbine speed sensor senses the number of revolutions of the front clutch drum, while the output speed sensor senses the number of revolutions of the output shaft.



Principles of Turbine Rotational Speed Sensor and Output Rotational Speed Sensor

- Each rotational speed sensor is composed of a hall element, a magnet and a built-in processing circuit.
- A hall element has the property of generating an electric current in a direction perpendicular to the magnetic field (between A and B in the figure) in which the hall element is placed if a current is passed through it.
- Using this property of hall elements, each rotational speed sensor senses the flux change (= change in voltage) caused by the rotation of the sensor rotor, and turns on and off the transistor in its processing circuit to put out rotation signals (square waves).



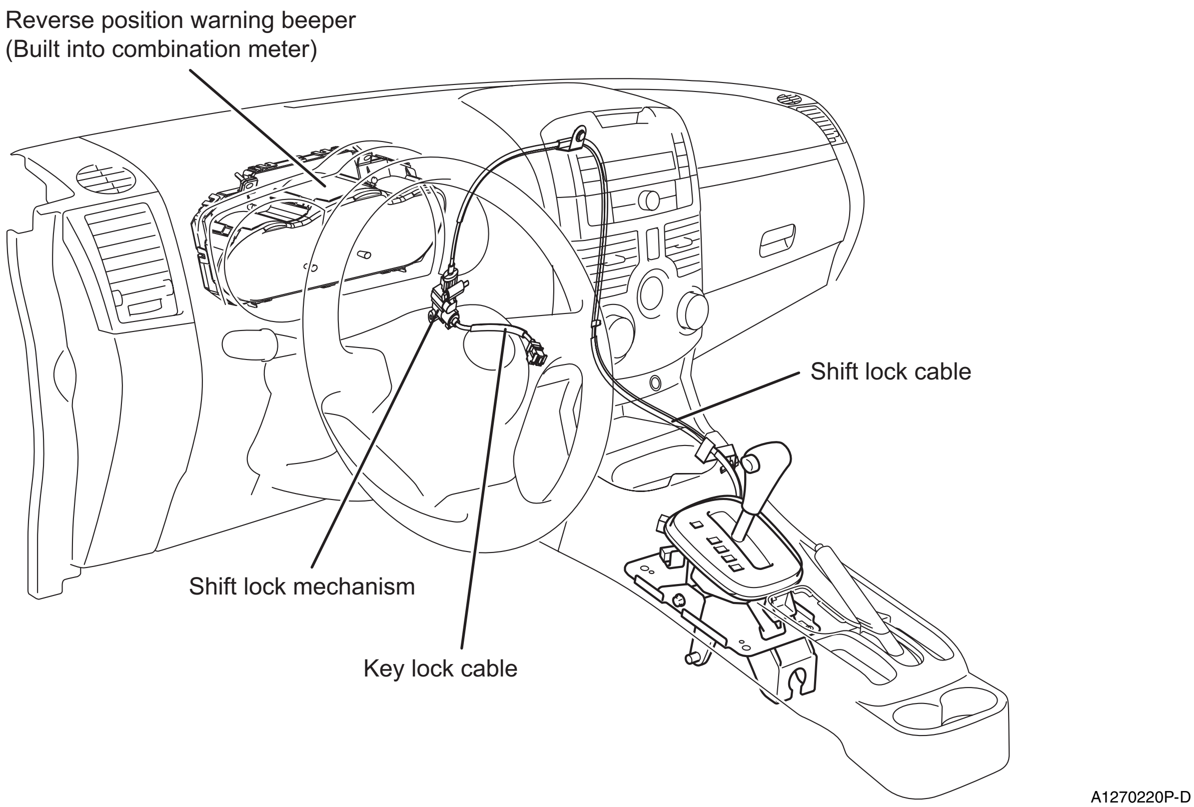
Neutral Start Switch

- The neutral start switch, which is mounted in the transmission case, determines the shift lever position (P, R, N, D, 2 and L).

SHIFT LOCK SYSTEM WITH KEY INTERLOCK

Outline of Shift Lock with Key Interlock Mechanism

- A/T models are provided with a shift lock system with key interlock and a reverse position warning beeper to prevent the shift lever from being operated incorrectly.
- The shift lock system with key interlock is a mechanical type that uses a combination of cables (shift lock release cable) to operate the shift lock mechanism and the key interlock device.
- The shift lock release cable consists of a key lock cable for operating the ignition key, a shift lock cable for operating the shift lever and a locking device for operating each cable. The locking device is mounted on the pedal supporting bracket. It determines whether the brake pedal is depressed (ON) or not (OFF) using a mechanical device.

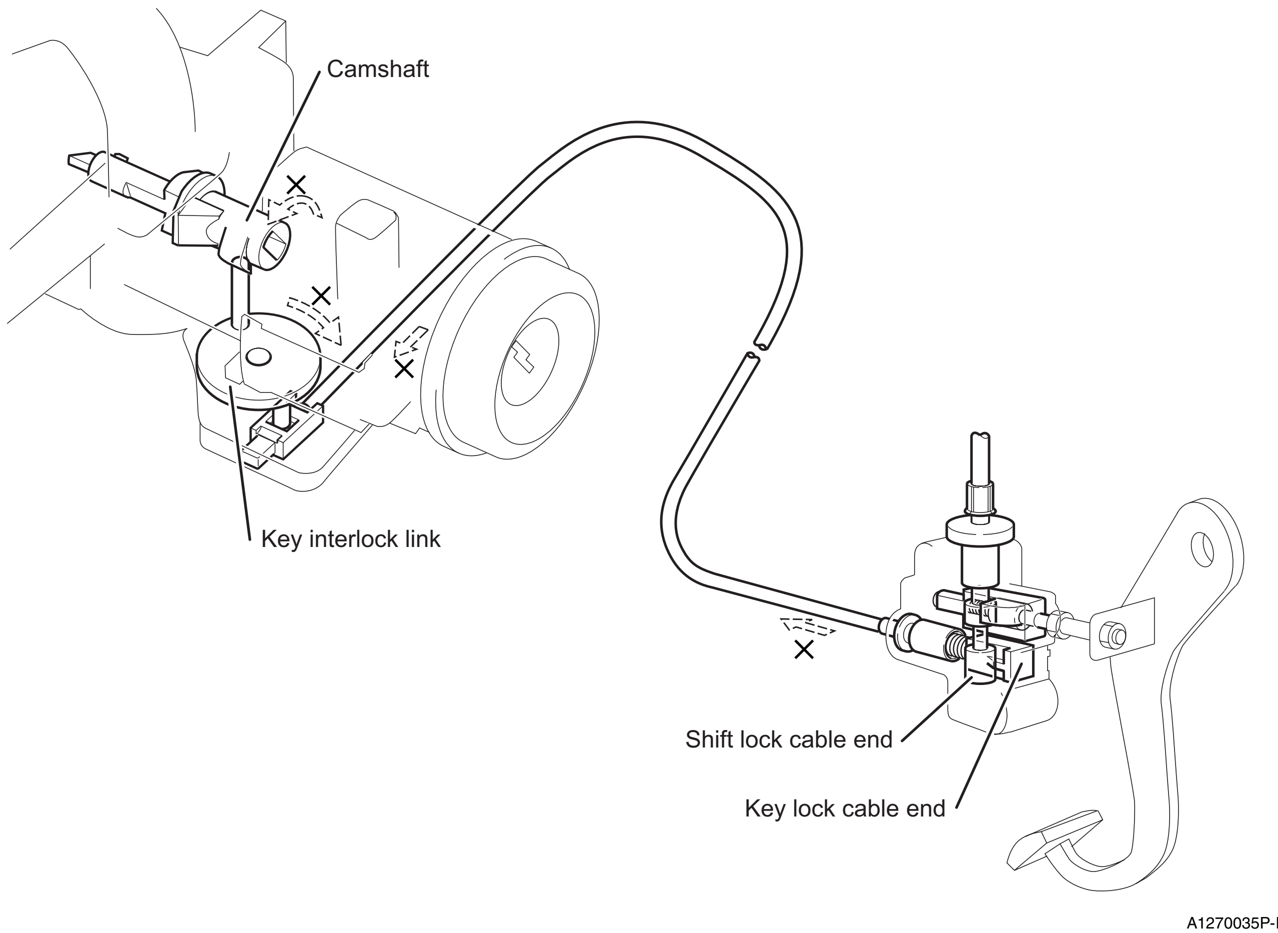


Key Interlock Mechanism

- The key interlock mechanism prevents the ignition key from being turned to the LOCK position and pulled out when the shift lever is in a position other than the P position.

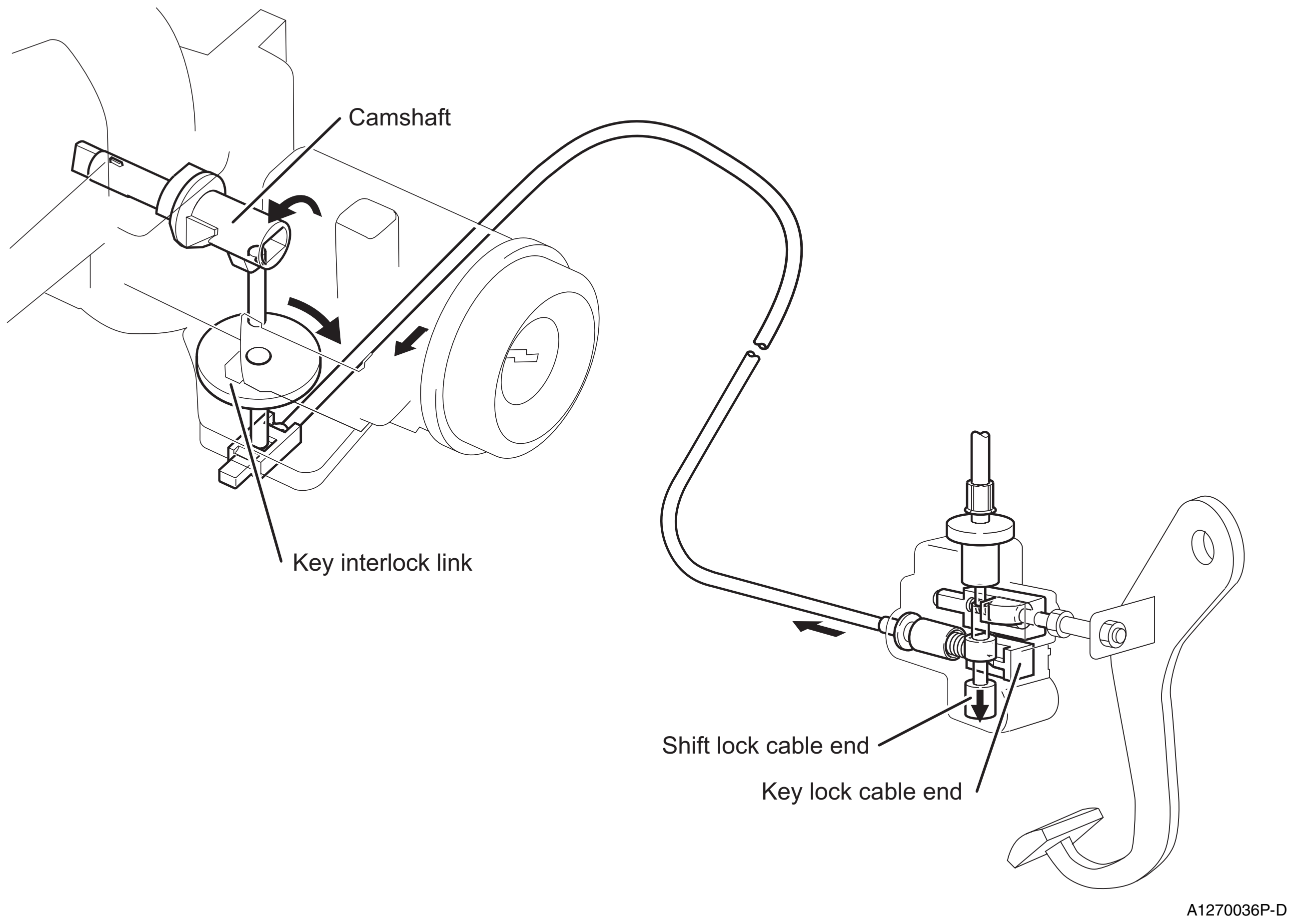
When the shift lever is in a position other than the P position

- When the shift lever is in a position other than the P position, the shift lock cable is located in the position shown in the figure below.
- The key lock cable end is blocked by the shift lock cable end so that the key lock cable does not move toward the ignition switch (to the left-hand side in the figure).
- The key lock cable is connected to the key cylinder's key interlock link, so when the ignition key is being turned to the LOCK position, the key interlock link rotates by cam action. Therefore, when the key lock cable is locked, the ignition key cannot be turned to the LOCK position, because the key interlock link does not rotate at that time.



When the shift lever is in the P position

- If the shift lever is put in the P position (without pressing the shift lever button), the shift lock cable end comes down and unlocks the key lock cable end. This makes the key lock cable free (ready to move) and puts the key interlock link in a state of readiness to rotate, thus allowing the ignition key to be turned to LOCK position.

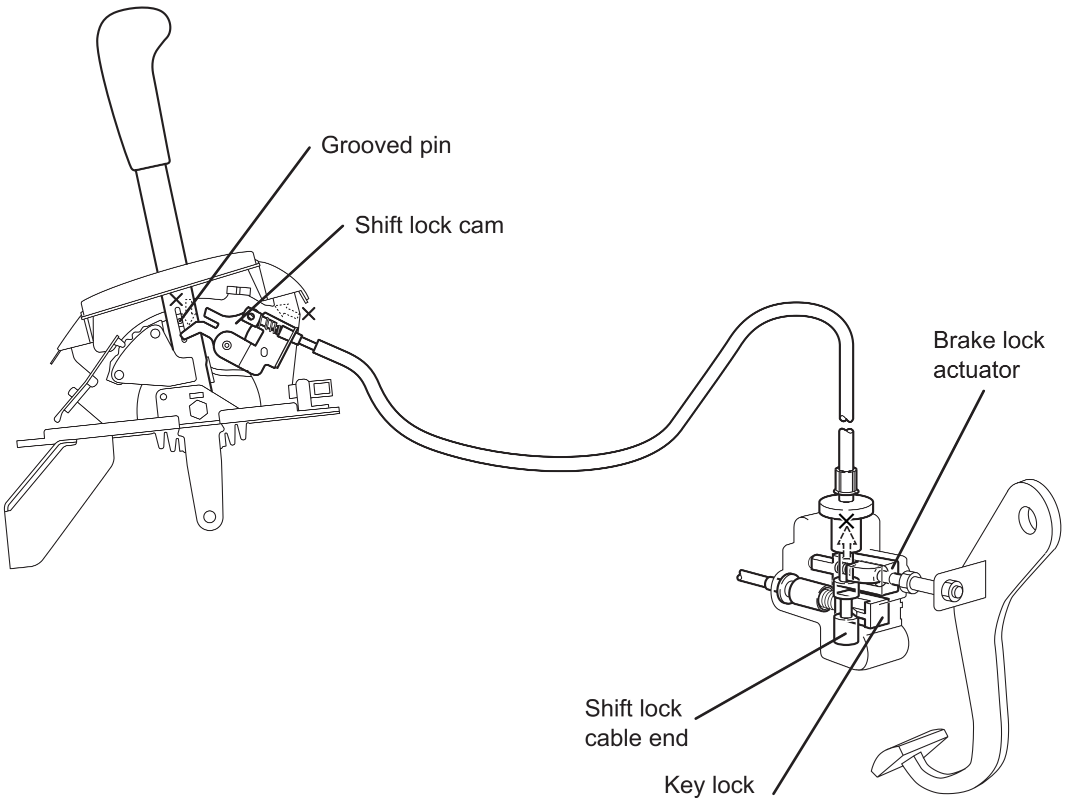


Shift Lock Mechanism

- The shift lock mechanism prevents the shift lever from being shifted from the P position to another position, unless the brake pedal is depressed and the ignition key is in the ACC or ON position.

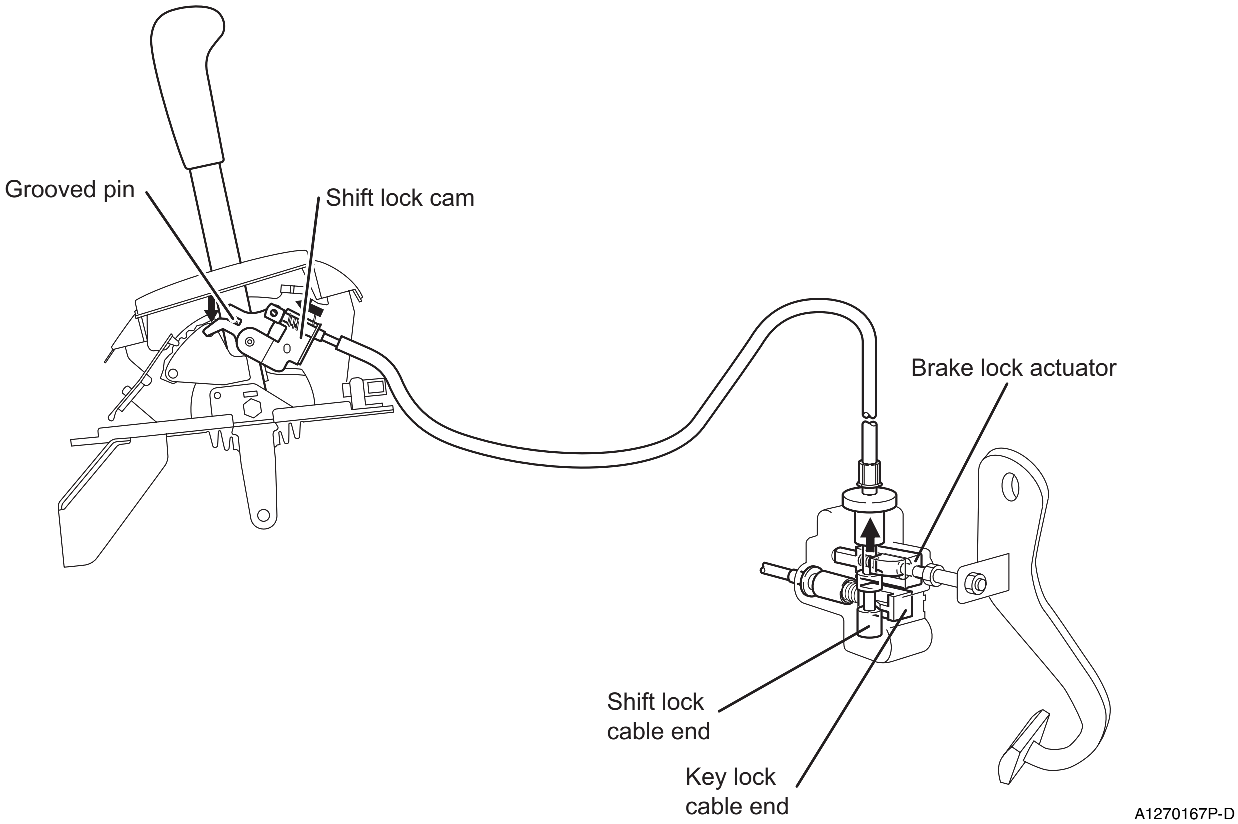
If the brake pedal is not depressed or the ignition key is in the LOCK position

- When the shift lever is in the P position, the shift lock cable is located in the position shown in the figure below.
- When the brake pedal is not depressed, it pushes the brake lock actuator to the left, and therefore the protrusion on the brake lock actuator blocks the shift lock cable end from moving upward.
- When the ignition switch is in the LOCK position, the key lock cable end is pulled and displaced to the ignition switch side (to the left-hand side in the figure), and therefore the protrusion on the brake lock actuator blocks the shift lock cable end from moving upward.
- The shift lock cable is coupled with the shift lock cam which rotates in synchronization with the sliding grooved pin, which unlocks the shift lever by sliding down in synchronization with the shift lever button. Therefore, when the shift lock cable is locked, the shift lever cannot be shifted to any position except the P position.



When the brake pedal is depressed and the ignition key is in the ACC or ON position

- When the brake pedal is depressed, the brake lock actuator springs out (to the left-hand side in the figure) and unlocks the shift lock cable end.
- Turning the ignition key from the LOCK position to the ACC or ON position frees the key lock cable and moves it by spring force (to the right-hand side in the figure) to unlock the shift lock cable end. This frees the shift lock cable, allowing the shift lever to be shifted to a position other than the P position.



Shift Lever Reverse Position Warning System

- A reverse position warning beeper in the combination meter beeps to remind the driver that shifting to the R position makes the vehicle ready to reverse.

TO FOREWORD

STEERING

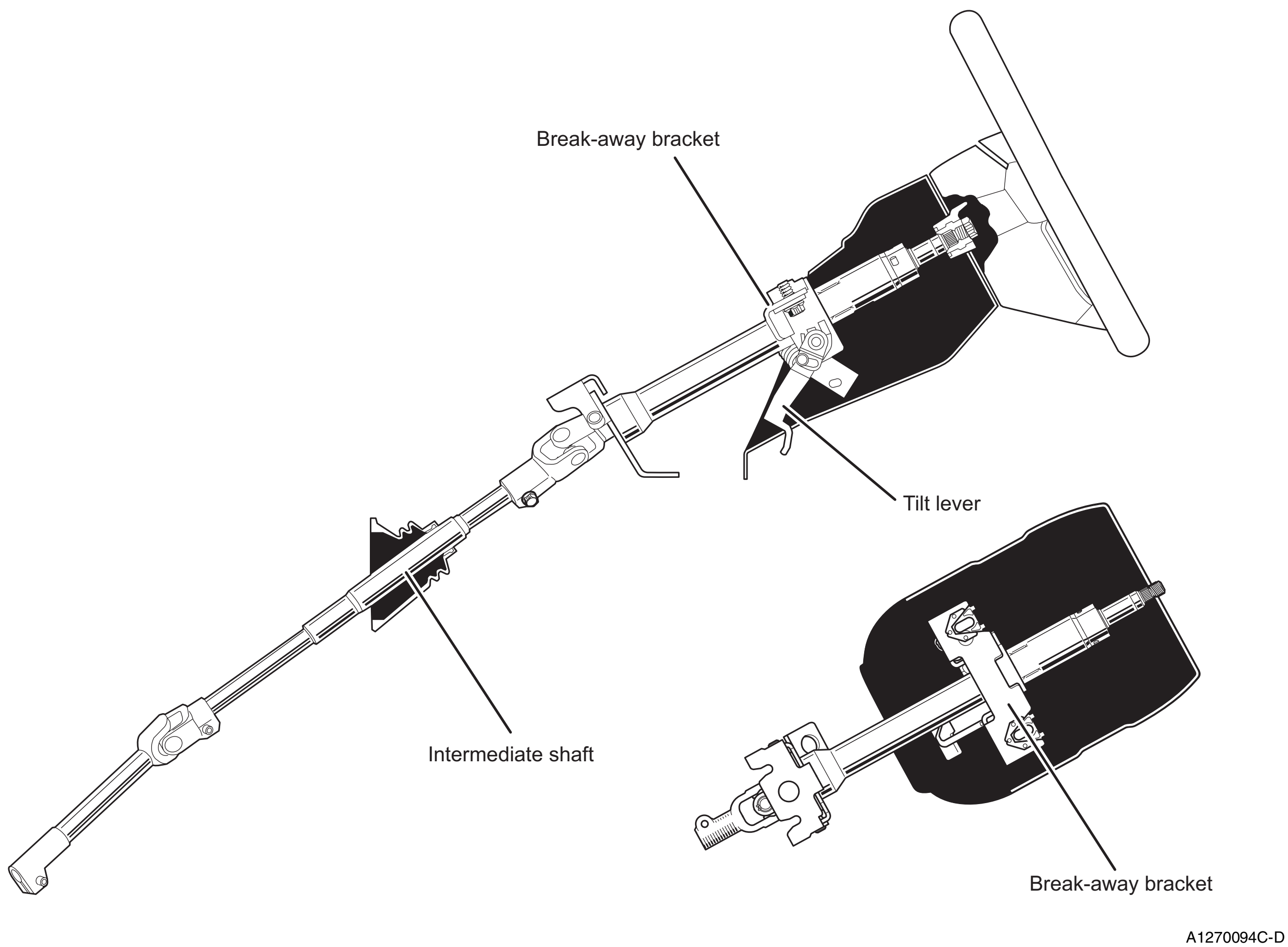
STEERING COLUMN

POWER STEERING SYSTEM (HYDRAULIC POWER STEERING)

STEERING COLUMN

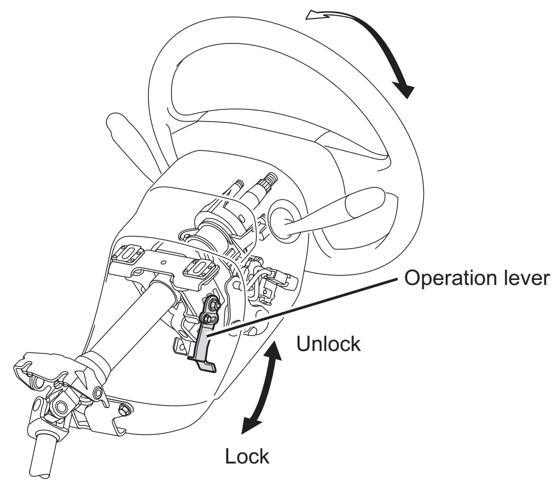
Outline of Steering Column

- A tilt steering column is employed for all models. This allows the driver to achieve the best driving position.
- Every model employs a hydraulic power steering system, and a steering wheel with a built-in airbag is provided as standard equipment for European models, or optionally available for models other than European models. To ensure the safety of the driver in the event of a vehicle collision, the steering column shaft and the intermediate shaft are provided with an energy absorbing mechanism.



Tilting Mechanism

- The tilt adjust mechanism allows the driver to adjust the height of the steering wheel. The lever on the left side of the steering column is used to lock and unlock the steering wheel.



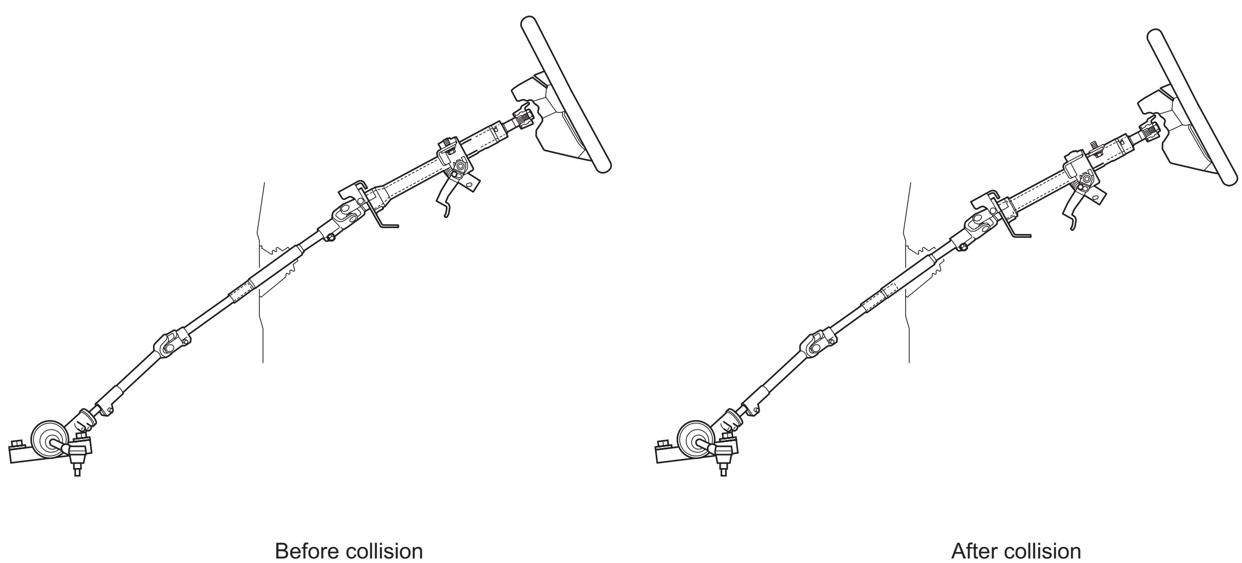
A1270128C-D

Collision Safety

- An energy absorbing mechanism and an intermediate shaft contraction mechanism are employed to ensure the safety of the driver in the event of a collision.

Intermediate Shaft

- The upper and lower sections of the intermediate shaft are press-fitted together in their serrated portion.
- In the event of a collision, the intermediate shaft contracts when exposed to the sliding resistance of the serrated joint, thus limiting the displacement of the steering column.

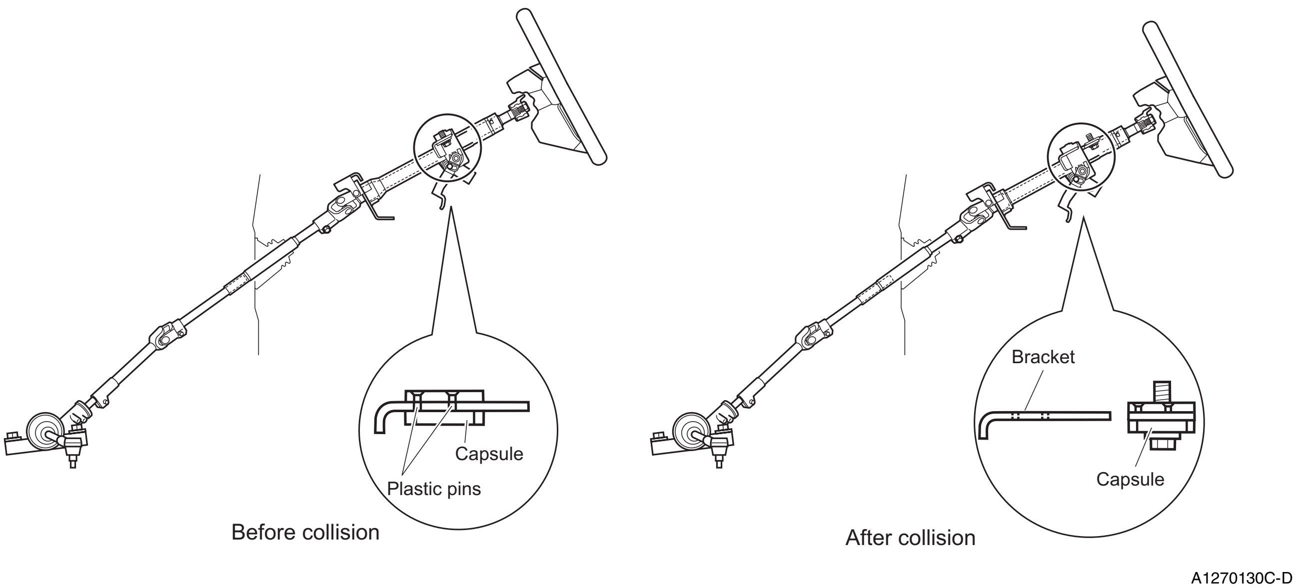


A1270129C-D

Energy Absorbing Mechanism

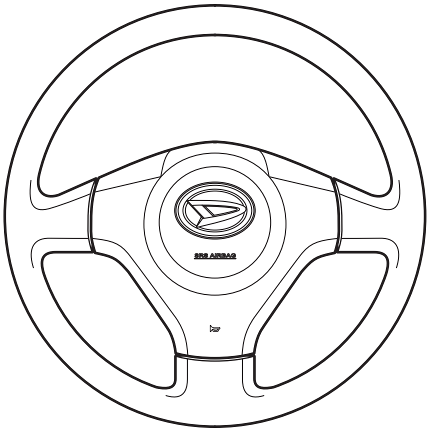
- A contracting tube type energy absorbing mechanism is employed. It uses the sliding resistance between the inner tube and the outer tube to absorb energy.

- The upper and lower sections of the main steering shaft are joined together in their serrated portion. The steering column inner tube is press-fitted in the outer tube.
- If an impact is transmitted to the steering column, the steering column outer tube contacts, expanding the outer tube, and the main steering shaft contracts because of the sliding resistance of the serrated joint. An impact is absorbed in this way.
- In addition to the above mechanism that absorbs energy causing the driver to hit against the steering wheel (secondary collision), a break-away method is employed for energy absorption.
- The steering column upper tube is provided with a flange used to mount the steering column on the vehicle, and a plastic capsule is fastened to the flange by means of plastic pins. If an impact is given to the steering column, the plastic pins break and the plastic capsule is detached from the flange. As a result, the steering column cover and the main steering shaft slide and contract, thus absorbing the impact.

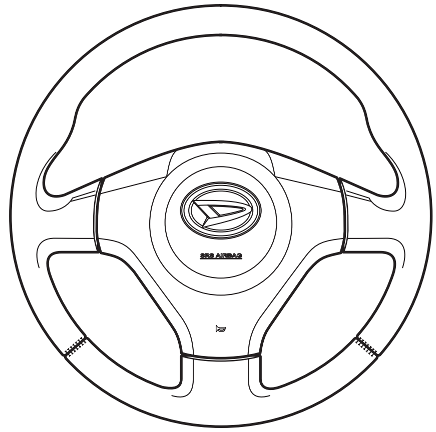


Steering Wheel

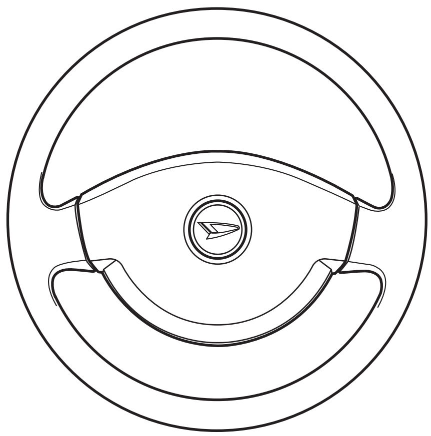
- Models come with one of three types of steering wheels: two-spoke urethane steering wheel, three-spoke urethane steering wheel or three-spoke leather steering.
- For added safety, a steering wheel with an SRS airbag is employed for certain models.



Three-spoke urethane steering wheel



Three-spoke leather steering wheel



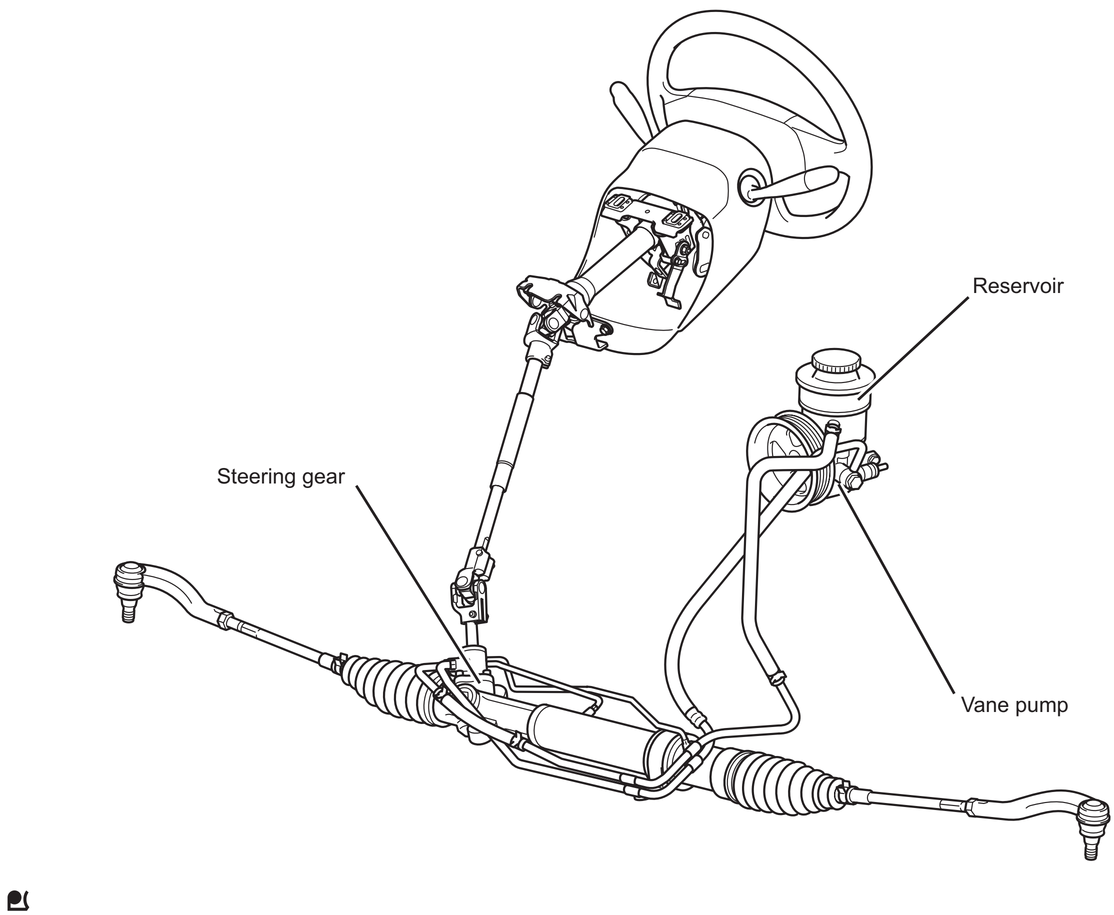
Two-spoke urethane steering wheel

A1270131C-D

POWER STEERING SYSTEM (HYDRAULIC POWER STEERING)

Outline of Hydraulic Power Steering System

- All models are equipped with an engine speed-responsive power steering system. This system reduces the steering effort required for stationary steering or steering during low-speed driving and increases it properly during intermediate- and high-speed driving delivering excellent steering performance, including responsibility, restorability and straight-running stability.



A1270013C-D

Steering Gear

- A rack-and-pinion type steering gear is employed for all models, since this type of steering gear is light and compact, and delivers excellent controllability.

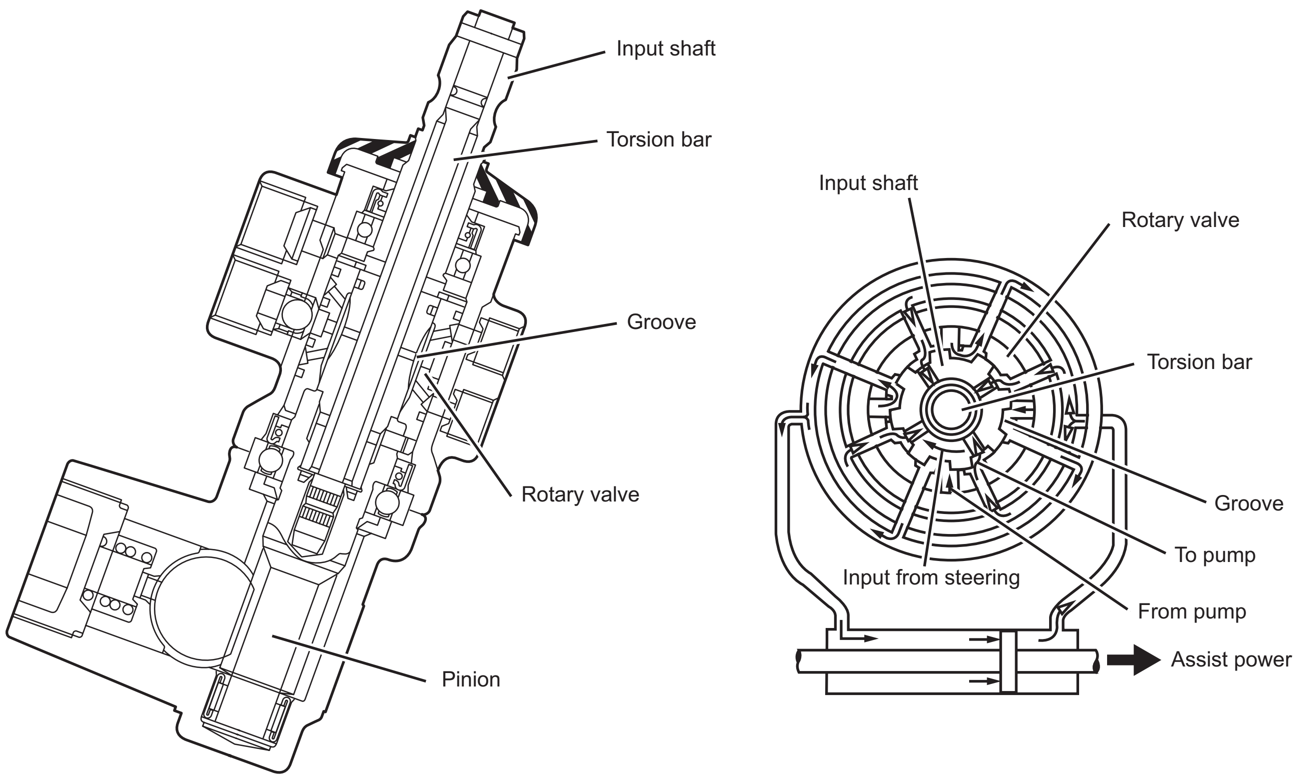
Steering gear specifications

	Tire size	
	215/65R16	235/60R16
Type	Rack-and-pinion type	←
Lock-to-lock number of revolutions	3.61	3.51
Rack travel	140	136

	Tire size	
	215/65R16	235/60R16
Number of pinion teeth	6	←

Structure of Control Valve

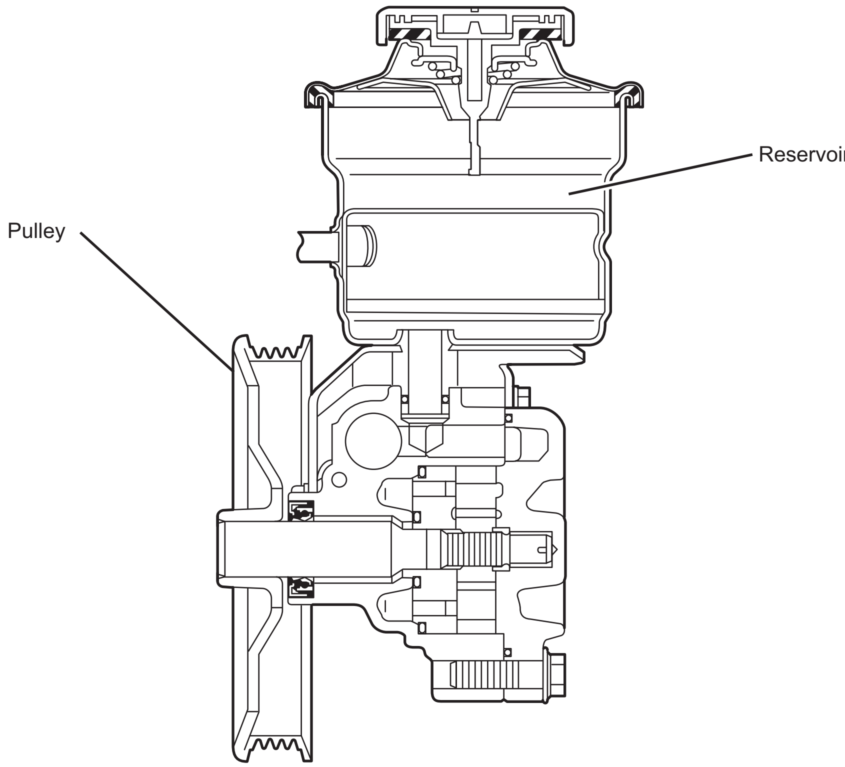
- The steering effort is transmitted from the steering wheel to the input shaft. The input shaft and the pinion are coupled together through a torsion bar, so if the road resistance prevents smooth rotation of the pinion, a difference in number of revolutions arises between them. On the other hand, the rotary valve is fixed to the pinion, and in the presence of considerable road resistance, a gap is developed between the rotary shaft and the groove in the input shaft, which is used to switch between hydraulic circuits.



A1270014C-D

Vane Pump and Reservoir

- The vane pump has a built-in flow control valve which regulates the amount of oil according to engine speed, and the flow control valve is provided with a relief valve that prevents the hydraulic pressure from exceeding the maximum allowable pressure. In addition, a pressure switch is placed on the delivery side of the pump to prevent the engine speed during idling from being reduced by steering (stationary steering).
- The reservoir is integrated with the pump for size reduction.



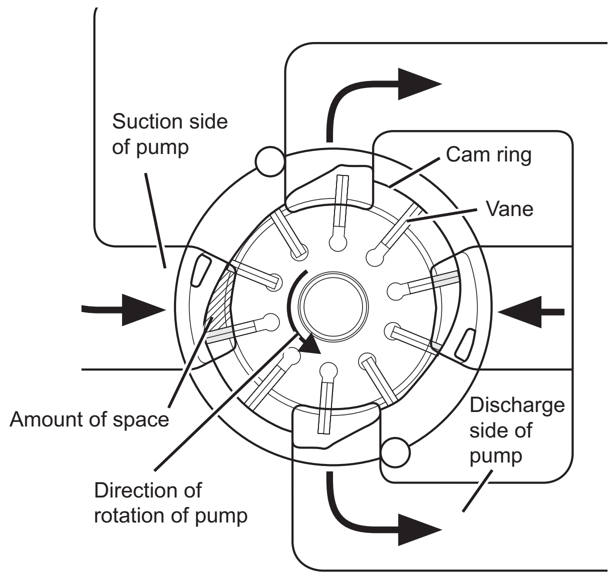
Section of vane pump

Vane pump specifications

	3SZ-VE	K3-VE
Working number of revolutions [r/min]	500 to 8000	←
Discharge [L/min] (at 1000 r/min)	7.5	←
Relief pressure [MPa{kgf/cm^2}]	7.4	←
Number of pulley grooves	6	4

Actuation of Vane Pump

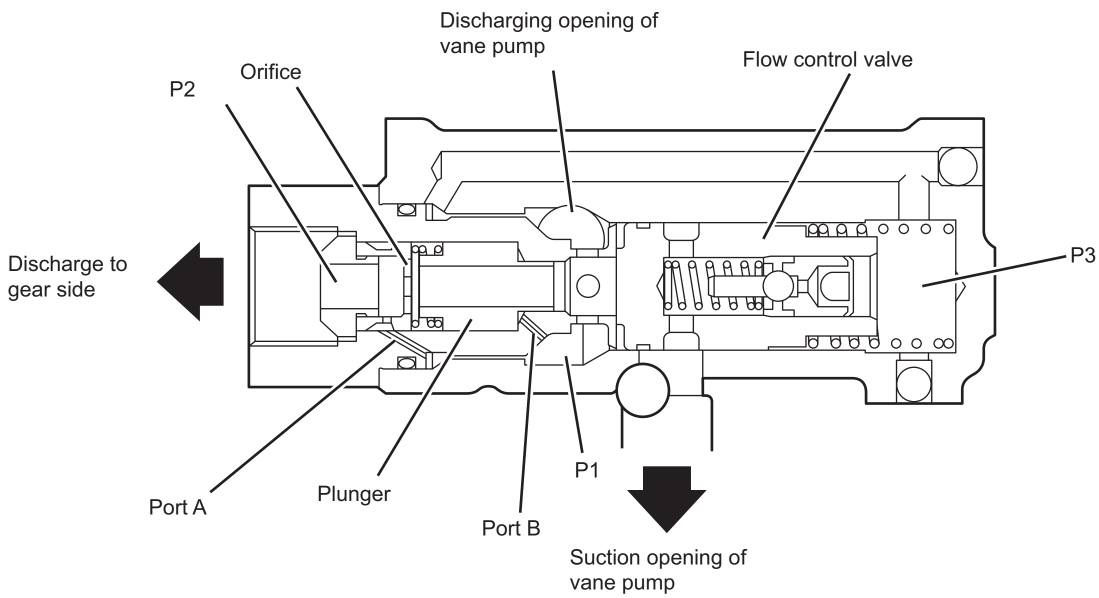
- The centrifugal force developed by the rotation of the rotor extends the vanes radially causing them to slide along the inner wall of the cam ring. This increases the amount of space between the rotor and the inner surface of the cam ring at the inlet allowing oil to be drawn in. In contrast, at the discharge opening, the volume of the space between the rotor and the inner wall of the cam ring decreases causing oil to be discharged through the discharge opening.



A1270023C-D

Actuation of Blow Control Valve (During Idling)

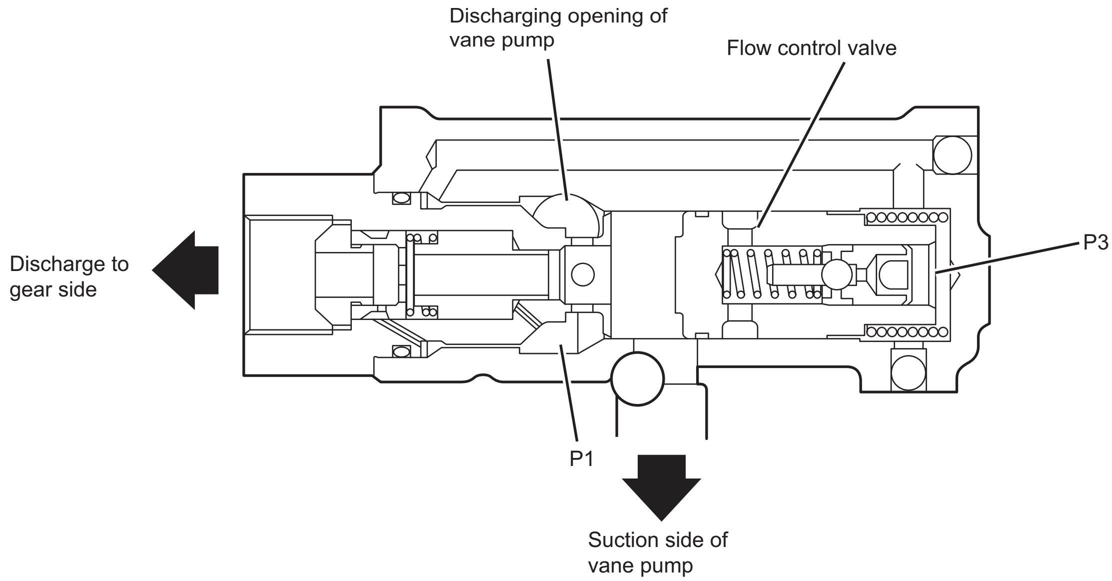
- The discharge pressure (P1) of the pump acts on the right side of the flow control valve and the end face (on port B side) of the plunger. After oil has passed through the plunger, it is discharged through an orifice into the gear housing, causing discharge pressure P2 to act. On the other hand, pressure P3 transmitted through port A acts on the left side of the flow control valve. As the discharge of the pump increases, the pressure difference between P1 and P3 increases (P1 > P3), and when it overcomes the force of the spring retaining the flow control valve, it pushes the flow control valve rightward.



A1270015C-D

Actuation of Blow Control Valve (During Low-Speed Driving)

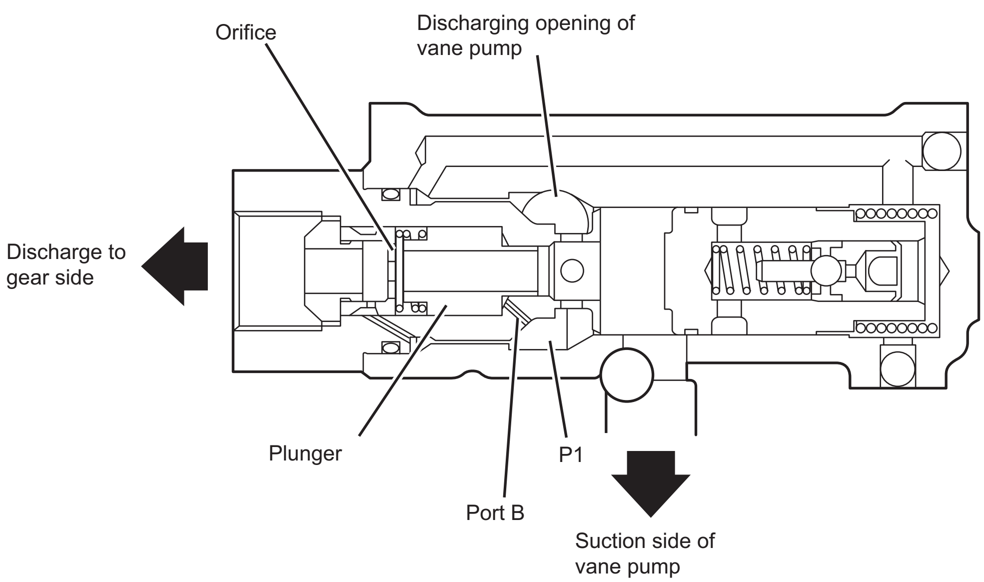
- As engine speed increases, the pressure difference between P1 and P3 further increases (P1 > P3), and accordingly the flow control valves moves further rightward. As a result, the opening through which oil is returned from the discharge side to suction side of the pump appears and oil is returned, which makes the amount of oil discharged into the gear housing constant.



A1270016C-D

Actuation of Blow Control Valve (During High-Speed Driving)

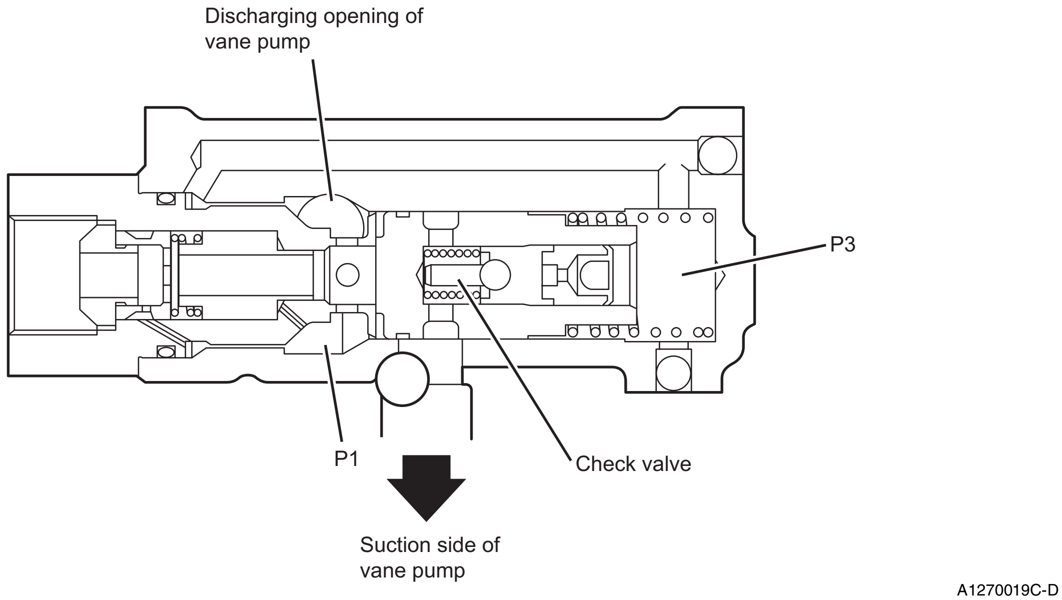
- When the engine speed further increases, discharge pressure P1 acting on the end face of the plunger overcomes the force of the spring retaining the plunger and moves the plunger leftward. As a result, the orifice narrows and reduces the amount of oil passing through it, so that the amount of oil discharged into the gear housing decreases. Accordingly, the required steering effort increases.



A1270017C-D

Relief Valve

- An increase in hydraulic pressure (P1) on the delivery side of the pump increases the hydraulic pressure (P3) acting on the right side of the flow control valve. When the relief pressure is exceeded, it overcomes the force of the spring retaining the check valve and pushes the check valve open so that oil is returned through part C to the suction side of the pump.


Discharging opening of vane pump
P3
P1
Check valve
Suction side of vane pump
A1270019C-D

TO FOREWORD

HEATER & AIR CONDITIONER

HEATER AND AIR CONDITIONER SYSTEM

AIR CONDITIONER UNIT COMPONENTS

OTHER AIR CONDITIONER COMPONENTS

HEATER AND AIR CONDITIONER SYSTEM

Outline of Heater and Air Conditioner System

Table of principal features of heater and air conditioner system

Items	Description
Air conditioner system	• Manual air conditioner
Air conditioner control panel	• Dial-operated control panel
Evaporator	• RS evaporator (RS: Revolutionary Super Slim) substantially lighter in weight and smaller in size than conventional ones
Heater core	• Compact, high-performance SFA-II heater core (SFA-II: Straight Flow Aluminum-II)
Blower motor	• K62 blower motor with a new type of sirocco fan is provided for every model to improve performance
Evaporator rear sensor	• Fin temperature sensor
Compressor	• SV07-modified vane compressor is provided for every model to save weight
Condenser	• High-efficiency, lightweight subcool condenser
Refrigerant	• Chlorine-free refrigerant HFC-134a (R-134a) employed to avoid damage to the ozone layer

Unit Performance and Component Specifications

Heater specifications

Items		Specifications
Heat dissipation capacity [W]	Temperate regions	3,370
	Tropical regions	3,610
	Without cooler	3,370
Quantity of air [m^3/h]	Temperate regions	205
	Tropical regions	225
	Without cooler	205
Power consumption [W]		200 or less
Blower fan <Dia. × H> [mm]		145 × 70
Blower switch		4 positions (except OFF position)

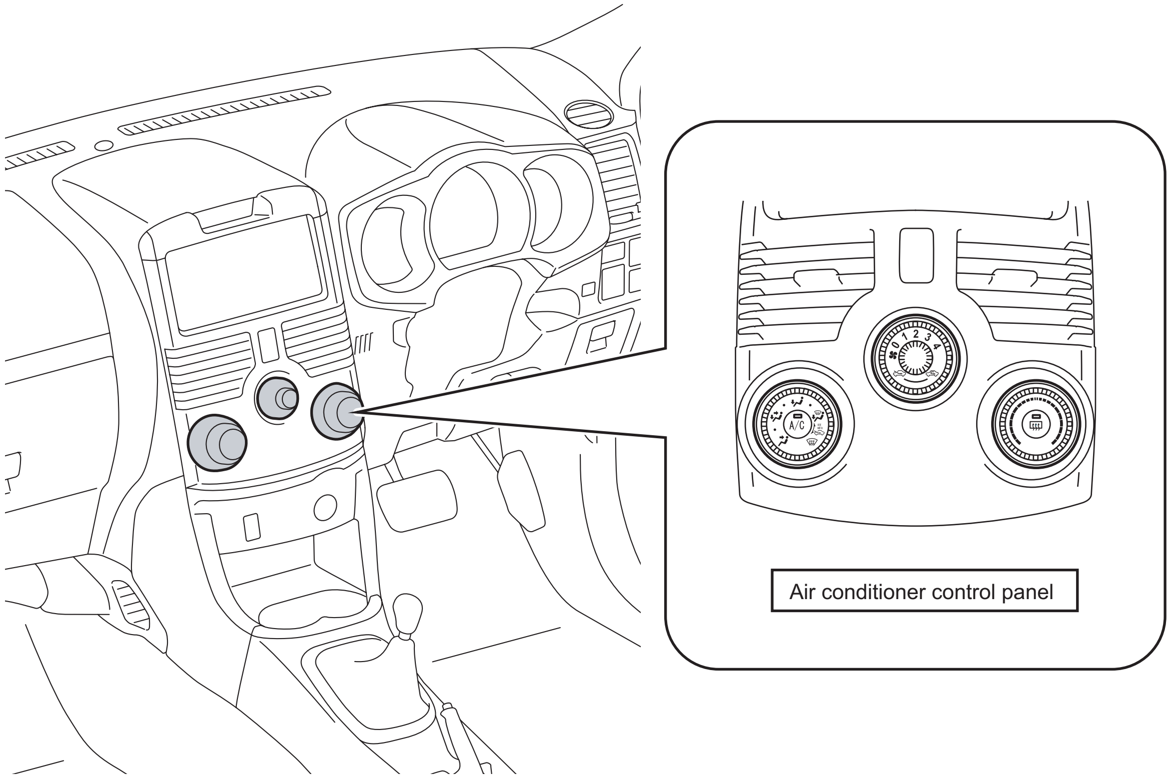
Items	Specifications
Heater core size <L × H × W × Fin pitch> [mm]	80 × 222.3 × 27 × 1.8

Air conditioner specifications

Items		Specifications
Cooling capacity [W]	Temperate regions	3,600
	Tropical regions	3,700
Quantity of air [m^3/h]	Temperate regions	360
	Tropical regions	390
Power consumption [W]		200 or less
Blower switch		4 positions (except OFF position)
Compressor type		SV07C
Pulley ratio <Crankshaft dia. to Compressor dia.> [mm]		139/93=1.495
Evaporator size <L × H × W × Fin pitch> [mm]		226.1 × 141 × 38 × 3.0
Condenser size <L × H × W × Fin pitch> [mm]		500 × 351 × 16 × 2.8

Air Conditioner Control Panel

- The dial-operated air conditioner control panel is mounted in the integration panel.
- A dial switch Easy-to-operate large dial switches are provided. Flexible cables integral with a pulley are employed for the dials to enhance ease of use.



A1270023E-D

Manual Air Conditioner System

- The manual air conditioner operates under the control of the engine control computer. For items controlled, refer to the “Engine control system” section.

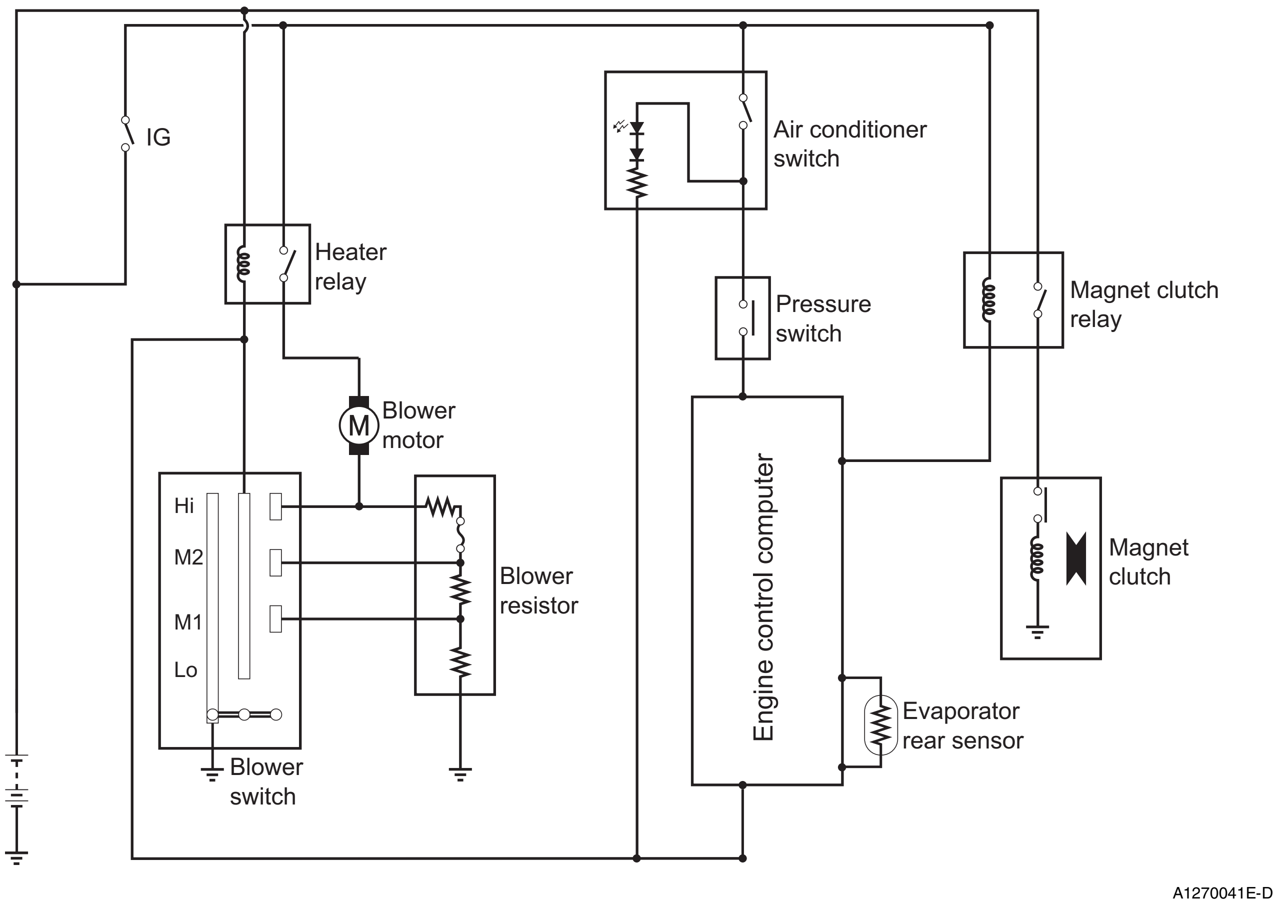
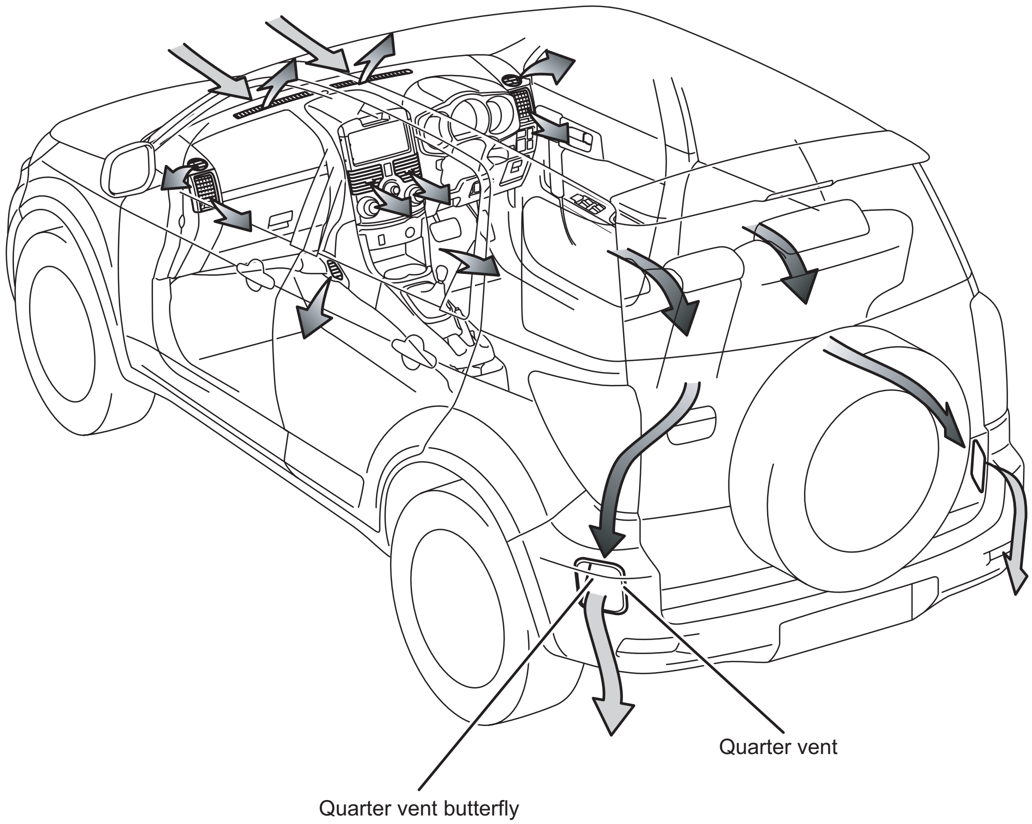


Table of items controlled by the engine control computer in connection with the manual air conditioner

Air conditioner cutoff control : 2-20
Idle speed control when air conditioner is ON : 2-21
Magnetic clutch control : 2-21

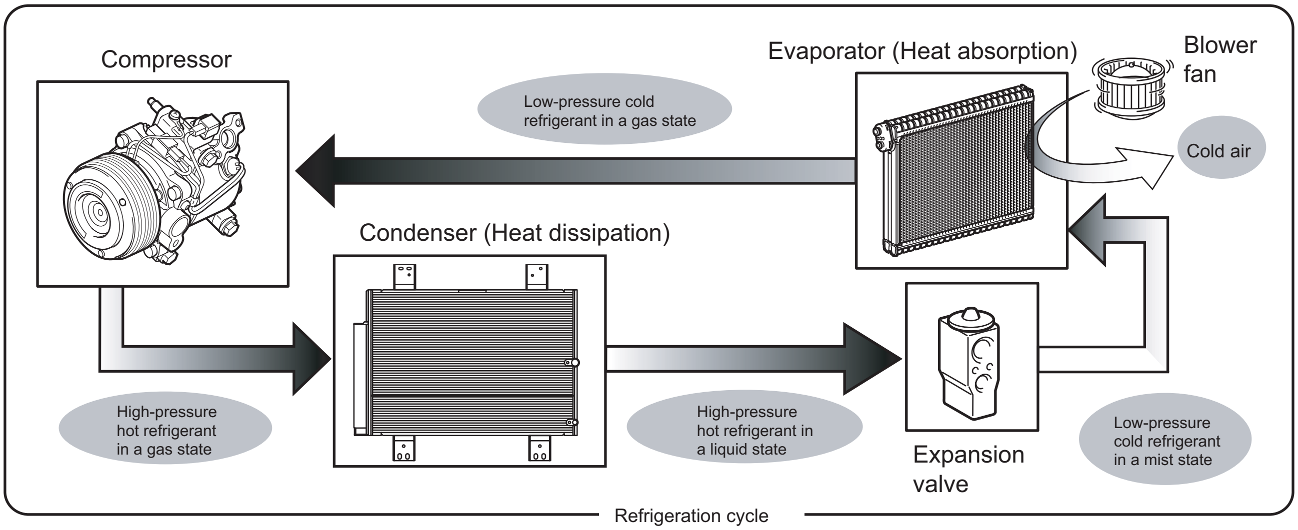
Ventilation

- Fresh air gets in the inlet on top of the cowl, passes through the air conditioner and enters the passenger compartment through air vents.
- Air in the passenger compartment is led through the body to each quarter vent duct.
- Each quarter vent duct has a butterfly damper that allows inside air to get out easily but prevents outside air and dust from getting into the passenger compartment.



Refrigeration Cycle

- A refrigeration cycle refer to circulating refrigerant through pines in a cooling system that is composed of a compressor, a condenser, an evaporator, etc. Refrigerant circulates in the cooling system while vaporizing and liquefying repeatedly, and it absorbs heat in the passenger compartment or discharges it from the passenger compartment, cooling air in the passenger compartment.



– : This is a conceptual diagram of refrigeration cycle.

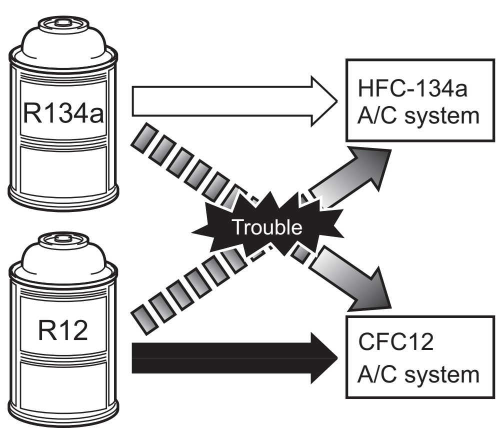
A1270049E-D

Refrigerant

- An HFC-134a (R-134a) refrigerant that contains no chlorine is used for the air conditioner to avoid damage to the ozone layer.
- To prevent the use of the wrong refrigerant or compressor oil, the applicable refrigerant and compressor oil are indicated on the back of the hood and on the compressor.

✦ **CAUTION** ✦

- **Air conditioner systems using the refrigerant HFC-134a (R-134a) use dedicated parts and joints. Using a part or joint other than the specified one may cause leakage of refrigerant.**
- **Special care must be taken to avoid selecting a compressor, compressor oil, O-rings and other items that are incompatible with HFC-134a.**



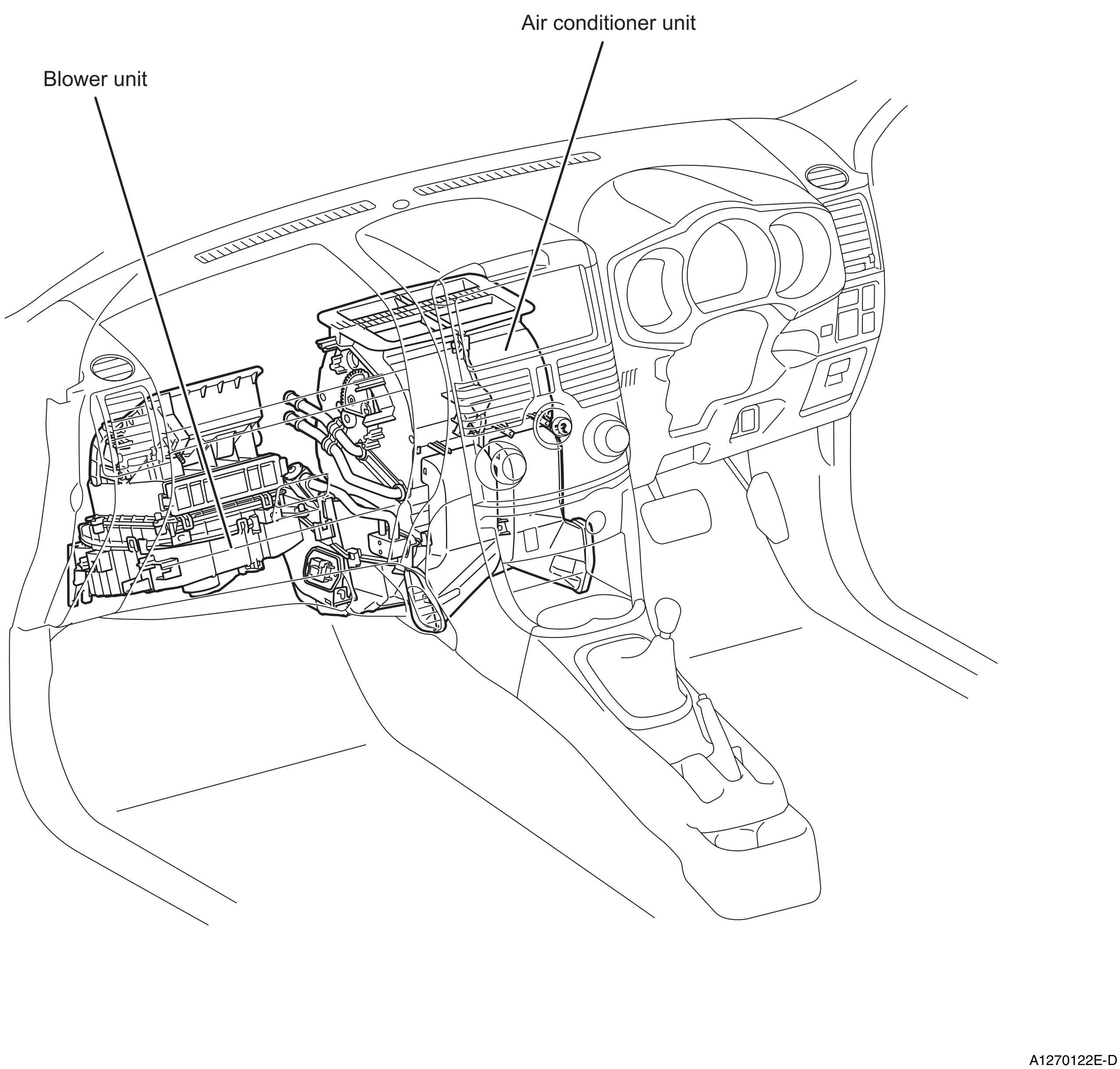
A1270158E-D

AIR CONDITIONER UNIT COMPONENTS

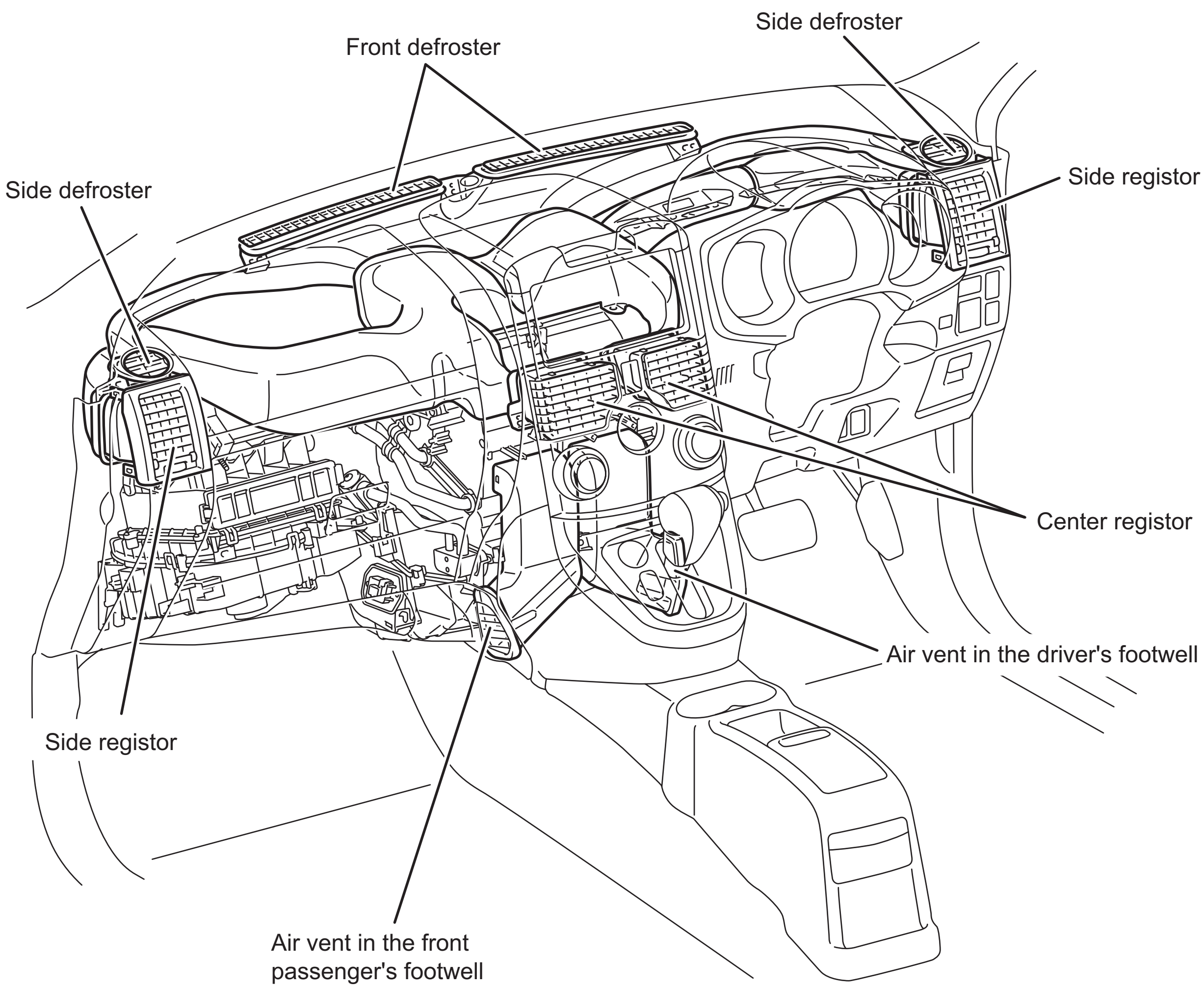
Air Conditioner Unit and Air Duct

- An all-in-one air conditioner unit consisting of a slim evaporator in the lower section of the unit and a heater core in the upper section is employed and installed at the center for space saving. The use of this type of air conditioner unit has made it possible to reduce the ventilation resistance in the air conditioner and provide a sufficient footwell on the front passenger seat side.

Arrangement of air conditioner unit

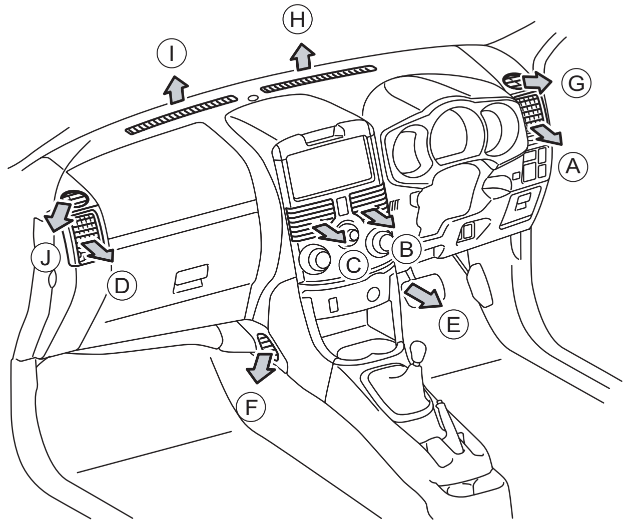


Arrangement of air ducts



Air Vent and Air Flow Rate

- The table below lists the quantities of air blowing out in each mode.

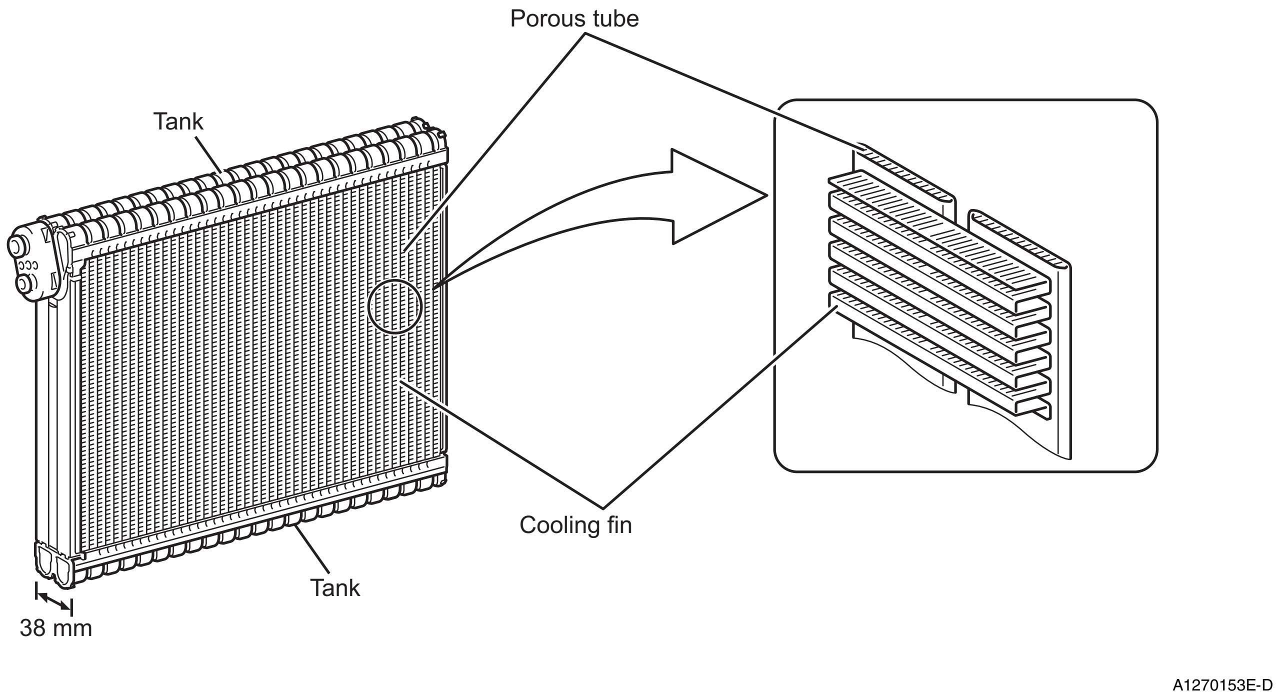


Icons	Mode	Resister				Footwell air vents		Defroster			
		Driver's seat		Front passenger seat		Driver's seat	Front passenger seat	Driver's seat		Front passenger seat	
		Side	Center	Center	Side			Side	Front	Front	Side
	FACE	→	→	→	→	/	/	/	/	/	/
	B/L	→	→	→	→	→	→	/	/	/	/
	FOOT	/	/	/	/	→	→	→	→	→	→
	F/D	/	/	/	/	→	→	→	→	→	→
	DEF	/	/	/	/	/	/	→	→	→	→
Air vent location symbols		A	B	C	D	E	F	G	H	I	J

A1270124E-D

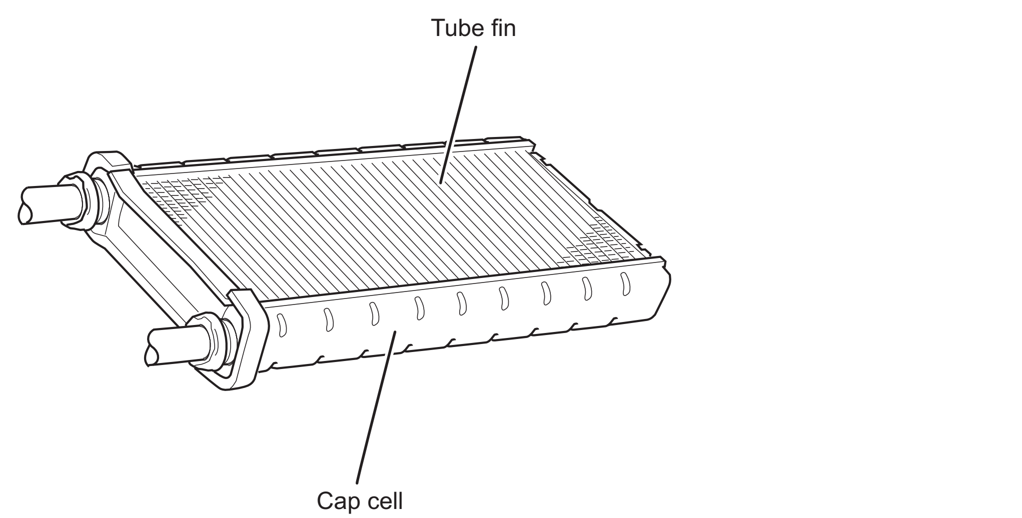
RS Evaporator (RS: Revolutionary Super Slim)

- The RS evaporator is composed of tanks, tubes and cooling fins. Tubes with minute flow paths made by extrusion molding are used to increase the heat transmission efficiency and reduce the width of the evaporator (to 38 mm). The fin height, the tube width and the fin pitch have been reduced to increase the heat transmission efficiency, and the size and weight of the RS evaporator has been reduced drastically by using a thin material for the core. The evaporator body is clean-coated to prevent the breeding of various kinds of bacteria that cause bad odor and an environmentally friendly chromium-free chemical was used for surface treatment.



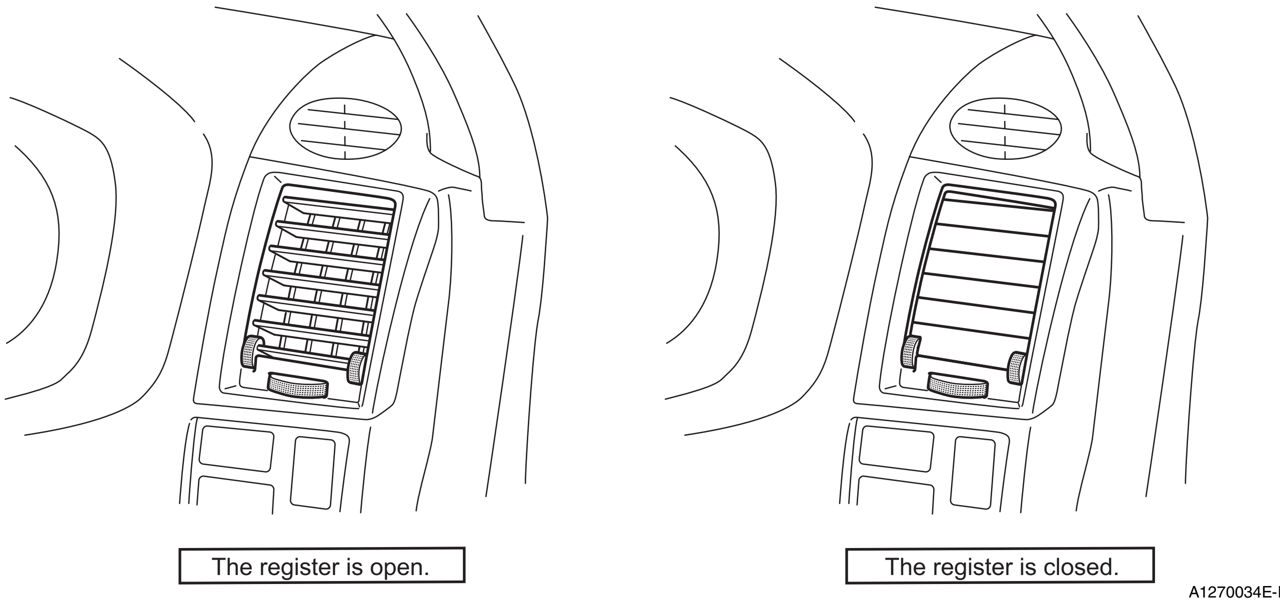
SFA-II Heater Core (SFA-II : Straight Flow Aluminum)

- The SFA-II heater has a denser core than its predecessor and its tank and liquid passages have been improved to reduce size and enhance performance.
- Aluminum replaces lead as the material used in the heater core to avoid discharging environmentally harmful lead.



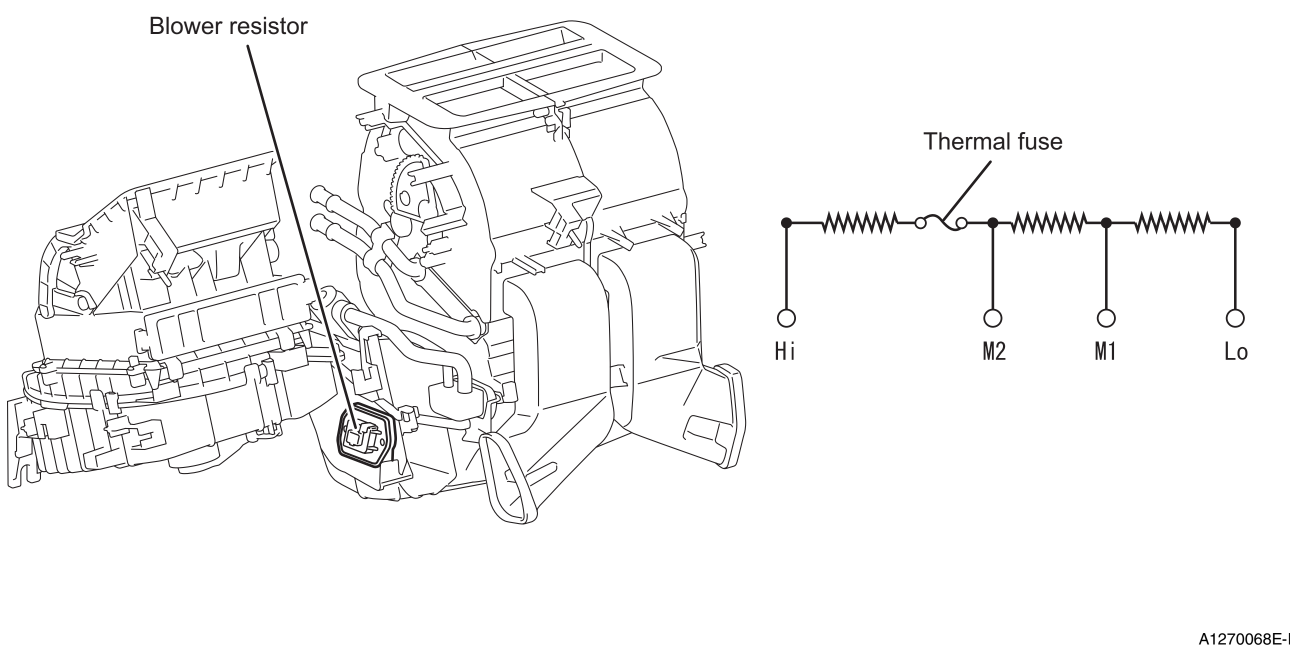
Register

- Each side register has a fin shutting mechanism, so that the blowing out of air can be blocked if necessary by shutting the air vent. The registers have a crisp feel and can be adjusted to the desired angle.



Blower Resister

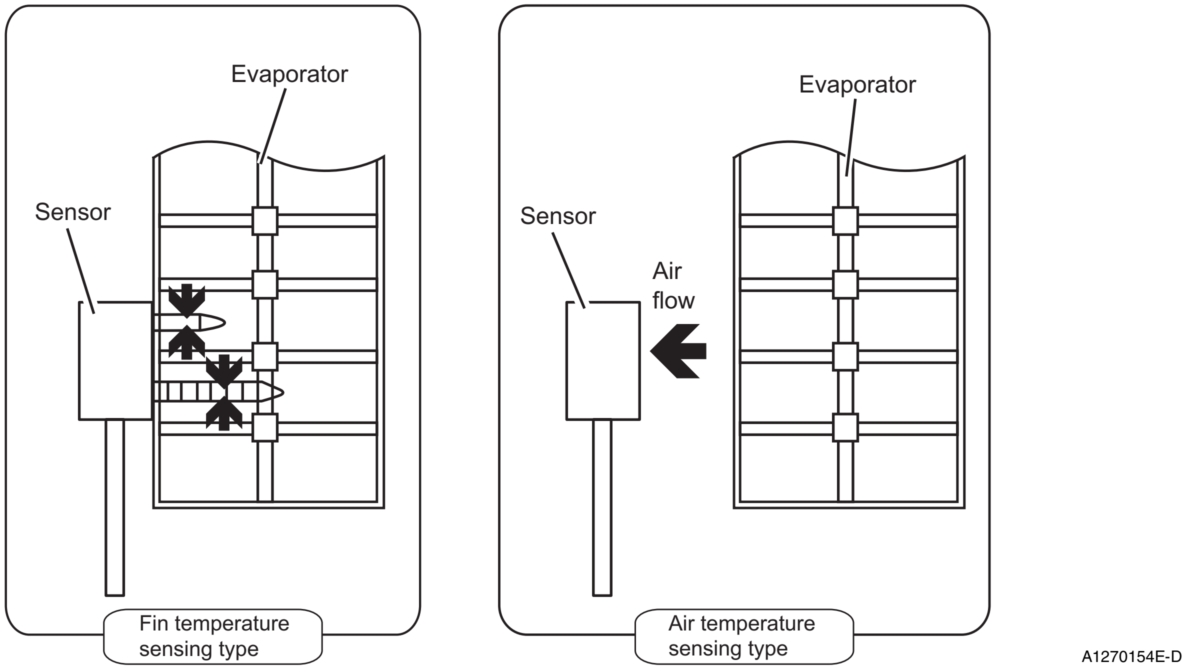
- A thin plate-type blower resistor with a thermal fuse is used to change the speed of the blower motor. It is mounted on the back of the air conditioner unit.



Evaporator Rear Sensor

- A fin temperature sensing evaporator sensor is employed. This evaporator rear sensor directly senses the surface temperature of the evaporator and provides more detailed information to the air conditioner computer. By using this sensor, fluctuations in the temperature at each air vent at the time the compressor is turned on of off have been reduced to enhance the cooling performance.

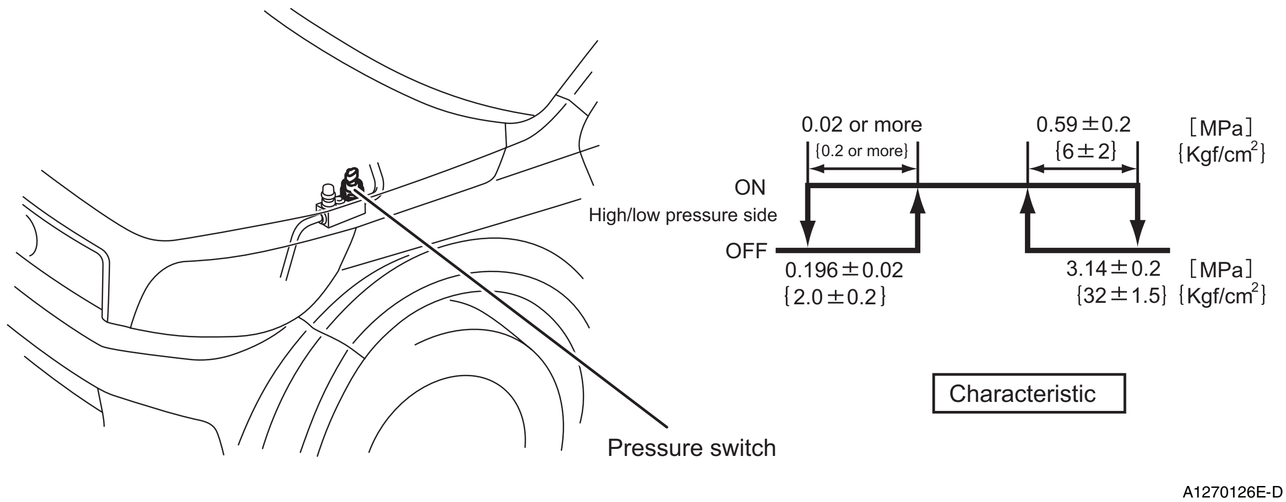
- The sensor is placed at the top of the air conditioner unit.



OTHER AIR CONDITIONER COMPONENTS

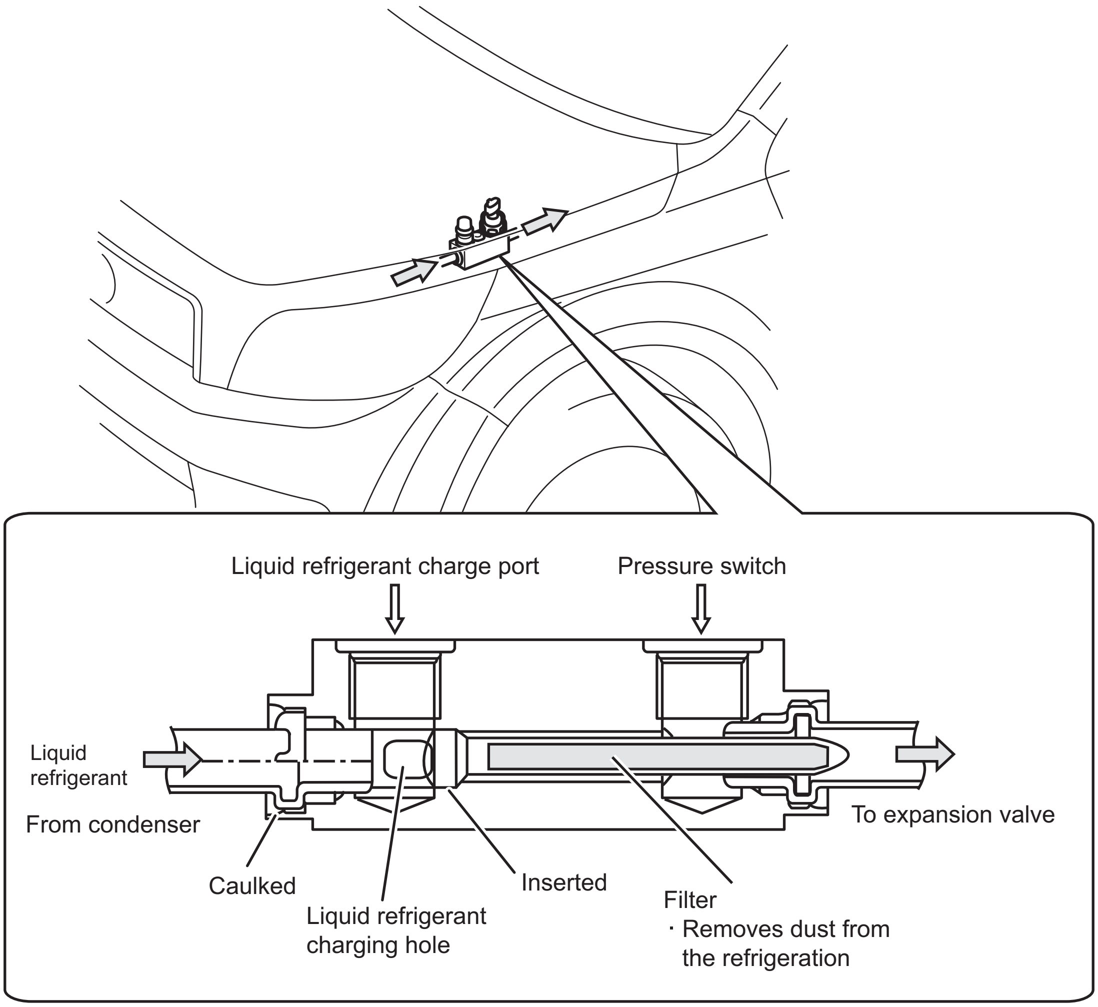
Pressure Switch

- A dual pressure switch is used to control the compressor.
- It is installed in the high-pressure block to the rear left of the condenser.



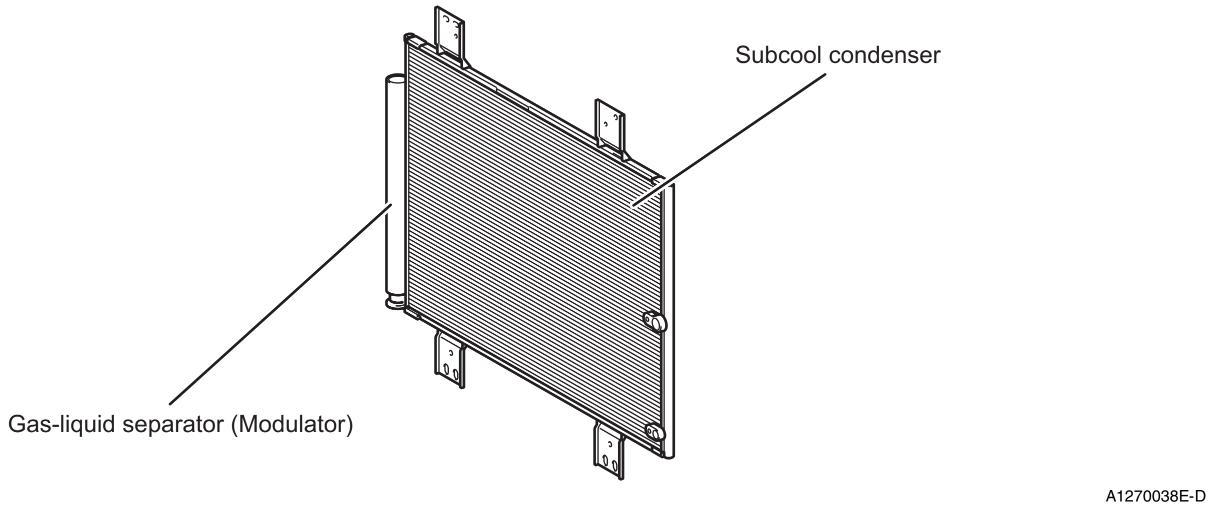
Refrigerant Filter

- The high-pressure piping block has a built-in filter to remove dust from the refrigerant.



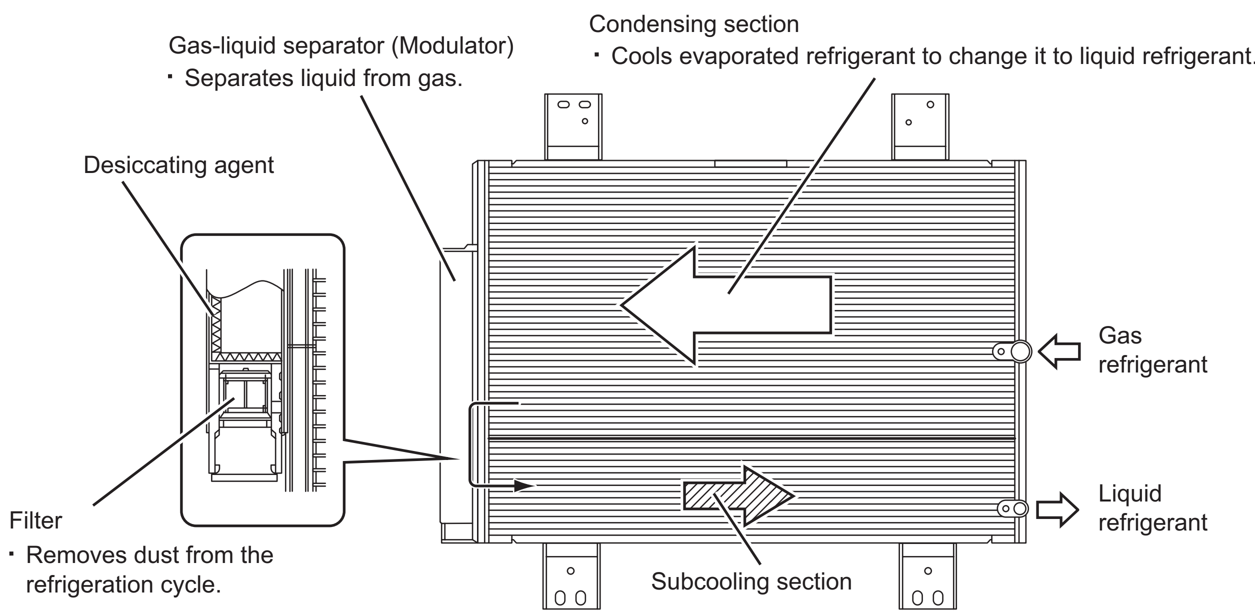
Condenser

- A standard or special-purpose lightweight condenser is used.
- A subcool condenser, which combines a multi-flow condenser and a gas-liquid separator (modulator) and constitutes a subcool cycle, is employed to increase the heat exchange efficiency.
- The special-purpose lightweight condenser has a modulator whose weight has been reduced by removing desiccating agent and moving the filter to the high-pressure piping block. The number of tubes has also be reduced, and aluminum tubes and a vane fan has been employed to improve performance and save weight.



Structure of Sub-Cooling Condenser

- The condenser in the subcool cycle is composed of a condensing section, a subcooling section and a gas-liquid separator that is installed between them. With these components, the condenser separates liquid refrigerant from gas refrigerant and further cool the liquid refrigerant to increase the amount of energy (enthalpy) that liquid refrigerant has, thus increasing the cooling efficiency.

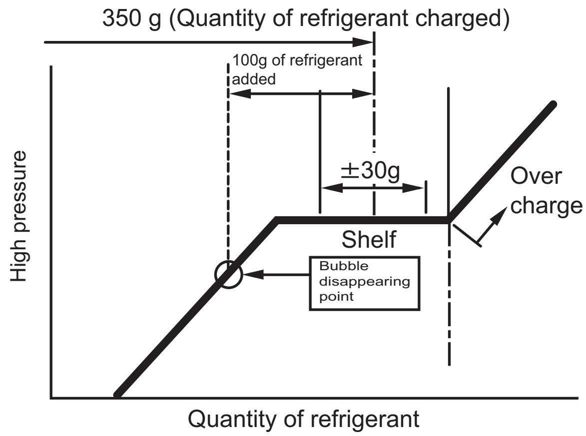


Note: The modulator for the special-purpose lightweight condenser has no desiccant or filter.

A1270064E-D

Filling of Refrigerant for Sub-Cooling Cycle

- Refrigerant gas bubbles in the receiver cycle disappear at the entrance to the stable cooling region (shelf in the figure below). In the subcool cycle, however, they disappear short of the stable cooling region, and therefore 100 g of refrigerant needs to be charged additionally to secure a proper quantity of refrigerant (proper quaintly of refrigerant: 350±30 g). (If the addition of refrigerant is stopped at the bubble disappearing point, the subcool cycle cannot deliver sufficient cooling performance.) The addition of an excess amount of refrigerant also results in a reduction in fuel efficiency and a degradation in cooling performance, and therefore a proper quaintly of refrigerant must be charged.



A1270113E-D

Electric Fan

- An electric suction fan is employed.

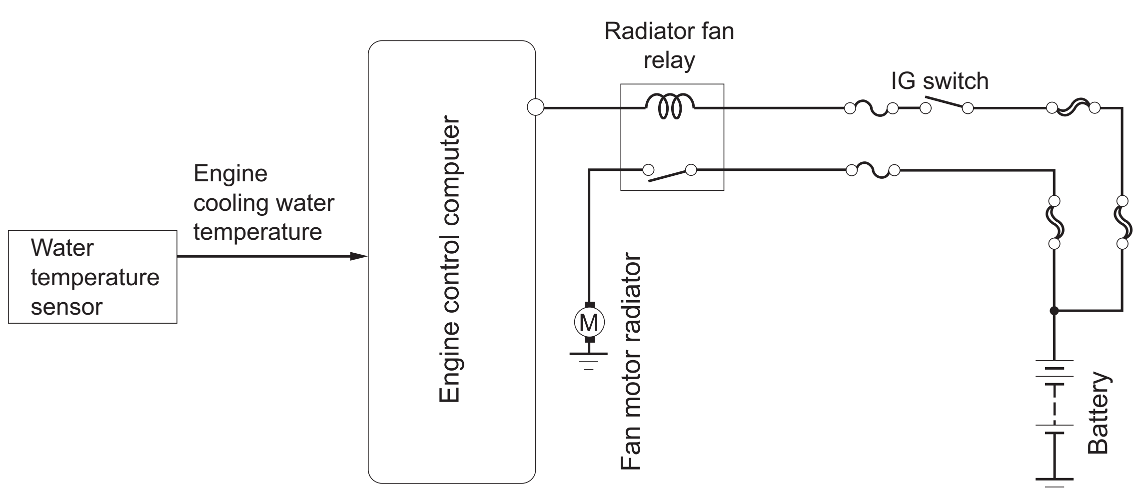
Electric fan specifications

Motor	Type	DC ferrite		
		Temperate regions	Tropical regions (M/T)	Tropical regions (A/T)
	Rated voltage [V]	12	←	←
	Output [W]	80	120	160
Fan	Outside diameter [mm]	ϕ340	←	←
	Number of blades	4	5	←

Function of Electric Fan System

- The radiator fan relay is activated to run the radiator fan motor if one of the following conditions is met: the cooling water temperature is above the specified limit, the air conditioner relay is activated, or the water temperature sensing system fails. If none of these conditions is met, the radiator relay is deactivated.

❖REFERENCE❖
In the event of a failure in the water temperature sensing system, the fail-safe function keeps the fan motor rotating.



A1270151P-D

Compressor

- An SV07C vane compressor is employed for every model.

TO FOREWORD

SRS AIRBAG

SRS AIRBAG

SRS AIRBAG AND SEAT WITH PRETENSIONER

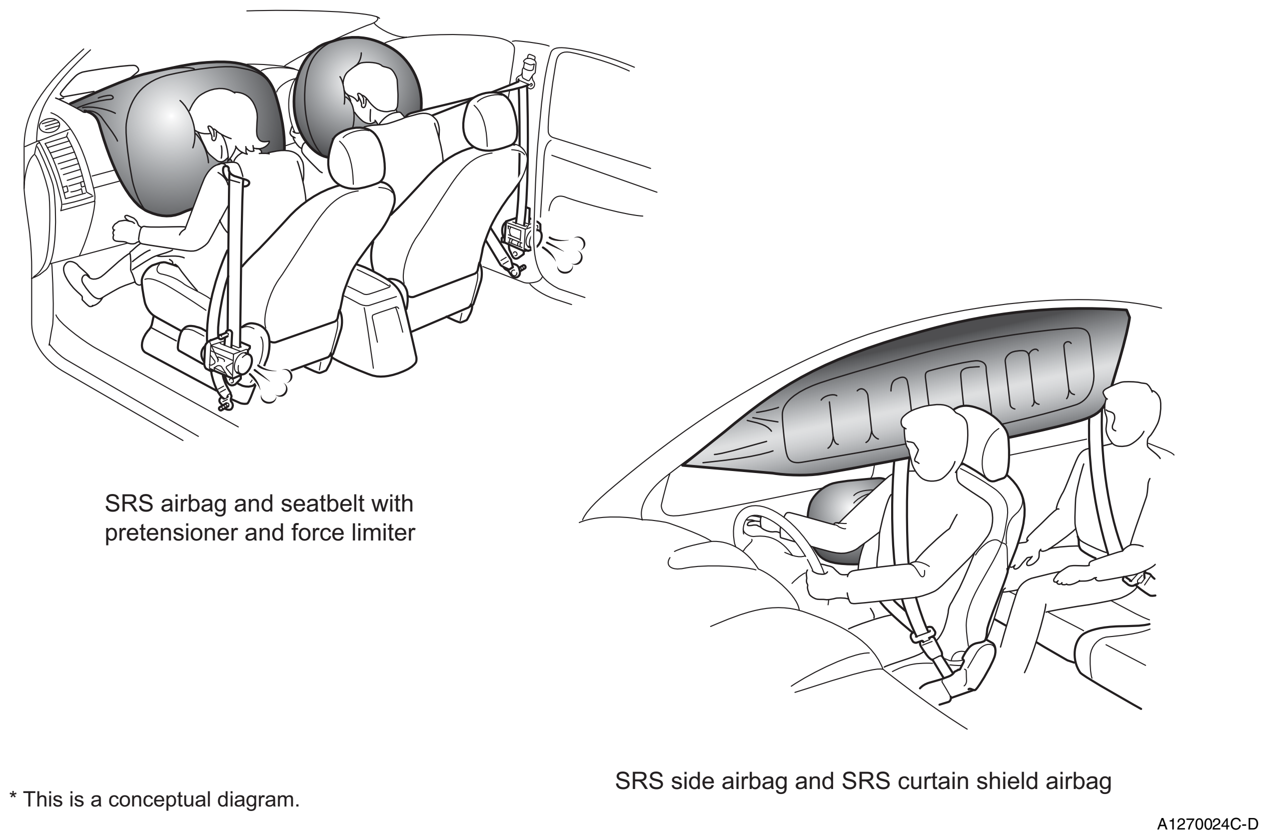
SRS SIDE AIRBAG AND SRS CURTAIN SEAL

SEAT BELT

SRS AIRBAG

Outline of SRS Airbag

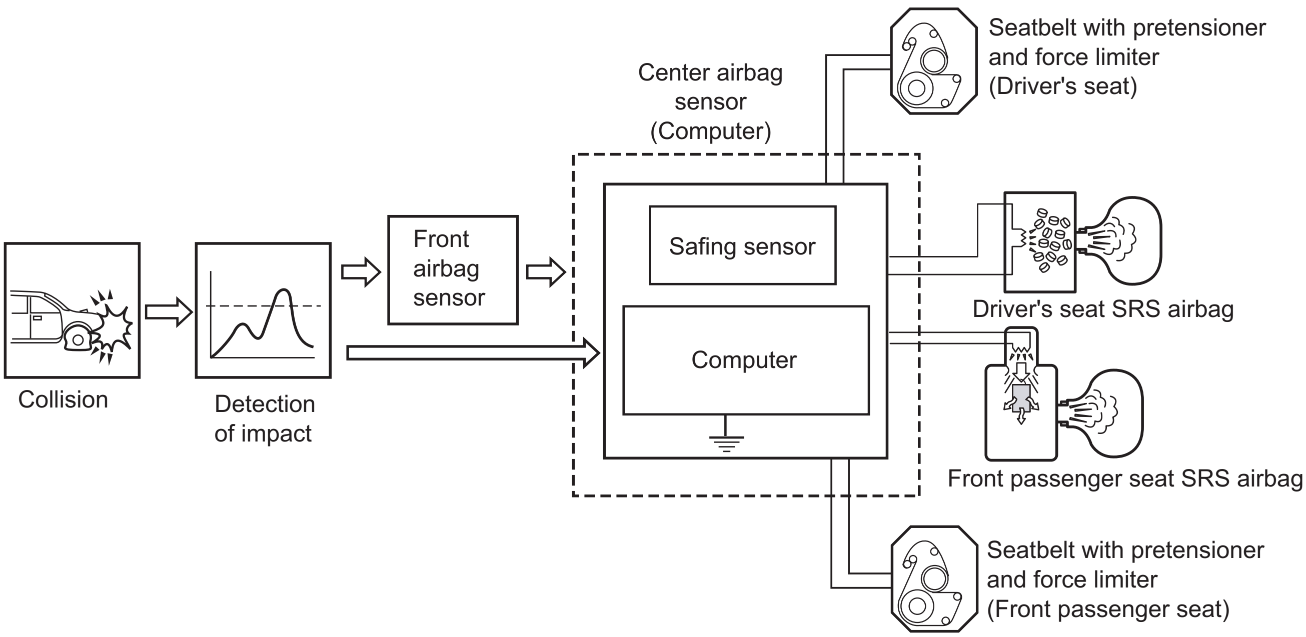
- SRS airbags and seatbelts with pretensioners and force limiters are provided as standard equipment for the driver seats and front passenger seats of European models. SRS side airbags and SRS curtain shield airbags are also available as maker options.
- For models other than European models, SRS airbags and seatbelts with pretensioners and force limiters are optionally available.
- To facilitate the disposal of airbags when scrapping the vehicle, a disposal function and a function for communication with a disposal tool are provided.

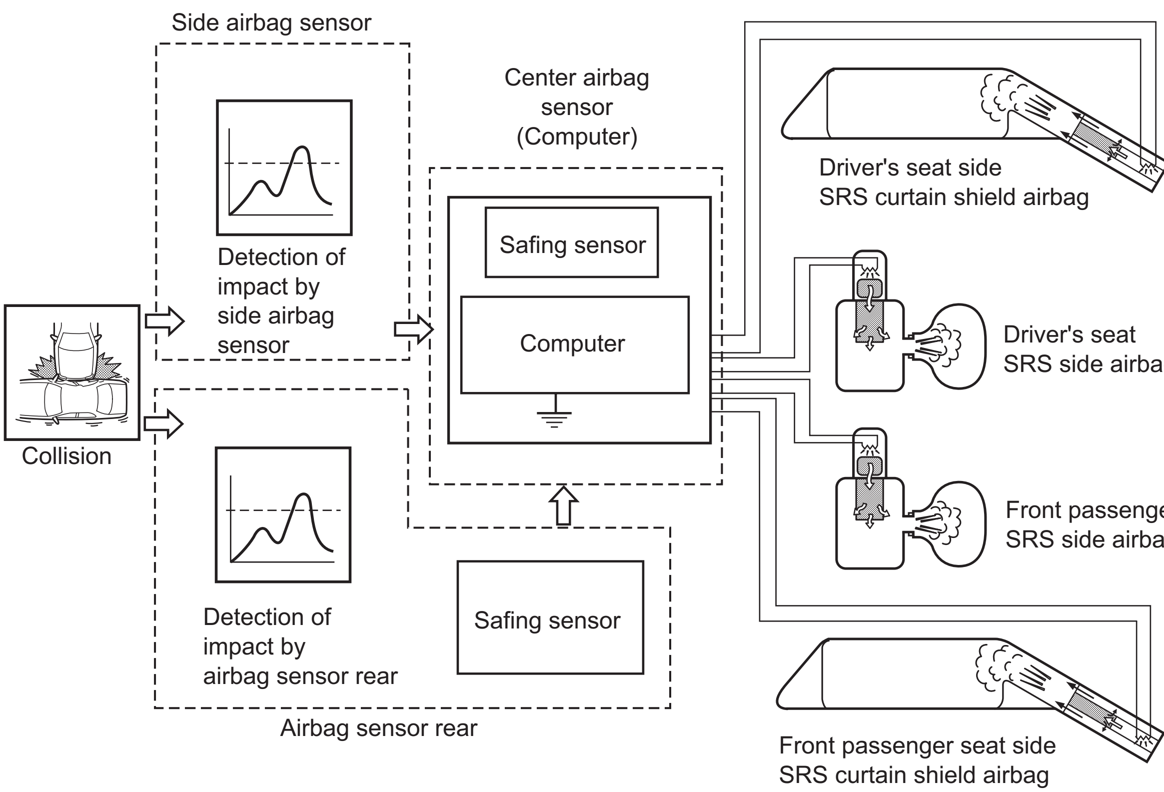


SRS airbag system

SRS airbag, SRS side airbag and SRS curtain shield airbag	If the vehicle is given a strong impact that may cause serious injury to the occupants, the airbags deploy instantaneously in conjunction with the body restraint function of the seatbelts and act as cushions to reduce the impact to the occupants' heads and chests.
Seatbelts with pretensioners and force limiters	If a strong impact is given from the front of the vehicle, the pretensioner mechanism winds back the seatbelt instantaneously to enhance the effect of restraining the occupant.
	If a load exceeding a predetermined level is applied to a seatbelt, the force limiter mechanism maintains the load at the specified level to reduce the impact to the occupant's chest.

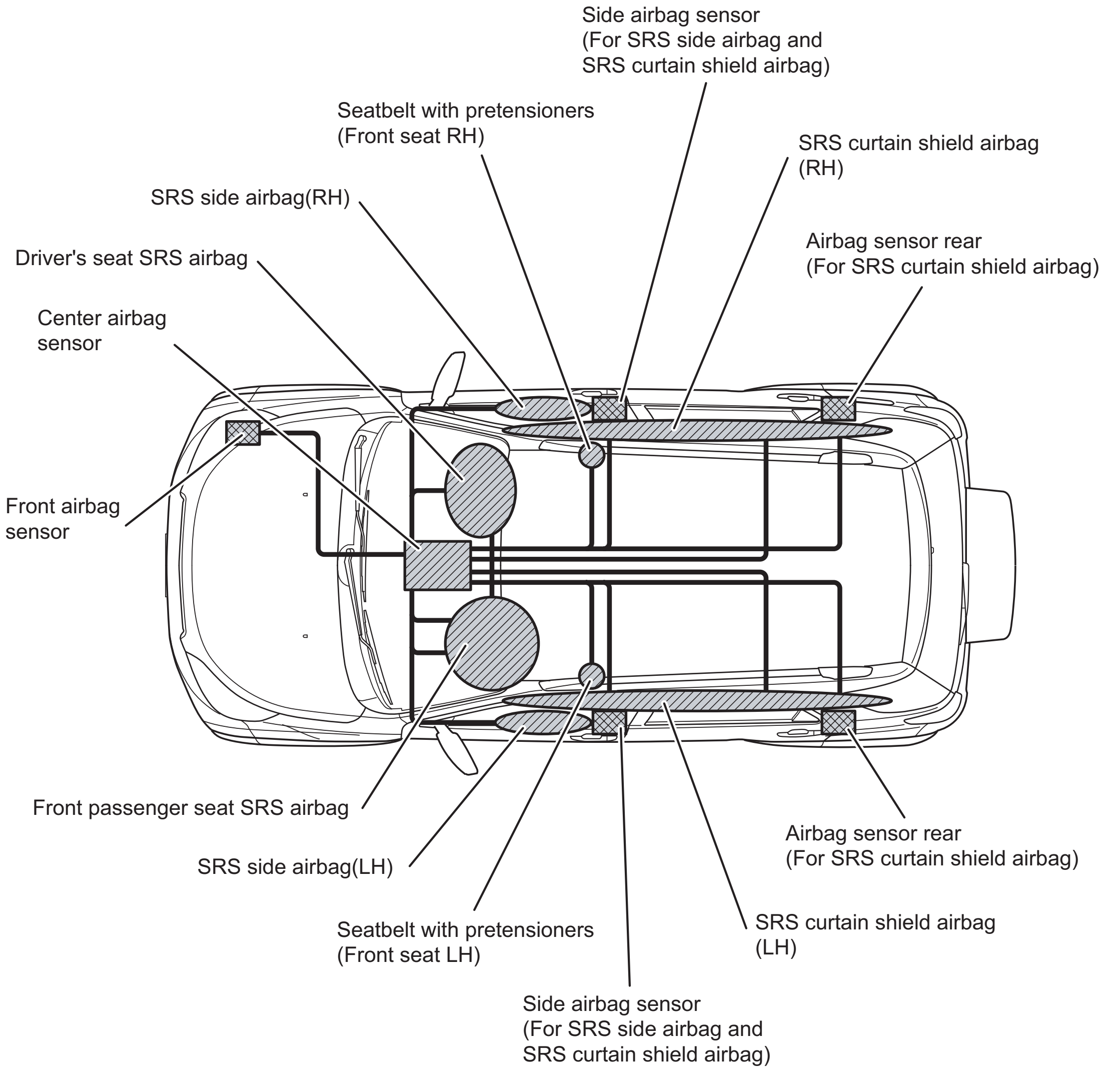
Function of System





A1270025C-D

Block diagram

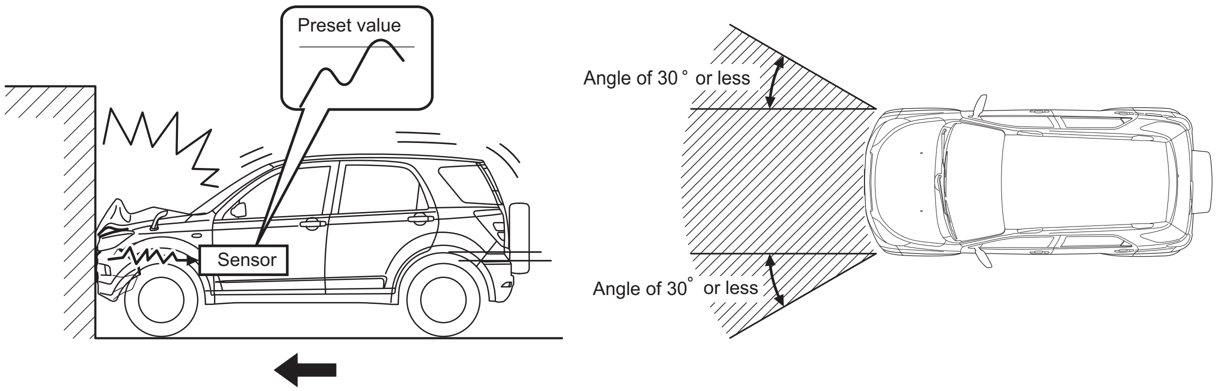


* This is a conceptual diagram of the exterior of the vehicle.

A1270026C-D

Actuation of SRS Airbag and Seat Belt with Pretensioner

- The SRS airbags and the seatbelts with pretensioners and force limiters are activated if an impact exceeding a certain level is detected at the time of a frontal collision.
- The SRS airbags and the seatbelts with pretensioners and force limiters are designed so that they will be activated if the vehicle collides head-on with a wall that does not shift or move at an angle of 30° or less at a speed of approx. 25 km/h or more.
- Since the front airbag sensor, the G sensor, and safing sensor in the center airbag ECU detect the change in speed caused by a collision, the airbags may also be activated if a strong impact is given from under the vehicle. (For example, in cases where the vehicle hits against a curb, falls into or passes over a deep hole or trench, bounds and hits against the road surface, or falls from the road shoulder.)



* This is a conceptual diagram.

A1270027C-D

Non-Actuation of SRS Airbag and Seat Belt with Pretensioner

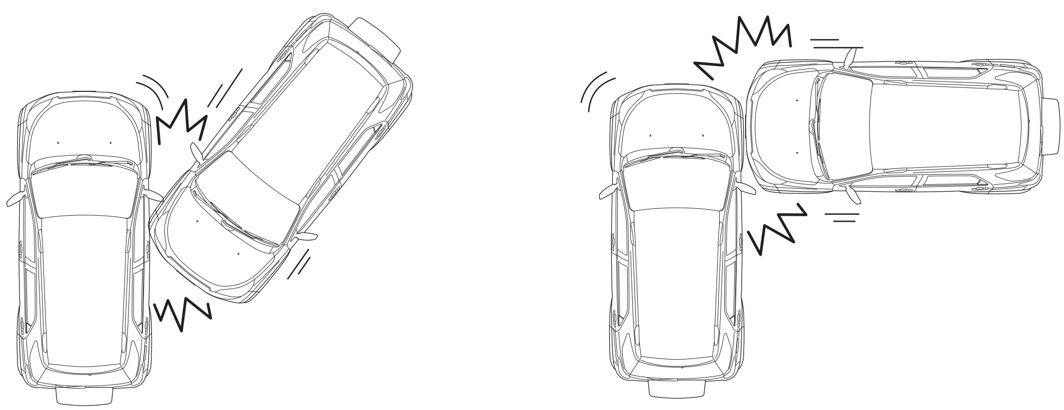
- Since the G sensor and safing sensor in the center airbag ECU and the front airbag sensor detect the change in speed caused by a collision, a collision may not necessarily activate the airbag system or only activate the seatbelts with pretensioners and force limiters. In cases where the deceleration does not reach the speed predetermined for the sensors, the system does not operate even in the event of a frontal collision.

Actuation of SRS Side Airbag and Seat Belt with Pretensioner

- A strong side impact to the passenger compartment that causes the G sensor, the safing sensor in the center airbag ECU, and the side airbag sensor to detect an impact exceeding a certain level will activate the SRS side airbags and the SRS curtain shield airbags. A strong side impact to the passenger compartment that causes the G sensor, the safing sensor in the center airbag ECU, and the side airbag rear sensor to detect an impact exceeding a certain level will also activate the SRS curtain shield airbags.

Non-Actuation of SRS Side Airbag and Seat Belt with Pretensioner

- The SRS side airbags or the SRS curtain shield airbags may not be activated, even in the event of a side collision, if the collision energy is reduced by the crumpling of the vehicle body or doors and does not meet the sensors' criteria for ignition.



If a vehicle collides diagonally with the side of the vehicle.

If a vehicle collides diagonally with a part of the vehicle other than the passenger compartment.

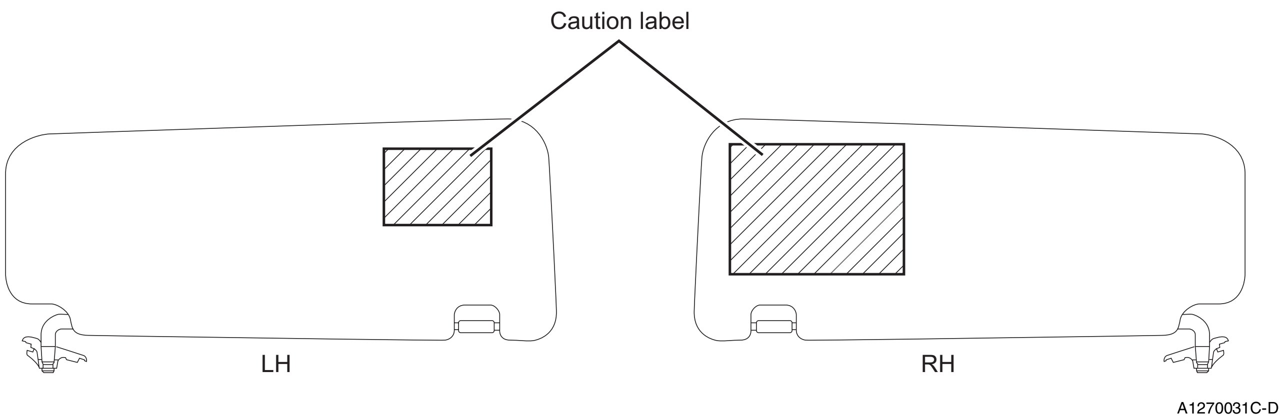
* This is a conceptual diagram.

A1270028C-D

Caution

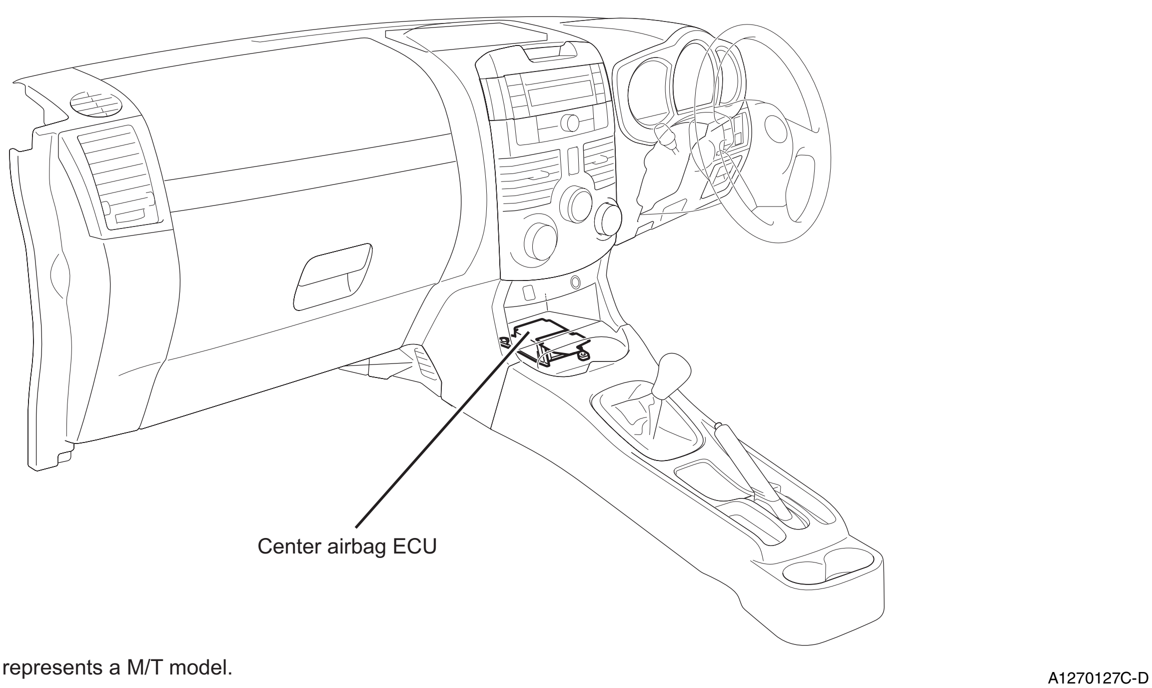
- The airbag system operates normally when the occupant is seated with good posture and their seatbelt fastened correctly.
- Do not stick labels onto or cover the airbag door as this may interfere with normal operation of the airbag system.

- Do not place any objects on or near an airbag door. Such objects may injure an occupant when the airbag deploys.
- In cases where the airbag warning lamp remains lit or it does not go on when the ignition switch is turned on, the airbag system may not operate normally even though the sensor detects an impact. Be sure to check whether the airbag warning lamp goes on and off normally.
- Caution plates are affixed to the sun visors in the driver and front passenger seats.

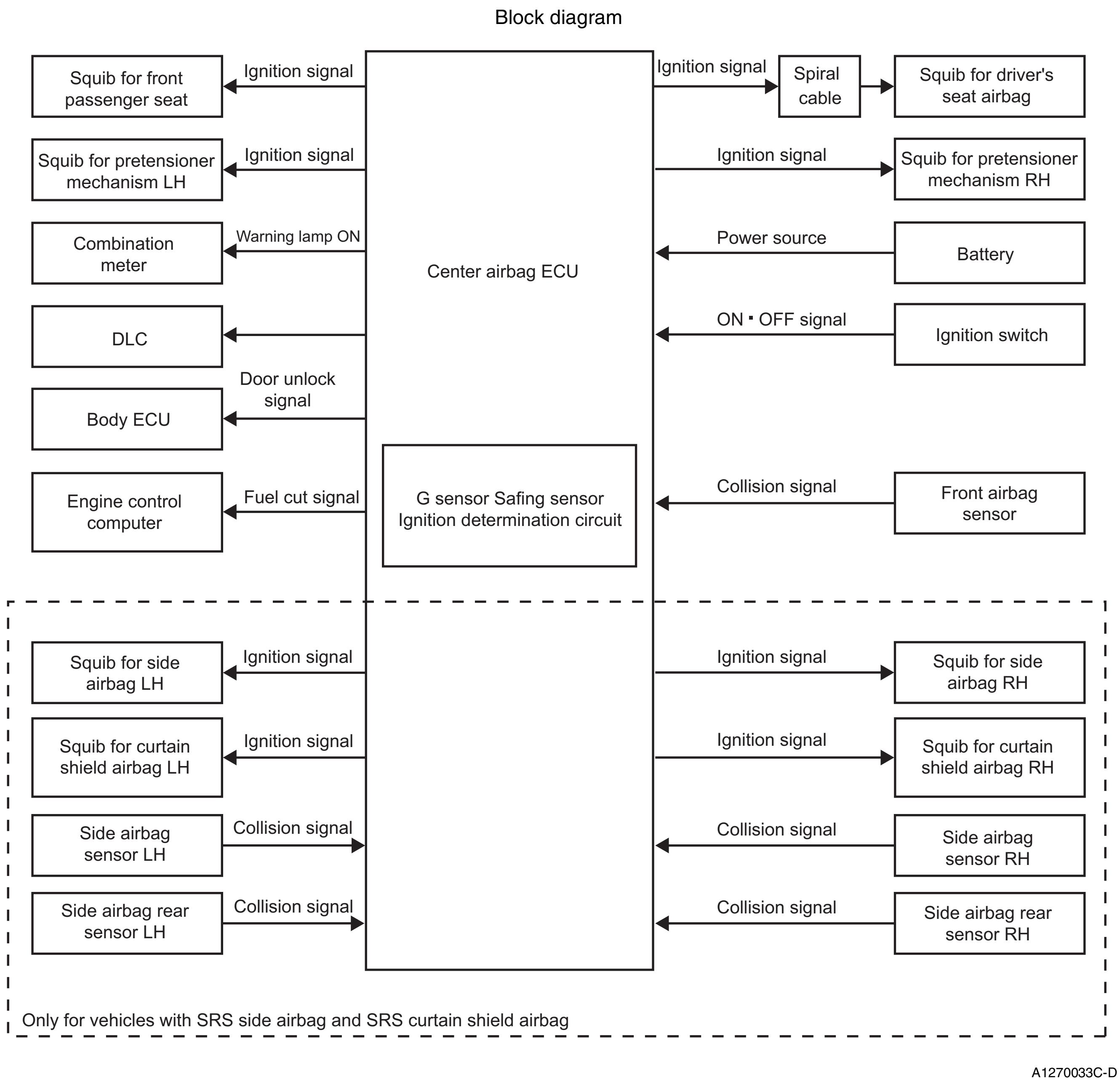


Center Airbag Sensor (Computer)

- The center airbag ECU consists of a G sensor, a safing sensor, a backup power supply, and an ignition determination circuit. To ensure reliability, the system is designed so that the failure of a single component will not cause a catastrophic failure of the whole system.
- The G sensor in the center airbag ECU is also used as a sensor for the fuel cutoff system, and the center airbag ECU is always in communication with the engine control computer.
- A caution label that shows handling methods and other matters is affixed to the top of the center airbag ECU.



* The illustration represents a M/T model.

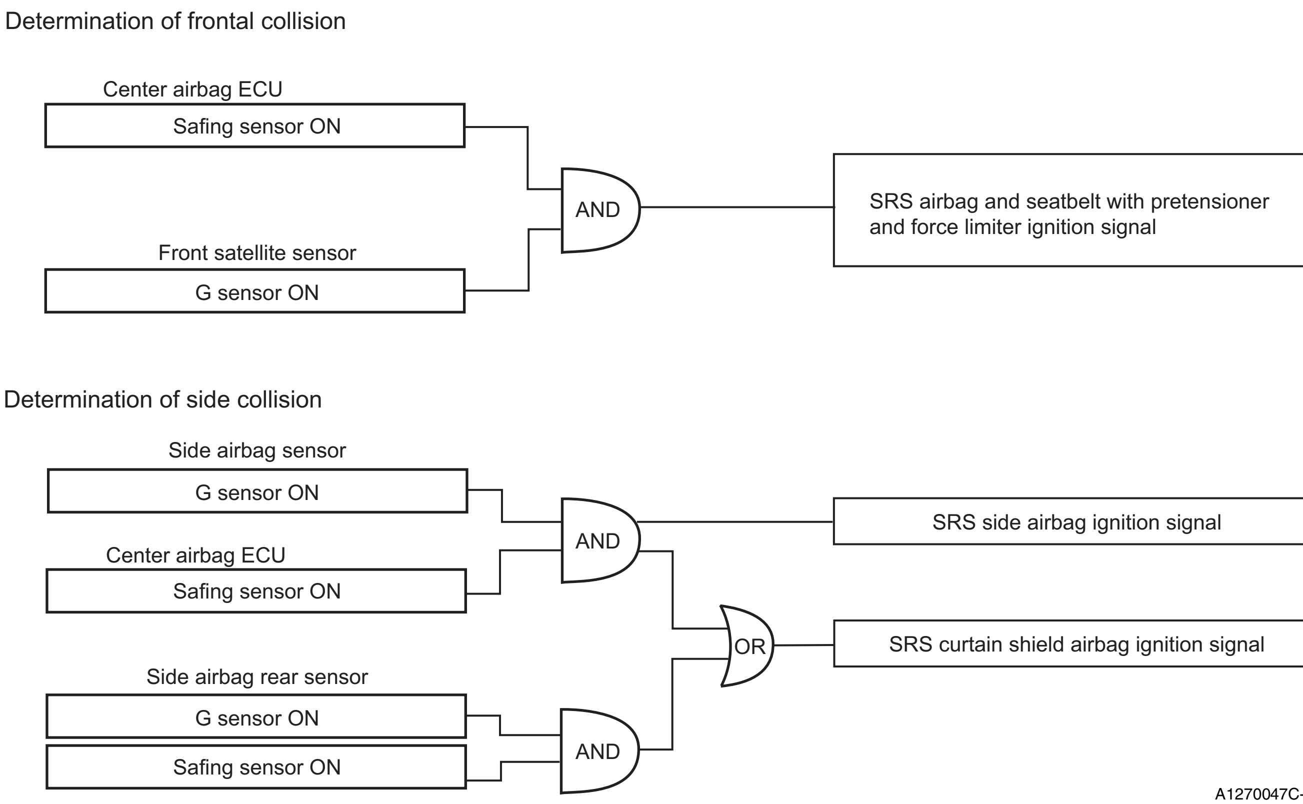


Center airbag ECU component list

Components	Functions
G-sensor and safing sensor:	Signals are output that vary linearly with change in speed if they detect the change in speed caused by an impact.
Backup power supply:	In the event of a collision or a failure of the main power supply system, a backup capacitor and a booster circuit will continue to supply power to the system.
Computer (ignition determination circuit):	It performs specific computations in response to a signal from the front airbag sensor, and if the computed value exceeds the predetermined value, it sends out an ignition signal. Its diagnostic circuit checks the whole system for abnormalities and informs the driver of malfunctions, if any, while its diagnosis function carries out a diagnosis of a faulty part of the system.

Judgement for Actuation

- Strong impact resulting from a frontal collision will trigger the SRS airbags and the seatbelts with pretensioners. Signals from the front satellite sensor, the G sensor and the safing sensor in the center airbag ECU determine whether they are to be triggered.
- The SRS side airbags are ignited if both the electronic sensor and safing sensor in the side airbag sensor turn on because of the impact caused by a side collision.
- The SRS curtain shield airbags are ignited if the above condition is met and an SRS side airbag ignition signal is given; or both the electric sensor and safing sensor in the rear airbag sensor are turned on.
- To keep a record of deployment, the center airbag ECU keeps the airbag warning lamp on even after the primary check. This warning record cannot be cleared.



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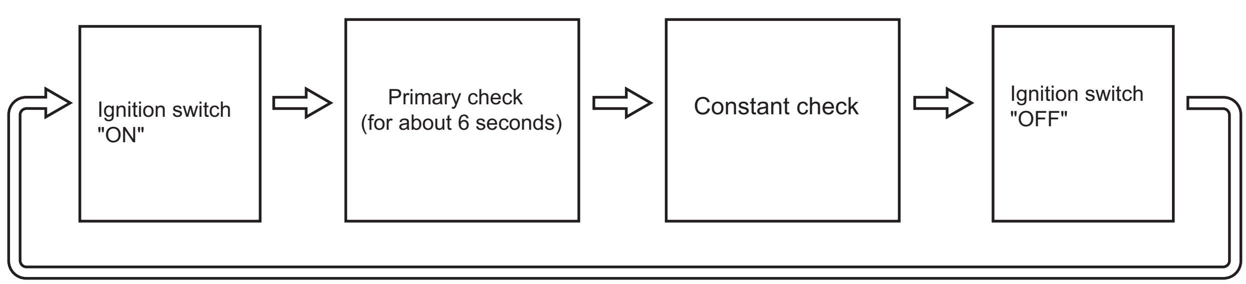
Actuation of Diagnostic Circuit

- Whether the diagnostic circuit is activated or not is indicated by the warning lamp in the meter section. The diagnostic circuit performs two kinds of checks: a primary check and a constant check.



A1270182C-D

Primary Check

- When the ignition switch is turned on, the airbag warning lamp goes on and a primary check is performed for about 6 seconds. During this period, the center airbag ECU is checked for proper functioning with its ignition function deactivated. If an abnormality is detected through this primary check, the airbag warning lamp will remain lit and not go out after the 6 second primary check.

- Once the center airbag ECU has deployed the airbags, the airbag warning lamp remains lit even after the completion of the primary check, regardless of whether or not there is something wrong with the system.

Permanent Check

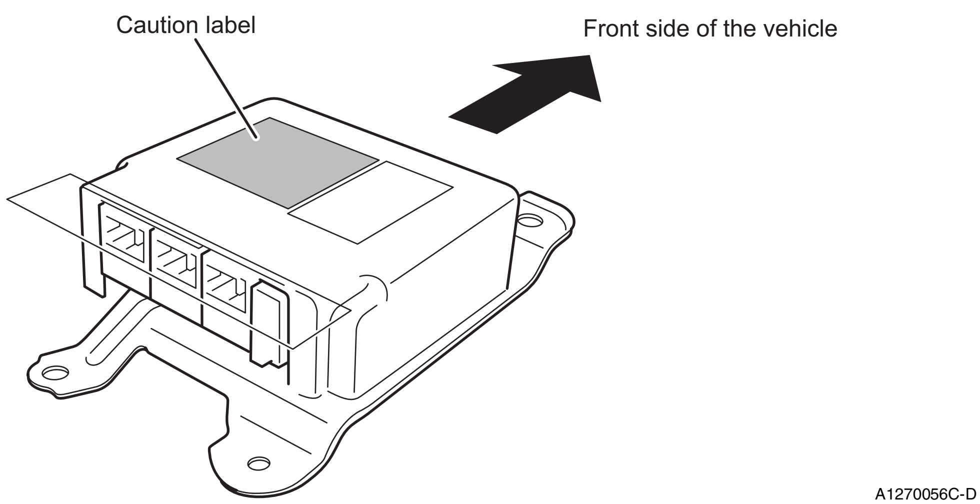
- After the completion of the primary check, the airbag warning lamp goes out and the airbag system becomes ready for ignition, while the diagnostic circuit continually checks the system for abnormalities. If an abnormality is detected in this constant check, the airbag warning lamp goes on or blinks. (If the warning lamp lights because of a drop in supply voltage, it will go out when the supply voltage is restored to a normal level.)

Diagnosis Function

- Switching to the diagnosis mode makes it possible to obtain the result of a diagnosis of a faulty part from the number of indicator lamp blinks. Furthermore, the newly adopted diagnosis function enables you to read the diagnosis code of a faulty part with the diagnostic tool connected to DLC. For more information about diagnosis mode, refer to the service manual.

Center Airbag Sensor Caution Label

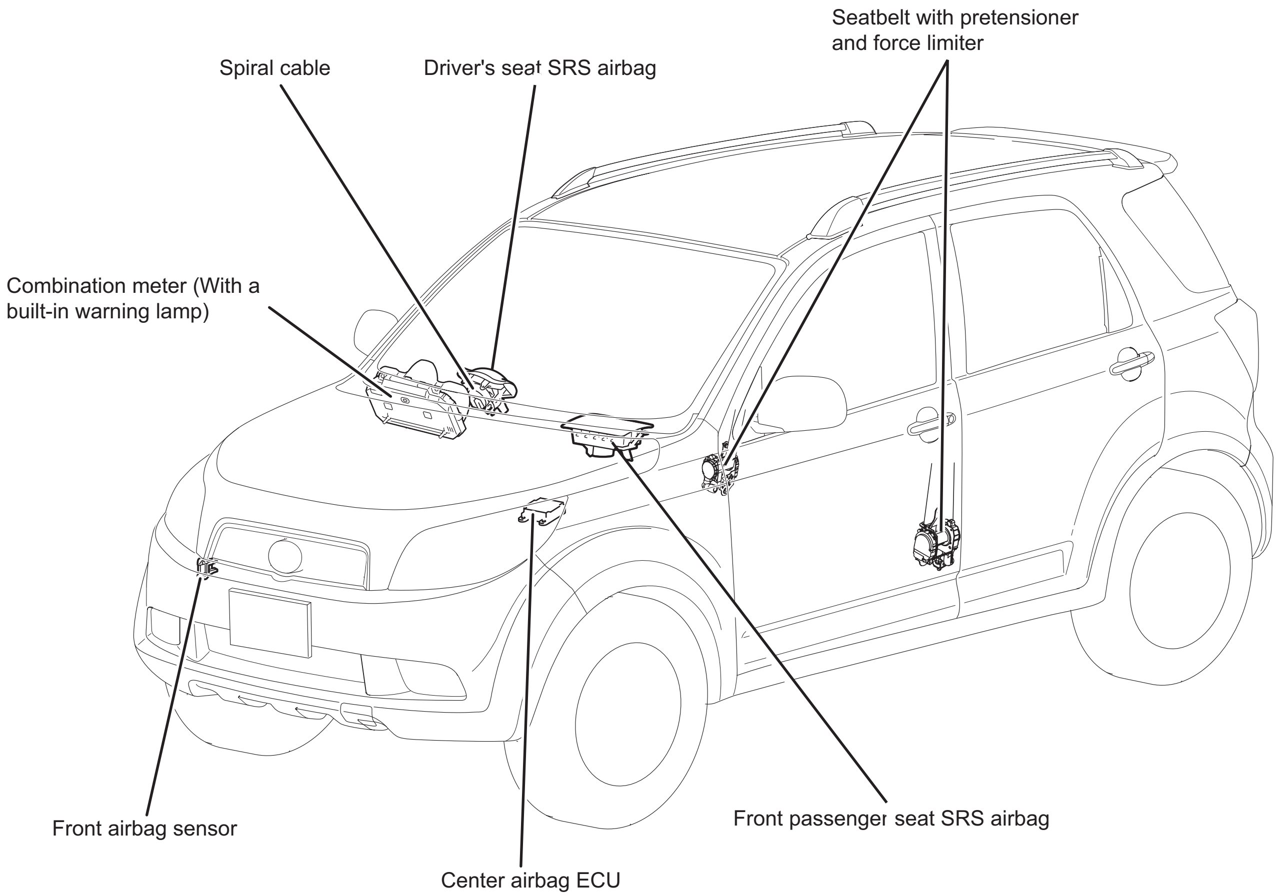
- A caution label is affixed to the top of the center airbag ECU.



SRS AIRBAG AND SEAT WITH PRETENSIONER

Outline of SRS Airbag and Seat Belt with Pretensioner

- The SRS airbag system consists of a driver's seat airbag, a front passenger seat airbag, a center airbag ECU, a front airbag sensor, and seat-belts with pretensioners and force limiters, etc.



Note: This is a conceptual diagram.
The exterior of the actual vehicle may look somewhat different from that illustrated above.

A1270034C-D

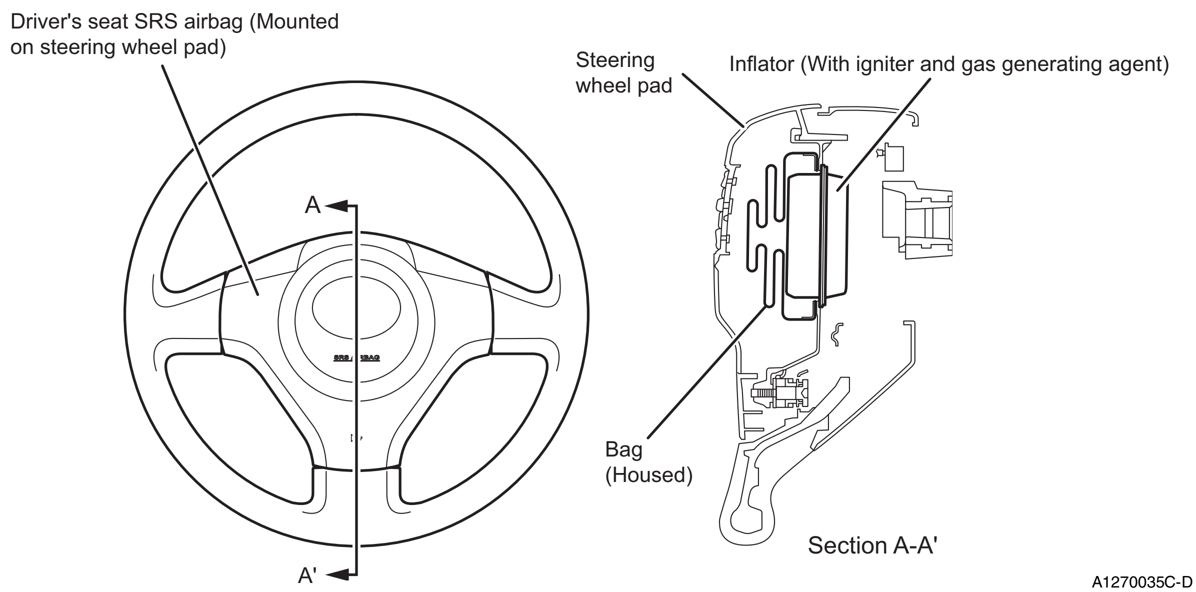
Principal components and their functions

Components	Functions
Driver's seat and front passenger seat SRS airbags	Each airbag consists of an inflator and a bag. When receiving an ignition signal from the center airbag ECU, the inflator generates gas and inflates the bag instantaneously to reduce and absorb the impact to the occupant.
Seatbelt with a pretensioner and a force limiter	If a strong impact is received from the front of the vehicle, the pretensioner rewinds the belt instantaneously to enhance the effect of restraining the occupant.
	If a load exceeding the specified level is applied to a seatbelt, the force limiter holds the load at the specified level to reduce the impact to the occupant's chest.

Components	Functions
Spiral cable	The spiral cable transmits the ignition signal from the center airbag ECU to the driver's seat airbag.
SRS airbag warning lamp	If the system fails, this warning lamp goes on to inform the driver that the system is faulty.
Front airbag sensor	The front airbag sensor detects the change in speed caused by a collision and sends a signal for the center airbag ECU to determine whether to ignite the airbags.
Center airbag ECU	This center airbag ECU consists of a safing sensor, an ignition determination circuit, and other safety controls. In the event of a collision, the safing sensor detects the change in speed to judge whether to ignite the airbags by the signal from the front airbag sensor ;and if necessary, the sensor sends an ignition signal to the SRS airbags and the seatbelts with pretensioners and force limiters. If the airbag ECU is put in diagnosis mode in the event of a system failure, it will perform a diagnosis of the failed system.

Driver's Seat SRS Airbag

- The driver's seat SRS airbag is mounted on the steering wheel pad. If the SRS airbag receives an ignition signal from the center airbag ECU, the igniter in the inflator starts a chemical reaction to generate gas in the inflator. As a result, the airbag deploys instantaneously, absorbs and reduces the impact to the driver, and then deflates.
- The SRS airbag, which cannot be disassembled, consists of an inflator, a bag, a steering wheel pad, etc.



Airbag

- The bag filled with gas deploys instantaneously, bursts the thin layer of the steering wheel pad, sustains the impact to the occupant's head, and then reduces the impact by releasing gas through the exhaust port on the back of the bag.

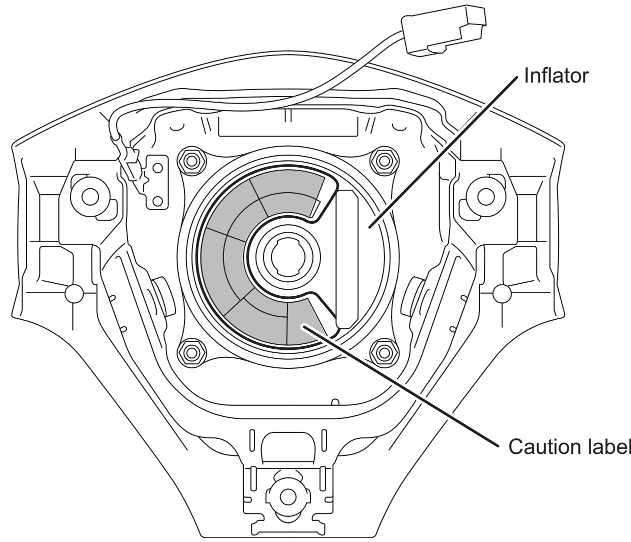
Inflator

- The inflator consists of an igniter, a fire propagating agent, a gas generating agent, etc. The gas generating agent is used as a material for generating nitrogen gas necessary to deploy the bag in the event of a collision. The inflator is completely sealed from the inside.
- If the igniter is energized because of the change in speed caused by a collision, the filament in the igniter generates heat, which makes

the igniting agent catch fire. Then, the fire spreads in an instant through the fire propagating agent to the gas generating agent, causing the fire propagating agent to generate a large amount of nitrogen gas. The generated gas, after passing through a filter for cooling and removing the burnt residue, fills up the bag.

Caution Label

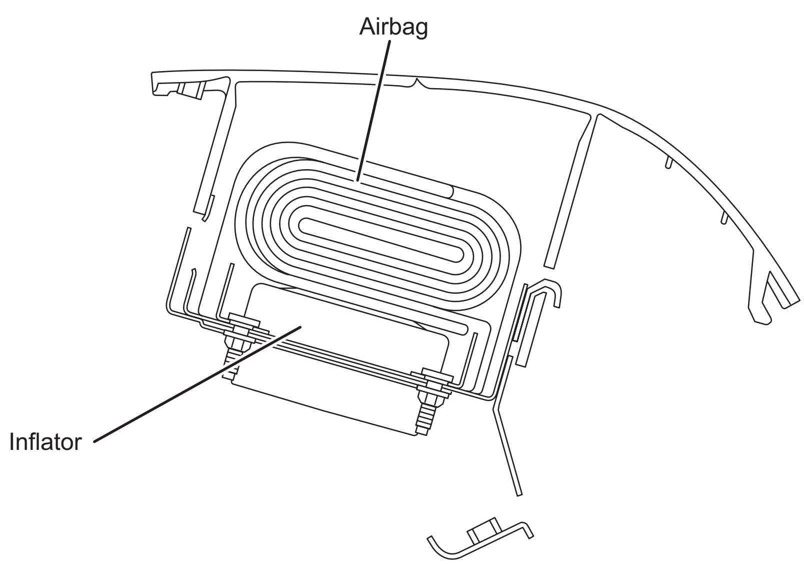
- A caution label for servicing is affixed to the inflator on the back of the steering wheel pad.



Back view of steering wheel pad
A1270036C-D

Front Passenger Seat SRS Airbag

- The front passenger seat SRS airbag is mounted on the top of the instrument panel of the front passenger seat side. The SRS airbag is fixed to the instrument panel and a reinforcement bracket, and consists of a case, an inflator and a bag.
- To improve the appearance, the boundaries of the instrument panel and airbag are aligned with a styling line.



A1270037C-D

Airbag

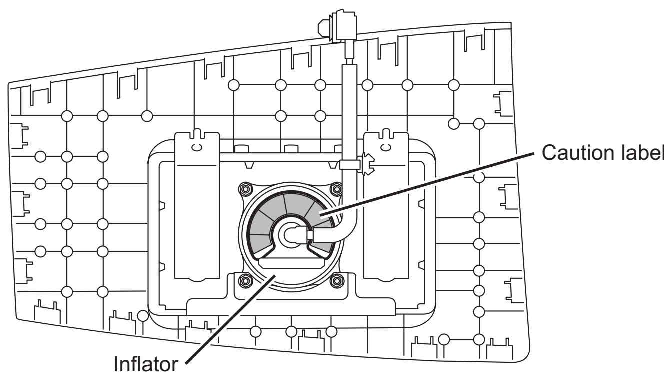
- The front passenger seat airbag filled with gas deploys instantaneously, bursting the bag protection cloth on the top surface of the bag. After absorbing the impact from the front seat occupant's head, the airbag eases the impact by releasing gas through the exhaust port on the back of the bag.

Inflator

- The inflator consists of an igniter, fire propagating agent, gas generating agent, etc. The gas generating agent is used as a source for generating nitrogen gas necessary to deploy the bag in the event of a collision. The inflator is completely sealed from the inside.
- If the igniter is energized because of change in speed caused by a collision, the filament in the igniter generates heat, which makes the igniting agent catch fire. Then, the fire spreads through the fire propagating agent to the gas generating agent in an instant, causing the fire propagating agent to generate a large amount of nitrogen gas. After passing through a filter for cooling and the removal of burnt residue, the gas fills up the bag.

Caution Label

- A caution label that explains handling and other matters is affixed to the inflator of the front passenger seat SRS airbag.

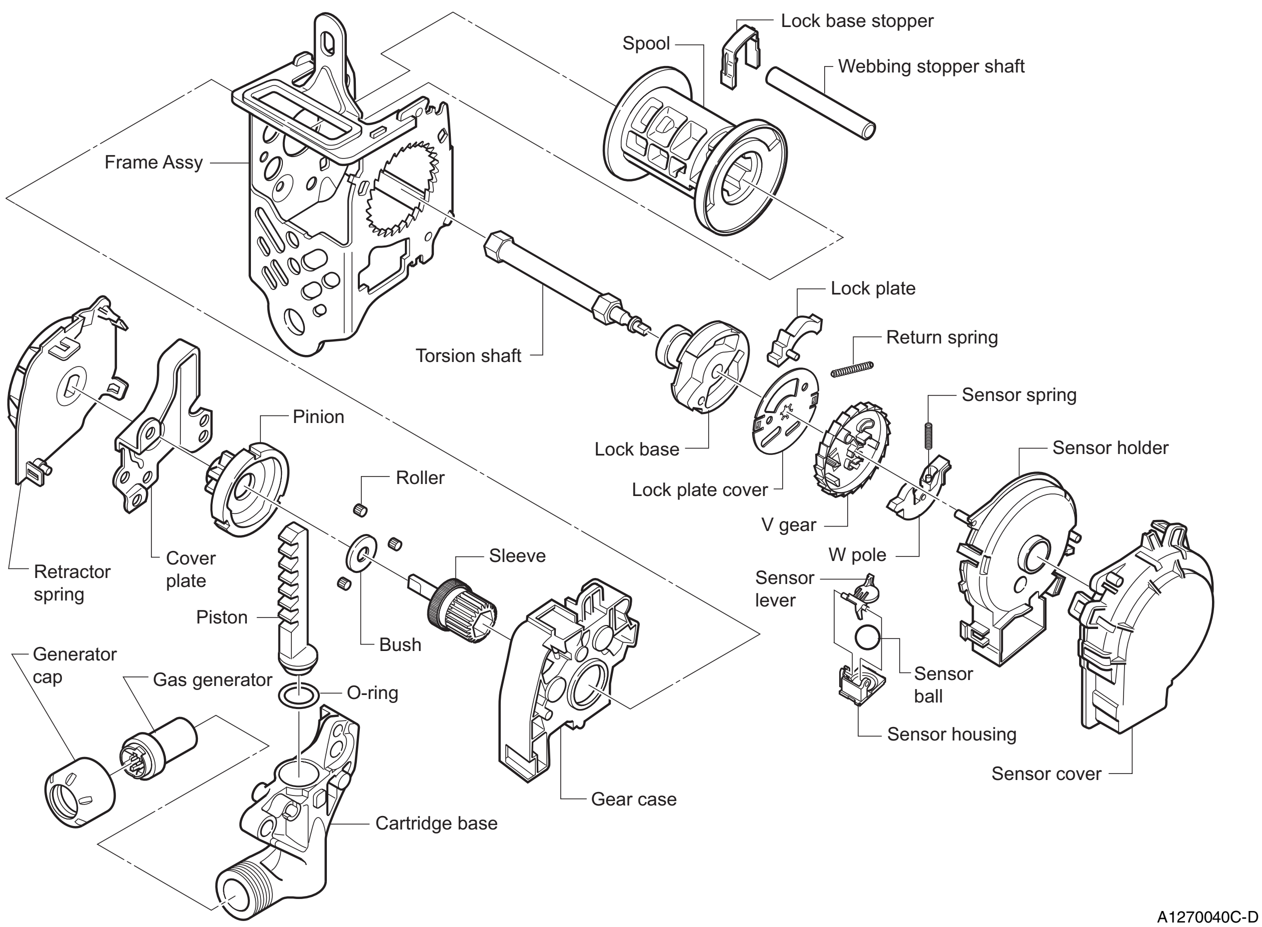


Back view of front passenger seat SRS airbag

A1270038C-D

Seat Belt with Pretensioner and Force Limiter

- Seatbelts with pretensioners and force limiters are employed for the driver's seat and the front passenger seat.
- The pretensioner consists of a gas generator, a cartridge base, a piston, a pinion, a roller, a sleeve, etc.
- The force limiter consists of a torsion bar along with other items.

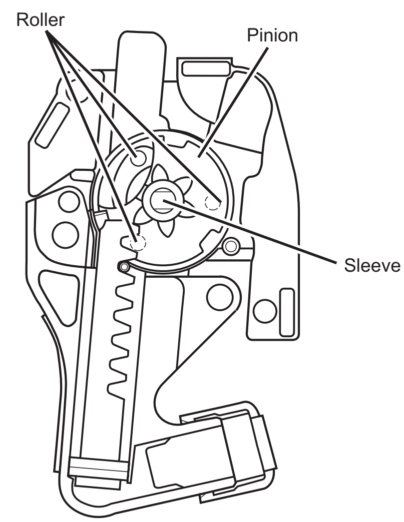


Actuation of Pretensioner

• In the event of a collision, the pretensioner is activated simultaneously with the airbag by an ignition signal from the center airbag ECU and rewinds the seatbelt to a certain length to advance the occupant restraint timing. The pretensioner works even if the seatbelt is not worn. Once activated, the pretensioner cannot be reused.

Operation 1

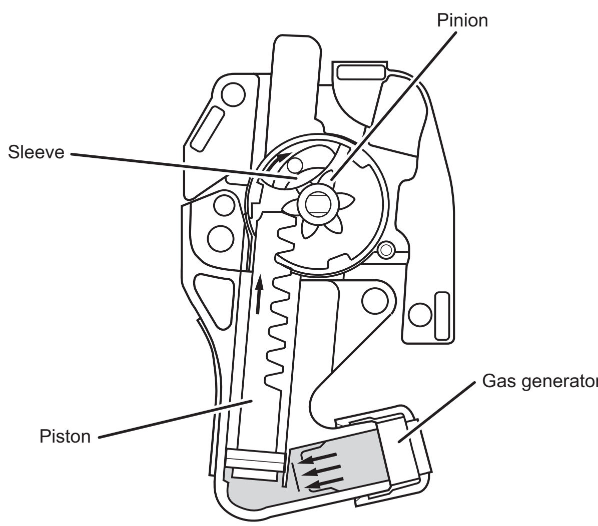
Under normal conditions, the sleeve is fixed to the spool through the torsion bar. Since there is a clearance between the sleeve and the roller/pinion, the sleeve rotates freely.



A1270041C-D

Operation 2

If the gas generator generates high pressure gas at an ignition signal from the center airbag ECU, the piston is pushed out by gas pressure and moves up. As a result, the rack on the piston is engaged with the pinion. When the pinion rotates, its slanted tooth moves the roller towards the direction of the axle and joins it to the sleeve. When joined together, the pinion, the sleeve and the spool start rewinding the belt.



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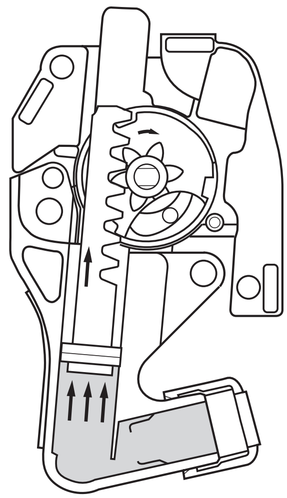
Operation 3

The piston goes up further by gas pressure and rewinds the belt by rotating the pinion, sleeve and the spool.



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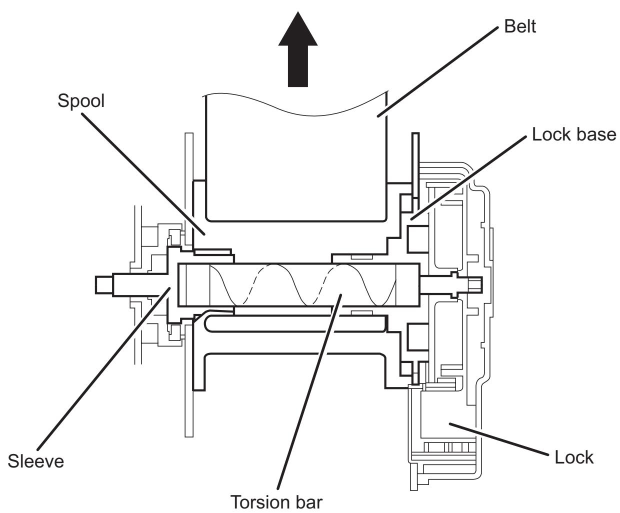
Actuation of Force Limiter

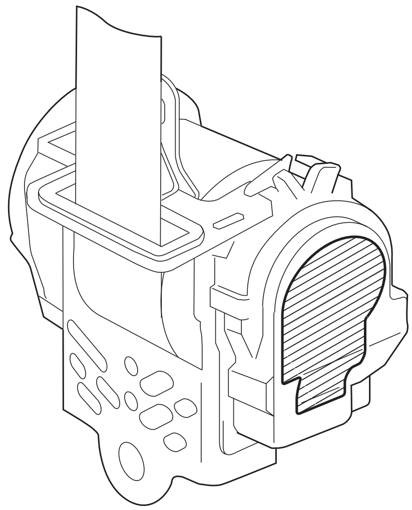
- If the seatbelt tension exceeds the predetermined level at the time of a vehicle collision, the force limiter lets the seatbelt out while keeping its tension constant to prevent excessive force from being applied to the occupant. Once activated, the force limiter cannot be reused.



A1270044C-D

Caution Label

- A caution label is affixed to each seat belt.



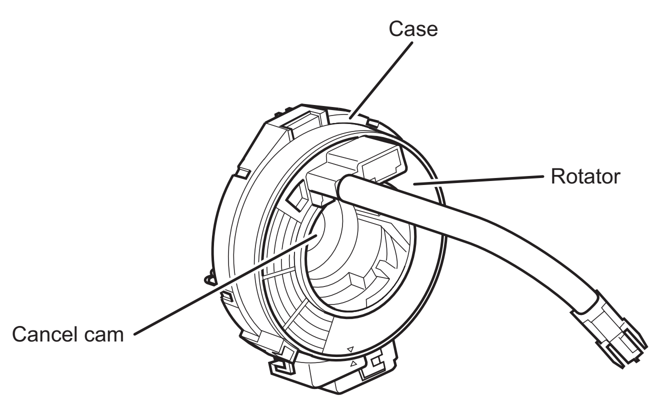
A1270039C-D

Spiral Cable

● A non-contact spiral cable is used to connect the cowl wire harness to the driver's seat SRS airbag. It is a snap-in type that can be connected with a single motion.

Structure of Spiral Cable

• The spiral cable consists of a rotator, a case, a cable, a bearing, a cancel cam, etc. When the protrusion on the steering wheel side is fit in the groove of the cancel cam and the steering wheel is turned, the rotator rotates together with the cancel cam. The cable is wound back to the midpoint and wound spirally back into the case. The rotator is given leeway to make 3 turns in each direction from the neutral position.



A1270057C-D

SRS Airbag Warning Lamp

● The SRS airbag warning lamp is positioned in the combination meter and if the system fails, it lights or blinks to inform the driver that the system is faulty.

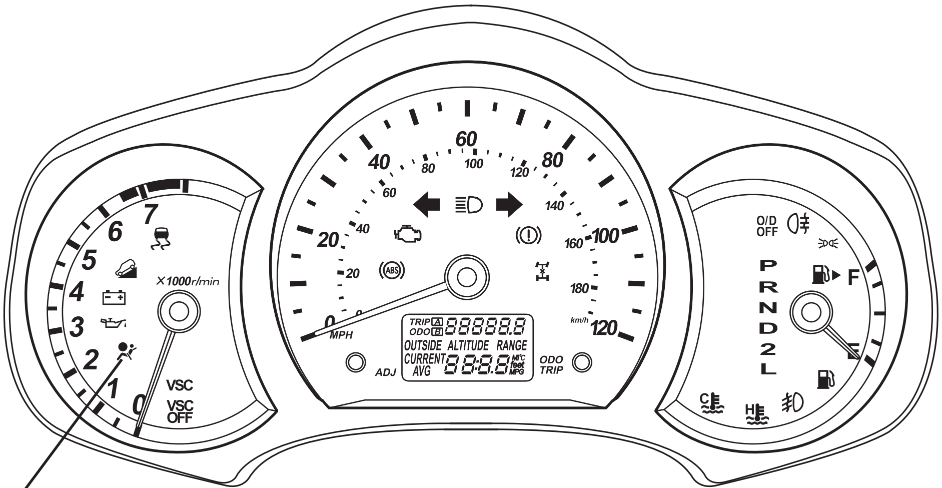
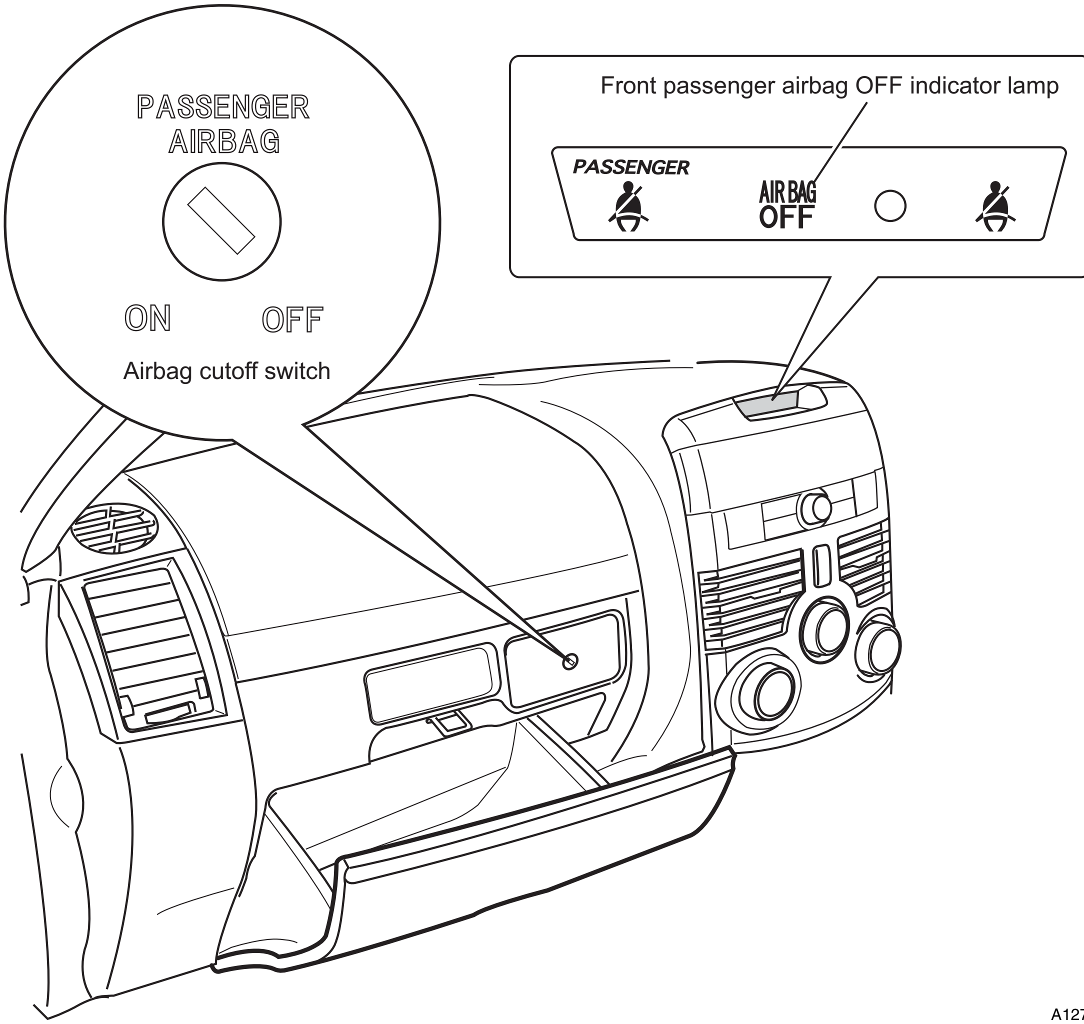


Table of functions of SRS airbag warning lamp

1.	If there is nothing wrong with the system, the airbag warning lamp goes on when the ignition switch is turned on and goes out after about 6 seconds.
2.	If there is something wrong with the system, the airbag warning lamp remains ON or stays OFF without performing the 6 second lamp check.
3.	After the system has started normally, the airbag warning lamp keeps blinking.
4.	The warning lamp puts out a diagnosis code.

Airbag Cutoff Switch

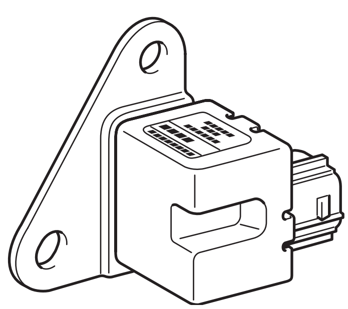
- An airbag cutoff switch option for turning on and off the SRS airbag and SRS side airbag for the front passenger seat is available for European models. If the airbag cutoff switch is turned off using a mechanical key, the SRS airbag and SRS side airbag for the front passenger seat will not be activated even in the event of a collision. The switch can be mounted in the glove box.
- An indicator lamp showing the ON-OFF status of the airbag cutoff switch is mounted in the middle of the instrument panel.



A1270121C-D

Front Airbag Sensor

- The front airbag sensor is mounted at the front of the vehicle on the driver's seat side (on a side surface of a side member), and consists of a G sensor and other parts.
- The front airbag sensor detects an impact from the front of the vehicle and sends a deceleration signal to the center airbag ECU.



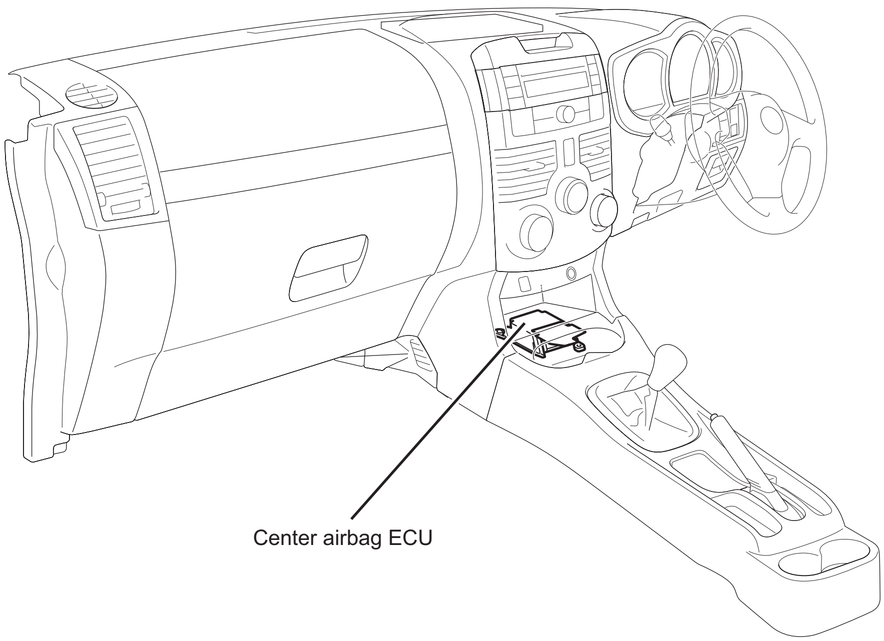
Front airbag sensor

A1270045C-D

Center Airbag Sensor (Computer)

- The center airbag ECU consists of a G sensor, a safing sensor, a backup power supply, and an ignition determination circuit. To ensure reliability, the system is designed so that the failure of a single component will not cause a catastrophic failure of the whole system.

- The G sensor in the center airbag ECU is also used as a sensor for the fuel cutoff system, and the center airbag ECU is always in communication with the engine control computer.
- A caution label that explains handling and other matters is affixed to the top of the center airbag ECU.



* The illustration represents a M/T model.

A1270127C-D

Block diagram

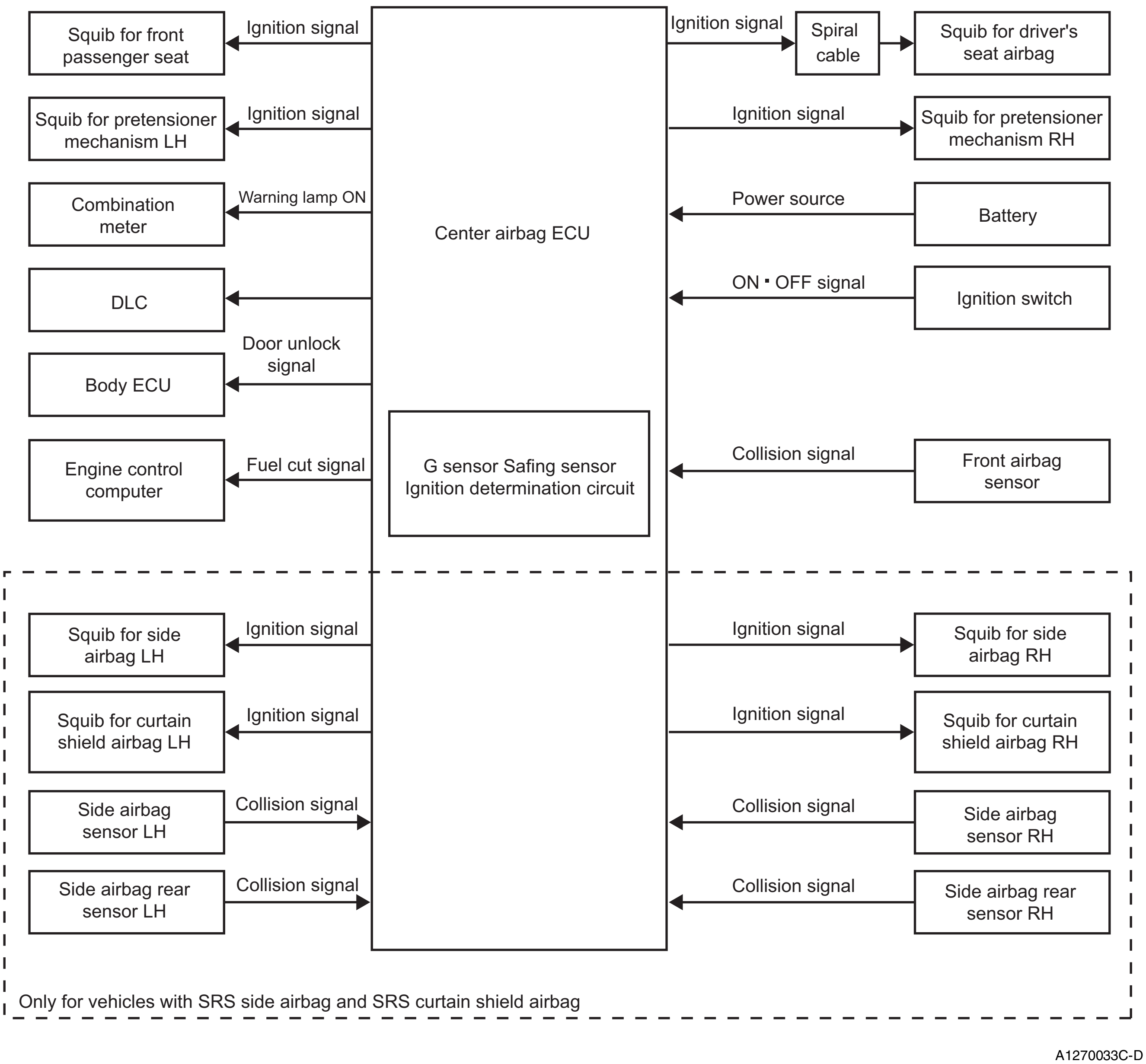
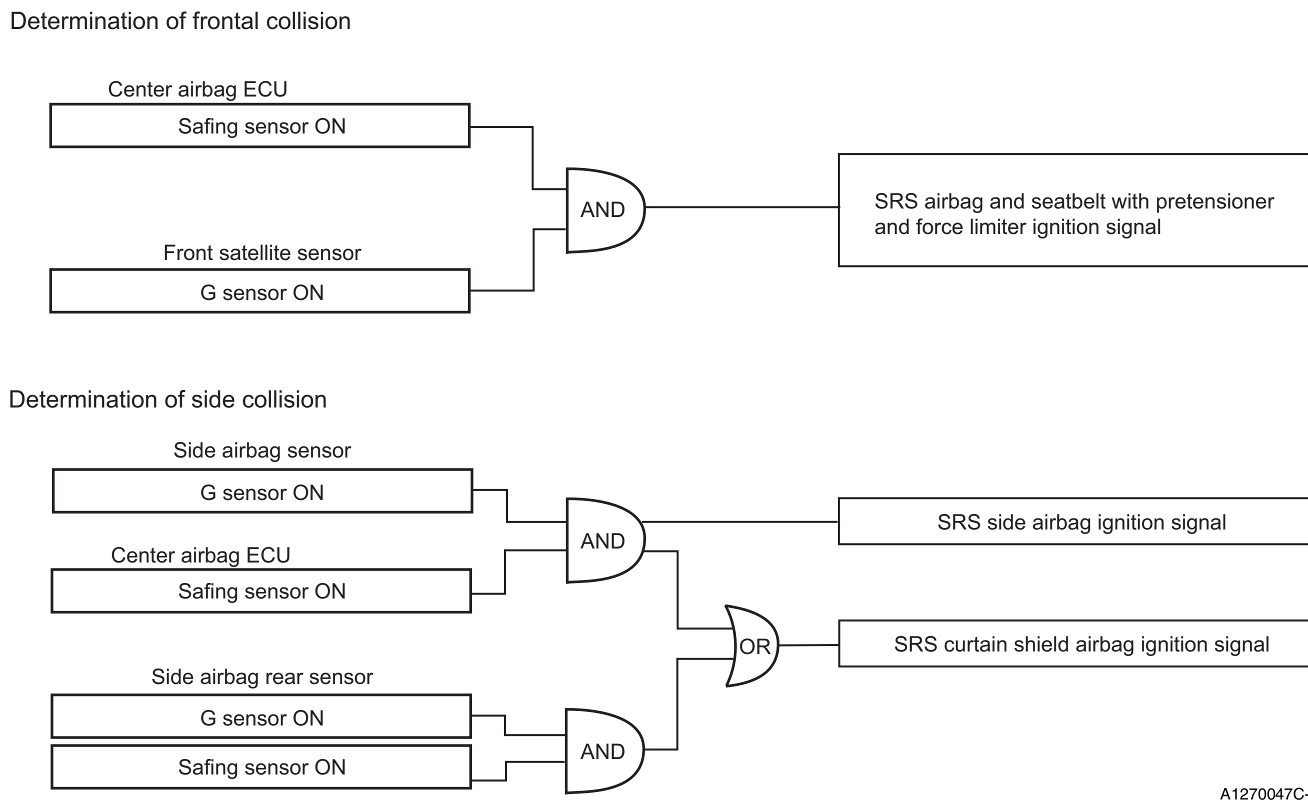


Table of center airbag ECU components

Components	Functions
G sensor and safing sensor	If these sensors detect the change in speed caused by an impact, they put out signals that vary linearly with the change in speed.
Backup power supply	The backup power supply consists of a backup capacitor and a booster circuit that supply power to the system in the event of a collision or a failure of the main power supply.
Computer (ignition determination circuit)	The computer performs specific computations in response to a signal from the front airbag sensor, and if the computed value exceeds the predetermined value, it sends out an ignition signal. Its diagnostic circuit checks the whole system for abnormalities and, if necessary, informs the driver that the system is faulty. In addition, the function performs a diagnosis of a faulty part of the system.

Judgement for Actuation

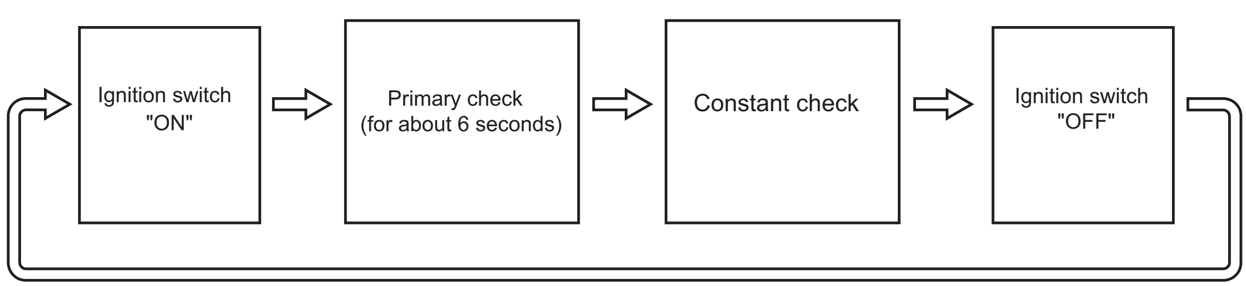
- Strong impact resulting from a frontal collision will trigger the SRS airbags and the seatbelts with pretensioners. Signals from the front satellite sensor, the G sensor and the safing sensor in the center airbag ECU determine whether they are to be triggered.
- The SRS side airbags are ignited if both the electronic sensor and safing sensor in the side airbag sensor turn on because of an impact caused by a side collision.
- The SRS curtain shield airbags are ignited if the above condition is met and an SRS side airbag ignition signal is given; or both the electronic sensor and safing sensor in the airbag rear sensor turn on.
- To keep a record of activation, the center airbag sensor holds the airbag warning lamp ON even after the primary check. This warning record cannot be cleared.



A1270047C-D

Actuation of Diagnostic Circuit

- Whether the diagnostic circuit is activated or not is indicated by the warning lamp in the meter section. The diagnostic circuit performs two kinds of checks: primary check and constant check.



A1270181C-D

Primary Check

- When the ignition switch is turned on, the airbag warning lamp goes on and a primary check is performed for about 6 seconds. During this period, the center airbag ECU is checked for proper functioning with its ignition function deactivated. If an abnormality is detected in this primary check, the airbag warning lamp will remain lit and not go out after 6 second primary check.
- If the center airbag ECU has deployed the airbags, the warning lamp will remain lit even after the completion of the primary check, regardless of whether there is something wrong with the system or not.

Permanent Check

- After the primary check, the airbag warning lamp goes out and the airbag system becomes ready for ignition, while the diagnostic circuit continually checks the system for abnormalities. If an abnormality is detected in this constant check, the airbag warning lamp will light or blink. (If the warning lamp light goes on because of a drop in supply voltage, it will go out when the supply voltage is restored to a normal level.)

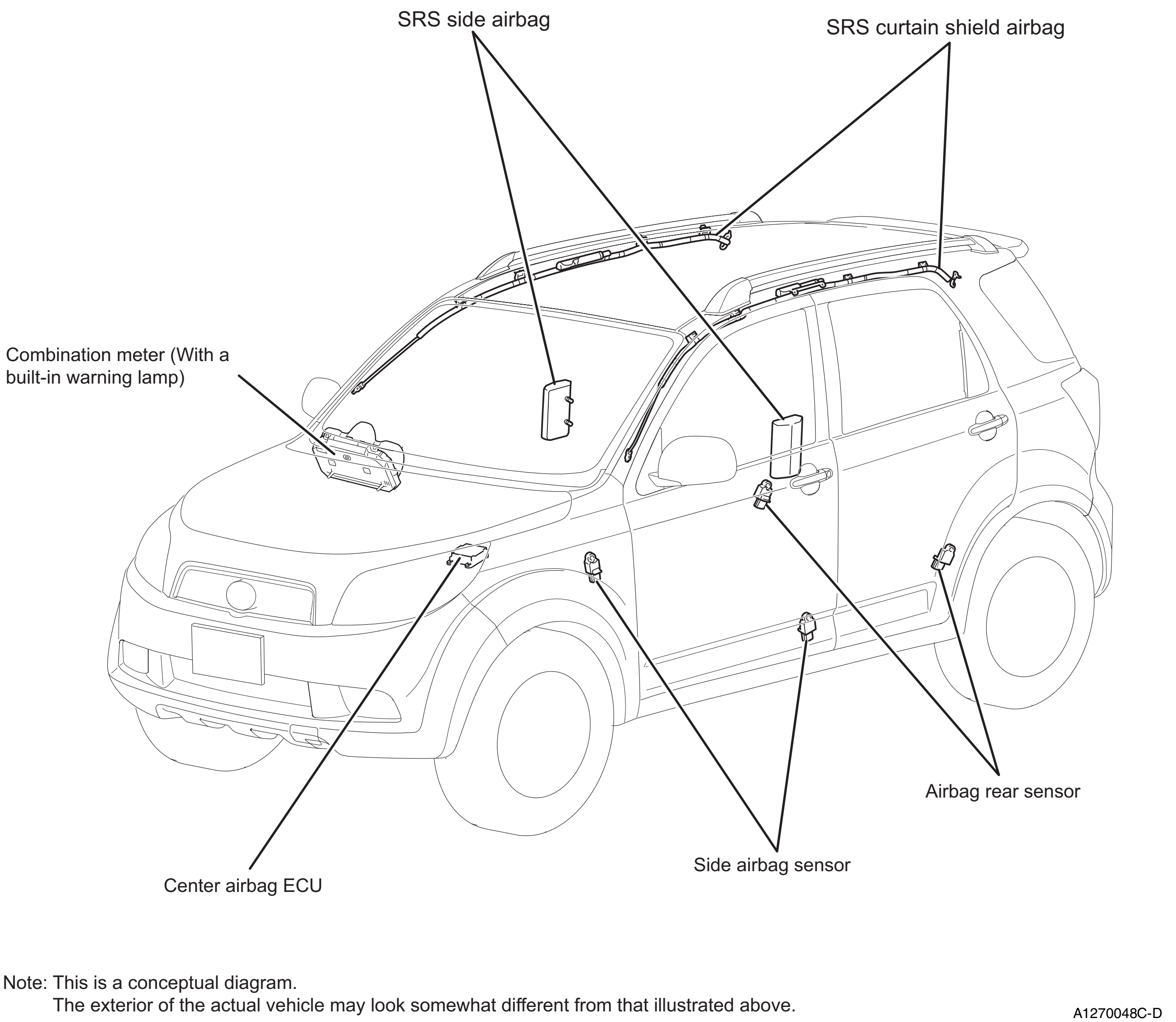
Diagnosis Function

- Switching to the diagnosis mode makes it possible to obtain the result of a diagnosis of a faulty part from the number of indicator lamp blinks. Furthermore, the diagnosis function newly adopted enables you to read the diagnosis code of a faulty part with the diagnostic tool connected to DLC. For more information about the diagnosis mode, refer to the service manual.

SRS SIDE AIRBAG AND SRS CURTAIN SEAL

SRS Side Airbag and SRS Curtain Shield Airbag

- The SRS side airbag system consists of SRS side airbags, SRS curtain shield airbags, side airbag sensors, side airbag rear sensors, and a center airbag ECU.



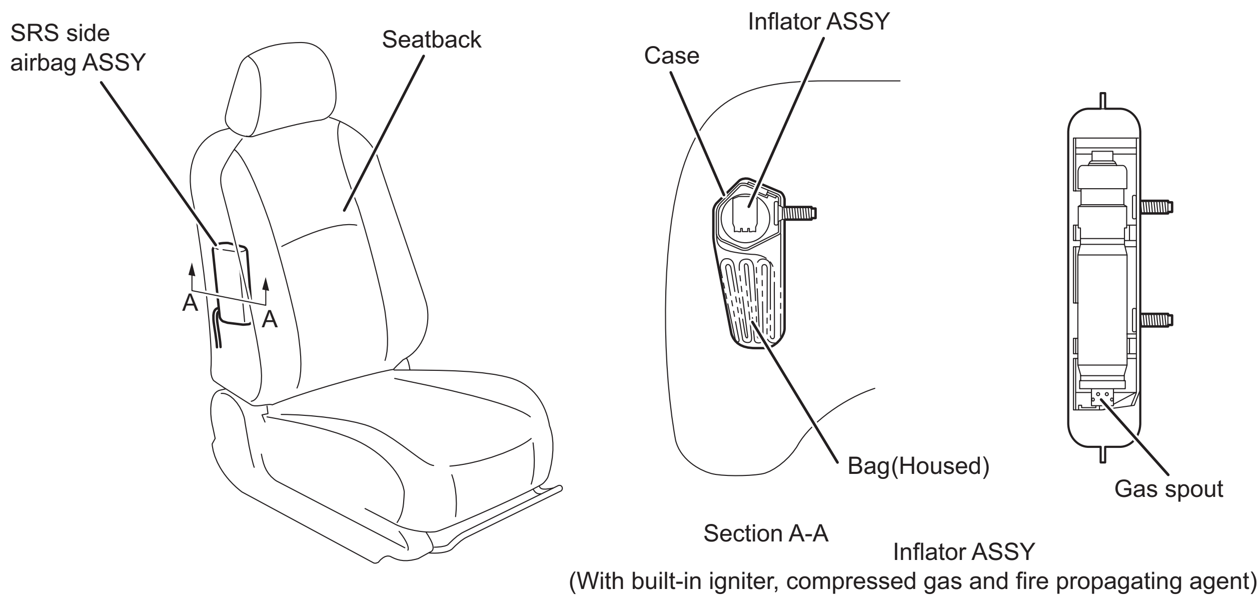
Principal components and their functions

Components	Functions
SRS side airbag and SRS curtain shield airbag	The airbag consists of an inflator and a bag. When receiving an ignition signal from the center airbag sensor, the inflator generates gas and inflates the bag instantaneously to reduce and absorb the impact to the occupant's chest.
Airbag warning lamp	If the system fails, the airbag warning lamp goes on to inform the driver that the system is faulty.

Components	Functions
Side airbag sensor and airbag rear sensor	These sensors detect the change in speed caused by a collision, determines whether to ignite the airbags and send ignition signals to the center airbag ECU.
Center airbag ECU	The center airbag ECU determines whether to ignite the airbags using the signals from the side airbag sensor and the side airbag rear sensor and if necessary, sends an ignition signal to the SRS side airbags and the SRS curtain shield airbags. If the ECU is switched to diagnosis mode in the event of a system failure, it will make a diagnosis of the failed system.

SRS Side Airbag

- SRS side airbags are mounted in the seatbacks of the driver's seat and front passenger seat.
- The SRS side airbag cannot be disassembled and consists of an inflator, a bag, a cover, etc.



Note: This is a conceptual diagram.
The shapes of the actual devices may look somewhat different from those illustrated above.

A1270049C-D

Airbag

- The bag filled with gas deploys instantaneously, bursting the seams of the seatback, sustains the impact to the occupant's chest, and then reduces the impact by releasing gas through the opening for the installation of wire harness at the rear end of the airbag.

Inflator

- The inflator consists of an igniter, a heating agent and a pressure vessel containing compressed gas, etc. The inflator is completely sealed from the inside.
- If the igniter is energized because of the change in speed caused by a collision, it is set off. As a result, the heating agent burns and generates gas, which increases the pressure of the compressed gas in the pressure vessel. The bulkhead is broken by increased gas pressure and gas is released in the bag.

Caution Label

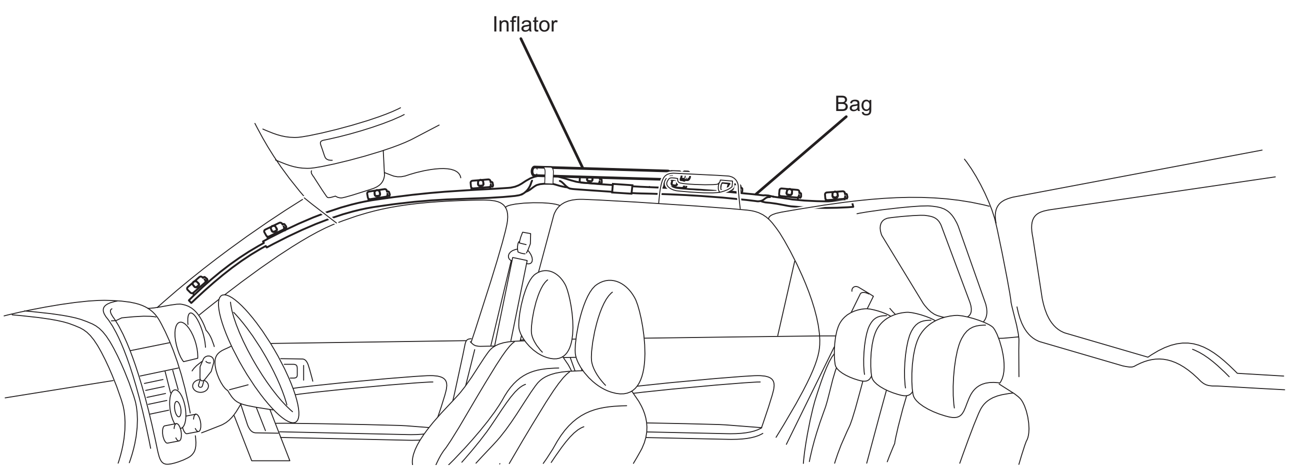
- A caution label for servicing that shows cautions in handling etc. is affixed to the SRS side airbag cover.

Note: This is a conceptual diagram.
The shapes of the actual devices may look somewhat different from those illustrated above.

A1270050C-D

SRS Curtain Shield Airbag

- An SRS curtain shield airbag is placed on each side between the front pillar and the C pillar (between the driver's seat/front passenger seat and the rear seat).
- The SRS airbag cannot be disassembled and consists of an inflator, a bag, etc.



A1270051C-D

Airbag

- The bag filled with gas deploys instantaneously, bursting the front pillar garnish and the roof head lining, absorbs the impact to the occupant's head, and then reduces it by releasing gas through the seams in the bag.

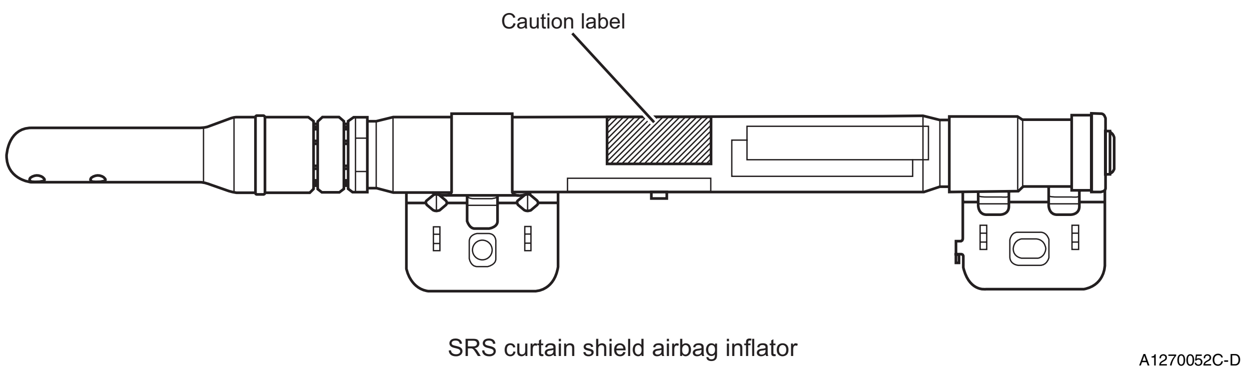
Inflator

- The inflator consists of an igniter, a heating agent, a pressure vessel containing compressed gas, etc. The inflator is completely sealed from the inside.

- If the igniter is energized because of change in speed caused by a collision, it is set off. As a result, the heating agent burns and generates gas, which increases the pressure of the compressed gas in the pressure vessel. The bulkhead is broken by increased gas pressure and gas is released in the bag.

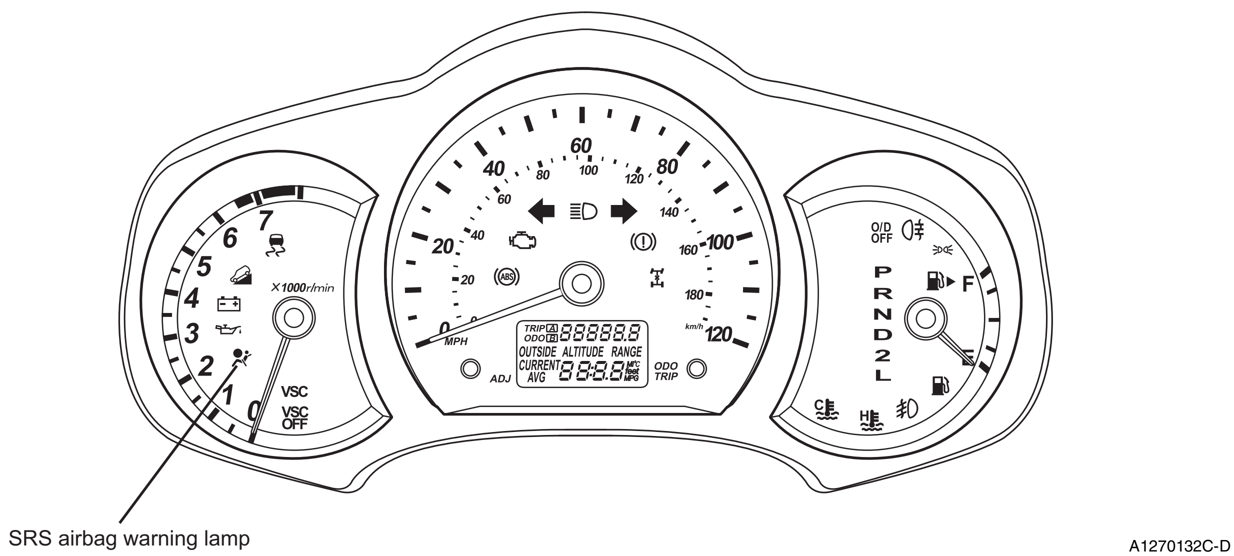
Caution Label

- A caution label for servicing that shows cautions in handling etc. is affixed to the inflator of each SRS curtain shield airbag.



SRS Airbag Warning Lamp

- The SRS airbag warning lamp is placed in the combination meter, and if the system fails, it lights up or blinks to inform the driver that the system is faulty.

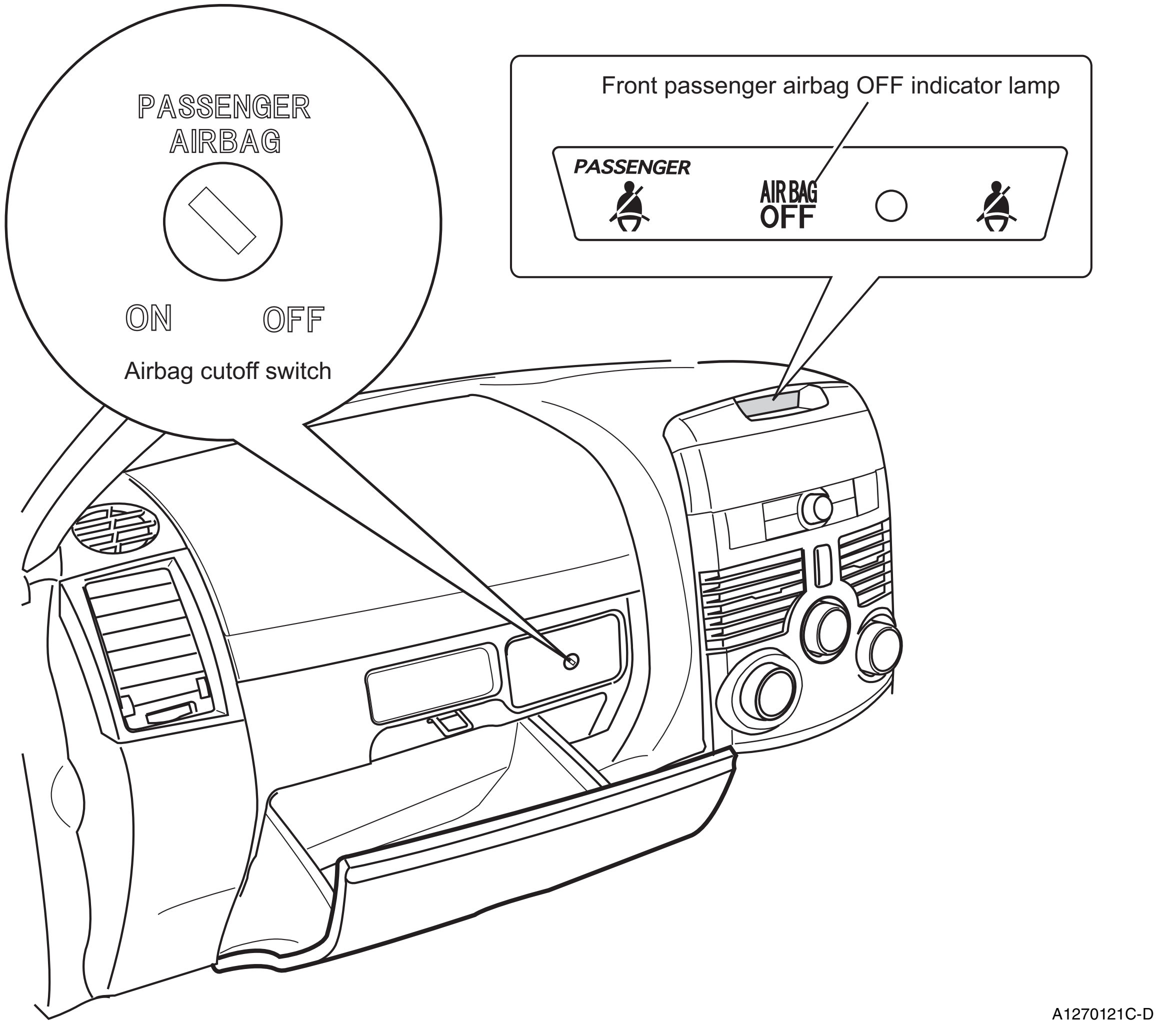


SRS airbag warning lamp function list

1.	If there is nothing wrong with the system, the warning lamp goes on when the ignition switch is turned on and goes off after about 6 seconds.
2.	If there is something wrong with the system, the warning lamp remains ON or stays OFF without performing the 6 second lamp check.
3.	After the system has started normally, the warning lamp keeps blinking.
4.	The warning lamp puts out a diagnosis code.

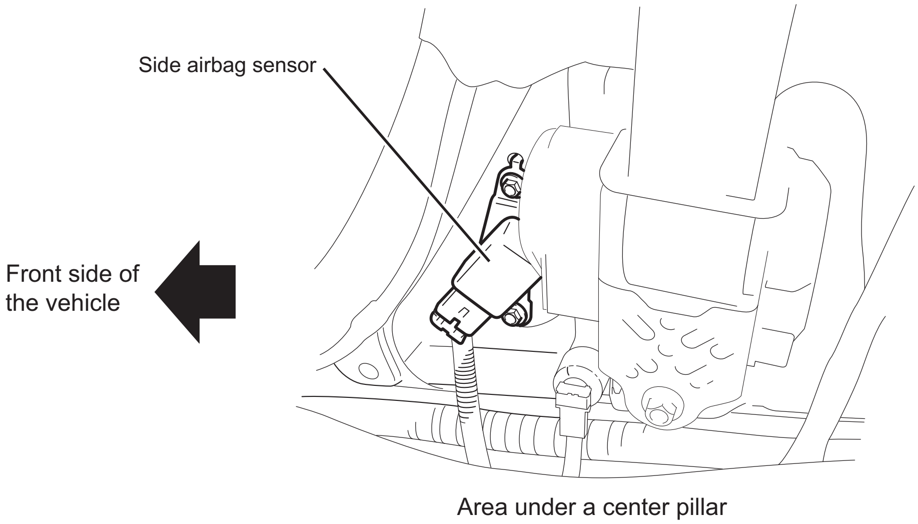
Airbag Cutoff Switch

- An airbag cutoff switch for turning on and off the SRS airbag and SRS side airbag in the front passenger seat is optionally available for European models. If the airbag cutoff switch is turned off using a mechanical key, the SRS airbag and SRS side airbag in the front passenger seat will not be activated even in the event of a collision. The switch can be mounted in the glove box.
- An indicator lamp showing the ON-OFF status of the airbag cutoff switch is placed in the middle of the instrument panel.



Side Airbag Sensor

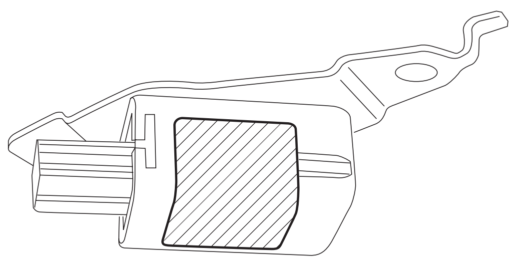
- A side airbag sensor is mounted in the lower section of the center pillar on each side. The side airbag sensor consists of a semiconductor G sensor, a collision determination circuit, a communication circuit, etc. It detects an impact from the side and sends a side airbag ignition signal to the center airbag ECU.



A1270053C-D

Caution Label

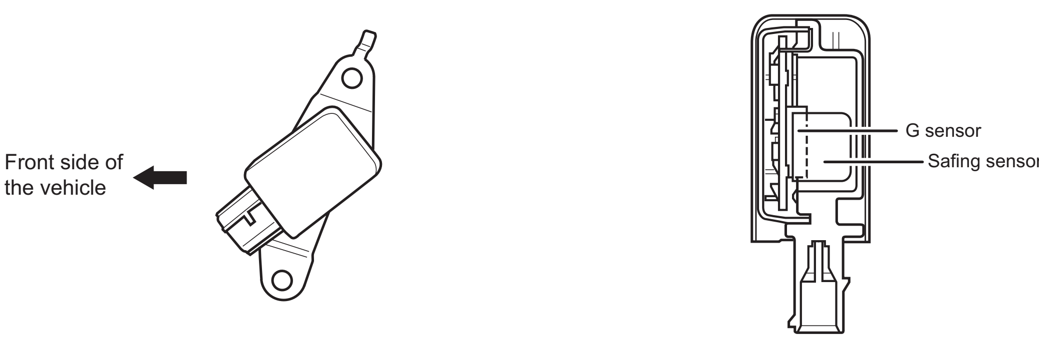
- A caution label for servicing is affixed to the part shown in the figure.



A1270054C-D

Rear Airbag Sensor

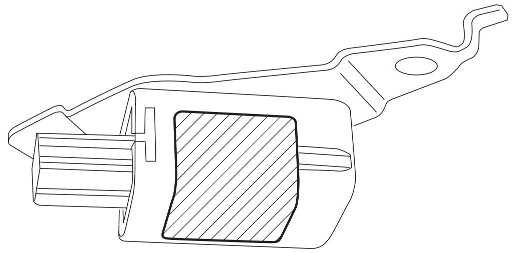
- The airbag rear sensor is mounted at the front of the quarter wheel house. The airbag rear sensor consists of a semiconductor G sensor, a safing sensor, a collision determination circuit, a communication circuit, etc. It detects an impact from the side and sends a curtain shield airbag ignition signal to the center airbag ECU.



A1270055C-D

Caution Label

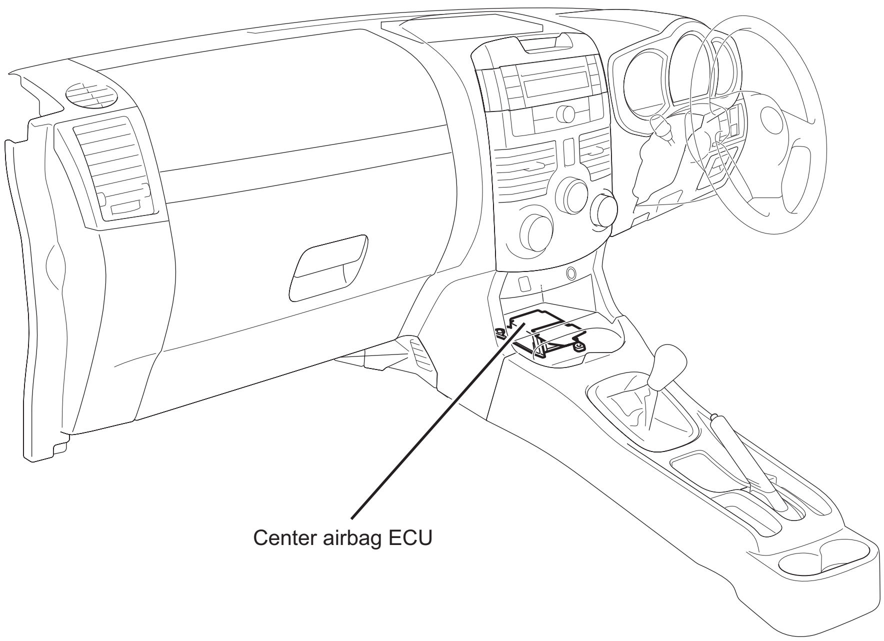
- A caution label for servicing is affixed to the part shown in the figure.



A1270054C-D

Center Airbag Sensor (Computer)

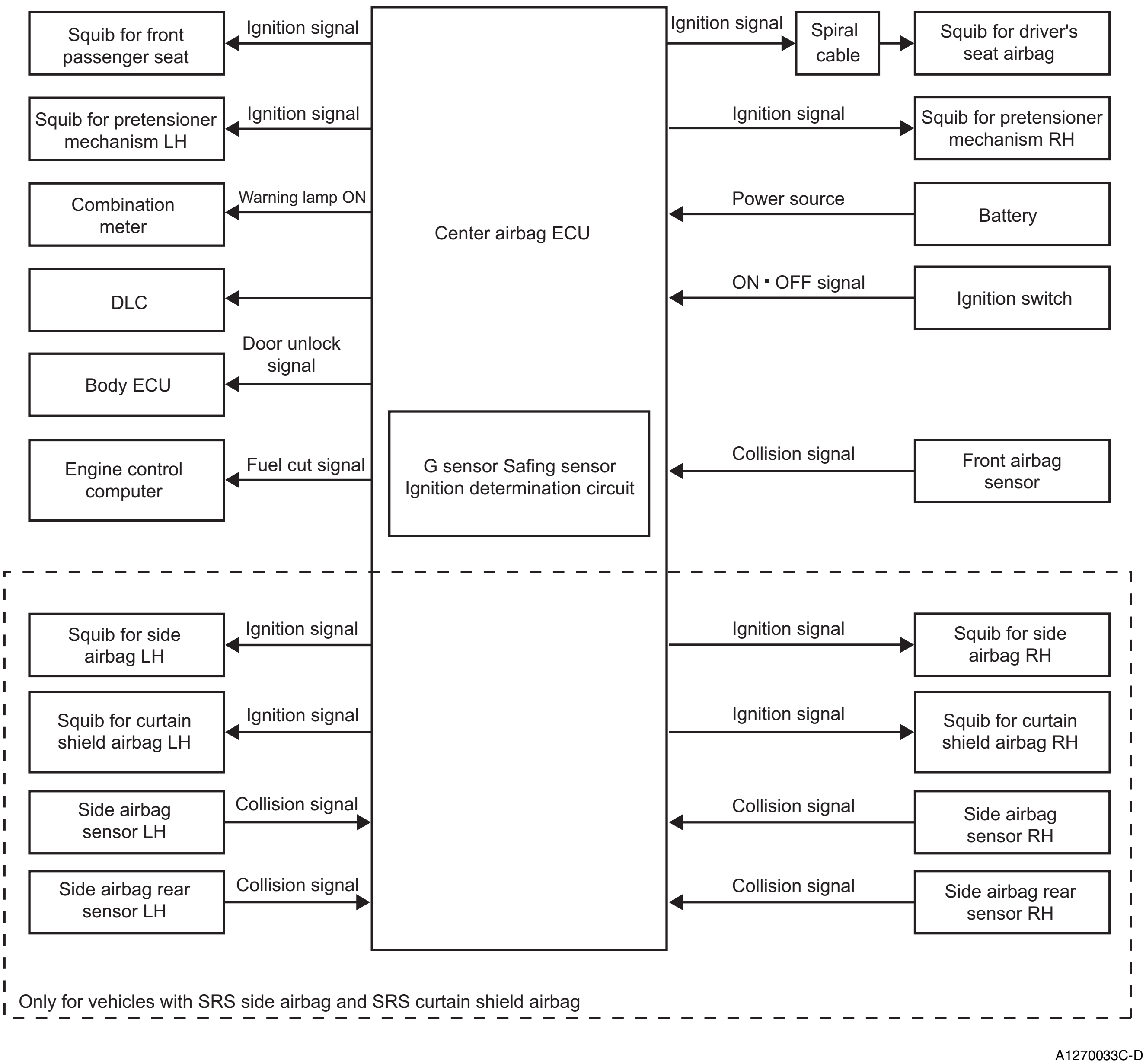
- The center airbag ECU consists of a G sensor, a safing sensor, a backup power supply, and an ignition determination circuit. To ensure the reliability, the system is so designed that a failure of a single component will not cause a catastrophic failure of the whole system.
- The G sensor in the center airbag ECU is also used as a sensor for the fuel cutoff system, and the center airbag ECU is always in communication with the engine control computer.
- A caution label for servicing that shows cautions in handling etc. is affixed to the top of the center airbag ECU.



* The illustration represents a M/T model.

A1270127C-D

Block diagram

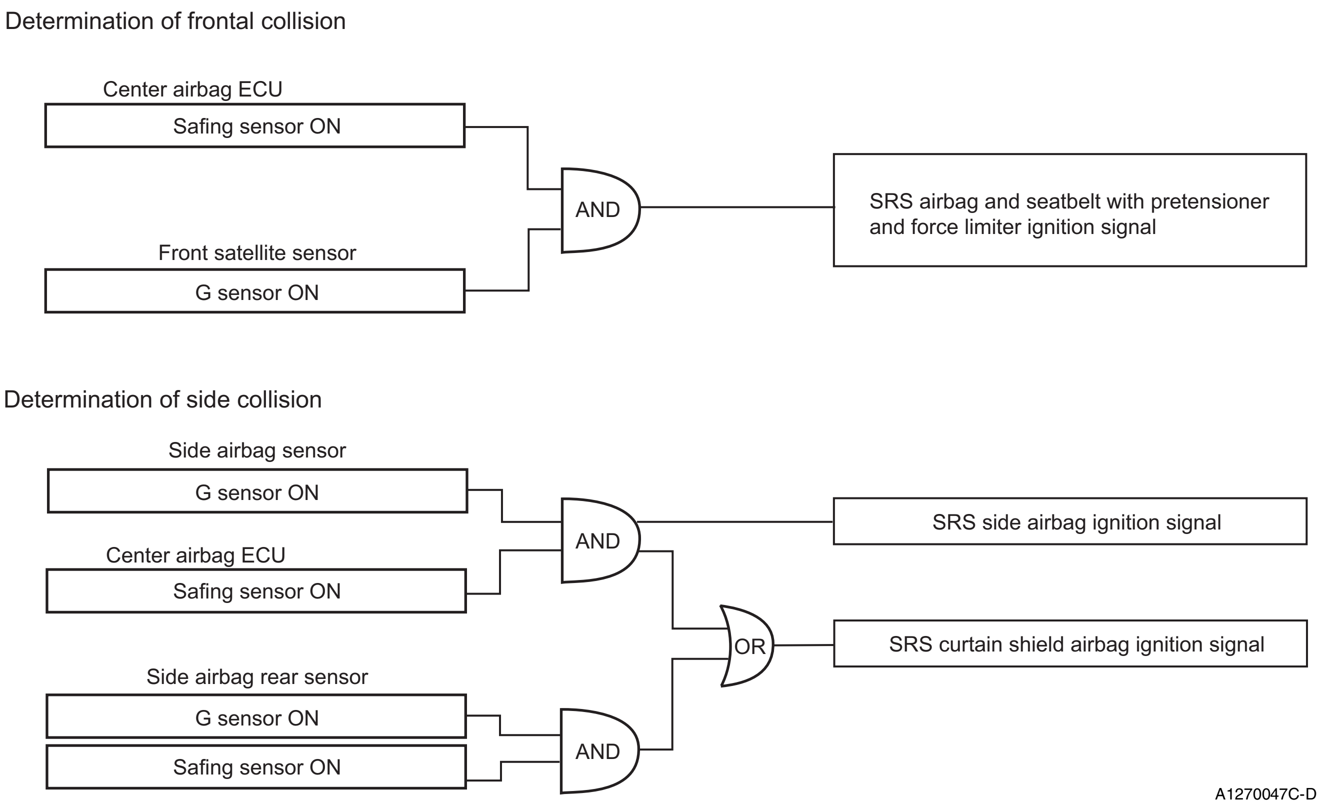


Center airbag ECU component list

Components	Functions
G sensor and safing sensor:	Put out signals that vary linearly with change in speed if they detect deceleration caused by an impact.
Backup power supply:	Consists of a backup capacitor and a booster circuit that will supply power to the system in the event of a collision or a failure of the main power supply system.
Computer (ignition determination circuit):	Performs specific computations in response to a signal from the front airbag sensor, and if the computed value exceeds the predetermined value, sends out an ignition signal. Its diagnostic circuit checks the whole system for abnormalities and informs the driver of malfunctions, if any, while its diagnosis function makes a diagnosis of a faulty part of the system.

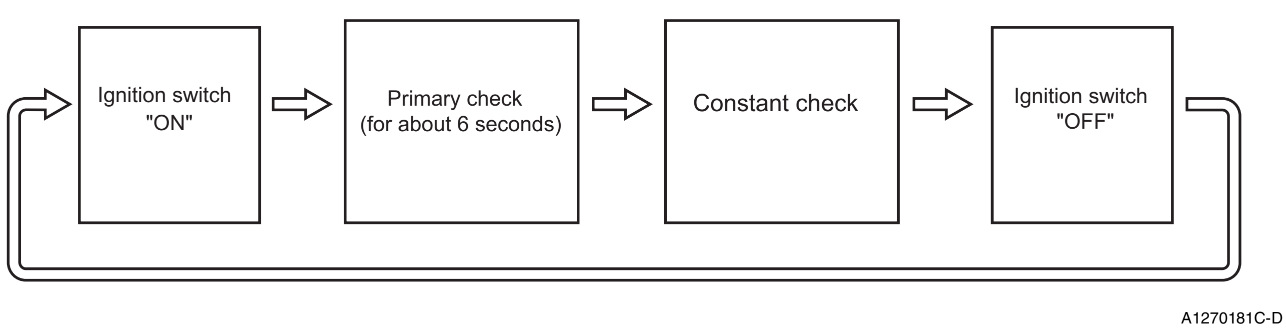
Judgement for Actuation

- Strong impact resulting from a frontal collision, will trigger the SRS airbags and the seatbelts with pretensioners. The signals from the front satellite sensor, the G sensor and the safing sensor in the center airbag ECU determine whether they are to be triggered.
- The SRS side airbags are ignited if both the electronic sensor and safing sensor in the side airbag sensor turn on because of an impact at the time of a side collision.
- The SRS curtain shield airbags are ignited if the above condition is met and an SRS side airbag ignition signal is given, or both the electric sensor and safing sensor and in the rear airbag sensor turn on.
- To keep a record of deployment, the center airbag sensor holds the airbag warning lamp ON even after the primary check. This warning record cannot be cleared.



Actuation of Diagnostic Circuit

- Whether the diagnostic circuit is activated or not is indicated by the warning lamp in the meter section. The diagnostic circuit performs two kinds of checks: primary check and constant check.



Primary Check

- When the ignition switch is turned on, the airbag waning lamp goes on and a primary check is performed for about 6 seconds. During this period, the center airbag ECU is checked for proper functioning with its ignition function deactivated. If an abnormality is detected through this primary check, the airbag warning lamp will remain lit without going out after 6 seconds.
- If the center airbag ECU has deployed the airbags, the warning lamp will remain lit even after the completion of the primary check, regardless of whether there is something wrong with the system or not.

Permanent Check

- After the completion of the primary check, the airbag warning lamp goes out and the airbag system becomes ready for ignition, and the diagnostic circuit constantly checks the system for abnormalities. If an abnormality is detected thorough this constant check, the airbag warning lamp lights or blinks. (If the warning lamp goes on because of a drop in supply voltage, it will go out when the supply voltage is restored to a normal level.)

Diagnosis Function

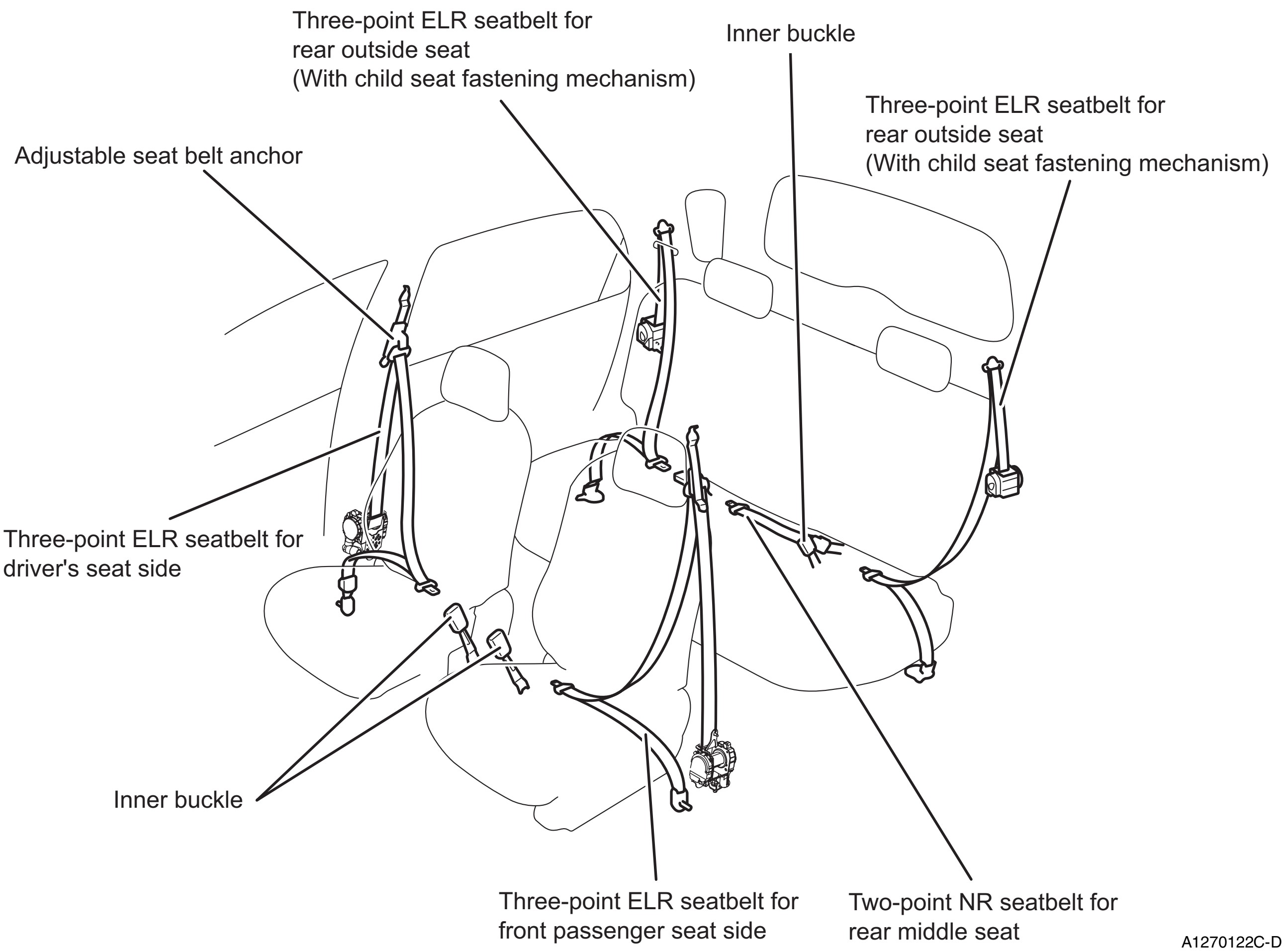
- Switching to the diagnosis mode makes it possible to obtain the result of a diagnosis of a faulty part from the number of indicator lamp blinks. Furthermore, the diagnosis function newly adopted enables you to read the diagnosis code of a faulty part with the diagnostic tool connected to DLC. For more information about diagnosis mode, refer to the service manual.

SEAT BELT

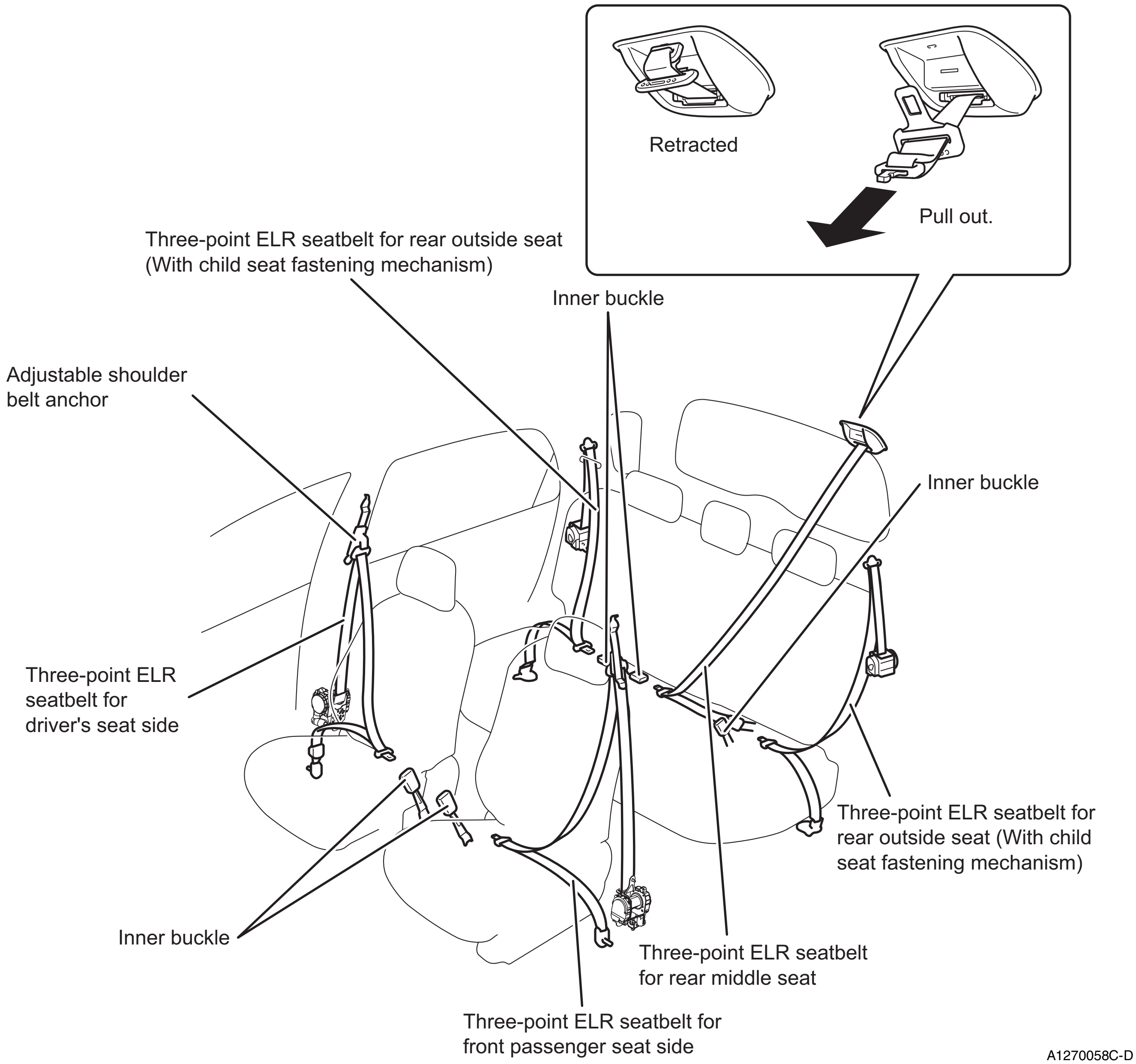
Outline of Seat Belts

- Seatbelts with pretensioners and force limiters are provided as standard equipment for the front seats of European models. Adjustable seat belt anchors (shoulder belt anchor whose position can be adjusted) are also employed.
- For models other than European models, three-point ER seatbelts are employed for all seats except the rear middle seat and a two-point NR seatbelt for the rear middle seat.
- Three-point ELR seatbelts with a child seat fastening mechanism are employed for the rear outside seats in European models. The child seat fastening mechanism is activated when the belt is fully pulled out and can be wound back but not pulled out any further. When the belt is rewound to a certain length, the child seat fixing mechanism is deactivated and the seat returns to its original ELR seat configuration.
- A retractable three-point seatbelt is employed for the rear middle seat in European models. The retractor is mounted on the ceiling.

Seatbelts for models other than European models

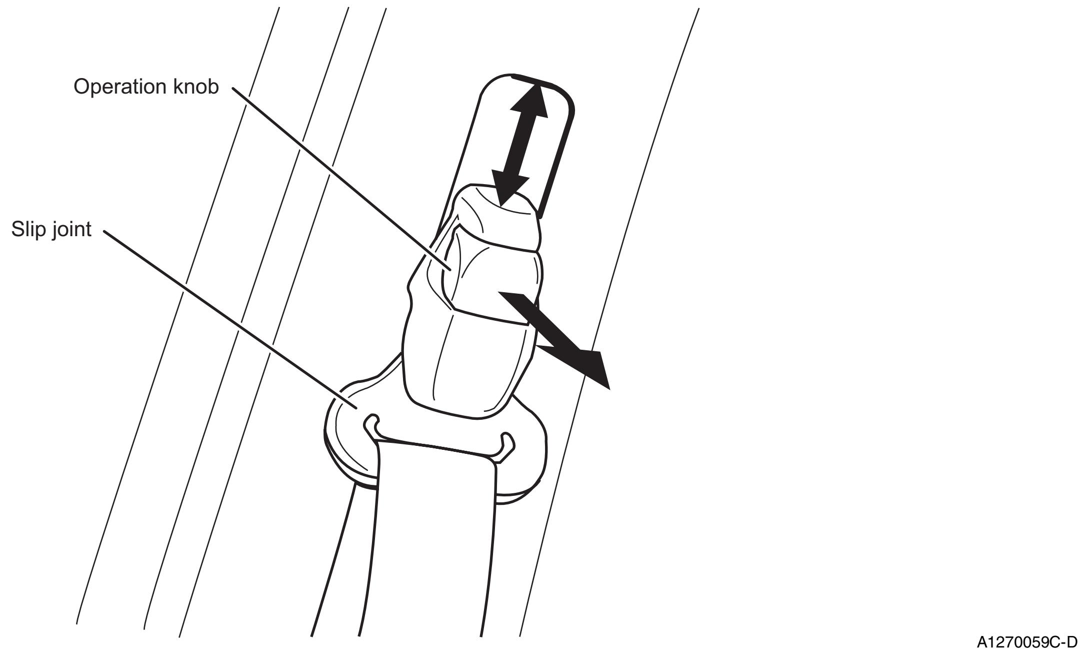


Seatbelts for European models



Adjustable Shoulder Belt Anchor

- Adjustable seatbelt anchors are provided for the front seatbelts on European models.
- The operation knob is a large-sized, separate pull type knob consistent with the design of the undercover covering the slip joint.
- An adjustable shoulder belt anchor, which has the upper portion in the shape of a slide, and a mechanism for adjusting the position by pulling up the operation knob have been structured with consideration given to the ease of deployment of the curtain shield airbag.
- If the lock is released by pulling up the operation knob, the shoulder belt anchor can be adjusted in 4 levels (vertically up to 45 mm).


Operation knob
Slip joint
A1270059C-D

TO FOREWORD

BODY & BODY ELECTRICAL SYSTEM

BODY STRUCTURE

BODY EXTERIOR DESIGN

BODY INTERIOR DESIGN

INSTRUMENT PANEL

WINDOW GLASS AND MIRROR

POWER WINDOW

SEAT

LIGHTING SYSTEM

METER AND GAUGE SYSTEM

WIPER AND WASHER SYSTEM

AUDIO SYSTEM

OTHER ELECTRICAL UNITS

SECURITY AND LOCK SYSTEM

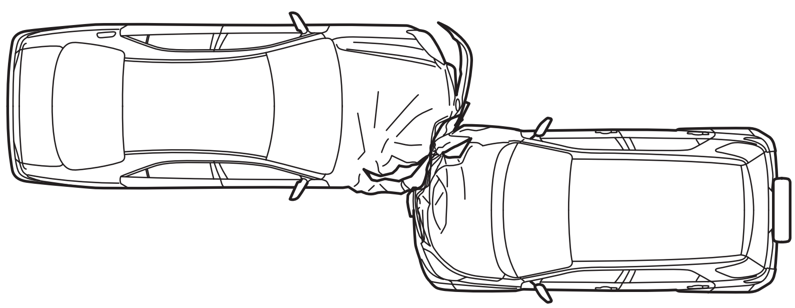
BODY STRUCTURE

Outline of Body Structure

- A total advance function body (TAF) *1 has been employed to satisfy not only Japanese safety standards *2 and European safety standards *3but also the strict Daihatsu standards and to provide the vehicle with world-class occupant protection *4. In addition to that, a head impact reducing structure, a brake pedal rearward displacement reducing structure, etc. have also been adopted to ensure all-round safety.
- An all-directional compatibility structure, which is a body structure evolving from a total advanced function body (TAF) structure, has been employed to cope with a collision with a vehicle of different weight and height. To achieve world-class collision safety *4 in terms of the ability to secure space for occupants in the event of a collision, frontal, side and rear collision tests were conducted using vehicles that were heavier and taller than Terrios.

❖ REFERENCE ❖

*1 : TAF, an acronym for Total Advanced Function, refers to vehicle bodies with totally advanced features.
*2 : Full-wrap frontal collision (50 km/h) and side collision (50 km/h)
*3 : 40% wrap offset frontal collision (56 km/h)
*4 : Compared with vehicles with the same engine displacement



Car-to-car 50% lap offset frontal collision test

Note: This illustration shows the conditions of vehicles subjected to a collision test. The conditions of vehicles damaged in an actual accident may look different from those shown in this illustration,depending on the speed at which and the portion in which they collided with each other. The illustration shows an external view of representative vehicles

A1270255B-D

- The vehicle employs a monocoque construction where framework members are optimally arranged and joined using high tension steel wherever possible to produce a lightweight stiff body that reduces vibrations and noise.
- A pedestrian injury-reducing body has been employed and various kinds of impact reducing structures have been adopted for the front section of the body to minimize injury in vehicle-pedestrian collisions.
- The body fitting accuracy has been increased to narrow gaps in the body panels and enhance body quality.

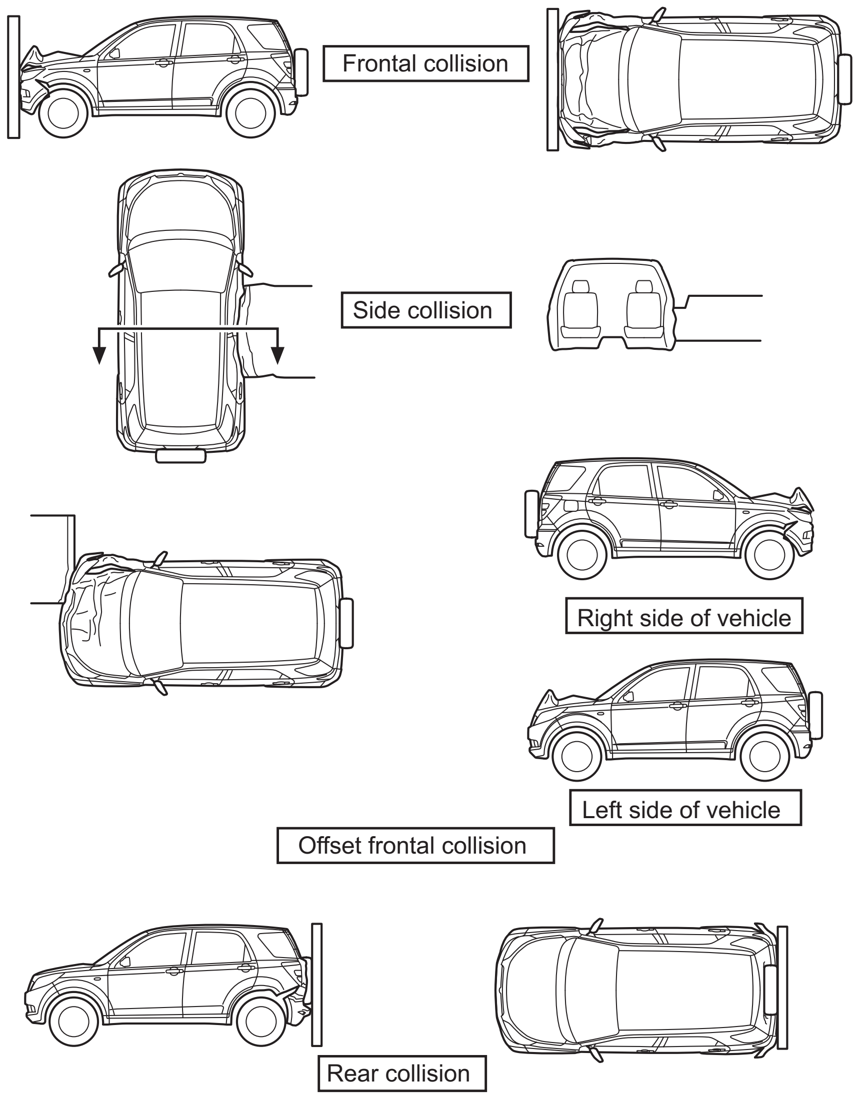
TAF (Total Advanced Function Body)

- Every model has a total advanced function body (TAF) consisting of crumpable front and rear sections and a stiff passenger compartment, which allow the body to efficiently absorb and disperse collision energy, reducing the deformation of the passenger compartment to a minimum.
- The body has an all-directional compatibility structure. This structure excels at securing space for the passengers in the event of a frontal, side or rear collision providing the vehicle with a world class level of collision safety.*
- Through computer simulations of collisions and a large number of vehicle tests, the body framework is designed so that it can efficiently

absorb and disperse the energy produced in the event of not only a frontal or side collision but an offset frontal collision that gives an impact to only one side of the vehicle.

❖ REFERENCE ❖

* : Compared with vehicles in the same engine displacement class

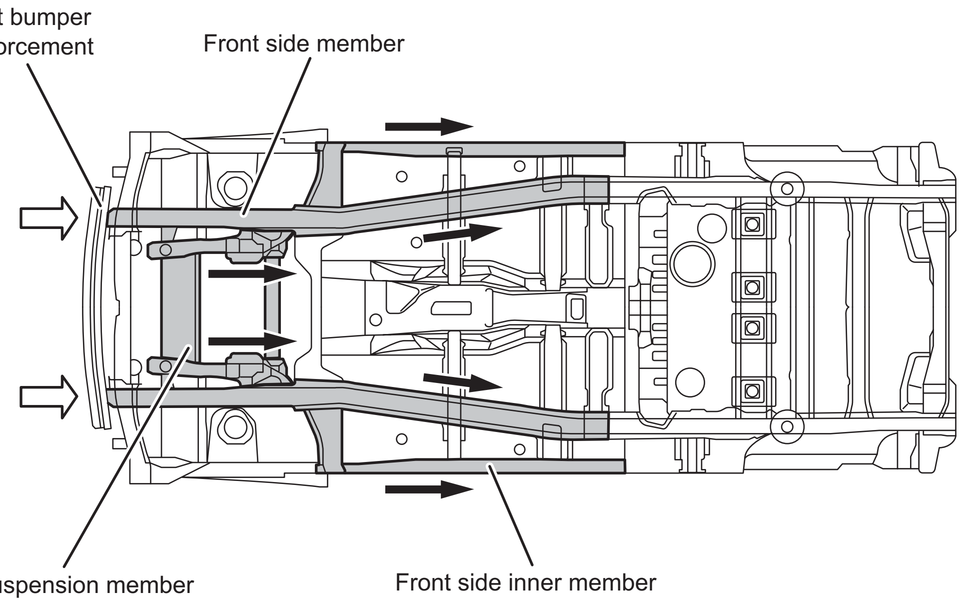


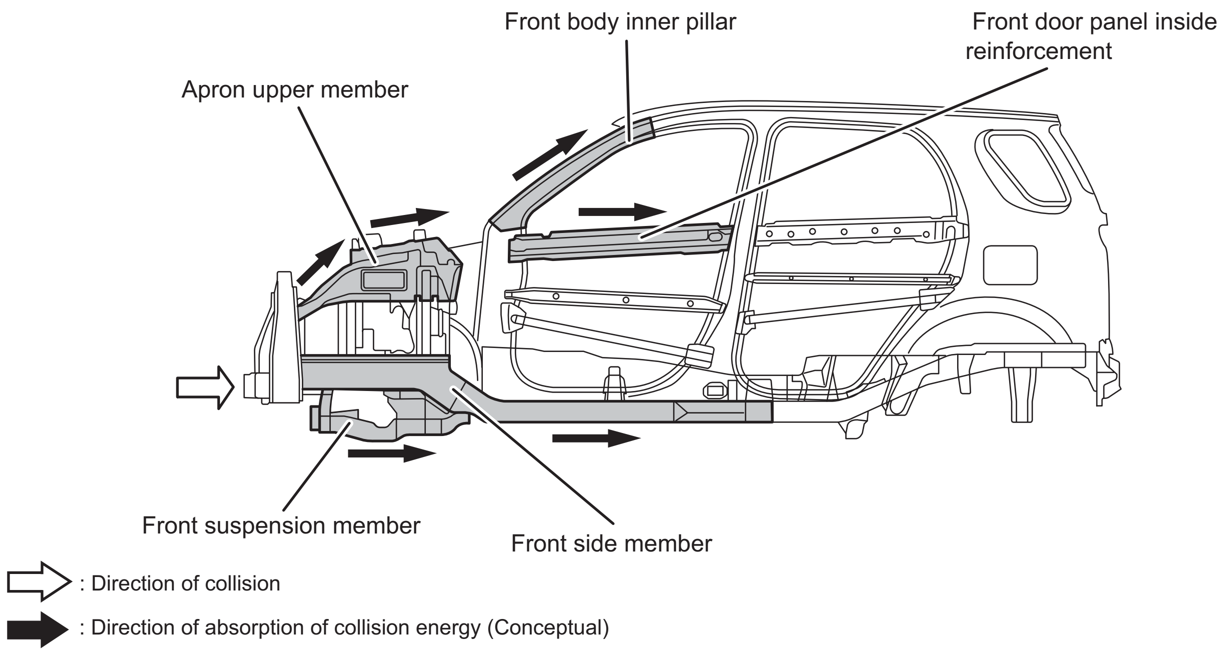
Note: These illustrations show the conditions of vehicles subjected to collision tests. The conditions of vehicles damaged in an actual accident may look different from those shown in these illustrations,depending on the speed at which and the portion in which they collided.

A1270256B-D

Front Energy Absorbing Structure

- To reduce the deformation of the passenger compartment in the event of a collision, the front section is so constructed that it can efficiently distribute the collision energy from the front of the vehicle to the front side members, front suspension members, front side inner members, apron upper members, front body inner pillars, front door panel inside reinforcements, etc.



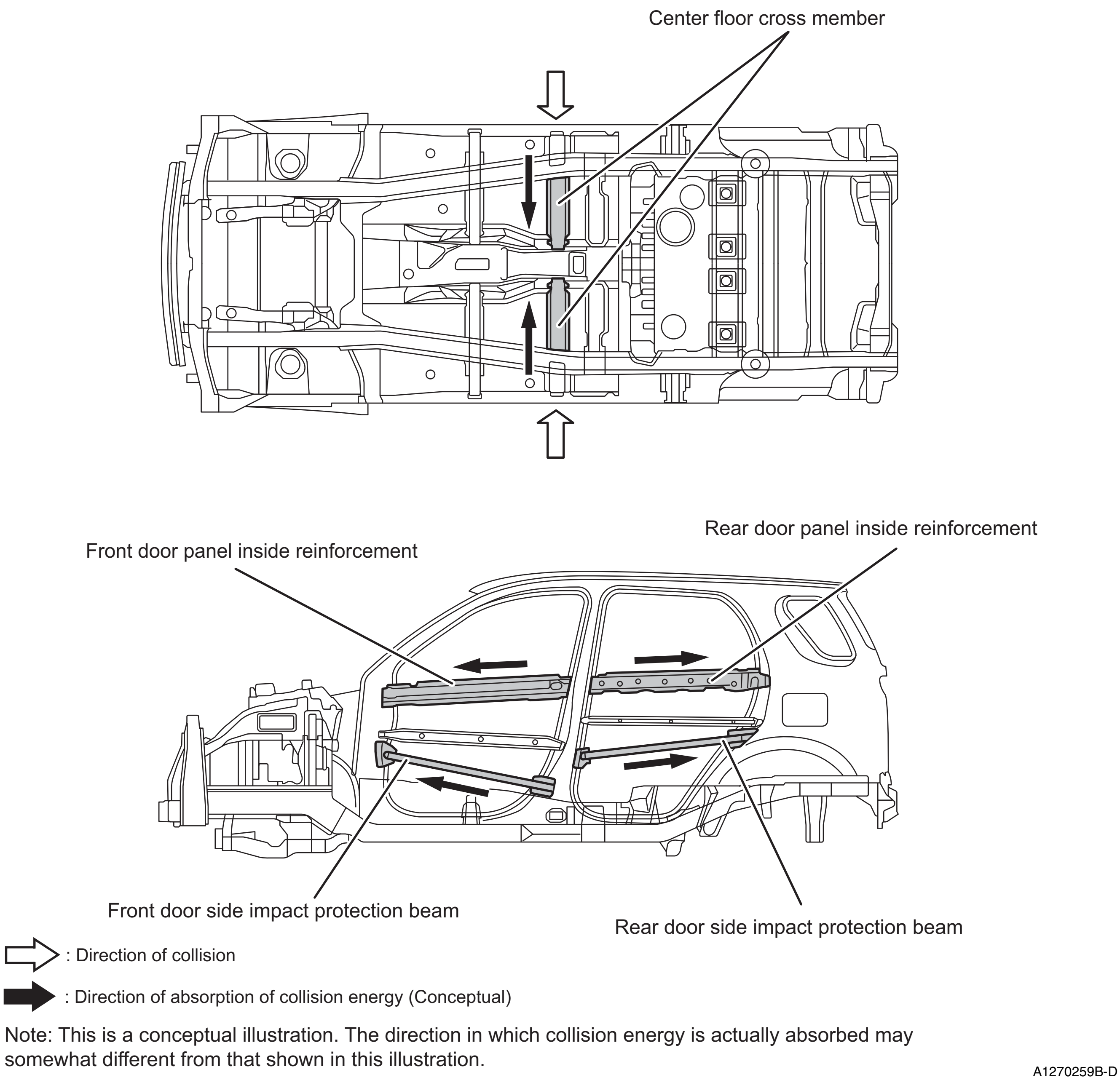


Note: This is a conceptual illustration. The direction in which collision energy is actually absorbed may somewhat different from that shown in this illustration.

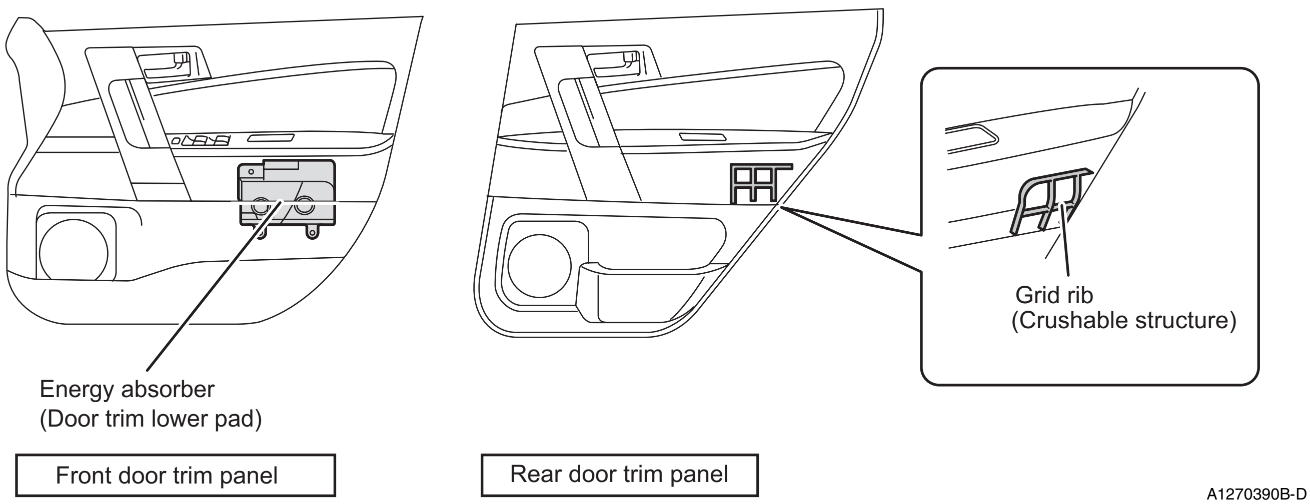
A1270257B-D

Side Energy Absorbing Structure

- To minimize the deformation of the passenger compartment in the event of a collision, the body framework is designed to efficiently distribute the collision energy from one side of the vehicle to the center floor cross members, front and rear door panel reinforcements, front and rear door side impact protection beams, etc.

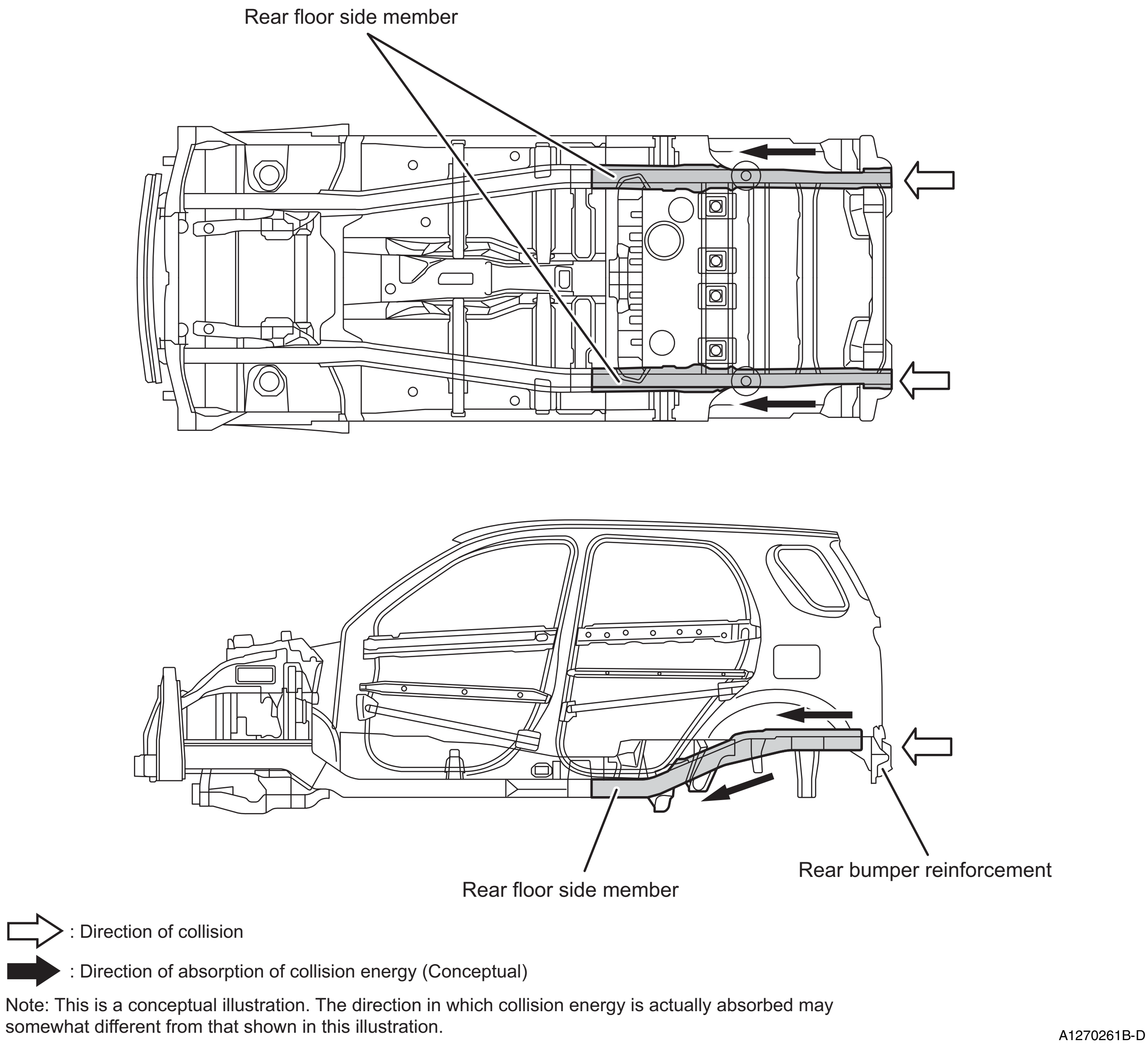


- An energy absorber (door trim lower pad) is provided for each front door, and crumpable lattice ribs are employed for the armrest on each rear door trim to reduce the impact to the occupants in the event of a collision.



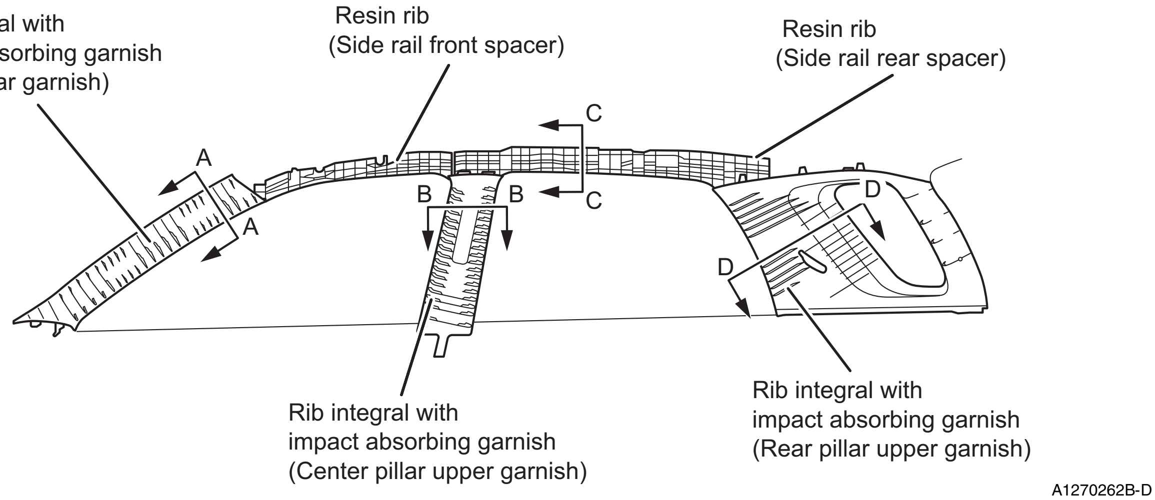
Rear Energy Absorbing Structure

- To reduce the deformation of the passenger compartment, the rear section is constructed such that it can efficiently distribute the collision energy from the rear of the vehicle to the rear floor side members with increased stiffness etc.

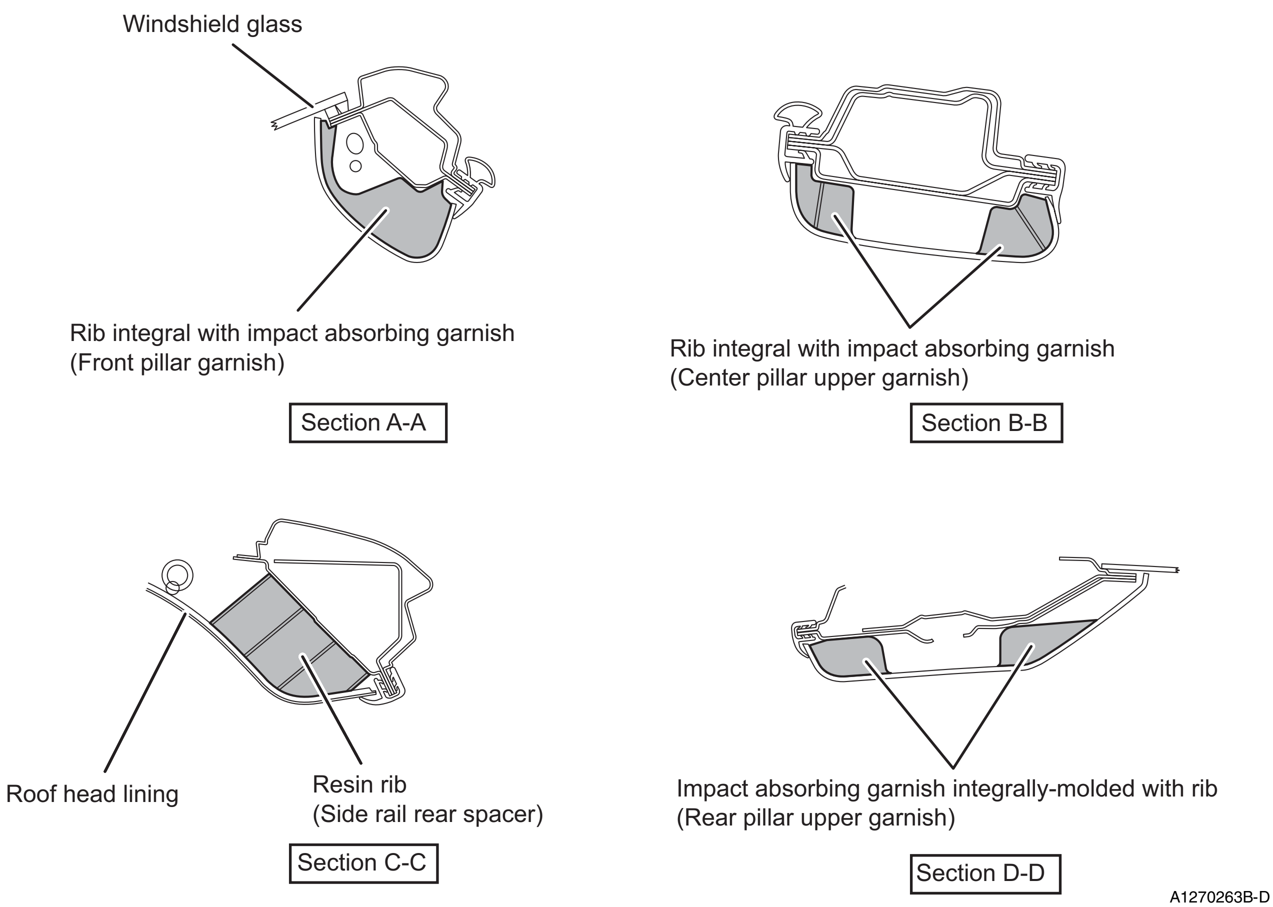


Head Shock Absorbing Structure

- The vehicle body has a head impact reducing structure that reduces the impact given to the head of an occupant if he or she hits a pillar or a side member of the roof in a collision.
- In the event of a collision, impact absorbing garnishes integrally-molded with ribs or impact absorbing resin ribs inside the roof head lining crumples and reduces the impact to the occupant's head.



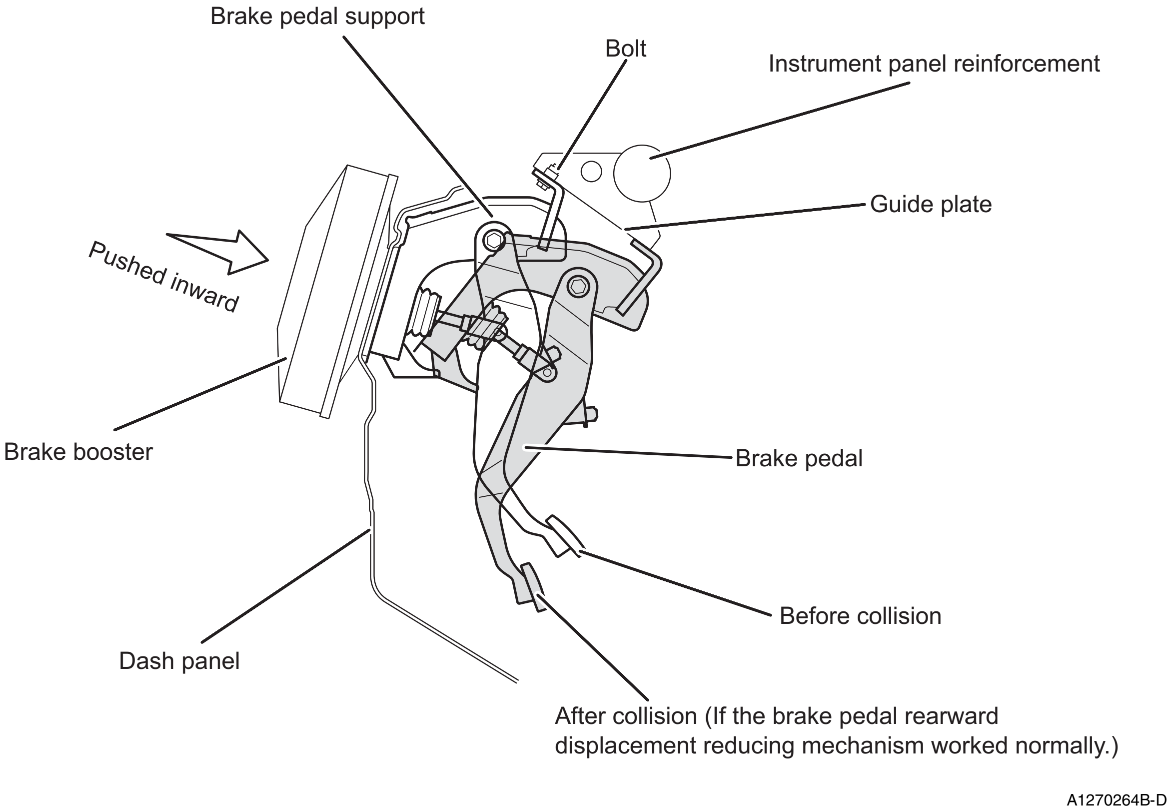
Head impact reducing structure (Sectional views)



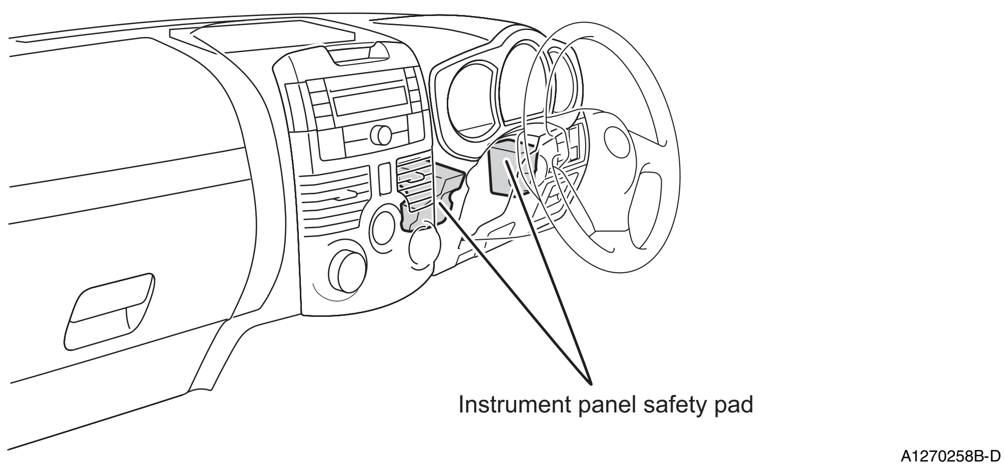
Brake Pedal Rearward Displacement Reduction Structure

- A brake pedal rearward displacement reducing structure, which reduces the amount of rearward displacement of the brake pedal by displacing it downward, is employed to reduce the impact to the driver's legs in the event of a frontal collision.
- If the brake booster is pushed backward because of a rearward displacement of the engine due to a collision, the bolts securing the brake pedal support to an instrument panel reinforcement come off the brake pedal support and the brake pedal support moves in a rear downward

direction. Consequently, the brake pedal moves in a front downward direction.



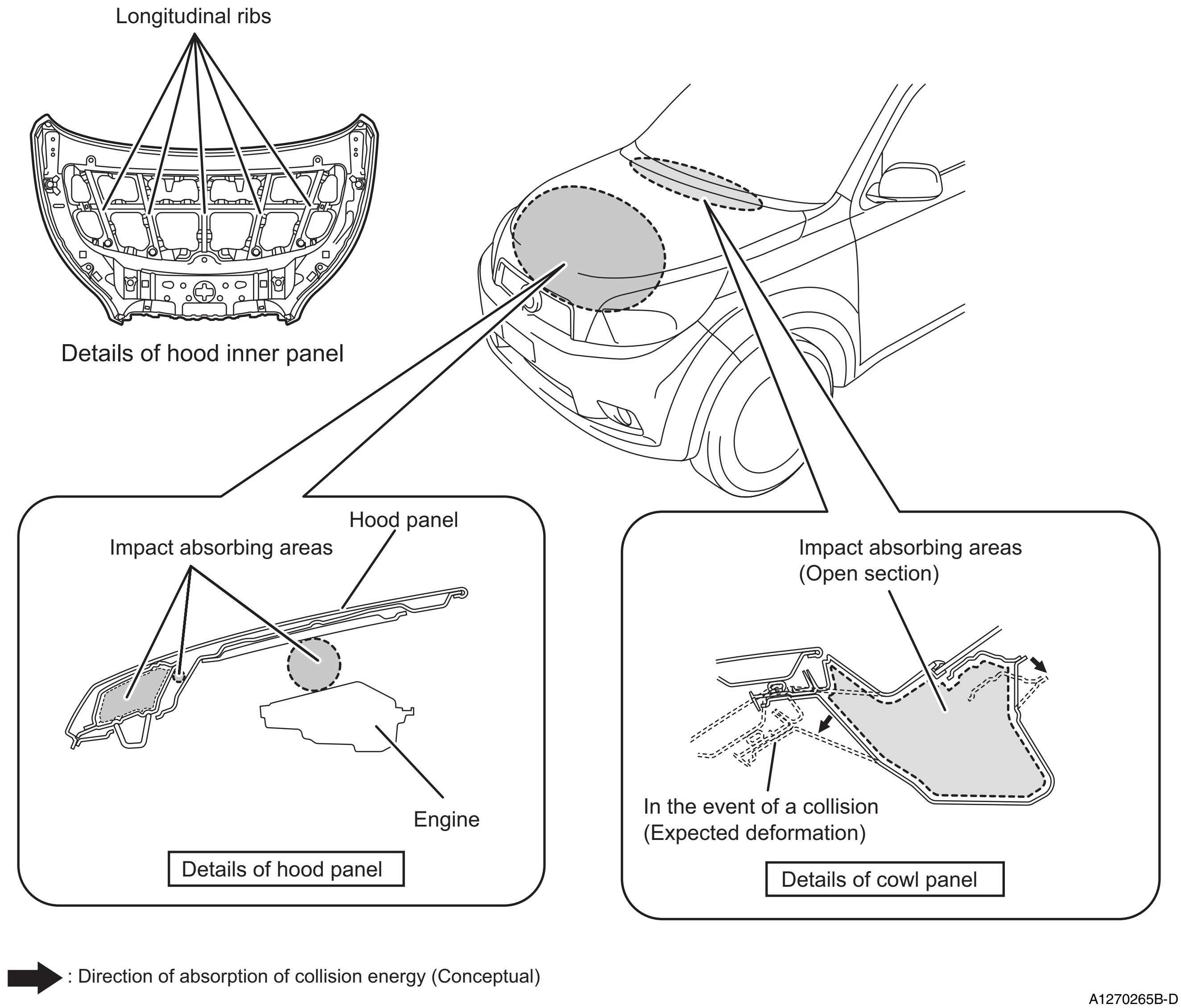
● An instrument panel safety pad is attached to the back of the instrument panel finisher lower panel to reduce the impact to the driver's legs.



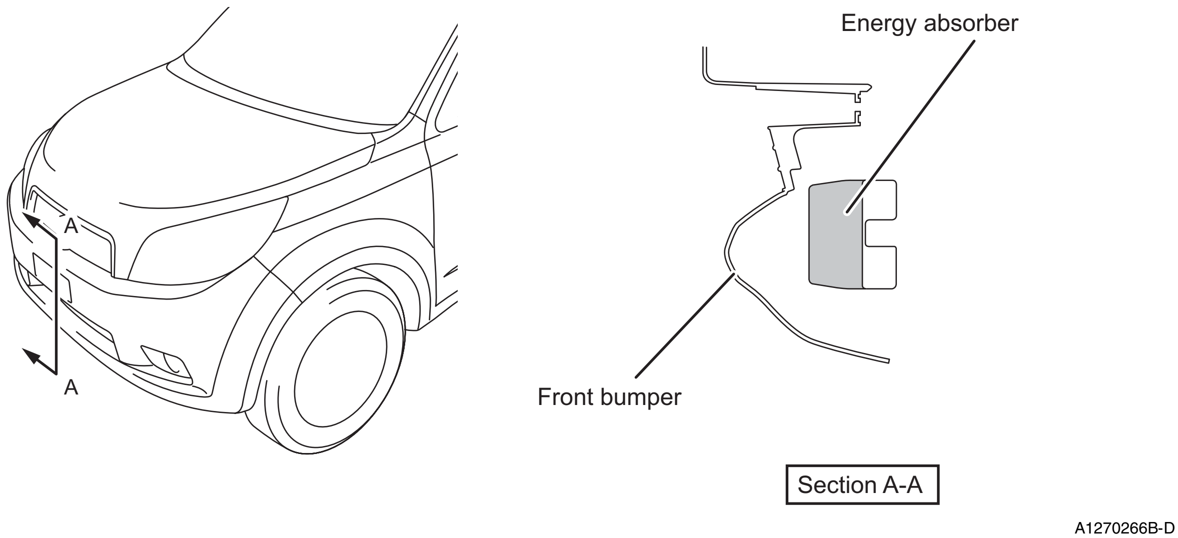
Pedestrian Injury Reducing Body

● A pedestrian injury-reducing body is employed to reduce injury in vehicle-pedestrian collisions. The cowl panel, the hood panel and their surroundings have an impact reducing structure to reduce the impact to the pedestrian's head in the event of an accident.

● The cowl panel has an open section around each wiper mounting part so that it can efficiently reduce the impact to the pedestrian.

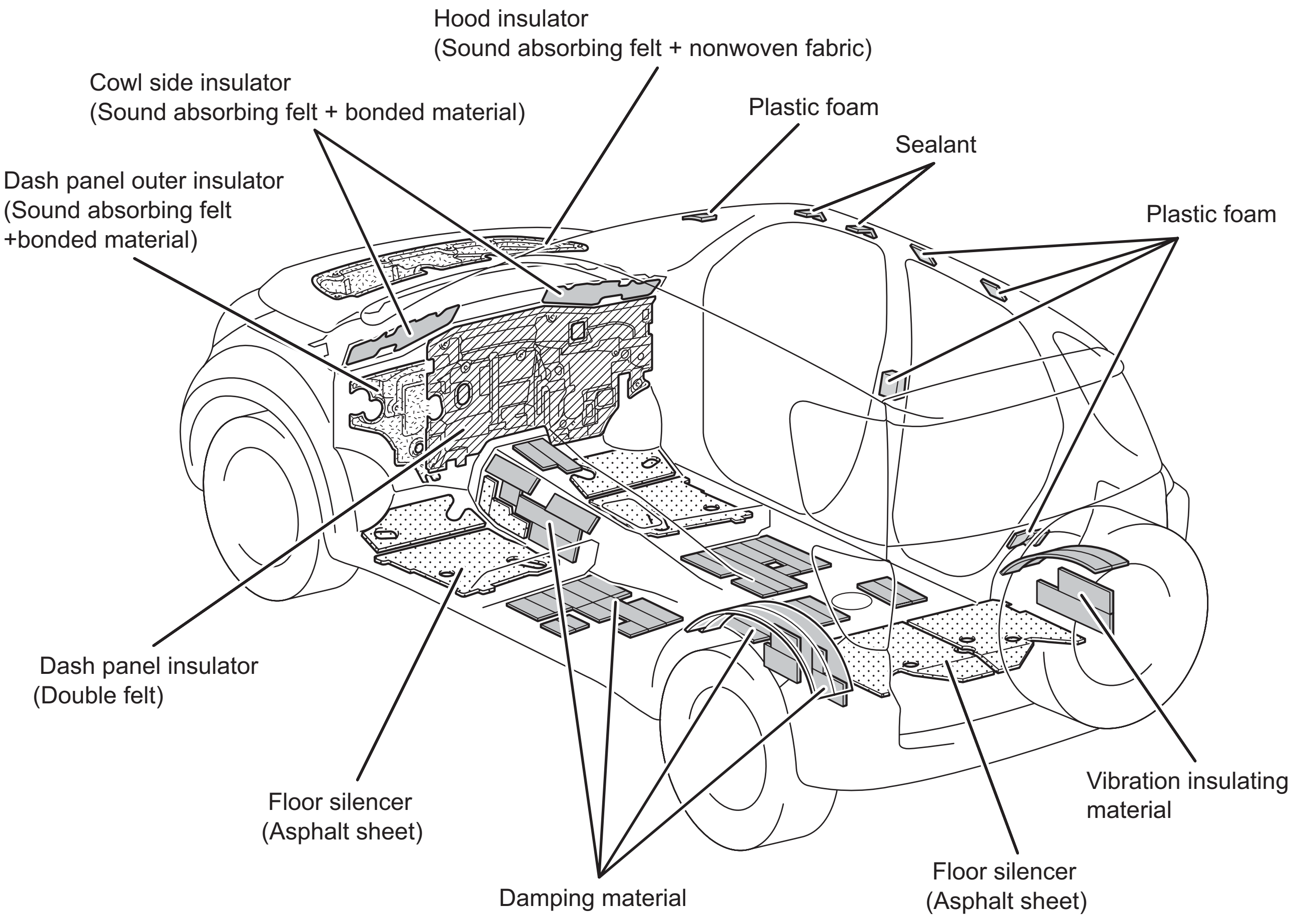


- To reduce injury to the pedestrian's legs, an energy absorber is provided for the front bumper on European models.



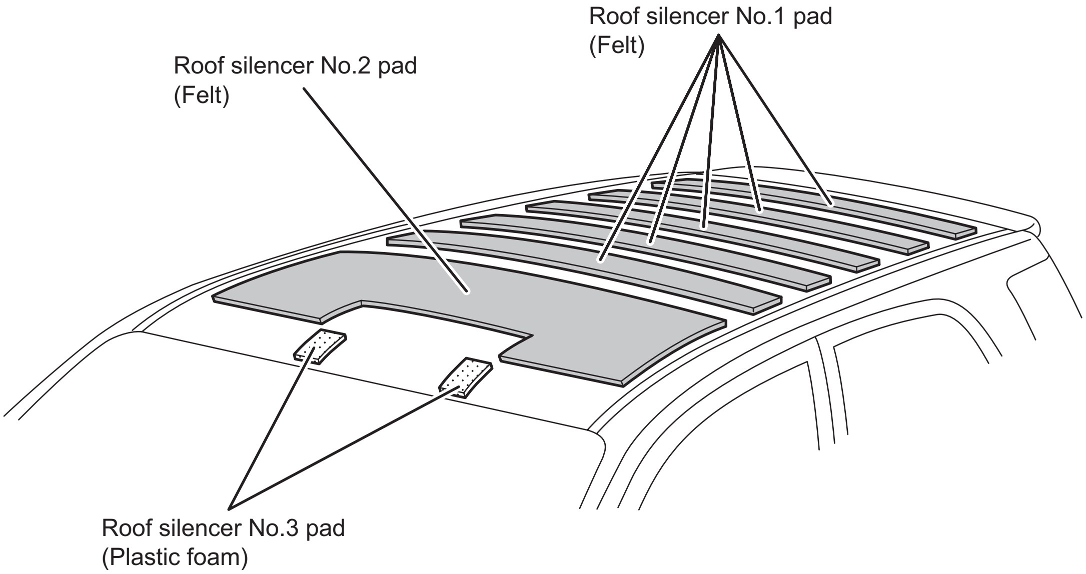
Body Sound Insulator

- The best silencers are placed in the exactly right locations to reduce the noise transmitted from the engine and the tires and achieve excellent quiet.
- Plastic foam for blocking the sections of body frames and working holes are sealed with sealant to reduce the noise transmitted through the pillars.
- Asphalt sheets are effectively laid on the floor as silencers to reduce the noise transmitted from the engine and the tires.



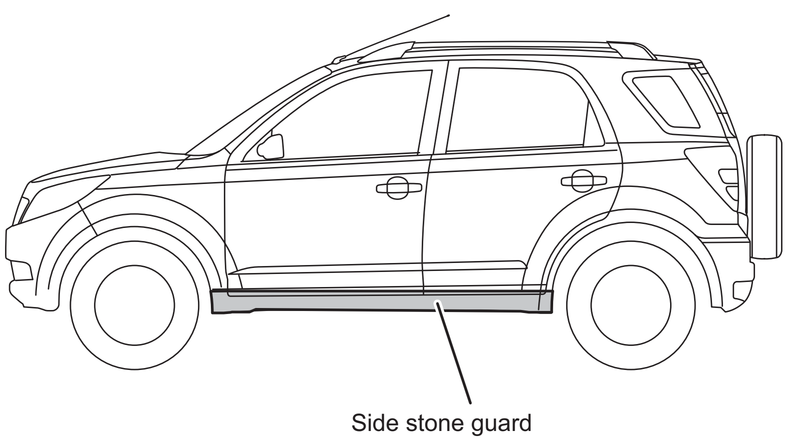
Roof Sound Insulator

- The roof is lined with plastic form and felt to reduce the noise entering the passenger compartment.



Sand Splash Noise Reducting Structure

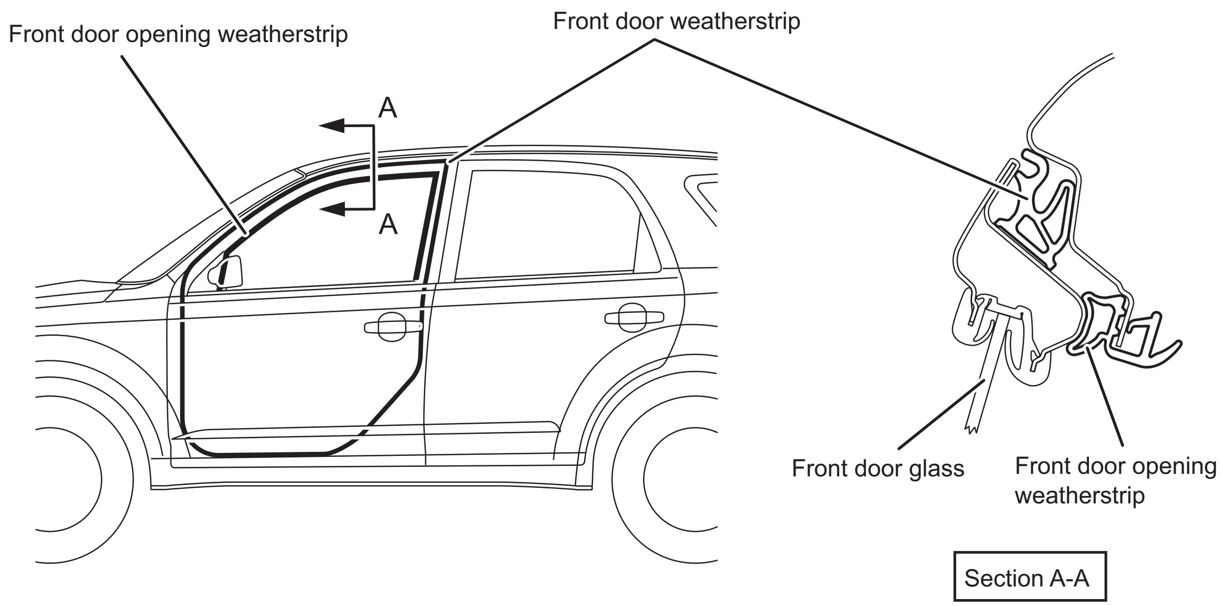
- A side stone guard designed to be attached under each rocker panel is available as a maker option. It not only reduces the sand splash noise, washer splash noise and road noise and but also protects the vehicle body from scuffs.



Note: The illustration shows a representative example.

Door Double-Sealing Structure

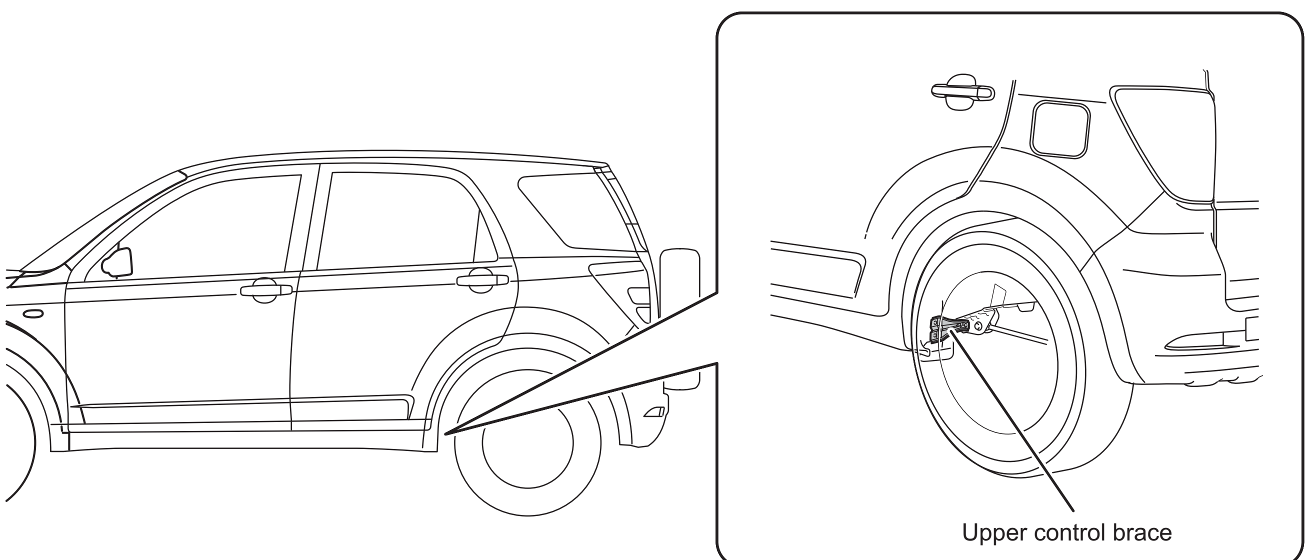
- Each door opening is double-sealed with the door weatherstrip and the door opening weatherstrip to reduce the wind noise entering the passenger compartment and thus to enhance sound insulation.



A1270277B-D

Body Shell

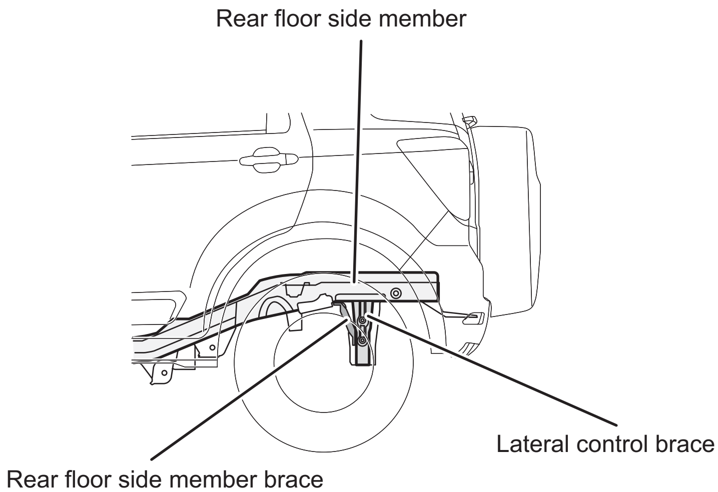
- An upper control brace is placed between the upper control arm mounting part and the rocker inner panel rear end to ensure the rigidity of the upper and lower control arm mounting surfaces and thus to achieve excellent driving stability.



Note: The illustration shows a representative example.

A1270403B-D

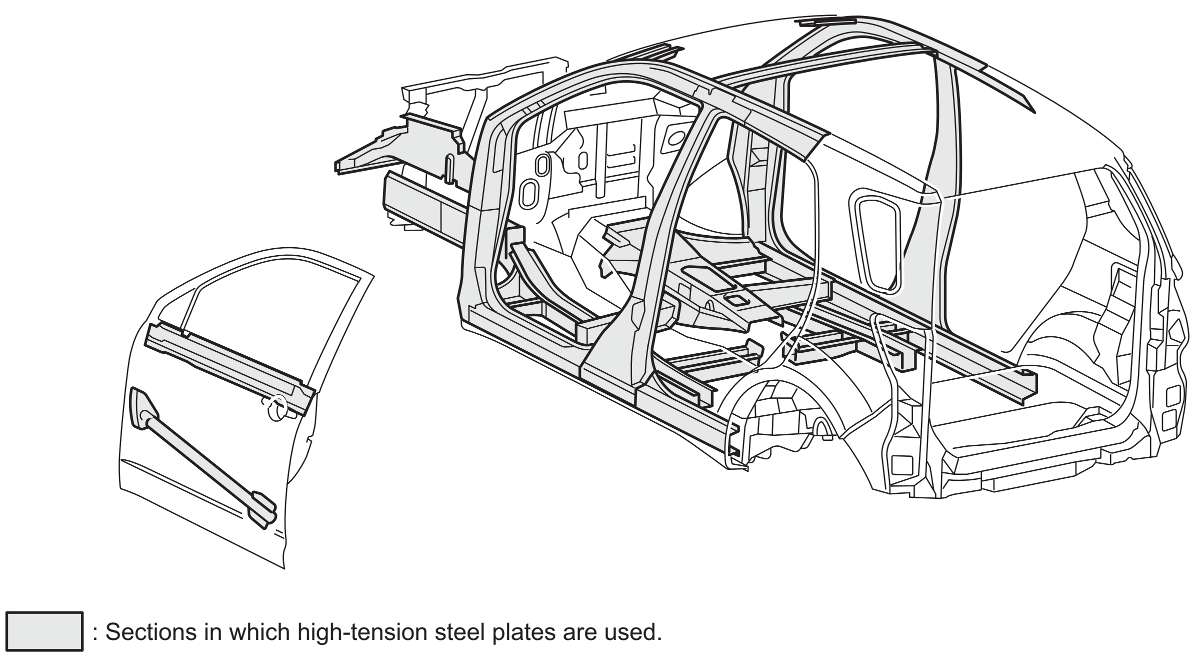
- European models are provided with a lateral control brace for connecting the rear left lateral control rod mounting part with a rear floor side member to ensure the rigidity of the lateral control rod mounting part and thus to achieve excellent driving stability.



A1270294B-D

High-Tension Steel Plate

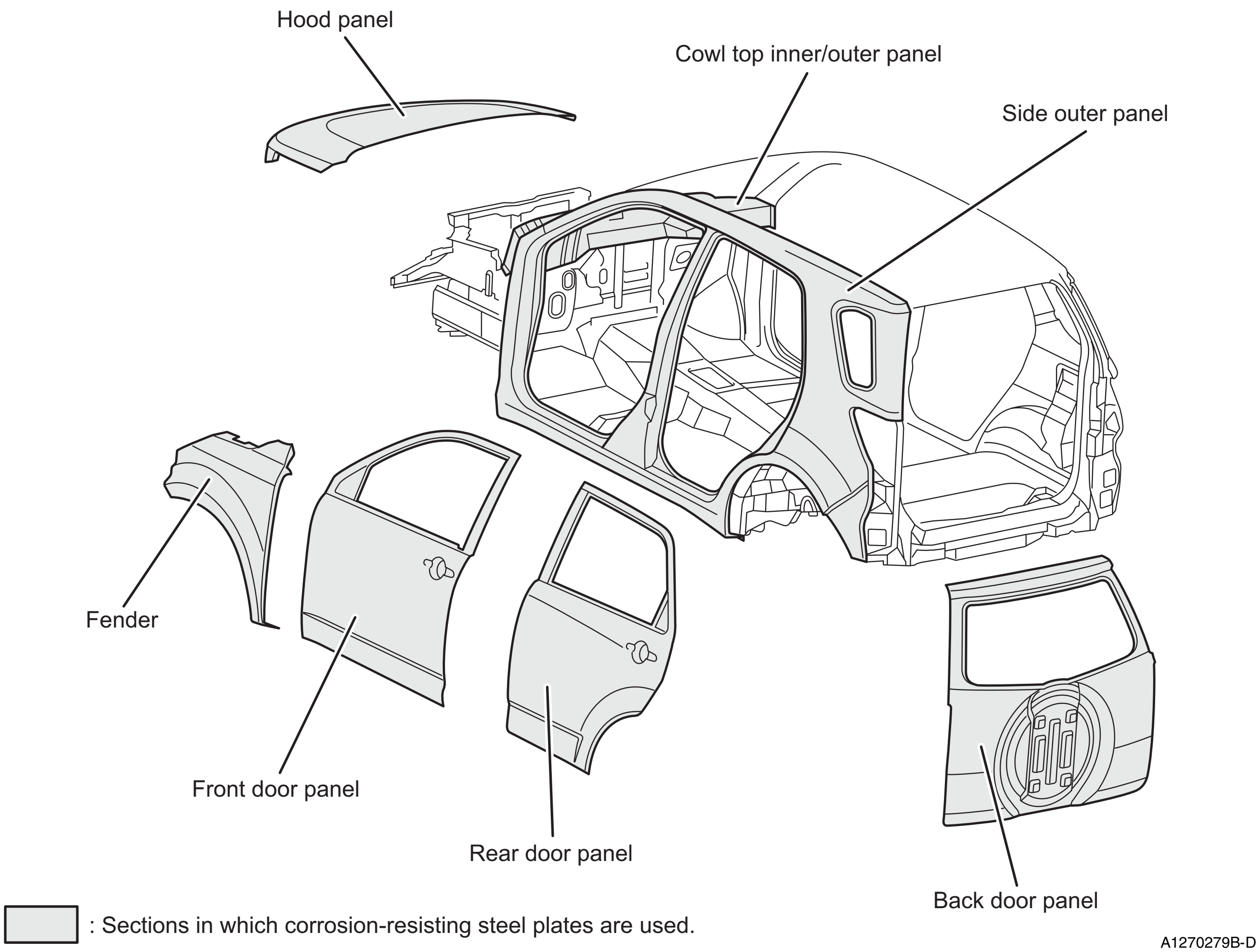
- High-tension steel plates are used for body frames to save weight and increase rigidity.



A1270278B-D

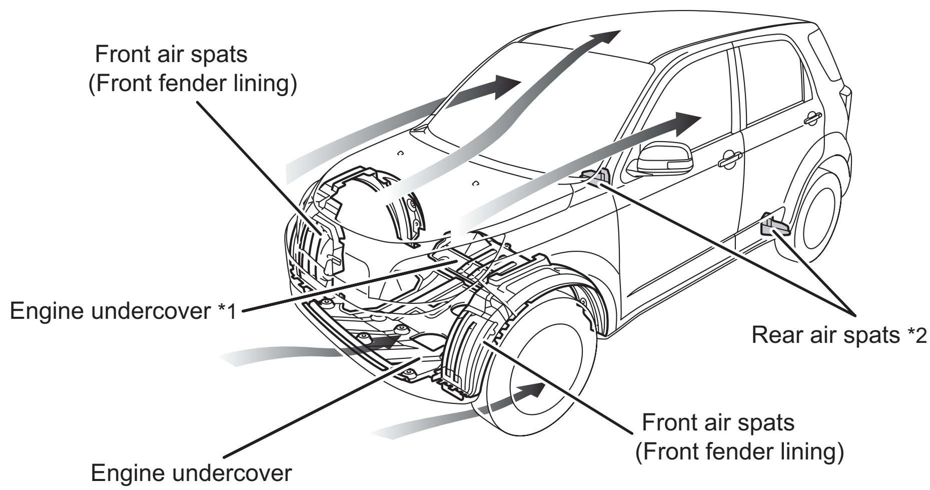
Corrosion-Resistant Steel Plate

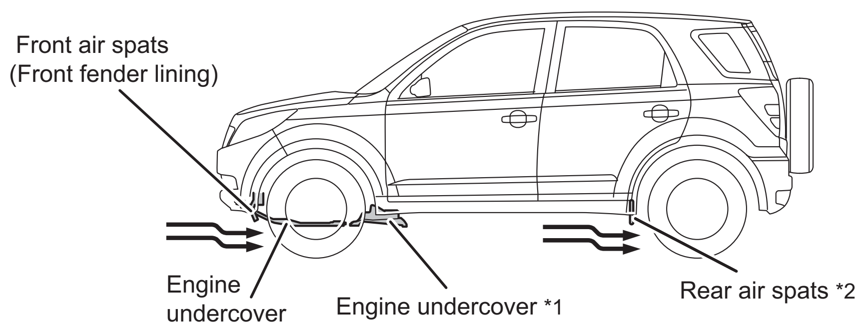
- European models use corrosion-resisting steel plates to protect parts susceptible to corrosion.



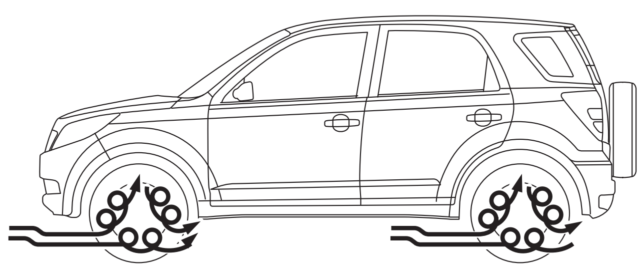
Aerodynamic Form

- Front air spats integral with fender lining are attached in front of the front tires to reduce the amount of change in the flow of air around each tire and thus to achieve excellent driving stability. In addition, an engine undercover is provided to control the flow of air under the floor.
- To reduce the air resistance of the tires, European models have also rear spats attached in front of the rear tires.





Vehicle with aerodynamic efficiency enhancing items



Vehicle without aerodynamic efficiency enhancing items

: Flow of air

*1: For European models with manual transmission

*2: Only for European models

A1270281B-D

BODY EXTERIOR DESIGN

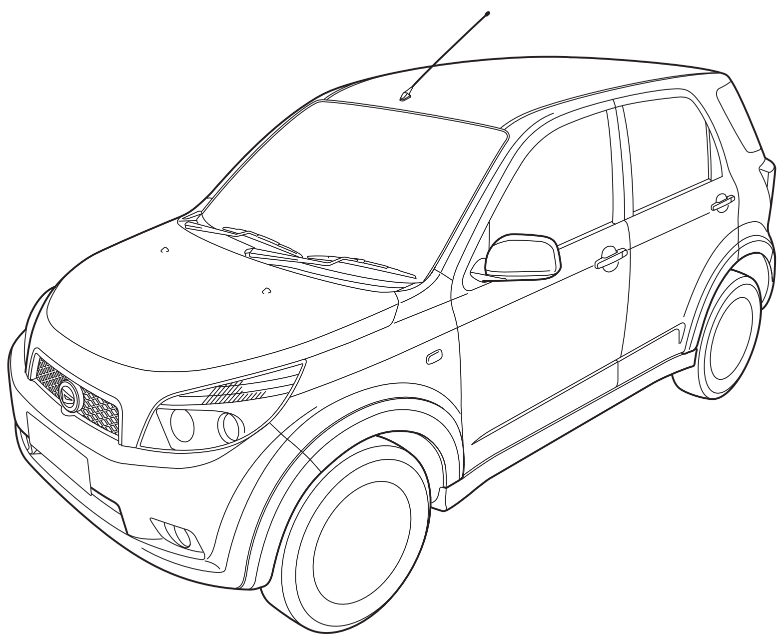
Exterior Design Concept

- Under the motto of a "real and sophisticated SUV," styling which produces a feeling of power and stability befitting an SUV has been created by extending the fenders outward, and the body has been rounded with smooth, flowing lines to give the vehicle a refined, urbanized appearance.

❖ REFERENCE ❖
Sophisticated: Refined, urbanized

Front and Side Sections

- The styling of the front section is characterized by a powerful, massive, steady look created by extending the wide front bumper and the front fenders on each side, and by the urbanized, modern appearance produced by the rounded, smooth body shape.
- The styling of the side section has been created so as to enhance the beauty of slim body lines, using smooth character lines flowing from the front to rear of the vehicle.

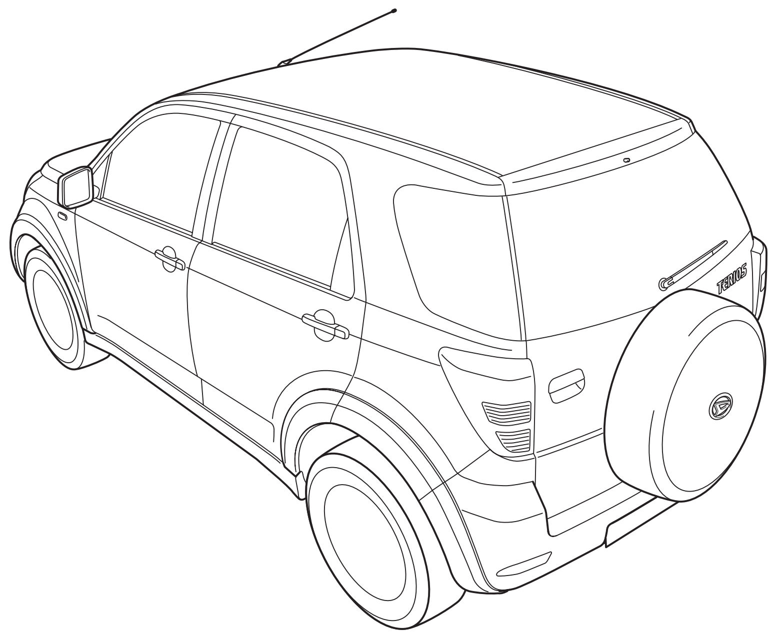


Note: The illustration shows a representative example.

A1270288B-D

Rear Section

- The styling of the rear section is characterized by a roundish body with smooth, flowing lines from the back door window glass to each quarter rear window glass, and protruding fender panels that stand in sharp contrast with the slimmed body. This styling gives the vehicle an urbanized, refined look with a feeling of powerfulness and stability.

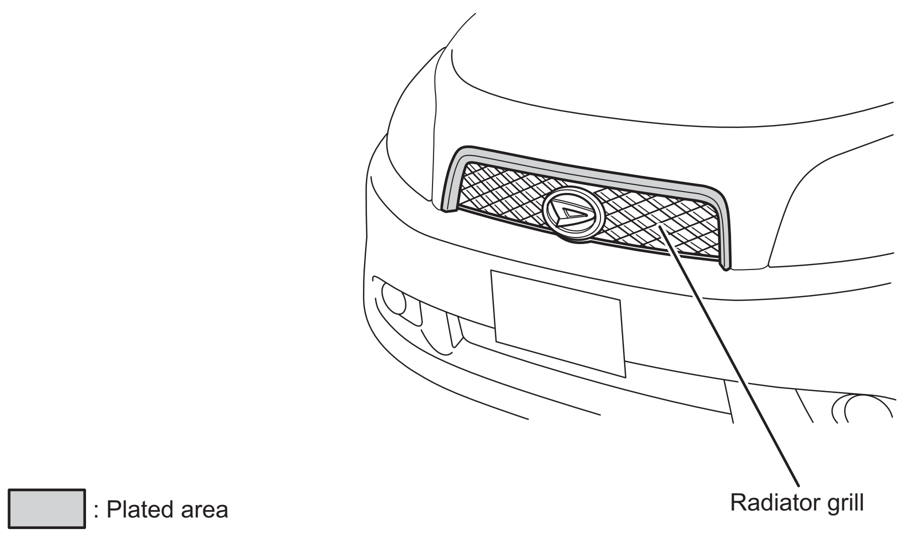


Note: The illustration shows a representative example.

A1270289B-D

Radiator Grill and Emblem

- A wide, trapezoidal radiator grill which protrudes on each side, as with the front fenders, has been employed to give the vehicle an appearance of power and stability befitting an SUV. In some models, the outer frame of the radiator grill is plated to give a refined appearance.



A1270387B-D

Outer Panel Painting Color

- A total of 8 colors are available. Each of them gives the vehicle an urbanized, refined appearance.

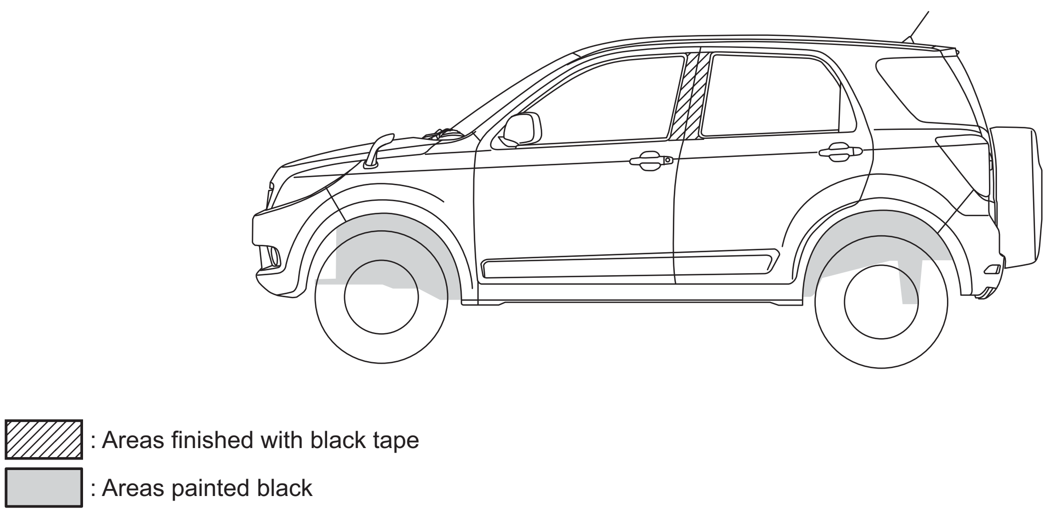
Table of outer panel colors

Colors	Color No.
Off white	W23
Bright silver metallic	S28

Colors	Color No.
Black mica metallic	X07
Shining red	R40
Clear lime green mica metallic	G41
Blue mica metallic	B58
Titanium gray metallic	S33
Festa yellow	Y09

Black-out Coating

- The parts of the body shown in the figure below are painted black to give the vehicle a solid appearance. The front and rear door sashes are finished with black-out tape.



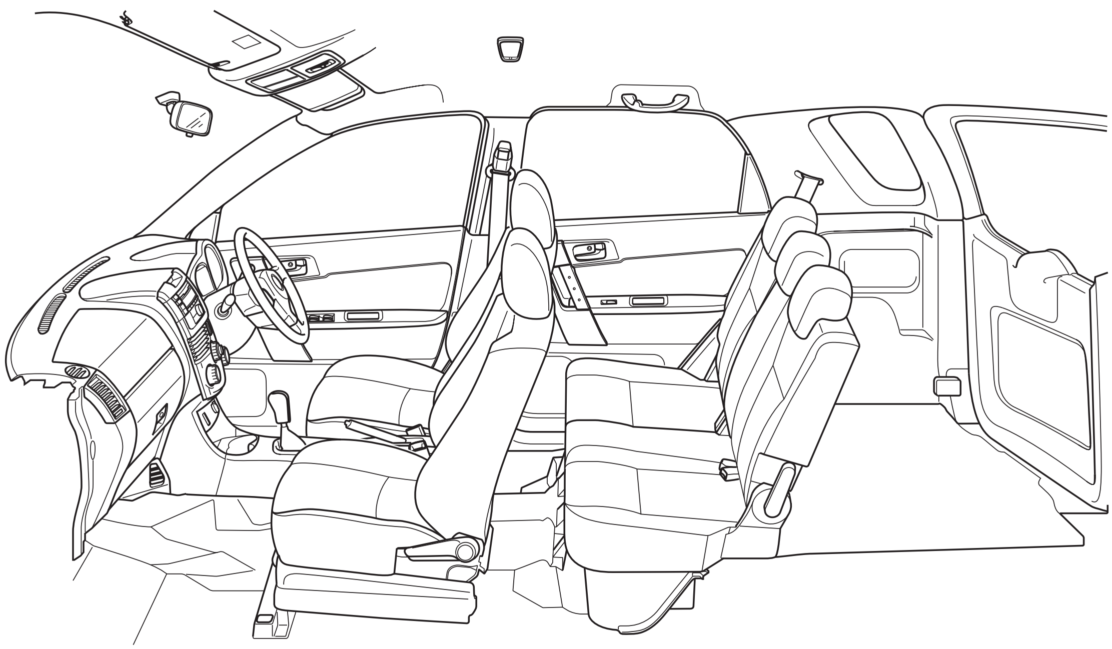
Note: The illustration shows a representative example.

A1270291B-D

BODY INTERIOR DESIGN

Interior Design Concept

- The instrument panel and each door trim are designed to give the feel of a large and powerful SUV. The meter cluster, center cluster and front and rear door grips are all metallic-finished to give them a high-grade, sporty appearance that higher grade vehicles would have.

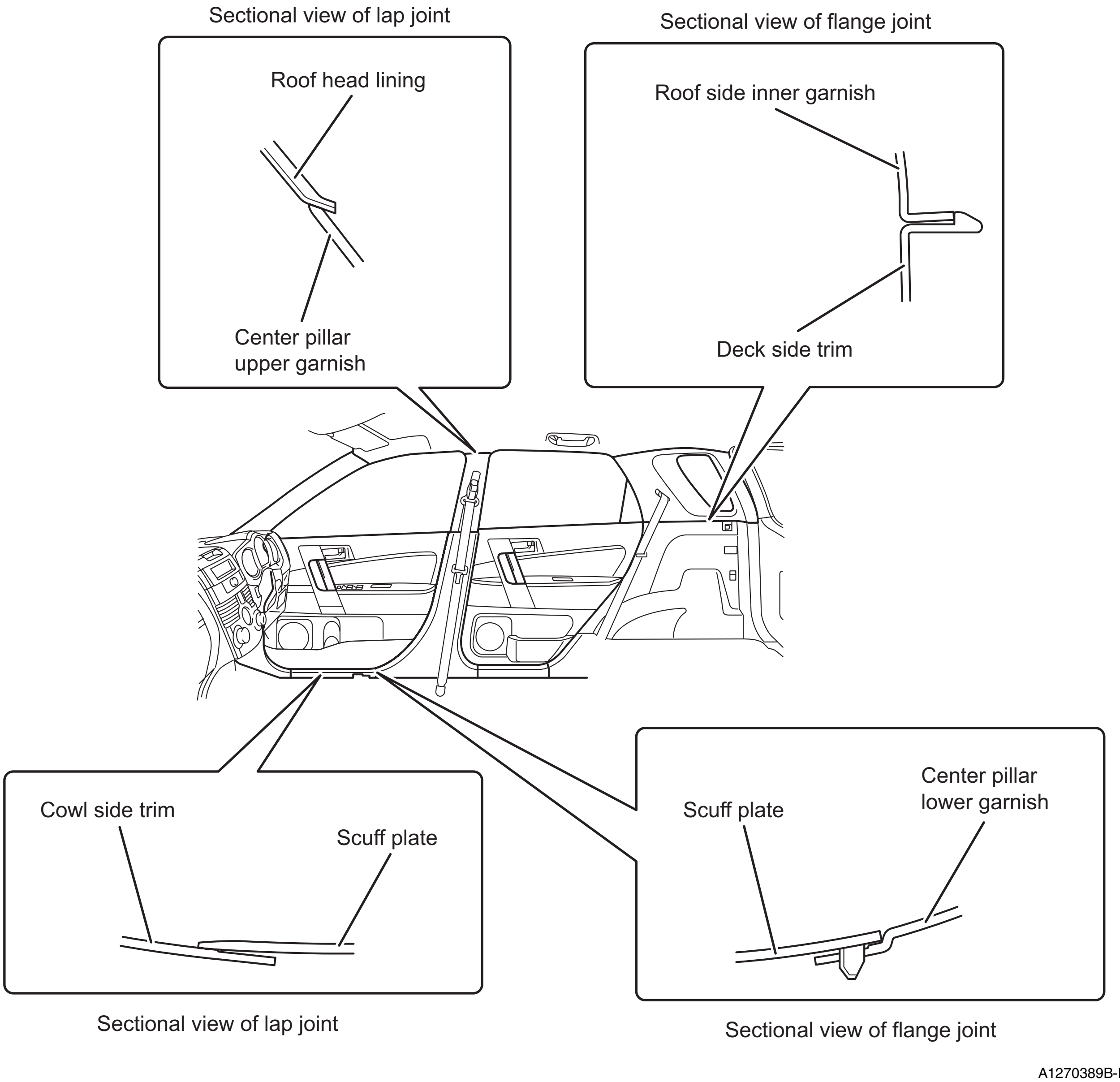


Note : The illustration shows a representative example.

A1270290B-D

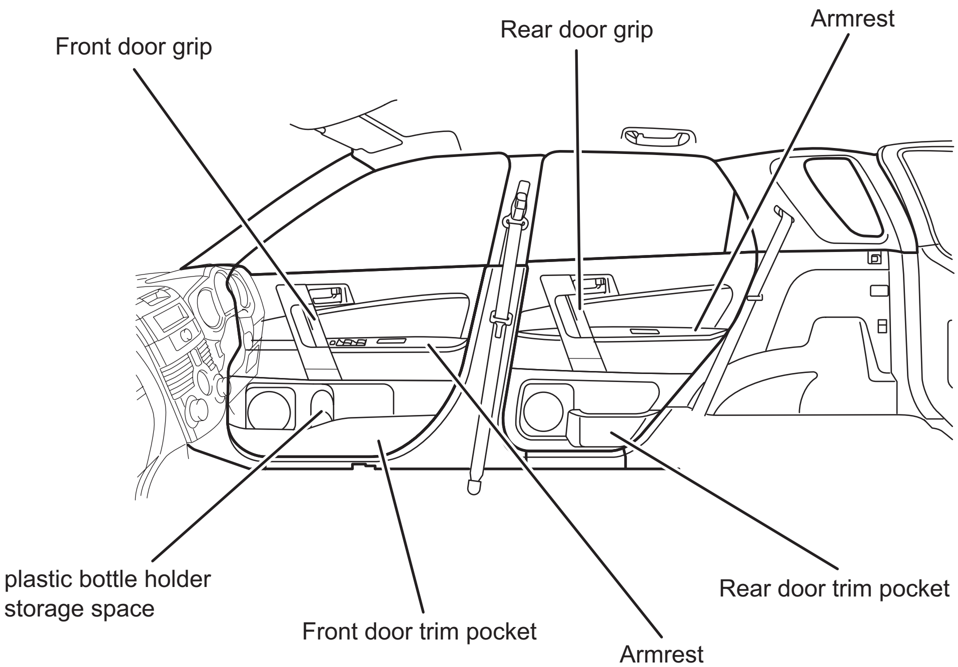
Side Section

- A head impact reducing structure has been used for the front pillar garnishes, center pillar upper garnishes and roof side inner garnishes. For details, refer to the “Body structure - head impact reducing structure” section. : 10-8
- Lap joints are used to join the roof head lining with each pillar garnish, cowl side trim and scuff plate. With these joints, they are lapped flush with each other, the width of each parting line are reduced to enhance their appearances.
- Flange joints are used to join the roof side garnishes with the deck side trims, center pillar garnishes, and scuff plates. These joints reduce level differences to enhance appearance.



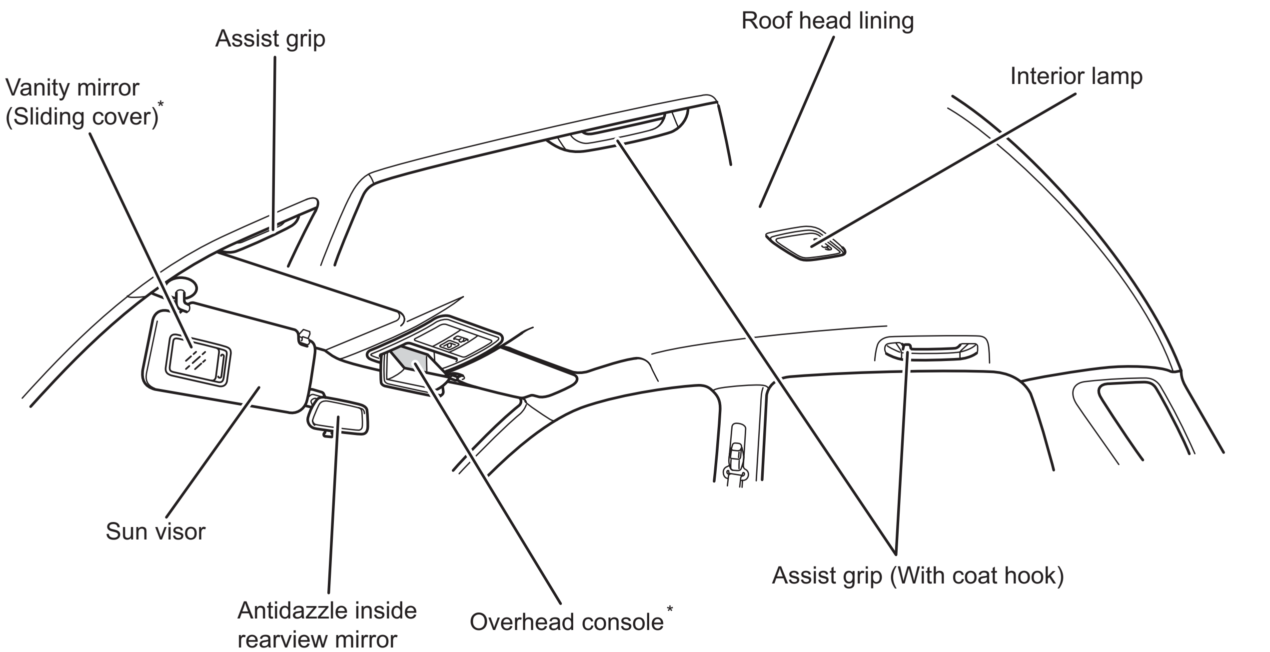
Door Trim

- Each front and rear door panel is split into two parts of different colors (two-tone): upper and lower parts, to enhance its appearance. In addition, a door grip, an armrest and a door trim pocket are provided for each front and rear door to ensure ease of use and provide sufficient storage space.



Roof Section

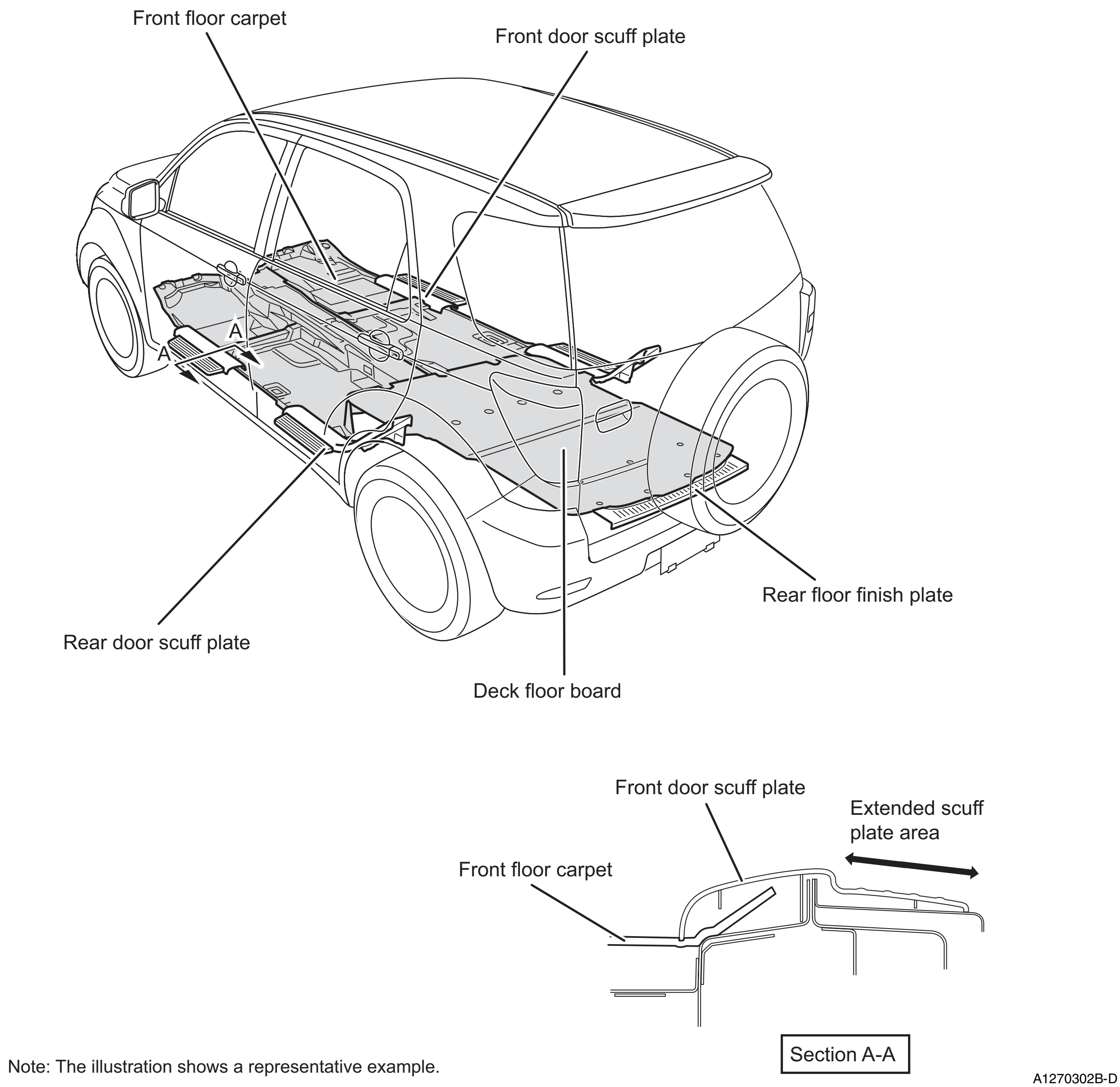
- A head impact reducing structure is employed for each roof side section. For details, refer to the “Body structure - head impact reducing structure” section. : 10-8
- An assist grip is provided for every seat except the driver's seat. The assist grip on each side of the rear seat has a coat hook.
- The interior lamp is mounted flush with the ceiling to enhance its appearance.
- Vanity mirrors with a sliding cover are attached to the backs of the sun visors in front of the driver's seat and front passenger seat, and a caddy designed to be mounted at the front of the roof head lining is available as a maker option.



* : Available as a maker option
Note : The illustration shows a representative example.

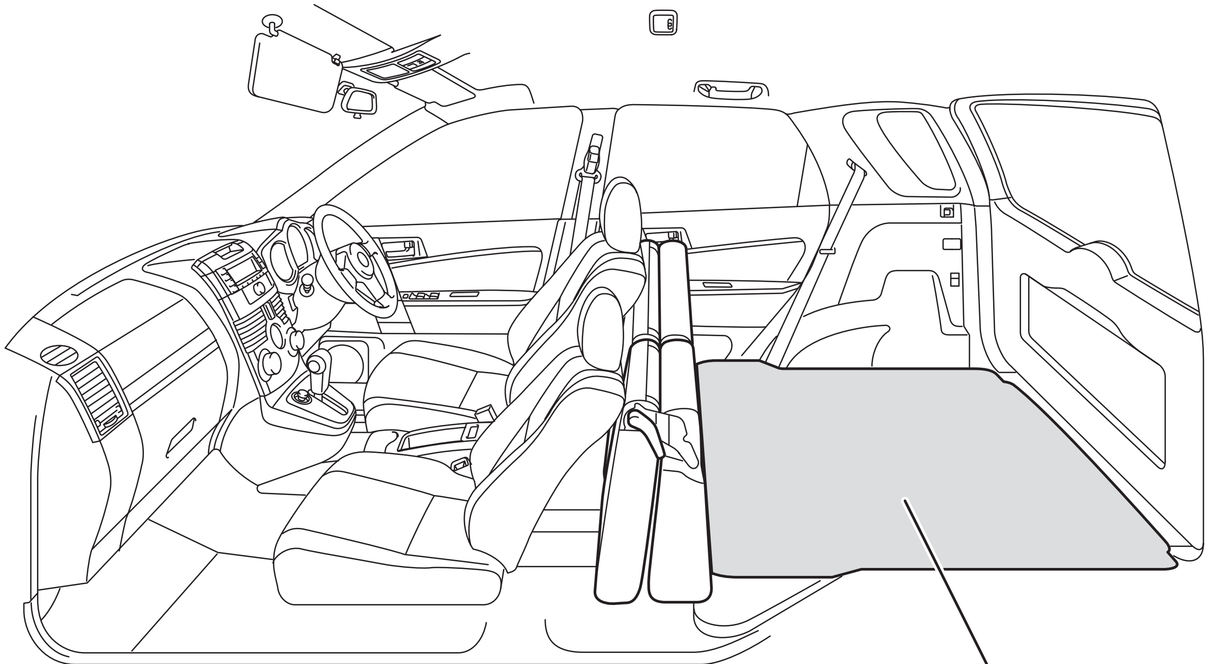
Floor and Rear Sections

- Velour knee pans are placed on the floor carpet and the deck floor boards.
- A front or rear scuff plate is placed under each front or rear door opening respectively, and a rear floor finish plate is provided for the back door to enhance ease of getting in and out of the vehicle and to protect the vehicle body from scuffs. Furthermore, the front and rear door scuff plates have been extended outward to enlarge the scuff protection areas of the body.
- The level difference between the front floor carpet and the front/rear door scuff plate has been reduced to ensure ease of getting in and out of the vehicle.



Luggage space

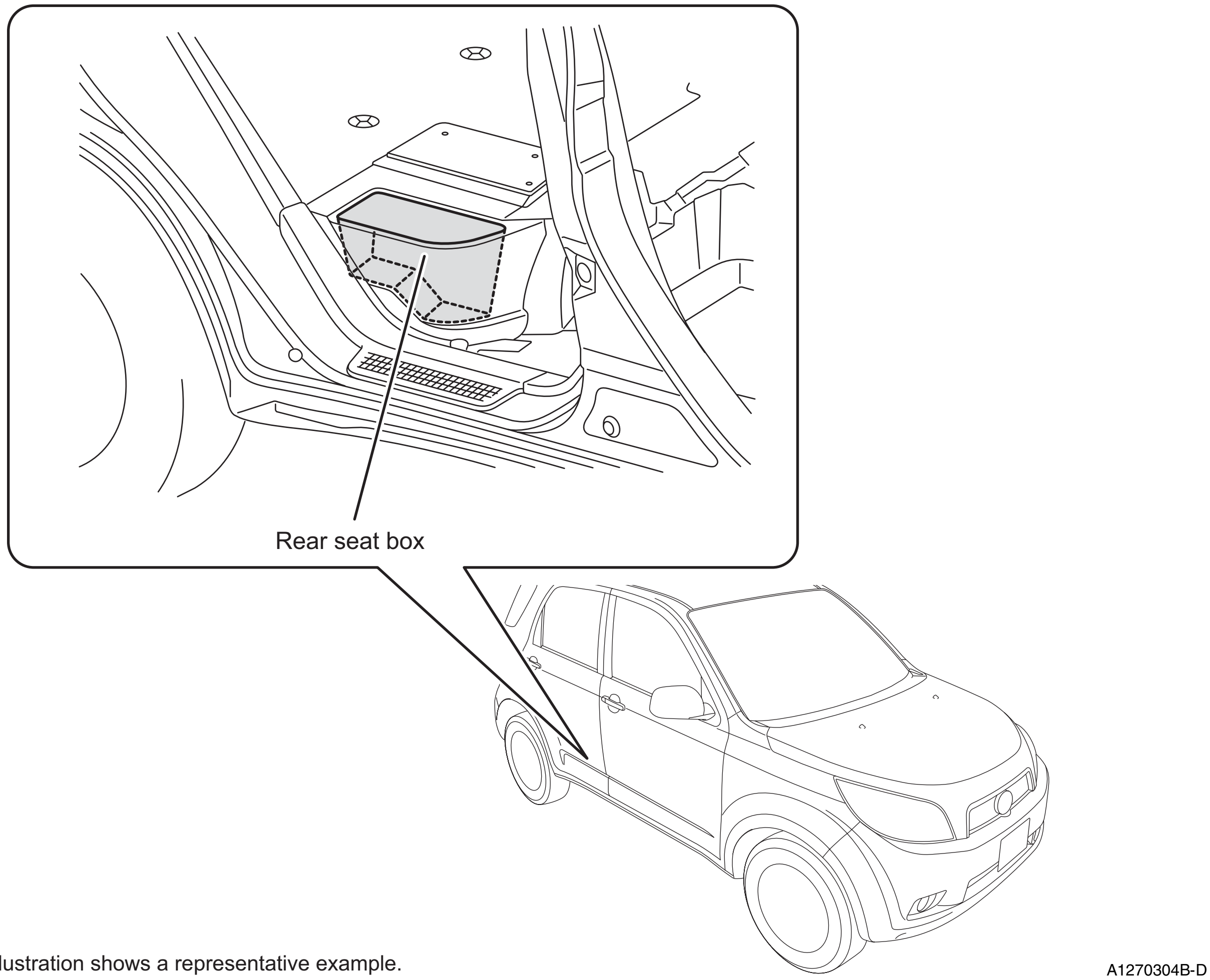
- The passenger compartment is so designed that a large luggage space can be secured on the rear floor by just tumbling the rear seat.



Note: The illustration shows a representative example.

Under floor Storage Space

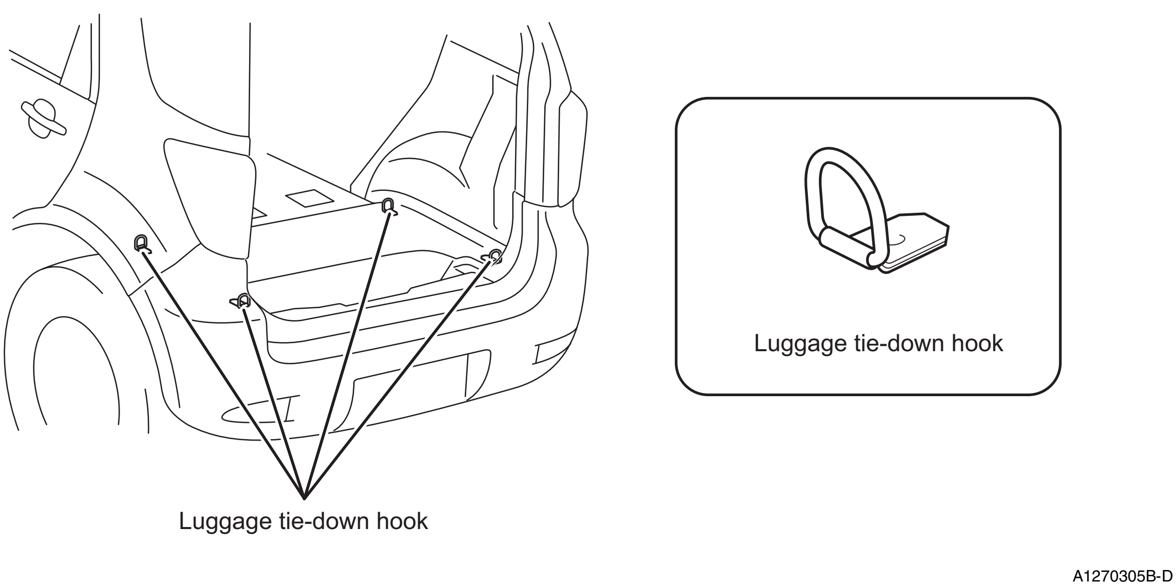
- A lidded rear seat box integral with the deck floor board is placed under the rear seat cushion to provide sufficient storage space.



Note: The illustration shows a representative example.

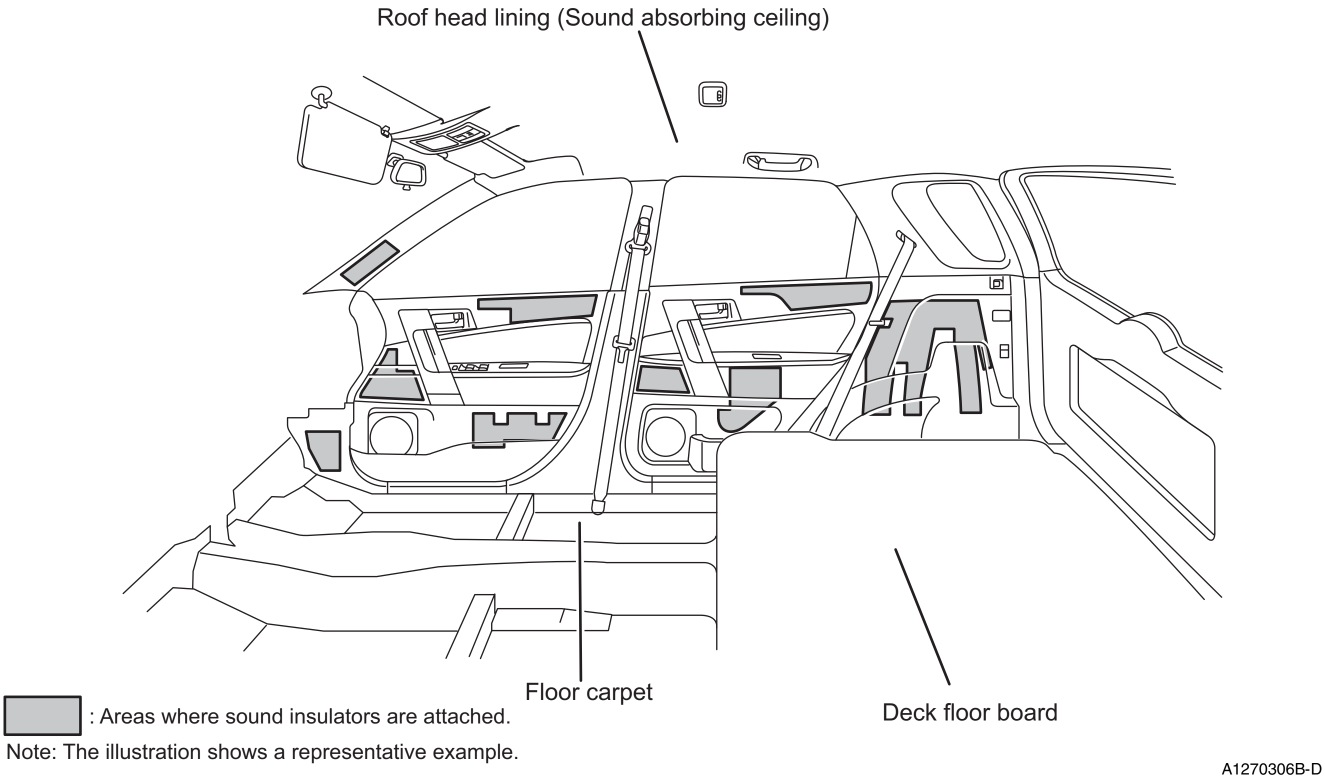
Hook and Net

- Four luggage tie-down hooks are mounted on the luggage floor to enhance ease of loading and ease of use.



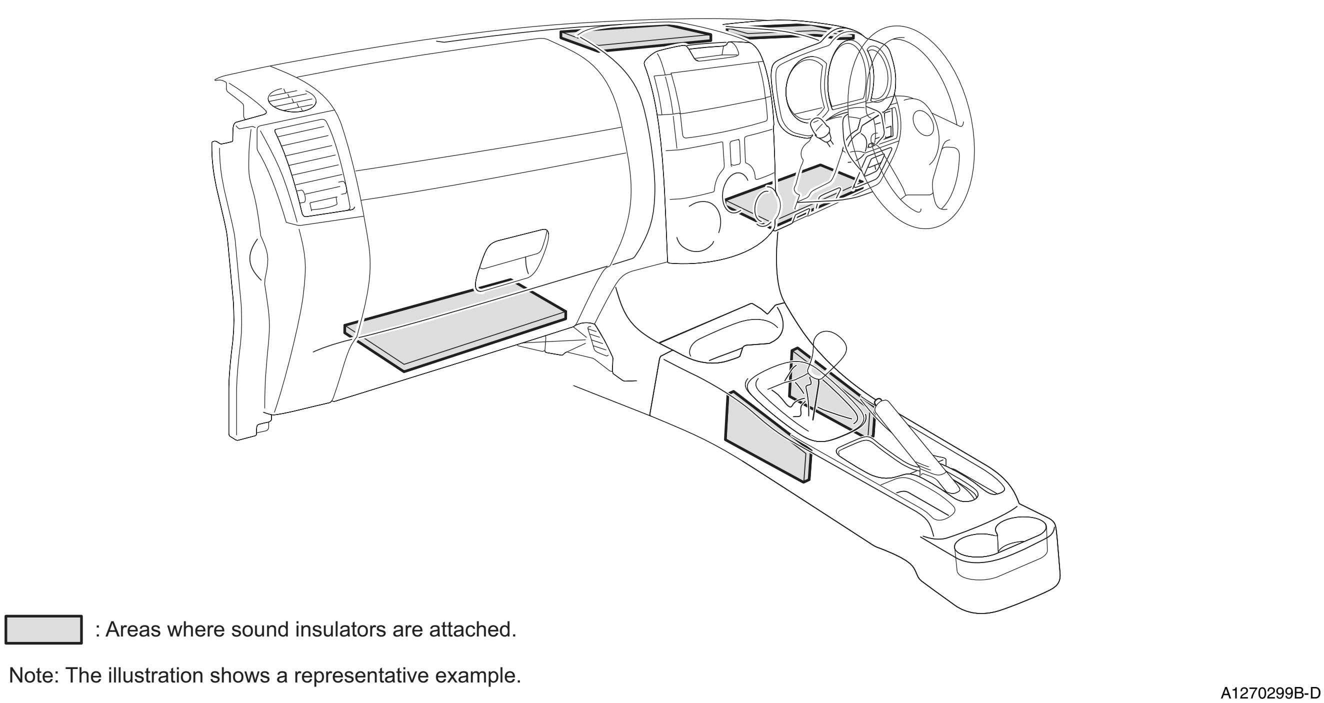
Sound Insulator and Sound Absorbing Material

- Sound absorbing materials are used for the roof head lining (sound absorbing ceiling), floor carpet, deck floor board, etc. to ensure a quieter passenger compartment.



Note: The illustration shows a representative example.

- The instrument panel is lined with felt and a silencer to ensure a quieter passenger compartment.

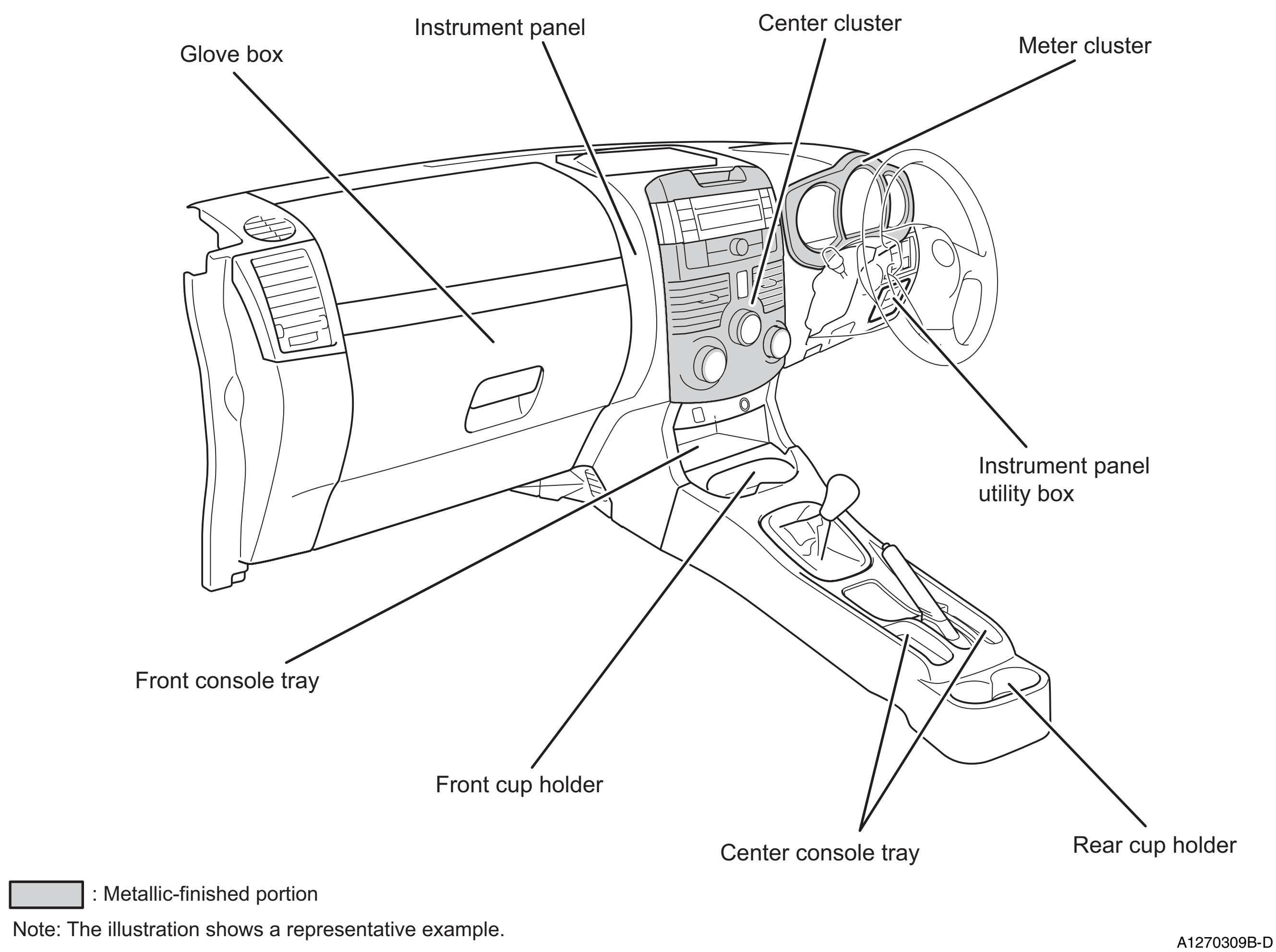


Note: The illustration shows a representative example.

INSTRUMENT PANEL

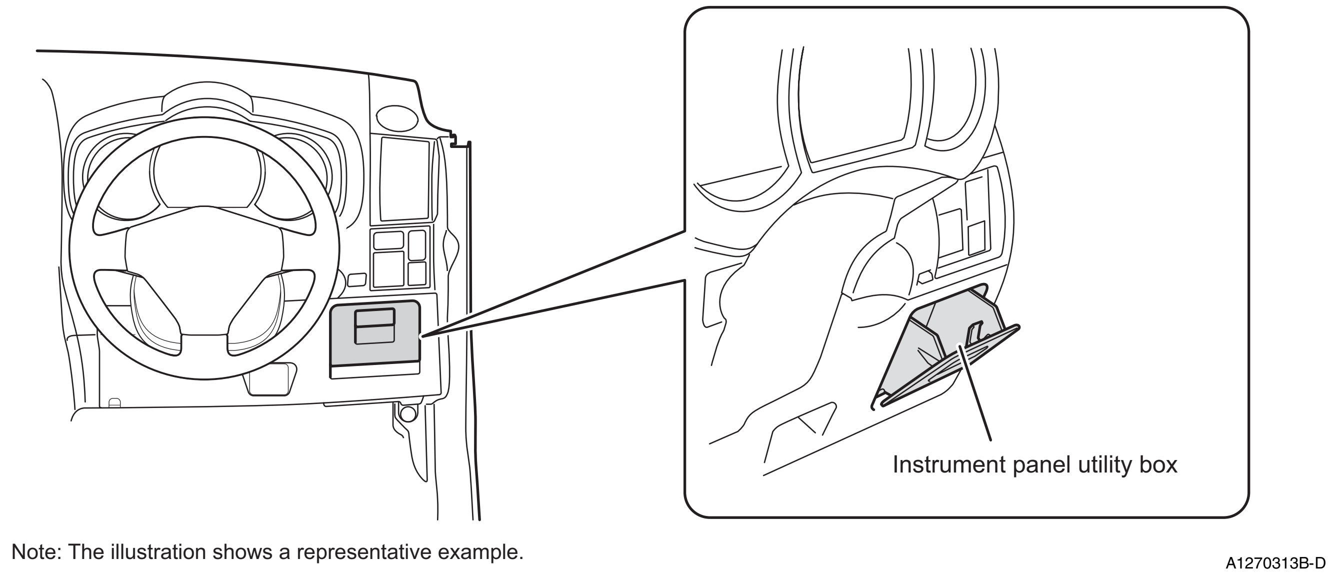
Around Instrument Panel

- The meter cluster and the center cluster are metallic-finished to give them a sporty look.
- Storage space and cup holders are provided for each section to enhance the convenience of the occupants.
- Parting lines on the front passenger seat SRS airbag door are aligned with those on the glove box to enhance their appearance.



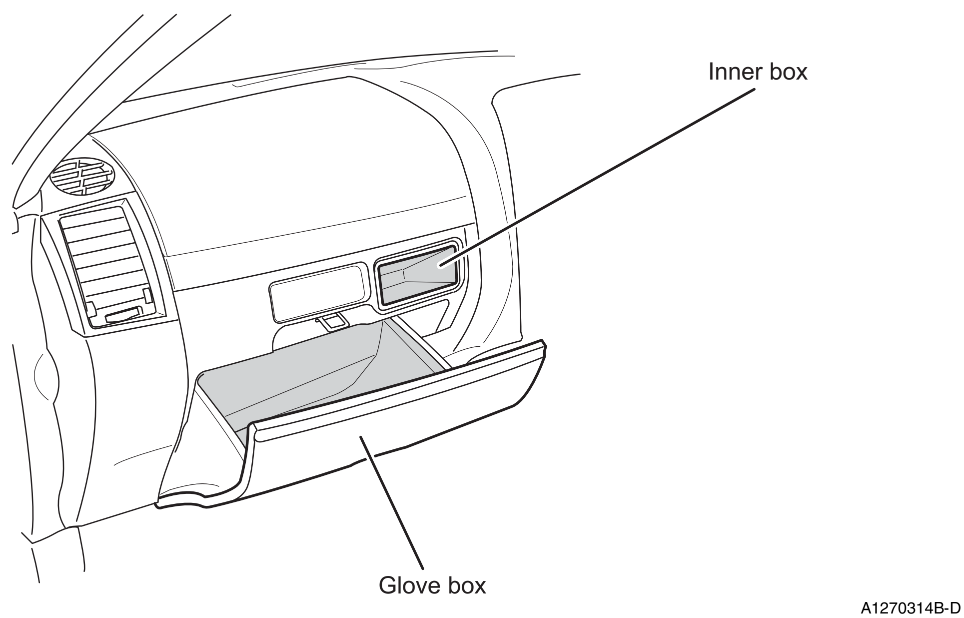
Instrument Panel Utility Box

- A utility box is installed under the side register on the driver's seat side to enhance the convenience of the driver.



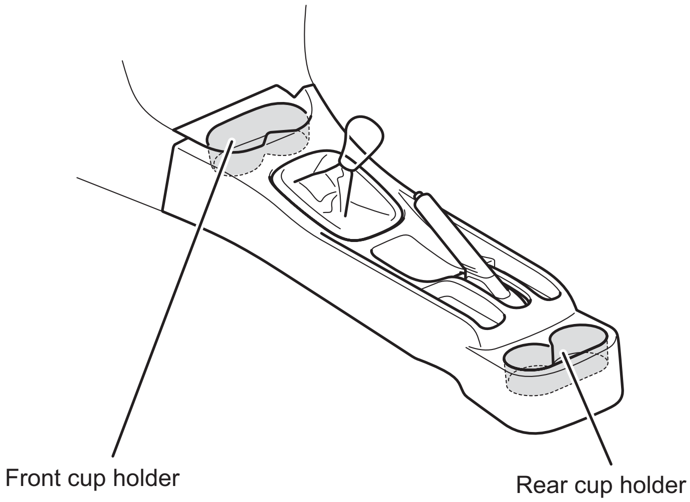
Glove Box

- The glove box has an inner box that allows small articles to be neatly stored.



Cup Holder

- Front and rear cup holders are placed in front of the shift lever and behind the parking brake lever, respectively.

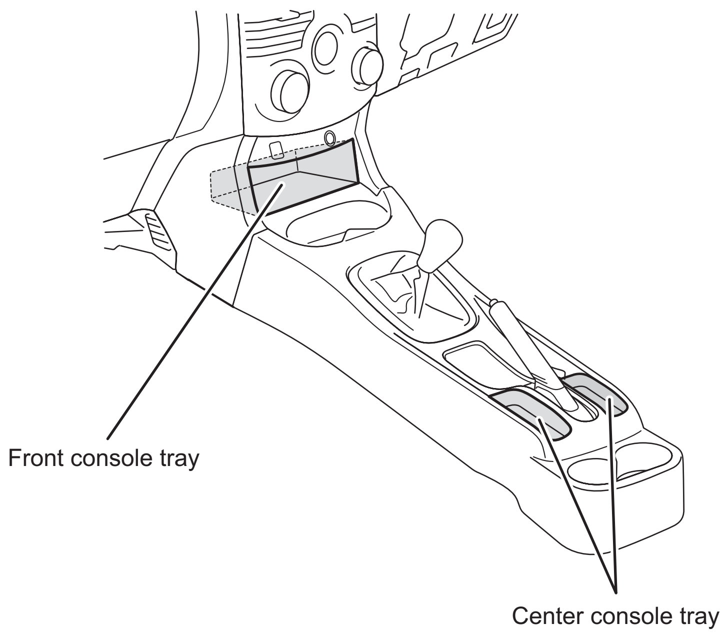


Note: The illustration shows a representative example.

A1270324B-D

Console Box

- A front console tray is placed under the air conditioner control panel and a center console tray by the side of the parking brake lever for the storage of small articles.



A1270308B-D

WINDOW GLASS AND MIRROR

Window Glass

- The windshield employs heat absorbing, laminated, green UV cut glass*.
- UV cut glass* which reduces the amount of ultraviolet rays passing through window glass is provided for the front door windows of some models.
- Privacy protection glass is provided for the rear door windows, rear quarter windows and backdoor window of some models.
- Light shielding ceramic-blended glass is partly used for the windshield to protect the occupants from sunlight.

❖ REFERENCE ❖

* : Glass made by adding a UV cut material to heat absorbing glass that cuts the amounts of ultraviolet rays

Window glass specifications

Glass	Fitting method	Type	Thickness (mm)	Visible ray transmittance (%)	Ultraviolet ray transmittance (%)
Windshield glass	Bonding	Heat absorbing laminated glass (Green + UV cut)	4.56	78.6	0.0
Front door glass	—	Heat absorbing reinforced glass (Green)	3.1	82.2	37.8
Front door glass	—	Heat absorbing reinforced glass (Green + UV cut)	3.1	75.4	10.0
Rear door glass	—	Heat absorbing reinforced glass (Green)	3.1	82.2	37.8
Rear door glass	—	Heat absorbing reinforced glass (Smoked)	3.1	24.6	4.7
Rear quarter window glass	—	Heat absorbing reinforced glass (Green)	3.1	82.2	37.8
Rear quarter window glass	—	Heat absorbing reinforced glass (Smoked)	3.1	24.6	4.7
Backdoor glass	Bonding	Heat absorbing reinforced glass (Green)	3.1	82.2	37.8
Backdoor glass	Bonding	Heat absorbing reinforced glass (Sun verre green)	3.1	57.4	11.1

Outer Rearview Mirror

- Motor-driven, remote-control door mirrors (with/without heaters) are provided for some models, or hand-operated door mirrors for the other models.

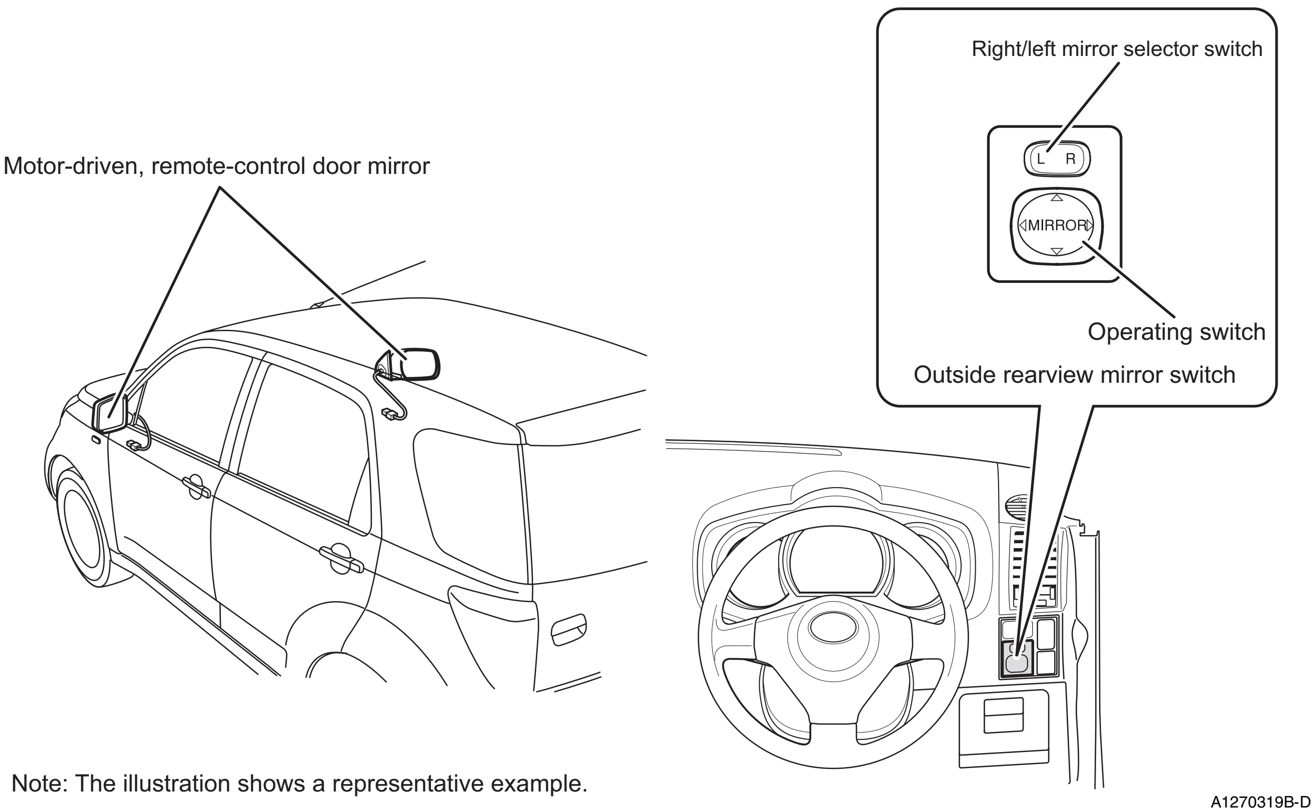
Inside Rearview Mirror

- A hand-operated, antidazzle inside rearview mirror is attached to the windshield.

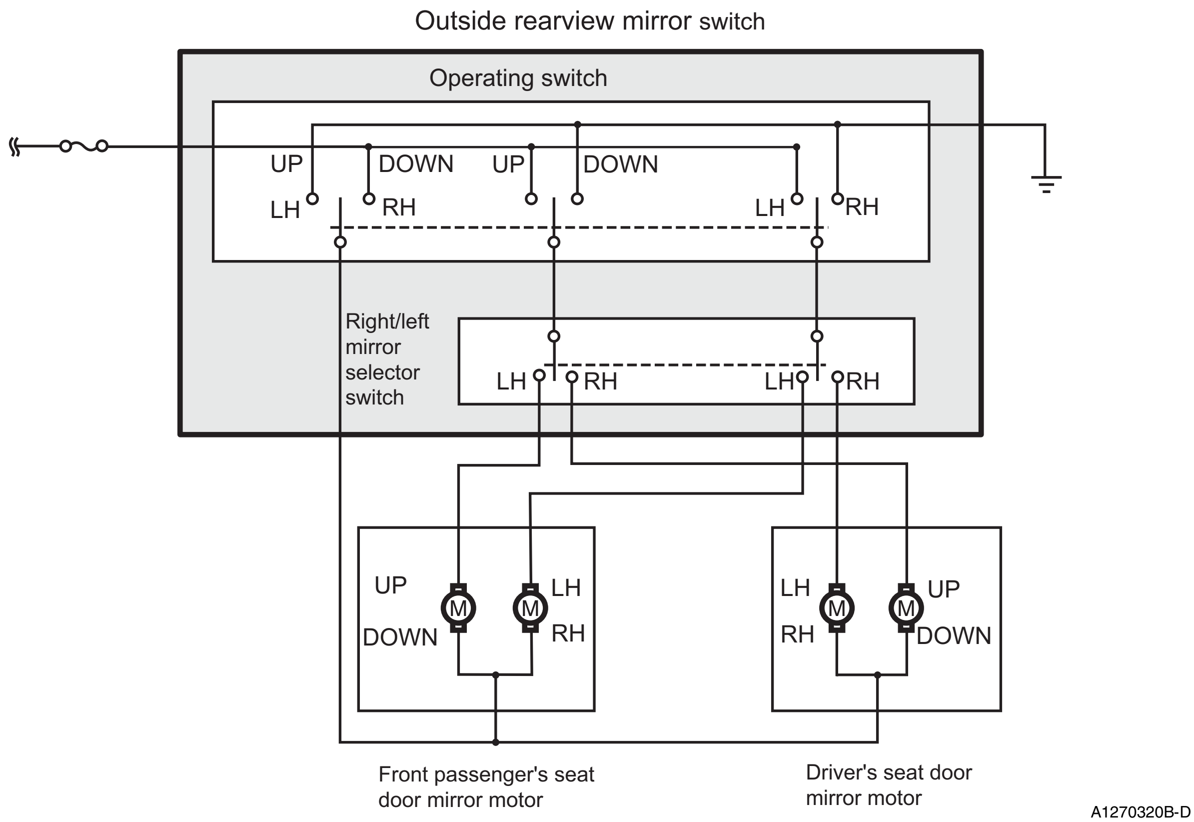
Power Mirror System

- Motor-operated, remote-control door mirrors which can be adjusted from inside the passenger compartment are provided for some models.
- The outside rearview mirror switch is placed under the side register on the instrument panel, on the driver's seat side.

Power mirror system components



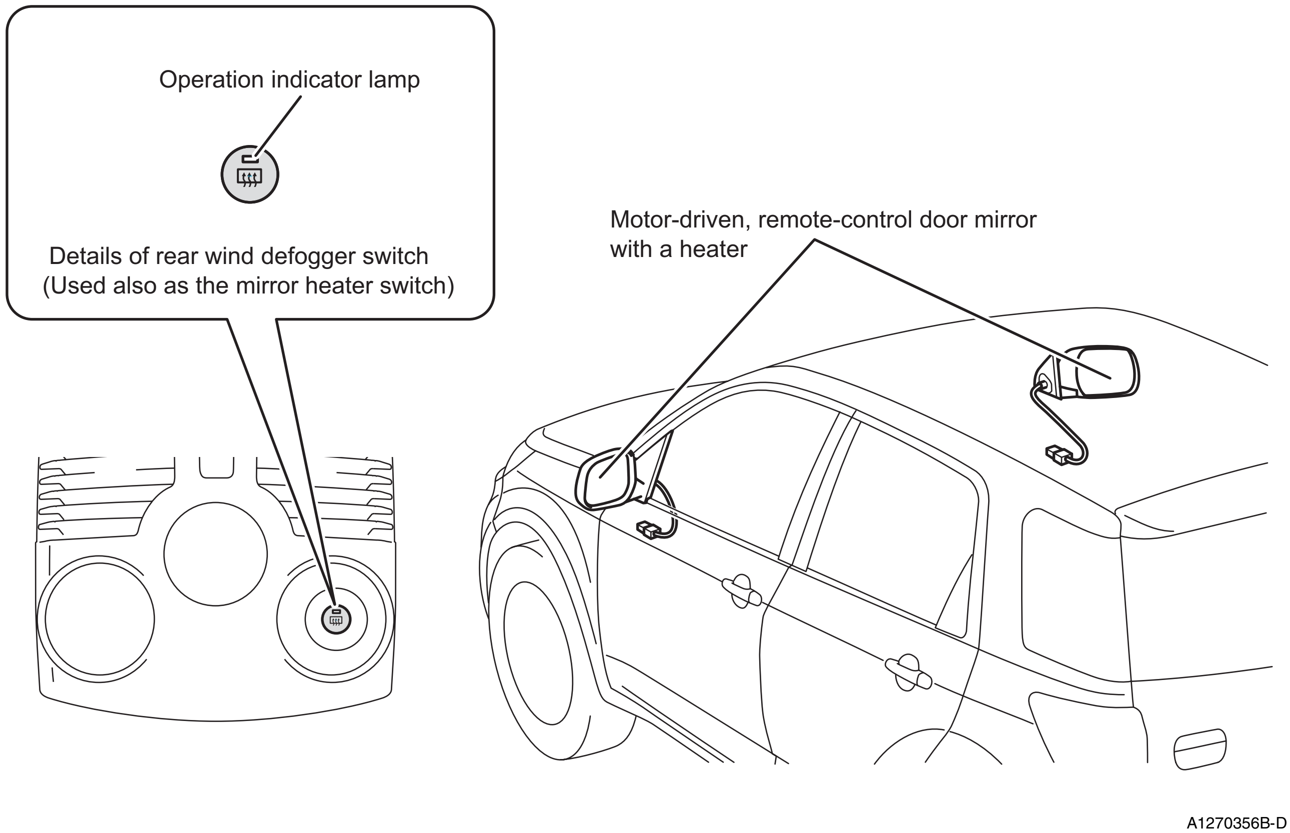
Power mirror system operation diagram



Mirror Heating System

- Motor-driven, remote-control door mirrors with a heater are provided for some models. The mirror heater switch is also used as the rear window defogger switch.
- If the mirror switch is turned on when the ignition switch is ON, each mirror heater works for about 15 minutes.

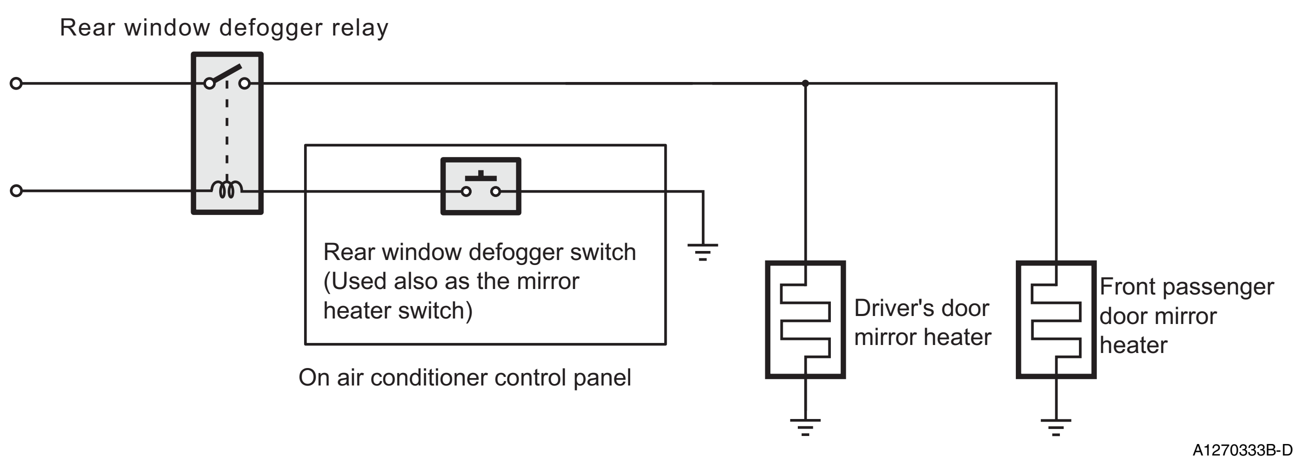
Mirror heating system components



Operation of Mirror Heater

- If the rear window defogger switch (used also as the mirror heater switch) on the air conditioner control panel is turned on when the ignition switch is ON, the rear window defogger relay is activated and each mirror heater generates heat.

Vehicle with a manual air conditioner

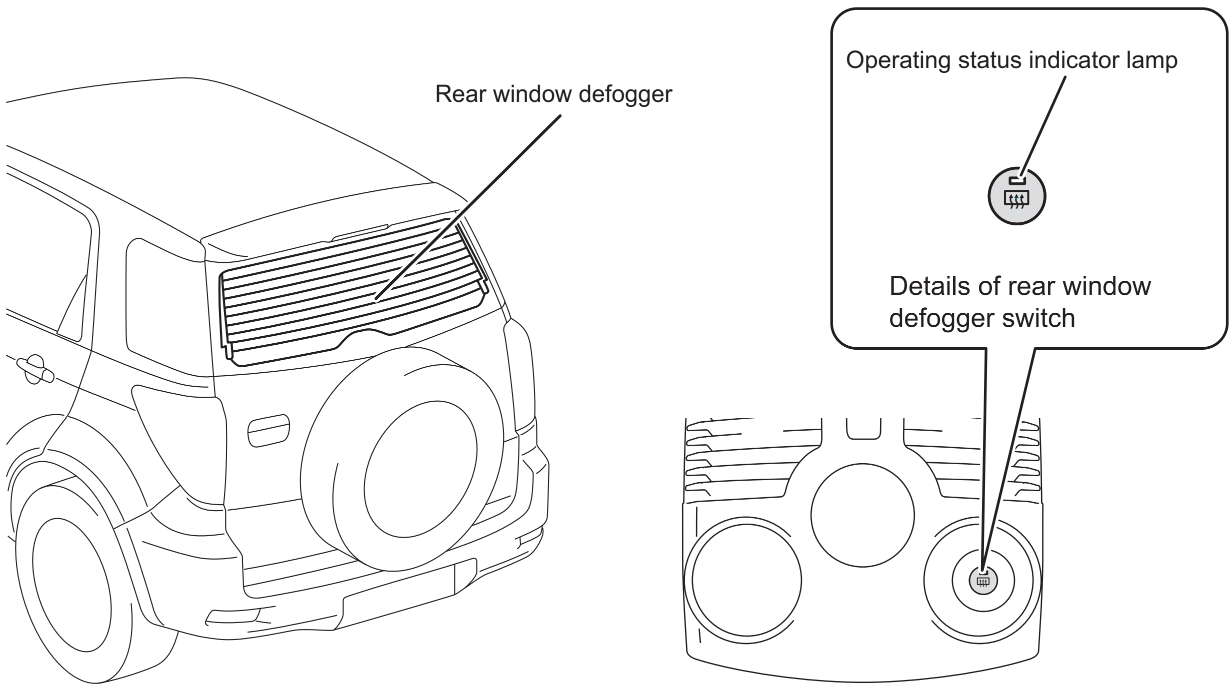


Rear Window Defogging System

● A rear defogger is provided as standard equipment. The rear defogger switch is placed on the air conditioner control panel and the operating status indicator lamp is built into the switch.

Rear defogger specifications

Items	Specifications
Number of hot wires [pieces]	11
Power consumption [W]	85 (±10%)

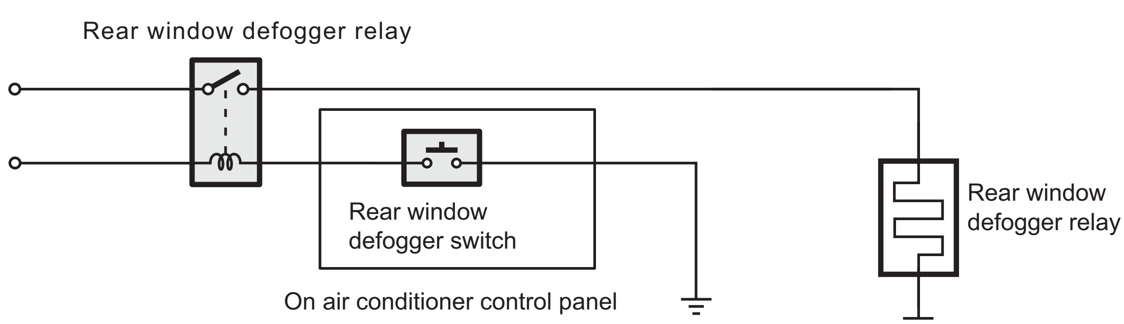


Note: The illustration shows a representative example.

A1270342B-D

Operation of Rear Window Defogger

• If the rear window defogger switch is turned on when the ignition switch is ON, the operating status indicator lamp lights and power is supplied to the rear defogger through the rear window defogger relay.



A1270335B-D

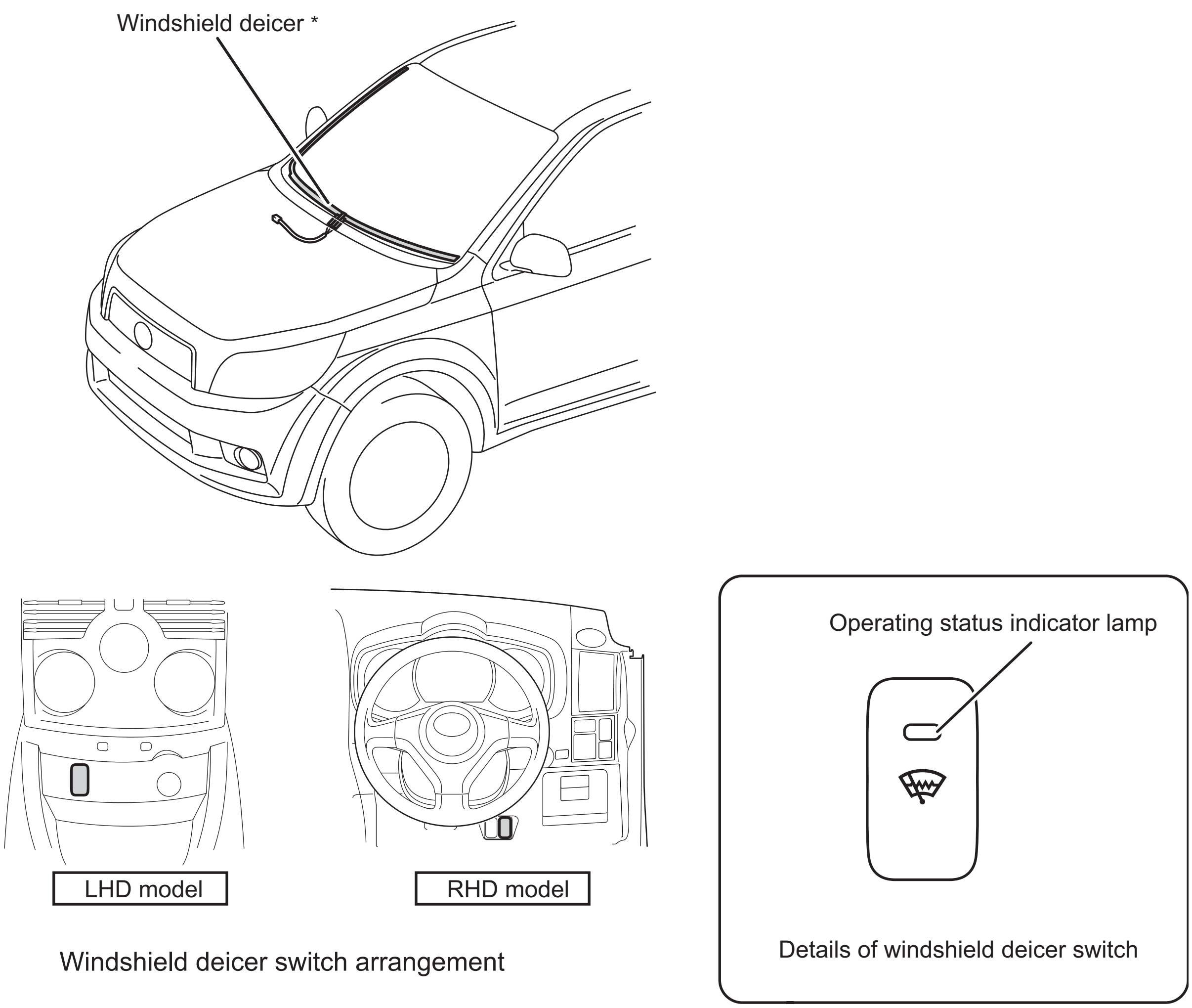
Windshield Deicer System

● A windshield deicer with a timer (15-minute timer) is provided for some models.

● The deicer switch is placed under the steering column cover in right-hand drive models, or under the air conditioner control panel in left-hand drive models.

Windshield deicer specifications

Items	Specifications
Power consumption [W]	83 (±10)
Timer turn-off period [Min.]	15



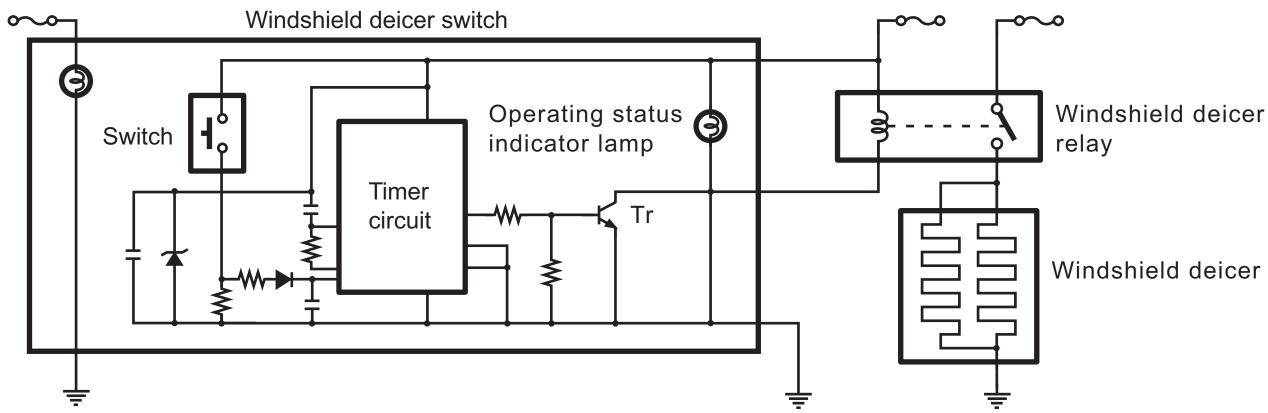
*: The illustration at the top shows the windshield deicer on a RHD model. (The shape of the deicer and the lead wire path on a LHD model are mirror images of those shown in the illustration.)

A1270321B-D

Operation of Windshield Deicer

- When the windshield deicer switch is turned on, the timer circuit turns Tr on to activate the windshield deicer relay and to supply power to the windshield deicer. As soon as the windshield deicer relay is activated, Tr turns on the deicer indicator.

❖REFERENCE❖
Tr: An abbreviation for transistors


Windshield deicer switch
Switch
Timer circuit
Operating status indicator lamp
Tr
Windshield deicer relay
Windshield deicer

A1270338B-D

POWER WINDOW

Power Window System

- The power window system allows driver's window to be rolled down by a simple one-touch operation.
- Window regulators with an X-arm are provided for both the front and rear doors.

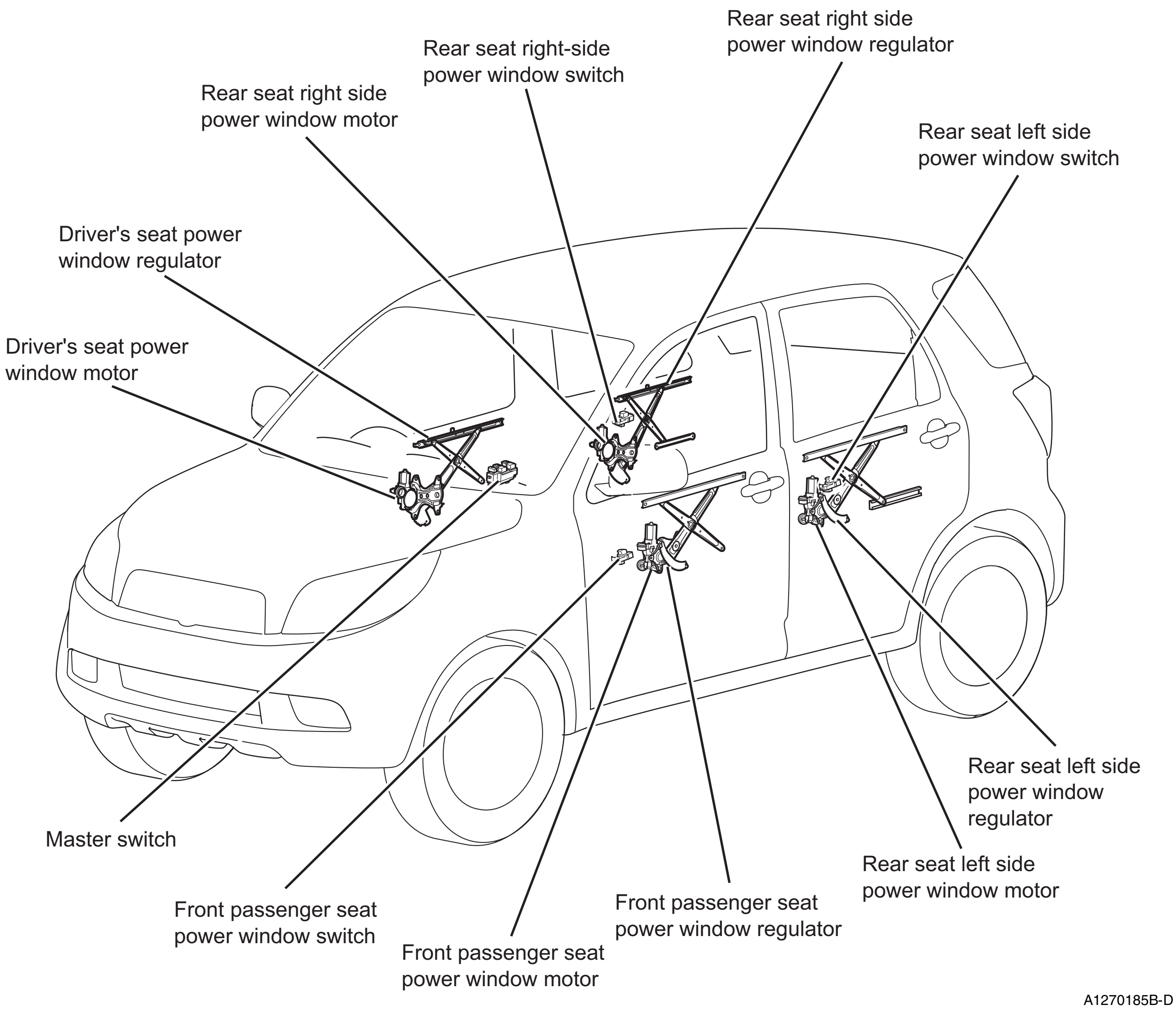


Table of power window system components and their principal functions

Components	Principal functions
Window regulator	• Raises and lowers the window glass by running the power window motor in the forward or reverse direction.
Power window motor	• Drives the window regulator by running in the forward or reverse direction.

Components	Principal functions
Master switch	• Controls the operation of the power window system. • Starts and stops the driver's seat power window motor, using a built-in relay. • Starts and stops the power window motor in each seat by operating the door window switch in each seat. • Receives window lock switch status signals and prohibits the operation of the power window motor in each seat if necessary. • Turns on the indicator lamp for the driver's seat switch each time the ignition switch is turned on.

Power window system circuit diagram

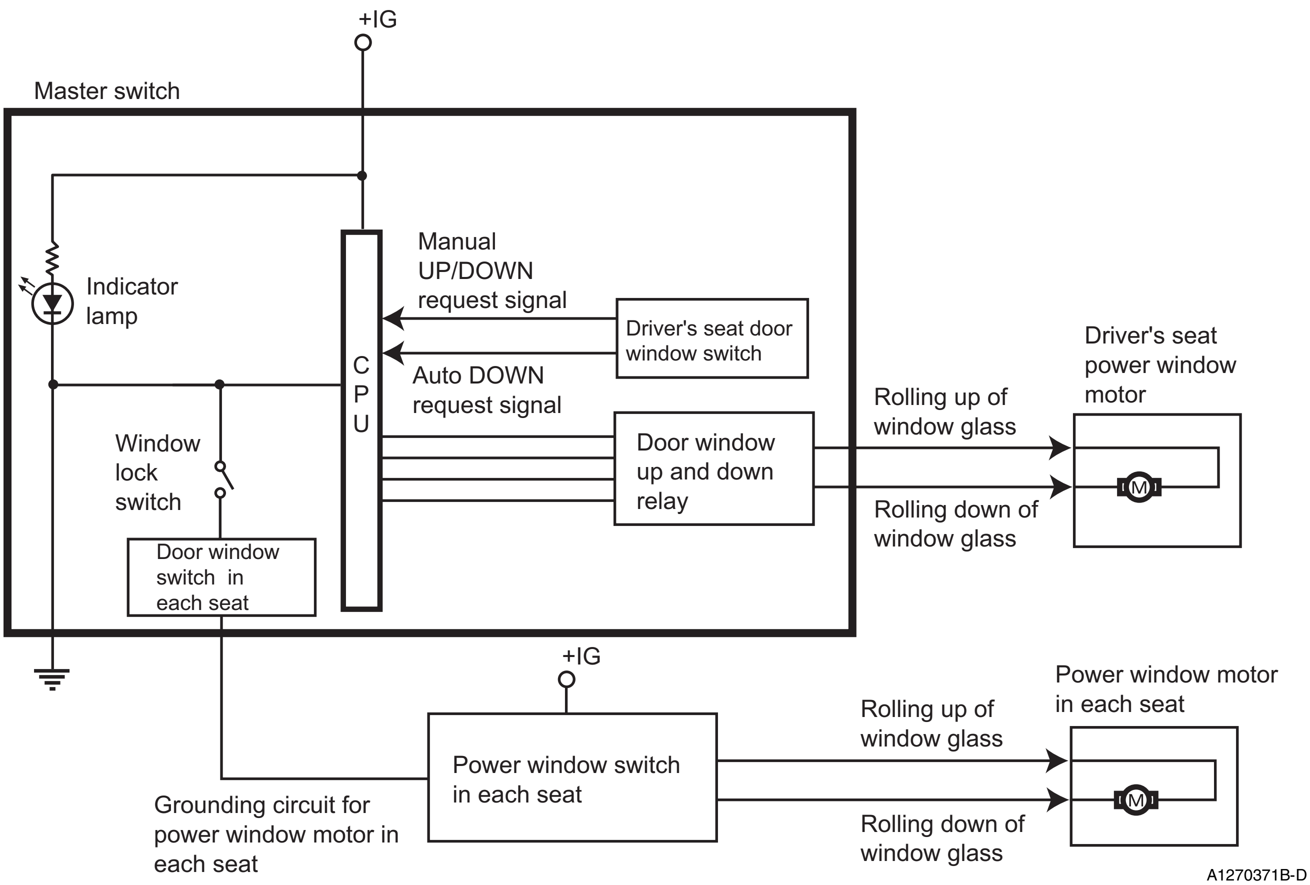


Table of functions of power window system

Functions	Description
Manual rolling up and down function	• Continues to roll up or down the window as long as the door window switch is lowered one notch and held in the Up position (pull) or the Down position (push).
One-touch automatic rolling down function	• Automatically rolls down the door window if the door window switch is lowered (pushed) two notches.
Window lock	• Prevents power window operation except the driver's door window when the master window lock switch is turned on (pushed).

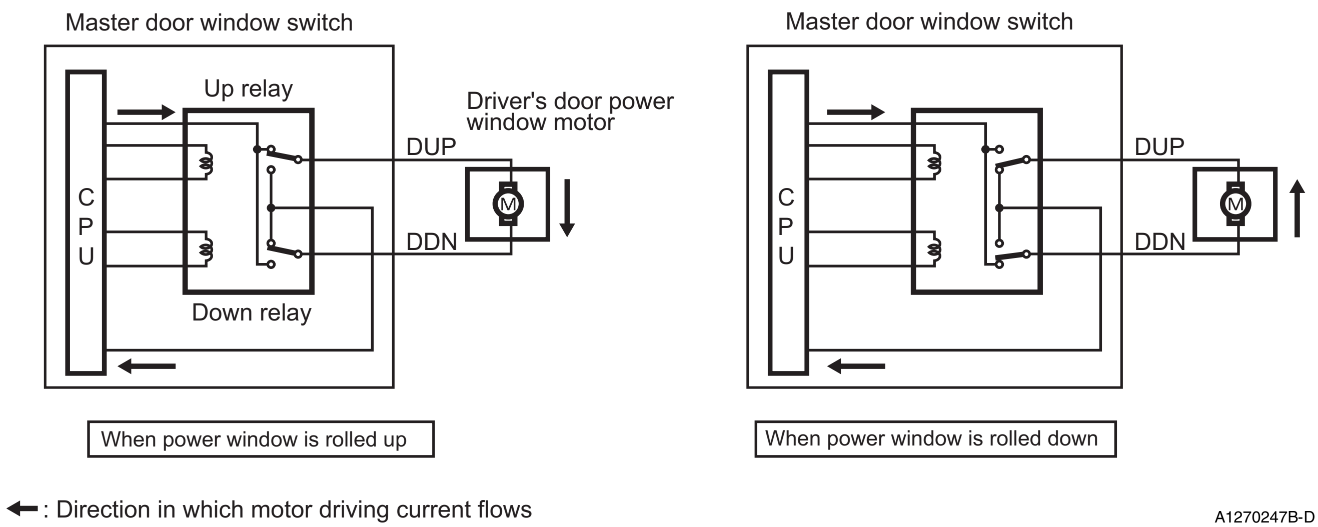
Manual Opening/Closing Operation of Window

Operation of driver's door power window

- If the driver's door window switch is operated to the up (down) side when the ignition switch is ON, the built-in CPU sends a manual Up (Down) signal to the Up (Down) relay to activate it.
- Then, the Down (Up) relay forms a grounding circuit and current flows from the Up (Down) relay through the power window motor and the Down (Up) relay to ground, with the result that the power window motor in each seat runs in the Up (Down) direction.
- If the CPU determines that the driver's door window switch is turned off, it deactivates the UP (Down) relay to stop the power window motor in each seat.

Operation of power windows other than driver's door window

- If the master door window switch or the door window switch in each seat is turned to the Up (Down) side, power is supplied from the IG + terminal to the power window motor to operate the power window.



Automatic Operation

Automatic operation by means of a door window switch

- If the driver's door window switch is lowered two notches when the ignition switch is ON, the built-in CPU receives signals indicating that the door window switch is turned to the Down position and the automatic operation switch is turned on. Then, the CPU activates the Down relay to run the power window motor like in a manual rolling down operation.

Canceling of automatic operation

- Automatic operation is canceled if one of the following conditions is satisfied.

Automatic operation canceling conditions

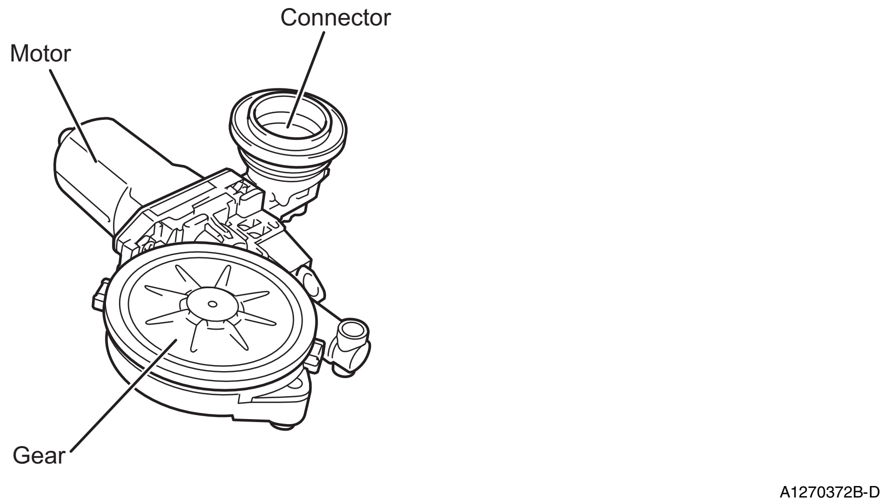
• It is determined that the door window is fully open. • The window switch is operated so as to move the window in the opposite direction.

Closing of Window Lock

- If the window lock switch is turned on, the grounding circuit for the power window in each seat is opened, preventing the operation of all window motors.

Power Window Motor Assembly

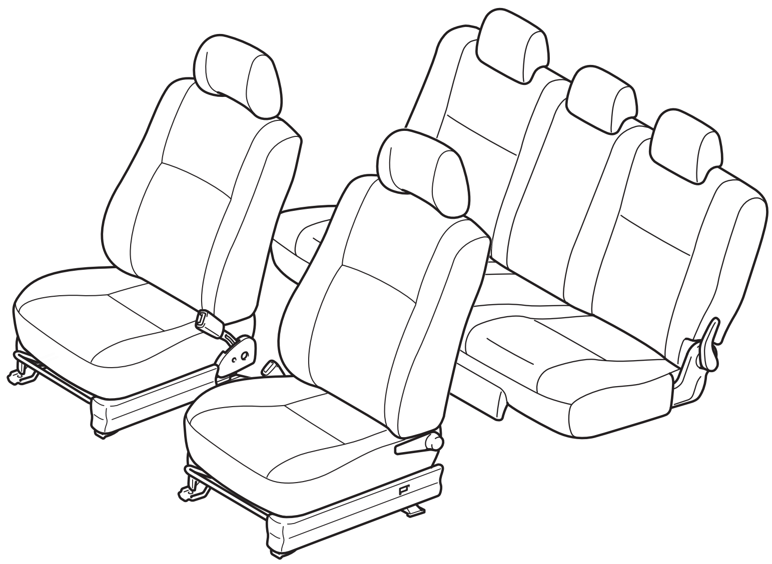
- Each power window motor assembly consists of a motor, a connector and gears.



SEAT

Seat Variations

- Manual seats and 6:4 split-folding seats are provided as front and rear seats, respectively.



Note: The illustration shows a representative example.

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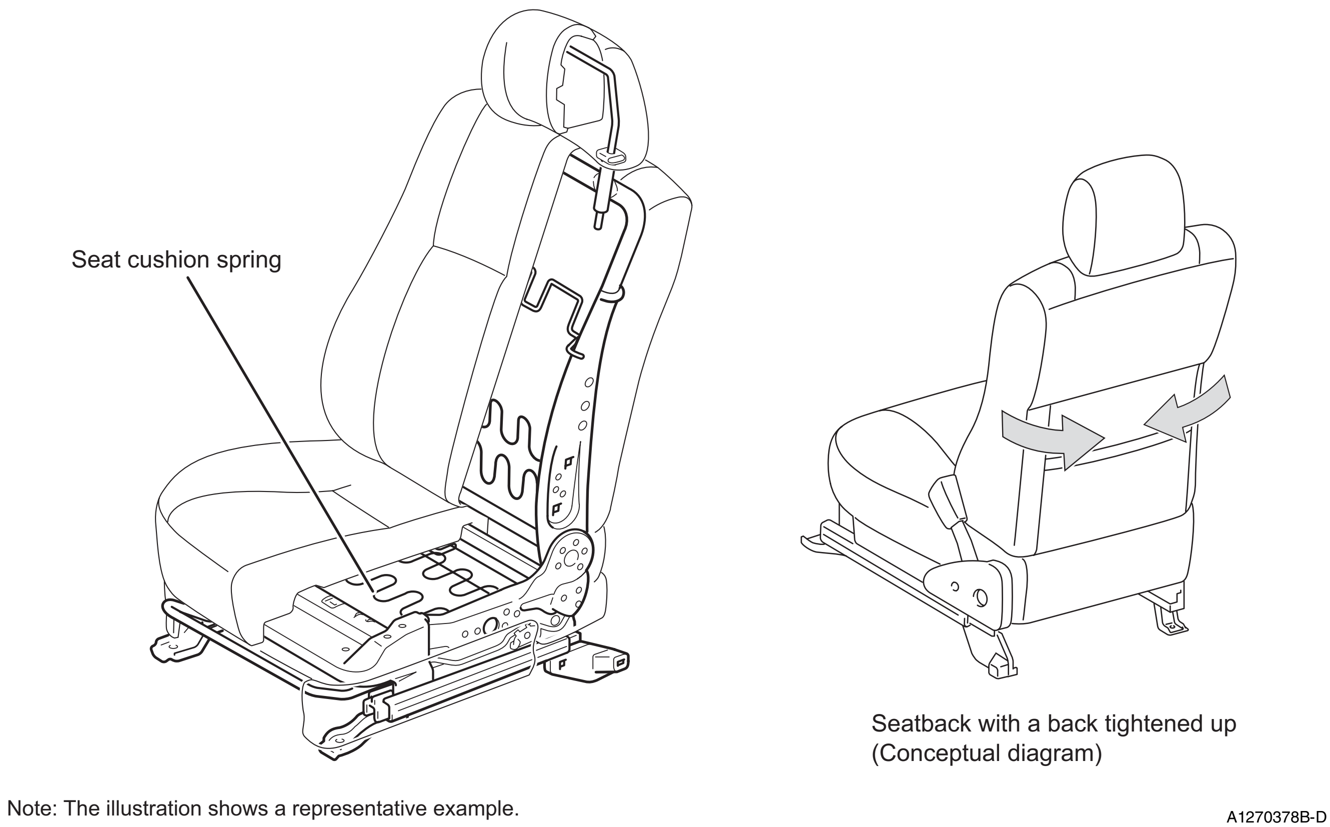
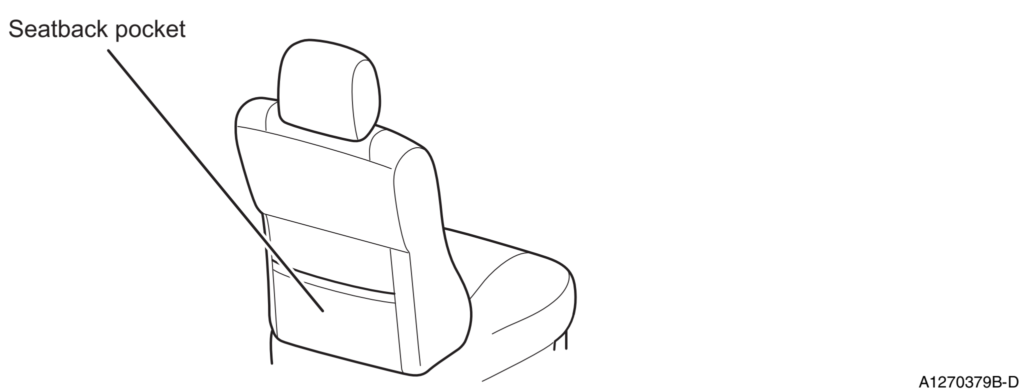
Front Seat

- Deeply contoured bucket seats capable of securely holding the occupant's body are employed to enhance the holding performance of the vehicle.
- Seatbacks with a tightened up back are employed to secure sufficient knee space for the passengers in the rear seats.
- S-type springs are used as cushion supports so that the seat cushions can absorb vibrations efficiently.
- Both the driver's seat and the front passenger seat are provided with seat sliding and reclining devices so that they can be adjusted to optimum positions.
- Seatbacks with a built-in SRS side airbag are provided for some models. For details, refer to “Outline of SRS side airbag and SRS curtain shield airbag - SRS side airbag” section. : 9-25



● The driver's seat and the front passenger seat are provided with seatback pockets to secure storage space.



Rear Seat

● Six-to-four split-folding rear seats with a tumbling mechanism are employed.

● The rear seat on each side has a saddle type headrest (vertically adjustable). A rear center seat with a saddle type headrest (vertically adjustable) is also provided for some models.

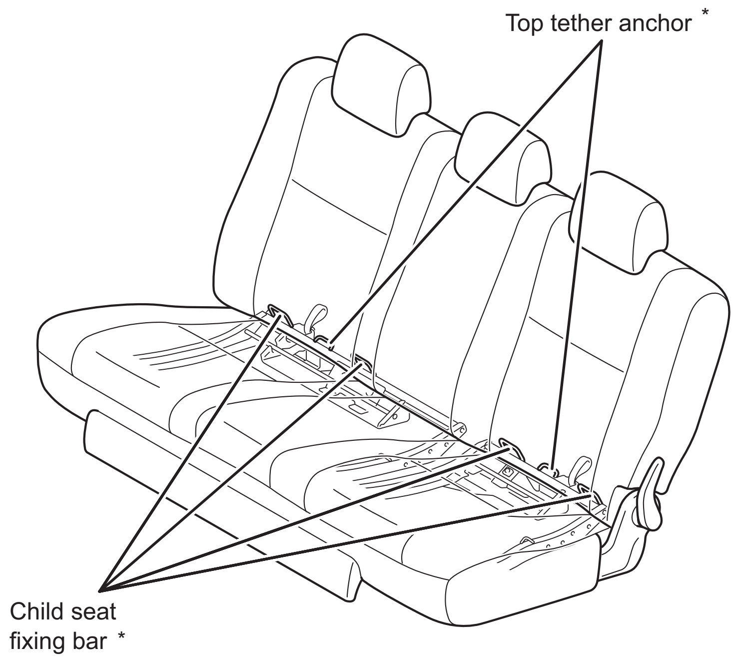
● The window-side rear seats of every European model are provided with ISO*FIX-compliant child seat fixing bars and top tether anchors. These fixing bars and anchors allow an ISOFIX-compliant child seat to be secured to the rear seat.

❖REFERENCE❖

* : International Organization for Standardization

✦ CAUTION ✦

Use an ISOFIX-compliant child seat that conforms to the safety standards for road transport vehicles when it is secured with the dedicated fixing bars provided for the vehicle.

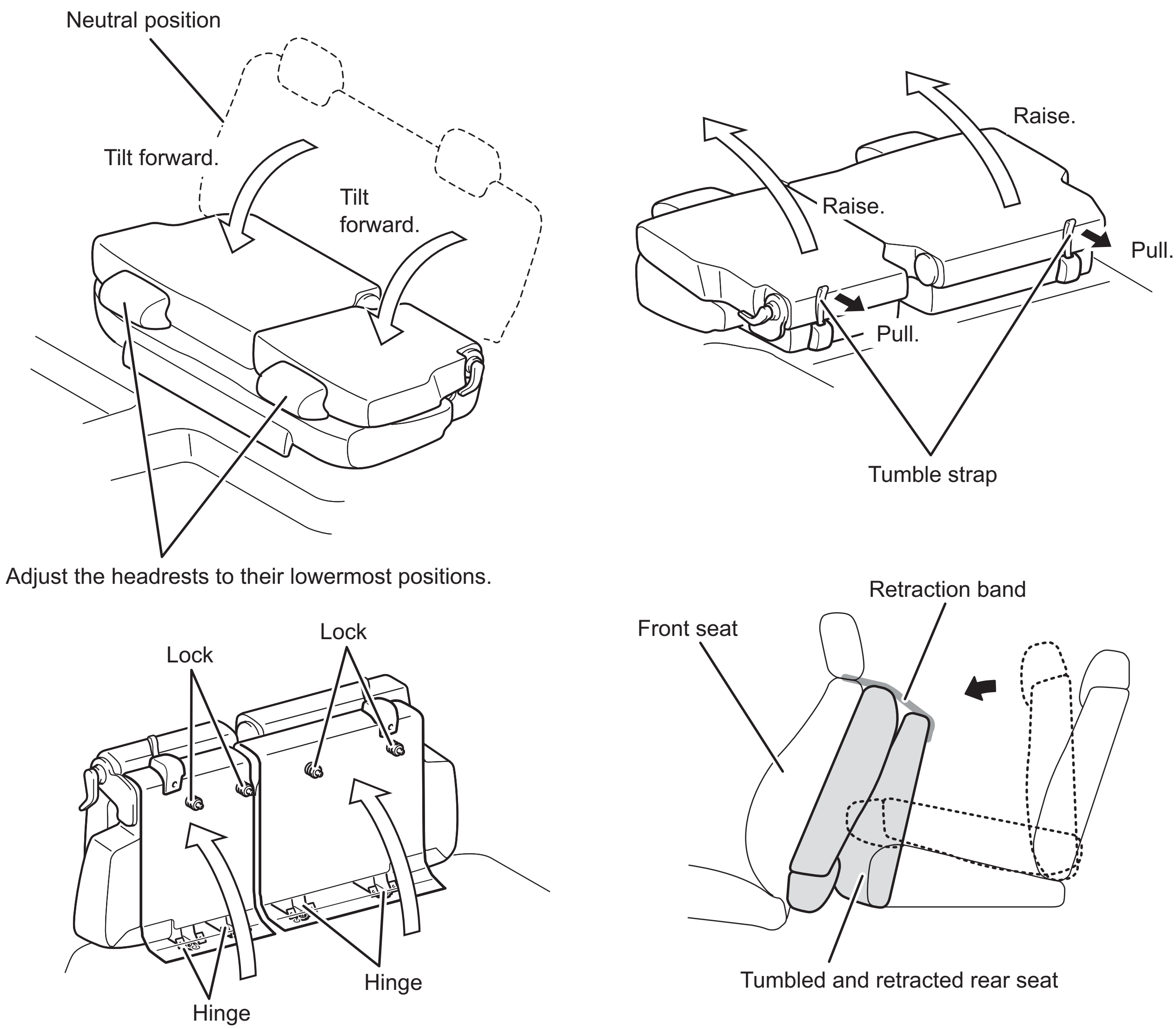


Tumbling Mechanism

- Each of the 6-to-4 split rear seats is provided with a tumbling mechanism to allow them to be tumbled individually.
- To tumble a seat, the seatback is first tilted forward with the reclining lever. Before the seat is tilted, the headrest needs to be adjusted to its lowermost position.
- Pulling the tumble strap on the seat placed this way releases the locks securing the rear end of the seat to the floor, allowing the rear end of the seat to be pulled up with the hinge as the point of support. The rear seat thus tumbled can be held in its retracted position by hooking the retraction band on the back of the rear cushion around the headrest of the front seat.

✦ CAUTION ✦

Return the rear seat by slowly lowering it to its original position with one hand while supporting it with the other hand making sure there is no person or luggage in the affected area that could be injured or damaged. After placing the seat in its original position, pull up its rear end (on each side) to make sure the seat is locked securely.



Note : The illustration shows a representative example.

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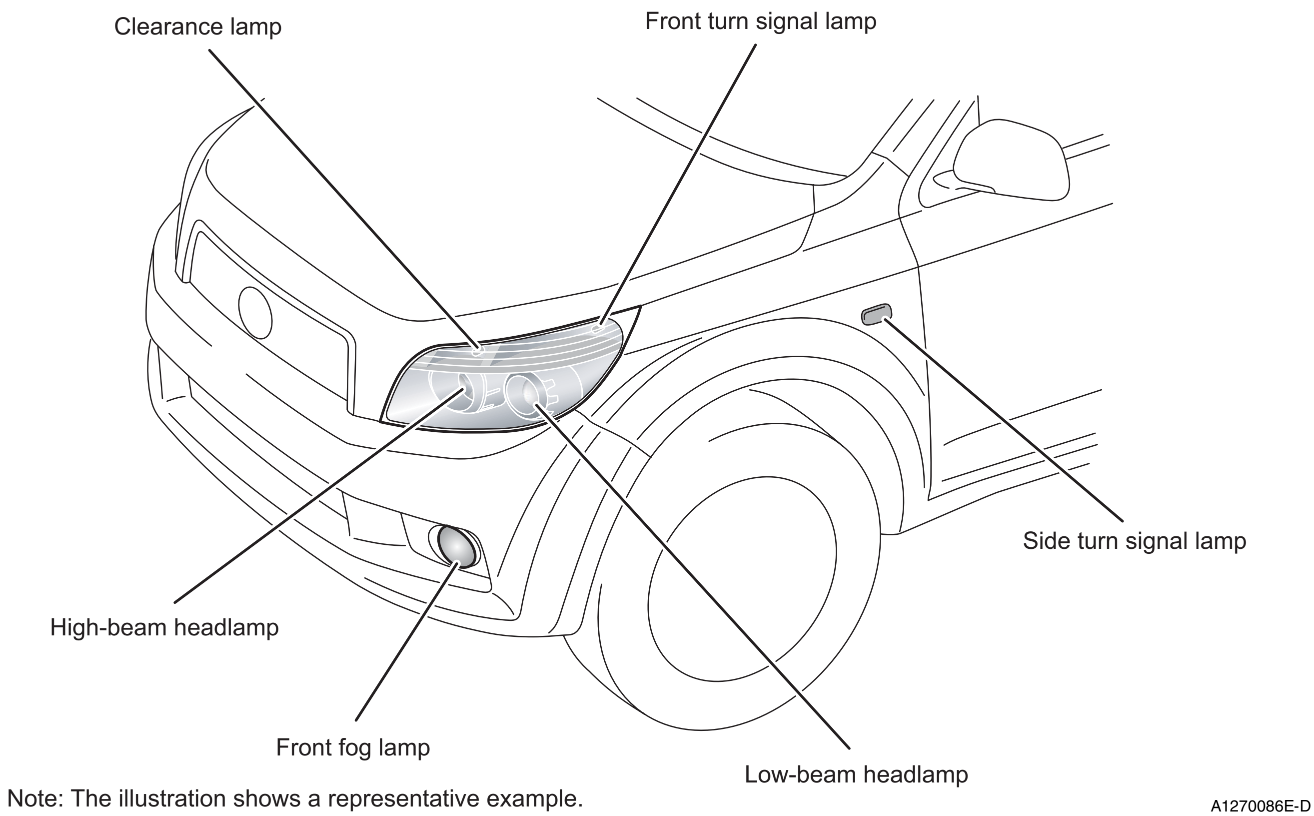
LIGHTING SYSTEM

Outline of Front Lamps

- A dedicated four-headlamp system or a dedicated two-headlamp system is provided. A clearance lamp and a front turn signal lamp are placed behind each headlamp lens.
- Front fog lamps that can be mounted in the front bumper are optionally available.
- Turn signal lamps are incorporated into the front fenders.

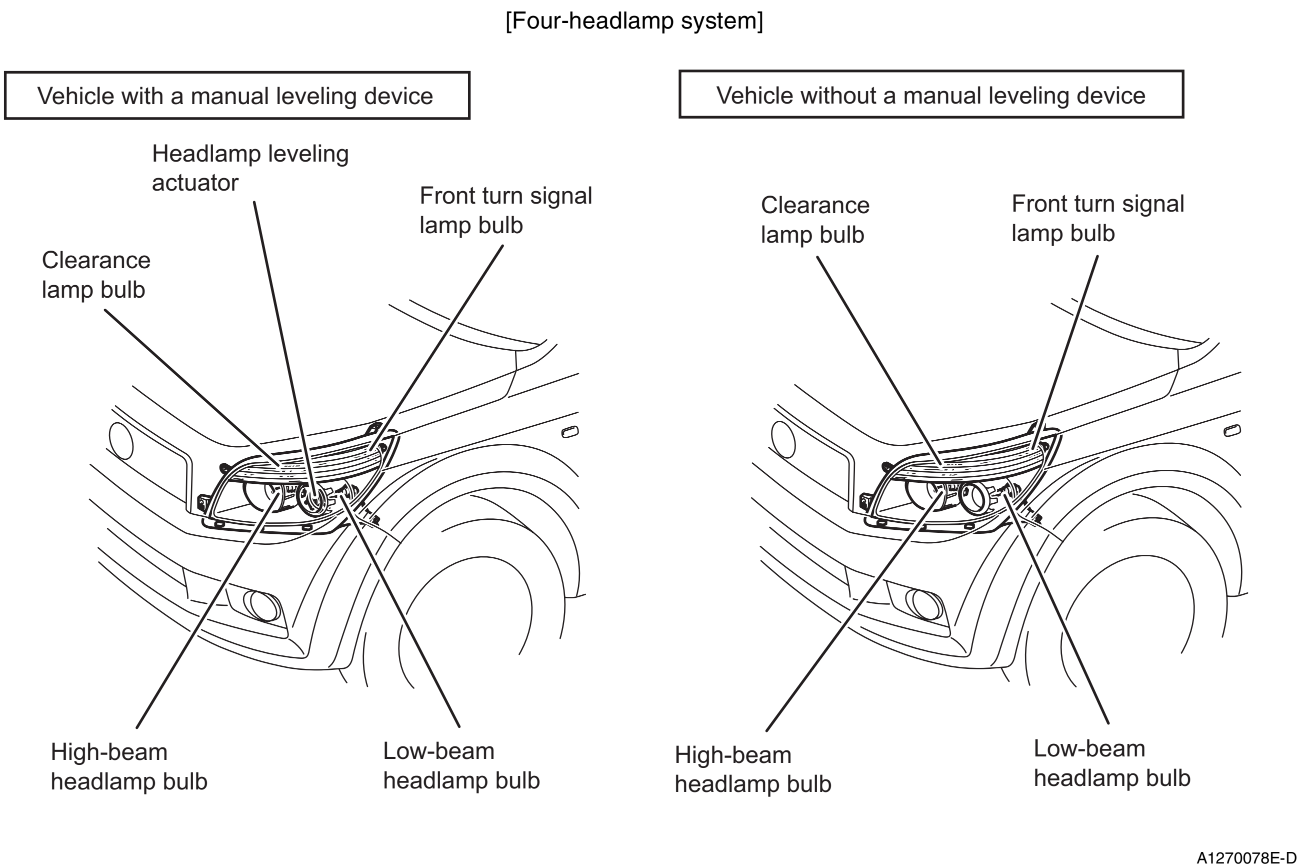


Headlamps (Halogen Type)

- A dedicated and perfectly integrated two-headlamp system or a dedicated four-headlamp system with low-beam projectors are provided.
- A front turn signal lamp and a clearance lamp are also mounted behind each headlamp lens.
- An actuator for manual leveling is mounted on the back of each headlamp body.*

❖REFERENCE❖

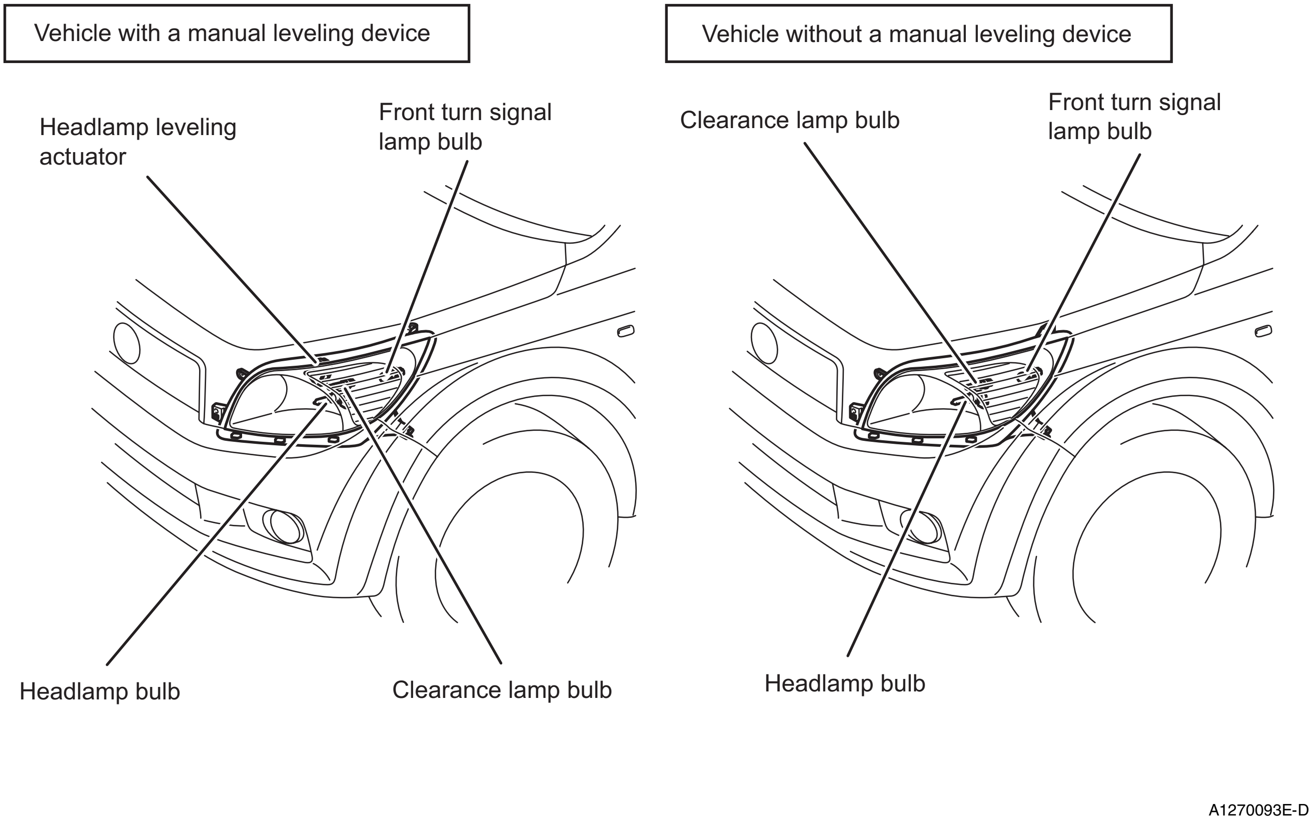
* : Only for European models



Four-headlamp (halogen) system specifications

Lamp name	Electric bulb specifications
Low-beam headlamp	12 V 55 W: H11
High-beam headlamp	12 V 60 W: HB3
Clearance lamp	12 V 5 W
Front turn signal lamp	12 V 21 W

[Two-headlamp system]

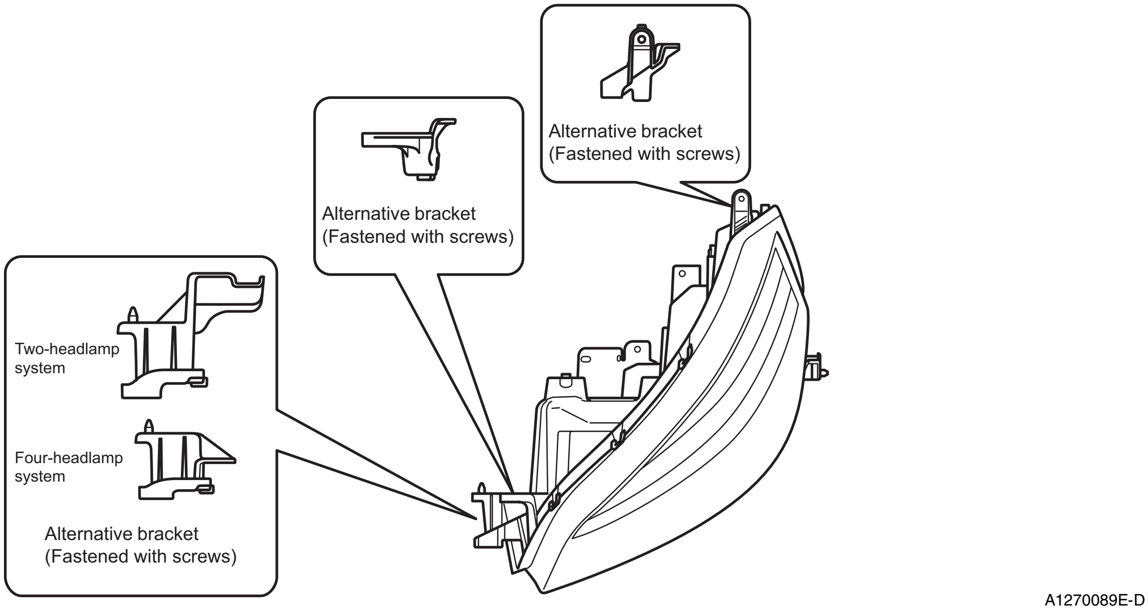


Two-headlamp system (halogen) specifications

Lamp name	Electric bulb specifications
Headlamps	12 V 60/55 W: H4
Clearance lamp	12 V 5 W
Front turn signal lamp	12 V 21 W

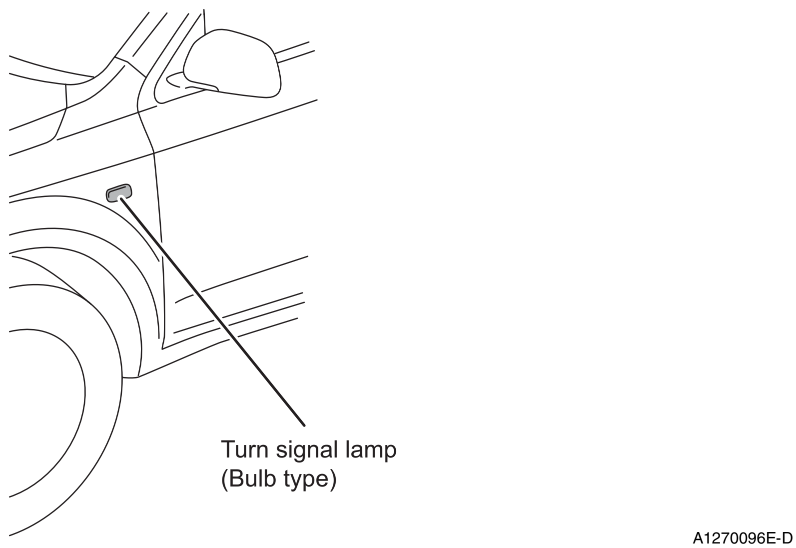
Minor Collision-Proof Headlamps (Alternative Bracket)

- Damage that is limited to the headlamp mounting bracket in a minor collision or other accident can be repaired by simply replacing the damaged bracket with an alternative bracket. The alternative bracket eliminates the need to replace the entire headlamp and thus helps cutting repair cost.



Side Turn Signal Lamp

● Electric bulb type side turn signals are employed and incorporated into the front fenders.

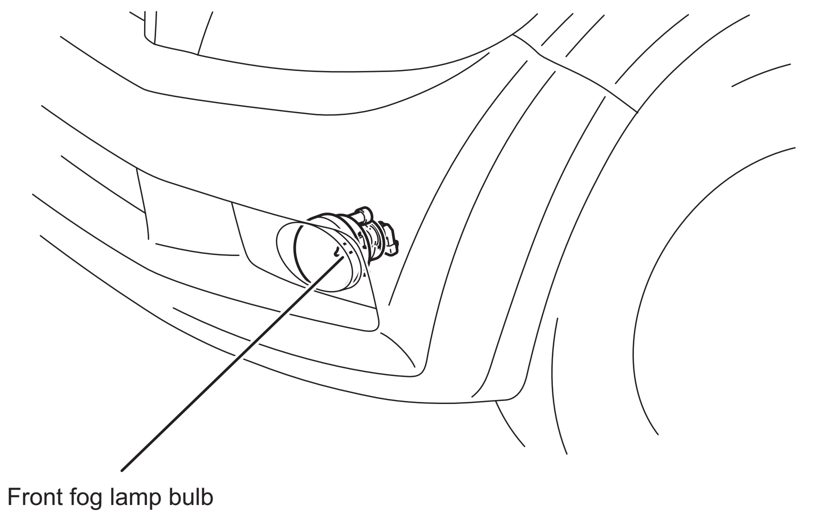


Side turn signal lamp specifications

Lamp name	Electric bulb specifications
Side turn signal lamp (bulb)	12 V 5 W

Front Fog Lamps

● Round front fog lamps are optionally available. They can be mounted on both sides of the front bumper.



Front fog lamp specifications

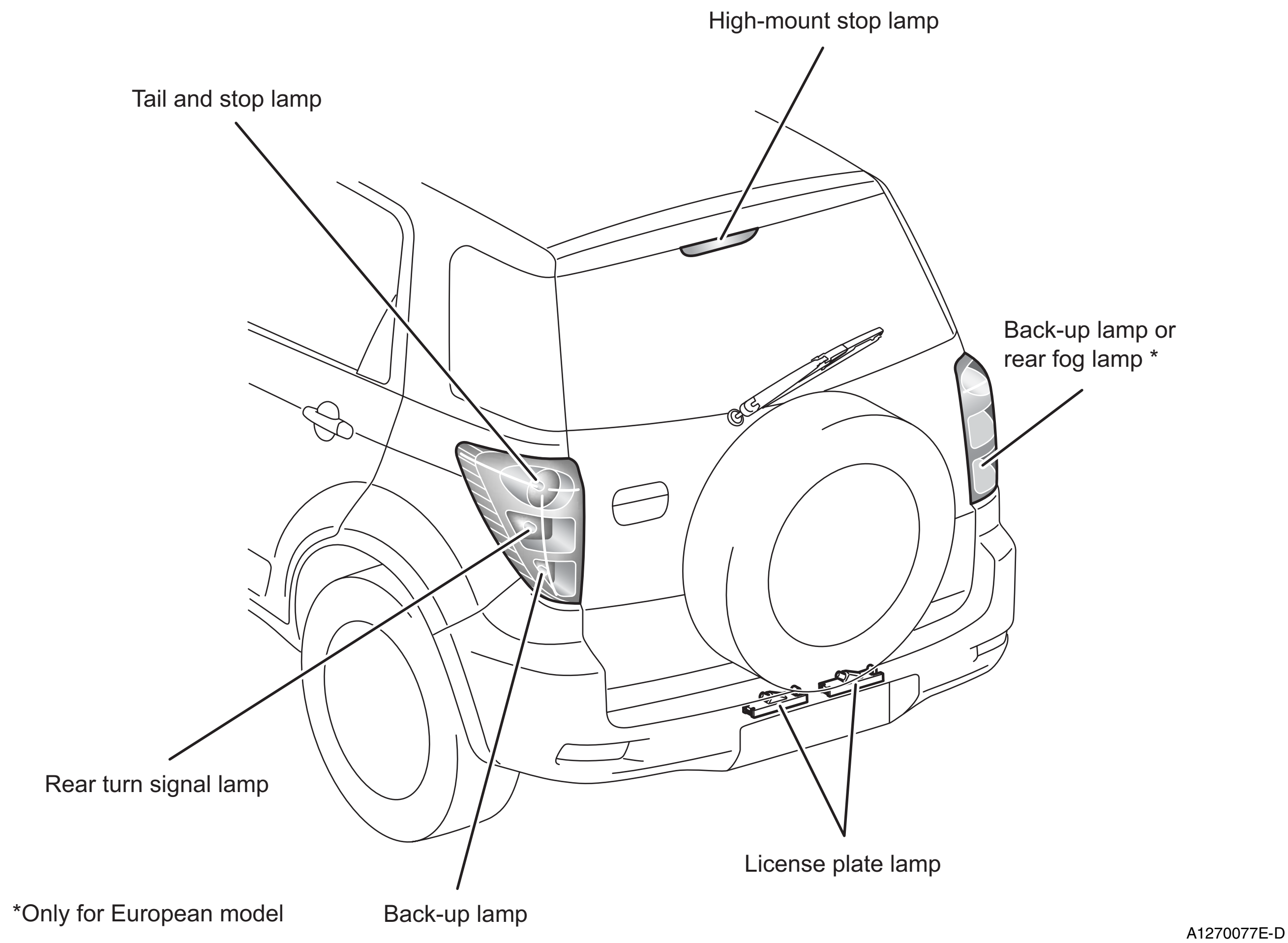
Lamp name	Bulb type
Front fog lamp	12 V 35 W: H8

Outline of Rear Lamps

- A combination lamp unit consisting of a tail and stop lamp and a rear signal lamp mounted in the same housing is employed and placed in each quarter panel.
- To ensure rear visibility in heavy weather, a rear fog lamp is provided as standard equipment for each rear combination lamp unit. *1
- An electric bulb type high-mount stop lamp designed to be mounted on the top of the back door is optionally available. *2
- Downward illumination type license plate lamps (two lamps) is provided for every model.

❖REFERENCE❖

*1 : Only for European models
*2 : Provided as standard equipment for European models

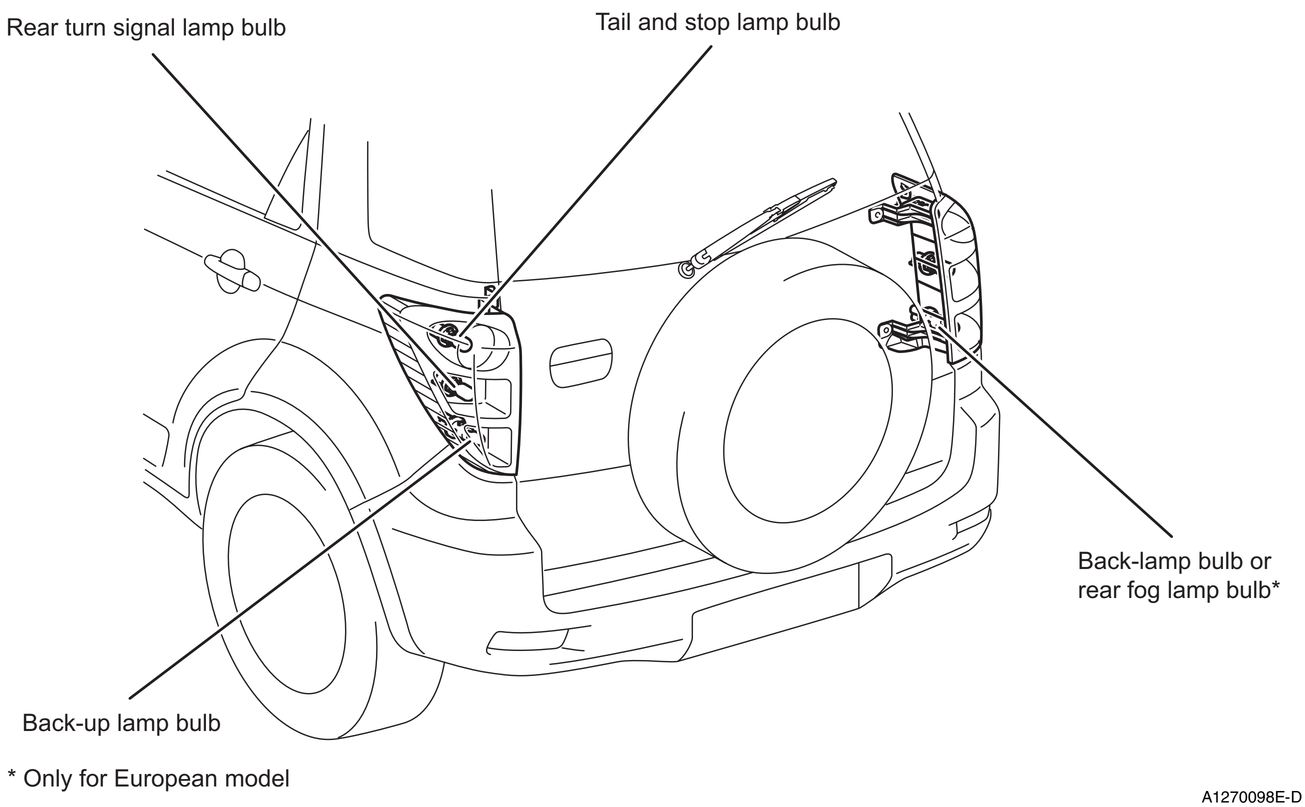


Rear Combination Lamps

- Each rear combination lamp consists of a tail and stop lamp, a rear turn signal lamp and a back-up lamp.
- The rear combination lamp on the right side of the vehicle when viewed from behind is provided with a rear fog lamp, in addition to a tail and stop lamp, a rear turn signal lamp and a back-up lamp. *
- The rear combination lamps are entirely aluminum-evaporated to give them a high-grade appearance.

❖REFERENCE❖

* : Only for European models



Rear combination lamp specifications

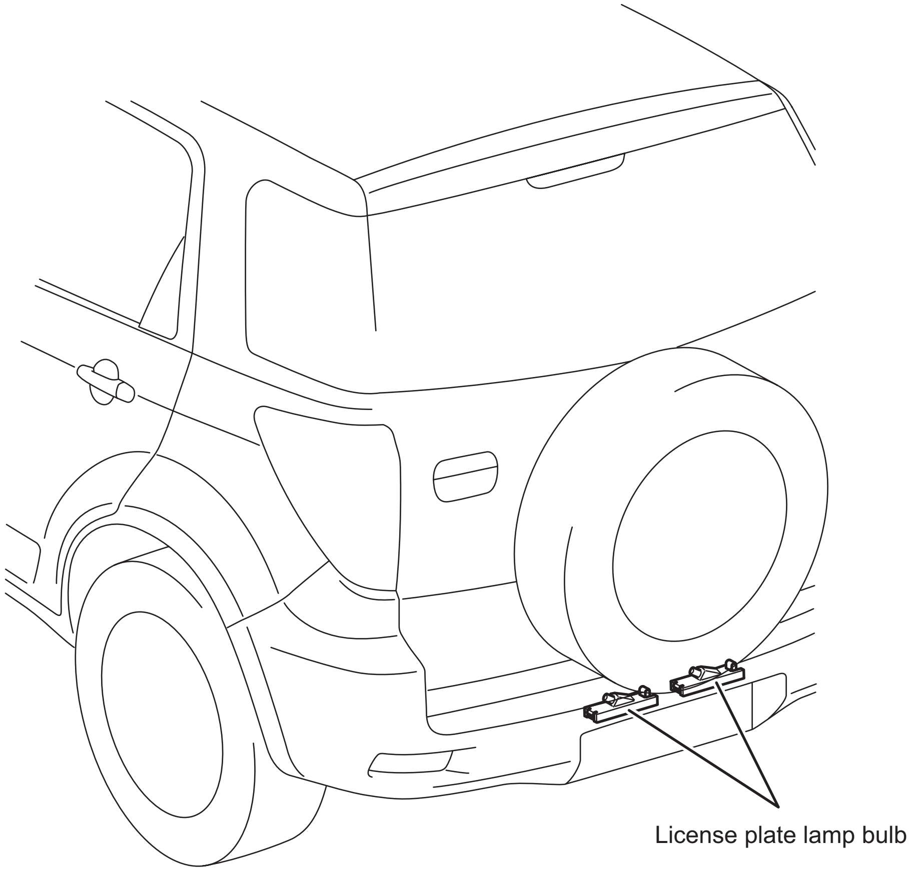
Lamp name	Electric bulb specifications
Tail and stop lamp	12 V 21/5 W
Rear turn signal lamp	12 V 21 W: Amber
Backup lamp	12 V 16 W
Rear fog lamp*	12 V 21 W

❖REFERENCE❖

* : Only for European models

License Plate Lamp

● Downward illumination lamps are provided for the license plate. They are mounted in the rear bumper. (Two-lamp type)



Note: The illustration shows a representative example.

A1270076E-D

License plate lamp specifications

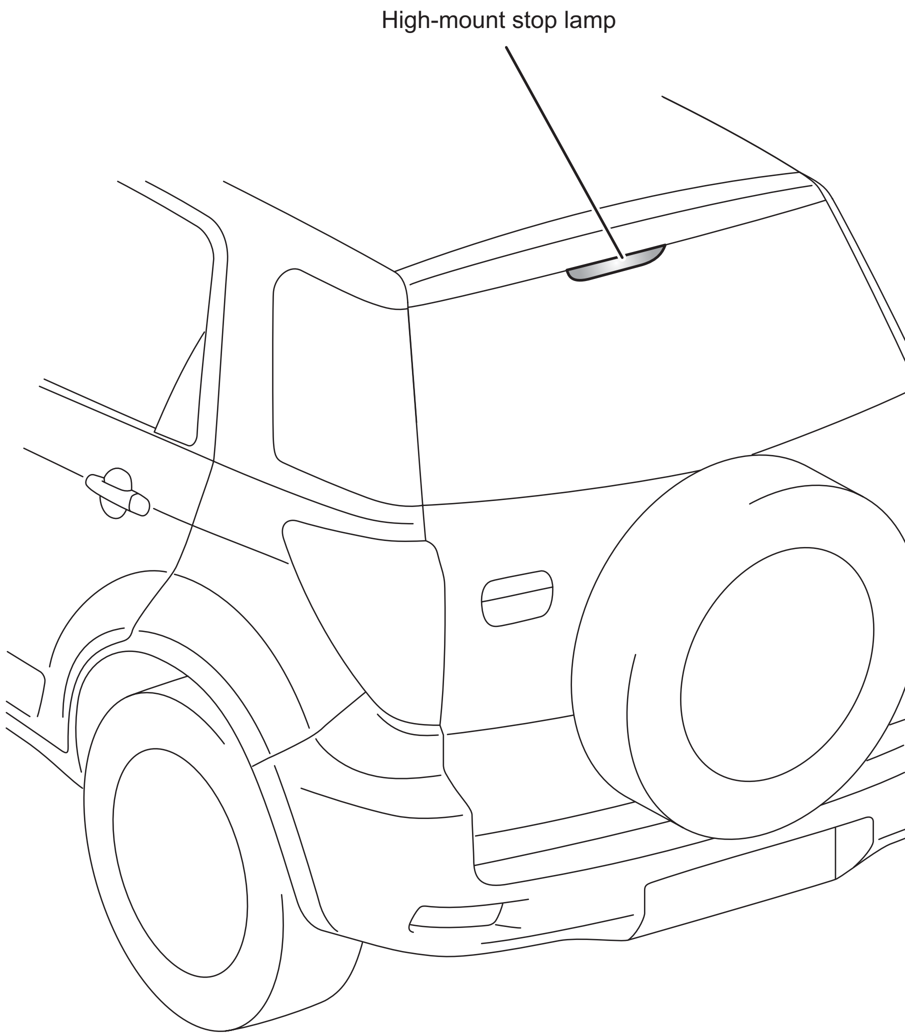
Lamp name	Electric bulb specifications
License plate lamp	12 V 5 W

High-Mount Stop Lamp

- An electric bulb-type (one bulb) high-mount stop lamp, which is designed to be mounted on the top of the back door (interior side), is optionally available.

❖ REFERENCE ❖

* : Provided as standard equipment for European models



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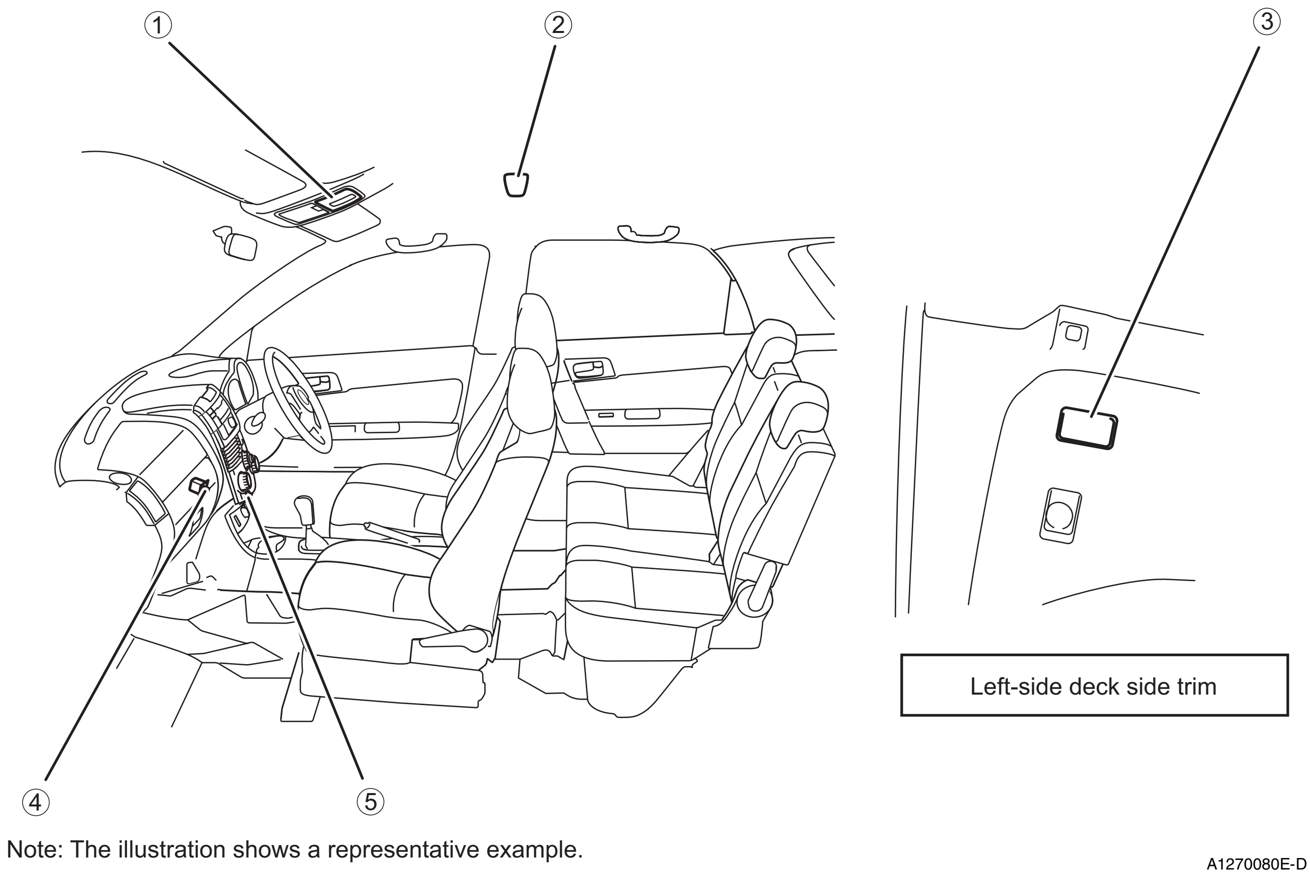
High-mount stop lamp specifications

Lamp name	Electric bulb specifications
High-mount stop lamp	12 V 16 W

Interior Lamps

- Interior lamps include a front interior lamp or a room and map lamp, a ceiling lamp and a luggage compartment lamp.
- The front interior lamp or the interior and map lamp has an interior lamp timer function. To improve convenience, the switch is so designed that turning it to the DOOR position starts the illuminated entry control system.
- A glove box lamp is optionally available.
- A floor shift console illumination unit is optionally available.



Interior lamp specifications

No.	Lamp name	Electric bulb specifications	No.	Lamp name	Electric bulb specifications
1	Front interior lamp*	12 V 10 W	3	Luggage compartment lamp	12 V 5 W
	Interior and map lamp*	12 V 8 W	4	Glove box lamp*	LED Amber
2	Ceiling lamp	12 V 8 W	5	Floor shift illumination*	LED Amber

❖REFERENCE❖

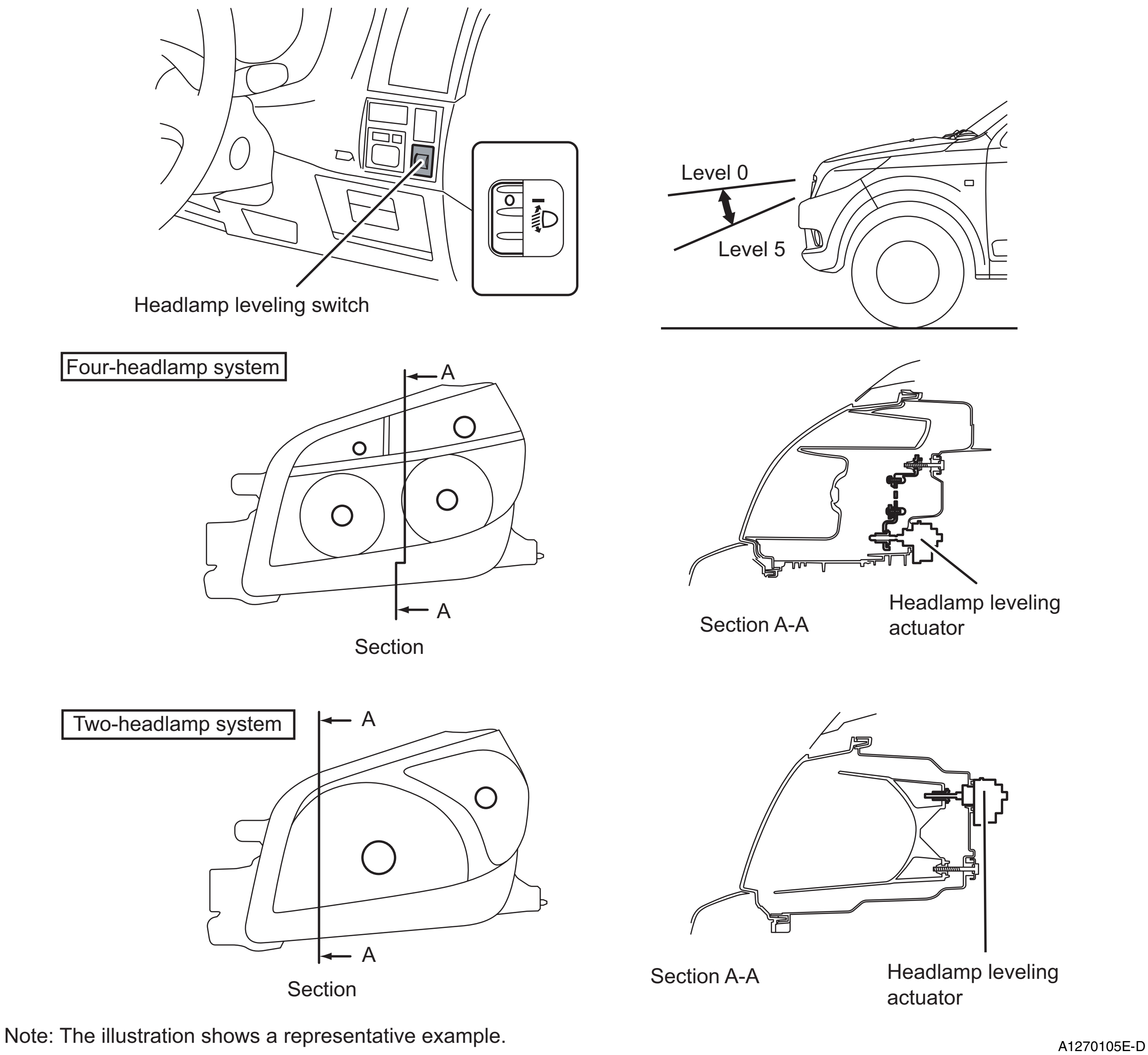
* : Vary from model to model.

Manual Leveling Function

- A leveling switch allowing the driver to adjust the optical axes of the headlamps vertically from the passenger compartment according to the change in vehicle posture cause by loading etc. is provided for some models to prevent the headlamps from dazzling the drivers of on-coming vehicles or vehicles ahead. *
- Under the control of vehicle state signals from the headlamp leveling switch (level 0: highest position, level 5: lowest position), each head-lamp actuator changes the orientation of the reflector vertically to adjust its optical axis. The headlamp leveling switch should be set to 0 when adjusting the optical axis of each reflector. *
- The headlamp leveling switch is mounted on the instrument panel finisher lower panel, on the driver's seat side, and a headlamp leveling actuator is mounted at the back of each headlamp body.*

❖REFERENCE❖

* : Only for European models

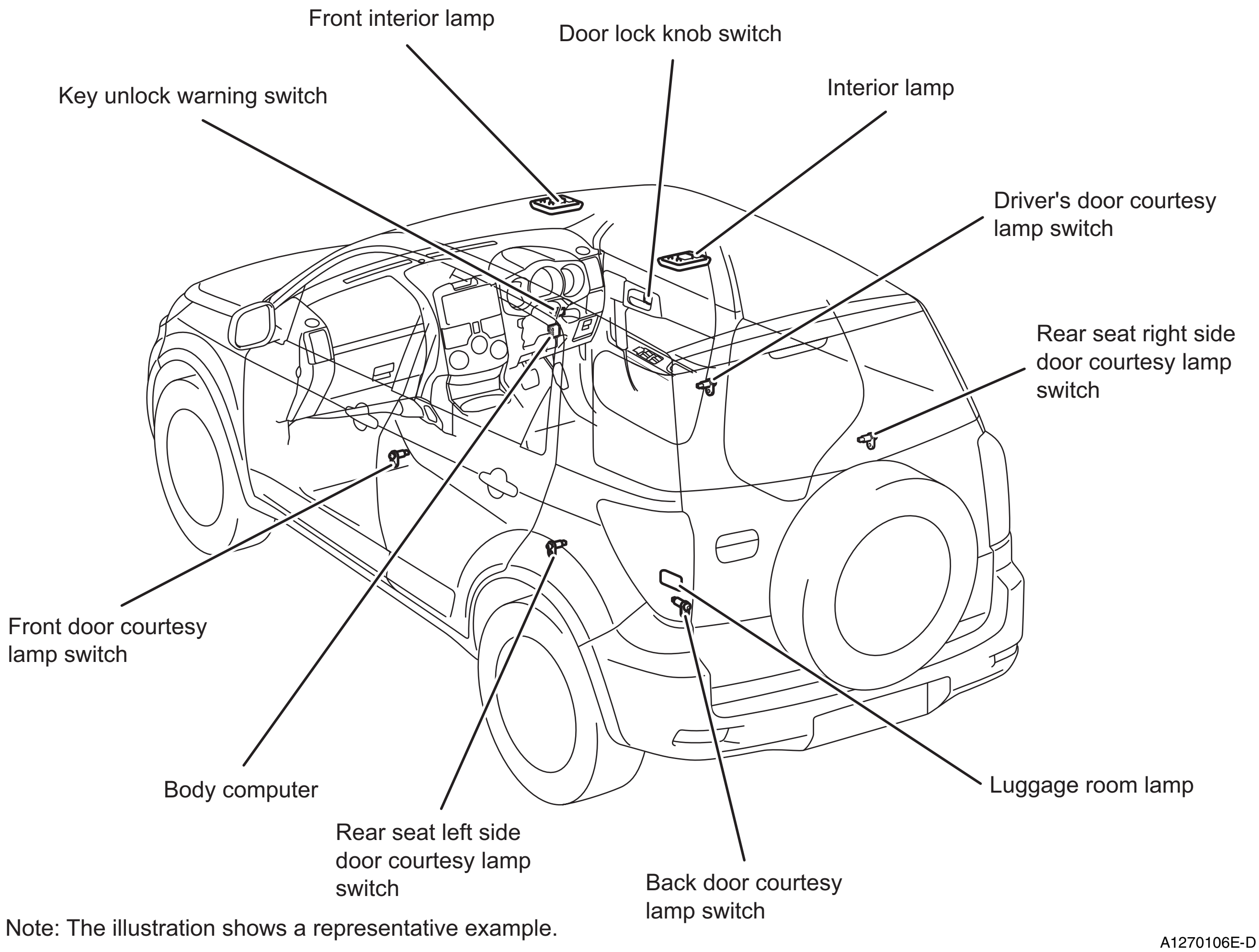


Illuminated Entry System

- An illuminated entry system that holds the front interior lamp lit for about 15 seconds after a door is closed is provided as standard equipment for all models.
- Locking the driver's door while the illuminated entry system is activated dims the lamp by 50% for about 3 seconds and then fades out.
- A door lock lamp control unit that holds the front interior lamp lit for about 15 seconds after the driver's door is unlocked with the door lock knob, ignition switch or transmitter* is provided as standard equipment for all models.
- A battery saver function that automatically turns off the front interior lamp about 10 minutes after the ignition switch is turned off, even though a door is half-open or fully open, is provided as standard equipment for all models.

❖REFERENCE❖

* : Vary from model to model.



Illuminated Entry System Control Function

- The illuminated entry system operates, as described in the table below.

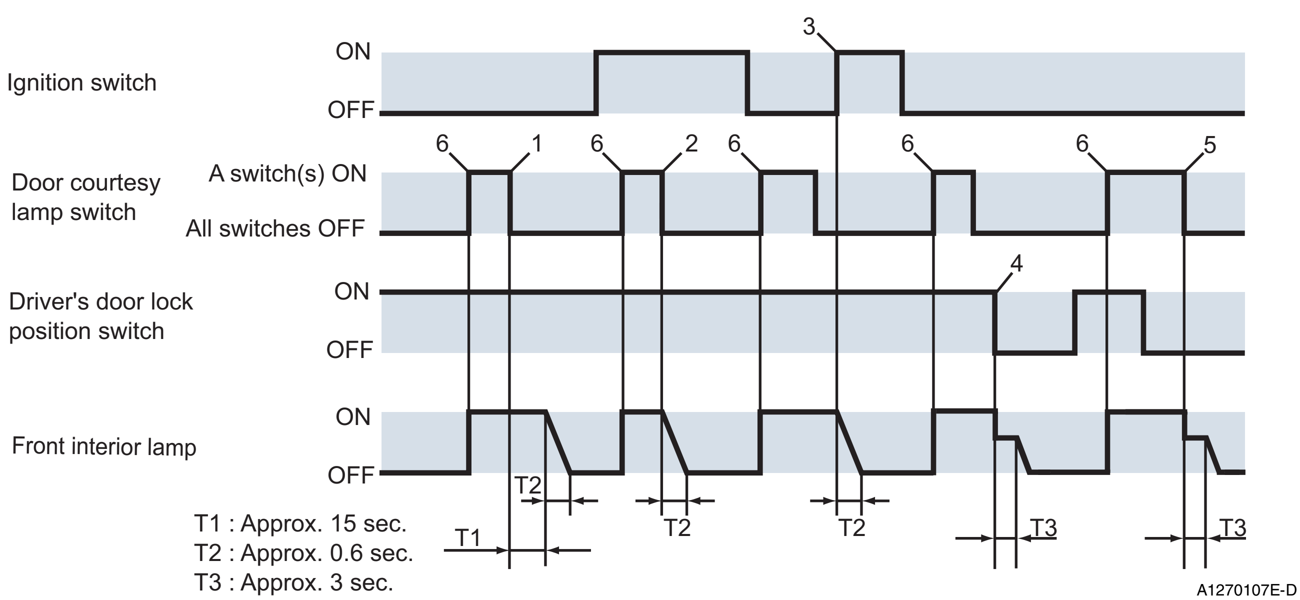


Table of operations of illuminated entry system

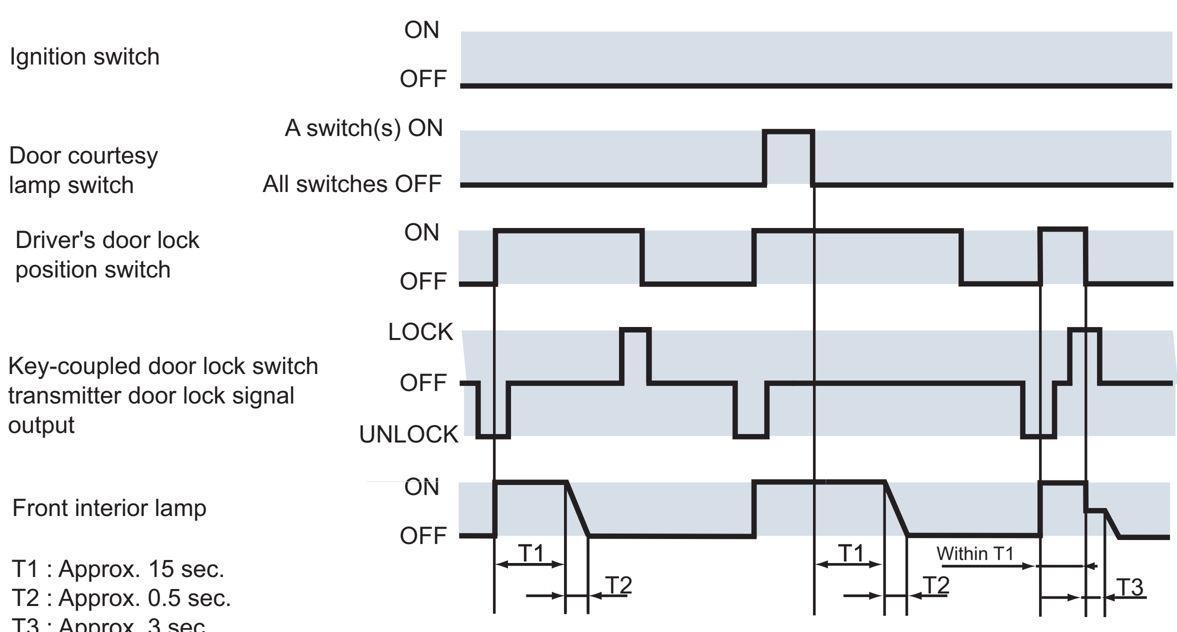
No.	Vehicle condition	ON/OFF state of lamp
1	Closing a door when the ignition switch is in the OFF position.	Goes out (fades out) after 15 seconds.
2	Closing a door when the ignition switch is in the ON position.	Goes out (fades out) immediately.
3	Closing all doors when the ignition switch is in the OFF position and the front interior lamp is held ON by the timer.	Goes out (fades out) immediately.
4	Closing all doors and locking the driver's door when the ignition switch is in the OFF position and the timer keeps the front interior lamp ON.	Door lock lamp control starts.
5	Closing all doors with the keyless lock unit when the ignition switch is in the OFF position and one door is open.	Door lock lamp control starts.
6	A door is opened, no matter whether the ignition switch is in the ON or OFF position.	Lights.

Door Lock Lamp Control Function

- If the driver's door is unlocked with the door lock knob, door key or transmitter* when all doors are closed and the ignition switch is in the OFF position, this function turns on and holds the front interior lamp lit for about 15 seconds.
- Opening or closing a door when the lamp is lit by the door lock lamp control function switches lamp control from door lock lamp control mode to illuminated entry control mode.
- Locking the driver's door with the door lock knob, door key, or transmitter* when illuminated entry control is performed dims the front interior lamp by 50% for 3 seconds and then fades out.

❖ REFERENCE ❖

* : Vary from model to model.



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Battery Saver Control Function

- The battery saver operates, as described in the table below.

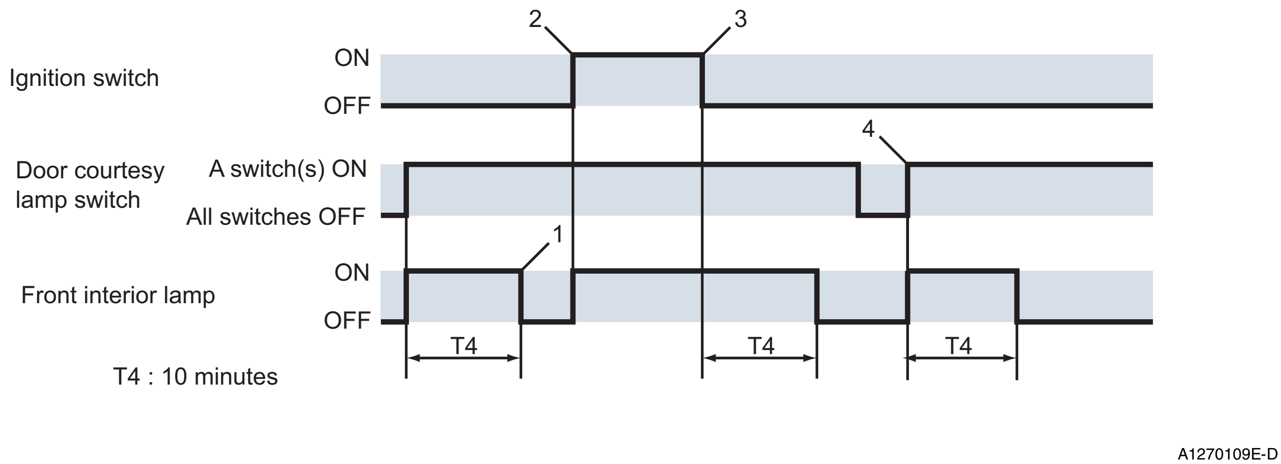
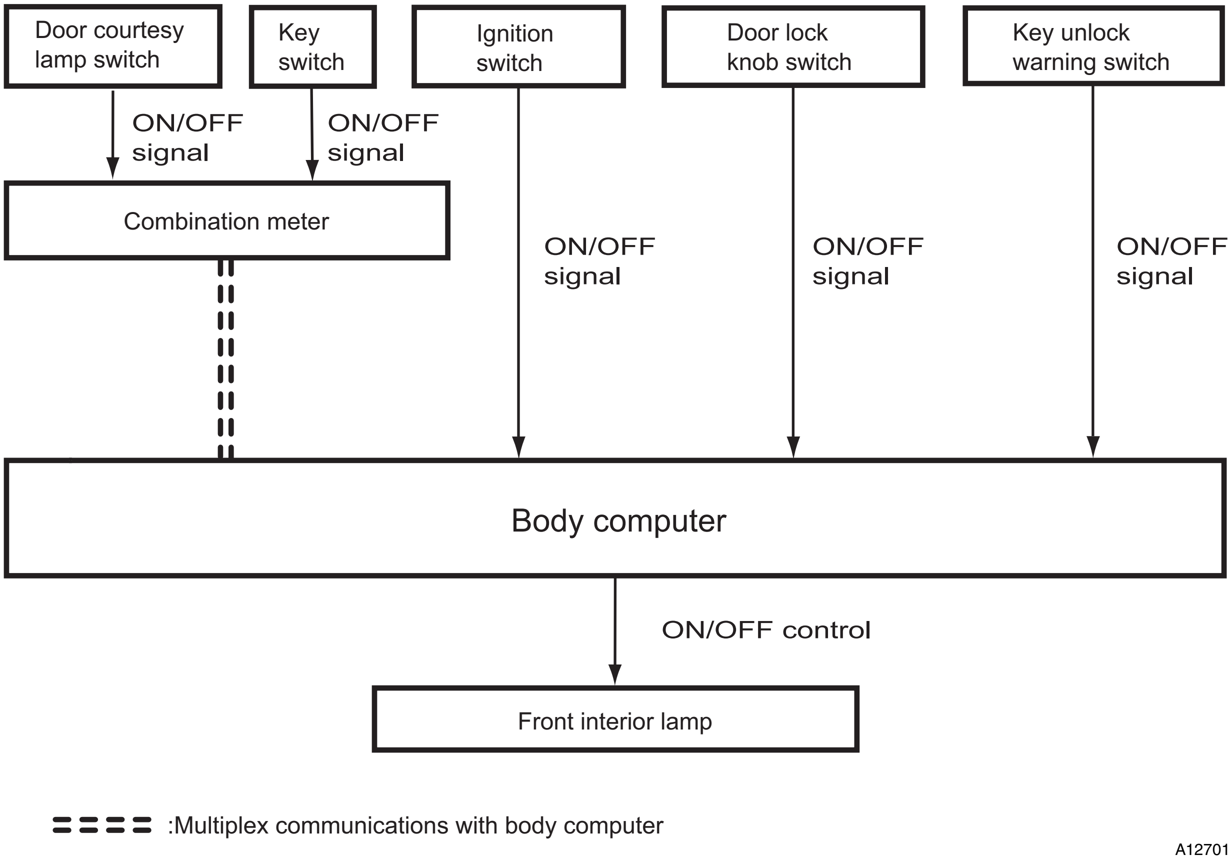


Table of operations of battery saver

No.	Vehicle condition	ON/OFF state of lamp
1	A door is half or fully open when the ignition switch is in the OFF position.	Goes out after 10 minutes.
2	Turning on the ignition switch in the condition described in 1 above (door half or fully open).	Lights.
3	Turning the ignition switch off in the condition described in 2 above (door half or fully open).	Goes out after 10 minutes.
4	Opening a door when all doors have been closed after the battery saver turns off the lamp.	Goes out after 10 minutes.

Actuation of Illuminated Entry System

- The front interior lamp is turned on and off by the integration relay that operates under the control of signals from the illuminated entry control system, the door lock lamp control unit and the battery saver.

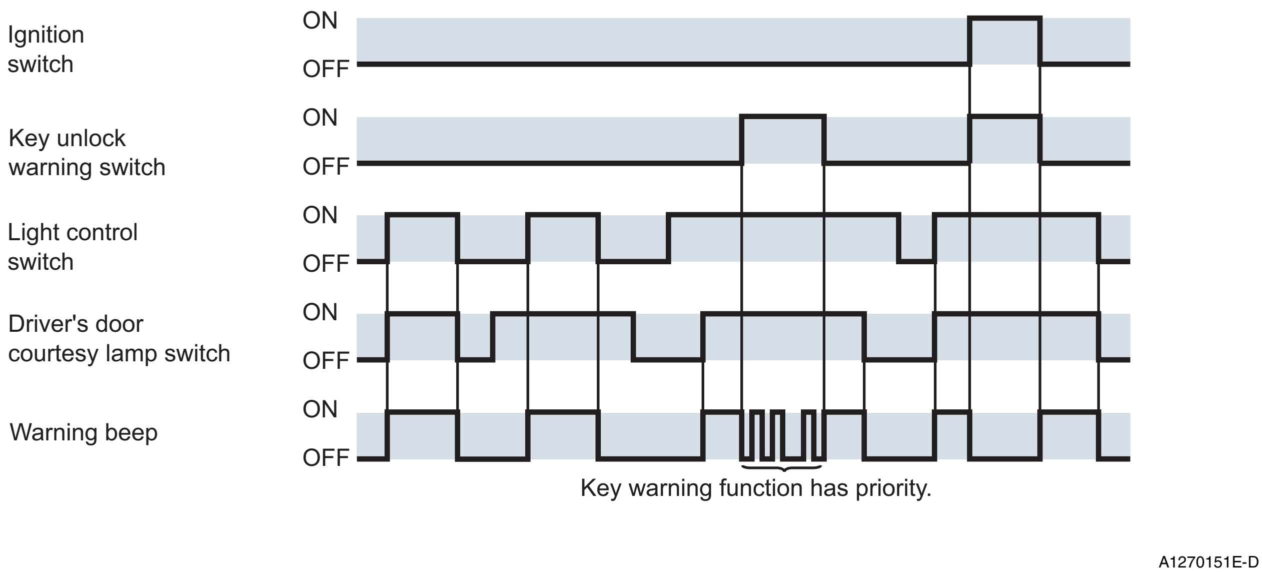


Lamp Warning System

- A lamp warning system is provided as standard equipment for every model. If a door is opened when the headlamps or the tail lamps are ON while the ignition switch is in the OFF position, the lamp warning system sounds a buzzer to remind the driver to turn off the lamps.
- A circuit for controlling the system is incorporated into the meter computer in the combination meter, and a multi-purpose buzzer that sounds warning beeps is also built into the combination meter.

Function of Lamp Warning System

- If the driver's door is opened (the driver's door courtesy lamp switch is turned on) when the headlamps or the tail lamps are ON while the ignition switch is in the OFF position, the lamp warning buzzer sounds a continuous beep to prompt the driver to turn off the lamps.
- The lamp warning buzzer stops sounding if the lamps are turned off or the driver's door is closed.
- If the ignition key is inserted (the key unlock warning switch is turned on) when the headlamps or the tail lamps are ON, priority is given to the key warning (reminder) system over the lamp warning system. Under these circumstances, the buzzer sounds short beeps intermittently at 0.5-sec. intervals.



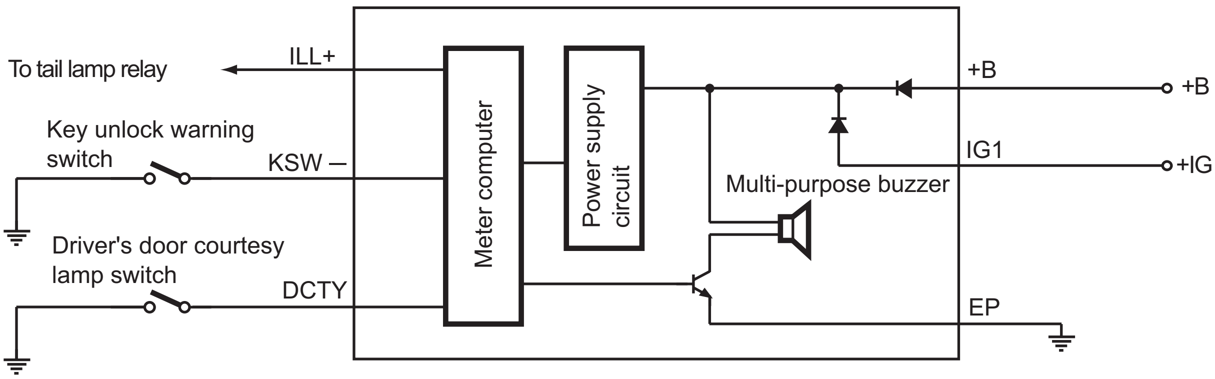
Actuation of Lamp Warning System

When the ignition key is not inserted

- If the headlamps or the tail lamps are ON when the ignition key is not inserted, the meter computer receives a tail lamp ON signal from the ILL + terminal, an IG OFF signal from the IG1 terminal, and a key unlock warning switch OFF signal from the KSW - terminal.
- If the driver's door is opened (the driver's door courtesy lamp is turned on) under these conditions, the DCTY terminal sends a driver's door courtesy lamp switch ON signal to the meter computer, which in turn makes the buzzer sound a continuous beep.
- The meter computer turns off the buzzer if the lamps are turned off (a tail lamp OFF signal is put out) or the driver's door is closed (a driver's door courtesy lamp switch OFF signal is put out).

When the ignition key is inserted

- If the headlamps or the tail lamps are ON when the ignition key is inserted, a tail lamp ON signal and an IG OFF signal are sent to the meter computer, just as in the above case where the ignition key is not inserted. Under these conditions, however, the key unlock warning switch turns on, and therefore the KSW - terminal sends a key unlock warning switch ON signal to the meter computer.
- If the driver's door is opened (the driver's door courtesy lamp is turned on) under these conditions, a driver's door courtesy lamp switch ON signal is sent to the meter computer, just as with the above case where the ignition key is not inserted. As a result, the meter computer makes the buzzer sound short beeps intermittently at 0.5-sec. intervals. (Key warning function has priority.)



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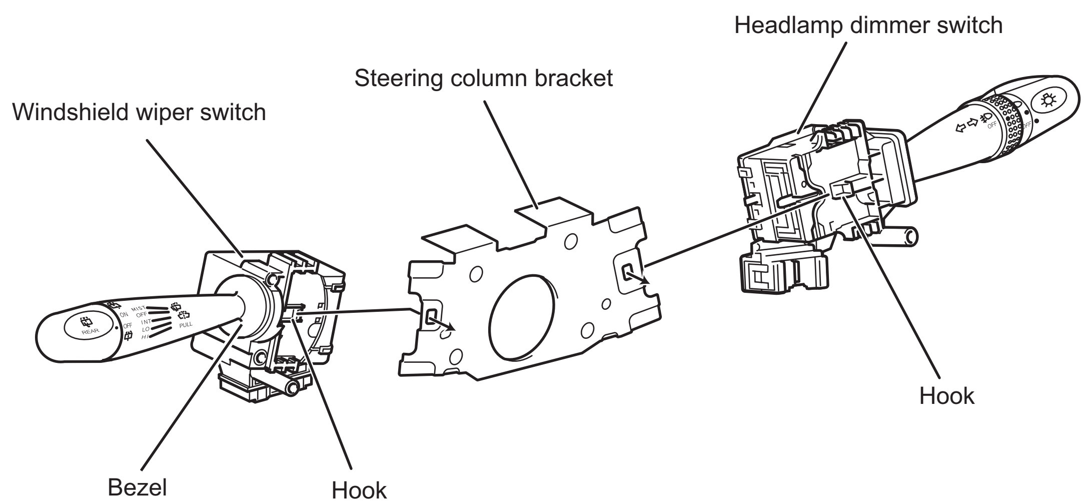
Headlamp Dimmer Switch

- The headlamp dimmer switch and the windshield wiper switch are placed separately so that each switch unit can be mounted and removed without removing the steering wheel. To reduce the number of parts and ensure ease of servicing, each switch unit is so designed that it can be secured directly to the steering column bracket by means of a hook.
- The headlamp dimmer switch has a turn canceling mechanism. In addition, direct connection type connectors are provided for the headlamp dimmer switch and the windshield wiper switch to simplify wiring.
- To improve appearance, a pivot joint is used for the switch lever and a bezel is provided for the opening in the steering column cover.



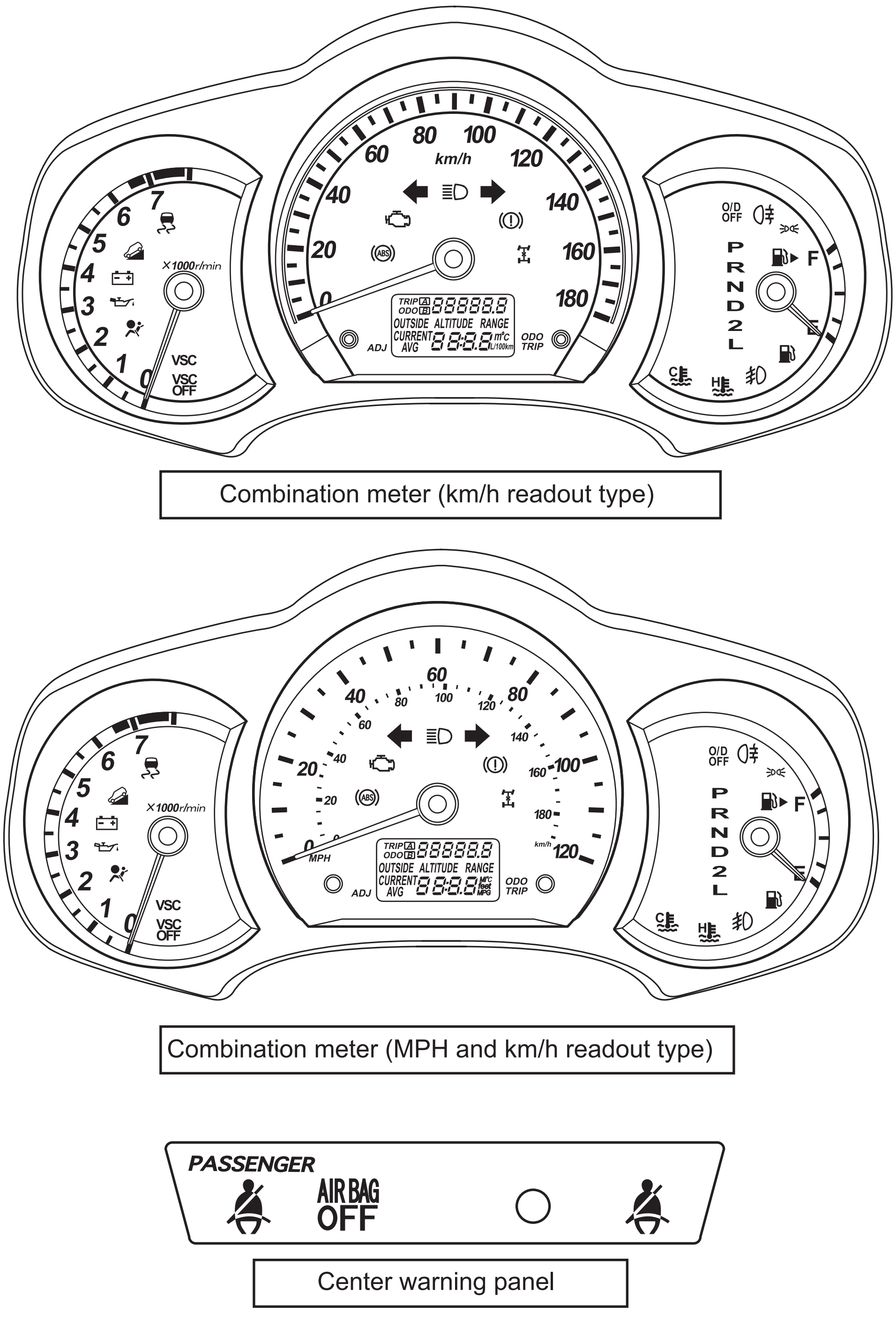
Note: The illustration shows a representative example.

A1270134E-D

METER AND GAUGE SYSTEM

Combination Meter in General

- The vehicle comes with a three-segment analog combination meter that has a large speedometer in the middle.
- A multi-information display panel that shows a variety of information in alphanumeric characters is mounted below the speedometer.
- Indicators, including a front passenger seatbelt warning indicator and a security warning indicator, which give warnings not only to the driver but also to the front passenger as the need arises, are placed in the middle of the instrument panel separately from the combination meter.



Note: As representative examples, the illustrations show all indicator lamps provided.

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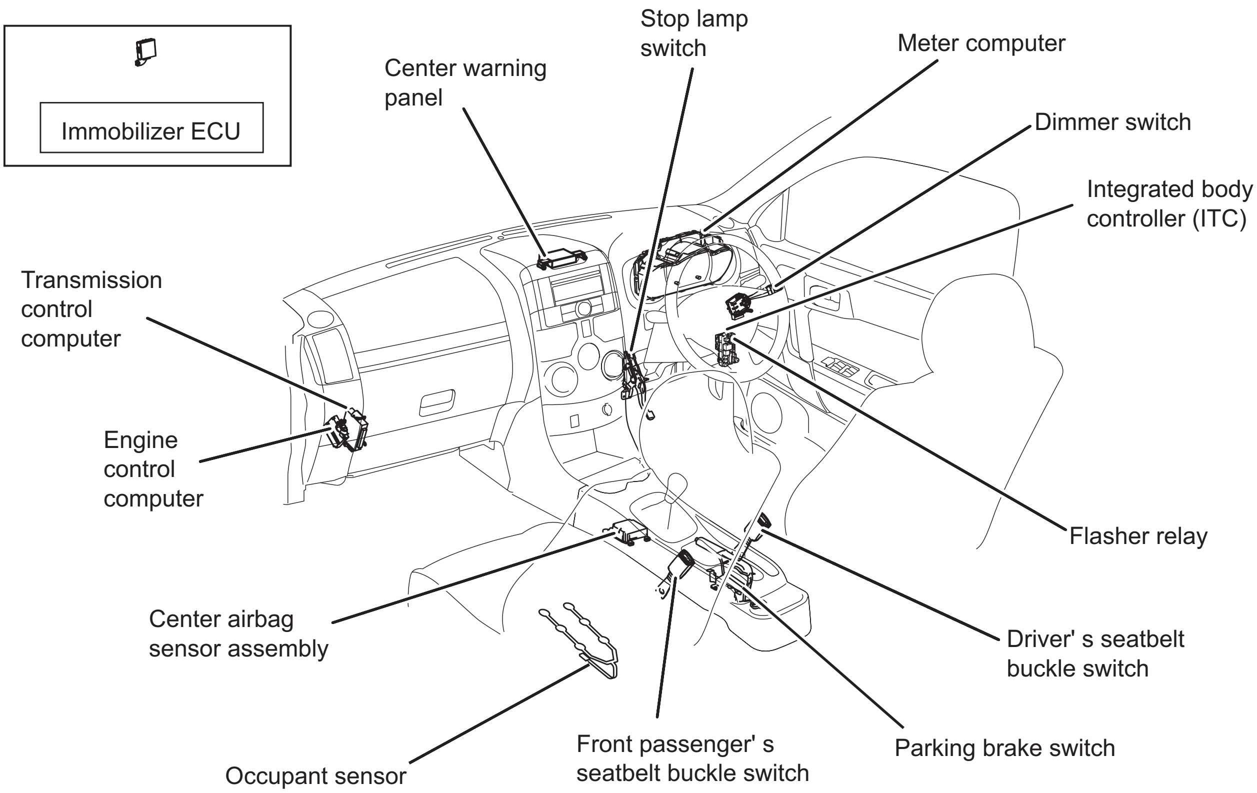
System components 1



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System components 2

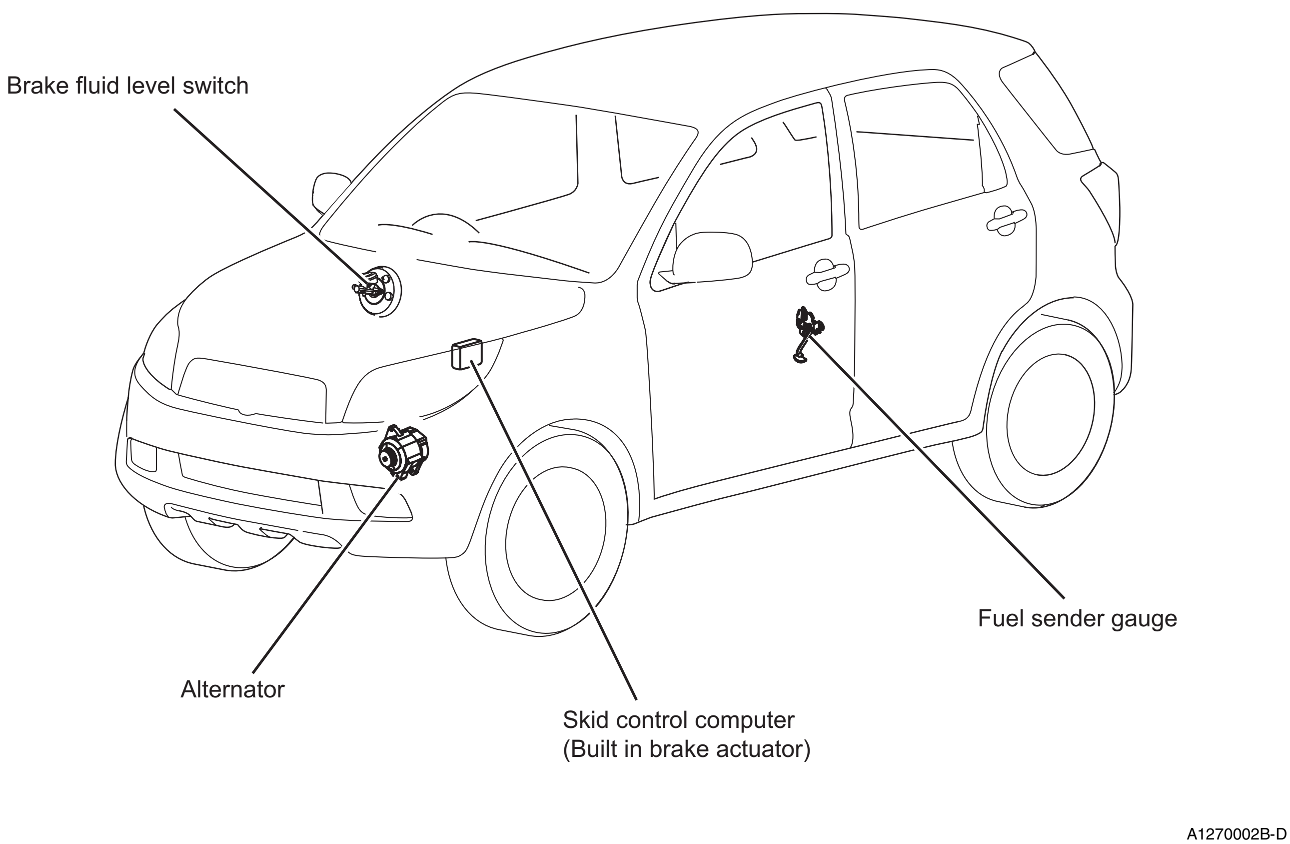


Table of Devices Connected to Combination Meter

Table of devices connected to combination meter

Indicators	Devices connected	Input signal
Speedometer	Skid control computer (VSC control computer)	Com-munica-tions
Speedometer (for models with ABS)	Skid control computer (ABS control computer)	Linear
Speedometer (for A/T models {without VSC and ABS})	Transmission control computer	Com-munica-tions
Speedometer (for M/T models {without VSC and ABS})	Vehicle speed sensor	Linear
Tachometer	Engine control computer	Com-munica-tions
Fuel gauge	Fuel sender gauge	Linear

Indicators	Devices connected	Input signal
Odometer/trip meter	Same as with the speedometer	—

Indicators		Devices connected	Input signal
Operating status and waning indicator lamps	Turn signal lamps ON	Flasher relay	Linear
	Tail lamps ON	Dimmer switch	Linear
	Front fog lamps ON	Front fog lamp switch	Linear
	Rear fog lamp ON	Rear fog lamp switch	Linear
	High-beam ON	Dimmer switch	Linear
	VSC ON*1	Skid control computer (VSC control computer)	Communications
	Skid*1	Skid control computer (VSC control computer)	Communications
	Check engine warning	Engine control computer	Linear
	ABS warning	Skid control computer	Linear
	Remaining fuel warning	Same as with the fuel gauge	—
	Parking brake ON/Brake fluid level warning	Skid control computer (ABS control computer)*2	Linear
		Skid control computer (VSC control computer)*1	Communications
		Parking brake switch	Linear
		Brake fluid level switch	Linear
	Downhill assist control ON	Skid control computer	Communications
	Battery charge warning	Alternator	Linear
	High water temperature	Engine control computer	Communications
	Low water temperature	Engine control computer	Communications
	Oil pressure warning	Oil pressure switch	Linear
	Overdrive OFF	Transmission control computer	Communications
	Center differential gear Locked	Center differential gear lock switch ON	Linear
	SRS airbag warning	Center airbag sensor assembly	Linear
	VSC warning*1	Skid control computer (VSC control computer)	Communications

Indicators		Devices connected	Input signal
Multi-information display	Indication of average fuel consumption	Engine control computer	Communications
		Same as with the speedometer (vehicle speed signals)	—
	Indication of instantaneous fuel consumption	Engine control computer	Communications
		Same as with the speedometer (vehicle speed signals)	—
	Indication of remaining cruising distance	Fuel sender gauge	Linear
		Engine control computer	Communications
	Indication of outside air temperature	Engine control computer	Communications
Multi-purpose buzzer	Ignition key warning	Ignition switch	Linear
		Door courtesy lamp switch	Linear
	Lamp warning	Dimmer switch	Linear
		Door courtesy lamp switch	Linear
	Reverse warning	Transmission control computer	Communications
	Seatbelt warning	Occupant sensor (only for the front passenger seat) and seatbelt buckle switch	Linear
		Same as with the speedometer (vehicle speed signals)	—
	VSC ON	Skid control computer (VSC control computer)	Communications
	Uphill start assist control ON	Skid control computer	Communications
	ABS actuator high temperature warning	Skid control computer	Communications
	Speed warning*3	Same as with the speedometer	—

❖ REFERENCE ❖

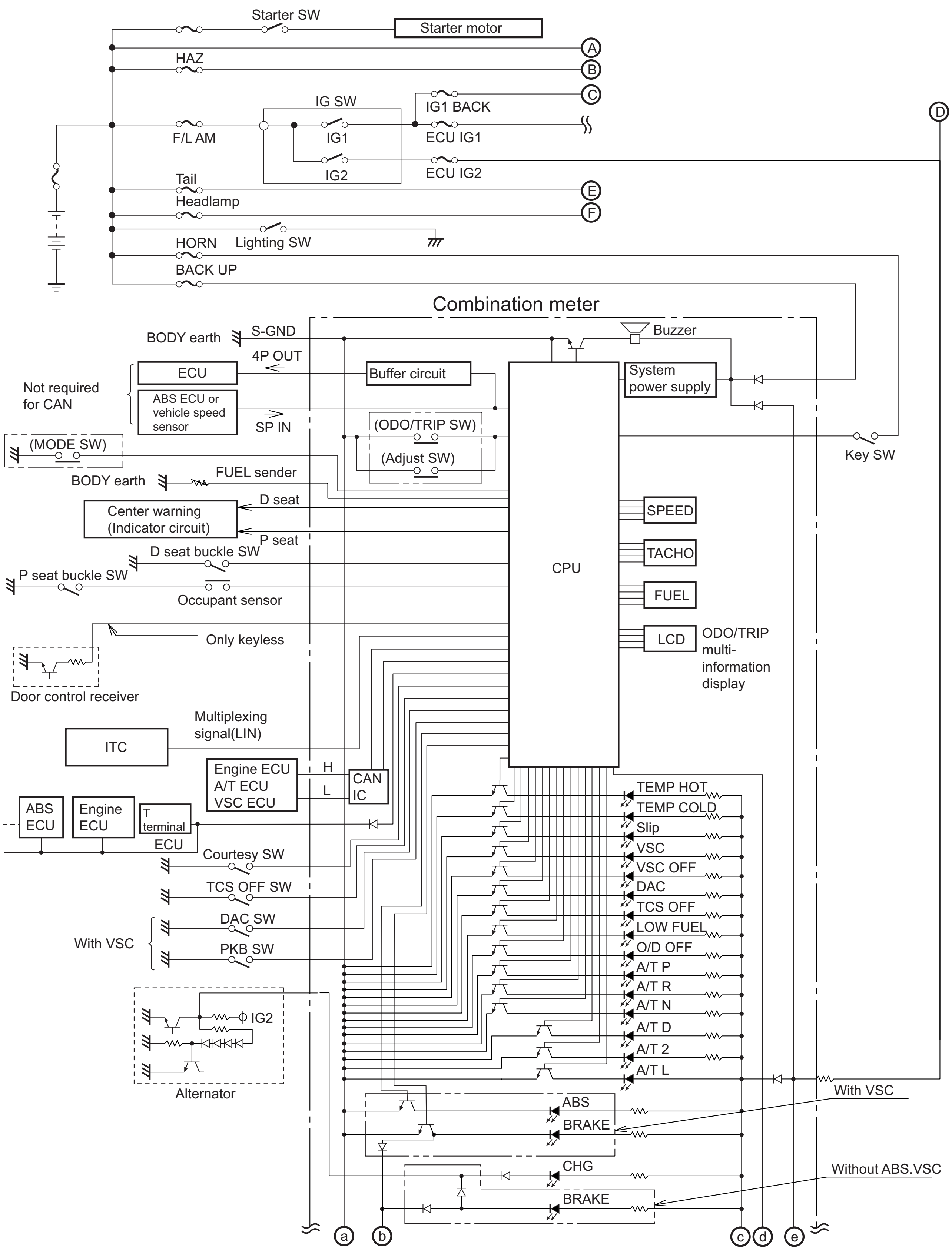
*1 : Only for models with VSC
*2 : Only for models with ABS
*3 : Only for models other than European models

Table of devices connected to center warning indictors

Indicators		Devices connected	Input signal
Operating status and warning indicator lamps	Security system ON	Immobilizer ECU	Linear
	Airbag OFF	Airbag OFF	Linear
	Driver's seatbelt warning	Transmission control computer	Communications
		Driver's seatbelt buckle switch	Linear
		Same as with the speedometer (vehicle speed signals)	—
	Front passenger's seatbelt warning	Transmission control computer	Communications
		Front passenger seatbelt buckle switch and occupant sensor	Linear
		Same as with the speedometer (vehicle speed signals)	—

Meter and Gauge System Operation Block Diagram

Block diagram 1


Starter SW
Starter motor
HAZ
IG SW
IG1 BACK
F/L AM
IG1
ECU IG1
IG2
ECU IG2
Tail
Headlamp
HORN
Lighting SW
BACK UP
Combination meter
BODY earth
S-GND
Buzzer
4P OUT
ECU
Buffer circuit
System power supply
Not required for CAN
ABS ECU or vehicle speed sensor
SP IN
(ODO/TRIP SW)
(MODE SW)
(Adjust SW)
Key SW
FUEL sender
Center warning (Indicator circuit)
D seat
P seat
SPEED
TACHO
D seat buckle SW
CPU
P seat buckle SW
FUEL
Occupant sensor
Only keyless
LCD
ODO/TRIP multi-information display
Door control receiver
Multiplexing signal(LIN)
ITC
Engine ECU
A/T ECU
VSC ECU
H
L
CAN IC
ABS ECU
Engine ECU
T terminal
ECU
Courtesy SW
TCS OFF SW
With VSC
DAC SW
PKB SW
IG2
Alternator
TEMP HOT
TEMP COLD
Slip
VSC
VSC OFF
DAC
TCS OFF
LOW FUEL
O/D OFF
A/T P
A/T R
A/T N
A/T D
A/T 2
A/T L
With VSC
ABS
BRAKE
CHG
BRAKE
Without ABS.VSC
A
B
C
D
E
F
a
b
c
d
e

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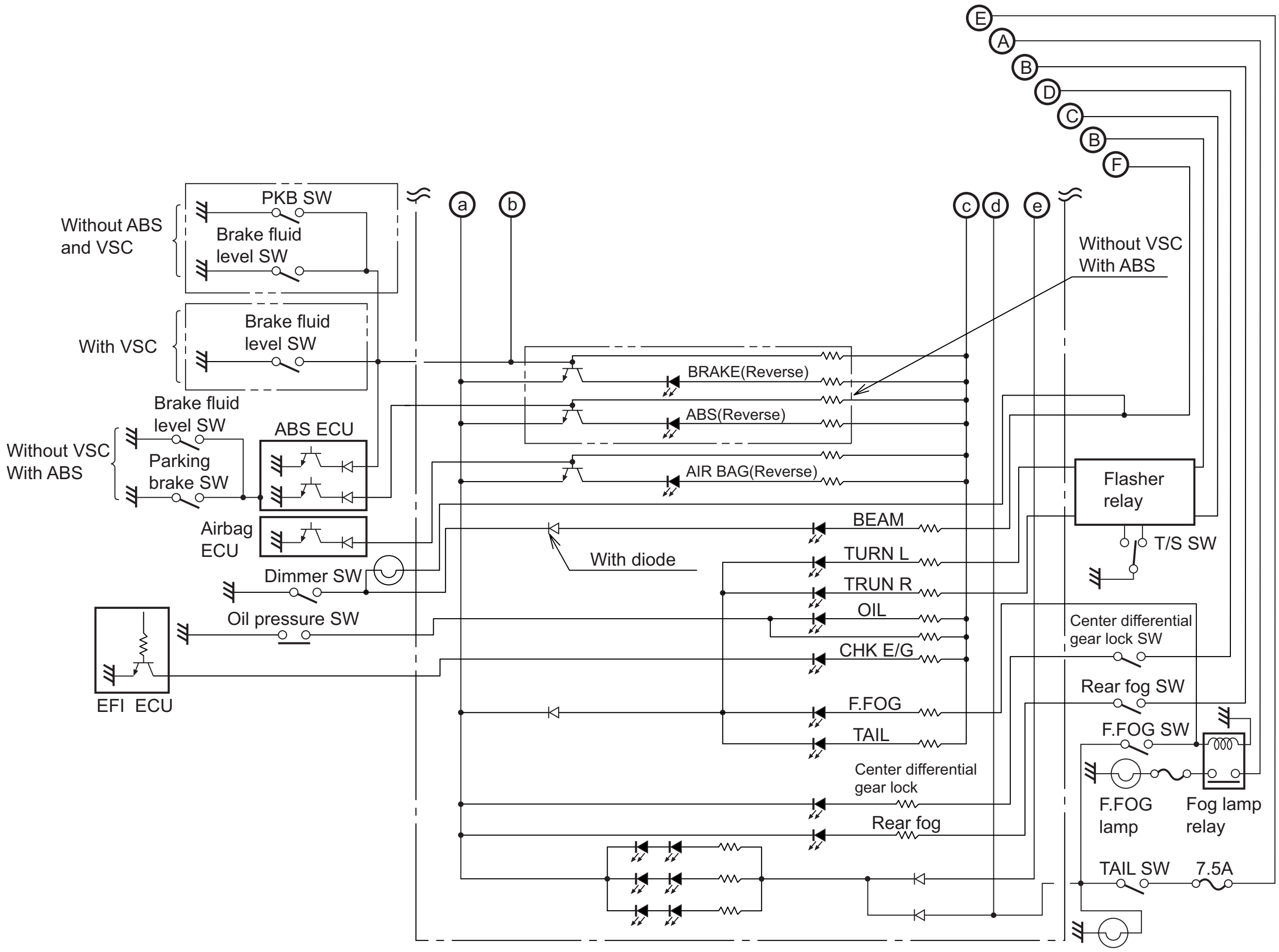
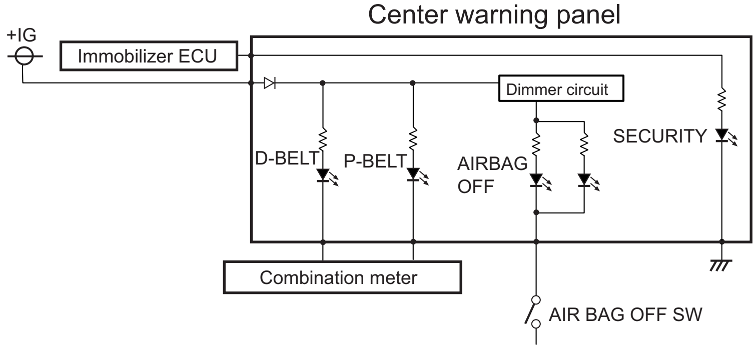
Block diagram 2



Combination meter

Center warning panel



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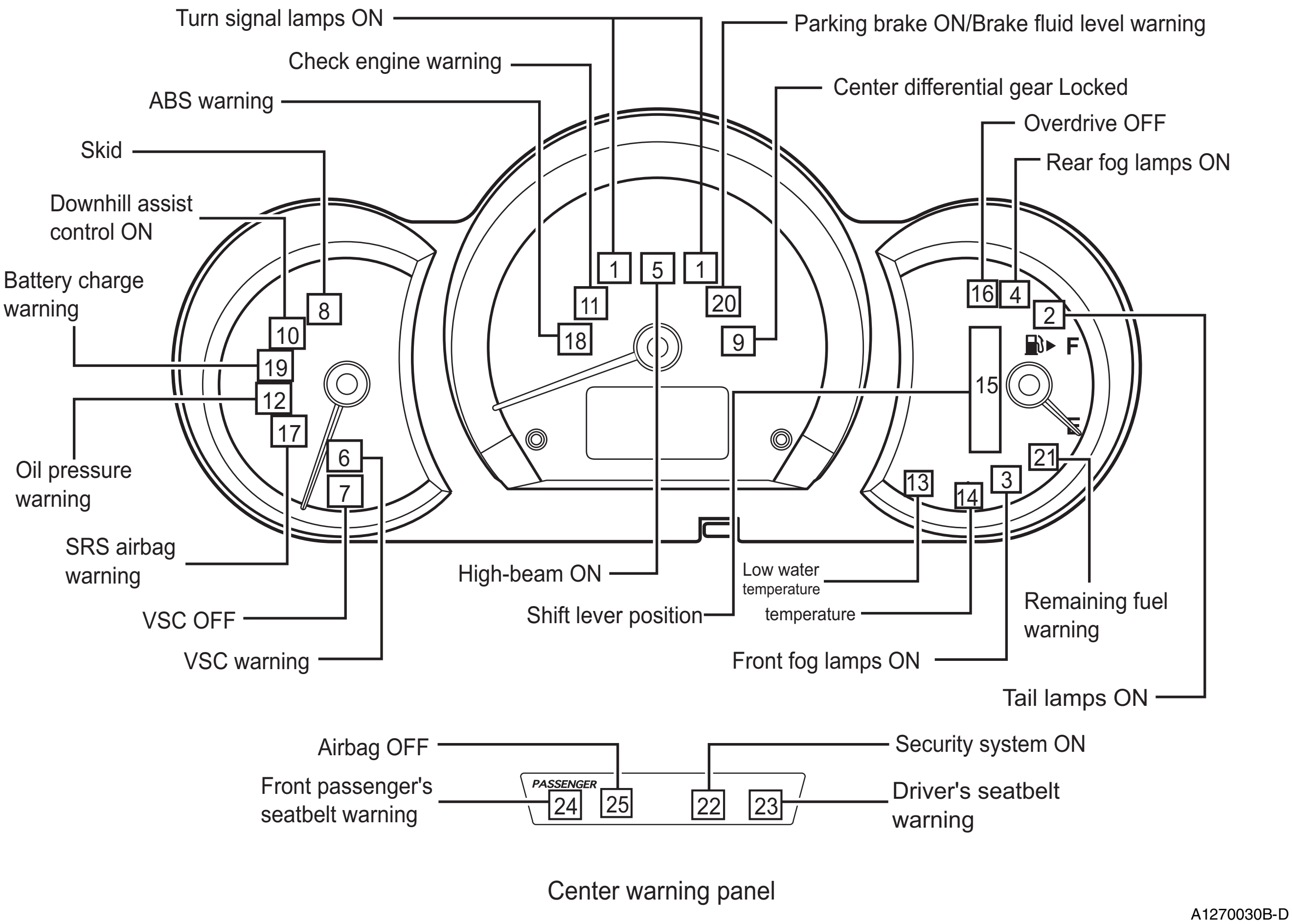
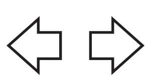
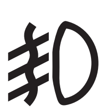
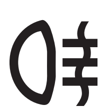
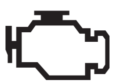
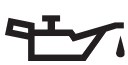
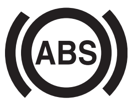
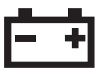
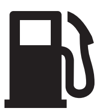
Operation/Warning Indicator Lamp Specifications



Operating status and warning indicator lamp specifications

No.	Icon	Name and indication	Functions
1		• Turn signal lamps ON • The LED indicates this by lighting green.	• When turn signal lamps are turned on, the flasher relay is activated and this indicator blinks in synchronization with the turn signals lamps.
2		• Tail lamps ON • The LED indicates this by lighting green.	• When the tail lamps is turned on, this indicator lights in conjunction with the dimmer switch.
3		• Front fog lamps ON • The LED indicates this by lighting green.	• When the front fog lamps are turned on, this indicator lights in conjunction with the front fog lamp switch.
4		• Rear fog lamp ON • The LED indicates this by lighting yellow.	• This indicators lights when the rear fog lamp switch is turned on.
5		• High-beam ON • The LED indicates this by lighting blue.	• When the high-beam headlamps are turned on, this indicator lights in conjunction with the dimmer switch.

No.	Icon	Name and indication	Functions
6	**VSC**	• VSC warning • The LED indicates this by lighting yellow.	• If something unusual occurs in a VSC-related device, this indicator lights under the control of the meter computer which receives signals from the skid control computer via the CAN network.
7	**VSC OFF**	• VSC OFF • The LED indicates this by lighting yellow.	• When VSC is deactivated, this indicator lights under the control of the meter computer which receives signals from the skid control computer via the CAN network.
8		• Skid • The LED Indicates this by lighting yellow.	• When TRC and VSC are activated, this indicator blinks under the control of the meter computer which receives signals from the skid control computer via the CAN network.
9		• Center differential gear Locked • The LED Indicates this by lighting green.	• This indicator lights when the center differential gear lock switch is turned on to lock the center differential gear.
10		• Downhill assist control ON • The LED Indicates this by lighting green.	• Under the control of the meter computer which receives signals from the skid control computer via the CAN network, this indicator lights to show the downhill assist control is ready.
11		• Check engine warning • The LED indicates this by lighting yellow.	• If something unusual occurs in the engine control system, this indicator lights under the control of the engine control computer.
12		• Oil pressure warning • The LED Indicates this by lighting red.	• This indicator lights if the oil pressure switch turns on because of a significant drop in oil pressure.
13		• Low water temperature • The LED Indicates this by lighting blue.	• Under the control of the meter computer, this indicator lights when the engine cooling water temperature is about 55° C or below. Engine cooling water temperature is input by means of signals sent from the engine control computer via the CAN network. (The indicator goes out when the water temperature rises to about 60° C or above.)
14		• High water temperature • The LED Indicates this by lighting red.	• Under the control of the meter computer, this indicator blinks if the cooling water temperature rises to about 117° C and lights when the water temperature rises to about 119° C or above. Engine cooling water temperature is input by means of signals sent from the engine control computer via the CAN network. (The indicator blinks when the water temperature drops to 118.5° C, and it goes out when the water temperature lowers to 112° C or below.)
15	D	• Shift lever position • This LED indicates the shift lever position by lighting green when it is in a position other than the R position, or yellow when it in the R position.	• This indicator indicates the current shift lever position under the control of the meter computer which receives signals from the transmission control computer via the CAN network.

No.	Icon	Name and indication	Functions
16	O/D OFF	• Overdrive OFF	• When the overdrive function is deactivated, this indicator lights under the control of the meter computer which receives signals from the transmission control computer via the CAN network.
17		• SRS airbag warning • The LED Indicates this by lighting red.	• If something unusual occurs in an SRS airbag-related part, this indicator lights under the control of the center airbag sensor.
18		• ABS warning • The LED Indicates this by lighting LED yellow.	• If something unusual occurs in an ABS-related part, this indicator lights under the control of the skid control computer.
19		• Battery charge warning • The LED Indicates this by lighting red.	• This indicator lights if an abnormal voltage is detected at the L terminal of the alternator.
20		• Parking brake ON/brake fluid level warning • The LED Indicates this by lighting red.	• This indicator lights when the parking brake is applied and the parking brake switch turns on. • This indicator lights when the quantity of brake fluid has decreased to a certain level and the brake fluid level switch turns on.
21		• Remaining fuel warning • The LED indicates this by lighting yellow.	• When the quantity of remaining fuel decreases to about 7.5 liters or less, this indicator lights under the control of the meter computer.
22	○	• Security system ON • The LED indicates this by lighting red.	• When the engine immobilizer is turned on, this indicator blinks under the control of the transponder key computer.
23		• Driver's seatbelt warning system • The LED indicates this by lighting red.	• If the driver's seatbelt is not fastened when the ignition switch is in the ON position, this indicator blinks under the control of the meter computer.
24		• Front passenger's seatbelt warning system • The LED indicates this by lighting red.	• When a passenger is seated in the front passenger seat without wearing his or her seatbelt and the ignition switch is in the ON position, this indicator blinks under the control of the meter computer.
25	AIR BAG OFF	• Airbag OFF • The LED indicates this by lighting yellow.	• The indicator lights if the activation of airbags is canceled by the airbag OFF switch.

Speedometer

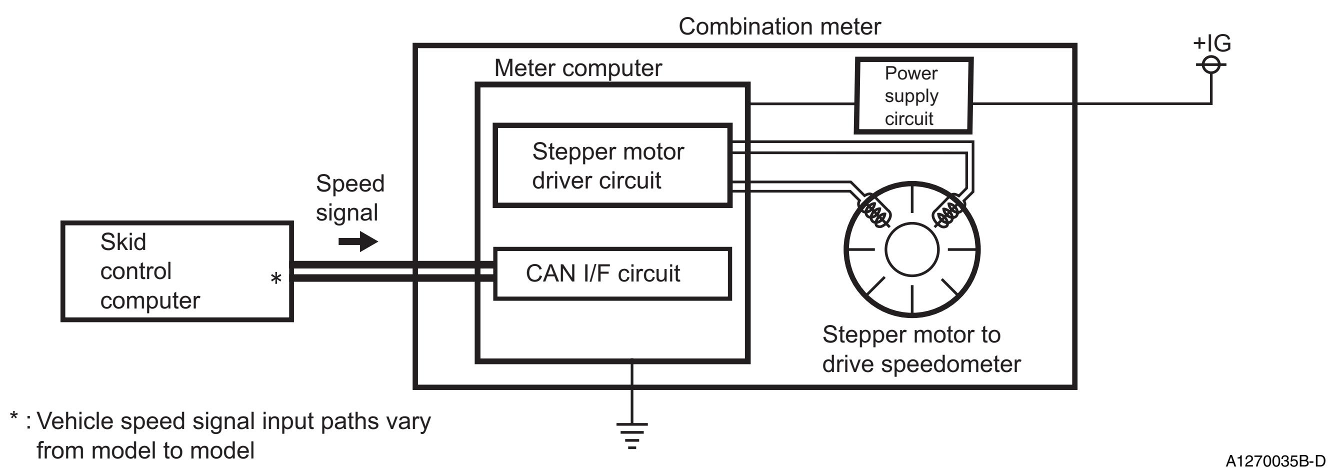
- The speedometer is an electric-motor driven type. To indicate the vehicle speed, the meter computer computes it from data received and according to the vehicle speed computed, it regulates the stepper motor that drives the speedometer pointer.
- The meter computer executes initialization, that is, it returns the pointer to the zero position, each time power is first supplied to the +B terminal of the combination meter, for example, after electric connection is established with the battery.

Speedometer specifications {( ): Speed indicated in miles}

Drive system	Stepper motor drive
Indication range	0 to 180 km/h (0 to 120 MPH)
Calibrations	In 5.0-km/h (5.0 MPH) increments
Signals from	Skid control computer {for models with ABS and VSC}
	Transmission control computer {for A/T models without ABS and VSC}
	Vehicle speed sensor {for M/T models without ABS and VSC}

Operation of Speedometer

- The meter computer determines the vehicle speed from vehicle speed signals received from the vehicle speed sensor, the skid control computer or the transmission control computer. : 10-82
- To indicate the vehicle speed, the meter computer regulates the angle of rotation, direction of rotation and rotational speed of the pointer (rotor of the stepper motor) according to the vehicle speed determined using the stepper motor driver circuit.



Tachometer

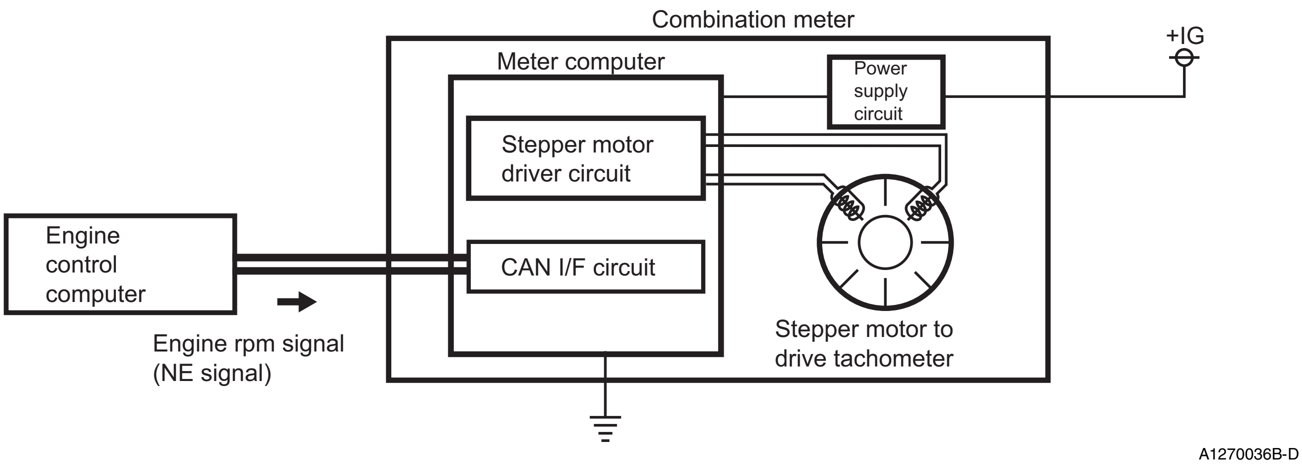
- The tachometer is an electric-motor driven meter. To indicate the engine speed, the meter computer calculates it from data received and according to the engine speed computed, it regulates the stepper motor that drives the tachometer pointer.
- The meter computer initializes the pointer by returning it to zero, each time power is first supplied to the +B terminal of the combination meter, for example, after electric connection is established with the battery.

Tachometer specifications

Drive system	Stepper motor drive
Indication range	0 to 8,000 r/min
Red zone	3SZ-VE engine-equipped model: 6,500 r/min, K3-VE engine-equipped model: 6,800 r/min
Calibrations	In 500-rpm/min increments
Signals from	Engine control computer

Operation of Tachometer

- The meter computer determines the engine speed from engine speed signals (NE signals) received from the engine control computer.
- To indicate the engine speed, the meter computer regulates the angle of rotation, direction of rotation and rotational speed of the pointer (rotor of the stepper motor) according to the engine speed determined using the stepper motor driver circuit.



Fuel Gauge

- The fuel gauge is an electric-motor driven meter. To indicate the remaining fuel, the meter computer calculates it from data received and according to the remaining fuel computed it regulates the stepper motor that drives the fuel gauge pointer.
- The meter computer initializes the pointer by returning it to zero, each time power is first supplied to the +B terminal of the combination meter, for example, after electric connection is established with the battery.

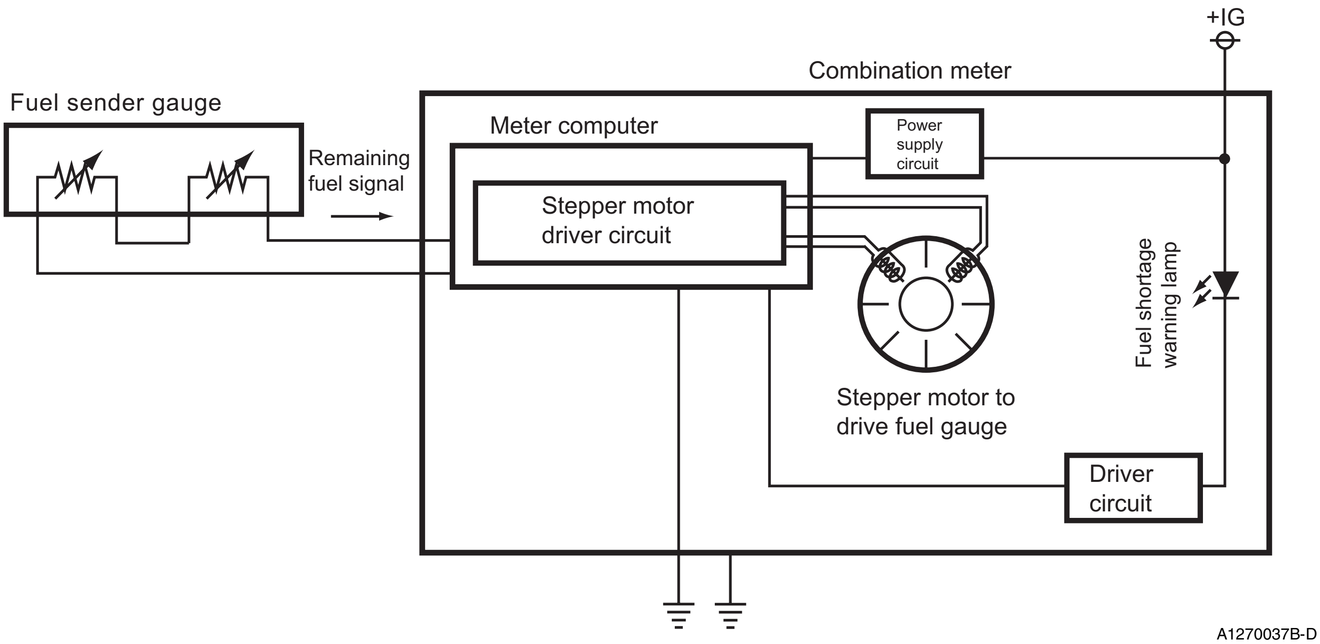
Fuel gauge specifications

Drive system	Stepper motor drive
Indication range	E to F
Signals from	Fuel sender gauge
Quantity of remaining fuel at which warning is given	Approx. 7.5 L (Warning canceled at approx. 9 L)

Operation of Fuel Gauge

Normal operation

- The meter computer calculates the quantity of remaining fuel from signals indicating the quantity of fuel in the fuel tank from the fuel sender gauge.
- To indicate the quantity of remaining fuel, the meter computer regulates the angle of rotation, direction of rotation and rotational speed of the pointer (rotor of the stepper motor) according to the quantity of remaining fuel determined using the stepper motor driver circuit.



Lighting of Fuel Shortage Warning Lamp

- If a calculation made to drive the fuel gauge shows that the quantity of fuel has decreased to approx. 7.5 L or less, the meter computer turns on the fuel shortage warning lamp in the combination meter.

Odometer/Trip Meter

- The odometer and the trip meter indicate the kilometrage (or mileage) in digital form on their LCD.
- There are three channels of display, two (A and B) for the trip meter and one for the odometer.

Odometer/trip meter specifications

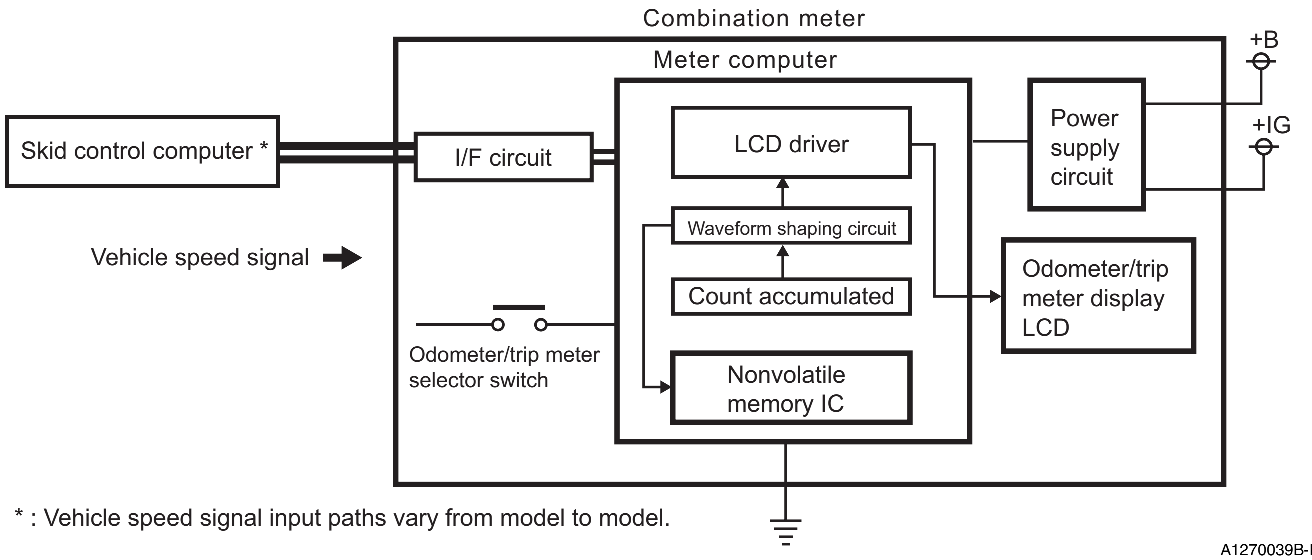
Display scheme	Display in digital form on LCD
Indication range	• 0 to 999999 km (Odometer) • 0.0 to 9999.9 km (Trip meter A·B)
Calibrations	• In 1-km increments (Odometer) • In 0.1-km increments (Trip meter A·B)
Signals from	Same as with the speedometer : 10-78

Operation of Odometer/Trip Meter

- The odometer and the trip meter calculate the kilometrage (mileage) from vehicle speed signals (rectangular-wave pulses) indicating the distance counted and accumulated by the meter computer, and they turn on the corresponding LCD segments using the LCD driver to indicate the kilometrage (mileage).
- Display modes are switched in the following sequence: trip meter A → trip meter B → odometer, each time the odometer/trip meter selector switch is pressed. The kilometrage (mileage) indicated by the trip meter is reset to 0.0 km if the odometer/trip meter selector switch is pressed and held down for about 0.8 second or more.
- Kilometrage (mileage) data is stored in the meter computer. The numerical value last indicated by the odometer is stored in a nonvolatile memory IC*, and remains stored even after the +B power supply is cut off.

❖REFERENCE❖

* : The memory IC capable of maintaining stored data even when no power is supplied



Speed Sensor

- Signals from the wheel speed sensor or the vehicle speed sensor are transmitted to the combination meter directly or through the skid control computer or the transmission control computer.

Vehicle speed sensor and computer (for models with ABS)

Related sensors and computers	Description of signals
Wheel speed sensor (front)	Wheel speed pulse signals that are generated 48 times for each wheel revolution.
Wheel speed sensor (rear)	Wheel speed pulse signals that are generated 38 times for each wheel revolution.
Skid control computer (ABS control computer)	Rectangular-wave pulse signals generated by converting one revolution of the transmission shaft into 4 pulses.

Vehicle speed sensor and computer (for models with VSC)

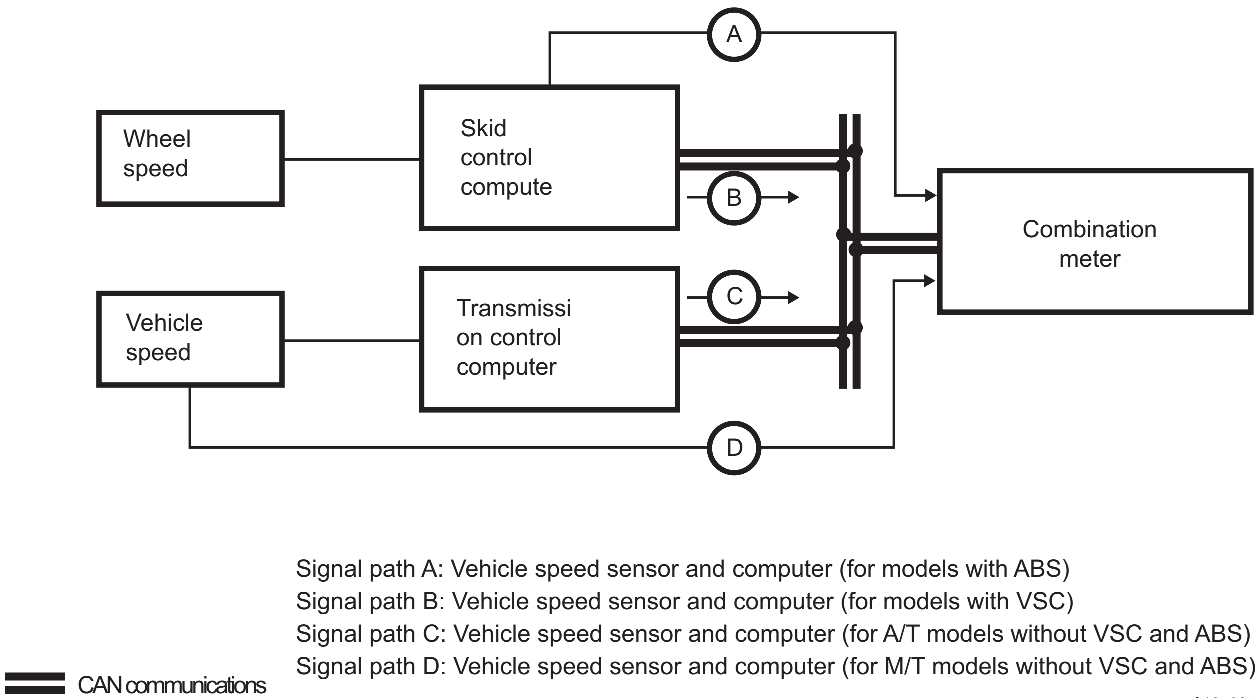
Related sensors and computers	Description of signals
Wheel speed sensor (front)	Wheel speed pulse signals that are generated 48 times for each wheel revolution.
Wheel speed sensor (rear)	Wheel speed pulse signals that are generated 38 times for each wheel revolution.
Skid control computer (VSC control computer)	Vehicle speed signals calculated from the wheel speed pulses received from the wheel speed sensor.

Vehicle speed sensor and computer (for A/T models without VSC and ABS)

Related sensors and computers	Description of signals
Transmission control computer	Vehicle speed signals calculated from the vehicle speed pulses received from the vehicle speed sensor.

Vehicle speed sensor and computer (for M/T models without VSC and ABS)

Related sensors and computers	Description of signals
Vehicle speed sensor	Rectangular-wave pulse signals that are generated 4 times for each transmission shaft revolution.



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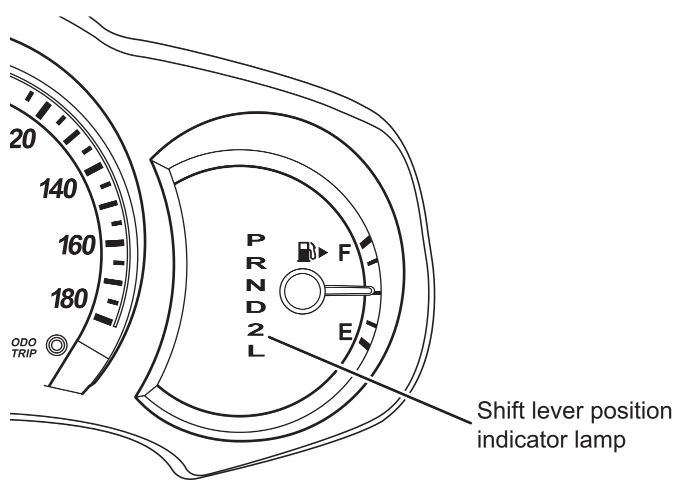
Shift Position Indicator Lamp

- The shift lever position indicator lamp for A/T models, which indicates the current shift lever position with an LED, is located to the left of the fuel gauge in the combination meter. The arrangement of the shift lever positions is: P·R·N·D·2·L.



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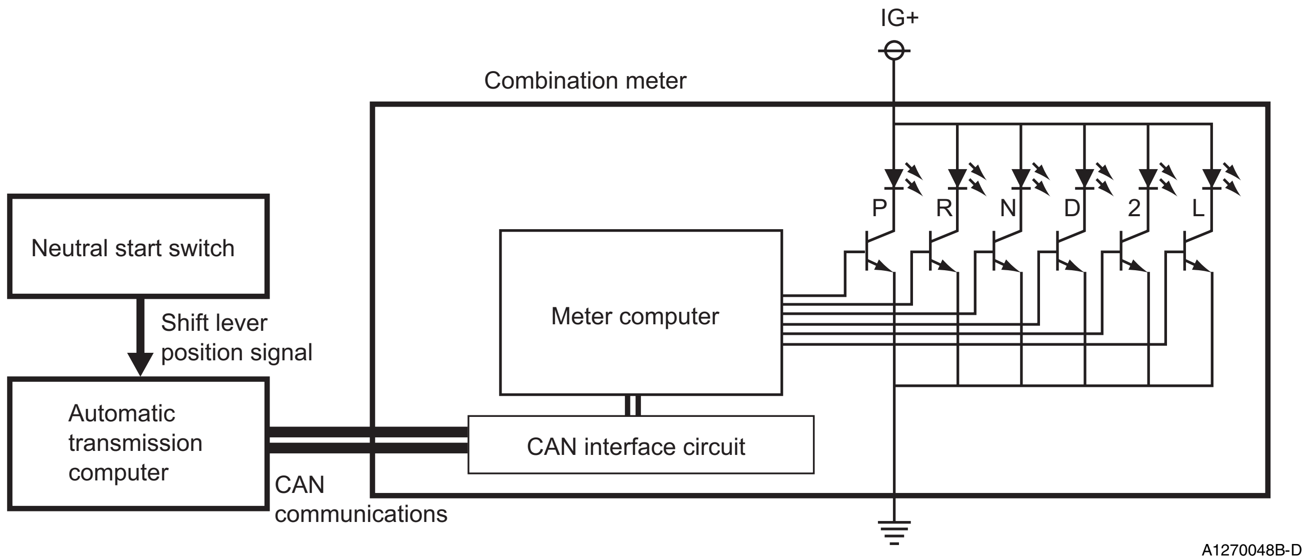
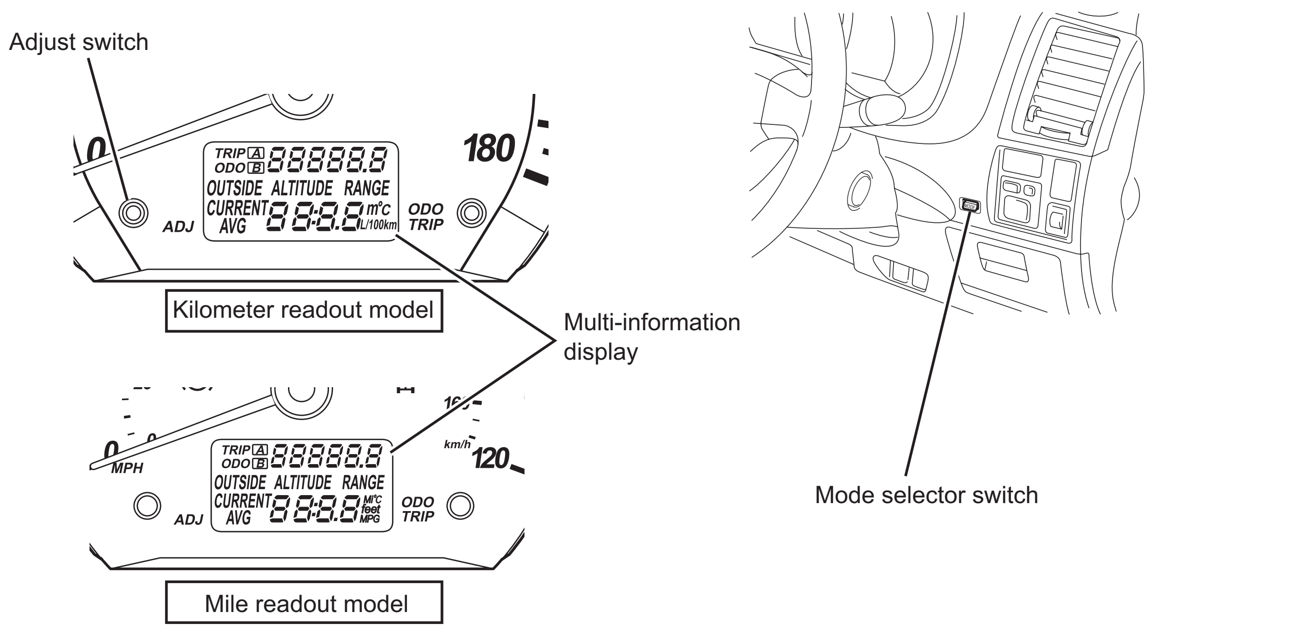
Lighting of Shift Position Indicator Lamp

- The automatic transmission computer receives position signals from the neutral start switch and transmits them to the meter computer, which then turns on the corresponding shift lever position indicator lamp in the combination meter.



Multi-Information Display

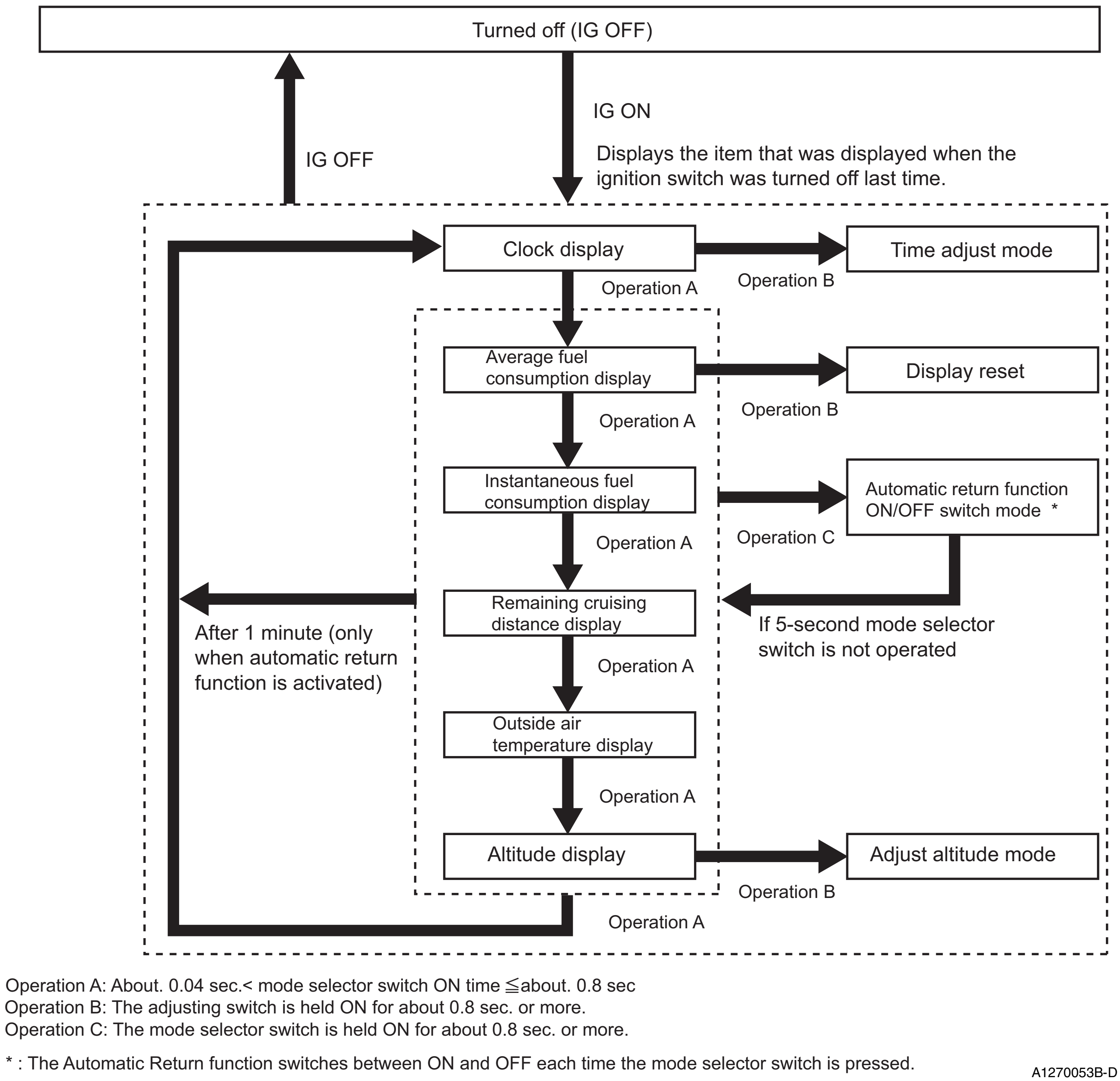
- The multi-information display indicates the current time, instantaneous fuel consumption, average fuel consumption, remaining cruising distance, outside air temperature and altitude, one at a time, on the LCD in the odometer/trip meter.
- The mode (display item) selector switch is used to switch from one mode to another. An adjust switch is also provided to allow the driver to set the clock in Clock display mode.
- The multi-information display has an automatic return function which changes automatically from the mode selected to Clock display mode after 1 minute. This function can be turned on and off in Automatic Return Function ON/OFF Switch mode. : 10-84



* As representative examples, the illustrations show the display panels with all information displayed on it.

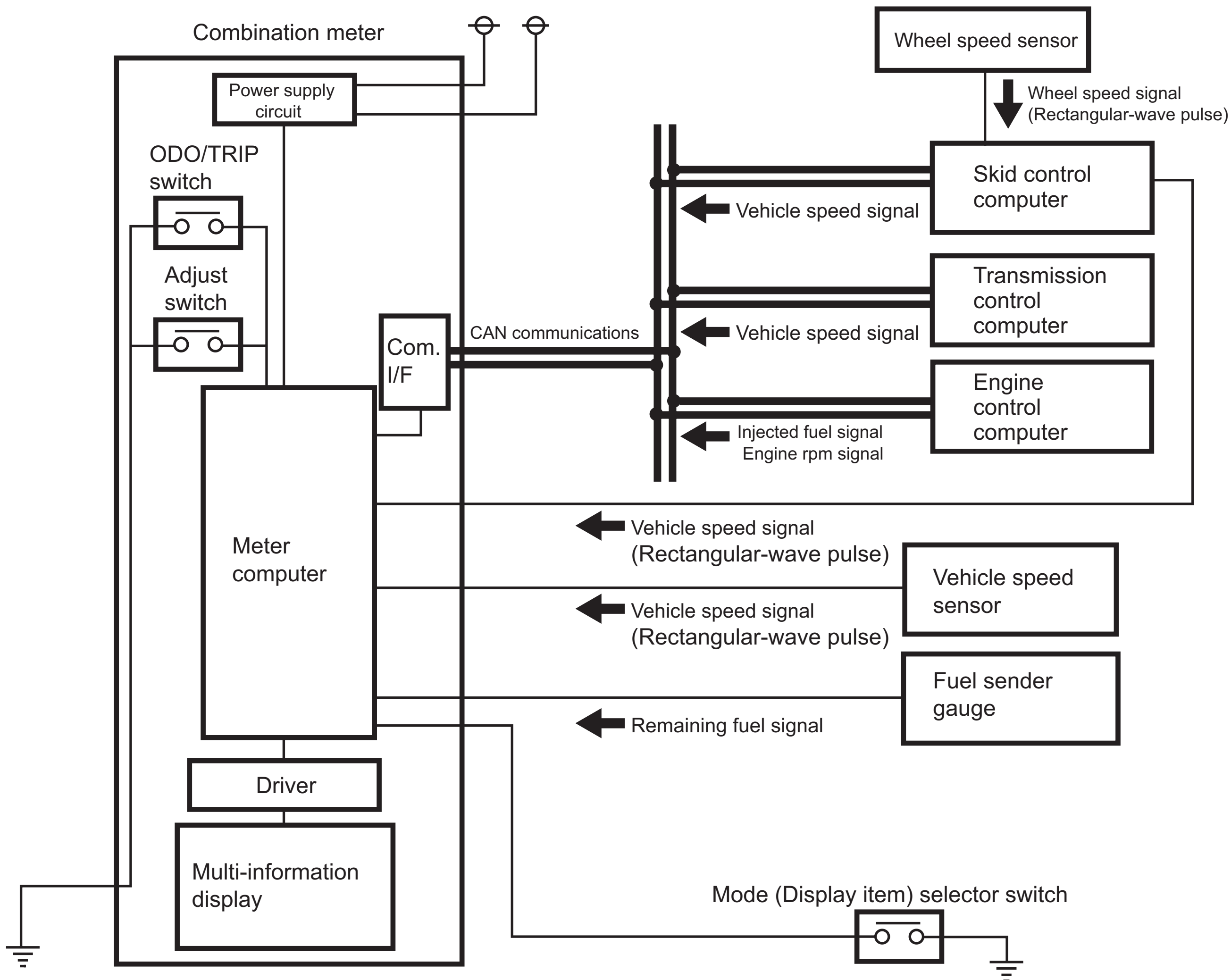
Multi-Information Display Sequence

• The display modes provided by the multi-information display change from one to another in the sequence shown in the figure below.



Actuation of Multi-Information Display

- The meter computer in the combination meter receives signals from various systems in the vehicle, and uses these signals to compute values to be displayed on the multi-information display. Furthermore, the meter computer switches from one display mode to another according to the signal from the mode (display item) selector switch, and makes corrections according to the instruction signals from the Adjust button.



Note: Vehicle speed signal input paths vary from model to model.

Cruising Distance Display Mode

- A measurement starts as soon as the engine is started, and the remaining cruising distance is computed from the driving conditions and the quantity of remaining fuel.

Remaining cruising distance display specifications

Input signal	Signals indicating the quantity of remaining fuel, quantity of fuel injected, and engine speed
Computation method	After the reset of data or during driving (when the fuel tank is full) • Learned kilometrage (mileage) × fuel tank capacity × correction factor After the reset of data or during driving (when the fuel tank is not full) • Quantity of remaining fuel × learned kilometrage (mileage) × correction factor During a halt • Estimated remaining cruising distance -0.1 (Calculated from the quantity of fuel required for 0.1 kilometer of driving)

Computation timing*	During driving: Data is updated every second. During a halt: Data is updated on receipt of each signal indicating the quantity of fuel injected.
Item displayed in the event of a failure	Blank (no value displayed) after a 3-second display of last value computed immediately before the occurrence of a failure.

❖ REFERENCE ❖

* : Data is not updated during refueling. Learned kilometrage (mileage) is updated on completion of refueling.

Average Fuel Consumption Display Mode

- Measurement starts after detecting a vehicle speed of 2 km/h or more after refueling. Values are computed and displayed once every 10 seconds. After the reset of data or the change of batteries, “99.9L/100km”* is displayed until new data is collected.

❖ REFERENCE ❖

* : “0.0MPG” for models with mile-scale indicators

After-refueling average fuel consumption display specifications {( ): For models with mile-scale indicators}

Input signal	Signals indicating the vehicle speed, quantity of fuel injected and engine speed
Indication range	• 00.0 L/100 km to 99.9 L/100 km (00.0 MPG to 99.9 MPG) • If the computed value exceeds the maximum value, then the maximum value is indicated.
Computation method	The accumulated quantity of fuel consumed after the connection of battery cables is divided by the accumulated distance of driving. (Or accumulated distance of driving/Accumulated quantity of fuel consumed)
Data reset conditions	Data is reset at each refueling or if the Adjust button is pressed and held down for 0.8 seconds or more.
Item displayed in the event of a failure	Blank (No value displayed)

Instantaneous Fuel Consumption Display Mode

- A measurement starts as soon as a vehicle speed signal is detected after the start of the engine, the value is computed and displayed once every 2 seconds. Before the start of the engine, “--.-L/100km” (or “--.-MPG” for models with mile-scale indicators) is displayed.

Instantaneous fuel consumption display specifications {( ): For models with mile-scale indicators}

Input signal	Signals indicating the vehicle speed, quantity of fuel injected and engine speed
Indication range	• 00.0 L/100 km to 99.9 L/100 km (00.0 MPG to 99.9 MPG) • “--.-L/100km” is displayed if the computed value exceeds the maximum value. (The maximum value is indicated if the computed value exceeds it.)
Computation method	The quantity of fuel consumed for 2 seconds is divided by the accumulated distance of driving for 2 seconds. (Or accumulated distance of driving for 2 seconds/quantity of fuel consumed for 2 seconds)
Item displayed in the event of a failure	Blank (No value displayed)

Outside Air Temperature Display Mode

- A measurement starts as soon as the ignition switch is turned on, and the value is computed and displayed once every 3.84 seconds. The multi-information display remains blank (no temperature is indicated) until the outside air temperature is calculated for the first time after the ignition switch is turned on.
- The multi-information display is provided with an ice warning function that blinks the indicated value if the outside air temperature comes down to 3°C or below.

Outside air temperature display specifications

Signals from	Engine control computer
Indication range	-30 to 50°C (in 1°C increments) -30°C when the outside air temperature is below -30°C, or 50°C when it is above 50°C
Computation method	16 pieces of outside air temperature data measured once every 0.24 seconds are averaged out. (Average of 4 pieces of data immediately after the IG switch is turned on)
Item displayed in the event of a failure	--°C

Ice warning display specifications

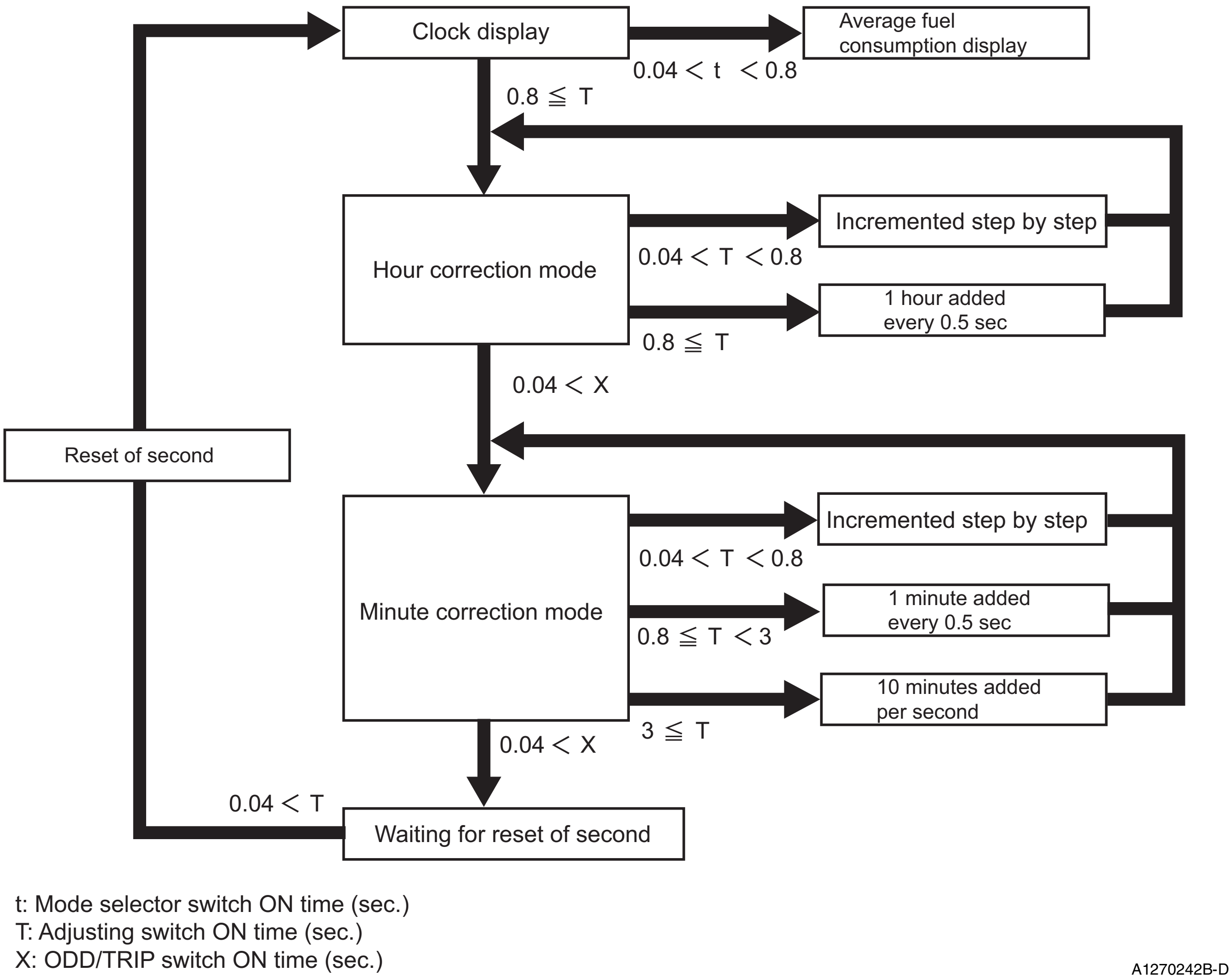
Blinking start temperature	3°C or below
Blinking interval	Turns on and off at 0.5-sec. intervals
Number of times the lamp blinks	5 times
Blinking stop temperature	4°C or above

Clock Display Mode

- The current time is displayed.
- If the Adjust button is pressed and held down for 0.8 seconds or more, the multi-information display is put into the Clock Setting mode.

Clock display specifications {( ): For models with 24-hour-scale indicators}

Hour indication range	1 to 12 (1 to 24)
Minute indication range	00 to 59

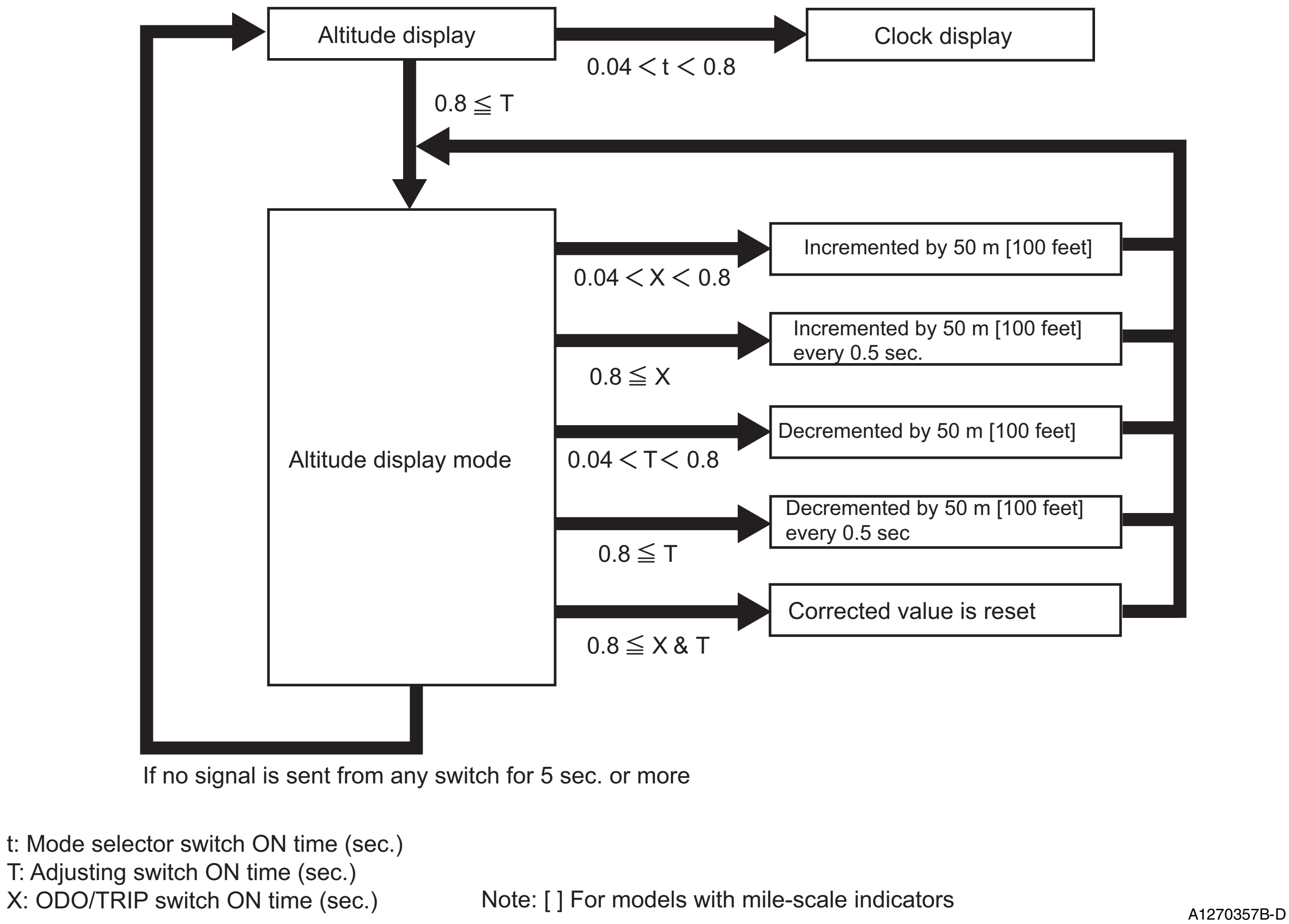


Altitude Display Mode

- A measurement starts as soon as the ignition switch is turned on, and the value is computed and displayed once every 5 seconds.
- In Altitude display mode, pressing and holding down the Adjust button for 0.8 seconds or more puts the multi-information display into Altitude Correction mode. In this mode, the correction factor currently specified is displayed where the odometer or the trip meter is usually displayed.

Altitude display specifications {[ ]: For models with mile-scale indicators}

Signals from	Altimeter IC (built into the combination meter)
Indication range	-200 m to 2,800 m (In 50-m increments) [-600 to 9,000 feet (In 100-feet increments)]
Computation method	To determine the altitude, an average calculated from 50 pieces of atmospheric pressure data sampled once every 0.1 seconds is compared to sea level pressure (1,013.25 hPa). (Average of 2 pieces of data immediately after IG switch is turned on)



Multi-Buzzer

- A multi-purpose buzzer that sounds if something unusual occurs is built into the combination meter.
- The multi-purpose buzzer gives the following warnings, changing sound patterns (cycles) variously.

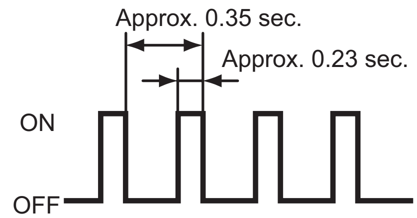
Key Warning Buzzer Specifications

- This buzzer sounds if the driver's door is opened while the mechanical key inserted in the key cylinder.

Buzzer sounding conditions

- This buzzer sounds if all the following conditions are met.

• The ignition switch is in the OFF position. • A door courtesy lamp switch is ON (door opened). • The key switch is ON (mechanical key inserted in the key cylinder).



[Frequency approx. 1.95 kHz]

A1270090B-D

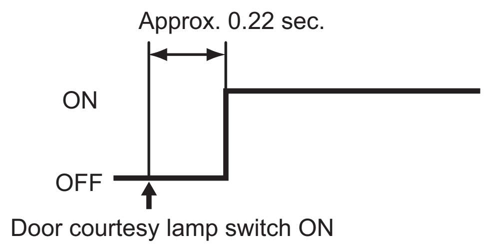
Lamp Warning Buzzer Specifications

- This buzzer sounds when the driver's door is opened with the tail lamps left ON.

Buzzer sounding conditions

● The buzzer sounds if all the following conditions are met, and it keeps sounding as long as the conditions hold true.

- The ignition switch is in the OFF position.
- 0.22 seconds or more have elapsed after a door courtesy lamp switch is turned on (door opened).
- The tail lamps are ON.

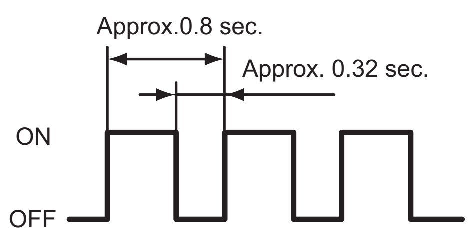


[Frequency approx. 1.95 kHz]

A1270089B-D

Reverse Warning Buzzer Specifications

- This buzzer sounds when the shift lever is in the R (reverse) position.

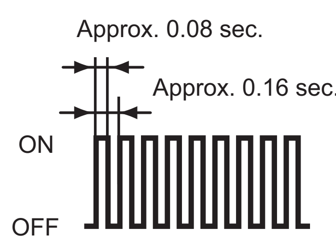


[Frequency approx. 1.95 kHz]

A1270084B-D

VSC Sideslip Warning Buzzer Specifications

- This buzzer sounds when VSC control is performed.

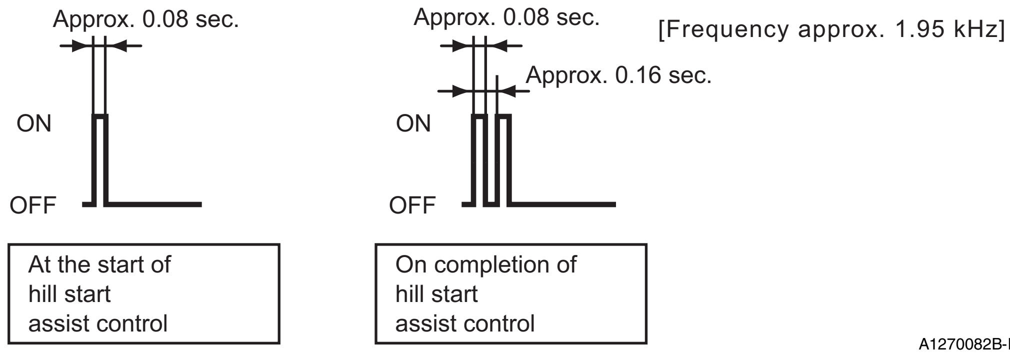


[Frequency approx. 1.95 kHz]

A1270086B-D

Uphill Start Assist Control Warning Buzzer Specifications

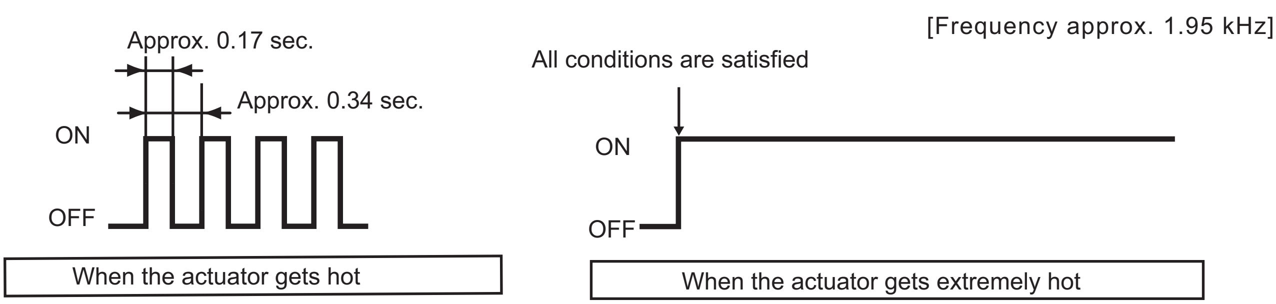
• This buzzer sounds a short beep at the start of uphill start assist control, and two short beeps at the completion of it.



A1270082B-D

ABS Actuator Temperature Warning Buzzer Specifications

• This buzzer starts sounding beeps if the ABS actuator temperature rises high, and it sounds a continuous beep if the temperature rises extremely high.



A1270083B-D

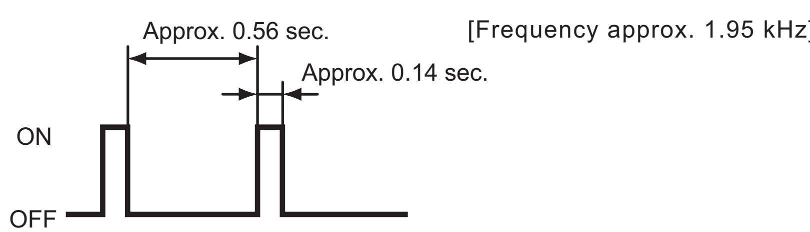
Speed Warning Buzzer Specifications

• This buzzer sounds when the vehicles speed exceeds 117.14 km/h.

Buzzer sounding conditions

● This buzzer sounds if all the following conditions are met, and it keeps sounding as long as the conditions hold true.

• The ignition switch is in the ON position. • The vehicle speed is 117.14 km/h or above.



A1270088B-D

Seat Belt Warning Buzzer Specifications

• This buzzer sounds when the vehicle speed is 20 km/h or more and either the driver or the front passenger does not wear his or her seatbelt.

• For more information, refer to the “Seatbelt warning buzzer” section. : 10-93

Multi-Buzzer (Seat Belt Warning Buzzer)

● If the driver or the front passenger does not wear his or her seatbelt when the vehicle speed reaches about 20 km/h or more with the ignition switch in the ON position, the meter computer triggers the buzzer in the combination meter, prompting the driver or the front passenger to fasten his or her seatbelt.

Actuation of Seat Belt Warning Buzzer

Driver's seatbelt warning buzzer

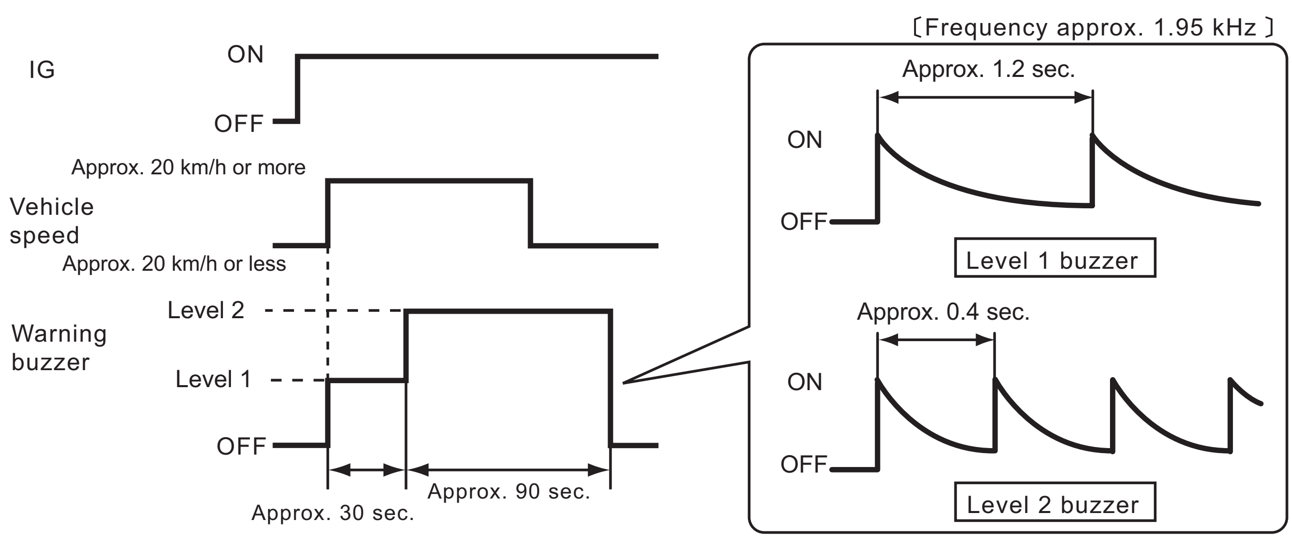
• When the ignition switch is turned on, the meter computer receives a driver's seatbelt inner buckle switch ON signal (indicating that the driver's seatbelt is not worn), and when the vehicle speed reaches 20 km/h or more, it sounds the buzzer at about 1.2-sec. intervals as a level 1 warning. If the situation is not improved within 30 seconds or so, it sounds the buzzer for 90 seconds or so at about 0.4-sec. intervals as a level 2 warning.

• Both the level 1 and level 2 warnings are canceled if the driver's seatbelt buckle switch is turned off (driver's seatbelt fastened) or the ignition switch is turned off.

• Even if the vehicle speed decreases below 20 km/h, a level 1 or level 2 warning is not canceled. If the vehicle slows down to 20 km/h or below and then picks up speed to 20 km/h or above after the buzzer has stopped sounding, the buzzer does not sound.

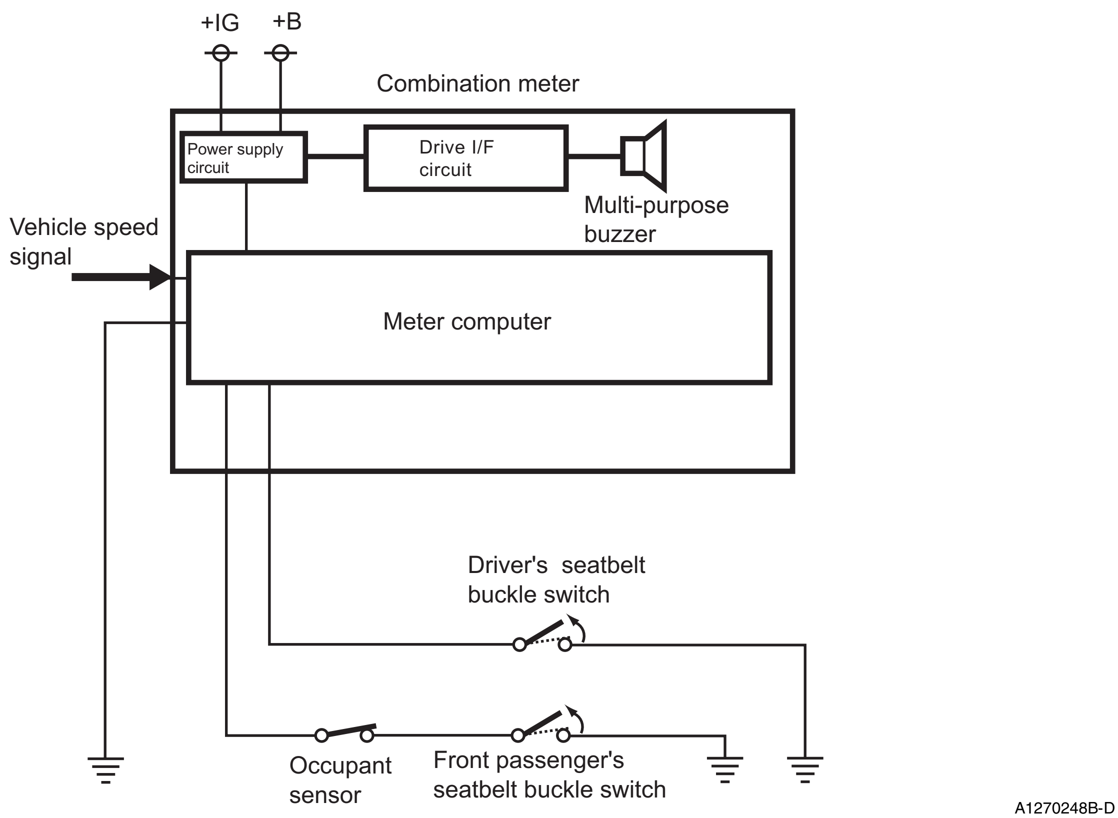
Front passenger seatbelt warning buzzer

• The meter computer receives a passenger sensor ON signal and a front passenger's seatbelt buckle switch ON signal (indicating that the front passenger's seatbelt is not fastened). When vehicle speed reaches 20 km/h or so under these conditions, the meter computer sounds the buzzer, as is the case with the driver's seatbelt.



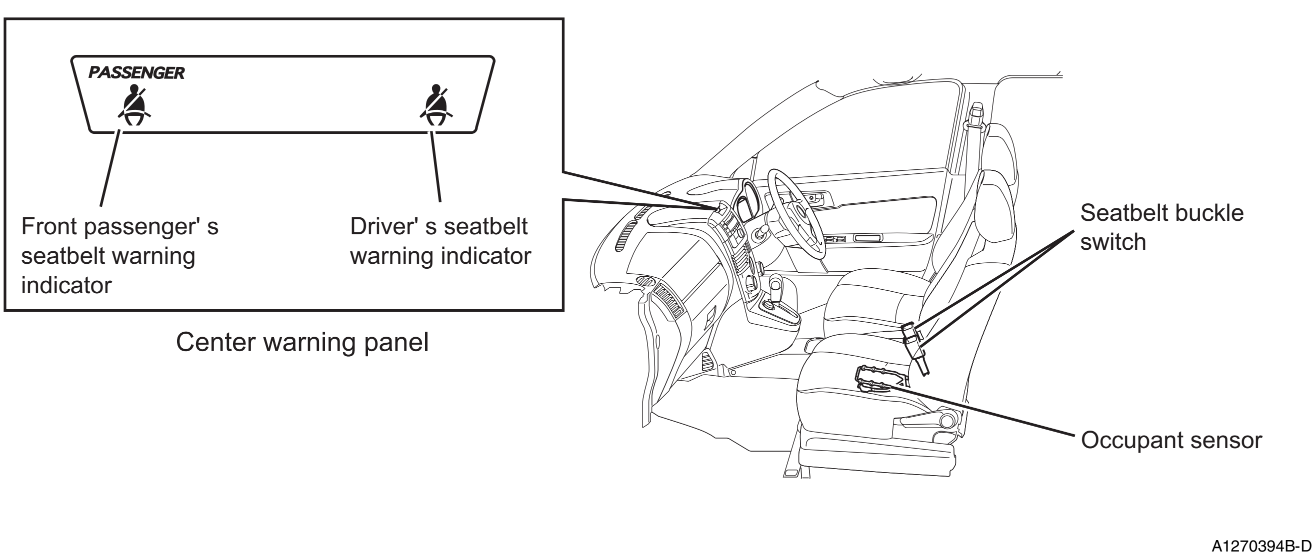
A1270093B-D

Seatbelt warning buzzer circuit



Seat Belt Warning System

- Every model is provided with a seatbelt warning system that prompts the driver and the front passenger to fasten their seatbelts by blinking warning lamps. The warning lamps for both the driver's seat and the front passenger seat are placed on the center warning panel.
- An occupant sensor (sensor for determining whether the front passenger seat is taken or not) is mounted under the front passenger seat cushion cover.



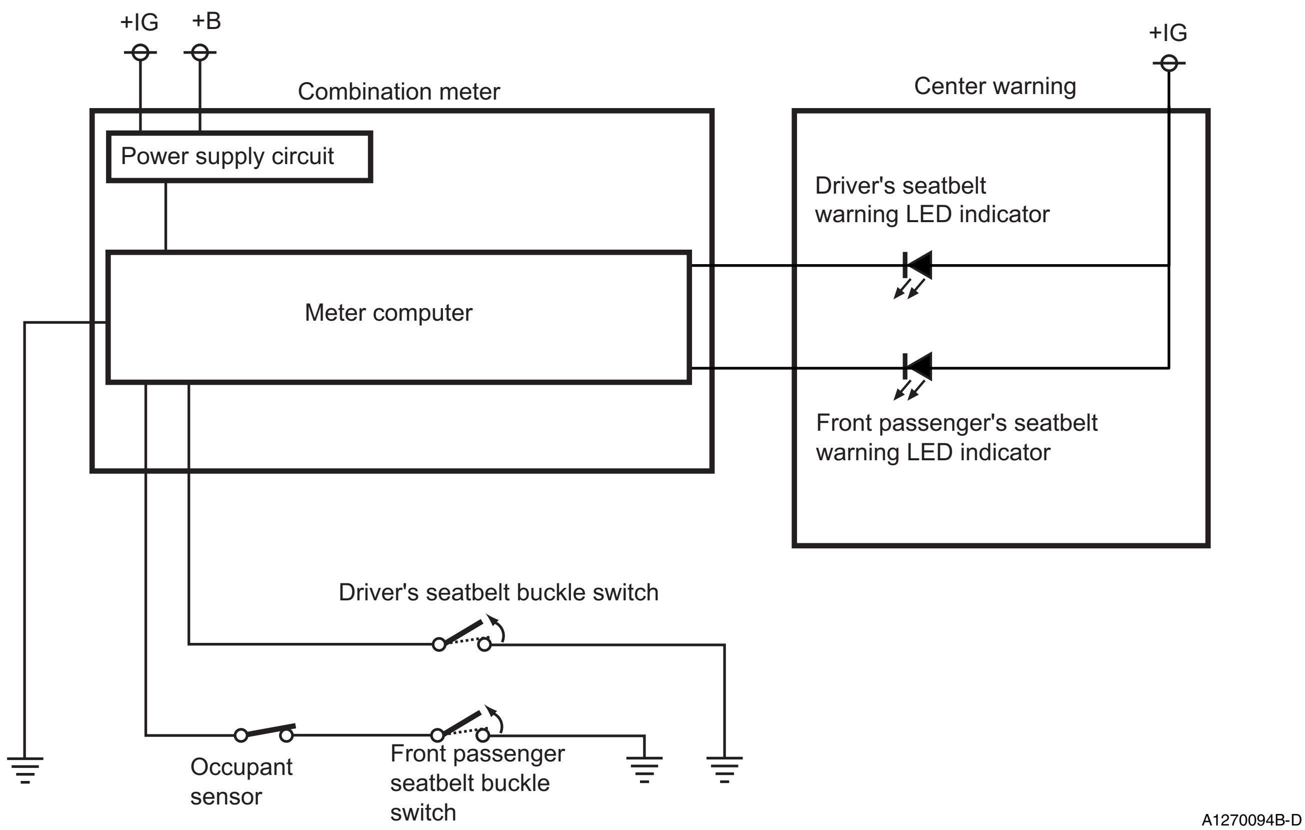
Actuation of Seat Belt Warning System

Driver's seatbelt warning system

- When the driver's seatbelt is not fastened (the tongue plate is not locked in the buckle), the meter computer turns on the driver's seatbelt buckle switch and blinks the driver's seatbelt warning LED indicator.
- When the driver's seatbelt is fastened (the tongue plate is locked securely in the buckle) and the meter computer receives a signal indicating that the driver's seatbelt buckle switch is turned off, the meter computer turns off the driver's seatbelt warning LED indicator.

Front passenger's seatbelt warning

- When a passenger is seated in the front passenger seat without wearing his or her seatbelt (the tongue plate is not locked in the buckle) while the ignition switch is in the ON position, the occupant sensor turns on the front passenger's seatbelt buckle switch. As a result, the meter computer blinks the front passenger's seatbelt warning LED indicator.
- When the occupant sensor turns off, or the front passenger's seatbelt is fastened (the tongue plate is locked securely in the buckle) and the front passenger's seatbelt buckle switch turns off, the meter computer turns off the front passenger's seatbelt warning LED indicator.



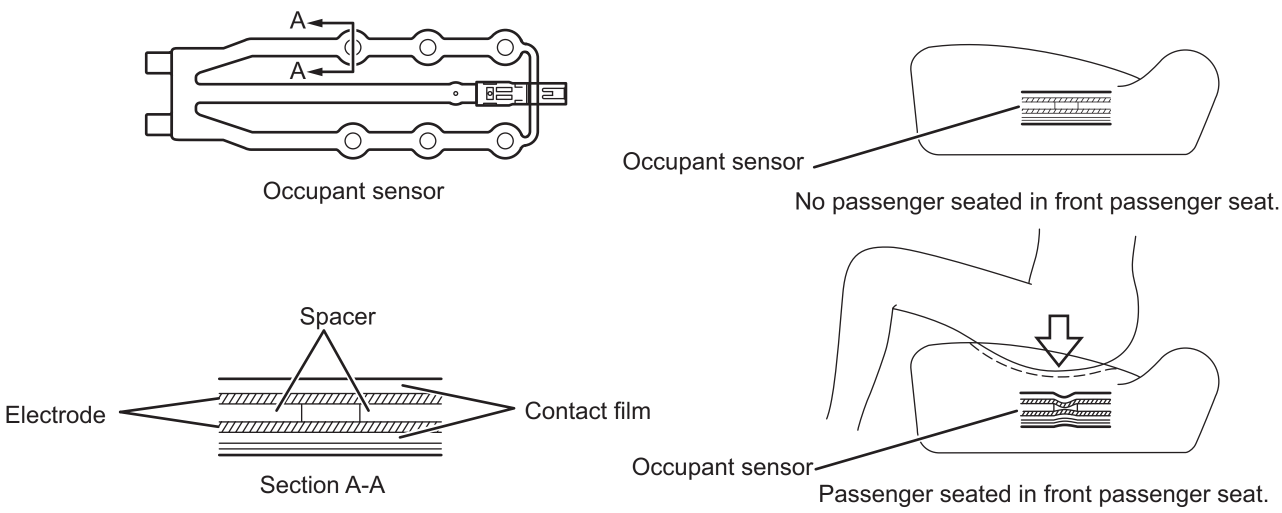
A1270094B-D

Occupant Detection Sensor

- The occupant sensor is so designed that, when a passenger sits in the front passenger seat and applies a load* to it, the electrodes in the occupant sensor set under the seat cushion cover come into contact with each other, allowing the sensor to determine the presence of a passenger.

❖ REFERENCE ❖

* : If a certain load is applied to the front passenger seat cushion, for example, by baggage put on it, the sensor may determine that a passenger is seated in the front passenger seat.

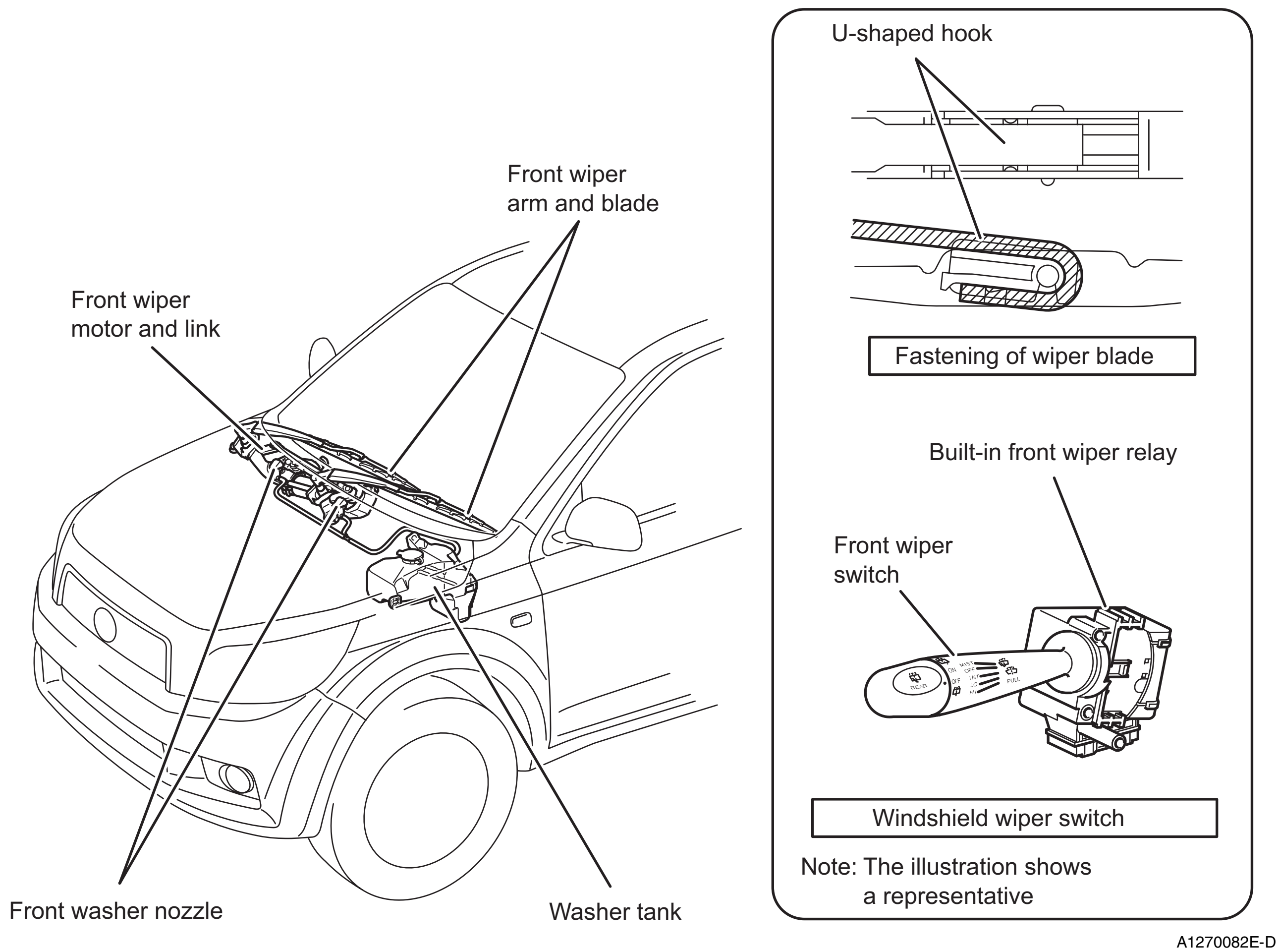

A
A
Occupant sensor
Spacer
Electrode
Contact film
Section A-A
Occupant sensor
No passenger seated in front passenger seat.
Occupant sensor
Passenger seated in front passenger seat.

A1270097B-D

WIPER AND WASHER SYSTEM

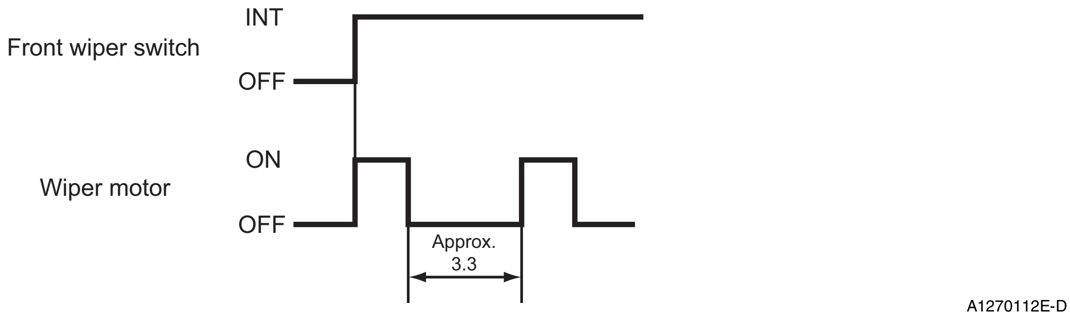
Front Wiper System

- For the front wipers, wiper arms and wiper blades that are attached together by means of U-shaped hooks are employed to improve the appearance and facilitate the replacement of wiper blades.
- The wiper blade on the driver's seat side is 525 mm in length, and the one on the front passenger side is 450 mm in length.
- The wiper system is a washer-coupled intermittent wiper system with a mist spray function.



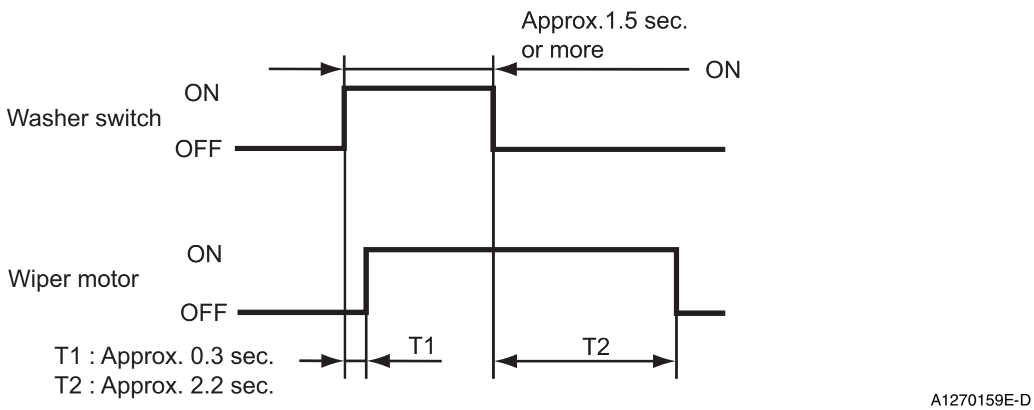
Intermittent Wiping Function

- The washer-coupled intermittent wiper system with a mist spray function has an intermittent wiping function.
- When the front wiper switch is put into the INT position, the front wipers operate intermittently at about 3.3-sec. intervals.



Washer-Coupled Wiping Function

- If the washer switch is pressed and held down for 0.3 seconds or more, the wipers start operating in LO mode with a jet of washer liquid. If the washer switch is pressed and held down for 1.5 seconds or more, the washers stop operating about 2.2 seconds after continuing to operate in LO mode.



Actuation of Front Wiper

Intermittent operation

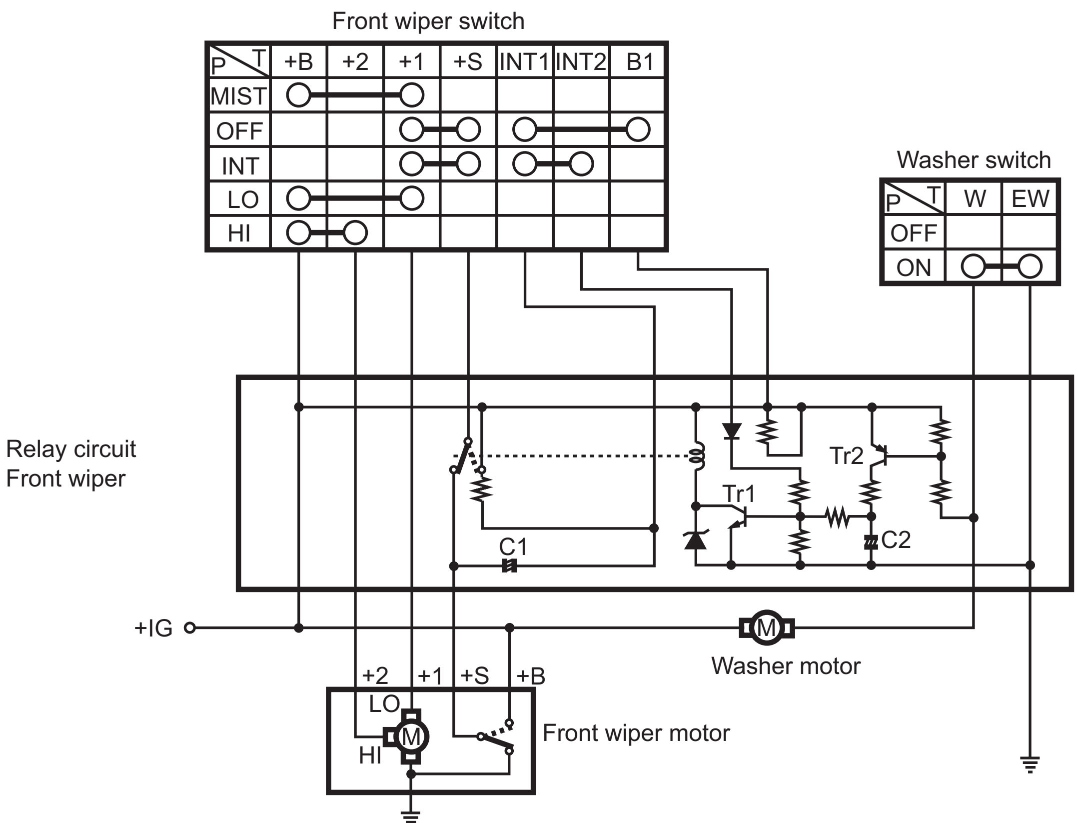
- When the front wiper switch is set to the INT position, an electric current flows from the fully-charged capacitor C1 through the front wiper switch INT1 terminal and the front wiper switch INT2 terminal to Tr1 to turn it on.
- When Tr1 turns on, a current flows from the front wiper switch +S terminal through the front wiper switch +1 terminal and the wiper motor to ground causing the motor to start running.
- As soon as the motor starts running, capacitor C1 discharges electricity through the front wiper switch INT1 terminal and the front wiper switch INT2 terminal. On completion of discharge, Tr1 turns off, deactivating the relay and stopping the motor.
- When the relay is deactivated, capacitor C1 starts recharging and holds Tr1 OFF until it becomes fully recharged. In the meantime the wipers suspend operation (intermittent stop time).
- On completion of the recharging of the C1 capacitor, Tr1 turns on again, reactivating the relay and restarting the wiper motor.
- As a result of repeated discharge and charge described above, the wipers operate intermittently.

Washer-coupled wiping

- When the washer switch is turned on, an electric current flows from the +B power supply through the washer switch W terminal and the washer switch EW terminal to ground causing ejection of washer liquid.
- As soon as windshield washer sprays washer liquid, a current flows into Tr2 and turns it on. As a result, Tr1 also turns on, and a current flows into the relay coil and activates the relay.
- When the relay is activated, a current flows from the wiper control switch +S terminal through the font wiper switch +1 terminal and the

wiper motor to ground causing the wiper motor to start running.

- Because capacitor C2 is fully recharged when the motor starts running, C2 continues to discharge electricity for about 2.2 seconds even after the washer switch is turned off.
- Tr1 is kept ON for about 2.2 seconds because the capacitor continues to discharge for the same length of time. Therefore, the wiper motor keeps running until capacitor C2 is completely discharged.



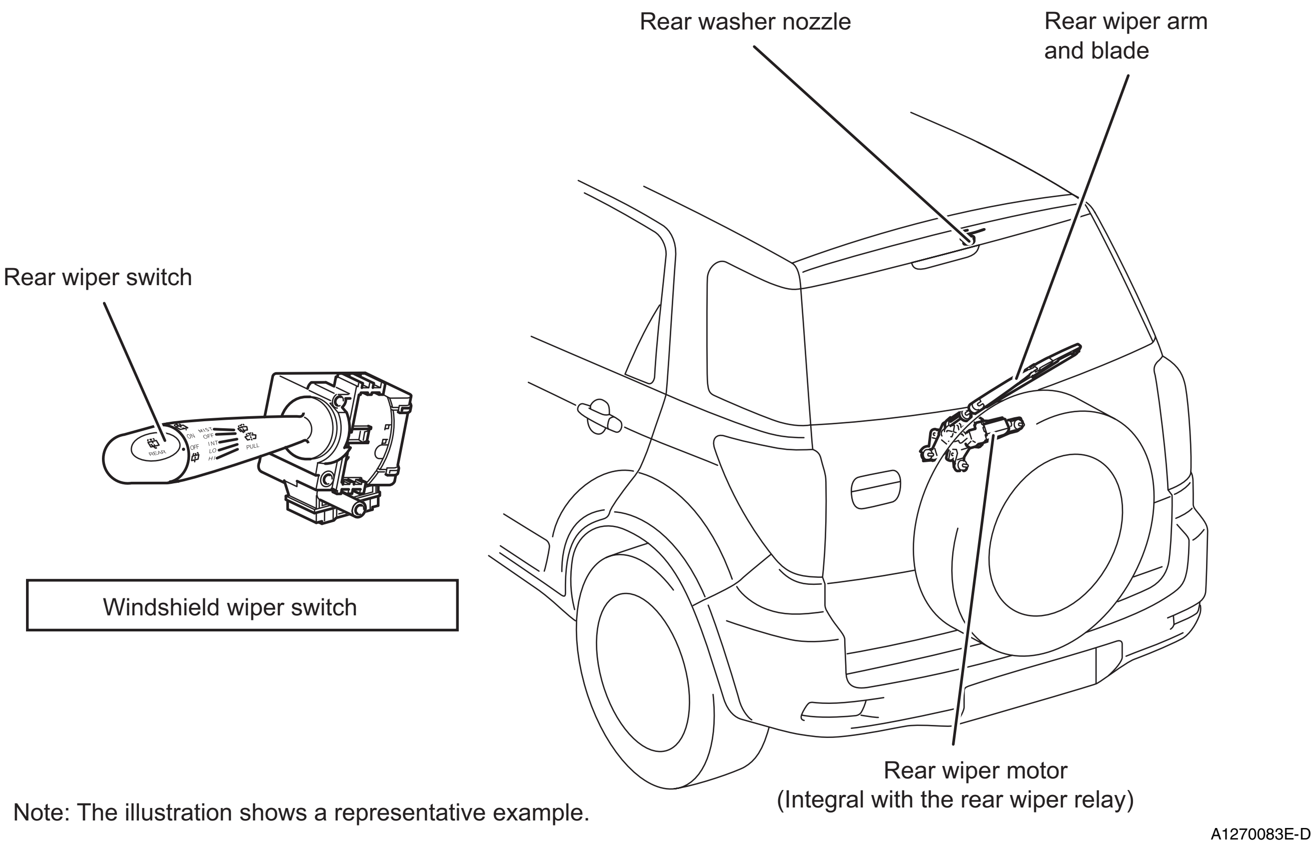
A1270111E-D

Rear Wiper System

- A rear wiper* or an intermittent rear wiper is optionally available.
- The rear wiper is provided with a resin arm and a blade. (Only for models with a rear wiper)
- The wiper blade is 300 mm in length.

❖REFERENCE❖

* : Provided as standard equipment for European models

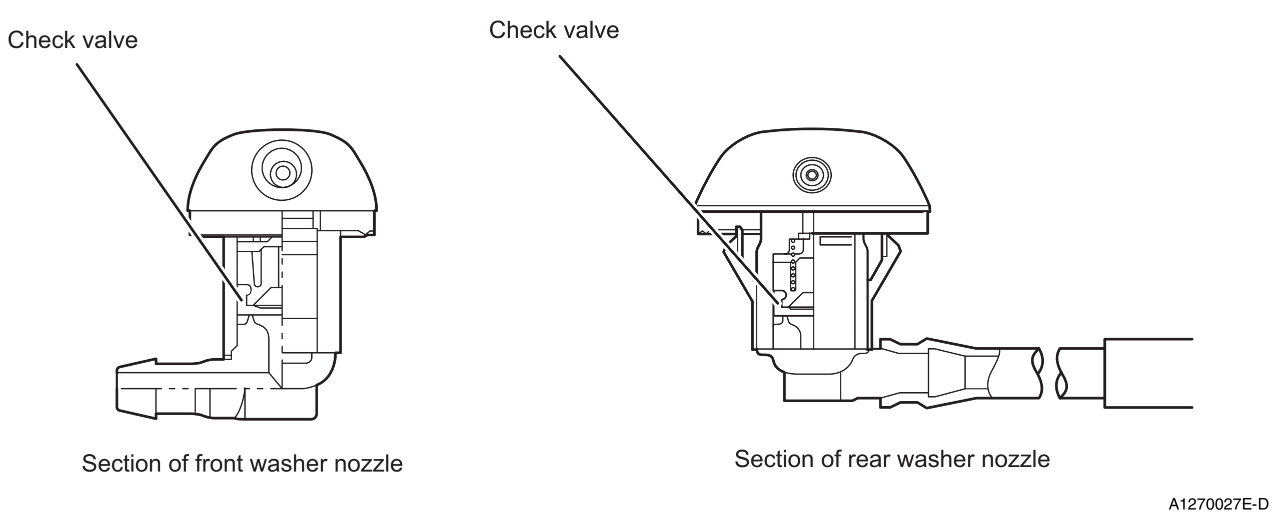


Washer System

- Two one-hole washer nozzles and one one-hole washer nozzle* are provided at the front and back of the vehicle, respectively.
- The washer reservoir is placed at the back of the engine compartment, on the front passenger seat side.

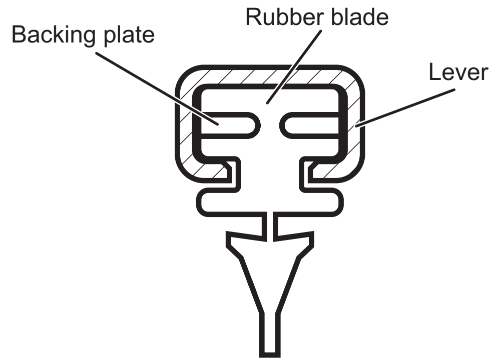
❖REFERENCE❖

* : Only for models with a rear wiper



Wiper Blade

- The rubber blade is inserted between the lever and the backing plate to prevent metal-to-metal contact and reduce the noise produced when the wiper blade flips over.



A1270045E-D

AUDIO SYSTEM

Outline of Audio System

- A front-mounted two-speaker system without radio is provided as standard equipment. A combination CD player-electronic AM/FM tuner is optionally available.

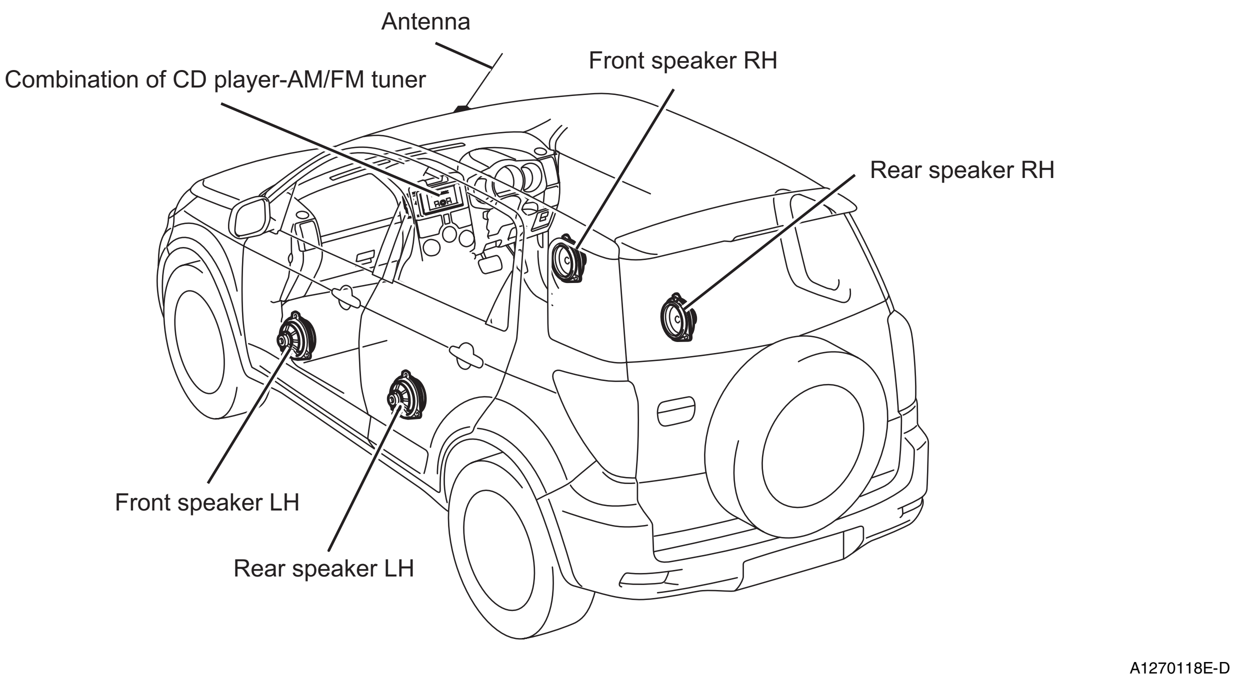
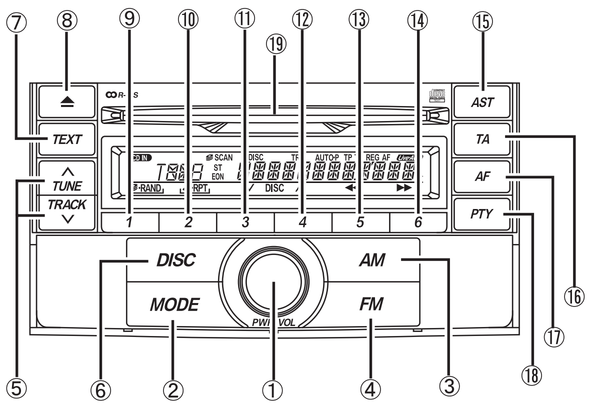


Table of audio system variations

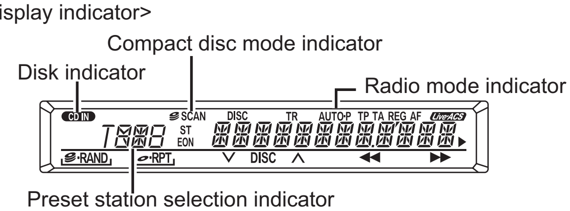
Audio head unit	Components
Combination of CD player-AM/FM tuner	4-speaker system (16 cm)
Combination of CD player-AM/FM tuner	2-speaker system (16 cm)
With no radio	2-speaker system (10 cm)

Combination CD Player-Electronic AM/FM Tuner

- To give the control panel a neat and professional appearance, it features symmetrically arranged short-stroke switches.
- A large audio control knob and separate AM and FM reception switches are employed to enhance controllability.
- A CD text display function is provided to display information (disc title, song titles, etc.) stored on the CD currently being played.
- A CD changer control function and a CD changer operating status display function are provided to allow connection of an optional CD changer.



<Display indicator>



① Power supply switch/Volume and mode control knob
② Mode button
③ AM button/AM auto store button
④ FM button/FM auto store button
⑤ Tuning button/track button
⑥ Compact disc selection button
⑦ Text display button
⑧ Eject button
⑨ Preset station selection button1
⑩ Preset station selection button2
⑪ Preset station selection button3
⑫ Preset station selection button4
⑬ Preset station selection button5
⑭ Preset station selection button6
⑮ AST(auto store)button
⑯ TA(traffic announcement)button
⑰ AF(alternative frequency)button
⑱ RTY(program type)button
⑲ Compact disk insertion slot

A1270119E-D

Speaker

- Two types of speaker systems are provided: two-speaker system and four-speaker system.

Speaker specifications

Specifications	Front speaker	Rear speaker
Standard equipment	10-cm speaker	—
Combination of CD player-AM/FM tuner	16-cm speaker	—
Combination of CD player-AM/FM tuner	16-cm speaker	16-cm speaker

Speaker specifications

Item / Speaker designation	Front speaker	Front speaker	Rear speaker
Installation location	At the lower part of the front door trim on each side	At the lower part of the front door trim on each side	At the lower part of the rear door trim on each side
Type	Single-cone, full-range speaker	Single-cone, full-range speaker	Single-cone, full-range speaker
Diameter [cm]	10	16	16
Rated (max) input power [W]	10 (20)	17.5 (40)	17.5 (40)
Voice coil impedance [Ω]	4	4	4

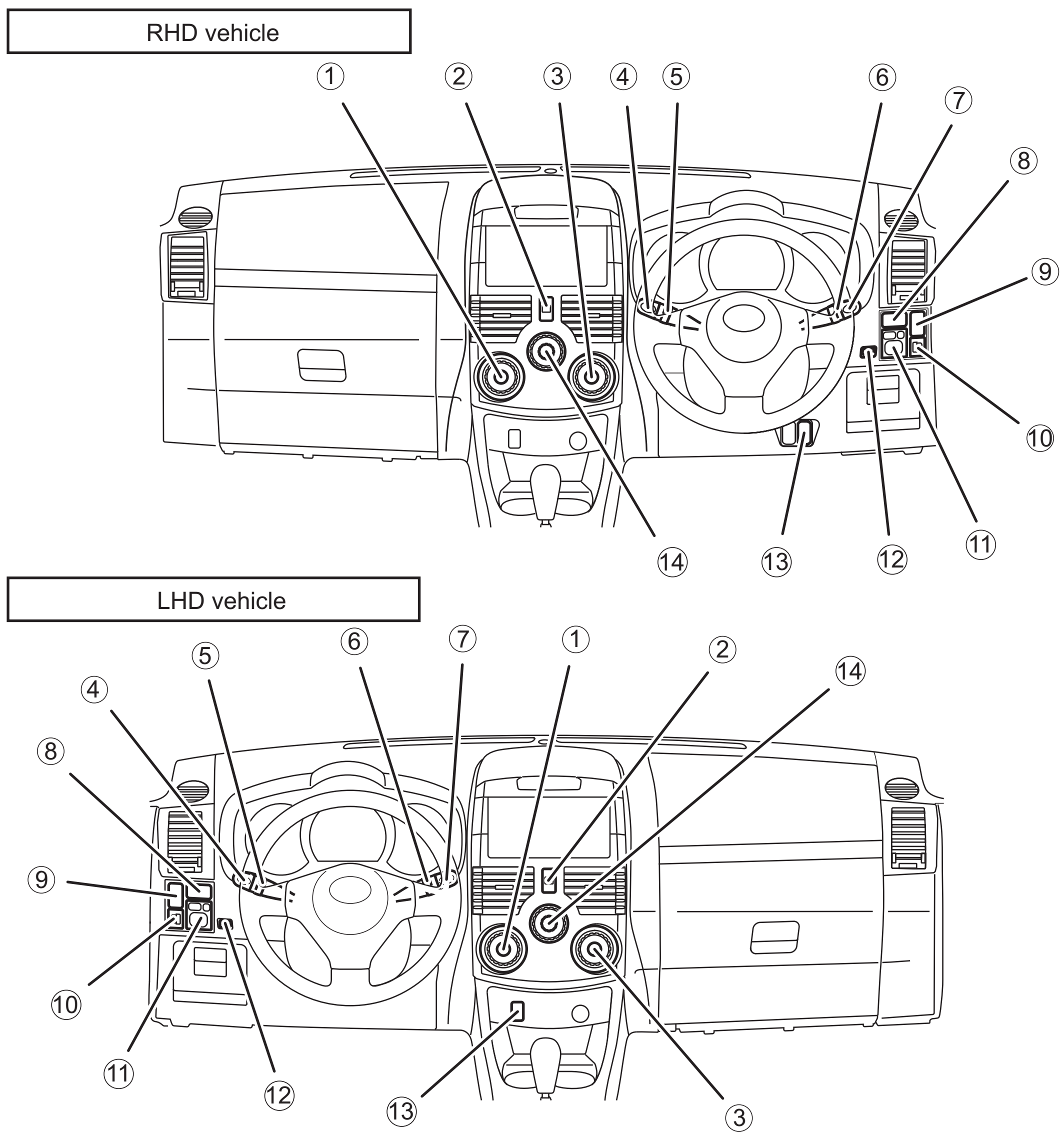
Antenna

- Every vehicle is provided with an antenna mounted at the front center of the roof.

OTHER ELECTRICAL UNITS

Switch Layout

- Switches are arranged on the instrument panel, around the driver's seat, to make them easier to use and operate.



Note: The illustration shows a representative example.

A1270114E-D

No.	Switch name	No.	Switch name
1	Fresh air/Air circulation selector dial*1	8	DAC and TRC OFF switch*2
2	Hazard switch		TRC OFF switch*3
3	A/C temperature control dial*1	9	Difflock switch*1
4	Rear wiper switch*1	10	Headlamp leveling switch*1

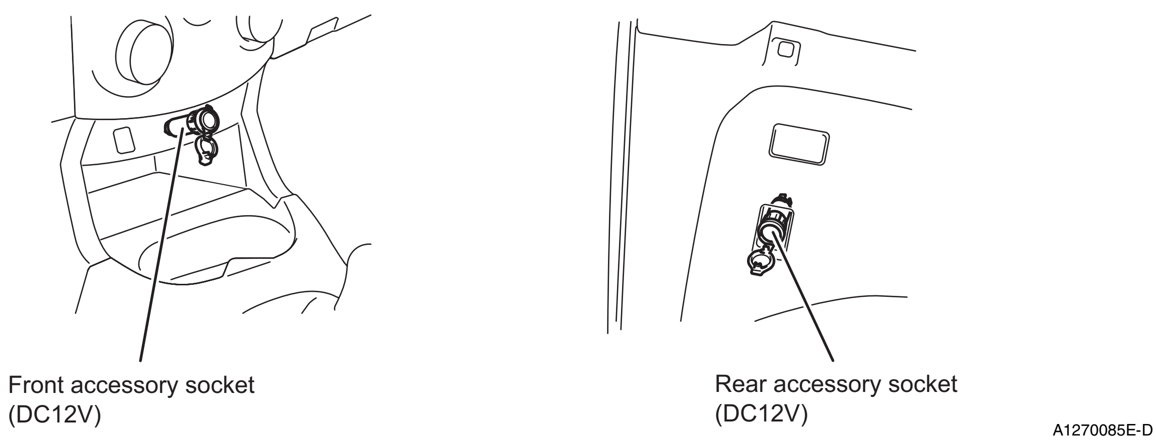
No.	Switch name	No.	Switch name
5	Front wiper switch	11	Mirror control switch
6	Fog lamp switch*1	12	Mode selector switch
7	Light control switch	13	Front deicer switch*1
		14	Blower changeover dial*1

❖REFERENCE❖

*1 : Vary from model to model.
*2 : Optionally available for A/T models
*3 : Optionally available for M/T models

Accessory Socket (DC12V)

- A front accessory socket for DC12V electrical appliances is provided for every model, and a rear accessory socket for some models.
- The front accessory socket is placed at the lower part of the center cluster, and the rear accessory socket on the deck side trim on the left side.



Accessory socket specifications

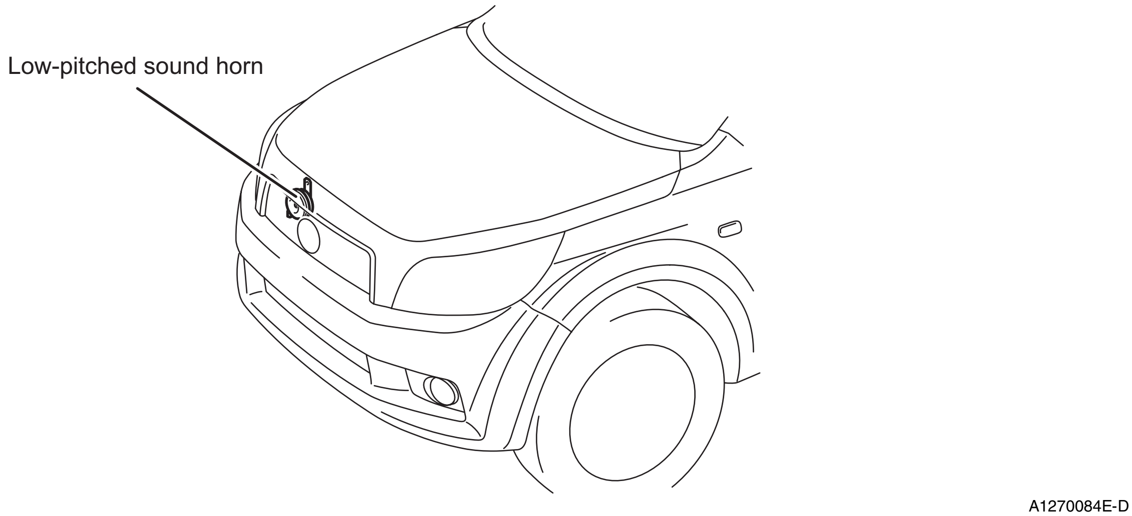
Items	Specifications
Rated voltage [V]	12
Maximum power consumption [W]	120 or less (total of front and rear)
Maximum current [A]	10 or less (total of front and rear)

Caution about use

Do not use the sockets when the engine is standing still. Do not use the sockets for electrical appliances of a voltage rating of 12 V which require a power of 120W or more a current of 10 A or more in total. Keep them capped when they are not in use.

Horn

- The vehicle is equipped with a compact, lightweight, flat, low-pitched sound horn.
- It is mounted on the radiator upper support on the right side of the vehicle.



Horn specifications

Items	Low pitched
Rated voltage [V]	12
Base frequency [Hz]	350±30
Sound pressure level [dB]	111±3
Operating current [A]	3±1

SECURITY AND LOCK SYSTEM

Power Door Lock System

● A power door lock system is provided as standard equipment for every model.

Table of power door lock system components

Principal functions	Outline
Driver's seat-coupled locking and unlocking function	Allows the driver to lock and unlock all doors at a time, using the door lock lever by the side of the driver's seat.
Door key-coupled locking and unlocking function	Allows the driver to lock and unlock all doors at a time by inserting a door key in the driver's door lock.
Key warning function	Prevents doors from being locked when the ignition key is left in the ignition switch.
Interior lamp turning off function*	Prevents the battery from going dead because a door is left half-open.

❖REFERENCE❖

* : Applicable only to the front interior lamp

Power door lock system components

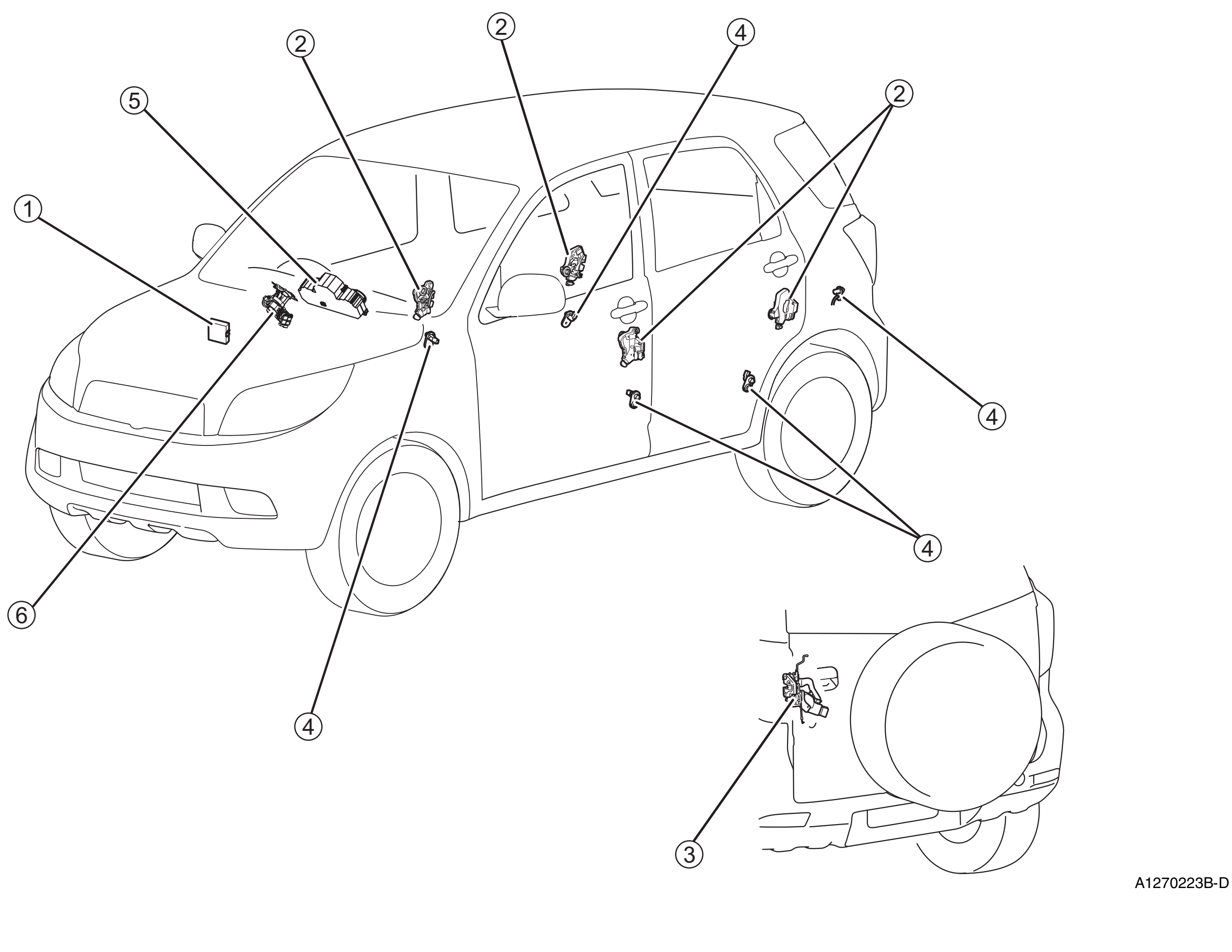
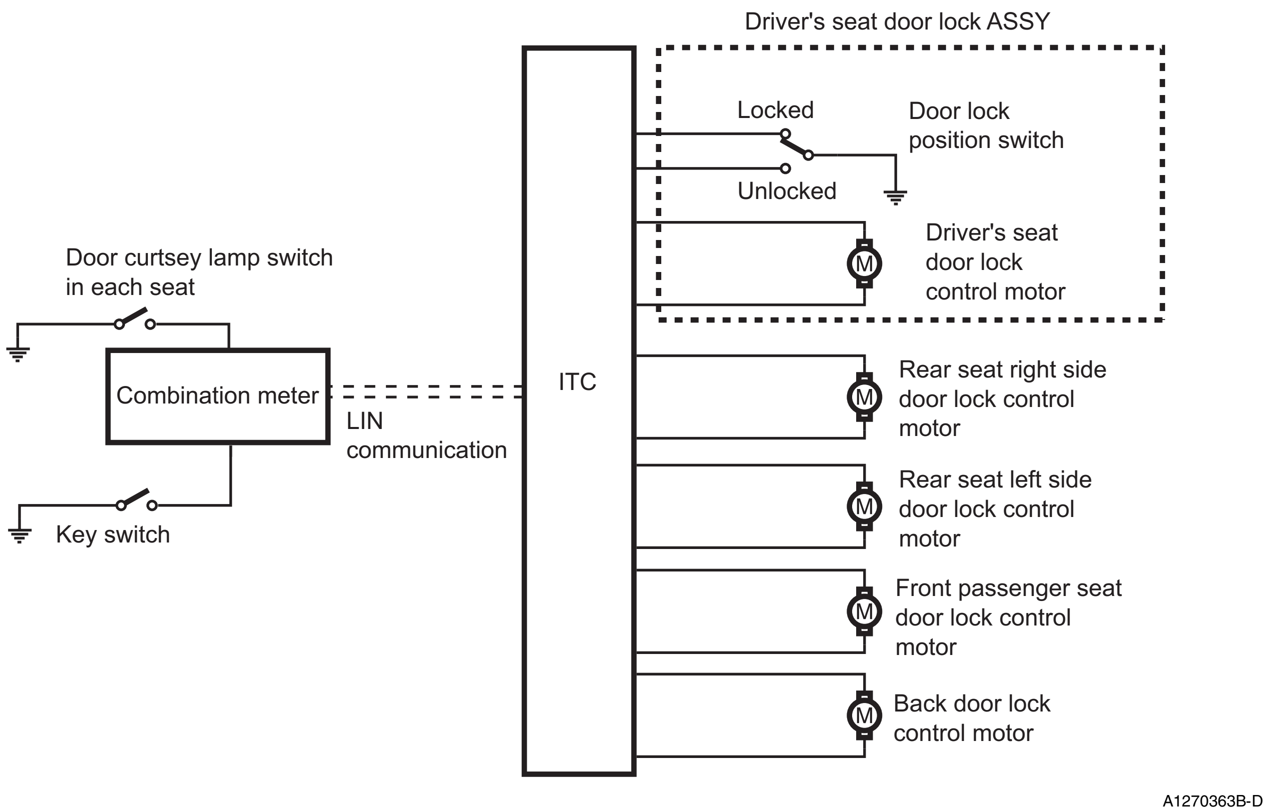


Table of power door lock system components and their principal functions

No.	Components	Principal functions
1	Body integration controller (ITC)	• Locks and unlocks the door on each seat under the control of signals from various switches and computers.
2	Door lock assembly on each seat	• Locks and unlocks the door by running the built-in motor in the forward or reverse direction. • Determines whether the door is locked or unlocked using the built-in door lock position switch, and sends signals to the body integration controller. (Only for the driver's seat)
3	Back door lock assembly	
4	Door courtesy lamp switch	• Determines whether the door is open or closed (open: ON, closed: OFF) and sends signals to the meter computer.
5	Combination meter (with a built-in meter computer)	• Sends signals indicating whether the door is open or closed and the position in which the key switch is placed to the body integration controller across the LIN network.
6	Key switch	• Determines whether the key is inserted in the ignition switch.

Power door lock system circuit diagram



Driver's Seat-coupled Locking (Unlocking) Operation

- When the door lock lever by the side of the driver's seat is tilted to the lock (unlock) side, the door position switch sends a signal to the body integration controller.
- When receiving this signal, the body integration controller runs the door lock motor on each seat to lock (unlock) all doors.

Opening of Driver Door Key-Coupled Lock

- If a mechanical key is inserted in the driver's door lock and turned to the lock (or unlock) side, the door lock position switch is turned to the Lock (Unlock) position. When receiving a signal indicating the ON/OFF state of the door lock, the body integration controller locks (or unlocks) all doors.

Actuation of Key Warning System

- If all the following conditions are satisfied, the key warning system immediately unlocks all doors locked by the door lock system in order to prevent the ignition key from being locked inside the vehicle.

• The ignition key is inserted in the ignition switch. (Key switch ON) • A door(s) is open. (Door courtesy switch ON) • The driver's door lock knob is switched from the Unlock position to the Lock position. (The driver's seat door lock position switch changes from the Unlock position to the Lock position.)

- One second after all the following conditions are met, the key warning system unlocks all doors to prevent the ignition key from being locked inside.

• The ignition key is inserted in the ignition switch. (Key switch ON) • The driver's door lock knob is in the LOCK position. (Driver's door lock position switch OFF) • A door(s) is open, and then all doors are closed. (Door courtesy switch turned from ON to OFF)

Interior Illumination Turning-off Function

- If a door(s) is left half-open for about 10 minutes when the interior lamp switch is in the DOOR position, the interior lamp* is automatically turned off to prevent the battery from going dead. After the interior lamp is automatically turned off, the Door function of the interior lamp switch is deactivated and ensures the interior lamp remains OFF until the ignition switch is turned on.

❖ REFERENCE ❖

* : Applicable only to the front interior lamp

Sleep and Wake-up Function

- The body integration controller has a Wake-up and Sleep function to reduce the amount of electric power consumed when the ignition switch is in the ACC or LOCK position.

Keyless Entry System

- A keyless entry system is provided for some models.
- To ensure security*, an encrypted code is used for weak radio waves (encrypted code) that are transmitted from the transmitter to the door control receiver.

❖ REFERENCE ❖

* : If 256 repeated attempts are made to unlock the doors using a transmitter(s) other than the regular transmitter, the keyless entry system rejects any transmitter unlocking operation to prevent theft. To recover the keyless entry system, repeat the unlocking operation 5 times using the regular transmitter.

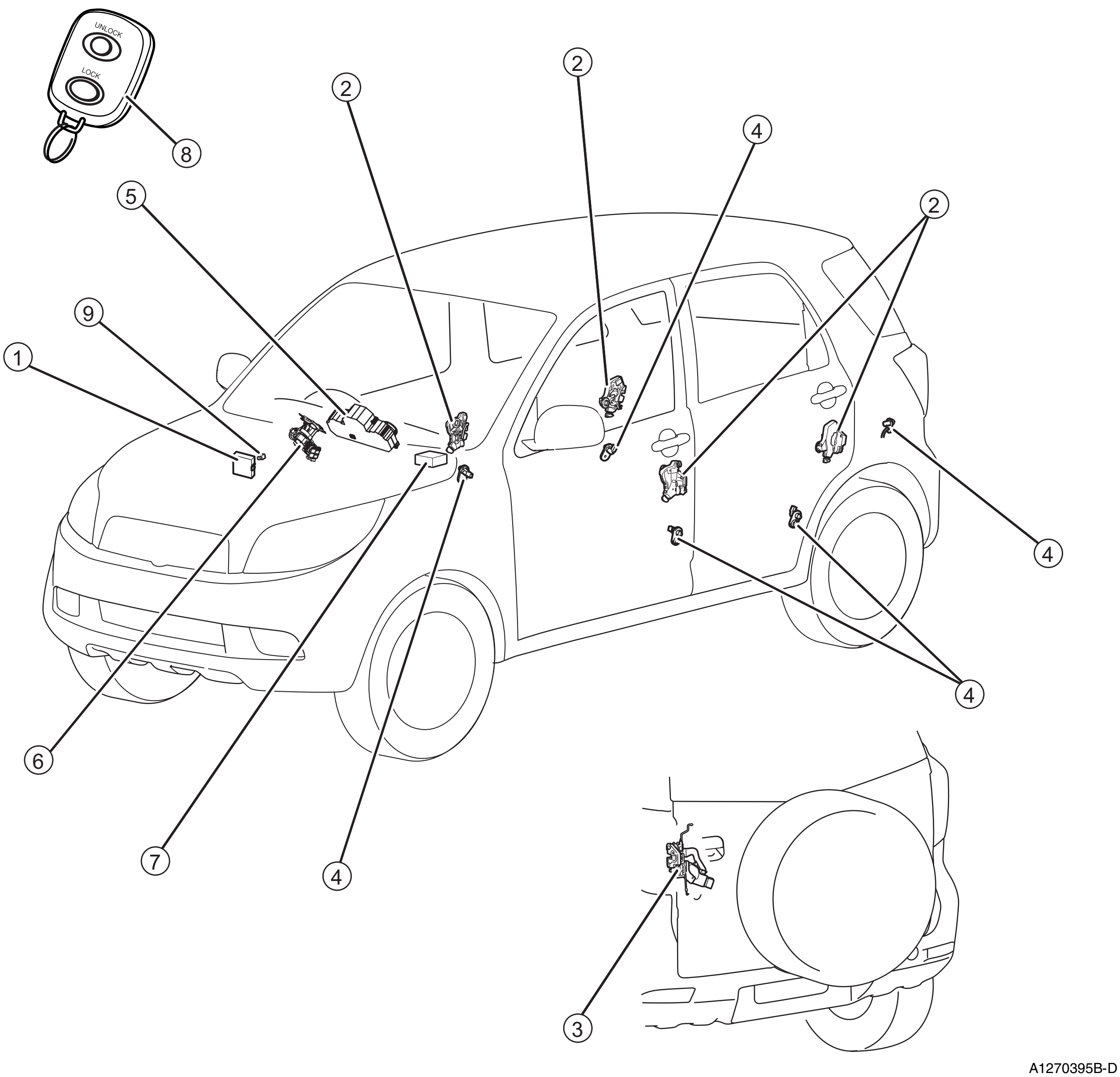
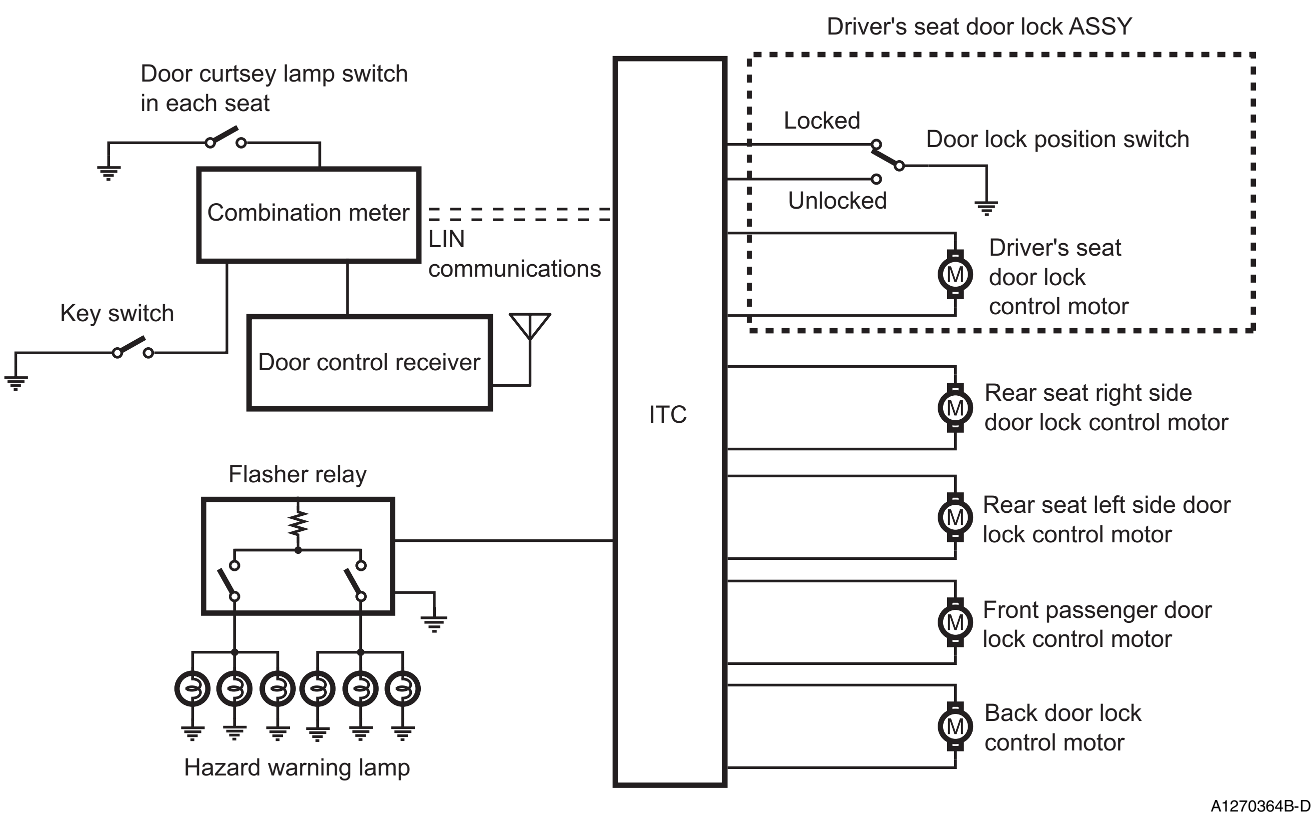


Table of keyless entry system components and their principal functions

No.	Components	Principal functions
1	Body integration controller (ITC)	• Locks and unlocks the door on each seat under the control of signals from various switches and computers.
2	Door lock assembly on each seat	• Locks and unlocks the door by running the built-in motor in the forward or reverse direction. • Checks with the built-in door lock position switch whether the door is locked or unlocked, and sends signals to the body integration controller. (Only for the driver's seat)
3	Back door lock assembly	
4	Door courtesy lamp switch	• Determines whether the door is open or closed (open: ON, closed: OFF) and sends signals to the meter computer.

No.	Components	Principal functions
5	Combination meter (with a built-in meter computer)	• Sends signals indicating whether the door is open or closed and the position in which the key switch is placed to the body integration controller across the LIN network. • Receives a door lock or unlock request signal from the door control receiver and transmits it to the body integration controller across the LIN network.
6	Key switch	• Checks whether the ignition key is inserted in the ignition switch or not.
7	Door control receiver	• Receives and identifies weak radio waves from the transmitter and sends a door lock or unlock request signal to the meter computer.
8	Transmitter	• Sends weak radio waves (identification code and function code) when the Lock or Unlock button is pressed.
9	Flasher relay	• Blinks the hazard warning lamp under the control of the body integration controller when receiving an answer back code.

Keyless entry system circuit diagram



30 Sec. Auto-Lock Function

- If the doors are left unlocked for about 30 seconds after unlocked by pressing the Unlock button on the transmitter, they are relocked automatically to prevent them from being left unlocked. The auto-lock function is canceled if one of the following conditions is met.

30-sec auto-lock function canceling conditions

- A door(s) is opened.
- All the doors are locked.
- The ignition key is inserted in the ignition switch.
- The ignition switch is turned on.

Function of Preventing Operation (When Doors are Open)

- When a door(s) is half-open or fully open or when a key is inserted in the ignition switch, this function prevents doors from being locked or unlocked with the keyless entry system.

Repeat Function

- If the keyless entry system fails, for some reason, to confirm whether all doors are locked securely (or unlocked), it tries to lock (unlock) the doors again after about 1 second.

Answer Back

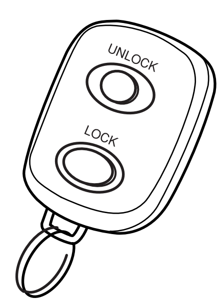
- The hazard warning lamp blinks once when all doors are locked securely by the keyless entry system, and it blinks twice when they are unlocked.

Activation of door lock

- When the Lock (Unlock) button is pressed, the transmitter sends a vehicle identification code and a function code by weak radio waves. When receiving these codes, the door control receiver checks the identification code against the vehicle identification code and identifies the function code. If it is determined that the identification code received matches the vehicle identification code and the function code received is a door lock (unlock) code, the door control receiver sends code data to the combination meter, which in turn transmits the data to the body integration controller through the LIN network.
- When receiving a lock (unlock) signal, the body integration controller runs all the door lock motors to lock (unlock) the doors.

Transmitter

- When the Send button is pressed, the transmitter sends an identification code by weak radio waves. There are 2^{69} codes in total, and codes assigned vary with the transmitter.
- The built-in button battery has a useful life of about 2 years when it is used to open and close a door 10 times each a day. The batteries are replaceable.
- The transmitter uses one CR1616 button battery.



Transmitter

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Outline of Security System

- An engine immobilizer that prevents the engine from being started with a key other than regular key registered in the vehicle is provided for some models.
- A security indicator lamp that indicates the operating status of the whole security system is employed and placed in the center warning indicator panel.

Engine Immobilizer System

- An engine immobilizer that prevents the engine from being started with a key other than the registered regular one is provided for certain models. It is aimed at preventing a vehicle from being stolen by the use of a duplicate key.
- The security indicator lamp that indicates the ON/OFF status of the engine immobilizer system is placed in the center warning panel.

Engine Immobilizer Function

- When the key is pulled out of the ignition switch, the security indicator lamp starts blinking at intervals of about 2 seconds (ON for 0.2 sec. and OFF for 1.8 sec.) to indicate that the engine immobilizer system is activated.
- When the key is inserted in the ignition switch, a magnetic field is created around the key cylinder. As a result, the transponder * (communications IC chip) built into the key grip issues an ID code, which is then checked against the ID code previously registered in the vehicle.
- If this check indicates that these ID codes match, the engine immobilizer system is deactivated, the security indicator lamp goes out and the engine is made ready for starting. In other words, if the ID code issued by the ignition key is not recognizable or the ID code does not perfectly agree with the registered one, the engine cannot be started.

❖REFERENCE❖

*IC that has the function of receiving radio waves of a certain frequency and of sending them back with their frequency changed.

Transponder Key

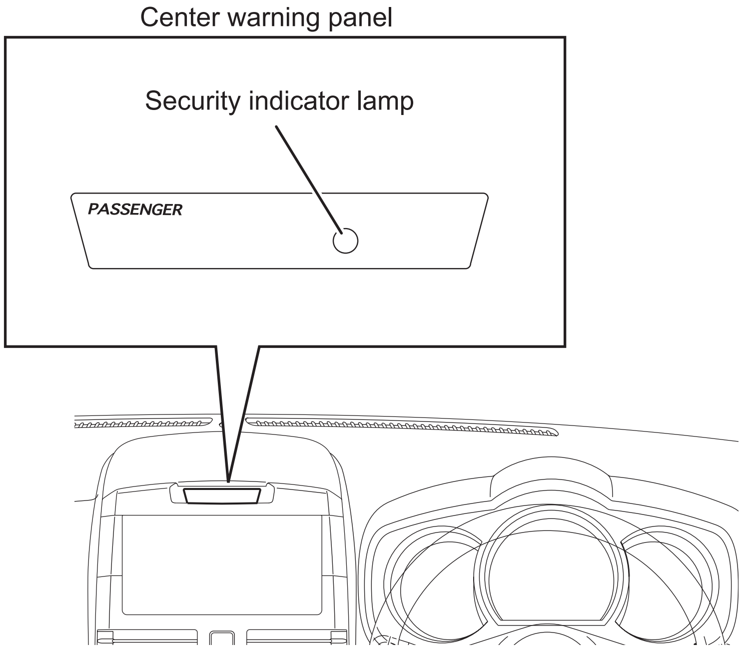
- A transponder* (communications IC chip) is mounted in the grip of the key with a built-in transponder. Therefore, if a strong impact is given to the key or the key is brought close to a magnetized object, the transponder may break or fail, causing the system not to function normally.
- A check of the ID code of the key against the vehicle ID code is made by means of electromagnetic waves. Therefore, if the key with a built-in transponder is inserted into the ignition key cylinder together with an ignition key for another vehicle or a steel plate, the system may not function.
- If a system-related part is replaced, all the keys with a built-in transponder you have need to be registered again.

❖REFERENCE❖

* : IC that has the function of receiving radio waves of a certain frequency and of sending them back with their frequency changed.

Security Indicator Lamp

- The security indicator lamp that indicates the ON/OFF status of the engine immobilizer system is placed in the center warning panel.
- When the engine immobilizer is turned on, the security indicator lamp starts blinking at intervals of about 2 seconds: ON for about 0.2 sec. and OFF for about 1.8 sec.
- This indicator lamp employs an LED (Light Emitting Diode) requiring a very small amount of power.



- The security indicator lamp is controlled by the immobilizer ECU.

Security indicator lamp and ON/OFF status of engine immobilizer system

Security indicator lamp	ON/OFF status of engine immobilizer system
OFF	Deactivated (Engine ready to start)
Blinks	Activated (Immobilizer in operation)

TO FOREWORD

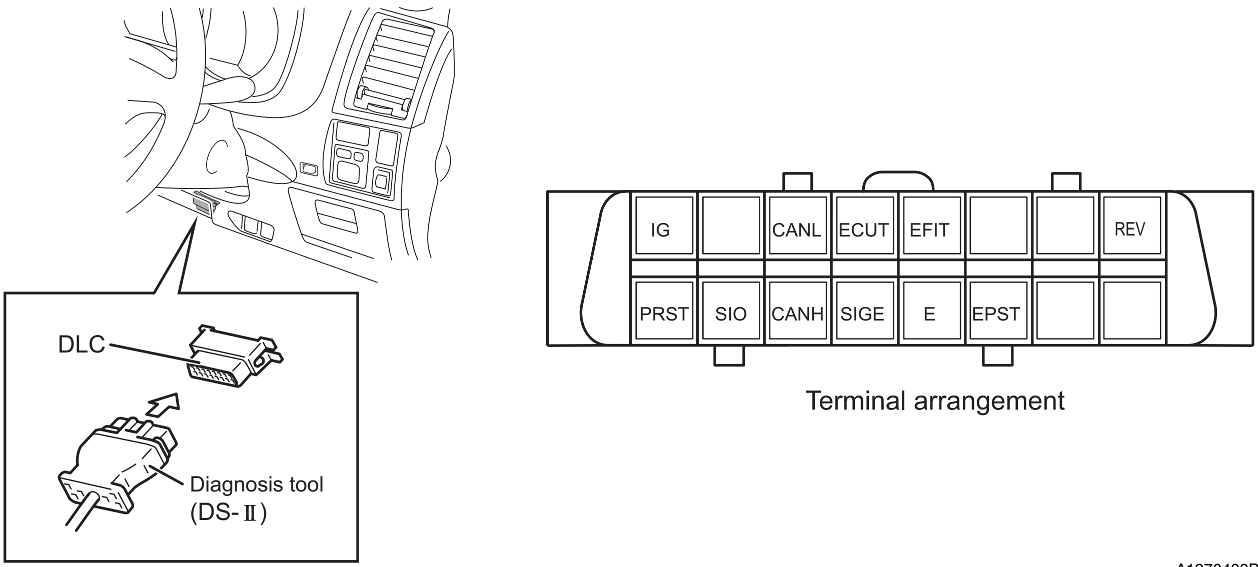
CONTROL SYSTEM

CAR-MOUNTED MULTIPLEX COMMUNICATION SYSTEM

CAR-MOUNTED MULTIPLEX COMMUNICATION SYSTEM

DLC (Data Link Connector)

● The DLC connector (DLC: Data Link Connector) is used to connect the diagnosis tool DS-II that provides access to each ECU. Using this connector along with a DS-II makes it possible to put out diagnosis codes, to monitor various kinds of data (including a check of ECU data), to conduct active tests (to operate actuators individually), and so on. For more information, refer to the service manual.



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CAN Communication System

● Every model employs a CAN* [ISO11898] communications system which converts multiple items of information and data into digital signals in its communications circuits and transmits them through a pair of communications cables (twisted-pair cables). Unlike systems which requires input devices (sensors, switches, etc.), control units, and output devices (motors, etc.) to be connected one to one, this system allows a reduction in the quantity of wire harness and the sliming down of the electronic control system.

❖ REFERENCE ❖

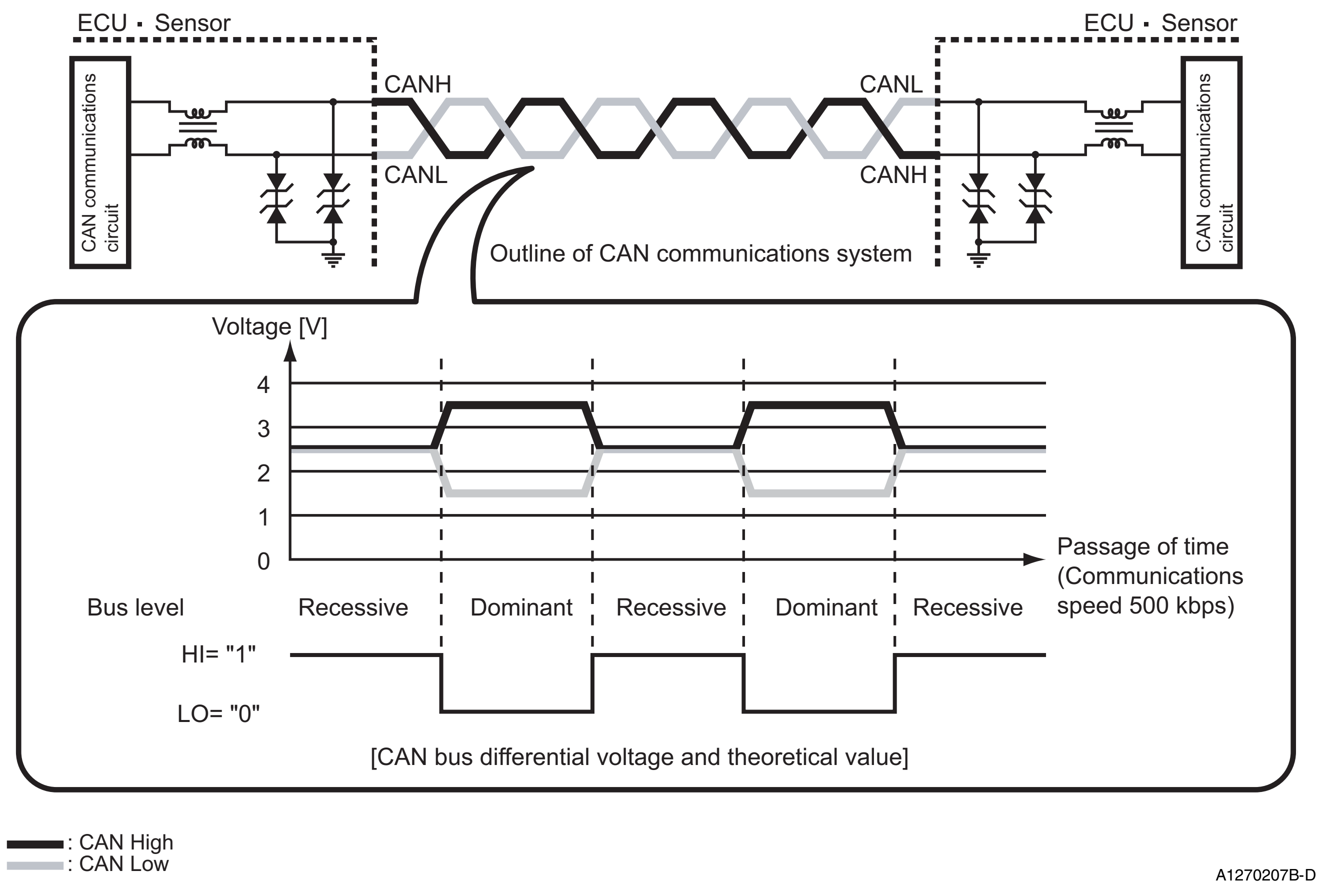
* : CAN, an acronym for Controller Area Network, is a serial communications network compliant with ISO (International Organization for Standardizations) standards.

● The CAN communications system determines the bus level*1 from the differential voltage between a pair of two communications cables (bus): CAN High and CAN Low, converts it into digital signals and transmits the digital signals at a rate of 500 kbps*2 in accordance with the dedicated communications protocol (communications rules).

❖ REFERENCE ❖

*1 : There are two bus levels: dominant level and recessive level. In the CAN communications system, a dominant lever is logically assumed to be a 0, and a recessive level to be a 1.

*2 : A unit of measurement for transmission speed of signals. 500 kbps means that 500,000 bits of data is transmitted per second.



CAN Communication Network

- The CAN communications system uses a bus network in which multiple computers are connected to each other through two shared communications cables, and the cables connecting the meter computer to the engine control computer are referred to as the bus (shared communications line).
- Two terminating resistors (120Ω) are installed on the bus. The terminating resistors enable the system to determine differential voltages in the network connected in a loop form.

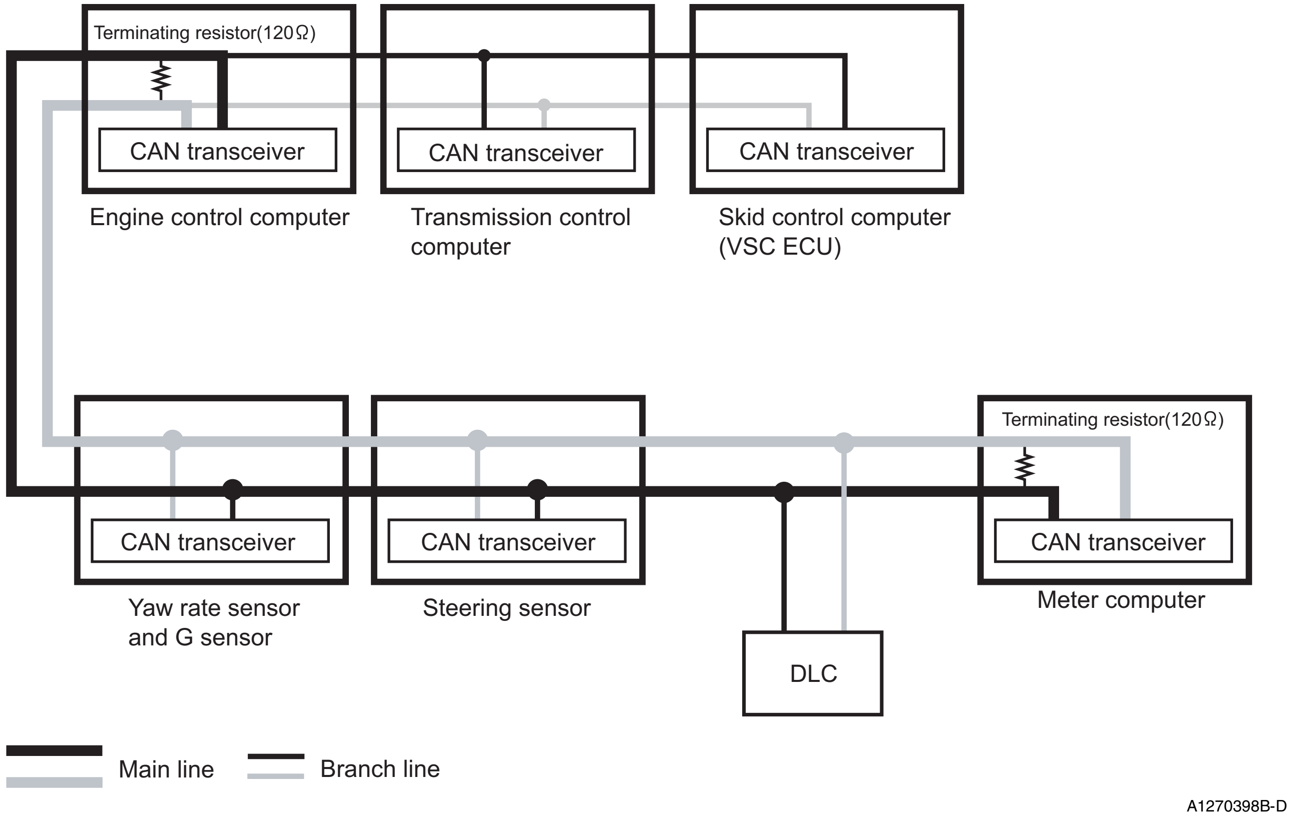


Table of computers (ECU) and sensors incorporated in CAN communications system

No.	Computers and sensors	Principal functions
A	Engine control computer	• Provides engine speed data etc.
B	Transmission control computer	• Controls the automatic transmission.
C	Skid control computer(VSC ECU)	• Controls the ABS, the brake assist system, etc.
D	Meter computer	• Provides vehicle speed data, switch data, etc.
E	Steering sensor	• Senses the steering angle and the direction of wheel heading.
F	Yaw rate sensor and G sensor	• Sense the decelerations in the longitudinal and lateral directions of the vehicle.
G	DLC (Data Link Connector)	• Used to connect a diagnosis tool for inspections through CAN communications network. • Used to connect an electrical tester for continuity tests of the CAN communications bus.

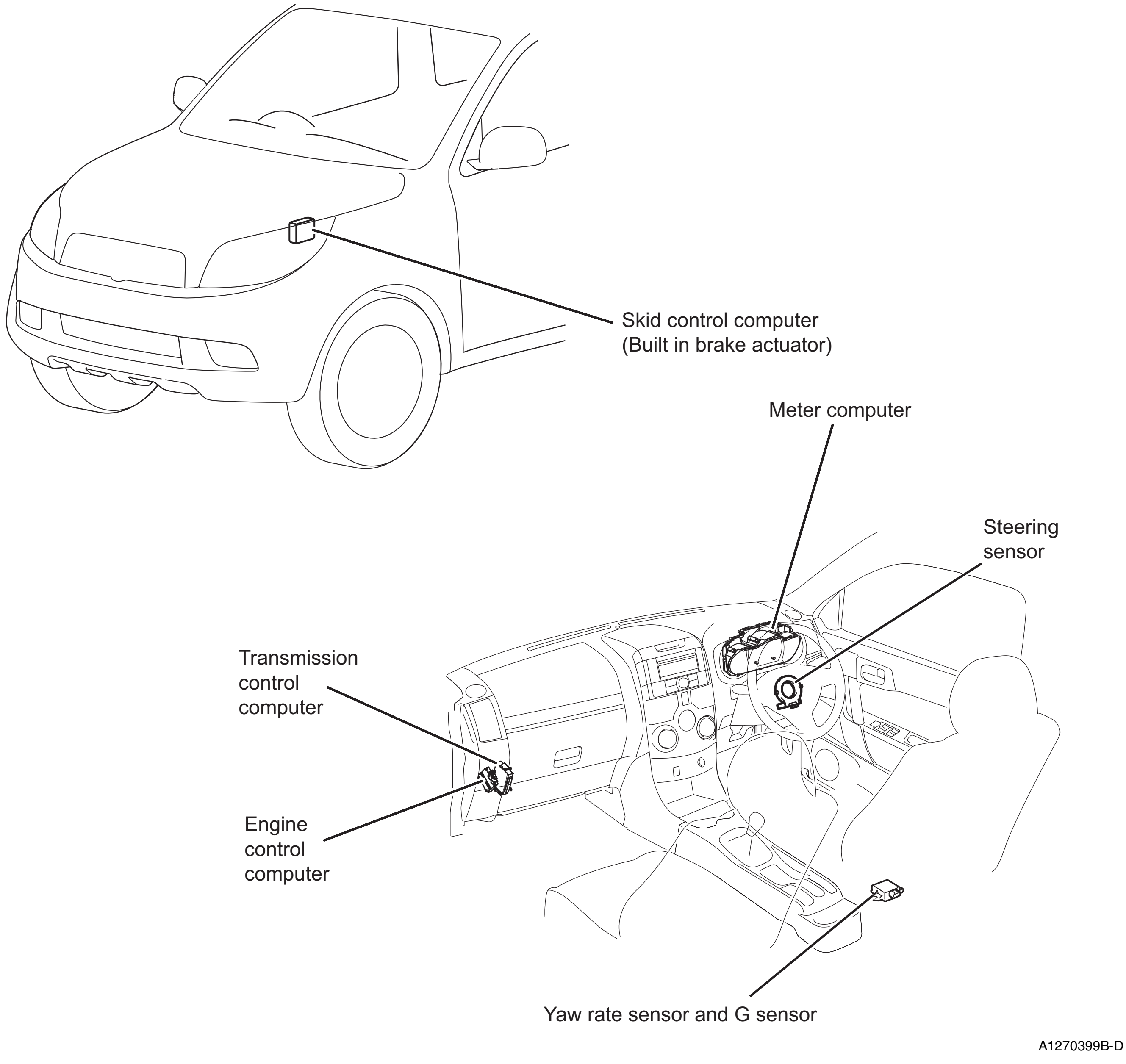
Table of CAN communications control signals (A, B, C ... at the top correspond to A, B, C ... in the above table.)

Signal names	A	B	C	D	E	F
Engine speed	●	❍	❍	❍		
Quantity of fuel injected	●			❍		
Throttle opening	●	❍	❍			

Signal names	A	B	C	D	E	F
Engine torque	●	❍				
Water temperature	●	❍				
Engine cooling water temperature	●	❍		❍		
Outside air temperature	●	❍		❍		
Vehicle speed signal	❍	●		❍		
Torque reduction request	❍	●				
Shift position information	❍	●	❍	❍		
O/D OFF information		●		❍		
A/T warning request		●		❍		
A/T learned value clearing completion		●		❍		
ATF oil temperature	❍	●				
Vehicle speed signal	❍		●			❍
Torque down request	❍		●			
Brake warning request			●	❍		
ABS warning request			●	❍		
Slip indicator lamp request			●	❍		
VSC OFF warning request			●	❍		
VSC warning buzzer request			●	❍		
DAC (Downhill Assist Control System) warning request			●	❍		
DAC (Downhill Assist Control System) ON switch			❍	●		
TRC OFF switch			❍	●		
Parking brake switch			❍	●		
ECU-T terminal		❍	❍	●		
Tail switch	❍			●		
Meter vehicle speed output	❍			●		❍
Steering angle			❍		●	
Yaw rate			❍			●
Magnet clutch activation request	❍					

❖REFERENCE❖
●: Sender, ❍: Receiver

CAN Communication System Configuration



CAN Communication Protocol (Communication Rules)

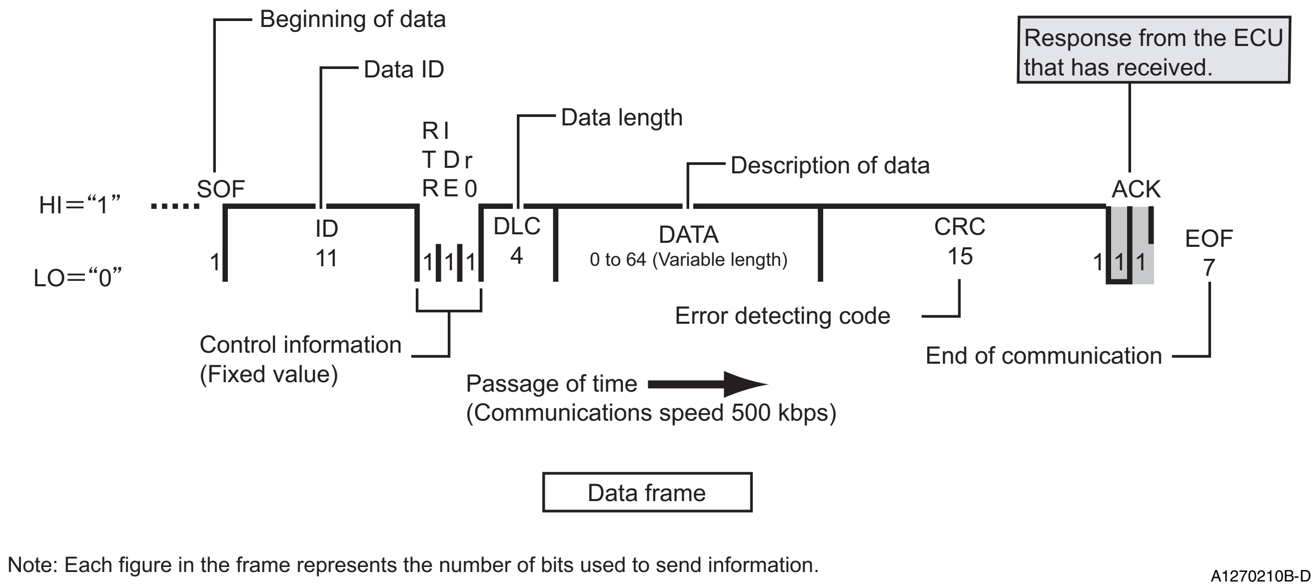
- The CAN communications system is a time-division multiplexing two-way communications system which allows every computer (ECU) and sensor constituting the network to send and receive data sequentially through a pair of communications cables (bus). To ensure smooth communications, therefore, every ECU and sensor needs to communicate in accordance with the common communications protocol (communications rules).
- The CAN communications protocol uses CSMA/CD (Carrier Sense Multiple Access with Collision Detection) scheme* as the technique for sending data to the communications line to allow every ECU and sensor to send and receive data, sharing a pair of communications cables.

❖REFERENCE❖

* : Carrier Sense Multiple Access with Collision Detection: A communications access control scheme in which each ECU is always placed in a state of readiness

to sense the condition (carrier waves) of the communication line as ECUs can send data only when the line is free. In addition, if a data collision occurs (two different ECUs sent data simultaneously), this control allows each ECU to send data again after a specified period of time.

- Each ECU and sensor can send data only when no data is being transmitted through the CAN bus. However, if two or more ECUs or sensors send data at the same time, the system sets priorities for data transmission based on the ID information contained in the data sent by each ECU.
- One frame of data used in the CAN communications system consists of ID, DLC, DATA, CRC and ACK, etc.



LIN Communication System

- Every model employs a LIN system which converts multiple items of information and data into digital signals and transmits them over a single communications line. Unlike systems which requires input devices (switches etc.) and output devices (motors etc.) to be connected one to one, this communications system allows a reduction in the quantity of wire harness and the slims down the electronic control system.
- A LIN communications circuit is composed of one computer (master node) which gives instructions to each control computer, and one or more computers (slave node) which performs control according to the instructions from the master node.
- The LIN communications system employs a single master scheme in which each slave node receives control instruction signals from the master node, sends signals according to the instructions, and controls the operation of the actuator(s) connected to it. Therefore, slave nodes do not send signals or operates actuators, unless they receive instructions from the master node.
- The master node keeps track of the state of connection of each ECU to communicate with, and if it finds that an ECU is incapable of communications, it instructs all other ECUs confirmed to be connected normally to perform control in disregard of the failed ECU. If the disabled ECU has recovered from an error and sends back a response again, then the master node sends normal control instruction signals to communicate with all ECUs.

LIN Communication Network

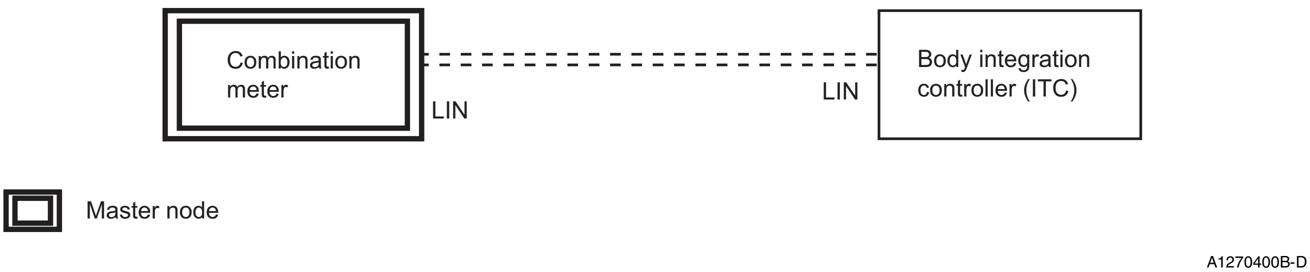


Table of computers (ECU) and sensors incorporated in LIN communications system

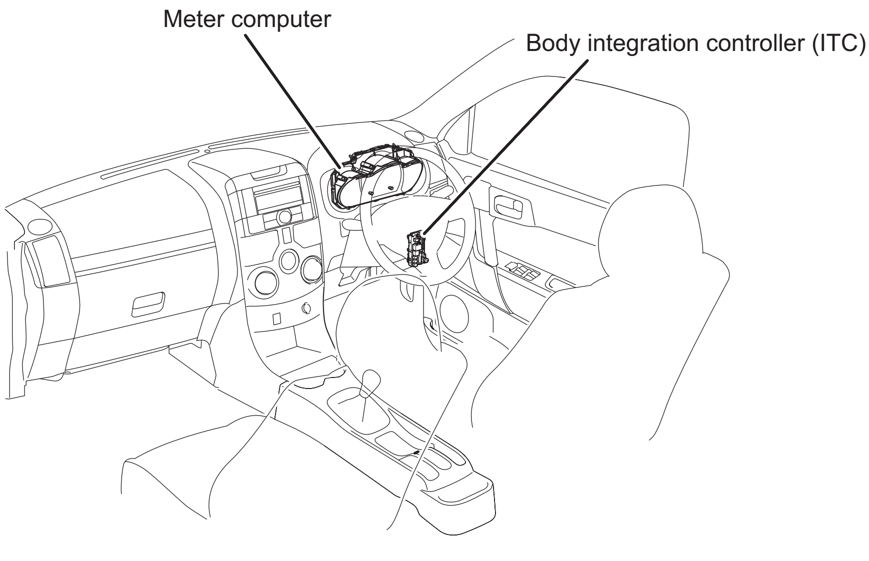
No.	Computers and sensors	Principal functions
A	Meter computer	• Provides vehicle speed data etc.
B	Body integration controller (ITC)	• Controls the door locks etc.

Table of LIN communications control signals (A, B at the top correspond to A, B of the above table.)

Signal names	A	B
Keyless door lock/unlock signal	●	❍
ECU-T terminal signal	●	❍
Half-open door signal	●	❍
Key switch signal	●	❍
Tail switch signal	●	❍
Vehicle speed signal	●	❍
Driver's door lock position signal	❍	●
Unlock answer back ON signal	❍	●
Sleep prevention request signal	❍	●
Multi-purpose buzzer setting off request signal	❍	●

❖REFERENCE❖
●: Sender, ❍: Receiver

LIN Communication System Configuration



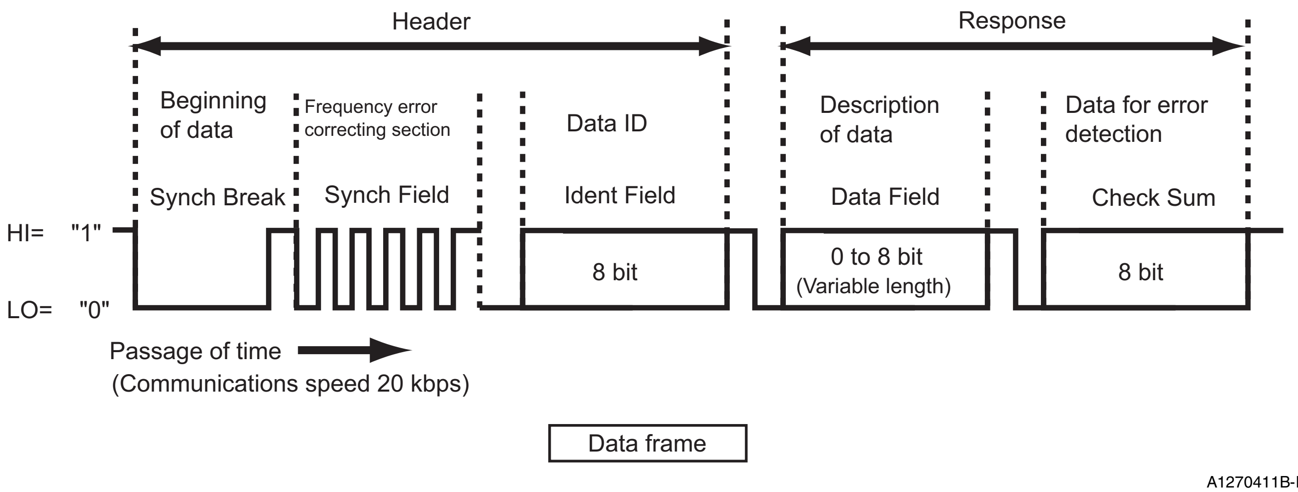
LIN Communication Protocol

- The LIN communications system is a time-division multiplexing one-way communications system in which each ECU sends multiple items of data one at a time over a single communications line.
- Each control computer connected to the bus (communications line) receives signals while sensing changes in bus level*1 caused by the transmission of signals.
- The LIN system handles two kinds of data: headers sent by the master node and responses sent by slave nodes, and it transmits these data types at a maximum rate of 20 kbps. *2
- A header is composed of three fields: Synch Break that indicates the start of a frame, Synch Field used to correct the frequency error between slave nodes, and Indent Field that specifies data.
- A response is composed of two fields: Data Field that contains control signals from a slave node, and Check Sum used to detect an error.

❖ REFERENCE ❖

*1 : There are two bus levels: a dominant level and a recessive level. In the LIN communications system, a dominant lever is logically assumed to be a 0, and a recessive level to be a 1.

*2 : A unit of measurement for transmission speed of signals. One kbps means that 1,000 bits of data are transmitted per second.



Sleep and Wake-up Function

- When a specified period of time has elapsed after the IG (or ACC) switch was turned off or when all ECUs on the communications line have finished control, sleep control (switching to energy saving mode) is performed to reduce the amount of dark current.
- If an ECU determines during sleep control that the control start conditions set for it are satisfied, the ECU sends a wake-up signal to all other ECUs, restarting the whole LIN communications system.