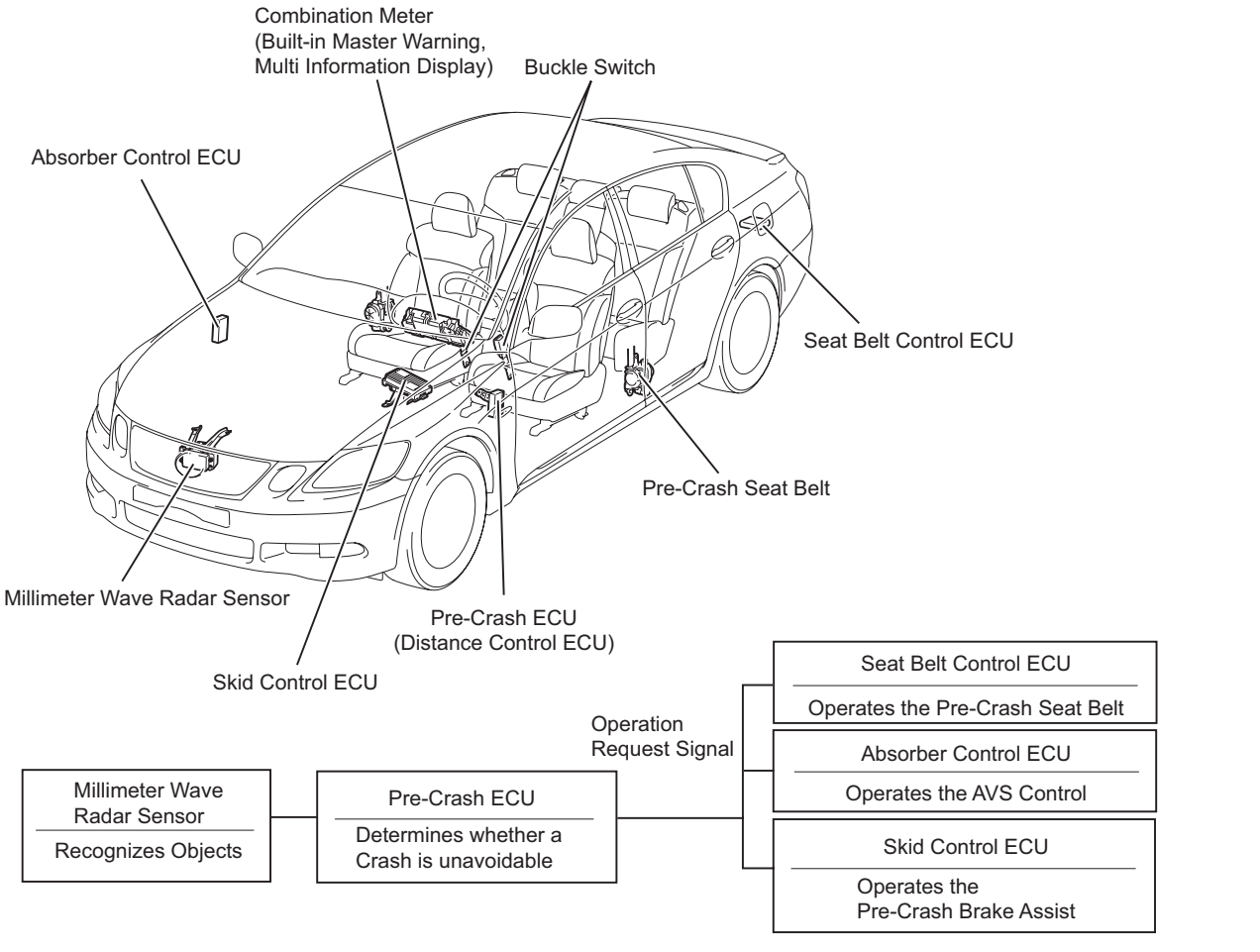
PRE-CRASH SAFETY

Pre-Crash Safety System Outline

- On all models, a (radar type) Pre-Crash Safety System with a millimeter wave radar sensor is available as an optional equipment.
- The Pre-Crash Safety System predicts a crash with a vehicle or obstacle in front of the driven vehicle, retracts the seat belts before a crash, and effects brake assist control, in order to lighten the impact in case of a crash.



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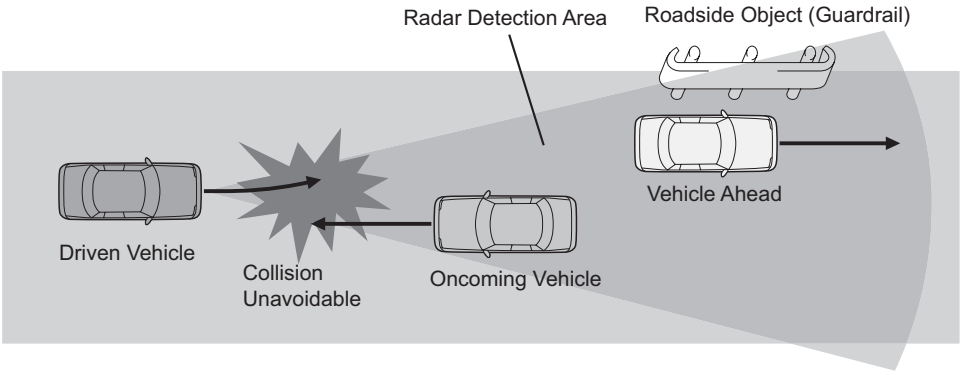
Main Components and Functions

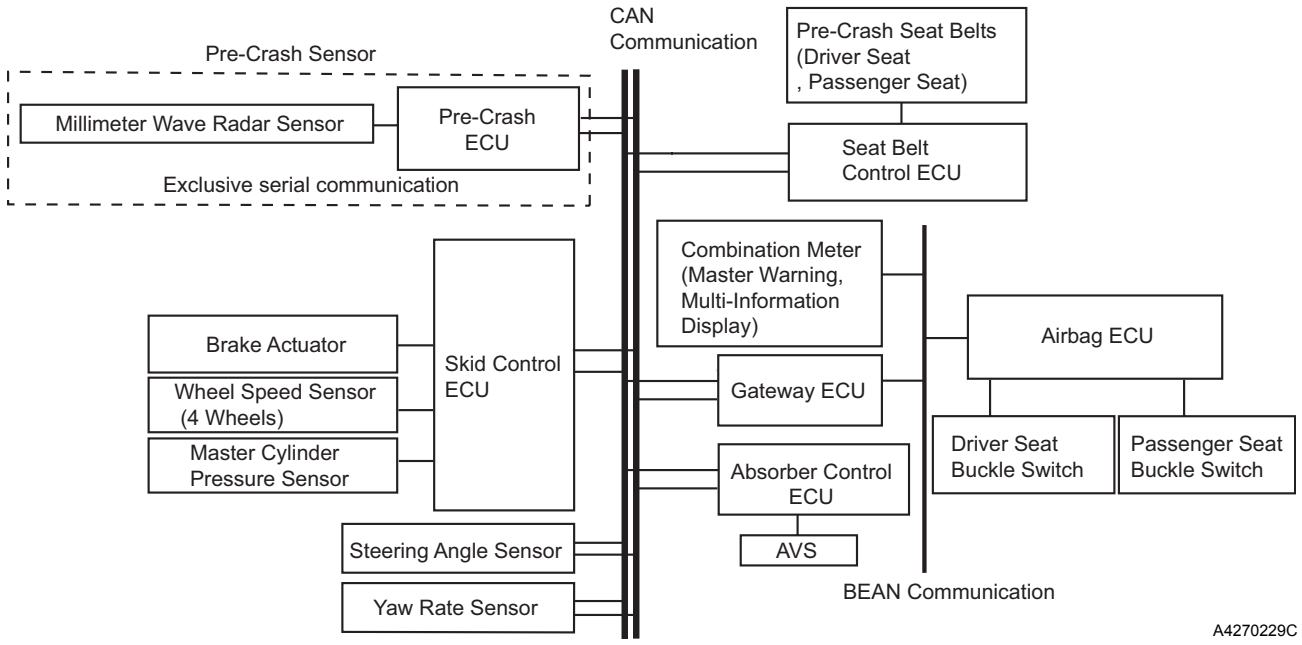
Components	Functions
Millimeter Wave Radar Sensor	Transmits and receives millimeter waves to recognize obstacles.
Pre-Crash ECU(Distance Control ECU)	Determines whether a crash is unavoidable based on information provided by various sensors, and sends an operation request signal.
Skid Control ECU	Sends a control signal to the brake actuator, based on a signal received from the Pre-Crash ECU.
Master Warning, Multi Information Display	Informs the driver of the state of the system.
Absorber Control ECU	Effects AVS control based on a signal received from the Pre-Crash ECU.

Components	Functions
Seat Belt Control ECU	Effects pre-crash seat belt control based on a signal received from the Pre-Crash ECU.
Pre-Crash Seat Belt	Operates a motor to retract the seat belt before a crash.
Buckle Switch	Detects whether the seat belt is buckled or not.

Pre-Crash Safety System Operation Outline

- The millimeter wave radar sensor recognizes a vehicle or an obstacle along the course of the vehicle. The Pre-Crash ECU determines whether a collision is unavoidable based on the position, speed, and course of the object.
- The Pre-Crash ECU transmits this information to the seat belt control ECU, absorber control ECU, and skid control ECU through the CAN (Controller Area Network), in order to operate the respective controls of the Pre-Crash Safety System.

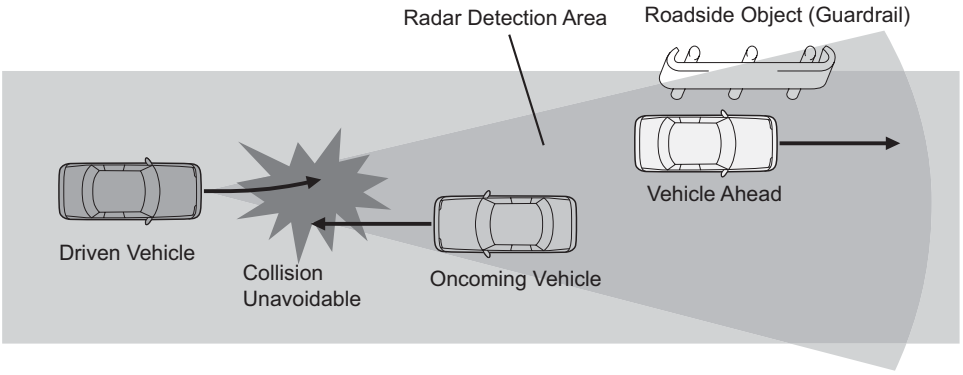


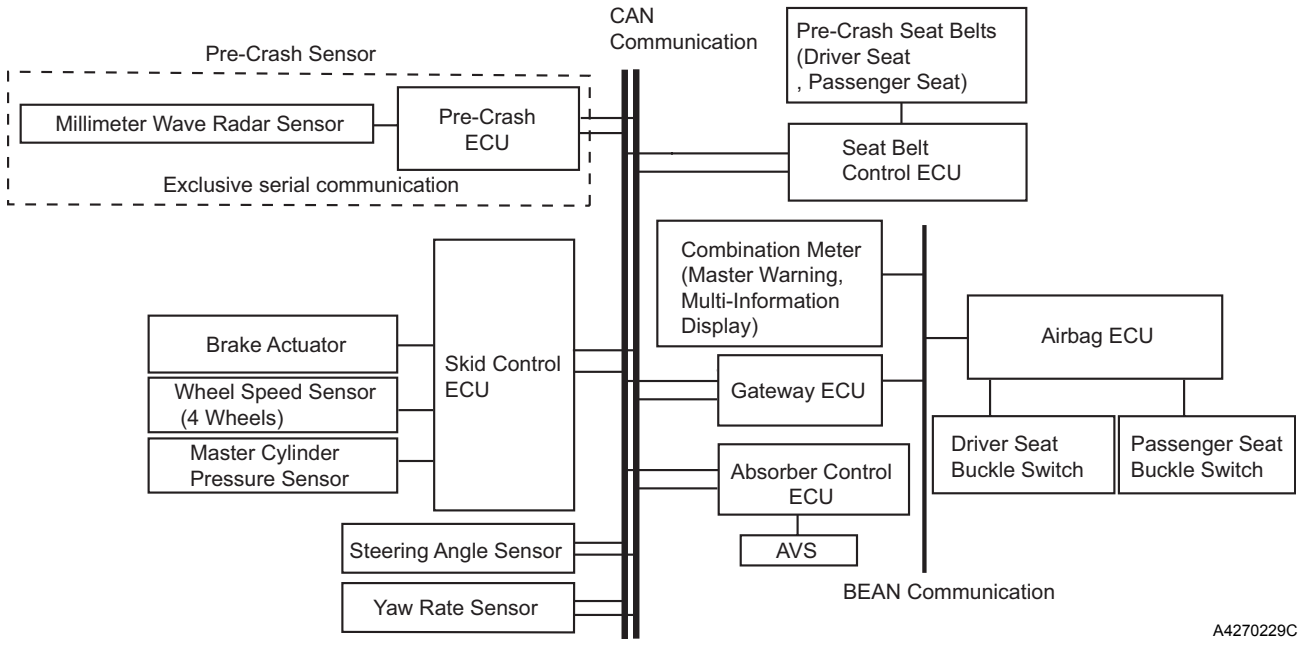


Components	Functions
Seat Belt Control ECU	Effects pre-crash seat belt control based on a signal received from the Pre-Crash ECU.
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Pre-Crash Safety System Operation Outline

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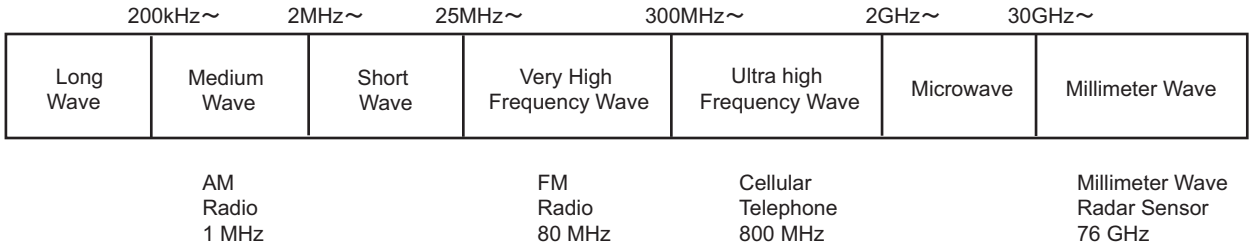


Control list

Control	Contents
Pre-Crash Seat Belt	If the Pre-Crash ECU determines that a collision is unavoidable, the motor retracts the belt to enhance the effectiveness of the pretensioner.
Pre-Crash Brake Assist Control	If the Pre-Crash ECU determines that a collision is unavoidable, this control provides assist by increasing the brake hydraulic pressure, thus enhancing the effectiveness of braking when the driver presses on the brake pedal.
AVS Control	If the Pre-Crash ECU determines that a collision is unavoidable, it sets the suspension shock absorbers to an appropriate amount of damping to suppress the nose dive that occurs during braking.

Millimeter Wave

- The millimeter waves occupy an extremely high frequency band of 30 to 300 GHz. Their wavelengths in a vacuum are extremely short, between 1 to 10mm. The millimeter waves are less likely to be affected by conditions such as rain, fog, or snow, and are able to exhibit superior performance to recognize objects. The pre-crash safety system uses a radar in the 76 GHz band.

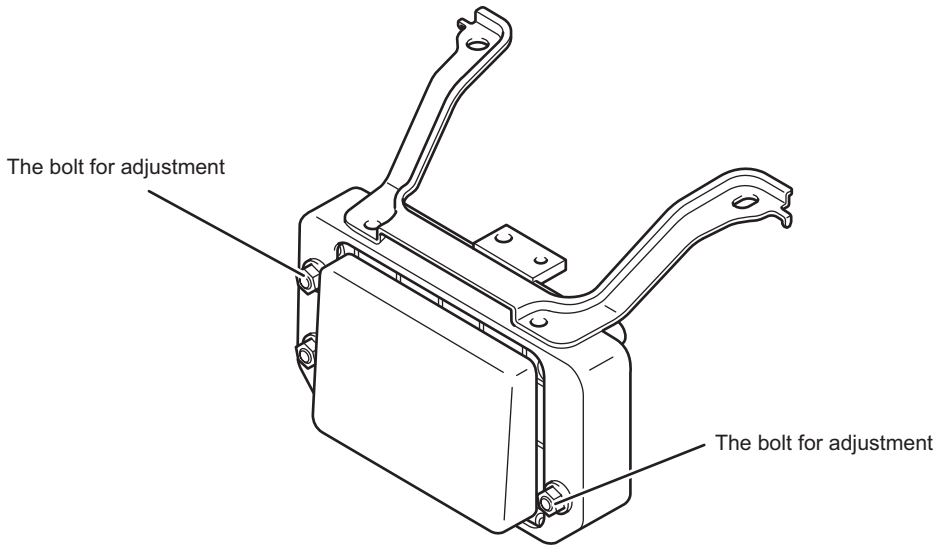


Main Wave Types and Frequencies

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Millimeter Wave Radar Sensor

- The millimeter wave radar sensor is installed behind the front grille.
- To adjust the millimeter wave radar sensor, do so carefully using an Intelligent tester II and a level.



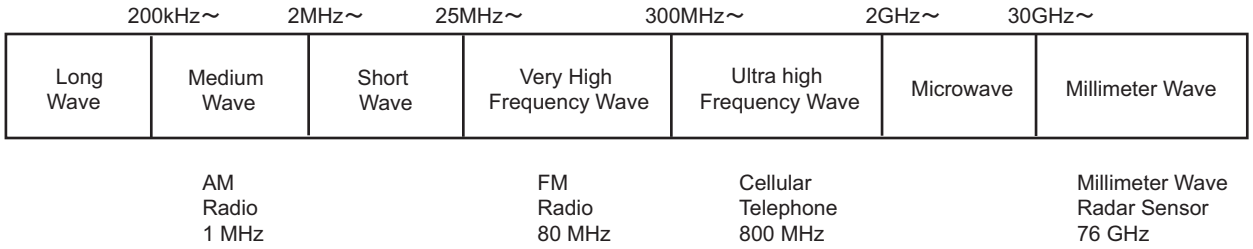
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Control list

Control	Contents
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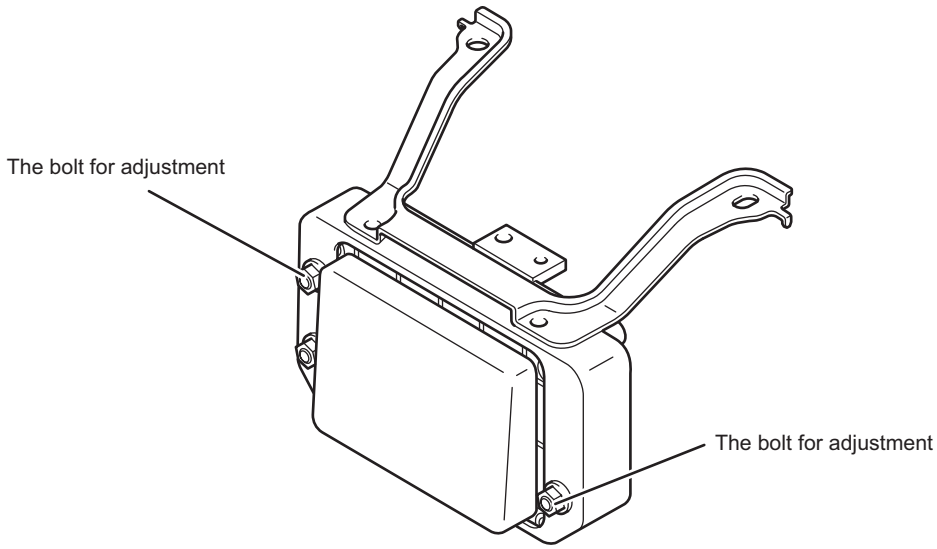


Main Wave Types and Frequencies

A4270170C

Millimeter Wave Radar Sensor

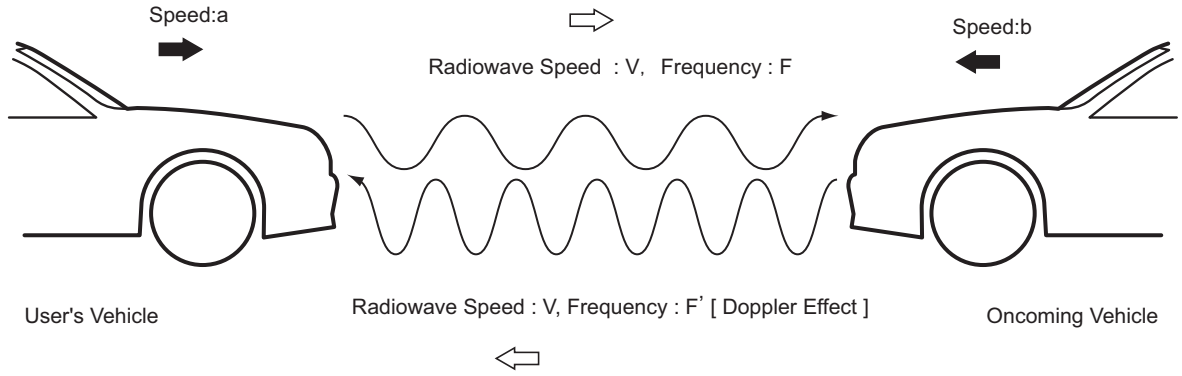
- The millimeter wave radar sensor is installed behind the front grille.
- To adjust the millimeter wave radar sensor, do so carefully using an Intelligent tester II and a level.



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Detection Method for Relative Distance and Relative Speed

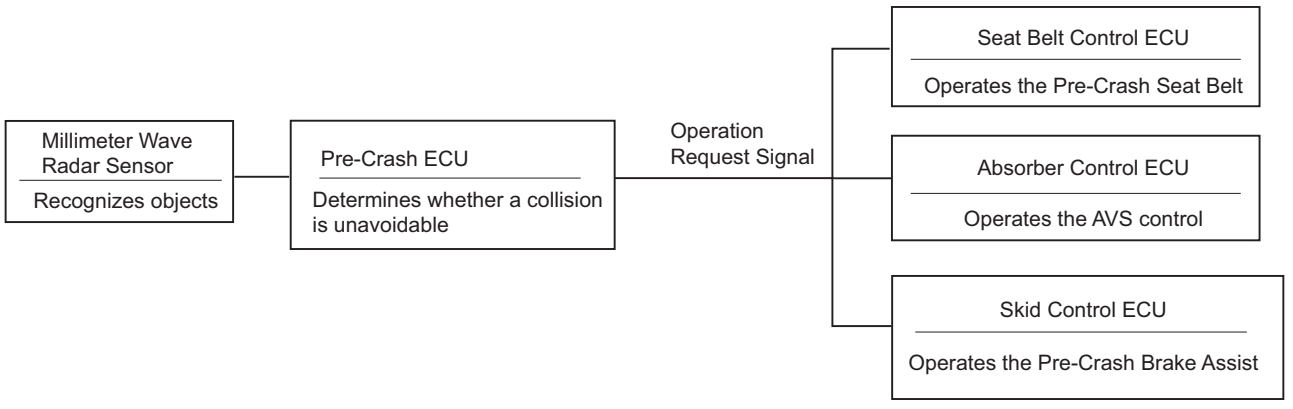
- If an object is present within range of the millimeter wave radar sensor, the radar detects the distance to the object, the relative speed, and the direction based on the reflected waves. Based on these pieces of data, the Pre-Crash ECU determines whether a collision is unavoidable.
- The radar uses the angle of the reflected waves to detect the direction to the object, the length of time that elapses after the radiowaves are emitted and the reflected waves return to detect the distance, and the changes in the frequency (the Doppler effect) of the reflected waves to detect the speed of the object.
- Along a curve, the system estimates the radius of the curve based on data provided by the yaw rate sensor and the steering angle sensor, and makes appropriate corrections to the course of travel.



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Pre-Crash ECU

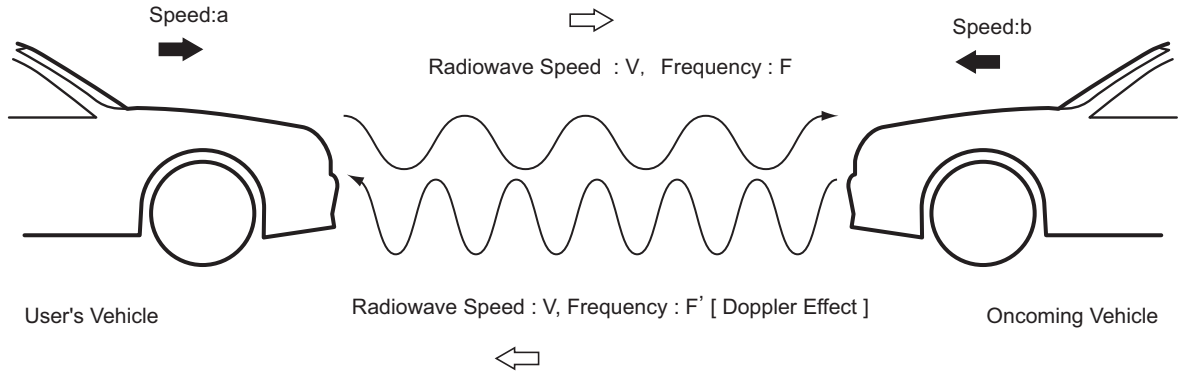
● This ECU recognizes an obstacle through the millimeter wave radar sensor, determines whether a collision is unavoidable, and sends an action request signal to the ECUs.



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Detection Method for Relative Distance and Relative Speed

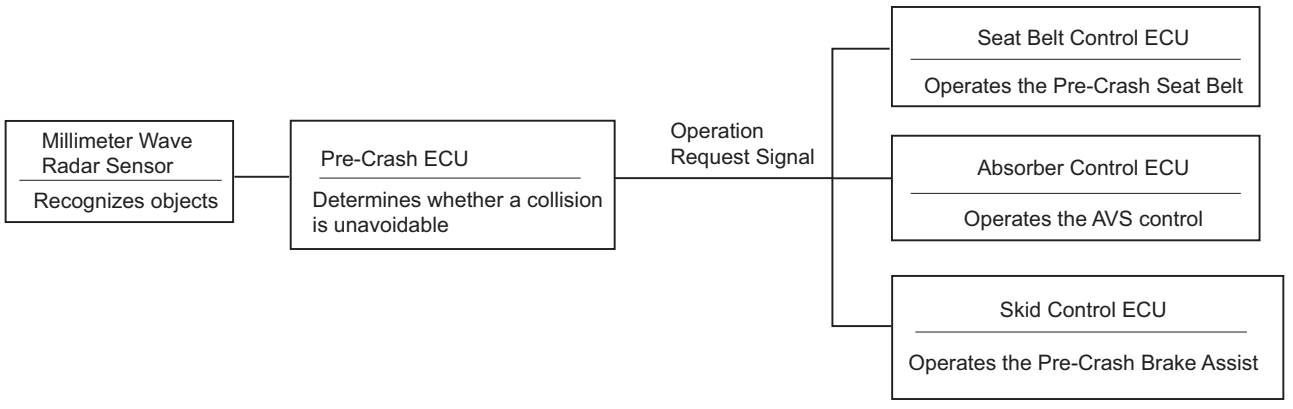
- If an object is present within range of the millimeter wave radar sensor, the radar detects the distance to the object, the relative speed, and the direction based on the reflected waves. Based on these pieces of data, the Pre-Crash ECU determines whether a collision is unavoidable.
- The radar uses the angle of the reflected waves to detect the direction to the object, the length of time that elapses after the radiowaves are emitted and the reflected waves return to detect the distance, and the changes in the frequency (the Doppler effect) of the reflected waves to detect the speed of the object.
- Along a curve, the system estimates the radius of the curve based on data provided by the yaw rate sensor and the steering angle sensor, and makes appropriate corrections to the course of travel.



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Pre-Crash ECU

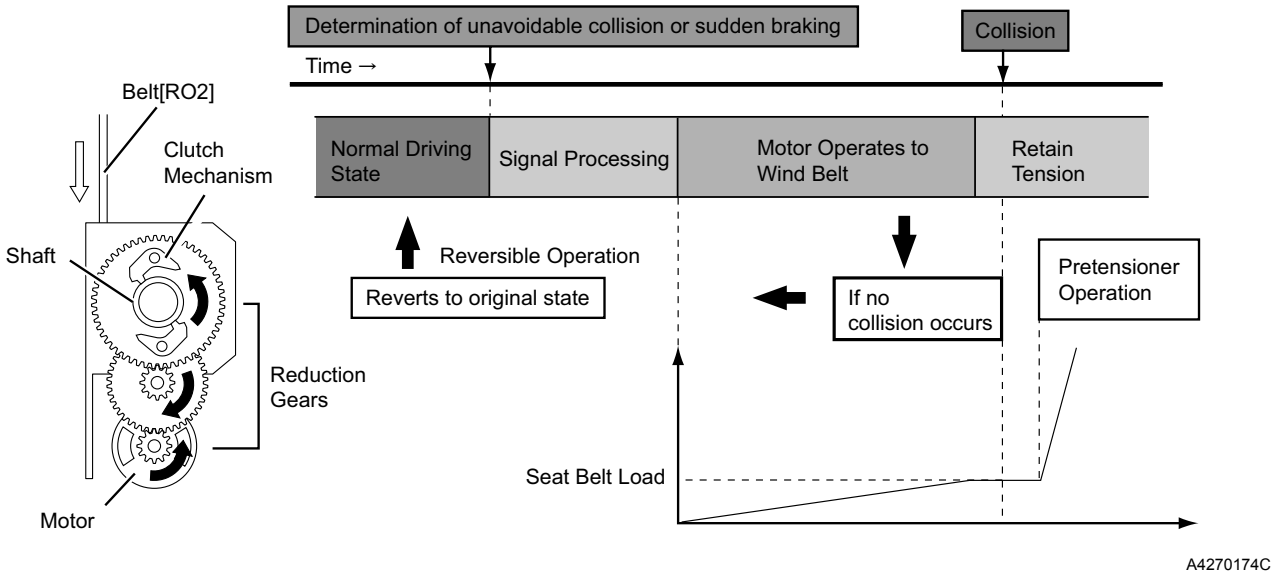
● This ECU recognizes an obstacle through the millimeter wave radar sensor, determines whether a collision is unavoidable, and sends an action request signal to the ECUs.



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Pre-Crash Seat Belt Operation

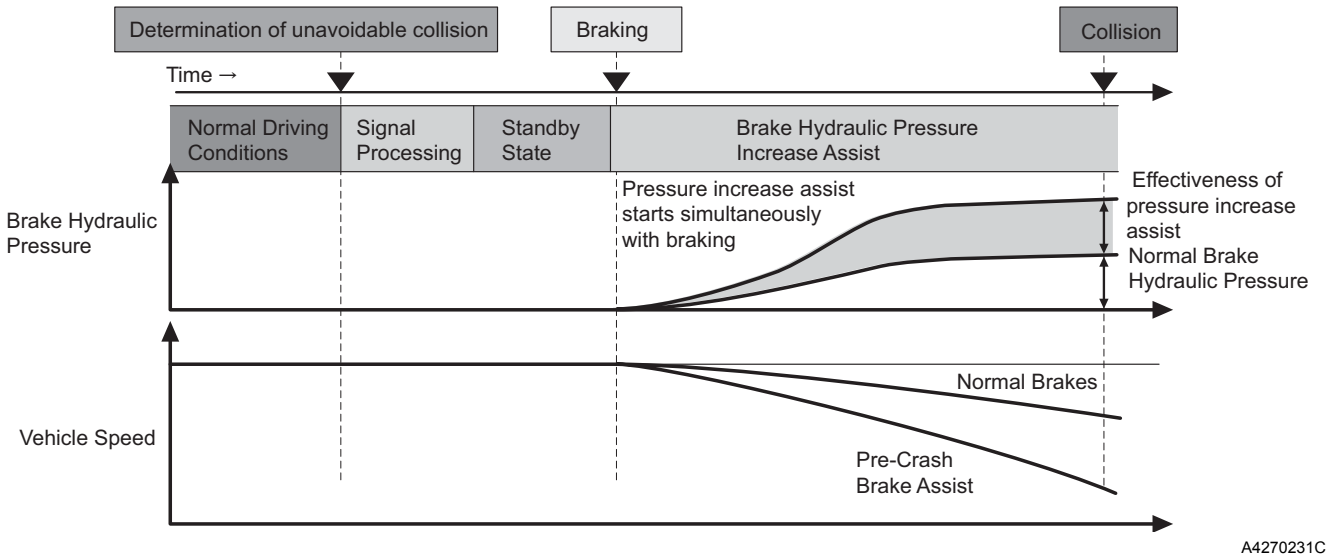
- The Pre-Crash ECU determines that a collision is unavoidable.
- The driver suddenly presses on the brake pedal (linked to sudden braking).
- Normally, the clutch mechanism keeps the shaft free.
- Upon receiving a current, the motor transmits a rotational movement to the clutch via the reduction gears. The clutch becomes engaged and winds the belt[RO1].
- To release the winding of the belt after the operation, the motor performs a winding movement again.



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Pre-Crash Brake Assist Control

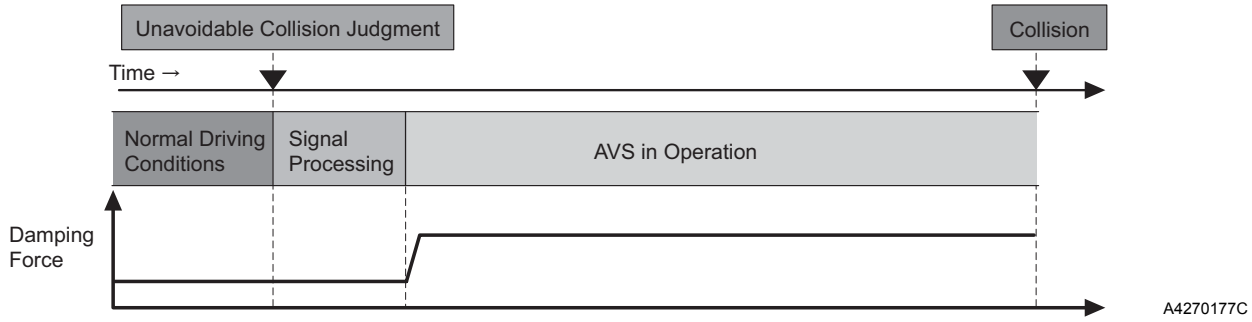
- When the Pre-Crash ECU determines that a collision is unavoidable and the driver presses on the brake pedal, this control provides an assist to increase the pressure.



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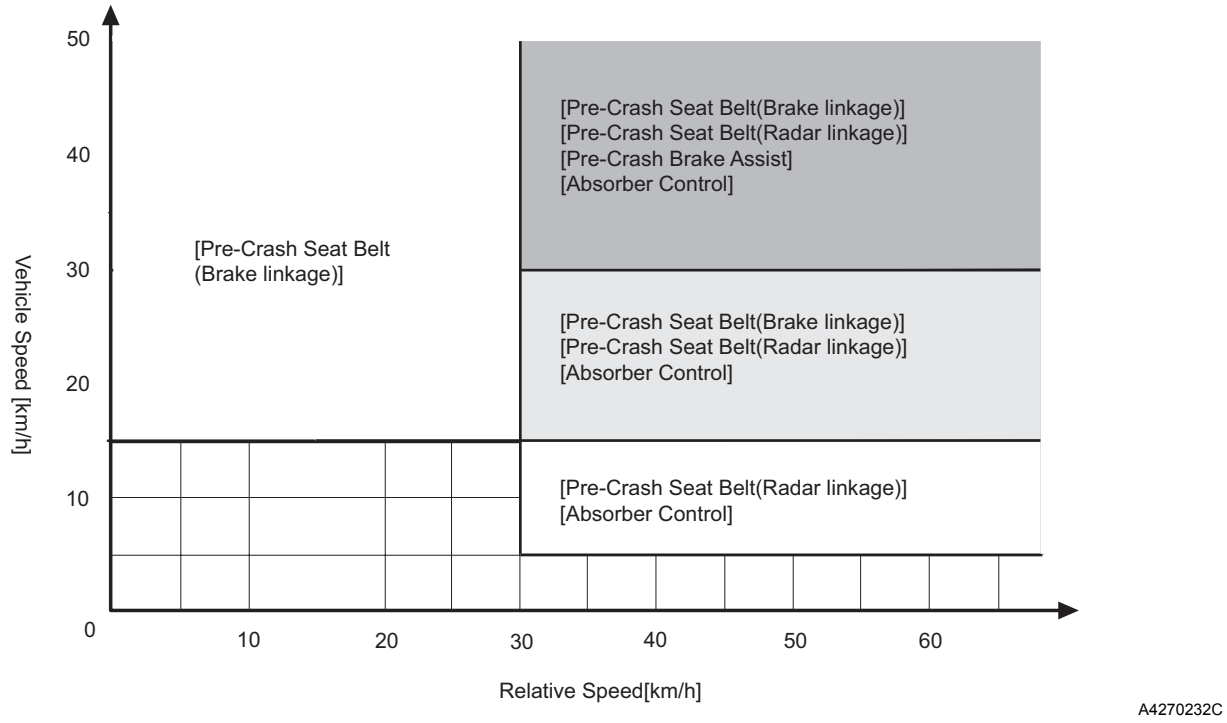
AVS Control

- This control operates if the millimeter wave radar sensor detects an object of collision, and determines that a collision is unavoidable.
- It reverts to the original state if no collision occurs.



The Control Area of Each Control

- The operation domain of each control of Pre-Crash Safety System is as follows.



Non-Operating Conditions

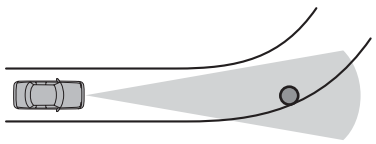
• The conditions of not operating are as follows.

The conditions of not operating

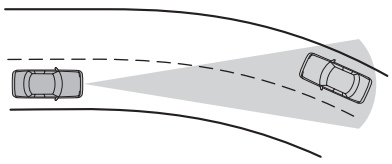
(1)Pre-Crash	The relative speed is below approximately 30 km/h (or pre-crash brake below 15 km/h)
	The driven vehicle's speed is below 15 km/h
	IG is at OFF and IG is at ACC
	The multi-information display indicates "CHECK PCS" or "PCS DISABLED NOW"
	The vehicle collides with an object outside of the detection area of the millimeter wave radar sensor (side collision or rear-end collision)
	The millimeter wave radar sensor is unable to detect an item as an object of collision
	(items that cannot be detected: plastic items such as pylons)
	(items that cannot be detected in a stable manner: people, motorcycles, trees, animals, snow walls)
(2)Pre-Crash Seat Belt	When the foregoing (1) applies
	The seat belt is unbuckled
(3)Pre-Crash Brake Assist	When the foregoing (1) applies
	The driven vehicle's speed is below 30 km/h
	The driver did not step on the brake pedal

Other Operation Cases

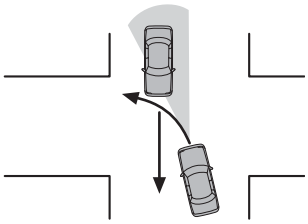
• In the situations described below, the millimeter wave radar sensor a detection object, causing the Pre-Crash Safety System to operate, even if there is no possibility of a collision. This is not a malfunction.



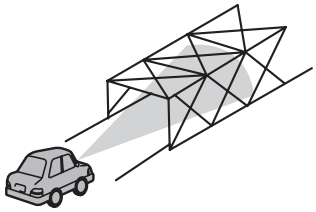
Roadside object at the beginning of a turn (guard rail, street light, signboard, etc.)



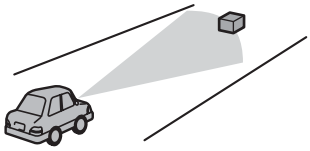
Passing an oncoming vehicle around a turn



Oncoming vehicle during a left turn



Narrow iron bridge



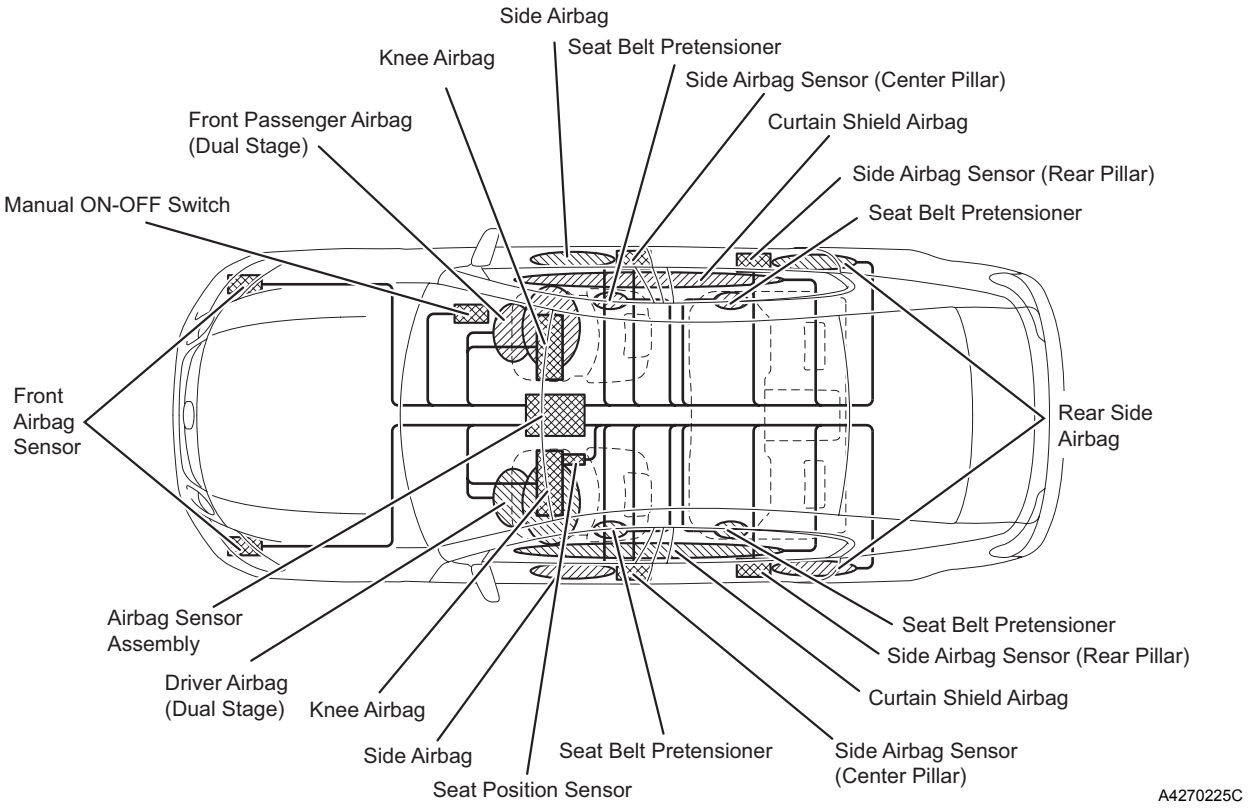
Metal object on the road surface (iron plate used for covering road construction, mesh for covering gutter, manhole, etc.)

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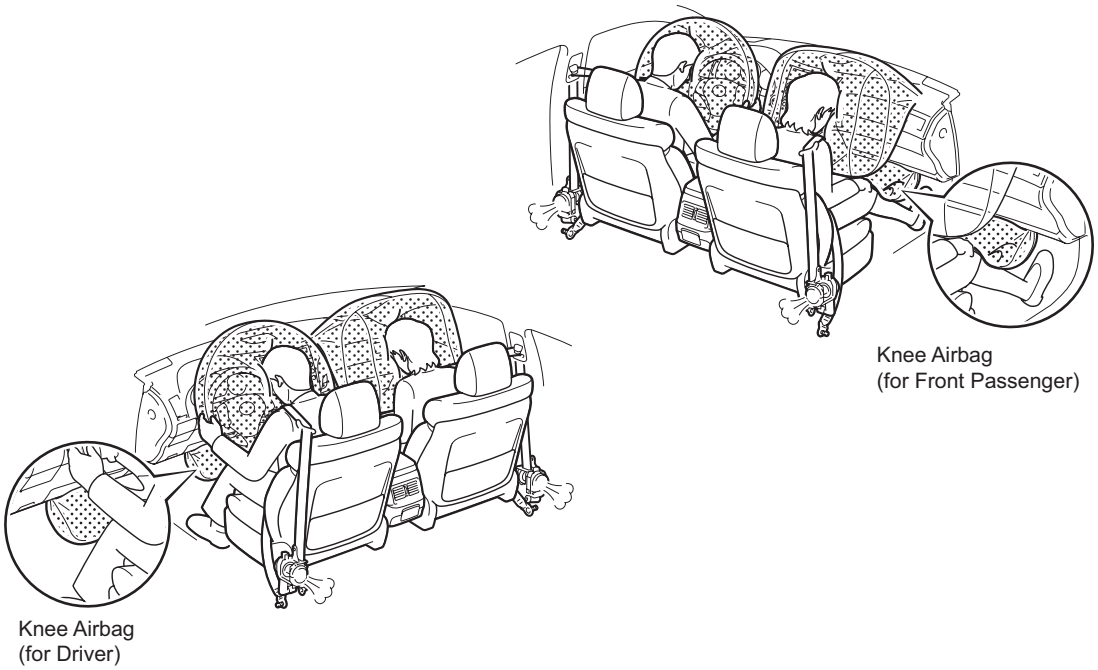
SUPPLEMENTAL RESTRAINT SYSTEM

Supplemental Restraint System Outline

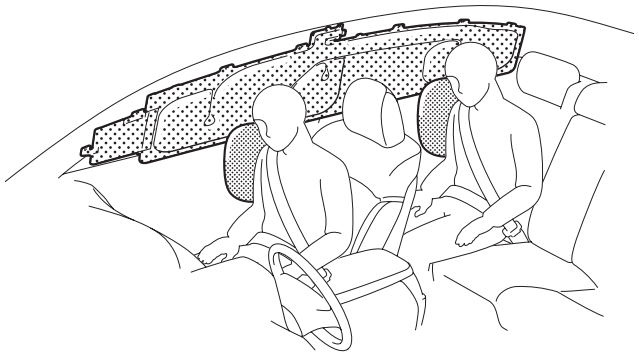
- Dual stage (two-step control type) driver and front passenger SRS airbag & driver and front passenger SRS knee airbag & seatbelt with pretensioner + force limiter, SRS side airbag, and SRS curtain shield airbag are provided on all models.
- The rear side airbags are available on all models as an optional equipment.



The Feature of a SRS Airbag System



Dual stage (two step control type) Driver / Front Passenger SRS Airbag,
Driver / Front Passenger SRS Knee Airbag, Seat Belts with Pretensioners and Force Limiters



SRS Side Airbag & SRS Curtain Shield Airbag

∗ The illustration depicts a conceptual image of the operation, which differs from an actual vehicle.

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SRS Airbag System

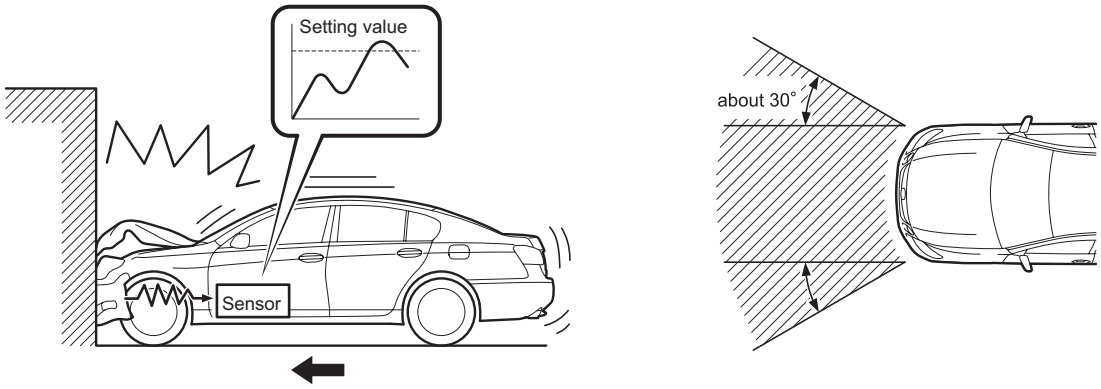
Each SRS Airbag	If the vehicle receives a strong impact energy that could seriously harm the occupants, the seat belts function to restrain the occupants. In addition, the airbags inflate instantly to act as cushions, in order to dampen the impact that is applied to the heads and chests of the occupants.
Seat Belts with Pretensioners and Force Limiters	If the vehicle receives a strong impact energy from the front, the pretensioner mechanism instantly retracts the seat belt to enhance the belt's effectiveness in restraining the occupant.
	If a load that exceeds a specified amount is applied to the seat belt, the force limiter mechanism holds the load at the specified amount, in order to lighten the impact that is applied to the occupant's chest area.

System Operation of SRS Airbag & Seatbelt with Pretensioner

- The dual stage (two-step control type) SRS airbag & SRS knee airbag & seatbelt with pretensioner and force limiter are deployed if the system detects an impact that exceeds a predetermined amount during a frontal collision.
- The operation of the dual stage (two-step control type) SRS airbag & SRS knee airbag is intended for a collision of the vehicle against a wall that does not become deformed or move upon collision, at a collision speed of approximately 25 km/h or higher, and within an approximate range of 30 degrees.

❖REFERENCE❖

* : The acceleration sensors in the front airbag sensor and the airbag sensor assembly detect the deceleration of the vehicle during a collision. Therefore, they could be deployed when a strong impact is received from the bottom of the vehicle (such as when the vehicle hits a curb, falls into a deep hole or groove, drives over a deep hole or groove, jumps and bottoms against the ground, or falls off the road).



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Non-Operation of SRS Airbag & Seatbelt with Pretensioner

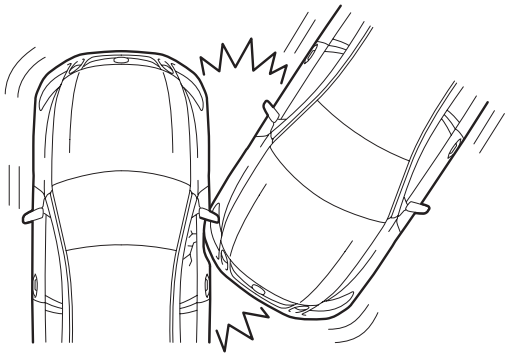
- The acceleration sensors in the front airbag sensor and the airbag sensor assembly detect the deceleration of the collision that is applied from the front of the vehicle. Therefore, the airbag system might not deploy in some circumstances. Even if the vehicle is involved in a frontal collision, the system will not deploy unless the deceleration of the vehicle reaches the specified values of the sensors.

System Operation of SRS Side Airbag & SRS Curtainshield Airbag

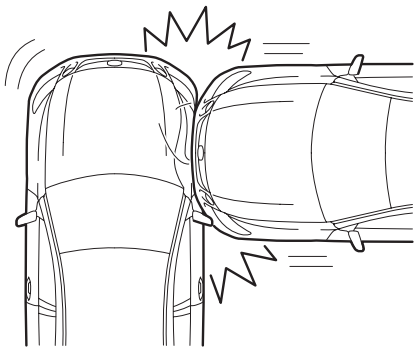
- The SRS side airbag is deployed if the cabin area of the body receives a strong impact from the side of the vehicle, causing the side airbag sensor and the Airbag Sensor Assembly to detect an impact that exceeds a predetermined amount. The SRS curtain shield airbag is deployed if the cabin area of the body receives a strong impact from the side of the vehicle, causing the side airbag sensor and the Airbag Sensor Assembly, or the rear side airbag sensor and the Airbag Sensor Assembly to detect an impact that exceeds a predetermined amount.

Non-Operation of SRS Side Airbag & SRS Curtainshield Airbag

- Even if the vehicle is involved in a side collision, the SRS side airbag & SRS curtain shield airbag might not deploy in some collision circumstances. This occurs when the energy of the collision is dampened by the deformation of the vehicle body or the door, which prevents the energy of the impact from reaching the ignition judgment criteria of the sensor.



Another vehicle colliding diagonally to the side of the vehicle

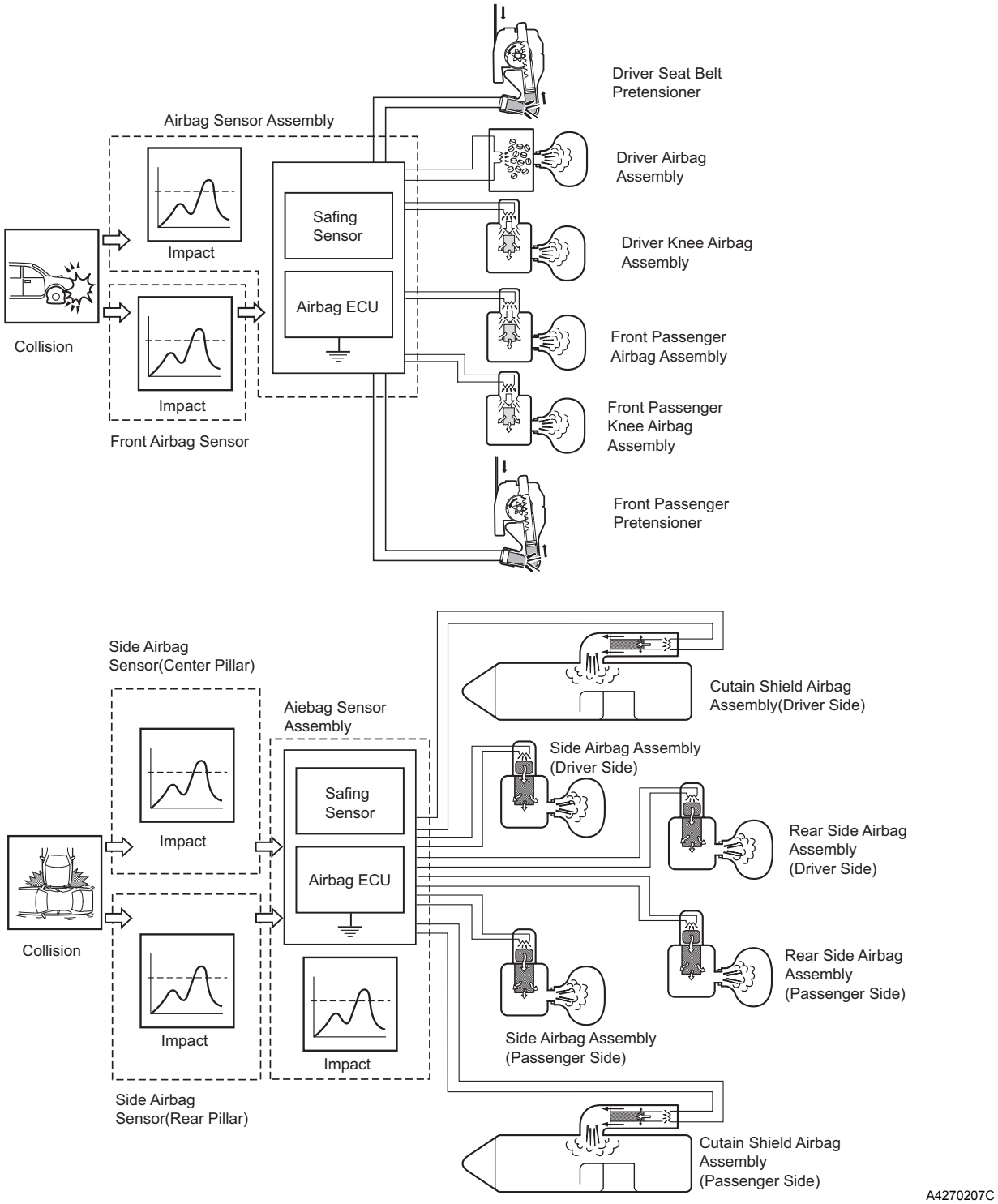


Another vehicle colliding to the side of the vehicle other than its cabin

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System Function

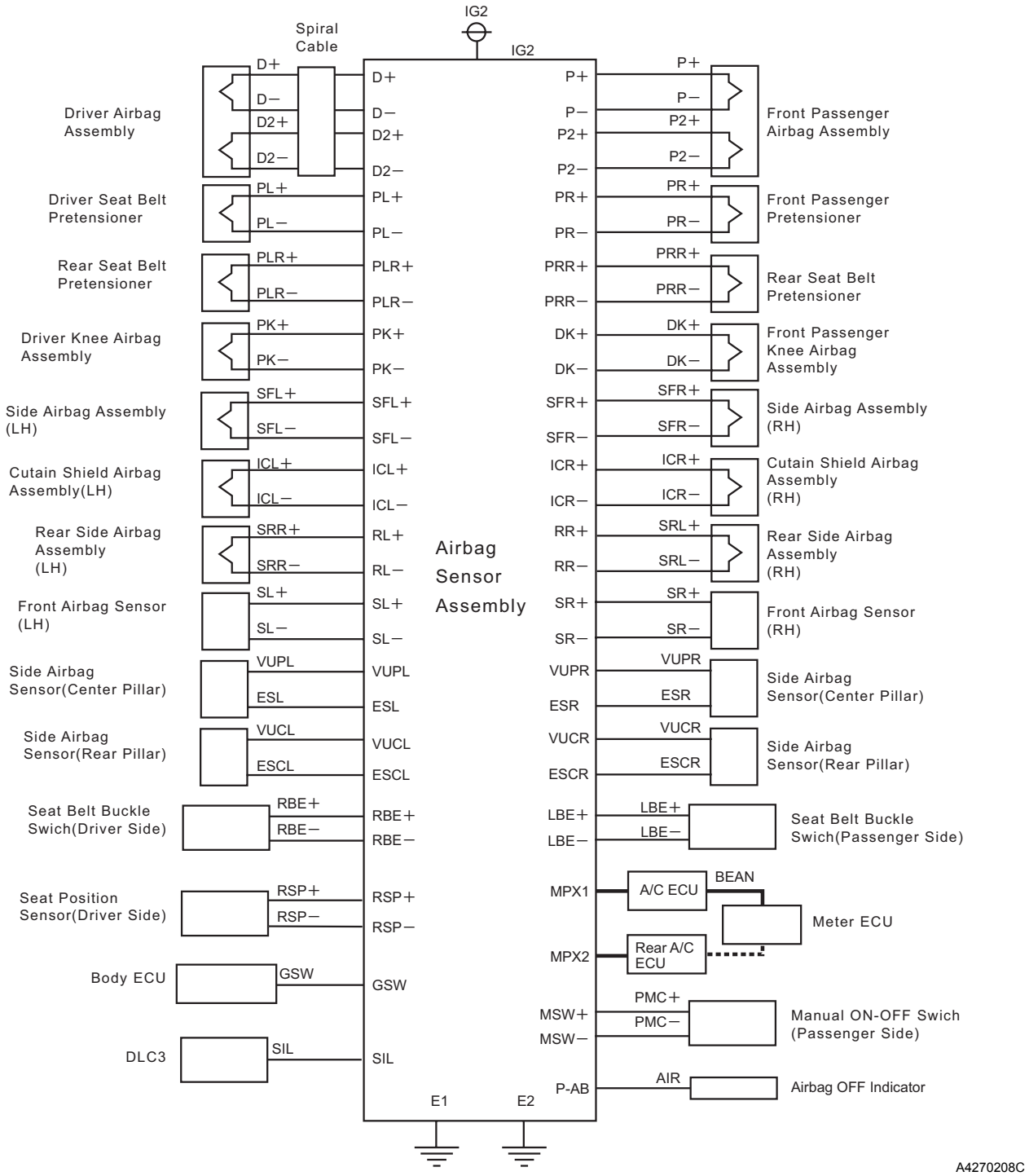
- The system reaches an ignition judgment to deploy the driver's airbag, front passenger's airbag, knee airbag, and pretensioner based on the signals received from the front airbag sensor and deceleration sensor. In addition, the system reaches an ignition judgment to deploy the SRS side airbags and SRS curtain shield airbags based on the signals received from the side airbag sensor and rear airbag sensor. Furthermore, the system is equipped with a diagnosis function to perform self-diagnosis in case of a system malfunction.



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Airbag Sensor Assembly

- The Airbag Sensor Assembly consists of a deceleration sensor, ignition judgment circuit, backup power supply, etc.
- It reaches an ignition judgment to deploy the dual stage (two-step control type) driver's and front passenger's airbags, driver's and front passenger's knee airbags, and pretensioner based on the signals received from the front airbag sensor and deceleration sensor. In addition, it reaches an ignition judgment to deploy the SRS side airbags and SRS curtain shield airbags based on the signals received from the side airbag sensor and rear side airbag sensor. Furthermore, it is equipped with a diagnosis function to perform self-diagnosis in case of a system malfunction.



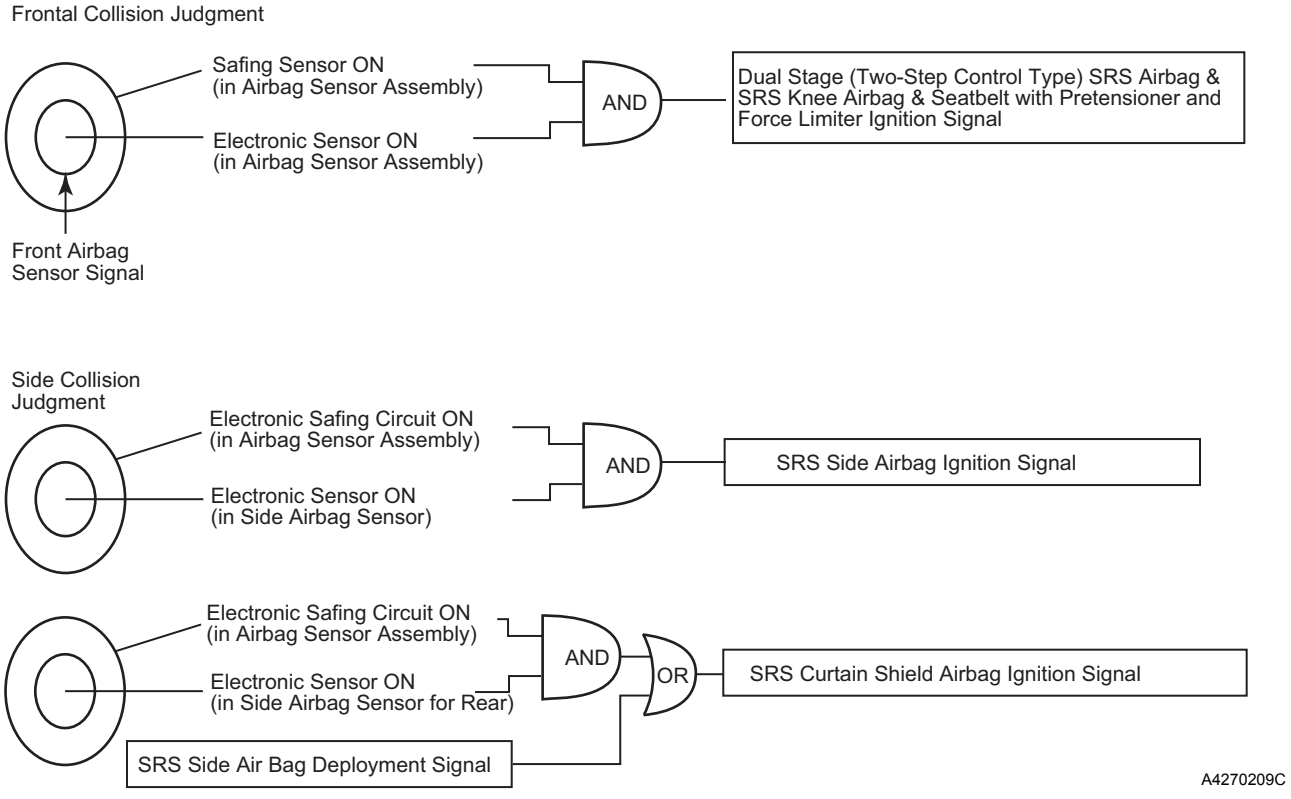
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Components and Functions

Components	Functions
Deceleration Sensor	Outputs a signal that is linear to the deceleration when deceleration is applied to the vehicle as the result of a collision.
Backup Power Supply	Consists of a backup condenser that supplies power to the system in case of a collision or a malfunction in the power supply system, and a booster circuit that boosts the voltage.
Ignition Judgment Circuit	Performs a prescribed calculation in accordance with a signal received from the Airbag ECU and the front airbag sensor. If the calculated value exceeds a predetermined value, the ECU sends an ignition signal. Also, it uses a malfunction diagnostic circuit to diagnose whether a malfunction exists in the entire system. If there is a malfunction, the ECU informs the driver of the failure in the system, and uses the diagnostic function to diagnose the section of the system failure.

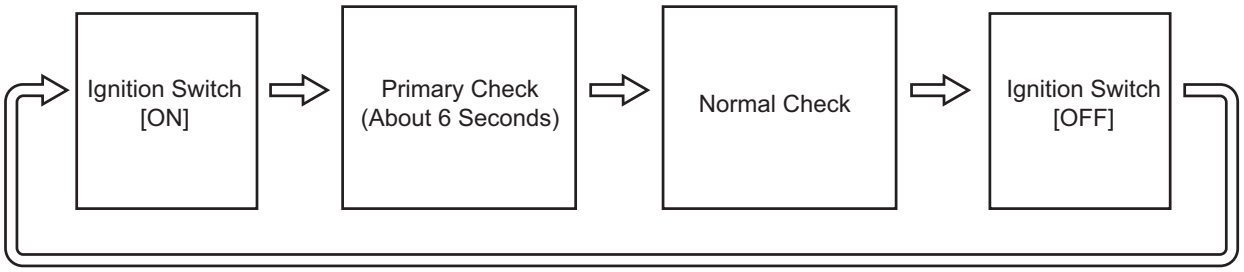
Operation Judgment

- The dual stage (two-step control type) SRS airbag & SRS knee airbag & seatbelt with pretensioner and force limiter are ignited by the impact of a frontal collision. The system reaches this judgment based on the signals from the front airbag sensor, electronic sensor in the airbag sensor assembly, and the safing sensor.
- The SRS side airbag is ignited when both the electronic sensor in the side airbag sensor and the electronic safing circuit in the airbag sensor assembly are turned ON by the impact of a side collision.
- The SRS curtain shield airbag is ignited upon receiving an ignition signal from the SRS side airbag that has met the aforementioned conditions; or, if both the electronic sensor in the rear side airbag sensor and the electronic safing circuit in the airbag sensor assembly are turned ON.
- To indicate that the airbags have operated, the airbag sensor assembly keeps the airbag warning light illuminated even after the primary check. This warning light cannot be turned OFF.



The Operation of a Diagnostic Circuit

- The warning light in the combination meter indicates the operation of the diagnostic circuit. The operation of the diagnostic circuit separates into two periods: the primary check and the regular check.



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Primary Check

- when the ignition switch is turned ON, the airbag warning light illuminates for approximately 6 seconds to perform a primary check. During this period, in which the ignition of the airbags is disabled, the system diagnoses the operation of the airbag sensor assembly. If a failure is detected during the primary check, the airbag warning light will not turn OFF, but will remain ON even after 6 seconds have elapsed.
- Once the airbag sensor assembly has been deployed, the warning light will remain ON after the primary check, regardless of whether or not a malfunction exists.

Normal Check

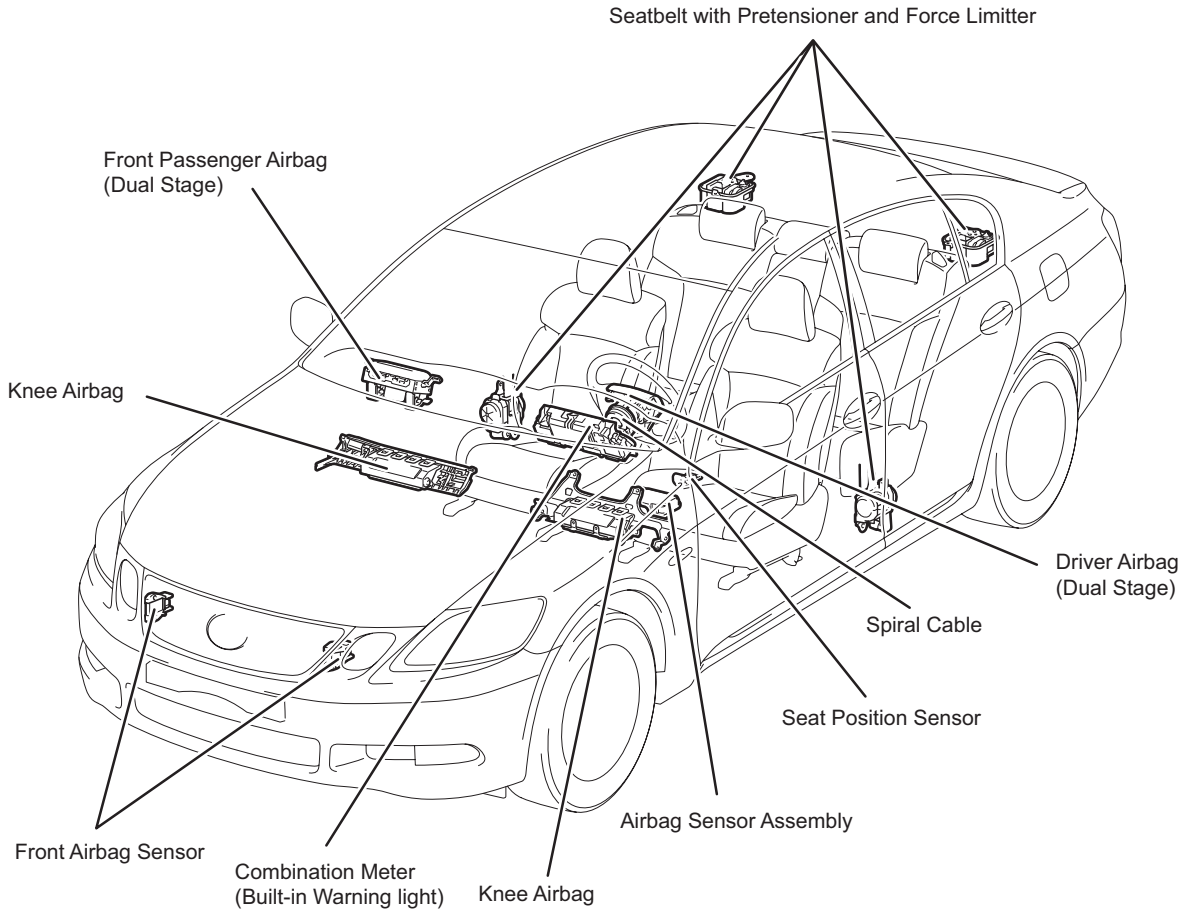
- After the primary check is completed and the airbag warning light turns OFF, the ignition of the airbags is enabled. The diagnostic circuit performs a regular check to determine whether a failure exists in the system. If a malfunction is detected during the regular check, the airbag warning light illuminates. (The warning that indicates a drop in the power supply voltage will turn OFF after the power supply voltage is restored to normal.)

Diagnosis

- When the system is switched to the diagnostic mode, the indicator light outputs the results of the diagnosis of a failed section by way of the frequency of the blinking. Also, because a new diagnostic function is used, a diagnostic tool can be connected to the DLC3 connector to read the DTC (Diagnostic Trouble Code) of the section with a malfunction. For details on the diagnostic mode, refer to the repair manual.

SRS Airbag & Seatbelt with Pretensioner Outline

● This system consists of dual stage (two-step control type) driver's and front passenger's SRS airbags, driver's and front passenger's SRS knee airbags, seat belts with pretensioner and force limiter, front airbag sensor, and airbag sensor assembly.



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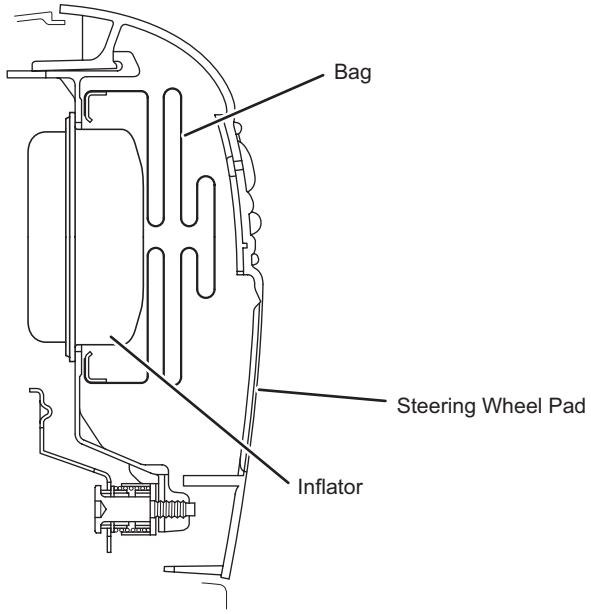
Main Components and Functions

Components	Functions
Spiral Cable	Transmits the ignition signal from the airbag sensor assembly to the driver's SRS airbag.
Dual stage (two step control type) driver seat / front passenger seat SRS airbags, driver seat / front passenger seat SRS knee airbags	Each airbag consists of an inflator and a bag. Upon receiving an ignition signal from the airbag sensor assembly, the inflator instantly ignites and generates gas to inflate the bag, in order to dampen and absorb the impact that is applied to the occupant.
Seat Belts with Pretensioners and Force Limiters	Upon receiving an ignition signal from the airbag sensor assembly, the gas generator ignites in order to instantly retract the seat belt, thus enhancing the restraining effect on the occupant.
SRS Airbag Warning Light	Illuminates in case of a system failure to alert the driver.
Front Airbag Sensor	Detects the deceleration during a collision and sends a signal for making an ignition judgment to the airbag sensor assembly.

Components	Functions
Seat Position Sensor(for Driver)	Detects the sliding position of the driver's seat.
Airbag Sensor Assembly	Make a deployment judgment based on the signal from the airbag sensor assembly and the front airbag sensor. A deployment judgment includes the safing sensor. It then sends a deployment signal to the SRS airbags, SRS knee airbags and seat belts with pretensioners and force limiter. During a system abnormality, malfunction diagnosis of the system can be performed by switching to diagnosis mode.

SRS Airbag for Driver

- The dual stage (two-step control type) driver's SRS airbag is built into the steering wheel pad.
- The SRS airbag, which is not disassemblable, consists of an inflator, bag, steering wheel pad, etc.



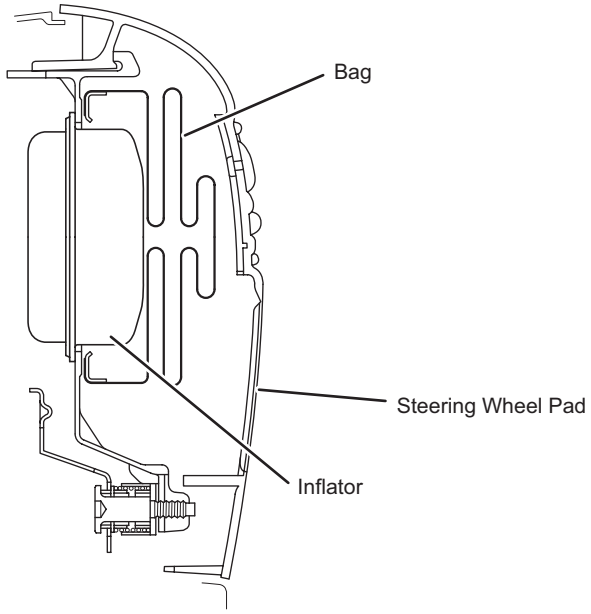
Dual Stage(two step control type)
Driver SRS Airbag

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Components	Functions
Seat Position Sensor(for Driver)	Detects the sliding position of the driver's seat.
Airbag Sensor Assembly	Make a deployment judgment based on the signal from the airbag sensor assembly and the front airbag sensor. A deployment judgment includes the safing sensor. It then sends a deployment signal to the SRS airbags, SRS knee airbags and seat belts with pretensioners and force limiter. During a system abnormality, malfunction diagnosis of the system can be performed by switching to diagnosis mode.

SRS Airbag for Driver

- The dual stage (two-step control type) driver's SRS airbag is built into the steering wheel pad.
- The SRS airbag, which is not disassemblable, consists of an inflator, bag, steering wheel pad, etc.

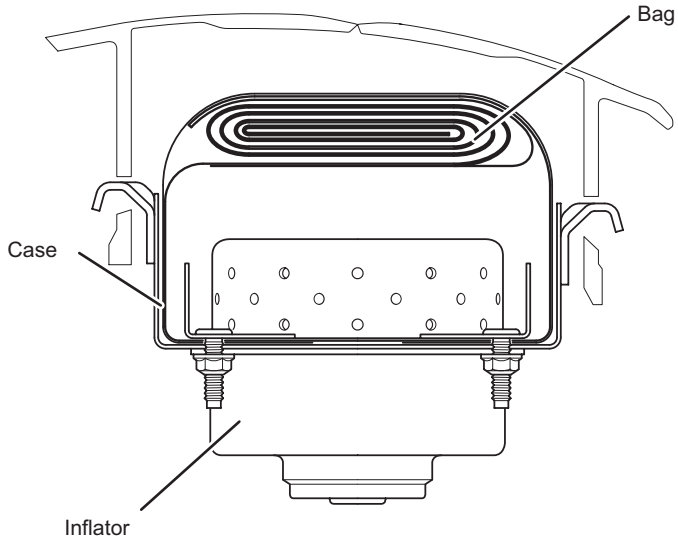


Dual Stage(two step control type)
Driver SRS Airbag

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SRS Airbag for Front Passenger

- The dual stage (two step control type) passenger seat SRS airbag is located in the upper part of the passenger side instrument panel.
- The SRS airbag, which is not disassemblable, consists of a case, inflator, and bag, etc.

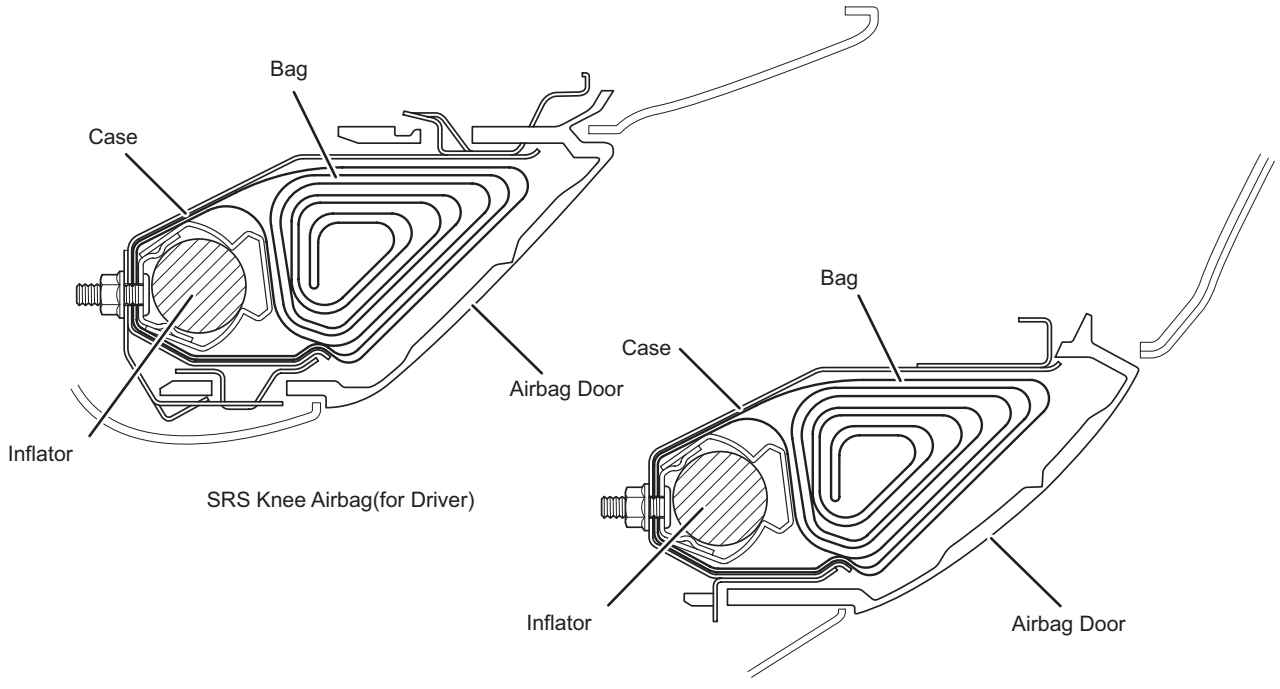


Dual Stage(two step control type)
Passenger SRS Airbag

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SRS Knee Airbag

- The driver's and front passenger's SRS knee airbags are located in the lower part of the instrument panel in front of the driver's and front passenger's seats, respectively.
- The SRS airbag, which is not disassemblable, consists of a case, inflator, and bag, etc.



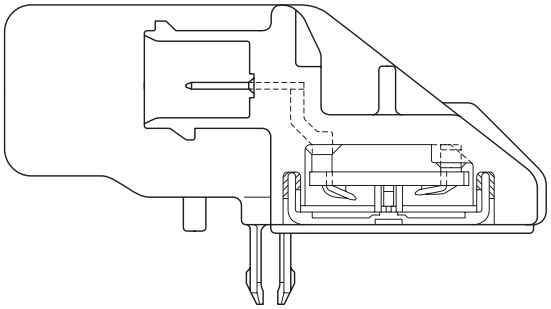
SRS Knee Airbag(for Driver)

SRS Knee Airbag(for Passenger)

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Front Airbag Sensor

- The front airbag sensor is installed on top of the front member.
- Upon detecting a frontal impact, the front airbag sensor sends a deceleration signal to the airbag sensor assembly.

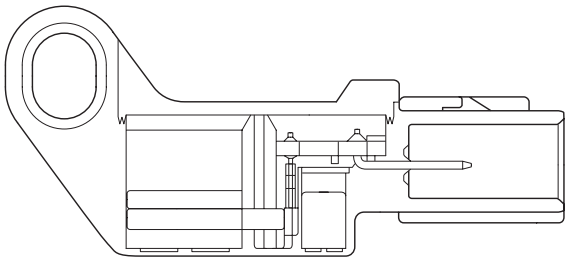


Sensor Sention

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Seat Position Sensor (for Driver)

- Along with the use of the two-step control type dual stage SRS airbag for the driver, a seat position sensor is provided inside the driver's seat.

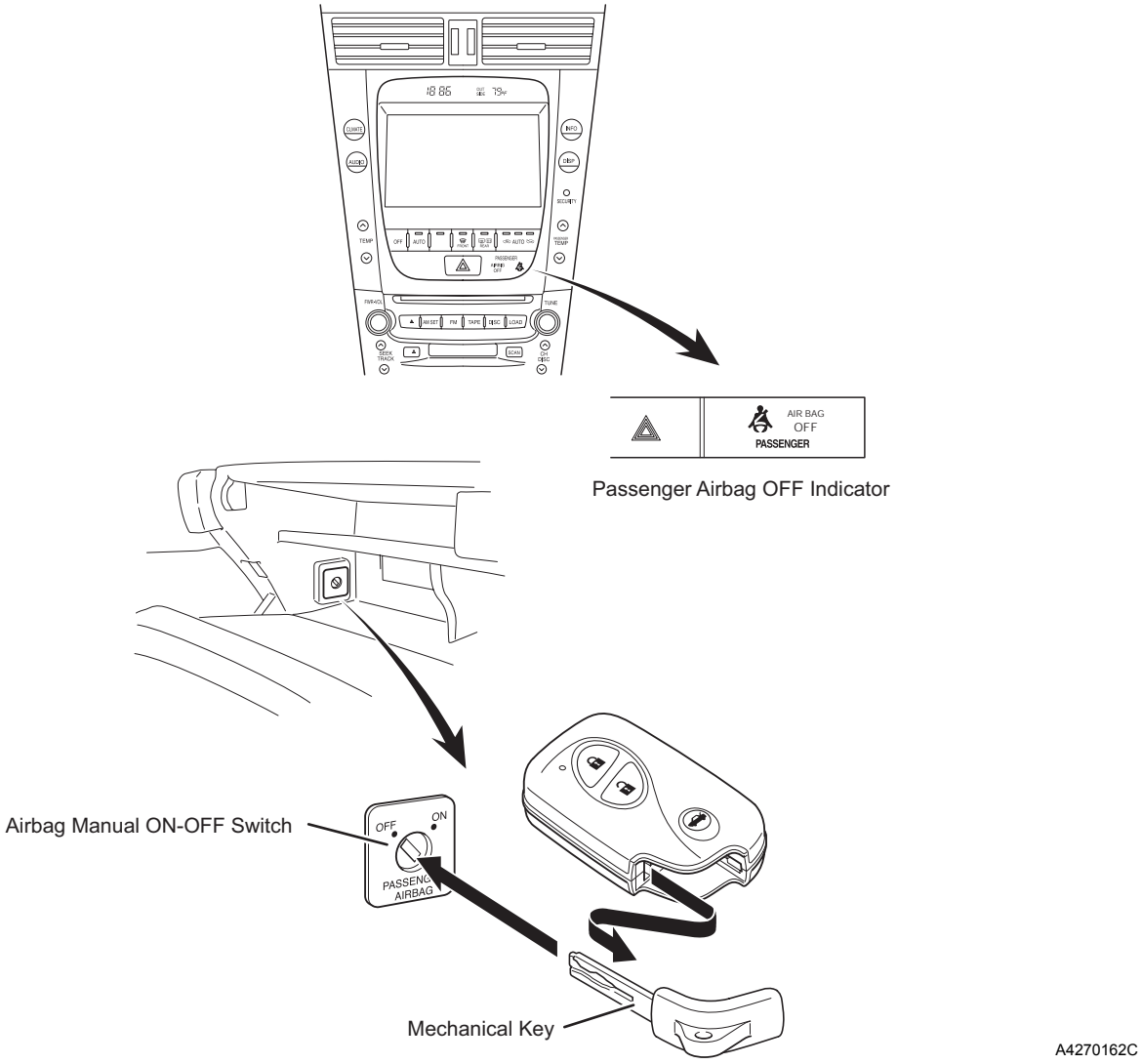


Sensor Section

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Airbag Manual ON-OFF Switch

- A switch to disable the deployment of the front passenger airbag and the passenger seat side airbag has been provided as standard equipment. This switch can be used if the deployment of those airbag is inconvenient,such as when the passenger is wearing a CRS seat belt.
- This switch is located in the back of the glove box.It is operated ON/OFF by a mechanical key,which is supplied with the wireless key. Once the airbag manual ON-OFF switch turned to OFF,the front passenger airbag and the passenger seat side airbag will be disabled,regardless of the collision conditions.
- If the deployment of the passenger airbag has been disabled,the passenger airbag OFF indicator light in the center cluster illuminates to inform the occupant.

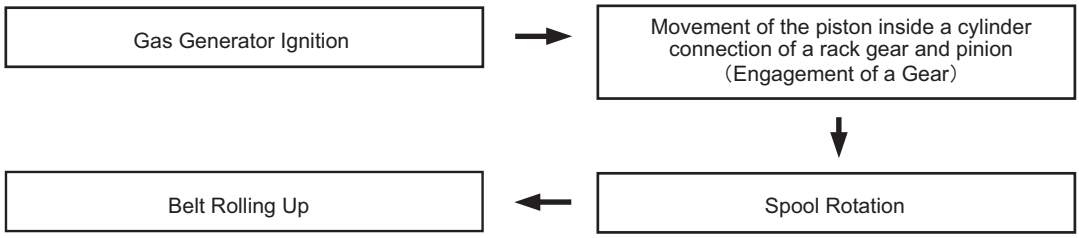


A Seat Belt with a Pretensioner and Force Limiter

- A pretensioner and force limiter mechanism is provided in the seat belt retractor for the driver's, front passenger's, and outer rear seats.
- A seat belt consists of a belt retractor mechanism, ELR (Emergency Locking Retractor) lock mechanism, pretensioner mechanism, and force limiter mechanism.
- A service caution label, which indicates precautions such as operation methods, is affixed to the surface of a seat belt.

Construction and Operation of the Pretensioner

• The pretensioner mechanism consists of a gas generator, piston rack, and pinion.



Pretensioner Operation

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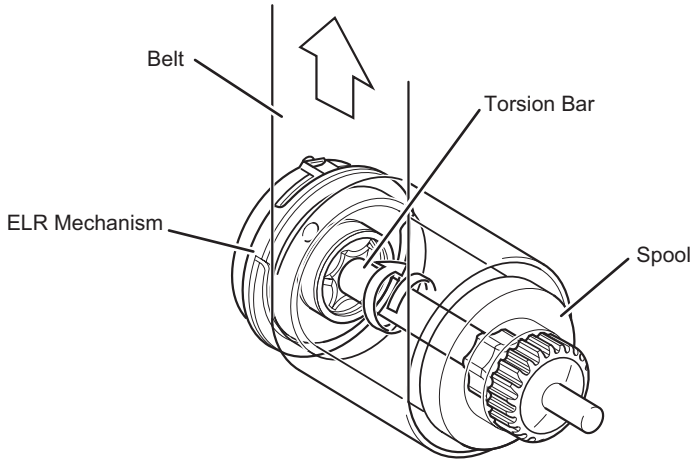
Construction and Operation of the Force Limiter

• The force limiter mechanism consists of a torsion bar and a spool.

• When the operation of the pretensioner is completed, and the movement of the occupant causes the seat belt to pull out, the ELR (Emergency Locking Retractor) locks, and the force limiter starts to operate. If the belt is pulled out at a speed that exceeds a specified acceleration or if an acceleration that exceeds a specified value acts on the vehicle, the ELR mechanism operates and prevents the belt from being pulled out.

• If the belt is pulled out at a speed that exceeds a specified acceleration or if an acceleration that exceeds a specified value acts on the vehicle, the ELR mechanism operates and prevents the belt from being pulled out.

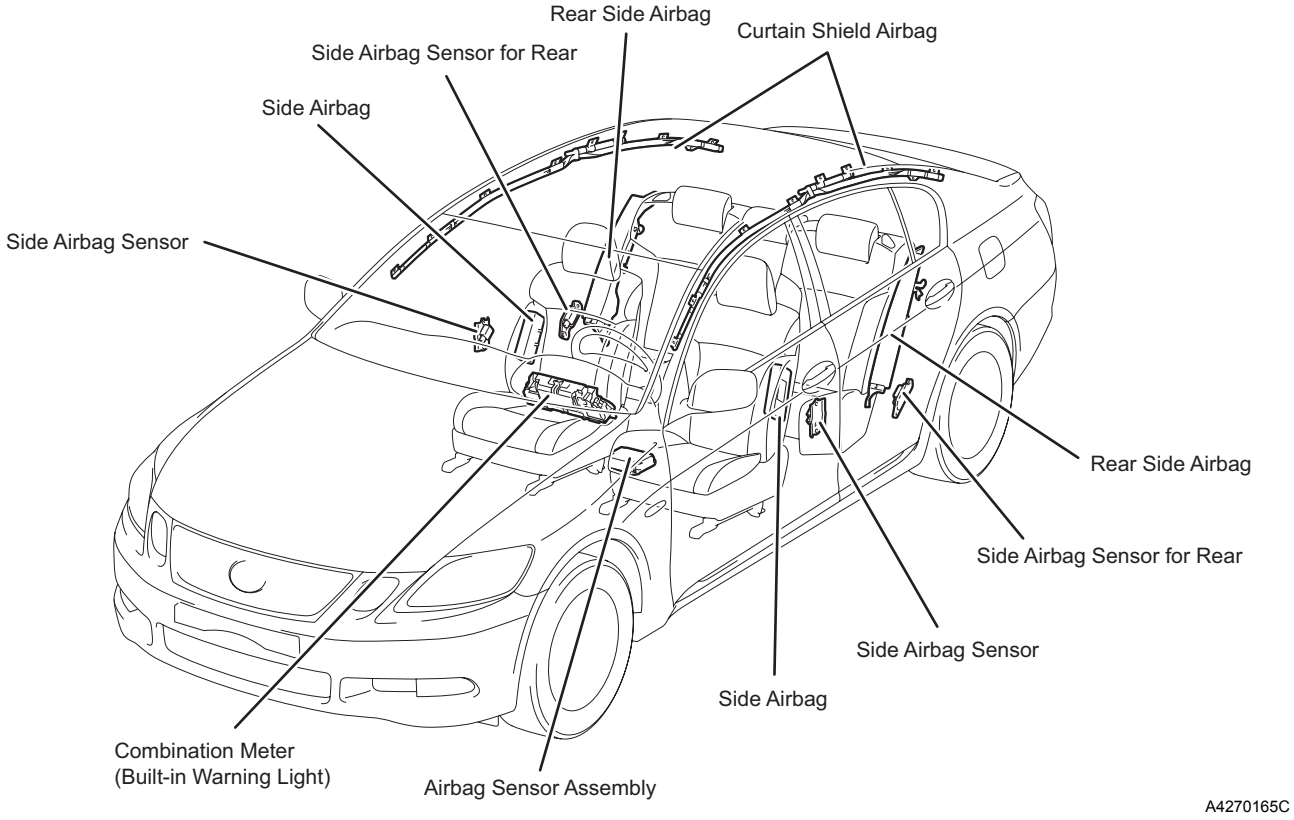
• If a tension that exceeds a specified load acts on the belt while the ELR remains locked, the torsion bar becomes twisted, and the spool that is integrated with the torsion bar rotates. As a result, the belt pulls out, thus maintaining a constant belt tension.



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SRS Side Airbag & SRS Curtain Shield Airbag Outline

● This system consists of an SRS side airbag, SRS curtain shield airbag, side airbag sensor, rear side airbag sensor, and airbag sensor assembly.

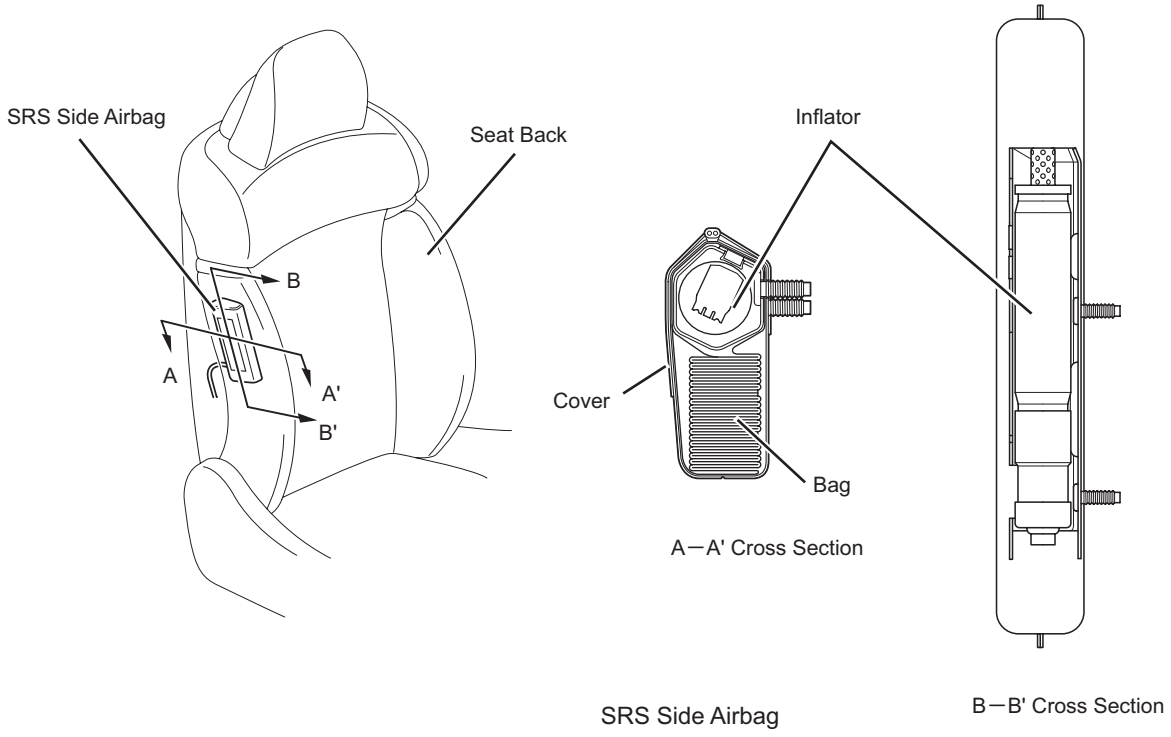


Main components and Functions

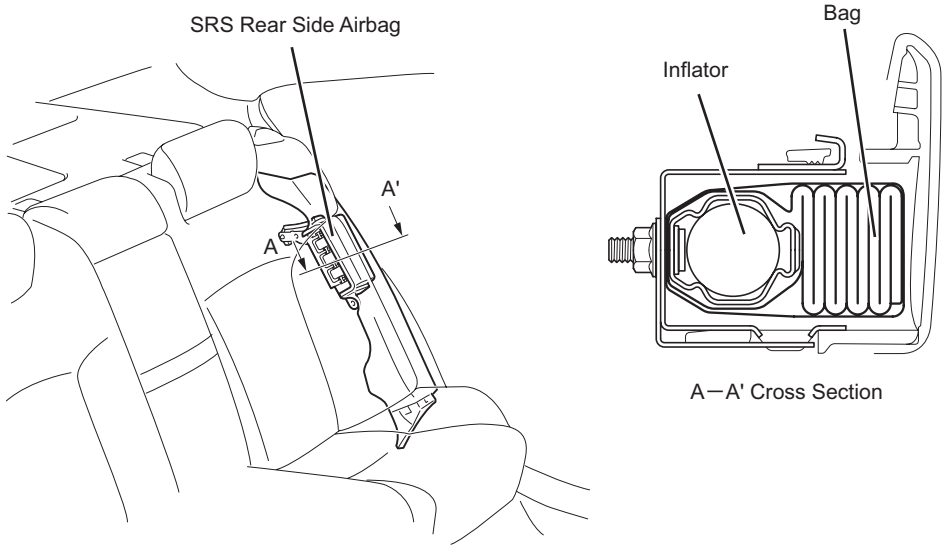
Components	Functions
SRS Side Airbag	Consists of an inflator and a bag. Upon receiving an ignition signal from the airbag sensor assembly, the inflator instantly ignites and generates gas to inflate the bag, in order to dampen and absorb the impact that is applied to the occupant's chest area.
SRS Curtainshield Airbag	Consists of an inflator and a bag. Upon receiving an ignition signal from the airbag sensor assembly, the inflator instantly ignites and generates gas to inflate the bag, in order to dampen and absorb the impact that is applied to the occupant's head area.
Airbag Warning Light	Illuminates in case of a system failure to alert the driver.
Side Airbag Sensor,Side Airbag Sensor for Rear	Upon detecting the deceleration of a collision, these sensors reach an ignition judgment and send ignition signals to the airbag sensor assembly.
Airbag Sensor Assembly	Upon receiving the signals from the side airbag sensor and the side airbag sensor for rear, the ECU reaches an ignition judgment and sends ignition signals to the SRS side airbag and the SRS curtain shield airbag. In case of a system failure, it can be switched to the diagnostic mode to perform the diagnosis of a system malfunction.

SRS Side Airbag

- SRS side airbags are located in the driver's and front passenger's seatbacks. Moreover, SRS rear side airbags are located in the rear passenger's seatbacks.
- The SRS airbag, which is not disassemblable, consists of an inflator, bag, cover, etc.



SRS Side Airbag

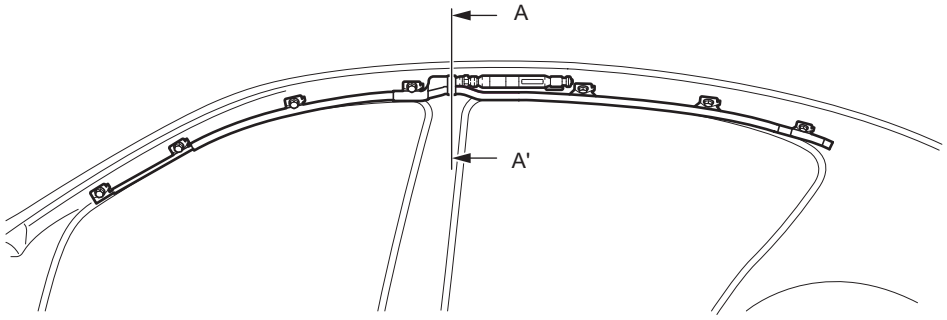


SRS Rear Side Airbag

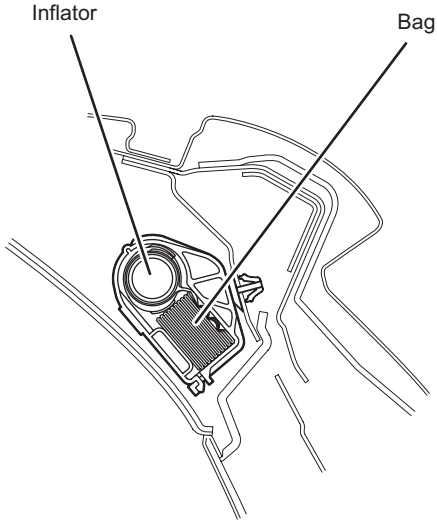
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SRS Curtain Shield Airbag

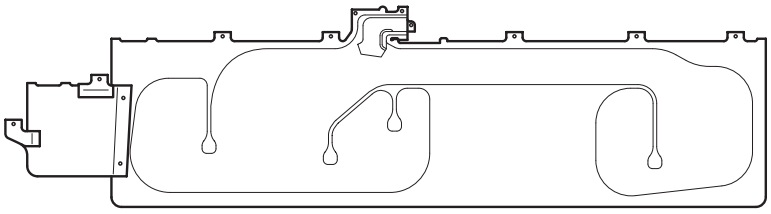
- SRS curtain shield airbags are located in the areas that extend from the driver's and front passenger's front pillars to the rear pillars in the rear seat areas.
- The SRS airbag, which is not disassemblable, consists of an inflator, bag, etc.



SRS Curtain Shield Airbag



A - A' Cross Section

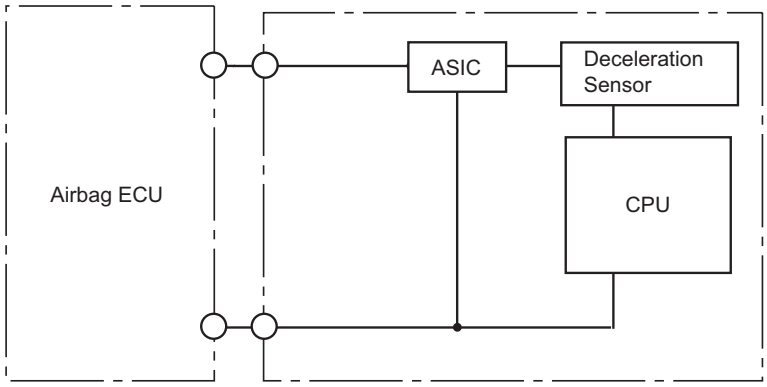


At the Time of Bag Deployment

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Side Airbag Sensor

- The side airbag sensor is installed at the bottom of the center pillar.
- The side airbag sensor, which is located at the bottom of the center pillar, consists of a semiconductor type deceleration sensor and a communication circuit. Upon detecting an impact from the side of the vehicle, it transmits an ignition signal to the airbag sensor assembly, and reaches an operation judgment for the SRS side airbag and SRS curtain shield airbag.

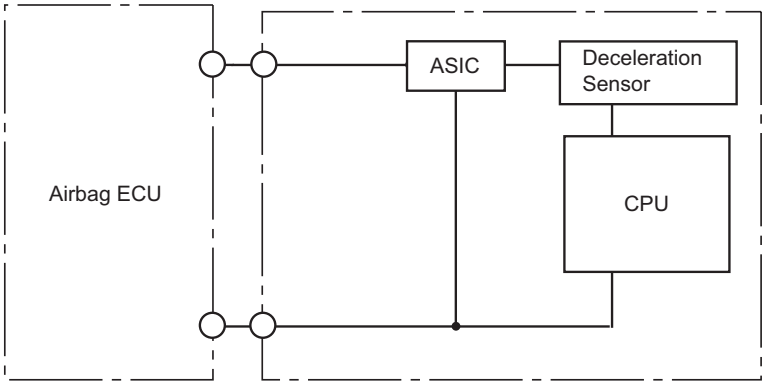


Side Airbag Sensor

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Side Airbag Sensor for Rear

- The side airbag sensor for rear is installed on the lower side of rear pillar.
- The components of the side air bag sensor on the lower side of rear pillar include a semiconductor type deceleration sensor and a communication circuit. It detects a side impact and sends a deployment signal to the airbag sensor assembly, which makes an operation judgment for the SRS side air bag and SRS curtain shield air bag.



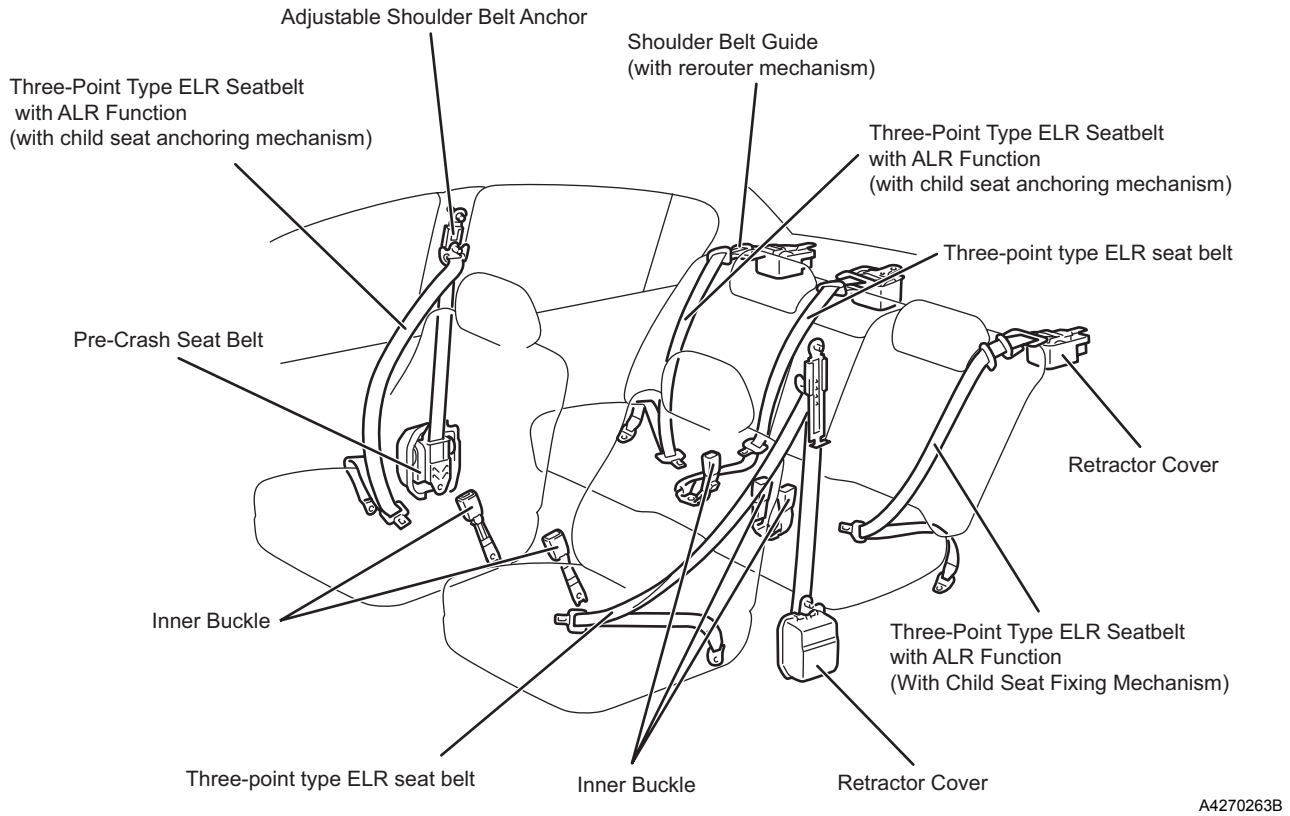
Side Airbag Sensor for Rear

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SEAT BELT

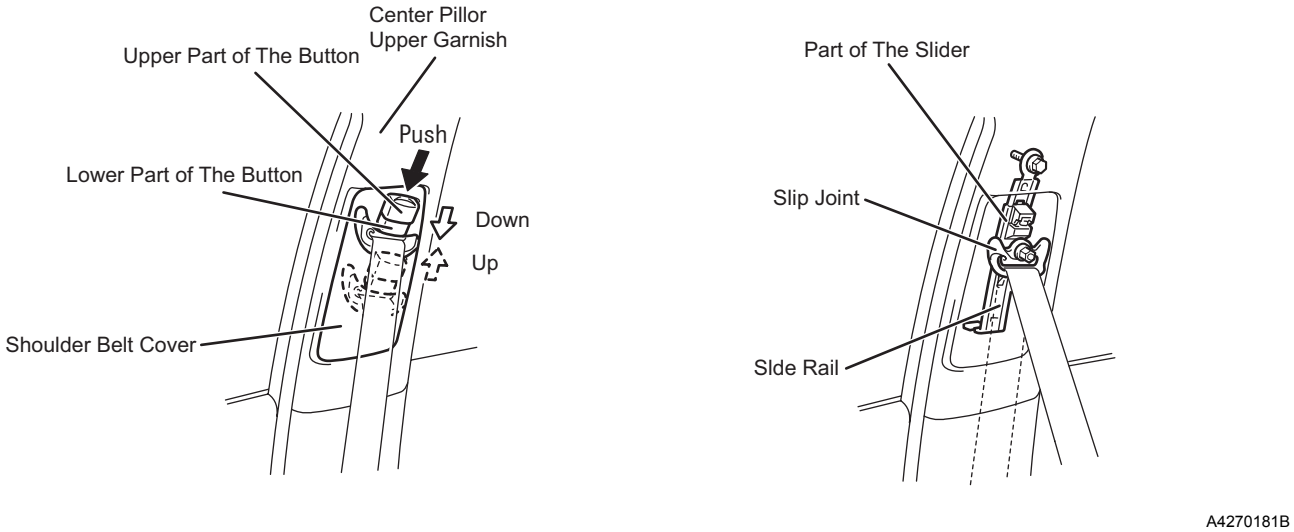
Seat Belt Outline

- All seats are provided with three-point ELR (Emergency Locking Retractor) seat belts.
- In the front seats, both the driver's and front passenger's seats use seat belts with a pretensioner + force limiter. In addition, a pre-crash seat belt, which uses a motor to wind the seat belt during sudden braking and thus enhance the effectiveness of the pretensioner is provided.
- Each rear outer seat uses a seat belt with a pretensioner + force limiter, which is equipped with a child seat anchoring mechanism. It changes into a child seat anchoring mechanism when the belt is pulled out entirely. In this state, the belt can be wound but cannot be pulled out. When the belt is wound over a predetermined amount, it cancels the child seat anchoring mechanism and reverts to the normal ELR state.
- The shoulder belt guide at each rear outer seat is provided with a rerouter mechanism that changes the routing of the seat belt.
- All seats except the rear center seat are provided with an electric tension reducer to reduce the sense of oppression felt by the occupants wearing the belts.
- The driver's and front passenger's seat belts use adjustable shoulder belt anchors. These anchors can be adjusted vertically in five steps to accommodate occupants of various physical sizes. In addition, slip joints are built into the center pillar upper garnishes to ensure the proper appearance.



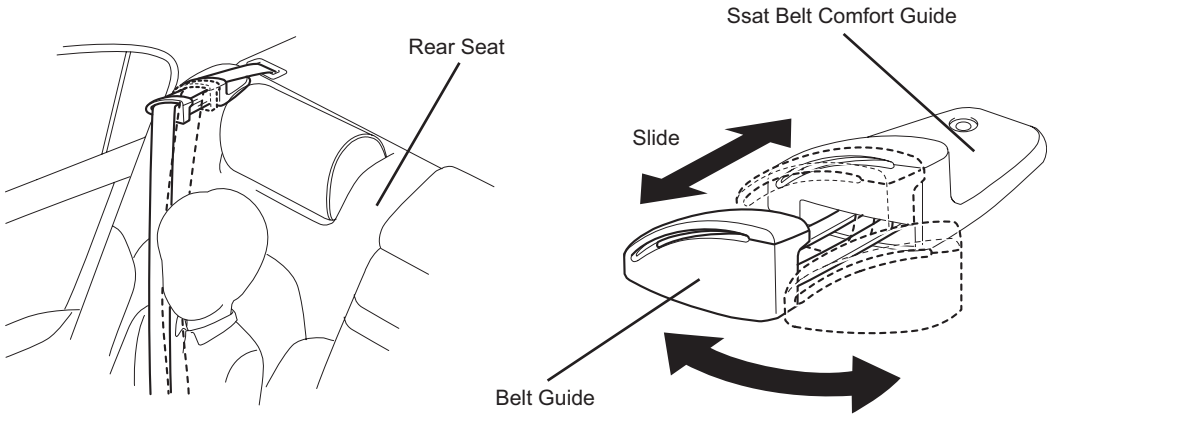
Adjustable Shoulder Belt Anchor

- To lower the adjustable shoulder belt anchor, pull it down while keeping the upper button pressed. To raise it, the anchor can be adjusted by pushing the lower button upward, without pressing the upper button.
- A slip joint is built into the center pillar upper garnish. Also, a shoulder belt cover that slides vertically in unison with the slip joint is provided.



Seat Belt Comfort Guide

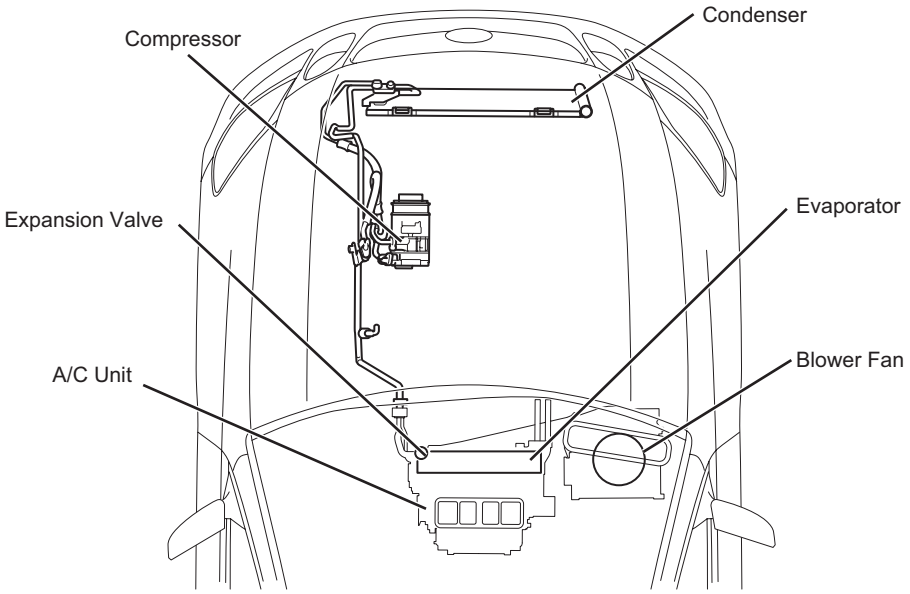
- Ssat belt comfort guides for children have been adopted on the both sides of rear seats.With this device,the belt guide can be slid to reduce the discomfort when the normal seat belt position would be too close to the person who is wearing the seat belt.

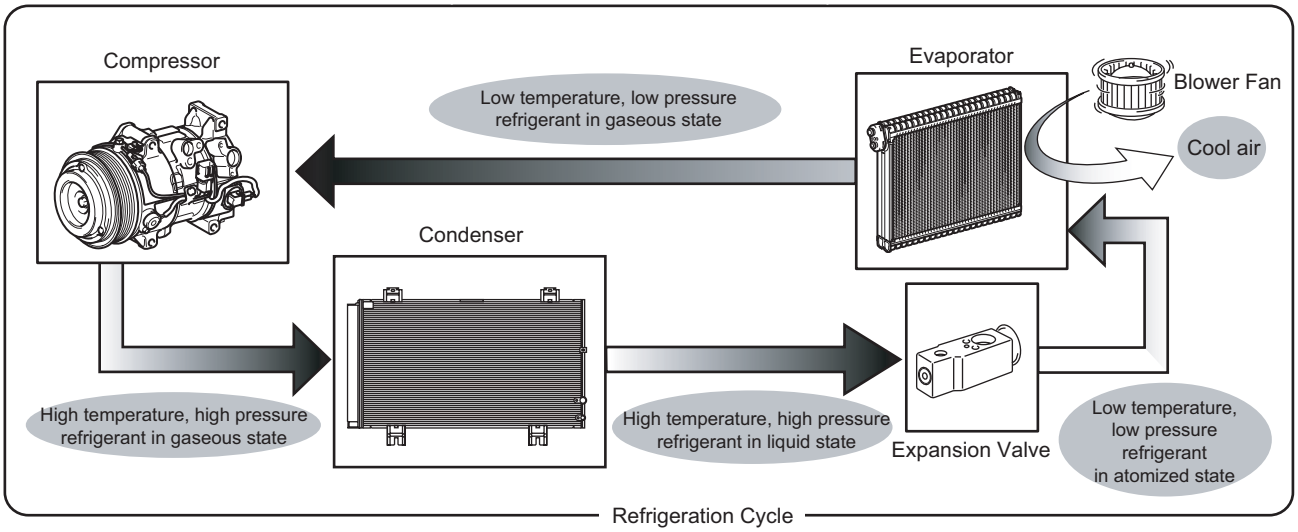


AIR CONDITIONER

Refrigeration Cycle

- A refrigeration cycle consists of a refrigerant that is sealed inside a pipe, which is circulated through components including a compressor, condenser, and evaporator. In the process of circulating inside the cycle, the refrigerant undergoes repetitive changes in its state from gas to liquid, and back to gas. Thus, it creates the refrigeration effect by absorbing the heat from the cabin and discharging it outside of the cabin.





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Air Conditioner Communication System

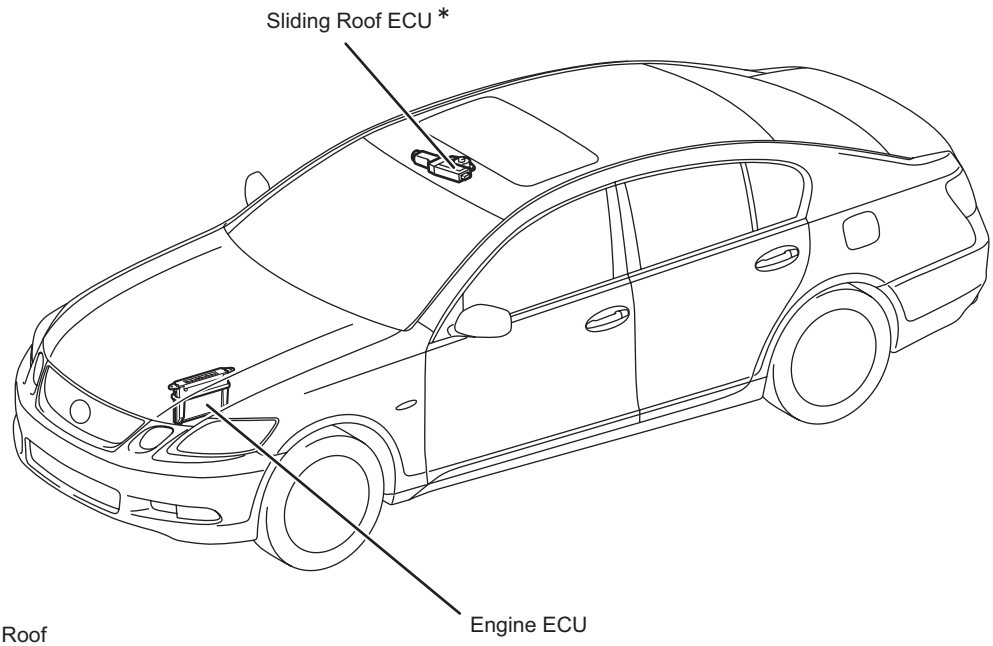
● The onboard multiplex communication that controls the entire vehicle system is a gateway configuration that includes the Body Electronics Area Network [BEAN*1] (which consists of three buses: door system bus, instrument panel system bus, and column system bus); Audio Visual Communication - Local Area Network [AVC-LAN*2]; and the Controller Area Network [CAN*3] communication system that transmits and receives high-speed data pertaining to the driving of the vehicle. They share only the communication data they need.he front air conditioner ECU, which controls the entire air conditioner, is connected to the instrument panel system bus. It receives the inputs of signals from various sensors and switches via dedicated lines. In addition, it receives the inputs of signals that are necessary for controlling the air conditioner from the engine ECU and MPX rear junction block ECU via the respective communication lines. Thus, the front air conditioner ECU is able to effect air conditioner control that is finely tuned to the operating conditions of the vehicle. Similarly, the front air conditioner ECU outputs signals pertaining to the air conditioner to other ECUs via the respective communication lines. For details on the Body Electronics Area Network, refer to the Control System Section.

❖REFERENCE❖

*1"BEAN" is an abbreviation for Body Electronics Area Network, which is Toyota Motor Corporation's proprietary bi-directional multiplex communication network that is used among various control ECUs of the body system.

*2"AVC-LAN" is an abbreviation for Audio Visual Communication - Local Area Network. This communication network establishes communication among the audio and visual devices, and is commonly used by various device manufacturers.

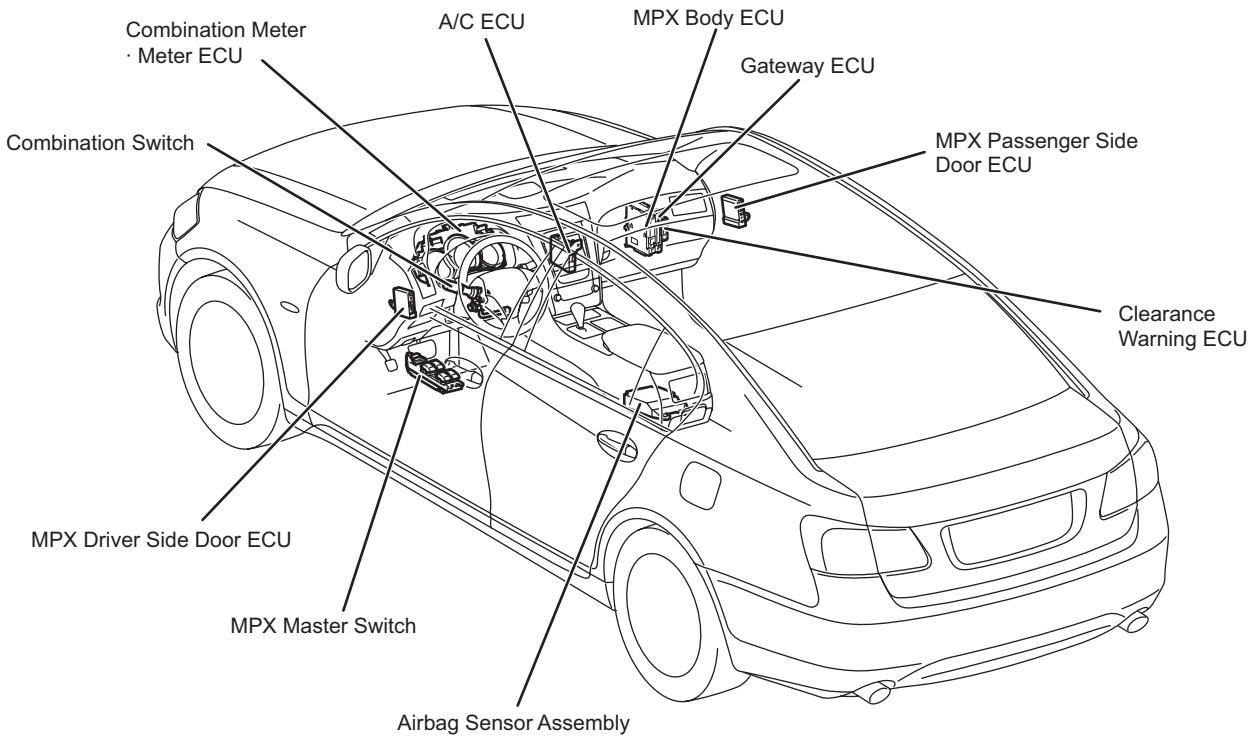
*3"CAN" is an abbreviation for Controller Area Network, which is serial communication that complies with the ISO (International Organization for Standardization) standards.



∗ : with Moon Roof

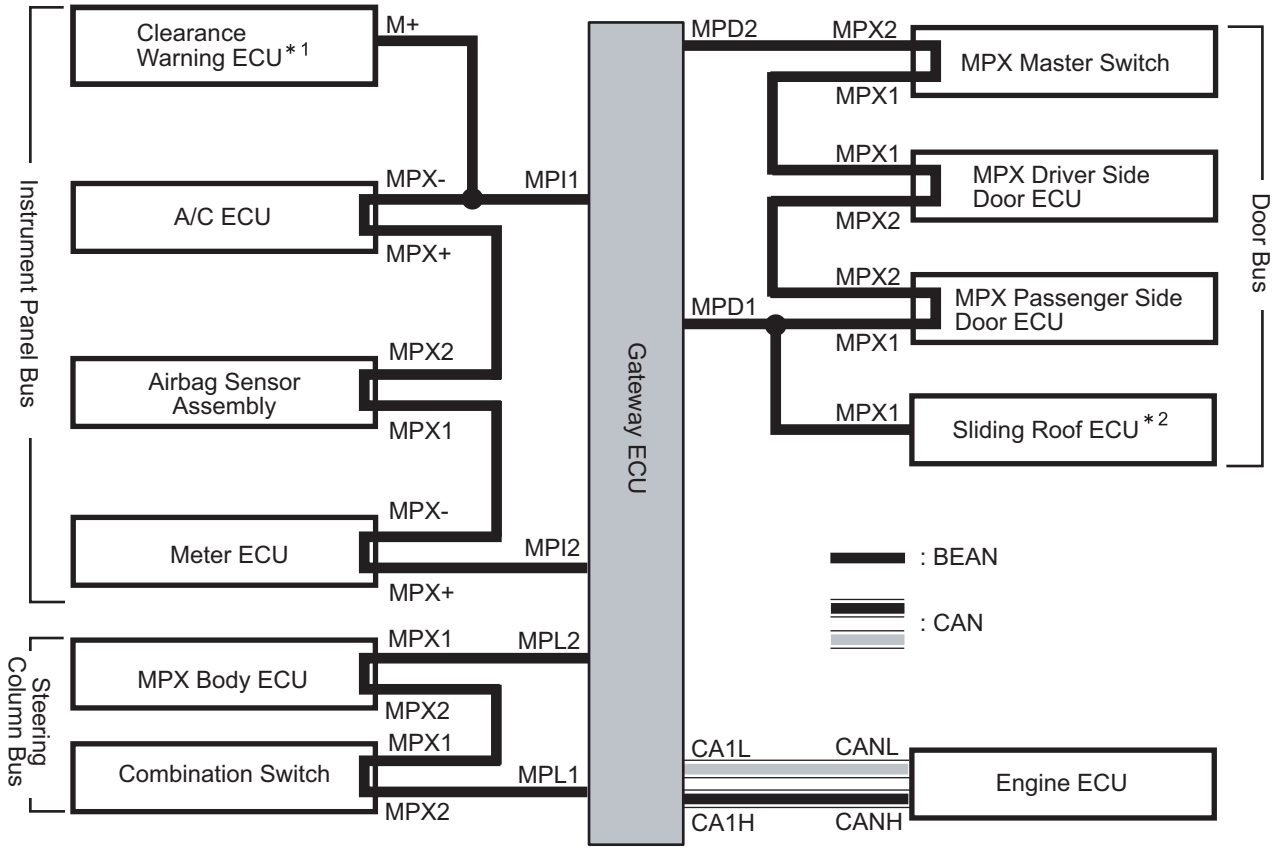
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Air conditioner Communication System



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Air conditioner Communication Diagram



∗1 : with Front & Clearance Sonar System
∗2 : with Moon Roof

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AC

Heater and Air Conditioner System Outline

List of Main Descriptions of Heater & Air conditioner System

Item	Description
Air conditioner system	• All models use a multi-zone auto air conditioner in front, which uses auto air conditioner control employing a neural network*. Thus, this system provides a more comfortable air conditioner performance to suit the sensory feel of the occupants.
Air conditioner Unit & Air Duct	• A brushless motor, in which a blower motor and a blower motor controller are integrated, is used. This realizes space savings and provides ample space in the footwell area for the front passenger. • A wide-angle, compact, high-flow defroster is used.
Evaporator	• An RS (Revolutionary Super Slim) evaporator that is dramatically compact and lightweight is used.
Heater core	• A compact and high performance SFA-II (Straight Flow Aluminum-II) heater core is used.
Clean air filter	• A clean air filter is provided on all models as standard equipment.
Room Temperature Sensor	• A sensor that is equipped with a humidity detection function is used.
Compressor	• All models use an externally controlled, continuously variable capacity compressor to improve fuel economy.
Condenser	• A highly efficient and lightweight sub-cool condensing is used.
Refrigerant	• To address the concerns on the destruction of the ozone layer, HFC-134a (R-134a), a refrigerant that does not contain chlorine, is used in the air conditioner.

❖REFERENCE❖

* The neural network is an engineering application that imitates the data processing method of the nervous system of a living organism. It can effect complex control by correlating the mutual relationships among complex inputs and outputs as skillfully as the human brain.

Performance and Specifications

Heater

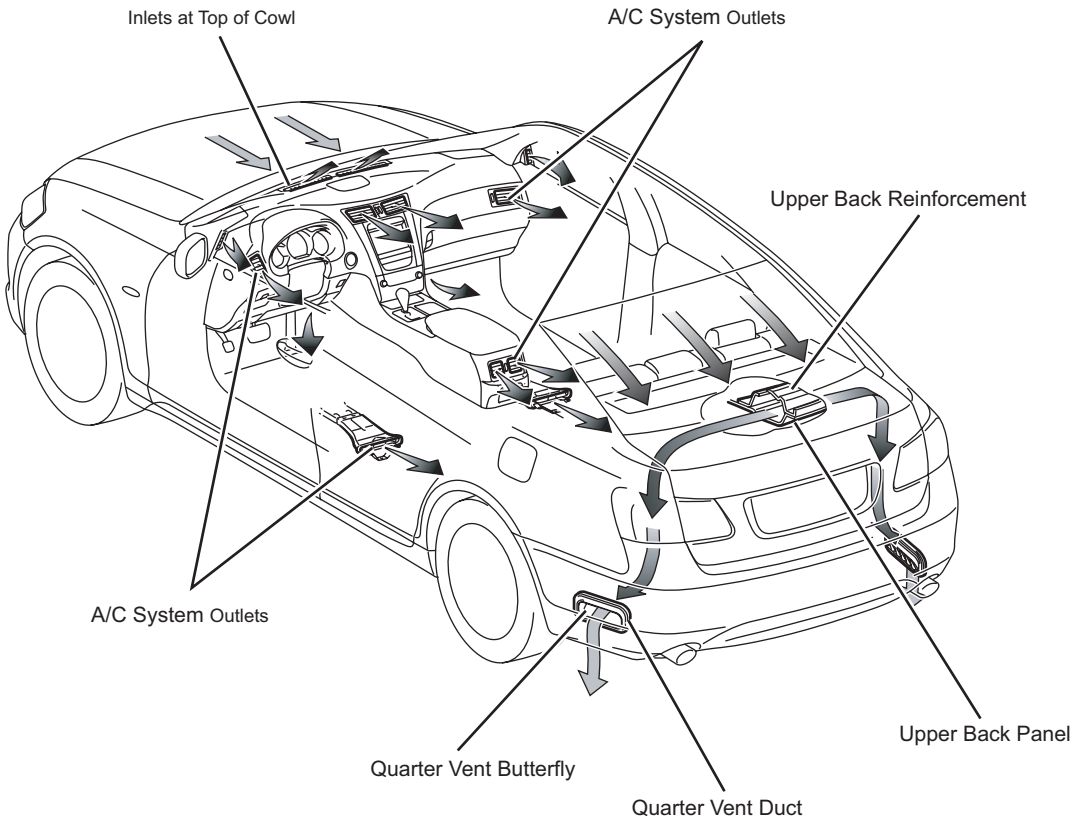
State	specifications
Heat Output [W]	5200
Air Flow Volume [m^3/h]	350
Power Consumption [W]	200 or less
Blower Fan Size <Dia.×H> [mm] (in.)	165×70
Blower Air Volume Selector	Auto: 31 steps (except OFF), Manual: 7 steps (except OFF)
Heater Core Size <W×H×L×Fin Pich> [mm] (in.)	263.9×100×27×1.8

Air Conditioner

State	specifications
Cooling Capacity [W]	5600
Air Flow Volume [m^3/h]	550
Power Consumption [W]	250 or less
Blower Air Volume Selector	Auto: 31 steps (except OFF), Manual: 7 steps (except OFF)
Compressor Type	6SEU16C,6SBU16C
Pulley Ratio (crankshaft pulley diameter/compressor pulley diameter) [mm] (in.)	145/115=1.26 (with 3UZ-FE Engine)
	140/115=1.22 (with 3GR-FE/FSE Engine)
Evaporator Size <W×H×L×Fin Pich> [mm] (in.)	293.1×211×38×3.0
Condenser Size <W×H×L×Fin Pich> [mm] (in.)	660×363.8×16×3.55 (except G.C.C. Countries Model)
	660×363.8×16×3.15 (G.C.C.Countries Model)

Ventilation

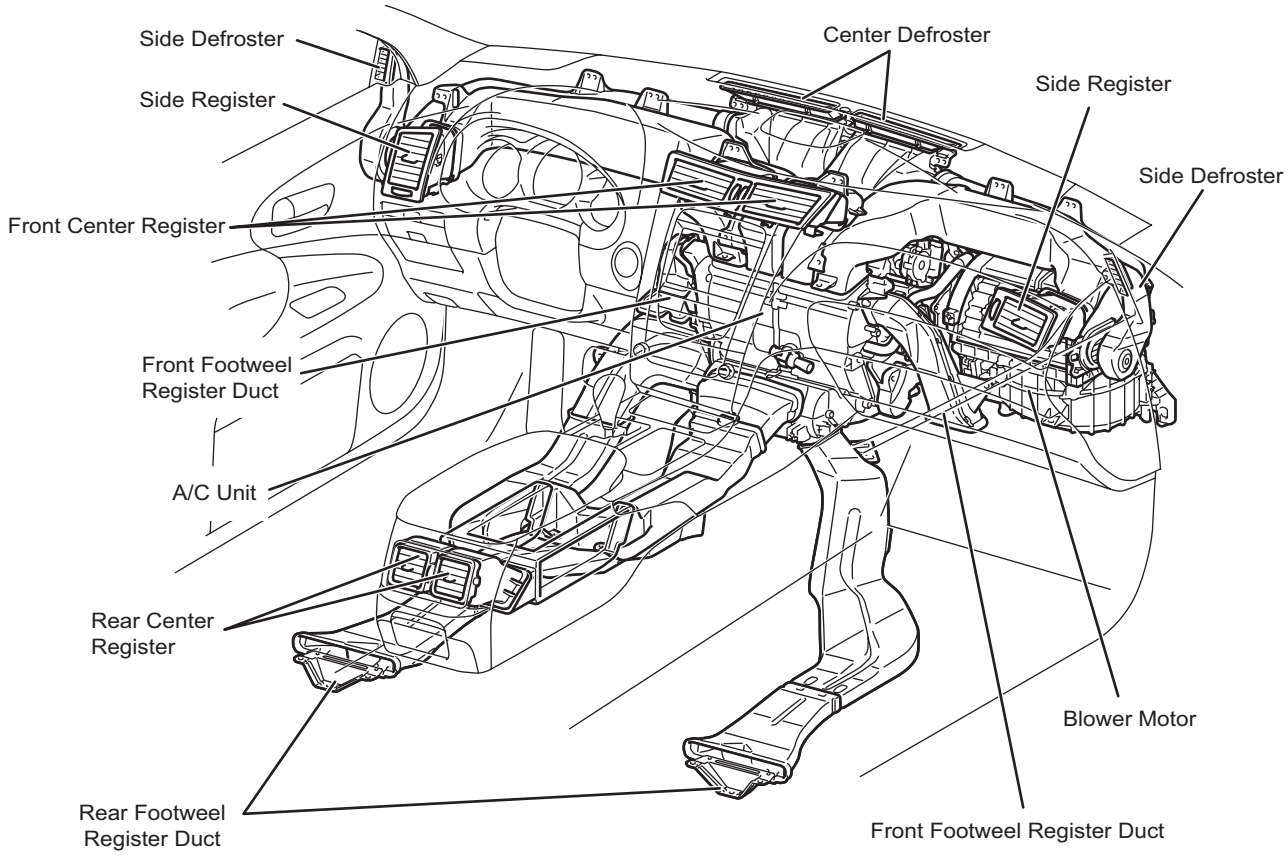
- Fresh air enters through the inlets above the cowl, passes through the air conditioner system, and enters the cabin via the outlets in the instrument panel and other areas.
- Cabin air is routed as follows: through the clearance between the back end of the package tray trim and the back window glass to the upper back panel, via the luggage compartment, and out through the quarter vent ducts.
- The quarter vent ducts are provided with quarter vent butterflies to allow the cabin air to exit easily but inhibit outside air from entering. Thus, they prevent dust from entering the cabin.



A4270004E

Front Air Conditioner Unit

- A centered integrated air conditioner unit with offset blowers, consisting of a thin evaporator and a heater core in front and back of the unit, is used to realize a compact configuration. A multi-duct system is used to minimize localized cooling in the cooling mode or localized heating in the heating mode. In addition, it reduces the airflow resistance in the unit and the wind noise during air conditioner, thus realizing a comfortable vehicle interior overall.
- An automatically controlled, cool air bypass damper is used to adjust the temperature of the airflow that is directed to the occupants' heads during cooling and heating (during air-mix control)
- A brushless motor, in which a blower motor and a blower motor controller are integrated, is used to save space. Thus, ample space is provided in the footwell area for the front passenger.
- A sub-cool condenser and a thin RS (Revolutionary Super Slim) evaporator are used to reduce the amount of refrigerant used, in order to address environmental concerns.
- As on the previous model, a wide-angle, high-flow defroster in which the inner shape of the front defrosters is radial, is used to realize excellent defroster performance. Side defrosters are provided on triangular patches to prevent the front windshield from fogging, and enhance the design of the door trims.
- Rear heater ducts and a console rear face register are provided as standard equipment to enhance the comfort of the rear seat occupants.
- A deodorizing filter (pollen deodorizer type) consisting of a clean air filter with enhanced deodorizing efficiency is provided on all models as standard equipment.

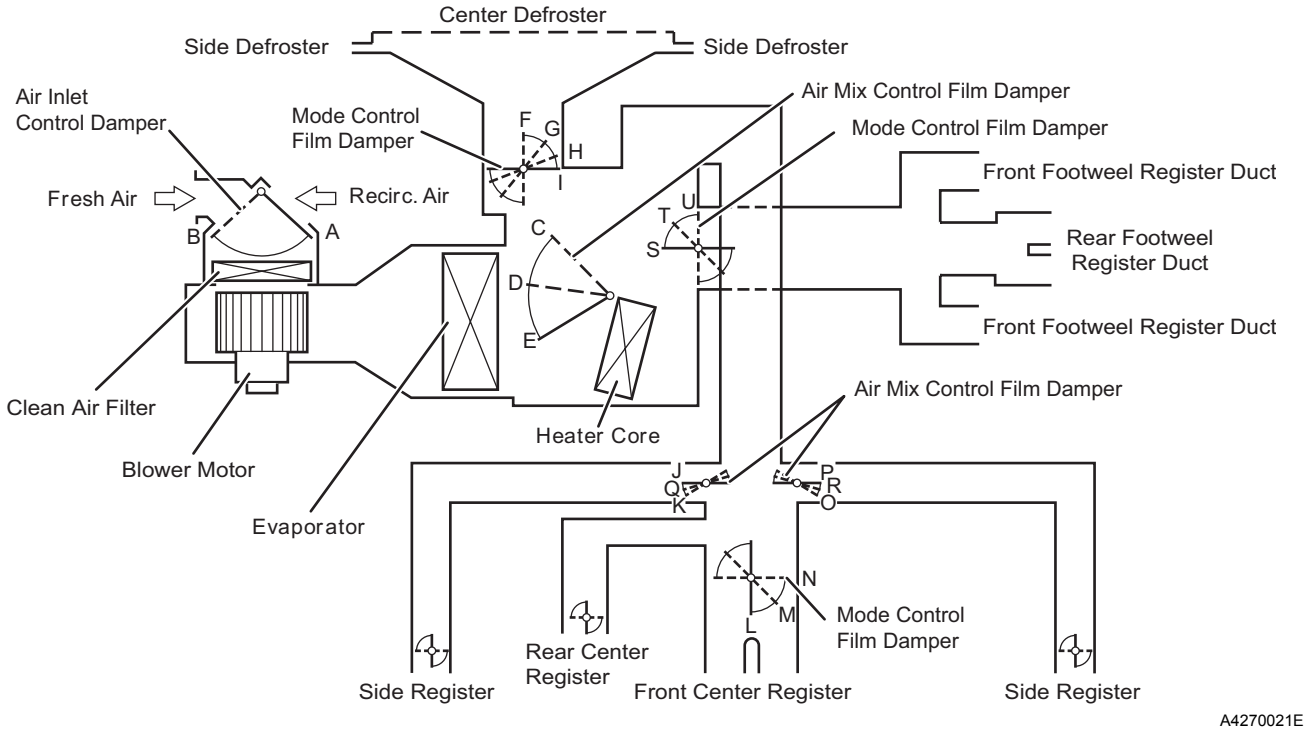


Note: The illustration gives a representative example.

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AC

Mode Position and Damper Operation



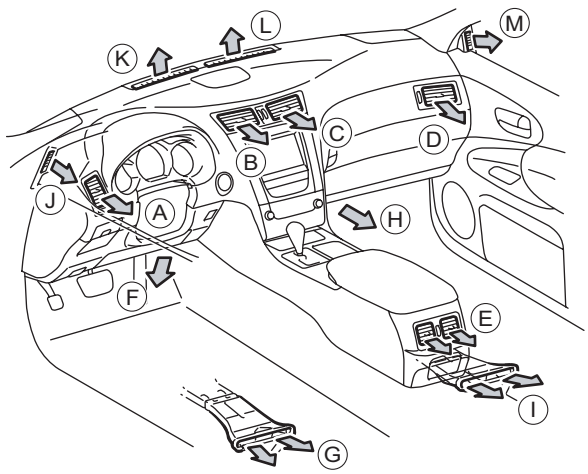
Function of Main Damper

Control Damper	Control Position	Damper Position	Operation
Air Inlet Control Damper	FRESH	A	Brings in fresh air.
	RECTRCUTION	B	Recirculates internal air.
Air Mix Control Dmper	MAX HOT ~ MAX COOL	C,D,E	Varies the mixture ratio of the cool air and the warm air in order to regulate the temperature continuously from HOT to COLD.
Mode Control Damper	FACE	I,J,L,P,U	Air blows out of the front and rear center registers, and side register.
	BI-LEVEL	I,Q,M,R,T	Air blows out of the front and rear center registers, side registers, and front and rear foot well register ducts.
	FOOT	H,K,N,O,S	Air blows out of the front and rear foot well register ducts, side register, and rear center registers. In addition, air blows out slightly from the center defroster.
	FOOT/DEF	G,K,N,O,T	Air blows out of the front and rear center registers, side registers, and front and rear foot well register ducts.
	DEF	F,K,N,O,U	Defrosts the windshield through the center defroster, side defroster, side register and rear center register.

AC

Air Outlets and Air Volume Rations

• The air outlet modes and their airflow volumes are shown below.



Graphic	Air Outlet Mode	Selectable Mode		Register					Foot				Defroster			
				Driver		Front Passenger		Rear	Driver		Front Passenger		Driver		Front Passenger	
		Automatic	Manual	Center	Side	Center	Side	Center	Front	Rear	Front	Rear	Front	Side	Front	Side
	FACE U *1	○	○	➡	➡	➡	➡	➡	／	／	／	／	／	／	／	／
	FACE L *2	○	–	➡	➡	➡	➡	➡	→	→	→	→	／	／	／	／
	BI-LEVEL U *1	○	○	→	→	→	→	→	➡	➡	➡	➡	／	／	／	／
	BI-LEVEL L *2	○	–	→	→	→	→	→	➡	➡	➡	➡	／	／	／	／
	FOOT (DEF=0)	–	–	→	→	→	→	→	➡	➡	➡	➡	／	／	／	／
	FOOT D *3	○	–	→	→	→	→	→	➡	➡	➡	➡	→	→	→	→
	FOOT R *4	○	–	→	→	→	→	→	➡	➡	➡	➡	→	→	→	→
	FOOT F *5	○	–	→	→	→	→	→	➡	→	➡	→	→	→	→	→
	FOOT /DEF	○	○	→	→	→	→	→	➡	→	➡	→	➡	➡	➡	➡
	DEF	○	○	／	／	／	／	／	／	／	／	／	➡	➡	➡	➡
Air Outlet Position Symbol				A	B	C	D	E	F	G	H	I	J	K	L	M

The size of an arrow indicates the proportion of air liow volume .

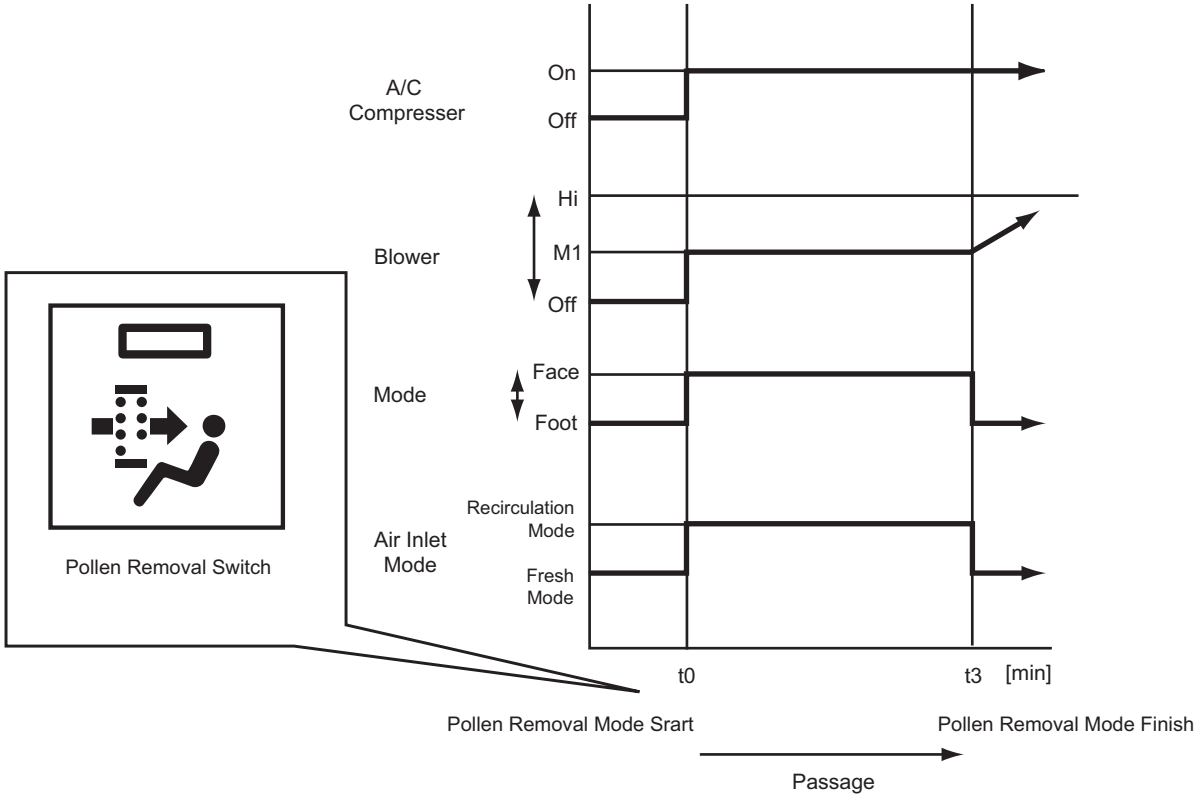
＊1 : Greater airflow volume at the upper area.
＊2 : Greater airflow volume at the lower area.
＊3 : Greater airflow volume at the defroster.
＊4 : Greater airflow volume at the rear.
＊5 : Greater airflow volume at the front.

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Pollen Removal Mode

- Press the pollen removal switch to enter the pollen removal mode. Then, transfer to the RECIRC mode and air conditioner compresser on mode, the FACE mode to supply clean, filtered air near the face of the occupants, in order to quickly remove the pollen from the area. This air continues to remove pollen from other areas of the cabin. After 3 minutes (or 1 minute when the outside air temperature is low) have elapsed, the air outlets will return automatically to the previous used mode.



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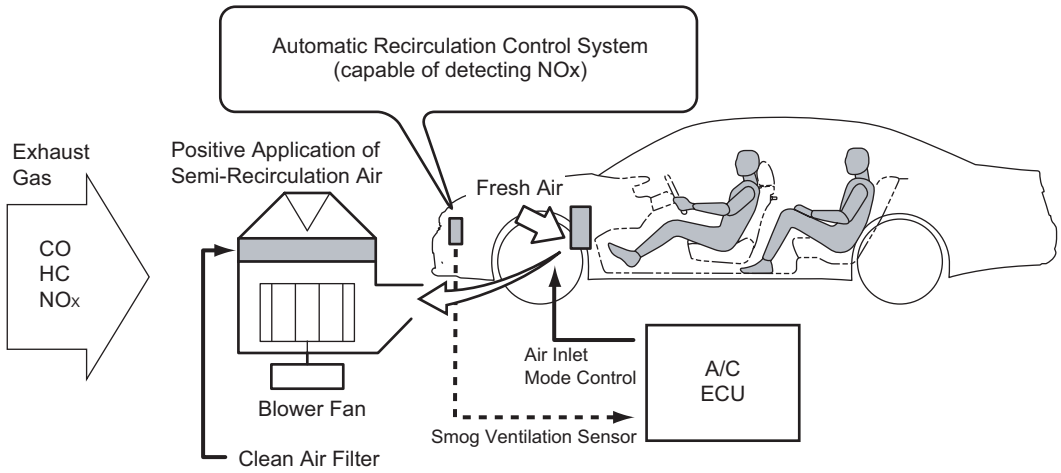
Automatic Recirculation Control

- This system uses a smog ventilation sensor to detect the harmful elements (CO, HC, NOx, etc.) in the exhaust gases. Then, it automatically prevents those harmful substances from entering the cabin and brings in clean air (by switching between fresh and recirculated air) in order to improve air quality in the cabin.
- The automatic exhaust gas sensing type fresh-recirculation switching system uses the front air conditioner ECU to comprehensively determine the signals detected by the smog ventilation sensor. Then, it automatically switches the air outlets between fresh and recirculation modes, and corrects the airflow volume of the recirculation, semi-recirculation, and fresh air. Regardless of the signals that are detected, this system automatically switches to recirculation or fresh air when the conditions require maximum cooling in the middle of the summer, or defog the windows in the winter. Thus, the design of this system does not impair the ease of use or safety of the air conditioner system.

❒ NOTICE

- This system is not used for some areas.
- The smog ventilation sensor cannnot detect elements such as the smoke from a bonfire or factory exhaust, foul or animal odors, and dirt or dust particles. Therefore, the air inlet modes are not switched in accordance with those elements.
- Depending on the direction of the wind, the smog ventilation sensor might noto be able to detect the exhaust gas elements, and could emit an odor.

Automatic Recirculation Control System



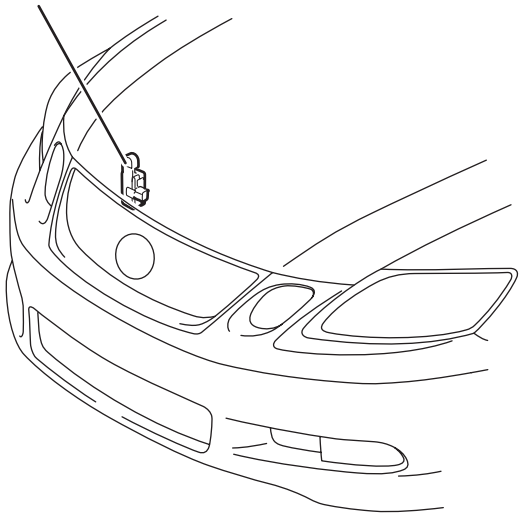
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Smog Ventilation Sensor

• Installed in front of the condenser, this sensor detects the harmful elements (CO, HC, NOx, etc.) in the exhaust gases and outputs them to the air conditioner ECU in the form of detection signals.

Smog Ventilation Sensor



A4270100E

Automatic Recirculation Switch

• This switch is located in the air conditioner operation area of the integration panel. Each time this switch is pressed, the air inlet modes change as follows: auto mode -> fresh air mode -> recirculation air mode -> auto mode. It will switch to the sensor sensitivity adjustment mode when this switch is pressed and held approximately 1.7 seconds while the vehicle is stopped.

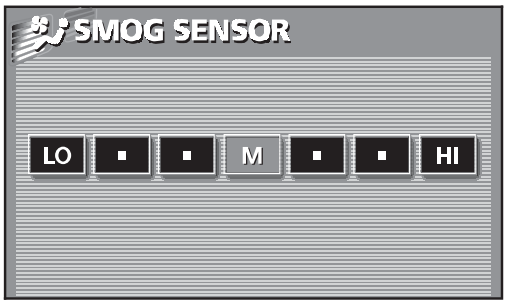


Automatic Recirculation Switch

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Sensor Sensitivity Adjustment Switch

• The detection sensitivity of the smog ventilation sensor can be adjusted as shown below.



K3940132E

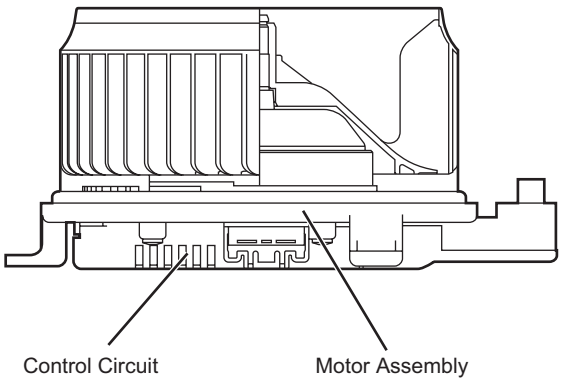
List of Operations

Item	Description
Operation	• Press and hold the automatic recirculation switch for approximately 1.7 seconds while the vehicle is stopped.
Display	• The multi display panel switches to the sensor sensitivity adjustment mode.
Adjustment	• Press the touch switches on the screen to adjust the detection sensitivity of the smog ventilation sensor. • The sensitivity adjustment ranges from HI to LO in 7 stages.

AC

Blower Fan

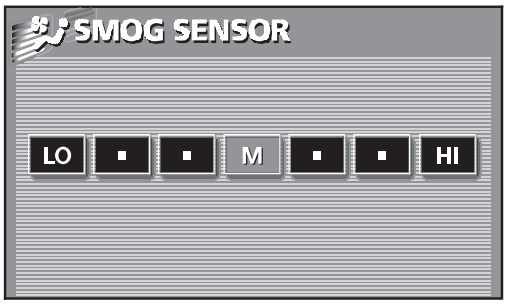
● As on the previous model, the blower motor and the blower motor controller have been integrated for space savings. In addition, a brushless motor is used, in which the brushes have been discontinued and the number of contacting parts has been reduced, thus realizing a low-noise operation.



A4270022E

Sensor Sensitivity Adjustment Switch

• The detection sensitivity of the smog ventilation sensor can be adjusted as shown below.



K3940132E

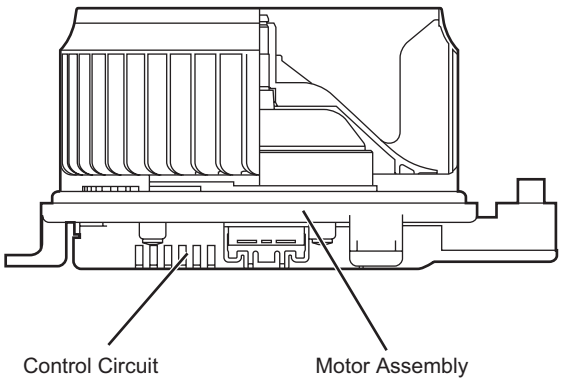
List of Operations

Item	Description
Operation	• Press and hold the automatic recirculation switch for approximately 1.7 seconds while the vehicle is stopped.
Display	• The multi display panel switches to the sensor sensitivity adjustment mode.
Adjustment	• Press the touch switches on the screen to adjust the detection sensitivity of the smog ventilation sensor. • The sensitivity adjustment ranges from HI to LO in 7 stages.

AC

Blower Fan

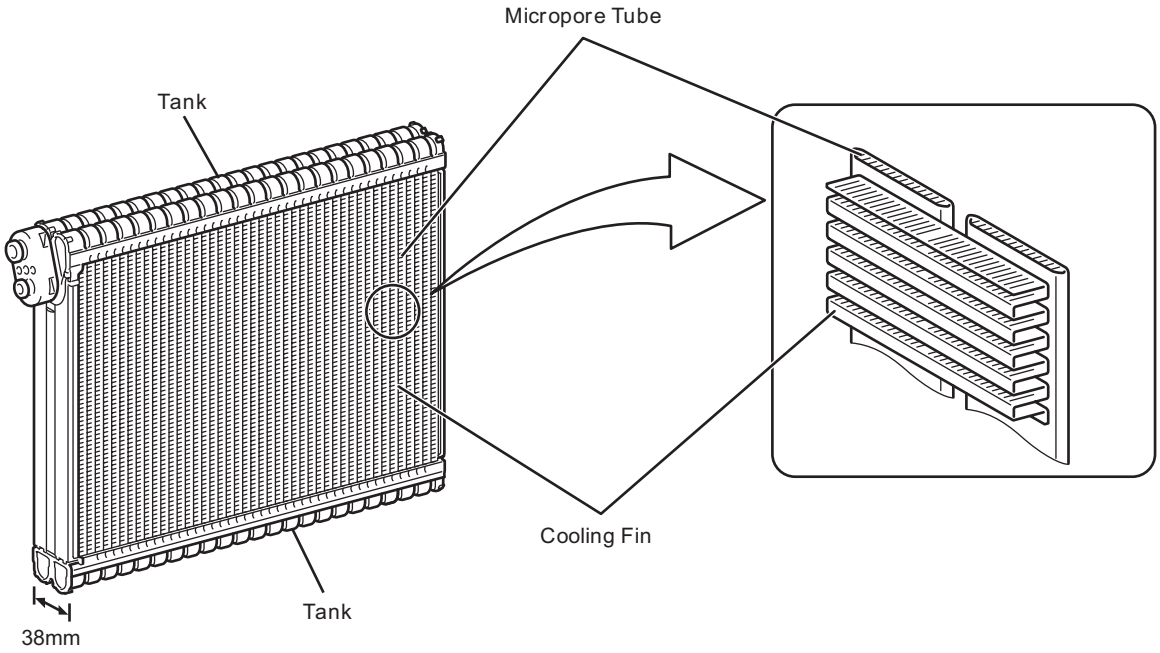
● As on the previous model, the blower motor and the blower motor controller have been integrated for space savings. In addition, a brushless motor is used, in which the brushes have been discontinued and the number of contacting parts has been reduced, thus realizing a low-noise operation.



A4270022E

Evaporator

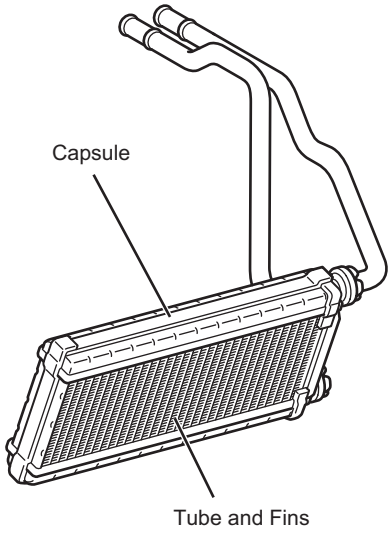
- The RS evaporator consists of a tank, tubes, and cooling fins. The tubes are extrusion molded to form micropore passages. Thus, this evaporator offers excellent heat transfer performance while realizing a thin (38mm) construction. The fin height and tube thickness have been optimized and the fin pitch has been minimized to promote heat transfer, and a thin material has been used in the core to realize an RS evaporator with a dramatically compact and lightweight construction. A clean coat is applied to the evaporator proper to inhibit the propagation of germs that create foul odors, and a chrome-free surface treatment is used to address environmental concerns.



A4270023E

Heater Core

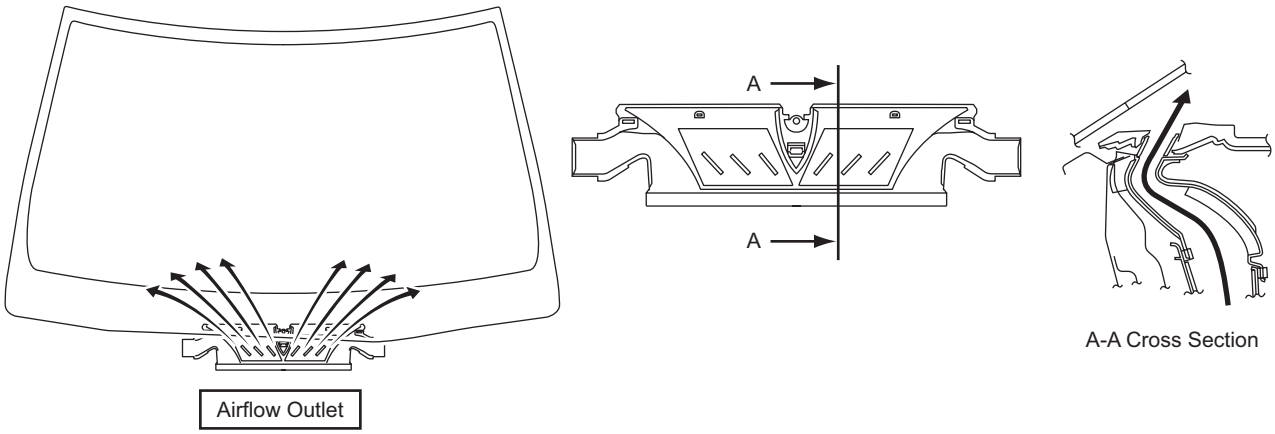
● Compared to the SFA heater core, the SFA-II uses a closer-packed core and the shape of its tank and the flow passage has been improved to realize a more compact package and higher performance.



A4270024E

Wide-Angle, High-Flow Defroster

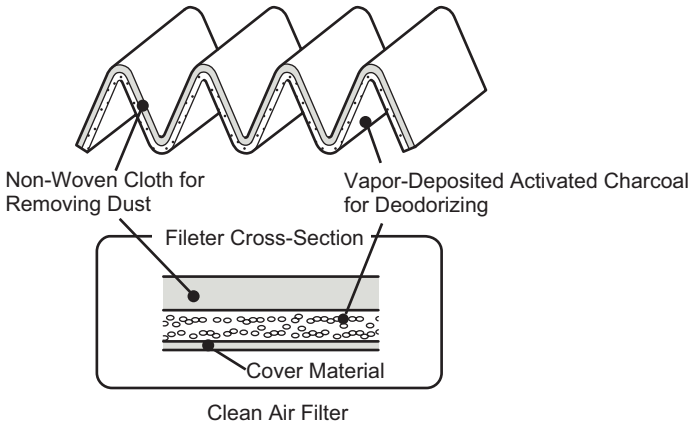
● As on the previous model, the inner wall of the front defroster is shaped radially to smooth the airflow through the outlet, thus realizing excellent defroster performance.



A4270007E

Clean Air Filter

● A deodorizer filter (pollen deodorizer type) is provided on all models as standard equipment. This filter uses non-woven cloth for removing dust, and vapor-deposited activated charcoal for deodorizing.



A4270025E

Performance and Setting

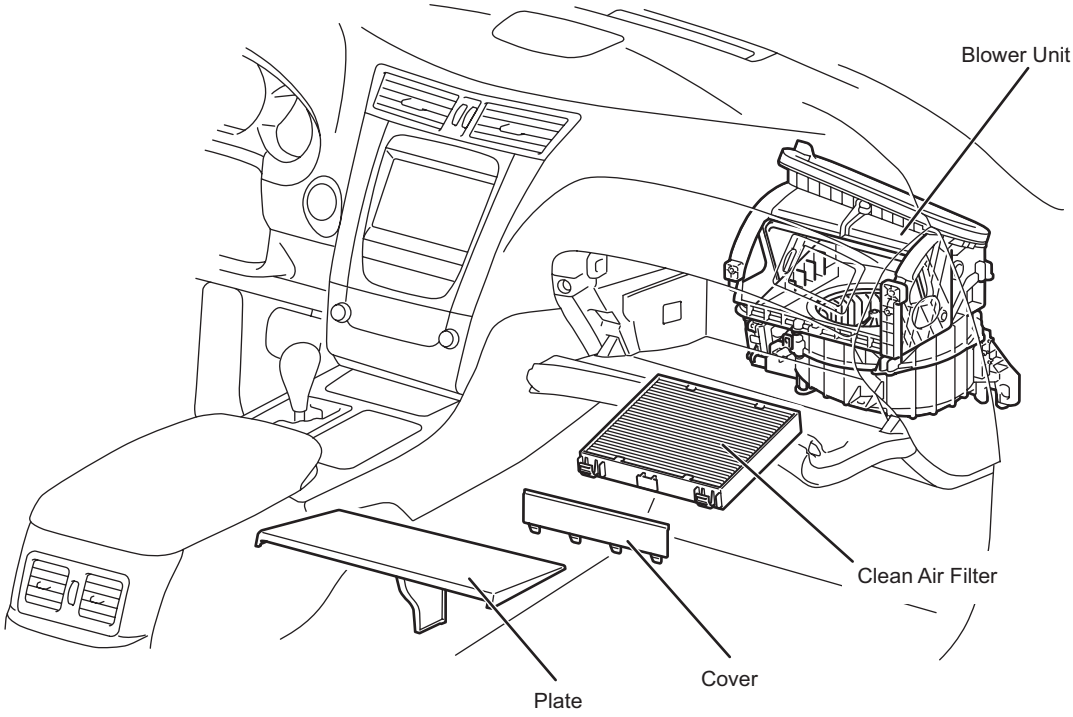
• The deodorizer filter (pollen deodorizer type) realizes a comfortable interior space by efficiently removing microscopic dust (micron particles) such as pollen and dust, in addition to removing odors such as acetaldehyde. Because it is installed above the blower fan in the blower unit, the clean air filter can be replaced without tools, by merely removing a plate and a cover in the glovebox. Thus, it also excels in serviceability.

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❒ **NOTICE**

• Make sure to turn the ignition OFF before replacing the filter.

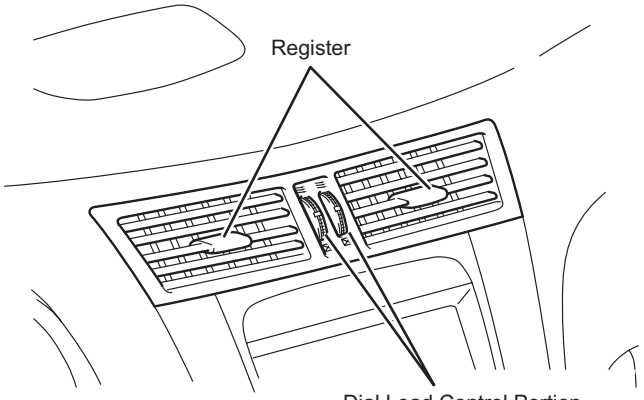
• Replace the filter regularly to ensure its proper dust collection capability.



A4270008E

Register

- The following functions are provided to the front center registers and side registers.
- The dial load control portion has been greased to improve the ease of use.
- A register dial illumination is used to improve the nighttime operation and appearance.

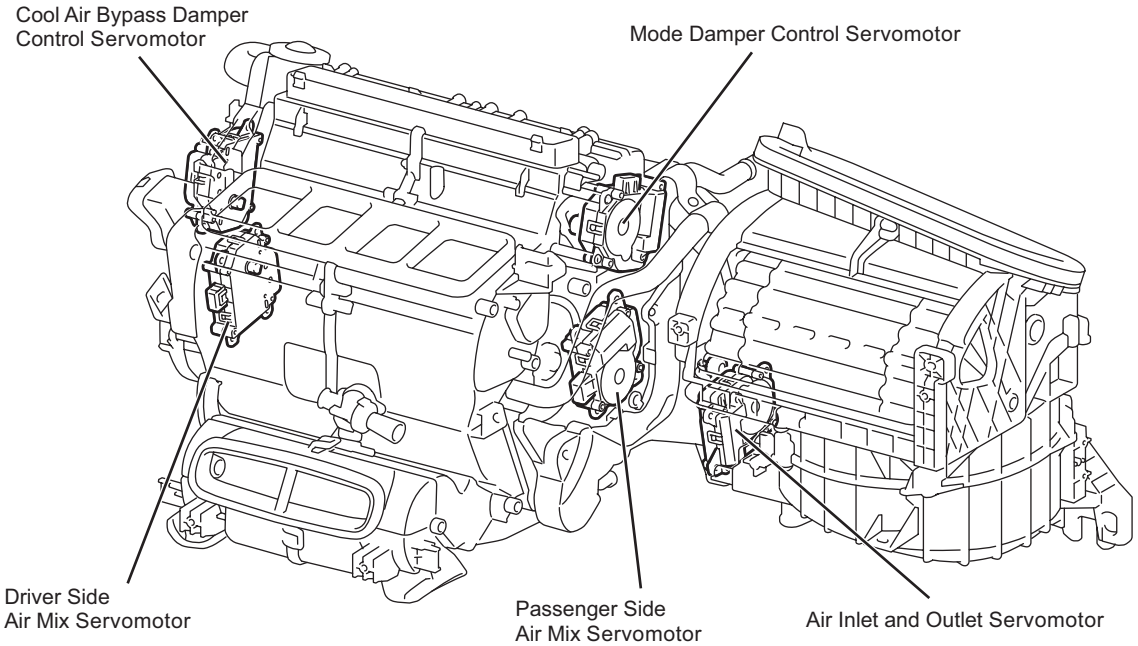


Note: The illustration gives a representative example.

A4270009E

Servomotor

- All models use servomotors for the following purposes: air inlet selector, cool air bypass damper selector, mode damper selector, and driver and front passenger air mix damper selector. These servomotors use the pulse pattern system that detects their position through pulse signals. Along with the pulse pattern type servomotors, a smart connector is used. The smart connector has a built-in IC (Integrated Circuit) with a function to maintain communication with the front air conditioner ECU.
- The servomotors are installed in the following positions: The servomotors for the driver air mix damper selector and cool air bypass damper selector are located on the left side of the heater & cooler unit. The servomotors for the mode damper selector and the front passenger air mix damper selector are located on the right side of the heater & cooler unit. The servomotor for the air inlet damper selector is located on the left side of the blower unit.

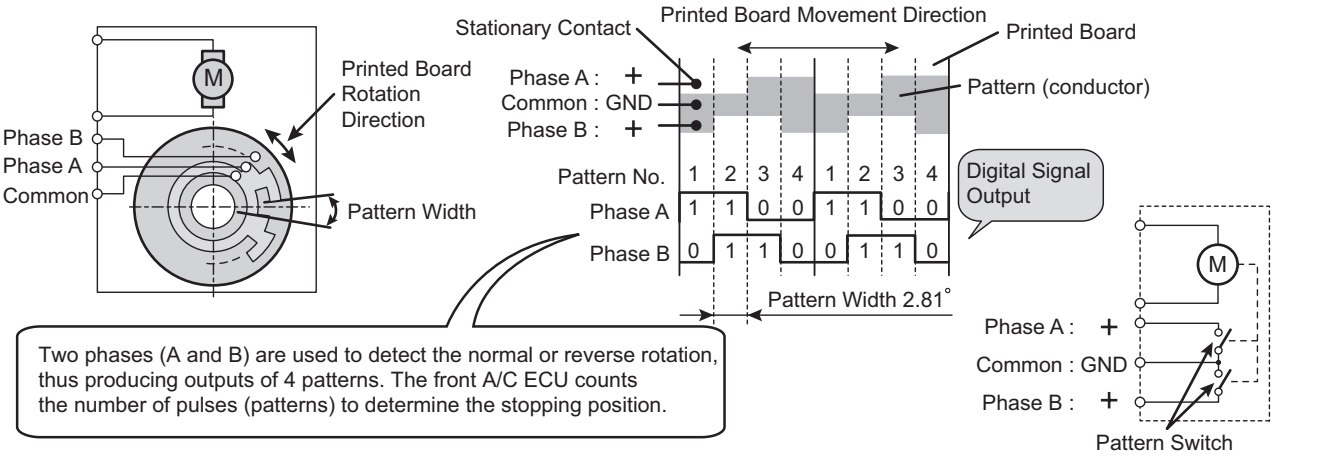


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Pulse Pattern Type Servomotor

• The conventional servomotor detects the position by way of the potentiometer voltage. In contrast, the pulse pattern servomotor is the type that detects the relative position by way of the 2-bit ON/OFF signals. The front air conditioner ECU counts the number of pulses (patterns) to determine the stopping position.

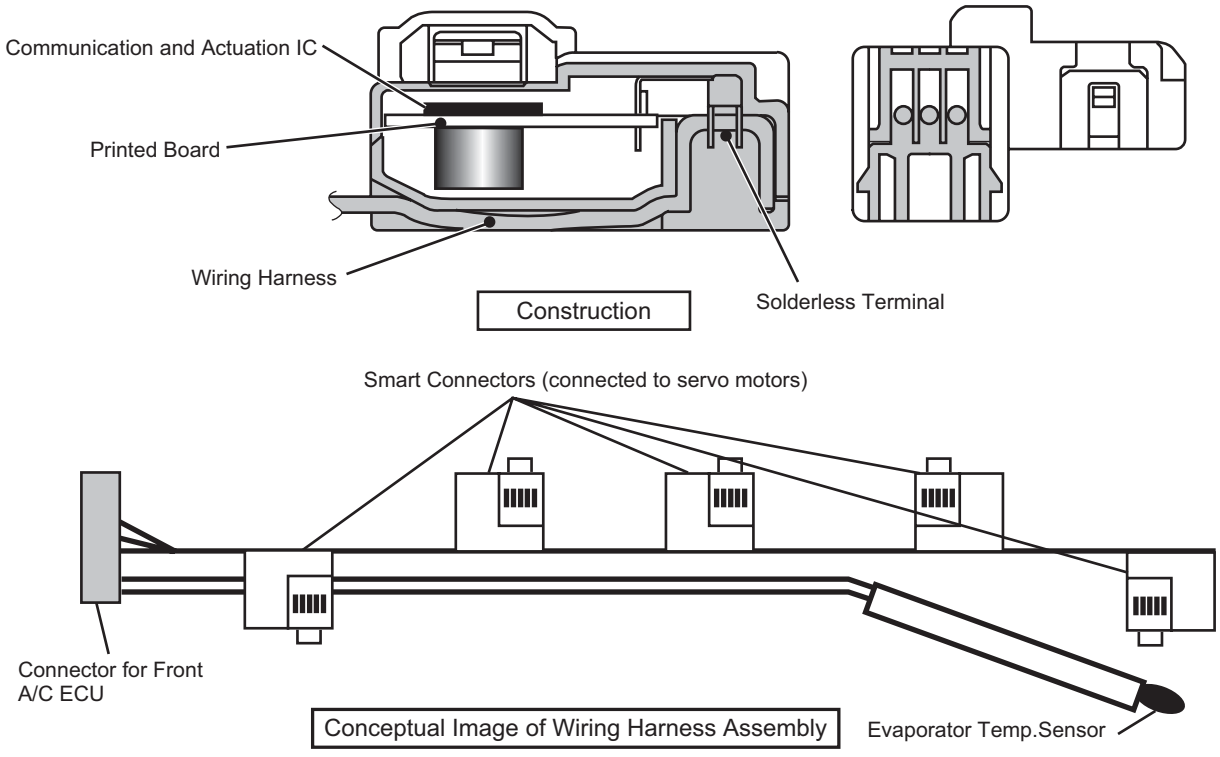


A4270026E

Bus Connectors

• Smart connectors are used to actuate the pulse pattern type servomotors, which control the air conditioner. These connectors are aimed at reducing weight and minimizing the number of wires. Each smart connector has a built-in IC (Integrated Circuit) with functions to maintain communication with the front air conditioner ECU, actuate the servomotor, and detect the position.

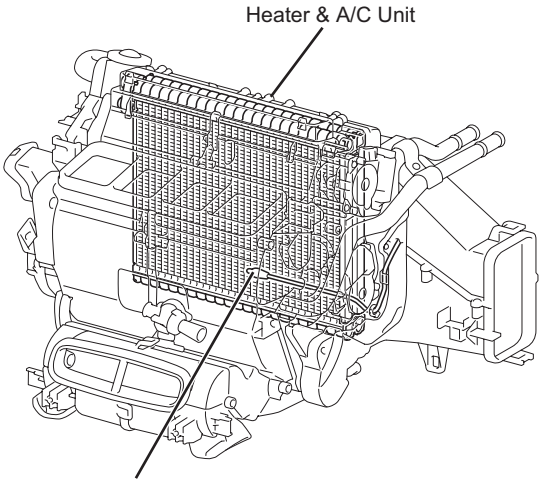
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Evaporator Temperature Sensor

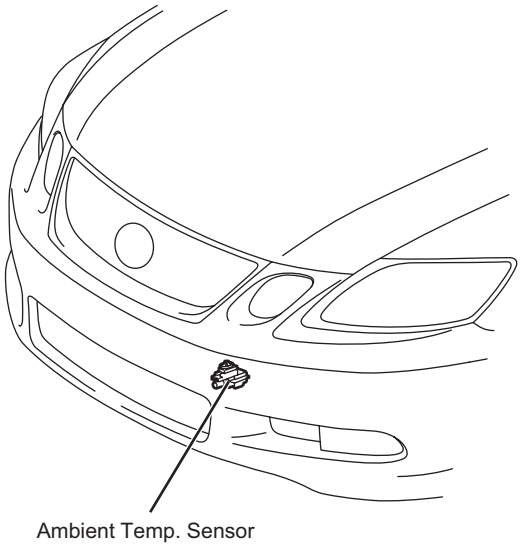
- This sensor detects the temperature of the cool air immediately past the evaporator in the heater & cooler unit in the form of resistance changes, and outputs it to the front air conditioner ECU.
- It is installed behind the evaporator in the heater & cooler unit.



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Ambient Temperature Sensor

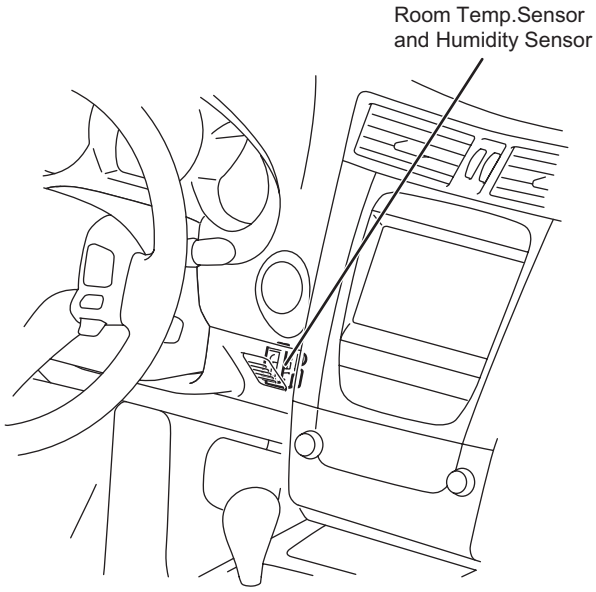
- This sensor detects the changes in the outside temperature in the form of resistance changes in the thermister, and outputs them from the engine ECU via the gateway ECU to the front air conditioner ECU.
- It is installed below the bumper reinforcement.



A4270015E

Room Temp. and Humidity Sensor

- A room temperature sensor in which a temperature sensor and a humidity sensor are integrated is used.
- It is installed on the right side of the steering column, in the instrument finish lower panel.



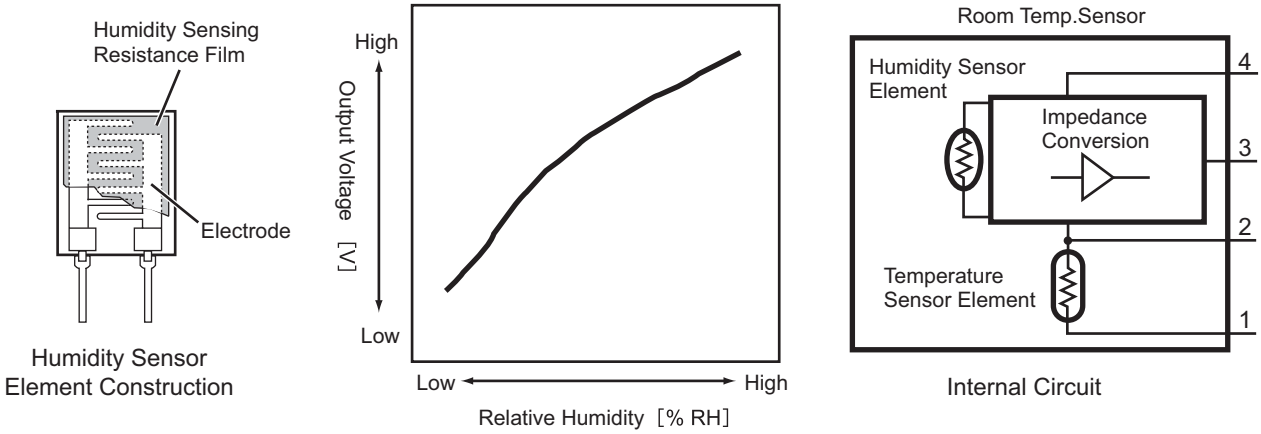
A4270011E

Room Temp Sensor

- This sensor utilizes the airflow of the front air conditioner unit to allow the air in the cabin to pass by the temperature sensor. Then, the thermister that is built into the sensor detects the air temperature in the cabin and outputs it to the front air conditioner ECU.

Humidity Sensor

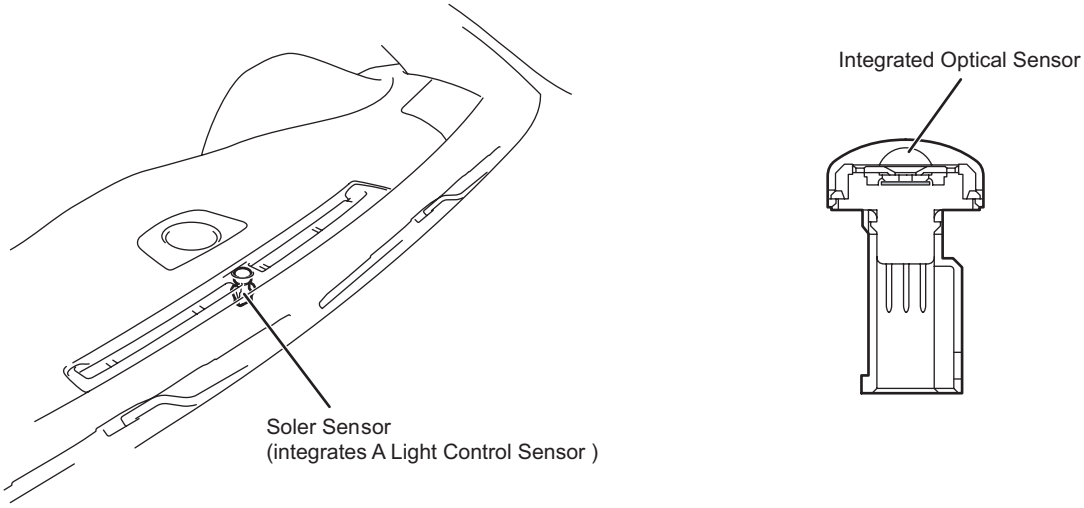
- A humidity sensor is used in the room temperature sensor to detect the humidity changes in the cabin. This prevents excessive dehumidification and reduces the power consumption of the air conditioner.
- This sensor contains a humidity sensing resistance film that absorbs and desorbs the humidity in the cabin and causes the resistance between the electrodes to change. The humidity sensor detects this change in resistance within its humidity detection range and outputs it to the front air conditioner ECU.



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Solar Sensor

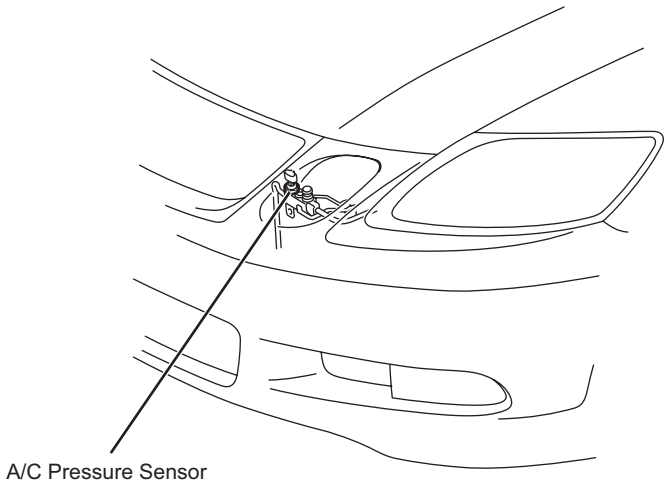
- This sensor uses a scanner portion (integrated optical sensor) to detect the changes in the solar amount, and outputs them to the front air conditioner ECU in the form of frequency signals.
- A solar sensor with a built-in light control sensor is used to reduce the number of parts and improve the appearance.
- It is installed in the center of the front defroster, on top of the instrument panel.



A4270012E

Air Conditioner Pressure Sensor

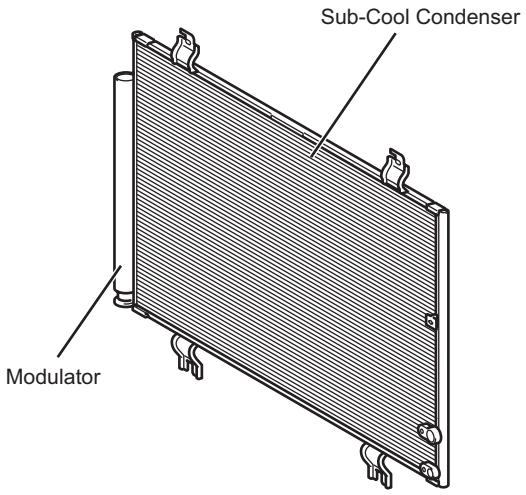
- A pressure sensor that detects the refrigerant pressure and outputs it to the front air conditioner ECU in the form of voltage changes is used.
- It is installed on the high-pressure pipe block in front of the condenser.



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Condenser

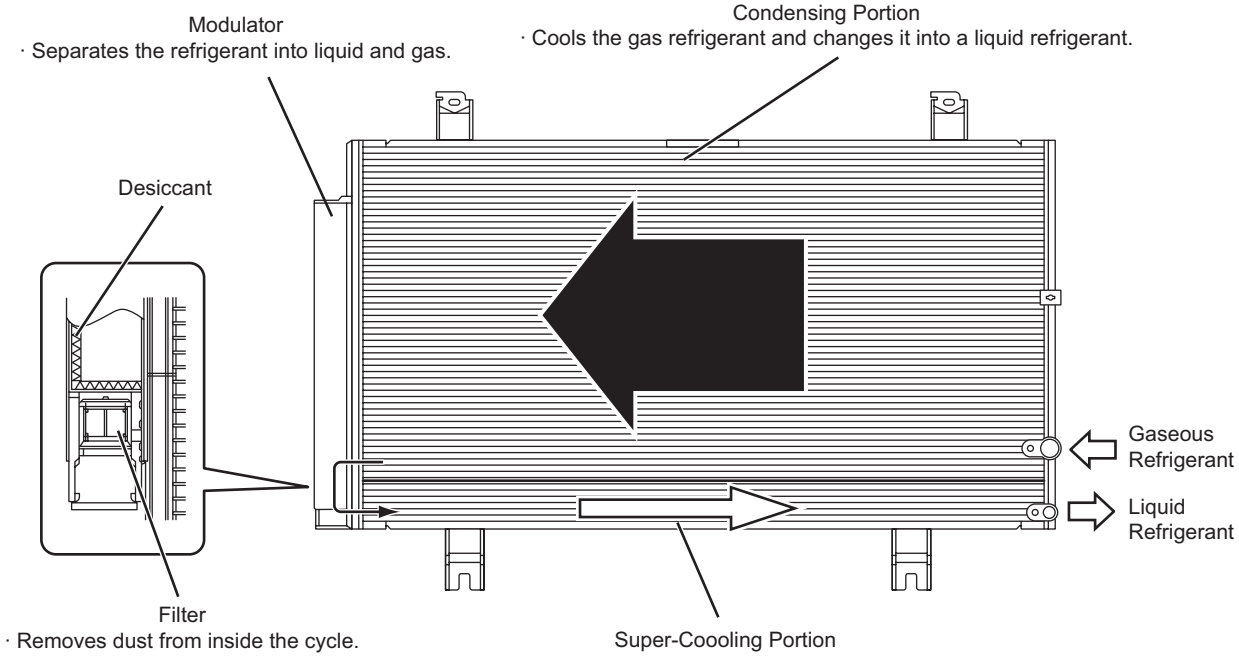
● The GS430 has been sub-cool condenser in which a multi-flow condenser(consisting of two cooling portions:a condensing portion asuper-cooling portion) and a gas-liquid separator(modulator)have been integrated.This Condenser adopted the sub-cool cycle for its cycle system to improve the heat exchanging efficiency.Furthermore, the effective surface area has been expanded through the use of a more closely packed core, resulting in better performance and reducing the volume of refrigerant used.



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Sub-Cool Condenser Structure

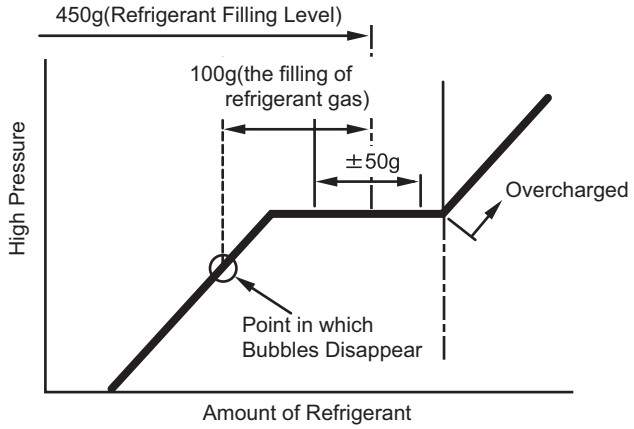
• The sub-cool cycle divides one condenser into a condensation area and a super-cooling area. A gas-liquid separator is located between the two areas in order to further cool the liquid refrigerant that has undergone a gas-liquid separation. This increases the energy (enthalpy) that the liquid refrigerant possesses and improves refrigeration efficiency.



A4270018E

Charging the Sub-Cool Cycle with Refrigerant Gas

- In a receiver cycle, the point at which the bubbles disappear from the refrigerant gas is at the entrance to the refrigeration capacity stabilization region (shelf). However, in a sub-cool cycle, the point at which the bubbles disappear is before the refrigeration stabilization region (shelf). For this reason, the cycle must be charged with an additional 100g to reach the proper charging volume (proper refrigerant charging volume: 450 ± 50g). (The proper refrigeration capacity cannot be reached if the charging of the cycle with refrigerant gas is stopped at the point at which the bubbles disappear.) Overcharging the cycle will also lead to poor fuel economy or insufficient refrigeration capacity. Therefore, make sure to charge the cycle with the proper volume of refrigerant gas.

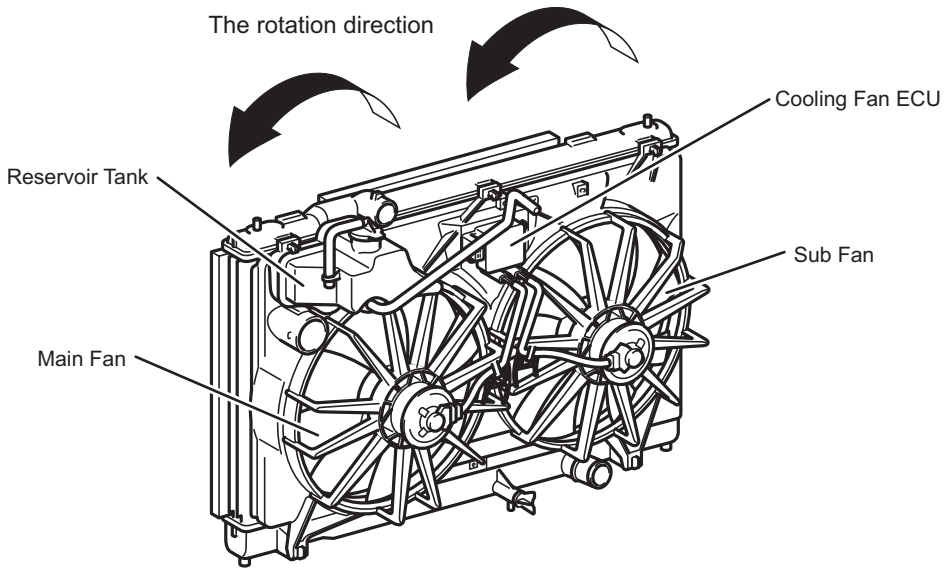


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AC

Electric Fan

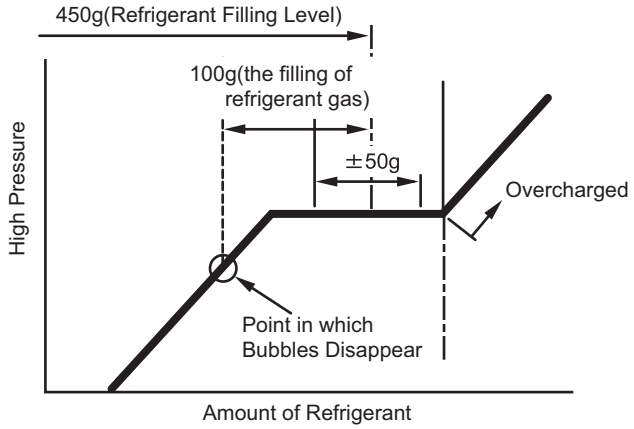
- Suction type electric fans are used on all models.
- A cooling fan ECU is used for controlling the electric fans, and is installed on the radiator fan shroud.



A4270153P

Charging the Sub-Cool Cycle with Refrigerant Gas

- In a receiver cycle, the point at which the bubbles disappear from the refrigerant gas is at the entrance to the refrigeration capacity stabilization region (shelf). However, in a sub-cool cycle, the point at which the bubbles disappear is before the refrigeration stabilization region (shelf). For this reason, the cycle must be charged with an additional 100g to reach the proper charging volume (proper refrigerant charging volume: 450 ± 50g). (The proper refrigeration capacity cannot be reached if the charging of the cycle with refrigerant gas is stopped at the point at which the bubbles disappear.) Overcharging the cycle will also lead to poor fuel economy or insufficient refrigeration capacity. Therefore, make sure to charge the cycle with the proper volume of refrigerant gas.

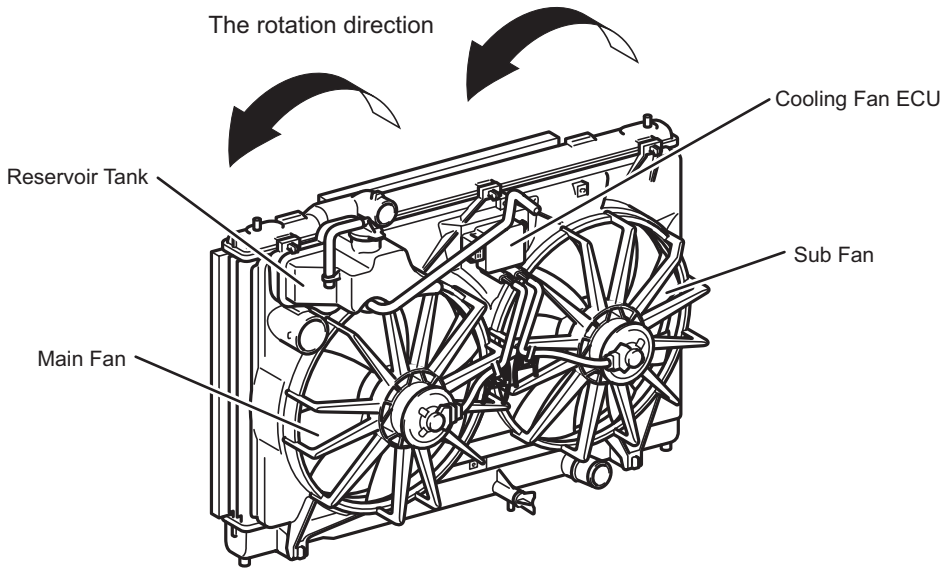


A4270029E

AC

Electric Fan

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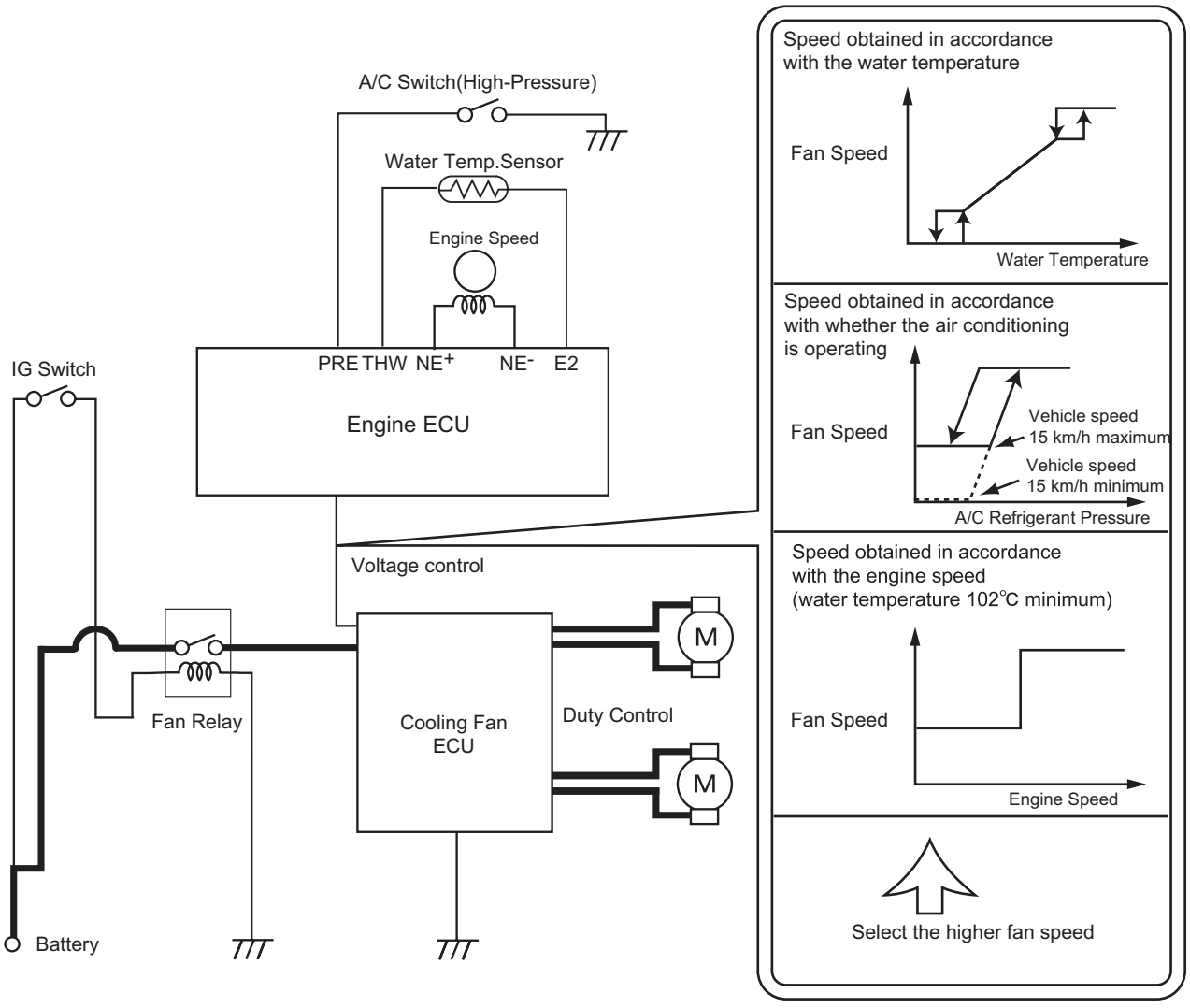
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Electric Fan Function

- The system steplessly controls the speed of the electric fans in accordance with the refrigerant pressure detected by the pressure sensor, the engine coolant temperature, and the engine speed.

Electric Fan Operation

- Upon receiving the inputs of the A/C switch ON/OFF signal, engine coolant temperature signal, engine speed signal, and the refrigerant pressure signal detected by the pressure sensor via the engine ECU, the cooling fan ECU controls the speed of the electric fans in the most suitable state.



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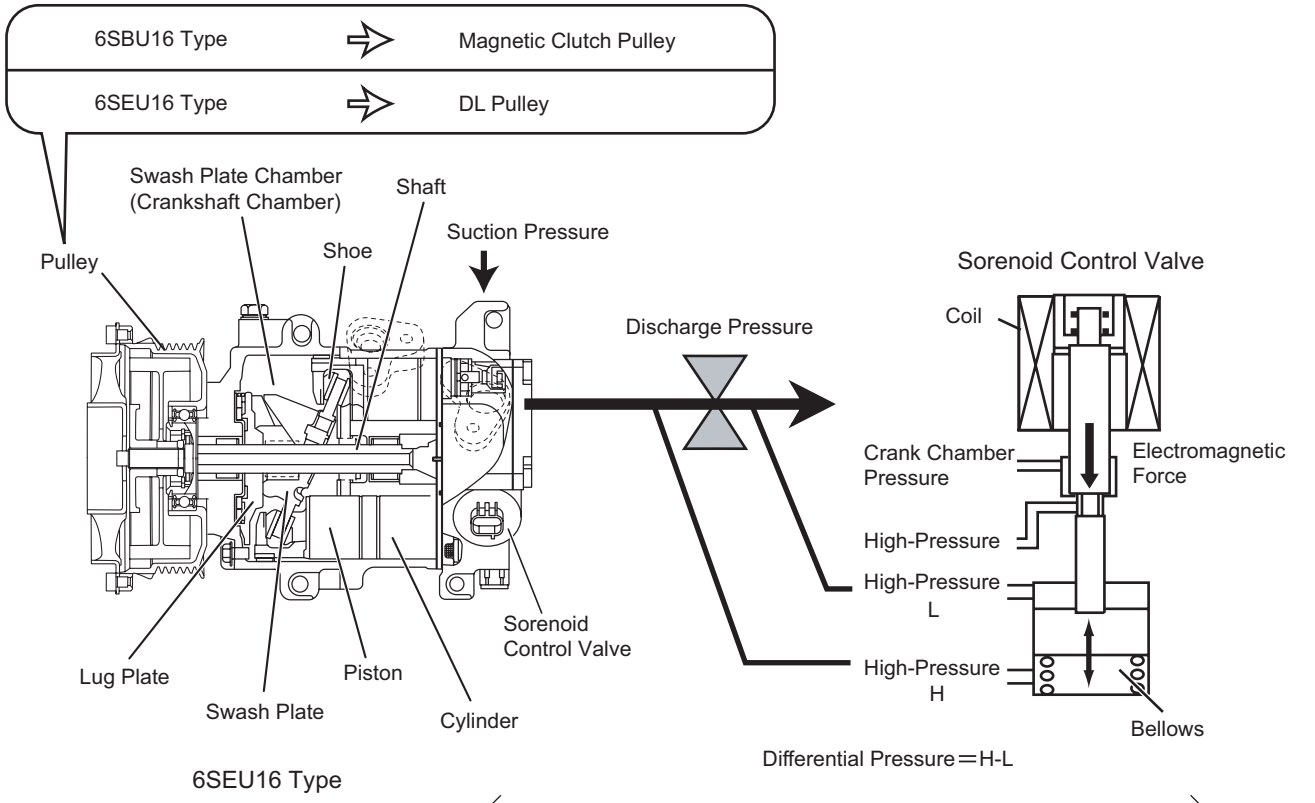
AC

Compressor

● An external control-type continuous variable capacity compressor is used.6SEU16-type is used for the vehicle with 3UZ-FE engine,6SBU16-type is used for the vehicle with 3GR-FSE engine and 3GR-FE engine.

External Control-Type Continuous Variable Capacity Compressor Structure

• When the shaft rotates, this movement is transmitted via the lug plate that is connected to the shaft to rotate the swash plate.This Rotational movement of the swash plate is transmitted via the shoe to the reciprocal movement of the piston in the cylinder, which performs the section, compression, and discharge of the refrigerant.The control for varying the compressor capacity is effected in the following manner: Based on the changes in pressure that occur in the low-pressure side in accordance with the cooling load, the control valve regulate the swash plate chamber's internal pressure to vary within the low-to medium pressure range.This change of pressure changes the swash plate angle, varies the piston stroke, and changes the amount of refrigerant that is discharged.Furthermore, by varying the control amperage applied to the solenoid control valve, the discharge capacity control range can be widened by steplessly varying the pressure in the low pressure side, in order to improve air conditioner performance and energy savings.



6SEU16 Type

The amperage (duty cycle value) that is applied to the coil of the flow volume control valve controls the electromagnetic force, which varies the internal pressure in the swash plate chamber by expanding or contracting the bellowss.

Note: The illustration is depicted as image.

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Flow Volume Control Valve

- The conventional variable capacity compressor is controlled by detecting the suction pressure. However, the new flow volume control valve effects control by detecting the pressure differential before and after the discharge pressure restrictor. In contrast to the conventional control valve, which cannot control torque, the flow volume control valve can estimate and control torque because the pressure differential is proportionate to torque. Thus, the system can effect optimal engine control in accordance with the torque of the compressor.

Lock Sensor

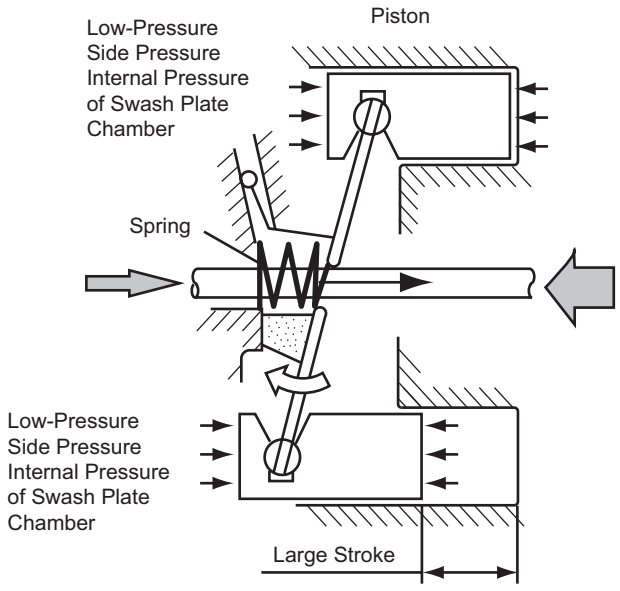
- A lock sensor that picks up the speed is incorporated in the 6SBU16 model. This enables the system to compare the crankshaft pulley speed and the compressor pulley speed. If the compressor pulley exceeds a predetermined slippage rate, the system controls the magnetic clutch to turn OFF.

DL Pulley

- The 6SEU16 type compressor uses a DL pulley. The DL pulley contains a damping mechanism and a limiter mechanism. The damping mechanism absorbs the torque fluctuations of the compressor, and the limiter mechanism protects the belt in case the compressor becomes locked. Consequently, the magnetic clutch that is used on the conventional system is no longer necessary.

When the cooling load is large(interior temperature is high), operating at100% capacity

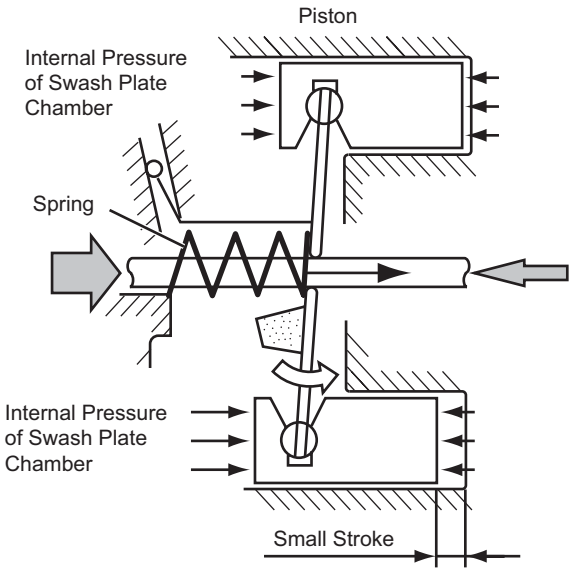
- When the cooling load becomes large and the pressure in the low-pressure side increases, the air conditioner ECU outputs signals to the solenoid control valve in accordance with the signals from the evaporator temperature sensor. This causes the bellows to contract, the valve to close,and the valve to close between the high-pressure chamber and the swash plate chamber. As a result, the internal plessure in the swash plate decreases gradually, causing the internal pressure in the swash plate and the pressure of the low-pressure side to ultimately reach equilibrium. At this time, the compound force(consisting of the pressure of the low-pressure side, and the reaction force from the lug plate)that is applied to the left side of the piston becomes lower than the internal pressure of the cylinder that is applied to the right side of the piston. Therefore, the piston moves towards the left, causing the tilt of the swash plate to increase. Accordingly,the amount of piston stroke increases, and when the piston stroke is at its maximum(when the tilt of the swash plate is at its maximum), the compressor operates at its 100% capacity.



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When the cooling load is small(interior temperature is low)

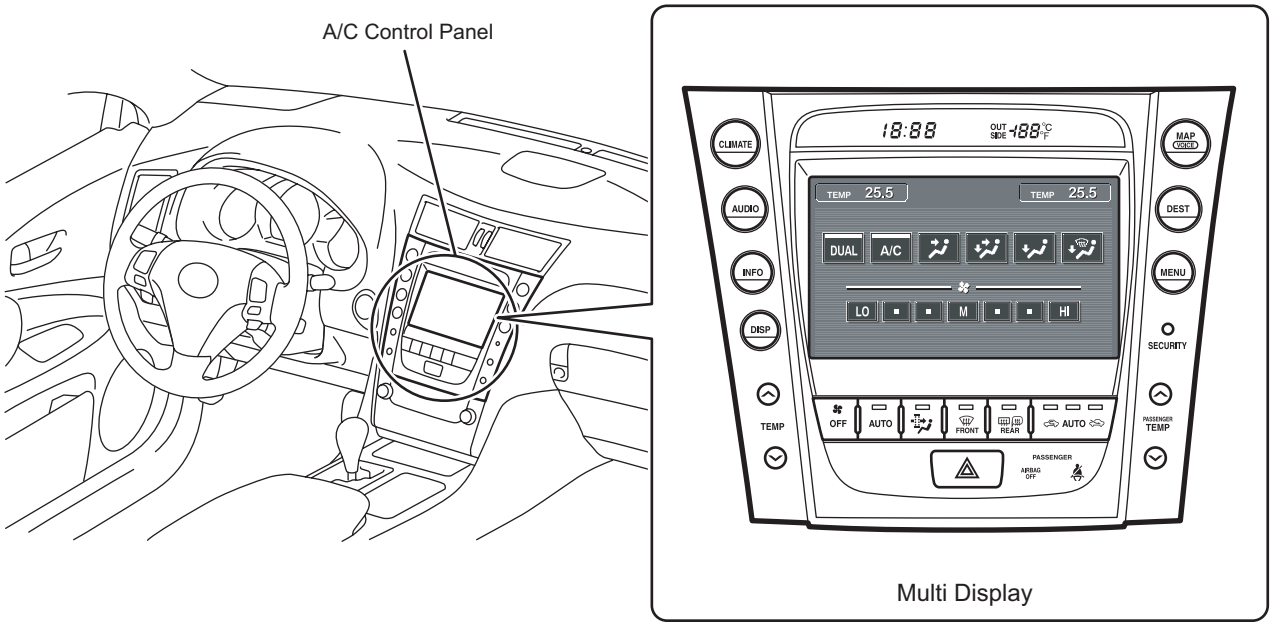
- When the cooling performance is low and the pressure of the low-pressure side decreases, the ECU outputs signals to the solenoid control valve in accordance with the signals from the evaporator temperature sensor. This causes the bellows to expand, the valve to open, and the valve between the high-pressure chamber and the swash plate chamber to open. As a result, the pressure of the high-pressure side is introduced into the swash plate chamber, causing the pressure in the swash plate chamber to increase. Therefore, the compound force(consisting of the pressure in the swash plate chamber and the reaction force from the lug plate)that is applied to the left side of the piston becomes higher than the internal pressure of the cylinder that is applied to the right side of the piston. Then, the piston moves to the right, causing the tilt of the swash plate to decrease. As a result, the piston stroke becomes shorter and the amount of refrigerant that is discharged becomes smaller. As the rotational resistance decreases in this manner,the engine load is reduced and fuel economy is improved.



A4270034E

Air Conditioner Control Panel

- The control switches for the air conditioner have been concentrated on the integration panel, which is located in the center of the instrument panel.
- On models equipped with the Electro Multivision, operations associated with the air conditioner are controlled by the push switches on the integration panel and the touch switches on the multi display.
- As on the previous model, a right-left independent temperature control system is used. With this system, the air conditioner control provides temperature setting switches independently for the driver and the front passenger. In addition, it provides a dual switch to switch from the linked control to the right-left independent temperature control.



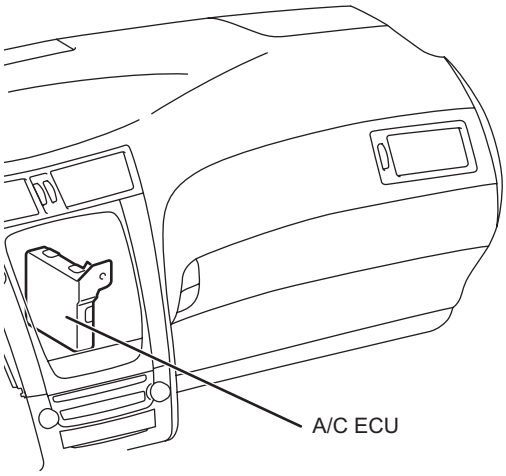
Note : The illustration gives a representative example.
and The Illustration of Multi Display excepts G.C.C. Countries Model.

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AC

Air Conditioner ECU

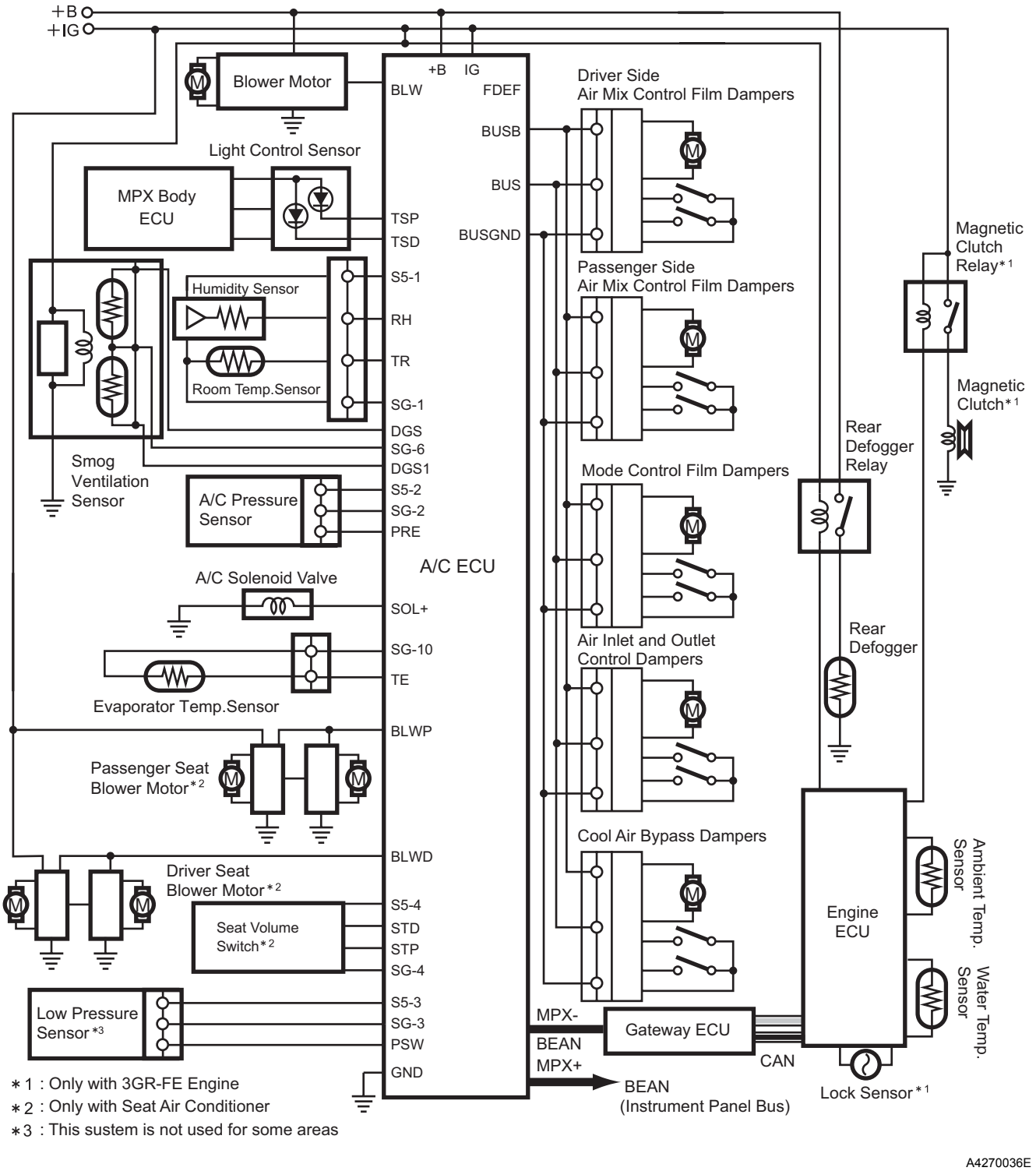
- The front air conditioner ECU is installed inside the instrument panel (on the side of the blower unit) on the front passenger side, in order to effect full air conditioner control. The front air conditionIing ECU functions as one of the ECUs that form part of the onboard multiplex communication system. Thus, it exchanges various types of data with the engine ECU or the meter ECU via various communication lines.
- As on the previous model, auto air conditioner control is used. This control uses a neural network as a means of effecting sophisticated air conditioner control to suit the sensory perception of the occupants. Thus, it enables a comfortable air conditioner operation. In addition, a new humidity sensor is used and the humidity inside the cabin is included as part of the air conditioner control. This ensures the proper anti-fogging performance and improves comfort. At the same time, it reduces the electric power consumption of the air conditionimg and realizes fuel economy.
- A customizable function is used to output DTCs (Diagnostic Trouble Codes) and various types of data through the use of a hand-held tester.
- A panel diagnostic function is used, which can be operated and displayed on the air conditioner control panel.



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Autmatic Control System

Automatic Air conditioner System Diagram

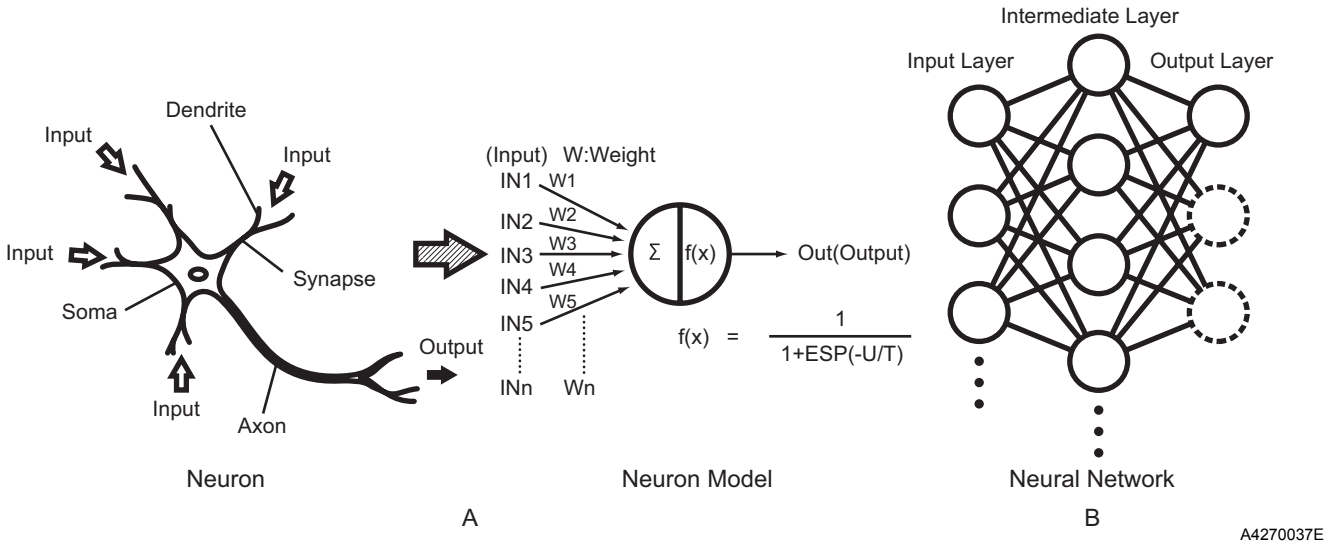


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Neural Network

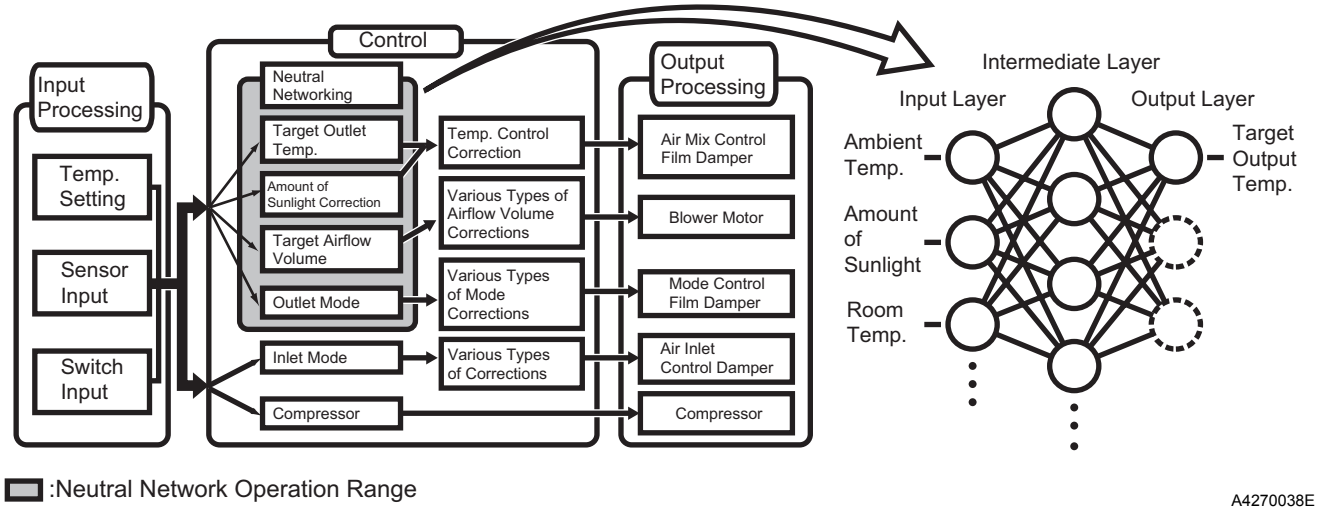
- The conventional auto air conditioner control calculates the required outlet temperature TAO (thermal load) in response to the set temperature. this calculation is performed in accordance with a predetermined formula, based on the temperature data provided by various sensors. Then, the front air conditioner ECU automatically controls the servomotors and the blower motor in response to the calculated TAO (thermal load). Thus, it is able to maintain the temperature in the cabin in a stable manner to ensure the comfort of the occupants. However, even if the TAO (thermal load) remains constant, the sensory perception of each and every occupant can vary significantly, depending on the environmental conditions that surround the occupants. Thus, the conventional auto air conditioner control, which determines all controls in response to the TAO (thermal load) that is calculated through a formula, cannot match all the conditions to the sensory perception of the occupants, which are complex and difficult to render into formulas. For this reason, the neural network is used as a means of effecting more sophisticated control to suit the sensory perception of the occupants. The neural network is an engineering application that imitates the data processing method of the nervous system of a living organism (see Figure A). It transposes the complex relationship between the inputs and outputs of the neural transmission such as the neurons of humans onto neuron models. Multiple models are combined to form a network, which consists of input, intermediate, and output layers (see Fig. B).



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Neural Network Control

- The neural network control consists of neurons in the input layer, intermediate layer, and output layer, The input layer neurons process the input data of the outside temperature, the amount of sunlight, and the room temperature based on the outputs of the switches and sensors, and output them to the intermediate layer neurons. Based on this data, the intermediate layer neurons adjust the strength of the links among the neurons. The sum of these is then calculated by the output layer neurons in the form of the required outlet temperature, solar correction, target airflow volume, and blower motors in accordance with the control volume that have been calculated by the neural network control.



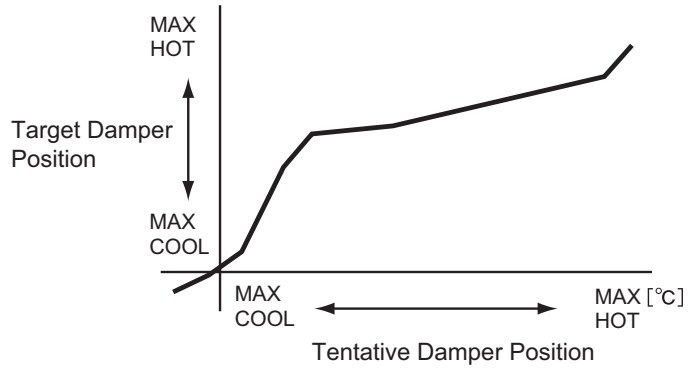
AC

Nozzle Temperature Control

● For outlet control, air-mix servomotor control and a cool air bypass damper servomotor control are used.

Air-Mix Servomotor Control

• In response to the temperature set at the temperature switch, the neural network calculates the required outlet temperature, based on the inputs from various sensors. The system adds corrections based on the post-evaporator sensor and the coolant temperature sensor to the required outlet temperature in order to calculate a tentative target damper position. Then, based on the tentative target damper position, the system calculates the true target damper position in accordance with the diagram, and outputs pulse signals to rotate the air-mix servomotor to the desired position.



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Cool Air Bypass Damper Servomotor Control

• The system determines the airflow volume ratio of the cool air bypass in accordance with the air-mix damper position and the outlet mode (BI-LEVEL, FOOT, FOOT/DEF), and controls the cool air bypass damper servomotor in order to attain the ratio. In the FACE mode, the cool air bypass damper opens fully only during MAX COOL. In the DEF mode, the cool air bypass damper closes fully only during MAX HOT.

Blower Control

● The following types of blower controls are used: multiple-stage blower control, warm-up control, delay blower control, etc.

Manual Control

• The airflow volume is determined by the position of the blower switch that has been selected.

Automatic Control

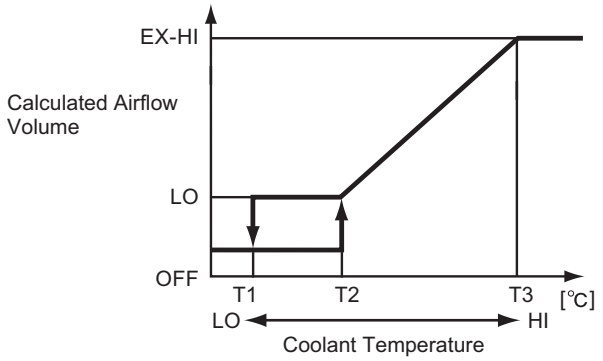
• When the AUTO switch on the air conditioner control is turned ON, the system effects various controls of the multiple-stage airflow volume, warm-up, cool down, and delay airflow volume. This is based on the target airflow volume that has been calculated by the neural network in accordance with the inputs received from various sensors.

Multiple-Stage Blower Control

• When the AUTO switch on the air conditioner control is turned ON, the front air conditioner ECU sends a signal to the blower motor controller in accordance with the target airflow volume that has been calculated by the neural network. Thus, the system automatically controls the airflow volume in multiple stages.

Warm-Up Control

- When the engine is cold and the air outlet mode is FOOT or BI-LEVEL FOOT/DEF, the system turns OFF the blower motor, and keeps it stopped until the engine coolant temperature (temperature detected by the coolant temperature sensor) reaches above a predetermined level. When the coolant temperature reaches T2°C, the system operates the blower motor at the LO speed, and turns it OFF below T1°C. Until the coolant temperature reaches T2°C to T3°C, the system compares the calculated airflow volume based on the coolant temperature sensor and the target airflow volume calculated by the neural network. Then, it automatically controls the blower motor at the lower airflow volume of the two. When the coolant temperature exceeds T3°C, the system operates the blower motor at the HI speed. Thereafter, the system controls the blower motor in accordance with the target airflow volume calculated by the neural network.



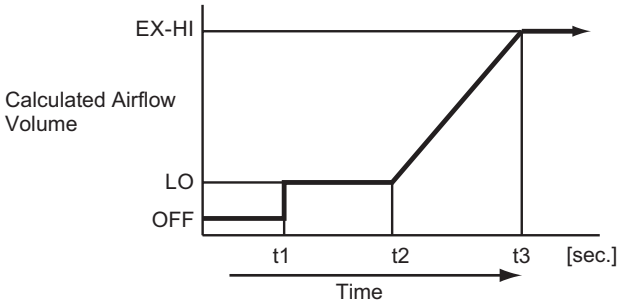
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Delay Blower Control

- The system effects two types of delay blower control in accordance with the temperature detected by the post-evaporator sensor. Thus, it prevents the center register from blowing out hot air when the air outlet mode is FACE or BI-LEVEL.

When the Post-Evaporator Sensor Temperature Is High (30°C minimum)

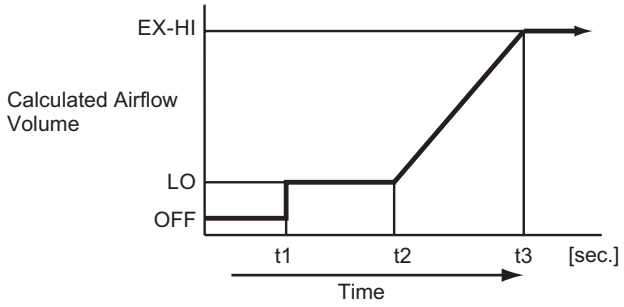
- As shown in the diagram, the system turns OFF the blower motor for approximately t1 seconds, and turns ON the compressor in order to cool the air conditioner unit. After approximately t1 seconds, the system operates the blower motor in the manual LO mode. This causes the cooled air to flow out of the air outlets, thus preventing the discomfort associated with the discharge of hot air. During approximately t2 to t3 seconds, the system compares the delay calculation airflow volume and the target airflow volume calculated by the neural network, and automatically controls the blower motor at the lower airflow volume of the two. After approximately t3 seconds have elapsed, the system controls the blower motor at the target airflow volume calculated by the neural network.



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When the Post-Evaporator Sensor Temperature Is Low (30°C maximum)

• As shown in the diagram, the system operates the blower motor for approximately t4 seconds in the manual LO mode. Then, until approximately t5 seconds, the system compares the delay calculation airflow volume and the target airflow volume calculated by the neural network, and automatically controls the blower motor at the lower airflow volume of the two. After approximately t5 seconds have elapsed, the system controls the blower motor in accordance with the target airflow volume calculated by the neural network.



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Air Flow Mode Control

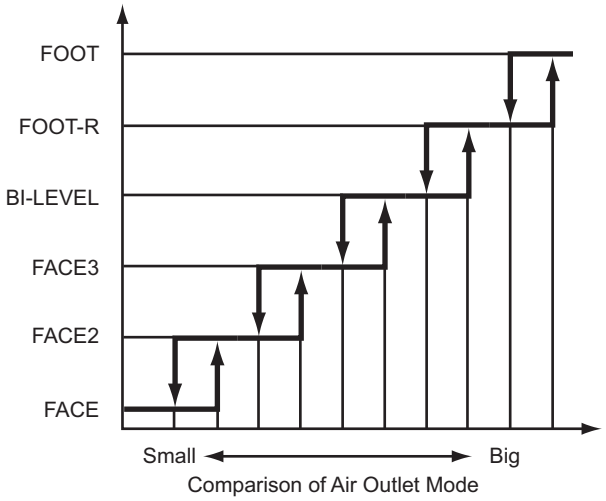
● Air outlet control that consists of air outlet servomotor control and low-temperature FOOT/DEF control is used.

Manual Control

• The system switches the air outlet to suit the position of the blower mode selector switch that has been selected.

Mode Damper Selector Servomotor Control

• When the AUTO switch on the air control is turned ON, the system calculates the target damper position in accordance with the air outlet mode ratio calculated by the neural network. Then, the system automatically switches the air outlet mode to FOOT, FOOT-R, BI-LEVEL, FACE3, FACE2, and FACE, in accordance with the target damper position.

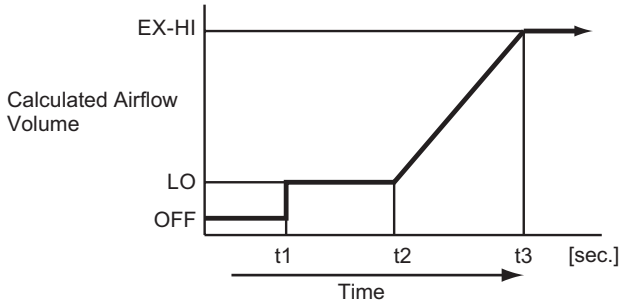


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When the Post-Evaporator Sensor Temperature Is Low (30°C maximum)

• As shown in the diagram, the system operates the blower motor for approximately t4 seconds in the manual LO mode. Then, until approximately t5 seconds, the system compares the delay calculation airflow volume and the target airflow volume calculated by the neural network, and automatically controls the blower motor at the lower airflow volume of the two. After approximately t5 seconds have elapsed, the system controls the blower motor in accordance with the target airflow volume calculated by the neural network.



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Air Flow Mode Control

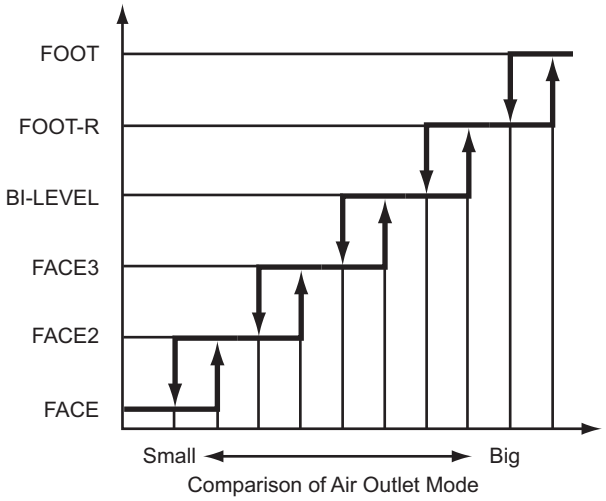
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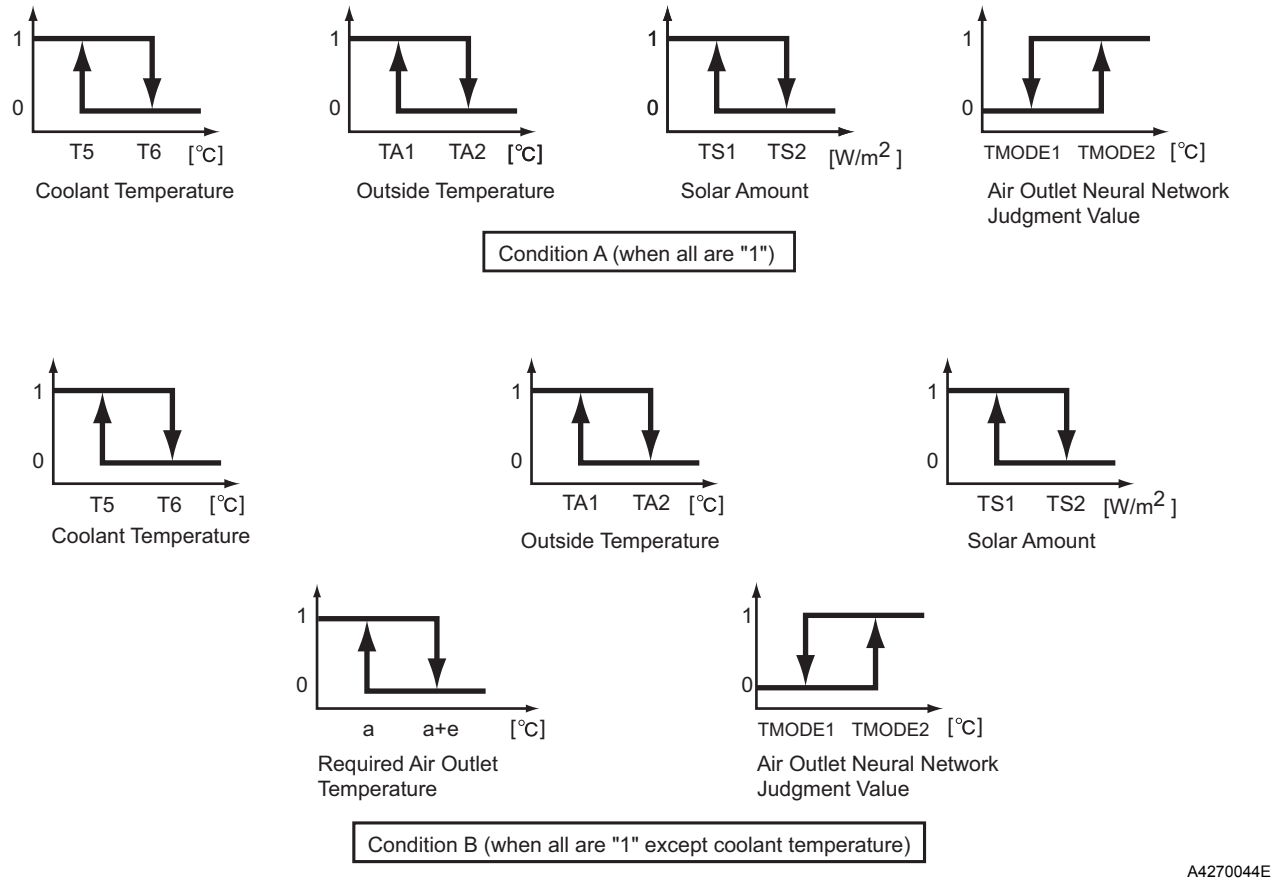


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Low-Temperature FOOT/DEF Control

• When one of the conditions (A or B) shown below is met, the system automatically switches the air outlet mode to FOOT/DEF, in order to prevent the windows from becoming fogged at a low temperature or when the vehicle is being driven at high speeds.



Air Inlet Control

● The following types of air inlet controls are used: air inlet servomotor control, exhaust gas & air inlet servomotor control, etc.

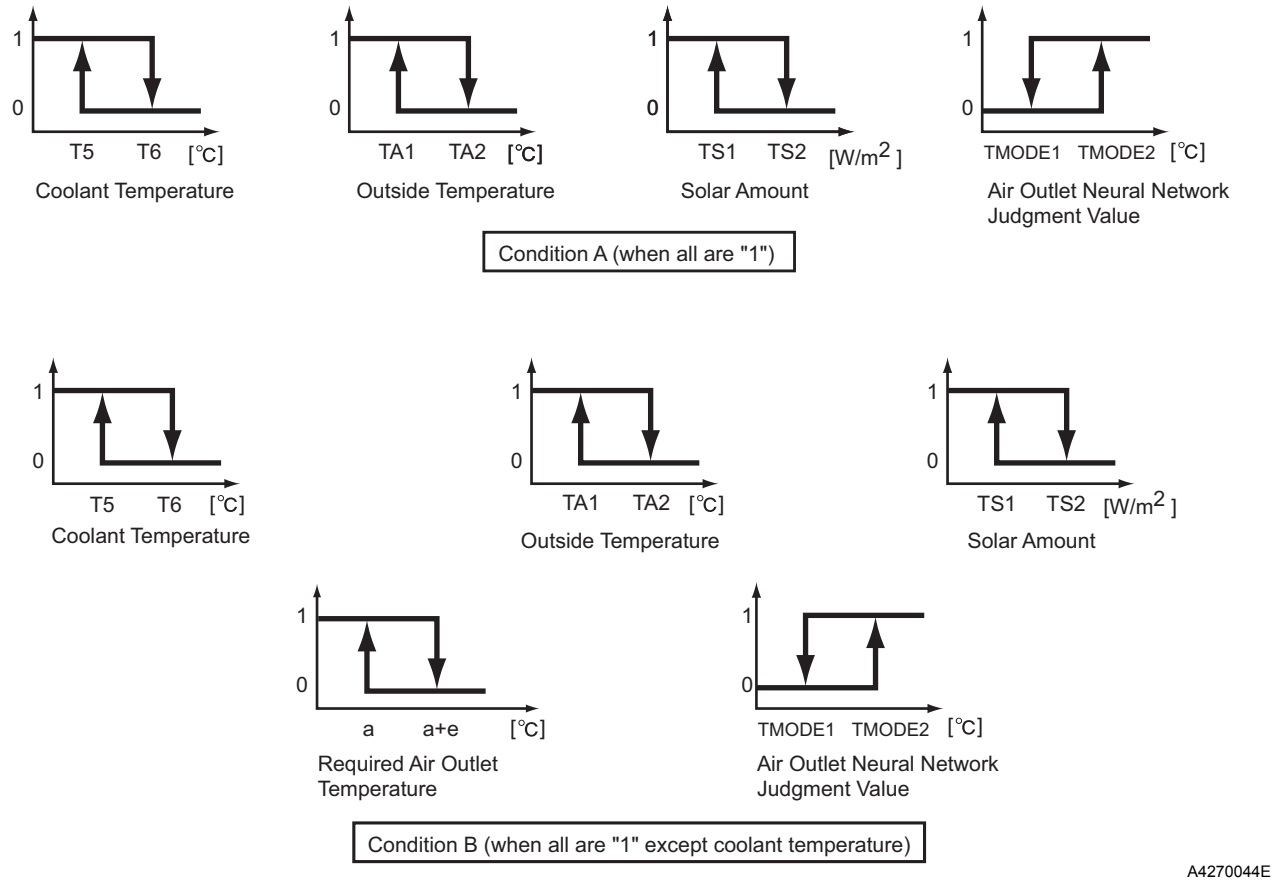
Manual Control

• This control switches the air inlet mode to suit the position of the automatic recirculation switch that has been selected.

AC

Low-Temperature FOOT/DEF Control

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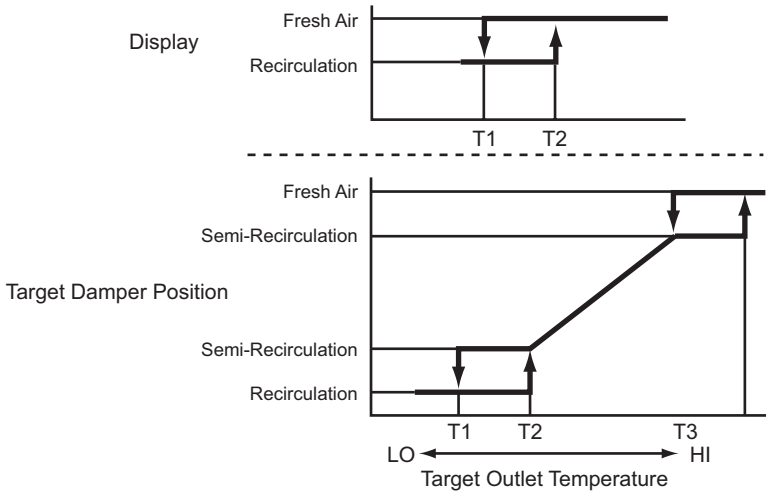
Manual Control

• This control switches the air inlet mode to suit the position of the automatic recirculation switch that has been selected.

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Air Inlet Servomotor Control

• This control calculates the target damper position as shown in the diagram, based on the driver's target outlet temperature calculated by the neural network. Then, this control automatically switches the air inlet mode in accordance with the target damper position. In addition, this control changes the timing in which the air inlet mode switches from recirculation to fresh air, or fresh air to recirculation, depending on the vehicle speed.



Note: The T1, T2, and T3 change to high when the vehicle speed is slow, and to low when the vehicle speed is fast.

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Exhaust Gas & Air Inlet Servomotor Control

• This control compares the aforementioned target damper position of the air inlet servomotor and the target damper position based on the contamination level of the recirculated air. Then, it controls the damper position closer towards recirculation.

AC

Air Quality Control

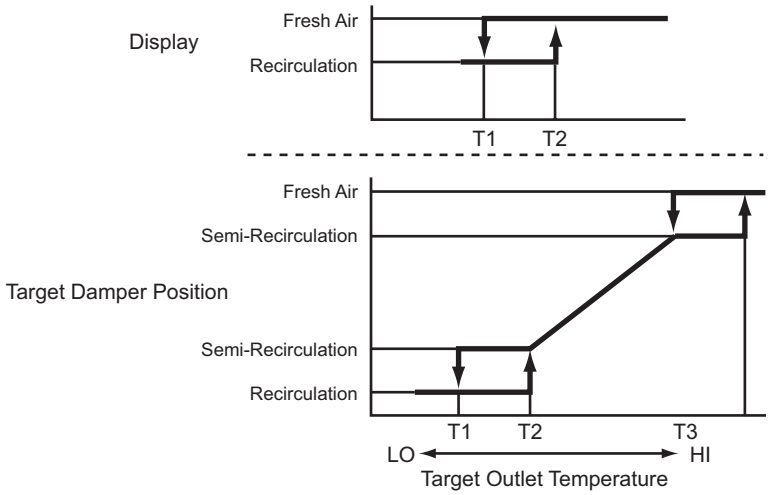
● This control is used for vehicle with the automatic recirculation control system. Upon receiving the input of a detection signal from the smog ventilation sensor, the air conditioner ECU calculates the contamination levels of the fresh air and the recirculated air. Then, it controls the air inlet modes as shown in the table (control list) below.

List of Air Quality Control

Input Signal		Output Signal
Contamination Levels of The Fresh Air	Contamination Levels of The Recirculated Air	Air Inlet Mode
4(High)	ON	The recirculation mode
	OFF	↑
3	ON	The fresh mode
	OFF	The recirculation mode
2	ON	The fresh mode
	OFF	Semi-Recirculation or fresh mode
1(Low)	ON	The fresh mode
	OFF	↑

Air Inlet Servomotor Control

• This control calculates the target damper position as shown in the diagram, based on the driver's target outlet temperature calculated by the neural network. Then, this control automatically switches the air inlet mode in accordance with the target damper position. In addition, this control changes the timing in which the air inlet mode switches from recirculation to fresh air, or fresh air to recirculation, depending on the vehicle speed.



Note: The T1, T2, and T3 change to high when the vehicle speed is slow, and to low when the vehicle speed is fast.

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Exhaust Gas & Air Inlet Servomotor Control

• This control compares the aforementioned target damper position of the air inlet servomotor and the target damper position based on the contamination level of the recirculated air. Then, it controls the damper position closer towards recirculation.

AC

Air Quality Control

● This control is used for vehicle with the automatic recirculation control system. Upon receiving the input of a detection signal from the smog ventilation sensor, the air conditioner ECU calculates the contamination levels of the fresh air and the recirculated air. Then, it controls the air inlet modes as shown in the table (control list) below.

List of Air Quality Control

Input Signal		Output Signal
Contamination Levels of The Fresh Air	Contamination Levels of The Recirculated Air	Air Inlet Mode
4(High)	ON	The recirculation mode
	OFF	↑
3	ON	The fresh mode
	OFF	The recirculation mode
2	ON	The fresh mode
	OFF	Semi-Recirculation or fresh mode
1(Low)	ON	The fresh mode
	OFF	↑

Compressor Control

● The following types of compressor controls are used: refrigerant pressure failure judgment, external variable compressor capacity control, etc.

Target Post-Evaporator Temperature

• While maintaining the required outlet temperature, the front air conditioner ECU calculates the target post-evaporator temperature. This is necessary for preventing the discomfort associated with a difference in temperature between the inside and outside of the vehicle, the humidity inside the vehicle interior, or to keep the windows from fogging. Also, it calculates the target post-evaporator temperature to prevent the discomfort associated with the excessive rise in temperature at the outlets when the outlet mode is FACE or BI-LEVEL, or to defog the windows quickly in the DEF mode. By comparing these temperatures, the front air conditioner ECU determines a target post-evaporator temperature that can realize the most power savings in accordance with the operating conditions of the vehicle. This target post-evaporator temperature is used for controlling the compressor in order to meet both ample cooling capability and fuel economy requirements.

Refrigerant Pressure Failure Judgment

• If a refrigerant pressure failure signal is input while monitoring the refrigerant pressure, the front air conditioner ECU turns the compressor OFF during the failure.

Evaporator Temperature Sensor Judgment

• When the post-evaporator sensor detects a temperature below -4°C, the front air conditioner ECU turns the compressor OFF to prevent the evaporator from frosting.

AC

60-Second Compressor ON Control (Window Fogging Prevention Control)

• Provided that the conditions for turning ON the compressor have been met, the air conditioner ECU will turn ON the compressor for 60 seconds in accordance with the variable capacity control value. The conditions for turning ON the compressor are the following: the air conditioner is operated for the first time after the front air conditioner ECU has been reset after the engine has started; the blowers are turned OFF by the warm-up control; post-evaporator sensor judgment; or outside temperature judgment. If any one of the foregoing conditions has not been met, the front air conditioner ECU will stop the 60-second compressor ON control. If the condition for turning OFF the compressor operation capacity is met through a refrigerant pressure failure judgment, the front air conditioner ECU will turn OFF the compressor even if it is operating under the 60-second control.

External Variable Compressor Capacity Control

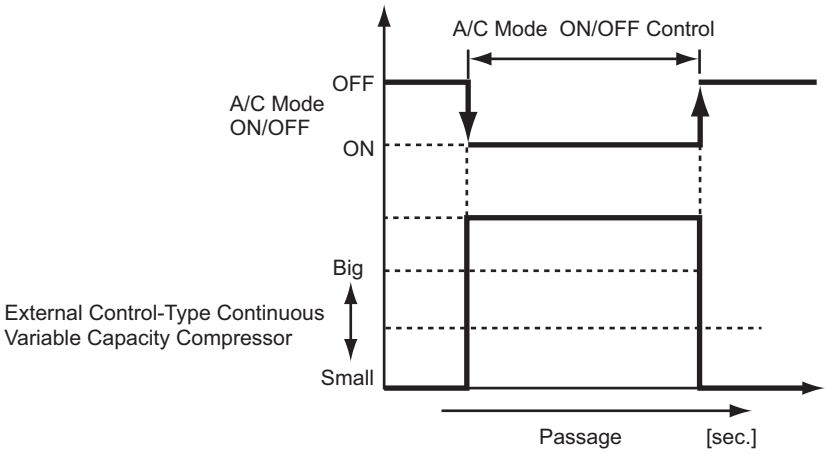
• The lowest compressor capacity control output that is calculated through the controls listed below, from the frost control to the low-speed cut control, is rendered as the compressor operation capacity. The front air conditioner ECU uses this compressor operation capacity to effect external variable compressor capacity control. This enables an efficient compressor control to suit the operating conditions of the air conditioner and the driving conditions of the vehicle, thus improving drive feel and fuel economy.

Frost Control

• The front air conditioner ECU uses the post-evaporator detection temperature and the refrigerant pressure to calculate the compressor capacity control output using the calculation formula indicated below, in order to effect frost control. Also, it calculates the target evaporator outlet temperature based on the ON/OFF operating condition in the manual DEF mode, the outside temperature, and the required outlet temperature (TAOB'i) obtained through the neural network. Then, it adds the post-evaporator detection temperature and the cooperative signal (input from the engine ECU via the gateway ECU) to the calculation.

A/C Mode ON/OFF Control

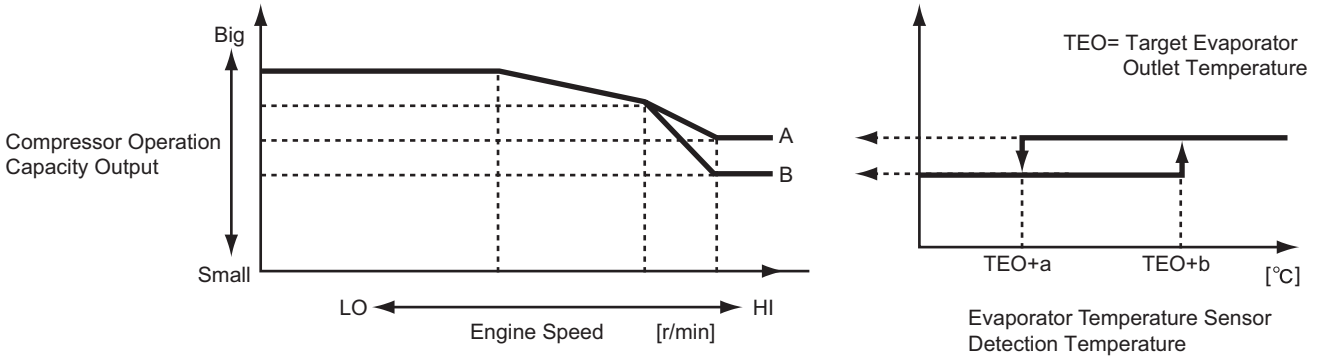
• This control outputs a compressor operation capacity as shown in the diagram, in accordance with whether the A/C mode is ON or OFF.



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Compressor Protect Control

• This control outputs a compressor operation capacity as shown in the diagram, in accordance with the engine speed. Also, it outputs two types of compressor operation capacities in accordance with the post-evaporator sensor detection temperature and the target evaporator outlet temperature.

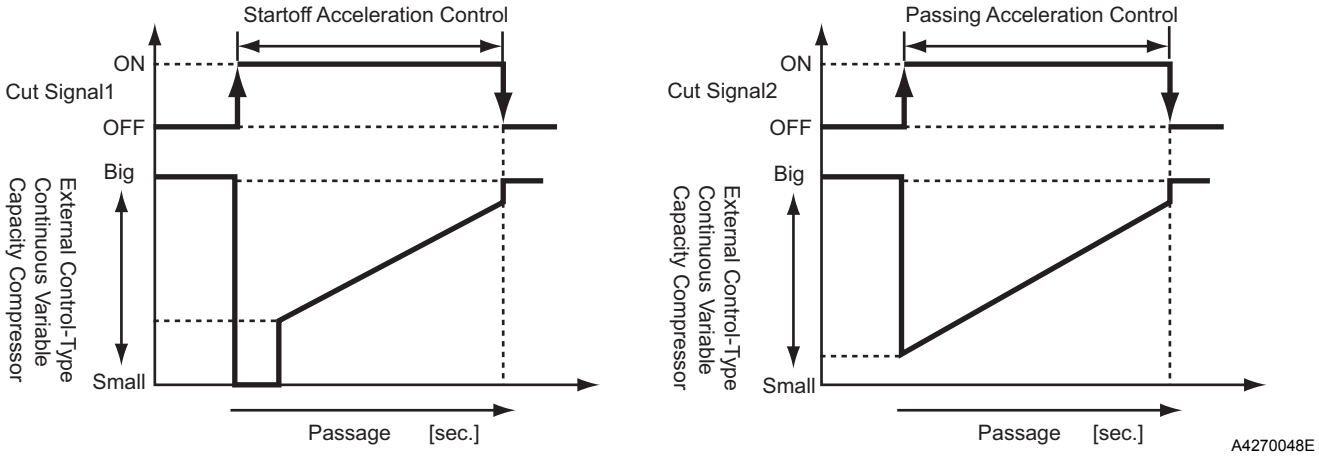


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Startoff/Passing Acceleration Control

• As shown in the diagrams, the front air conditioner ECU reduces the operation capacity output of the compressor in order to lower the fuel injection volume during acceleration, while improving acceleration performance, under the following conditions: the front air conditioner ECU receives from the engine ECU the input of cut signal 1 during startoff acceleration, or cut signal 2 during passing acceleration. To reduce the operation capacity output of the compressor, the front air conditioner ECU makes gradual changes to suit the cooling load, without causing the occupants to feel a difference in effective temperature.

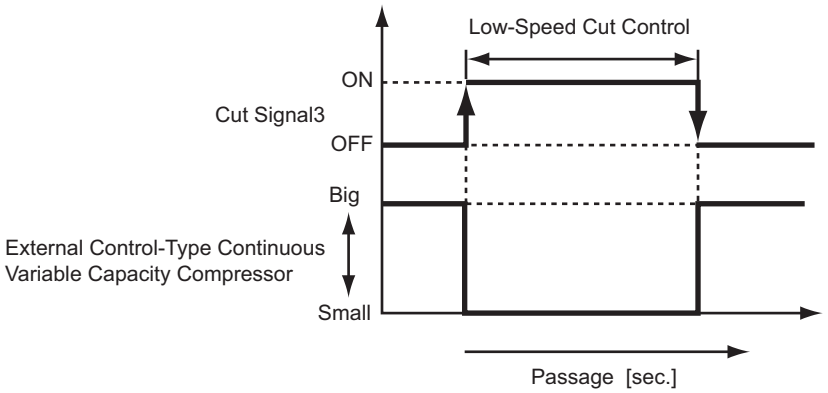


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Low-Speed Cut Control

• When the engine speed is low, if the front air conditioner ECU receives the input of cut signal 3 from the engine ECU, the air conditioner ECU outputs a compressor operation capacity as shown in the diagram.

AC



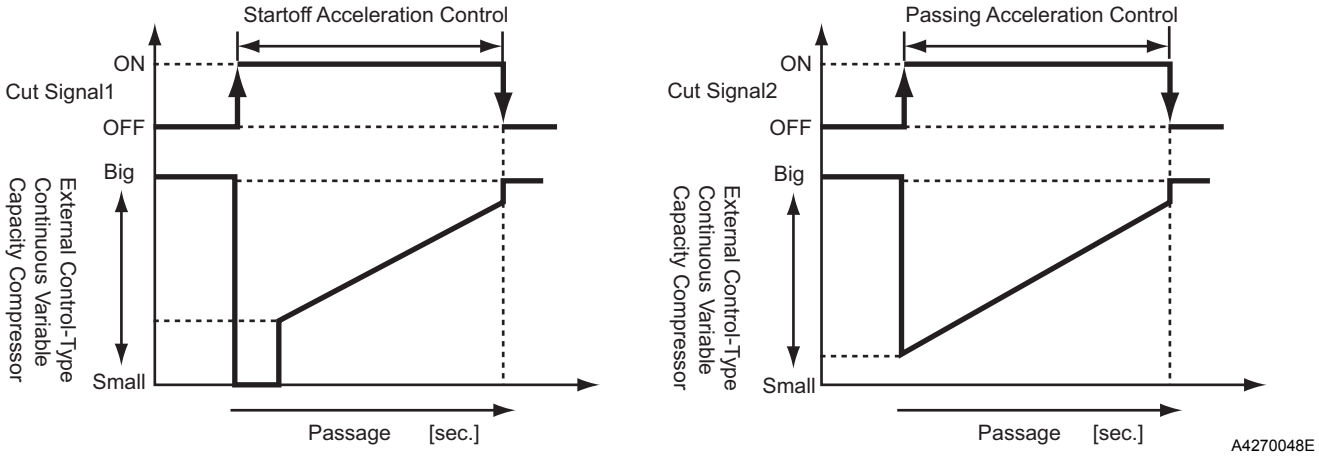
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Rear Window Defogger Control

● While the rear window defogger can be turned ON or OFF manually, it will turn OFF automatically after the rear window defogger switch is left ON for 15 minutes.

Startoff/Passing Acceleration Control

• As shown in the diagrams, the front air conditioner ECU reduces the operation capacity output of the compressor in order to lower the fuel injection volume during acceleration, while improving acceleration performance, under the following conditions: the front air conditioner ECU receives from the engine ECU the input of cut signal 1 during startoff acceleration, or cut signal 2 during passing acceleration. To reduce the operation capacity output of the compressor, the front air conditioner ECU makes gradual changes to suit the cooling load, without causing the occupants to feel a difference in effective temperature.

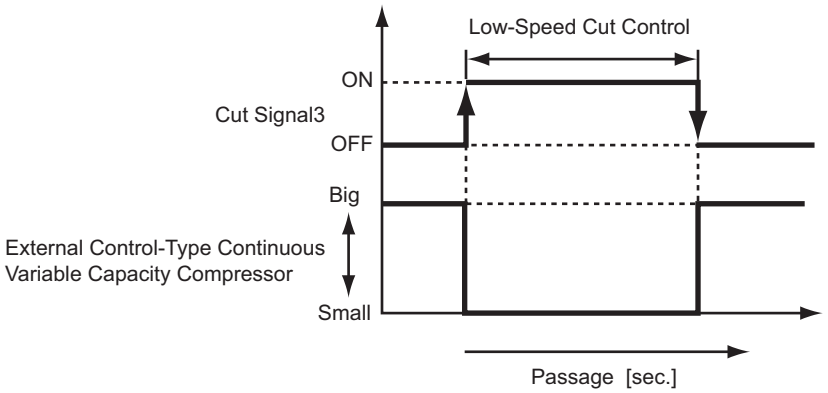


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Low-Speed Cut Control

• When the engine speed is low, if the front air conditioner ECU receives the input of cut signal 3 from the engine ECU, the air conditioner ECU outputs a compressor operation capacity as shown in the diagram.

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Rear Window Defogger Control

● While the rear window defogger can be turned ON or OFF manually, it will turn OFF automatically after the rear window defogger switch is left ON for 15 minutes.

Self-Diagnosis

● The DTCs (Diagnostic Trouble Codes) and various types of data can be output by connecting a hand-held tester to the DLC3 external terminal of the vehicle, and operating the tool.

Diagnosis Functions

Function Name	Description
DTC Output Function	• Outputs the DTCs indicating the normal conditions and existing malfunctions (which have been determined by the sensor check of the diagnostic control) to the gateway ECU.
DTC Data Deletion Function	• Deletes the past malfunctions determined by the sensor check of the diagnostic control.
Data Output Function	• Outputs the values input by the outside temperature sensor and the coolant temperature sensor, as well as the outside temperature display value. • Outputs the blower level. • Outputs the set temperatures (for driver and front passenger sides) and the external variable output current to the gateway ECU.
Actuator Check Function	• Outputs control in accordance with the individual movement instructions provided by the gateway ECU.
Customizable Function	• Refer to the customizable function for details.

● Panel diagnostic control is used. If a failure occurs in the display, various sensors, or the actuator, this control stores the failure in memory, and provides DTCs to the service technician by displaying them on the air conditioner control panel.

Panel Diagnosis

Function	Outline
Indicator Check	• Checks mode and temperature setting display.
Sensor Check	• Checks the past and present malfunctions of the sensors,and clearing the past malfunction data.
Actuator Check	• Checks against actuator check pattern if blower motor, servomotors and magnetic clutch(except for 3UZ-FE models) are operating correctly according to signals from ECU

OUTLINE

Outline

Major Dimension & Vehicle Weights

			Europe			
Body Type			4-Door Sedan			
Model Name			GS300		GS430	
Model Code			GRS190L-BETQHW	GRS190R-BETQHW	UZS190L-BETQKW	UZS190R-BETQKW
Overall	Length	mm(in.)	4825(190.0)	←	←	←
	Width	mm(in.)	1820(71.7)	←	←	←
	Height	mm(in.)	1430(56.3)	←	←	←
Wheel Base		mm(in.)	2850(112.2)	←	←	←
Tread	Front	mm(in.)	1535(60.4)	←	←	←
	Rear	mm(in.)	1540(60.6)	←	←	←
Effective Head Room	Front	mm(in.)	985(38.8)	←	←	←
	Rear	mm(in.)	940(37.0)	←	←	←
Effective Leg Room	Front	mm(in.)	1105(43.5)	←	←	←
	Rear	mm(in.)	925(36.4)	←	←	←
Shoulder Room	Front	mm(in.)	1430(56.3)	←	←	←
	Rear	mm(in.)	1400(55.1)	←	←	←
Overhang	Front	mm(in.)	855(33.7)	←	←	←
	Rear	mm(in.)	1120(44.1)	←	←	←
Min.Running Ground Cleaance		mm(in.)	130(5.1)	←	←	←
Angle of Approach		degrees	14	←	←	←
Angle of Departure		degrees	14	←	←	←
Curb Weight	Front	kg(Ib)	865(1907)	←	915(2017)	←
	Rear	kg(Ib)	755(1664)	←	780(1720)	←
	Total	kg(Ib)	1620(3571)	←	1695(3737)	←
Cross Vehicle Weight	Front	kg(Ib)	1005(2216)	←	1045(2304)	←
	Rear	kg(Ib)	1120(2469)	←	1115(2458)	←
	Total	kg(Ib)	2125(4685)	←	2160(4762)	←
Fuel Tank Capacity		L(Imp.gal)	71(15.6)	←	←	←
Luggage Compartment Capacity		m^3(cu.ft)	0.43(15.2)	←	←	←

			G.C.C Countries		General Countries
Body Type			4-Door Sedan		
Model Name			GS300	GS430	GS300
Model Code			GRS190L-BETQKV	UZS190L-BETQKV	GRS190R-BETQK
Overall	Length	mm(in.)	4825(190.0)	←	←
	Width	mm(in.)	1820(71.7)	←	←
	Height	mm(in.)	1430(56.3)	←	←
Wheel Base		mm(in.)	2850(112.2)	←	←
Tread	Front	mm(in.)	1535(60.4)	←	←
	Rear	mm(in.)	1540(60.6)	←	←
Effective Head Room	Front	mm(in.)	985(38.8)	←	←
	Rear	mm(in.)	940(37.0)	←	←
Effective Leg Room	Front	mm(in.)	1105(43.5)	←	←
	Rear	mm(in.)	925(36.4)	←	←
Shoulder Room	Front	mm(in.)	1430(56.3)	←	←
	Rear	mm(in.)	1400(55.1)	←	←
Overhang	Front	mm(in.)	855(33.7)	←	←
	Rear	mm(in.)	1120(44.1)	←	←
Min.Running Ground Cleaance		mm(in.)	130(5.1)	←	←
Angle of Approach		degrees	14	←	←
Angle of Departure		degrees	14	←	←
Curb Weight	Front	kg(Ib)	865(1907)	915(2017)	865(1907)
	Rear	kg(Ib)	755(1664)	780(1720)	755(1664)
	Total	kg(Ib)	1620(3571)	1695(3737)	1620(3571)
Cross Vehicle Weight	Front	kg(Ib)	1005(2216)	1045(2304)	1005(2216)
	Rear	kg(Ib)	1120(2469)	1115(2458)	1120(2469)
	Total	kg(Ib)	2125(4685)	2160(4762)	2125(4685)
Fuel Tank Capacity		L(Imp.gal)	71(15.6)	←	←
Luggage Compartment Capacity		m^3(cu.ft)	0.43(15.2)	←	←

Performance

		Europe			
Body Type		4-Door Sedan			
Model Name		GS300		GS430	
Model Code		GRS190L-BETQHW	GRS190R-BETQHW	UZS190L-BETQKW	UZS190R-BETQKW
Max. Speed	km/h(mph)	240(149)	←	250(155)	←
Max. Cruising Speed	km/h(mph)	215(134)	←	225(140)	←
Acceleration	0 to 100 km/h sec.	7.2	←	6.1	←
	0 to 400 m sec.	15.2	←	14.4	←
Max.Permissible Speed	1st Gear km/h(mph)	57(35)	←	60(37)	←
	2nd Gear km/h(mph)	98(61)	←	101(63)	←
	3rd Gear km/h(mph)	144(89)	←	147(91)	←
	4th Gear km/h(mph)	203(126)	←	198(123)	←
	5th Gear km/h(mph)	240(149)	←	250(155)	←
	6th Gear km/h(mph)	240(149)	←	250(155)	←
Min. Turning Radius	Tire m(ft.)	5.2(17.1)	←	←	←
	Body m(ft.)	5.6(18.4)	←	←	←

		G.C.C Countries		General Countries
Body Type		4-Door Sedan		
Model Name		GS300	GS430	GS300
Model Code		GRS190L-BETQKV	UZS190L-BETQKV	GRS190R-BETQK
Max. Speed	km/h(mph)	235(146)	250(155)	235(146)
Max. Cruising Speed	km/h(mph)	210(130)	225(140)	210(130)
Acceleration	0 to 100 km/h sec.	7.5	6.1	7.5
	0 to 400 m sec.	15.4	14.4	15.4
Max.Permissible Speed	1st Gear km/h(mph)	57(35)	60(37)	57(35)
	2nd Gear km/h(mph)	98(61)	101(63)	98(61)
	3rd Gear km/h(mph)	144(89)	147(91)	144(89)
	4th Gear km/h(mph)	203(126)	198(123)	203(126)
	5th Gear km/h(mph)	235(146)	250(155)	235(146)
	6th Gear km/h(mph)	235(146)	250(155)	235(146)
Min. Turning Radius	Tire m(ft.)	5.2(17.1)	←	←
	Body m(ft.)	5.6(18.4)	←	←

Engine & Engine Electrical

	Europe			
Body Type	4-Door Sedan			
Model Name	GS300		GS430	
Model Code	GRS190L-BETQHW	GRS190R-BETQHW	UZS190L-BETQKW	UZS190R-BETQKW
Engine Type	3GR-FSE	←	3UZ-FE	←
Valve Mechanism	24-Valve DOHC,Chain Drive	←	32-Valve DOHC,Belt & Gear Drive	←
Bore × Stroke mm(in.)	87.5×83.0 (3.44×3.27)	←	91.0×82.5 (3.58×3.25)	←
Displacement cm^3(cu.in.)	2995(182.7)	←	4293 (261.9)	←
Compression Ratio	11.5	←	10.5	←
Carburetor Type	EFI • D-4	←	EFI	←
Research Octane No.	95 or higher	←	←	←
Max.Output(EEC) kW/rpm	—	—	208/5600	←
Max.Torque(EEC) N·m/rpm	—	—	417/3500	←
Battery Capacity(5HR) Voltage & Amp.hr.	12-55	←	←	←
Alternator Output Watts	1800	←	1560	←
Starter Output kW	1.7	←	2.0	1.4

	G.C.C Countries		General Countries
Body Type	4-Door Sedan		
Model Name	GS300	GS430	GS300
Model Code	GRS190L-BETQKV	UZS190L-BETQKV	GRS190R-BETQK
Engine Type	3GR-FE	3UZ-FE	3GR-FE
Valve Mechanism	24-Valve DOHC,Chain Drive	32-Valve DOHC,Belt & Gear Drive	24-Valve DOHC,Chain Drive
Bore × Stroke mm(in.)	87.5×83.0 (3.44×3.27)	91.0×82.5 (3.58×3.25)	87.5×83.0 (3.44×3.27)
Displacement cm^3(cu.in.)	2994 (182.7)	4293 (261.9)	2994 (182.7)
Compression Ratio	10.5	←	←
Carburetor Type	EFI	←	←
Research Octane No.	95 or higher	←	←
Max.Output(EEC) kW/rpm	170/6200	208/5600	170/6200
Max.Torque(EEC) N·m/rpm	300/4400	417/3500	300/4400
Battery Capacity(5HR) Voltage & Amp.hr.	12-55	←	←
Alternator Output Watts	1560	←	←

	G.C.C Countries		General Countries
Body Type	4-Door Sedan		
Model Name	GS300	GS430	GS300
Model Code	GRS190L-BETQKV	UZS190L-BETQKV	GRS190R-BETQK
Starter Output kW	1.3	1.4	1.3

Chassis

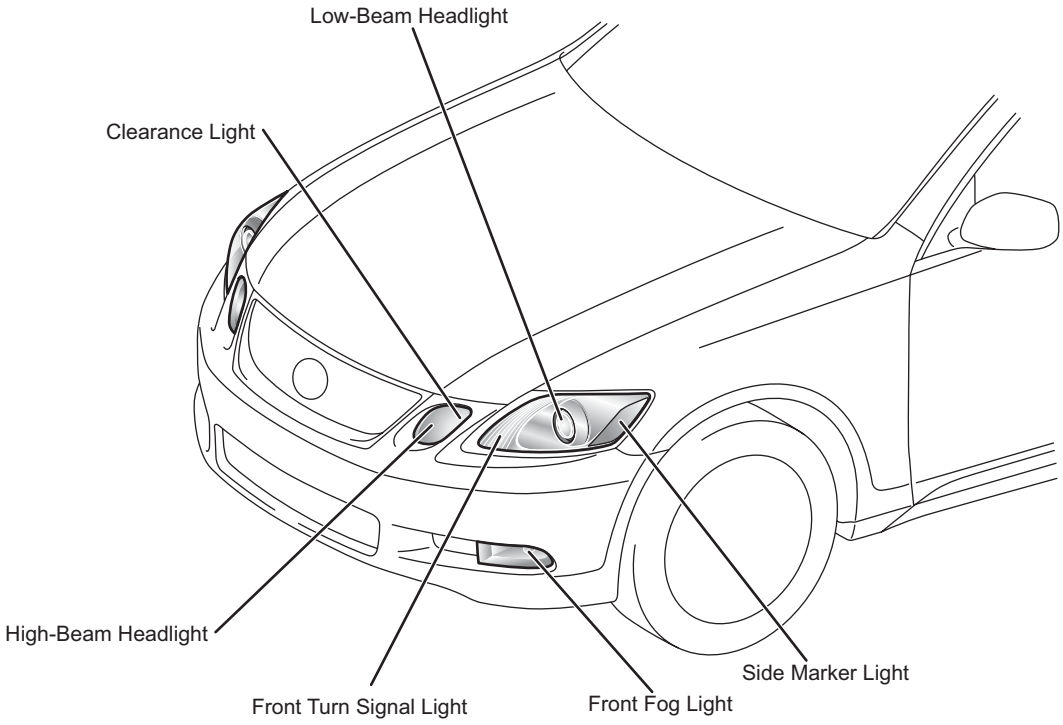
		Europe			
Body Type		4-Door Sedan			
Model Name		GS300		GS430	
Model Code		GRS190L-BETQHW	GRS190R-BETQHW	UZS190L-BETQKW	UZS190R-BETQKW
Clutch Type		—	—	—	—
Transmission Type		A960E	←	A761E	←
Transmission Gear Ratio	In First	3.538	←	3.296	←
	In Second	2.060	←	1.958	←
	In Third	1.404	←	1.348	←
	In Fourth	1.000	←	1.000	←
	In Fifth	0.713	←	0.725	←
	In Sixth	0.582	←	0.582	←
	In Reverse	3.168	←	2.951	←
Differential Gear Ratio		3.727	←	3.615	←
Differential Gear Size in.		8.10	←	8.20	←
Brake Type	Front	Ventilated Disc	←	←	←
	Rear	Ventilated Disc	←	←	←
Parking Brake Type		Duo Servo	←	←	←
Brake Booster Type and Size in.		10"Single	←	—	—
Proportioning Valve Type		—	—	—	—
Suspension Type	Front	Double Wishbone	←	←	←
	Rear	Multi Link	←	←	←
Stabilizer Bar	Front	Standard	←	←	←
	Rear	Standard	←	←	←
Steering Gear Type		Rack & Pinion	←	←	←
Steering Gear Ratio(Overall)		14.6	←	12.4~17.2	←
Power Steering Type		Electric Motor	←	←	←

		G.C.C Countries		General Countries
Body Type		4-Door Sedan		
Model Name		GS300	GS430	GS300
Model Code		GRS190L-BETQKV	UZS190L-BETQKV	GRS190R-BETQK
Clutch Type		—	—	—
Transmission Type		A760E	A761E	A760E
Transmission Gear Ratio	In First	3.520	3.296	3.520
	In Second	2.042	1.958	2.042
	In Third	1.400	1.348	1.400
	In Fourth	1.000	1.000	1.000
	In Fifth	0.716	0.725	0.716
	In Sixth	0.586	0.582	0.586
	In Reverse	3.224	2.951	3.224
Differential Gear Ratio		3.727	3.769	3.727
Differential Gear Size in.		8.10	8.20	8.10
Brake Type	Front	Ventilated Disc	←	←
	Rear	Ventilated Disc	←	←
Parking Brake Type		Duo Servo	←	←
Brake Booster Type and Size in.		10"Single	—	10"Single
Proportioning Valve Type		—	—	—
Suspension Type	Front	Double Wishbone	←	←
	Rear	Multi Link	←	←
Stabilizer Bar	Front	Standard	←	←
	Rear	Standard	←	←
Steering Gear Type		Rack & Pinion	←	←
Steering Gear Ratio(Overall)		14.6	12.4~17.2	14.6
Power Steering Type		Electric Motor	←	←

LIGHTING

Description

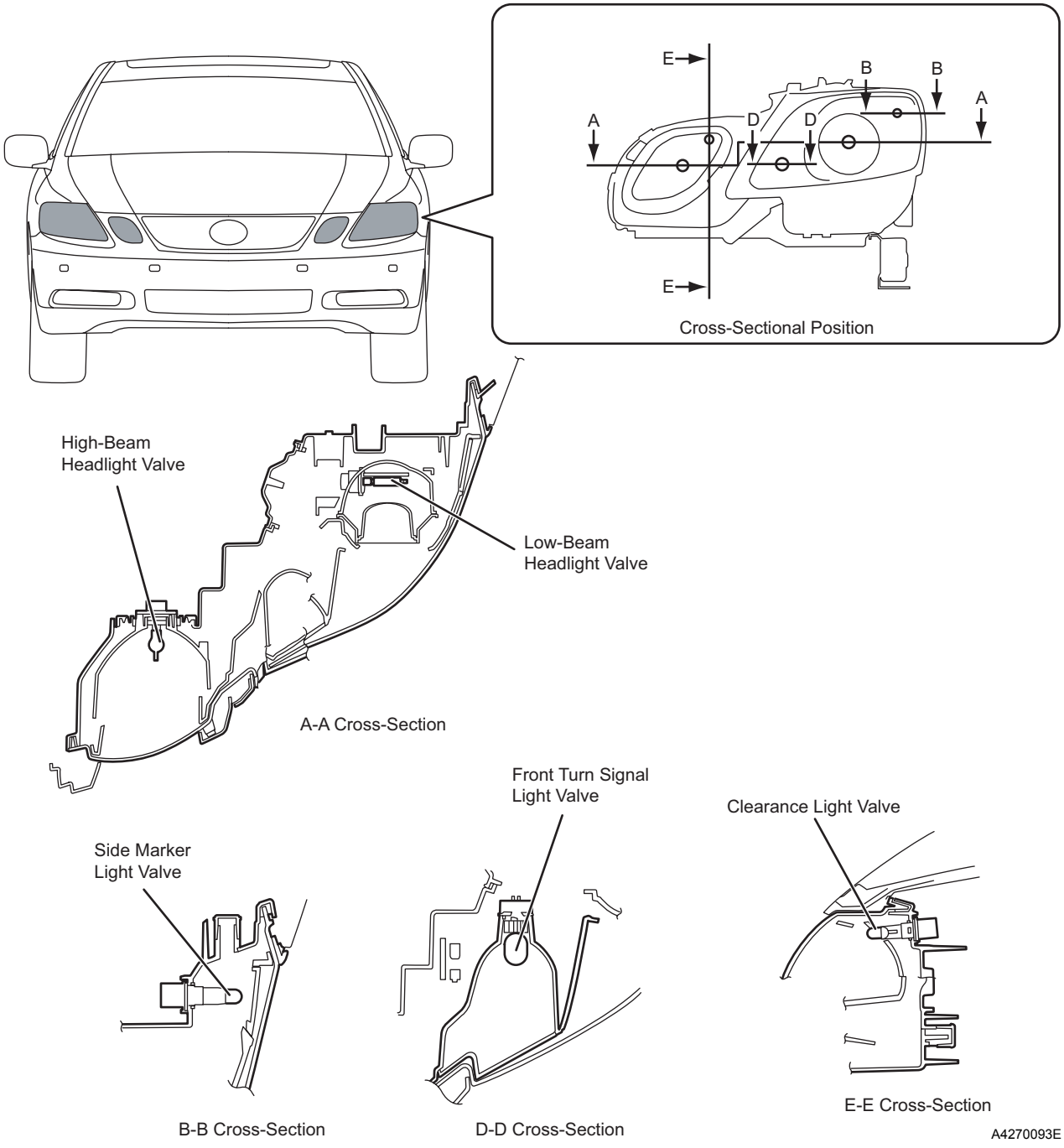
- All models use contoured, 4-beam headlights with built-in clearance lights and front turn signal lights.
- All models use projector type, high-intensity discharge low-beam headlights. These headlights use projectors in which the bulbs are inserted sideways. This reduces the space behind the units, allowing the headlights to be placed in the back.
- The low-beam headlights use an intelligent AFS (Adaptive Front-Lighting System). By combining a swivel function that controls the horizontal optical axes with an auto leveling function that controls the vertical optical axes, the intelligent AFS provides excellent nighttime visibility.
- The extension inside each headlight is treated with vapor-deposition aluminum. Combined with a see-through outer lens, this gives the headlight an excellent appearance.
- Front fog lights that are mounted on the front bumper are provided on all models as standard equipment.
- The high-intensity discharge lights use mercury-free bulbs that reduce the environmental impact while enhancing light distribution.



A4270092E

Head Light

- A front turn signal light and a clearance light are enclosed in the same lens as the headlight.
- Projector type, high-intensity discharge low-beam headlights are used.
- A swivel actuator for the swivel function is provided below the low beam bulb in the headlight. A headlight leveling actuator for the auto leveling function is provided behind the headlight. In addition, a light control ECU, which controls the illumination of the high-intensity discharge lights, is enclosed in the bottom of the headlight.



Headlight Specifications

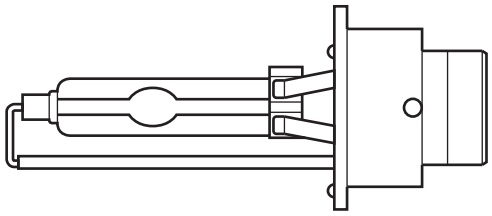
Light Names	Valve Specifications	Light Names	Valve Specifications
Low-Beam Headlight	12V 35W : D2S	Clearance Light	12V 5W
High-Beam Headlight	12V 60W : HB3	Front Turn Signal Light	12V 21W : Amber

The Feature Of The High-Intensity Discharge Headlight

- The high-intensity discharge headlights use HID (High-Intensity Discharge) bulbs as the light source.
- An HID bulb emits a light that has a natural, daylight color that is close to the sunlight and illuminates the area forward of the vehicle to a considerable distance. Therefore, it enhances the visibility of the driver. In addition, it offers the advantages of low electrical consumption, thus minimizing the load on the battery, as well as furnishing a long bulb life.
- The high-intensity discharge headlights are provided with a compact and lightweight light control ECU that realizes an instantaneous illumination of the bulbs and a stable power supply. In addition, the headlights are provided with an auto leveling function that keeps the vertical optical axes constant, as an antiglare measure for the vehicles in oncoming traffic.

The Components Of The HID Bulbs

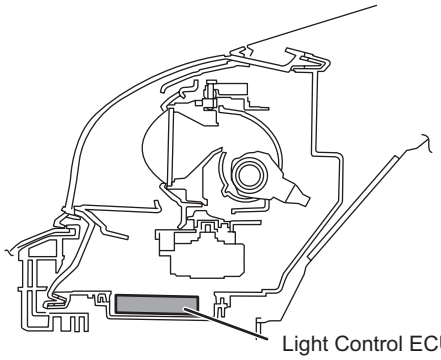
- Mercury-free HID bulbs are used to reduce the environmental impact while enhancing light distribution.
- The arc tube of the HID bulb is filled with an inert gas (xenon) and metal iodes (zinc, sodium, scandium). The voltage that is applied to the base of the bulb and the lead wire cause arcs to be discharged inside the arc tube.
- The outer tube of the arc tube is made of UV-reduction glass, which absorbs ultraviolet rays. Thus, the amount of radiation of ultraviolet rays is reduced to the level of a halogen bulb.



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Light Control ECU

- The light control ECU provides an alternating current (AC) power supply that is necessary for illuminating the HID bulbs.
- The frequency of the alternating current power supply is set above several hundred Hz, so that the lights do not appear to be flickering. Furthermore, an electromagnetic shield is provided so that the onboard radio would not be affected by electromagnetic interference.



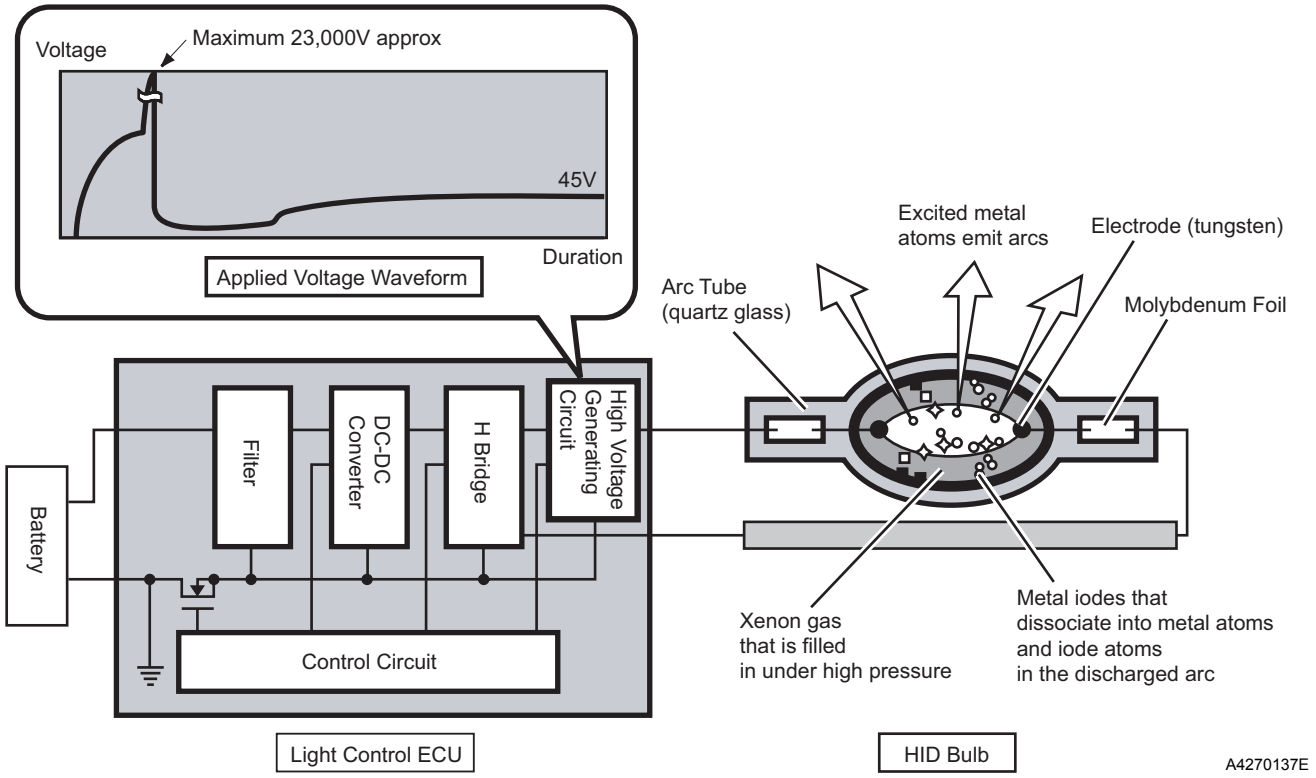
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Light Control ECU Specifications

Items	Specifications
Rated Voltage [V]	13.5
Operating Voltage [V]	9~16
Maximum Generated Voltage [V]	22000±3000
Maximum Input Amperage [A]	20 or less
Maximum Output Amperage [A]	2.4±0.2
Maximum Output Wattage [W]	64±6
Normal Input Amperage [A]	3.5 or less
Normal Output Wattage [A]	34±2
Normal Illumination Frequency [Hz]	320+70/—50

Operation

- The light control ECU effects control to generate a high voltage of up to approximately 20,000V in order to ensure the instantaneous and stable illumination of the HID bulbs. Because this ECU generates a high voltage, it is provided with various types of failsafe functions. In addition, measures are provided to ensure its reliability against heat, humidity, and vibration.



Flow of HID Bulb Illumination Control

1.High voltage (approx. 20,000V) is applied to both electrodes of the HID bulb.
2.After the xenon gas that is filled in the arc tube at a high pressure is dissociated electrolytically, it discharges arcs.
3.The temperature in the arc tube rises as a result of the discharging of arcs. This causes the metal iodes to vaporize.
4.The vaporized metal iodes (sodium and scandium) dissociate into metal atoms and iode atoms in the discharged arc.
5.Metal atoms become excited and emit light of a particular spectrum.

Failsafe

• When there is a failure in the output voltage, input voltage, or headlight voltage, the light control ECU performs the failsafe functions indicated below.

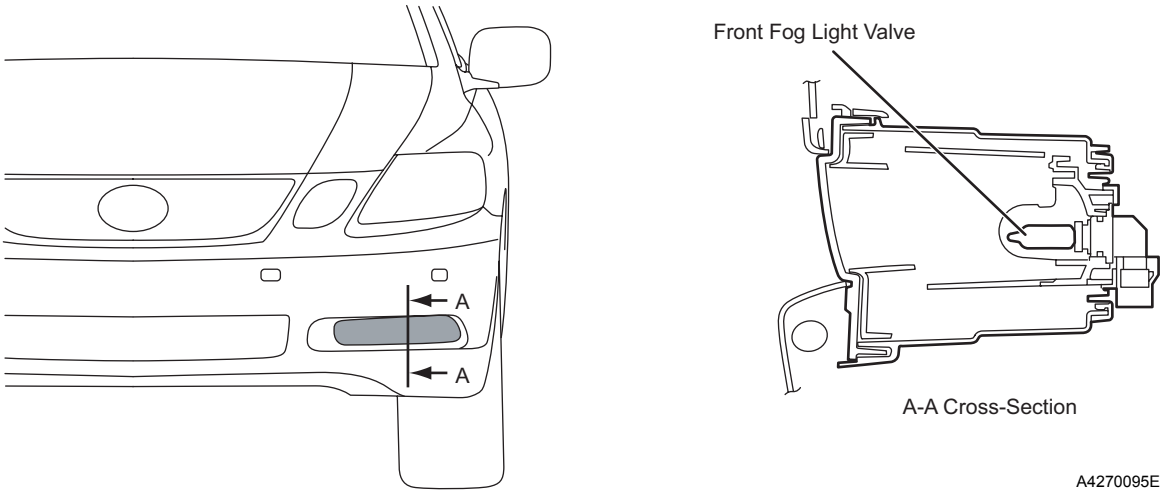
List of Failsafe Functions of Light Control ECU

Failure Detection Condition	Failsafe Description
Detection of an output failure (short, open, or leak) or flashing bulbs	If there is a failure in the output voltage or the bulbs flash continuously over 60 seconds, the light control ECU stops the illumination of the headlights, and maintains this state until the power supply is restored (headlight switch turned from OFF to ON, or ignition turned from OFF to ON).
Detection of an input failure	If the input voltage deviates from the operating voltage (between 9 and 16V), the light control ECU stops the illumination of the headlights. It resumes the illumination of the headlights as soon as the input voltage reverts to the operating voltage range. However, if the input voltage drops after the headlights illuminate, the light control ECU will continue illuminating the headlights until the critical illumination holding voltage (below 6V) is reached.
Detection of a headlight voltage failure	If the light control ECU detects a headlight voltage failure, it will stop the illumination of the headlights and maintains this state until the power supply is restored (headlight switch turned from OFF to ON, or ignition turned from OFF to ON).

Front Fog Light

● Contoured, rectangular front fog lights are provided on all models as standard equipment. The illumination color of the front fog lights is white.

● The outer lenses have the see-through look, and multi-reflectors treated with vapor-deposition aluminum are used.



Front Fog Light Specifications

Light Names	Valve Specifications
front fog lights	12V 51W : HB4

Failsafe

• When there is a failure in the output voltage, input voltage, or headlight voltage, the light control ECU performs the failsafe functions indicated below.

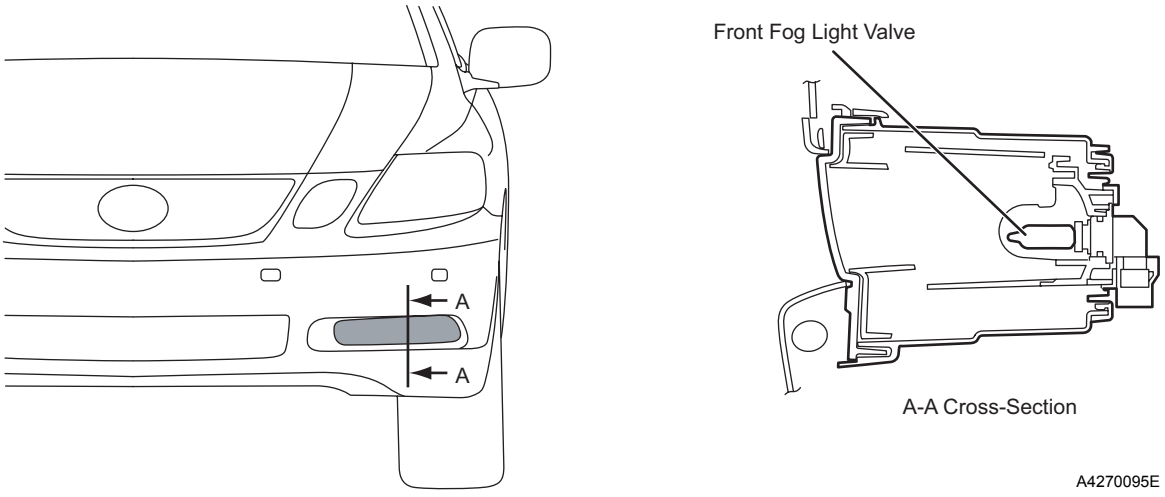
List of Failsafe Functions of Light Control ECU

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Detection of a headlight voltage failure	If the light control ECU detects a headlight voltage failure, it will stop the illumination of the headlights and maintains this state until the power supply is restored (headlight switch turned from OFF to ON, or ignition turned from OFF to ON).

Front Fog Light

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● The outer lenses have the see-through look, and multi-reflectors treated with vapor-deposition aluminum are used.

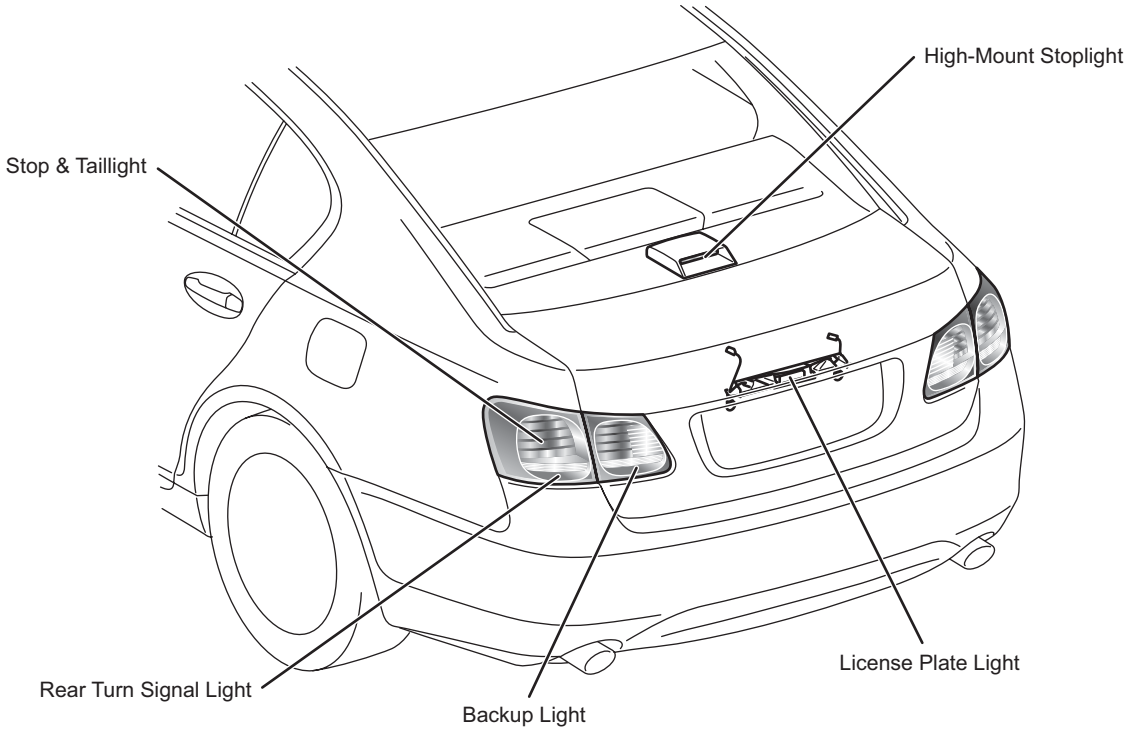


Front Fog Light Specifications

Light Names	Valve Specifications
front fog lights	12V 51W : HB4

Description

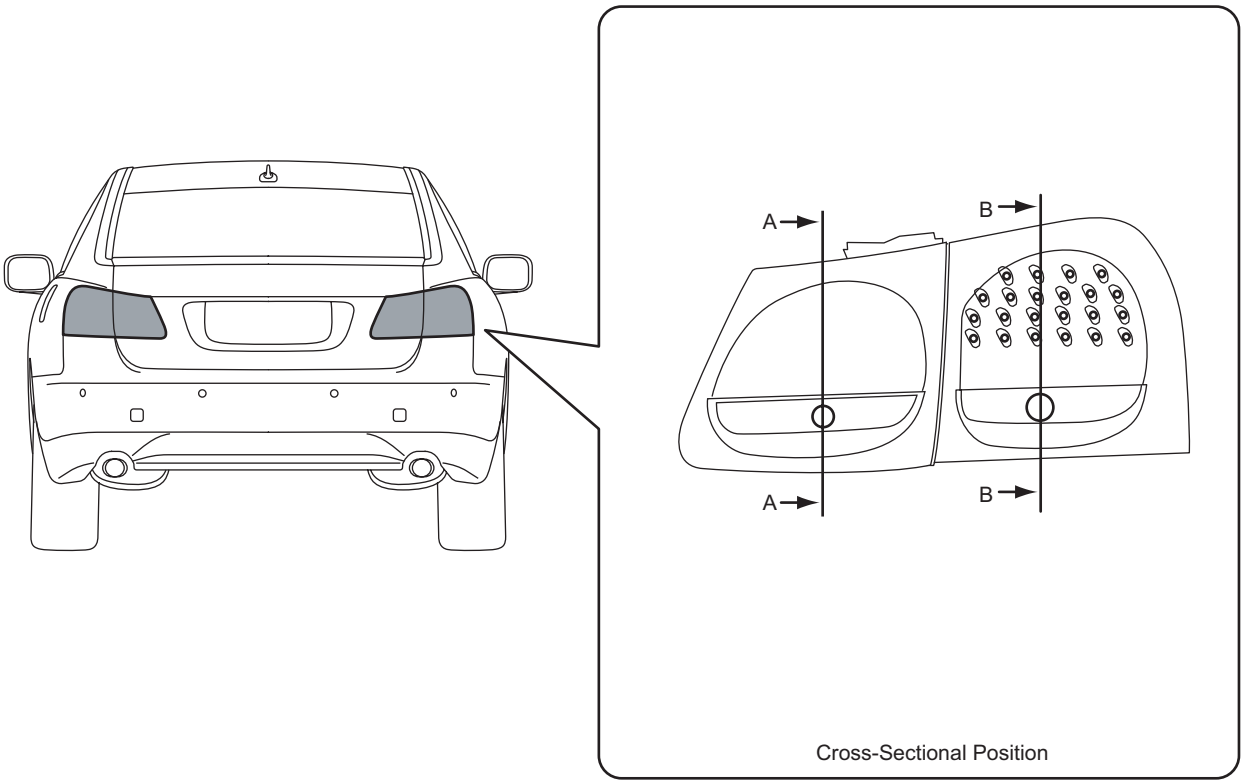
- Rear combination lights, which consist of stop & taillights and rear turn signal lights, are located in the quarter panels. Backup lights are located on the luggage compartment door.
- LEDs are used as light sources for the stop & taillights. Two inner lenses are combined to control light distribution, thus saving electrical power (which is one of the characteristics of LEDs), and changing the dotted lights into plane lights with an unparalleled appearance.
- All models are provided with license plate lights using white LEDs.
- All models are provided with high-mount stoplight LEDs on the package tray trim as standard equipment.

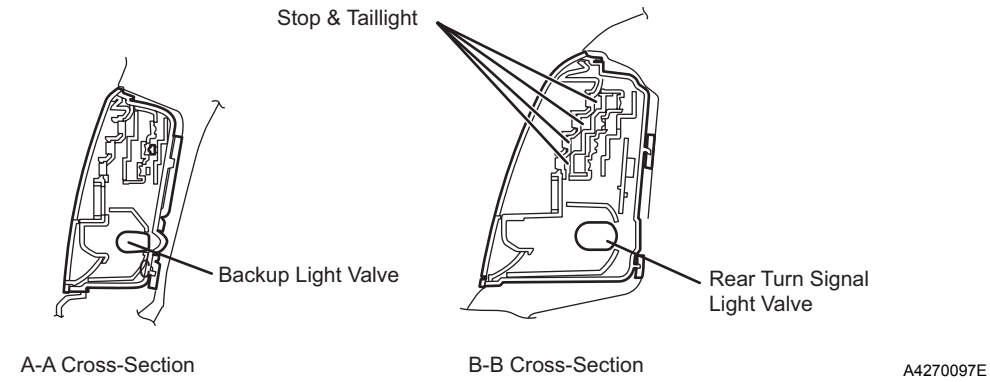


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Rear combination Light

- The rear combination lights consist of stop & taillights, and rear turn signal lights.
- The stop & taillight area uses a see-through (red) outer lens and is combined with a reflector housing that is treated with vapor-deposition aluminum.



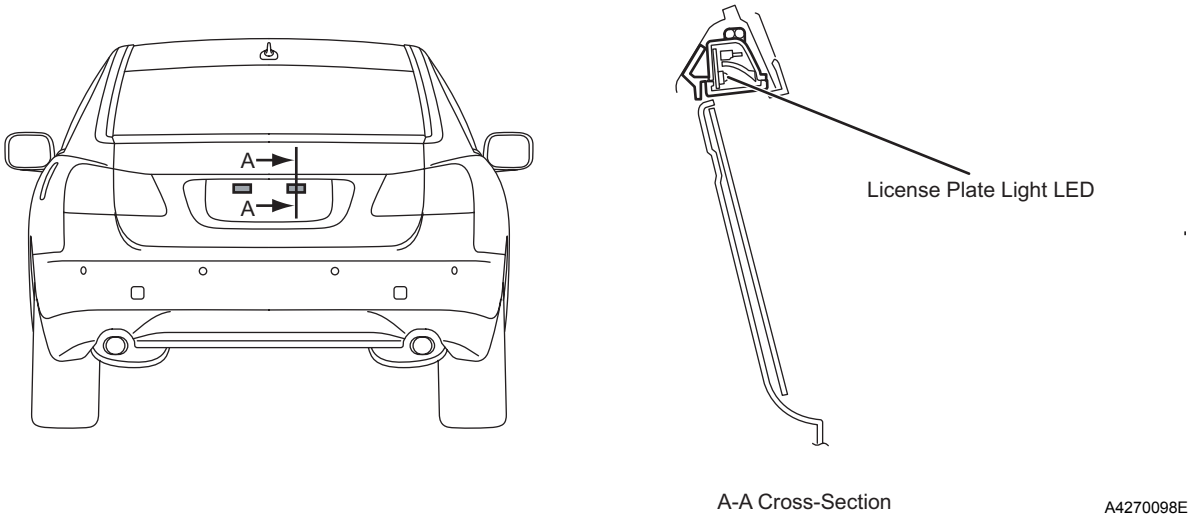


Rear Combination Light Specifications

Light Names	Valve Specifications	Light Names	Valve Specifications
stop & taillights	12V 3.6/0.5W(LED18)	rear turn signal lights	12V 21W : Amber

License Plate Light

- License plate lights that illuminate downward are provided in the outside garnish of the luggage compartment door. These lights use white LEDs that save electrical power and offer good looks.

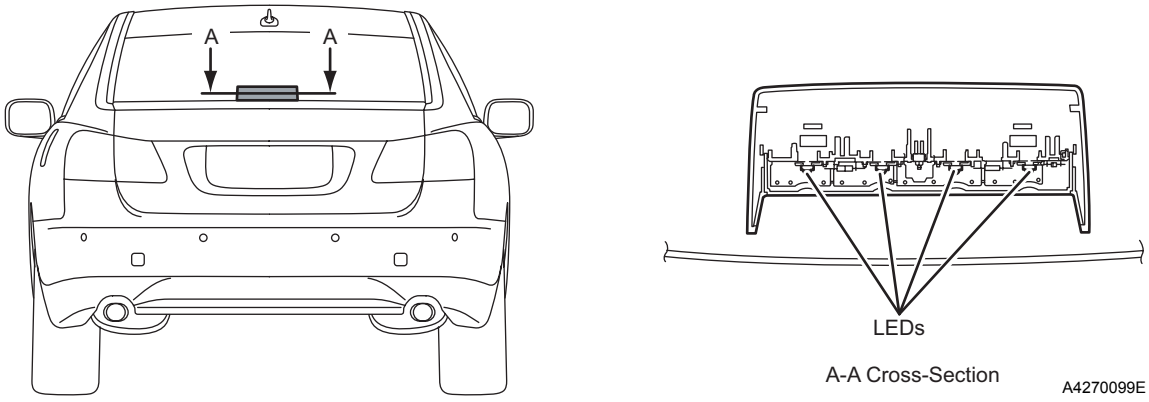


License Plate Light Specifications

Light Names	Valve Specifications
License plate lights	12V 5W

High-mount Stop Light

- High-mount stoplight LEDs are provided on the package tray trim.



High-Mount Stoplight Specifications

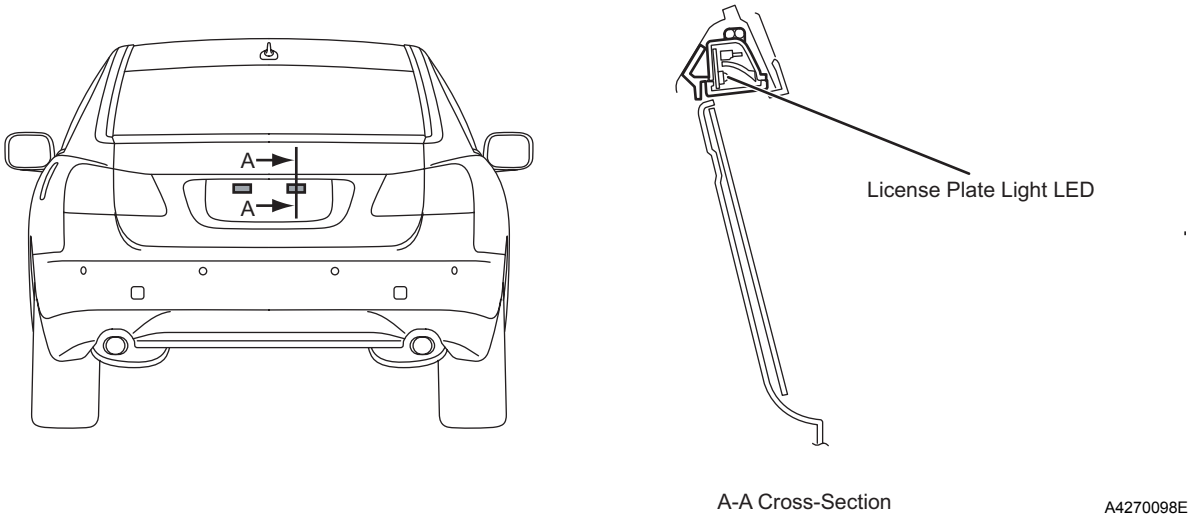
Light Names	Valve Specifications
High-mount stoplight	12V 2.1W:LED32

Rear Combination Light Specifications

Light Names	Valve Specifications	Light Names	Valve Specifications
stop & taillights	12V 3.6/0.5W(LED18)	rear turn signal lights	12V 21W : Amber

License Plate Light

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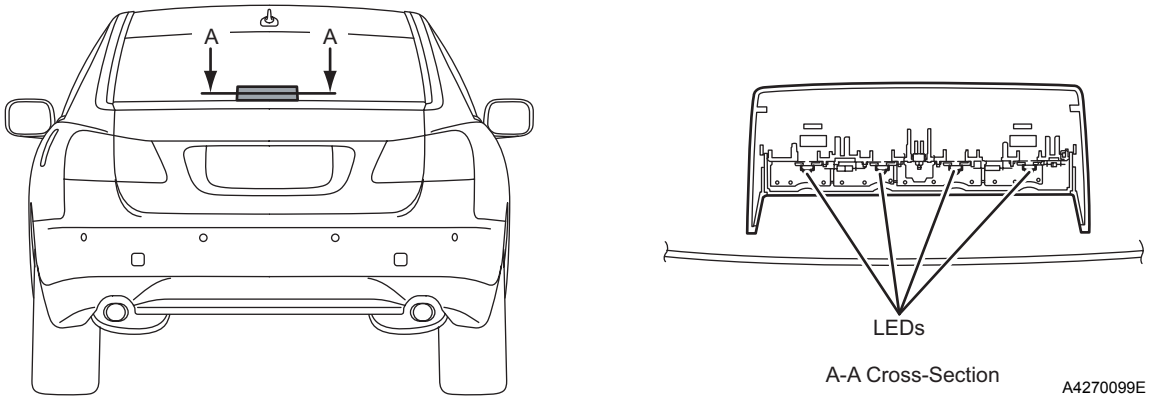


License Plate Light Specifications

Light Names	Valve Specifications
License plate lights	12V 5W

High-mount Stop Light

- High-mount stoplight LEDs are provided on the package tray trim.

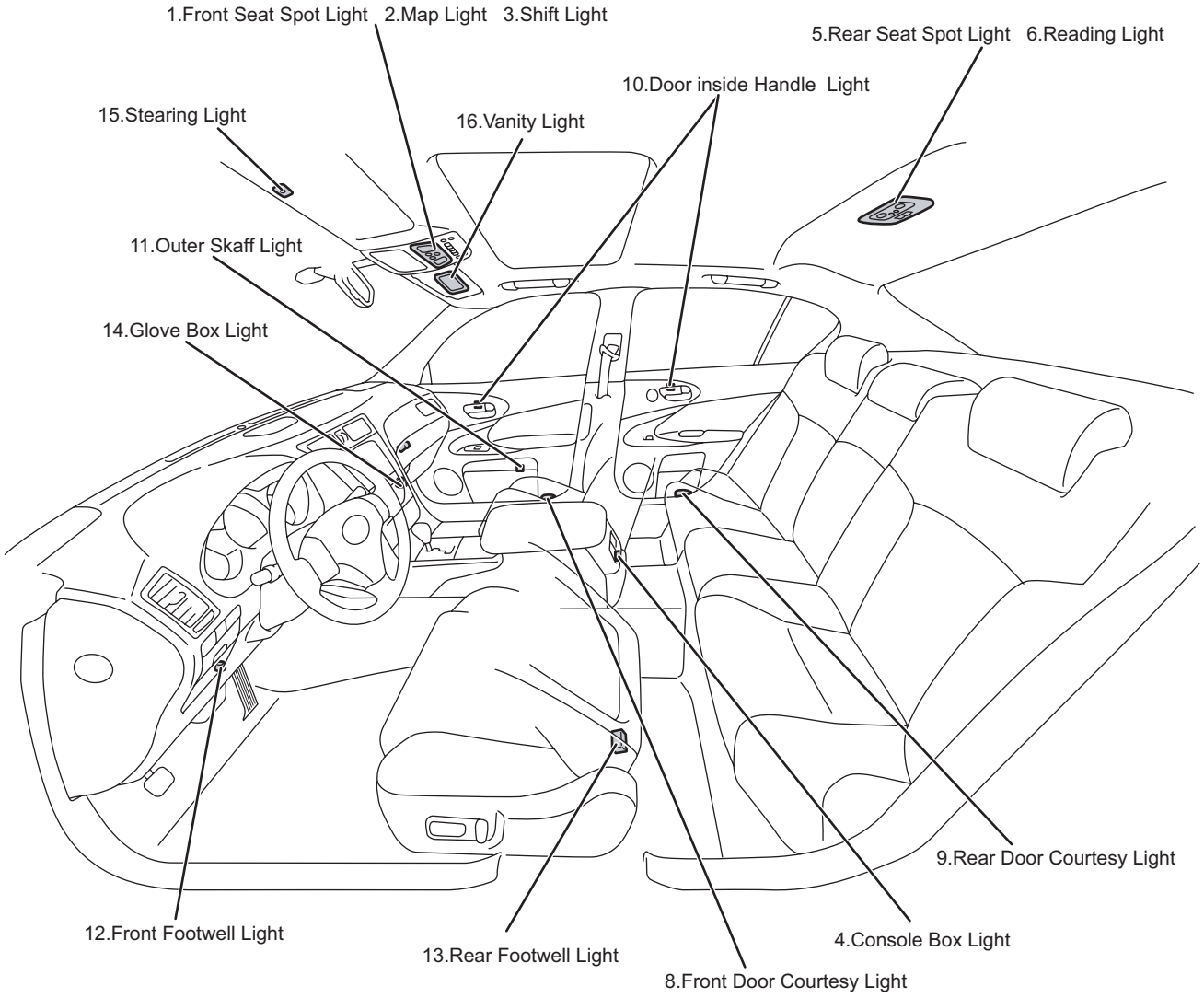


High-Mount Stoplight Specifications

Light Names	Valve Specifications
High-mount stoplight	12V 2.1W:LED32

Interior Lights

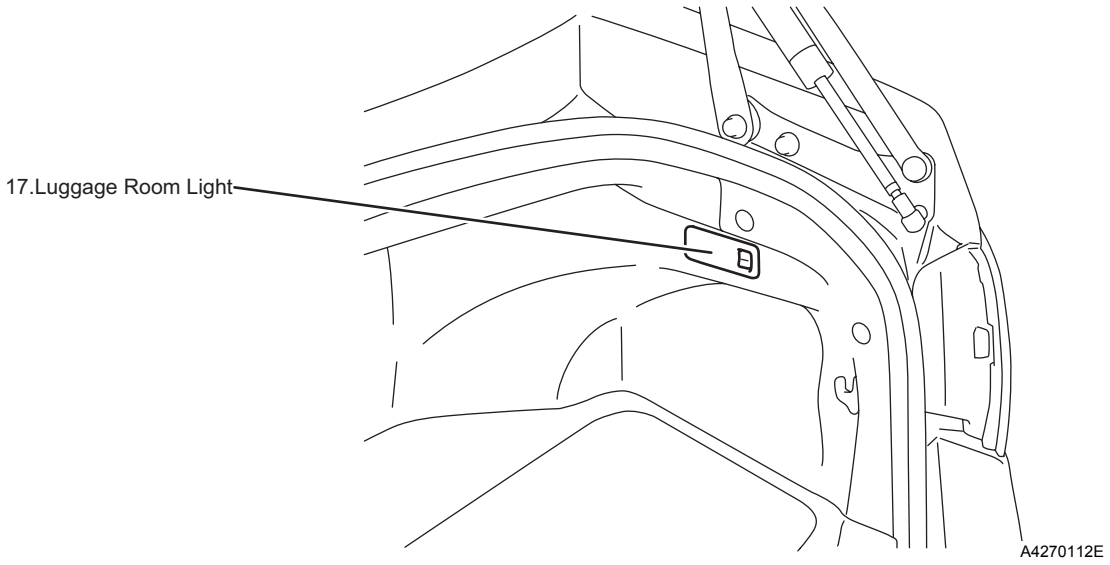
- Various types of interior lights help stage an elegant interior space that provides both comfort and convenience.
- An illuminated entry system, which illuminates the interior as the doors are opened, is provided for nighttime use. In addition, the interior illumination that help stage an elegant interior space.



Note: The illustration gives a representative example.

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Luggage Room Light

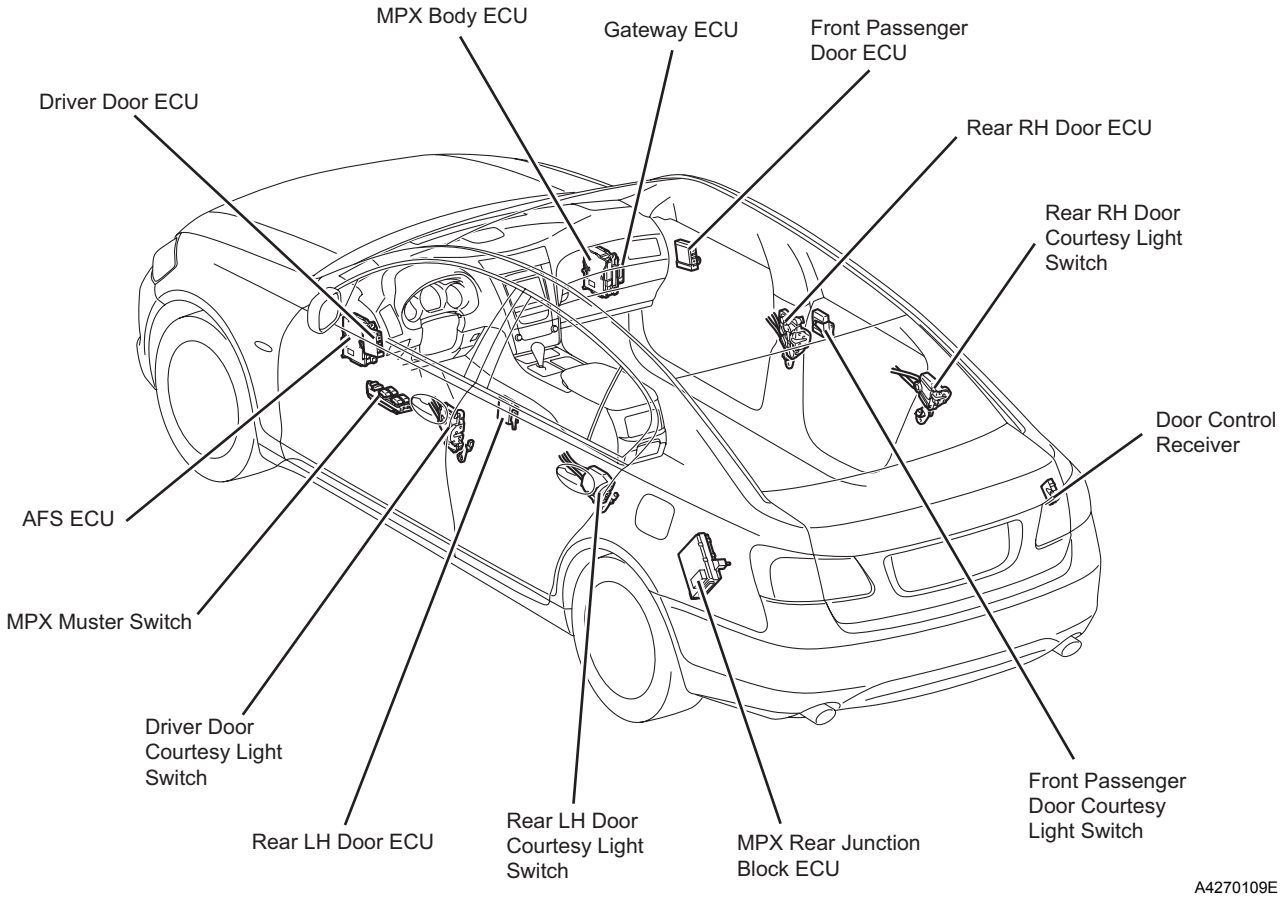


Interior Lights Specifications

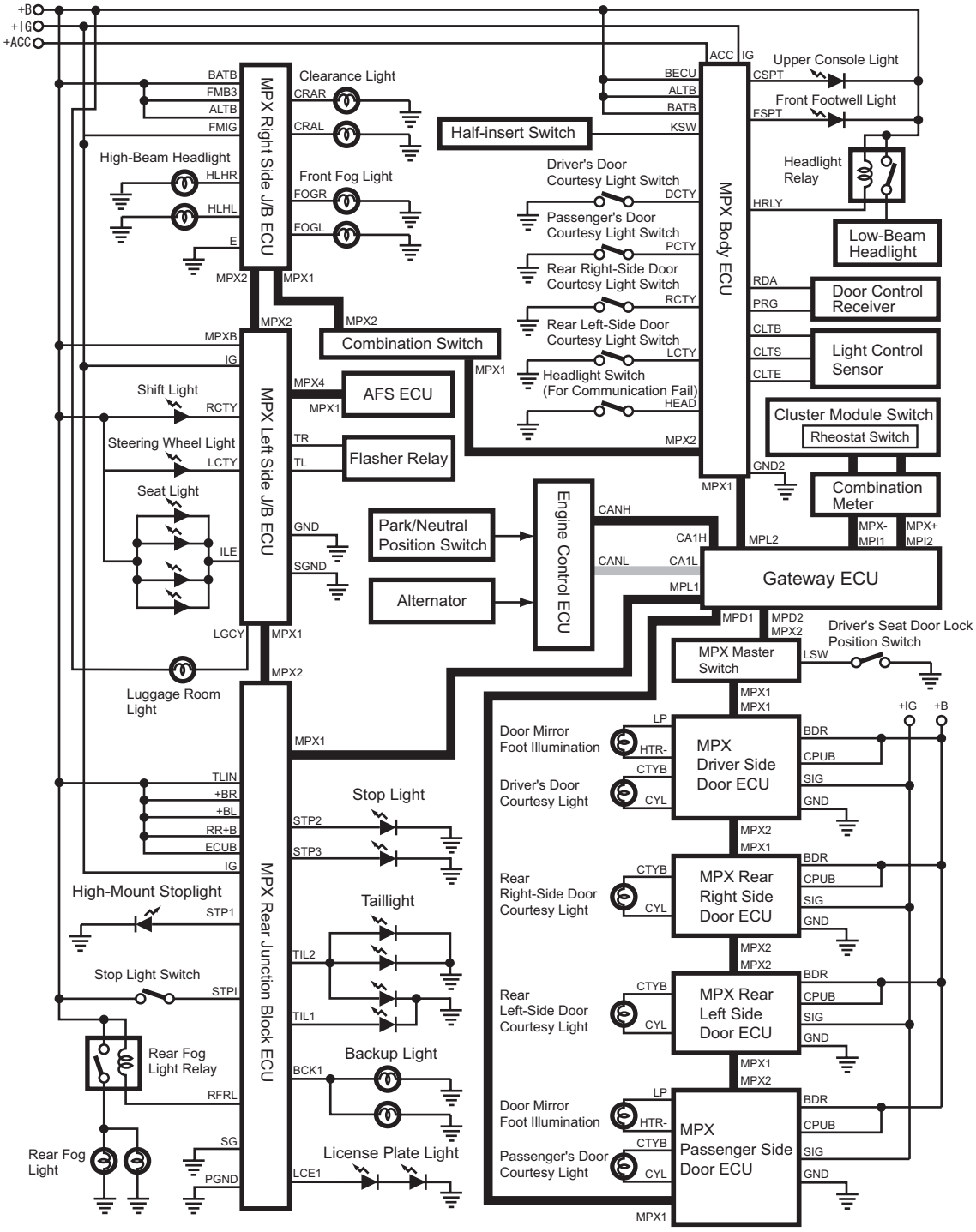
No.	Light Names	No.	Light Names
1	Front Seat Spot Light	10	Door Inside Handle Light
2	Map Light	11	Outer Skaff Light
3	Shift Light	12	Front Footwell Light
4	Console Box Light	13	Rear Footwell Light
5	Rear Seat Spot Light	14	Glove Box Light
6	Reading Light	15	Steering Light
7	Glove Box Light	16	Vanity Light
8	Front Door Courtesy Light	17	Luggage Room Light
9	Rear Door Courtesy Light		

Lighting System Control

- The onboard systems are connected by the BEAN (Body Electronics Area Network) and CAN (Controller Area Network) via the following three buses: instrument panel system bus, column system bus, and door system bus. They use a gateway configuration that enables them to share only the communication data they need via a gateway ECU.
- The ECUs (MPX body ECU, MPX left side J/B ECU, MPX right side J/B ECU, and MPX rear junction block ECU) that control the lighting system receive the input of signals they need for controlling various types of lights from the combination switch and the individual door ECUs via the BEAN (Body Electronics Area Network). Thus, they are able to control the light control system and the illuminated entry system in accordance with the operating conditions of the vehicle.



System Operation



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Intelligent AFS System

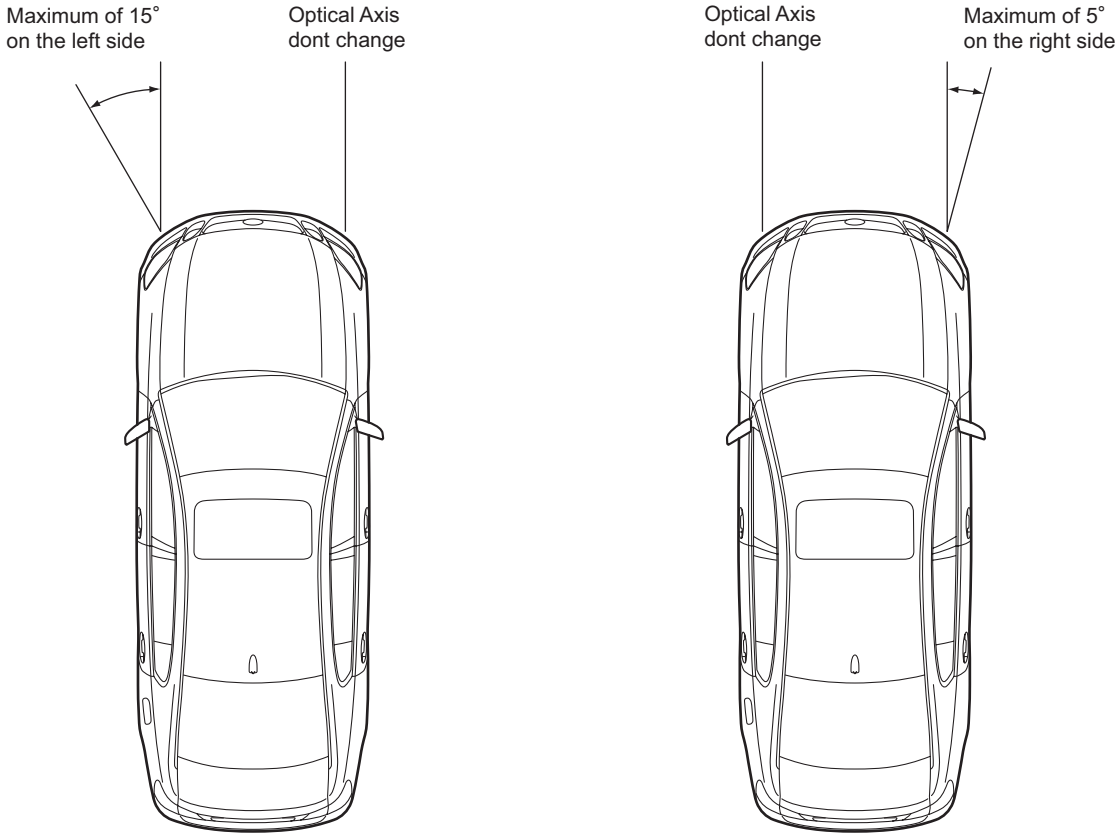
- The intelligent AFS combines the following:a swivel function that automatically changes the horizontal optical axes of the low-beam headlights in accordance with steering operation or vehicle speed; and an auto leveling function that automatically keeps the vertical optical axes constant. This system realizes optimal headlight distribution in all possible driving conditions.
- The unit that controls the intelligent AFS consists of an AFS ECU, swivel actuator, and a leveling actuator.

Intelligent AFS System Function

- If the vehicle speed is over* 10 km/h and the operating angle of the steering is over* 7.5°, the system can change the optical axes of the low-beam headlight on the inside of the turn a maximum of 15° on the left side, and a maximum of 5° on the right side for forward illumination during a turn.

❖REFERENCE❖

*These values change with the relationship between the vehicle speed and the operating angle of the steering.

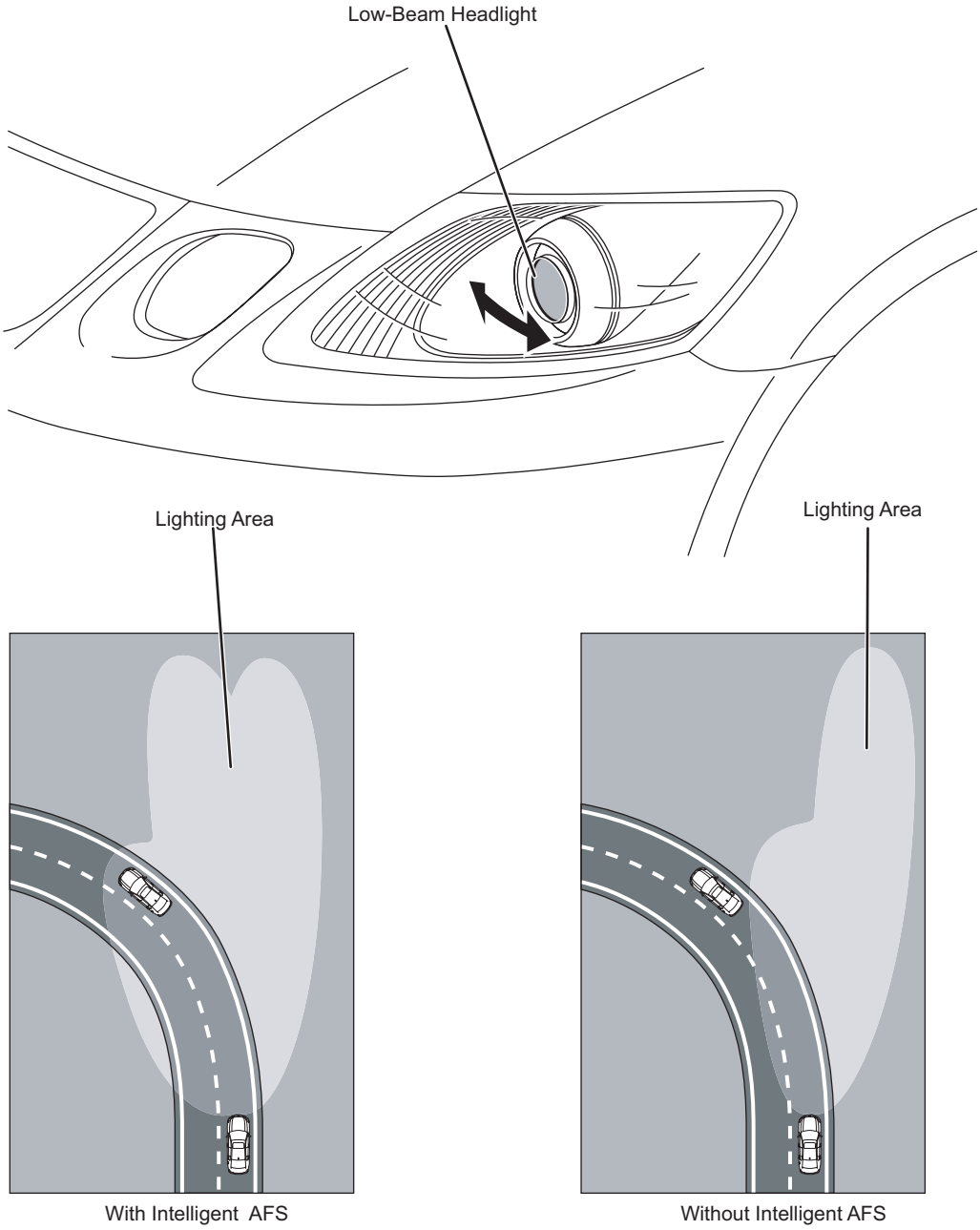


Optical Axis Variable Range by Intelligent AFS

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Conceptual Image of Intelligent AFS System Illumination

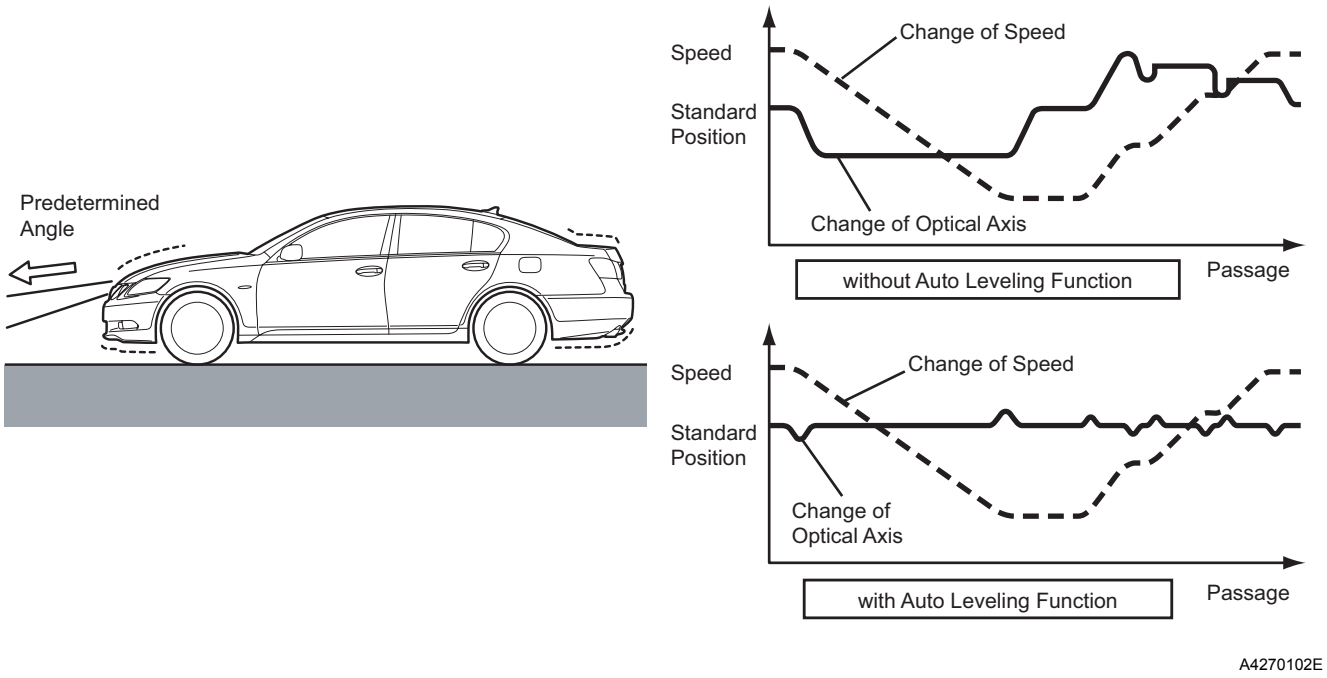
- In the intelligent AFS system, the AFS ECU calculates and estimates the curve based on the vehicle speed and the operating angle of the steering. Then, the system automatically changes the optical axes (operating angle of the swivel actuator) in accordance with the size of the curve, in order to illuminate the area in the direction of travel of the vehicle.



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Auto Leveling Function

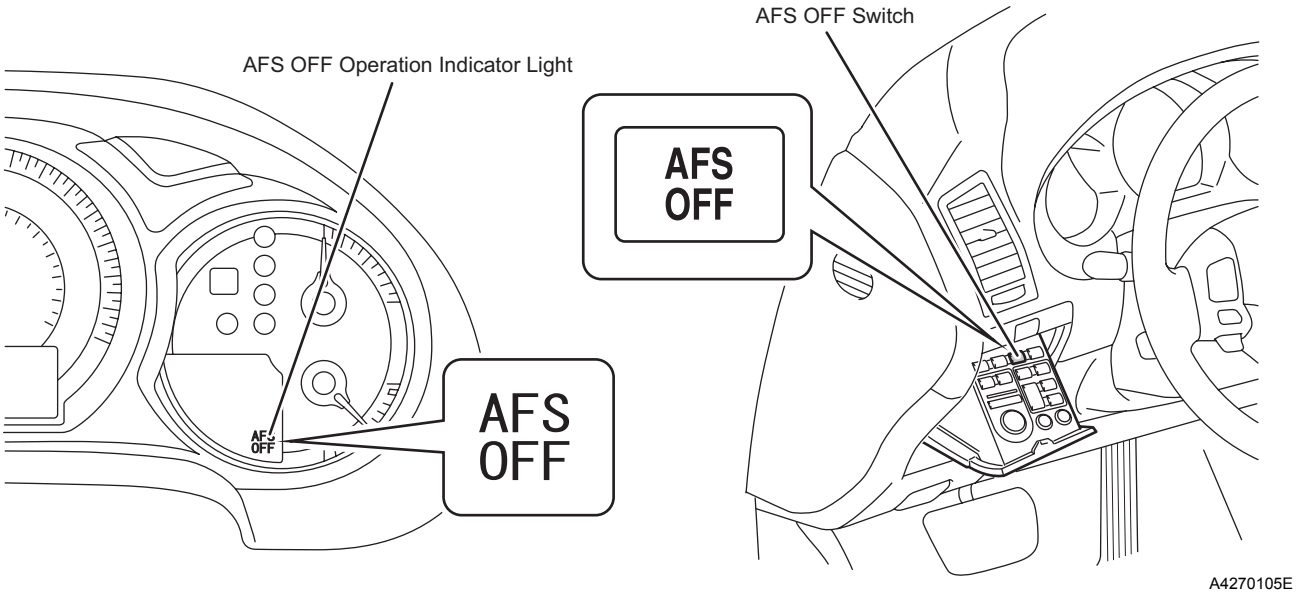
• The height control sensors, which are installed on the suspension for the front and rear axles on the left side of the vehicle, detect the changes in the vehicle posture that result from acceleration, deceleration, or the loading of cargo. Then, the sensors input the amount of change via the height control ECU. This causes the headlight leveling actuators, which are installed on the headlights, to actuate in accordance with the changes in the vehicle posture. As a result, the system automatically maintains the vertical movement of the optical axes of the headlights within a predetermined angle.



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Intelligent AFS System Cancel Function

- By pressing the AFS OFF switch, which is located below the lower instrument panel on the driver side, the driver will be able to cancel the swivel control of the intelligent AFS system. After the intelligent AFS system has been canceled, the AFS OFF operation indicator light will illuminate in the combination meter.
- After the intelligent AFS system has been canceled, the driver can press the AFS OFF switch again to resume the swivel control of the intelligent AFS system. At the same time, the AFS OFF operation indicator light will turn OFF in the combination meter.



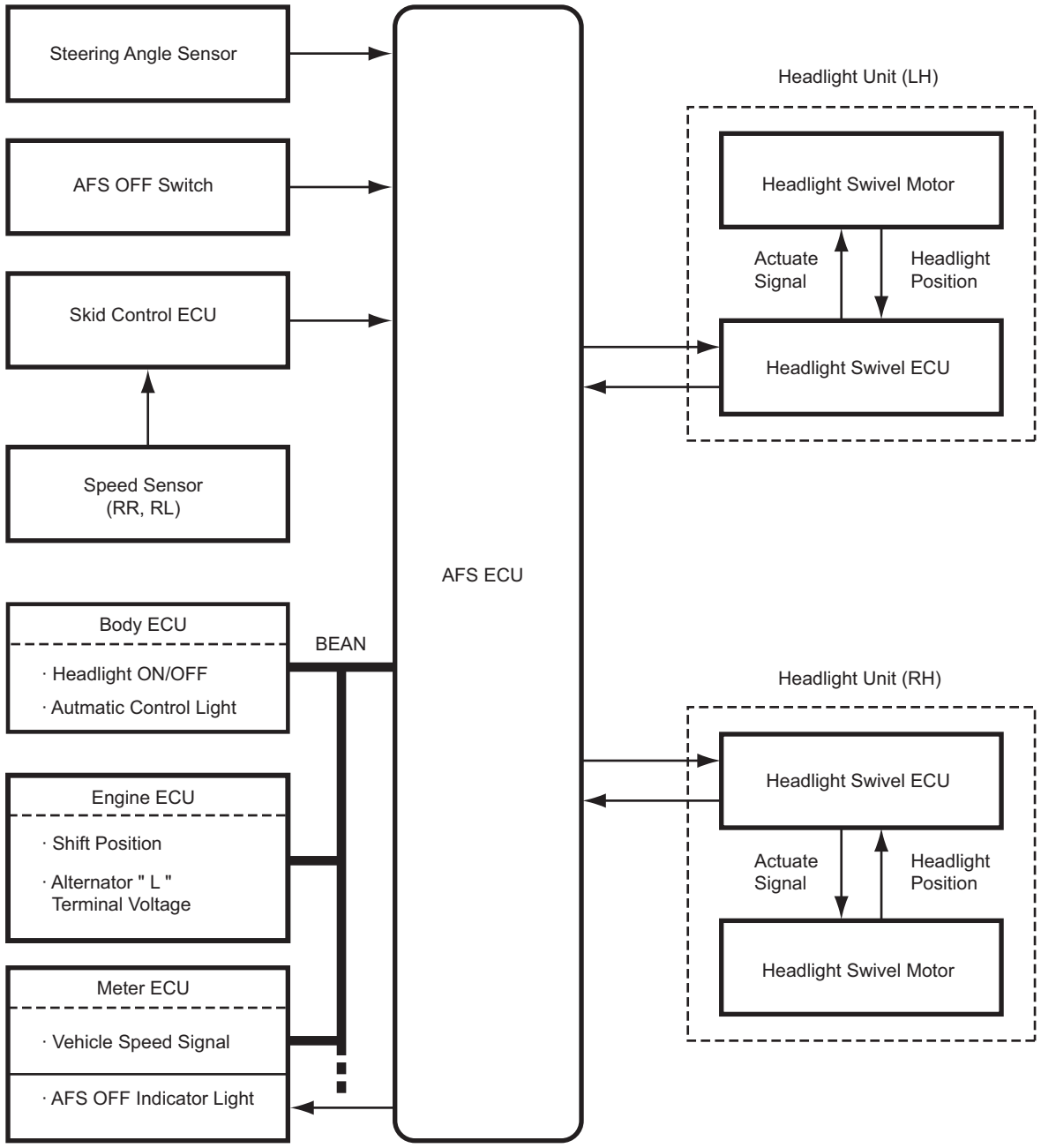
Intelligent AFS System Operation

Intelligent AFS System Operation

- The AFS ECU receives the input of the vehicle speed signal that is output by the front wheel speed sensor via the skid control ECU (which is built into the brake actuator), as well as the steering turning angle signal that is output by the steering angle sensor. In addition, the AFS ECU receives the input of headlight ON/OFF signals and the shift position signal by way of the BEAN (Body Electronics Area Network). Thus, the AFS ECU is able to control the swivel actuators.

Auto Leveling Function Operation

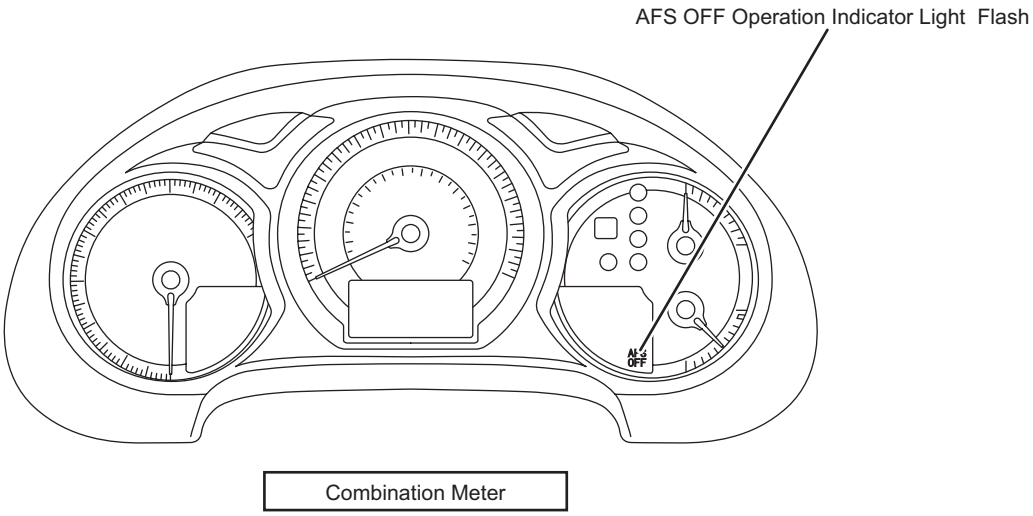
- The AFS ECU receives the input of the vehicle speed signal that is output by the front wheel speed sensor via the skid control ECU (which is built into the brake actuator). In addition, the AFS ECU receives the input of the vehicle height signals, which are output by the height control sensors that are installed on the front and rear axles on the left side of the vehicle, via the height control ECU. The AFS ECU obtains the changes in the pitch angle of the vehicle posture through these signals. Then, in accordance with the amount of these changes, the AFS ECU controls the angle of the headlights by actuating the headlight leveling actuators to the same angle as the pitch angle, in the opposite direction.



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Failsafe

- If the AFS ECU detects a failure indicated in the table (List of Main Failsafe Functions), it effects failsafe control, and outputs a request signal to the meter ECU (built into the combination meter) in order to flash the AFS OFF operation indicator light. Upon receiving this signal, the meter ECU flashes the AFS OFF operation indicator light in 1-second cycles (0.5 seconds ON, and 0.5 seconds OFF).
- Upon receiving the signal requesting the flashing of the AFS OFF operation indicator light, the meter ECU will transmit a warning indication request signal to the Electro Multivision. As a result, the warning icon will appear on the multi-display. The driver can touch the icon for a full-screen view of the details.



Note: The illustration gives a representative example, which may differ from the actual vehicle.

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List of Main Failsafe Functions

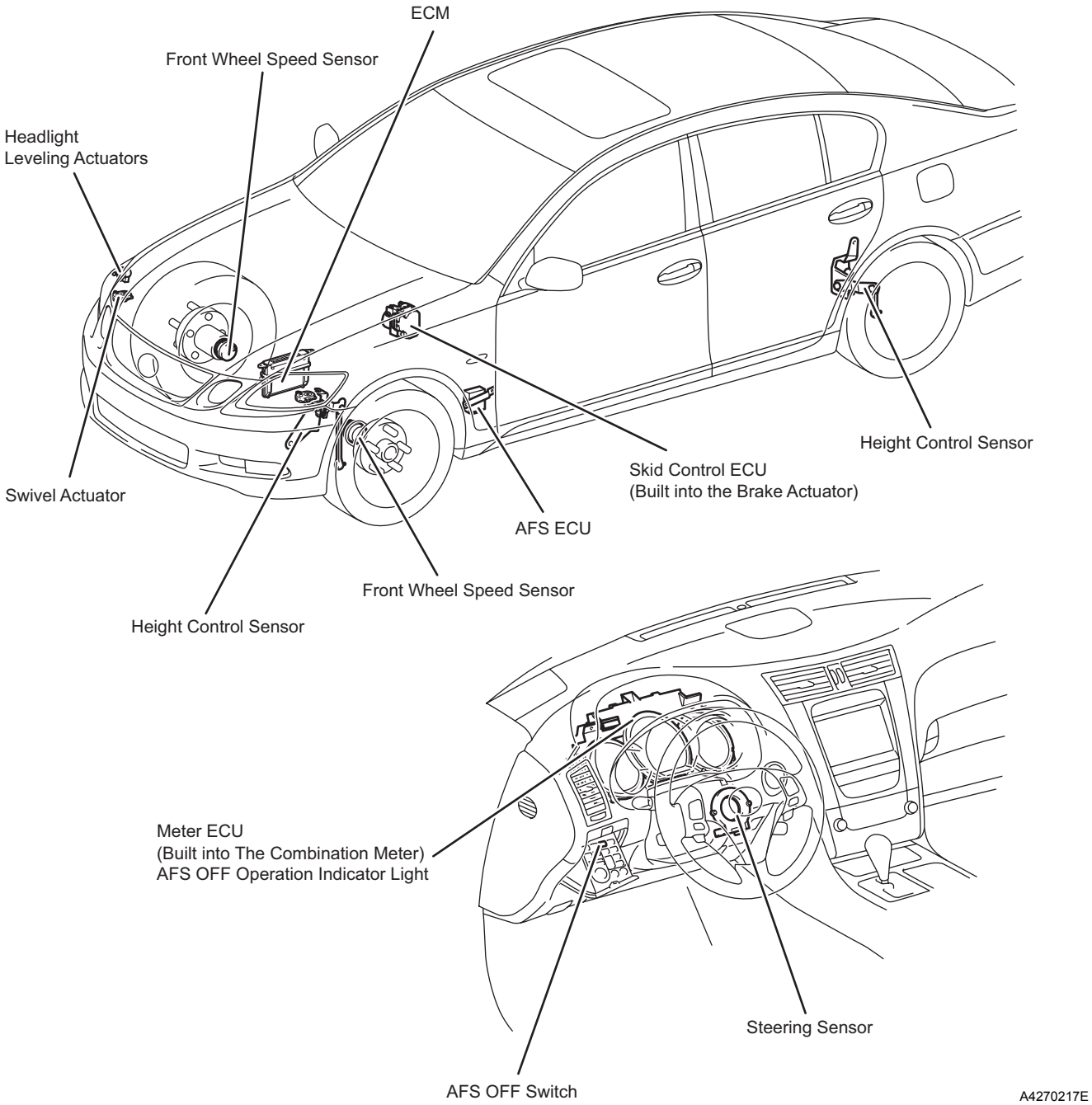
Item	Failure Detection Condition	Swivel Control	Auto Leveling Function Control	Light*
Swivel Actuator	Open, short, overheating	Returns the headlights to a straight-ahead aim.(Only the side that is operating normally)	Continues to effect control by aiming the headlights 0.8°downward from the present position.	Flashing
	Gear malfunction			
	Faulty stop position			
	Faulty sensor input	Returns the headlights to a straight-ahead aim.	Continues to effect control.	
Steering Angle Sensor	Failure information	Stops the headlights at the present position, and returns them to a straight-ahead aim 10 seconds later.	Continues to effect control by aiming the headlights 0.8°downward from the present position. Reverts to the normal control after the headlights return to a straight-ahead aim.	Flashing
	Communication failure			
Vehicle Speed Signal	Failure at one side	Returns the headlights to a straight-ahead aim.	Effects control with the vehicle speed of the normal side.	Flashing
	Failure at both sides	Returns the headlights to a straight-ahead aim.	Continues to effect control of the stopped vehicle.	
Height Control Sensor	Open or short	Returns the headlights to a straight-ahead aim.	Returns the headlights to the default position if they are aimed higher than the default position. Keeps the headlights stopped at the present position if they are aimed lower than the default position.	Flashing
Headlight Leveling Actuator	Open, short, overheating	Returns the headlights to a straight-ahead aim.	Returns the normal side to the default position if it is aimed higher than the default position. Keeps it stopped at the present position if it is aimed lower than the default position. (Keeps the abnormal side at the present position.)	Flashing
Communication	Headlight signal, gear position signal, etc.	Returns the headlights to a straight-ahead aim.	Continues to effect control.	Flashing
	Alternator signal, vehicle speed signal	Continues to effect control.		

❖REFERENCE❖

*AFS OFF operation indicator light.

Components

● The intelligent AFS system consists of the following components:



The intelligent AFS system consists of the following components:

Component	Main Function
AFS ECU	• Upon receiving the signals from the height control sensor and the skid control ECU, the AFS ECU determines the vehicle posture and driving conditions, and controls the headlight leveling actuators (auto leveling function). • Upon receiving the signals from the height control sensor and the skid control ECU, the AFS ECU determines the vehicle posture and driving conditions, and controls the headlight leveling actuators (auto leveling function). • If a failure occurs in the swivel or auto leveling function, the AFS ECU will output a request to flash the AFS OFF operation indicator light in the combination meter. • When the driver presses the AFS OFF switch, the AFS ECU will prohibit the control of the swivel function, and output a request to illuminate the AFS OFF operation indicator light in the combination meter.
Swivel Actuators	• Upon receiving control signals from the AFS ECU, the swivel actuators control the direction of the optical axes by actuating the low-beam headlights in the horizontal direction.
Headlight Leveling Actuators	• Upon receiving control signals from the AFS ECU, the headlight leveling actuators control the direction of the optical axes by actuating the low-beam headlights in the vertical direction.
Steering Sensor	• Detects the operating angle of the steering and outputs a steering angle signal to the AFS ECU.
Front Wheel Speed Sensor	• Detects the wheel speed and outputs it to the skid control ECU.
Skid Control ECU	• Upon receiving signals input by the front wheel speed sensors, the skid control ECU outputs vehicle speed signals to the AFS ECU. • Outputs a steering correction signal in the form of a BEAN (Body Electronics Area Network) signal.
AFS OFF Switch	• When the AFS OFF switch is pressed, it cancels the control of the swivel function.
Meter ECU	• Upon receiving an illumination request signal from the AFS ECU, the meter ECU illuminates the AFS OFF operation indicator light in the combination meter. • Upon receiving a flashing request signal from the AFS ECU, the meter ECU flashes the AFS OFF operation indicator light (0.5 seconds ON, and 0.5 seconds OFF).
MPX Body ECU	• Outputs the ON or OFF signal of the headlights in the form of the BEAN (Body Electronics Area Network) signals.
Gateway ECU	• Exchanges data between the BEAN (Body Electronics Area Network) system and the CAN (Controller Area Network) system.
Engine ECU	• Outputs shift position signals via the CAN (Controller Area Network).
Height Control Sensor	• Detects the height of the vehicle and outputs height change signals to the height control ECU.
Height Control ECU	• Upon receiving the signals input by the height control sensor, the height control ECU outputs height change signals to the AFS ECU.

Light Control System

- Provided that the ignition is ON and the light control switch is in the AUTO position, the light control system detects whether the surroundings are bright or dark and automatically illuminates the taillights and headlights. This system is provided on all models as standard equipment.
- The circuit that controls this system is built into the MPX body ECU, which is installed in the driver's side of the instrument panel.
- A function is provided to extend the light OFF delay time in order to prevent the headlight from momentarily turning back ON, such as when the headlights are momentarily relit under the control of the light control system after they are turned OFF.

Function

- The light control system controls the taillights and headlights as indicated in the table below, in accordance with the conditions such as the position of the light control switch or whether the surroundings are bright or dark.

Light operation by the light control system

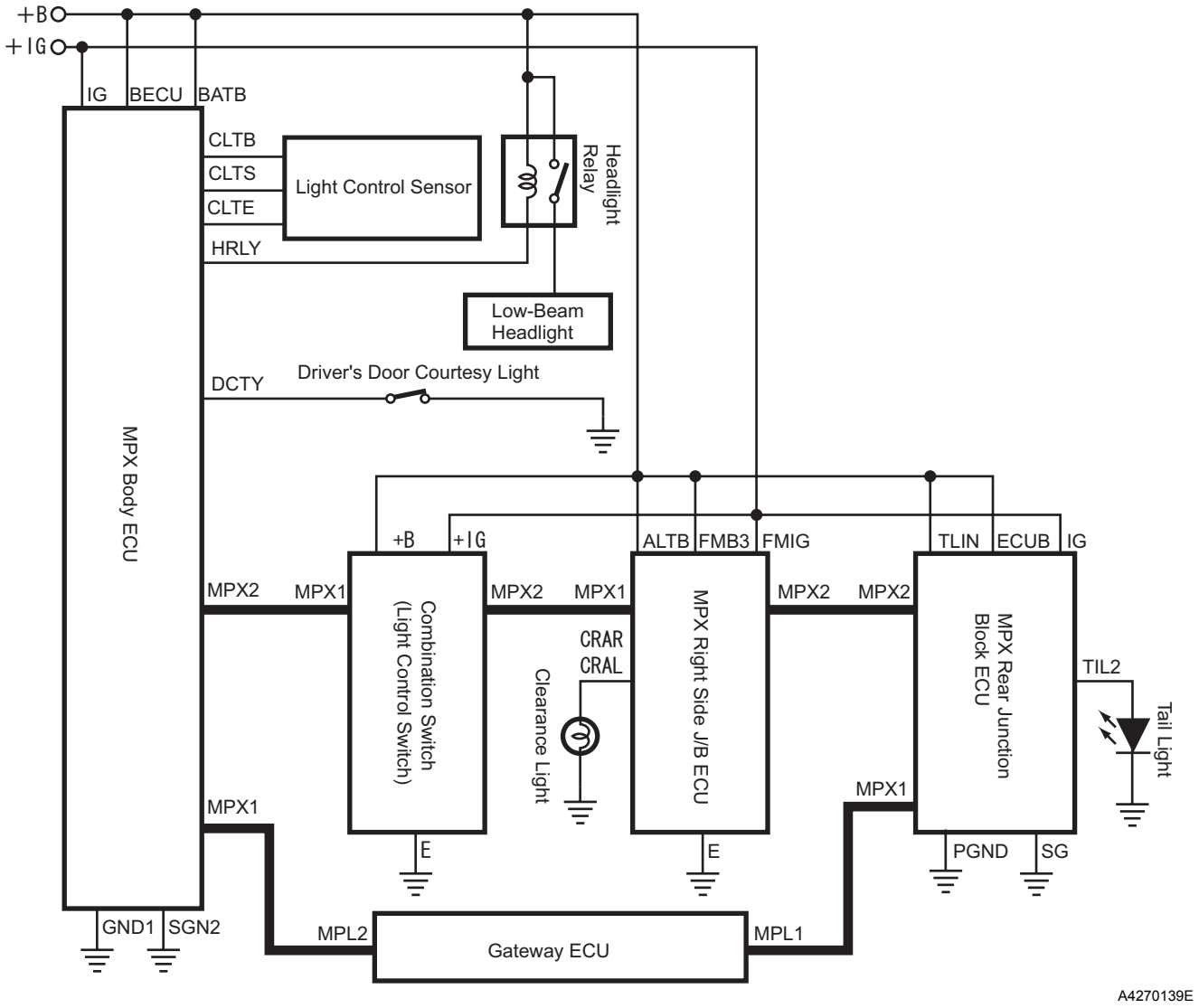
No.	Light Control Switch Position	IG	Driver Door Courtesy Light Switch	Surrounding Conditions	Taillights	Headlights
1	OFF	—	—	—	OFF	OFF
2	TAIL	—	—	—	Illumination	OFF
3	HEAD	—	—	—	Illumination	OFF
4	AUTO	ON	OFF	Bright	OFF	OFF
5	↑	↑	↑	Momentarily Dark	Illumination	OFF
6	↑	↑	↑	Semi-Dark	Illumination	OFF
7	↑	↑	↑	Dark	Illumination	Illumination
8	↑	↑	↑	Momentarily Bright	Illumination	Illumination
9	↑	OFF	↑	Dark	Illumination	Illumination
10	↑	↑	ON	↑	OFF	OFF
11	↑	↑	OFF	↑	OFF	OFF
12	↑	ON	↑	↑	Illumination	Illumination
13	↑	↑	ON	↑	Illumination	Illumination

Operation

• The control of the light control system is effected primarily by the MPX body ECU. However, the combination switch, MPX right side J/B ECU, and the MPX rear junction block ECU, which are connected by the BEAN (Body Electronics Area Network), exchange signals to control the light control switch operating signals, clearance light illumination, and the taillight illumination. The numbers used in the operations described below correspond to the numbers used in the List of Light Operations by the Light Control System.

Light Control System Operation

Condition	Basic Operation
The surroundings are bright (No. 4)	• If the surroundings are brighter than the taillight OFF brightness level or the headlight OFF brightness level, the system will turn OFF both the taillights and headlights.
The surroundings that are bright become momentarily dark (No. 5)	• While the surroundings are bright, if the headlight OFF brightness level changes to the ON brightness level, the taillights will turn ON because the taillight ON brightness level has already been reached. However, the headlights will not turn ON. If the surroundings are darker than the ON brightness level after the delay time has elapsed, the headlights will turn ON. However, if the surroundings are brighter than the ON brightness level after the delay time has elapsed, the headlights will remain OFF. This function prevents the headlights from momentarily turning ON when the surroundings become momentarily dark, such as when a vehicle that is being driven in bright surroundings encounters a spot of darkness under an overpass or along a tree-lined road. However, the headlights will turn ON if the surroundings become dark to the urgent headlight ON brightness level.
The surroundings are semi-dark, dark, or momentarily bright (No. 6 to No. 8)	• If the surroundings are semi-dark and darker than the taillight ON brightness level, the taillights will turn ON (No. 6) • From the state described above, if the surroundings become darker than the headlights ON brightness level, the headlights will turn ON (No. 7) • Even if the surroundings suddenly become bright with streetlights while the headlights are ON, the headlights will not turn OFF (No. 8)
The ignition is turned OFF (No. 9)	• If the driver turns the ignition OFF while any one of the foregoing states (No. 6 to No. 8) is in effect, both the taillights and headlights will remain ON. Then, if the driver turns OFF the light control switch and sets it again to OFF, both the taillights and headlights will turn OFF.
The driver turns the ignition OFF and opens the driver's door, or subsequently closes it (No. 10 and No. 11)	• If the driver's door is opened (thus turning ON the driver's door courtesy light switch) from the previous state (No. 9), both the taillights and headlights will turn OFF (No. 10) • If the driver's door is closed (thus turning OFF the driver's door courtesy light switch) from the foregoing state, both the taillights and headlights will remain OFF (No. 11)
The driver turns the ignition ON again while the driver's door remains closed (No. 12)	• If the driver turns the ignition ON again from the previous state (No. 10 or No. 11), and the surroundings are dark, both the taillights and headlights will turn ON.
The driver opens the driver's door again from the previous state (No. 13)	• Even if the driver opens the driver's door again (thus turning ON the driver's door courtesy light switch) from the previous state (No. 12), both the taillights and headlights will remain ON, provided that the surroundings are dark.

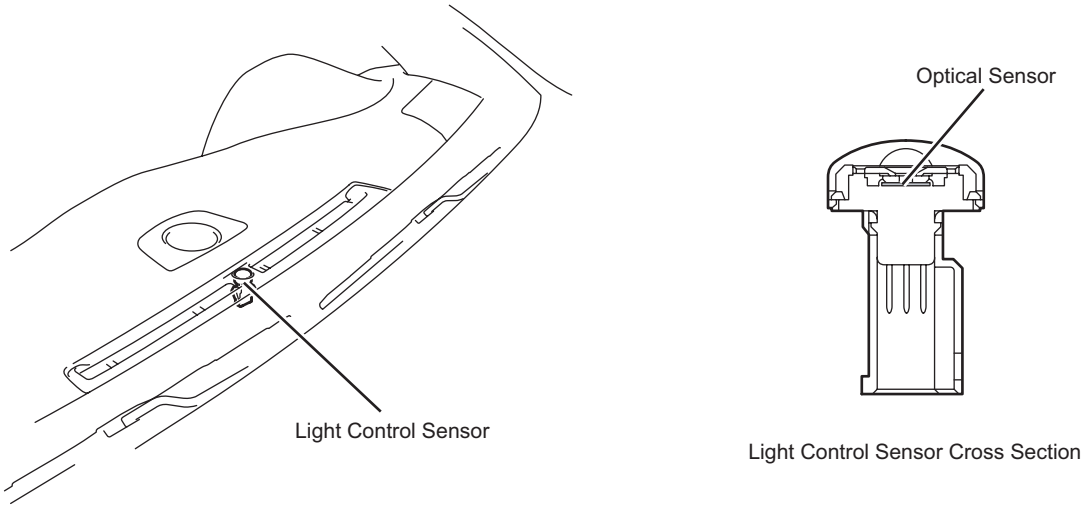


Failsafe

- If the light control sensor outputs a frequency below 30Hz, the MPX body ECU determines that the light control sensor has failed or the wiring harness has an open or short circuit. Then, the MPX body ECU performs a failsafe function.
- The MPX body ECU recognizes an input failure from the light control sensor while the light control switch is in the AUTO position and the ignition is ON. Then, if the headlights and taillights are ON, the light auto cut system will turn them OFF or keep them ON until the light control switch is turned OFF. If the headlights and taillights are OFF, the light control system will not effect control, and the lights will remain OFF. If the light control sensor restores the output of the normal frequency while the failsafe function is being effected, the light control system will automatically restore its control.

Light Control Sensor

- This sensor contains a scanner portion (integrated photosensor) that detects the brightness of the area surrounding the vehicle and outputs it in the form of a frequency signal to the MPX body ECU. This sensor is located in the center of the front defroster above the instrument panel.



Light Auto Cut System

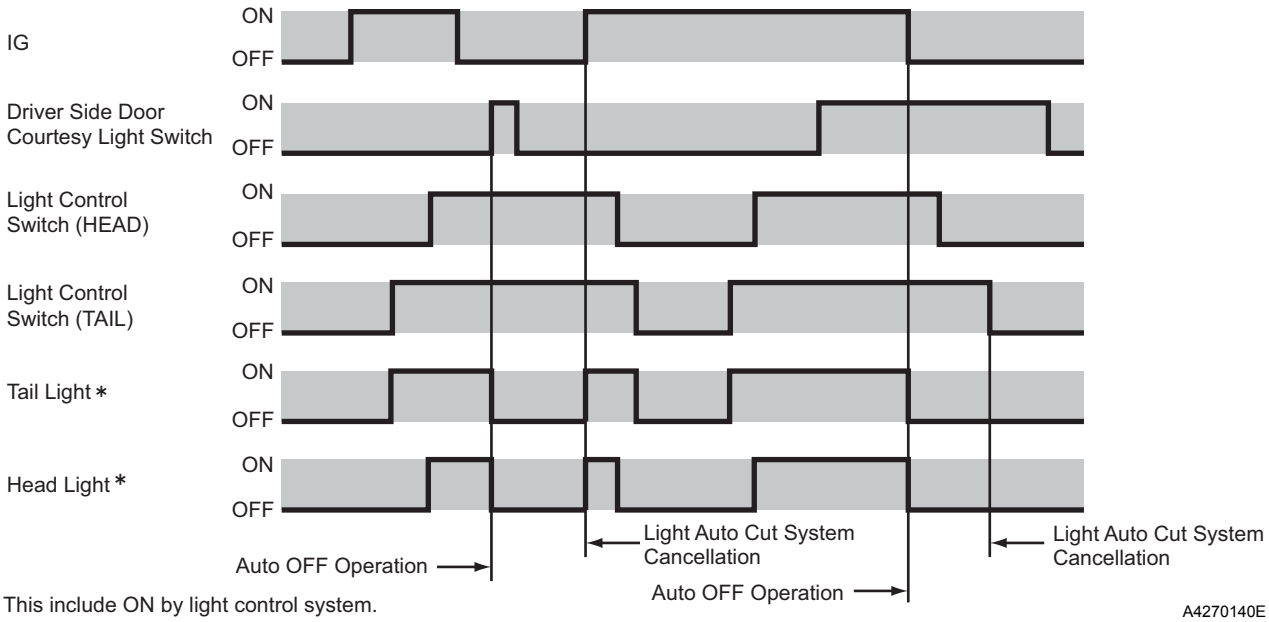
- A light auto cut system is provided on all models as standard equipment. This system prevents the headlights and taillights from being inadvertently left ON.
- The circuit that controls this system is built into the MPX body ECU.

Light Control System Function

- The ignition is ON and the light control switch (HEAD or TAIL) is ON or set to AUTO, allowing the headlights or taillights (including the front fog lights and the rear fog lights) to stay ON. In this state, if the driver turns the ignition OFF and opens the driver's door, this function will automatically turn OFF the headlights and taillights.
- While the ignition is ON, if the driver opens the driver's door, then turns the ignition OFF, this function will also automatically turn OFF the headlights and taillights.
- After the lights have been turned OFF automatically, the driver can operate the light control switch again from a position other than OFF to OFF, or turn the ignition ON in order to cancel the light auto cut system.*

❖REFERENCE❖

*If the driver performs a passing operation while the lights are automatically turned OFF, the headlights will turn ON, but the light auto cut system will not cancel.



* : This include ON by light control system.

Light Control System Operation

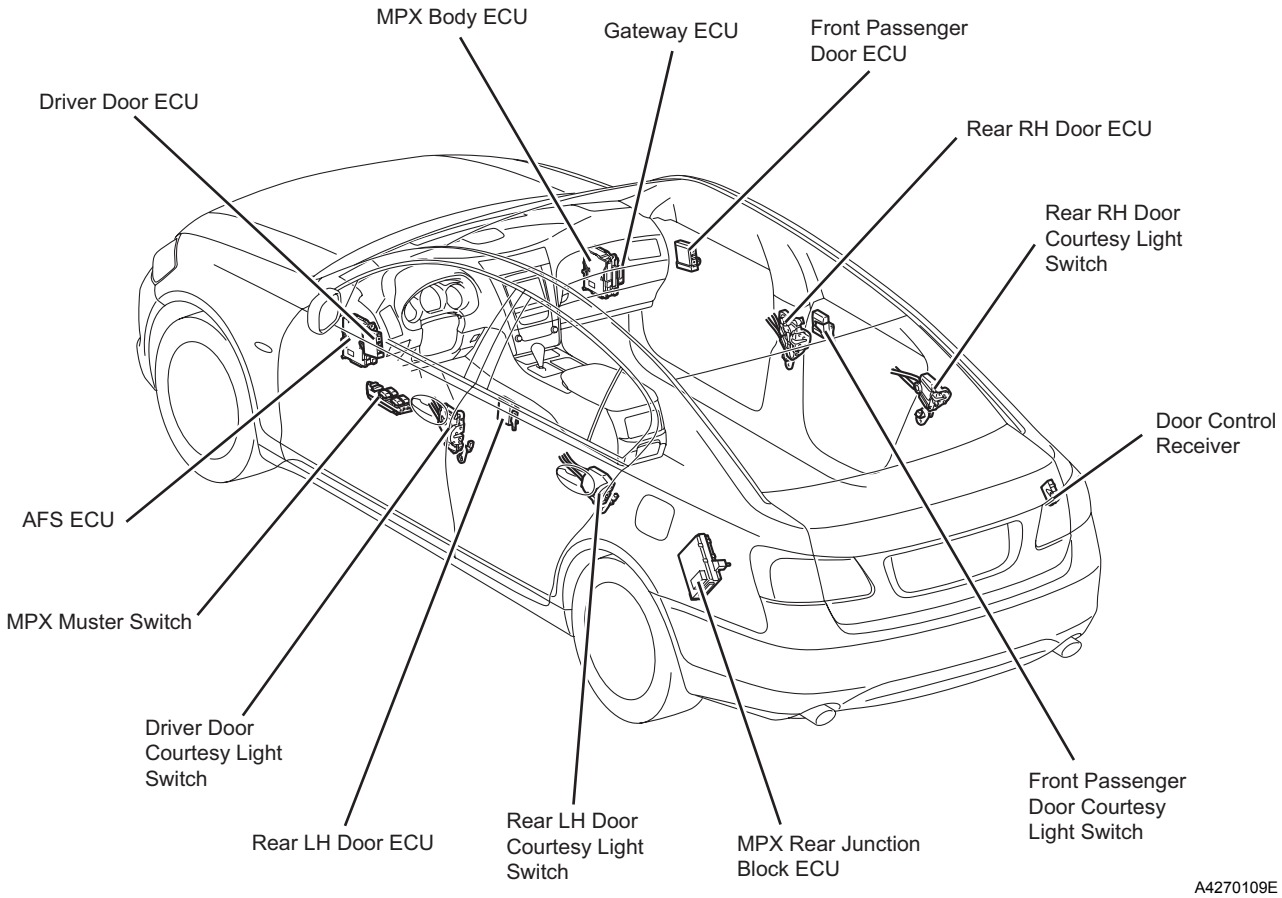
• Refer to the circuit diagram for the operation of the light control system. : BE-27

Light Auto Cut System Operation

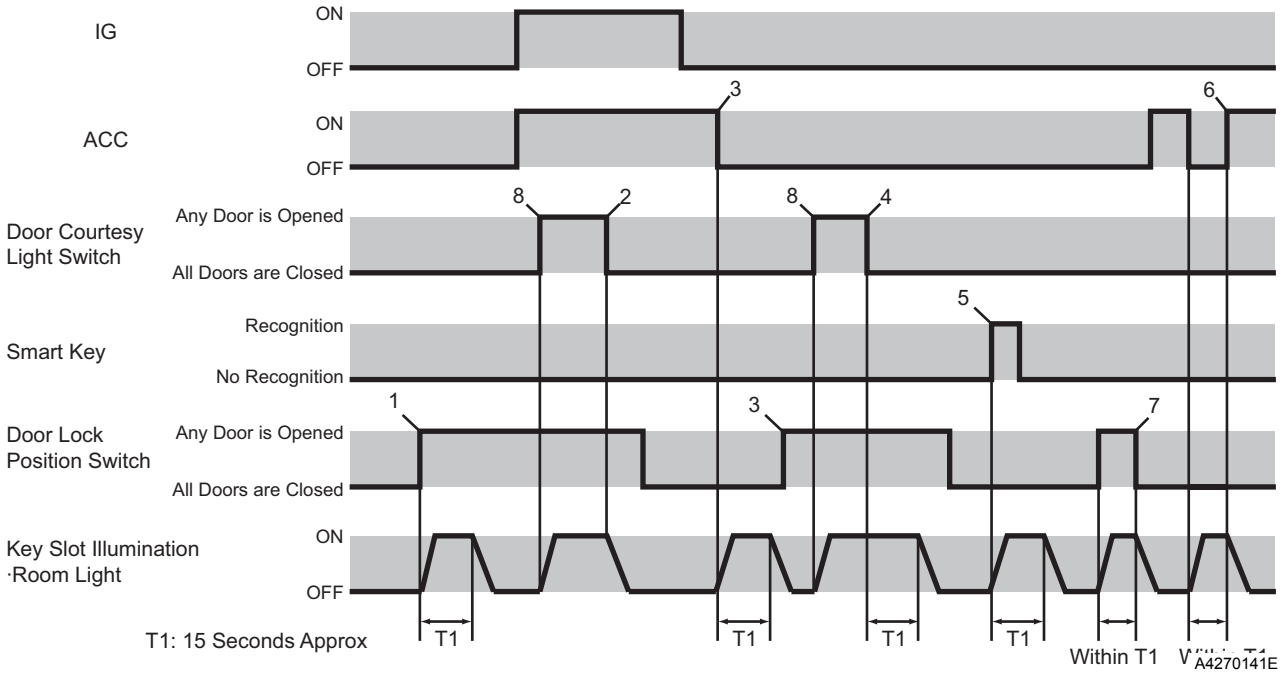
Operation Name	Condition	Basic Operation
Normal ON Operation	While the ignition is ON, the light control switch is turned ON.	While the ignition is ON, if the driver turns ON the light control (TAIL or HEAD) switch, the ON signal of the light control switch is input into the MPX body ECU. Consequently, the MPX body ECU will output a taillight ON signal. If the headlight switch is ON, the MPX body ECU will actuate the headlight relay.
Auto OFF Operation	In the normal light ON state, the driver turns the ignition OFF and opens the driver's door.	In the foregoing normal light ON operation state, if the driver turns the ignition OFF, the MPX body ECU will keep the lights ON. In this state, if the driver opens the driver's door (thus causing the driver's door courtesy light switch to input an ON signal), the MPX body ECU will stop the actuation of the headlight relay and stops the taillight ON signal.

Illuminated Entry System

- The illuminated entry system keeps the key slot illumination, front personal light (interior light function), and the door mirror foot illumination ON for approximately 15 seconds even after the individual doors have been closed. This system is provided on all models as standard equipment.
- A battery saver function is used. If the key slot illumination and the front personal light (interior light function) remain ON for approximately 20 minutes or more while any door is ajar or open and no key is inserted in the key slot, this function automatically turns off those lights.
- Under the control of the illumination entry system, an upper console illumination LED (built into the front personal light) and an interior illumination that turns the front footwell illumination ON/OFF are provided to help stage an elegant interior space in the nighttime.
- The circuits that control the illuminated entry system and the interior illumination are built into the MPX body ECU and the MPX left side J/B ECU.
- By connecting a hand-held tester to the DLC3 connector and operating the tool, the ON duration of the illuminated entry lights can be changed (to approx. 7.5, 15, and 30 seconds), the interior illumination ON prohibition can be set, and the battery saver function can be set ON/OFF (customizable function)



Illuminated Entry Control Function



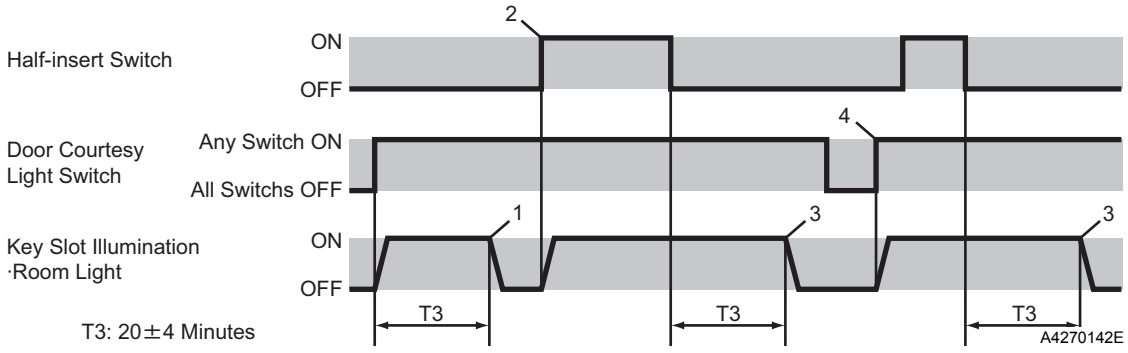
List of Illuminated Entry Control Function

No.	Vehicle State	Light*State
1	ACC or IG OFF, all doors are closed and all doors are locked; then, any door is unlocked.	ON for 15 seconds (including fade in), and then OFF (fade out)
2	ACC or IG ON; any door that is open is closed.	OFF (fade out)
3	All doors are closed, all doors are locked, and ACC and IG are ON; then, ACC and IG are turned OFF.	ON for 15 seconds (including fade in), and then OFF (fade out)
4	ACC or IG OFF, any door that is open is closed.	ON for 15 seconds (including fade in), and then OFF (fade out)
5	ACC or IG OFF, all doors are closed, all doors are locked; then, the system recognizes the presence of a smart key in the vehicle exterior.	ON for 15 seconds (including fade in), and then OFF (fade out)
6	ACC or IG OFF, the lights are turned ON by the timer; then, the ACC or IG is turned ON.	OFF (fade out)
7	ACC or IG OFF, the lights are turned ON by the timer; then, all doors are closed and all doors are locked.	OFF (fade out)
8	The lights are OFF; then, any door is opened.	ON (fade in)

❖REFERENCE❖

*"Light" indicates the key slot illumination and the interior lights.

Battery Saving Control Function



List of battery saver control functions

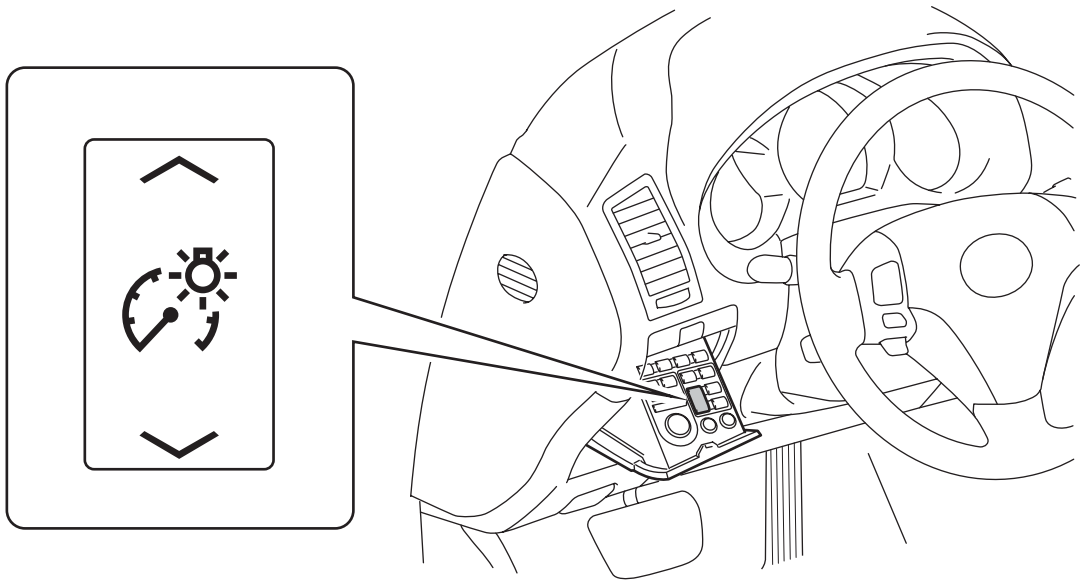
No.	Vehicle State	Light*State
1	Any door is ajar or open, and no key is inserted.	ON for approximately 20 minutes; then OFF (fade out)
2	In the foregoing state No. 1, the key is inserted.	ON (fade in)
3	In the foregoing state No. 2, the key is pulled out.	ON for approximately 20 minutes; then OFF (fade out)
4	After the battery saver function turns OFF the interior lights, the opened doors are closed; then, any door is opened again.	ON (fade in) -> after ON for approximately 20 minutes, OFF (fade out)

❖REFERENCE❖

*"Light" indicates the key slot illumination and the interior lights.

Interior Illumination OFF Function

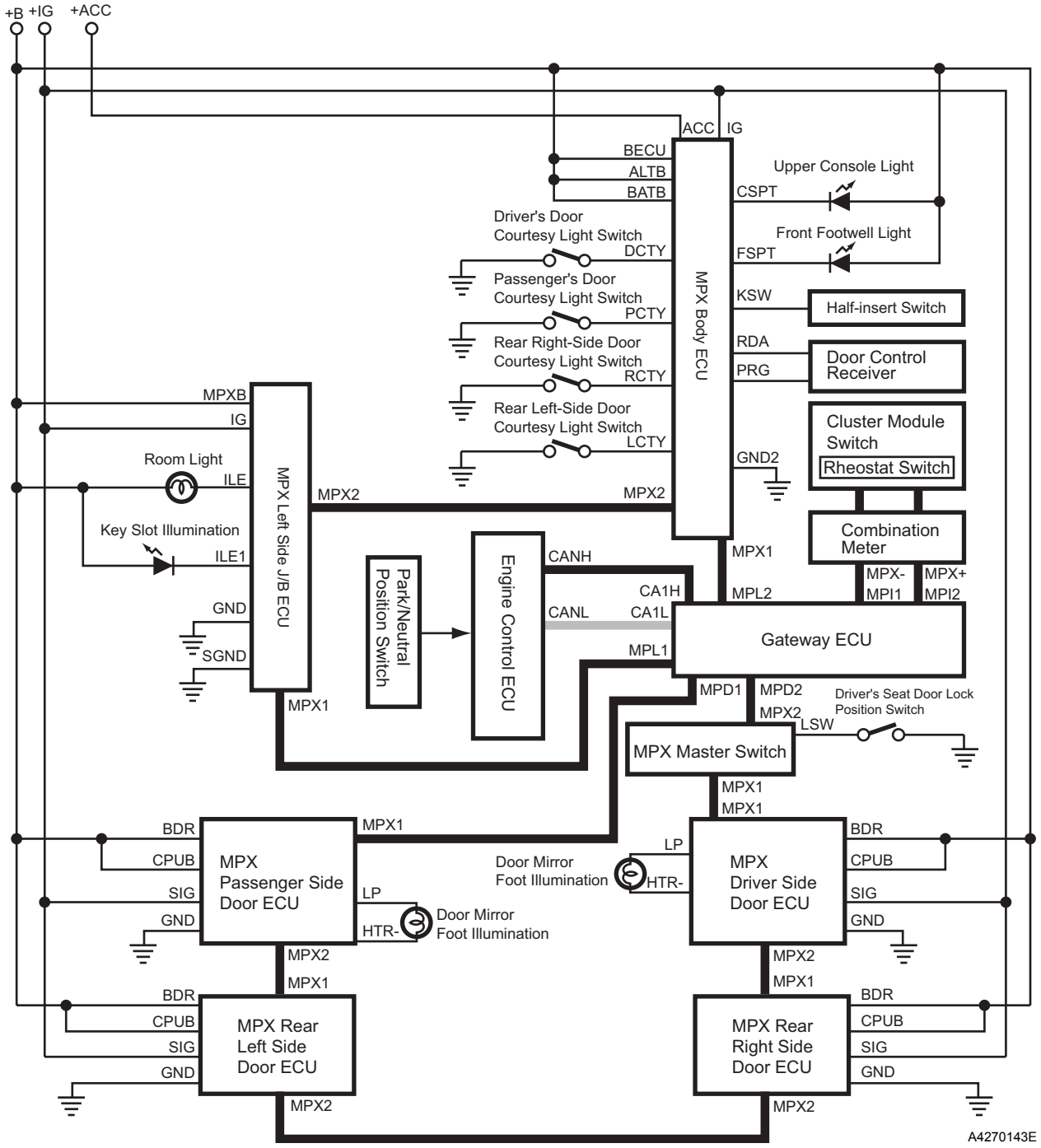
- The interior illumination lights (upper console illumination and the front footwell illumination) can be turned OFF by turning the rheostat knob (installed on the right side of the steering column in the instrument panel) fully counterclockwise.



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Illuminated Entry System Operation

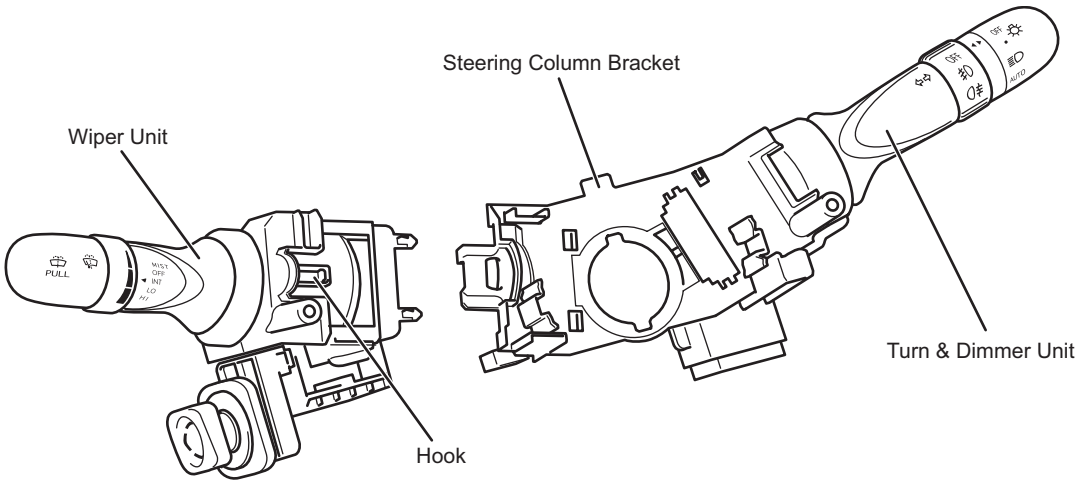
• The ECUs to which the lights are connected control the illuminated entry, interior illumination, and door mirror foot illumination by inputting and outputting switch signals and BEAN (Body Electronics Area Network) signals.



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Combination Switch

- The combination switch consists of a light control switch and a wiper control switch that provide excellent operating feel and create a minimal amount of operating sound.
- The turn & dimmer unit and the wiper unit are located independently, and the wiper unit can be removed without removing the steering wheel. The wiper unit has been secured directly to the steering column bracket through a hook, for serviceability.
- The fulcrum point of each lever has a pivot construction, and a turn cancel construction is built into the turn & dimmer unit.
- A circuit, which is connected to the BEAN (Body Electronics Area Network) and outputs the operating signals of the switches in the form of BEAN (Body Electronics Area Network) signals, is built into the wiper unit. The operating signals of the turn & dimmer unit switches are output via the wiper unit.



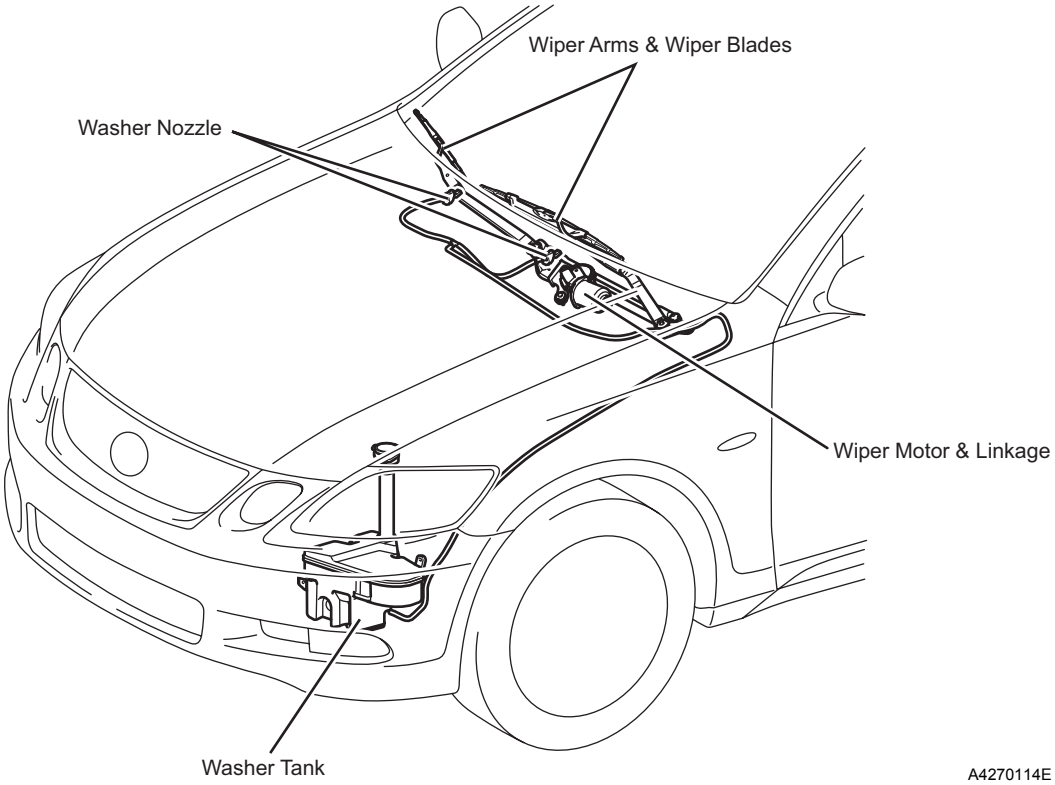
Note: The illustration gives a representative example.

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WIPER AND WASHER

Front Wiper System

- Washer-linked, vehicle speed-sensing, adjustable duration, intermittent function wipers are provided on all models as standard equipment. These wipers are equipped with a function that automatically switches the operating conditions of the wipers in accordance with the driving conditions of the vehicle (vehicle speed switching function), and other features.
- In addition to the washer-linked function, a drip prevention function is provided on all models to ensure excellent usability. After a washer-linked operation, this function operates the wipers once more to prevent the washer fluid from dripping.
- Fully concealed wipers are provided on all models to realize good looks when the wiper blades are retracted. Also, wiper arms with a mechanism that switches between fully concealed and semi-concealed states and a lock back mechanism are provided on all models. These mechanisms prevent the wipers from being damaged when the weather is cold.
- A motor & linkage with a built-in frame is used to ensure the rigidity of the front wipers. In addition, it reduces the operating sound and minimizes the variances in the wiping angle.
- A U-hook type of construction is used for joining the wiper blade to the wiper arm. This construction has better looks and facilitates the operation for replacing the blade.
- The wiper blade has a cross-sectional shape without causing metal-to-metal contact. The rubber surface of the blade is coated with graphite to minimize the sound of the impact that is created when the blade moves in the opposite direction, and prolong the life of the rubber blade.
- A 4.7-liter washer tank is provided on all models as standard equipment and installed in the left front member area.

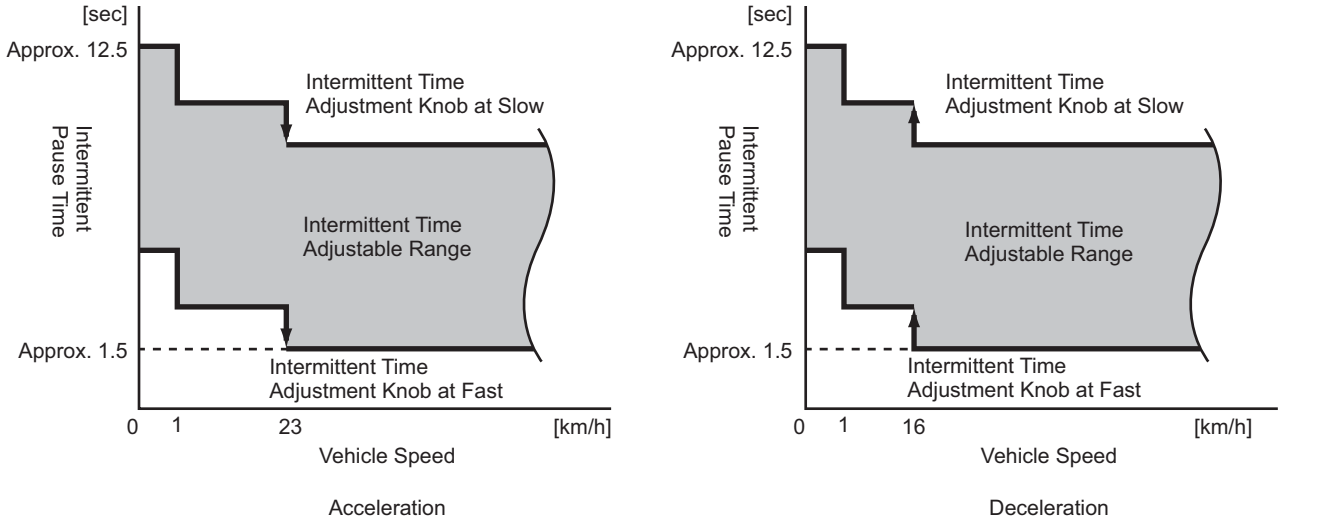


Wiper & Washer System

● Wipers with a washer-linked, vehicle speed-sensing, adjustable duration function are used. These wipers are equipped with a function (vehicle speed switching function) that automatically switches the operating conditions of the wipers in accordance with the driving conditions of the vehicle by receiving BEAN (Body Electronics Area Network) signal inputs.

Function Of Vehicle Speed Sensing, Intermittent Time Adjustment Wipers

• If the driver turns the wiper control switch to the INT position, the wipers will operate intermittently to suit the vehicle speed. The driver can operate the intermittent duration adjustment knob in order to adjust the intermittent pause time between approximately 1.5 to 12.5 seconds. Thus, the system can change the intermittent adjustable time range in three steps, to suit the vehicle speed while the vehicle is being driven.



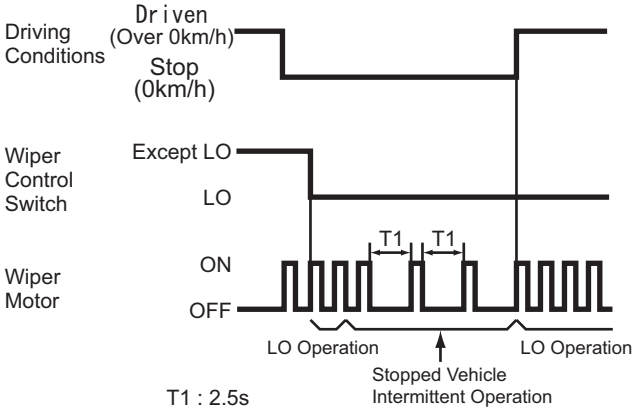
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Vehicle Speed Switching Function

• A stopped vehicle intermittent operation is used as part of the vehicle speed switching function. When the vehicle is stopped, this function automatically switches the LO wiper operation to an intermittent operation. This enables the wipers to operate appropriately whether the vehicle is being driven or stopped, with no need for the driver to operate the switch when the amount of rain is relatively small. This can be set to a "no vehicle speed switching function" through the use of the customizable function.

Stopped Vehicle Intermittent Function

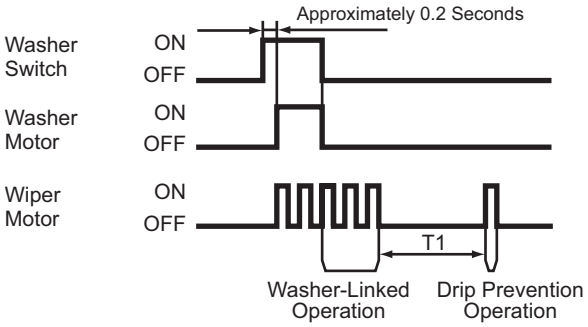
- If the driver turns the wiper control switch from a position other than LO to LO while the vehicle is stopped, the wipers will operate three times in LO. Then, the wipers will switch automatically to an intermittent operation, with an approximate intermittent pause time of 2.5 seconds. If the vehicle that is being driven is stopped with the wiper control switch in the LO position, the wipers will operate two times in LO. Then, the wipers will switch automatically to an intermittent operation, with an approximate intermittent pause time of 2.5 seconds.
- If the driver starts the vehicle during the intermittent operation, the wipers will revert automatically to the LO operation. If the driver sets the intermittent duration adjustment knob to the FAST position, the wipers will operate at LO even when the vehicle is stopped.



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Washer-Linked Function with Drip Prevention Mechanism

- If the driver turns ON the washer switch for approximately 0.2 seconds or more while the wiper control switch is at the OFF or INT position, the washer nozzles spray washer fluid. This operation is linked to a simultaneous operation of the wipers, which start operating at LO. The wipers continue to operate at LO three more times after the driver turns the washer switch OFF (washer-linked function). After the washer-linked operation is completed, the wipers operate once more to wipe away the washer fluid that may have dripped. This operation takes place after an operation delay time that suits the vehicle speed has elapsed, as shown in the table below (List of Operation Delay Time) (drip prevention function). By connecting a hand-held tester to the DLC3 connector, a "no drip prevention function" can also be set (customizable function)



T1 : Operation Delay Time,
which is decided by the List of Operation Delay Time

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List of Operation Delay Time

Vehicle Speed	Operation Delay Time
0~59km/h	Approx. 3
60~79km/h	Approx. 5
80~119km/h	Approx. 7
120~159km/h	Approx. 5
160~169km/h	Approx. 3
170km/h or over	Not (Drip Prevention Operation Cancellation)

Fail Safe

• The MPX left side J/B ECU is equipped with a failsafe function. Even if a failure occurs in the wiper control switch, intermittent time adjustment knob, or BEAN (Body Electronics Area Network), the MPX left side J/B ECU will be able to control the wipers as indicated below.

List of Operation Delay Times

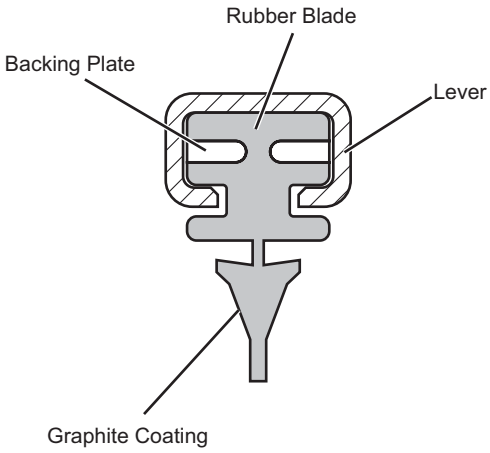
Function Item	Description
Intermittent time adjustment knob failure	• The failsafe function forcibly fixes the intermittent pause time during the intermittent operation to approximately 4 seconds. Furthermore, it does not perform the vehicle speed switching operation (for switching from LO to INT when the vehicle is stopped). It performs other operations as normal.
Vehicle speed signal failure	• The failsafe function does not perform the vehicle speed switching operation (for switching from LO to INT when the vehicle is stopped). It forcibly fixes the intermittent pause time during the intermittent operation to approximately 4 seconds.
Wiper motor operation signal failure	• The failsafe function does not perform the intermittent operation, vehicle speed switching operation, or the washer fluid drip prevention operation. It performs other operations as normal.
Body Electronics Area Network failure	• When a failure associated with the BEAN (Body Electronics Area Network) occurs, the MPX left side J/B ECU will be unable to receive the input of wiper operation request signals via the BEAN (Body Electronics Area Network). However, when a wiper ON signal (wiper control switch set to HI) is input directly by the wiper control switch, the wiper motor can operate at the HI speed. If a failure associated with the BEAN (Body Electronics Area Network) occurs while the wipers are operating, the wipers will maintain the existing operation state until the ignition is turned OFF.

Operation of Washer-Linked, Vehicle Speed Sensing, Intermittent Time Adjustment Wipers

- The MPX left side J/B ECU receives the input of the following signals that are output by the combination switch, via the BEAN (Body Electronics Area Network) wires: switch position signals (OFF, INT, LO, HI, and MIST) of the wiper control switch, and the intermittent time adjustment knob position signals. Consequently, the MPX left side J/B ECU controls the built-in wiper control relay or the wiper HI/LO switching relay based on the vehicle speed signals that are input by the meter ECU via the BEAN (Body Electronics Area Network) wires. The MPX right side J/B ECU inputs the washer switch position signals via the BEAN (Body Electronics Area Network) wires in order to control the built-in washer relay ON and OFF. In case of a failure in the BEAN (Body Electronics Area Network) system, a dedicated wire is used to operate the wiper motor at the HI speed.

Wiper Blade

● As in the previous models, the wiper blade is constructed so that the rubber blade is inserted between the lever and the backing plate, thus eliminating metal-to-metal contact. In addition, the surface of the rubber blade is coated with graphite to minimize the sound of the impact that is created when the blade moves in the opposite direction, and prolong the life of the rubber blade.



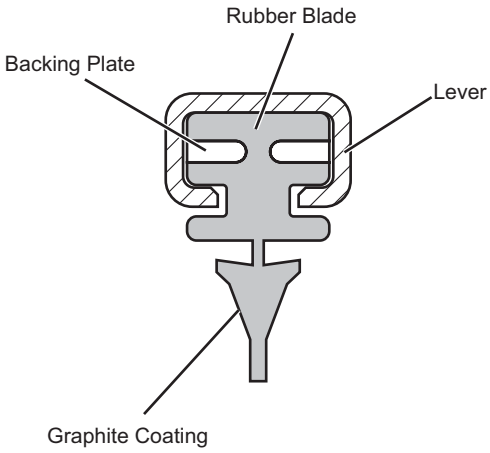
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Operation of Washer-Linked, Vehicle Speed Sensing, Intermittent Time Adjustment Wipers

- The MPX left side J/B ECU receives the input of the following signals that are output by the combination switch, via the BEAN (Body Electronics Area Network) wires: switch position signals (OFF, INT, LO, HI, and MIST) of the wiper control switch, and the intermittent time adjustment knob position signals. Consequently, the MPX left side J/B ECU controls the built-in wiper control relay or the wiper HI/LO switching relay based on the vehicle speed signals that are input by the meter ECU via the BEAN (Body Electronics Area Network) wires. The MPX right side J/B ECU inputs the washer switch position signals via the BEAN (Body Electronics Area Network) wires in order to control the built-in washer relay ON and OFF. In case of a failure in the BEAN (Body Electronics Area Network) system, a dedicated wire is used to operate the wiper motor at the HI speed.

Wiper Blade

● As in the previous models, the wiper blade is constructed so that the rubber blade is inserted between the lever and the backing plate, thus eliminating metal-to-metal contact. In addition, the surface of the rubber blade is coated with graphite to minimize the sound of the impact that is created when the blade moves in the opposite direction, and prolong the life of the rubber blade.



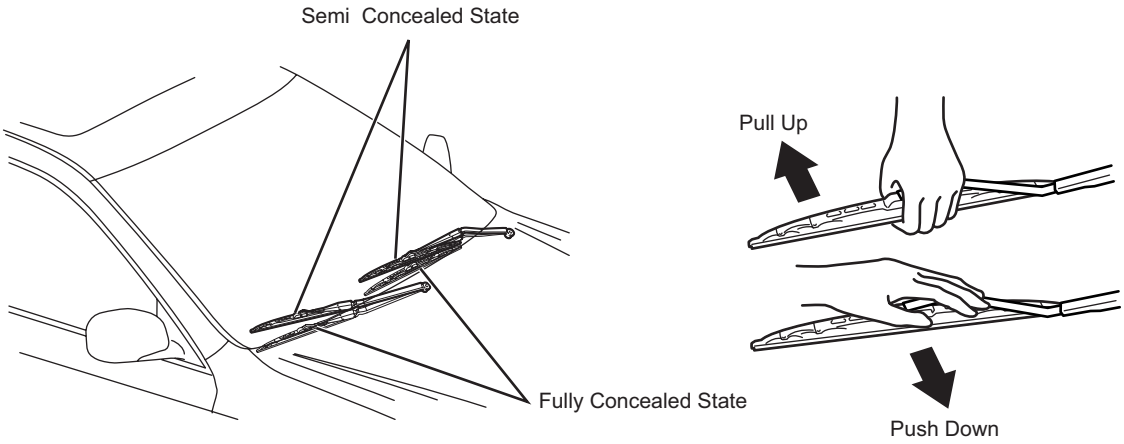
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Front Wiper Link

● Wiper arms with a mechanism that switches between fully concealed and semi-concealed states and a lock back mechanism are provided on all models.

Semi Concealed/Fully Concealed Switching Function

• To switch between the fully concealed and semi-concealed states, manually move either the right or left wiper arm in the direction of rotation along the windshield glass, while the wipers are in the automatically stopped state. While the wipers are in the fully concealed state, grasp a wiper arm at an area near the joint between the wiper arm and the wiper blade, and pull it upward in order to switch to the semi-concealed state. While the wipers are in the semi-concealed state, push the joint downward with the palm of your hand in order to switch to the fully concealed state. (Do not grasp the wiper blade to perform this operation because it could deform the wiper blade. Therefore, make sure to perform this operation by grasping the wiper arm.) Make sure to set the wipers in the semi-concealed state when using winter blades on them.

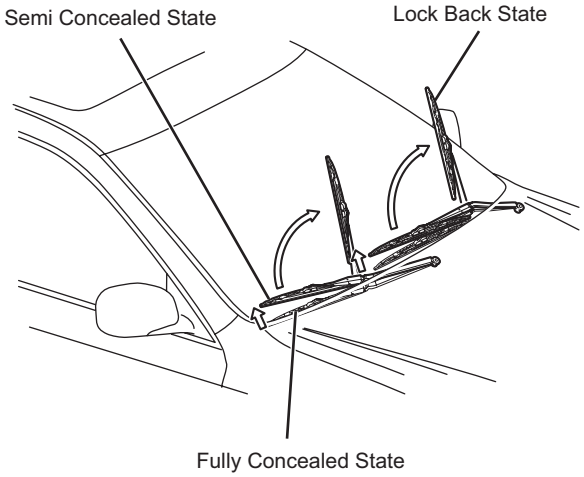


Semi Concealed/Fully Concealed Switching Function

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Lock Back Formula Wiper Arm

• Before locking back the front wipers, switch them to the semi-concealed state using the aforementioned procedure. Then, move the wiper arms in the arrow direction shown in the diagram in order to lock them back.



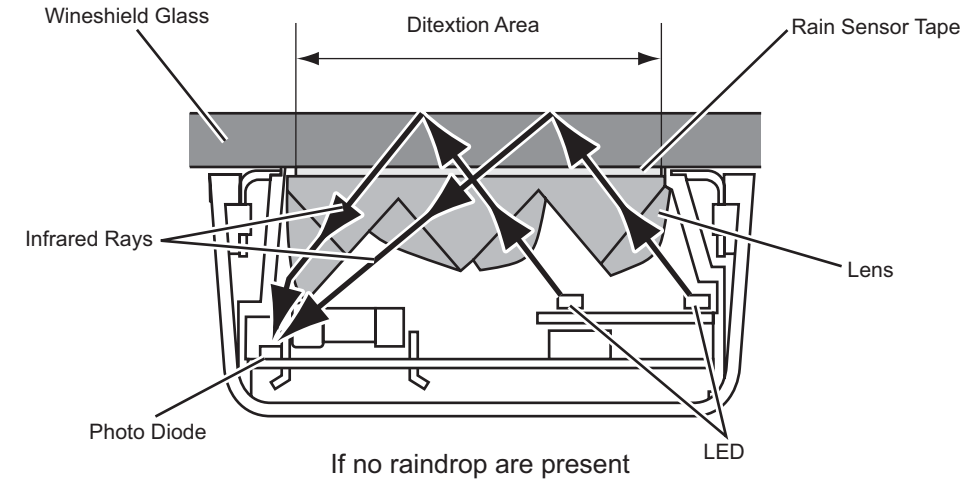
A4270151E

Rain Sensor

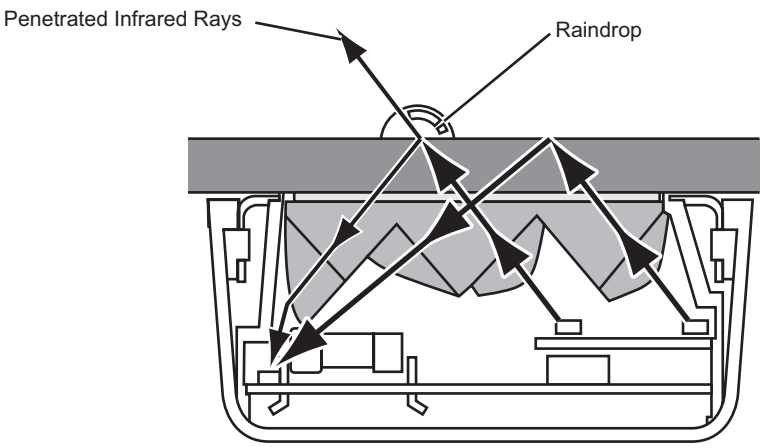
● When rhe wiper switch is in yhe AUTO position,this function uses a rain sensor that is mounted on the front windshield glass to detect the amount of raindrops,and controls anoptimal wiping timing accrdingly.

Function

- The rain sensor consists mainly of 4 LED(Light Emitting Diode)that emits infrares rays,and 2 photo diode that receivesthose rays.The detection method is based on the infrared rays that are reflected by the front windshield glass.
- For example,if no raindrops are present in the detection area ,the infrared rays emitted by the LED are all reflected from the windshield glass and are received by the photo diode.If raindrops are present in the detection area,a portion of the emitted infrared rays penetrates with the change of index of reflection outward of the windshield glass via the raindrops,thus reducing the amount of infrared rays that are received by the photo diode.The amount of this reduction is then used to detect the amount of raindorops.Thus,this function controls the INT,LO,and,HI operations in order to orerate the wipers at an optimal wiping timing.



If no raindrop are present



If raindrop are present

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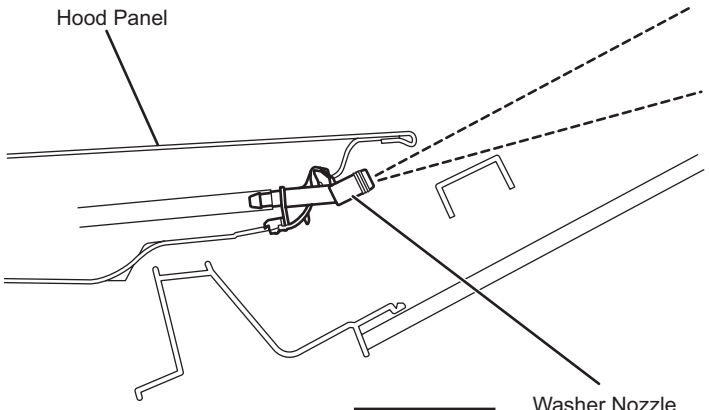
Washer

- On all models, the front washer nozzles are provided with diffusion type orifices that offer excellent washing performance when the washers are used. The washer nozzles are installed under the engine hood panel for good looks.
- The diffusion type washer nozzle utilizes the thrust of the washer fluid to create vibrations in the flow as it passes through the nozzle and spreads it in a fan shape. Thus, it is able to spray the washer fluid to a wide range of the front wiper wiping area. In addition, the flow volume in the center of the spray range has been reduced so as not to obstruct the driver's view when the washers are used while the vehicle is being driven.

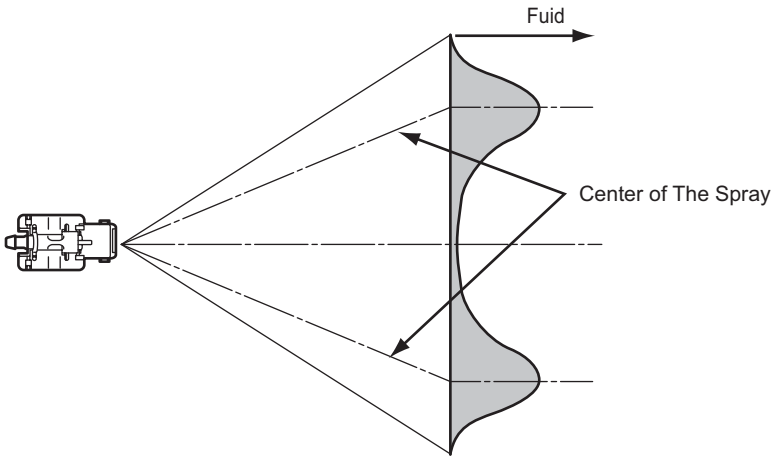
❖REFERENCE❖

Due to the nature of the construction of the diffusion type washer nozzle, the point at which the spray lands on the windshield cannot be adjusted. Never attempt to adjust the point at which the spray lands on the windshield because it can damage the front washer nozzle. To change the point at which the spray lands on the windshield, replace the nozzle with one that has a different spray angle (for details, refer to the repair manual)

- All models are provided with a 4.7-liter washer tank as standard equipment.



Location



Injected Fluid Volume Distribution (top view)

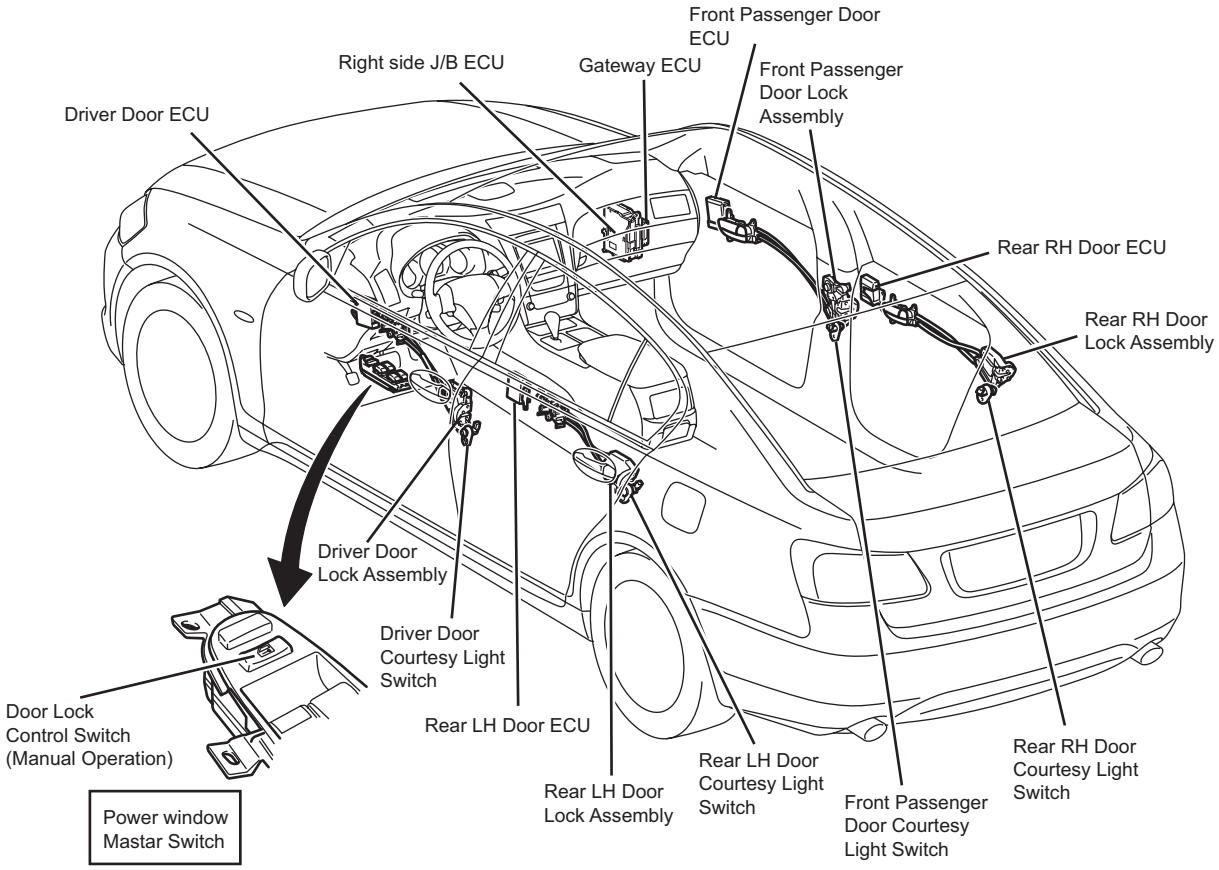
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DOOR LOCK

Door Lock Control System

- As on the previous model, power door lock system is provided as standard equipment on all vehicles.
  This system is provided with a key lockout prevention function, shift linked door unlock function, etc.
- A user-customizable function can be used. With this function, the user can set/cancel a function such as a vehicle speed-sensing auto lock function at will, through the operation of the door lock control switch (for manual operation).

Auto Power Door Lock System Main Composition Parts



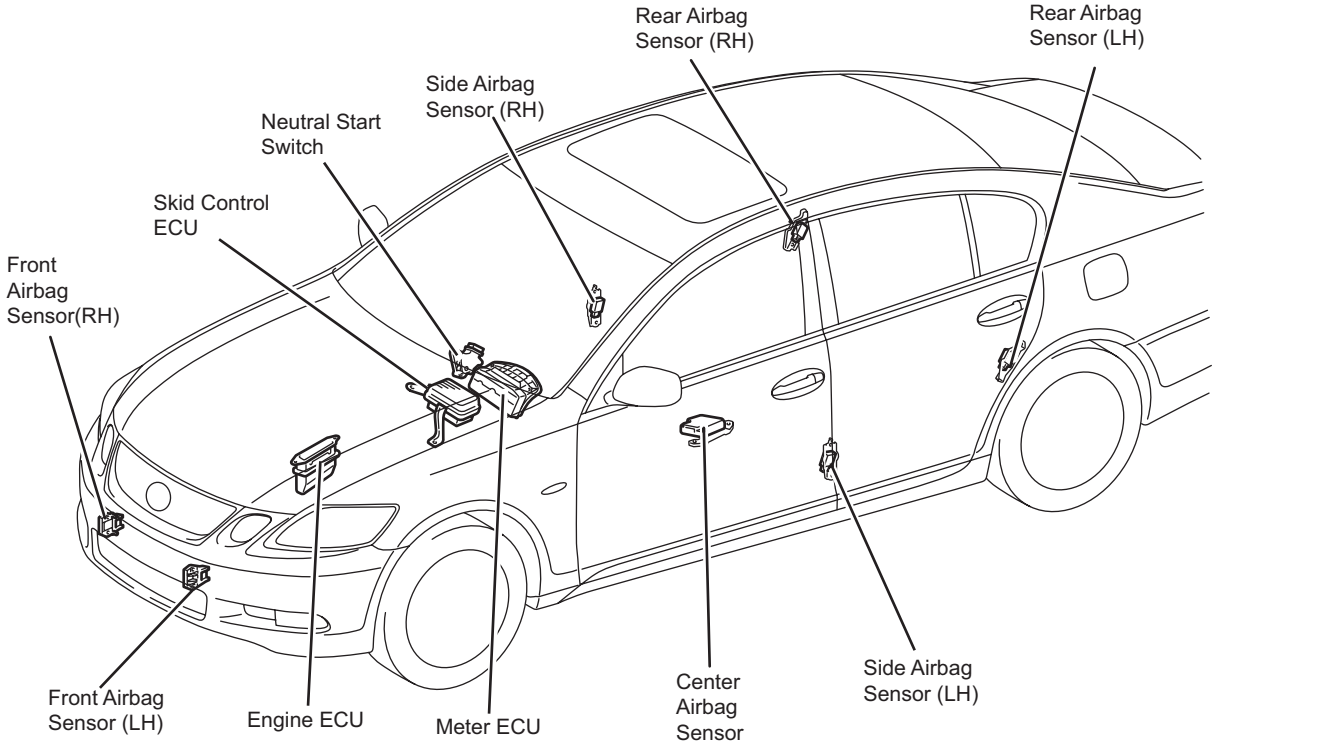
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List power door lock system main composition parts function

Composition parts	Main function
Right side J/B ECU]	• Detects the conditions of the vehicle through the use of the signals from various switches, vehicle speed, and impact detection data, and transmits them to various ECUs via BEAN (Body Electronics Area Network).
MPX driver door /passenger door/ rear RH/rearLH door ECU (driver door /passenger door/rear RH/rearLH door ECU)	• Controls the locking and unlocking of the individual doors in accordance with the instructions from the right side J/B ECU. • Detects the state of the individual door lock position switches and transmits this information to the right side J/B ECU via BEAN (Body Electronics Area Network).

Composition parts	Main function
Individual door lock ASSY(driver door /passenger door/rear RH/ rearLH)	• Locks and unlocks the respective door through the normal rotation or reverse rotation of the door lock motors that are built into the individual doors. • Detects the locked and unlocked states (locked: OFF, unlocked: ON) of the individual doors by way of the door lock position switches that are built into the individual door locks.
Power window master switch	• Detects the states of the individual door lock control switches (for manual operation) and of the driver's door lock position switch and transmits them to the right side J/B ECU via BEAN (Body Electronics Area Network).
Individual door courtesy light switch(driver door /passenger door/ rear RH/rearLH)	• Detects the open and closed states (door open: ON, door closed: OFF) of the individual doors and transmits this information to the right side J/B ECU.
Gateway ECU	• Serves as a connecting point to relay communication data between the communication networks (BEAN {Body Electronics Area Network} ,CAN {Controller Area Network} and AVC-LAN.

Composition parts 2



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List auto power door lock system main composition parts Function

Composition parts	Main function
Meter ECU	• Calculates the vehicle speed based on the vehicle speed signal provided by the skid control ECU, and transmits it to the right side J/B ECU via BEAN (Body Electronics Area Network).
Skid control ECU	• Averages the vehicle wheel speed pulses provided by the wheel speed sensors and outputs the vehicle speed data to the meter ECU. [Vehicle speed-sensing auto lock function]
Wheel speed sensors(FR/FF/RR/RL)	• Detects the speeds of the wheels and outputs the information to the skid control ECU.
Center airbag sensor assembly	• Detects the impact that is applied to the vehicle by way of the signals from the individual air-bag sensors and the built-in impact detection sensor, and outputs it to the right side J/B ECU.
Individual airbag senser	• Detects an impact and outputs it to the center airbag sensor assembly.
Engine ECU	• Transmits the shift position state that is input by the neutral start switch (ON or OFF state of the "P" position) and transmits it to the right side J/B ECU via BEAN (Body Electronics Area Network).
Neutral start switch	• Detects the shift position (ON or OFF state of the "P" position) and outputs it to the ECM.

Manual Lock & Manual Unlock Function

• When the user pushes the lock or unlock side of the door lock control switch (for manual operation), this operation is linked to lock or unlock all the doors.

Door Key Linked Lock and UnLock Function

• When the user inserts a mechanical key into the driver's door key cylinder and turns it towards the front or the back of the vehicle, this operation is linked to lock or unlock all the doors.

• The door key-linked lock and unlock operations through the foregoing operations will be canceled when the driver's seat belt is buckled.*

❖REFERENCE❖

* When the driver's seat belt is buckled, the system determines that an occupant is present in the vehicle. Thus, it prevents the door key-linked function from operating against the intention of the user, such as when an impact is applied to the door during a collision.

Key Lockout Prevention Function

• When the driver's door is open while the smart key is located in the vehicle interior, this function prevents the doors from being locked through the operation of the door control switch (for manual operation or key-linked operation) or the door lock knob. Thus, it prevents the user from being locked out with a key in the vehicle.

Impact Sensing Door Unlock Function

• When the vehicle is involved in a collision, this function automatically unlocks the door locks of all the doors to facilitate the escape or rescue operation.

Door Lock Security Function

• Locking the doors through the use of the door lock function (including wireless remote control) sets the door lock security function, which prohibits* the doors from being unlocked through the use of the door lock control switch (for manual operation).*

• The door lock security function supports the customizable function through the use of the Intelligent tester II diagnostic tool.

❖REFERENCE❖

*This function prevents the doors from being unlocked by operating the door lock control switch (for manual operation) by inserting a rod or the like from a clearance between the door glass and the door frame, such as when the door glass is inadvertently left slightly open.

Door lock security set conditions

- The driver's door is locked through the key-linked operation.
- The driver's door is locked through a keyless lock operation (by locking the inside door lock knob and closing the door). (However, the security function sets only if the driver's door is locked and the door is closed 0.25 seconds later.)
- The doors are locked through the use of the wireless remote control or the door lock function (including the 30-second auto lock function).

Door lock security cancel conditions

- The ignition is turned from OFF to ON.
- The driver's door is unlocked through the key-linked operation.
- The doors are unlocked through the use of the wireless remote control or the door lock function
- The doors are unlocked through the operation of the door lock control switch (for manual operation), after the driver's door lock knob has been unlocked.

Driver's Door Key Twice Operation Unlock

- Inserting a mechanical key in the driver's door key cylinder and turning it once in the unlocking direction unlocks only the driver's door. Turning the key once again in the unlocking direction unlocks all the doors.(excluding the Europe and China)
- The driver's door key twice operation unlock function can be switched alternately to the door key-linked all-door unlock function by performing a customize function on a Intelligent tester II.

Dabble lock Function

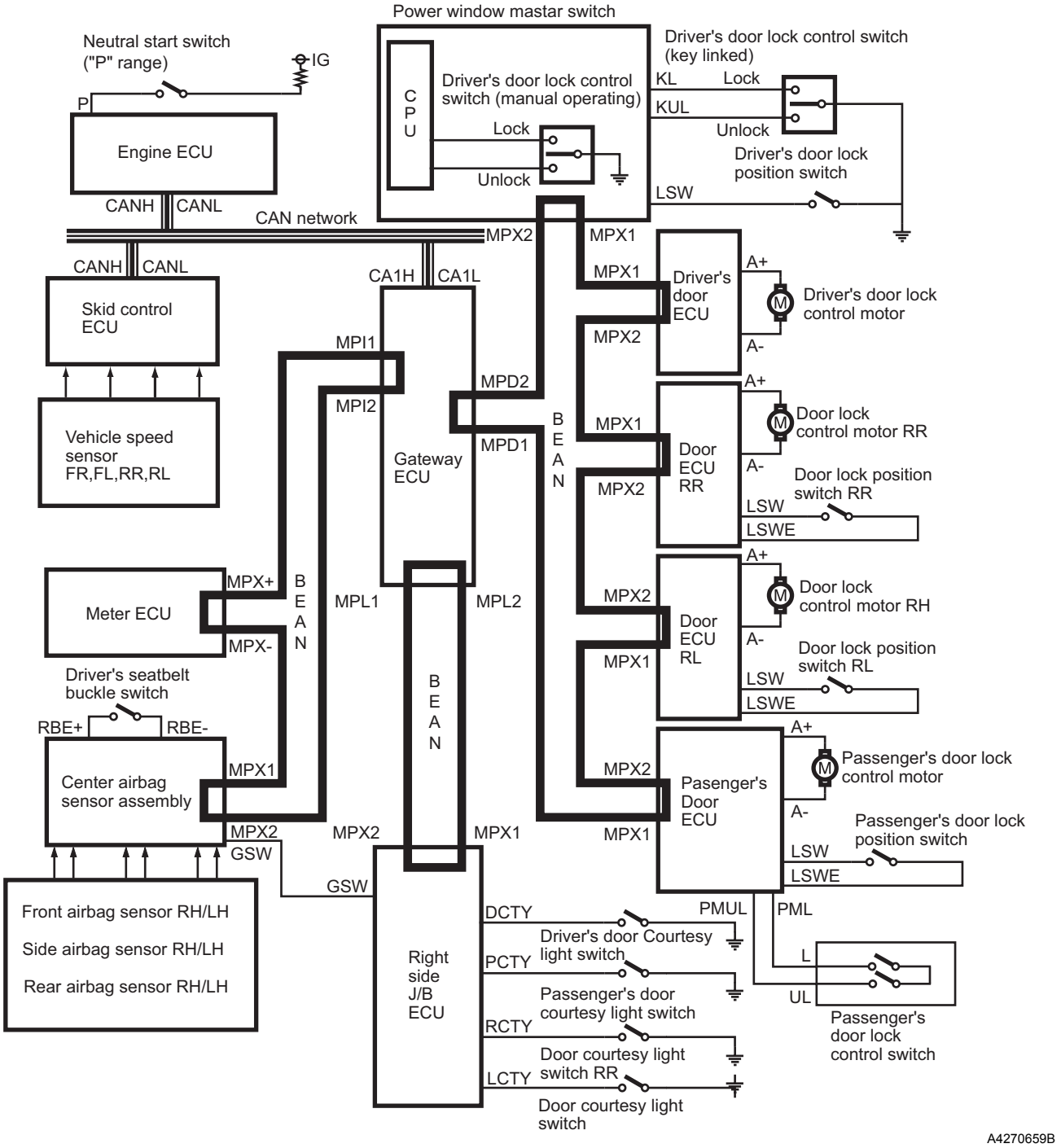
- The double-lock function is a theft deterrent device with an additional, dedicated locking mechanism. It prevents the doors from being unlocked through the operation of the lock knobs from the vehicle interior. This door locking device aims at deterring unauthorized persons from entering the vehicle.
- When the wireless lock switch of an electronic key is operated (including the locking operation of the lock switch on the door outside handle), this function sets the double lock. When a wireless unlock switch, touch sensor unlock, or key-linked unlock operation is performed, this function unsets the double lock and unlocks the doors.
- When a electronic key is used to perform a wireless door lock operation twice within a predetermined length of time after all of the conditions indicated below has been met, the system will set the double-lock function. Thus, the system will effect control to prevent the doors from being unlocked through the use of all door lock switches inside or outside of the vehicle.

Double-Lock Set Standby Conditions

• IG OFF -> door open
• All Door close
• window fully close

- The double-lock and ordinary door lock functions can be canceled at once by performing an unlock operation with a wireless key.
- To ensure safety while the vehicle is being driven, the system automatically cancels the double-lock function if any one of the doors is set to double-lock if the vehicle is being driven.
- In case of an emergency, such as a depleted battery in the electronic key or a malfunction in the ECU, insert a mechanical key in the key cylinder of the This will cancel the double-lock function. driver's door to unlock the door.

Auto Power Door Lock System Circuit



BE

Manual Lock (Unlock) Operation

- When the driver operates the door lock control switch (for manual operation) on the MPX master switch to the lock (or unlock) side, the MPX master switch transmits a driver's door manual lock (unlock) switch signal to the right side J/B ECU via BEAN (Body Electronics Area Network).
- Upon receiving this signal, the right side J/B ECU transmits a door lock (or unlock) request signal to the ECUs of the individual doors through BEAN (Body Electronics Area Network).
- Upon receiving this signal, the ECUs of the individual doors turn ON their lock (or unlock) relays in order to lock (or unlock) the doors by actuating their respective door lock motors.

Door Key Linked Lock (Unlock) Operation

- When a mechanical key is inserted in the driver's door key cylinder and turned to the lock (or unlock) side, the door lock control switch (for key linked operation) turns ON to the lock (or unlock) side. As a result, the MPX master switch transmits a driver's door key-linked lock (or unlock) switch signal to the right side J/B ECU via BEAN (Body Electronics Area Network). This causes the individual doors to lock (or unlock) in the same way as the manual lock (or unlock) operation.

Key Lockout Prevention Operation

- This function operates under the following conditions: the electronic key is located in the vehicle interior, the ON signal of the driver's door courtesy light switch is input in the right side J/B ECU, and a vehicle speed signal of approximately 3 mph(5km/h) or below is received from the meter ECU. Then, when the driver's door lock knob is turned to the lock side, the power window master switch detects that the driver's door lock position switch is OFF.
- Upon receiving this signal, the right side J/B ECU transmits a door unlock request signal to the ECUs of the individual doors via BEAN (Body Electronics Area Network).
- Upon receiving this signal, the ECUs of the individual doors turn ON the unlock relays for the respective doors in order to lock (or unlock) the doors by actuating their respective door lock motors.

Impact Sensing Door Unlock Operation

Operation outline

- Upon receiving impact-sensing information from the center airbag sensor assembly, the right side J/B ECU effects control to unlock all the doors.

Operation

- When an impact that is greater than a predetermined value is applied to the vehicle within approximately 4 seconds after the ignition is turned ON or is turned from ON to OFF, the center airbag sensor assembly detects this impact and outputs an impact-sensing signal to the right side J/B ECU.
- Upon receiving the impact-sensing signal from the center airbag sensor assembly, and after the impact-sensing unlock delay time (approximately 10 seconds) has elapsed, the right side J/B ECU transmits an unlock request signal to the ECUs of the individual doors via BEAN (Body Electronics Area Network). Upon receiving this signal, the ECUs of the individual doors turn ON the unlock relay for the respective unlock relays in order to unlock* the doors by actuating their respective door lock motors.
- For approximately 5 seconds after the ignition is turned ON, the right side J/B ECU determines whether the impact-sensing sensor is normal or abnormal. If it determines that the sensor is abnormal, the system will prohibit the operation of all auto lock functions.

❖REFERENCE❖

*The right side J/B ECU receives the lock position signals from the doors for approximately 1 second after the unlock operation. If the right side J/B ECU receives a signal indicating that any door is locked (its door lock position switch is OFF), it will transmit a unlock request signal again.

Prohibition of Door Lock Signal Input During Impact-Sensing Unlock Operation

• After the unlock operation is completed, the right side door J/B ECU prohibits the input of all door lock signals. It permits the input of lock signals if the conditions listed below have been met.

Lock Signal Input Permission Conditions

- The ignition is turned from OFF to ON, and the vehicle speed of below 10 mph(16km/h) has changed to approximately 12 mph(20km/h) and continued for 5 seconds or more.
- The doors are locked through the use of the door lock control switch (for manual operation).
- The ignition is turned from ON to OFF, and the driver's door that is open is closed (the driver's door courtesy light switch is turned from ON to OFF).

SMART ENTRY & START SYSTEM

- The SMART ENTRY & START SYSTEM is used on all models. An extremely convenient feature, this system also showcases the innovative aspect of the vehicle.
- The SMART ENTRY & START SYSTEM effects various types of controls based on the check results of the electronic ID codes exchanged wirelessly between the electronic key and the vehicle. The user can perform these controls without the need to handle the key.
- This system provides a convenient warning function that alerts the user of various problems that could arise if the user's awareness of the electronic key in his/her possession recedes.
- A cancel function is provided to enable the user to cancel the system control at will.
- It uses an ID code registration function to support the use of multiple electronic keys.
- Through the use of the hand-held tester diagnostic tool, the functions that support the customizable function can be changed in accordance with the user's preference.

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Lock Signal Input Permission Conditions

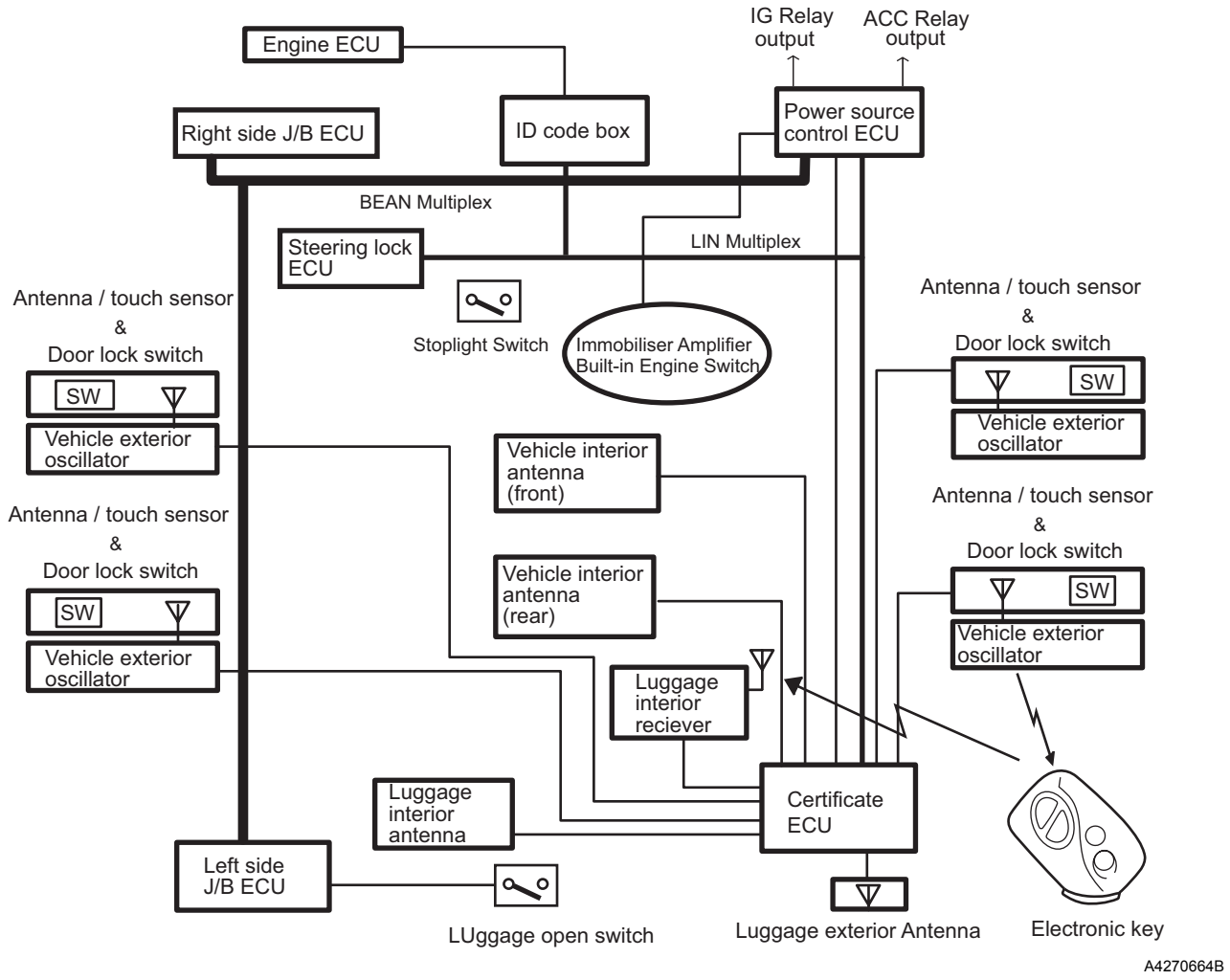
- The ignition is turned from OFF to ON, and the vehicle speed of below 10 mph(16km/h) has changed to approximately 12 mph(20km/h) and continued for 5 seconds or more.
- The doors are locked through the use of the door lock control switch (for manual operation).
- The ignition is turned from ON to OFF, and the driver's door that is open is closed (the driver's door courtesy light switch is turned from ON to OFF).

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SMART ENTRY & START SYSTEM summary

- Based on the results of the ID code check in and out of the vehicle through bi-directional communication between the electronic key and the vehicle, the certificate ECU communicates with the following computers via BEAN (Body Electronics Area Network) in order to control the system: right side J/B ECU, computers at the individual doors, left side J/B ECU, power source control ECU.
- Depending on the function to be executed, the certificate ECU outputs a request signal to the vehicle interior, vehicle exterior, luggage interior, and luggage exterior transmitters for the purpose of "checking the ID code with the electronic key" or "verifying the position of the electronic key (or the person possessing it)". Then, upon receiving an ID code, including a response code, from the electronic key that received the request signal, the certificete ECU distinguishes and checks the code, and transmits an operation instruction signal to the individual ECUs according to the function.

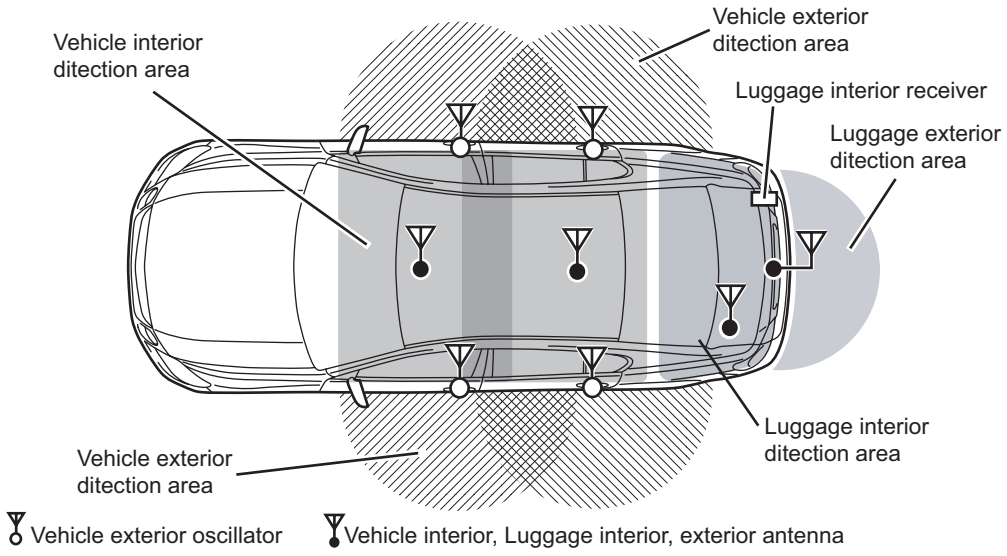


Detection Area of SMART ENTRY & START SYSTEM

- The request signal that is sent by the certifcate ECU is transmitted from an antenna by way of the respective oscillator, thus forming a detection area for the electronic key. The detection area formed by the vehicle exterior and luggage exterior antenna extends approximately 0.7 to 1.0 meter from the individual outside door handles, and from the center of the rear bumper.
- The detection area of the vehicle exterior oscillator is formed by request signals that are transmitted regularly at approximately 0.3-second intervals while the vehicle is parked (engine switch OFF, and doors locked*), in order to constantly monitor the approach of the electronic key (or the person possessing it). The detection area is formed when the lock switch is turned ON through the door lock operation, in order to detect the presence of the electronic key (or the person possessing it) in the vehicle exterior.*
- The detection area of the luggage exterior antenna is formed when the luggage door open switch is turned ON through the luggage open operation.
- The vehicle interior detection area, which is formed when the driver's door is opened or closed, the Power switching or engine starting function is operated, the required conditions for the respective warning have been met, and the lock switch is turned ON, detects the presence of the electronic key (or the person possessing it) in the vehicle interior.
- The detection area of the luggage interior antenna is formed when the luggage compartment door is closed or the luggage door open switch (vehicle exterior) is pressed.

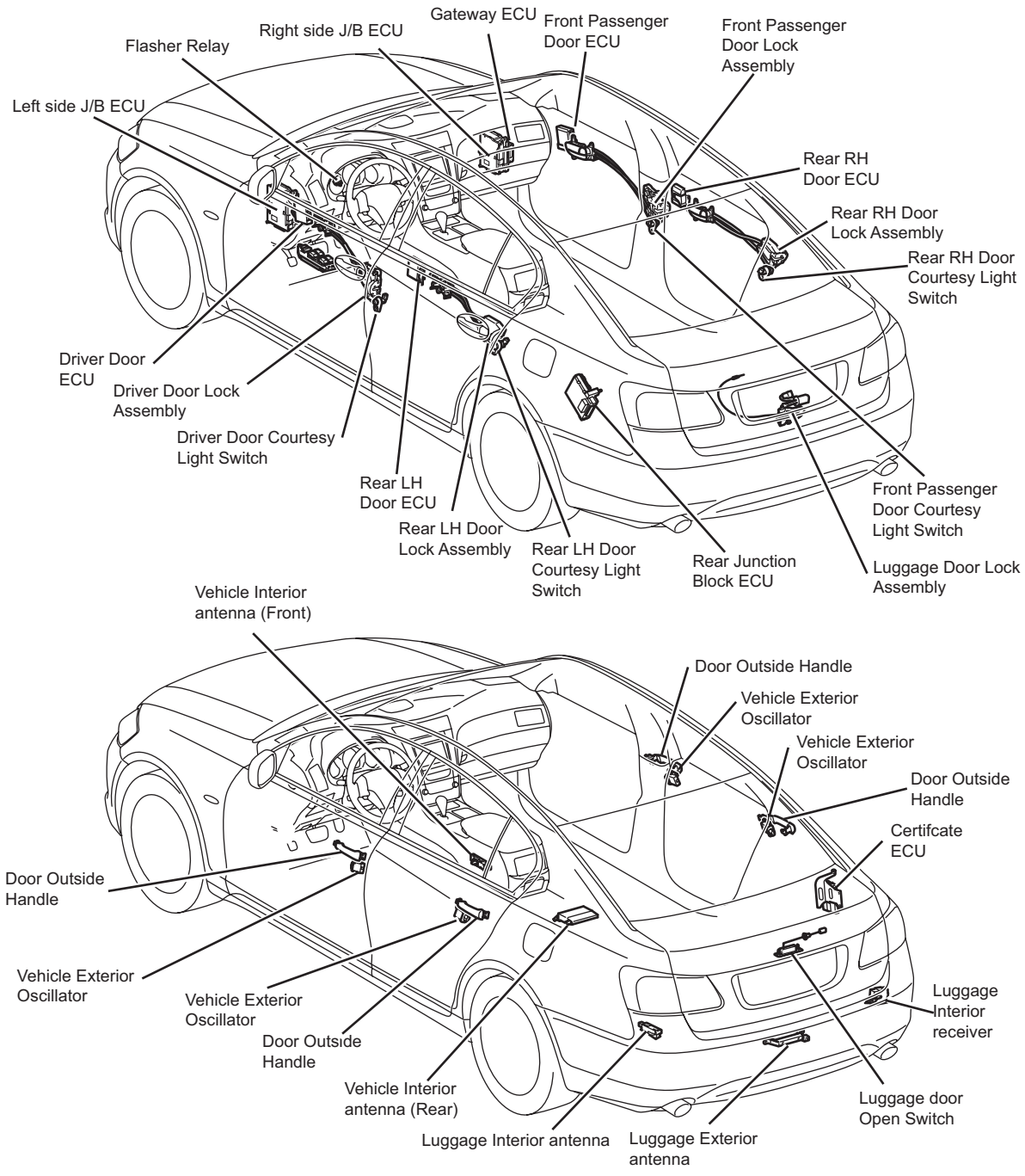
❖REFERENCE❖

*SMART ACCESS SYSTEM with PUSH-BUTTON START control is effected for every individual door. After the doors are locked through the use of the door lock switch or the wireless remote control function, the detection areas are formed at the locked doors, even if not all the doors are locked.



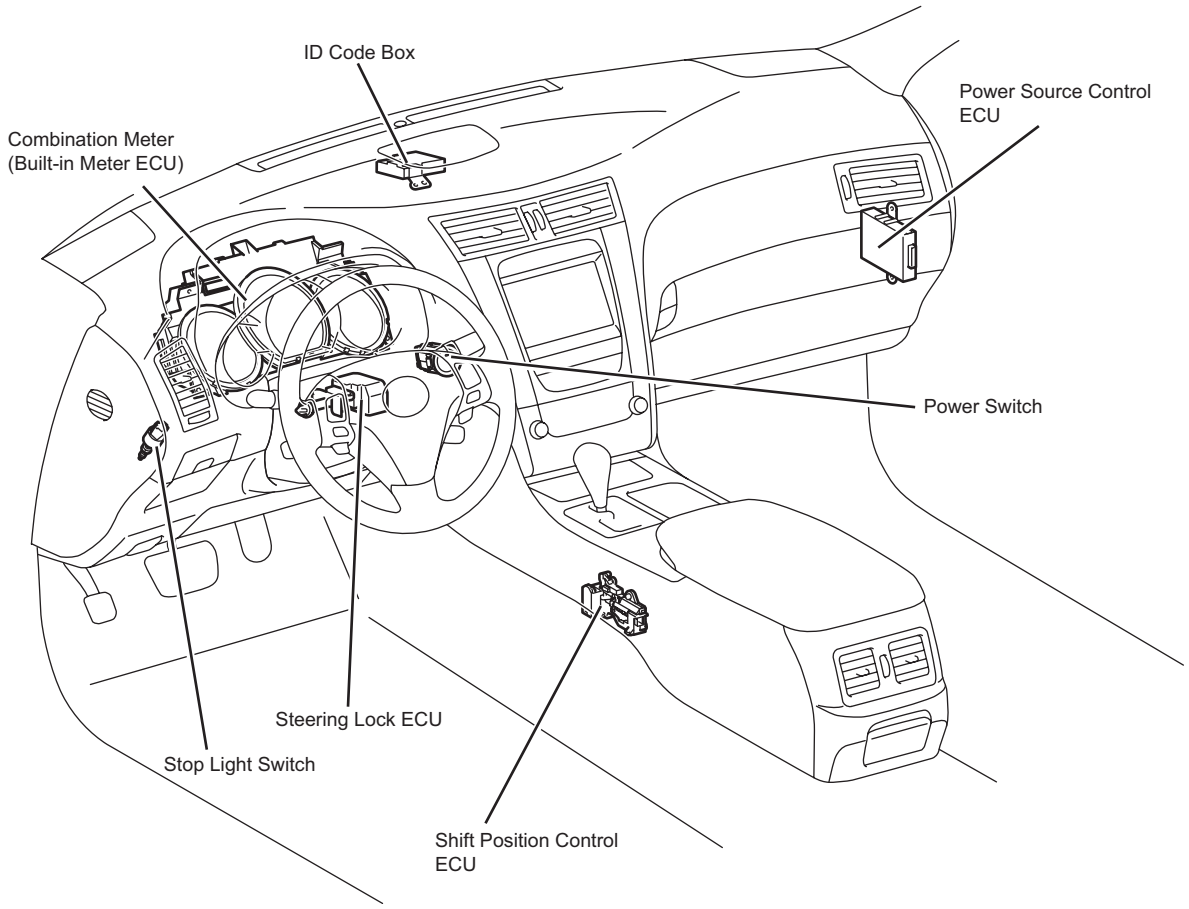
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SMART ENTRY & START SYSTEM Composition Parts

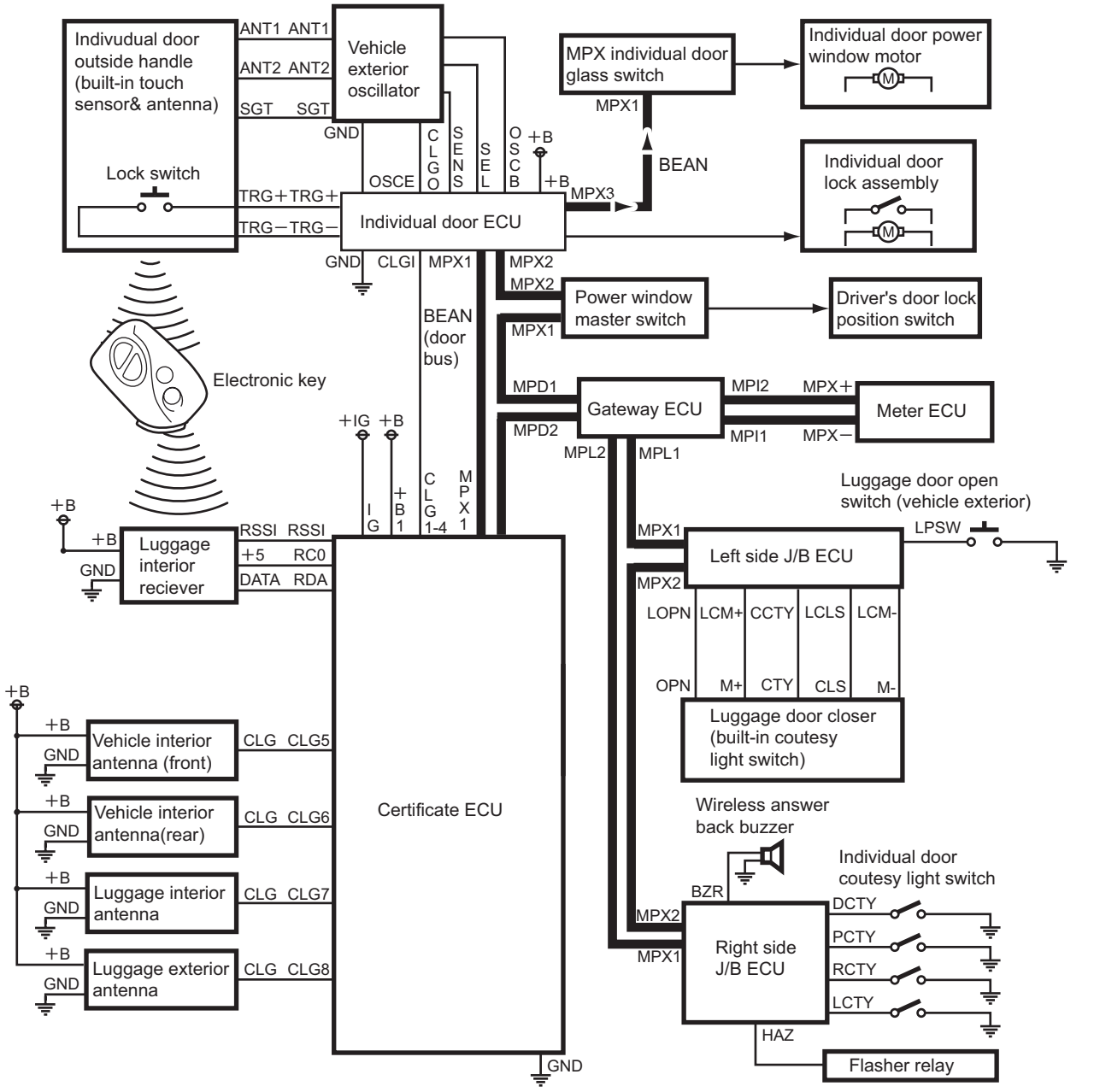


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ID Code Box
Power Source Control ECU
Combination Meter (Built-in Meter ECU)
Power Switch
Steering Lock ECU
Stop Light Switch
Shift Position Control ECU
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Door lock/Unlock /Luggage Door Open Circuit



A4270410B

Description of Parts

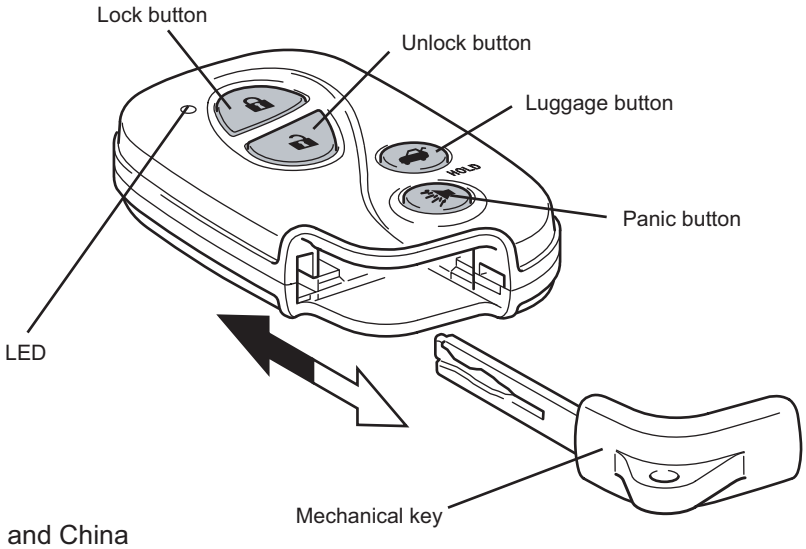
List door lock / unlock and luggage door open main composition parts function

Composition parts (abbreviated name)	Main function
Certificate ECU	• Checks electronic keys (verifies whether the keys are legitimate). • Controls the vehicle interior and exterior oscillators and touch sensors. • Transmits door lock/unlock commands in the SMART ACCESS SYSTEM with PUSH-BUTTON START. • Transmits steering lock unlock/lock commands • Transmits immobiliser set/unset commands • Records codes for checking between multiple units
Power source control ECU	• Controls the ACC and IG power supply ON/OFF. • Transmits engine starting commands to the Engine ECU. • Controls the engine switch indicator and lettering illumination. • Performs auxiliary actuation of the starter relay.
ID code BOX	• Receives commands from the certificate ECU and transmits immobiliser set/unset commands to the Engine ECU. • Records codes for checking between multiple units.
Steering lock ECU	• Receives lock/unlock commands from the certificate ECU and actuates the steering lock actuator. • Records codes for checking between multiple units.
Engine switch	• Switch used for supplying power and starting the engine. • Has a built-in indicator to inform the driver whether the engine is in a startable state. • Has a built-in immobiliser amplifier to start the engine if the electronic key battery is low.
Vehicle interior(Front/Rear)antenna	• Emits LF radiowaves (approximately 134 kHz) inside the vehicle interior to determine whether a electronic key is present in the vehicle interior.
Luggage interior antenna	• Emits LF radiowaves (approximately 134 kHz) inside the luggage room to determine whether a electronic key is present inside the luggage compertment room.
Glass antenna/Luggage interior receiver	• Responds to the LF radiowaves or receives the RF radiowaves that are output from a electronic key through a wireless operation.
Luggage exterior antenna	• Generates and emits the LF radiowaves (approximately 134 kHz) for determining whether a electronic key is present in an area that enables a luggage door open operation.
Luggage open switch	• Switch that is pressed when performing a luggage door open operation.
Vehicle exterior oscillator	• Generates the LF radiowaves (approximately 134 kHz) for determining whether a electronic key is present in an area that enables a SMART ACCESS SYSTEM with PUSH-BUTTON START operation.
Vehicle exterior antenna	• Emits the LF radiowaves generated by the vehicle exterior oscillator.
Touch sensor	• Actuated when the system determines the presence of a electronic key in an area that enables a SMART ACCESS SYSTEM with PUSH-BUTTON START operation, this sensor detects whether a user has touched a door handle.
Lock switch	• Switch that is pressed in order to lock the door during a SMART ACCESS SYSTEM with PUSH-BUTTON START.

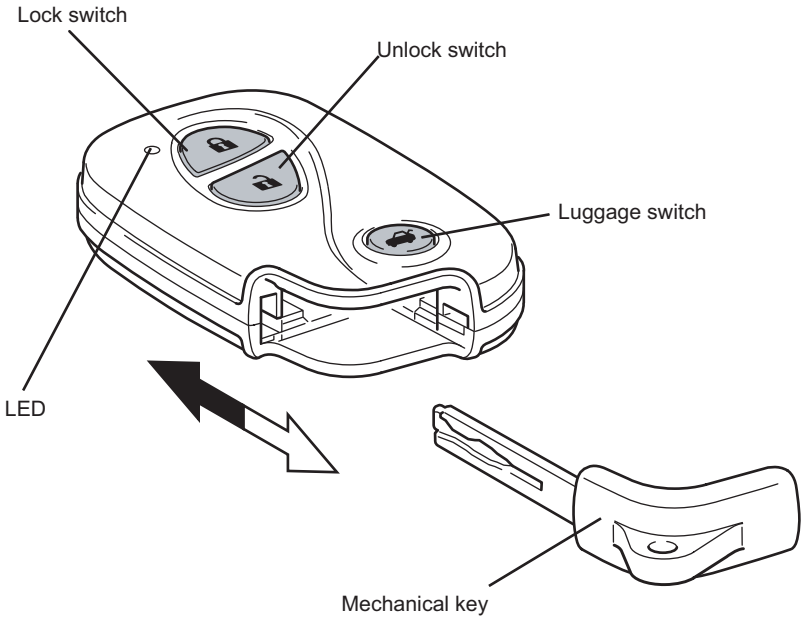
Composition parts (abbreviated name)	Main function
Electronic key	• Upon receiving the LF radiowaves that are output by the vehicle interior and exterior antennas, the electronic key outputs information including the key ID and vehicle ID by modulating them into RF radiowaves • When the driver presses the lock, unlock, panic(excluding Europe and China), or luggage open button on the surface of the key, the electronic key outputs the description of the operation by modulating it into RF radiowaves • Upon receiving the radiowaves that are output by the immobiliser amplifier in the engine switch, the electronic key outputs information including the key ID and vehicle ID through immobiliser communication • Has a built-in mechanical key to unlock the door if the electronic key battery is low

Electronic Key

- The electronic key, which is provided with the lock, unlock, luggage, and panic(excluding the Europe and China) switches, is able to perform the same operations as the wireless remote control system. It uses the CR1632 battery.
- The electronic key can be used to start the engine by holding it near the engine start switch in case the key battery is depleted.



Excluding the Europe and China



Europe and China

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Key Set Specification

• The standard key set consists of the following: 2 electronic keys.

Auto Power OFF

• Even if the user continues to press the buttons on the electronic key, this function stops the transmission of the feeble radiowave signals in approximately 20 seconds.

Transmitter operation Check Indicator Light

• In addition, when the buttons are operated, the operation indicator light (LED) illuminates during the communication (transmission) to check the ID. Thus, this light can be used to check the operating state and whether the battery is depleted.

Door Unlock Operation

• When a electronic key (or the person possessing it) enters the vehicle exterior detection area, the certificate ECU distinguishes and checks (vehicle exterior check) the ID code of the key that the luggage interior receiver has received. If the check results are OK, the certifcate ECU will transmit, a door unlock standby control signal to the door exterior oscillator that has been checked OK. Upon receiving this signal, the door exterior oscillator activates the touch sensor via the vehicle exterior oscillator in order to set the door unlock standby mode.*1

• When the door ECU of the door that is in the door unlock standby mode detects, via the touch sensor, that the door outside handle has been touched, the door ECU transmits a touch sensor ON signal to the certifcate ECU via BEAN (Body Electronics Area Network). Upon receiving this signal, the certificate ECU transmits a door unlock control signal to the individual door ECUs that assumed the unlock mode.

• The door ECU that has received the door unlock control signal unlocks the door (by turning the door lock position switch ON).*2

❖REFERENCE❖

*1From the time of the door unlock standby mode until there is an input from the touch sensor, it implements a vehicle exterior check at 3-second intervals. When the check results are OK, it will await again for an input from the touch sensor. If there is no input for over 10 minutes, it will be in a standby mode with its check function stopped. Then, it will resume the mode that enables a door unlock operation again (thus canceling the standby mode) in accordance with the lock operation, and door key-linked lock/unlock signals, as a result of the door lock switch being turned ON by the wireless remote control function (excluding the luggage door open).

*2When the right side J/B ECU receives a door lock position switch ON signal from the door ECU and verifies that the door is unlocked, it outputs an answer-back signal. If the door does not open (courtesy light switch ON) for approximately 30 seconds, the right side J/B ECU will output a door lock signal to all the doors in order to lock them (and start auto alarm control).

Door Lock Operation

- When the engine switch is OFF and the courtesy light switches of all the doors are OFF (all the doors are closed), if any door lock switch is turned ON, the door ECU of the door whose door lock switch has been turned ON will transmit a door lock switch ON signal to the certifcate ECU via BEAN (Body Electronics Area Network).
- Upon receiving the door lock switch ON signal, the certificate ECU will transmit a request signal to the door exterior oscillator. Upon receiving this signal, the vehicle interior antennas (front and rear) will form detection areas in the vehicle interior and exterior. Then, the certificate ECU distinguishes and checks the ID code of the electronic key that has been received by the luggage interior receiver.
- The certificate ECU performs checks to detect*1 that the vehicle exterior check is OK and the vehicle interior check is NG, thus verifying that the key is located in the vehicle exterior. Then, the certifcate ECU will transmit a door lock request signal to all the door ECUs via BEAN (Body Electronics Area Network). Upon receiving this signal, the individual door ECUs will lock the doors (door lock position switch OFF).*2

❖REFERENCE❖

*1If the electronic key is inadvertently left in the vehicle interior, and the user presses the door lock switch, a warning function (that sounds the wireless answer-back buzzer for 2 seconds) will operate, indicating that the "key was inadvertently left inside". Even if the electronic key is located in the vehicle exterior and placed near the door, the "key was inadvertently left inside" warning function could operate as the user presses the door lock switch. Furthermore, if any one of the courtesy light switches is ON even if the vehicle exterior check is OK and the vehicle interior check is NG, the system will determine that a door is ajar and will operate the warning function.

*2Upon receiving a door lock position switch OFF signal from the door ECU, the right side J/B ECU will output an answer-back signal and also start the auto alarm control. A standby time of approximately 3 seconds is provided after the driver's door is locked, until the system performs a vehicle exterior check for the purpose of door unlock. This feature is provided in the event that after the door is locked, the user pulls on the door handle to check that it is locked.

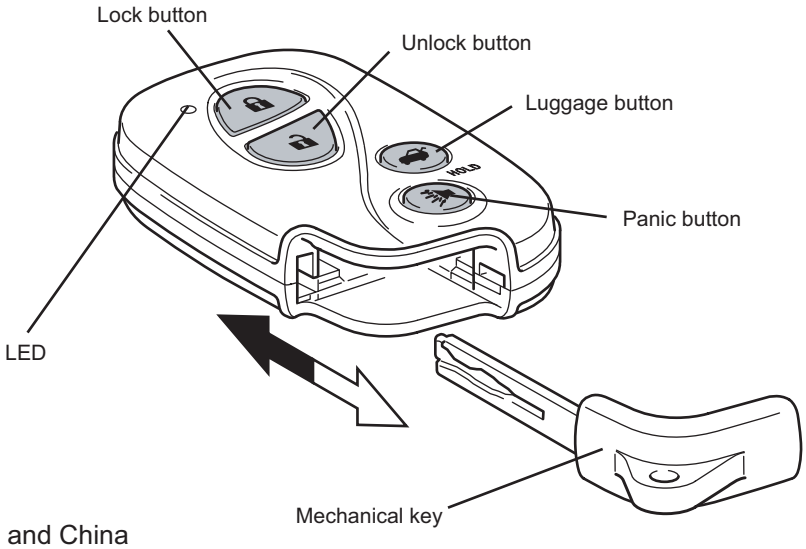
Description of Functions

List SMART ACCESS SYSTEM with PUSH-BUTTON START function

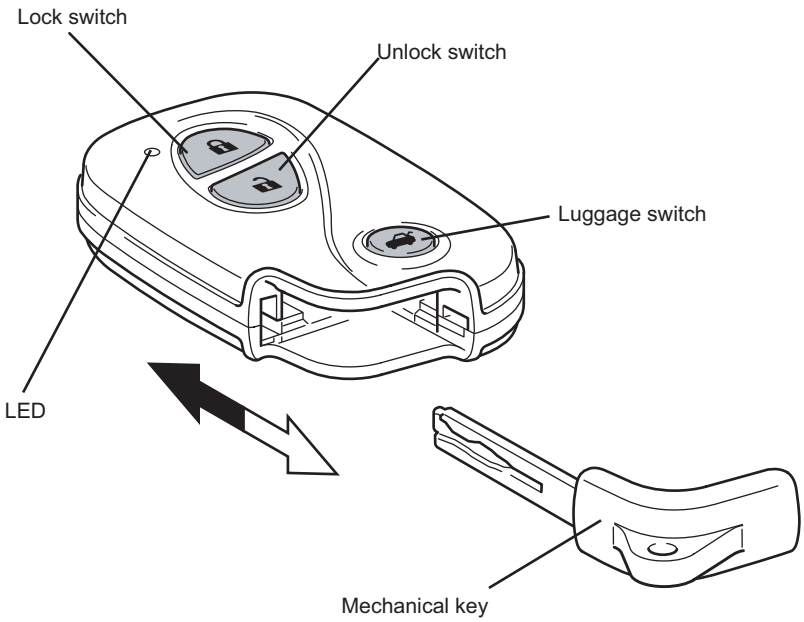
1	Wireless Function
2	Door Unlock Function
3	Door Lock Function
4	ACC/IG Power Supply ON Function (when using electronic key)
5	Engine Starting Function(when using electronic key)
6	ACC/IG Power Supply ON Function (when electronic key battery is low)
7	Engine Starting Function (when electronic key battery is low)
8	Engine Stopping, Steering Locking, and Immobiliser Setting Function
9	Luggage Door Open Function
10	Vehicle Interior Key Lockout Prevention Function
11	Luggage Compartment Key Lockout Prevention Function
12	Answer-Back (sounds the buzzer and frashes the hazard warning light) Function
13	Power Saving Function

Wireless Remote Control Function

- A "multi-function remote control", which consists of a electronic key (wireless door lock key) with additional functions to operate the power windows and the moon roof, is used.
- By pressing the switch on the electronic key, the user can perform a door lock/unlock operation, panic warning sound(excluding Europe and China), or a luggage open operation.



Excluding the Europe and China

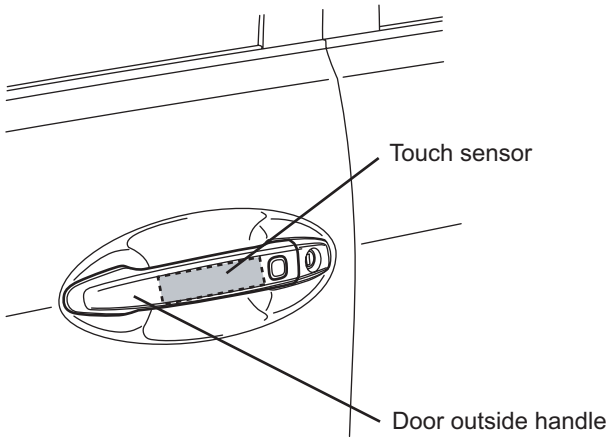


Europe and China

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Door Unlock Function

- To enable the system to detect the approach of a user with a electronic key in possession, the vehicle exterior oscillator and antenna emit signals on a regular basis when the vehicle's doors are locked. This forms vehicle exterior detection areas (approximately 0.7 to 1.0 meters around each door handle).
- When a user approaches the vehicle with a electronic key in possession and enters a vehicle exterior detection area, the door oscillator in the area and the electronic key in that user's possession will simultaneously perform an ID code check automatically. Upon the completion of the ID code check, that door enters the unlock standby mode.
- When a door is in the unlock standby mode, the touch sensor that is built into the door handle starts sensing, allowing the door to unlock when a user grasps the door handle (or touches its inner surface). (If an ID code check results in a failure, the door will not unlock even if a user touches the door handle.)
- If none of the doors are opened after the doors are unlocked, all doors will lock automatically 30 seconds after they have been unlocked (30-second auto lock function).



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Middle East, Australia, New Zealand door unlock mode

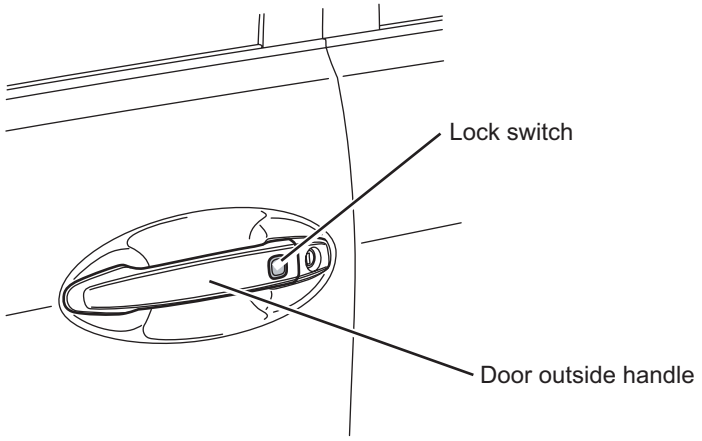
When a user touches the driver's door handle, this mode unlocks only the driver's door. If a user touches a door handle of a door other than the driver's, this mode unlocks all the doors.

Europe, Aftermarket, China: all door unlock mode

When a user touches any door handle, this mode unlocks all the doors.

Door lock Function

- A user exits the vehicle with a electronic key in possession.
- When a user presses the lock switch on a door handle while all the doors are closed, the system checks for a electronic key in the vehicle interior and exterior.
- When the vehicle interior check results in NG, and the vehicle exterior check results in OK, the system locks the doors.
- If a electronic key is present in the vehicle interior, the system sounds a warning buzzer (beeps for 2 seconds) without locking the doors.
- If a user presses the lock switch while a door is ajar (or open), the wireless buzzer sounds for 10 seconds. During a door ajar warning, if a user closes all the doors or presses the unlock switch to unlock the doors, the warning will stop.



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ACC/IG Power Supply ON Function(when using electronic key)

ACC/IG power supply ON function (when using electronic key)

1	The driver enters the vehicle with a electronic key in possession.
2	When the driver presses the engine switch without pressing the brake pedal, the system checks the ID code in the vehicle. When the ID code checks OK, the engine switch illuminates in amber. Then, the power supply changes each time the engine switch is pressed: ACC -> IG -> OFF -> ACC -> and so on.

Engine Starting Function(when using electronic key)

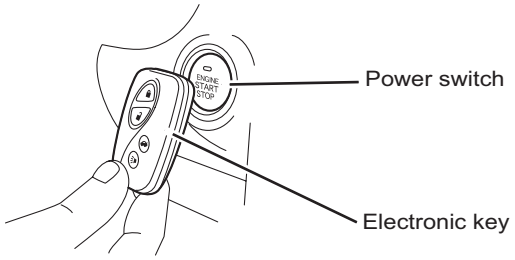
Engine starting function (when using electronic key)

1	The driver enters the vehicle with a electronic key in possession.
2	When the driver presses the brake pedal, the system checks the ID code in the vehicle.The indicator of the engine switch illuminates green and the system cancels the immobiliser and the steering lock. When the driver presses the engine switch while the engine switch indicator is green, the engine starts.

ACC/IG Power Supply ON Function(when electronic key battery is low)

ACC/IG power supply ON function (when electronic key battely is low)

1	The driver enters the vehicle with a electronic key in possession (by using the mechanical key that is built into the electronic key to unlock the door lock).
2	The driver presses the brake pedal and holds the electronic key with its ornament surface facing the engine switch(for the immobilizer and steering lock unset).
3	Within 5 seconds after the buzzer makes a "bong" sound, the driver releases the brake pedal and presses the engine switch.

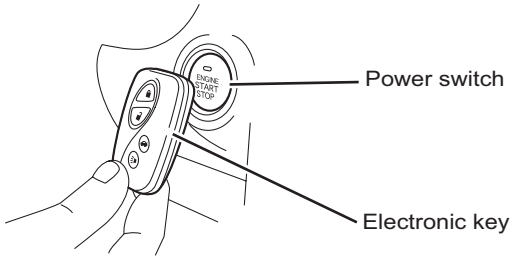


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Engine Starting Function(when electronic key battery is low)

Engine starting function (when electronic key battely is low)

1	The driver enters the vehicle with a electronic key in possession (by using the mechanical key that is built into the electronic key to unlock the door lock).
2	The driver presses the brake pedal and holds the electronic key with its ornament surface facing the engine switch.
3	Within 5 seconds after the buzzer makes a "bong" sound, the driver presses the brake pedal and engine switch.



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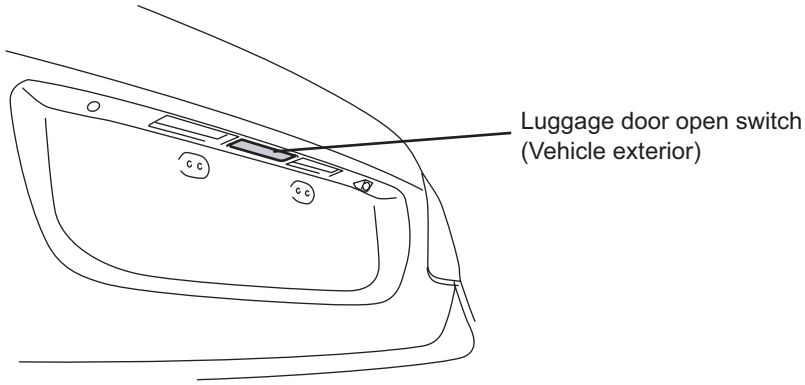
Engine Stopping,Steering Locking,and Immobiliser Setting Function

Engine Stopping Steering Locking and Immobilliser Setting function

1	After stopping the vehicle(vehicle speed absent),After the driver stops the vehicle (vehicle speed absent), moves the shift lever to the "P" position, and presses the engine switch, the engine stops, all power supply turns OFF, and the immobiliser sets.
2	The driver opens the door to operate the steering lock.

Door Luggage Door Open Function

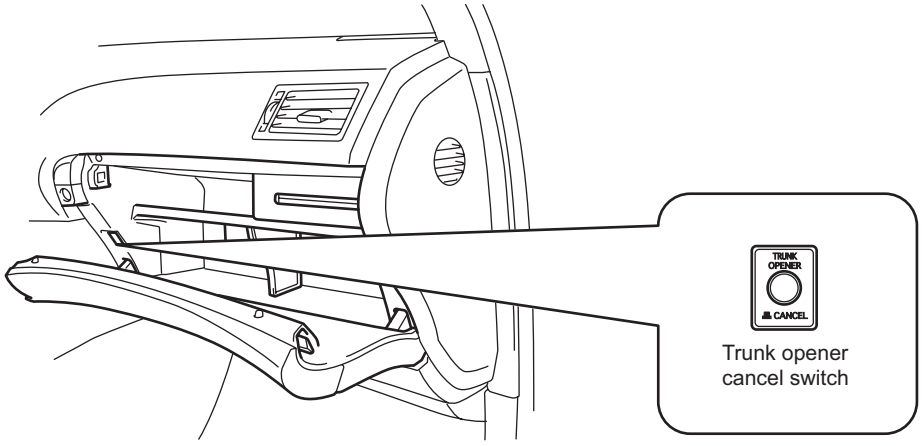
- When the user with a electronic key in possession stands behind the luggage and presses the Luggage door open switch, the certificate ECU starts to check the ID code. When the ID code checks OK, the system opens the luggage door.



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Luggage Door open Cancel Function

- The luggage door open function (including the wireless luggage door open function) can be canceled by turning ON the trunk opener cancel switch.
- When this function is canceled, the luggage compartment door can be opened through the use of a mechanical key.
- A trunk opener key cancel switch is provided inside the glove box. The security of the luggage compartment room can be ensured by locking the glove box with a mechanical key.



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Vehicle Interior Key Lockout Prevention Function

• If the user attempts to perform a door lock (by opening a door, tilting the lock knob in the locking direction, and closing the door) and door lock while a electronic key is left in the vehicle interior, the system determines that a electronic key is left in the vehicle interior, and it unlocks the door.

Luggage Compartment Key Lockout Prevention Function

• If the luggage door is closed while an electronic key is left inside the luggage compartment room, the certificate ECU recognizes the presence of the electronic key in the luggage compartment room and sounds the buzzer. Meanwhile, the user can press the luggage door open switch ON to open the luggage door.

Answer-Back(Sounds the Buzzer and Frashes the Hazard Warning Light) Function

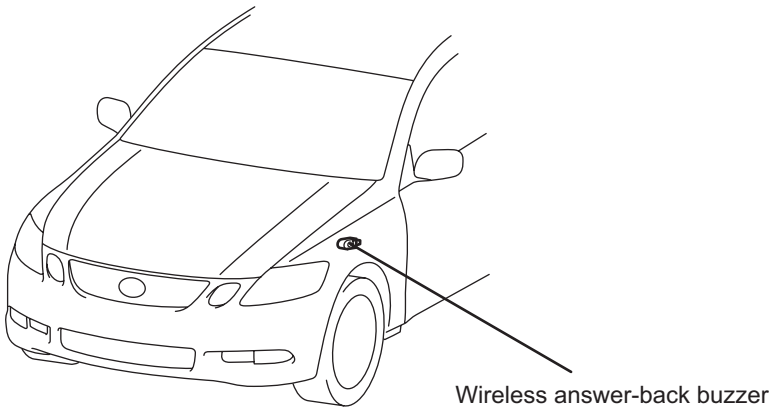
• If the user locks/unlocks the doors through the function or locks/unlocks the doors and operates the luggage door wirelessly, the system will provide an answerback as described below.

Function	Descript
SMART ACCESS SYSTEM with PUSH-BUTTON START/ Wireless Lock	• Wireless buzzer sounds once (beep)*2 • Hazard light flashes once
SMART ACCESS SYSTEM with PUSH-BUTTON START/ Wireless Unlock	• Wireless buzzer sounds twice (beep-beep)*2 • Hazard light flashes twice
Wireless luggage door open*1	• Wireless buzzer sounds once (for 500 ms)*2

❖REFERENCE❖

*1 : The system will not provide an answerback during a SMART ENTRY & START SYSTEM Luggage door open.

*2 : Excluding Europe and China



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Power Savings Function

Vehicle Battery Saving Function

- When the doors are locked, the electronic key system transmits vehicle external signals on a regular basis. Therefore, if the vehicle is parked for a long period of time, it might drain the onboard battery. Therefore, the following controls are provided in order to prevent the battery from draining:

Vehicle Battery Saving Function

- If no response is received from an electronic key for 4 days or more, this function extends the check interval from approximately 400 milliseconds to 800 milliseconds.
- If no response is received from a electronic key for 14 days or more, the system will stop the SMART ACCESS SYSTEM with PUSH-BUTTON START.

Resumption Conditions:

1	Any one of the wireless operations is performed: lock, unlock, or luggage door open
2	Doors locked by turning the trigger lock switch ON
3	Doors locked or unlocked by a key-linked switch

Electronic key and Vehicle Battely Saving Function

- If a electronic key is left constantly in the vehicle exterior detection area, the electronic key and the vehicle will maintain a regular communication. If this condition is allowed to continue for a long period of time, it will use the electronic key battery and the vehicle battery. In the worst case, this could cause the electronic key battery and the vehicle battery to become drained. To prevent the batteries from draining, the following controls are provided:
- The SMART ENTRY & START SYSTEM function stops if a electronic key is present in a vehicle exterior detection area for longer than 10 minutes.

Resumption Conditions:

1	Any one of the wireless operations is performed: lock, unlock, or luggage door open
2	Doors locked by turning the trigger lock switch ON
3	Doors locked or unlocked by a key-linked switch

Unlock Mode Switching Function

- While the power supply is OFF, pressing and holding the lock button and the luggage button on a electronic key for 5 seconds to switch the modes of the door unlock. Make sure to do so within 1 meter of the vehicle. When the default value is "driver's door unlock": The door unlock modes switch in the following order each time a button is pressed and held for 5 seconds: driver's door unlock -> adjacent door unlock -> individual door unlock -> all doors unlock.

Individual Door Unlock Mode

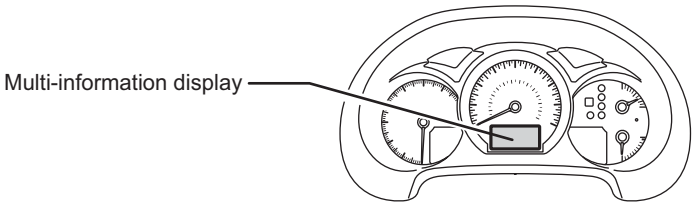
This mode unlocks only the door whose handle has been touched. (Example: if a user touches the driver's door handle, it unlocks only the driver's door.)

Adjacent Door Unlock Mode

When a user touches the driver's door handle, this mode unlocks only the driver's door and the door behind. When a user touches the front passenger's door handle, this mode unlocks only the front passenger's door and the door behind. (Thus, only the doors of the same side as the door handle that has been touched are unlocked.)

• When the modes are switched, the system informs the user through the following means: Wireless buzzer, Information on the meter, Buzzer in the meter

Information / Mod	Wireless answer back buzzer	Combination meter		
		Multi-information display		Multi-buzzer
Driver'S door	Each interval approximately 0.13 second ON OFF One second		(5 seconds indication)	One "bong" sound
Adjacent door	ON OFF		(5 seconds indication)	One "bong" sound
Individual door	ON OFF		(5 seconds indication)	One "bong" sound
All door	ON OFF		(5 seconds indication)	One "bong" sound



Information provided to the driver during the switching of the unlock modes

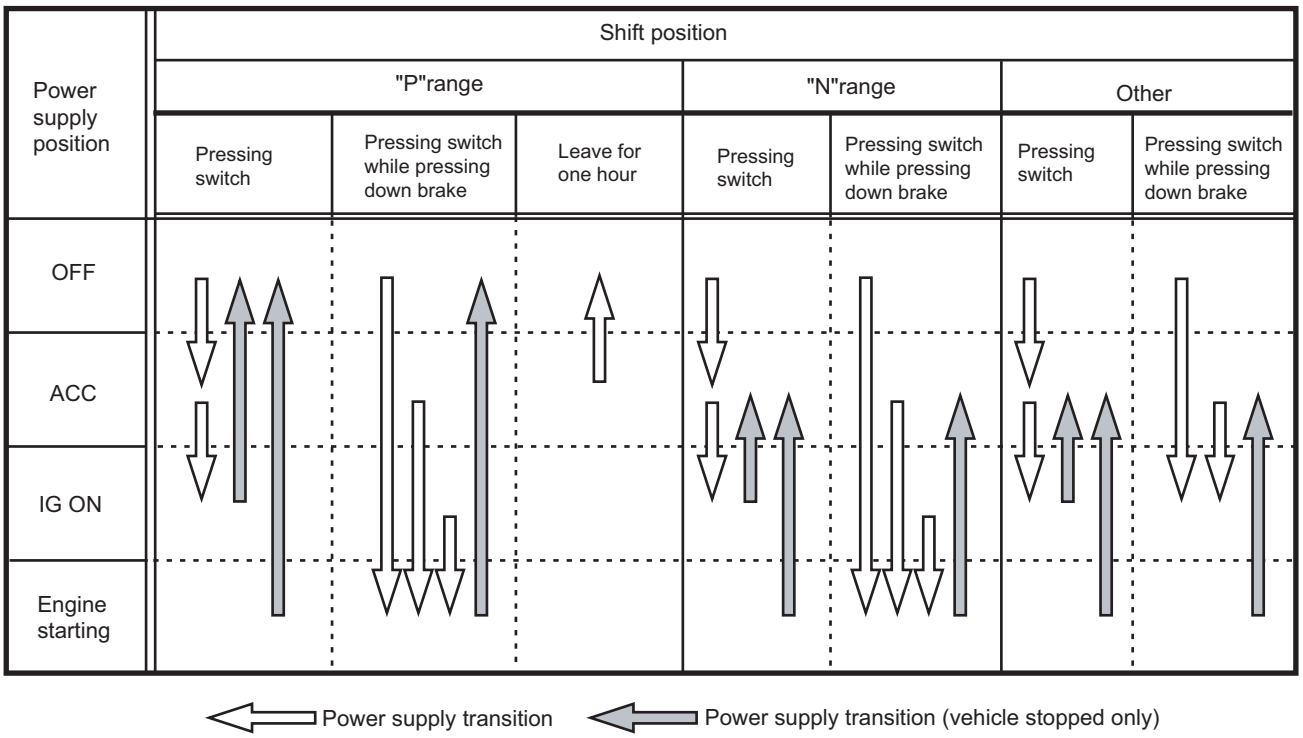
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Power Switching or Engine Starting Function

- When the driver has a electronic key in possession within the vehicle interior detection area and presses the engine switch while pressing on the brake pedal, the driver will be able to change the power supplies. The same function can be accomplished by holding a electronic key near the engine switch.
- When the driver presses the engine switch without pressing on the brake pedal, the power supply position will transfer as follows: OFF -> ACC -> IG ON -> OFF (and repeats the cycle).
- When the driver presses the engine switch while pressing on the brake pedal, the engine will start.
- When the driver presses the engine switch while the vehicle is stopped and the engine is running, the power supply position will transfer to OFF.

Automatic transmission function operation list



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Warning Function

- Because the electronic key system is so convenient, the driver could become unaware of the presence of this key, which could lead to human errors.

Examples:

1	The driver is unaware that the key has been taken out of the vehicle (by an occupant).
2	The driver exits the vehicle with its engine running.
3	The driver exits the vehicle with its shift lever in a position other than "P".

- If the situations described above occur, they could lead to a serious problem, such as an inability to restart the engine once it has been turned OFF, the possible theft of the vehicle, or vehicle rollaway. For this reason, some kind of countermeasure must be taken.

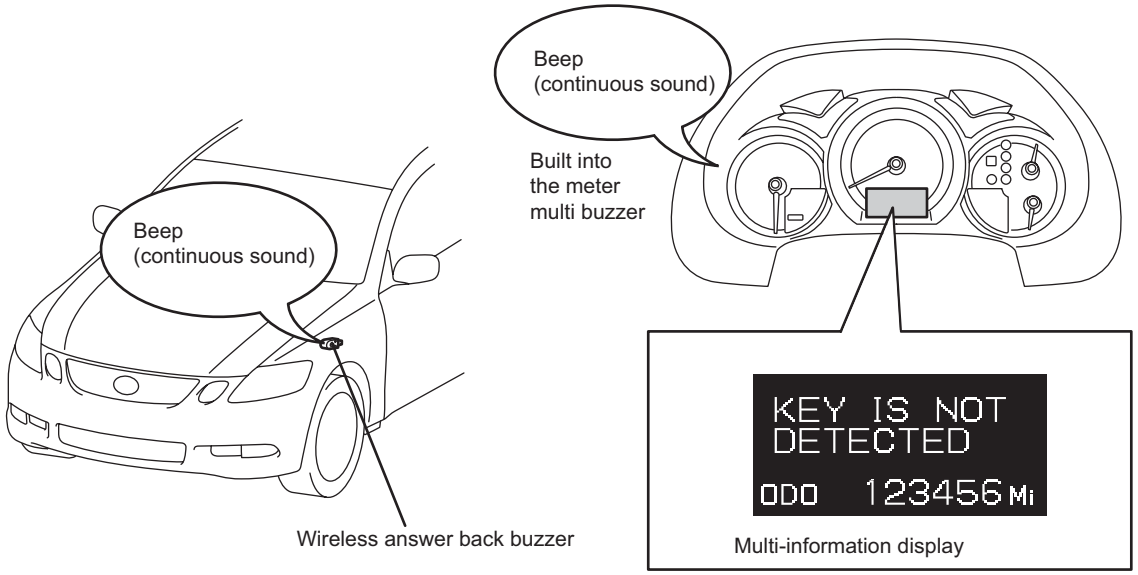
Countermeasure:

The addition of a key search function and a key absence warning to alert the driver of a key being taken out of the vehicle, being left inadvertently in the vehicle interior, or the engine left running, in order to prevent serious problems.

- The human errors (as well as some non-human errors) that can be foreseen with the present control specifications, as well as their warning items are listed below.

Warning Function List

	Warning function list	Meaning of Warning
1	Exiting the vehicle with the shift lever in a position other than "P" (power supply ON) warning	To prevent an A/T vehicle from starting off suddenly, vehicle theft, and vehicle rollaway.
2	Exiting with shift lever in the "P" position, power supply ON warning	To prevent vehicle theft and the inability to restart the engine
3	Electronic key taken out by occupant warning	To prevent the inability to restart the engine
4	Electronic key out of area warning	To prevent user confusion
5	Electronic key confinement warning	To prevent vehicle theft
6	Electronic key battery low warning	Useful function
7	Steering lock unlocked warning	Useful function
8	Steering lock failure warning	Malfunction detection



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• 1.Exiting the vehicle with the shift lever in a position other than "P" (power supply ON) warning

Situation: The driver opens the door with the shift lever in a position other than "P" and is about to exit the vehicle.

Conditions	• 1.Shift lever in a position other than "P" • 2.Power supply ON (ACC/IG ON) • 3. Driver's door open, and Vehicle speed absent	
Description of warning	Buzzer in meter	• Description of control: Continuous "beep" sound • Stopping conditions: Power supply OFF (ACC/IG OFF), shift lever in "P" position, or vehicle speed present

Situation: Furthermore, the driver exits the vehicle with a electronic key in possession, closes the door, and is about to leave the vehicle.

Conditions	• 1.Shift lever in a position other than "P" and Power supply ON (ACC/IG ON) and Driver's door open -> closed and Vehicle speed absent • 2.No electronic key in vehicle interior (electronic vehicle interior check NG)	
Description of warning	Buzzer in meter	• Description of control: Continuous "beep" sound • Stopping conditions: Stops with power supply OFF (ACC/IG OFF), shift lever in "P" position, or vehicle interior check OK
	Meter information	• Description of control: The following information appears alternately on the meter: • 1. "Shift to P range" • 2. "Key is not detected" • Stopping conditions: • 1. Stops with shift lever in the "P" position, power supply OFF, or vehicle speed present • 2. Stops with power supply OFF, or vehicle interior check OK
	Wireless buzzer	• Description of control: Continuous "beep" sound • Stopping conditions: Stops with power supply OFF, shift lever in the "P" position, vehicle interior check OK, or vehicle speed present

• 2.Exiting with shift lever in the "P" position, power supply ON warning

Situation: With the shift lever in the "P" position, and the power supply ON, the driver opens the door and is about to exit the vehicle.

Conditions	• 1.Shift lever in the "P" position and (ACC ON or steering lock unlocked), and Driver's door open	
Description of warning	Buzzer in meter	• Description of control: Intermittent "bong - bong - bong ..." sound • Stopping conditions: Shift lever in a position other than "P", (ACC OFF and steering lock locked), IG ON, or driver's door closed

Situation: Furthermore, the driver exits the vehicle with a electronic key in possession, closes the door, and is about to leave the vehicle.

Conditions	• 1.Shift lever in the "P" position and Power supply ON (ACC/IG ON) and Driver's door open -> closed and No electronic key in vehicle interior (vehicle interior check NG)	
Description of warning	Buzzer in Meter	• Description of control: Sounds "bong" once(When the vehicle interior check continues to be NG, the buzzer sounds once again when the vehicle is driven for the first time.)
	Meter information	• Description of control: The following information appears on the meter: "Key is not detected" • Stopping conditions: Stops with power supply OFF or vehicle interior check OK
	Wireless buzzer	• Description of control: Sounds "beep - beep - beep" three times. • Stopping conditions: Stops with power supply OFF or vehicle speed present.

Situation: Furthermore, the driver has pressed the lock switch on the door handle in an attempt to perform a door lock.

Conditions	• 1. Shift lever in the "P" position and Power supply ON (ACC/IG ON) and All doors closed and Door handle lock switch ON and No electronic key in vehicle interior (vehicle interior check NG), electronic key present in vehicle exterior (vehicle exterior check OK)	
Description of warning	Wireless Buzzer	• Description of control: sounds "beep" for 2 seconds.

• 3.Electronic key taken out by occupant warning

Situation: With the power supply ON, an occupant exited the vehicle with a electronic key in possession, which was left inside a briefcase or the like.

Conditions	• 1. Power supply ON (ACC/IG ON) and Door other than driver's open -> closed and Vehicle speed absent and No electronic key in vehicle interior (vehicle interior check NG)	
Description of warning	Buzzer in Meter	• Description of control: The following information appears on the meter: "Key is not detected". • Stopping conditions: Stops with power supply OFF or vehicle speed present.
	Meter information	• Sounds three times upon detection • Stops when the engine switch is OFF or a vehicle speed is present
	Wireless buzzer	• Description: Sounds "beep - beep - beep" three times • Stopping conditions: Stops with power supply OFF or vehicle speed present.

• 4.Electronic key out of area warning

Situation: The driver is about to start the system (power supply ON) with no electronic key in the vehicle interior.

Conditions	• 1.Engine switch ON and No electronic key in vehicle interior (vehicle interior check NG)	
Description of warning	Buzzer in Meter	• Description of control: Sounds "bong" once.
	Meter information	• Description of control: The following information appears on the meter for 8 seconds (and disappears automatically after 8 seconds have elapsed): "Key is not detected"

• ACC is ON and the "driver's door closed -> open" conditions have been met:

When the engine switch is turned ON and the vehicle interior check is NG, the system issues a electronic key out-of-area warning

• 5.Electronic key confinement warning

Situation: The driver exits the vehicle while a electronic key is in the vehicle interior, and presses the door handle switch in an attempt to perform a door lock.

Conditions	• 1.Power supply OFF (ACC/IG OFF) and All doors closed and Door handle lock switch ON and electronic key present in vehicle interior (vehicle interior check OK)	
Description of warning	Wireless Buzzer	• Description of control: sounds "beep" for 2 seconds.

• 6.Electronic key battery low warning

Situation: The driver uses a electronic key with a low battery to drive the vehicle.

Conditions	• After the IG is ON continuously for 20 minutes or more, the IG is turned from ON to OFF and The electronic key battery is low.	
Description of warning	Buzzer in Meter	• Description of control: Sounds "bong" once.
	Meter information	• Description of control: The following information appears on the meter: "Low key battery".

• 7.Steering lock unlocked warning

Situation: The steering lock wedges into the steering wheel, preventing it from being unlocked.

Conditions	• The driver has attempted to unlock the steering lock but failed.	
Description of warning	Meter information	• Description of control: The following information appears on the meter for 15 seconds (and disappears automatically after 15 seconds have elapsed): "S/T is not unlocked" "Steering locked"

• 8.Steering lock failure warning

Situation: The system detects a failure that could lead to an improper operation of the steering lock ECU.

Conditions	• A driver malfunction in the steering lock ECU, power supply ECU, or a malfunction in the lock/unlock position switch.	
Description of warning	Meter information	• Description of control: The following information appears on the meter: "Check steering lock"

SMART ENTRY & START SYSTEM User Customize Function

SMART ACCESS SYSTEM with PUSH-BUTTON START customized function Setup Value Data Check

Function	Default setting
Power switching or engine starting function (front doors/front and rear doors)	Front and rear
Standby time in parking standby mode(1.0s/2.0s/3.0s/5.5s)	3.0
luggage door open (spec yes/no)	Yes

SMART ACCESS SYSTEM with PUSH-BUTTON START Warning customized function Setup Value Data Check

Function	Default setting
Electronic key taken out by occupant warning (spec yes/no)	Yes
Key battery low warning (spec yes/no)	Yes
Electronic key out-of-area warning (spec yes/no)	Yes

Cancel Function

• The SMART ACCESS SYSTEM with PUSH-BUTTON START controls listed below can be canceled by operating the cancel function.

Cancel Operation Stopping Function

• SMART ACCESS SYSTEM with PUSH-BUTTON START Control	• Electronic key Confinement Prevention
• Memory Call Control	• luggage door Open Control
• Door Unlock Customizable Function Mode	• Warning Function

• Under the prerequisites indicated below, the cancel can be set and unset in the manner described below.

Prerequisites: all power supply OFF (ACC and IG OFF), driver's door closed, and driver's door unlocked

Cancel Operation Method

NO.	Operation
1	Perform wireless unlock operation once
2	Open the driver's door within 5 seconds
3	Perform wireless unlock operation twice within 5 seconds*
4	Repeat open -> close driver's door twice within 30 seconds, then open it again (driver's door open -> close -> open -> close -> open)
5	Perform wireless door unlock operation twice within 30 seconds*
6	Repeat open -> close driver's door once within 30 seconds, then open it again (driver's door open -> close -> open)
7	Close driver's door within 5 seconds

❖REFERENCE❖

* : The cancel operation stops if the driver's door is operated open -> close in steps 3 and 5.

• To return the cancel mode to its original mode, perform the "cancel operation method" again as described above.

• When it is canceled, the doors can be locked and unlocked through the use of the wireless remote control function or a mechanical key. Also, the driver can start the engine by holding a electronic key near the engine switch.

Wireless Communication Check Function

● Whether normal communication is established or not in the SMART ENTRY & START SYSTEM, immobiliser, and wireless systems can be checked through the modes listed below on the customized function.

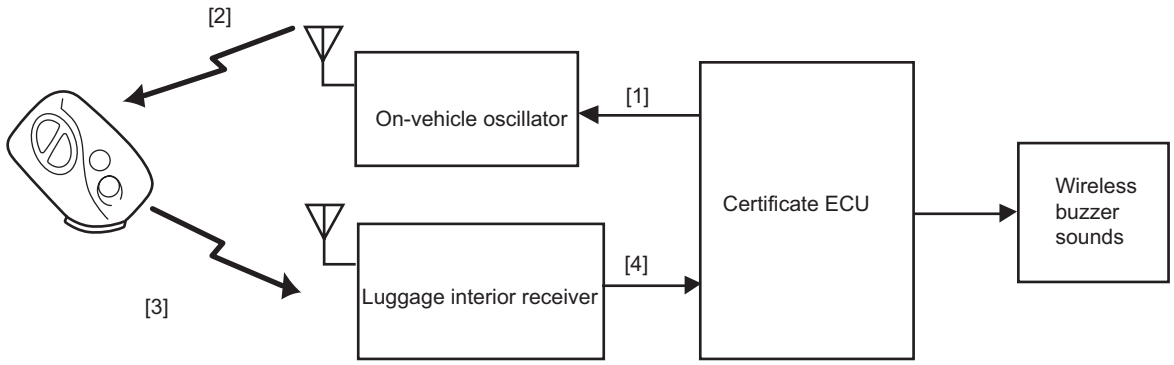
Electronic Key Transmitter Diagnosis Mode

• Whether normal communication is established or not between [1] through [4] in Figure "a" can be checked by performing the key transmitter diagnosis mode and the transmitter selection.

Example: If a smart key is placed near the detection area outside of the driver's door

• If normal communication is established	• Sounds the wireless buzzer
• If normal communication is not established	• Does not sound the wireless buzzer

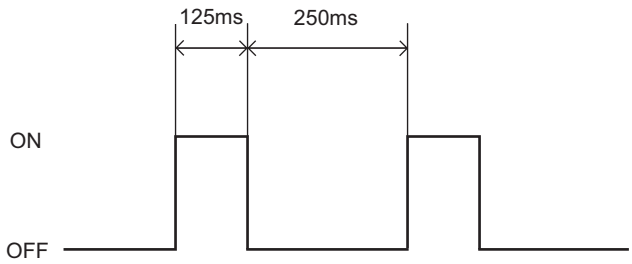
Fig "a"



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• During normal communication (transmission and reception of registered code): the buzzer sounds continuously as described below.

Fig "b"



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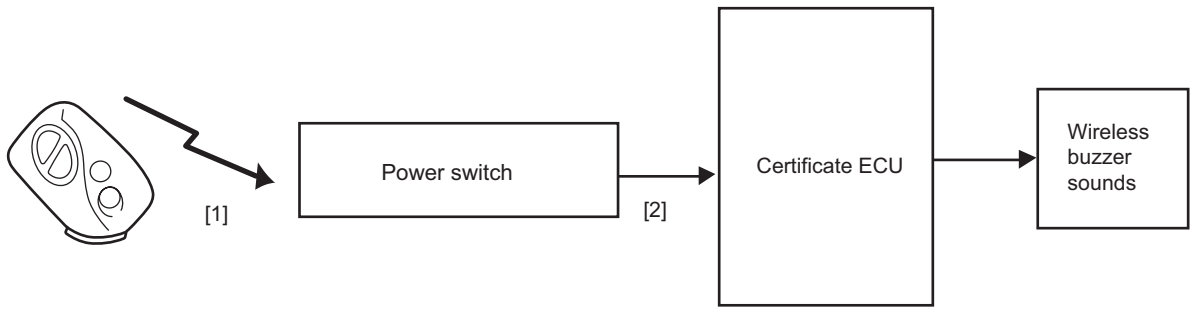
Immobilizer amp Diagnosis Mode

• Whether normal communication is established or not between [1] and [2] in Fig. "c" can be checked through the amplifier diagnosis mode.

Example:If a electronic key is placed near the immobilizer amplifier

• If normal communication is established	• wireless buzzer (Fig. "b") will sound.
• If normal communication is not established	• wireless buzzer will not sound.

Fig "C"



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Wireless Diagnosis Mode

• Whether normal communication is established or not between [1] and [2] in Fig. "d" can be checked through the wireless diagnosis mode, by pressing any one of the following switches: wireless lock, unlock, luggage or panic*.

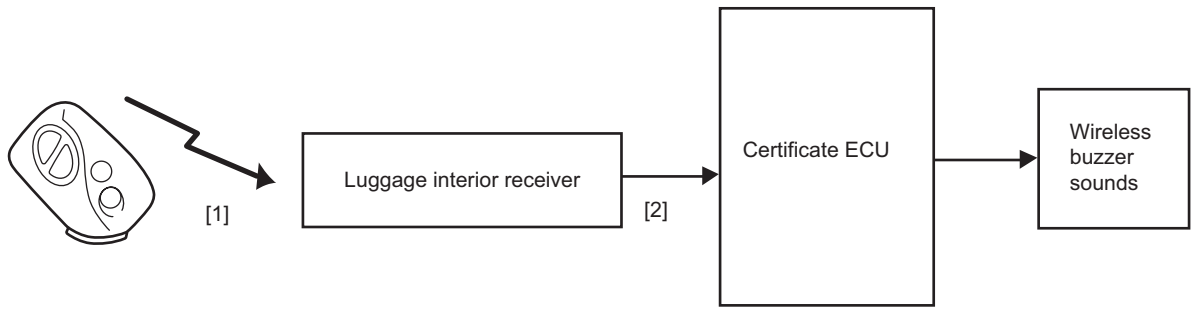
Example:When a wireless operation is performed

• If normal communication is established	• wireless buzzer (Fig. "b") will sound.
• If normal communication is not established	• Does not sound the wireless buzzer

❖REFERENCE❖

* : Excluding the Europe and China.

Fig "d"

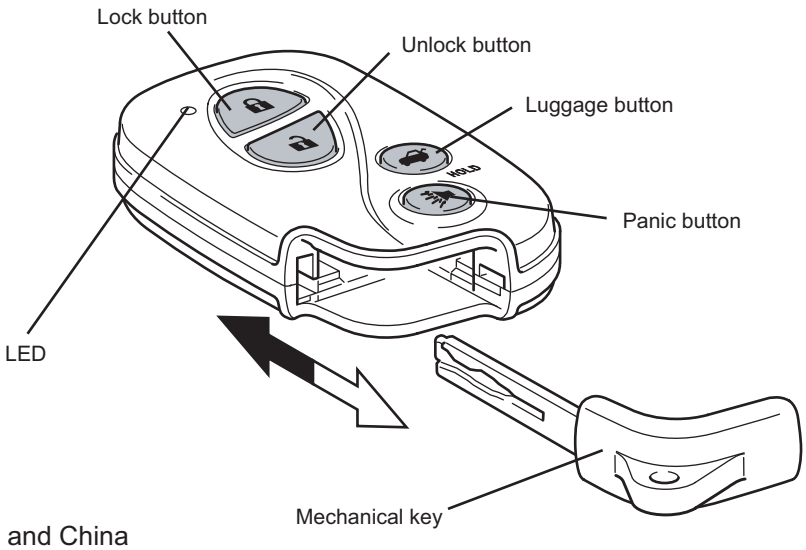


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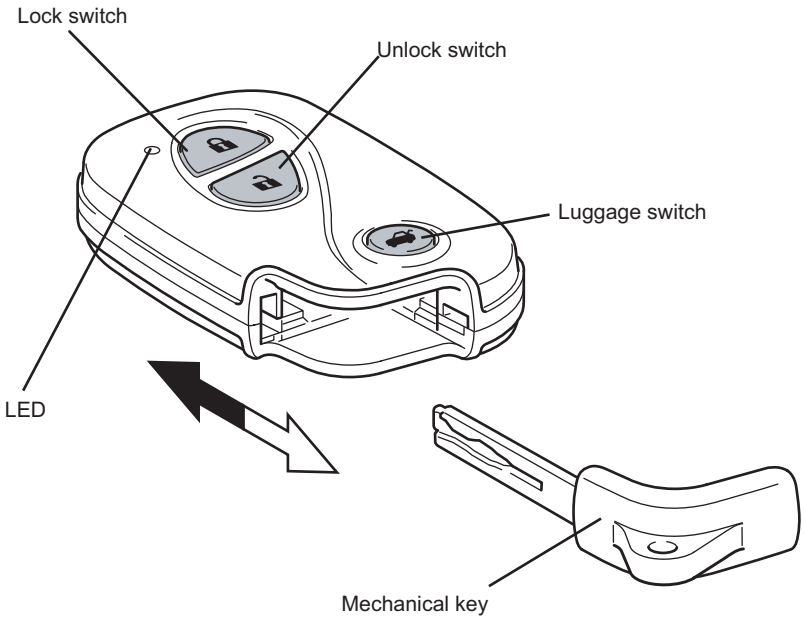
BE

Wireless Remote Control System

- A "multi-function remote control", which consists of a electronic key (wireless door lock key) with additional functions to operate the power windows and the moon roof, is used.
- By pressing the switch on the electronic key, the user can perform a door lock/unlock operation,panic warning sound*, or a luggage door open operation.



Excluding the Europe and China



Europe and China

A4270400B

❖REFERENCE❖

* : Excluding Europe and China.

Wireless Function

Function	Description
All door lock	Lock switch locks all the doors.
All Door Unlock	Unlock switch unlocks all the doors.
Twice operation unlock	Pressing the unlock switch once
30-Second Auto Lock	Approximately 30 seconds after the doors are unlocked with the unlock switch (wireless door lock), if none of the doors are opened and the power supply is not turned ON, this function locks all the doors.
Panic*	pressing and holding the panic switch for approximately 0.8 seconds causes a panic warning to sound for 30 seconds. During a panic warning,pressing either the lock ,unlock luggage or panic switch will cause the warning to stop.
Luggage open	Pressing and holding the luggage switch for approximately 0.8 seconds causes the luggage to open.
Door Ajar Warning	If the user presses the lock switch while a door is ajar (or open), the wireless buzzer sounds for 10 seconds.During a door ajar warning, closing all the doors, turning the power supply ON, or pressing the unlock switch will cause the warning to stop.

Wireless function operation inter lock

Wireless Function Operation Interlock On models equipped with the SMART ACCESS SYSTEM with PUSH-BUTTON START, this interlock prevents the wireless lock, unlock, and luggage door opener, and wireless panic functions from operating when the power supply is ON (ACC ON or above).
It also prevents the wireless lock function from operating (and sounds a door ajar warning) if a door is open.

Wireless Lock and Unlock Function

- Press the lock button once to lock all the doors. Press the unlock button once to unlock all the doors.
- Pressing the lock button once locks all the doors, pressing the unlock button once unlocks the driver's door, and pressing it twice unlocks all the doors (for Australia, and Middle East).

Luggage Door Open Function

- Press and hold the luggage switch for approximately 0.8 second to automatically open the luggage compartment door.
- The luggage door open function will not operate when the trunk opener cancel switch is ON.

Power Window / Moon Roof Open-Close Function

- Press and hold the lock button for approximately 3 seconds or more to close the window glass of all the doors and the moon roof. Press and hold the unlock button for approximately 3 seconds or more to open the window glass of all the doors and the moon roof.
- The power windows and the moon roof continue to open or close while the button is being pressed and stop when the button is released. They do not operate when the window lock switch is ON.
- For details on the power window open-close function, refer to the Transmitter-Linked Functions of the Power Window System.For details on the moon roof open-close function, refer to the Transmitter-Linked Functions of the Moon Roof System.For details on the moon roof open-close function, refer to the Transmitter-Linked Functions of the Moon Roof System.

30 Seconds Auto Lock Function

• If the doors remain unlocked for approximately 30 seconds as a result of the user pressing the unlock button, all the doors lock automatically, thus preventing the doors from remaining unlocked. The system cancels the auto lock function if any one of the conditions indicated below occurs within 30 seconds.

30-Second Auto Lock Function Canceling Conditions

• Any door is opened. • All the doors are locked.

Door opening operation not function

• If any door is ajar or open, the system will prohibit the operation of the door lock, the opening or closing of the power windows, and the opening and closing of the moon roof through the use of the wireless remote control.

Repetition Function

• After the system has completed a locking operation, if it cannot verify the locking operation for some reason, the system will perform another locking operation approximately 1 second later.

Ajar Door Warning

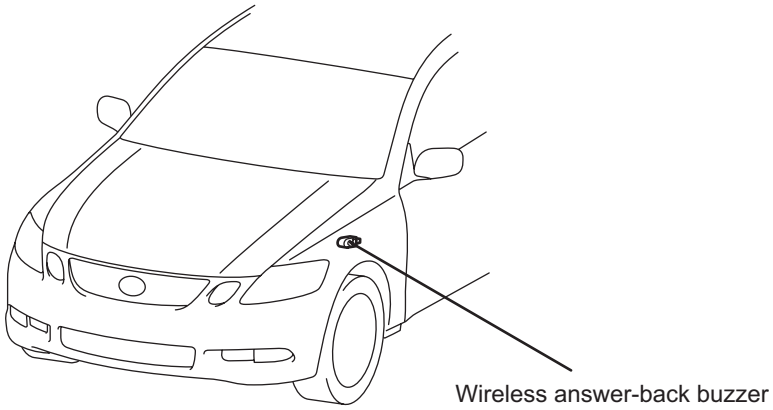
• While any door is ajar or open, if the user presses the lock button to lock the doors, the wireless answer-back buzzer will sound for approximately 10 seconds to alert the user that the doors have inadvertently been left open. The system will stop sounding the buzzer if any one of the conditions indicated below occurs.

Ajar Door Warning Buzzer Sound Stopping Conditions

• All the doors are closed. • The door lock control switch (for key-linked operation) is operated. • The doors are unlocked as a result of the unlock button being pressed.

Answer-Back(Sounds the Buzzer and Frashes the Hazard Warning Light) Function

- When the doors are locked or unlocked through the use of the wireless remote control, this function sounds the wireless answer-back buzzer(excluding the Europe and China) and flashes the hazard warning light once for locking and twice for unlocking. The answer-back function will operate even if the doors are locked through the 30-second auto lock function.
- When the wireless remote control is used to open the luggage compartment door, or to open or close the power windows and the moon roof, this function will sound the wireless answer-back buzzer once(excluding the Europe and China).



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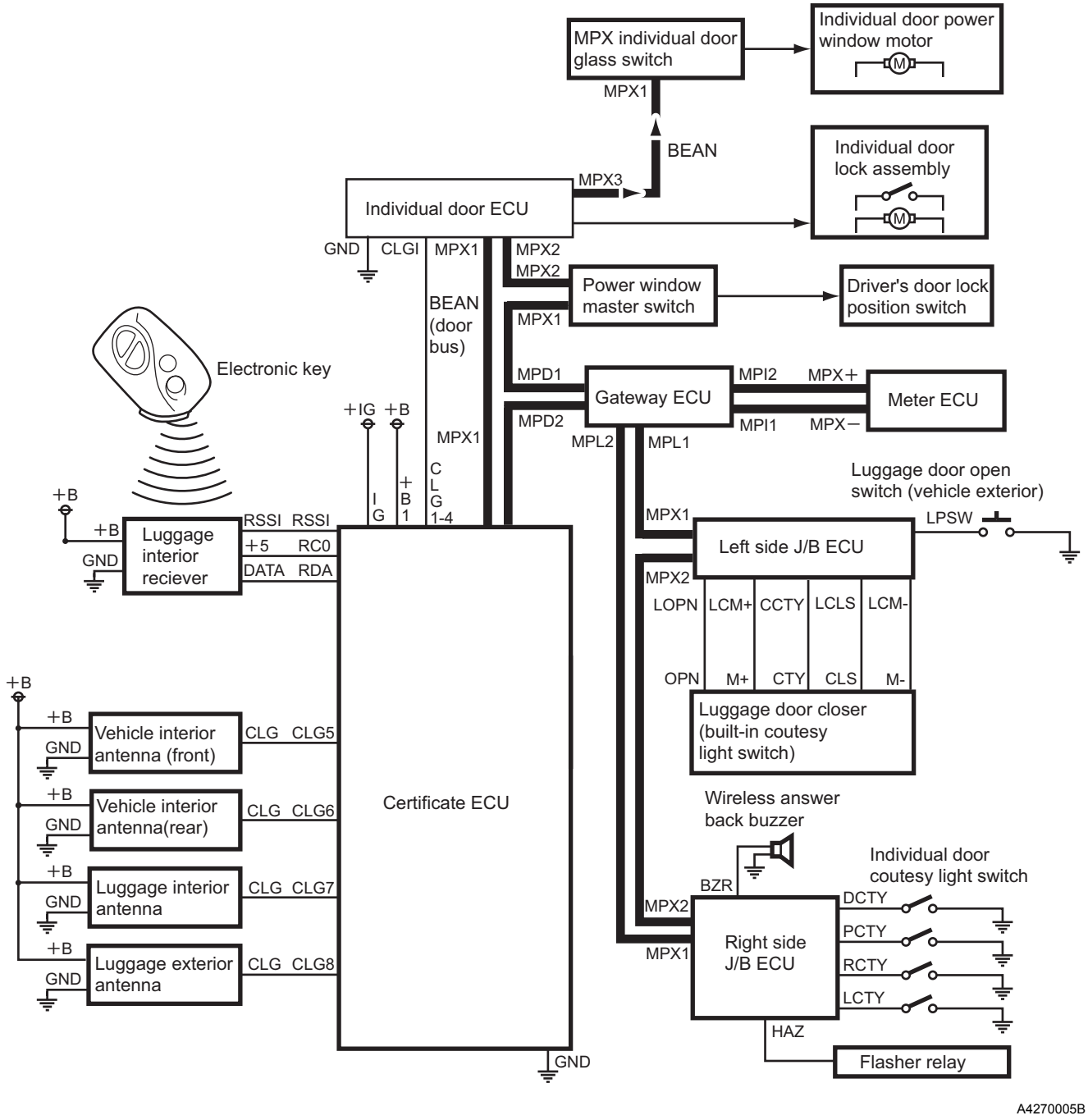
Interior Light Illuminates Function

- If the door unlock function is used, the interior light will illuminate for approximately 15 seconds, provided that the interior light switch is in the DOOR position.

Wireless Security Function

- This security function is used for controlling the unlocking of the doors after the encrypted code, which is transmitted by the electronic key/wireless door lock key, has been checked and recognized by the Luggage interior receiver as being the code for this vehicle.

Wireless Remote Control System Operation



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Wireless Door Lock (Unlock) Operation

- When the user presses the lock button (or unlock button), the electronic key transmits feeble radiowave signals consisting of the vehicle's identification code and the function code. Upon receiving these signals, the luggage interior receiver sends them to the certificate ECU.
- The certificate ECU checks the identification code and distinguishes the function code. If the certificate ECU determines that the identification code matches the code of the vehicle and recognizes that the function code is "door lock" (or "unlock"), the certificate ECU will output it to the right side J/B ECU in the form of code data.
- Upon receiving the input of the lock (or unlock) signal, the right side J/B ECU will turn ON the lock relay (or unlock relay) in order to lock (or unlock) all the doors. This operation is the same as the manual lock (or unlock) operation of the electronic door lock system.

❖REFERENCE❖

The right side J/B ECU receives the door lock position switch OFF (or ON) status signals via BEAN (Body Electronics Area Network). It receives the signals for the driver's door from the MPX master switch, and the signals for the front passenger, rear right, and rear left doors from the individual door ECUs. When the right side J/B ECU checks that the doors are locked (or unlocked), it will output an answer-back signal. After a door unlock operation, if the doors are not opened for approximately 30 seconds (thus not turning ON the door courtesy light switch), the right side J/B ECU will lock all the doors (by starting the auto lock control).

Panic Function

If the user senses personal danger while being in the vicinity of the vehicle, the user can press and hold the panic switch* (for over 1 seconds) on the electronic key. This will cause the system to issue a warning by sounding the horns and flashing the hazard warning lights.

❖REFERENCE❖

* : Excluding the Europe and China

Wireless Remote Control User Customize Function

Wireless Customizable Functions

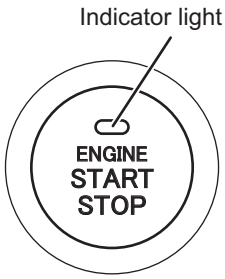
Function	Default setting
Wireless main switch (spec yes/no)	Yes
Wireless answer-back buzzer (spec yes/no)	Yes
Wireless hazard answer-back (spec yes/no)	Yes
Wireless door ajar warning (spec yes/no)	Yes
Wireless auto lock variable time (30s/60s)	30 second
Wireless twice operation unlock (spec yes/no)	NO(Europe and China), YES(other country)
Wireless trunk open function code (ON/0.8s ON/twice ON/prohibit)	0.8 second
Wireless panic function* (spec yes/no)	YES

❖REFERENCE❖

* : Excluding Europe and China

Power Switch

- The engine switch has a built-in indicator light. The present power supply mode can be checked by its illumination condition or the color that is emitted.



Power switch design

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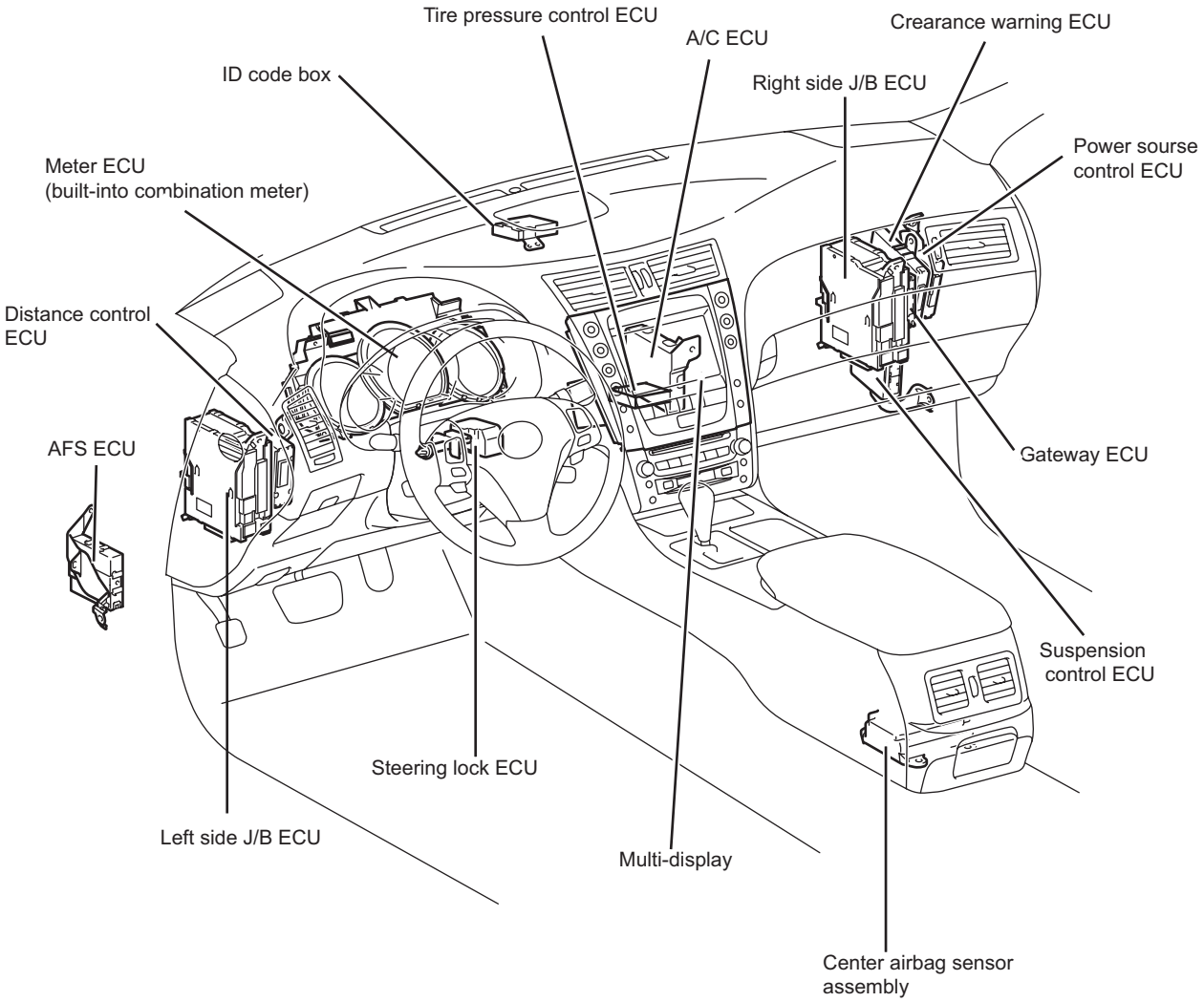
List indicator light condition

Power supply condition	Light condition
OFF	OFF
ACC	Illuminates(orange)
IG ON	Illuminates(orange)
Under un Engine opration	OFF
Steering lock not unlocked	Frashed(green)
System failure	Frashed(orange)
Brake ON and electronic key present in vehicle interior (vehicle interior check OK)	Illuminates(green)

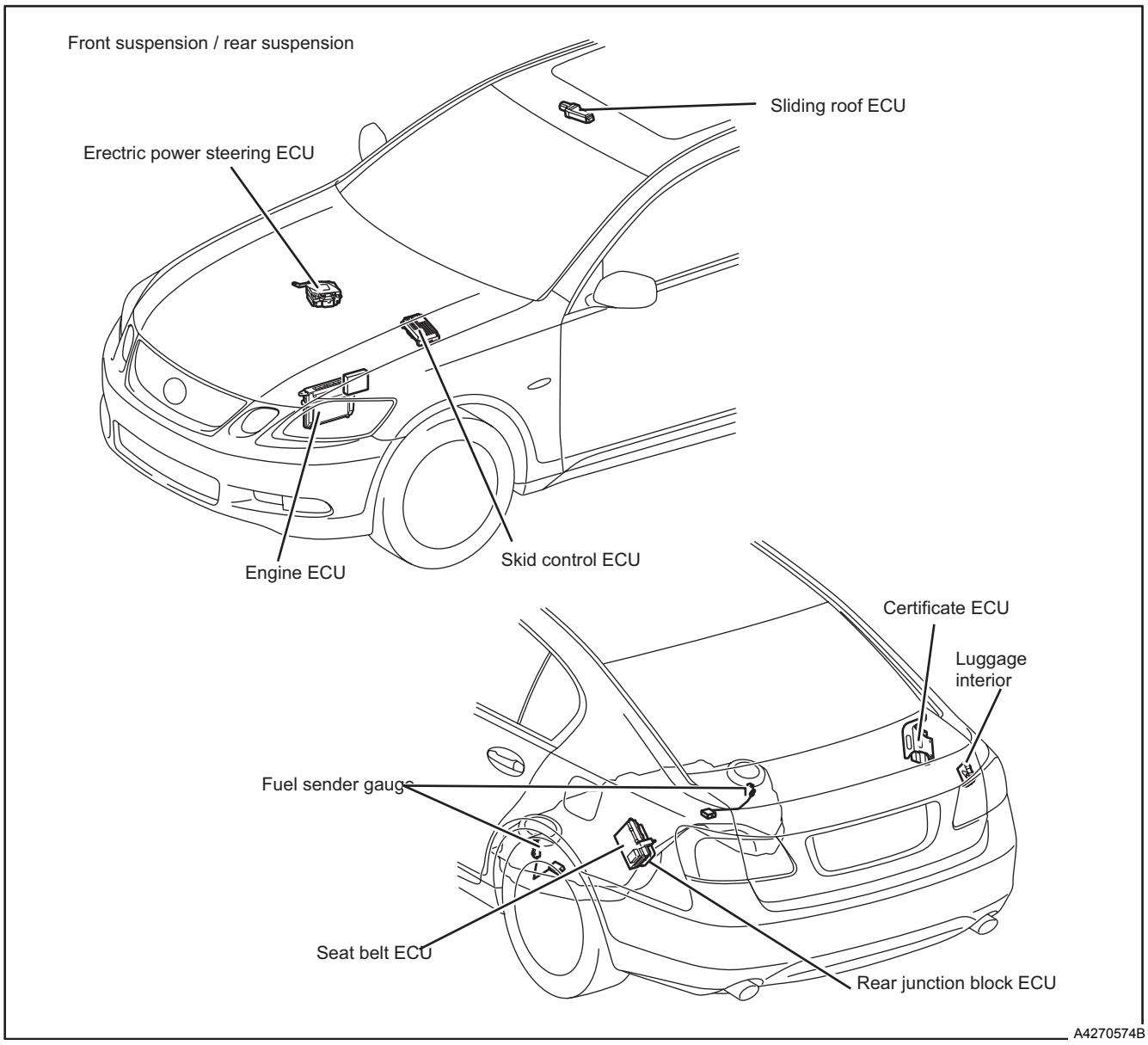
METER

Meter & Gauge System

- The combination meter has a built-in meter ECU that receives and inputs signals from other ECUs, sensors, and switches in order to display various types of information concerning the present state of the vehicle.



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List of Connected the Combination Meter

List of Items Connected to the Combination Meter

Display Section Name	Connected Item Name	Input Signal
Speed Meter	Skid Coutrol ECU	Line
Tacho Meter	Engine ECU	Line
Fuel Gauge	Fuel Sender Gauge	Network
	Engine ECU	Network
Water temperature Gauge	Engine ECU	Network

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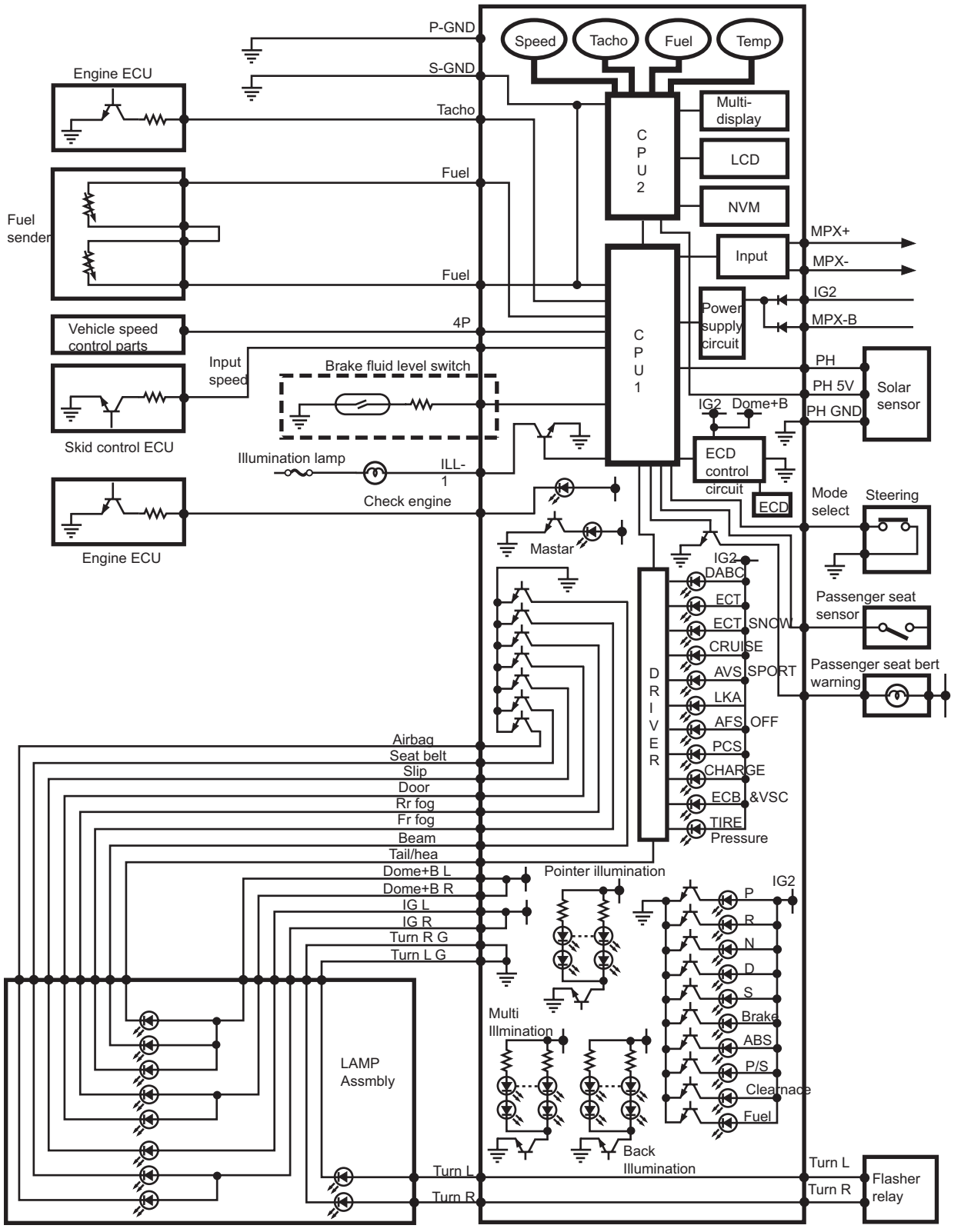
Display Section Name		Connected Item Name	Input Signal
Operation/Warning indicater light	Turn signal indicator light	Flasher Relay	Line
	Tail Light indicator light	Right side J/B ECU	Network
	Front Fog Light indicator light	Right side J/B ECU	Network
	Headlight High Beam indicator light	Right side J/B ECU	Network
	Snow mode indicator light	Engine ECU	Network
	Power mode indicator light	Engine ECU	Network
	Slip indicator light	Skid Control ECU	Network
	Malfunction indicator light	Engine ECU	Line
	Anti-lock brake system warning light	Skid Control ECU	Network
	Adaptive front-lighting system off indicator light	AFS ECU	Network
	Master Warning light*4	-	-
	Damping mode indicator light	Suspension Control ECU	Network
	Cruise control indicator light	Engine ECU	Network
	Low fuel level warning light	Fuel Sender gauge	Line
		Engine ECU	Network
	Brake system warning light	Skid Control ECU	Network
		Brake Fluid Level Switch	Line
	Open door warning	Right side J/B ECU	Network
		Rear Junction Block ECU	Network
	Driver's Seatbelt reminder light	Center Airbag Sensor ASSY	Network
	Discharge Warning	Engine ECU	Network
	Electric power steering system warning light	Electric Power steering ECU	Network
	SRS Warning light	Center Airbag Sensor Assembly	Network
	Brake system warning light	Skid Control ECU	Network
	pre-crash safety system indicator light	Skid control ECU	Network
	Low tire pressure warning light	Tire pressure control ECU	Network
	LEXUS parking assist-sensor(steering guided) system indicator light	Clearance warning ECU	Network

Display Section Name		Connected Item Name	Input Signal
Multi infomation display	Cluise Infomation Mode	Front Air-conditioner ECU	Network
		Skid Control ECU	Line
		Engine ECU	Network
		Fuel Sender Gauge	Line
	Warning Mode	individual ECU*4	Network
	Electronic key Mode	Certificate ECU	Network
	Radar Cruise Control Mode*1	Engine ECU	Network
	LEXUS Parking Asist Sensor (steering guided)System Mode*2	Clearance Warning ECU	Network
Multi Buzzer	Key Reminder Warning	Certificate ECU	Network
	Reject warning	Engine ECU	Network
	Driving with parking Brake Applied Warning	Skid Control ECU	Network
			Line
	Driving with Doors Open Warning	Right side J/B ECU	Network
		Front control ECU	Network
		Rear Junction Block ECU	Network
		Skid Control ECU	Line
	Warning Mode Display-Linked Buzzer	Individual ECU*4	-
	Moon Roof Open Warning*3	Sliding Roof ECU	Network
	Seat Belt Unbuckled Warning	Center Airbag Sensor ASSY	Network
		Passenger Seat SeatBelt Buckle Switch / Occupant Detection sensor	Line
		Skid control ECU	Line
	Radar Cruise Warning*1	Engine ECU	Network
	Electronic key Warning	Certificate ECU	Network
		ID Code Box	Network
	Speed Warning*5	Meter ECU	-

❖REFERENCE❖

*1Model with Dynamic radar cruise control system
*2Model with LEXUS parking assist-sensor (steering guided)system
*3Model with moon loof
*4Refer to each item because numerous items are connected.
*5Provision available for the middle east only

Meter and Gauge System Operation Block Figure

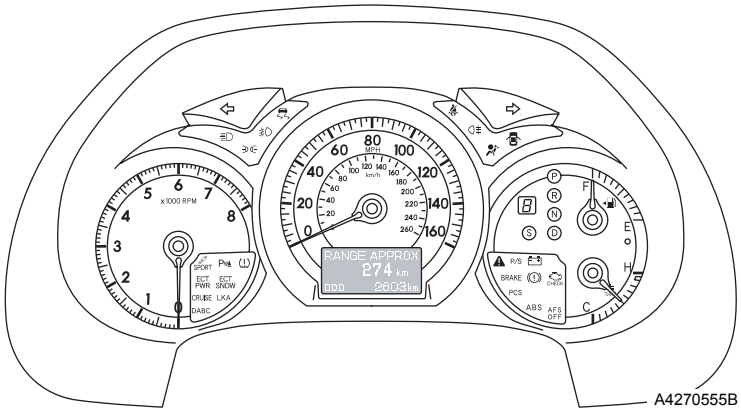


Note: This diagram shows all the indicator lights that are provided, which may differ from the actual vehicle

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Combination Meter

- A triple-lens, self-illuminating type analog Optitron meter is provided on all models. This meter uses LEDs (Light Emitting Diodes) that illuminate the dials, various meters, and gauges.
- A multi information display is provided below the speed meter. This display uses text, numbers, and graphics to show cruise information, various warnings, state of the radar cruise control (on model equipped with the radar cruise control), state of the LEXUS parking assist-sensor(steering-guided) system detection {on model equipped with the LEXUS parking assist-sensor(steering guided)}, etc.
- An ECD (Electronic Chromatic Device) system is used on the meter lens surface. This system automatically adjusts the brightness of the meter in accordance with the intensity of the outdoor light that enters the meter. This feature minimizes glare and ensures excellent visibility of the meter at all times.
- A rheostat is used for adjusting the meter brightness for both nighttime and daytime driving.
- LEDs (Light Emitting Diodes) are used for all illuminations, including the dials and indicator lights, to realize electric power savings and long life.



Speed Meter Specification

Speed meter specification

Indication	Function
• Indication range 0 to 160 mph, 0 to 260 km/h(EU Right handle vehicle except Ireland and Cyprus) • Indication range 0 to 260 km/h,0 to 160 mph(Taiwan) • Indication range 0 to 260 km/h(other country) • 5 mph, 10 km/h increments (EU Right handle vehicle except Ireland and Cyprus) • 5km/h,10 mph increments (Taiwan) • 5km/h increments(other country)	• Uses a stepper motor system. • Receives the input of rectangular wave pulse signals from the wheel speed sensors via the skid control ECU, and indicates the vehicle speed.

Tacho Meter Specification

Tacho meter Specification

Indication	Function
• Indication area0~8000r/min • 100r/min increments • Red zone:V6 engine 6400~8000r/min, V8 engine 6200~8000r/min	• Uses a stepper motor system. • Receives the input of rectangular wave pulse signals from the engine ECU (V6 engine: 6 pulses per 2 revolutions; V8 engine: 4 pulses per 2 revolutions) and indicates the engine speed.

Fuel Gauge Specification

Fuel gauge specification

Indication	Function
• Indication area R~1/1(EU Left handle vehicle) • Indication area E~F (other country) • Warning appears with a residual volume of approximately 12L	• Uses a stepper motor system. • Receives the input of the fuel tank residual volume signal from the fuel sender gauge and the fuel injection volume signal from the engine ECU, processes the data, and indicates the fuel residual volume.

Water Temperature Gauge Specification

Water temperature gauge specification

Indication	Function
• Indication area C~H • Red zone: 120°C	• Uses a stepper motor system. • Receives the input of the engine coolant temperature signal {BEAN (Body Electronics Area Network) signal} from the engine ECU and displays the engine coolant temperature.

Odo / Trip Meter Specification

Odo / trip meter specification

Indication	Function
• Digital indication on LCD • Indication area • 0~999999mile {(odo meter)EU right handle vehicle except Ireland and Cyprus} • 0.0~9999.9mile {(trip meter A,B)EU right handle vehicle except Ireland and Cyprus} • 0~999999km {(odo meter)other country} • 0.0~9999.9km{(trip meter A,B)other country}	• Uses an SMART ENTRY & START SYSTEM. Also logs the reverse travel distance. • Receives and integrates the input of the rectangular wave pulse signals from the wheel speed sensors via the skid control ECU, and indicates the driven distance. • Displays in the following order, when the odo/trip selector switch is pressed: odometer -> tripmeter A -> tripmeter B.

Multi Buzzer Specification

Multi-buzzer specification

Buzzer	Function
Reverse Warning	• Sounds the buzzer when the shift lever is moved to the "R" (reverse) position with the ignition ON.
Key Reminder Warning	• Sounds the buzzer when a electronic key is in the vehicle interior (IG OFF or ACC OFF), and an attempt is made to perform a door lock from the outside of the vehicle.
Reject Warning	• Sounds the warning if the driver attempts to shift down when shift down is not allowed.
Driving with Parking Brake Applied Warning	• Sounds the buzzer if the vehicle is driven {approximate vehicle speed of 3 mph (5 km/h) or higher continues for 1 second} with the parking brake applied.
Driving with Doors Open Warning	• Sounds the buzzer if any of the individual doors, engine hood, or the luggage compartment door is open or ajar while driving {approximate vehicle speed of 3 mph (5 km/h) or higher}.
Warning Mode Display-Linked Buzzer	• Sounds the buzzer when a warning display item occurs for the first time on the multi-information display.
Moon Roof Open Warning*1	• Sounds the buzzer when the driver's door is opened while the ignition is OFF and the moon roof is open.
Seat Belt Unbuckled Warning	• Sounds the buzzer when the driver's or front passenger's seat belt is unbuckled while the ignition is ON and the vehicle speed is approximately 10 mph (16 km/h) or higher.
Radar Cruise Warning*2	• Sounds the buzzer when a radar cruise warning occurs.
Electtonic Key Warning	• Sounds the buzzer the door unlock mode is switched or a electronic key warning item occurs.
Speed Warning*3	• Sounds the buzzer if the vehicle speed is approximately 120 km/h or higher.*3

❖REFERENCE❖

*1Model with moon roof

*2Model with Dynamic radar cruise control system

*3Provision available for the Middle east only

Multi Information Display Specification

Dot Display Type Multi-Information Display Specifications

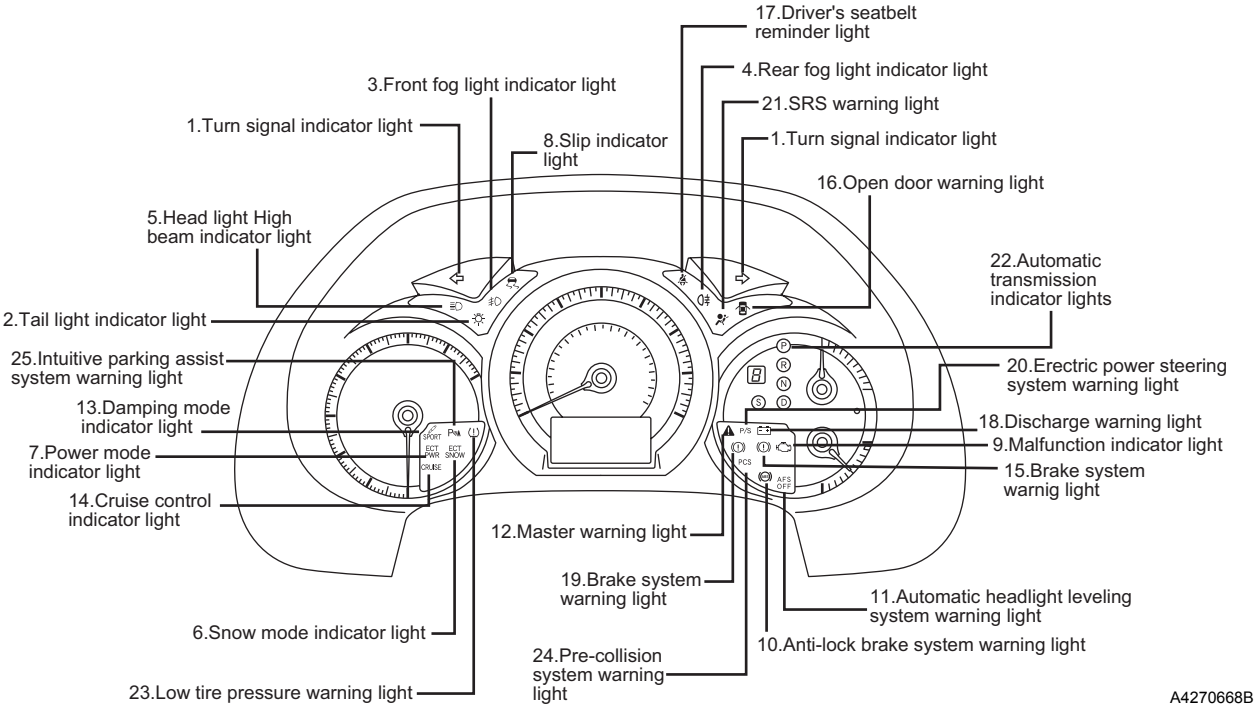
Indication	Function
• Dot composition display by FSTN liquid crystals	• This display uses text and graphics to show cruise information items, warning items, state of the radar cruise control*1, state of the front & clearance sonar detection*2, description of the electronic key system warning, state of the door unlock switching, etc.

❖REFERENCE❖

*1Model with Dynamic radar cruise control system

*2Model with LEXUS parking assist-sensor (steering guided)system

Operation / Warning Indicator Light Specification



Operation / warning indicator Light specification

No.	Design	Name and indication	Function
1		• Turn signal indicator light • Indicated by green LED	• This light illuminates in sync with the turn signal light when the flasher relay turns ON to turn ON the turn signal light.
2		• Tail light indicator light • Indicated by green LED	• When the taillights are ON, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the right side J/B ECU and effects control to illuminate this light.
3		• Front fog light indicator light • Indicated by green LED	• When the front fog lights illuminate, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the right side J/B ECU and effects control to illuminate this light.
4		• Rear fog light indicator light • Indicated by yellow LED	• When the rear fog lights illuminate, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the right side J/B ECU and effects control to illuminate this light.
5		• Headlight high beam indicator light • Indicated by blue LED	• When the high-beam headlights illuminate, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the right side J/B ECU and effects control to illuminate this light.

No.	Design	Name and indication	Function
6	ECT SNOW * ETCS	• Snow mode indicator light • Indicated by yellow LED	• When the Snow (ETCS) mode is selected, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the engine ECU and effects control to illuminate this light.
7	ECT PWR	• Power mode indicator light • Indicated by green LED	• When the Power mode is selected, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the engine ECU and effects control to illuminate this light.
8		• Slip indicator light • Indicated by yellow LED	• When the TRC and VSC are operating, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the skid control ECU and effects control to flash this light. • When the TRC operation is canceled at the TRC OFF switch, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the skid control ECU and effects control to illuminate this light.
9		• Malfunction indicator lamp • Indicated by yellow LED	• When a failure occurs in the engine control system, the engine ECU effects control to illuminate this light.
10		• Anti-lock brake syastem warning light • Indicated by yellow LED	• When a failure associated with the ABS occurs, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the skid control ECU and effects control to illuminate this light.
11	AFS OFF	• Adaptive front -lighting system off indicator light • Indicated by yellow LED	• When the AFS operation is canceled at the AFS OFF switch, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the AFS ECU and effects control to illuminate this light. • When a failure occurs in the AFS system or the auto leveling function, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the AFS ECU and effects control to flash this light.
12		• master warning light • Indicated by red LED	• When a failure occurs in the system that corresponds to the warning indicated by the master warning, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the ECU in which the failure occurred and effects control to illuminate or flash this light.
13	 SPORT	• Damping mode indicator light • indicated by green LED	• When the AVS SPORT mode is selected, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the suspension control ECU and effects control to illuminate or flash this light.

No.	Design	Name and indication	Function
14	CRUISE	• Cruise control indicator light • Indicated by green LED	• When the cruise control system is operating (main switch ON), the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the engine ECU and effects control to illuminate this light. • When a failure occurs in the cruise control system, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the engine ECU and effects control to flash this light.
15		• Brake system warning light • Indicated by yellow LED	• When a failure occurs in the ECB & VSC system, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the skid control ECU and effects control to illuminate or flash this light.
16		• Open door warning light • Indicated by red LED	• When any of the individual doors or the luggage compartment door is open or ajar, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the right side J/B ECU and the rear junction block ECU and effects control to illuminate this light.
17		• Driver's seatbelt reminder light • Indicated by red LED	• When the ignition is ON and the driver's seat belt is unbuckled, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the center airbag sensor assembly and effects control to flash this light.
18		• Discharge warning • Indicated by red LED	• When a failure occurs in the L terminal voltage of the alternator, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the engine ECU and effects control to illuminate this light.
19		• Brake system warning light • Indicated by red LED	• When the parking brake is ON or a failure occurs in the EBD system, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the skid control ECU and effects control to illuminate this light. • When the brake fluid level switch turns ON as a result of a low brake fluid level, this light illuminates.
20	P/S	• Electric power steering system warning light • Indicated by yellow LED	• If a failure occurs in the electric power steering system, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the electronic power steering ECU and effects control to illuminate this light.
21		• SRS warning light • Indicated by red LED	• If a failure associated with the SRS airbags occurs, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the center airbag sensor assembly and effects control to illuminate this light.

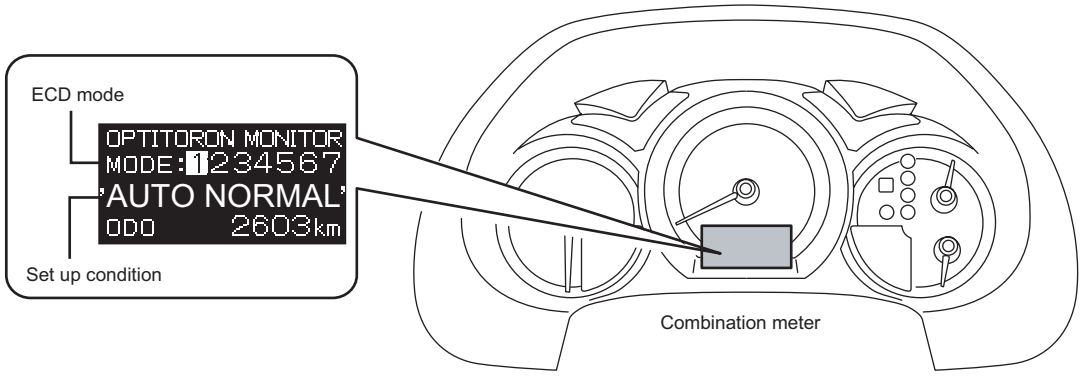
No.	Design	Name and indication	Function
22		• Automatic transmission indicator lights • indicated by green LED ("N","S","P") or yellow LED("R") • Shittrange Indicated by Shift-rangeLCD	• When the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the engine ECU, it effects control to indicate the shift positions and shift ranges.
23		• Low tire pressure warning light • Indicated by yellow LED	• When the tire pressur warning system is operating , the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the tire pressure control ECU and effects control to illuminate this light. • When a failure occurs in the tire pressure warning system, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the tire pressure control ECU effects control to flash this light.
24	PCS	• Pre-Crash safety system indicator light • Indicated by yellow LED	• When the pre-crash safety system is operating , the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the engine ECU and effects control to illuminate this light. • When a failure occurs in the tire pressure warning system, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the tire pressure control ECU effects control to flash this light.
25		• LEXUS park assist-sensor (steering guided) system indicator light • Indicated by green LED	• When the LEXUS park assist-sensor (steering guided) system is operating , the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the crearance warning ECU and effects control to illuminate this light. • When a failure occurs in the LEXUS parking assist-sensor(steerning guided) system, the meter ECU receives the input of BEAN (Body Electronics Area Network) signals from the crearance warning ECU effects control to flash this light.

❖REFERENCE❖

* : provision available for the middle east only

ECD(Electronic Chromatic Device)

- Based on the intensity (solar level) of the outdoor light detected by a solar sensor, the meter ECU calculates an optimal brightness level to automatically adjust the light transmission rate of the meter lens.
- The user can press the MODE switch to select the meter brightness level as desired from seven levels. The meter control ECU adjusts the light transmission rate of the meter lens in accordance with the respective MODE.
- When the user turns the MODE switch from OFF to ON while the ignition switch is ON, the multi-information display panel will show the previously set mode for 6 seconds. Then, the system will adjust the brightness of the meter to suit the present level of the outdoor light. When the user presses the MODE switch while the display shows the previously set mode, the system switches to the next mode. At the same time, it will show the set mode on the multi-information display panel for 6 seconds.



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Meter Lens Light Transmission Rate by Mode (reference value)

MODE		Solar Sensor Detection Value (lx)						
		0~4000	4000~8000	8000~12000	12000~20000	20000~40000	40000~60000	60000~
1	AUTO-Norm	70%	←	40%	←	30%	←	←
2	AUTO-Lo	70%	40%	30%	←	←	←	←
3	AUTO-Hi	70%	←	←	←	←	40%	30%
4	MANUAL-1	70%	30%	←	←	←	←	←
5	MANUAL-2	70%	40%	←	←	←	←	←
6	MANUAL-3	70%	50%	←	←	←	←	←
7	MANUAL-4	70%	←	←	←	←	←	50%

- The meter control ECU switches the light transmission level of the meter lens in accordance with the conditions, in five levels when the ignition is ON in the daytime. It switches in two levels at nighttime or when the ignition is OFF.
- The light transmission levels of the meter lens changes from 70% to 50%, 40%, and 30%. During the transition period in which the light transmission levels are switched, it decreases to the minimum level (30%), thus rendering the dial surface on the meter invisible.

Light Transmission Level Transition Pattern

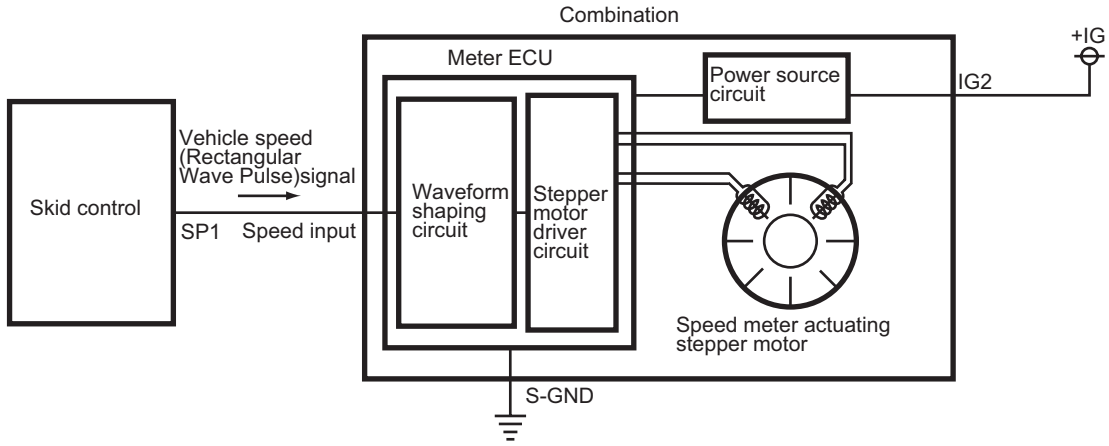
ACC ON→ACC OFF	After transferring to a 0% light transmission rate, and 10 seconds have elapsed, it will transfer to 70%
IG ON→IG OFF	After transferring to a 0% light transmission rate, and 60 seconds have elapsed, it will transfer to 70%
IG OFF→ON{daytime}	After transferring to a 0% light transmission rate, and 10 seconds have elapsed, the light transmission level will transfer to suit the solar level
IG OFF→ON{nighttime}	After transferring to a 0% light transmission rate, and 10 seconds have elapsed, it will transfer to 70%
Daytime→Nighttime	After transferring to a 0% light transmission rate, and 10 seconds have elapsed, it will transfer to 70%
Nighttime→Daytime	After transferring to a 0% light transmission rate, and 10 seconds have elapsed, the light transmission level will transfer to suit the solar level
When accepting the MODE switching request (MODE indicated on multi-information display, and MODE switch ON) [daytime]	After transferring to a 0% light transmission rate, and 10 seconds have elapsed, the light transmission level will transfer to suit the solar level
When accepting the MODE switching request (MODE indicated on multi-information display, and MODE switch ON) [nighttime]	After transferring to a 0% light transmission rate, and 10 seconds have elapsed, it will transfer to 70%
Light Transmission Level Transfer	Transfers to a light transmission level to suit the solar level
10 seconds elapsed after IG OFF	Transfers to a light transmission rate of 70%
Light transmission rate high -> low	Transfers to a light transmission rate of 70%

Speed Meter

- The speedometer consists of an electronic meter that actuates the indicator. The meter ECU inputs and processes the data for actuating the indicator, and controls a stepper motor in accordance with the data in order to indicate the vehicle speed.
- The meter ECU effects initialization control to return the indicator to the zero position each time power is applied to the combination meter.

Speed Meter Operation

- The skid control ECU outputs vehicle speed (rectangular wave pulse) signals that are equivalent to 4 pulses for every revolution of the axis of rotation of the transmission. Upon receiving the input of these signals, the meter ECU counts those waveforms in order to detect the vehicle speed.
- Based on the detected vehicle speed, the meter ECU controls the rotational angle, direction, and speed of the indicator (the rotor of the stepper motor) by actuating the stepper motor driver circuit in order to indicate the vehicle speed.

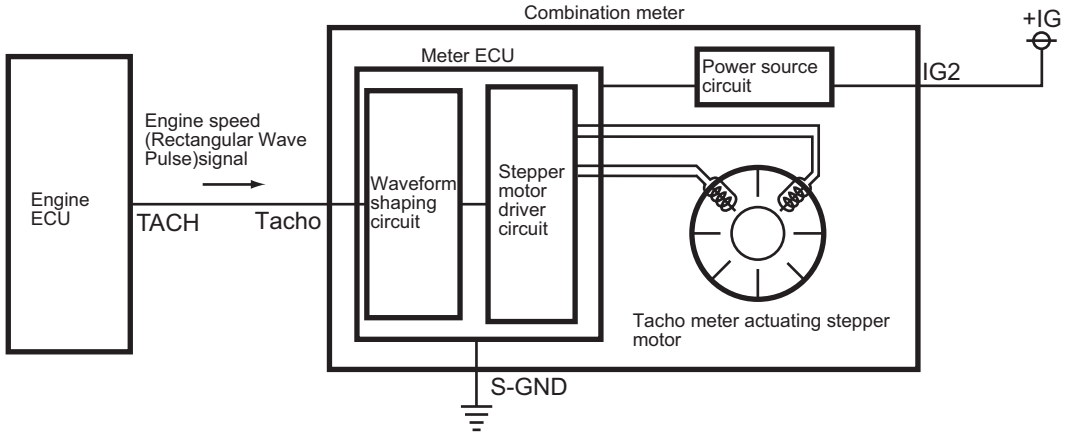


Tacho Meter

- The tachometer consists of an electronic meter that indicates the engine speed. This is accomplished by the meter ECU inputting data for actuating the indicator, and controlling the stepper motor in accordance with the data.
- The meter ECU effects initialization control to return the indicator to the zero position each time power is applied to the combination meter.

Tacho Meter Operation

- The engine ECU outputs engine speed (rectangular wave pulse) signals that are equivalent to 4 pulses (or 6 pulses on V6 engine) for every 2 revolutions of the engine. Upon receiving the input of these signals, the meter ECU counts those waveforms in order to detect the engine speed.
- Based on the detected engine speed, the meter ECU controls the rotational angle, direction, and speed of the indicator (the rotor of the stepper motor) by actuating the stepper motor driver circuit in order to indicate the engine speed.



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Fuel Gauge

- The fuel gauge consists of an electronic meter that actuates the indicator on the fuel gauge. The meter ECU inputs and processes the data for actuating the indicator, and controls a stepper motor in accordance with the data in order to indicate the fuel residual volume.
- The meter ECU effects initialization control to return the indicator to the zero position each time power is applied to the combination meter.

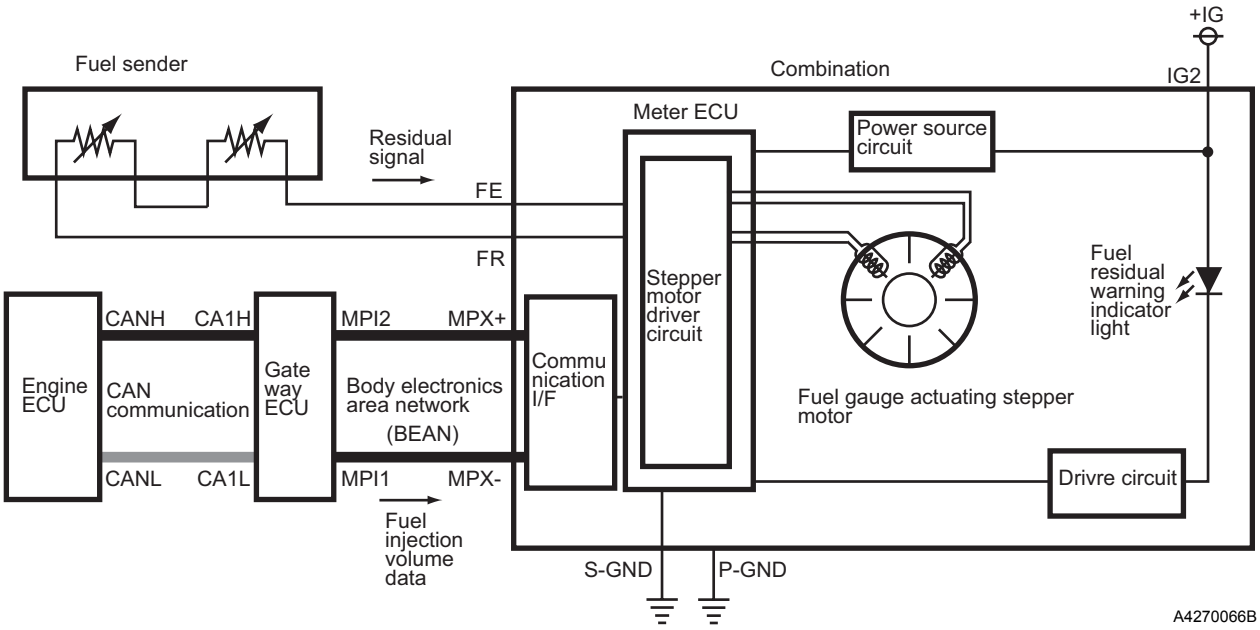
Fuel Gauge Operation

Normal operation

- The meter ECU receives the input of the fuel residual volume (residual volume signal) from inside the fuel tank and the fuel consumption volume of the engine (fuel injection volume data from the BEAN (Body Electronics Area Network)). The meter ECU processes these pieces of data in order to calculate the fuel residual volume display data. This minimizes the fluctuation of the indicator and calculates the residual volume more accurately when the fuel level fluctuates, such as when the vehicle is being driven on a slope or turning.
- Based on the calculated fuel residual volume data, the meter ECU controls the rotational angle, direction, and speed of the indicator (the rotor of the stepper motor) by actuating the stepper motor driver circuit in order to indicate the fuel residual volume.

Handling a Failure in Fuel Injection Volume Data

- If the meter ECU cannot receive the fuel consumption volume of the engine {fuel injection volume data from the BEAN (Body Electronics Area Network)}, it will calculate the fuel residual volume display data based only on the residual volume of the fuel tank (residual volume signal).



Fuel Residual Warning Operation

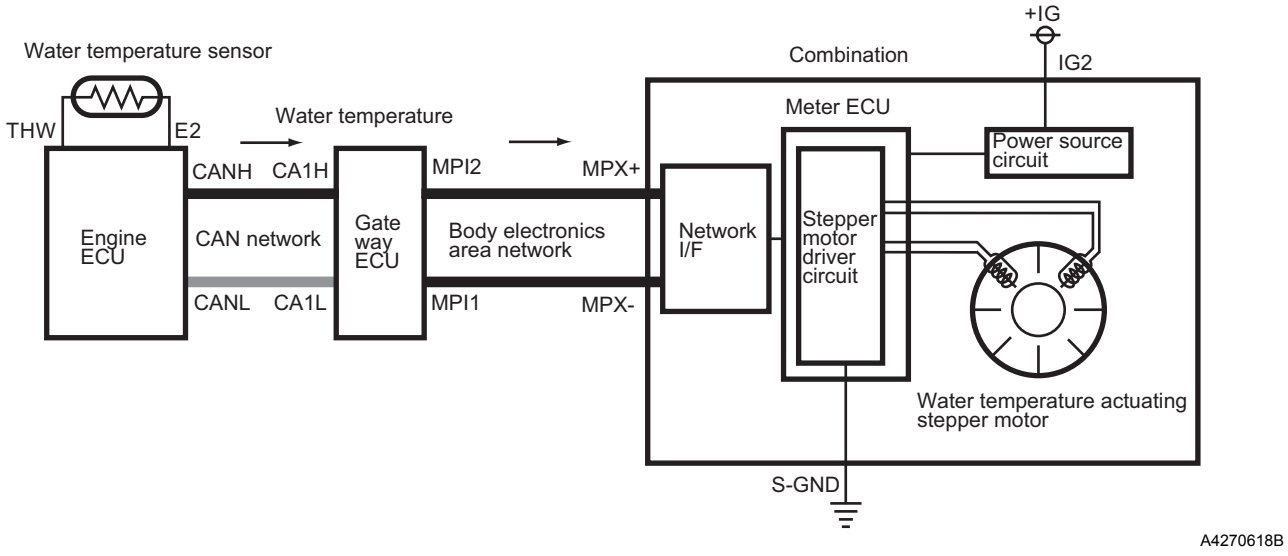
- If the fuel residual volume display data that the meter ECU has calculated for the purpose of actuating the fuel gauge has decreased to an approximately fuel residual volume of 12 liters, the fuel residual volume warning indicator light illuminates in the combination meter.

Water temperature gauge

- The water temperature gauge consists of an electronic meter that actuates the indicator on the water temperature gauge. The meter ECU inputs and processes the data for actuating the indicator, and controls a stepper motor in accordance with the data in order to indicate the engine coolant temperature.
- The meter ECU effects initialization control to return the indicator to the zero position each time power is applied to the combination meter.

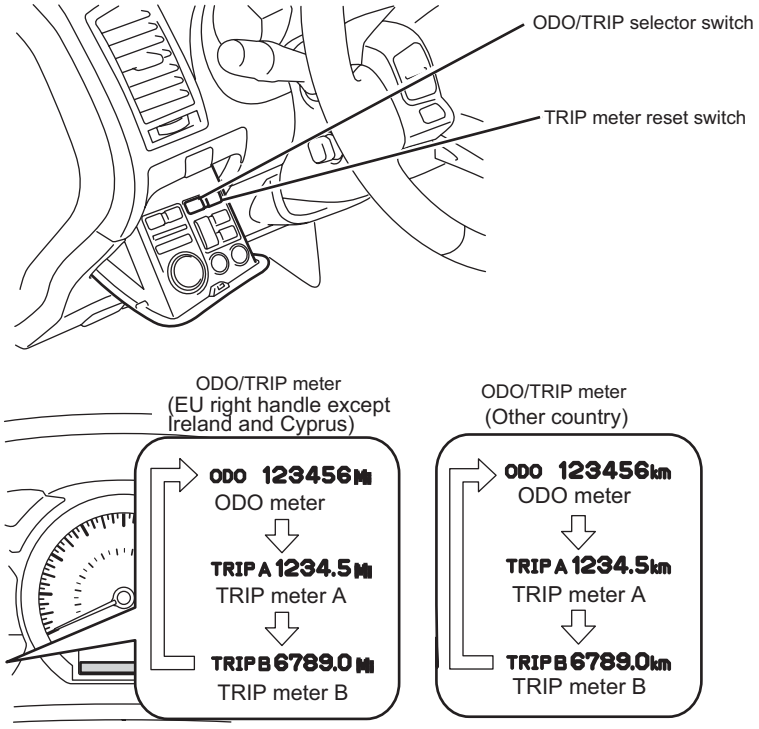
Water Temperature Gauge Operation

- The engine ECU receives the input of a change in resistance detected by the water temperature sensor and sends a water temperature signal to the gateway ECU via the CAN (Controller Area Network).
- The meter ECU receives the water temperature signal from the gateway ECU via the BEAN (Body Electronics Area Network). Based on the received data, the meter ECU controls the rotational angle, direction, and speed of the indicator (the rotor of the stepper motor) by actuating the stepper motor driver circuit in order to indicate the engine coolant temperature.



Odo/trip Meter

- The odo/tripmeter digitally indicates the driven distances on an LCD, which appear alternately in the same position below the tachometer.
- The maximum indication range for the odometer is 999,999 kms in 1-km increments(999,999 miles in 1-mile increments), and for the tripmeter is 9,999.9 kms in 0.1-km increments(9,999.9 miles in 0.1-mile increments). The tripmeter has two display functions, A and B. Thus, including the odometer, 3 channels can be displayed.
- To switch between modes, the user turns ON the odo/trip selector switch that is provided in the module switch located below the left side of the meter cluster. The modes will display in the following order: odometer -> tripmeter A -> tripmeter B -> odometer.
- If the user turns ON (by pressing) the tripmeter reset switch while the display shows the tripmeter A or B, the driven distance indicated by the currently shown tripmeter will revert to 0.0 km(mile). The tripmeter will start counting when the user turns OFF the tripmeter reset switch.



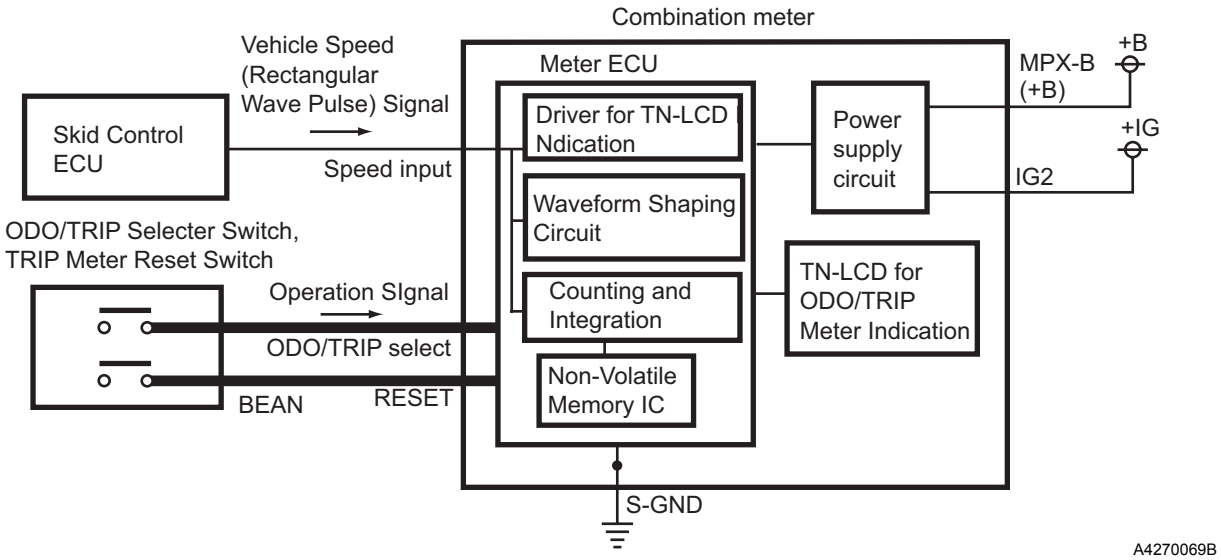
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Odo / Trip Meter Operation

- The meter ECU calculates the driven distance data by counting and estimating the vehicle speed (rectangular wave pulse) signals that are output by the skid control ECU. Then, the meter ECU actuates the LCD display driver to illuminate the corresponding segment of the LCD, in order to indicate the driven distance.
- When the meter ECU receives the input of an operating signal of the odo/tripmeter selector switch, the meter ECU will switch the display in the following order: odometer -> tripmeter A -> tripmeter B -> odometer. When the meter ECU receives the input of an operating signal of the tripmeter reset switch, it reverts the driven distance indication on the tripmeter to 0.0 mile.
- The meter ECU stores the driven distance data. A non-volatile memory IC* is used to store the odometer values in order to keep the data in memory even after the +B power supply is turned OFF.

❖REFERENCE❖

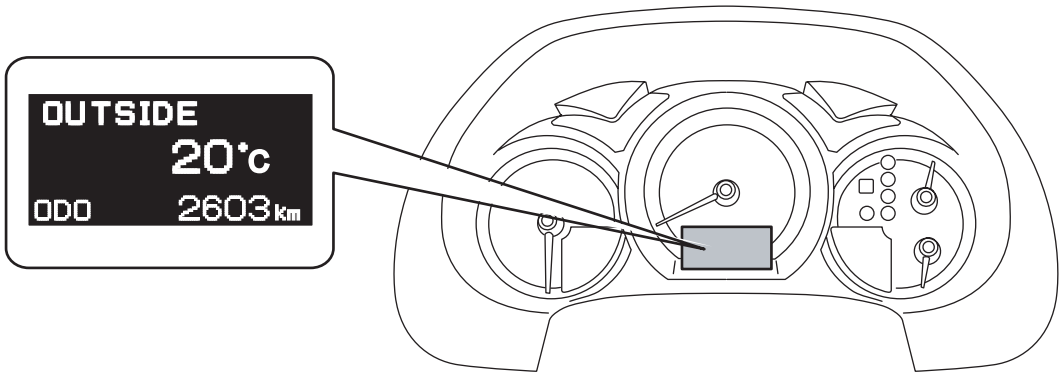
*A type of memory IC that keeps data in memory even if no electric power is supplied to it.



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Outside Temp. Display

- The outside air temperature gauge is located in the same display area as the odo/tripmeter. It digitally indicates the outside air temperature on the LCD.



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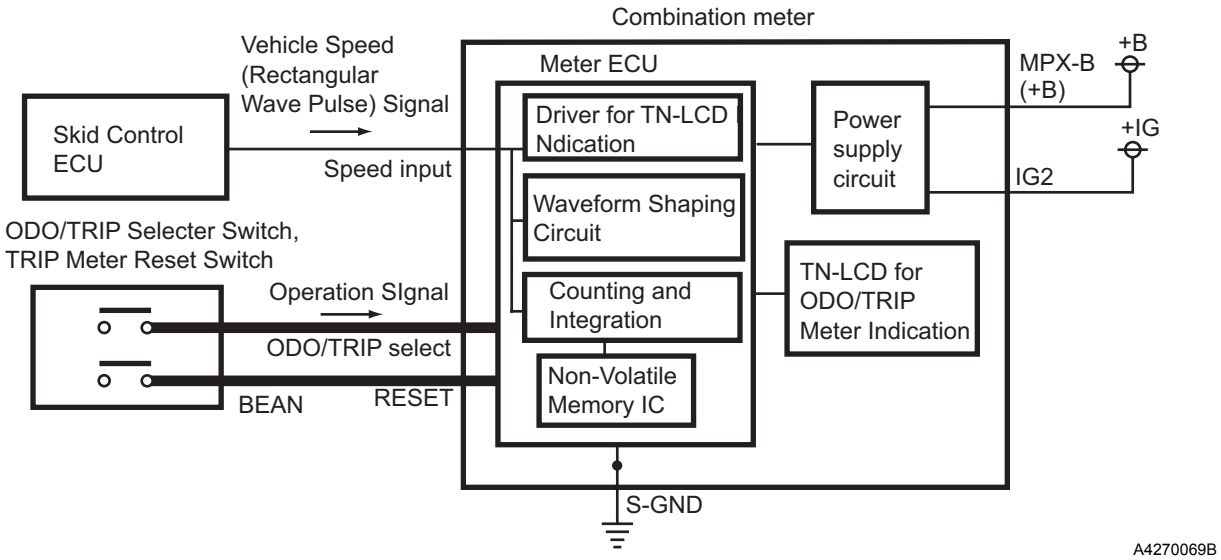
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Odo / Trip Meter Operation

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- When the meter ECU receives the input of an operating signal of the odo/tripmeter selector switch, the meter ECU will switch the display in the following order: odometer -> tripmeter A -> tripmeter B -> odometer. When the meter ECU receives the input of an operating signal of the tripmeter reset switch, it reverts the driven distance indication on the tripmeter to 0.0 mile.
- The meter ECU stores the driven distance data. A non-volatile memory IC* is used to store the odometer values in order to keep the data in memory even after the +B power supply is turned OFF.

❖REFERENCE❖

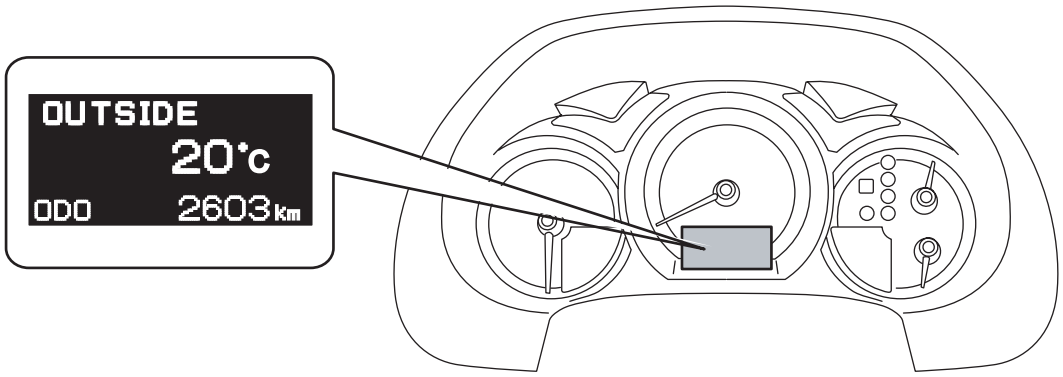
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A4270069B

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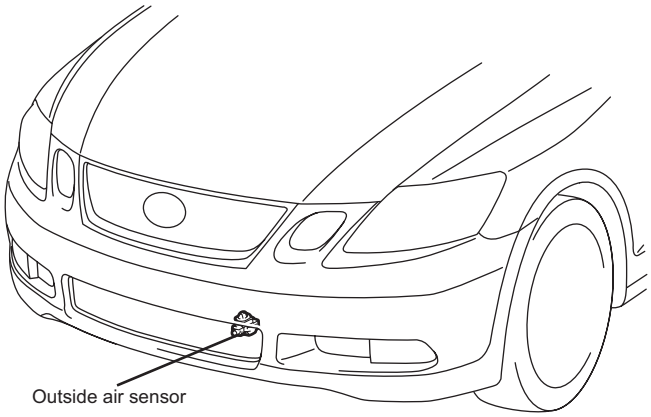
BE

Outside Air tempterature Specifecation

Indication Area	Indication Configuration	Function
• -40~50°C.(1°C increments)	• Displays "E" if the meter ECU cannot receive an outside air temperature display signal. • Displays "E° C" if the meter ECU cannot receive outside air temperature data. • Displays "--°C" in case of a failure in the outside air temperature sensor.	• The front air conditioning ECU receives outside air temperature data from the engine ECU and calculates the display outside air temperature. Then, it sends the outside air temperature display signal to the meter ECU. • The meter ECU receives the outside air temperature display data from the front air conditioning ECU, and displays the outside air temperature.

Ambient Temperature Sensor

● To indicate outside air temperature on the display located in the center instrument panel, the meter ECU receives the input of a signal from the outside air sensor, which is mounted below the bumper reinforcement. This signal is input via the engine ECU in the form of the BEAN (Body Electronics Area Network).



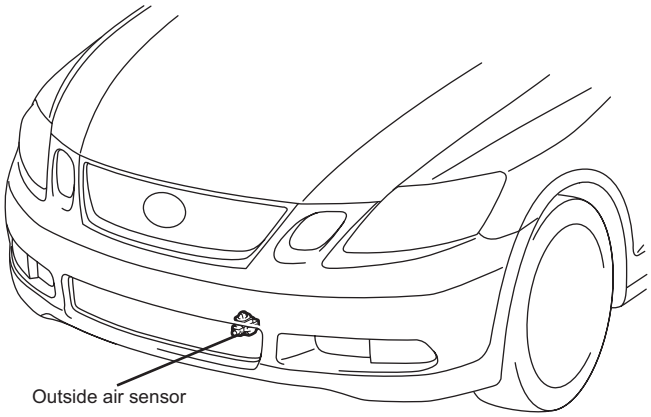
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Outside Air tempterature Specifecation

Indication Area	Indication Configuration	Function
• -40~50°C.(1°C increments)	• Displays "E" if the meter ECU cannot receive an outside air temperature display signal. • Displays "E° C" if the meter ECU cannot receive outside air temperature data. • Displays "--°C" in case of a failure in the outside air temperature sensor.	• The front air conditioning ECU receives outside air temperature data from the engine ECU and calculates the display outside air temperature. Then, it sends the outside air temperature display signal to the meter ECU. • The meter ECU receives the outside air temperature display data from the front air conditioning ECU, and displays the outside air temperature.

Ambient Temperature Sensor

● To indicate outside air temperature on the display located in the center instrument panel, the meter ECU receives the input of a signal from the outside air sensor, which is mounted below the bumper reinforcement. This signal is input via the engine ECU in the form of the BEAN (Body Electronics Area Network).



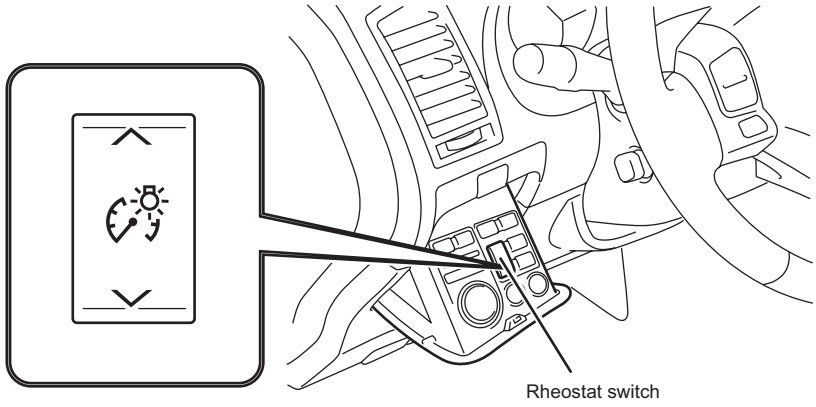
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Rheostat

- Light dimming characteristics that are appropriate for the respective conditions have been provided through the operation of the light control switch or the daytime judgment based on the surrounding brightness detection signal provided by the light control sensor.
- The rheostat is mounted inside the module switch, which is located below the left side of the meter cluster. By operating the rheostat switch, the driver will be able to adjust the brightness of the meter.

Dimmable Sections

Stepless Dimming	Fixed Dimming (2 steps)
speed meter,tachometer,fuel gauge,water temperature gauge,odo/ tripmeter,multi infomation display,outside air temperature gauge	operation/warning indicator lights (taillight,ECT POWER,ECT SNOW,CRUISE,AVS,AFS OFF),shift position indicator lights(P,N,D,S)



A4270354B

Dimming Characteristics

Daytime

UP	1	1/1
	2	5/10
Rheostat Switch	3	4/5
	4	7/10
	5	3/5
DOWN	6	1/2

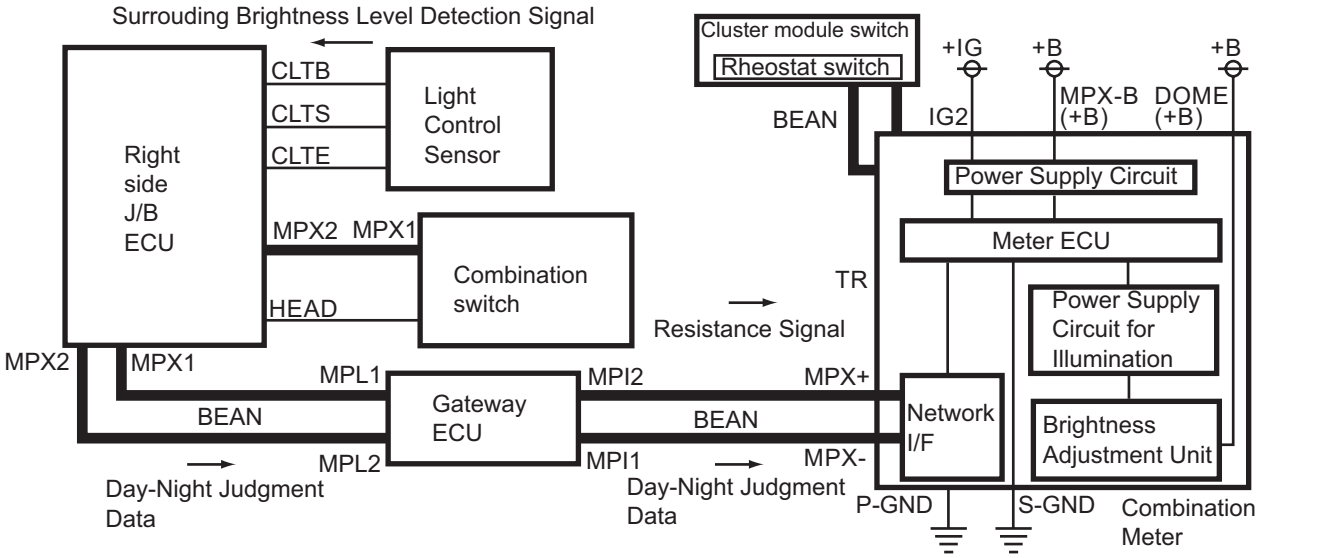
Nighttime

UP	1	1/5
	2	3/20
	3	2/15
	4	3/26
	5	19/200
Rheostat Switch	6	3/40
	7	11/200
	8	1/40
	9	1/100
DOWN	10	1/300

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Rheostat Operation

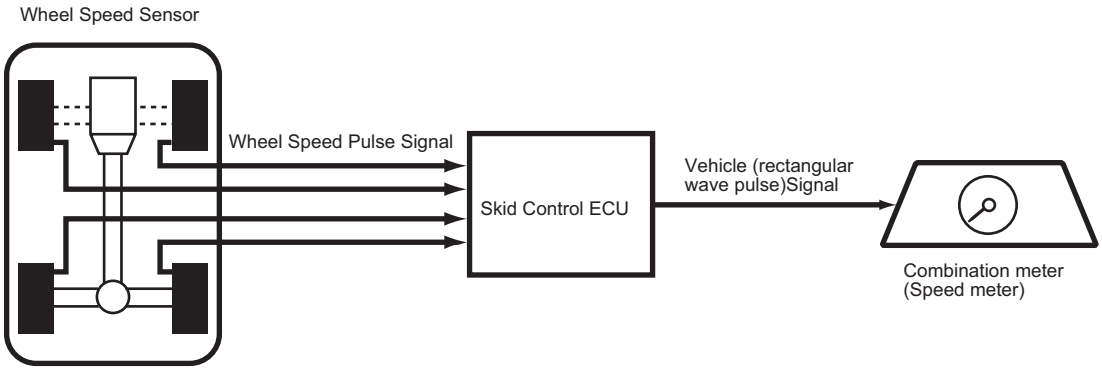
- Based on the taillight ON/OFF signal that is output by the operation of the light control switch, and the surrounding brightness level detection signal provided by the light control sensor, the right side J/B ECU determines whether it is daytime or nighttime. Then, it outputs the daytime/nighttime judgment data to the meter ECU via BEAN (Body Electronics Area Network).
- The meter ECU receives the input of this data, as well as the input of the changes in resistance that result from the operation of the rheostat, in order to adjust the lights to a brightness level that suits the daytime/nighttime judgment data.



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Speed Sensor

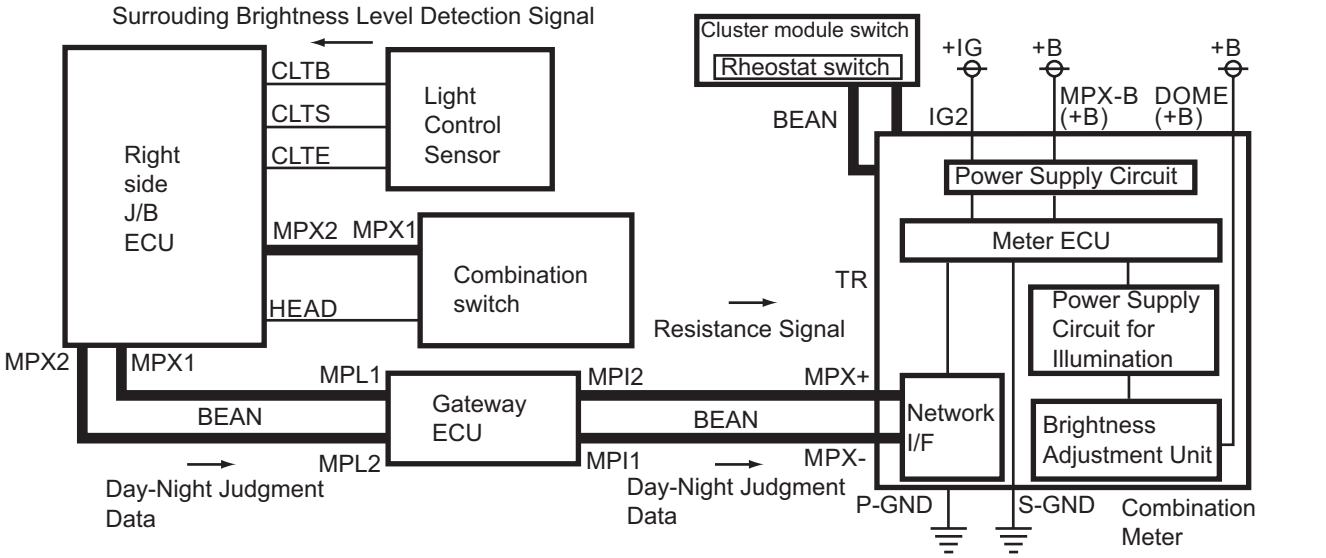
- A wheel speed sensor that is provided at each wheel outputs 48 pulses of wheel speed pulse signals per revolution of the wheel. The skid control ECU converts this signal into vehicle speed rectangular wave pulse signals that are equivalent to 4 pulses for every revolution of the axis of rotation of the transmission, and outputs them to the combination meter.



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Rheostat Operation

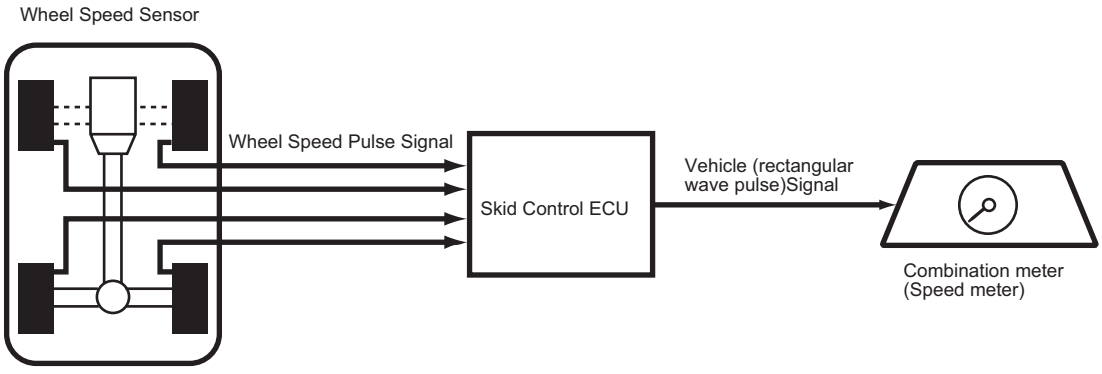
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Speed Sensor

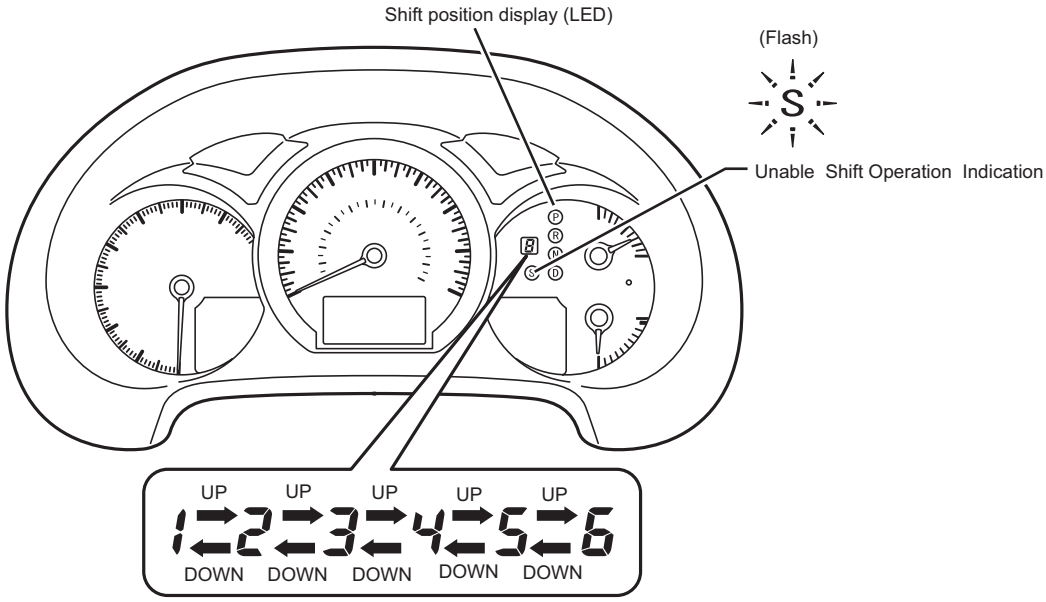
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Shift Position Indicator

- A shift position indicator is used. It receives a signal from the engine ECU via the BEAN (Body Electronics Area Network) and indicates the present shift position and the shift range during the "S" mode.
- The shift position indicator is located on the right side of the combination meter. It consists of a combination of LEDs (Light Emitting Diodes) and an LCD (Liquid Crystal Display) to indicate the present shift position and shift range.



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Shift Position Indication Function

- Indicates the present shift position by illuminating one of the following LEDs: "P", "R", "N", "D", or "S".

Shift Range Indication Function

- When the driver moves the shift lever to the "S" position, this function indicates the shift position through the use of Arabic numerals consisting of 7 segments.
- If it is unable to shift, the engine ECU outputs a signal in order to flash the "S" position.

Shift Position Signal Failure Indication Function

- If the meter ECU simultaneously receives multiple shift position signals (P, R, N, D, and S) indicated by LEDs, it will indicate the multiple shift positions in accordance with the states of the signals. If the meter ECU simultaneously receives multiple shift range signals, or if it cannot receive none of the shift range signals, the meter ECU will turn OFF all the shift range indications on the LCD.

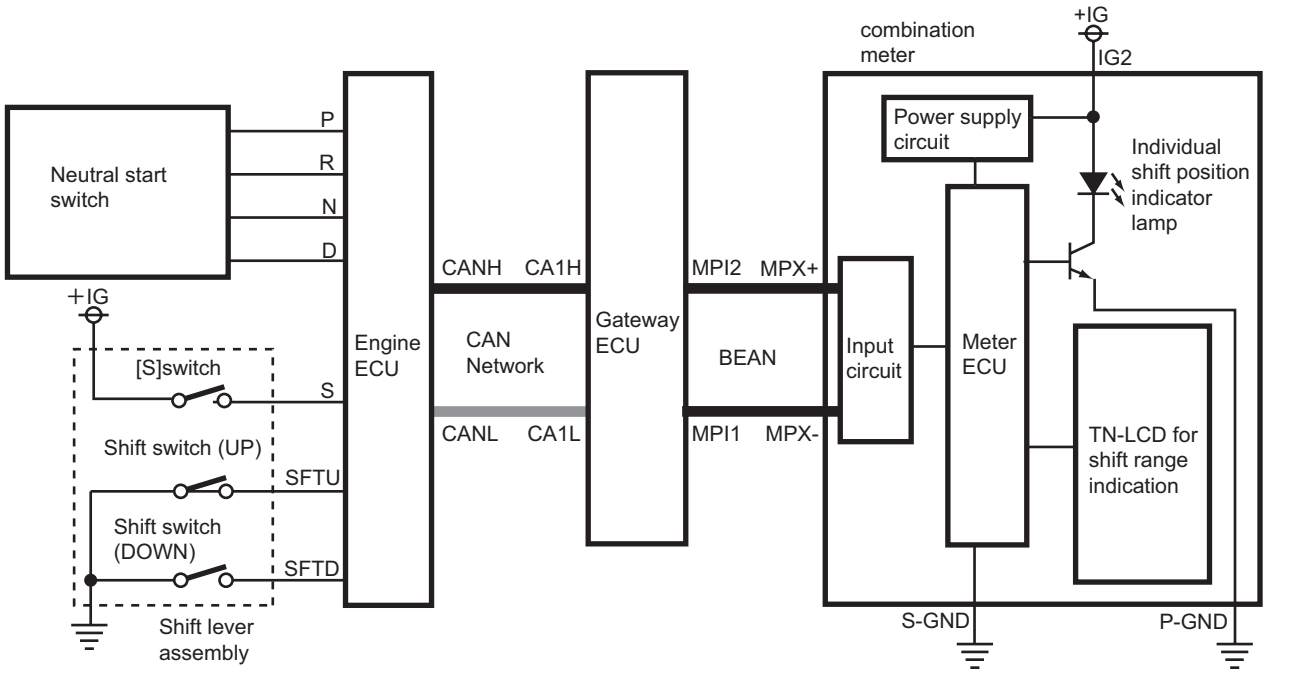
Shift Position Indicator Operation

Shift position indication

- The engine ECU receives the input of the shift position signal from the neutral start switch and transmits it to the gateway ECU in the form of a CAN (Controller Area Network) signal. The meter ECU receives this signal from the gateway ECU in the form of a BEAN (Body Electronics Area Network) signal in order to illuminate the corresponding shift position indicator light (LED).

Shift range indication

- When the engine ECU receives the input of the "S" shift position signal, it simultaneously receives the input of an UP/DOWN shift switch operation signal, and transmits them to the gateway ECU in the form of a CAN (Controller Area Network) signal. Upon receiving these signals from the gateway ECU in the form of a BEAN (Body Electronics Area Network) signal, the meter ECU actuates the built-in LCD driver. Then, it uses Arabic numerals to indicate the presently selected shift range on the shift range display LCD.



A4270619B

Warning Indicator Active Circuit

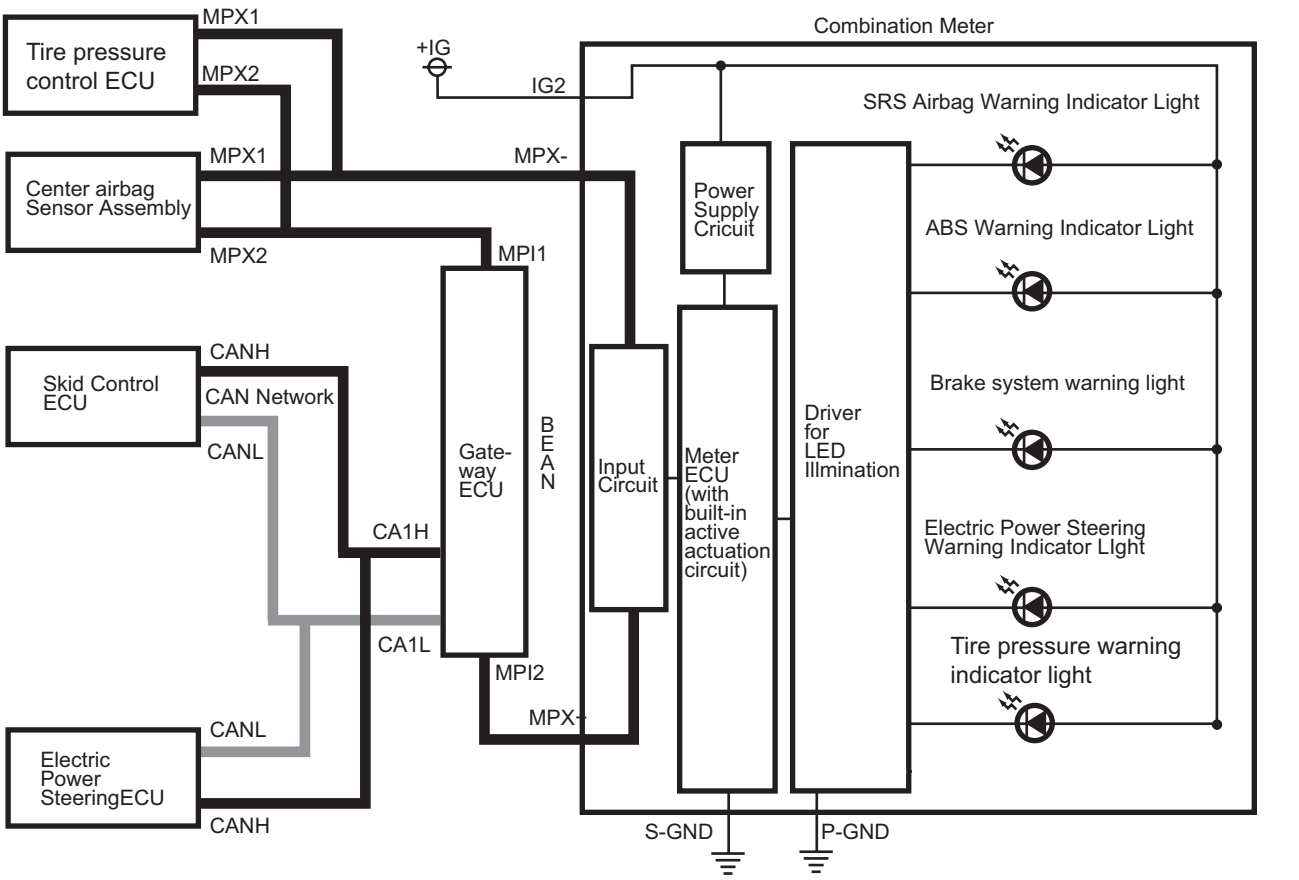
- An active circuit is used to cause the combination meter to effect control to illuminate the operation/warning indicator light of the corresponding system, if a wiring or communication failure occurs in the connection between the combination meter and some of the ECUs.
- An active circuit is provided to the indicator lights for the SRS airbag, ABS, brake, electronic power steering, tire pressure. If a wiring or communication failure occurs between the combination meter and the respective system (such as incompletely coupled connectors, wedged wiring harnesses, or open circuits), the combination meter effects control to illuminate the operation/warning indicator light of the corresponding system to alert the driver of the failure.

Warning Indicator Active Circuit Operation

- Ordinarily, each ECU monitors the operating condition or failure of its own system and transmits the operation/warning indicator light illumination request signal to the meter ECU via the routes shown in the table, in order to illuminate the warning indicator light of the corresponding system.
- If the meter ECU detects a connection or communication failure in the transmission route of the operation/warning indicator light illumination request signal, its built-in active actuation circuit will illuminate the respective operation/warning indicator light in accordance with the state of the detected failure.

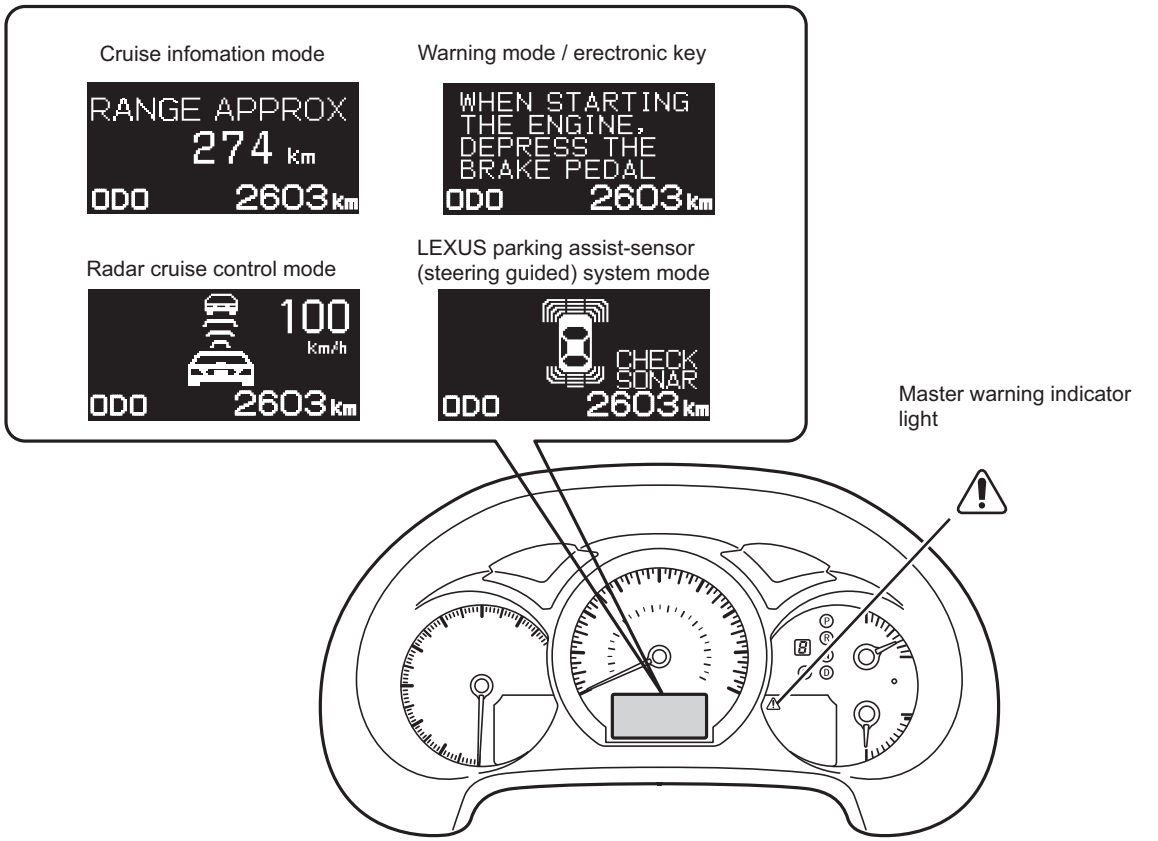
Transmission route of operation/warning indicator light illumination request signal (corresponding to active actuation)

Transmission Source of Illumination Request Signal	Signal Route	Indicator Light to Illuminate
Center airbag sensor assembly	->Body Electronics Area Network(BEAN)->Meter ECU	• SRS airbag warning
SKid control ECU	->(CAN network)->Gateway ECU->Body Electronics Area Network(BEAN)->Meter ECU	• ABS warning • Brake system warning
Electric power steering ECU	->(CAN network)->Gateway ECU->(Body Electronics Area Network(BEAN)->Meter ECU	• Electric power steering warning
Tire pressure ECU	->Body electronics area network(BEAN)->Meter ECU	• Tire pressure warning


Tire pressure control ECU
MPX1
MPX2
Center airbag Sensor Assembly
MPX1
MPX2
Skid Control ECU
CANH
CAN Network
CANL
Electric Power SteeringECU
CANL
CANH
+IG
IG2
MPX-
MPI1
MPI2
MPX+
Gate-way ECU
BEAN
CA1H
CA1L
Combination Meter
Input Circuit
Power Supply Cricuit
Meter ECU (with built-in active actuation circuit)
Driver for LED Illmination
SRS Airbag Warning Indicator Light
ABS Warning Indicator Light
Brake system warning light
Electric Power Steering Warning Indicator LIght
Tire pressure warning indicator light
S-GND
P-GND
A4270076B

Multi-information Display

- The multi-information display is a dot matrix display that uses FSTN (Film Compensated Super Twisted) liquid crystals to indicate various modes through numbers, text, or vehicle marks.
- A master warning indicator light is provided in the combination meter. Linked to the warning mode indications on the multi-information display, this light illuminates or flashes in unison with those indications.



*1:Models equipped with Radar cruise control system
*2:Models equipped with LEXUS parking assist-sensor(steering guided) system

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Multi Information Display Indication and Function

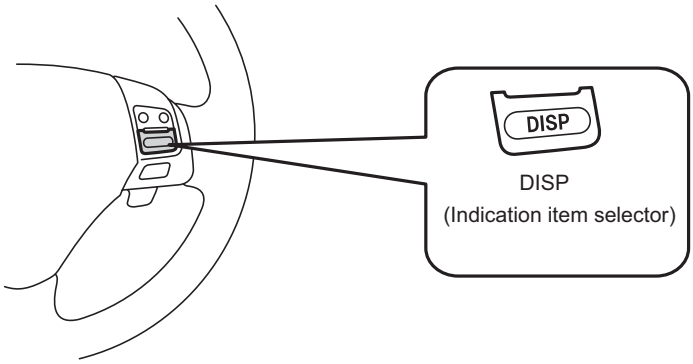
• The multi-information display puts the unrestricted display pattern characteristics of the dot matrix to good use, and indicates numerous pieces of information interchangeably to suit various situations.

Multi information display indication and function

Indication	Key position	Operation condition	Function
Cruise information mode	IG ON	• Indicates constantly when the ignition is ON.	Indications change as follows: blank (no indication) -> continuous drivable range -> average fuel consumption after refueling -> instant fuel consumption.
Warning mode	-	• When a failure signal is input from a system.	Indicates the name of the failed system.
Radar cruise control mode	IG ON	• During the operation of radar cruise control. • When a failure signal is input from radar cruise control.	Indicates the control state of the radar cruise control and the radar cruise control warning item.
LEXUS parking assist-sensor(steering guided) system mode	IG ON	• During the operation of the front & clearance sonar	Indicates the obstacle detection information of the front & clearance sonar system.
Electronic key mode	-	• When a failure signal is input from the Electronic key system. • During the operation to select the unlock mode.	Indicates the selected state of the electronic key unlock mode and the electronic key warning item.
Inspection mode	-	• Turn the ignition ON while keeping the DISP switch pressed.	Illuminates all the multi-display indicator lights to inspect for an open circuit.

Indication Select Control

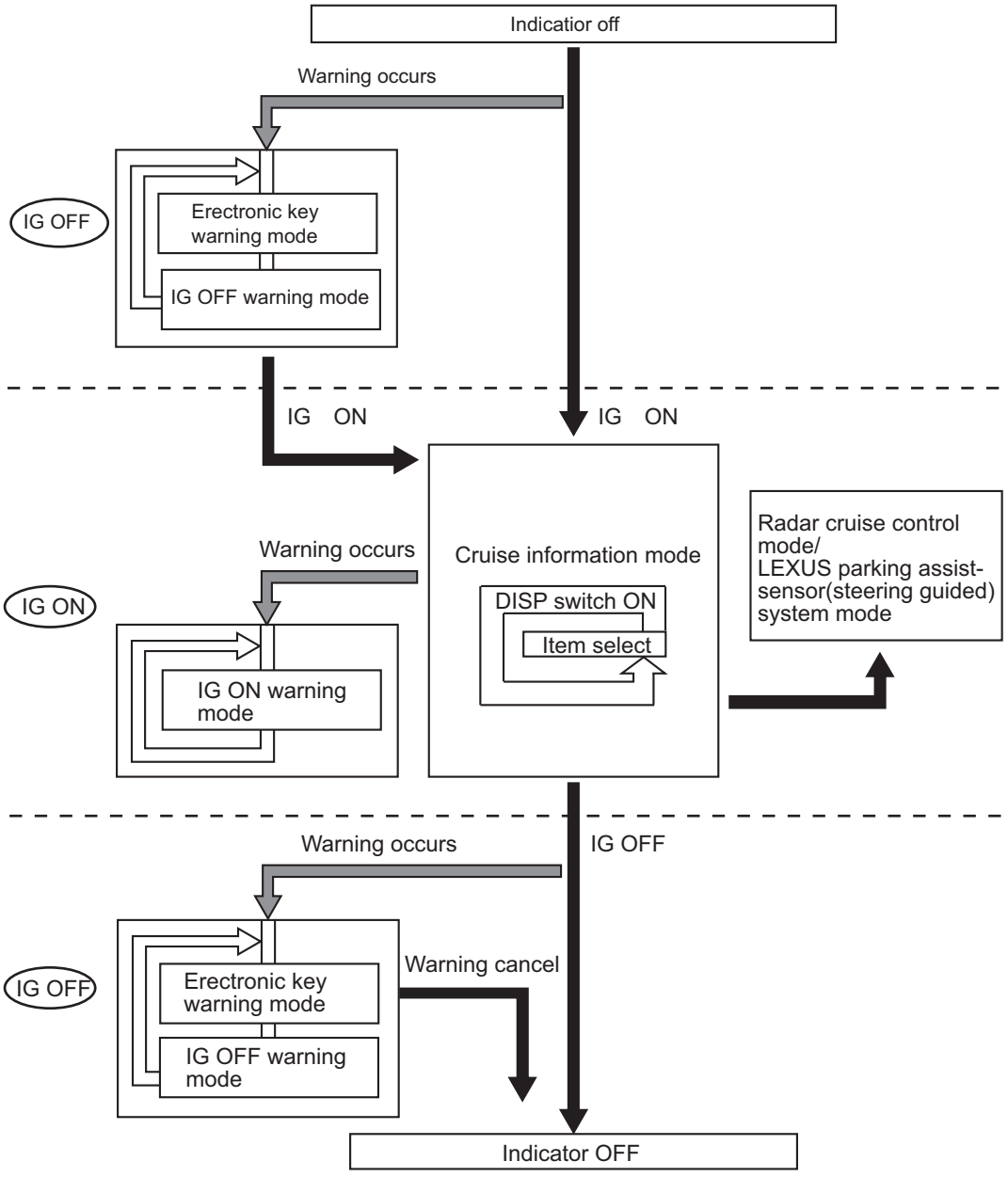
- In the cruise information mode, the driver can press the DISP (indication item selector) switch, which is located on the right side of the steering wheel, to access the required item.
- While the cruise information mode is shown, if the warning mode, radar cruise control mode, or the LEXSUS parking assist-sensor (steering guided) mode cuts in, the driver can press the DISP (indication item selector) switch to switch between those modes and the cruise information mode.



A4270357B

Flow of Multi-Information Display Indication

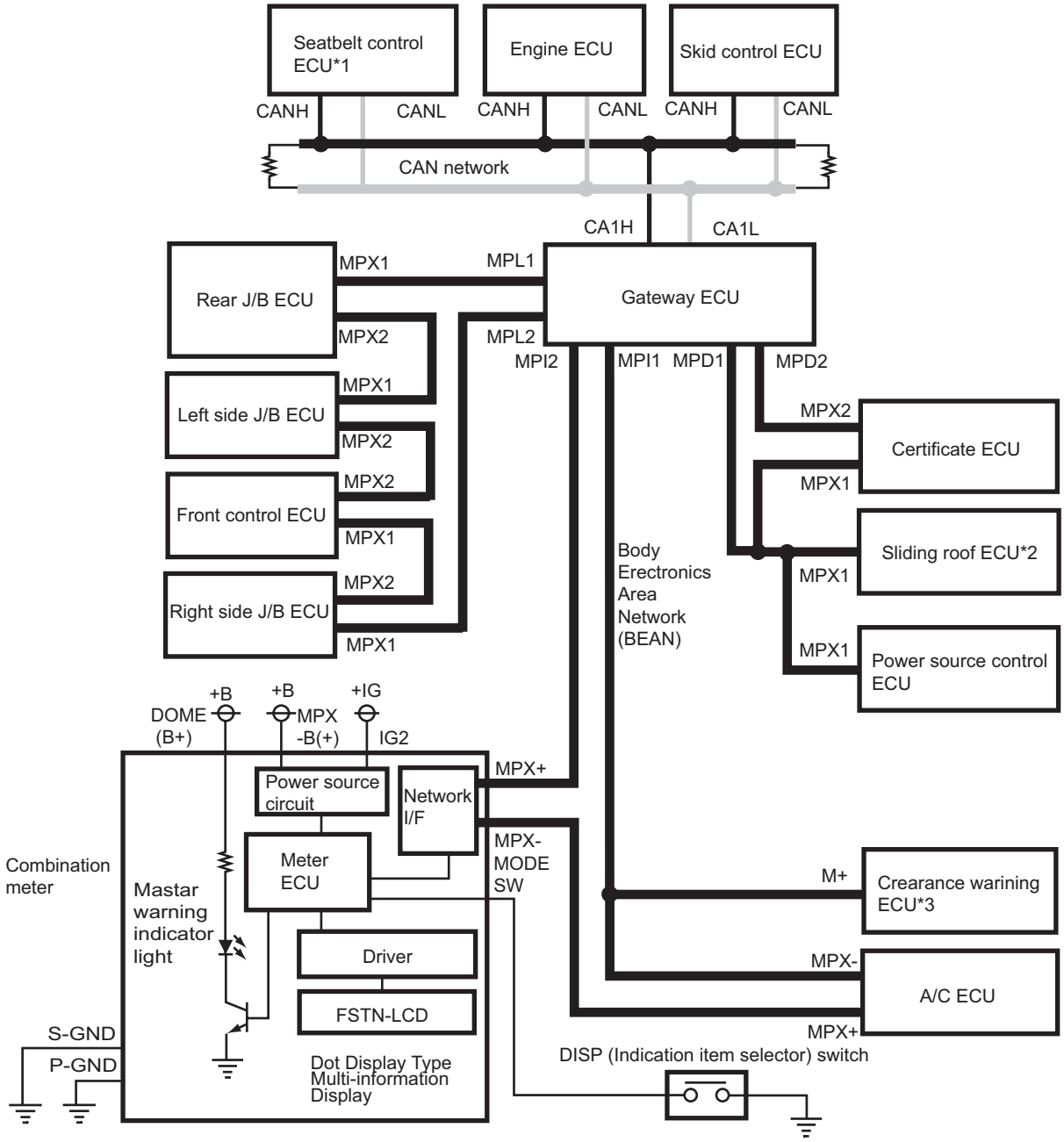
- The diagram below shows the flow of the multi-information display to indicate the modes. For details on the description of the indication of each mode, refer to the explanation of the respective mode given below.



A4270630B

Multi-Information Display Operation

- The signals from the systems on the vehicle are input in the meter ECU located in the combination meter. Based on these signals, the meter ECU calculates various values to be indicated in the cruise information mode, indicates information via the FSTN liquid crystal driver, and effects control to illuminate and flash the master warning indicator light. In addition, the meter ECU receives the input of signals from the DISP (indication item selector) switch in order to change the indication items and the indication modes.



*1: Model with Pre-Crash system
*2: Model with moon roof
*3: Model with LEXUS parking assist-sensor (steering guided) system

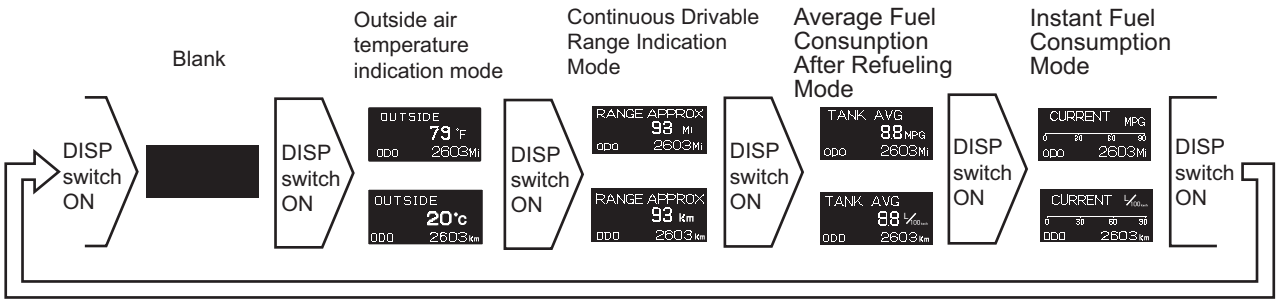
A4270631B

Multi Information Display "Cruise Information Mode"

● The cruise information indication mode indicates information such as the continuous drivable range and fuel consumption.

Indication Flow in Cruise Information Indication Mode

- The display shows the cruise information mode when the ignition is turned ON.
- The indication items change in the order shown below each time the DISP switch is turned ON.



A4270358B

Continuous Drivable Range Indication Mode





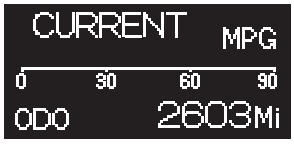
A4270359B

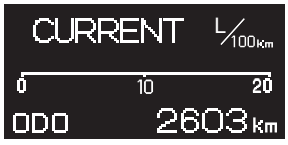
Continuous Drivable Distance Specifications

Indication Area	Indication Configuration	Function
• 0~999mile.(EU right handle vehicle except Ireland and Cyprus) • 0 ~ 999km(other country)	• Shows the previous data when the ignition is turned ON. • Starts the continuous calculation when the engine is started. • Leaves the value blank (no indication) if a failure is detected in the fuel gauge.	• The meter ECU learns the fuel consumption rate based on the vehicle speed signals and the fuel consumption volume data. Then, based on the present fuel residual volume signal the meter ECU calculates the continuous drivable range and indicates it on the display.

BE

Instant Fuel Consumption Indication Mode





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Instant Fuel Consumption Specifications

Indication Area	Indication Configuration	Function
• 0.0~90.0MPG{0.1MPG increments(EU right handle vehicle except Ireland and Cyprus)} • 0.0~20.0L/100km(0.1L/100km increments)(otehr country) • Bar graph indication.	• Shows 0.0 MPG(L/100km) when the ignition is turned ON and when the engine is started. • Starts calculating when the vehicle starts to move. • Shows 0.0 MPG(L/100km) if fuel injection volume data cannot be received.	• The meter ECU calculates the instant fuel consumption rate based on the driven distance (per vehicle speed signals) for every 20 revolutions of the engine and the fuel consumption volume (per fuel injection volume data), and indicates it on the display.

Refueling Average Consumption Indication Mode



A4270361B

Average fuel consunption after refueling specification

Indication area	Indication configuration	Function
• 0.0~90.0MPG (0.1MPG increments(EU right handle vehicle except Ireland and Cyprus)} • 0.0~30.0L/100km{0.1L/100km increments(other country)}	• Shows the previous data when the ignition is turned ON. • Starts the continuous calculation when the engine is started. • Leaves the value blank (no indication) if the fuel injection volume data cannot be received.	• The meter ECU detects refueling based on the fuel residual volume signal. It resets the data when the vehicle starts to move. Then, it calculates the average fuel consumption following the refueling and indicates it on the display.

Multi Information Display "Warning Indication Mode"

● If a failure occurs in a section of the vehicle, the warning indication mode cuts in to alert the driver of the failure, even when another item is shown on the display.

Flow of Indication in Warning Indication Mode

- When a failure occurs in a system (and the respective condition is met), the display will show the corresponding warning and illuminate or flash the master warning indicator light. When a failure is shown initially, the multi buzzer also sounds to alert the driver as quickly as possible.
- When there are multiple warning indication items, the display will show the warning items that are occurring in the order shown below. The display will show the first indication (when a new warning occurs) for approximately 6 seconds, and the second and subsequent indications for approximately 2 seconds each.

Instant Fuel Consumption Specifications

Indication Area	Indication Configuration	Function
• 0.0~90.0MPG{0.1MPG increments(EU right handle vehicle except Ireland and Cyprus)} • 0.0~20.0L/100km(0.1L/100km increments)(otehr country) • Bar graph indication.	• Shows 0.0 MPG(L/100km) when the ignition is turned ON and when the engine is started. • Starts calculating when the vehicle starts to move. • Shows 0.0 MPG(L/100km) if fuel injection volume data cannot be received.	• The meter ECU calculates the instant fuel consumption rate based on the driven distance (per vehicle speed signals) for every 20 revolutions of the engine and the fuel consumption volume (per fuel injection volume data), and indicates it on the display.

Refueling Average Consumption Indication Mode



A4270361B

Average fuel consunption after refueling specification

Indication area	Indication configuration	Function
• 0.0~90.0MPG (0.1MPG increments(EU right handle vehicle except Ireland and Cyprus)} • 0.0~30.0L/100km{0.1L/100km increments(other country)}	• Shows the previous data when the ignition is turned ON. • Starts the continuous calculation when the engine is started. • Leaves the value blank (no indication) if the fuel injection volume data cannot be received.	• The meter ECU detects refueling based on the fuel residual volume signal. It resets the data when the vehicle starts to move. Then, it calculates the average fuel consumption following the refueling and indicates it on the display.

Multi Information Display "Warning Indication Mode"

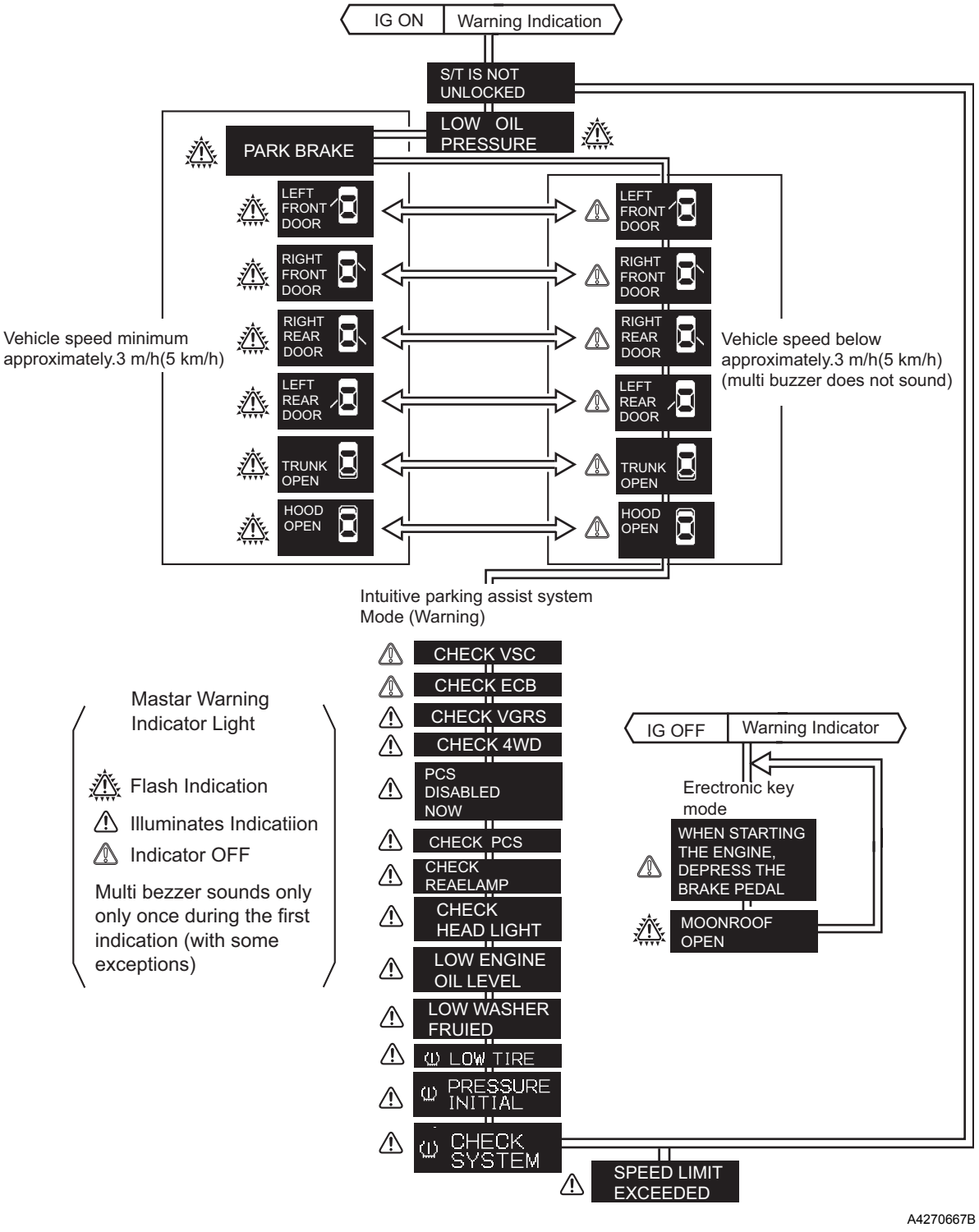
● If a failure occurs in a section of the vehicle, the warning indication mode cuts in to alert the driver of the failure, even when another item is shown on the display.

Flow of Indication in Warning Indication Mode

- When a failure occurs in a system (and the respective condition is met), the display will show the corresponding warning and illuminate or flash the master warning indicator light. When a failure is shown initially, the multi buzzer also sounds to alert the driver as quickly as possible.
- When there are multiple warning indication items, the display will show the warning items that are occurring in the order shown below. The display will show the first indication (when a new warning occurs) for approximately 6 seconds, and the second and subsequent indications for approximately 2 seconds each.

• If a warning item occurs in the SMART ACCESS SYSTEM with PUSH-BUTTON START, the display will show the electronic key mode.

• If a warning item occurs in the LEXUS parking assist-sensor (steering guided) system, the display will show the clearance sonar mode (warning).



A4270667B

BE

Engine Oil Pressure Warning Indication

- Alerts the driver that the engine oil pressure is extremely low.



A4270367B

Parking Brake Warning

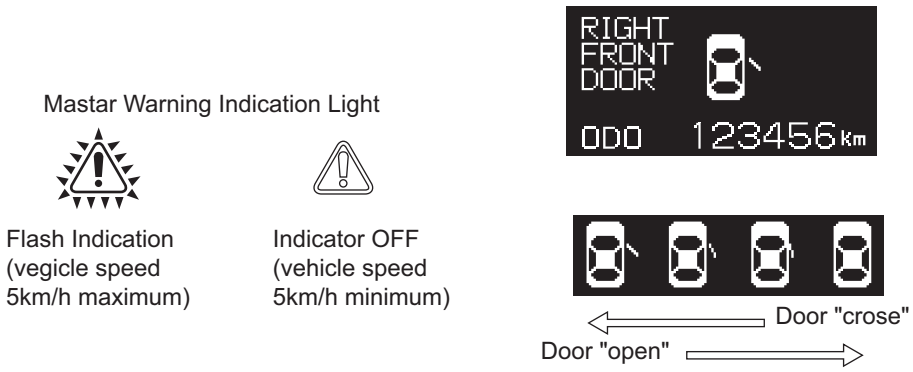
- Alerts the driver that the vehicle is being driven {approximate minimum vehicle speed of 5 km/h(5 mph)} without releasing the parking brake.



A4270582B

Individual Door Warning

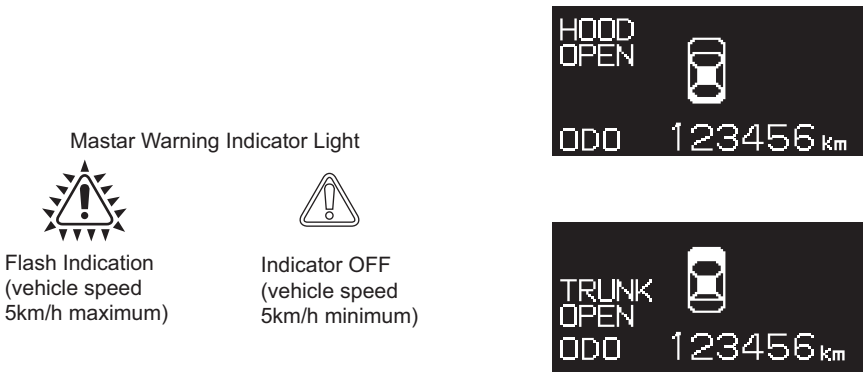
- Alerts the driver of an individual door that is open or ajar, for every individual door.
- When a door that is open is closed (or vice versa), the display will indicate the movement of the door through a four-stage animation.



A4270583B

Engine Hood / Luggage Compartment Door Warning

• Alerts the driver that the engine hood (bonnet) or the luggage compartment door (trunk) is open.



A4270584B

VSC Warning

• Alerts the driver that a failure has occurred in the VSC system.



A4270090B

ECB Warning

• Alerts the driver that a failure has occurred in the ECB system.



A4270625B

BE

PCS Warning

Operation Stop Warning

• Alerts the driver that the pre-crash safety system is currently disabled, as a result of this system being tripped repeatedly within a short time.



A4270371B

System Failure Warning

• Alerts the driver that a failure has occurred in a part related to the pre-crash safety system, and a portion of the system is inactive.

Mastar Warning Indicator LIght



Illuminates Indication



A4270372B

Rear Light System Warning

• Alerts the driver that a failure has occurred in the stoplight, high-mount stoplight, taillight system or that the communication has been disrupted.

Mastar Warning Indicator Light



Illuminates Indication



A4270373B

Headlight System Warning

• Alarts the driver that a failure has occurred in the headlight system or that the communication has been disrupted

Mastar Warning Indicator Light



Illuminates Indication



A4270622B

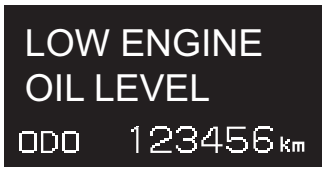
Engine Oil Level Warning

• Alarts the driver that the engine oil level is extremely low.

Mastar Warning Indicator Light



Illuminates Indication



A4270621B

Tire Air Pressure Warning

Low Tire Air Pressure Warning

• Alerts the driver that the air pressure in the tires has dropped.

Mastar Warning Indicator Light



Illuminates Indication



A4270375B

Tire Air Pressure Initialization Indication

• Indicates that the initialization of the tire air pressure has been completed.

Mastar Warning Indication Light



Illuminates Indication



A4270376B

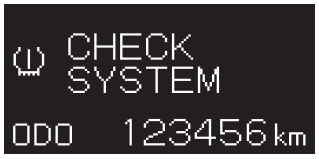
Tire Air Pressure System Warning

• Alerts the driver that a failure has occurred in the tire air pressure system.

Mastar Warning Indicator Light



Illuminates Indication



A4270378B

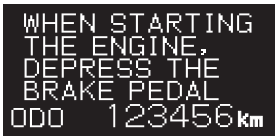
Engine Starting Warning

• Indicates when the driver presses the engine switch without pressing the brake pedal, and switches the engine switch twice.

Mastar Warning Indicator Light



Indicator OFF



A4270593B

Steering Lock Warning

Steering lock not unlock warning

• Alerts the driver that the steering lock has not been unlocked.

Mastar Warning Indicator Light



Illuminates Indication



A4270492B

Steering system check warning

• Alerts the driver that a failure has occurred in the steering lock system.

Mastar Warning Indicator Light



Illuminates Indication



A4270531B

Moon Roof Warning

• Alerts the driver that the moon roof is left inadvertently open.

Mastar Warning Indicator Light



Illuminates Indication



A4270380B

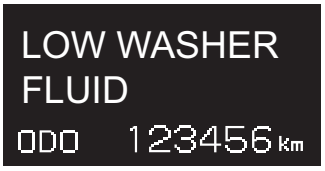
Body Proper Rust proofing Countermeasure

• Alerts the driver that the washer fluid level is low.

Mastar Warning Indicator Light



Illuminates Indication



A4270596B

Speed Warning

• Indicates when the vehicle speed exceeds 120 km/h.*

Mastar Warning Indicator Light



Illuminates Indication



A4270528B

❖REFERENCE❖

* : Provision available for the Middle East only.

Multi Information Display "SMART ENTRY & START SYSTEM Mode"

- Indicates the electronic key mode if a electronic key warning item occurs, or the driver switches the door unlock mode.



A4270362B

Multi Information Display "Lexus Parking Assist Indication Mode"

- If the front & clearance sonar system detects an obstacle, it cuts in to indicate the front & clearance sonar mode while another mode is being shown.



A4270598B

Multi Information Display "Dynamic Radar Cruise Control System Indication Mode"

- Indicates the radar cruise control mode during the constant-speed control mode and the vehicle-to-vehicle control mode of the radar cruise control.



A4270599B

Multi Information Display Inspection Mode

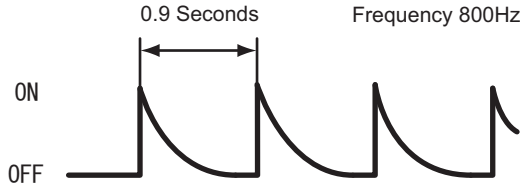
- While keeping the DISP (indication item selector) switch pressed, turn the ignition from OFF to ON, in order to transfer to the inspection mode. This will cause all the multi-information display indicator lights to turn ON. Thus, it is possible to inspect for an open circuit in the multi-information display by visually checking this state (and determine whether all the lights are ON).
- To cancel the inspection mode, turn the ignition OFF.

Buzzer

- A multi buzzer is used, which sounds when various types of warnings occur, such as a key reminder. It is located in the combination meter.
- he multi buzzer uses a single sound source (buzzer) to issue the various warnings described below, by switching the sounding patterns (such as cycles).

Key Reminder Warning Buzzer Specification

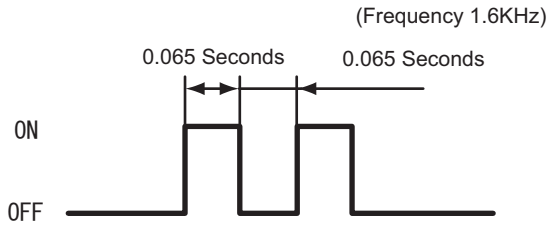
- Sounds the buzzer when a electronic key is in the vehicle interior (IG OFF or ACC OFF), and an attempt is made to perform a door lock from the outside of the vehicle.



A4270104B

Reject Warning Buzzer Specification

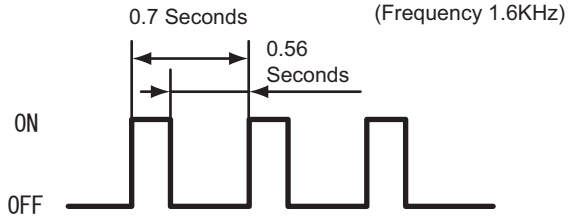
- The buzzer sounds only twice if the driver performs a shifting operation in the "S" position that is rejected.



A4270106B

Speed Warning Buzzer Specification

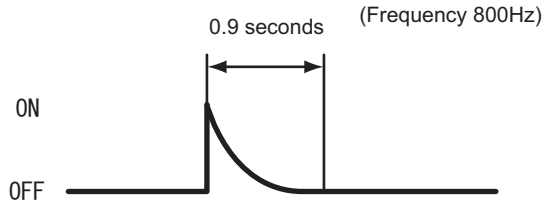
- The buzzer sounds when the vehicle speed exceeds approximately 120 km/h (only for the Middle East).



A4270107B

Parking Brake Without Release Driven Warning Buzzer Specification

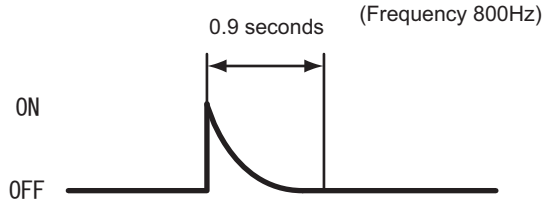
• The buzzer sounds only once if the vehicle is driven {approximate minimum vehicle speed of .5 mph(5 km/h) continues for 1 second} without releasing the parking brake.



A4270108B

Door Open Drive Warning Buzzer Specification

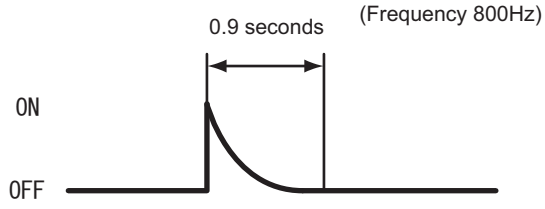
• The buzzer sounds only once if an approximate minimum vehicle speed of 5 mph(5 km/h) continues for 1 second while an individual door, engine hood, or the luggage compartment door is open (or ajar).



A4270108B

Warning Mode Indication Liked Buzzer Specification

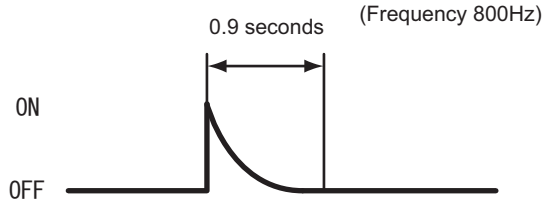
• The buzzer sounds only once when the display shows the warning mode.



A4270108B

Moon Roof Open Warning Buzzer Specification

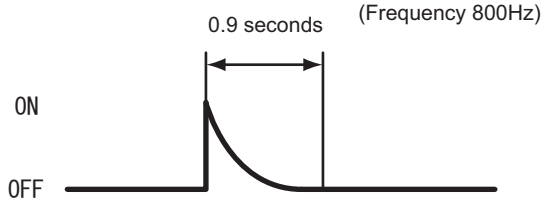
• The buzzer sounds only once when the driver's door is opened with the IG (ACC) OFF and the moon roof is open.



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Radar Cruise Warning Buzzer Specification

• The buzzer sounds only once if a failure occurs in the Dynamic Dynamic radar cruise control system.



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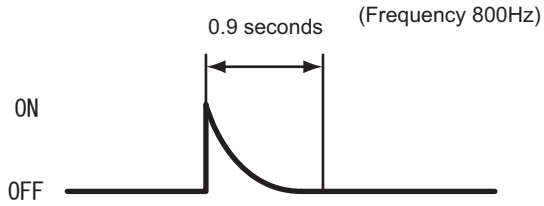
Seatbelt Unbuckled warning Buzzer Specification

• The buzzer sounds when the driver's or front passenger's seat belt is unbuckled while the approximate minimum vehicle speed is 10 mph(16 km/h).

• For details, refer to the unbuckled seat belt warning buzzer. (Reference: multi buzzer (unbuckled seat belt warning buzzer)

Washer Fruid Warning Buzzer Specification

• The buzzer sounds only once if the washer fluid drops below a specified level.



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Multi Buzzer Operation

Key reminder warning buzzer

When the meter ECU receives the input of a key reminder warning buzzer sounding request signal from the certificate ECU via the BEAN (Body Electronics Area Network) while the ignition is OFF, it sounds the multi buzzer.

reject warning buzzer

When the meter ECU receives the input of a shift down reject signal from the engine ECU via the BEAN (Body Electronics Area Network), it sounds the multi buzzer.

Speed warning buzzer

When the vehicle speed signal used for indicating the speed on the speedometer exceeds approximately 120 km/h, the meter ECU sounds the multi buzzer (for the Middle East only).

Parking brake un-canseling driven warning buzzer

With the ignition ON, the meter ECU determines that the sounding condition has been met when it receives the input of a parking brake ON signal from the skid control ECU via the BEAN (Body Electronics Area Network), or a vehicle speed signal through a direct wire, it sounds the multi buzzer.

Door open driven warning buzzer

With the ignition ON, the meter ECU determines that the sounding condition has been met when it receives the input of the following signals via the BEAN (Body Electronics Area Network): an individual door courtesy light switch signal from the right side J/B ECU, an engine hood state signal from the front control ECU, and a luggage compartment door state signal from the rear J/B ECU, or a vehicle speed signal through a direct wire from the skid control ECU. Then, it sounds the multi buzzer.

Warning mode indication linked buzzer

For the detailed operation of the warning mode display-linked warning, refer to the multi-information display. (Reference: multi-information display warning display mode,)

Moon roof open warning buzzer

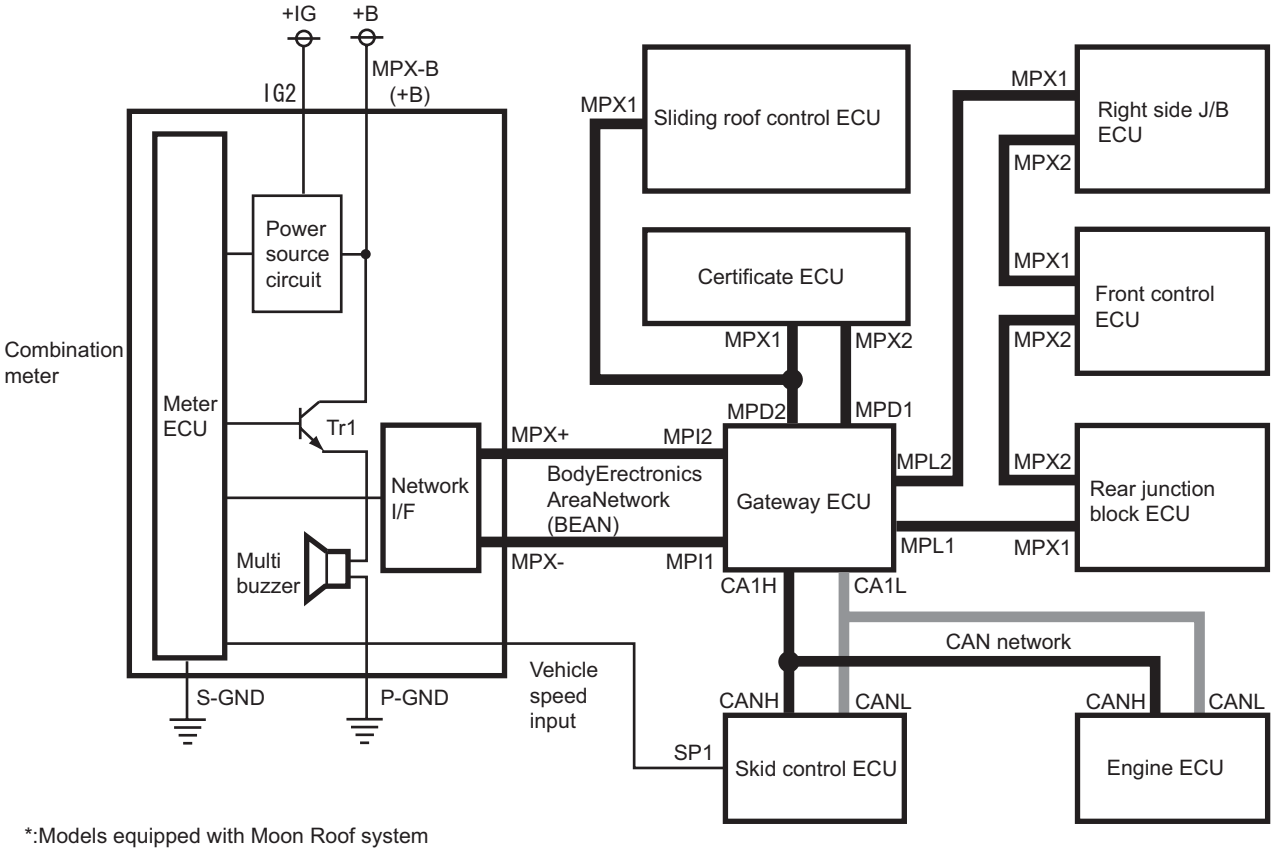
With the ignition OFF, when the meter ECU receives the input of a sliding roof warning buzzer sounding request signal from the sliding roof ECU via the BEAN (Body Electronics Area Network), it sounds the multi buzzer.

Radar cruise warning buzzer

When the meter ECU receives the input of a warning sounding request signal from the distance control ECU via the BEAN (Body Electronics Area Network), it sounds the multi buzzer.

Seat belt unbuckled warning buzzer

With the ignition ON, if the vehicle speed exceeds approximately 15 mph(25 km/h) while the meter ECU detects a driver's seat belt inner buckle switch ON signal or a front passenger's seat belt inner buckle switch ON (when an occupant is seated in the front passenger seat) via the BEAN (Body Electronics Area Network), it sounds the multi buzzer.



*:Models equipped with Moon Roof system

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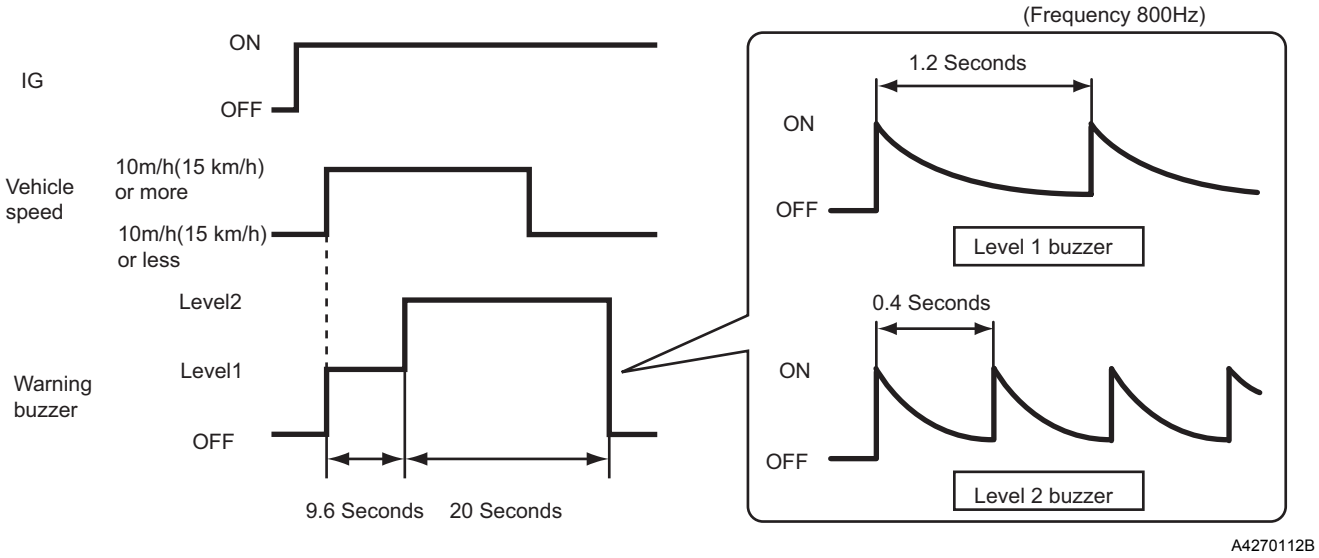
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Seat Belt Warning Buzzer

● With the ignition ON, and the vehicle speed exceeds approximately 10 mph(15 km/h) while the driver's or the front passenger's seat belt is unbuckled, the meter ECU will sound the multi buzzer in the combination meter to urge the occupants to buckle their seat belts.

Seat Belt Unbuckled Warning Buzzer Function

- After 1.8 seconds have elapsed with the ignition turned ON, the level 1 type will sound the buzzer for 6 seconds.
- After 13.8 seconds have elapsed with the ignition turned ON, the vehicle speed exceeds approximately 10 mph(15 km/h), and the driver's or front passenger's seat belt is unbuckled, the level 1 and level 2 unbuckled seat belt warning buzzer will sound.
- The sounding of the unbuckled seat belt warning buzzer consists of the following: During the first 9.6 seconds, approximately, level 1 emits intermittent sounds at 1.2-second intervals. Level 1 is followed by level 2, during which the buzzer emits intermittent sounds at 0.4-second intervals for approximately 20 seconds.
- While the buzzer is emitting level 1 or 2 sounds, it will stop sounding if the driver's or front passenger's seat belt is buckled.
- While the buzzer is emitting level 1 or 2 sounds, it will continue sounding even if the vehicle speed decreases below approximately 10 mph(15 km/h). After the buzzer has sounded and the vehicle speed has momentarily decreased below approximately 10 mph(15 km/h), and increased again above approximately 10 mph(15 km/h), the buzzer will continue sounding.



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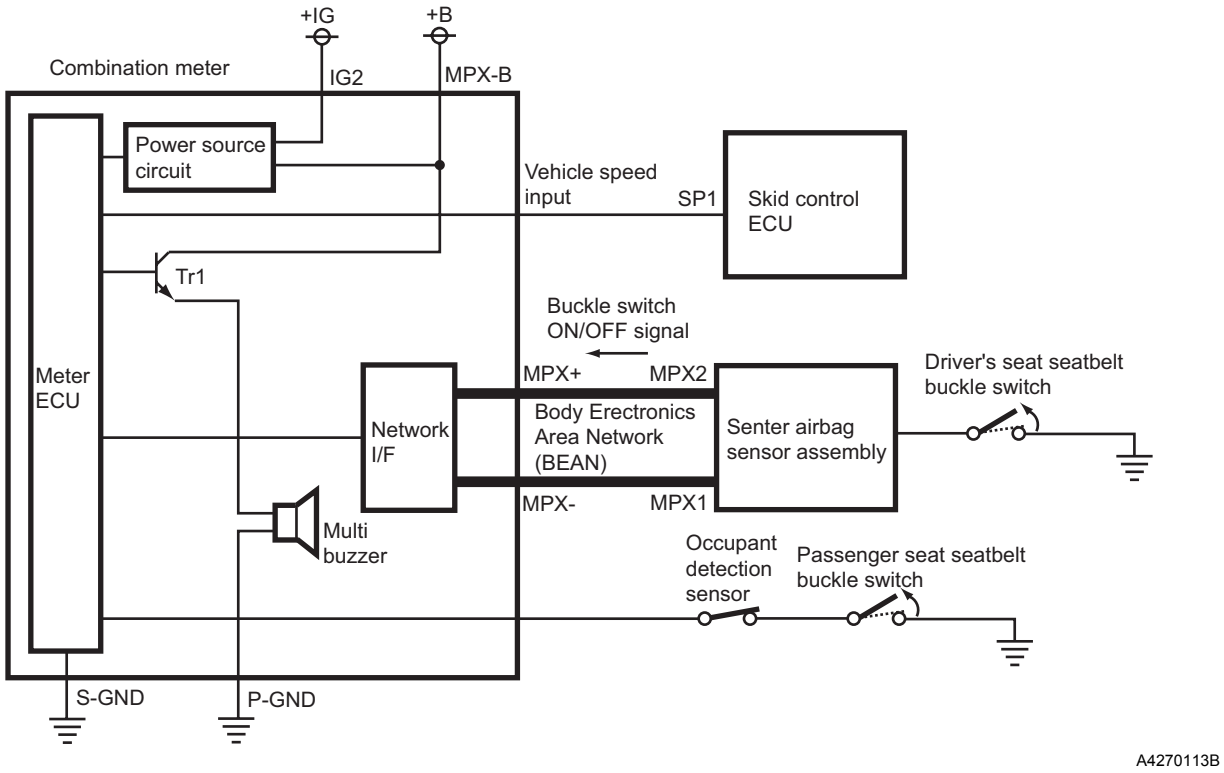
Seat Belt Unbuckled Warning Buzzer Operation

Driver's seat belt unbuckled warning buzzer

- The meter ECU will sound the buzzer at level 1, with approximately 1.2-second intervals, provided that the following conditions are met: With the ignition ON, the meter ECU receives the input of a driver's seat belt inner buckle switch ON signal (indicating that the driver's seat belt is unbuckled) from the center airbag sensor assembly via the BEAN (Body Electronics Area Network). And receives the input of vehicle speed signal exceeding approximately 10 mph(15 km/h) from the skid control ECU. After approximately 9.6 seconds have elapsed in this condition, the buzzer sounds at level 2, with approximately 0.4-second intervals for approximately 20 seconds.
- The buzzer that sounds with the ignition ON and the vehicle stopped, will stop when the driver's seat belt buckle switch is turned OFF (indicating that the driver's seat belt is buckled) or when the ignition is turned OFF.
- The buzzer that sounds after the vehicle is in motion will stop when both the driver's and front passenger's seat belt buckle switches are turned OFF (indicating that both the driver's and front passenger's seat belts are buckled) or when the ignition is turned OFF.

Passenger's seat belt unbuckled warning buzzer

- When the meter ECU receives the inputs of an occupant detection sensor ON signal and a front passenger seat belt buckle switch ON signal (indicating that the front passenger's seat belt is unbuckled), and the vehicle speed exceeds approximately 10 mph(15 km/h), it will sound the buzzer.



Seat Belt Unbuckled Warning Buzzer Cancel Function

- The buzzer can be canceled if a user has a special reason to cancel the buzzer. Only the buzzer that sounds after the vehicle is moving can be canceled. The buzzer that sounds with the ignition turned ON cannot be canceled.

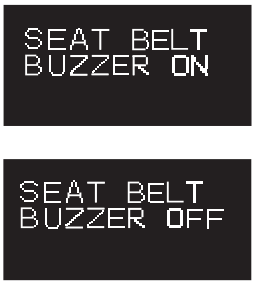
Buzzer Cancellation Operation Method

- In the ODO display mode, within 6 seconds after the ignition has been turned ON, press and hold the ODO/TRIP switch for 10 seconds or more.
- Then, when the buckle switch is turned ON (by buckling the seat belt), the system will enter the cancel mode.

Enter the buzzer cancel mode

Operation switch	Function
Driver's buckle switch ON	Cancels the sounding of the buzzer for both the driver's and front passenger's seat belts
Passenger's buckle switch ON	Cancels the sounding of the buzzer for only the front passenger's seat belt

- When the system enters the cancel mode, the mode will appear on the multi-information display. The driver can press the ODO/TRIP switch to switch between ON and OFF.



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- The cancel mode will end if the ODO/TRIP switch is not pressed for 10 seconds.
- After a cancellation, if the system enters the cancel mode again, the buzzer is restored by the buckle switch that is turned ON.

buzzer mode

Operation switch	Function
Driver's buckle switch	The buzzer sounds ON for both the driver's and front passenger's seat belts
Passenger's buckle switch	The buzzer sounds ON only for the front passenger's seat belt

Seat Belt Warning System

- A flashing type unbuckled seat belt warning system is used to urge the driver and the front passenger to buckle their seat belts. The warning indicator light for the driver is located in the combination meter, and for the front passenger is located in the multi display assembly.
- An occupant detection sensor is provided under the front passenger seat cushion cover to detect whether the seat is occupied.

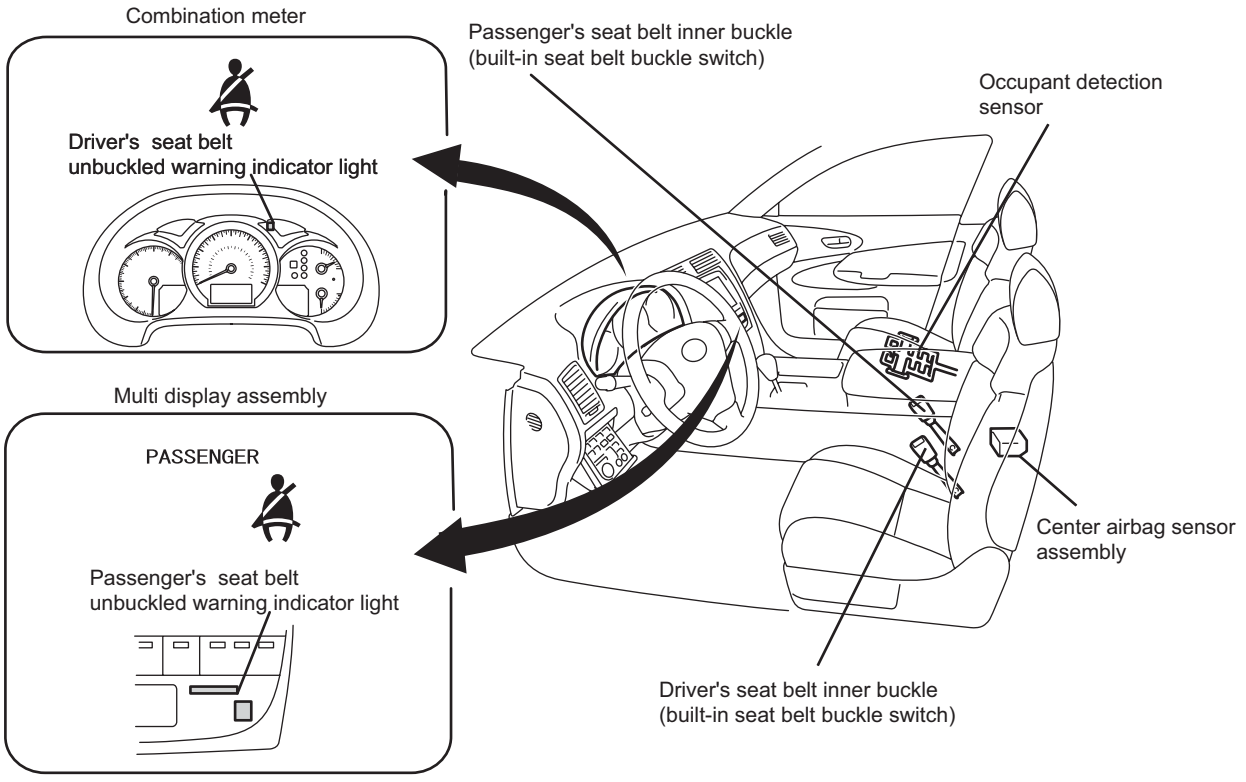
Seat Belt Unbuckled Warning Function

Driver's seatbelt unbuckled warning

- When the ignition is turned ON, the driver's unbuckled seat belt warning indicator light starts to flash, in order to urge the driver to buckle the seat belt.
- When the meter ECU detects that the driver's seat belt is buckled (the tongue plate is locked into the driver's seat belt inner buckle) it turns OFF the warning indicator light.

Passenger's seatbelt unbuckled warning

- When the ignition is turned ON, if the occupant detection sensor detects the presence of an occupant in the front passenger seat, it starts to flash the front passenger's unbuckled seat belt warning indicator light, in order to urge the front passenger to buckle the seat belt.
- When the meter ECU detects that the front passenger's seat belt is buckled (the tongue plate is locked into the front passenger's seat belt inner buckle) it turns OFF the warning indicator light.



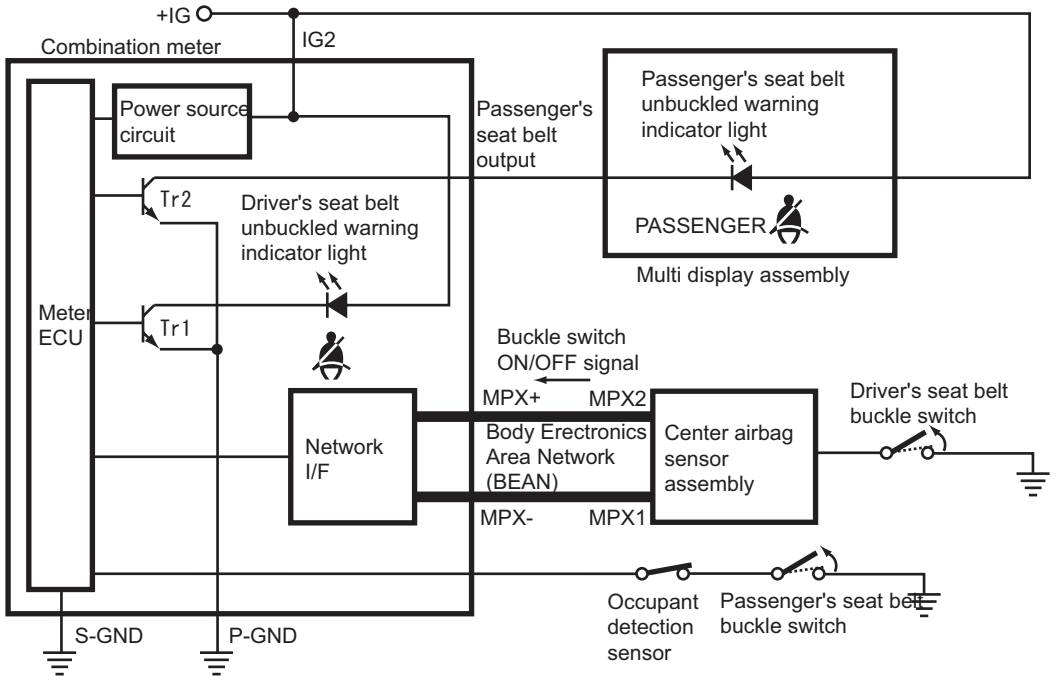
Seat Belt Unbuckled Warning Operation

Driver's seatbelt unbuckled warning

- If the driver's seat belt is unbuckled (the tongue plate is not locked into the buckle) when the ignition is ON, the center airbag sensor assembly will input a driver's seat belt buckle switch ON signal.
- Upon receiving the driver's seat belt buckle switch ON signal from the center airbag sensor assembly in the form of a BEAN (Body Electronics Area Network) signal, the meter ECU will turn the Tr1 terminal ON, in order to flash the LED for the driver's unbuckled seat belt warning indicator.
- Upon receiving a driver's seat belt buckle switch OFF signal as a result of the buckling of the driver's seat belt (the tongue plate is locked into the buckle), the meter ECU will turn OFF the LED for the driver's unbuckled seat belt warning indicator.

Passenger's seatbelt unbuckled warning

- When the ignition is ON, if a person occupies the front passenger seat without buckling the front passenger seat belt (the tongue plate is not locked into the buckle), the meter ECU will receive the inputs of an occupant detection sensor ON signal and a front passenger seat belt buckle switch ON signal. Consequently, the meter ECU will turn ON the Tr2 terminal, in order to flash the LED for the front passenger's unbuckled seat belt warning indicator.
- If the meter ECU receives the input of an occupant detection sensor OFF signal, or a front passenger's seat buckle switch OFF signal as a result of the buckling of the front passenger's seat belt (the tongue plate is locked into the buckle), the meter ECU will turn OFF the LED for the front passenger's unbuckled seat belt warning indicator.



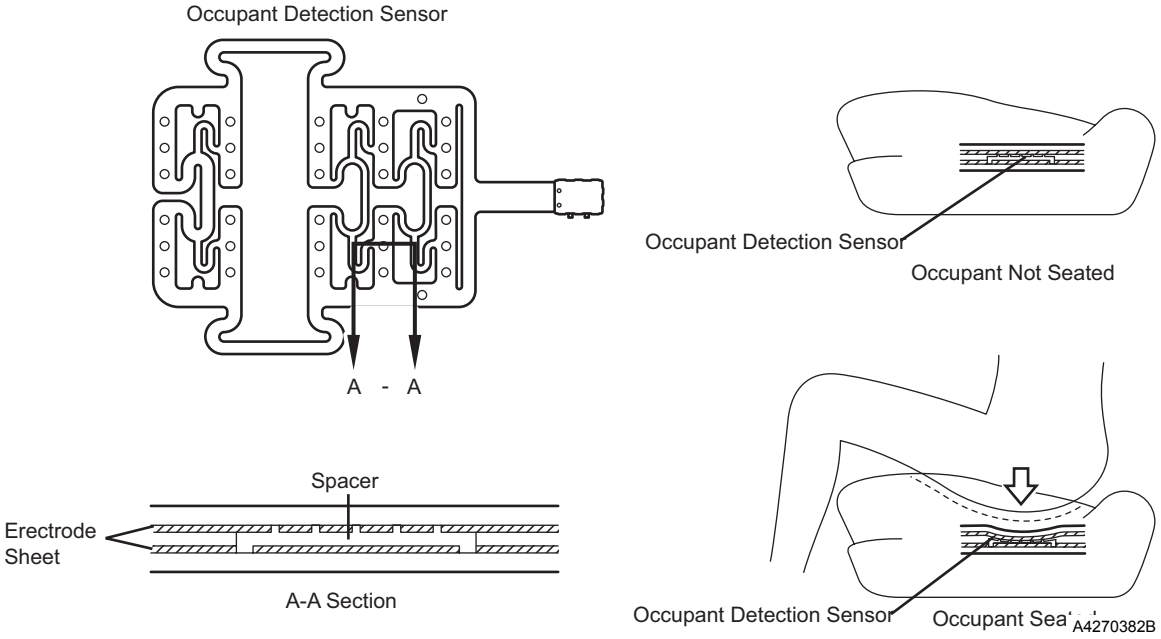
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Occupant Detection Sensor

● When an occupant is seated in the front passenger seat, a load is applied to the seat cushion. This load causes the electrodes in the occupant detection sensor located under the seat cushion cover to come in contact. Thus, the meter ECU detects the presence of an occupant.*

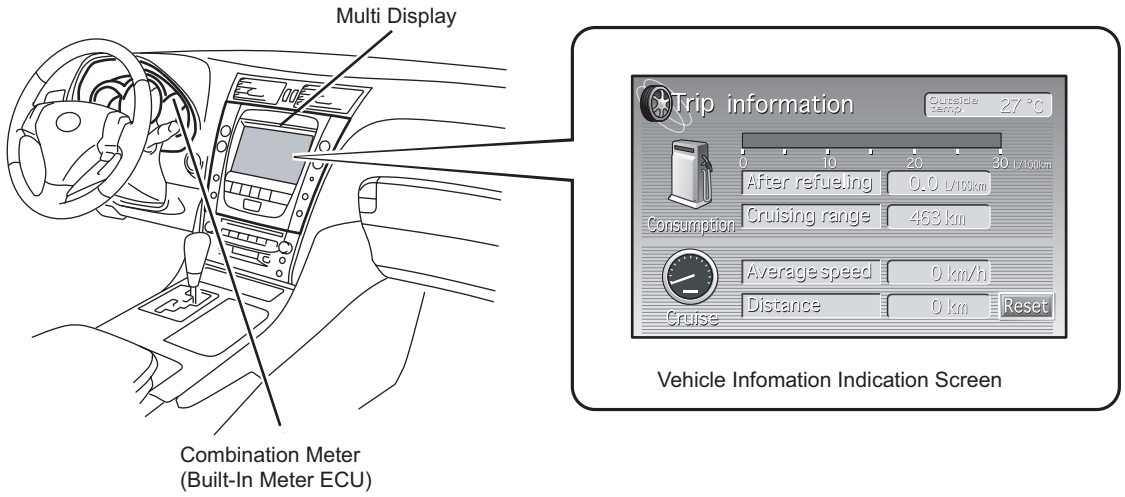
❖REFERENCE❖

*If a load exceeding a predetermined amount acts on the seat cushion, such as when luggage is placed on the front passenger seat cushion, this load may be detected by the sensor.



Vehicle Information Screen Indication

● The vehicle information screen uses the multi display that is located in the upper center area of the instrument panel to show vehicle information, such as the fuel consumption rate or the driven distance, based on various pieces of information provided by the combination meter.



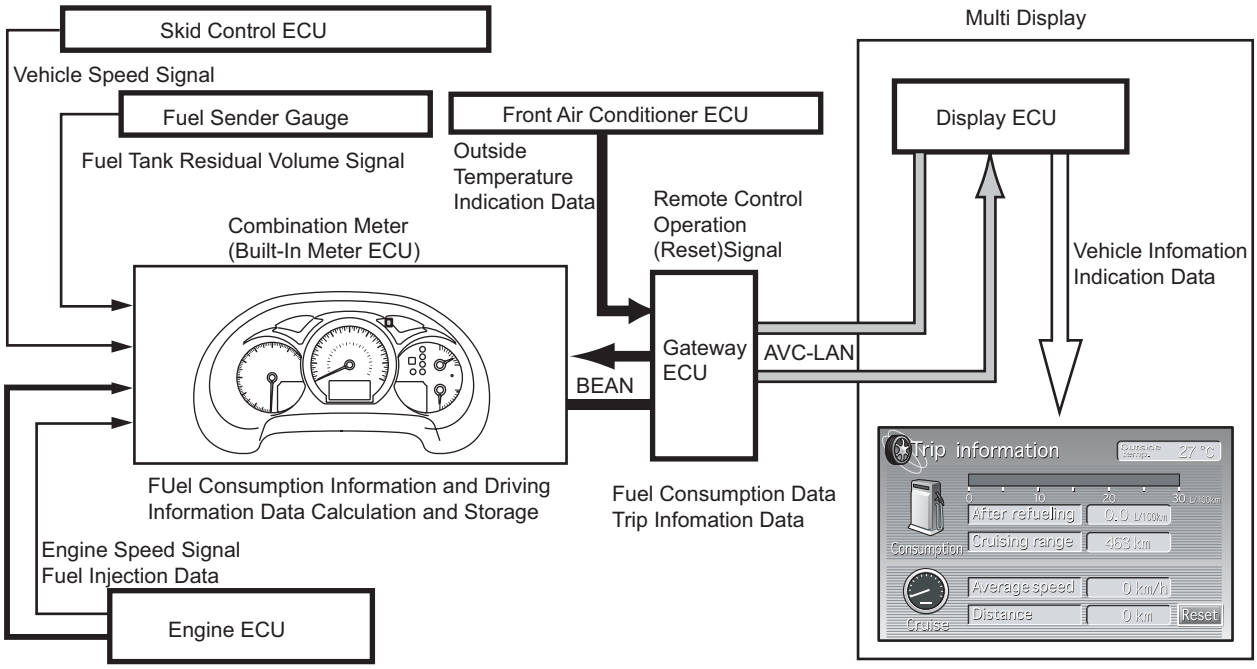
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Vehicle Information Screen Indication System summary

• The meter ECU calculates the individual pieces of vehicle information by receiving the inputs of various pieces of data from the skid control ECU, fuel sender gauge, and the engine ECU. Then, it outputs them in the form of vehicle information signals to the multi display.

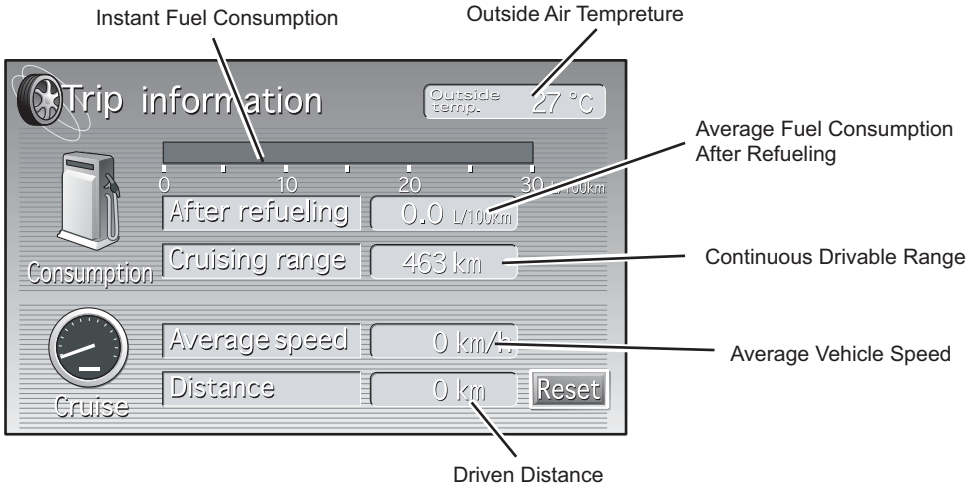
Fuel Consumption Information and Driving Information Data Calculation and Storage



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Vehicle Information Screen Indication Function

• The vehicle information screen consists of a single screen on which the following pieces of information are listed: fuel consumption information (instant fuel consumption, average fuel consumption after refueling, and continuous drivable range), and trip information (average vehicle speed and driven distance).

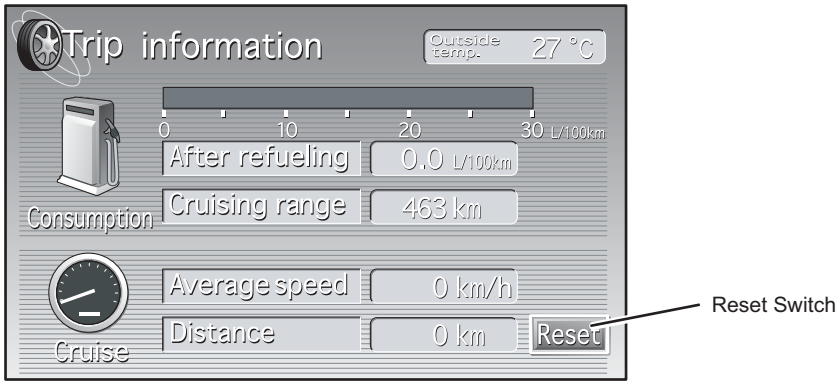


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Vehicle Information Screen Switch Operation

- For details on how to indicate vehicle information on the multi display, refer to the Toyota Electro Multivision. (Reference: Toyota Electro Multivision information mode function,)
- By touching "Reset" on the trip information screen, the driver can reset the average vehicle speed and driven distance data. This allows the system to start recounting.



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Instant Fuel Consumption Indication Specification

Instant Fuel Consumption Indication Specifications

Indication Area	Indication Configuration	Function
• 0.0~90.0MPG{0.1MPG increments(EU right handle vehicle except Ireland and Cyprus)} • 0.0 ~ 20.0L/100km{0.1L/100km increments(other country)} • Bar indication using dots	• Shows 0.0 MPG(0.0L/100km) when the ignition is turned ON and when the engine is started. • Starts calculating when the vehicle starts to move. • Shows 0.0 MPG(0.0L/100km) if fuel injection volume data cannot be received.	• The meter ECU calculates the instant fuel consumption rate based on the driven distance (per vehicle speed signals) for every 20 revolutions of the engine and the fuel consumption volume (per fuel injection volume data). Upon receiving the input of this data via AVC-LAN, the display ECU shows the instant fuel consumption on the display.

Refueling Average Consumption Indication Specification

Average Fuel Consumption After Refueling Indication Specifications

Indication Area	Indication Configuration	Function
• 0.0~90.0MPG{0.1MPG increments(EU right handle vehicle except Ireland and Cyprus)} • 0.0 ~ 30.0L/100km{0.1L/100km increments(other country)}	• Shows the previous data when the ignition is turned ON. • Starts the continuous calculation when the engine is started. • Leaves the value blank (no indication) if the fuel injection volume data cannot be received.	• The meter ECU detects refueling based on the fuel residual volume signal. It resets the data when the vehicle starts to move. It calculates the average fuel consumption following the refueling. Upon receiving the input of this data via AVC-LAN, the display ECU shows the average fuel consumption after refueling on the display.

Continuous Drivable Range Indication Specification

Continuous Drivable Distance Indication Specifications

Indication Area	Indication Configuration	Function
• 0~999 mile{1mile increments(EU right handle vehicle except Ireland and Cyprus)} • 0 ~ 999 km{1km increments(other country)	• Shows the previous data when the ignition is turned ON. • Starts the continuous calculation when the engine is started. • Leaves the value blank (no indication) if a failure is detected in the fuel gauge.	• The meter ECU learns the fuel consumption rate based on the vehicle speed signals and the fuel consumption volume data. Then, based on the present fuel residual volume signal the meter ECU calculates the continuous drivable range. Upon receiving the input of this data via AVC-LAN, the display ECU shows the continuous drivable range on the display.

Average Vehicle Speed Indication Specification

Average Vehicle Speed Indication Specifications

Indication Area	Indication Configuration	Function
• 0~180mph {1mph increments(EU right handle vehicle except Ireland and Cyprus)} • 0 ~ 300km/h{1 km/h increments(other country)}	• Shows the previous data when the IG or ACC is ON. • Resets the data through a reset operation or when the vehicle starts to move. Then, the calculation starts after the reset. • Updates the data every 10 seconds after the calculation starts.	• The meter ECU resets the data by receiving the input of one of the following signals: a data reset signal from the display ECU, as a result of operating the switch; or a vehicle speed signal from the skid control ECU. Then, the meter ECU integrates the engine operation duration and the driven distance after the reset, in order to calculate the average vehicle speed. Upon receiving the input of this data via AVC-LAN, the display ECU shows the average vehicle speed on the display.

Driven Distance Indication Specification

Driven Distance Indication Specifications

Indication Area	Indication Configuration	Function
• 0~999mile (1mile increments(EU right handle vehicle except Ireland and Cyprus) • 0 ~ 999km{1km increments(other country)	• Shows the previous data when the IG or ACC is ON. • Resets the data through a reset operation or when the vehicle starts to move. Then, the calculation starts after the reset. • Updates the data when the data is switched at 1km intervals.	• The meter ECU resets the data by receiving the input of one of the following signals: a data reset signal from the display ECU, as a result of operating the switch; or a vehicle speed signal from the skid control ECU. Then, the meter ECU calculates the driven distance after the data reset. Upon receiving the input of this data via AVC-LAN, the display ECU shows the driven distance on the display.

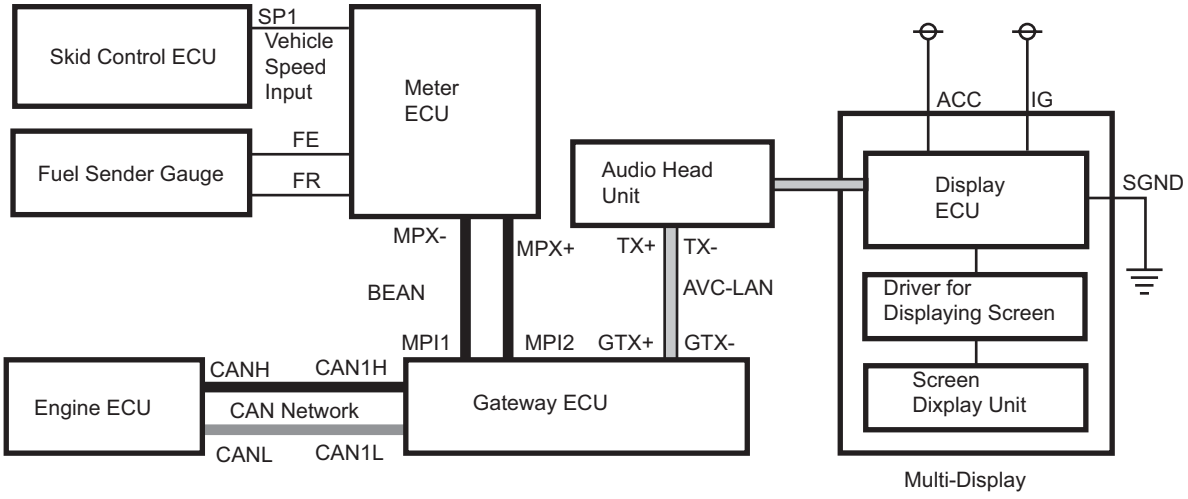
Outside Air Temperature Indication Specification

Outside Temperature Indication Specifications

Indication Area	Indication Configuration	Function
• -40 ~ 50°C(1°C increments)	• Shows "E" if the display ECU is unable to receive the outside temperature indication signal. • Shows "E°C" or "--°C" in case of a system failure.	• The display ECU receives the input of the outside temperature indication data from the front air conditioning ECU via AVC-LAN to show the outside temperature.

Vehicle Information Screen Indication Operation

- The meter ECU calculates the fuel consumption information and trip information display data by receiving the inputs of the following pieces of information: a vehicle speed signal from the skid control ECU, fuel injection volume data from the engine ECU, a fuel tank residual volume signal from the fuel sender gauge, etc. The meter ECU outputs these pieces of data to the display ECU via the Audio Visual Communication - Local Area Network (AVC-LAN).
- Upon receiving the input of these pieces of data, the display ECU actuates the screen display driver based on a switch operation signal. Thus, it indicates the individual fuel consumption displays and trip information on the multi display.
- The meter ECU stores the fuel consumption display (except instant fuel consumption) and trip information display data in its memory, even after the ignition has been turned OFF.



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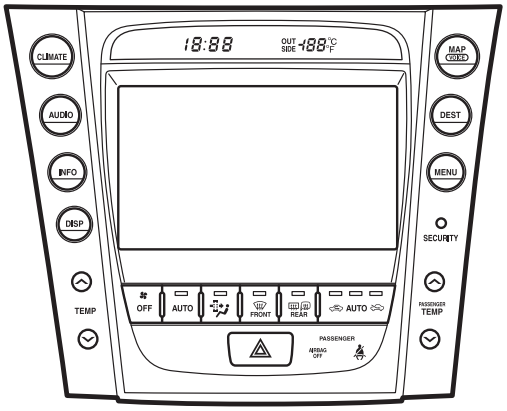
AUDIO / VISUAL

Description of Audio & Visual System

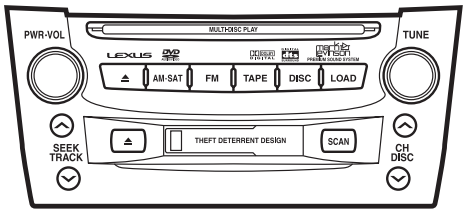
- A visual system consisting of a wide, 8-inch multi-display and the Electro Multi-Vision is provided on all models as standard equipment. The multi-display is a EGA display that provides high resolution. The Electro Multi-Vision displays various types of information such as navigation, audio, and air conditioner.
- A "Mark Levinson Premium Surround System" is available as a manufacturer's option on all models. This audio system consists of a power amplifier made by Mark Levinson, 14 speakers, a multi-display, and a contoured size in-dash AM/FM electronic tuner with a built-in 6-disc DVD changer and a cassette player*1 or a contoured size in-dash AM/FM electronic tuner with a built-in CD changer*2. Also, a "Super Live Sorround System" is provided on all models as standard equipment. This system consists of a power amplifier made by Pioneer, 10 speakers, a multi-display, and a contoured size in-dash AM/FM electronic tuner with a built-in CD changer and cassette player.

❖REFERENCE❖

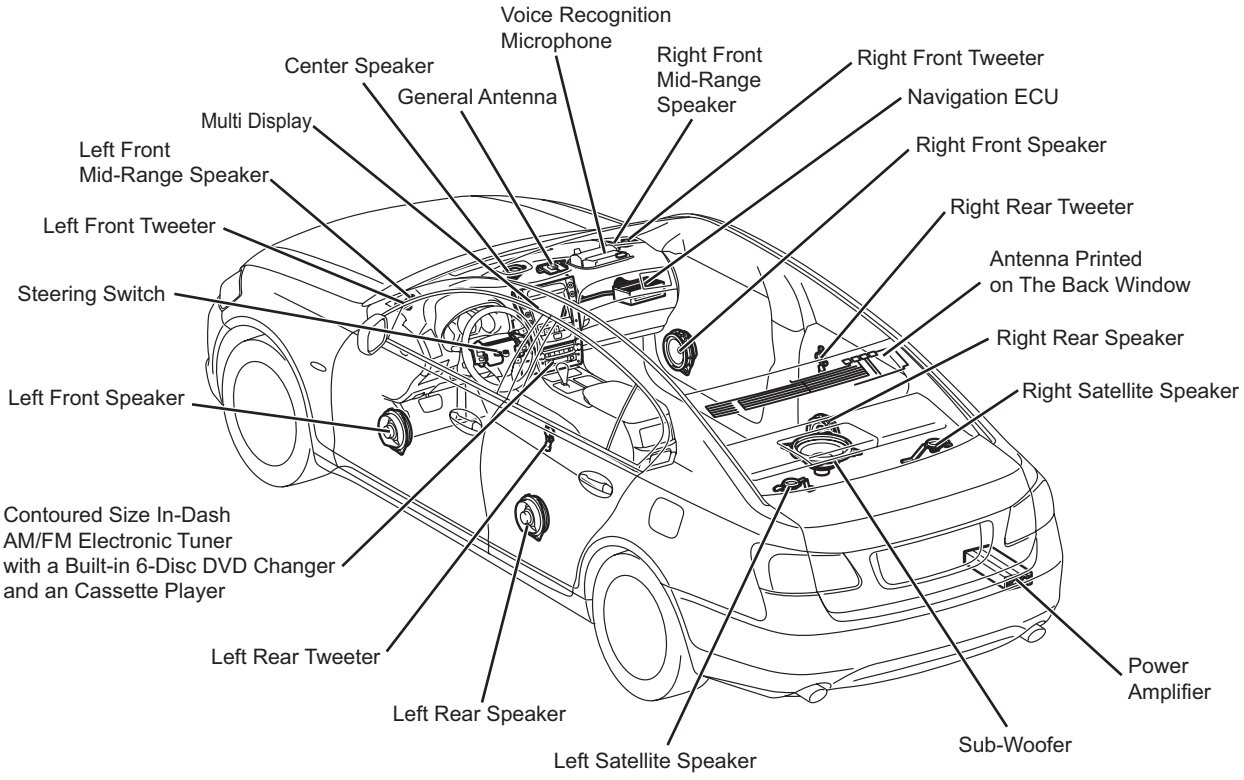
*1 : Models for General Countries except Some Areas
*2 : Models except for *1



Multi Display



Contoured Size In-Dash AM/FM Electronic Tuner
with a Built-in 6-Disc DVD Changer and an Cassette Player



Mark Levinson Premium Surround System

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Note : The illustration gives a representative example.
and The Illustration of Multi Display excepts G.C.C. Countries Model.

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Description of Audio System

- Two types of audio systems are available: a "Mark Levinson Premium Surround System" consisting of a wide, 7-inch EGA multi-display, a contoured size in-dash AM/FM electronic tuner with a built-in 6-disc DVD changer and an cassette player*1 or a contoured size in-dash AM/FM electronic tuner with a built-in CD changerand an cassette player*2 , a power amplifier made by Mark Levinson, and a 14-speaker system; and a "LEXUS Super Live Sound System" consisting of a contoured size in-dash AM/FM electronic tuner with a built-in CD changer and an cassette player, a power amplifier, and an 10-speaker system.
- Steering switches are provided to enable the driver to perform various types of audio operations with no need to remove his or her hands from the steering wheel, thus realizing a system that excels in ease of use.
- An antenna printed on the back window glass is provided on all models as standard equipment.

Audio sustem setting

System Name	System Component	Provision
Mark Levinson Premium Surround System	• Multi-display • Contoured size in-dash AM/FM electronic tuner with a built-in 6-disc DVD changer and an cassette player*1 • Contoured size in-dash AM/FM electronic tuner with a built-in CD changer and an cassette player*2 • Power amplifier made by Mark Levinson • 14 speakers	• Available on all models as a manufacturer's option
Super Live Sound System	• Multi-display • Contoured size in-dash AM/FM electronic tuner with a built-in CD changer and an cassette player • Power amplifier made by Pioneer • 10 speakers	• Provided on all models as standard equipment

❖REFERENCE❖

*1 : Models for General Countries except Some Areas

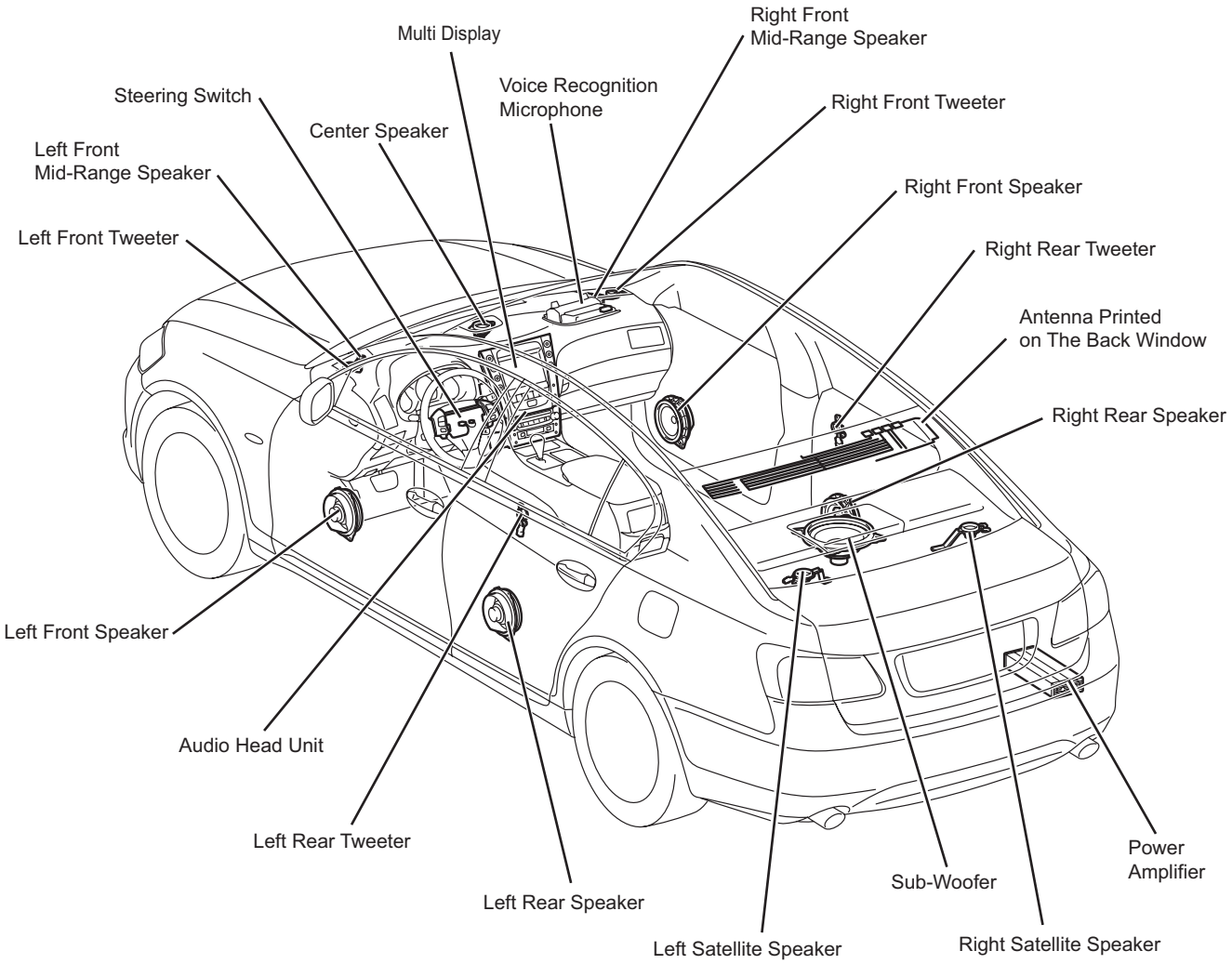
*2 : Models except for *1

"Mark Levinson" Premium Surround System

- The "Mark Levinson Premium Surround System" uses a combination consisting of a multi-display, a contoured size in-dash AM/FM electronic tuner with a built-in 6-disc DVD changer and an cassette player*1 or a contoured size in-dash AM/FM electronic tuner with a built-in CD changer and an cassette player*2, a power amplifier made by Mark Levinson, and a 14-speaker system.
- "Mark Levinson Multi-Channel Sound"*1 is used as a function to play the multi-channel DVD. This function realistically reproduces the depth, width, and movement of the sounds when playing a DVD video with the 5.1 channel.

❖REFERENCE❖

*1 : Models for General Countries except Some Areas
*2 : Models except for *1



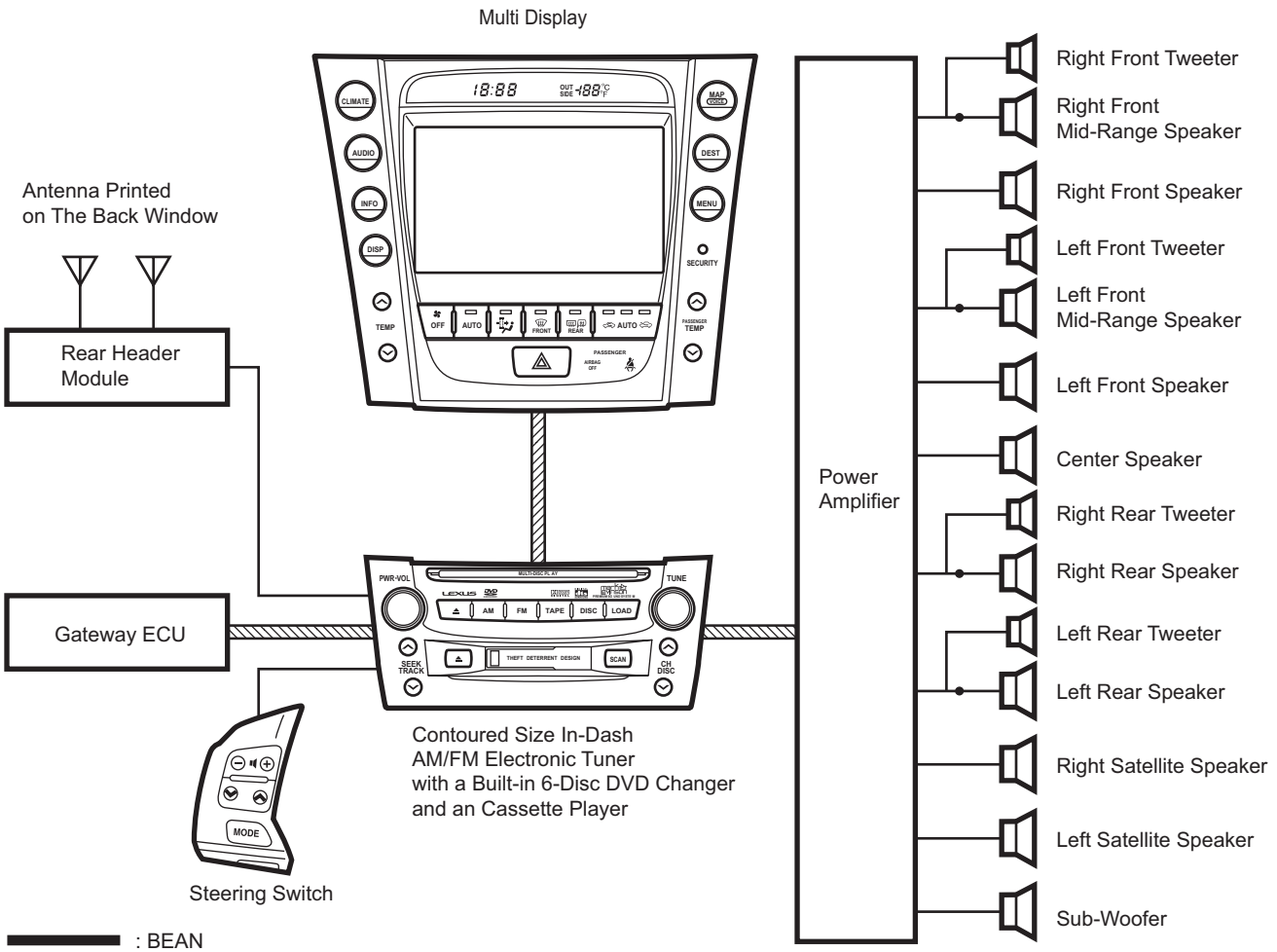
Mark Levinson Premium Surround System

Note : The illustration gives a representative example.

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"Mark Levinson" Premium Surround System Diagram

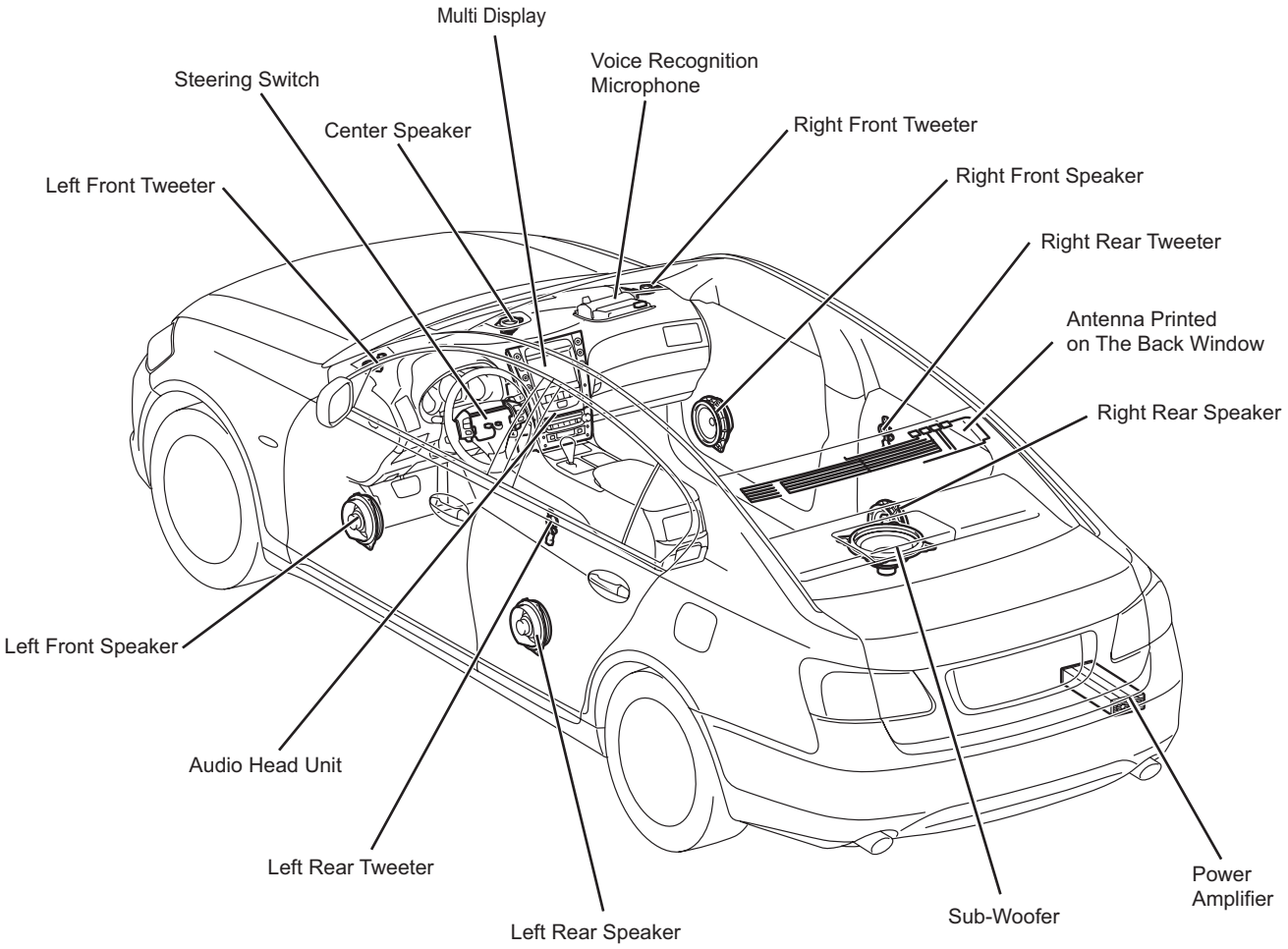


Note : The illustration gives a representative example.
and The Illustration of Multi Display excepts G.C.C. Countries Model.

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Super Live Sound System

- The "Super Live Sound System" uses a combination of a multi-display, a contoured size in-dash AM/FM electronic tuner with a built-in CD changer and an cassette player, a power amplifier made by Pioneer, and a 10-speaker system.

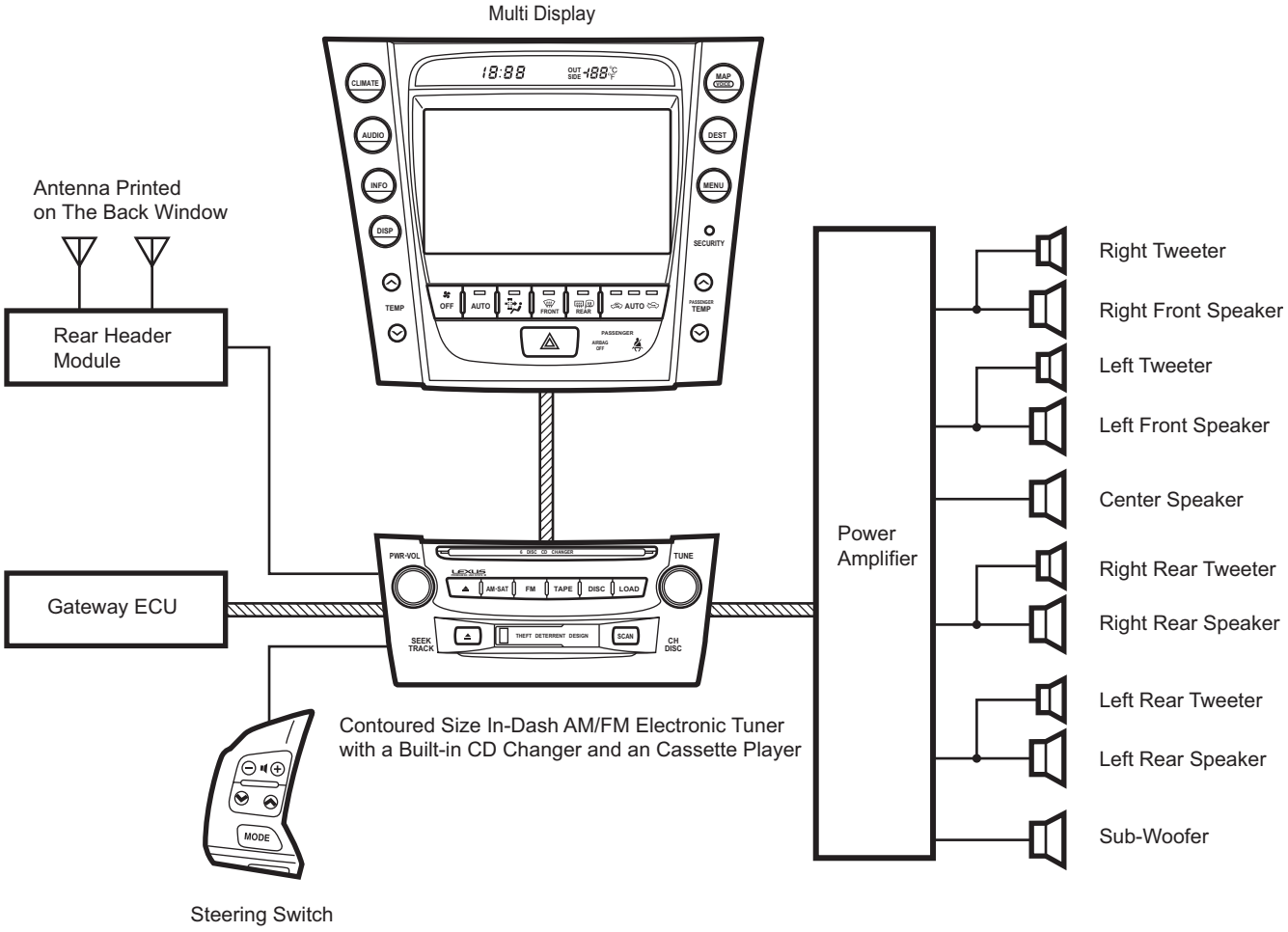


Super Live Sound System

Note: The illustration gives a representative example.

A4270153E

Super live sound system diagram



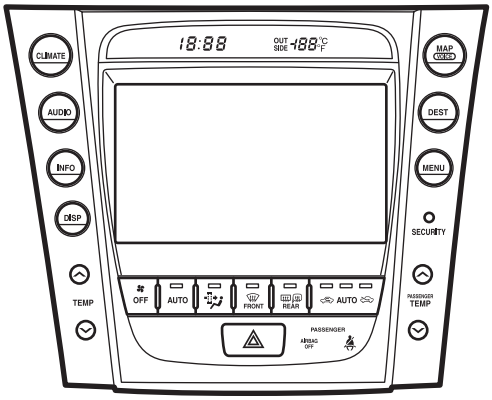
: BEAN
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Note : The illustration gives a representative example.
and The Illustration of Multi Display excepts G.C.C. Countries Model.

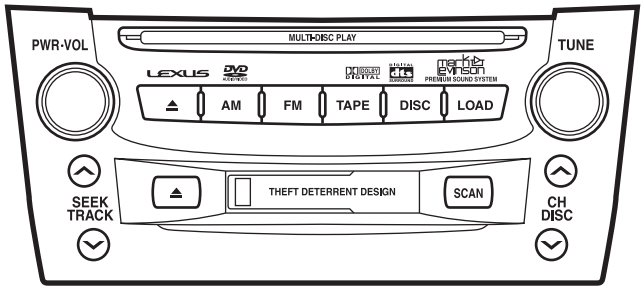
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Contoured Size In-Dash AM/FM Electronic Tuner with A Built-In 6-Disc DVD Changer and A Cassette Player

- A contoured size in-dash AM/FM electronic tuner with a built-in 6-disc DVD changer and an cassette player is used for the some models with "Mark Levinson Premium Sound System".
- This system is equipped with a DSP (Digital Signal Processor). Through dedicated tuning, this processor digitally processes signals to suit the shape of the cabin, thus realizing a clear sound with rich expressions.
- With a built-in disc slot-in type, in-dash 6-disc DVD changer that supports DVD and CD, this system excels in ease of use. As a result of having a built-in DVD player, this system can play a DVD video with a 5.1-channel multi-surround sound, thus enhancing the product appeal.



Multi Display



Contoured Size In-Dash AM/FM Electronic Tuner
with a Built-in 6-Disc DVD Changer and an Cassette Player

Note : The Illustration of Multi Display excepts G.C.C. Countries Model

A4270129E

Contoured Size In-Dash AM/FM Electronic Tuner with A Built-In 6-Disc DVD Changer and A Cassette Player Function

Type	Function
Radio	PLL synthesizer tuning, maximum manual presets of 6 stations each for AM and FM, maximum auto presets of 6 stations each for AM and FM.Automatic reception sensitivity selection (AM). Traffic information reception.RDS(Radio Data System)
Disc (CD or DVD)	DISC UP/DOWN. TRACK UP/DOWN. DISC RANDOM. TRACK RANDOM. FAST UP/DOWN. DISC RPT. TRACK RPT. DISC SCAN. TRACK SCAN. CD TEXT DISPLAY FUNCTION.
Cassette	FF/REW. DolbyB. BLANK SKIP. PROGRAM. REPEAT. Auto TAPE Selector. Search FF/REW(9music).
Other	Sound quality control (low, medium, high). Sound volume balance control (front-back, right-left). Direct change of source. Automatic sound levelizer function. Separate power amplifier location.

Panel Switch Operation

The basic operations, such as the switching of the audio modes, can be accomplished by operating the panel switches that are located around the multi-display.

Touch Switch Operation

After the audio mode screen has been accessed through the operation of the panel switches, the user can directly touch the switch frame (touch switch) that appears on the screen with a finger to operate the system.

Steering Switch Operation

The driver can press the steering switches that are located on the steering wheel to operate various functions, including the switching of the audio modes. For details, refer to "Steering Switches".

Voice Operation (Only for Europe Models)

By pressing the talk switch, displaying a voice recognition mark on the screen, and speaking into the voice recognition microphone, the user can operate various functions, including the switching of the audio sources. Thus, it excels in ease of use. For details on voice operation, refer to "LEXUS Electro Multivision System".

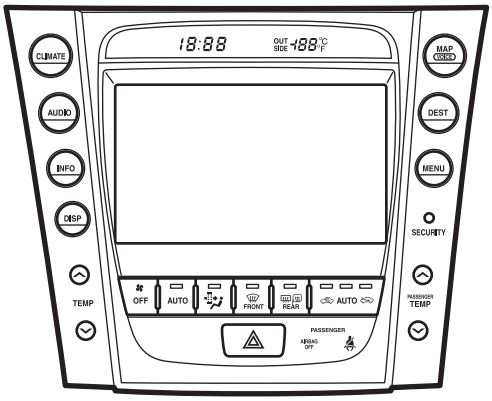
Function

Automatic Sound Levelizer (ASL) Function

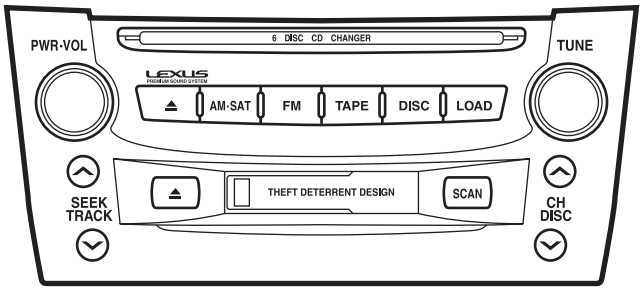
- As on the previous model, this function can change the sound volume and the acoustic field characteristics in accordance with the level of noise in the vehicle cabin (vehicle noise). Thus, when noises such as the road noise or wind noise increase while the vehicle is being driven, the occupants in the vehicle can listen to music at an appropriate sound volume and quality.
- To turn the automatic sound levelizer function ON and OFF, touch "DSP" on the audio operation screen. Then, use the DSP setup screen that appears on the screen.

Contoured Size In-Dash AM/FM Electronic Tuner with A Built-In CD Changer and A Cassette Player

- A contoured size in-dash AM/FM electronic tuner with a built-in CD changer and an cassette player is used for "Super Live Sound System" and some Models with "Mark Levinson Premium Surround System".
- As with the contoured size in-dash AM/FM electronic tuner with a built-in CD changer and an cassette player, this system uses the network follow-up function, position select function, and automatic sound levelizer function. Thus, it excels in ease of use.



Multi Display



Contoured Size In-Dash AM/FM Electronic Tuner with a Built-in CD Changer and an Cassette Player

Note : The Illustration of Multi Display excepts G.C.C. Countries Model

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Contoured In-Dash AM/FM Electronic Tuner with A Built-In CD Changer and A Cassette Player Function

Type	Function
Radio	PLL synthesizer tuning, maximum manual presets of 6 stations each for AM and FM, maximum auto presets of 6 stations each for AM and FM.Automatic reception sensitivity selection (AM). Traffic information reception.RDS(Radio Data System)
CD	DISC UP/DOWN. TRACK UP/DOWN. DISC RANDOM. TRACK RANDOM. FAST UP/DOWN. DISC RPT. TRACK RPT. DISC SCAN. TRACK SCAN. CD TEXT DISPLAY FUNCTION.
Cassette	FF/REW. DolbyB. BLANK SKIP. PROGRAM. REPEAT. Auto TAPE Selector. Search FF/REW(9music).
Other	Sound quality control (low, medium, high). Sound volume balance control (front-back, right-left). Direct change of source. Position select function. Automatic sound levelizer function. Separate power amplifier location.

Operation

As with the contoured size in-dash AM/FM electronic tuner with a built-in CD changer and a cassette player, various audio operations can be performed through the use of the panel switch, touch switch, steering switch, and voice function*.

❖REFERENCE❖

* : Only for Europe Models.

Function

Position Select (POS) Function*

- As on the previous model, the following four modes can be selected in accordance with the number of occupants and their seating positions: all seat mode, driver's seat mode, front seat priority mode, and rear seat priority mode. Thus, the system can reproduce sounds with the best position in the acoustic field.
- To switch the position select functions, touch "DSP" on the audio operation screen. Then, use the DSP setup screen that appears on the screen.

❖REFERENCE❖

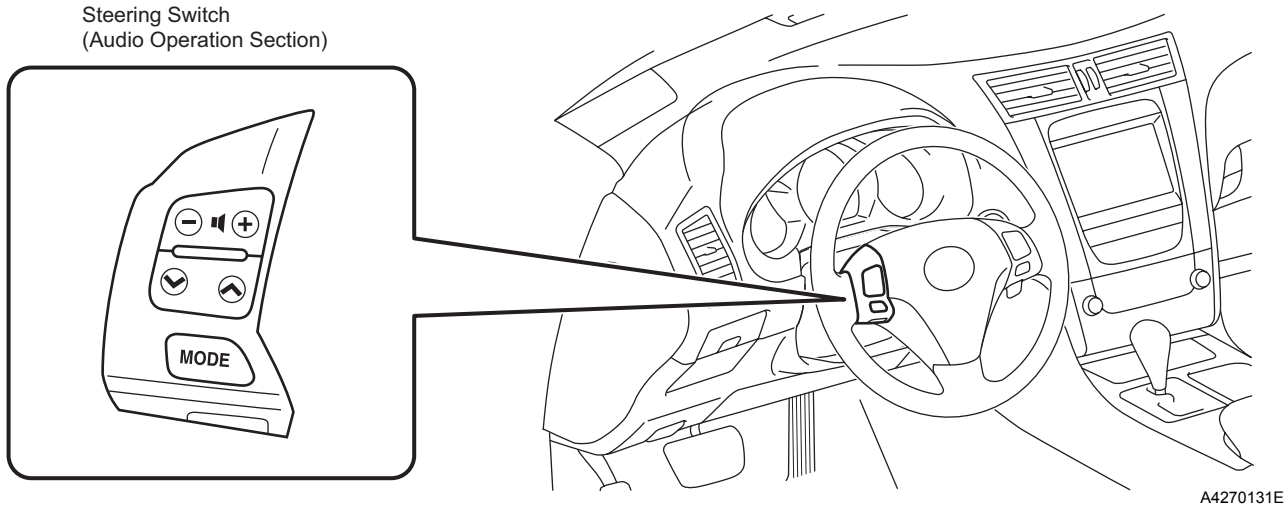
* : Models without "Mark Levinson Premium Surround System"

Power Amplifier

● A power amplifier made by Mark Levinson is provided for the "Mark Levinson Premium Surround System". A power amplifier made by Pioneer, with a maximum total output of 323W (43W x 4, 19W x 1, 66W x 2) is provided for the "Super Live Sound System". It is installed on the right surface in the luggage compartment.

Steering Switches

● As on the previous model, steering switches are provided to enable the driver to adjust the sound volume and switch the audio modes with no need to remove his or her hands from the steering wheel. The switches have been relocated from the side of the steering wheel of the previous model to the left front face of the steering pad. Thus, it enhances ease of use.



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❖REFERENCE❖

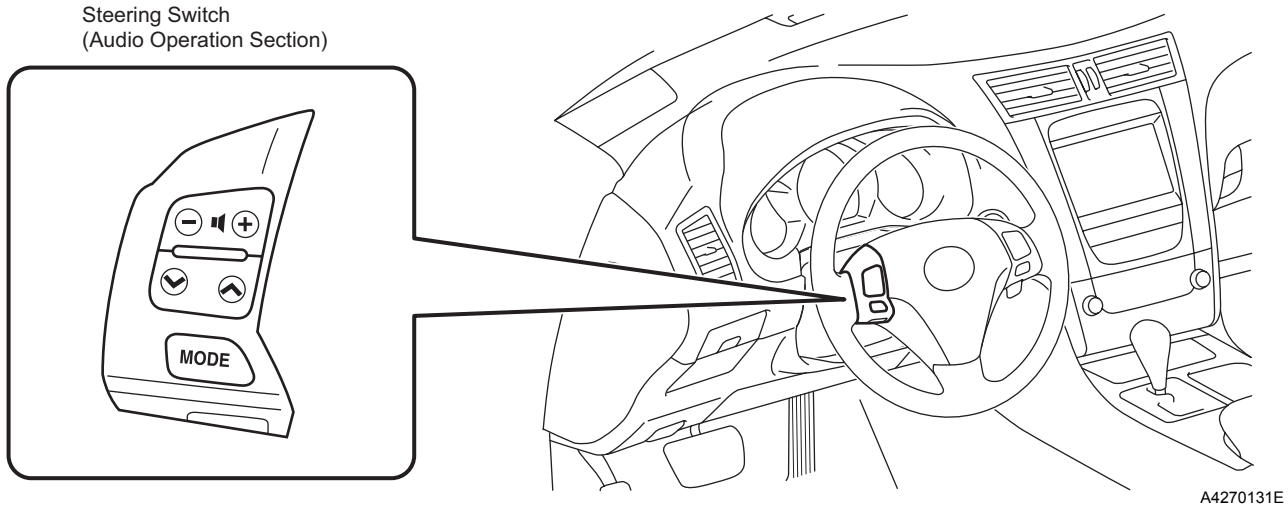
* : Models without "Mark Levinson Premium Surround System"

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Speaker

● A 14-speaker system is provided for the "Mark Levinson Premium Surround System". A 10-speaker system is provided for the "Super Live Sound System".

Speaker Specifications (for the "Mark Levinson Premium Surround System")

Items/ Speaker Name	Center Speaker	Front Tweeter/ Squawker	Front/Rear Speaker	Rear Tweeter	Satellite Speaker	Sub-Woofer
Set Position	Center of the instrument panel upper surface	Right and left of the instrument panel upper surface	Right and left front/rear door trim lower parts	Right and left rear door trim upper parts	Right and left of the package tray trim	Center of the package tray trim
Type	Mid-Range	Tweeter + Mid-Range	Woofer	Tweeter	Mid-Range	Sub-Woofer
Caliber (cm)	6.5	2.5+6.5	16	2.5	6.5	25
Rated MAX Power Input(W)	25(—)	20(—)	25(—)	20(—)	25(—)	25(—)
Voice Coil Impedance(Ω)	8	7	8	6	8	14

Speaker Specifications (for the "Super Live Sound System")

Items/ Speaker Name	Center Speaker	Front Tweeter	Rear Tweeter	Front/Rear Speaker	Sub-Woofer
Set Position	Center of the instrument panel upper surface	Right and left of the instrument panel upper surface	Right and left rear door trim upper parts	Right and left front/ rear door trim lower parts	Center of the package tray trim
Type	Mid-Range	Soft Dome type Tweeter	Soft Dome type Tweeter	Singlcone Full-Range	Sub-Woofer
Caliber (cm)	6.5	2.5	2.5	16	25
Rated MAX Power Input(W)	10(20)	25(50)	25(50)	21(50)	30(66)x 2
Voice Coil Impedance(Ω)	10	4	4	4	2.5

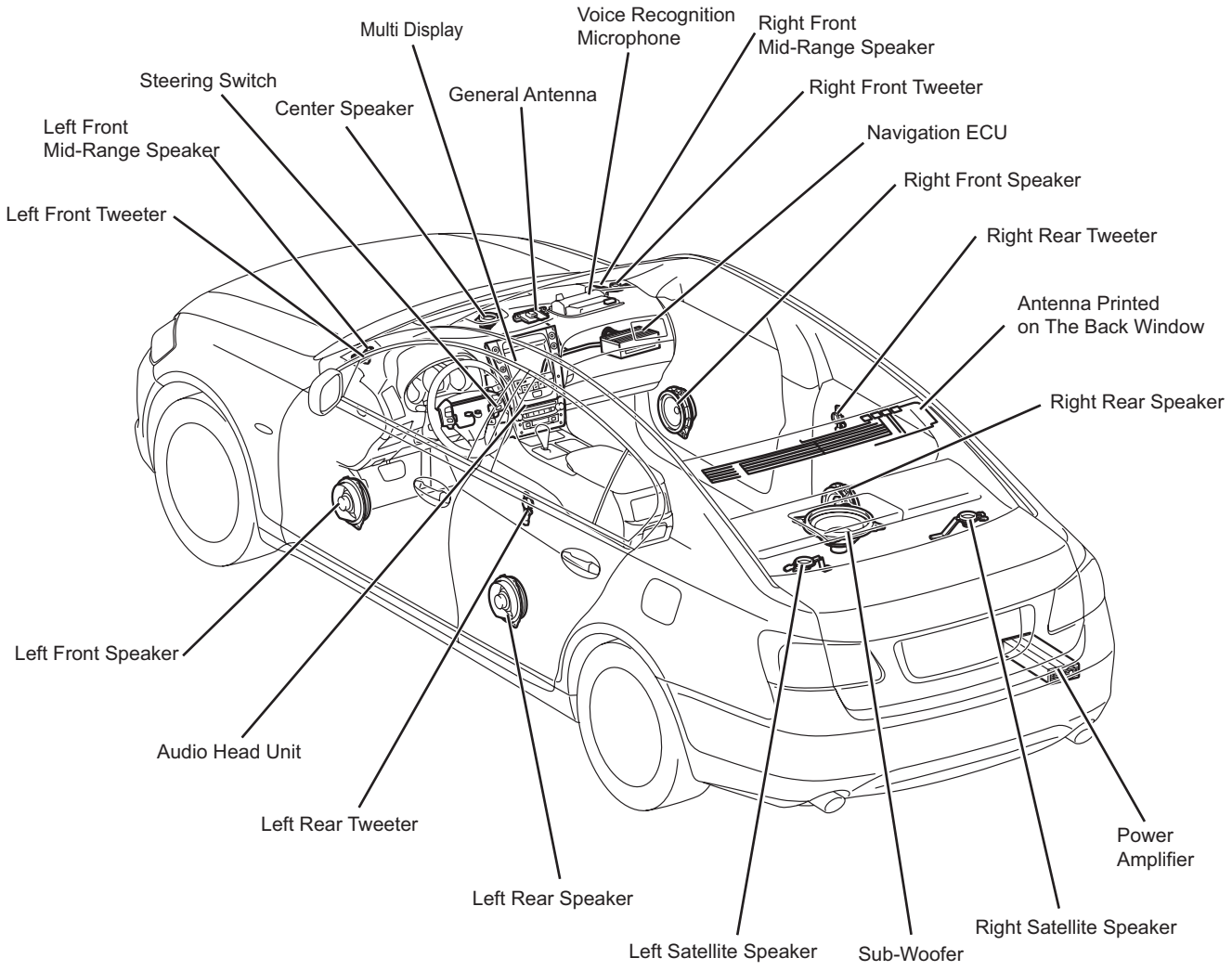
Description of Multi Display

- A multi display consisting of a 7-inch wide screen that excels in visibility is used. This screen switches between navigation, information, and audio screens. In addition, an ultra-fine EMV (Electro Multi Vision) with DVD voice navigation to operate the foregoing functions is provided on all models as standard equipment.
- An ultra high-speed interface called GVIF (Gigabit Video Interface) is used as the method for transmitting images on the multi display. It gives the screen a high graphic and appearance quality
- This system supports Bluetooth, a wireless communication system. When a person is using*1 a mobile telephone that supports Bluetooth, this system enables handsfree calls with no need to connect the telephone via a cable or cradle. Thus, it excels in ease of use.
- The design of the operation screens and the map screen display of the navigation system have been renewed for enhanced looks.
- A voice operation function is used. Thus, the system can be operated by voice commands through the use of the voice recognition system.*2

❖REFERENCE❖

*1Only mobile telephones that support Bluetooth and are equipped with a handsfree profile.
*2Only for Europe Models.

Multi Display : System Configuration



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Note: The illustration gives a representative example.

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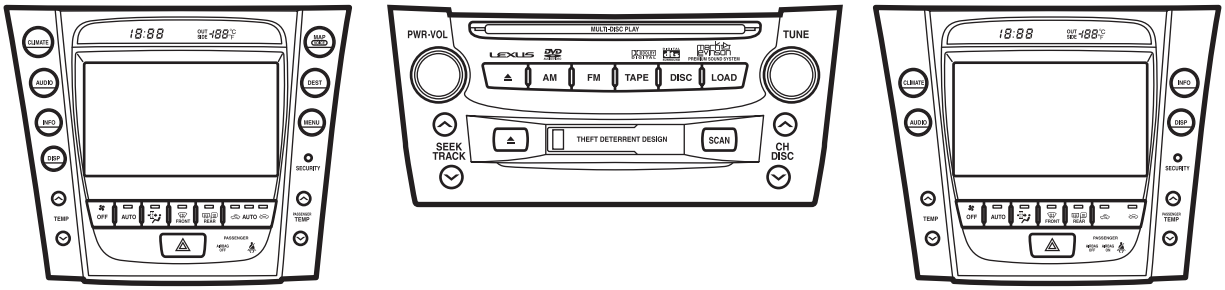
Main Component

Component	Main Function
Multi Display	• The multi display performs various controls including the navigation system and the Electro Multivision system, and displays various screens on the multi display.

Component		Main Function
Built-In Components	Main ECU (for display)	• Inputs and controls the video signals provided by the main ECU for the navigation system and outputs them to the display panel. • Controls the various displays and functions for the Electro Multivision system in accordance with the various operating signals that are input. • Adjusts the color balance of the display screen.
	Display Panel	• Displays the map screen or the operation screen in accordance with the video signals provided by the main ECU for the display. • Outputs the various operating signals that are input to the main computer for the navigation system.
	Main ECU (for navigation system)	• Detects the position of the vehicle in accordance with the signals provided by the GPS receiver. • Calculates the driven distance in accordance with the vehicle speed signals provided by the combination meter. • Detects the direction of travel in accordance with the signals provided by the gyro sensor. • Outputs the map information data that is read from the DVD-ROM player and the position of the vehicle that is calculated to the main ECU for the display in the form of video signals. • Outputs the navigation voice guidance signals to the right tweeter and the right front speaker.
	GPS Receiver	• Demodulates the signals received via the GPS antenna and outputs them to the main ECU for the navigation system.
	Gyro Sensor	• Detects the speed of the vehicle in the vertical axis direction (yaw rate and rotational movement) and outputs it to the main ECU for the navigation system.
	DVD-ROM Player	• Reads the data that is stored on a map DVD-ROM disc, and outputs it to the main ECU for the navigation system.
Audio Head Unit		• Reads data from the DVD disc and outputs the video signals to the multi display and the audio signals to the power amplifier (only on vehicles equipped with the contoured size in-dash AM/FM electronic tuner with a built-in 6-disc DVD changer and a cassette player)
Power Amplifier (made by Mark Levinson or Pioneer)		• Outputs audio signals, such as those from the audio unit, to the speakers. • Inputs audio signals from the DVD player and outputs them independently through a built-in decoder (made only by Mark Levinson)
Map DVD-ROM Disc		• One disc is loaded on the DVD-ROM player for the navigation system, located under the multi display. It stores various pieces of data including map information, voice guidance, and destination searches.
General Antenna (made by Denso)		• Receives orbital signals and signal transmission time signals (which are constantly transmitted by the GPS satellites that are placed along the orbits surrounding the earth at an altitude of approximately 20,000 km) and transmits them to the GPS receiver.
Speaker		• Outputs navigation voice guidance and audio system.
Combination Meter		• Outputs vehicle speed signals (pulse signals) to the multi display.
Taillight Relay		• Outputs a taillight ON signal to the multi display.
Parking Brake Switch		• Outputs a parking brake ON signal to the multi display.
MPX Left Side J/B ECU		• Outputs a shift position signal to the multi display.

Multi Display

● The multi display is integrated with a display portion which is modularized. The display portion consists of a display panel that displays a screen, and a built-in main ECU that controls the display. The navigation portion consists of a main ECU that controls the navigation system, a GPS receiver that demodulates the signals from the GPS antenna and outputs them to the main ECU, a gyro sensor that detects the yaw rate and outputs it to the main ECU, and a DVD-ROM player that reads data from the map DVD-ROM disc and outputs it to the main ECU.



Note : The Illustration of Multi Display excepts G.C.C. Countries Model

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Display Section

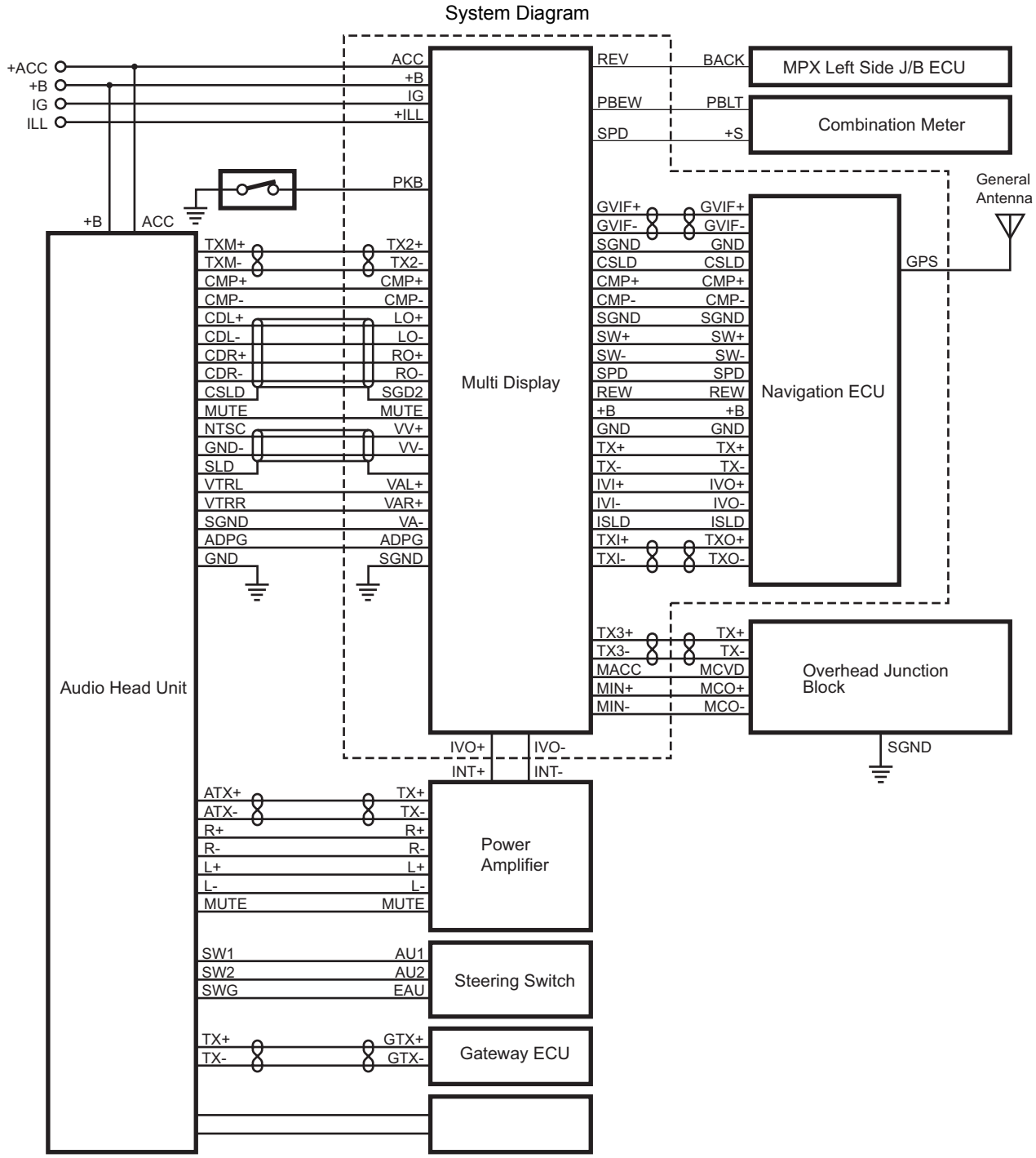
EGA (Enhanced Graphics Adapter) display panel is used. The display supports digital transmission through GVIF (Gigabit Video Interface), and has a built-in wireless transceiver that supports the Bluetooth function.

Display Panel Specifications

Display System	TN liquid crystal type
Color Display	RGB color filter, additive colors
Actuation System	TFT, active matrix actuation
Display Screen Size [mm]	Vertical 104.4 x horizontal 174
Display pixel size [dots]	Vertical 480 x horizontal 800
Display pixel Size [mm]	Vertical 0.2175 x horizontal 0.2175
Color Filter Arrangement	RGB stripe arrangement

Multi Display System Control

System Diagram



Note: The illustration gives a representative example.

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Multi Display Functions Overview

● On the 2003 year model, the Multi Display is provided with the main functions listed below.

List of The Multi Display Function Outline

Mode	Items	Main Function
Navigation System		To display and operate the navigation screen
Information System	Information Mode	To display and operate various information screens
	Audio Mode	To display and operate audio operation screens
	DVD Mode*1	To display and operate DVD video screens
	Air conditioner Mode	To display and operate air conditioner mode screens
	Picture Quality Adjustment	To adjust picture quality
Communication System	Handsfree*2	To display and operate handsfree call screens

❖REFERENCE❖

*1Models equipped with a contoured size in-dash AM/FM electronic tuner with a built-in 6-disc DVD changer and an cassette player.

*2When using a mobile telephone that supports the Bluetooth function. Or, when a mobile telephone is connected to a handsfree system that is available as a dealer-installed option. Only the specified models of mobile telephones can be used.

Operation

Panel Switch Operation

- As on the previous model, the display screens of the Multi Display consist of an information mode screen, navigation mode screen, etc. The respective mode screens can be accessed by operating the panel switches that are provided around the multi display.

Touch Switch Operation

- As on the previous model, after the respective mode screen (information, etc.) has been accessed, the user can enter the desired operation by using a finger to directly touch the touch switches in the switch frame that appears in the display screen.

Steering Switch Operation

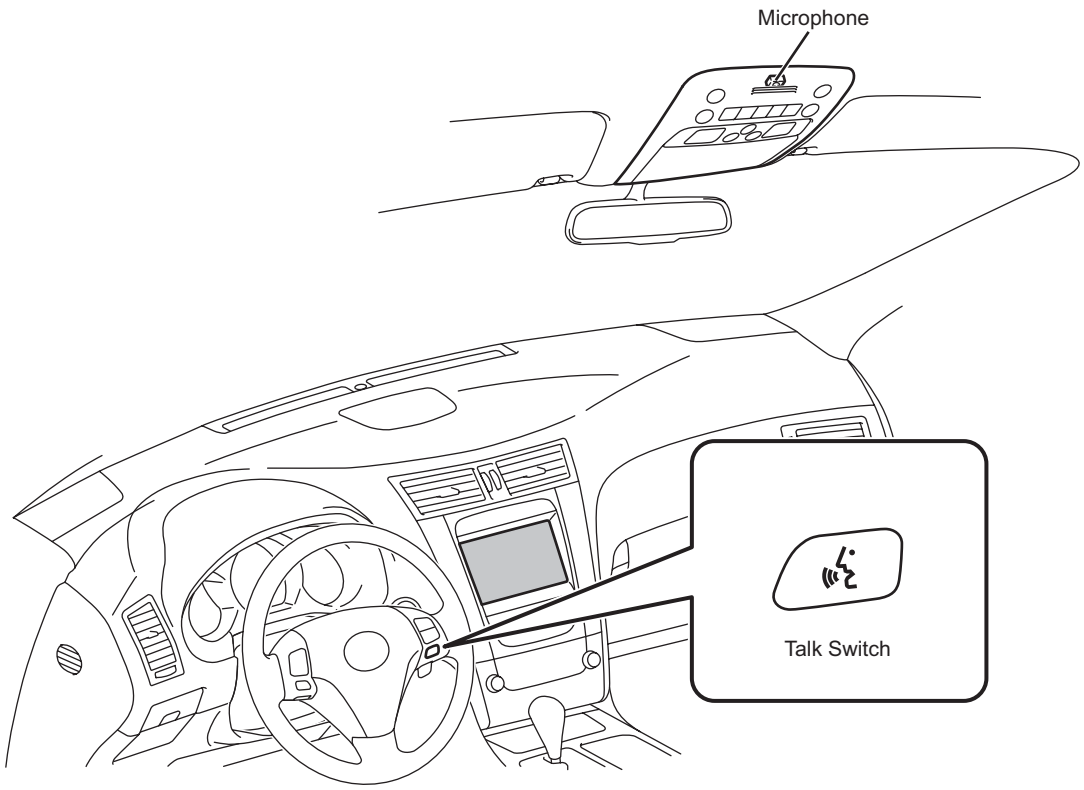
- The steering switches that are provided on the steering wheel enable the driver to adjust the sound volume. For details on the steering switches, refer to the Steering Switches in the Audio System.

Voice Operation*

- By pressing the talk switch, displaying a voice recognition mark on the screen, and speaking into the voice recognition microphone, the driver can issue a voice command to operate the navigation system. Thus, it excels in ease of use.

❖REFERENCE❖

* : Only for Europe Models



Note: The illustration gives a representative example.

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Multi Display Navigation Functions

- The navigation screen is a function that is provided in the GPS (Global Positioning System) voice navigation system.
- Based on the map date on the DVD,signals from the GPS satelites,signals from the built-in gyro sensor,and signals from the vehicle's speed-sensor,the vehicle's present position,direction of travel,and driven distance are calculated and displayed on this screen.This screen has the display functions listed below.

List of functions

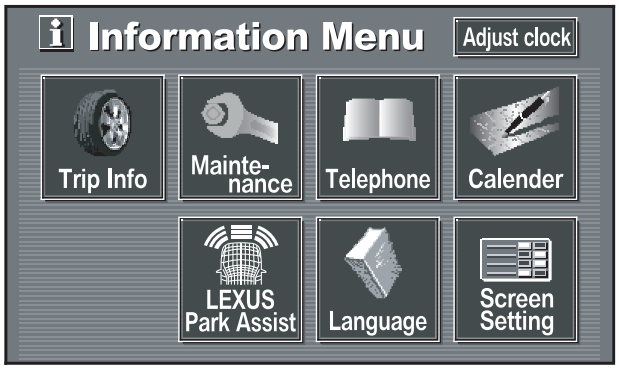
Item		Function
Voice Recognition		Voice commands can operate the navigation snd audio sytem that could not be oparated previously during driving.Only English and German can be recognized in this function.
Map Display	Compass Mode Display	Shows a compass in order to indicate the direction of the destination or the coordinates of the present location.
	RDS-TMC Information Indication	Shows RDS(Radio Date System)information.
	Map Coverage Information Display	Shows information(coverage area)contained in the map DVD
	Whole Route Function	Shows all the routes to the destination on the map.
	Street Name Indication on Scrolled Map	Shows the name of street on which the vehicle is currently traveling.
Destination Display	Coordinate Search	Searches for the destination by coordinates.
	Telephone Number Search	Searches for addresses by telephone number.
	Brand Icon Indication	Registers a memory point and its information on a map and shows the memory point information when needed.
	Intersection Search	The intersection serch has been improved.(By specifyins two streets,the point at which they intersect can be set as a destination point.)
	Freeway Entrance/Exit Search	The freeway entrance/exit search has been improved.(It searches for the destination by the name of the street that connects to a freeway entrance oe exit.)
Route Search/Route Guidance	Route Search Considering Trafific information	Shows traffic volume information during route search.
	Motorway/Freeway MOde Display	Shows the distance to the next motorway facility or point-of-interest while the vehicle is being driven on a motorway.
	Border Guidance	Gives guidance when the vehicle crosses a border.
Others	User Customization Display	Enables the user to customize the background color of the menu screen,setup items,etc.
	Voice Recognition Help Display	Shows a help screen in how to use the voice recognition function.

❖REFERENCE❖

* : Only for Europe Model

Multi Display Information Mode Functions

● When the "information" switch is pressed on the panel switch, the screen will transfer to the information mode screen, where the user can select various information displays.



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List of The Information Mode Function

Function Name	Main Function	Required Option Instruments
Repeat Warning Display	Repeats the vehicle warning display	—
Delete Beep	Sets beep sound (switch response sound) ON or OFF	—
Vehicle Information	Displays vehicle information such as fuel consumption, distance driven, etc.	—
TEL (telephone book display)	Displays a list of telephone numbers	—
TEL (handsfree calls)	Handsfree calls	Handsfree system
Clearance Sonar	Sets front & clearance sonars	Front & clearance sonar system
Maintenance	Inputs and displays maintenance information	—
Setting	Sets the displays for information screen, audio screen, etc.	—
Language	Sets the language	—

Warning Repeat Display

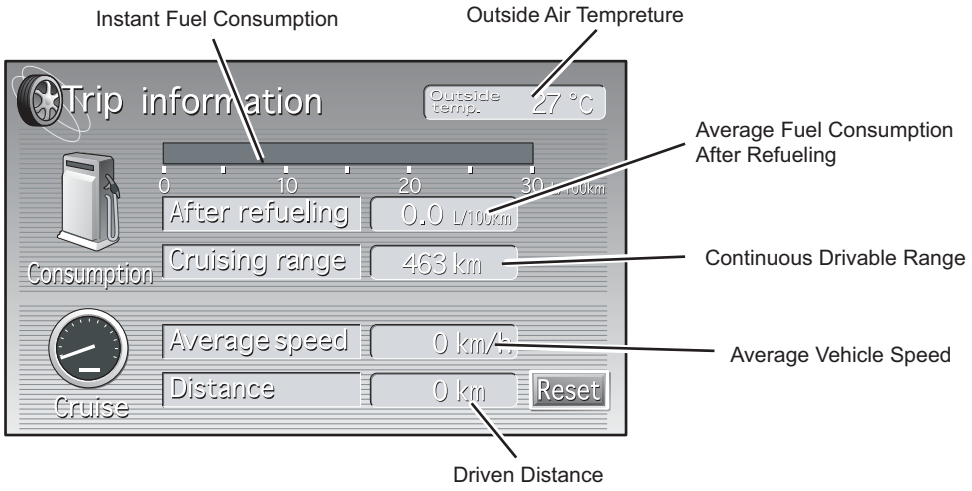
• By touching "warning repeat display" on the information mode screen, the screen transfers to the vehicle warning display. Thus, it can display again the vehicle warning display that was displayed once before. For details, refer to the vehicle warning display screen.

Delete Beep

• By touching "delete beep" on the information mode screen, the user can turn the beep sound (switch response sound) that is emitted when the touch switch is operated ON or OFF. After the beep sound is set to OFF, the operation indicator light on top of the switch will turn OFF.

Vehicle Information

• By touching "Trip Info" on the information mode screen, the screen transfers to the trip information display, where various types of information can be displayed, such as average fuel consumption, or continuous drivable range. Also, by touching "Reset" on the screen shown at the right side of the driven distance , the user can reset the average vehicle speed and driven distance.



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List of The Trip Information Display Content

Outside Air Temperature	Continuous Drivable Range
Instant Fuel Consumption	Average Vehicle Speed
Average Fuel Consumption After Refueling	Driven Distance

Telephone Directory

Telephone Book Display (when a handsfree system, which is available as a dealer installed option, is not installed, or when a mobile telephone that supports Bluetooth is not being used)

• By touching "Telephone" on the information mode screen, followed by the touching of "traffic•navi" on the telephone screen, the screen transfers to the telephone book screen. This will display a list of telephone numbers for the facilities (such as JAF or road traffic information center) that are stored on a map DVD-ROM disk.

• If telephone numbers are input at preset destinations, registered memory spots, and special memory spots, the telephone numbers for those spots can also be displayed.

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Telephone (Handsfree Call)

Handsfree Call (when a handsfree system, which is available as a dealer installed option, is installed, or when a mobile telephone that supports Bluetooth is being used)

• By touching "Telephone" on the information mode screen, the screen transfers to the telephone screen. This enables the user to make a handsfree call on the user's mobile telephone. For details, refer to the handsfree call function.

Clearance Sonar

• By touching "clearance sonar" on the information mode screen, the screen transfers to the clearance sonar setting screen, where various settings related to the front & clearance sonars can be performed. For details on the clearance sonar setting screen, refer to the front & clerance sonar system.

Maintenance

- By touching "maintenance" on the information mode screen, the screen transfers to the maintenance menu screen, where various types of maintenance information, such as the oil change timing, can be displayed and input (timing, distance, dealer, etc.). Also, by touching "PERSONAL ITEMS" on the screen while the maintenance menu screen is being displayed, the screen transfers to the personal items screen. This screen can display personal information such as when to update the driver's license can be displayed and the timing can be input.

List of maintenance menu

Change engine oil	Replace wiper rubber blade
Replace oil filter	Change engine coolant (LLC)
Rotate tires	Change brake fluid
Replace tires	Change automatic transmission fluid (ATF)
Replace battery	Personal items (transfer to personal items menu)
Replace brake pads	

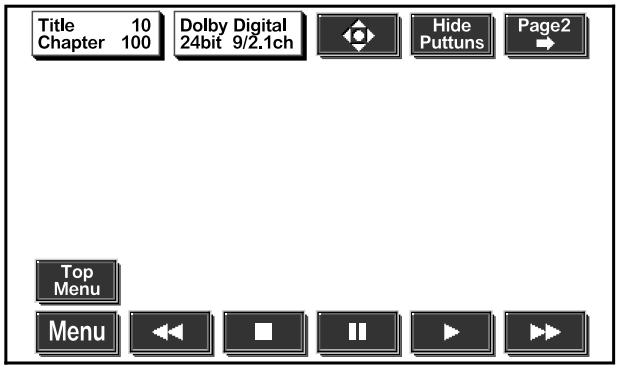
List of personal items menu

Procare 10	Polymer maintenance
Mileage service	Replace air purifier filter
12-month inspection	Insurance expiration
Vehicle inspection	Update driver's license
Glass coating	Personal reminder (set by placing your own title)

Multi Display DVD Mode Function

DVD Mode Screen

- When the "audio" switch on the panel switch is pressed while a DVD video or a video CD is being played, the screen transfers to the DVD mode screen, where the operating conditions of the DVD video or video CD, as well as the operating screen, can be displayed.
- When a DVD video that supports 5.1 channel multi surround is being played, the "Mark Levinson Premium Sound System" reproduces in-your-face sound quality.

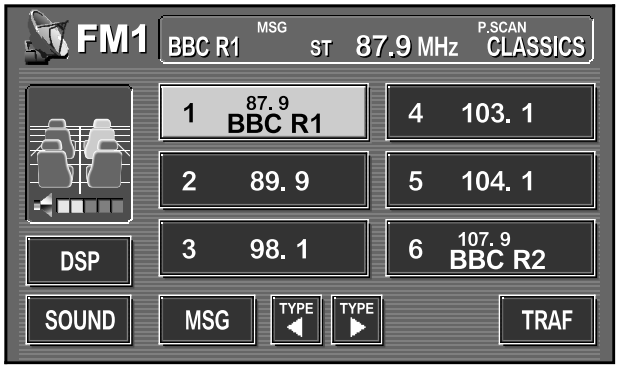


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Multi Display Audio Mode Functions

Audio Mode Screen

- When the "audio" switch on the panel switch is pressed while the audio system is being used, the screen transfers to the audio mode screen, where various types of audio adjustments can be made. This includes the displaying of the operating conditions of the music sources (AM/FM radio, Cassette, CD, etc.), operating them, and adjusting sound quality, sound volume, and balance.

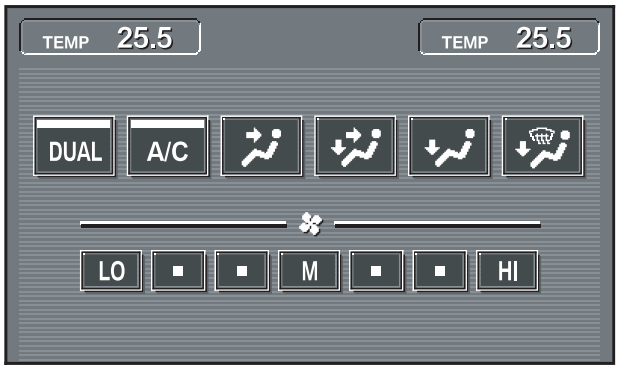


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Multi Display Air Conditioner Mode Functions

Air Conditioner Mode Screen

- When the individual air conditioner operation switches or the "air Conditioner" switch on the panel switch is pressed, the screen transfers to the air Conditioner mode screen, where the operating conditions of the air Conditioner and the operat.

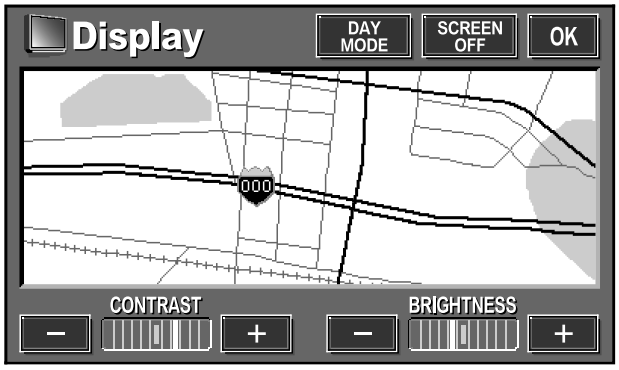


A4270053E

Multi Display Picture Quality Adjustment Mode Functions

Picture Quality Adjustment Mode Screen

- When the "picture quality·delete" switch on the panel switch is pressed, the screen transfers to the picture quality adjustment mode screen, where the picture quality can be adjusted.
- On the NTSC video display screen for DVD and other functions, four items can be adjusted, including color, contrast, and brightness. On the RGB video display screen for the navigation screen and other functions, contrast and brightness can be adjusted.



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Bluetooth Function

- The Blietooth phone operates when the navigation door is open with the ignition switch in either ACC or ON.However,for safety,some functions may become inoperable when vehicle start driving.
- This system has the function listed below.

List of functions

Function		Outline
Enter the Bluetooth phone		In order to use hands-free function of the Bluetooth phone,it is necessary to register it in the multi display.When a phone is registered once,the hands-free function becomes available automatically. Up to four Bluetooth phones can be registered.
Select the Bluetooth phone		When two or more registered Bluetooth phones are in the cabin,it is necessary to select which phone to use to prevent the lines from being crossed.Onlyselected phone is available for use as a hands-free phone.The phone registered last is automatically selected.
Delete the Bluetooth phone		The registered Bluetooth phone can be cleared.
Call the Bluetooth phone	By dial	User can call by inputting the telephone number.
	By phonebook	User can call by phonebook data which has been trnsferred from user's cellular phone. the system has two phonebooks.User can register up to 500 numbers in phonebook.
	By dialed numbers	User can call by dial number.The system memorize up to five dialed numbers.If it is over five,the oldest number is deleted.
	By received calls	User can call by received calls.When a call is received,the system memorize up to five numbers.If it is over than five,the oldest number is deleted.
	By one touch call	User can call by registered telephone number which user selected from a phonebook,dialed numbers and received calls.
	By POL(Point of interest)call	User can call by operating a switch when "Call"displayed on the screen from Navigation system.
Receive the Bluetooth phone		When a call is received,receive screen is displayed with a sound.
Talk on the Bluetooth phone		While user is talking on the phone,talking screen is displayed.
Vhange the settings of the Bluetooth phone	Change the phonebook	This system has two phonebooks.User can select either of a phonebook.
	Transfer the telephone number	User can transfer the telephone number in user's Bluetooth phone to the system.Up to 500 numbers can be registered in one phonebook.
	Register the one touch dial	User can register the desired telephone number from phonebooks,dialed numbers and received calls.Up to 17 items the one touch dial can be registered.
	Delete the memory	Delete the telephone number in the phonebook.

❖REFERENCE❖

* : User can operate it while driving.

■ **Service Tip** ■

Enter the Bluetooth Phone

1. Push the "INFO"button to display the "Information Menu" screen.
2. Touch the "Telephone"switch to the display "Telephone" screen.
3. Touch the "Setting"switch to display"Setting"screen and scroll with" ▼ ".
4. Touch the "Entry"(Europe and Australia)or"ADD Phone"(G.C.C.Countries)switch to connect cellular phone to the system.Operate the phone and input the PASS-KEY displayed on the screen.
5. When the connection is completed,device name and Bluetooth Device Address is displayed.

- For details,see the Navigaion System Owner's Manual.

CLEARANCE SONAR SYSTEM PARK ASSIST / MONITORING

General

- A Lexus Parking Assist-sensor(Steering-guided) is available on all models as optional equipment. Using ultrasonic sensors to detect the presence of obstacles in the vicinity of the front and rear bumpers as well as their distance, this system assists the driver during a turnaround in a tight space or to park the vehicle in a garage.
- This system uses the multi-information display and the screen and a buzzer to inform the driver of the obstacle data detected by the sensors.
- The following ultrasonic sensors are provided to detect obstacles: one sensor each at the right and left corners of the front and rear bumpers, two in the center of the front bumper, and two in the center of the rear bumper. The sensors are painted with the same color as the outer panels to ensure the proper appearance.
- The sound volume of the buzzer and whether to turn the display ON or OFF can be adjusted through the customizable function. In addition, the sound volume of the buzzer can be adjusted by operating the clearance sonar setting screen on the display.

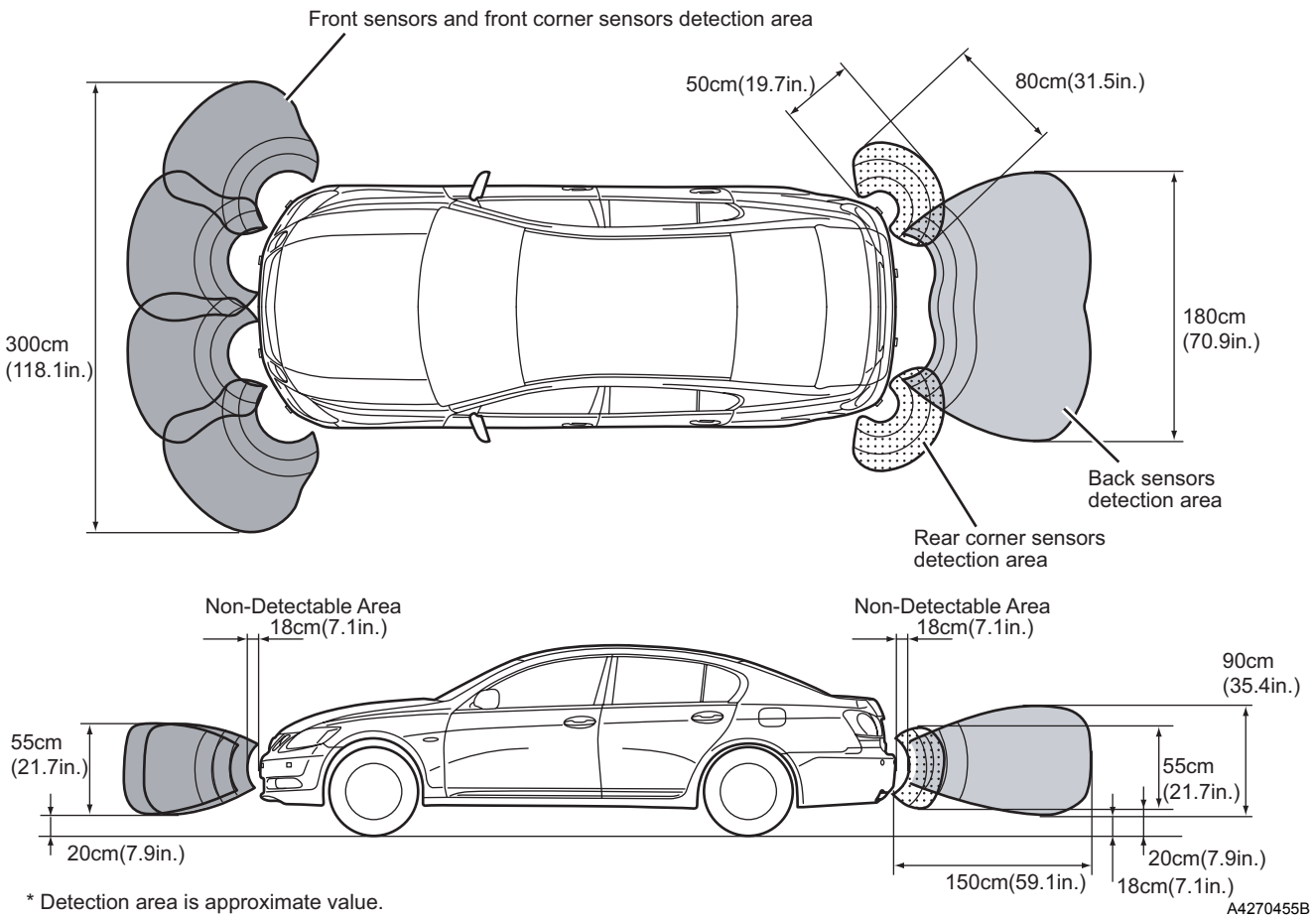
Function

- The ultrasonic waves that are output by a sensor bounce off an obstacle, back to the sensor. The length of time this process takes is used for estimating the distance between the sensor and the obstacle. Thus, the system is able to inform the driver of the distance of the obstacle through a graphic display and sounding a buzzer.

Detection Range

- The front sensors and the front corner sensors detect obstacles in an area within approximately 100cm(39.4in.). The rear corner sensors detect within approximately 50cm(19.7in.), and the back sensors within approximately 150cm(59.1in). There are some areas in which the sensors cannot detect obstacles if they are too close to the bumpers.

Sensor detection area



- The system switches from the "steering guidance mode" to the "normal clearance sonar mode" if any one of the conditions listed below is met. The sensor detection area during the "normal clearance sonar mode" differs from the sensor detection area during the "steering guidance mode".

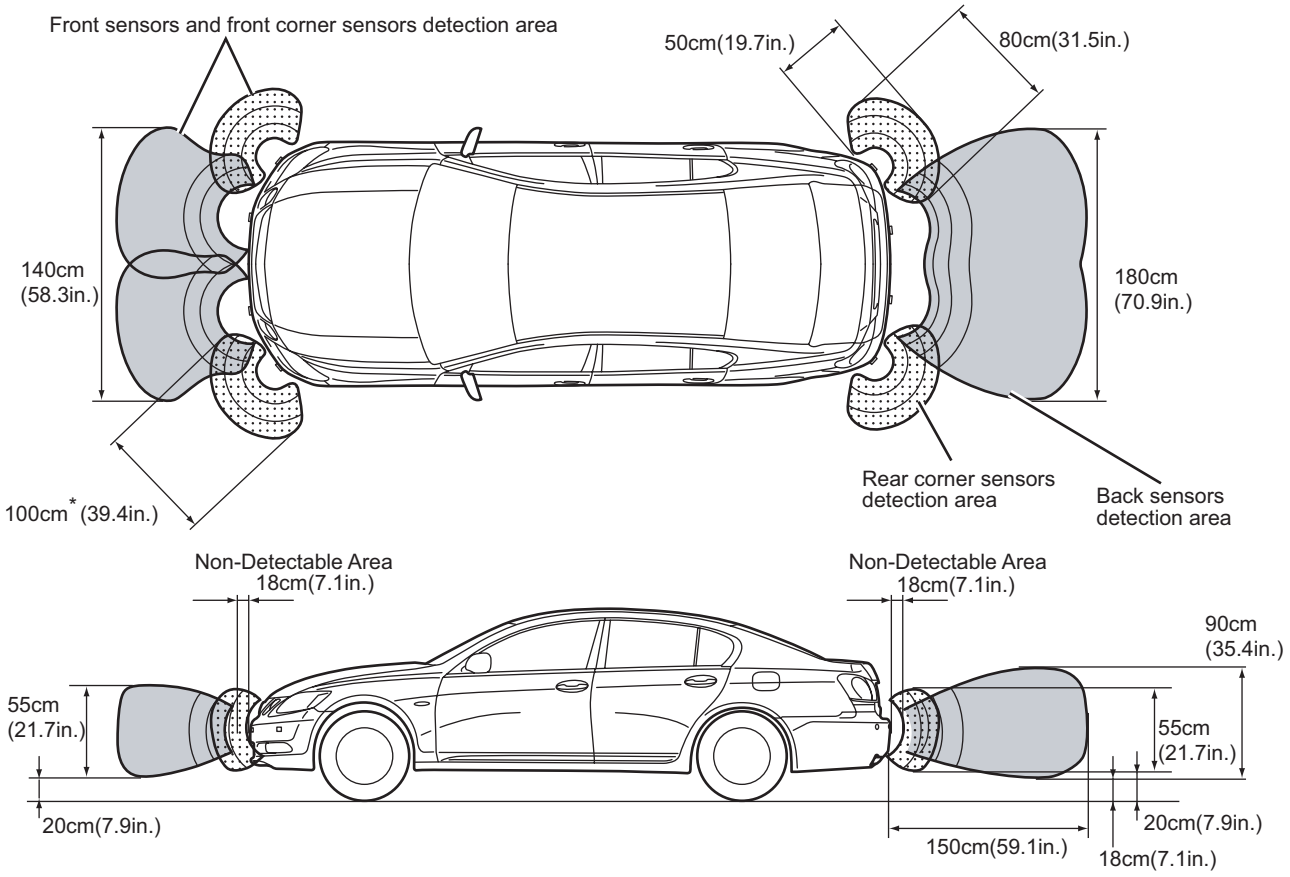
Changes conditions to normal clearance sonar mode

"Normal clearance sonar mode" is selected through the customizable function
A failure is detected in any one of the sensors
The input of a steering angle signal or VGRS signal is disrupted
Neutral point learning mode*

❖REFERENCE❖

* : If the system voltage drops momentarily to an abnormal level(When ECU is exchanged etc.), the system will transfer to the neutral point learning mode. Then, a steering mark will illuminate in the multi-information display and the screen.In that case,make sure to perform the neutral mode learning mode and the maximum steering angle learning mode by turning the steering wheel lock-to-lock. Otherwise, the system may not be able to make a proper contact/avoidance judgment.

Sensor detection area(Normal clearance sonar mode)

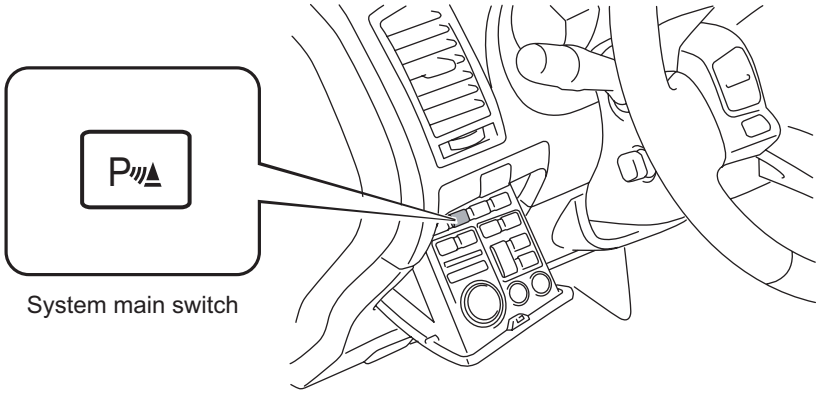


*:Detection area is approximate value.

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Detection Activation

- The clearance sonar main switch is located in the switch module area on the left side of the driver. This switch turns the power to the LEXUS Parking Assist-sensor(steering-guided) ON and OFF.



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• The system starts the obstacle detection operation when all the conditions listed in the table below have been met.

Sonar operation conditions

Dual sonar(front & front corner)	Rear corner sonar	Back sonar
• IG ON • Clearance sonar main switch ON • Shift lever is in a position other than "P" (Only front cornersensor detect an obstacle while the shift lever is in the "R" range) • Less than about 10 km/h(5.9m/h)	• IG ON • Clearance sonar main switch ON • Shift lever is in the "R" range • Less than about 10 km/h(5.9m/h)	• IG ON • Clearance sonar main switch ON • Shift lever is in the "R" range

• After the driver turns the ignition ON and the clearance sonar main switch ON, the system will perform a system check operation for approximately 0.8 seconds, in order to check the sensors for an open circuit or other failures. At the same time, the system sounds the buzzer and flashes the LEDs on the multi-information display.

Contact/Avoidance Judgment(Judgment Line)

• Based on a value obtained from the steering sensor signal and the relative angle of the VGRS (Variable Gear Ratio Steering), the system selects a judgment line that is preset in the clearance warning ECU, and effects a three-stage contact/avoidance judgment in accordance with the position of the obstacle.

Contact/Avoidance judgment

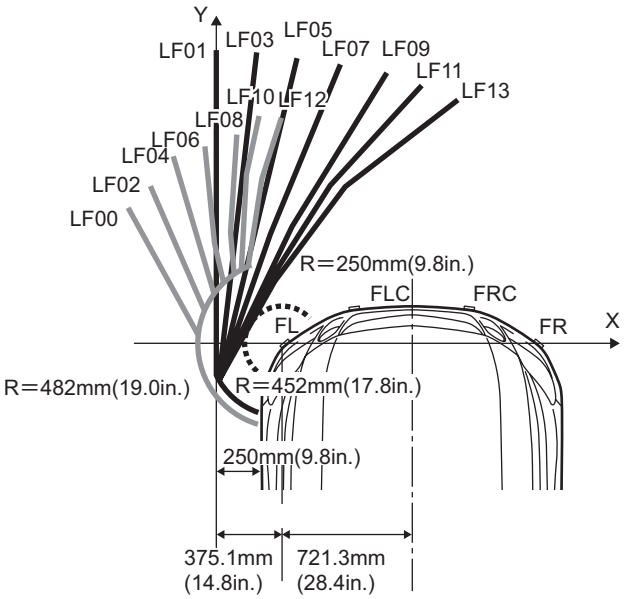
	State
Contact Judgment(Collision will be unavoidable)	State in which the obstacle cannot be avoided even if the driver fully turns the steering wheel.
Avoidance Judgment(Collision will be avoided by changing the steering)	State in which the vehicle will contact the obstacle at the present steering angle, but will be able to avoid contact with the obstacle by turning the steering.
Absolute Avoidance Judgment(Collision will be avoided with the present steering angle)	State in which the vehicle will not contact the obstacle even at the present state of steering.

Judgment Line Except in the P or R Position

- The judgment lines from LF00 to LF13 correspond to the turning angle of the steering wheel. If there is an obstacle in the area on the vehicle side of the LF13 judgment line, there is a risk of the vehicle approaching within 25cm(9.8in) of the obstacle, regardless the steering maneuver that the driver may make. To counter the obstacle that is present within the sensor detection area, the clearance warning ECU makes an avoidance judgment by using a judgment line (odd number from LF01 to LF13) in accordance with the amount of effort that is applied to the steering wheel. (It illuminates the steering assist mark to urge the driver to avoid the obstacle through a steering maneuver.) The even-numbered judgment lines from LF00 to LF12 are the hystereses that correspond to the odd-numbered judgment lines from LF01 to LF13. They are used for making absolute avoidance judgments in the following combinations: LF00 and LF01, LF02 and LF03, up to LF12 and LF13. For example, the system will reach an absolute avoidance judgment if an obstacle that is detected at the LF13 judgment line moves outward of the vehicle, away from the LF12 judgment line, due to a steering maneuver.
- The system issues an contact judgment, avoidance judgment, or absolute avoidance judgment report by illuminating or blinking• the (front) indicator light in the clearance warning indicator assembly, and sounding• the buzzer. In addition, the steering assist mark illuminates during an avoidance judgment.

❖REFERENCE❖

- :Function of multi-information display only
- :Buzzer sounds only upon contact judgment and avoidance judgment



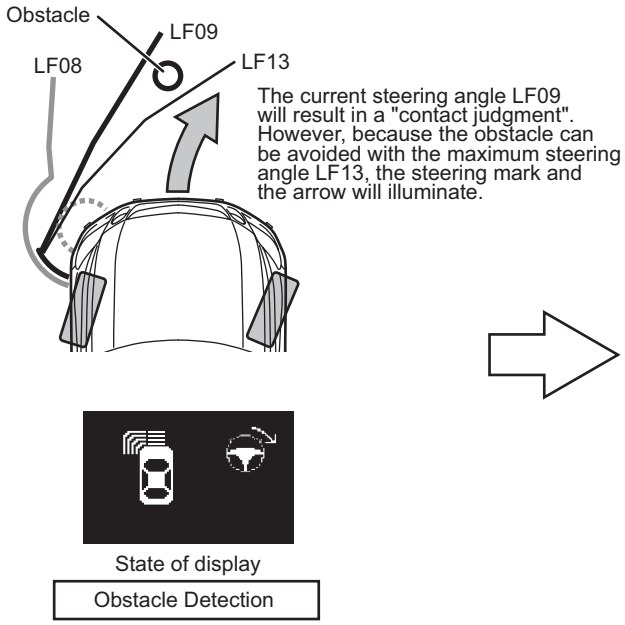
Note: The illustration shows the vehicle making a right turn. In the case of a left turn, the system selects the judgment lines that are formed in a laterally symmetrical manner.

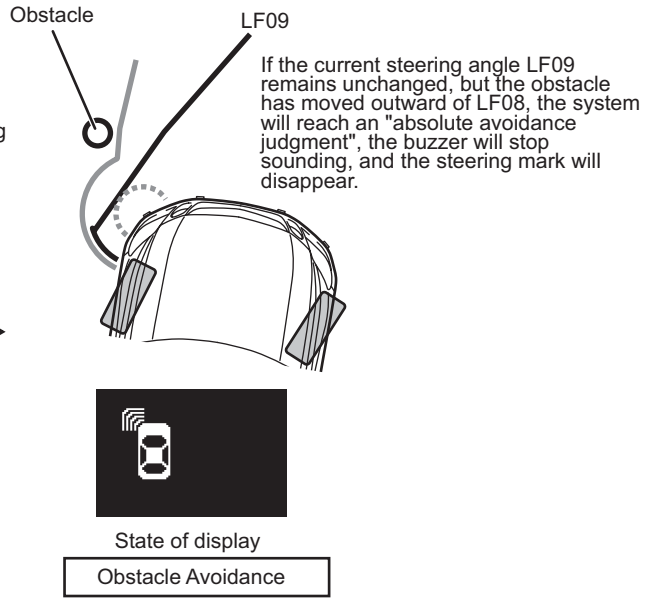
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States and Indication Examples (Except in the P or R Position)

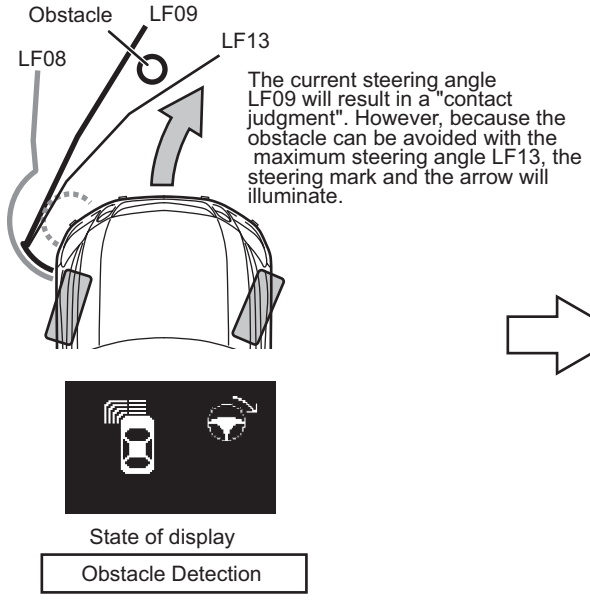
- If an obstacle is detected at the LF09 judgment line, and the obstacle can be avoided through a steering maneuver, a steering guide mark will appear and the buzzer will sound. (The sounding intervals of the buzzer vary by the distance between the sensor and the obstacle.) Thus, the driver will be able to avoid the obstacle by performing a steering maneuver in accordance with the steering guide mark. (The obstacle will move outward of the vehicle, away from the LF08 judgment line.) The combination of the judgment lines changes continuously with the turning angle of the steering wheel.

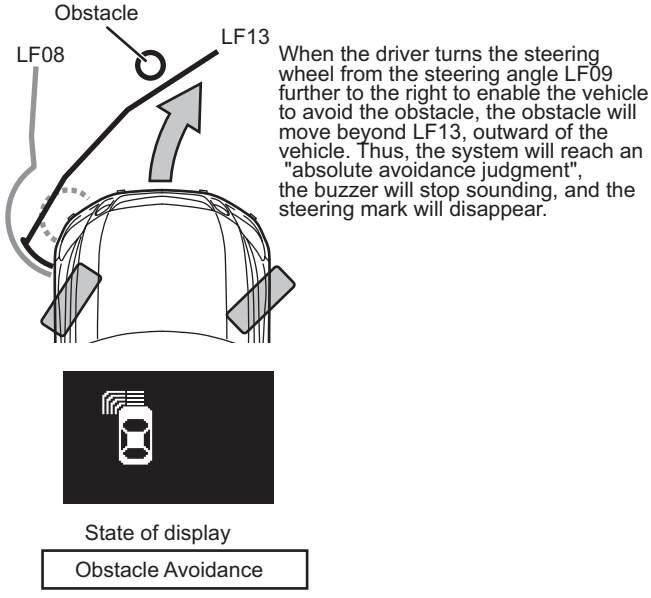
(1) If, once the system has made an avoidance judgment on an obstacle, the vehicle continues to approach the obstacle without changing its steering angle, or the obstacle has moved, causing the system to change to an "absolute avoidance judgment":





(2) If, once the system has made an avoidance judgment on an obstacle, the driver performs a steering maneuver to the extent that the vehicle can avoid the obstacle:



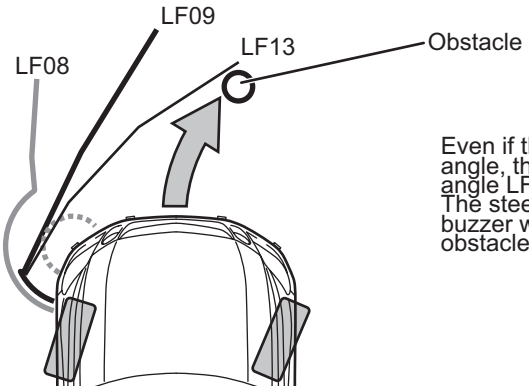


* This illustration is a typical example.

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(3) If an obstacle is detected inward of the vehicle from the maximum steering angle LF13:



Even if the driver turns the steering wheel to its maximum angle, the object will remain inward of the maximum steering angle LF13. Thus, the system will reach a "contact judgment". The steering mark and the arrow will not illuminate, and the buzzer will sound in accordance with the distance to the obstacle.



State of display

Obstacle Detection

* This illustration is a typical example.

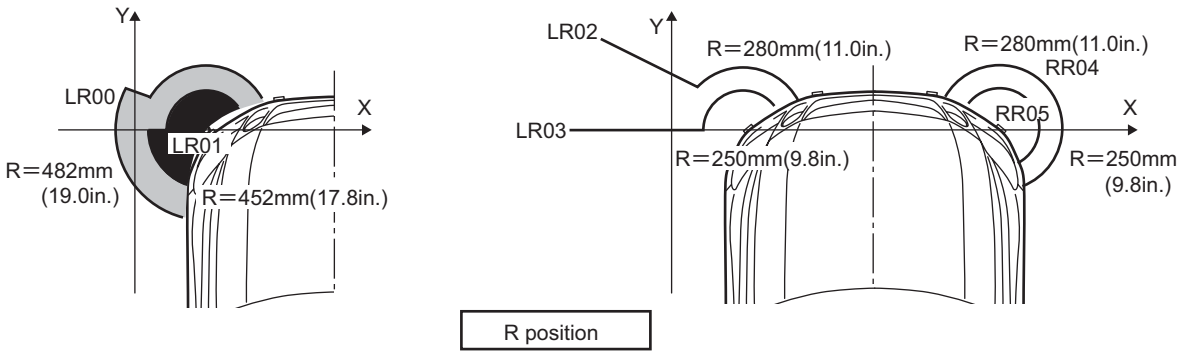
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Judgment Line in the R Position

- The judgment lines LR00 and LR01 are present when the steering turning angle is below 90 degrees. The judgment lines LR02 to RR05 are present when the steering turning angle is over 90 degrees. When an obstacle is present within the area of the judgment line LR03, the system determines that the obstacle can be avoided, provided that there are no obstacles within the LR01 and RR05 areas. (The steering assist mark will illuminate to urge the driver to avoid the obstacle through a steering maneuver.) The even-numbered judgment lines LR00, LR02, and RR04 are hystereses that correspond to the odd-numbered judgment lines LR01, LR03, and RR05. If the driver continues to operate the vehicle with the current steering angle unchanged, or if the driver operates the vehicle by turning the steering wheel to the extent that does not cause the judgment lines to change, these judgment lines will cause the system to reach an "absolute avoidance judgment". If the driver turns the steering wheel until the judgment lines change, the system will make an contact/avoidance judgment based on a newly selected judgment line.
- The system issues an contact judgment, avoidance judgment, or absolute avoidance judgment report by illuminating or blinking the (front) indicator light in the clearance warning indicator assembly, and sounding• the buzzer. In addition, the steering assist mark illuminates during an avoidance judgment.

❖REFERENCE❖

- :Buzzer sounds only upon contact judgment and avoidance judgment

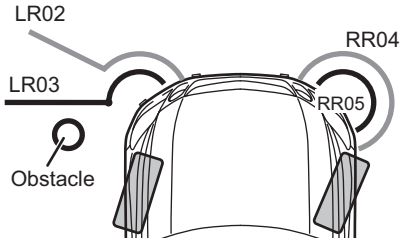


Note: The illustration shows the front left state. In the case of the front right state, the system selects the judgment lines that are formed in a laterally symmetrical manner.

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States and Indication Examples (in the R Position)

- If an obstacle is detected at the LR03 judgment line, and the obstacle can be avoided through a steering maneuver, a steering guide mark will appear and the buzzer will sound. (The sounding intervals of the buzzer vary by the distance between the sensor and the obstacle.) Thus, the driver will be able to avoid the obstacle by performing a steering maneuver in accordance with the steering guide mark. (The obstacle will move outward of the vehicle, away from the LR02 judgment line.) The combination of the judgment lines changes continuously with the turning angle of the steering wheel.



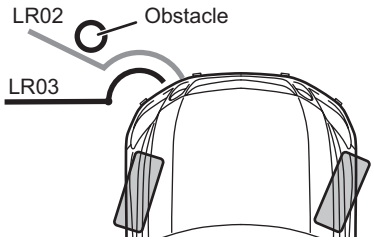
The obstacle is within the LR03 area, and there are no obstacles within the LR01 and RR05 judgment lines with the steering wheel directed straight ahead. Thus, the system will reach an "avoidance possible" judgment, and the steering mark and the arrow will illuminate.



State of display

Obstacle Detection

(1) If the driver continues to operate the vehicle with the current steering angle unchanged, or if the driver operates the vehicle by turning the steering wheel to the extent that does not cause the judgment lines to change:

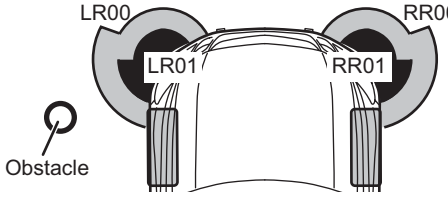




State of display

If the obstacle moves outward of LR02 while the current steering angle LR03 remains unchanged, the system will reach an "absolute avoidance judgment", the buzzer will stop sounding, and the steering mark will disappear.

(2) If the steering wheel is turned straight ahead:

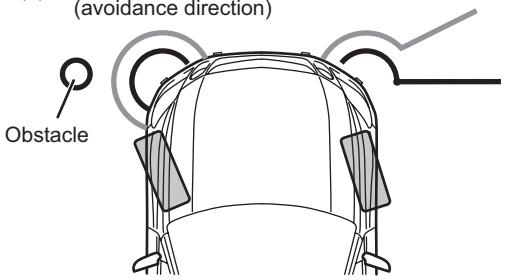




State of display

If the driver turns the steering wheel in the avoidance direction, thus aiming the vehicle straight ahead, the judgment lines will change. This will cause the obstacle to move outward of the judgment line, causing the system to reach an "absolute avoidance judgment", the buzzer to stop sounding, and the steering mark to disappear.

(3) If the steering wheel is turned in the opposite direction (avoidance direction)





State of display

If the driver turns the steering wheel in the avoidance direction, the judgment lines will change. This will cause the obstacle to move outward of the judgment line, causing the system to reach an "absolute avoidance judgment", the buzzer to stop sounding, and the steering mark to disappear.

*This illustration is a typical example.

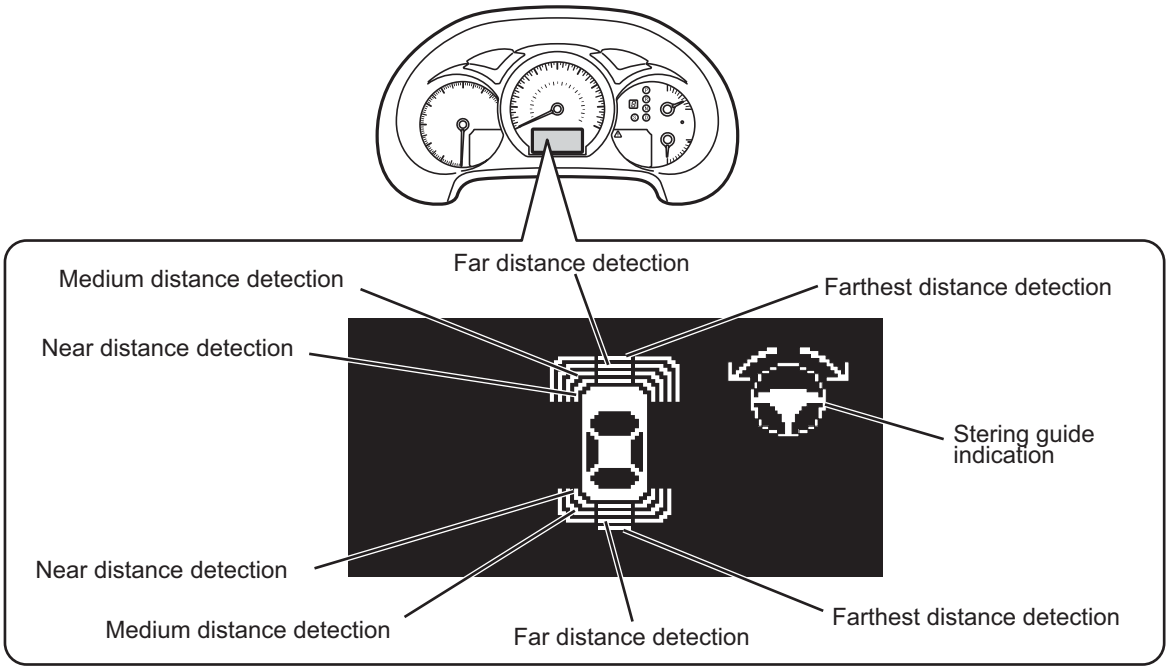
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Display & Function

- When a sensor detects an obstacle, the display panels (the multi-information display and the screen) will graphically display the area of the sensor that detected the obstacle and the approximate distance to the obstacle.
- The clearance warning buzzer sounds in accordance with the indication of the obstacle detection. The buzzer sounds intermittently or continuously depending on the approximate distance from the individual sensor to the obstacle.
- Whether to show a graphic display or the buzzer sound volume can be adjusted through the customizable function. In addition, adjustments can be made by operating the EMV(Electro Multi Vision) information screen.

Indication of Multi-information Display

- If the rear corner sensor (rear corner sonar) detects an obstacle, the display will indicate the detection distances in three stages: far distance detection (approximately 50cm{19.7in.} to 37.5cm{14.8in.}), medium distance detection (approximately 37.5cm{14.8in.} to 25cm{9.8in.}), and near distance detection (approximately 25cm{9.8in.}) or less).
- If the front sensors (dual sonars) detect an obstacle, the display will indicate the detection distances in four stages: farthest distance detection (approximately 100cm{39.4in.} to 50cm{19.7in.}), far distance detection (approximately 50cm{19.7in.} to 37.5cm{14.8in.}), medium distance detection (approximately 37.5cm{14.8in.} to 25cm{9.8in.}), and near distance detection (approximately 25cm{9.8in.} or less).
- If the back sensor (back sonar) detects an obstacle, the display will indicate the detection distances in three stages: farthest distance detection (approximately 150cm{59.1in.} to 60cm{23.6in.}), far distance detection (approximately 60cm{23.6in.} to 45cm{17.7in.}), medium distance detection (approximately 45cm{17.7in.} to 35cm{13.8in.}), and near distance detection (approximately 35cm{13.8in.} or less).
- The indicator light will flash during a near distance detection and illuminate during a detection of other distances. During an avoidance judgment of the dual sonars, the display will simultaneously indicate steering advice, in order to urge the driver to avoid the obstacle by turning the steering.
- When the system detects a sensor failure, it will show a warning in the detected distance display area.



* This illustration is a typical example.

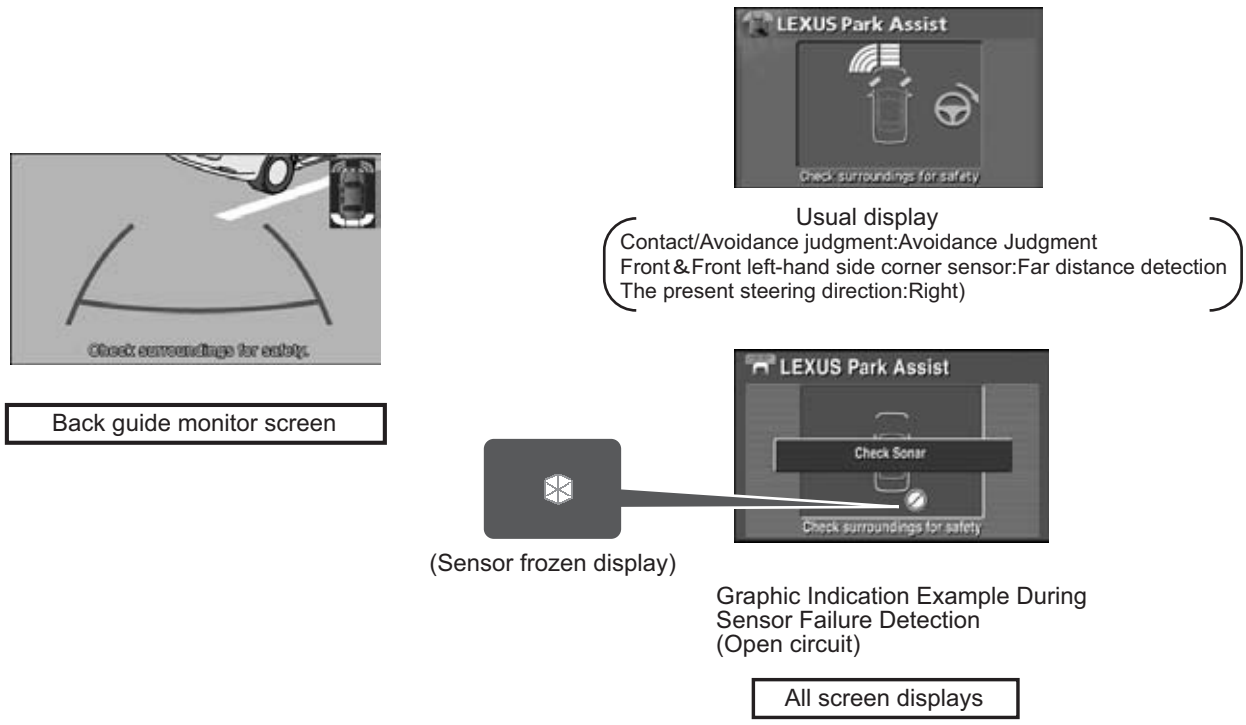
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Indication of the Multi Display

- In addition to the combination meter, the distance detected by the sensor is shown on the screen (7-inch color liquid crystal wide display). There are two ways in which a detection is displayed on the screen: displayed in combination with the video image captured by the back monitor camera, and a full-screen display. When the back guide monitor is used, the display will appear in the upper right area of the back guide monitor screen. The full screen is used for display at other times.
- When an obstacle or a failure is detected, a warning display cuts in to the full screen in accordance with the sensor detection distance information transmitted by the clearance warning ECU via the BEAN (Body Electronics Area Network). When an obstacle is detected, the present steering direction will appear on the display in the form of the direction of the wheels*. When a sensor failure is detected, a mark that corresponds to the failure appears on the screen, accompanied by a message: "Check Sonr"or"Clean Sonar".
- When the front dual sonars detect an obstacle when the shift lever is in a position other than "P" or "R", the following color bars will illuminate: green for "absolute avoidance judgment"; yellow for "avoidance judgment" and "contact judgment" except during a near distance detection; and red for "contact judgment" during a near detection. The basic graphic displays are the same as those in the combination meter.
- If the front dual sonars detect an obstacle while the shift lever is in the "R" range, the following bars will flash or illuminating: flashing green for "absolute avoidance judgment", flashing yellow for "avoidance judgment" and "contact judgment" except during a near distance detection; and illuminating red for "contact judgment" during a near detection. The basic graphic displays are the same as those in the combination meter.
- If the rear clearance sonar detects an obstacle, the following bars will flash or illuminate: flashing yellow for a far distance or medium distance detection, and illuminating red for a near distance detection.
- When the back sonar detects an obstacle, the following bars will flash or illuminate to indicate the corresponding sensor area: flashing yellow for a farthest distance, far distance or medium distance detection, and illuminating red for a near distance detection.

❖REFERENCE❖

* : When the shift lever is in the "R" position, the system will not provide a steering operation advice display in the Back guide monitor screen.



* This illustration is a typical example.

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Set up(In the Multi Display)

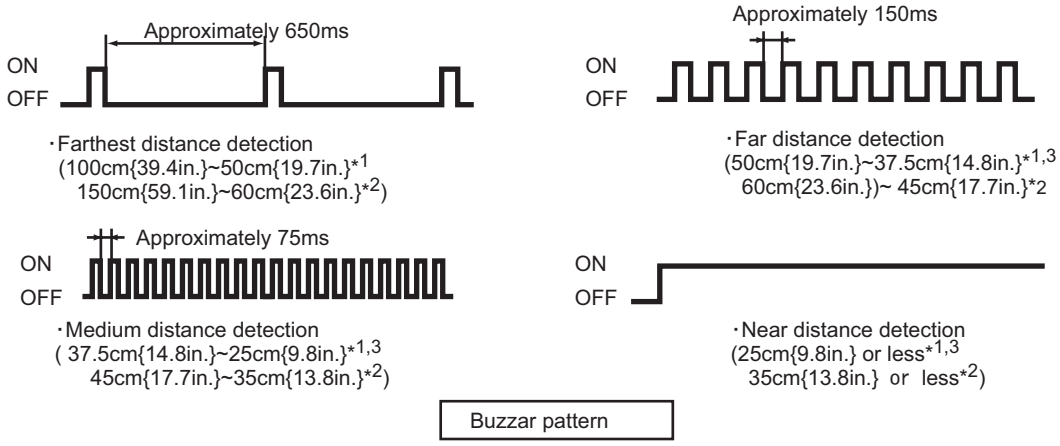
- The following settings can be made: buzzer sound volume (5 stages)display settings (Whether or not display during the "absolute avoidance judgement"), and turning OFF the screen (stopping the sonar display).
- The following three display patterns can be selected and set in case an obstacle is detected: "Static" (to show the display when an obstacle is detected), "Dynamic" (to show the display only during a contact judgment), and "Display OFF" (to not show the display).*

❖REFERENCE❖

* : Shift lever is in a position other than "P" or "R"

Sound the Buzzer

• The sounding cycle of the buzzer becomes shorter as the obstacle gets closer, in accordance with the detection distance of the sensors: 1/16 duty cycle during farthest distance detection (approximately 150ms ON, 650ms OFF), 1/7 duty cycle during far distance detection (approximately 150ms ON, 150ms OFF), and 1/3 duty cycle during medium distance detection (approximately 75ms ON, 75ms OFF). The buzzer will sound continuously during a near distance detection.



*1:Front and front corner sensors *3Rear corner sensors
*2:Back sensors

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• If both the front and rear sensors detect obstacles simultaneously, the buzzer will sound under the following conditions.

Buzzer Sounding Cycles When Multiple Objects Are Detected(Second)

	Near distance detection	Medium distance detection	Far distance detection	Farthest distance detection
Near distance detection	Pattern A*1	Pattern B*2	Pattern B	Pattern B
Medium distance detection	Pattern B	0.15	0.15	0.15
Far distance detection	Pattern B	0.15	0.3	0.3
Farthest distance detection	Pattern B	0.15	0.3	0.8

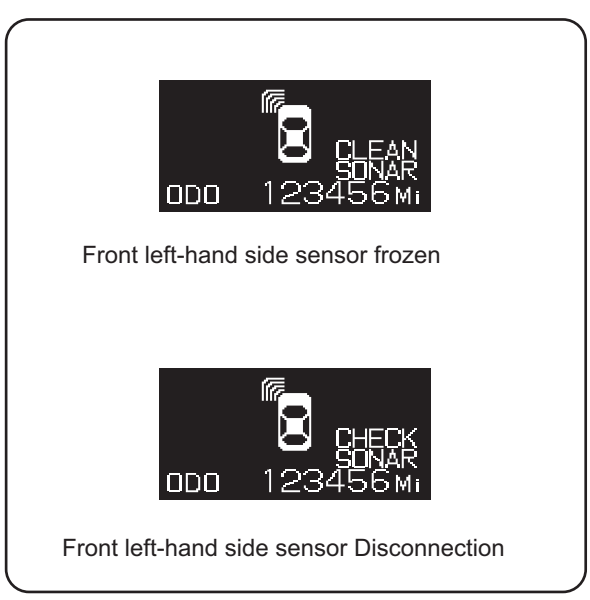
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❖REFERENCE❖

*1 : Pattern A:The buzzer sounds repetitively for 0.05 seconds six times and 0.85 seconds once.
*2 : Pattern B:The buzzer sounds repetitively for 0.05 seconds six times and 0.25 seconds once.

Initial Check

- After the driver turns the ignition ON and the clearance sonar main switch ON, the system will sound the buzzer for approximately 0.8 seconds, in order to diagnose the buzzer and detect sensor failures. If the driver turns the ignition ON while the clearance sonar main switch is already ON, the buzzer will not sound. If there is an open circuit failure in the sensor, the display will show a "sensor failure detection display". If a frozen sensor failure is detected for approximately 5 seconds or more, the display will show a "sensor frozen display". Even when failure detection is being displayed, the system will continue to monitor for sensor failures and will show a failure display if a failure is found.
- If a sensor (other than the one in which a failure is detected) detects an obstacle, or if a sensor failure occurs while the display shows a failure detection display, the graphic display area that corresponds to the sensor for which a failure has been detected will show a "sensor failure detection display". The buzzer will output a detection distance of the closest detection area.
- When the sensors revert to normal, the system will transfer to the detection operation at that time.
- If sonar does not perform a detection operation in any shift position, it performs a self-check only when the system power supply is ON and immediately after a shift lever position has been changed. If a failure has already been detected, the display continues (but the buzzer does not sound). Furthermore, while a signal is being transmitted as a result of the detection of a failure, the system can be restored from the failure and to detect the failure.

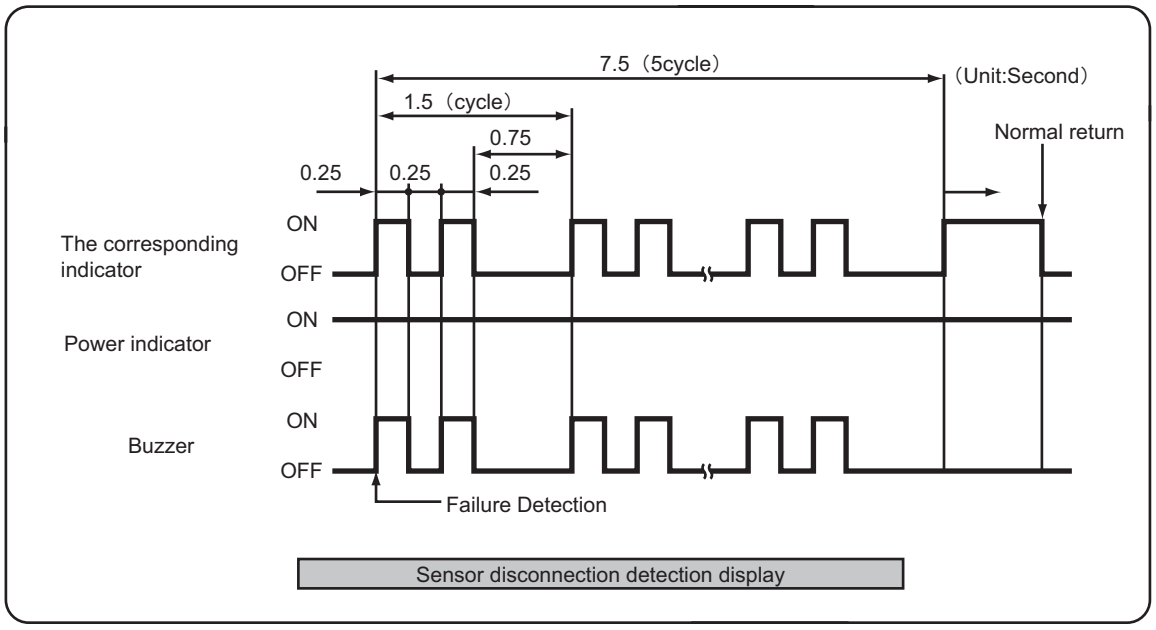


* This illustration is a typical example.

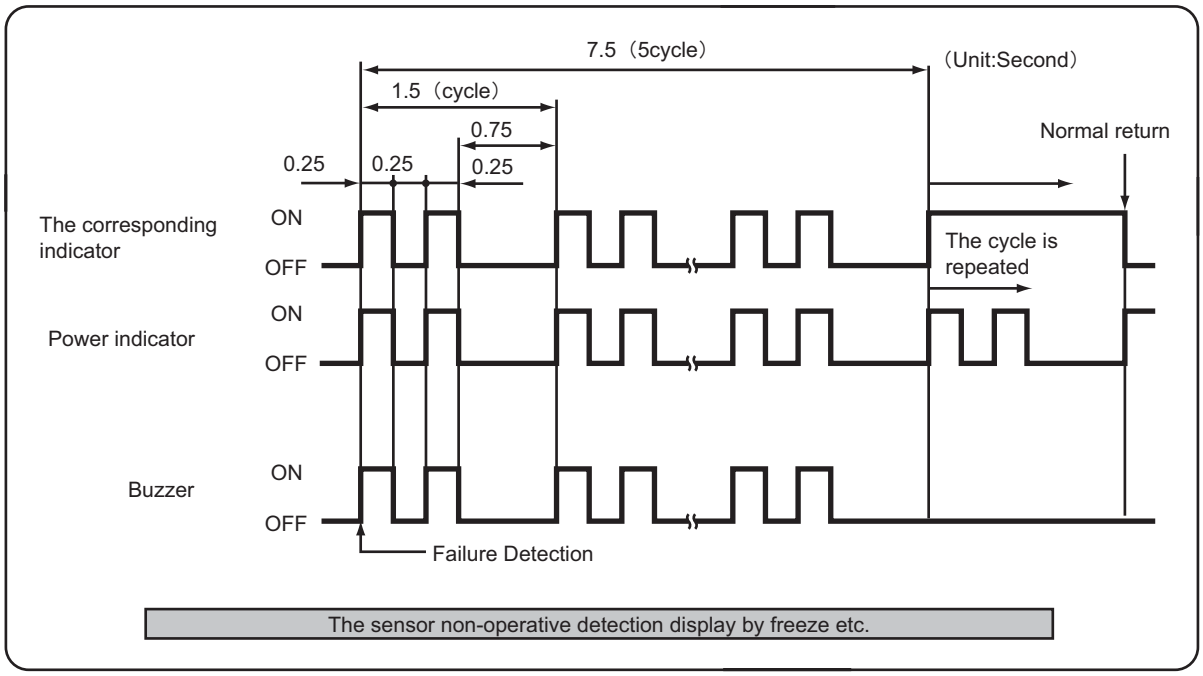
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- After the conditions for activating the system are met and a system check results in a failure, the corresponding indicator light will blink or illuminate continuously as illustrated below. Also, the buzzer will sound as illustrated below. If the system detects an open circuit in a sensor, it will illuminate the power indicator light continuously. If the system detects an inoperative, frozen sensor due to the adhesion of snow or ice, the power indicator light will also blink.
- If a failure occurs while detecting an obstacle, the system will give priority to sound the buzzer with a sounding pattern that indicates the distance to the obstacle.

- On the screen, the display will indicate the failure detection items.
- On the screenw, the failure detection items will appear in the full screen indication mode. The system will use the full screen indication mode to interrupt the display with a failure item mark and a message corresponding to a failure detection item.When the driver operates the screen selector switch to access another screen, the system will cancel the full screen indication of any subsequent clearance sonar failure items. If the screen changes as a result of a change in the display indication condition (such as the main switch or the vehicle speed), without the driver operating the screen selector switch, the system will revert to full screen indication when the display indication conditions are reestablished.



Sensor disconnection detection display



The sensor non-operative detection display by freeze etc.

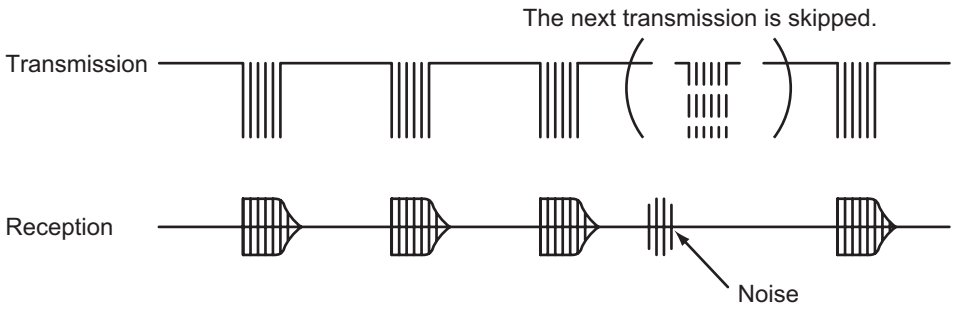
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Processing Detected Ultrasound Noise

- If a sonar detects a noise during its pre-transmission noise monitoring interval, that sensor skips the subsequent transmission to prevent erroneous detection. The following are some of the possible noises: the vehicle's own horn, horn of other vehicles, motorcycle engine sound, air brake sound of large vehicles, and the ultrasound noise emitted by other vehicles equipped with the sonar system*.
- Only the sensor that detected an ultrasound noise skips a transmission, and other sensors will continue their transmission in the normal manner.

❖REFERENCE❖

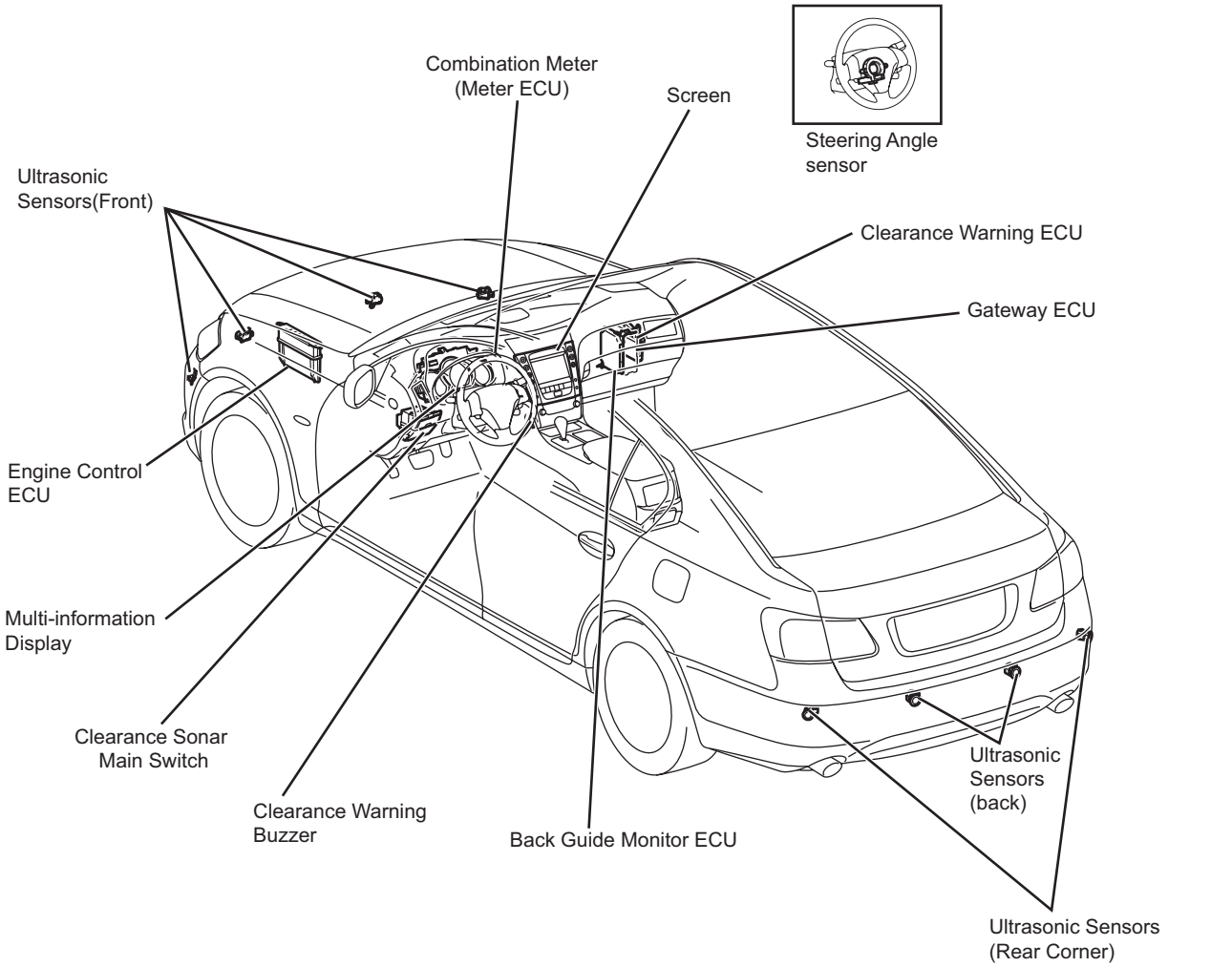
*It is not a reason effective in all ultrasound noises.



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Layout of Main Components

● The LEXUS Parking Assist-sensor(steering-guided) consists primarily of the following components.

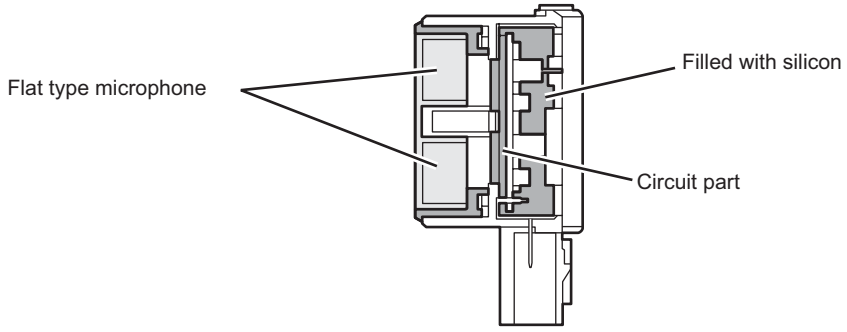


Function of main components

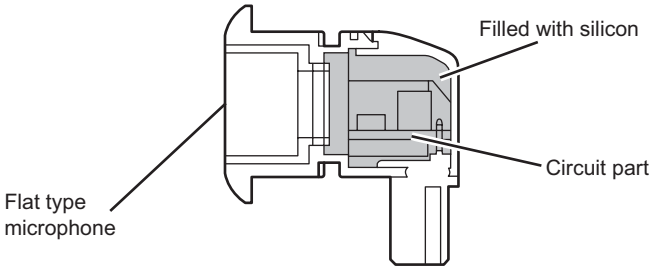
Components	Function
Clearance Warning ECU	• Switches the transmission and reception of a sensor, amplifies and processes the received waves, controls the actuation of the buzzer, and determines a failure in the sensor. • Transmits the detection condition display data via the BEAN (Body Electronics Area Network). • Actuates the clearance warning buzzer in accordance with an obstacle judgment. • Outputs an obstacle detection data to the back guide monitor ECU.Via the BEAN. • Judges the operating conditions and effects correction control in accordance with the individual pieces of data received via the BEAN (Body Electronics Area Network).
Ultrasonic Sensors	• Transmits and receives ultrasound waves to detect an obstacle and outputs signals to the clearance warning ECU.
Clearance Sonar Main Switch	• Outputs the ON/OFF of the system to the clearance warning ECU.
Combination Meter(Meter ECU)	• Receives the detection condition display data from the clearance warning ECU via the instrument panel system BEAN (Body Electronics Area Network), and displays graphics on the multi-information display.
Clearance Warning Buzzer	• Sounds in accordance with the control of the clearance warning ECU.
Gateway ECU	• Relays and transmits the individual pieces of data from the door bus, steering column bus, and instrument panel bus BEAN (Body Electronics Area Network) and AVC-LAN.
Engine Control ECU	• Transmits the shift position data based on the signals from the neutral start switch via the CAN (Controller Area Network).
Screen	• Receives the video signals from the back guide monitor ECU via AVC-LAN and displays graphics. • Transmits the various types of adjustment data that is set on the display information screen to the clearance warning ECU.
Back Guide Monitor ECU	• Receives the obstacle detection data from the clearance warning ECU and outputs video signals to the screen.

Ultrasonic Sensor

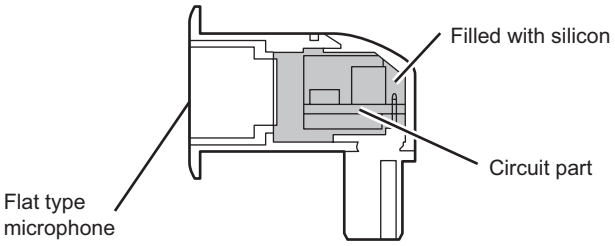
- An individual sensor has built-in circuits to perform amplification, reverberation adjustment, and sensitivity adjustment, in addition to a microphone to transmit and receive ultrasound waves. The circuits are protected with a waterproof construction filled with silicon. The front and front corner sensors use dual sonars in which two microphones are integrated, in order to expand the obstacle detection areas.
- The microphone is a flat type that does not have a depression at its tip. It is painted the same color as the outer panels to ensure the proper appearance.
- The sensor has an integrated construction in which the connector is joined directly to the sensor unit. A retainer is used to mount the sensor to the bumper to ensure serviceability.



Front sensors and front corner sensors cross section



Back sensors cross section



Rear corner sensors cross section

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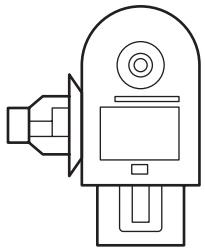
Clearance Warning ECU

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- The clearance warning ECU is mounted on the right side of the Gateway ECU in the instrument panel on the front passenger side.
- The clearance warning ECU contains circuits to control the entire system, including the switching of the transmission and reception of the ultrasound waves, processing the received waves, determining the presence of obstacles, determining a sensor failure, controlling the actuation of the indicator lights and buzzer, and sensor open circuit.

Clearance Warning Buzzer

- The clearance warning buzzer is mounted on the left instrument panel brace.
- The buzzer sounds under the control of the clearance warning ECU.



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Specification

Drive frequency [kHz]	2.4±0.1
Sound pressure [dB]	70±10

Handling Precautions

- The detection areas of the LEXUS Parking Assist-sensor(steering-guided) are limited to the areas around the front and rear bumpers. Before driving the vehicle forward or backward, make sure to check the area surrounding the vehicle for safety, and drive slowly.
- If a strong impact is applied to a sensor by striking it or hitting it with an object, it might not detect properly.
- Sensors do not detect objects in the area directly below the bumper. Also, if an object is placed lower than the sensors, or a thin pole, the sensors might suddenly fail to detect after the vehicle approaches the object, even if they have detected it once.
- If an object is too close to a sensor, the sensor might stop detecting it.
- If an accessory such as a fender pole or a wireless antenna is placed in a detection area of a sensor, the sensor might detect that accessory as an obstacle.

● If the display shows a sensor failure, the sensors might be covered with water, mud, or snow. Therefore, check the condition of the sensors. If the display shows a sensor failure even if the sensors are not covered with mud or snow, the sensors may be malfunctioning. In this case, have the system inspected at a dealer.

● The detection function may not operate properly under the following conditions:

- When the detection portion becomes frozen (the function returns to normal after it is defrosted). Particularly at low temperatures when the components are frozen, the display could show a malfunction and the system might not properly detect even if an obstacle is present.
- When the sensors are covered with foreign matter such as snow or mud.
- When the sensors are covered by a hand, and covered with foreign matter such as snow or mud (the function returns to normal after these are removed).
- When the vehicle posture tilts significantly.
- When the vehicle is operated under a scorching sun or in a freezing climate.
- When the vehicle is being driven on a bumpy road, gravel road, sloping road, or on grass.
- Another vehicle equipped with a sonar system is approaching.
- When the sound of horns from other vehicles, the sound of a motorcycle engine, the sound of air brakes of a large truck, or an object that generates ultrasonic waves is in the vicinity.
- When there is a downpour or water is splashing on the vehicle.
- A towing hook is attached to the vehicle.
- When the sensors are covered with mud, ice or snow.
- When the vehicle travels in the direction of a tall curb or a square curb.

● The steering sensing function may not operate correctly under the following conditions:

- Non-standard size tires are installed.
- The neutral point of the steering is not correctly set (this must be set in the customizable mode).

● The clearance sonar can be used in the normal mode* under the following conditions:

❖REFERENCE❖

* : The tire mark disappears at this time.

- A failure in any one of the sensors is detected.•
- Any one of the steering sensors is malfunctioning.•
- The steering sensor signal cannot be received properly.•
- Accurate steering angle information cannot be obtained due to a considerable drop in battery voltage of a failure in the steering angle sensor.•
- Propersteering detection(going straight) can not be detected.•

❖REFERENCE❖

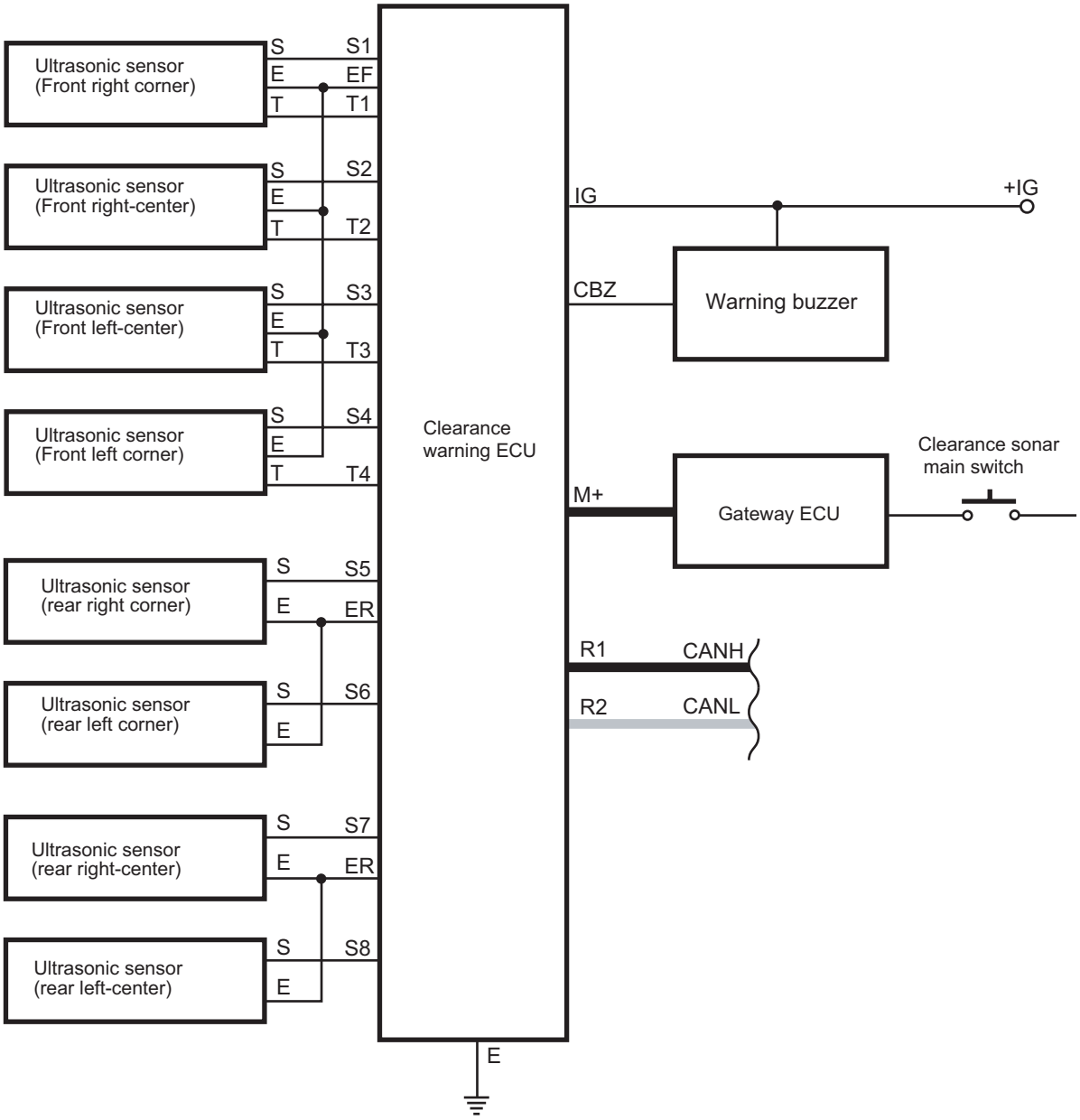
- :When the system returns to nomal,the steering guidance also come back automatically.
- :The steering guidance also comesback automatically after the neutral point of the steering sensor calibration is completed.

● The system may not be able to detect the following items:

- Thin objects such as wire or rope.
- Objects that absorb sound waves such as sponge, snow or cotton.
- Objects that have sharp edges.
- Objects that are short in height.
- Objects that are tall and protrude at the top.

Park Assist Communication System

- The clearance warning ECU transmits the sensor detection data to the meter ECU or the screen through the communication wires of the individual systems to effect display control. In addition, the clearance warning ECU receives data from the individual ECUs via the BEAN (Body Electronics Area Network) and CAN (Controller Area Network) in order to determine the operating conditions of the system and effect correction control.



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Judgment of Operation Conditions.

- The clearance warning ECU receives the "vehicle speed signal" from the meter ECU and the "shift position signal" from the engine ECU through the communication wires of the individual systems, in order to determine* their operating conditions.

❖REFERENCE❖

*If the communication between the clearance warning ECU, the engine ECU, and the meter ECU is disrupted, the system prohibits its operation.

Basic Operation

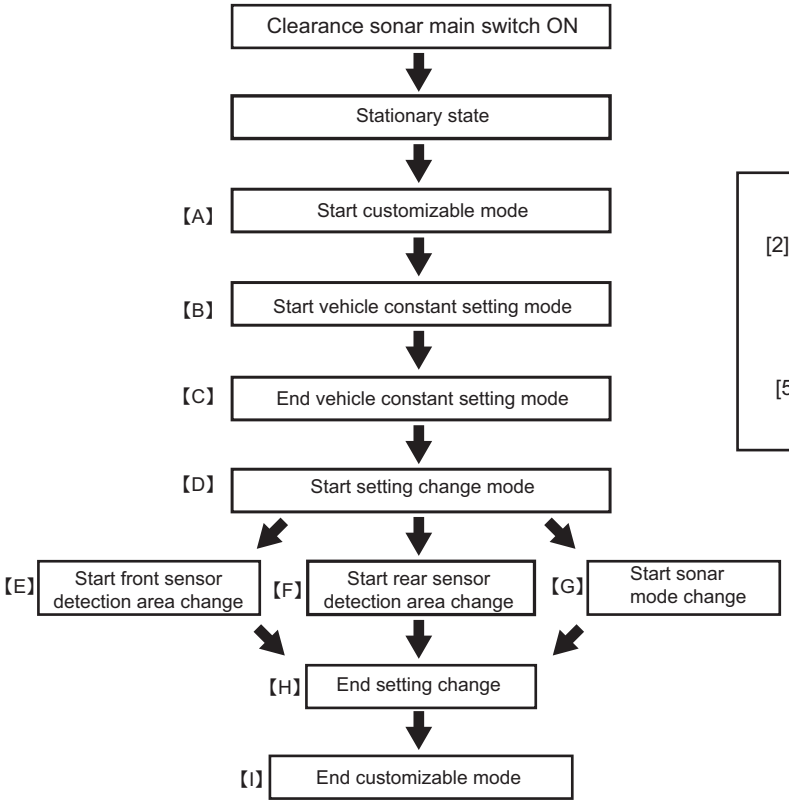
- Upon receiving the inputs of the IG ON and the clearance sonar main switch ON signals, the clearance warning ECU determines the operating conditions based on the signals provided by the BEAN (Body Electronics Area Network), and supplies power to the sensors in order to start the control of the system.
- The individual sensors transmit ultrasound waves at a predetermined interval, under the control of the CPU that is built into the clearance warning ECU. The signal of the sensor to which these ultrasound waves are reflected become amplified and sent to the CPU. Then, the CPU calculates the distance to the obstacle based on the length of time that elapses from the transmission to the reflection.
- The clearance warning ECU transmits the data containing the position of the sensor that detected an obstacle and the distance to the obstacle to the screen through the BEAN (Body Electronics Area Network), via the meter ECU or gateway ECU, in order to control the display. At the same time, it actuates the built-in driver circuit to control the sounding of the buzzer.

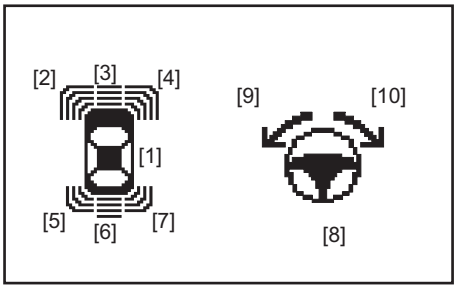
Customizable Function

- A customizable mode is used to set the various functions of the clearance sonar.
- When the vehicle is stopped (0km/h vehicle speed), the system can be transferred to a desired customizable mode or an intelligent tester II may be used to utilize the customizable mode*.

❖REFERENCE❖

* : Make sure to start the customizable mode with the steering wheel aimed straight ahead. Otherwise, the system may not be able to make a proper contact/avoidance judgment.





Multi-information display

Multi-Information Display Indication Settings in Each Mode

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	Note
【A】	○	×	×	×	×	-	×	△	△	△	[8],[9],[10] will illuminate if the steering wheel neutral point is not set
【B】	◌	×	×	×	×	-	×	◌	◌	◌	[1],[8] to [10] will flashing for 2 seconds; then, only [1] will flash* Simultaneously,[2],[4]will illuminate
【C】	◌	×	×	×	×	-	×	×	×	×	[1] will flash
【D】	◌	×	×	×	×	-	×	×	×	×	[1] will flash
【E】	◌	◌	×	×	△	-	△	×	×	×	[1],[2] will flash. At the same time, if the front sensor detection area is set to 50cm(19.7in.) to 1m(39.4in.), [5] will illuminate. If it is not set, [7] will flash.
【F】	◌	×	◌	×	△	-	△	×	×	×	[1],[3] will flash. At the same time, if the rear sensor detection area is set to 60cm(23.6in.) to 1.5m(59.1in.), [5] will illuminate. If it is not set, [7] will flash.
【G】	◌	×	×	◌	△	-	△	×	×	×	[1],[4] will flash. At the same time, if the steering sensing mode is set, [5] will flash. If the normal mode is set, [7] will illuminate.
【H】	◌	△	△	△	△	-	△	×	×	×	[E],[F],and [G] will flash their changed settings for 5 seconds.
【I】	○	○	○	○	○	-	○	○	○	○	All except [6] will illuminate for 2 seconds.*

○ :Illumination ◌ :Flashing
△ :Flashes depending on condition
× :No illumination or flashing

*:Will flash (or illuminate) simultaneously with the buzzer.

Note:Even if [8], [9], or [10] is flashing due to a steering angle sensor or other abnormality, during customized mode, steering-related functions are treated as normal and the set status is displayed.

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Customizable Mode State Transition Conditions

1:Start customizable mode and set the constant setting mode

	Mode			Transition Conditions	Buzzer Sounding State When Conditions Are Met
1	Start customizable mode*1			With the main switch pressed, repeat the light control switch turn on and off three times.	Sound for 2 second(once)
	End vehicle constant setting mode			After the steering wheel is operated full lock-to-lock to the right and left, the clearance warning ECU verifies and memorizes the neutral point and the maximum right-left steering angle value.*2	Sound twice
	Start setting change mode			Operate the clearance sonar main switch five times.	Sound 5 times
2	a		Start front sensor detection area change	Operate the clearance sonar main switch once.	Sound once
			Front sensor has 50cm(19.7in.) to 1m detection	Operate the clearance sonar main switch once.	Sound once
			Front sensor does not have 50cm(19.7in.) to 1m detection	Operate the clearance sonar main switch twice	Sound twice
	b		Start rear sensor detection area change	Operate the clearance sonar main switch twice	Sound twice
			Rear sensor has 60cm{23.6in.} to 150cm{59.1} detection	Operate the clearance sonar main switch once.	Sound once
			Rear sensor does not have 60cm{23.6in.} to 150cm{59.1} detection	Operate the clearance sonar main switch twice	Sound twice
	c		Start sonar mode change	Operate the clearance sonar main switch three times.	Sound 3 times
			Change to steering guidance mode	Operate the clearance sonar main switch once.	Sound once
			Change to normal sonar mode	Operate the clearance sonar main switch twice	Sound twice
3	End vehicle constant setting mode			End setting change.	Sound for 2 second(Sound once)

❖REFERENCE❖

*1 : Simultaneously with the start of the customizable mode, the system starts the vehicle constant setting mode and temporarily memorizes the present steering angle as the neutral point.

*2 : To transfer to the distance changing setup mode without resetting the neutral point, press the clearance sonar switch once to transfer the mode.

List of Setting Items

Setting item	Initial value	Setting value
Changing sonar modes	steering guidance mode	normal clearance sonar mode/steering guidance mode/customizable mode
Changing front detection area (display 50cm{19.7in.}to 100cm{39.4in.}and sound buzzer)	With Function	With Function /Without Function
Changing back sonar detection area (display 60cm{23.6in.} to 150cm{59.1in.} and sound buzzer)	With Function	With Function /Without Function
Setting steering neutral angle point	—	Determined during the customizable mode in accordance with the lock-to-lock movement of the steering wheel.
Setting maximum steering angle value	—	Determined during the customizable mode in accordance with the lock-to-lock movement of the steering wheel.

• When the following conditions apply, the system will sound a buzzer to inform the end of the customizable mode, and ends the customizable mode.

Customizable Mode Interruption Conditions

During the vehicle constant setting mode, the steering wheel right and left full lock-to-lock movement is not completed within 30 seconds.
After transferring to one mode, it does not transfer to another mode within 30 seconds.
A number of clearance sonar main switch operations that are not in the transition conditions are performed.
The clearance sonar main switch is operated while the buzzer is sounding*.

❖REFERENCE❖

* : During the vehicle constant setting mode, the system will not interrupt the customizable mode, but will end the vehicle constant setting mode.

• Various settings can be made by utilizing the intelligent tester II, in addition to the setting items in the customizable mode.

List of Setting Items Other Than Customizable Mode

Setting item	Initial value	Setting value
Function to sound the buzzer if the position of the obstacle does not change over 3 seconds	With Function	With Function /Without Function
Operation of the back sonar in a position other than "P" or "R"	Without Function	With Function /Without Function

LEXUS PARKING MONITOR SYSTEM FOR EU PARK ASSIST / MONITORING

Rear View Monitor System

- To assist the driver in parking the vehicle by monitoring the rear view, this system has a television camera mounted on the back door to display the rearview of the vehicle on the display.
- This system consists of the television camera, television camera ECU and multi display.

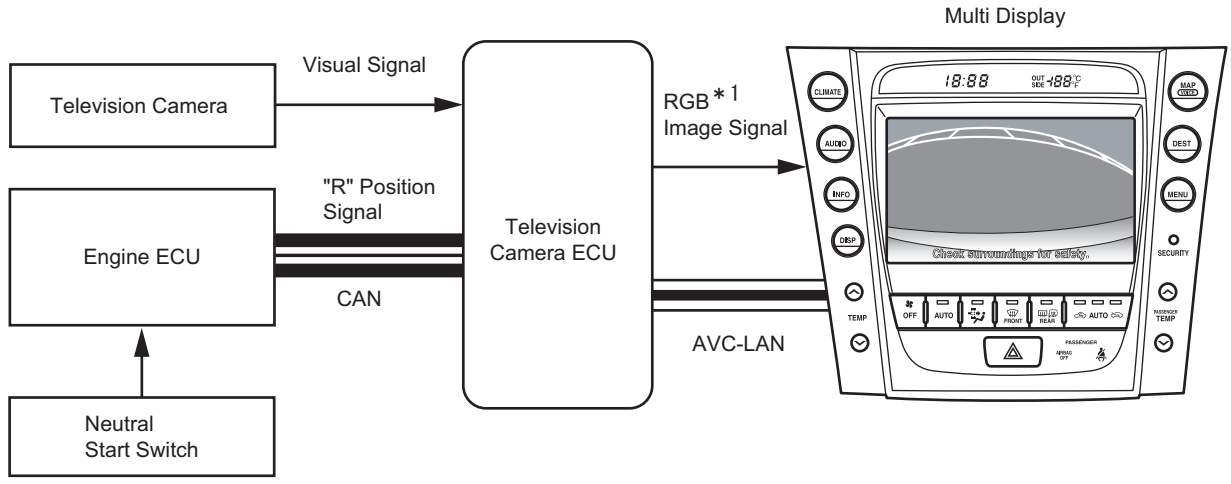
The functions of the LEXUS parking assist system very by destination, as follows

Destination		Europe	China	G.C.C. Countries
Function	Rear View Monitor	Option*1	-	Option
	LEXUS Parking Assist Monitor	Option*2	Option	-

❖REFERENCE❖

*1 : without Navigation System

*2 : with Navigation System



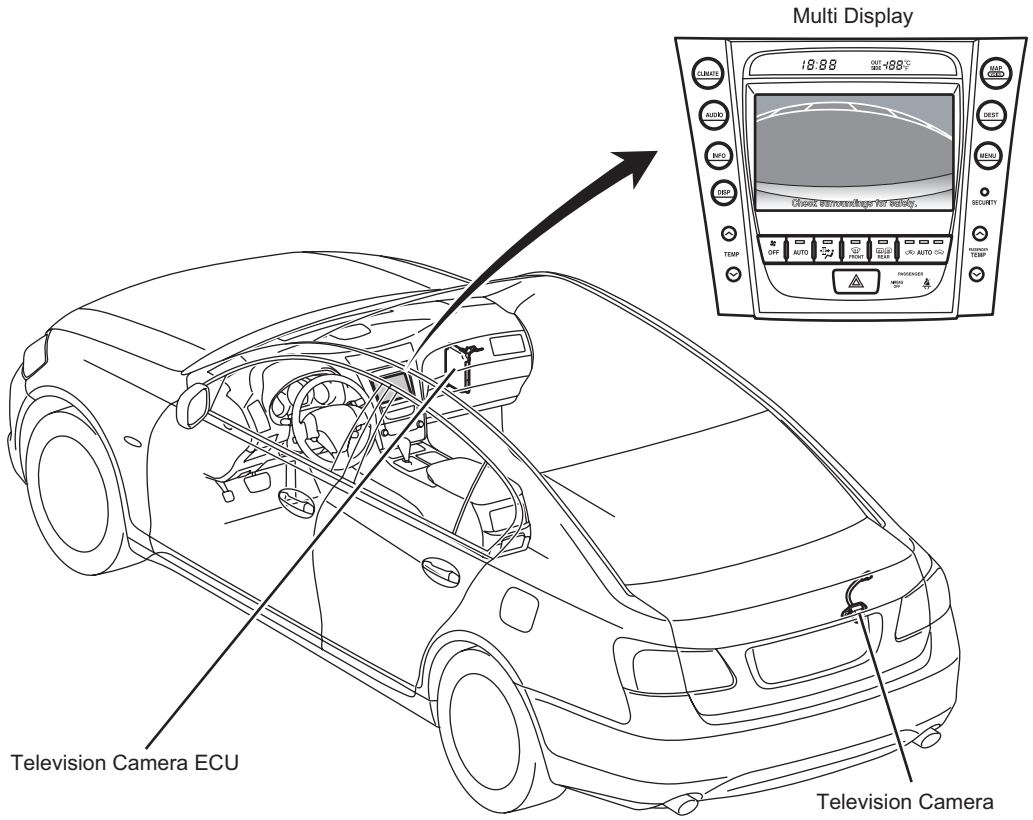
∗1 : RGB (Red Green Blue)

Note : The Illustration of Multi Display excepts G.C.C. Countries Model

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Components



Note : The Illustration of Multi Display excepts G.C.C. Countries Model

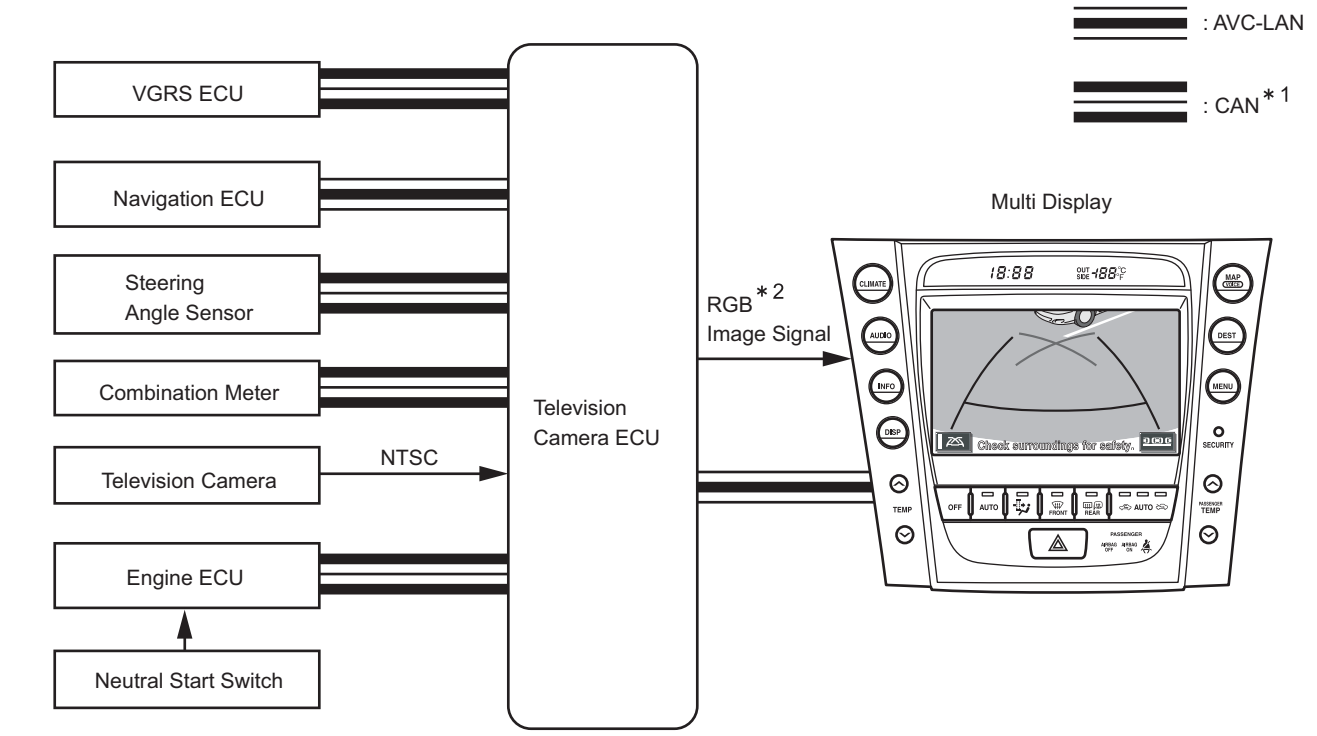
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Function of Main Components

Item	Function
Television Camera	Mounted on the back door to transmit the rearview of the vehicle to the television camera ECU.
	A color video camera that uses a CCD (Charge Coupled Device) and a wide-angle lens.
Television Camera ECU	Transmits video signals, which contain a composite of the rear view of the vehicle taken with the television camera and the warning message, to the multi display.
	Television camera ECU effects control of the system by receiving the signal from the neutral start switch.
Multi Display	Receives video signals containing a composite of the rear view of the vehicle and the warning message from the television camera ECU, and displays on the multi display.
Neutral Start Switch	Transmits a reverse shift position signal to the television camera ECU.

Description

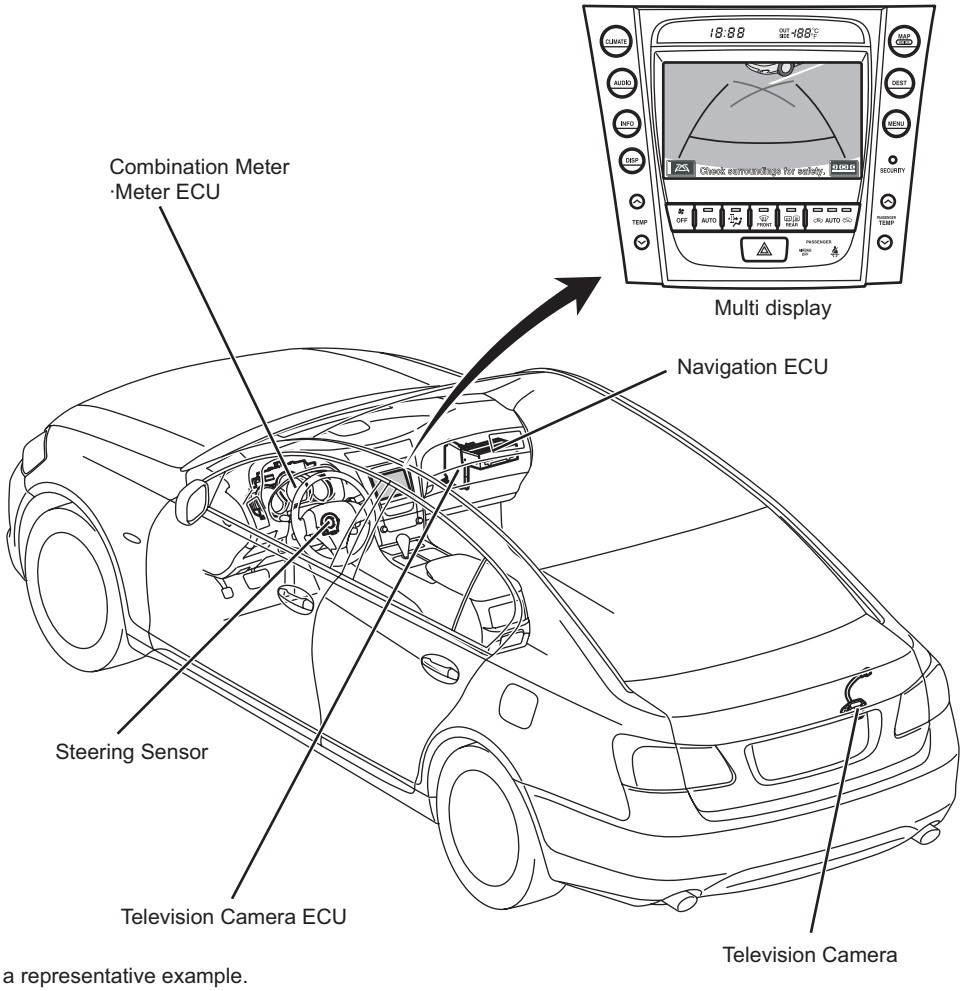
- This system has a television camera mounted on the trunk lid to display the rearview of the vehicle on the display panel of the multi display. The display panel also shows a composite view consisting of the rearview and parking guide lines to assist the driver in parking the vehicle by monitoring the rearview.
- With the ignition switch ON, if the driver shifts the shift lever to reverse, the display panel of the multi display switches to operate this system.
- This system consists of the following: television camera ECU, television camera, multi display, steering angle sensor, and navigation ECU.
- This system is equipped with a self-diagnosis system, which is operated on a dedicated window that appears on the display panel, just as in the navigation system.



*1 : Controller Area Network
*2 : RGB (Red Green Blue)
*3 : Models equipped with VGRS system
Note : The Illustration of Multi Display excepts G.C.C. Countries Model

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LEXUS Parking Monitor System Components



Note: The illustration gives a representative example.

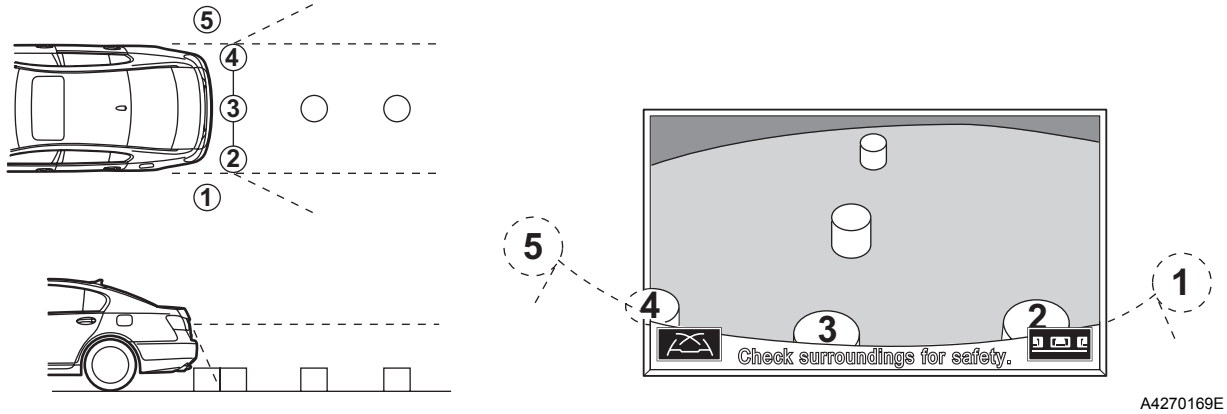
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LEXUS Parking Assist Monitor components

Item	Function
Television Camera	• Mounted on the trunk lid to transmit the rearview of the vehicle to the television camera ECU. • A color video camera that uses a CCD (Charge Coupled Device) and a wide-angle lens.
Television Camera ECU	• Transmits video signals, which contain a composite of the rearview of the vehicle taken with the television camera and the parking assist guide lines, to the multi display. Furthermore, it effects overall control of the system by receiving the signal from the sensors and the navigation ECU.
Multi Display	• Receives RGB image signals which are composite of the vehicle rearview video signal and the parking assist guide line signal from the television camera ECU, and displays them on the display panel.
Navigation ECU	• Uses the yaw rate detected by the gyro sensor that is built into the navigation ECU to transmit the movement of the vehicle to the television camera ECU.
Steering Angle Sensor	• Detects the angle of the steering wheel and sends the resulting signals to the television camera ECU. This sensor is also shared by the VSC function.
Vehicle Speed Signal	• A vehicle speed signal transmitted by the combination meter.
Neutral Start Switch	• Transmits a reverse shift position signal to the television camera ECU.

Area Displayed on Screen

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



❖REFERENCE❖

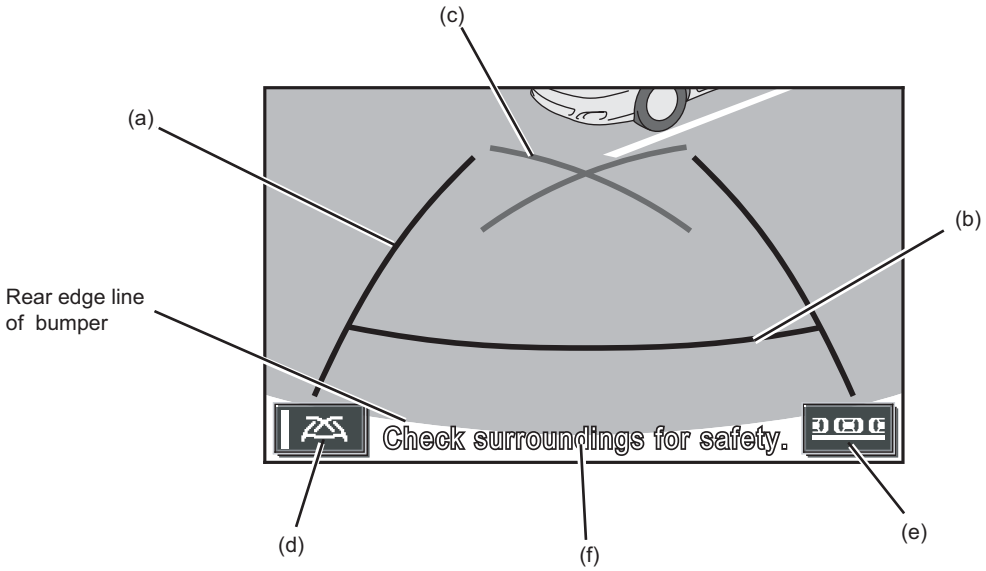
* : Area displayed on screen may vary according to vehicle status or road conditions.The area covered by the television camera is limited. The television camera dose not show objects close to either corner of the bumper or under bumper.

Description of Display

- This system displays in the following two modes: the manual assist mode used for parking the vehicle in a garage or parking area, and the parallel parking assist mode, which assists the driver by providing the appropriate steering angle and timing during parallel parking.
- The driver can switch the system modes by pressing the touch switch, although the display is initially set to the parallel parking assist mode at the factory. The ECU stores in its memory the mode at the time the engine switch is turned OFF. Therefore, the mode that is stored in the ECU appears when the engine switch is subsequently turned ON.

Manual Assist Mode

- When the system operates in the manual assist mode, fixed guide lines appear with the rearview of the vehicle as illustrated below. These guide lines can be used to assist the driver while the vehicle is moving backward.
- In this mode, the driver can press the changeover switch on the display to change the guide line pattern.



A4270077E

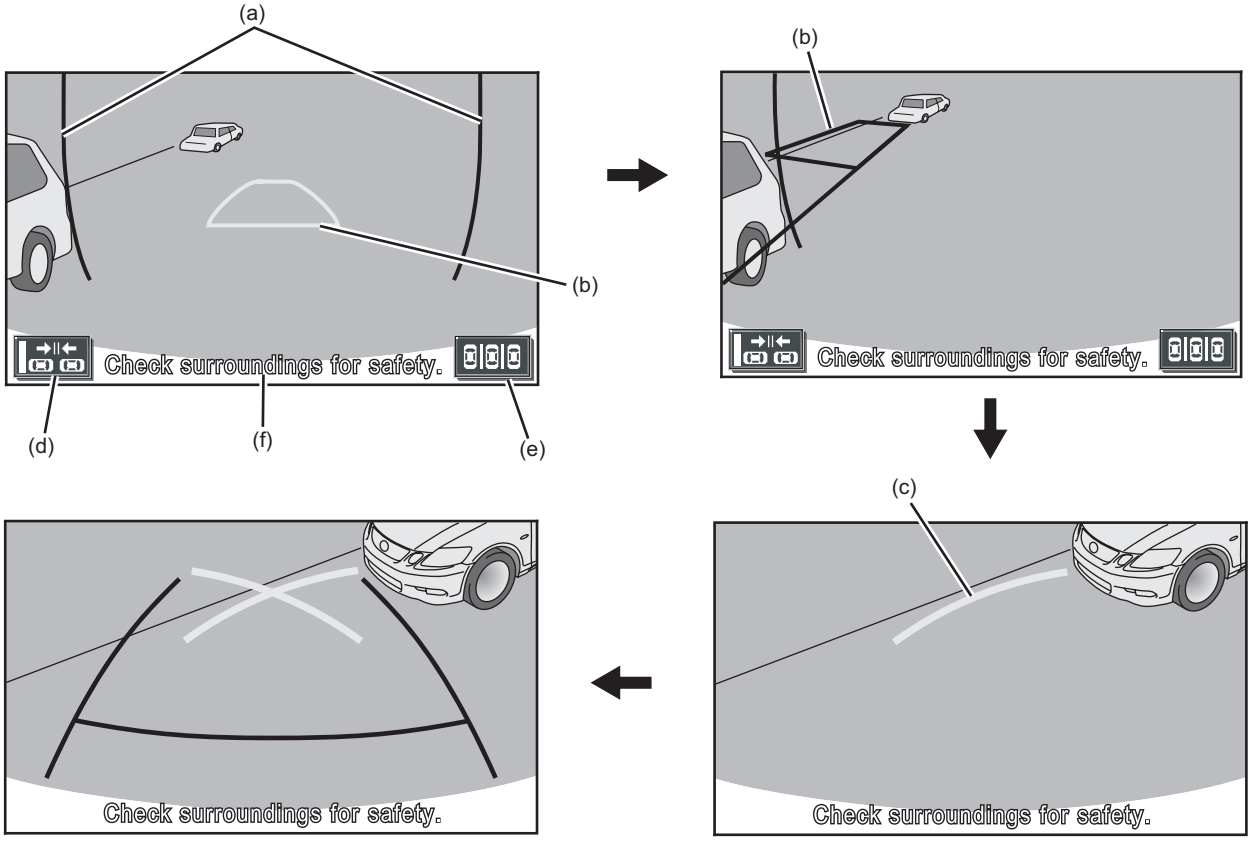
List of LEXUS parking assist monitor display screen contents

Item			Description of Display
(a)	Vehicle Width ExtensionLine		A guide line for assisting the driver's assessment of the width of the vehicle.
(b)	Distance Guide Line(Red)		A guide line that serves as a reference for the driver to assess the distance from the rear of the vehicle.{Approximately 50 cm (1.6 ft.) from rear end of bumper}
(c)	Parking Guide Line		A guide line indicating the prospective outer path of the vehicle when the steering is turned fully to the right or left end.
(d)	Changeover Switch		Two guide line patterns are available, and can be switched by pressing this switch.
(e)	Touch Switch	Manual Mode Switch	The system switches from the manual assist mode to the parallel parking assist mode by pressing this switch.
		Parallel Parking Assist Mode Switch	
(f)	Warning Message Display Area		Displays a warning message.

BE

Parallel Parking Assist Mode

- In this mode used for parallel parking, the ECU switches the display of the guide lines in accordance with the parking maneuvers of the vehicle. This provides the driver with an appropriate steering angle and timing during parallel parking.



(The same guidelines are shown as in manual assist)

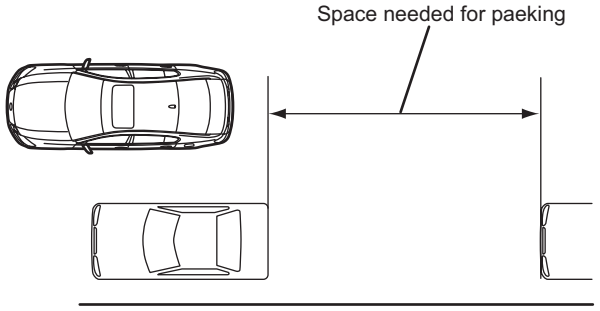
A4270156E

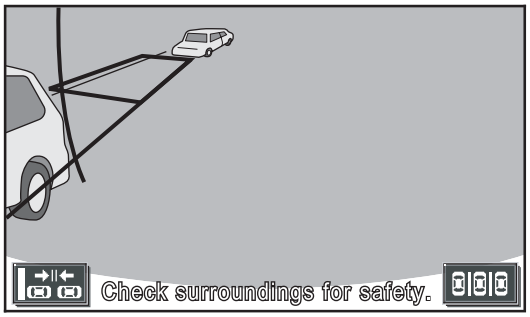
List of LEXUS parking assist monitor display screen contents

Item			Description of Display
(a)	Green Vertical Line		A guide line that serves as a reference position for starting parallel parking
(b)	Green Outline		A guide line that serves as a reference position for completing the intended parking. This guide line disappears once the vehicle starts moving backward.
(c)	Parking Guide Line		A guide line indicating part of the prospective outer path of the vehicle when the steering is turned fully to the right or left end.This guide line appears only after the guide lines (a) and (b) disappear.
(d)	Changeover Switch		Two parallel parking assist mode are available, and can be switched by pressing this switch.
(e)	Touch Switch	Manual Mode Switch	The system switches from the parallel parking assist mode to the manual assist mode when this switch is pressed.
		Parallel Parking Assist Mode Switch	
(f)	Warning Message Display Area		Displays a warning message.

- In the parallel parking assist mode,the driver can press the mode select switch to select the following two display mode:the standard mode and the narrow mode.The narrow mode is designed for situations in which the parking space is narrowew than the standard mode.This system is set to the standard mode at the factory.The ECU stores in its memory the mode at the time the engine switch is turned OFF.Therefore,the mode that is stored in the ECU appears when the engine awitch is subsequentry turned ON.

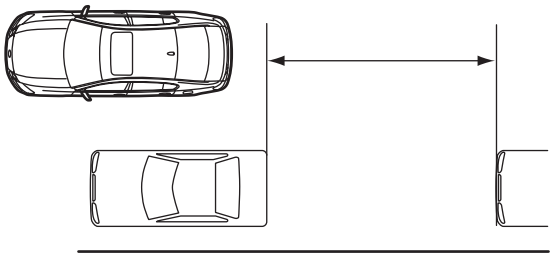
Standard Mode

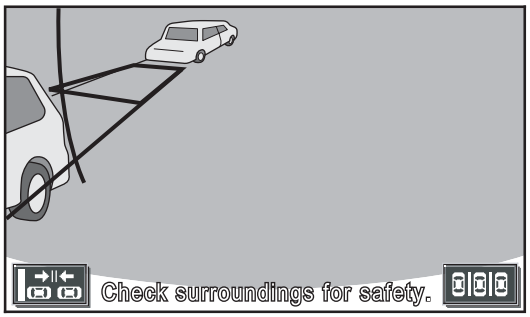




Display Status

Narrow Mode





Display Status

BE

A4270157E

Warning Message

• A warning message appears at the bottom or the center of the screen under the conditions listed below, regardless of whether the system is in the manual or parallel parking assist mode.The warning message appears in the same language that has been selected by the language selector of the navigation screen display (from among English,Danish,Dutch,French,German,Itarian,Spanish and Swedish).

Message appearing at the Bottom on the screen

Warning Message	Outline
Checks surroundungs for safety	This message always appears during system operation.
System initializing	This message appears when the system is restarted if the television camera ECU detects that a battery terminal has been disconnected and subsequently reconnected.
Guidance unavailable	This message is displayed under the following situations: · When the vehicle is moved backward further, even though a message, “Steering wheel turned too far,please return”, is displayed in the center of the display and also the system judges it is impossible to perform the assist operation.* · When the television camera ECU recieves the flag for disabling relative angle from VGRS ECU.*

❖REFERENCE❖

* : It is not necessary to replace the VGRS ECU.

Message appearing at the center on the screen

Warning Message	Outline
System not ready	This message appears if the system is started without initializing after a part is replaced.
Steering wheel is turned too far,please return	This message is displayed when the system cannot perform the assist operation under the following situations: · When the vehicle starts in the parallel parking assist mode, a side-to-side clearance between your vehicle and the other parked vehicles is not approximately 1 m (3.3 ft.) (too far or too close). · The steering wheel is turned too far.

Operation

● Listed below are some examples of operating the system in the manual assist mode and parallel parking assist mode.

❒ **NOTICE**

• Do not rely entirely on the rear view monitor system. Use caution,just as you wuould when backing up any vehicle.

• Never back up while looking only at the screen .The image on the screen may differ from actual conditions.If you back up while looking only at the screen,you may hit a vihicle or have an unexpected accident.When backing up ,be sure to check visually behind and all around the vehicle,both directly and with mirrors,before proceeding.

• Use your own eyes to assure rearward clearance,as the displayed image may become faint or dark,and moving images will be distorted or not entirely visible when outside temperature is cold.

• Make sure to use the system with the trunk closed properly.

• Never use the system in the following conditions.Otherwisw,you may hit a vehiclr or have an unexpected accident.

  • When the road ia slippely due to an icy road,snowy road,etc.

  • When using tire chain.

Warning Message

• A warning message appears at the bottom or the center of the screen under the conditions listed below, regardless of whether the system is in the manual or parallel parking assist mode.The warning message appears in the same language that has been selected by the language selector of the navigation screen display (from among English,Danish,Dutch,French,German,Itarian,Spanish and Swedish).

Message appearing at the Bottom on the screen

Warning Message	Outline
Checks surroundungs for safety	This message always appears during system operation.
System initializing	This message appears when the system is restarted if the television camera ECU detects that a battery terminal has been disconnected and subsequently reconnected.
Guidance unavailable	This message is displayed under the following situations: · When the vehicle is moved backward further, even though a message, “Steering wheel turned too far,please return”, is displayed in the center of the display and also the system judges it is impossible to perform the assist operation.* · When the television camera ECU recieves the flag for disabling relative angle from VGRS ECU.*

❖REFERENCE❖

* : It is not necessary to replace the VGRS ECU.

Message appearing at the center on the screen

Warning Message	Outline
System not ready	This message appears if the system is started without initializing after a part is replaced.
Steering wheel is turned too far,please return	This message is displayed when the system cannot perform the assist operation under the following situations: · When the vehicle starts in the parallel parking assist mode, a side-to-side clearance between your vehicle and the other parked vehicles is not approximately 1 m (3.3 ft.) (too far or too close). · The steering wheel is turned too far.

Operation

● Listed below are some examples of operating the system in the manual assist mode and parallel parking assist mode.

❒ **NOTICE**

• Do not rely entirely on the rear view monitor system. Use caution,just as you wuould when backing up any vehicle.

• Never back up while looking only at the screen .The image on the screen may differ from actual conditions.If you back up while looking only at the screen,you may hit a vihicle or have an unexpected accident.When backing up ,be sure to check visually behind and all around the vehicle,both directly and with mirrors,before proceeding.

• Use your own eyes to assure rearward clearance,as the displayed image may become faint or dark,and moving images will be distorted or not entirely visible when outside temperature is cold.

• Make sure to use the system with the trunk closed properly.

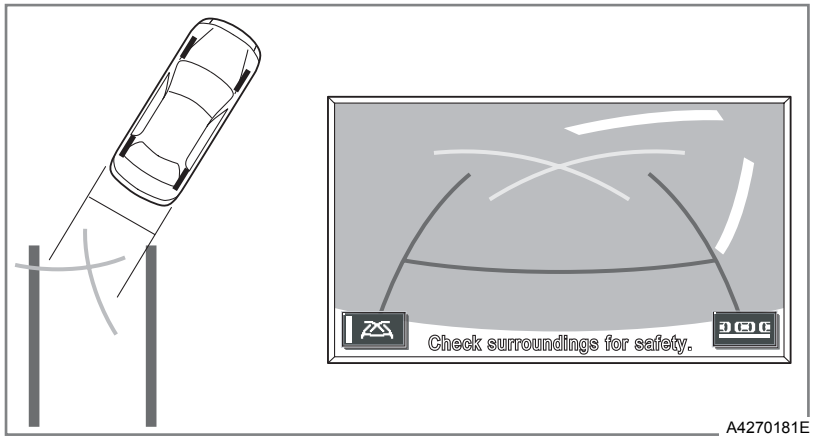
• Never use the system in the following conditions.Otherwisw,you may hit a vehiclr or have an unexpected accident.

  • When the road ia slippely due to an icy road,snowy road,etc.

  • When using tire chain.

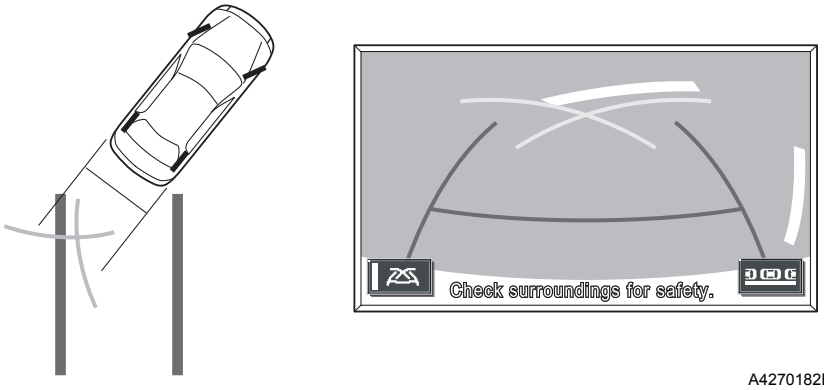
Manual Assist Mode

- To use the manual assist mode to park the vehicle in the parking space illustrated below, perform the following procedure:
- Move the shift lever to reverse.
- Verify that the manual assist mode is selected.
- An image appears on the display panel as illustrated on the right.



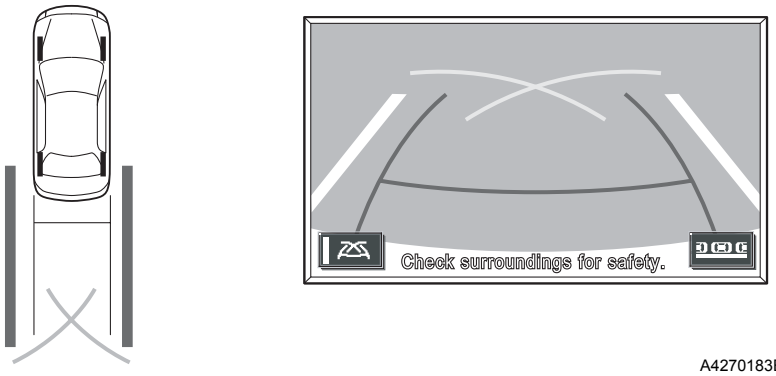
A4270181E

- Back the vehicle and stop at the position in which the parking guide line comes in contact with the left side of the intended parking position.
- Turn the steering wheel fully to the right and back the vehicle.



A4270182E

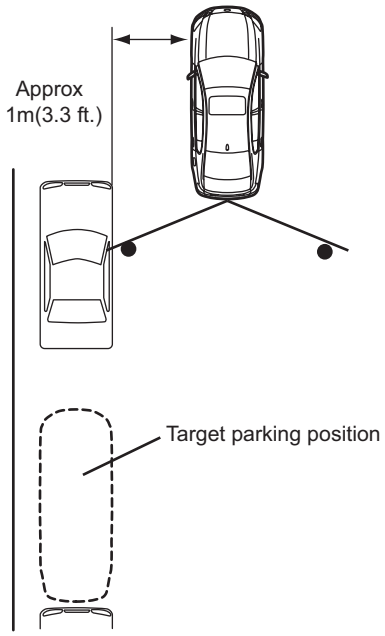
- Continue backing the vehicle until the vehicle is parallel to the plotted lines.
- Once the vehicle is parallel, aim the steering wheel straight ahead and back the vehicle to the target stop position.



A4270183E

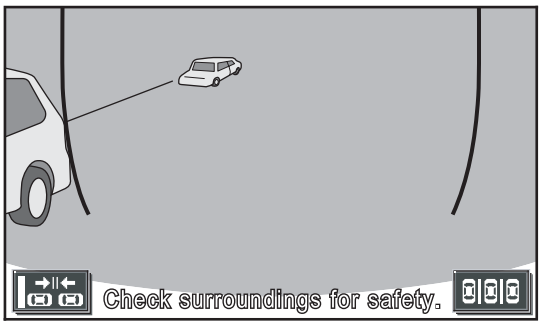
Parallel Parking Assist Mode

- To use the parallel parking assist mode to park the vehicle in the parking space illustrated below, perform the following procedure:
- Stop the vehicle parallel to the road or the curb, at a side-to-side clearance of approximately 1 m (3.3 ft.) from the parked vehicle, approximately one-half car length forward of the parked vehicle.



A4270158E

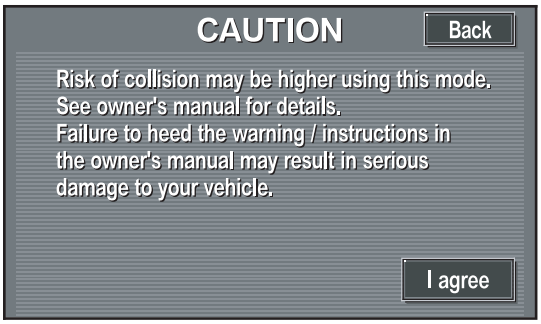
- Aim the steering wheel straight ahead and move the shift lever to reverse.
- Verify that the parallel parking assist mode is selected.
- An image shows on the display panel as illustrated below.



A4270159E

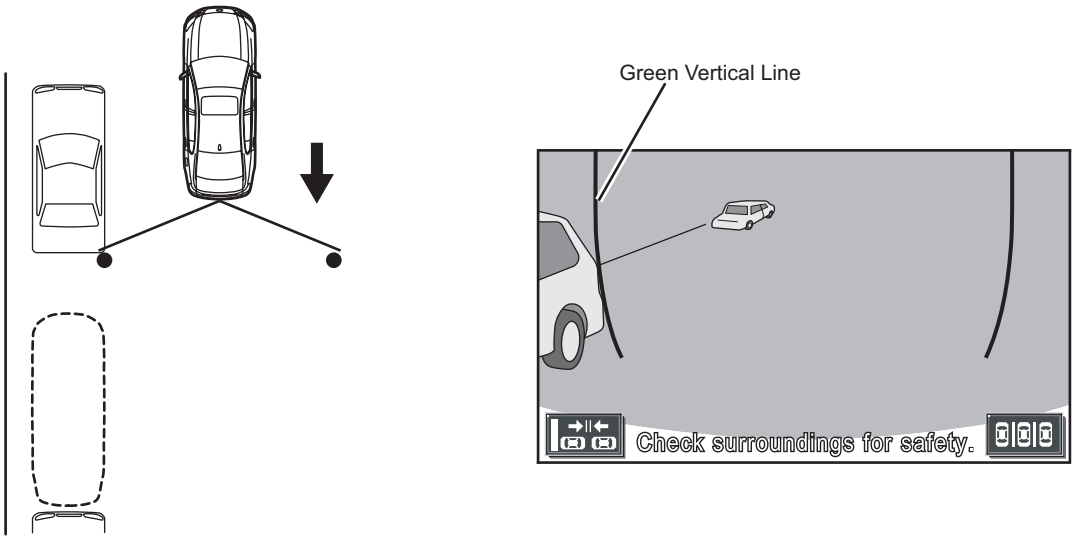
• Press the mode select switch to select either the standard mode or narroe mode.

• The message shown below apperes if the narrow mode is selected.When the driver agrees to this message,the displat changes to the narrow mode.



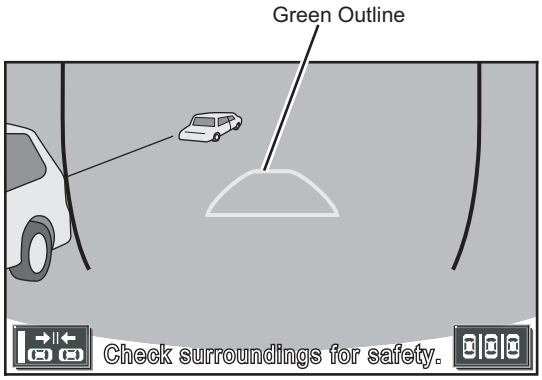
A4270160E

• Drive the vehicle straight back and stop when the green vertical line of the target parking position is aligned with the rear end of the parked vehicle.



A4270161E

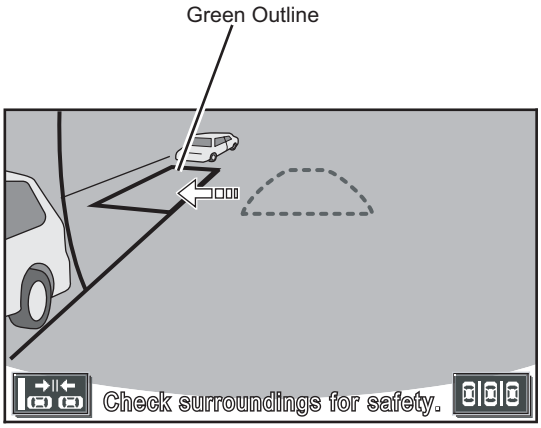
• The green outline appears on the screen after 5 seconds elapse from the time the shift lever is moved to reverse, or if the steering wheel is turned with the vehicle at a standstill.



A4270162E

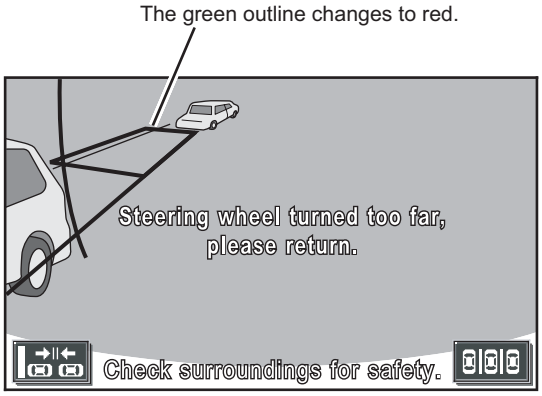
BE

- Continue turning the steering wheel, and the green outline will move in the direction of the target parking position, while the outline changes into a shape as illustrated below.
- Keep turning the steering wheel until the green outline reaches the target parking position.
- At this time, the green vertical line opposite to the target parking position disappears when the steering wheel is turned more than 90 degrees.



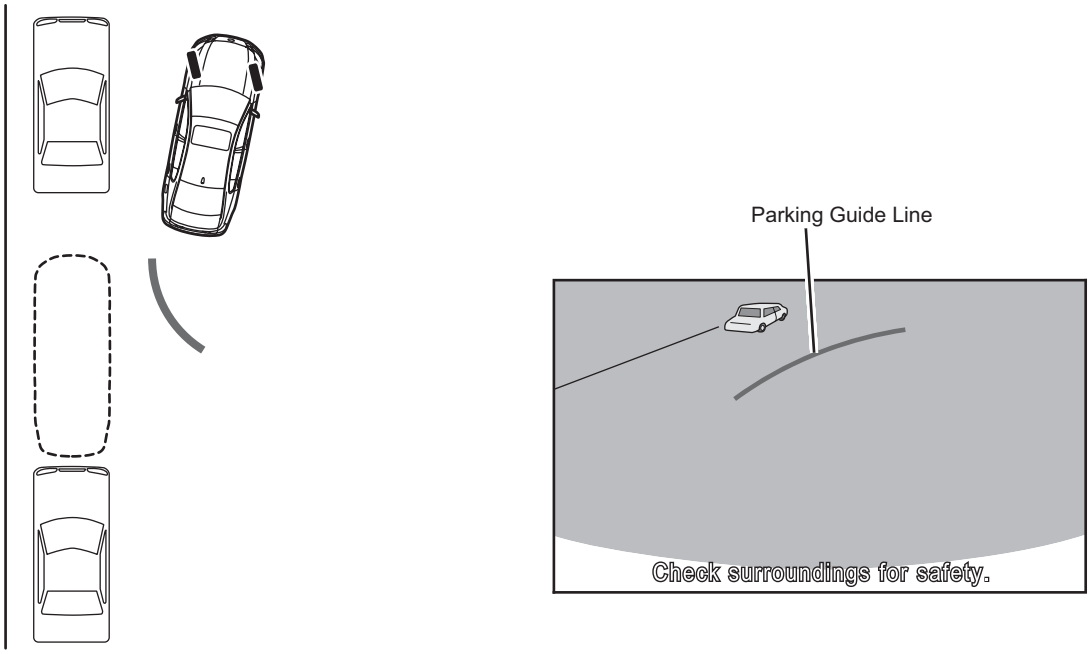
A4270163E

- However, if the steering wheel is turned too much, the message as shown in the illustration below is displayed and the green outline change to red to inform the driver that the assist operation is not capable.
- Also, when your vehicle is away from the shoulders too much, the same condition will occur even adjusting the green outline at the normal position.



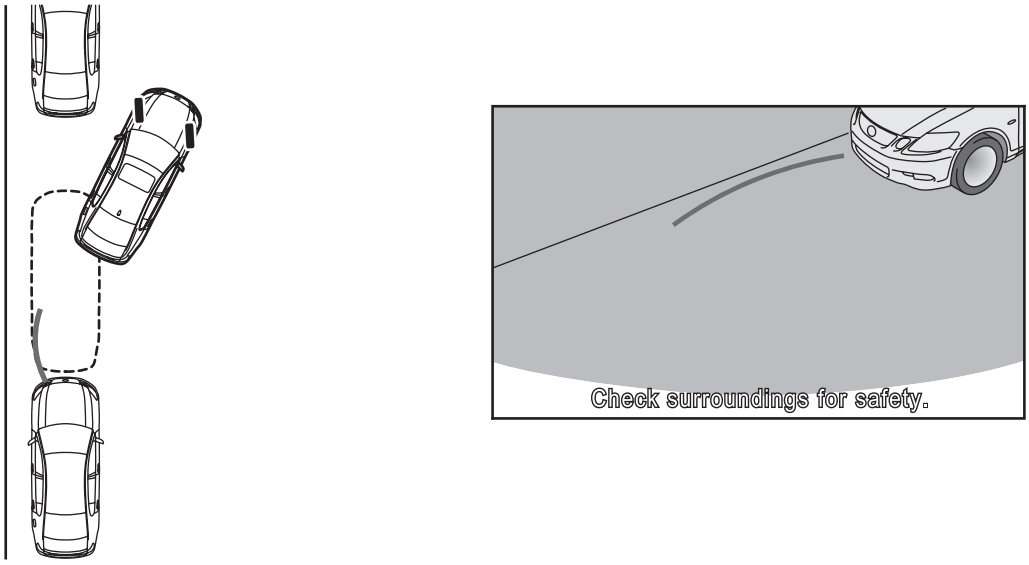
A4270164E

• Keep the steering wheel in the same position and start backing up. Then, the green vertical line and green outline disappear, and a parking guide line (maximum steering angle line) appears in the direction of the target parking position.



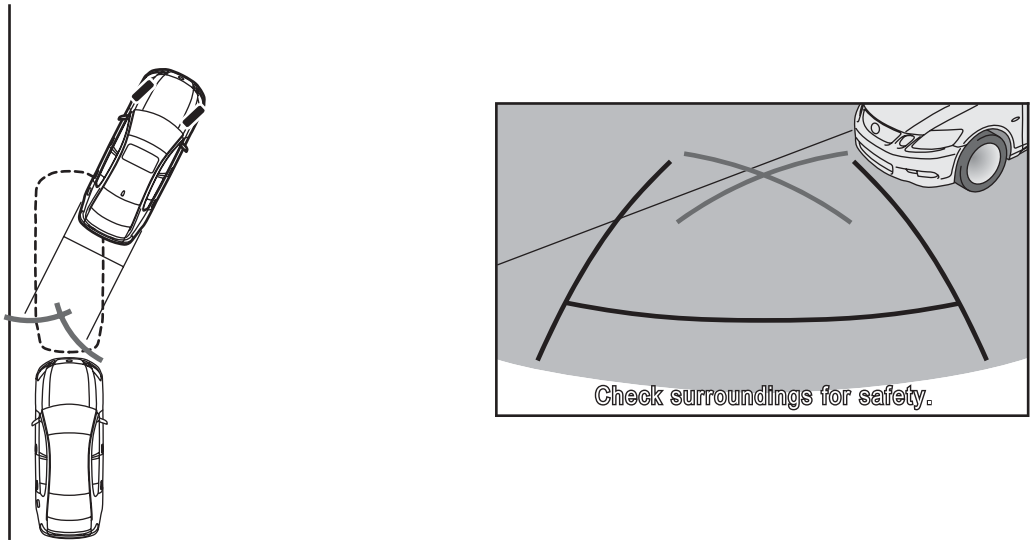
A4270165E

• Keep the steering wheel in the same position and back up. Stop when the parking guide line reaches the left end of the target parking position.



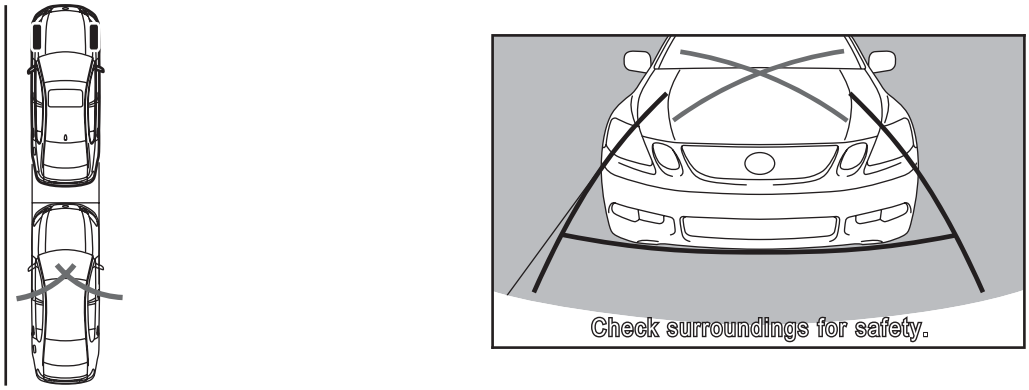
A4270166E

• With the vehicle at a standstill, fully turn the steering wheel in the opposite direction. Then, as illustrated on the right, the same guide line appears as in the manual assist mode.



A4270167E

• Using the distance guide line, slowly back the vehicle until the vehicle is parallel to the road or curb, while paying attention to the vehicles in front and in back. The parking maneuver is completed once the vehicle is parallel.



A4270168E

■ **Service Tip** ■

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● If a battery terminal is disconnected,the assist function will not operate properly.This is because the present neutral steering point that is derected by the steering angle sensor dose not match the neutral steering point that is stored in the memory of the television camera ECU.

● Therefore,if the television camera ECU detects that a battery terminal has been disconnected and the system is operated again by subsequenly reconnecting the battely terminal,a "System initializing"warning message appears at the bottom of the screen.When this occurs,take one of the following correctiveactions:

– With the engine switch IG-ON and the vehicle at a atandstill,fully turn the steering wheel to the right,then fully turn it to the left(this procedure can be started either with a right or left turn).

– Drive the vehicle for approximately 5 minutes on the road with a minimal nimber of cueves.

Initialize Function During Part Replacement

● The initialize function must invariably be performed whenever one of the conditions indicated in the table below occurs.

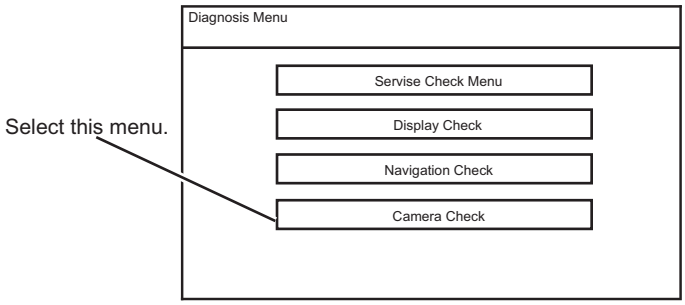
List of initialize item

Parts Name	Condition	Initialize Item
Television Camera	• Camera position shifted • Removal and reassembly • Replacement • Deformed when the mounted area is struck	• Camera position adjustment – Vertical position – Horizontal position – Roll angle, pan angle, tilt angle
Television Camera ECU	Replacement	• Neutral steering point in memory • Maximum side-to-side steering angle in memory • Camera position adjustment – Vertical position – Horizontal position – Roll angle, pan angle, tilt angle
Steering Angle Sensor	• Replacement • Removal and reassembly	• Neutral steering point in memory • Maximum side-to-side steering angle in memory

● The initialize function described above is performed on the diagnosis menu screen.

● When the initialize function be performed, the VGRS system is autmatically set up by CAN (Controller Area Network) comunications.*

● The method for starting the diagnosis menu screen is the same as in the navigation system.



A4270206E

❖REFERENCE❖

* : Only with 3UZ-FE engine.

Failsafe Functions

● The table below indicates the conditions of detecting malfunctions in the sensors and ECUs in this system.

List of function

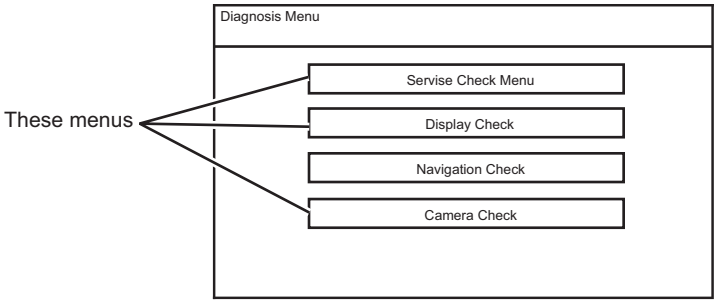
Malfunction Part	Detection Item	Function	
		Manual Assist Mode	Parallel Parking Assist Mode
Steering Angle Sensor	• Transmission of sensor malfunction signal • Open circuit in sensor signal	-	Switches to the manual assist mode automatically.
	Transmission of signal of incompletion of neutral steering point correction	-	Displays “System initializing”.
	Communication malfunction between the steering angle sensor and television camera ECU	-	Switches to the manual assist mode automatically.
Television Camera	Transmission of television camera malfunction signal	Stops signal reception and displays a dark screen.	
Television Camera ECU	Malfunction of television camera ECU unit	Stops system operation.	
Navigation ECU	• No response from navigation ECU • Transmission of navigation ECU malfunction signal	-	Switches to the manual assist mode automatically.
VGRS ECU*	Malfunction of VGRS ECU	-	Switches to the manual assist mode automatically.
	Communication malfunction between the VGRS ECU and television camera ECU	-	Switches to the manual assist mode automatically.
	Transmission of the flag for disabling relative angle	-	Displays “Guidance unavailable”.

❖REFERENCE❖

* : Only with VGRS ECU system.

Self-Diagnosis Function

- The LEXUS parking assist monitor system is equipped with a self-diagnosis system and can display the diagnosis menus shown on the right.
- The diagnosis menu that pertains to this system contains the following three items:
  - Service Check Menu
  - Display Check
  - Camera Check



A4270207E

- The method for starting the diagnosis menu screen is the same as in the navigation system.

Handling Precaution

- The television camera uses a wide-angle lens. The perceived distance from images that appear on the screen differs from the actual distance.
- In the following cases, it may become difficult to see the images on the screen, but this is not a malfunction.
  - In the dark (for example, at night)
  - When the temperature near the lens is very high or low
  - When water droplets are adhering to the television camera, or when humidity is high (for example, when it rains)
  - When foreign matter (for example, mud) is adhering to the television camera lens
  - When the sun or the beam of headlights is shining directly into the television camera lens
- If a bright light (for example, sunlight reflected off the vehicle body) is picked up by the television camera, the smear effect*, peculiar to the CCD camera, may occur.



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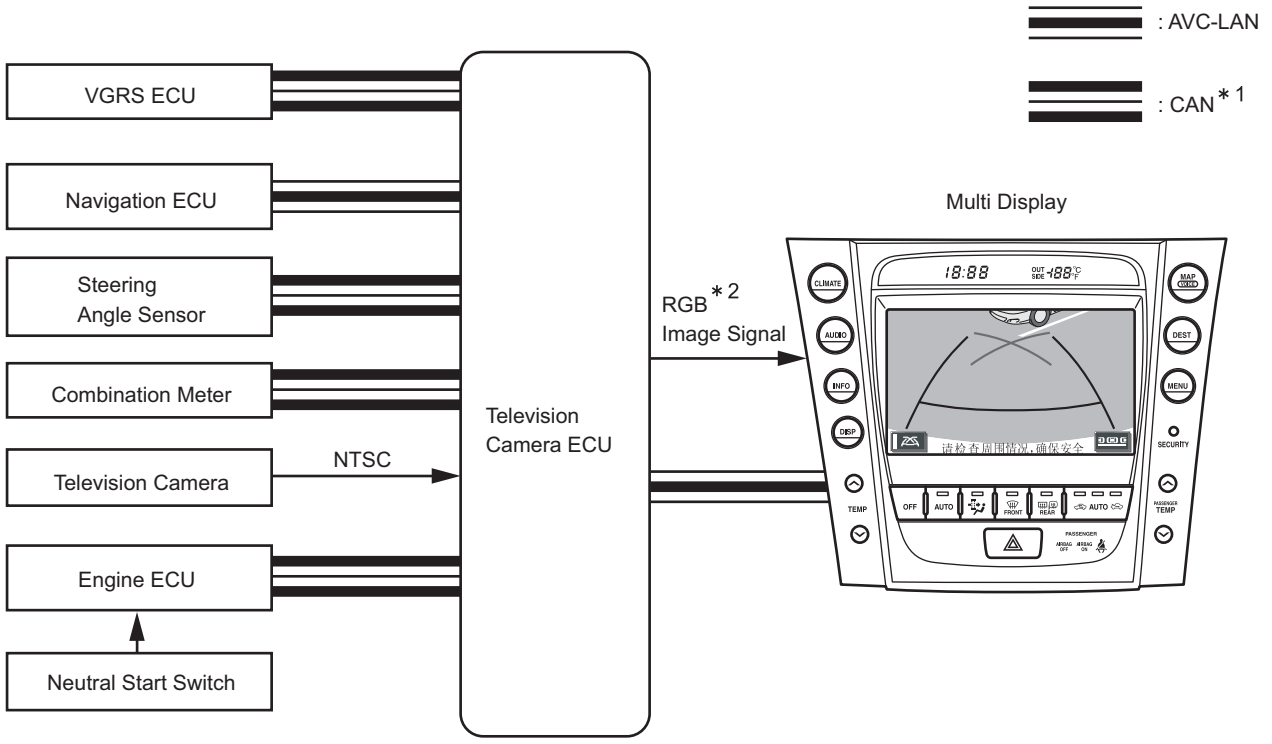
❖REFERENCE❖

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

LEXUS PARKING MONITOR SYSTEM FOR CHINA PARK ASSIST / MONITORING

Description

- This system has a television camera mounted on the trunk lid to display the rearview of the vehicle on the display panel of the multi display. The display panel also shows a composite view consisting of the rearview and parking guide lines to assist the driver in parking the vehicle by monitoring the rearview.
- With the ignition switch ON, if the driver shifts the shift lever to reverse, the display panel of the multi display switches to operate this system.
- This system consists of the following: television camera ECU, television camera, multi display, steering angle sensor, and navigation ECU.
- This system is equipped with a self-diagnosis system, which is operated on a dedicated window that appears on the display panel, just as in the navigation system.

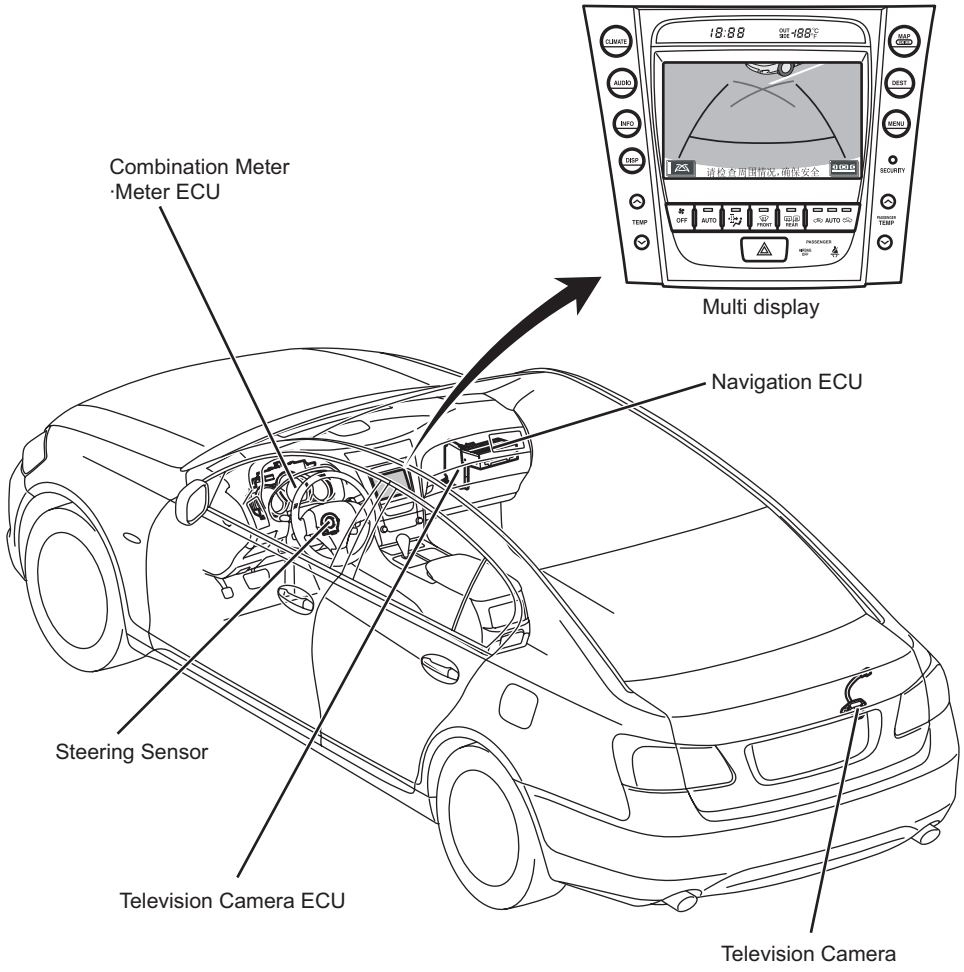


*1 : Controller Area Network
*2 : RGB (Red Green Blue)
*3 : Models equipped with VGRS system

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BE

LEXUS Parking Monitor System Components



Note : The illustration gives a representative example.

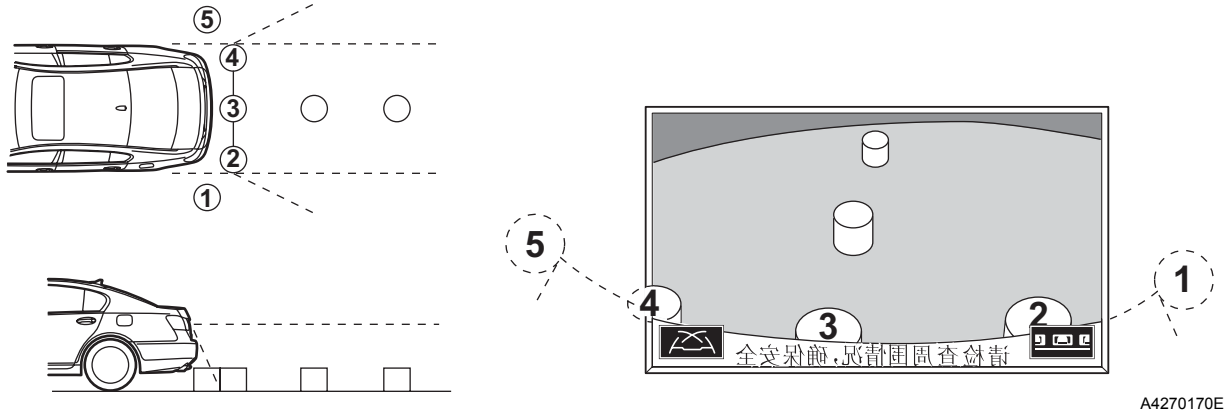
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LEXUS parking assist monitor system components

Item	Function
Television Camera	• Mounted on the trunk lid to transmit the rearview of the vehicle to the television camera ECU. • A color video camera that uses a CCD (Charge Coupled Device) and a wide-angle lens.
Television Camera ECU	• Transmits video signals, which contain a composite of the rearview of the vehicle taken with the television camera and the parking assist guide lines, to the multi display. Furthermore, it effects overall control of the system by receiving the signal from the sensors and the navigation ECU.
Multi Display	• Receives RGB image signals which are composite of the vehicle rearview video signal and the parking assist guide line signal from the television camera ECU, and displays them on the display panel.
Navigation ECU	• Uses the yaw rate detected by the gyro sensor that is built into the navigation ECU to transmit the movement of the vehicle to the television camera ECU.
Steering Angle Sensor	• Detects the angle of the steering wheel and sends the resulting signals to the television camera ECU. This sensor is also shared by the VSC function.
Vehicle Speed Signal	• A vehicle speed signal transmitted by the combination meter.
Neutral Start Switch	• Transmits a reverse shift position signal to the television camera ECU.

Area Displayed on Screen

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



A4270170E

❖REFERENCE❖

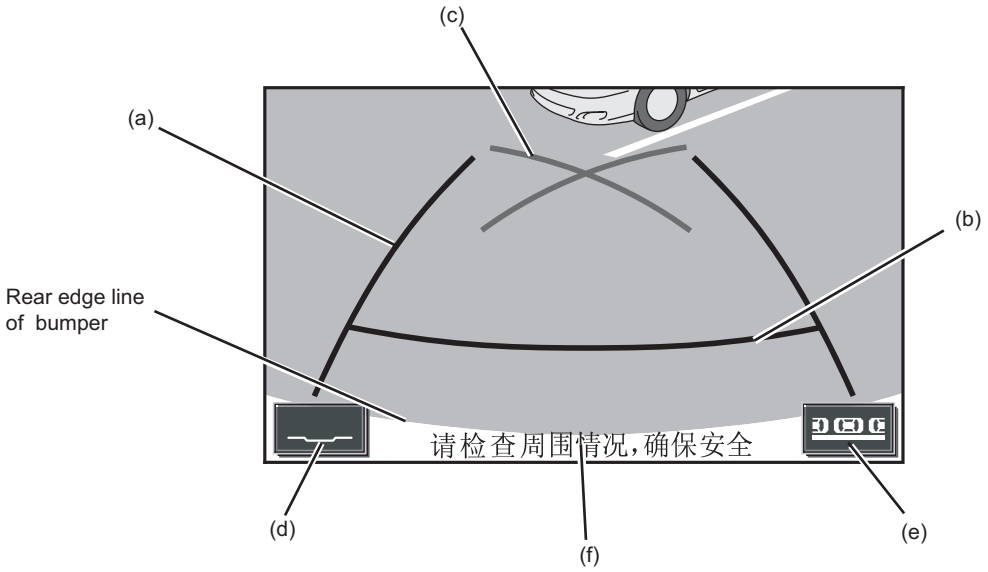
* : Area displayed on screen may vary according to vehicle status or road conditions.The area covered by the television camera is limited. The television camera dose not show objects close to either corner of the bumper or under bumper.

Description of Display

- This system displays in the following two modes: the manual assist mode used for parking the vehicle in a garage or parking area, and the parallel parking assist mode, which assists the driver by providing the appropriate steering angle and timing during parallel parking.
- The driver can switch the system modes by pressing the touch switch, although the display is initially set to the parallel parking assist mode at the factory. The ECU stores in its memory the mode at the time the engine switch is turned OFF. Therefore, the mode that is stored in the ECU appears when the engine switch is subsequently turned ON.

Manual Assist Mode

- When the system operates in the manual assist mode, fixed guide lines appear with the rearview of the vehicle as illustrated below. These guide lines can be used to assist the driver while the vehicle is moving backward.
- In this mode, the driver can press the changeover switch on the display to change the guide line pattern.



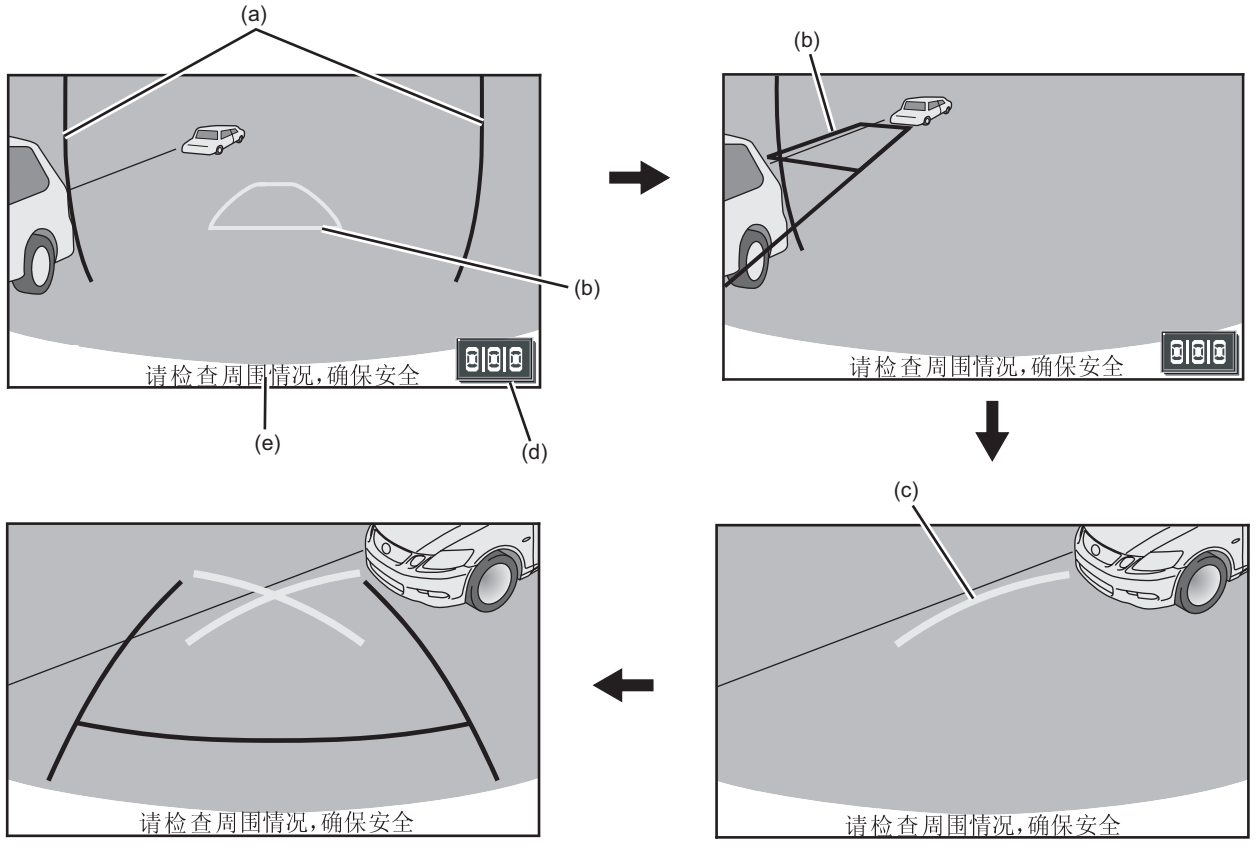
A4270186E

List of LEXUS parking assist monitor display screen contents

Item			Description of Display
(a)	Vehicle Width ExtensionLine		A guide line for assisting the driver's assessment of the width of the vehicle.
(b)	Distance Guide Line(Red)		A guide line that serves as a reference for the driver to assess the distance from the rear of the vehicle.{Approximately 50 cm (1.6 ft.) from rear end of bumper}
(c)	Parking Guide Line		A guide line indicating the prospective outer path of the vehicle when the steering is turned fully to the right or left end.
(d)	Changeover Switch		Three guide line patterns are available, and can be switched by pressing this switch.
(e)	Touch Switch	Manual Mode Switch	The system switches from the manual assist mode to the parallel parking assist mode by pressing this switch.
		Parallel Parking Assist Mode Switch	
(f)	Warning Message Display Area		Displays a warning message.

Parallel Parking Assist Mode

- In this mode used for parallel parking, the ECU switches the display of the guide lines in accordance with the parking maneuvers of the vehicle. This provides the driver with an appropriate steering angle and timing during parallel parking.



(The same guidelines are shown as in manual assist)

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BE

List of LEXUS parking assist monitor display screen contents

Item			Description of Display
(a)	Green Vertical Line		A guide line that serves as a reference position for starting parallel parking
(b)	Green Outline		A guide line that serves as a reference position for completing the intended parking. This guide line disappears once the vehicle starts moving backward.
(c)	Parking Guide Line		A guide line indicating part of the prospective outer path of the vehicle when the steering is turned fully to the right or left end.This guide line appears only after the guide lines (a) and (b) disappear.
(d)	Touch Switch	Manual Mode Switch	The system switches from the parallel parking assist mode to the manual assist mode when this switch is pressed.
		Parallel Parking Assist Mode Switch	
(e)	Warning Message Display Area		Displays a warning message.

Warning Message

• A warning message appears at the bottom or the center of the screen under the conditions listed below, regardless of whether the system is in the manual or parallel parking assist mode.

Message appearing at the Bottom on the screen

Warning Message	Outline
请检查周围情况，确保安全	This message always appears during system operation.
系统初始化中	This message appears when the system is restarted if the television camera ECU detects that a battery terminal has been disconnected and subsequently reconnected.
导航无效	This message is displayed under the following situations: · When the vehicle is moved backward further, even though a message, 方向盘转向速度，请回转方向盘, is displayed in the center of the display and also the system judges it is impossible to perform the assist operation.* · When the television camera ECU recieves the flag for disabling relative angle from VGRS ECU.* · When the steering angle sensor or the VGRS ECU is abnomal in the displaying plotted lines mode of the manual assist mode. · When the steering angle sensor, the VGRS ECU or gyro is abnomal in the parallel parking assist mode.

❖REFERENCE❖

* : It is not necessary to replace the VGRS ECU.

Message appearing at the center on the screen

Warning Message	Outline
系统未准备	This message appears if the system is started without initializing after a part is replaced.
方向盘转向速度，请回转方向盘	This message is displayed when the system cannot perform the assist operation under the following situations: · When the vehicle starts in the parallel parking assist mode, a side-to-side clearance between your vehicle and the other parked vehicles is not approximately 1 m (3.3 ft.) (too far or too close). · The steering wheel is turned too far.

Operation

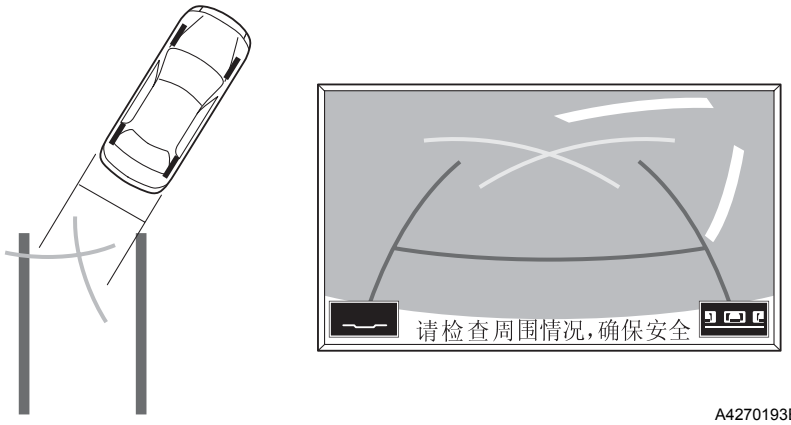
● Listed below are some examples of operating the system in the manual assist mode and parallel parking assist mode.

❒ **NOTICE**

- Do not rely entirely on the rear view monitor system. Use caution,just as you wuould when backing up any vehicle.
- Never back up while looking only at the screen .The image on the screen may differ from actual conditions.If you back up while looking only at the screen,you may hit a vihicle or have an unexpected accident.When backing up ,be sure to check visually behind and all around the vehicle,both directly and with mirrors,before proceeding.
- Use your own eyes to assure rearward clearance,as the displayed image may become faint or dark,and moving images will be distorted or not entirely visible when outside temperature is cold.
- Make sure to use the system with the trunk closed properly.
- Never use the system in the following conditions.Otherwisw,you may hit a vehiclr or have an unexpected accident.
  - When the road ia slippely due to an icy road,snowy road,etc.
  - When using tire chain.

Manual Assist Mode

- To use the manual assist mode to park the vehicle in the parking space illustrated below, perform the following procedure:
- Move the shift lever to reverse.
- Verify that the manual assist mode is selected.
- An image appears on the display panel as illustrated on the right.



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Message appearing at the center on the screen

Warning Message	Outline
系统未准备	This message appears if the system is started without initializing after a part is replaced.
方向盘转向速度，请回转方向盘	This message is displayed when the system cannot perform the assist operation under the following situations: · When the vehicle starts in the parallel parking assist mode, a side-to-side clearance between your vehicle and the other parked vehicles is not approximately 1 m (3.3 ft.) (too far or too close). · The steering wheel is turned too far.

Operation

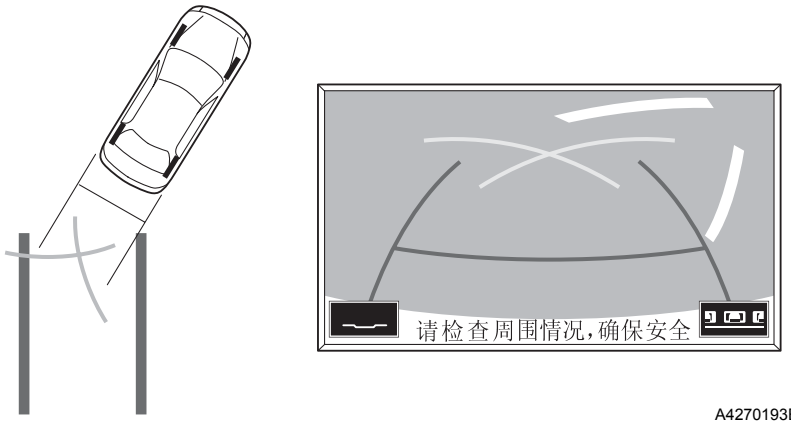
● Listed below are some examples of operating the system in the manual assist mode and parallel parking assist mode.

❒ **NOTICE**

- Do not rely entirely on the rear view monitor system. Use caution,just as you wuould when backing up any vehicle.
- Never back up while looking only at the screen .The image on the screen may differ from actual conditions.If you back up while looking only at the screen,you may hit a vihicle or have an unexpected accident.When backing up ,be sure to check visually behind and all around the vehicle,both directly and with mirrors,before proceeding.
- Use your own eyes to assure rearward clearance,as the displayed image may become faint or dark,and moving images will be distorted or not entirely visible when outside temperature is cold.
- Make sure to use the system with the trunk closed properly.
- Never use the system in the following conditions.Otherwisw,you may hit a vehiclr or have an unexpected accident.
  - When the road ia slippely due to an icy road,snowy road,etc.
  - When using tire chain.

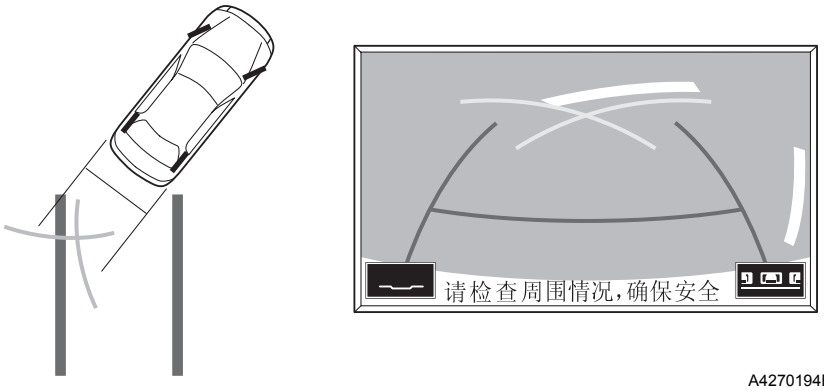
Manual Assist Mode

- To use the manual assist mode to park the vehicle in the parking space illustrated below, perform the following procedure:
- Move the shift lever to reverse.
- Verify that the manual assist mode is selected.
- An image appears on the display panel as illustrated on the right.



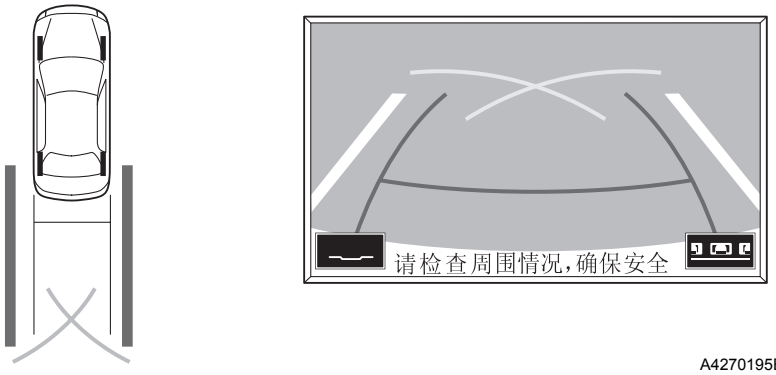
A4270193E

- Back the vehicle and stop at the position in which the parking guide line comes in contact with the left side of the intended parking position.
- Turn the steering wheel fully to the right and back the vehicle.



A4270194E

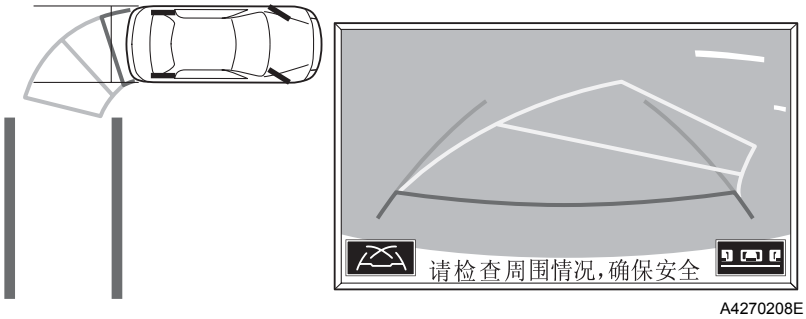
- Continue backing the vehicle until the vehicle is parallel to the plotted lines.
- Once the vehicle is parallel, aim the steering wheel straight ahead and back the vehicle to the target stop position.



A4270195E

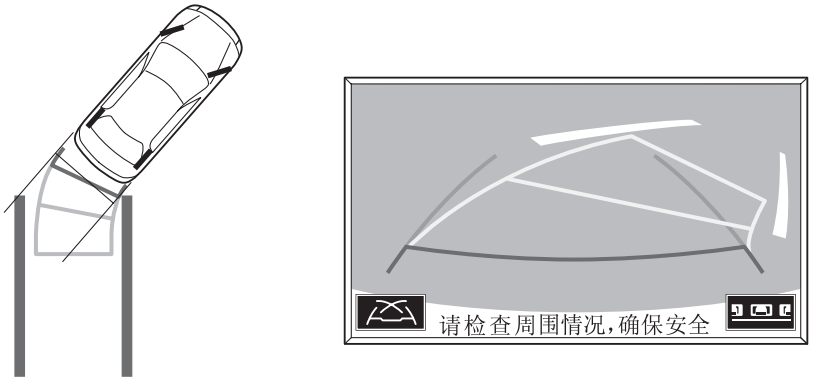
Perpendiculer Parking Mode

- To use the perpendicular parking mode to park the vehicle in the parking space illustrated below, perform the following procedure:
- Move the shift lever to reverse.
- Verify that the perpendicular parking mode is selected.
- An image appears on the display panel as illustrated on the right.



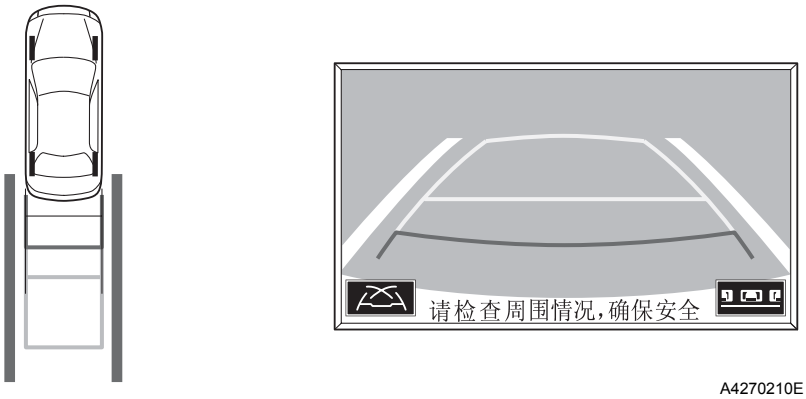
A4270208E

- Back the vehicle and stop at the position in which the anticipated pathway line comes in contact with the left side of the intended parking position.
- Turn the steering wheel fully to the right and back the vehicle.



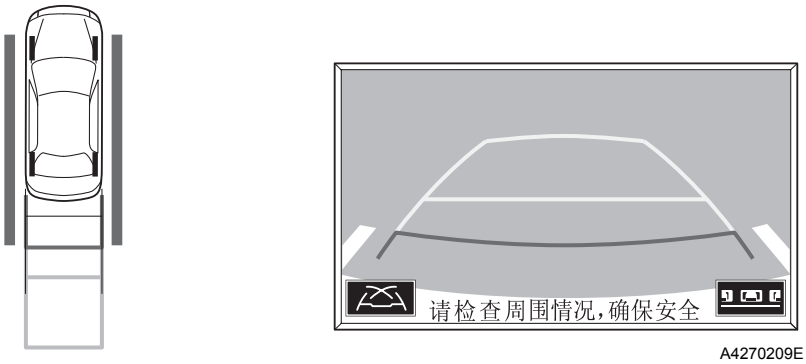
A4270211E

- Continue backing the vehicle until the vehicle is parallel to the plotted lines.
- Once the vehicle is parallel, aim the steering wheel straight ahead.



A4270210E

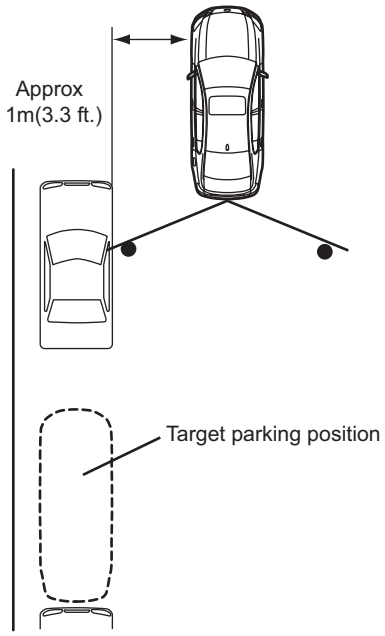
- Continue backing the vehicle until the vehicle is in the target stop position.
- You can use the distance guide line (red, 50cm(1.64 ft) from the vehicle) as a reference. However, make sure to visually check directly.



A4270209E

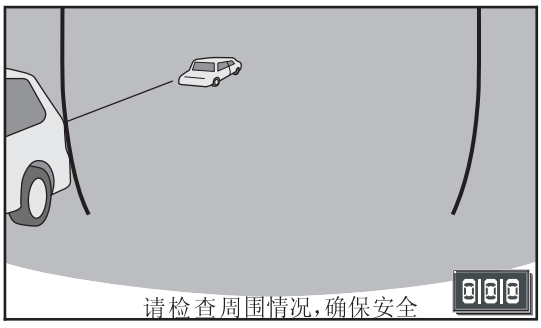
Parallel Parking Assist Mode

- To use the parallel parking assist mode to park the vehicle in the parking space illustrated below, perform the following procedure:
- Stop the vehicle parallel to the road or the curb, at a side-to-side clearance of approximately 1 m (3.3 ft.) from the parked vehicle, approximately one-half car length forward of the parked vehicle.



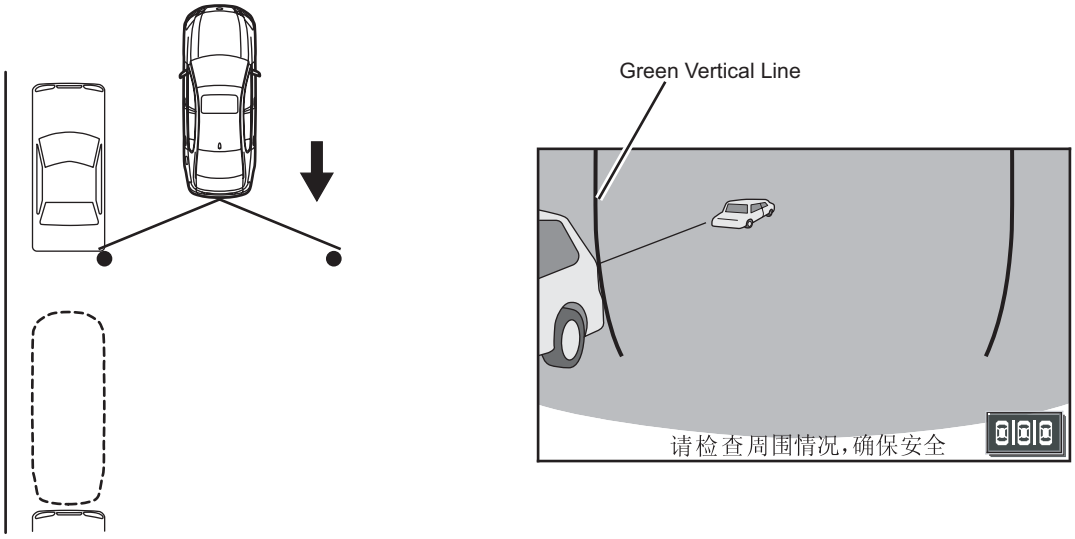
A4270158E

- Aim the steering wheel straight ahead and move the shift lever to reverse.
- Verify that the parallel parking assist mode is selected.
- An image shows on the display panel as illustrated below.



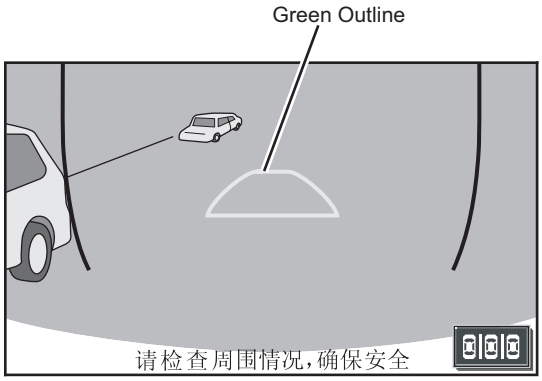
A4270196E

• Drive the vehicle straight back and stop when the green vertical line of the target parking position is aligned with the rear end of the parked vehicle.



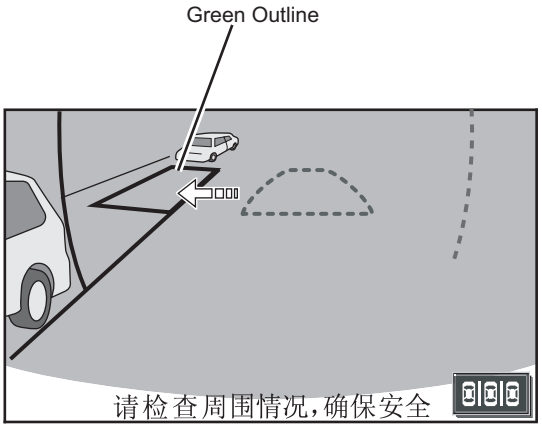
A4270197E

• The green outline appears on the screen after 5 seconds elapse from the time the shift lever is moved to reverse, or if the steering wheel is turned with the vehicle at a standstill.



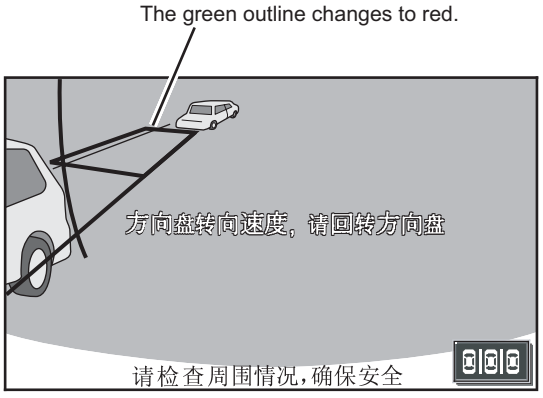
A4270198E

- Continue turning the steering wheel, and the green outline will move in the direction of the target parking position, while the outline changes into a shape as illustrated below.
- Keep turning the steering wheel until the green outline reaches the target parking position.
- At this time, the green vertical line opposite to the target parking position disappears when the steering wheel is turned more than 90 degrees.



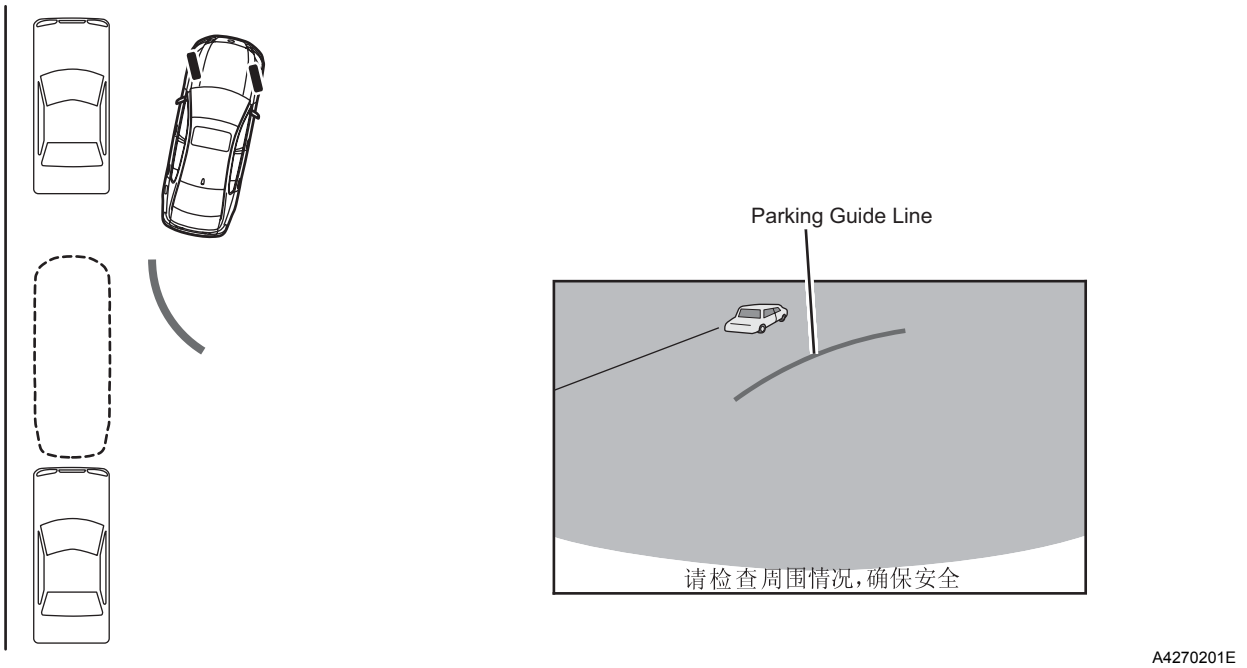
A4270199E

- However, if the steering wheel is turned too much, the message as shown in the illustration below is displayed and the green outline change to red to inform the driver that the assist operation is not capable.
- Also, when your vehicle is away from the shoulders too much, the same condition will occur even adjusting the green outline at the normal position.



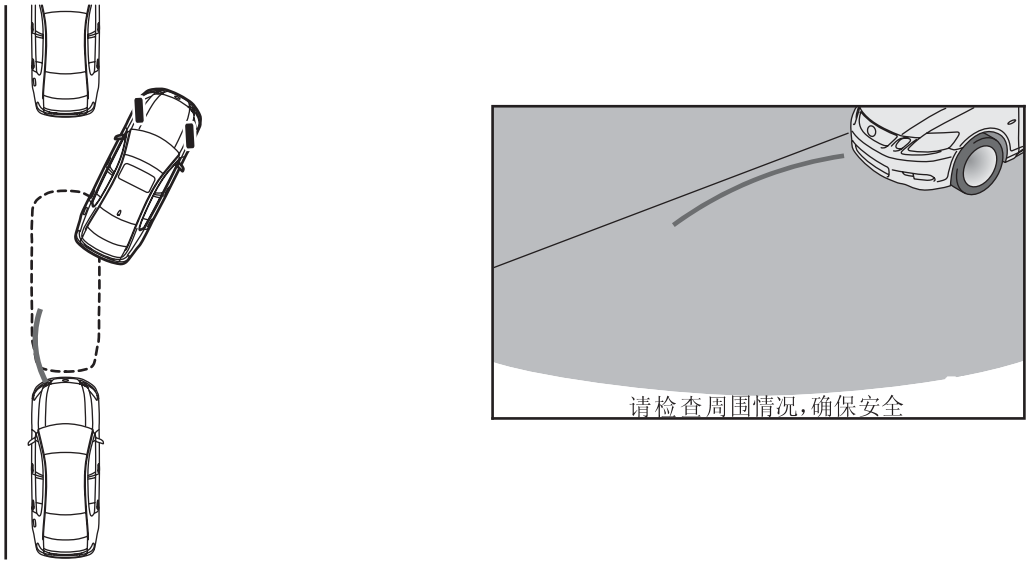
A4270200E

• Keep the steering wheel in the same position and start backing up. Then, the green vertical line and green outline disappear, and a parking guide line (maximum steering angle line) appears in the direction of the target parking position.



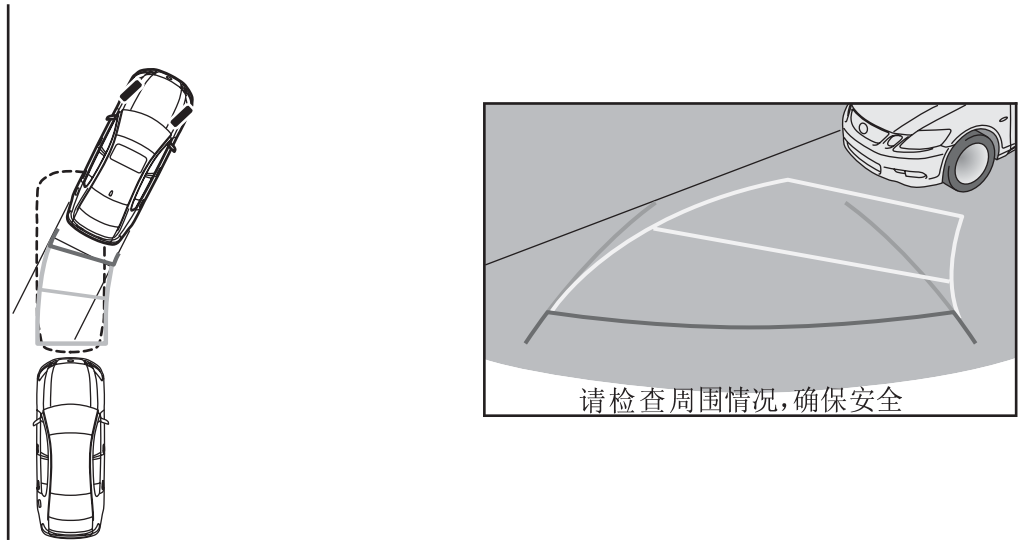
A4270201E

• Keep the steering wheel in the same position and back up. Stop when the parking guide line reaches the left end of the target parking position.



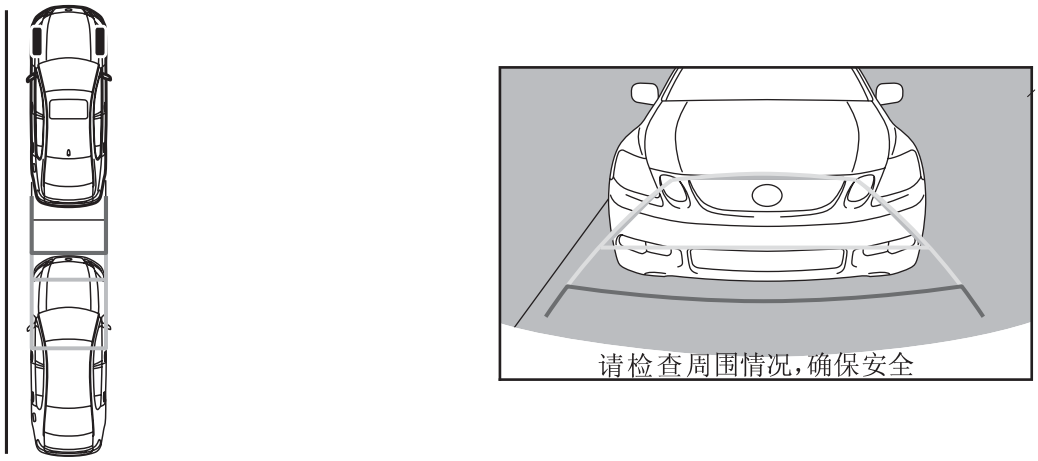
A4270202E

• With the vehicle at a standstill, fully turn the steering wheel in the opposite direction. Then, as illustrated on the right, the same guide line appears as in the manual assist mode.



A4270203E

• Using the distance guide line, slowly back the vehicle until the vehicle is parallel to the road or curb, while paying attention to the vehicles in front and in back. The parking maneuver is completed once the vehicle is parallel.



A4270204E

■ **Service Tip** ■

● If

系统初始化中

A4270189E

appears,the assist function will not operate properly.This is because the present neutral steering point that is detected by the steering angle sensor dose not match the neutral steering point that is stored in the memory of the television camera ECU.

● Therefore,if the television camera ECU detects that a battery terminal has been disconnected and the system is operated again by subsequenyly reconnecting the battely terminal,a

系统初始化中

A4270189E

warning message and "HELP" switch appears at the bottom of the screen. When this occurs,take one of the following correctiveactions as displayed by pushing "HELP" switch:

– With the engine switch IG-ON and the vehicle at a atandstill,fully turn the steering wheel to the right,then fully turn it to the left(this procedure can be started either with a right or left turn).
– Drive the vehicle for approximately 5 minutes on the road with a minimal nimber of cueves.

Initialize Function During Part Replacement

● The initialize function must invariably be performed whenever one of the conditions indicated in the table below occurs.

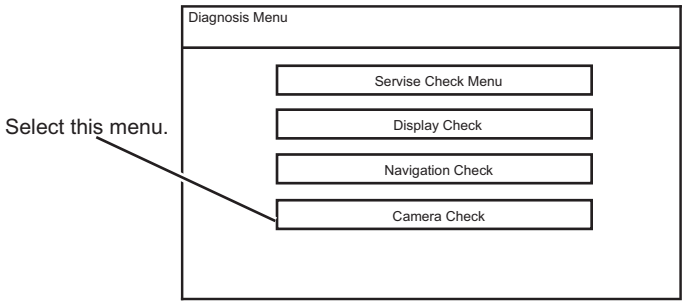
List of initialize item

Parts Name	Condition	Initialize Item
Television Camera	• Camera position shifted • Removal and reassembly • Replacement • Deformed when the mounted area is struck	• Camera position adjustment – Vertical position – Horizontal position – Roll angle, pan angle, tilt angle
Television Camera ECU	Replacement	• Neutral steering point in memory • Maximum side-to-side steering angle in memory • Camera position adjustment – Vertical position – Horizontal position – Roll angle, pan angle, tilt angle
Steering Angle Sensor	• Replacement • Removal and reassembly	• Neutral steering point in memory • Maximum side-to-side steering angle in memory

● The initialize function described above is performed on the diagnosis menu screen.

● When the initialize function be performed, the VGRS system is autmatically set up by CAN (Controller Area Network) comunications.*

● The method for starting the diagnosis menu screen is the same as in the navigation system.



A4270206E

❖REFERENCE❖

* : Only with 3UZ-FE engine.

Failsafe Functions

● The table below indicates the conditions of detecting malfunctions in the sensors and ECUs in this system.

List of function

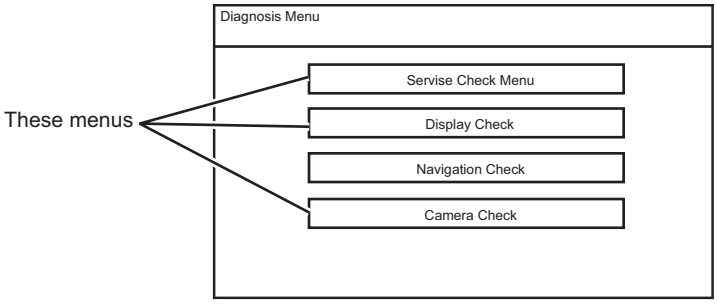
Malfunction Part	Detection Item	Function	
		Manual Assist Mode	Parallel Parking Assist Mode
Steering Angle Sensor	• Transmission of sensor malfunction signal • Open circuit in sensor signal	a message, 导航无效 , is displayed in the displaying plotted lines mode.	a message, 导航无效 , is displayed in the displaying plotted lines mode.
	Transmission of signal of incompletion of neutral steering point correction	a message, 系统初始化中 , is displayed in the displaying plotted lines mode.	a message, 系统初始化中 , is displayed.
	Communication malfunction between the steering angle sensor and television camera ECU	a message, 导航无效 , is displayed in the displaying plotted lines mode.	a message, 导航无效 , is displayed in the displaying plotted lines mode.
Television Camera	Transmission of television camera malfunction signal	Stops signal reception and displays a dark screen.	
Television Camera ECU	Malfunction of television camera ECU unit	Stops system operation.	
Navigation ECU	• No response from navigation ECU • Transmission of navigation ECU malfunction signal	-	a message, 导航无效 , is displayed.
VGRS ECU*	VGRS ECU malfunction	a message, 导航无效 , is displayed in the displaying plotted lines mode.	a message, 导航无效 , is displayed in the displaying plotted lines mode.
	Communication malfunction between the VGRS ECU and television camera ECU	a message, 导航无效 , is displayed in the displaying plotted lines mode.	a message, 导航无效 , is displayed in the displaying plotted lines mode.
	Transmission of the flag for disabling relative angle.	a message, 导航无效 , is displayed in the displaying plotted lines mode.	a message, 导航无效 , is displayed in the displaying plotted lines mode.

❖REFERENCE❖

* : Only with VGRS ECU system.

Self-Diagnosis Function

- The LEXUS parking assist monitor system is equipped with a self-diagnosis system and can display the diagnosis menus shown on the right.
- The diagnosis menu that pertains to this system contains the following three items:
  - Service Check Menu
  - Display Check
  - Camera Check

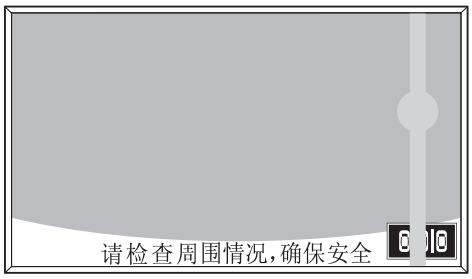


A4270207E

- The method for starting the diagnosis menu screen is the same as in the navigation system.

Handling Precaution

- The television camera uses a wide-angle lens. The perceived distance from images that appear on the screen differs from the actual distance.
- In the following cases, it may become difficult to see the images on the screen, but this is not a malfunction.
  - In the dark (for example, at night)
  - When the temperature near the lens is very high or low
  - When water droplets are adhering to the television camera, or when humidity is high (for example, when it rains)
  - When foreign matter (for example, mud) is adhering to the television camera lens
  - When the sun or the beam of headlights is shining directly into the television camera lens
- If a bright light (for example, sunlight reflected off the vehicle body) is picked up by the television camera, the smear effect*, peculiar to the CCD camera, may occur.



A4270205E

❖REFERENCE❖

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

OTHER SYSTEM

Horn

● Double horns consisting of a low pitch and a high pitch horns are provided on all models as standard equipment. They are the vortex type horns with an elegant blue color.

Horns Specification

Item	high pitch horn	low pitch horn
Rated Voltage [V]	12	12
Normal Frequency [Hz]	500±20	400±20
Sound Pressure Level [dB]	110±3	110±3
Current[A]	3	3

Battery

● LHD: 80D26R RHD: 80D26L Use as standard equipment.

WINDSHIELD/WIDOWGLASS

Windshield and Door Glass

- Windshields using green, heat-absorbing laminated UV cut glass* is used on all models.

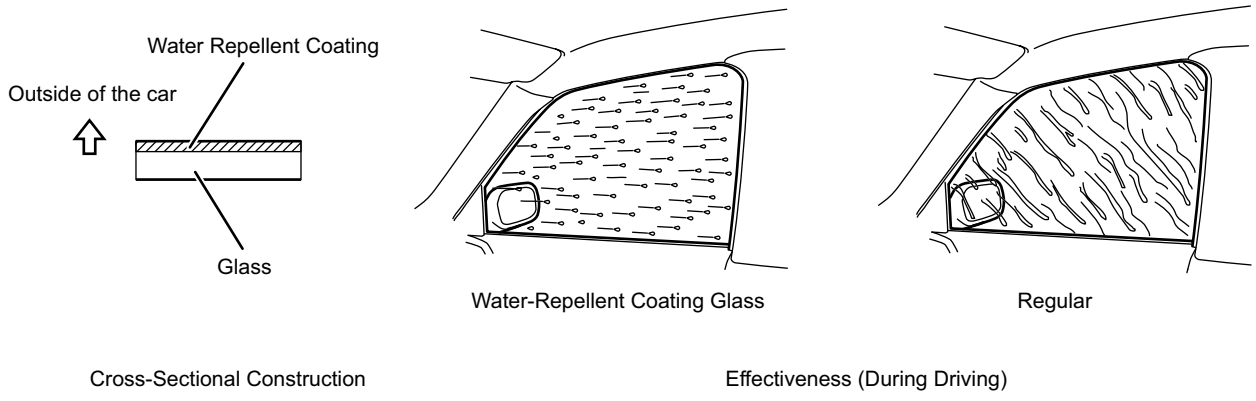
❖REFERENCE❖
* A type of heat-absorbing glass with an infrared cutting function with additional elements to cut ultraviolet rays.

- Front door windows using green, heat-absorbing reinforced UV cut glass with a water repellent function, which ensures visibility while driving in the rain, are used on all models.
- For the rear doors and the back window, the green, heat-absorbing reinforced UV cut glass is used on all models.
- A light blocking ceramic portion has been provided in the windshield glass to protect the occupants from the glare of the sunlight.

Glass Portion	Provided	Glass Type	UV Reduction Rate (%)(as reference)	Visible Light Penetration(%)(as reference)
Windshield	Standard	Green Laminated	100%	70%Min.
Front Door	Standard	Green	90%	75%Min.
Rear Door	Standard	Green	90%	70%Min.
Rear Quarter	Standard	Green	90%	70%Min.
Back Window	Standard	Green	90%	70%Min.

Water Repellent Clating Glass

- The glass surface is coated with a water-repellent film. By minimizing the adhesion of raindrops on the surface while driving in the rain, this glass ensures the driver's view of the sides and the outer rearview mirrors. Furthermore, this glass is effective in minimizing the adhesion of dew, ice, and mud, and facilitating their removal.



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Water Repellent Clating Glass : Operetion Precautions

- Water alone is sufficient to clean the mirror surface. Do not rub the mirror surface with a cloth that contains an oil film removal agent (such as a rubbing compound) or sand, or apply wax or a water-repellent agent on the mirrors. These substances can negatively affect the hydrophilic effect of the mirrors by scratching or damaging the silica and titania layers that are coated on the mirror surface.
- If ice forms on the mirror surface, do not attempt to scrape it off with a plastic plate or the like. Instead, use running water or lukewarm water to melt the ice.
- The hydrophilic effect of the mirrors could decrease temporarily under the circumstances described below, which are normal. The mirrors will recover their hydrophilic effect after they are exposed to the sunlight for a few days. To accelerate their recovery, clean them by following the instructions given in the repair manual.

Circumstances in which hydrophilic effectiveness will decrease temporarily

- Touching the mirror surface with bare hands or using an oily cloth to wipe off dirt from the mirror surface
- Parking the vehicle in an area that is not exposed to the sunlight, such as in an underground parking lot, for a prolonged time
- Wax remover has adhered to the mirror surface while removing wax from the vehicle
- Wax has adhered to the mirror surface while the vehicle was washed in an automatic car wash

Power Window System

- "Power windows with a one-touch auto function" are provided as standard equipment on all models. They consist of a jam protection function, a key-off operation function, as well as a key-linked up-and-down function, and a transmitter-linked up-and-down function in all door glass windows. The jam protection function operates not only during an auto-up operation, but during a manual-up operation, as well.
- The front doors use X-arm window regulators and the rear doors use single-arm regulators.
- The remote control of the individual door glass window uses the BEAN (Body Electronics Area Network) (bi-directional body and unidirectional multiplex communication) via the door ECU in the individual doors, in order to reduce the number of wiring harnesses.
- A pulse sensor (Hall IC) detects the position of the door glass window and its movement direction, which are needed for system control, thus simplifying the system. After an inspection or maintenance service, these pieces of data must be initialized.

Water Repellent Clating Glass : Operetion Precautions

- Water alone is sufficient to clean the mirror surface. Do not rub the mirror surface with a cloth that contains an oil film removal agent (such as a rubbing compound) or sand, or apply wax or a water-repellent agent on the mirrors. These substances can negatively affect the hydrophilic effect of the mirrors by scratching or damaging the silica and titania layers that are coated on the mirror surface.
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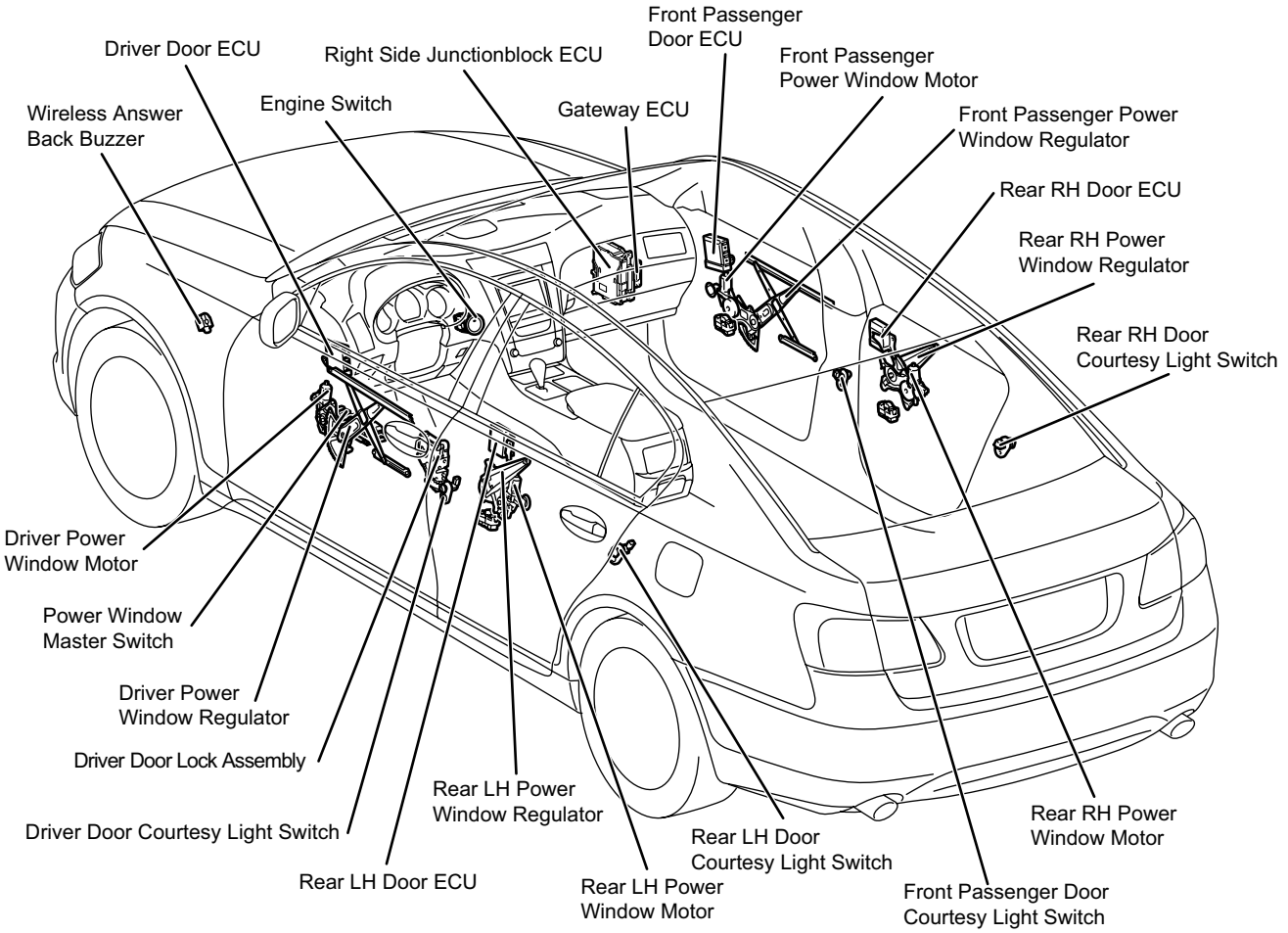
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Power Window System

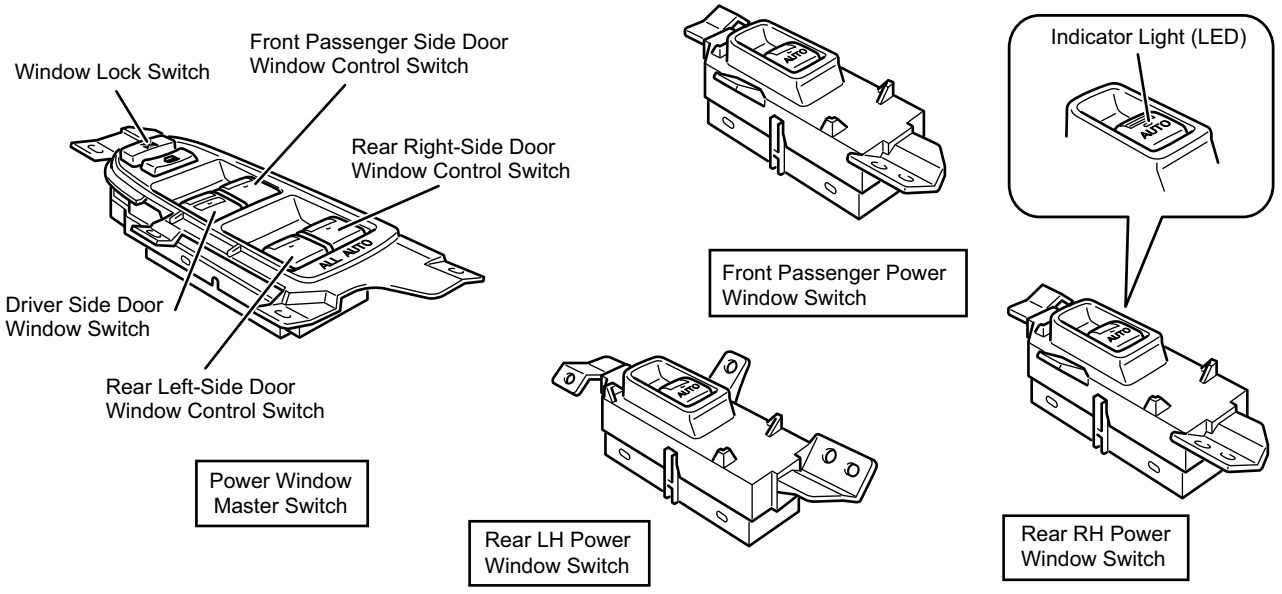
- "Power windows with a one-touch auto function" are provided as standard equipment on all models. They consist of a jam protection function, a key-off operation function, as well as a key-linked up-and-down function, and a transmitter-linked up-and-down function in all door glass windows. The jam protection function operates not only during an auto-up operation, but during a manual-up operation, as well.
- The front doors use X-arm window regulators and the rear doors use single-arm regulators.
- The remote control of the individual door glass window uses the BEAN (Body Electronics Area Network) (bi-directional body and unidirectional multiplex communication) via the door ECU in the individual doors, in order to reduce the number of wiring harnesses.
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Power Window Components



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Power Window Switch Composition



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List of Main Components of the Power Window System and Functions

Component	Main Function
Window Regulator	• Moves the door glass window up or down by operating the power window motor in each door in the normal or reverse direction.
Power Window Motor	• Operates in the normal or reverse direction to actuate the window regulator in each door. • Outputs pulse signals to the power window master switch and the power window switch at each door.
Power Window Master Switch	• Effects main control of the power window system. • Uses a built-in relay to actuate the driver's power window motor. • Transmits a power window remote control signal for the door glass windows in the individual doors to the individual door ECUs via the BEAN (Body Electronics Area Network). • Detects the mode signal of the window lock switch and transmits it to the individual door ECUs via the BEAN (Body Electronics Area Network). • Receives the wireless power window control signal from the right side junctionblock ECU. • Detects the jamming of the driver's door glass window.
Right Side Junctionblock ECU	• Transmits mode signals of the key unlock warning switch and the driver's door courtesy light switch to the via the BEAN (Body Electronics Area Network). • Sends a control signal permitting a key-off power window operation to the power window master switch via the BEAN(Body Electronics Aera Network).
Front Passenger/ Rear RH/ Rear LH Door ECU	• Relays the power window control signal between the power window master switch and the individual Power window switch.
Front Passenger/ Rear RH/ Rear LH Power Window Switch	• Uses a built-in relay to actuate the respective individual power window motor. • Determines the jamming of the respective individual door glass window.
Ignition Switch	• Detects the state of the ignition switch (IG ON or IG OFF) and outputs it to the power window master switch.
Individual door courtesy light switch(driver door /passenger door/ rear RH/rearLH)	• Detects the open or close state of the individual door (ON with door open, and OFF with door closed) and outputs it to the right side junctionblock ECU. [key-off operation judgment condition]
Driver Door Lock Assembly	• Detects the modes of the built-in door lock control switch (for key-linked operation) and the driver's door lock position switch (OFF with door locked, ON with door unlocked), and outputs them to the power window master switch.
Luggage interior Receiver	• Receives and distinguishes the feeble radiowave signals (containing an identification code) from the electronic key. If the receiver recognizes the code as belonging to the vehicle, it transmits various types of operation request signals to the electronic key ECU.
Gateway ECU	• Serves as a connecting point for the buses of the BEAN (Body Electronics Area Network) in order to relay the BEAN signals between buses.
Electronic Key	• Transmits feeble radiowave signals (containing an identification code) to the luggage interior receiver.

Power Window Initialization

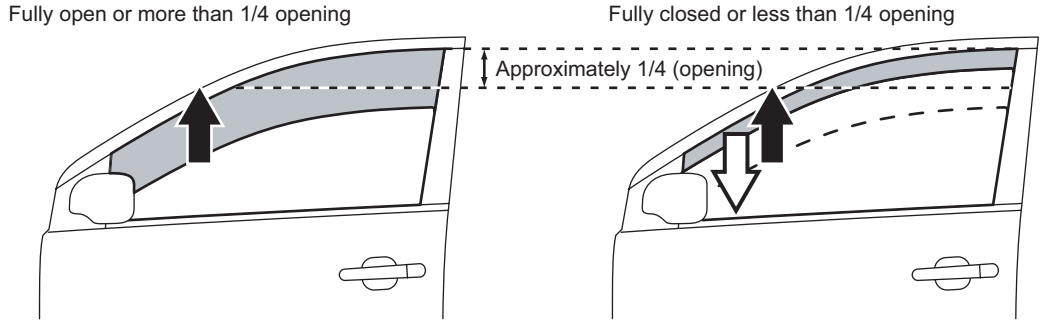
- This system uses a pulse sensor to electrically determine the position of the door glass window by way of the rotational movement of the motor. Based on this information, this system controls various types of functions.
- If the battery is reconnected (initial application of the +B power supply) after an inspection or maintenance service, or the connector of a power window switch is disconnected and reconnected, the door glass window position information that is presently stored in the system memory becomes lost. For this reason, the system must be initialized to "teach" the door glass window position to the system.
- Beware that some functions, such as the jam protection mechanism, do not operate if the system has not been properly "taught" the present door glass window position.

Initialization Operation

- An initialization operation must be performed with the door glass window opened more than approximately 1/4.
- An initialization operation must be performed for each individual door glass window. (Initialization is not possible through the use of the remote control operation)
- Turn the ignition ON, and hold the individual door glass window switch in the auto-up position. Even after the door glass window is fully closed, hold the switch in the auto-up position for approximately 1 second. This will allow the system to memorize the fully closed state of the door glass window as its reference position (origin point 0)*
- After performing an initialization operation, make sure to inspect the functions of the power window system. For details on the initialization operation and the inspection of functions, refer to the repair manual.

❖REFERENCE❖

*The reference position (origin point 0) of the door glass window is updated each time the system detects the fully closed state.



Power Window Initialization Operation

Note: Although the illustration shows the glass window of a front door, the initialization operation must be performed for each door glass window.

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Manual Up-and-Down Function

- When the user performs a one-step operation to pull a door glass window switch up (or to push a door glass window switch down) while the ignition is ON, the corresponding door glass window moves up (or down).
- Similarly, the driver can operate the switches for the individual door glass windows on the power window master switch to remotely control the manual operation of the individual door glass windows from the driver's door. With either operation, the door glass window stops at the position when the switch is released.

One-Touch Auto Up-and-Down Function

- When the user performs a two-step operation to pull a door glass window switch up (or to push a door glass window switch down) while the ignition is ON, the corresponding door glass window automatically moves up (or down) until it reaches the fully closed or fully open position. These are called "auto-up" and "auto-down" operations.
- Similarly, the driver can operate the switches for the individual door glass windows on the power window master switch to remotely control the automatic operation of the individual door glass windows from the driver's door. With either operation, the door glass window stops at the position when the switch is released.
- With either automatic operation, perform a one-step operation of the corresponding switch in the opposite direction of the operation to interrupt the automatic operation.

Jam Protection Function

- If a foreign object gets jammed in the door glass window during a manual-up or auto-up operation, the door glass window will operate approximately 50mm down (or approximately 1 second). If the opening of the door glass window has not reached approximately 200mm, the door glass window will operate down until the opening is approximately 200mm (or approximately 5 seconds).

Jam Protection Function Cancel Operation

- In the event of an improper operation of the jam protection function in which a door glass window does not close fully, the operation of the jam protection function can be canceled by holding the switch of the corresponding door glass window in the auto-up position for more than approximately 10 seconds.

Key-Off Operation Function

- This function enables the power window operation of all door glass windows for approximately 45 seconds after the ignition is turned from ON to OFF, or until the driver's door is operated from open to close. If approximately 45 seconds have elapsed during an automatic operation, or if the driver's door is operated from open to close, the automatic operation will continue until it is completed (the jam protection function will also operate).

Key-Linked Up-and-Down Function

- When there is no electronic key in the vehicle interior, and all doors are closed, if the user inserts a key plate into the driver's door key cylinder, turns it in the locking or unlocking direction, and holds it in that position for more than approximately 1.5 seconds, this function will operate all the door glass windows up or down. During this operation, the user can turn the key plate back to its neutral position to stop the operation (the jam protection function will also operate).
- The key-linked up and down function supports the customizable function through the use of the diagnosis tool(hand-held tester).

Transmitter-Linked Up-and-Down Function

- When there is no electronic key in the vehicle interior, and all doors are closed, if the user keeps the lock or unlock button on the Electronic key for more than approximately 3 seconds, all the door glass windows will start moving down (unlock button: down, lock button: up), and the wireless answerback buzzer will sound (answerback). The transmitter-linked operation will continue while the button is pressed, and stop when the button is released (the jam protection function will also operate).
- The transmitter-linked up-and- down function supports the customizable function through the use of the diagnosis tool (hand-held tester).

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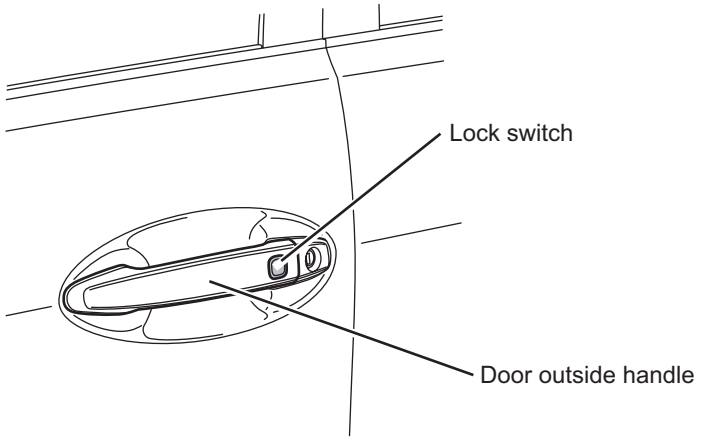
*On the models with a moon roof, the operation of the moon roof glass to slide open/tilt up or slide close/tilt down is linked to the down operation of all the door glass windows.

SMART ENTRY & START SYSTEM Power Window Function

• After door lock operation is effected by the SMART ENTRY & START SYSTEM, if the user continues to operate the lock switch of an individual door for more than 3 seconds, the power windows of all the doors will start moving up and they will continue moving up while the switch is being pressed. For details on the SMART ENTRY & START SYSTEM power window functions, refer to SMART ENTRY & START SYSTEM.

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On the models with a moon roof, the operation of the moon roof glass to slide close/tilt down is linked to the up operation of the power windows of all the doors.



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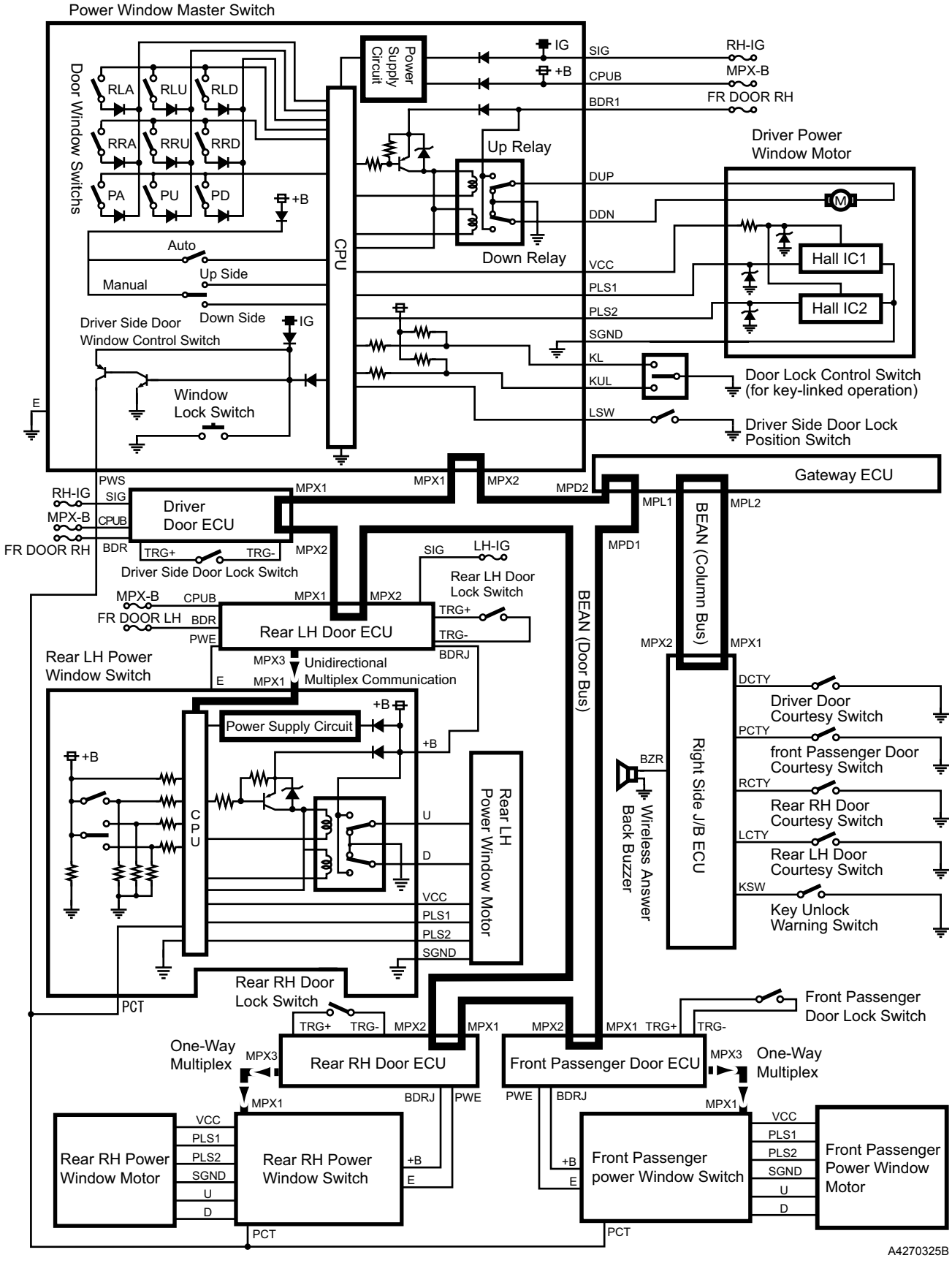
Window Lock

• By pushing the window lock switch ON (and keeping it pushed in) on the power window master switch, the driver can prohibit the door key-linked, transmitter-linked and SMART ENTRY & START SYSTEM power window functions, in addition to the power window operations of the individual doors other than the driver's door. When the window lock is operated, the indicator lights (LEDs) that are built into all the power window switch knobs will go OFF, except in the door glass window switch for the driver's door.

Fail Mode LED Flashing

• If a failure occurs in the Hall IC that is used for detecting the position, speed, and direction of the door glass window, or if an error exceeding a predetermined value occurs between the position information detected by the Hall IC and the position information that is memorized in the power window switch, the system will transfer to the fail mode as a result of a self diagnosis. The indicator light (LED) that is built into the switch knob will blink to indicate the failure.

Power Window system Operation



Operation of Manual Up-and-Down Function

Operation by an individual door glass window switch

- When the user performs a one-step operation to operate the driver's door glass window switch of the power window master switch up (or down) while the ignition is ON, a built-in CPU receives the input of a manual up (or down) ON signal, causing the up relay (or down relay) to turn ON.
- At this time, the down relay (or up relay) forms a ground circuit. Thus, the current will flow from the BDR1 terminal to the up relay (or down relay), DUP terminal (or DDN relay), power window motor, DDN terminal (or DUP terminal), down relay (or up relay) and ground. Thus, the power window motors of the respective doors will rotate in the up (or down) direction.
- When the CPU detects that the switch is OFF, it stops the up relay (or down relay) at that time, and stops the power window motor.

Remote control operation by power window master switch

- When the user performs a one-step operation to operate an individual door glass window switch of the power window master switch up (or down) while the ignition is ON, a built-in CPU receives the input of an up switch (or down switch) ON signal. Then, the CPU sends this signal in the form of a "remote control up (or down)" signal of the corresponding switch to the ECU of the individual door, via the BEAN (Body Electronics Area Network).
- Upon receiving the BEAN (Body Electronics Area Network) data, the individual door ECU converts it into unidirectional multiplex communication data and forwards it to the individual power window switch.
- While the corresponding individual power window switch receives the "remote control up (or down)" signal, it operates the power window motor of its own door in the up (or down) direction, in the same way as the manual operation of an individual door glass window switch.
- When the switch for the individual door glass window in the power window master switch turns OFF, the CPU stops the transmission of the "remote control up (or down)" signal and stops the operation of the door glass window switch of the corresponding door.

Operation of One-Touch Auto Up-and-Down Function

Auto operation by an individual door glass window switch

- When the user performs a two-step operation to operate the driver's door glass window switch of the power window master switch or an individual power window switch up (or down) while the ignition is ON, a built-in CPU receives the input of a manual up (or down) ON signal, as well as the input of an auto switch ON signal. As a result, the CPU turns the up relay (or down relay) ON, and causes the power window motor of the individual door to operate in the same way as the manual up (or down) operation.
- At this time, the built-in CPU counts the pulse signals provided by the Hall IC that is built into the power window motor. Even if the CPU detects that the switch is OFF, until it detects from the speed of the motor that the door glass window has reached the fully closed (or fully open) position, it will keep the up relay (or down relay) ON.

Remote control auto operation by power window master switch

- When the user performs a two-step operation to operate an individual door glass window switch of the power window master switch up (or down) while the ignition is ON, a built-in CPU receives the input of an up switch (or down switch) ON signal and an auto switch ON signal. Then, the CPU transmits these signals to the individual door ECU in the form of a "remote control auto-up (or down)" signal of the corresponding switch via the BEAN (Body Electronics Area Network).
- Upon receiving the BEAN (Body Electronics Area Network) data, the individual door ECU converts it into unidirectional multiplex communication data and forwards it to the individual power window switch.
- While the corresponding individual power window switch receives the "remote control auto-up (or auto-down)" signal, it operates the power window motor of its own door up (or down) to the fully closed (or fully open) position, in the same way as the auto operation performed by an individual power window switch.

Stopping the automatic operation

- The system stops the automatic operation if any one of the following conditions is met.

Auto Operation Stop Conditions

- A switch that is operating with automatic operation control detects that the door glass window is fully closed (or fully open).
- A switch that is operating with automatic operation control inputs an operation switch ON signal in the opposite direction.
- Approximately 10 seconds have elapsed after an automatic operation has started.
- A switch that is operating with automatic operation control receives a "remote control" or "window lock" signal in the opposite direction via unidirectional multiplex communication.

Operation of Jam Protection Function

Operation Outline

- The power window switch of an individual door controls the jam protection function of the corresponding door glass window.
- If either the power window motor locks, its speed changes, the pulses are disturbed, or the voltage drops while all the prerequisites listed below have been met, the power window switch determines that jamming has occurred, and operates the power window motor in reverse. To prevent an improper operation, the power window switch will not make a jamming judgment when the door glass window position is within a specified section.

Prerequisites

- The door glass window is operating up through the manual, auto, key-off operation (manual/auto), door key-linked, transmitter-linked, or SMART ENTRY & START SYSTEM power window function.
- The power window switch is being "taught" with the fully closed position of the door glass window as a reference point (origin point 0).
- The door glass window is in a position other than immediately before the fully closed position or immediately after starting an up operation from the fully open position (specified section).

Reverse Conditions and the Amount of Descent After Jamming Detection

- After the jam protection function operates and the door glass window moves down approximately 50mm or until 1 second has elapsed, if the opening (clearance) of the glass window has not reached approximately 200mm, the power window motor will continue its reverse operation until the opening is approximately 200mm or 5 seconds have elapsed. However, if the door glass window reaches its fully open position before the down operation reaches approximately 50mm, the power window motor will end the operation at that time.
- During a reverse operation, the power window switch will prohibit the input of a manual-up or auto-up switch signal, or an up actuation instruction signal from the key-linked, transmitter-linked, or SMART ENTRY & START SYSTEM power window function. (It will accept a switch input after the reverse operation has been completed.) During a reverse operation, the power window switch will accept a manual-down or auto-down switch signal or a down actuation instruction signal from the key-linked or transmitter-linked function. However, it will perform a down operation after the reverse operation has been completed.

Jamming Reverse Operation

- When the power window switch determines that jamming has occurred, it turns OFF the built-in up relay, and simultaneously turns ON the down relay. As a result, the current flows in the down direction to operate the power window motor in reverse.

Key-OFF Operation

- When the driver turns the ignition from ON to OFF, the CPU in the right side junctionblock ECU detects this action and starts counting approximately 45 seconds for the key-off operation. At the same time, the CPU will continue transmitting a "key-off operation authorization" signal to the individual power window switches via the individual door ECUs through the BEAN (Body Electronics Area Network) and the unidirectional multiplex communication. Thus, the CPU authorizes the power window operation at all doors.
- After approximately 45 seconds have elapsed, or the right side junctionblock ECU has received a signal indicating that the driver's door courtesy light switch has been turned from ON to OFF via the BEAN (Body Electronics Area Network), it will stop the transmission of the "key-off operation authorization" signal. However, if the transmission of the "key-off operation authorization" signal stops during an automatic operation or jamming protection control, the operations will be performed until they are completed. Thus, the jamming protection control is effected even with the automatic operation.

Operation of Key-Linked Up-and-Down Operation

- While the key semi-push switch is OFF, if the user holds the door lock control switch (for key-linked operation) in the lock <or unlock> direction for more than 1.5 seconds, the power window master switch will detect a driver's door lock position switch OFF <or ON> signal at the time 1.5 seconds have elapsed. Then, it will start the door key-linked control.
- After the door key-linked control starts, the power window master switch turns the up relay <or down relay> ON, in order to rotate the driver's door power window motor in the up <or down> direction. At the same time, the power window master switch transmits an individual door key-linked up <or down> operation instruction signal to the individual door ECUs via the BEAN (Body Electronics Area Network).
- Upon receiving the key-linked up <or down> operation instruction signals for the front passenger, rear right, and rear left doors, the individual door ECUs will transmit this signal to the corresponding individual power window switches in the form of unidirectional multiplex communication data. Thus, the power window motors of the individual doors will rotate in the up <or down> direction in the same way as in the remote control manual operation.
- If any one of the conditions listed below is met, the system will stop the operation.

Door Key-Linked Operation Stopping Conditions

- The power window master switch detects that the door lock control switch (for key-linked operation) is operated from ON to OFF in the lock direction <or unlock direction>.
- The power window master switch detects that the driver's door glass window is fully closed <or fully open>.
- During operation, the power window master switch receives a key unlock warning switch ON signal via the BEAN (Body Electronics Area Network).
- During operation, the power window master switch receives a wireless (lock or unlock) signal via the BEAN (Body Electronics Area Network).
- During operation, the power window master switch receives a door outside handle switch (lock) signal via the BEAN (Body Electronics Area Network).
- During operation, the power window master switch detects that the ignition is ON.
- During operation, the driver operates the power window master switch.
- After the operation has started, the timer stopping time (approximately 10 seconds) has elapsed.

Operation of Transmitter-Linked Up-and-Down Function

- Upon receiving a wireless power window up (or down) operation instruction signal from the driver's J/B ECU via the BEAN (Body Electronics Area Network), the power window master switch turns ON the built-in up relay (or down relay) in order to rotate the driver's door power window motor in the up (or down) direction. At the same time, the power window master switch transmits an individual door wireless power window up (or down) operation instruction signal to the individual door ECUs via the BEAN (Body Electronics Area Network)..
- Upon receiving the wireless power window up (or down) operation instruction signals for the front passenger, rear right, and rear left doors, the individual door ECUs will transmit this signal to the corresponding individual power window switches in the form of unidirectional multiplex communication data. Thus, the power window motors of the individual doors will rotate in the up (or down) direction in the same way as in the remote control manual operation.
- If any one of the conditions listed below is met, the system will stop the operation.

Stop Conditions Linked to Transmitter Operations

- If any one of the conditions listed below is met, the system will stop the operation.
- After the power window master switch outputs a wireless power window up (or down) signal to the driver's door power window motor and transmits it to the front passenger, rear right, and rear left door ECUs, the timer stopping time (approximately 10 seconds) has elapsed.
- During operation, the power window master switch receives a key unlock warning switch or semi-push switch ON signal via the BEAN (Body Electronics Area Network).
- During operation, the power window master switch receives a courtesy light switch ON signal from any one of the doors via the BEAN (Body Electronics Area Network) (down operation only).
- During operation, the power window master switch detects that the ignition is ON.
- During operation, any one of the doors is unlocked (during up operation) or all doors are locked (during down operation).
- During operation, the power window master switch receives a door key-linked operation instruction signal via the BEAN (Body Electronics Area Network).
- The power window master switch and an individual power window switch detects that the driver's door glass window and its own door glass window are fully closed (or fully open).
- During operation, the driver operates the power window master switch.

Window Lock Operation

- When the driver turns the window lock switch ON with the ignition ON or during a post-key OFF operation, it cuts off the power supply from the PWS terminal of the power window master switch to the PCT terminals of the individual power window switches. Furthermore, when the CPU in the power window master switch detects the ON signal of the window lock switch, it transmits a "window lock signal" to the individual power window switches via the individual door ECUs, by way of the BEAN (Body Electronics Area Network) and the unidirectional multiplex communication.
- If an individual power window switch detects that the PCT current has been shut down or while it receives a "window lock" signal, it will stop the power window control of its own door glass window.

Fail-Safes Pertaining to the Detection of Door Window Position Information

- If a failure is detected in the Hall IC that is used for detecting the position, speed, and direction of the door glass window, or if an error exceeding a predetermined value occurs between the fully closed position of the door glass window that has been "taught" to the power window switch and the actual door glass window position, the system will transfer to the fail mode as a result of a self diagnosis.
- After the system transfers to the fail mode as a result of a self diagnosis, the system effects the same control as when the power window switch is not "taught" the position information of the door glass window. Thus, the illumination on the switch knob for the driver's door glass window will blink to indicate the failure for approximately 45 seconds after the switch is operated or until the ignition is turned OFF.

List of Failsafe Functions Pertaining to the Detection of Door Glass Window Position Information

Item	Status
Malfunction of pulse sensor (Hall IC)	• Pulses exceeding a specified amount are detected continuously only from one of the two Hall ICs, which are used for detecting the position, speed, and direction of the door glass window, during a close or open operation.
Abnormal pulse direction	• Pulses exceeding a specified amount are detected continuously in the opposite direction of the actuation of the power window motor during a close or open operation.
Abnormal stoppage of both pulses	• No pulses are detected from the two Hall ICs exceeding a specified length of time during a close or open operation, or for 1 second while the door glass window operates to open from the fully closed state (or nearby).
Abnormal door glass position information	• An error exceeding a predetermined value occurs between the actual door glass window position and the fully closed position (origin point 0) that is memorized by the power window master switch and the individual power window switches during a close operation.
Microprocessor failure	• A reset signal is output by the watchdog IC to the microprocessor.
Communication failure (front passenger, rear right, or rear left only)	• Unable to properly receive a BEAN (Body Electronics Area Network) signal from the power window master switch for approximately 10 seconds.

Failsafe Pertaining to Power Window Motor Actuation Control

- This function prevents the motor from actuating in excess of a specified length of time during an automatic operation, in order to protect the motor and the circuit. If there is an error in the door glass window position information, causing the jam protection function to operate in the fully closed position, and thus preventing the door glass window from closing fully, this function renders the system to a state in which it is not "taught" the position information. Thus, the door glass window is able to close fully.

Continuous Operation Restriction Mechanism

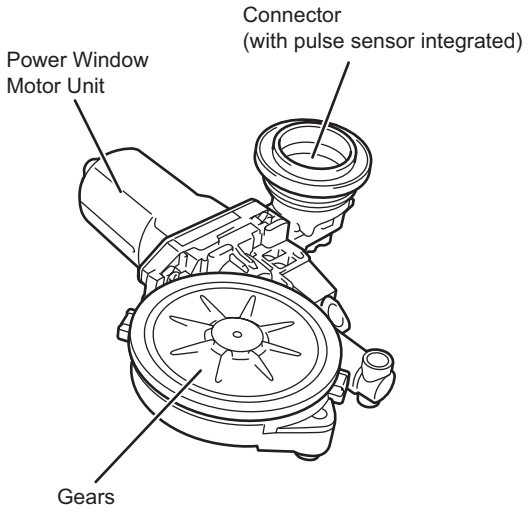
- If the motor actuation time (relay ON time) by the power window switch is too long, this mechanism automatically turns OFF the relay after approximately 10 seconds have elapsed.

Forced Teaching Operation (jam protection function Cancel Operation)

- A failure in the jam protection function may create a problem of preventing the door glass window from closing fully (by preventing it from stopping at the fully closed position). If this occurs, the driver can perform an auto-up operation continuously for more than approximately 10 seconds in order to force the system to transfer into a state in which it is not "taught" any position information. Then, the driver can correct the position information by fully closing the door glass window.

Power Window Motor

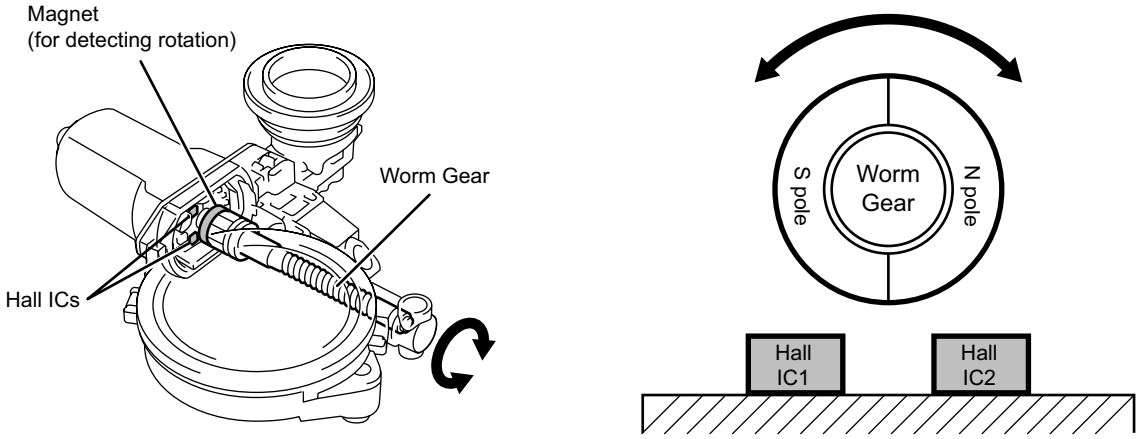
- The power window motor assembly consists of a power window motor unit, connector, and gear.
- A pulse sensor, which is used for the jam protection function, is integrated in the connector to detect the rotational movement of the power window motor.



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Hall IC

- The two Hall ICs output the pulse signals, which are synchronized to the rotation of the motor by a magnet that is provided on the worm gear of the power window motor, to the IC in the power window switch of its own door.

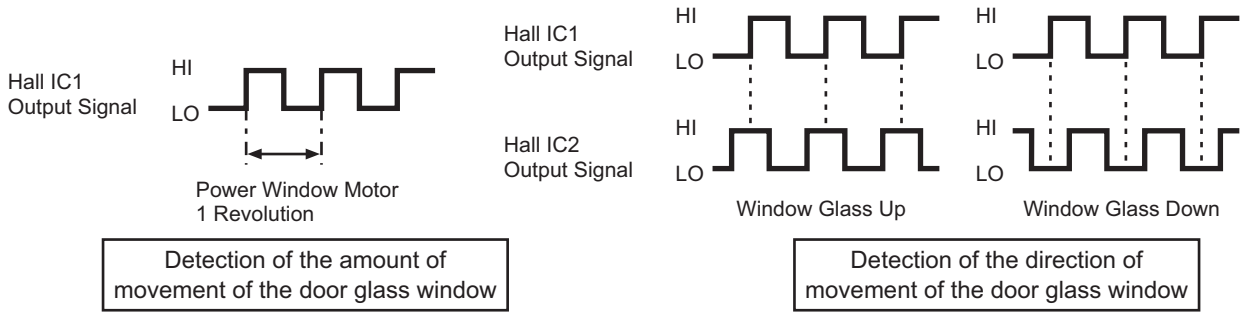


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• The power window switch counts one cycle of pulse per rotation of the axis of rotation of the motor that is output by Hall IC1, in order to detect the amount of movement of the door glass window. In addition, the power window switch detects the HI/LO cycles of pulses that vary in accordance with the direction of rotation of the motor, which are output by Hall IC2. Thus, it detects the direction of the movement of the door glass window. The power window switch memorizes these pieces of information in order to recognize the present position of the door glass window. *Based on the position information that is obtained from these two Hall ICs, the power window switch controls various types of functions.

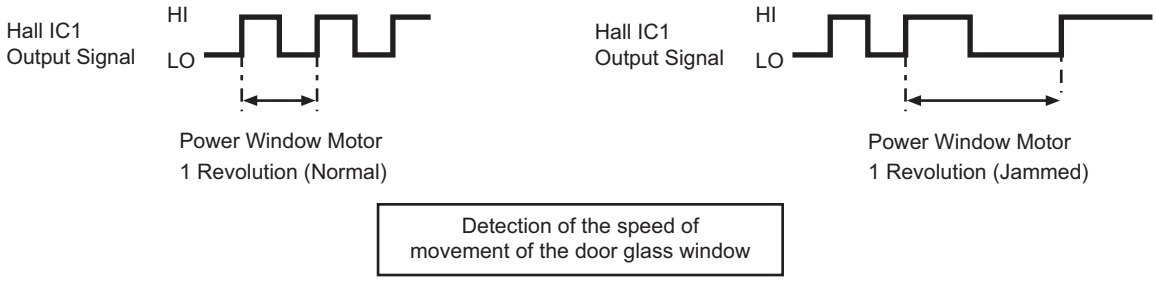
❖REFERENCE❖

*The position information of the door glass windows is backed up by the +B power supply. Therefore, if the +B power supply to the power window switch is cut off, the system must be initialized.



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• At the same time, the power window switch detects the changes in the rotational speed of the motor based on the intervals of the pulses that are output by Hall IC1. Thus, it detects the changes in the movement speed of the door glass window. As a result, it recognizes the load that acts on the door glass window, in order to control the jam protection function and the overload stop function.



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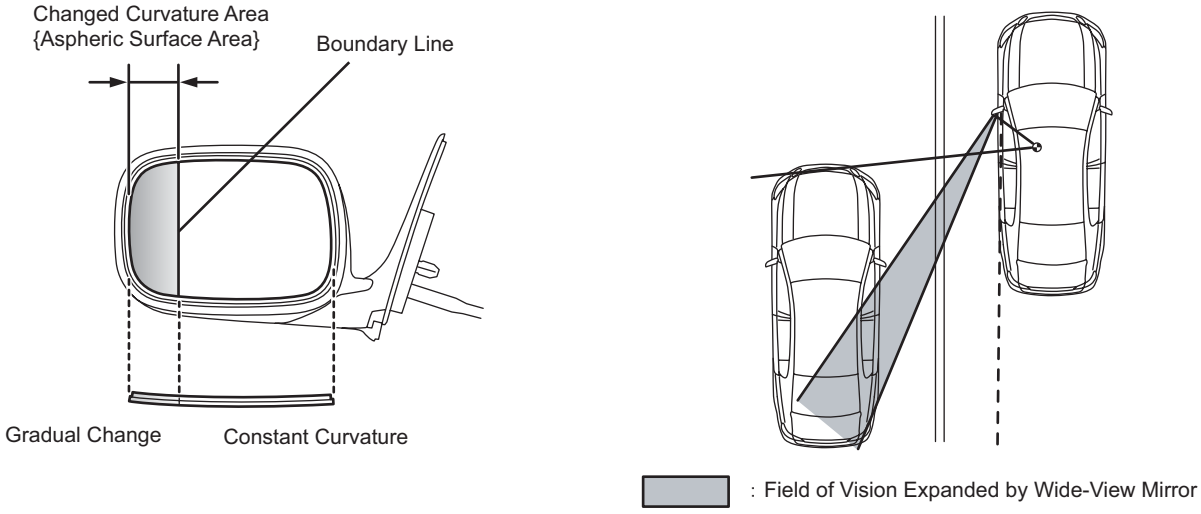
MIRROR

Outside Rear View Mirror

● Power retractable, remote-control door mirrors with a mirror heater function are provided on all models as standard equipment.

Wide View Door Mirror

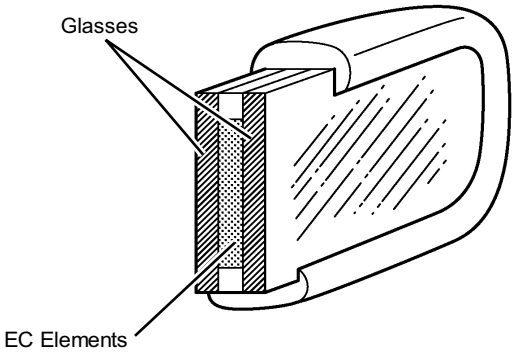
• Compound curvature mirrors, in which the curvature at the outer area has been changed (to form an aspheric surface), are used on the driver's door to supplement the rear view of the vehicle.



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EC Mirror Cell

• An EC mirror cell consists of 2 layers of glass, which sandwich the EC (Electrchromic) elements in the middle. The EC elements control coloring and discoloring characteristics through their electro-chemical oxidation reduce reaction. These characteristics are utilized to electronically vary the mirror's reflection rate.

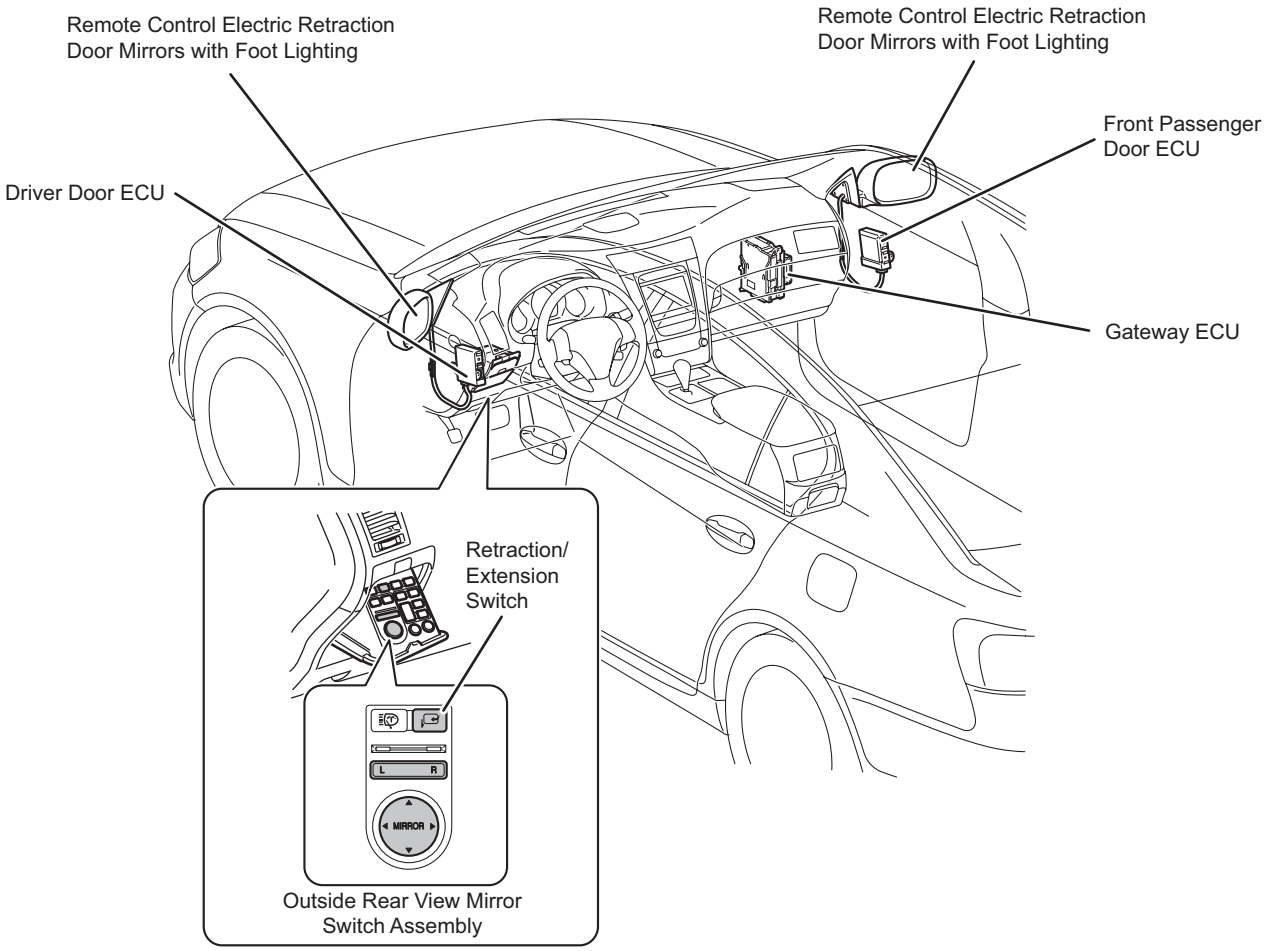


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Electric Mirror System

- "Power retractable remote control door mirrors with foot illumination" are used on all models as standard equipment. This system consists of door mirrors with a power retraction/resumption remote control function and foot illumination, in addition to the remote control of the mirror surface from the vehicle interior. The retraction/resumption switch for the door mirrors is located in the switch module on the instrument panel, on the right side of the driver.
- A foot illumination is provided on the bottom surface of each door mirror to facilitate the in-and-out access of the occupants at night. For details on the door mirror foot illumination, refer to the Illuminated Entry System (The Japanese is not consistent in its phrasing for this).

Electric Retraction Door Mirror System Components



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List of main component functions

Component (Abbreviation)	Main function
Power Retractable Remote Control Door Mirrors With Foot Illumination	—
Outside rear view mirror switch in module switch	• The operation of the switches enables the adjustment of the mirror surface angle, as well as the retraction and resumption of the mirrors.
Gateway ECU	• Relays bus-to-bus BEAN signals as the connection points for the buses of the bidirectional body multiplex communications.
driver /Front passenger door ECU	• Upon receiving the operation request and mode signals, the ECU actuates the mirror surface control motor and the retraction/resumption motor.

Electric Retraction/Extension Function

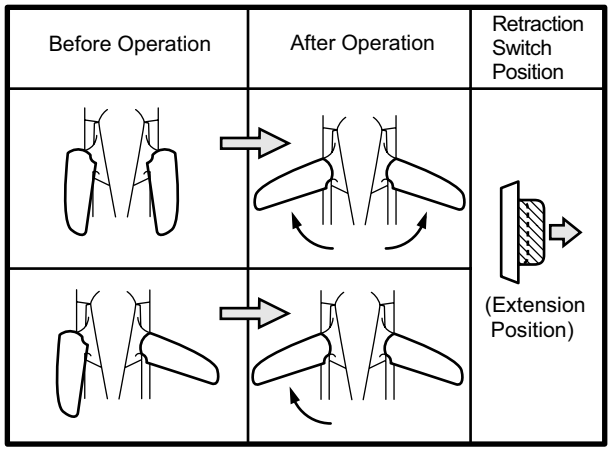
- When the driver operates the retraction/resumption switch while the power supply is in the ACC or IG ON position, the mirrors perform a retraction or resumption operation.
- When the driver turns the power supply to the IG OFF position during the retraction or resumption of the mirrors, the mirrors stop operating at the instant the power supply has been turned to the IG OFF position. When the driver turns the power supply to the ACC or IG ON position again, the mirrors will continue their operation to reach the retraction or resumption position.
- If the state of the retraction/resumption switch differs from the position of the mirrors while the power supply is in the IG OFF position (such as when the retraction/resumption switch is pressed to the retraction side but the mirrors are in the resumption position), the driver can turn the power supply from the IG OFF to the ACC or IG ON position to enable the mirrors to perform the retraction or resumption operation in accordance with the state of the switch.

Foot Lighting Function

- When the vehicle interior and exterior ID code check performed by the SMART ENTRY & START SYSTEM is OK, the foot illumination of the door mirror turns ON for approximately 15 seconds to illuminate the foot area while the occupant enters or exits the vehicle.

Door Mirror Extension

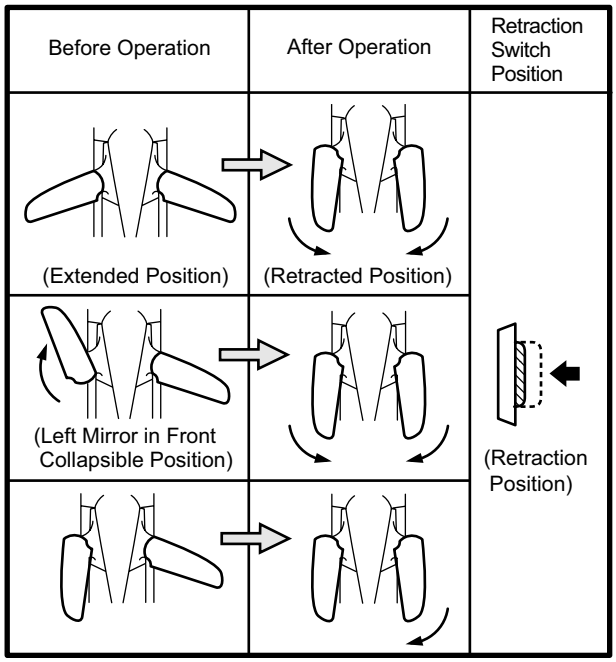
- When the driver pushes the switch to the resumption side while both right and left mirrors are in the retracted position, both the right and left mirrors will perform a resumption operation.
- If the mirrors are in the retracted position and the driver manually moves one of the mirrors to the resumption position, that mirror will maintain that state. If the driver pushes the switch to the resumption side, only one of the mirrors will perform a resumption operation.



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Door Mirror Retraction

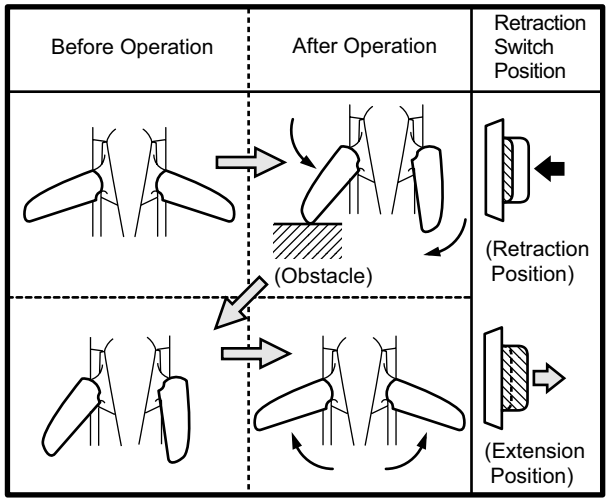
- If the mirrors are in the resumption position and the driver pushes the switch to the retraction side, both the right and left mirrors will perform a retraction operation.
- If the mirrors are in the resumption position and the driver manually moves one of the mirrors to the forward folding position, that mirror will maintain that state. If the driver pushes the switch to the retraction side, both the right and left mirrors will perform a retraction operation.
- If the mirrors are in the resumption position and the driver manually moves one of the mirrors to the retraction position, that mirror will maintain that state. If the driver pushes the switch to the retraction side, only one of the mirrors will perform a retraction operation.



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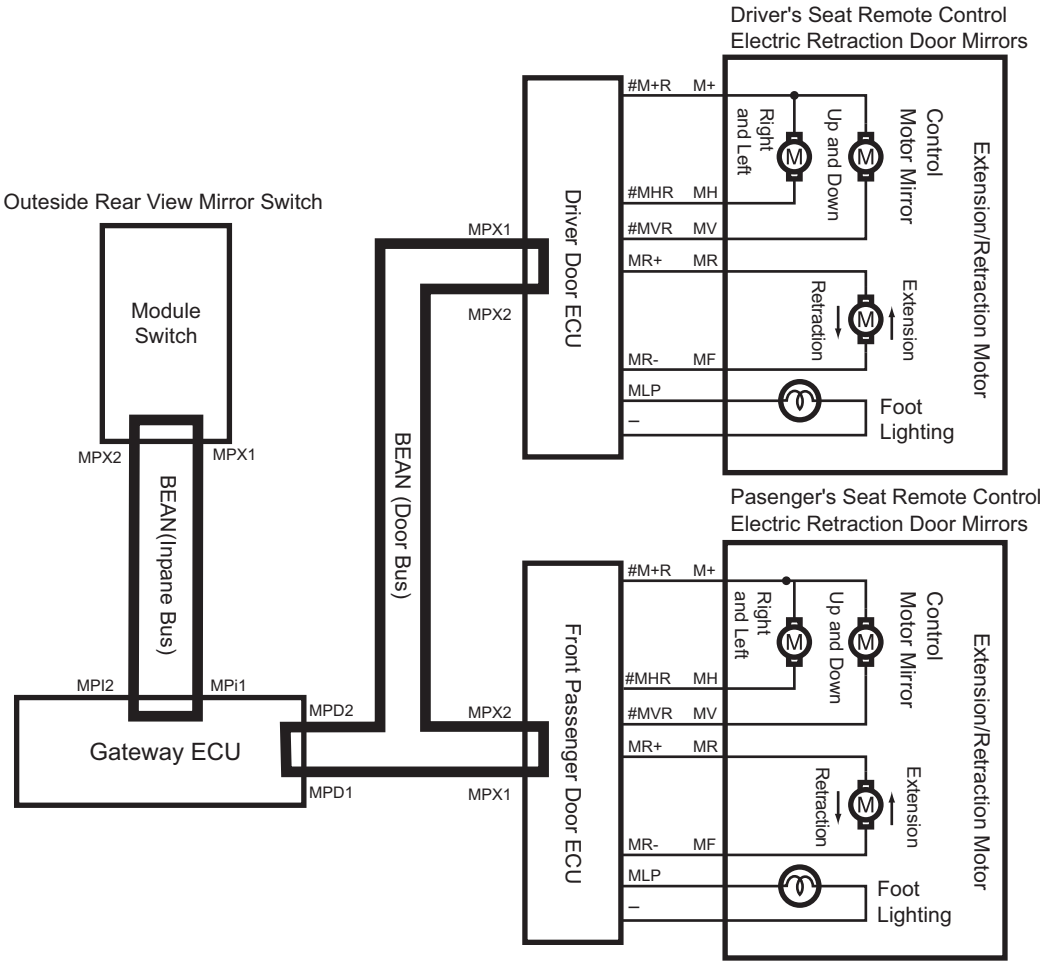
Fail-Safe of Door Mirror

- If the movement of a mirror is stopped by an obstacle, it will remain in that state. For this reason, the driver must operate the switch to move the mirrors in the retraction or resumption position after removing the obstacle.



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Electric Mirror System Operation



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Power Retraction/Resumption Operation

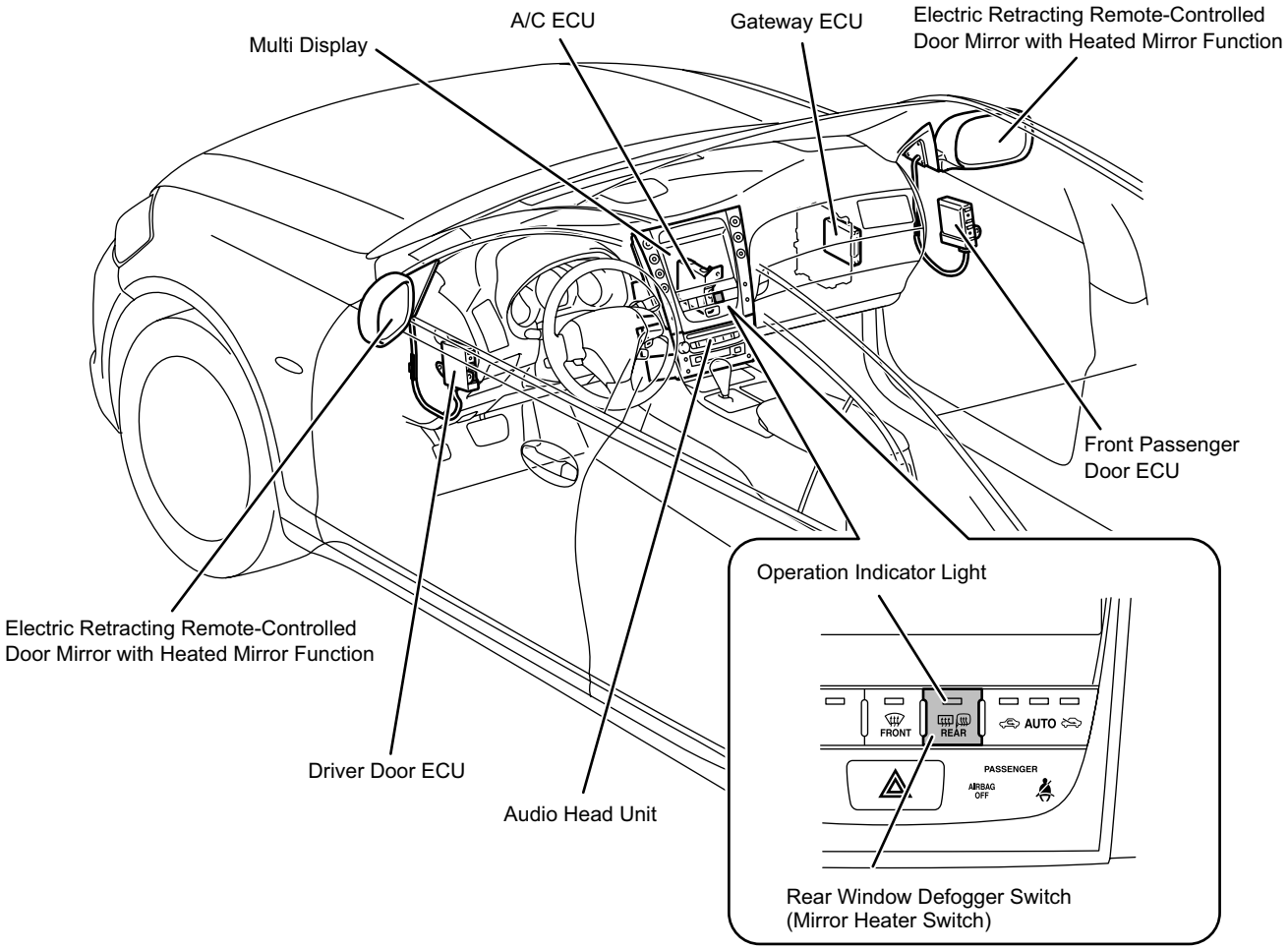
- When the power supply is in the ACC or IG ON position, the module switch detects the state of the retraction/resumption switch, and transmits a "mirror retraction <or mirror resumption>" signal to the driver and front passenger door ECUs via the BEAN.
- Upon receiving the "mirror retraction <or mirror resumption>" signal, the driver and front passenger door ECUs will perform a retraction or resumption operation in the same way as the auto power operation.

Heated Mirror System

● As on the previous model, "power retractable remote control door mirrors with a mirror heater function" are provided as standard equipment on all models. The rear window defogger switch is used concurrently as a mirror heater switch.

Heated Mirror System Components

• The mirror heater system consists of the following parts.



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List of Main Components and Functions

Component (Abbreviation)	Main Function
Power Retractable Remote Control Door Mirror with a Mirror Heater Function	—
Gateway ECU	• Serves as a connecting point for the communication networks (Body Electronics Area Network [BEAN] and AVC-LAN) in order to relay communication data between them)
Driver/Front Passenger Door ECU	• Upon receiving the operation request and mode signals, the ECU actuates the mirror heater.
Center Integration Panel	• Transmits an operation request signal for the mirror heater to the air conditioner ECU.
Air conditioner ECU	• Transmits a mirror heater relay actuation request signal to the driver's and front passenger's door ECUs.

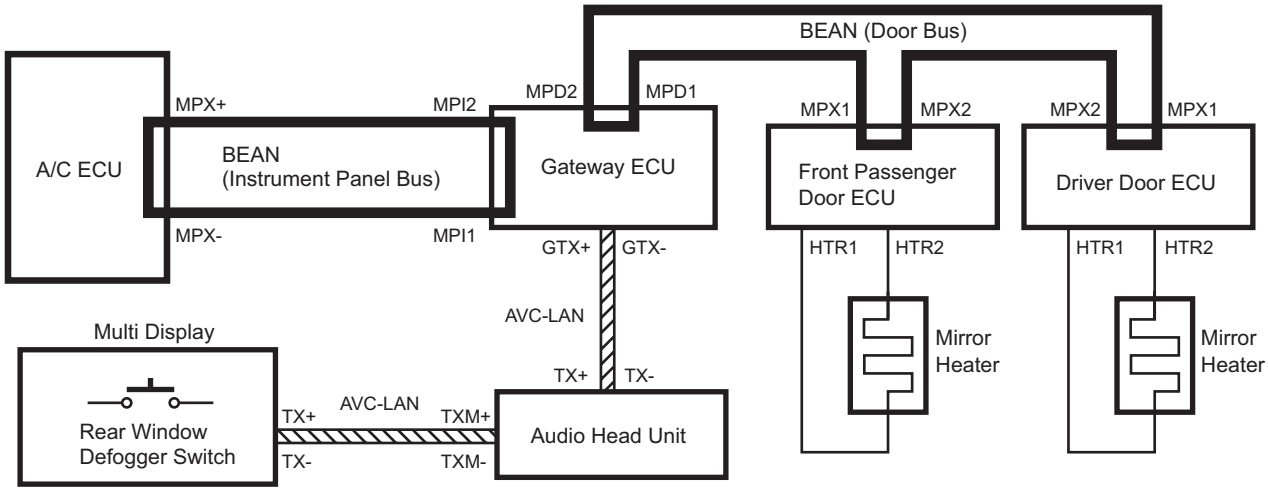
Heated Mirror Function

• When the driver pushes the mirror heater switch (used concurrently as the rear window defogger switch) while the ignition is ON, the mirror heaters generate heat for approximately 15 minutes to clear the surfaces of the outer rear view mirrors that are covered with frost or water drops.

Heated Mirror Operation

• When the driver turns ON the rear window defogger switch (used concurrently as the mirror heater switch) in the center integration panel while the ignition is ON, the switch transmits a rear window defogger operation request signal to the front air conditioner ECU via the AVC-LAN and the BEAN (Body Electronics Area Network). Upon receiving this signal, the front air conditioner ECU transmits a mirror heater relay actuation signal to the driver and front passenger door ECUs via the BEAN (Body Electronics Area Network). Upon receiving this signal, the driver and front passenger door ECUs turn ON the mirror heater relay in the door ECUs, causing the mirror heaters to generate heat.

• The front air conditioner ECU counts the timer time and stops transmitting the signal after the transmission of the mirror heater relay actuation signal continues for approximately 15 minutes.



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Rear Window Defogger System

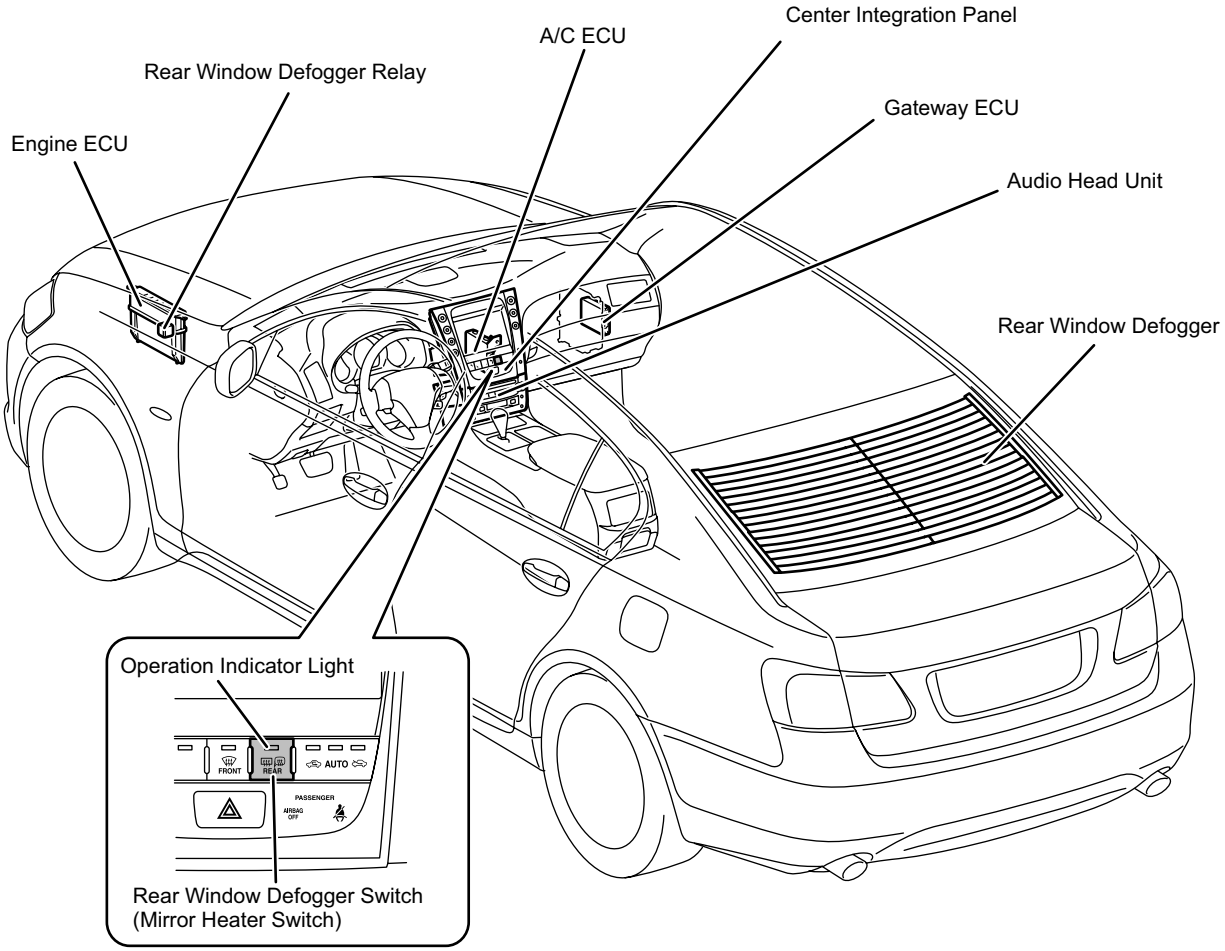
- A rear window defogger with a timer function (approximately 15 minutes) is used and provided on all models as standard equipment.
- A push type switch with a built-in operation indicator light is used and located in the multi display. This switch is used concurrently for both the rear window defogger and the mirror heaters.

Rear window defogger control

Item	specification
Number of Heating Elements (N)	16
Consumption Wattage (W)	267(±10)
Timer Time (minutes)	15

Rear Window Defogger Components

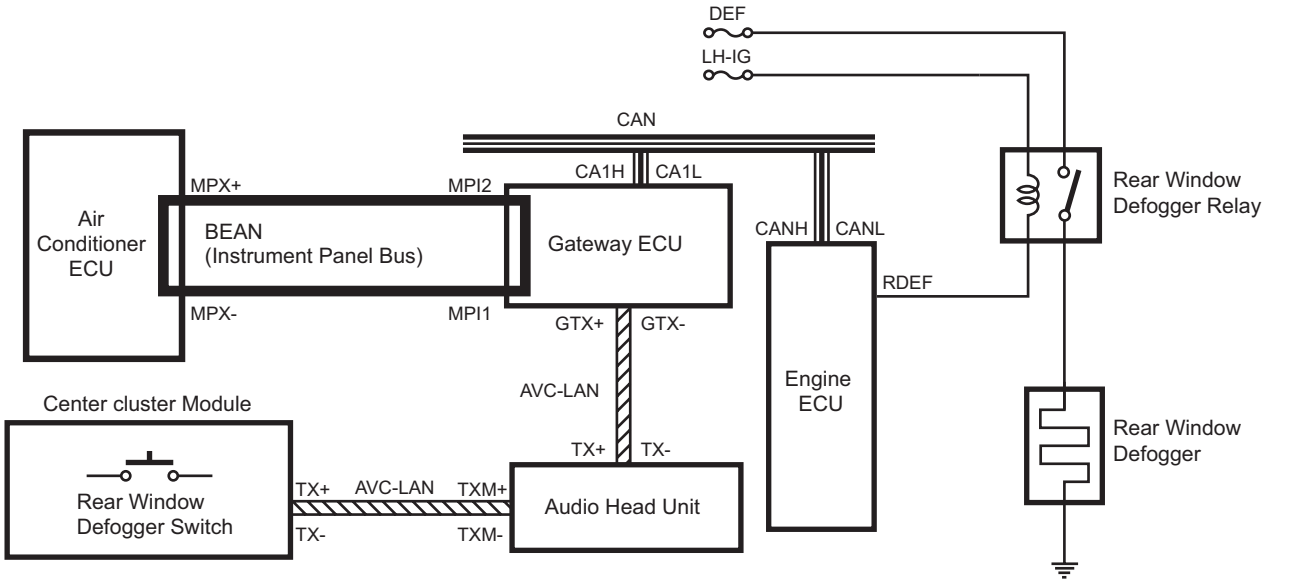
• The rear window defogger consists of the following parts.



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Rear Window Defogger Operation

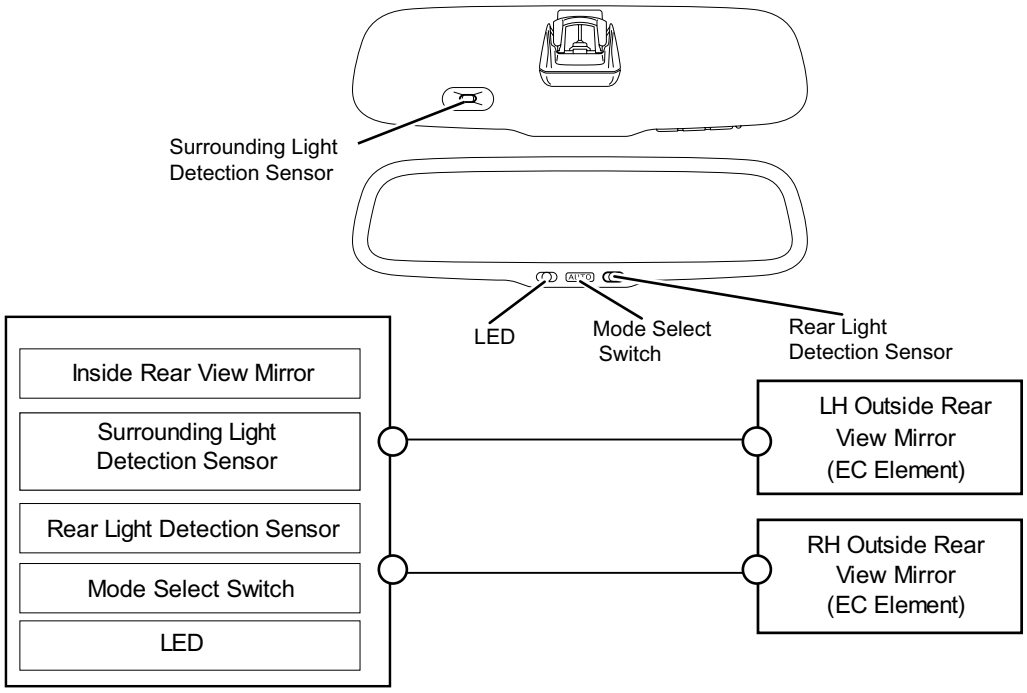
- When the driver turns the rear window defogger switch ON while the ignition is ON, the switch transmits a rear window defogger operation request signal to the front air conditioner ECU via the AVC-LAN and the BEAN (Body Electronics Area Network). Upon receiving this signal, the front air conditioner ECU transmits a rear window defogger relay actuation signal to the engine ECU via the BEAN (Body Electronics Area Network) and the CAN (Controller Area Network). Upon receiving this signal, the engine ECU turns the rear window defogger relay ON, which causes the rear window defogger to generate heat.
- The front air conditioner ECU counts the timer time and stops transmitting the signal after the transmission of the rear window defogger relay actuation signal continues for approximately 15 minutes.



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Inside Rear View Mirror

● During nighttime driving, if a large difference in intensity exists between the surrounding light and the light entering the inside rear view mirror from the headlights behind, automatic glare resistant EC (Electrochromic) mirror automatically reduce the reflection rate of the inside rear view mirror and thus dampens the glare on the mirror. The reflection rate of the outside rear view mirrors varies in accordance with the change in the reflection rate of the inside rear view mirror. This system uses 2 sensors that are attached the inside rear view mirror to detect the difference between the intensity of light entering the inside rear view mirror from the rear of the vehicle. When the ignition switch is turned from OFF to ON, this system always turns on in the AUTO mode.



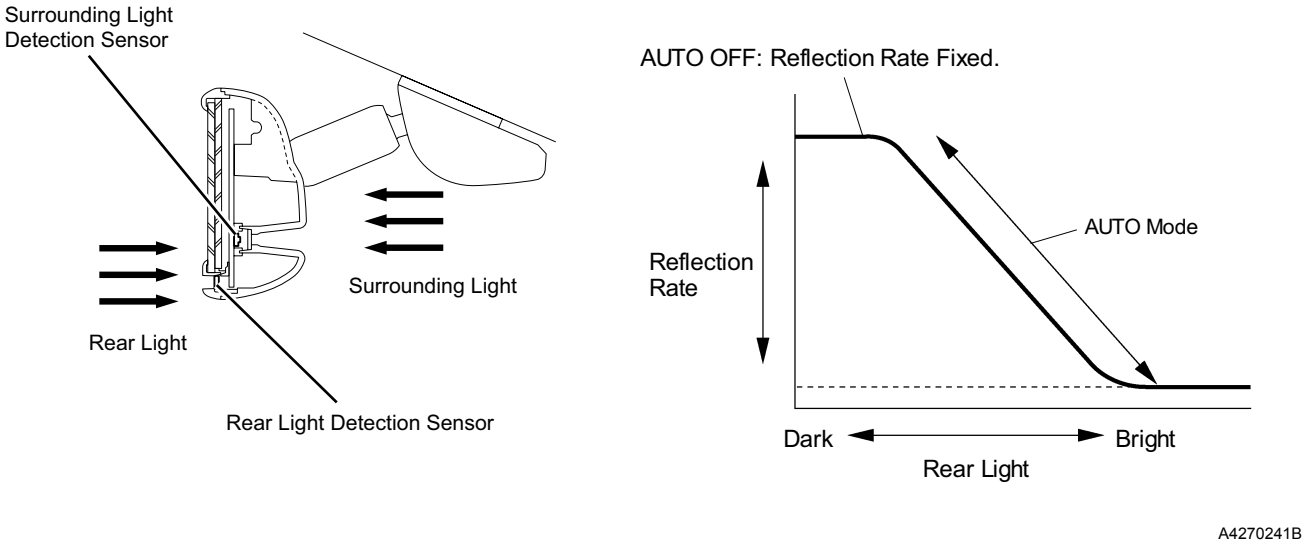
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Table of Component Function

Component	Function
Surrounding Light Detection Sensor	Detect the intensity of the light surrounding the vehicle.
Rear Light Detection Sensor	Detects the intensity of the light entering the inside rear view mirror from the rear of the vehicle.
LED	Turns on to inform the driver the AUTO mode is operating.
Mode Select Switch (AUTO, OFF)	Selects the inside and outside rear view mirror control to AUTO mode or AUTO OFF mode.
EC Mirror Cell	Varies the refection rate of the mirror through the function of EC element.
CPU	Controls the reflection rate in accordance with the signals from the 2 sensors.

Reflection Rate Control

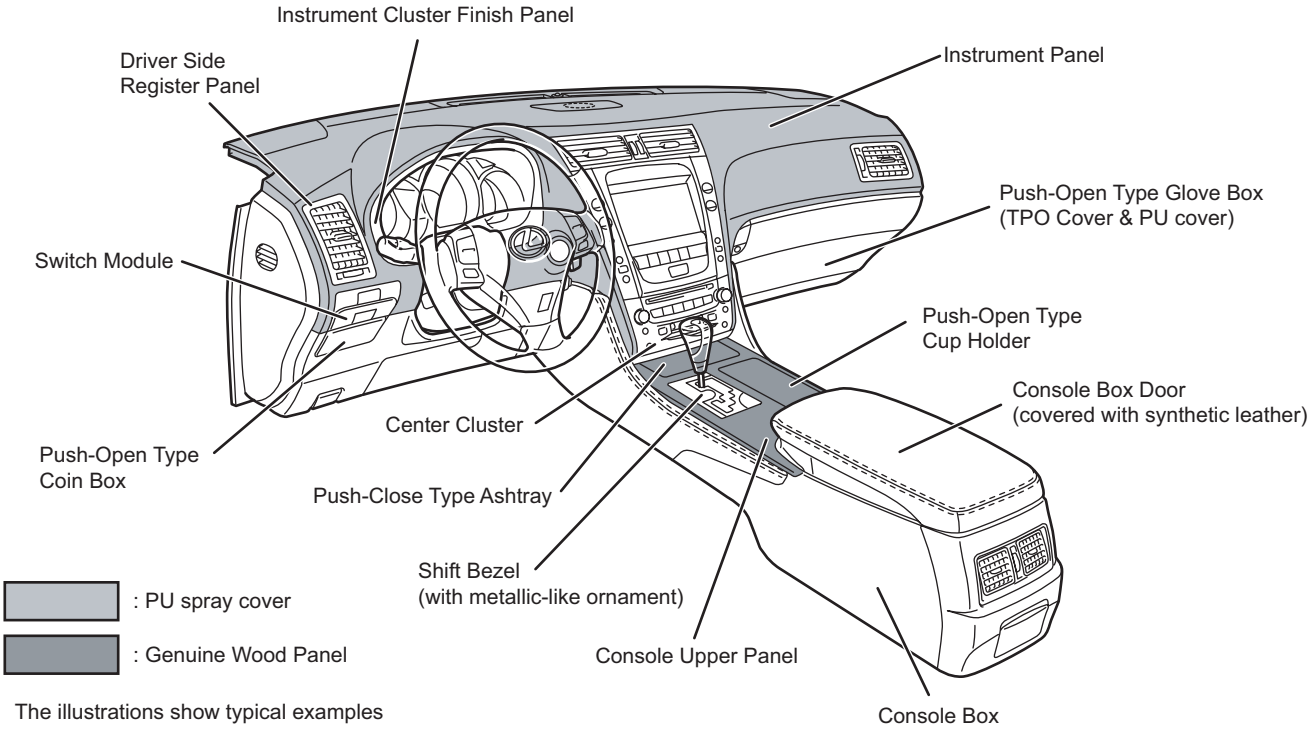
- This CPU detects the surrounding light through its surrounding light detection sensor, the rear light through its rear light detection sensor, and determines whether it is day or night through the intensity of the surrounding light. At the same time, the intensity of the glare from the rear determined through the difference in intensity between the surrounding and rear light. In accordance with the intensity of the rear light, the reflection rate varies steplessly.



INSTRUMENT PANEL

Around The Instrument Panel

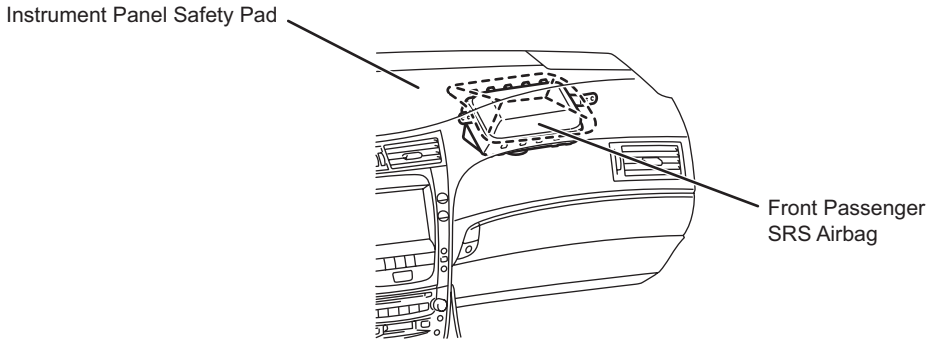
- The instrument panel cluster finish panel and the column cover use a type of construction that does not show any gaps. The components in the upper area of the instrument panel have been made flush. By reducing offsets and gaps, a superior appearance has been achieved.
- The instrument panel has a PU spray cover, while the console box unit and glove box have a TPO (Thermo Plastic Olefin) cover, for improved recyclability.
- Genuine wood panels are provided at the upper console panel, ashtray door, and cup holder door. The console box door covered with synthetic leather is double-stitched to produce a luxurious look. The genuine wood panels are available in Three colors to match the interior color or grade.
- A push-open coin box is provided under the driver's side register, a push-open cup holder is provided on the upper console panel, and a push-close ashtray is provided under the center cluster for superior ease of use.
- SRS knee airbags are provided for the driver and front passenger on the lower instrument panel.
- An invisible type SRS airbag is used for the front passenger for good looks.
- The glove box, which uses a push-button, open-close latch lock construction, is provided with a damper and illumination in order to improve its fit, ease of use, and appearance.
- The console box has a inner tray and a large box to provide superior storability and ease of use. A slide & turn console box door is used so that the console box can be used for various purposes.
- A metallic-like ornament is provided on the shift bezel of the upper console panel to stage a sporty look.



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Front Passenger SRS Airbag Door

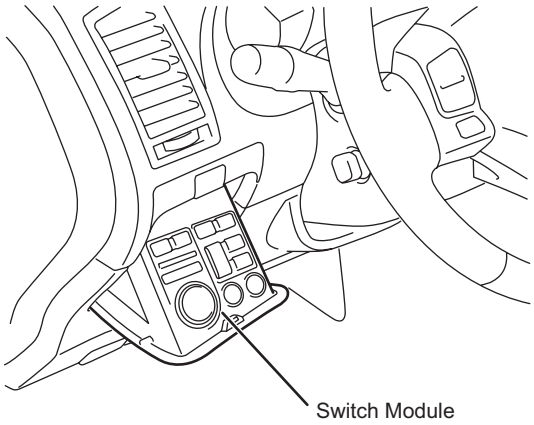
- The skin covering the front passenger SRS airbag door is integrated with the skin covering the instrument panel safety pad. This makes the front passenger SRS airbag door invisible and realizes good looks.

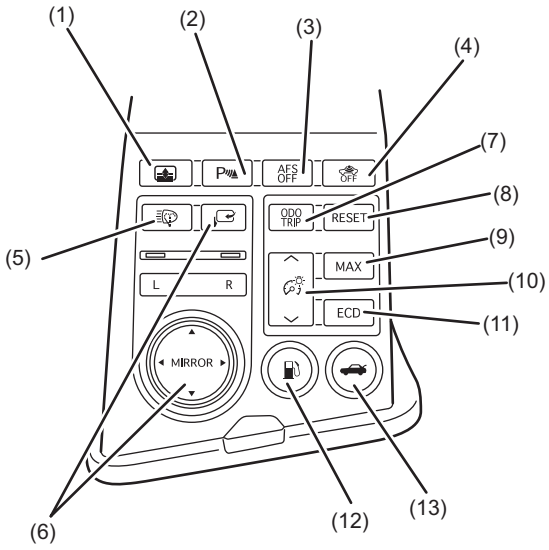


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Module Switch

- The infrequently used switches are placed together in a switch module under the driver's side register, and the switch module has been made retractable. This keeps the switches (which have increased in number with numerous functions) out of sight and realizes a streamlined design.





The illustration shows a representative example.

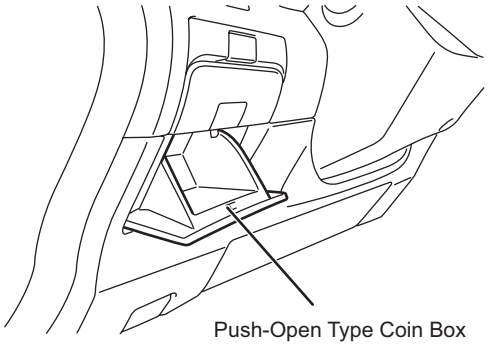
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Switch layout

No.	switch
(1)	Rear Sunshade Switch
(2)	LEXUS Parking Assist-Sensor (steering guided) System Switch
(3)	AFS OFF Switch
(4)	Intrusion Sensor OFF Switch
(5)	Head Lamp Cleaner Switch
(6)	Outside Rear View Switch
(7)	Odo/Trip Change Switch
(8)	Trip Reset Switch
(9)	Rheostat MAX Level Switch
(10)	Rheostat Switch
(11)	ECD Mode Change Switch
(12)	Fuel Lid Opener Switch
(13)	Luggage Door Open Switch

Coin Box

- A push-open coin box is provided under the driver's side register for superior ease of use by the driver. In addition to coins.



Push-Open Type Coin Box

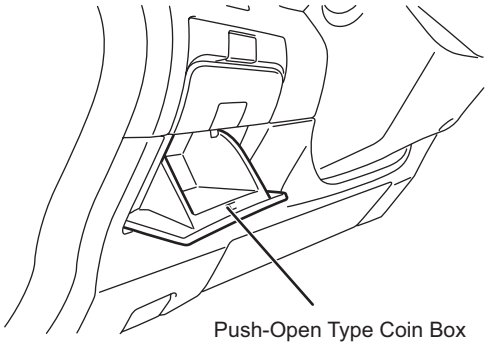
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Switch layout

No.	switch
(1)	Rear Sunshade Switch
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(3)	AFS OFF Switch
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(5)	Head Lamp Cleaner Switch
(6)	Outside Rear View Switch
(7)	Odo/Trip Change Switch
(8)	Trip Reset Switch
(9)	Rheostat MAX Level Switch
(10)	Rheostat Switch
(11)	ECD Mode Change Switch
(12)	Fuel Lid Opener Switch
(13)	Luggage Door Open Switch

Coin Box

- A push-open coin box is provided under the driver's side register for superior ease of use by the driver. In addition to coins.

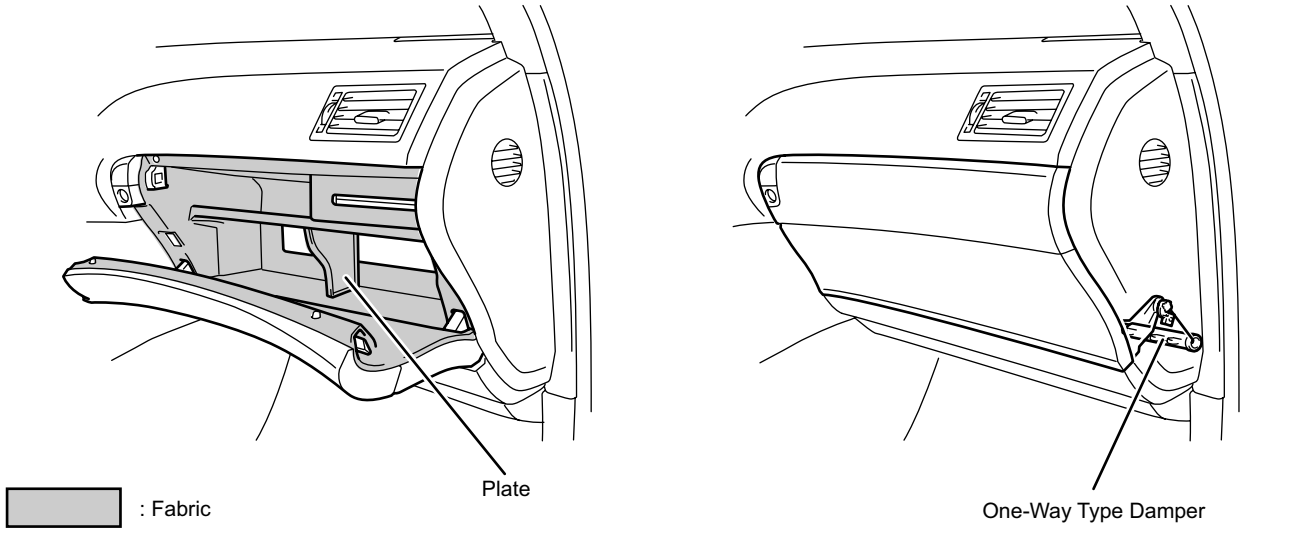


Push-Open Type Coin Box

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Glove Box

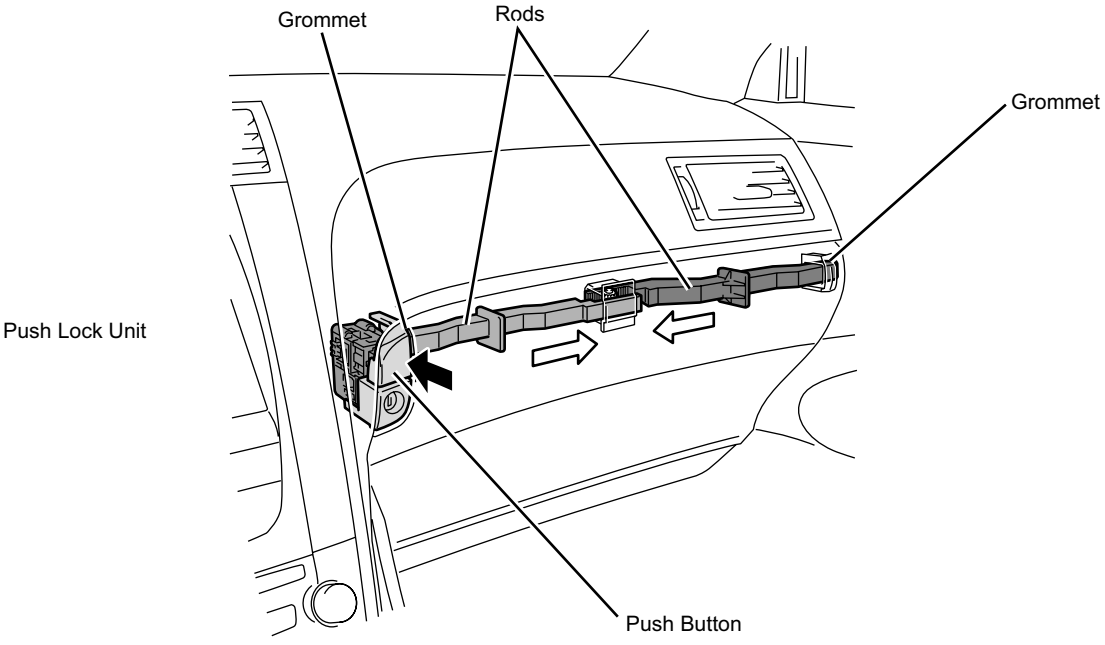
- A plate is provided inside the glovebox to provide superior storage. The plate can be removed to store a large item.
- The imside of the glove box is covered with a flocked fabric to protect the stored objects from damage. A glove box light is provided for superior ease of use at night.
- A one-way damper is provided behind the glove box to achieve a smooth operating feel during the closing or opening of the glove box.



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Push Open Type Glove Box

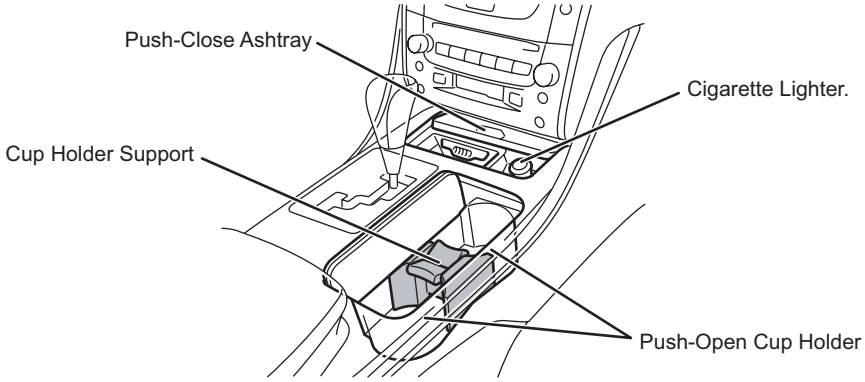
- The push lock unit converts the longitudinal movement to the push button into a lateral movement, which pushes the end of the rod and releases the glove box door.
- A helical gear is used in the area between the right and left rods where force is applied, and a grommet is provided on the side that receives the rod end. These measures effectively minimize wobble in the movable areas and realize an improved quietness.



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Cup Holder & Ashtray

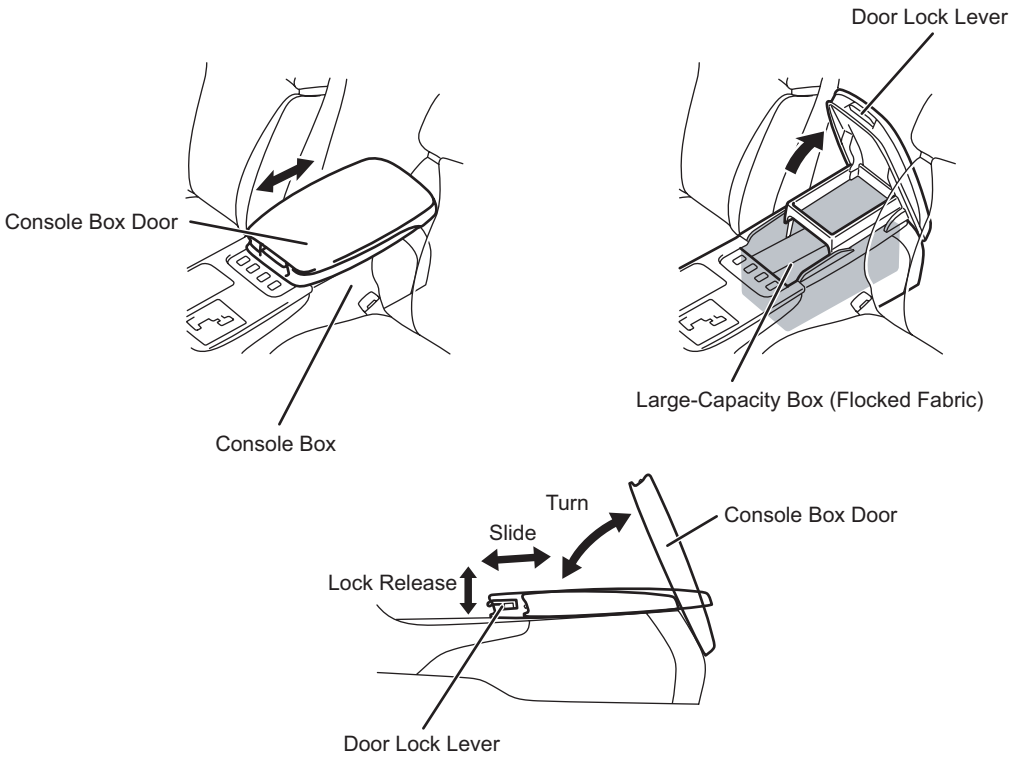
- A push-open cup holder is provided in the upper console panel. Also, a removable cup holder support is used.
- The end of the cup holder door is positioned low when it is open in order to facilitate the placement of cups. When the cup holder door is closed, the gap between it and the upper console panel has been reduced for good looks.
- A push-close ashtray is provided under the center cluster.



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Console Box

- The console box is provided with a inner tray and a large box. A slide & turn console box door is provided to achieve superior ease of use.
- The ECT pattern select switch and the absorber control switch (3UZ-FE only) will appear when the console box door is slid backward.
- To use the large box located in the bottom of the console box, slide the console box door backward and turn it upward. When the door is turned, the end of the door is positioned "low and forward" for ease of operation.
- The inside of the large box and the bottom of the inner tray are covered with flocked fabric for a luxurious look.



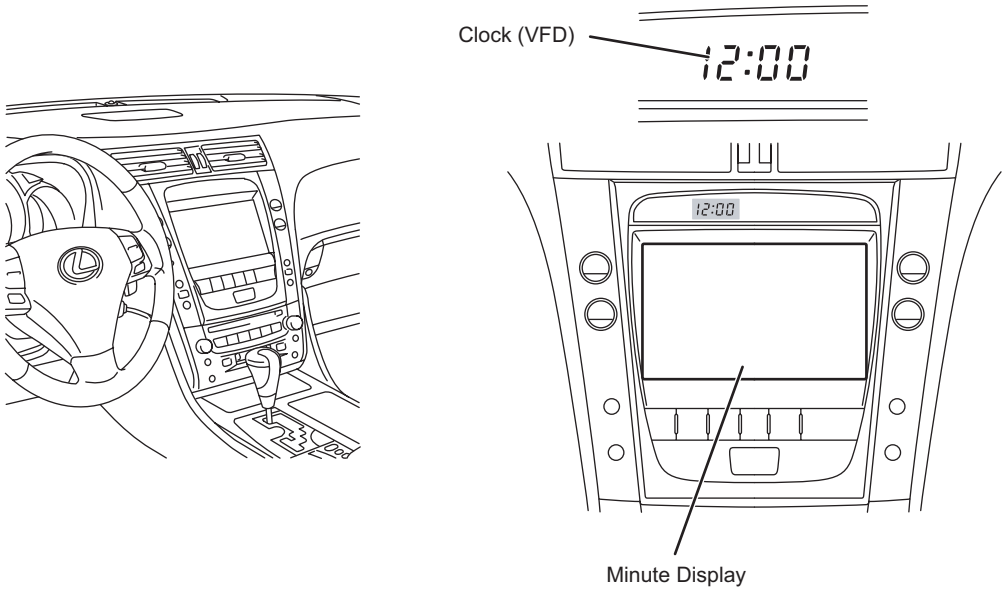
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Clock

● A VFD (Vacuum Fluorescent Display) digital clock is provided in the upper area of the multi display. It uses an automatic GPS correction function that receives signals from the GPS satellites to automatically correct the indicated time. A clock correction switch (touch panel) appears in the multi display if the automatic GPS correction function is not being used.

Clock Specifications

Rated Voltage [V]	DC12
Accuracy [sec/day]	-2.0~+6.0sec.(when automatic GPS correction function is not used)
Hour Digit Indication	1~12
Minute Digit Indication	00~59



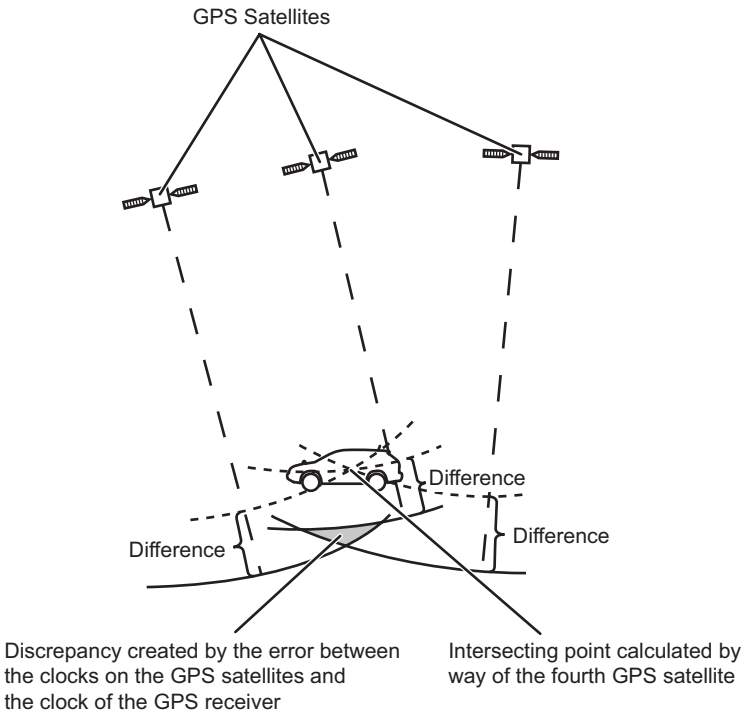
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Clock Setting Switch

- Press the H button of the clock correction switch to correct the hours. Keep this button pressed more than 0.5 seconds to increase the number of hours at 0.5-second intervals.
- Press the M button of the clock correction switch to correct the minutes. Keep this button pressed more than 0.5seconds to increase the number of minutes at 0.5-second intervals.
- Press the rest button on the clock correction switch to reset the data for the minutes and seconds. While the minutes show 30 to 59, press this button to increase the number of hours by 1 hour.
- The clock correction switch is provided with an operating sound for ease of use.

Clock with The GPS Automatic Correction Function(Principle)

- The clock with the automatic GPS correction function, which operates under the principle of trilateration, uses a GPS receiver that is built into the navigation ECU to calculate the signals transmitted by the GPS satellites, in order to constantly indicate accurate time.
- The GPS satellites, which carry high-precision clocks onboard, constantly transmit orbital signals and radiowave transmission time signals. The GPS receiver also has a built-in clock function, which determines the time that the radiowave signals transmitted by the GPS satellites are received. This enables the GPS receiver to measure the length of time taken by the radiowave signals from the GPS satellites to reach the GPS antenna.
- The GPS receiver multiplies the length of time taken by the radiowave signals from the three GPS satellites to reach the GPS antenna by the velocity of light (speed of light transmission: approximately 300,000 km/s). The product of this multiplication is the distance between the GPS satellites and the GPS antenna.
- The positions of the GPS satellites are known by their signals. Therefore, the crossing point of three spheres centered on the three GPS satellites, respectively, is the reception point (position of the driven vehicle). However, because of an error that exists between the clocks on the GPS satellites and the clock on the GPS receiver, the three spheres do not intersect at a single point. For this reason, the GPS receiver uses a fourth GPS satellite and calculates the single point at which the three spheres intersect, in order to correct the time of the GPS receiver clock function. The clock with the automatic GPS correction function receives the input of this information in order to constantly indicate the correct time.



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Clock with The GPS Automatic Correction Function(Function)

- On the "Adjust Clock" screen, touch "ON" Auto Adjust to show "Time Zone" on the screen. Touch "Time Zone" to show the offset mode. Use the offset mode to advance or retard the time indicated on the radiowave signal clock (which is corrected automatically in accordance with the standard radiowave signals {standard time} only in the amount of time desired).
- On the "Adjust Clock" screen, touch "OFF" Auto Adjust, to show the clock correction mode on the screen. The clock correction mode enables the manual correction of the clock, in the same way as the ordinary clock, through the operation of the "H', "M", and ":00" switches (of the touch panel).
- To exit "Adjust Clock", touch "OK".

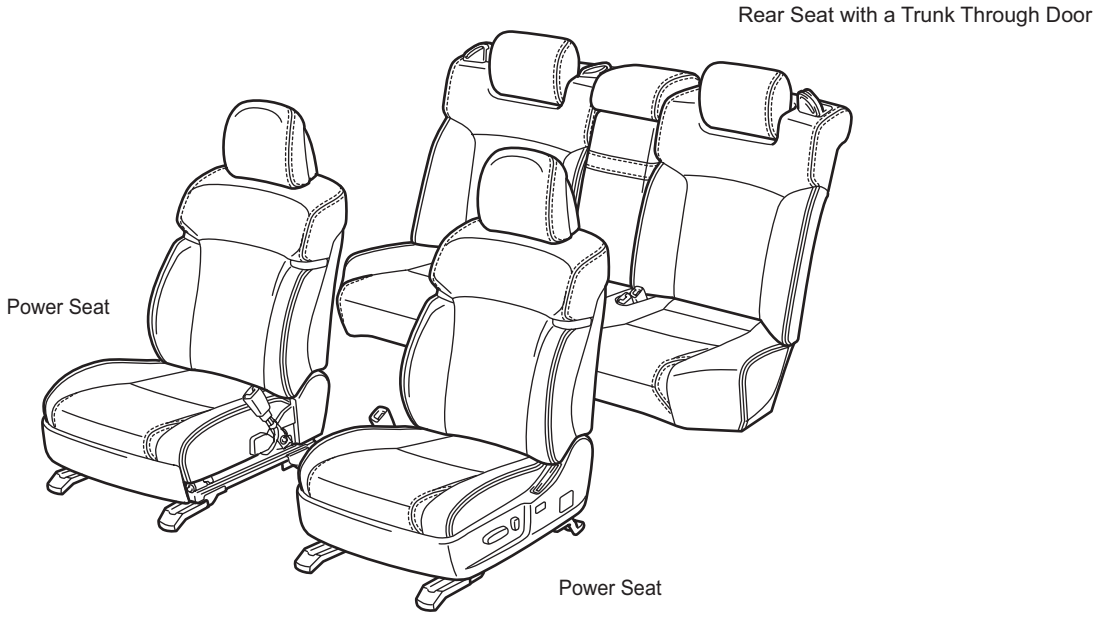
Clock with The GPS Automatic Correction Function(Offset Mode)

- The ordinary clock with the automatic GPS correction function indicates the standard time in synchronization with the standard radiowave signals. However, by using the offset mode to input time, the user can accordingly retard or advance the indicated time.
- To input offset time, touch "triangle" on the screen. A maximum of 6 hours can be set at either retard or advance.
- The +B power supply for the radiowave signal clock backs up the time that is input during the offset mode. If the +B power supply for the radiowave signal clock is disrupted during an inspection or maintenance service, the clock will revert to the default of "no offset time (0:00).

SEAT

Seat Variation

- Power front seats are provided on all models, and a slide-linked headrest is provided on the driver's seat.
- A trunk access door is used in the armrest area of the rear seat on all models.

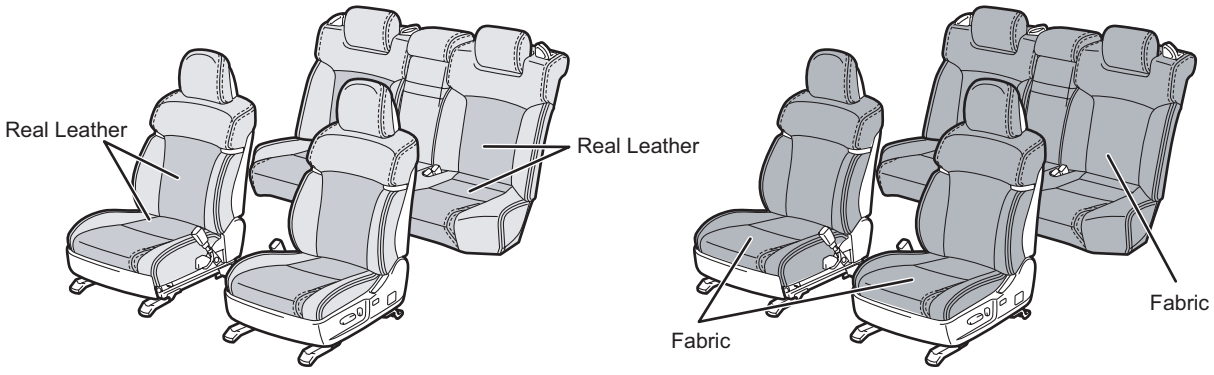


Note: The seat covers shown in the illustration are the standard setting used as a typical example.

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Seat Cover

- Fabric seat covers are provided on all models. Genuine leather is available as a manufacturer's option on all models.



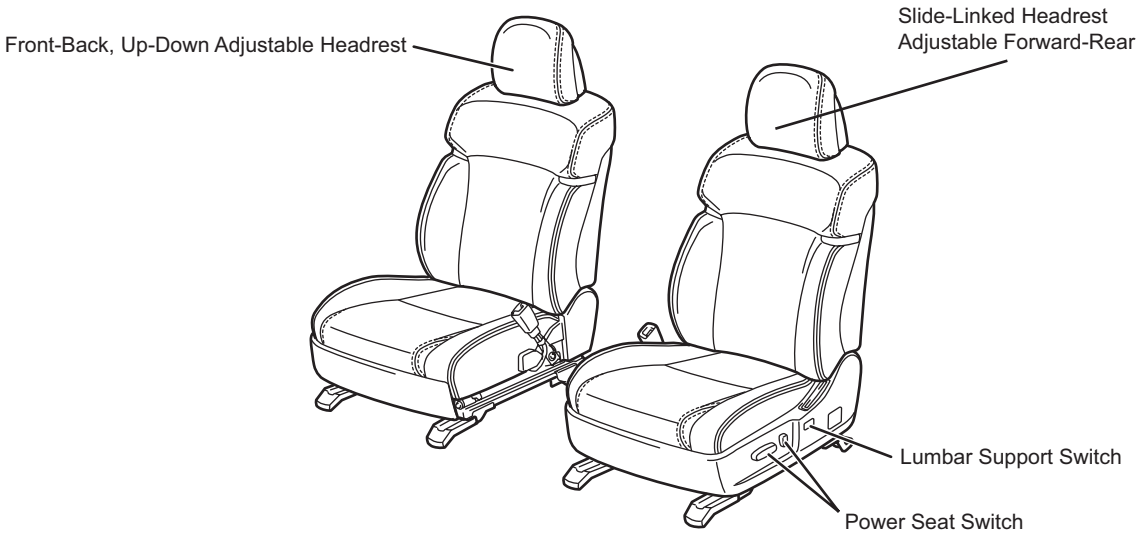
Leather Sheet Wearing Vehicle (option)

All Vehicles

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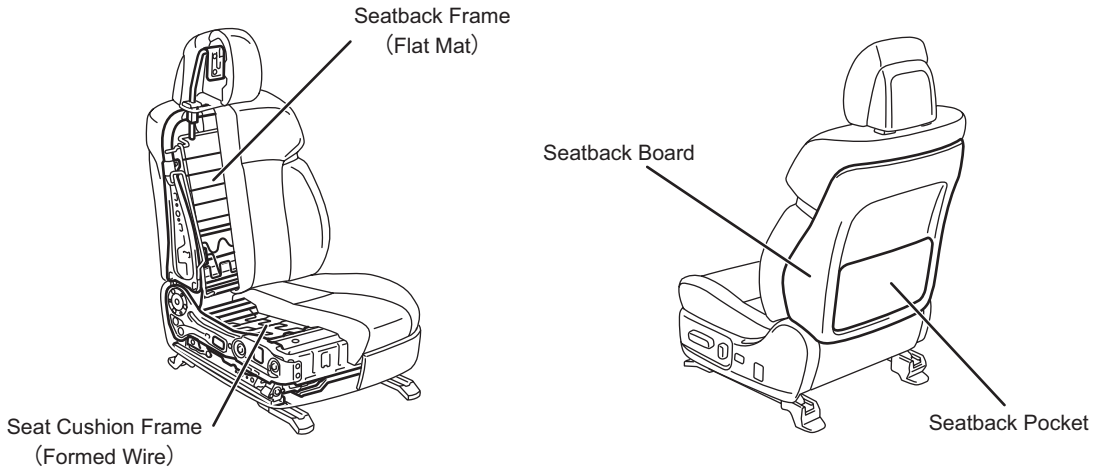
Front Seat

- Power seats are provided for the driver and front passenger. Computerized power seats, which are equipped with seat position memory and retrieval functions are available as optional equipment. : BO-42
- Front seat heaters are available as a manufacturer's option on all models. Driver's and front passenger's seats with a ventilation function are available as an option on the models with genuine leather seats.
- A built-in type SRS side airbag is provided in the driver's and front passenger's seatbacks.
- The driver's and front passenger's seats are provided with sliding, reclining, lifter, front vertical, and lumbar support functions that enable optimal seat position adjustment.
- A slide-linked headrest is provided on the driver's seat, and a front-back, up-down adjustable headrest is provided on the front passenger's seat. The front-back adjustment is the fold-down type, which expands the surface area that supports the head of the occupant.



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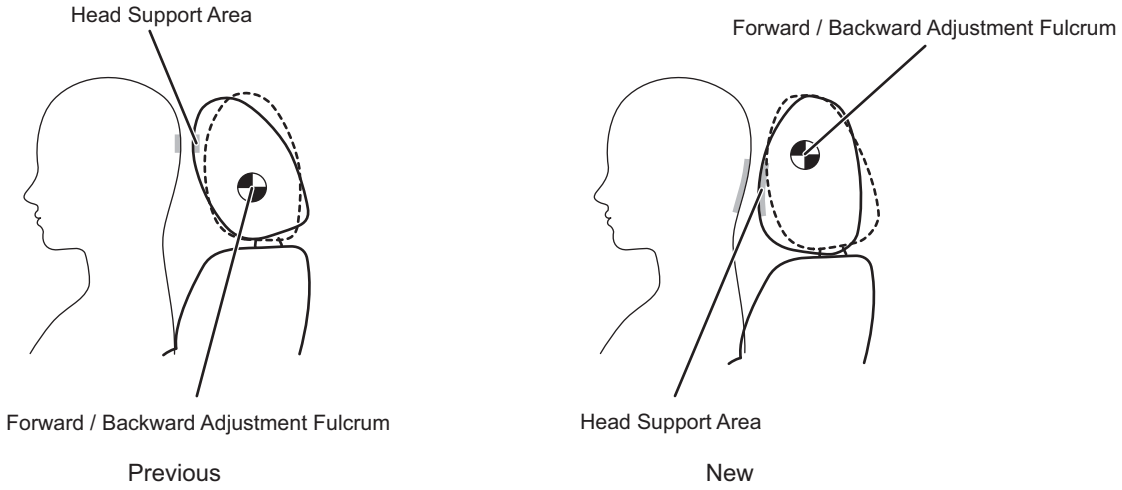
- The seatback frame uses a flat-mat construction consisting of springs and straight wires. This construction offers an excellent fit by providing a surface that supports the occupant's pelvis and spine areas.
- The seat cushion frame uses a formed wire construction consisting of S-shaped springs and rectangular wires. This construction provides a surface that supports the occupant to ensure a comfortable ride.
- A seatback board and seatback pocket are provided on the back surface of the driver's and front passenger's seatbacks for superior in-and-out access and storability.



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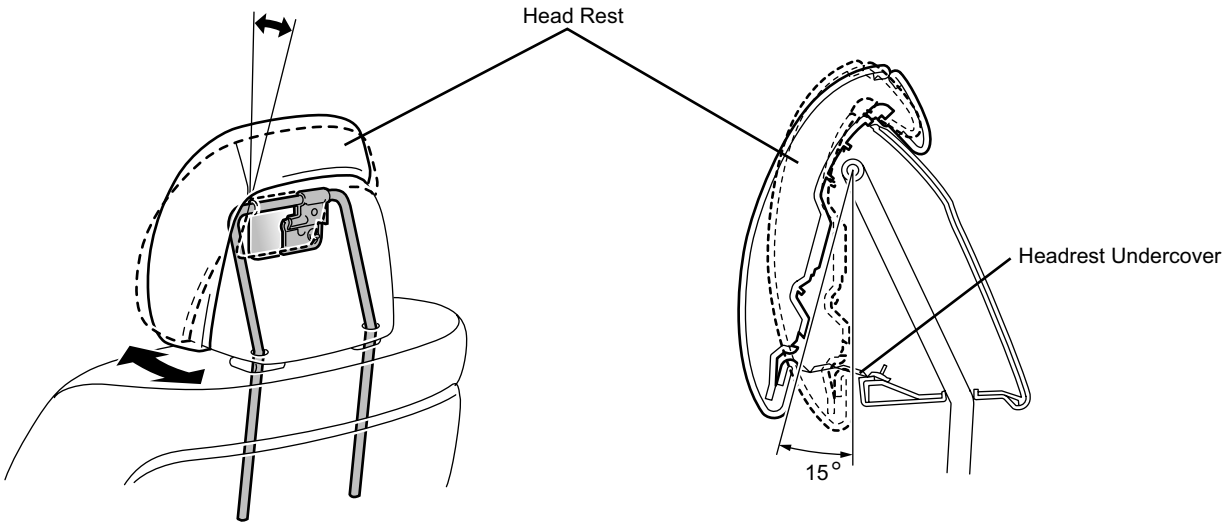
Head rest adjustable forward-rear and up-down

- A friction front-back adjustable headrest that adjusts steplessly to the occupant's figure is provided. The front-back adjustment fulcrum of the headrest has been relocated upward, and the adjustment operation of the headrest has been changed from a fold-up type to a fold-down type, which expands the surface area that supports the head of the occupant.



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- The headrest undercover stretches and contracts so that the headrest can be adjusted steplessly in the longitudinal direction.
- The operation range is within 15°, until the headrest undercover is fully stretched.



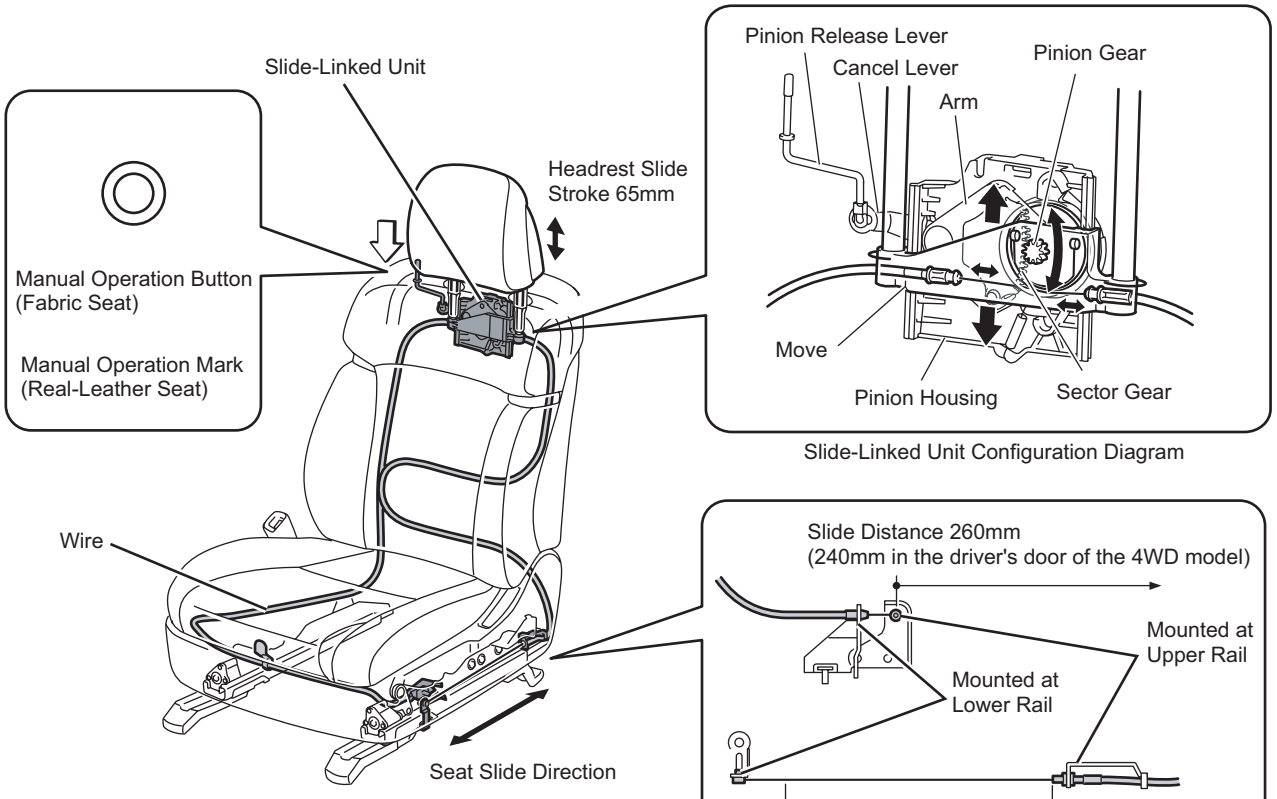
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Seat Slide Linked Headrest

- All models use a driver's seat that has an automatic headrest height adjustment function. When the driver adjusts the seat position by sliding the seat, the slide-linked unit adjusts the headrest to a height that suits the amount of seat slide. In addition, a manual operation button that manually adjusts the position of the headrest is provided on the right shoulder area of the seatback.
- When the driver slides the seat backward, this movement causes the wire that is mounted on the lower seat rail to pull, which causes the drum that is mounted on the wire to rotate counterclockwise. Accordingly, the pinion gear that is integrated with the drum rotates counterclockwise, causing the sector gear, which is integrated with the arm, to rotate clockwise around the shaft acting as the fulcrum. This causes the boom to move in unison with the arm, which lowers the headrest. When the driver slides the seat forward, this movement causes the wire that is mounted on the upper seat rail to pull, which creates a movement that is opposite to the backward slide of the seat, thus raising the headrest.
- For manual adjustment, the driver presses on the manual operation button, causing the cancel lever to push down the pinion release lever (which is integrated with the pinion housing). This causes the pinion to separate from the sector gear, enabling the driver to adjust the headrest up or down.

❖REFERENCE❖

When the seat is at the rearmost (or frontmost) sliding position, the headrest is at the topmost (or bottommost) position. However, if the headrest position was adjusted manually, the headrest might not reach its topmost (or bottommost) position even if the seat is slid to the rearmost (or frontmost) position. If the headrest has already reached its topmost (or bottommost) position while the driver is adjusting the seat to slide backward (forward), the headrest will not move further.



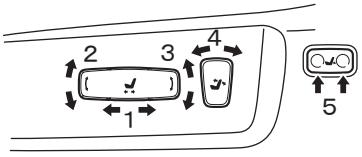
Slide-Linked Unit Configuration Diagram

Cable Connected at Slide Rail

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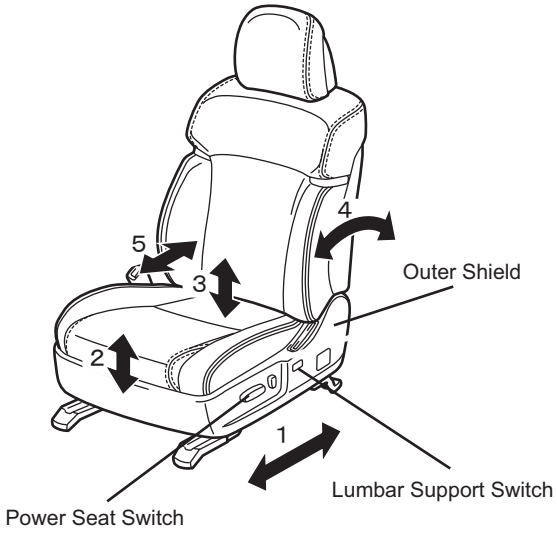
Front Power Seat

● The driver's and front passenger's seats use a power-adjustable sliding, reclining, front vertical, lifter, and lumbar support mechanism to facilitate the adjustment of their positions.



Power Seat Switch Design

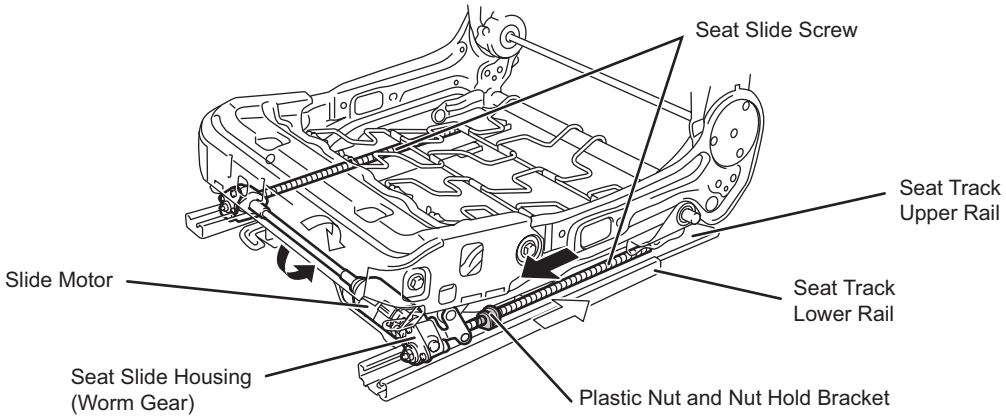
1	Fore-and-Aft Slide
2	Front Vertical Height
3	Rear Vertical
4	Reclining
5	Lumbar Support



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Power Slide Mechanism

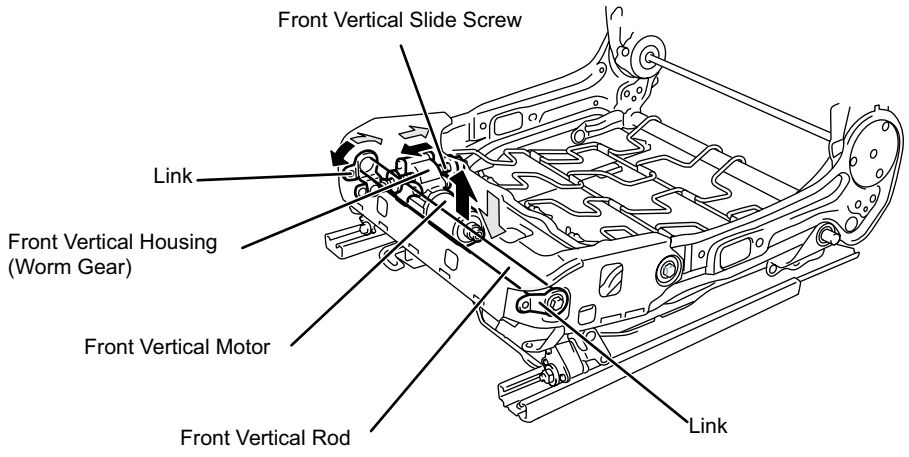
- When the user operates a power seat switch to perform a sliding adjustment, the sliding motor will rotate. This rotational movement will transfer to the seat sliding screw via the worm gear in the seat sliding housing.
- The seat sliding screw is meshed to the plastic nut. Because the plastic nut is mounted to the lower seat track rail via the nut hold bracket, the transmitted rotational movement causes the seat sliding screw to move forward or backward in relation to the lower seat track rail. This causes the upper seat track rail, to which the seat sliding screw is mounted, to slide. The sliding of the seat can be adjusted approximately 260mm forward or backward.



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Front Vertical Mechanism

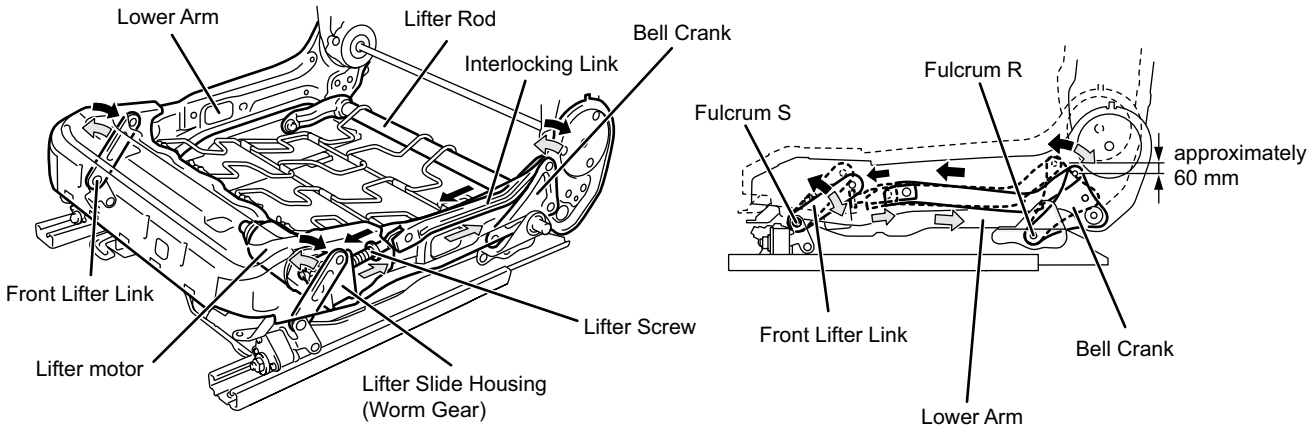
- When the user operates a power seat switch to perform a front vertical operation, the front vertical motor will rotate. This rotational movement will cause the vertical screw to move forward or backward, via the worm gear in the front vertical housing.
- A linkage is mounted to the end of the vertical screw. The forward or backward movement of the vertical screw causes the linkage to rotate and move the front end of the seat cushion up or down. In addition, the linkage transmits the movement to the inner linkage via the front vertical rod.
- The front vertical function adjusts the seat 5° up or down.



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Power Lifter Mechanism

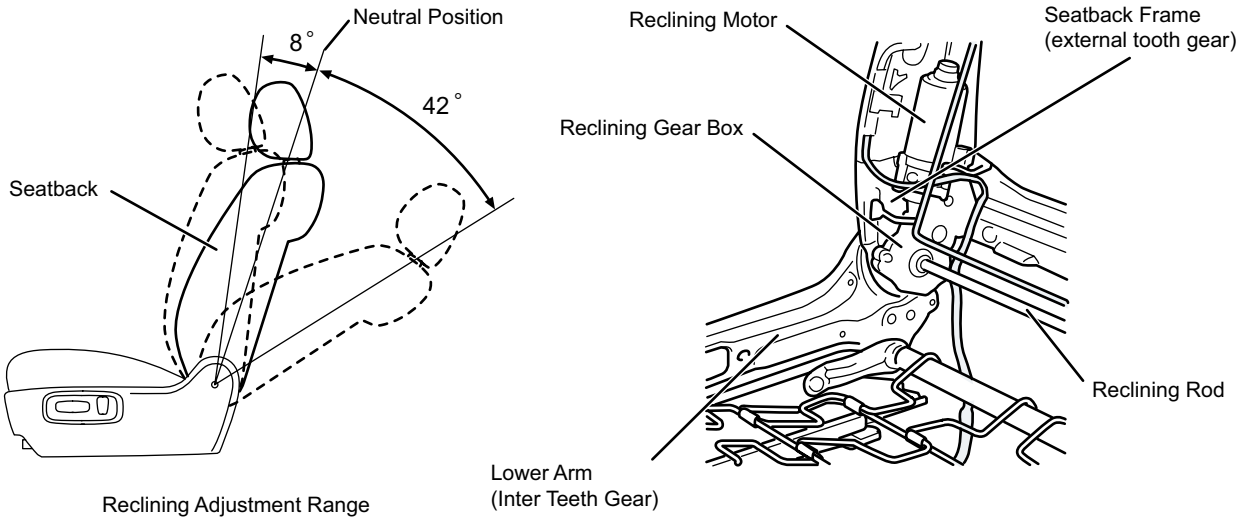
- When the user operates a power seat switch to perform a lifter adjustment, the lifter motor will rotate. This rotational movement causes the lifter screw to move forward or backward via the worm gear in the lifter housing.
- A connecting linkage is mounted to the end of the lifter screw. The connecting linkage transmits the forward or backward movement of the lifter screw to the bell crank.
- The bell crank transmits the movement of the lifter screw to the outer side via the lifter rod. At the same time, the bell crank rotates around fulcrum R as the center and lifts the rear end of the lower arm. Along with this movement, the front return linkage rotates around fulcrum S as the center and lifts the front end of the lower arm, thus lifting up the entire seat.
- The lifter adjusts the seat approximately 60mm up or down.



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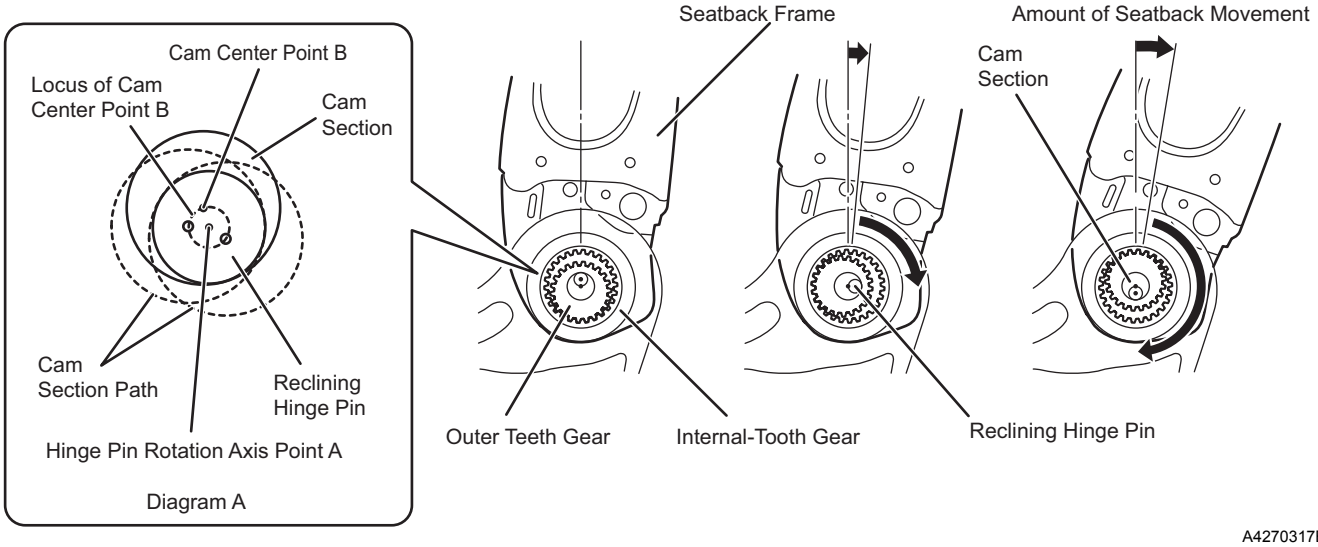
Power reclining Mechanism

- The reclining mechanism consists of the following parts: an external tooth gear provided in the seatback frame, an internal tooth gear provided in the lower arm, a reclining hinge pin that restricts the engagement of the external tooth and internal tooth gears, a reclining motor that rotates the reclining hinge pin, and a reclining rod that transmits the movement of the reclining gearbox and seatback to the inner side.
- The reclining angle of the seat can be adjusted 8° forward from the neutral position, and 42° rearward.



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- When the user operates a power seat switch to perform a reclining adjustment, the reclining motor will rotate. This rotational movement transfers to the reclining hinge pin via the reclining gearbox.
- The reclining hinge pin has a cam, whose center point B is offset from point A of the rotational axis of the hinge pin. The cam rotates as it draws a loop locus (see Fig. A) along with the rotational movement of the hinge pin.
- The reclining hinge pin cam, which is mounted in the seat cushion, has an external-tooth gear that meshes with the internal-tooth gear that is mounted in the seatback frame. Compared to the external-tooth gear on the cam, the internal-tooth gear has one additional tooth. Therefore, each time the external-tooth gear completes one turn as it draws a loop locus (see Fig. A), the position at which the external-tooth gear and the internal-tooth gear mesh changes, causing the seatback frame to move gradually.

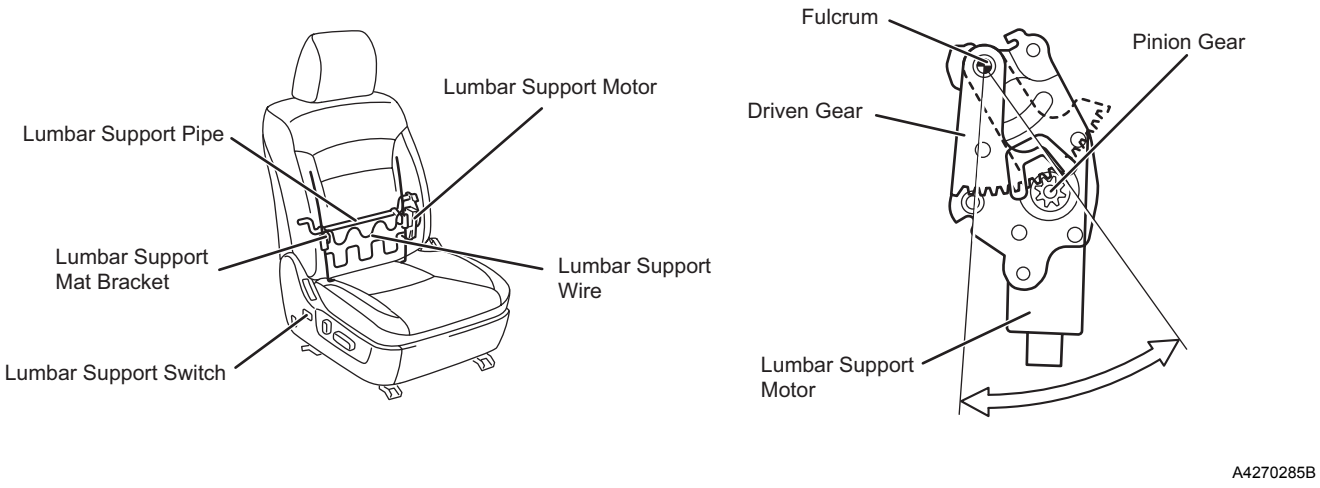


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BO

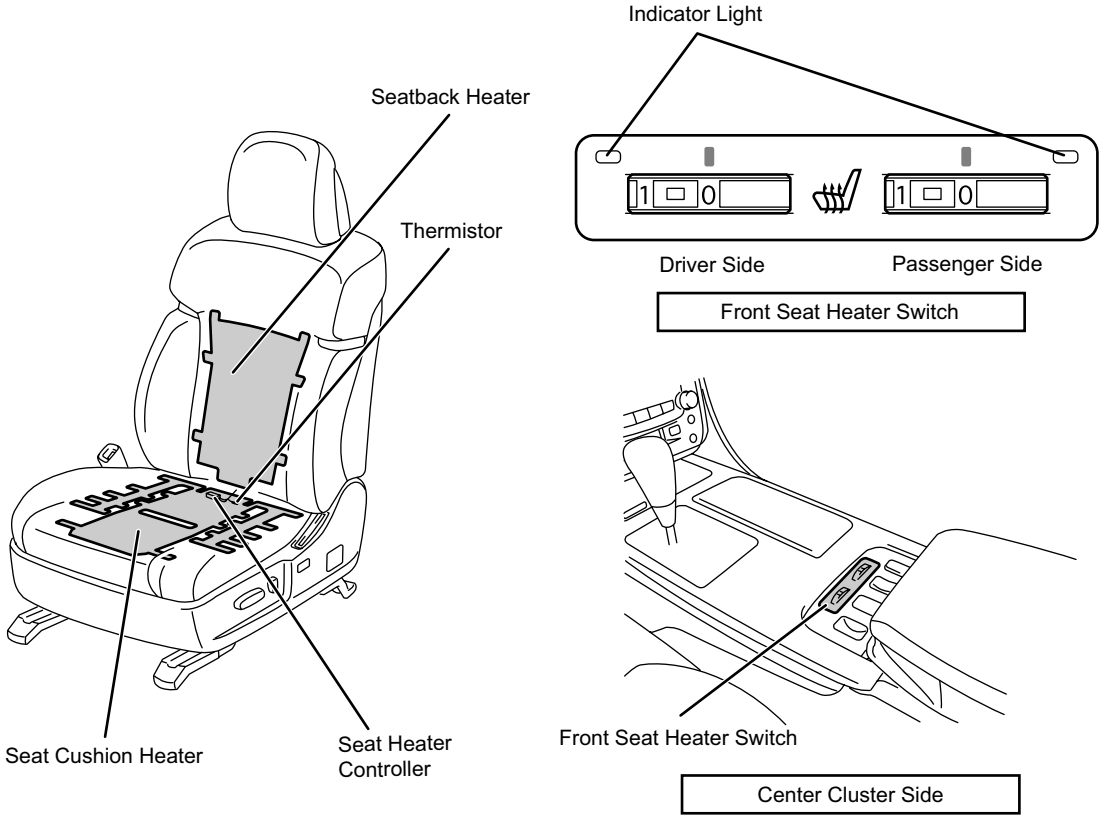
Power Lumbar Support

- By operating the lumbar support switch that is mounted on the seat cushion shield on the outer side of the seat, the user can adjust the lumbar support wire, which is built into the seatback, steplessly forward of backward.
- Both ends of the lumbar support pipe are mounted to the seatback frame. The lumbar support wire pushes out via the lumbar support mat bracket to adjust the amount of lumbar support. Together with the lumbar support wire, the lumbar support mat bracket pushes the seatback spring out in order to provide a uniform support force without the feeling of something sticking out.
- When the user operates the lumbar support switch, causing the lumbar support motor to rotate, the pinion gear rotates the lumbar support pipe via the driven gear, thus moving the lumbar support mat bracket forward or backward.



Front Seat Heater

- A front seat heater for the driver seat and front passenger seat is available for all vehicles as a manufacturer's option.
- The front seat heater comprises the seat heaters installed in the main sections of the seat back and the seat cushion and the front seat heater switch installed in the console box front section
- By turning the front seat heater switch clockwise from OFF, the seat heater can be adjusted to three levels. An indicator light is provided in front of the switch so that the operating state of the seat heater can be checked.



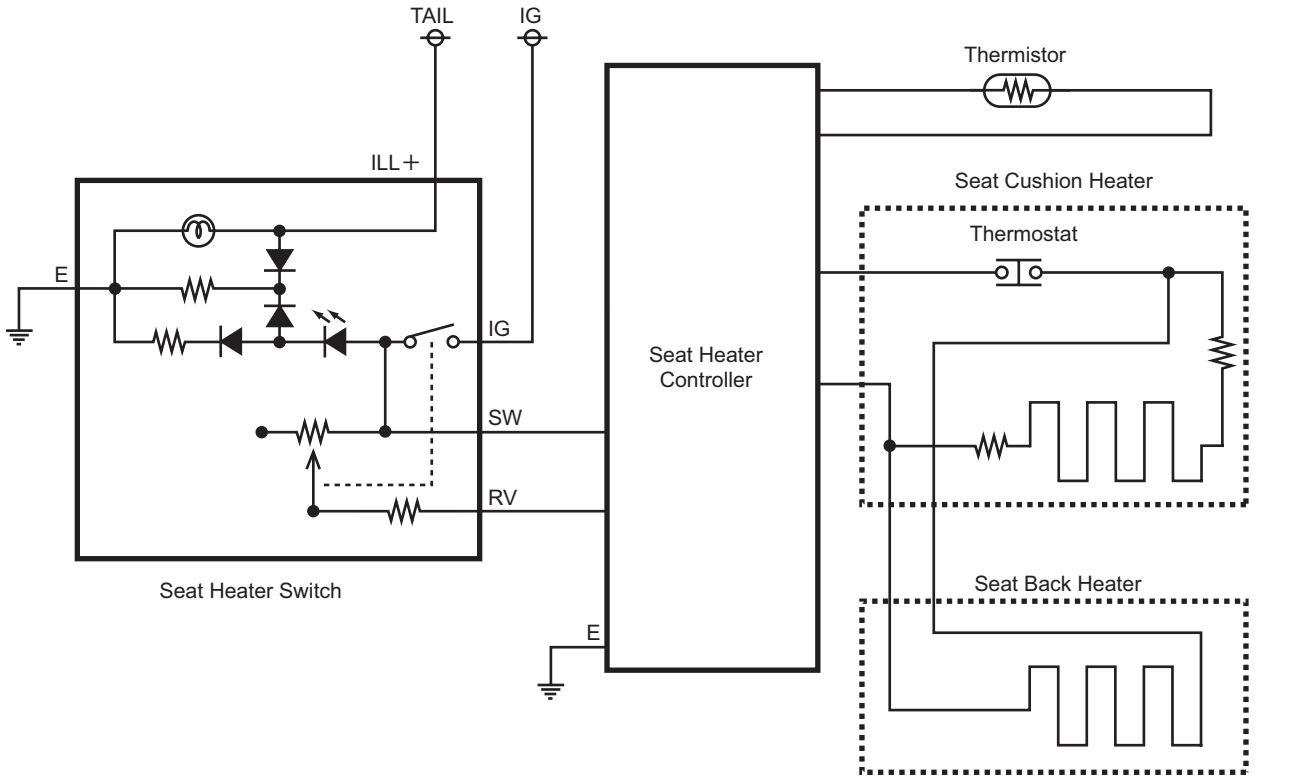
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● When the user turns the front seat heater switch ON, the seat heater controller detects the temperature that is set at the front seat heater switch. At the same time, the seat heater controller detects the temperature of the seat cover by way of the thermister*1 that is provided in the seat cushion. Then, the seat controller applies a quantity of electricity in accordance with the circumstances in order to adjust the seat cover temperature to the set temperature. When the seat cover temperature reaches approximately 50°C, the thermostat*2 in the seat cushion heater cuts off the current to the seat heaters (and restores the current when the seat cover temperature reaches approximately 30°C).

❖REFERENCE❖

*1An element that uses a semiconductor (with properties in which the resistance is high at the normal temperature and gets low as the temperature rises) in which the electrical resistance changes considerably with slight changes in temperature.

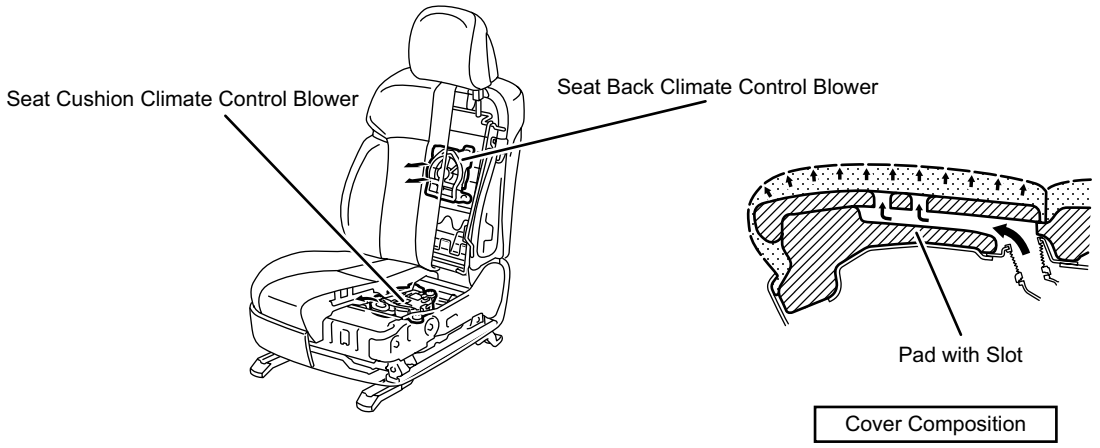
*2A temperature adjustment device that automatically controls the heat source through the use of a switch that utilizes a bimetal or the expansion of mercury.



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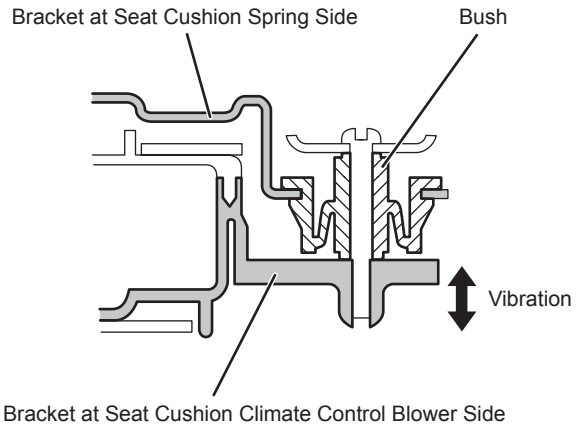
Climate Control Seat System

- The front seat with the ventilation function consists of a seat heater & ventilation volume switch, seatback climate control blower, seat cushion climate control blower, etc.
- By turning the seat heater & ventilation volume switch counterclockwise from OFF in the center position, the ventilation volume can be adjusted to three levels. The indicator light illuminates green to indicate that the ventilation function is operating.
- When the user operates the seat heater & ventilation volume switch located forward of the console box, the blower motor in the seat back/seat cushion climate control blower operates to direct the air that is drawn in from behind the climate control blower to both the seatback and seat cushion pads.
- After the air is directed to both the seatback and seat cushion pads, it travels throughout the pads along the grooves that are provided in the pads. Then, it spreads to the entire seat along the slab urethane layer, and becomes discharged through the perforations in the genuine leather seat cover.



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- A floating construction is used for installing the seat cushion climate control blower and the seat cushion spring. This construction allows the bushings to absorb the vibrations of the blower motor and the fan and suppresses their transmission to the seat cushion springs.



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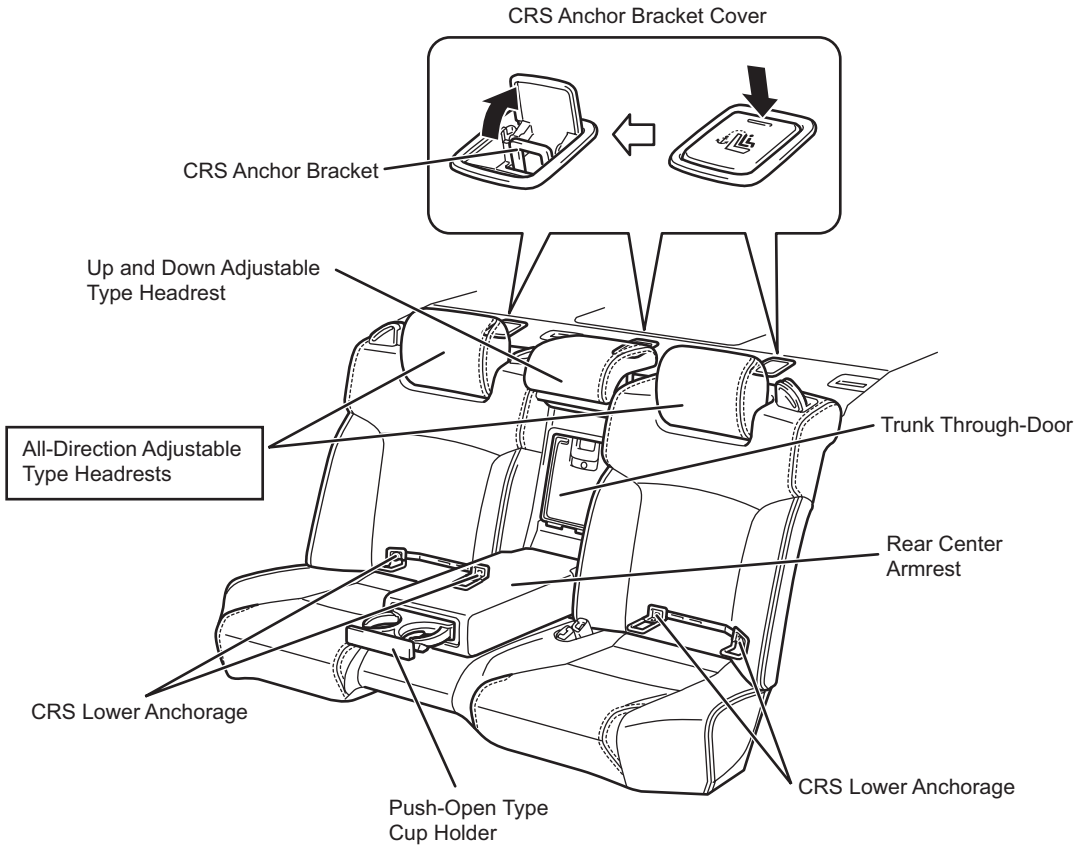
Rear Seat

- An up-down headrest is used on the center seat to ensure the rear view of the driver. A front-back, up-down adjustable headrest is provided on each of the outer seats.
- A rear center armrest, which is provided with a push-open cup holder on the seatback, is provided on the center seat. The armrest can be tilted forward to enable the use of the trunk access door, to accommodate a long object.
- A dedicated bar to secure an ISO* FIX support child seat in place, and a CRS (Child Restraint System) Anchor Bracket are provided on each outer seat. A cover is used on the CRS Anchor Bracket for good looks.

❖REFERENCE❖
*International Standard Organization

✦ CAUTION ✦

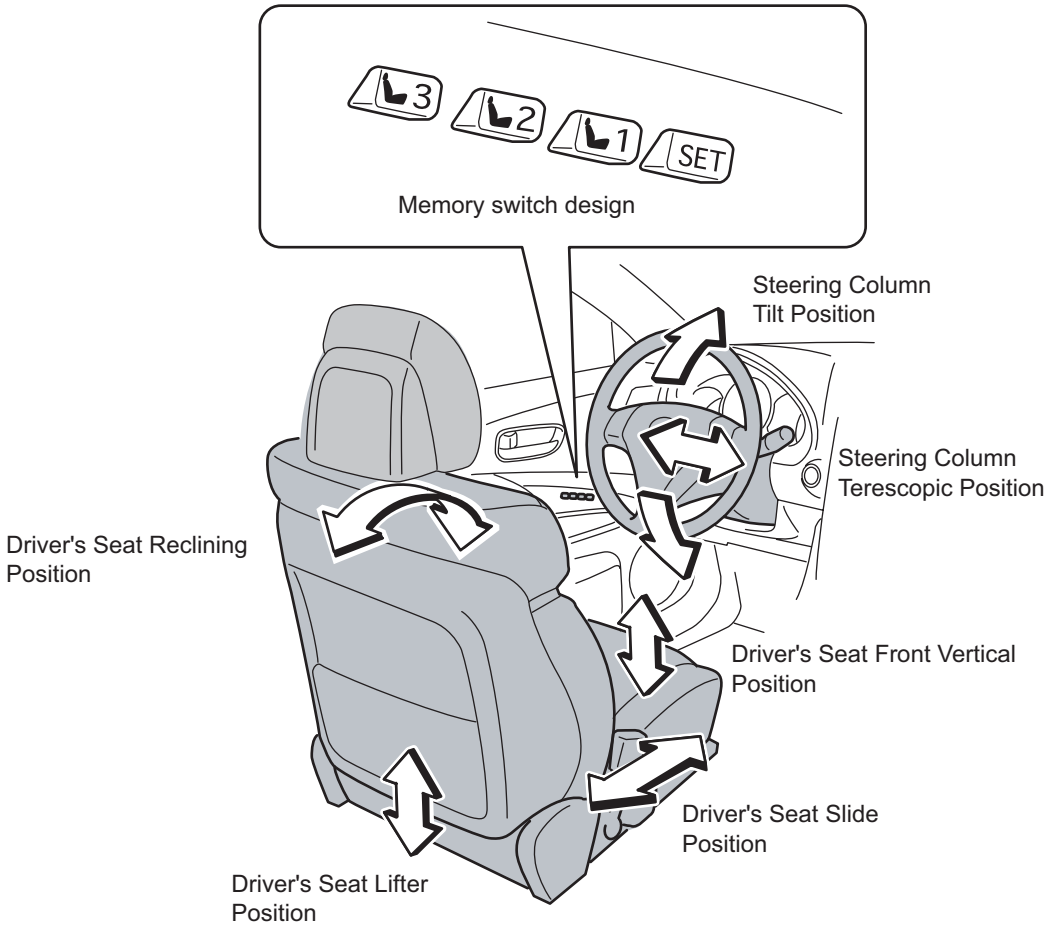
Use an ISO-FIX support child seat that complies with the safety standards for road transport vehicles by securing it to the dedicated anchor bar of this vehicle and the top tether anchor bar (only on a child seat with a top tether).



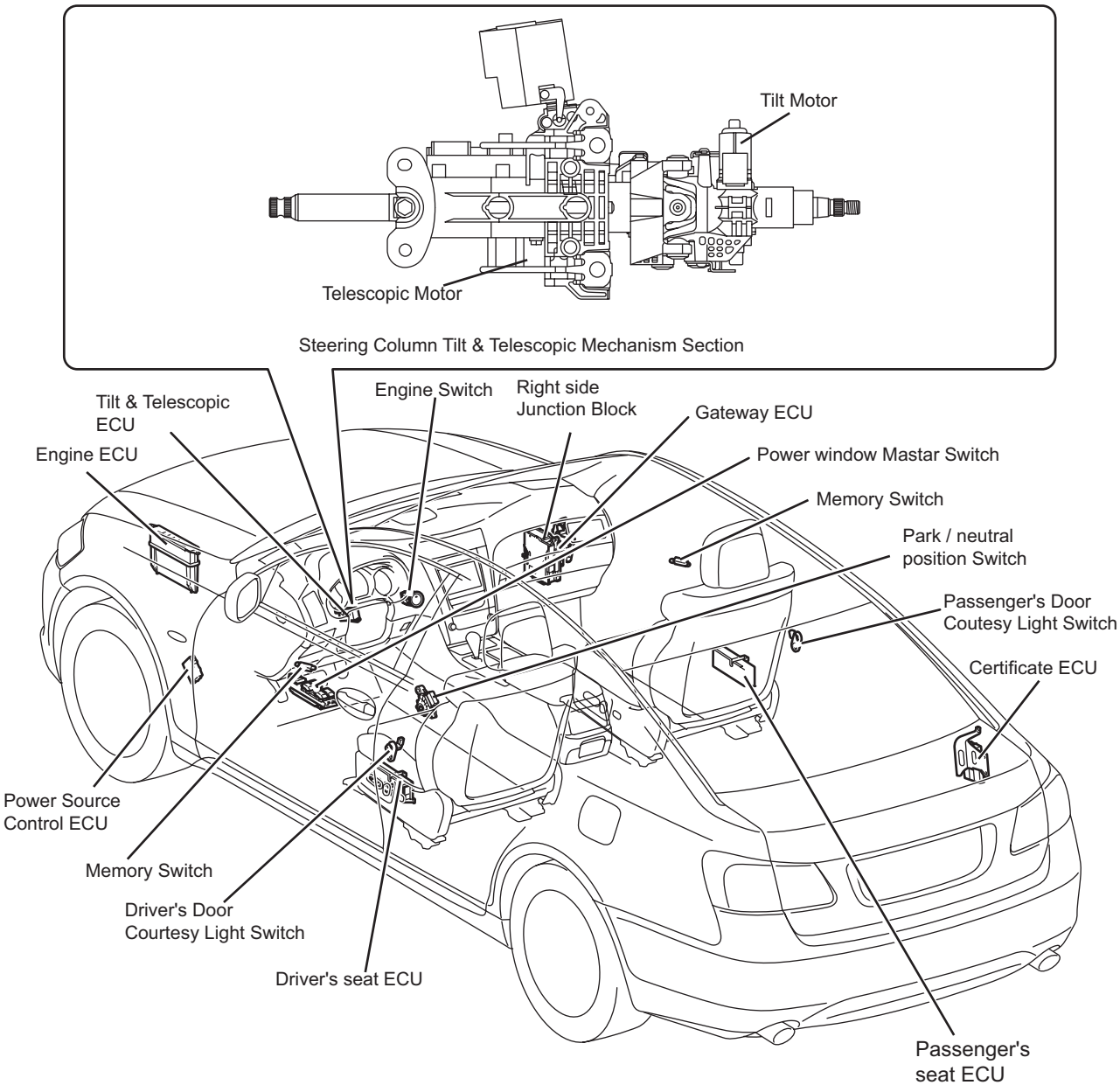
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Memory System Function

- A computer-preset driving position system, in which the driving positions (including the steering position, the driver's seat position, and the front passenger's position) for up to three persons can be memorized and retrieved at the touch of a switch, is provided on all models.
- The system memorizes the adjustment positions of the steering column, the driver's seat, and the front passenger's seat. Therefore, even if these adjustment positions change during exit or reentry, they can be retrieved from memory at the touch of the memory switch. The system can memorize the adjustment positions for up to three persons.
- A memory switch, which is used for memorizing and retrieving the driving positions, is located on the front door upper trim of the driver's door and the front passenger door.
- A memory call function, which utilizes the key IDs of the smart key or wireless door key, is used to memorize and retrieve the optimal driving positions for the people possessing the master key and the sub key.
- A "power tilt & telescopic steering column" is used as the system for adjusting the steering position.
- A "computer power seat", which is equipped with a seat ECU that is integrated in the power seat switch, is used as the system for adjusting the driver's and front passenger's seat positions.



Micro Computer Preset Driving Position System Composition



Main Components of the Computer-Preset Driving Position System

Component [Abbreviation]	Main Function
Driver's Seat Position Control Computer [Driver's Seat ECU]	• Receives various pieces of data from the power source control ECU and the engine ECU via the BEAN (Body Electronics Area Network) and the CAN (Controller Area Network), and determines the operating conditions for the computer-preset driving position system. • Receives the inputs of the current waveforms from the seat adjuster motors of the driver's seat, in order to detect the sliding, reclining, front vertical, and lifter positions of the driver's seat. • Receives the memory switch data from the power window master switch via the BEAN (Body Electronics Area Network) in order to memorize and retrieve the driver's seat position. • Sounds a built-in buzzer when a memory operation is completed or a retrieval operation is started.
Tilt & Telescopic ECU	• Receives the input of pulse signals from the tilt motor and the telescopic motor in order to detect the tilt and telescopic positions of the steering column. • Receives the input of a signal [memory or retrieval command] from the driver's seat ECU via the BEAN (Body Electronics Area Network) and memorizes or retrieves the steering position.
Neutral Start Switch	• Detects the shift position and outputs it to the engine ECU.
Engine ECU	• Receives the input of a signal from the neutral start switch and transmits the shift position data to the driver's seat ECU via the CAN (Controller Area Network) and the BEAN (Body Electronics Area Network).
Right side J/B ECU	• Receives the input of signals from the driver's door courtesy light switch, and transmits the data on whether there is a open or close data of the driver's door to the driver's seat ECU via the BEAN (Body Electronics Area Network). • Receives the input of the key ID signal and the door unlock signal, and transmits the key ID and the door lock or unlock signal to the driver's seat ECU via the BEAN (Body Electronics Area Network). • Detects the state of the power supply and transmits it to the driver's seat ECU via the BEAN (Body Electronics Area Network).
Driver's Door Courtesy Light Switch	• Detects whether the driver's door is open or closed and outputs it to the right side J/B ECU.
Memory Switch	• Outputs [SET], [1], [2], or [3] switch operating signal to the power window master switch.
power window Master Switch	• Receives the input of a signal from the memory switch, and transmits the switch operation data to the driver's seat ECU via the BEAN (Body Electronics Area Network).
Certificate ECU	• Transmits a smart memory call retrieval instruction signal to the driver's seat ECU via the BEAN (Body Electronics Area Network).
Power Source Control ECU	• Transmits the key code verification signal to the driver's seat ECU via the BEAN (Body Electronics Area Network).
Gateway ECU	• Relays the BEAN (Body Electronics Area Network) and the CAN (Controller Area Network).

Driving Position Memorize Function

- When the driver simultaneously presses*1 "SET" and [1] (or [2], or [3]) on the memory switch while the engine switch is ON and the shift position is "P"*2, the system memorizes the driving position at the time the switches are pressed (the sliding, reclining, front vertical, and lifter positions of the driver's seat; and the tilt and telescopic positions of the steering column).
- When the engine switch is ON and the shift position is in "P"*1, if memory switches "SET" and "1" (or "2" and "3") are pressed at the same time*2, the driving position at the moment the switch was pressed is memorized by the system (slide, reclining, front vertical and lifter position of the driver seat).

❖REFERENCE❖

*1 : The memory operation will be invalidated if multiple buttons [1], [2], and [3] on the memory switch are pressed simultaneously. In this case, first release the switch, and then perform the operation again.

*2 : The system will not memorize the driver's seat position while the driver is operating the driver's power seat switch (excluding the lumbar support switch). The memory operation will be invalidated during the retrieval operation of the driving position. In these cases, perform an operation after the power seat switch operation has ended or the retrieval operation has ended.

Driving Position playback Function

- When the driver presses [1] (or [2], or [3]) on the memory switch while the engine switch is ON and the shift position is "P", the system retrieves the driver's seat position and the steering position from memory in the following sequence.

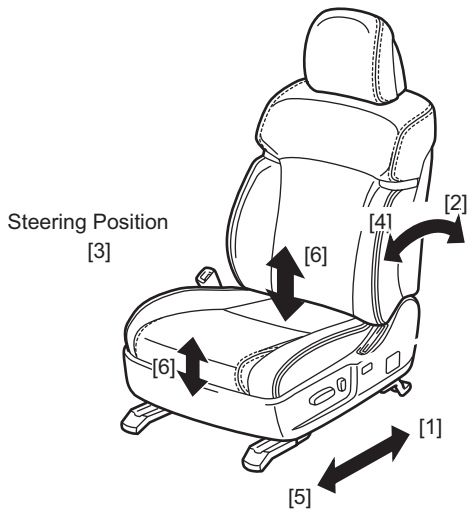
Driving position playback operation preparation

No.	Playback operation part
[1]	Drives seat slide (rear)adjustment*1
[2]	Driver seat reclining(rear)adjustment*1
[3]	Steering position adjustment
[4]	Driver seat reclining(forward)adjustment*2
[5]	Driver seat slide (forward)adjustment*2
[6]	Driver seat front vertical / lifter adjustment

❖REFERENCE❖

*1Only if the retrieval position of the driver's seat is backward of the position before the retrieval. (Retrieval sequence example - [1] Backward slide -> [2] Backward reclining -> [3] Steering position -> [6] Front vertical/lifter)

*2Only if the retrieval position of the driver's seat is forward of the position before the retrieval. (Retrieval sequence example - [3] Steering position -> [4] Forward reclining -> [5] Forward sliding -> [6] Front vertical/lifter)



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Driving Position Key Off Playback Function

- Even when the engine switch is not ON, the driver can press memory switch [1] (or [2], or [3]) within approximately 30 seconds from the time the driver's door has been opened. This will allow the driver's seat to retrieve the driving position in the same sequence as the normal driving position retrieval function. In this case, the system will not retrieve the steering position unless the driver presses the engine switch before the driver's seat position retrieval is completed.
- When the driver presses the engine switch ON during the key-OFF retrieval operation of the driver's seat position, the system will start retrieving the steering position at the time the retrieval operation of the reclining adjustment or sliding adjustment is completed. When the driver presses the engine switch ON during a front vertical or lifter retrieval operation, the system will simultaneously retrieve the steering position.

When Driving Position playback is Stopped

- If the driver moves the shift lever to a position other than "P" during a driving position retrieval operation, or if the driver presses any one of the memory switches [SET], [1], [2], or [3], the system will stop the driving position retrieval operation at that time.
- If the driver operates the driver's power seat switch (excluding the lumbar support switch) during a driving position retrieval operation, the system will stop the driver's seat position retrieval operation.

Memory Call Registration Function

- When the driver presses the key lock or unlock button while pressing memory switch [1] (or [2], or [3]) with the engine switch pressed OFF and the driver's door closed (driver's door courtesy light switch OFF), the system will assign the ID of the key, which is used for this operation, to the corresponding memory switch.

Memory Call Registration Cancel Function

- When the driver presses the key lock or unlock button while pressing memory switch [SET] with the engine switch pressed OFF and the driver's door closed (driver's door courtesy light switch OFF), the system will cancel the ID of the key, which is used for this operation, in the memory call registration.

Memory Call playback Function

- When the driver opens the driver's door by unlocking it with the door unlock function (or the unlock button of the key), the system will retrieve the driver's seat position, which corresponds to the memory switch [1] (or [2], or [3]) that is assigned to the respective key, in the same sequence as the normal driving position retrieval function. In this case, the system will not retrieve the steering position unless the driver presses the engine switch before the driver's seat position retrieval is completed.
- When the driver presses the engine switch ON during the memory call retrieval operation of the driver's seat position, the system will start retrieving the steering position at the time the retrieval operation of the reclining adjustment or sliding adjustment is completed. When the driver presses the engine switch ON during a front vertical or lifter retrieval operation, the system will simultaneously retrieve the steering position.

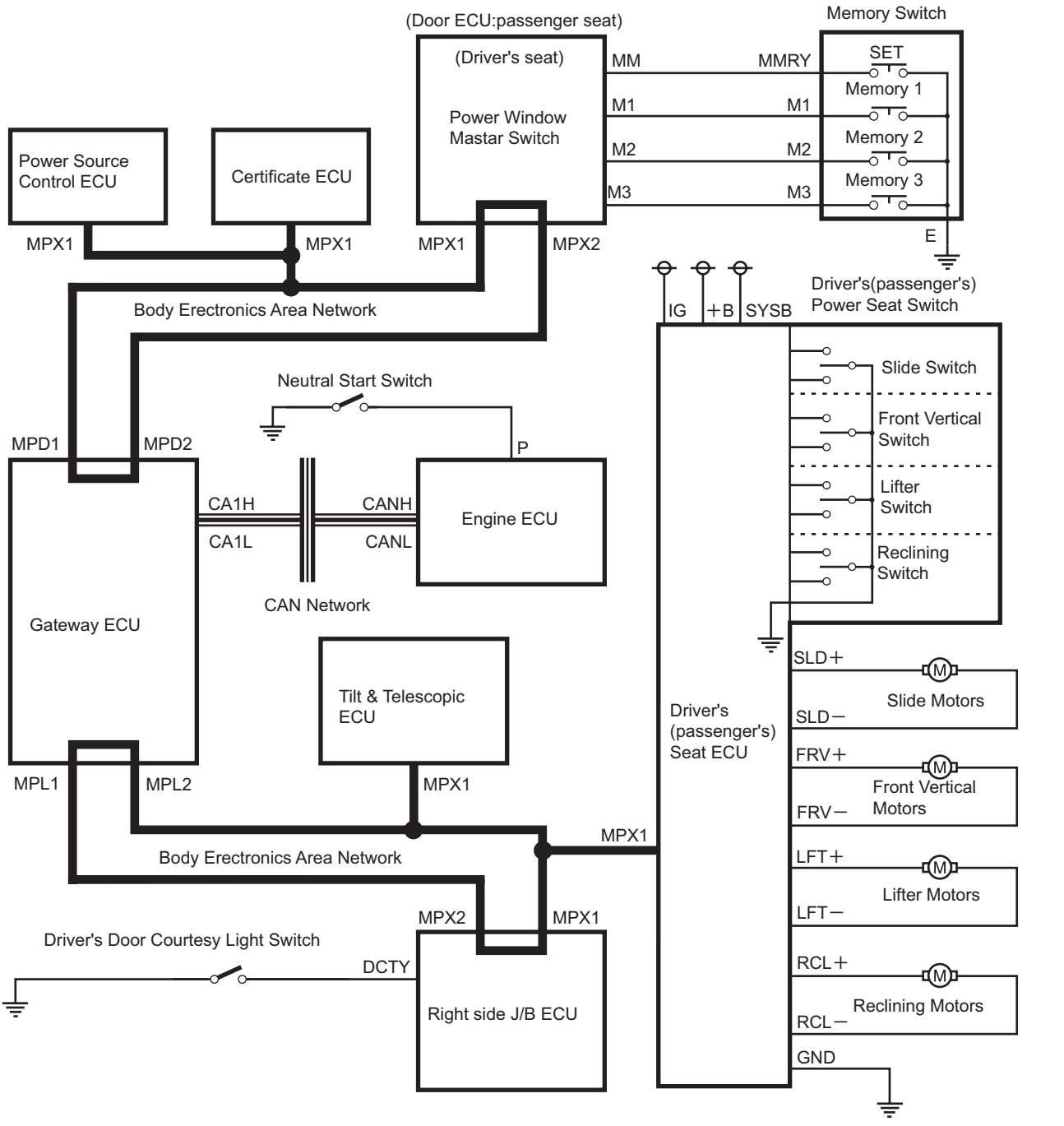
Table of Memory Call Functions

Function	Condition on Vehicle	User Operation or Vehicle Operation
Memory Call Registration	Engine switch OFF, driver's door closed	• Press the lock or unlock button on the key while pressing memory switch [1] (or [2], or [3]). • Buzzer sounds approximately 0.5 seconds (upon completion of registration).
Memory Call Registration Cancellation	Engine switch OFF, driver's door closed	• Press the lock or unlock button on the key while pressing memory switch [SET]. • Buzzer sounds twice at an approximate 0.1-second interval (upon completion of registration cancellation).
Memory Call Retrieval	Engine switch OFF, ACC OFF, key ID signal OFF, driver's door closed	• Use a key registered in the memory call function to unlock the door. • Opens the driver's door. • Press the engine switch ON.* • Buzzer sounds approximately 0.1 second (upon starting of retrieval).

❖REFERENCE❖

*When the driver presses the engine switch ON during the retrieval of the driver's seat position, the electronic key will start the retrieval of the steering position.

Memory System Control



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Driving Position Memorize Operation Conditions

- The transfer of the system to the memory operation mode requires that the driver's seat ECU meets all the conditions listed in the table below, based on the inputs received from the BEAN (Body Electronics Area Network) (or the CAN (Controller Area Network)) and the power seat switch operation signal.

Driving Position Memory Operation Condition

- "Engine switch ON" signal is received from the right side J/B ECU.
- "Retrieval stop signal" is received from the tilt & telescopic ECU.
- "Shift position P" signal is received from the engine ECU.
- There is no input of power seat switch operation signal and the seat adjuster motors are stopped.

Driving Position Memorize Operation

- Upon receiving the input of the current waveforms from the sliding motor, front vertical motor, lifter motor, and reclining motor, the driver's seat ECU performs an internal process to detect the driver's seat position. The tilt & telescopic ECU detects the steering position based on the pulse signals from the tilt motor and the telescopic motor.
- After the memory operation conditions have been met, the driver's seat ECU memorizes the driver's seat position at the time the memory switch [SET] signal and the [1] (or [2] or [3]) signal are received from the power window master switch via the BEAN (Body Electronics Area Network).
- The driver's seat ECU memorizes the driver's seat position while simultaneously transmitting a "memory command" signal to the tilt & telescopic ECU via the BEAN (Body Electronics Area Network). The tilt & telescopic ECU memorizes the steering position at the time it receives this signal.
- The buzzer sounds approximately 0.5 seconds upon the completion of the memorization of the driving position.

Driving Position playback Operation Conditions

- The transfer of the system to the retrieval operation mode requires that the driver's seat ECU meets all the conditions listed in the table below, based on the inputs of the vehicle condition signals received from the BEAN (Body Electronics Area Network) or the CAN (Controller Area Network) and the state of the position data in memory.

Driving Position Retrieval Operation Conditions

- "Engine switch ON" signal is received from the right side J/B ECU.
- "Memory switch OFF" signal is received from the power window master switch.
- "Shift position P" signal is received from the engine ECU.
- Driving position data is stored in memory.

Driving Position Key Off playback Operation Conditions

- The transfer of the system to the key-OFF retrieval mode requires that the driver's seat ECU meets all the conditions listed in the table below, based on the inputs of the vehicle condition signals received from the BEAN (Body Electronics Area Network) and the state of the position data in memory.

Key-OFF Retrieval Operation Conditions

- "Engine switch OFF" signal is received from the right side J/B ECU.
- Within approximately 30 seconds upon receiving a "driver's door courtesy light switch ON" signal from the right side J/B ECU.
- "Memory switch OFF" signal is received from the power window master switch.
- Driving position data is stored in memory.

Driving Position playback Operation

- After the retrieval operation conditions or the key-OFF retrieval operation conditions have been met, if the driver's seat ECU receives the memory switch [1] (or [2], or [3]) signal from the power window master switch via the BEAN (Body Electronics Area Network), the system actuates the buzzer for approximately 0.1 second. Then, the system actuates the seat adjuster motors using a programmed, predetermined retrieval operation sequence until the seat position that is currently being recognized matches the memorized driver's seat position.
- When the system reaches the retrieval operation sequence for the steering position, the driver's seat ECU transmits a "retrieval starting command signal" to the tilt & telescopic ECU. Upon verifying the completion of the steering position retrieval operation through communication with the tilt & telescopic ECU, the seat position ECU starts the actuation of the seat adjuster motors, which corresponds to the next retrieval sequence.

Driving Position playback Operation Stopped Conditions

- During a retrieval operation, if the driver's seat ECU detects any one of the conditions listed below based on the inputs of the vehicle condition signals received from the BEAN (Body Electronics Area Network) and the power seat switch signal, the ECU will stop the retrieval operation.

Retrieval Operation Stopping Conditions

- A shift position signal other than "P" is received from the engine ECU.
- Any one of the memory switch signals, [SET], [1], [2], or [3] is received from the power window master switch.

Processing of System Failured

- During a seat position retrieval operation, if the driver's seat ECU detects a failure in a seat adjuster motor, the ECU will stop the retrieval operation of the corresponding seat adjuster at that time, and transfers to the retrieval operation that corresponds to the next retrieval operation sequence.
- If the communication between the driver's seat ECU and the tilt & telescopic ECU via the BEAN (Body Electronics Area Network) is disrupted, the system will transfer to the retrieval operation that corresponds to the next retrieval operation sequence, instead of performing steering position retrieval control.

Memory Call Operation Conditions

- The transfer of the system to the memory call operation mode requires that the driver's seat ECU meets all the conditions listed in the table below, based on the inputs of the vehicle condition signals received from the BEAN (Body Electronics Area Network).

Memory Call Operation Conditions

- "Engine switch OFF" signal is received from the right side J/B ECU.
- "Driver's door courtesy light switch OFF" signal is received from the right side J/B ECU.
- "ACC OFF" signal* is received from the right side J/B ECU.
- "Key code check OFF" signal* is received from the power source control ECU.
- A memory call registration* that corresponds to memory switch [1] (or [2] or [3]) is present.

❖REFERENCE❖

*For memory call retrieval operation only

Memory Call Registration Operation

- After the memory call operation conditions have been met, when the driver presses the lock or unlock button on the key while keeping the [1] (or [2] or [3]) button on the memory switch pressed, the driver's seat ECU will receive a key ID signal and a key command (lock or unlock) signal from the right side J/B ECU, while continuing to receive the memory switch [1] (or [2] or [3]) signal from the power window master switch via the BEAN (Body Electronics Area Network).
- Upon receiving the foregoing signals, the driver's seat ECU assigns the key ID to the memory switch [1] (or [2] or [3]) to complete the memory call registration.
- The buzzer sounds approximately 0.5 seconds upon the completion of the memory call registration.

Memory Call Registration Cancel Operation

- After the memory call operation conditions have been met, when the driver presses the lock or unlock button on the key while keeping the [SET] button on the memory switch pressed, the driver's seat ECU will receive a key ID signal and a key command (lock or unlock) signal from the right side J/B ECU, while continuing to receive the memory switch [SET] signal from the power window master switch via the BEAN (Body Electronics Area Network).
- Upon receiving the foregoing signals, the driver's seat ECU cancels the memory call registration of the key that was used in the operation.
- The buzzer sounds twice at an approximate 0.1-second interval upon the completion of the memory call registration cancellation.

Memory Call playback Operation

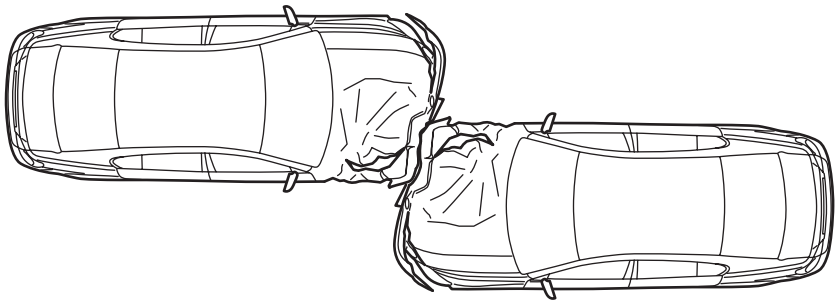
- After the memory call operation conditions have been met, when the driver unlocks the door through the use of the door unlock function (or the unlock button on the key), the driver's seat ECU will receive a key ID signal and a door unlock signal from the right side J/B ECU via the BEAN (Body Electronics Area Network).
- When the driver opens the driver's door during the foregoing conditions, the driver's seat ECU will receive a memory call retrieval instruction signal from the certificate ECU (or a driver's door courtesy light switch ON signal from the right side J/B ECU) via the BEAN (Body Electronics Area Network), in order to start the memory call retrieval operation.
- The buzzer sounds approximately 0.1 second upon the starting of the memory call retrieval.

BODY STRUCTURE

Body Structure Outline

- A crash safety body is used to ensure the world's top-level occupant protection performance in its class, as well as Toyota's own stringent targets. Moreover, this vehicle pursues safety from various aspects, such as through the use of the "head impact protection structure" or the "Brake Pedal Construction for Colision".
- An "omni-directional compatibility body structure", an evolved form of the crash safety body structure that aims at the preservation of both vehicles during a collision between vehicles of different weight classes, is used. In terms of ensuring the survival space for the occupants, this vehicle aims at the world's top level of crash safety performance in its class.

Comparison of vehicles with the same cylinder displacement in the class.



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

Note: The illustration has been created based on the vehicles used in a collision test. In an actual accident, the conditions of the vehicle may differ from those in the illustration, depending on the speed and the area of the vehicles where the collision occurred. Also, the appearance of the vehicles depicts representative vehicles.

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- Based on a monocoque structure, the allocation of the various parts and materials and their joining structure have been optimized. High-tensile sheet steel is positively used, comprising 45% of the entire body frame. Thus, a lightweight and highly rigid body with a minimal amount of vibration and noise has been achieved.
- To ensure a high level of rustproofing performance, the body uses rustproof sheet steel extensively, and the wheel housings and the front floor area (which are exposed to water and gravel) have been provided with a lightweight, chip-resistant undercoating.
- Sound-absorbing materials have been used throughout the body to ensure its quietness.
- To reduce wind noise, the shape of the various areas of the upper body has been optimized in accordance with the movement of air that flows from the front to the rear of the vehicle. Furthermore, items that guide airflow such as an engine under cover and spats have been provided under the floor in order to achieve superior aerodynamics.

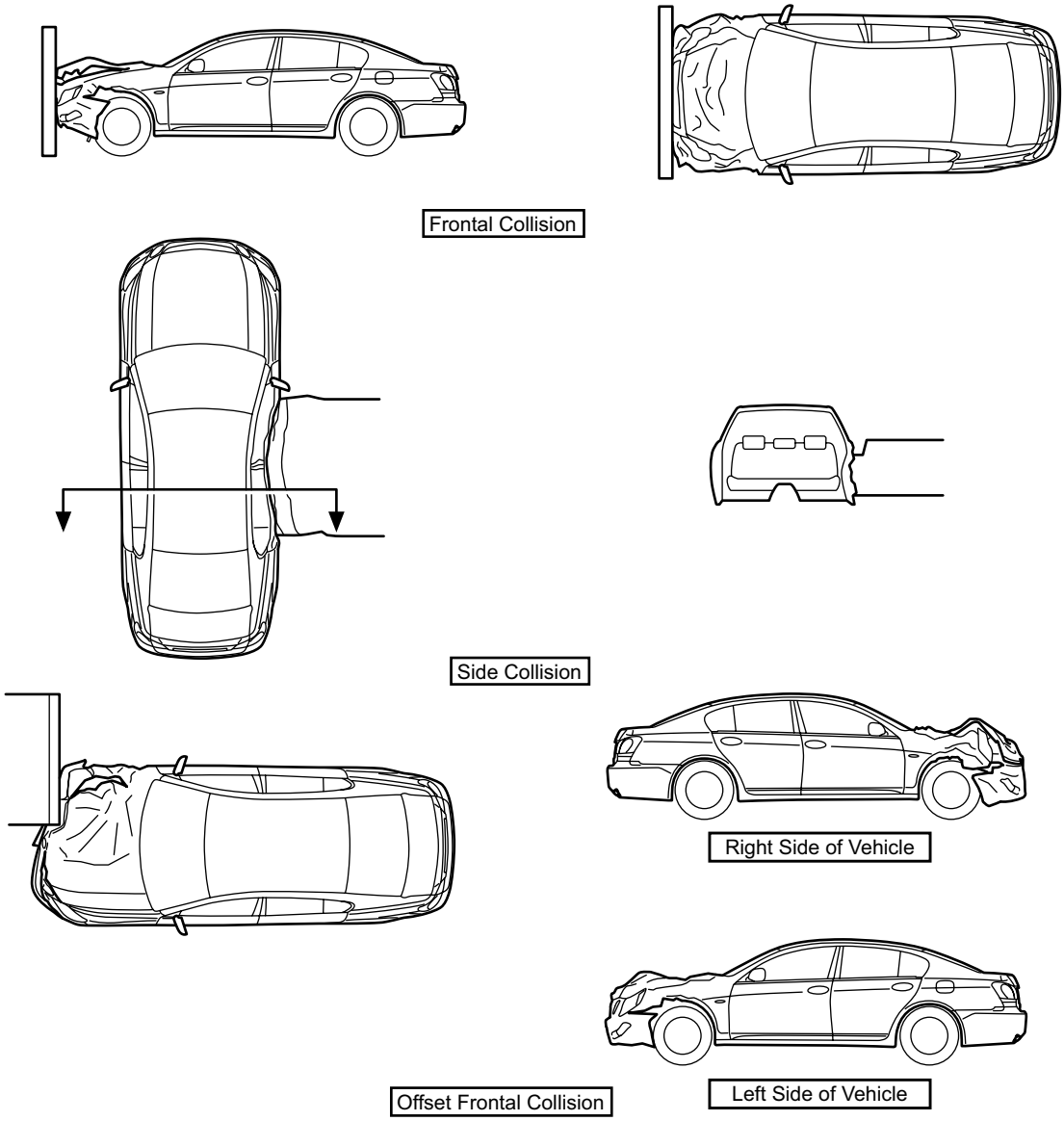
Safety Features

- A crash safety body, which minimizes the deformation of the cabin by effectively absorbing and dissipating the energy of a collision through the use of crushable front and rear body sections and highly rigid cabin parts, is used.
- It has an omni-directional compatibility body structure that gives the vehicle the world's top-level collision safety performance in its class* for preserving the cabin space during a frontal, side, or rear collision.

❖REFERENCE❖

*Comparison of vehicles with the same cylinder displacement in the class.

- A rational body structure has been achieved through the use of computer-generated collision simulations and numerous on-vehicle tests. It effectively absorbs and dissipates the energy of the impact not only during a frontal or side collision, but during an offset frontal collision (in which an impact is applied only to one end of the vehicle) as well.

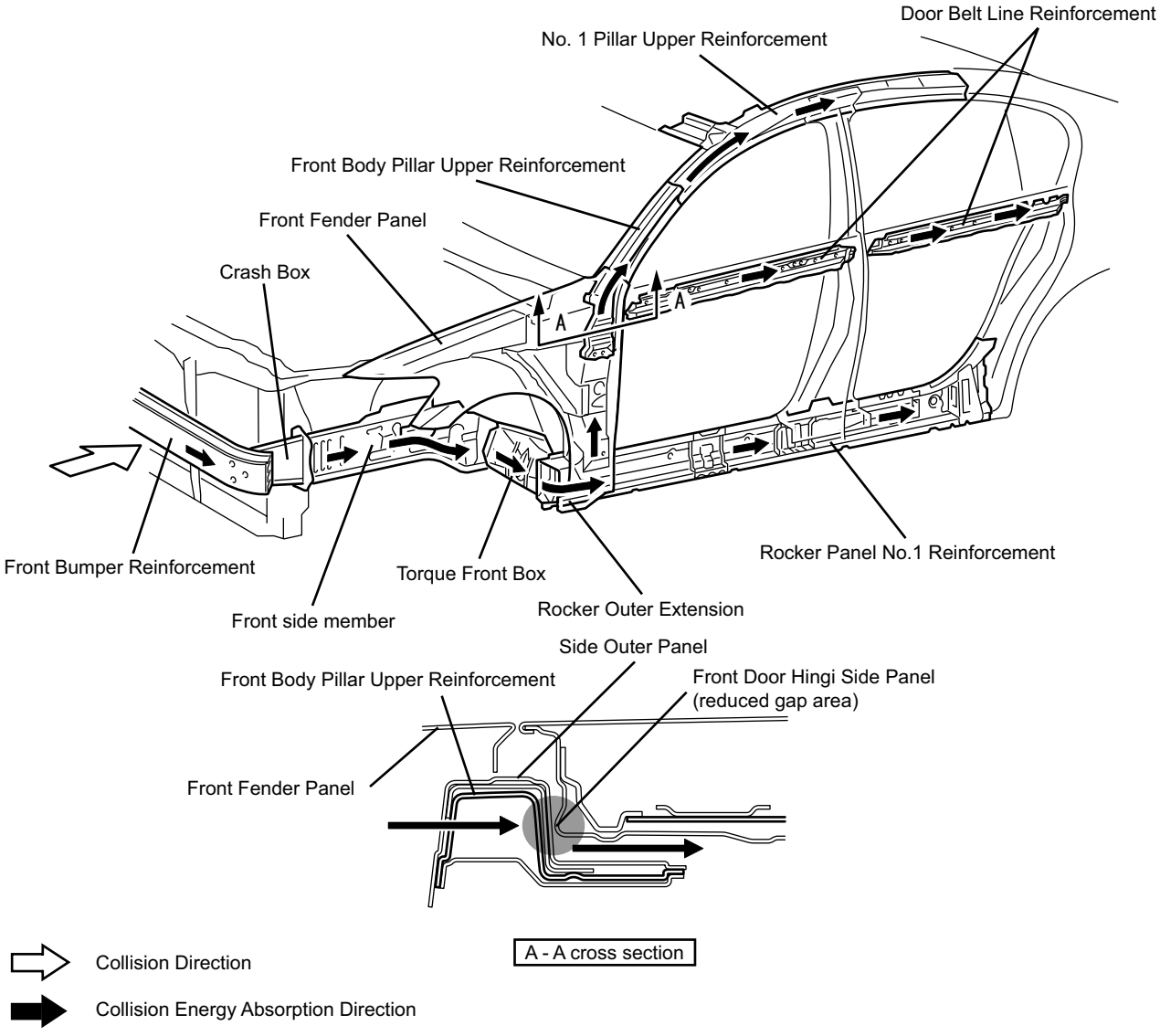


Note: The illustration above is based on a collision test between two vehicles.
A real accident will be different from the illustration in terms of speed and collision location.
Typical vehicle examples have been used.

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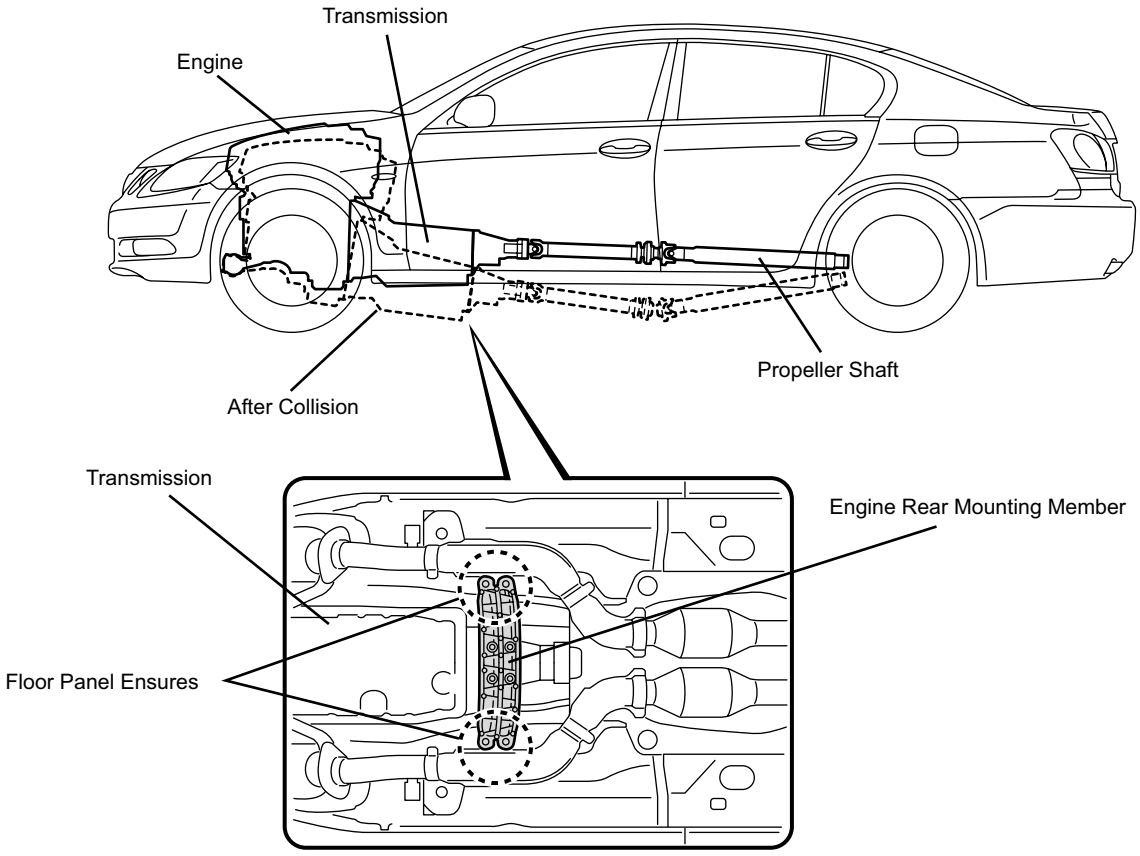
Impact Absorbing Structure for Front Collision

- This structure effectively dissipates the energy of a frontal collision to the right and left front side members by way of large front bumper reinforcements. Furthermore, crush boxes have been designed with repairability in mind, and front side members with a hexagon-shaped cross section provide high yield strength. Thus, an efficient energy absorbing structure has been achieved.
- With respect to the energy of an offset frontal collision, the load that is applied to the front pillar is effectively dissipated by enhancing the energy transmission to the door belt line area. This has been accomplished by reducing the gap between the front door hinge side panel and the side outer panel (see A-A cross section).
- A rocker outer extension is provided at the front end of the rocker, and the rocker has been extended forward, in order to absorb the impact of a collision that is transmitted from the wheel during an offset frontal collision. This feature minimizes the deformation of the body around the cabin.



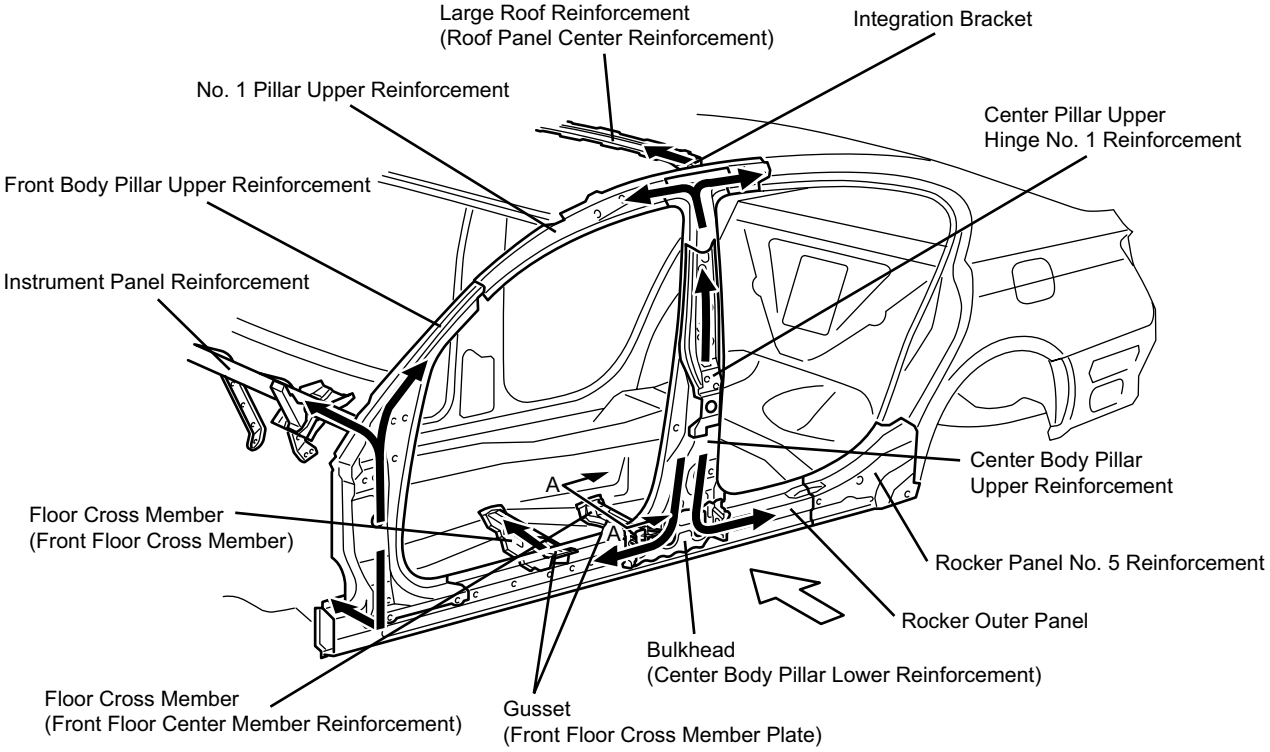
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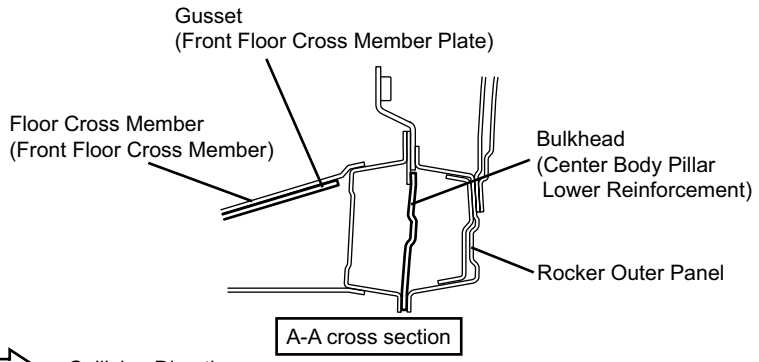
• The portion in which the engine rear mounting member is mounted to the floor panel has been revised. When the load from the engine and the transmission is applied to this area during a frontal collision, this portion separates. By suppressing the intrusion of the dash panel into the cabin in this manner, this structure helps to reduce the injury sustained by the occupants.



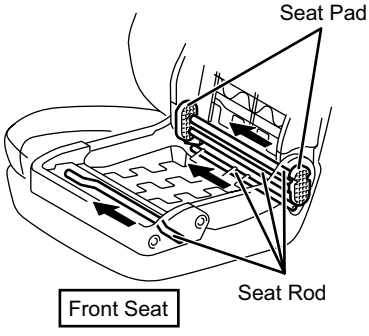
Impact Absorbing Structure for Side Collision

- A center body pillar upper reinforcement, which is shaped with different thicknesses by joining materials with different thicknesses, is provided at the center pillar. In addition, the strength distribution of the center pillar has been optimized. Furthermore, the center pillar upper hinge No. 1 reinforcement is provided inside the center pillar to ensure its rigidity. As a result, a structure that minimizes cabin deformation has been achieved.
- Various materials are used effectively in order to transmit the energy of the collision (which has dissipated from the center pillar to the rocker during a side collision) to the floor tunnel via pads and rods provided in the seats, thus reducing the extent of body deformation. A bracket is provided to join the roof side rail and the large roof reinforcement in order to effectively transmit the energy of the collision that has dissipated above the center pillar, thus suppressing the intrusion of the roof side rail into the cabin.
- The rocker consists of a rocker outer panel made of high tensile strength sheet steel and a bulkhead that is provided in the cross section in order to effectively dissipate the energy of the collision, which is input from the bottom of the center pillar, to the floor.
- The portion of the floor cross member that is joined to the rocker has been raised (see A-A cross section) in order to strengthen the joint between the floor and the rocker. In addition, gussets made of high tensile strength sheet steel are provided to ensure the proper strength.





A-A cross section



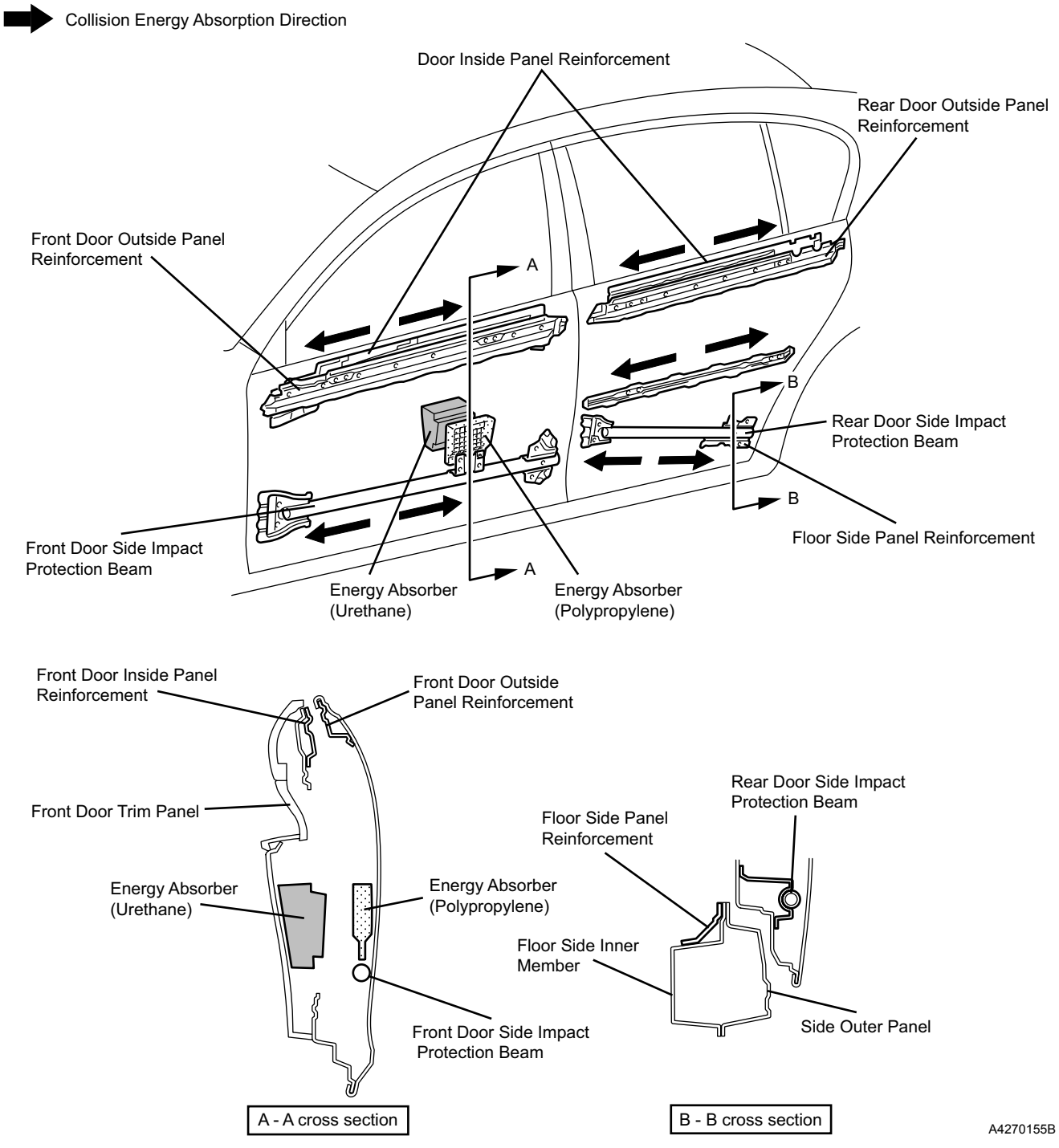
Front Seat

Collision Direction

Collision Energy Absorption Direction

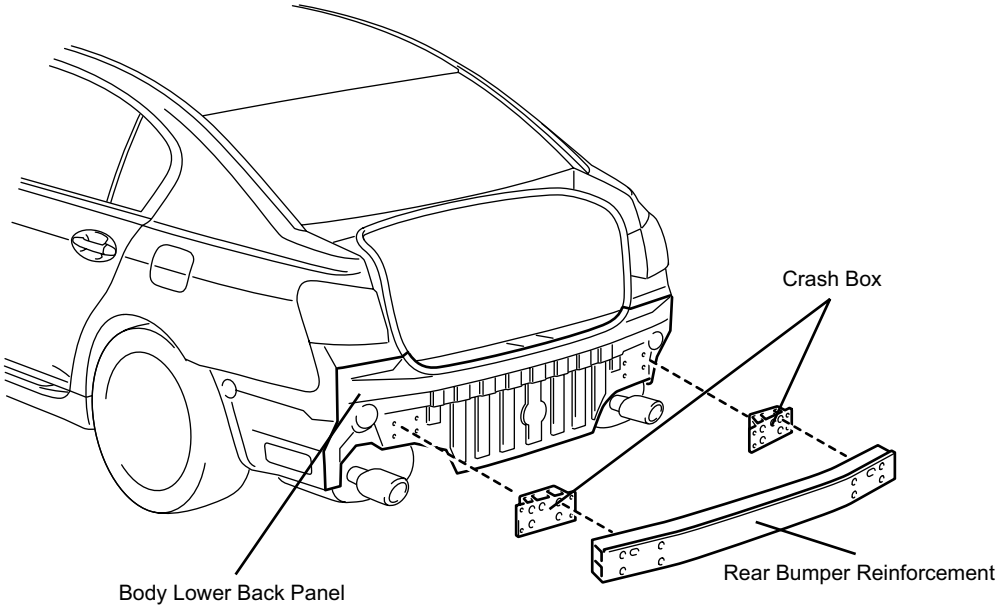
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- In the door panel, the side impact protection beam has been located to overlap at the bottom with the pillars in order to effectively absorb and dissipate the energy of a collision. Furthermore, the reinforcements at the belt line and inside the door panel have been located optimally in order to ensure the proper door strength.
- Energy absorbers are provided inside the front doors in order to dampen the impact that is applied to the occupants during a collision (see A-A cross section).
- A floor side panel reinforcement, which overlaps with the rear door side impact protection beam, is provided at the rear end of the rocker facing the cabin, in order to ensure the proper strength and reduce the extent of body deformation during a collision (see B-B cross section).



Impact Absorbing Structure for Rear Collision

• On all models, an aluminum rear bumper reinforcement is provided inside the rear bumper for weight reduction. In addition, crush boxes are provided between the rear bumper and the body lower back panel in order to absorb the impact of a minor collision.

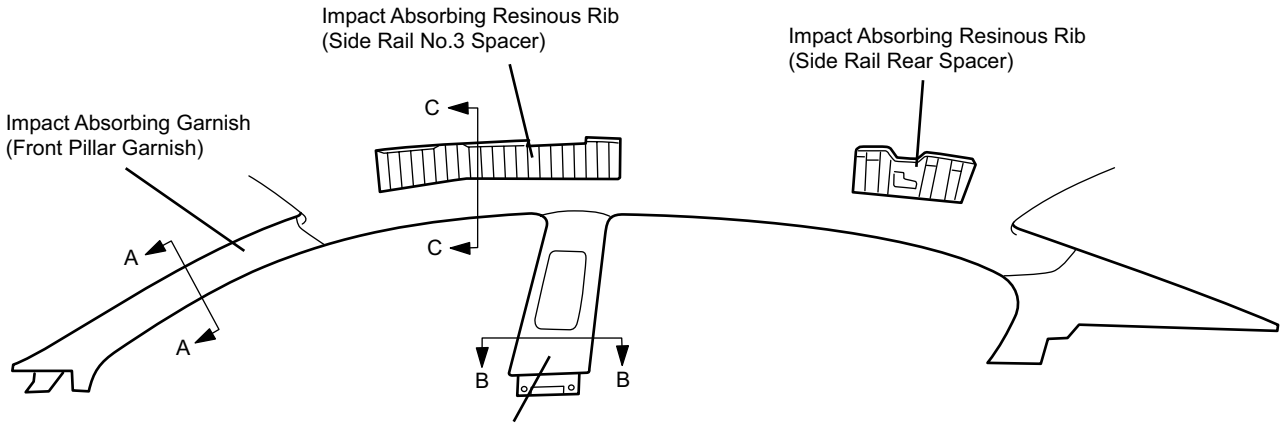


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Head Impact Protection Structure

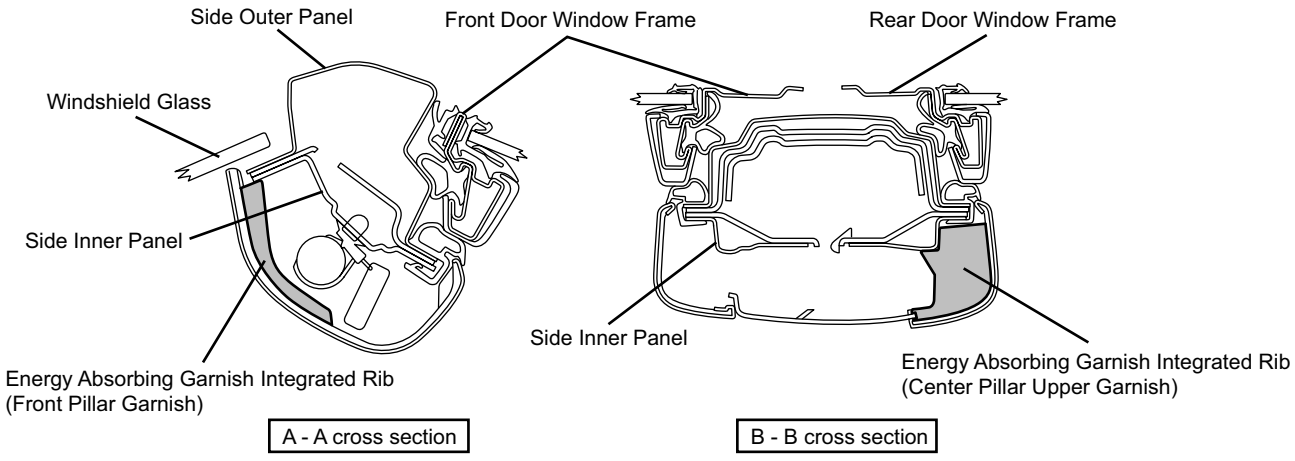
- A "head impact protection structure" is provided to dampen the impact applied to the head of an occupant in the event the occupant's head collides with a pillar or the roof side, as a reaction during a vehicle collision.
- The impact-absorbing garnishes integrated with ribs, and the impact-absorbing hard urethane pads provided inside the roof headlining collapse to dampen the impact that is applied to the occupant's head.

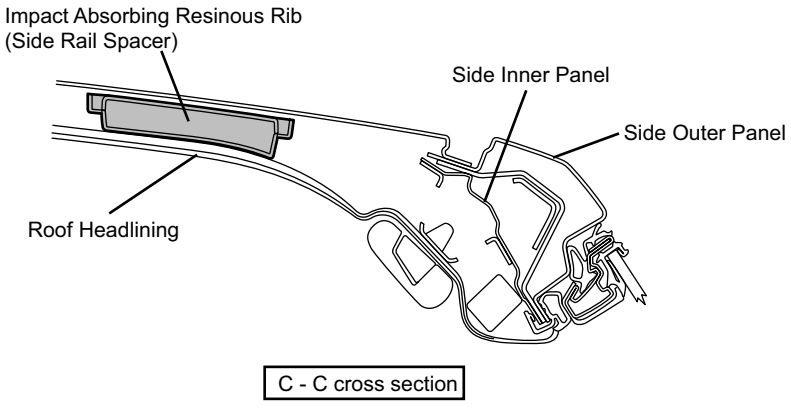
Shock absorbing section material position



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Energy Absorption Material Allocation (cross-sectional view)

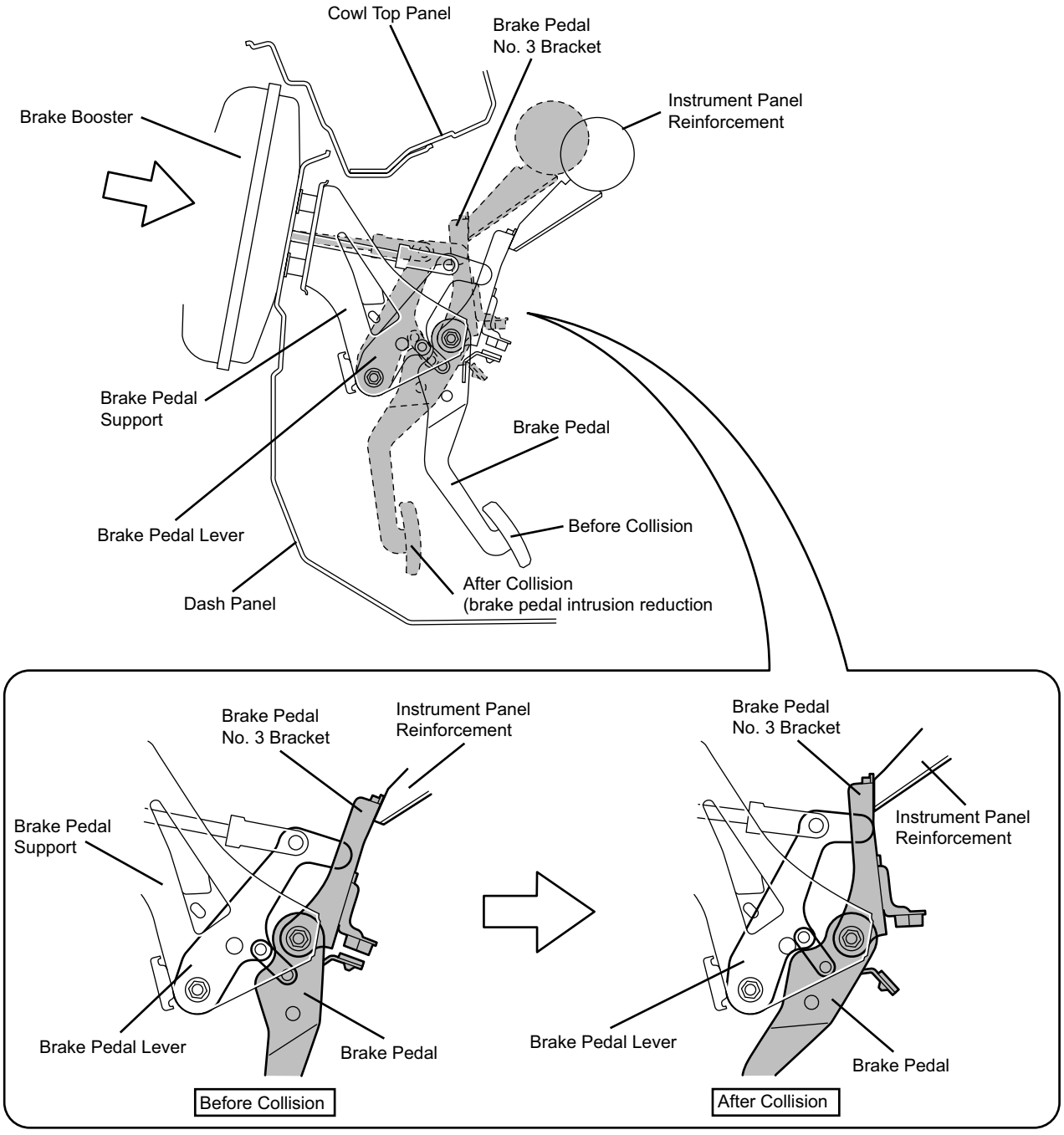




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Brake Pedal Construction for Collision

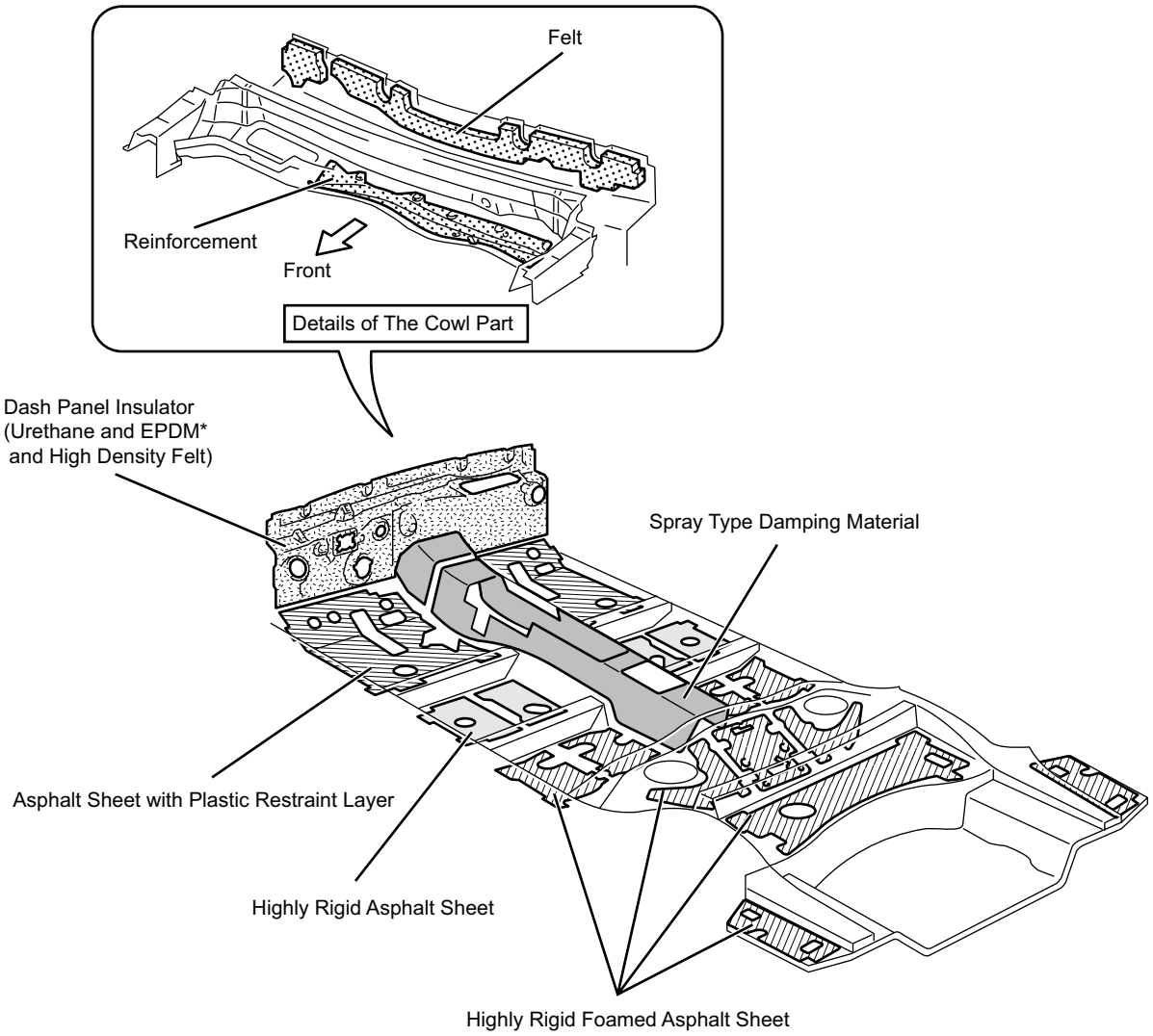
- A "Brake Pedal Construction for Colision" is used so that the brake pedal moves downward during a frontal collision, in order to minimize the extent of the backward movement of the brake pedal and dampen the impact that is applied to the driver's lower limbs.
- The brake pedal is joined to the brake pedal lever. If the backward movement of the engine during a collision pushes on the brake booster, the dash panel intrudes into the floor and the instrument panel reinforcements move, causing the No. 3 brake pedal bracket and the brake pedal lever to rotate forward. As a result, the brake pedal, which is joined to the brake pedal lever, moves forward and downward.



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Sound Absorbing and Vibration Damping Materials

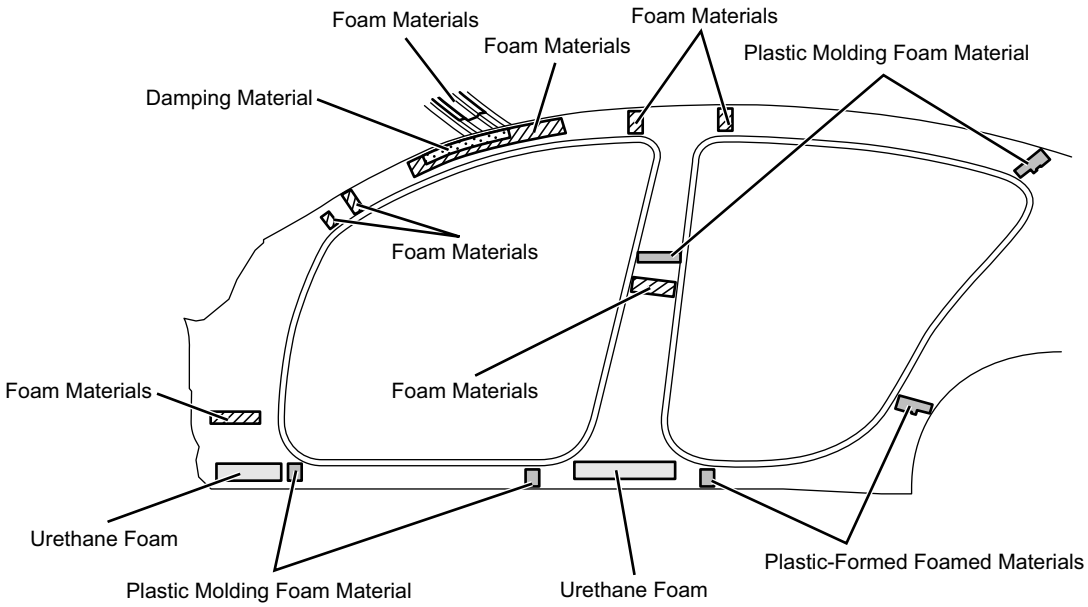
- To achieve a body that excels in quietness, various types of silencers, which suppress the sounds that are transmitted from the engine or wheels, have been appropriately allocated.
- A felt-type sound absorption material is provided on the back surface of the cowl to ensure pedestrian protection performance and improve quietness. Furthermore, reinforcements have been added to the lower part of the body to reduce the amount of sound created at the cowl.
- Various types of asphalt sheets have been effectively allocated as floor silencers in order to reduce the amount of sounds that are transmitted from the engine or wheels, while reducing weight.



* : Ethylene Propylene Rubber

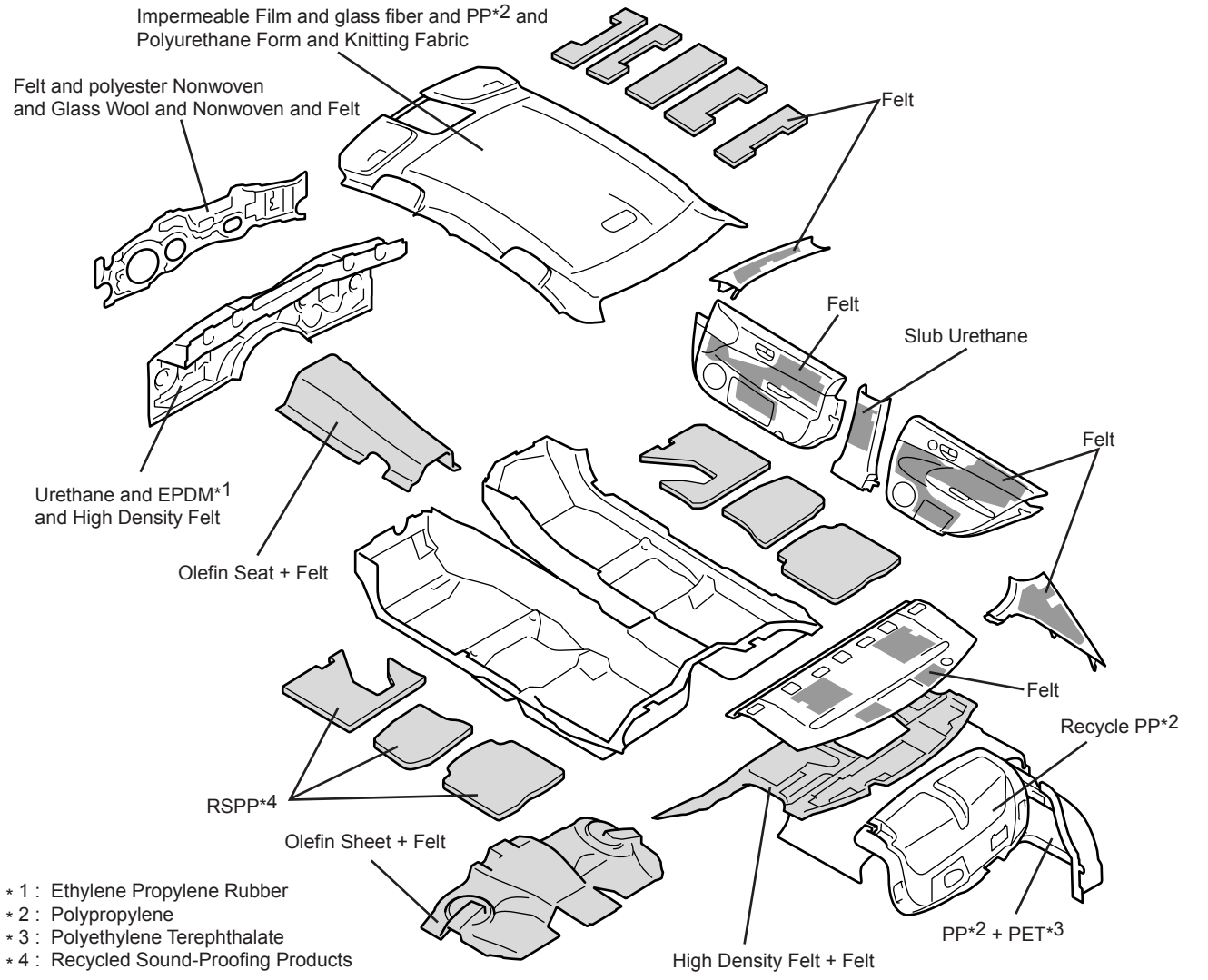
A4270149B

- Foamed materials, vibration damping materials, and plastic formed foamed materials for blocking the cross sections are provided at the door opening areas of the side panels and the front header area. These materials reduce wind noise and the amount of sounds that are transmitted from the pillars.



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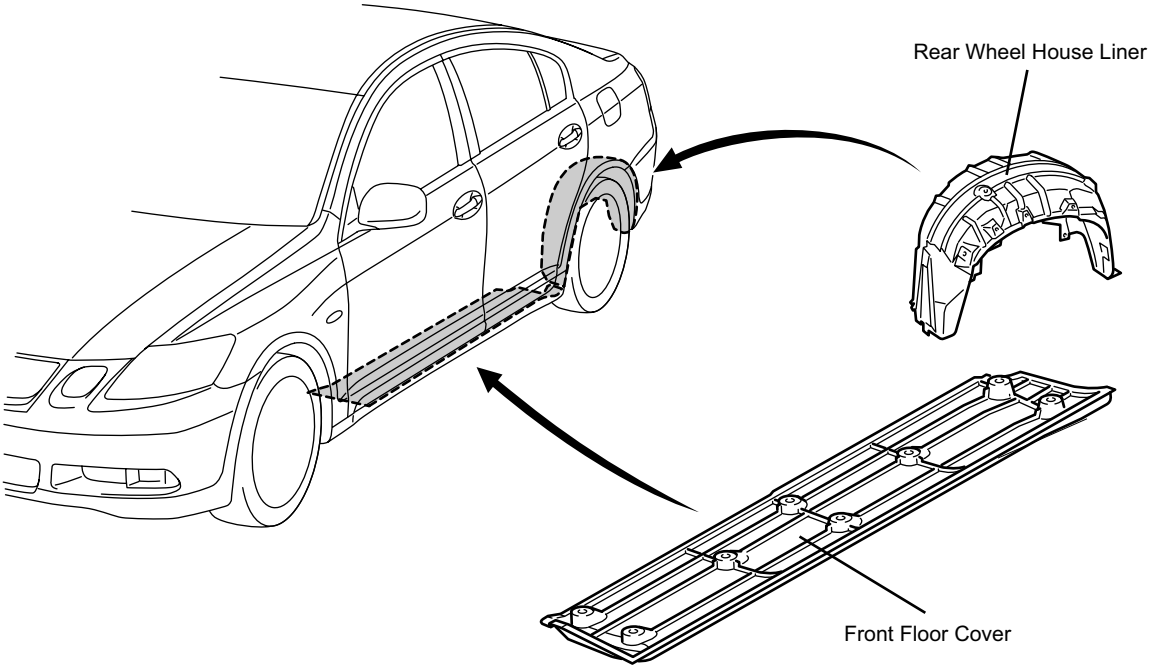
● Sound insulation and absorption materials have been allocated in accordance with the acoustic characteristics of the cabin in order to realize superior quietness and weight reduction.



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Sand Splashing Noise Reduction Construction

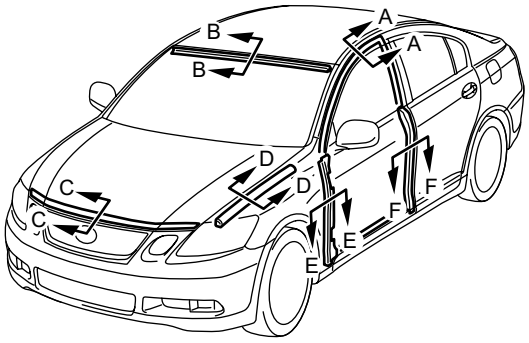
- A rear wheel housing liner (SBR {styrene butadiene rubber} resin material), which excel in sound absorption effect, is provided in the rear wheel housings. As a result, sand spattering sound, road noise, and water splashing sound have been reduced.
- A front floor cover made of a recyclable bumper material with an additional 10% EPR (ethylene propylene rubber) is used. This material, which is pliable, yet ensures the proper rigidity, helps reduce the amount of sand spattering sound.

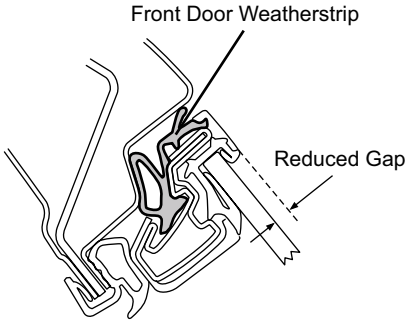


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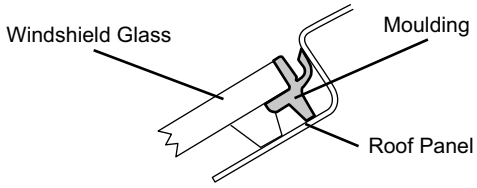
Reducing Wind Noise

- The offset between the moldings and door glass or windshield glass molding has been minimized to reduce wind noise.(see A-A, B-B cross sections).
- A parting seal that makes the gap flush between the radiator grille and the engine hood, is provided. This reduces the amount of wind noise that is generated along the parting area(see C-C cross section).
- A hood-to-front fender seal is provided to seal the area from the cowl side to the front edge of the front fender. This seal suppresses the amount of engine sound that leaks outside of the vehicle or enters the cabin (see D-D cross section).
- A front fender side panel protector is provided to seal the gap between the front fender panel and the body. This protector limits the amount of road noise that enters from the wheels and reduces the amount of wind noise that is created by the inflow of air (see E-E cross section).
- A parting seal that makes the gap flush between the front fender panel and the front door, as well as between the front door and the rear door, is provided. This reduces the amount of wind noise that is generated along the parting area (see E-E, F-F cross sections).

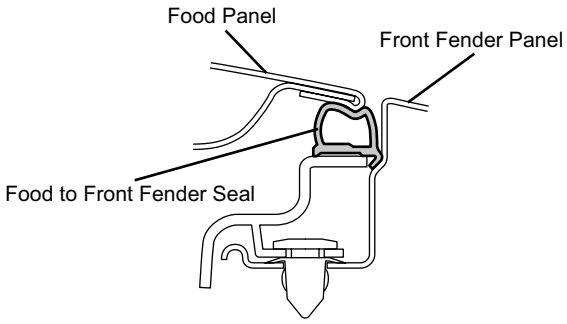




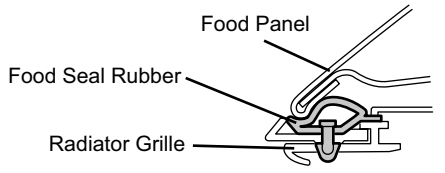
A - A cross section



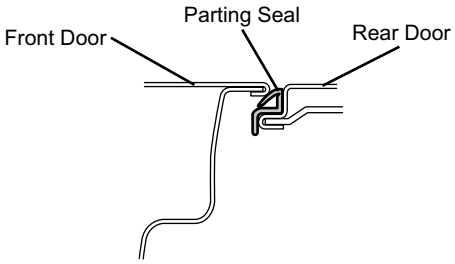
B - B cross section



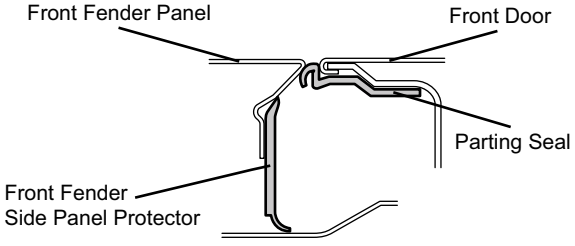
D - D cross section



C - C cross section



F - F cross section

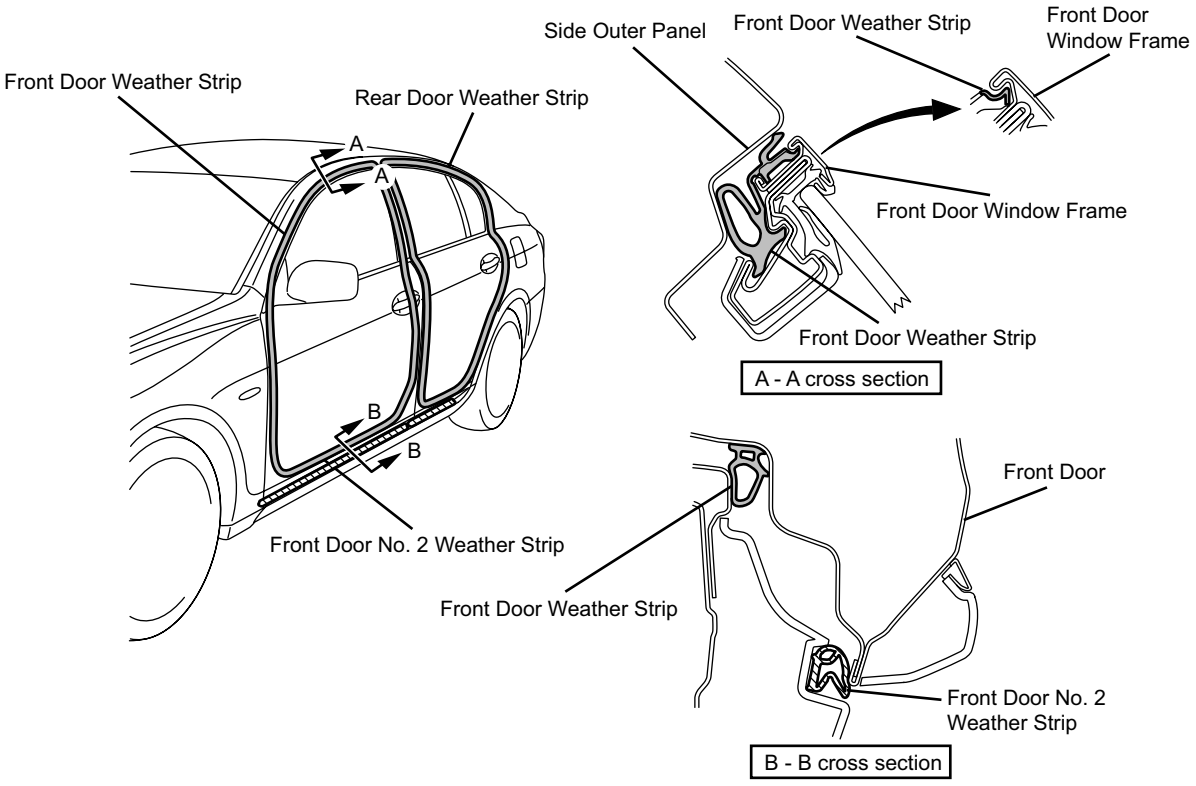


E - E cross section

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Door closure Sound Improvement

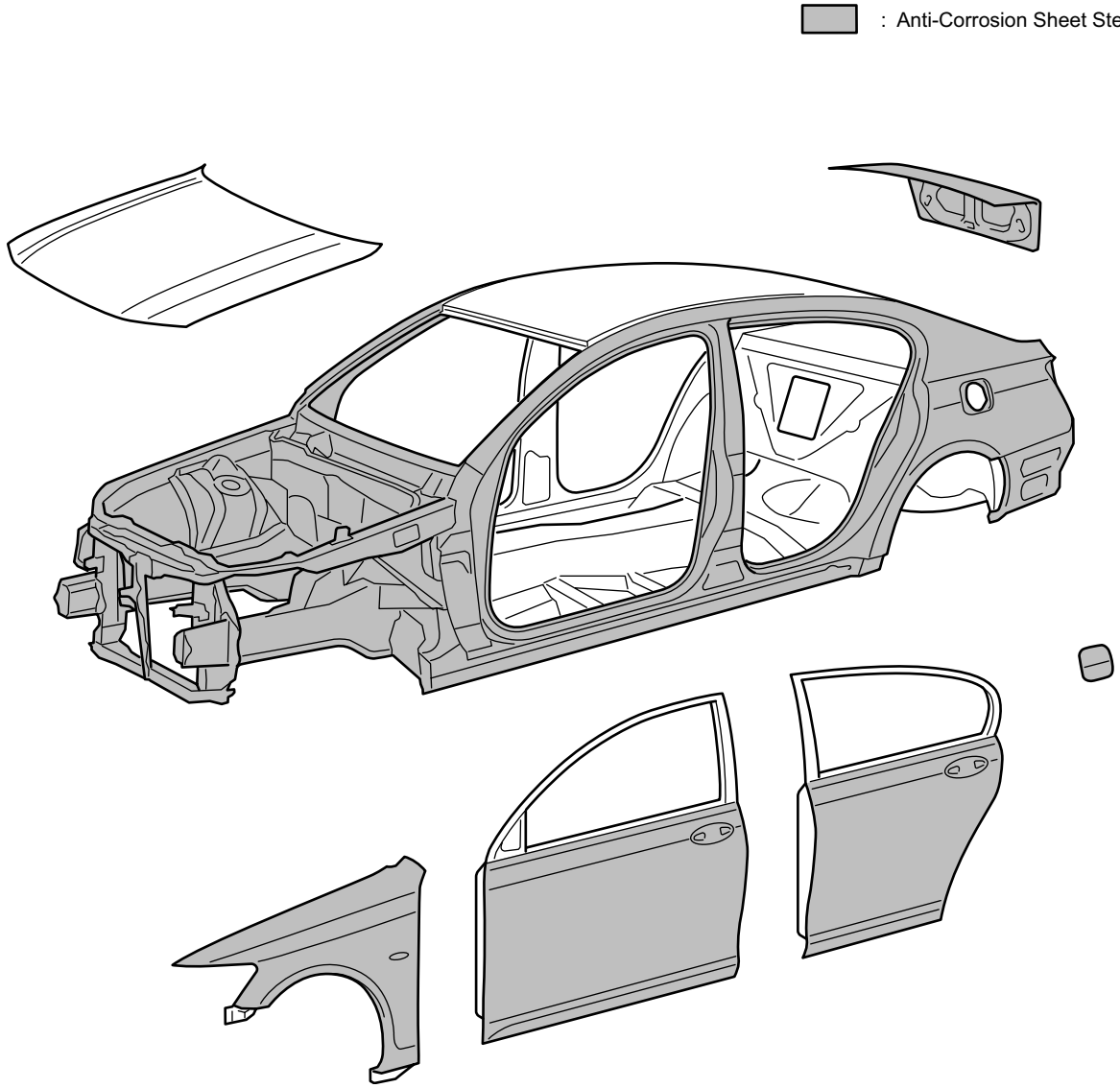
- A sponge layer is provided to the front and rear door weatherstrips in order to reduce the rattling sound that is created when the door comes in contact with the door window frame as the door is being closed (see A-A cross section).
- A hollow front door No. 2 weatherstrip is provided at the rocker in order to reduce the sound that is created when the door is being closed (see B-B cross section).



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Rust-Resistant Body

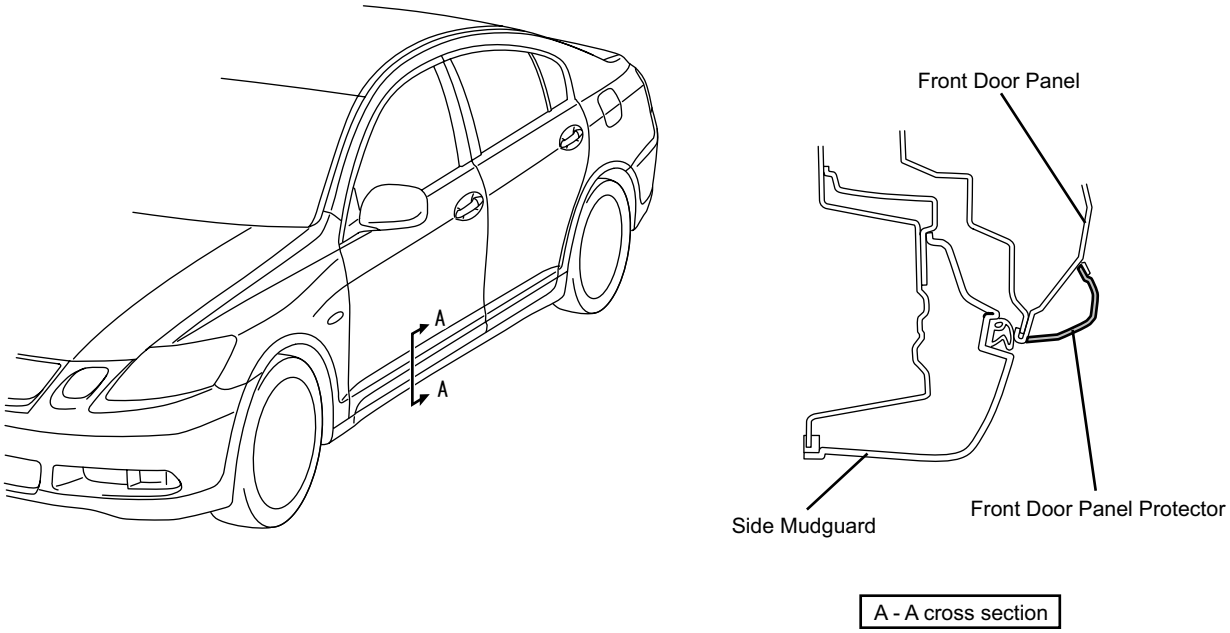
- Galvanized rust preventive sheet steel is used in a wide range of areas to ensure a high level of rust preventive performance.
- Wax has been applied to the moving areas of the door hinges and the fuel lid. Sealer has been effectively applied to the edges and hemmed areas of the door panels and the luggage door panel to ensure rust preventive performance.



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Anti-Chipping Application

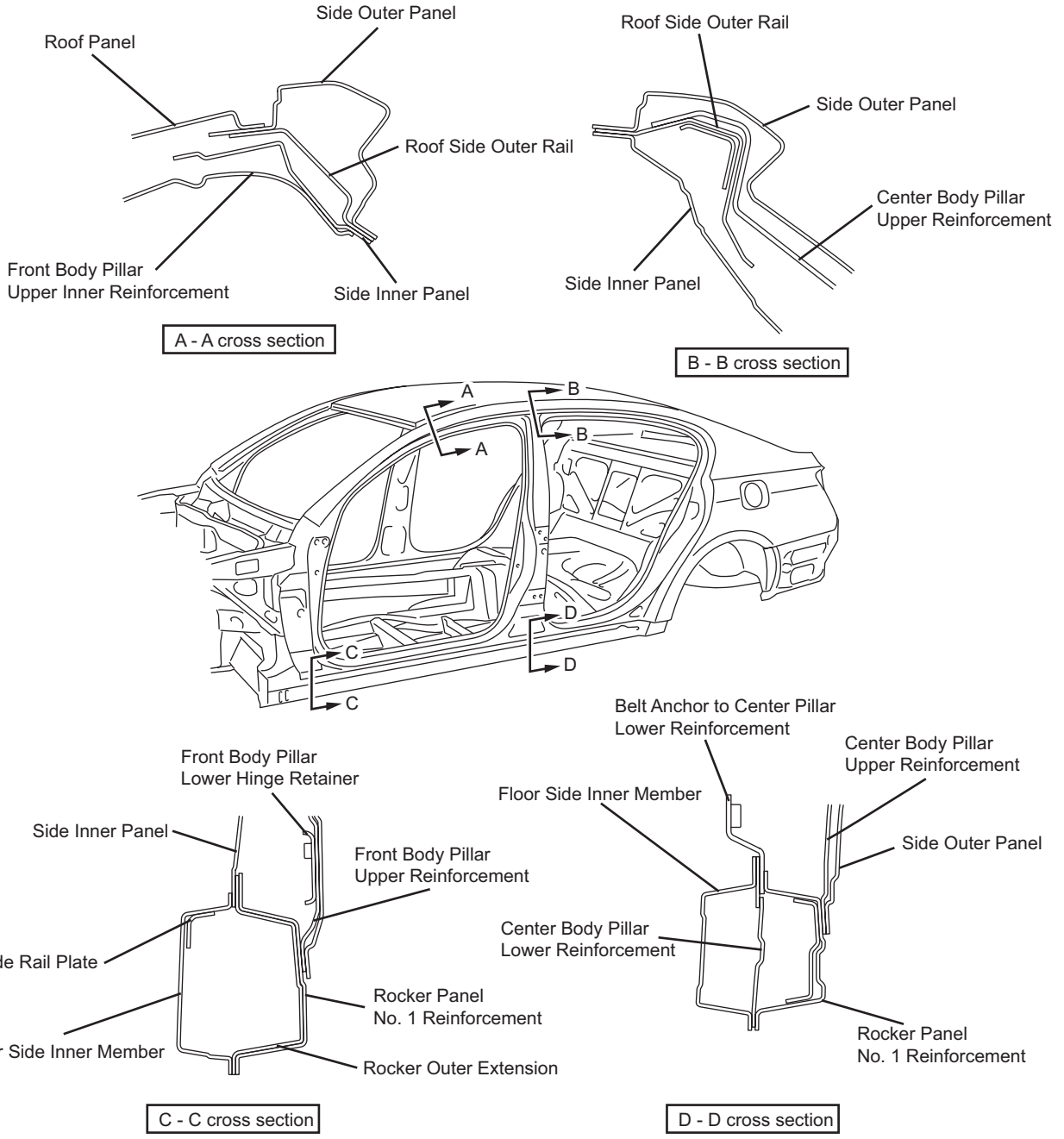
• Under-the-door moldings are used to protect the lower areas along the side of the body, thus ensuring the chip resistant performance of the areas that are susceptible to chipping by stones.



Cabin Frame Construction

● In addition to optimizing the cross-sectional areas of the pillars, frame materials are provided effectively in the side outer panels. These strengthening measures increase rigidity and reduce road noise.

Panel Joint (cross-sectional view)

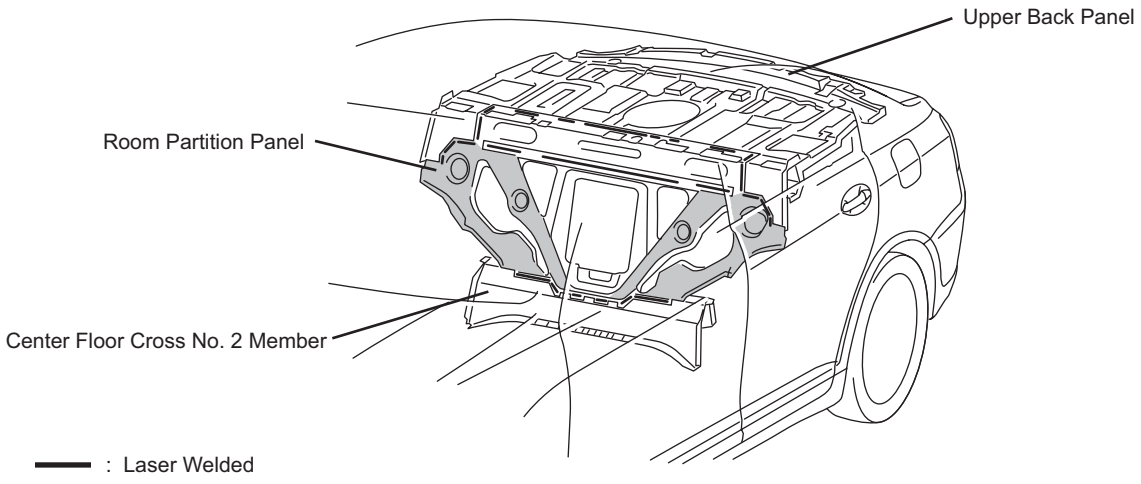


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BO

Body Shell(Around The Rear)

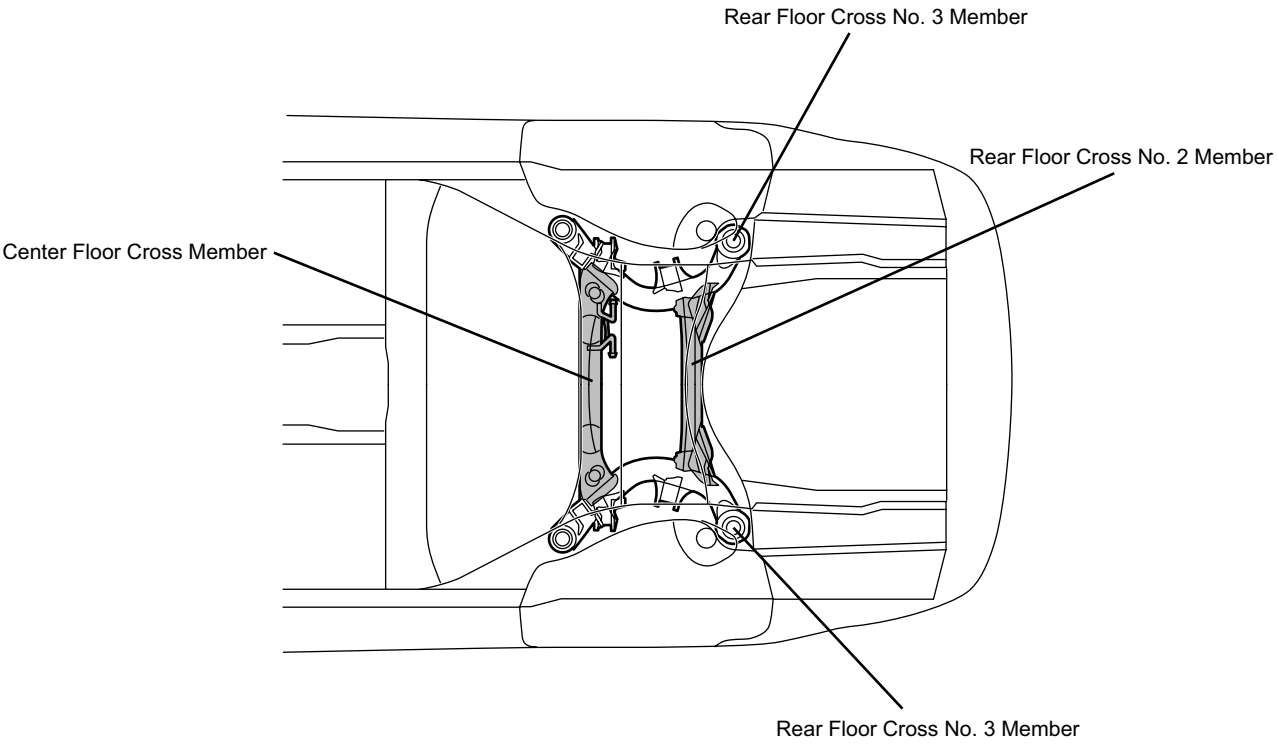
● A large room partition panel has been created by laser welding the upper back panel and the No. 2 center floor cross member, thus achieving both weight reduction and improved rigidity.



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Body Shell (Suspension member fitting portion)

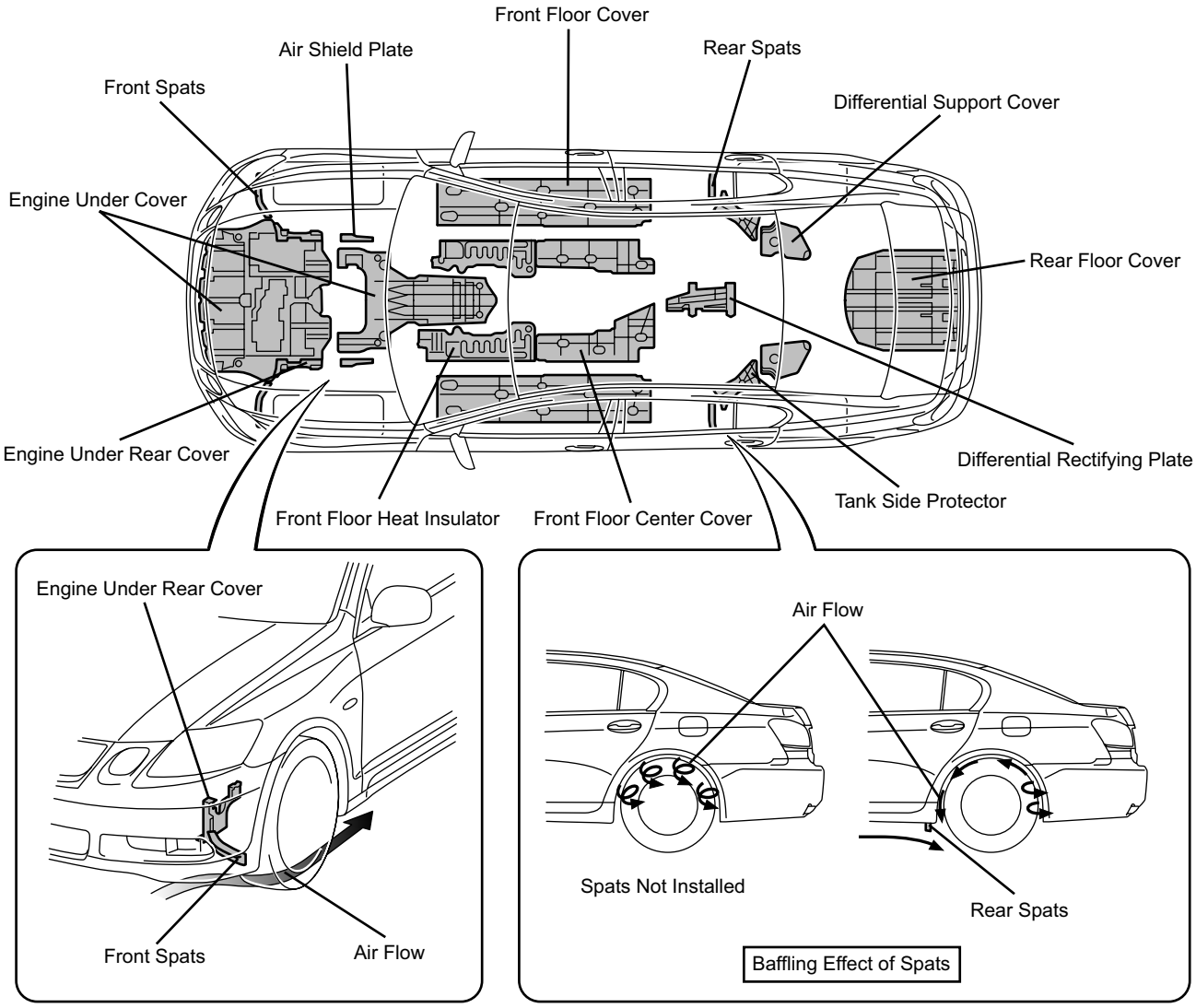
● Various types of floor cross members are provided to join the right and left areas to which the rear suspension member is mounted. This ensures the proper rigidity at the force application point, which reduces road noise.



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Aerodynamics

- In addition to using various flush-surface parts on the upper body, various types of airflow guiding parts have been provided under the body to control the flow of air under the floor. Together with a flat underfloor, superior aerodynamic performance has been achieved. Thus, high levels of driving stability and straightline stability at high driving speeds have been achieved. Furthermore, wind noise during high driving speeds has been reduced to enhance the level of comfort.
- Fairings have been provided in front of the front and rear tires in order to guide the airflow in front of the tires. Thus, the amount of air that drags into the wheel housings has been reduced. As a result, the fluctuation of airflow that occurs around the tires has been suppressed, thus ensuring a high level of straightline stability during high-speed driving.
- An engine under rear cover and an air shield plate have been provided at the engine under cover side in order to reduce the amount of air that flows under the floor from the engine compartment.



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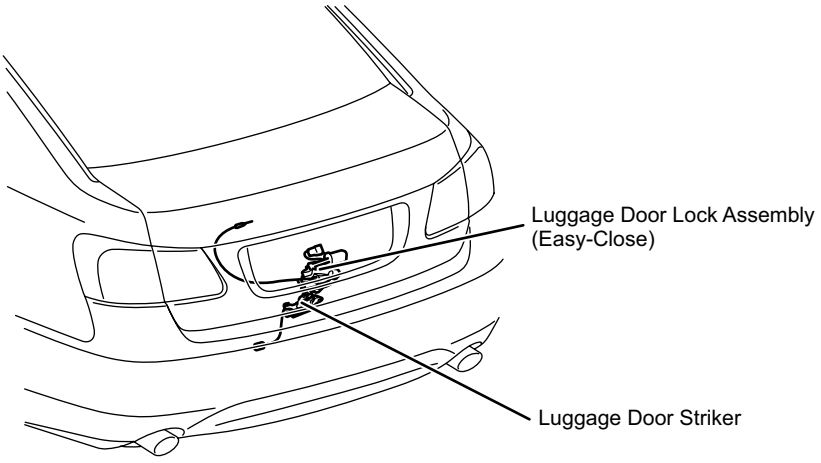
BO

ENGINE HOOD / DOOR

Luggage Door Easy-Close System

- A "luggage door easy closer" system, which is operated by a motor, is used to fully close the luggage compartment door automatically if it is left ajar, and is provided on all models as standard equipment. As a result, the user is able to close the luggage compartment door by applying a slight force.
- The left side J/B ECU controls the system based on the information provided by the various switches that are built into the luggage door lock assembly.

Luggage Door Easy-Close System Components

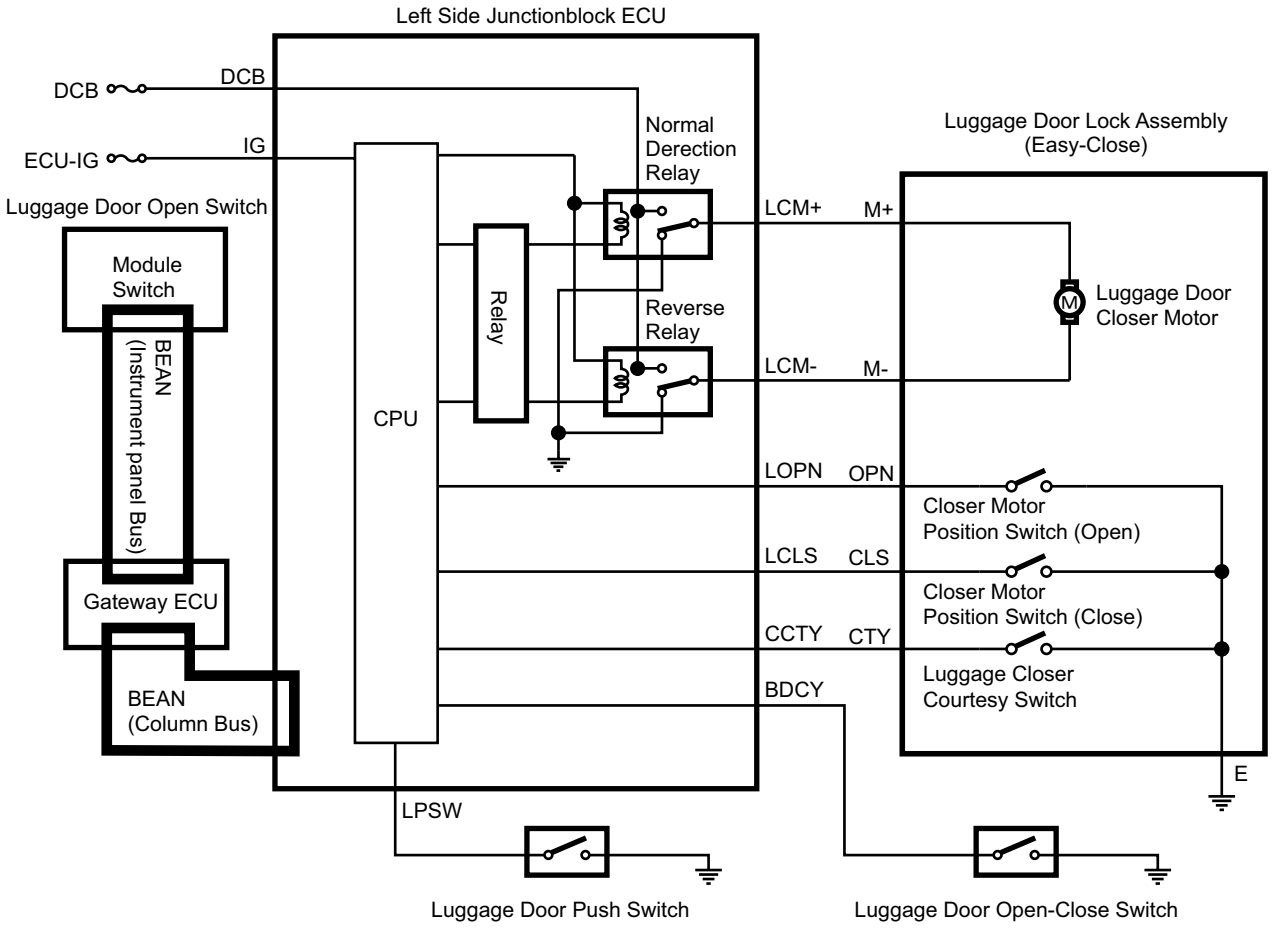


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Luggage Door Easy-Close System Function

- When the user closes the luggage compartment door to the ajar state, the luggage door closer motor operates in the normal direction, in order to fully close the luggage compartment door automatically.
- If the ECU detects that a foreign object is jammed in the door while the motor is operating, the ECU stops the closing operation (normal direction of the motor) and performs a reversal operation (reverse direction of the motor).

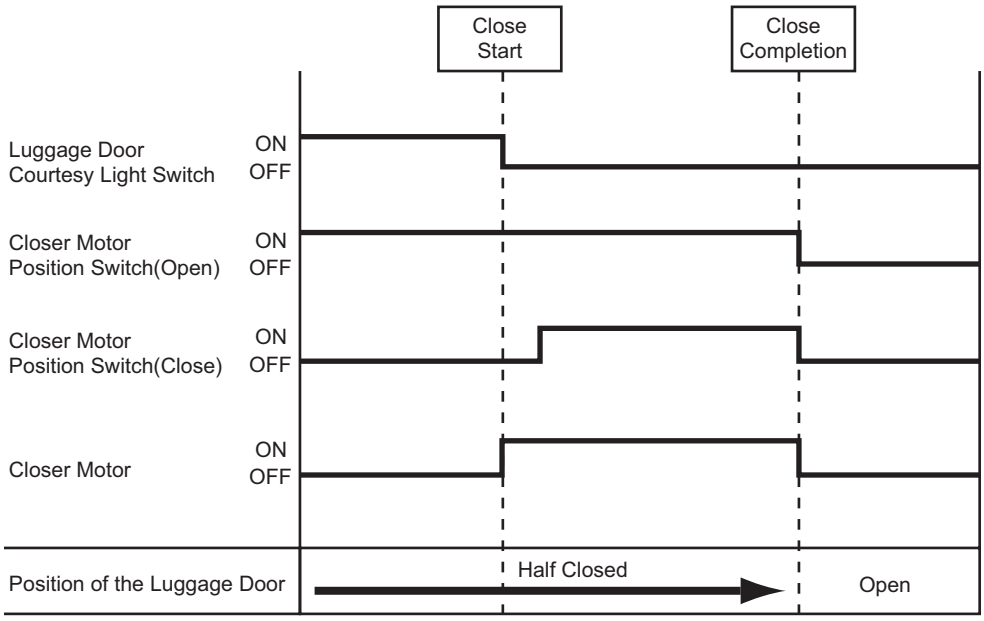
Luggage Door Easy-Close System Operation



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BO

Luggage Door Close Operation

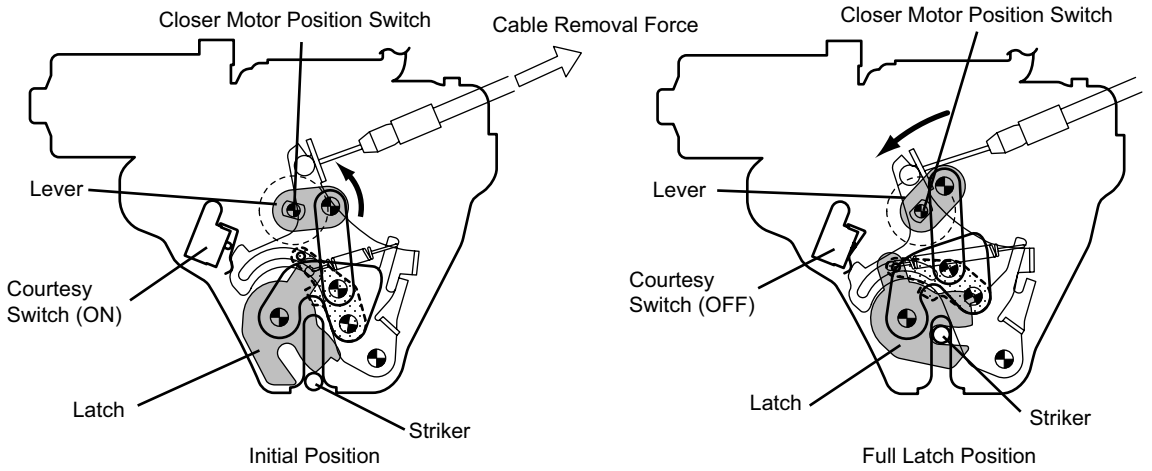


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- Upon detecting that the luggage door courtesy light switch has been turned from ON to OFF as the luggage door moves from the "open" to the "ajar" position, the left side J/B ECU turns ON the normal rotation relay to operate the closer motor in the normal direction until it reaches the "complete closed position".

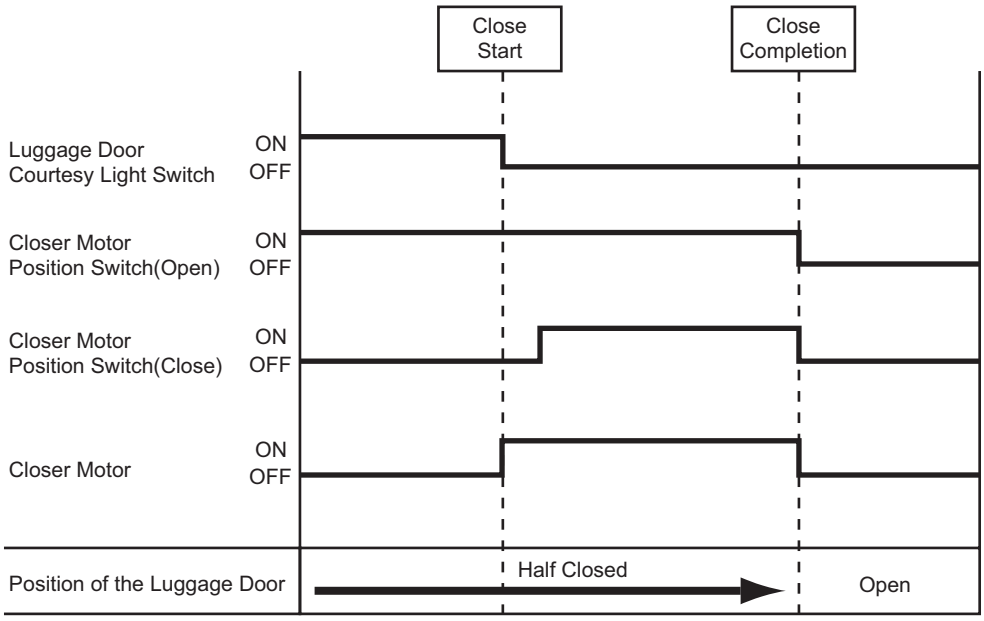
Luggage Door Lock Assembly (Easy-Close)

- This construction consists of a lever that transmits the motive force of the motor and various linkages that are connected to the lever in order to both engage and disengage the latch by operating the motor in the normal direction.
- A courtesy light switch, which turns ON and OFF in accordance with the engagement and disengagement of the latch, is provided inside the luggage door lock assembly.
- "Open" and "Close" closer motor position switches are provided in the luggage door closer motor unit to detect the rotational position of the motor.
- The latch mechanism is connected mechanically to the luggage door key cylinder via a cable. Thus, the latch mechanism is actuated when the user inserts a mechanical key into the luggage door key cylinder and turns it.



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Luggage Door Close Operation

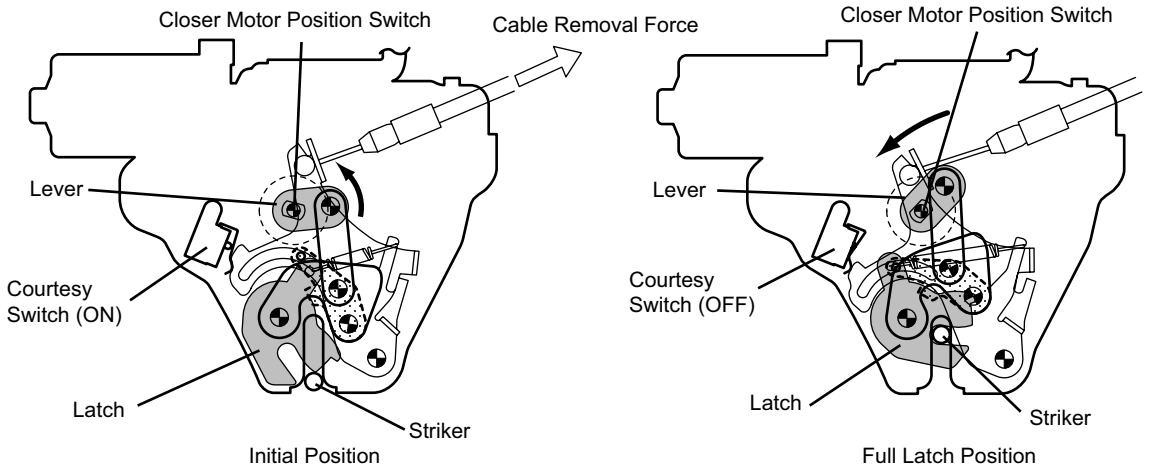


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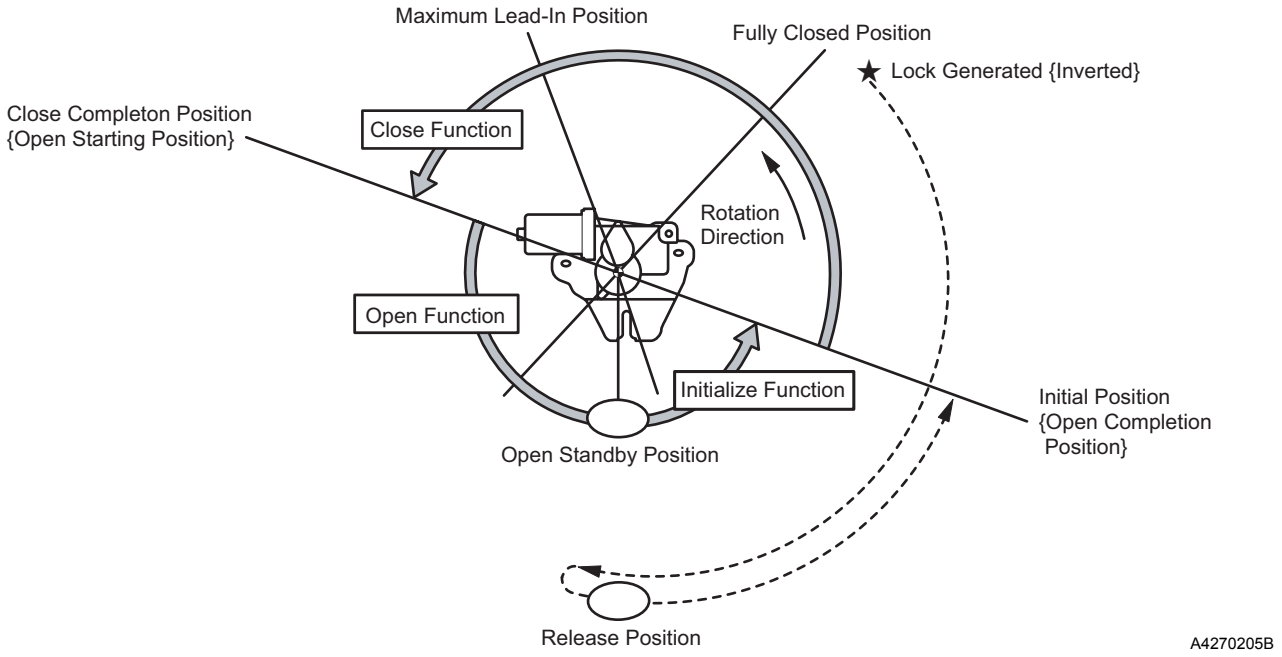


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Luggage Door Easy Closer Position Detection Switch

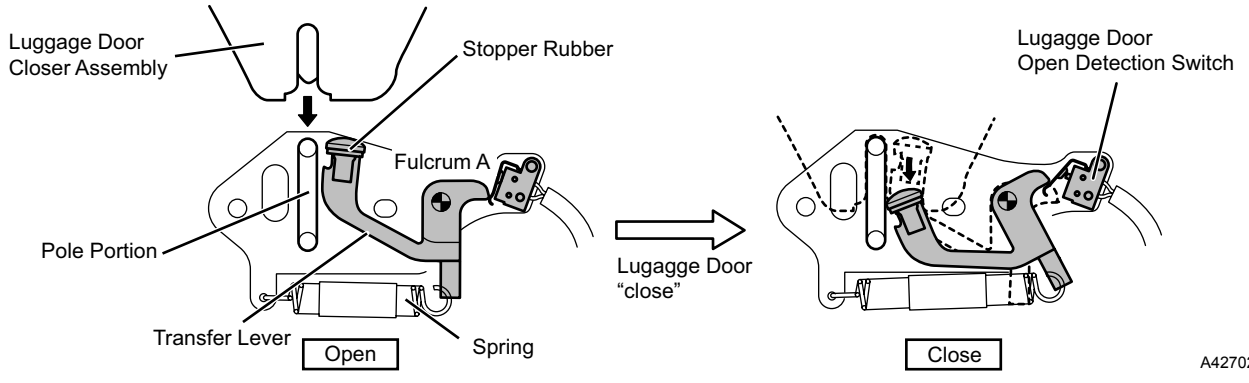
Closer Motor Position Switches (Open and Close)

- The "Open" and "Close" closer motor position switches are provided coaxially to the lever and their ON and OFF operations are linked to the rotational movement of the motor. Upon receiving the ON and OFF input signals from these two switches, the left side J/B ECU detects the rotational position of the closer motor in accordance with the combination of the two signals.
- One rotation of the lever is divided into the following regions, based on the angle of the lever at the center of the rotation: close operation region, open operation region, and initialization operation region. The left side J/B ECU controls the motor in accordance with the ON and OFF signals of the luggage door courtesy light switch or the "Open" and "Close" closer motor position switches, in order to perform the closer operation.
- When the luggage door closer system is normal, the system controls the motor to operate in the normal direction, based on the position detected from the combination of the two signals from the "Open" and "Close" switches: open completion position, close completion position, open standby position, and open completion position.



Luggage Door Open Detection Switch

- When the luggage compartment door is open, the rubber stopper end of the luggage door transfer lever is always higher than the striker. Thus, fulcrum A and the spring adjust the striker so that its opposite end pushes on the door opening detection switch. Accordingly, the door opening detection switch turns ON when the luggage compartment door is open, and turns OFF when the door is closed.

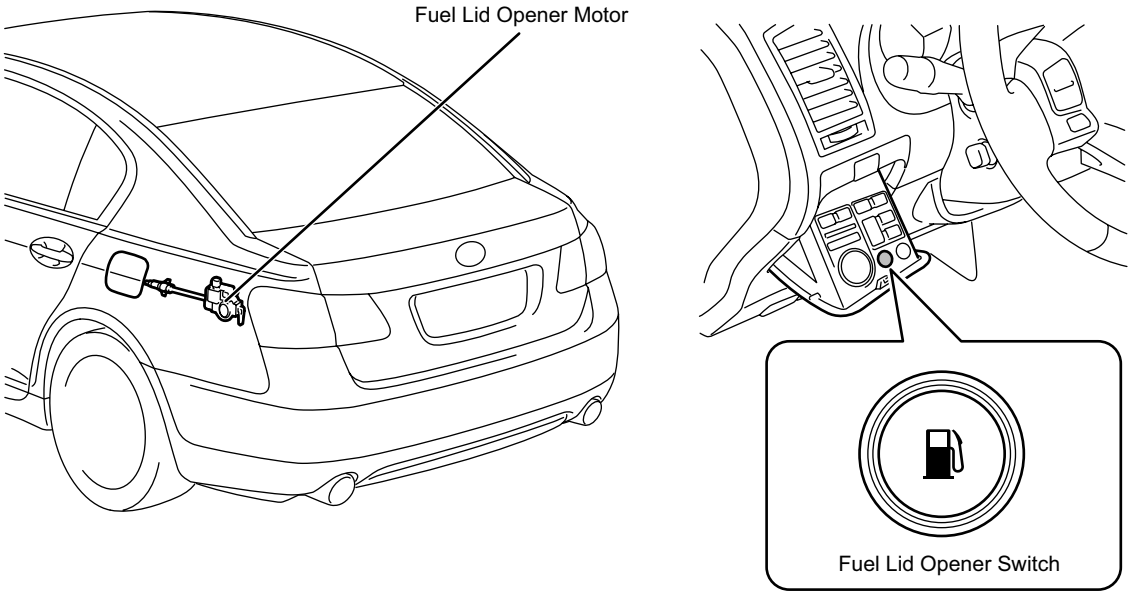


Fuel Lid Opener

● An "electric fuel lid opener" is used and provided on all models as standard equipment.

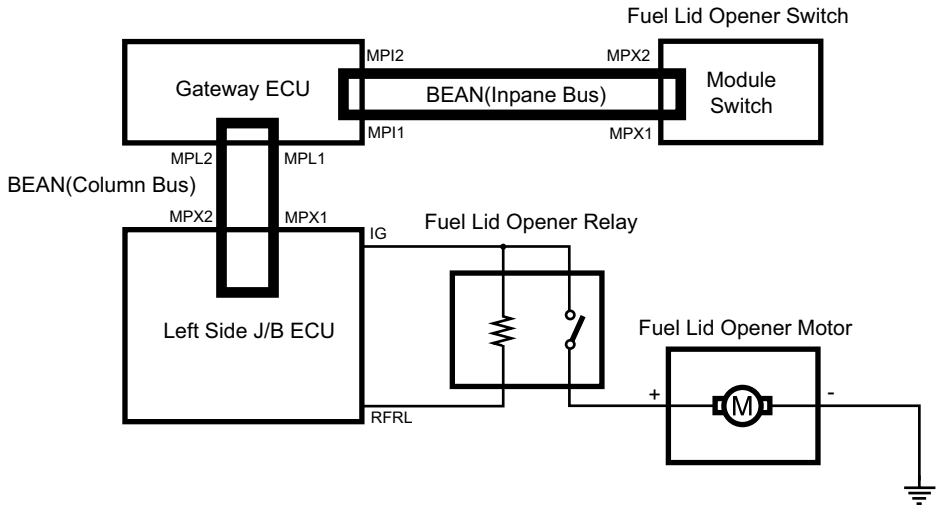
Fuel Lid Opener System Components

• Press the fuel lid opener switch in the integration switch mounted on the left side of the instrument panel in order to open the fuel lid.



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Fuel Lid Opener System Operation



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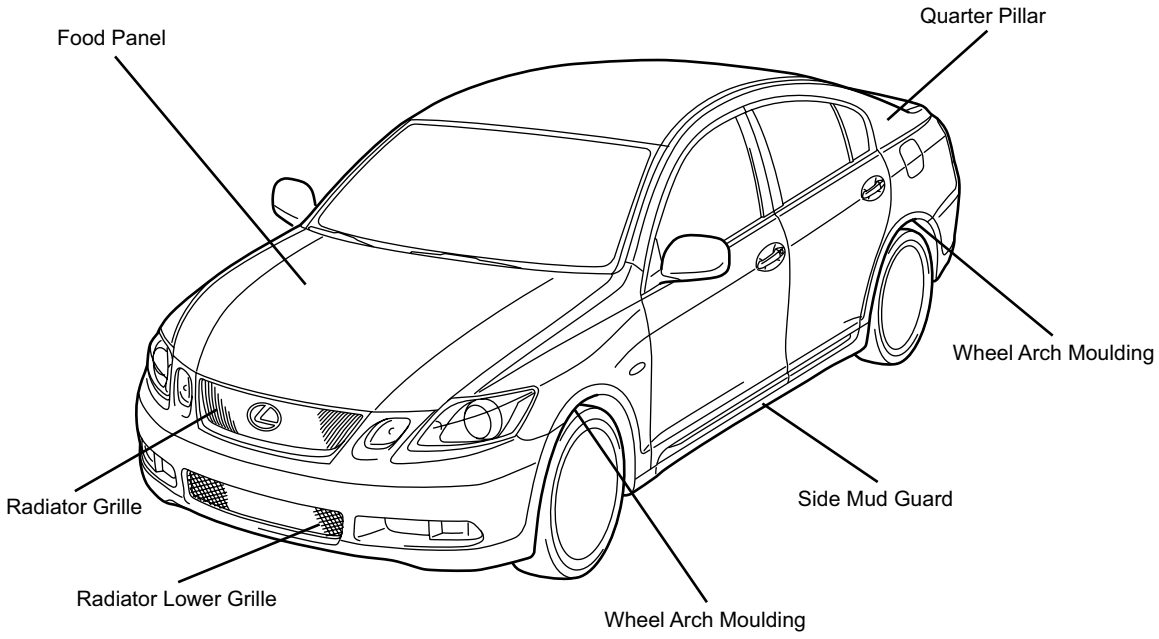
EXTERIOR

Exterior Design Concept

- The GS model's original long-cabin, monoform design has further evolved into a dynamic monoform design that exudes with movement.
- Under the theme of the "dynamics of contrast", the contrasts between the engine hood and the fenders, and the luggage compartment and the shoulders portray a powerful dynamism.
- Under the theme of "shadow surfacing", the changes created by a strong and taut general surface and a shallow camber surface that support it express depth and softness.

Front

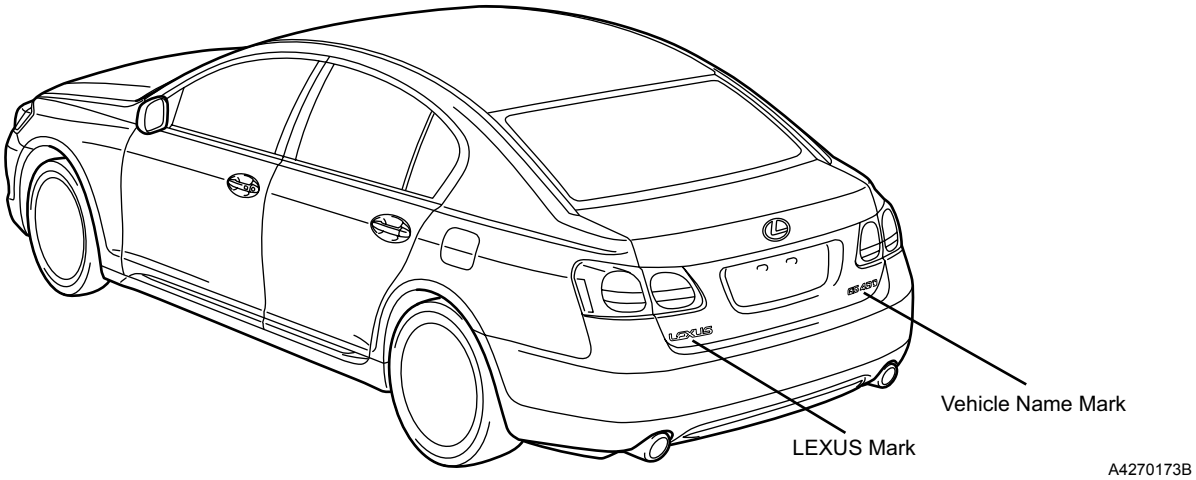
- The graphic theme of the front area is to integrate the flow of the cabin. The prominent fender silhouette emphasizes the chassis, in order to express the stately and lively forms that are worthy of the Lexus sport sedan. Contoured, four-beam headlights, which are part of the GS identity, are used. The outer lights are flush against the body, and use plated frames whose width and shape change, to provide a dauntless expression.
- The side area consists of a pillar that is shaped to synchronize with the flow of the cabin, and a shoulder portion that sweeps from the front to the rear at a stretch, thus expressing a calm and sharp design.



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Rear

- The rear design is focused primarily on the tires that are planted firmly on the ground, as seen from the back of the vehicle. Thus, it showcases a high-performance vehicle that is specialized in drivin.
- The rear combination lights carry over the four-beam image, which is part of the GS identity. They use LEDs and light panels that emit light horizontally, instead of emitting dots of light as in the conventional type. Thus, the rear combination lights offer a new type of appearance.
- The luggage compartment door bears the Lexus mark and the model mark.

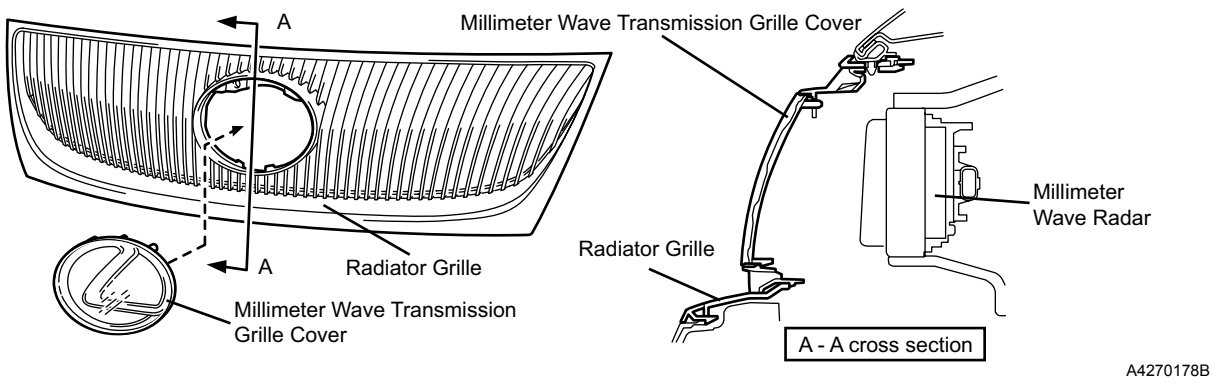


Exterior Parts

- The fitting accuracy of the bumper and the outer panels has been improved to minimize the parting gaps at various areas of the body, thus improving the appearance of the vehicle.
- The materials used in the exterior parts have been revised to realize a parts configuration to promote recycling and address environmental concerns.
- Blackout paint is applied to the front surface of the radiator supper and the inside of the front and rear wheel housings to improve the appearance of the vehicle.

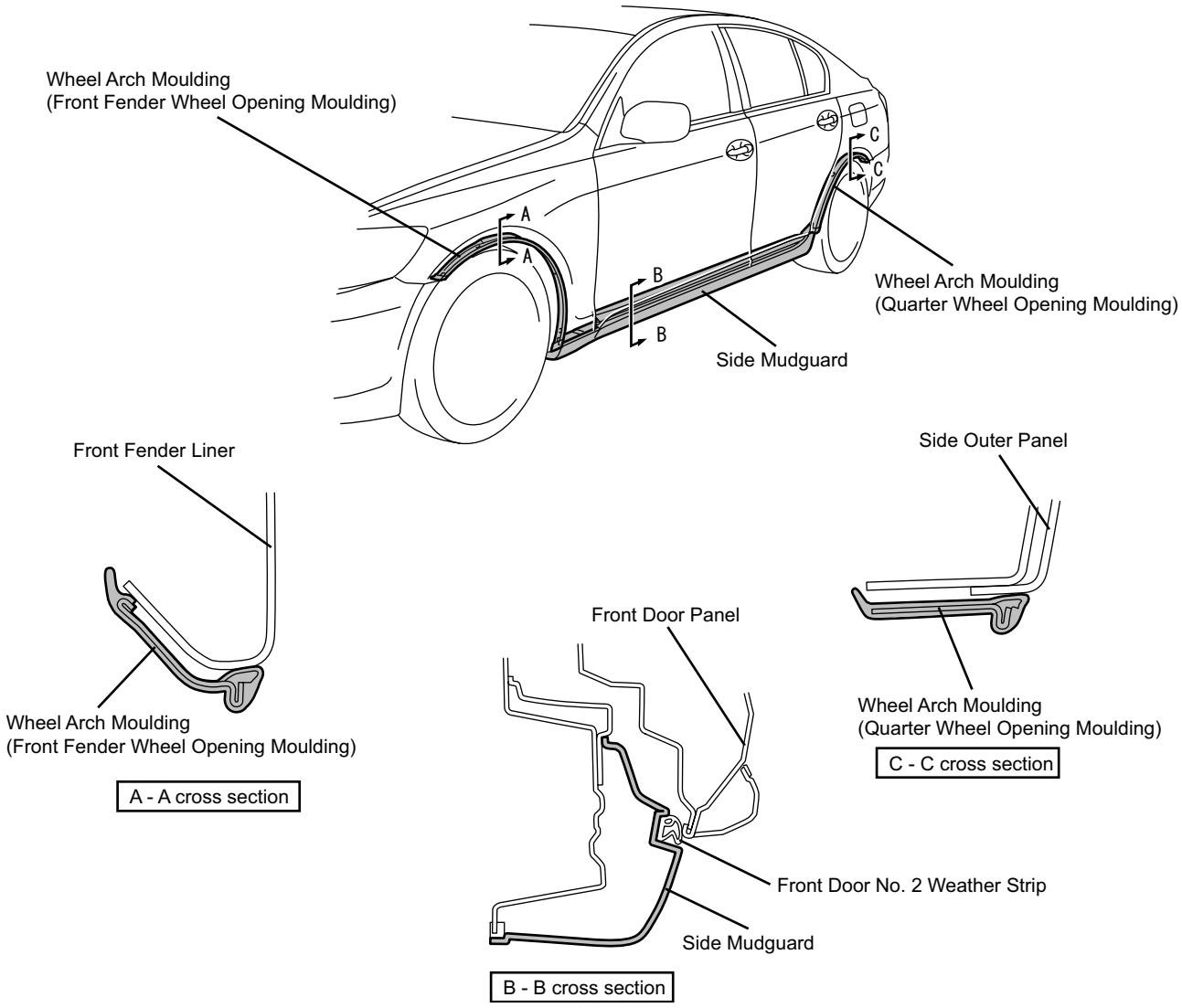
Radiator Grill

- A radiator grille with a millimeter-wave transmission grille cover is provided on the models with the pre-crash safety system.
- The millimeter wave transmission grille cover is constructed to transmit the beams emitted by the millimeter-wave radar, which is located in the center inside the radiator grille.



Wheel Arch Molding And Side Mudguard

- All models use wheel arch moldings and side mudguards to protect the paint from chipping caused by gravel or frozen snow that is flung by the tires.

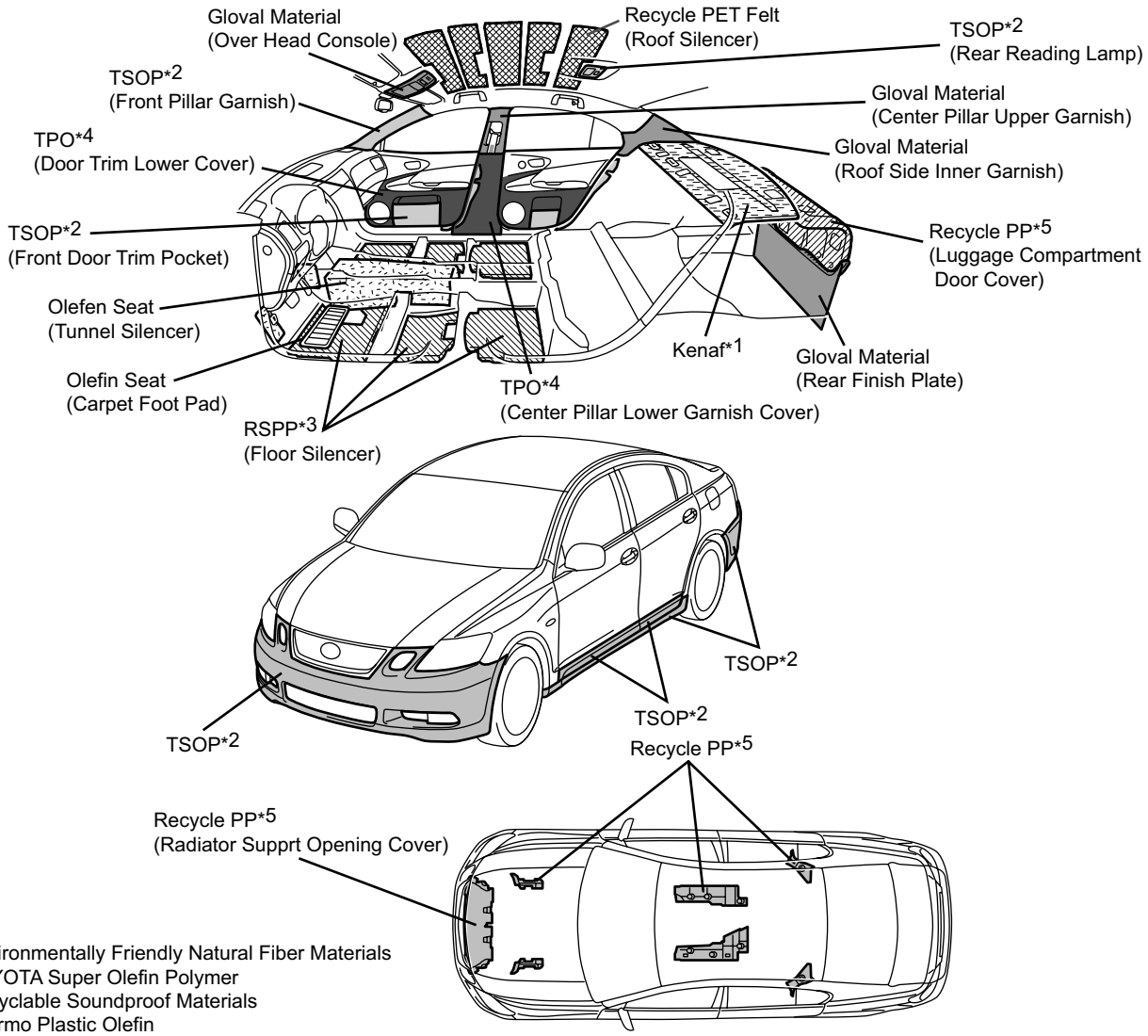


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Environment

- TSOP (TOYOTA super olefin polymer) and TPO (thermo plastic olefin) materials that excel in recyclability, are used in the bumpers, pillar garnishes, and door trim skins. Furthermore,RSPP (Recycled Sound-Proofing Products) and recycled PP (polypropylene) are used in the engine under covers and floor silencers to promote recycling.
- Natural fibers, such as kenaf and sisal, which are effective in protecting natural resources and stabilizing CO2, are used in the roof headlining and the package tray trim in order to address environmental concerns.

Recycle-Related Material Application Areas



*1 : Environmentally Friendly Natural Fiber Materials
*2 : TOYOTA Super Olefin Polymer
*3 : Recyclable Soundproof Materials
*4 : Thermo Plastic Olefin
*5 : Polypropylene

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Exterior Color

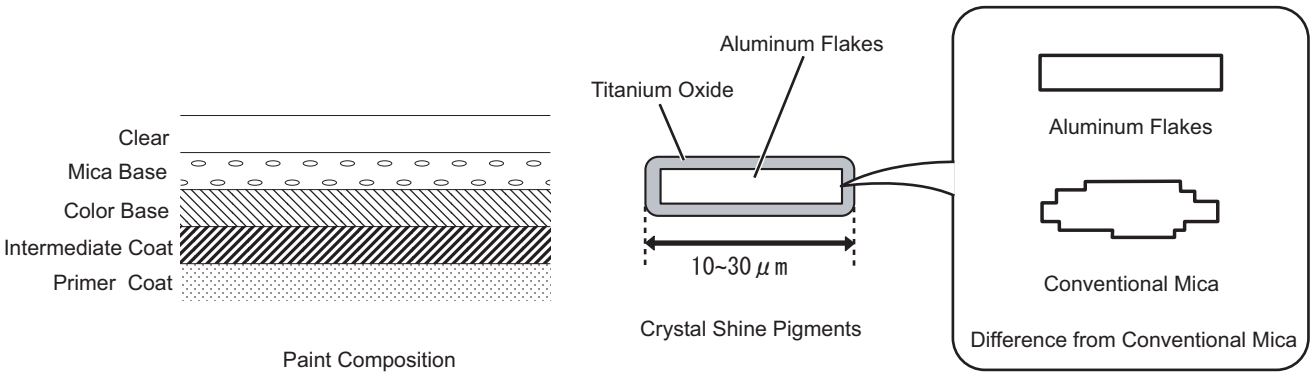
● A total of 10 colors are provided, consisting of character colors that highlight lively styles and pursue superior design that leave others behind, and basic colors with a high quality that are well-suited to the Lexus sport sedan.

Body Color List

Color Name	Color No.
Bluish Purple Crystal Shine	074
Premium Beige	4S7
Red Mica Crystal Shine	3R1
Dark Purple Mica Metallic	9AB
White pearl Crystal Shine	062
Olive Mica Metallic	6T7
Dark Blue Mica	8P8
Gray Metallic	1E0
Black	202
Premium Silver	1F2

White Pearl Crystal Shine

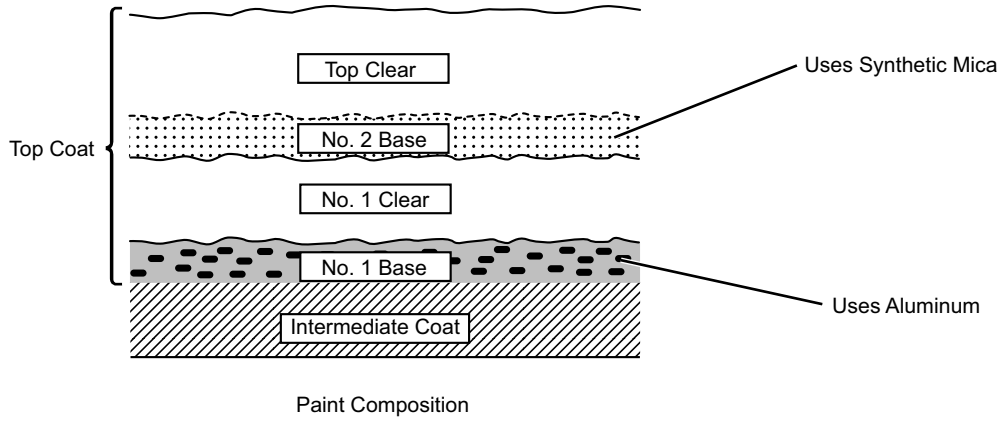
- The white pearl crystal shine has the same paint composition as the conventional pearl mica color. However, instead of the conventional mica pigments that are included in the mica base, it uses "crystal shine" pigments consisting of aluminum flakes coated with oxidized titanium.
- The aluminum flakes in the "crystal shine pigments" have grain diameters that are more uniform and thin, and have a smoother surface than the conventional mica. Thus, it produces a powerful brightness without impurities.



A4270179B

Premium Beige

- The top-coat composition of the premium beige consists of base layers that use aluminum and pearl mica to express color changes, elaborateness, and depth.
- The No. 1 base uses aluminum, which provides the proper radiance even with low incident light when it is cloudy, gives the paint a metallic look. The No. 2 base uses artificial mica to add brightness, eliminate turbidity, and realize a high level of color expression.

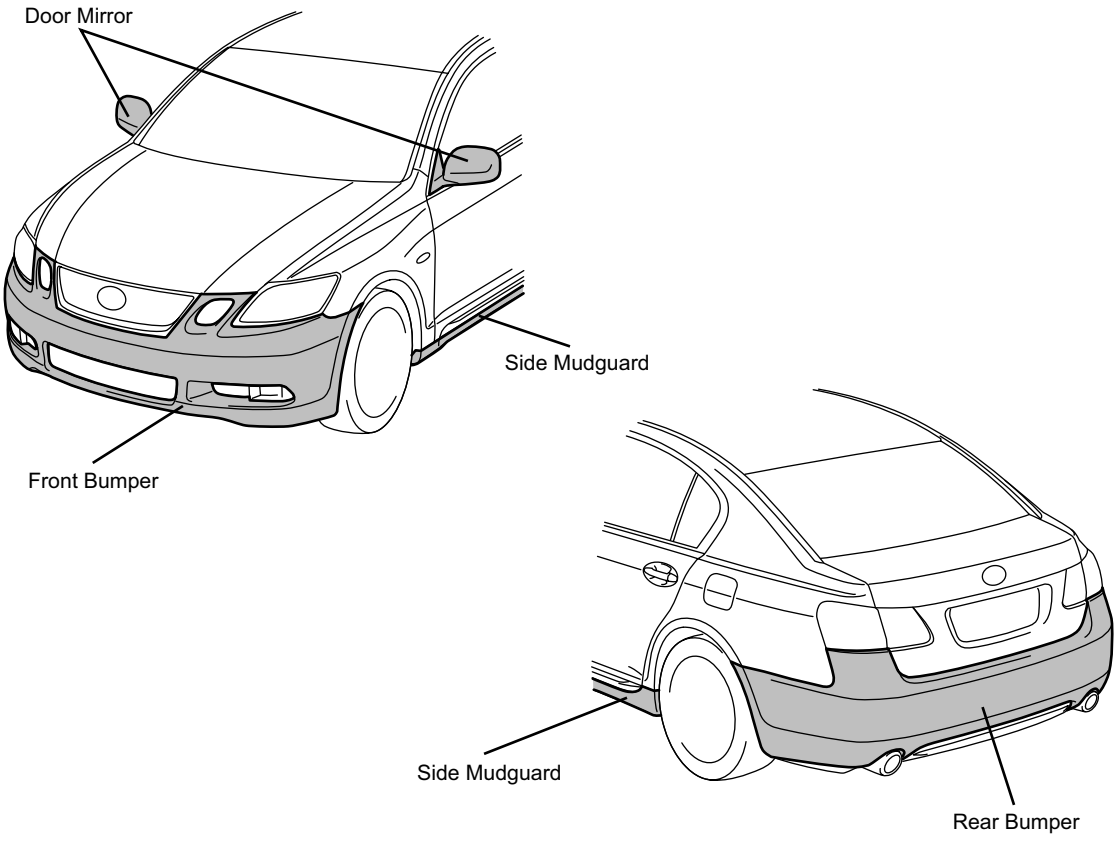


Paint Composition

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Colored Exterior Parts

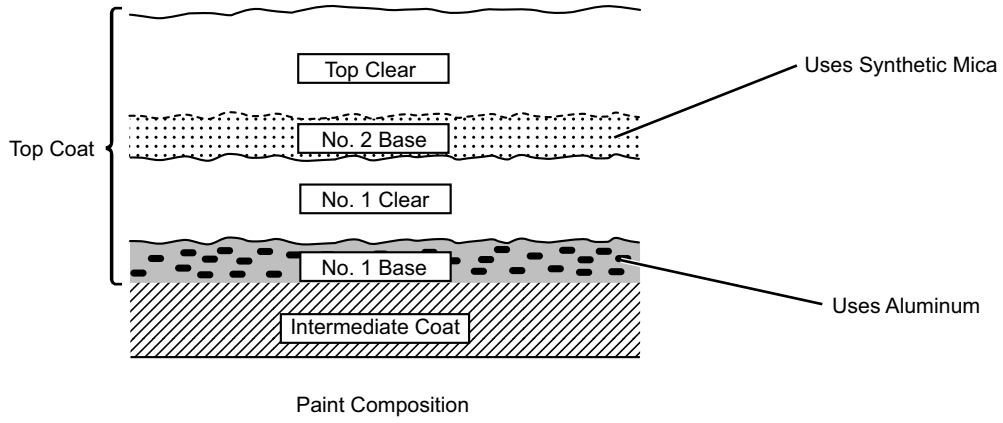
● The exterior parts listed below are painted the same color as the exterior panels for enhanced color coordination.



A4270176B

Premium Beige

- The top-coat composition of the premium beige consists of base layers that use aluminum and pearl mica to express color changes, elaborateness, and depth.
- The No. 1 base uses aluminum, which provides the proper radiance even with low incident light when it is cloudy, gives the paint a metallic look. The No. 2 base uses artificial mica to add brightness, eliminate turbidity, and realize a high level of color expression.

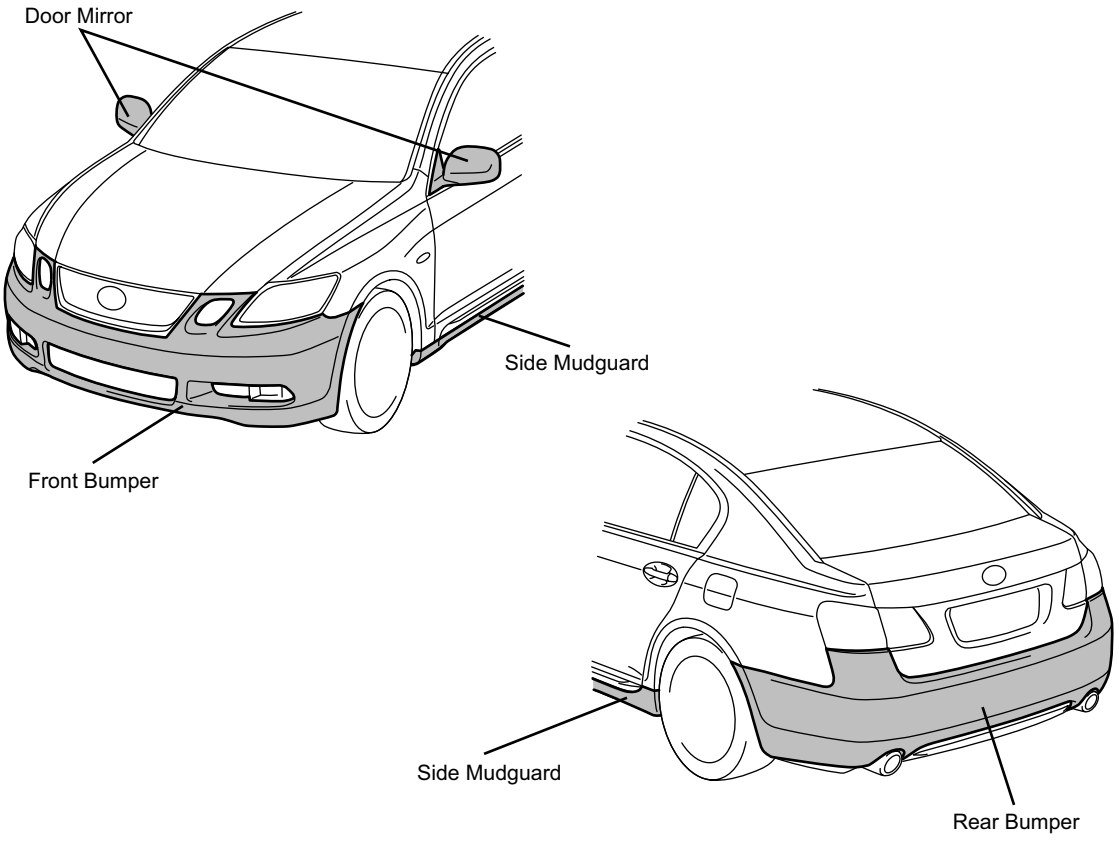


Paint Composition

A4270175B

Colored Exterior Parts

● The exterior parts listed below are painted the same color as the exterior panels for enhanced color coordination.

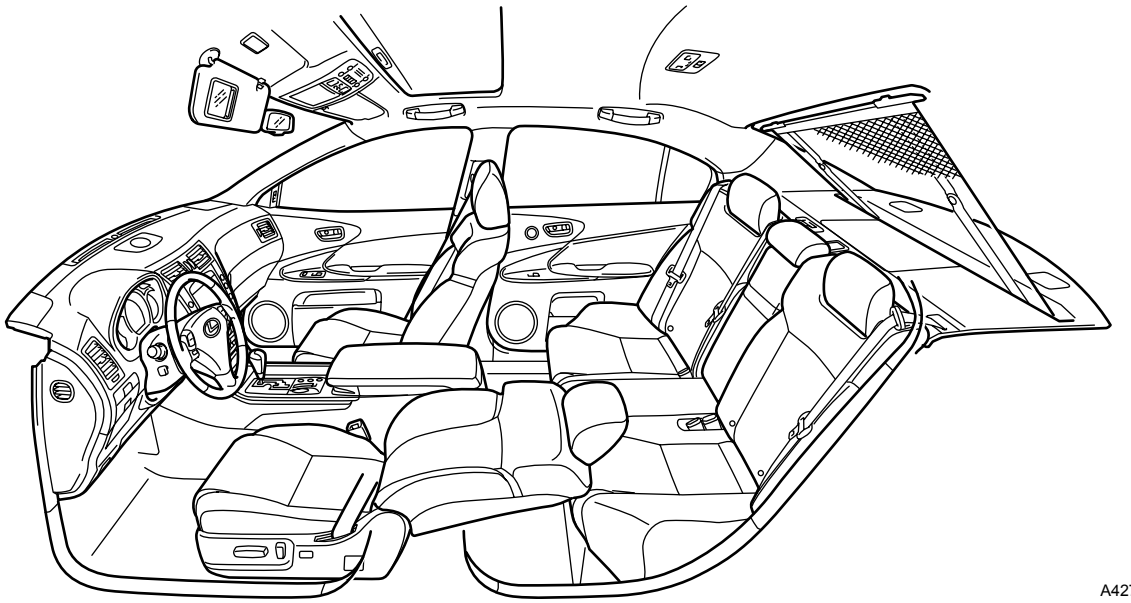


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INTERIOR

Interior Design Concept

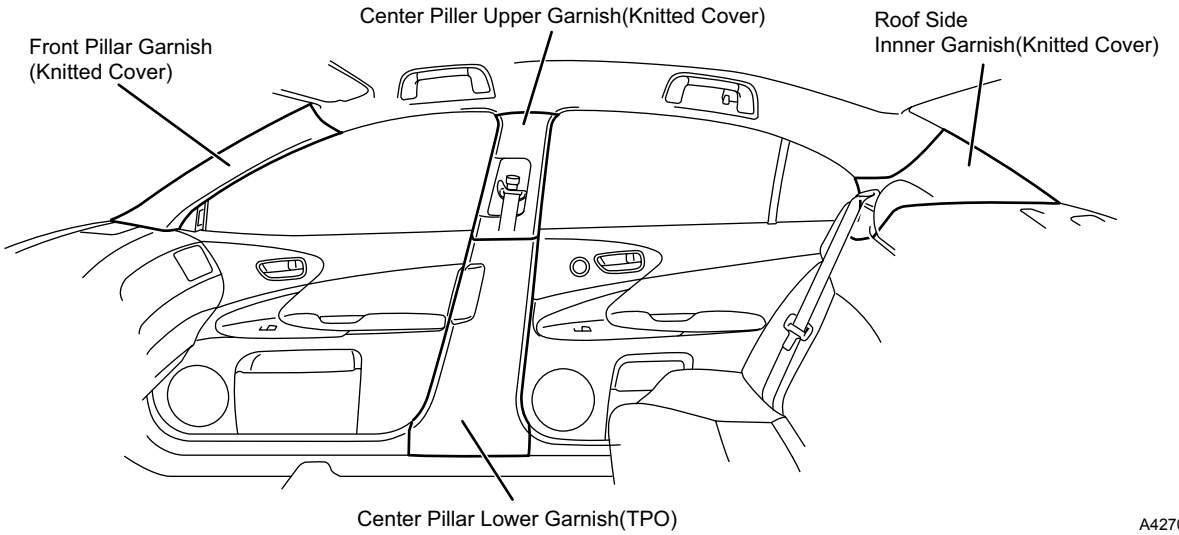
- The constituent interior elements, such as the combination meter, center cluster, registers, inside door handles, armrests, etc. have been designed with a continuous sweep, and the materials have been coordinated along the flow.
- The interior is available with three types of color configurations: black & ebony, dark orchid & ivory, and black & gray.



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Side

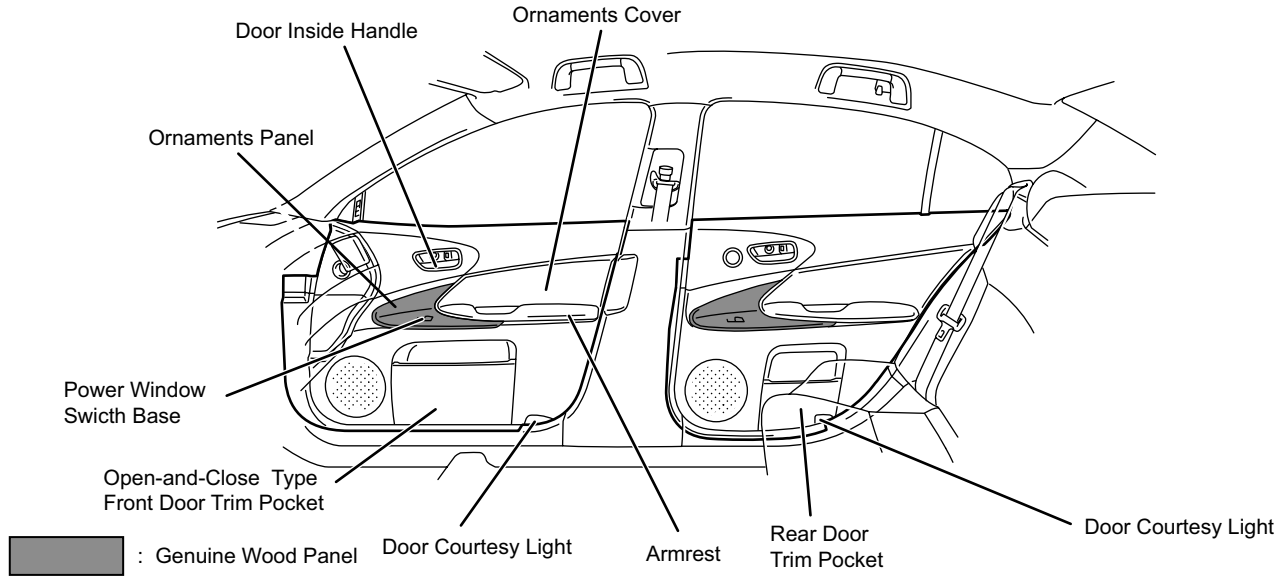
- The center pillar lower garnish uses a TPO (Thermo Plastic Olefin) cover for recyclability.
- A head impact protection structure is used in the front pillar garnish, center pillar upper garnish, and roof side inner garnish.
- Knit covers are used on the front pillar garnish, center pillar upper garnish, and roof side inner garnish to realize a luxurious look.
- The gap in each area between a pillar garnish and a door frame has been reduced and the seal portion of the weatherstrip has been placed behind the parting line to realize a streamlined look.



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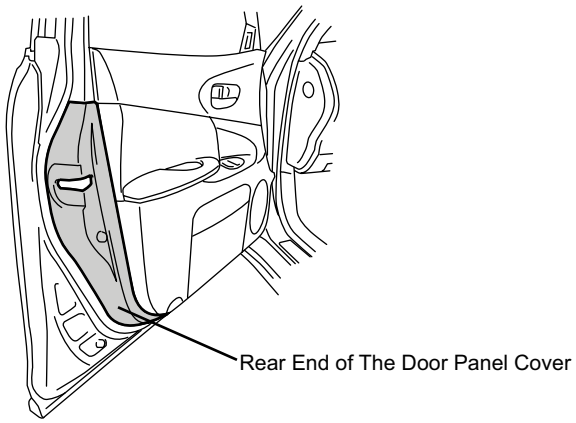
Door Trim

- The door trim uses formed urethane as the base material for weight reduction. It is constructed to comprehensively cover the inner door panel to realize a good appearance when the door is open.
- A power window switch base made of genuine wood panel is provided. The armrest cover is double-stitched to produce a luxurious look.
- The models equipped with genuine leather seats use ornaments covered with genuine leather.
- TPO (Thermo Plastic Olefin) cover is used on the door trim for recyclability.
- Open-and-close type front door trim pockets and rear door trim pockets are provided to ensure superior storability. Both the front and rear doors are provided with door courtesy lights to facilitate the in-and-out access of the occupants at night.



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- A plastic cover is provided at the back end of the door panel. This conceals the body panel and the lock fastening bolts to improve the appearance.

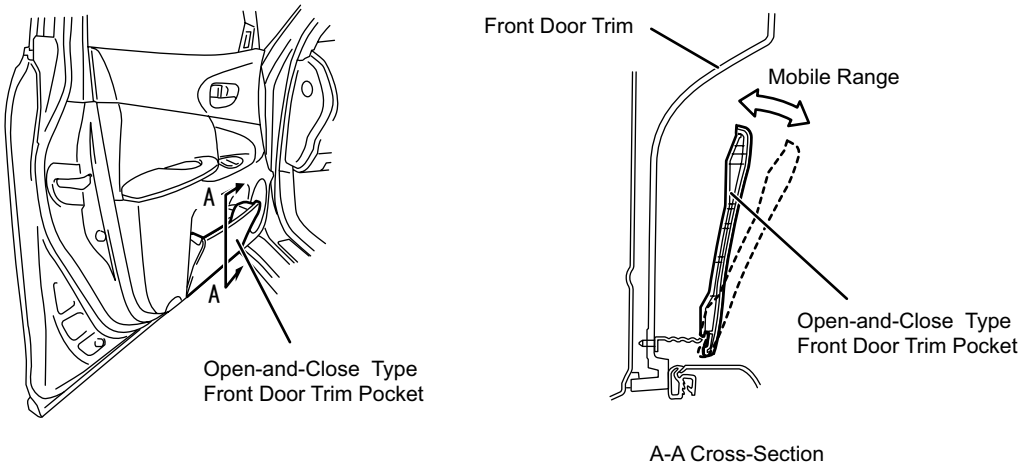


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Front Door Pocket

• The door pocket is the open-and-close type, which provides a greater storage space to store A4-size maps and the like.

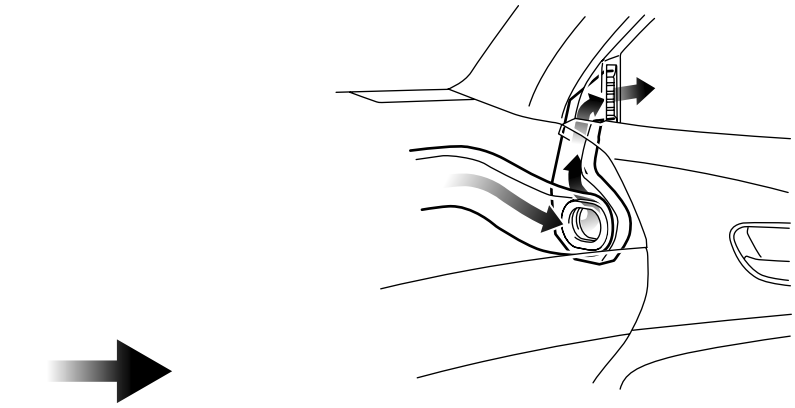
Front Door Pocket

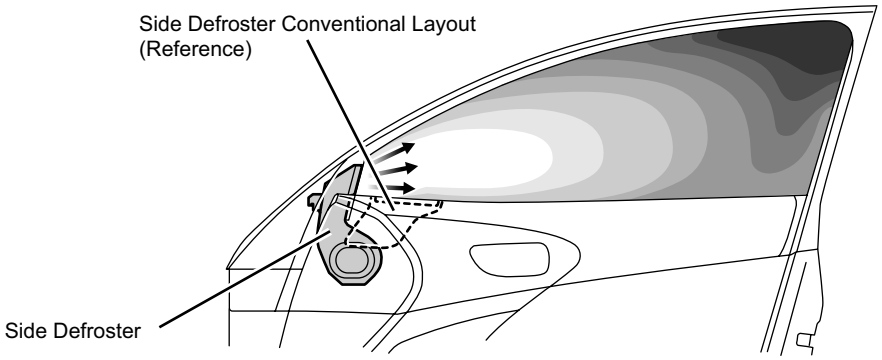


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Front Door Glass Defroster

• The defroster, which was located in the door trim on the previous model, has been relocated to the triangular patch to improve the clearing performance of the front door glass and enhance the door trim design.



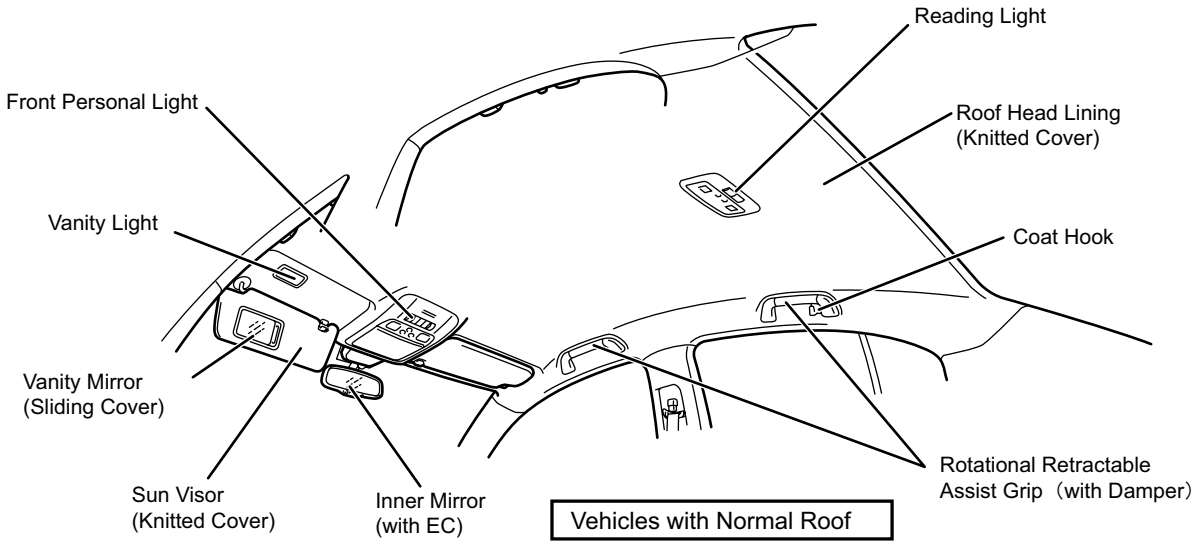


Front Door Window Glass Sunshine Pattern

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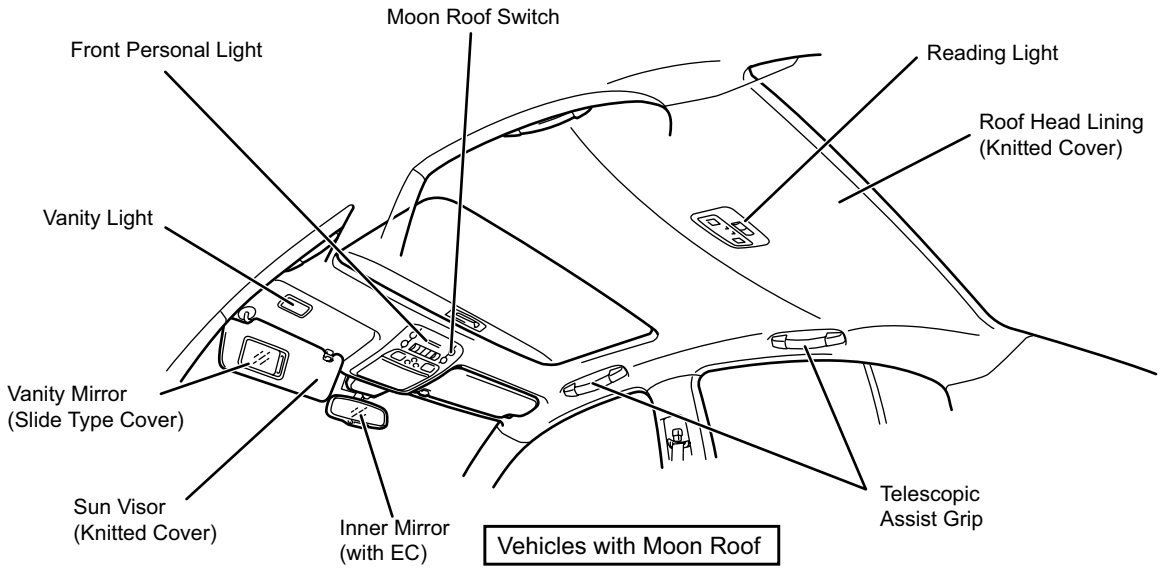
Roof

- A molded roof headlining with a knit cover is used.
- A vanity mirror with a sliding cover is provided on the back of the sun visor for the driver and the front passenger. A vanity light is located on the roof headlining for ease of use.
- A front personal light and a reading light are provided under the roof. A small storage box is provided in front of the front personal light.
- A head impact protection structure is used on the roof side.
- A rotational retractable assist grip with a damper is used on the roof side of the models with the normal roof. A coat hook is provided on the rear assist grip.



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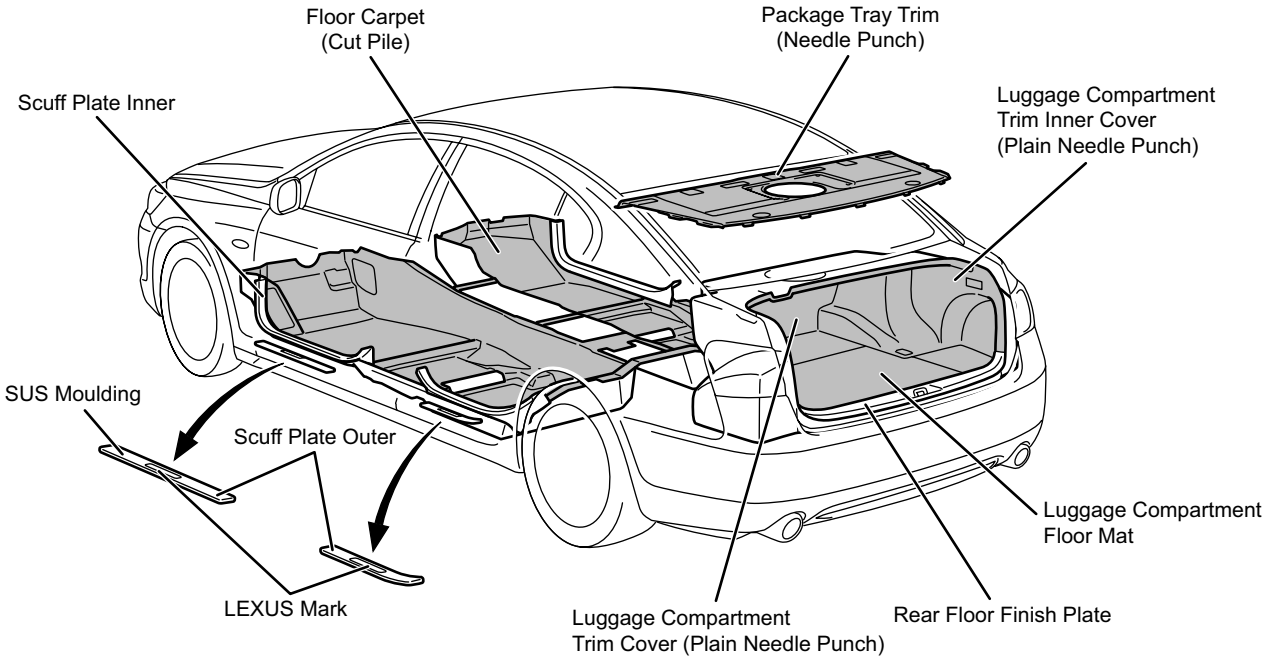
- A moon roof is available on all models as a manufacturer's option.
- A telescopic assist grip is used on the roof side of the models equipped with a moon roof. A coat hook is provided on the rear assist grip.
- A moon roof switch is provided inside the front personal light on the models equipped with a moon roof.



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Floor and Rear

- A cut pile carpet is provided on the floor and a plain knee pan is provided in the luggage compartment.
- Inner and outer scuff plates are provided at the bottom of the front and rear door openings, and a rear floor finish plate is provided at the luggage compartment door to facilitate the in-and-out access and protect the body from scratches.
- Inner and outer scuff plates are provided at the bottom of the front and rear door openings, and a rear floor finish plate is provided at the luggage compartment door to facilitate the in-and-out access and protect the body from scratches.
- Luggage hooks and rope hooks are provided in the luggage compartment for usability.

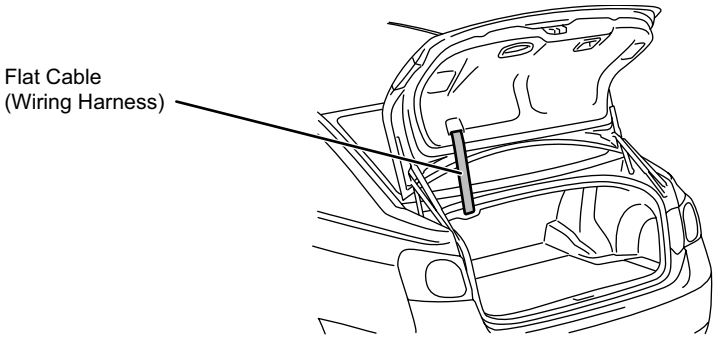


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- A flat cable (wiring harness) is provided between the luggage compartment door and the luggage compartment. Accordingly, the cable (wiring harness) becomes stored in the luggage compartment when the luggage compartment door is closed.

❒ **NOTICE**

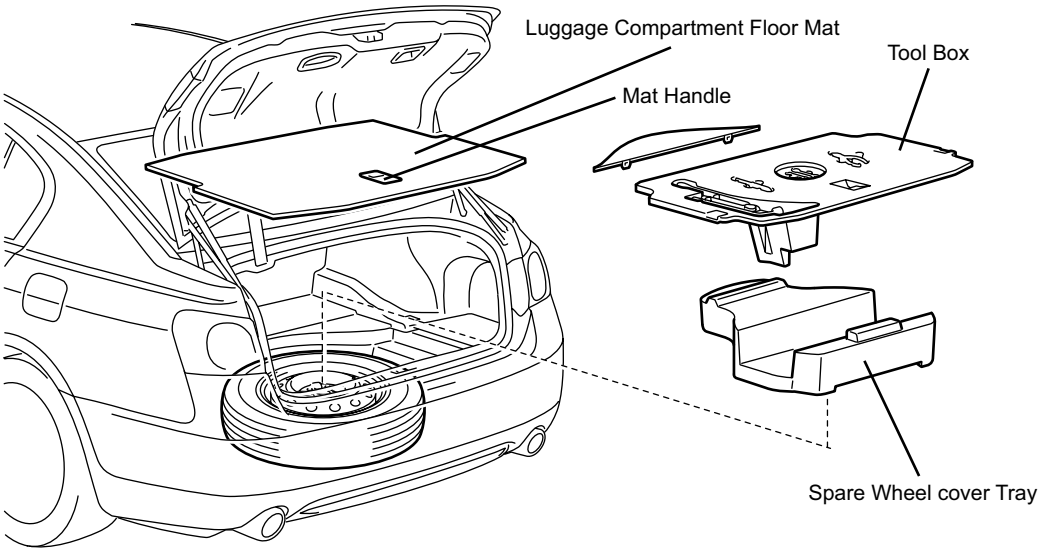
The flat cable contains a wiring harness. Pulling the flat cable with your hands or suspending a clothes hanger on it could cause an open circuit. Therefore, handle it carefully.



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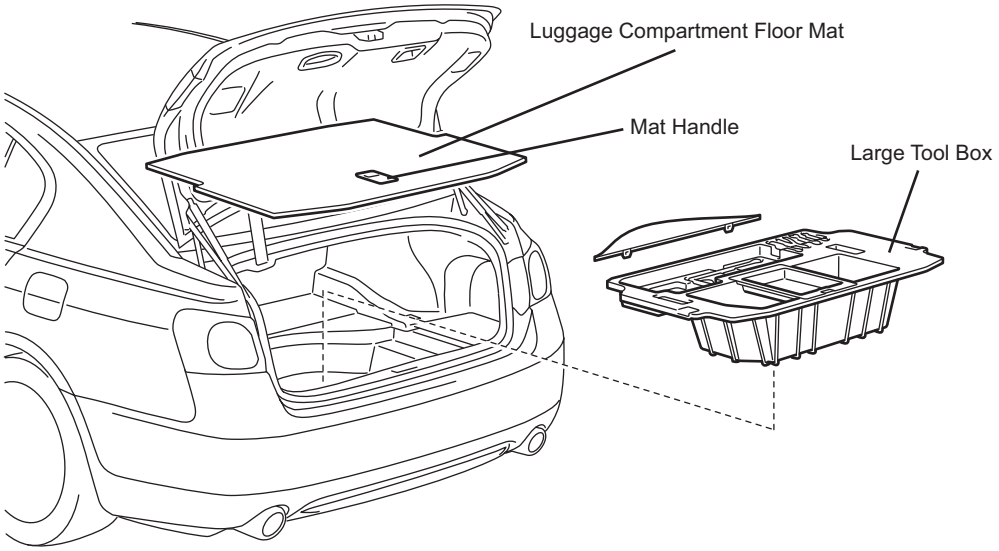
Underfloor Storage space

- A mat handle is provided. It raises the floor mat in the luggage compartment, while it can be hooked simultaneously to the upper area of the luggage compartment opening.
- A tool box that can store tools in an orderly manner is provided under the floor mat in the luggage compartment.
- A large toolbox is provided on the model equipped with the run-flat tires. It can display tools neatly while excelling in storage performance.



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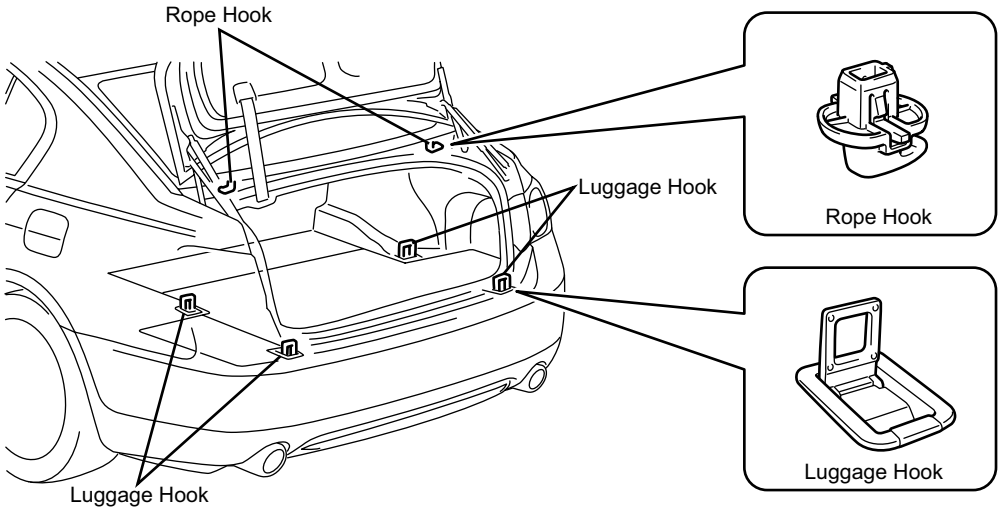
Model Equipped With The Run-Flat Tires



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Luggage Hook

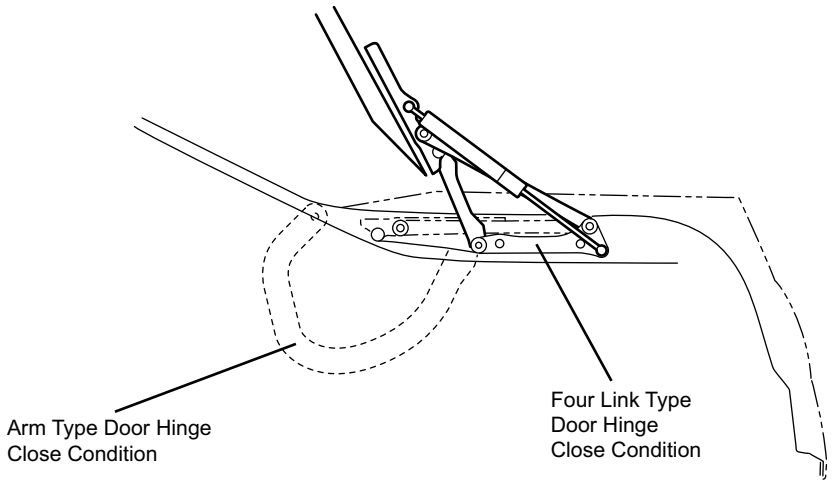
• Luggage hooks are provided on the floor of the luggage compartment and rope hooks are provided in the upper back area of the luggage compartment trim cover. The luggage hooks are plated for good looks.



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Luggage Door Hinge

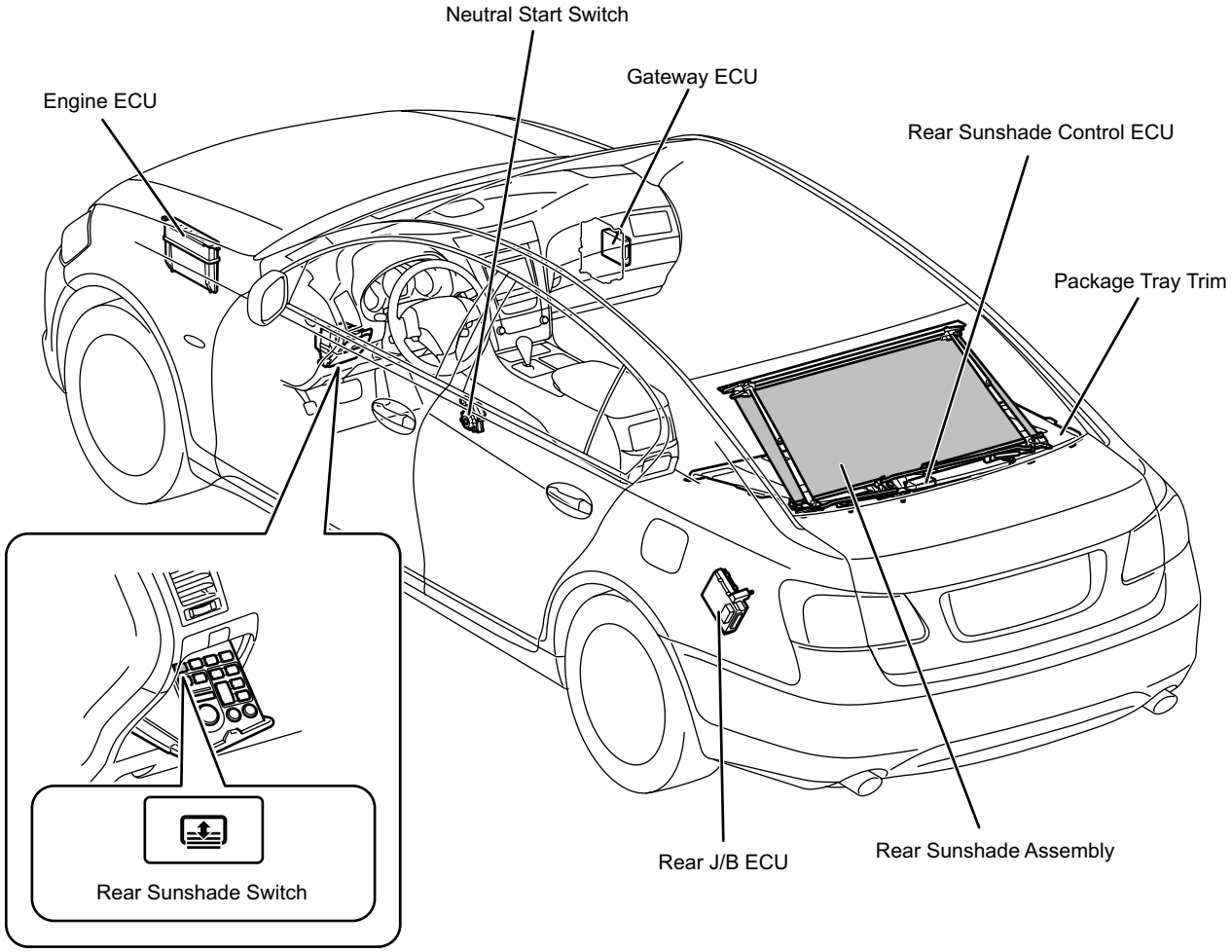
• Four-link type hinges have been adopted for the luggage door.These hinges,which eliminate the protrusion of the door hinges into the luggage compartment when the luggage door is closed,effectively increase the luggage compartment capacity and helps to prevent luggage from being damaged.



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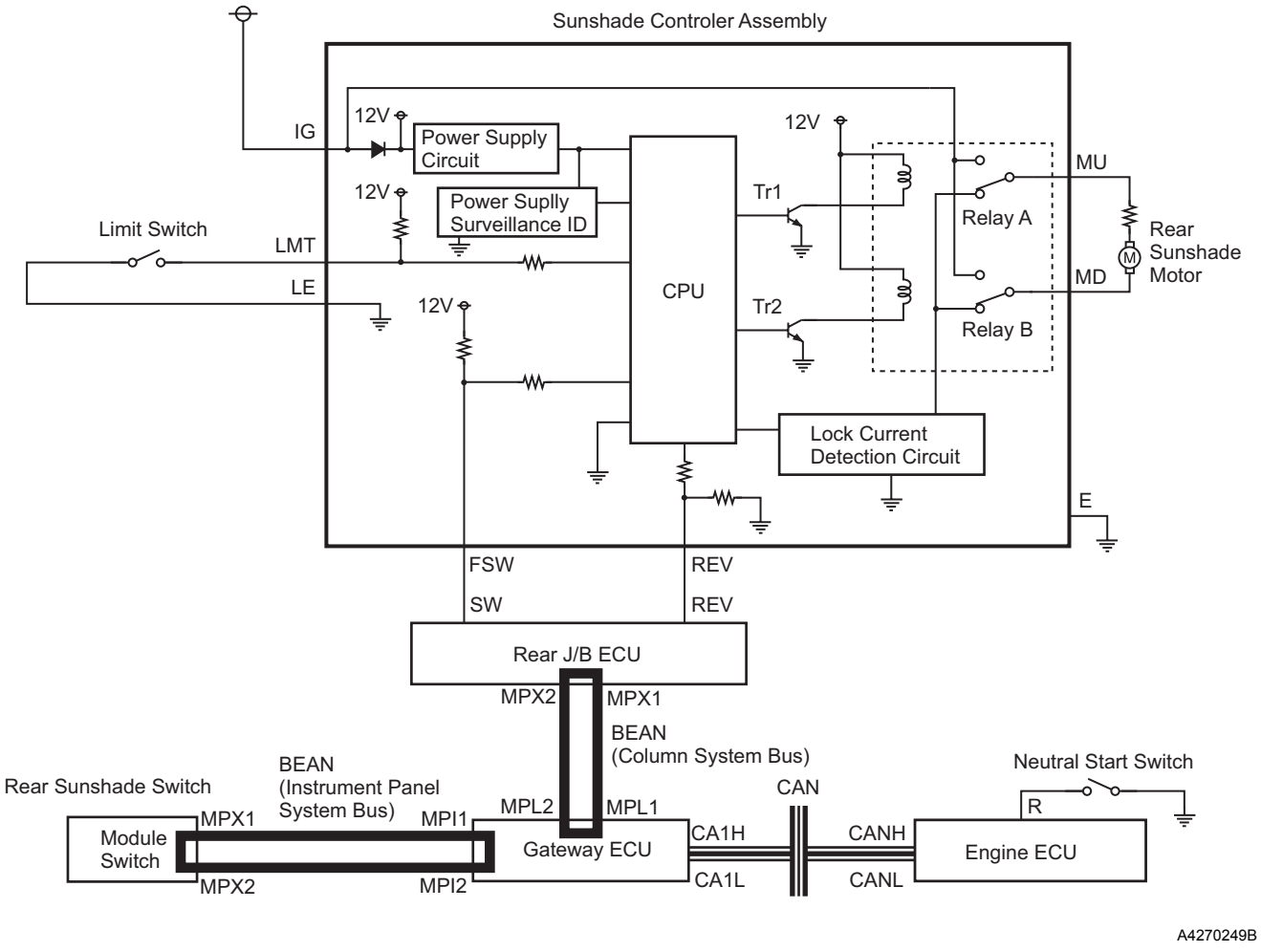
Rear Sunshade

- A power rear sunshade located on the package tray trim is available as optional equipment on all models.
- When the user operates the rear sunshade switch while the engine switch is ON, the power rear sunshade is deployed to cover the back window glass and protect the rear seat occupants from direct sunlight.
- To prevent the rear view from being blocked by the deployed sunshade, this system is provided with a reverse-linked auto-down function, which automatically lowers the sunshade when the shift lever is engaged in R (reverse). The reverse-linked auto-down function supports the customizable function through the use of the diagnosis tool (hand-held tester). Thus, the response time of the reverse-linked auto-down function can be changed as follows: 0.7 seconds, 1.2 seconds, 0.9 seconds, and none: 0 seconds.
- The power rear sunshade stores completely in the package tray trim, thus ensuring good looks when it is not being used.
- The power rear sunshade consists of the following components: the rear sunshade assembly, rear sunshade control ECU, and rear sunshade switch. In addition, it uses the following ECUs that are related to the reverse-linked auto-down control: engine ECU, luggage room J/B ECU, etc.



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System Diagram



Open/Store Operation

- When the user operates the rear sunshade switch, the sunshade controler receives the input of this signal.
- Upon receiving the input of the ON signal from the rear sunshade switch while the ignition is ON and the limit switch is ON (rear sunshade in the retracted position), the CPU in the sunshade controler turns Tr1 ON. This causes relay A to turn ON, thus allowing the current to flow from the MU terminal to the rear sunshade motor, and the MD terminal. As a result, the motor operates in the normal direction to deploy the rear sunshade. After the rear sunshade completes its deployment, the CPU detects that the motor has locked, and turns Tr1 and relay A OFF, in order to stop the operation of the motor.
- Upon receiving the input of the ON signal from the rear sunshade switch while the ignition is ON and the limit switch is OFF (rear sunshade in a position other than retracted), the CPU in the sunshade controler turns Tr2 ON. This causes relay B to turn ON, allowing the current to flow from the MD terminal to the rear sunshade motor and the MU terminal. As a result, the motor operates in the reverse direction to retract the rear sunshade. After the rear sunshade completes its retraction, the CPU detects that the motor has locked, and turns Tr2 and relay B OFF, in order to stop the operation of the motor.

Reverse-Linked Retraction Operation

- When the shift lever is put into the R (Reverse) range, the reverse signal from the neutral start switch is input by the engine ECU, and is transmitted to the gateway ECU using CAN communication. The gateway ECU uses bidirectional body electronics area network (column system bus) to transmit the signal it received to the luggage room J/B ECU, which then transmits from terminal REV to the sunshade controler.
- When the CPU in the sunshade controler inputs a reverse signal from terminal REV while the limit switch is ON (rear sunshade is not stored), relay A is turned OFF and relay B is turned ON. This rotates the motor in reverse to store the rear sunshade.

Fail-Safe Operation

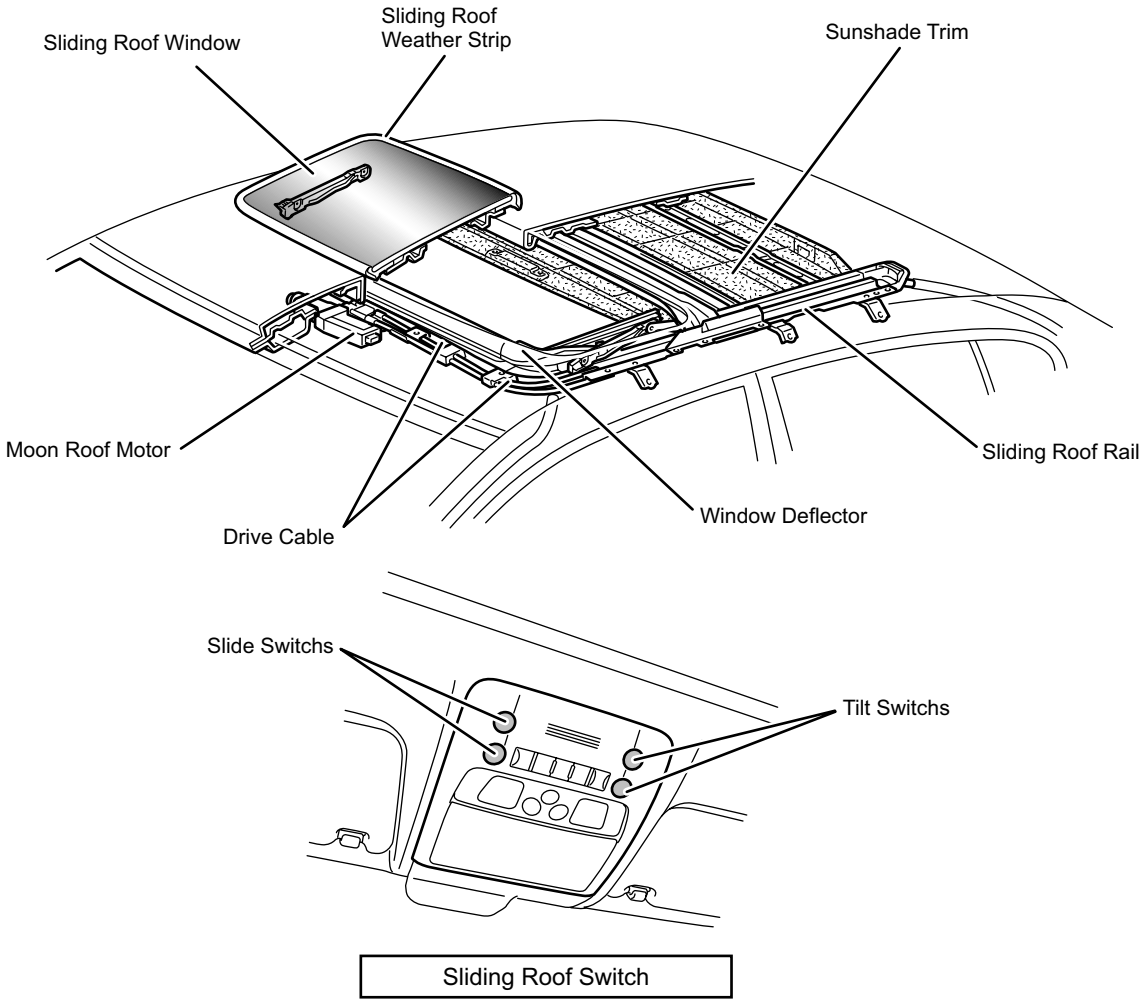
- If the motor does not stop (the CPU does not detect the locking of the motor) after approximately 15 seconds have elapsed from the time the motor started its normal or reverse operation, a timer function that is programmed in the CPU of the sunshade controler turns relay A or B OFF, in order to stop the operation of the motor.

SLIDING ROOF

Moon Roof System

- A "tilt & slide power moon roof", which is provided with various functions such as a one-touch auto function and a jam protection function, is used and made available on all models as a manufacturer's option.
- In addition to a key-off operation function, the moon roof system is provided with a warning function to warn the user if the sliding roof is left open, as well as a door key-linked and a transmitter-linked open-close function for superior ease of use.
- Two switches are provided for the sliding roof: a dedicated tilt switch and a dedicated slide switch. They are located in the front personal light area.
- A pulse sensor (with Hall ICs) is used to detect the position and the movement direction of the sliding roof glass, which is needed for system control. After an inspection or maintenance service is performed, the system must be initialized.
- Privacy glass (dark gray) is used for the sliding roof glass.

Moon Roof System Components



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Necessity of Initializing Moon Roof Glass Position

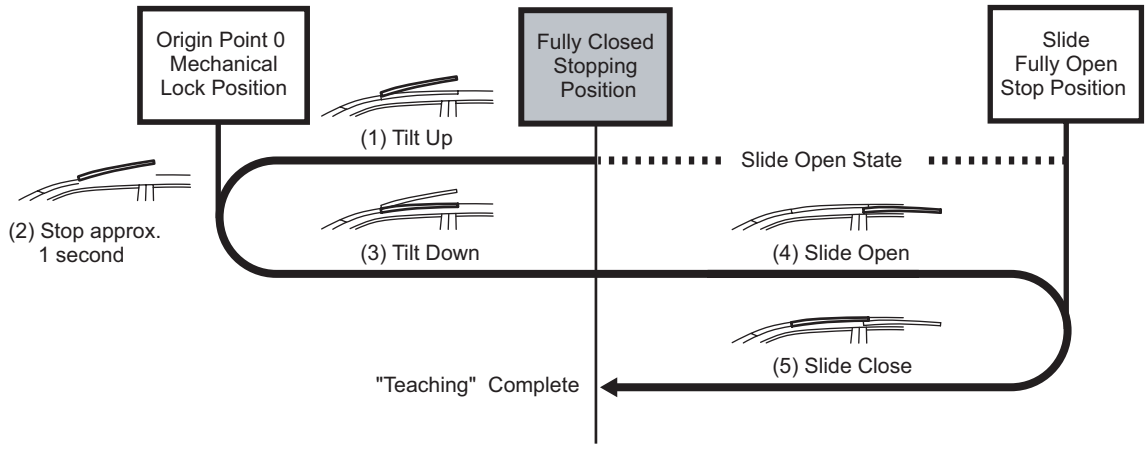
- This system uses a pulse sensor to electrically fetch information pertaining to the current position of the sliding roof glass by way of the rotational movement of the motor. Based on this position information, this system controls various types of functions.
- If the battery is reconnected (initial application of the +B power supply) after an inspection or maintenance service, or the connector of the sliding roof control ECU is disconnected and reconnected, the sliding roof glass position information that is presently stored in the system memory becomes lost. For this reason, the system must be initialized to "teach" the sliding roof glass position to the system.
- Beware that some functions, such as the jam protection function, do not operate if the system has not been properly "taught" the present sliding roof glass position.

Precautions in case the system has not been properly "taught" the sliding roof glass position

- The jam protection function will not function. (If a foreign object gets jammed between the sliding roof glass and the roof opening, causing a load exceeding a predetermined value to act on the sliding roof glass, the sliding roof glass will stop but it will not operate in reverse.)
- The one-touch auto function, key-off operation, and the door key-linked function will not operate.
- The user can operate the sliding roof glass while pressing the sliding roof switch. However, the sliding roof glass will not stop automatically when it reaches the fully closed position.

Initialization Operation

- If the sliding roof glass is open, first operate the sliding roof glass to the vicinity of the fully closed position.
- Turn the ignition ON, and press and hold the slide-close or tilt-up side of the sliding roof switch.
- While the switch is held pressed, the sliding roof glass operates in the following sequence: tilt up (stopping approximately 1 second), tilt down, slide open, and slide close.
- Thereafter, the sliding roof glass comes to stop at the fully closed position, thus completing the initialization operation.
- If you release the switch during the initialization operation, start the operation from the beginning. After completing the initialization operation, make sure to inspect the functions of the sliding roof system. For details on the initialization operation and the inspection of functions, refer to the repair manual.



Transition of Sliding Roof Glass During Initialization Operation

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One-Touch Tilt Up-and-Down Function

- When the up <or down> side of the tilt switch is pressed for more than approximately 0.3 seconds while the ignition is ON, the sliding roof glass will automatically perform a tilt-up operation <or tilt-down operation> until it reaches the fully open <or fully closed> position.
- The auto tilt operation can be interrupted by pressing the tilt switch while the sliding roof glass is undergoing an auto tilt operation.

One-Touch Sliding Open-and-Close Function

- When the user presses the open <or close> side of the slide switch for more than approximately 0.3 seconds while the ignition is ON, the sliding roof glass will automatically perform a slide open <or slide close> operation until it reaches the fully open <or fully closed> position.
- The auto slide operation can be interrupted by pressing the slide switch while the sliding roof glass is undergoing an auto slide operation.

Manual Adjustment Function

- The user can manually operate the sliding roof glass to either direction by pressing an individual sliding roof switch for less than approximately 0.3 seconds while the ignition is ON.
- During an automatic operation, the user can press a sliding roof switch to momentarily stop the automatic operation. Then, the user can manually operate the sliding roof glass to either direction by pressing a sliding roof switch for less than approximately 0.3 seconds, in order to adjust the amount of roof opening.

Jam Protection Function

- If the system detects the jamming of a foreign object between the sliding roof and the roof opening during a tilt-down or slide-close operation, the sliding roof will automatically operate in reverse (tilt-up or slide-open). The jam protection function detects jamming through the changes in the rotational speed of the motor (or the locking of the motor). Therefore, if the rotational speed of the motor is unaffected, such as when a thin object is jammed along the side of the sliding roof, the system might not recognize it as being jammed.
- If the system does not detect jamming for some reason, such as in the event of a failure in a sensor, the one-touch auto function will not operate.

Jam Protection During Tilt-Down

The system will perform a tilt-up operation until the sliding roof reaches the fully open (full tilt-up) position, regardless of the position in which the system has detected jamming.

Jam Protection During Slide-Close

The system will perform a slide-open operation until the sliding roof reaches approximately 218mm from the position in which the system has detected jamming or until the sliding roof reaches the fully open (full slide-open) position.

Key-OFF Operation Function

- For approximately 45 seconds after the ignition is turned from ON to OFF, or until the driver's door is operated from open to close, this function enables the operation of the sliding roof in the same way as when the ignition is ON. If approximately 45 seconds have elapsed during a roof glass operation, or if the driver's door is operated from open to close, the post-key OFF function will continue until this operation is completed.

Key-Linked Open and Close Function

- If the user inserts a key plate into the driver's door key cylinder, turns it in the locking direction, and holds it in that position for more than approximately 2.5 seconds, the sliding roof will perform a 'close' operation (and the jam protection function will also function). While the user keeps the key plate turned in the unlocking direction, the sliding roof will perform an 'open' operation.
- The door key-linked function is a type of manual operation that maintains an operation while the user holds the key plate in the locking or unlocking direction. Therefore, this function stops the operation when the user returns the key plate to the neutral position.
- The door key-linked open and close function of the sliding roof system is linked to the door key-linked door glass window up and down function of the power window system.

Transmitter-Linked Open and Close Function

- If the user holds the lock button of the transmitter pressed for more than approximately 2.5 seconds, the sliding roof will perform a 'close' operation (and the jam protection function will also function). If the user holds the unlock button pressed, the sliding roof will perform an 'open' operation. The wireless buzzer will sound (an answerback function) at the start of this operation.
- The transmitter-linked function is a type of manual operation that maintains an operation while the user keeps the button pressed and stops the operation when the user releases the button.
- The transmitter-linked open and close function of the sliding roof system is linked to the transmitter-linked door glass window up & down function of the power window system.

Moon Roof Closing Reminder Warning Function

- When the driver turns the ignition from ON to OFF and opens the driver's door while the sliding roof glass is open, the multi-buzzer in the combination meter emits an attenuated sound once to warn the driver that the sliding roof glass has been left open.

SMART ENTRY & START SYSTEM-Linked Close Function

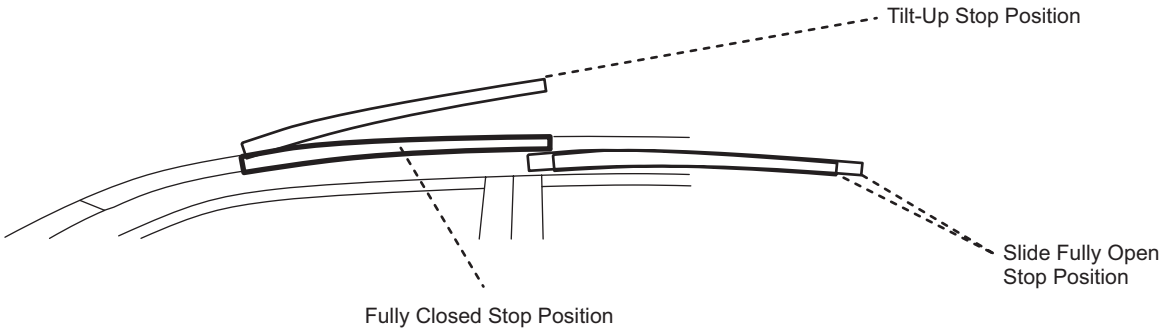
- After door lock operation is effected by the SMART ENTRY & START SYSTEM, if the user continues to press the lock switch for more than approximately 3 seconds, the sliding roof will start a tilt-down or a slide-close operation that is linked to the power window up operation.
- The door lock by the SMART ENTRY & START SYSTEM-linked close function is a type of manual operation that maintains an operation while the user keeps the lock switch pressed and stops the operation when the user releases the switch.

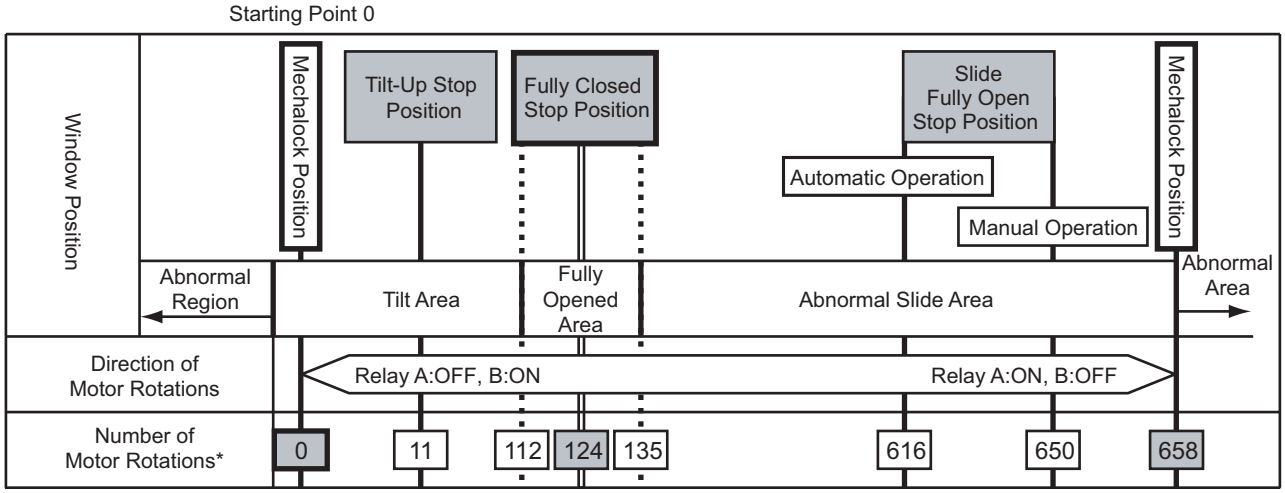
The Overload Stop Function

- If the system detects a load that exceeds a predetermined amount as a result of an obstacle coming in contact with the sliding roof glass during a tilt-up or slide-open operation, this function automatically stops the operation.
- The overload stopping function operates during a tilt-down or slide-close operation as well, if the system is not initialized.

Moon Roof System Control

- The sliding roof control ECU recognizes the position of the sliding roof glass as illustrated in the diagram below. It uses the mechanical lock position of the tilt-up side as the origin point, in accordance with the input pulse signals received from Hall IC1 and Hall IC2. The sliding roof control ECU compares this positional information against the operation signal from the sliding roof switch in order to control the sliding roof control motor.





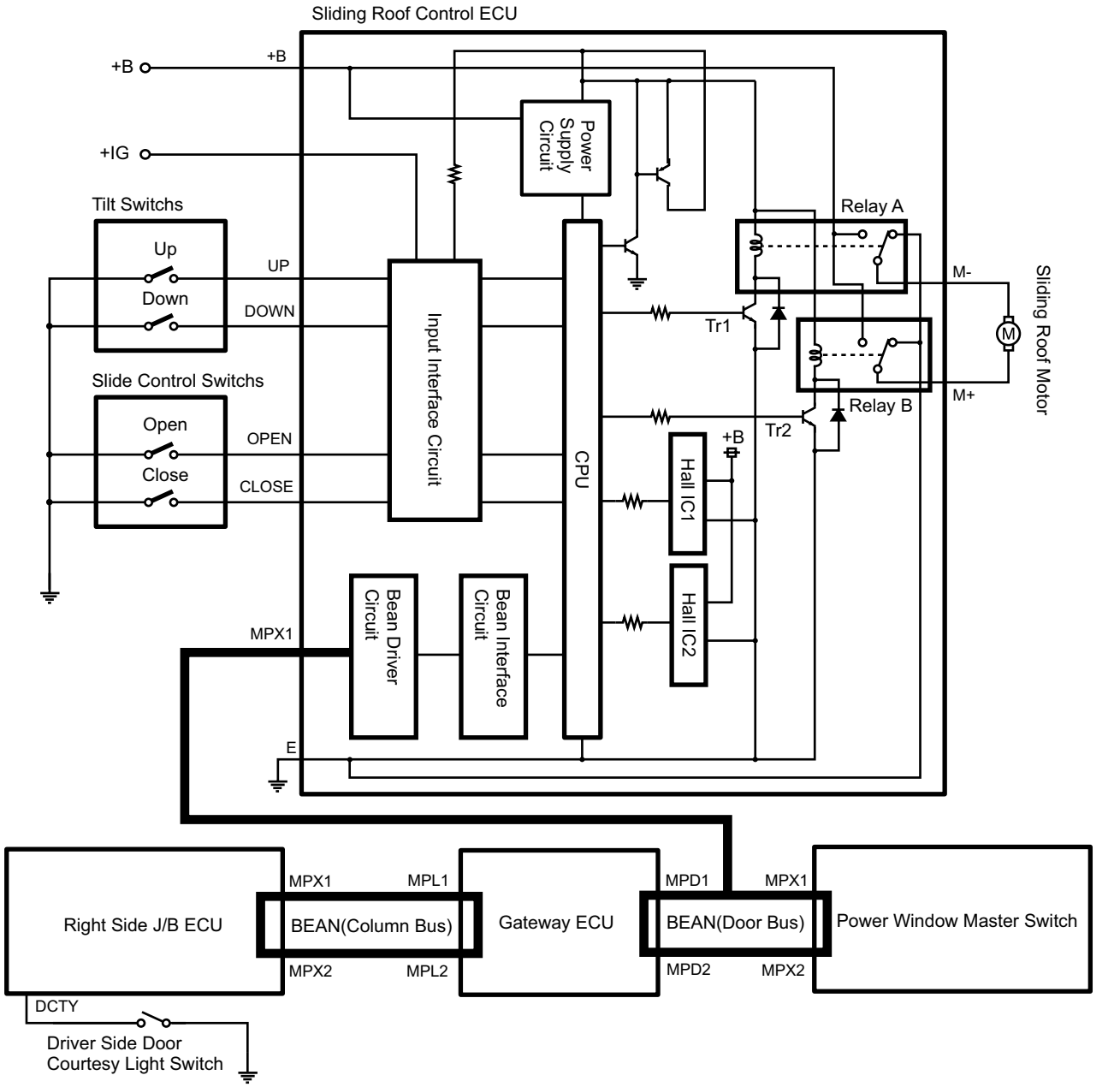
* : The figures representing the sliding roof motor speeds are approximations and may differ from the actual measurement data.

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Initialization

With respect to the sliding roof glass position information recognized by the sliding roof control ECU, the full tilt-up position (mechanical lock position) is stored in memory as the origin point 0. If this position information is lost, it is necessary to initialize the system by "teaching" the system the sliding roof glass position information. To do so, the system must be made to recognize the origin point by performing a tilt-up operation. : BO-102

System Diagram



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BO

Operation of One-Touch Tilt Up-and-Down Function

- While the sliding roof control ECU detects the fully closed region (tilt region), if the ECU receives the input of an UP-ON <or DOWN-ON> signal from the tilt switch for more than approximately 0.3 seconds, the ECU causes relay A <or relay B> to turn ON, and rotates the sliding roof motor in the close/up direction <or open/down direction>.
- The sliding roof control ECU counts the pulse signals from the Hall ICs. When the sliding roof control ECU detects that the sliding roof glass has reached the full tilt-up stop position <or fully closed stop position> based on the motor speed, it turns relay A <or relay B> OFF to stop the sliding roof motor. If the sliding roof control ECU receives the input of either ON signal from the tilt switch during an automatic operation, it will turn relay A <or relay B> OFF in the same way.

Operation of One-Touch Sliding Open-and-Close Function

- While the sliding roof control ECU detects the fully closed region (slide region), if the ECU receives the input of an OPEN-ON <or CLOSE-ON> signal from the slide switch for more than approximately 0.3 seconds, the ECU causes relay B <or relay A> to turn ON, and rotates the sliding roof motor in the open/down direction <or close/up direction>.
- The sliding roof control ECU counts the pulse signals from the Hall ICs. When the sliding roof control ECU detects that the sliding roof glass has reached the full slide open stop position <or fully closed stop position> based on the motor speed, it turns relay B <or relay A> OFF to stop the sliding roof motor. If the sliding roof control ECU receives the input of either ON signal from the slide switch during an automatic operation, it will turn relay B <or relay A> OFF in the same way.

Operation of Jam Protection Function

- During a tilt-down/slide-close operation (excluding manual control effected through the operation of the sliding roof switch), if the sliding roof control ECU detects changes in the pulse signals from the Hall ICs (detecting that the motor rotational speed has decreased or the motor has locked), the sliding roof control ECU determines that a foreign object is jammed in the sliding roof glass. Therefore, the sliding roof control ECU turns OFF the relay that is currently ON and turns ON the relay that is currently OFF, in order to operate the sliding roof motor in the reverse direction.
- The sliding roof control ECU will turn the relay OFF to stop the sliding roof motor if it detects any of the following: the full tilt-up position (jamming during tilt-down), the position in which approximately 218mm of reverse operation is detected by way of pulse signals from the Hall ICs, or the full slide-open position (jamming during slide-close).

Key-Off Operation

- Approximately 45 seconds after the ignition is turned from ON to OFF, or during the time the driver's door courtesy light switch changes from ON to OFF, the right side junctionblock ECU transmits a "post key-OFF operation authorization" signal to the sliding roof control ECU via the BEAN (Body Electronics Area Network).
- While receiving the "post key-OFF operation authorization" signal, the sliding roof control ECU effects the same control as when the ignition is ON. However, if the sliding roof is undergoing an automatic operation or a jamming reverse operation when the reception of the signal is completed, the sliding roof control ECU will continue this control until the operation is completed.

Operation of Key-Linked Open and Close Function

- When the power window master switch receives the input of a signal indicating the UNLOCK-ON <or LOCK-ON> state of the door lock control switch (for key-linked operation) for more than approximately 2.5 seconds, the power window master switch will transmit a "door key-linked open <or close> operation" signal to the sliding roof control ECU via the BEAN (Body Electronics Area Network).
- While receiving the "door key-linked open <or close> operation" signal, the sliding roof control ECU implements open control <or close control> by turning ON the corresponding relay.

Operation of Transmitter-Linked Open and Close Function

- When the power window master switch receives a door unlock signal <or door lock signal> from the right side junctionblock ECU for more than 2.5 seconds, the power window master switch transmits a "sliding roof open <or close> operation" signal to the sliding roof control ECU via the BEAN (Body Electronics Area Network).
- While receiving the open signal <or close signal>, the sliding roof control ECU implements open control <or close control> by turning ON the corresponding relay.

Failsafe Pertaining to Setting Moon Roof Glass Position Data

Abnormal Moon Roof Glass Position Information

If the sliding roof control ECU determines that an error exceeding a predetermined value exists between the mechanical lock position of the sliding roof glass or the motor lock detection position and the position information that is memorized based on the pulse count provided by the Hall ICs (thus detecting that the sliding roof glass is in the abnormal region), the ECU will delete the memorized position information and transfers the control to the state in which it is not "taught" any position information.

Sensor (Hall IC) Failure Judgment

If a failure occurs in one of the two Hall ICs that are used for detecting the position, speed, and direction of the sliding roof glass, the sliding roof control ECU transfers the control to be the same as in the state in which it is not "taught" any position information. If a failure occurs in both Hall ICs, the sliding roof control ECU will effect control by changing the overload detection function that operates by way of a motor lock judgment.

Failsafe Pertaining to Moon Roof Motor Actuation

Continuous Operation Restriction Function

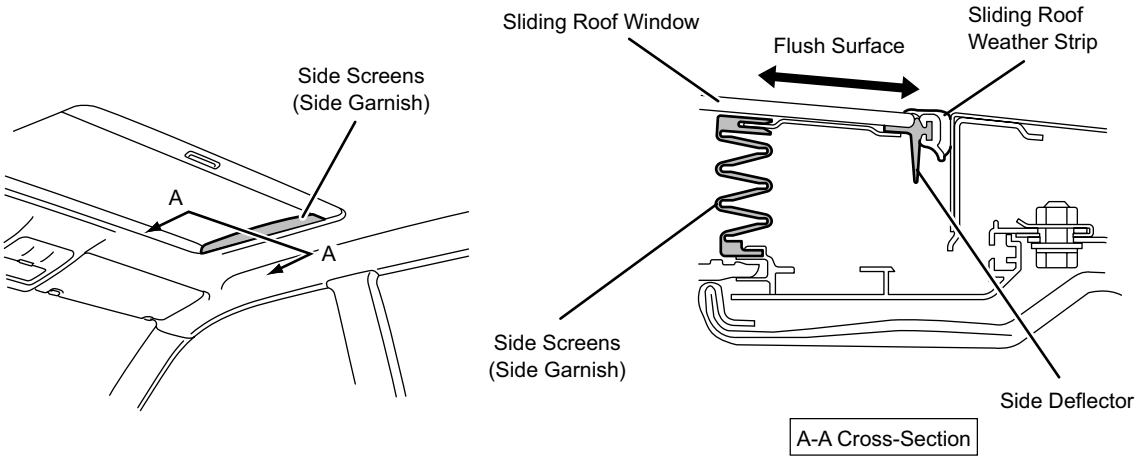
If the motor actuation time (relay ON time) provided by the sliding roof control ECU is too long, this function automatically turns OFF the relay after approximately 20 seconds (during slide operation) or approximately 3.5 seconds (during tilt operation) have elapsed. Thus, it protects the motor and the circuit.

Forced Teaching Operation (jam protection function Cancel Operation)

A failure in the jam protection function may create the problem of preventing the sliding roof glass from closing fully (by preventing it from stopping at the fully closed position). If this occurs, the driver can press the tilt switch UP or the slide switch CLOSE for more than approximately 10 continuous seconds in order to force the control to transfer into a state in which it is not "taught" any position information. Then, the driver can correct the position information by performing an initialization operation.

Moon Roof Glass and Side Garnish

- The offset between the sliding roof glass and the weatherstrip has been reduced to enhance the appearance from the vehicle exterior.
- A side deflector and a side screen (side garnish) are provided along the sides of the sliding roof glass to reduce wind noise during a tilt-up and to enhance the appearance from the vehicle interior.



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Failsafe Pertaining to Setting Moon Roof Glass Position Data

Abnormal Moon Roof Glass Position Information

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Failsafe Pertaining to Moon Roof Motor Actuation

Continuous Operation Restriction Function

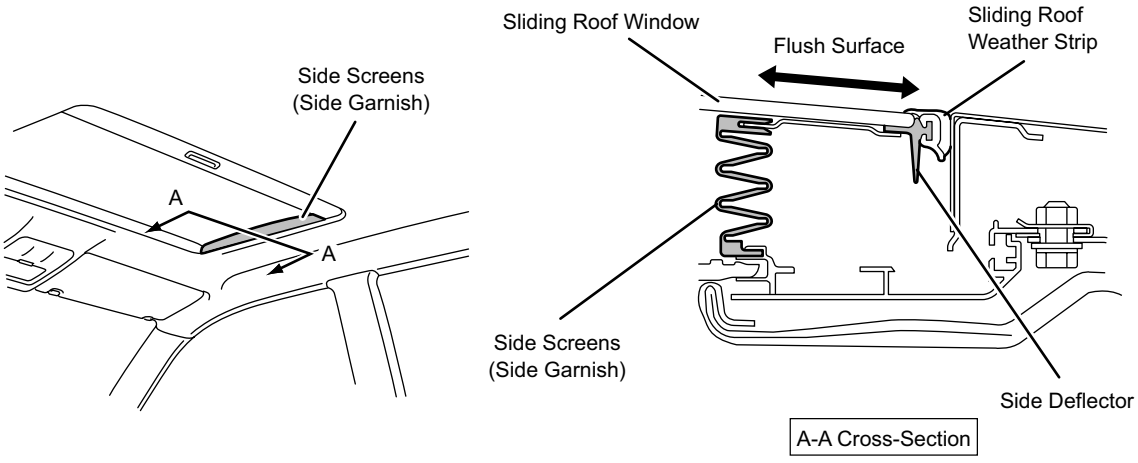
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Moon Roof Glass and Side Garnish

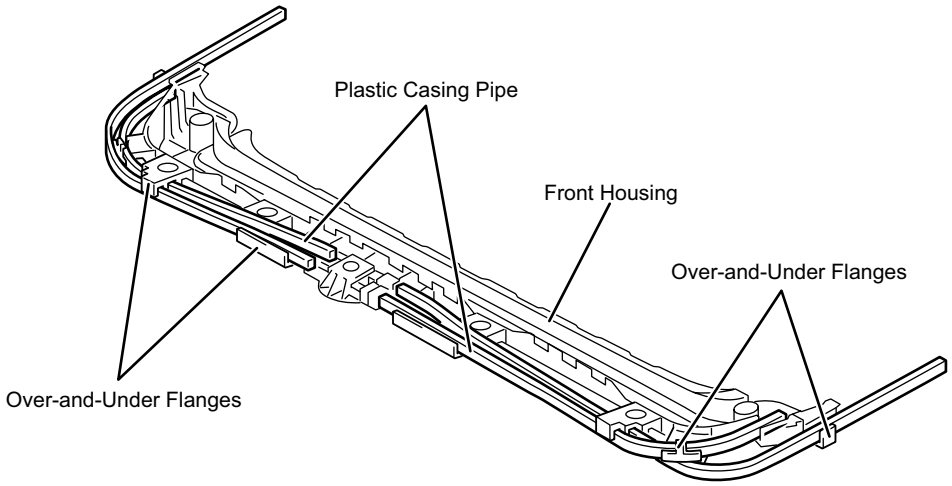
- The offset between the sliding roof glass and the weatherstrip has been reduced to enhance the appearance from the vehicle exterior.
- A side deflector and a side screen (side garnish) are provided along the sides of the sliding roof glass to reduce wind noise during a tilt-up and to enhance the appearance from the vehicle interior.



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Casing Pipe

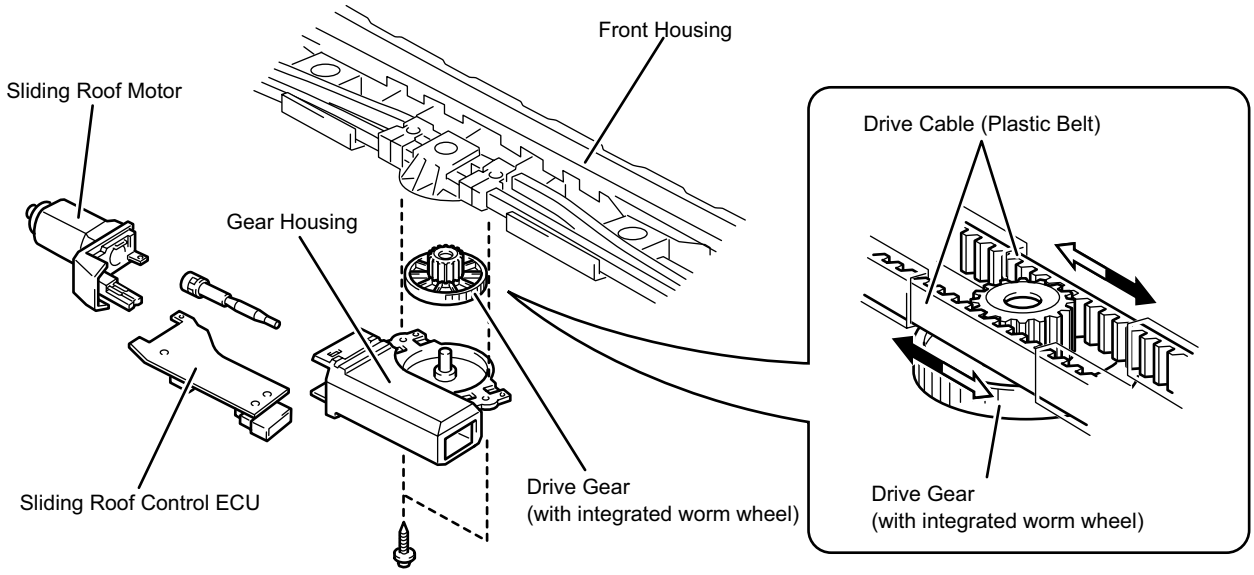
- A casing pipe made of plastic is used for the drive cable for weight reduction.
- The casing pipe is fitted in flanges that form an over-and-under zigzag construction in the front housing to simplify assembly.



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Roof Motor & Drive Cable

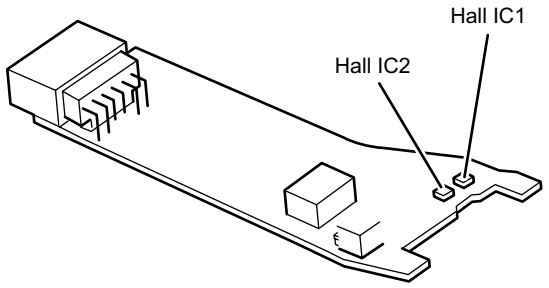
- The sliding roof motor assembly consists of a sliding roof motor, drive gear (with integrated worm wheel), sliding roof control ECU, etc.
- A plastic belt is used for the drive cable to improve sliding performance, and to reduce sliding resistance and operating sound. In addition, the use of a compact motor with a lower torque has been made possible by improving the torque transmission efficiency.
- The construction of the sliding roof motor assembly has been simplified by integrating the cover for the gear with the front housing, as well as integrating the drive gear with the worm wheel.



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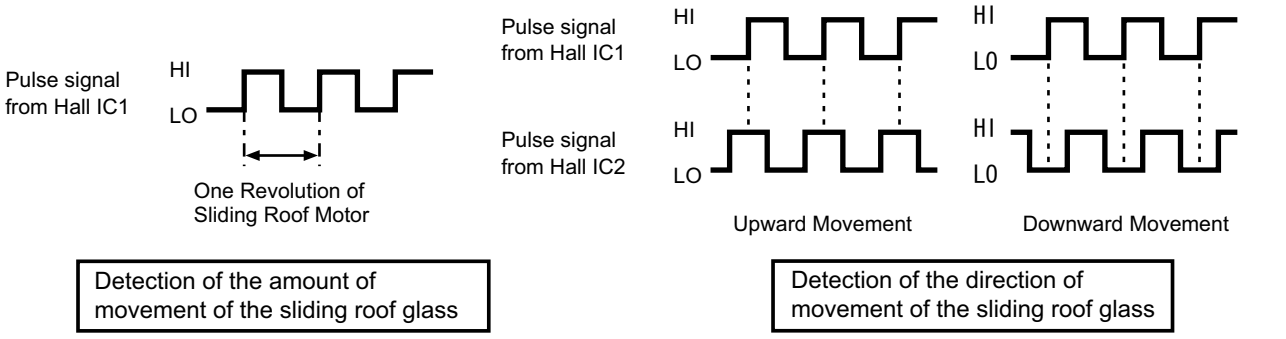
Hall IC

• The two Hall ICs output pulse signals, which are synchronized to the rotational movement of the sliding roof motor, to the CPU in the sliding roof control ECU.



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• The CPU counts one cycle of pulse per rotation of the axis of rotation of the motor that is output by Hall IC1, in order to detect the amount of movement of the sliding roof glass. In addition, the ECU detects the HI/LO cycles of pulses, which are output by Hall IC2, that vary in accordance with the direction of the motor. Thus, it detects the direction of the movement of the sliding roof glass. The ECU memorizes these pieces of information in order to recognize the present position of the sliding roof glass. *Based on the position information that is obtained from these two Hall ICs, the ECU controls various types of functions.

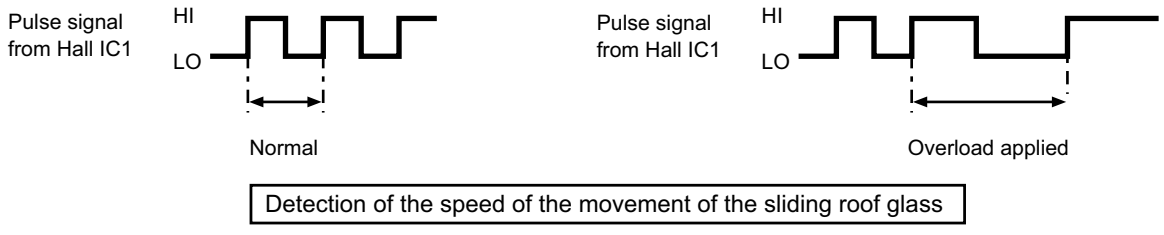


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❖REFERENCE❖

*The position information of the sliding roof glass is backed up by the +B power supply. Therefore, if the +B power supply to the sliding roof control ECU is cut off, the system must be initialized.

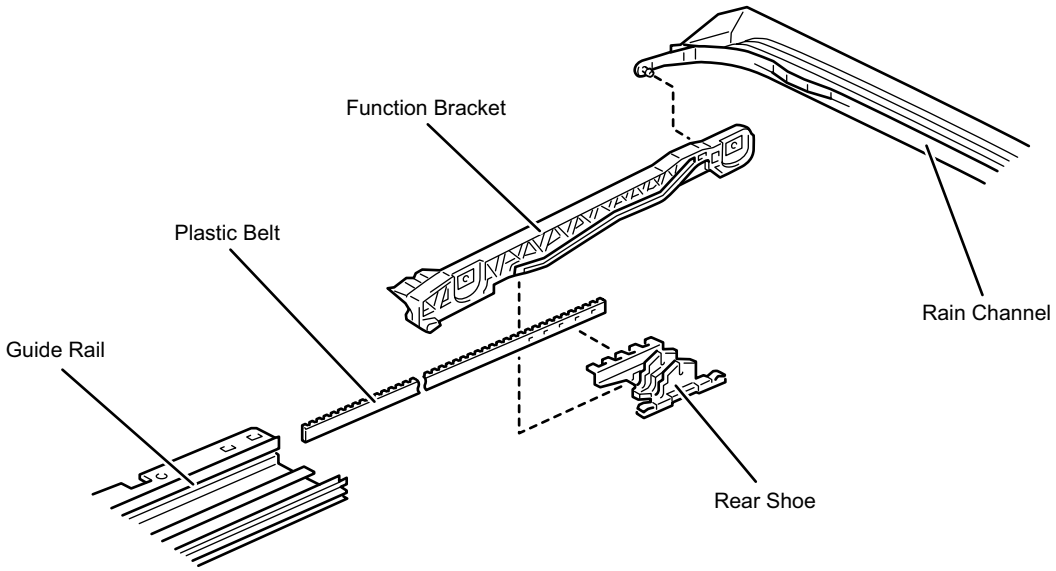
• At the same time, the CPU detects the changes in the rotational speed of the motor based on the intervals of the pulses that are output by Hall IC1. Thus, it detects the changes in the movement speed of the sliding roof glass. As a result, it recognizes the load that acts on the sliding roof glass, in order to control the jam protection mechanism and the overload stop function.



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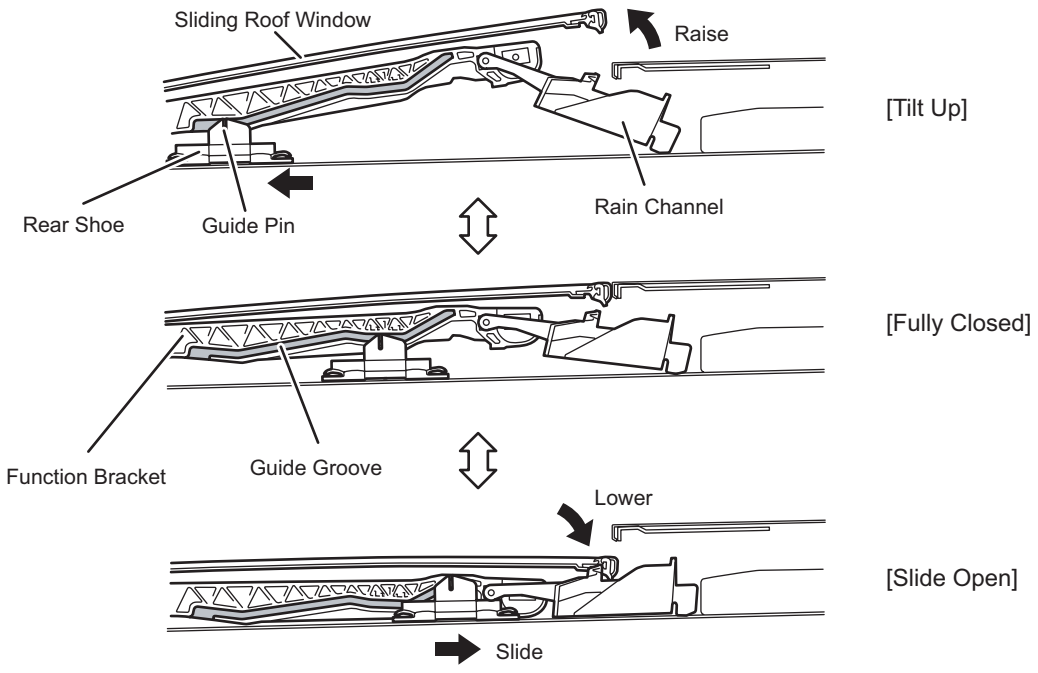
Function Bracket, Rear Shoe and Rain Channel

- The number of parts has been reduced in the function bracket and the rear shoe, and their construction has been simplified. The function bracket is an integrated plastic construction with a built-in front shoe, which is found in an ordinary sliding roof. The rear shoe is constructed without a linkage.
- The rain channel has been made compact for weight reduction.



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- When the rear shoe moves forward from the closed state of the sliding roof, the guide pin of the rear shoe slides along the guide groove in the function bracket. The guide groove in the function bracket is shaped to lift the sliding roof glass as the guide pin slides in the groove. This causes the rain channel, which is linked to the function bracket, to lift simultaneously.
- When the rear shoe moves backward from the closed state of the sliding roof, the guide pin slides along the guide groove of the function bracket in the same way as the forward movement of the shoe. The guide groove in the function bracket, in which the guide pin slides, is shaped to pull the sliding roof glass down. Then, the function bracket slides the sliding roof glass.

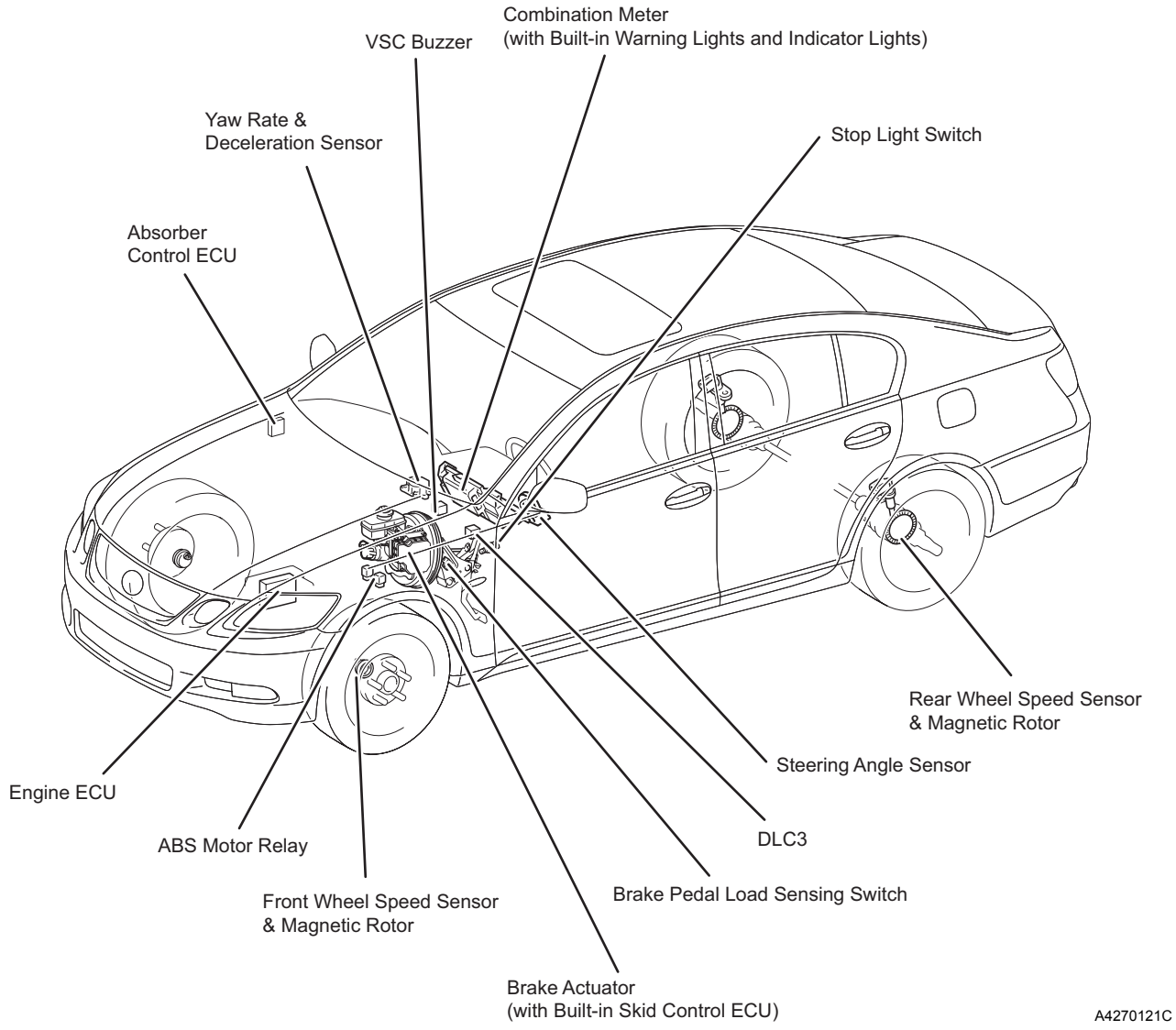


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ABS with EBD & BRAKE ASSIST & TRC & VSC BRAKE CONTROL

ABS with EBD & Brake Assist & TRC & VSC

- The skid control ECU processes the signals from the sensors in order to effect the brake control of the ABS, TRC, VSC, and the electronically controlled brake assist. Also, the skid control ECU maintains communication with the engine ECU by outputting control signals.
- The skid control ECU forms a part of the CAN (Controller Area Network) system. Similarly, the steering sensor, yaw rate & acceleration sensor, and the DLC3 connector maintain communication with the skid control ECU via the CAN (Controller Area Network).



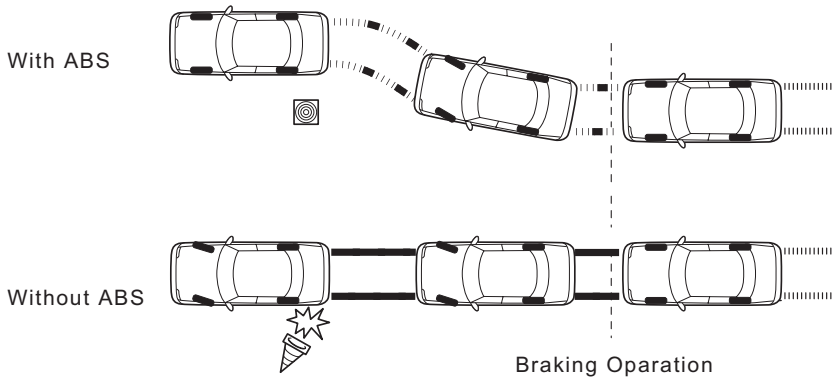
Main Components and Functions

Composition parts	Function
Vehicle Speed Sensor (semiconductor)	Detects the wheel speed and inputs the results to the skid control ECU.
Ignition Switch	Supplies power to the skid control ECU.
Yaw Rate & Deceleration Sensor	Detects the yaw rate (axial rotation) and the forward, rearward and lateral acceleration, and inputs the results to the skid control ECU.
Stop Light Switch	Detects the brake operating conditions and inputs the results to the skid control ECU.
Brake Pedal Load Sensing Switch	Brake pedal depression force is detected and it inputs into a skid control ECU.
Steering Angle Sensor	Detects the steering angle and direction, and outputs the results to the skid control ECU via a CAN communication.
Master Cylinder Pressure Sensor	Detects the pressure of the master cylinder and inputs the results to the skid control ECU.
Combination Meter	A slip indicator light, brake warning light, ABS warning light, and VSC warning(displayed on the multi-information display) are included in the combination meter.
Brake Actuator	Controls the hydraulic pressure of each of the four wheel cylinders using the output signal of the skid control ECU.
ABS Motor Relay	Controlled by the skid control ECU. Supplies power to the pump motor.
ABS Motor Breaker Relay	The power supply to the pump motor of an actuator is intercepted at the time of the abnormalities in a motor relay.
ABS Solenoid Relay(Built-in Brake Actuator)	Supplies power to the solenoid valves in the brake actuator.
VSC Buzzer	Sounds intermittently to inform the driver that the VSC is active.
Skid Control ECU	Processes the signals from each sensor to perform brake control for ABS, TRC, VSC, brake assist and hill assist. In addition, it communicates with the engine control ECU to output a control signal.
Engine ECU	Controls the engine output during the operation of TRC and VSC by communicating with the skid control ECU.
DLC3	Enables access to the DTC (Diagnostic Trouble Code) and ECU data when a diagnosis tool (Intelligent Tester II) is connected to this connector and operated.

ABS with EBD

Description

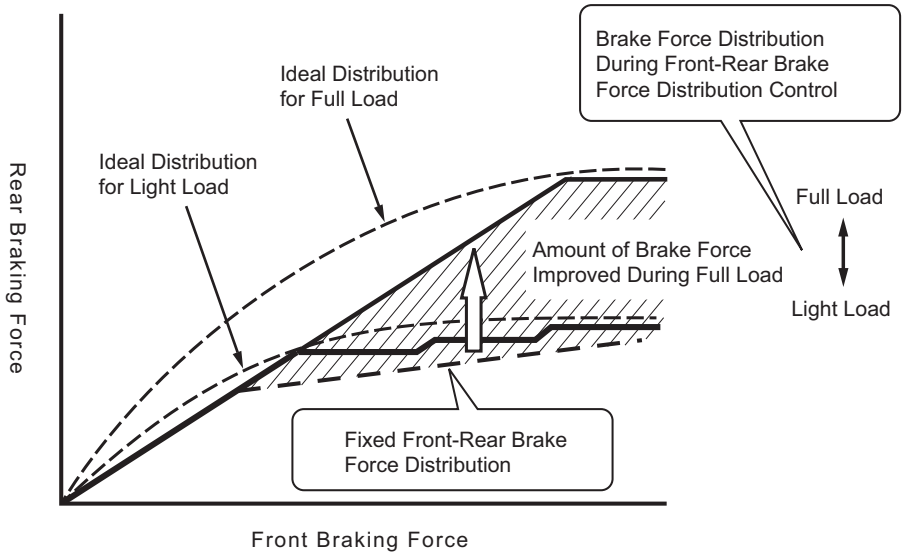
- To enable a vehicle to run, turn, and stop, it is imperative that the tires perform their function of gripping the road. However, during sudden braking or braking in slippery surfaces, such as on a road that has puddles or is covered with snow, the wheels could lock up while the vehicle is still moving. This results in a slippage between the tires and the surface. During braking in these situations, the ABS (Antilock Brake System) detects the wheel speeds and uses a computer to control the brake fluid pressure to all four wheels. This control prevents the wheels from locking and provides the proper brake performance, thus ensuring steering maneuverability and vehicle stability.
- In addition to the conventional ABS functions, the ABS with EBD appropriately distributes the braking force between the front and rear wheels and the right and left wheels. Thus, the ABS with EBD ensures superior brake performance that is unaffected by changes in load, such as when the vehicle is empty or fully loaded.



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Front-Rear Brake Force Distribution Control

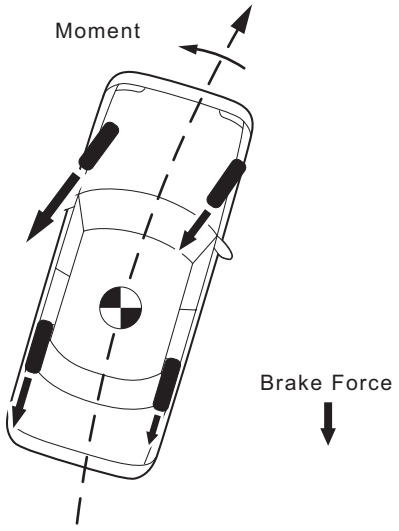
- The front-rear brake force distribution control aims at maximizing "stopping" performance, which is the basic function of the brakes. Thus, it distributes the brake force appropriately to the front and rear wheels in accordance with the driving conditions of the vehicle.
- This control enables the vehicle to effectively utilize the brake force of the rear wheels in accordance with the changes in the load that occur with the loading condition and deceleration rate. Particularly when the vehicle is fully loaded, this control reduces the amount of brake pedal effort needed and ensures an excellent braking effect.



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Right-Left Brake Force Distribution Control

- The right-left brake force distribution control ensures vehicle stability during braking along turns by regulating the brake force of the right and left wheels. Thus, it ensures an excellent braking effect.



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Precautions on ABS with EBD

- The ABS is not intended to extend the actual braking performance of the tires. Therefore, drive safely by paying attention to your speed, as well as the distance between your vehicle and others.
- The use of non-standard parts such as tires of a non-standard size will negatively affect the ABS control.
- Immediately after the engine starts and the vehicle starts off, the system performs an initial check. The sound of the motor can be heard at this time, which is normal.
- During the initial check, the brake pedal might feel firm when you apply a slight pressure to it, which is normal.
- Under the conditions listed below, the braking distance with the ABS operating may be longer than on vehicles without ABS.

Conditions

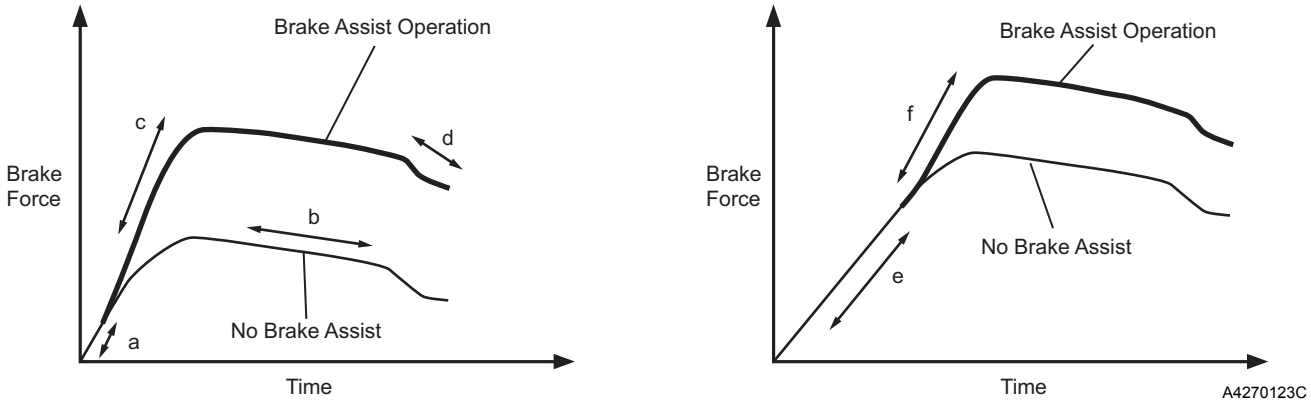
Driving on a gravel road or fresh snow
Using tire chains
Driving over an offset such as a seam on the road
Driving on a rough road with an irregular surface or stone pavement

Brake Assist System

● The system determines emergency braking based on the amount and speed of the brake pedal effort and generates a strong brake force accordingly.

Concept of Brake Assist

- In emergency braking, the driver in a panic state might press the brake pedal quickly but not firmly, generating only a small amount of braking force (see "a" in the figure).
- In that state, the driver might not be able to keep the brake pedal depressed during the latter half of braking, and cause the brake force to drop (see "b" in the figure).
- The brake assist system estimates the intention of the driver to apply emergency braking upon detecting a quick application of the brake pedal. Thus, even if the driver is unable to press the brake pedal firmly, this system increases the brake force (see "c" in the figure).
- If the driver intentionally eases the brakes after the brake assist operates, the system reduces the amount of brake force assist to reduce the sense of intrusiveness (see "d" in the figure).
- There are other instances that require a strong brake force even if the driver does not press the brake pedal quickly, such as when the vehicle is fully loaded with occupants or cargo (see "e" in the figure).
- The brake assist system increases the brake force in those instances when a strong brake force is required (see "f" in the figure).



Precautions on Brake Assist

- The brake assist is not intended to extend the actual capability of the brakes. Therefore, drive safely by paying attention to your speed, as well as the distance between your vehicle and others.
- If you press the brake pedal quickly, the brake force will increase, and the brake pedal could pulsate, along with making an operation sound. These occurrences indicate the normal operation of the brake assist system.

Servo Failure Auxiliary Control

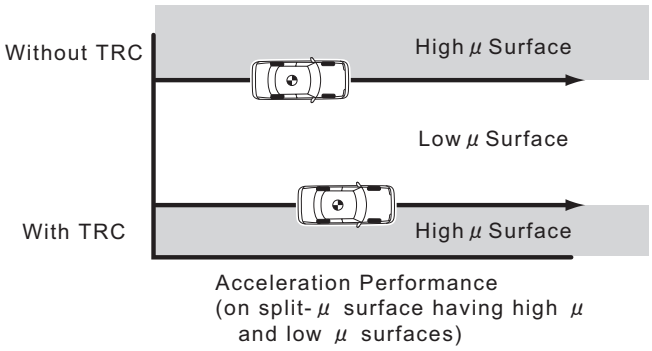
- If the boost (servo) function decreases below normal due to a malfunction in the brake booster, the skid control ECU might determine that the driver's operating force (pedal effort) is insufficient to provide the proper brake force. In this case, the system actuates the brake actuator pump to increase the brake hydraulic pressure, in order to increase the brake force.

TRC

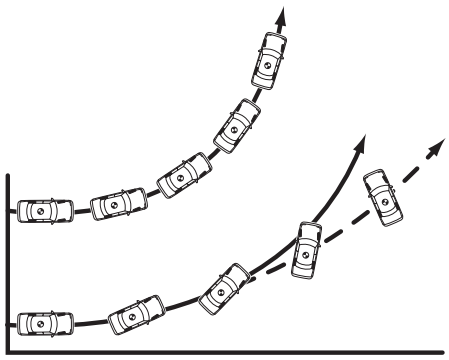
- If the throttle is opened too far during starting off or accelerating on a slippery road, the excessive torque may make the drive wheels slip, reducing the start off acceleration and steerability. The TRC is a system that controls the engine output with drive wheel brake hydraulic pressure control to suppress the drive wheel slipping and secure the drive force according to the road surface conditions and secure the vehicle start off acceleration, stability, and turning stability.
- The TRC has the following features.

Features

The precision accelerator work required for starting off and acceleration on slippery roads is no longer needed.
Provides superior steerability and stability during acceleration.
You can turn more stably even when accelerating during a turn.
Stable acceleration is obtained even on split road surfaces where the road conditions are different for the left and right drive wheels.



Acceleration Performance
(on split-μ surface having high μ and low μ surfaces)



Turning Stability (on low μ surface)

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VSC

● The primary purpose of the ABS and TRC systems is to ensure stability during the braking and acceleration associated with brake or accelerator maneuvers. In contrast, the VSC (Vehicle Stability Control) system ensures stability in the turning direction of the vehicle. Ordinarily, a vehicle turns stably in accordance with the steering maneuver. However, under unexpected conditions or external factors, such as surface conditions, vehicle speed, or emergency turning, the vehicle will exhibit a strong sideslip tendency at the front or rear wheels. To ensure stability under these conditions, the VSC automatically controls the engine power output and the brakes at the individual wheels in order to ease the strong sideslip tendency at the front or rear wheels.

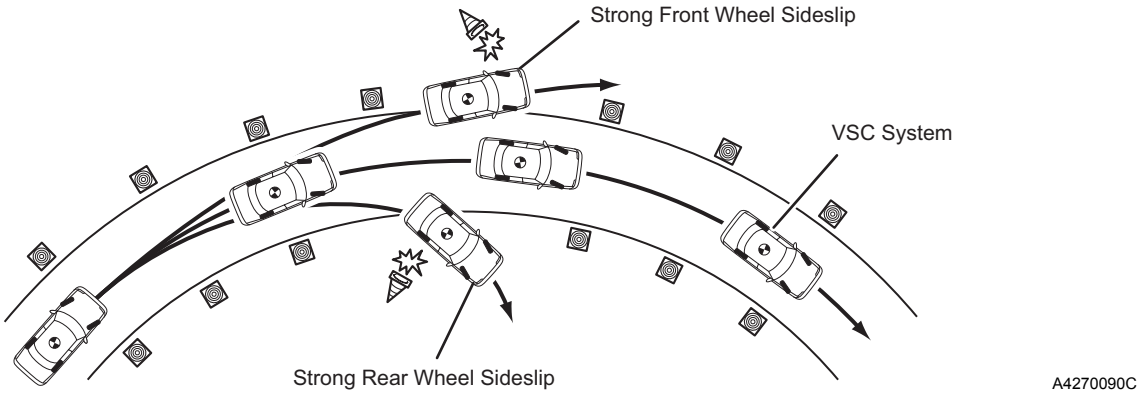
Control Performance Outline

- The VSC detects the conditions of the vehicle based on the signals received from various sensors including the yaw rate sensor and acceleration sensor, and controls the brake hydraulic pressure and the engine output torque.
- The following are two examples of circumstances in which the wheels exceed their side grip threshold:

Two Examples

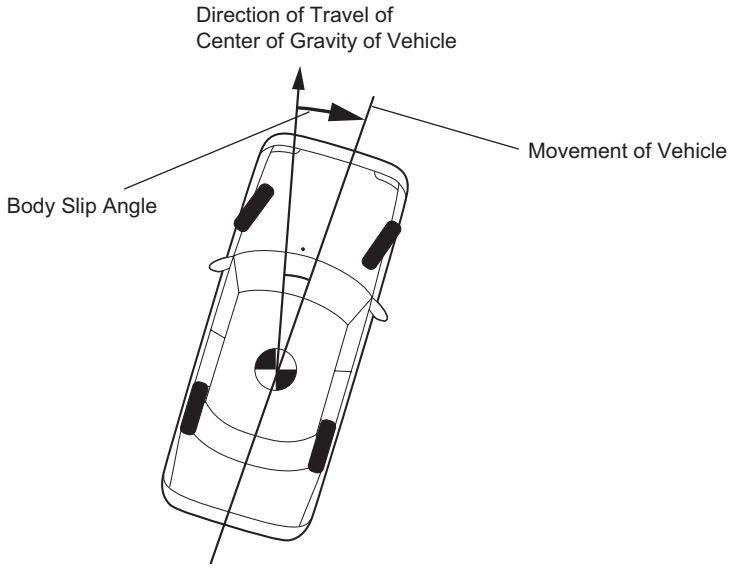
[1] The rear wheels are losing their grip relative to the front wheels (strong rear wheel sideslip).
[2] The front wheels are losing their grip relative to the rear wheels (strong front wheel sideslip).

- The VSC operates in the circumstances illustrated below to ease the vehicle's strong rear or front wheel sideslip tendency.



Judging the Vehicle's Strong Rear Wheel Sideslip Tendency

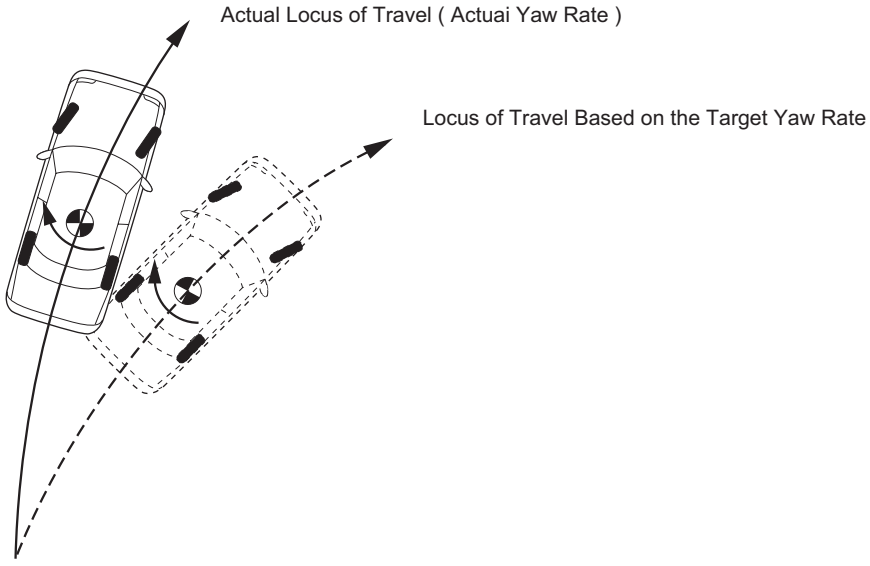
- The skid control ECU determines whether a rear wheel sideslip tendency exists based on the body slip angle and slip angle velocity values obtained by the yaw rate & deceleration sensor. When both the body slip angle and the slip angle velocity are large, the body is said to exhibit a rear wheel sideslip tendency.



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Judging the Vehicle's Strong Front Wheel Sideslip Tendency

- The skid control ECU determines whether a front wheel sideslip tendency exists based on a comparison of the target yaw rate and the vehicle's actual yaw rate value. As the driver turns the steering wheel, if the vehicle's actual yaw rate is lower than the target yaw rate that should be generated (determined by the steering angle and vehicle speed), it means that the body is not turning as intended. Thus, the body is said to exhibit a large front wheel sideslip tendency.



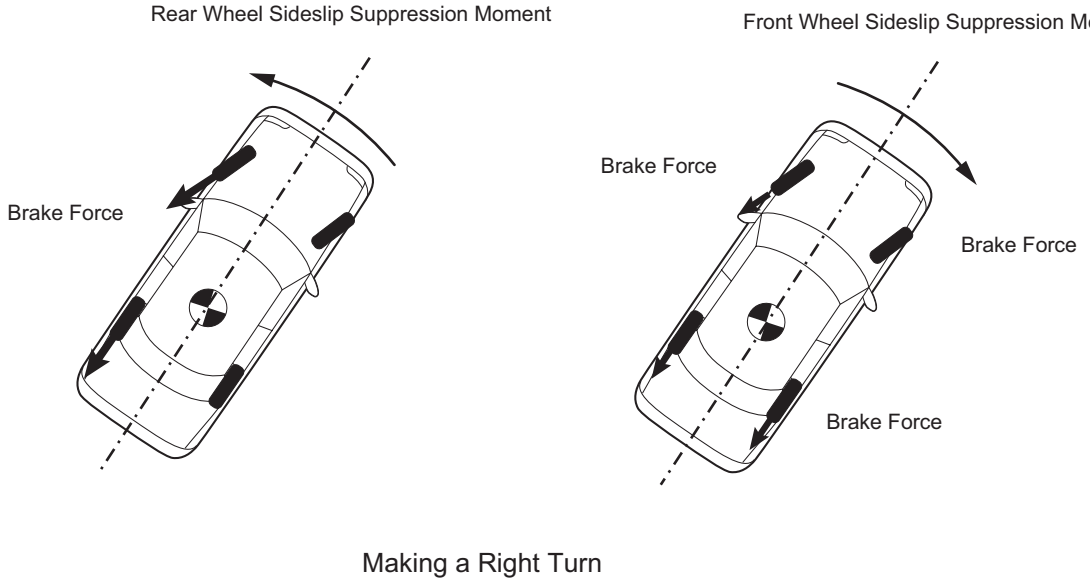
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VSC Opeation Method

- Easing a Strong Rear Wheel Sideslip Tendency of the Vehicle

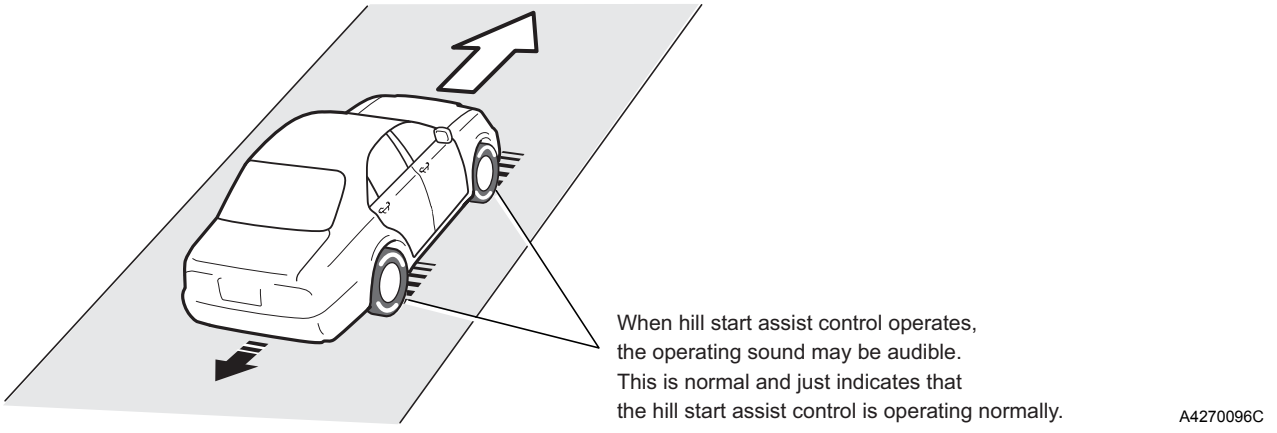
  When the skid control ECU judges that the vehicle exhibits a large rear wheel sideslip tendency, it applies the brakes on the front and rear wheels on the outside of the turn in accordance with the extent of that tendency. This suppresses the rear wheel sideslip tendency by generating a moment outward of the vehicle. In addition, the vehicle speed that is reduced by the application of the brake force also contributes to ensuring vehicle stability.
- Easing a Strong Front Wheel Sideslip Tendency of the Vehicle

  When the skid control ECU judges that the vehicle exhibits a large front wheel sideslip tendency, it controls the engine power output in accordance with the extent of that tendency. Then, the skid control ECU applies the brakes on the front and rear wheels to reduce the side force, in order to suppress the front wheel sideslip tendency.



Hill Start Assist Control

- When the hill start assist control detects that the vehicle is rolling backwards, it automatically applies brake hydraulic pressure to the four wheels, in order to reduce the reverse speed of the vehicle.
- This function is effective in a situation in which it is difficult to start off the vehicle, such as starting off on a steep or slippery hill, where the vehicle is likely to roll backwards as the driver switches from the brake pedal to the accelerator pedal.

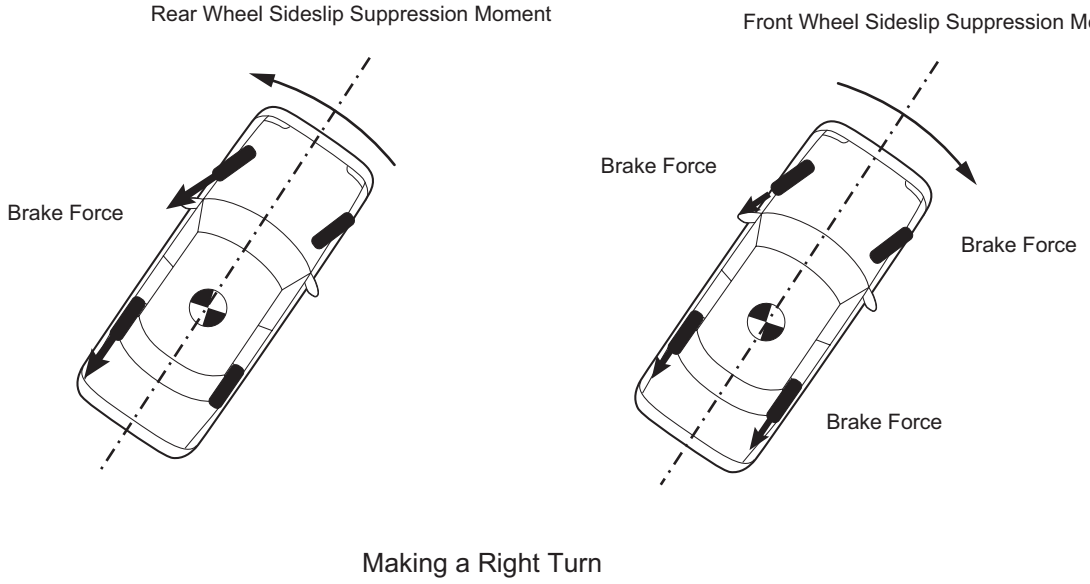


VSC Opeation Method

- Easing a Strong Rear Wheel Sideslip Tendency of the Vehicle

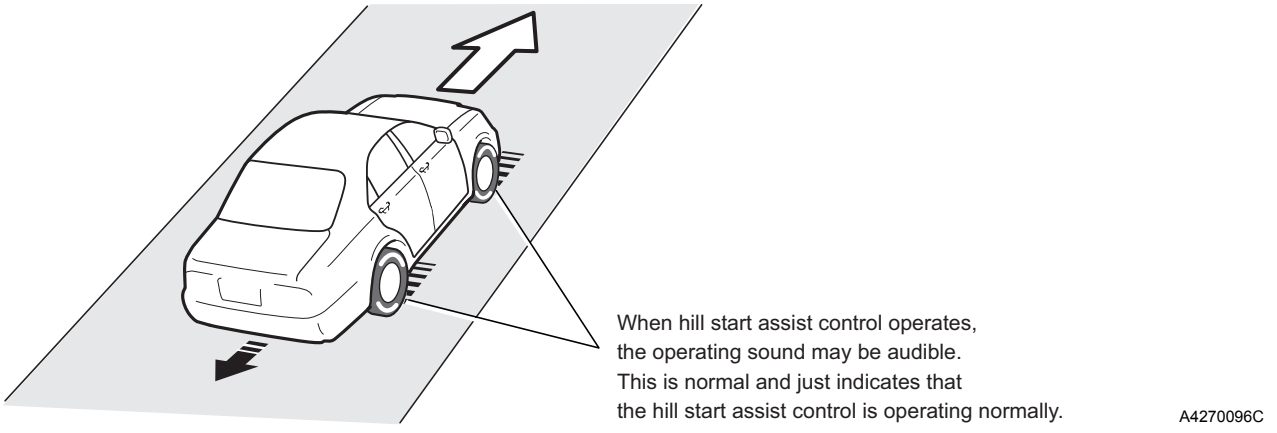
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Operation Conditions

Shift position D, 6, 5, 4, 3, 2, or 1 selected	Operates during start-off acceleration while driving uphill. Therefore, it does not operate with the shift lever in the P or N position. It does not operate when driving uphill in reverse, with the shift lever in the R position.
Brake Pedal OFF	Prohibits the operation of the system when the driver presses the brake pedal, so as not to prevent the driver from stopping the vehicle.
Limited time operation	The hill start assist control, which is intended to assist the driver in starting off, operates only approximately 5 seconds at the maximum. After that, it gradually reduces the brake hydraulic pressure and ends the control.

Effectiveness of the Hill Start Assist Control

- Because it reduces the chance of the vehicle rolling backwards as the driver switches from the brake pedal to the accelerator pedal, it allows the driver to perform the pedal maneuver comfortably.
- Because it reduces the speed of the vehicle rolling backwards, it minimizes the wheel spin when the driver presses the accelerator pedal, thus facilitating the startoff on a slippery surface.
- Because it optimally controls the brake hydraulic pressure to the four wheels, it ensures vehicle stability without causing the wheels to lock up on slippery hills.

Description of the Hill Start Control

- The skid control ECU receives the inputs of signals from various sensors that detect the shift position and the travel direction of the vehicle body (such as by way of the wheel speed sensors, which are capable of detecting the rotational direction). Then, the system determines whether the vehicle body is rolling backwards while the driver is attempting to drive it uphill.
- The acceleration sensors detect the gradient of the hill and the acceleration state of the vehicle body. The wheel speed sensors detect the locking state of the wheels and their rotational direction. Then, the skid control ECU calculates the amount of control that is needed and implements brake hydraulic pressure control to the wheels.
- When the vehicle starts to move forward, the system releases the brake hydraulic pressure and stops the control.

Precautions for Hill Start Assist Control

- The hill start assist control is not a function for keeping the vehicle stopped on a hill.
- During a hill start assist control operation, the slip indicator light blinks in the combination meter, and the brake lights illuminate.
- The hill start assist control system controls the brakes at four wheels to reduce the reverse movement of the vehicle. However, it might not be fully effective on extremely steep slopes or on icy roads or other surfaces with very low friction.
- When the hill start assist control is operating, a sound indicating its proper operation may be heard, which is normal.

Radar Cruise Control Brake Operation

● If a greater deceleration rate is required while driving in the vehicle control mode, this control generates a brake force by controlling the brake hydraulic pressure in accordance with the signals received from the distance control ECU.

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Brake Pedal OFF	Prohibits the operation of the system when the driver presses the brake pedal, so as not to prevent the driver from stopping the vehicle.
Limited time operation	The hill start assist control, which is intended to assist the driver in starting off, operates only approximately 5 seconds at the maximum. After that, it gradually reduces the brake hydraulic pressure and ends the control.

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Precautions for Hill Start Assist Control

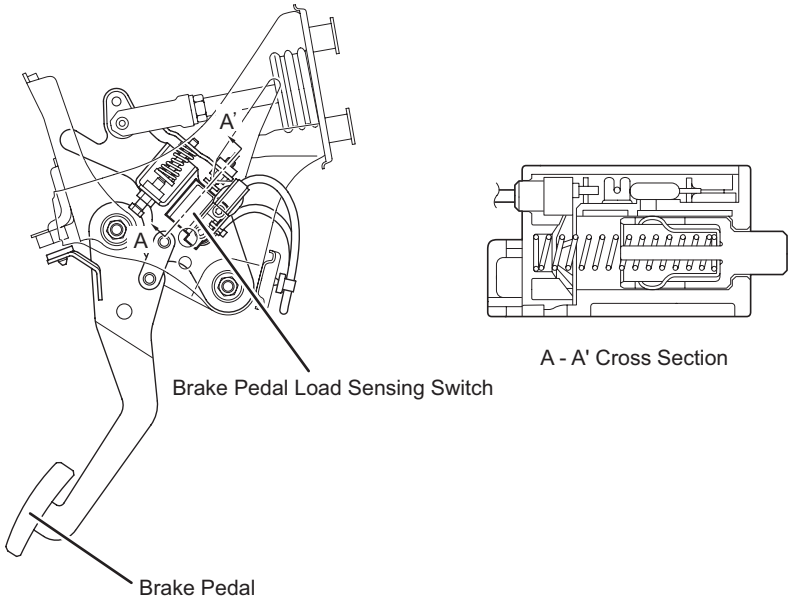
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Brake Pedal Load Sensing Switch

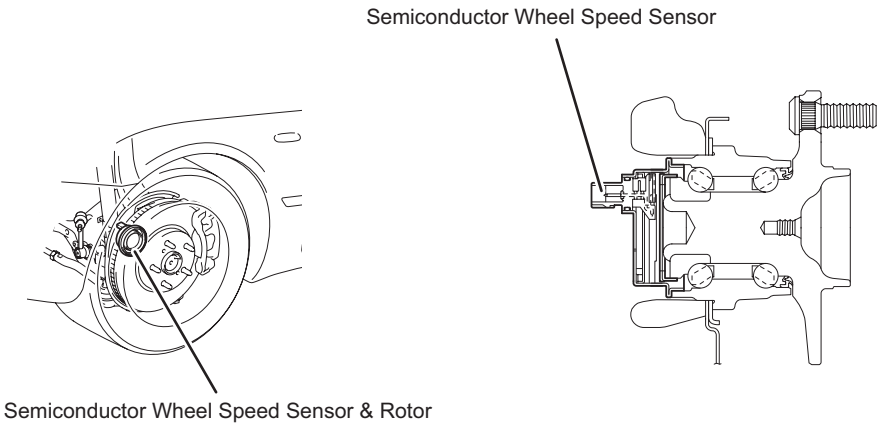
● This switch is mounted on the brake pedal. As the brake pedal pushes on the pushrod of the master cylinder, this movement moves a lever, which turns ON the brake pedal load sensing switch. The brake pedal load sensing switch signal is used as part of the control data for the servo failure auxiliary control.



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Front Wheel Speed Sensor

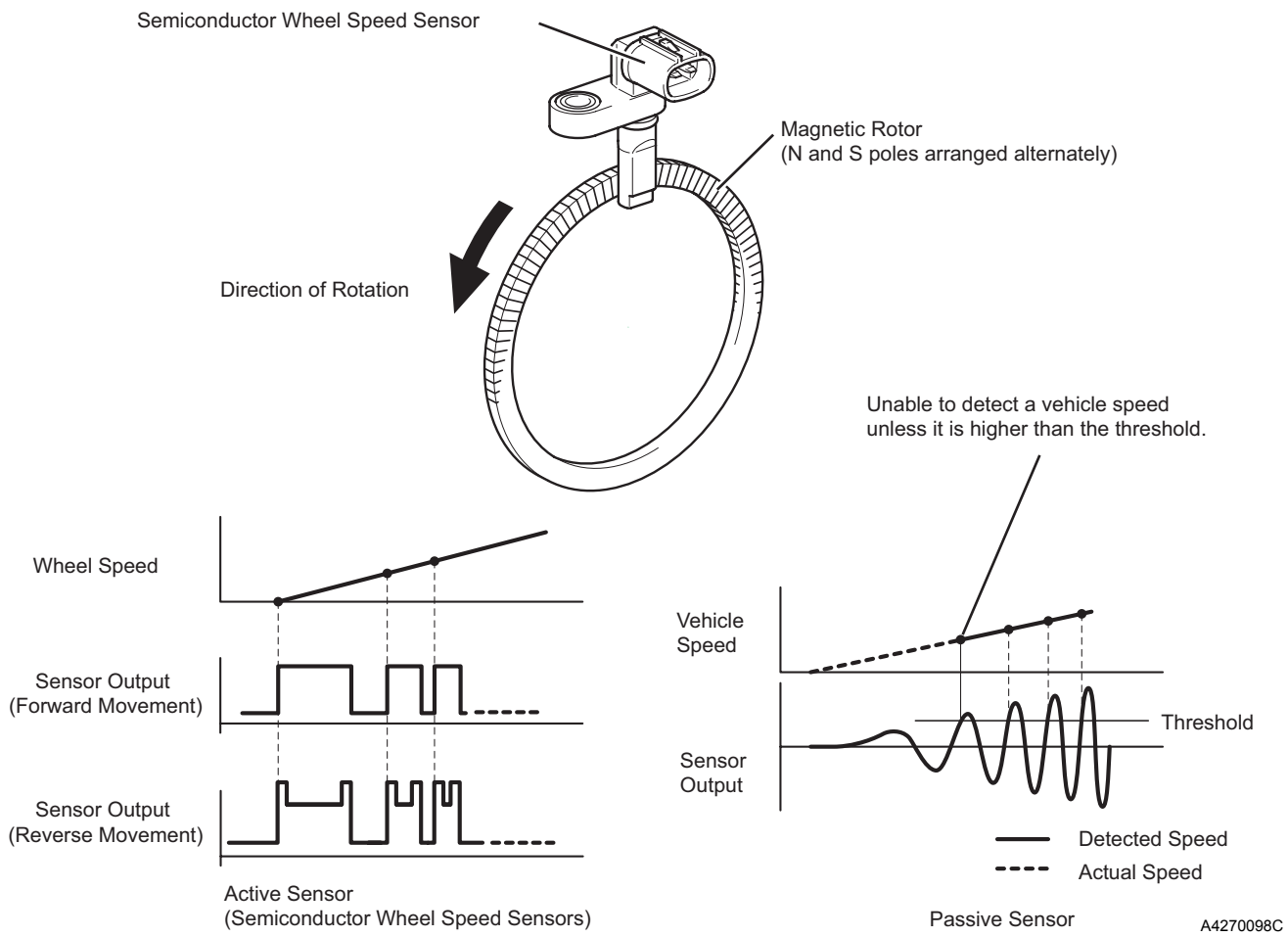
● A semiconductor wheel speed sensor & magnetic rotor, which is integrated in the bearing unit, is installed on the front axle hub. The magnetic rotor is fixed to the inner race of the bearing unit and the sensor is installed on the cap.



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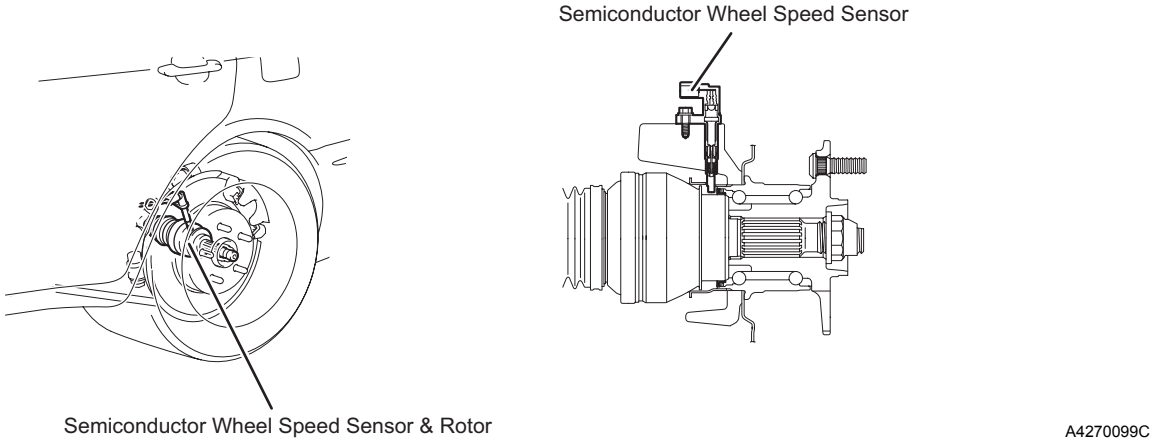
Detection Principle

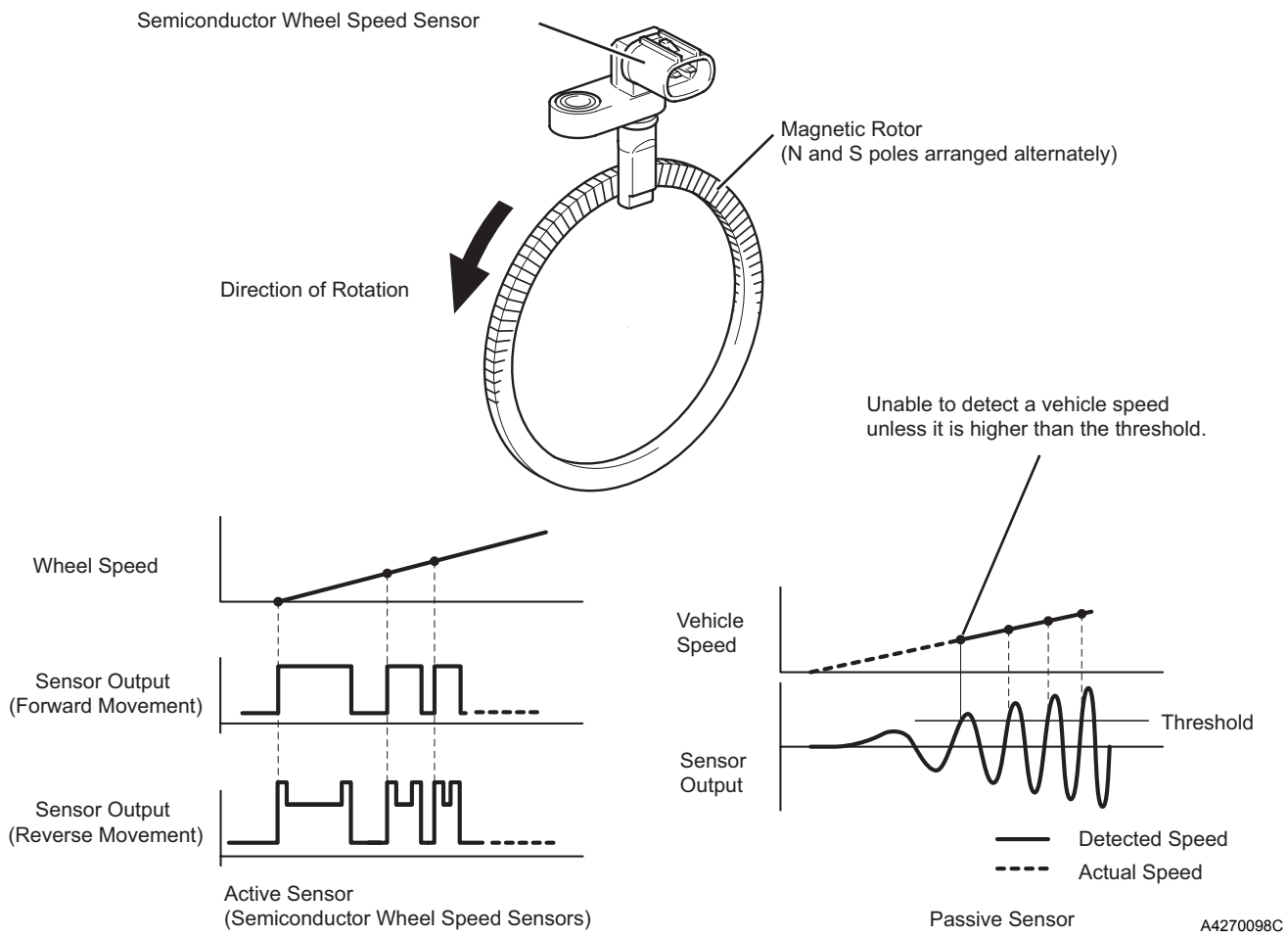
- The magnetic rotor consists of a rubber matrix embedded with magnetic particles, with N/S poles (48 N and S poles each) arranged uniformly in the circumferential direction.
- The rotational movement of the magnetic rotor causes the magnetic field to change. The active sensor detects the changes and outputs them in the form of wheel speed pulses.
- In contrast to the widely used passive sensors, this sensor is able to detect vehicle speeds starting from approximately 0 km/h. In addition, because it can detect the rotational direction of the rotor, it enables the system to differentiate between the forward and reverse movement of the vehicle.



Rear Wheel Speed Sensor

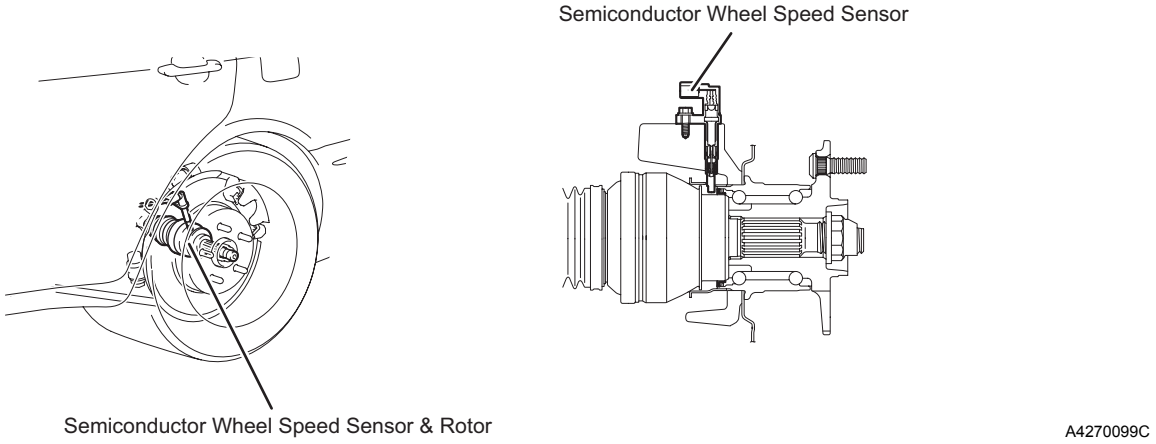
- A semiconductor wheel speed sensor is installed on the rear axle carrier, and a sensor rotor is installed on the inner race.





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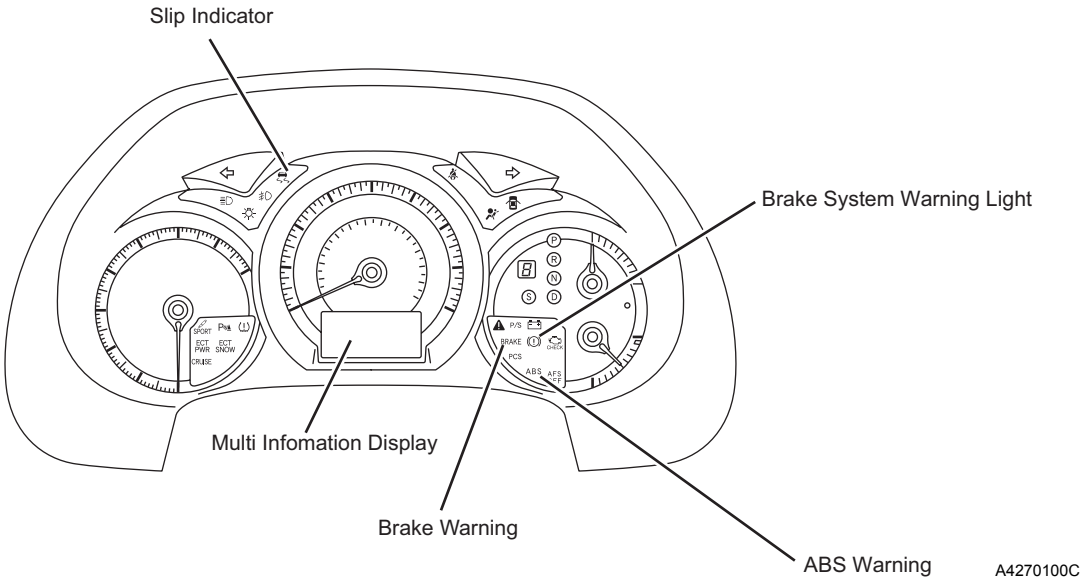


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Warning & Indicator

● Indicators and warning lights are installed in the combination meter.



Warning & Indicator

Slip Indicator	The light flashes to alert the driver that ABS, TRC, hill start assist control or VSC is operating.
Brake Warning	Warns the driver during normal operation that the parking brake is ON, or that the brake fluid is low. In addition, if it lights at the same time as the ABS warning light, it warns the driver of an abnormality that prevents the operation not only of the ABS, but also the EBD.
ABS Warning	When an abnormality occurs in the ABS or the brake assist system the light goes on to alert the driver. In diagnosis mode, the diagnosis code is shown by the flashing light.
VSC Warning (on multi-information display)	If there is a failure in the VSC, the master caution light illuminates and "VSC System Check" appears on the multi-information display to inform the driver. In the diagnosis mode, the multi-information display will show a DTC (Diagnostic Trouble Code).

VSC Buzzer

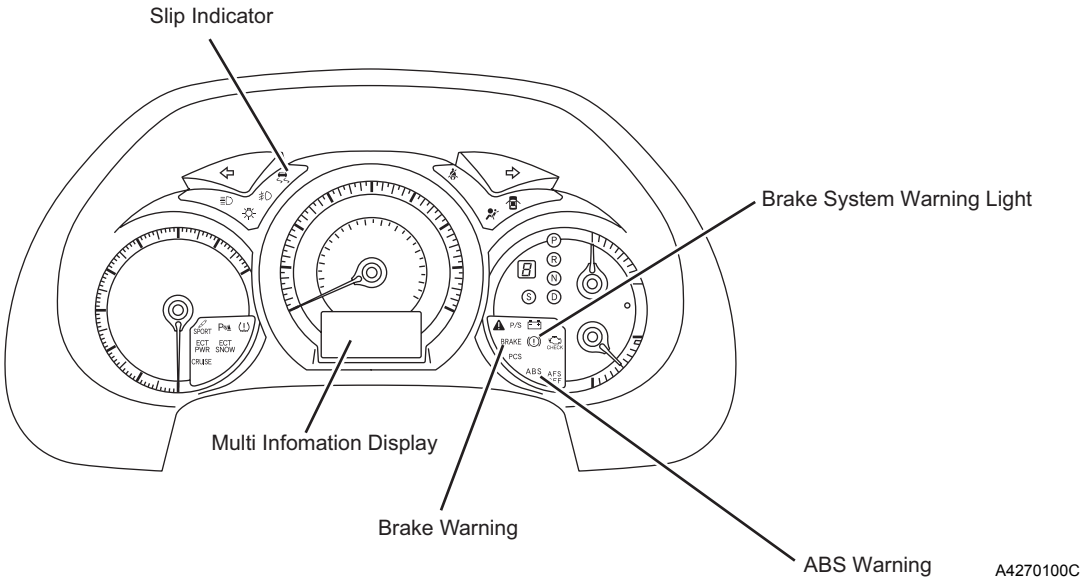
● The buzzer sounds intermittently to inform the driver that the VSC is operating.

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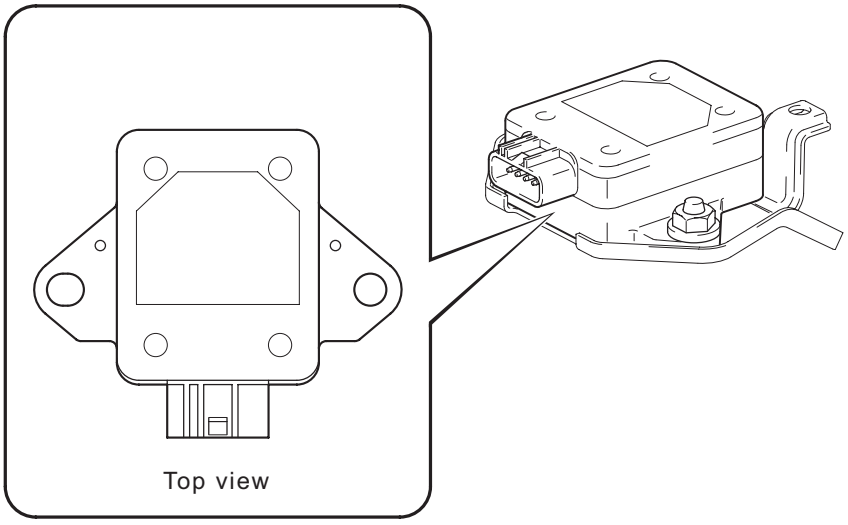
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Yaw Rate & Deceleration Sensor

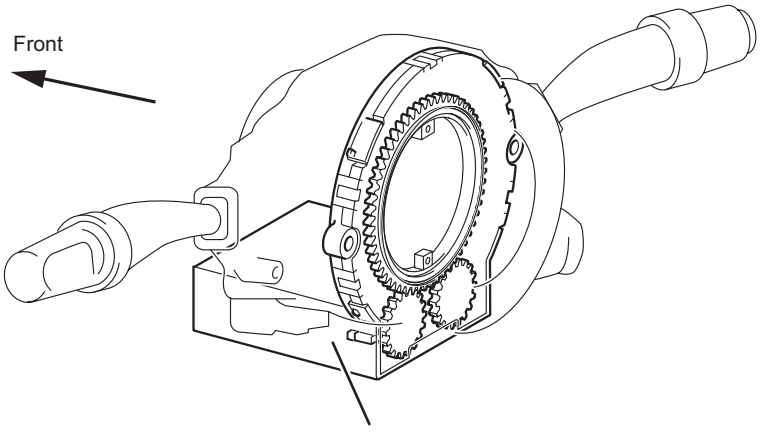
- A semiconductor yaw rate sensor and two acceleration sensors are integrated into a compact unit and installed under the center console. When the vehicle accelerates, the beams in the acceleration sensors flex, and the measurements of their distortion are converted into electrical signals. Each of the two acceleration sensors is positioned 45 degrees to the longitudinal direction of the vehicle. Thus, the combination of the two acceleration sensors can detect the deceleration rate of the vehicle across the entire horizontal plane. Coupled with linear output characteristics, the acceleration sensors enable precise control over a wide variety of surfaces.
- The yaw rate sensor detects the vehicle's rotational angle speed (yaw rate and rotating speed) in the vertical axis direction based on the amount and direction of the flexing of the piezoelectric ceramic. A dedicated IC (integrated circuit) is used for the oscillation of the sensor unit and for signal processing, thus realizing a compact and reliable sensor.



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Steering Angle Sensor

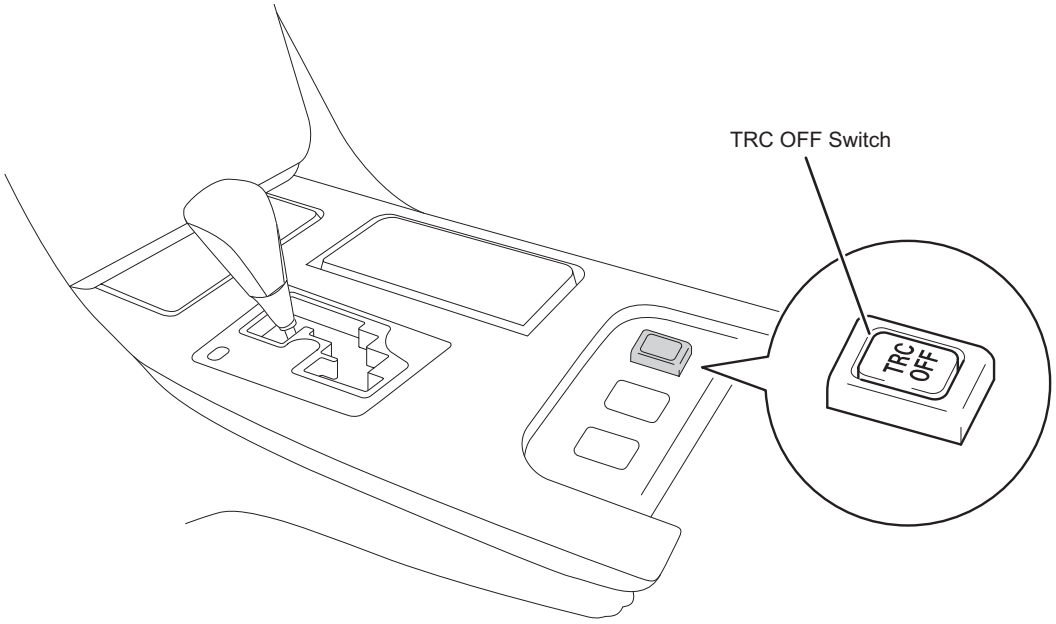
- A steering angle sensor is provided in the combination switch area. This sensor detects the amount of steering effort and the direction of steering and inputs them in the skid control ECU.
- The sensor assembly contains two sets of magnetic reluctance elements that detect the rotational movement of a magnet that is built into the detection gear. Thus, the sensor detects the changes that occur in the magnetic reluctance along with the rotational movement of the detection gear, in order to detect the rotational movement of the steering wheel.



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TRC OFF Switch

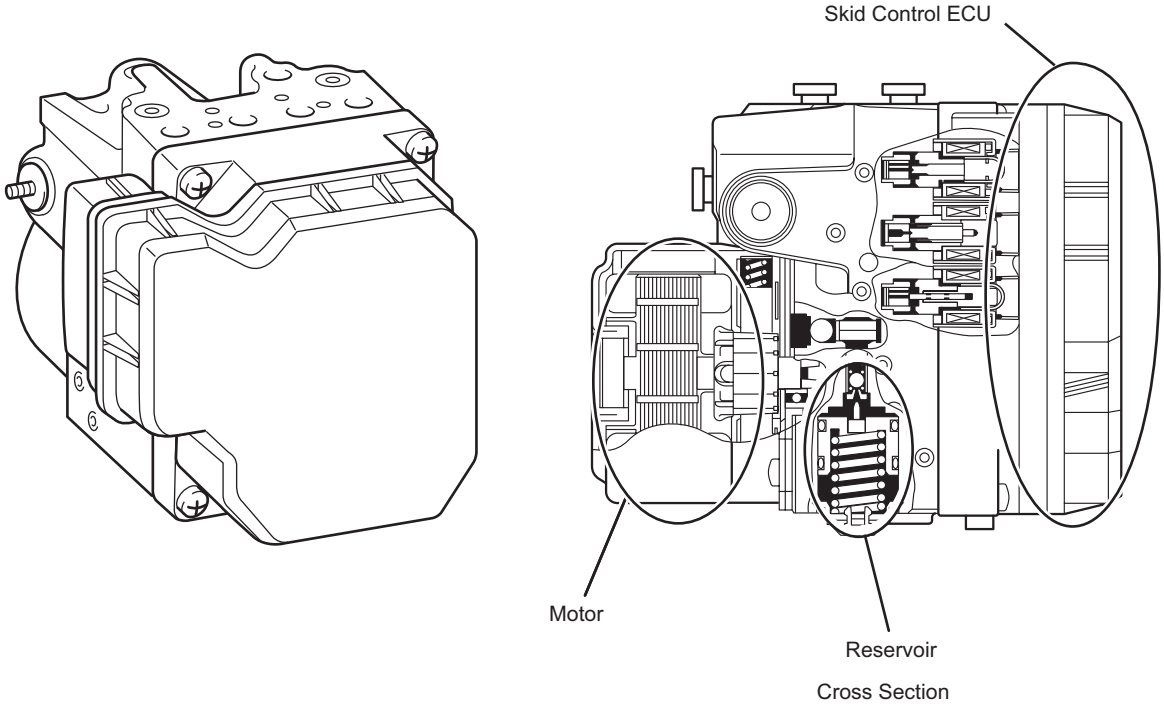
● A momentary switch is used and installed on the center console. The driver can set the operation of the TRC ON and OFF by pressing the TRC OFF switch. When the driver presses TRC turns the ignition switch from OFF to ON, the system switches automatically to the normal driving mode.



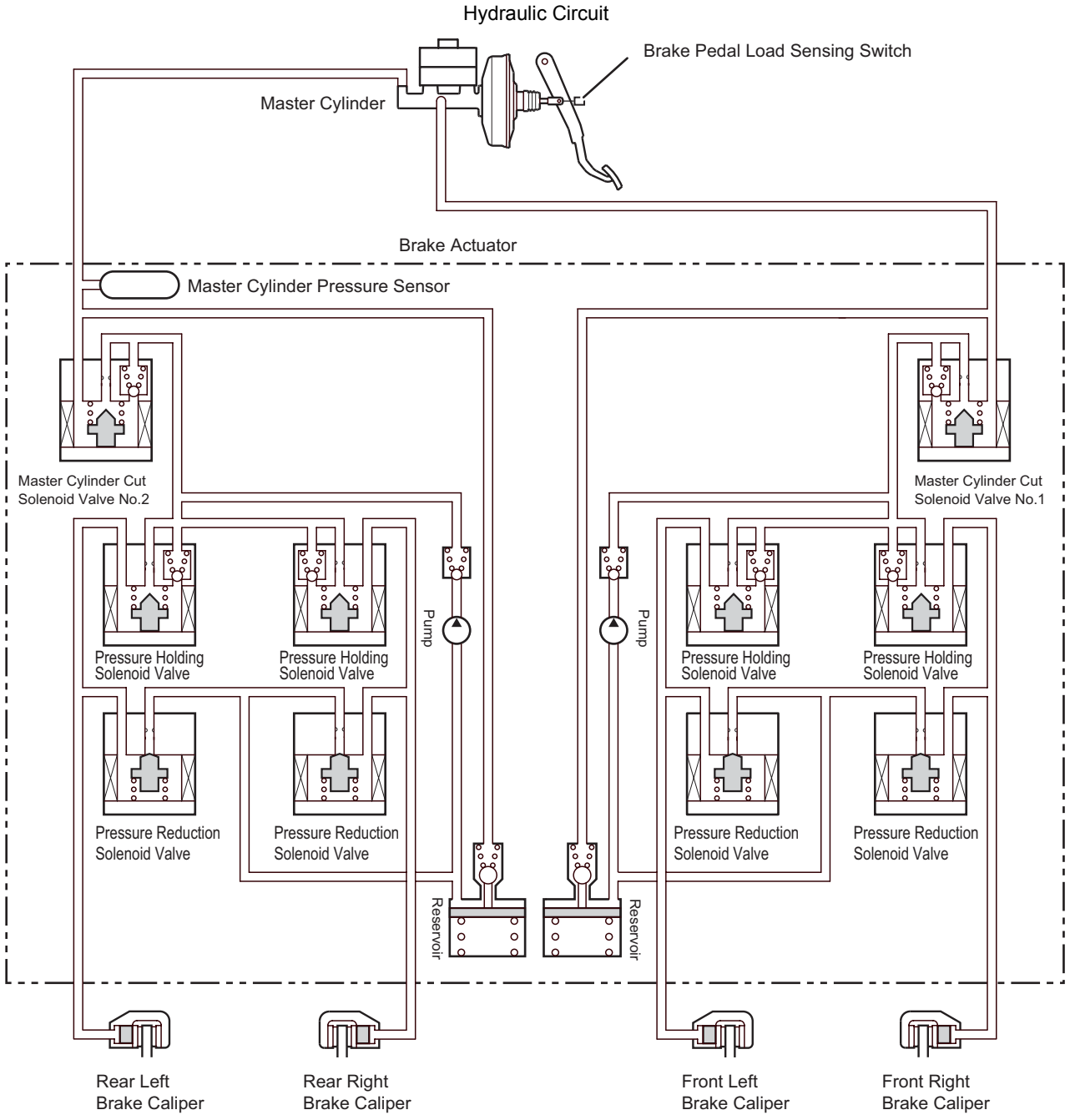
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Brake Actuator

● The brake actuator consists of a master cylinder cut solenoid valve, pressure holding solenoid valve, pressure reduction solenoid valve, pump, and reservoir. The actuator adjusts the brake hydraulic pressure applied to the wheel cylinders. In addition, it is integrated with the skid control ECU to achieve a compact construction.



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Non-Operation (All Input Signals OFF)

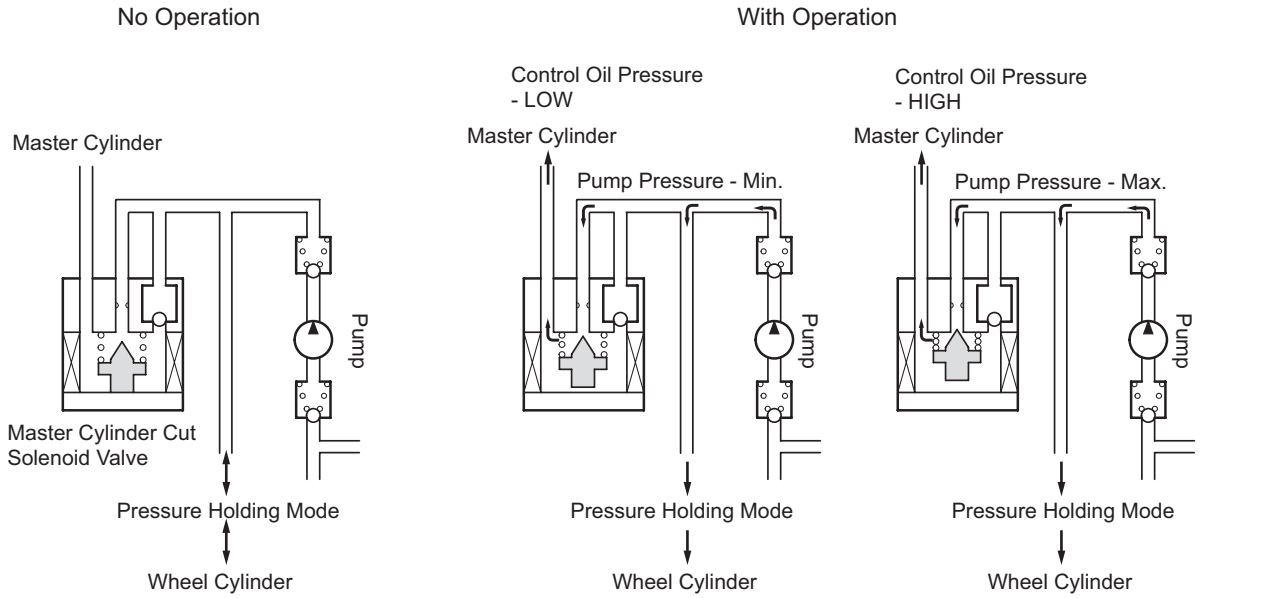
A4270128C

Pressure Holding and Reduction Solenoid Valves

- The skid control ECU outputs control signals to actuate the solenoid valves in order to switch the brake hydraulic pressure circuit between three modes: increasing, holding, and reduction.

Master Cylinder Cut Solenoid

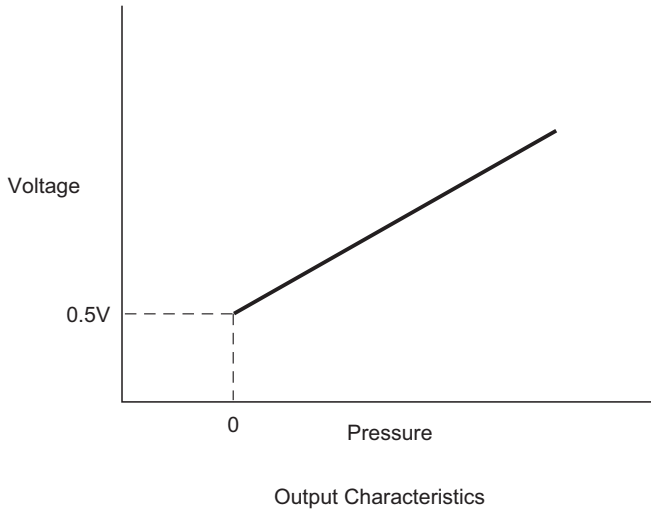
- The master cylinder cut solenoid uses a linear solenoid valve for smooth changes in the hydraulic pressure during brake assist control.
- The system controls the opening and closing of the valve in order to regulate the hydraulic pressure generated by the pump. Thus, it is able to generate a control hydraulic pressure in accordance with the operating conditions.



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Master Cylinder Pressure Sensor

- The master cylinder pressure sensor, which is built into the brake actuator, outputs a master cylinder pressure signal to the skid control ECU.

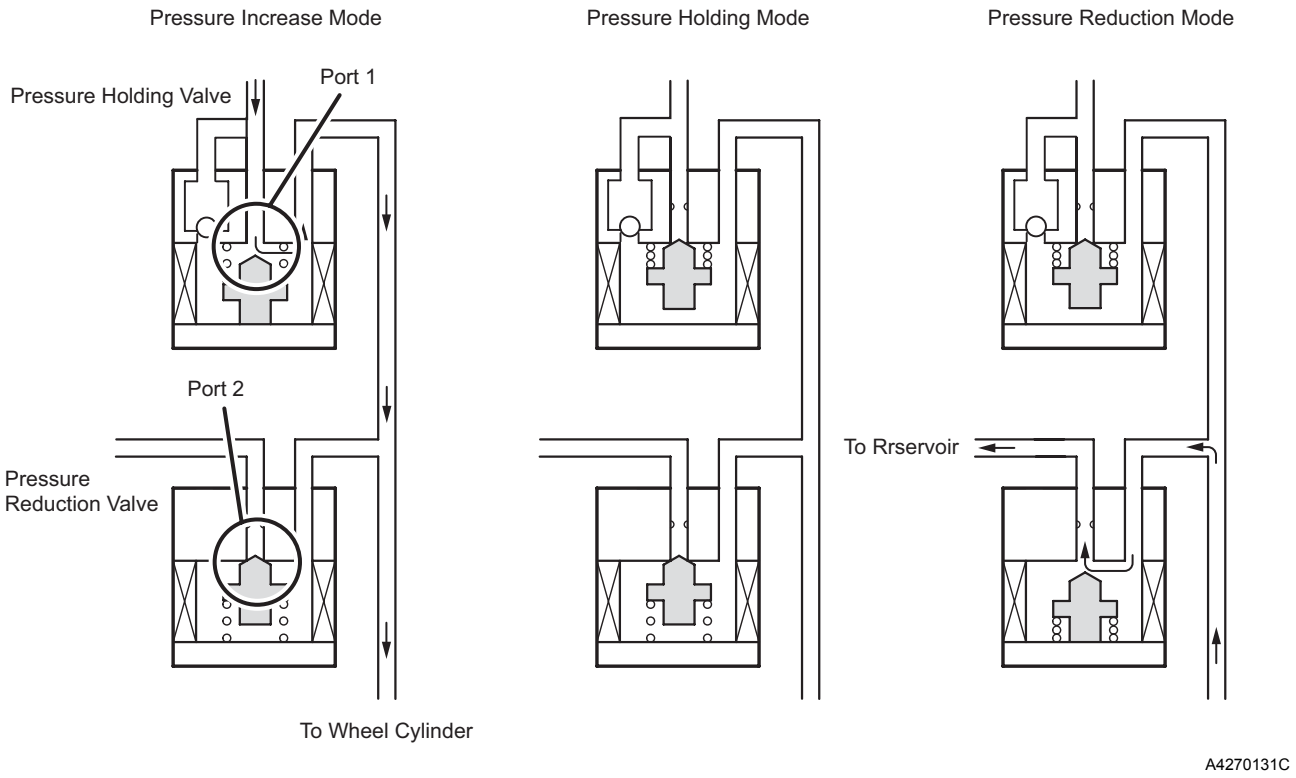


Output Characteristics

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ABS with EBD Operation

• This system controls the hydraulic pressure of four wheels by operating the pressure holding and reduction solenoid valves, the pump, and the reservoir.

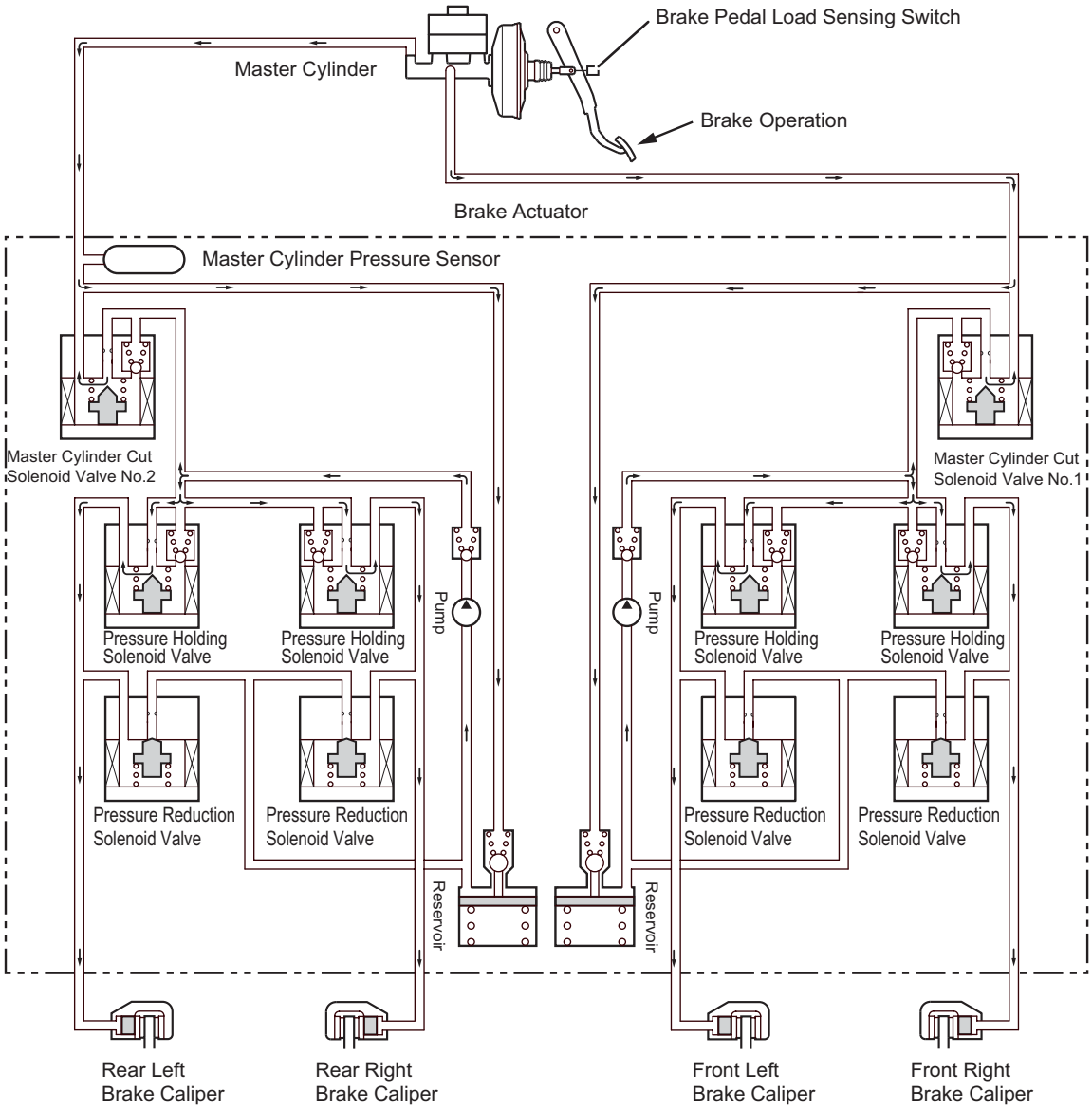


Operation

Not Activated	Normal Braking	—	—
Activated	Increase Mode	Holding Mode	Reduction Mode
Pressure Holding Valve	OFF	ON	←
Pressure Reduction Valve	OFF	←	ON
Port 1	Open	Close	←
Port 2	Close	←	Open
Wheel Cylinder Pressure	Increase	Hold	Reduction

Brake Assist Operation

- The brake assist control directs the hydraulic pressure generated by the pump in the brake actuator to the wheel cylinders, thus generating a hydraulic pressure that is higher than the master cylinder.



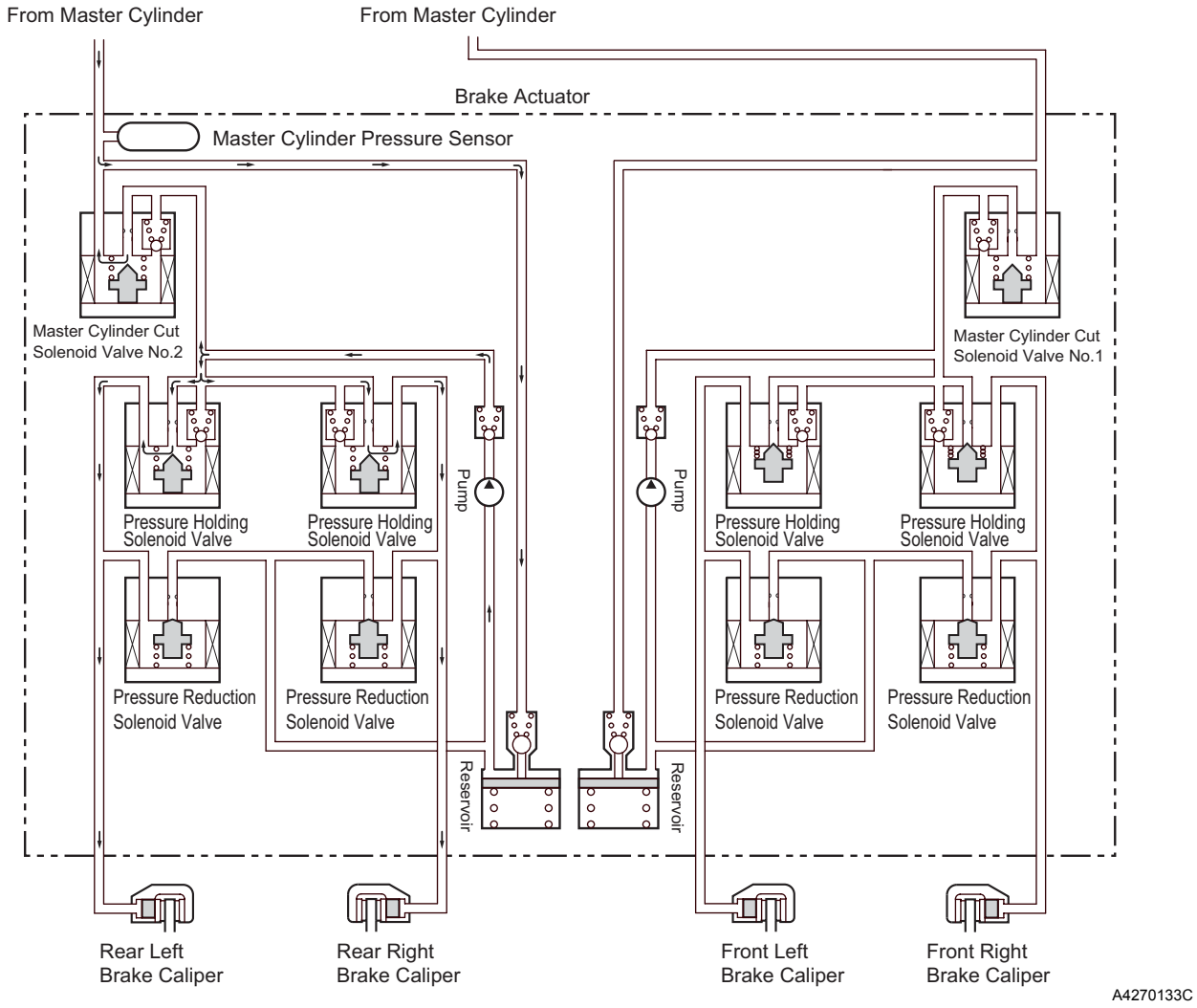
A4270132C

Brake Assist Operation

Item	Brake Assist Not Activated	Brake Assist Activated
Master Cylinder Cut Solenoid Valve No.1	OFF(Open)	ON(regulate pressure)
Master Cylinder Cut Solenoid Valve No.2	OFF(Open)	ON(regulate pressure)
Pressure Holding Valve	OFF(Open)	←
Pressure Reduction Valve	OFF(Close)	←
Wheel Cylinder Pressure	—	Boosts the hydraulic pressure higher than the master cylinder

TRAC Operation

• The TRC directs the hydraulic pressure generated by the pump in the brake actuator to the wheel cylinders, thus generating a hydraulic pressure that is higher than the master cylinder.

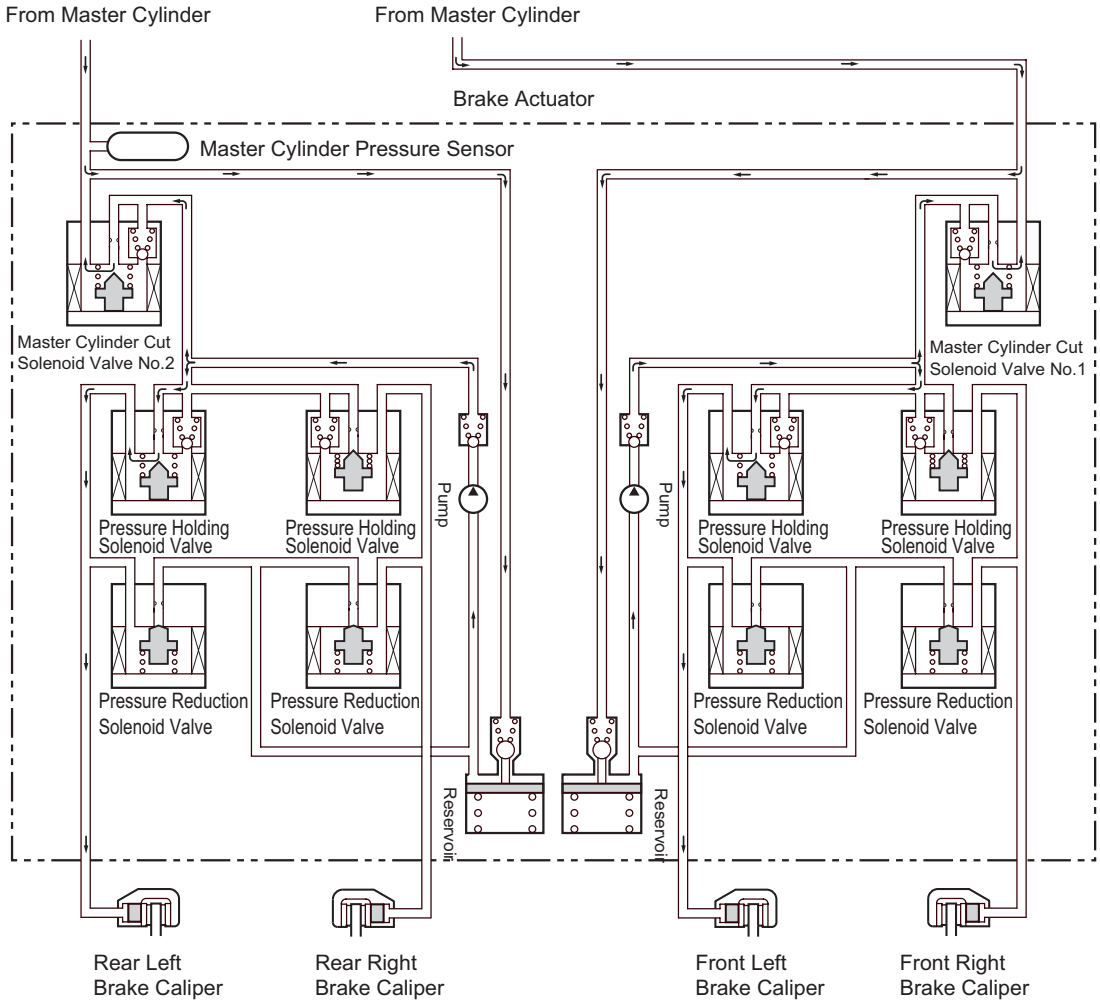


TRC Operation

Item		TRC Not Activated	TRC Activated		
			Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valve No.1		OFF(Open)	←	←	←
Master Cylinder Cut Solenoid Valve No.2		OFF(Open)	ON (regulate pressure)	←	←
Front Wheel	Pressure Holding Valve	OFF(Open)	←	←	←
	Pressure Reduction Valve	OFF(Close)	←	←	←
	Wheel Cylinder Pressure	—	—	—	—
Rear Wheel	Pressure Holding Valve	OFF(Open)	←	ON(Close)	←
	Pressure Reduction Valve	OFF(Close)	←	←	ON(Open)
	Wheel Cylinder Pressure	—	Increase	Hold	Reduction

Rear Wheel Sideslip Suppression Control

- This control directs the hydraulic pressure generated by the pump in the brake actuator to the wheel cylinders, and controls the brake hydraulic pressure to suppress the rear wheel or front wheel sideslip.
- The rear wheel sideslip suppression control applies the brakes of the outer front and rear wheels of the turn. The illustration shows the rear wheel sideslip suppression control of a vehicle making a right turn.



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VSC Operation(Rear Wheel Sideslip Suppression Control)

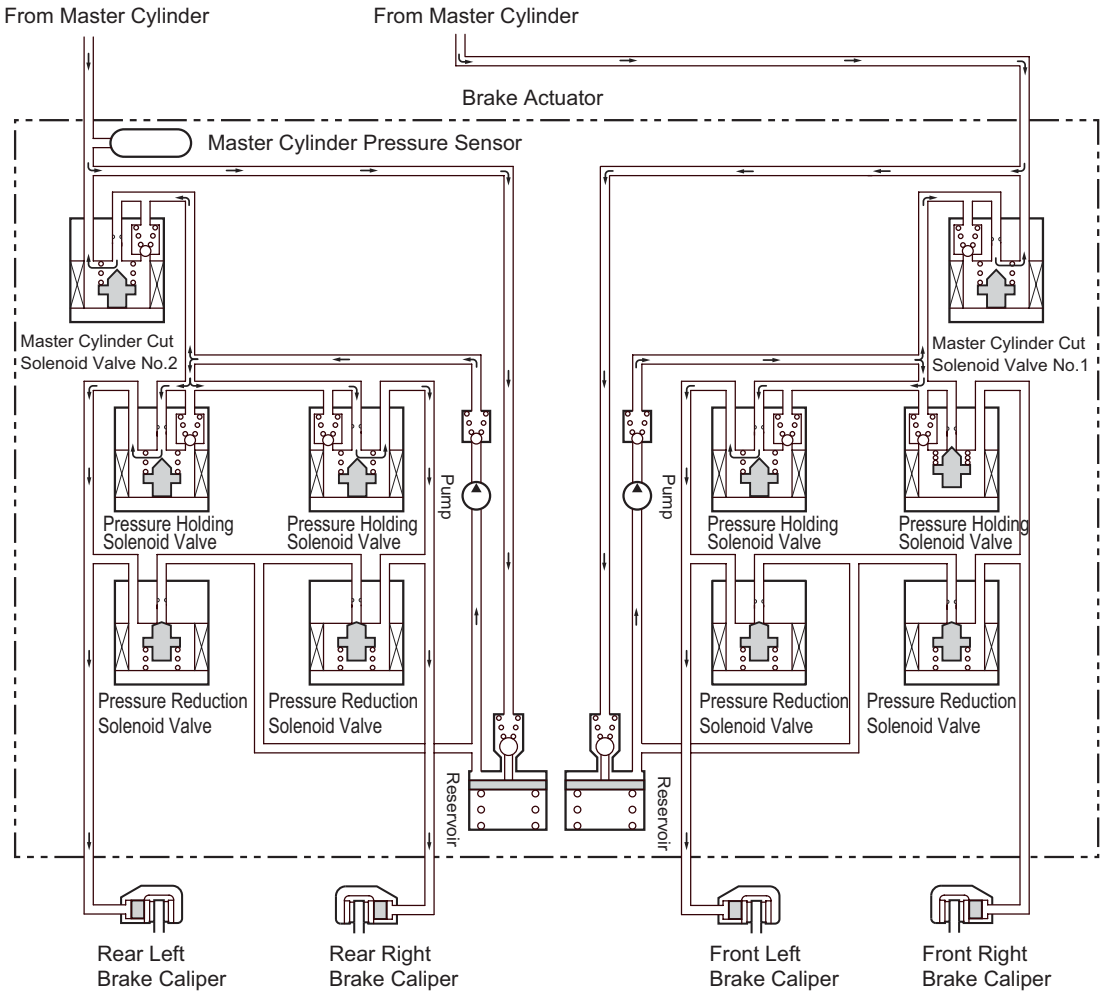
Item		VSC Not Activated	VSC Activated		
			Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valve No.1		OFF(Open)	ON (regulate pressure)	←	←
Master Cylinder Cut Solenoid Valve No.2		OFF(Open)	ON (regulate pressure)	←	←
Front Wheel	Pressure Holding Valve	OFF(Open)	←*	ON(Close)	←
	Pressure Reduction Valve	OFF(Close)	←	←	ON(Open)
	Wheel Cylinder Pressure	—	Increase	Hold	Reduction
Rear Wheel	Pressure Holding Valve	OFF(Open)	←*	ON(Close)	←
	Pressure Reduction Valve	OFF(Close)	←	←	ON(Open)
	Wheel Cylinder Pressure	—	Increase	Hold	Reduction

❖REFERENCE❖

* : The brake actuator turns the holding solenoid valve ON to close the passage to the non-control wheel.

Front Wheel Sideslip Suppression Control

- The VSC control directs the hydraulic pressure generated by the pump in the brake actuator to the wheel cylinders, and controls the brake hydraulic pressure to suppress the rear wheel or front wheel sideslip.
- The front wheel sideslip suppression control applies both rear brakes, as well as the outer front wheel brake of the turn as needed.



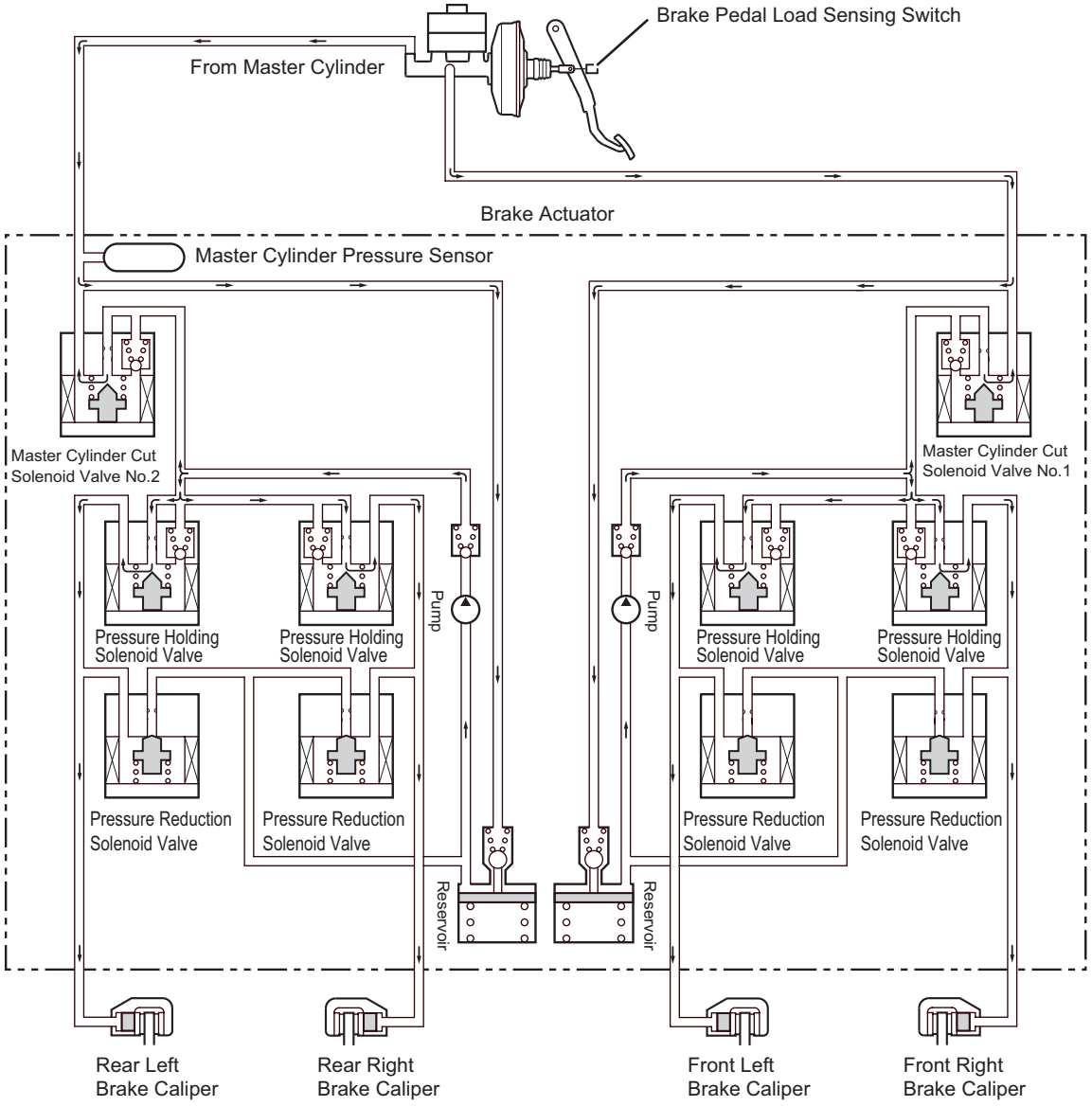
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VSC Operation(Front Wheel Sideslip Suppression Control)

Item		VSC Not Activated	VSC Activated		
			Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valve No.1		OFF(Open)	ON (regulate pressure)	←	←
Master Cylinder Cut Solenoid Valve No.2		OFF(Open)	ON (regulate pressure)	←	←
Front Wheel	Pressure Holding Valve	OFF(Open)	←*	ON(Close)	←
	Pressure Reduction Valve	OFF(Close)	←	←	ON(Open)
	Wheel Cylinder Pressure	—	Increase	Hold	Reduction
Rear Wheel	Pressure Holding Valve	OFF(Open)	←	ON(Close)	←
	Pressure Reduction Valve	OFF(Close)	←	←	ON(Open)
	Wheel Cylinder Pressure	—	Increase	Hold	Reduction

Radar Cruise Control Brake Control

• This control directs the hydraulic pressure generated by the pump in the brake actuator to the wheel cylinders, and generates a braking force that is needed for the cruise control.



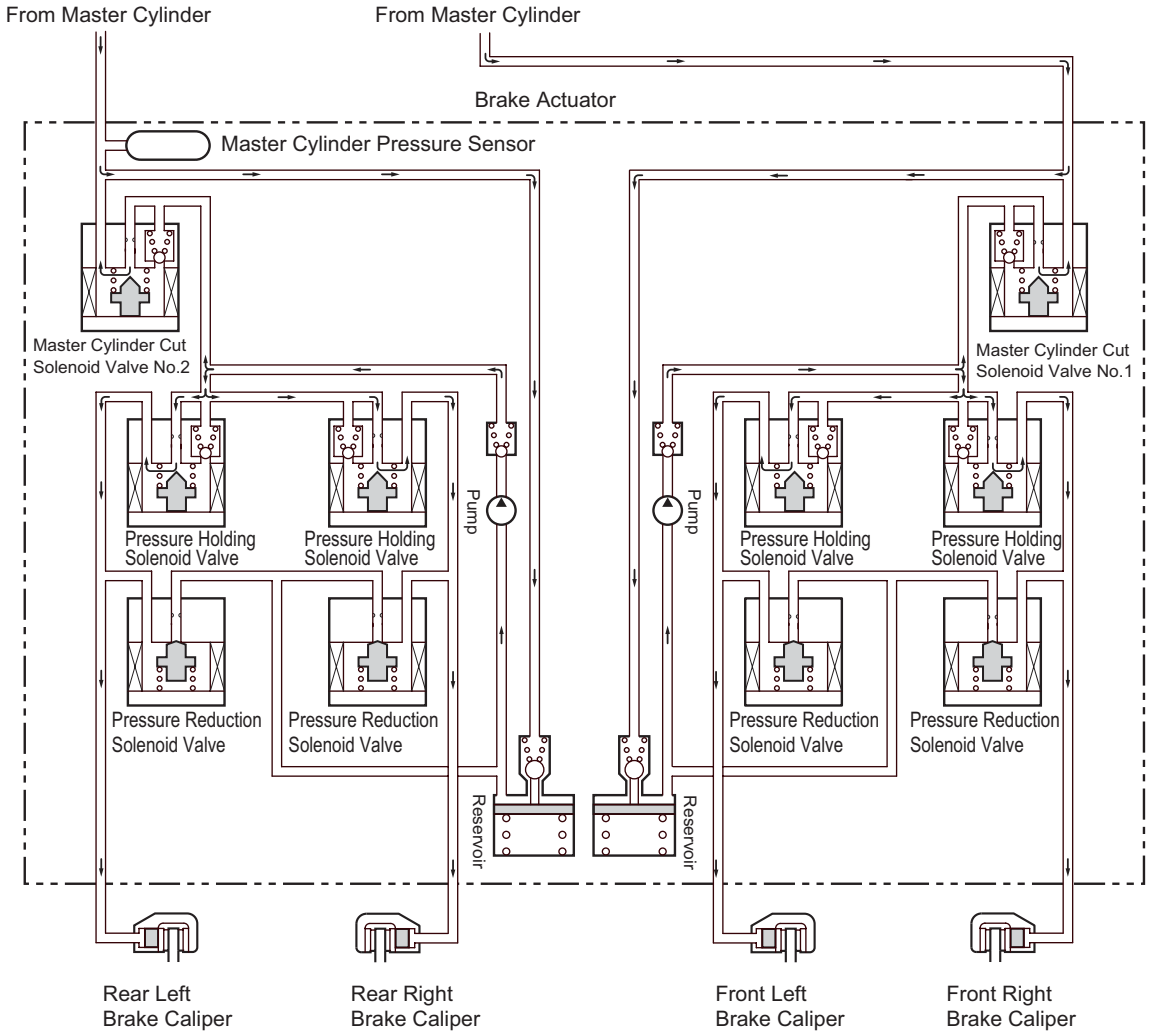
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Radar Cruise Control Brake Operation

Item	Radar cruise control brake control Not Activated	Radar cruise control brake control Activated
Master Cylinder Cut Solenoid Valve No.1	OFF(Open)	ON(regulate pressure)
Master Cylinder Cut Solenoid Valve No.2	OFF(Open)	ON(regulate pressure)
Pressure Holding Valve	OFF(Open)	←
Pressure Reduction Valve	OFF(Close)	←
Wheel Cylinder Pressure	—	Increase

Hill Start Assist Control Brake Control

- This control directs the hydraulic pressure generated by the pump in the brake actuator to the wheel cylinders, and generates a brake force that is needed for the hill start assist control.



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Hill Start Assist Brake Control Operation

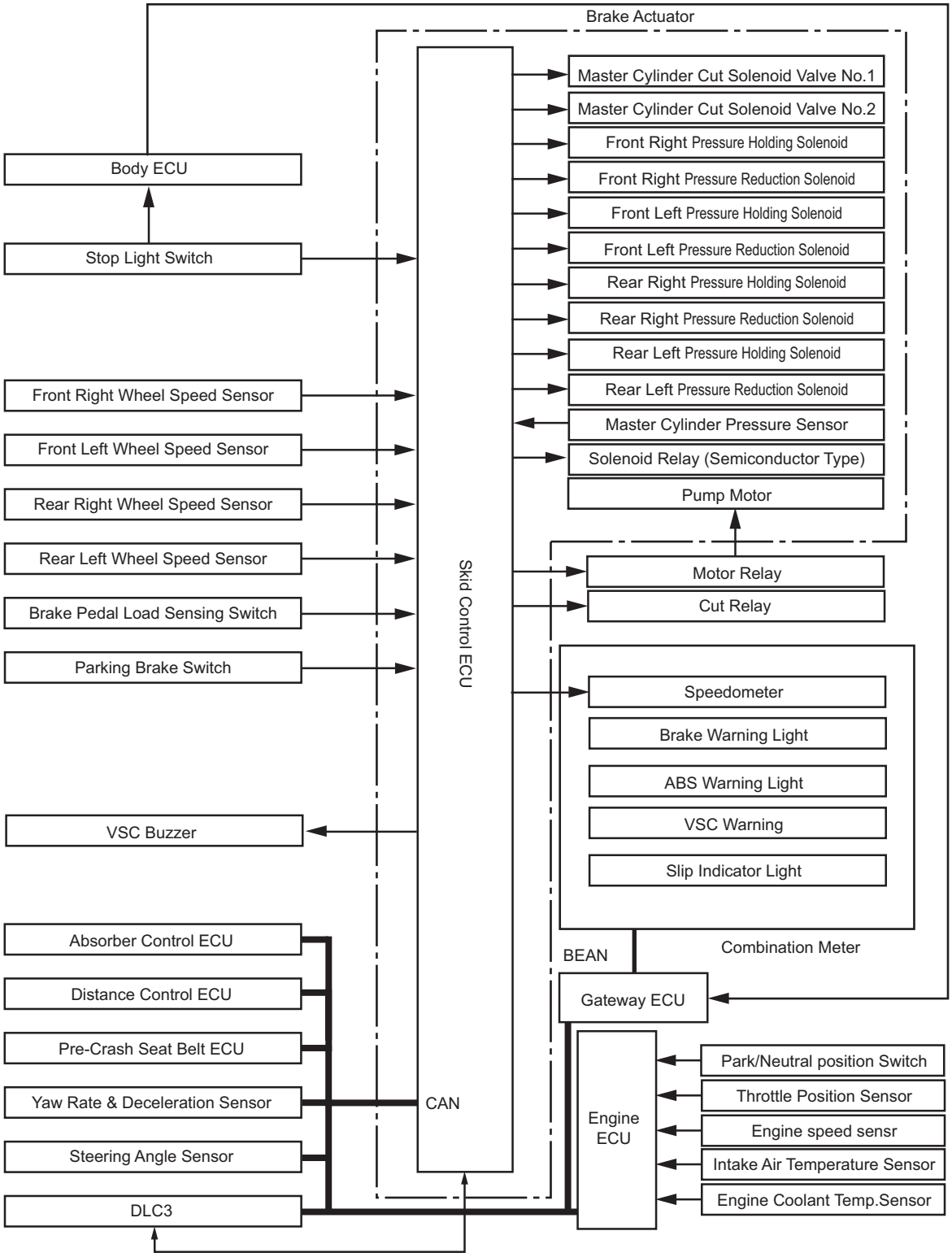
Item		Hill Start Assist Brake Control Not Activated	Hill Start Assist Brake Control Activated		
			Increase Mode	Holding Mode	Reduction Mode
Master Cylinder Cut Solenoid Valve No.1		OFF(Open)	ON(regulate pressure)	←	←
Master Cylinder Cut Solenoid Valve No.2		OFF(Open)	ON(regulate pressure)	←	←
Front Wheel	Pressure Holding Valve	OFF(Open)	←*	ON(Close)	←
	Pressure Reduction Valve	OFF(Close)	←	←	ON(Open)
	Wheel Cylinder Pressure	—	Increase	Hold	Reduction
Rear Wheel	Pressure Holding Valve	OFF(Open)	←*	ON(Close)	←
	Pressure Reduction Valve	OFF(Close)	←	←	ON(Open)
	Wheel Cylinder Pressure	—	Increase	Hold	Reduction

❖REFERENCE❖

* : Turn the holding solenoid valve ON (closed) for the non-control wheel.

Skid Control ECU

● The skid control ECU processes the signals from the sensors and effects the brake control for the ABS, TRC, VSC, and brake assist systems. It also maintains communication with the engine ECU and outputs control signals.



∗ : Displayed on The Multi-Information Display

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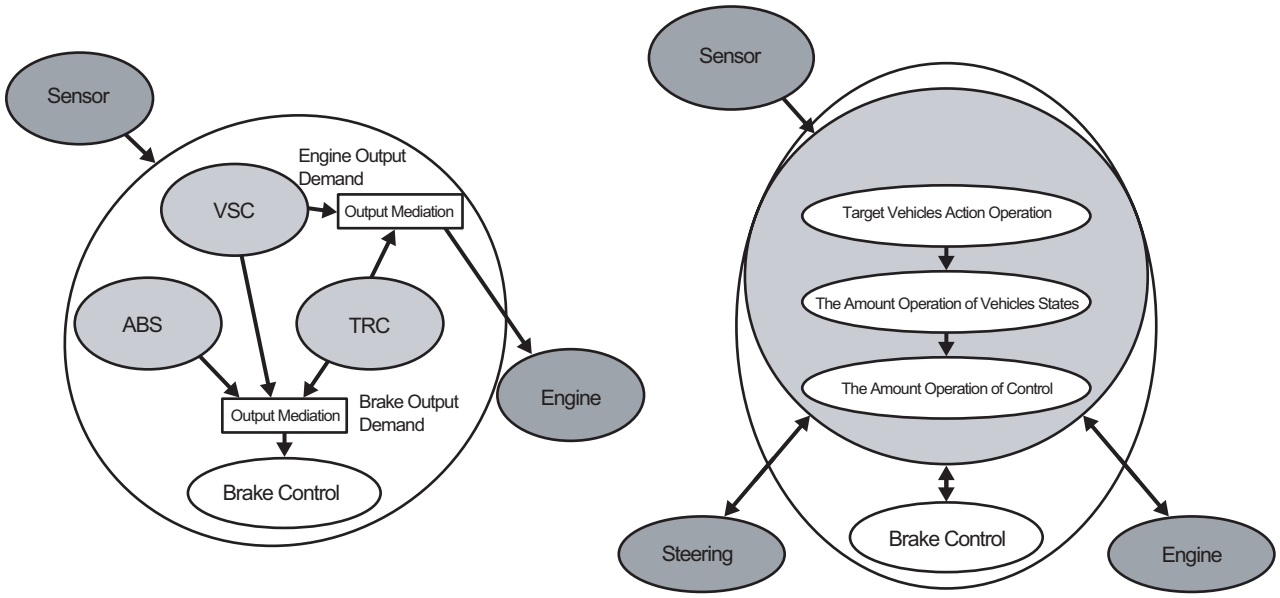
Initial Check Function

- When the vehicle first reaches a speed of more than approximately 6 km/h after the driver turns the ignition switch ON, the system actuates the solenoid valves and the motor in the brake actuator in sequence to perform an electrical check. During the initial check, the solenoid valves and the motor will make an operating sound in the engine compartment, which is normal.

VDIM BRAKE CONTROL

VDIM Outline

- A new concept of vehicle motion control called VDIM (Vehicle Dynamics Integrated Management) is used, which integrates brake control, drive force control, and steering control.
- Conventional vehicles use a combination of independent functions such as the ABS, TRC, VSC, EPS and VGRS. In contrast, the VDIM integrates these systems to enhance the motion performance of the vehicle to "run, turn, and stop".
- Conventional vehicles start their control in the vicinity of their threshold. In contrast, the VDIM starts control before the threshold is reached, in order to realize a smooth vehicle behavior. Thus, it expands the threshold of the vehicle, as well as the fun of driving.

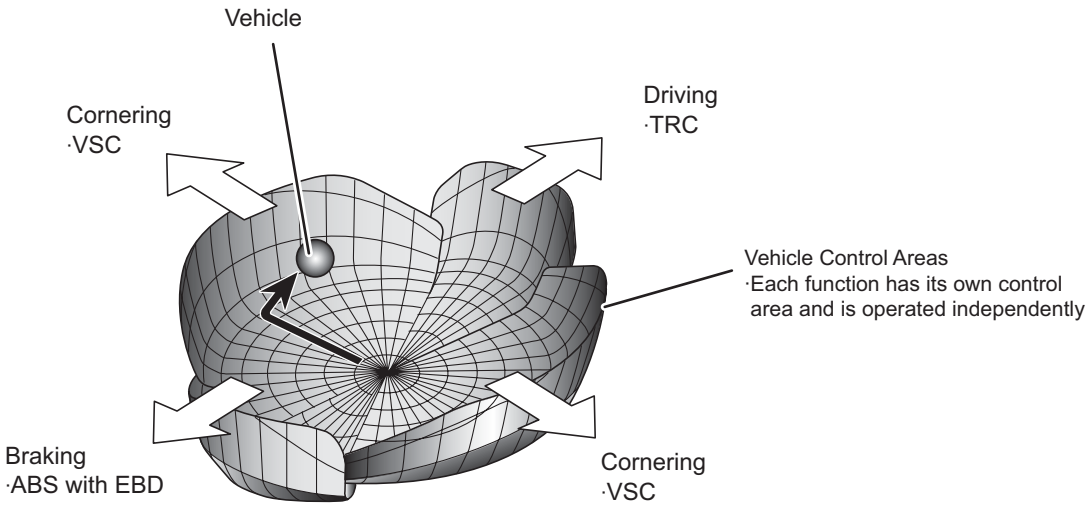


The Conventional Control VDIM

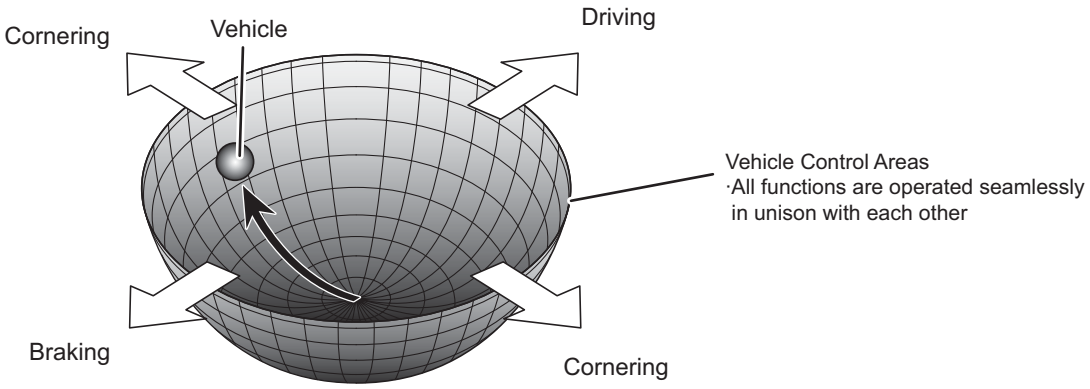
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- The VDIM manages all functions,such as the ABS with EBD,the Brake Assist,the TRC, and the VSC. And is operated by the ECB2 system, which the regulates a brake fluid pressure/ In addition, steering cooperative control functions are also available, thus this allowing the VDIM to perform the comprehensive management.
- Conventional brake control systems begin to control either the braking or motive force to in order to stabilize the vehicle motion,when it becomes unstable due to loss of tire traction. in contrast, in order to maintain stable vehicle control, the VDIM commences controlling the brake and steering systems in accordance with changes in balance before the vehicle becomes unstable. As a result, maintenance smooth vehicle control is achieved.
- Conventional brake control systems manage all related functions, such as the ABS with EBD, the Brake Assist, the TRC and the VSC, independently, according to the vehicle dynamics. In contrast, the VDIM provides smooth control by seamlessly integrating all those functions.

Conceptual Diagram of Control Management



Conventional



VDIM

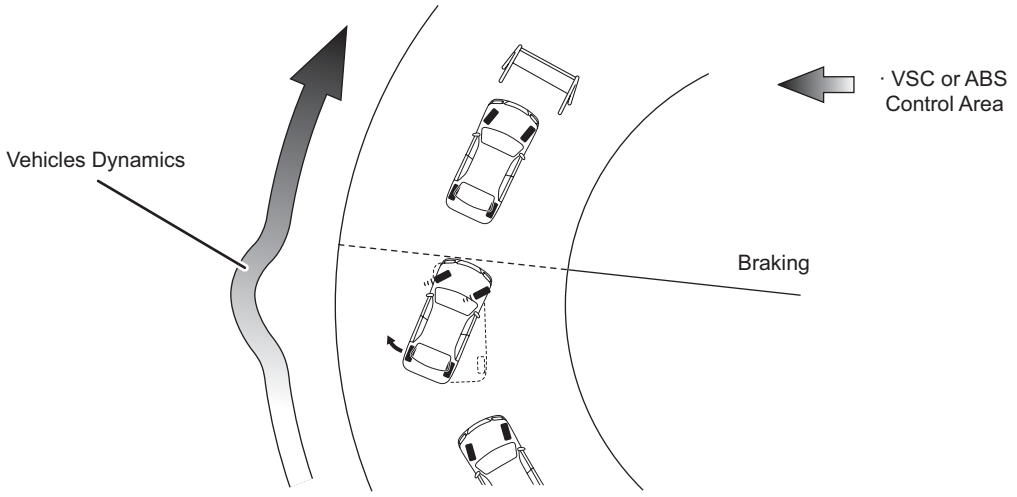
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BR

VDIM Operation

- The Difference in vehicle control during harsh braking situations while cornering, with the VDIM and conventional brake control systems, is as follows.
- Conventional

  Conventional brake control systems calculate vehicle motion based on signals transmitted by yaw rate and deceleration sensors, the speed sensors and the steering sensors,and activates VSC systems when vehicles are determined to be skidding. If the driver brakes suddenly, brake control systems perform assisting control to stabilize the vehicle dynamics, by activating the ABS system when a locked wheel is detected, or by affecting the VSC system when skidding is detected.

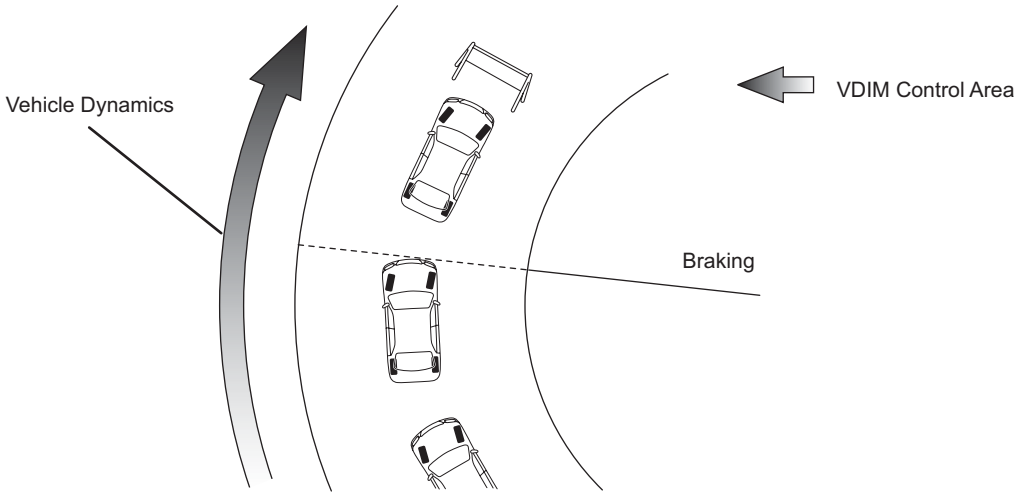


Hrash Braking

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- VDIM

  The VDIM also calculates vehicle motion based on signals from the yaw rate and deceleration sensor, speed sensor and steering sensor. When the calculations indicate that the vehicle is likely to skid, the VDIM begins vehicle control with the VSC function. In addition, if the driver brakes suddenly, the VDIM reduces vehicle instability to a minimum and assists in achieving optimum driving stability by seamlessly delivering a suitable combination of the VSC and ABS functions.

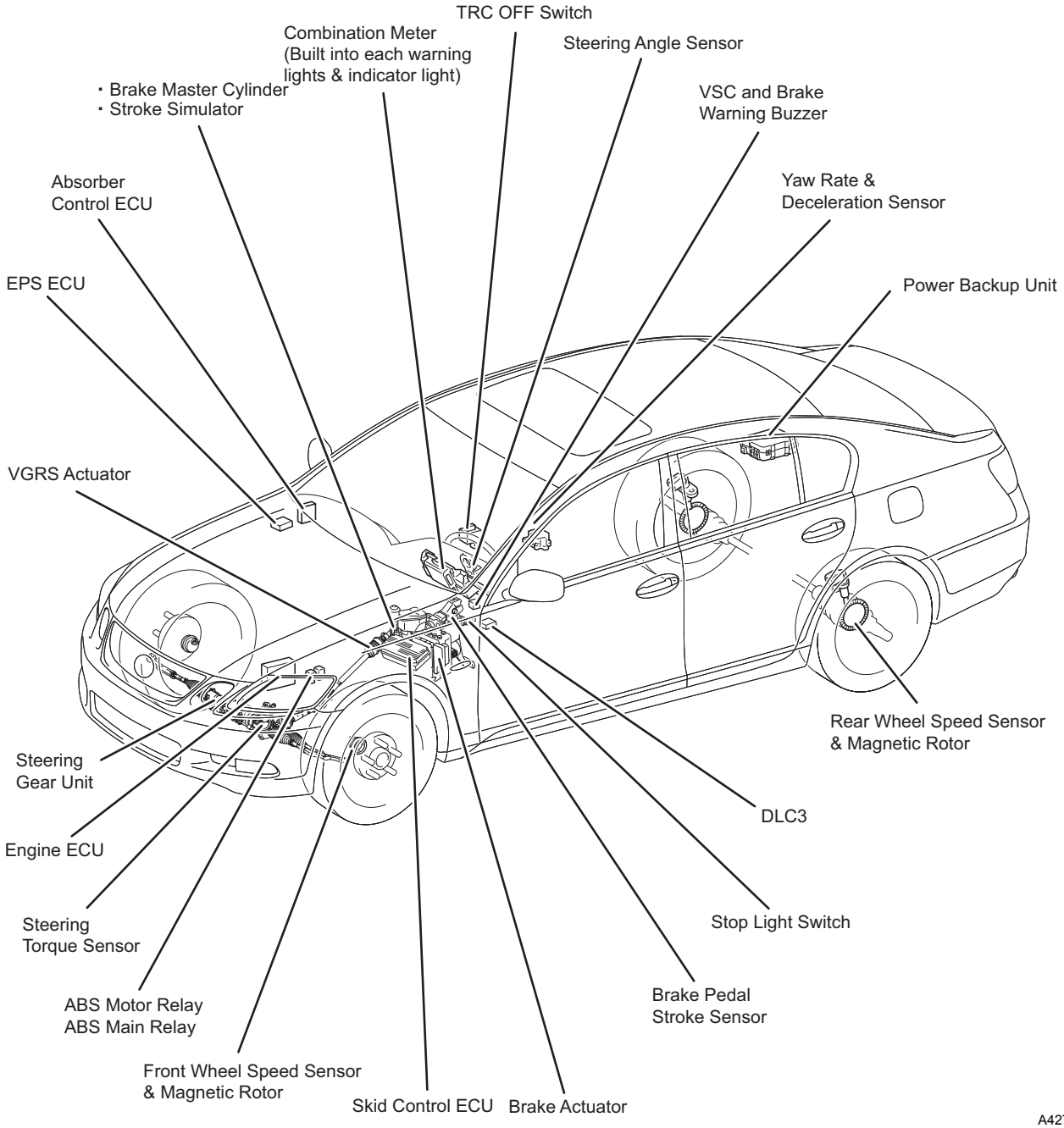


Hrash Braking

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Main Components and Functions

● Components such as the sensors, actuator, and skid control ECU are located as illustrated below.



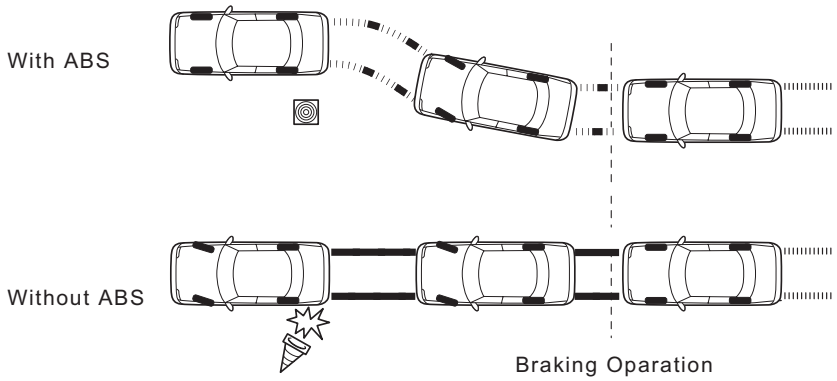
Main Components and Functions

Composition parts	Function
Vehicle speed sensor (semiconductor type)	Detects the wheel speed and inputs it into the skid control ECU.
Ignition Switch	Supplies power to the skid control ECU.
Yaw Rate & Deceleration Sensor	Detects the yaw rate (rotational movement) of the vehicle body, as well as its longitudinal and lateral acceleration rates and inputs them into the skid control ECU.
Brake Pedal Stroke Sensor	Detects the amount of brake pedal stroke and inputs it into the skid control ECU.
Stop Light Switch	Detects the state of the brake pedal operation and inputs it into the skid control ECU.
Master Cylinder Pressure Sensor (built into the brake actuator)	Detects the master cylinder pressure and inputs it into the skid control ECU.
Wheel Cylinder Pressure Sensor	Built into the brake actuator, this sensor detects the brake hydraulic pressure of the wheel cylinders.
Accumulator Pressure Sensor	Built into the brake actuator, this sensor detects the accumulator hydraulic pressure.
Steering Angle Sensor	Detects the turning angle and direction of the steering wheel and inputs it into the skid control ECU via the CAN (Controller Area Network).
Combination Meter	The combination meter contains a master warning, slip indicator light, brake warning light, ABS warning light, ECB warning light, and VSC warning (on multi-information display).
VSC Buzzer	Sounds intermittently to inform the driver that the VSC is operating.
Brake Warning Buzzer	Sounds continuously to warn the driver of a drop in the accumulator hydraulic pressure in the brake actuator, a failure in the power supply system, or a drop in the vehicle power voltage (12V).
Brake Actuator	Controls the individual hydraulic pressure of the four wheels in accordance with the signals that are output by the skid control ECU.
Main Relay (built into the relay box)	Operates under the control of the skid control ECU to supply power to the solenoids, as well as to the skid control ECU.
Motor Relay (built into the relay box)	Operates under the control of the skid control ECU to supply power to the pump motor.
Power Backup Unit (located on the right side of the luggage compartment)	Contains a capacitor that accumulates an electrical charge, and discharges it to supply power to the system if there is a drop in the vehicle power voltage (12V).
Skid Control ECU	Processes the signals from the sensors and effects the brake control for the ABS, TRC, VSC, brake assist, and hill assist systems. Also, it maintains communication with the engine ECU and outputs control signals.
Engine ECU	Maintains communication with the skid control ECU in order to control the engine output during the TRC or VSC operation.
DLC3	Enables access to the DTC (Diagnostic Trouble Code) and ECU data when a diagnosis tool (Intelligent Tester II) is connected to this connector and operated.

ABS with EBD Function

Description

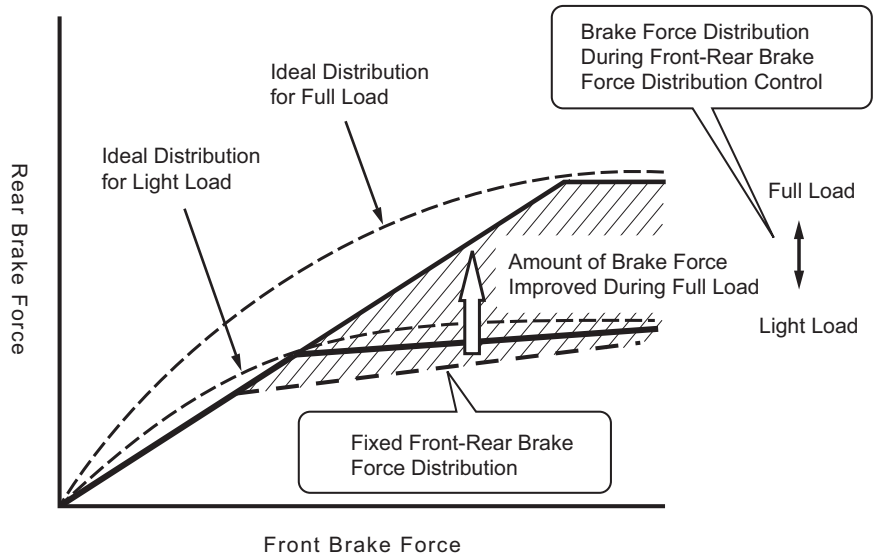
- To enable a vehicle to run, turn, and stop, it is imperative that the tires perform their function of gripping the road. However, during sudden braking or braking on slippery surfaces, such as on a road that has puddles or is covered with snow, the wheels could lock up while the vehicle is still moving. This results in a slippage between the tires and the surface. During braking in these situations, the ABS (Antilock Brake System) detects the wheel speeds and uses a computer to control the brake fluid pressure to all four wheels. This control prevents the wheels from locking and provides the proper brake performance, thus ensuring steering maneuverability and vehicle stability.
- In addition to the conventional ABS functions, the ABS with EBD appropriately distributes the braking force between the front and rear wheels and the right and left wheels. Thus, the ABS with EBD ensures superior brake performance that is unaffected by changes in load, such as when the vehicle is empty or fully loaded.



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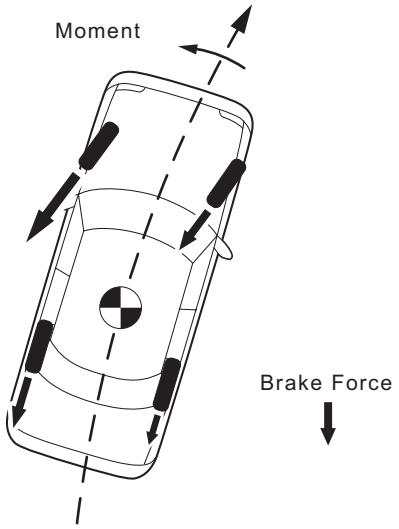
Brake Force Distribution Control

- The front-rear brake force distribution control aims at maximizing "stopping" performance, which is the basic function of the brakes. Thus, it distributes the brake force appropriately to the front and rear wheels in accordance with the driving conditions of the vehicle.
- In addition to the conventional ABS functions, the ABS with EBD appropriately distributes the braking force between the front and rear wheels and the right and left wheels. Thus, the ABS with EBD ensures superior brake performance that is unaffected by changes in load, such as when the vehicle is empty or fully loaded.



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• The right-left brake force distribution control ensures vehicle stability during braking along turns by regulating the brake force of the right and left wheels. Thus, it ensures an excellent braking effect.



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Precautions on ABS with EBD

• The ABS is not intended to extend the actual braking performance of the tires. Therefore, drive safely by paying attention to your speed, as well as the distance between your vehicle and others.
• The use of non-standard parts such as tires of a non-standard size will negatively affect the ABS control.
• Under the conditions listed below, the braking distance with the ABS operating may be longer than on vehicles without ABS.

Conditions

Driving on a gravel road or fresh snow
Using tire chains
Driving over an offset such as a seam on the road
Driving on a rough road with an irregular surface or stone pavement

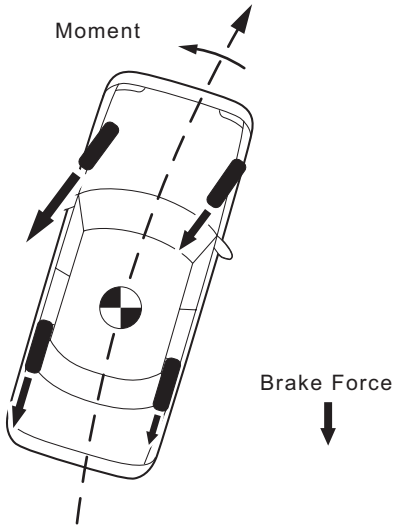
Brake Assist Function

● The system determines emergency braking based on the amount and speed of the brake pedal effort and generates a strong brake force accordingly.

Concept of Brake Assist

• In emergency braking, the driver in a panic state might press the brake pedal quickly but not firmly, generating only a small amount of braking force (see "a" in the figure).
• In that state, the driver might not be able to keep the brake pedal depressed during the latter half of braking, and cause the brake force to drop (see "b" in the figure).
• The brake assist system estimates the intention of the driver to apply emergency braking upon detecting a quick application of the brake pedal. Thus, even if the driver is unable to press the brake pedal firmly, this system increases the brake force (see "c" in the figure).
• If the driver intentionally eases the brakes after the brake assist operates, the system reduces the amount of brake force assist to reduce the sense of intrusiveness (see "d" in the figure).

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A4270087C

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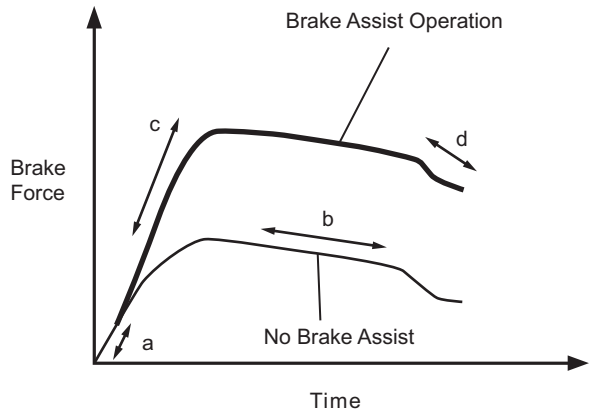
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Precautions on Brake Assist

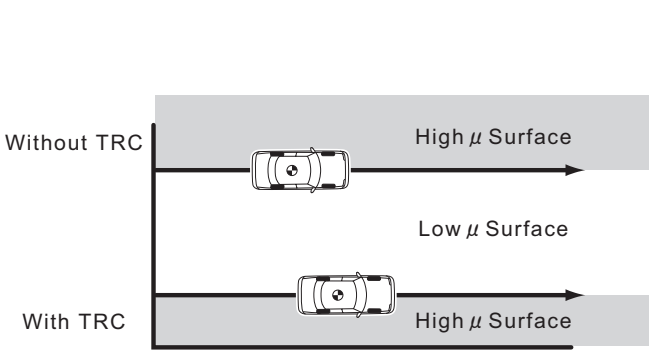
- The brake assist is not intended to extend the actual capability of the brakes. Therefore, drive safely by paying attention to your speed, as well as the distance between your vehicle and others.

TRC Function

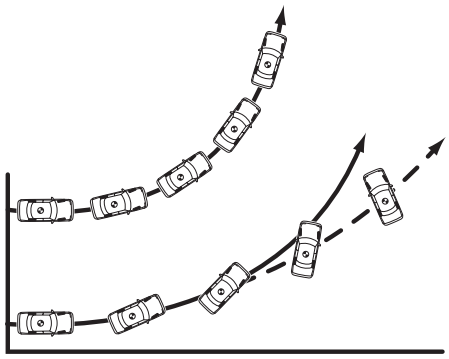
- If the driver opens the throttle too far while starting off or accelerating on a slippery surface, the engine will generate excessive torque, causing the drive wheels to slip. This could negatively affect the vehicle's startoff acceleration and maneuverability. The TRC (Traction Control) controls the power output of the engine in accordance with the brake hydraulic pressure control of the drive wheels. This system suppresses the slippage of the drive wheels and provides a drive force that suits the surface conditions. Thus, it ensures the vehicle's startoff acceleration, straightline performance, and cornering stability.
- The TRC provides the following features:

Features

Eliminates the need for the driver to perform intricate accelerator pedal maneuvers while starting off and accelerating on slippery surfaces.
Realizes excellent maneuverability and stability during acceleration.
Enables the vehicle to turn more stably while accelerating around a turn.
Enables the vehicle to accelerate stably even on a split-surface, where the surface conditions differ between the right and left drive wheels.

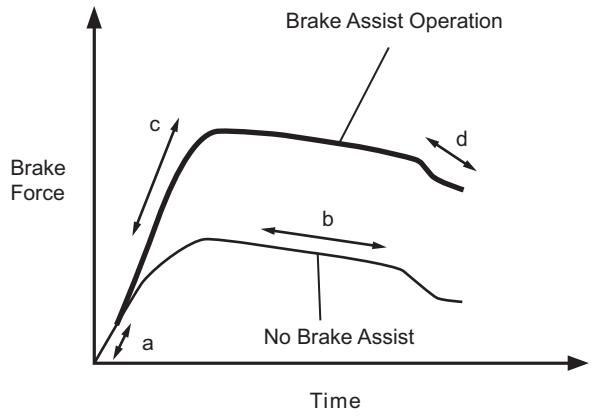


Acceleration Performance
(on split-μ surface having high μ and low μ surfaces)



Turning Stability (on low μ surface)

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Precautions on Brake Assist

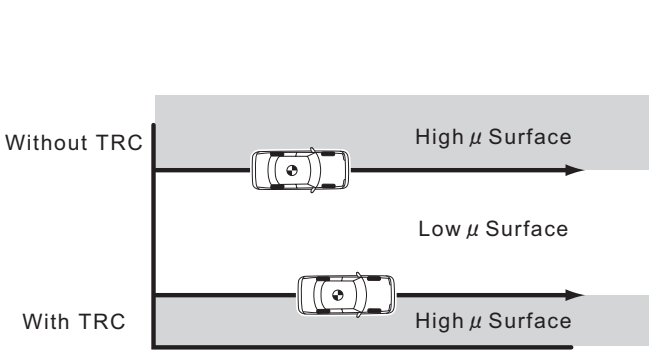
- The brake assist is not intended to extend the actual capability of the brakes. Therefore, drive safely by paying attention to your speed, as well as the distance between your vehicle and others.

TRC Function

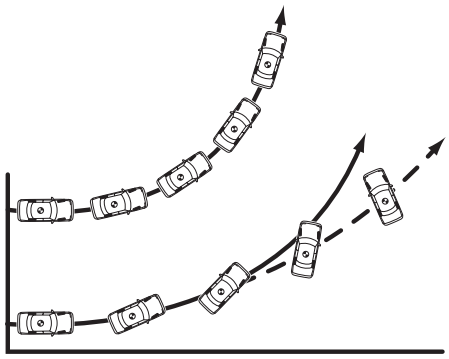
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- The TRC provides the following features:

Features

Eliminates the need for the driver to perform intricate accelerator pedal maneuvers while starting off and accelerating on slippery surfaces.
Realizes excellent maneuverability and stability during acceleration.
Enables the vehicle to turn more stably while accelerating around a turn.
Enables the vehicle to accelerate stably even on a split-surface, where the surface conditions differ between the right and left drive wheels.



Acceleration Performance
(on split-μ surface having high μ and low μ surfaces)



Turning Stability (on low μ surface)

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VSC Function

● The primary purpose of the ABS and TRC systems is to ensure stability during the braking and acceleration associated with brake or accelerator maneuvers. In contrast, the VSC (Vehicle Stability Control) system ensures stability in the turning direction of the vehicle. Ordinarily, a vehicle turns stably in accordance with the steering maneuver. However, under unexpected conditions or external factors, such as surface conditions, vehicle speed, or emergency turning, the vehicle will exhibit a strong sideslip tendency at the front or rear wheels. To ensure stability under these conditions, the VSC automatically controls the engine power output and the brakes at the individual wheels in order to ease the strong sideslip tendency at the front or rear wheels.

Control Performance Outline

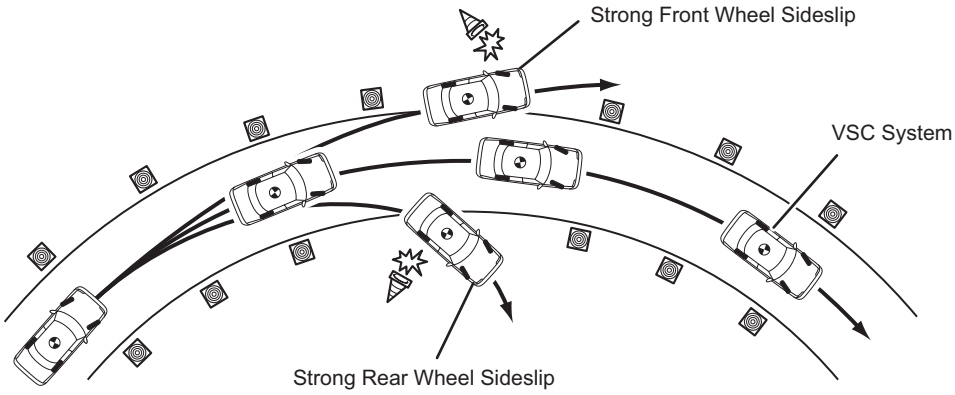
- The VSC detects the conditions of the vehicle based on the signals received from various sensors including the yaw rate sensor and deceleration sensor, and controls the brake hydraulic pressure and the engine output torque.
- The following are two examples of circumstances in which the wheels exceed their side grip threshold:

Two Examples:

[1] The rear wheels are losing their grip relative to the front wheels (strong rear wheel sideslip).
[2] The front wheels are losing their grip relative to the rear wheels (strong front wheel sideslip).

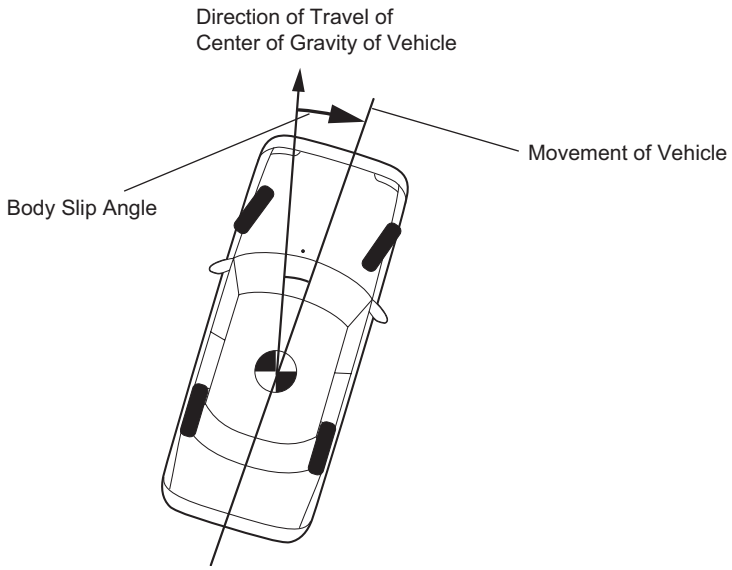
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- The VSC operates in the circumstances illustrated below to ease the vehicle's strong rear or front wheel sideslip tendency.



Judging the Vehicle's Strong Rear Wheel Sideslip Tendency

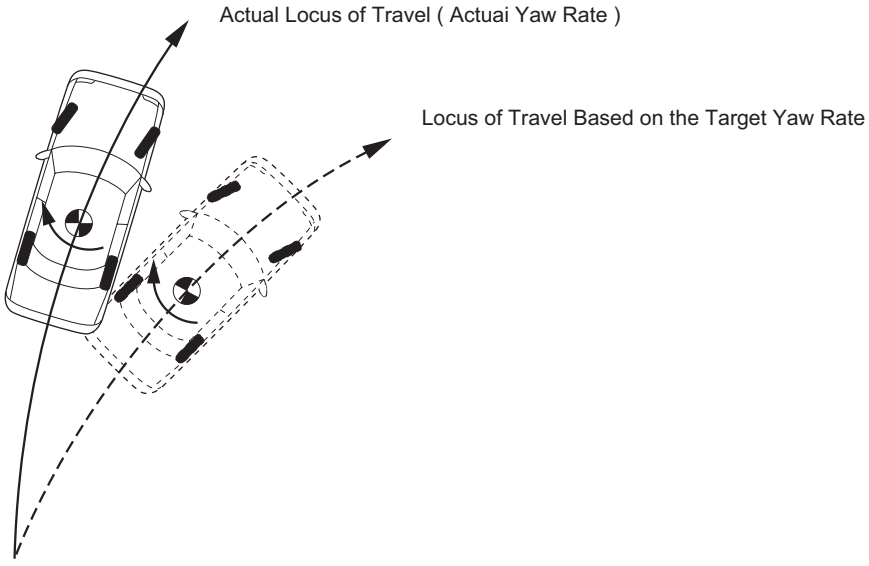
- The skid control ECU determines whether a rear wheel sideslip tendency exists based on the body slip angle and slip angle velocity values obtained by the yaw rate & deceleration sensor. When both the body slip angle and the slip angle velocity are large, the body is said to exhibit a rear wheel sideslip tendency.



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Judging the Vehicle's Strong Front Wheel Sideslip Tendency

- The skid control ECU determines whether a front wheel sideslip tendency exists based on a comparison of the target yaw rate and the vehicle's actual yaw rate value. As the driver turns the steering wheel, if the vehicle's actual yaw rate is lower than the target yaw rate that should be generated (determined by the steering angle and vehicle speed), it means that the body is not turning as intended. Thus, the body is said to exhibit a large front wheel sideslip tendency.



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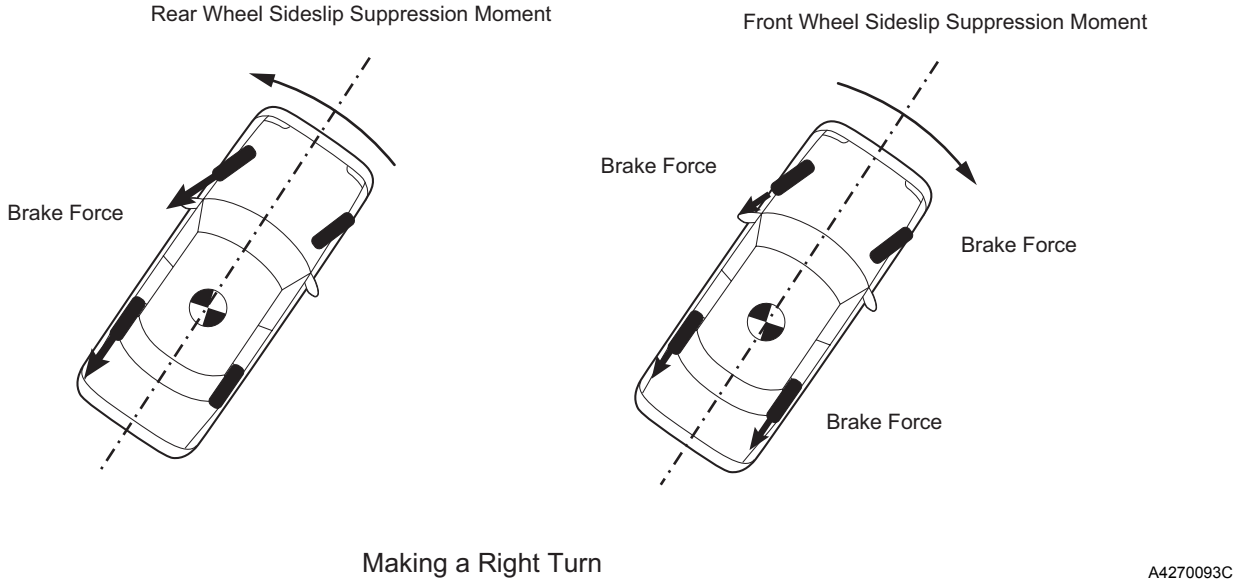
VSC Operation Method

- Easing a Strong Rear Wheel Sideslip Tendency of the Vehicle

  When the skid control ECU judges that the vehicle exhibits a large rear wheel sideslip tendency, it applies the brakes on the front and rear wheels on the outside of the turn in accordance with the extent of that tendency. This suppresses the rear wheel sideslip tendency by generating a moment outward of the vehicle. In addition, the vehicle speed that is reduced by the application of the brake force also contributes to ensuring vehicle stability.

- Easing a Strong Front Wheel Sideslip Tendency of the Vehicle

  When the skid control ECU judges that the vehicle exhibits a large front wheel sideslip tendency, it controls the engine power output in accordance with the extent of that tendency. Then, the skid control ECU applies the brakes on the front and rear wheels to reduce the side force, in order to suppress the front wheel sideslip tendency.

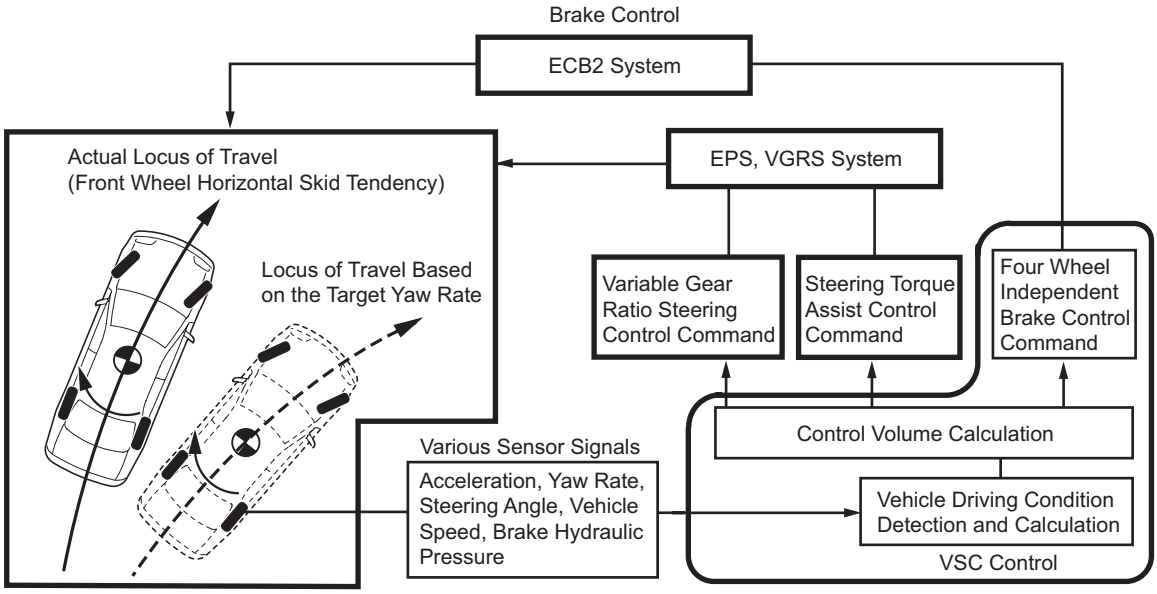


Making a Right Turn

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Steering Coordination Function

- The VDIM system effects coordinated control consisting of VSC (Vehicle Stability Control), EPS (Electric Power Steering), and VGRS (Variable Gear Ratio Steering). By integrating these preventive safety functions, the VDIM system ensures excellent driving stability and maneuverability of the vehicle.
- This is the world's first system to use the following steering coordinated control functions: Steering control with braking on sprit μ, Steering control with driving on sprit μ, and Steering control in understeer condition.
- If the vehicle loses stability due to a slippage, this function effects brake control by applying hydraulic pressure to the wheels. At the same time, the EPS provides steering torque assist control or active steering wheel angle control and the VGRS provides variable gear ratio steering control to facilitate the driver's steering maneuver.



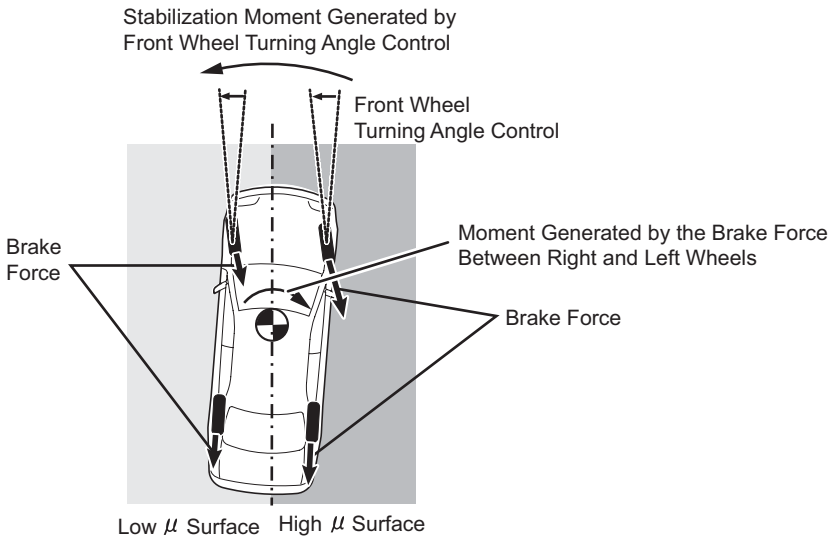
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Steering Coordination Function List

	First in the world
Steering control with braking on sprit μ	❍
Steering control with driving on sprit μ	❍
Steering control in understeer condition	❍
Steering control in oversteer condition	
Variable Gear Ratio Control (VGRS function)	
Differential Steering Control (VGRS function)	

Steering Control with Braking on Sprit μ

- When the driver applies the brakes, the surface could have different slippage rates, such as when the right wheels are on asphalt pavement and the left wheels are on the snow. In this case, the difference that is created in the brake force between the right and left wheels could cause the vehicle to veer to the side that has the higher friction coefficient.The VDIM (Vehicle Dynamics Integrated Management) controls the turning angle of the front wheels in the direction that suppresses the moment that is generated by the brake force difference between the right and left wheels. Thus, this system makes the driver's corrective steering maneuver practically unnecessary and ensures a high level of vehicle stability. Consequently, it maintains the brake force that is generated between the surface and the tires at an even higher level than in the past, thus ensuring vehicle stability.

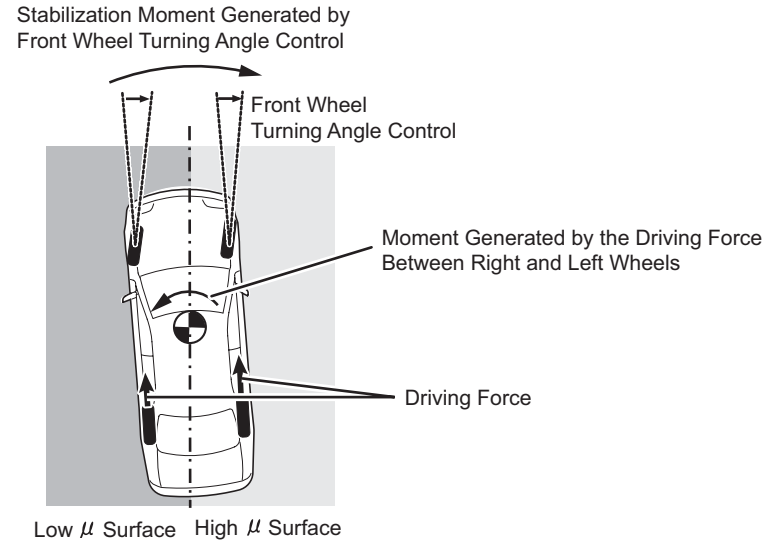


Steering Control with braking on sprit μ

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Steering Control with Driving on Sprit μ

- The driver might start off the vehicle on a surface with different slippage rates, such as when the right wheels are on asphalt pavement and the left wheels are on the snow. In this case, the difference that is created in the drive force between the right and left wheels could cause the vehicle to veer to the side with the lower friction coefficient.
- The VDIM (Vehicle Dynamics Integrated Management) controls the turning angle of the front wheels in the direction that suppresses the moment that is generated by the drive force difference between the right and left wheels. Thus, this system makes the driver's corrective steering maneuver practically unnecessary and ensures a high level of vehicle stability. Consequently, it provides driving performance of a higher level than in the past, thus ensuring vehicle stability.

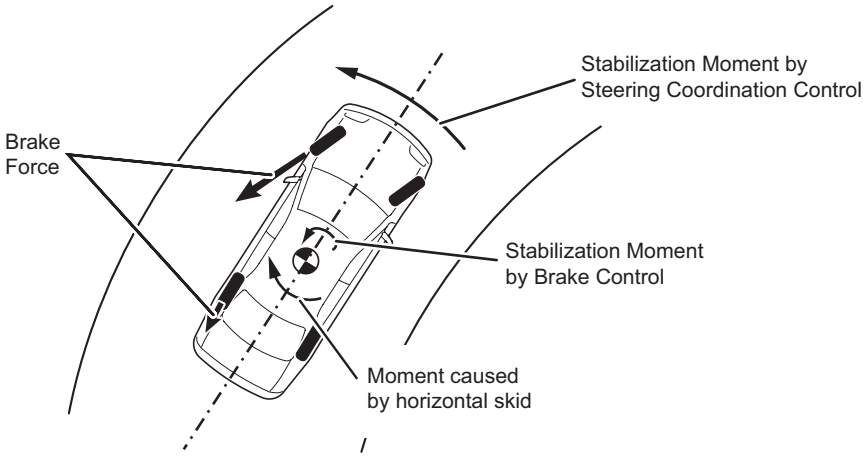


Steering Control with driving on sprit μ

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Steering Control in Oversteer Condition

- The system determines the existence of a rear wheel sideslip tendency based on the information provided by various sensors that detect the conditions of the vehicle. Then, it applies the brakes primarily on the outer wheels of the turn, depending on the extent of that tendency. This generates a stabilization moment in the outward direction of the turn, thus suppressing the rear wheel sideslip tendency.
- The VDIM uses a VGRS (Variable Gear Ratio Steering) actuator to control the front wheel angle to suit the extent of the aforementioned sideslip, thus generating a stabilization moment. Unlike the conventional stabilization control that relies solely on the brakes, this system stabilizes the vehicle by effecting steering control in addition to brake control. Thus, this system ensures stability without causing the driver to feel an excessive feeling of deceleration.

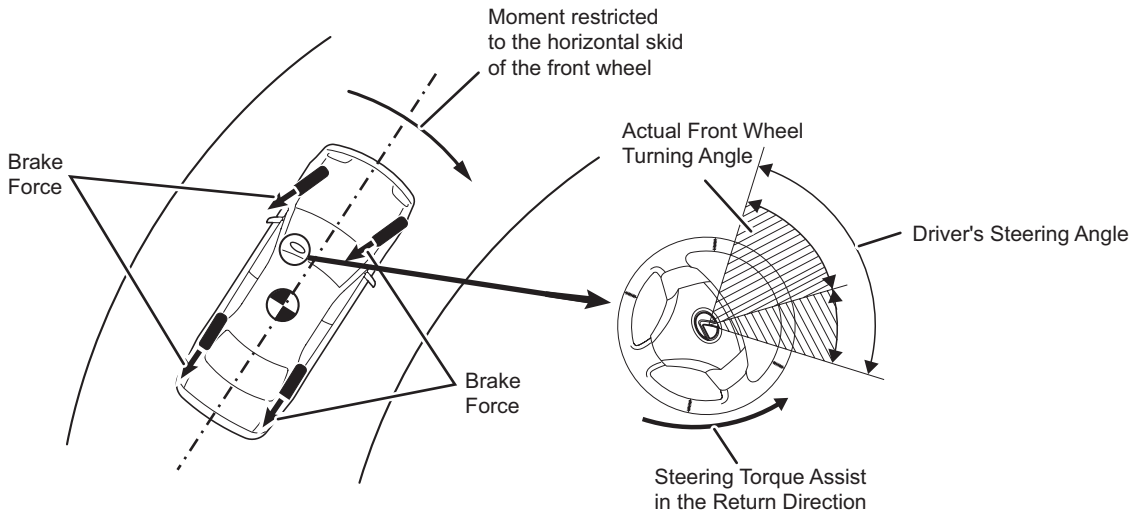


Steering control in oversteer condition

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Steering Control in Understeer Condition

- The skid control ECU calculates the driver's target yaw rate based on the steering angle and vehicle speed. Then, it determines whether a front wheel sideslip tendency exists based on a comparison of the target yaw rate and the vehicle's actual yaw rate value. Then, it controls the engine output characteristics and operates the brakes in accordance with the extent of that tendency, thus generating a moment in the turning direction of the vehicle, in order to suppress the front wheel sideslip tendency.
- When the vehicle exhibits this type of front wheel sideslip tendency, in which the vehicle's direction of travel will not change even if the driver steers the front wheels further, the VDIM employs the VGRS to increase the steering gear ratio and the EPS to provide steering torque assist in the direction to return the turning angle of the front wheels. Thus, it suppresses the front wheels from turning in excessively.



Steering Control In Understeer Condition

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Steering Gear Ratio Changed to Suit Vehicle Speed

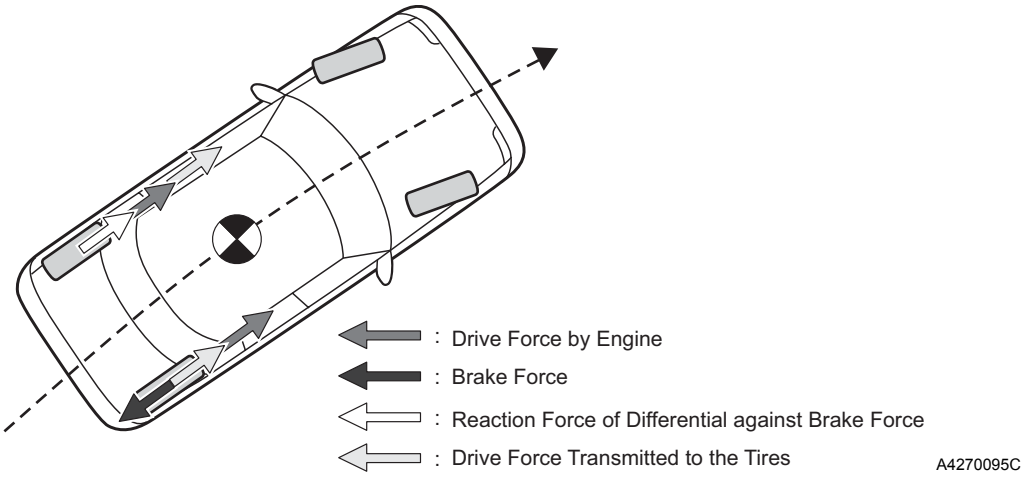
- In the conventional steering system, the steering gear ratio is set to enable the vehicle to respond gently to the amount of steering effort, with high-speed driving in mind. This requires the driver to increase the amount of steering effort while driving at low speeds. Because the VGRS can change the steering gear ratio at will, it is able to optimize the steering gear ratio in accordance with the driving conditions.
- For further details regarding the above, refer to page ST-7.

Driving Feel Through Differential Steering Control

- The system controls the VGRS actuator with very small angles in accordance with the speed of the driver's steering maneuver (differential of the steering turning angle), in order to correct the response delay of the vehicle. Thus, it supports the vehicle with the proper driving feel during lane changes or while driving on a winding road.
- For further details regarding the above, refer to page ST-8.

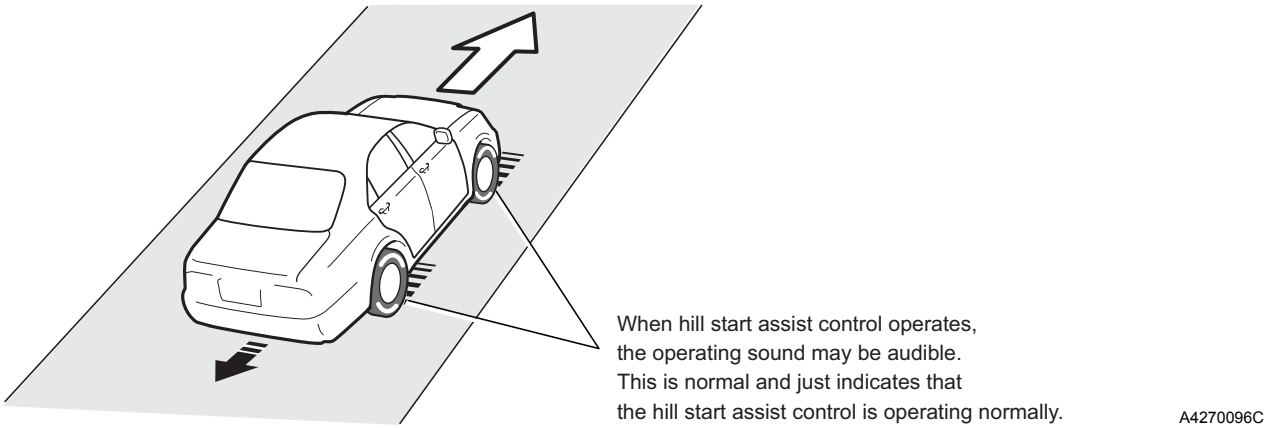
LSD Function

- When the vehicle accelerates around a turn, the load shifts outward of the turn. This hinders the transfer of the drive force from the inner wheels of the turn to the surface, and causes those wheels to spin.
- Upon detecting the turning conditions and the spinning of the wheels, the VDIM system applies the brake on the inner drive wheel of the turn. This suppresses the spinning, transfers the drive force to the outer wheel of the turn, and thus realizes the intended acceleration of the driver.



Hill Start Assist Control Function

- When the hill start assist control detects that the vehicle is rolling backwards, it automatically applies brake hydraulic pressure to the four wheels, in order to reduce the reverse speed of the vehicle.
- This function is effective in a situation in which it is difficult to start off the vehicle, such as starting off on a steep or slippery hill, where the vehicle is likely to roll backwards as the driver switches from the brake pedal to the accelerator pedal.



Operation Conditions

Shift position D, 6, 5, 4, 3, 2, or 1 selected	Operates during start-off acceleration while driving uphill. Therefore, it does not operate with the shift lever in the P or N position. It does not operate when driving uphill in reverse, with the shift lever in the R position.
Brake Pedal OFF	Prohibits the operation of the system when the driver presses the brake pedal, so as not to prevent the driver from stopping the vehicle.

Effectiveness of the Hill Start Assist Control

- Because it reduces the chance of the vehicle rolling backwards as the driver switches from the brake pedal to the accelerator pedal, it allows the driver to perform the pedal maneuver comfortably.
- Because it reduces the speed of the vehicle rolling backwards, it minimizes the wheel spin when the driver presses the accelerator pedal, thus facilitating the startoff on a slippery surface.
- Because it optimally controls the brake hydraulic pressure to the four wheels, it ensures vehicle stability without causing the wheels to lock up on slippery hills.

Description of the Hill Start Control

- The skid control ECU receives the inputs of signals from various sensors that detect the shift position and the travel direction of the vehicle body (such as by way of the wheel speed sensors, which are capable of detecting the rotational direction). Then, the system determines whether the vehicle body is rolling backwards while the driver is attempting to drive it uphill.
- The deceleration sensors detect the gradient of the hill and the acceleration state of the vehicle body. The wheel speed sensors detect the locking state of the wheels and their rotational direction. Then, the skid control ECU calculates the amount of control that is needed and implements brake hydraulic pressure control to the wheels.
- When the vehicle starts to move forward, the system releases the brake hydraulic pressure and stops the control.

Precautions for Hill Start Assist Control

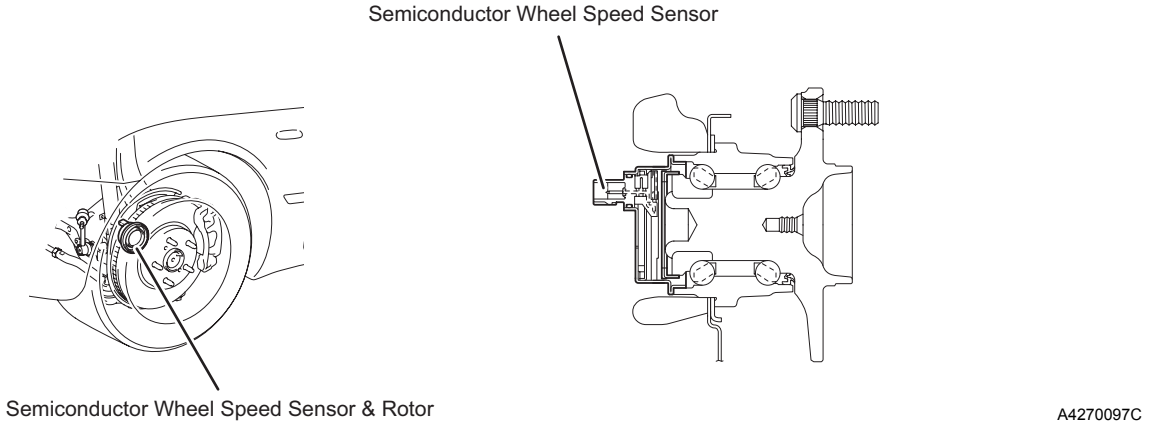
- The hill start assist control is not a function for keeping the vehicle stopped on a hill.
- During a hill start assist control operation, the slip indicator light blinks in the combination meter, and the brake lights illuminate.
- The hill start assist control system controls the brakes at four wheels to reduce the reverse movement of the vehicle. However, it might not be fully effective on extremely steep slopes or on icy roads or other surfaces with very low friction.

Radar Cruise Control Brake Operation

- If a greater deceleration rate is required while driving in the vehicle control mode, this control generates a brake force by controlling the brake hydraulic pressure in accordance with the signals received from the distance control ECU.

Front Wheel Speed Sensor

- A semiconductor wheel speed sensor & magnetic rotor, which is integrated in the bearing unit, is installed on the front axle hub. The magnetic rotor is fixed to the inner race of the bearing unit and the sensor is installed on the cap.



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Precautions for Hill Start Assist Control

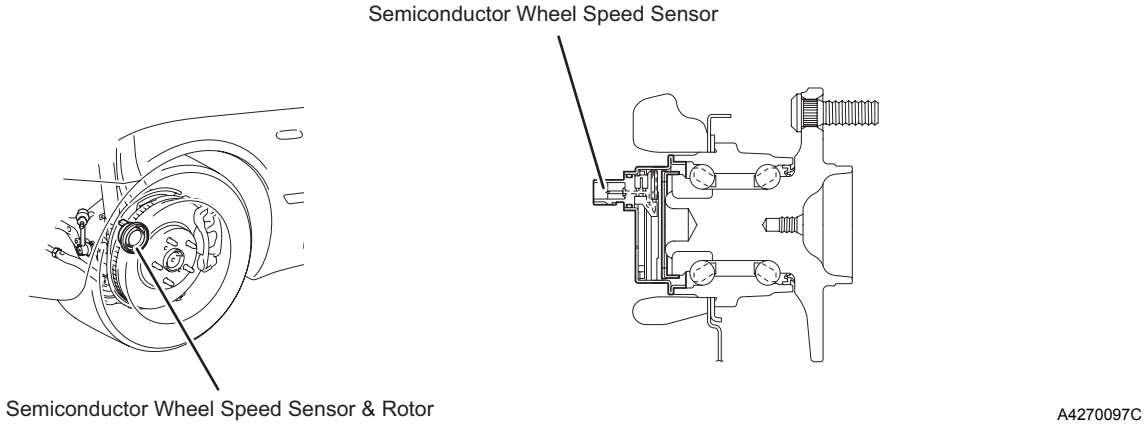
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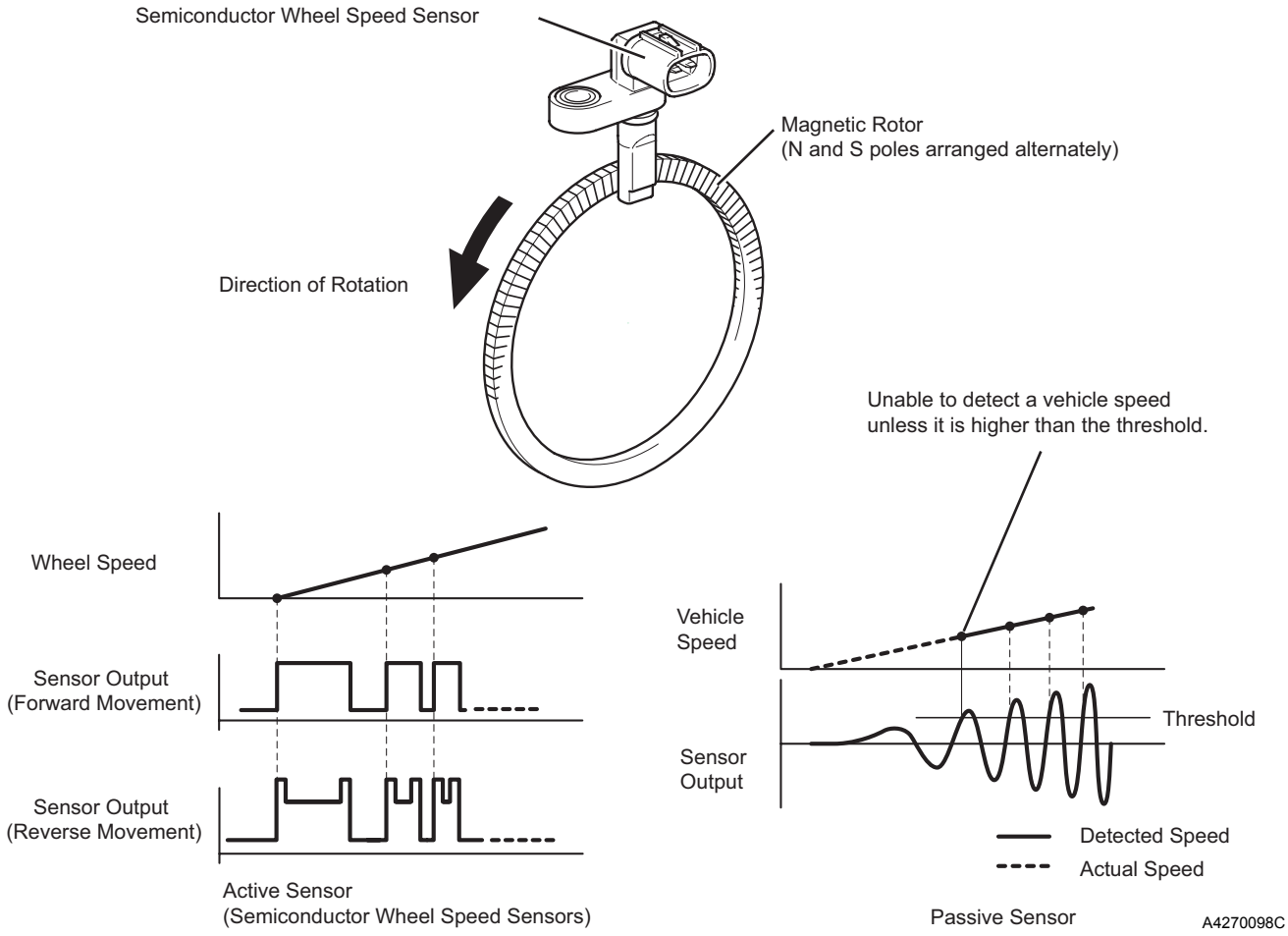
Front Wheel Speed Sensor

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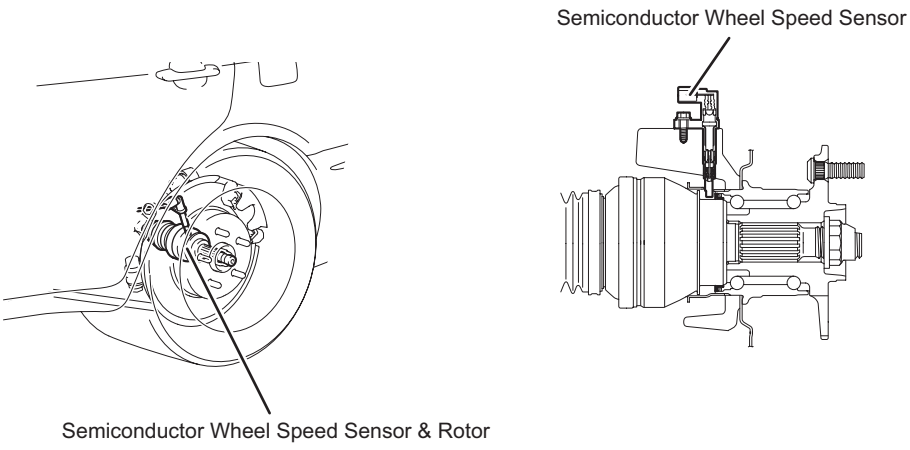
Detection Principle

- The magnetic rotor consists of a rubber matrix embedded with magnetic particles, with N/S poles (48 N and S poles each) arranged uniformly in the circumferential direction.
- The rotational movement of the magnetic rotor causes the magnetic field to change. The active sensor detects the changes and outputs them in the form of wheel speed pulses.
- In contrast to the widely used passive sensors, this sensor is able to detect vehicle speeds starting from approximately 0 km/h. In addition, because it can detect the rotational direction of the rotor, it enables the system to differentiate between the forward and reverse movement of the vehicle.



Rear Wheel Speed Sensor

● A semiconductor wheel speed sensor is installed on the rear axle carrier, and a sensor rotor is installed on the inner race.

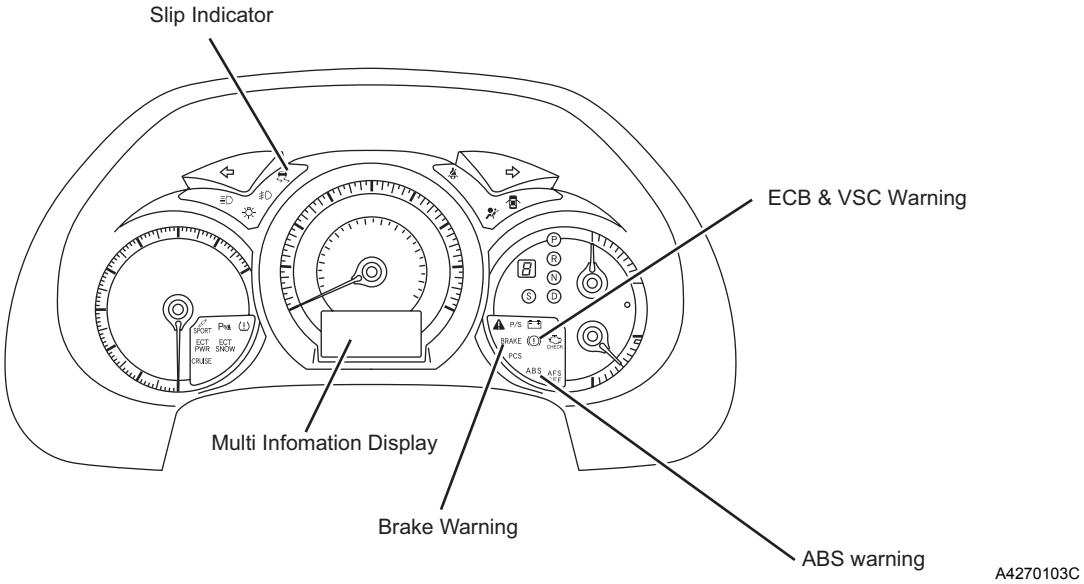


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Warning & Indicator

● Indicators and warning lights are installed in the combination meter.



Warning & Indicator

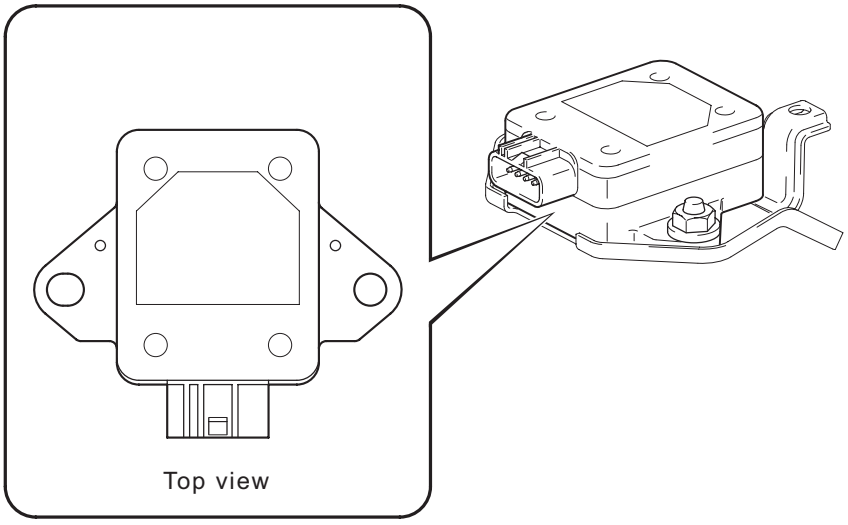
Slip Indicator	This light blinks to alert the driver that the ABS, TRC, hill start assist control, and VSC are operating. If there is a failure in the TRC or VSC, a message appears on the multi-information display to inform the driver. In the diagnosis mode, the multi-information display will show a DTC (Diagnostic Trouble Code).
Brake Warning (Red)	Illuminates simultaneously with the ABS warning light to warn the driver of a failure in which not only the ABS but the EBD is also inoperative. This is in addition to the ordinary parking brake ON and low brake fluid level warnings.
ABS Warning	Illuminates to inform the driver of a failure in the ABS or the brake assist system. In the diagnosis mode, the light blinks to indicate a DTC (Diagnostic Trouble Code).
ECB Warning(displayed in multi-information display)	When there is a malfunction in the normal brakes or a slight malfunction in the brake system that does not interfere with driving, the driver is notified by lighting up the ECB & VSC warning light and displaying “CHECK ECB” on the multi-information display. Also, in diagnosis mode, the diagnosis code is displayed on the multi-information display.
VSC Warning(displayed in multi-information display)	If there if any abnormality in the VSC, the driver is notified by lighting up the ECB & VSC warning light and displaying "CHECK VSC" on the multi-information display. Also, in diagnosis mode, the diagnosis code is displayed on the multi-information display.
ECB & VSC Warning (Yellow)	In addition to displaying abnormalities on the multi-information display, the ECB & VSC warning lights to warn the driver.

VSC Buzzer & Brake Warning Buzzer

● These buzzers are installed in the instrument panel on the right side of the driver. If the vehicle is about to slip sideways, the buzzers sound intermittently to inform the driver. Also, the buzzers sound continuously to inform the driver if the accumulator hydraulic pressure in the brake actuator has dropped, there is a failure in the power supply system, or the vehicle power voltage (12V) has dropped.

Yaw Rate & Deceleration Sensor

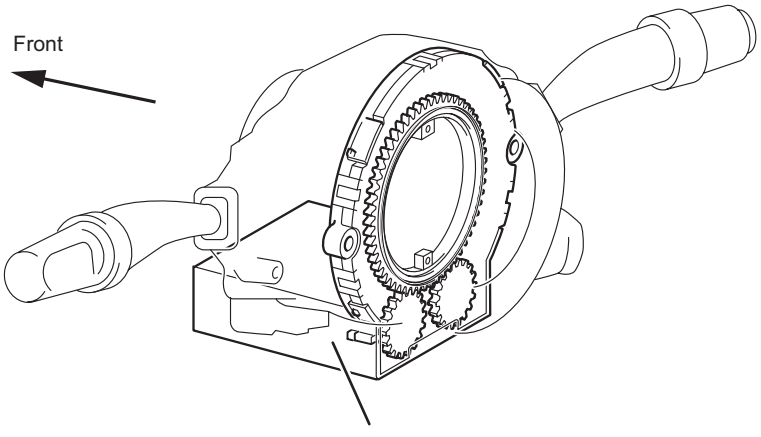
- A semiconductor yaw rate sensor and two acceleration sensors are integrated into a compact unit and installed under the center console. When the vehicle accelerates, the beams in the acceleration sensors flex, and the measurements of their distortion are converted into electrical signals. Each of the two acceleration sensors is positioned 45 degrees to the longitudinal direction of the vehicle. Thus, the combination of the two acceleration sensors can detect the deceleration rate of the vehicle across the entire horizontal plane. Coupled with linear output characteristics, the acceleration sensors enable precise control over a wide variety of surfaces.
- The yaw rate sensor detects the vehicle's rotational angle speed (yaw rate and rotating speed) in the vertical axis direction based on the amount and direction of the flexing of the piezoelectric ceramic. A dedicated IC (integrated circuit) is used for the oscillation of the sensor unit and for signal processing, thus realizing a compact and reliable sensor.



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Steering Angle Sensor

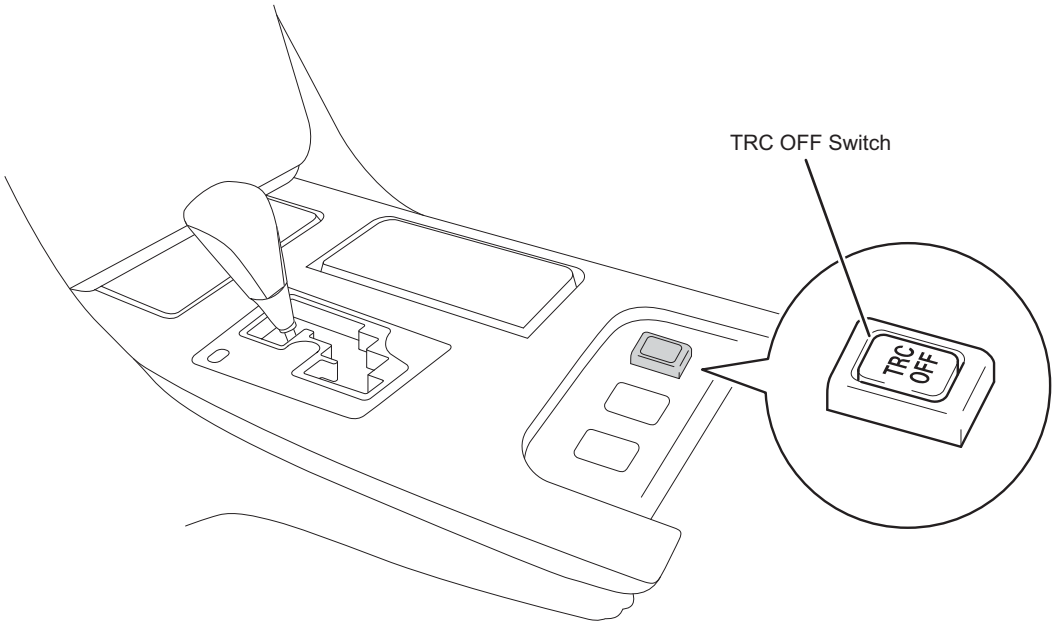
- A steering angle sensor is provided in the combination switch area. This sensor detects the amount of steering effort and the direction of steering and inputs them in the skid control ECU.
- The sensor assembly contains two sets of magnetic reluctance elements that detect the rotational movement of a magnet that is built into the detection gear. Thus, the sensor detects the changes that occur in the magnetic reluctance along with the rotational movement of the detection gear, in order to detect the rotational movement of the steering wheel.



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TRC OFF Switch

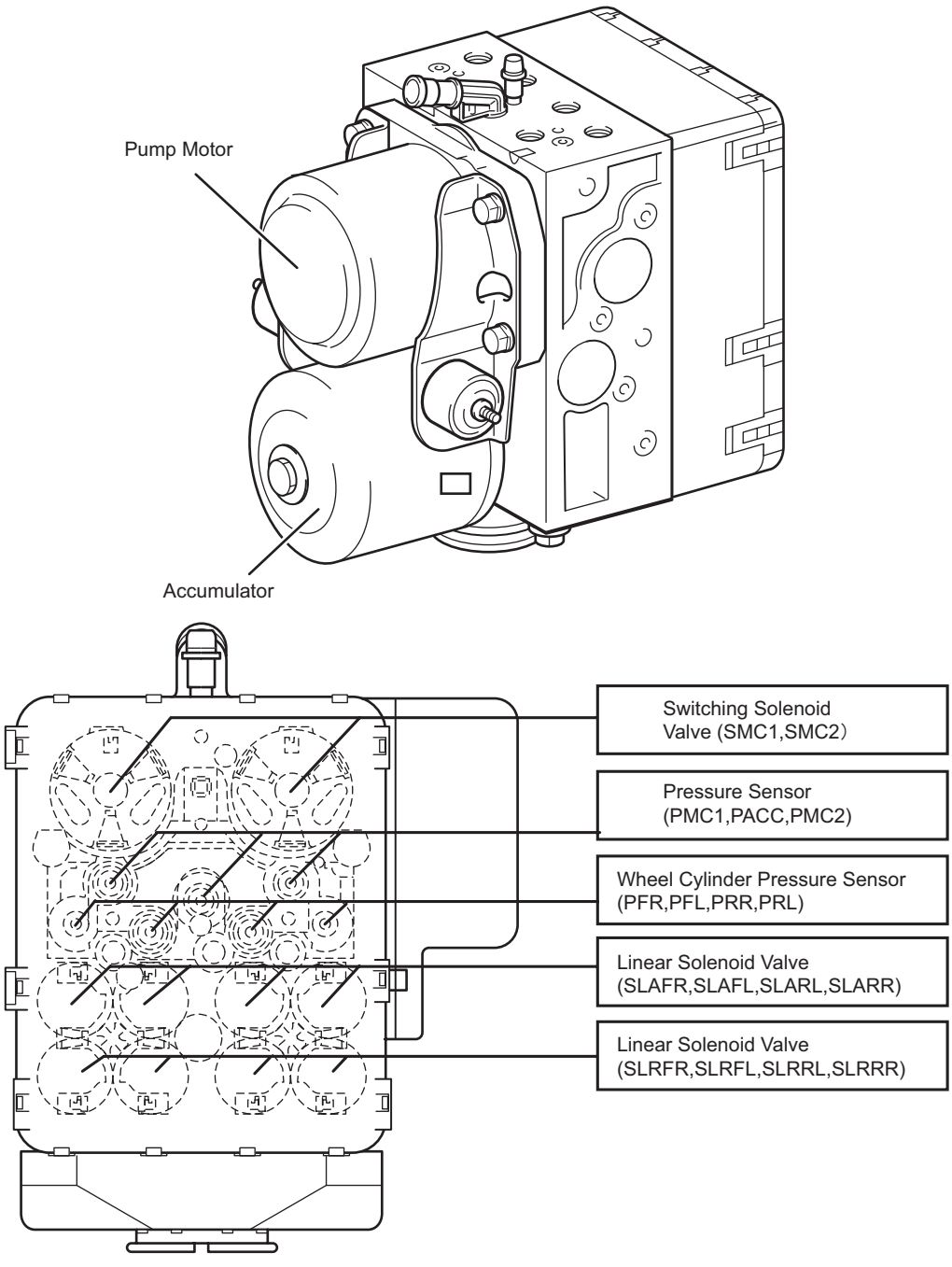
- A momentary switch is used and installed on the center console. The driver can set the operation of the TRC ON and OFF by pressing the TRC OFF switch. When the driver presses TRC turns the ignition switch from OFF to ON, the system switches automatically to the normal driving mode.



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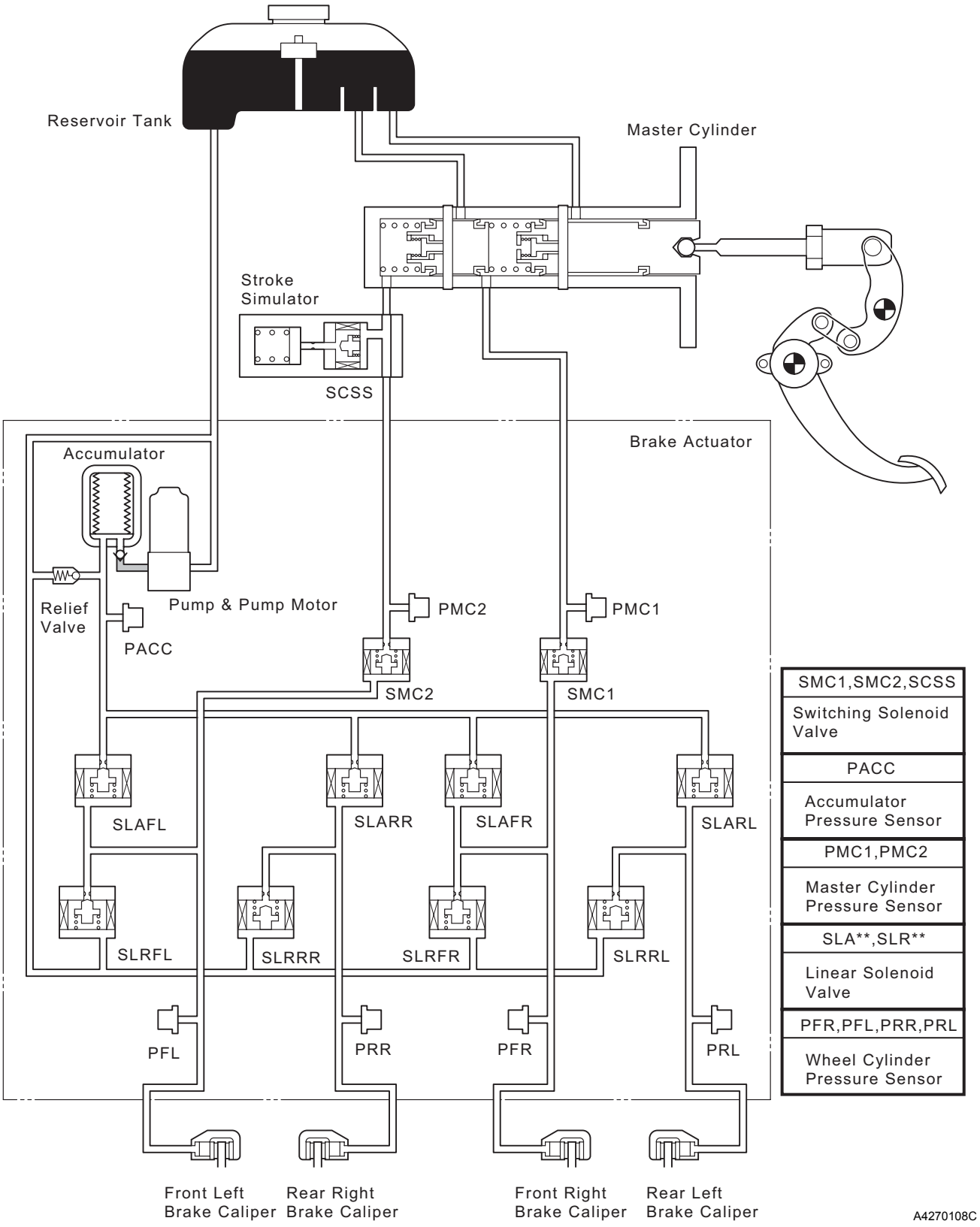
Brake Actuator

- The brake actuator consists of the following components: switching solenoid valves (SMC1, SMC2), accumulator pressure sensor (PACC), master cylinder pressure sensors (PMC1, PMC2), wheel cylinder pressure sensors (PFR, PFL, PRR, PRL), and linear solenoid valves (SLAFR, SLAFL, SLARL, SLARR, SLRFR, SLRFL, SLRRL, SLRRR).



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Hydraulic Circuit



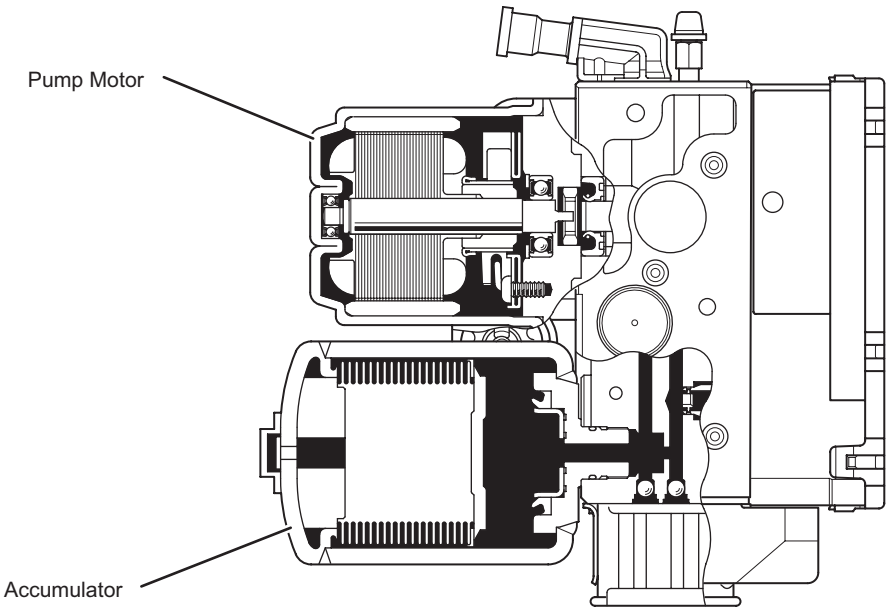
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Main Components and Functions

	Item	Functions
Master Cylinder	Piston,Cylinder	Generates pressure in accordance with the pedal effort.
	Reservoir	Stores brake fluid for the master cylinder system and power supply system.
	Reservoir Level Warning Switch	Detects a drop in the brake fluid level in the reservoir.
Stroke Simulator	Stroke Simulator	Generates a natural pedal stroke in accordance with the pedal effort applied by the driver during system operation. (It is integrated in the master cylinder.)
	Stroke Simulator Cut Valve(SCSS)	Generates a natural pedal stroke in accordance with the pedal effort applied by the driver during system operation.
Brake Actuator	Pump & Motor	Draws brake fluid from the reservoir and supplies high hydraulic pressure to the accumulator.
	Accumulator	Accumulates the hydraulic pressure for the power supply system that is generated by the pump.
	Accumulator Pressure Sensor (PACC)	Monitors the accumulator hydraulic pressure and outputs control signals to the pump motor.
	Relief Valve	If the pump operates continuously due to a malfunction of the accumulator hydraulic pressure sensor, this valve relieves the pressure by returning the brake fluid to the reservoir, thus preventing excessively high pressure from developing in the power supply system.
	Master Cylinder Pressure Sensor(PMC1,PMC2)	Detects the hydraulic pressure that is generated in accordance with the pedal effort applied to the front and rear systems.
	Wheel Cylinder Pressure Sensor(PFR,PFL,PRR,PRL)	Detects the brake hydraulic pressure at the wheel cylinders.
	Switching Solenoid Valve (SMC1,SMC2)	Switches the brake hydraulic pressure passages depending on whether the normal brakes are used, or the ABS, TRC, VSC, or brake assist control is used.
	linear Solenoid Valve(SLA**,SLR**)	Controls the wheel cylinder hydraulic pressure during normal brake operation and ABS, TRC, VSC, and brake assist control. The SLA** solenoids are for pressure increase control, and the SLR** solenoids are for pressure decrease control.

Pump Motor, Accumulator

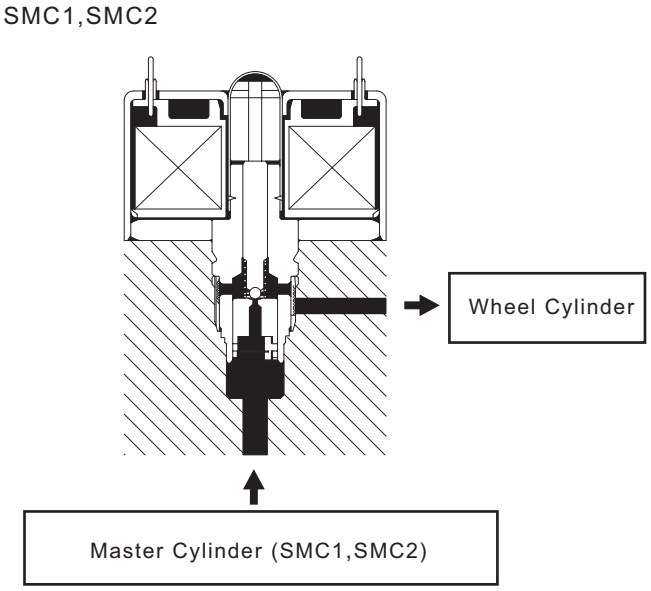
- An electric pump motor is used. The accumulator consists of a metal bellows that seals in nitrogen, and accumulates hydraulic pressure generated by the pump. When the pressure sensor (PACC) detects a drop in the accumulator hydraulic pressure, the skid control ECU causes the contact points of the motor relay to close, allowing the pump motor to operate.
- The pump motor transmits its rotational force to the pump camshaft. Because the camshaft is eccentric to the rotational axis, the pistons in the cylinders that are located along the outer circumference of the camshaft move reciprocally with the rotational movement of the camshaft. A piston draws brake fluid as it moves towards the center and discharges pressurized brake fluid as it moves outward. The discharged brake fluid travels through the check valve and accumulates in the accumulator.
- By performing the aforementioned actions, the pump generates hydraulic pressure (high pressure) for the power supply system that is needed for normal braking, and for the ABS, TRC, VSC, and brake assist operations. When the pressure sensor (PACC) detects a further drop in the accumulator hydraulic pressure, the system illuminates the brake warning light and sounds the buzzer. Then, when the pressure sensor (PACC) detects that the accumulator hydraulic pressure has risen, the system stops the operation of the pump motor. If the pump operates continuously due to a malfunction of the accumulator hydraulic pressure sensor, the relief valve opens to prevent an excessive increase in the pressure.



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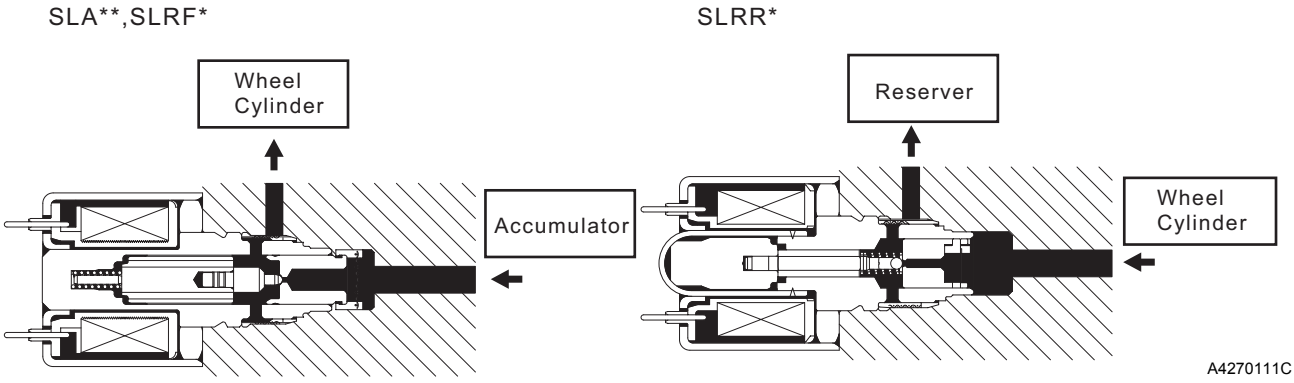
Switching Solenoid Valve

• The skid control ECU outputs control signals to open and close the valves to switch the brake fluid passages. Two switching solenoids (SMC1, SMC2) are provided, to turn ON and OFF the hydraulic passages from the master cylinder to the wheel cylinders.



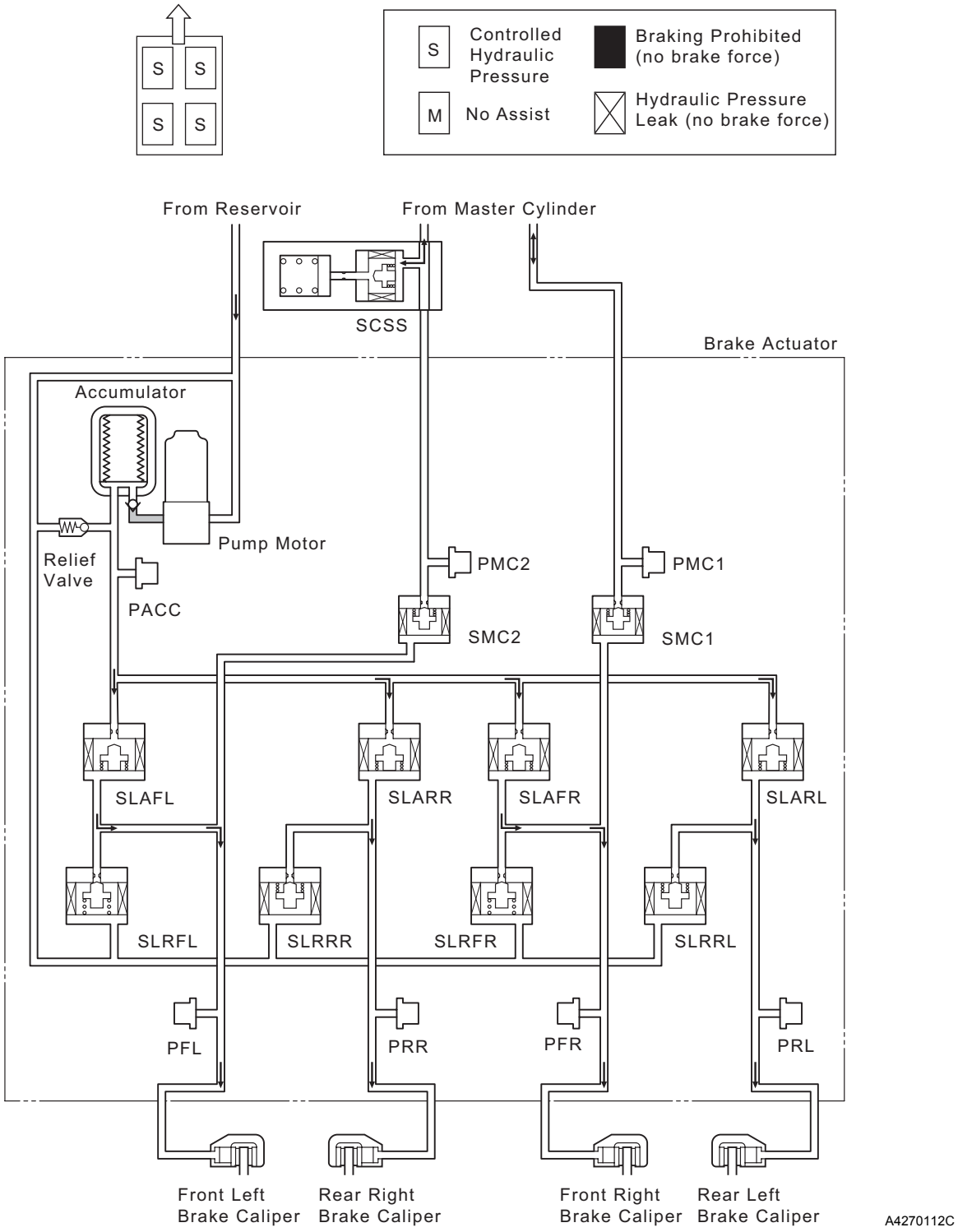
Linear Solenoid Valve

• The skid control ECU outputs control signals to open and close the valves to control the hydraulic pressure to the wheel cylinders. Two control solenoids are provided per wheel. Thus, a total of eight solenoids are provided for the four wheels. The SLA** solenoids are for pressure increase control, and the SLR** solenoids are for pressure decrease control.



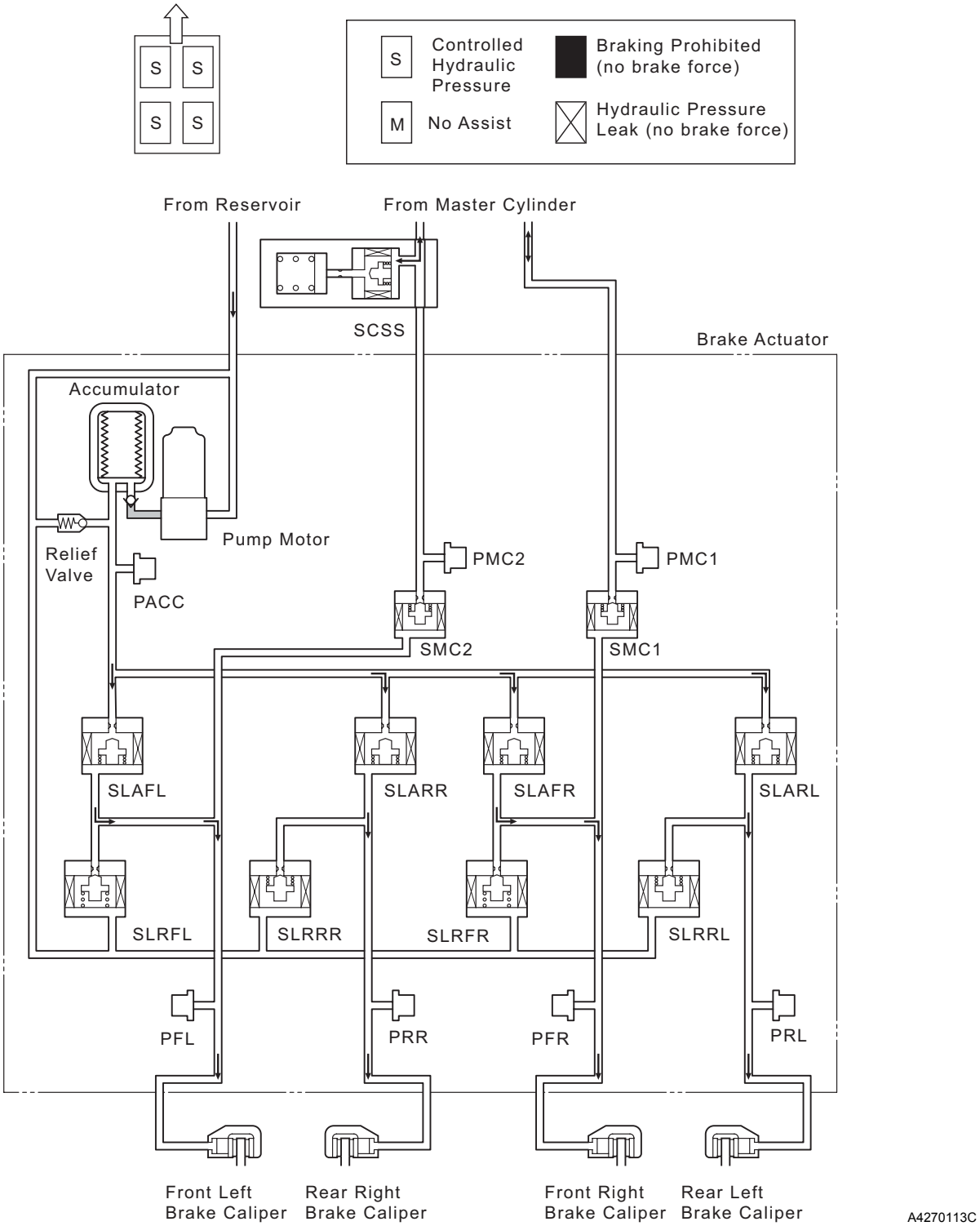
System Operation (Normal Operation)

- The SMC1 and SMC2 solenoid valves are closed and the hydraulic pressure circuits to the wheel cylinders become independent. In this state, the system controls the SLA** and SLR** solenoid valves to increase, hold, and decrease the hydraulic pressure to the wheels.



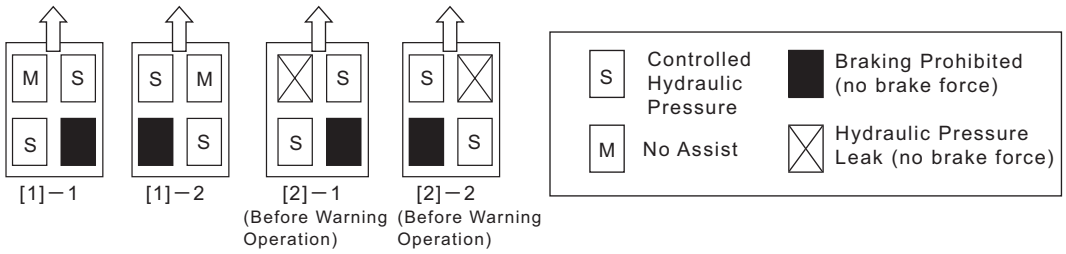
System Operation (Backup Operation During a Failure) Four Wheel Braking

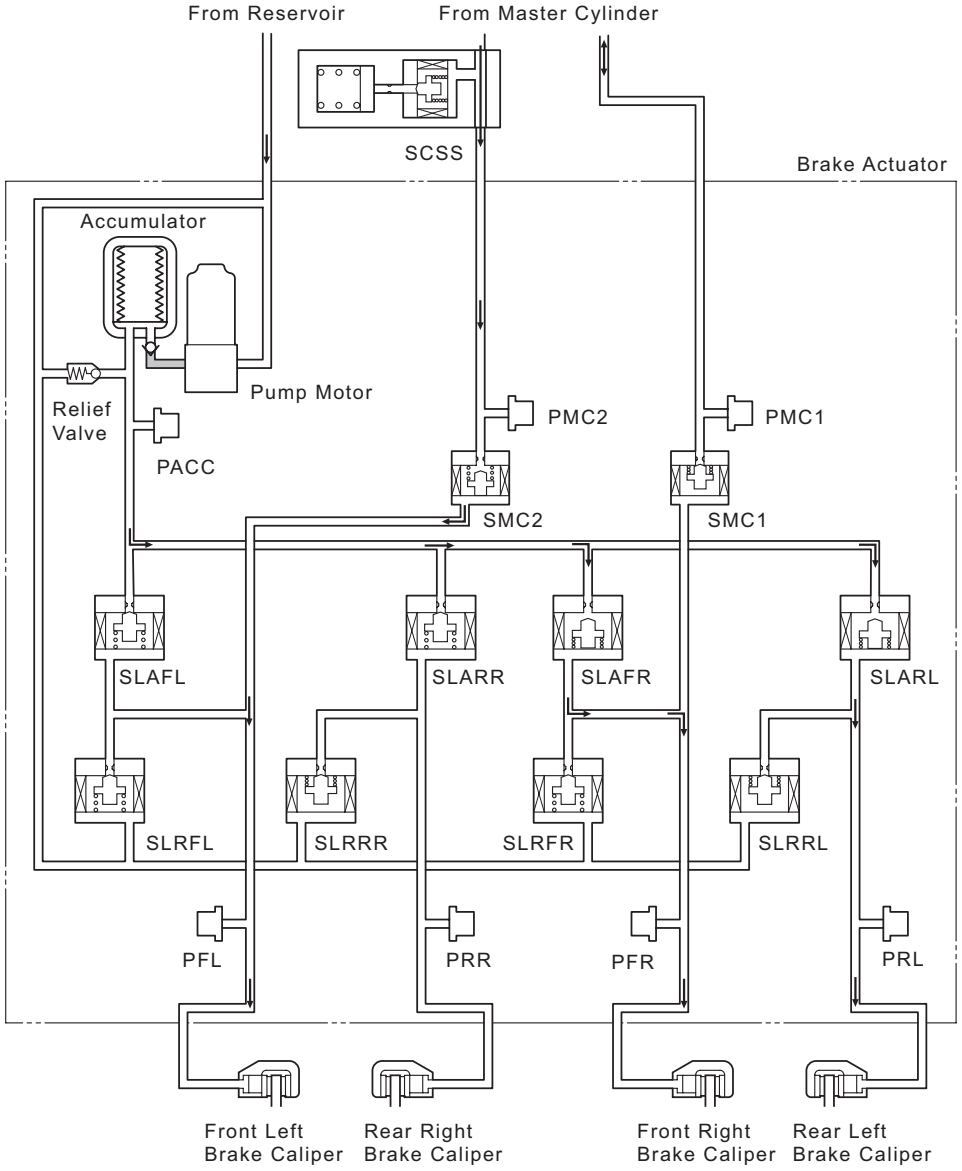
- The system maintains the control of hydraulic pressure to the four wheels in case of a failure in the pedal input sensor (brake pedal stroke sensor, master cylinder pressure sensor) signal, a malfunction in the backup power, or a voltage drop in the vehicle power (12V).



System Operation (Backup Operation During a Failure) Diagonally Opposite Two Wheel Braking + One Wheel Static Pressure

- The system controls the hydraulic pressure to the two diagonally opposite wheels and applies a no-assist brake to one front wheel if any one of the following conditions occurs: a failure in the front wheel system hydraulic pressure sensor (PF*), a malfunction in the control portion of the skid control ECU from the left front wheel to the right rear wheel, a malfunction in the pressure increase or pressure decrease solenoid valve (SLAF*, SLRF*), switching solenoid valve (SMC*), or stroke simulator cut valve (SCSS).



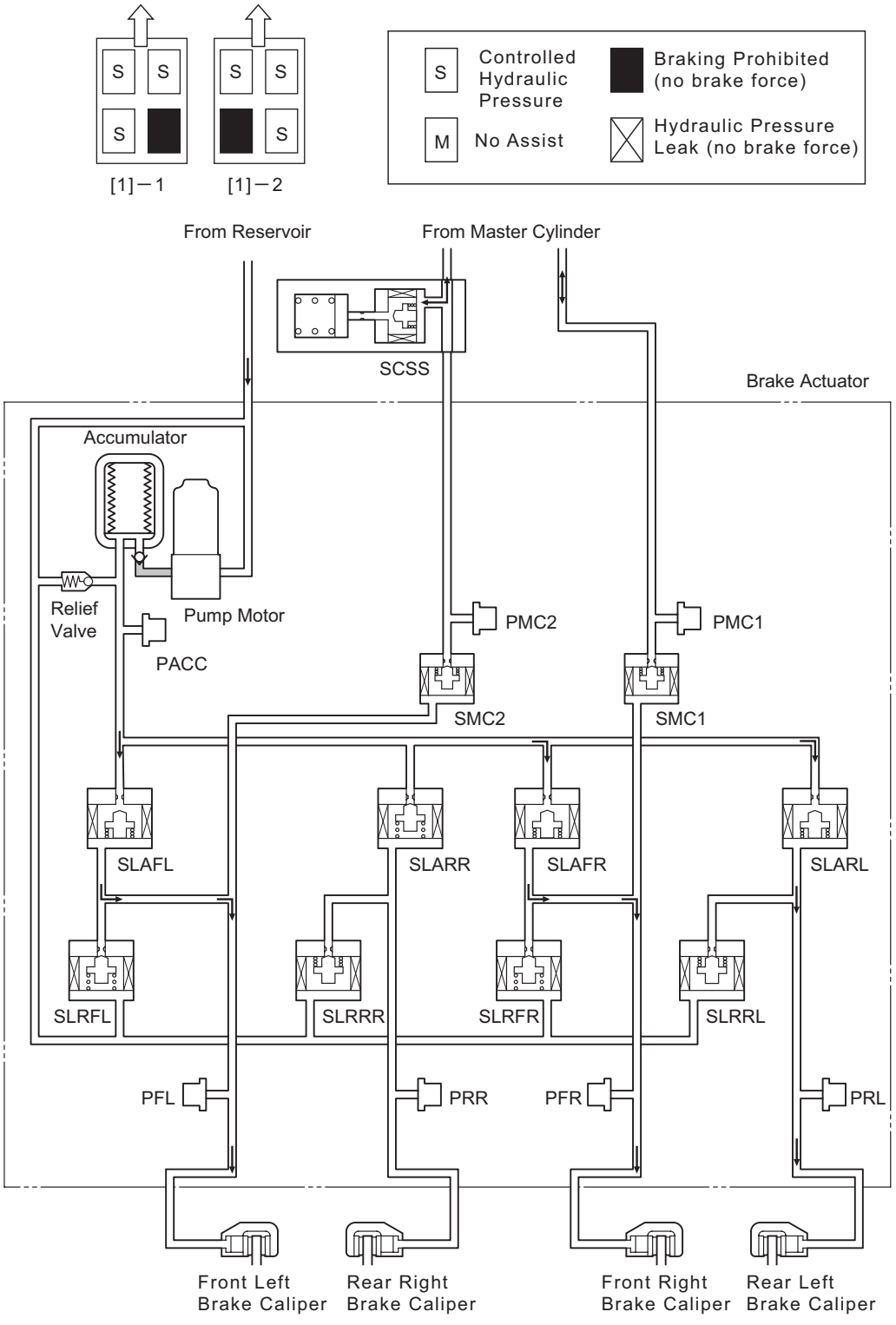


∗ The above illustration shows the [1]-1 state.

A4270114C

System Operation (Backup Operation During a Failure) Three Wheel Braking

- The system applies the brakes at three wheels, excluding the area with a malfunction, if a failure occurs in a rear wheel system hydraulic pressure sensor (PR*), or a malfunction occurs in a pressure increase or pressure decrease solenoid valve (SLAR*, SLRR*).

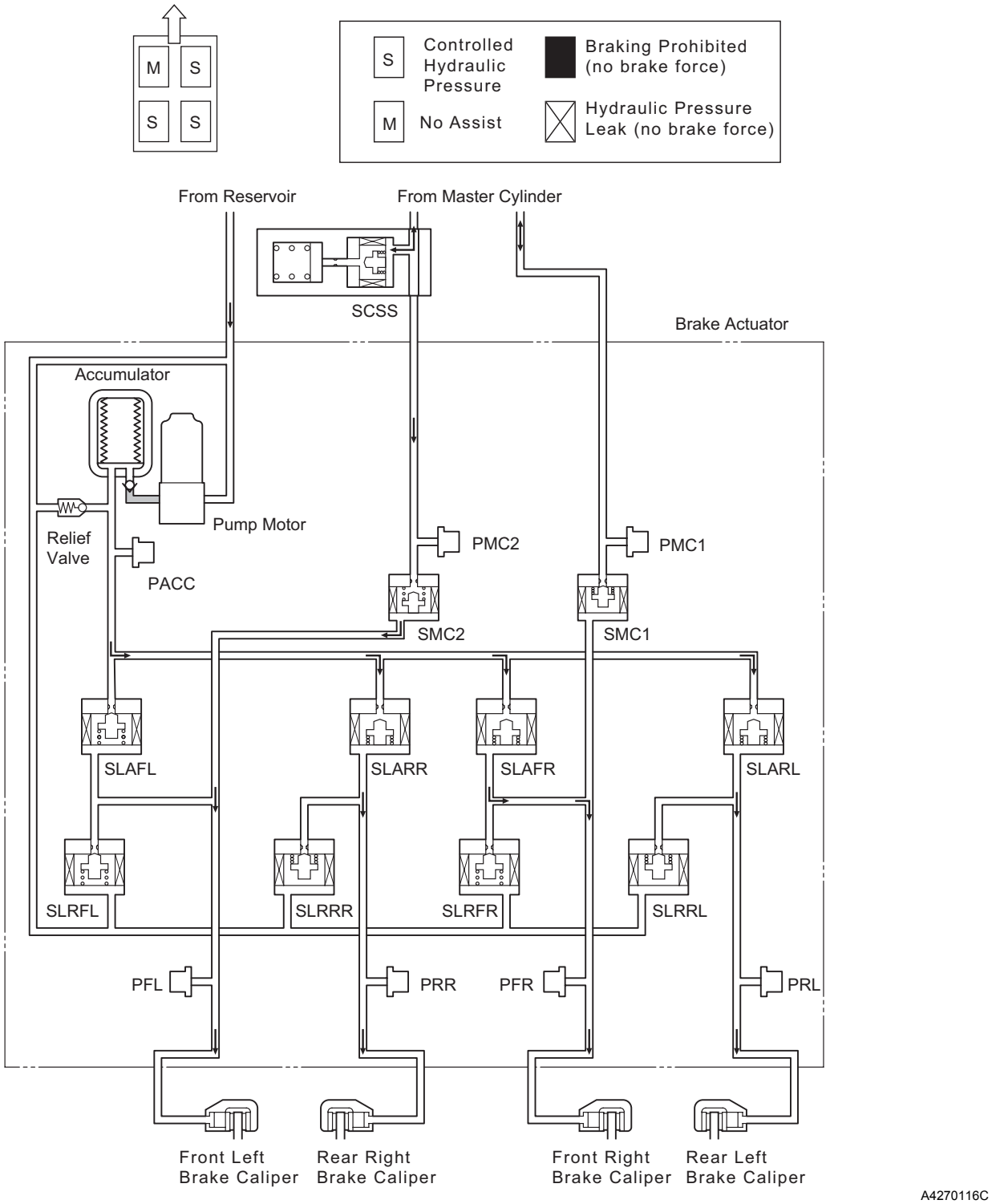


∗ The above illustration shows the [1]-1 state.

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System Operation (Backup Operation During a Failure) Three Wheel Braking + One Wheel Static Pressure

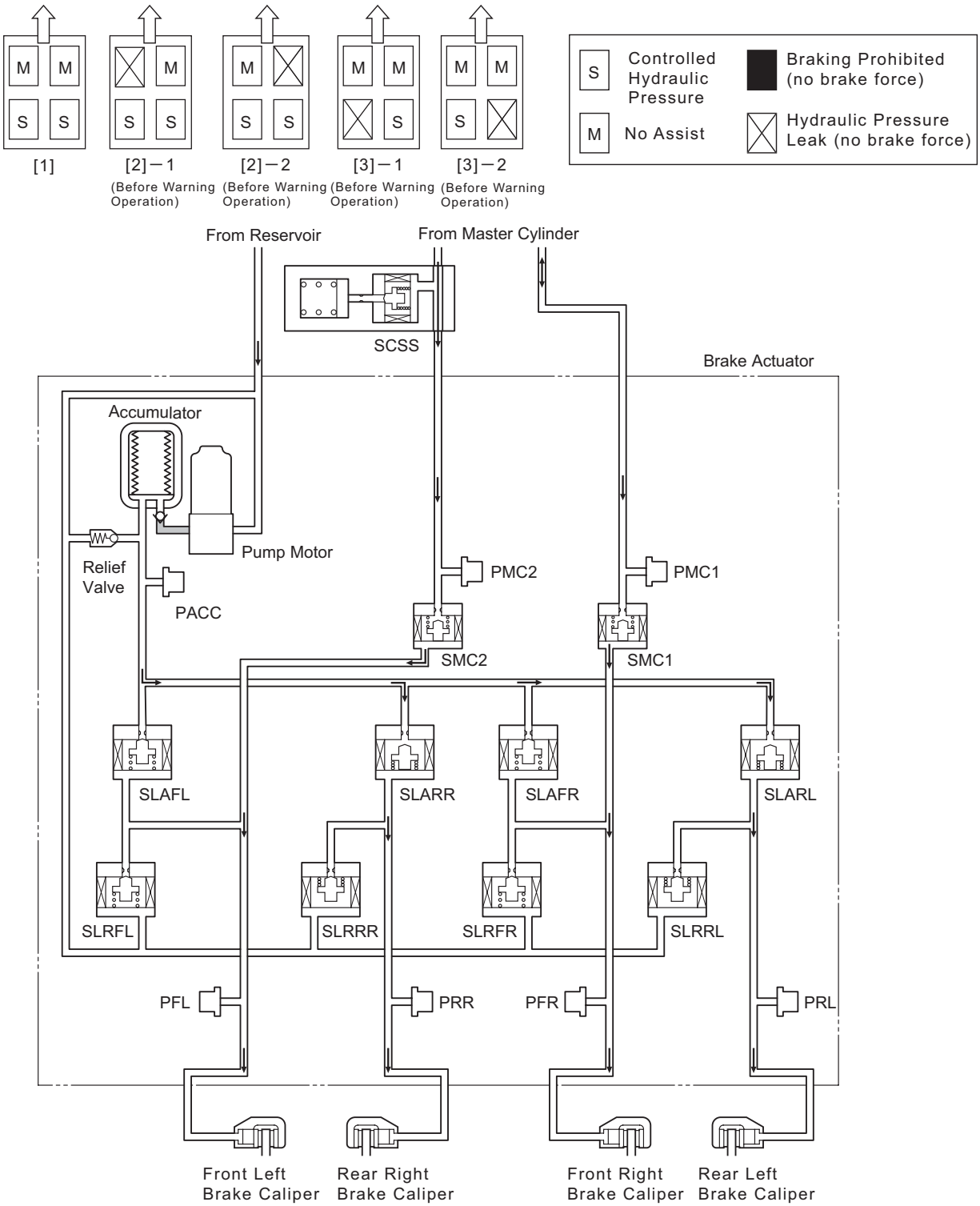
• The system applies no-assist braking to the left front wheel only, if a malfunction occurs in the skid control ECU.



A4270116C

System Operation (Backup Operation During a Failure) Front Two Wheels Static Pressure + Rear Two Wheels Braking

- The system switches to the [1] braking pattern if a failure occurs in the accumulator pressure sensor signal or a malfunction occurs in the pipe from the master cylinder to the brake actuator. The system switches to the [2]-1·2 braking pattern if a malfunction occurs in the pipe in the front wheel system, or to the [3]-1·2 braking pattern if a malfunction occurs in the pipe in the rear wheel system.



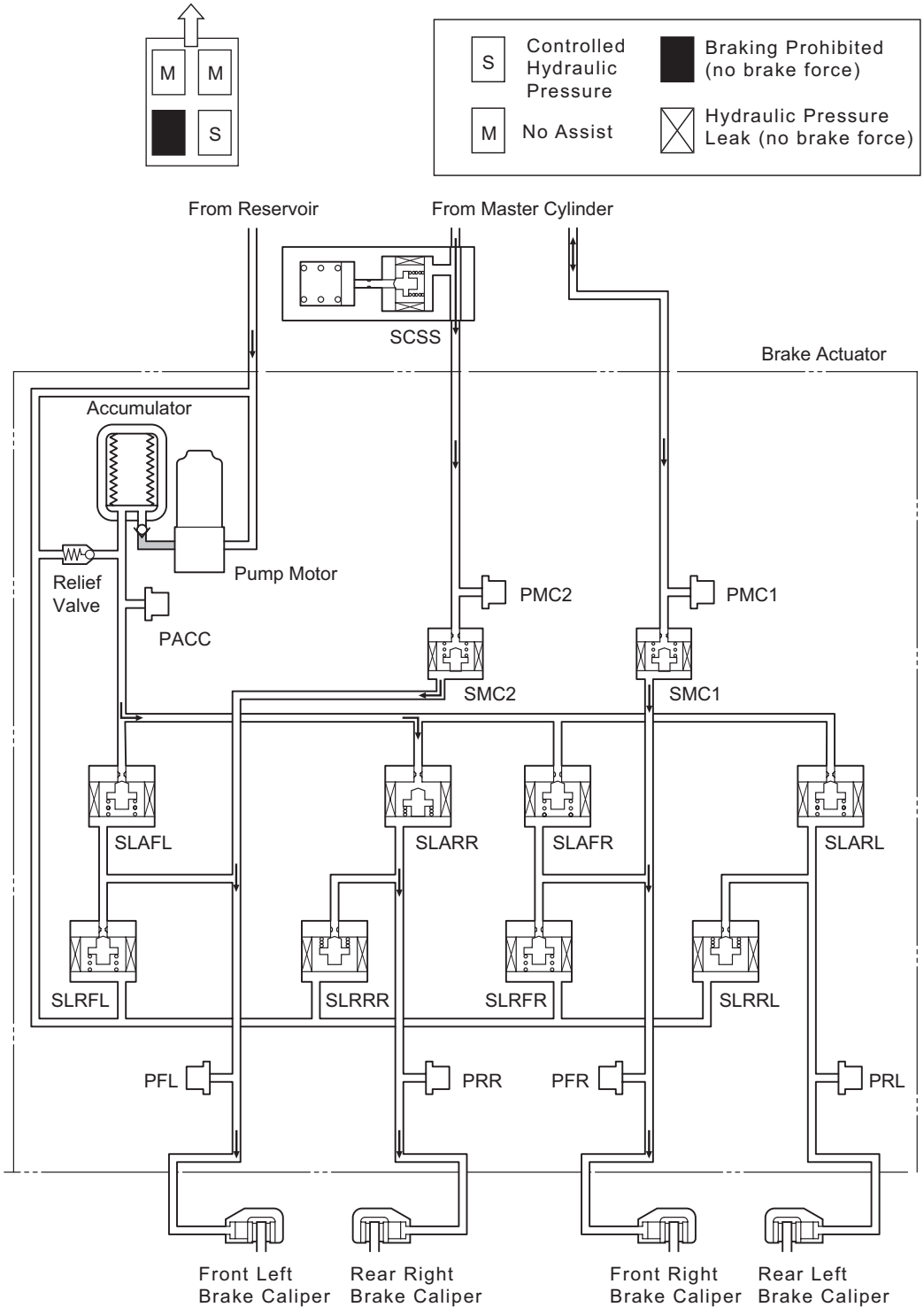
∗ The above illustration shows the [1] state.

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BR

System Operation (Backup Operation During a Failure) Front Two Wheels Static Pressure + Rear One Wheel Braking

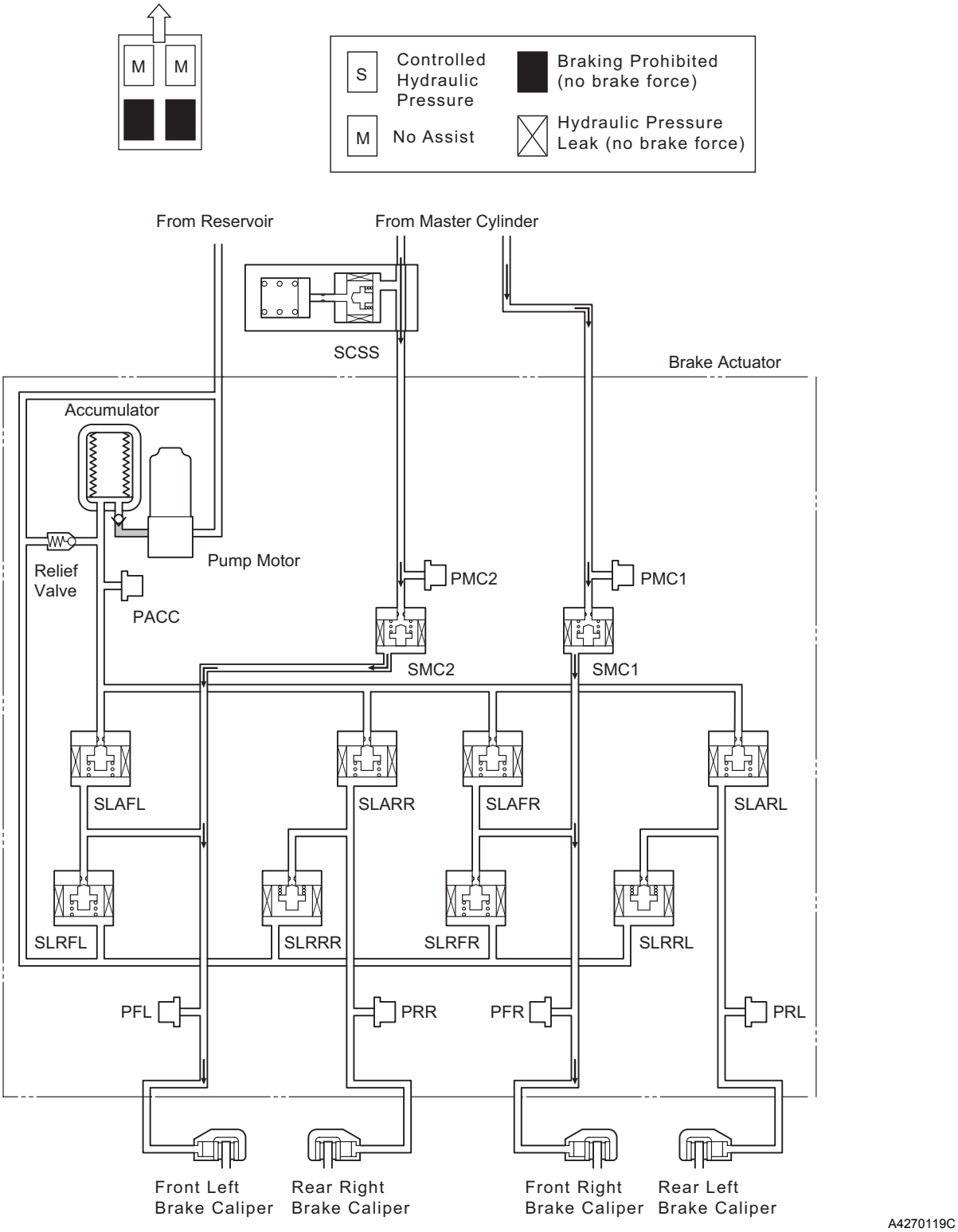
- The system switches the front two wheels to no-assist braking and the right rear wheel to controlled hydraulic pressure if a malfunction occurs in the control portion of the skid control ECU from the right front wheel to the left rear wheel.



A4270118C

System Operation (Backup Operation During a Failure) Front Two Wheels Static Pressure

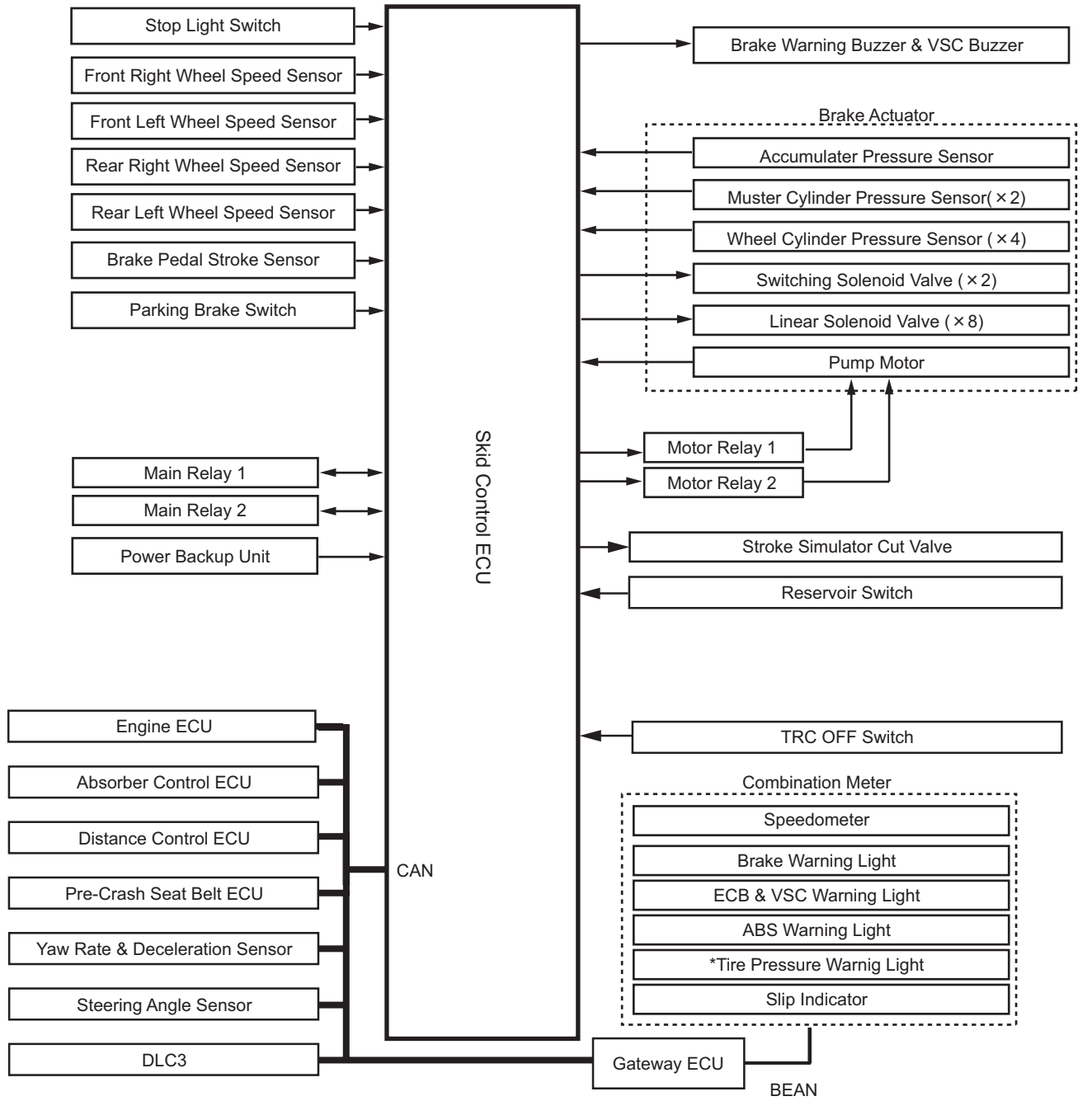
- The system applies no-assist braking only to the front two wheels if the system stops due to a malfunction in the vehicle power (12V) or power supply system (pump motor, accumulator, etc.).



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Skid Control ECU

● The skid control ECU processes the signals received from the sensors and effects brake control for the ABS, TRC, VSC, and brake assist. Also, it maintains communication with the engine ECU by outputting control signals.



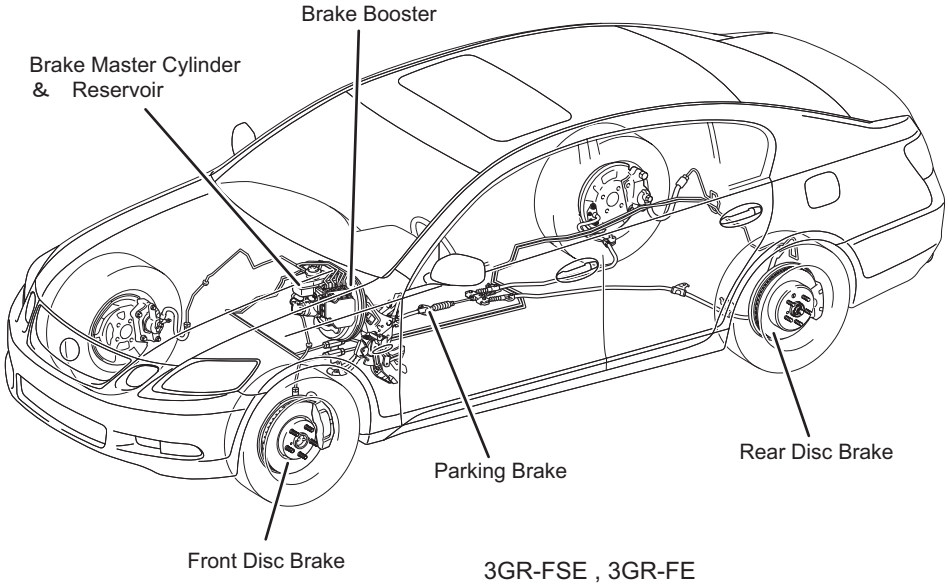
∗ Appears on the multi-information display.

A4270234C

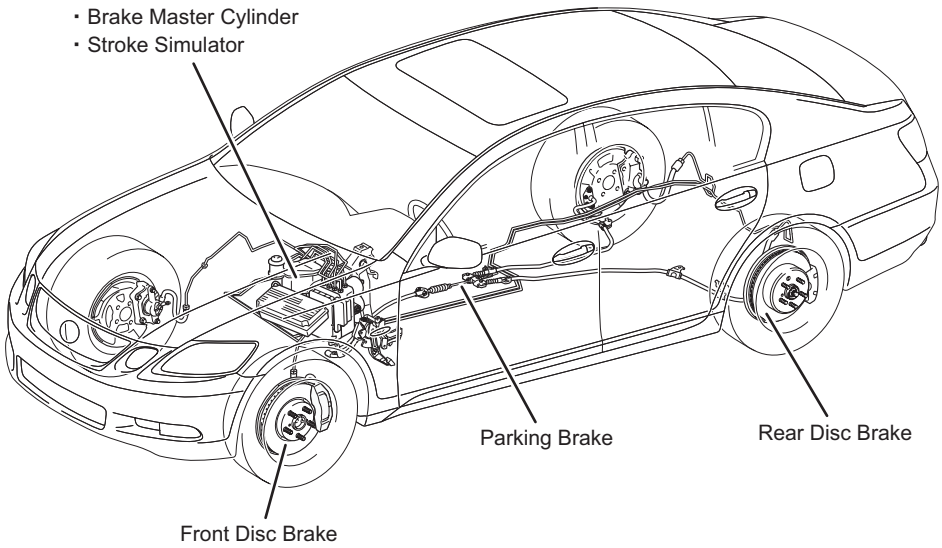
BRAKE

Brake Outline

- The 3GR-FSE and 3GR-FE engine models use a hydraulic brake system, in which the following brake controls are used: ABS with EBD (Electronic Brake-force Distribution), electronically controlled BA (Brake Assist), TRC (Traction Control), and VSC (Vehicle Stability Control).
- The 3UZ-FE engine models use ECB2 (Electronically Controlled Brake system 2). This system uses sensors to detect the driver's brake pedal effort and the conditions of the vehicle in order to effect optimal brake control. For brake control, the VDIM (Vehicle Dynamics Integrated Management) system, which integrates brake control, drive force control, and steering control, is used.
- Four-wheel ventilated disc brakes are used to ensure high brake performance and excellent brake feel.



3GR-FSE , 3GR-FE



3UZ-FE

A4270222C

Master Cylinder Specification

Engine		3GR-FSE,3GR-FE	3UZ-FE
Type		Tandem(Plunger)	Tandem(Portless + Portless)
Diameter	[mm(in)]	22.2(0.89)	19.0(0.76)
Stroke	[mm(in)]	30 + 20(1.2 + 0.8)	17.5 + 11.8(0.7 + 0.47)

Brake Booster Specification

Engine	3GR-FSE,3GR-FE	3UZ-FE
Type	Single	—
Size	10"	—

Front Brake Specification

Engine		3GR-FSE,3GR-FE	3UZ-FE
Caliper Model		OS12WC	←
Cylinder Inner Diameter	[mm(in)]	42.8(1.71)	←
Pad Surface (one pad)	[cm^2(in)]	44.4(1.78)	←
Pad Dimensions (length x width x thickness)	[mm(in)]	116.0 × 55.0 × 12.5 (4.64×2.12×0.50)	←
Disc Rotor Type		Ventilated	←
Rotor Dimensions (outer diameter x thickness)	[mm(in)]	334 × 30 (13.36 × 1.2)	←

Rear Brake Specification

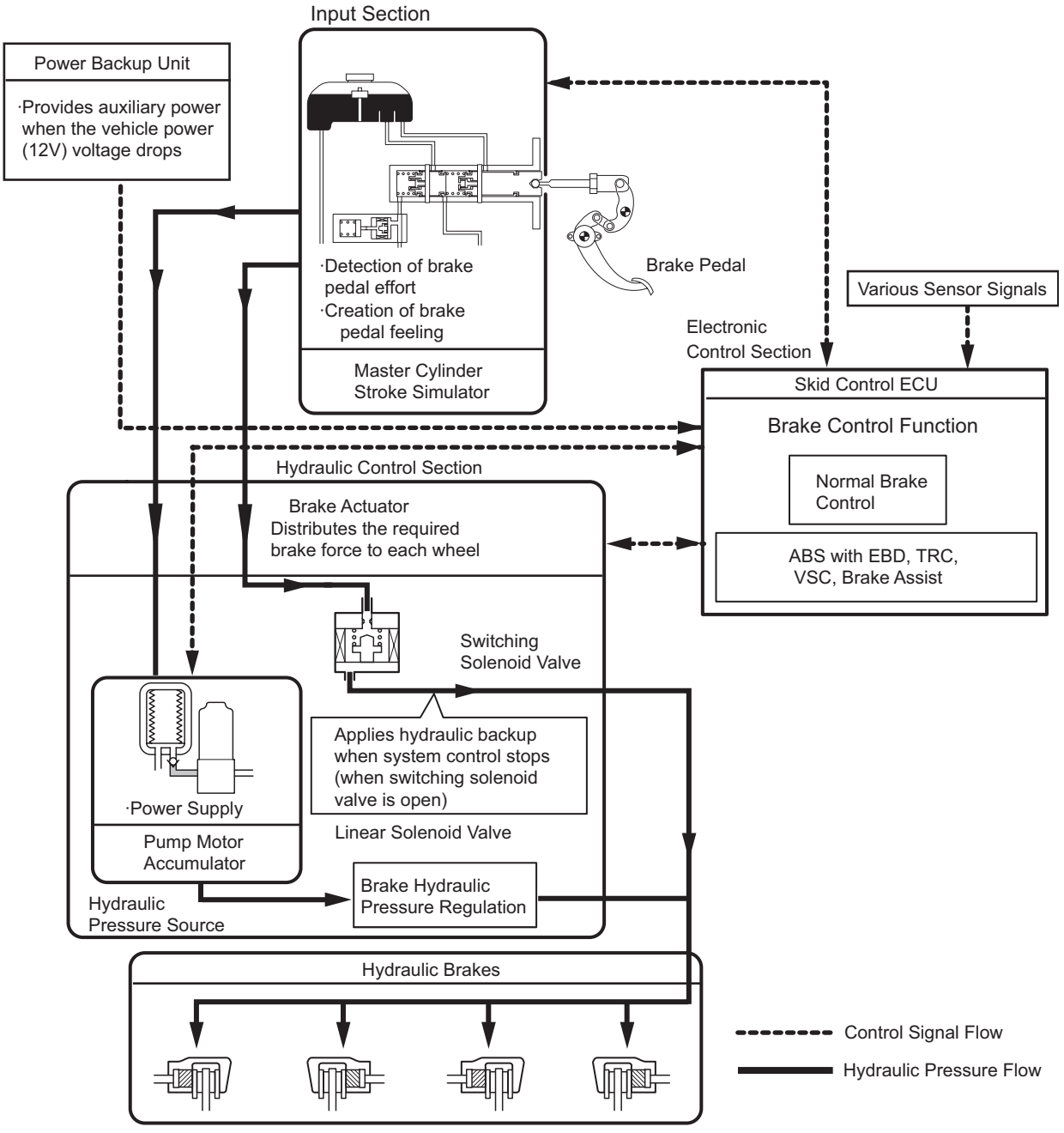
Engine		3GR-FSE,3GR-FE	3UZ-FE
Caliper Model		PG45R	←
Cylinder Inner Diameter	[mm(in)]	44.4(1.78)	←
Pad Surface (one pad)	[cm^2(in)]	18.8(0.75)	←
Pad Dimensions (length x width x thickness)	[mm(in)]	85.0 × 35.5 × 10.5 (3.40 × 1.42 × 0.42)	←
Disc Rotor Type		Ventilated	←
Rotor Dimensions (outer diameter x thickness)	[mm(in)]	310 × 18 (12.4 × 0.7)	←

Parking Brake Specification

Engine		3GR-FSE,3GR-FE	3UZ-FE
Type		Duo Servo	←
Drum Inner Diameter	[mm(in)]	190(7.60)	←
Lining Surface Area	[cm^2(in)]	45(1.80)	←
Lining Dimensions	[mm(in)]	181.0 × 25.0 × 2.4 (7.2 × 1.0 × 0.1)	←
Operation Type		Foot-operated	←

ECB2 System Outline

- The system uses a sensor to detect the amount of brake pedal effort and calculates the optimal hydraulic brake force accordingly. Based on this data, the system regulates the hydraulic pressure at the source, in order to optimally effect independent hydraulic control for all four wheels.
- At this time, the ECB2 system controls the normal brakes, ABS, TRC, VSC, and brake assist in accordance with the driver's pedal effort.
- The system contains a hydraulic backup mechanism that applies the master cylinder pressure generated by human power to the wheel cylinders in the event the brake control stops. In addition, the system provides a failsafe measure in the event of a malfunction in brake control. It excludes the area with the malfunction and uses the normal area to continue the brake control. Furthermore, the system uses a power backup unit to ensure a stable supply of power to the system.

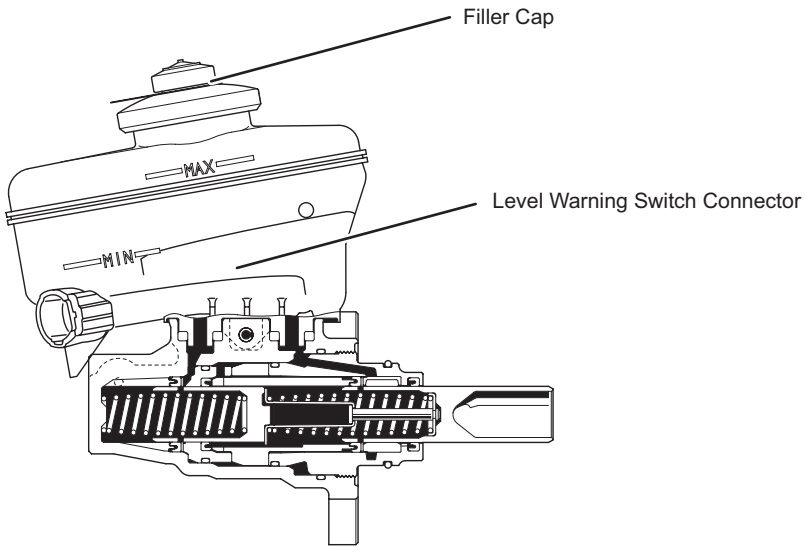


ECB2 System Outline

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Brake Master Cylinder & Reservoir

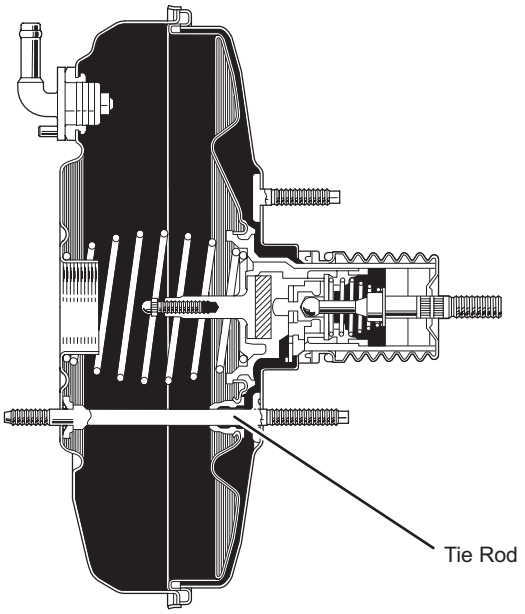
- The 3GR-FSE and 3GR-FE engine models use a small-diameter, long-stroke master cylinder to ensure an excellent brake feel.
- The installed length has been shortened through the use of a plunger type, and by placing it deeper into the booster.
- The reservoir tank is integrated with the master cylinder to achieve a compact package. It contains a level warning switch to detect the brake fluid level.



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Brake Booster

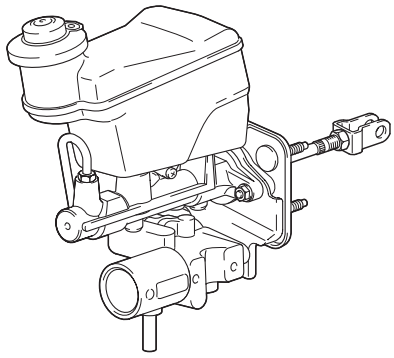
- The 3GR-FSE and 3GR-FE engine models use a 10" single-diaphragm brake booster.
- The booster uses a tie-rod inside to ensure rigidity during booster operation. This enables the booster body to be made with a thinner sheet metal, thus reducing weight.



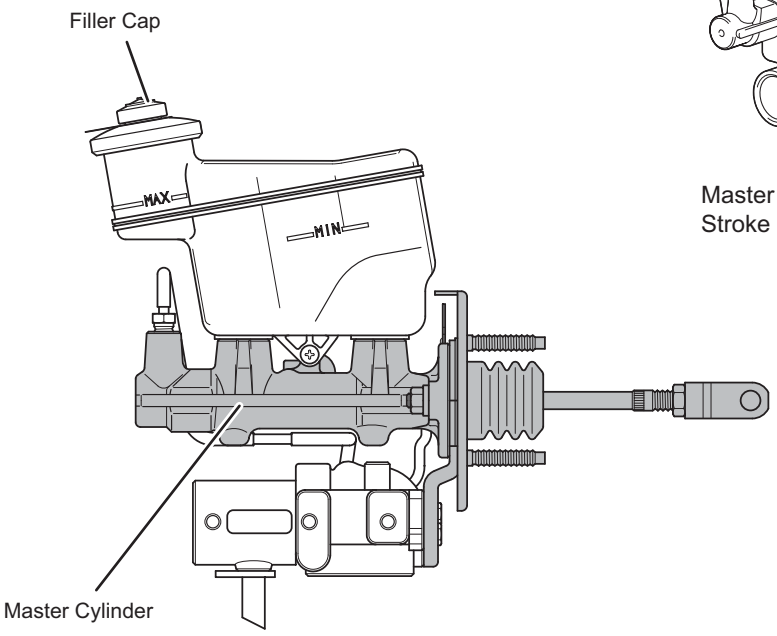
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Brake Master Cylinder

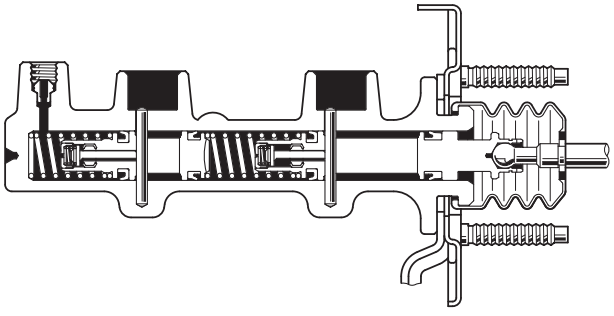
- The 3UZ-FE engine models use a P+P (portless + portless) type master cylinder that uses a center valve.
- The amount of idle stroke and the spring constant of the return spring have been increased. This produces a reaction force characteristic that is linear to the pedal stroke from the beginning of the brake pedal application, thus ensuring ease of operation in the normal range.
- The master cylinder is integrated with the reservoir tank for serviceability.



Master Cylinder &
Stroke Simulator Appearance



Master Cylinder & Stroke Simulator Side View

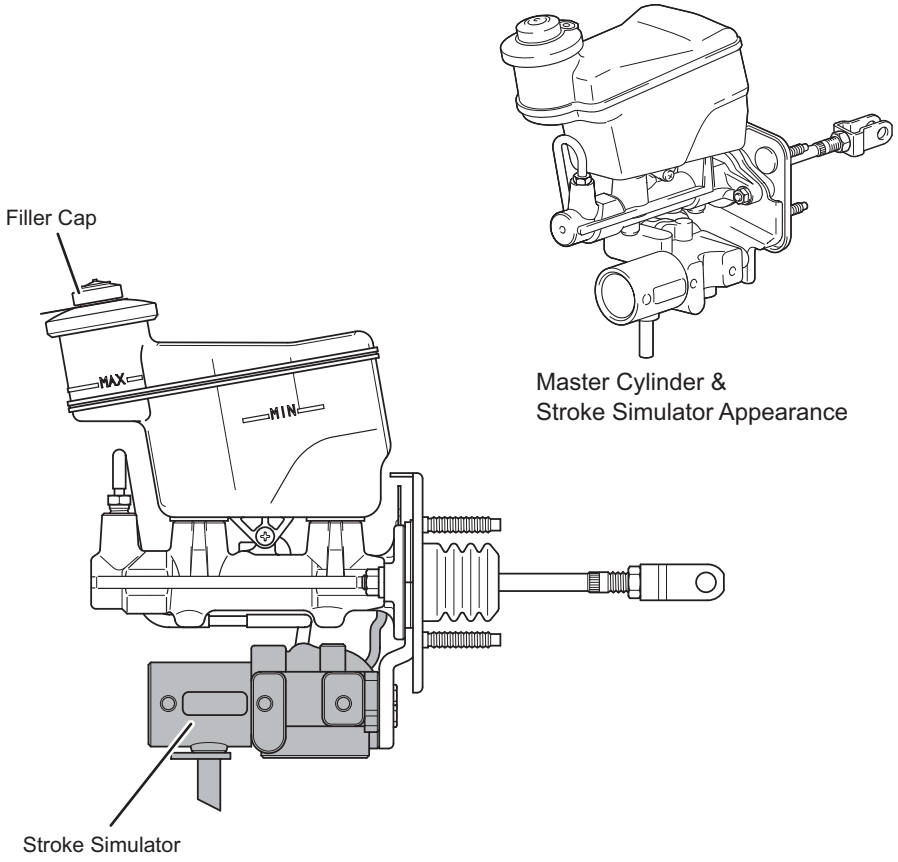


Master Cylinder Cross Section

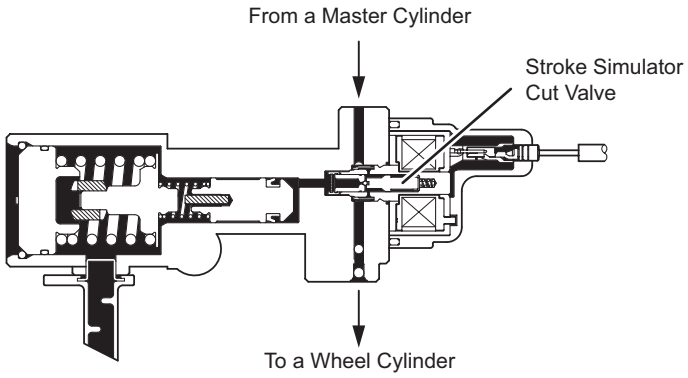
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Stroke Simulator

- The 3UZ-FE engine models use a stroke simulator that generates a natural pedal stroke during system control in accordance with the driver's pedal effort.



Master Cylinder & Stroke Simulator Side View

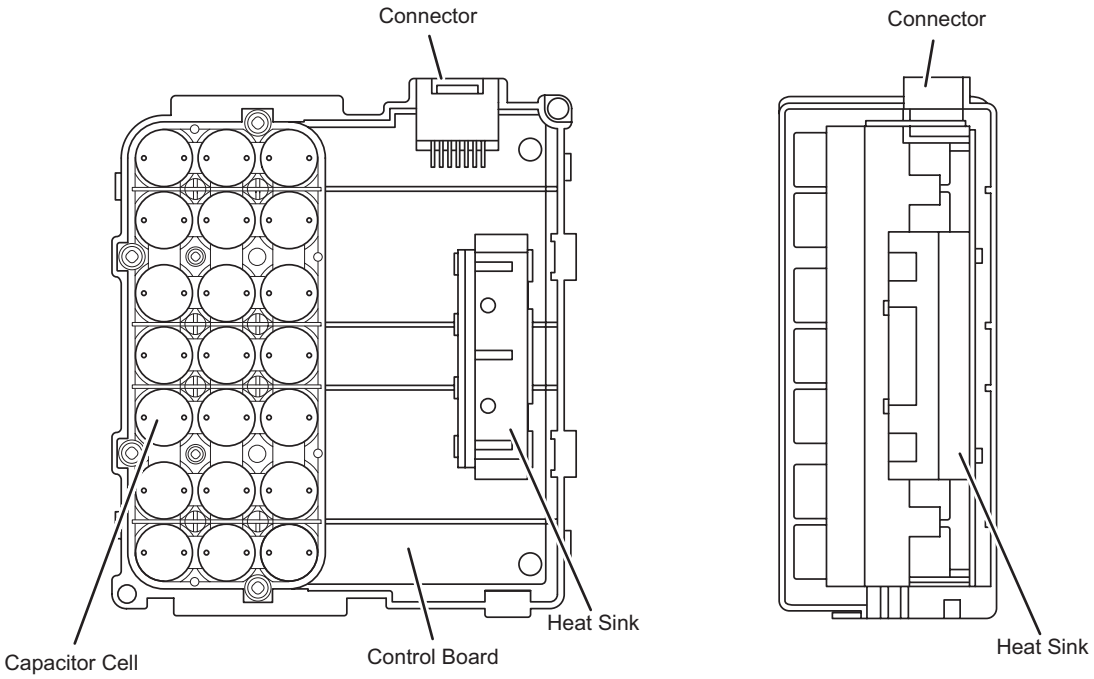


Stroke Simulator Cross Section

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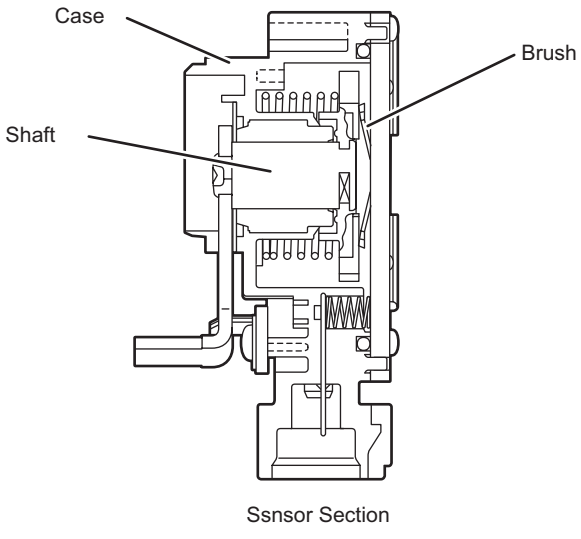
Power Backup Unit

- A power backup unit is used as an auxiliary source to supply stable power to the brake system, and is located on the right side of the luggage compartment.
- The unit has a built-in capacitor (high-capacity condenser), which receives the electric charge discharged by the vehicle's 12V power source.
- When there is a voltage drop in the vehicle's 12V power source, the capacitor discharges the electric charge that is stored in it in order to supply power to the brake system.



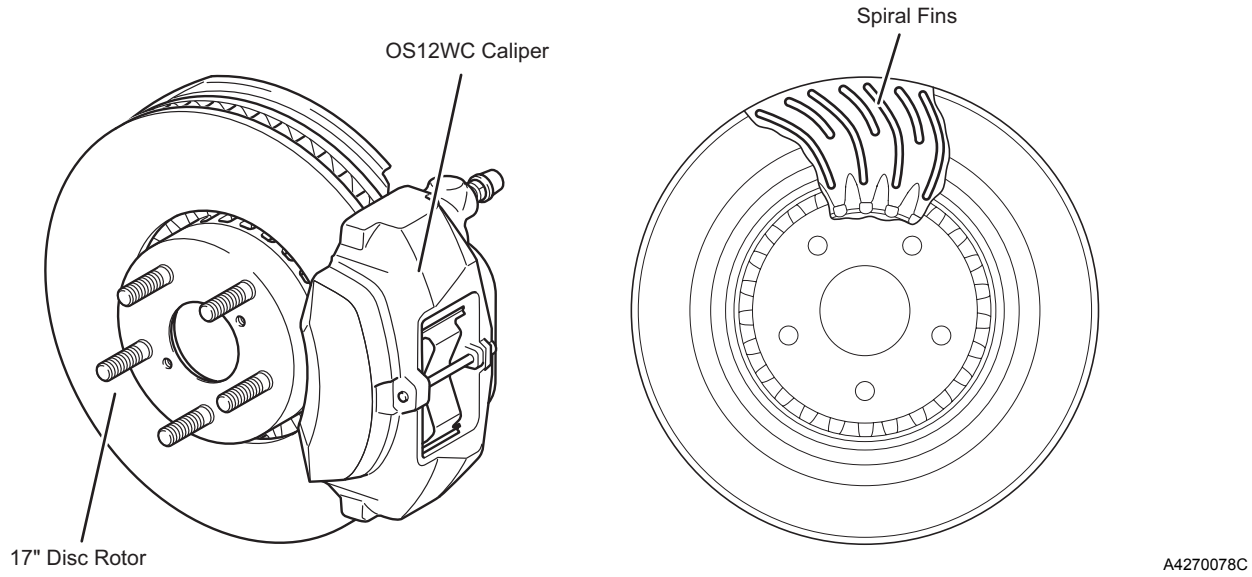
Brake Pedal Stroke Sensor

- The 3UZ-FE engine models use a brake pedal stroke sensor.
- The sensor is mounted to the brake pedal to detect the amount of brake pedal effort.
- The stroke sensor is a sliding resistance type.



Front Brake

- 17" high performance brake system is equipped on all models. High friction pads are installed in order to achieve high brake performance and excellent brake feeling.
- They are the ventilated type that excels in heat dissipation to ensure reliability. Furthermore, spiral fins are used to ensure superior cooling performance.
- All models use the OS12WC type front brake calipers. The shapes of the pads, mounting, and cylinder have been optimized to achieve a compact and lightweight construction.

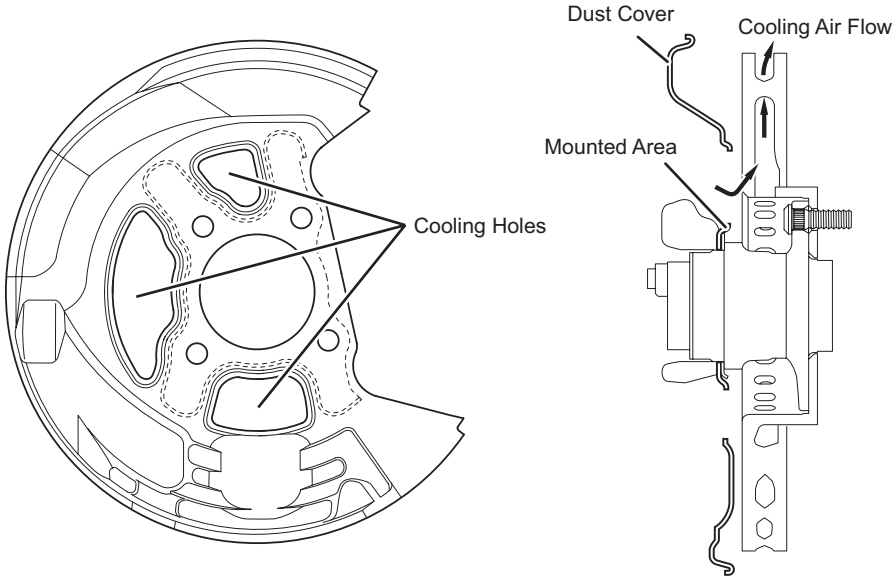


■ **Service Tip** ■

- The high brake performance is achieved by proper wear of brake pads and discs. As a result, the brake discs may wear earlier than the ones on the conventional brake system.
- When brake pads are replaced, brake disc thickness is required to be measured.
- It is dangerous to continue driving when brake pads and discs have exceeded the wear limit.
- Brake dust can be easily removed from the wheel by washing the wheel with water.

Dust Cover Construction

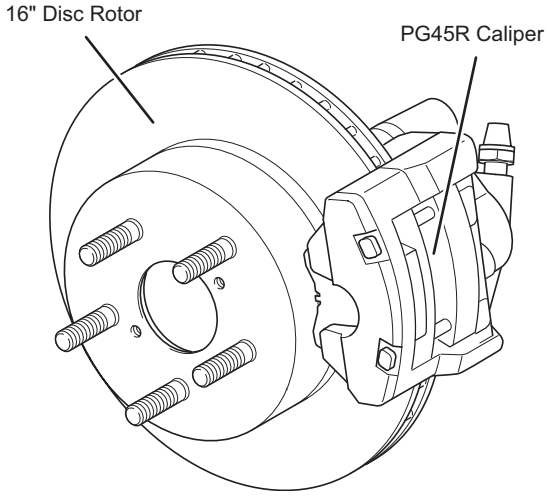
• The shape of the front dust cover has been optimized to efficiently direct cool air to the ventilated disc, thus ensuring excellent cooling performance. In addition, a brake cooling air duct that extends from the front bumper through the fender liner is provided to further improve cooling performance.



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Rear Brake

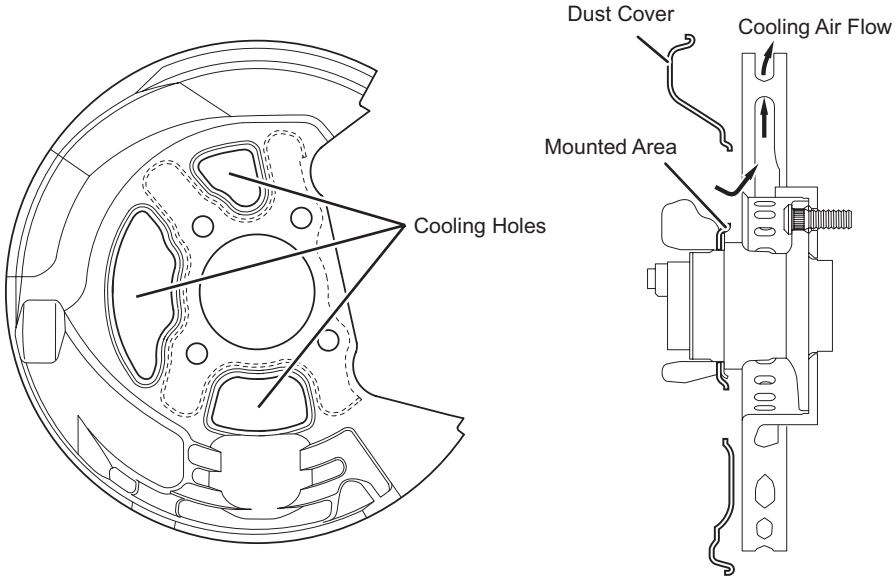
- All models use the PG45R type rear brake calipers.
- The disc rotor is a 16" ventilated type. It has an in-built duo servo type parking brake.



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Dust Cover Construction

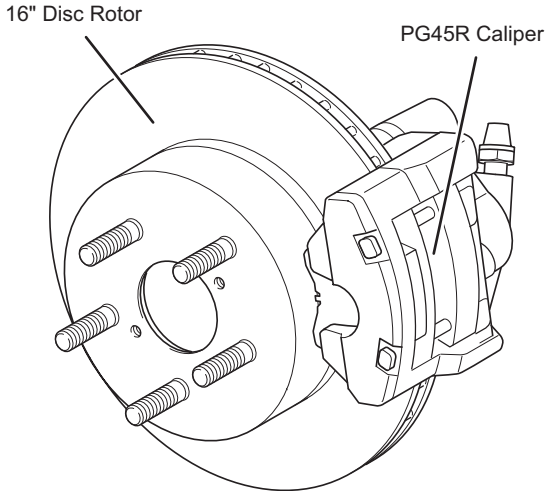
• The shape of the front dust cover has been optimized to efficiently direct cool air to the ventilated disc, thus ensuring excellent cooling performance. In addition, a brake cooling air duct that extends from the front bumper through the fender liner is provided to further improve cooling performance.



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Rear Brake

- All models use the PG45R type rear brake calipers.
- The disc rotor is a 16" ventilated type. It has an in-built duo servo type parking brake.

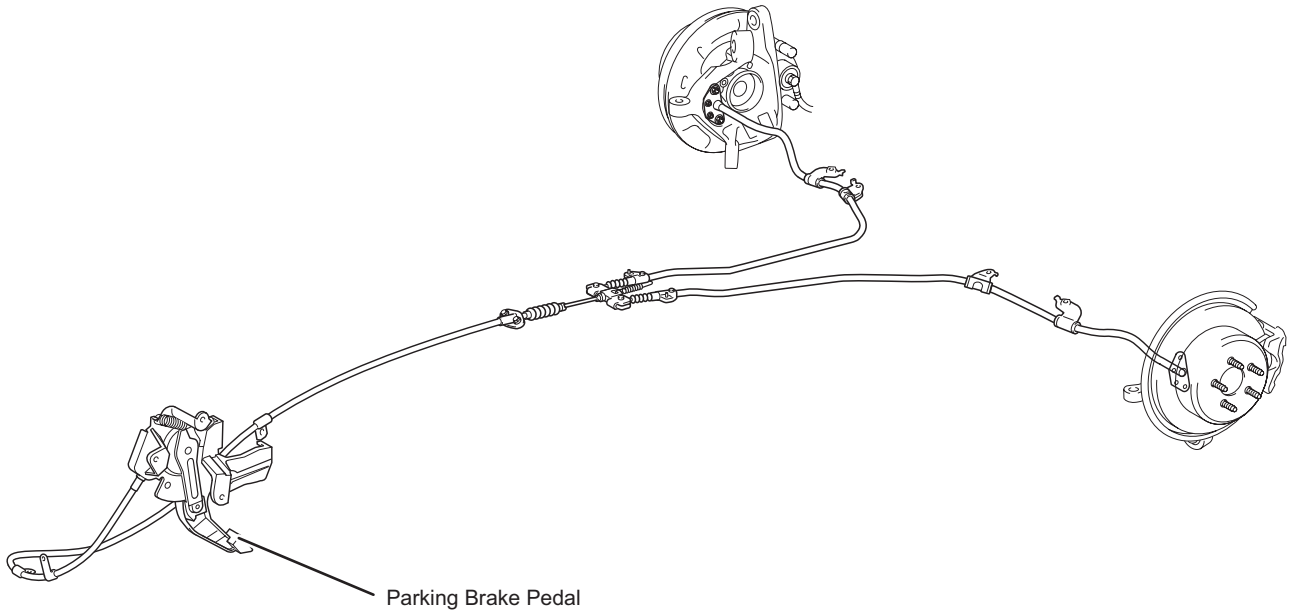


A4270080C

PARKING BRAKE

Parking Brake

- A foot-operated parking brake is used. It uses a foot-operated release for ease of operation.
- The parking brake pedal can be adjusted inside the vehicle for serviceability.



Parking Brake

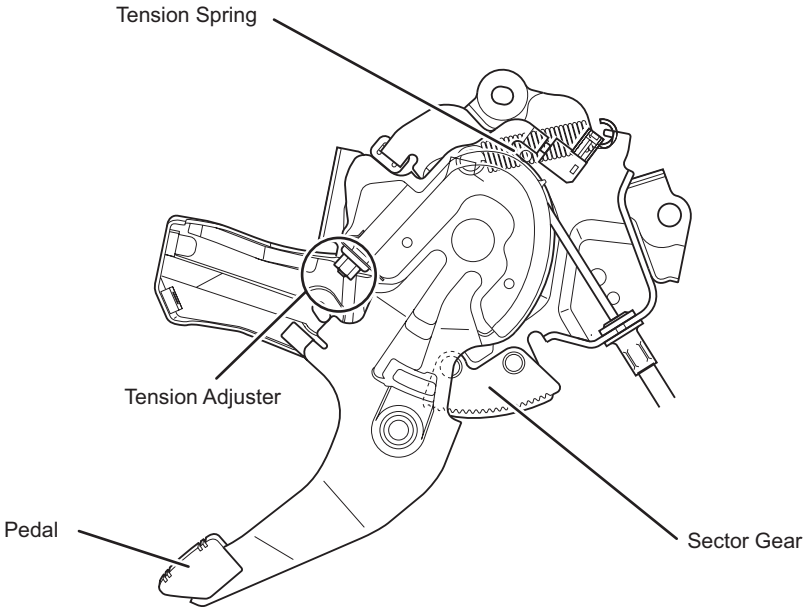
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Parking Brake Specification

Type		Duo Servo
Drum Inner Diameter	[mm]	190
Lining Surface Area	[cm^2]	45
Lining Dimensions	[mm]	181.0 × 25.0 × 2.4
Operation Type		Foot-operated

Construction of the Foot-Operated Parking Brake

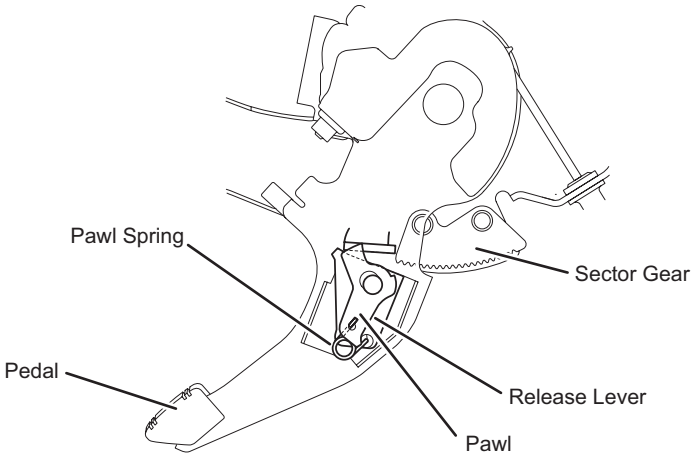
- The parking brake, which consists of a parking brake pedal, sector gear, pawl, pawl spring, and tension spring, is locked or released by operating the pedal.



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Parking Brake Non-Operation

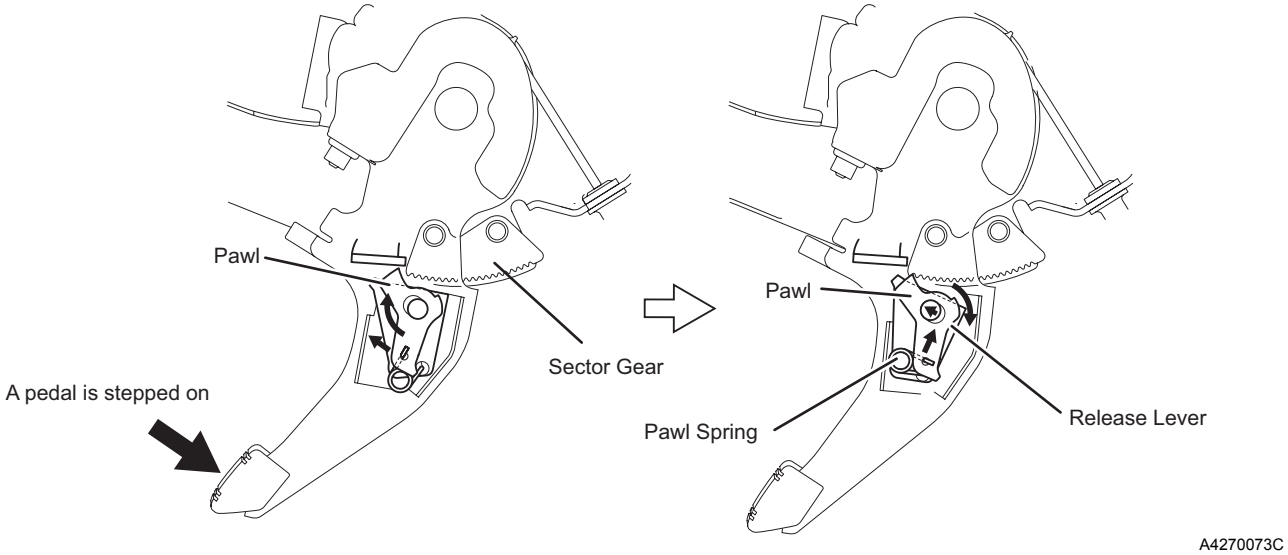
- The parking brake is released because the pawl and the sector gear are not meshed.



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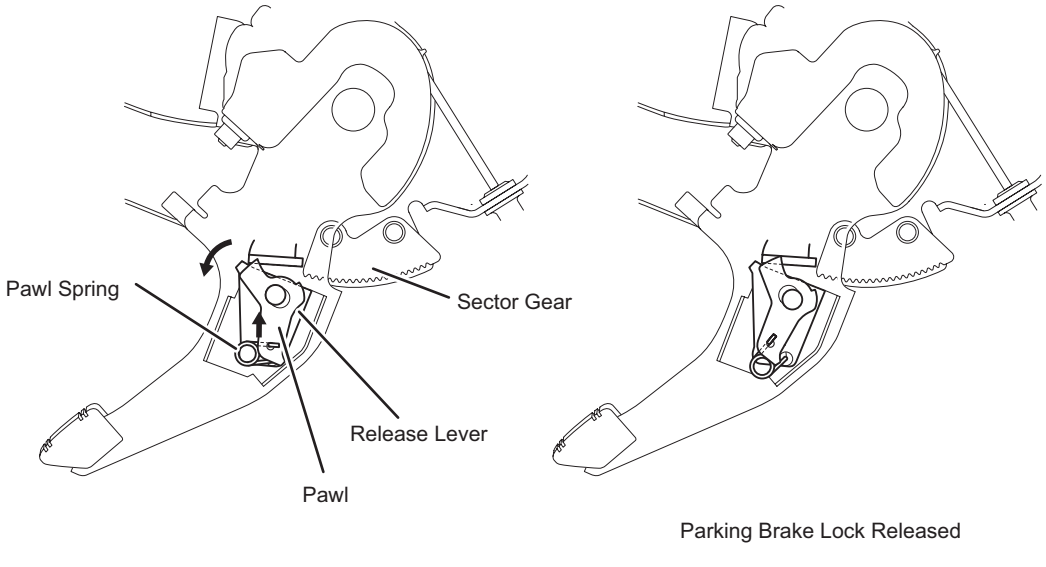
Lock Operation

- When the driver presses the parking brake pedal, the sector gear, which is mounted to the pedal, meshes with the pawl.
- When the driver releases the pedal at a fully depressed position, the reaction force of the cable causes the pawl to slide and turn the release lever. Then, the pawl spring flips and applies a counterclockwise force to the pawl, and a clockwise force to the release lever. Thus, the pawl remains stationary in this state and maintains the parking brake pedal in the depressed position.



Lock Release

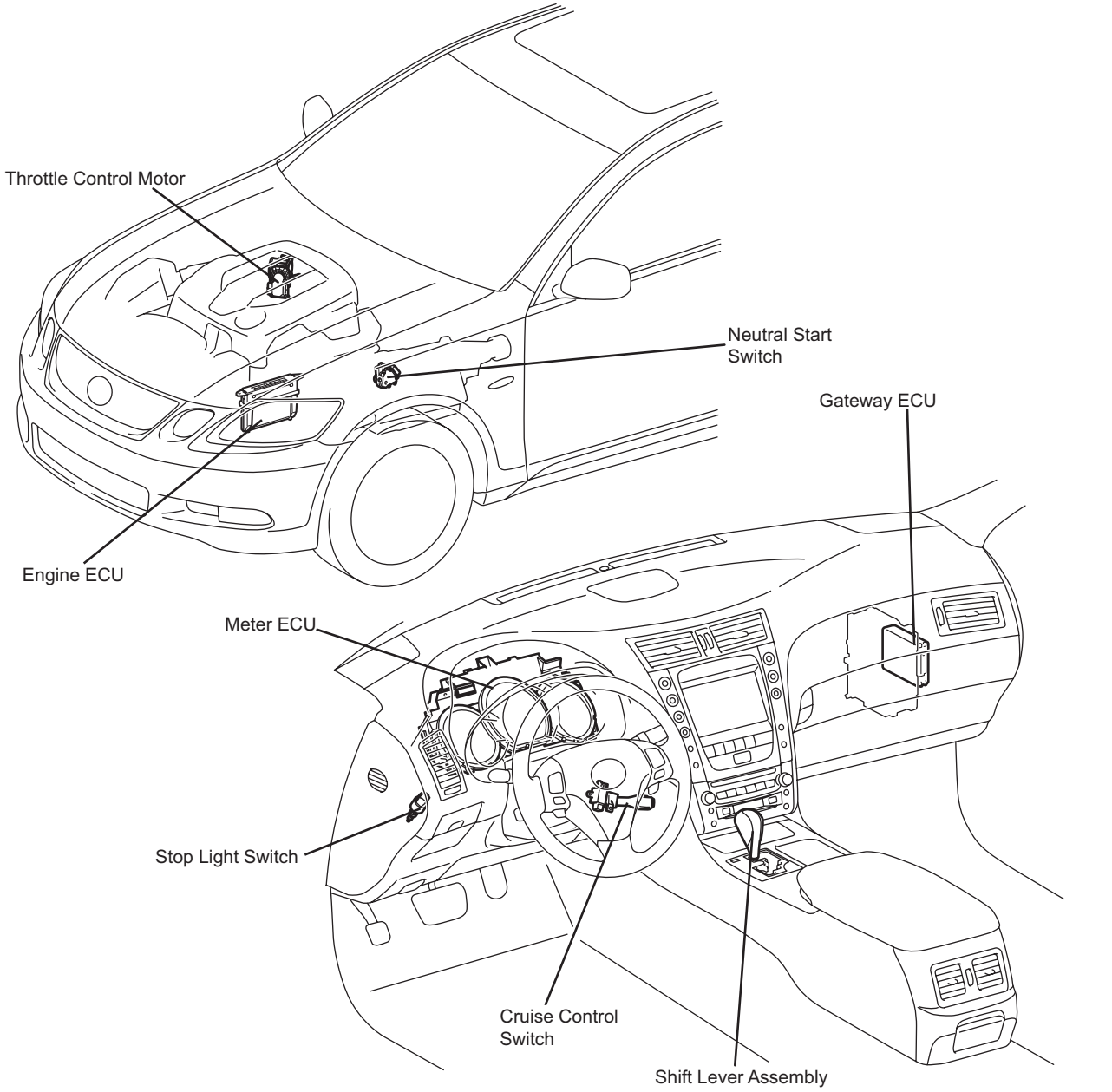
- When the driver presses the parking pedal again, the meshed parts become disengaged. The force of the pawl spring causes the pawl to turn and the cable returns the pedal, thus releasing the locking of the parking brake.
- Simultaneously with the turning of the release lever at the release lever return portion provided on the pedal, the pawl returns to the original position, which causes the parking brake to return to the non-operating state.



CRUISE CONTROL

Cruise Control System

- All models use a cruise control system, which operates the vehicle at a constant driving speed, as standard equipment.
- A cruise control switch, in which the main switch and the operation switch are integrated, is used. It is installed on the right side of the steering wheel to ensure the ease of use.
- All the functions of the cruise control system are controlled by the engine ECU.
- A cruise control indicator light is located in the combination meter. This light indicates whether the main power supply of the cruise control system is ON or OFF, and issues a warning in case of a system failure.



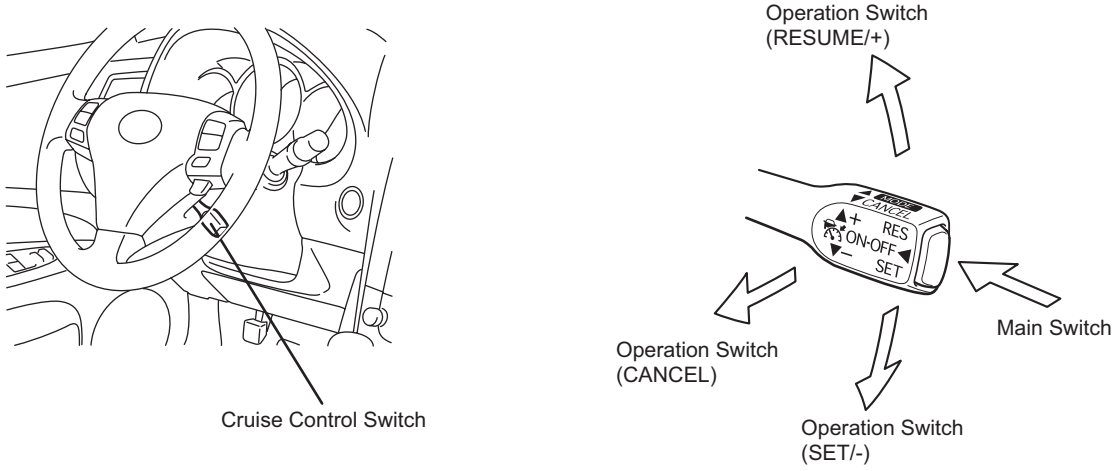
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Cruise control system composition parts list

Name	Main function
Cruise Control Switch (with integrated main switch and operation switch)	• Turns the main power supply of the cruise control system ON and OFF. • When the driver operates the SET/-, RESUME/+, and CANCEL switches, the switches output their respective vehicle speed setting/deceleration control, resume control/acceleration control, and control cancel operation signals to the engine ECU.
Meter ECU (built into the combination meter)	• The combination meter contains a cruise operation/warning indicator light to indicate whether the cruise control system is ON or OFF, and to indicate a warning.
Engine ECU	• Controls all the functions of the cruise control system in accordance with the signals received from the switches, sensors, and ECUs.
throttle control moter	• Adjusts the throttle valve to the target opening in accordance with the signals received from the engine ECU.
Stoplight Switch	• Detects that the driver has pressed the brake pedal and outputs a control cancel signal to the engine ECU.
Neutral Start Switch	• Detects the shift position and outputs a shift position signal to the engine ECU.
Shift Lever Assembly	• Detects the shift position "S" and the shift operation (up or down) and outputs a signal to the engine ECU.
Gateway ECU	• Transmits and receives data mutually between the BEAN (Body Electronics Area Network) and the CAN (Controller Area Network).

Cruise Control Switch

● The cruise control switch, which is installed on the right side of the steering wheel, integrates a push-type main switch and a lever-type, three-way operation switch to ensure the ease of use. The lever-type operation switch is an auto-retract type that switches ON while it is being operated and switches OFF when it is released. The operations of this switch are valid only when the main switch is turned ON.



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Cruise control switch function list

Switch name	Function
Main Switch (Push Type)	Toggles between ON and OFF to supply the main power to the cruise control system each time the driver pushes this switch.
Operation Switch (three-way lever type)	While the main switch is ON, the driver operates this switch to perform the following controls: SET/- (vehicle speed setting/deceleration control), RESUME/+ (resume control/acceleration control), and CANCEL (control cancel).

Cruise Control Cancel Function

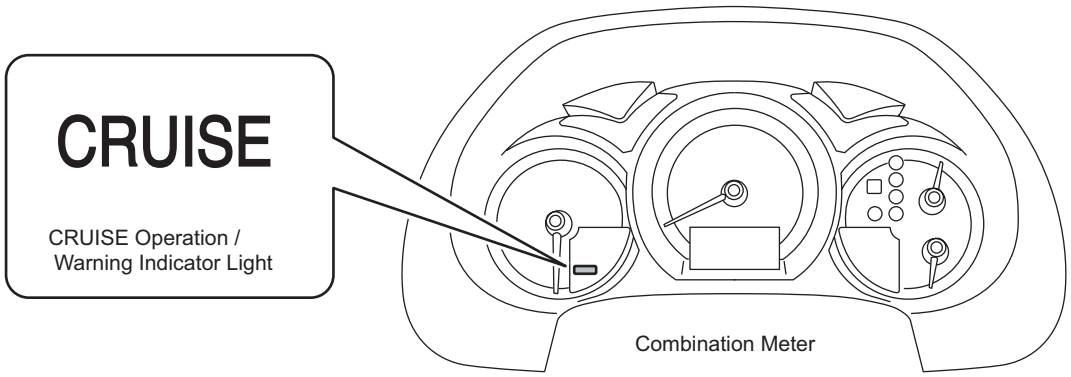
● When the driver performs any of the cancel operations listed below, the cruise control system cancels the driving operation under its control, and the system remains in the standby mode except when the driver presses the main switch.

Release operation list

Release operation	State
Pulls the cruise control operation switch towards the driver.	Cruise control operation switch: CANCEL
Pushes the cruise control main switch.	Cruise control main switch: OFF
Presses the brake pedal.	Stoplight switch: ON
Shifts to "D" position or a gear other than 6th, 5th, or 4th in the "S" mode.	In neutral start switch, "D" position signal: OFF, or a gear other than 6th, 5th, or 4th selected in the "S" mode

CRUISE Control Indicator Light

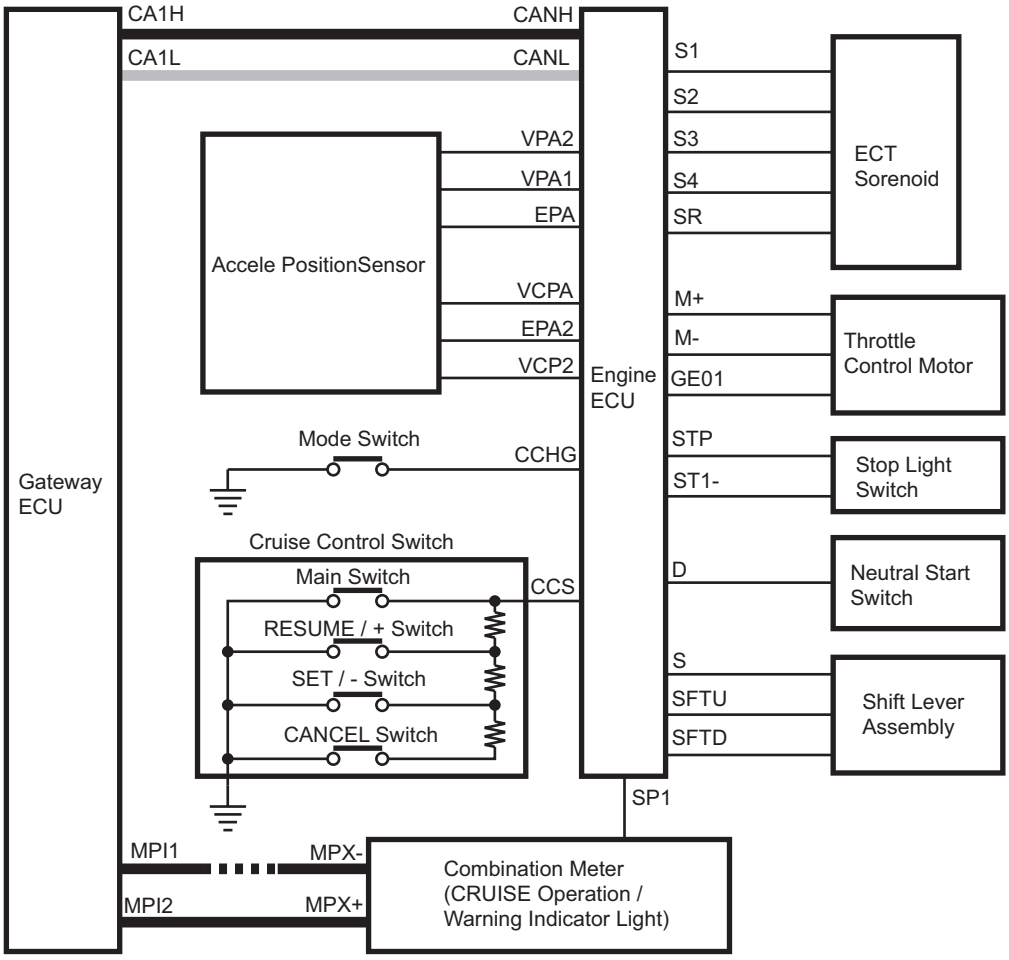
- Located in the combination meter, this light illuminates when the cruise control main switch is ON, and blinks when there is a failure in the cruise control system. Thus, it informs the driver of the operating condition of the cruise control system or a failure in the system.



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Engine ECU

● The engine ECU, which has a built-in microprocessor, provides the following types of functions: SET/- (deceleration control), RESUME/+ (acceleration control), CANCEL, vehicle speed calculation, motor output control, and overdrive control. The built-in microprocessor receives the inputs of signals from the switches and sensors, processes those signals in accordance with a program that is stored in memory, and controls the throttle control motor. In addition, it has a built-in function to diagnose a system malfunction through the use of the cruise operation/warning indicator light in the combination meter.



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Control by Engine ECU

• The engine ECU controls the cruise control system as described below.

Cruise control function list

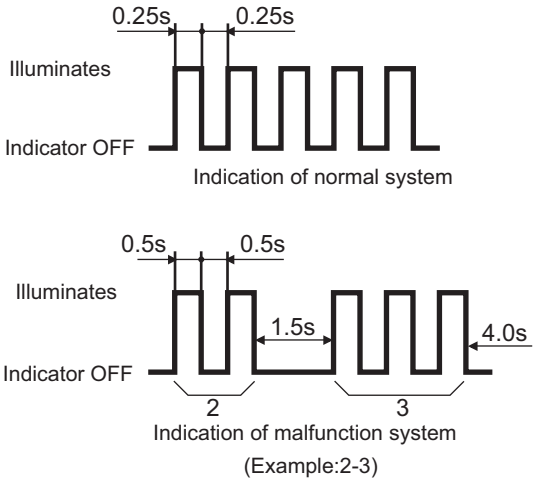
Control name	Control contents	
Set Control	·	When the driver operates the SET/- switch while the main switch is ON and the vehicle is being driven at an approximate speed between 43 and 170 km/h(EU)43 and 106 mph(EU right handle except Ireland and Cyprus) ,43 and 139 km/h(other country) the ECU memorizes the vehicle speed at the time the driver releases the switch OFF, and controls the vehicle at a constant speed.
Set speed(low speed limit)	·	The low speed limit is the lowest speed that cruise control can be set and is designed at approx. 25mph(40km/h). The cruise control cannot be set below that speed. If the vehicle speed drops below that speed while running in the cruise control mode, the cruise control is cancelled (deletes the vehicle speed memory) automatically.
Set speed(High Speed Limit)	·	The upper limit of the settable speed range is approximately 125 mph(200 km/h). Thus, the driver cannot set a driving speed that exceeds the high speed limit. Furthermore, the driver cannot accelerate the vehicle higher than the high speed limit by operating the RESUME/+ switch in an attempt to increase the speed.
Constant-Speed Control	·	The ECU compares the driving speed against the memorized speed, calculates the cruise control request value so that the driving speed will match the memorized speed, and controls the throttle control motor.
Acceleration Control	·	If the driver continues to press the RESUME/+ switch ON while the vehicle is being driven under cruise control, the ECU actuates the throttle control motor in the opening direction of the throttle valve, in order to increase the speed. The ECU memorizes the vehicle speed at the time the driver releases the switch OFF, and controls the vehicle at a constant speed. The ECU accepts a switch operation signal while the vehicle speed is between approximately 25 and 125 mph(43 and 200 km/h).
	·	If the driver momentarily (approximately 0.5 seconds) presses the RESUME/+ switch ON while the vehicle is being driven under cruise control, the ECU increases the memorized speed by approximately 5 mph(5 km/h) with each pressing of the switch (this is called a "tap-up" function). However, the ECU will not change the memorized speed if the difference between the memorized speed and the driving speed is above approximately 3 mph(5 km/h).

Control name	Control contents	
Deceleration Control	·	If the driver continues to press the SET/- switch ON while the vehicle is being driven under cruise control, the ECU actuates the throttle control motor in the closing direction of the throttle valve (without fully closing the throttle valve) in order to decelerate the vehicle. The ECU memorizes the vehicle speed at the time the driver releases the switch OFF, and controls the vehicle at a constant speed. The ECU accepts a switch operation signal while the vehicle speed is between approximately 25 and 125 mph (43 and 200 km/h).
	·	If the driver momentarily (approximately 0.5 seconds) presses the SET/- switch ON while the vehicle is being driven under cruise control, the ECU decreases the memorized speed by approximately 5 mph(5km/h) with each pressing of the switch (this is called a "tap-down" function). If the difference between the memorized speed and the driving speed is above approximately 3 mph(5 km/h), the ECU memorizes the vehicle speed at the time the driver releases the SET/- switch OFF and controls the vehicle at a constant speed.
Resume Control	·	If the driver effects manual cancel control to cancel the driving operation of the vehicle under cruise control (without turning the cruise control main switch OFF), the driver can operate the RESUME/+ switch from OFF to ON to resume the speed that the ECU has memorized when the driver effected manual cancel control. Then, the ECU effects constant acceleration control. This control is enabled provided that the vehicle speed is above approximately 25 mph(40 km/h).
Manual cancelle function	·	The ECU cancels cruise control if it receives the input of any of the signals listed below while the vehicle is being driven under cruise control.
	1	Stoplight switch is ON (by pressing the brake pedal).
	2	"D" position signal is OFF or a gear other than 6th, 5th, or 4th is selected in the "S" mode.
	3	CANCEL switch of the operation switch is ON.
	4	Cruise control main switch is OFF.
	5	VSC is operating.

Control name	Control contents	
Auto cancelle function	·	If any one of the conditions listed below occurs while the vehicle is being driven under cruise control, the ECU deletes the memorized speed and cancels the control. Then, it blinks the cruise control indicator light and disables the control until the main switch is turned ON again.
	1	An open or short circuit in the stoplight switch.
	2	A failure in the vehicle speed signal.
	3	A failure in the throttle control motor.
	·	If any one of the conditions listed below occurs while the vehicle is being driven under cruise control, the ECU deletes the memorized speed and cancels the control. Then, it blinks the cruise control indicator light until the main switch is turned ON again. The ECU will not accept the operation of the main switch until the ignition is turned OFF.
	1	A failure in the stoplight switch signal input circuit.
	2	A failure in the cancel circuit.
	·	If any one of the conditions listed below occurs while the vehicle is being driven under cruise control, the ECU deletes the memorized speed and cancels the control (and the control can be reset).
	1	The vehicle speed is below approximately 25 mph(40 km/h).
	2	The vehicle speed is approximately 10 mph(16 km/h) less than the memorized speed.
Over drive function	·	While the vehicle is being driven under cruise control, the ECU might cancel the over-drive, particularly if the vehicle is being driven uphill. After the overdrive cancellation, if the ECU determines that the uphill drive has ended, it will resume the overdrive mode after the counting of the overdrive resume timer has been completed. However, if the vehicle speed drops below the overdrive resume speed before the counting of the resume timer has been completed, the timer resets itself. The timer will restart counting after the vehicle reaches the overdrive resume speed again.

Indication of Results of Diagnosis of System Failure Location

• To access the results of the diagnosis in the form of DTCs (Diagnostic Trouble Codes), short the terminals Tc and E of the DLC3 connector located below the instrument finish lower panel on the driver side while the ignition is ON. The DTCs are determined by counting the blinking of the cruise operation/warning indicator light. If the system has diagnosed malfunctions in multiple sections, the light will output the DTCs in ascending order.



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LIst of failure diagnotic result display

Code No.	Failure diagnostic item
2-1	• An open in the vehicle speed signal.
2-3	• Malfunction in the vehicle speed signal.
5-2	• An open or short circuit in the stop light switch.
5-4	• Malfunction in the stop light switch input circuit • Malfunction in the cancel circuit

The Cautions On Cruise Control System Handing

- Pay attention to the precautions listed below when operating the cruise control system.
- Beware of the increase in speed when driving downhill with cruise control.

> • If the vehicle speed gets too high, cancel the cruise control. Then, apply the engine brake by shifting down, in order to decelerate the vehicle.

- If the cruise control has been canceled, press the RESUME/+ switch to resume control. If the vehicle is being driven at a constant speed with cruise control, press the RESUME/+ switch to increase the speed (acceleration control).
- If the cruise control indicator light blinks while the vehicle is being driven under cruise control, turn the main switch OFF. Then, perform the set operation again.

> • If you are unable to set a vehicle speed, or if it gets canceled immediately after you have set it, the cruise control system may be malfunctioning. This will not affect your ordinary driving, but you should take it to a dealer to have it inspected.

- Do not operate the vehicle under cruise control under any of the conditions listed below. Failure to observe this precaution may prevent the vehicle from operating at a speed that suits the road conditions or the wheels may spin, causing you to lose control of the vehicle, and lead to an unforeseen accident.

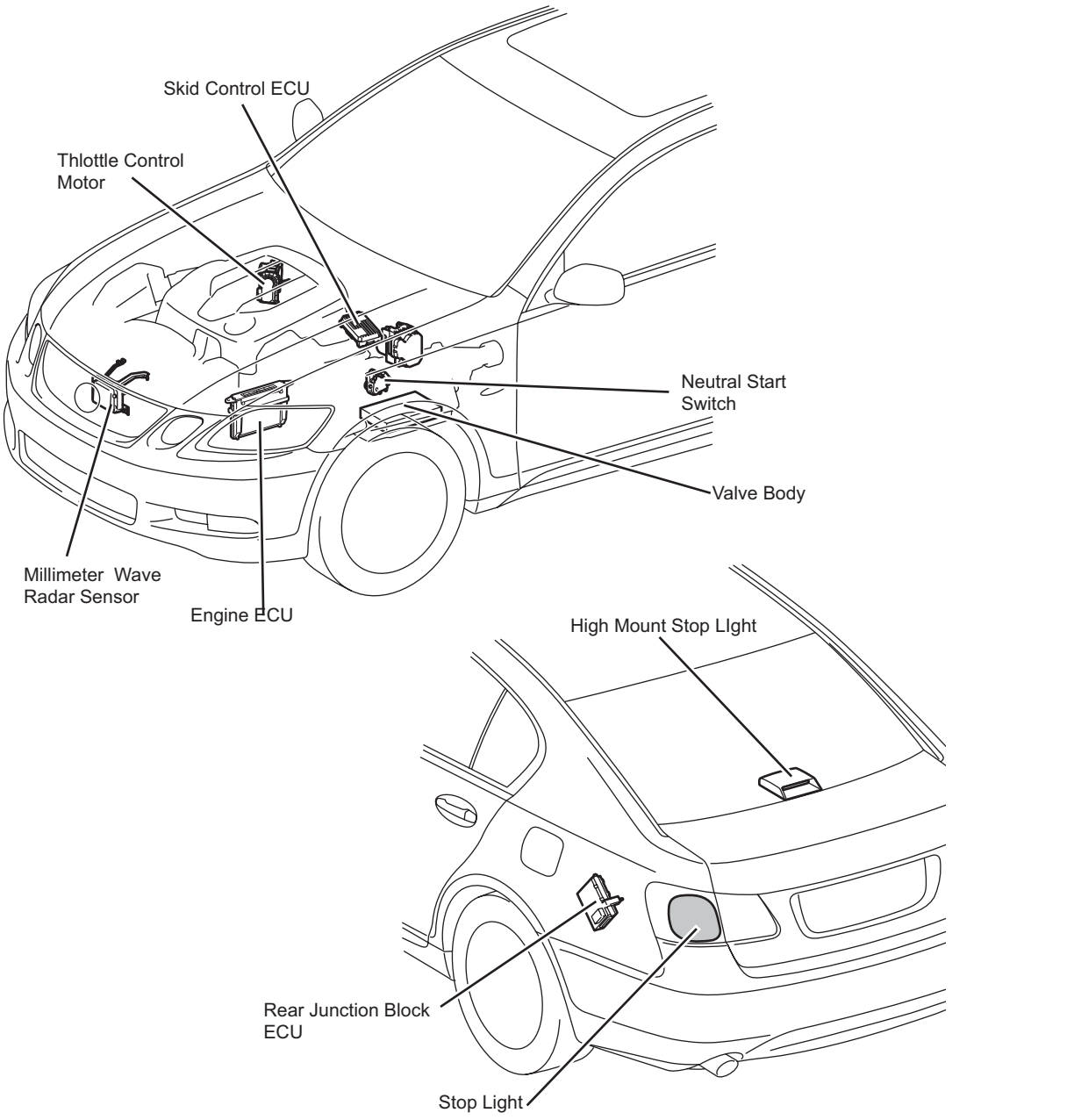
> • Road with heavy traffic.
> • Steep downhill.
> • Sharp curve.
> • Frozen or snow-covered road.
> • Other slippery road surfaces.

Dynamic Radar Cruise Control System

- A "Dynamic radar cruise control system" is available on manufacturer's option*. Refer to the appendix at the end of this manual for details on the available models. In addition to the function to keep the driven speed constant, this system comprises a "vehicle-to-vehicle control" mode. This function recognizes and determines the lanes in which the vehicle ahead and the driven vehicle are present and allows the driven vehicle to follow the vehicle ahead by keeping the proper distance between the vehicles, proportionate to the vehicle speed.
- A millimeter wave radar sensor is used for detecting the distance to the vehicle ahead and the relative speed. To detect a vehicle ahead, this sensor transmits and receives millimeter waves, which are less vulnerable to the effects of foul weather.
- A "vehicle-to-vehicle distance selector switch" is used to set the vehicle-to-vehicle distance to three distances, long, medium, and short, in order to enable the vehicle to follow a vehicle ahead. This switch is installed on the steering wheel.
- The multi-information display in the combination meter indicates the operating state and the control mode of the radar cruise control system.
- If the driven vehicle gets too close to the vehicle ahead, the system automatically applies the brakes, thus enhancing the follow control performance during the vehicle speed control mode.
- The Dynamic radar cruise control system is controlled primarily by the engine ECU and the distance control ECU.

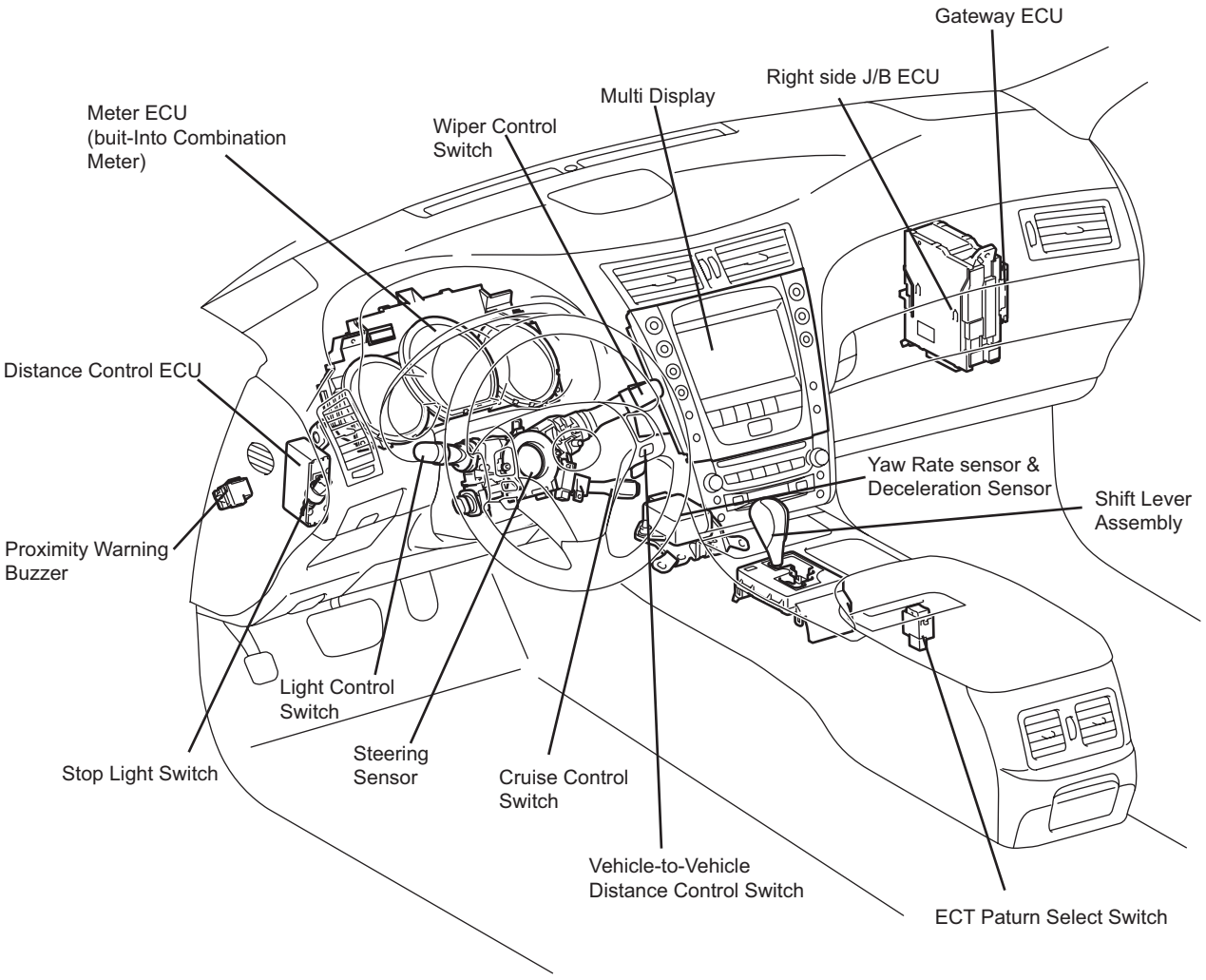
❖REFERENCE❖

* : Excluding the G.C.C country


Skid Control ECU
Thlottle Control Motor
Neutral Start Switch
Valve Body
Millimeter Wave Radar Sensor
Engine ECU
High Mount Stop LIght
Rear Junction Block ECU
Stop Light
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Dynamic Radar Cruise Control System Main Components and Functions List - Part 1

Composition parts	Main function
Millimeter wave radar sensor	• Emits millimeter wave band radiowaves forward and receives the radiowaves that are reflected by the forward objects. It monitors the changes in the frequencies of the received radiowaves and scans them electronically to calculate the presence of a vehicle ahead in the same lane, the distance between the driven vehicle and the vehicle ahead, and their relative speed. Then, it outputs the resultant data to the distance control ECU.
Engine ECU	• Controls the functions of the Dynamic radar cruise control system. • Actuates the throttle control motor to accelerate or decelerate the engine. • Outputs the state of system control to the meter ECU.
Throttle control motor	• Adjusts the throttle valve to the target opening in accordance with the signals received from the engine ECU.
Valve body	• Contains a solenoid that shifts down or up in accordance with the signals provided by the engine ECU.
Skid control ECU	• Effects brake control in accordance with a signal received from the distance control ECU. • Sounds the approach warning buzzer in accordance with a signal received from the distance control ECU.
Neutral start switch	• Detects that the shift position has been moved from D to a position other than D, and outputs a control cancel signal to the engine ECU.
Rear junction block computer	• Turns the stoplight ON upon receiving the input of a stoplight illumination request signal from the right side J/B ECU.


Gateway ECU
Right side J/B ECU
Multi Display
Meter ECU
(buit-Into Combination
Meter)
Wiper Control
Switch
Distance Control ECU
Yaw Rate sensor &
Deceleration Sensor
Shift Lever
Assembly
Proximity Warning
Buzzer
Light Control
Switch
Steering
Sensor
Stop Light Switch
Cruise Control
Switch
Vehicle-to-Vehicle
Distance Control Switch
ECT Paturn Select Switch

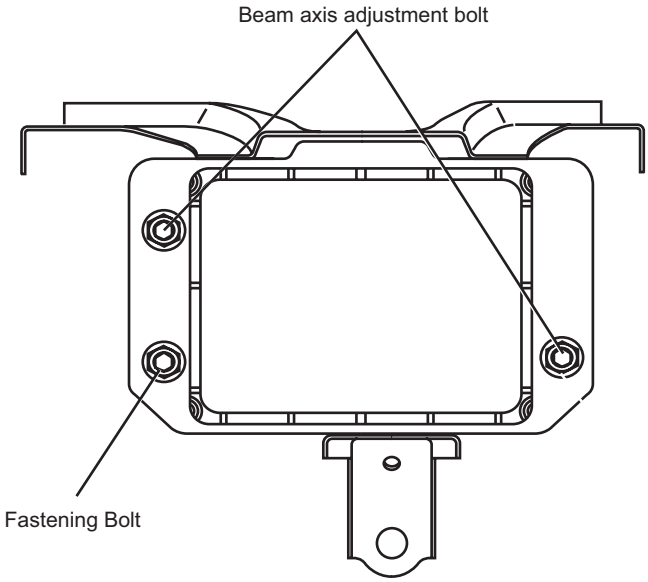
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Dynamic Radar Cruise Control System Main Components and Functions List - Part 2

Composition parts	Main function
Distance control ECU	• Determines the vehicle to follow in accordance with the data received from the radar sensor, and determines the acceleration rate to attain the target vehicle-to-vehicle distance. Then, outputs the brake control request and the approach warning buzzer request signals.
Cruise control switch (Integrated Main Switch/Operation Switch Type)	• Turns the main power supply of the Dynamic radar cruise control system ON or OFF (main switch). • When the driver operates the four-way switch (SET/-, RESUME/+, CANCEL, and MODE), it outputs the respective switch operation signals (vehicle speed setting/deceleration control, control resume/acceleration control, control cancel, and vehicle-to-vehicle control mode/constant control mode selector) to the distance control ECU (operation switch).
vehicle-to-vehicle distance control switch	• Changes the vehicle-to-vehicle distance setting for following a vehicle in the vehicle-to-vehicle control mode in three steps with each pressing of the switch, and outputs a switch operation signal to the meter ECU and the distance control ECU.
Stop light switch	• Detects that the driver has pressed the brake pedal, and outputs a control cancel signal to the engine ECU.
Steering sensor	• Detects the amount and direction of steering and outputs a steering angle signal to the Distance control ECU.
Proximity warning buzzer (common with VDIM Buzzer)	• When the distance to the vehicle driven ahead is reduced. The skid control ECU outputs a signal to sound the buzzer.
Meter ECU (built into combination meter)	• Causes the cruise operation/warning indicator light to turn ON, OFF, or blink in accordance with a signal received from the engine ECU. • Indicates the control state of the system and a description of a failure on the multi-information display in accordance with a signal received from the engine ECU.
Wiper Control Switch	• Outputs a HI or LO operation signal to the distance control ECU, which in turn, outputs a control cancel signal to the engine ECU.
Light Control Switch	• Outputs a taillight illumination signal to the engine ECU when the taillights are turned ON.
Right side J/B ECU	• Receives the input of a brake control signal from the skid control ECU, and outputs a stoplight illumination request signal to the rear junction block ECU.
Yaw rate sensor and Deceleration sensor	• Detects the yaw rate of the vehicle and outputs to the distance control ECU.
Shift Lever Assembly	• Detects the shift position "S" and the gear shift operation (up or down) and outputs a signal to the engine ECU.
ECT Pattern Select Switch	• Detects the ECT SNOW mode and outputs a control cancel signal to the engine ECU.
Gateway ECU	• Transmits and receives data mutually between the BEAN (Body Electronics Area Network) and the CAN (Controller Area Network).

Millimeter Wave Radar Sensor

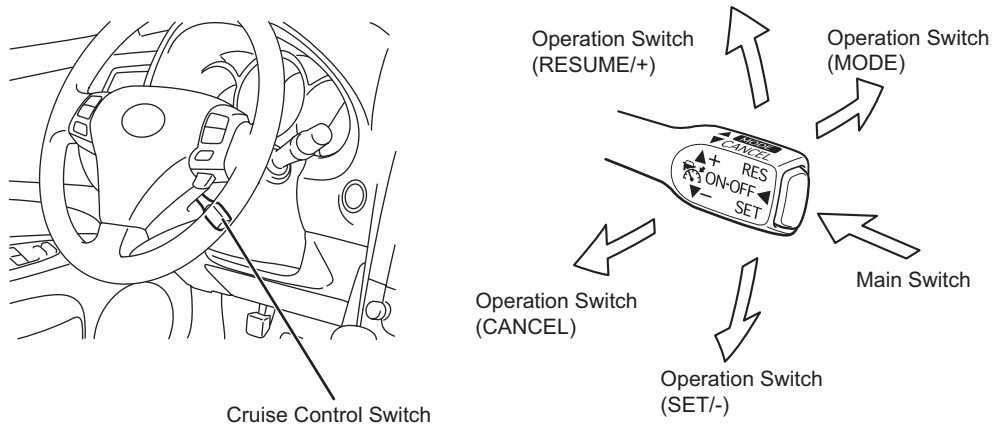
- The millimeter wave radar sensor emits millimeter wave band radiowaves forward and receives the radiowaves that are reflected by the rear end of the vehicle if there is a vehicle ahead. It monitors the changes in the frequencies of the received radiowaves and scans them electronically to calculate the presence of a vehicle ahead in the same lane, the distance between the driven vehicle and the vehicle ahead, and their relative speed. Then, it outputs the resultant data to the distance control ECU. The millimeter wave radar sensor is installed in the center of the upper radiator support.



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Dynamic Radar Cruise Control Switch

- The cruise control switch, which is installed on the right side of the steering wheel, integrates a push-type main switch and a lever-type, four-way operation switch to ensure the ease of use.
- The lever-type operation switch is an auto-retract type that switches ON while it is being operated and switches OFF when it is released. The operations of this switch are valid only when the main switch is turned ON.
- To change to the constant-speed control mode, the cruise control main switch must be turned ON, and the cruise control operation switch must be pushed forward for more than approximately 1 second. Once the driver performs some other operation after the cruise control main switch is turned ON, the system will not accept an attempt to change to the constant-speed control mode. This feature prevents the control from unintended operation.



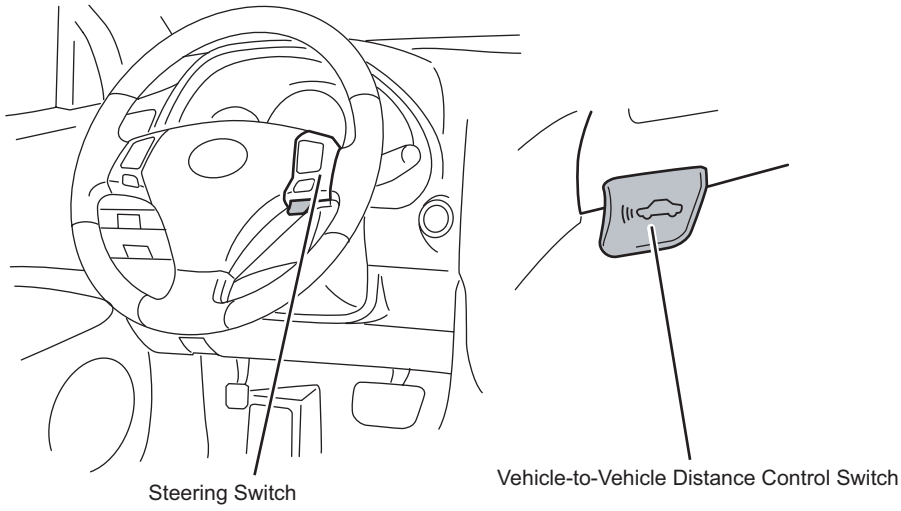
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Vehicle-to-Vehicle Control Mode, Constant-Speed Control Mode Radar Cruise Control Switch Operation List

Switch name	Function
Main switch(push type)	Toggles between ON and OFF to supply the main power to the Dynamic radar cruise control system each time the driver pushes this switch.
Operation switch(4-way rever type)	While the main switch is ON, the driver operates this switch to perform the following controls: SET/- (vehicle speed setting/deceleration control), RESUME/+ (resume control/acceleration control), CANCEL (control cancel), and MODE (vehicle-to-vehicle control mode/ constant-speed control mode).

Vehicle-To-Vehicle Distance Control Switch

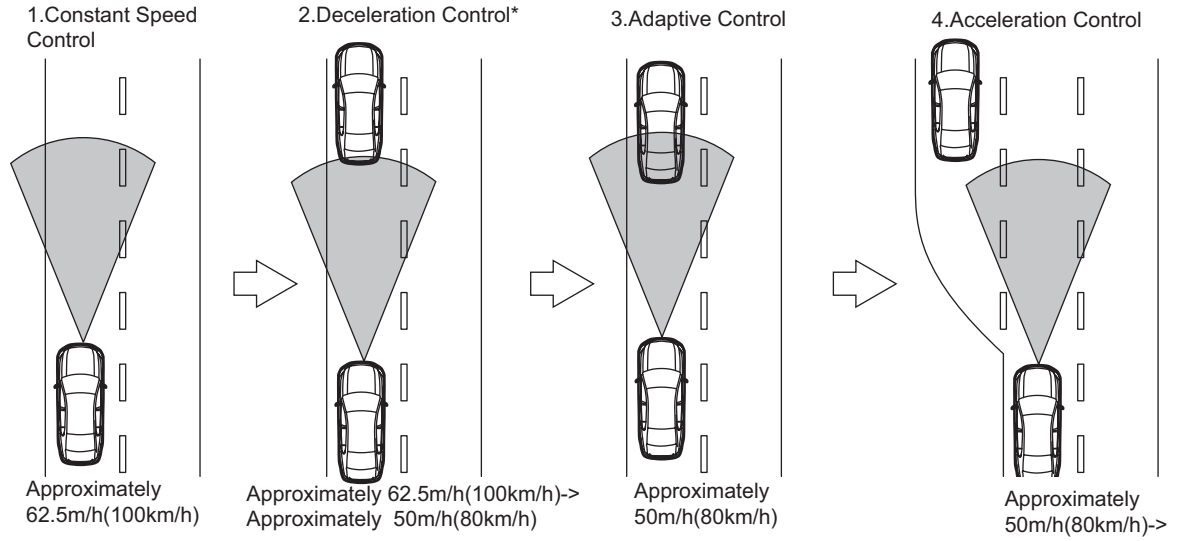
- The vehicle-to-vehicle distance selector switch, which is installed on the right side of the steering pad, changes the vehicle-to-vehicle distance setting in three stages, long, medium, and short.
- The driver can check the vehicle-to-vehicle distance setting by looking at the indication on the multi-information display in the combination meter.



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Foundations Function of Dynamic Radar Cruise Control System

● The Dynamic radar cruise control system effects control as follows:



Note: The illustration shows the control examples with the speed of the driven vehicle set to approximately 62.5 m/h(100km/h) and the speed of the vehicle ahead being approximately 50 m/h(80km/h).

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The flow of Dynamic radar cruise control system function

No.	Control state	Foundations control operation
1	Constant-Speed Control	• No vehicle detected ahead • Drives constantly at a set vehicle speed {example: approx. 62.5 mph(100km/h)}
2	Deceleration Control	• Vehicle detected ahead {example: approx. 50 mph(80km/h)} • Decelerates*1 from a set vehicle speed {approx. 62.5 mph(100km/h)} to the speed of the vehicle ahead {approx. 50 mph(80km/h)}
3	Follow Control	• Vehicle being detected ahead {approx. 50 mph(80km/h)} • Follows the vehicle ahead by maintaining a vehicle-to-vehicle distance*2 that is proportionate to the speed of the vehicle ahead {approx. 50 mph(80km/h)}
4	Acceleration Control	• Detects that the vehicle ahead has changed lanes or that the driven vehicle has changed lanes • Accelerates gradually to a set vehicle speed {approx. 62.5 mph(100km/h)}, and drives at the constant speed.

❖REFERENCE❖

*1The system effects shift-down control and brake control if a greater amount of deceleration is needed. If the driven vehicle approaches the vehicle ahead to an extent that prevents the vehicle from decelerating sufficiently, the system sounds the approach warning buzzer to alert the driver to take an action (such as braking).

*2As a rule of thumb, the following controlled vehicle-to-vehicle distances apply when the driven vehicle follows a vehicle ahead at a speed of 50 mph(80km/h): approx. 50 meters for "long", approx. 40 meters for "medium", and "approx. 30 meters for "short".

Dynamic Radar Cruise Control Cancel Function

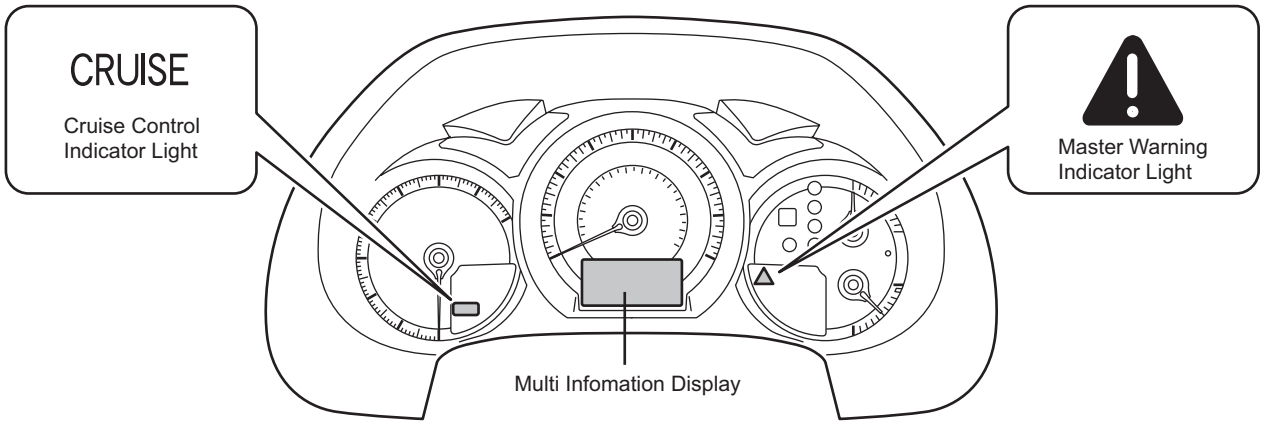
- When the driver performs any of the cancel operations listed below, the system cancels the driving operation under radar cruise control and remains in the standby mode, except when the driver presses the main switch.

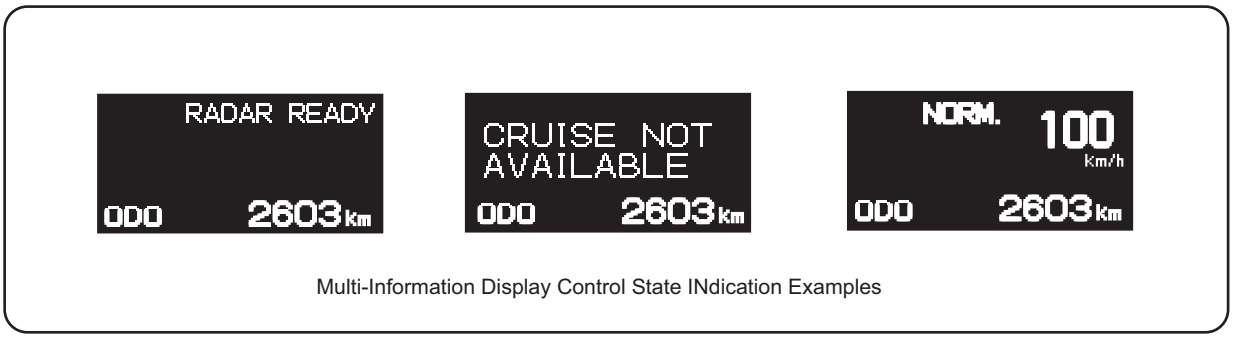
Cancel operation list

Release operation	The state of a cancel switch
Radar Cruise control operation switch is pulled forward.	Radar cruise control operation switch CANCELL
Radar Cruise control main switch is pushed.	Radar Cruise control main switch OFF
Brake pedal is depressed.	Stop Light Switch ON
Shifts to "D" position or a gear other than 6th, 5th, or 4th in the "S" mode.	In neutral start switch, "D" position signal: OFF, or a gearother than 6th, 5th, or 4th selected in the "S" mode

Indication Of Dynamic Radar Cruise Control System Control Condition

- When the system is in the vehicle-to-vehicle control mode, the cruise operation/warning indicator light illuminates and the multi-information display indicates information such as the set vehicle speed, the presence of a vehicle ahead, and the set vehicle-to-vehicle distance.
- When the system is in the constant-speed control mode, the cruise control indicator light illuminates and the multi-information display indicates "NORM" and the set vehicle speed.





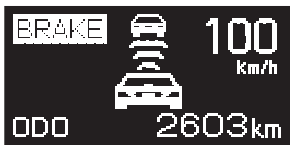
Multi-Information Display Control State INdication Examples

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Dynamic Radar Cruise Control System Control State Display List

Control state		Multi-infomation display	Light*1
control mode	main switch state		
Non-Control Mode	OFF/Non-Control	No Indication	OFF
		[redacted]	

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Control state		Multi-infomation display	Light*1
control mode	main switch state		
Vehicle-to-Vehicle Distance Control Mode	ON/Non-Control	Set vehicle -to-Vehicle Distance not input,set vehicle speed not input	ON
			
	ON/Non-Control	Set vehicle-to-vehicle distance "long" *2set vehicle speed not input	ON
			
	ON/Constant Speed Control	No vehicle ahead,set vehicle-to-vehicle"medium"*2set vehicle speed	ON
			
	ON/Following Control	Vehicle ahead,set vehicle-to-vehicle distance"short"*2set vehicle speed	ON
			
	ON/Rollowing Control,Proximity Warning	Vehicle ahead,set vehicle-to-vehicle distance"long"*2set vehicle speed appear alternately in 0.5-second intervals	ON
			
	ON/Following Control,Brake Control	Vehicle ahead,set vehicle-to-vehicle distance"long*2set vehicle speed,brake operation	ON
			

Control state		Multi-infomation display	Light*1
control mode	main switch state		
Constant Speed Control Mode	ON/Non-Control	Set vehicle speed not input	ON
			
	ON/Constant Speed Control	Set vehicle speed	ON
			
Non-Control Mode	ON→OFF/Non-Control	Control cancel	ON->OFF
			

❖REFERENCE❖

*1Illuminates the cruise control indicator light.

*2Indicates "long", "medium", or "short", depending on the vehicle-to-vehicle distance setting.

Warning Indication (Vehicle-to-Vehicle Distance Control Mode is Impossible)

- If the self-check function of the millimeter wave radar sensor detects that the transmitter or the receiver is dirty, the system sounds the warning buzzer, illuminates the master warning indicator light, and indicates "CREAN RADAR SENSOR" on the display.
- If the detection performance of the millimeter wave radar sensor is negatively affected by foul weather*, the system sounds the warning buzzer, illuminates the master warning indicator light, and indicates "CHECK CRUISE SYSTEM" on the display.*

❖REFERENCE❖

*On a model equipped with a millimeter wave radar sensor, when the wipers are operating at the HI speed.

Warning Indication (Cruise Control Driven is Impossible)

• If the self-check function of the millimeter wave radar sensor detects any failure in the system, the system sounds the warning buzzer, blinks the cruise operation/warning indicator light, illuminates the master warning indicator light, and indicates "CRUISE SYSTEM CHECK" on the display.

List Dynamic Radar Cruise Control System Warning Display

Warning Item	Multi Infomation Display	CRUISE Operation/ Warning Indicator Light	Mastar Warning Indicator Light
If the grille cover for the millimeter wave radar sensor (of a model equipped with a millimeter wave radar sensor) is dirty.		Frashed	illuminated
In case of foul weather*. Snow mode.		↑	↑
If a failure occurs in the Dynamic radar cruise control system.		↑	↑

❖REFERENCE❖

* For vehicles equipped with the millimeter wave radar sensor, this executes when the wiper is changed to HI.

Resume of Warning Indication

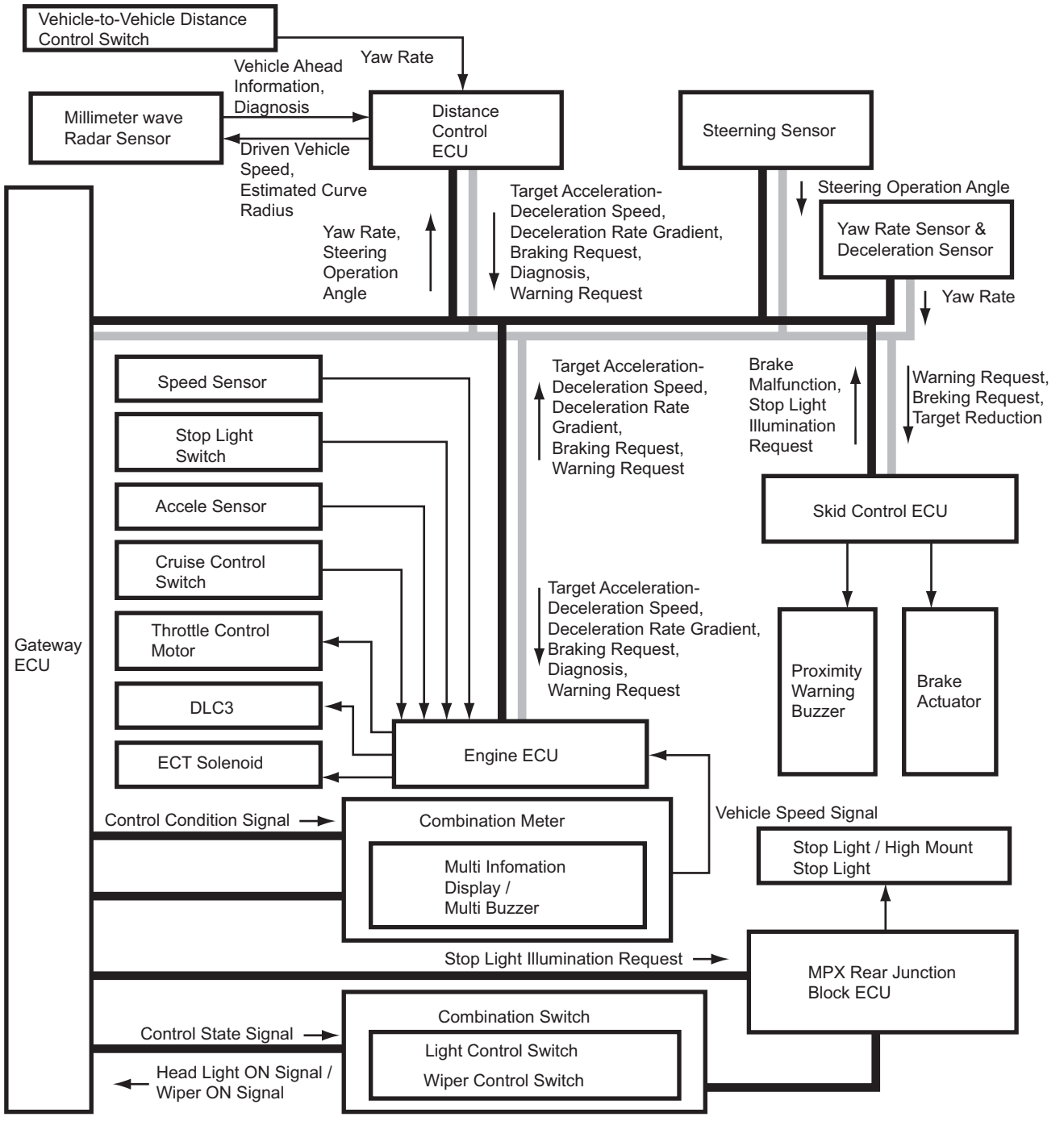
• If the conditions listed in the table below are met in accordance with the contents of the display, the multi-information display and the cruise control indicator light revert to indicate the state of the system control.

Dynamic Radar Cruise Control System Warning Indication Resumption Conditions

Multi-Information Display Indication	Resumption Condition
CREAN RADAR SENSOR	The window of the transmitter or receiver of the radar sensor is no longer dirty. The grille cover for the millimeter wave radar sensor (of a model equipped with a millimeter wave radar sensor) is no longer dirty.
CRUISE NOT AVAILABLE	After the weather recovers, various conditions are met, including the driver turning the wiper control switch to INT or OFF, and the laser radar sensor is not exposed to strong light.
CHECK CRUISE SYSTEM	No system failure is detected when the driver turns the ignition OFF, and turns it back ON (Dynamic radar cruise control system ON).

Dynamic Radar Cruise Control System Control

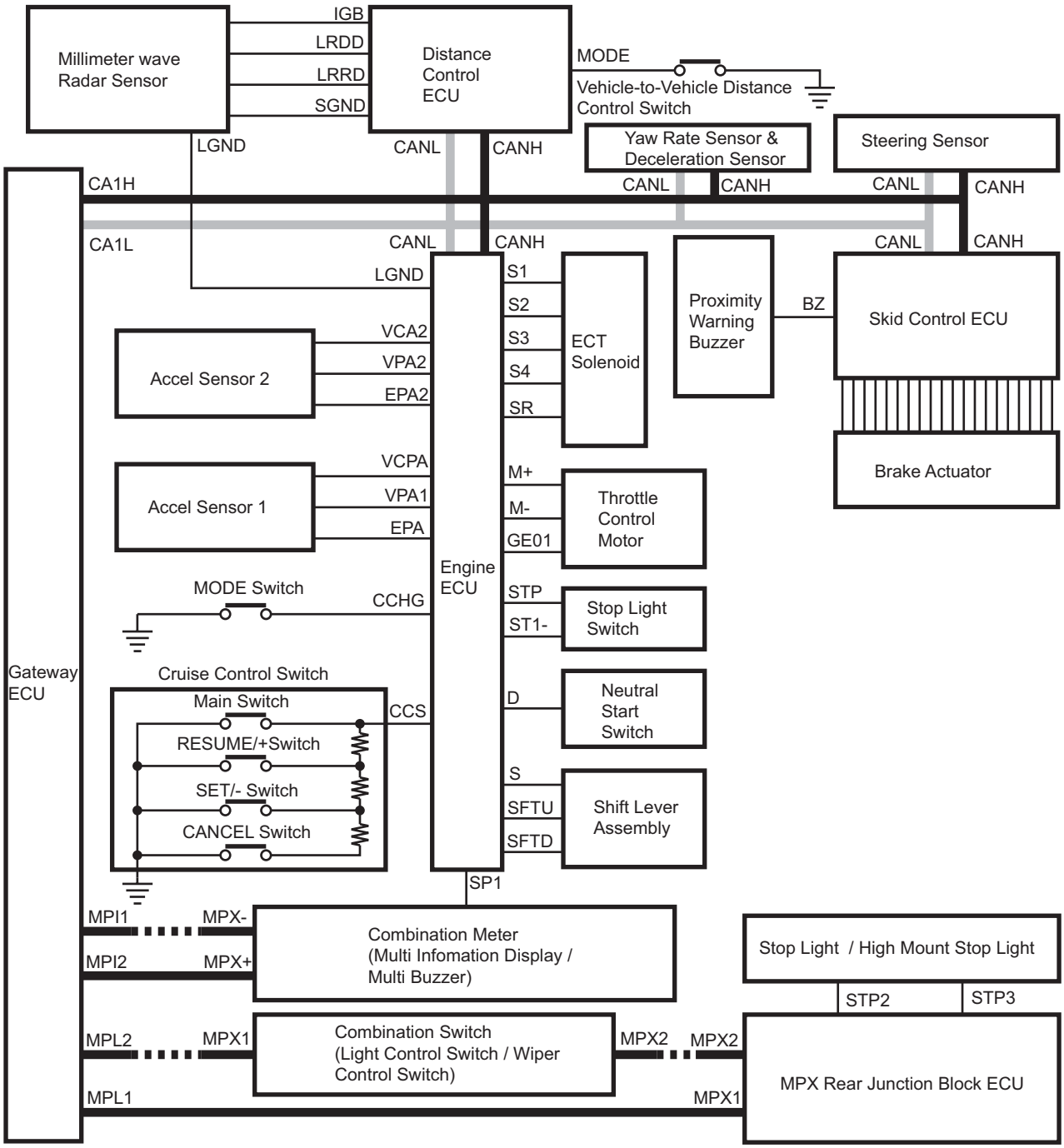
● The Dynamic radar cruise control system is controlled by the systems indicated in the diagram.



*:Represents vehicle distance, relative speed,same lane probability,new target / target lost determination.

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Dynamic radar cruise control system circuit figure



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Vehicle-to-Vehicle Distance Control Mode

• In the vehicle-to-vehicle control mode, the Dynamic radar cruise control system effects the controls described below.

Cruise control system control (vehicle-to-vehicle distance mode)

Control name		Control contents
Set control	·	When the driver turns the SET/- switch ON while the main switch is ON and the vehicle is traveling between approximately {27 and 87 mph, 43 and 170 km/h(EU)} 43 and 139 km/h(other country), this function memorizes the vehicle speed at the time the switch is OFF as the set speed, and starts the control.
Low-Speed Limit, Set Lower Limit Vehicle Speed	·	The low speed limit is set to approximately 25 mph,(40km/h). If the vehicle speed drops below the low-speed limit while the vehicle is being driven in the vehicle-to-vehicle control mode, the system automatically cancels its control while keeping the set vehicle speed in memory.
	·	The set lower limit vehicle speed is set to approximately 27 mph(43 km/h). If the vehicle is being driven below the set lower limit vehicle speed, the system will not accept the driver's set operation. If the vehicle speed drops below the set lower limit vehicle speed while the SET/- switch is ON, the system automatically cancels its control while keeping the set vehicle speed in memory.
High-Speed Limit	·	The high-speed limit is set to approximately 125 mph(200 km/h). If the driver performs a set operation while the vehicle is traveling at a speed higher than the high-speed limit, the system will set the speed to the high-speed limit {approximately 125 mph(200 km/h)}. Likewise, the driver cannot increase the speed by setting a speed higher than the high speed limit through the operation of the RESUME/+ switch.
Constant-Speed Control	·	The ECU compares the present driving speed against the set speed, and regulates the position of the throttle control valve by actuating the throttle control motor in order to reach the set vehicle speed.
Follow Control	·	The ECU compares the present driving speed against the follow driving target acceleration data. Then, it regulates the position of the throttle control valve by actuating the throttle control motor in order to maintain the proper vehicle-to-vehicle distance in accordance with the changes in the speed of the vehicle ahead. This control will not perform a follow drive towards a vehicle or object ahead that is stopped.
Vehicle-to-Vehicle Control Mode/Constant-Speed Control Mode Selector	·	In the state ("RADAR READY" shown on display) in which no control at all is effected after the driver turns ON the cruise control main switch, if the driver pushes the mode switch ON longer than approximately 1 second, the system will transfer to the constant-speed control mode. (The radar cruise control system initially starts in the vehicle-to-vehicle control mode.)

Control name		Control contents
Acceleration Control	·	If the driver continues to push the RESUME/+ switch ON while the vehicle is being driven in the vehicle-to-vehicle control mode, the ECU increases the vehicle speed and applies a speed increase update to the set speed. This is accomplished by actuating the throttle control motor in the direction to open the throttle control valve. In the follow control mode, if the driver continues to push the RESUME/+ switch ON, and there is a vehicle ahead, precedence is given to continue performing the follow control, without increasing the vehicle speed. However, the system will apply a speed increase update on the set speed.
	·	If the driver momentarily (approximately 0.5 seconds) presses the RESUME/+ switch ON while the vehicle is being driven under cruise control, the ECU increases the memorized speed by approximately 5 mph(5 km/h) with each pressing of the switch (this is called a "tap-up" function). However, the ECU will not change the memorized speed if the difference between the memorized speed and the driving speed is greater than approximately 3 mph(5 km/h).
	·	While the vehicle is being driven under follow control, if the vehicle ahead is no longer present because it has changed lanes or the driven vehicle has changed lanes, the vehicle will automatically accelerate gradually to reach the set vehicle speed. If the driver pushes the RESUME/+ switch ON at this time, the vehicle will accelerate more quickly.
Deceleration Control	·	If the driver continues to push the SET/- switch ON while the vehicle is being driven in the vehicle-to-vehicle control mode, the ECU decreases the vehicle speed by actuating the throttle control motor in the direction to close the throttle control valve. The ECU applies a vehicle speed reduction update by using the vehicle speed that existed at the time the driver had released the switch OFF as the set vehicle speed. If the set vehicle speed after the update is slower than the speed of the vehicle ahead, the system will transfer to the constant-speed control. If the set vehicle speed after the update is faster than the speed of the vehicle ahead, the system will continue effecting the follow control.
	·	If the vehicle speed exceeds the high-speed limit speed due to a downhill slope while the driver operates the SET/- switch, and the driver subsequently releases the switch OFF, the ECU will memorize the high-speed limit speed as the set vehicle speed and transfer the system to the constant-speed control mode.
	·	If the system needs to decelerate the vehicle operating under the follow drive control, the system decelerates the vehicle to the follow drive target vehicle speed. This is accomplished by actuating the throttle control motor in the direction to close the throttle control valve. If a greater rate of deceleration is required, the driver can apply shift-down control and brake control.

Control name		Control contents
Auto cancel control	·	If any of the conditions listed below occurs while the vehicle is being driven in the vehicle-to-vehicle control mode, the ECU deletes the set vehicle speed and cancels the control. In this case, it will indicate a CHECK CRUISE SYSTEM warning on the multi-information display, sound the warning buzzer, illuminate the master warning indicator light, and blink the cruise operation/warning indicator light. Furthermore, the ECU will disable the control until the main switch is turned ON again.
	6	A failure in the vehicle speed signal.
	7	A failure in the throttle control motor.
	8	An open or short circuit in the stoplight switch.
	·	If any of the conditions listed below occurs while the vehicle is being driven in the vehicle-to-vehicle control mode, the ECU deletes the set vehicle speed and cancels the control. In this case, it will indicate a CHECK CRUISE SYSTEM warning on the multi-information display, sound the warning buzzer, illuminate the master warning indicator light, and blink the cruise operation/warning indicator light. Furthermore, the ECU will disable the control until the ignition switch is turned ON again. (Vehicle-to-vehicle control mode only)
	9	A failure in the cruise control system.
	·	If any of the conditions listed below occurs while the vehicle is being driven in the vehicle-to-vehicle control mode, the ECU cancels the control while keeping the set vehicle speed in memory. In this case, it will indicate a CREAN RADAR SENSOR or CRUISE NOT AVAILABLE warning on the multi-information display, sound the warning buzzer, illuminate the master warning indicator light, and blink the cruise operation/warning indicator light. Furthermore, the ECU will disable the control until the system recovers from the conditions listed below or the main switch is turned ON again. If the system is restored from the conditions listed below, the driver can operate the RESUME/+ switch to resume the control.
	10	The wipers operate at the HI speed (on model equipped with a millimeter wave radar sensor).
	11	The driver selects the ECT SNOW mode.
	·	If any of the conditions listed below occurs while the vehicle is being driven in the vehicle-to-vehicle control mode, the ECU cancels the control while keeping the set vehicle speed in memory.
	12	The driving speed drops below approximately 25 mph(40 km/h).
	13	The driving speed drops below approximately 27 mph(43 km/h) while the SET/- switch is turned ON.
Manual cancel control	·	If any of the signals listed below is input while the vehicle is being driven in the vehicle-to-vehicle control mode, the ECU cancels the control while keeping the set vehicle speed in memory.
	1	Stoplight switch is ON (by pressing the brake pedal).
	2	"D" position signal is OFF or a gear other than 6th, 5th, or 4th is selected in the "S" mode.
	3	CANCEL switch of the cruise control operation switch is ON.
	4	VSC is operating .
	5	Cruise control main switch is OFF (set vehicle speed is deleted).

Control name		Control contents
Resume control	·	Suppose the driver performs a control cancel operation through the foregoing manual cancel controls (except by pressing the main switch OFF) or through the auto cancel controls (6 to 13) while the vehicle is being driven in the vehicle-to-vehicle control mode. If the driving speed is above approximately 25 mph(40 km/h), the driver can turn the RESUME/+ switch ON to resume the control at the set vehicle speed that existed at the time the driver performed the control cancel operation.
Shift down control	·	While the vehicle is being driven in the vehicle-to-vehicle control mode, the transmission might shift down on an uphill slope.
	·	When the system determines that the vehicle has completed the uphill drive, the transmission shifts up automatically after a predetermined length of time has elapsed.
Brake control	·	While the vehicle is being driven in the vehicle-to-vehicle control mode, if a greater amount of deceleration is needed, the system applies braking control by actuating the brake actuator. At this time, the stoplights will illuminate.

Constant Speed Control Mode

• The constant speed mode of the Dynamic radar cruise control system is performed according to the following.

Radar cruise control system control(constant speed mode)

Control name		Control contents
Set control	·	When the driver turns the SET/- switch ON while the main switch is ON and the vehicle is being driven at an approximate speed between {27 and 87 mph,43 and 170 km/h(EU)},43 and 139 km/h(other country), the ECU memorizes the vehicle speed at the time the driver releases the switch OFF as the set vehicle speed, and starts the control.
lowest vehicle speed	·	The set lower limit vehicle speed is set to approximately 27 mph (43 km/h). If the vehicle is being driven below the set lower limit vehicle speed, the system will not accept the driver's set operation. If the vehicle speed drops below the set lower limit vehicle speed while the SET/- switch is ON, the system automatically cancels its control.
high speed limit	·	The high-speed limit is set to approximately 125 mph(200 km/h). If the vehicle is traveling at a speed higher than the high-speed limit, the system will not memorize the set vehicle speed. Likewise, the driver cannot increase the speed by setting a speed higher than the high speed limit through the operation of the RESUME/+ switch.
Constant-speed control	·	The ECU compares the present driving speed against the set vehicle speed. Then, it regulates the position of the throttle control valve by actuating the throttle control motor in order to approach the set vehicle speed.

Control name		Control contents
Acceleration control	·	If the driver continues to push the RESUME/+ switch ON while the vehicle is being driven in the constant-speed control mode, the ECU increases the vehicle speed by actuating the throttle control motor in the direction to open the throttle control valve. Then, the ECU memorizes the vehicle speed that existed at the time the driver had released the switch OFF as the set vehicle speed, and transfers to the constant-speed control mode.
	·	If the vehicle speed exceeds the high-speed limit {approximately 125 mph(200 km/h)} while the driver is operating the RESUME/+ switch, the ECU memorizes the high-speed limit speed as the set vehicle speed, and transfers to the constant-speed control mode.
	·	If the driver momentarily (below approximately 0.5 seconds) presses the RESUME/+ switch ON while the vehicle is being driven in the constant-speed control mode, the ECU increases the set vehicle speed by approximately 5 mph (5 km/h) with each pressing of the switch (this is called a "tap-up" function). However, the ECU will not change the set speed through the tap-up function if the difference between the set speed and the present vehicle speed is greater than approximately 3 mph(5 km/h).
Deceleration control	·	If the driver continues to push the SET/- switch ON while the vehicle is being driven in the constant-speed control mode, the ECU decreases the vehicle speed by actuating the throttle control motor in the direction to close the throttle control valve. The ECU applies a vehicle speed reduction update by using the vehicle speed that existed at the time the driver had released the switch OFF as the set vehicle speed. Then, the system transfers to the constant-speed control mode.
	·	While the driver operates the SET/- switch, and the vehicle speed exceeds the high-speed limit speed due to a downhill slope, and the driver subsequently releases the switch OFF, the ECU memorizes the high-speed limit speed as the set vehicle speed and transfers the system to the constant-speed control mode.
	·	If the driver momentarily (below approximately 0.5 seconds) presses the SET/- switch ON while the vehicle is being driven in the constant-speed control mode, the ECU decreases the set speed by approximately 5 mph (5 km/h) with each pressing of the switch (this is called a "tap-down" function). If the difference between the memorized speed and the driving speed is above approximately 3 mph (5 km/h), the ECU memorizes the vehicle speed at the time the driver releases the switch OFF as the set vehicle speed. Then, the ECU transfers the system to the constant-speed control mode.

Control name		Control contents
Auto cancel control	·	If any of the conditions listed below occurs while the vehicle is being driven in the constant-speed control mode, the ECU deletes the set vehicle speed and cancels the control. In this case, it will indicate a CHECK CRUISE SYSTEM warning on the multi-information display, sound the warning buzzer, illuminate the master warning indicator light, and blink the cruise operation/warning indicator light. Furthermore, the ECU will disable the control until the main switch is turned ON again.
	1	A failure in the vehicle speed signal.
	2	A failure in the throttle control motor.
	3	An open or short circuit in the stoplight switch.
	·	If any of the conditions listed below occurs while the vehicle is being driven in the constant-speed control mode, the ECU deletes the set vehicle speed and cancels the control.
	4	The driving speed drops below approximately 25 mph (40 km/h).
	5	The driving speed drops below approximately 27 mph (43 km/h) while the SET/- switch is turned ON.
	6	The driving speed is approximately 10 mph (16 km/h) less than the memorized speed.
Manual cancel control	·	f any of the signals listed below is input while the vehicle is being driven in the constant-speed control mode, the ECU cancels the control while keeping the set vehicle speed in memory.
	1	"D" position signal is OFF or a gear other than 6th, 5th, or 4th is selected in the "S" mode.
	2	"D" Position Signal OFF or "S" Position is selected (excluding 6,5,4)
	3	CANCEL switch of the cruise control operation switch is ON.
	4	VSC is operating.
	5	Cruise control main switch is OFF (set vehicle speed is deleted).
Resume control	·	Suppose the driver performs a control cancel operation through the foregoing manual cancel controls (except by pressing the main switch OFF) while the vehicle is being driven in the constant-speed control mode. If the driving speed is still above approximately 25 mph (40 km/h), the driver can turn the RESUME/+ switch ON to resume the control at the set vehicle speed that existed at the time the driver performed the control cancel operation. (The control cannot be resumed if the vehicle speed drops below approximately 25 mph (40 km/h) even once after the cancellation.)
Shift down control	·	While the vehicle is being driven in the constant-speed control mode, the transmission might shift down on an uphill slope.
	·	When the system determines that the vehicle has completed the uphill drive, the transmission shifts up automatically after a predetermined length of time has elapsed.

Warning Indication During System Failure

• If the engine ECU detects a failure in the input signals received from various switches, sensors, and ECUs that comprise the system, it will inform the driver of the system failure as follows.

List of System Failure Warning Indications

• Blinks the cruise operation/warning indicator light in the combination meter. • Illuminates the master warning indicator light in the combination meter. • Sounds the warning buzzer. • Indicates a warning item on the multi-information display in the combination meter.

• he illumination and the blinking of the lights and the indication of the display will be unlit when the cruise control switch is turned OFF.

Indication of results of diagrosis of system failure location

• If the display indicates a warning in the event of a failure in the system, a technician can access the location of the failure in the system, which is stored in the memory of the engine ECU, by operating the diagnosis function.

• The location of the failure in the system is indicated on the multi-information display or through the use of the check mode of the Intelligent tester II diagnosis tool.

List failure diagnosis result indication

code No.	diagnosis result	mode
21	• Open circuit in vehicle speed signal	Vehicle-to-vehicle distance Control mode/Constant Speed Control Mode
23	• Interruption or noise in vehicle speed signal	Vehicle-to-vehicle distance Control Mode
52	• Open or short circuit in stoplight switch	
54	• Failure in stoplight switch input circuit • Failure in cancel circuit	
61	• Failure in communication between distance control ECU and engine ECU	
62	• Failure in communication between engine ECU and distance control ECU	
63	• Failure in distance control ECU	
64	• Failure in communication between skid control ECU and engine ECU	
65	• Failure in communication between engine ECU and skid control ECU	
66	• Failure in warning buzzer	
69	• Failure in brake system	
77	• Disruption in communication between engine ECU and distance control ECU	
78	• Disruption in communication between engine ECU and skid control ECU	
79	• Failure in communication with steering sensor	
80	• Failure in communication with yaw rate sensor & Deceleration sensor	
81	• Disruption in communication between distance control ECU and engine ECU	
82	• Disruption in communication between skid control ECU and engine ECU	

The Notes On Dynamic Radar Cruise Control System (Vehicle-To-Vehicle Distance Control Mode) Handing

- Use this system on highways or other roads used exclusively by automobiles, where it is easy to maintain the proper vehicle-to-vehicle distance between your vehicle and the vehicle ahead.
- Do not put too much trust in the vehicle-to-vehicle control mode of the Dynamic radar cruise control system because the performance of this system is limited.
- While driving, always pay attention to the vehicle-to-vehicle distance between your vehicle and the vehicle ahead, as well as the conditions of your surroundings. Ensure safe driving by pressing on the brake pedal to decelerate or pressing the accelerator pedal to accelerate, thus maintaining the proper vehicle-to-vehicle distance between your vehicle and the vehicle ahead or behind, as the situation may require.
- This system does not automatically apply the brakes until the vehicle comes to a stop.
- Although this system applies the brakes automatically, its deceleration control is limited. If the vehicle ahead of you decelerates suddenly or if a vehicle cuts in front of you, you might not be able to decelerate sufficiently, and you will get very close to the vehicle ahead. In this case, the system issues a warning through an indication on the multi-information display and the sounding of the buzzer.
- This system is not intended to help you if you take your eyes off the road or you are driving carelessly without paying attention to the road ahead of you.
- Do not operate the Dynamic radar cruise control system under the conditions given below. Failure to observe this precaution could lead to an unforeseen accident. In addition, the Dynamic radar cruise control system may cancel itself automatically if the system has detected foul weather.
- Foul weather conditions: rain, fog, snow, or sandstorm

  • In these conditions, the system might not be able to correctly measure the vehicle-to-vehicle distance between your vehicle and the vehicle ahead. If you operate the wipers at the HI speed, the Dynamic radar cruise control system will cancel automatically and assume the set standby state. (It will not cancel if the wipers are operated at the intermittent or LO speed.)

- Roads with heavy traffic or sharp curves

  • These conditions prevent the vehicle from operating at speeds that suit the road conditions, and could lead to an unforeseen accident.

- Slippery road surfaces that are frozen or covered with snow

  • The wheels can spin causing you to lose control of the vehicle.

- Steep downhill

  • If there are no vehicles ahead, your vehicle will exceed the set speed because it cannot apply the engine brake adequately, which could lead to an unforeseen accident. (In this case, the system will not effect brake control.) Even if there is a vehicle ahead, and the system is applying follow control, a timing lag in deceleration could lead to an unforeseen accident.

- Stop-and-go traffic

  • These conditions prevent the vehicle from operating at speeds that suit the traffic conditions, and could lead to an unforeseen accident.

- Entering an interchange, parking area, or service area from a highway (away from the main traffic lane)

  • If your vehicle is traveling on the main traffic lane and is following a vehicle that is slower than the vehicle speed that is set by the Dynamic radar cruise control system, there will be no vehicle ahead if you exit the main traffic lane. Then, your vehicle will accelerate to the set vehicle speed, which could lead to an unforeseen accident.

- Roads with frequent sharp uphills and downhills

  • These conditions prevent the system from detecting the vehicles ahead, or approach them too closely, and lead to an unforeseen accident.

- This system effects control primarily by detecting the radiowaves that are reflected by the rear end of a vehicle. For this reason, it is unable to maintain the proper vehicle-to-vehicle distance because it is incapable of correctly detecting the vehicle ahead in the situations listed below.

  • The vehicle ahead is traveling in your lane or another lane while swirling up water or snow on the road.
  • The vehicle ahead is an unladen trailer, which has an extremely small area at its rear end.
  • Your vehicle is tilting significantly due to an extremely heavy load in the luggage compartment or rear seats.

- The millimeter wave radar sensor is equipped with an automatic function to determine whether its front surface is dirty and inform the driver. However, this function is not omnipotent. In some conditions, it might not be able to detect that the sensor is dirty. Also, it might not be able to detect if a cookie bag containing aluminum foil, ice, icicle, or snow gets stuck on the sensor.

  • Always pay attention to the area ahead of you because the system will be unable to maintain the proper vehicle-to-vehicle distance under these conditions. If the system has detected that the sensor is dirty, it will automatically cancel the Dynamic radar cruise control system. Always keep the front surface of the sensor and the grille cover for the millimeter wave radar sensor clean.

- Depending on the shape of the road (corners, roads with continuous right and left corners, entrances and exits to corners, a road with narrow lanes due to road work or lane restriction) or the condition of your vehicle (unstable driving conditions due to steering maneuvers, position of the vehicle in the lane, accident, or breakdown), the system may momentarily detect the vehicles in the adjacent lanes or peripheral objects. In these conditions, the system may activate the control or approach warning, may momentarily fail to detect the vehicle ahead, and approach the vehicle ahead.
- The Dynamic radar cruise control system will not effect control or issue an approach warning on stopped vehicles or vehicles that are extremely slower than your vehicle. Therefore pay particular attention to a vehicle that is stopped at a toll booth, at the tail end of congested traffic, or is extremely slow.
- In the near distance, the detection area of the radar sensor is narrow. Therefore, the system might be slow to detect a vehicle ahead that cuts in front of you at the last minute, or unable to detect a motorcycle that is traveling along the edge of your lane, and is thus unable to maintain the proper vehicle-to-vehicle distance.
- Keep the main switch OFF if you are not using the Dynamic radar cruise control system. Failure to observe this precaution could cause the Dynamic radar cruise control system to operate improperly, which could lead to an unforeseen accident.
- When your vehicle is operating in the follow control mode, the system controls the vehicle speed to match the vehicle ahead. Therefore, it will not accelerate even if you attempt to increase the set vehicle speed by operating the RESUME/+ switch. However, because the set vehicle speed is relatively high at this time, your vehicle could continue accelerating once the vehicle ahead is gone. Therefore, check the set vehicle speed indicated on the multi-information display.

● Select the vehicle-to-vehicle distance that matches the traffic conditions.

• As a rule of thumb, the following controlled vehicle-to-vehicle distances apply when your vehicle follows a vehicle ahead at a speed of approx. 50 mph(80 km/h): approx. 50 meters(175 foot) for "long", approx. 40 meters(132 foot) for "medium", and "approx. 30 meters(100 foot) for "short". The slower the vehicle speed, the shorter the vehicle-to-vehicle distance will be than the foregoing.

● When you are driving on a long downhill slope, the controlled vehicle-to-vehicle distance might become shorter than the set vehicle-to-vehicle distance.

● Do not operate the Dynamic radar cruise control system in a situation in which the approach warning buzzer sounds frequently.

● Under the conditions indicated below, the approach warning buzzer might not sound even if the vehicle-to-vehicle distance becomes short.

• The relative speed between your vehicle and the vehicle ahead is low (traveling at almost the same speed).
• The vehicle ahead is traveling faster than your vehicle (the vehicle-to-vehicle distance is increasing gradually).
• Immediately after performing a set operation.
• While you are pressing the accelerator pedal or immediately after you have released the accelerator pedal.

● Ordinarily, when your vehicle is operating in the follow control mode, the radar Dynamic cruise control system (vehicle-to-vehicle control mode) automatically accelerates and decelerates your vehicle to match the speed of the vehicle ahead. If you need to accelerate to change lanes, press the accelerator pedal to accelerate the vehicle. If the vehicle ahead decelerates suddenly, or another vehicle cuts in front of you, causing you to approach the vehicle ahead, press the brake pedal to decelerate or press the accelerator pedal to accelerate.

● While you are operating your vehicle with the Dynamic radar cruise control system, and the cruise operation/warning indicator light in the combination meter blinks, the master warning indicator light illuminates, and the multi-information display indicates a warning item together with a "bong" sound, turn the main switch OFF once. Then, set it again.

• If you are unable to set a vehicle speed by performing the foregoing operations, or if it gets canceled immediately after you have set it, the Dynamic radar cruise control system may be malfunctioning. This will not affect your ordinary driving, but you should take it to a dealer to have it inspected.

● To operate the Dynamic radar cruise control system correctly, observe the following precautions.

• Always keep the front surface of the millimeter wave radar sensor and the front and back surfaces of the grille cover clean.
• Use a soft cloth to clean the window without scratching it.

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● Do not apply strong shocks to the millimeter wave radar sensor and its surrounding area. Do not disassemble the sensor because it could lead to a malfunction or improper operation.

● Do not affix stickers or attach accessories in the periphery of the grille cover of the vehicle equipped with a millimeter wave radar sensor. Do not modify or paint the grille cover, or replace it with a non-genuine part. Failure to observe these precautions can lead to the improper operation of the radar.

● Do not apply strong water pressure to the front surface of the sensor, such as through the use of a high-pressure car wash.

• This will cause moisture to enter the sensor, which will cause the sensor to malfunction.

● Different control methods are used for the vehicle-to-vehicle control mode and the constant-speed control mode. Make sure to check which mode is selected before operating the Dynamic radar cruise control system.

The Notes On Dynamic Radar Cruise Control System (Constant Speed Control Mode) Handing

- When the constant-speed control mode is selected in the Dynamic Dynamic radar cruise control system, the system does not determine whether a vehicle is present ahead, or the vehicle-to-vehicle distance to the vehicle ahead, unlike when the vehicle-to-vehicle control mode is selected. Therefore, the system will not sound the approach warning buzzer. Pay particular attention to the vehicle-to-vehicle distance to the vehicle ahead.

  • If necessary, decelerate the vehicle using the engine brake or foot brake after performing a cancel operation.

- Do not operate the constant-speed mode of the cruise control system under the conditions listed below. Failure to observe this precaution could lead to an unforeseen accident.

  • Keep the main switch OFF if you are not using the constant-speed control mode of the cruise control system.
  • Pay particular attention to the increase in the vehicle speed when you drive the vehicle downhill under the control of the constant-speed control mode of the cruise control system. (If the vehicle speed gets too high, cancel the cruise control. Then, apply the engine brake by shifting down, in order to decelerate the vehicle.)

- After the constant-speed control mode of the cruise control system has been canceled, press the RESUME/+ switch to resume control. While driving at a constant speed with cruise control, press the RESUME/+ switch to increase the speed (acceleration control).
- If the cruise operation/warning indicator light blinks while driving in the constant-speed control mode of the cruise control system, turn the main switch OFF. Then, perform the set operation again.

  • If you are unable to set a vehicle speed, or if it gets canceled immediately after you have set it, the Dynamic Dynamic radar cruise control system may be malfunctioning. This will not affect your ordinary driving, but you should take it to a dealer to have it inspected.

- Do not operate the vehicle with the constant-speed control mode of the cruise control system under any of the conditions listed below. Failure to observe this precaution may prevent the vehicle from operating at a speed that suits the road conditions, or the wheels may spin, causing you to lose control of the vehicle, and lead to an unforeseen accident.

  • Road with heavy traffic.
  • Steep downhill.
  • Sharp curve.
  • Frozen or snow-covered road.
  • Other slippery road surfaces.

MULTIPLEX COMMUNICATION SYSTEM

Gateway ECU

- The gateway ECU contains the three types of communication circuits (CAN, BEAN, and AVC-LAN) whose communication protocols differ.

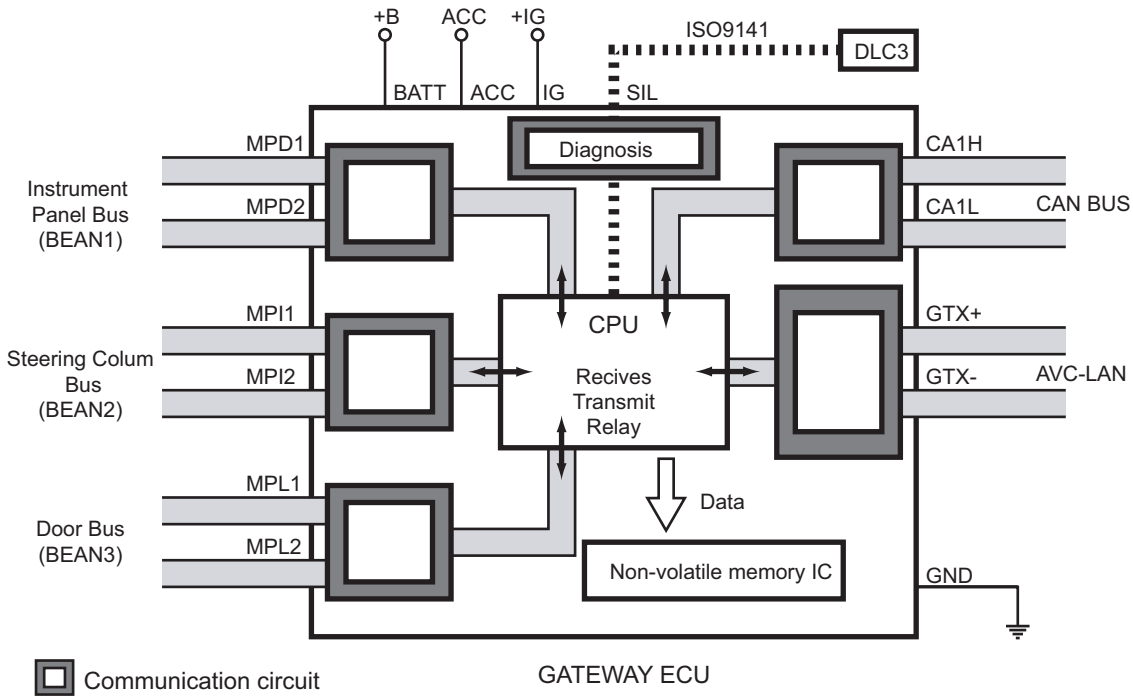
Communication specification

	CAN	BEAN	AVC-LAN
Communication Speed	500kbps	10kbps	17.8kbps
Communication Wire	Twisted-pair Wire	AV Single Wire	Twisted-pair Wire
Drive Type	Differential Voltage Drive	Single Wire Voltage Drive	Differential Voltage Drive
Length of data	1~8Byte(Variable)	1~11Byte(Variable)	0~32Byte(Variable)

- The gateway ECU receives data from the buses and transmits it to other buses. While doing so, it converts the data to suit the communication protocols used by the receiving buses.
- The gateway ECU provides a function to act as a relay for the communication of the diagnosis system* [ISO 9141] and the communication of the buses. The high-level diagnosis system supports the ECUs to ensure superior serviceability.

❖REFERENCE❖

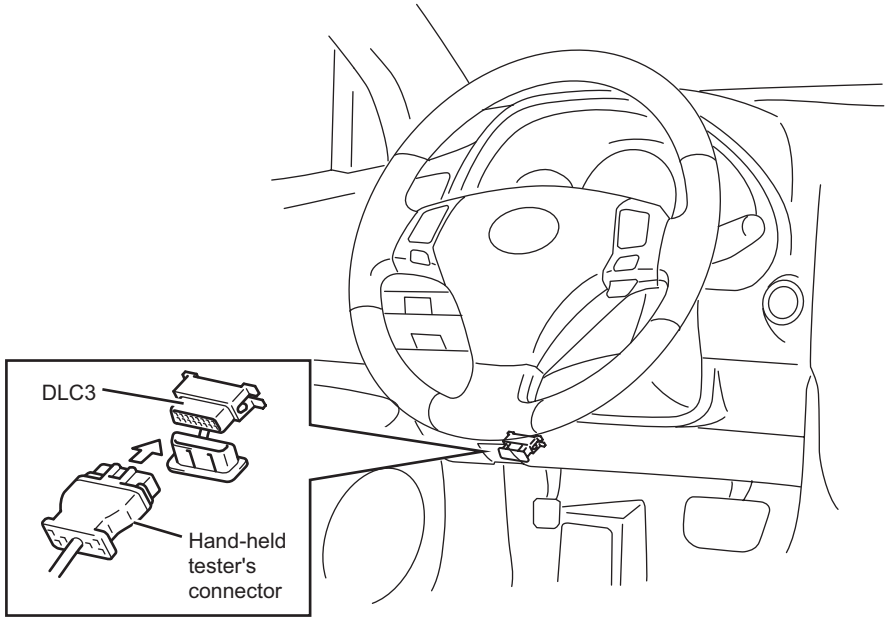
*Serial communication used for diagnosis data communication between a hand-held tester diagnosis tool and the onboard ECUs, in compliance with the ISO (International Organization for Standardization).



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DLC3(Data Link Connector 3)

- By connecting a Intelligent tester II diagnosis tool to the DLC3 connector (Data Link Connector No. 3) on the vehicle, a technician can gain access to the ECUs via the gateway ECU and the various types of multiplex communication lines. This enables the technician to output the DTCs (Diagnostic Trouble Codes), monitor data (by checking ECU data), perform active tests (by operating the actuators at will), and customize the functions (by changing the settings of the control program). For details, refer to the repair manual.
- Along with the use of the CAN (Controller Area Network), the terminals of the DLC3 connector have been partially changed.



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Customizable Function

- By connecting an Intelligent Tester II diagnosis tool to the DLC3 connector and overwriting the non-volatile memory IC that is built into the ECUs, a technician is able to adjust various types of functions (by changing their setting values).

Customizable mode

ECU	Contents	Set up(The initial setting is the prefix)
Front Air Conditioner ECU Heater & Air Conditioner-Air Conditioner Communication System		

ECU	Contents	Set up(The initial setting is the prefix)
	• Adjusting the set temperature [°C]	Standard/+1/+2/-1/-2
	• Adjusting the outside temperature indication value [°C]	Standard/+1/+2/+3/-1/-2/-3
	• Setting the compressor auto mode	With Function /Without Function
	• Setting the inlet auto mode	With Function /Without Function
	• Setting the compressor-inlet DEF-linked control	With Function /Without Function
	• Setting the cool air outlet (footwell outlet in the FACE mode during auto control)	With Function /Without Function
	• DEF airflow volume up control	With Function /Without Function
	• Canceling the FOOT/DEF auto mode	With Function /Without Function
	• Setting the compressor externally variable capacity control	With Function /Without Function
	• Setting the buzzer sound on the air conditioner operation switch	standard/+1/+2/+3/-1/-2/-3
	• Setting whether to operate the air purifier at HI in the AUTO mode	With Function /Without Function
	• Executing the initialization of the step motor after the ignition is turned OFF	Without Function/With Function
Clearance Warning ECU Body & Electrical -The Lexus Parking Assist-sensor(Steering-guided)		
	• Setting the sounding of the clearance sonar warning buzzer and the indication for the farthest distance detection (approx. 100 to 50cm) of the front sensor	With Function /Without Function
	• Setting the sounding of the clearance sonar warning buzzer and the indication for the farthest distance detection (approx. 150 to 60cm) of the back sensor	With Function /Without Function
	• Setting the sounding of the buzzer when the distance of a detected obstacle has not changed over 3 seconds	With Function /Without Function
	• Adjusting the sound volume of the clearance sonar warning buzzer	With Function /Without Function
	• Changing the sonar mode	Steering sensing mode/normal Clearance sonar mode/ Customizable mode
Meter ECU Body & Electrical -Combination Meter system		
	• Setting the speed warning buzzer	Without Function/With Function
	• Key Reminder Buzzer Volume Adjustment	Loud/Medium/Small
	• Adjusting the sounding cycle [ms] of the key confinement warning buzzer	900/600/1200
Right Side J/B ECU Security-Electrical Door Lock System		
	• Setting the driver's door key twice operation unlock function*4	With Function /Without Function
Security-Wireless Remote Control System		

ECU	Contents	Set up(The initial setting is the prefix)
	• Setting the door lock & unlock, and luggage door open function	With Function /Without Function
	• Setting the number of seconds of the auto lock function operation time [sec]	30/60
	• Setting the answerback (buzzer sounding) function	With Function /Without Function
	• Setting the answerback (hazard light blinking) function	With Function /Without Function
	• Setting the door ajar warning function	With Function /Without Function
	• Setting the twice operation unlock functionn*4	With Function /Without Function
Security-Security System(Auto Alarm)		
	• Wireless panic function*3	With Function /Without Function
	• Self power siren function*1	Without Function/With Function
	• Setting the horn sounding function during auto alarm warning*1	With Function /Without Function
Body & Electrical -Lighting System(Illuminated Entry System)		
	• Adjusting the ON time [sec] of the illuminated entry system	7.5/15/30
	• Setting the room illumination ON control by turning the IG (ACC) OFF	With Function /Without Function
	• Setting the room illumination ON control during unlocking	With Function /Without Function
	• Underfoot lighting light function.	With Function /Without Function
	• Setting the room illumination ON control during unlocking	With Function /Without Function
	• Setting and adjusting the ON time [sec] of the door mirror foot illumination	15/7.5/30/0:Without Function
Body & Electrical -Lighting System(Light Control System)		
	• Selecting the taillight ON delay time*2	Standard/More long
	• Adjusting the light control sensor sensitivity [%]	±0/-40/-20/+20/+40
	• Adjusting the display dimming [level] sensitivity (DN: dimming)	Standard/-2/-1/+1/+2
	• Adjusting the display dimming [level] sensitivity (DF: dimming cancel)	Standard/-2/-1/+1/+2
Left Side J/B ECU Body & Electrical -Lighting System(Illuminated Entry System)		
	• Steering wheel illumination light up function	With Function /Without Function
	• Seat illumination light up function	With Function /Without Function
	• Shift knob illumination light up function	With Function /Without Function
Rear J/B ECU Body & Electrical -Wiper & Washer System		
	• Setting the vehicle speed selector function	With Function/Without Function(Function fixed to Lo)
	• Setting and adjusting the washer drip prevention function	With Function/3 second/Without Function
	• Rain detection type wipers yes/no	With Function /Without Function

ECU	Contents	Set up(The initial setting is the prefix)
Body & Electrical-Rear Sunshade System		
	• Setting and adjusting the response time [sec] of the reverse-linked retraction function	0.7/0.9/1.2/0:Without Function
MPX Master Switch Body & Electrical -Power Window system		
	• Setting the door key-linked power window (up) function	With Function /Without Function
	• Setting the door key-linked power window (down) function	With Function /Without Function
	• Setting the transmitter-linked power window (up) function	With Function /Without Function
	• Setting the transmitter-linked power window (down) function	With Function /Without Function
	• Setting the door lock switch-linked power window (up) function	With Function /Without Function
Sliding Roof ECU Body & Electrical -Sliding Roof System		
	• Setting the door key-linked moon roof opening function mechanism	With Function /Without Function
	• Setting the door key-linked moon roof closing function mechanism	With Function /Without Function
	• Setting the transmitter-linked moon roof opening function mechanism	With Function /Without Function
	• Setting the transmitter-linked moon roof closing function mechanism	With Function /Without Function
	• Selecting the door key-linked moon roof operation	Slide/Tilt
	• Transmitter-linked moon-roof operation selection	Slide/Tilt
Certificate ECU Security-SMART ACCESS SYSTEM with PUSH-BUTTON START system		
	• Selecting the door touch sensor-linked unlock mode	All/Front side
	• Adjusting the standby time [sec] for the parking standby state	3.0/1.0/2.0/5.5
	• Setting the luggage door open switch-linked luggage door opening function	With Function /Without Function
	• Warning Setting Against an Occupant Taking Key Outside the Vehicle	With Function /Without Function
	• Warning Setting on Low Capacity of Battery in Key	With Function /Without Function
	• Setting the key out of area warning during ignition operation	With Function /Without Function
Tilt & Telescopic ECU Chassis-Steering Columns		
	• Setting the auto-away operation	With Function /Without Function

❖REFERENCE❖

*1 : The setup cannot be changed for Europe & China.
*2 : The setup cannot be changed for Europe.
*3 : With no function for Europe & China.
*4 : An initial-setting value is nothing for Europe & China.

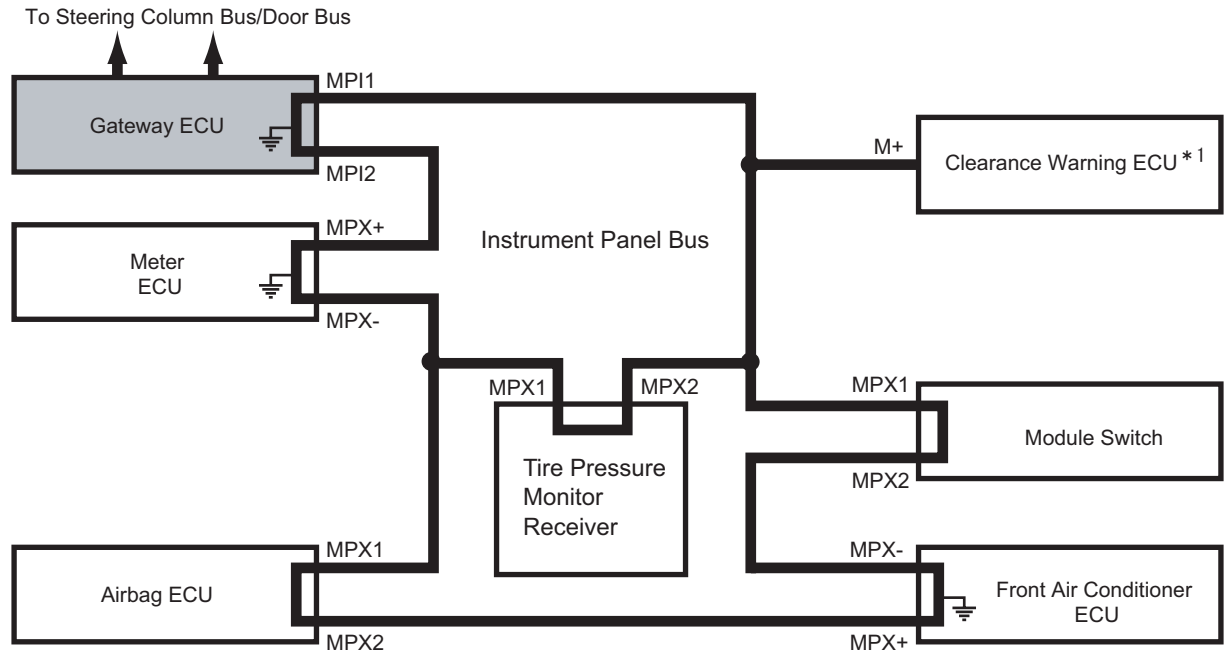
Body Multiplex Communication System[BEAN]

● The BEAN* increases the volume of control data by expanding and making more multifunctional the object of control. In addition, it is a multibus body electronics area network consisting of a network of three systems (instrument panel system, column system, door system). This reduces the number of wires in the wiring harness and reduces the thickness of the electronic control system.

❖REFERENCE❖

*BEAN = Body Electronics Area Network (Toyota Motor Corporation's proprietary bi-directional multiplex communication network used among the ECUs for body system control)

BEAN System Diagram (Instrument Panel Bus)



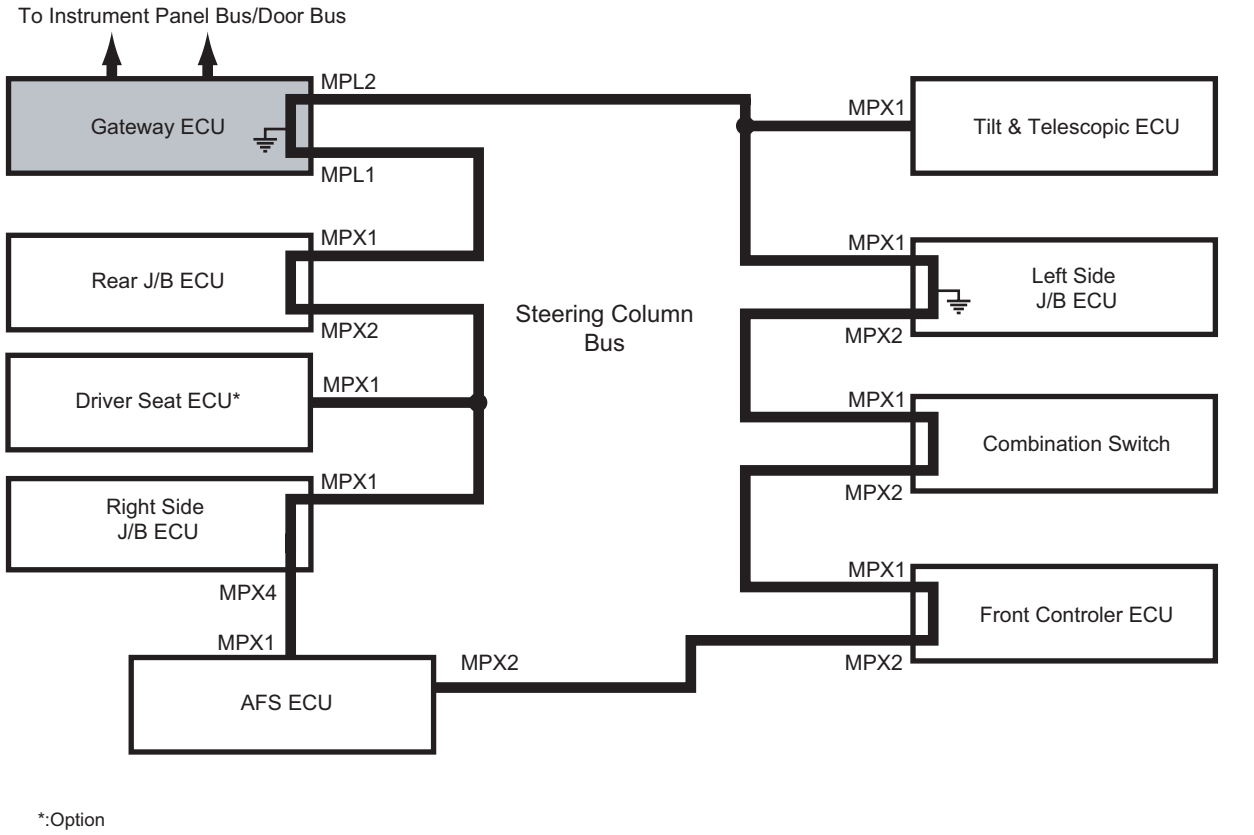
*1 :Option

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Multiplex communications control ECU list(Instrument Panel Bus)

ECU & Switch	Function
Airbag ECU	Supplies Airbag operation and other operation data
Clearance Warning ECU	Controls the Clearance sonar system
Meter ECU	Controls the Combination meter system
Front Air Conditioner ECU	Controls the Heater & Air Conditioner system·window defogger system
Tire Pressure Monitor Receiver	Monitors the tire air pressure
Module Switch	Centralized switch for combination meter, outer mirror, and other operation

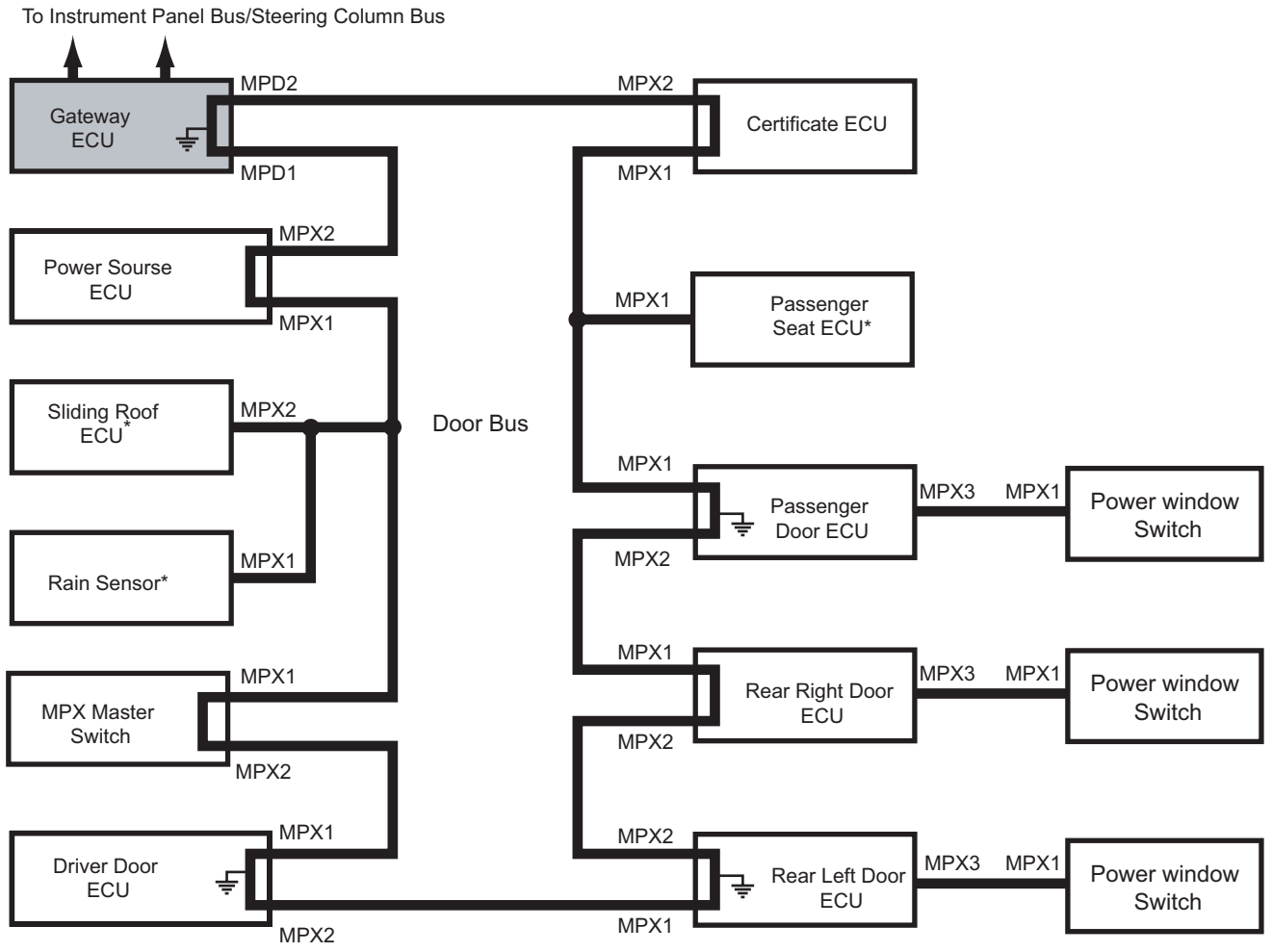
BEAN System Diagram (Steering Column Bus)



Multiplex communications control ECU list(Steering Column Bus)

ECU & Switch	function
Right Side J/B ECU	Controls the Power window ·Electrical door lock ·Security system
Left Side J/B ECU	Controls the Wiper & Washer ·Illuminated entry system
Front Controler ECU	Controls the Lighting(Front circumference lamp)·Washer system·Horn
Rear J/B ECU	Controls the Lighting(Rear circumference lamp)
Driver Seat ECU	Controls the Microcomputer preset driving position system
AFS ECU	Controls the Intelligent AFS system
Combination Switch	Supplies lighting, wiper, and other switch operation data.
Tilt & Telescopic ECU	Controls the Microcomputer preset steering columns system

BEAN System Diagram (Door Bus)



* :option

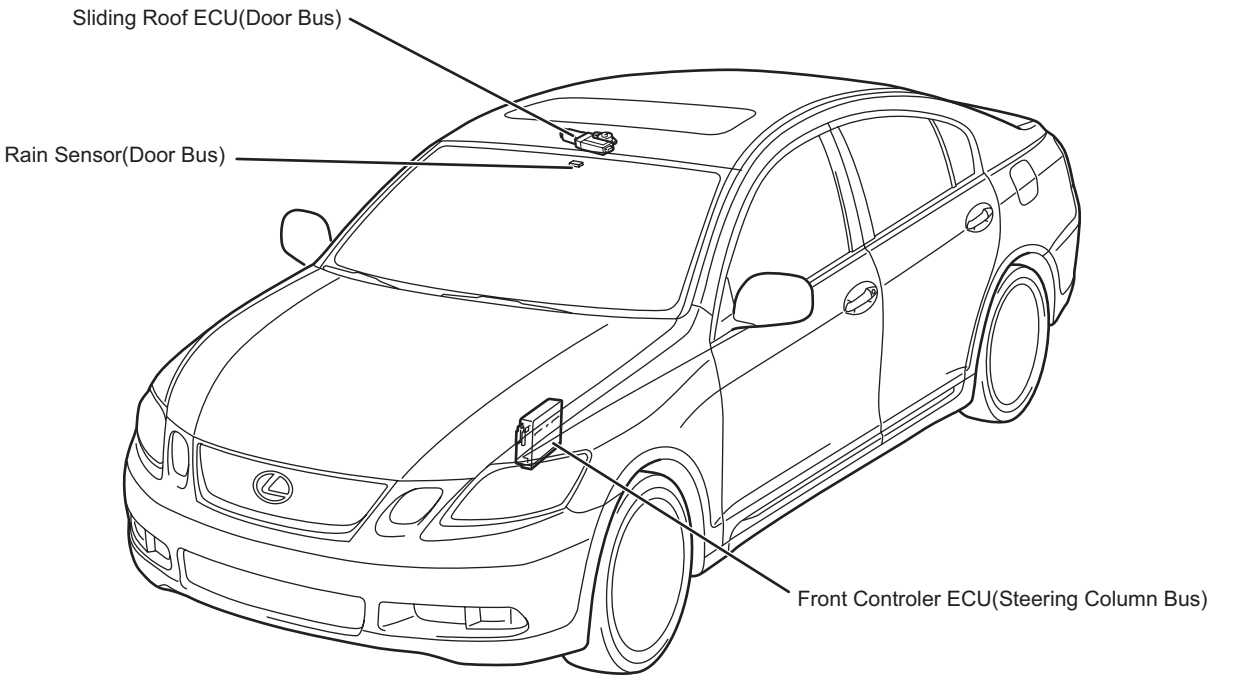
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Multiplex communications control ECU list(Door Bus)

ECU	Function
Driver Door ECU	Controls the corresponding seat's window regulator and door lock assembly.
Passenger Door ECU	
Rear Right Door ECU	
Rear left door ECU	
MPX Master Switch	Controls the Power window system
Passengers Seat ECU	Controls the Microcomputer preset driving position system
Rain Sensor	Detects rain on the windshield
Certificate ECU	Controls the Smart entry & start system
Sliding Roof ECU	Controls the Sliding roof system
Power Sourse ECU	Controls the Push button start system

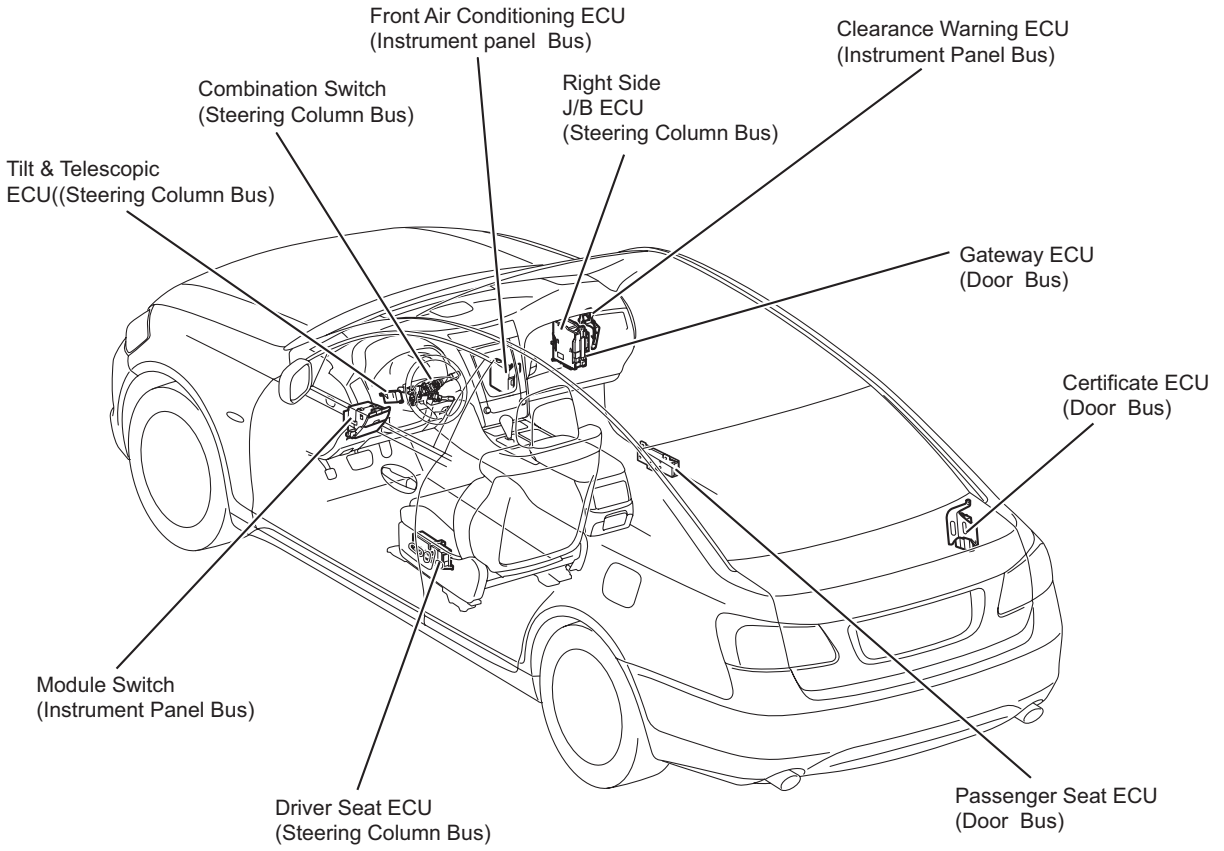
Layout of Component

Layout of BEAN component 1



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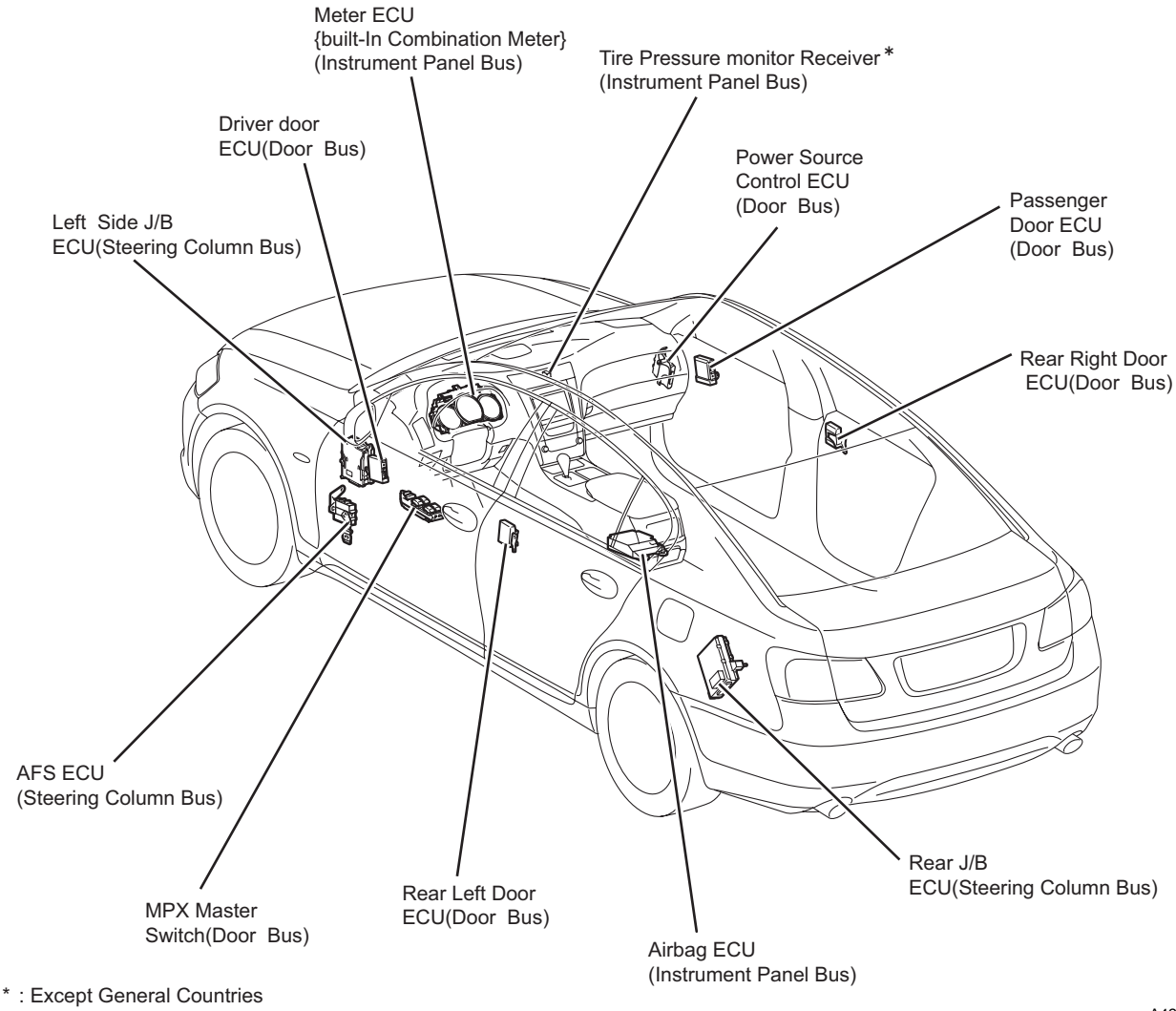
Layout of BEAN component 2



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CM

Layout of BEAN component 3



* : Except General Countries

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Communication Frame

- The Body Electronics Area Network [BEAN] system is a time division multiplex bi-directional communication system that enables all the ECUs that comprise the network to transmit or receive data by staggering their time, using a single communication line (bus). Therefore, the ECUs operate in accordance with a common communication protocol to ensure smooth and reliable communication.
- he data used in the Body Electronics Area Network system consists of digital signals containing information such as priority (PRI), destination (DST-ID), data type (MES-ID), etc. The BEAN communication circuits that are built into the ECUs transmit these signals at a speed of 10 kbps*.

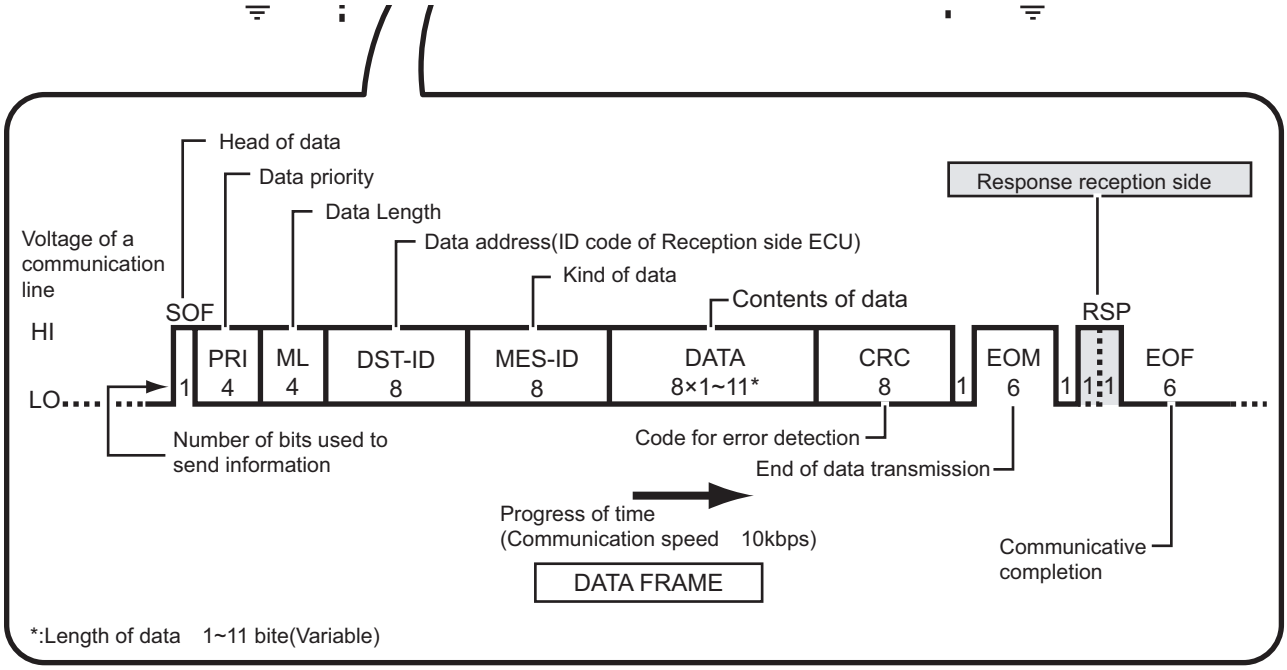
❖REFERENCE❖

*A unit that indicates the transmission speed of signals. The "10 kbps" indicates that 10,000 bits of data are transmitted per second.

• The BEAN communication uses the CSMA/CD (Carrier Sense Multiple Access with Collision Detection)* communication protocol for transmitting data to a communication line. This protocol enables all ECUs to share a single communication line while granting them the right to start transmitting data. Furthermore, this system determines their transmission priority in accordance with the priority (PRI) information contained in the respective transmitted data.

❖REFERENCE❖

*Carrier Sense Multiple Access with Collision Detection - Controls communication access by allowing the ECUs to constantly monitor the state (carrier waves) of the communication line, and start data transmission only when there is no other data present on the communication line. In addition, if an ECU detects a data collision (because another ECU has transmitted data simultaneously), this control allows the ECU to stand by for a predetermined length of time, and transmit the data again.



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Sleep & Wakeup Function

• When an ECU that does not stop its control with the ignition turned OFF (because it operates with the +B power supply) detects certain conditions indicating that the user has left the vehicle, it effects sleep control (by transferring to the low current consumption mode) in order to reduce dark current*.

❖REFERENCE❖

*When an ECU detects the conditions indicating that the user is near the vehicle in accordance with the signals from sensors and switches, it transmits a "sleep NG signal" to the ECUs that are related to the control. This prevents them from transferring to the sleep control and enables the BEAN (Body Electronics Area Network) to continue its control.

• When any one of the ECUs under sleep control detects a "control start condition" that is prescribed to the individual ECUs, that ECU will transmit a "wakeup signal" to other ECUs via the Body Electronics Area Network communication line, in order to start the entire Body Electronics Area Network system.

Fail-Safe

• The communication line forms a loop (except in a certain area) to prevent communication from being disrupted in case an open circuit occurs in one area.

• The ECUs are equipped with a backup control function that enables the ECUs to continue control in case of a disruption in communication with other ECUs related to control.

CAN COMMUNICATION SYSTEM

CAN(CONTROLLER AREA NETWORK)

- The CAN (Controller Area Network)* [ISO 11898] communication system, which uses a pair of communication wires (twisted pair wiring) to transmit multiple pieces of information or data that have been converted into digital signals via a communication circuit, is used. Compared to a system that connects the input devices (sensors, switches, etc.), control units, and output devices (motors, etc.), this network uses a fewer number of wiring harnesses and makes for a leaner electronic control system.

❖REFERENCE❖

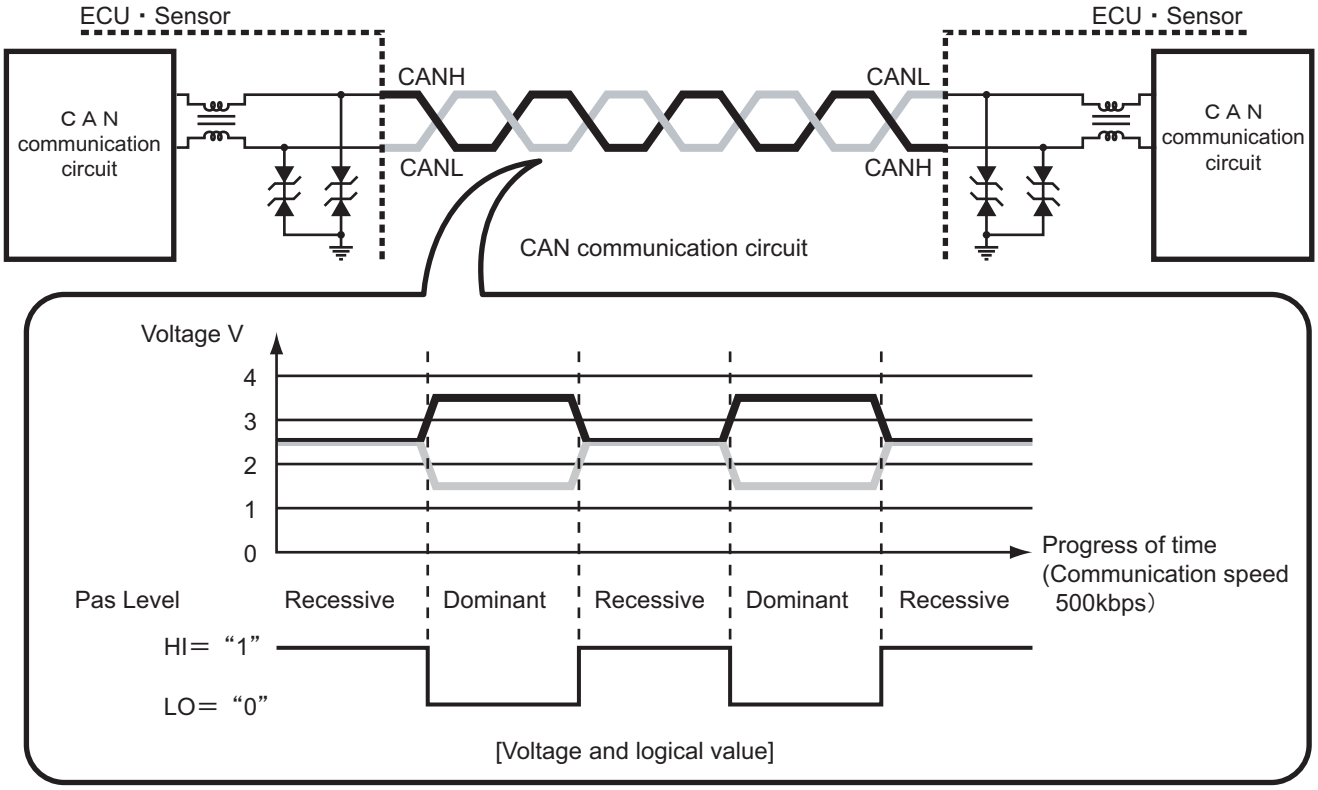
* : CAN is an abbreviation for Controller Area Network, a serial communication network that complies with the ISO (International Organization for Standardization) standards.

- In the CAN communication system, two communication wires (buses), the CAN High, and CAN low, form a pair. The level*1 of a bus is determined by its differential voltage. The system converts this voltage into a digital signal that complies with a dedicated communication protocol and transmits it at a speed of 500 kbps*2.

❖REFERENCE❖

*1 : Bus levels are either dominant or recessive. Theoretically, the CAN communication system determines the dominant level as "0" and the recessive level as "1".

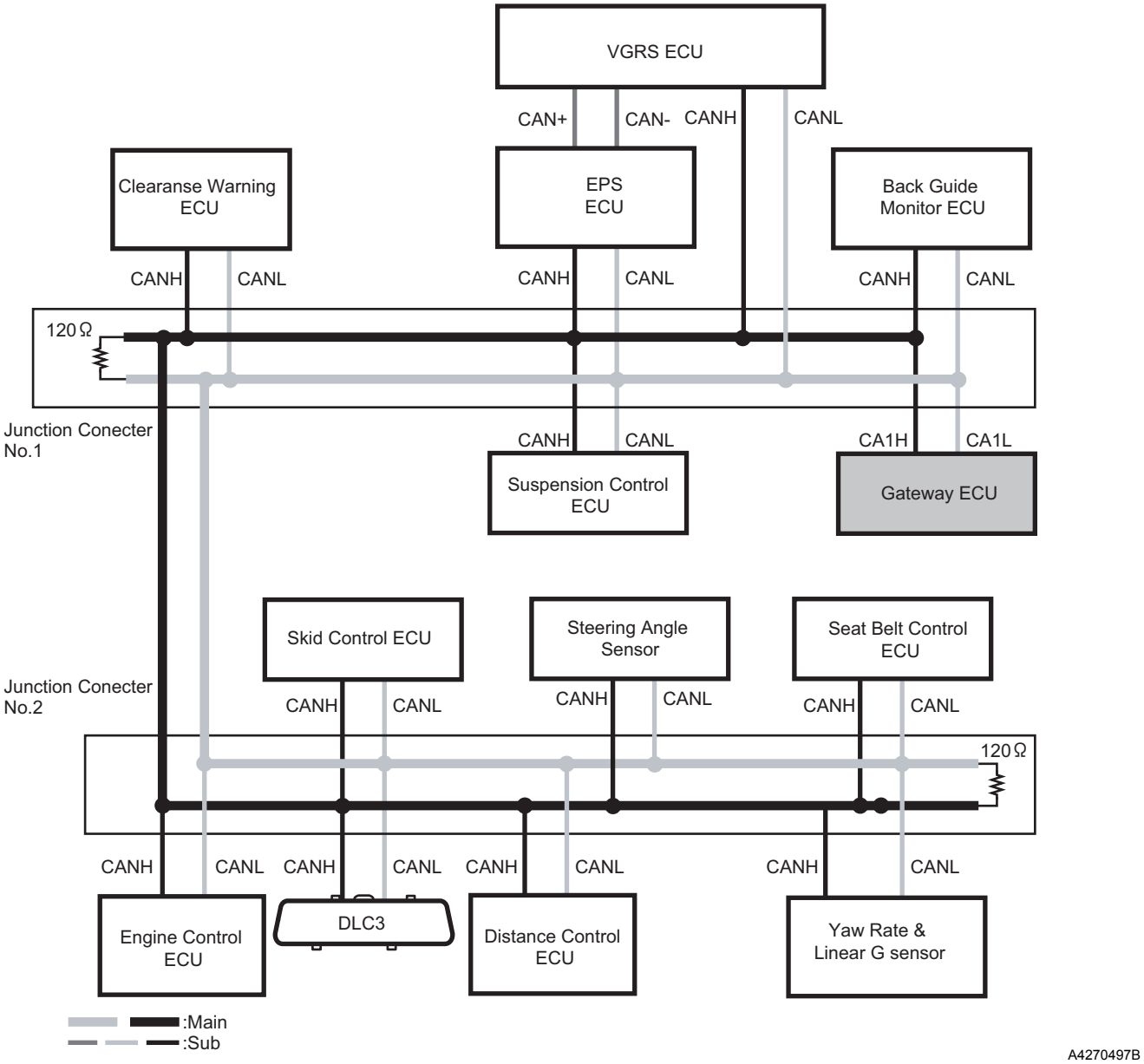
*2 : A unit that indicates the transmission speed of signals. The "500 kbps" indicates that 500,000 bits of data are transmitted per second.



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CAN Communication Network

- The CAN communication system consists of a bus type network configuration in which multiple ECUs are connected to a single, common communication line. The CAN communication line is the main line (common communication line) that connects junction connectors No. 1 and No. 2.
- A termination resistor (120Ω) is provided on the bus main line, enabling the differential voltage to be determined from the network that is wired into a loop.

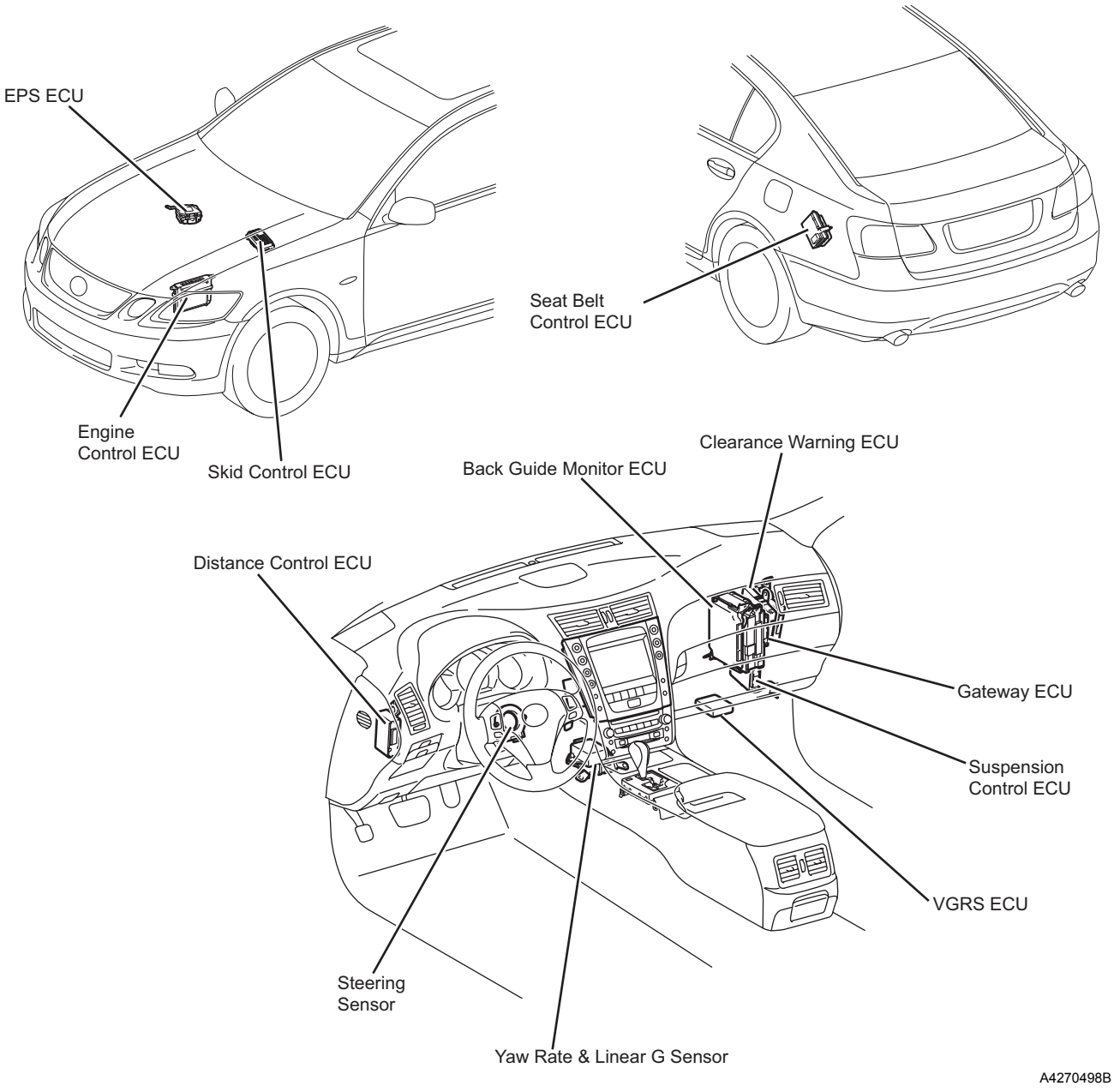


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Computer & Sensor corresponding to CAN communication system

Computer & Sensor	Function
Skid Control ECU	• Controls the ABS, brake assist, etc.
Traction Control ECU	• Controls the torque distribution for the front and rear wheels.
Yaw Rate & Linear G sensor	• Detects the deceleration speed of the vehicle proper in the fore-aft and side-to-side directions.
Distance Control ECU	• Effects vehicle-to-vehicle control in the Dynamic radar cruise control system.
Gateway ECU	• Relays data between the CAN communication and various types of onboard multiples communication.
Seat Belt Control ECU	• Controls the pre-crash seat belt.
EPS ECU	• Controls the electric power steering system.
VGRS ECU	• Controls the Variable gear ratio steering system.
Steering Angle sensor	• Detects the steering angle and direction of the steering wheel.
Engine ECU	• Provides data such as engine speed.
Back Guide Monitor ECU	• Controls the back guide monitor system.
Clearanse Warning ECU	• Controls the clearance sonar system .
Suspension Control ECU	• Controls the electronically controlled air suspension.
DLC3(Data link connector No.3)	• Inspection of the CAN communication with the diagnosis tool (Intelligent tester II). • Enables the continuity inspection of the CAN communication bus through the use of a Toyota electrical tester.

Layout of Component



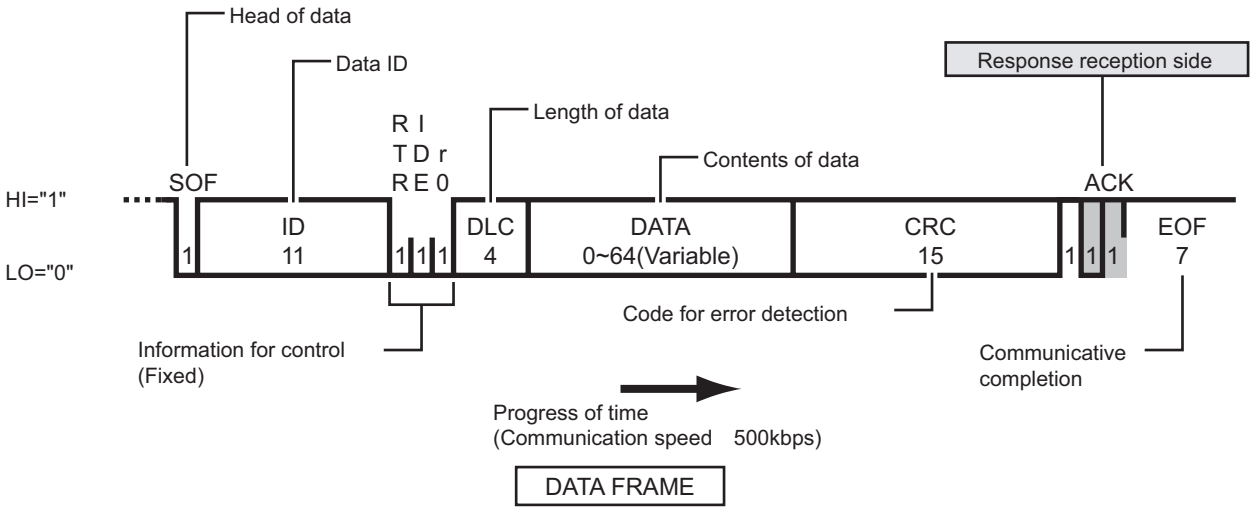
Communication Frame

- The CAN communication system is a time division multiplex bi-directional communication system that also enables all the computers (ECUs) and sensors that comprise the network to transmit data by staggering their time, using a pair of communication lines (bus). Therefore, the ECUs and sensors operate in accordance with a common communication protocol to ensure smooth and reliable communication.
- The CAN communication uses the CSMA/CD (Carrier Sense Multiple Access with Collision Detection) communication protocol*. This protocol enables all ECUs and sensors to share a pair of communication lines while granting them the right to start transmitting data.

❖REFERENCE❖

*Carrier Sense Multiple Access with Collision Detection - Controls communication access by allowing the ECUs to constantly monitor the state (carrier waves) of the communication line, and start data transmission only when there is no other data present on the communication line. In addition, if an ECU detects a data collision (because another ECU has transmitted data simultaneously), this control allows the ECU to stand by for a predetermined length of time, and transmit the data again.

- Each ECU or sensor starts transmitting data when there is no other data present on the CAN bus. If two or more ECUs or sensors start transmitting simultaneously, this system determines their transmission priority in accordance with the ID information contained in the respective transmitted data.
- The pieces of data used in the CAN communication system comprise a single frame, each containing the following: ID, DLC, DATA, CRC, and ACK.



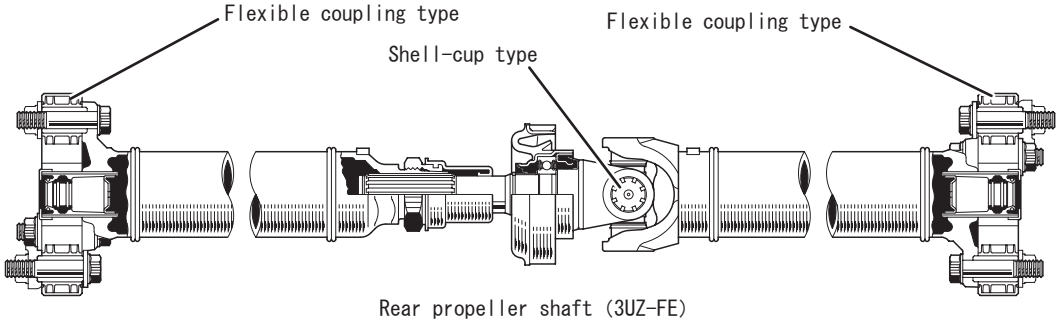
Note: he numbers in the frame indicate the number of bits that are used for transmitting information.

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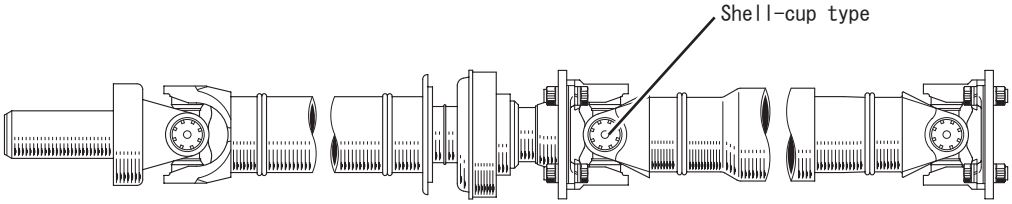
PROPELLER SHAFT

Propeller Shaft

● A flexible coupling type, three-joint propeller shaft is used at the rear of the models with the 3UZ-FE engine. A compact, lightweight, shell cup type three-joint propeller shaft is used at the rear of the models with the 3GR-FSE and 3GR-FE engine.



Rear propeller shaft (3UZ-FE)



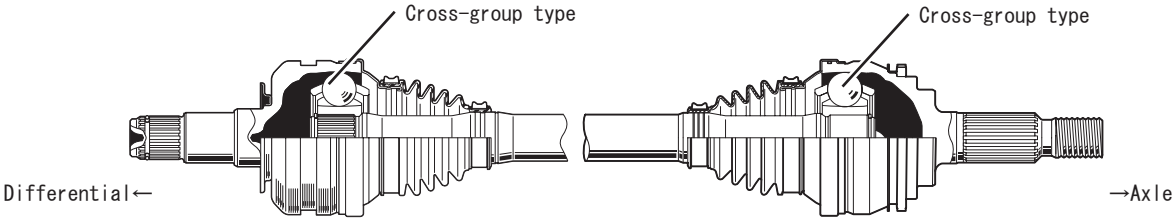
Rear propeller shaft (3GR-FSE, 3GR-FE)

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DRIVE SHAFT

Drive Shaft

● For the rear, compact, lightweight, cross groove type constant velocity joints are used. A type that couples directly to the rear differential is used for weight reduction.



Rear drive shaft

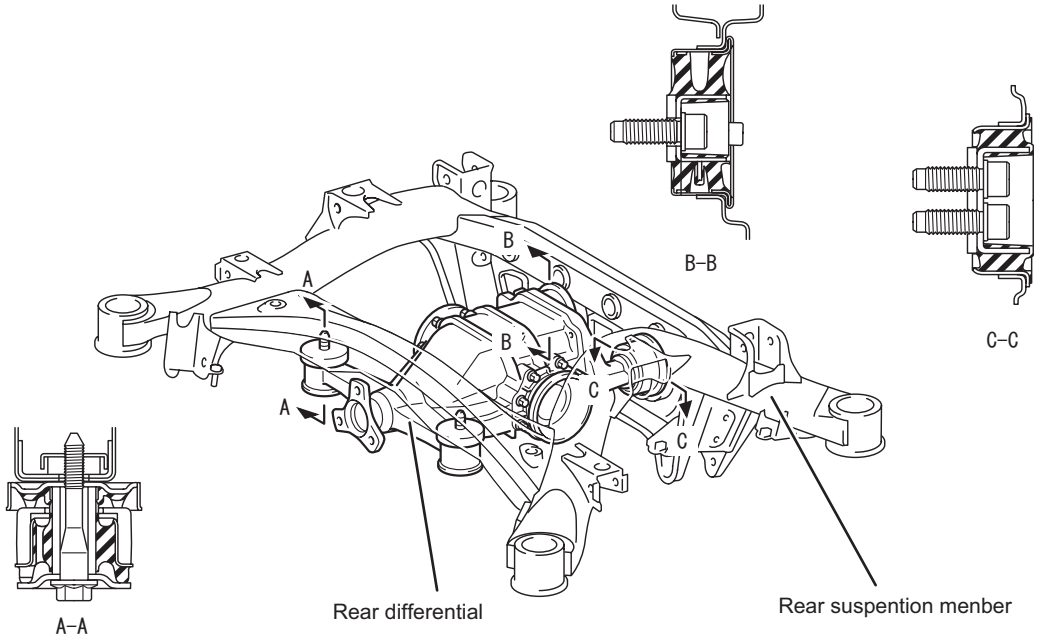
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DIFFERENTIAL

Rear Differential Mount

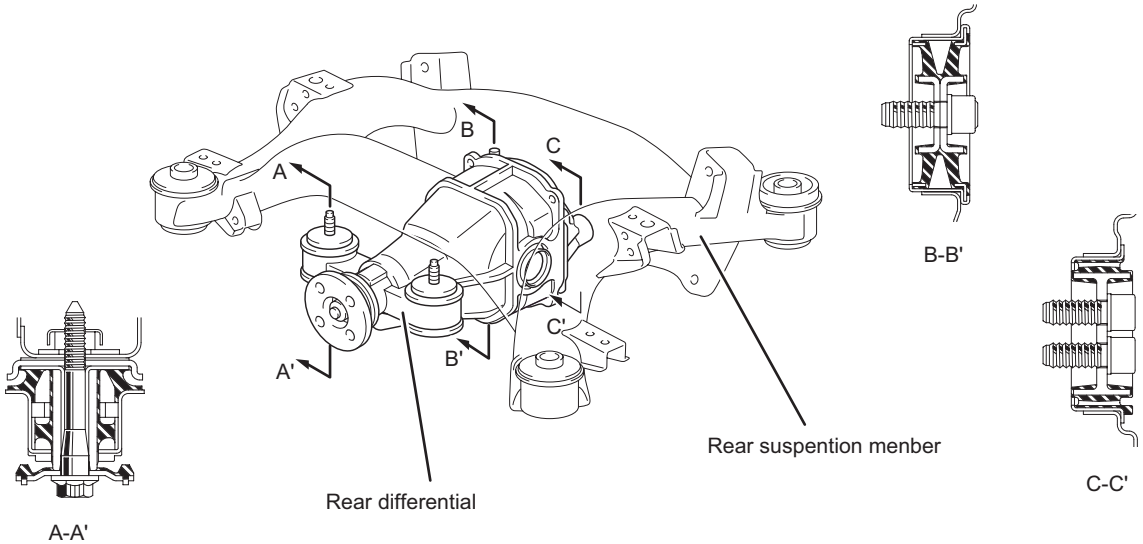
- The differential is supported at 4 points : 2front and 2rear.
- The rear differential is supported by the suspension member at four points. A liquid-filled differential mount is used at the rear right of the 3UZ-FE engine models and at except the rear left of the 3GR-FSE and 3GE-FE engine models to reduce vibration and noise. (conventional mounts are used at the other three points)

3UZ-FE



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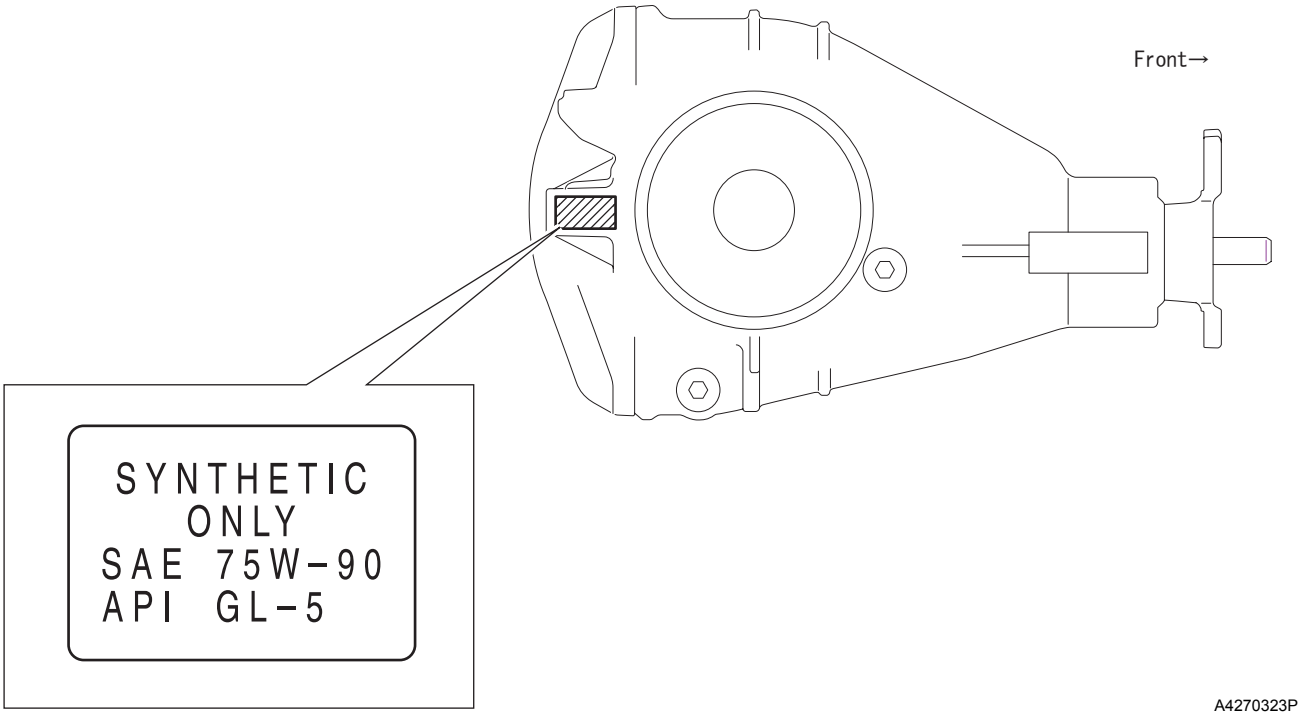
3GR-FSE,3GR-FE



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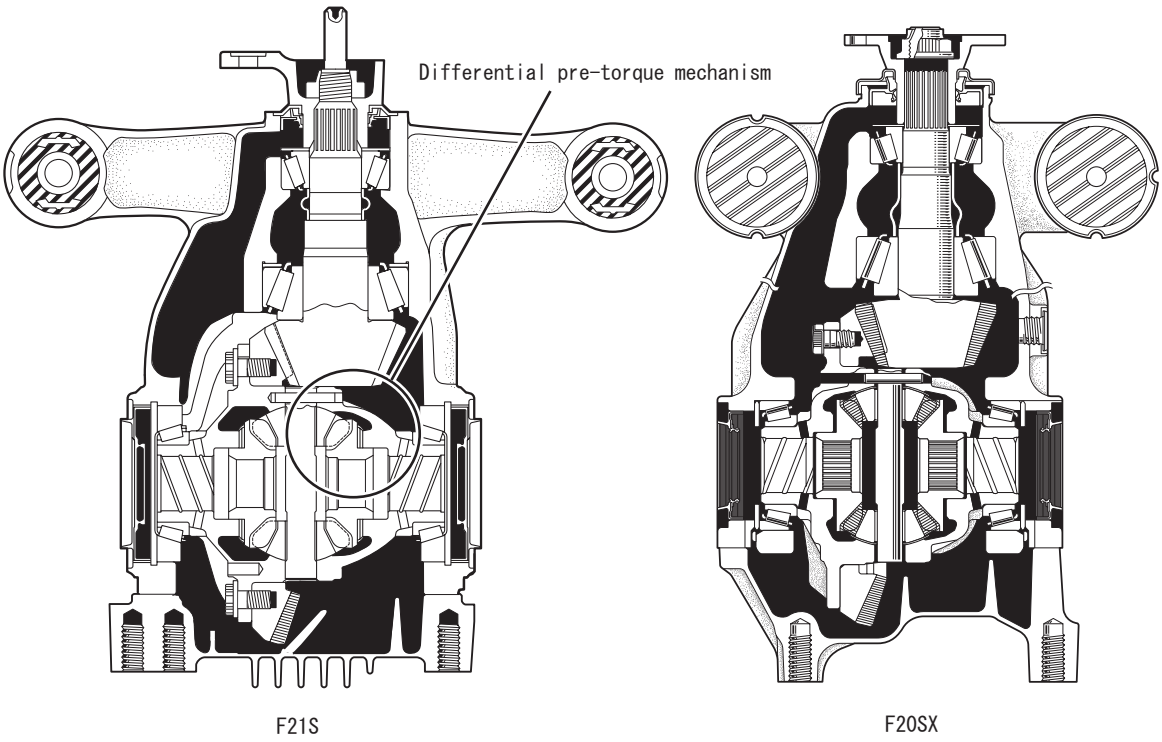
Rear Differential Caution Plate

● Low-viscosity, multi-grade oil is used in order to reduce the stirring resistance of the oil at low temperatures, as well as the rolling resistance of the bearings, in order to enhance fuel economy characteristics.



Rear Differential

- The following types of rear differentials are used: F21SF type on the models with the 3UZ-FE engine, F20SX type on the 3GR-FSE and 3GR-FE engine.
- A conical spring (pre-torque device) is used in the differential portion of the models equipped with the 3UZ-FE engine to improve the start off performance of the vehicle on slippery road surfaces.
- A type of outer race support for the side bearing that is fitted directly to the rear drive shaft is used on all the models, thus realizing weight reduction.

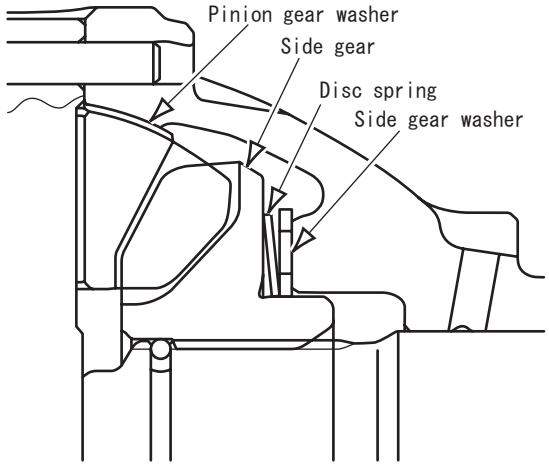


Specifications

Engine Type	3UZ-FE	3GE-FSE,3GR-FE
Differential Type	F21SF	F20SX
Differential Gear Ratio	3.615	3.727
Ring Gear Size mm(in.)	208(8.2)	205(8.1)
The No. of Dive PinionTeeth	13	11
The No. of Ring Gear teeth	47	41
The No.of Differential Pinion	2	←
Name of oil used	Toyota Genuine Differential Synthetic gear oil API GL-5 SAE75W-90	←

Differential Pre-Torque Mechanism

• A conical spring is provided between the side gear and the side washer in the differential area. The load of the conical spring applies a friction force to the sliding area to improve the start off performance of the vehicle on slippery road surfaces.



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OUTLINE

Engine Description

- Newly developed V6 gasoline engines, the 3GR-FE (3.0L gasoline) and the 3GR-FSE (3.0L gasoline) are used. The 3UZ-FE (4.3L gasoline) engine continues to be used, and the 2JZ-GE (3.0L gasoline) engine has been discontinued.
- The 3GR-FE engine complies with the EURO-IV exhaust regulations in Europe by realizing high performance/high power output and low fuel consumption/low emissions through the use of the following features: linkless electronic throttle system, Dual VVT-i (Dual Variable Valve Timing-intelligent = continuously variable intake and exhaust valve timing mechanism) system, electronic ACIS (Acoustic Control Induction System), long dual exhaust system, etc.
- The 3GR-FSE uses the D-4 (Direct injection 4-stroke gasoline engine) system to achieve efficient combustion. In addition, this engine complies with the EURO-IV exhaust regulations in Europe by realizing high performance/high power output and low fuel consumption/low emissions through the use of the following features: linkless electronic throttle system, Dual VVT-i (Dual Variable Valve Timing-intelligent = continuously variable intake and exhaust valve timing mechanism) system, electronic ACIS (Acoustic Control Induction System), electronic SCV (Swirl Control Valve), long dual exhaust system, etc.
- The 3UZ-FE engine on the '05 model GS430 is the same as on the '04 model GS430.
- This engine produces ample torque in all speed ranges, particularly in the low- to medium-speed range, through the use of the VVT-i (Variable Valve Timing-intelligent) system and the ACIS (Acoustic Control Induction System).
- This engine complies with the EURO-IV exhaust regulations in Europe through optimal combustion achieved through the use of air-assist type fuel injectors, as well as through reduced exhaust emissions achieved with a compact exhaust manifold made of stainless steel, and an ultra thin-wall, high cell density ceramic catalyst.

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Main Features of 3GR-FE

3GR-FE Engine Features List

Item	High Performance/ Fuel Economy	Compact/ Lightweight	Cleaner Exhaust Gas	Low Noise/ Low Vibration	Reliability	Serviceability
Dual VVT-i(Dual Variable Valve Timing-intelligent)	❍		❍			
Roller Rocker Arm	❍					
Lash Adjuster	❍					❍
Slanted Squish Combustion Chamber	❍		❍			
Cast Aluminum Alloy Hypereutectic Type Piston	❍	❍			❍	
High Precision Aluminum Alloy Cylinder Block		❍		❍		
Spiny Surface Cylinder Liner	❍	❍				
Water Jacket Spacer	❍					
Aluminum Alloy Oil Pan		❍		❍		
Replaceable Element Oil Filter						❍
Auxiliary Equipment Bracket Integrated with Engine Block		❍		❍	❍	
Single High-Strength Timing Chain Drive		❍			❍	
Alternator Pulley with Clutch	❍				❍	
Electronic ACIS (Acoustic Control Induction System)	❍				❍	
Plastic Surge Tank	❍	❍				
Single-Valve Electronically Controlled Throttle System	❍	❍				
Full Fabric Air Filter Element		❍				
Compact Plug-In Type Hot-Wire Airflow Meter	❍	❍				
Exhaust Manifold Integrated Three-Way Catalyst			❍			
Stainless Steel Exhaust Manifold		❍	❍			
Fuel Return Less System		❍				
Long-Reach Iridium Spark Plug	❍		❍			
DIS(Direct Ignition System)	❍	❍	❍		❍	
Liquid-Filled Double-Orifice Mount Insulator		❍		❍		
Oil Level Sensor					❍	
Air-Fuel Ratio Sensor	❍		❍		❍	
Diagnosis					❍	

High Performance/Fuel Economy

- Through the use of the Dual VVT-i system, optimal valve timing is set to suit the engine conditions in various speed ranges. Thus, high power output, high torque, and low emissions have been realized.
- The 4-valve DOHC cylinder head uses roller rocker arms, thus narrowing the angle between the intake and exhaust valves to 25.6 degrees. This results in a compact combustion chamber shape that offers a superior S/V* ratio. Furthermore, long-reach iridium spark plugs are used, enabling an optimal placement of the water jacket in the cylinder head. As a result, the knock threshold has been improved.
- The shapes of the intake ports have been optimized and slanted squish combustion chambers are used to increase the intake air volume, thus improving engine performance. In addition, the combustion chambers generate a tumble flow that is optimal for improving combustion.
- A thin-wall, cast aluminum intake manifold is used. The diameter, length, and shape of the ports are optimized to achieve a high torque and fuel economy in all operating ranges. In addition, the manifold pressure loss is minimized to improve engine performance.
- By optimizing the exhaust port and using a stainless steel exhaust manifold, the torque in the low- to medium-speed range has been improved.
- An electronic ACIS (Acoustic Control Induction System) is used. The length of the intake manifold and the capacity of the surge tank have been changed to increase the torque in all speed ranges.
- A clutch is provided on the alternetor pulley to lower the tension of the accessory belt and reduce friction, in order to improve fuel economy.
- To reduce the friction of the valve train and reciprocal movement parts, comprehensive measures have been taken: a roller rocker type of mechanism is used to open and close the valves, a new type of resin coat is applied to the pistons, low-tension piston rings are used, and a uniform bore wall temperature has been ensured by improving the roundness of the cylinder bore and using a water jacket spacer.

❖REFERENCE❖

* : S/V = combustion chamber surface/volume ratio. The lower the S/V ratio, the lesser the cooling loss, enabling the effective use of fuel.

Low Exhaust Emissions

- Each stainless steel (dual pipe) exhaust manifold has a built-in three-way catalyst. The warm-up performance of the catalyst has been improved by placing the catalyst directly below the engine and through the optimal use of precious metal. This improves exhaust emission performance immediately after the engine is started.

Lightweight and Compact

- The cylinder block is made of aluminum alloy for weight reduction.
- A serpentine drive system, which uses a single belt to drive the accessories, is used in order to shorten the overall length of the engine.
- The brackets for the accessories are integrated with the engine in order to reduce the number of parts and achieve a compact construction.
- The exhaust manifold is made of stainless steel, and the portion that mounts to the cylinder head is made of thin-wall stamped steel for weight reduction.

Low Vibration, Low Noise, and Quietness

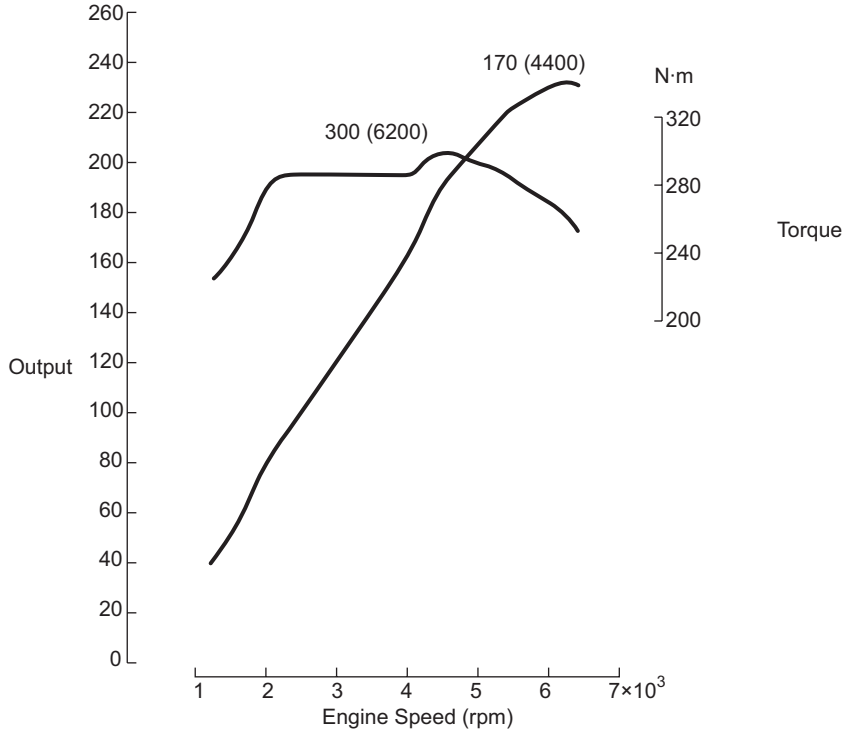
- A highly rigid, aluminum alloy oil pan with integrated stiffeners is used. By improving the joining rigidity between the oil pan and the power plant, low vibration and low noise have been achieved.
- A high strength, highly rigid forged steel crankshaft that has 4 journals and 5 balance weights is used. In addition to weight reduction, this crankshaft has achieved low vibration and noise due to the optimal allocation of balance weights.
- A liquid-filled, double-orifice mount insulator is used in the front engine mount to reduce vibration and noise.

Serviceability

- The maintenance interval has been extended through the use of iridium spark plugs.
- A replaceable element oil filter is used due to environmental concerns.
- Hydraulic lash adjusters are used, making valve clearance adjustments unnecessary.

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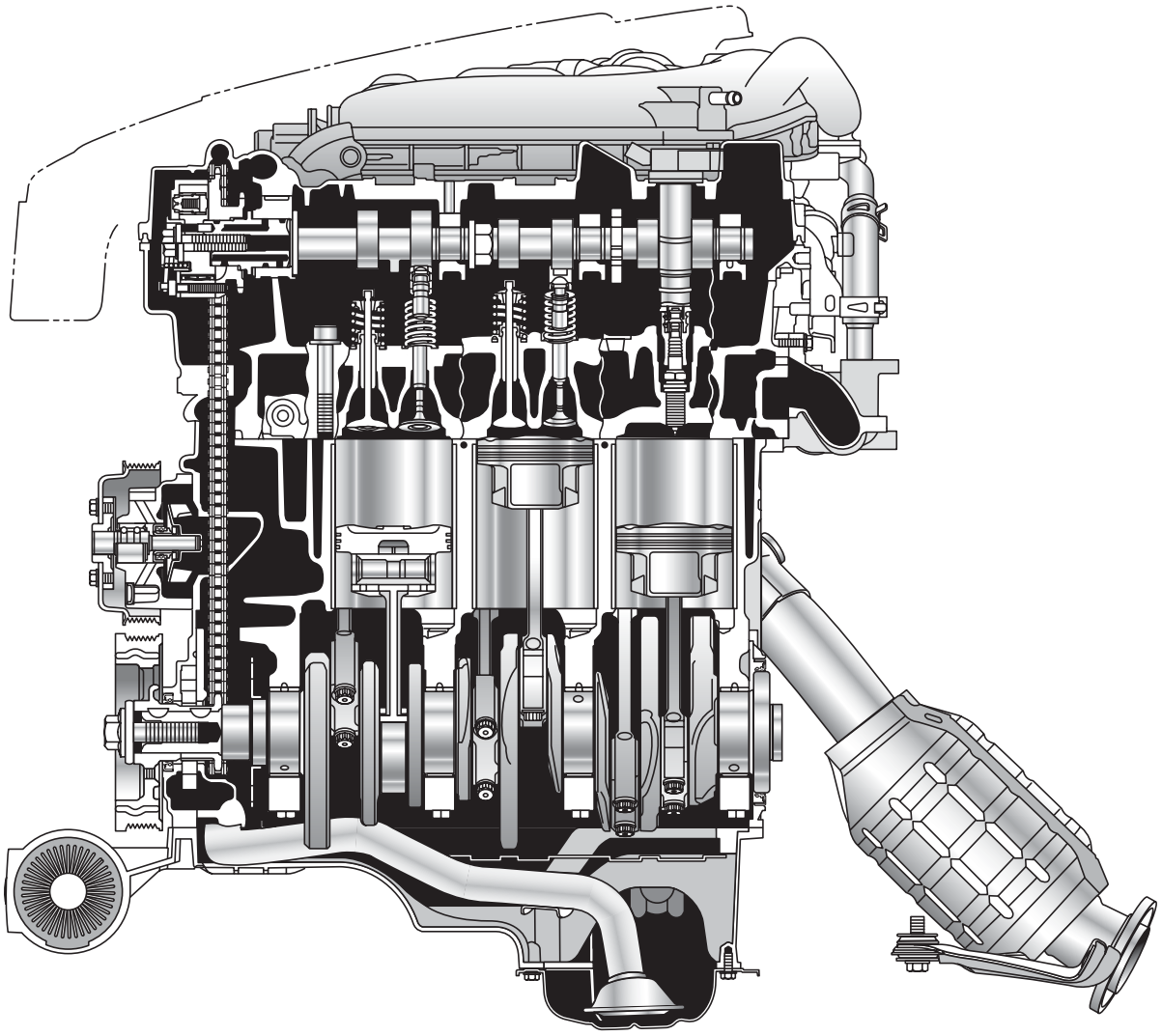
3GR-FE Engine Spec



3GR-FE

Displacement [cm^3 (cu.in.)]		2994 (182.7)
No. of Cyls. & Arrangement		6-Cylinder, V Type
Combustion Chamber		Pentroof Type
Valve Mechanism		24-Valve DOHC, Chain Drive
Bore × Stroke [mm (in.)]		87.5×83.0 (3.44×3.27)
Compression Ratio		10.5
Fuel System		EFI
Max. Output(SAE-NET) [kW](rpm)		170(6200)
Max. Torque(SAE-NET) [N·m](rpm)		300(4400)
Intake Valve Timing	Open	-3 ~ 37°BTDC
	Close	71 ~ 31°ABDC
Exhaust Valve Timing	Open	64 ~ 29°BBDC
	Close	0 ~ 35°ATDC
Firing Order		1-2-3-4-5-6
Research Octane Number		95 or higher
No-Load Speed (rpm)		650
Default Ignition Timing (BTDC°·rpm)		10·650
Weight [kg(lb)]		171 (377)

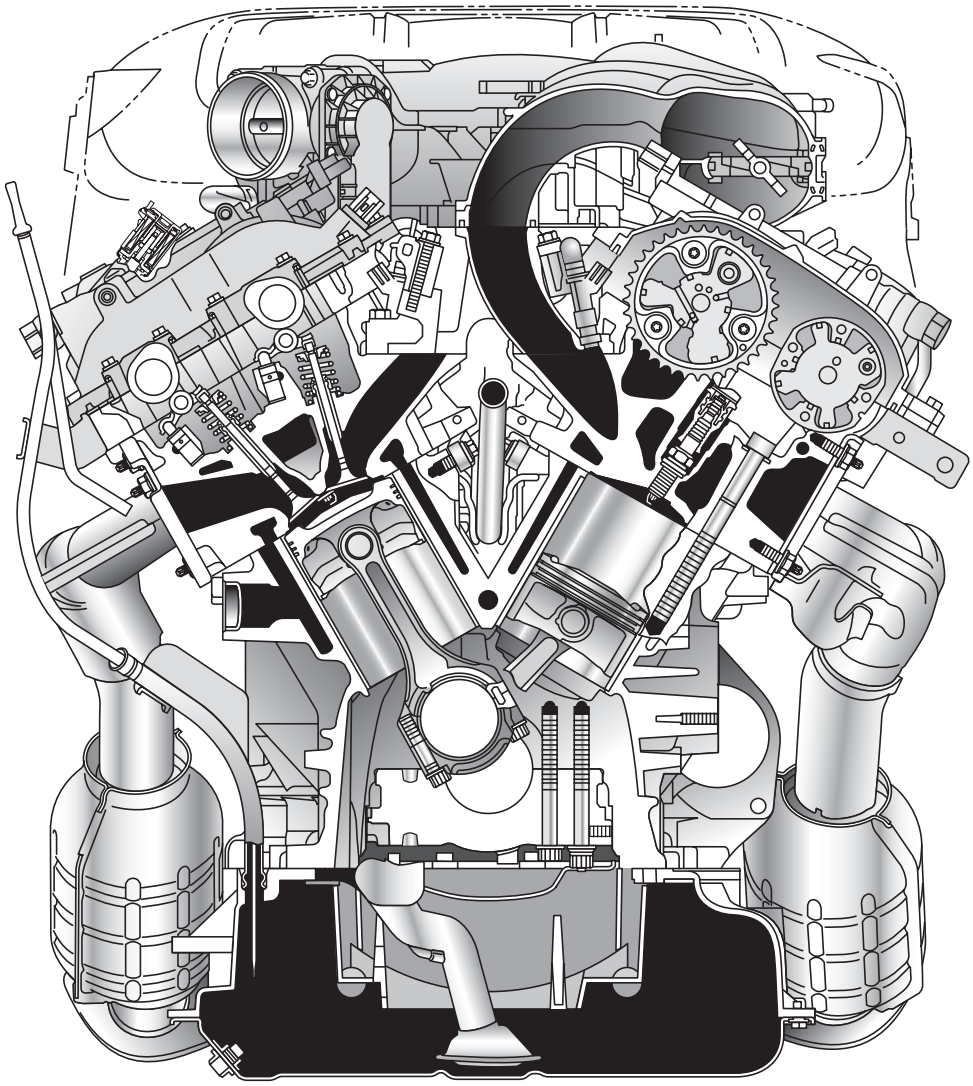
3GR-FE Engine Sectional View



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Engine Cross Section



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Main Features of 3GR-FSE

3GR-FSE Engine Features List

Item	High Performance/ Fuel Economy	Compact/ Lightweight	Cleaner Exhaust Gas	Low Noise/ Low Vibration	Reliability	Serviceability
Dual VVT-i(Dual Variable Valve Timing-intelligent)	❍		❍			
Roller Rocker Arm	❍					
Lash Adjuster	❍			❍		❍
Highly Efficient High Tumble Intake Port	❍		❍			
Slanted Squish Combustion Chamber	❍		❍			
Cast Aluminum Alloy Hypereutectic Type Piston	❍	❍			❍	
High Precision Aluminum Alloy Cylinder Block		❍		❍		
Spiny Surface Cylinder Liner	❍	❍				
Water Jacket Spacer	❍					
Aluminum Alloy Oil Pan		❍		❍		
Replaceable Element Oil Filter						❍
Auxiliary Equipment Bracket Integrated with Engine Block		❍		❍	❍	
Single High-Strength Timing Chain Drive		❍			❍	
Serpentine Drive System		❍				
Alternator Pulley with Clutch	❍				❍	
Electronic ACIS (Acoustic Control Induction System)	❍				❍	
Plastic Surge Tank	❍	❍				
Single-Valve Electronically Controlled Throttle System	❍	❍				
Electronic SCV (Swirl Control Valve) & Link Mechanism	❍	❍	❍			
Full Fabric Air Filter Element		❍				
Compact Plug-In Type Hot-Wire Airflow Meter	❍	❍				
Exhaust Manifold Integrated Three-Way Catalyst			❍			
Stainless Steel Exhaust Manifold		❍	❍			
D-4 (Direct injection 4-stroke gasoline engine)	❍		❍			
Fuel Return Less System (low pressure side)		❍				
Compact Highly Atomized Fuel Injector	❍	❍	❍			
Long-Reach Iridium Spark Plug (single tip, triple ground electrode)	❍		❍			
DIS(Direct Ignition System)	❍	❍	❍		❍	

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Item	High Performance/ Fuel Economy	Compact/ Lightweight	Cleaner Exhaust Gas	Low Noise/ Low Vibration	Reliability	Serviceability
EDU (Electronic Driver Unit)						❍
Liquid-Filled Double-Orifice Mount Insulator		❍		❍		
Oil Level Sensor					❍	
Air-Fuel Ratio Sensor	❍		❍		❍	
Diagnosis					❍	

High Performance/Fuel Economy

- The 3GR-FSE uses the D-4 (Direct injection 4-stroke gasoline engine) system. The intake cooling effect of the direct injection improves charging efficiency and improves knocking, making a higher compression ratio possible. As a result, the output performance and fuel economy have been improved.
- Through the use of the Dual VVT-i system, optimal valve timing is set to suit the engine conditions in various speed ranges. Thus, high power output, high torque, and low emissions have been realized.
- The 4-valve DOHC cylinder head uses roller rocker arms, thus narrowing the angle between the intake and exhaust valves to 25.6 degrees. This results in a compact combustion chamber shape that offers a superior S/V* ratio. Furthermore, long-reach iridium spark plugs (single tip, triple ground electrode) are used, enabling an optimal placement of the water jacket in the cylinder head. As a result, the knock threshold has been improved.
- Highly efficient, high tumble intake ports and slanted squish combustion chambers are used to increase the intake air volume, thus improving engine performance. In addition, the combustion chambers generate an optimal tumble flow to improve combustion.
- A thin-wall, cast aluminum intake manifold is used. The diameter, length, and shape of the ports are optimized to achieve a high torque and fuel economy in all operating ranges. In addition, the manifold pressure loss is minimized to improve engine performance.
- By optimizing the exhaust port and using a stainless steel exhaust manifold, the torque in the low- to medium-speed range has been improved.
- An electronic ACIS (Acoustic Control Induction System) is used. The length of the intake manifold and the capacity of the surge tank have been changed to increase the torque in all speed ranges.
- An electronic SCV (Swirl Control Valve) is used to stabilize combustion.
- A clutch is provided on the alternator pulley to lower the tension of the accessory belt and reduce friction, in order to improve fuel economy.
- To reduce the friction of the valve train and reciprocal movement parts, comprehensive measures have been taken: a roller rocker type of mechanism is used to open and close the valves, a new type of resin coat is applied to the pistons, low-tension piston rings are used, and a uniform bore wall temperature has been ensured by improving the roundness of the cylinder bore and using a water jacket spacer.

❖REFERENCE❖

* : S/V = combustion chamber surface/volume ratio. The lower the S/V ratio, the lesser the cooling loss, enabling the effective use of fuel.

Low Exhaust Emissions

- Each stainless steel (dual pipe) exhaust manifold has a built-in three-way catalyst. The warm-up performance of the catalyst has been improved by placing the catalyst directly below the engine and through the optimal use of precious metal. This improves exhaust emission performance immediately after the engine is started.

Lightweight and Compact

- The cylinder block is made of aluminum alloy for weight reduction.
- A serpentine drive system, which uses a single belt to drive the accessories, is used in order to shorten the overall length of the engine.
- The brackets for the accessories are integrated with the engine in order to reduce the number of parts and achieve a compact construction.
- The intake manifold is made of thin-wall cast aluminum for weight reduction.
- The exhaust manifold is made of stainless steel, and the portion that mounts to the cylinder head is made of thin-wall stamped steel for weight reduction.

Low Vibration, Low Noise, and Quietness

- A highly rigid, aluminum alloy oil pan with integrated stiffeners is used. By improving the joining rigidity between the oil pan and the power plant, low vibration and low noise have been achieved.
- A high strength, highly rigid forged steel crankshaft that has 4 journals and 5 balance weights is used. In addition to weight reduction, this crankshaft has achieved low vibration and noise due to the optimal allocation of balance weights.
- A liquid-filled, double-orifice mount insulator is used in the front engine mount to reduce vibration and noise.

Serviceability

- The maintenance interval has been extended through the use of iridium spark plugs.
- A replaceable element oil filter is used due to environmental concerns.
- Hydraulic lash adjusters are used, making valve clearance adjustments unnecessary.

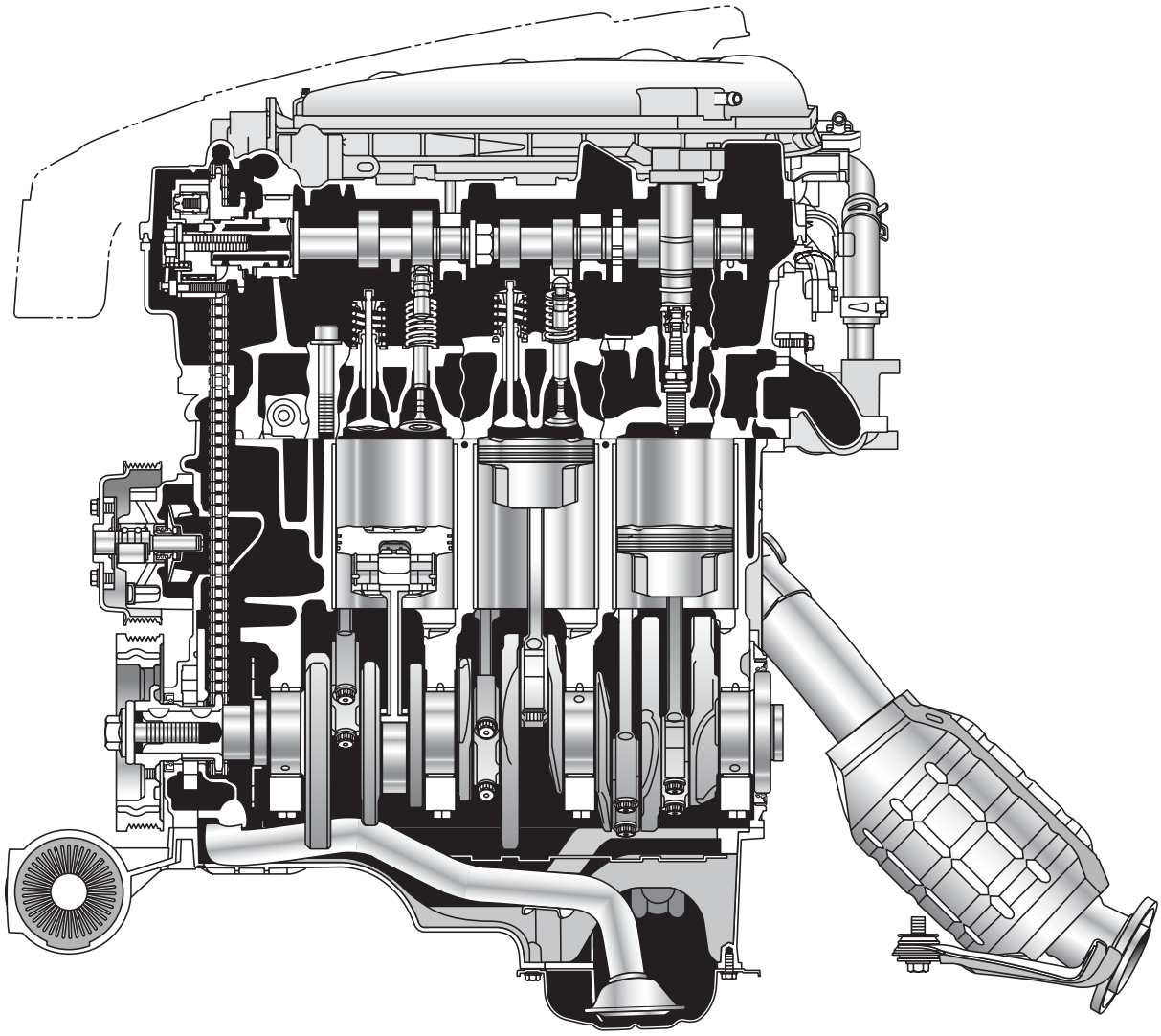
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3GR-FSE Engine Spec

3GR-FSE

Displacement [cm^3 (cu.in.)]		2995 (182.7)
No. of Cyls. & Arrangement		6-Cylinder, V Type
Combustion Chamber		Pentroof Type
Valve Mechanism		24-Valve DOHC, Chain Drive
Bore × Stroke [mm (in.)]		87.5×83.0 (3.44×3.27)
Compression Ratio		11.5
Fuel System		EFI·D-4
Intake Valve Timing	Open	-6 ~ 34°BTDC
	Close	70 ~ 30°ABDC
Exhaust Valve Timing	Open	57 ~ 22°BBDC
	Close	3 ~ 38°ATDC
Firing Order		1-2-3-4-5-6
Research Octane Number		95 or higher
No-Load Speed (rpm)		650
Default Ignition Timing (BTDC°·rpm)		10·650
Weight [kg(lb)]		174 (383)

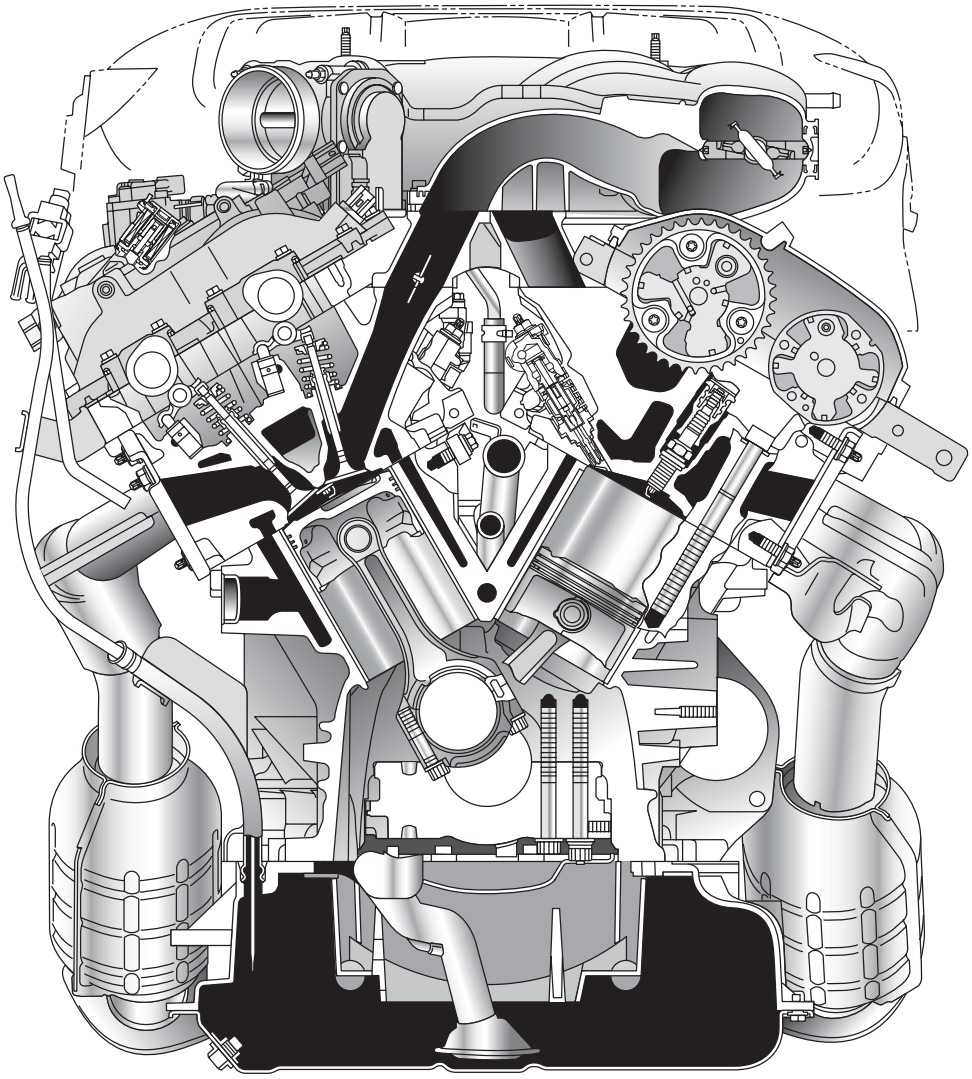
3GR-FSE Engine Sectional View



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Engine Cross Section



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Main Features of 3UZ-FE

● Torque in all speed ranges, particularly in the low- to medium-speed range, has been improved through the use of the VVT-i (Variable Valve Timing-intelligent) system and the ACIS (Acoustic Control Induction System). In addition, low exhaust emissions have been achieved through precision exhaust gas feedback using an air assist system and an O2 sensor, a stainless steel exhaust manifold, and an ultra thin-wall, high cell density ceramic catalyst that excels in catalyst warm-up performance.

3UZ-FE Engine Features List

Item	High Performance/Fuel Economy	Compact / Lightweight	Cleaner Exhaust Gas	Low Noise/ Low Vibration	Improved Reliability
VVT-i(Variable Valve Timing-intelligent)	❍		❍		
Plastic Engine Cover				❍	
Aluminum Alloy Cylinder Head	❍	❍			
Aluminum Alloy Cylinder Block	❍	❍			
Aluminum Alloy Oil Pan No. 1 Integrated with Stiffeners		❍		❍	
Vertical Intake Port	❍		❍		
Slanted Squish Combustion Chamber	❍		❍		
Three-Way Split Timing Belt Cover				❍	
Inner Shim Type Valve Lifter	❍				
Resin Coated Piston	❍				❍
Accessory Serpentine Drive	❍				❍
Electronically Controlled Cooling Fan	❍			❍	❍
Fuel Returnless System		❍	❍		
Air Assist Type Compact Fuel Injector		❍	❍		
ACIS(Acoustic Control Induction System)	❍				
Compact Plug-In Type Hot Wire Airflow Meter	❍	❍			
Full Fabric Air Filter Element		❍			
Single Valve Electronically Controlled Throttle Valve	❍	❍			
Long Port Intake Manifold	❍				
Stainless Exhaust Manifold		❍	❍	❍	
Exhaust Manifold Insulator with Vent Holes	❍				❍
Ultra Thin-Wall High Cell Density Ceramic Catalyst		❍	❍		
Large-Diameter Water Pump	❍				❍
Segment Conductor Type Alternator	❍	❍		❍	
DIS(Direct Ignition System)	❍			❍	❍
Iridium Center Core Spark Plug	❍				

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Item	High Performance/Fuel Economy	Compact / Lightweight	Cleaner Exhaust Gas	Low Noise/ Low Vibration	Improved Reliability
Liquid-Filled Engine Mount				❍	
Diagnosis					❍

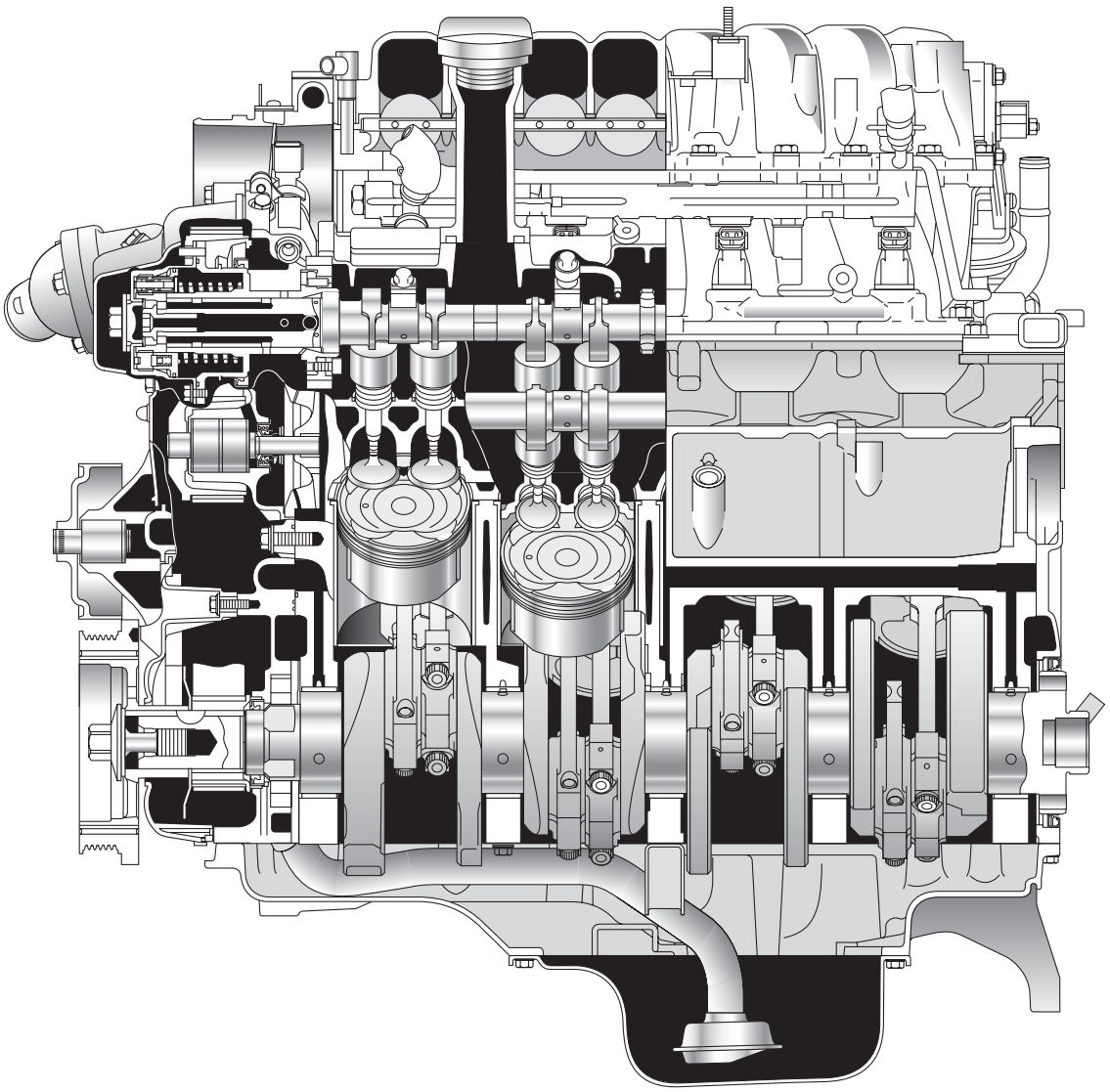
3UZ-FE Engine Spec

3UZ-FE

Displacement [cm^3 (cu.in.)]		4293 (261.9)
No. of Cyls. & Arrangement		8-Cylinder, V Type
Combustion Chamber		Pentroof Type
Valve Mechanism		32-Valve DOHC, Belt & Gear Drive
Bore × Stroke [mm (in.)]		91.0×82.5 (3.58×3.25)
Compression Ratio		10.5
Fuel System		EFI
Max. Output(SAE-NET) [kW](rpm)		208 (5600)
Max. Torque(SAE-NET) [N·m](rpm)		417 (3500)
Intake Valve Timing	Open	-14 ~ 31°BTDC
	Close	64 ~ 19°ABDC
Exhaust Valve Timing	Open	46°BBDC
	Close	3°ATDC
Firing Order		1 - 8 - 4 - 3 - 6 - 5 - 7 - 2
Research Octane Number		95 or higher
Weight [kg(lb)]		190 (419)

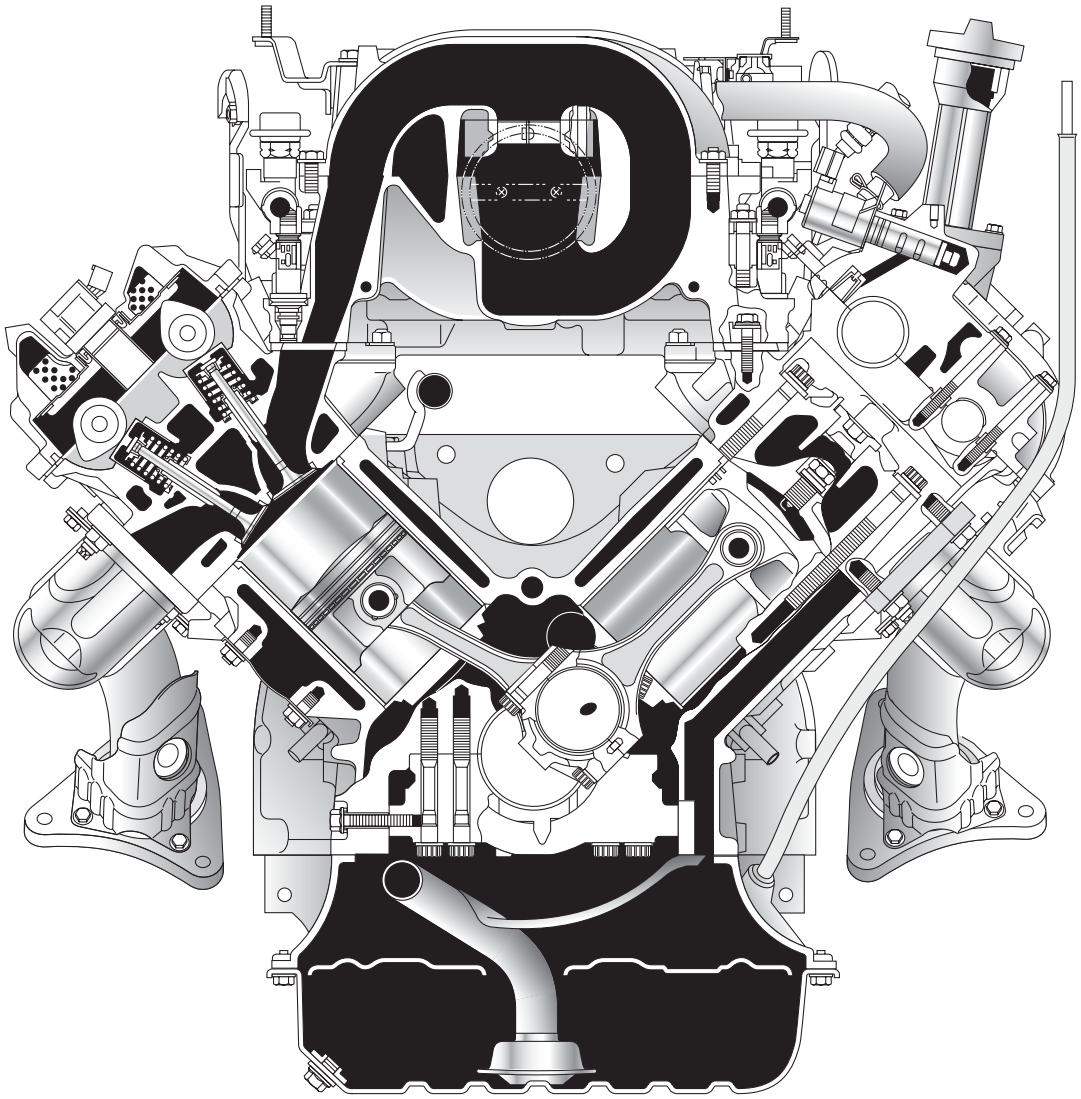
3UZ-FE Engine Sectional View

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Engine Cross Section



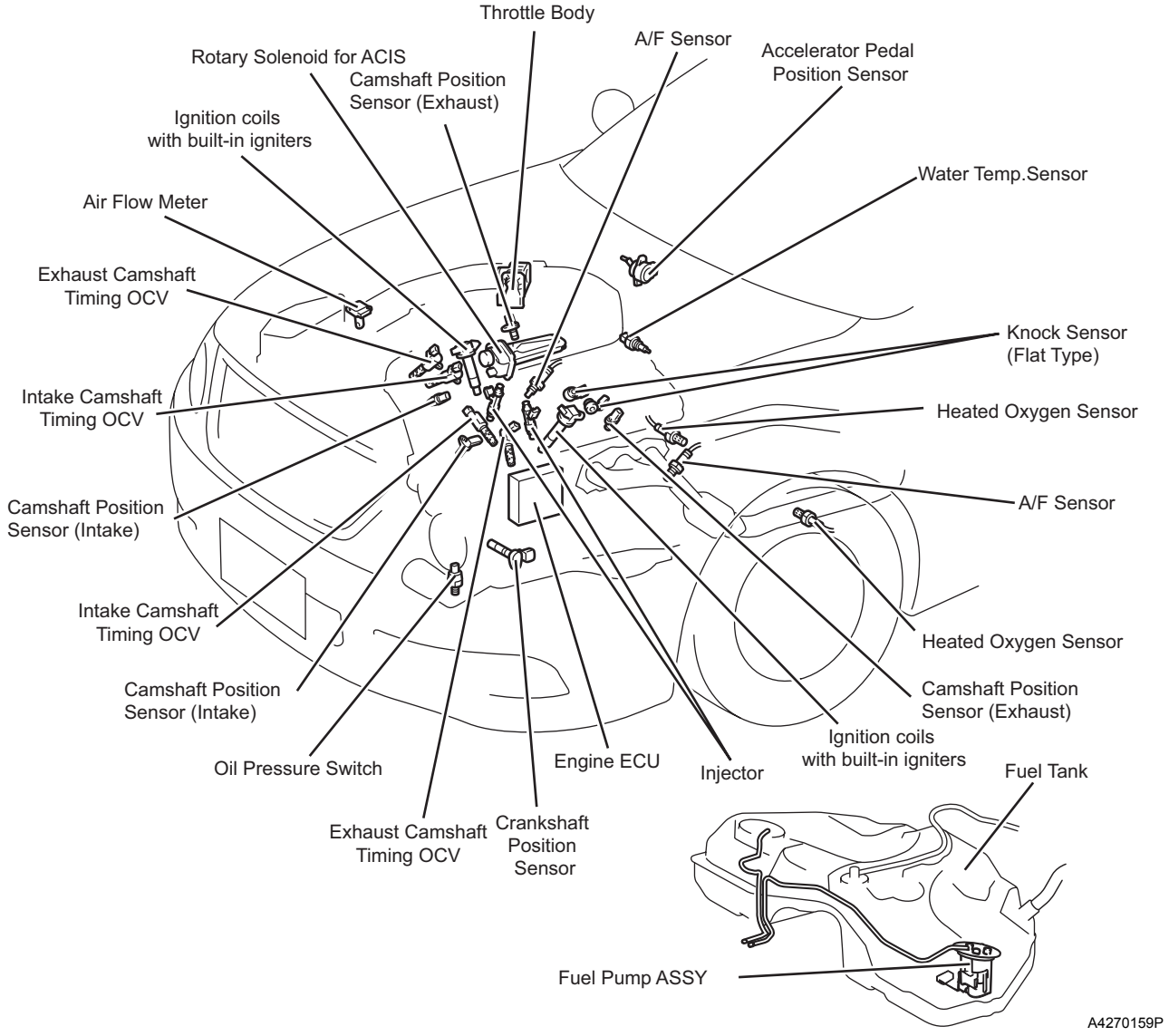
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3GR-FE ENGINE CONTROL SYSTEM

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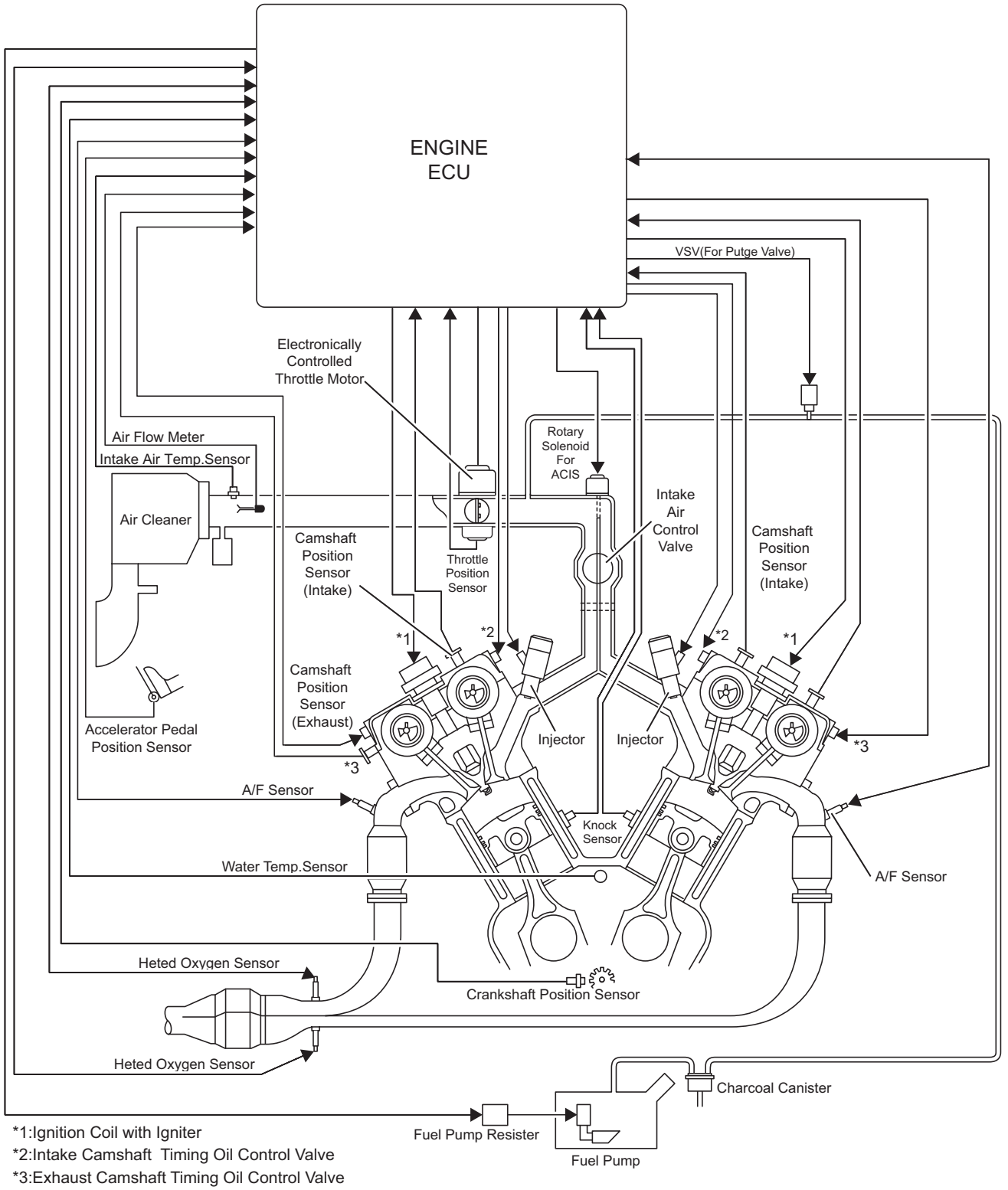
Engine Control System Description

- This engine controls the following systems in a highly accurate manner: Electronic Fuel Injection (EFI), Electronic Spark Advance (ESA), Electronic Throttle Control System-intelligent (ETCS-i), and Dual Variable Valve Timing-intelligent (Dual VVT-i). As a result, high performance, high power output, fuel economy, and improved exhaust emission performance have been achieved.
- CAN (Controller Area Network) communication is used to exchange data with other ECUs.
- The electronic ACIS (Acoustic Control Induction System) control generates high torque in the practical speed range.
- A diagnosis and a failsafe function are provided to ensure serviceability and safety.



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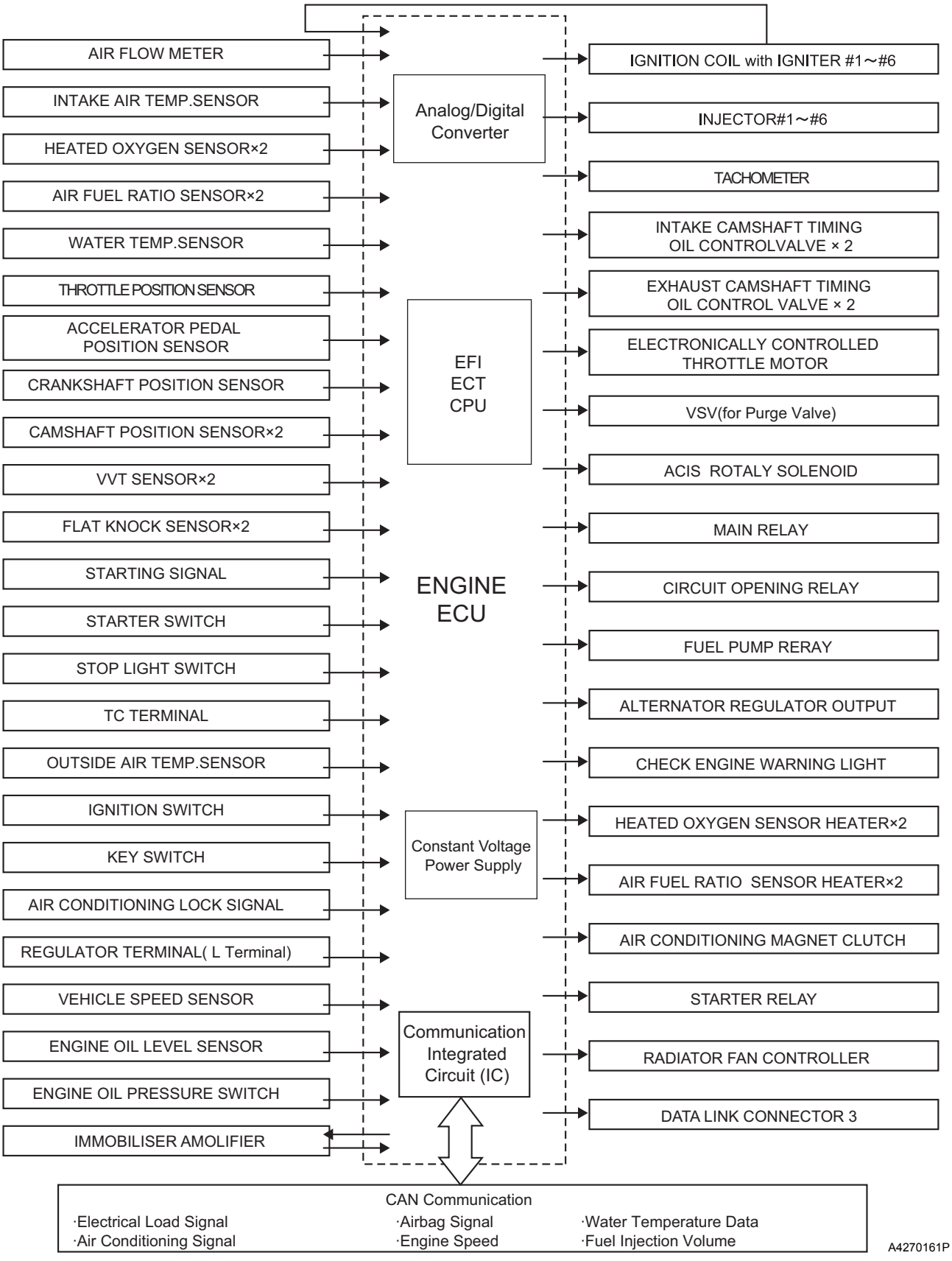
Engine Control System Diagram



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Construction



Control List

System	Outline	
EFI (Electronic Fuel Injection)	An L-type EFI system directly detects the intake air mass with a hot wire type mass air flow meter.	
ESA (Electronic Spark Advance)	Ignition timing is determined by the engine ECU based on signals from various sensors. Corrects ignition timing in response to engine knocking.	
	Knocking Judgment Control(KCS)	2 knock sensors are used to improve knock detection.
	ECT Shifting Torque Control	The torque control correction during gear shifting has been used to minimize the shift shock.
ETCS-i (Electronic Throttle Control System-intelligent)	Ignition timing is determined by the engine ECU based on signals from various sensors. Corrects ignition timing in response to engine knocking.	
	VSC Control	Controls the throttle valve position when the VSC is operating.
	Maximum Speed Control	When the vehicle speed reaches 240 km/h, this control closes the throttle valve to suppress the increase in vehicle speed.
	Idle Speed Control(ISC)	Controls the fast idle speed in accordance with the water temperature, and the idle speed after the engine has been warmed up. It controls the idle speed by regulating the fuel injection volume and the throttle position.
Dual VVT-i Control	Controls the optimal intake and exhaust valve timing in accordance with the conditions of the engine.	
ACIS (Acoustic Control Induction System) Control	Varies the intake manifold length to suit the conditions of the engine.	
Fuel Pump Control	Turns the fuel pump ON/OFF in accordance with the starter signal and the engine speed signal. Stops the operation of the fuel pump in accordance with the signals from the airbag ECU	
Cranking Hold Control	After the starter starts to crank the engine, this control continues to apply current to the starter until the engine starts. Thus, it prevents the failure of the engine to start when the driver inadvertently turns the ignition switch to OFF just before the engine fires.	
Air-Fuel Ratio Sensor Heater Control	Turns the air-fuel ratio sensor heater ON/OFF in accordance with the water temperature and the driving conditions.	
Heated Oxygen Sensor Heater Control	Maintains the temperature of the Heated Oxygen Sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.	
Evaporative Emission Control	The engine ECU controls the purge flow of evaporative emissions (HC) in the charcoal canister in accordance with engine conditions.	
Air ConditioningCut-Off Control	By controlling the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.	
Engine Immobiliser	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.	
Function to communicate with multiplex communication system	Communicates with the meter ECU, A/C ECU, etc., on the body side, to input/output necessary signals.	

System	Outline
Diagnosis	Enables the accurate and detailed diagnosis of malfunctions through the use of the intelligent Tester II diagnostic tool to access the SAE-prescribed DTC (Diagnostic Trouble Code) and data, as well as to perform active tests.
Fail-Safe	When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in the memory.

■ **Service Tip** ■

The uses the CAN protocol for diagnostic communication. Therefore, a intelligent Tester II and a dedicated adapter [CAN VIM (Vehicle Interface Module)] are required for accessing diagnostic data. For details, see the 2005 Lexus GS430/300 Repair Manual(Pub. No. RM1168E)

Sensor List

Name	Function and Construction	EFI	ESA	ISC	VVT-i
Air Flow Meter	Detects the intake air volume.	❍	❍	❍	❍
Intake Air Temperature Sensor	Detects the intake air temperature.	❍	❍	❍	❍
Camshaft Position Sensor	Identifies the cylinder and detects the actual camshaft position.	❍	❍	❍	❍
Crankshaft Position Sensor	Detects the crankshaft position.	❍	❍	❍	❍
Accelerator Pedal Position Sensor	It is attached to the accelerator pedal to detect the accelerator pedal position.	❍	❍	❍	❍
Throttle Position Sensor	Detects the throttle valve position.	❍	❍	❍	❍
Water Temp.Sensor	Detects the water Ftemperature.	❍	❍	❍	❍
Air-Fuel Ratio Sensor	Detects the state of the air-fuel ratio in the exhaust gas.	❍			
Heated Oxygen Sensor	Detects the oxygen concentration in the exhaust gas.	❍			
Igniter	Sends the ignition verification signal.		❍		
Starter Signal	Sends the starter voltage in the form of a signal when the engine is started.	❍	❍	❍	❍
Neutral Start Switch	Detects the P, N, and D positions of the automatic transmission.	❍	❍	❍	❍
Knock Sensor	Detects the knocking of the engine by way of the resonance of the piezoelectric element.		❍		
Vehicle Speed Signal	Detects vehicle speed.	❍	❍	❍	❍

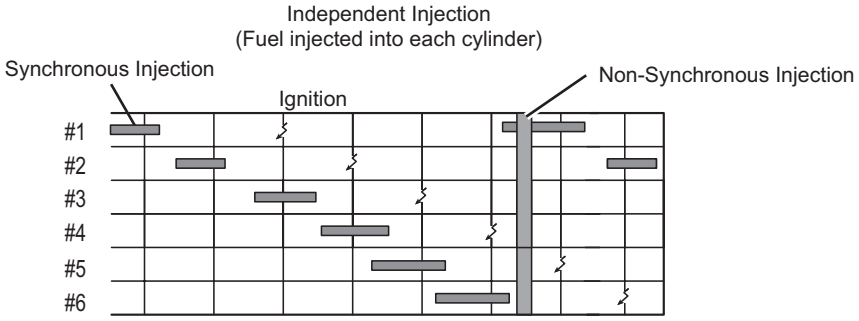
Actuator List

Name	Function and Construction
Main Relay	Supplies main power to the EFI, ESA system, etc
Circuit Opening Relay	Supplies power to the fuel pump system.
Fuel Injector	Injects an optimal volume of fuel at an optimal timing.
Air-Fuel Ratio Sensor Heater	Heats the air-fuel ratio sensor to promote feedback control when the engine is cold.

Name	Function and Construction
Heated Oxygen Sensor Heater	Heats the heated oxygen sensor to promote feedback control when the engine is cold.
Igniter	Turns the current to the ignition coil ON/OFF at an optimal timing.
Electronically Controlled Throttle Motor	Controls the position of the throttle valve in accordance with driving conditions.
Intake Camshaft Timing OCV	Controls the intake VVT-i at an optimal valve timing.
Exhaust Camshaft Timing OCV	Controls the exhaust VVT-i at an optimal valve timing.
Rotary Solenoid for ACIS	Opens and closes the ACIS valve in accordance with driving conditions.
Evaporative Purging VSV	Regulates the purge volume of the canister.

EFI (Electronic Fuel Injection) System

- An L-type EFI system directly detects the intake air mass with a hot wire type air flow meter.
- An independent injection system (in which fuel is injected once into each cylinder for each two revolutions of the crankshaft) has been adopted.
- There are two types of fuel injection: One is synchronous injection in which corrections based on the signals from the sensors are added to the basic injection time so that injection occurs always at the same position. The other is non-synchronous injection in which injection is effected by detecting the requests from the signals of the sensors regardless of the crankshaft angle. Furthermore, to protect the engine and improve fuel economy, the system effects fuel cutoff in which the injection of fuel is stopped temporarily in accordance with the driving conditions.

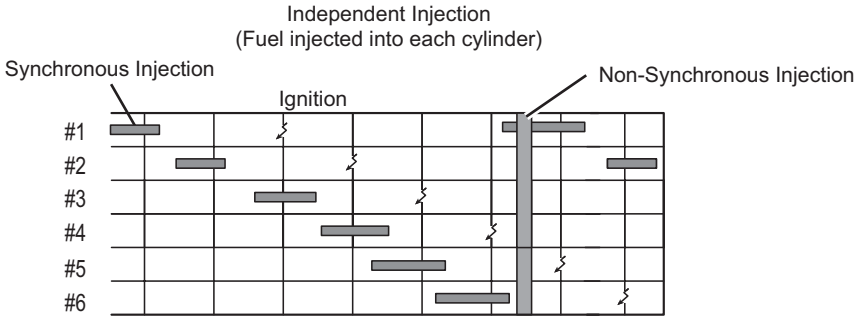


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Name	Function and Construction
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Synchronous Injection

• The synchronous injection time can be expressed by the formula given below. During the starting of the engine, the injection time is determined in accordance with the engine speed, battery voltage, and the water temperature. To prevent excessive amounts of fuel from being injected during starting, the injection volume is regulated in accordance with the cranking time.

Synchronous Injection = A. Basic Injection Time + B. Correction Injection Time + C. Ineffective Injection Coefficient

A.Basic Injection Time	It is the basic injection time that is determined by the intake air volume and the engine speed.
B.Correction Injection	It is a coefficient that is used to achieve the air-fuel mixture that is appropriate for the engine condition at that time, in accordance with the signals from the sensors.
B-1 Intake Temperature Correction	Enriches the mixture when the intake air temperature is low because the air density is high.
B-2 Post-Warm-Up Enrichment Correction	Enriches the mixture when the water temperature is low to ensure drivability during cold operation.
B-3 Post-Start Enrichment Correction	Enriches the mixture after the engine is started in accordance with the water temperature and the engine speed in order to ensure a stable engine operation after starting. The enrichment is at the highest ratio immediately after the engine is started, and decreases gradually thereafter.
B-4 Transient Air-Fuel Ratio Correction	Enriches or leans the mixture in accordance with the acceleration or deceleration conditions determined by the changes in the intake air volume.
B-5 Wall Adhesion Correction	Correction is made by calculating the adhesion of fuel to the wall surface based on the water temperature, engine speed, and throttle valve opening.
B-6 High-Load Enrichment Correction	Prevents the exhaust temperature from rising by detecting the high-load driving conditions in accordance with the signals from the sensors and enriching the mixture.
B-7 Constant Fuel Pressure Control	Corrects the deviation of the fuel injection volume that results from the changes in the intake manifold pressure to achieve a constant pressure.
B-8 Air-Fuel Ratio Feedback Control	Controls the air-fuel ratio to a narrow range near the stoichiometric ratio (in which the cleaning performance of the three-way catalyst is at the highest level) by making corrections based on the signals from the heated heated oxygen sensor.
C.Ineffective Injection	Corrects the operation lag of the injectors.

Non-Synchronous Injection

• Apart from the normal (synchronous) fuel injection, this function simultaneously injects a prescribed volume of fuel to all the cylinders only immediately after the signals from the sensors are input, in order to ensure the proper startability and acceleration response.

• During synchronous injection, the injection time is extended for the amount of non-synchronous injection.

The following are the three types of non-synchronous injection

Starting Non-Synchronous Injection	Effects non-synchronous injection immediatelyafter the starter signal is input,thus improving startablility.
Acceleration Non-Synchronous Injection	Effects non-synchronous injection when the increased amount of the throttle valve opening is greater than the preset value, to improve response during acceleration.
Engine Speed Drop Non-SynchronousInjection	Effects non-synchronous injection when the engine speed drops suddenly during a fuel cutoff or when resuming from a fuel cutoff, thus ensuring the proper drivability.

Fuel Cut

• Temporarily stops the injection of fuel to protect the engine and improve fuel economy.

The following are the three types of fuel cutoff

Deceleration Fuel Cutoff	Stops the injection of fuel when the engine speed is higher than the specified value during deceleration (throttle OFF detected by engine ECU). This prevents the TWC (Three-Way Catalyst) from overheating due to misfiring and improves fuel economy. The fuel cutoff and resumption speeds are higher when the coolant temperature is low.
Engine Speed Fuel Cutoff	Stops the injection of fuel when the engine speed is higher than the specified value to prevent over-revolution.
N → D Shift Fuel Cutoff	Stops the injection of fuel for a prescribed length of time when shifting from N→ D, if the engine speed is higher than the specified value to reduce shift shock.

Fuel Cut Resumption Speed During Deceleration

While lockup control is operating	[rpm]	1000
While lockup control is not operating	[rpm]	1200

Fuel Cut Speed During High-Speed Operation

Engine Speed	[rpm]	6500

ESA (Electronic Spark Advance)

● This system selects the optimal ignition timing in accordance with the signals received from the sensors and sends the (IGt) ignition signal to the igniter. The ignition timing can be expressed by the formula given below. The default ignition timing is set to 5° BTDC.

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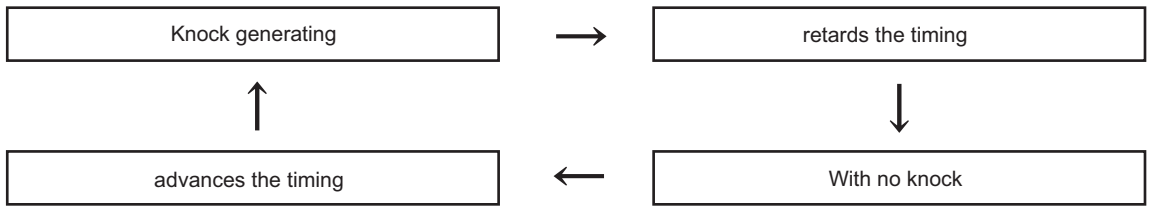
Calculation of ignition timing

❖REFERENCE❖
Ignition Timing = A. Default Ignition Timing or B. Basic Timing Advance + C. Correction Timing Advance

A.Fixed Timing Advance Characteristic	During the starting of the engine, the timing is fixed to 5° BTDC. If the throttle valve is turned OFF by shorting the service terminals, the timing becomes fixed to 10° BTDC.
B.Basic Timing Advance Characteristic	The optimal ignition timing is selected from the map based on the signals received from the sensors.
C.Correction Timing Advance Characteristic	Appropriately advances or retards the timing in accordance with the conditions of the engine based on the signals received from the sensors.
C-1 Warm-Up Timing Advance Characteristic	Advances the ignition timing in accordance with the driving conditions when the water temperature is low, in order to improve drivability.
C-2 Idle Stabilization Timing Advance Characteristic	Advances the ignition timing when the idle speed decreases, in order to stabilize the idle speed. Conversely, retards the timing if the idle speed increases.
C-3 Transient Correction Timing Retard	Retards the ignition timing during sudden acceleration when the water temperature is higher than 60°C, in order to prevent the engine from knocking.
C-4 Acceleration Timing Retard	Temporarily retards the ignition timing during acceleration in order to improve drivability.
C-5 Knock Correction Timing Retard	Corrects the ignition timing in accordance with the signals received from the knock sensor when knocking occurs. Depending on the extent of the knocking that is detected, this function retards the timing by a prescribed angle at a time until there is no more knocking. After no more knocking occurs, this function advances the timing by a prescribed angle at a time. If knocking occurs again while advancing the timing, it retards the timing again.

Knock Control System

- When the engine ECU detects the engine knocking, it retards the timing, depending on the extent of knocking, by one predetermined angle at a time until the engine stops knocking.
- When the engine stops knocking, the engine ECU advances the timing by one predetermined angle at a time. If the engine starts knocking again, the engine ECU retards the timing again.



Knocking Feedback Control

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Maximum and Minimum Timing Advance Characteristics

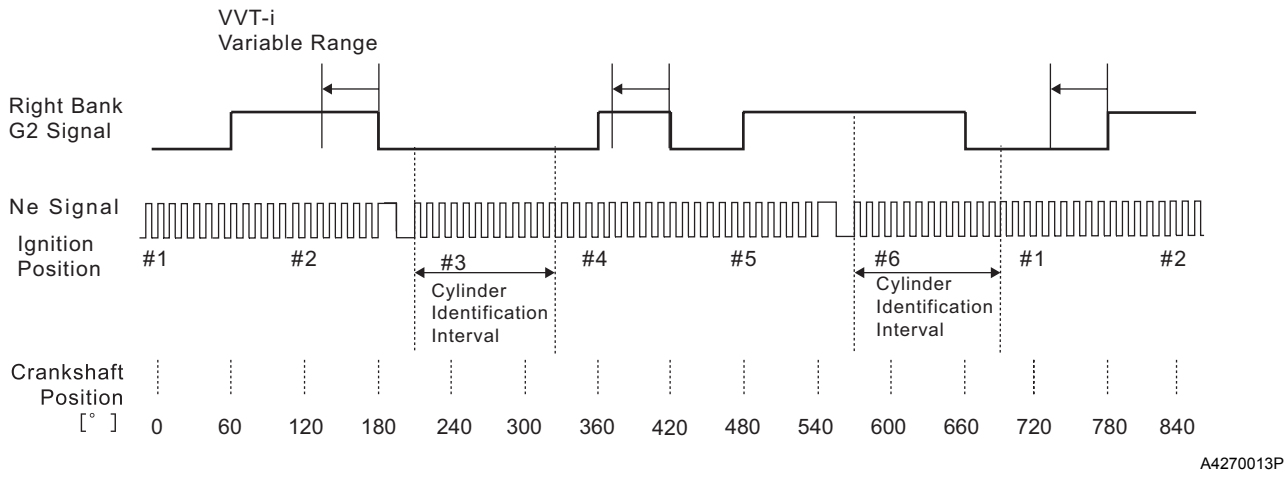
- The maximum and minimum timing advance angles are fixed because the engine can be adversely affected if the ignition timing advances or retards abnormally.

Maximum and Minimum Timing Advance Angles

Maximum Timing Advance Angle (BTDC)	49°
Minimum Timing Advance Angle (ATDC)	-10°

Calculation of ignition timing

- Based on the Ne and G2 signals, airflow meter signal, accelerator position signal, and water temperature signal, the engine ECU calculates the optimal ignition timing to suit the driving conditions. Then, the engine ECU sends an ignition signal to the ignition coil with a built-in igniter.



Idle Speed Control

● Controls the fast idle speed in accordance with the water temperature, and the idle speed after the engine has been warmed up. It controls the idle speed by regulating the fuel injection volume and the throttle position.

Idle Speed Control

Starting Control	When starting the engine, this control opens the throttle valve to increase the intake air volume, which improves the startability of the engine.
Forecast Control	When the system detects any one of the signals listed below, it controls the position of the throttle valve to suppress speed fluctuations.
	·A change in the idle speed has been forecasted.
	·A change occurred in the electrical load.
	·The air conditioning switch has been switched.
	·The shift lever has been shifted. (N → D, D → N)
Deceleration Control	This control increases the airflow volume by opening the throttle valve during deceleration, thus lowering the vacuum in the intake manifold. This decreases the volume of oil consumed through suction into the combustion chamber, prevents the engine from stalling through a sudden drop in engine speed, and improves drivability.
Feedback Control	While measuring the engine speed for a certain length of time, if there is a difference between the actual speed and the target speed, this control regulates the throttle valve position in order to bring the idle speed to the target speed.

Target Speed

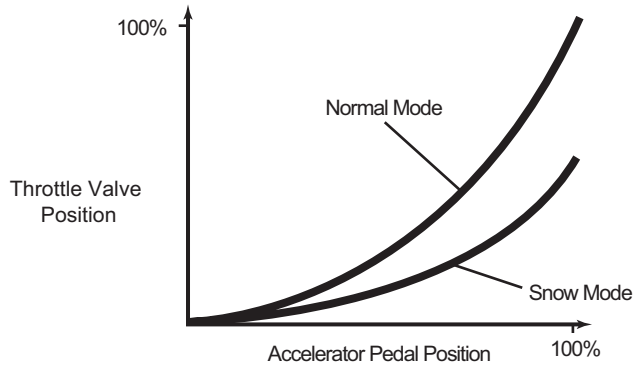
		3GR-FE		
		Europe	General countries	G.C.C.countries
No-load speed [rpm]		650	←	←
With an electrical load [rpm]		650	←	←
A/C ON [rpm]	Low load	650	675	←
	High load	800	←	875

ETCS-i (Electronic Throttle Control System-intelligent)

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

ETCS-i Control

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



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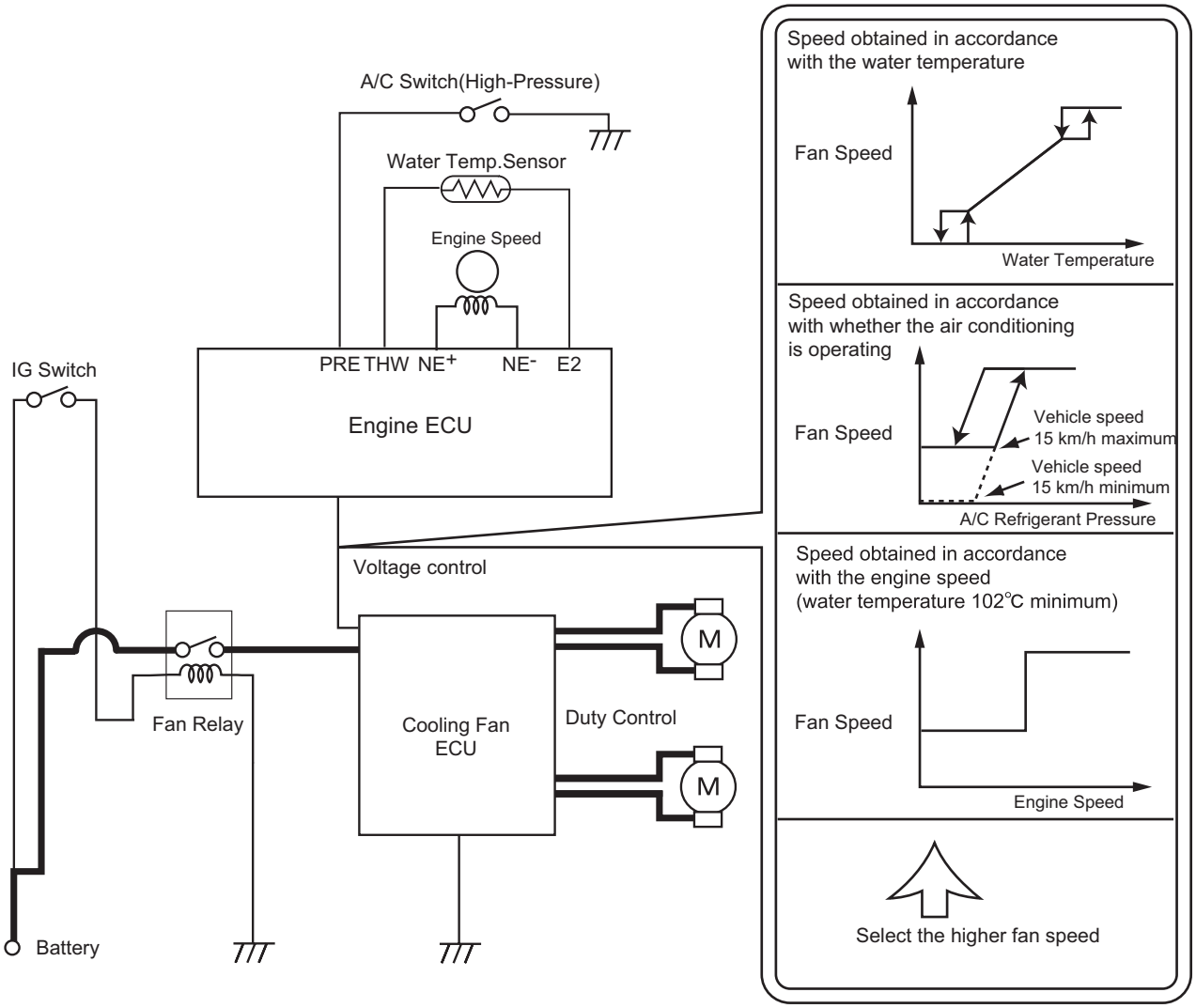
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VVT-i System

● This engine uses a Dual VVT-i (Variable Valve Timing-intelligent) system that continuously varies the phases of the camshafts. By regulating the timing of the intake and exhaust valves in accordance with the driving conditions, this system realizes fuel economy, high power output, and low exhaust emissions.

Cooling Fan System

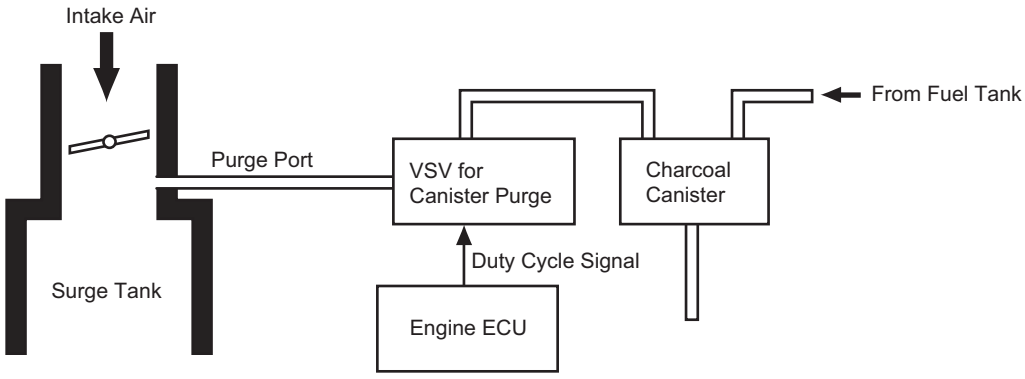
● To achieve an optimal fan speed in accordance with the engine coolant temperature, vehicle speed, engine speed, and air conditioning operating conditions, the engine ECU calculates the proper fan speed and sends the signals to the cooling fan ECU. Upon receiving the signals from the engine ECU, the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



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Evaporative Emission Control System

- A single system purge flow path is provided in order to control the fuel evaporative gas that flows from the charcoal canister to the purge port in accordance with the conditions of the engine. Then, the fuel evaporative gas that has been absorbed by the canister is drawn into the engine, thus suppressing the discharge of fuel evaporative gas.
- The purge port, which is provided downstream of the throttle valve, draws the fuel evaporative gas into the intake manifold in accordance with the driving conditions. The engine ECU applies current to the VSV, which is provided midstream of the purge pipe, in order to control the purge to an optimal volume.

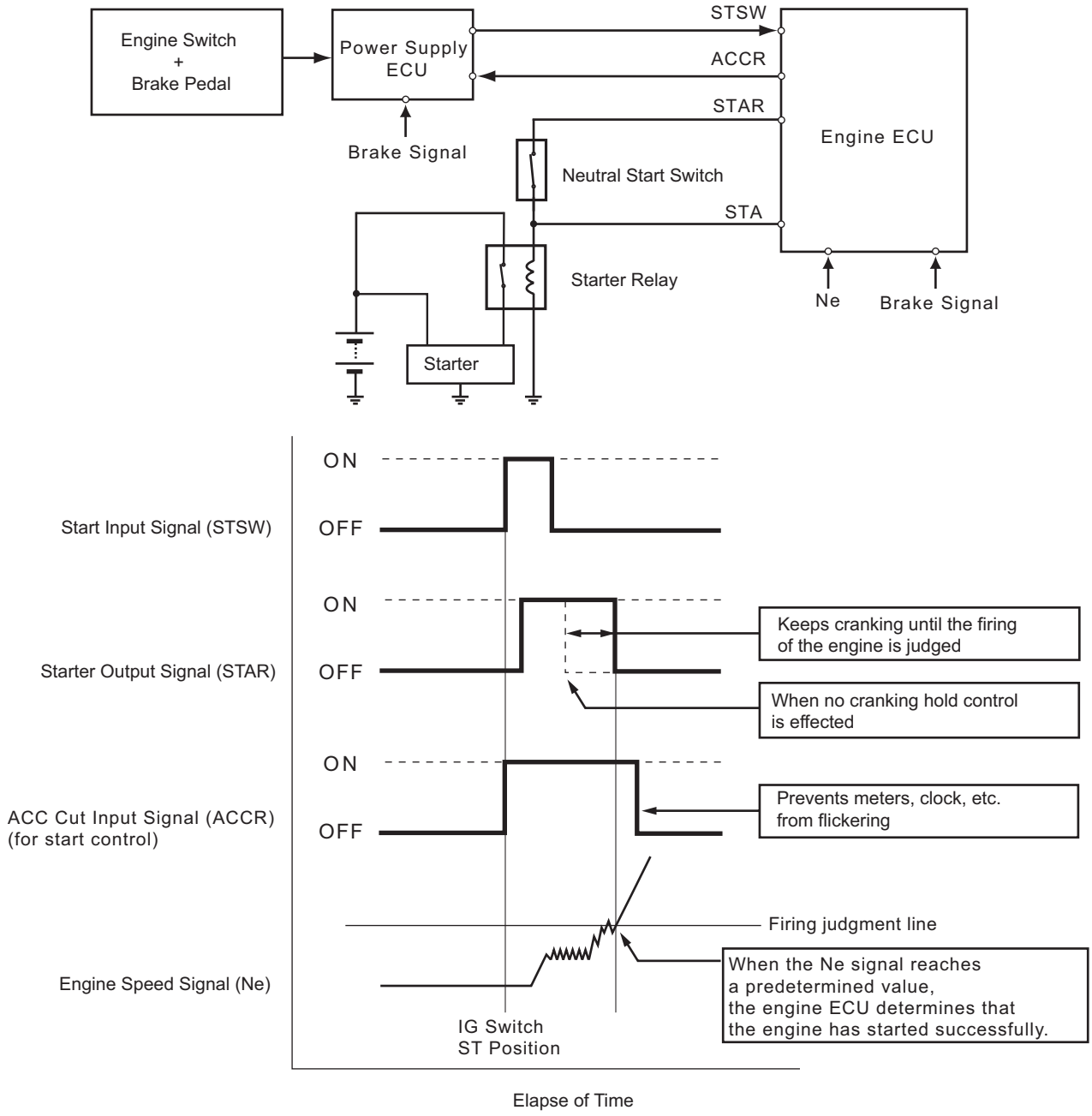


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Cranking Hold Control

- When a start signal (STSW) is input by the engine switch, the engine ECU sends a signal (STAR) to the starter relay via the Park/Neutral Position switch (to determine P or N position), in order to start the starter. At this time, the engine ECU turns ON the ACC cut (ACCR) switch to prevent the meters, clock, and audio unit from flickering.
- After the starter starts, the engine ECU continues to output a signal to the starter until it detects that the engine has fired. After cranking, when the engine speed becomes higher than a predetermined speed, the engine ECU determines that the engine has fired, and stops the signal that is output to the starter relay.

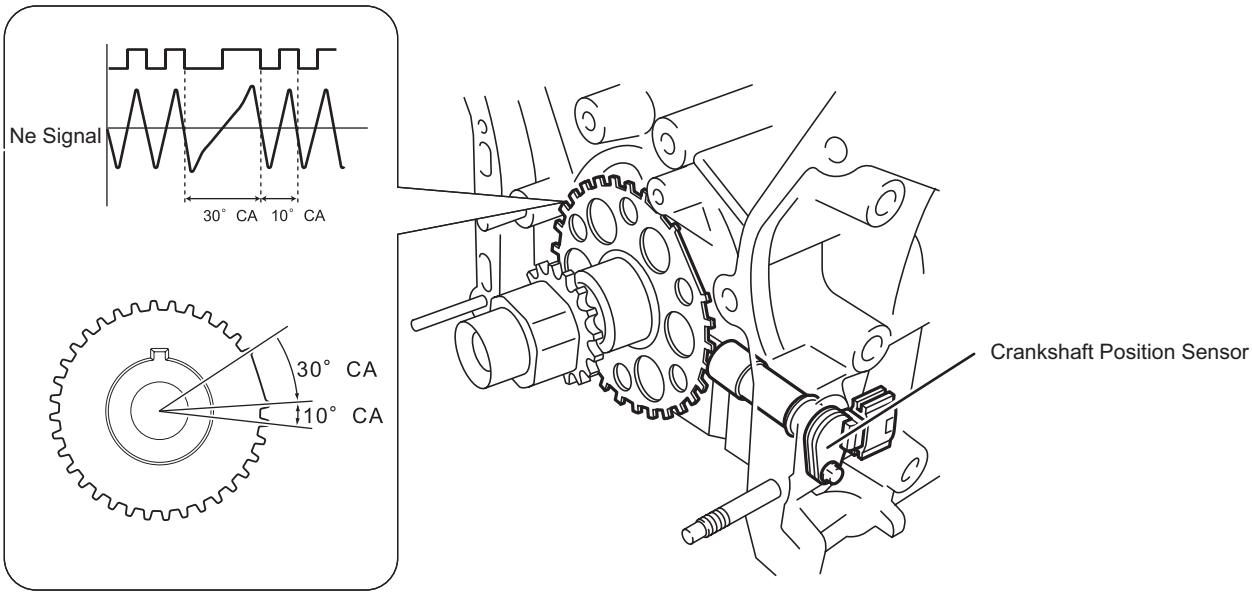


Cranking Hold Control Circuit Diagram (SMART ACCESS SYSTEM with PUSH-BUTTON START Type) and System Diagram

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Crankshaft Position Sensor

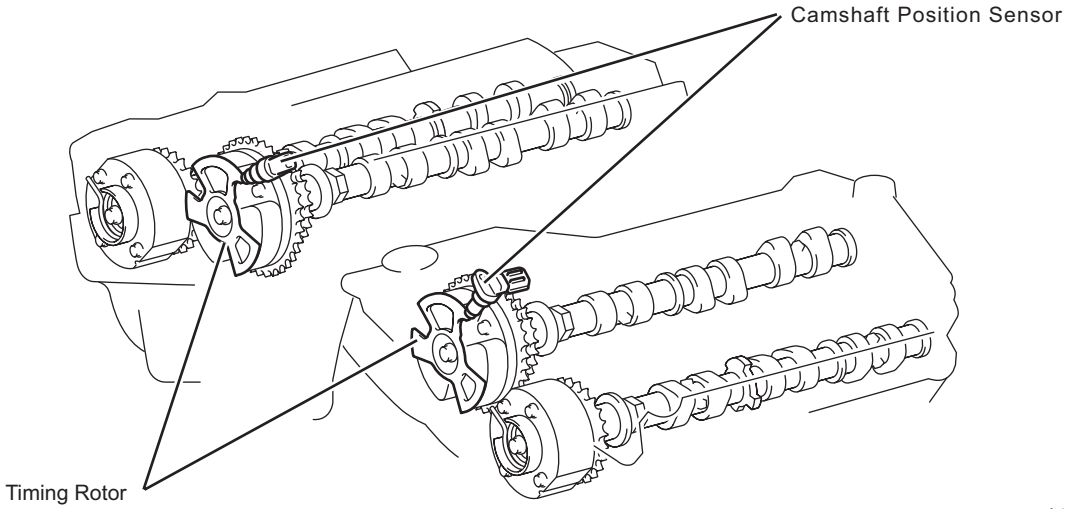
- The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.
- This engine uses an electromagnetic pickup sensor that provides a high level of detection accuracy. When the crankshaft rotates, the air gap between the protrusion on the timing rotor and the crankshaft position sensor changes. This causes the magnetic flux that passes through the coil of the crankshaft position sensor to increase and decrease, causing the coil to generate an electromotive force. This electromotive force generates voltage in opposing directions, depending on whether the protrusion of the timing rotor approaches the crankshaft position sensor or withdraws from the sensor. Thus, the voltage appears in the form of alternating current voltage.



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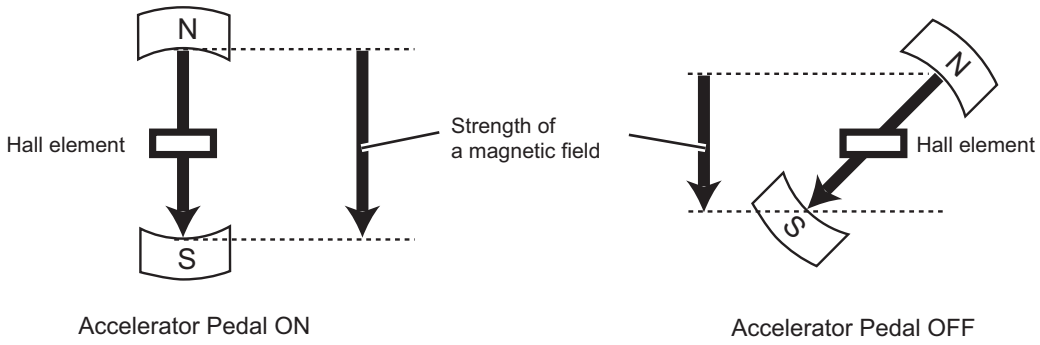
Camshaft Position Sensor

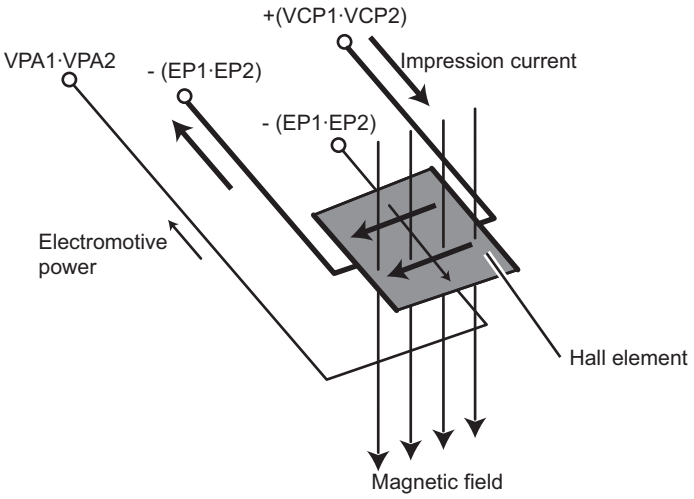
- These sensors are the MRE (Magnetic Resistance Element) type. The rotational movement of the timing rotor (which is provided in the VVT-i controller of the intake camshaft) causes a magnetic field to act on the magnetic resistance element in the sensor. The sensor utilizes the changes that occur in the direction of the magnetic field to detect the position of the timing rotor, which determines the position of the actual camshaft. The cylinders are identified by the input sequence of the Ne and G2 signals.

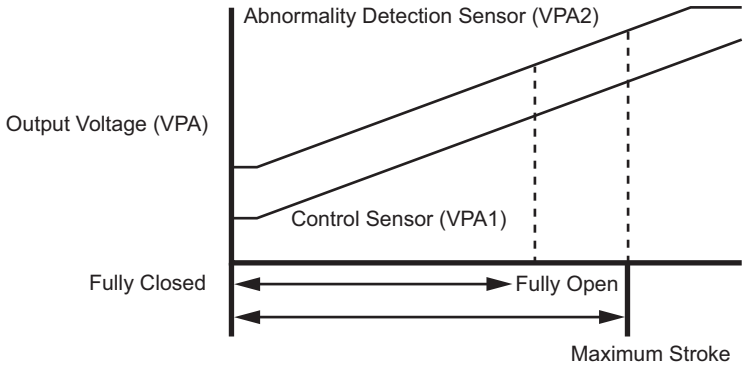


Accelerator Pedal Position sensor

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







Accelerator Position Sensor Output Voltage Characteristics

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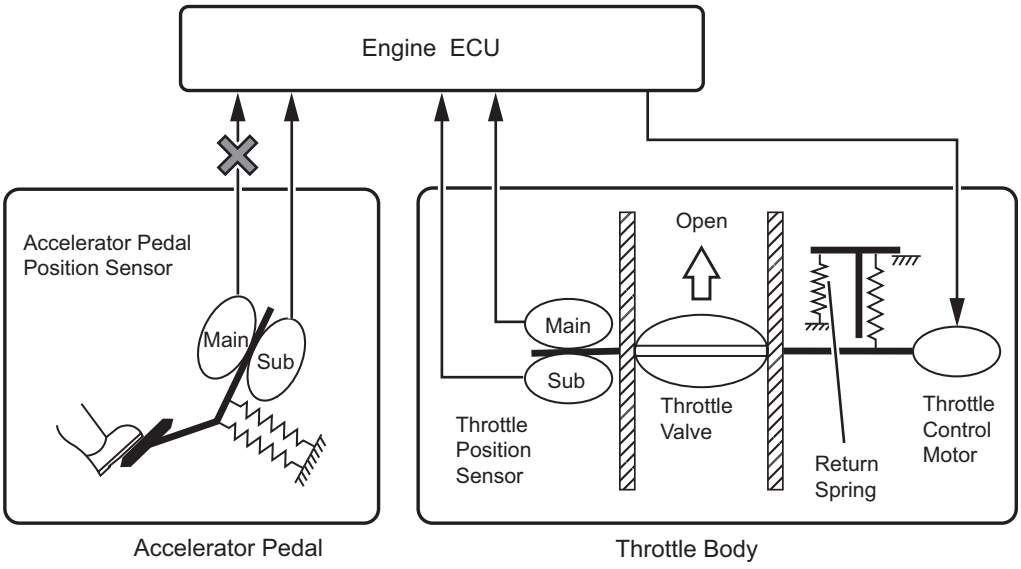
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Fail Safe

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

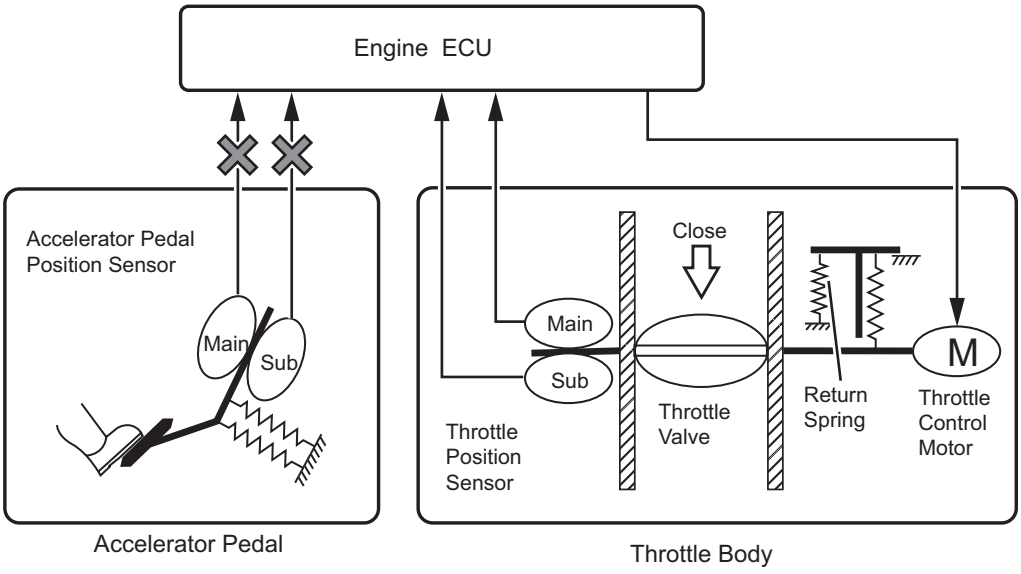
System 1 Failure

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



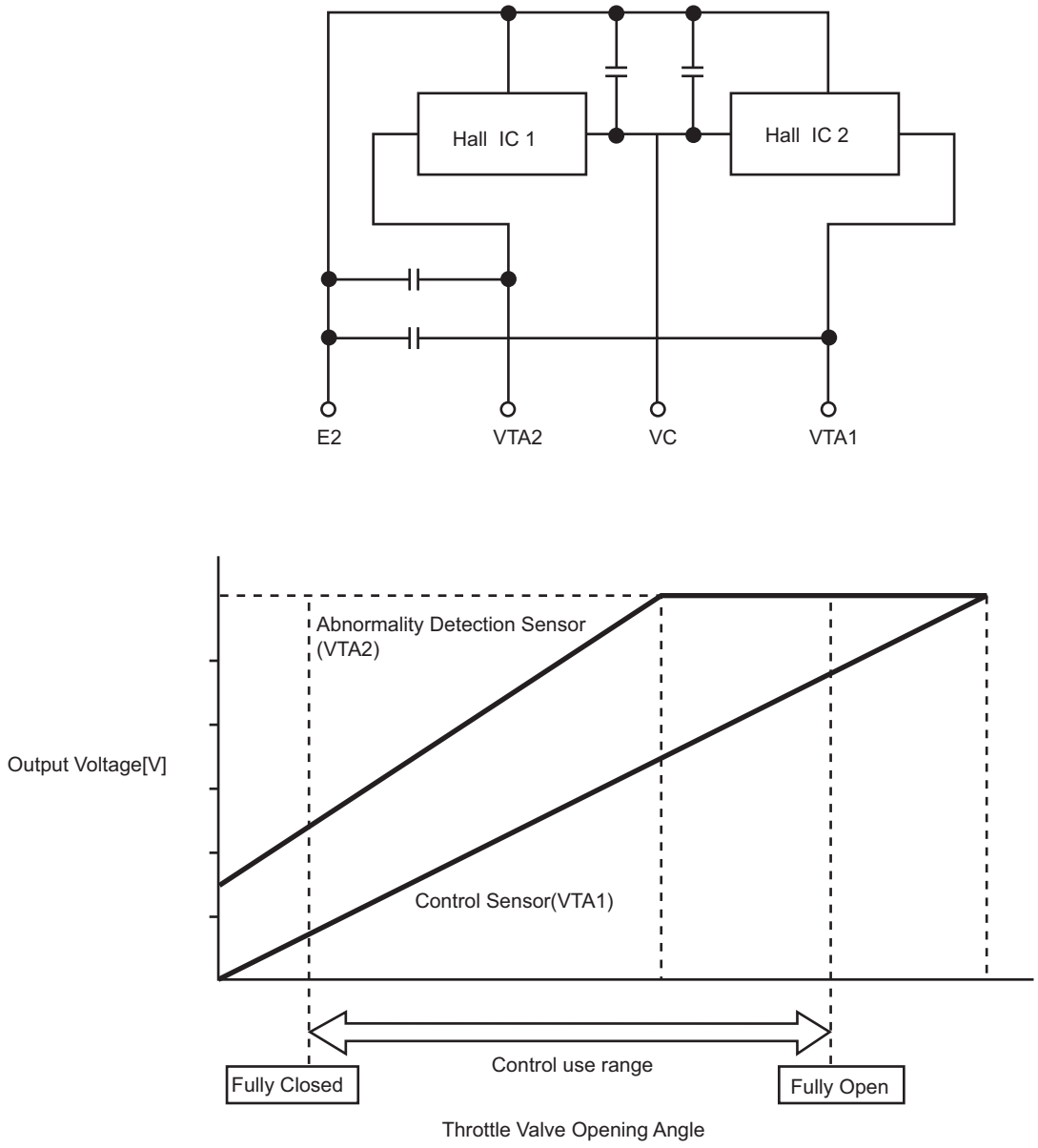
System 2 Failure

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



Throttle Position Sensor

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



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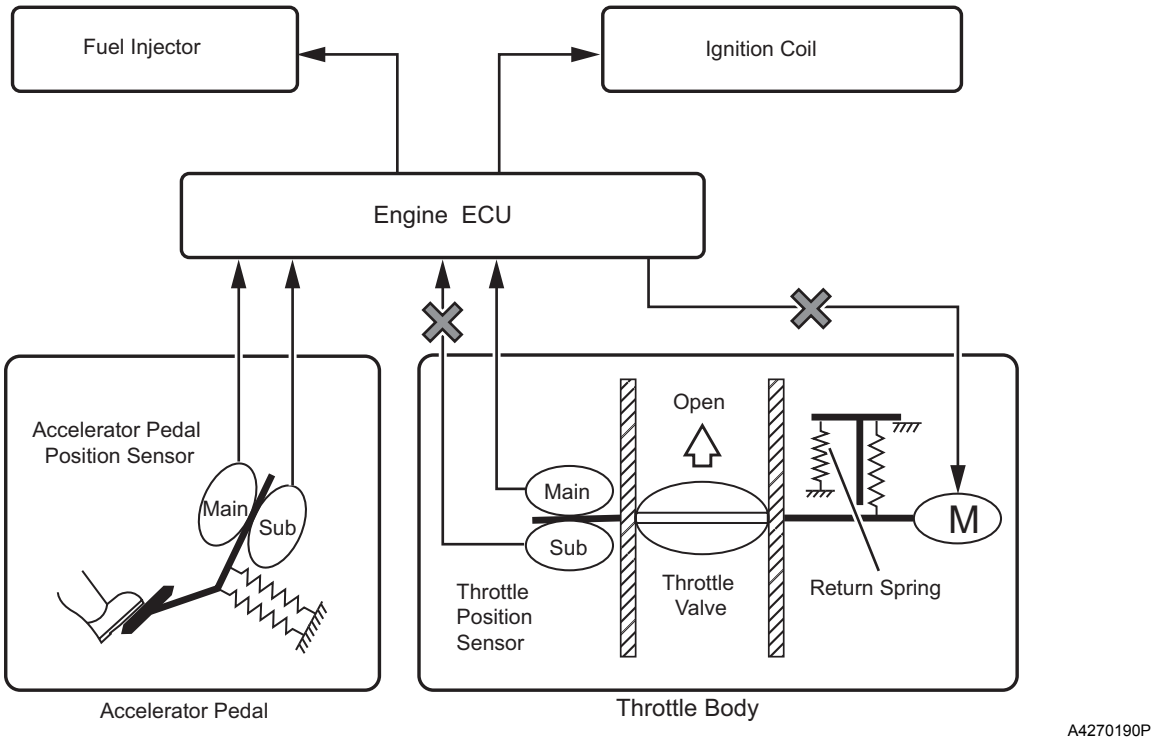
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Fail Safe

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

Failure Detection

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

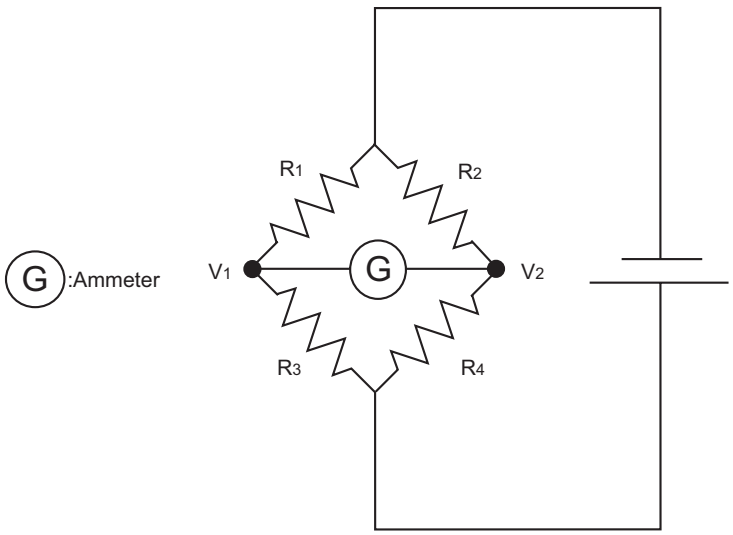


Air Flow Meter

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

Hot Wire Type Air flow Meter Operation

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

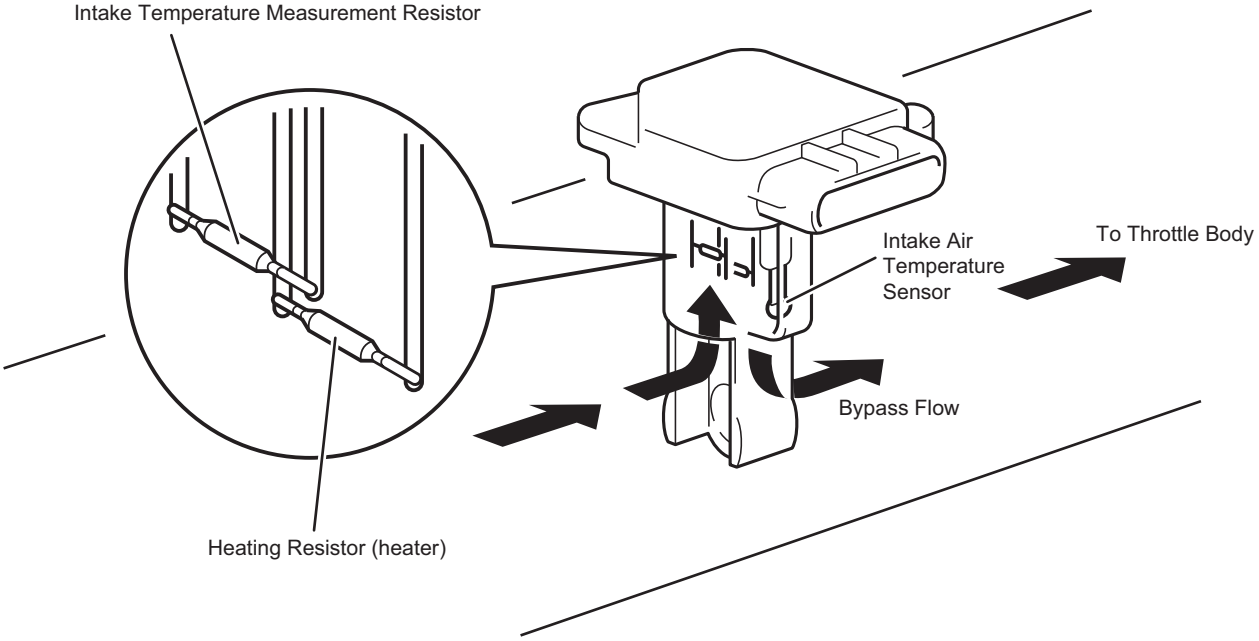


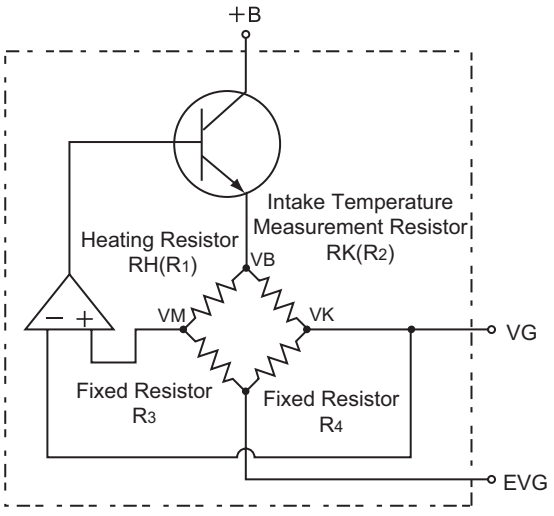
Bridge Circuit

A4270025P

EG

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



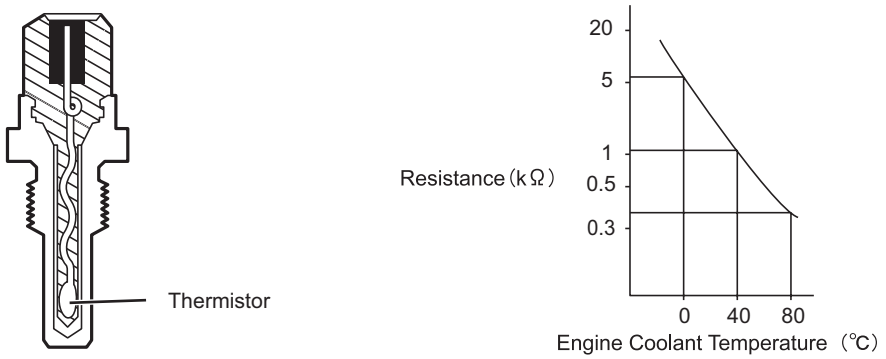


Bridge Circuit

A4270026P

Water Temp.Sensor

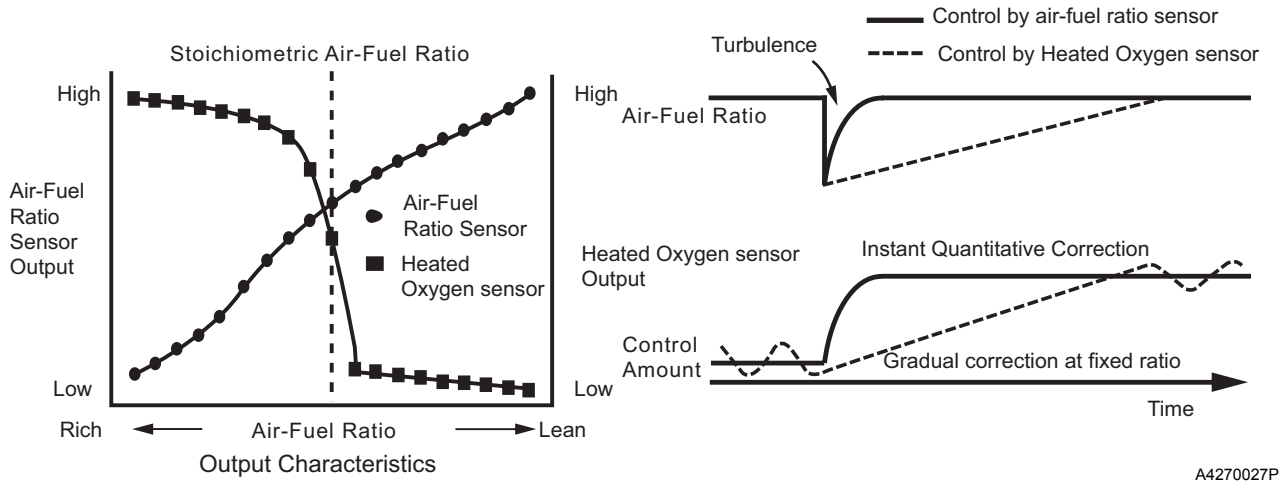
- This sensor detects the water temperature and sends a signal to the engine ECU.



A4270105P

Air Fuel Ratio Sensor

- An air-fuel ratio sensor is used to ensure the reliable feedback of the state of the air-fuel ratio in the exhaust gas. An heated oxygen sensor outputs a lean or rich signal bordering on the stoichiometric air-fuel ratio. In contrast, the air-fuel ratio sensor has output characteristics that are proportionate to the air-fuel ratio. Therefore, the engine ECU is able to effect a more precise control.
- As with the heated oxygen sensor, a heater is used to heat and maintain a constant temperature in the air-fuel ratio sensor, thus promoting the proper feedback control.



A4270027P

Heated Oxygen Sensor

- This sensor detects the oxygen concentration in the exhaust gas.

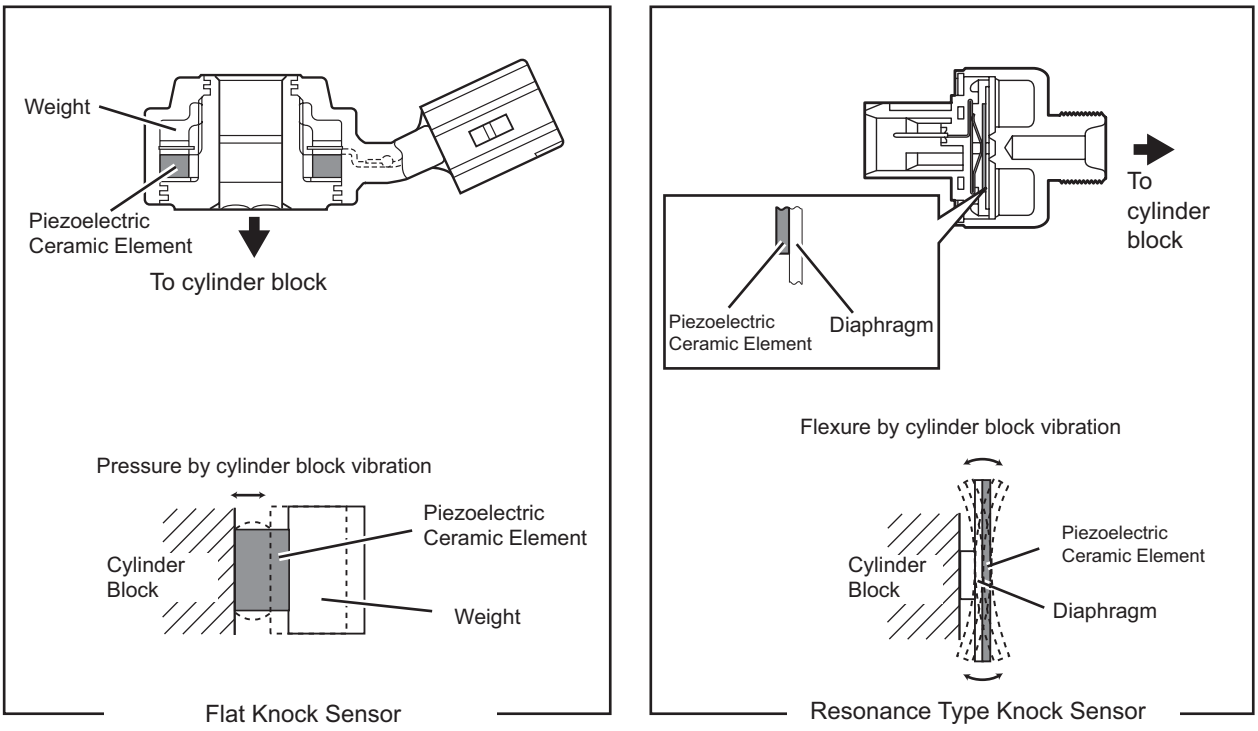
EG

Knock Sensor (Flat Type)

● When the conventional resonance type knock sensor receives vibrations from the cylinder block, a diaphragm on a piezoelectric ceramic element flexes along the area where it is mounted to the cylinder block acting as the fulcrum. This causes a pressure to act on the piezoelectric ceramic element, which generates a voltage. In contrast, when the flat (non-resonance type) knock sensor receives vibrations from the cylinder block, a delayed movement of the weight occurs in the sensor due to the inertial force of the weight. This causes a pressure to be applied to a piezoelectric ceramic element, which is provided between the cylinder block and the weight, thus generating a voltage.

Knock Sensor Operation

• In the conventional resonance type knock sensor, the diaphragm resonates at a certain frequency at which the engine knocks. Therefore, when the knock sensor generates an output, the engine ECU determines that knocking has occurred. In contrast, the flat (non-resonance type) knock sensor has practically constant output characteristics in all frequency ranges. Therefore, the engine ECU can detect a target frequency at which knocking occurs, enabling a more accurate knocking detection.



A4270028P

Camshaft Timing Oil Control Valve

- In accordance with the duty cycle signals received from the engine ECU, this OCV controls the position of the spool valve in order to constantly achieve optimal valve timing. When the engine is stopped, the force of a spring keeps the intake side of the spool valve in the most retarded state, and the exhaust side to the most advanced state, in order to ready the valves for the subsequent starting.
  (See page EG-63)

Injector

- Injectors with 4 orifices are used. They are mounted directly into the cylinder heads to shorten the distance to the combustion chambers, thus reducing the adhesion of fuel to the intake ports.
  (See page EG-76)

Fuel Pump

- A fuel pump assembly consisting of a fuel pump, fuel filter, and sender gauge is used.
  (See page EG-73)

Ignition Coil (with Igniter)

- Ignition coils with built-in igniters are used and placed directly over the spark plugs.
  (See page EG-95)

VSV (For EVAP)

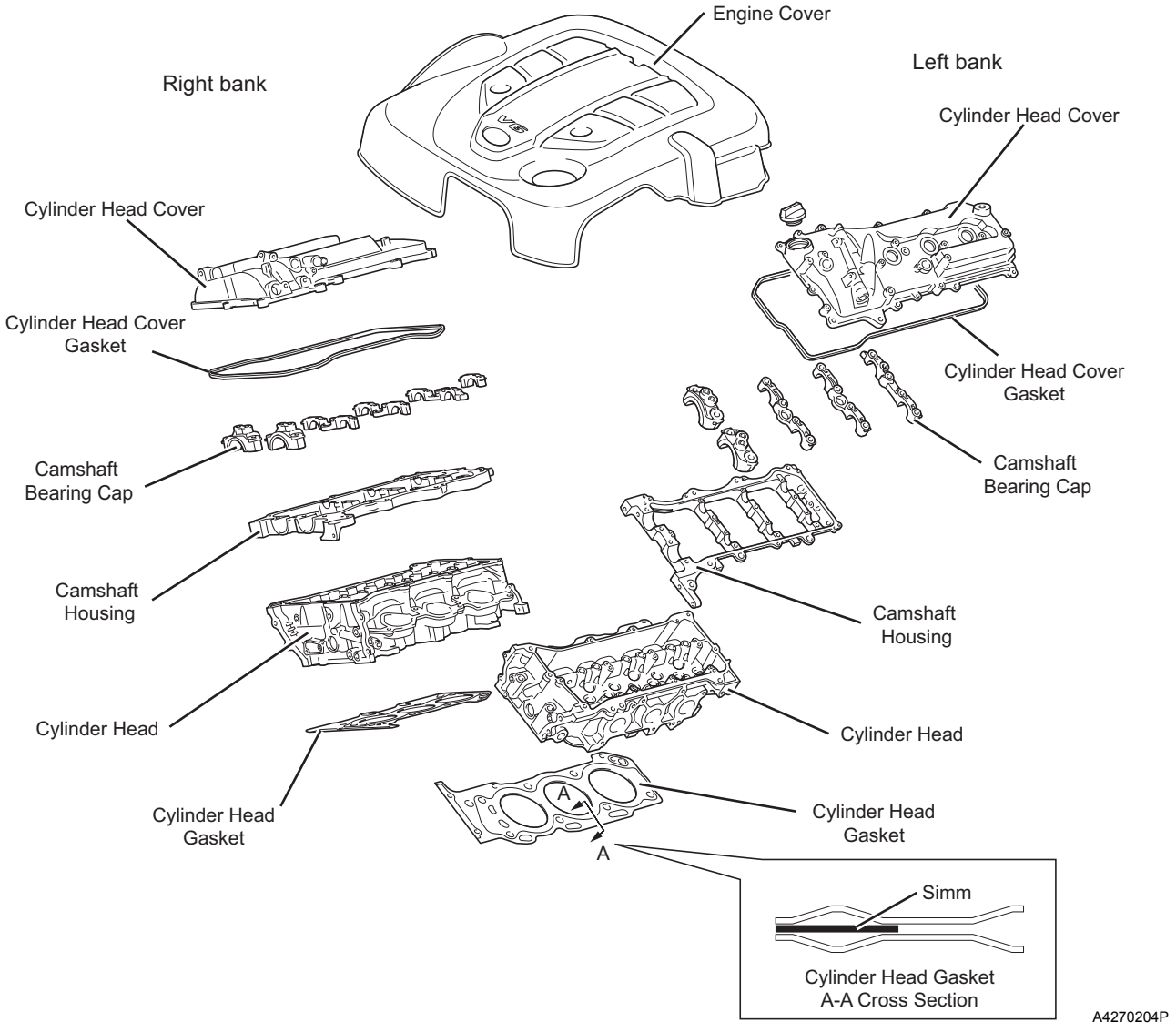
- Regulates the purge volume of the canister.

3GR-FE ENGINE MECHANICAL

EG

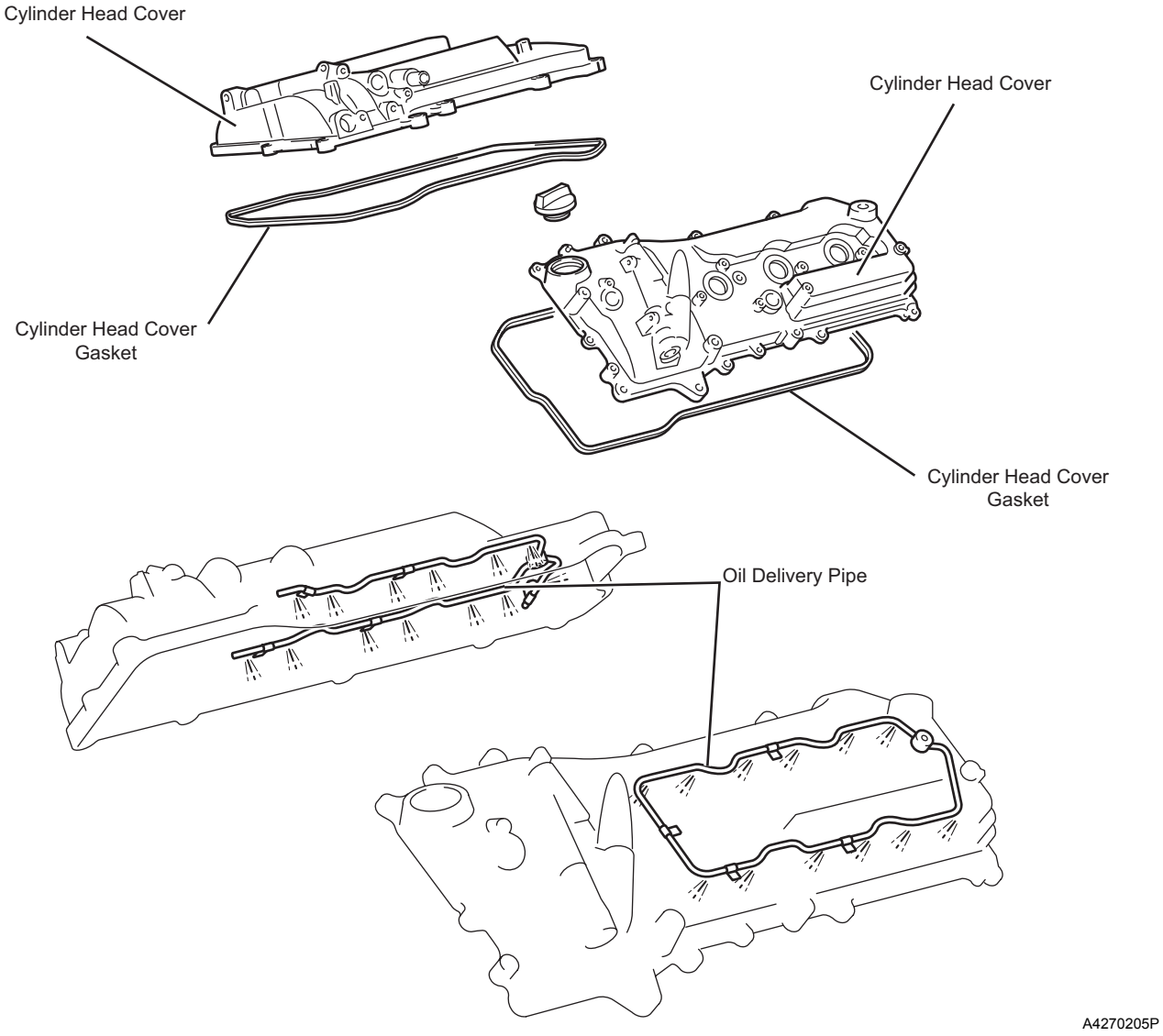
Cylinder Head Fitting Parts

- The cylinder heads are made of a lightweight and highly rigid aluminum alloy. Also, the VVT-i supply oil passage has been separated from the cylinder heads to simplify the oil passage in the cylinder heads.
- The cylinder head gaskets are the two-layer metal type. Shims are provided around the bores to ensure sealing performance and durability.
- The cylinder head covers are made of a lightweight aluminum alloy. They are tightened to the cylinder heads by way of fixed-dimension flanges along their periphery to ensure the proper sealing performance.
- OCVs (oil control valves) for Dual VVT-i are mounted on both the right and left cylinder head covers.
- The cylinder head cover gaskets are made of acrylic rubber, which excels in heat resistance and oil resistance.



Cylinder Head Cover

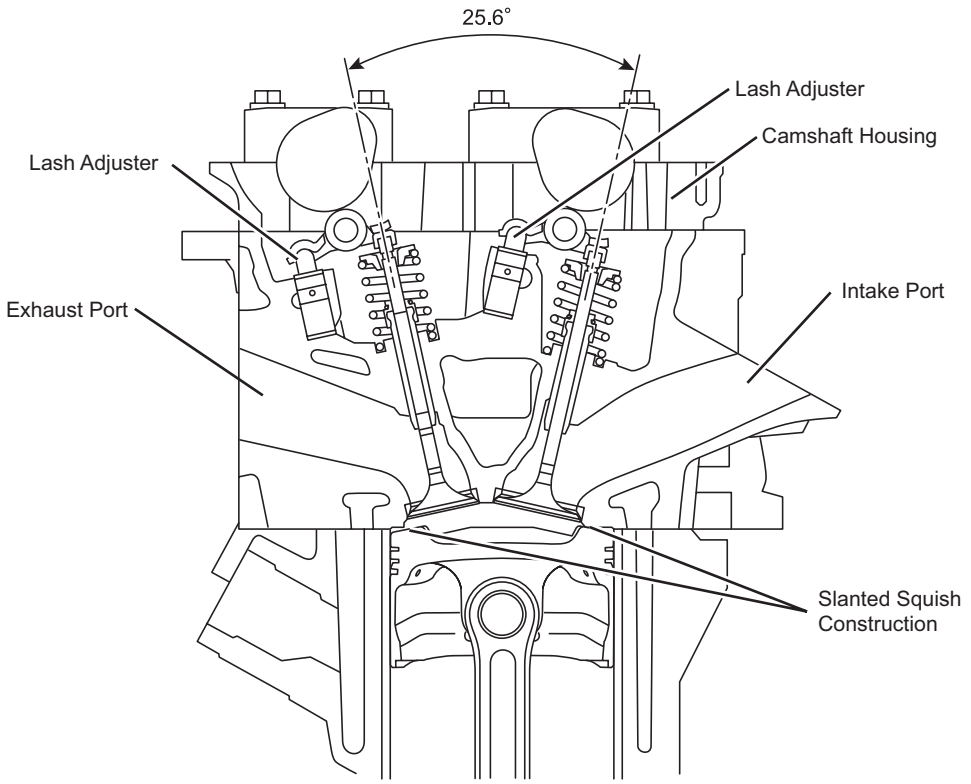
- Large baffle plates are built into the right and left head covers. By reducing the flow rate of blowby gas, these baffle plates remove oil droplets and oil mist, thus reducing the volume of oil taken away.
- Oil delivery pipes are provided to supply engine oil, in order to properly lubricate the sliding areas of the roller rocker arms, thus enhancing their reliability.



EG

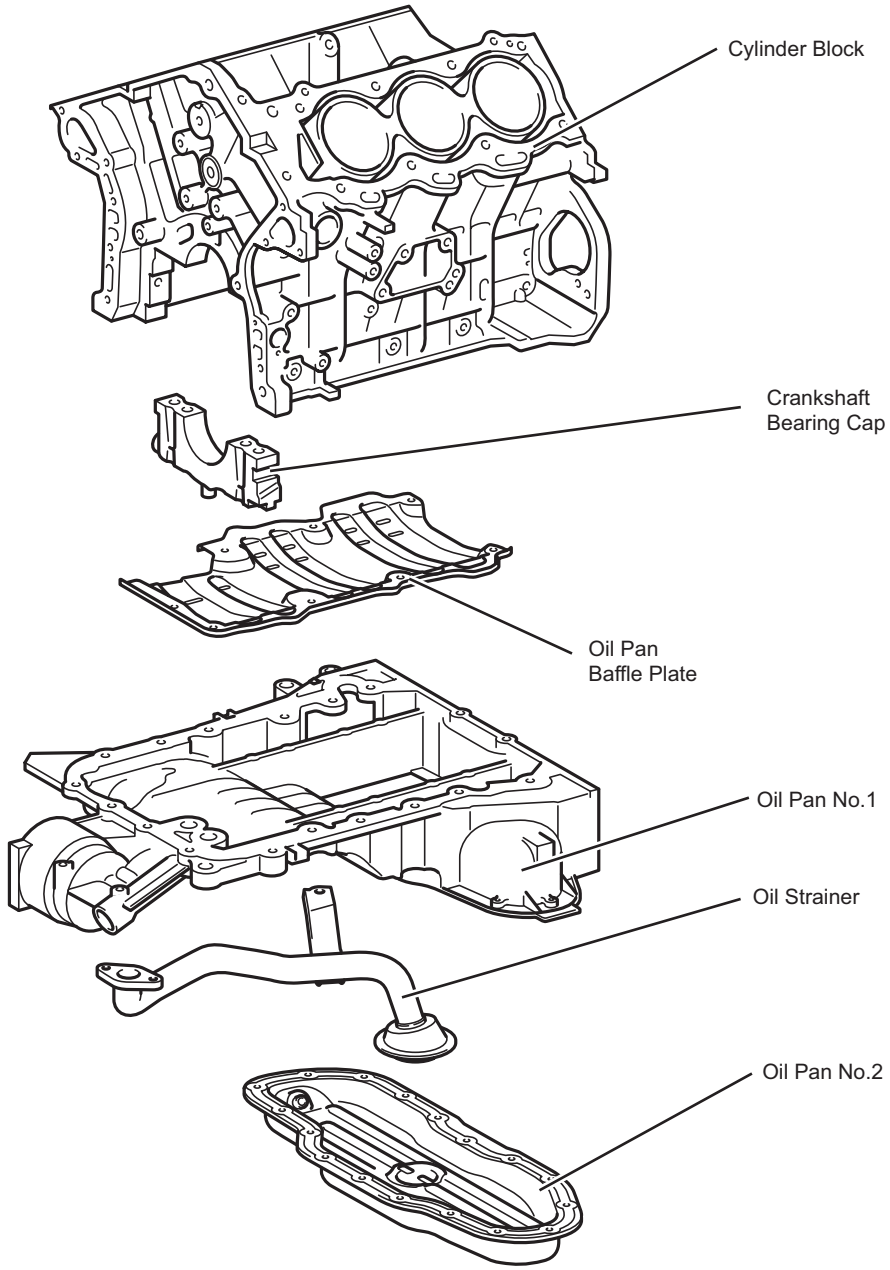
Cylinder Head

- By using a two-piece construction in which the portion that receives the cam journals is separate from the cylinder head proper, the configuration of the cylinder head proper has been simplified. This results in weight reduction and improved serviceability.
- Pentroof combustion chambers are used. A spark plug is located practically in the center of each combustion chamber to enhance combustion efficiency and knock resistance. Furthermore, the angle between the intake and exhaust valves has been narrowed to 25.6 degrees, thus making the combustion chamber compact.
- The port configuration is an efficient cross-flow type in which the intake ports face the inside of the V bank and the exhaust ports face the outside. The intake and exhaust ports have a Siamese construction. The intake port configuration has been optimized to realize high intake efficiency.
- The diameter of the valve stem and the outer diameter of the valve guide have been reduced to reduce intake resistance.
- The cylinder head bolts are tightened with the plastic region tightening method in order to stabilize the axial tension of the bolts.



Cylinder Block Fitting Parts

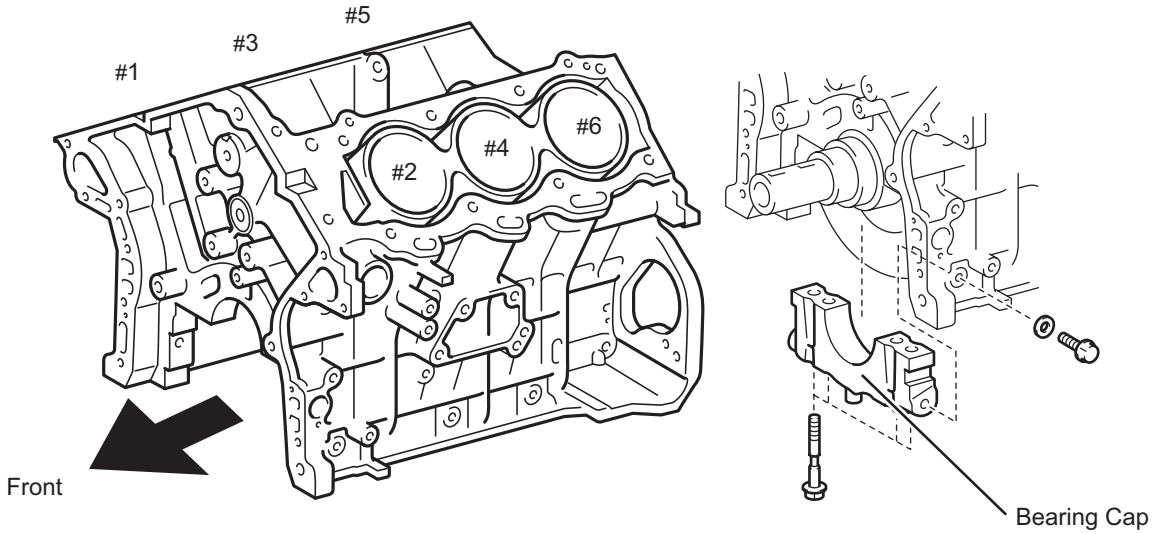
- The cylinder block is made of an aluminum alloy to realize a dramatic weight reduction. Furthermore, it has been made compact in terms of both overall length and width as follows: a 60° V6 bank angle, a 36.6mm(1.441in.) bank offset, and a 105.5mm(4.154in.) bore center distance.
- The oil pan consists of a two-piece construction. Oil pan No. 1 is made of an aluminum alloy, and oil pan No. 2 is made of stamped steel sheet. Oil pan No. 1 has built-in stiffeners that tighten the cylinder block and the transaxle case together. This increases the rigidity of the entire power plant, resulting in reduced vibration and weight reduction.
- Appropriate ribs are placed on the outer wall of the cylinder block to increase rigidity.
- An FIPG (Formed-In-Place Gasket), which excels in sealing performance, is used on the mating surfaces of the oil pan.



EG

Cylinder Block

- The cylinder liner is a centrifugal cast iron liner insert. Its outer spiny surface enhances contact with the aluminum block, thus improving heat dissipation. This lowers the temperature of the piston and suppresses the deformation of the bore.
- The outer walls of the block are curved and reinforcement ribs are provided on the end of the block that is coupled to the transmission in order to attain a high level of rigidity.
- The oil return holes from the cylinder heads and the blowby gas passages have been optimally arranged to ensure the smooth return of oil and heighten the rigidity of the side faces of the cylinder block.
- Drilled coolant passages are provided between the bores in order to positively cool the upper areas of the cylinder bores, which are easily affected by heat. Thus, a more uniform temperature distribution has been achieved in the circumferential direction of the bore wall surface. This improves knocking resistance and minimizes the heat deformation that occurs between the cylinder bores. Thus, an engine with low friction, high performance, and enhanced fuel economy has been achieved.
- A knock sensor is provided on both the right and left sides of the V bank, enabling optimal knock control.
- The crankshaft bearing caps are made of cast iron, and each is tightened with 4 bolts from the bottom, using the plastic region tightening method. Also, each bearing cap is tightened from both sides together with the cylinder block, which increases rigidity and decreases vibration and noise.



Bearing cap attachment appearance

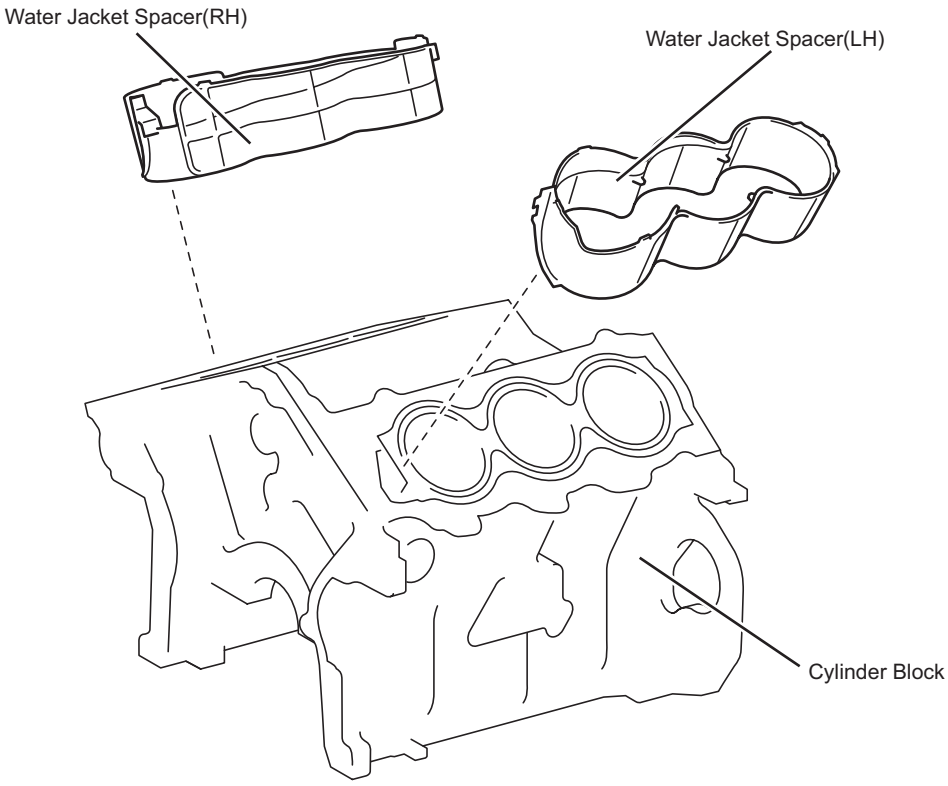
A4270061P

Cylinder Block

Overall Length	[mm (in.)]	402.1 (15.831)
Overall Width	[mm (in.)]	408.0 (16.063)
Overall Height	[mm (in.)]	320.1 (12.606)
Bore Diameter	[mm (in.)]	87.5 (3.445)
Bore Center Distance	[mm (in.)]	105.5 (4.154)
Bank Offset	[mm (in.)]	36.6 (1.441)

Water Jacket Spacer

- A water jacket spacer made of plastic, which excels in heat resistance and forming precision, is provided in the water jacket of the cylinder block. This optimizes heat distribution along the cylinder bore wall and reduces friction.



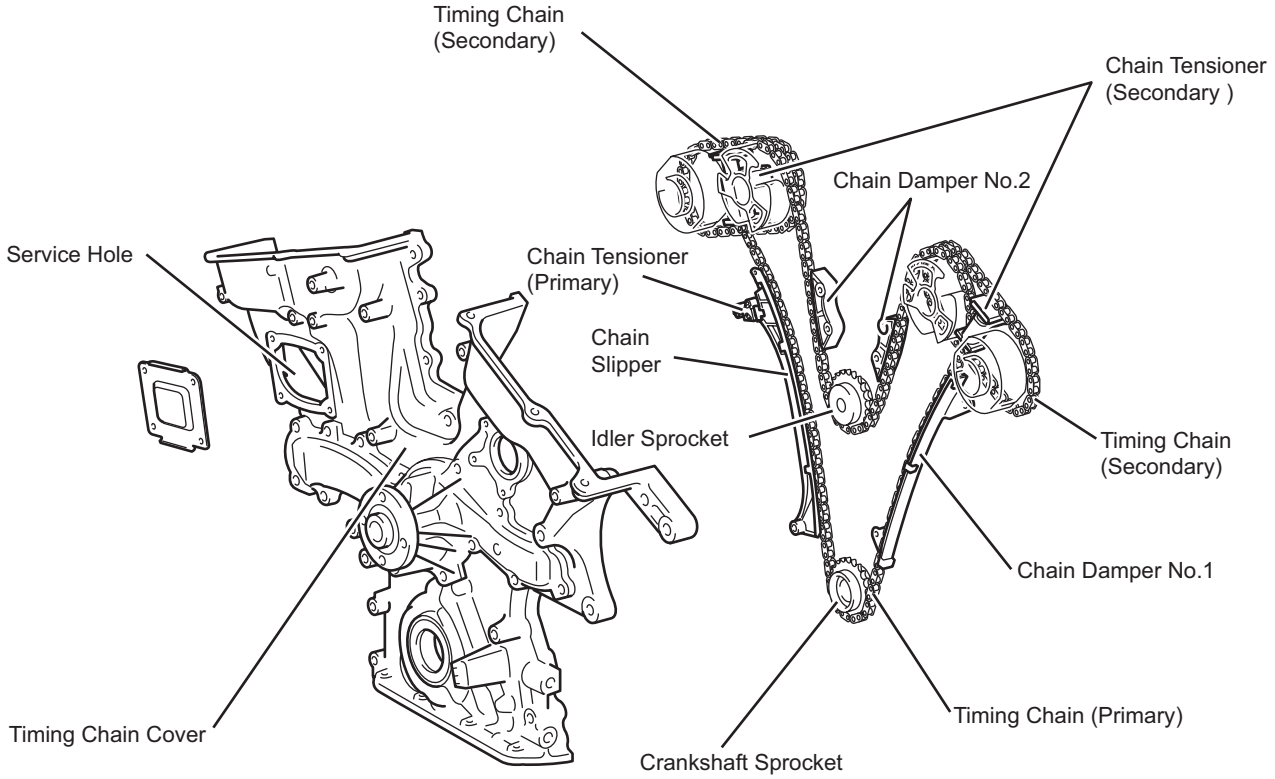
Function of Water Jacket Spacer

The water jacket spacer suppresses the water flow in the center of the water jacket. This increases the flow speed of the coolant along the upper part of the cylinder bore, thus improving the cooling of the upper area of the cylinder block and between the cylinder bores. Furthermore, the area near the center of the cylinder bore becomes less susceptible to the influences of the coolant, allowing the temperature along the wall surface to rise. These measures decrease the temperature differences along the surface of the cylinder bore wall and enable uniform thermal expansion. In addition, these measures lower the viscosity of the engine oil that adheres to the surface of the bore wall, thus reducing friction.

EG

Timing Chain

- The timing mechanism is a chain-driven system that is maintenance-free. Both the primary and secondary timing chains consist of 9.525mm (0.375in.)pitch, high-strength, single-row roller chains and compact sprockets, which contribute to making the engine compact.
- A two-stage chain system is used. It consists of a primary chain that enables the crankshaft to drive the right and left intake camshafts, and a secondary chain that enables the intake camshafts to drive the exhaust camshafts.
- The primary chain uses a check ball type chain tensioner with a ratchet mechanism that uses both engine oil pressure and a spring force. The secondary chain uses a compact tensioner that directly pushes on the chain by using engine oil pressure and a spring force. These tensioners constantly apply optimal tension to the timing chains in order to ensure a quiet and reliable operation.
- The timing chain cover is made of an aluminum alloy that is lightweight and excels in sound insulation capability. The one-piece cover seals the front of the cylinder block, camshaft housing, and cylinder head. The crankshaft sprocket is provided with a guide that prevents the chain links from jumping. This prevents the chain from being installed incorrectly during maintenance, as a result of the chain falling out. A service hole for the primary chain tensioner is provided in the timing chain cover to facilitate maintenance.
- The chain dampers and the tensioner shoes are made of a plastic material that excels in wear resistance.



A4270063P

Sprocket

	Number of Teeth
Crankshaft Sprocket	18
Idler Sprocket	18
Camshaft Sprocket (Primary)	36
Camshaft Sprocket (Secondary: IN)	24
Camshaft Sprocket (Secondary: EX)	24

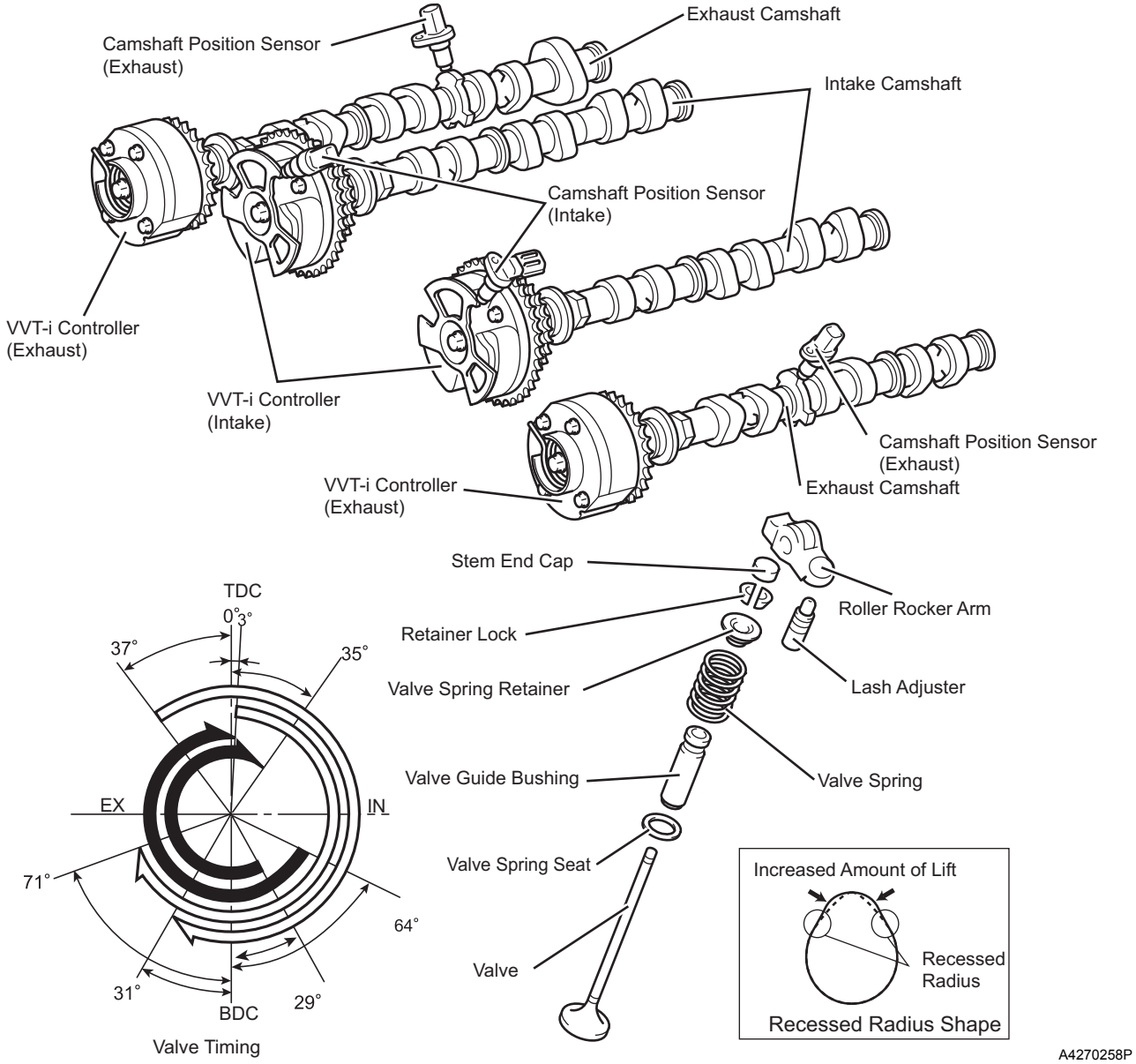
Timing Chain

	Number of Links
Timing Chain (Primary)	170
Timing Chain (Secondary)	46

EG

Valve Mechanism

- A Dual VVT-i (Dual Variable Valve Timing-intelligent : continuously variable intake and exhaust valve timing mechanism) system is used to control the intake camshaft and the exhaust camshaft to an optimal valve timing in accordance with the driving conditions.
- The camshafts are made of alloyed cast iron. Their cams are induction hardened and their surfaces are finished with a higher precision to improve wear resistance and reduce friction.
- Roller rocker arms are used in the valve train in order to dramatically reduce friction between the cams and the sliding surfaces to improve fuel economy. In addition, hydraulic lash adjusters are used, making valve clearance adjustments unnecessary and facilitating service.
- Along with the use of the roller rocker arms, the cam profile has been shaped with recessed radii. This increases the amount of valve lift near the beginning of the opening of the valve and near the end of the closing of the valve, in order to further increase power output.



Camshaft

	Intake	Exhaust
Cam Lift Amount [mm (in.)]	5.99 (0.236)	6.14 (0.241)
Cam Lobe Width [mm (in.)]	15.35 (0.604)	14.1 (0.555)

Valve

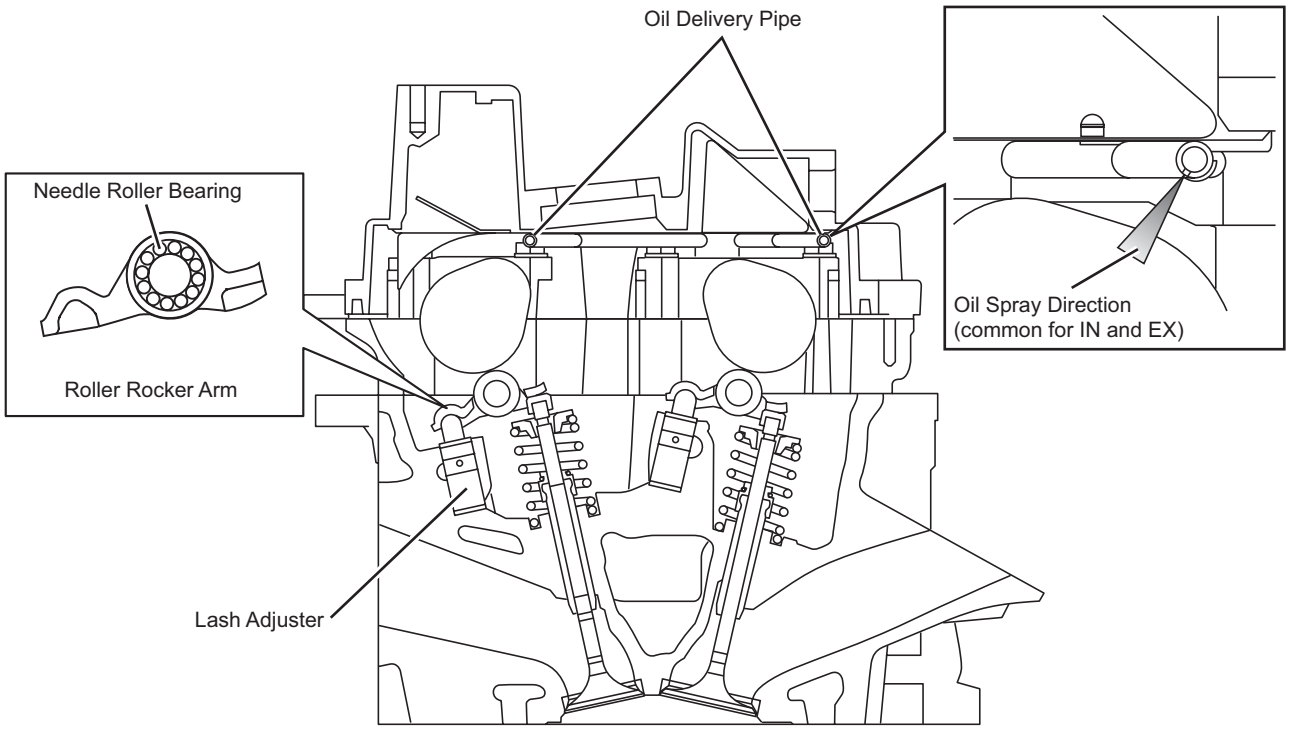
	Intake	Exhaust
Overall Length [mm (in.)]	105.65 (4.159)	111.5 (4.390)
Face Diameter [mm (in.)]	34.5 (1.358)	29.0 (1.142)
Stem Diameter [mm (in.)]	5.5 (0.217)	←

Valve Spring

Wire Diameter [mm (in.)]	3.3 (0.130)
Coil Inner Diamet [mm (in.)]	18.0±0.2 (0.709±0.008)
Free Length [mm (in.)]	46.51 (1.831)

Roller Rocker Arm

- The rocker arm is made compact and lightweight with a stamped steel arm with built-in needle bearings. The roller is supported by needle roller bearings that dramatically reduce friction at the sliding area, which contributes to fuel economy.
- An oil delivery pipe system is used for supplying oil to the roller rocker arms. This system positively supplies oil from above the camshaft to the lubrication area to ensure reliability.



A4270209P

Camshaft

	Intake	Exhaust
Cam Lift Amount [mm (in.)]	5.99 (0.236)	6.14 (0.241)
Cam Lobe Width [mm (in.)]	15.35 (0.604)	14.1 (0.555)

Valve

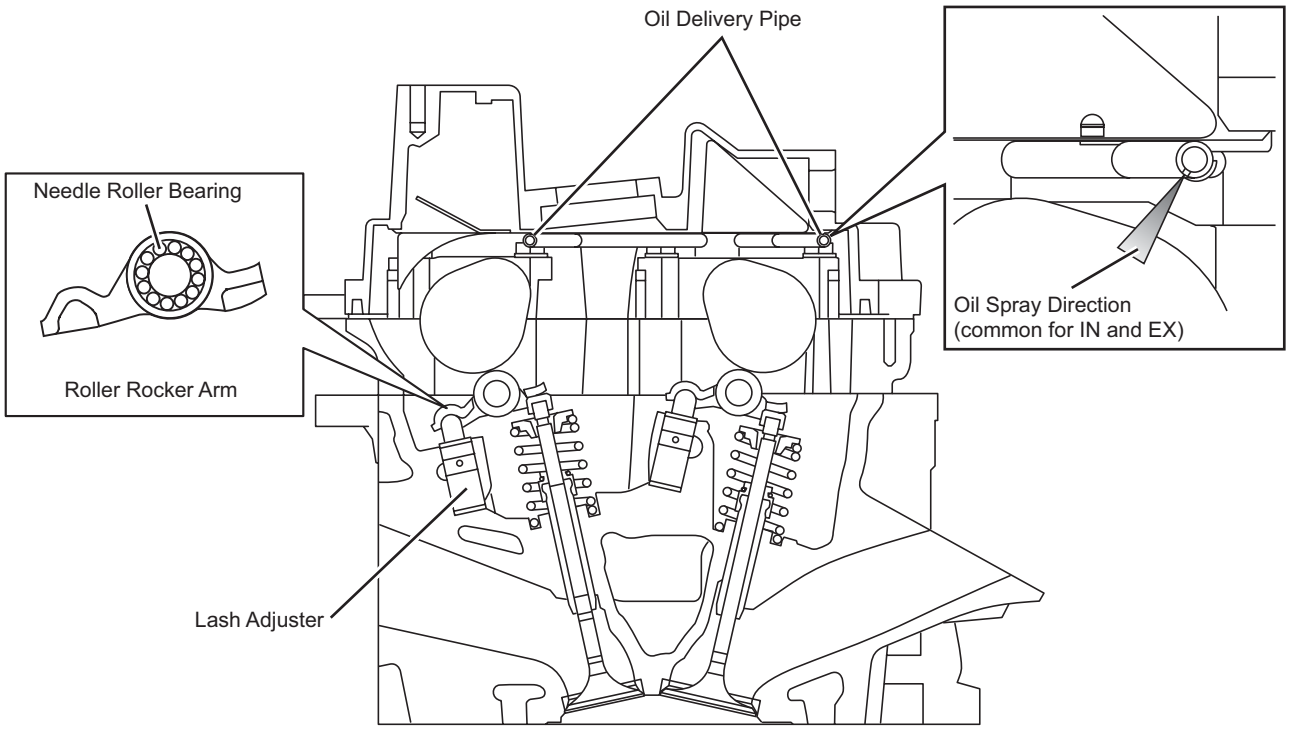
	Intake	Exhaust
Overall Length [mm (in.)]	105.65 (4.159)	111.5 (4.390)
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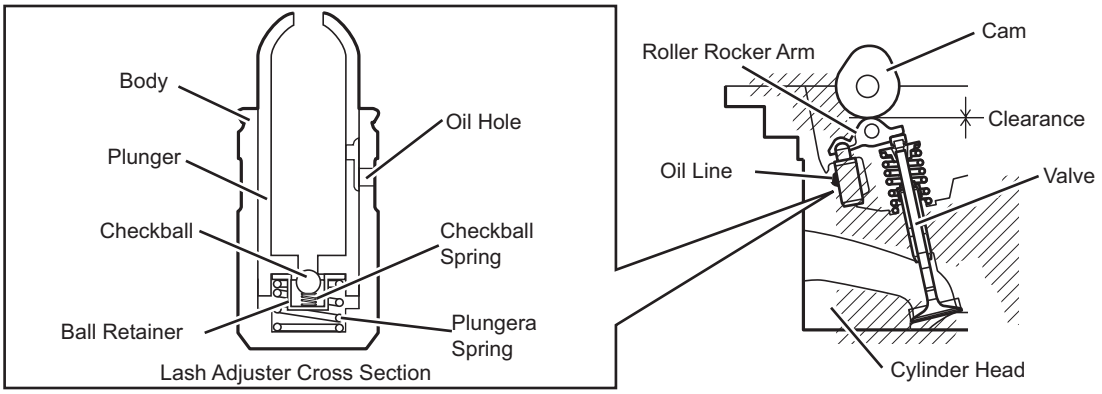
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EG

Lash Adjuster

Lash Adjuster Construction

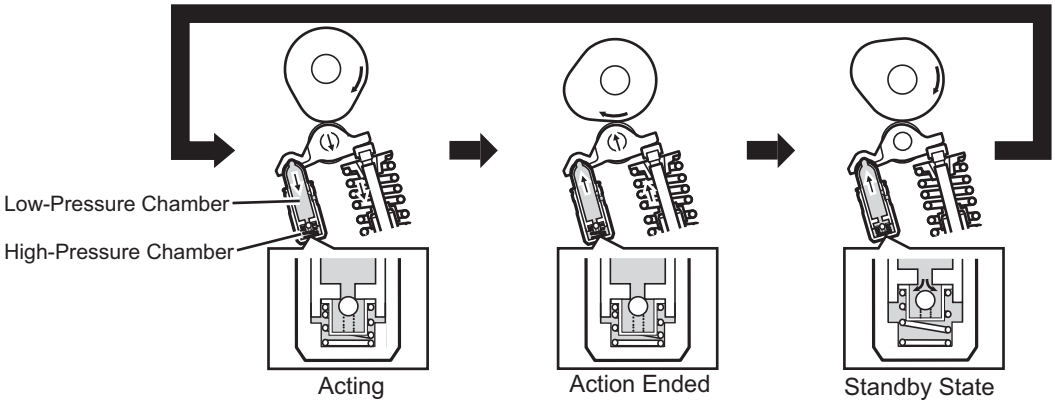
- Compact, hydraulic lash adjusters are used to constantly eliminate the gap (clearance) between the cams and rocker arms, thus enhancing the quiet performance of the engine.
- The lash adjuster is placed at the fulcrum of the rocker arm at the opposite end of the valve, and uses the oil that is supplied by the cylinder head as the operating fluid. The plunger in the lash adjuster body slides vertically due to the repulsion of the plunger spring or the hydraulic force in order to adjust the clearance.



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Lash Adjuster Operation

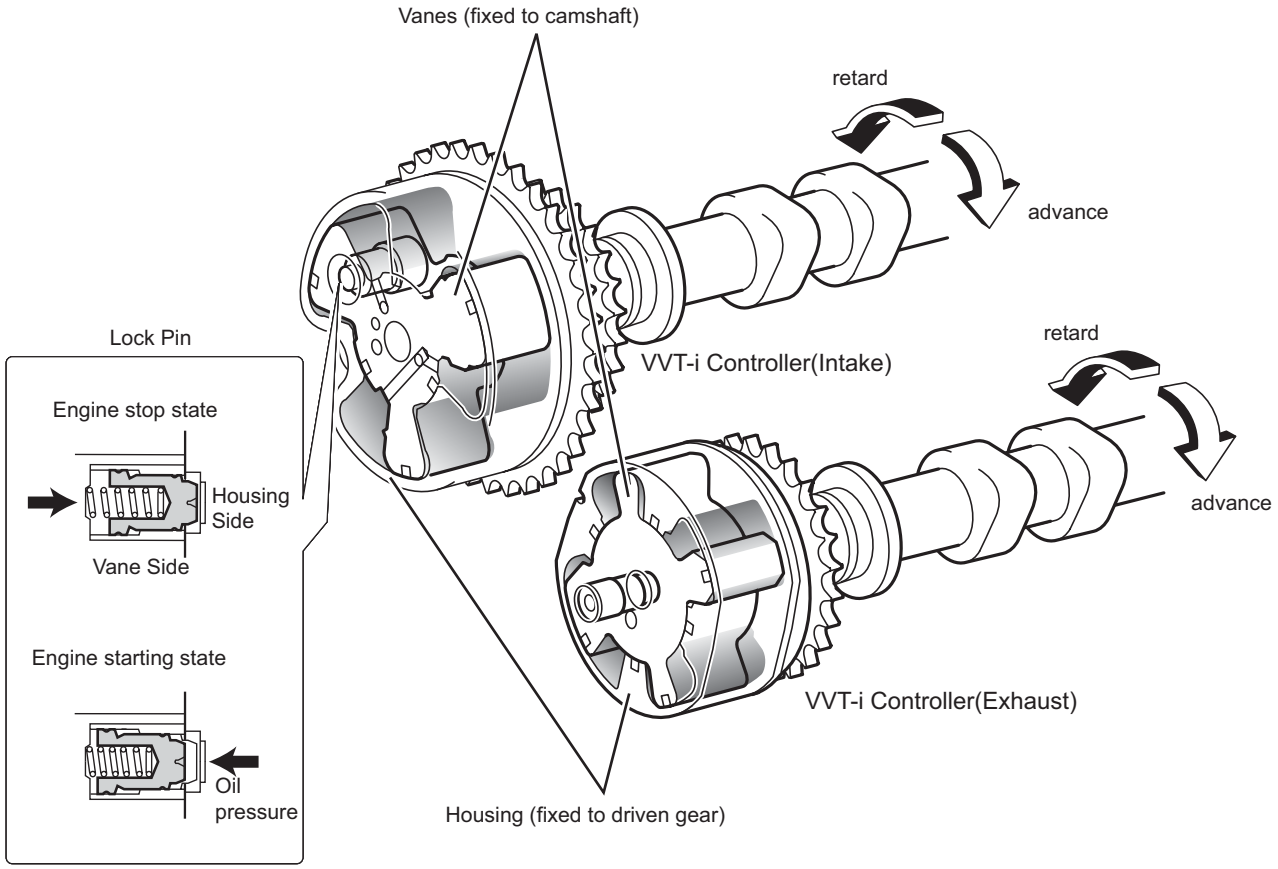
- The camshaft rotates clockwise, causing the cam to push on the rocker arm (acting), and a load is applied to both the valve and the plunger. At this time, the plunger almost gets pushed in, but because the check ball closes, the plunger stops. This allows the rocker arm to tilt in the clockwise direction, using the top of the plunger as the fulcrum, thus pushing the valve down.
- When the cam gets past the apex, the force of the valve spring causes the rocker arm to start ascending. However, because the force of the valve spring also acts on the lash adjuster, the high pressure chamber maintains its hydraulic pressure.
- When the valve closes (action ended), the oil in the high-pressure chamber is released from the pressurized state. At this time, a valve clearance is about to be created. However, the force of the plunger spring causes the plunger to push the rocker arm upward in order to maintain a constant zero valve clearance. At the same time, the capacity of the high-pressure chamber increases, creating a pressure difference between the high-pressure and low-pressure chambers. When this pressure difference becomes greater than the force of the check ball spring, the check ball moves downward to provide an oil passage. This allows the oil to flow from the low-pressure chamber to the high-pressure chamber in preparation for the next movement (standby state).



A4270067P

Dual VVT-i Controller

- The VVT-i controller is a vane type that has low friction and is highly efficient while it is being driven.
- The VVT-i controller for the intake is a 3-vane type, and a 4-vane type for the exhaust. When the engine is stopped, a lock pin locks the vanes for the intake in the most retarded position and the vanes for the exhaust in the most advanced position.
- The VVT-i for the exhaust is provided with an advance assist spring that provides a torque assist in the advance direction so that the lock pin engages securely when the engine is stopped.
- Based on the signals provided by the sensors, the ECM controls the hydraulic pressure that acts on the advance chamber and retard chamber in the VVT-i controller, via an OCV (Oil Control Valve) that is mounted on the cylinder head cover. Thus, it continuously varies the phases of the intake and exhaust camshafts.



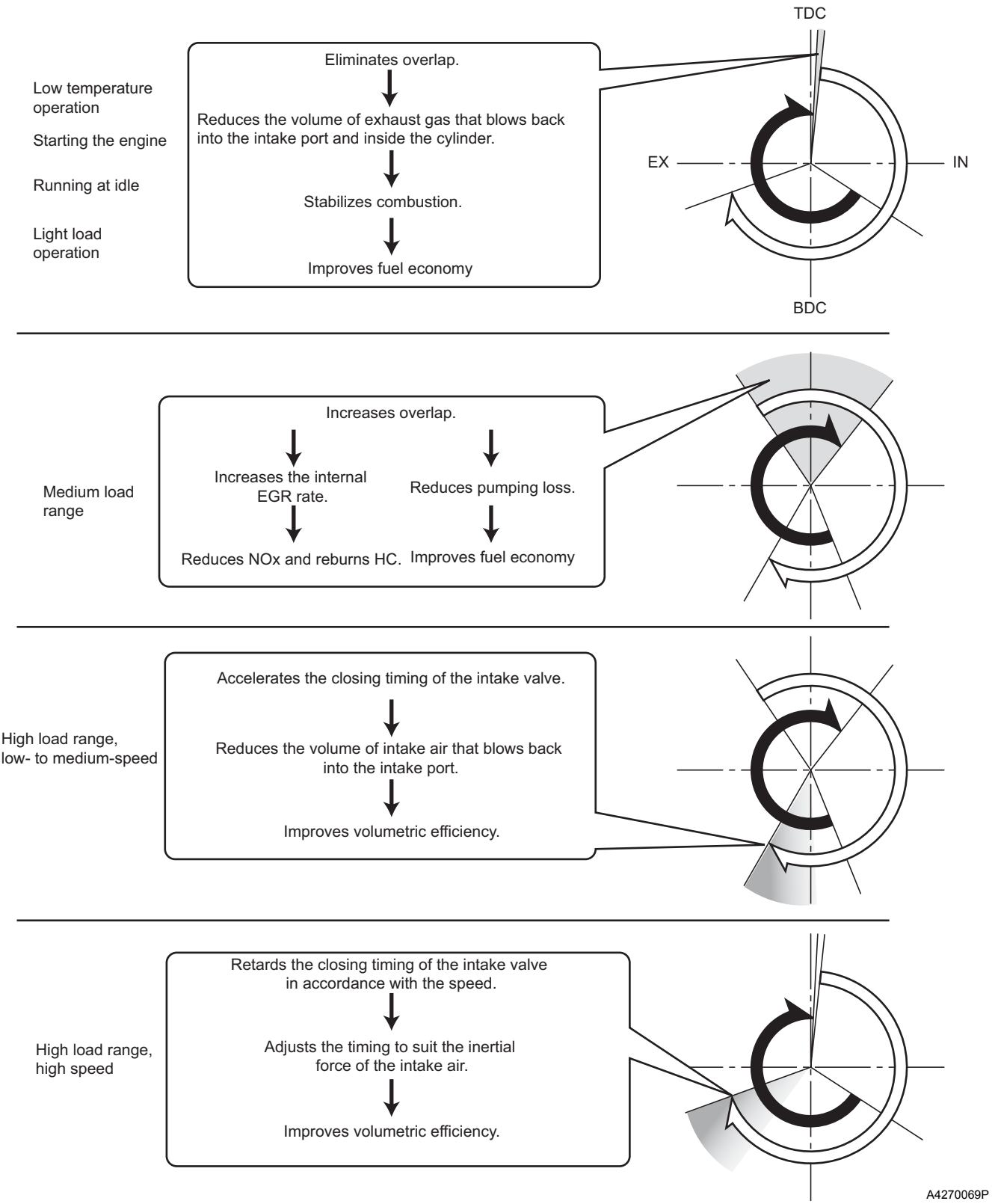
*The drawing shows the VVT-i controller for the intake in the retarded state and the VVT-i controller for the exhaust in the advanced state.

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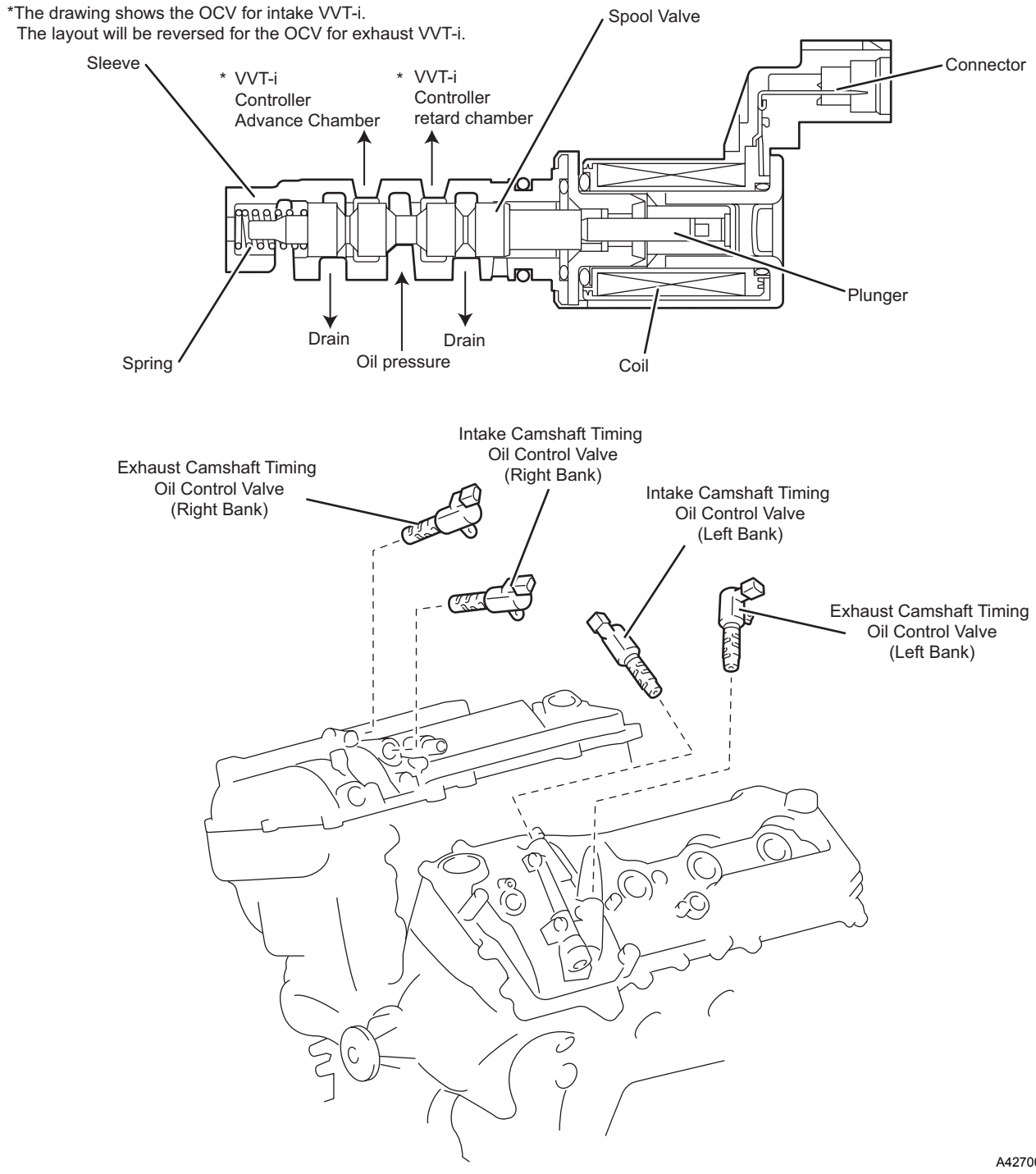
Effects of Dual VVT-i

• By advancing and retarding the intake and exhaust valves, the Dual VVT-i provides the following effects.



Camshaft Timing Oil Control Valve

- In accordance with the duty cycle signals received from the engine ECU, this OCV controls the position of the spool valve in order to constantly achieve optimal valve timing. When the engine is stopped, the force of a spring keeps the intake side of the spool valve in the most retarded state, and the exhaust side to the most advanced state, in order to ready the valves for the subsequent starting.



EG

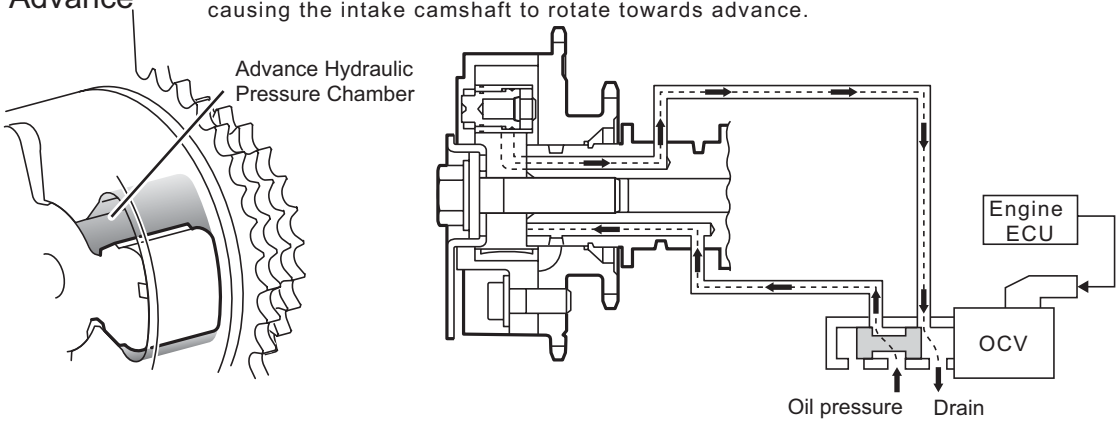
Dual VVT-i Operation

• The Dual VVT-i controls the advance, retard, and holding states as illustrated below, in accordance with the driving conditions.

Outline of Intake VVT-i Operation

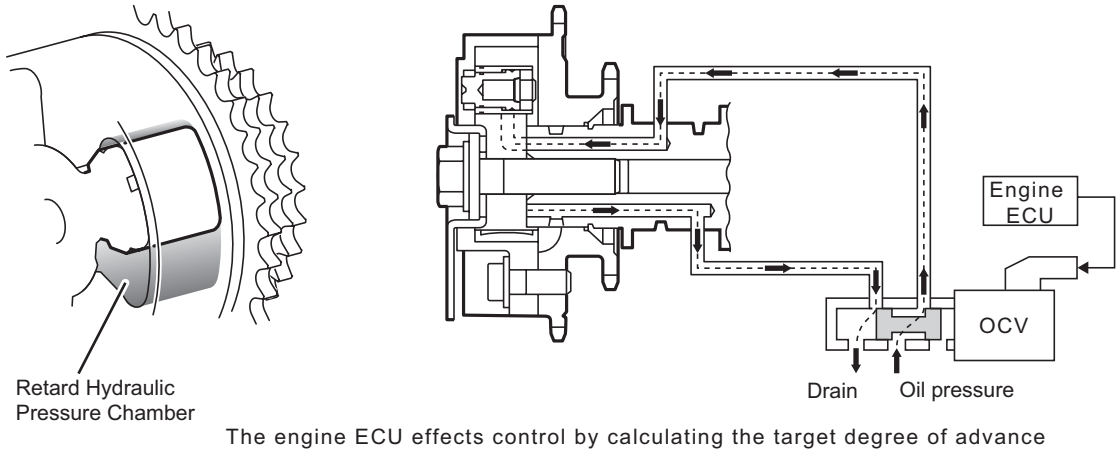
The spool valve of the OCV reaches the position shown in the drawing, as a result of receiving a signal from the engine ECU. Then, hydraulic pressure is applied to the hydraulic pressure chamber for advance, causing the intake camshaft to rotate towards advance.

Advance



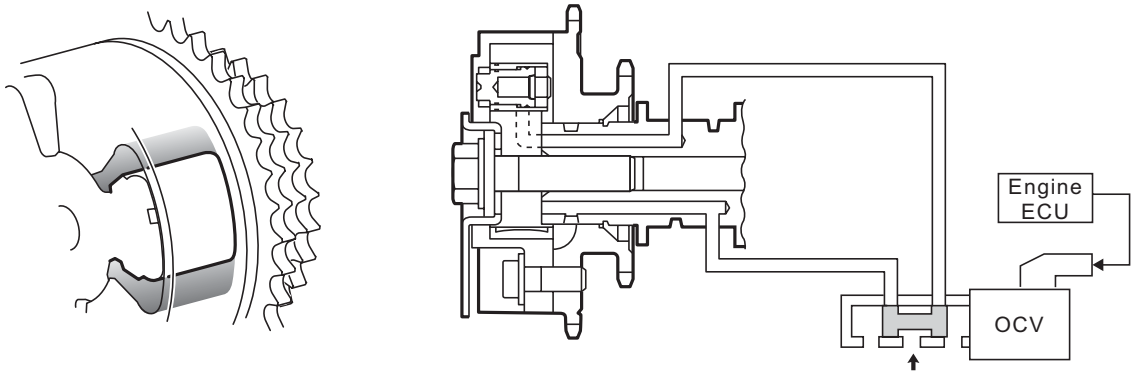
The spool valve of the OCV reaches the position shown in the drawing, as a result of receiving a signal from the engine ECU. Then, hydraulic pressure is applied to the hydraulic pressure chamber for retard, causing the intake camshaft to rotate towards retard.

Retard



The engine ECU effects control by calculating the target degree of advance in accordance with the driving conditions. After reaching the target timing, the engine ECU maintains the timing by setting the OCV to neutral, provided that the driving conditions do not change. As a result, the valve timing can be set to any target position. At the same time, the engine oil is prevented from flowing out needlessly.

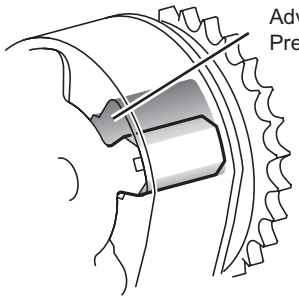
Hold

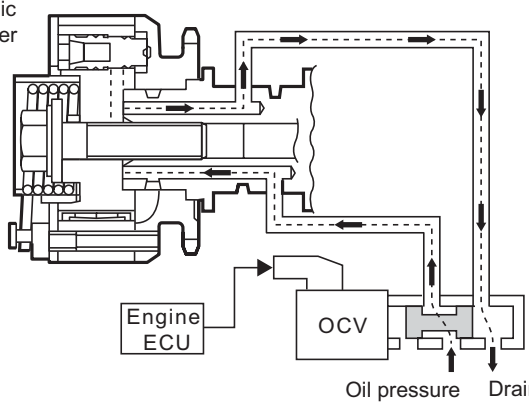


Outline of Exhaust VVT-i Operation

Advance

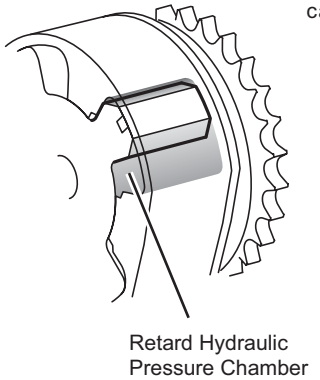
The spool valve of the OCV reaches the position shown in the drawing,
as a result of receiving a signal from the engine ECU.
Then, hydraulic pressure is applied to the hydraulic pressure chamber for advance,
causing the exhaust camshaft to rotate towards advance.

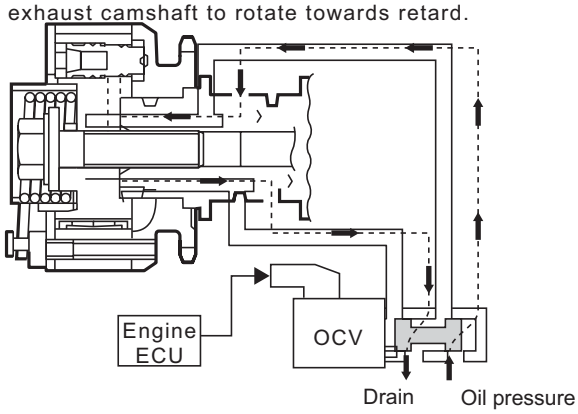




Retard

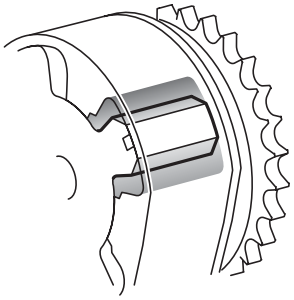
The spool valve of the OCV reaches the position shown in the drawing,
as a result of receiving a signal from the engine ECU.
Then, hydraulic pressure is applied to the hydraulic pressure chamber for retard,
causing the exhaust camshaft to rotate towards retard.

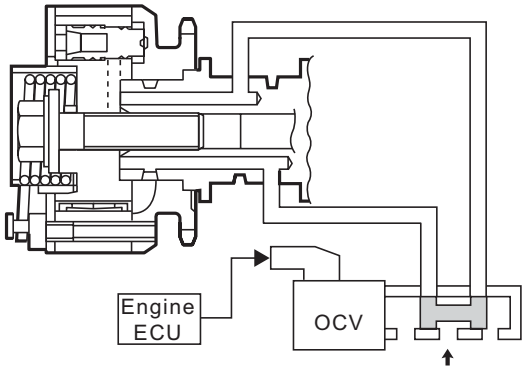




Hold

The engine ECU effects control by calculating the target degree of advance
in accordance with the driving conditions. After reaching the target timing,
the engine ECU maintains the timing by setting the OCV to neutral,
provided that the driving conditions do not change. As a result,
the valve timing can be set to any target position.
At the same time, the engine oil is prevented from flowing out needlessly.



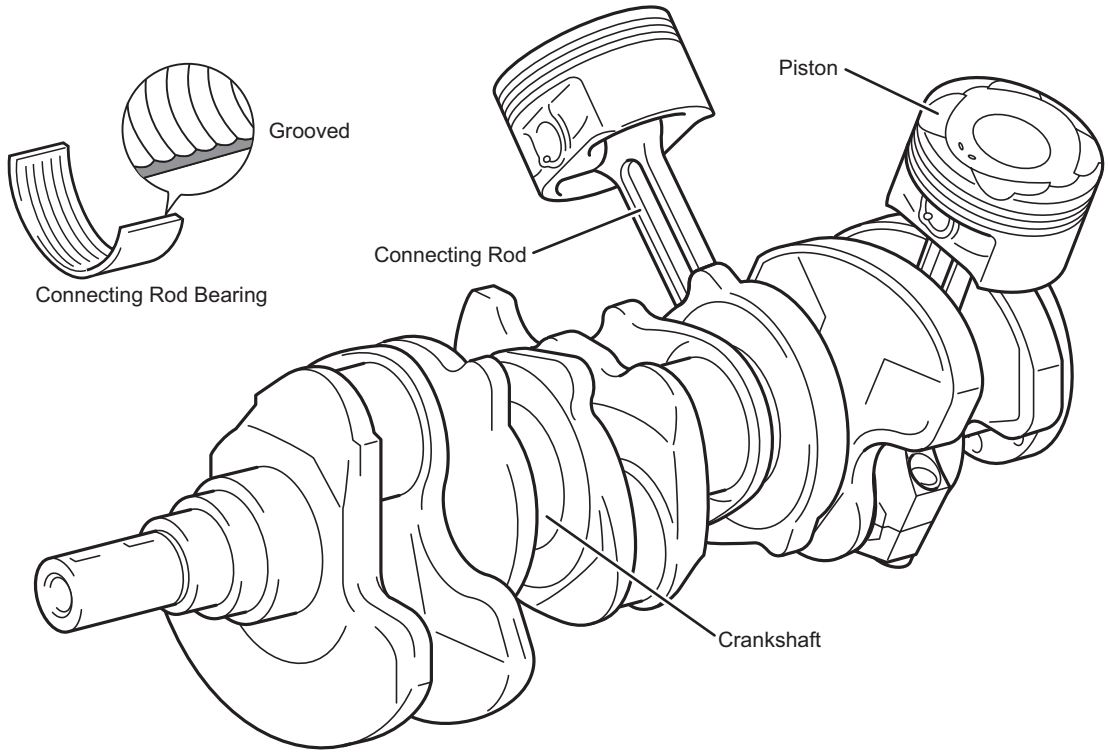


A4270256P

EG

Piston and Crankshaft

- The pistons are made of a lightweight and highly rigid aluminum alloy.
- The connecting rods are made of highly rigid, sintered forged steel that ensures a high level of reliability.
- The crankshaft, which is made of forged steel, is a type that has 4 journals and 5 balance weights. It is lightweight and the balance weights are placed optimally to reduce vibration and noise. The crank pin width and the journal fillet have been made narrower to shorten the length of the crankshaft, in order to realize both high rigidity and low friction. The fillets have been induction hardened to ensure ample strength.
- The connecting rod bearings and the crankshaft bearings have been made narrower to reduce friction. The bearing lining is made of an aluminum alloy to realize both wear resistance and seizure resistance.
- The crankshaft pulley is provided with a torsional damper to reduce vibration and noise.



A4270210P

Connecting Rod

Big End Inner Diameter	[mm (in.)]	56.0 (2.204)
Small End Inner Diameter	[mm (in.)]	22.0 (0.866)
Center Distance Between Big and Small Ends	[mm (in.)]	147.5 (5.807)

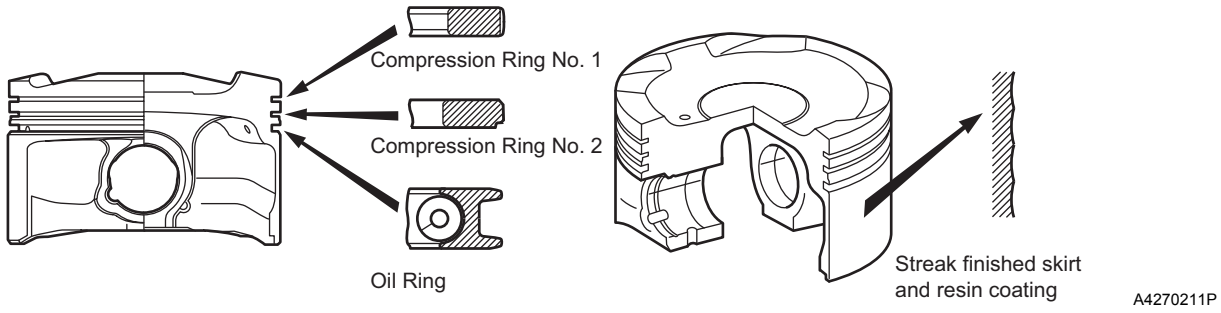
Crankshaft

Journal Diameter	[mm (in.)]	61.0 (2.402)
Crank Pin Diameter	[mm (in.)]	53.0 (2.087)
Crank Pin Stroke Radius	[mm (in.)]	41.5 (1.634)

EG

Piston

- The pistons have been made lightweight with a short compression height and a short skirt. The piston skirt has a streak finish and a plastic coating that excel in seizure resistance, in order to reduce noise and friction.
- A compact combustion chamber is provided on top of the piston to realize stable combustion. Together with the pentroof type combustion chamber on the cylinder head, this realizes a high compression ratio, resulting in both high performance and fuel economy.
- Each piston ring is made thinner and with low tension to reduce friction.



Piston

Basic Diameter [mm (in.)]	87.465 (3.444)
Pin Hole Offset [mm (in.)]	0.5 (0.020)
Compression Height [mm (in.)]	31.05 (1.222)

Piston Pin

Outer Diameter [mm (in.)]	22.0 (0.87)
Inner Diameter [mm (in.)]	12.7 (0.5)
Length [mm (in.)]	56.0 (2.2)

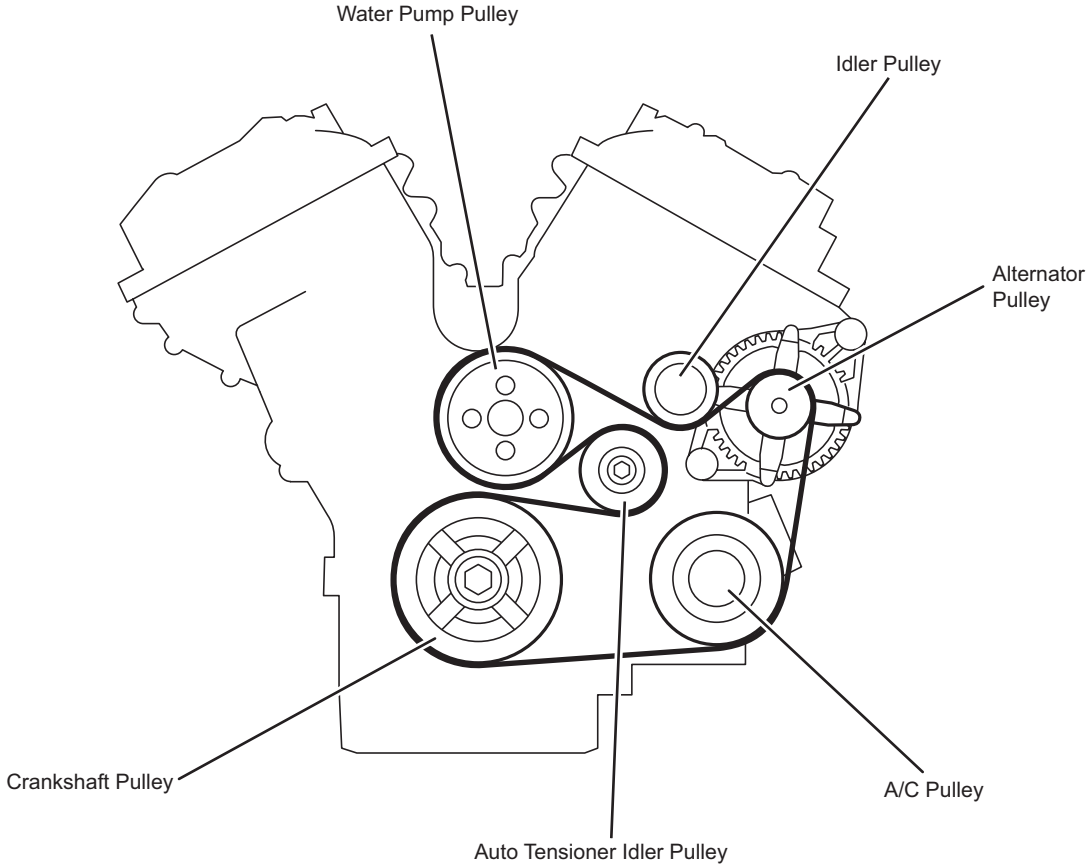
Piston Ring

	Compression Ring No. 1	Compression Ring No. 2	Oil Ring
Material	Stainless Steel	Steel	Steel
Shape	Barrel Face	Tapered Face + Undercut	Combination
Width [mm (in.)]	1.2 (0.047)	1.2 (0.047)	2.0 (0.079)
Thickness[mm (in.)]	2.7 (0.106)	2.7(0.106)	2.75 (0.108)
Surface Treatment	PVD (Physical Vapor Deposition) (Periphery)	Anti-Corrosion	Gas Nitriding

EG

Serpentine Belt Drive System

- A serpentine drive system, which uses a single V-ribbed belt to drive all accessories, is used in order to shorten the overall length of the engine and make it lightweight.
- An auto tensioner is used for the V-ribbed belt to ensure the long life of the belt and accessories, make them maintenance free, and improve serviceability by facilitating the removal and reinstallation of the belt.



Pulley Specifications

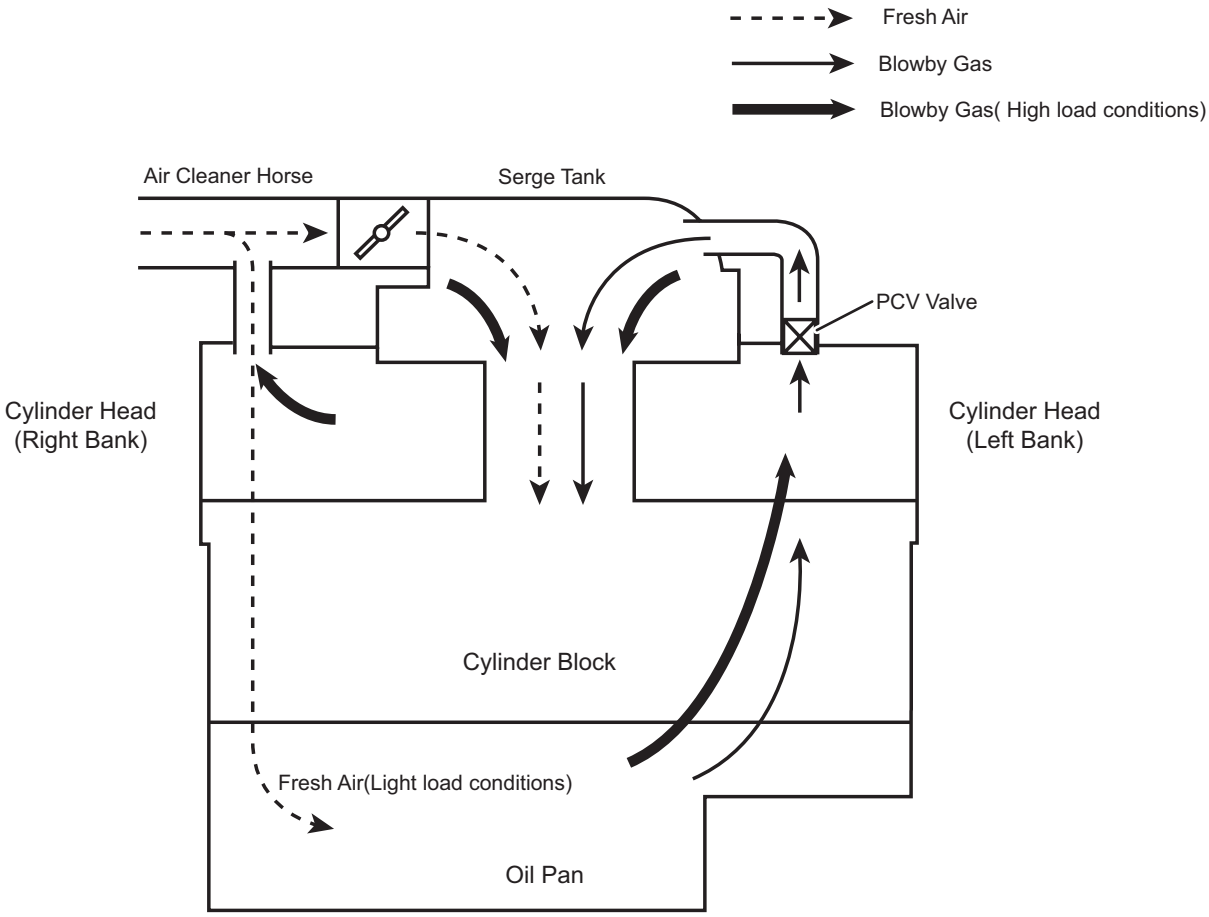
	Pulley Diameter [mm (in.)]
Crankshaft Pulley	140 (5.512)
Auto Tensioner Idler Pulley	70 (2.756)(driven from back face)
A/C Pulley	115 (4.528)
Idler Pulley	70 (2.756)(driven from back face)
Water Pump Pulley	120 (4.724)
Alternator Pulley	52.5 (2.067)

V Ribbed Belt Specifications

Width [mm (in.)]	24.92 (0.981)
Length [mm (in.)]	1550 (61.024)
Number of Ribs	7

Blowby Gas Reduction System

- A PCV hose and a PCV valve are provided to forcefully feed the blowby gas into the intake system for combustion, in order to prevent the blowby gas, which includes a large amount of HC, from being discharged into the atmosphere. A new air circulating system is used wherein fresh air from the air cleaner hose is introduced via the right bank head cover and the blowby gas is discharged into the surge tank via the left bank head cover.
- Under light load conditions, the intake manifold vacuum causes the blowby gas to be drawn via the PCV valve into the intake manifold, to be combusted. The internal pressure is regulated in the crankcase, where fresh air is introduced from the cylinder head cover.
- Under high load conditions, the intake manifold vacuum forcefully introduces the blowby gas into the intake system, where it is combusted. This prevents the blowby gas, which contains a large amount of HC, from being released to the atmosphere.
- A dedicated oil return passage and a blowby gas passage are provided in the cylinder block and the cylinder head to enhance the oil return function and minimize the volume of oil that is taken away.



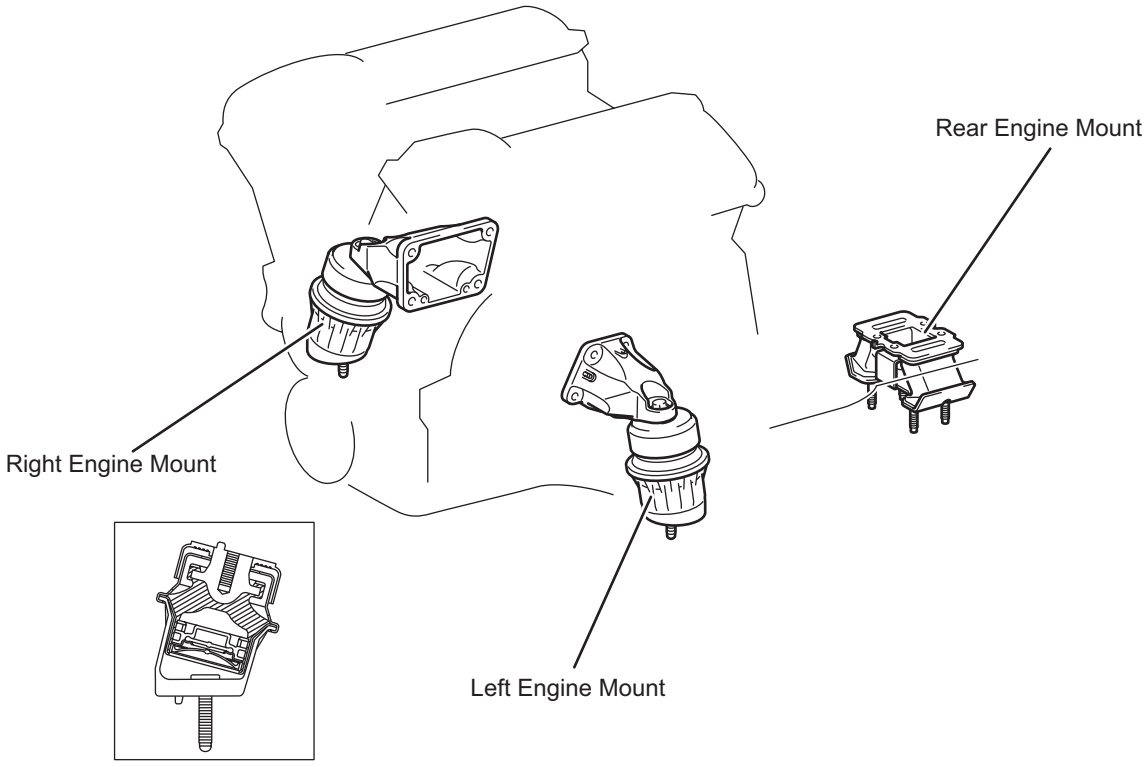
Conceptual operation image of the blowby reduction system

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EG

Engine Mounts

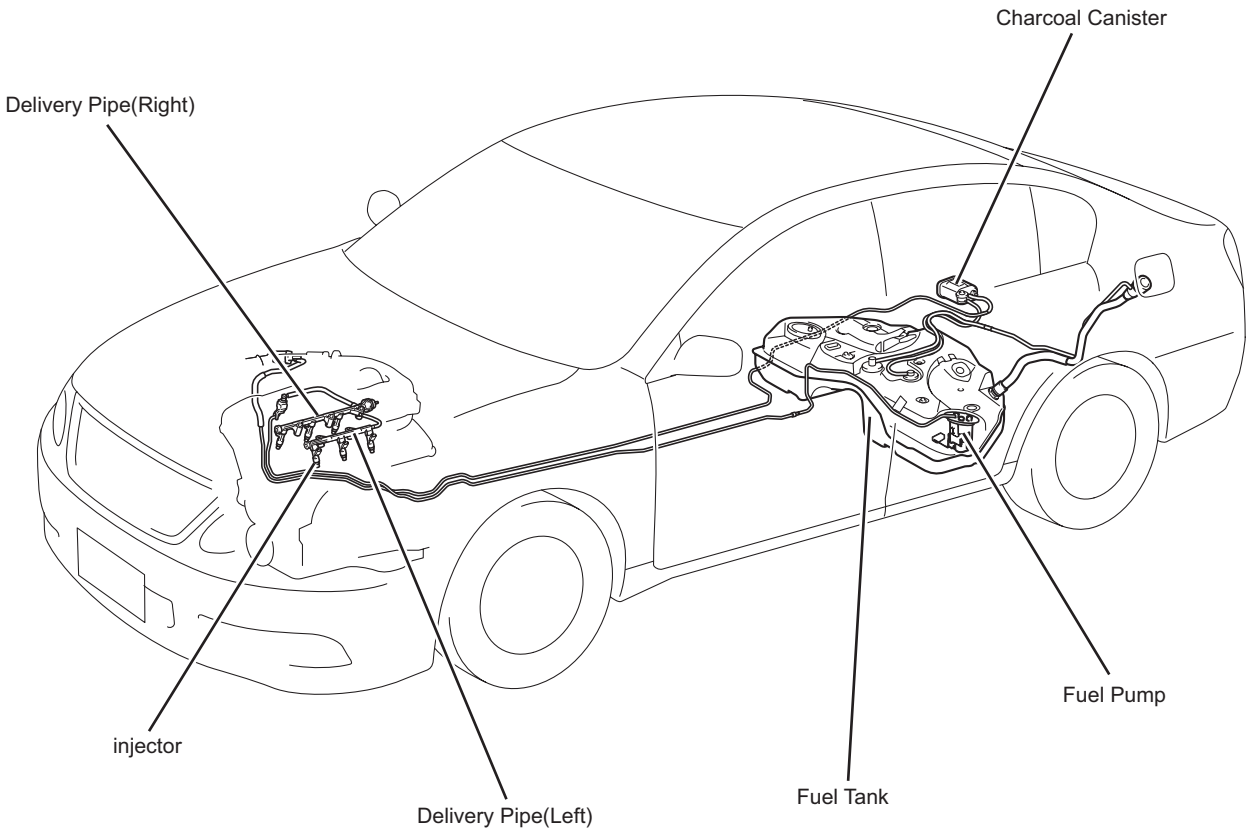
- The front engine mounts are installed on the upper area of the cylinder block where the vibration is minimal. In addition, the brackets have been angled more moderately to reduce vibration and noise in all operating ranges. The brackets are made of cone-shaped aluminum alloys to reduce weight, vibration, and noise.
- The front engine mount uses a liquid-filled double-orifice mount insulator to reduce vibration and noise in the operating range of the engine.
- The die shape for the rear engine mount has been optimized to reduce vibration in the operating range.



3GR-FE FUEL

General

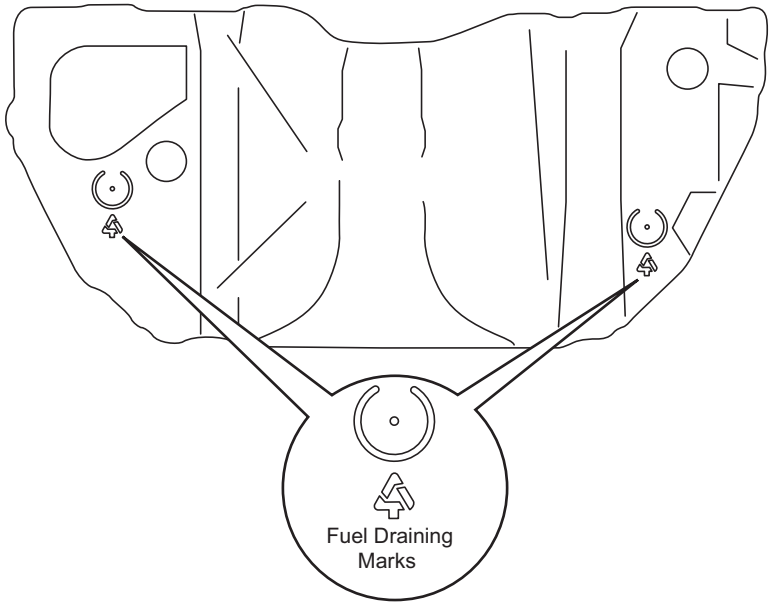
- A fuel returnless system has been used to reduce evaporative emissions.
- To prevent fuel from leaking during a collision (in which air bags are deployed), a system that turns OFF the circuit opening relay is used to ensure safety.



A4270192P

Fuel Tank

- The fuel tank is mounted in the center of the vehicle, forward of the rear axle. It has a capacity of 71.0 liters.
- The fuel tank adopts a saddle shape to allow the propeller shaft to pass through its center portion.
- Two sender gauges (main, sub), fuel pump, fuel filter, pressure regulator, and jet pump have been integrated.
- Fuel draining marks have been provided on the bottom of the fuel tank. These marks clearly indicate the position for aligning the fuel draining device during dismantling, and simplify and ensure the reliable draining of fuel.

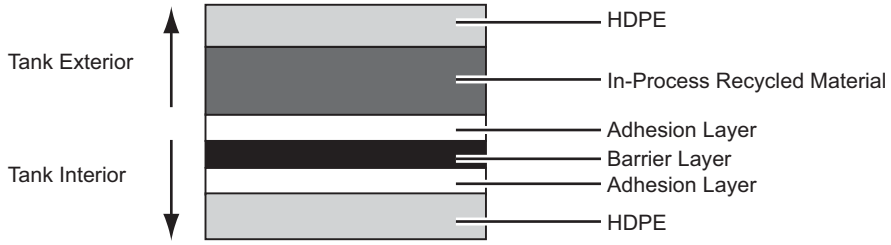


Fuel Tank Bottom View

A4270047P

Plastic Fuel Tank

• A fuel tank made of plastic is used for weight reduction. It consists of six layers of plastic to ensure the long life of the tank and the low permeation of fuel.



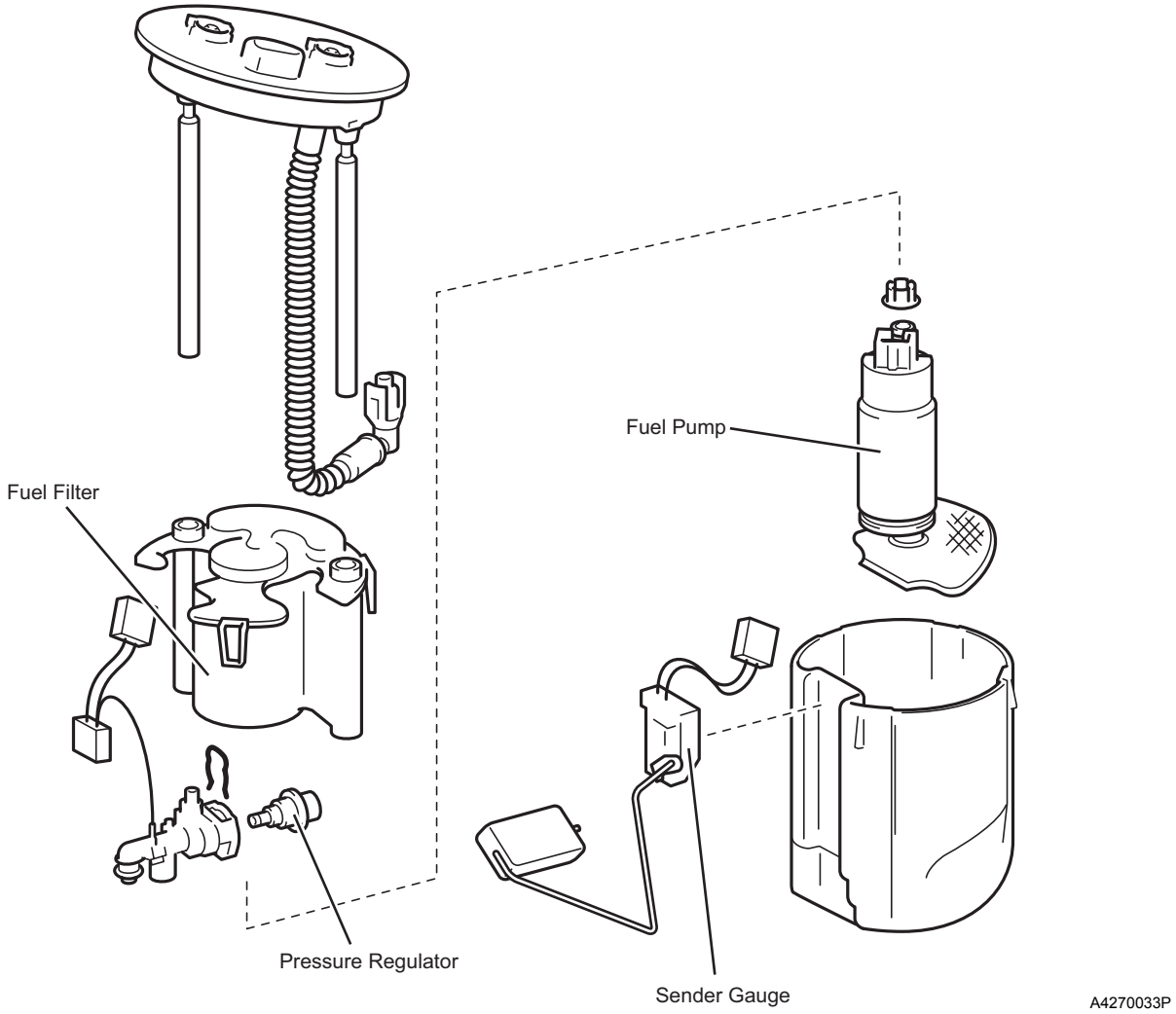
*HDPE(High Density Polyethylene):High Density Polyethylene It is lightweight, high strength,and excels in water and solvent resistance.

Layer Composition of Fuel Tank

A4270048P

Fuel Pump

- A fuel pump assembly consisting of a fuel pump, fuel filter, and sender gauge is used.
- To prevent fuel from leaking during a collision (in which air bags are deployed), a system that turns OFF the circuit opening relay, in accordance with a signal from the airbag ECU, is used to ensure safety.



Fuel Pump

Discharge Pressure [kPa]	324
Discharge Volume [L·h]	150 Minimum

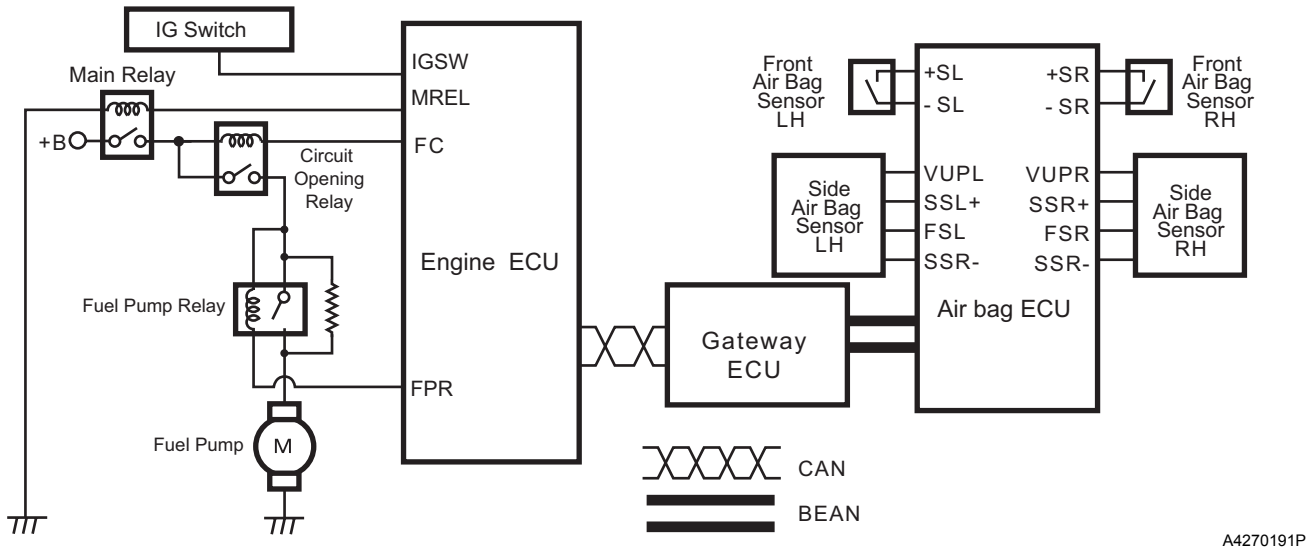
Fuel Filter

Filter System	Paper Filter Type
Filtering Surface Area [cm2]	1550

EG

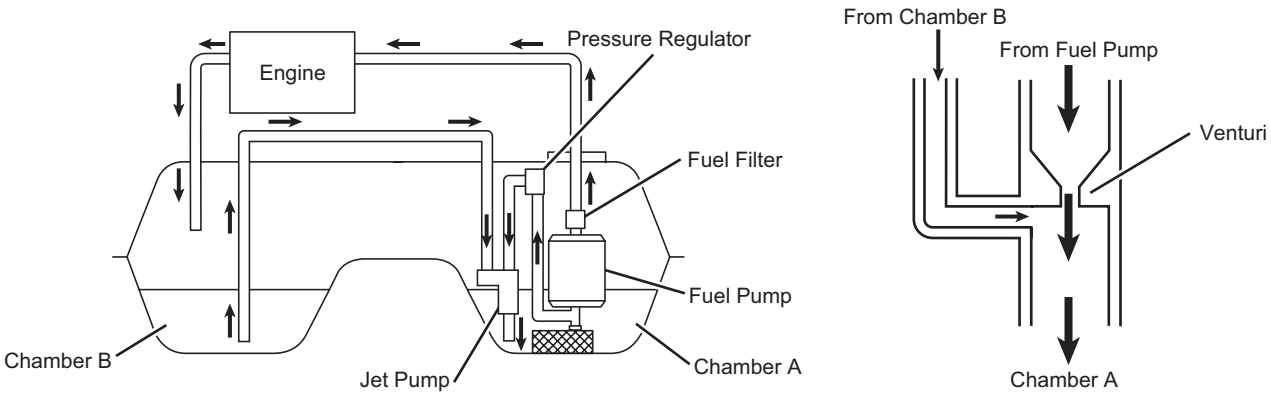
Fuel Pump Control

- When the starter signal is ON and the engine speed signal is input continuously for 2 seconds or longer, the circuit opening relay turns ON to actuate the fuel pump.
- A fuel cut control is adopted to stop the fuel pump when the airbag is deployed at the front or side collision. In this system, the airbag deployment signal from the airbag sensor assembly is detected by the engine ECU, which turns OFF the circuit opening relay.
- After the fuel cut control has been activated, turning the ignition switch from OFF to ON cancels the fuel cut control, thus engine can be restarted.



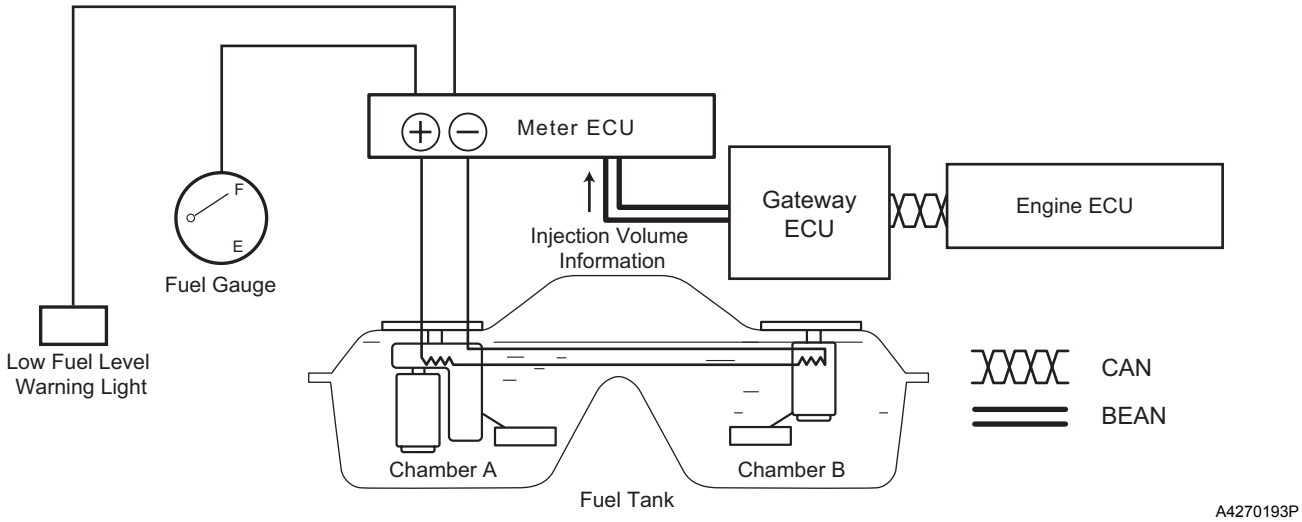
Jet Pump

- The jet pump operates as described below.
- A jet pump is adopted in the fuel tank. Since the propeller shaft is located below its center bottom, the fuel tank of the GS430 is shaped as indicated below.
- A fuel tank with such a shape tends to cause the fuel to be dispersed into both chamber A and chamber B when the fuel level is low, stopping the fuel in chamber B from being pumped out. To prevent this from occurring, a jet pump has been provided to transfer the fuel from chamber B to chamber A.
- This is accomplished by utilizing the flow of the fuel, so that the vacuum created by the fuel, as it passes through the venturi is used to suck the fuel out of chamber B and send it to chamber A.



Fuel Sender Gauge

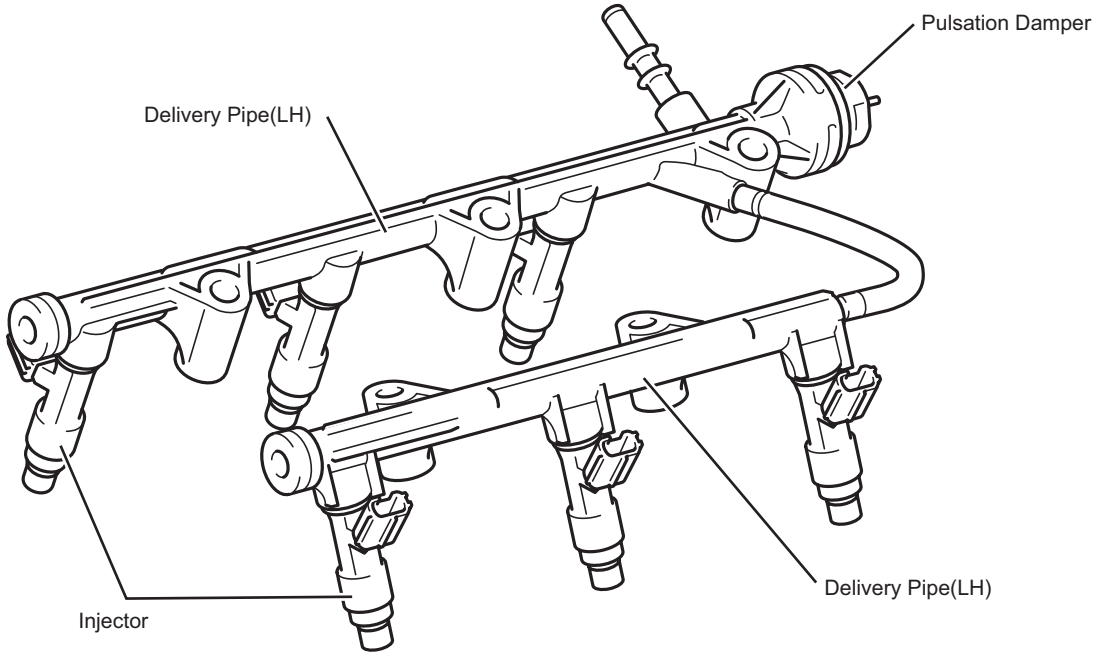
- To accurately inform the driver of the residual fuel volume in the saddle-shaped tank, inline sender gauges are provided in the two chambers, A and B. These sender gauges output the residual fuel volume of both chambers to the meter ECU.
- Based on the signals received from the two sender gauges and the EFI control information received from the engine ECU, the meter ECU calculates the residual fuel volume, and activates the fuel gauge.



EG

Delivery Pipe

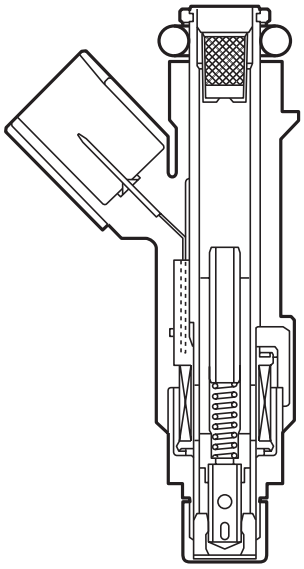
- A fuel delivery pipe made of an aluminum alloy is used.
- A pulsation damper is provided to reduce the pulsation and noise of the fuel.



A4270194P

Injector

- Injectors with 4 orifices are used. They are mounted directly into the cylinder heads to shorten the distance to the combustion chambers, thus reducing the adhesion of fuel to the intake ports.



Fuel Injector Cross-Sectional Diagram

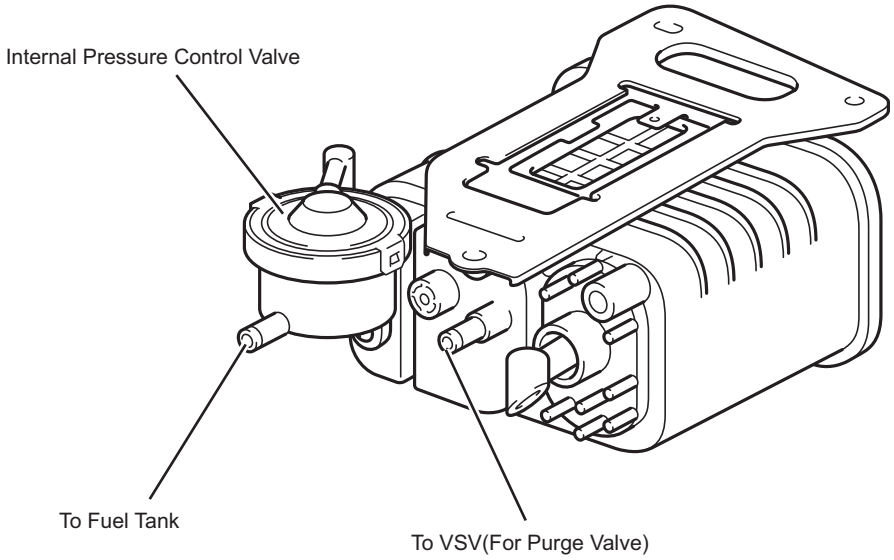
A4270195P

Fuel Injector

Number of Orifices	4
Orifice Dimensions [mm (in.)]	0.34 (0.013)

Charcoal Canister

- Canister purge control is used to draw the fuel evaporative gas created in the fuel tank into the intake port, to be burned during combustion.
- The charcoal canister is mounted behind the fuel tank.
- An internal pressure control valve is provided at the fuel passage inlet from the fuel tank in order to maintain the proper pressure in the fuel tank.



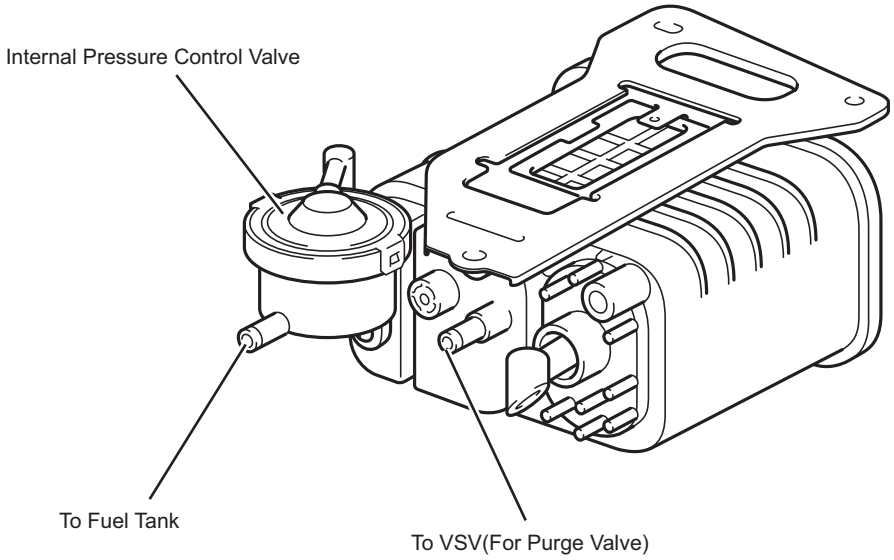
A4270164P

Fuel Injector

Number of Orifices	4
Orifice Dimensions [mm (in.)]	0.34 (0.013)

Charcoal Canister

- Canister purge control is used to draw the fuel evaporative gas created in the fuel tank into the intake port, to be burned during combustion.
- The charcoal canister is mounted behind the fuel tank.
- An internal pressure control valve is provided at the fuel passage inlet from the fuel tank in order to maintain the proper pressure in the fuel tank.



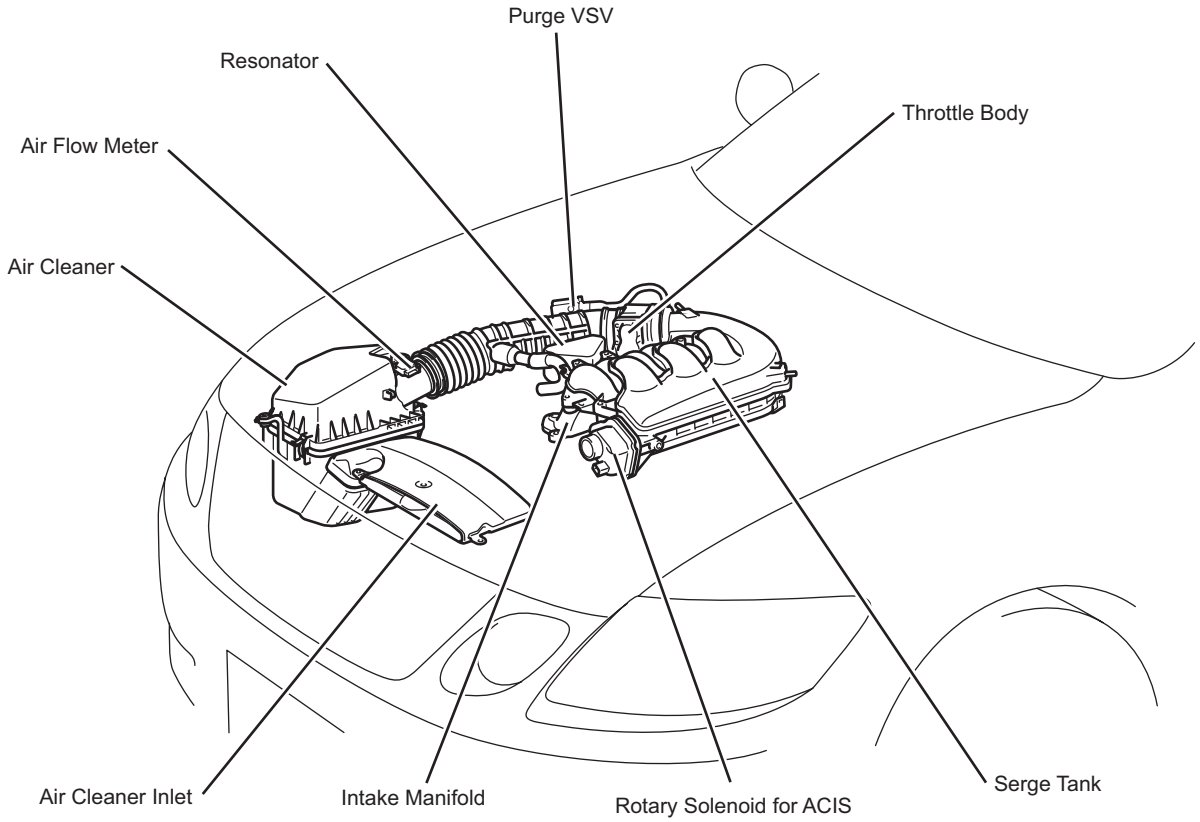
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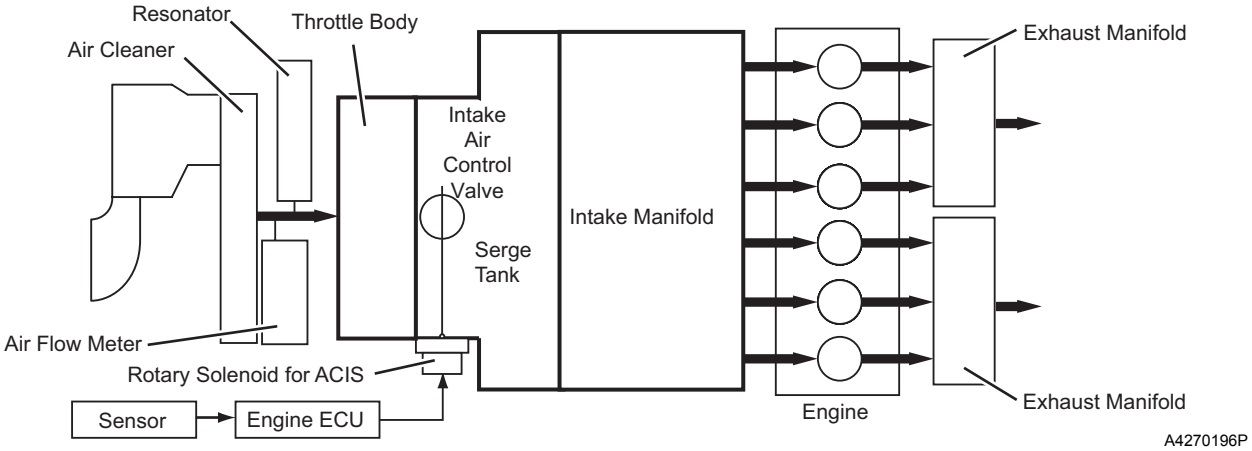
3GR-FE INTAKE

EG

General

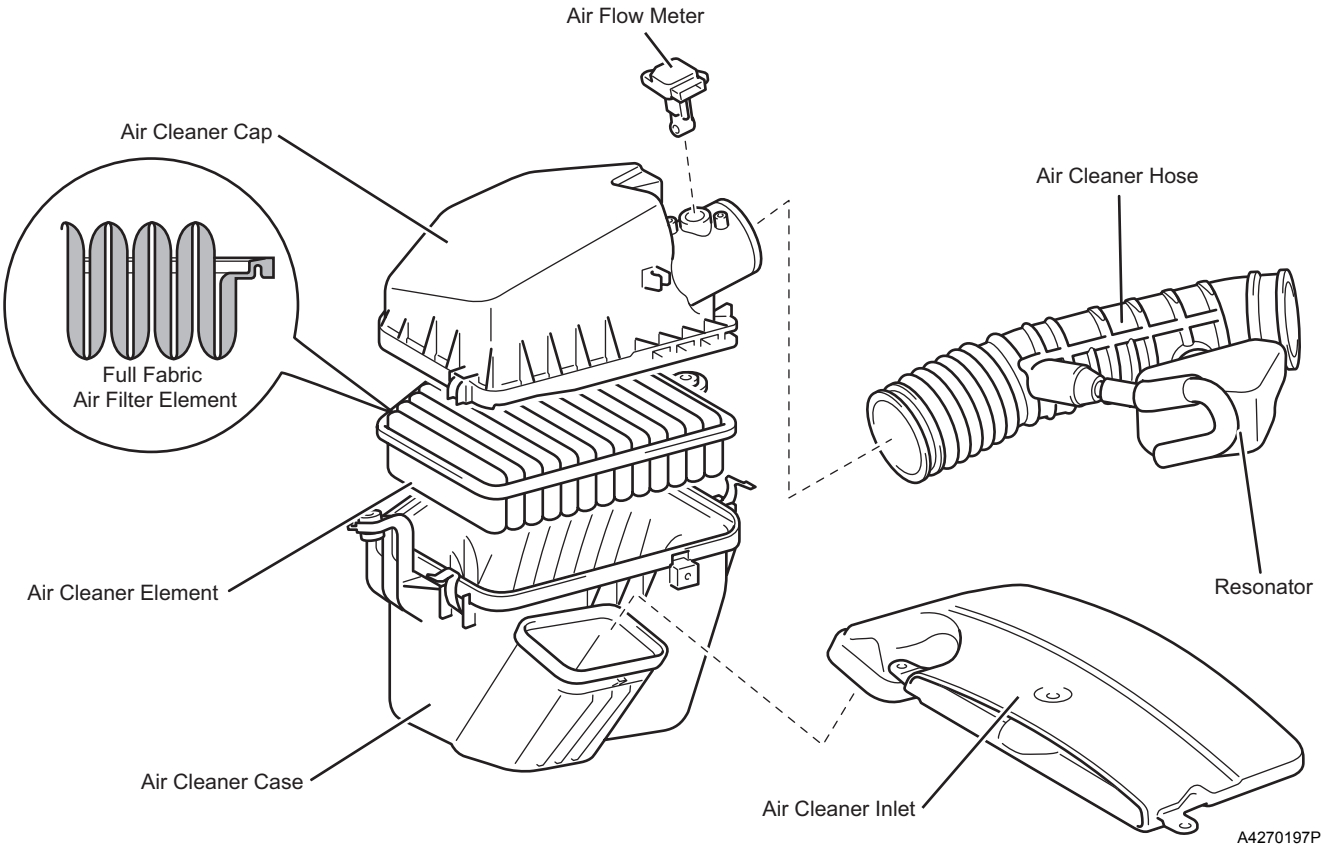
- A surge tank with a built-in ACIS (Acoustic Control Induction System) is used.
- A hot-wire type airflow meter (with a built-in intake air temperature sensor) is provided in the air cleaner cap.
- The ETCS-i system is used and a single-valve, electronically controlled throttle body is installed.





Air Cleaner

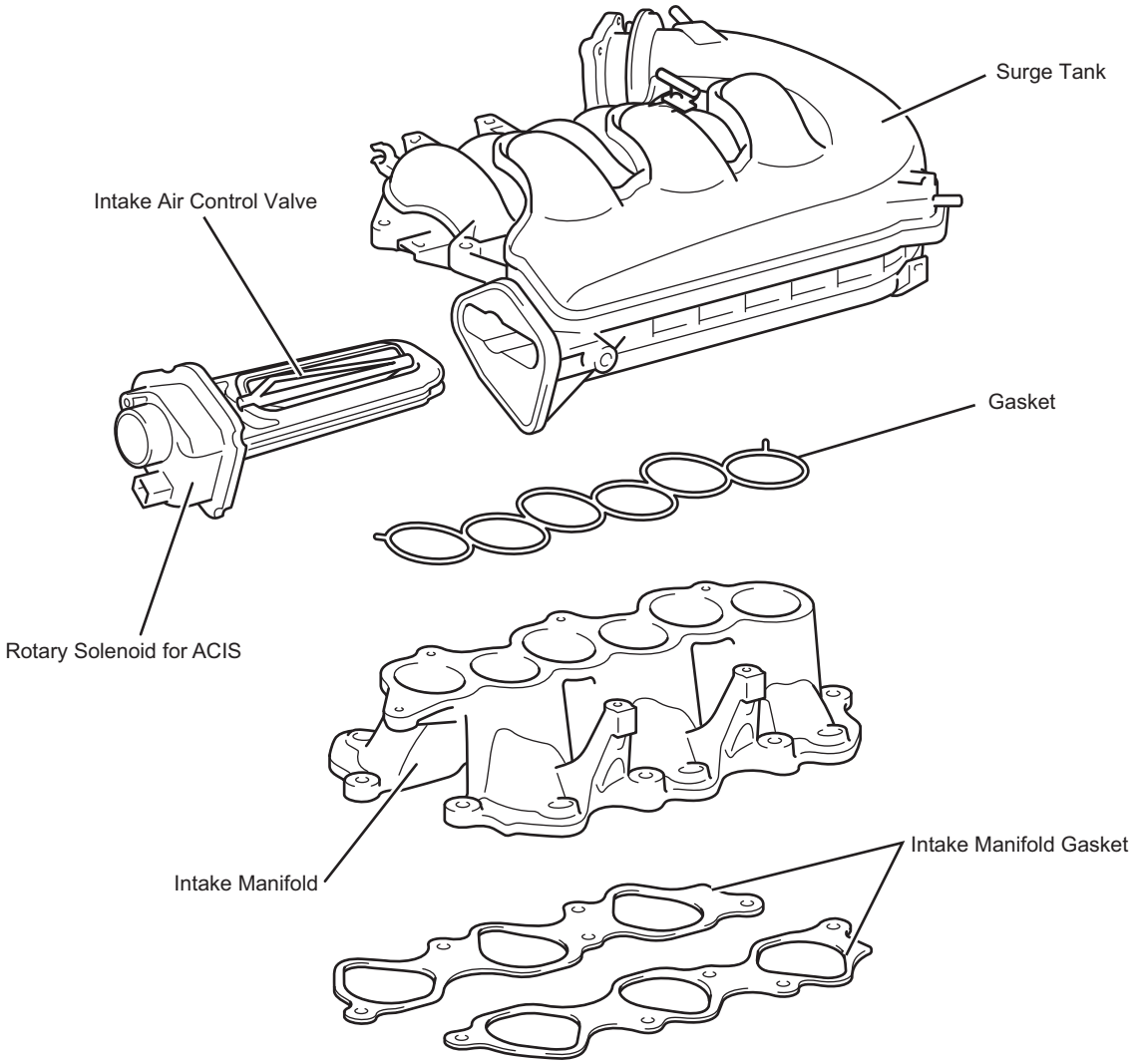
- A removable cap type air cleaner case is used for enhanced serviceability. Also, an airflow meter (with a built-in intake air temperature sensor) is provided in the air cleaner cap.
- A dry type air cleaner element is used and provided with an ample filtering surface area
- A compact resonator is provided in the air cleaner hose to reduce intake noise.
- A full fabric air filter element, which does not contain an outer frame or rubber seal, is used. As a result, the case could be made compact, with recyclability in mind.



EG

Intake Manifold

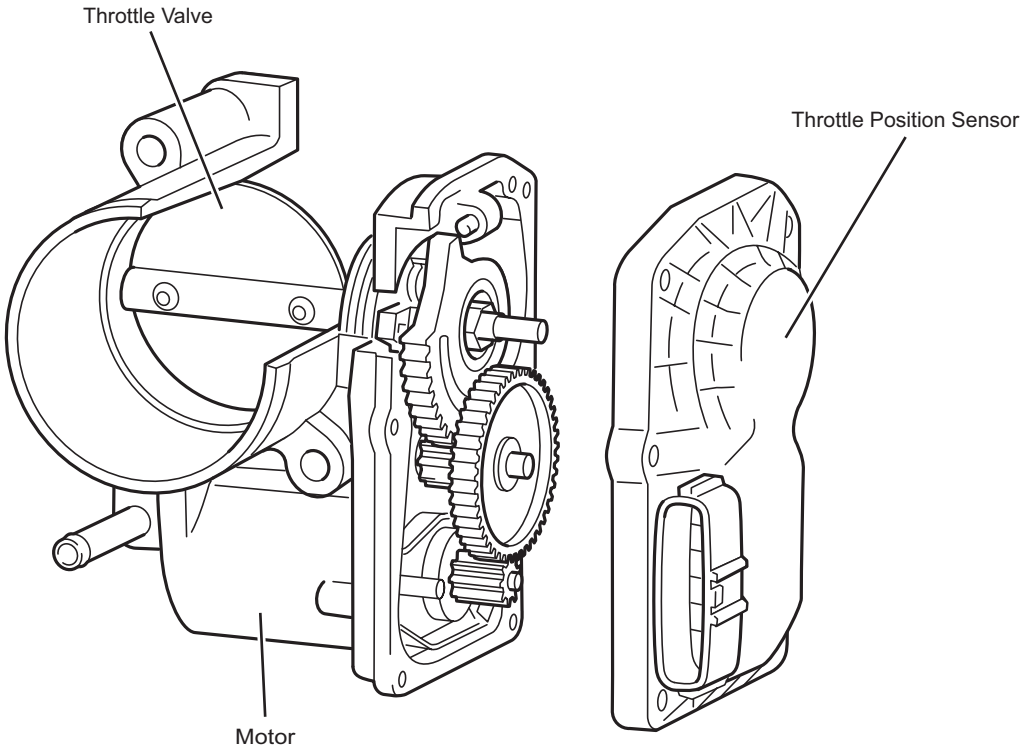
- An intake system with an ACIS (Acoustic Control Induction System) consisting of independent ports is used. The port diameter and length have been optimized to strike a balance between high torque in all driving ranges and fuel economy performance.
- A plastic surge tank is used for weight reduction. An ACIS (Acoustic Control Induction System) is used to vary the effective length of the intake manifold, thus increasing the torque in all ranges.



A4270198P

Throttle Body

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



Air Flow Meter

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

(See page EG-45)

Accelerator Pedal Position sensor

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

(See page EG-41)

Throttle Position Sensor

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

(See page EG-43)

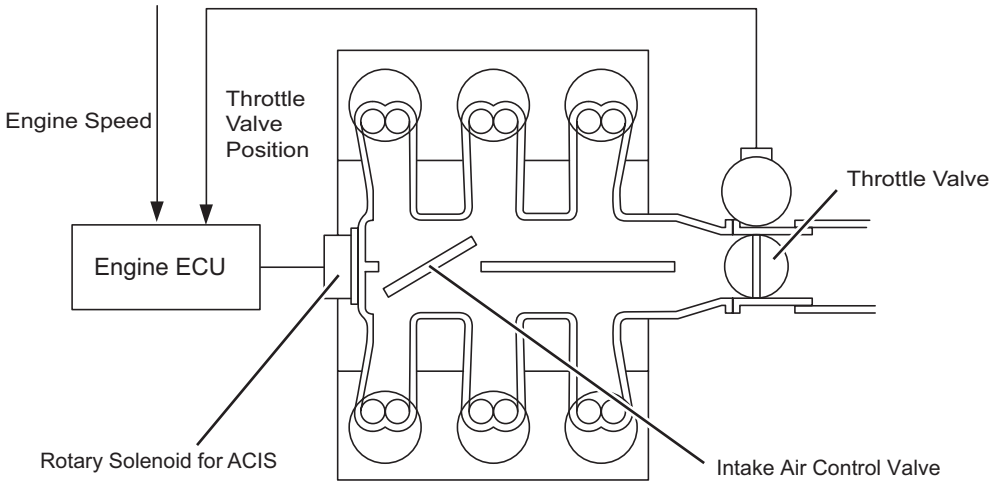
ETCS-i (Electronic Throttle Control System-intelligent)

- In the conventional throttle body, the throttle valve opening is determined invariably by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the engine ECU to calculate the optimal throttle valve opening that is appropriate for the respective driving condition and uses a throttle control motor to control the opening.
- The functions of the ordinary throttle position control (nonlinear control), idle speed control (ISC), traction control (including VSC), and cruise control have been integrated in the single-valve electronically controlled throttle body.

(See page EG-35)

Electronic ACIS (Acoustic Control Induction System)

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



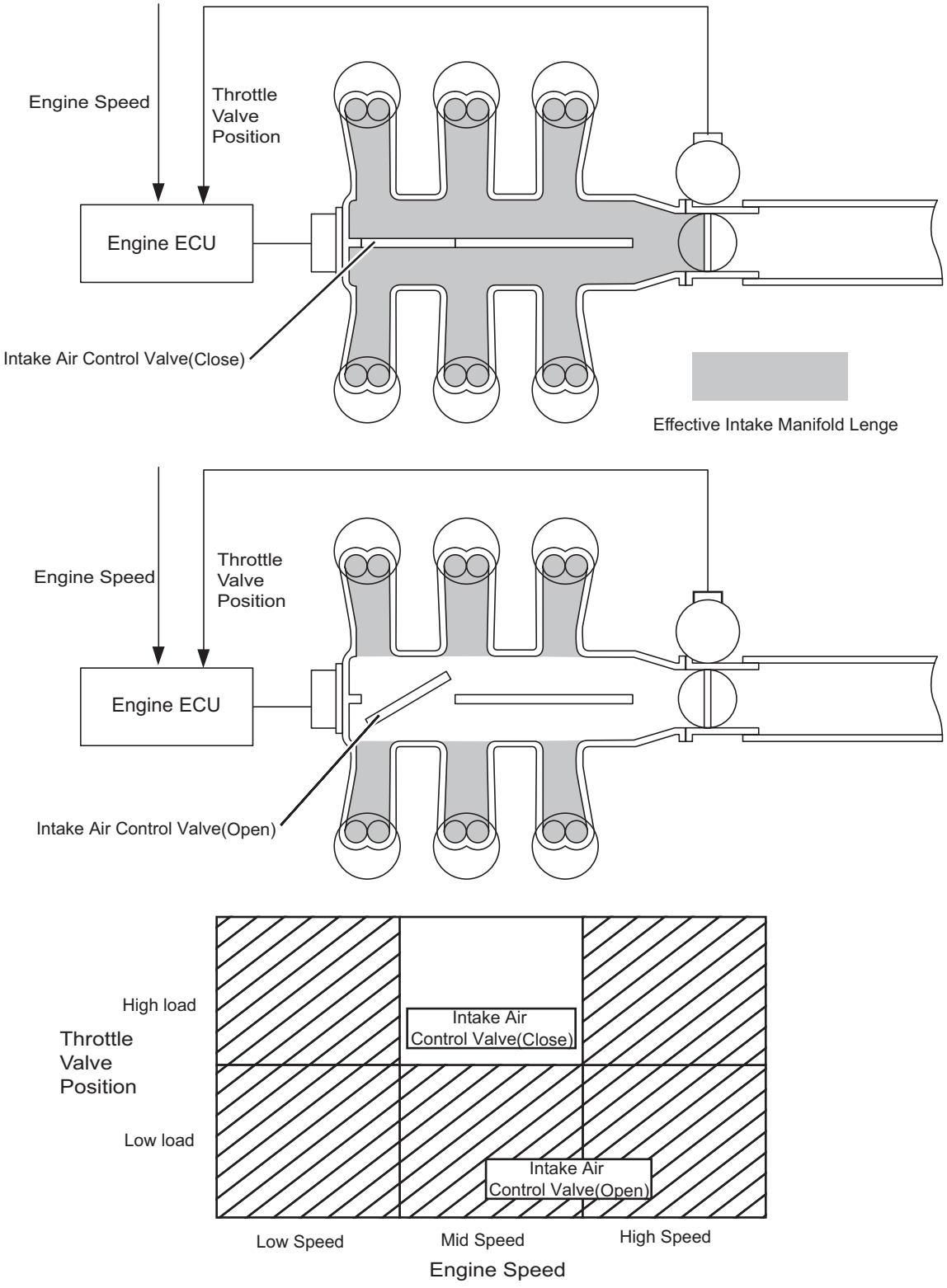
List of Functions

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

EG

Electronic ACIS Operation

- The engine ECU opens and closes the intake air control valve in accordance with the engine speed and the throttle valve position, in order to enhance the torque in all ranges, particularly in the medium-speed range.

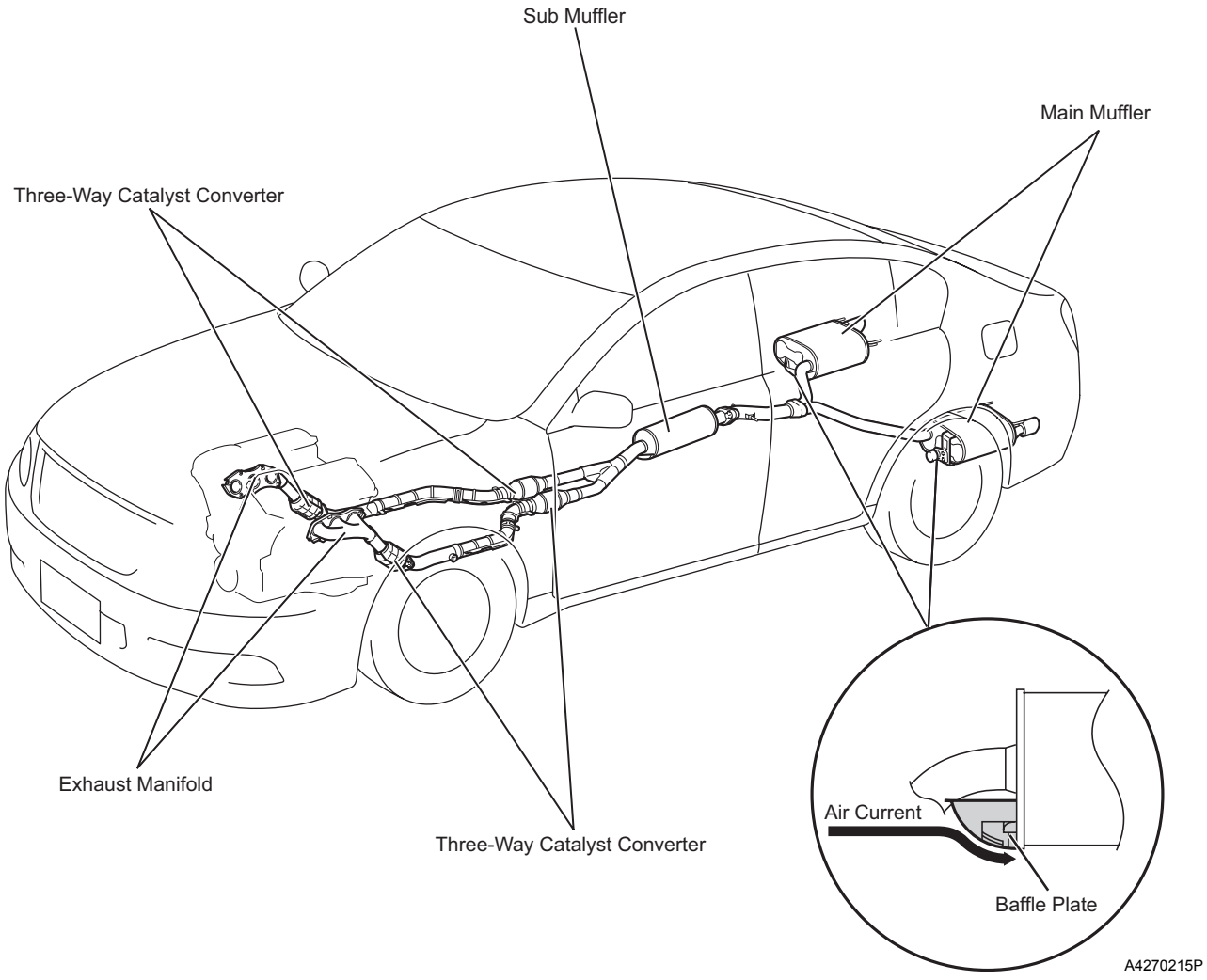


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3GR-FE EXHAUST

General

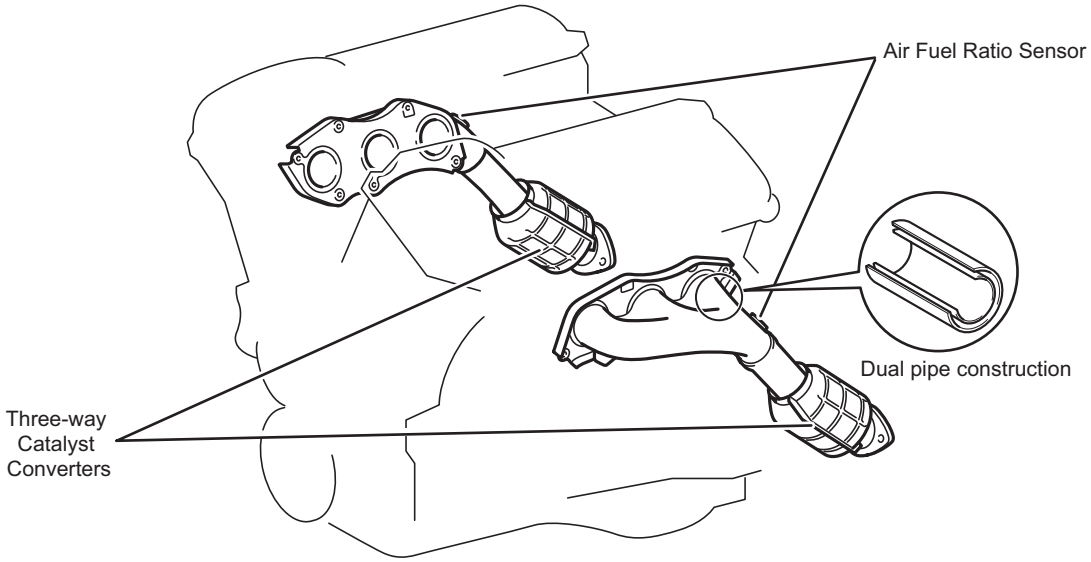
- The entire exhaust system from the exhaust manifold to the tail pipe is made of stainless steel to realize weight reduction and improve corrosion resistance.
- Three-way catalysts are placed directly below the exhaust manifold and in the front pipes to ensure ample emission reduction performance, in order to comply with the Step IV European Tailpipe Emission Regulations.
- An exhaust manifold with a built-in Three-way catalyst Converter is placed directly below each bank of the engine to ensure low exhaust emissions immediately after the engine is started.
- The exhaust pipe diameter has been optimized to reduce exhaust loss and optimize engine power output.
- A baffle plate is provided in front of the main muffler to straighten the airflow under the floor, thus improving dynamic performance.
- An air-fuel ratio sensor is provided upstream of the Three-way catalyst Converter in each exhaust manifold. An heated oxygen sensor is provided downstream of the Three-way catalyst Converter in each exhaust manifold. These sensors enable precise control of the air-fuel ratio.



EG

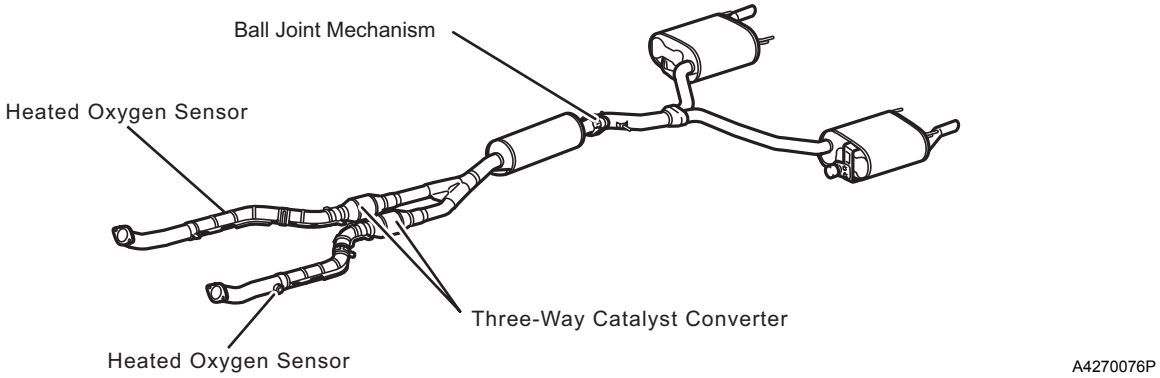
Exhaust Manifold

- The exhaust manifolds are made of dual pipe construction stainless steel to reduce noise and enhance heat resistance. Also, they accelerate the warm-up of the catalysts immediately after the engine is started, thus reducing exhaust emissions.
- Built into each exhaust manifold, the three-way catalyst converter consists of an ultra thin-wall, high-cell density ceramic catalyst in which precious metals are optimally used. It accelerates the warm-up of the catalytic converter, thus improving exhaust emission performance immediately after the engine is started.
- The flow of the exhaust gases has been optimized and the exhaust gas pressure loss has been reduced to produce a higher power output.



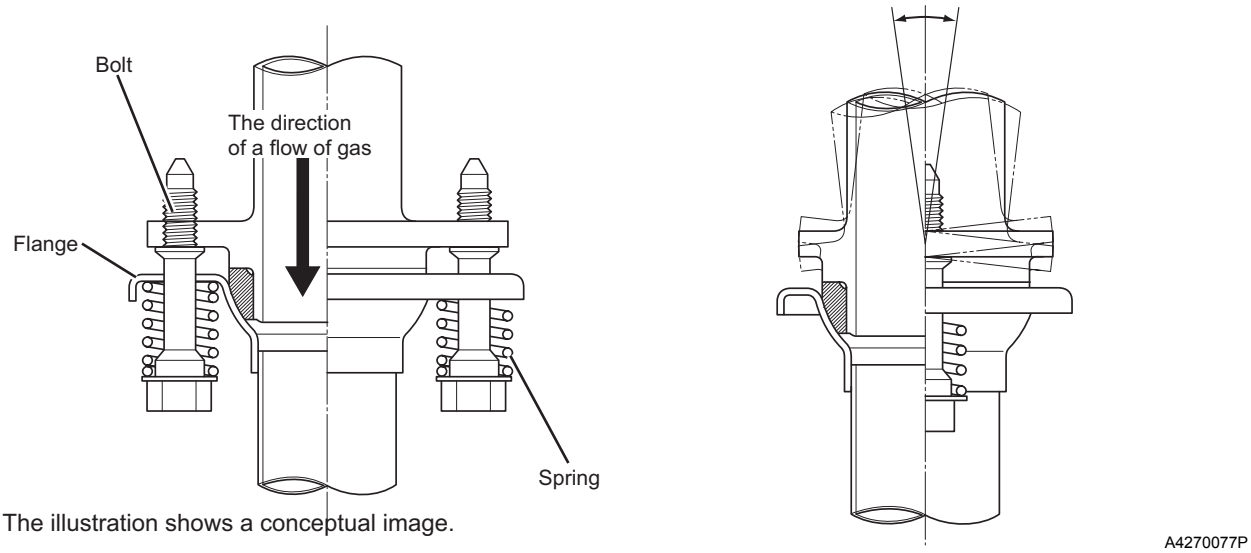
Exhaust Pipe

- Long, dual construction exhaust pipes are used from the exhaust manifolds to the front pipe junction. By optimizing the lengths of the exhaust pipes and utilizing the fluctuation of the exhaust pressure, exhaust gases are discharged effectively to improve the torque in the low- to medium-speed range.
- Ball joint mechanism is used to join the front pipe to the tail pipe in order to reduce the droning sound and vibration in the cabin and reduce weight. The ball joint mechanism consists of a spherical flange, and a bolt and a spring to support the sealing area of the gasket. The ball joint (the spherical areas of the flange and the gasket) absorbs the vibration of the engine as well as the vibration of the exhaust pipe in order to reduce the droning sound and vibration in the cabin.



Ball Joint Mechanism

- The ball joint mechanism consists of a spherical flange, a bolt, and a spring to support the sealing area of the gasket. This is more compact than a flexible pipe, and can be installed in an optimal position to counter vibrations.
- The ball joint (the spherical areas of the flange and the gasket) absorbs the vibration of the engine as well as the vibration of the exhaust pipe in order to reduce the droning sound and vibration in the cabin.

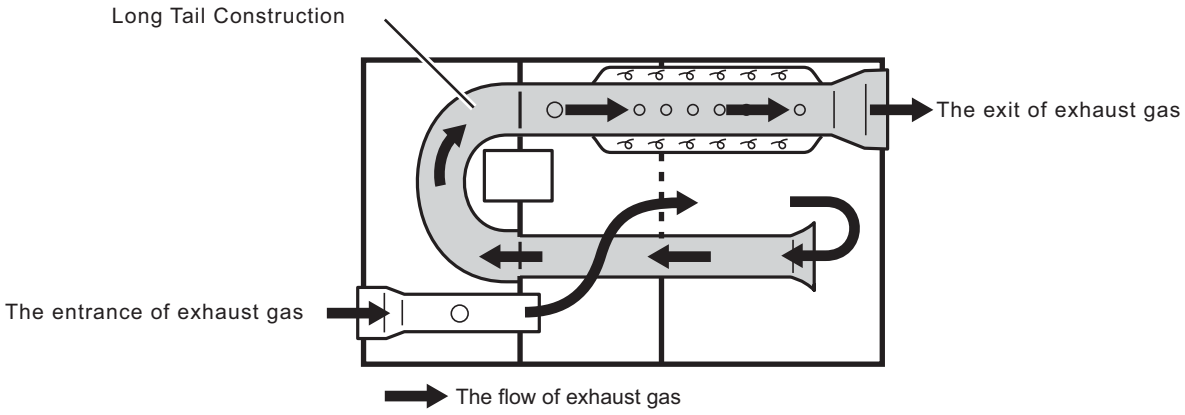


* The illustration shows a conceptual image.

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Muffler

● Dual main mufflers are provided to reduce back pressure, which improves the power output of the engine. A long tail construction is used inside the main muffler to suppress the low-frequency exhaust sounds, thus reducing the sounds in the cabin.



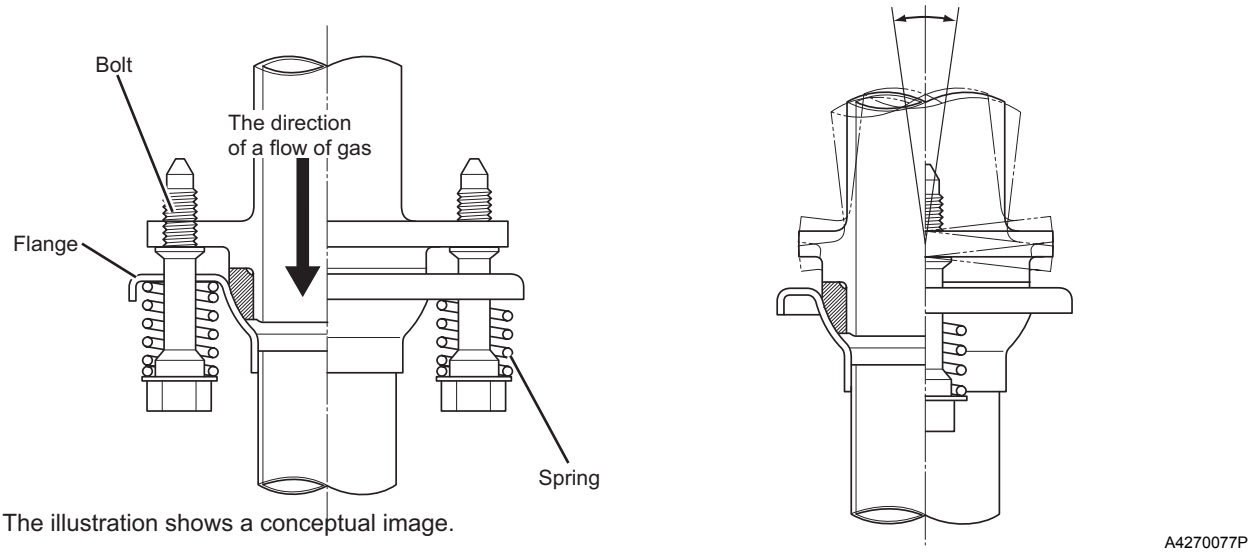
A4270078P

Three Way Catalytic Converter

● An ultra thin-wall, high cell density ceramic catalyst with an optimized amount of precious metals held is placed directly below each exhaust manifold and in each front pipe. These catalysts ensure a high level of warm-up performance immediately after the engine is started, thus reducing exhaust emissions and complying with the Step-IV European Tailpipe Emission Regulations.

Ball Joint Mechanism

- The ball joint mechanism consists of a spherical flange, a bolt, and a spring to support the sealing area of the gasket. This is more compact than a flexible pipe, and can be installed in an optimal position to counter vibrations.
- The ball joint (the spherical areas of the flange and the gasket) absorbs the vibration of the engine as well as the vibration of the exhaust pipe in order to reduce the droning sound and vibration in the cabin.

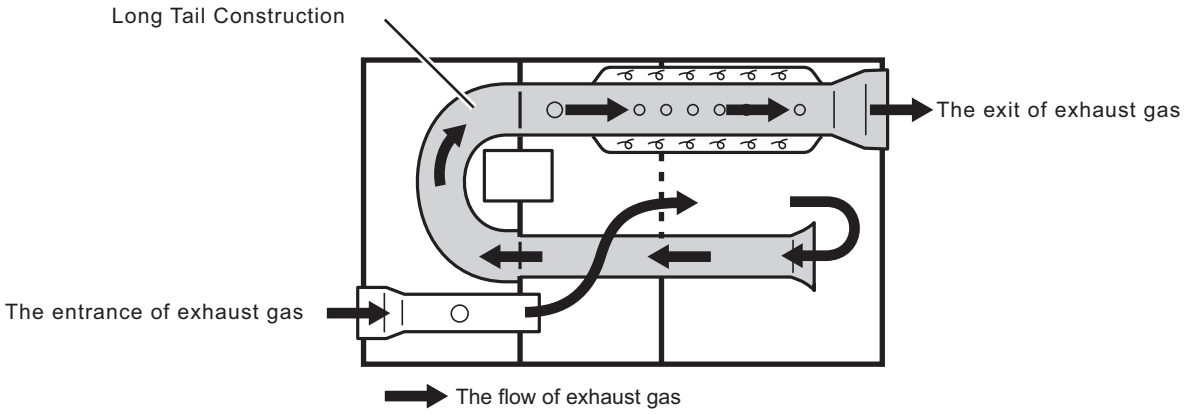


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A4270077P

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Three Way Catalytic Converter

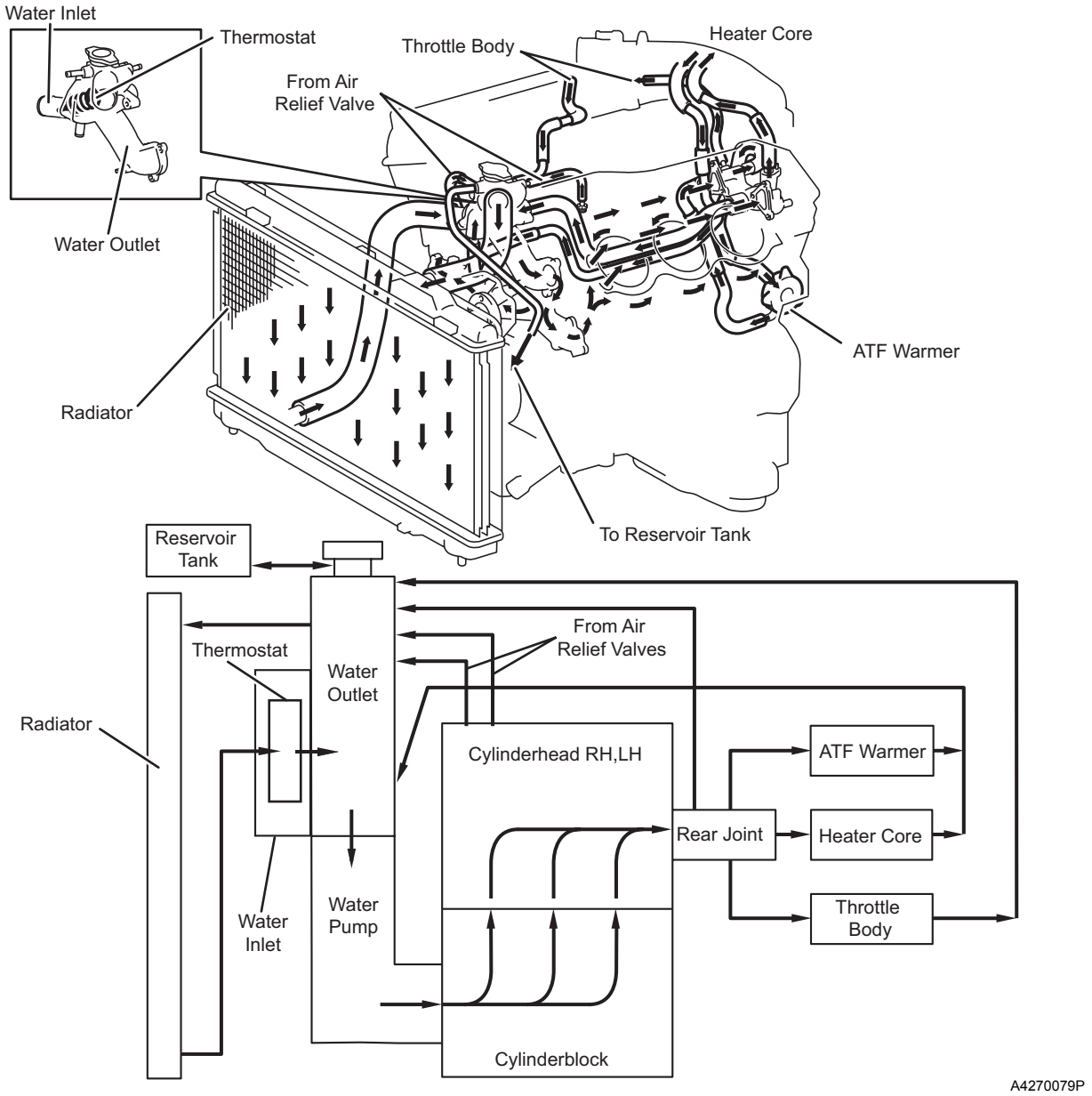
● An ultra thin-wall, high cell density ceramic catalyst with an optimized amount of precious metals held is placed directly below each exhaust manifold and in each front pipe. These catalysts ensure a high level of warm-up performance immediately after the engine is started, thus reducing exhaust emissions and complying with the Step-IV European Tailpipe Emission Regulations.

3GR-FE COOLING

EG

General

- The cooling system is a water-cooled, forced-pressure circulation type in which a bypass valve type thermostat is integrated in the water inlet housing. The thermostat is the bottom bypass type.
- In this system, the engine ECU turns the cooling fan ON-OFF and controls the fan speed.
- To reduce the formation of air pockets in the cylinder head, air relief valves are provided in the right and left cylinder heads.
- An ATF warmer is provided to accelerate the warm-up speed, thus reducing the friction of the automatic transmission.



Radiator

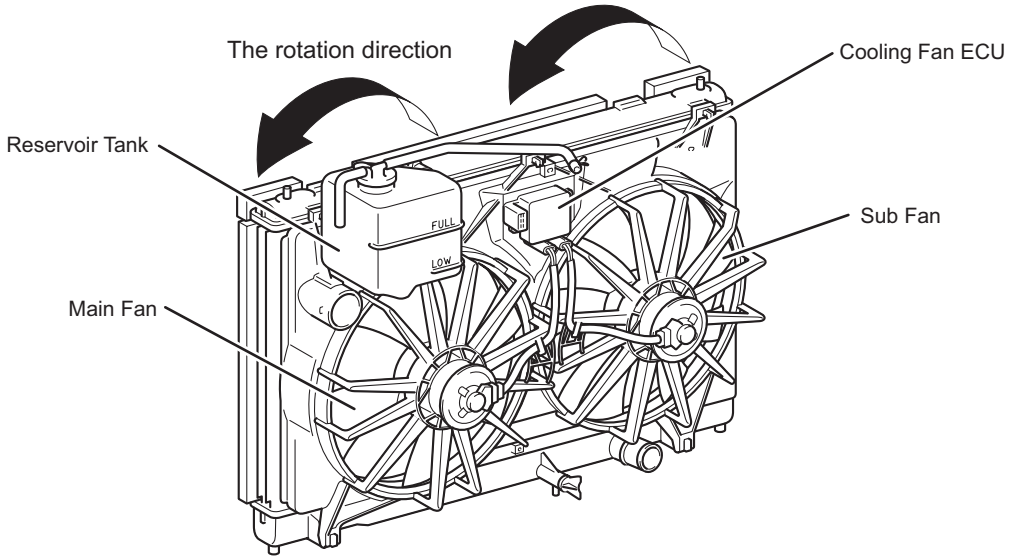
- A lightweight, high-performance aluminum core radiator is used to improve cooling performance and reduce weight.

Radiator

Core Type	Corrugated Fin
Fin Pitch [mm (in.)]	2.5 (0.098)/2
Core Dimensions (width x height x thickness) [mm (in.)]	709.0×399.2×27 (27.913×15.717×1.063)
Dry Weight [kg]	3.59

Cooling Fan

- The fan shroud is secured to the radiator without bolts.
- Ring fans, which are provided with band-shaped rings around them are used, which enhance rigidity and realize a lightweight and compact construction.
- The engine ECU outputs a signal to the cooling fan ECU, which steplessly controls the speed of the two fans in accordance with the engine conditions, driving conditions, and whether the air conditioner is operating. Through optimally controlled speeds, the fans operate significantly quieter and improve cooling performance.



Cooling fan

	Main Fan	Sub Fan
Outer Diameter [mm (in.)]	340 (13.386)	←
Number of blades	5	7

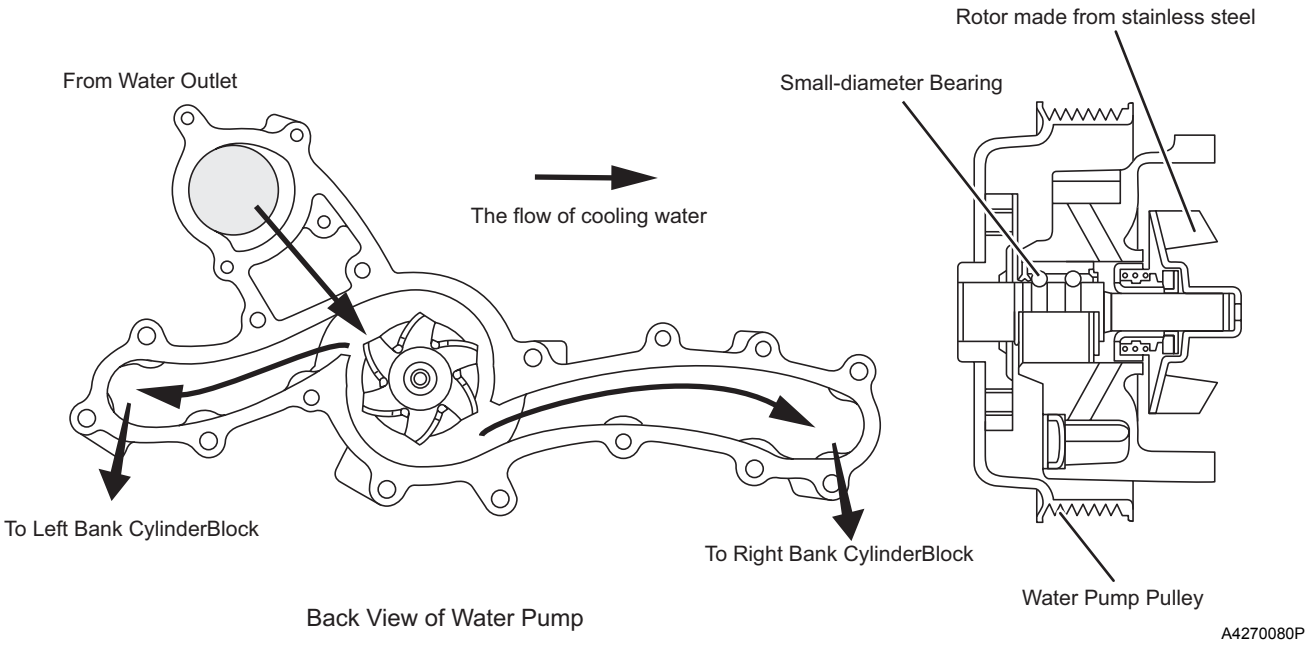
Cooling Fan motor

	Main Fan Motor	Sub Fan Motor
Rated voltage [V]	12	←
Rated Output [W]	160	←

EG

Water Pump

- The water pump uses a V ribbed belt driven system.
- It uses a small-diameter bearing to achieve a compact construction.
- The rotor is made of stainless steel to improve corrosion resistance and ensure reliability.



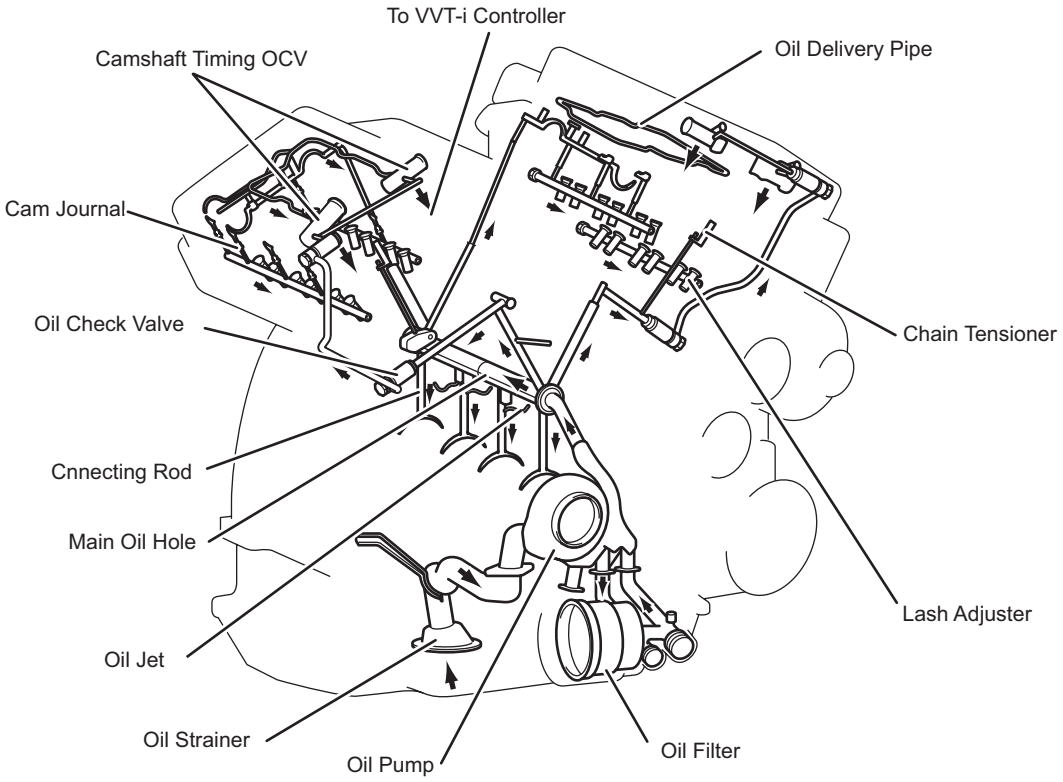
Water Pump

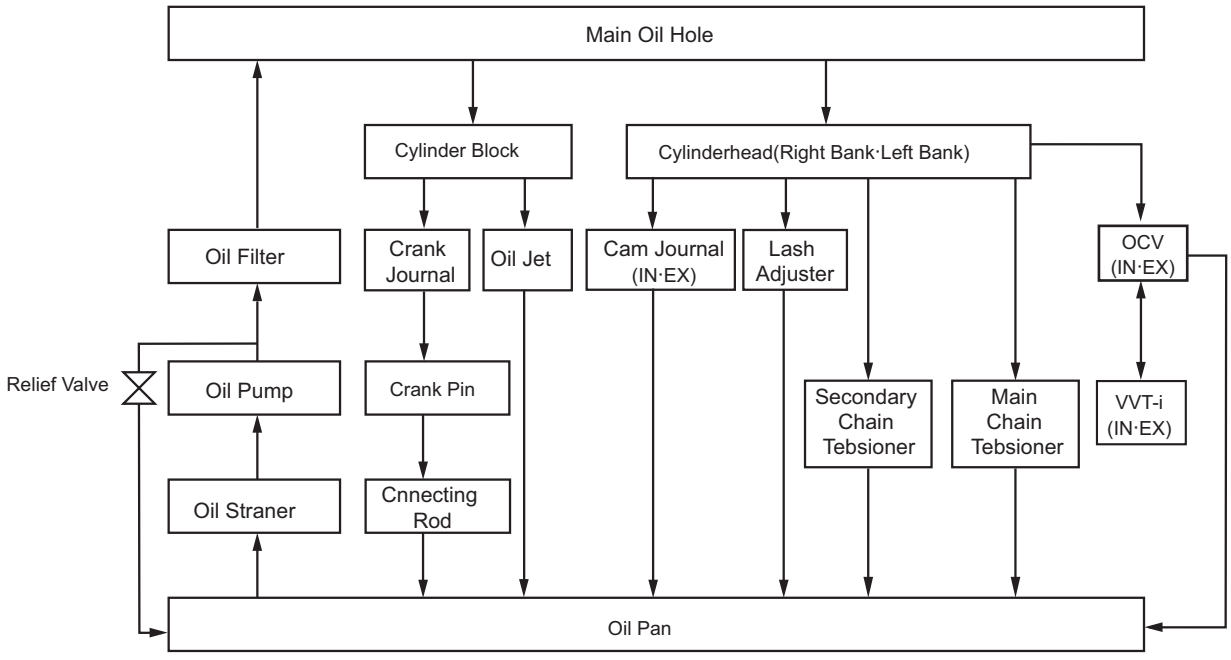
Drive System	V Ribbed Belt Driven
Rotor Diameter [mm (in.)]	60.0 (2.362)
Bearing Diameter [mm (in.)]	30.0 (1.181)
Number of Blades	6
Discharge Performance [L/min](at 80 ± 2°C, 4,000 rpm)	46

3GR-FE LUBRICATION

General

- A full-pumping, full-filtering lubrication system is used.



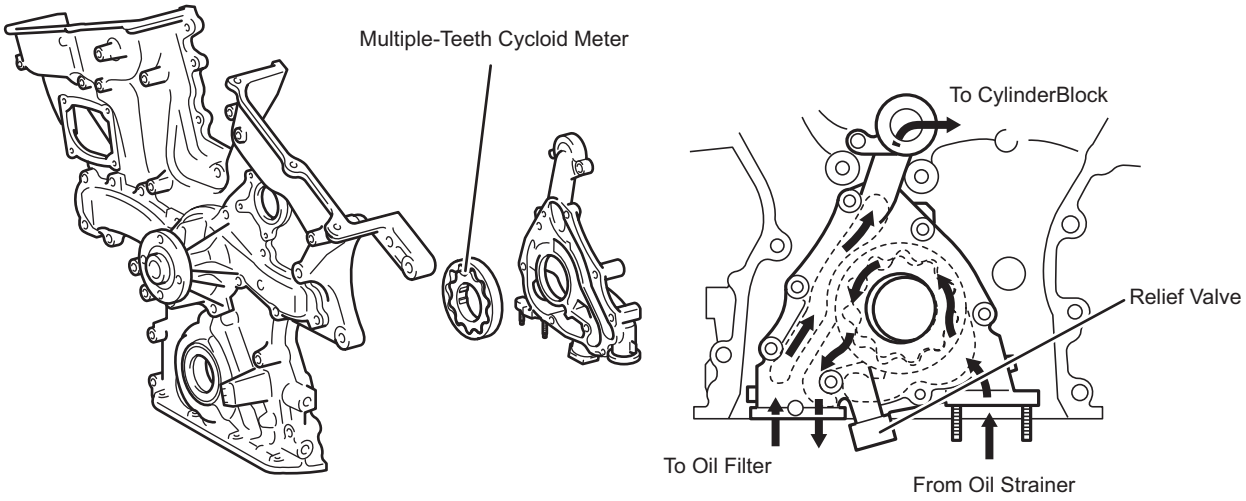


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EG

Oil Pump

- The oil pump consists of a compact, highly efficient, and multiple-teeth cycloid rotor that is driven directly by the crankshaft. The drive rotor is a flangeless type, which enables the use of a driven rotor with a small diameter, thus reducing friction.
- An internal oil relief system is used to circulate the relief oil through the suction passage in the oil pump. This suppresses the oil level fluctuations in the oil pan, reduces friction, and reduces the rate of mixing air bubbles in the oil.



The oil passage in an oil pump

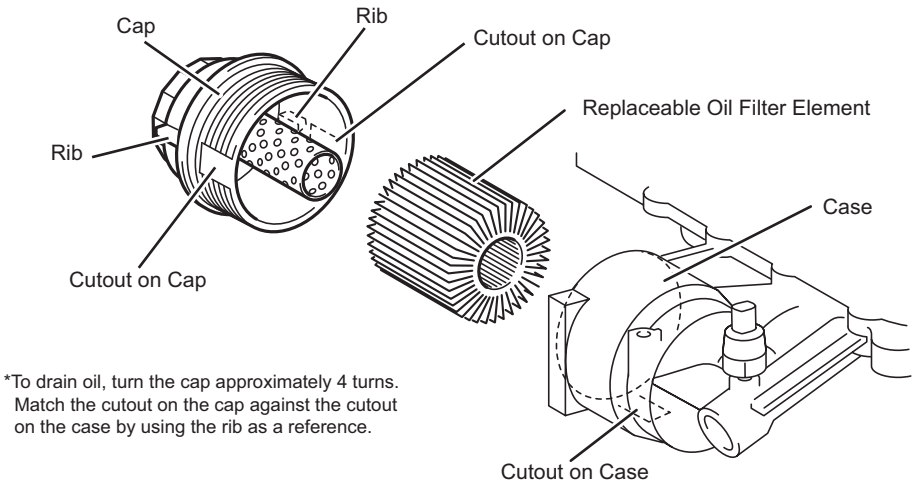
A4270252P

Oil Pump

Pump Speed [rpm]	600	2000	6400
Discharge Volume [L/min]	6.0 Minimum	—	89.6 Minimum
Discharge Pressure [kPa]	100	—	290
Relief Valve Opening Pressure [kPa]	—	490	—

Oil Filter

- A newly developed oil filter with a replaceable element is used. The element uses high-performance filter paper that ensures ample filtering performance, and is made completely burnable.
- The cap is made of an aluminum alloy for a long life.
- A drain construction is provided to suppress the splashing of the oil during the replacement of the oil filter element. Oil can be drained by matching the thread cutout on the cap against the thread cutout on the case.



Drain construction

A4270222P

■ **Service Tip** ■

To replace the oil filter, turn the cap approximately 4 turns, match the cutout on the cap against the cutout on the case, and drain the oil. Use the rib on the cap as a reference for matching the cutout on the cap against the cutout on the case. For details, refer to the GS430/300 Repair Manual(Pub. No. RM1168E)

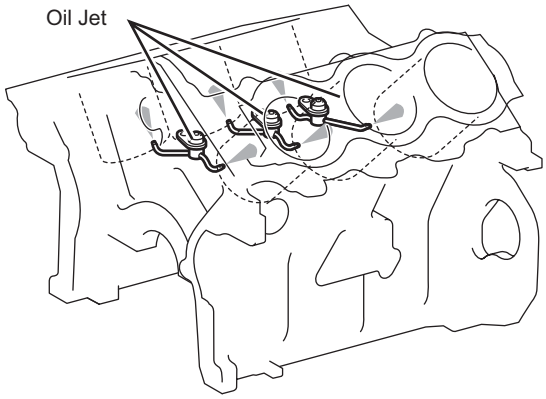
Oil Filter

Type		Full-flow
Filtration area	[cm^2]	1260
Outer diameter×Height	[mm (in.)]	82.1×70.5 (3.232×2.776)
Relief Valve Opening Pressure	[kPa]	100

EG

Oil Jet

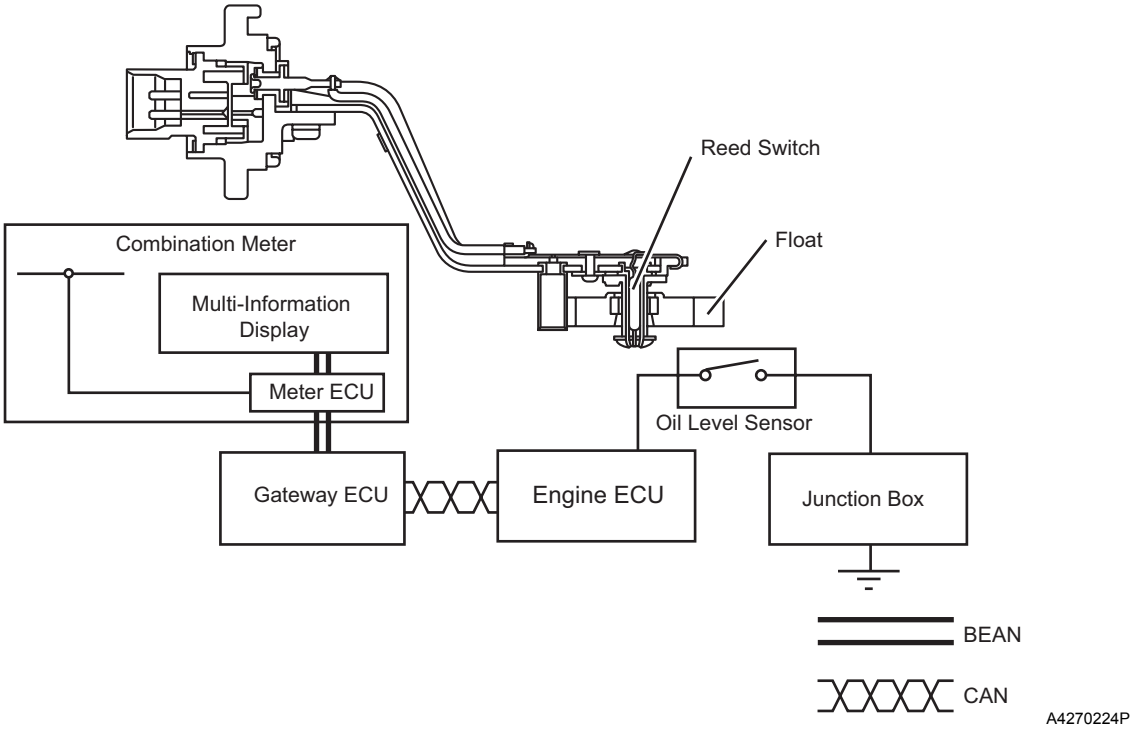
- Oil jets are provided in the cylinder block. These jets spray oil into the cylinders to reduce friction and suppress the increase in temperature. As a result, they improve the durability of the pistons and prevent them from knocking.



A4270084P

Oil Level Sensor

- The oil level sensor consists of a reed switch, which turns ON and OFF with the vertical movement of the float. When the engine oil level decreases, the system informs the driver of it in the following manner. On the multi-information display in the combination meter, a warning appears on the multi-information display. In addition, the system is provided with a 40-second delay circuit to prevent the display from indicating improperly as a result of biased behavior of the oil while the vehicle is in motion.
- A warning appears when the float descends as a result of a reduction in the engine oil level (when the reed switch is OFF).

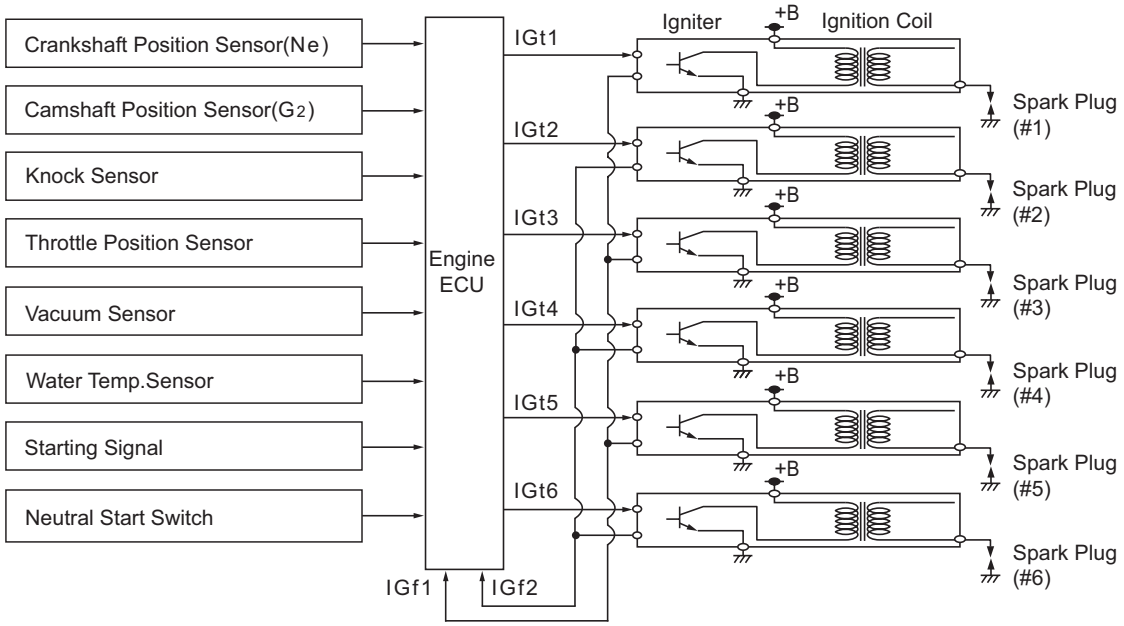


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3GR-FE IGNITION

General

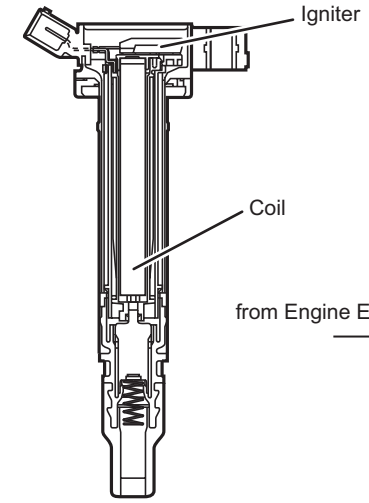
- The Direct Ignition system(DIS) is used, in which an ignition coil with a built-in igniter is provided for every cylinder. This system enhances the ignition timing control precision and makes the ignition timing completely adjustment-free.
- Independent ignition coils are provided to each of the cylinders #1 to #6, thus making a distributor or high tension cord unnecessary. This reduces the power loss associated with high-voltage areas, improves reliability, and reduces electro-magnetic interference.



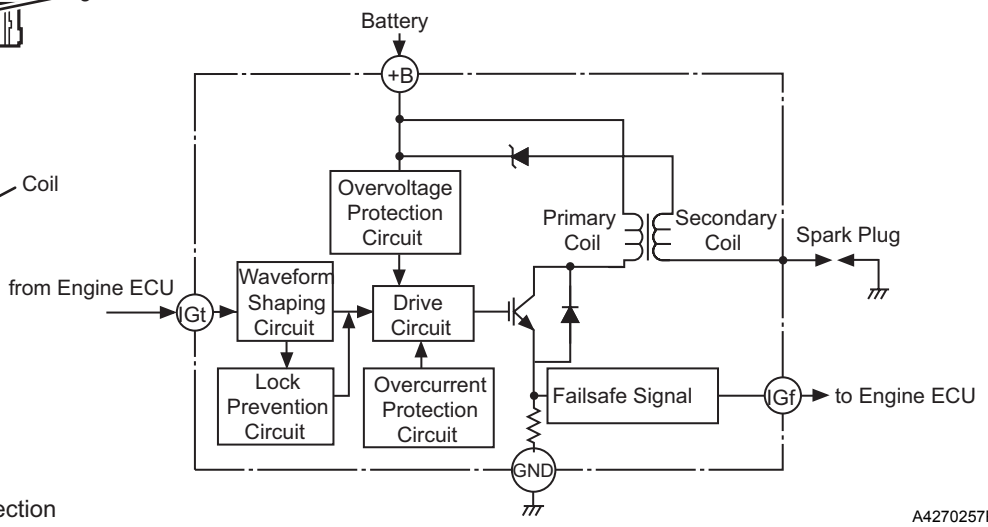
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Ignition Coil (with Igniter)

- Ignition coils with built-in igniters are used and placed directly over the spark plugs.



Ignition Coil Cross Section

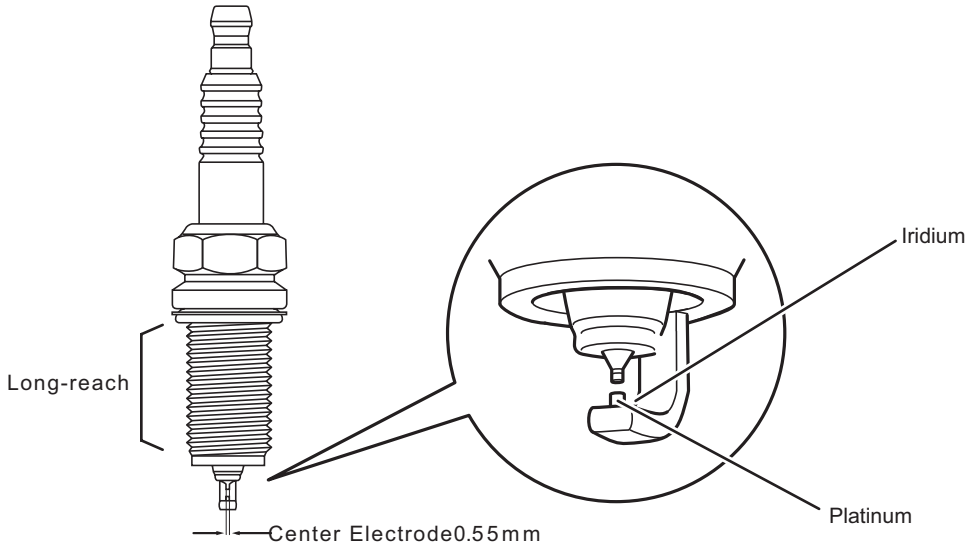


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EG

Spark Plug

- Long-reach spark plugs are used to improve the cooling performance of the cylinder heads.
- They are iridium spark plugs that use an iridium alloy in their center electrode. Because the iridium alloy has extremely superior wear resistance, the center electrode can be made with a small diameter. This produces reliable ignition while improving durability.



Spark Plug

DENSO	FK20HR11
NGK	ILFR6D11
Plug Gap [mm (in.)]	1.0 ~ 1.1 (0.0394~ 0.043)

Crankshaft Position Sensor

- The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.
(See page EG-39)

Camshaft Position Sensor

- These sensors are the MRE (Magnetic Resistance Element) type. The rotational movement of the timing rotor (which is provided in the VVT-i controller of the intake camshaft) causes a magnetic field to act on the magnetic resistance element in the sensor. The sensor utilizes the changes that occur in the direction of the magnetic field to detect the position of the timing rotor, which determines the position of the actual camshaft. The cylinders are identified by the input sequence of the Ne and G2 signals.
(See page EG-40)

3GR-FE STARTING

Starter

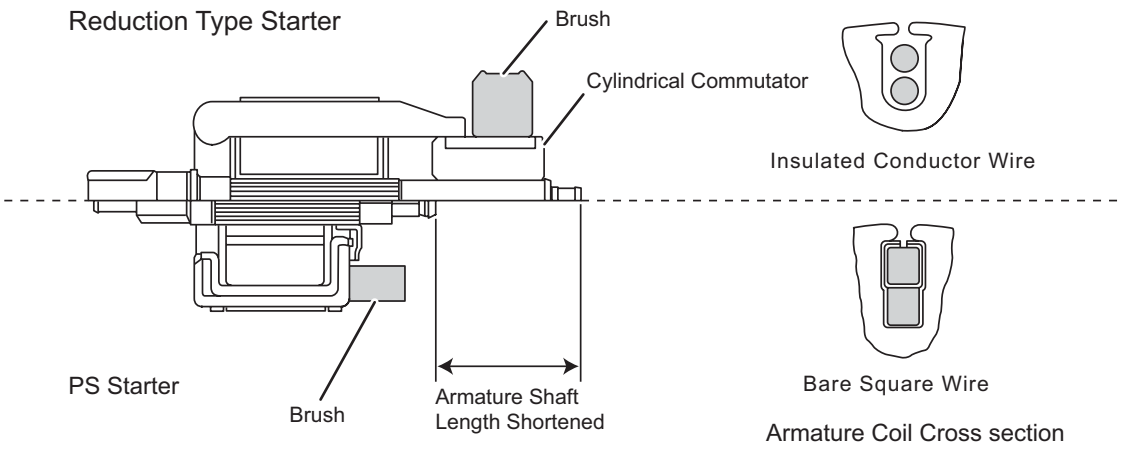
- A compact, lightweight, high power output, and highly efficient PS (Planetary reduction - Segment conductor motor) starter is used.
- A square conductor armature coil is used to achieve a compact and lightweight construction.

Starter

	Standard	For China
Type	PS Type	←
Rated Voltage [V]	12	←
Rated Output [kW]	1.3	1.7

Armature Coil

- The armature coil consists of bare square wire, which improves the space factor, and improves the torque of the starter.
- The cylindrical commutator has been discontinued to shorten the length of the armature shaft.

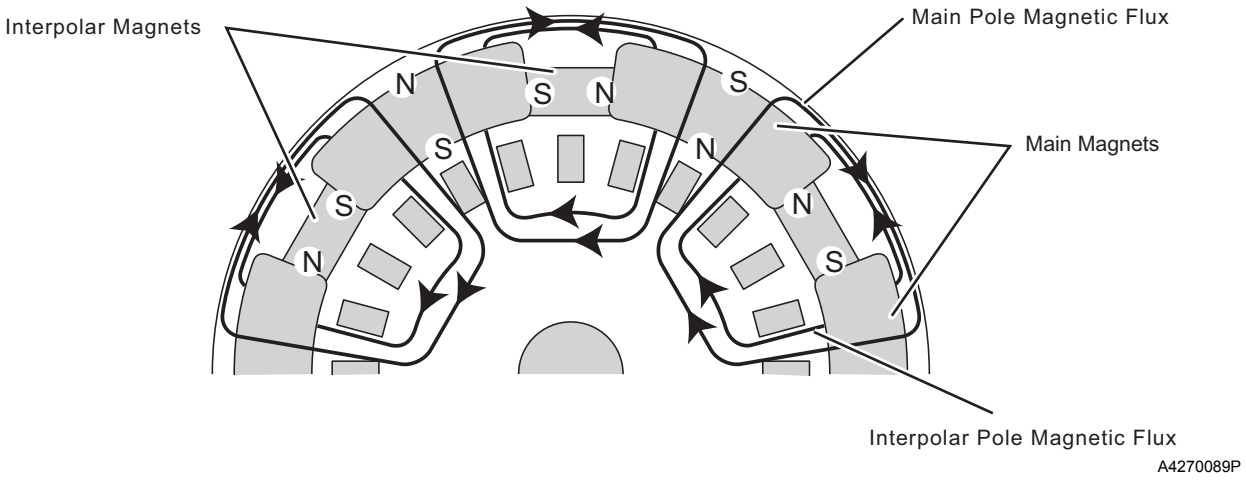


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EG

Field Coil

• Interpolar magnets are used between the field coils. This improves the magnetic circuit and increases the amount of magnetic flux. Because the same amount of magnetic flux as the conventional type can be attained with a compact construction, the length of the yoke shaft has been shortened.



3GR-FE CHARGING

Alternator

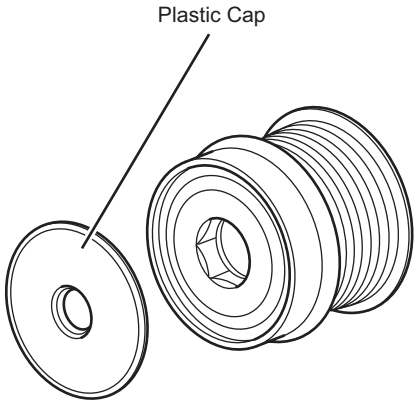
- A compact, lightweight, high power output, and highly efficient segment conductor type alternator is used.
- A clutch is provided in the alternator pulley. By reducing friction on the accessory belt, this clutch contributes to fuel economy.

Alternator

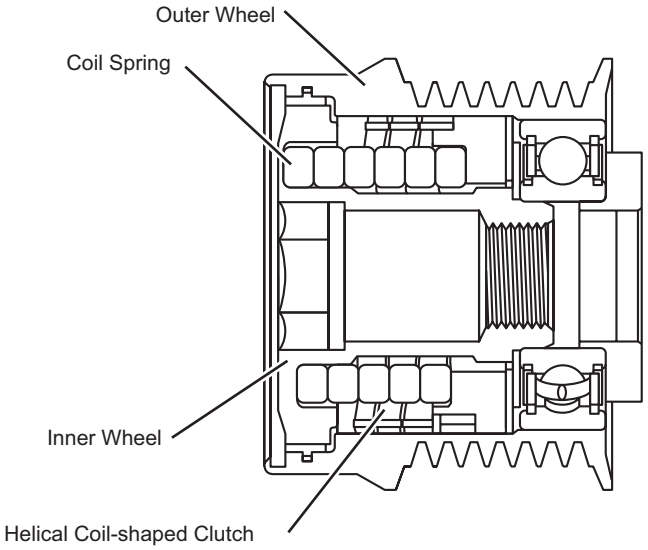
	Standard	For China
Rated Voltage [V]	12	12
Rated Output [A]	130	150
Regulator Setting Voltage [V](5000rpm,10A,25°C)	12.1 ~ 15.4	←
Permissible Max Speed [rpm]	18000	←

Alternator Pulley

- A helical coil-shaped clutch, which is located between the inner and outer wheels of the pulley, transmits power to the alternator only in the forward rotational direction of the engine. Thus, it reduces the load that acts on the accessory belt.
- The pulley is made compact by shaping the inner wheel together with the nut used for tightening the alternator shaft.
- A plastic cap that covers the interior is provided in front of the pulley. This prevents mud from entering, thus ensuring reliability under poor environmental conditions.



Alternator Pulley



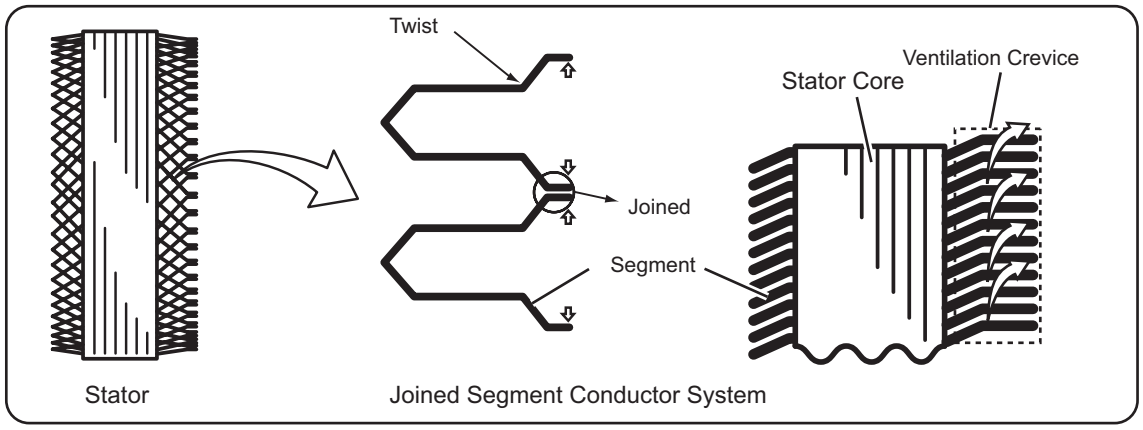
Alternator Pulley Cross Section

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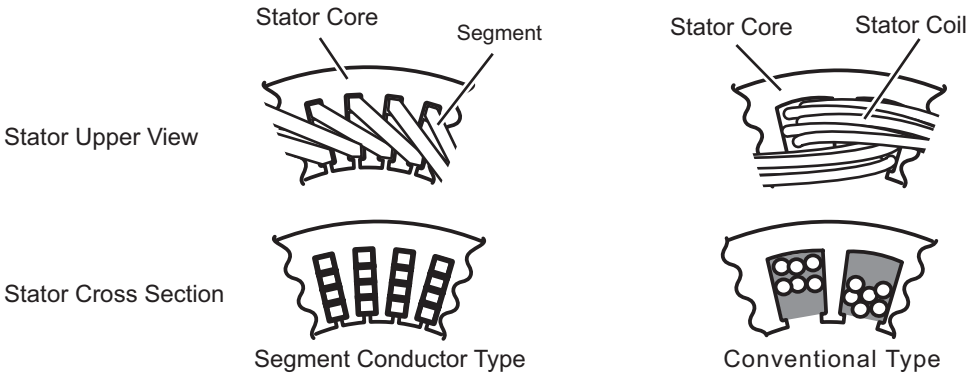
EG

Stator Coil

- A compact and lightweight Segment Conductor type alternator that generates high amperage output in a highly efficient manner has been adopted on standard equipment.
- This alternator has a joined segment conductor system, in which multiple segment conductors are welded together to form the stator. Compared to the conventional winding system, the electrical resistance is reduced due to the shape of the segment conductors, and their arrangement helps to make the alternator more compact.



〈Segment Conductor Type Alternator〉

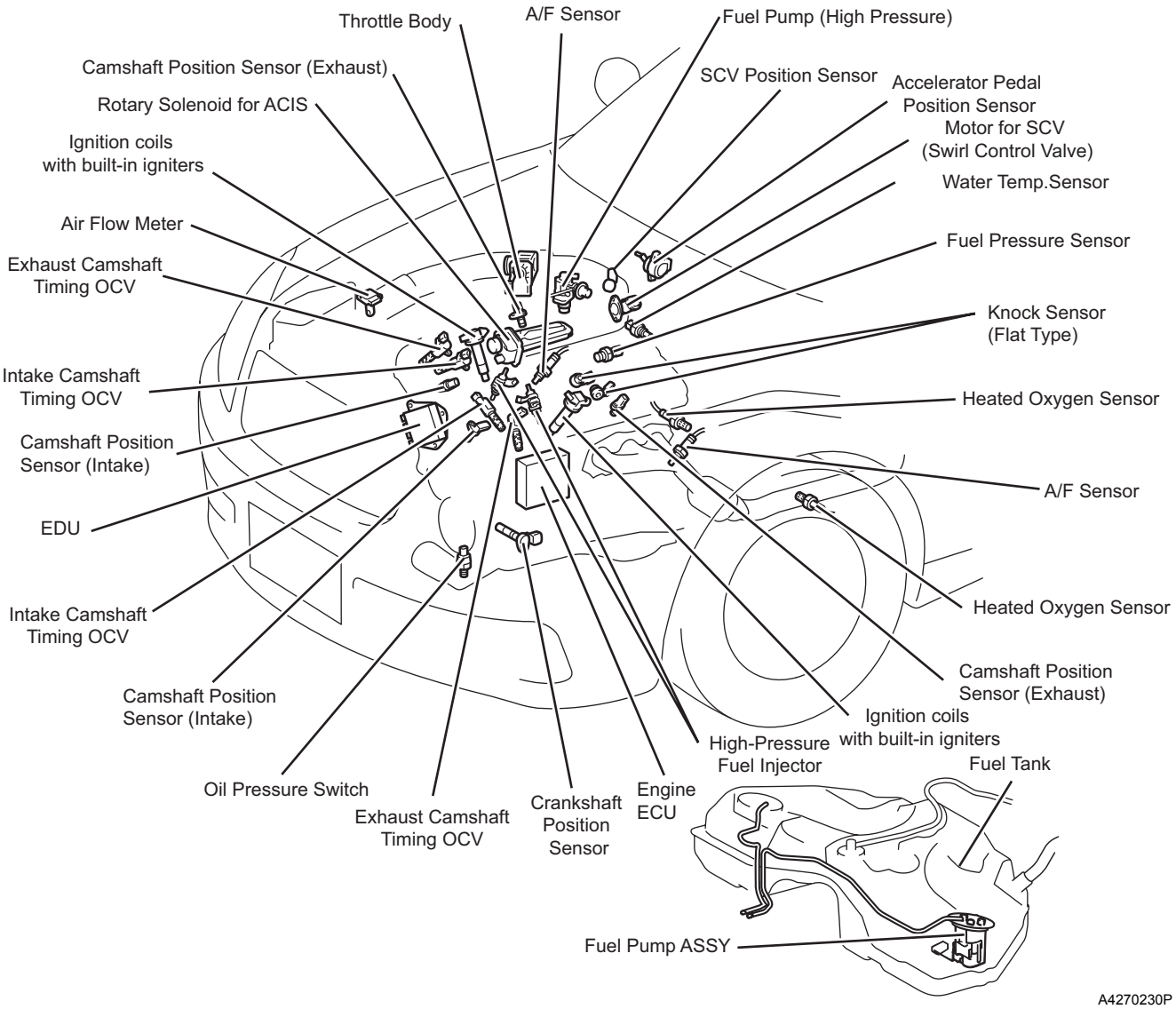


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3GR-FSE ENGINE CONTROL SYSTEM

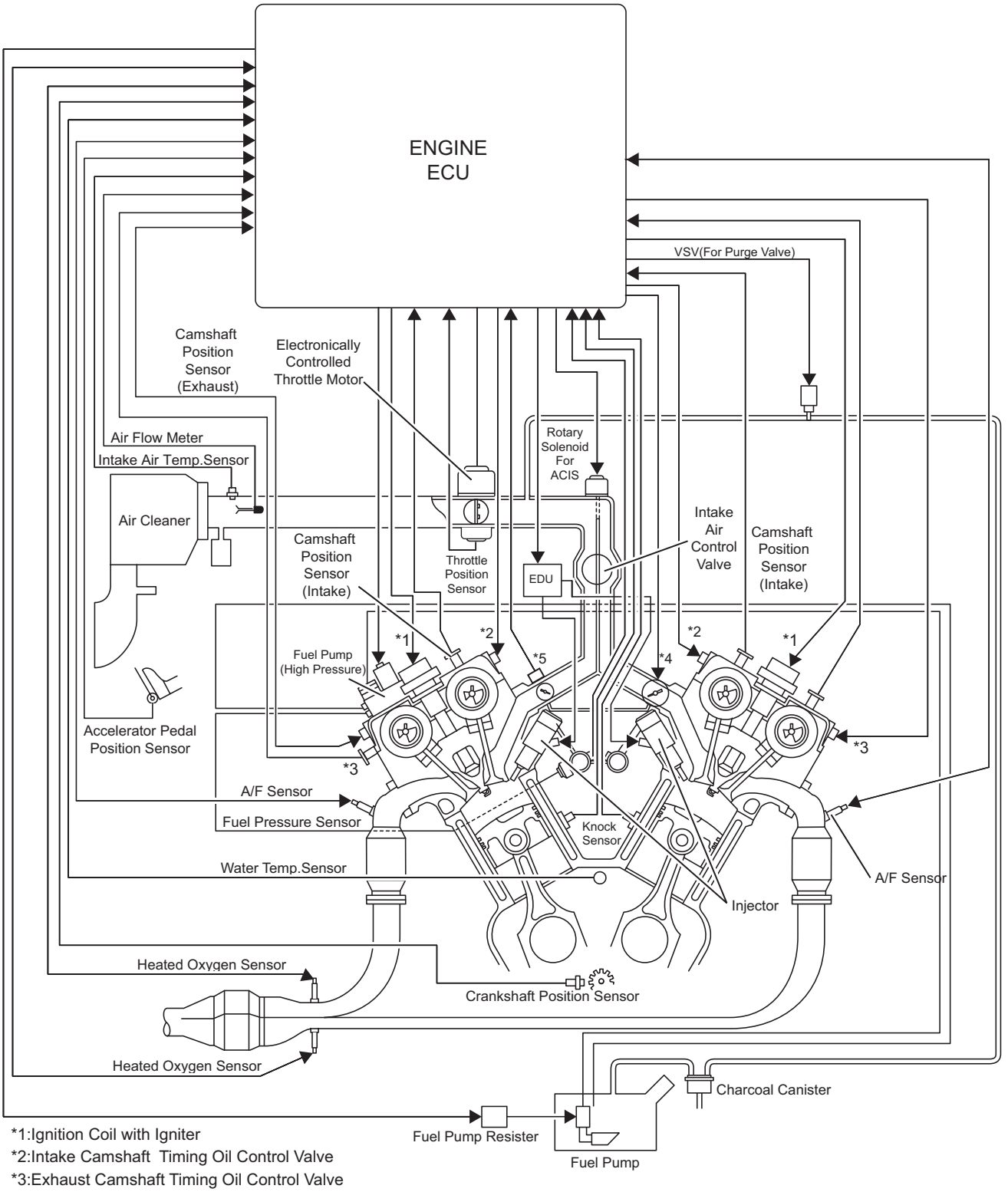
Engine Control System Description

- This engine controls the following systems in a highly accurate manner: Electronic Fuel Injection (EFI), Electronic Spark Advance (ESA), Electronic Throttle Control System-intelligent (ETCS-i), and Dual Variable Valve Timing-intelligent (Dual VVT-i). As a result, high performance, high power output, fuel economy, and improved exhaust emission performance have been achieved.
- A D-4 (Direct injection 4-stroke gasoline engine) system is used. The engine ECU effects centralized control to achieve an optimal state of combustion that suits the driving conditions, in order to realize fuel economy and a high power output in the practical range.
- CAN (Controller Area Network) communication is used to exchange data with other ECUs.
- The electronic SCV (Swirl Control Valve) control stabilizes combustion when the water temperature is low, and the electronic ACIS (Acoustic Control Induction System) control generates high torque in the practical speed range.
- A diagnosis and a failsafe function are provided to ensure serviceability and safety.



EG

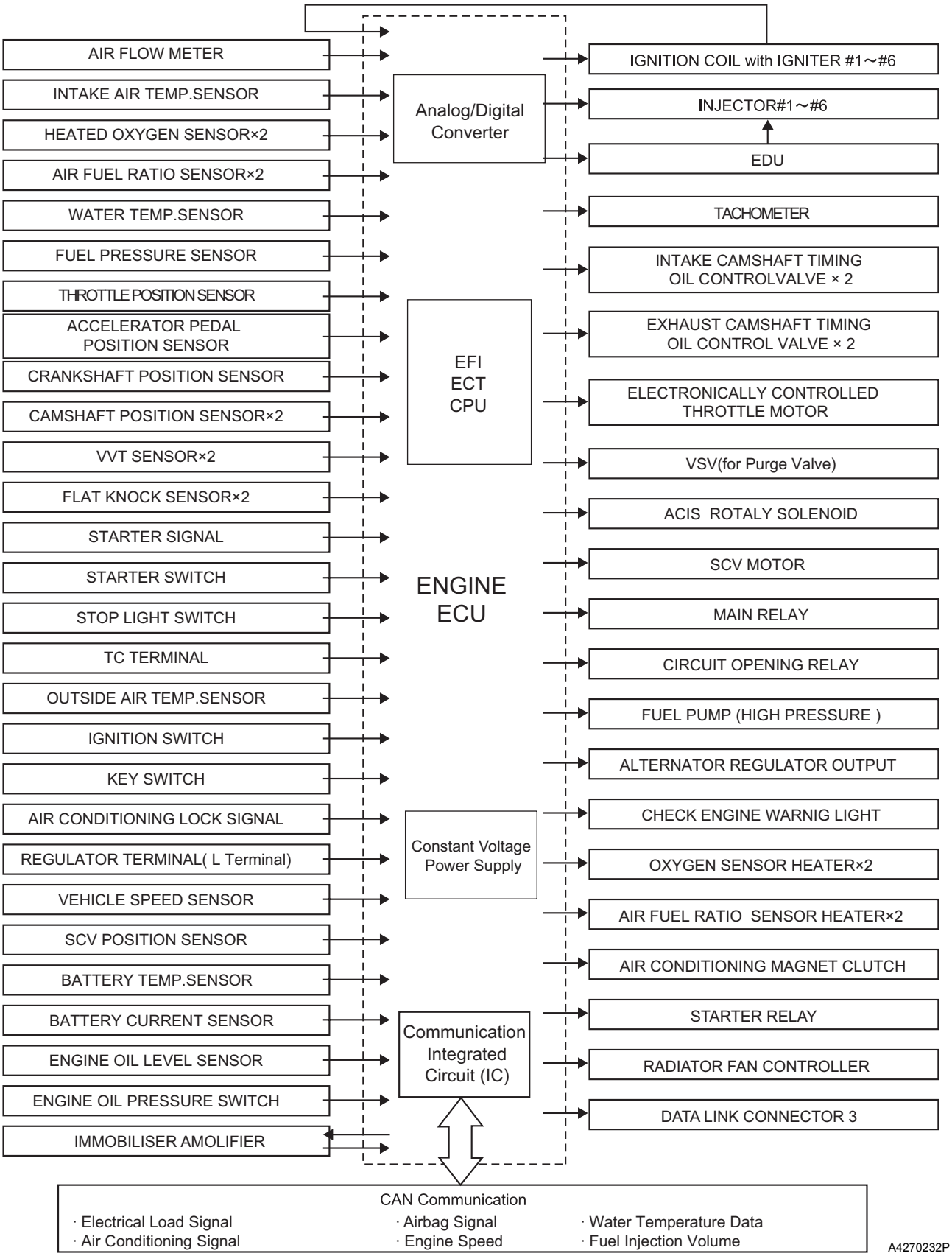
Engine Control System Diagram



*1:Ignition Coil with Igniter
*2:Intake Camshaft Timing Oil Control Valve
*3:Exhaust Camshaft Timing Oil Control Valve
*4:SCV(Swirl Control Valve) Motor
*5:SCV Position Sensor

A4270231P

Construction



A4270232P

Control List

System	Outline	
D-4 EFI (Electronic Fuel Injection)	An L-type EFI system directly detects the intake air mass with a hot wire type mass air flow meter.	
ESA (Electronic Spark Advance)	An L-type EFI system directly detects the intake air mass with a hot wire type mass air flow meter.	
	Ignition timing is determined by the engine ECU based on signals from various sensors. Corrects ignition timing in response to engine knocking.	
	Knocking Judgment Control(KCS)	2 knock sensors are used to improve knock detection.
ETCS-i (Electronic Throttle Control System-intelligent)	Based on the signals provided by the sensors, this system applies corrections to the throttle position that has been calculated in accordance with the condition of the engine, in order to achieve an appropriate throttle position.	
	VSC Control	Controls the throttle valve position when the VSC is operating.
	Maximum Speed Control	When the vehicle speed reaches 240 km/h, this control closes the throttle valve to suppress the increase in vehicle speed.
	Idle Speed Control(ISC	Controls the fast idle speed in accordance with the water temperature, and the idle speed after the engine has been warmed up. It controls the idle speed by regulating the fuel injection volume and the throttle position.
Dual VVT-i Control	Controls the optimal intake and exhaust valve timing in accordance with the conditions of the engine.	
SCV(Swirl Control Valve) Control	Optimally controls the air current in the combustion chamber by closing one of the independent intake ports in accordance with the water temperature and engine condition, in order to stabilize the combustion and improve performance.	
ACIS (Acoustic Control Induction System) Control	Varies the intake manifold length to suit the conditions of the engine.	
Fuel Pump Control (For High Pressure Side)	Controls the discharge pressure of the high-pressure fuel pump in accordance with the conditions of the engine.	
Fuel Pump Control	Turns the fuel pump ON/OFF in accordance with the starter signal and the engine speed signal. Stops the operation of the fuel pump in accordance with the signals from the airbag ECU.	
Alternator Charging Control	Controls the charging voltage of the alternator in accordance with the driving conditions, thus reducing the charging load and contributing to fuel economy.	
Cranking Hold Control	After the starter starts to crank the engine, this control continues to apply current to the starter until the engine starts. Thus, it prevents the failure of the engine to start when the driver inadvertently turns the ignition switch to OFF just before the engine fires.	
Air-Fuel Ratio Sensor Heater Control	Turns the air-fuel ratio sensor heater ON/OFF in accordance with the water temperature and the driving conditions.	
Heated Oxygen Sensor Heater Control	Maintains the temperature of the heated oxygen sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.	
Evaporative Emission Control	The engine ECU controls the purge flow of evaporative emissions (HC) in the charcoal canister in accordance with engine conditions.	

System	Outline
Air ConditioningCut-Off Control	By controlling the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.
Engine Immobiliser	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.
Function to communicate with multiplex communication system	Communicates with the meter ECU, A/C ECU, etc., on the body side, to input/output necessary signals.
Diagnosis	Enables the accurate and detailed diagnosis of malfunctions through the use of the intelligent Tester II diagnostic tool to access the SAE-prescribed DTC (Diagnostic Trouble Code) and data, as well as to perform active tests.
Fail-Safe	When the engine ECU detects a malfunction, the engine ECU stops or controls the engine according to the data already stored in the memory.

■ **Service Tip** ■

The uses the CAN protocol for diagnostic communication. Therefore, a intelligent Tester II and a dedicated adapter [CAN VIM (Vehicle Interface Module)] are required for accessing diagnostic data. For details, see the 2005 Lexus GS430/300 Repair Manual(Pub. No. RM1168E)

Sensor List

Name	Function and Construction	EFI	ESA	ISC	VVT-i
Air Flow Meter	Detects the intake air volume.	❍	❍	❍	❍
Intake Air Temperature Sensor	Detects the intake air temperature.	❍	❍	❍	❍
Camshaft Position Sensor	Identifies the cylinder and detects the actual camshaft position.	❍	❍	❍	❍
Crankshaft Position Sensor	Detects the crankshaft position.	❍	❍	❍	❍
Accelerator Pedal Position Sensor	It is attached to the accelerator pedal to detect the accelerator pedal position.	❍	❍	❍	❍
Throttle Position Sensor	Detects the throttle valve position.	❍	❍	❍	❍
SCV Position Sensor	Detects the SCV position.				
Water Temp.Sensor	Detects the water Ftemperature.	❍	❍	❍	❍
Fuel Pressure Sensor	It is mounted on the fuel delivery pipe to detect fuel pressure.	❍			
Air-Fuel Ratio Sensor	Detects the state of the air-fuel ratio in the exhaust gas.	❍			
Heated Oxygen Sensor	Detects the oxygen concentration in the exhaust gas.	❍			
Igniter	Sends the ignition verification signal.		❍		
Starter Signal	Sends the starter voltage in the form of a signal when the engine is started.	❍	❍	❍	❍
Neutral Start Switch	Detects the P, N, and D positions of the automatic transmission.	❍	❍	❍	❍
Knock Sensor	Detects the knocking of the engine by way of the resonance of the piezoelectric element.		❍		

Name	Function and Construction	EFI	ESA	ISC	VVT-i
Vehicle Speed Signal	Detects vehicle speed.	❍	❍	❍	❍

Actuator List

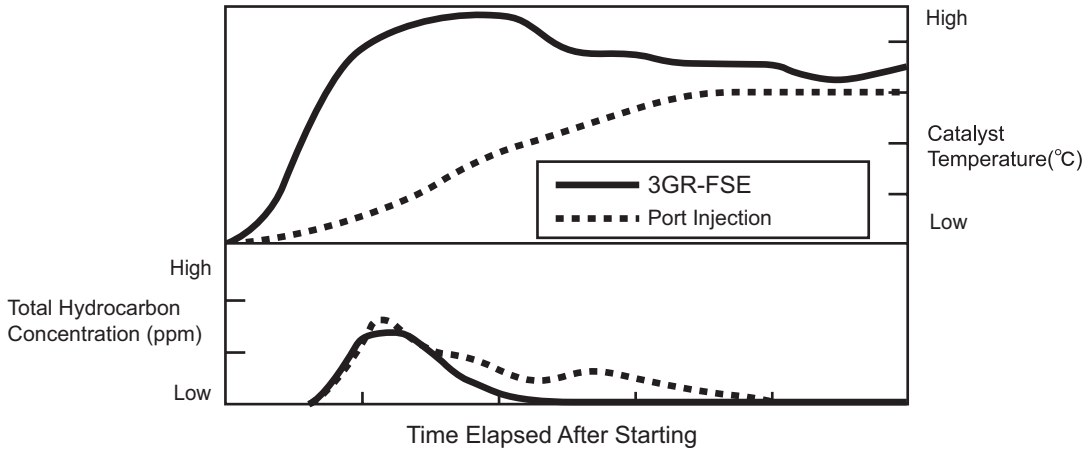
Name	Function and Construction
Main Relay	Supplies main power to the EFI, ESA system, etc.
Circuit Opening Relay	Supplies power to the fuel pump system.
High-Pressure Fuel Pump	Pressurizes fuel.
Fuel Injector	Injects an optimal volume of fuel at an optimal timing.
Air-Fuel Ratio Sensor Heater	Heats the air-fuel ratio sensor to promote feedback control when the engine is cold.
Heated Oxygen Sensor Heater	Heats the heated oxygen sensor to promote feedback control when the engine is cold.
Igniter	Turns the current to the ignition coil ON/OFF at an optimal timing.
Electronically Controlled Throttle Motor	Controls the position of the throttle valve in accordance with driving conditions.
Intake Camshaft Timing OCV	Controls the intake VVT-i at an optimal valve timing.
Exhaust Camshaft Timing OCV	Controls the exhaust VVT-i at an optimal valve timing.
Rotary Solenoid for ACIS	Opens and closes the intake air control valve in accordance with driving conditions.
Motor for SCV (Swirl Control Valve)	Opens and closes the swirl control valve in accordance with driving conditions.
Evaporative Purging VSV	Regulates the purge volume of the canister.
EDU(Electronic Driver Unit)	Converts the injection request signal from the engine ECU into a high voltage, high amperage injector actuation signal in order to actuate the high-pressure fuel injector.

D-4 EFI (Electronic Fuel Injection) System

- The D-4 (Direct Injection 4-Stroke Gasoline Engine) consists of a high-pressure fuel injector that is installed directly in the combustion chamber in order to precisely and optimally control the fuel injection timing in accordance with the driving conditions.
- Uses an airflow meter to detect the intake air volume in order to control the fuel injection volume.
- Based on the signals obtained from various sensors, the engine ECU controls the injection volume and injection timing to suit the engine speed and the engine load, in order to achieve an optimal state of combustion.
- Unlike an ordinary gasoline engine, the fuel injection system simultaneously controls the injection timing and injection volume in order to inject fuel directly into the cylinders. In addition, asynchronous injection that takes place in an ordinary gasoline engine does not exist in this engine.
- To promote the warm-up of the catalyst during cold starting, this system effects lean-burn control through weak stratification combustion.

Weak Stratification Combustion

- The system injects fuel during the latter half of the compression stroke immediately after the engine is cold-started, to effect a weak stratification combustion. This raises the combustion temperature, promotes the warm-up of the catalyst, and dramatically improves exhaust emission performance.



The effect of reducing the total hydrocarbon concentration by injecting fuel during the compression stroke during cold starting

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Homogeneous Combustion

• By injecting fuel during the first half of the intake stroke, the engine creates a more homogeneous air-fuel mixture. In addition, by utilizing the heat of evaporation of the injected fuel to cool the compressed air, the engine has increased its charging efficiency and produces a higher power output.

Air-Fuel Ratio Control

Air-Fuel Ratio Control	The system determines the fuel injection volume based on the engine speed and the intake air volume (which is detected by the airflow meter). After the engine is started, feedback control is effected on the air-fuel ratio based on signals from the air-fuel ratio sensor.

Control and Combustion Classification

		State of Combustion	Injection Timing	Control Condition
(1)	Lean Air-Fuel Ratio Control	weak stratification combustion	compression stroke	At the time of starting between the colds
(2)	Stoichiometric Air-Fuel Ratio Control	homogeneous combustion	intake stroke	Except (1) and (3)
(3)	Air-Fuel Ratio Feedback Control Prohibition	homogeneous combustion	intake stroke	High load driving (large)
				At the time of low engine coolant temperature

Fuel Cut

• The system temporarily stops the injection of fuel to protect the engine and improve fuel economy.

The following are the three types of fuel cutoff

Deceleration Fuel Cutoff	Stops the injection of fuel when the engine speed is higher than the specified value during deceleration (throttle OFF detected by ECM). This prevents the TWC (Three-Way Catalyst) from overheating due to misfiring and improves fuel economy. The fuel cutoff and resumption speeds are higher when the coolant temperature is low.
Engine Speed Fuel Cutoff	Stops the injection of fuel when the engine speed is higher than the specified value to prevent over-revolution.
N → D Shift Fuel Cutoff	Stops the injection of fuel for a prescribed length of time when shifting from N→ D, if the engine speed is higher than the specified value to reduce shift shock.

Fuel Pump Control (For High Pressure Side)

● The system varies the high fuel pressure between 4 and 13 MPa to suit the driving conditions, in order to reduce friction loss.

● When the engine is started, the solenoid spill valve opens, allowing the fuel to be sent to the delivery pipe at the pressure regulator pressure (400 kPa).

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ESA (Electronic Spark Advance)

● This system selects the optimal ignition timing in accordance with the signals received from the sensors and sends the (IGt) ignition signal to the igniter. The ignition timing can be expressed by the formula given below. The default ignition timing is set to 5° BTDC.

Calculation of ignition timing

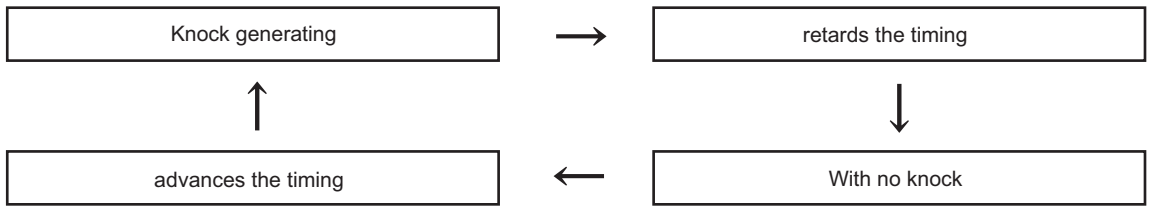
❖REFERENCE❖

Ignition Timing = A. Default Ignition Timing or B. Basic Timing Advance + C. Correction Timing Advance

A.Fixed Timing Advance Characteristic	During the starting of the engine, the timing is fixed to 5° BTDC. If the throttle valve is turned OFF and shorting the service terminals, the timing becomes fixed to 10° BTDC.
B.Basic Timing Advance Characteristic	The optimal ignition timing is selected from the map based on the signals received from the sensors.
C.Correction Timing Advance Characteristic	Appropriately advances or retards the timing in accordance with the conditions of the engine based on the signals received from the sensors.
C-1 Warm-Up Timing Advance Characteristic	Advances the ignition timing in accordance with the driving conditions when the engine coolant temperature is low, in order to improve drivability.
C-2 Idle Stabilization Timing Advance Characteristic	Advances the ignition timing when the idle speed decreases, in order to stabilize the idle speed. Conversely, retards the timing if the idle speed increases.
C-3 Transient Correction Timing Retard	Retards the ignition timing during sudden acceleration when the water temperature is higher than 60°C, in order to prevent the engine from knocking.
C-4 Acceleration Timing Retard	Temporarily retards the ignition timing during acceleration in order to improve drivability.
C-5 Knock Correction Timing Retard	Corrects the ignition timing in accordance with the signals received from the knock sensor when knocking occurs. Depending on the extent of the knocking that is detected, this function retards the timing by a prescribed angle at a time until there is no more knocking. After no more knocking occurs, this function advances the timing by a prescribed angle at a time. If knocking occurs again while advancing the timing, it retards the timing again.

Knock Control System

- When the engine ECU detects the engine knocking, it retards the timing, depending on the extent of knocking, by one predetermined angle at a time until the engine stops knocking.
- When the engine stops knocking, the engine ECU advances the timing by one predetermined angle at a time. If the engine starts knocking again, the engine ECU retards the timing again.



Knocking Feedback Control

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Maximum and Minimum Timing Advance Characteristics

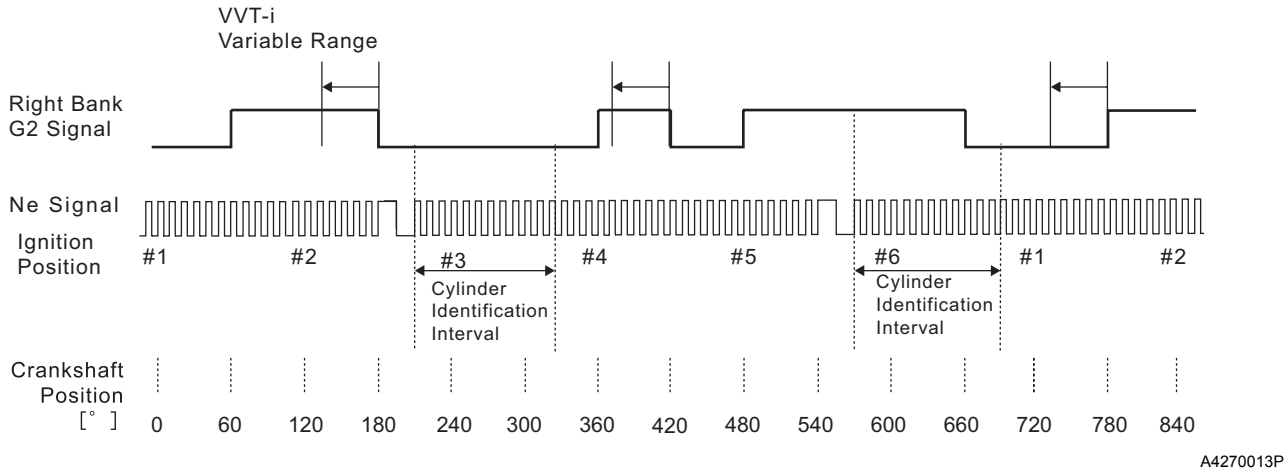
• The maximum and minimum timing advance angles are fixed because the engine can be adversely affected if the ignition timing advances or retards abnormally.

Maximum and Minimum Timing Advance Angles

Maximum Timing Advance Angle (BTDC)	49°
Minimum Timing Advance Angle (ATDC)	-20°

Calculation of ignition timing

• Based on the Ne and G2 signals, airflow meter signal, accelerator position signal, and water temperature signal, the engine ECU calculates the optimal ignition timing to suit the driving conditions. Then, the engine ECU sends an ignition signal to the ignition coil with a built-in igniter.



Idle Speed Control

● Controls the fast idle speed in accordance with the engine coolant temperature, and the idle speed after the engine has been warmed up. It controls the idle speed by regulating the fuel injection volume and the throttle position.

Idle Speed Control

Starting Control	When starting the engine, this control opens the throttle valve to increase the intake air volume, which improves the startability of the engine.
Forecast Control	When the system detects any one of the signals listed below, it controls the position of the throttle valve to suppress speed fluctuations.
	·A change in the idle speed has been forecasted.
	·A change occurred in the electrical load.
	·The air conditioning switch has been switched.
	·The shift lever has been shifted. (N → D, D → N)
Deceleration Control	This control increases the airflow volume by opening the throttle valve during deceleration, thus lowering the vacuum in the intake manifold. This decreases the volume of oil consumed through suction into the combustion chamber, prevents the engine from stalling through a sudden drop in engine speed, and improves drivability.
Feedback Control	While measuring the engine speed for a certain length of time, if there is a difference between the actual speed and the target speed, this control regulates the throttle valve position in order to bring the idle speed to the target speed.

Target Speed

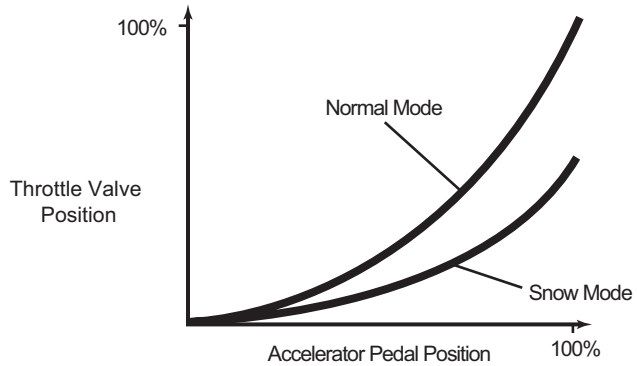
		3GR-FSE
No-load speed [rpm]		650
With an electrical load [rpm]		650
A/C ON [rpm]	Low load	650
	High load	800

ETCS-i (Electronic Throttle Control System-intelligent)

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

ETCS-i Control

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



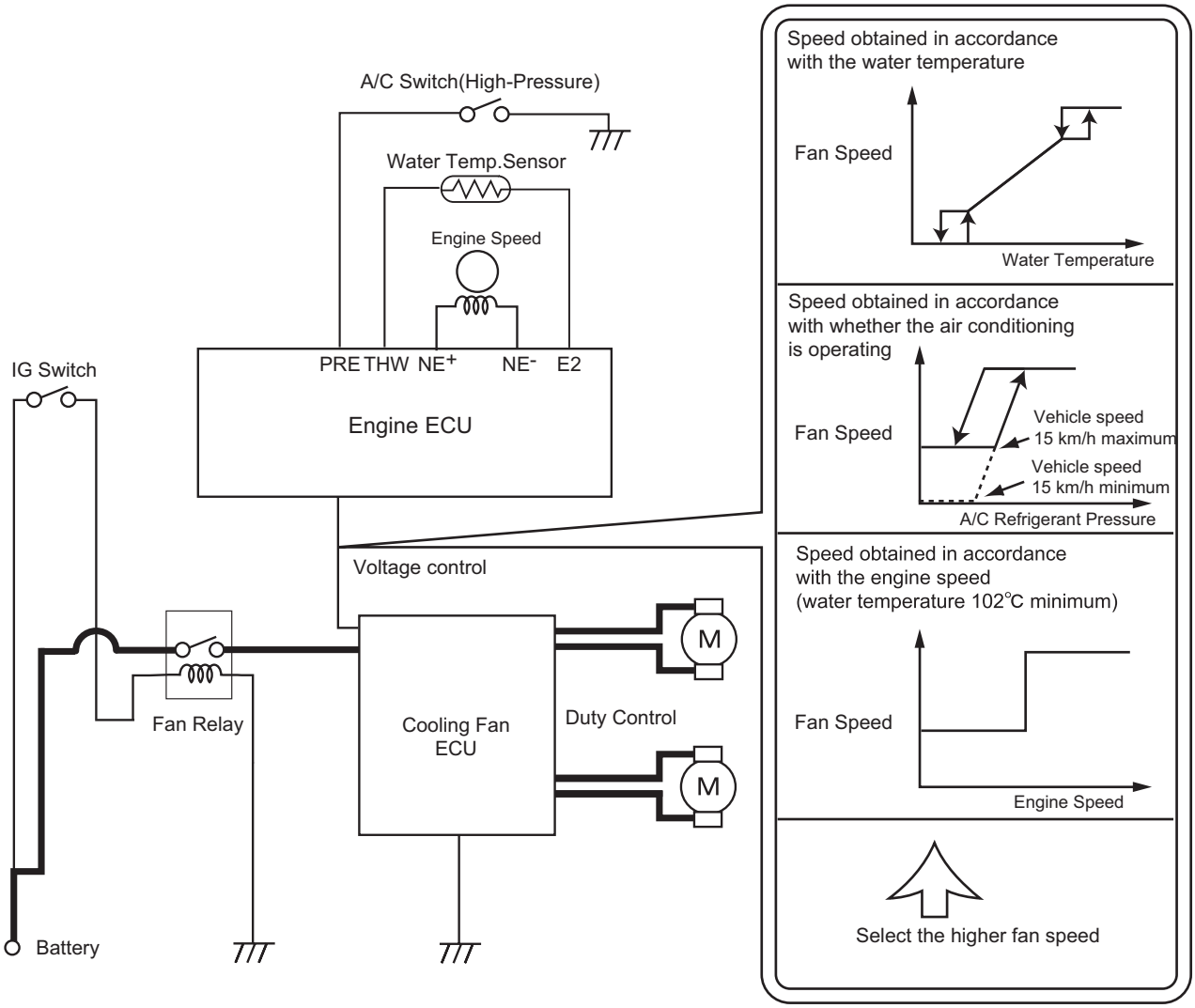
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VVT-i System

- This engine uses a Dual VVT-i (Variable Valve Timing-intelligent) system that continuously varies the phases of the camshafts. By regulating the timing of the intake and exhaust valves in accordance with the driving conditions, this system realizes fuel economy, high power output, and low exhaust emissions.

Cooling Fan System

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

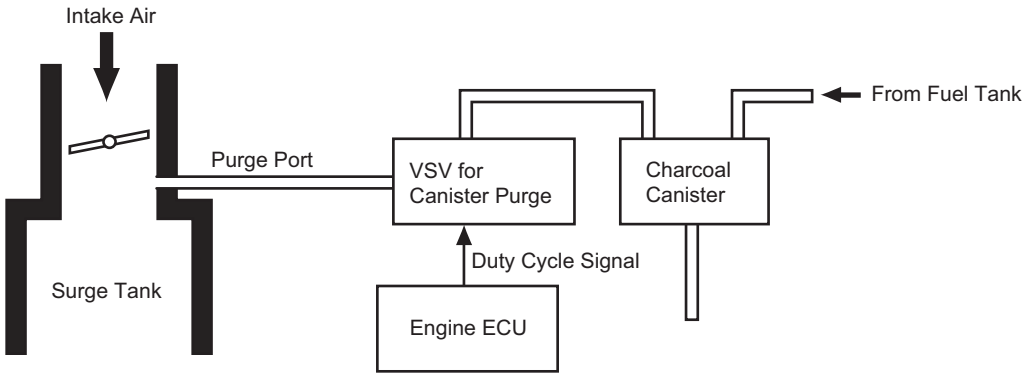


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Evaporative Emission Control System

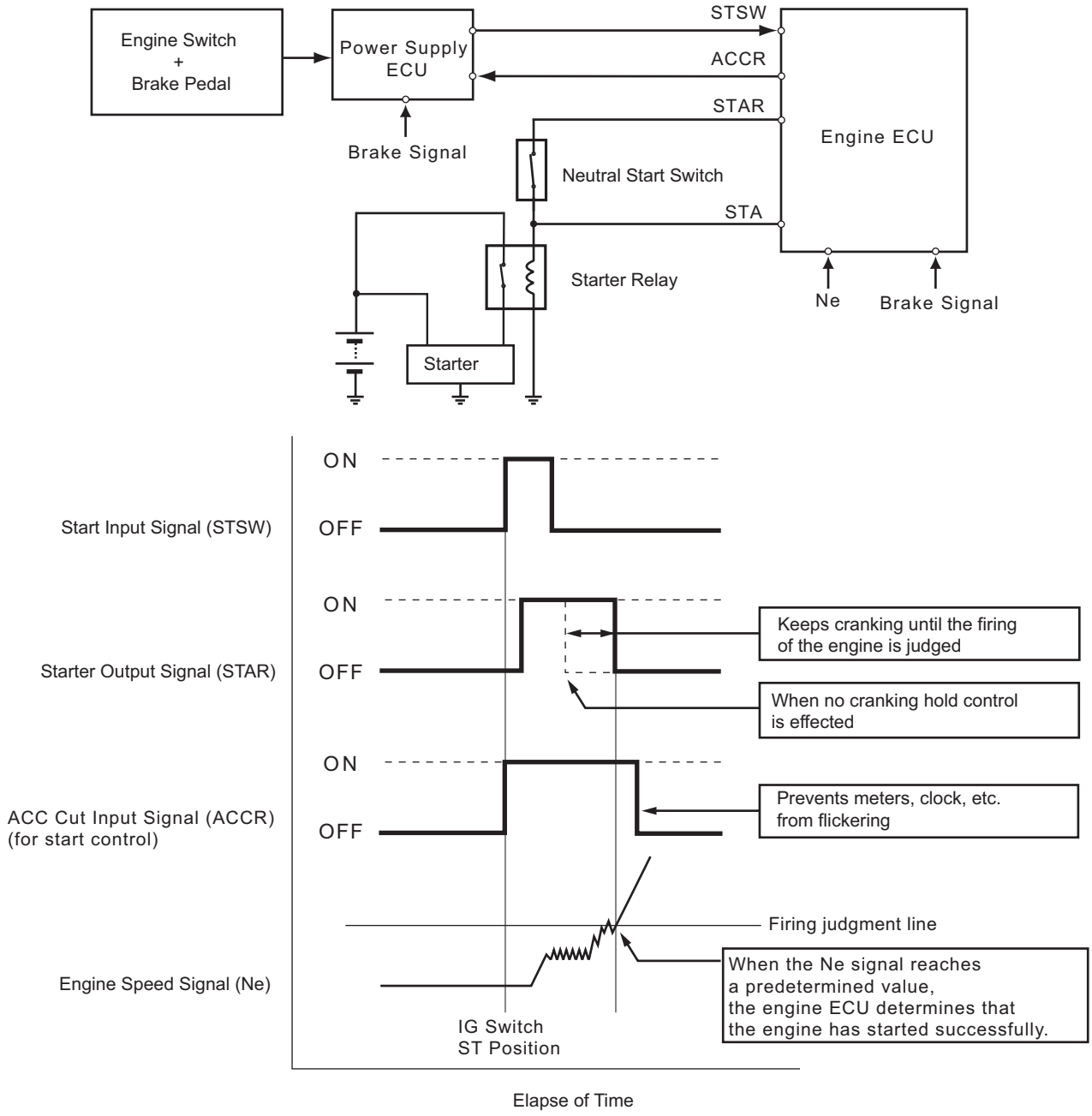
- A single system purge flow path is provided in order to control the fuel evaporative gas that flows from the charcoal canister to the purge port in accordance with the conditions of the engine. Then, the fuel evaporative gas that has been absorbed by the canister is drawn into the engine, thus suppressing the discharge of fuel evaporative gas.
- The purge port, which is provided downstream of the throttle valve, draws the fuel evaporative gas into the intake manifold in accordance with the driving conditions. The engine ECU applies current to the VSV, which is provided midstream of the purge pipe, in order to control the purge to an optimal volume.



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Cranking Hold Control

- When a start signal (STSW) is input by the engine switch, the engine ECU sends a signal (STAR) to the starter relay via the Park/Neutral Position switch (to determine P or N position), in order to start the starter. At this time, the engine ECU turns ON the ACC cut (ACCR) switch to prevent the meters, clock, and audio unit from flickering.
- After the starter starts, the engine ECU continues to output a signal to the starter until it detects that the engine has fired. After cranking, when the engine speed becomes higher than a predetermined speed, the engine ECU determines that the engine has fired, and stops the signal that is output to the starter relay.



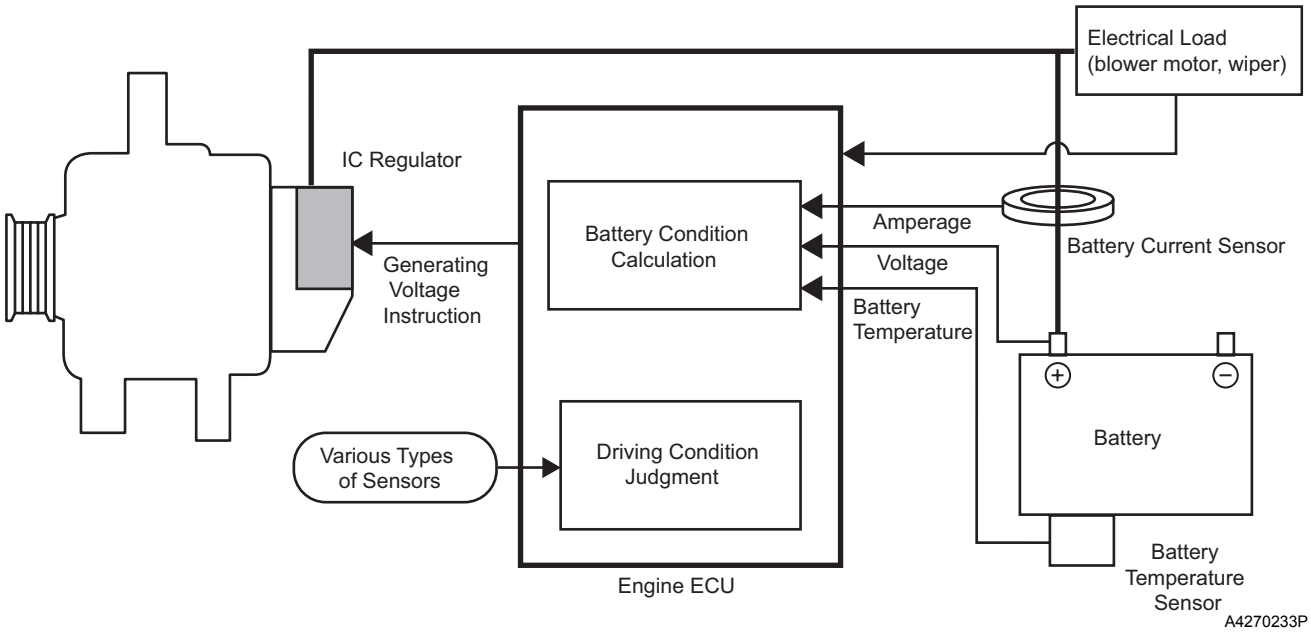
Cranking Hold Control Circuit Diagram (SMART ACCESS SYSTEM with PUSH-BUTTON START Type) and System Diagram

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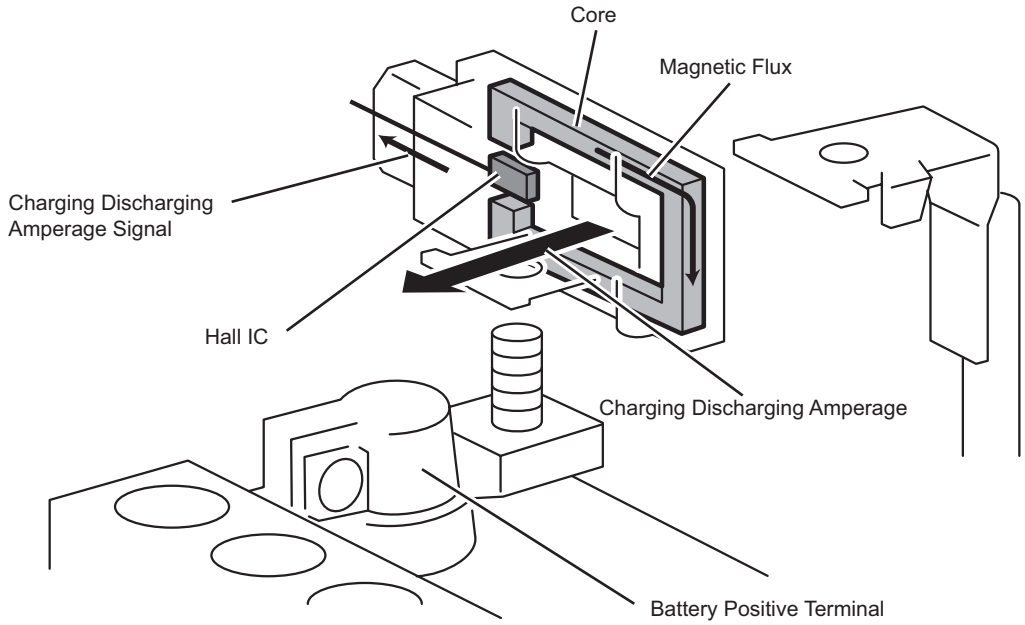
Charging Control System

- This system lowers the generating voltage when the vehicle is idling or is being driven at a constant speed, and raises the generating voltage when the vehicle is decelerating. This reduces the load on the engine as a result of the electric generation of the alternator, thus contributing to the fuel economy of the engine. During acceleration, this system regulates the generating voltage in order to place the amperage estimation value* close to the target value.



Battery Current Sensor

• Installed on the positive terminal of the battery, this sensor detects the amount of charging and discharging amperage of the battery and sends a signal to the engine ECU. Based on this signal, the engine ECU calculates the battery capacity. A Hall IC is used for detecting the amount of charging and discharging amperage. The changes that occur in the magnetic flux density in the core as a result of the charging and discharging amperage of the battery are converted and output as voltage.

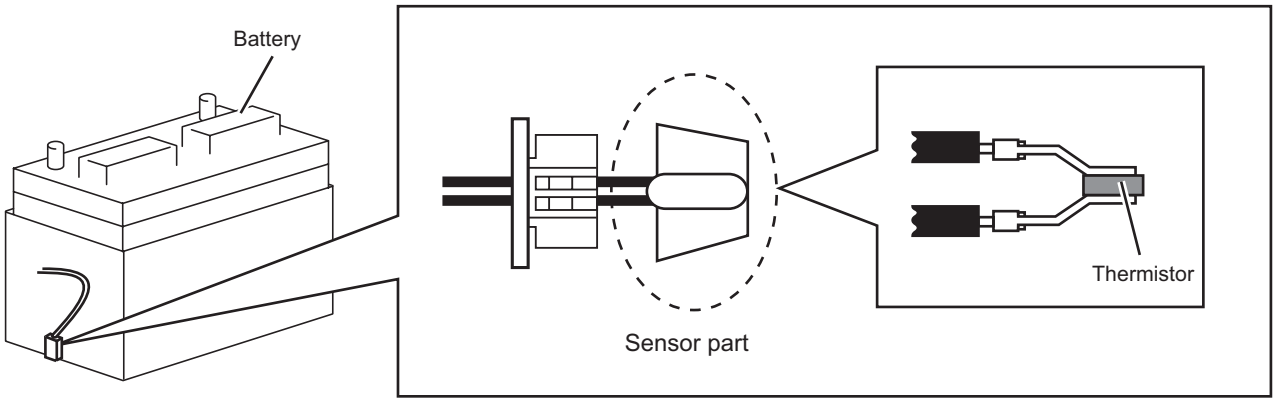


*The illustration shows a conceptual image.

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Battery Temperature Sensor

• A battery fluid temperature that is too low or too high can accelerate the deterioration of the battery or cause the battery to become discharged. In addition, the characteristics of the battery to accept current changes with the temperature of the battery fluid. For these reasons, the battery temperature sensor detects the battery fluid temperature and sends a signal to the engine ECU, in order to protect the battery. This sensor is installed on the side of the battery insulator.



*The illustration shows a conceptual image.

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Fail Safe

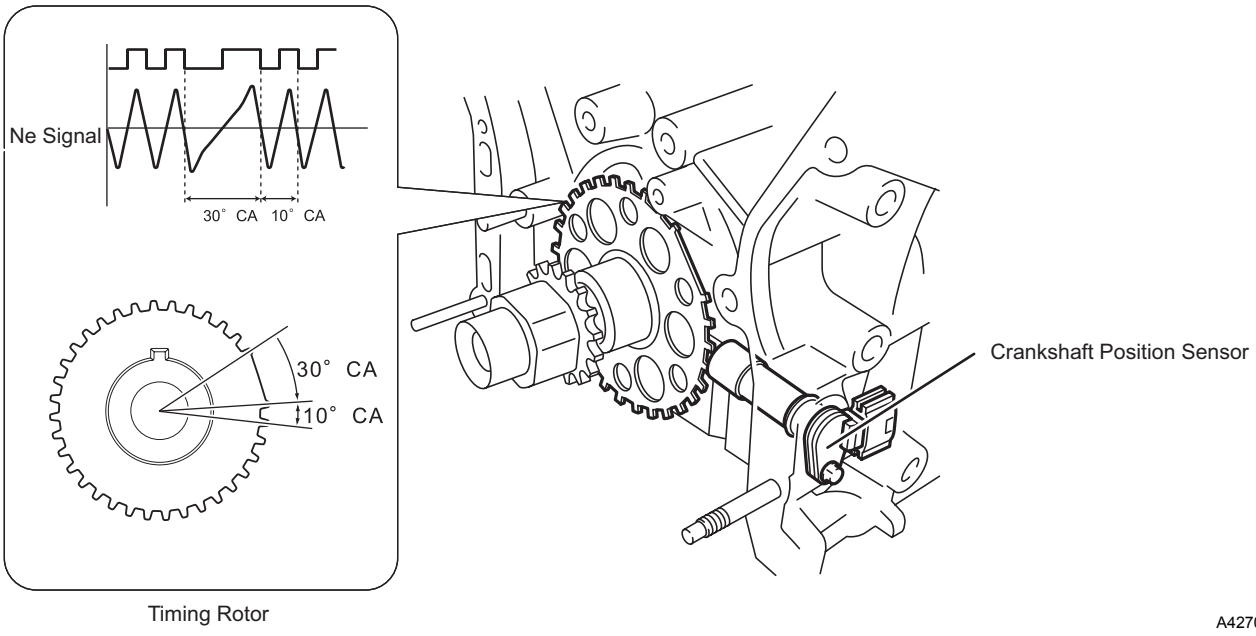
- Due to a failure in the sensors, the condition of the battery, or the operating state of electrical loads, the engine ECU may determine the necessity of performing a failsafe operation. Then, the engine ECU stops the alternator charging control and transfers the operation to the constant voltage generation mode.

Conditions for Transferring to Failsafe Mode

Condition	Control
Low battery capacity	The engine ECU determines the state of charge of the battery through its capacity or fluid temperature. If the battery is excessively charged or discharged, the engine ECU stops the charging control to protect the battery, as well as to prevent the capacity from dropping
Low or high battery temperature	
Wipers operating or blower motor operating at high load	When a particular electrical load is operating, the engine ECU stops the changes in voltage through charging control, in order to prevent the unpleasant operation of the electrical load due to the fluctuations in voltage.
Malfunction detected in the following sensors and switches: current sensor, temperature sensor, throttle position sensor, vehicle speed sensor, crankshaft position sensor, stoplight switch, or shift position switch	During a failure of a sensor system, the engine ECU stops the charging control to prevent the battery capacity from dropping.

Crankshaft Position Sensor

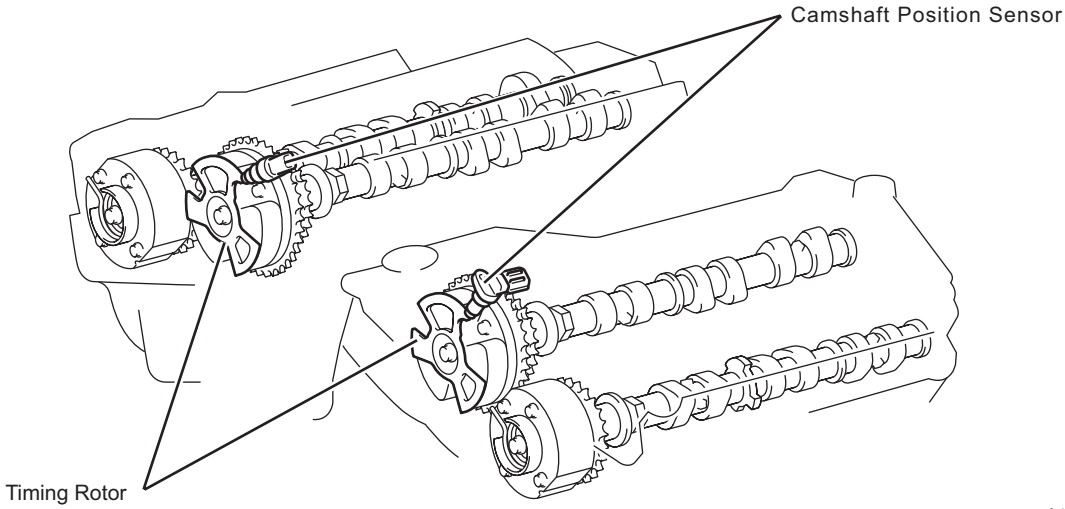
- The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.
- This engine uses an electromagnetic pickup sensor that provides a high level of detection accuracy. When the crankshaft rotates, the air gap between the protrusion on the timing rotor and the crankshaft position sensor changes. This causes the magnetic flux that passes through the coil of the crankshaft position sensor to increase and decrease, causing the coil to generate an electromotive force. This electromotive force generates voltage in opposing directions, depending on whether the protrusion of the timing rotor approaches the crankshaft position sensor or withdraws from the sensor. Thus, the voltage appears in the form of alternating current voltage.



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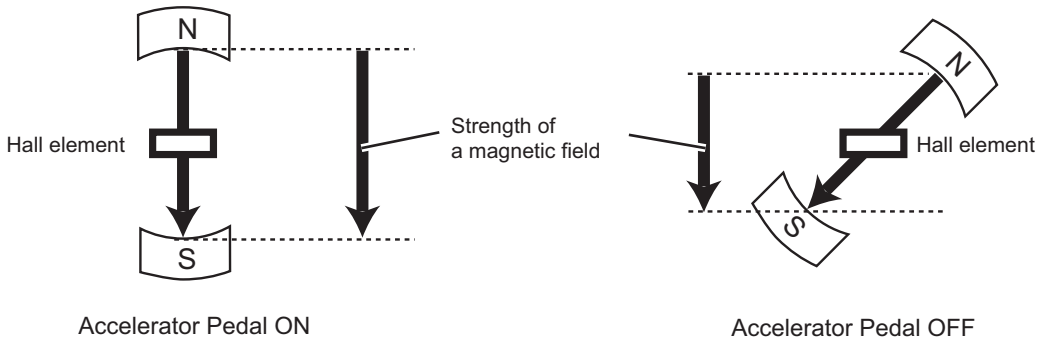
Camshaft Position Sensor

- These sensors are the MRE (Magnetic Resistance Element) type. The rotational movement of the timing rotor (which is provided in the VVT-i controller of the intake camshaft) causes a magnetic field to act on the magnetic resistance element in the sensor. The sensor utilizes the changes that occur in the direction of the magnetic field to detect the position of the timing rotor, which determines the position of the actual camshaft. The cylinders are identified by the input sequence of the Ne and G2 signals.



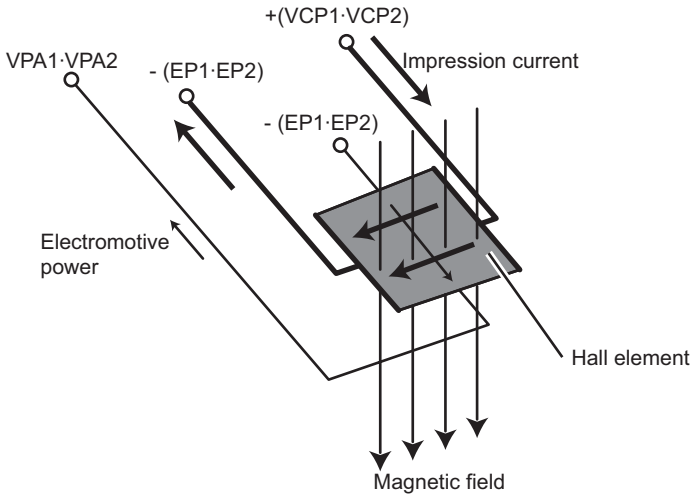
Accelerator Pedal Position sensor

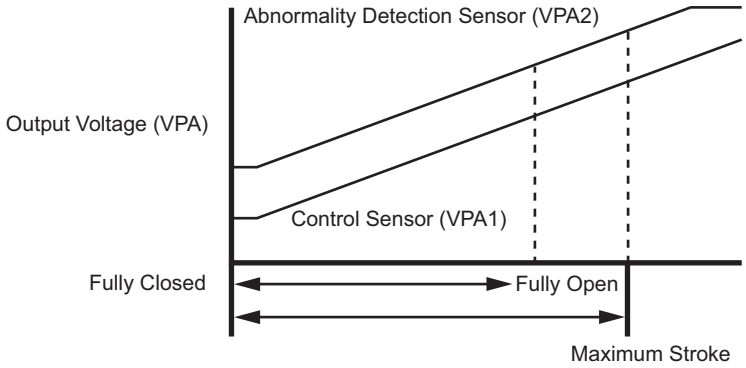
- This sensor, which is mounted on the accelerator pedal, detects the amount of pedal effort applied to the accelerator. By using a Hall element, this electronic position sensor enables accurate control and ensures permanent reliability. When the amount of pedal effort applied to the accelerator changes,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



Accelerator Pedal ON

Accelerator Pedal OFF





Accelerator Position Sensor Output Voltage Characteristics

A4270020P

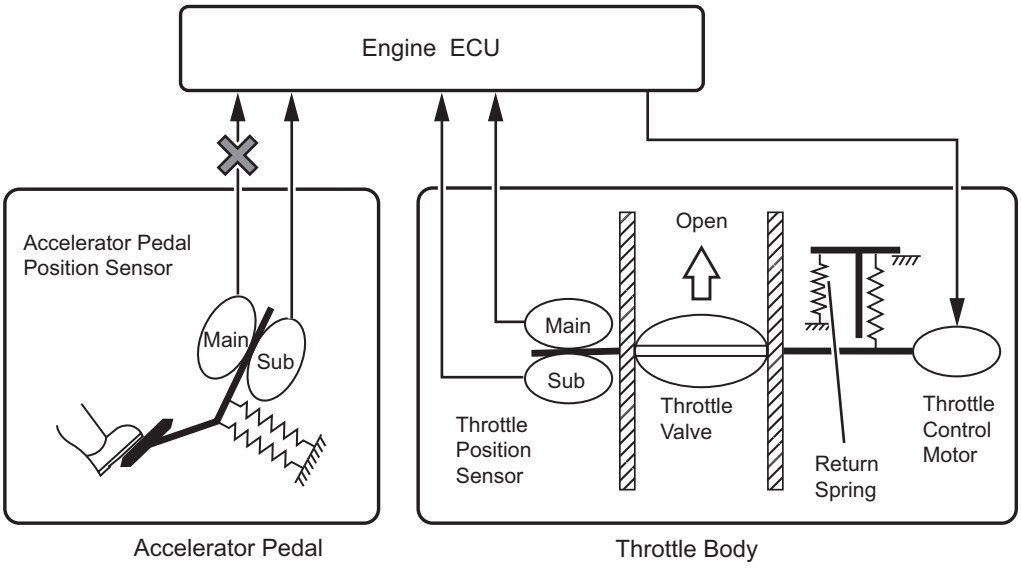
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Fail Safe

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

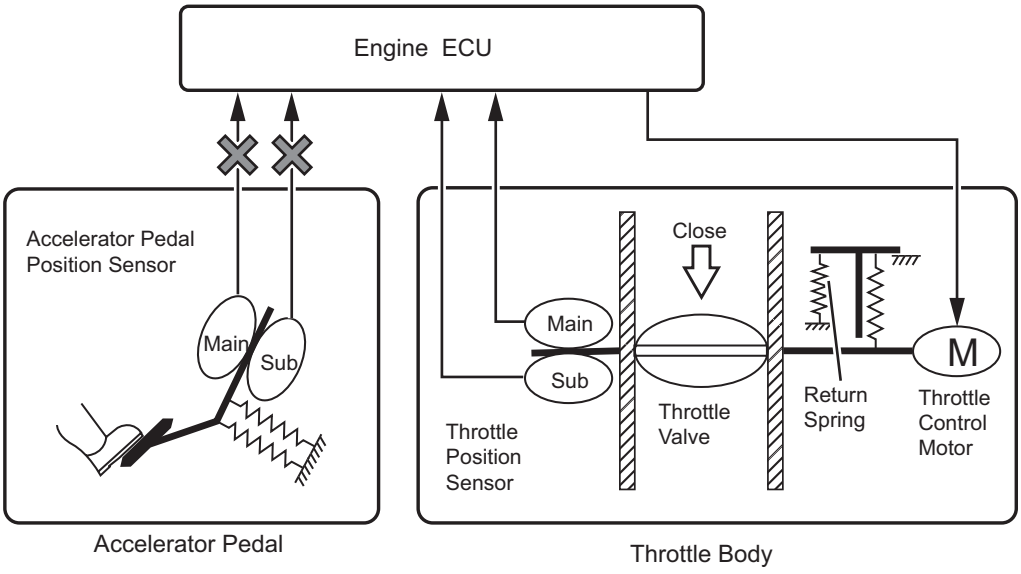
System 1 Failure

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



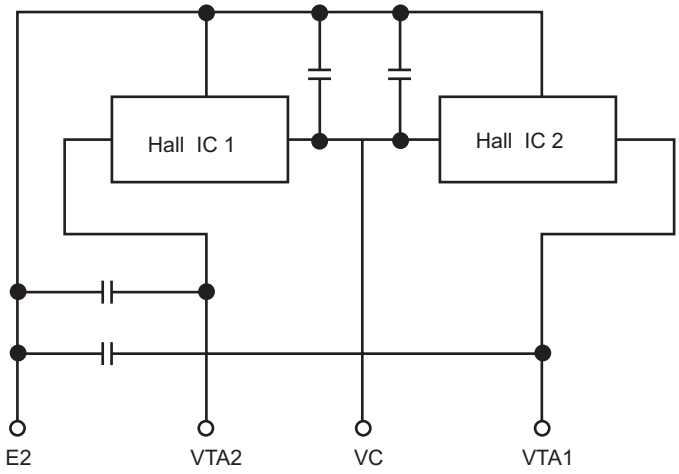
System 2 Failure

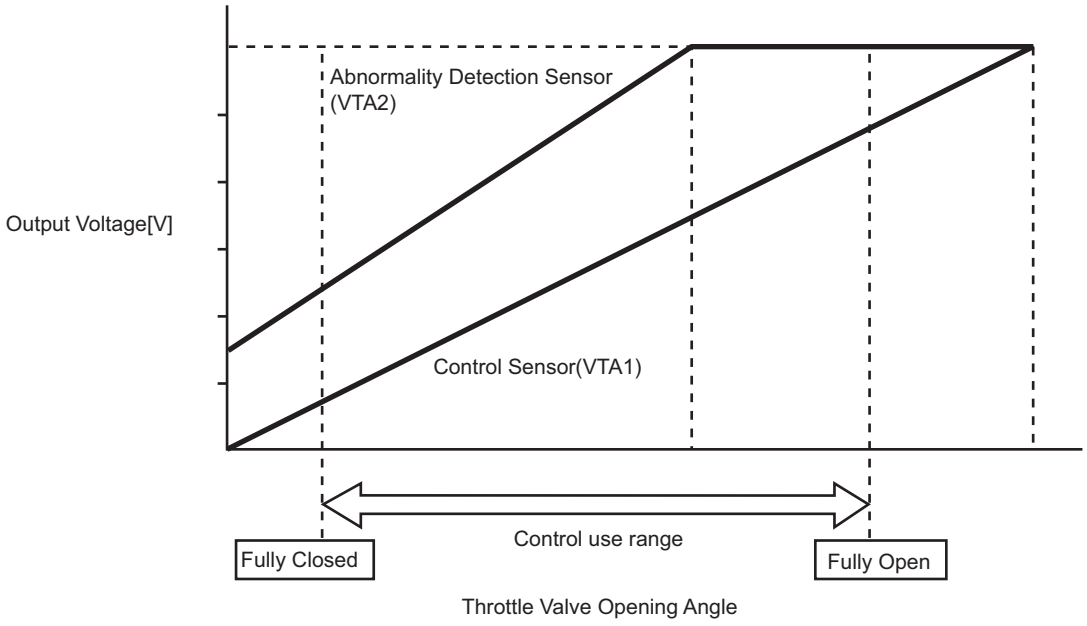
If both systems malfunction, the engine ECU detects the abnormal signal voltage between these two sensor circuits and regards that the opening angle of the accelerator pedal is fully opened and then continues the throttle control. At this time, the vehicle can be driven within its idling range.



Throttle Position Sensor

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





A4270023P

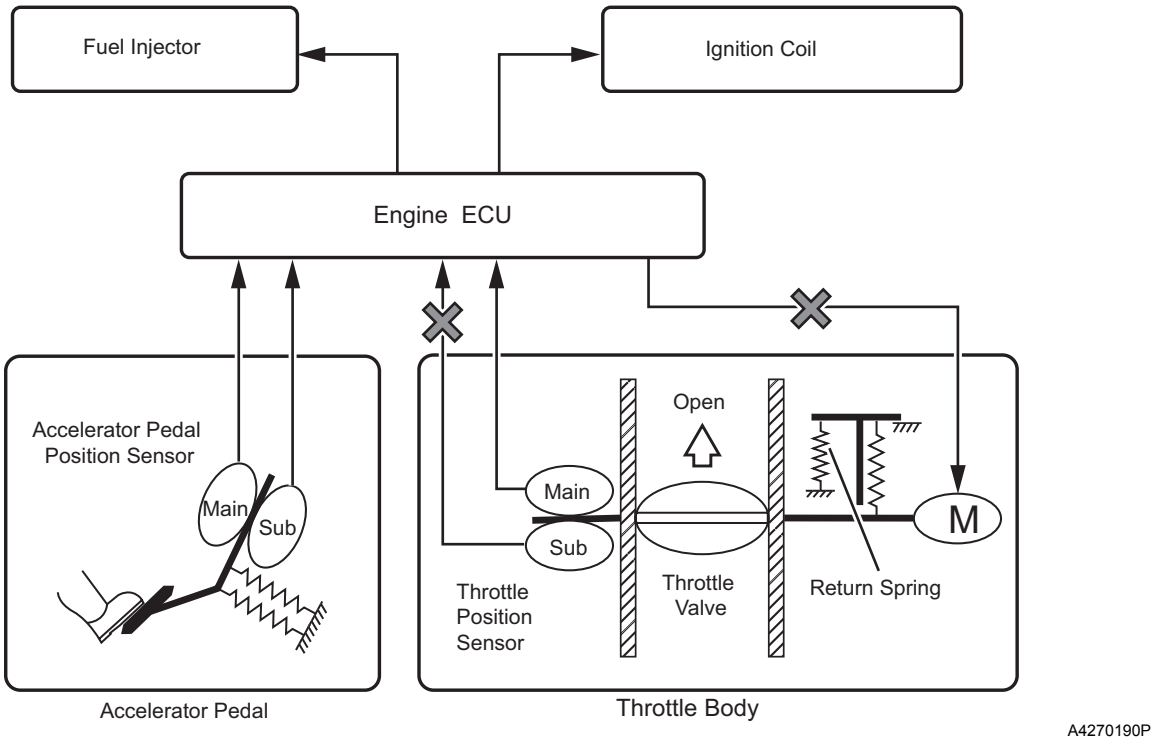
EG

Fail Safe

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

Failure Detection

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

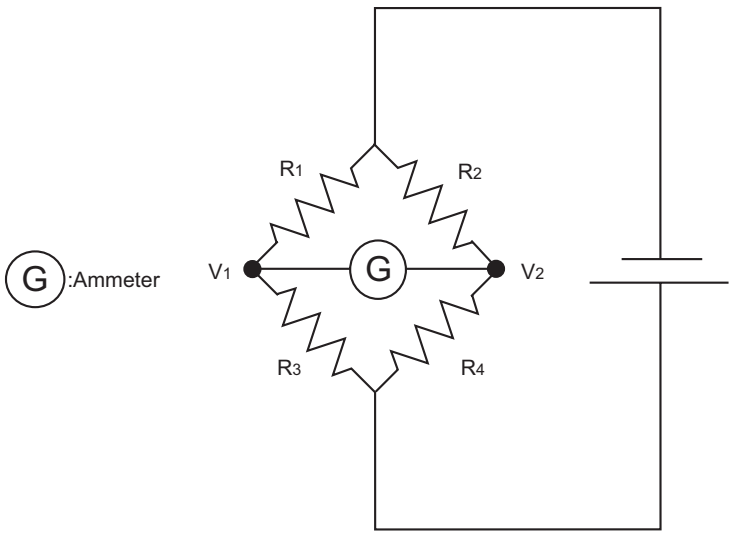


Air Flow Meter

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

Hot Wire Type Air flow Meter Operation

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

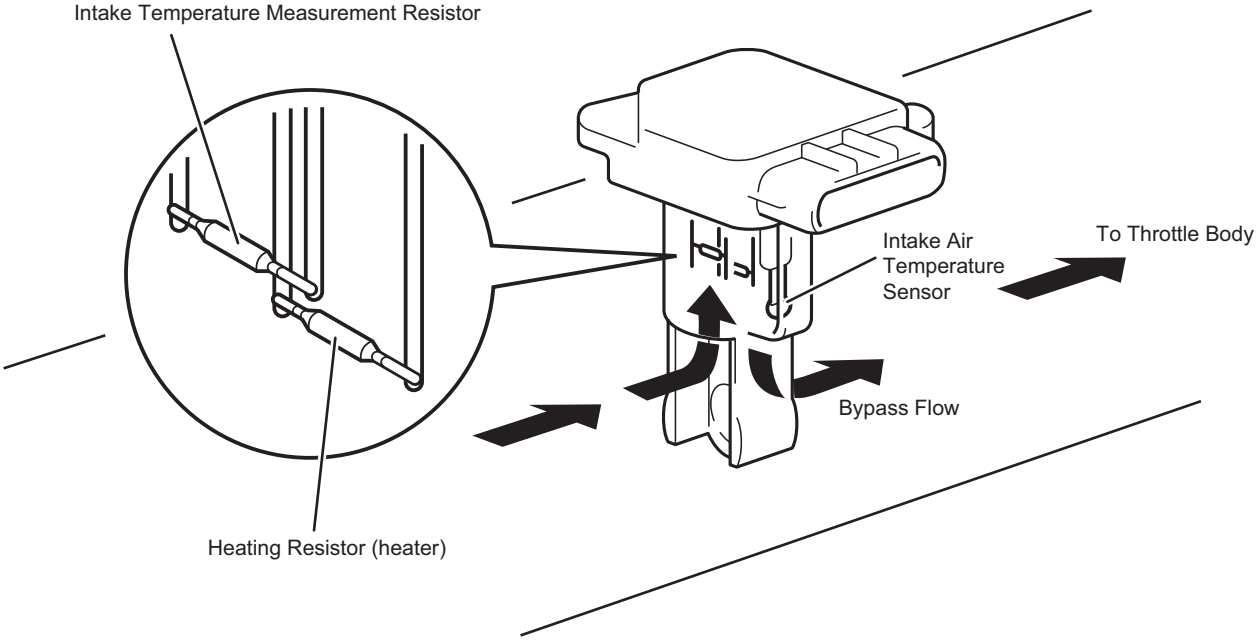


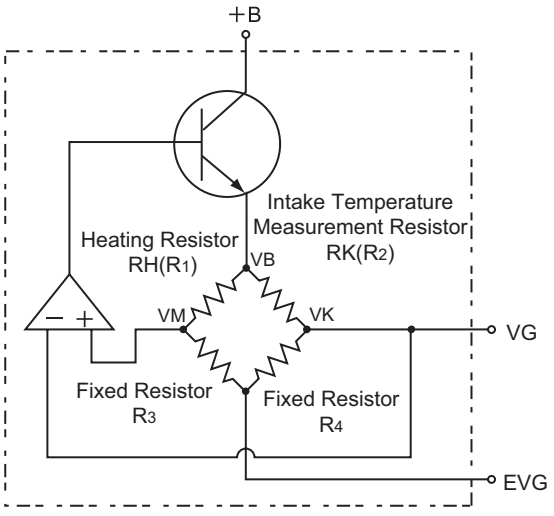
Bridge Circuit

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





Bridge Circuit

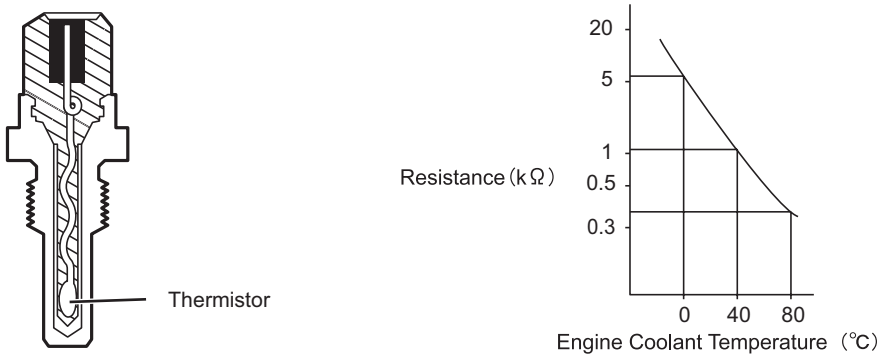
A4270026P

Fuel Pressure Sensor

- This sensor is installed on the fuel delivery pipe to detect fuel pressure.

Water Temp.Sensor

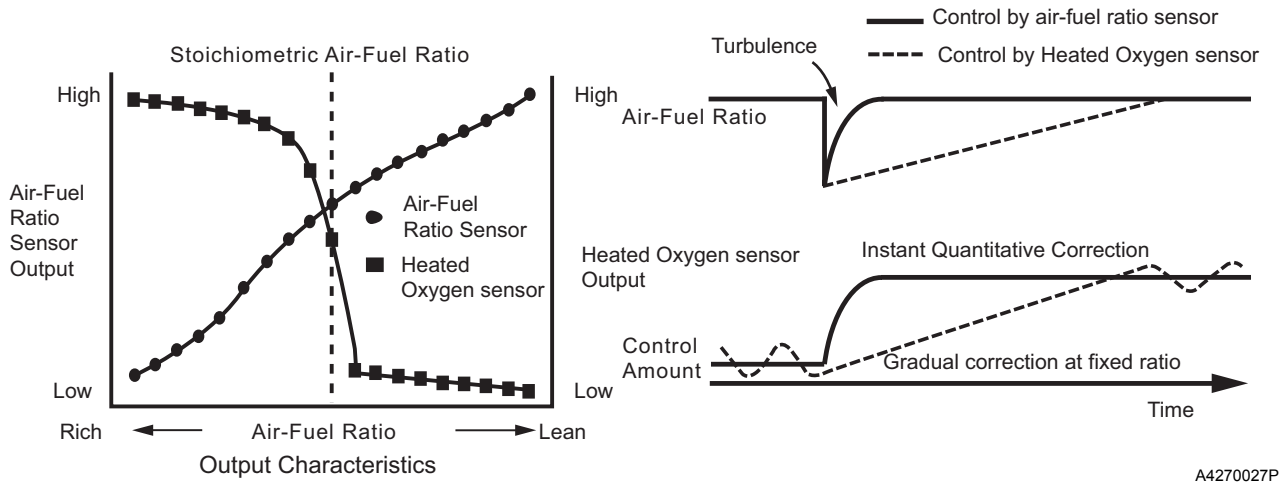
- This sensor detects the water temperature and sends a signal to the engine ECU.



A4270105P

Air Fuel Ratio Sensor

- An air-fuel ratio sensor is used to ensure the reliable feedback of the state of the air-fuel ratio in the exhaust gas. An heated oxygen sensor outputs a lean or rich signal bordering on the stoichiometric air-fuel ratio. In contrast, the air-fuel ratio sensor has output characteristics that are proportionate to the air-fuel ratio. Therefore, the engine ECU is able to effect a more precise control.
- As with the heated oxygen sensor, a heater is used to heat and maintain a constant temperature in the air-fuel ratio sensor, thus promoting the proper feedback control.



A4270027P

Heated Oxygen Sensor

- This sensor detects the oxygen concentration in the exhaust gas.

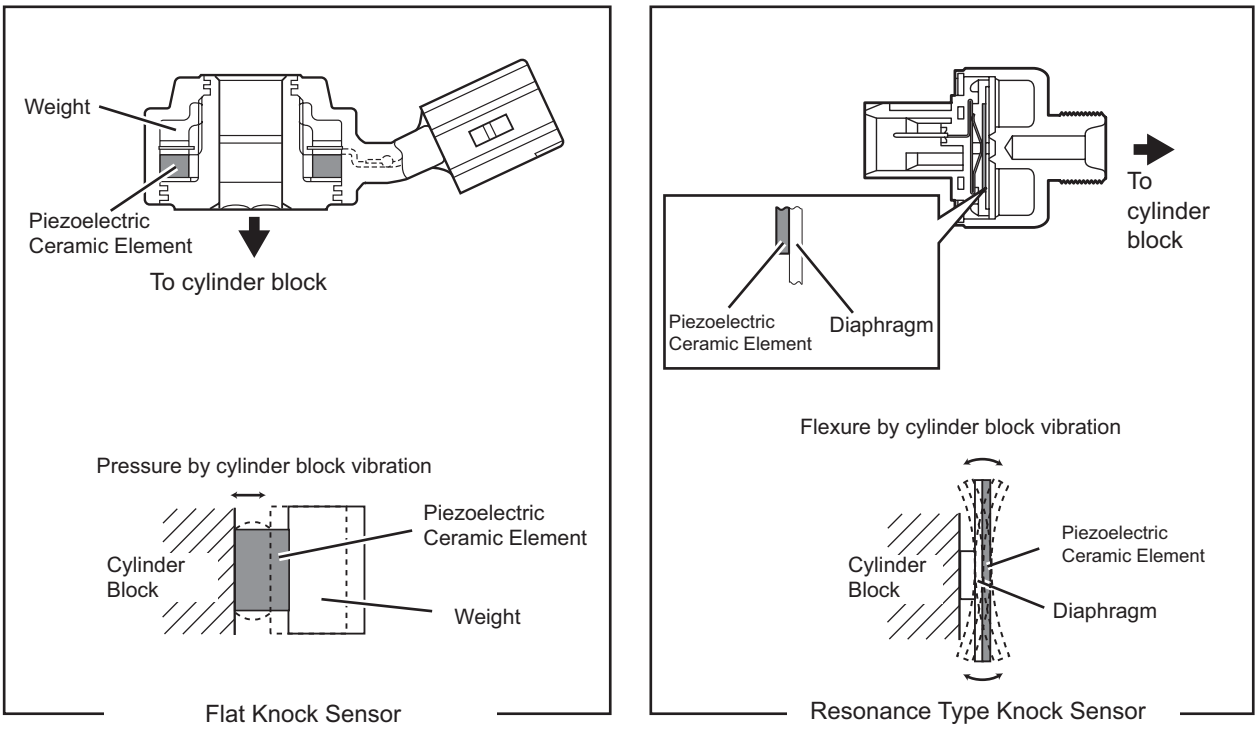
EG

Knock Sensor (Flat Type)

● When the conventional resonance type knock sensor receives vibrations from the cylinder block, a diaphragm on a piezoelectric ceramic element flexes along the area where it is mounted to the cylinder block acting as the fulcrum. This causes a pressure to act on the piezoelectric ceramic element, which generates a voltage. In contrast, when the flat (non-resonance type) knock sensor receives vibrations from the cylinder block, a delayed movement of the weight occurs in the sensor due to the inertial force of the weight. This causes a pressure to be applied to a piezoelectric ceramic element, which is provided between the cylinder block and the weight, thus generating a voltage.

Knock Sensor Operation

• In the conventional resonance type knock sensor, the diaphragm resonates at a certain frequency at which the engine knocks. Therefore, when the knock sensor generates an output, the engine ECU determines that knocking has occurred. In contrast, the flat (non-resonance type) knock sensor has practically constant output characteristics in all frequency ranges. Therefore, the engine ECU can detect a target frequency at which knocking occurs, enabling a more accurate knocking detection.



A4270028P

Camshaft Timing Oil Control Valve

- In accordance with the duty cycle signals received from the engine ECU, this OCV controls the position of the spool valve in order to constantly achieve optimal valve timing. When the engine is stopped, the force of a spring keeps the intake side of the spool valve in the most retarded state, and the exhaust side to the most advanced state, in order to ready the valves for the subsequent starting.
  (See page EG-143)

Injector

- A single-orifice, high-pressure slit nozzle injector is used.
  (See page EG-160)

Fuel Pump

- A fuel pump assembly consisting of a fuel pump, fuel filter, and sender gauge is used.
- To prevent fuel from leaking during a collision (in which air bags are deployed), a system that turns OFF the circuit opening relay, in accordance with a signal from the airbag ECU, is used to ensure safety.
  (See page EG-154)

Ignition Coil (with Igniter)

- Ignition coils with built-in igniters are used and placed directly over the spark plugs.
  (See page EG-183)

VSV (For EVAP)

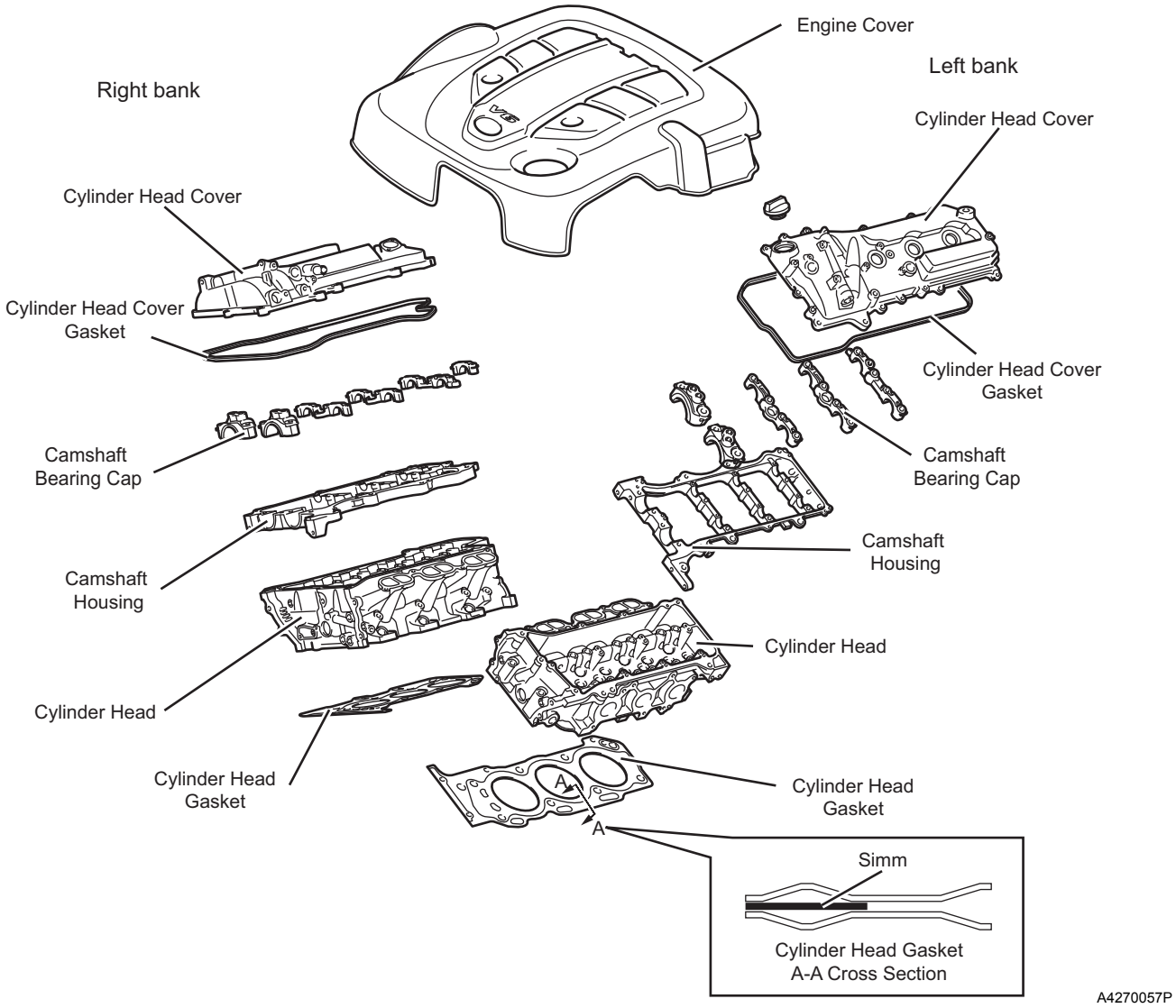
- Regulates the purge volume of the canister.

3GR-FSE ENGINE MECHANICAL

EG

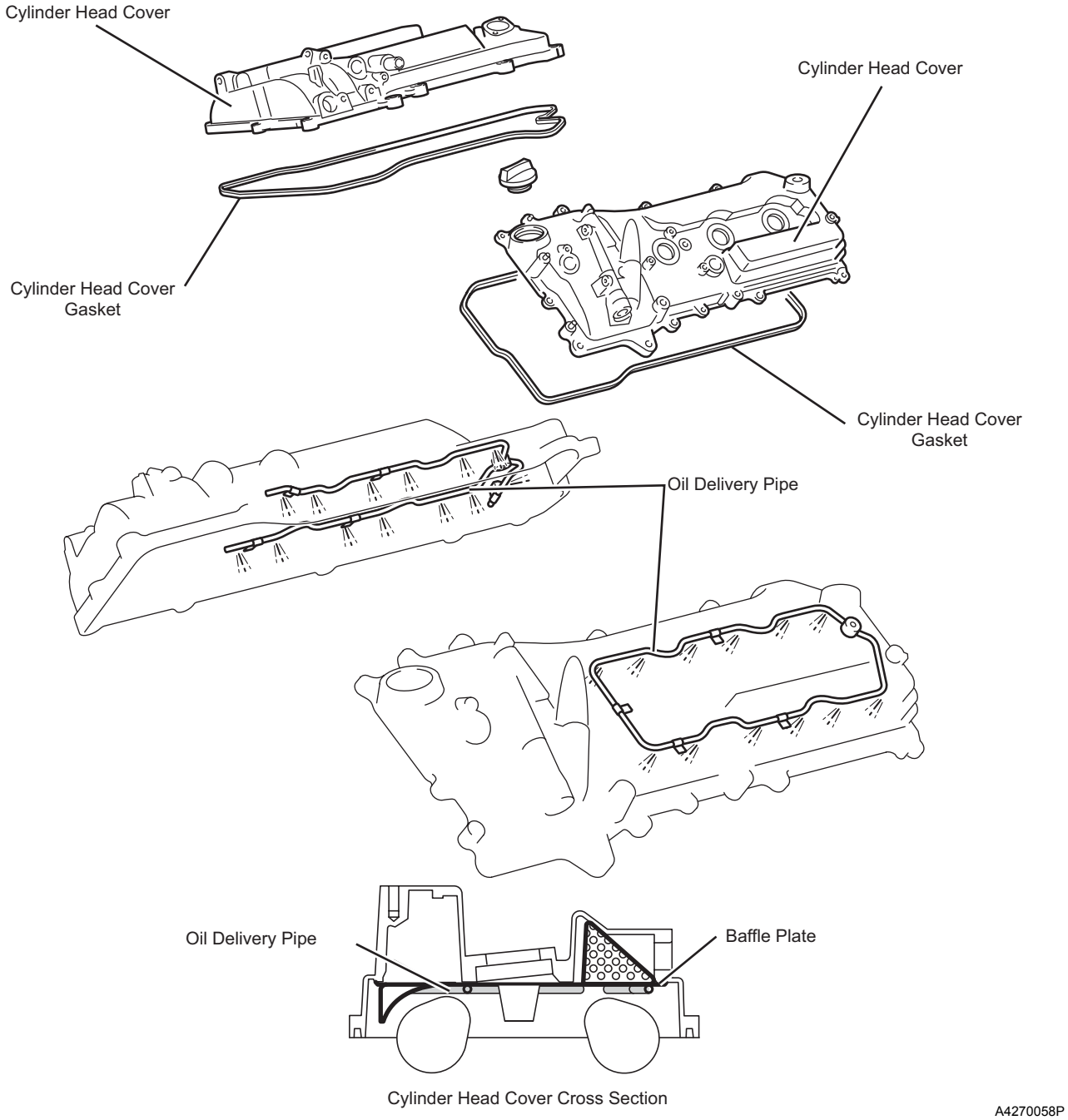
Cylinder Head Fitting Parts

- The cylinder heads are made of a lightweight and highly rigid aluminum alloy. Also, the VVT-i supply oil passage has been separated from the cylinder heads to simplify the oil passage in the cylinder heads.
- The cylinder head gaskets are the two-layer metal type. Shims are provided around the bores to ensure sealing performance and durability.
- The cylinder head covers are made of a lightweight aluminum alloy. They are tightened to the cylinder heads by way of fixed-dimension flanges along their periphery to ensure the proper sealing performance.
- OCVs (oil control valves) for Dual VVT-i are mounted on both the right and left cylinder head covers.
- The cylinder head cover gaskets are made of acrylic rubber, which excels in heat resistance and oil resistance.



Cylinder Head Cover

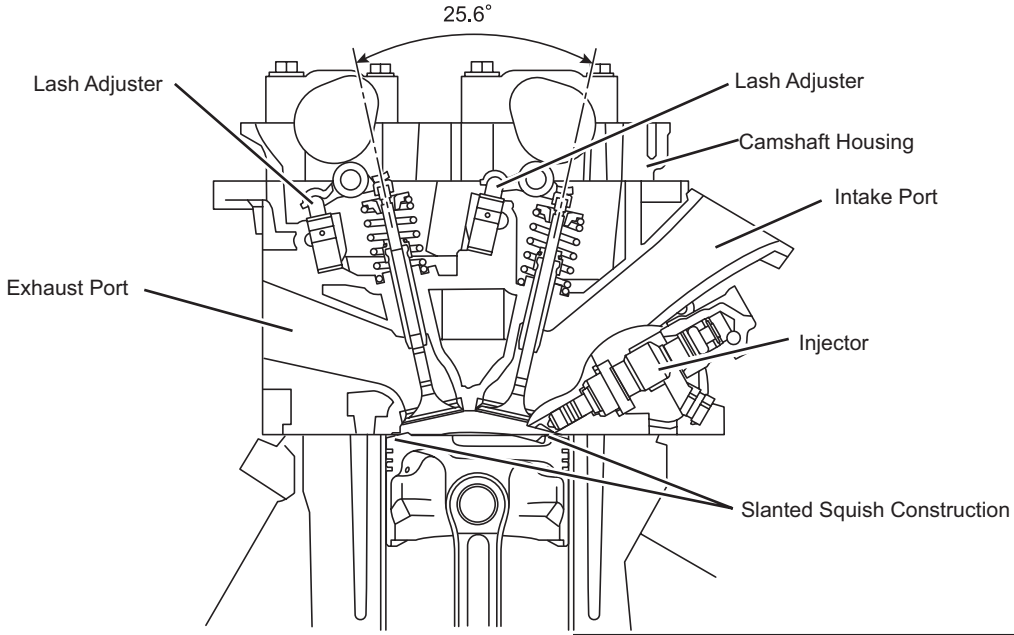
- Large baffle plates are built into the right and left head covers. By reducing the flow rate of blowby gas, these baffle plates remove oil droplets and oil mist, thus reducing the volume of oil taken away.
- Oil delivery pipes are provided to supply engine oil, in order to properly lubricate the sliding areas of the roller rocker arms, thus enhancing their reliability.



EG

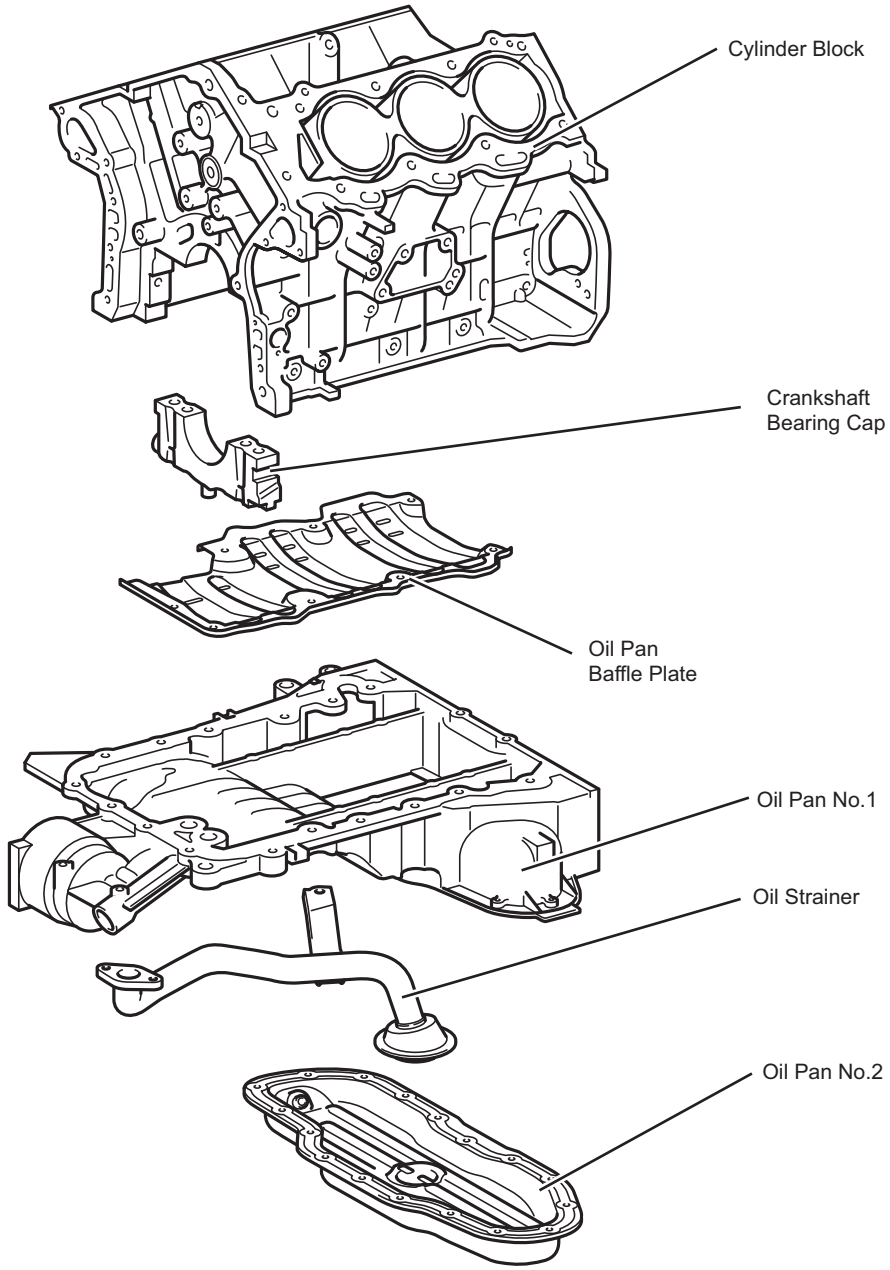
Cylinder Head

- By using a two-piece construction in which the portion that receives the cam journals is separate from the cylinder head proper, the configuration of the cylinder head proper has been simplified. This results in weight reduction and improved serviceability.
- Pentroof combustion chambers are used. A spark plug is located practically in the center of each combustion chamber to enhance combustion efficiency and knock resistance. Furthermore, the angle between the intake and exhaust valves has been narrowed to 25.6 degrees, thus making the combustion chamber compact.
- The port configuration is an efficient cross-flow type in which the intake ports face the inside of the V bank and the exhaust ports face the outside. The intake ports have an independent, narrow-diameter construction and the exhaust ports have a Siamese construction to enhance low- to medium-speed torque. The intake ports are the vertical type that has a cutout and an edge at the bottom of each port outlet to realize a high tumble and high intake efficiency.
- The diameter of the valve stem and the outer diameter of the valve guide have been reduced to reduce intake resistance.
- The cylinder head bolts are tightened with the plastic region tightening method in order to stabilize the axial tension of the bolts.



Cylinder Block Fitting Parts

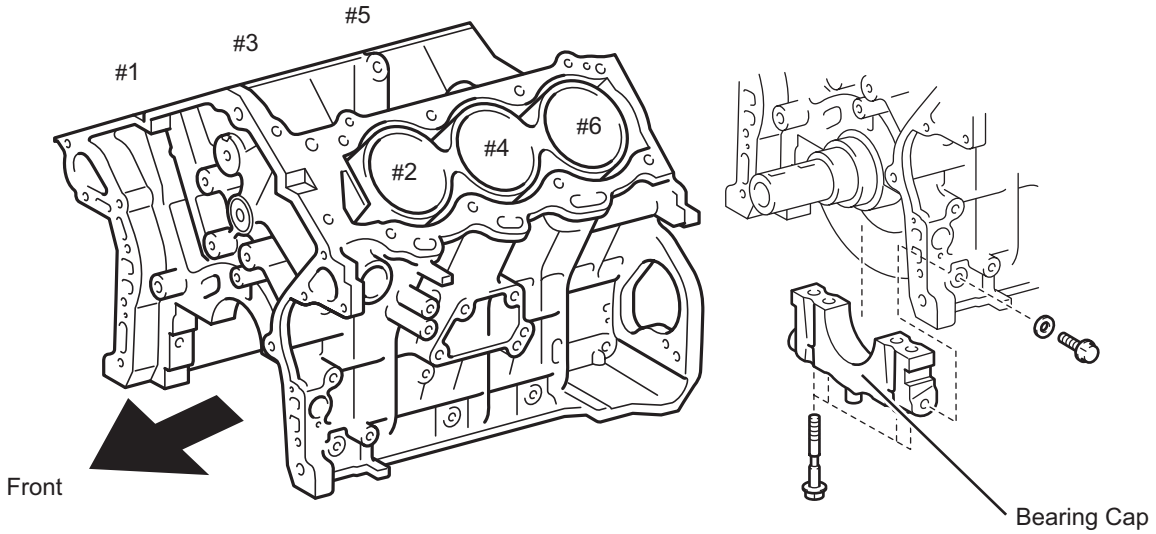
- The cylinder block is made of an aluminum alloy to realize a dramatic weight reduction. Furthermore, it has been made compact in terms of both overall length and width as follows: a 60° V6 bank angle, a 36.6mm(1.441in.) bank offset, and a 105.5mm(4.154in.) bore center distance.
- The oil pan consists of a two-piece construction. Oil pan No. 1 is made of an aluminum alloy, and oil pan No. 2 is made of stamped steel sheet. Oil pan No. 1 has built-in stiffeners that tighten the cylinder block and the transaxle case together. This increases the rigidity of the entire power plant, resulting in reduced vibration and weight reduction.
- Appropriate ribs are placed on the outer wall of the cylinder block to increase rigidity.
- An FIPG (Formed-In-Place Gasket), which excels in sealing performance, is used on the mating surfaces of the oil pan.



EG

Cylinder Block

- The cylinder liner is a centrifugal cast iron liner insert. Its outer spiny surface enhances contact with the aluminum block, thus improving heat dissipation. This lowers the temperature of the piston and suppresses the deformation of the bore.
- The outer walls of the block are curved and reinforcement ribs are provided on the end of the block that is coupled to the transmission in order to attain a high level of rigidity.
- The oil return holes from the cylinder heads and the blowby gas passages have been optimally arranged to ensure the smooth return of oil and heighten the rigidity of the side faces of the cylinder block.
- Drilled coolant passages are provided between the bores in order to positively cool the upper areas of the cylinder bores, which are easily affected by heat. Thus, a more uniform temperature distribution has been achieved in the circumferential direction of the bore wall surface. This improves knocking resistance and minimizes the heat deformation that occurs between the cylinder bores. Thus, an engine with low friction, high performance, and enhanced fuel economy has been achieved.
- A knock sensor is provided on both the right and left sides of the V bank, enabling optimal knock control.
- The crankshaft bearing caps are made of cast iron, and each is tightened with 4 bolts from the bottom, using the plastic region tightening method. Also, each bearing cap is tightened from both sides together with the cylinder block, which increases rigidity and decreases vibration and noise.



Bearing cap attachment appearance

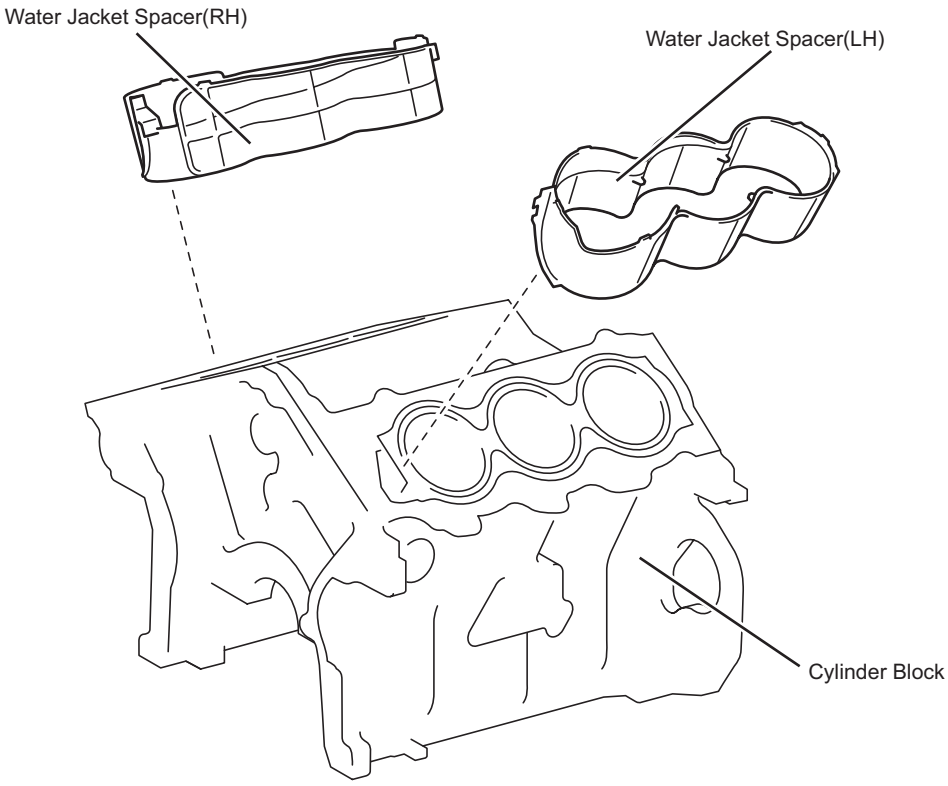
A4270061P

Cylinder Block

Overall Length	[mm (in.)]	402.1 (15.831)
Overall Width	[mm (in.)]	408.0 (16.063)
Overall Height	[mm (in.)]	320.2 (12.606)
Bore Diameter	[mm (in.)]	87.5 (3.445)
Bore Center Distance	[mm (in.)]	105.5 (4.154)
Bank Offset	[mm (in.)]	36.6 (1.441)

Water Jacket Spacer

- A water jacket spacer made of plastic, which excels in heat resistance and forming precision, is provided in the water jacket of the cylinder block. This optimizes heat distribution along the cylinder bore wall and reduces friction.



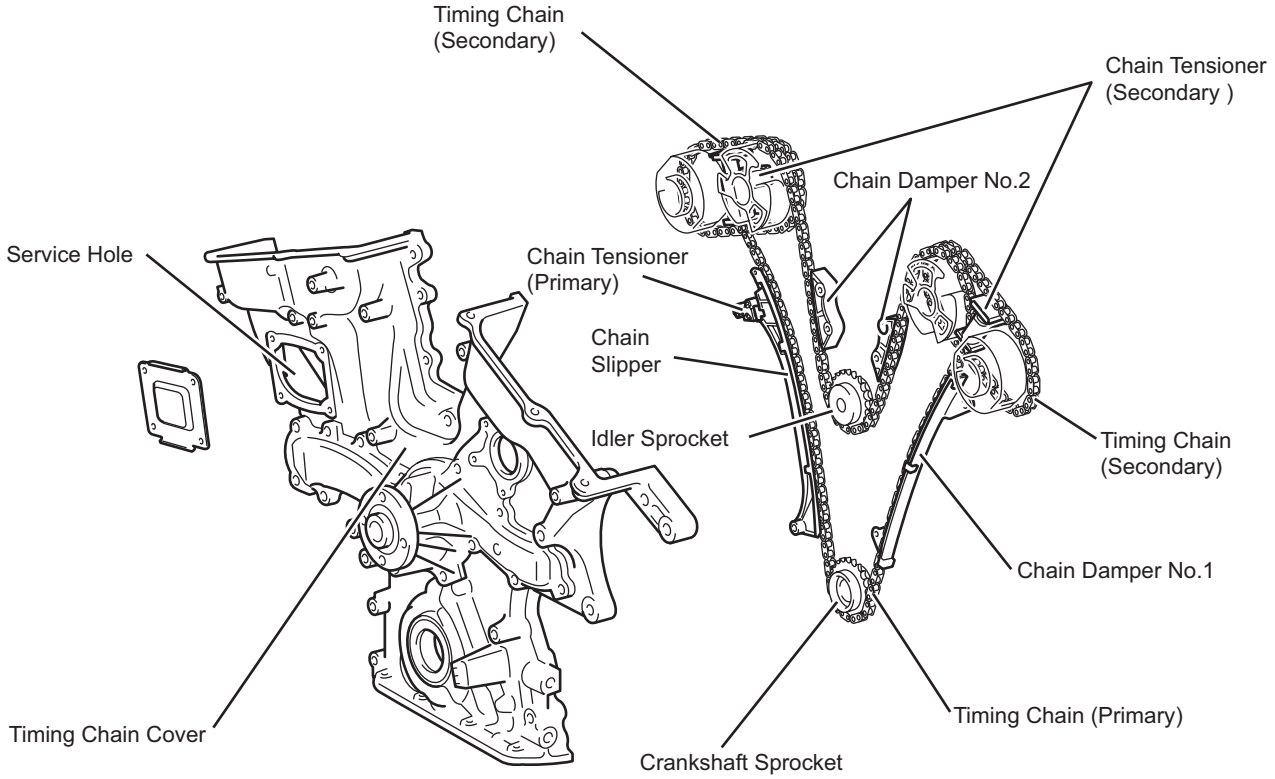
Function of Water Jacket Spacer

The water jacket spacer suppresses the water flow in the center of the water jacket. This increases the flow speed of the coolant along the upper part of the cylinder bore, thus improving the cooling of the upper area of the cylinder block and between the cylinder bores. Furthermore, the area near the center of the cylinder bore becomes less susceptible to the influences of the coolant, allowing the temperature along the wall surface to rise. These measures decrease the temperature differences along the surface of the cylinder bore wall and enable uniform thermal expansion. In addition, these measures lower the viscosity of the engine oil that adheres to the surface of the bore wall, thus reducing friction.

EG

Timing Chain

- The timing mechanism is a chain-driven system that is maintenance-free. Both the primary and secondary timing chains consist of 9.525mm(0.375in.) pitch, high-strength, single-row roller chains and compact sprockets, which contribute to making the engine compact.
- A two-stage chain system is used. It consists of a primary chain that enables the crankshaft to drive the right and left intake camshafts, and a secondary chain that enables the intake camshafts to drive the exhaust camshafts.
- The primary chain uses a check ball type chain tensioner with a ratchet mechanism that uses both engine oil pressure and a spring force. The secondary chain uses a compact tensioner that directly pushes on the chain by using engine oil pressure and a spring force. These tensioners constantly apply optimal tension to the timing chains in order to ensure a quiet and reliable operation.
- The timing chain cover is made of an aluminum alloy that is lightweight and excels in sound insulation capability. The one-piece cover seals the front of the cylinder block, camshaft housing, and cylinder head. The crankshaft sprocket is provided with a guide that prevents the chain links from jumping. This prevents the chain from being installed incorrectly during maintenance, as a result of the chain falling out. A service hole for the primary chain tensioner is provided in the timing chain cover to facilitate maintenance.
- The chain dampers and the tensioner shoes are made of a plastic material that excels in wear resistance.



A4270063P

Sprocket

	Number of Teeth
Crankshaft Sprocket	18
Idler Sprocket	18
Camshaft Sprocket (Primary)	36
Camshaft Sprocket (Secondary: IN)	24
Camshaft Sprocket (Secondary: EX)	24

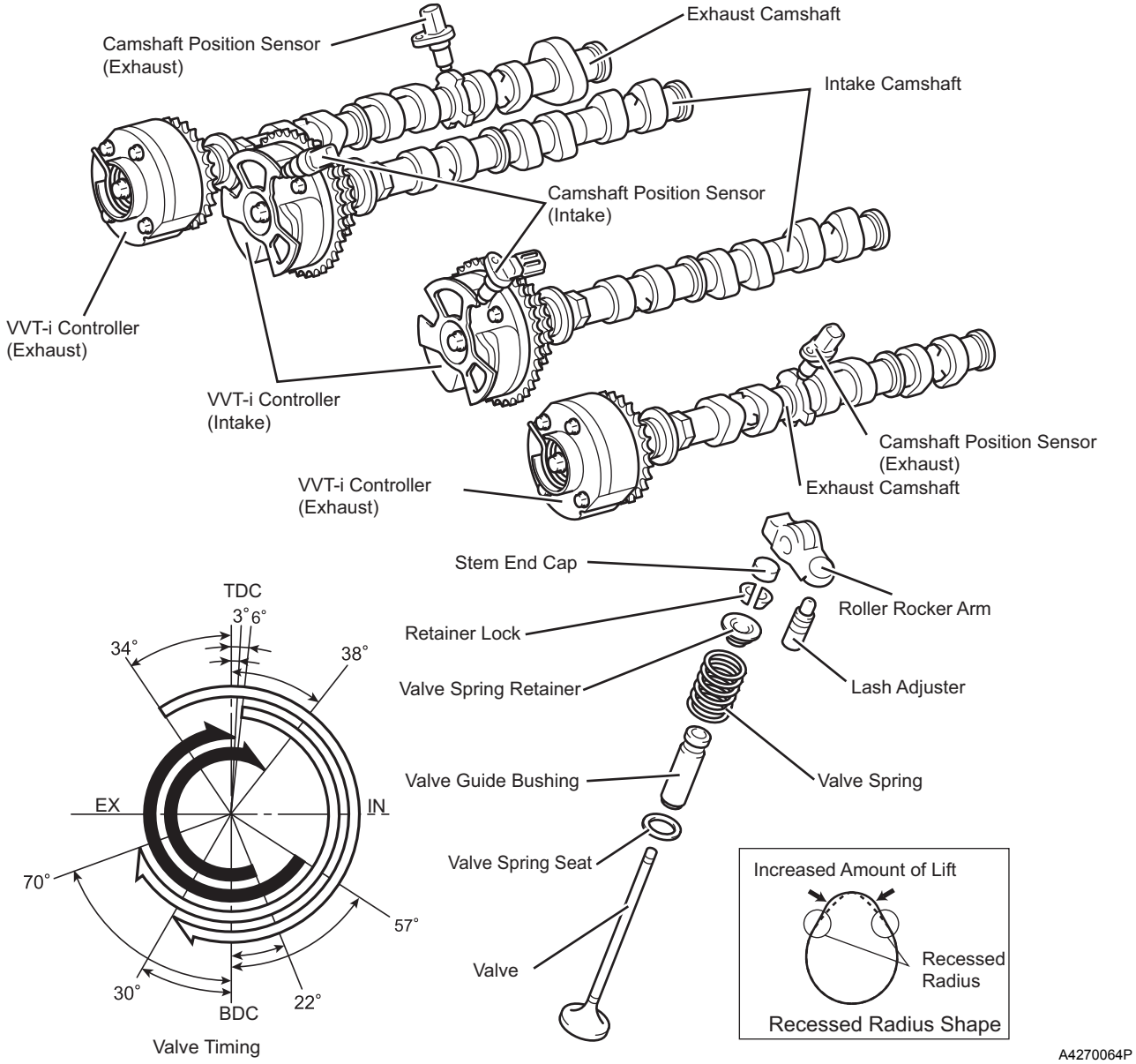
Timing Chain

	Number of Links
Timing Chain (Primary)	170
Timing Chain (Secondary)	46

EG

Valve Mechanism

- A Dual VVT-i (Dual Variable Valve Timing-intelligent : continuously variable intake and exhaust valve timing mechanism) system is used to control the intake camshaft and the exhaust camshaft to an optimal valve timing in accordance with the driving conditions.
- The camshafts are made of alloyed cast iron. Their cams are induction hardened and their surfaces are finished with a higher precision to improve wear resistance and reduce friction.
- Roller rocker arms are used in the valve train in order to dramatically reduce friction between the cams and the sliding surfaces to improve fuel economy. In addition, hydraulic lash adjusters are used, making valve clearance adjustments unnecessary and facilitating service.
- Along with the use of the roller rocker arms, the cam profile has been shaped with recessed radii. This increases the amount of valve lift near the beginning of the opening of the valve and near the end of the closing of the valve, in order to further increase power output.



Camshaft

	Intake	Exhaust
Cam Lift Amount [mm (in.)]	5.99 (0.236)	6.14 (0.242)
Cam Lobe Width [mm (in.)]	15.35 (0.604)	14.1 (0.555)

Valve

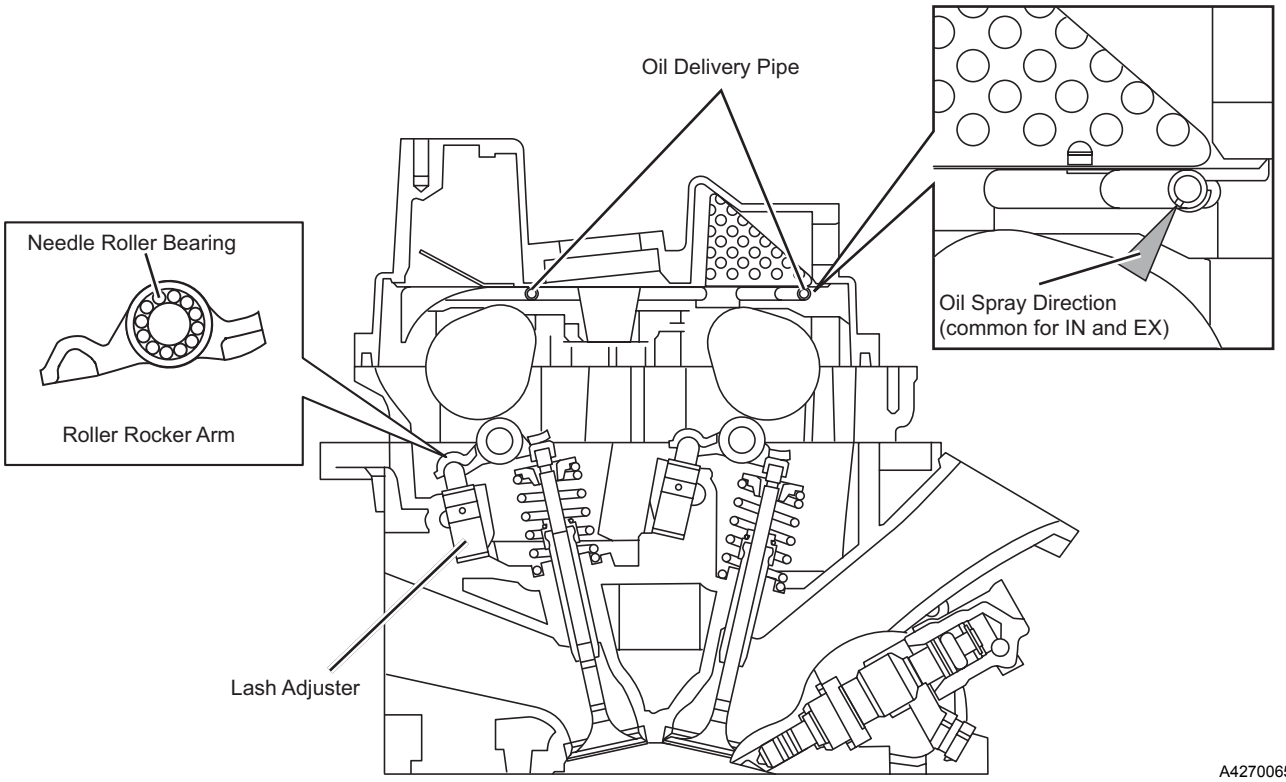
	Intake	Exhaust
Overall Length [mm (in.)]	105.65 (4.159)	111.5 (4.390)
Face Diameter [mm (in.)]	34.5 (1.358)	29.0 (1.142)
Stem Diameter [mm (in.)]	5.5 (0.216)	←

Valve Spring

Wire Diameter [mm (in.)]	3.3 (0.130)
Coil Inner Diamet [mm (in.)]	18.0±0.2 (0.709±0.08)
Free Length [mm (in.)]	46.51 (1.831)

Roller Rocker Arm

- The rocker arm is made compact and lightweight with a stamped steel arm with built-in needle bearings. The roller is supported by needle roller bearings that dramatically reduce friction at the sliding area, which contributes to fuel economy.
- An oil delivery pipe system is used for supplying oil to the roller rocker arms. This system positively supplies oil from above the camshaft to the lubrication area to ensure reliability.



Camshaft

	Intake	Exhaust
Cam Lift Amount [mm (in.)]	5.99 (0.236)	6.14 (0.242)
Cam Lobe Width [mm (in.)]	15.35 (0.604)	14.1 (0.555)

Valve

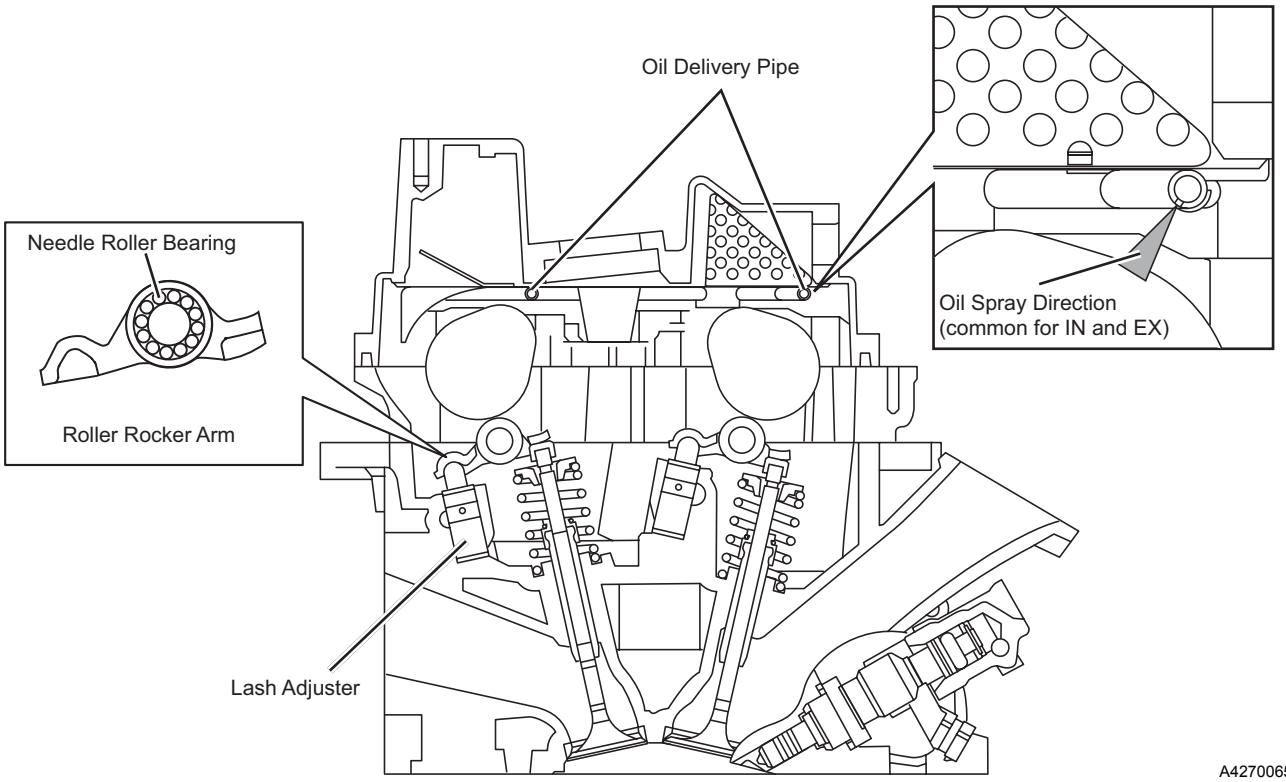
	Intake	Exhaust
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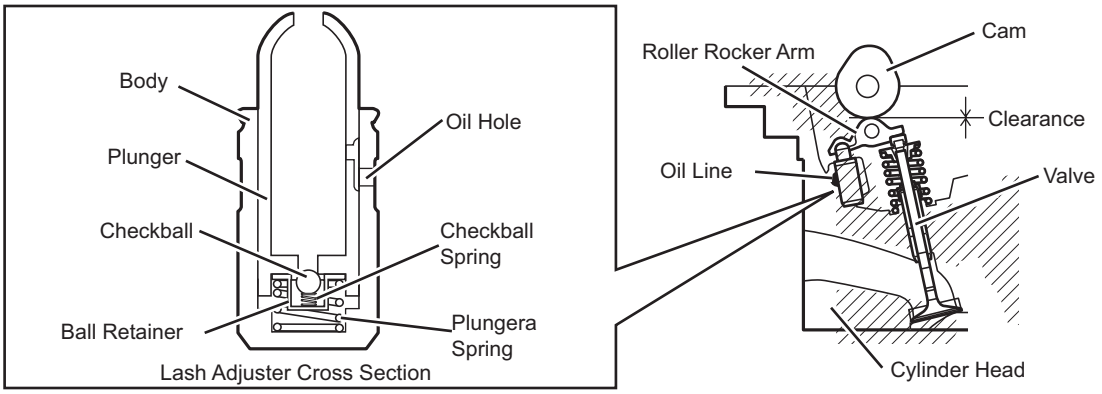


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Lash Adjuster

Lash Adjuster Construction

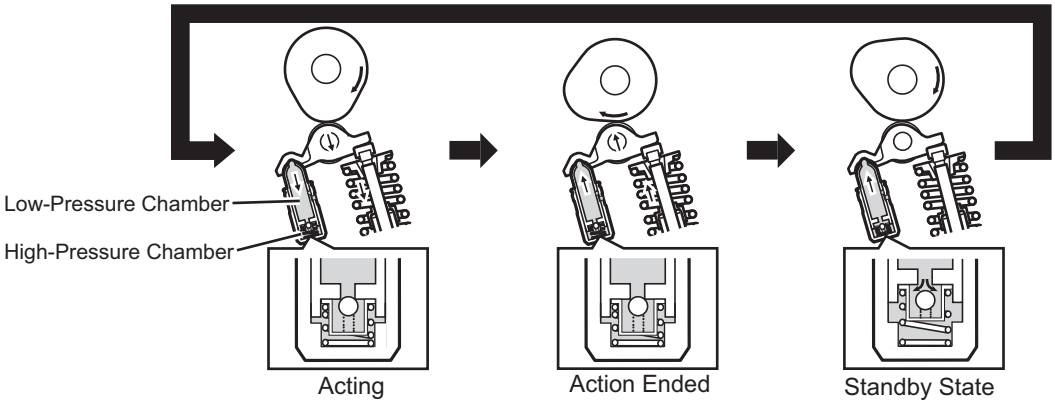
- Compact, hydraulic lash adjusters are used to constantly eliminate the gap (clearance) between the cams and rocker arms, thus enhancing the quiet performance of the engine.
- The lash adjuster is placed at the fulcrum of the rocker arm at the opposite end of the valve, and uses the oil that is supplied by the cylinder head as the operating fluid. The plunger in the lash adjuster body slides vertically due to the repulsion of the plunger spring or the hydraulic force in order to adjust the clearance.



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Lash Adjuster Operation

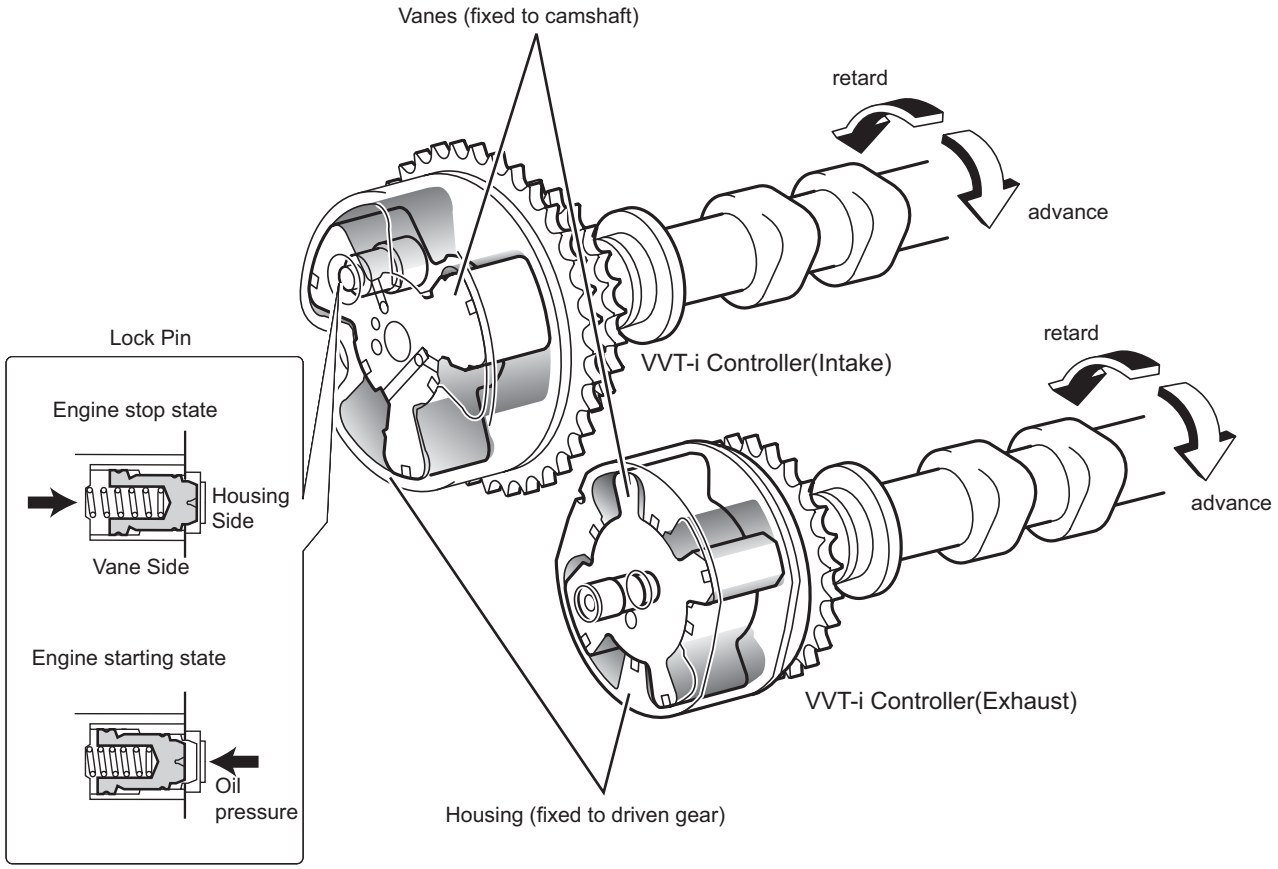
- The camshaft rotates clockwise, causing the cam to push on the rocker arm (acting), and a load is applied to both the valve and the plunger. At this time, the plunger almost gets pushed in, but because the check ball closes, the plunger stops. This allows the rocker arm to tilt in the clockwise direction, using the top of the plunger as the fulcrum, thus pushing the valve down.
- When the cam gets past the apex, the force of the valve spring causes the rocker arm to start ascending. However, because the force of the valve spring also acts on the lash adjuster, the high pressure chamber maintains its hydraulic pressure.
- When the valve closes (action ended), the oil in the high-pressure chamber is released from the pressurized state. At this time, a valve clearance is about to be created. However, the force of the plunger spring causes the plunger to push the rocker arm upward in order to maintain a constant zero valve clearance. At the same time, the capacity of the high-pressure chamber increases, creating a pressure difference between the high-pressure and low-pressure chambers. When this pressure difference becomes greater than the force of the check ball spring, the check ball moves downward to provide an oil passage. This allows the oil to flow from the low-pressure chamber to the high-pressure chamber in preparation for the next movement (standby state).



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Dual VVT-i Controller

- The VVT-i controller is a vane type that has low friction and is highly efficient while it is being driven.
- The VVT-i controller for the intake is a 3-vane type, and a 4-vane type for the exhaust. When the engine is stopped, a lock pin locks the vanes for the intake in the most retarded position and the vanes for the exhaust in the most advanced position.
- The VVT-i for the exhaust is provided with an advance assist spring that provides a torque assist in the advance direction so that the lock pin engages securely when the engine is stopped.
- Based on the signals provided by the sensors, the engine ECU controls the hydraulic pressure that acts on the advance chamber and retard chamber in the VVT-i controller, via an OCV (Oil Control Valve) that is mounted on the cylinder head cover. Thus, it continuously varies the phases of the intake and exhaust camshafts.



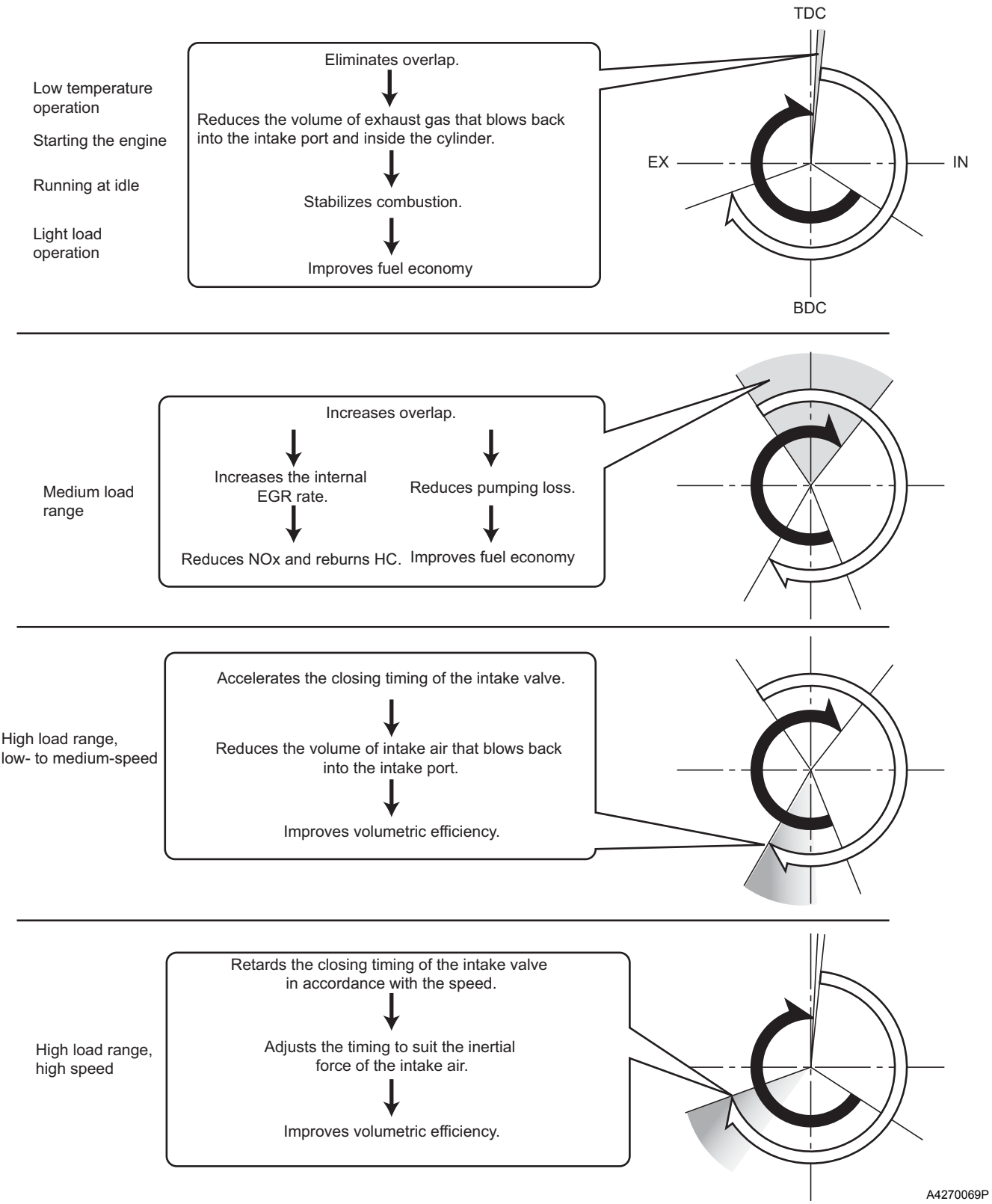
*The drawing shows the VVT-i controller for the intake in the retarded state and the VVT-i controller for the exhaust in the advanced state.

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EG

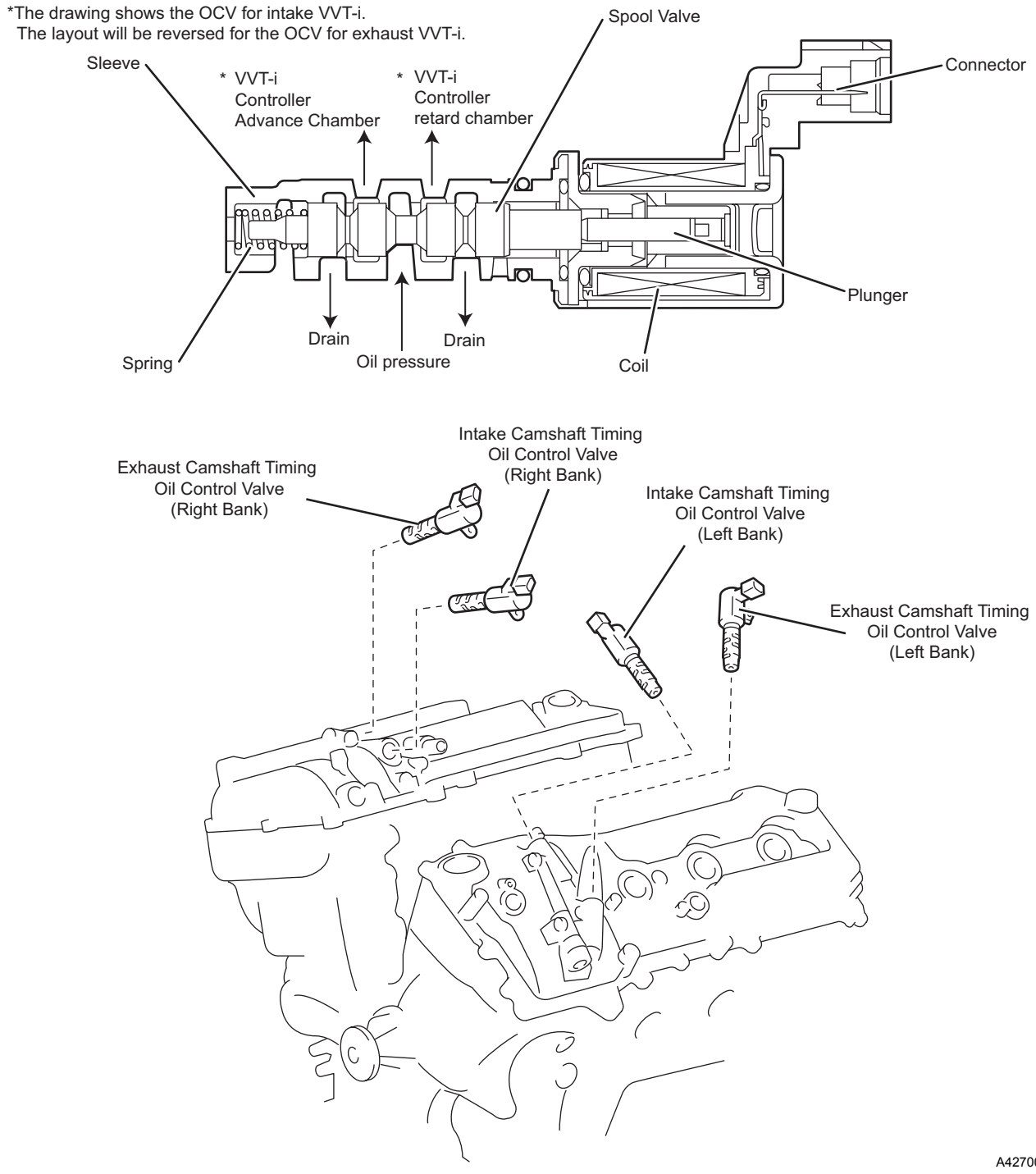
Effects of Dual VVT-i

• By advancing and retarding the intake and exhaust valves, the Dual VVT-i provides the following effects.



Camshaft Timing Oil Control Valve

- In accordance with the duty cycle signals received from the engine ECU, this OCV controls the position of the spool valve in order to constantly achieve optimal valve timing. When the engine is stopped, the force of a spring keeps the intake side of the spool valve in the most retarded state, and the exhaust side to the most advanced state, in order to ready the valves for the subsequent starting.



EG

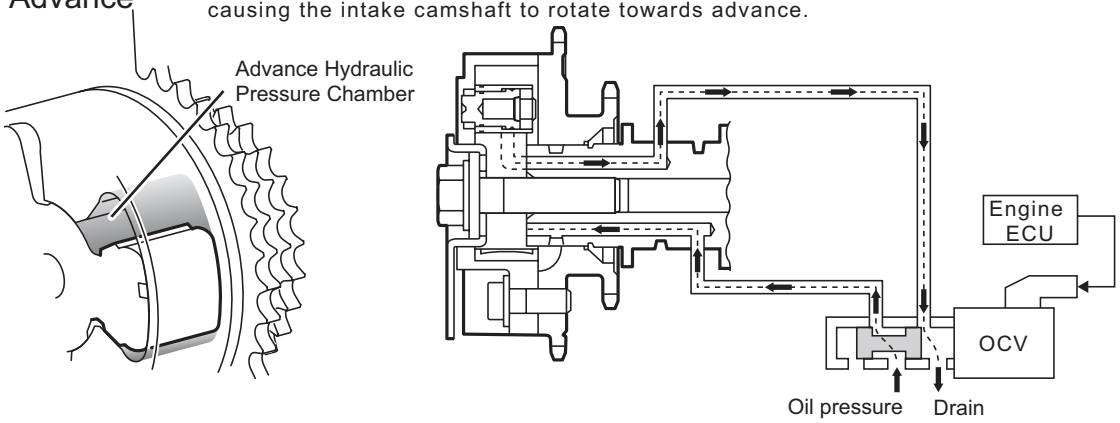
Dual VVT-i Operation

• The Dual VVT-i controls the advance, retard, and holding states as illustrated below, in accordance with the driving conditions.

Outline of Intake VVT-i Operation

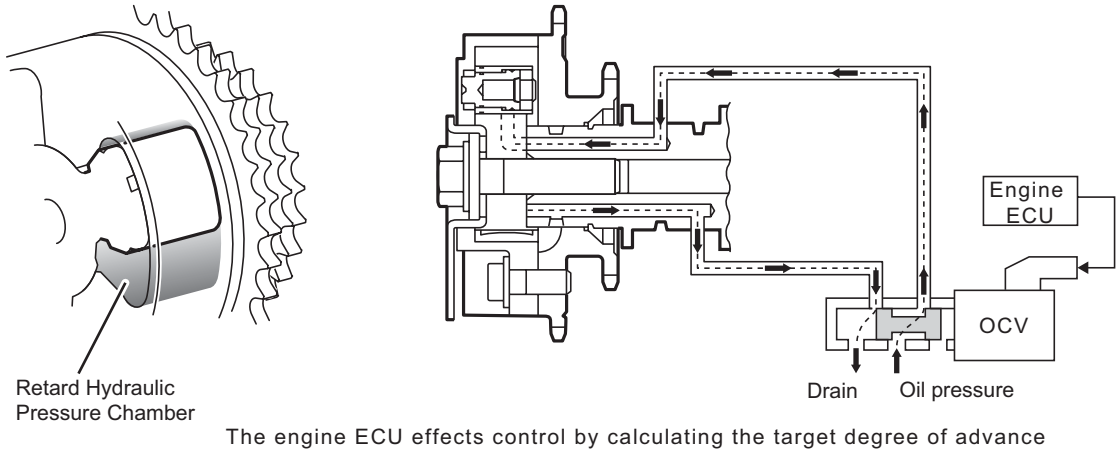
The spool valve of the OCV reaches the position shown in the drawing,
as a result of receiving a signal from the engine ECU.
Then, hydraulic pressure is applied to the hydraulic pressure chamber for advance,
causing the intake camshaft to rotate towards advance.

Advance



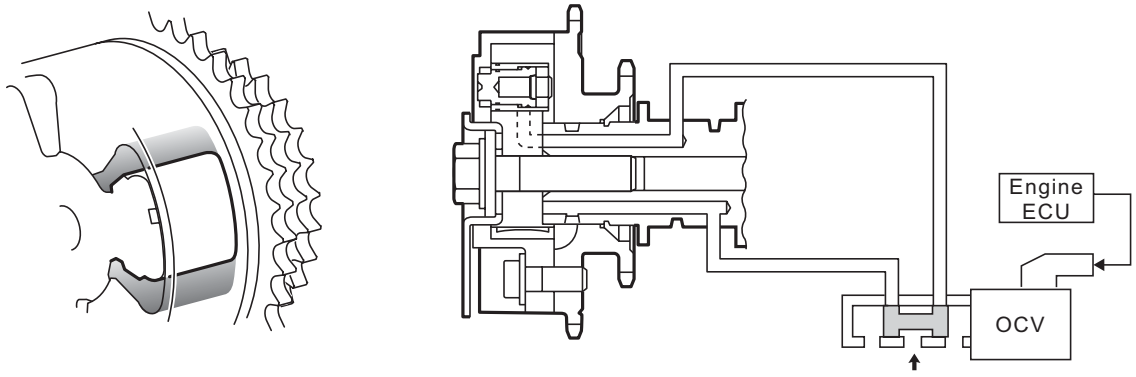
The spool valve of the OCV reaches the position shown in the drawing,
as a result of receiving a signal from the engine ECU.
Then, hydraulic pressure is applied to the hydraulic pressure chamber for retard,
causing the intake camshaft to rotate towards retard.

Retard



The engine ECU effects control by calculating the target degree of advance
in accordance with the driving conditions. After reaching the target timing,
the engine ECU maintains the timing by setting the OCV to neutral,
provided that the driving conditions do not change. As a result,
the valve timing can be set to any target position.
At the same time, the engine oil is prevented from flowing out needlessly.

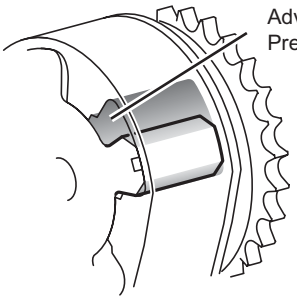
Hold

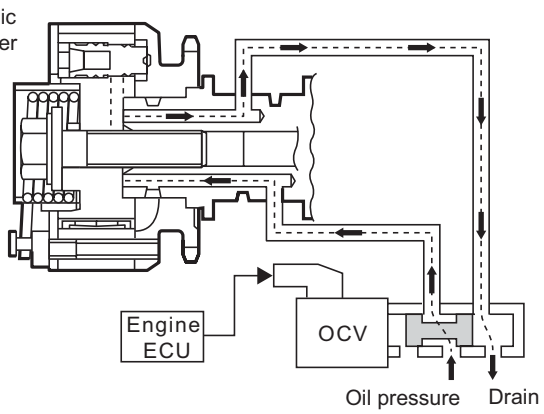


Outline of Exhaust VVT-i Operation

Advance

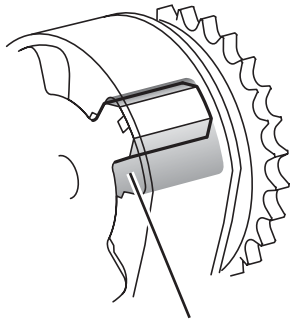
The spool valve of the OCV reaches the position shown in the drawing,
as a result of receiving a signal from the engine ECU.
Then, hydraulic pressure is applied to the hydraulic pressure chamber for advance,
causing the exhaust camshaft to rotate towards advance.

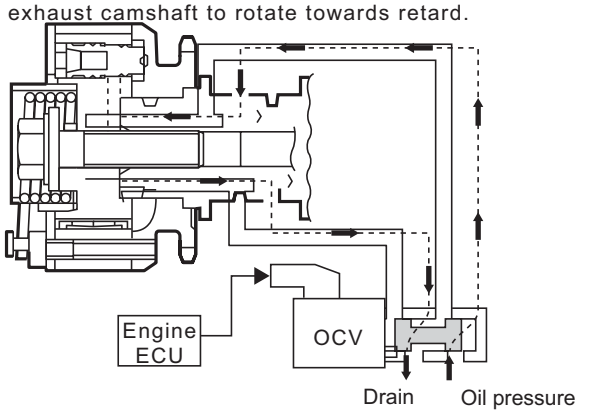




Retard

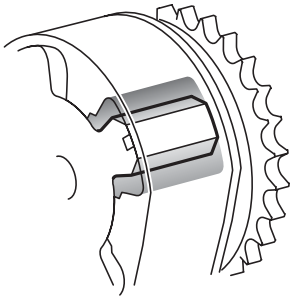
The spool valve of the OCV reaches the position shown in the drawing,
as a result of receiving a signal from the engine ECU.
Then, hydraulic pressure is applied to the hydraulic pressure chamber for retard,
causing the exhaust camshaft to rotate towards retard.

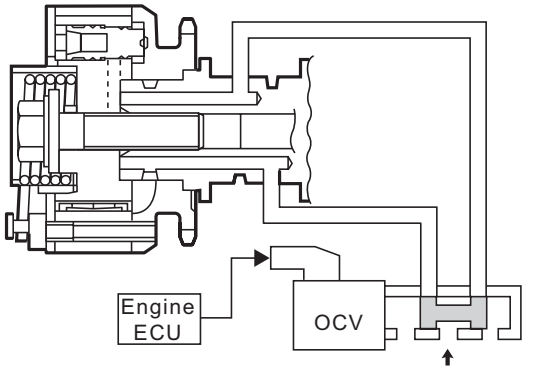




Hold

The engine ECU effects control by calculating the target degree of advance
in accordance with the driving conditions. After reaching the target timing,
the engine ECU maintains the timing by setting the OCV to neutral,
provided that the driving conditions do not change. As a result,
the valve timing can be set to any target position.
At the same time, the engine oil is prevented from flowing out needlessly.



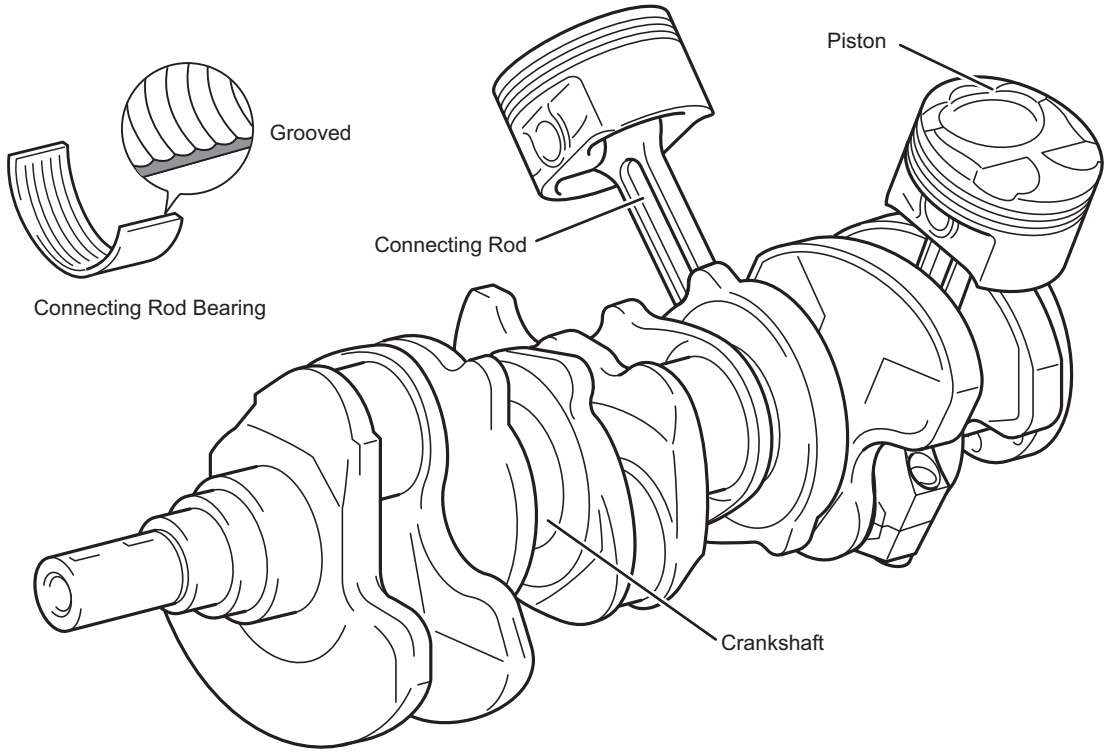


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EG

Piston and Crankshaft

- The pistons are made of a lightweight and highly rigid aluminum alloy.
- The connecting rods are made of highly rigid, sintered forged steel that ensures a high level of reliability.
- The crankshaft, which is made of forged steel, is a type that has 4 journals and 5 balance weights. It is lightweight and the balance weights are placed optimally to reduce vibration and noise. The crank pin width and the journal fillet have been made narrower to shorten the length of the crankshaft, in order to realize both high rigidity and low friction. The fillets have been induction hardened to ensure ample strength.
- The connecting rod bearings and the crankshaft bearings have been made narrower to reduce friction. The bearing lining is made of an aluminum alloy to realize both wear resistance and seizure resistance.
- The crankshaft pulley is provided with a torsional damper to reduce vibration and noise.



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Connecting Rod

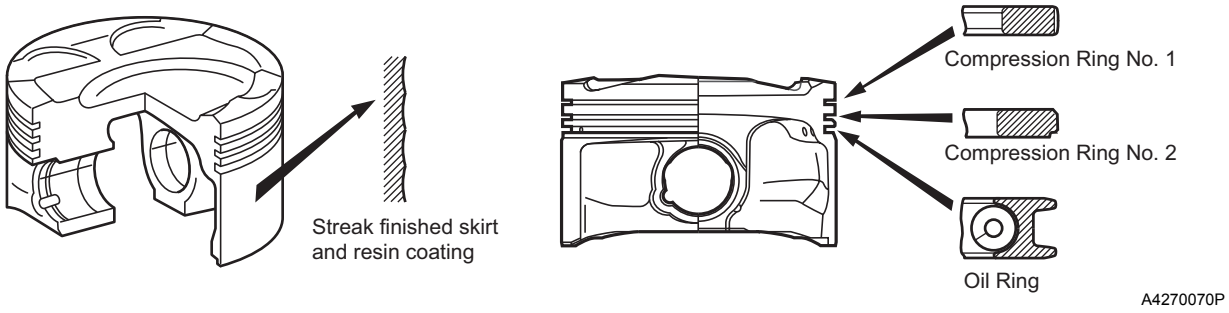
Big End Inner Diameter	[mm (in.)]	56.0 (2.205)
Small End Inner Diameter	[mm (in.)]	22.0 (0.866)
Center Distance Between Big and Small Ends	[mm (in.)]	147.5 (5.807)

Crankshaft

Journal Diameter	[mm (in.)]	61.0 (2.402)
Crank Pin Diameter	[mm (in.)]	53.0 (2.087)
Crank Pin Stroke Radius	[mm (in.)]	41.5 (1.634)

Piston

- The pistons have been made lightweight with a short compression height and a short skirt. The piston skirt has a streak finish and a plastic coating that excel in seizure resistance, in order to reduce noise and friction.
- A compact combustion chamber is provided on top of the piston to realize stable combustion. Together with the pentroof type combustion chamber on the cylinder head, this realizes a high compression ratio, resulting in both high performance and fuel economy.
- Each piston ring is made thinner and with low tension to reduce friction.



Piston

Basic Diameter	[mm (in.)]	87.465 (3.444)
Pin Hole Offset	[mm (in.)]	0.5 (0.020)
Compression Height	[mm (in.)]	31.05 (1.222)

Piston Pin

Outer Diameter	[mm (in.)]	22.0 (0.866)
Inner Diameter	[mm (in.)]	12.7 (0.5)
Length	[mm (in.)]	56.0 (2.205)

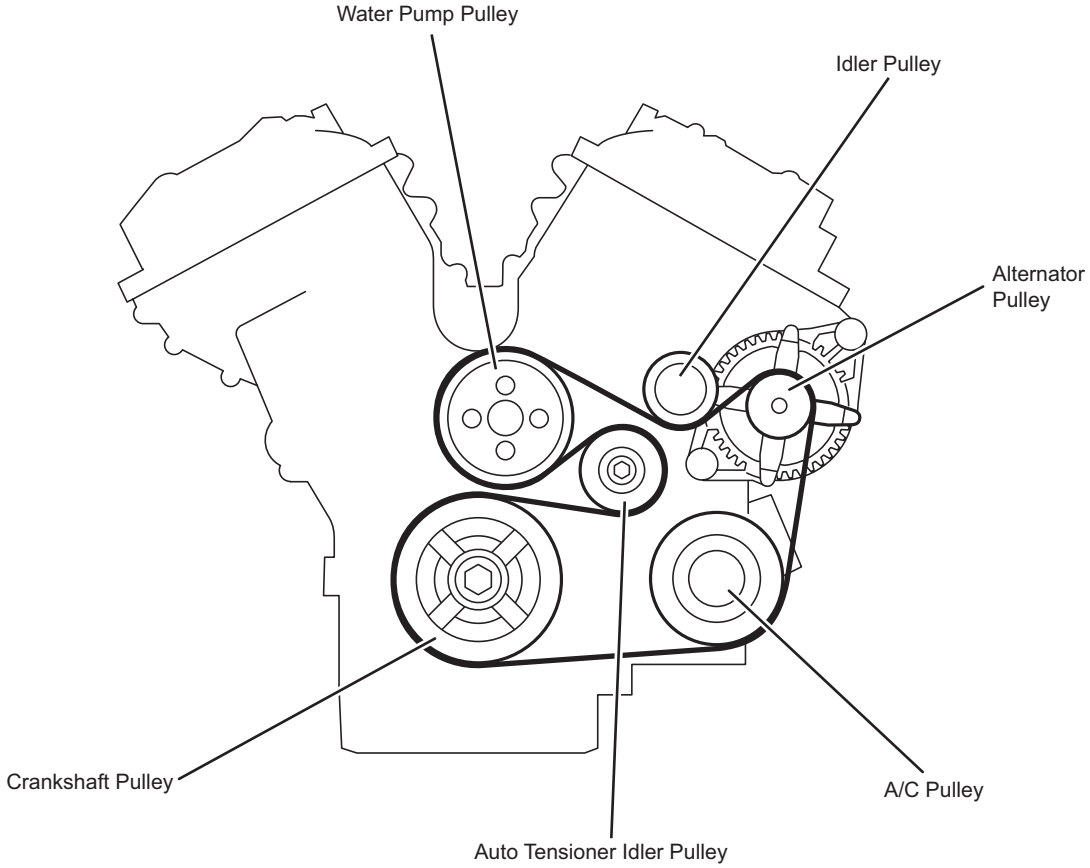
Piston Ring

	Compression Ring No. 1	Compression Ring No. 2	Oil Ring
Material	Stainless Steel	Steel	Steel
Shape	Barrel Face	Tapered Face + Undercut	Combination
Width [mm (in.)]	1.2 (0.047)	1.2 (0.047)	2.0 (0.079)
Thickness [mm (in.)]	2.7 (0.106)	2.7 (0.106)	2.75 (0.108)
Surface Treatment	PVD (Physical Vapor Deposition) (Periphery)	Anti-Corrosion	Gas Nitriding

EG

Serpentine Belt Drive System

- A serpentine drive system, which uses a single V-ribbed belt to drive all accessories, is used in order to shorten the overall length of the engine and make it lightweight.
- An auto tensioner is used for the V-ribbed belt to ensure the long life of the belt and accessories, make them maintenance free, and improve serviceability by facilitating the removal and reinstallation of the belt.



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Pulley Specifications

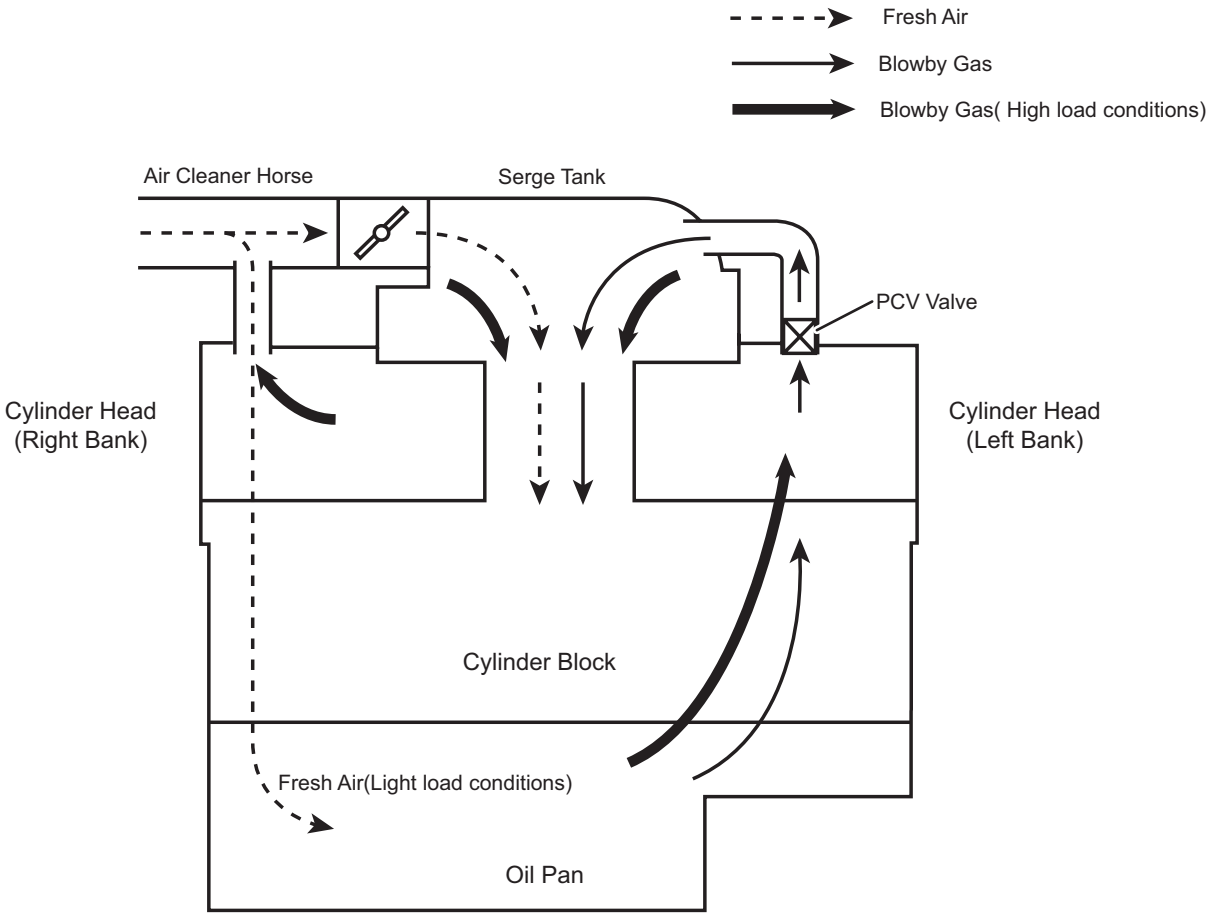
	Pulley Diameter [mm (in.)]
Crankshaft Pulley	140 (5.512)
Auto Tensioner Idler Pulley	70 (2.756)(driven from back face)
A/C Pulley	115 (4.528)
Idler Pulley	70 (2.756)(driven from back face)
Water Pump Pulley	120 (4.724)
Alternator Pulley	52.5 (2.067)

V Ribbed Belt Specifications

Width [mm (in.)]	24.92 (0.981)
Length [mm (in.)]	1550 (61.024)
Number of Ribs	7

Blowby Gas Reduction System

- A PCV hose and a PCV valve are provided to forcefully feed the blowby gas into the intake system for combustion, in order to prevent the blowby gas, which includes a large amount of HC, from being discharged into the atmosphere. A new air circulating system is used wherein fresh air from the air cleaner hose is introduced via the right bank head cover and the blowby gas is discharged into the surge tank via the left bank head cover.
- Under light load conditions, the intake manifold vacuum causes the blowby gas to be drawn via the PCV valve into the intake manifold, to be combusted. The internal pressure is regulated in the crankcase, where fresh air is introduced from the cylinder head cover.
- Under high load conditions, the intake manifold vacuum forcefully introduces the blowby gas into the intake system, where it is combusted. This prevents the blowby gas, which contains a large amount of HC, from being released to the atmosphere.
- A dedicated oil return passage and a blowby gas passage are provided in the cylinder block and the cylinder head to enhance the oil return function and minimize the volume of oil that is taken away.



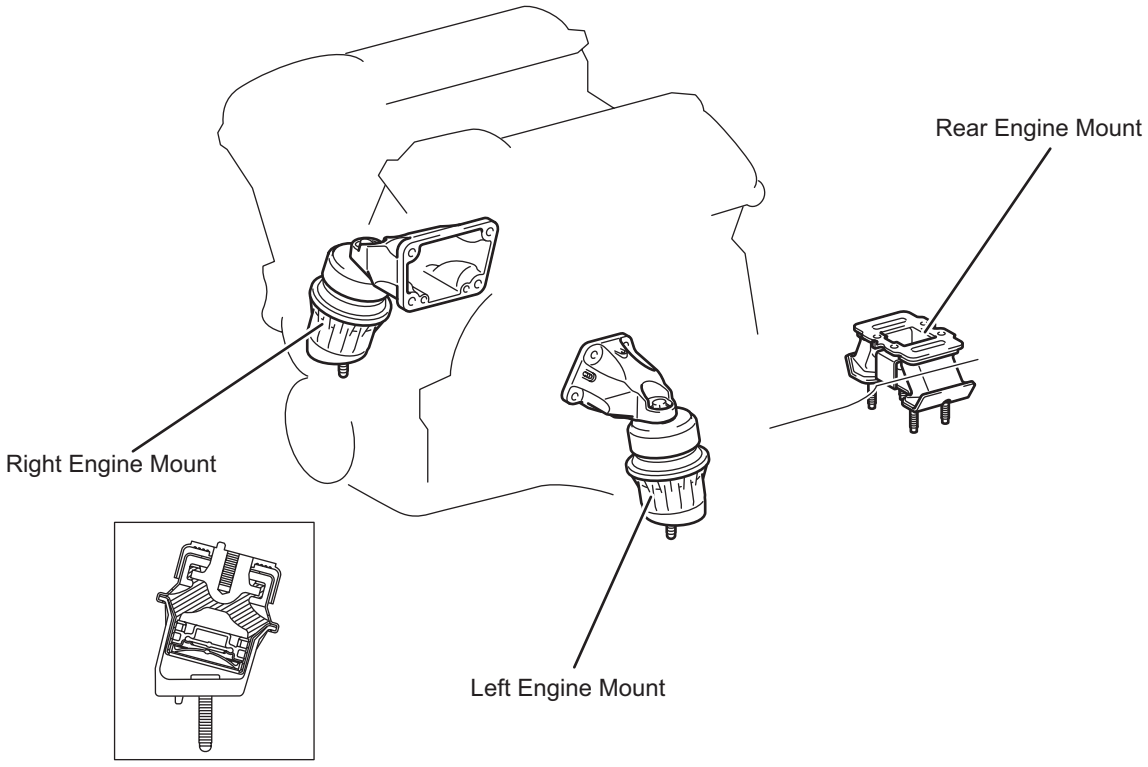
Conceptual operation image of the blowby reduction system

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EG

Engine Mounts

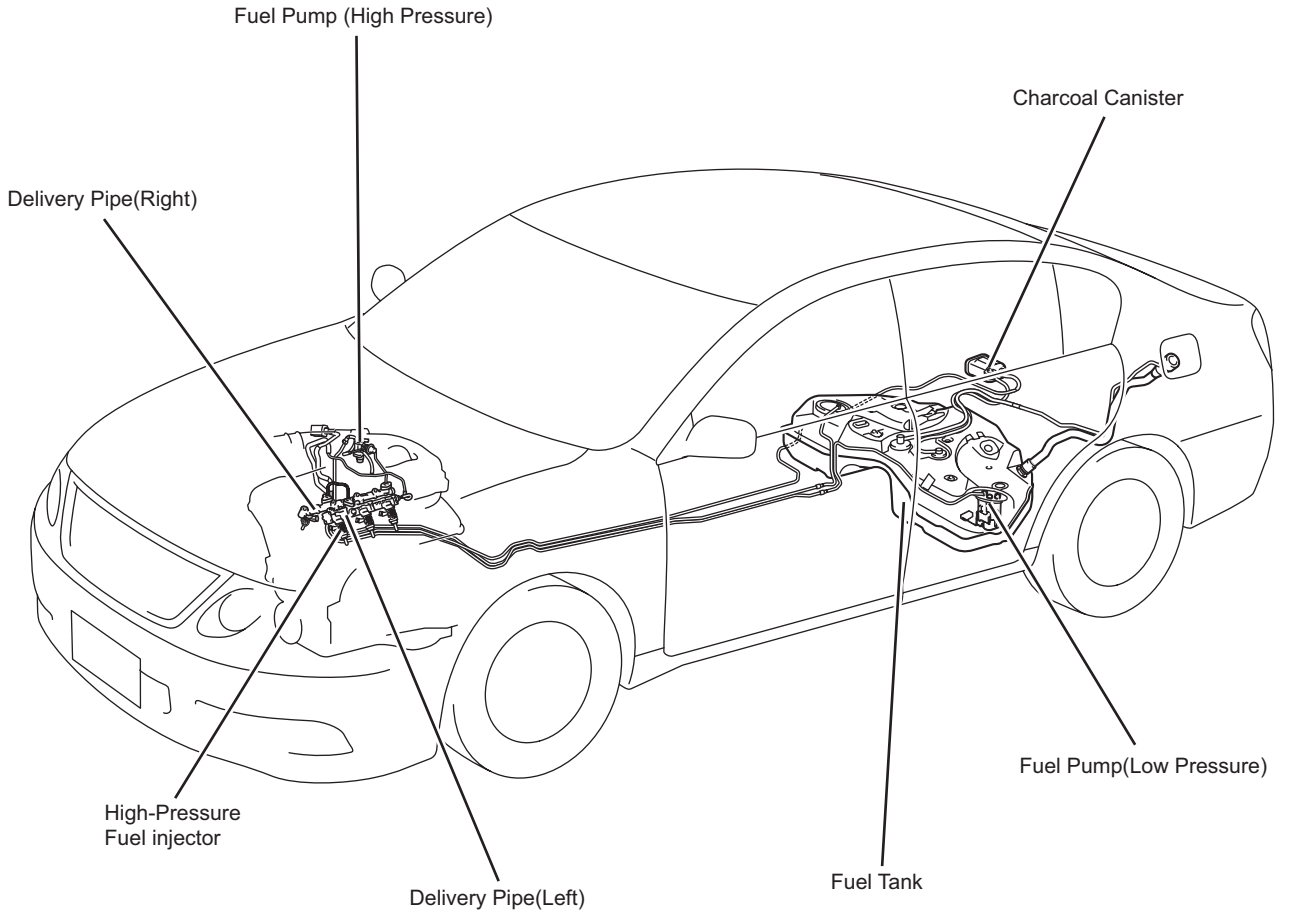
- The front engine mounts are installed on the upper area of the cylinder block where the vibration is minimal. In addition, the brackets have been angled more moderately to reduce vibration and noise in all operating ranges. The brackets are made of cone-shaped aluminum alloys to reduce weight, vibration, and noise.
- The front engine mount uses a liquid-filled double-orifice mount insulator to reduce vibration and noise in the operating range of the engine.
- The die shape for the rear engine mount has been optimized to reduce vibration in the operating range.



3GR-FSE FUEL

General

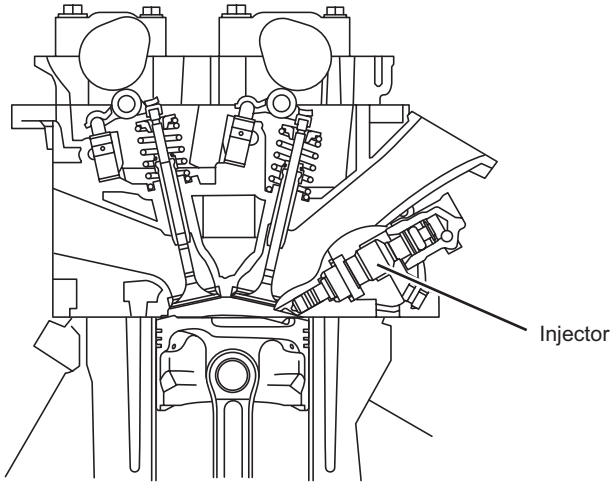
- This engine uses the D-4 (Direct injection 4-stroke gasoline engine) system. A (low pressure) fuel pump located inside the fuel tank pumps fuel to the high-pressure fuel pump located in the cylinder head cover. Then, the fuel is boosted to a pressure between 4 and 13 MPa in accordance with the driving conditions, and sent to the high-pressure fuel injectors.
- A fuel returnless system, which controls the fuel pressure for the low pressure side by way of a pressure regulator installed in the fuel tank, is used. However, the leak fuel from the high-pressure fuel pump and the fuel from the relief valve return to the fuel tank.
- To prevent fuel from leaking during a collision (in which air bags are deployed), a system that turns OFF the circuit opening relay is used to ensure safety.



EG

Direct injection 4-stroke Gasoline Engine (D-4)

- The D-4 (Direct injection 4-stroke gasoline engine) directly injects highly pressurized fuel into the cylinders. This engine effects comprehensive control of the fuel injection timing, air-fuel ratio, throttle valve position, etc., to realize both a high power output and low exhaust emissions.
- The high-pressure slit nozzle injector atomizes fuel into a fine mist while expanding it to form a large, fan-shaped pattern. Then, the fuel mist enters the combustion chamber while drawing in a large volume of air. The fuel mist that is sprayed at high-pressure expands into the combustion chamber on its own energy, without depending on the air current. Thus, it mixes efficiently with the intake air in order to achieve ideal combustion in all driving ranges.

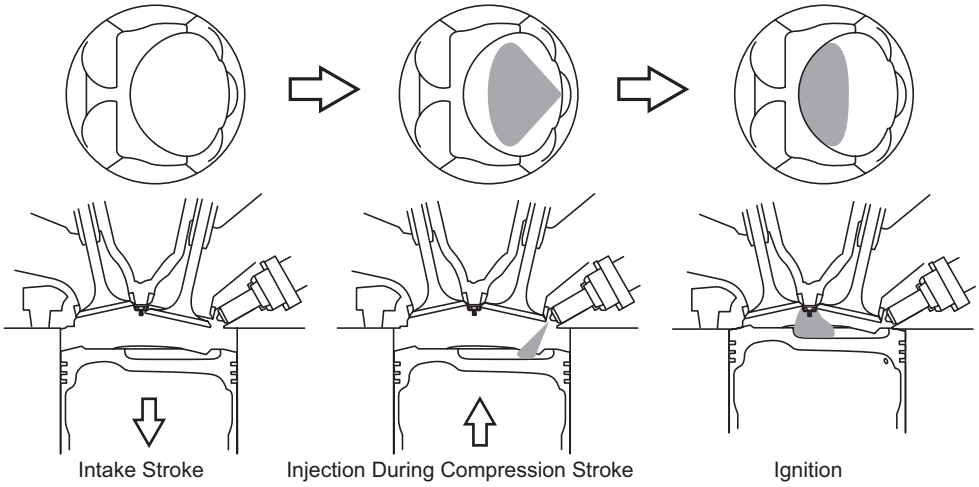


Direct injection 4-stroke Gasoline Engine(D-4)

A4270037P

Air Fuel Ratio Control

- One of the two independent straight ports contains an SCV (Swirl Control Valve), which opens and closes to enhance both charging efficiency and combustion efficiency.
- When the engine is operating at low speed and low load conditions, the SCV remains fully closed. Thus, only one port is used for intake, in order to promote the mixture of air and fuel. This also accelerates the intake flow speed, which enhances combustion and improves fuel economy.
- When the engine is operating at high load conditions, the SCV opens to allow the intake of air through both straight ports. This increases the intake air volume and improves charging efficiency. At the same time, this creates a vertical swirl current (tumble current) in the combustion chamber to promote the mixture of air and fuel, thus improving performance.
- Fuel is injected during the compression stroke immediately after cold-starting. This enables the catalyst to warm up quickly, resulting in a dramatic reduction in exhaust emissions.



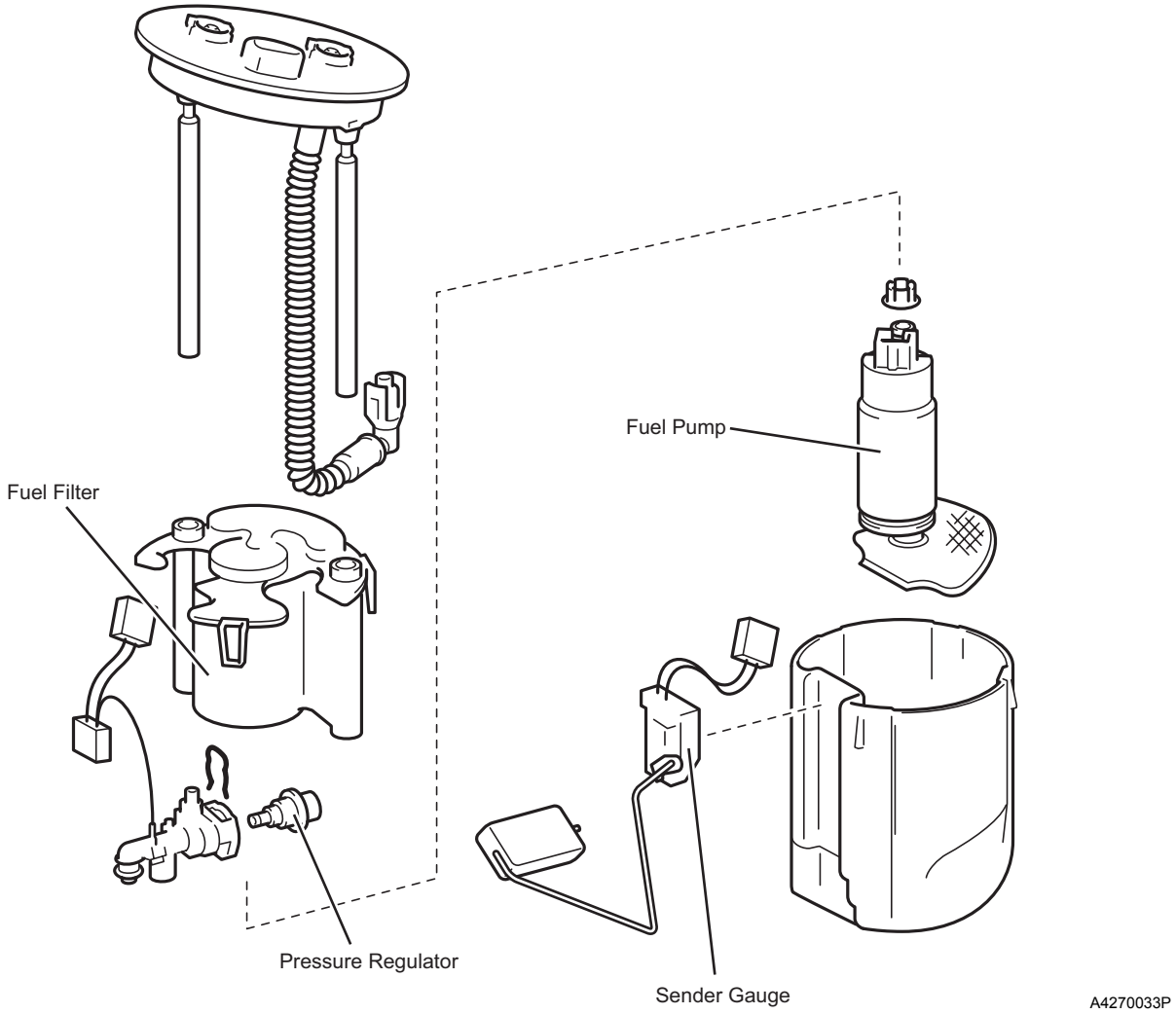
Conceptual image of fuel injection during cold starting

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EG

Fuel Pump

- A fuel pump assembly consisting of a fuel pump, fuel filter, and sender gauge is used.
- To prevent fuel from leaking during a collision (in which air bags are deployed), a system that turns OFF the circuit opening relay, in accordance with a signal from the airbag ECU, is used to ensure safety.



Fuel Pump

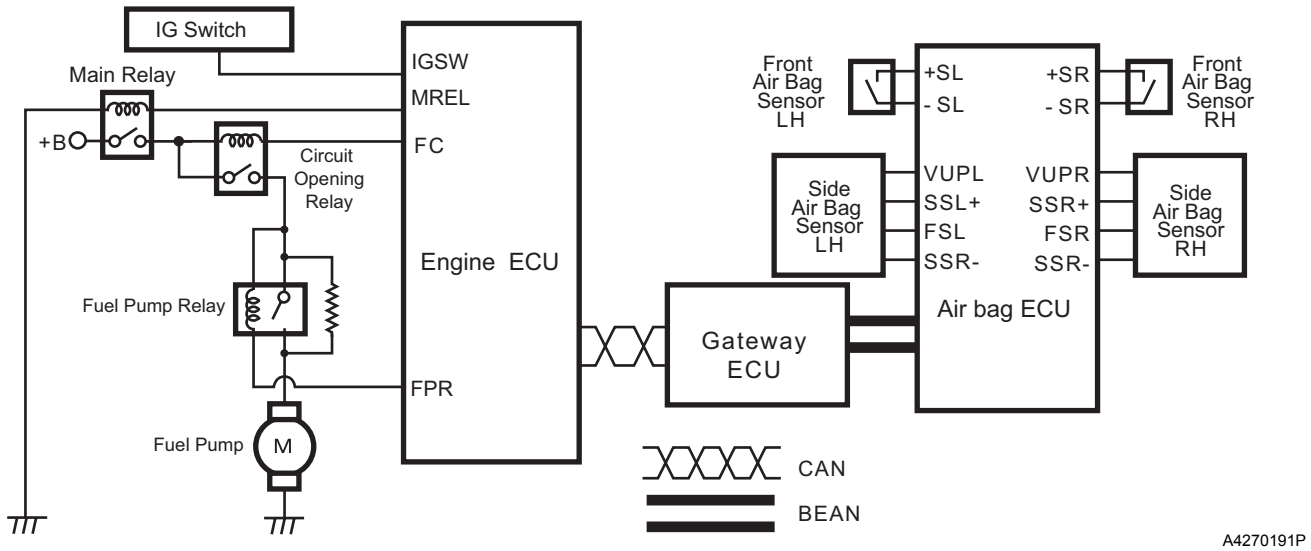
Discharge Pressure [kPa]	400
Discharge Volume [L·h]	190 Minimum

Fuel Filter

Filter System	Paper Filter Type
Filtering Surface Area [cm2]	1550

Fuel Pump Control

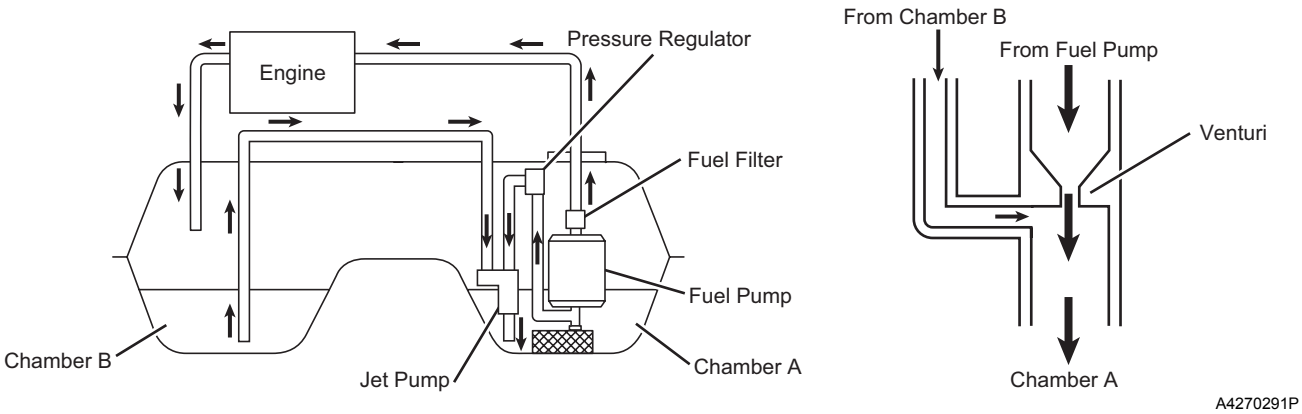
- When the starter signal is ON and the engine speed signal is input continuously for 2 seconds or longer, the circuit opening relay turns ON to actuate the fuel pump.
- A fuel cut control is adopted to stop the fuel pump when the airbag is deployed at the front or side collision. In this system, the airbag deployment signal from the airbag sensor assembly is detected by the engine ECU, which turns OFF the circuit opening relay.
- After the fuel cut control has been activated, turning the ignition switch from OFF to ON cancels the fuel cut control, thus engine can be restarted.



EG

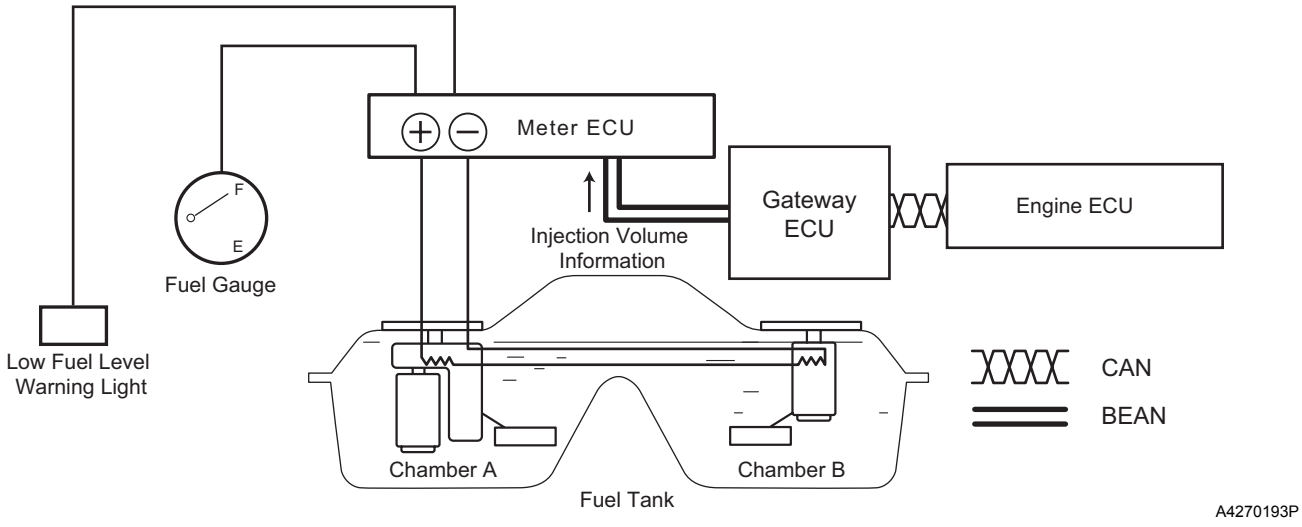
Jet Pump

- The jet pump operates as described below.
- A jet pump is adopted in the fuel tank. Since the propeller shaft is located below its center bottom, the fuel tank of the GS430 is shaped as indicated below.
- A fuel tank with such a shape tends to cause the fuel to be dispersed into both chamber A and chamber B when the fuel level is low, stopping the fuel in chamber B from being pumped out. To prevent this from occurring, a jet pump has been provided to transfer the fuel from chamber B to chamber A.
- This is accomplished by utilizing the flow of the fuel, so that the vacuum created by the fuel, as it passes through the venturi is used to suck the fuel out of chamber B and send it to chamber A.



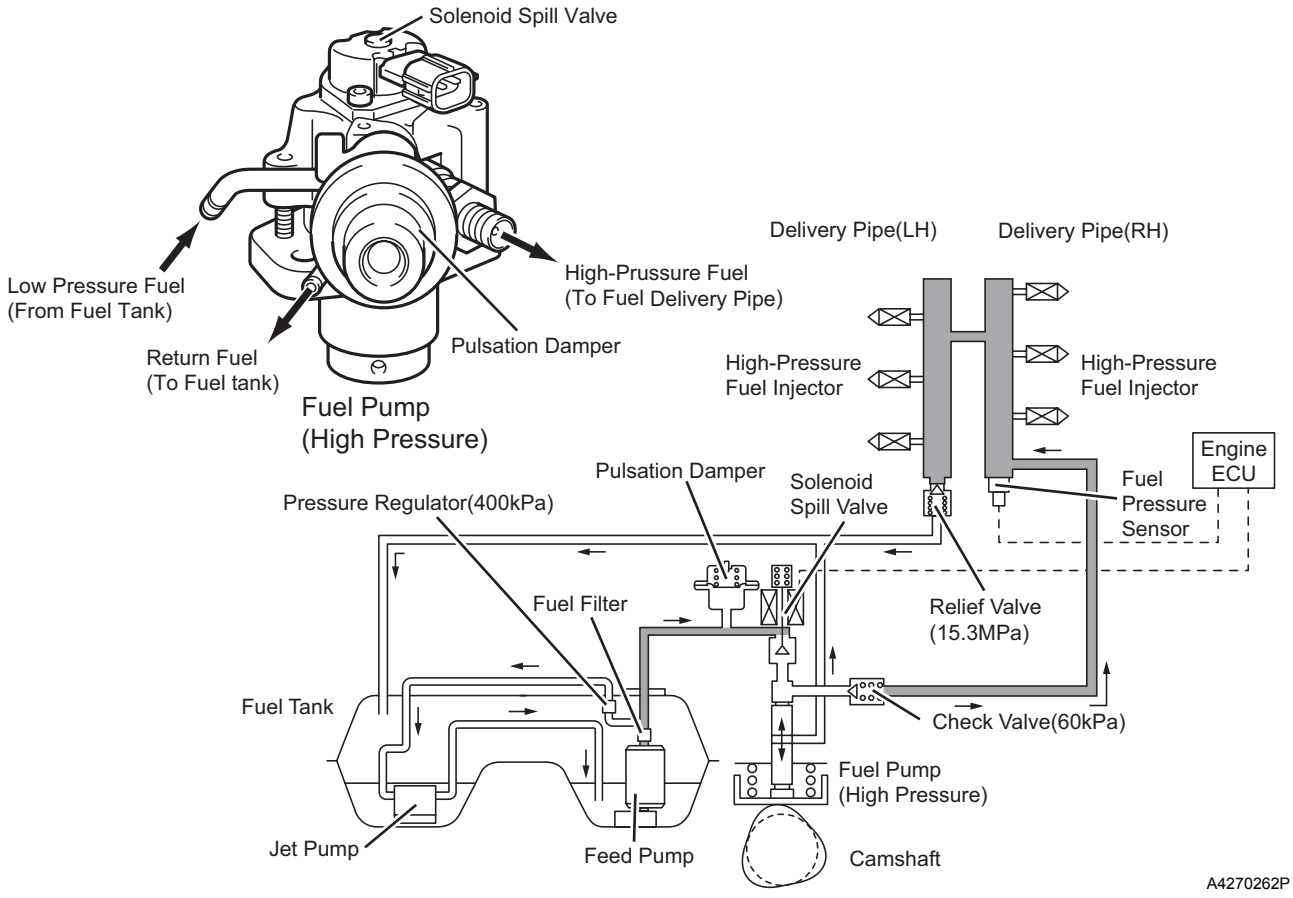
Fuel Sender Gauge

- To accurately inform the driver of the residual fuel volume in the saddle-shaped tank, inline sender gauges are provided in the two chambers, A and B. These sender gauges output the residual fuel volume of both chambers to the meter ECU.
- Based on the signals received from the two sender gauges and the EFI control information received from the engine ECU, the meter ECU calculates the residual fuel volume, and activates the fuel gauge.



Fuel Pump (High Pressure)

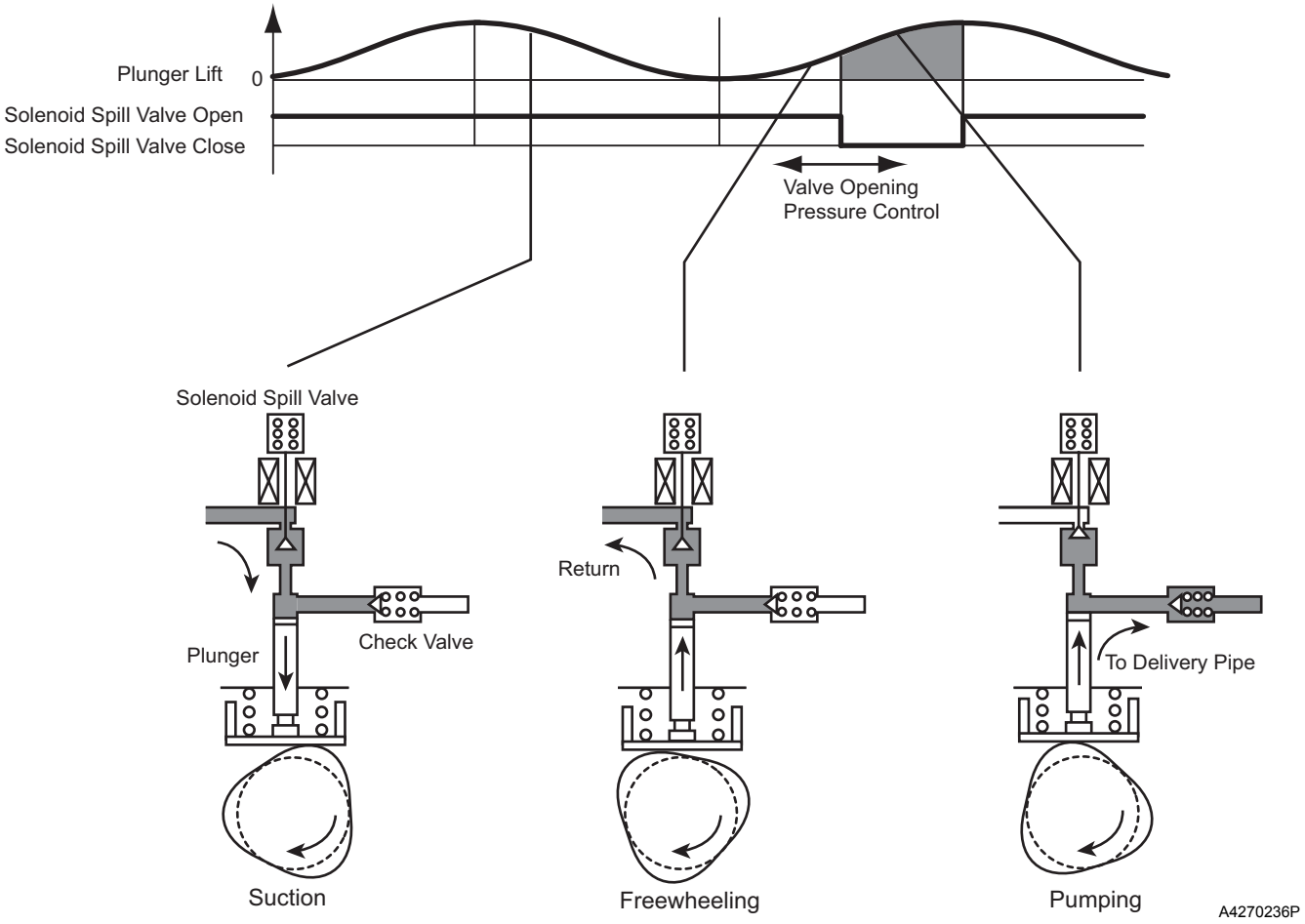
- This fuel pump is a highly efficient, single-plunger type in which the drive torque has been reduced. In addition, a solenoid spill valve and a check valve have been integrated to achieve a lightweight and compact system. Also, a pulsation damper has been installed at the low-pressure fuel inlet.
- Mounted on the cylinder head cover, this fuel pump is driven by a cam that is provided at the rear end of the exhaust camshaft on the right bank of the engine. A heat insulator is provided on the surface of the fuel pump that mounts to the cylinder head cover in order to suppress the increase in fuel temperature.
- The engine ECU variably controls the fuel to a high-pressure that suits the driving conditions. Because this system uses a solenoid spill valve to control and discharge only the necessary volume of fuel, the drive torque and noise have been reduced.
- A fuel pressure sensor, which is provided in the fuel delivery pipe, gives feedback to the engine ECU in order to maintain an optimal fuel pressure at all times. This system varies the high fuel pressure between 4 and 13 MPa to suit the driving conditions, in order to reduce friction loss.
- A tapered seal metal joint is used for joining the high-pressure fuel delivery pipes.
- It consists of a solenoid spill valve that regulates the discharge volume of high-pressure fuel, a plunger that is driven by the camshaft and pressurizes fuel, and a check valve that mechanically opens and closes the passage to the fuel delivery pipe.
- A pulsation damper is provided at the low-pressure fuel inlet from the fuel tank, in order to reduce the pulsation of fuel.



EG

High Pressure Fuel Pump Operation

- The plunger in the pump moves up and down to pressurize fuel. The solenoid spill valve, which is provided at the suction side of the pump, closes at an optimal timing during the compression stroke in order to control the fuel to the required pressure and volume. If the solenoid spill valve closes at an early timing, the effective stroke of the plunger becomes longer, thus pressurizing the fuel to an even higher pressure.
- The fuel that has been pressurized by the plunger pushes open the check valve (60 kPa), flows into the fuel delivery pipe, and is controlled to a pressure between 4 and 13 MPa (approximately 40 to 130 bars).
- The fuel pressure sensor that is provided on the fuel delivery pipe detects the fuel pressure and gives feedback to the engine ECU, enabling the engine ECU to control the fuel to a target pressure.

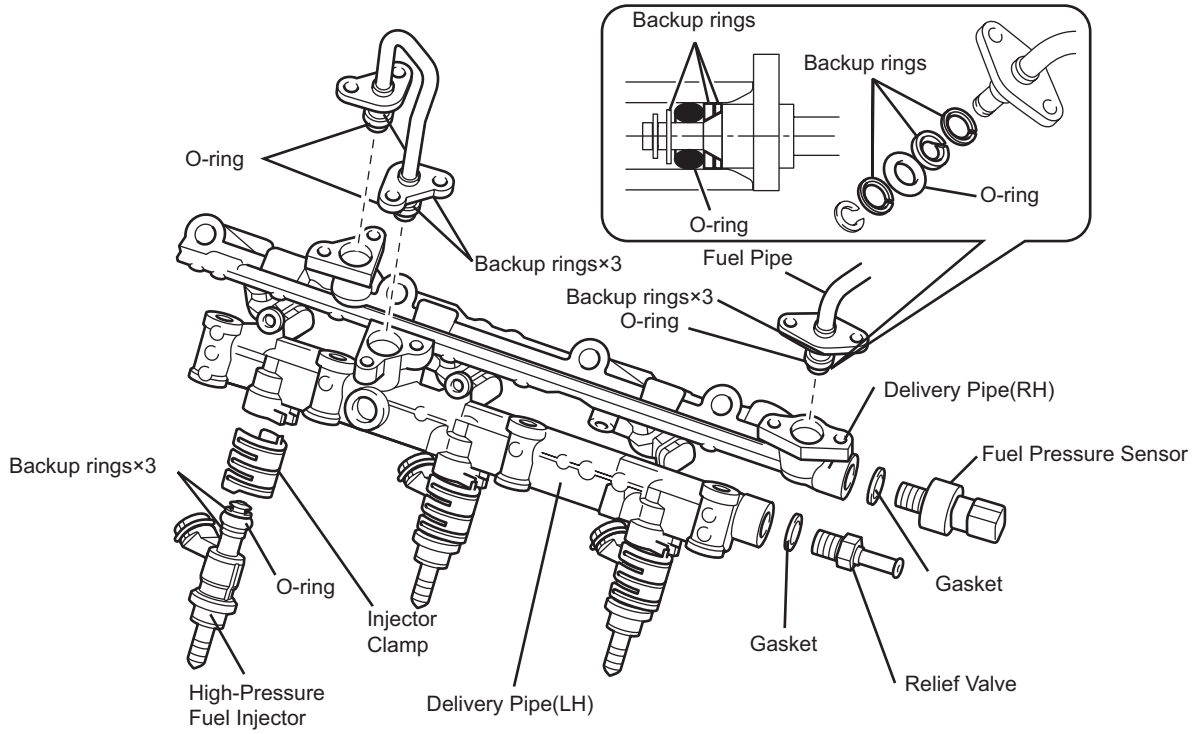


Delivery Pipe

- An aluminum alloy fuel delivery pipe is used.
- A fuel pressure sensor and a relief valve are provided on the fuel delivery pipe.
- An injector clamp is provided to each area of the fuel delivery pipe where a high-pressure fuel injector is installed. This clamp applies a constant spring force to the injector to prevent the injector from moving when the combustion pressure is applied to the injector while the engine is being started, during which the fuel pressure is low. As a result, it increases the sealing performance of the injector, while reducing vibration and noise.
- O-rings and backup rings* are used in the areas in which the high-pressure fuel injectors and high-pressure fuel delivery pipes are joined. This reduces the transmission of the operating sounds of the high-pressure fuel injectors, enhances quiet operation, and ensures the sealing performance of the joined areas.

❖REFERENCE❖

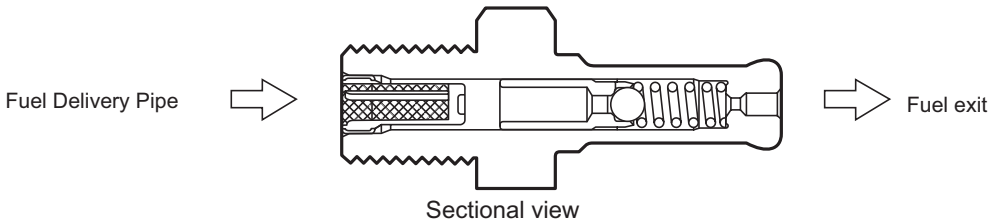
* : The backup ring is provided to securely support the rubber O-ring, which is exposed to high fuel pressure. During assembly, make sure to install it with the correct position and orientation.



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Relief Valve

- A relief valve is provided in the fuel delivery pipe. When the fuel in the fuel delivery pipe increases to a predetermined pressure (15.3 MPa), the relief valve returns the fuel to the fuel tank.

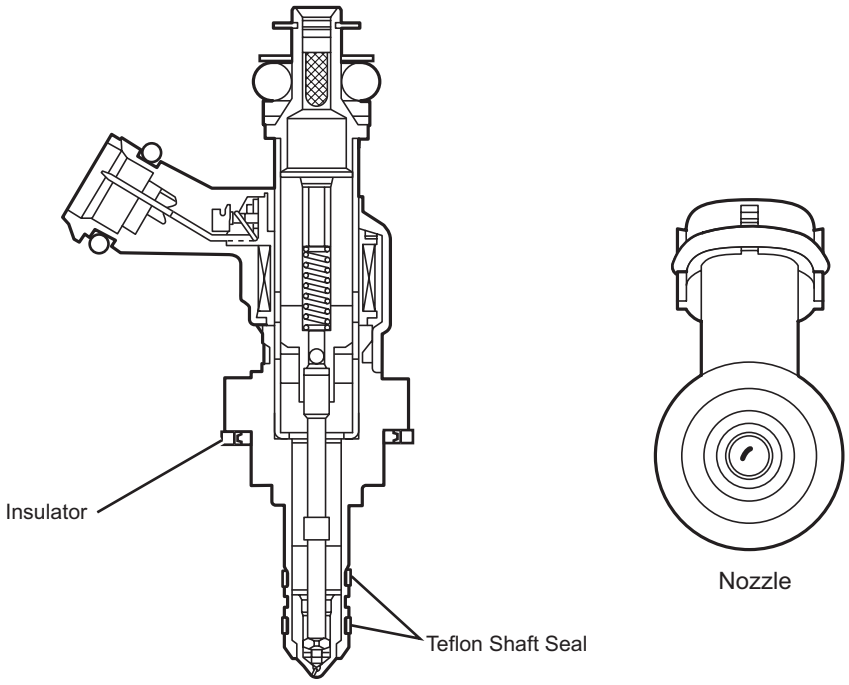


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EG

Injector

- A single-orifice, high-pressure slit nozzle injector is used.
- The injector atomizes fuel into a fine mist and expands it to form a large, fan-shaped pattern. Then, the fuel mist enters the combustion chamber while drawing in a large volume of air. This increases the intake air volume and improves charging efficiency. Furthermore, the intake air forms a vertical swirl current (tumble current) in the combustion chamber to promote the mixture of air and fuel, thus achieving high performance and a high power output.
- Because the injector is exposed inside the combustion chamber, a special coating has been applied to the nozzle in order to suppress the adhesion of carbon deposits created by the combustion gas.
- An insulator is used in the area in which the injector comes in contact with the cylinder head, and a Teflon shaft seal is used for sealing the injector against the cylinder pressure in order to reduce vibration and noise and enhance sealing performance.
- An EDU (Electronic Driver Unit) is used in order to operate the high-pressure fuel injectors speedily and precisely.



High-Pressure Fuel Injector Cross-Sectional Diagram

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Fuel Injector

Number of Orifices	1
Orifice Dimensions [mm (in.)]	0.15 × 0.71 (0.006 × 0.028)
Injection Pressure [MPa]	4 ~ 13

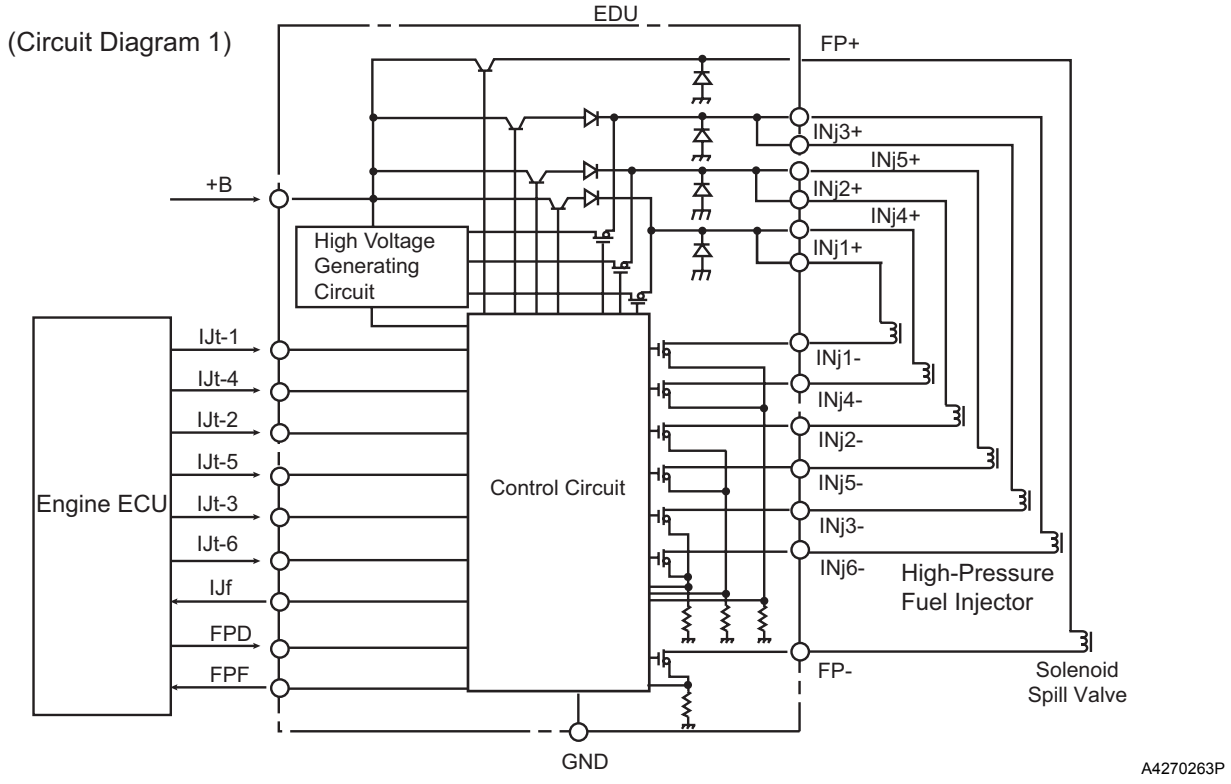
EDU(Electronic Driver Unit)

An EDU to operate the high-pressure fuel injectors at high speedsis placed in the engine compartment. The engine EDU converts theinjection request signal received from the engine ECU into high-voltage,high-amperage injector actuation signals, in order to actuate thehigh-pressure fuel injectors.

EDU Operation

EDU Operation (Circuit Diagram 1)

- When the engine ECU sends injection signals (IJt-1 to IJt-6) to the EDU, the COM terminal outputs a high voltage for actuating the injectors. When the injectors open the voltage switches to 12V to keep the injectors open. The current will flow from INj#+ to INj#- and to GND, in order to actuate the high-pressure fuel injectors.
- The control circuit constantly monitors the actuating state of the injectors, and sends an IJf fail signal to the engine ECU when the INj-# is actuated normally.

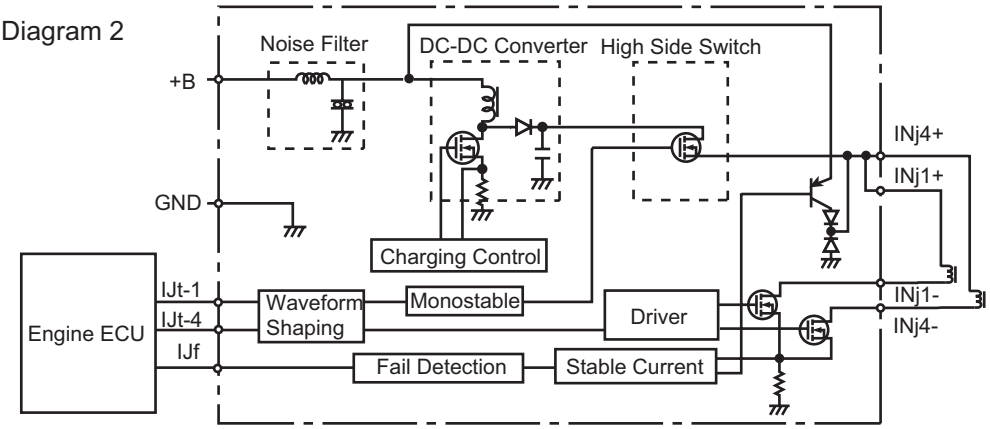


EG

Example of IJt-1 Actuation (Circuit Diagram 2)

- The fuel injection request signal IJt-1 from the engine ECU passes through the waveform shaping circuit, and separates into the monostable circuit - high side switch and the driver circuit. Then, the high side switch applies the high voltage boosted by the DC-DC converter, in accordance with the fuel injection request signal, from the INj1+ and INj4+ terminal to the INj1- and INj4- terminals (injectors #1 and #4).
- In accordance with a signal received from the waveform shaping circuit, the driver circuit grounds the INj1- terminal in a timely manner, in order to control the fuel injection volume and injection timing of injector #1.

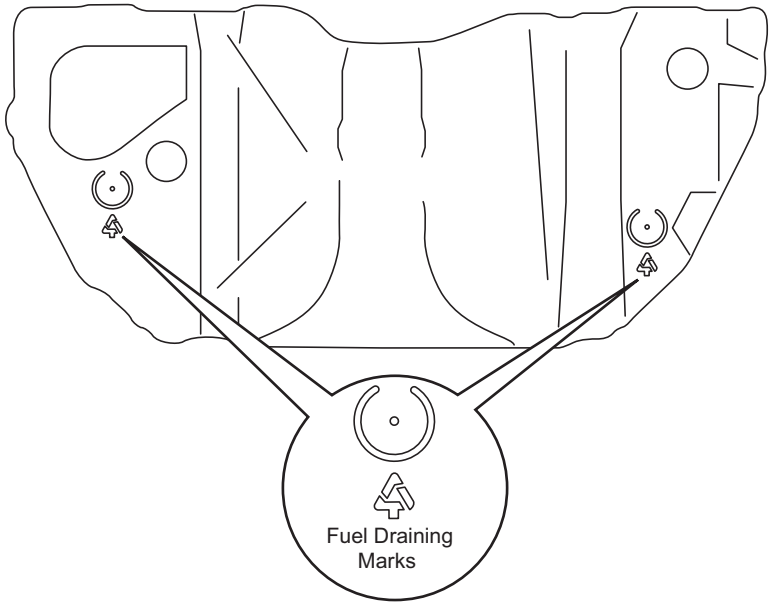
Circuit Diagram 2



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Fuel Tank

- The fuel tank is mounted in the center of the vehicle, forward of the rear axle. It has a capacity of 71.0 liters.
- The fuel tank adopts a saddle shape to allow the propeller shaft to pass through its center portion.
- Two sender gauges (main, sub), fuel pump, fuel filter, pressure regulator, and jet pump have been integrated.
- Fuel draining marks have been provided on the bottom of the fuel tank. These marks clearly indicate the position for aligning the fuel draining device during dismantling, and simplify and ensure the reliable draining of fuel.

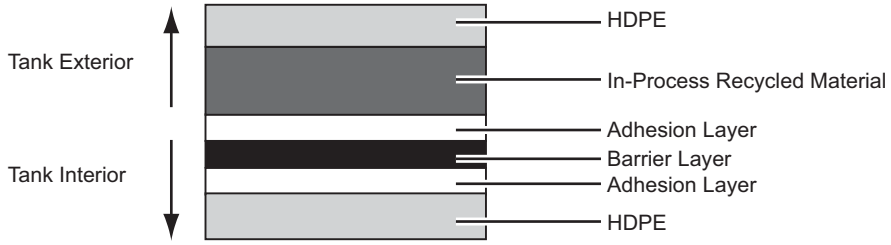


Fuel Tank Bottom View

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Plastic Fuel Tank

• A fuel tank made of plastic is used for weight reduction. It consists of six layers of plastic to ensure the long life of the tank and the low permeation of fuel.



*HDPE(High Density Polyethylene):High Density Polyethylene It is lightweight, high strength,and excels in water and solvent resistance.

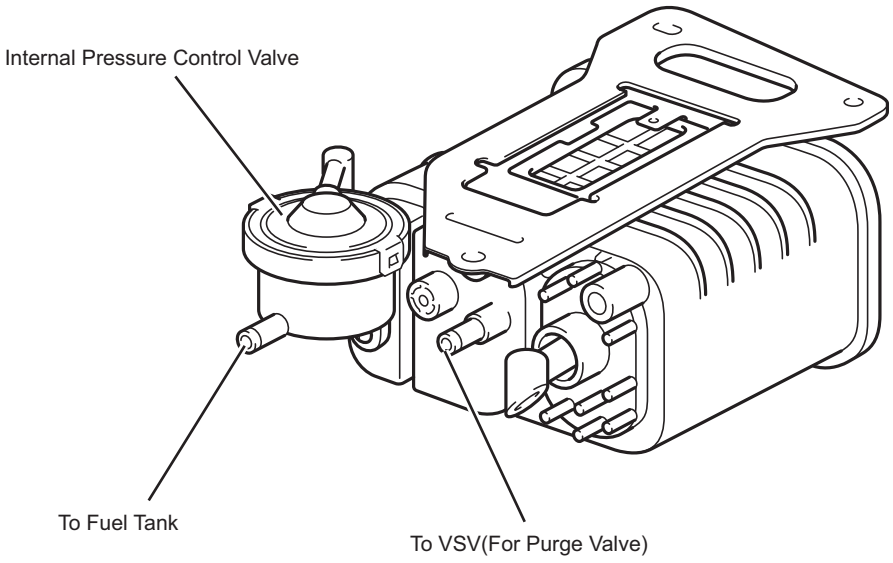
Layer Composition of Fuel Tank

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EG

Charcoal Canister

- Canister purge control is used to draw the fuel evaporative gas created in the fuel tank into the intake port, to be burned during combustion.
- The charcoal canister is mounted behind the fuel tank.
- An internal pressure control valve is provided at the fuel passage inlet from the fuel tank in order to maintain the proper pressure in the fuel tank.

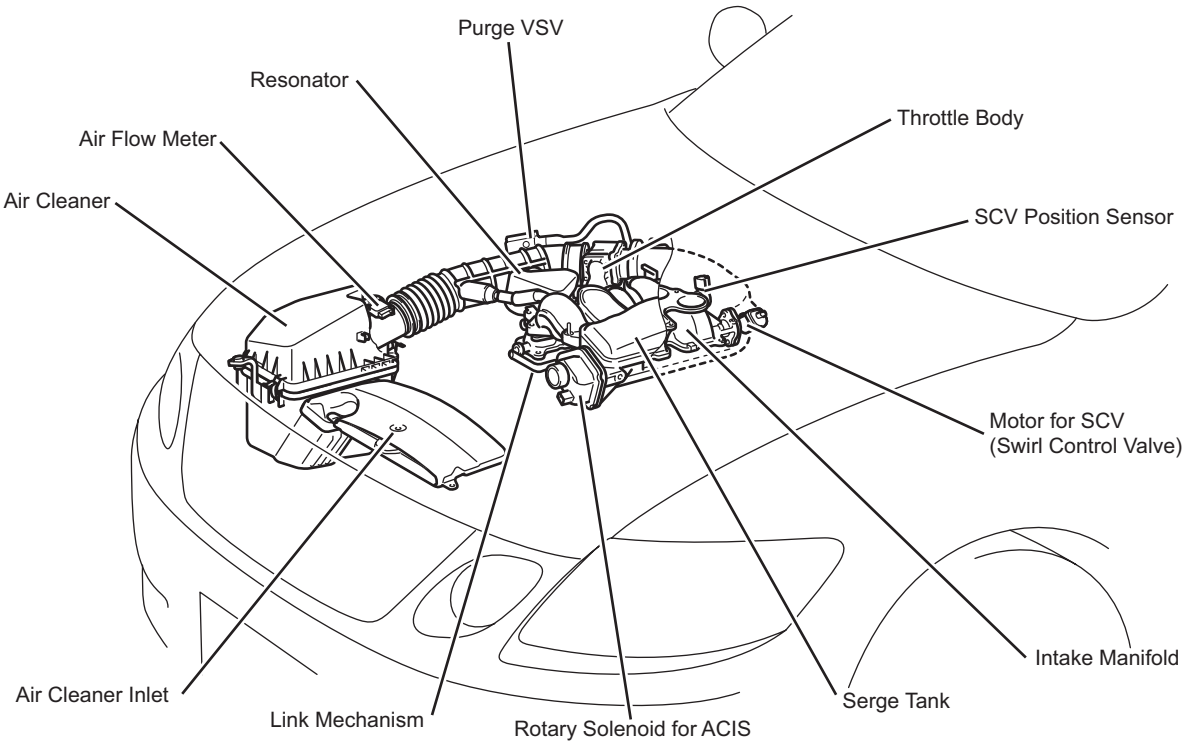


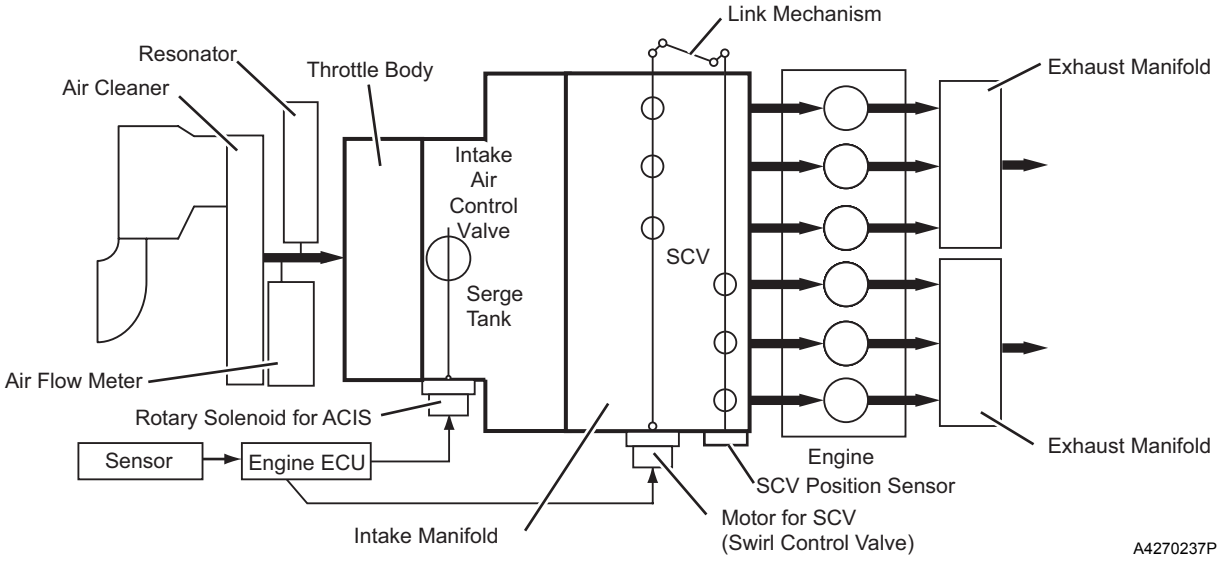
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3GR-FSE INTAKE

General

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

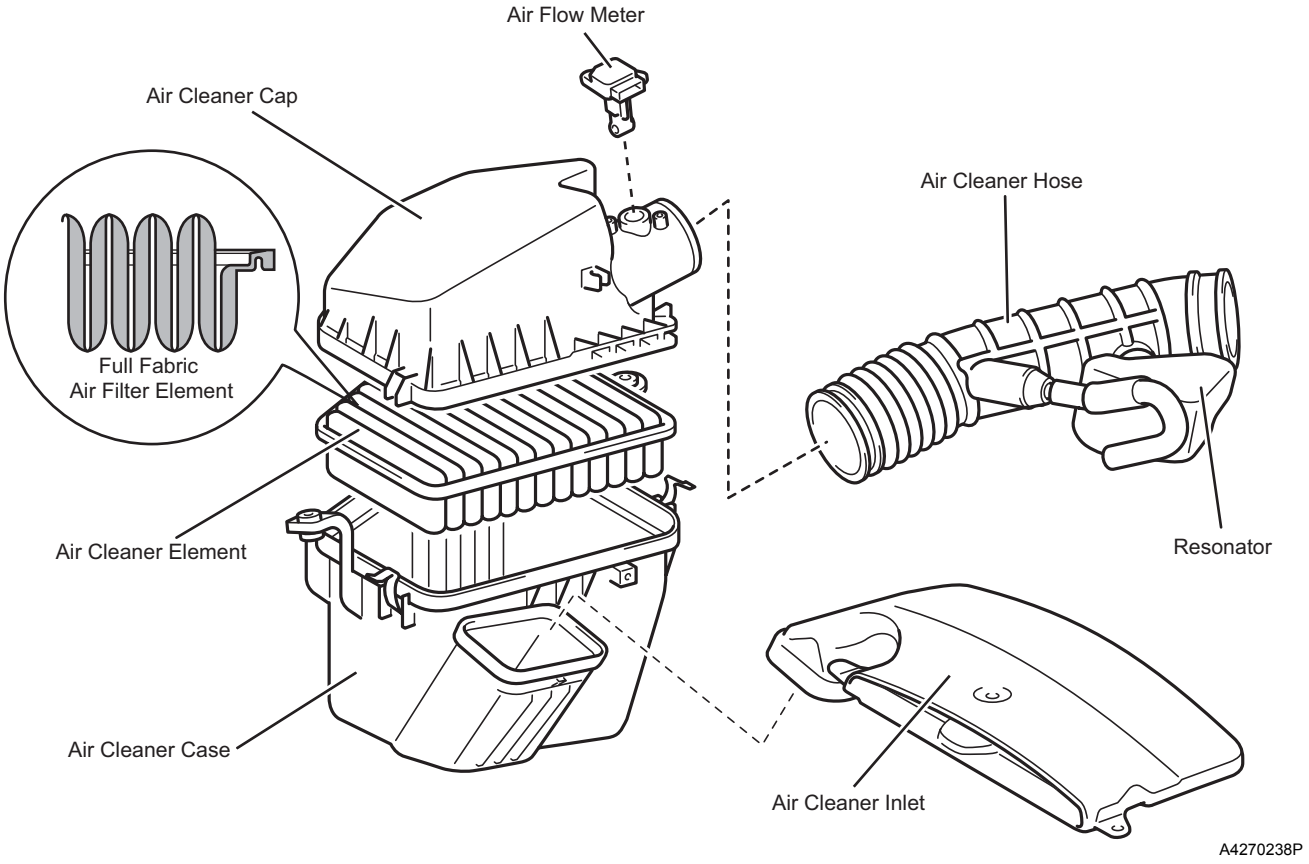




EG

Air Cleaner

- A removable cap type air cleaner case is used for enhanced serviceability. Also, an airflow meter (with a built-in intake air temperature sensor) is provided in the air cleaner cap.
- A dry type air cleaner element is used and provided with an ample filtering surface area.
- A compact resonator is provided in the air cleaner hose to reduce intake noise.
- A full fabric air filter element, which does not contain an outer frame or rubber seal, is used. As a result, the case could be made compact, with recyclability in mind.



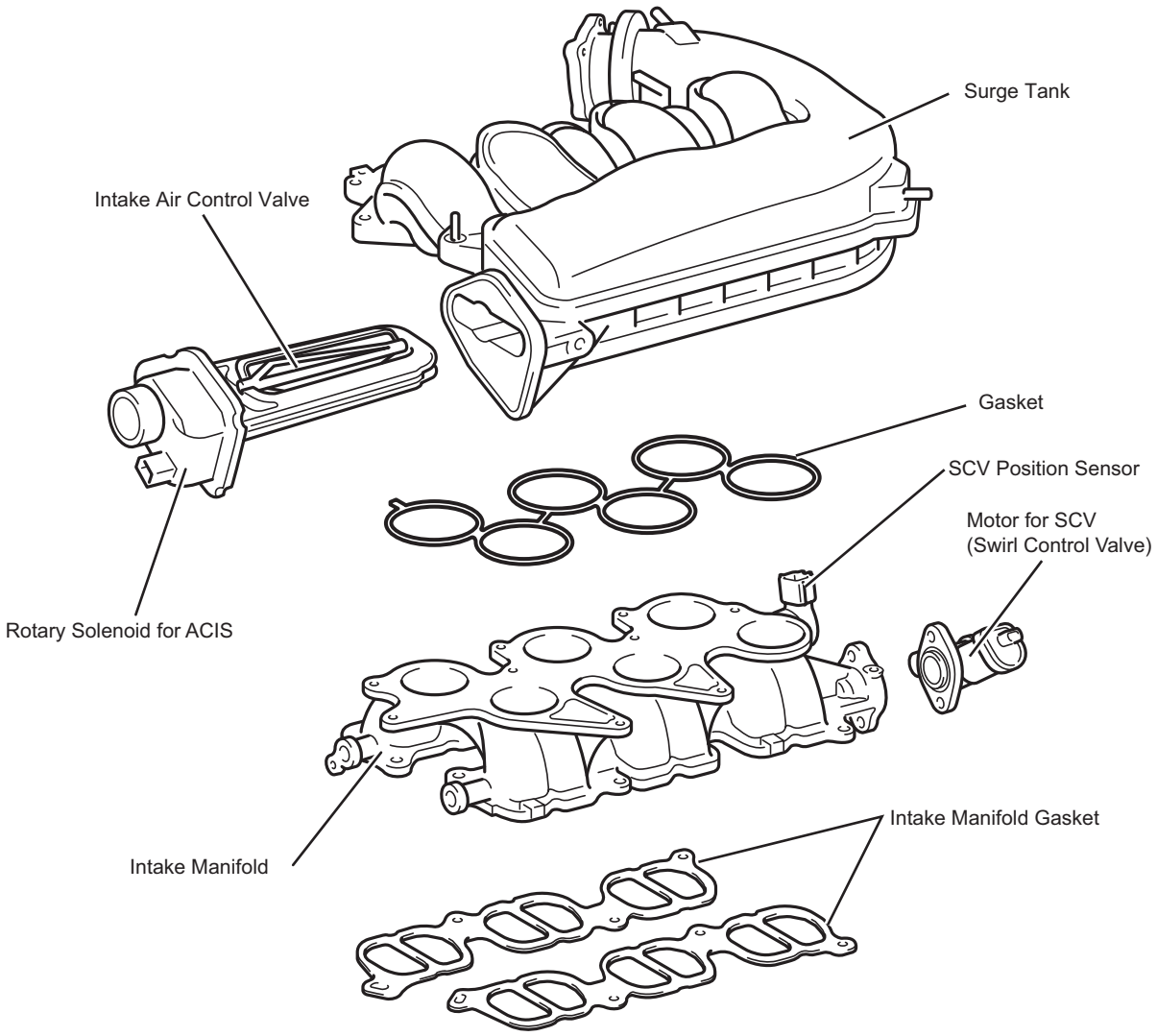
Air Flow Meter

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

(See page EG-125)

Intake Manifold

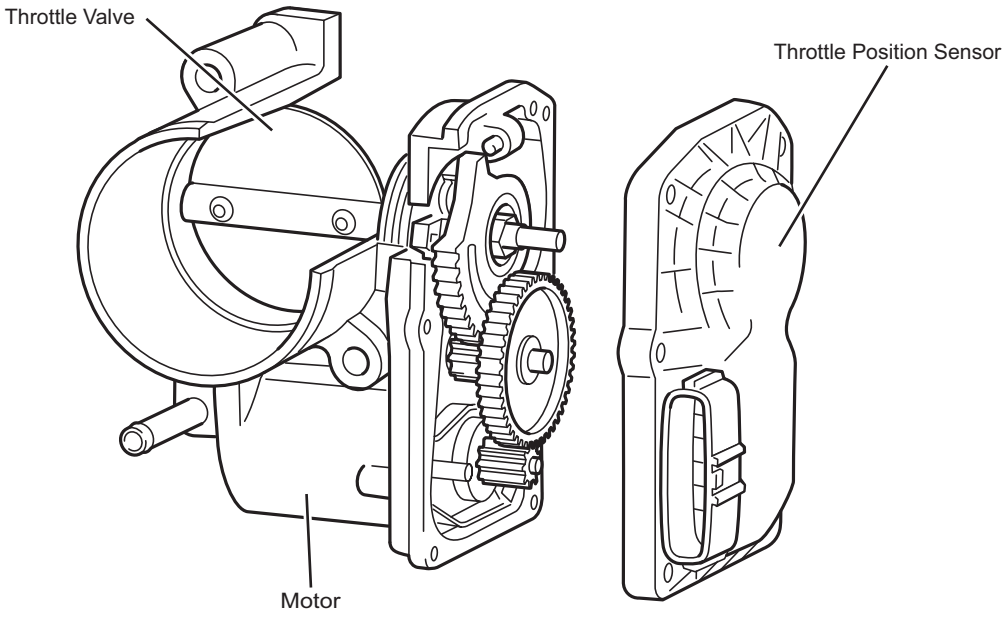
- An ACIS (Acoustic Control Induction System) with independent ports and an intake system with a swirl control valve (SCV) are used. The port diameter and length have been optimized to strike a balance between high torque in all driving ranges and fuel economy performance.
- A swirl control valve (SCV)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



EG

Throttle Body

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



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Accelerator Pedal Position sensor

- This sensor, which is mounted on the accelerator pedal, detects the amount of pedal effort applied to the accelerator. By using a Hall element, this electronic position sensor enables accurate control and ensures permanent reliability. When the amount of pedal effort applied to the accelerator changes, this sensor sends the angle of the magnetic field in relation to the flow of the applied current in the Hall element (VCP1 → EP1, VCP2 → EP2) in the form of an accelerator pedal effort signal to the engine ECU. In addition, this sensor consists of a dual system having different output characteristics to ensure reliability.
  (See page EG-121)

Throttle Position Sensor

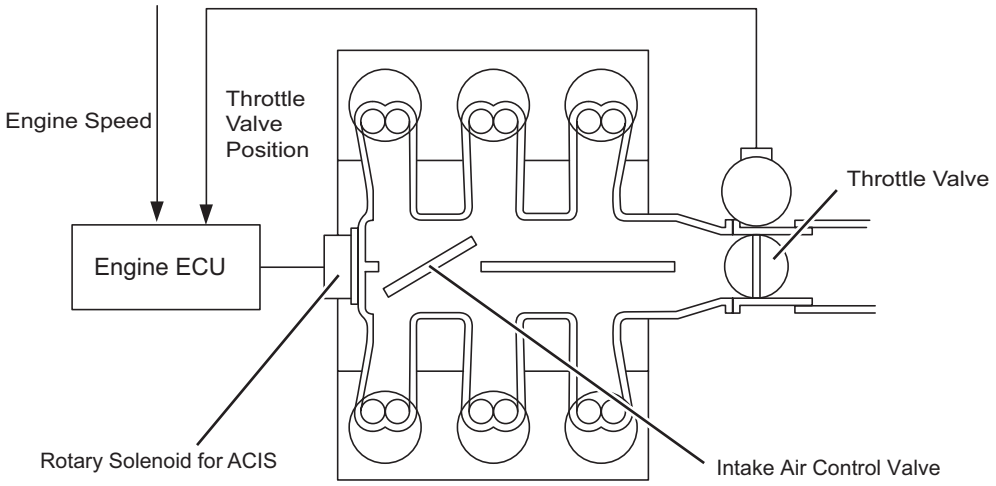
- This sensor, which is located in the throttle body, detects the position of the throttle valve. By using a Hall element, in the same way as the accelerator position sensor, this electronic position sensor enables accurate control and ensures permanent reliability. In addition, this sensor consists of a dual system having different output characteristics to ensure reliability.
  (See page EG-123)

ETCS-i (Electronic Throttle Control System-intelligent)

- In the conventional throttle body, the throttle valve opening is determined invariably by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the engine ECU to calculate the optimal throttle valve opening that is appropriate for the respective driving condition and uses a throttle control motor to control the opening.
- The functions of the ordinary throttle position control (nonlinear control), idle speed control (ISC), traction control (including VSC), and cruise control have been integrated in the single-valve electronically controlled throttle body.
- Excellent driving stability and comfort have been achieved by effecting integrated control with the power train, and vehicle stability has been ensured through cooperative control with the ECT and VSC systems.
- Two CPUs, one for the ETCS-i, and the other for the EFI control, monitor each other to ensure a reliable system.
- A dual system is used so that the vehicle can continue to operate in the event of a problem, thus ensuring reliability.
  (See page EG-112)

Electronic ACIS (Acoustic Control Induction System)

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



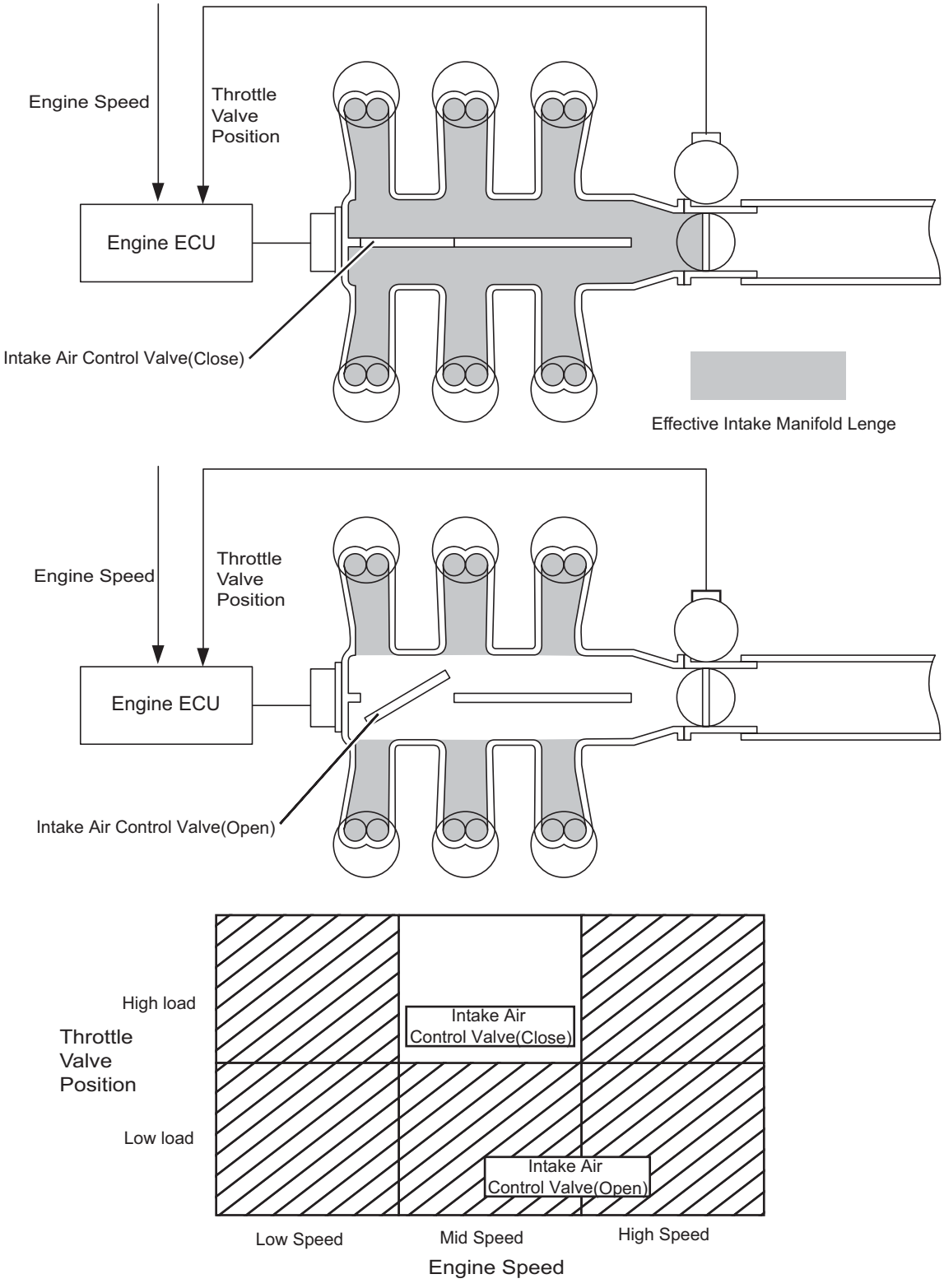
List of Functions

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

EG

Electronic ACIS Operation

- The engine ECU opens and closes the intake air control valve in accordance with the engine speed and the throttle valve position, in order to enhance the torque in all ranges, particularly in the medium-speed range.

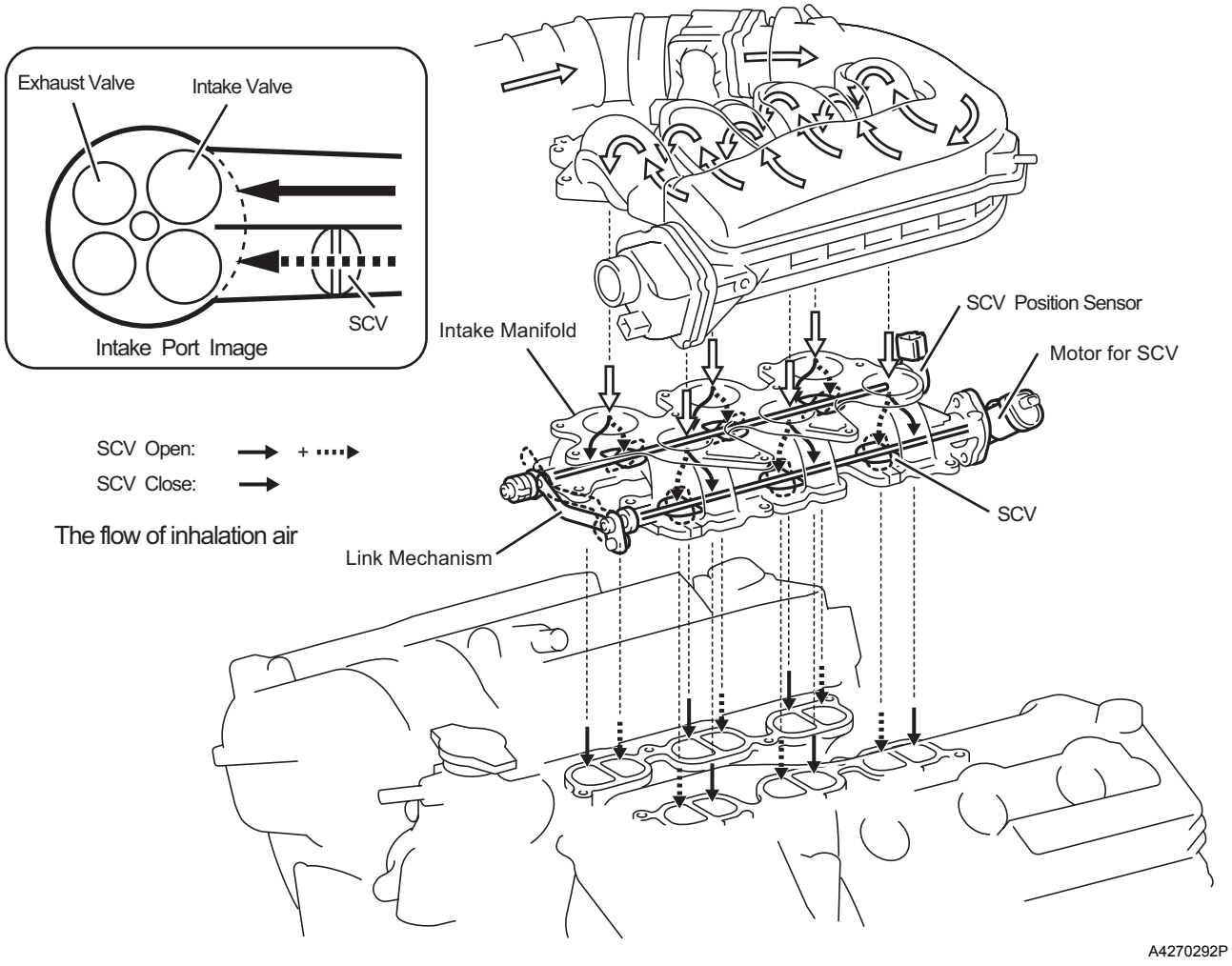


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EG

Electronic SCV (Swirl Control Valve)

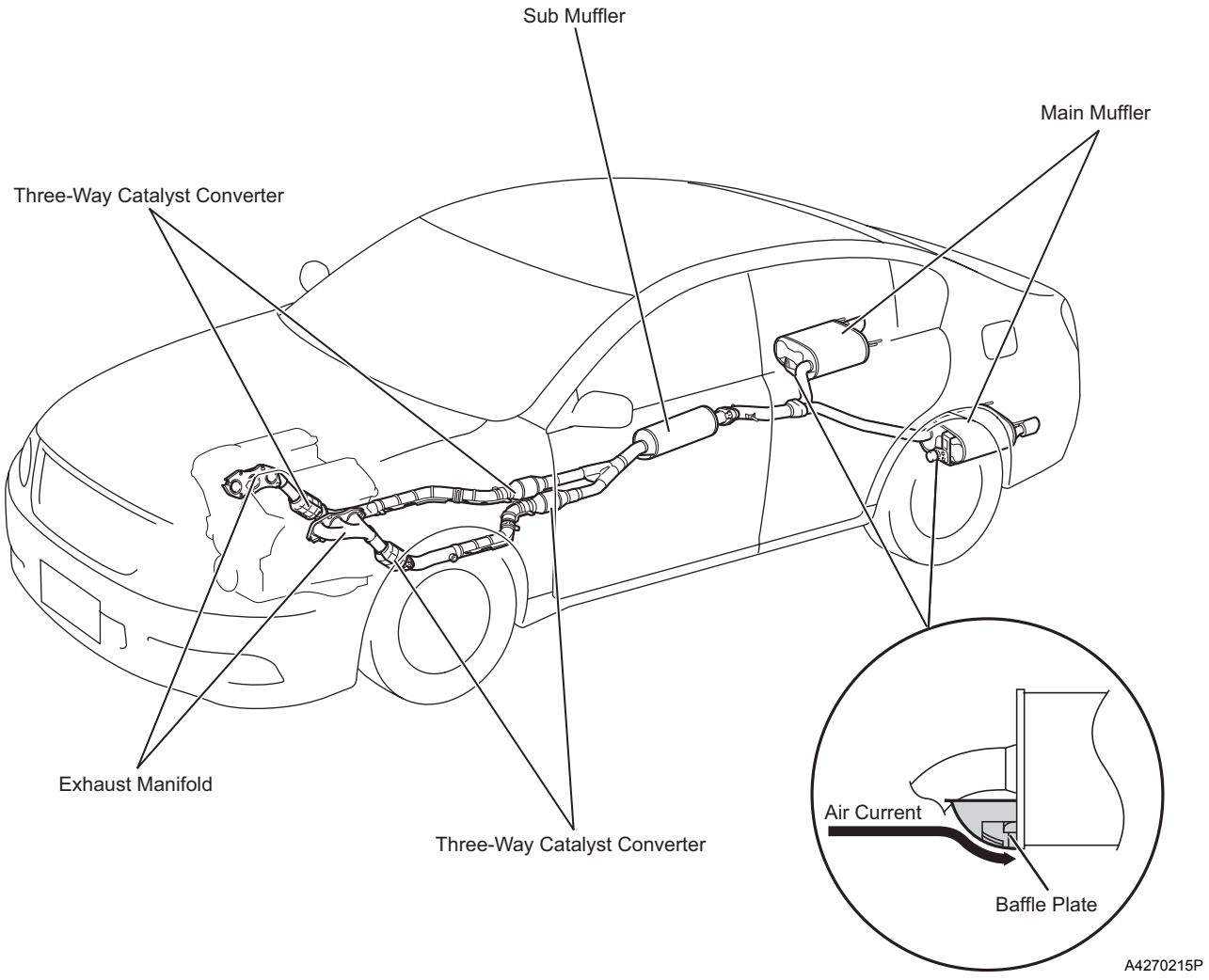
- The SCVs on the right and left banks are connected with a linkage mechanism, enabling both SCVs to be actuated with a single, compact motor, thus realizing a lightweight and compact construction.
- An SCV, which is provided at one of the two independent intake ports, opens and closes under the control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



3GR-FSE EXHAUST

General

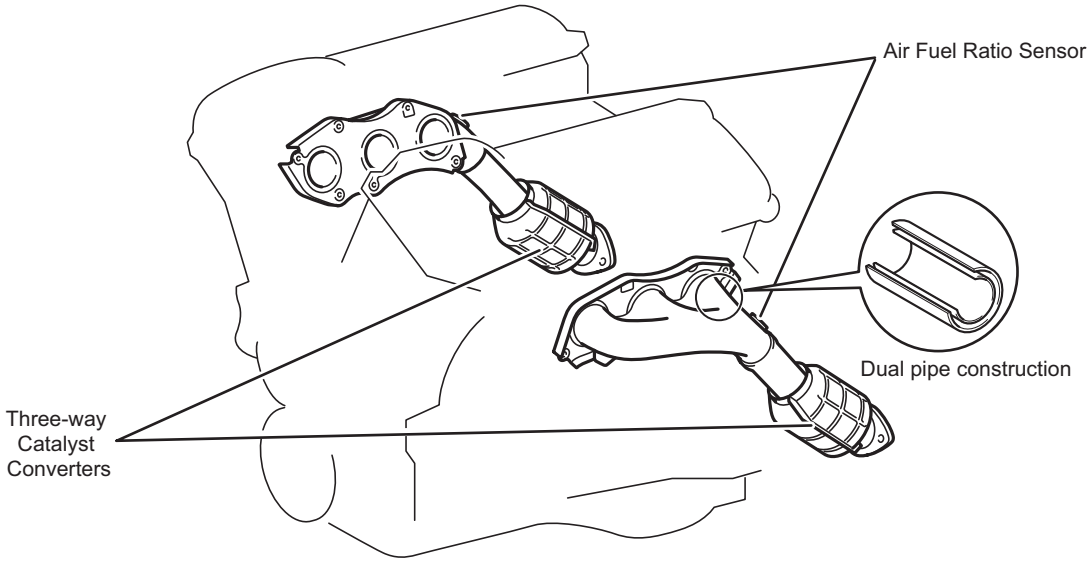
- The entire exhaust system from the exhaust manifold to the tail pipe is made of stainless steel to realize weight reduction and improve corrosion resistance.
- Three-way catalysts are placed directly below the exhaust manifold and in the front pipes to ensure ample emission reduction performance, in order to comply with the Step IV European Tailpipe Emission Regulations.
- An exhaust manifold with a built-in Three-way catalyst Converter is placed directly below each bank of the engine to ensure low exhaust emissions immediately after the engine is started.
- The exhaust pipe diameter has been optimized to reduce exhaust loss and optimize engine power output.
- A baffle plate is provided in front of the main muffler to straighten the airflow under the floor, thus improving dynamic performance.
- An air-fuel ratio sensor is provided upstream of the Three-way catalyst Converter in each exhaust manifold. An heated oxygen sensor is provided downstream of the Three-way catalyst Converter in each exhaust manifold. These sensors enable precise control of the air-fuel ratio.



EG

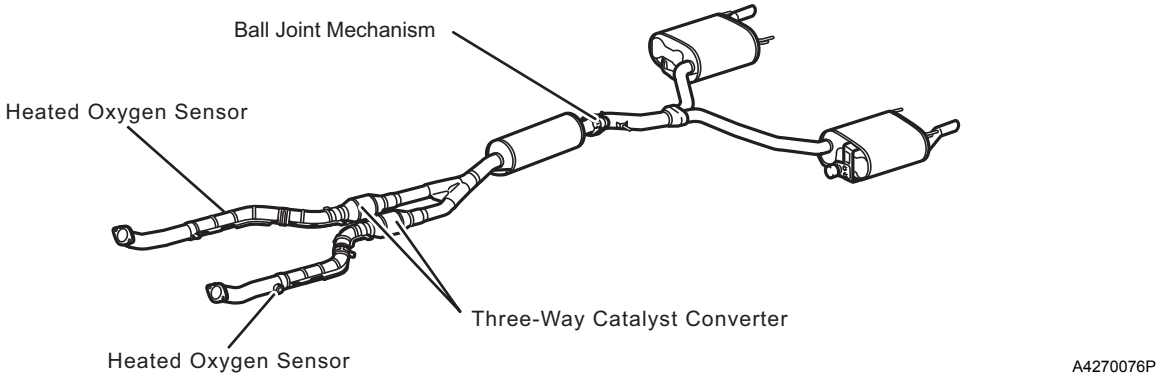
Exhaust Manifold

- The exhaust manifolds are made of dual pipe construction stainless steel to reduce noise and enhance heat resistance. Also, they accelerate the warm-up of the catalysts immediately after the engine is started, thus reducing exhaust emissions.
- Built into each exhaust manifold, the three-way catalyst converter consists of an ultra thin-wall, high-cell density ceramic catalyst in which precious metals are optimally used. It accelerates the warm-up of the catalytic converter, thus improving exhaust emission performance immediately after the engine is started.
- The flow of the exhaust gases has been optimized and the exhaust gas pressure loss has been reduced to produce a higher power output.



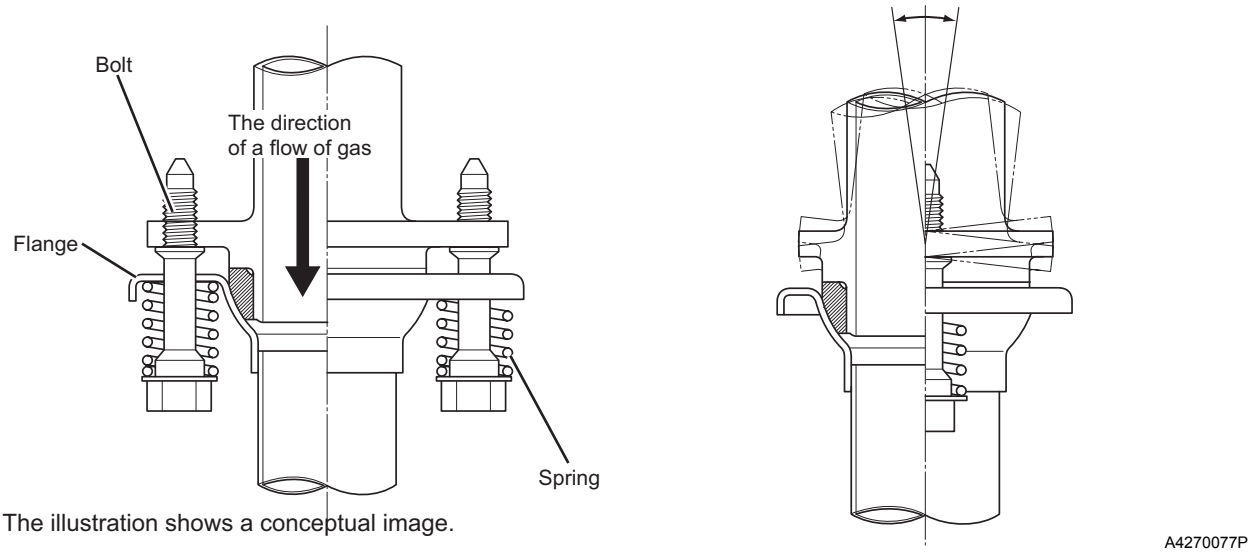
Exhaust Pipe

- Long, dual construction exhaust pipes are used from the exhaust manifolds to the front pipe junction. By optimizing the lengths of the exhaust pipes and utilizing the fluctuation of the exhaust pressure, exhaust gases are discharged effectively to improve the torque in the low- to medium-speed range.
- Ball joint mechanism is used to join the front pipe to the tail pipe in order to reduce the droning sound and vibration in the cabin and reduce weight. The ball joint mechanism consists of a spherical flange, and a bolt and a spring to support the sealing area of the gasket. The ball joint (the spherical areas of the flange and the gasket) absorbs the vibration of the engine as well as the vibration of the exhaust pipe in order to reduce the droning sound and vibration in the cabin.



Ball Joint Mechanism

- The ball joint mechanism consists of a spherical flange, a bolt, and a spring to support the sealing area of the gasket. This is more compact than a flexible pipe, and can be installed in an optimal position to counter vibrations.
- The ball joint (the spherical areas of the flange and the gasket) absorbs the vibration of the engine as well as the vibration of the exhaust pipe in order to reduce the droning sound and vibration in the cabin.

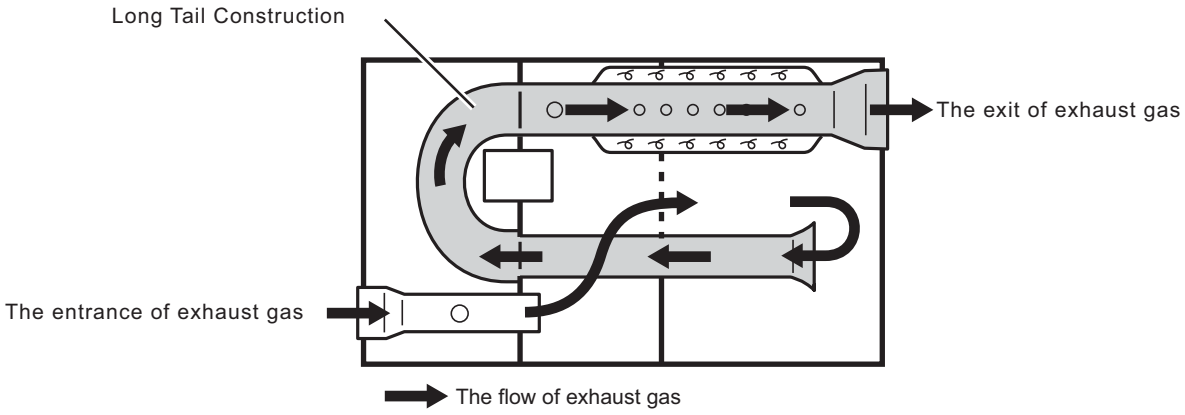


* The illustration shows a conceptual image.

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Muffler

- Dual main mufflers are provided to reduce back pressure, which improves the power output of the engine. A long tail construction is used inside the main muffler to suppress the low-frequency exhaust sounds, thus reducing the sounds in the cabin.



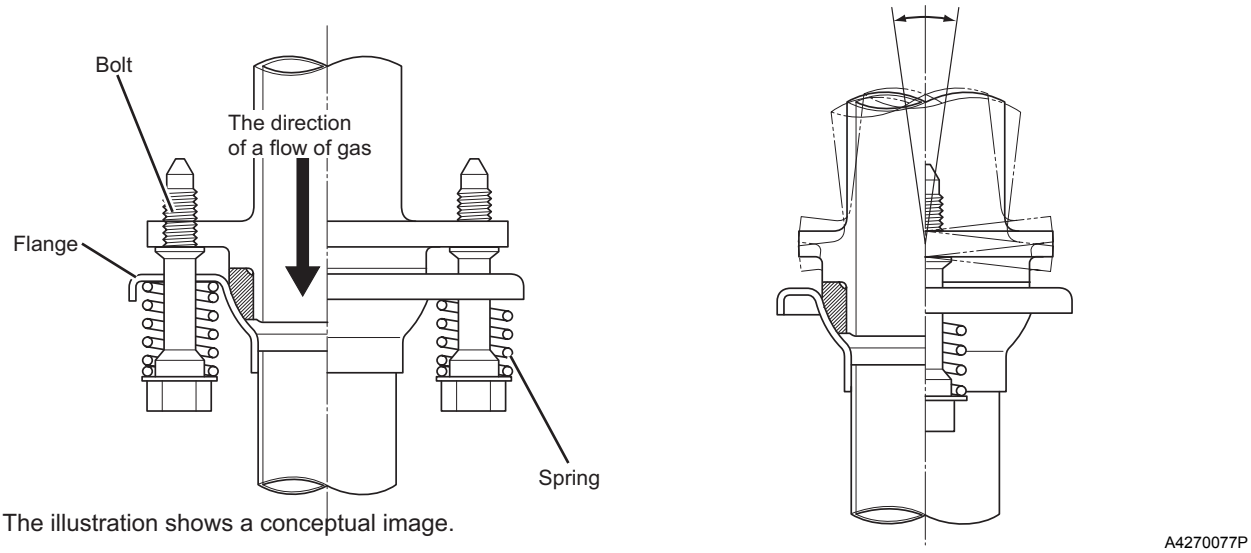
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Three Way Catalytic Converter

- An ultra thin-wall, high cell density ceramic catalyst with an optimized amount of precious metals held is placed directly below each exhaust manifold and in each front pipe. These catalysts ensure a high level of warm-up performance immediately after the engine is started, thus reducing exhaust emissions and complying with the Step-IV European Tailpipe Emission Regulations.

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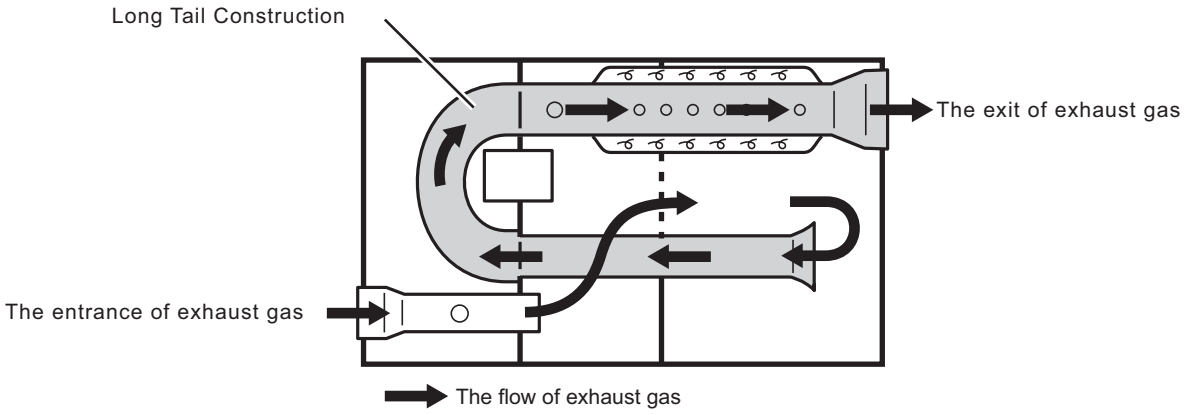


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Three Way Catalytic Converter

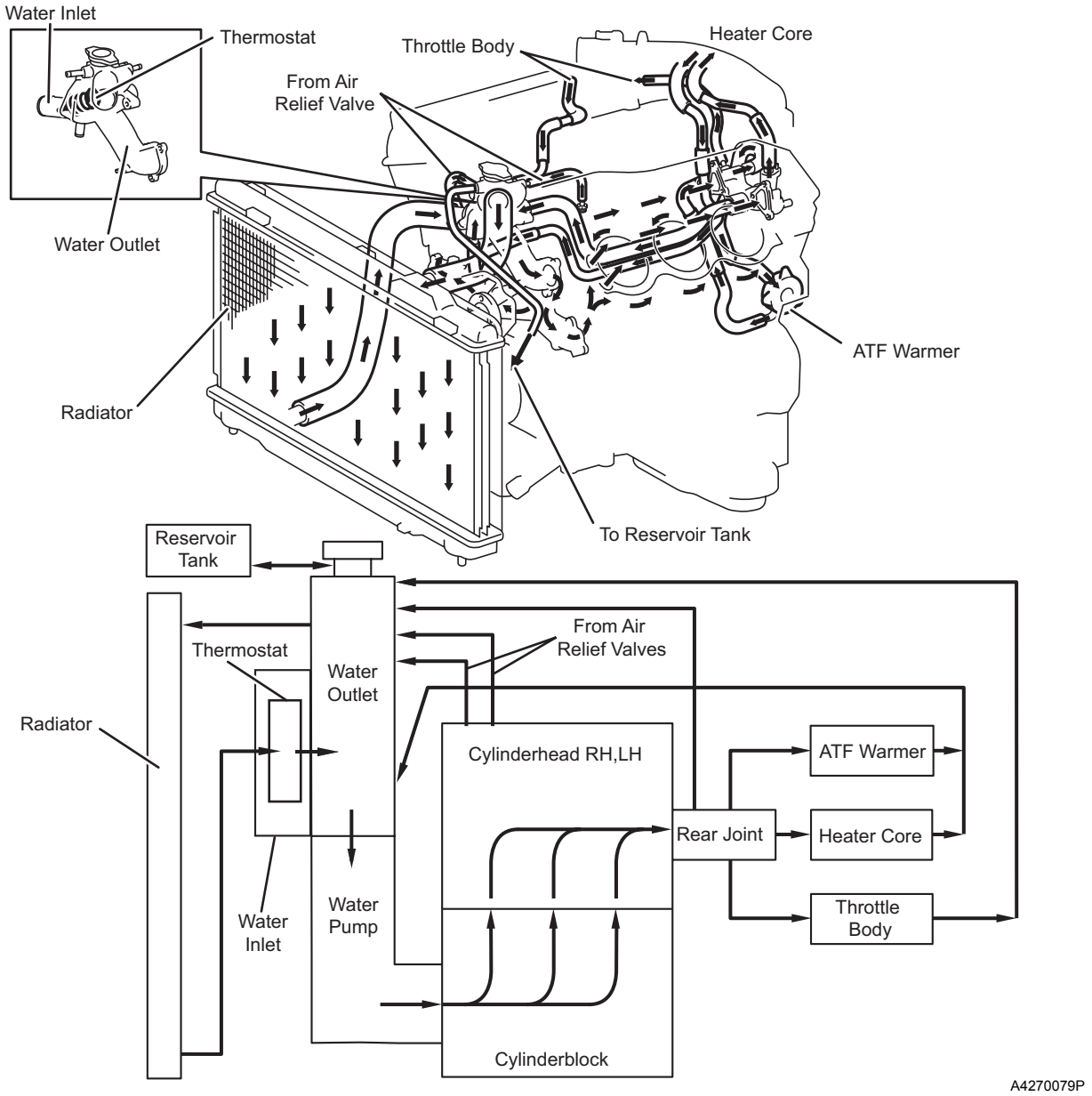
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3GR-FSE COOLING

EG

General

- The cooling system is a water-cooled, forced-pressure circulation type in which a bypass valve type thermostat is integrated in the water inlet housing. The thermostat is the bottom bypass type.
- In this system, the engine ECU turns the cooling fan ON-OFF and controls the fan speed.
- To reduce the formation of air pockets in the cylinder head, air relief valves are provided in the right and left cylinder heads.
- An ATF warmer is provided to accelerate the warm-up speed, thus reducing the friction of the automatic transmission.



Radiator

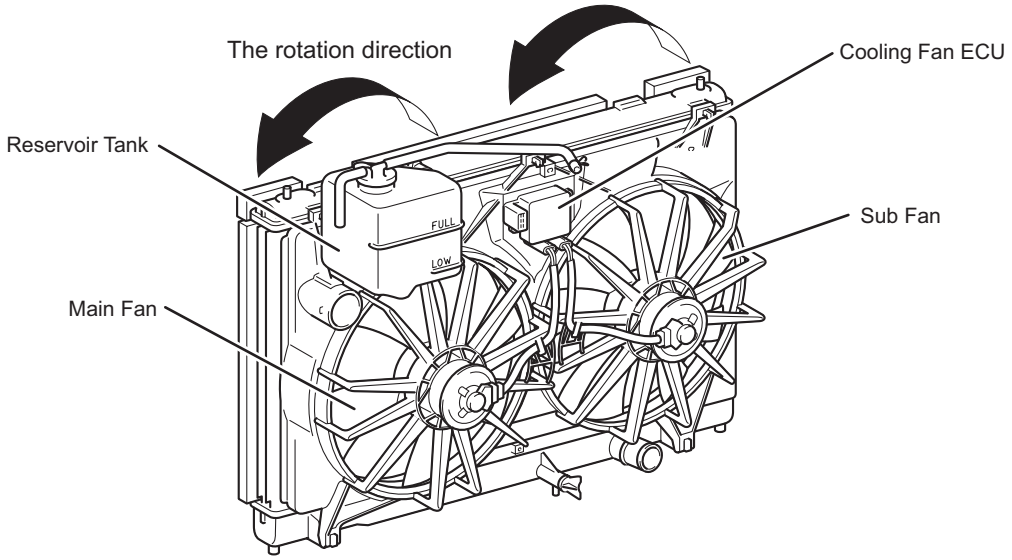
- A lightweight, high-performance aluminum core radiator is used to improve cooling performance and reduce weight.

Radiator

Core Type	Corrugated Fin
Fin Pitch [mm (in.)]	2.5 (0.098)/2
Core Dimensions (width x height x thickness) [mm (in.)]	709.0 × 399.2 × 16 (27.913 × 15.717 × 0.630)
Dry Weight [kg]	2.55

Cooling Fan

- The fan shroud is secured to the radiator without bolts.
- Ring fans, which are provided with band-shaped rings around them are used, which enhance rigidity and realize a lightweight and compact construction.
- The engine ECU outputs a signal to the cooling fan ECU, which steplessly controls the speed of the two fans in accordance with the engine conditions, driving conditions, and whether the air conditioner is operating. Through optimally controlled speeds, the fans operate significantly quieter and improve cooling performance.



Cooling fan

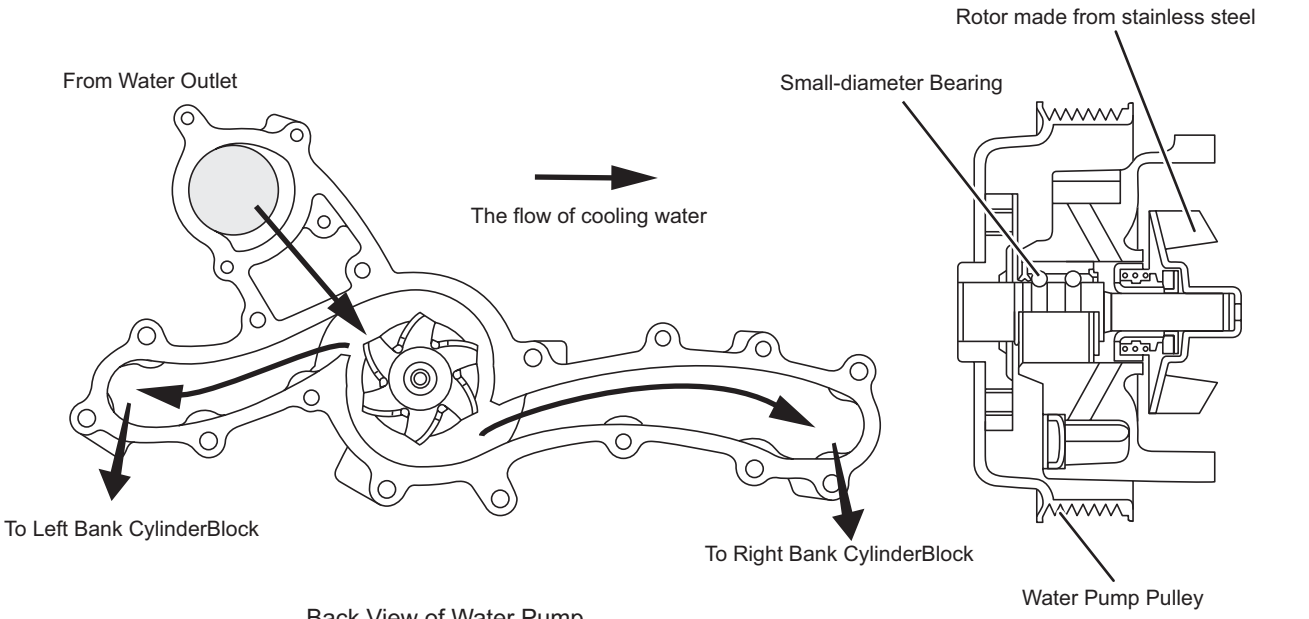
	Main Fan	Sub Fan
Outer Diameter [mm (in.)]	340 (13.386)	←
Number of blades	5	7

Cooling fan

	Main Fan Motor	Sub Fan Motor
Rated voltage [V]	12	←
Rated Output [W]	100	←

Water Pump

- The water pump uses a V ribbed belt driven system.
- It uses a small-diameter bearing to achieve a compact construction.
- The rotor is made of stainless steel to improve corrosion resistance and ensure reliability.



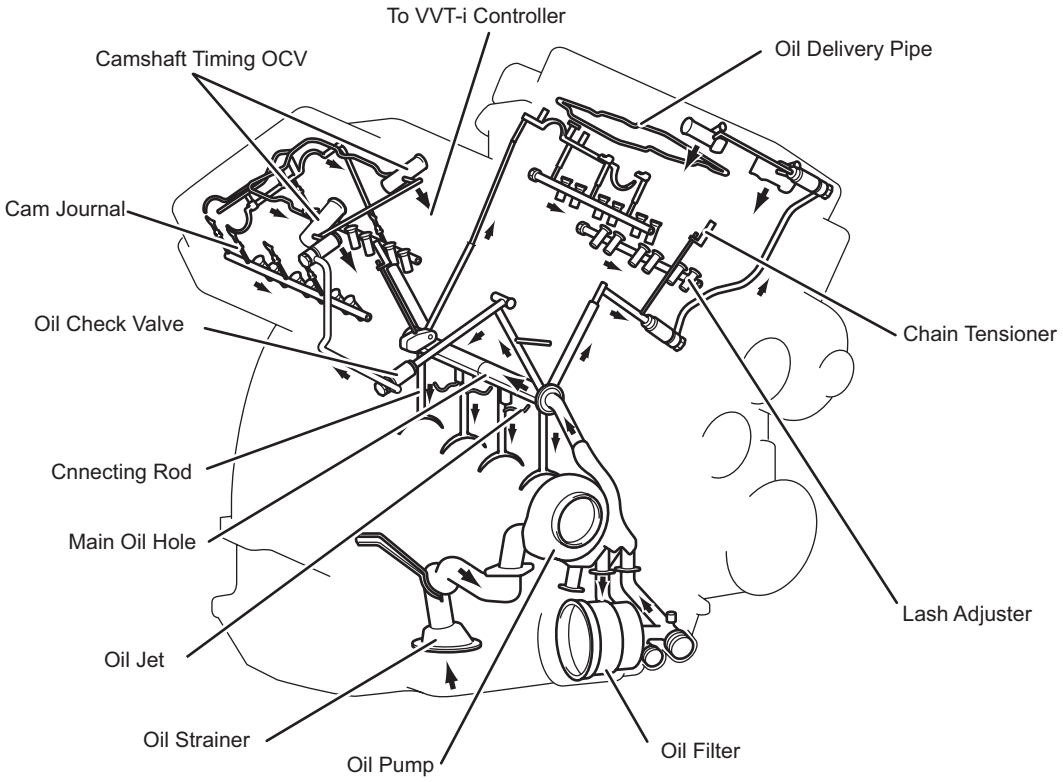
Water Pump

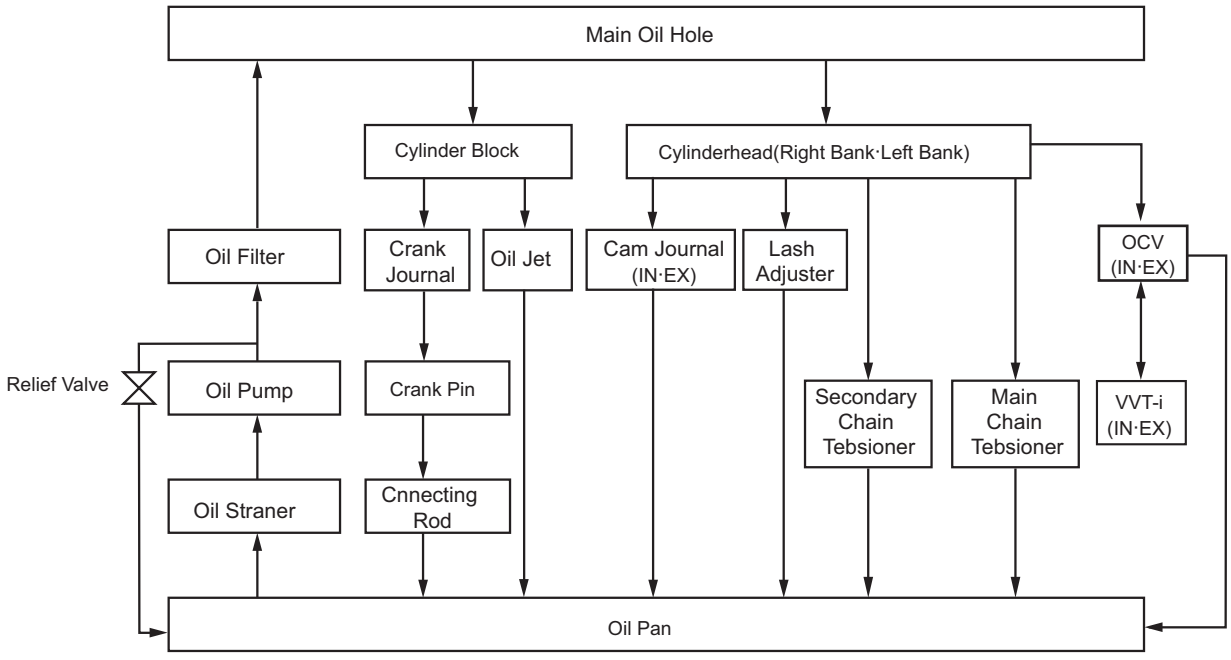
Drive System	V Ribbed Belt Driven
Rotor Diameter [mm (in.)]	60.0 (2.362)
Bearing Diameter [mm (in.)]	30.0 (1.181)
Number of Blades	6
Discharge Performance [L/min] (at 80 ± 2°C, 4,000 rpm)	46

3GR-FSE LUBRICATION

General

- A full-pumping, full-filtering lubrication system is used.



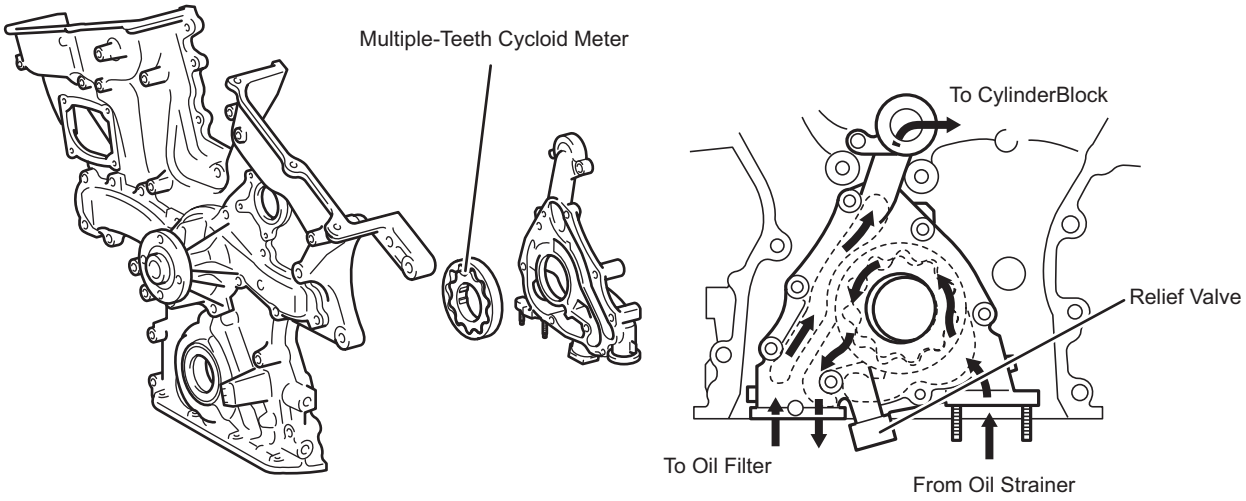


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Oil Pump

- The oil pump consists of a compact, highly efficient, and multiple-teeth cycloid rotor that is driven directly by the crankshaft. The drive rotor is a flangeless type, which enables the use of a driven rotor with a small diameter, thus reducing friction.
- An internal oil relief system is used to circulate the relief oil through the suction passage in the oil pump. This suppresses the oil level fluctuations in the oil pan, reduces friction, and reduces the rate of mixing air bubbles in the oil.



The oil passage in an oil pump

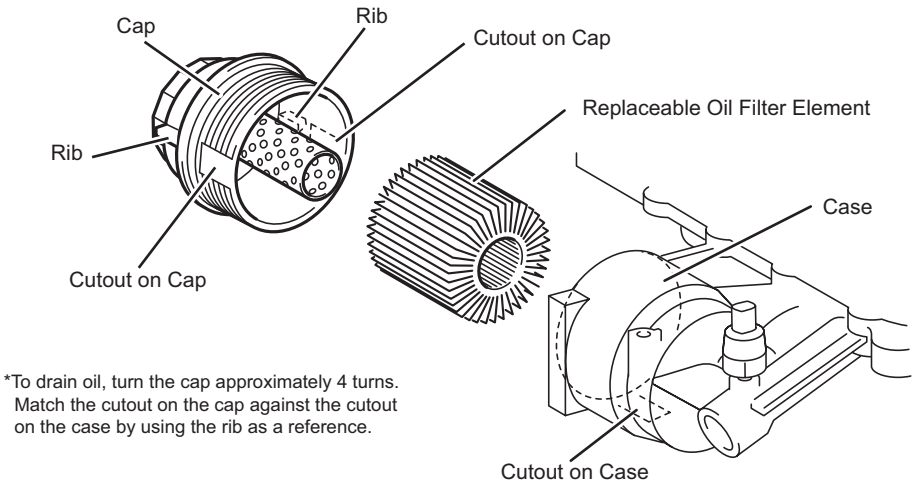
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Oil Pump

Pump Speed [rpm]	600	2000	6400
Discharge Volume [L/min]	6.0 Minimum	—	89.6 Minimum
Discharge Pressure [kPa]	100	—	290
Relief Valve Opening Pressure [kPa]	—	490	—

Oil Filter

- A newly developed oil filter with a replaceable element is used. The element uses high-performance filter paper that ensures ample filtering performance, and is made completely burnable.
- The cap is made of an aluminum alloy for a long life.
- A drain construction is provided to suppress the splashing of the oil during the replacement of the oil filter element. Oil can be drained by matching the thread cutout on the cap against the thread cutout on the case.



Drain construction

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■ **Service Tip** ■

To replace the oil filter, turn the cap approximately 4 turns, match the cutout on the cap against the cutout on the case, and drain the oil. Use the rib on the cap as a reference for matching the cutout on the cap against the cutout on the case. For details, refer to the GS430/300 Repair Manual(Pub. No. RM1168E)

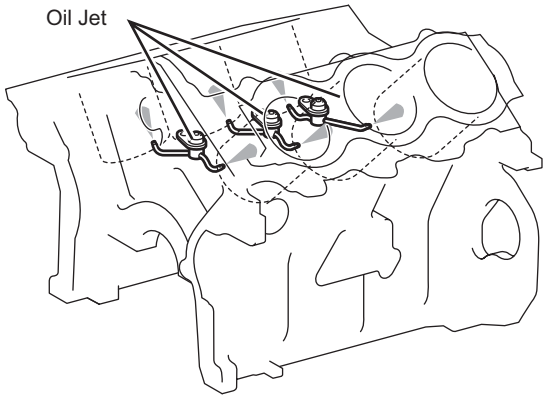
Oil Filter

Type	Full-flow
Filtration area [cm^2]	1260
Outer diameter×Height [mm (in.)]	82.1 × 70.5 (3.232 × 2.776)
Relief Valve Opening Pressure [kPa]	100

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Oil Jet

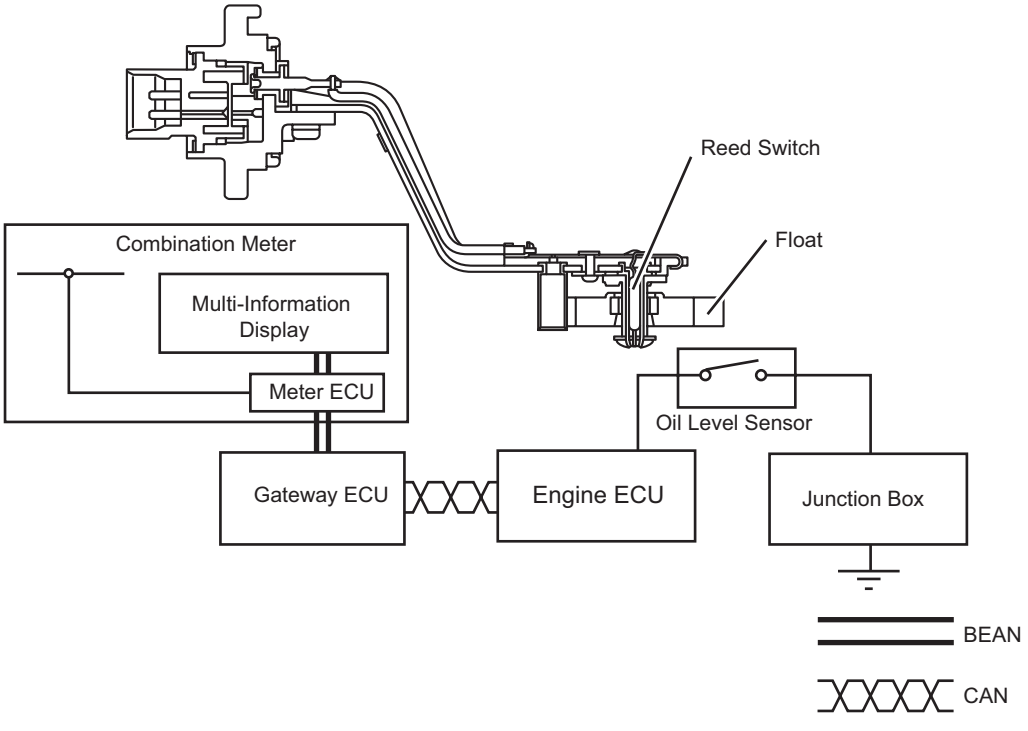
- Oil jets are provided in the cylinder block. These jets spray oil into the cylinders to reduce friction and suppress the increase in temperature. As a result, they improve the durability of the pistons and prevent them from knocking.



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Oil Level Sensor

- The oil level sensor consists of a reed switch, which turns ON and OFF with the vertical movement of the float. When the engine oil level decreases, the system informs the driver of it in the following manner. On the multi-information display in the combination meter, a warning appears on the multi-information display. In addition, the system is provided with a 40-second delay circuit to prevent the display from indicating improperly as a result of biased behavior of the oil while the vehicle is in motion.
- A warning appears when the float descends as a result of a reduction in the engine oil level (when the reed switch is OFF).



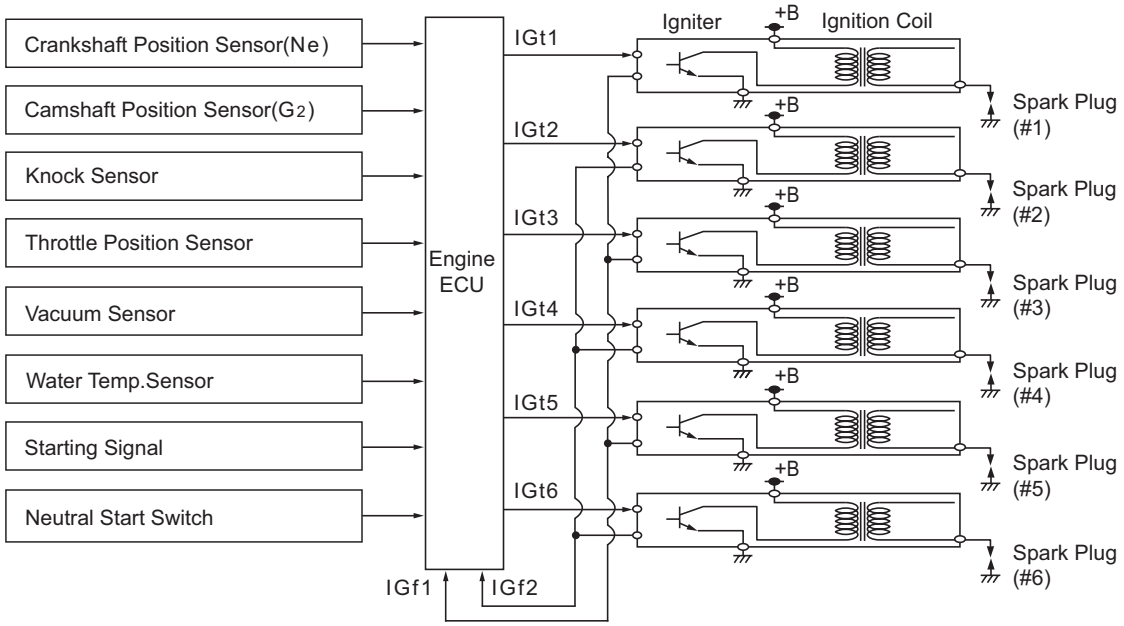
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3GR-FSE IGNITION

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General

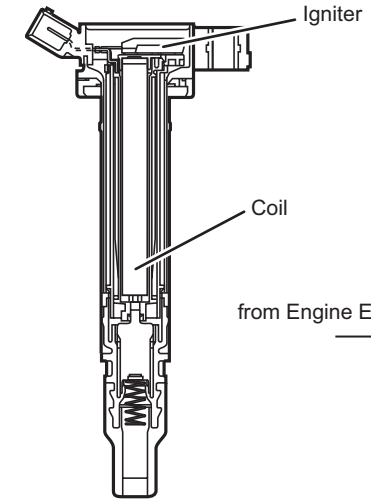
- The Direct Ignition system(DIS) is used, in which an ignition coil with a built-in igniter is provided for every cylinder. This system enhances the ignition timing control precision and makes the ignition timing completely adjustment-free.
- Independent ignition coils are provided to each of the cylinders #1 to #6, thus making a distributor or high tension cord unnecessary. This reduces the power loss associated with high-voltage areas, improves reliability, and reduces electro-magnetic interference.



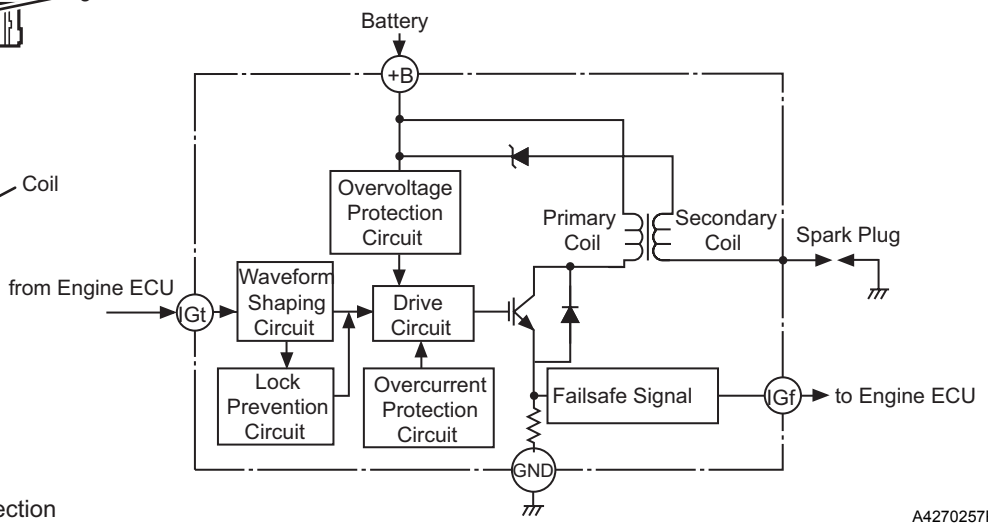
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Ignition Coil (with Igniter)

- Ignition coils with built-in igniters are used and placed directly over the spark plugs.



Ignition Coil Cross Section

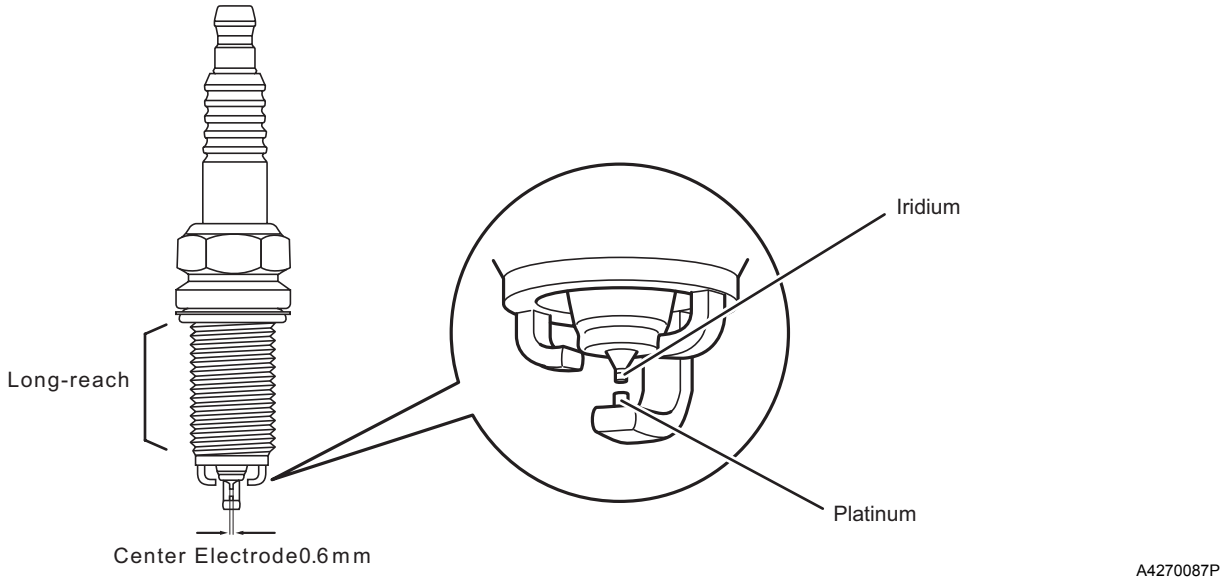


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Spark Plug

- Long-reach spark plugs are used to improve the cooling performance of the cylinder heads.
- The spark plug is the triple ground electrode type that uses an iridium alloy in its center electrode. Because the iridium alloy has extremely superior wear resistance, the center electrode can be made with a small diameter. This produces reliable ignition while improving durability. Furthermore, two ground electrodes have been added to further improve ignitability, wear resistance, and fouling resistance.



Spark Plug

DENSO	FK20HBR11
NGK	ILFR6D11T
Plug Gap [mm (in.)]	1.0 ~ 1.1 (0.0394 ~ 0.043)

Crankshaft Position Sensor

- The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.
(See page EG-119)

Camshaft Position Sensor

- These sensors are the MRE (Magnetic Resistance Element) type. The rotational movement of the timing rotor (which is provided in the VVT-i controller of the intake camshaft) causes a magnetic field to act on the magnetic resistance element in the sensor. The sensor utilizes the changes that occur in the direction of the magnetic field to detect the position of the timing rotor, which determines the position of the actual camshaft. The cylinders are identified by the input sequence of the Ne and G2 signals.
(See page EG-120)

3GR-FSE STARTING

Starter

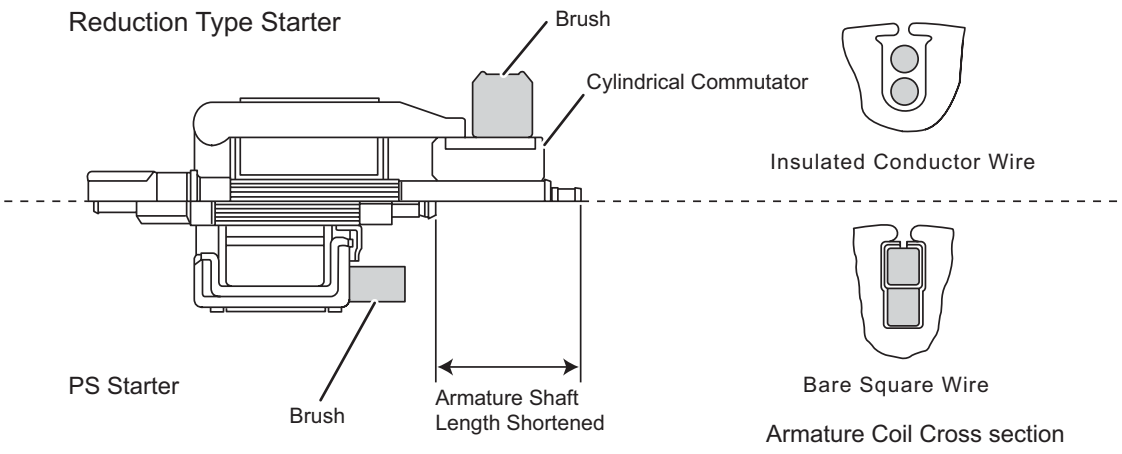
- A compact, lightweight, high power output, and highly efficient PS (Planetary reduction - Segment conductor motor) starter is used.
- A square conductor armature coil is used to achieve a compact and lightweight construction.

Starter

Type	PS Type
Rated Voltage [V]	12
Rated Output [kW]	1.7

Armature Coil

- The armature coil consists of bare square wire, which improves the space factor, and improves the torque of the starter.
- The cylindrical commutator has been discontinued to shorten the length of the armature shaft.

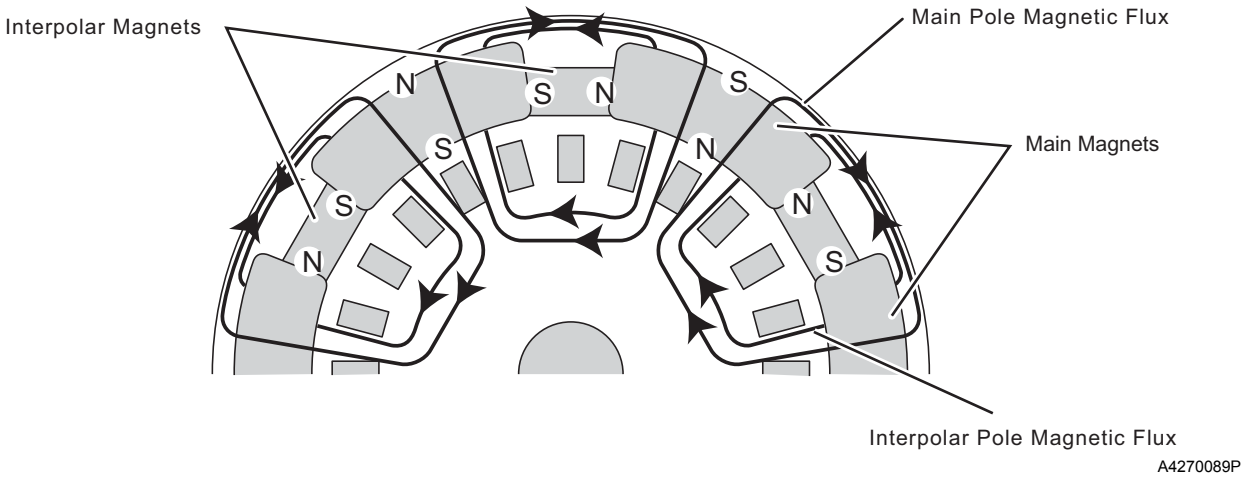


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Field Coil

• Interpolar magnets are used between the field coils. This improves the magnetic circuit and increases the amount of magnetic flux. Because the same amount of magnetic flux as the conventional type can be attained with a compact construction, the length of the yoke shaft has been shortened.



3GR-FSE CHARGING

Alternator

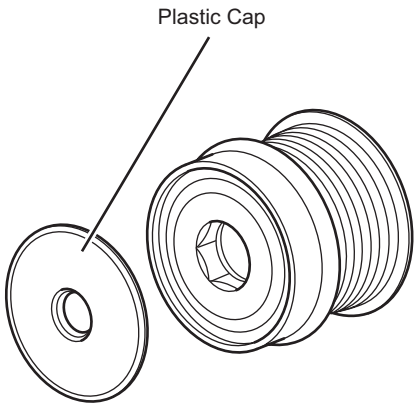
- A compact, lightweight, high power output, and highly efficient segment conductor type alternator is used.
- A charging control system is used. This system controls the generating load of the alternator in accordance with the driving conditions of the engine. By optimally controlling the generating voltage, this system contributes to fuel economy.
- A clutch is provided in the alternator pulley. By reducing friction on the accessory belt, this clutch contributes to fuel economy.

Alternator

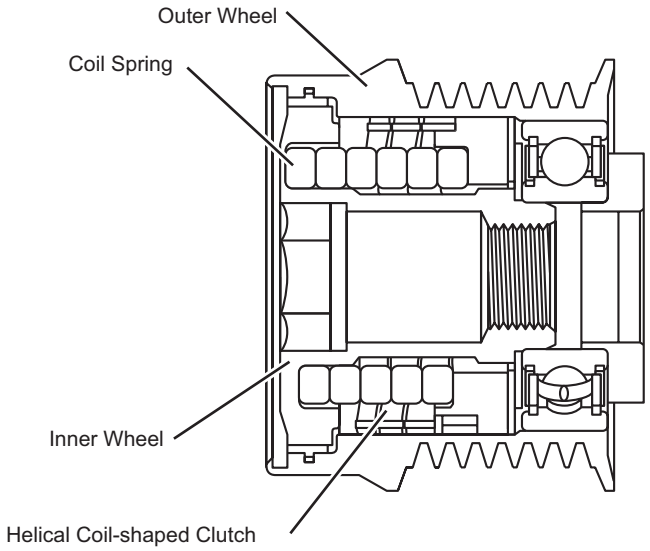
Rated Voltage [V]	12
Rated Output [A]	130
Regulator Setting Voltage [V] (5000rpm,10A,25°C)	12.1 ~ 15.4
Permissible Max Spee [rpm]	18000

Alternator Pulley

- A helical coil-shaped clutch, which is located between the inner and outer wheels of the pulley, transmits power to the alternator only in the forward rotational direction of the engine. Thus, it reduces the load that acts on the accessory belt.
- The pulley is made compact by shaping the inner wheel together with the nut used for tightening the alternator shaft.
- A plastic cap that covers the interior is provided in front of the pulley. This prevents mud from entering, thus ensuring reliability under poor environmental conditions.



Alternator Pulley



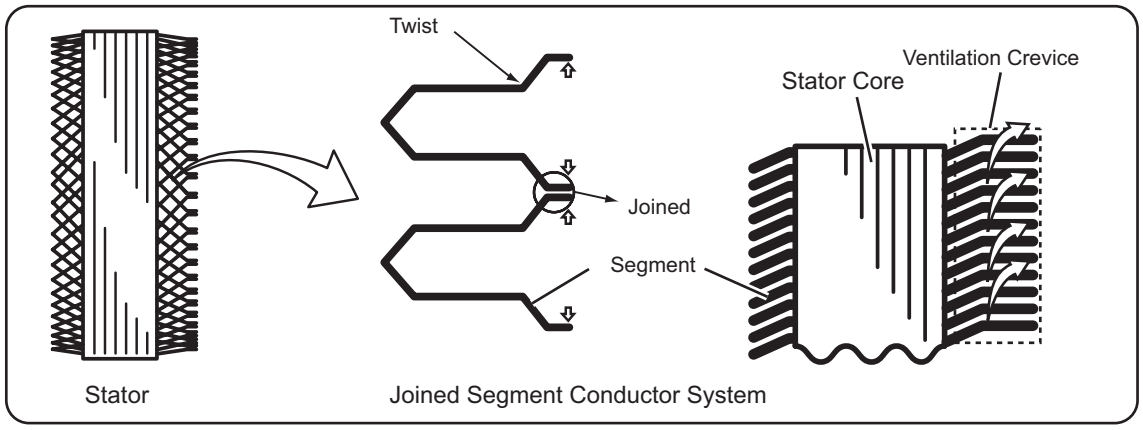
Alternator Pulley Cross Section

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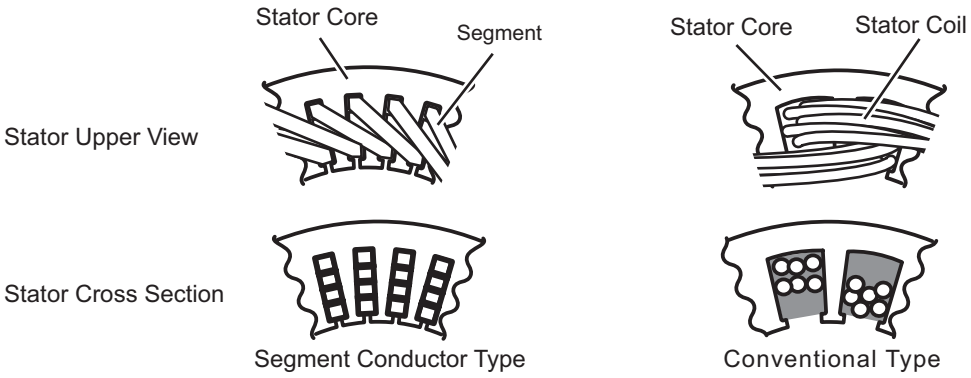
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Stator Coil

- A compact and lightweight Segment Conductor type alternator that generates high amperage output in a highly efficient manner has been adopted on standard equipment.
- This alternator has a joined segment conductor system, in which multiple segment conductors are welded together to form the stator. Compared to the conventional winding system, the electrical resistance is reduced due to the shape of the segment conductors, and their arrangement helps to make the alternator more compact.



〈Segment Conductor Type Alternator〉

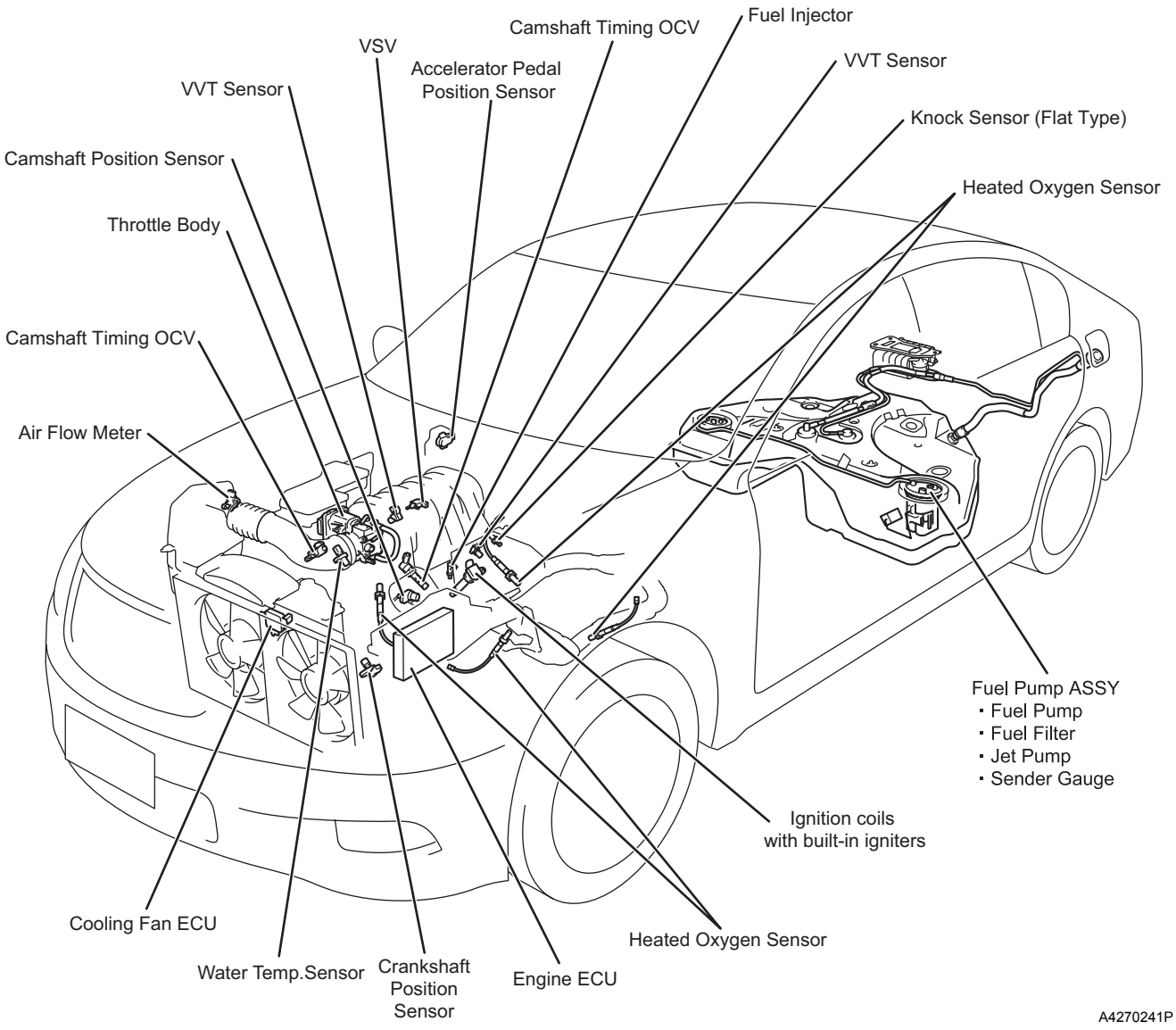


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3UZ-FE ENGINE CONTROL SYSTEM

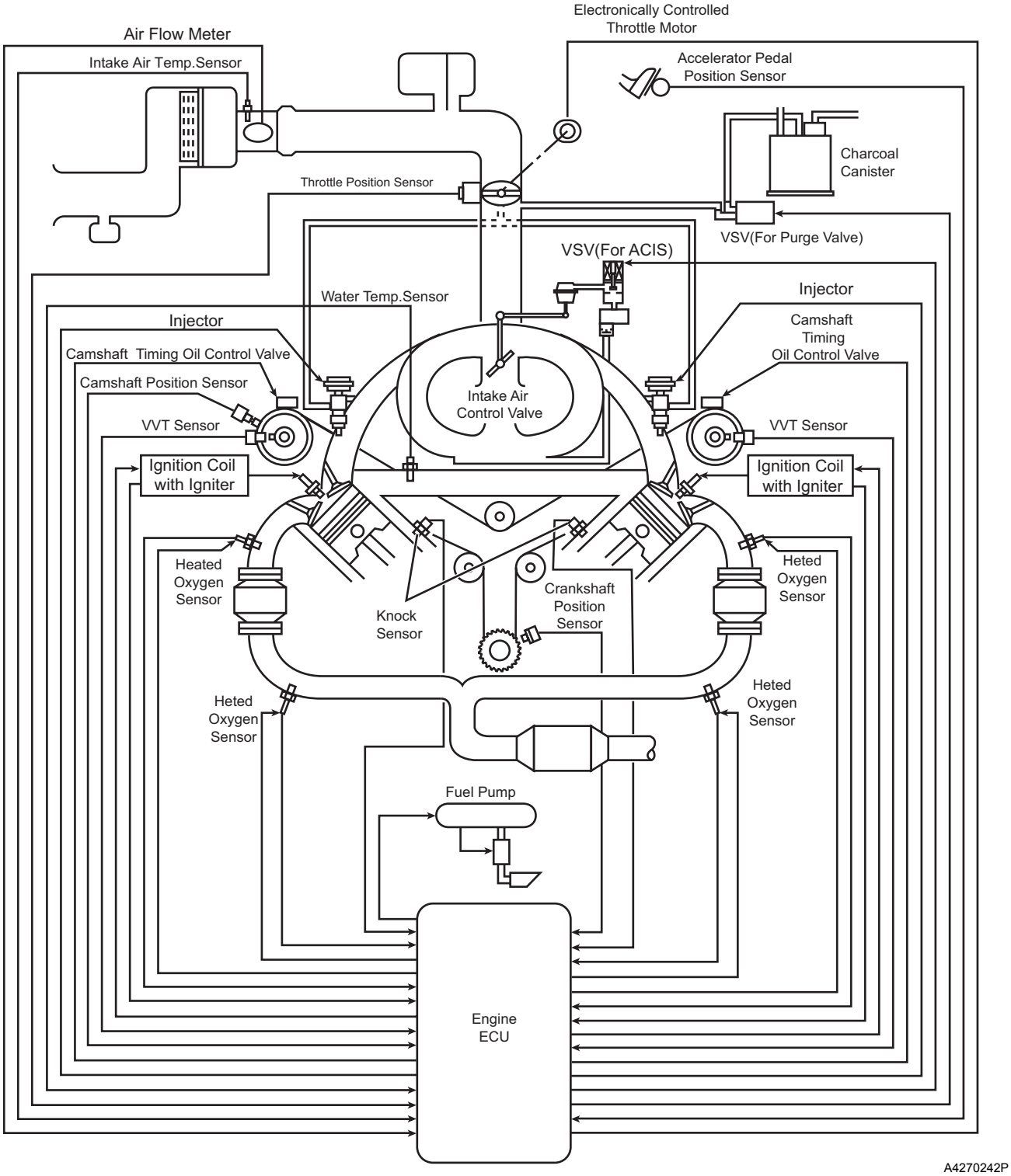
Engine Control System Description

- This engine controls the following systems in a highly accurate manner: Electronic Fuel Injection (EFI), Electronic Spark Advance (ESA), Electronic Throttle Control System-intelligent (ETCS-i), and Variable Valve Timing-intelligent (VVT-i). As a result, high performance, high power output, fuel economy, and improved exhaust emission performance have been achieved.
- Diagnostic and failsafe functions have also been provided to ensure serviceability and safety.



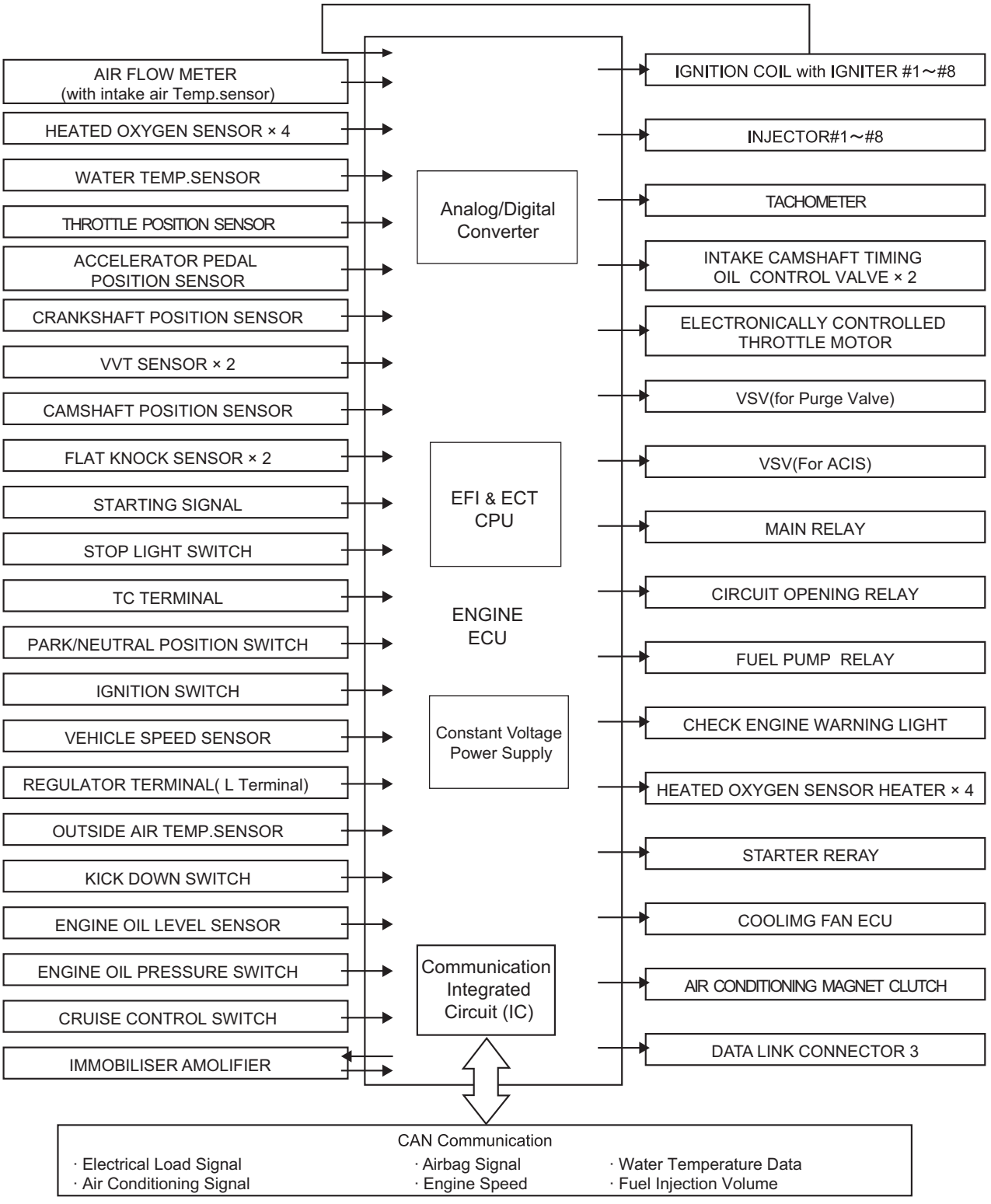
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Engine Control System Diagram



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Construction



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Control List

System	Outline	
EFI (Electronic Fuel Injection)	An L-type EFI system directly detects the intake air mass with a hot wire type air flow meter	
ESA (Electronic Spark Advance)	Ignition timing is determined by the Engine ECU based on signals from various sensors. Corrects ignition timing in response to engine knocking.	
	Knocking Judgment Control(KCS)	2 knock sensors are used to improve knock detection.
	ECT Shifting Torque Control	The torque control correction during gear shifting has been used to minimize the shift shock.
ETCS-i (Electronic Throttle Control System-intelligent)	Based on the signals provided by the sensors, this system applies corrections to the throttle position that has been calculated in accordance with the condition of the engine, in order to achieve an appropriate throttle position.	
	VSC Control	Controls the throttle valve position when the VSC is operating.
	Maximum Speed Control	When the vehicle speed reaches 240 km/h, this control closes the throttle valve to suppress the increase in vehicle speed.
	Idle Speed Control(ISC)	Controls the fast idle speed in accordance with the water temperature, and the idle speed after the engine has been warmed up. It controls the idle speed by regulating the fuel injection volume and the throttle position.
VVT-i (Variable ValveTiming-intelligent)	Controls the intake camshaft to an optimal valve timing in accordance with the engine condition.	
	Torque activated power train control has been adopted.	
ACIS (Acoustic Control Induction System)	The intake air passage are switched according to the engine speed and throttle valve angle to increase performance in all speed ranges.	
Cooling Fan Control	An electric cooling fan system has been adopted. The Engine ECU steplessly controls the speed of the fans in accordance with the water temperature, vehicle speed, engine speed, and air conditioning operating conditions. As a result, the cooling performance has been improved.	
Fuel Pump Control	Turns the fuel pump ON/OFF in accordance with the starter signal and the engine speed signal. Stops the operation of the fuel pump in accordance with the signals from the airbag ECU.	
Cranking Hold Control	After the starter starts to crank the engine, this control continues to apply current to the starter until the engine starts. Thus, it prevents the failure of the engine to start when the driver inadvertently turns the ignition switch to OFF just before the engine fires.	
Heated Oxygen Sensor Heater Control	Maintains the temperature of the heated oxygen sensor at an appropriate level to increase accuracy of detection of the oxygen concentration in the exhaust gas.	
Evaporative Emission Control	The Engine ECU controls the purge flow of evaporative emissions (HC) in the charcoal canister in accordance with engine conditions.	
Air ConditioningCut-Off Control	By controlling the air conditioning compressor ON or OFF in accordance with the engine condition, drivability is maintained.	
Engine Immobiliser	Prohibits fuel delivery and ignition if an attempt is made to start the engine with an invalid ignition key.	

System	Outline
Function to communicate with multiplex communication system	Communicates with the meter ECU, A/C ECU, etc., on the body side, to input/output necessary signals.
Diagnosis	Enables the accurate and detailed diagnosis of malfunctions through the use of the Intelligent Tester II diagnostic tool to access the SAE-prescribed DTC (Diagnostic Trouble Code) and data, as well as to perform active tests.
Fail-Safe	When the Engine ECU detects a malfunction, the Engine ECU stops or controls the engine according to the data already stored in the memory.

■ **Service Tip** ■

The uses the CAN protocol for diagnostic communication. Therefore, a Intelligent Tester II and a dedicated adapter [CAN VIM (Vehicle Interface Module)] are required for accessing diagnostic data. For details, see the 2005 Lexus GS430/300 Repair Manual(Pub. No. RM1168E)

Sensor List

Name	Function and Construction	EFI	ESA	ISC	VVT-i
Air Flow Meter	Detects the intake air volume.	❍	❍	❍	❍
Intake Air Temperature Sensor	Detects the intake air temperature.	❍	❍	❍	❍
Camshaft Position Sensor	Identifies the cylinder.	❍	❍		❍
VVT Sensor	Detects the actual camshaft position.	❍	❍	❍	❍
Crankshaft Position Sensor	Detects the crankshaft position.	❍	❍	❍	❍
Accelerator Pedal Position Sensor	It is attached to the accelerator pedal to detect the accelerator pedal position.	❍	❍	❍	❍
Throttle Position Sensor	Detects the throttle valve position.	❍	❍	❍	❍
Water Temp.Sensor	Detects the water temperature.	❍	❍	❍	❍
Heated Oxygen Sensor	Detects the oxygen concentration in the exhaust gas.	❍			
Igniter	Sends the ignition verification signal.		❍		
Starter Signal	Sends the starter voltage in the form of a signal when the engine is started.	❍	❍	❍	❍
Neutral Start Switch	Detects the P, N, and D positions of the automatic transmission.	❍	❍	❍	❍
Knock Sensor	Detects the knocking of the engine by way of the resonance of the piezoelectric element.		❍		
Vehicle Speed Signal	Detects vehicle speed.	❍	❍	❍	❍

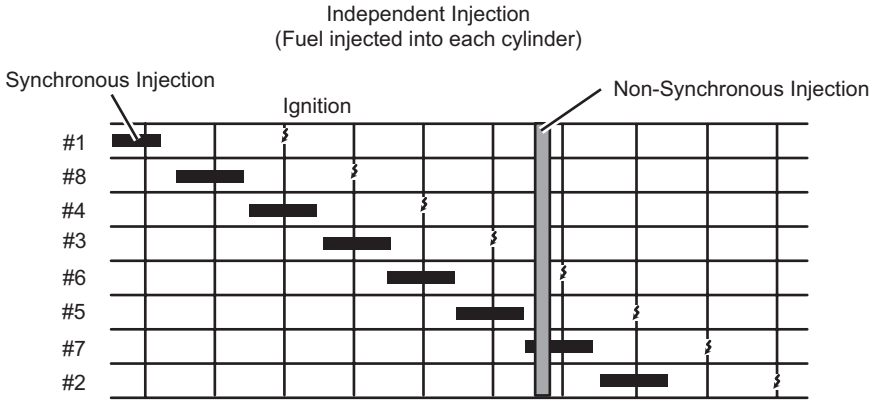
Actuator List

Name	Function and Construction
Main Relay	Supplies main power to the EFI, ESA system, etc.
Circuit Opening Relay	Supplies power to the fuel pump system.

Name	Function and Construction
Fuel Injector	Injects an optimal volume of fuel at an optimal timing.
Heated Oxygen Sensor Heater	Heats the heated oxygen sensor to promote feedback control when the engine is cold.
Igniter	Turns the current to the ignition coil ON/OFF at an optimal timing.
Electronically Controlled Throttle Motor	Controls the position of the throttle valve in accordance with driving conditions.
Camshaft Timing OCV	Controls the phases of the intake camshaft to achieve an optimal valve timing.
VSV(For ACIS)	Opens and closes the intake air control valve in accordance with the driving conditions.
Evaporative Purging VSV	Regulates the purge volume of the canister.

EFI (Electronic Fuel Injection) System

- An L-type EFI system directly detects the intake air mass with a hot wire type air flow meter.
- An independent injection system (in which fuel is injected once into each cylinder for each two revolutions of the crankshaft) has been adopted.
- There are two types of fuel injection: One is synchronous injection in which corrections based on the signals from the sensors are added to the basic injection time so that injection occurs always at the same position. The other is non-synchronous injection in which injection is effected by detecting the requests from the signals of the sensors regardless of the crankshaft angle. Furthermore, to protect the engine and improve fuel economy, the system effects fuel cutoff in which the injection of fuel is stopped temporarily in accordance with the driving conditions.

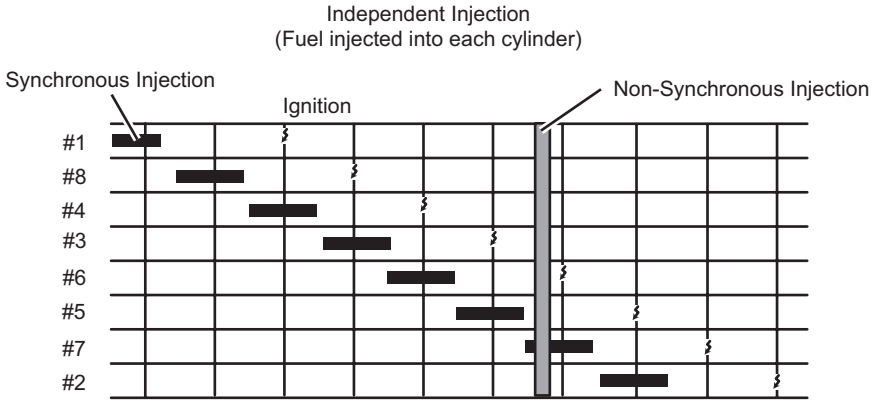


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Name	Function and Construction
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Synchronous Injection

• The synchronous injection time can be expressed by the formula given below. During the starting of the engine, the injection time is determined in accordance with the engine speed, battery voltage, and the water temperature. To prevent excessive amounts of fuel from being injected during starting, the injection volume is regulated in accordance with the cranking time.

Synchronous Injection = A. Basic Injection Time + B. Correction Injection Time + C. Ineffective Injection Coefficient

A.Basic Injection Time	It is the basic injection time that is determined by the intake air volume and the engine speed.
B.Correction Injection	It is a coefficient that is used to achieve the air-fuel mixture that is appropriate for the engine condition at that time, in accordance with the signals from the sensors.
B-1 Intake Temperature Correction	Enriches the mixture when the intake air temperature is low because the air density is high.
B-2 Post-Warm-Up Enrichment Correction	Enriches the mixture when the water temperature is low to ensure drivability during cold operation.
B-3 Post-Start Enrichment Correction	Enriches the mixture after the engine is started in accordance with the water temperature and the engine speed in order to ensure a stable engine operation after starting. The enrichment is at the highest ratio immediately after the engine is started, and decreases gradually thereafter.
B-4 Transient Air-Fuel Ratio Correction	Enriches or leans the mixture in accordance with the acceleration or deceleration conditions determined by the changes in the intake air volume.
B-5 Wall Adhesion Correction	Correction is made by calculating the adhesion of fuel to the wall surface based on the water temperature, engine speed, and throttle valve opening.
B-6 High-Load Enrichment Correction	Prevents the exhaust temperature from rising by detecting the high-load driving conditions in accordance with the signals from the sensors and enriching the mixture.
B-7 Constant Fuel Pressure Control	Corrects the deviation of the fuel injection volume that results from the changes in the intake manifold pressure to achieve a constant pressure.
B-8 Air-Fuel Ratio Feedback Control	Controls the air-fuel ratio to a narrow range near the stoichiometric ratio (in which the cleaning performance of the three-way catalyst is at the highest level) by making corrections based on the signals from the heated oxygen sensor.
C.Ineffective Injection	Corrects the operation lag of the injectors.

Non-Synchronous Injection

• Apart from the normal (synchronous) fuel injection, this function simultaneously injects a prescribed volume of fuel to all the cylinders only immediately after the signals from the sensors are input, in order to ensure the proper startability and acceleration response.

• During synchronous injection, the injection time is extended for the amount of non-synchronous injection.

The following are the three types of non-synchronous injection

Starting Non-Synchronous Injection	Effects non-synchronous injection once immediatelyafter the starter signal is input, thus improving startability.
Acceleration Non-Synchronous Injection	Effects non-synchronous injection when the increased amount of the throttle valve opening is greater than the preset value, to improve response during acceleration.
Engine Speed Drop Non-SynchronousInjection	Effects non-synchronous injection when the engine speed drops suddenly during a fuel cutoff or when resuming from a fuel cutoff, thus ensuring the proper drivability.

EG

Fuel Cut

• Temporarily stops the injection of fuel to protect the engine and improve fuel economy.

The following are the three types of fuel cutoff

Deceleration Fuel Cutoff	Stops the injection of fuel when the engine speed is higher than the specified value during deceleration (throttle OFF detected by Engine ECU). This prevents the TWC (Three-Way Catalyst) from overheating due to misfiring and improves fuel economy. The fuel cutoff and resumption speeds are higher when the coolant temperature is low.
Engine Speed Fuel Cutoff	Stops the injection of fuel when the engine speed is higher than the specified value to prevent over-revolution.
N → D Shift Fuel Cutoff	Stops the injection of fuel for a prescribed length of time when shifting from N→ D, if the engine speed is higher than the specified value to reduce shift shock.

Fuel Cut Resumption Speed During Deceleration

While lockup control is not operating [rpm]	1000

Fuel Cut Speed During High-Speed Operation

Engine Speed [rpm]	6450

ESA (Electronic Spark Advance)

● This system selects the optimal ignition timing in accordance with the signals received from the sensors and sends the (IGt) ignition signal to the igniter. The ignition timing can be expressed by the formula given below. The default ignition timing is set to 5° BTDC.

Calculation of ignition timing

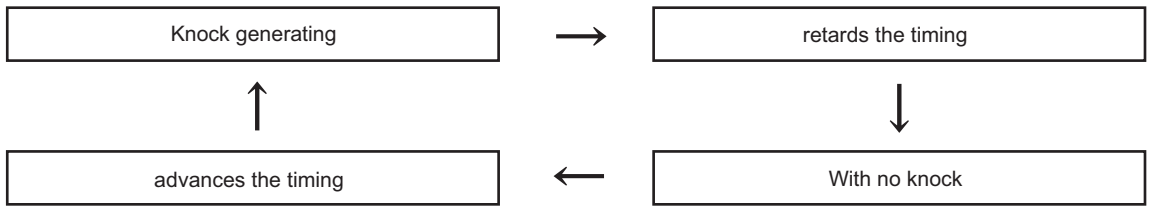
❖REFERENCE❖

Ignition Timing = A. Default Ignition Timing or B. Basic Timing Advance + C. Correction Timing Advance

A.Fixed Timing Advance Characteristic	During the starting of the engine, the timing is fixed to 5° BTDC. If the throttle valve is turned OFF by shorting the service terminals, the timing becomes fixed to 10° BTDC.
B.Basic Timing Advance Characteristic	The optimal ignition timing is selected from the map based on the signals received from the sensors.
C.Correction Timing Advance Characteristic	Appropriately advances or retards the timinginaccordancewith the conditions of the engine based on the signalsreceivedfromthe sensors.
C-1 Warm-Up Timing Advance Characteristic	Advances the ignition timing in accordance with the driving conditions when the water temperature is low, in order to improve drivability.
C-2 Idle Stabilization Timing Advance Characteristic	Advances the ignition timing when the idle speed decreases, in order to stabilize the idle speed. Conversely, retards the timing if the idle speed increases.
C-3 Fuel Cutoff Resumption Timing Retard	Retards the ignition timing when the fuel injection is resumed from a fuel cutoff, in order to lessen the shock.
C-4 Acceleration Timing Retard	Temporarily retards the ignition timing during acceleration in order to improve drivability.
C-5 Knock Correction Timing Retard	Corrects the ignition timing in accordance with the signals received from the knock sensor when knocking occurs. Depending on the extent of the knocking that is detected, this function retards the timing by a prescribed angle at a time until there is no more knocking. After no more knocking occurs, this function advances the timing by a prescribed angle at a time. If knocking occurs again while advancing the timing, it retards the timing again.

Knock Control System

- When the engine ECU detects the engine knocking, it retards the timing, depending on the extent of knocking, by one predetermined angle at a time until the engine stops knocking.
- When the engine stops knocking, the engine ECU advances the timing by one predetermined angle at a time. If the engine starts knocking again, the engine ECU retards the timing again.



Knocking Feedback Control

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Maximum and Minimum Timing Advance Characteristics

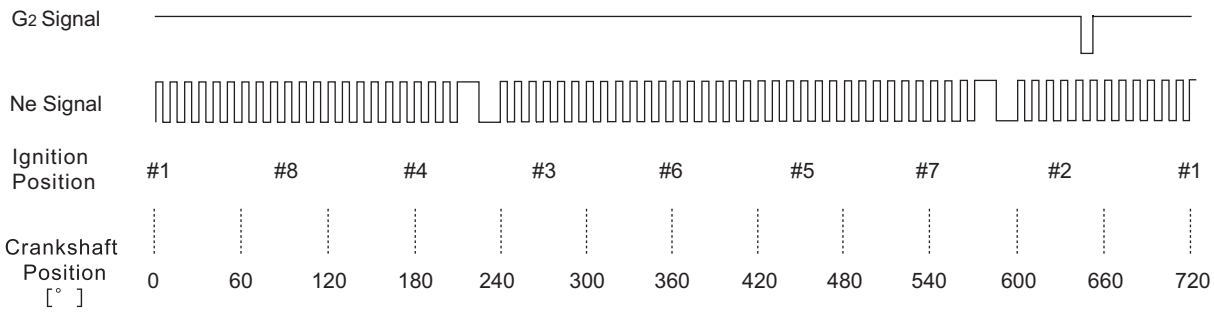
• because the engine can be adversely affected if the ignition timing advances or retards abnormally.

Maximum and Minimum Timing Advance Angles

Maximum Timing Advance (BTDC)	54°
Minimum Timing Advance (ATDC)	-10°

Calculation of ignition timing

• Based on the Ne and G2 signals, airflow meter signal, accelerator position signal, and water temperature signal, the engine ECU calculates the optimal ignition timing to suit the driving conditions. Then, the engine ECU sends an ignition signal to the ignition coil with a built-in igniter.



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Idle Speed Control

● Controls the fast idle speed in accordance with the water temperature, and the idle speed after the engine has been warmed up. It controls the idle speed by regulating the fuel injection volume and the throttle position.

Idle Speed Control

Starting Control	When starting the engine, this control opens the throttle valve to increase the intake air volume, which improves the startability of the engine.
Forecast Control	When the system detects any one of the signals listed below, it controls the position of the throttle valve to suppress speed fluctuations.
	·A change in the idle speed has been forecasted.
	·A change occurred in the electrical load.
	·The air conditioning switch has been switched.
	·The shift lever has been shifted. (N → D, D → N)
Deceleration Control	This control increases the airflow volume by opening the throttle valve during deceleration, thus lowering the vacuum in the intake manifold. This decreases the volume of oil consumed through suction into the combustion chamber, prevents the engine from stalling through a sudden drop in engine speed, and improves drivability.
Feedback Control	While measuring the engine speed for a certain length of time, if there is a difference between the actual speed and the target speed, this control regulates the throttle valve position in order to bring the idle speed to the target speed.

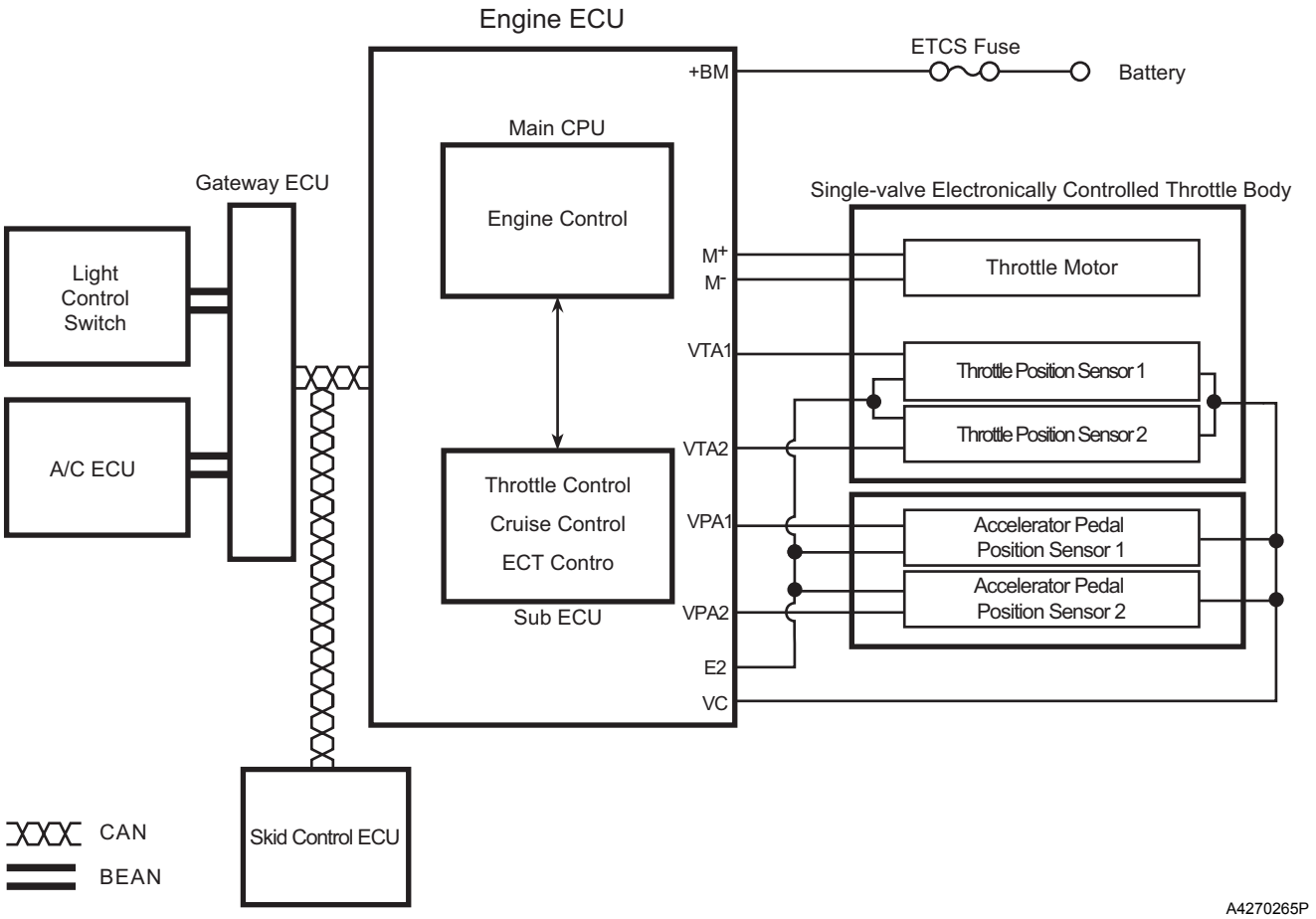
Target Speed

No-load speed [rpm]		750
With an electrical load [rpm]		750
A/C ON [rpm]	Low load	750
	High load	750

EG

ETCS-i (Electronic Throttle Control System-intelligent)

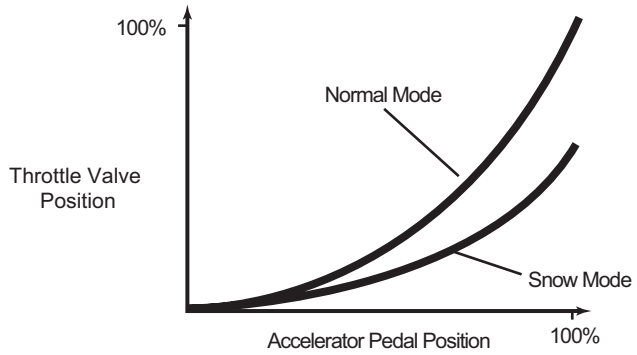
- In the conventional throttle body, the throttle valve opening is determined invariably by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the engine ECU to calculate the optimal throttle valve opening that is appropriate for the respective driving condition and uses a throttle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



ETCS-i Control

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

Relationship Between Amount of Accelerator Pedal Effort and Throttle Valve Position



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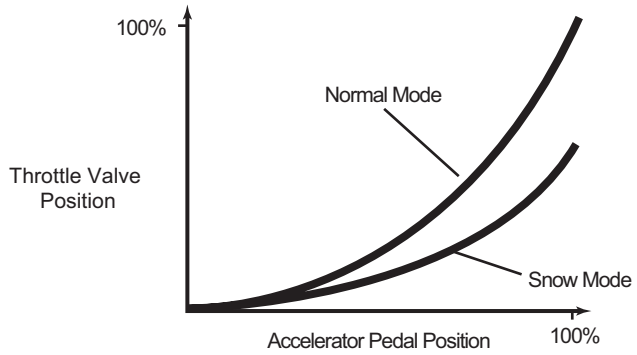
VVT-i System

- The VVT-i system is designed to control the intake camshaft within a wide range of 45° (of crankshaft angle) to provide a valve timing that is optimally suited to the engine condition, thus realizing improved torque in all the speed ranges and fuel economy, and reduce exhaust emissions.
- In proportion to the engine speed, intake air volume, throttle position and engine coolant temperature, the engine ECU calculates an optimal valve timing under each driving condition and control the camshaft timing oil control valve. In addition, engine ECU uses signal from the VVT sensors and the crankshaft position sensor to detect the actual valve timing, thus performing feedback control to achieve the target valve timing.

ETCS-i Control

Nonlinear Control	Normal-mode Control	Controls the throttle to an optimal throttle valve opening that is appropriate for the driving condition such as the amount of the accelerator pedal effort and the engine operating condition in order to realize excellent throttle control and comfort in all operating ranges.
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Relationship Between Amount of Accelerator Pedal Effort and Throttle Valve Position



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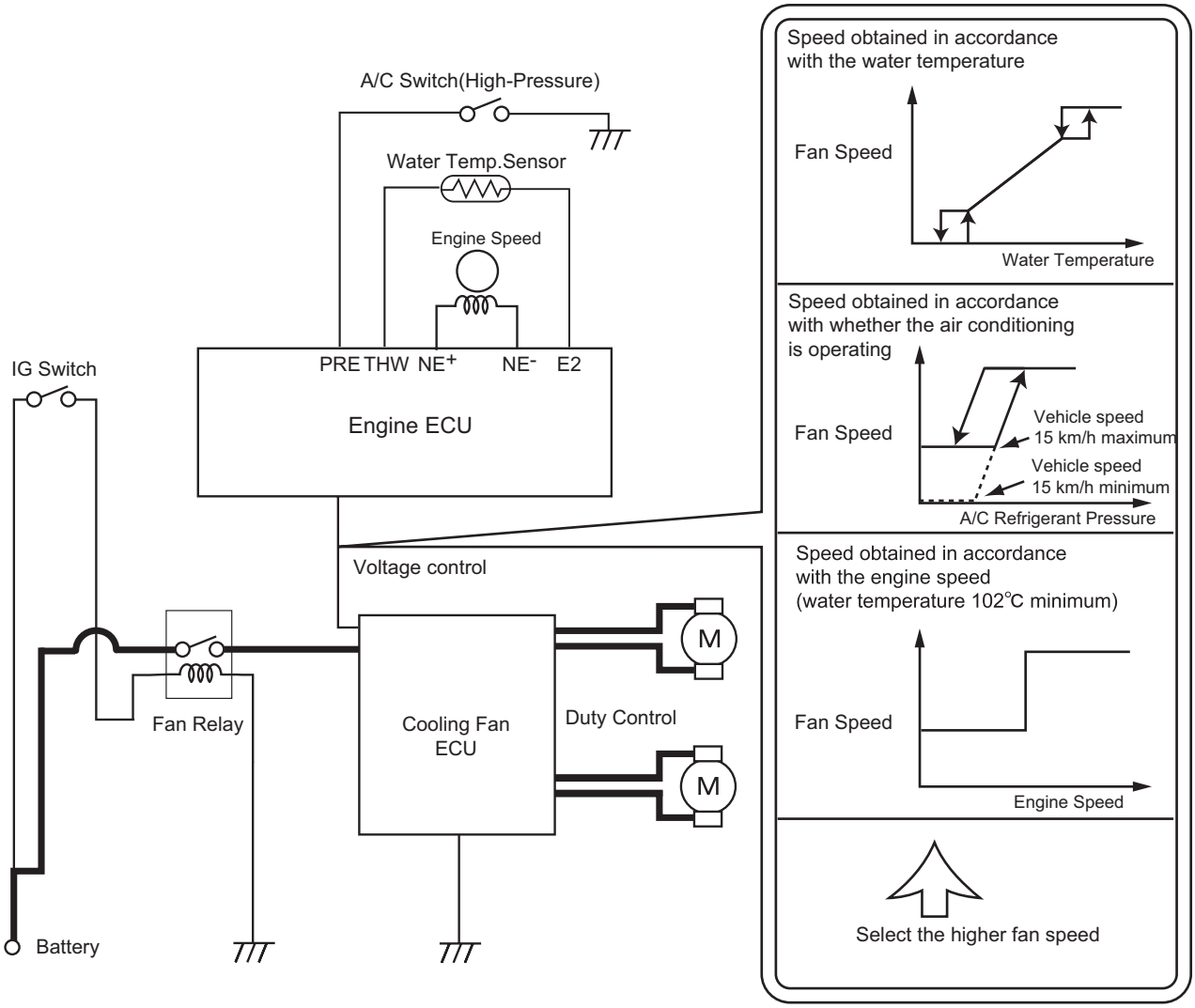
VVT-i System

- The VVT-i system is designed to control the intake camshaft within a wide range of 45° (of crankshaft angle) to provide a valve timing that is optimally suited to the engine condition, thus realizing improved torque in all the speed ranges and fuel economy, and reduce exhaust emissions.
- In proportion to the engine speed, intake air volume, throttle position and engine coolant temperature, the engine ECU calculates an optimal valve timing under each driving condition and control the camshaft timing oil control valve. In addition, engine ECU uses signal from the VVT sensors and the crankshaft position sensor to detect the actual valve timing, thus performing feedback control to achieve the target valve timing.

EG

Cooling Fan System

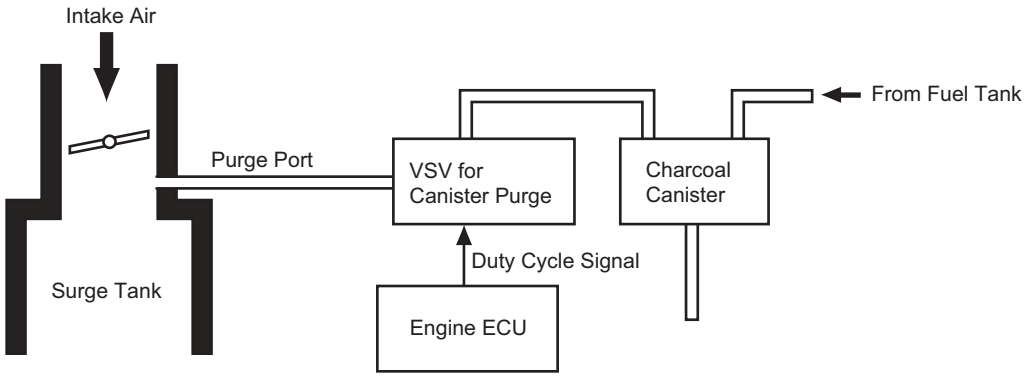
- To achieve an optimal fan speed in accordance with the engine coolant temperature, vehicle speed, engine speed, and air conditioning operating conditions, the engine ECU calculates the proper fan speed and sends the signals to the cooling fan ECU. Upon receiving the signals from the engine ECU, the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



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Evaporative Emission Control System

- A single system purge flow path is provided in order to control the fuel evaporative gas that flows from the charcoal canister to the purge port in accordance with the conditions of the engine. Then, the fuel evaporative gas that has been absorbed by the canister is drawn into the engine, thus suppressing the discharge of fuel evaporative gas.
- The purge port, which is provided downstream of the throttle valve, draws the fuel evaporative gas into the intake manifold in accordance with the driving conditions. The engine ECU applies current to the VSV, which is provided midstream of the purge pipe, in order to control the purge to an optimal volume.

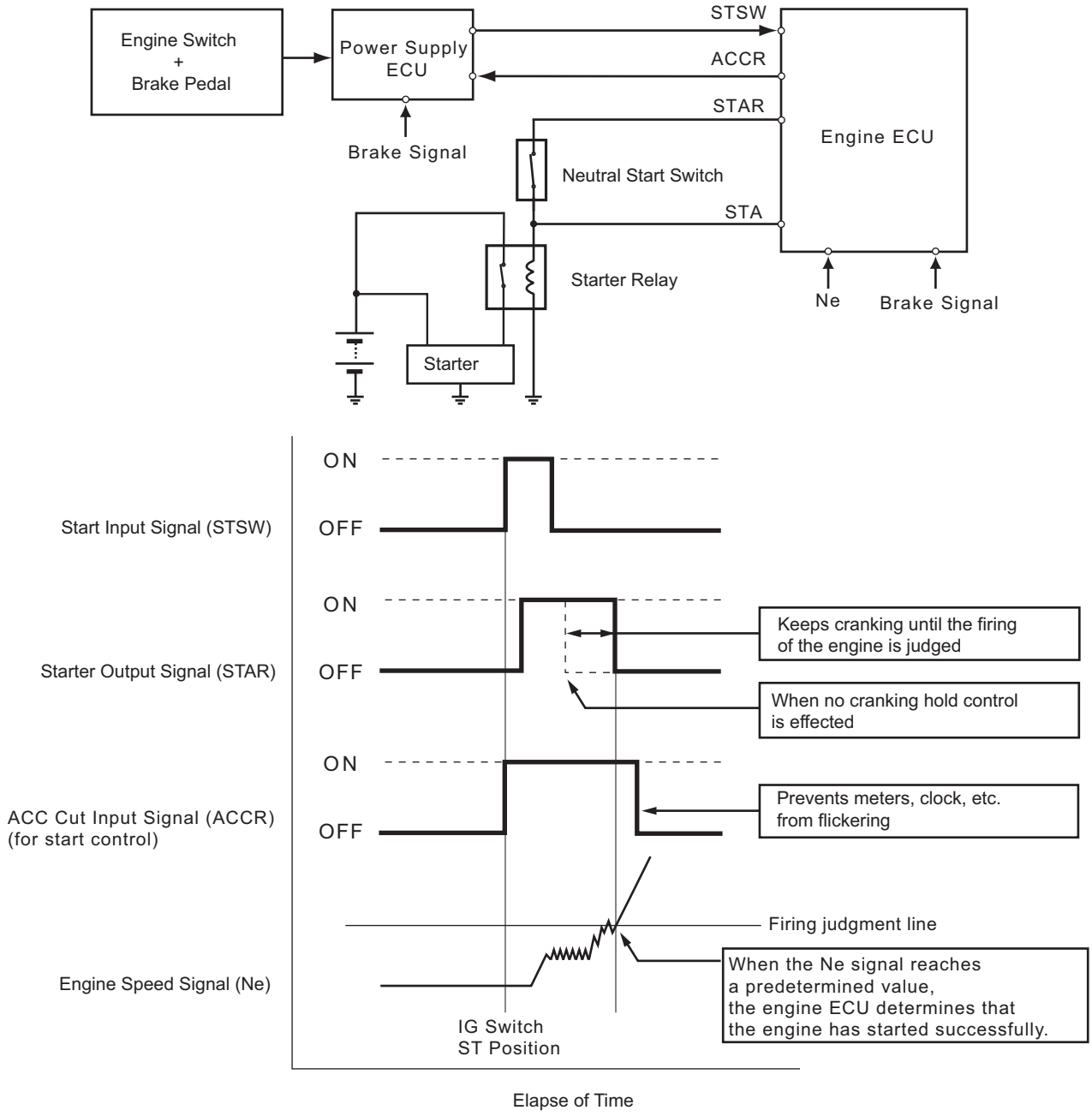


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Cranking Hold Control

- When a start signal (STSW) is input by the engine switch, the engine ECU sends a signal (STAR) to the starter relay via the Park/Neutral Position switch (to determine P or N position), in order to start the starter. At this time, the engine ECU turns ON the ACC cut (ACCR) switch to prevent the meters, clock, and audio unit from flickering.
- After the starter starts, the engine ECU continues to output a signal to the starter until it detects that the engine has fired. After cranking, when the engine speed becomes higher than a predetermined speed, the engine ECU determines that the engine has fired, and stops the signal that is output to the starter relay.



Cranking Hold Control Circuit Diagram (SMART ACCESS SYSTEM with PUSH-BUTTON START Type) and System Diagram

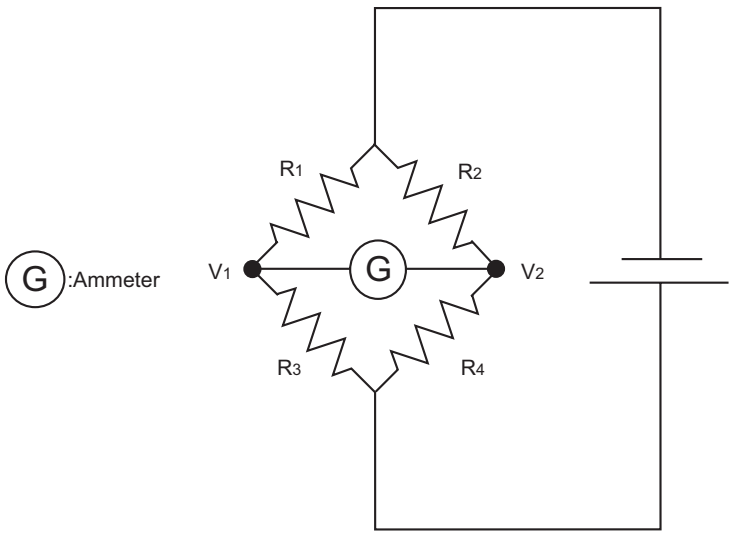
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Air Flow Meter

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

Hot Wire Type Air flow Meter Operation

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

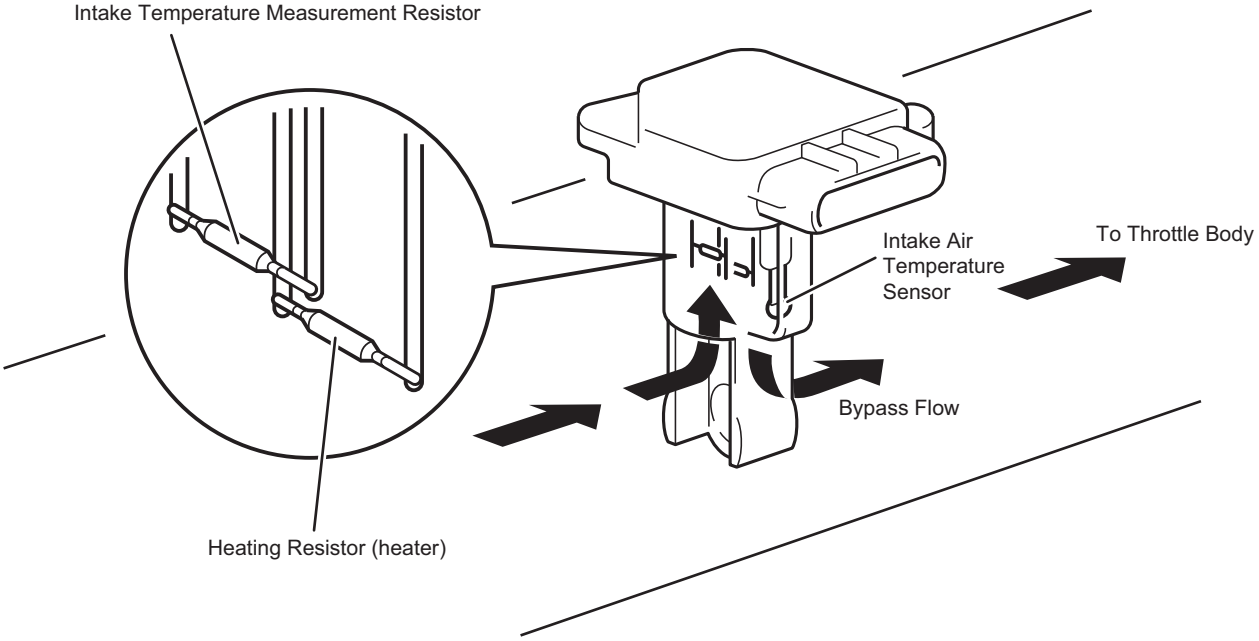


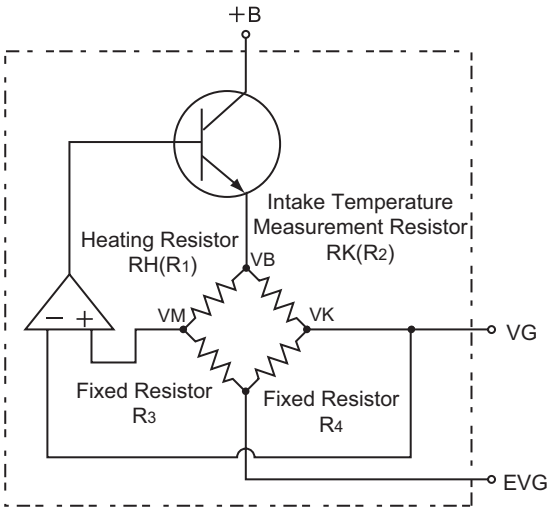
Bridge Circuit

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



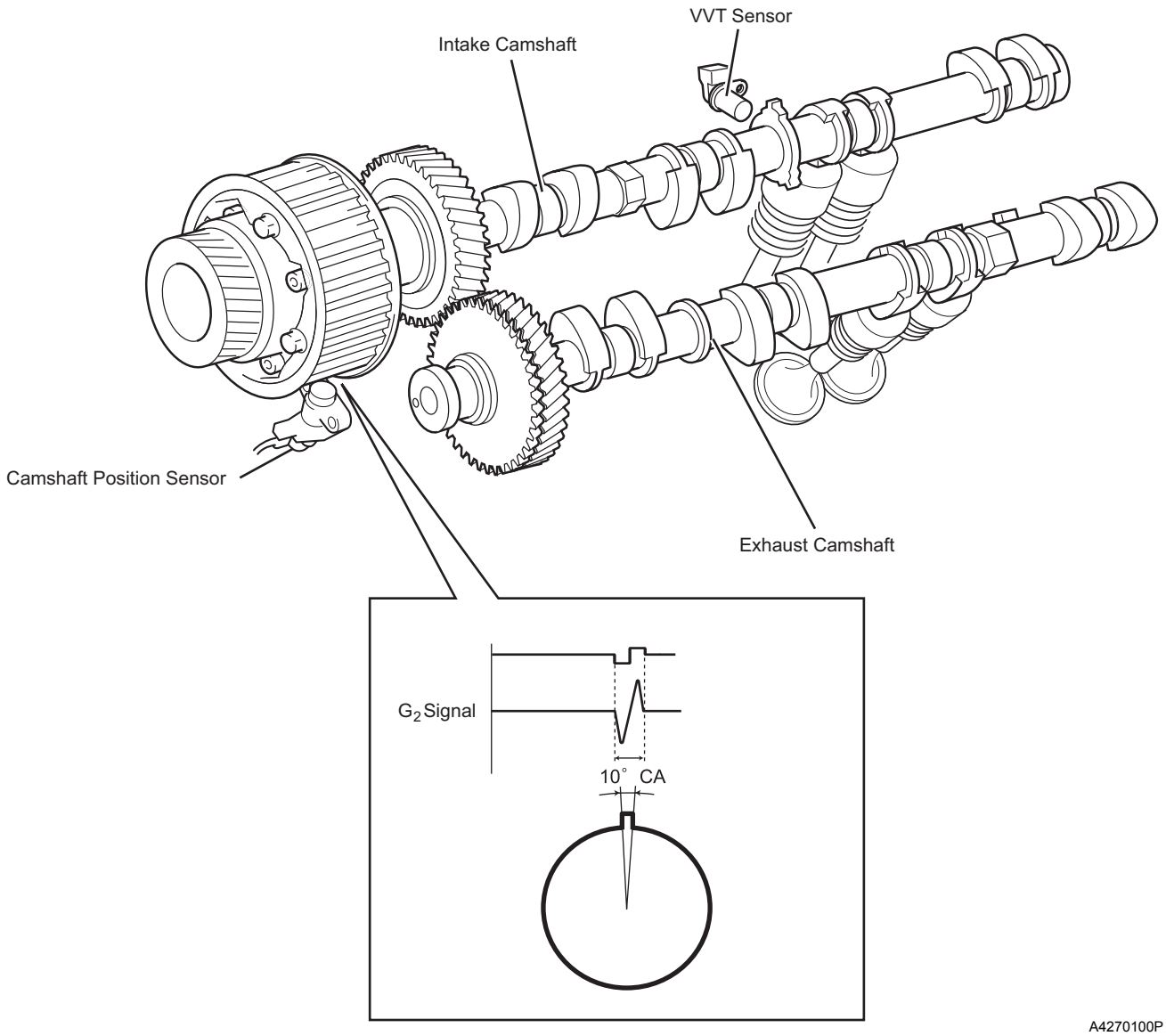


Bridge Circuit

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Camshaft Position Sensor

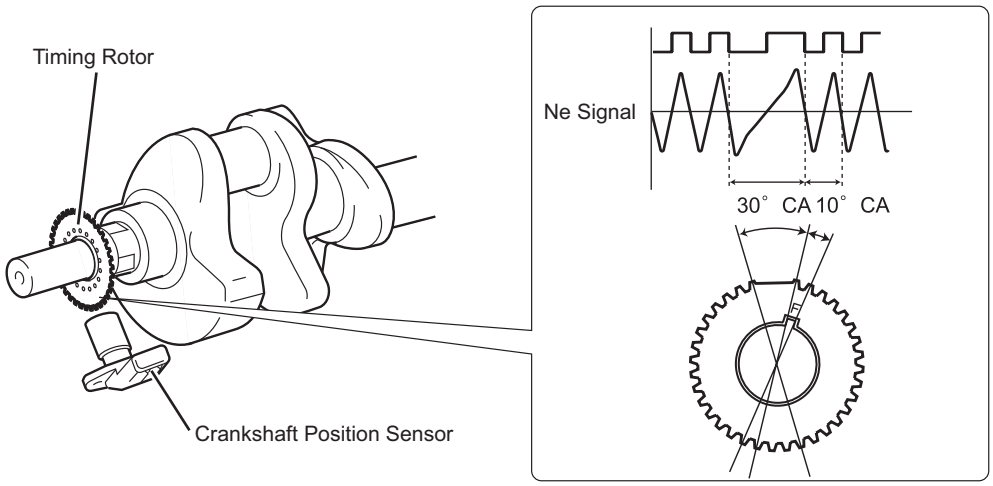
- This engine uses an electromagnetic pickup sensor that provides a high level of detection accuracy. When the camshaft rotates, the air gap between the protrusion on the timing rotor and the camshaft position sensor changes. This causes the magnetic flux that passes through the coil of the camshaft position sensor to increase and decrease, causing the coil to generate an electromotive force. This electromotive force generates voltage in opposing directions, depending on whether the protrusion of the timing rotor approaches the camshaft position sensor or withdraws from the sensor. Thus, the voltage appears in the form of alternating current voltage.
- The camshaft position sensor is mounted on the left bank cylinder head. To detect the camshaft position, a protrusion that is provided on the timing pulley is used to generate 1 pulse for every 2 revolution of the crankshaft.
- A VVT sensor is mounted on the intake side of each cylinder head. To detect the camshaft position, a timing rotor that is provided on the intake camshaft is used to generate 3 pulses for every 2 revolutions of the crankshaft.



EG

Crankshaft Position Sensor

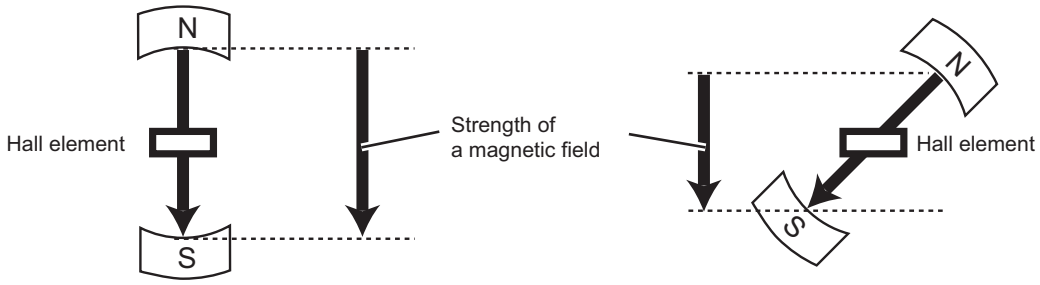
- The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.
- This engine uses an electromagnetic pickup sensor that provides a high level of detection accuracy. When the crankshaft rotates, the air gap between the protrusion on the timing rotor and the crankshaft position sensor changes. This causes the magnetic flux that passes through the coil of the crankshaft position sensor to increase and decrease, causing the coil to generate an electromotive force. This electromotive force generates voltage in opposing directions, depending on whether the protrusion of the timing rotor approaches the crankshaft position sensor or withdraws from the sensor. Thus, the voltage appears in the form of alternating current voltage.



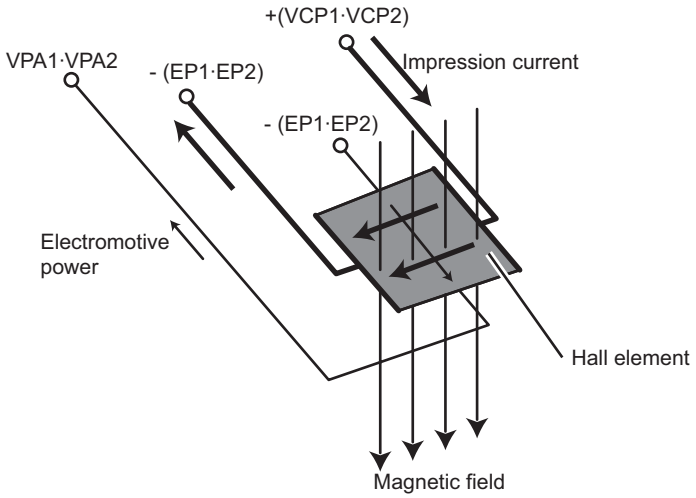
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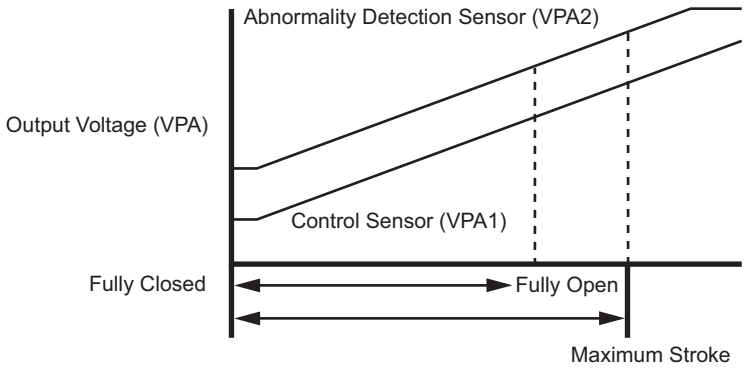
Accelerator Pedal Position sensor

- A no-contact accelerator position sensor is used. This sensor uses a Hall element, which can output the intensity of the magnetic field in the form of electrical signals. This is accomplished through the use of the Hall effect*1, which can attain output voltage linearly in proportion to the amount of pedal effort applied on the accelerator.
- When the amount of pedal effort applied to the accelerator changes, the angle of the magnetic field changes in relation to the current (VC → E2) applied in the Hall element. Therefore, the intensity of the magnetic field that is perpendicular to the applied current changes. Then, the resulting changes in the VPA1 and VPA2 terminal voltage are sent to the engine ECU in the form of a throttle valve position signal. Furthermore, this sensor comprises two (main, sub) sensor circuits with different output characteristics to ensure reliability.



Accelerator Pedal ON　　Accelerator Pedal OFF





Accelerator Position Sensor Output Voltage Characteristics

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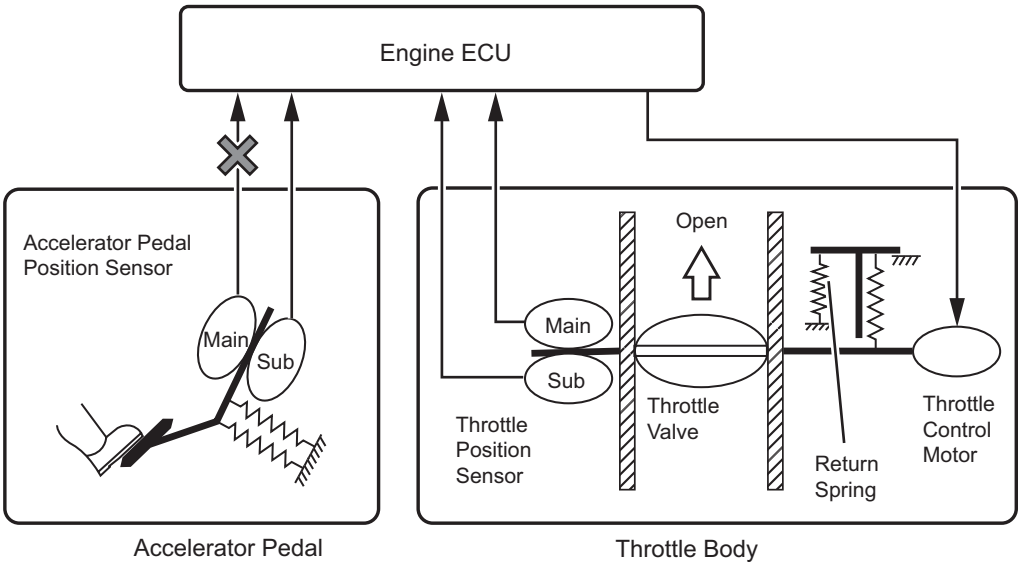
EG

Fail Safe

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

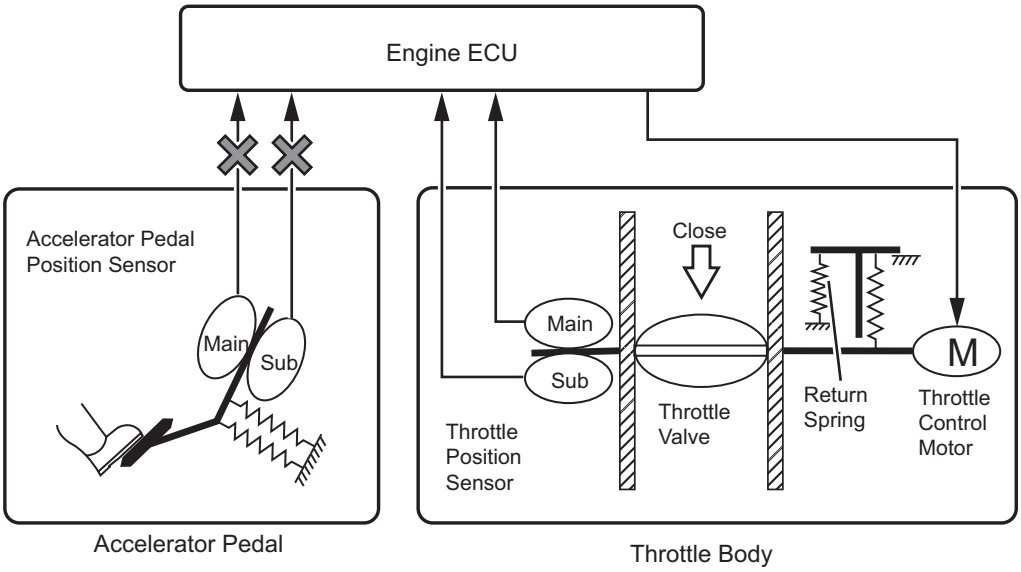
System 1 Failure

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



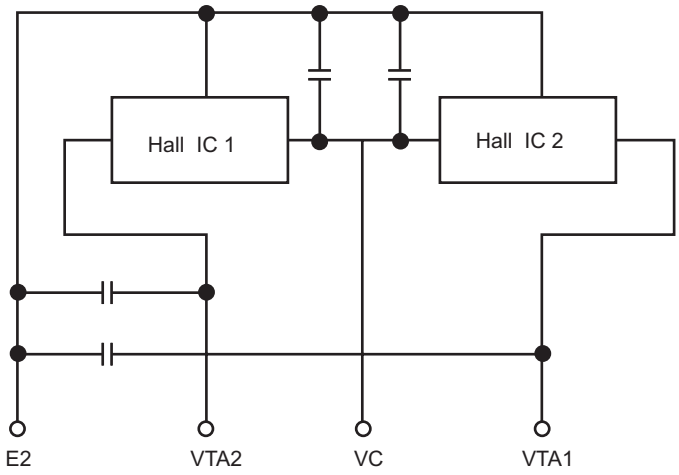
System 2 Failure

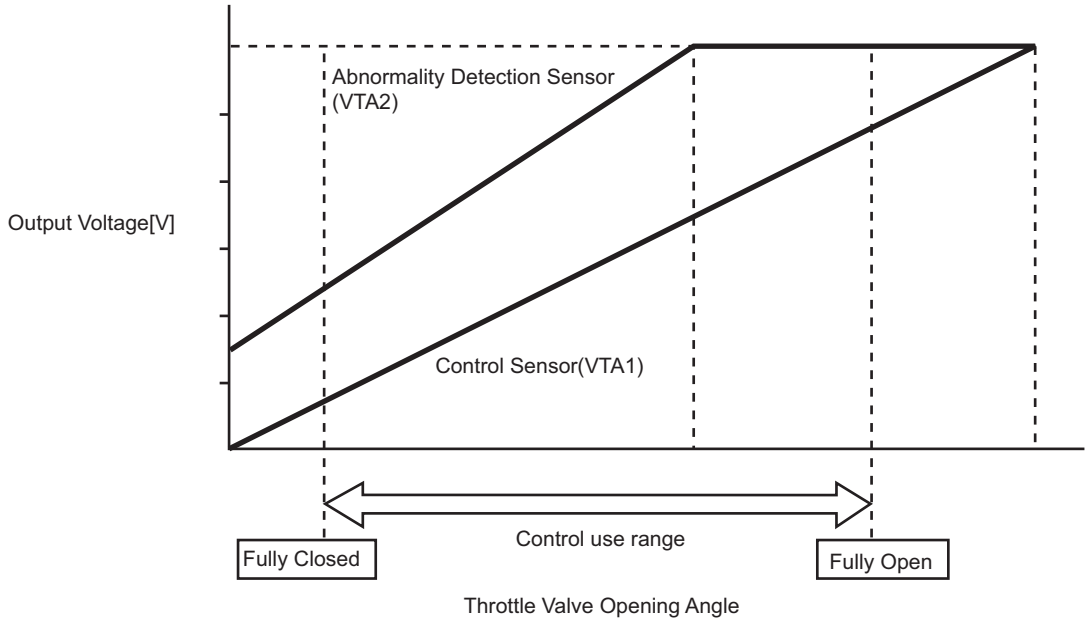
If both systems malfunction, the engine ECU detects the abnormal signal voltage between these two sensor circuits and regards that the opening angle of the accelerator pedal is fully opened and then continues the throttle control. At this time, the vehicle can be driven within its idling range.



Throttle Position Sensor

- A no-contact throttle position sensor is used. This sensor uses a Hall element, which can output the intensity of the magnetic field in the form of electrical signals. This is accomplished through the use of the Hall effect*1, which can attain output voltage linearly in proportion to the position of the throttle valve.
- When the position of the throttle valve changes, the angle of the magnetic field changes in relation to the current (VC → E2) applied in the Hall element. Therefore, the intensity of the magnetic field that is perpendicular to the applied current changes. Then, the resulting changes in the VTA1 and VTA2 terminal voltage are sent to the engine ECU in the form of a throttle valve position signal. Furthermore, this sensor comprises two (main, sub) sensor circuits with different output characteristics to ensure reliability.





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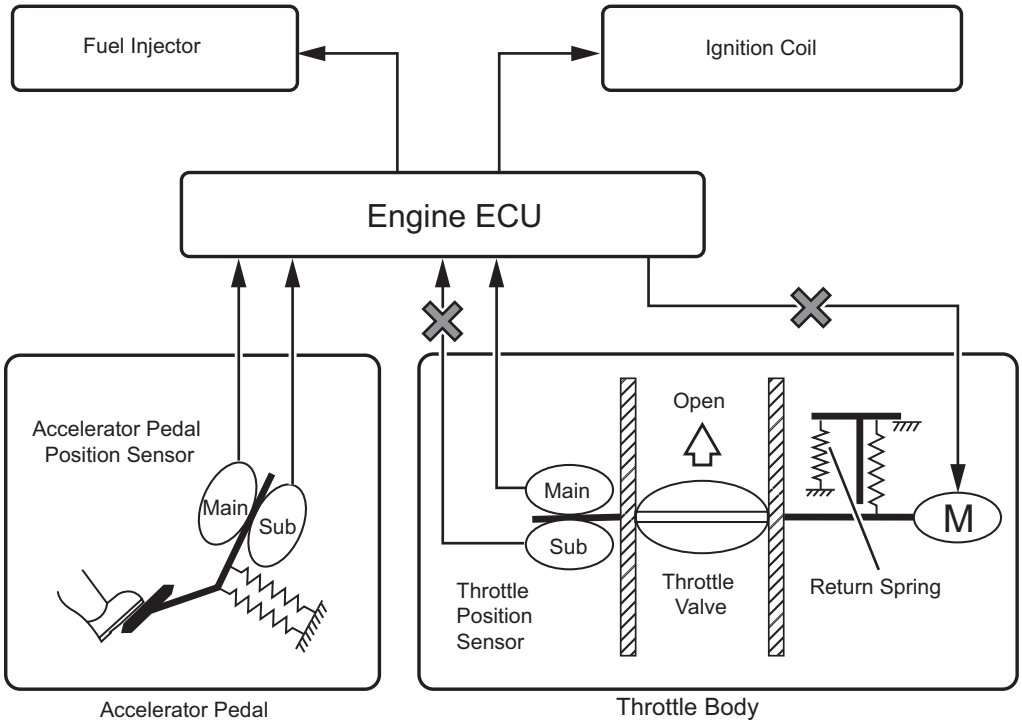
EG

Fail Safe

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

Failure Detection

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



A4270268P

Throttle Body

- The adoption of the ETCS-i has realized excellent throttle control.
- The accelerator pedal position sensor is attached to the accelerator pedal.
- A link-less type throttle body has been adopted.

(See page EG-246)

ACIS (Acoustic Control Induction System)

- ACIS (Acoustic Control Induction System) is used.
- The ACIS (Acoustic Control Induction System) is realized by using a bulkhead to divide the intake manifold into 2 stages, with an intake air control valve in the bulkhead being opened and closed to vary the effective length of the intake manifold in accordance with the engine speed and throttle valve opening angle. This increases the power output in all ranges from low to high speed.

(See page EG-248)

Water Temp.Sensor

- This sensor detects the water temperature and sends a signal to the engine ECU.

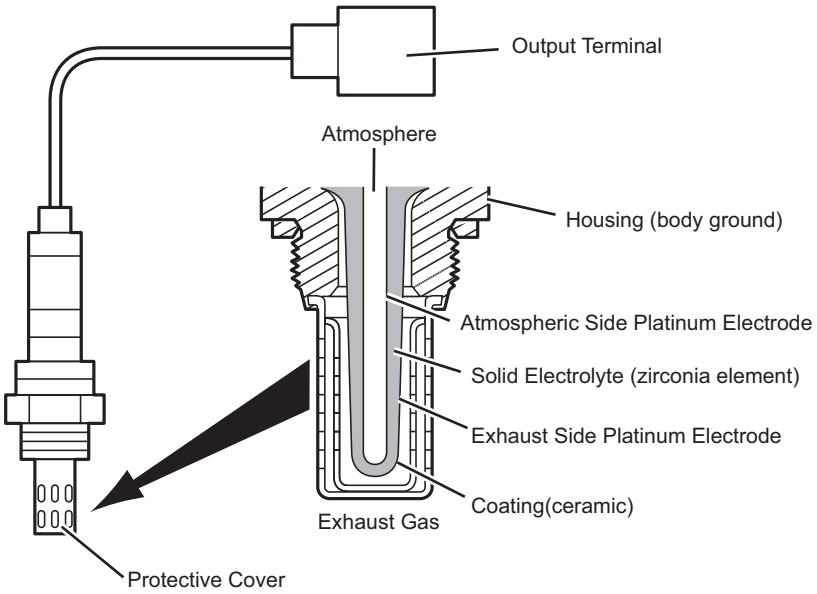


A4270105P

EG

Heated Oxygen Sensor

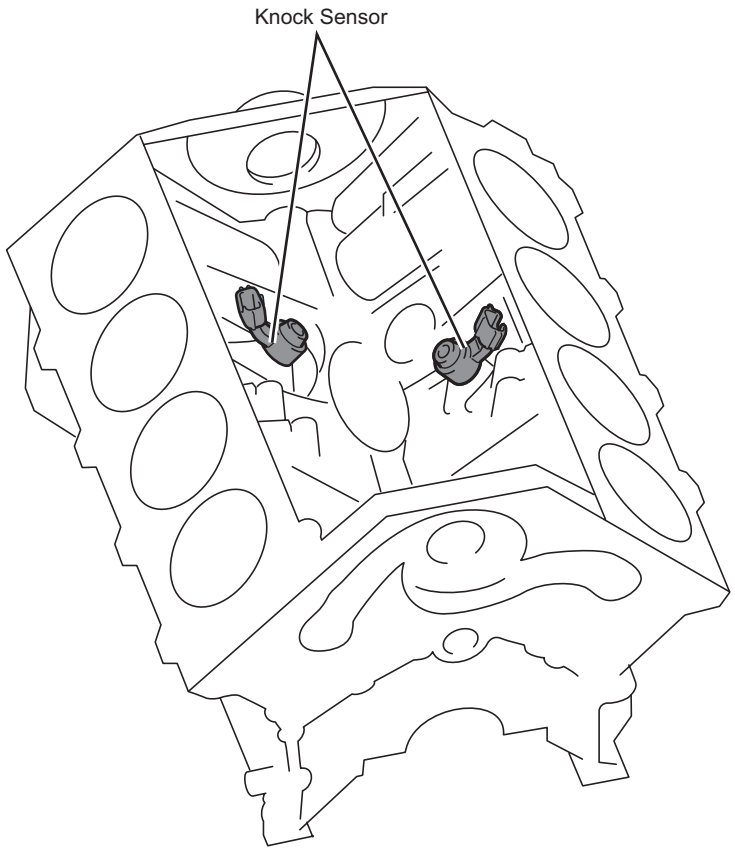
● This sensor converts the oxygen concentration in the exhaust gas into an electromotive force in order to determine whether the mixture is rich or lean in relation to the stoichiometric air-fuel ratio.



A4270106P

Knock Sensor (Flat Type)

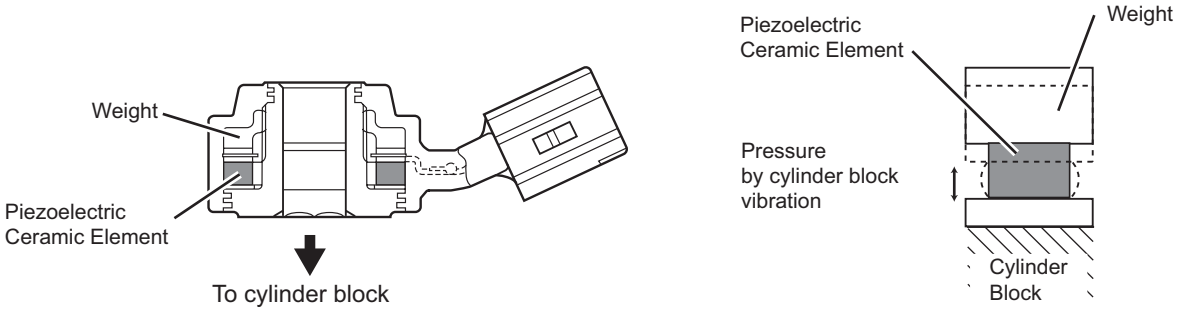
- Newly developed flat knock sensors are used.
- One sensor is provided on both the right and left inner sides of the V bank to ensure reliability.



A4270107P

Knock Sensor Operation

• When the knock sensor receives vibrations from the cylinder block, a delayed movement of the weight occurs in the sensor due to the inertial force of the weight. This causes a pressure to be applied to a piezoelectric ceramic element, which is provided between the cylinder block and the weight, thus generating a voltage. The knock sensor has practically constant output characteristics in all frequency ranges. Therefore, the engine ECU can detect a target frequency to determine that knocking has occurred.



A4270108P

EG

Camshaft Timing Oil Control Valve

- The camshaft timing oil control valve controls the spool valve position in accordance with the duty control from the engine ECU.
- When the engine is stopped, the camshaft timing oil control valve is in the most retarded state.

(See page EG-207)

Injector

- A compact 4-hole type fuel injector has been used.
- Air introduced from the throttle body and air gallery flows through the air chamber formed by the O-ring and insulator under the fuel injector and then is mixed with the fuel. This design promotes atomization of the fuel.
- Air assist injectors that excel in the atomization of fuel are used. They are installed so as to connect the air gallery of the intake manifold to the nozzle of the injector.

(See page EG-240)

Fuel Pump

- A compact fuel pump in which a fuel filter, pressure regulator, and jet pump are integrated in the fuel pump assembly has been adopted.
- A circular flow type in-tank fuel pump is used.

(See page EG-237)

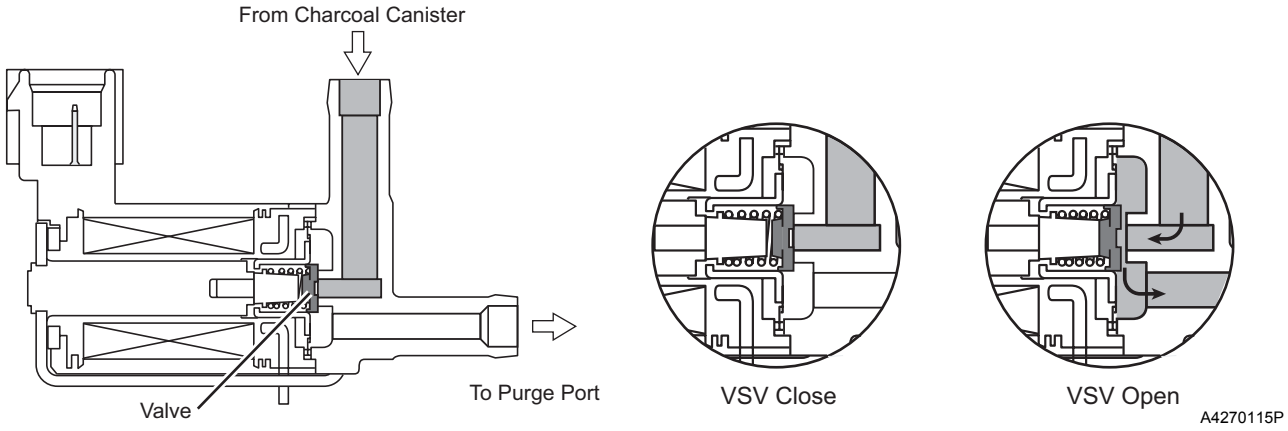
Ignition Coil (with Igniter)

- Independent ignition coils are provided to each of the cylinders, thus making a distributor or high tension cord unnecessary. This reduces the power loss at high-voltage areas, improves reliability, and reduces electro-magnetic interference.
- Each ignition coil has a built-in compact and lightweight igniter, which induces high voltage to the secondary coil in accordance with the signals received from the engine ECU.

(See page EG-261)

VSV (For EVAP)

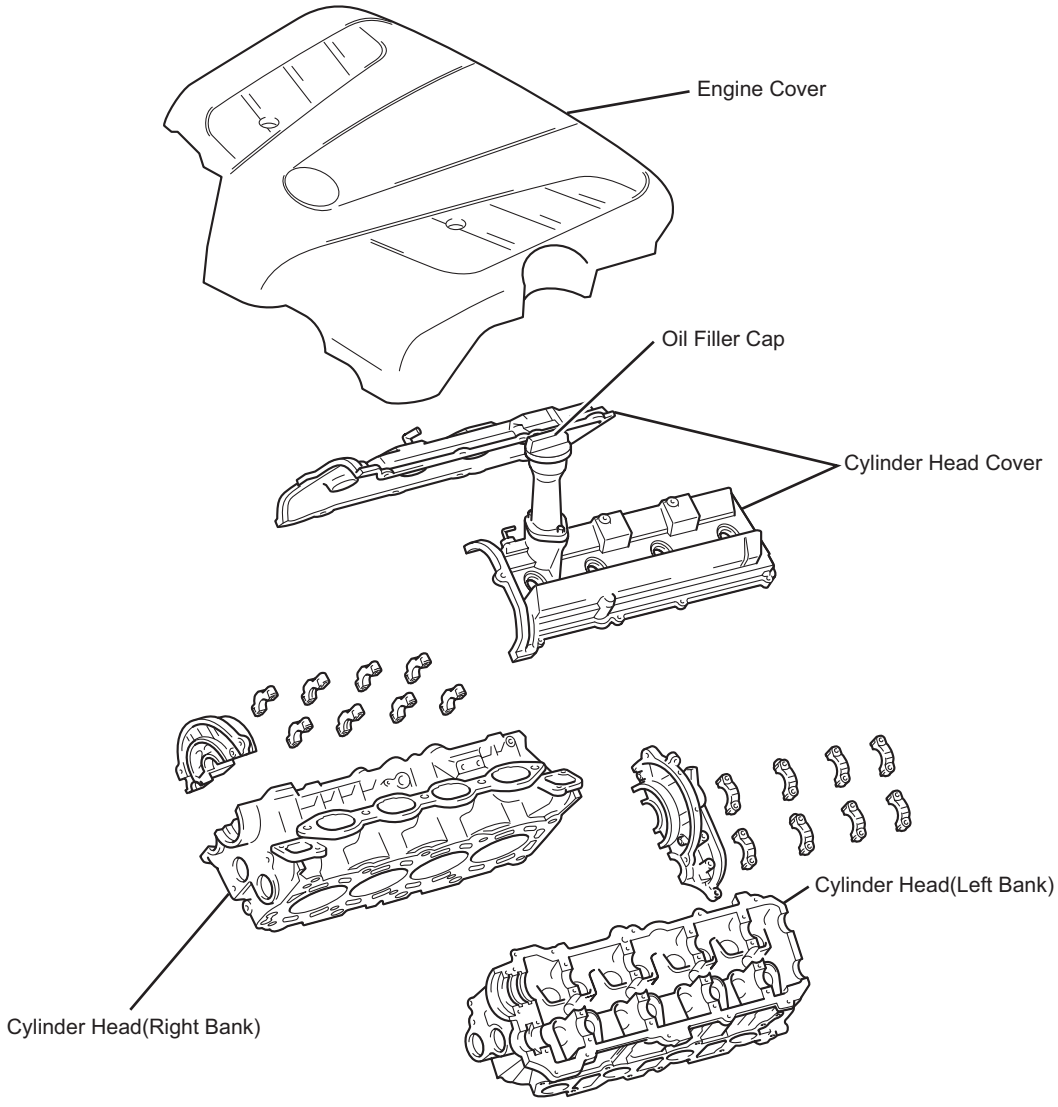
- This VSV regulates the purging volume of the canister in accordance with the duty cycle signals provided by the engine ECU. The purging volume is determined by the ratio of the OFF and ON duration (duty cycle ratio) of the signal.
- It is mounted on the left of the intake manifold.



3UZ-FE ENGINE MECHANICAL

Cylinder Head Fitting Parts

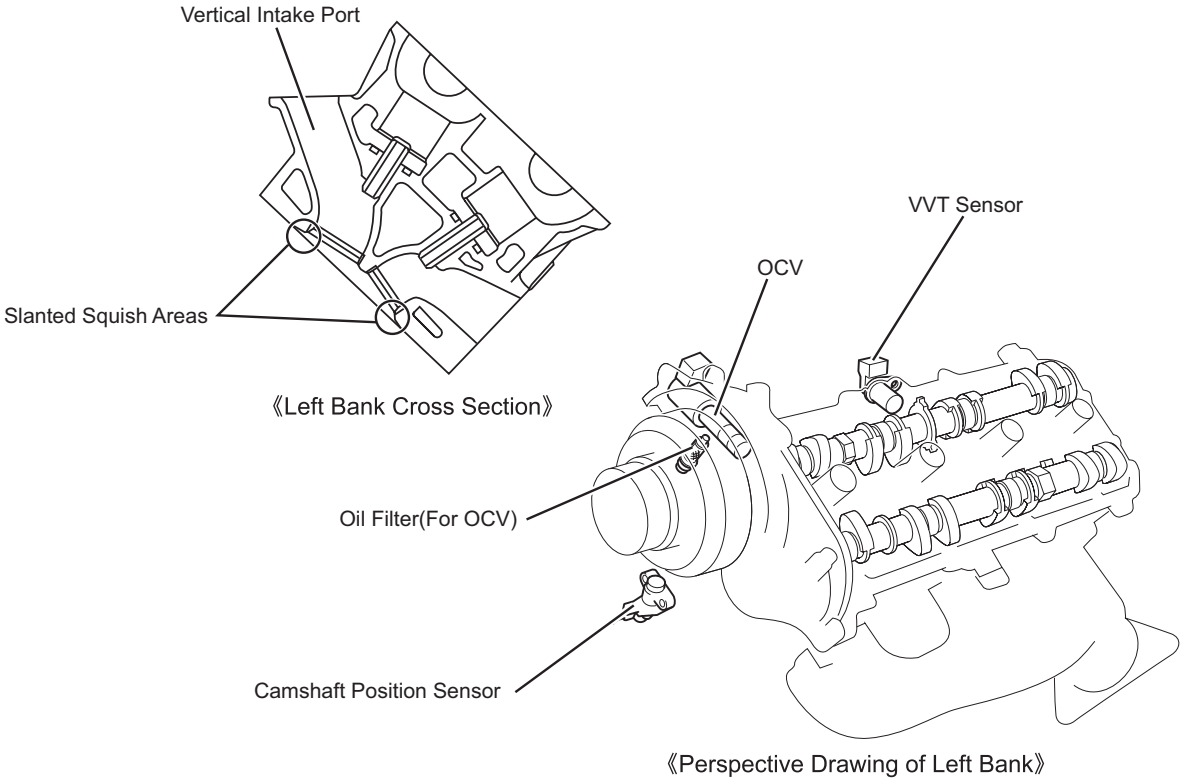
- A large engine cover made of plastic is used to improve quietness and realize a high-quality look.
- The cylinder head covers are made of an aluminum alloy and are shaped to support the installation of the VVT-i and DIS systems.
- The oil filler cap has a keen shape that matches the design of the engine cover. In addition, it is provided with a ratchet mechanism to ensure a uniform tightening torque.
- Rubber ring type cylinder head cover gaskets made of acrylic are used.
- Cylinder heads made of an aluminum alloy, which excel in thermal conductivity, are used. They are the cross-flow type in which the intake system faces the inside of the V bank and the exhaust system faces the outside.
- Cylinder head gaskets made of metal are used.



EG

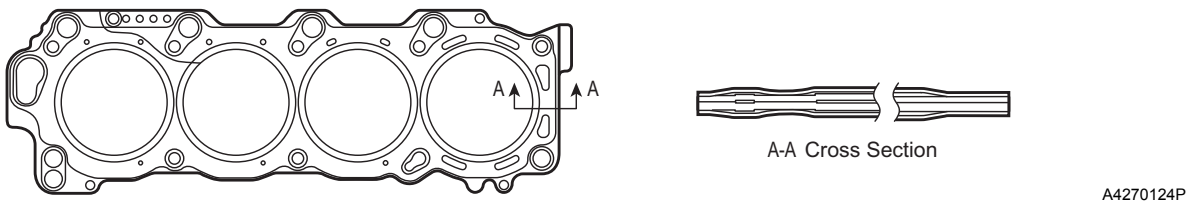
Cylinder Head

- Pentroof type combustion chambers are used. Thus, the wall surface area of each combustion chamber has been reduced, thus ensuring combustion efficiency in all operating ranges.
- Vertical intake ports are used to ensure intake efficiency.
- Slanted squish combustion chambers are used, ensuring combustion efficiency particularly in the low- to medium-speed range.
- A camshaft position sensor that detects the G2 signal is installed on the camshaft timing pulley on the left bank.
- A VVT sensor is installed between the intake #3 journal and the intake #4 journal.
- Along with the use of the VVT-i, an OCV (Oil Control Valve) for VVT-i control is installed on the camshaft bearing cap on the intake #1 journal. In addition, an oil filter for the OCV is installed between the camshaft bearing cap and the cylinder head.



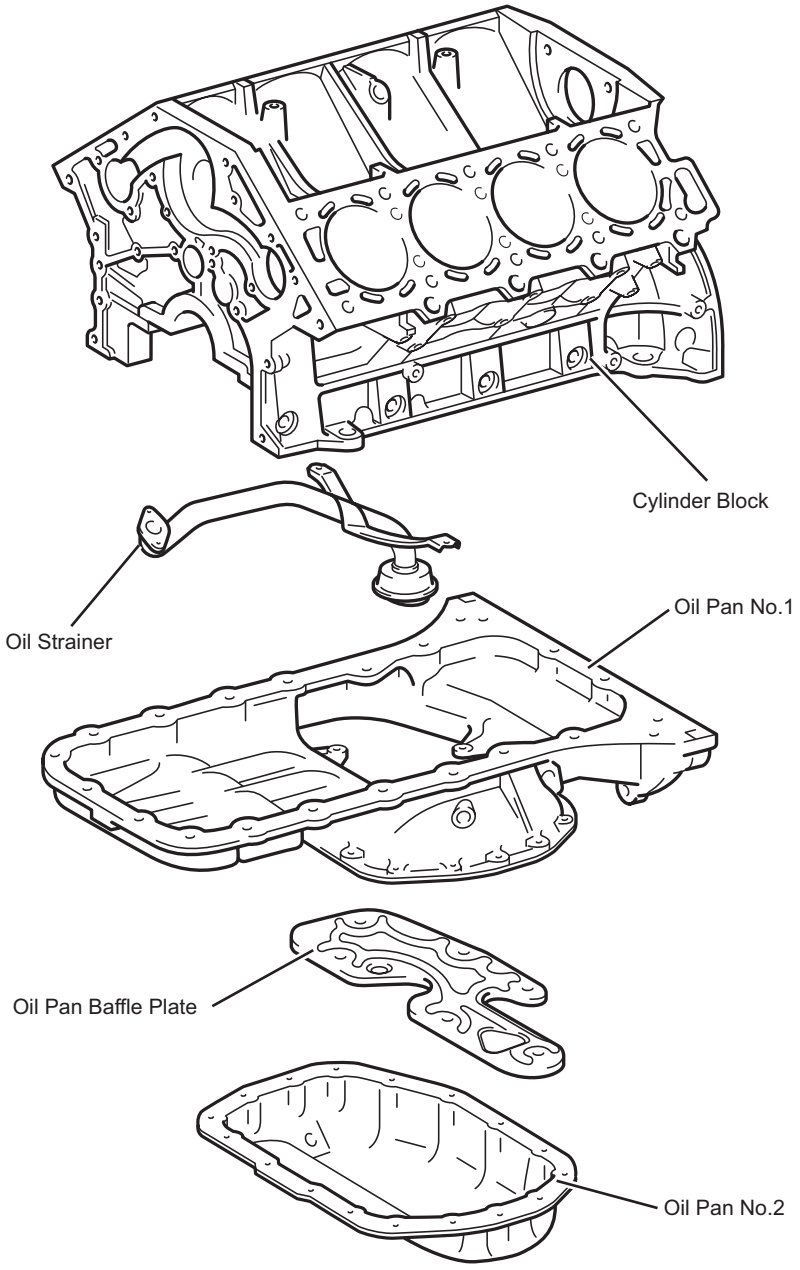
Cylinder Head Gasket

- Cross SectionCylinder head gaskets made of four-layer metal are used to improve reliability. In addition, they reduce the deformation of the cylinder bore to suppress oil consumption, improve exhaust gas emissions, and achieve better fuel economy.



Cylinder Block Fitting Parts

- A lightweight aluminum alloy is used. The outer wall of the block is curved and ribs are provided at the crankshaft journals to improve rigidity.
- Oil pan No. 1 is made of aluminum alloy. It has built-in stiffeners that tighten the cylinder block and the torque converter housing together. This improves rigidity, and results in reducing the vibration from the powerplant and weight reduction.
- Oil pan No. 2 is made of steel plate.
- An FIPG (Formed-In-Place Gasket), which excels in sealing performance, is used on the mating surfaces of the oil pan.

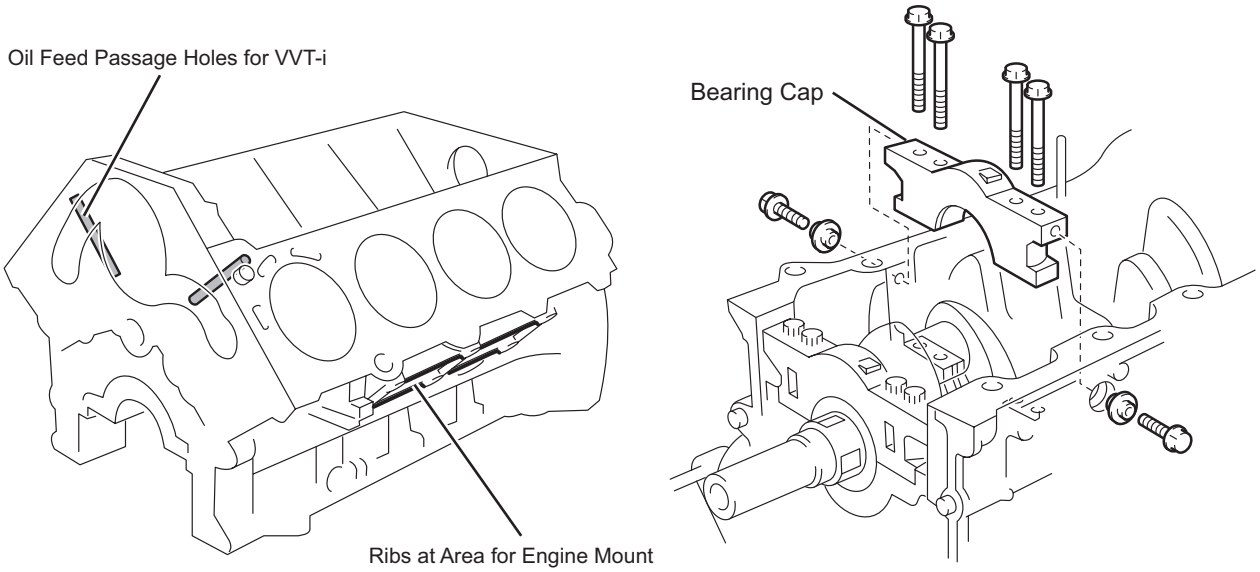


A4270125P

EG

Cylinder Block

- With a 90° bank angle, a 21mm(0.827in.) bank offset, and a 105.5mm(4.154in.) bore pitch, a compact cylinder block has been achieved by keeping the overall length and overall width down.
- A thin cast-iron liner is press-fitted inside the cylinder to ensure an added reliability.
- Passage holes have been added in the No. 2 crankcase bulkhead to reduce pumping loss.
- Ribs have been added to the area for receiving the engine mount brackets to reduce noise.
- The bearing caps have been tightened with the plastic region tightening method to enhance the reliability at the areas for the journals.
- Oil feed passage holes for the VVT-i have been provided inside the V bank in front of the engine.



A4270126P

Cylinder Block

Overall Length [mm (in.)]	495.0 (19.488)
Overall Width [mm (in.)]	440.0 (17.323)
Overall Height [mm (in.)]	320.0 (12.598)
Bore Diameter [mm (in.)]	91.0 (3.583)
Bore Center Distance [mm (in.)]	105.5 (4.154)

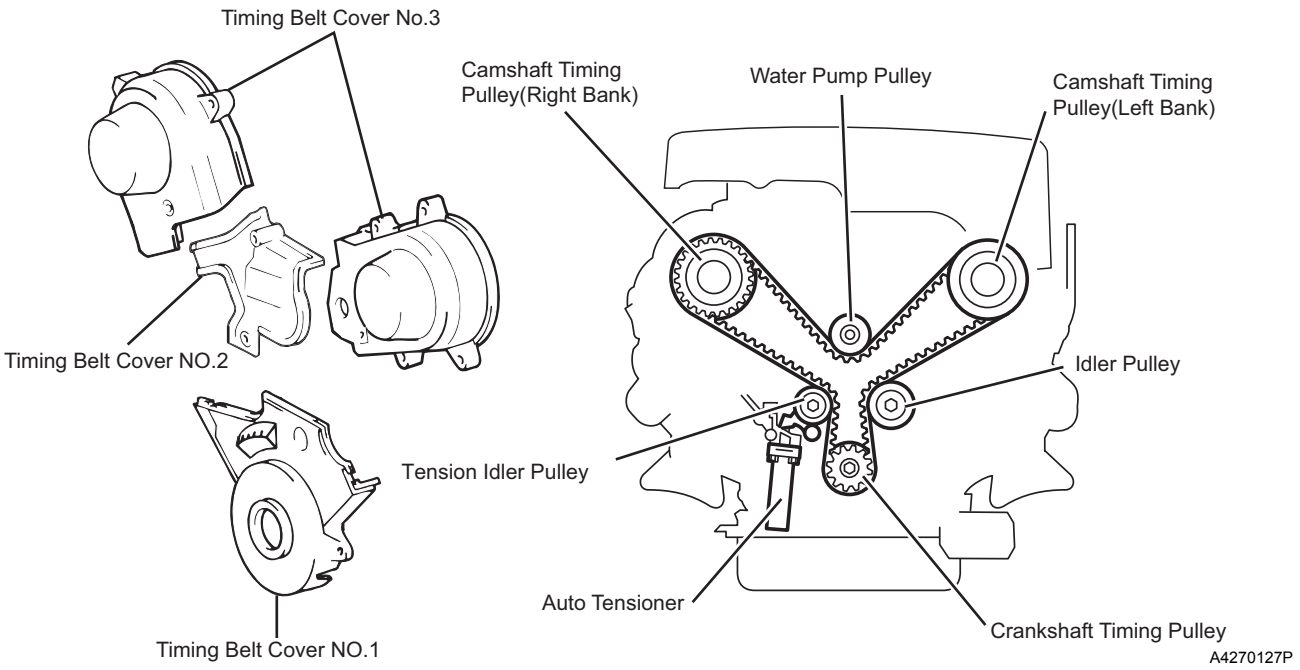
EG

Timing Chain

- The maintenance interval of the timing belt is every 90,000 miles (150,000 km).
- The timing belt cover No. 1 and No. 2 are composite formed with a gasket to improve serviceability.
- The timing belt cover No. 3 is made of aluminum to reduce noise.
- The automatic tensioner suppresses noise generated by the timing belt.
- During a timing belt replacement, the pulleys and the new timing belt have installation marks. Furthermore, the crankshaft timing pulley and the oil pump, as well as the camshaft timing pulleys and the camshaft bearing caps have installation marks.

❒ **NOTICE**

Do not rotate the crankshaft or camshaft with the timing belt removed because it will lead to engine damage when the valves come in contact with the piston head.



Timing Related Pulley Specifications

	Number of Teeth	Pulley Diameter [mm (in.)]
Crankshaft Timing Pulley	24	59.743 (2.352)
Camshaft Timing Pulley	48	120.86 (4.758)
Water Pump Pulley	—	64.0 (2.520)
Idler Pulley	—	66.0 (2.598)
Tension Idler Pulley	—	62.0 (2.441)

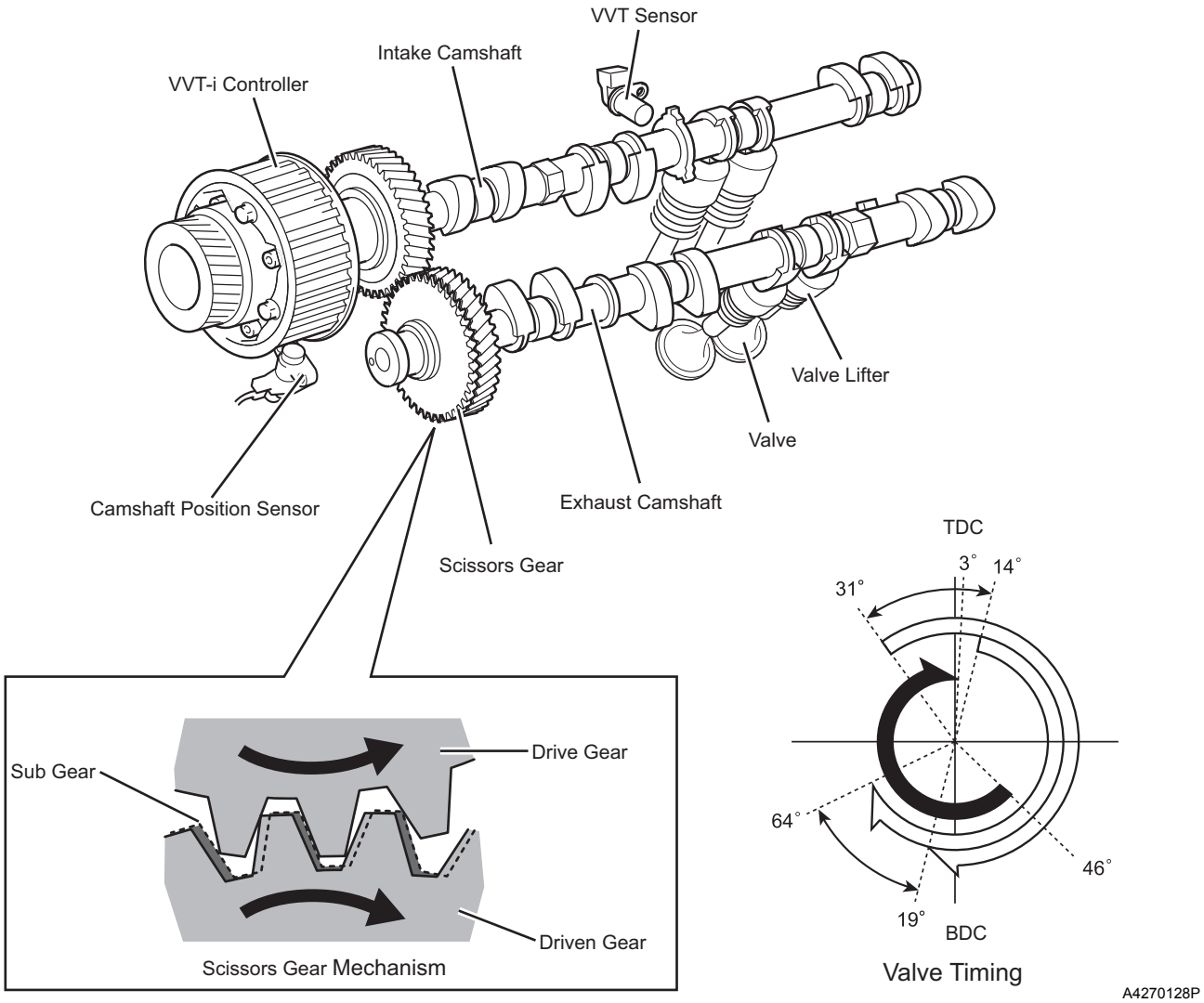
Timing Belt

Length [mm (in.)]	1689.48 (66.515)
Width [mm (in.)]	34.0 (1.339)
Number of Teeth	211

EG

Valve Mechanism

- The VVT-i (Variable Valve Timing-intelligent) system is used to improve fuel economy, engine performance and reduce exhaust emission.
- Inner shim type valve adjusting shims, which allows a greater amount of valve lift, have been adopted.
- The intake camshaft is driven by the crankshaft via the timing belt. The exhaust camshaft is gear-driven by the intake camshaft. Thus, the cylinder head has been made compact.
- The scissors gear mechanism is used on the driven gear of the exhaust camshaft to reduce backlash and suppress gear noise.
- The cam nose has been chill treated to increase its abrasion resistance.
- The valves are made of heat-resistant steel, and the stems and the faces have been nitrocarburized.
- A cam position sensor for detecting the G2 signal is installed on the camshaft timing pulley on the left bank.
- A VVT sensor is installed between the intake #3 journal and the intake #4 journal.



Camshaft

	Intake	Exhaust
Cam Lift Amount [mm (in.)]	8.3 (0.327)	8.27 (0.326)
Cam Lobe Width [mm (in.)]	12.0 (0.472)	←

Valve

	Intake	Exhaust
Overall Length [mm (in.)]	95.05 (3.742)	95.1 (3.744)
Face Diameter [mm (in.)]	34.5 (1.358)	29.0 (1.142)
Stem Diameter [mm (in.)]	5.5 (0.217)	←

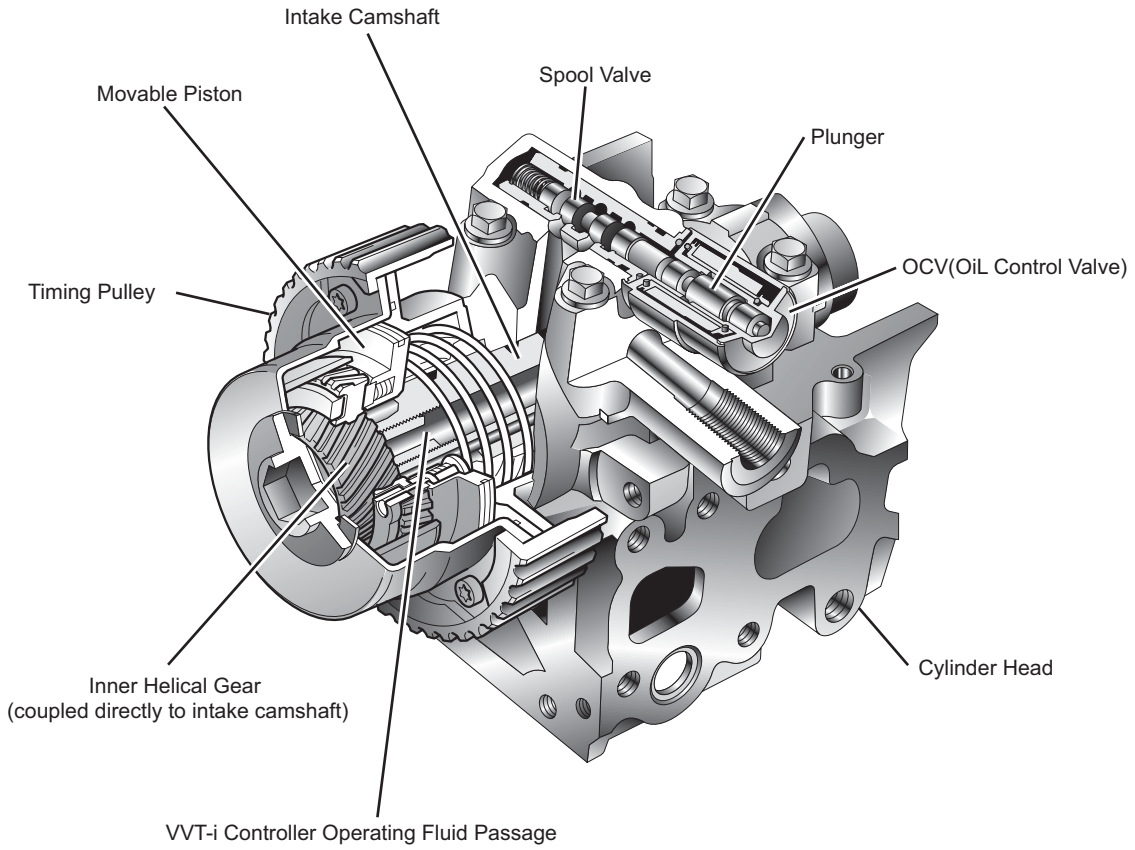
Valve Spring Specifications (common for intake and exhaust)

Coil Inner Diameter [mm (in.)]	18.0 (0.709)
Wire Diameter [mm (in.)]	2.9 (0.114)

EG

VVT-i Controller

- The VVT-i controller consists of an outer helical gear that is mounted to the timing pulley, an inner helical gear that is mounted to the intake camshaft, and a movable piston that contains helical splines along its inner and outer peripheries.
- The duty cycle signals from the engine ECU cause the plunger in the OCV (Oil Control Valve) to actuate, thus moving the spool valve to switch the hydraulic pressure that acts on the advance chamber and the retard chamber of the VVT-i controller.
- The hydraulic pressure from the OCV acts on the movable piston through the oil passage inside the intake camshaft, causing the movable piston to rotate axially. At this time, the helical splines cause the outer helical gear and the inner helical gear to rotate in the relative directions, and a phase difference is created between the timing pulley and the intake camshaft.
- The VVT-i controller controls this phase difference in order to constantly achieve optimal valve timing in accordance with the driving conditions.

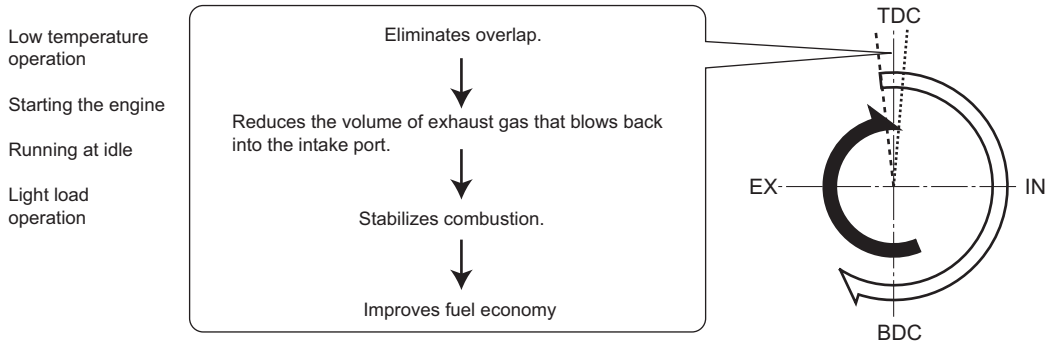


*The illustration shows a conceptual image. The actual shape differs slightly.

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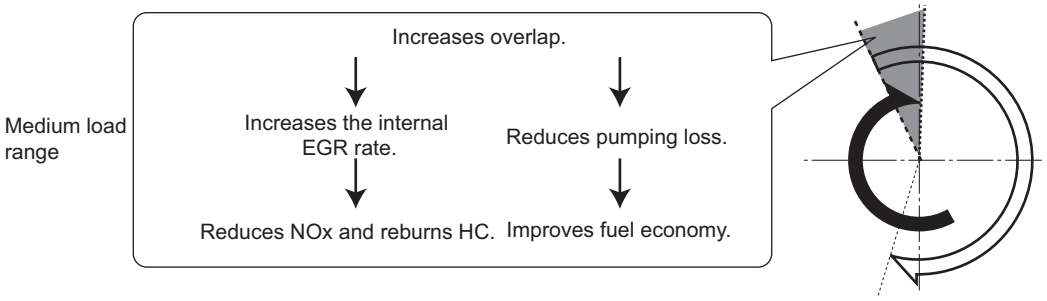
Effects of VVT-i

- The VVT-i continuously varies the phases of the camshaft in order to regulate the valve timing in accordance with the driving conditions. Thus, it realizes fuel economy, high power output, and low emissions.



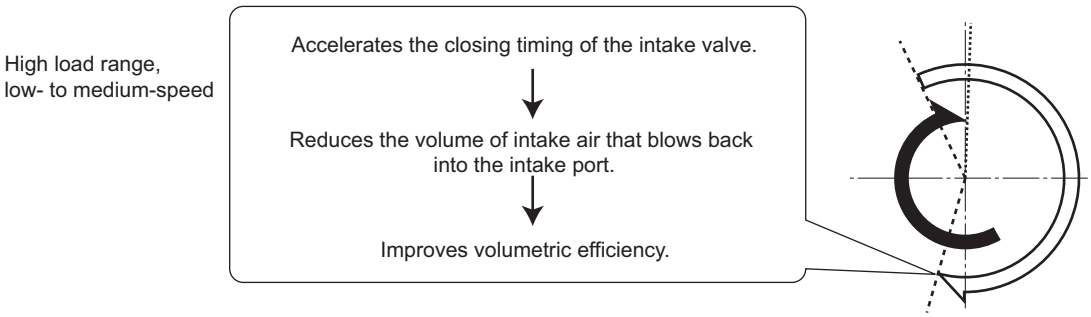
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Medium load range



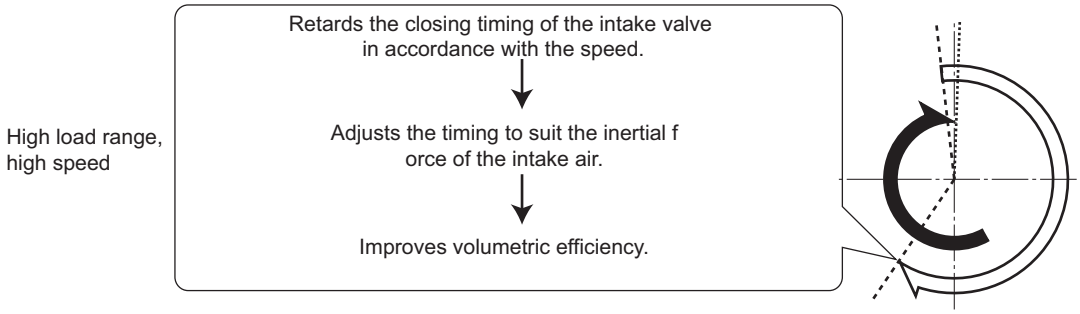
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High load range,low- to medium-speed



A4270132P

High load range, high speed

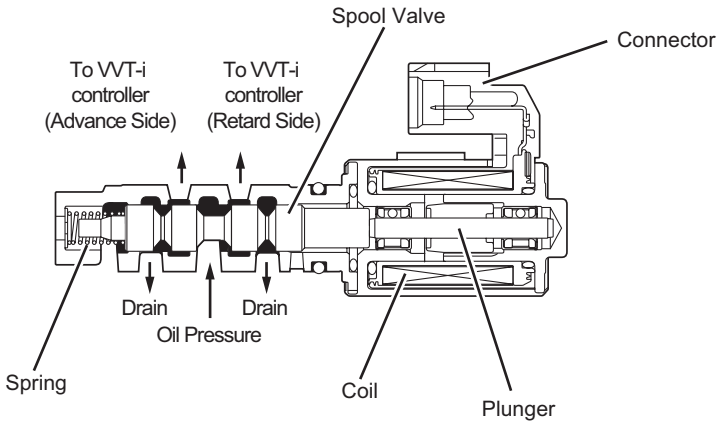


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EG

Camshaft Timing Oil Control Valve

- The camshaft timing oil control valve controls the spool valve position in accordance with the duty control from the engine ECU.
- When the engine is stopped, the camshaft timing oil control valve is in the most retarded state.

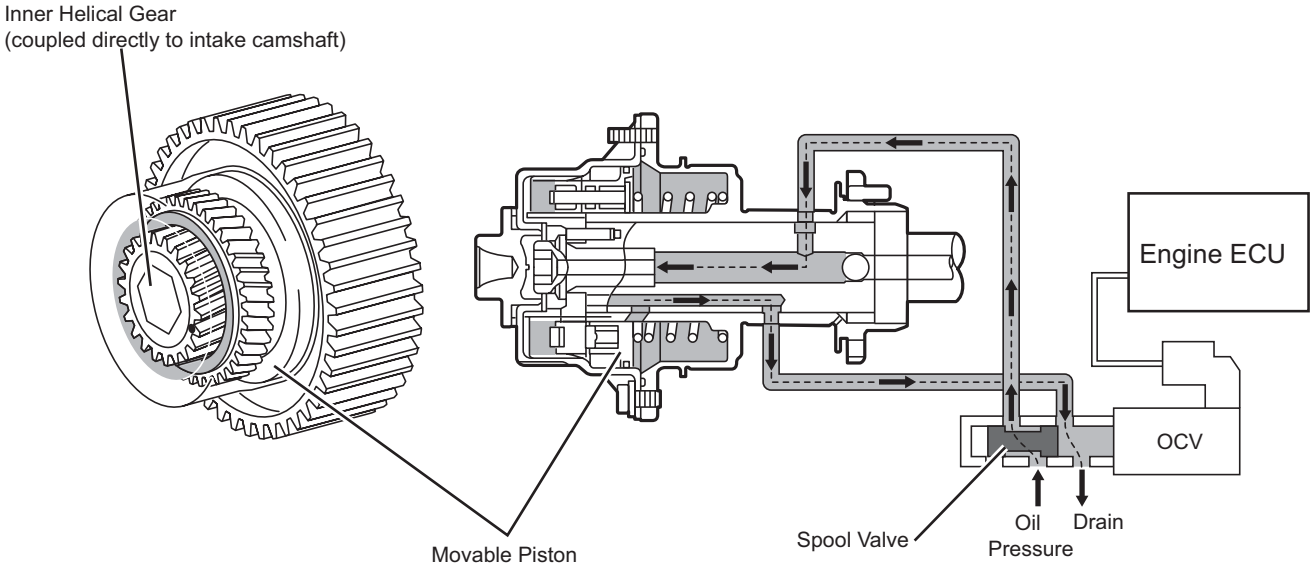


*The illustration shows the OCV for the right bank.

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Advance

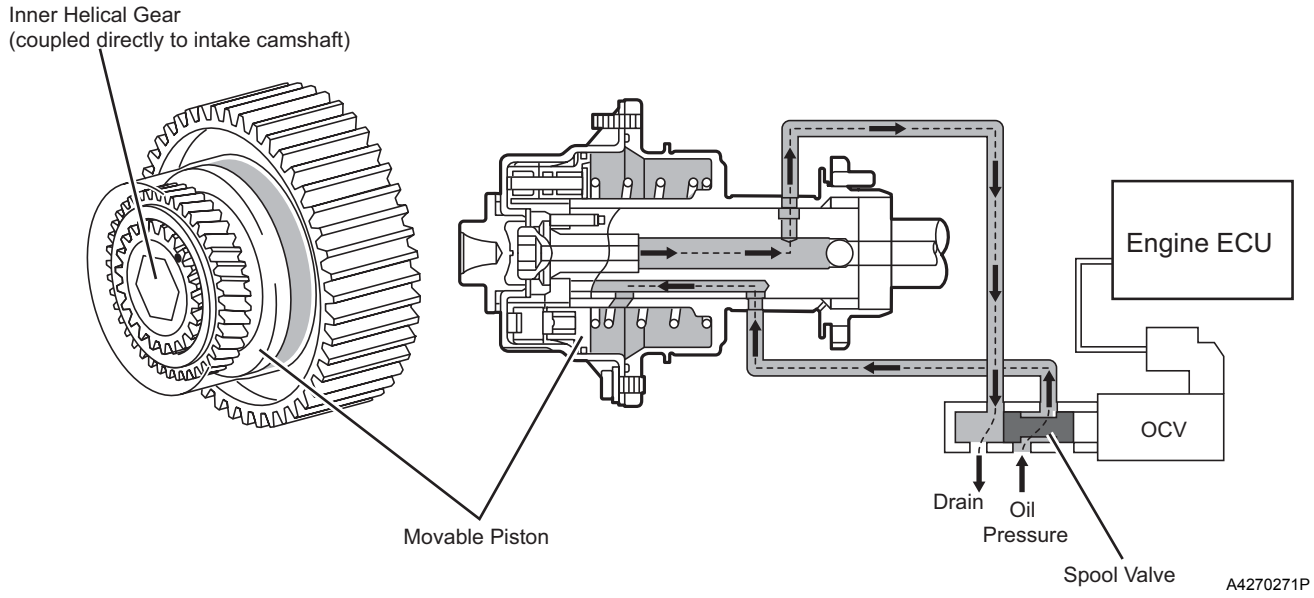
- When the camshaft timing oil control valve is positioned as illustrated in accordance with the advance signal from the engine ECU, the oil pressure is applied to the chamber at the advance side. Then, the twist of the helical spline causes the camshaft to rotate in the direction of timing advance.



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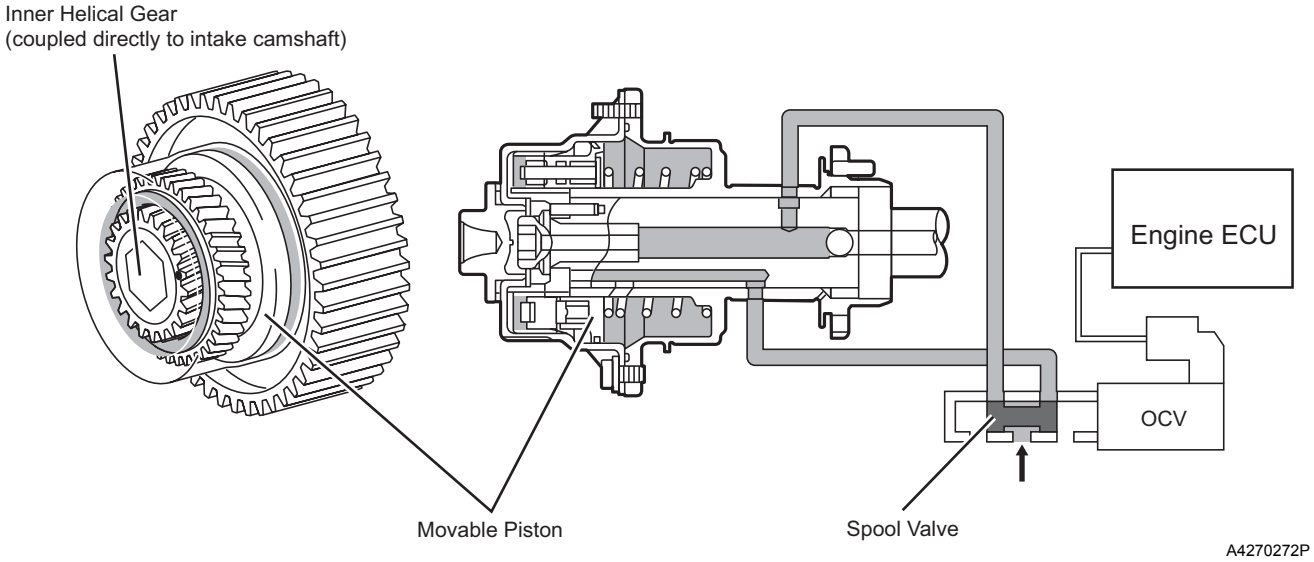
Retard

• When the camshaft timing oil control valve is positioned as illustrated in accordance with the retard signal from the engine ECU, the oil pressure is applied to the chamber at the retard side. Then, the twist of the helical spline causes the camshaft to rotate in the direction of timing retard.



Hold

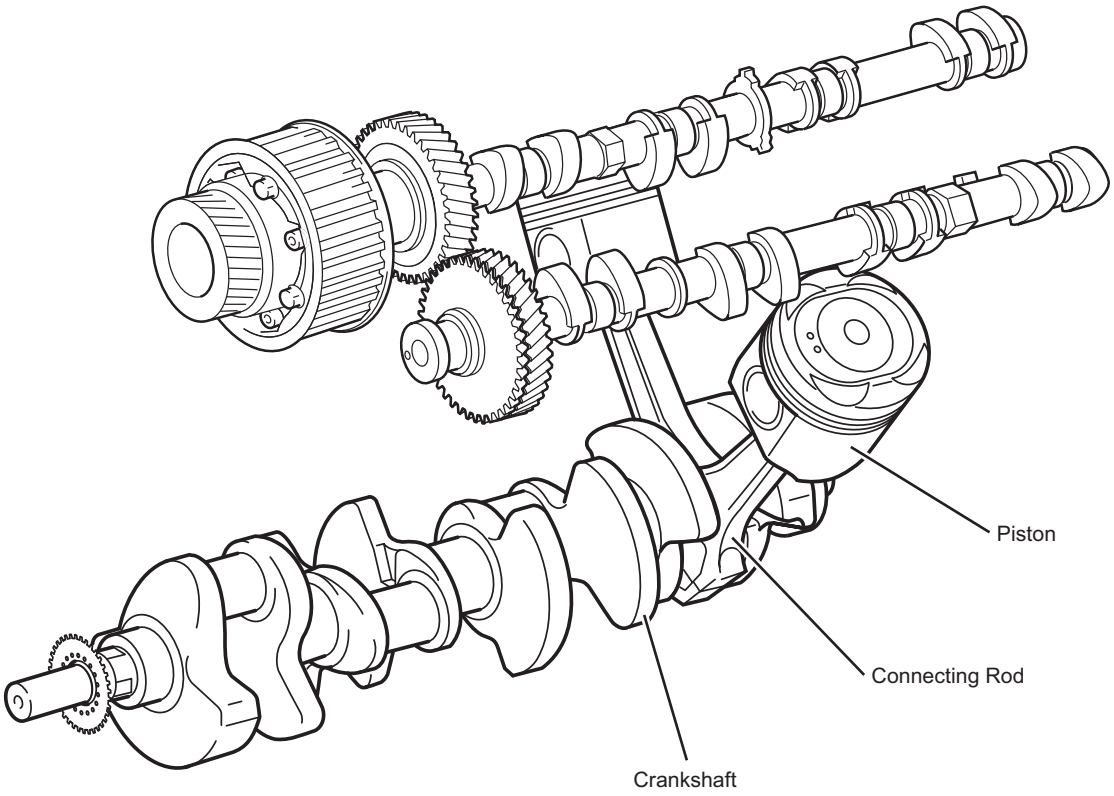
• The engine ECU calculates the target timing angle according to the traveling state to perform control as described above. After setting at the target timing, the valve timing is held by keeping the camshaft timing oil control valve in the neutral position unless the traveling state changes.This adjusts the valve timing at the desired target position and prevents the engine oil from running out when it is unnecessary.



EG

Piston and Crankshaft

- The pistons are made of high temperature strength aluminum alloy.
- The highly rigid sintered and forged connecting rod is used.
- A forged crankshaft with 5 main journals, 4 connecting rod pins and 8 balance weights is used.



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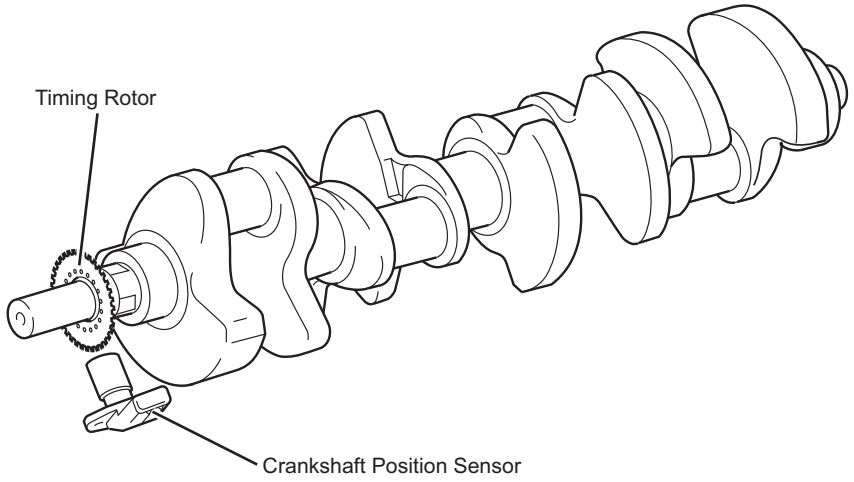
Connecting Rod

Big End Inside Diameter	[mm (in.)]	55.0 (2.165)
Small End Inside Diameter	[mm (in.)]	22.0 (0.866)
Center distance between big and small ends	[mm (in.)]	146.0 (5.748)

EG

Crankshaft

- By optimizing the shape of the balance weights, the crankshaft has been made lightweight, and its response has been improved. In addition, the weights have been arranged optimally to reduce the bearing load, thus improving the reliability of the bearings and reducing friction.
- A forged crankshaft with 5 main journals, 4 connecting rod pins and 8 balance weights is used.
- Crank pins and main journals are induction-hardened to make sure the reliability.
- A timing rotor for detecting the crankshaft position has been installed.



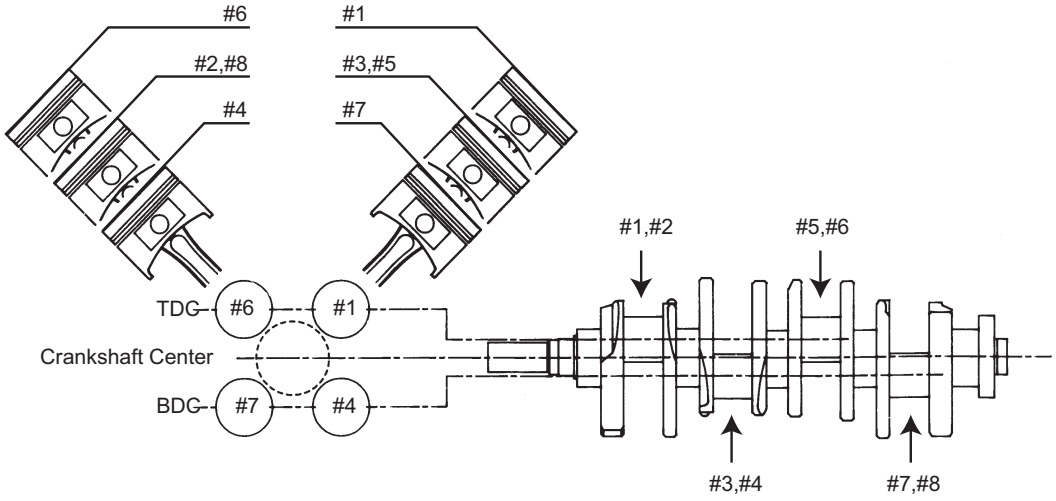
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Crankshaft

Journal Diameter	[mm (in.)]	67.0 (2.638)
Crank Pin Diameter	[mm (in.)]	52.0 (2.047)
Crank Pin Stroke Radius	[mm (in.)]	41.25 (1.624)

Relation between a crank pin position and a piston position

- The drawing below shows the positions of the crankshaft pins and pistons.
- Numbers of the crankshaft and pistons are shown on the right side.

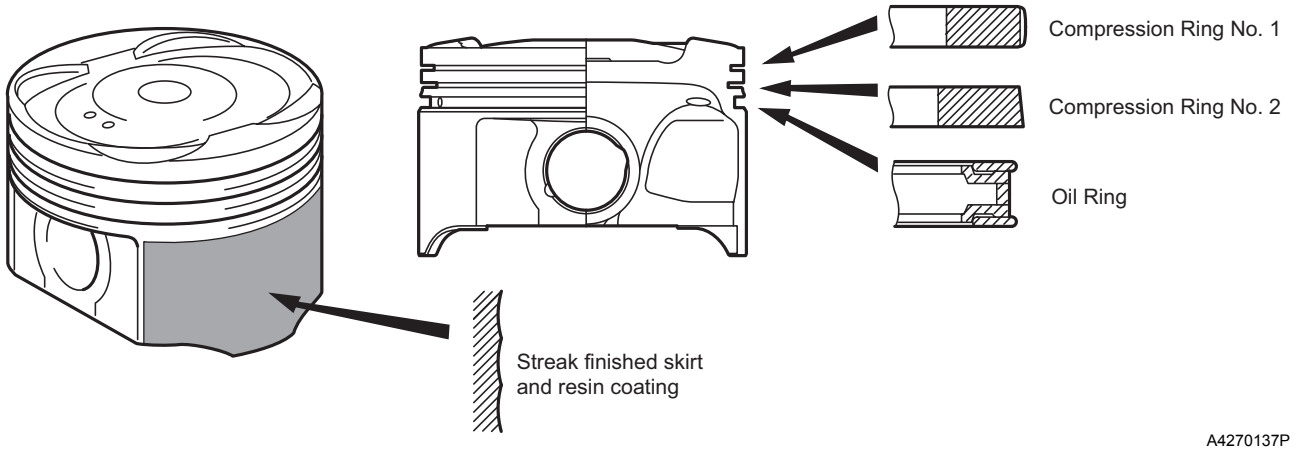


A4270136P

EG

Piston

- The piston head portion has adopted a taper squish shape to improve the fuel combustion efficiency.
- The piston skirt has been coated with resin to reduce the friction loss.
- Full floating type piston pins are used.
- The bearing pressure on compression rings No. 1 and No. 2 has been secured to reduce the tension of the oil ring, which realizes fuel economy.



Piston

Basic Diameter	[mm (in.)]	91.0 (3.583)
Piston Pin Offset	[mm (in.)]	1.0 (0.039)
Height	[mm (in.)]	60.5 (2.382)
Compression Height	[mm (in.)]	34.0 (1.339)

Piston Pin

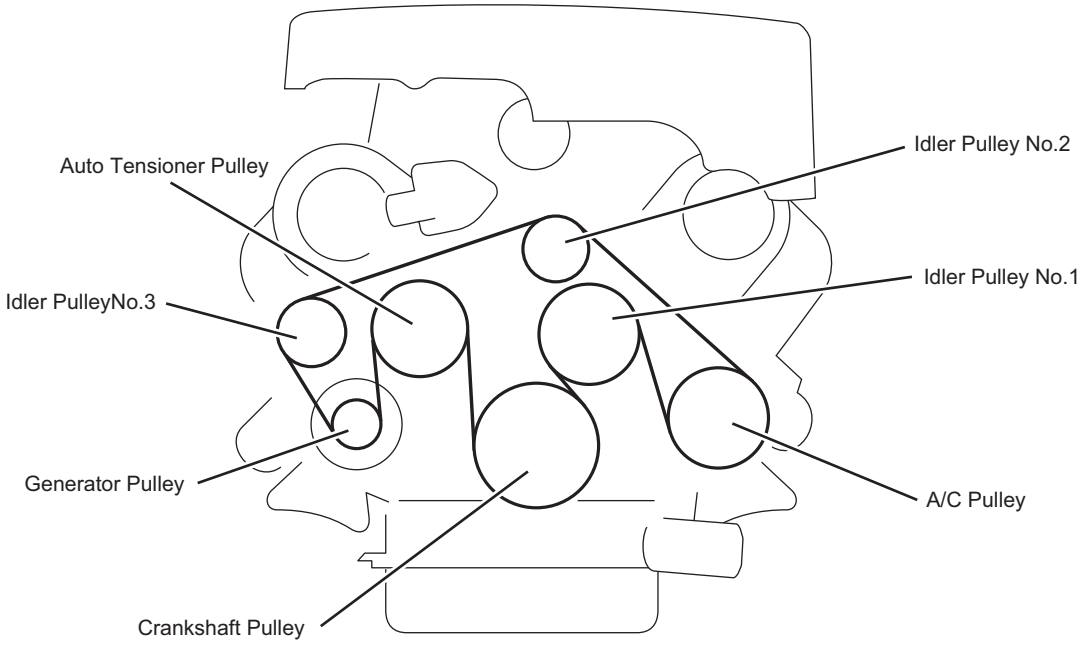
Diameter	[mm (in.)]	22.0 (0.866)
Inner Diameter	[mm (in.)]	13.5 (0.531)
Length	[mm (in.)]	62.0 (2.441)

Piston Ring

	Compression Ring No. 1	Compression Ring No. 2	Oil Ring
Material	Stainless Steel	Cast Iron	Stainless Steel
Shape	Barrel Face	Tapered Face + Undercut	Combination
Width [mm (in.)]	1.2 (0.047)	1.2 (0.047)	3.0 (0.118)
Thickness [mm (in.)]	2.9 (0.114)	3.6 (0.142)	2.55 (0.1)
Surface Treatment	Gas nitriding	Zinc phosphate film	Side rail: zinc phosphate film Periphery: buff finish

Serpentine Belt Drive System

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



Pulley Specifications

Crankshaft Pulley	[mm (in.)]	145 (5.709)
Idler Pulley No.1	[mm (in.)]	110 (4.331) (driven from back face)
A/C Pulley	[mm (in.)]	115 (4.528)
Idler Pulley No.2	[mm (in.)]	70 (2.756)
Idler Pulley No.3	[mm (in.)]	70 (2.756)
Generator Pulley	[mm (in.)]	52.5 (2.067)
Auto Tensioner Pulley	[mm (in.)]	90 (3.543) (driven from back face)

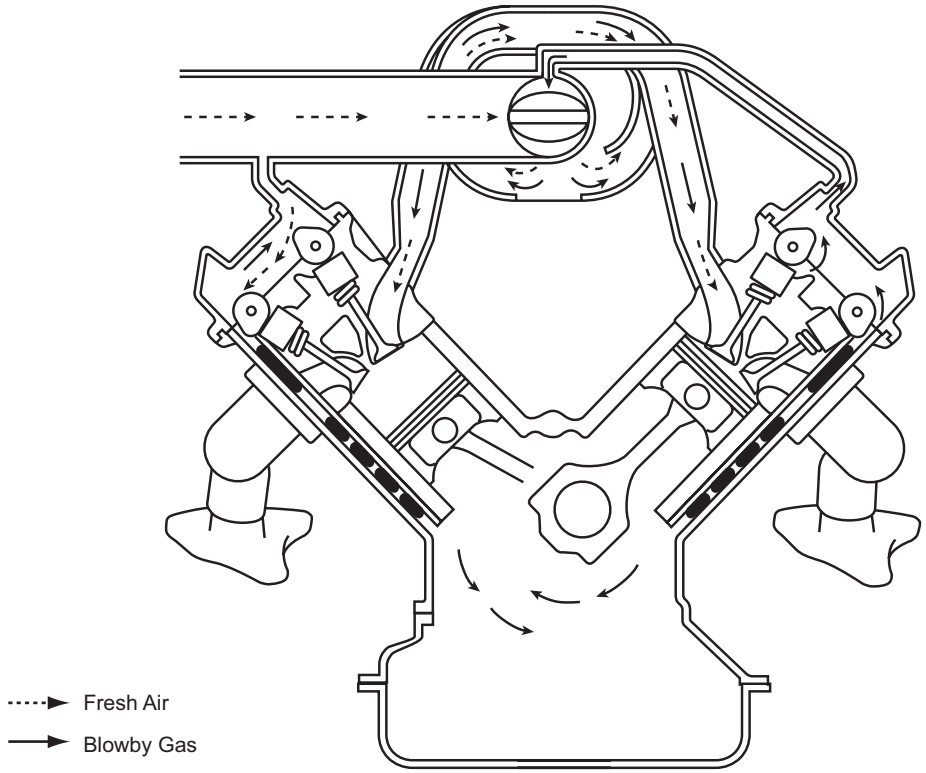
V Ribbed Belt Specifications

Width	[mm (in.)]	21.36 (0.841)
Length	[mm (in.)]	2120 (83.465)
Number of Ribs		6

EG

Blowby Gas Reduction System

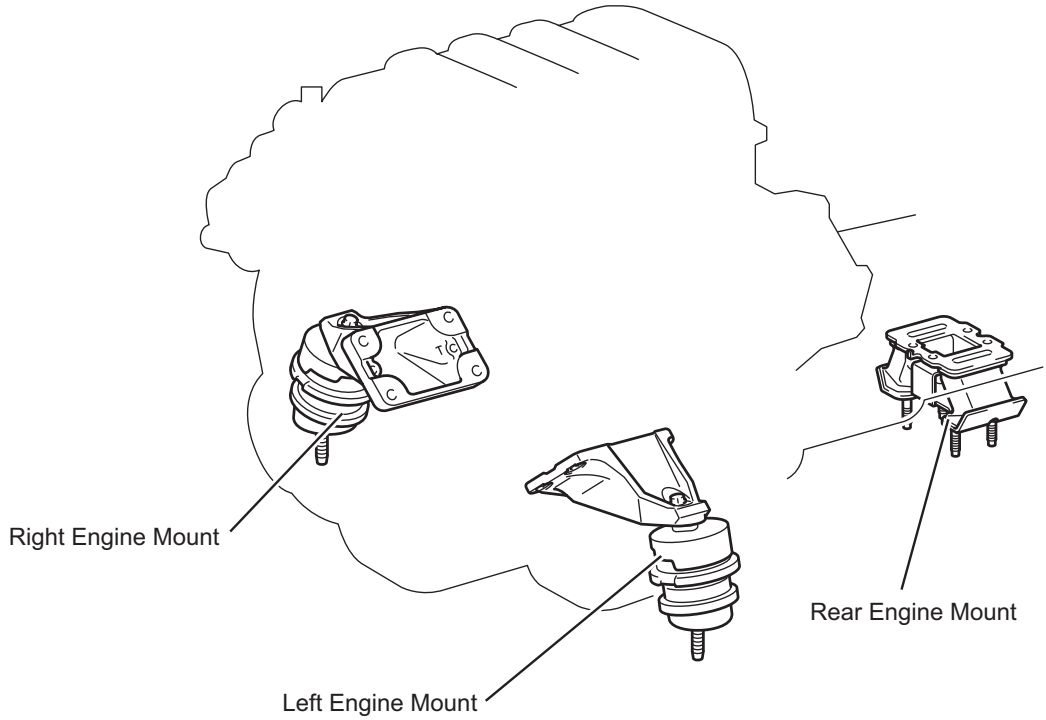
- A blowby gas reduction system is used. This system forcefully introduces the blowby gas in the engine into the intake system, to be combusted. A PCV valve is provided in the cylinder head cover, in order to reduce the volume of the blowby gas in accordance with the driving conditions, the volume of oil that is taken away has been reduced, and the idle speed has been lowered.
- Fresh air enters the cylinder head cover on the right bank via the air cleaner hose. After it has circulated inside the crankcase, it travels together with the blowby gas via the inside of the cylinder head cover in the left bank, and becomes drawn into the intake manifold.

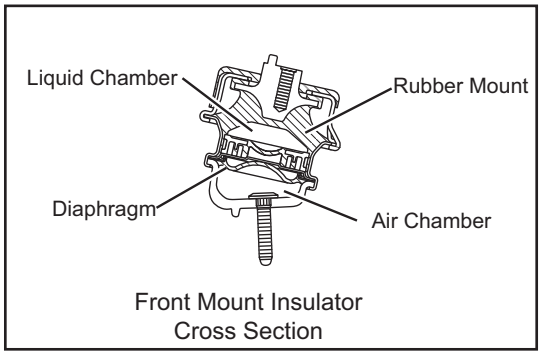


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Engine Mounts

- Liquid-filled engine mounts are used in front, and the shape of the rubber mounts has been optimized to reduce vibration and noise.
- The shape of the rear engine mount has been optimized to improve reliability and inhibit the transfer of the transmission gear noise to the body.





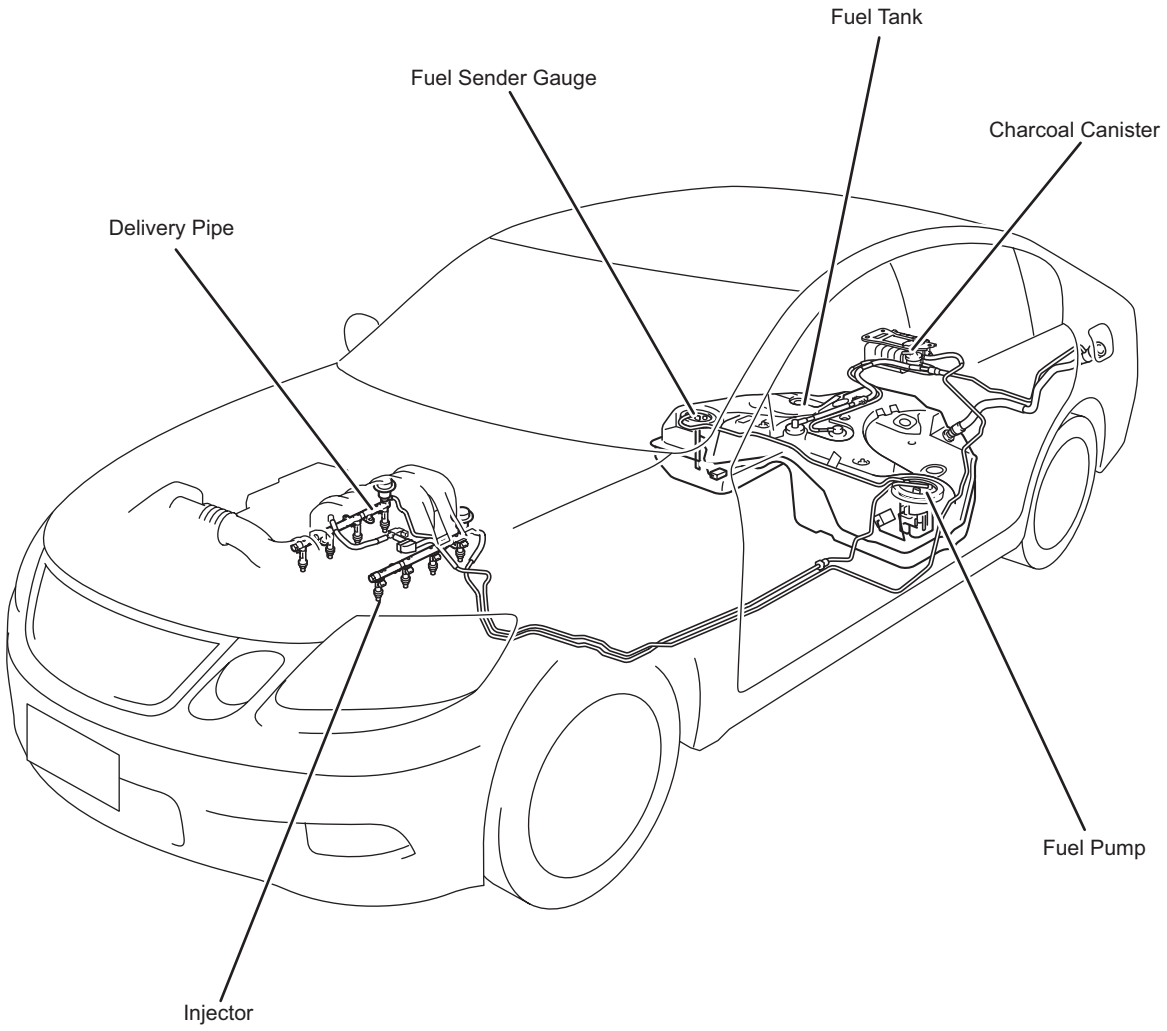
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3UZ-FE FUEL

EG

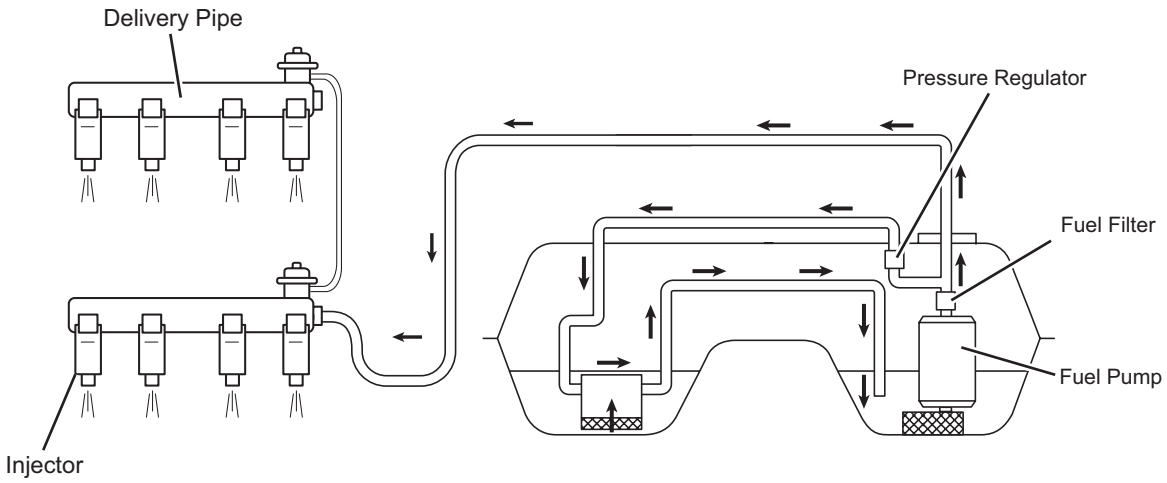
General

- A fuel returnless system has been used to reduce evaporative emissions.
- 2 pulsation dampers are used to realize a quieter operation.
- An air-assist system has been adopted.



Fuel Returnless System

- The system is to reduce the evaporative emission. As shown below, integrating the pressure regulator, jet pump, and fuel filter with the fuel pump assembly made it possible to discontinue the return of fuel from the engine area and prevent temperature rise inside the fuel tank.

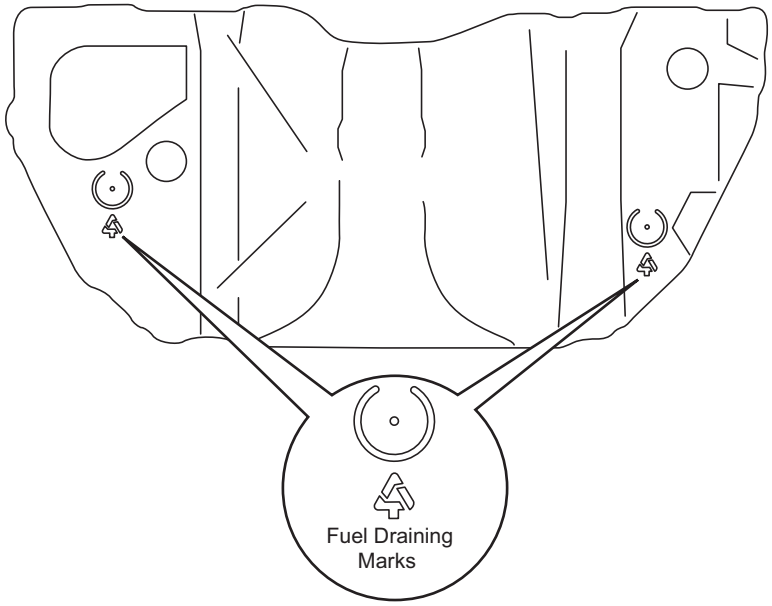


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EG

Fuel Tank

- The fuel tank is mounted in the center of the vehicle, forward of the rear axle. It has a capacity of 71.0 liters.
- The fuel tank adopts a saddle shape to allow the propeller shaft to pass through its center portion.
- Two sender gauges (main, sub), fuel pump, fuel filter, pressure regulator, and jet pump have been integrated.
- Fuel draining marks have been provided on the bottom of the fuel tank. These marks clearly indicate the position for aligning the fuel draining device during dismantling, and simplify and ensure the reliable draining of fuel.

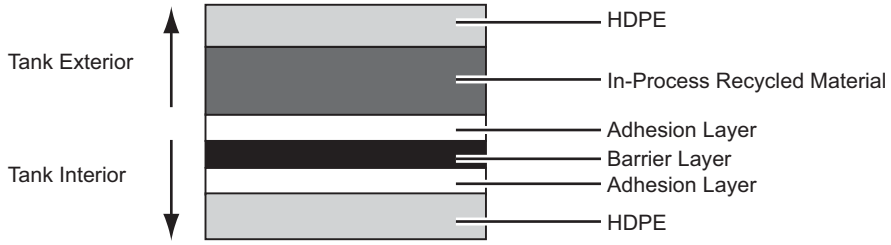


Fuel Tank Bottom View

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Plastic Fuel Tank

• A fuel tank made of plastic is used for weight reduction. It consists of six layers of plastic to ensure the long life of the tank and the low permeation of fuel.



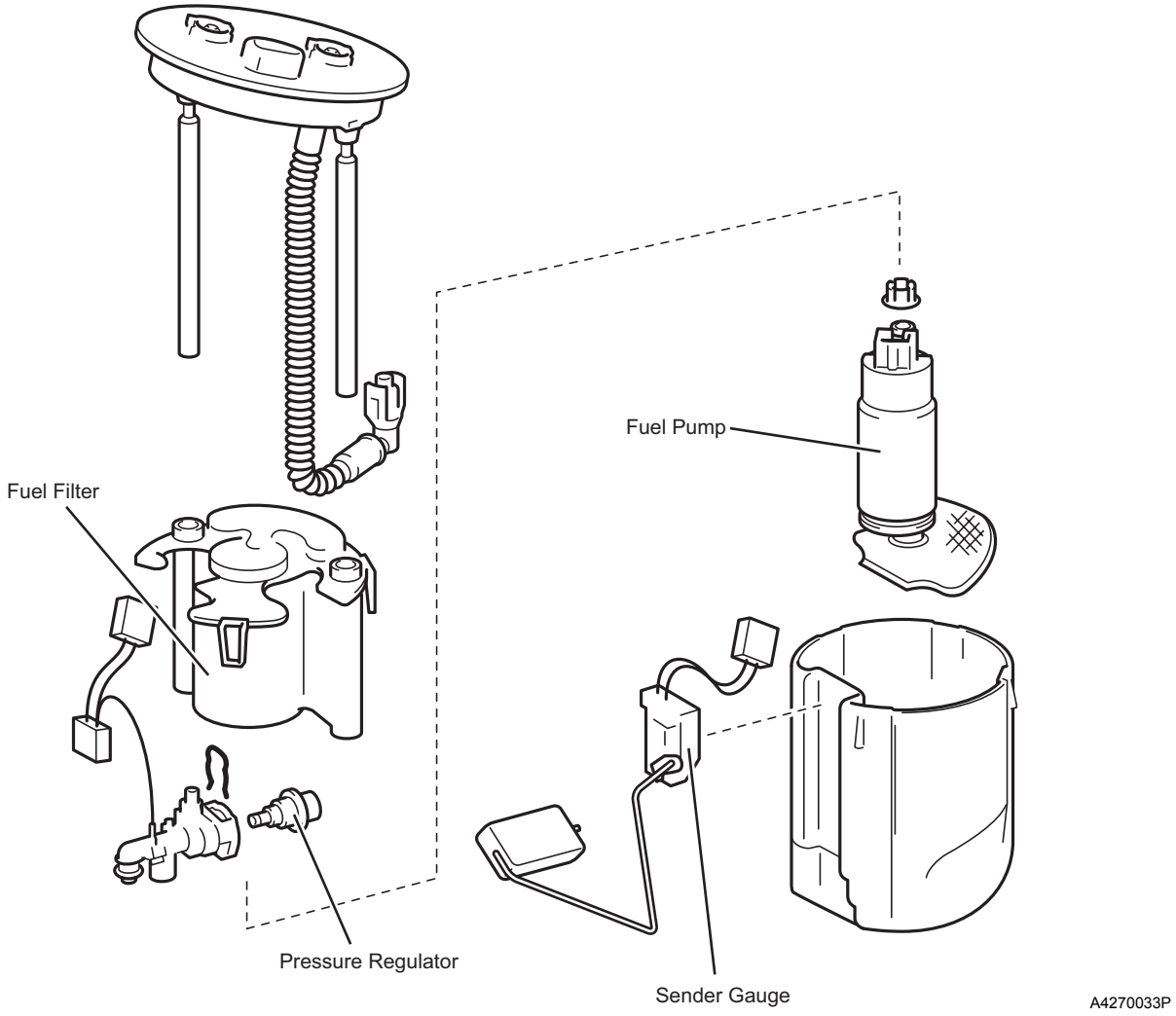
*HDPE(High Density Polyethylene):High Density Polyethylene It is lightweight, high strength,and excels in water and solvent resistance.

Layer Composition of Fuel Tank

A4270048P

Fuel Pump

- A compact fuel pump in which a fuel filter, pressure regulator, and jet pump are integrated in the fuel pump assembly has been adopted.
- A circular flow type in-tank fuel pump is used.



Fuel Pump

Pressure Regulator Control Pressure [kPa]	324
Discharge Volume [L/h] (at discharge pressure 324 kPa)	150 Minimum

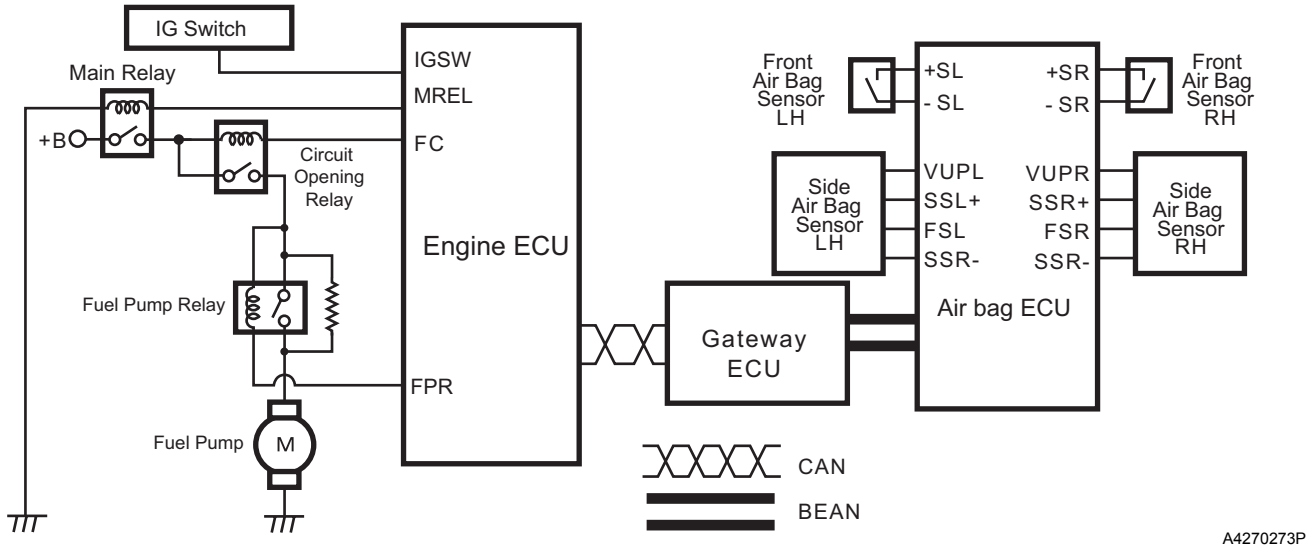
Fuel Filter

Filter System	Paper Filter Type
Filter Area [cm^2]	1550

EG

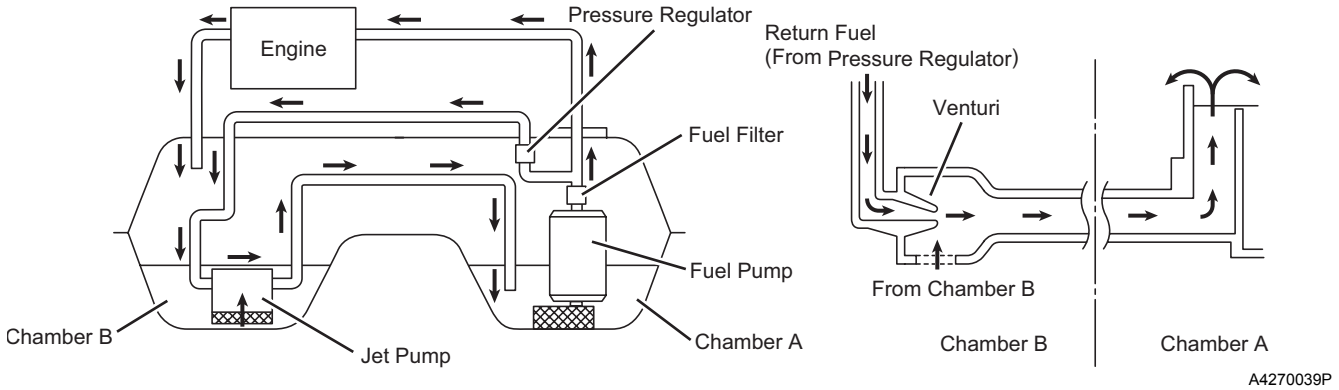
Fuel Pump Control

- When the starter signal is ON and the engine speed signal is input continuously for 2 seconds or longer, the circuit opening relay turns ON to actuate the fuel pump.
- A fuel cut control is adopted to stop the fuel pump when the airbag is deployed at the front or side collision. In this system, the airbag deployment signal from the airbag sensor assembly is detected by the engine ECU, which turns OFF the circuit opening relay.
- After the fuel cut control has been activated, turning the ignition switch from OFF to ON cancels the fuel cut control, thus engine can be restarted.



Jet Pump

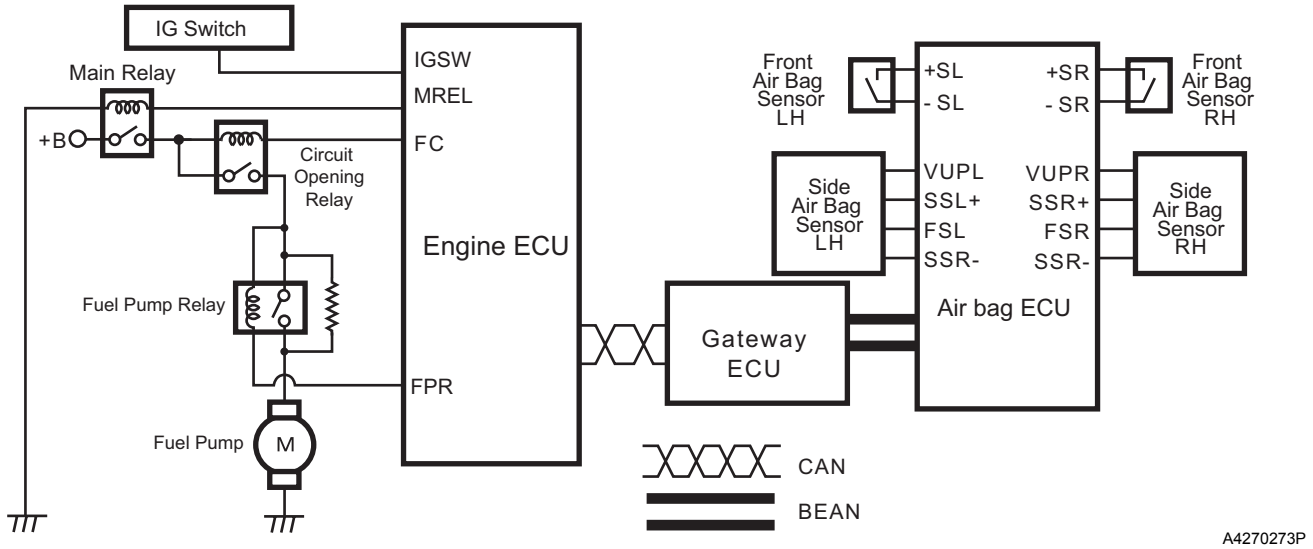
- The jet pump operates as described below.
- A jet pump is adopted in the fuel tank. Since the propeller shaft is located below its center bottom, the fuel tank of the GS430 is shaped as indicated below.
- A fuel tank with such a shape tends to cause the fuel to be dispersed into both chamber A and chamber B when the fuel level is low, stopping the fuel in chamber B from being pumped out. To prevent this from occurring, a jet pump has been provided to transfer the fuel from chamber B to chamber A.
- This is accomplished by utilizing the flow of the fuel, so that the vacuum created by the fuel, as it passes through the venturi is used to suck the fuel out of chamber B and send it to chamber A.



EG

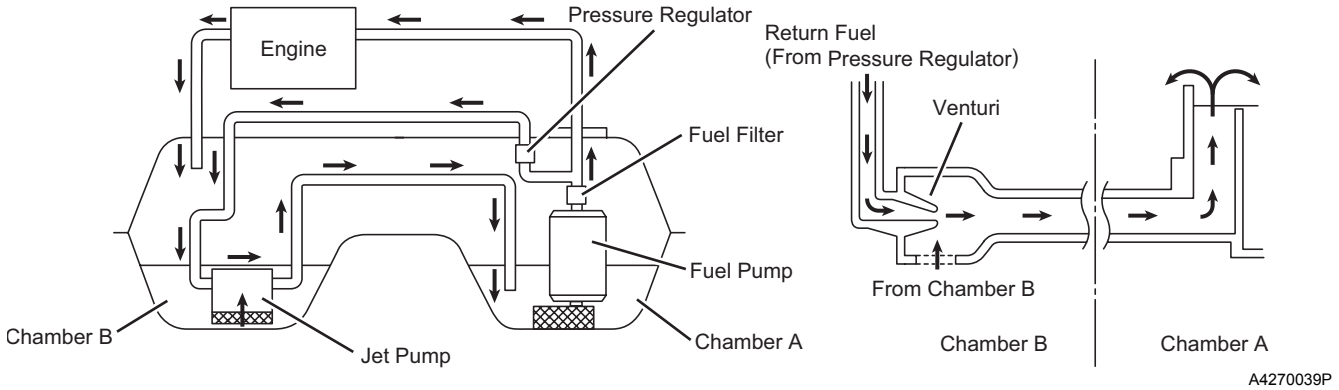
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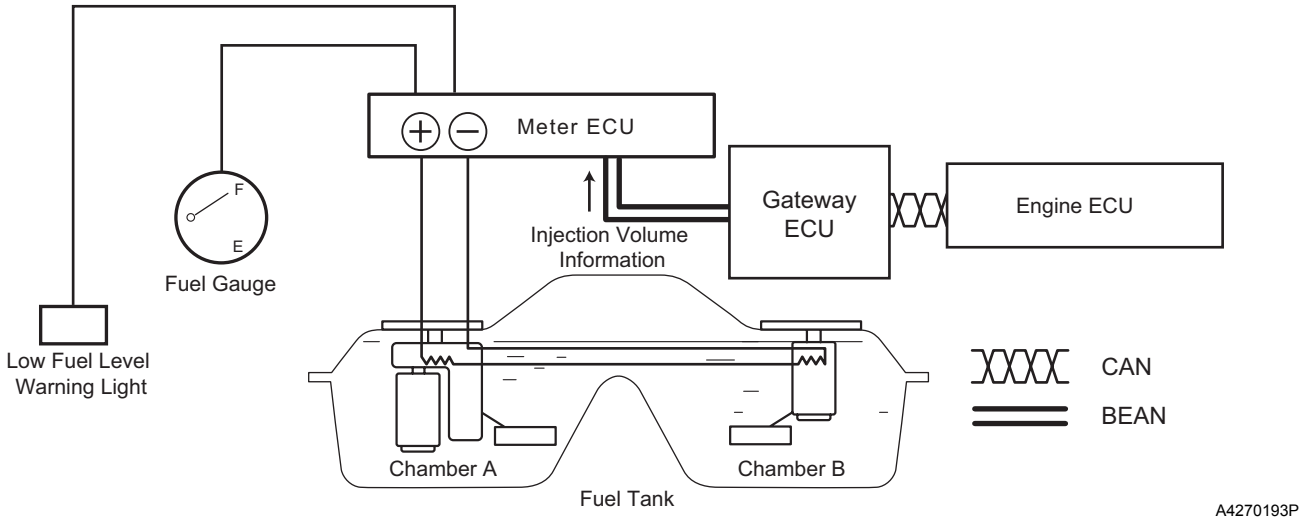
Jet Pump

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Fuel Sender Gauge

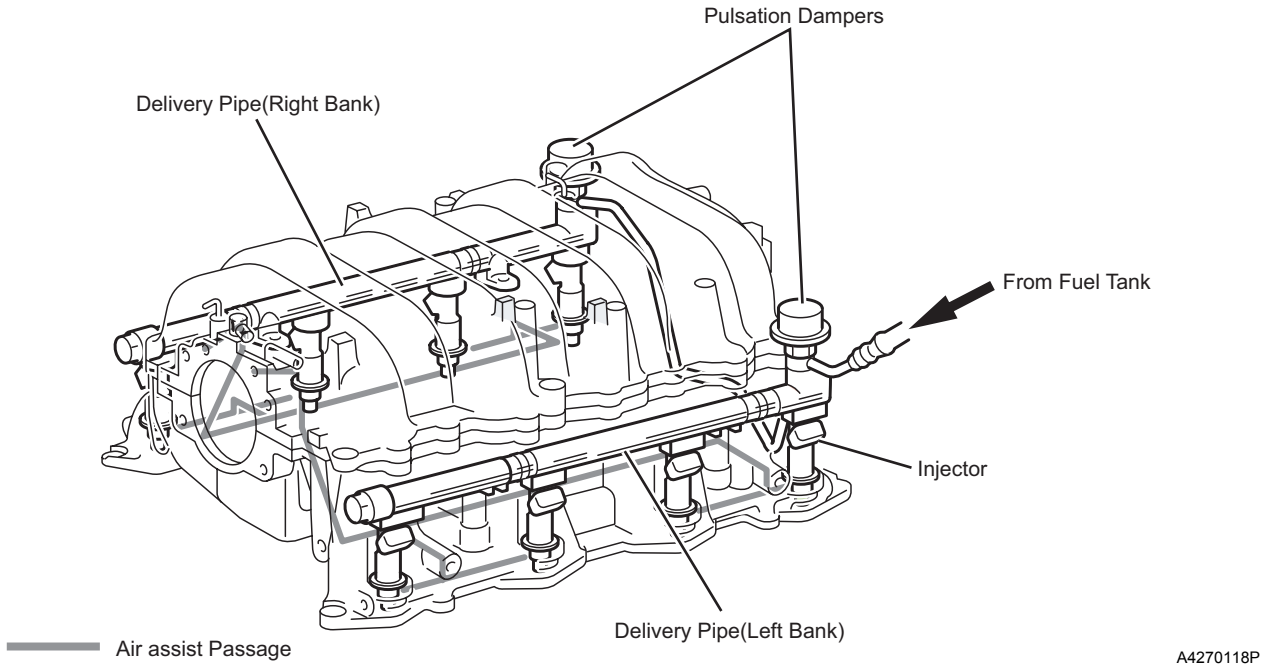
- To accurately inform the driver of the residual fuel volume in the saddle-shaped tank, inline sender gauges are provided in the two chambers, A and B. These sender gauges output the residual fuel volume of both chambers to the meter ECU.
- Based on the signals received from the two sender gauges and the EFI control information received from the engine ECU, the meter ECU calculates the residual fuel volume, and activates the fuel gauge.



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Delivery Pipe

- A delivery pipe made of lightweight aluminum is used.
- Pulsation dampers are provided on the right and left banks, respectively, to prevent the pulsation of the fuel.

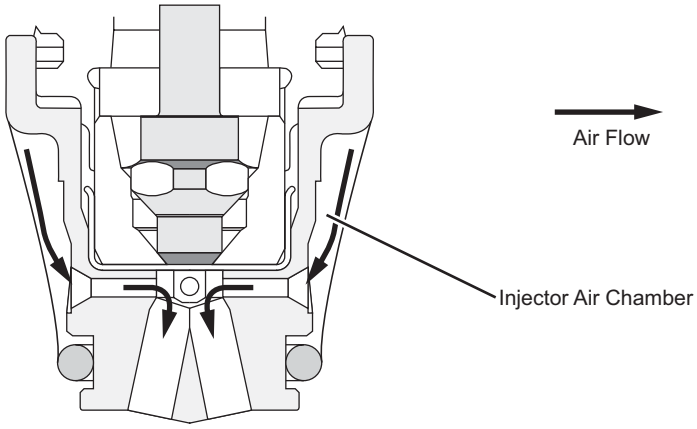


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EG

Injector

- A compact 4-hole type fuel injector has been used.
- Air introduced from the throttle body and air gallery flows through the air chamber formed by the O-ring and insulator under the fuel injector and then is mixed with the fuel. This design promotes atomization of the fuel.
- Air assist injectors that excel in the atomization of fuel are used. They are installed so as to connect the air gallery of the intake manifold to the nozzle of the injector.



Air Assist Injector Tip

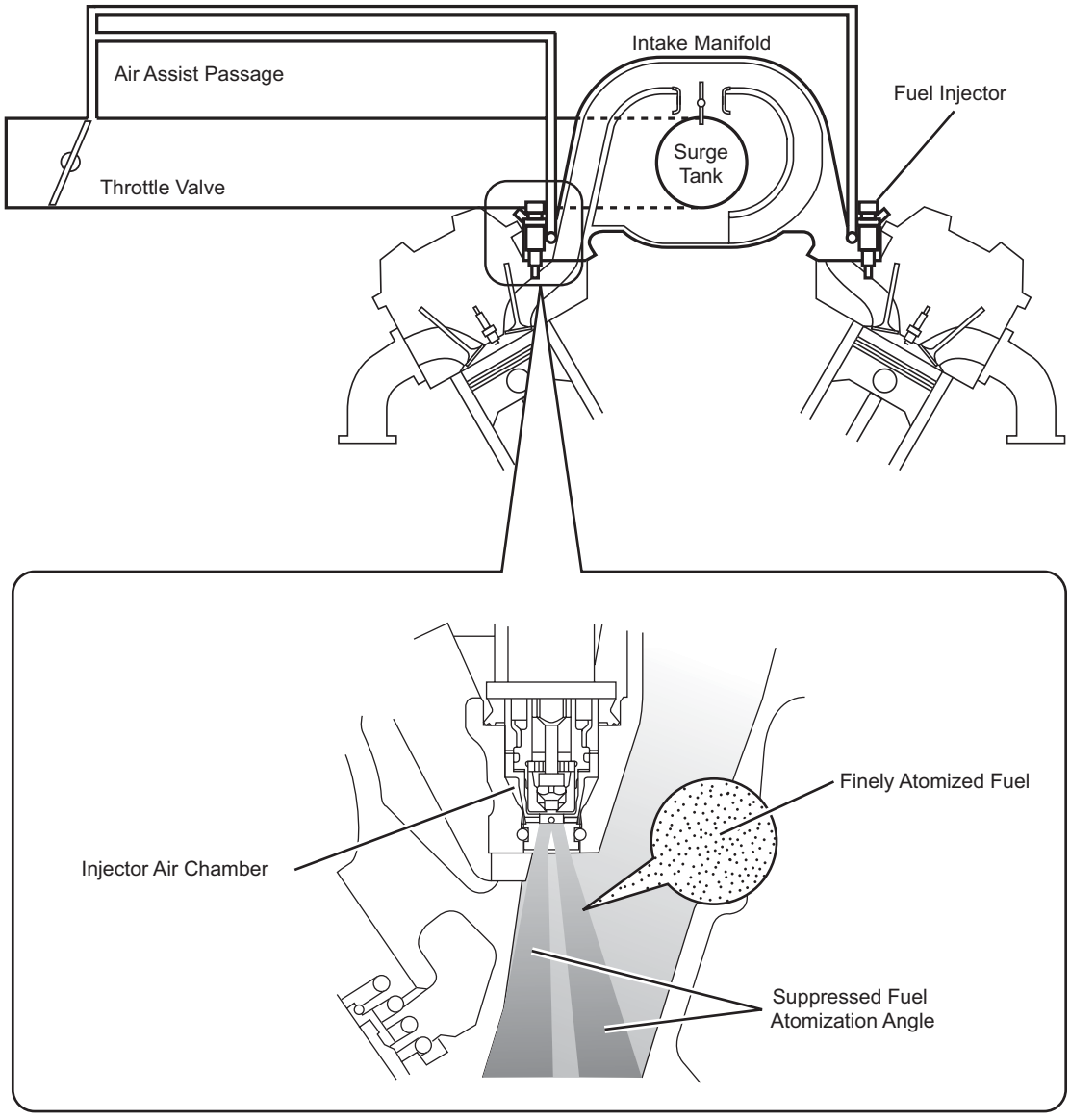
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Fuel Injector

Nozzle Diameter [mm (in.)]	0.29 (0.011)
Number of Orifices	4

Air Assist System

- An air assist fuel injector mixes air and fuel at the end of the injector. It atomizes fuel to ensure complete combustion and suppresses the adhesion of fuel against the wall of the intake port, thus realizing a favorable engine response.
- This system is designed to regulate air intake (atmospheric side) using the throttle valve, and direct it to the nozzle of the fuel injector inside the intake manifold (negative pressure side). This promotes atomization of the fuel while reducing emissions and improving fuel economy and idle stability.

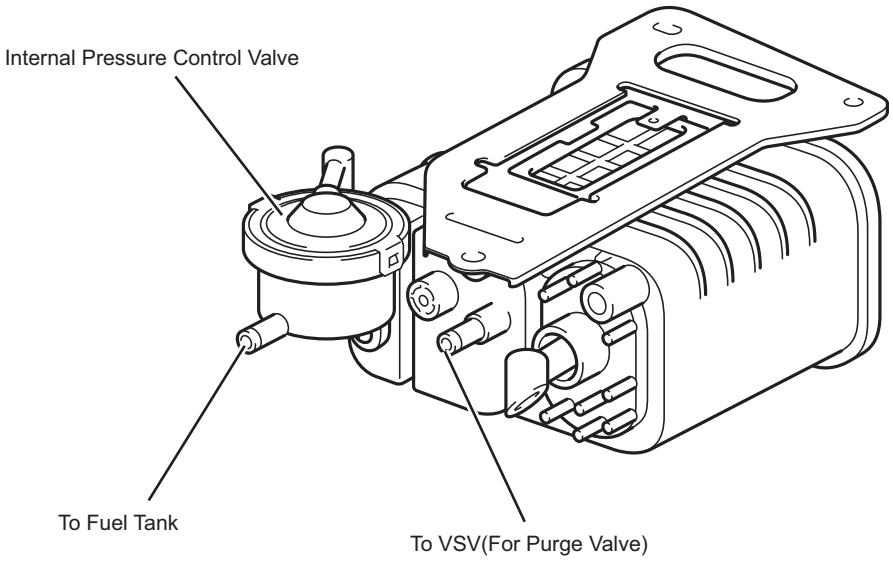


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EG

Charcoal Canister

- Canister purge control is used to draw the fuel evaporative gas created in the fuel tank into the intake port, to be burned during combustion.
- The charcoal canister is mounted behind the fuel tank.
- An internal pressure control valve is provided at the fuel passage inlet from the fuel tank in order to maintain the proper pressure in the fuel tank.

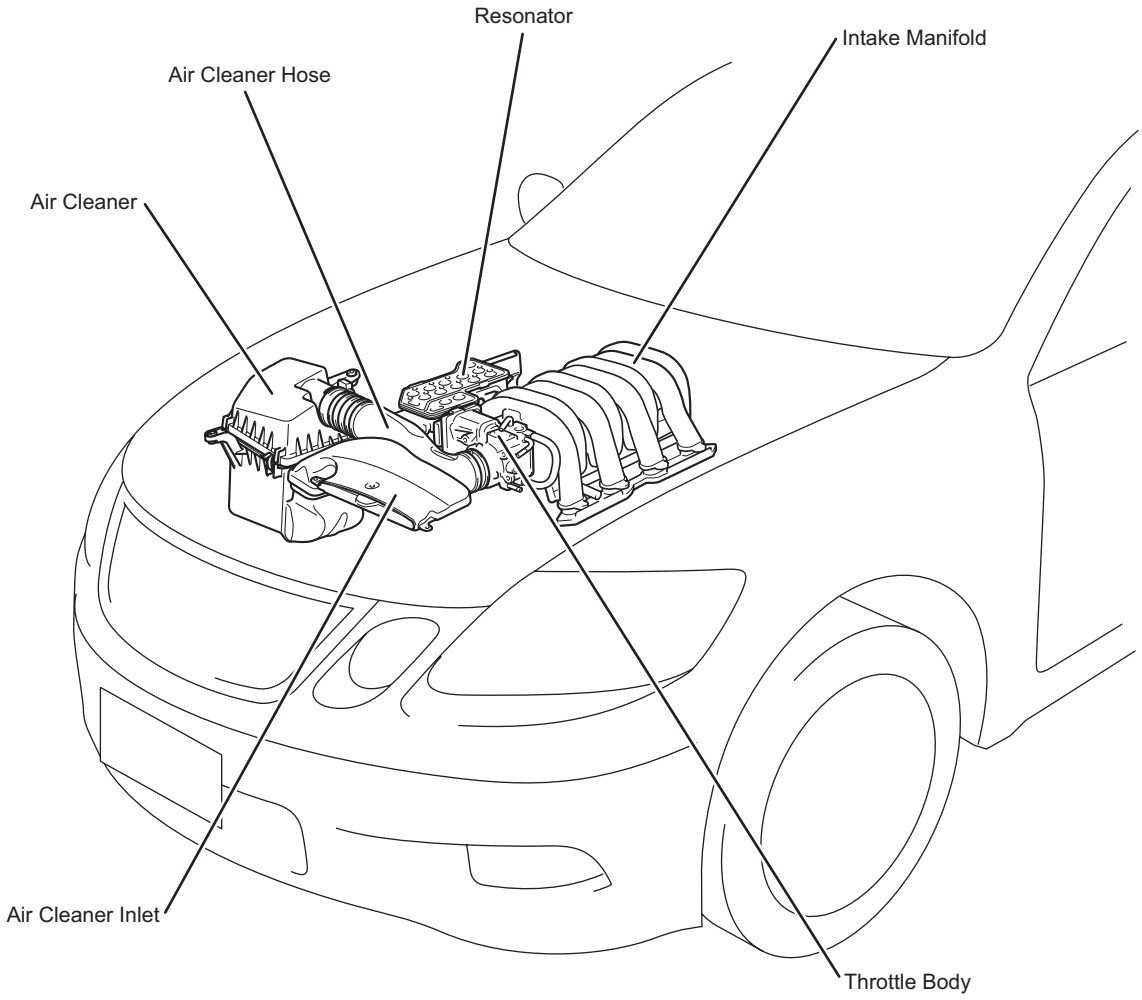


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3UZ-FE INTAKE

General

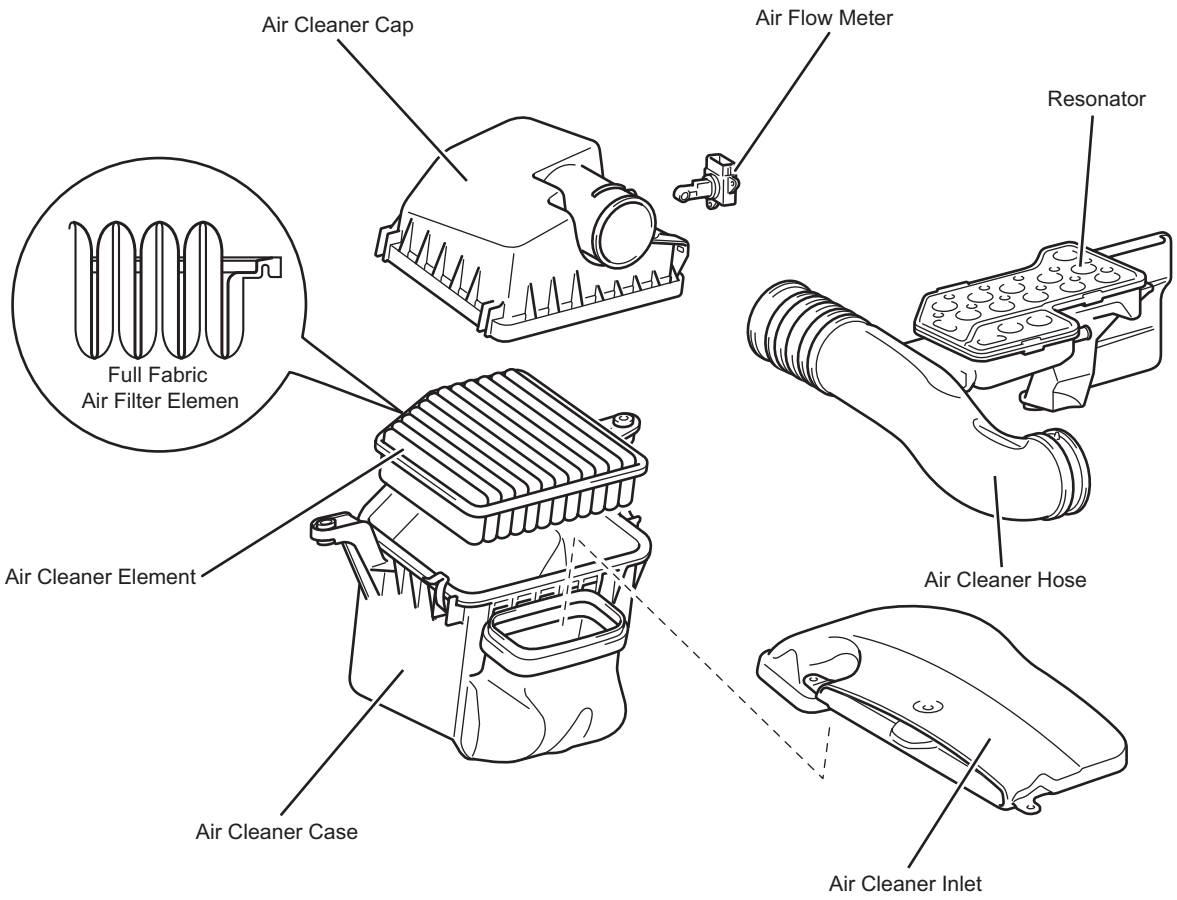
- The soft and hard areas of the air cleaner hose are composite-formed to ensure reliability. In addition, a large resonator is installed to reduce intake noise.
- The adoption of the ETCS-i (Electronic Throttle Control System-intelligent) has realized excellent throttle control.
- The adoption of the ACIS (Acoustic Control Induction System) has improved the engine performance.



EG

Air Cleaner

- An air cleaner case and air cleaner cap made of lightweight plastic are used.
- A resonator is provided on the air cleaner hose to reduce intake noise.
- A compact, lightweight, hot-wire type plug-in air flow meter is provided on the air cleaner cap.
- A frameless, full-fabric air filter has been adopted to reduce weight and to simplify its disposal.
- The air cleaner case has been increased in size to reduce the amount of intake air noise, and the construction of the air cleaner element has been optimized to achieve weight reduction.



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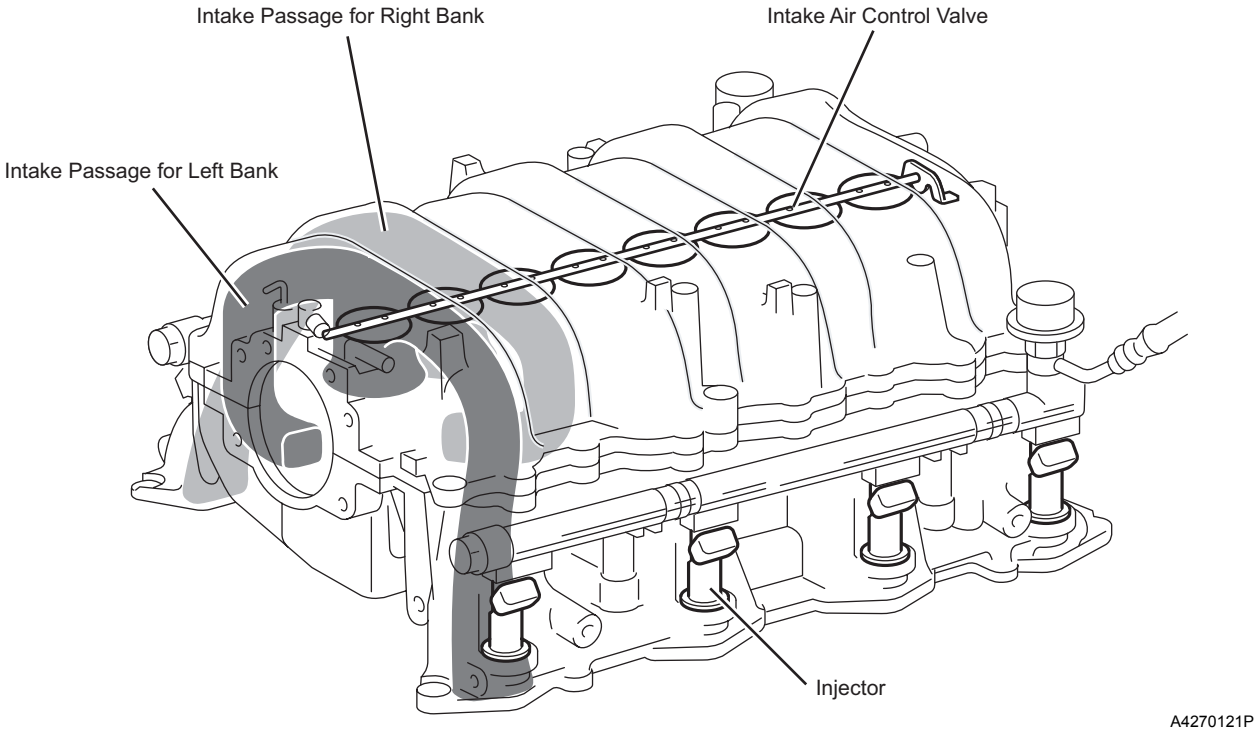
Air Flow Meter

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

(See page EG-205)

Intake Manifold

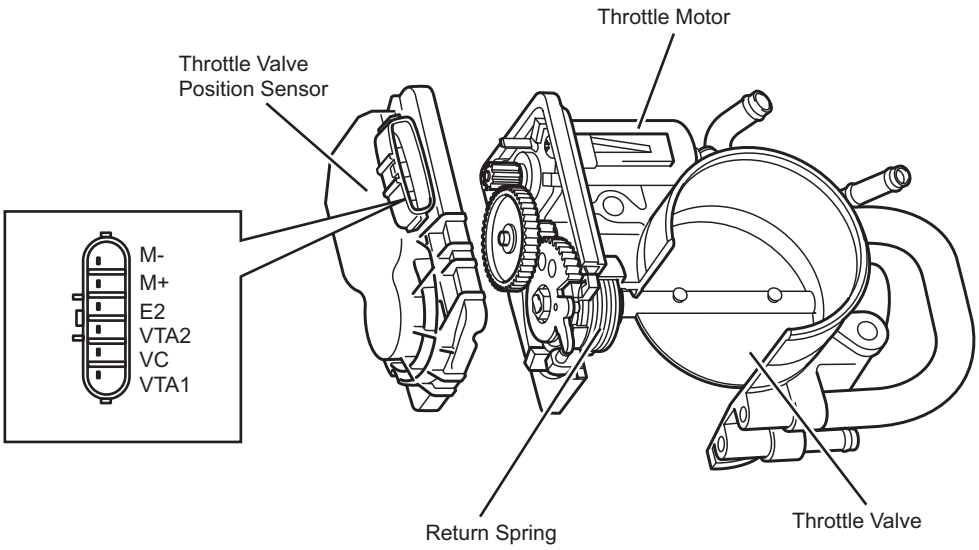
- The low-to mid-speed range has been improved by increasing the length of the intake manifold port.
- This valve is activated by ACIS and is used to alter the intake pipe length to improve the engine performance in all speed ranges.
- The intake manifold is oriented so that it draws air from the front of the engine, enabling a uniform distribution of intake air to the right and left banks.
- Long ports are used to ensure torque in the low- to medium-speed range.
- Along with the use of the air assist system, an air passage for air assist is provided in the intake manifold.
- The distance between the injector and the intake valve has been shortened. This reduces the amount of adhesion of fuel against the inner surface of the intake port, decreases the amount of HC in the exhaust gas, and improves exhaust emission performance.



EG

Throttle Body

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



Throttle Body

M- : Motor Terminal (input at throttle valve "open" {output to M+})
M+: Motor Terminal (input at throttle valve "closed" {output to M-})
E2: Ground Terminal
VTA2: Sensor Output Terminal
VC: Power Supply Terminal
VTA1: Sensor Output Terminal

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Accelerator Pedal Position sensor

- A no-contact accelerator position sensor is used. This sensor uses a Hall element, which can output the intensity of the magnetic field in the form of electrical signals. This is accomplished through the use of the Hall effect*1, which can attain output voltage linearly in proportion to the amount of pedal effort applied on the accelerator.
  (See page EG-209)

Throttle Position Sensor

- A no-contact throttle position sensor is used. This sensor uses a Hall element, which can output the intensity of the magnetic field in the form of electrical signals. This is accomplished through the use of the Hall effect*1, which can attain output voltage linearly in proportion to the position of the throttle valve.
  (See page EG-213)

ETCS-i (Electronic Throttle Control System-intelligent)

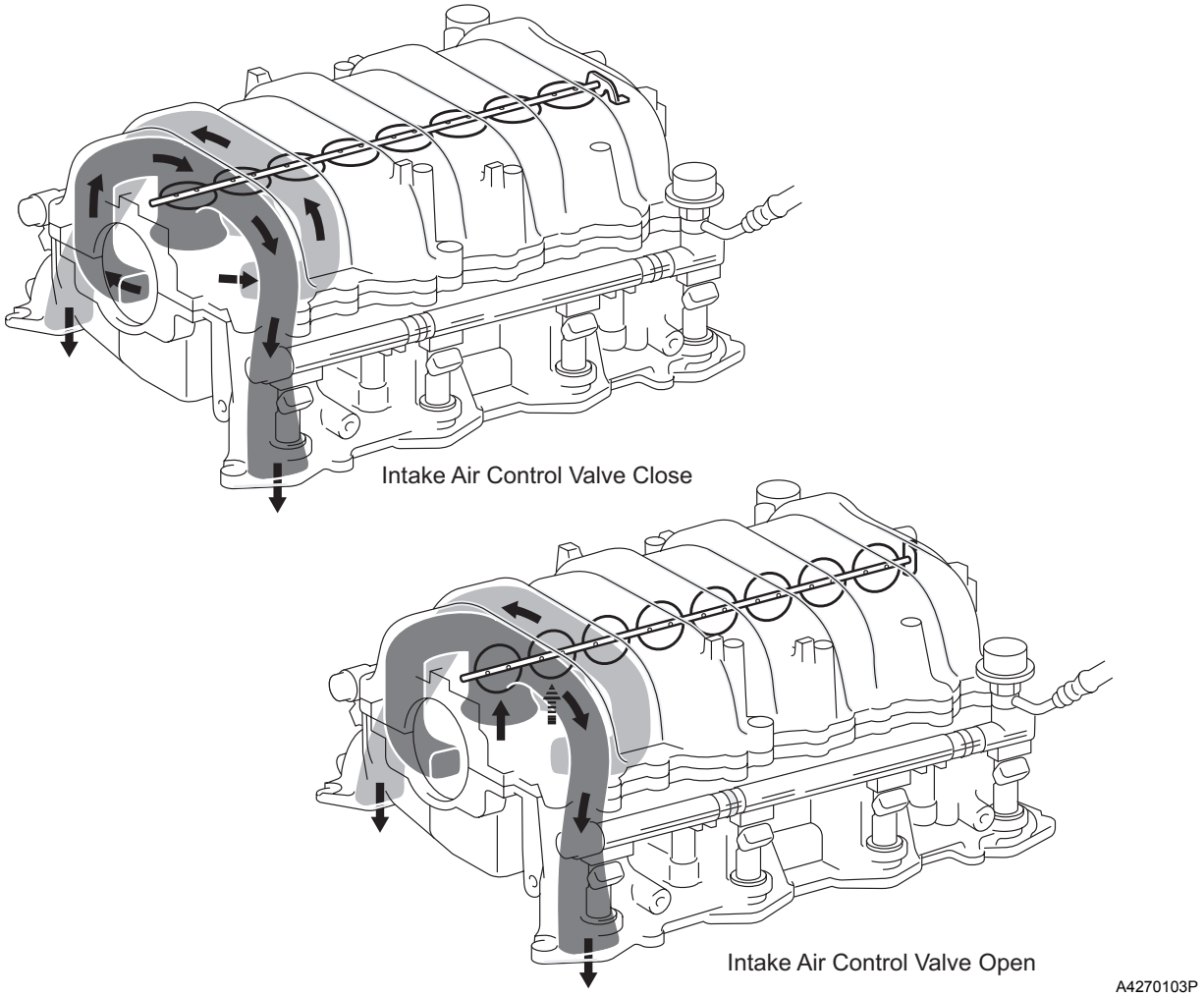
- In the conventional throttle body, the throttle valve opening is determined invariably by the amount of the accelerator pedal effort. In contrast, the ETCS-i uses the engine ECU to calculate the optimal throttle valve opening that is appropriate for the respective driving condition and uses a throttle control motor to control the opening.
- The functions of the ordinary throttle position control (nonlinear control), idle speed control (ISC), traction control (including VSC), and cruise control have been integrated in the single-valve electronically controlled throttle body.
- Excellent driving stability and comfort have been achieved by effecting integrated control with the power train, and vehicle stability has been ensured through cooperative control with the ECT and VSC systems.
- Two CPUs, one for the ETCS-i, and the other for the EFI control, monitor each other to ensure a reliable system.
- A dual system is used so that the vehicle can continue to operate in the event of a problem, thus ensuring reliability.
  (See page EG-200)

ACIS (Acoustic Control Induction System)

- ACIS (Acoustic Control Induction System) is used.
- The ACIS (Acoustic Control Induction System) is realized by using a bulkhead to divide the intake manifold into 2 stages, with an intake air control valve in the bulkhead being opened and closed to vary the effective length of the intake manifold in accordance with the engine speed and throttle valve opening angle. This increases the power output in all ranges from low to high speed.

Construction

- A pressure fluctuation is indirectly created in the intake manifold by the intake stroke. The pressure fluctuation that remains in the intake manifold even after the intake valve has closed exerts an influence on the subsequent intake stroke, a phenomenon known as a pulsation effect. When the pressure fluctuation that remains after the intake valve has closed coincides with the subsequent intake stroke, the pressure increases at the time the valve opens, thus increasing the intake air volume and increasing the torque.
- To positively utilize the pulsation effect, the acoustic control induction system switches the effective intake manifold length in two stages in accordance with the cycle of the pulsation flow, which changes with the engine speed. Thus, this system increases the torque in all ranges.

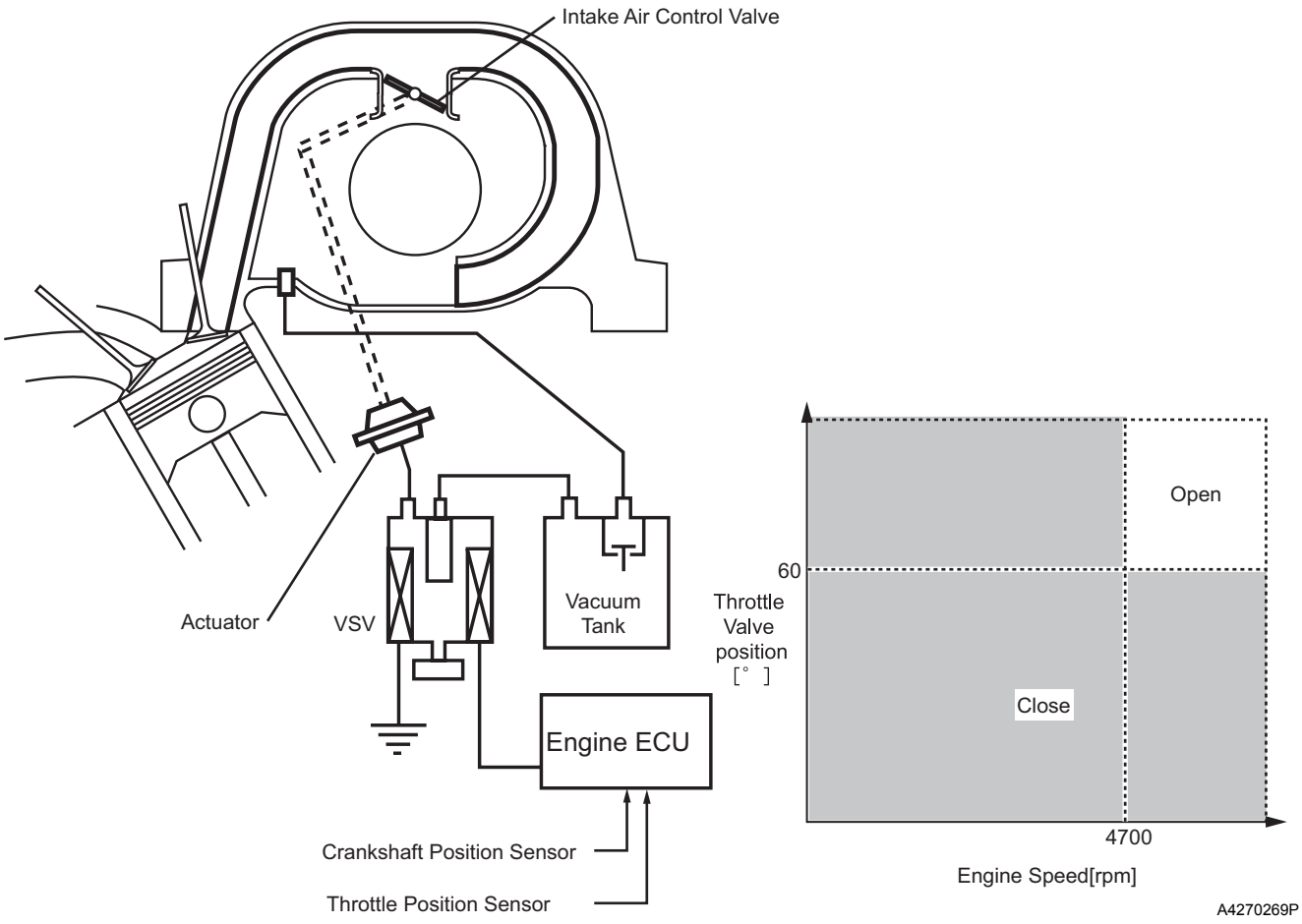


List of Functions

Device Name	Function
Crankshaft Position Sensor	Detects engine speed.
Throttle Position Sensor	Detects throttle valve position.
Intake Air Control Valve	The intake air control valve, which is provided in the middle of the intake manifold in the intake air chamber, opens and closes to change the effective length of the intake manifold in two stages.
VSV (Vacuum Switching Valve)	Controls the vacuum that is applied to the actuator by way of the signal (ACIS) that is output by the engine ECU.
Vacuum Tank	Equipped with an internal check valve, the vacuum tank stores the vacuum that is applied to the actuator in order to maintain the intake air control valve fully closed even during low-vacuum conditions.
Engine ECU	Sends a signal to the VSV(For ACIS) at an appropriate timing in accordance with the signals received from the sensors.

Operation

- The engine ECU opens and closes the intake air control valve in accordance with the engine speed and the throttle valve position. Accordingly, it ensures torque while the vehicle operates in the medium-speed range, under high-load conditions.

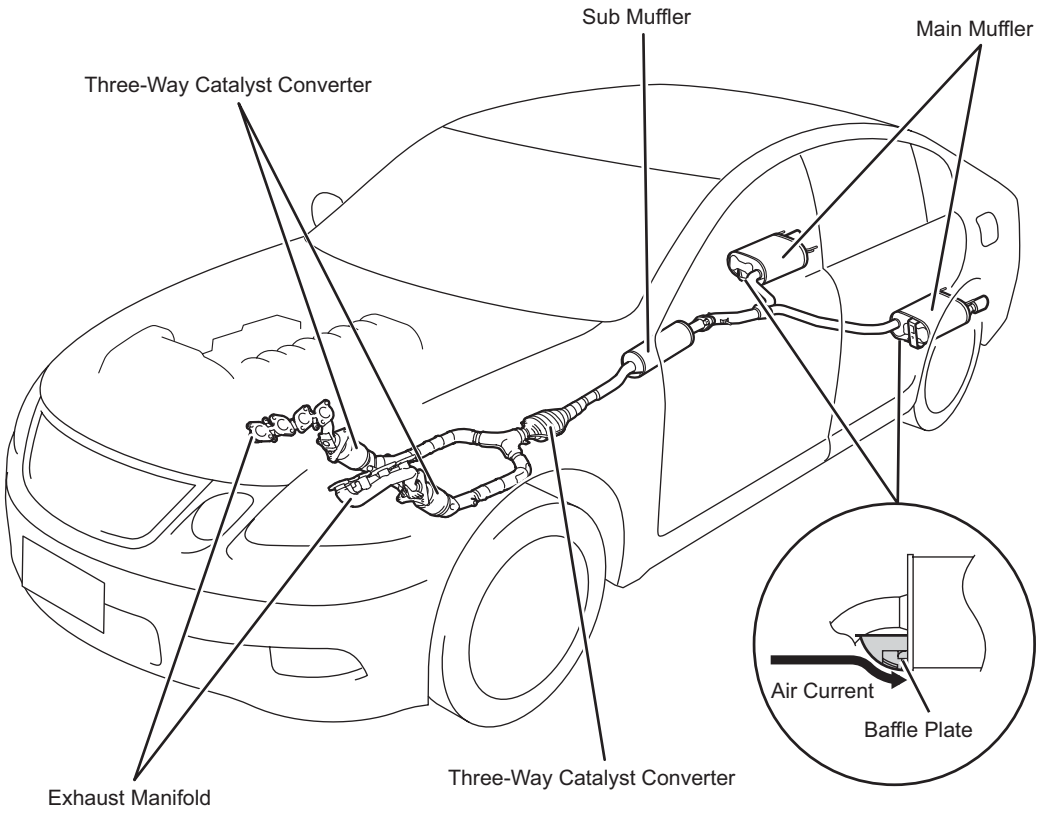


When the Intake Control Valve Closes (VSV ON)	The engine ECU activates the VSV to match the longer pulsation cycle so that the negative pressure acts on the diaphragm chamber of the actuator. This closes the control valve. As a result, the effective length of the intake manifold is lengthened and the intake efficiency in the low-to-medium speed range is improved due to the dynamic effect of the intake air, thereby increasing the power output.
When the Intake Control Valve Open (VSV OFF)	The engine ECU deactivates the VSV to match the shorter pulsation cycle so that atmospheric air is led into the diaphragm chamber of the actuator and opens the control valve. When the control valve is open, the effective length of the intake air chamber is shortened and peak intake efficiency is shifted to the high engine speed range, thus providing greater output at high engine speeds.

3UZ-FE EXHAUST

General

- The entire exhaust system from the exhaust manifold to the tail pipe is made of stainless steel to realize weight reduction and improve corrosion resistance.
- The shape of the exhaust manifold has been changed for weight reduction. This resulted in reducing thermal capacity, improving the warm-up performance of the TWC immediately after cold-starting the engine, and improved the exhaust gas emissions.
- A baffle plate is provided in front of the main muffler to straighten the airflow under the floor, thus improving dynamic performance.
- Heated oxygen sensors are provided upstream and downstream of the right and left three-way catalysts to enable a precise air-fuel ratio control.

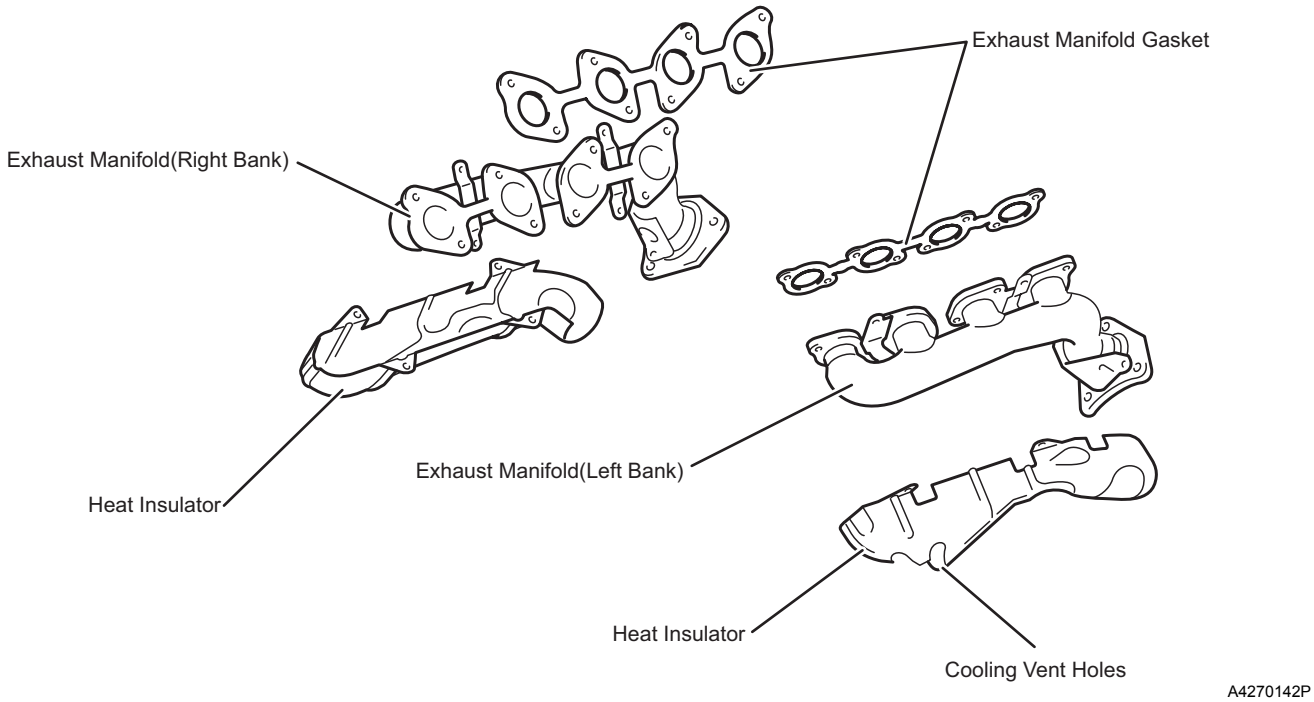


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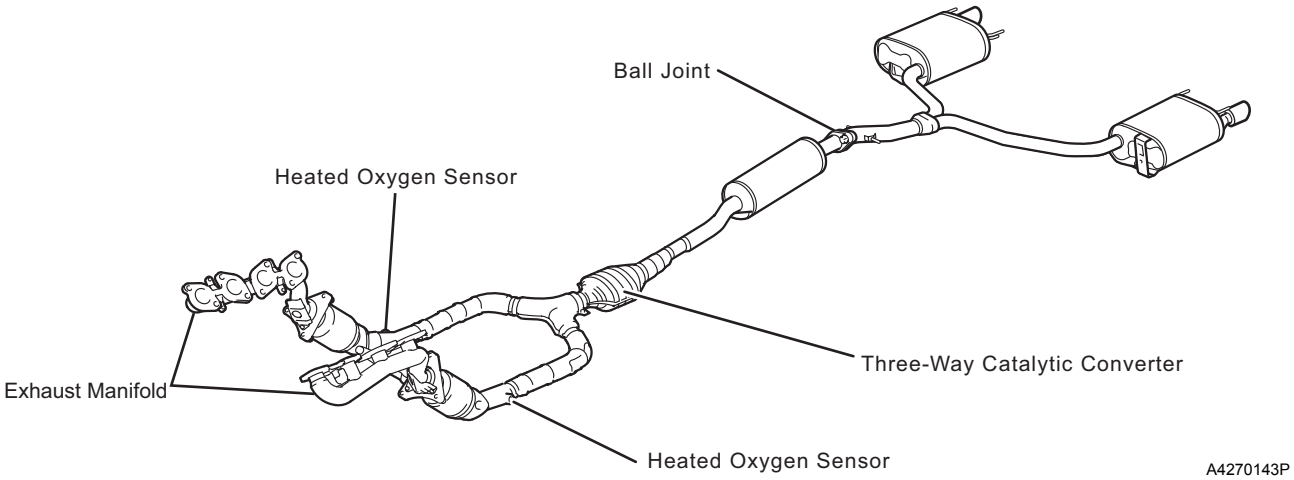
Exhaust Manifold

- The exhaust manifold is made of stainless steel, which excels in heat resistance and corrosion resistance. It is made of a single pipe construction.
- Cooling holes have been provided in the heat insulator for cooling the exhaust manifold. This improves reliability under high-speed, high-load conditions, enables a stoichiometric air-fuel ratio operation in a wider range, and improves fuel economy.



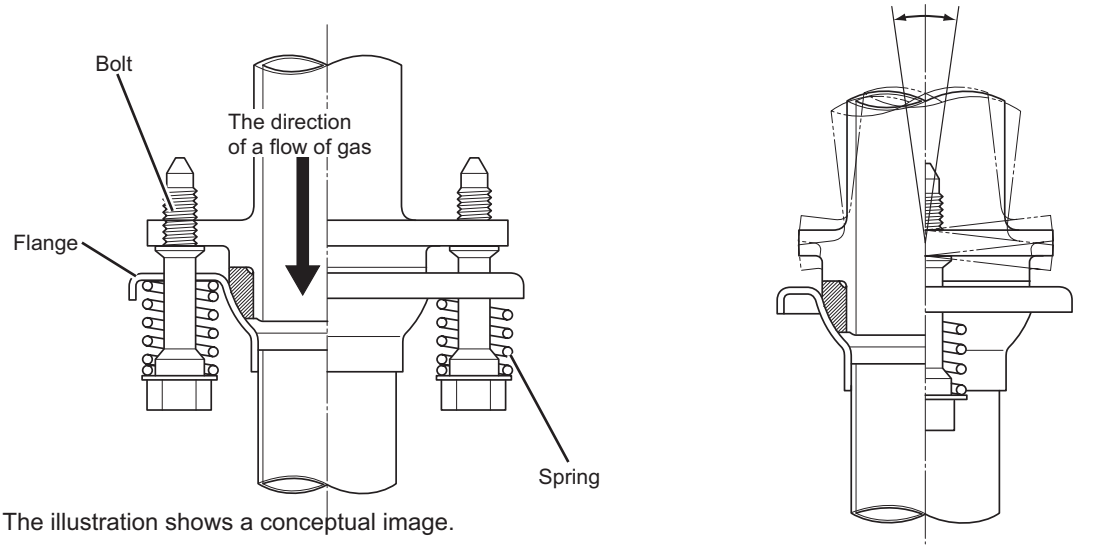
Exhaust Pipe

- A ball joint mechanism is used to join the front pipe to the tail pipe in order to reduce the droning sound and vibration in the cabin.



Ball Joint Mechanism

- The ball joint mechanism consists of a spherical flange, a bolt, and a spring to support the sealing area of the gasket. This is more compact than a flexible pipe, and can be installed in an optimal position to counter vibrations.
- The ball joint (the spherical areas of the flange and the gasket) absorbs the vibration of the engine as well as the vibration of the exhaust pipe in order to reduce the droning sound and vibration in the cabin.

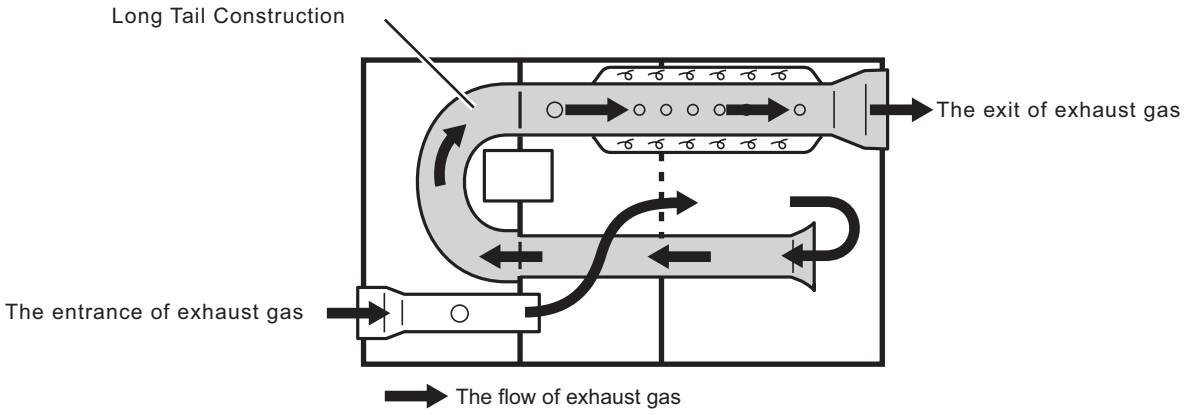


* The illustration shows a conceptual image.

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Muffler

● Dual main mufflers are provided to reduce back pressure, which improves the power output of the engine. A long tail construction is used inside the main muffler to suppress the low-frequency exhaust sounds, thus reducing the sounds in the cabin.



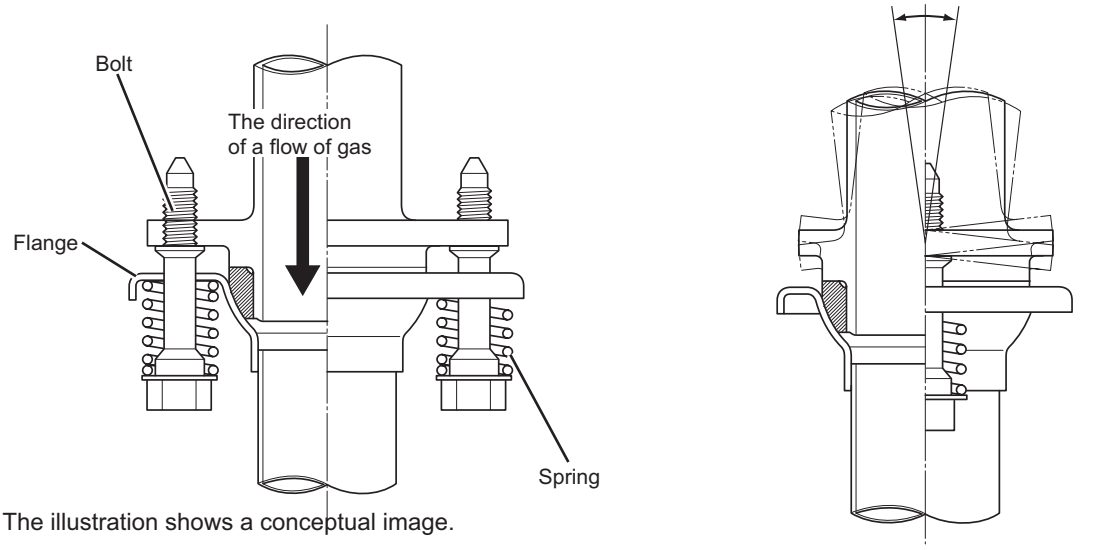
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Three Way Catalytic Converter

● An ultra thin-wall, high cell density ceramic catalyst holding an optimized amount of precious metals is placed directly below each exhaust manifold for the right and left banks. These catalysts ensure a high level of warm-up performance immediately after the engine is started, thus reducing exhaust emissions. As a result, they comply with the Step IV European Emission Regulations.

Ball Joint Mechanism

- The ball joint mechanism consists of a spherical flange, a bolt, and a spring to support the sealing area of the gasket. This is more compact than a flexible pipe, and can be installed in an optimal position to counter vibrations.
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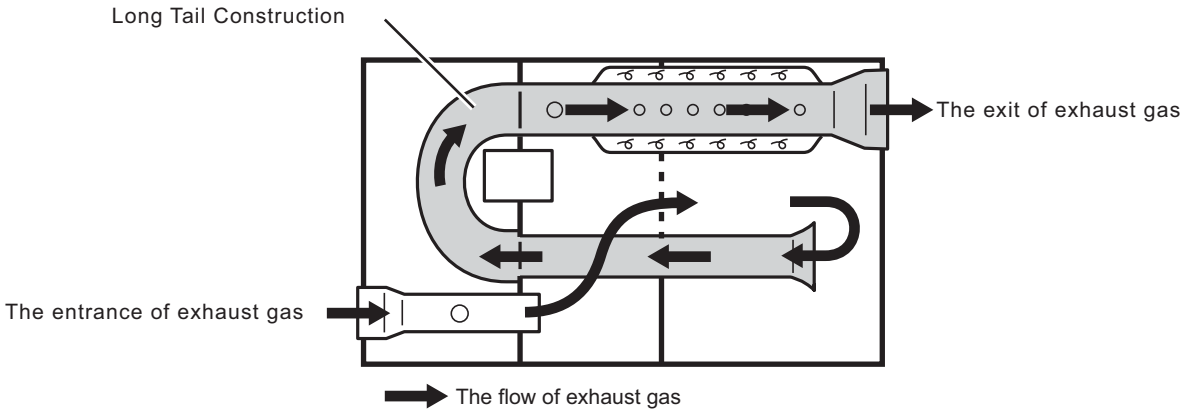


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A4270077P

Muffler

● Dual main mufflers are provided to reduce back pressure, which improves the power output of the engine. A long tail construction is used inside the main muffler to suppress the low-frequency exhaust sounds, thus reducing the sounds in the cabin.



A4270078P

Three Way Catalytic Converter

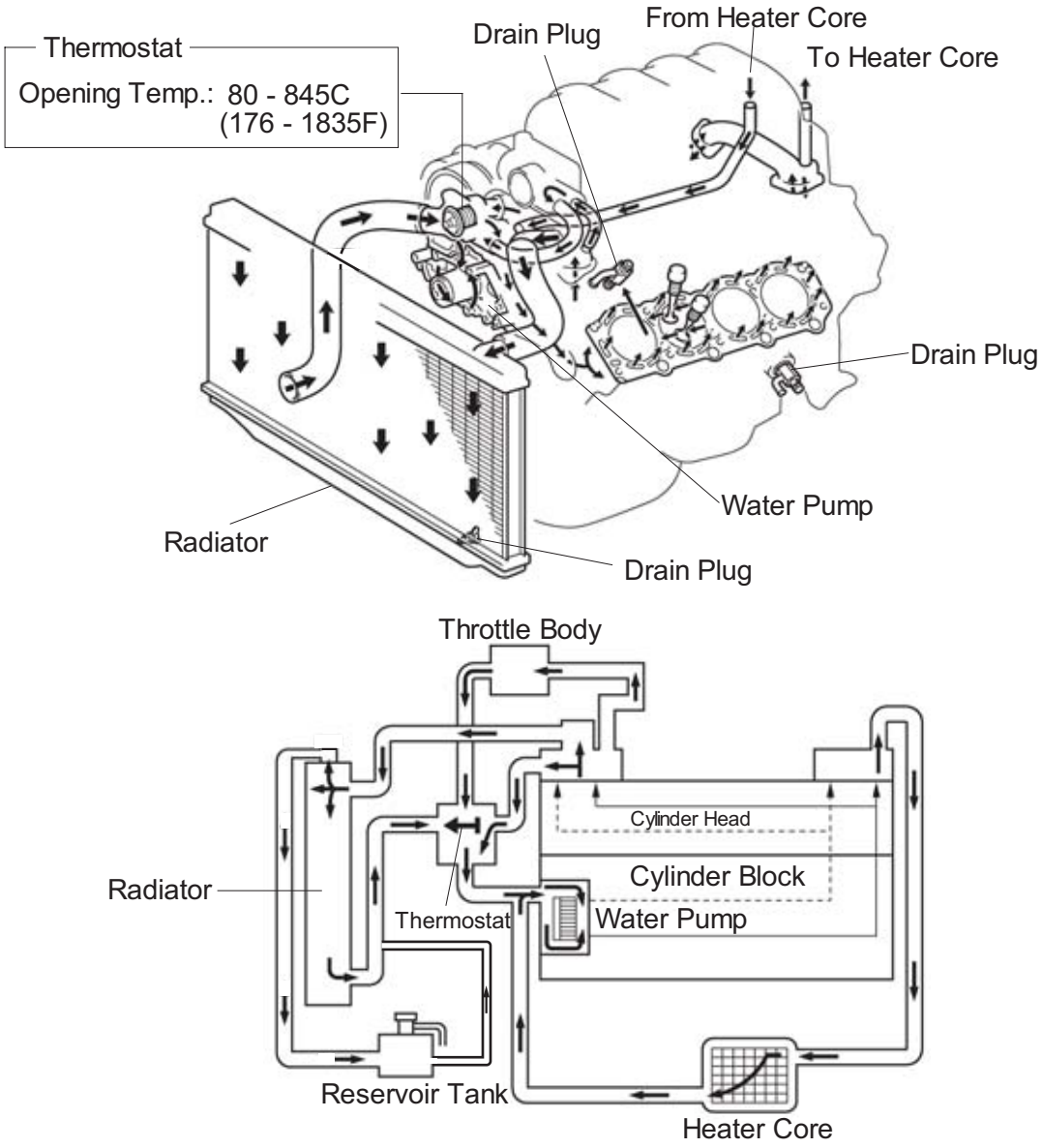
● An ultra thin-wall, high cell density ceramic catalyst holding an optimized amount of precious metals is placed directly below each exhaust manifold for the right and left banks. These catalysts ensure a high level of warm-up performance immediately after the engine is started, thus reducing exhaust emissions. As a result, they comply with the Step IV European Emission Regulations.

3UZ-FE COOLING

EG

General

- The cooling system is a pressurized, forced-circulation type.
- A thermostat, having a bypass valve, is located on the water pump inlet side of the coolant circuit. As the coolant temperature rises, the thermostat opens and the bypass valve closes, so the system maintains suitable temperature distribution in the cylinder head.
- In this system, the cooling fan ECU controls the cooling fan ON and OFF and the fan speed in accordance with the signals from the engine ECU.



A4270289P

Radiator

- A lightweight, high-performance, down-flow type aluminum core radiator is used to improve cooling performance and weight reduction. In addition, the diameters of the inlet and outlet pipes on the radiator have been optimized to reduce water passage resistance.
- An automatic transmission oil cooler is built in below the radiator to achieve a compact construction.

Radiator

Core Type	Corrugated Fin
Fin Pitch [mm (in.)]	2.5 (0.098)/2
Core Dimensions (width x height x thickness) [mm (in.)]	709.0 × 399.2 × 16.0 (27.913 × 15.716 × 0.630)
Dry Weight [kg]	4.47

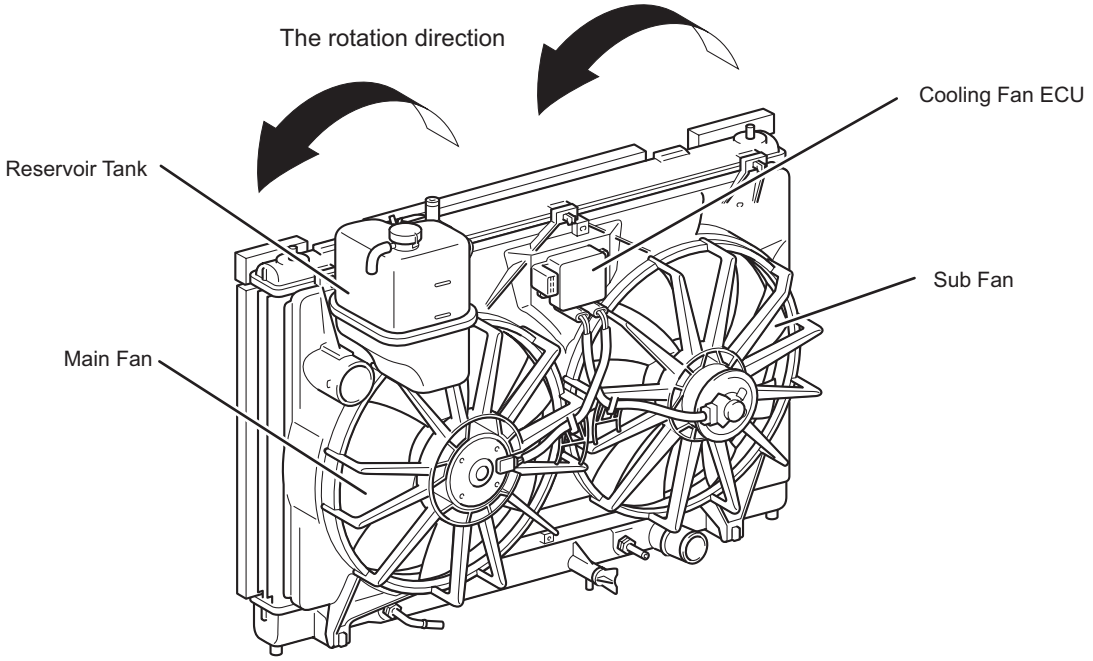
A/T Oil Cooler

Type	Dual Pipe Type (with inner fins)
Core Dimensions (width x height x thickness) [mm (in.)]	28.0 × 20.0 × 375.0 (1.102 × 0.787 × 14.764)

EG

Cooling Fan

- The ECM outputs a signal to the cooling fan ECU, which steplessly controls the speed of the two fans in accordance with the engine conditions, driving conditions, and whether the air conditioner is operating. Through optimally controlled speeds at all times, the fans operate significantly quieter and improve cooling performance.
- Ring fans that are provided with band-shaped rings around them are used, which enhance rigidity and realize a lightweight and compact construction.
- The fan shroud is secured to the radiator without bolts.



A4270275P

Cooling Fan

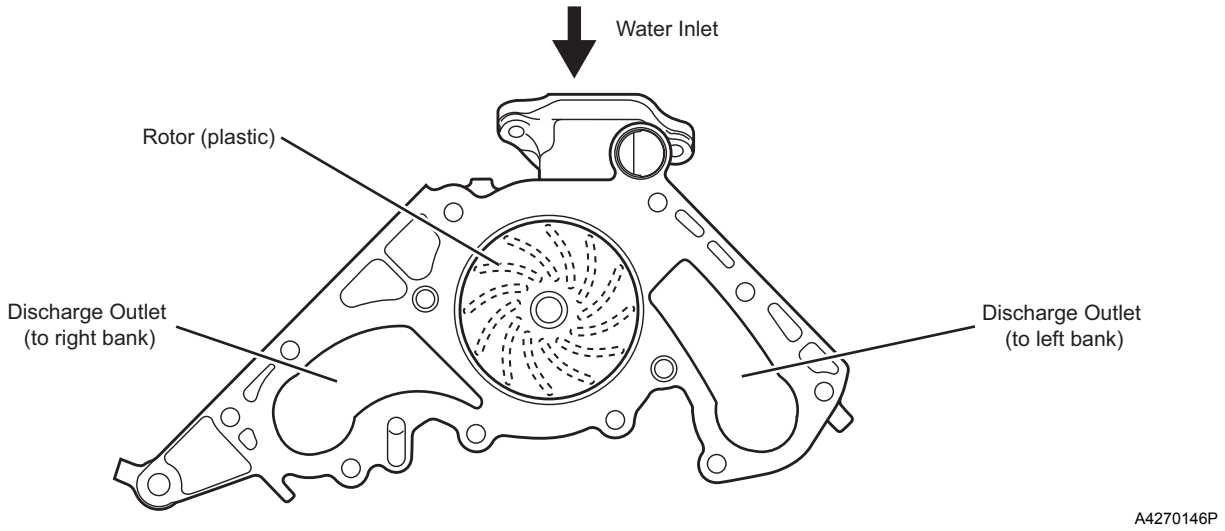
	Main Fan	Sub Fan
Diameter [mm (in.)]	340.0 (13.386)	←
Number of Blades	5	7

Cooling Fan motor

	Europe		G.C.C.Countries	
	Main Fan Motor	Sub Fan Motor	Main Fan Motor	Sub Fan Motor
Rated voltage [V]	12	←	←	←
Rated Output [W]	160	100	160	←

Water Pump

- The water pump has two volute chambers, are circulates coolant uniformly to the left and right banks of the cylinder block.
- The water pump is driven by the bank of the timing belt.
- The rotor is made of plastic and the shape of its blades has been optimized to achieve high efficiency and improve reliability.



Water Pump

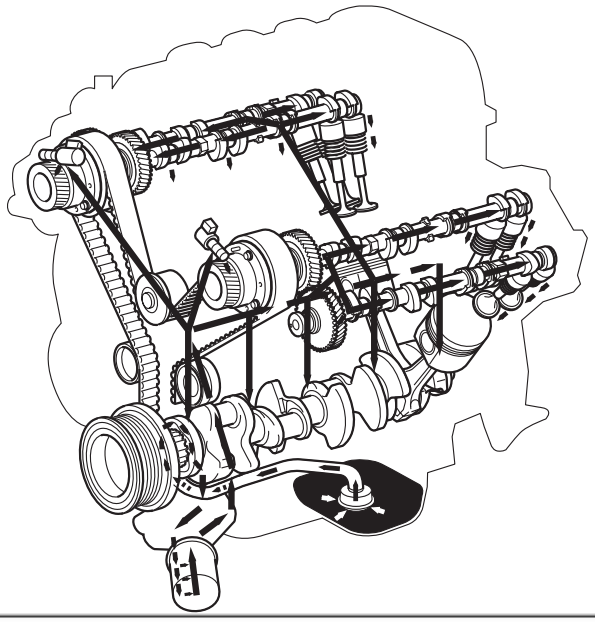
Drive System		Timing Belt Driven
Rotor Diameter [mm (in.)]		80.0 (3.150)
Bearing Diameter [mm (in.)]		35.0 (1.378)
Number of Blades		12
Discharge Volume [L/min] (80±2°C)	2000rpm	40
	3500rpm	75

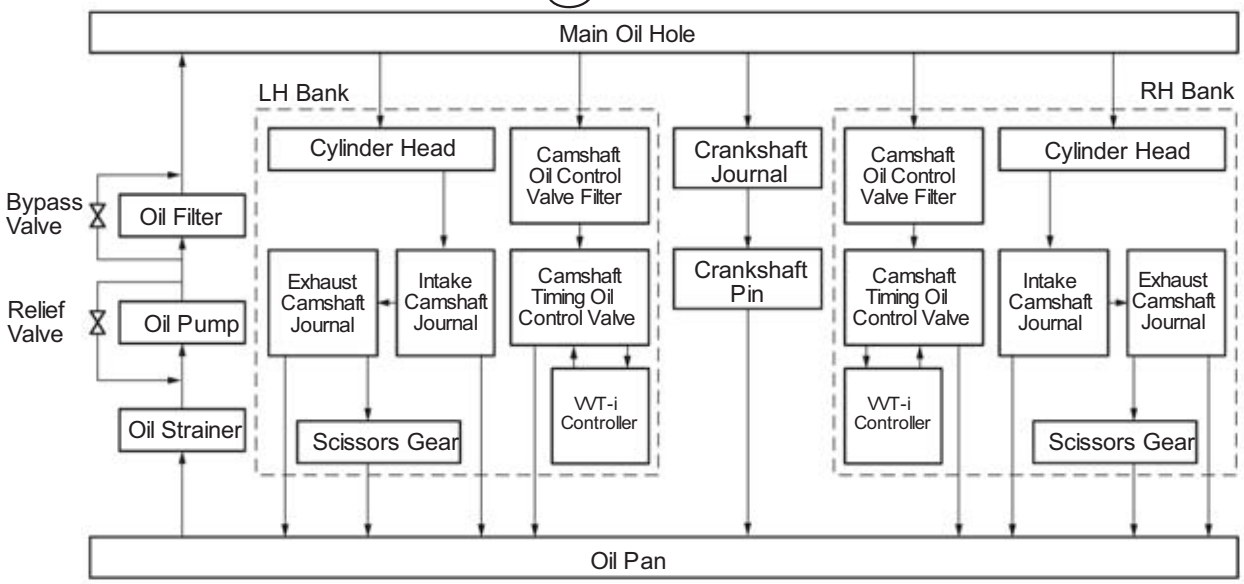
3UZ-FE LUBRICATION

EG

General

- The lubrication circuit is fully pressurized and oil passes through an oil filter.
- The trochoid gear type oil pump is directly driven by the crankshaft.
- Along with the adoption of the VVT-i, right and left bank cylinder heads are provided with VVT-i controllers and camshaft timing oil control valves. This system is operated by the engine oil.
- An oil level sensor is provided in the oil pan for efficient servicing.

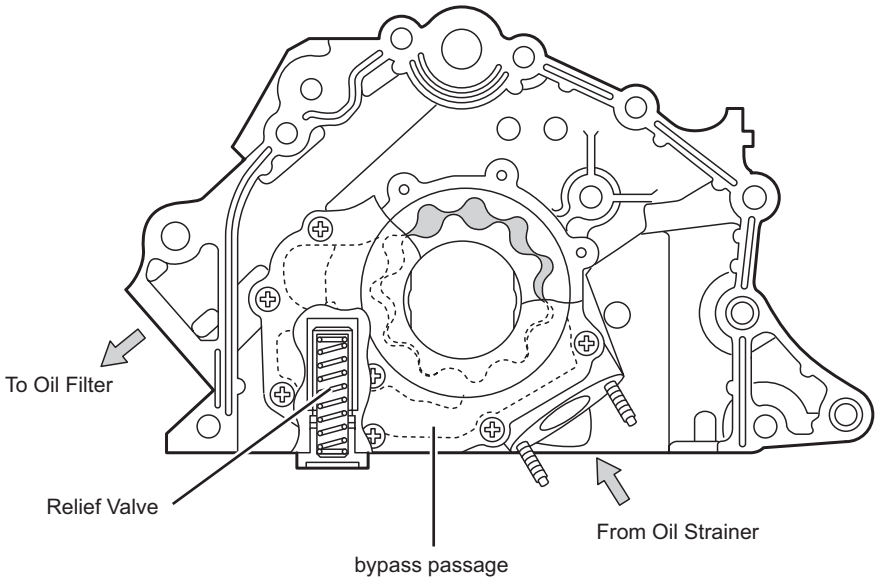




A4270147P

Oil Pump

- The oil pump consists of a compact, highly efficient, and multiple-teeth cycloid rotor that is driven directly by the crankshaft. Its discharge volume has been optimized to reduce friction loss. The drive rotor is a flangeless type, which enables the use of a rotor with a small diameter, thus reducing friction loss.
- An internal oil relief valve is used, and a bypass passage is provided to prevent the relieved oil from returning directly to the oil pan. This suppresses the oil level fluctuations in the oil pan and reduces friction.
- An FIPG (Formed-In-Place Gasket), which excels in sealing performance, is used on the mating surfaces between the cylinder block and the oil pan, to ensure reliability.



A4270148P

Oil Pump

Type		Trochoid Gear	
Pump Speed	[rpm]	700	5600
Discharge Volume	[L/min]	7.0	78.7
Discharge Pressure	[kPa]	150	290
Relief Valve Opening Pressure	[kPa]	—	440±39

Oil Filter

- An oil filter is installed facing down from the side of the cylinder block via a bracket, to facilitate service.
- An oil pressure switch is provided on the union bolt for the oil filter bracket.

Oil Filter

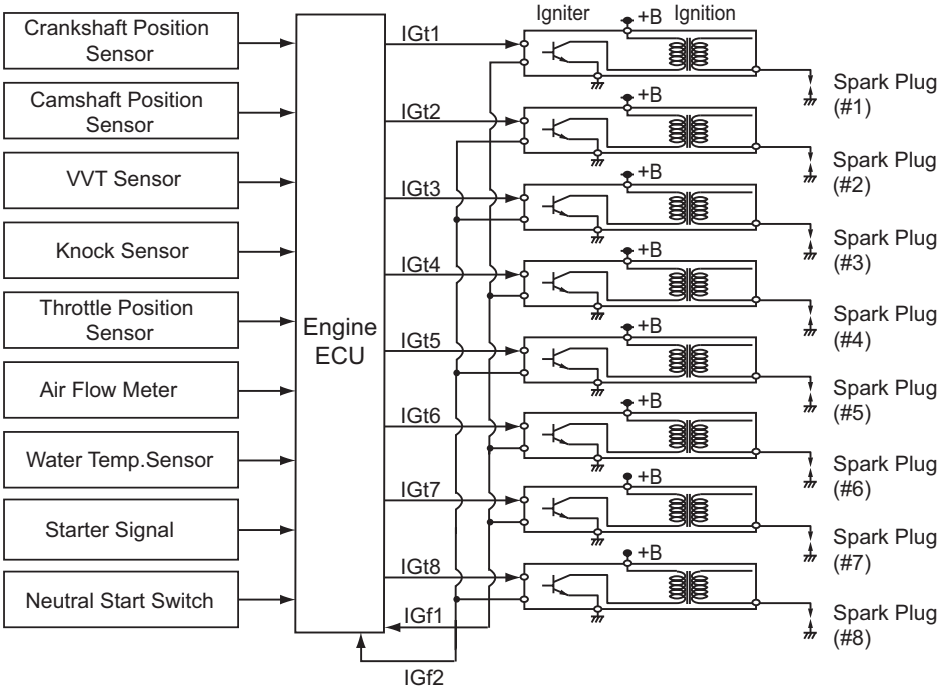
Type		Full-flow
Filtration Area	[cm^3(cu.in.)]	110.0 (6.711)
Outer diameter × Height	[mm (in.)]	76.3 × 99.4 (3.004 × 3.913)
Relief Valve Opening Pressure	[kPa]	100 ± 20

3UZ-FE IGNITION

EG

General

- A DIS (Direct Ignition System) has been adopted. The DIS improves the ignition timing accuracy, reduces high-voltage loss, and enhances the overall reliability of the ignition system by eliminating the distributor. The DIS in this engine is an independent ignition system which has one ignition coil (with igniter) for each cylinder.
- An ESA (Electronic Spark Advance) system is used. Based on the signals received from the sensors, the engine ECU controls the ignition timing in accordance with the conditions of the engine.
- High-precision control is effected through the use of knock control using a knock sensor and ECT shift torque control that reduces the shift shocks of the automatic transmission.
- Iridium-tipped spark plugs have been adopted to realize a 120,000 mile (192,000 km) maintenance-free operation.

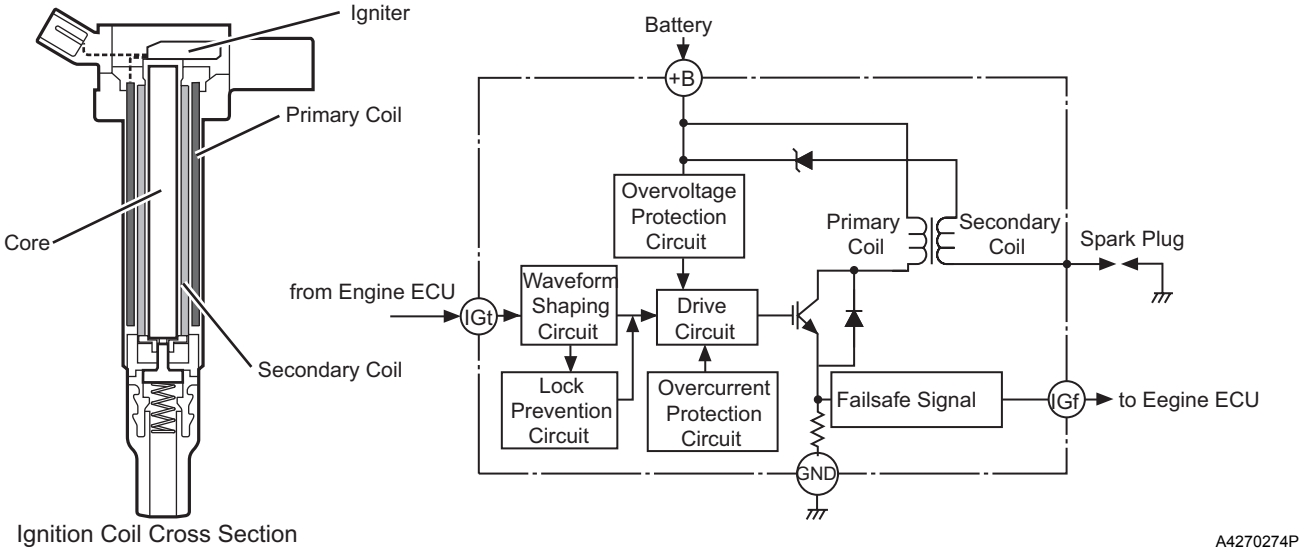


A4270276P

EG

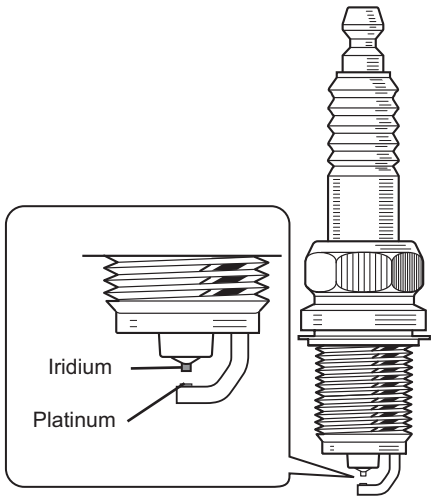
Ignition Coil (with Igniter)

- Independent ignition coils are provided to each of the cylinders, thus making a distributor or high tension cord unnecessary. This reduces the power loss at high-voltage areas, improves reliability, and reduces electro-magnetic interference.
- Each ignition coil has a built-in compact and lightweight igniter, which induces high voltage to the secondary coil in accordance with the signals received from the engine ECU.



Spark Plug

- Iridium-tipped spark plugs have been adopted to realize a 120,000 mile (192,000 km) maintenance-free operation. By making the center electrode of iridium, the same ignition performance as of the platinum-tipped spark plug and further improvement of durability have been realized.



Spark Plug

DENSO	SK20R11
NGK	IFR6A11
Plug Gap [mm (in.)]	1.0 ~ 1.1 (0.0394 ~ 0.043)

Crankshaft Position Sensor

- The timing rotor of the crankshaft consists of 34 teeth, with 2 teeth missing. The crankshaft position sensor outputs the crankshaft rotation signals every 10°, and the missing teeth are used to determine the top-dead-center.
- This engine uses an electromagnetic pickup sensor that provides a high level of detection accuracy.

(See page EG-208)

Camshaft Position Sensor

- This engine uses an electromagnetic pickup sensor that provides a high level of detection accuracy.
- The camshaft position sensor is mounted on the left bank cylinder head. To detect the camshaft position, a protrusion that is provided on the timing pulley is used to generate 1 pulse for every 2 revolution of the crankshaft.
- A VVT sensor is mounted on the intake side of each cylinder head. To detect the camshaft position, a timing rotor that is provided on the intake camshaft is used to generate 3 pulses for every 2 revolutions of the crankshaft.

(See page EG-207)

3UZ-FE STARTING

Starter

● A compact, lightweight, high power output, and highly efficient reduction type starter is used.

Starter

	Europe & Australia	G.C.C.Countries
Type	Reduction Starter	←
Rated Voltage [V]	12	←
Rated Output [kW]	2.0	1.4

3UZ-FE CHARGING

EG

Alternator

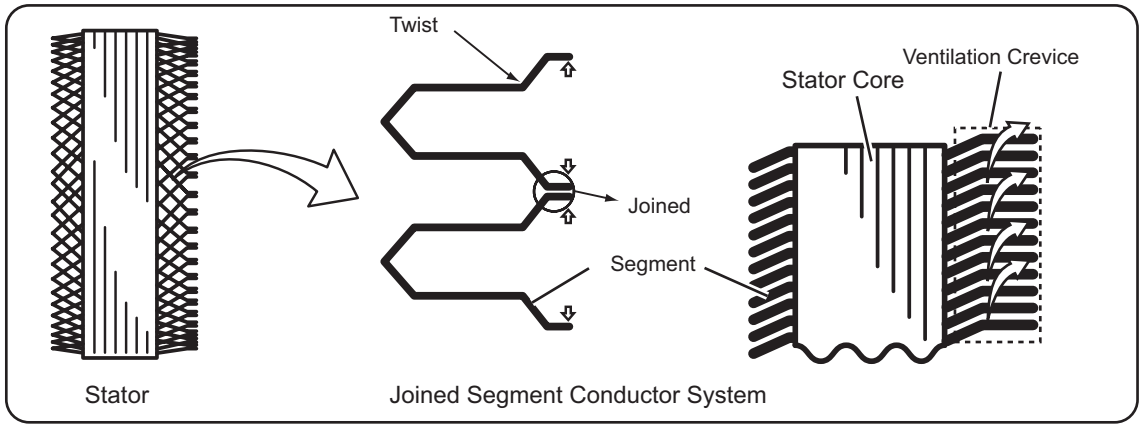
● A compact, lightweight, high power output, and highly efficient segment conductor type alternator is used.

Alternator

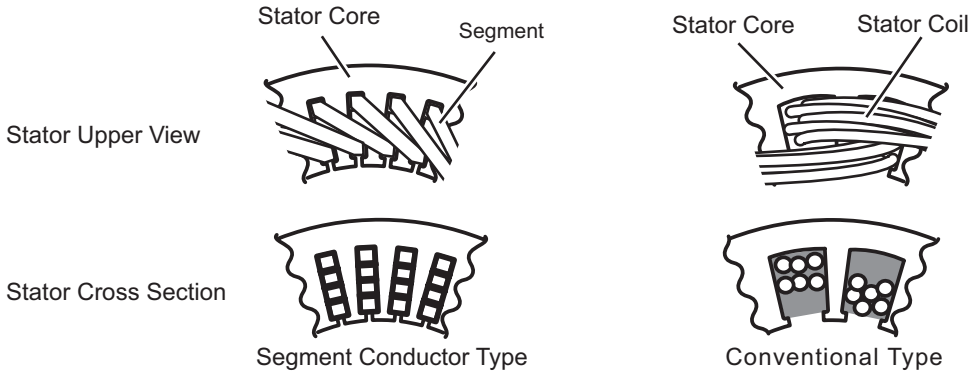
Rated Voltage [V]	12
Rated Output [A]	130
Regulator Setting Voltage [V] (5000rpm,10A,25°C)	13.2 ~ 15.0
Permissible Max Speed [rpm]	18000

Stator Coil

- A compact and lightweight Segment Conductor type alternator that generates high amperage output in a highly efficient manner has been adopted on standard equipment.
- This alternator has a joined segment conductor system, in which multiple segment conductors are welded together to form the stator. Compared to the conventional winding system, the electrical resistance is reduced due to the shape of the segment conductors, and their arrangement helps to make the alternator more compact.



〈Segment Conductor Type Alternator〉



A4270259P

IN

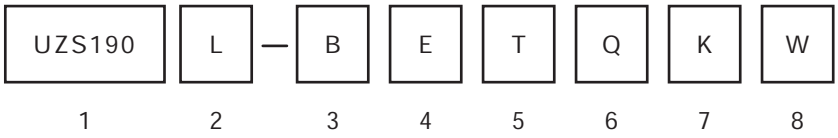
OUTLINE

MODEL LINE-UP

MODEL LINE-UP

DESTINATION	MODEL	BODY TYPE	ENGINE	DRIVE TYPE	TRANSMISSION	MODEL CODE
Europe	GS430	4-Door Sedan	3UZ-FE	2WD	A761E (6-Speed Automatic)	UZS190L-BETQKW
						UZS190R-BETQKW
	GS300		3GR-FSE		A960E (6-Speed Automatic)	GRS190L-BETQHW
						GRS190R-BETQHW
G.C.C Countries	GS430		3UZ-FE		A761E (6-Speed Automatic)	UZS190L-BETQKV
	GS300		3GR-FE		A760E (6-Speed Automatic)	GRS190L-BETQKV
General Countries	GS300		3GR-FE		A760E (6-Speed Automatic)	GRS190R-BETQK

MODEL CODE



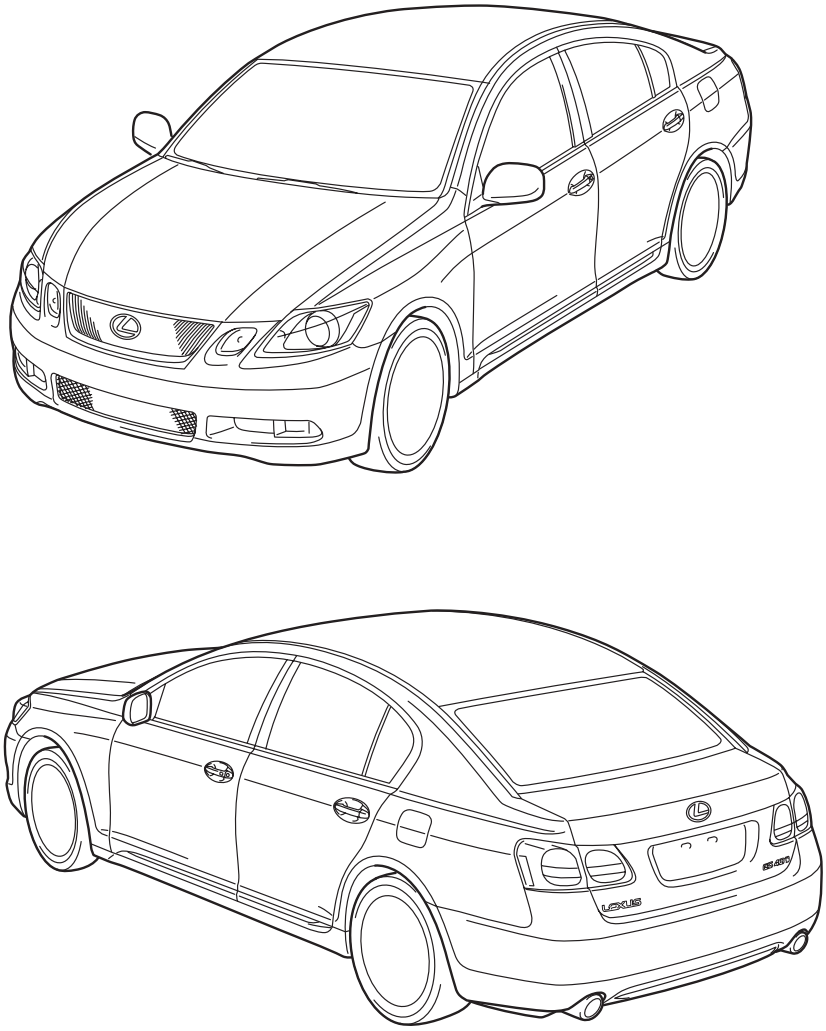
A4270002S

MODEL CODE

1	BASIC MODEL CODE
	UZS190:With 3UZ-FE Engine
	GRS190:With 3GR-FSE Engine
2	STEERING WHEEL POSITION
	L:Left-Hand Drive
	R:Right-Hand Drive
3	MODEL NAME
	B:GS430/300
4	BODY TYPE
	E:4-Door Sedan
5	GEAR SHIFT TYPE
	T:6-Speed Automatic,Floor
6	GRADE
	Q:—

7	ENGINE SPECIFICATION
	K:Compact DOHC and EFI
	H:DOHC EFI and Direct Injection
8	DESTINATION
	W:Europe
	V:G.C.C Countries
	Blank:General Countries

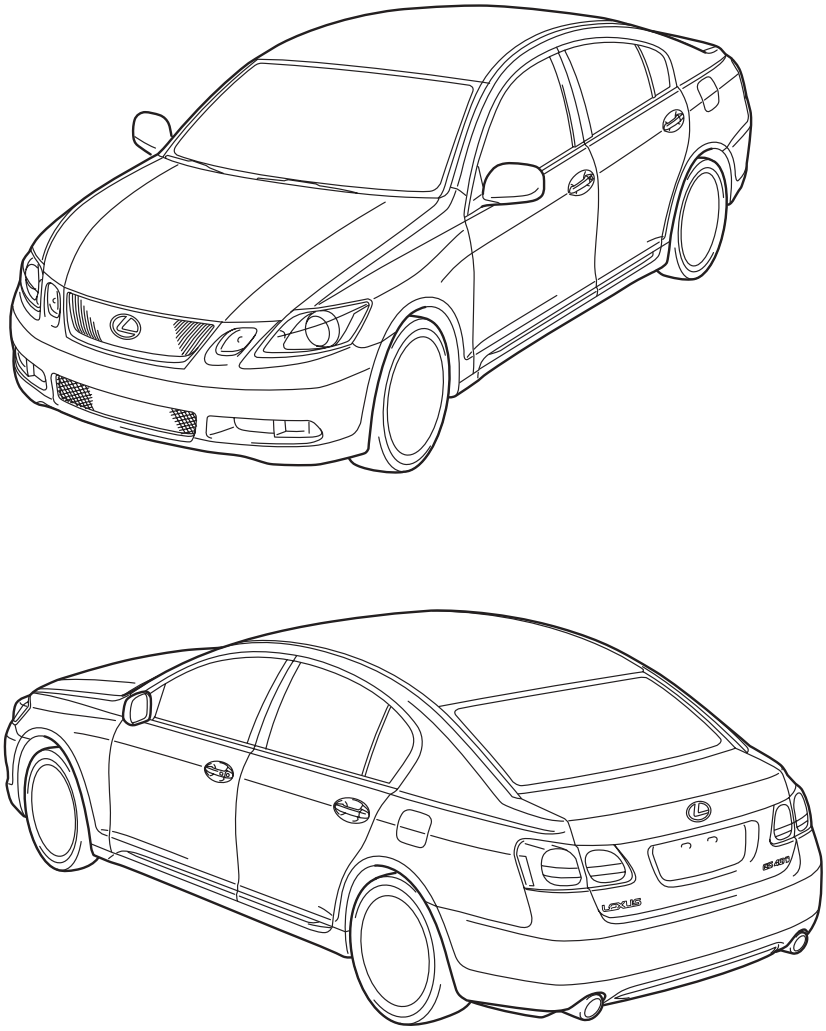
Exterior Appearance



A4270003S

7	ENGINE SPECIFICATION
	K:Compact DOHC and EFI
	H:DOHC EFI and Direct Injection
8	DESTINATION
	W:Europe
	V:G.C.C Countries
	Blank:General Countries

Exterior Appearance

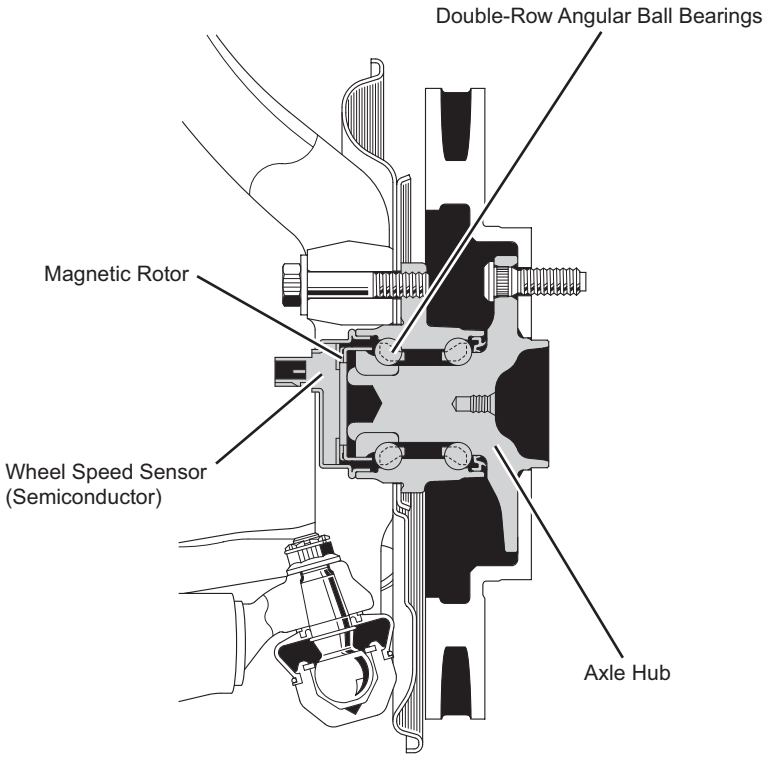


A4270003S

AXLE

Front Axle

- Compact and highly rigid double-row angular ball bearings are used. The bearings and the axle hub have been integrated to ensure high rigidity, while realizing excellent drivability, stability, and braking stability.
- Semiconductor wheel speed sensors and magnetic rotors are built into the axles.



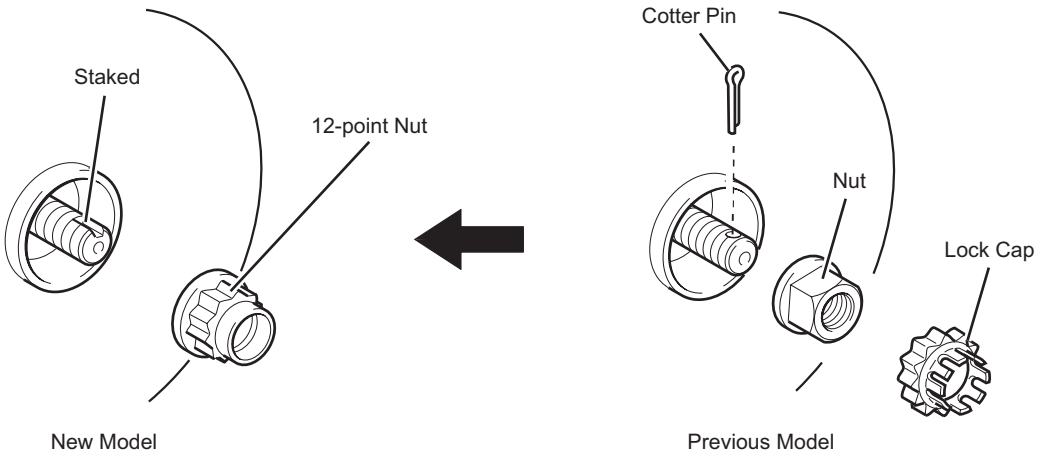
A4270200C

❒ **NOTICE**

The vehicle speed sensors and rotors contain magnets. Therefore, do not place a magnetic object near the sensors or rotors.

Axle Hub Fastening Nut

• The axle hub fastening nuts are staked securely in place. This ensures the proper joining performance, prevents the axles from creating noise, reduces the number of parts, and improves the ease of assembly operation.This nut cannot reuse.



A4270198C

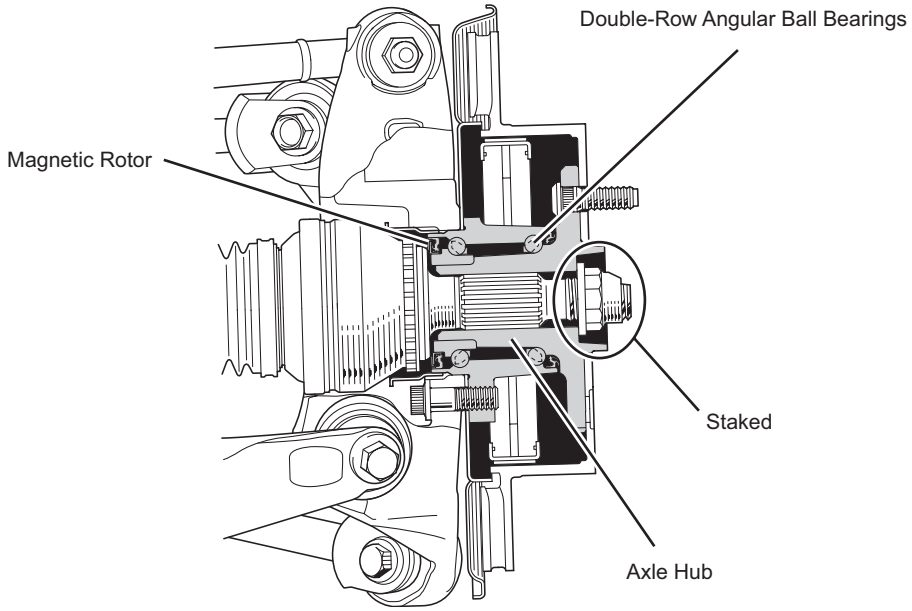
❖REFERENCE❖

* : The nut used for fastening the axle hub is staked and its surface is treated to stabilize the friction coefficient. For these reasons, the nut must not be reused. Before loosening the nut to remove it, make sure to completely unstake the nut in order to prevent the threads on the drive shaft from damage.

Rear Axle

● As with the front axle, the rear axle uses compact and highly rigid double-row angular ball bearings. The bearings and the axle hub have been integrated to ensure high rigidity, while realizing excellent drivability, stability, and braking stability.

● The axle hubs are fastened with 12-point nuts. The nuts are staked securely in place, thus ensuring a high level of joining performance.



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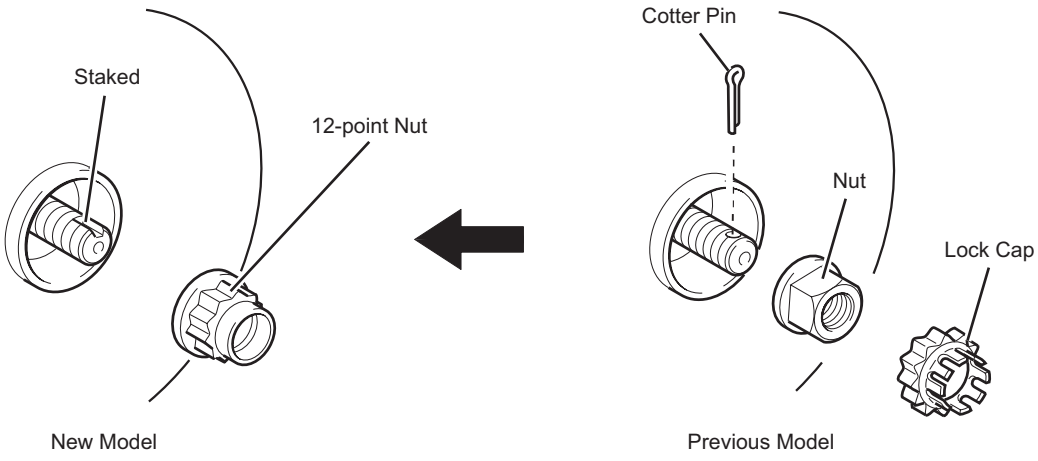
❒ **NOTICE**

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SA

Axle Hub Fastening Nut

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A4270198C

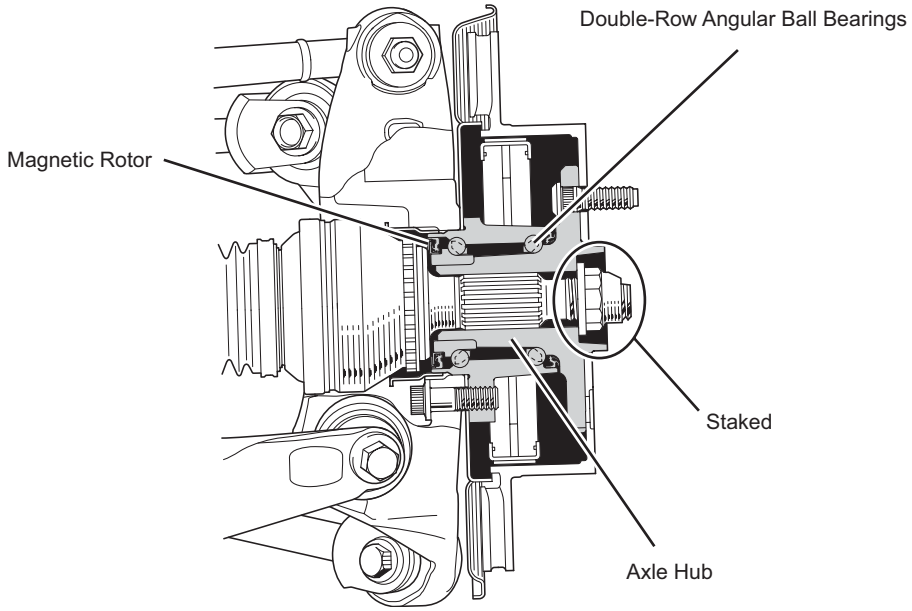
❖REFERENCE❖

* : The nut used for fastening the axle hub is staked and its surface is treated to stabilize the friction coefficient. For these reasons, the nut must not be reused. Before loosening the nut to remove it, make sure to completely unstake the nut in order to prevent the threads on the drive shaft from damage.

Rear Axle

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● The axle hubs are fastened with 12-point nuts. The nuts are staked securely in place, thus ensuring a high level of joining performance.



A4270199C

❒ **NOTICE**

The vehicle speed sensors and rotors contain magnets. Therefore, do not place a magnetic object near the sensors or rotors.

SA

SUSPENSION CONTROL

AVS System Outline

- The 3UZ-FE engine models use the AVS (Adaptive Variable Suspension System) as standard equipment.
- The AVS operates with computer control to independently change the damping force of the newly developed, high-response monotube type shock absorbers at the four wheels, in accordance with the driving maneuvers and road surface conditions. Thus, it realizes a comfortable ride and excellent drivability and stability at high levels.
- Generally speaking, shock absorbers with a lower damping force are able to absorb the vibrations of rough road surfaces and give a more comfortable ride. However, when the vehicle body makes a large movement, such as during high-speed driving, braking, or cornering, or when the vehicle is driven on a winding road or over a large bump, those shock absorbers will be unable to handle the vibrations very well. During ordinary driving in urban areas, the AVS gives precedence to ride comfort by setting the damping force low. Furthermore, the AVS enhances drivability and stability by changing the damping force to a higher level in accordance with the driving maneuvers, such as increased vehicle speed, braking, or steering operation. In addition, the AVS changes the damping force to a higher level if repercussions (sprung vibrations) are created in the vehicle due to the road surface conditions.
- The system determines the presence of repercussions by processing the signals provided by the G sensor. The system uses a leading-edge, nonlinear H∞ (H infinity) control logic to control the damping force in order to realize a "natural and smooth driving experience".
- The shock absorbers used in the AVS change the damping force in nine steps.
- An absorber control switch is provided to enable the driver to select from two types of modes.

AVS : Realizes a "comfortable ride", "excellent drivability and stability", with a "natural feel"

Comfortable Ride
During ordinary driving, the system sets the damping force low to give precedence to ride comfort

Controls the damping force in nine steps

Excellent Drivability and Stability

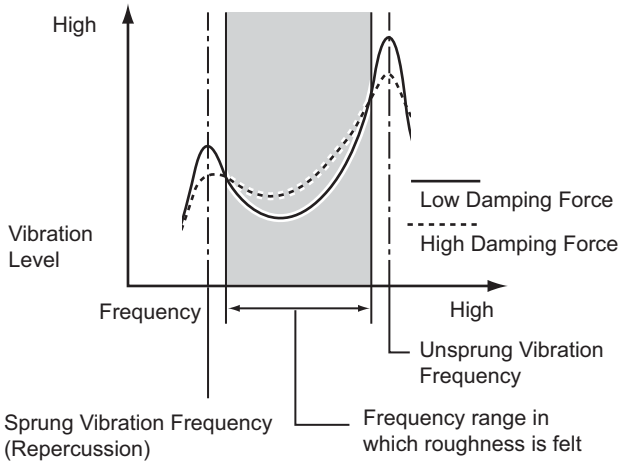
Changes the damping force to high in accordance with the driving maneuvers and road surface conditions to improve drivability and stability

Damping force control in accordance with driving maneuvers
- Vehicle Speed Sensing Control
- Anti-Dive Control
- Anti-Squat Control
- Roll Posture Control

Damping force control in accordance with road surface conditions
- Repercussion Control (H^{∞} control)
- Roughness Sensing Control
- Unsprung Damping Control

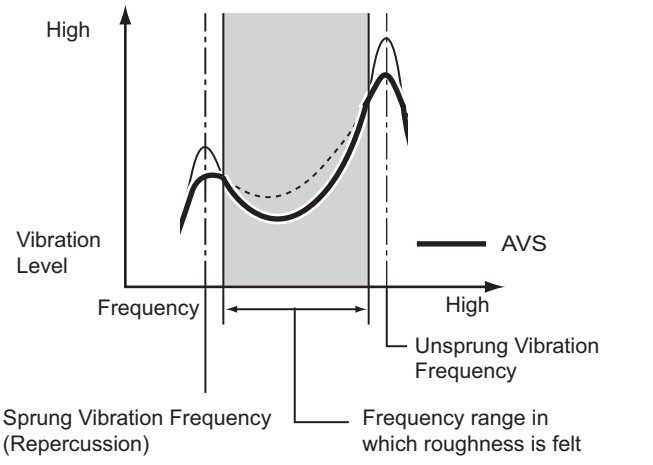
Conventional Suspension

In a frequency range in which roughness can be felt, a low damping force can keep the vibration level low and improves ride comfort. Conversely, the vibration level will increase if the damping force is low in the vicinity of the sprung and unsprung vibration frequency.



AVS

In the frequency range in which roughness is felt, the AVS sets the damping force low. In the vicinity of the sprung and unsprung vibration frequency, it sets the damping force high. Thus, it ensures ride comfort by constantly suppressing vibrations.

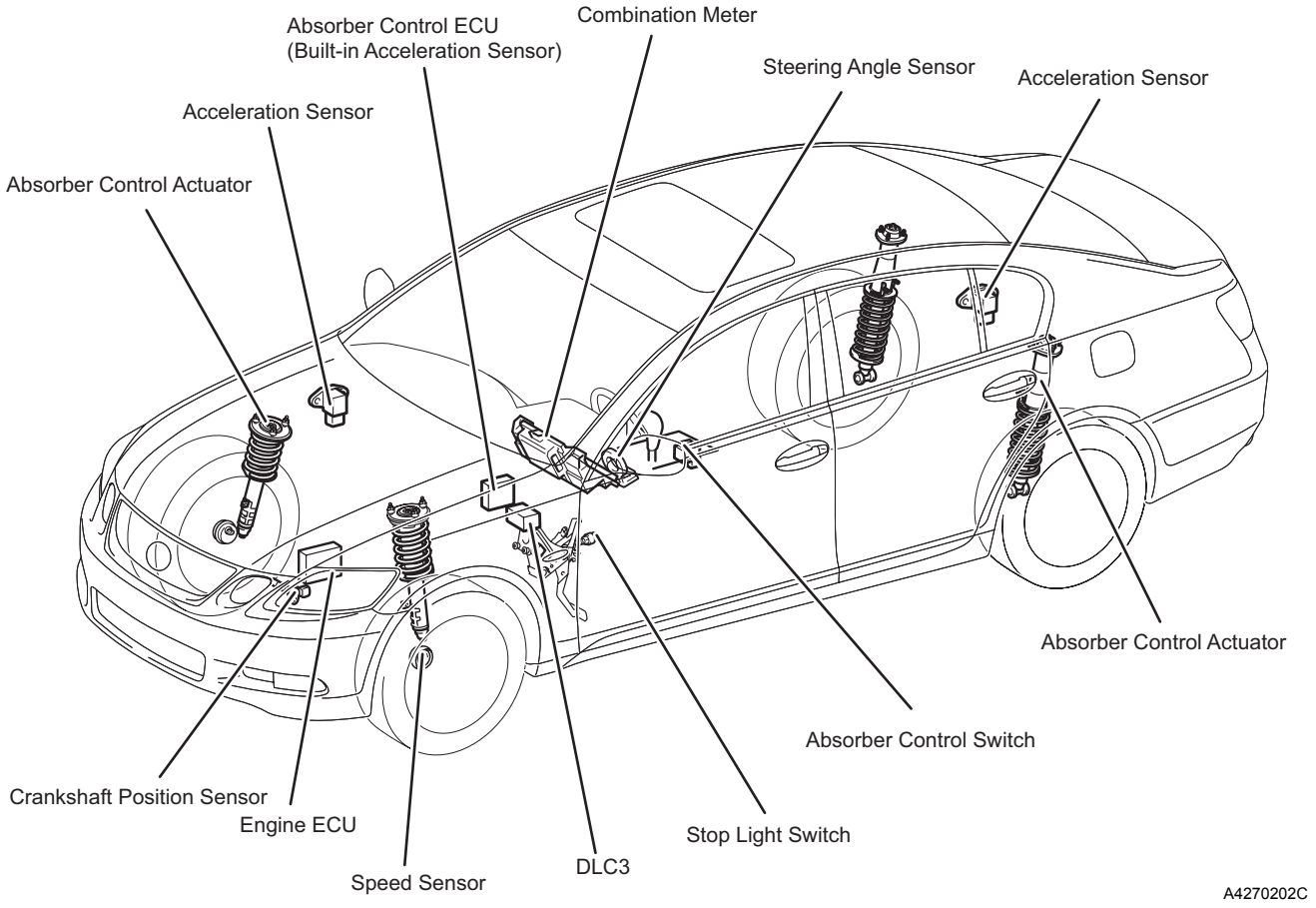


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SA

Main Components and Functions

● The components, including the sensors, actuators, and the absorber control ECU are located as follows:

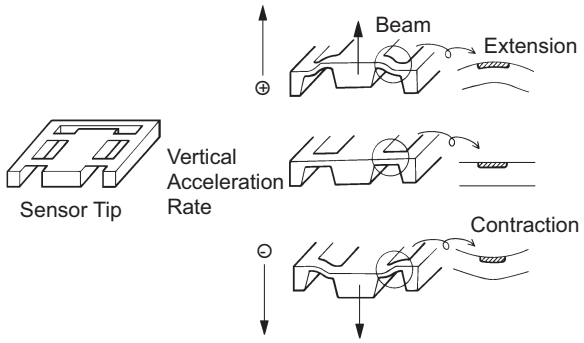


Main Components and Functions

Components	Function
Absorber Control Switch	Switches between the damping force control modes.
Steering Angle Sensor	Detects the amount of steering effort and the direction of the steering wheel.
Acceleration Sensor	Detects the vertical acceleration rate of the body.
Combination Meter	Contains the AVS indicator light, which informs the driver of the selected state of the absorber control switch.
Stop Light Switch	Detects the brake signal.
Speed Sensor	Detects the wheel speed.
Crankshaft Position Sensor	Detects the engine speed.
Absorber Control Actuator	Changes the damping force of the shock absorbers.
Absorber Control ECU	Based on the signals provided by various sensors, this ECU estimates the state of the vehicle and outputs a control signal to the absorber control actuator. It has a built-in acceleration sensor that detects the vertical acceleration rate at the right front side of the vehicle.
DLC3	Enables access to the DTC (Diagnostic Trouble Code) and ECU data when a diagnosis tool (Intelligent Tester II) is connected to this connector and operated.

Acceleration Sensor

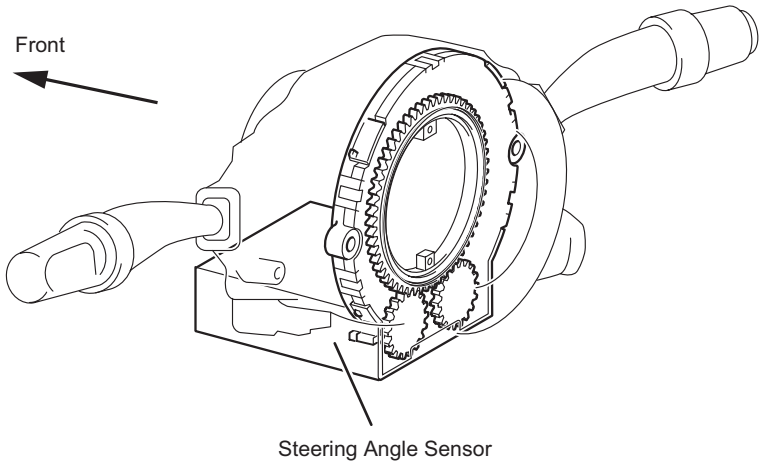
- These sensors detect the vertical movement above the body. In the front, one sensor is located in the absorber control ECU and another sensor is located in front of the glove box in the instrument panel. In the rear, one sensor is located in the luggage compartment. Thus, these sensors independently detect the vertical acceleration rate of the vehicle.



A4270051C

Steering Angle Sensor

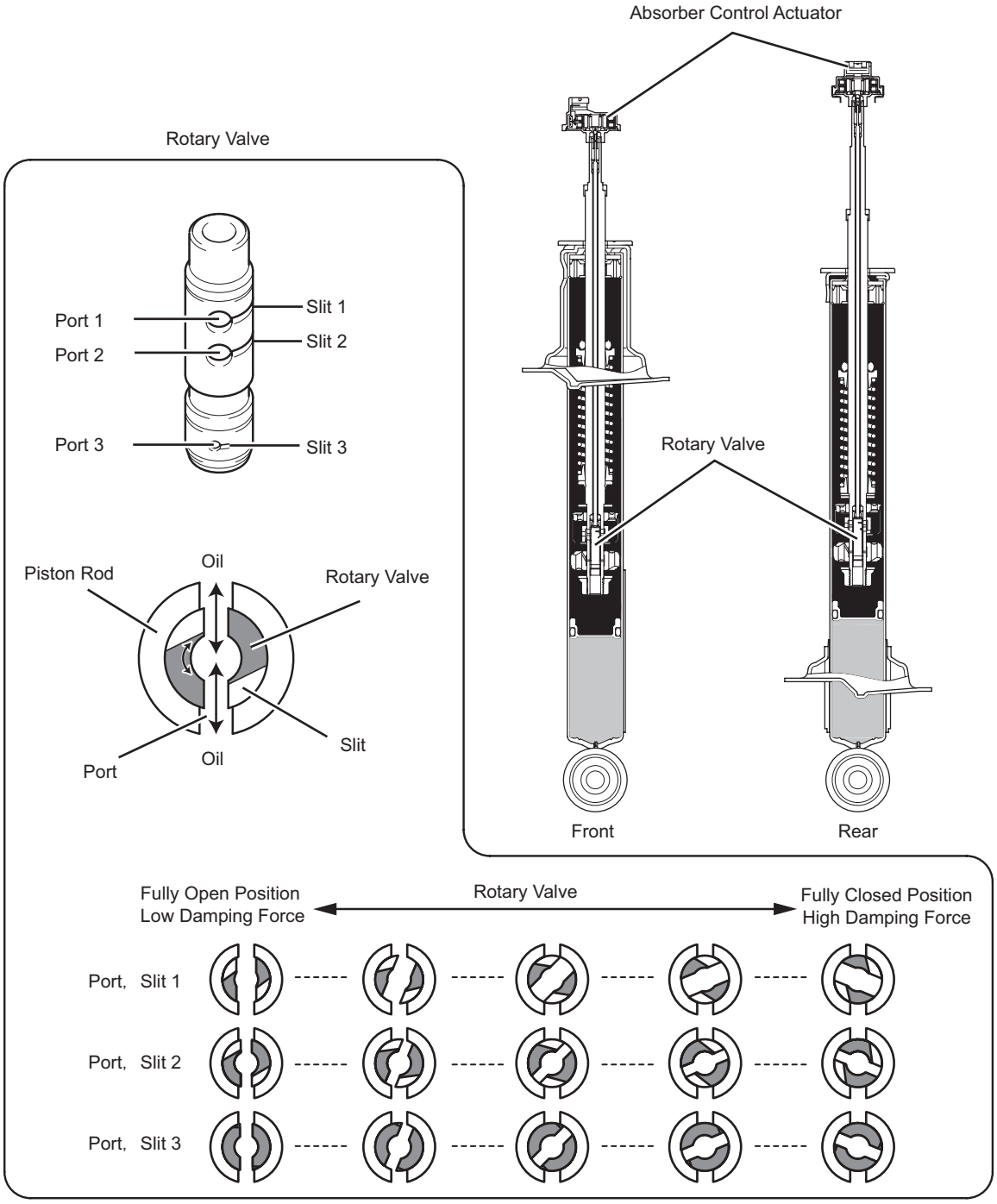
- A steering angle sensor is provided in the combination switch area. This sensor detects the amount of steering effort and the direction of steering and inputs them in the skid control ECU.
- The sensor assembly contains two sets of magnetic reluctance elements that detect the rotational movement of a magnet that is built into the detection gear. Thus, the sensor detects the changes that occur in the magnetic reluctance along with the rotational movement of the detection gear, in order to detect the rotational movement of the steering wheel.



A4270106C

Shock Absorber & Absorber Control Actuator

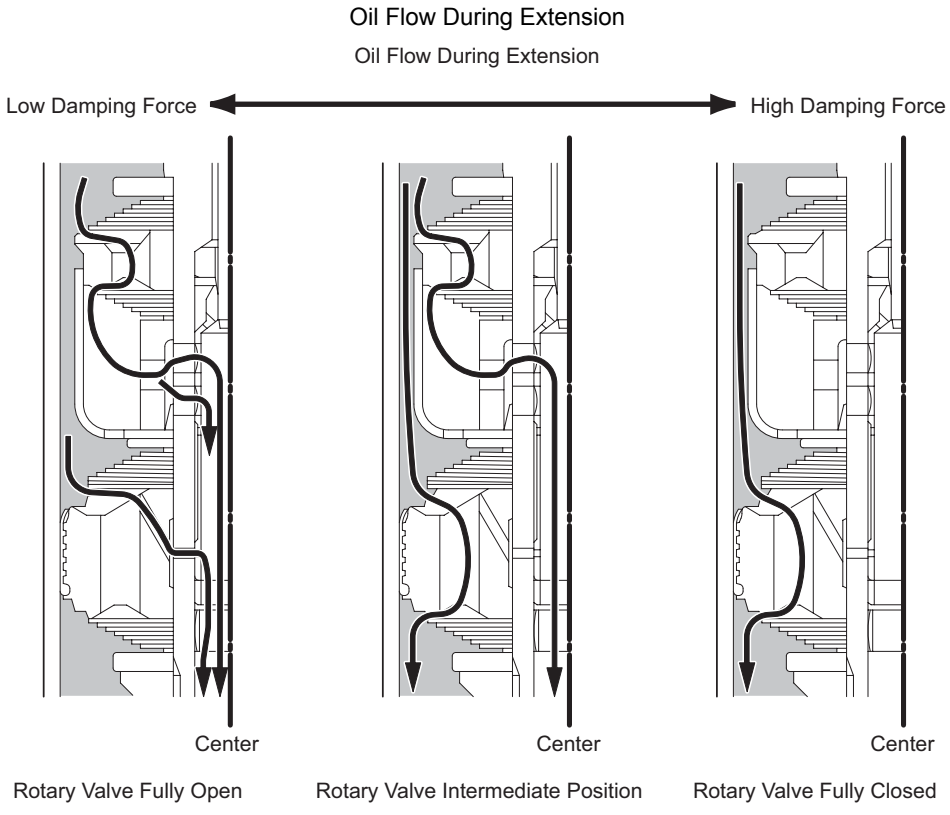
- To change the damping force, the step motor in the absorber control actuator turns the rotary valve on the piston. This varies the opening of the oil passage that connects the upper and lower chambers of the piston.
- The rotary valve, which contains two sets of ports and slits at three locations, varies the damping force in nine steps.

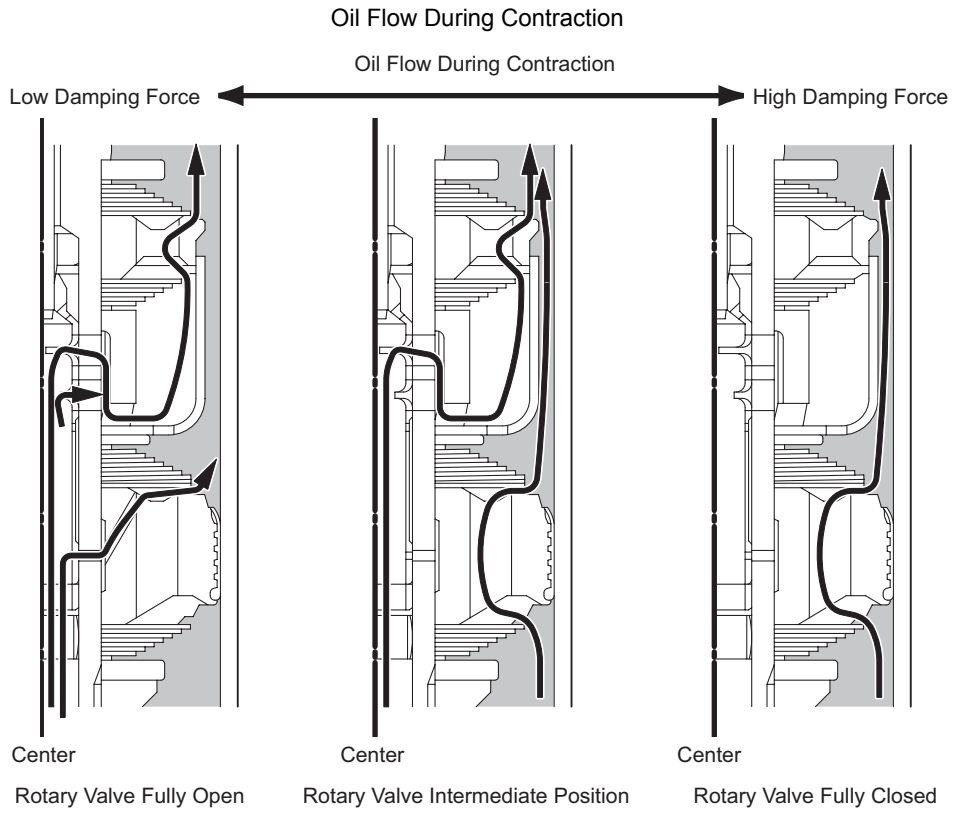


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Flow of Shock Absorber Oil in Piston

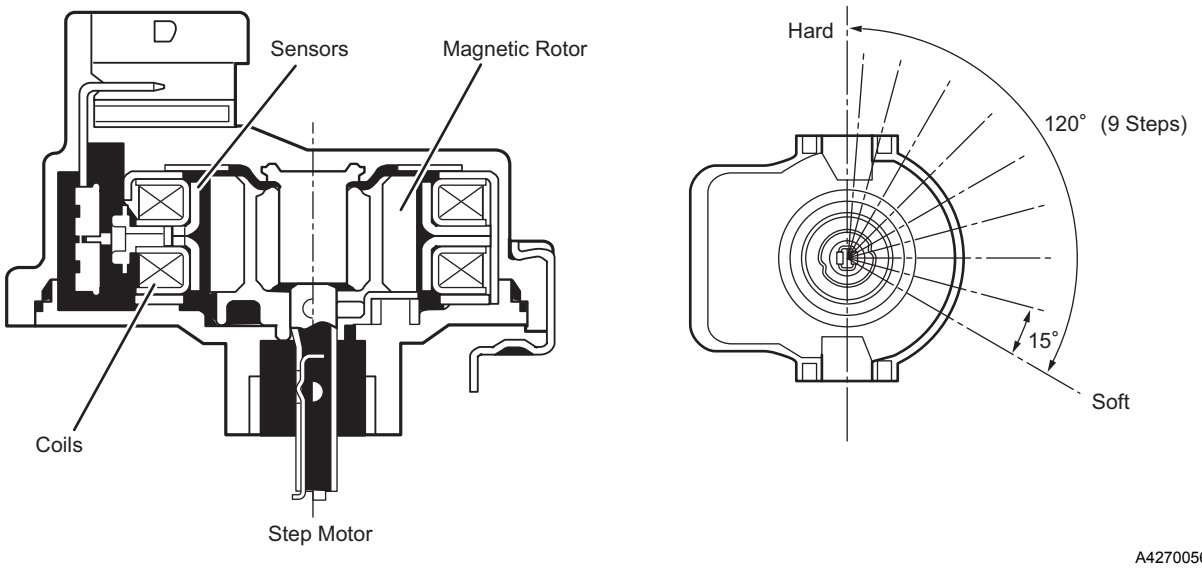
- When the rotary valve is fully closed, the damping force is provided only by the piston valve.
- When the rotary valve is in the intermediate position, the slit opens, allowing the passage between the piston valve and the rotary valve to control the damping force.
- When the rotary valve is fully open, the port opens widely, allowing the rotary valve passage to provide the damping force. If the piston speed is slow, the piston valve will remain practically inactive.





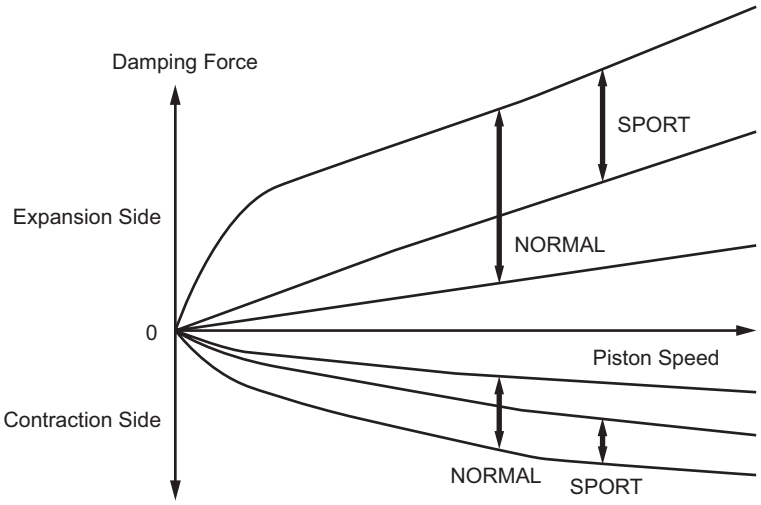
Absorber Control Actuator

- An absorber control actuator, which changes the damping force in accordance with the signals received from the absorber control ECU, is located above the shock absorber. A nine-step step motor turns the rotary valve in the shock absorber to vary the opening of the oil passage. This enables the damping force to be changed smoothly.

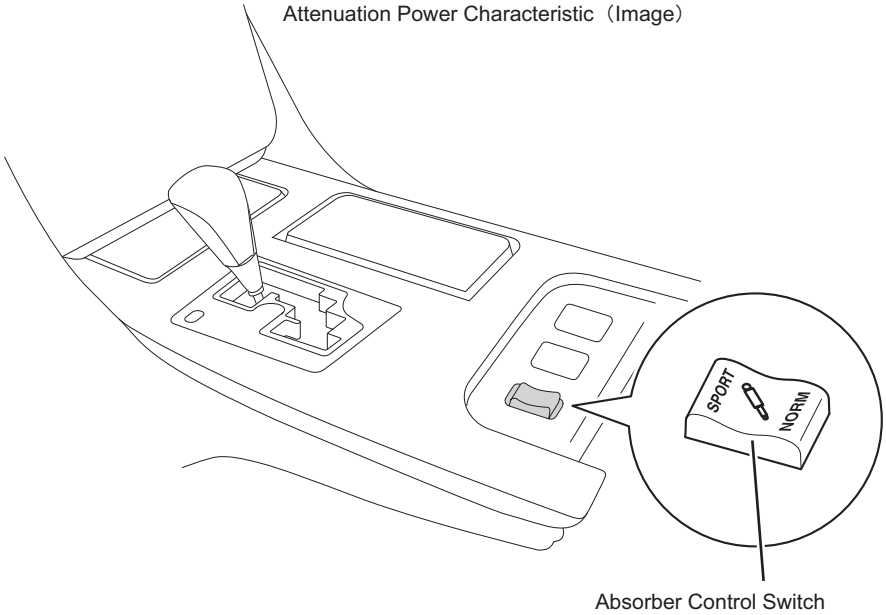


Absorber Control Switch

- An absorber control switch is located on the center console. This switch enables the driver to select the damping force mode of the shock absorbers at will. The driver can select between two types of modes, NORMAL and SPORT.
- The NORMAL mode ensures the proper drivability and stability while emphasizing the ride comfort by controlling the damping force in accordance with the driving maneuvers and road surface conditions.
- Compared to the NORMAL mode, the SPORT mode frequently uses the high damping force range during its damping force control, in order to further enhance drivability and stability.



Attenuation Power Characteristic（Image）

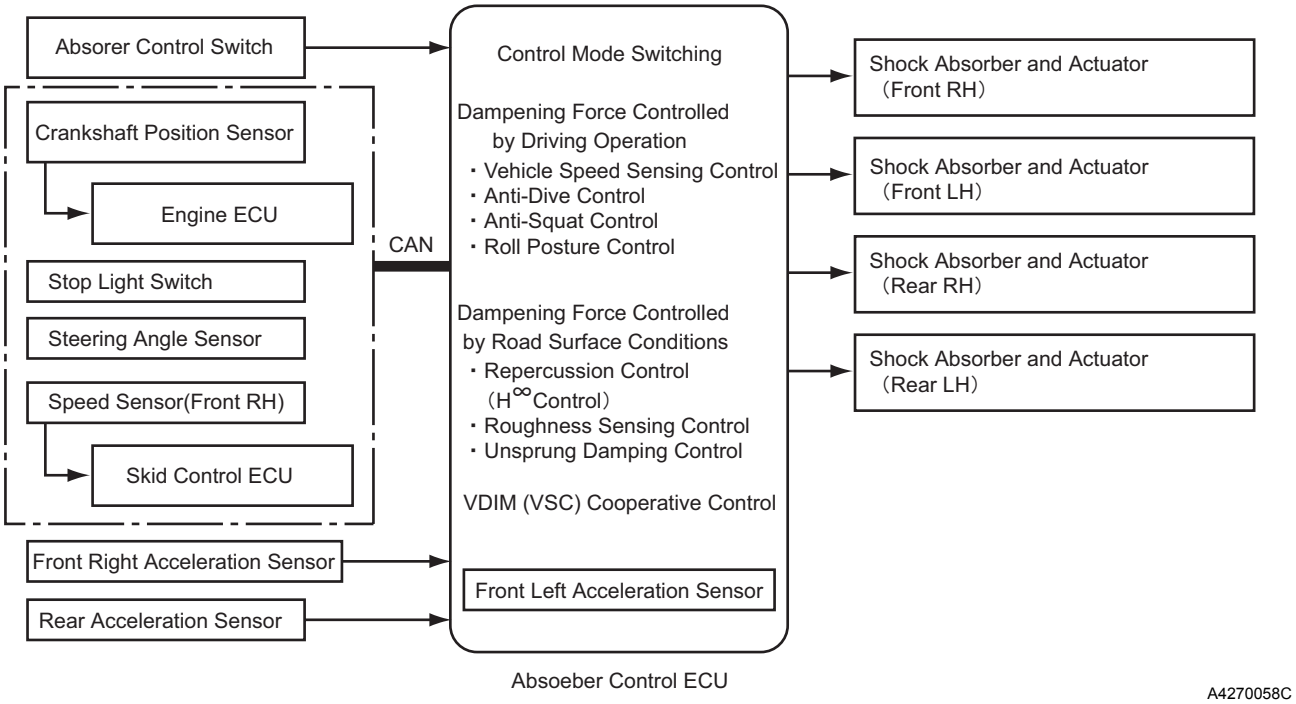


Absorber Control Switch

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Absorber Control ECU

- Based on the setting mode selected at the absorber control switch and the data received from various types of sensors, the absorber control ECU changes the damping force of the shock absorbers independently at the four wheels.
- The following controls are available for changing the damping force: the vehicle speed-sensing control, anti-dive control, anti-squat control, and roll posture control that are effected in accordance with driving maneuvers; and repercussion control (H∞ control), roughness sensing control, and unsprung damping control that are effected in accordance with the vehicle movement (road surface conditions). In addition, a VSC cooperative control is available to support the operation of the VSC.
- The repercussion control uses nonlinear H∞ (H infinity) control that is based on a modern control logic to realize a finely tuned damping force control. This control detects the acceleration sensor signals in order to monitor the frequencies in which repercussions can be felt, as well as the frequencies in which roughness can be felt. Also, it detects the wheel speed sensor signals in order to monitor the frequencies of the unsprung vibrations, thus realizing a smooth damping performance that suits the driving conditions.



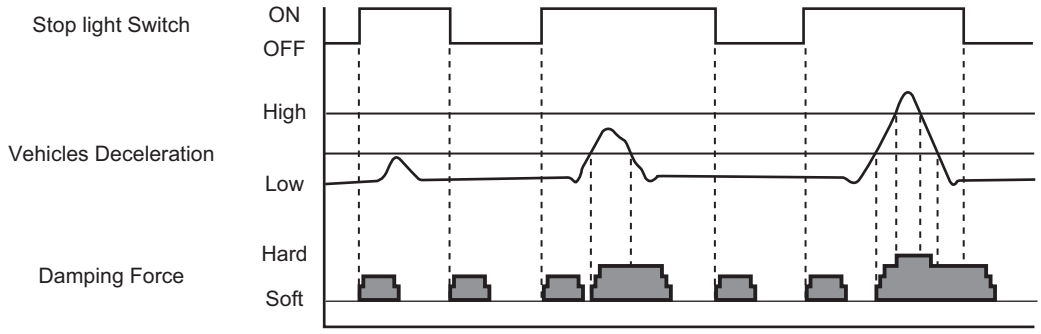
A4270058C

Vehicle Speed Sensing Control

- This control optimally sets the damping force to suit the vehicle speed, based on the data received from the wheel speed sensors. Thus, it realizes the proper ride comfort at low speeds and drivability and stability at high speeds.

Anti-Dive Control

- The absorber control ECU forecasts the extent of the dive of the vehicle caused by a brake application, based on the stoplight switch signal and the wheel speed signal. Then, it moderates the dive speed of the vehicle during deceleration by delicately controlling the damping force in accordance with the extent of the dive. Thus, it ensures the proper drivability and stability.
- Even when the driver releases the brake pedal or the deceleration increases, this control sets the damping force high to ensure a comfortable ride, while ensuring the proper drivability and stability during braking.



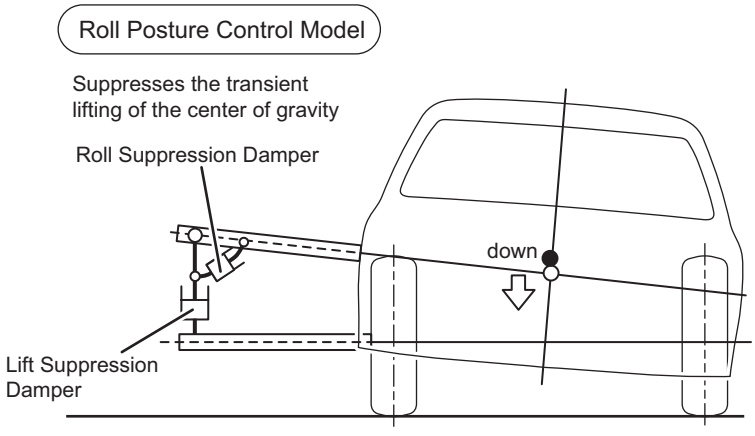
A4270059C

Anti-Squat Control

- The absorber control ECU forecasts the squat of the vehicle during acceleration based on the engine speed data. Then, it finely controls the damping force in order to reduce the changes in the vehicle posture and ensure the proper drivability and stability.

Roll Posture Control

- The absorber control ECU calculates the lateral acceleration rate based on the vehicle speed signal provided by the wheel speed sensors and the steering signal provided by the steering sensor. Then, the ECU controls the damping force in accordance with the extent of the lateral acceleration rate. Thus, it realizes excellent drivability and stability while the vehicle is making a turn.
- As illustrated, a control logic based on a roll posture control model is used for controlling the damping force inside and outside of the turn (independently at four wheels). In the roll posture control model, shock absorbers (for roll suppression and lift suppression) for suppressing the movements in two directions are located in the virtual points inside of the turn. Thus, this control optimizes the posture of the vehicle while making a turn. As a result, it ensures the proper ground holding performance and turn following performance, in order to realize excellent drivability and stability.

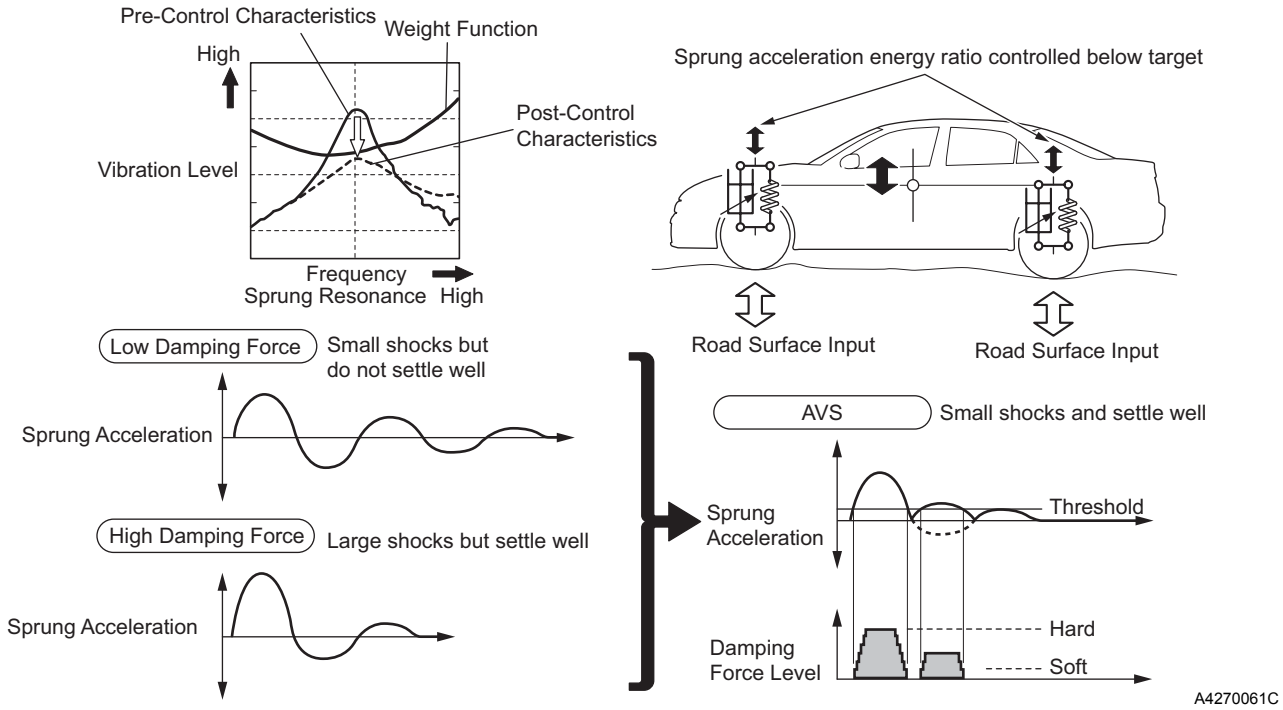


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SA

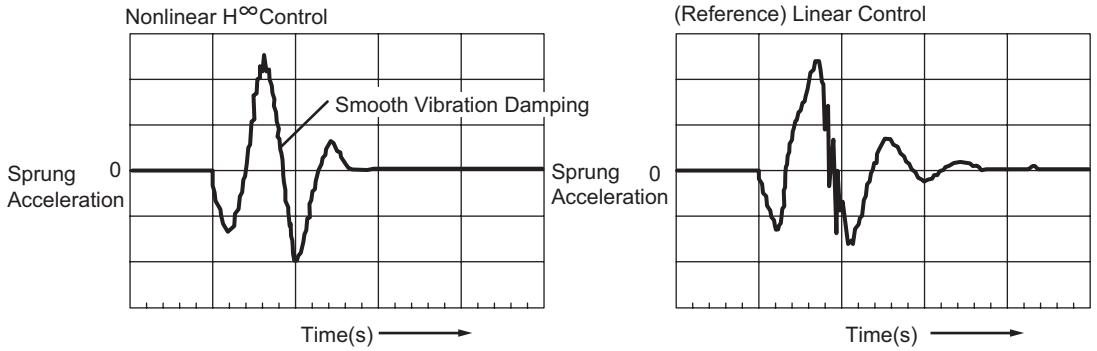
Repercussion Control (H∞ Control)

- When the repercussion is small in the rolling and pitching directions, the repercussion can be dampened by increasing the damping force for a certain length of time. However, if the repercussion becomes greater, merely increasing the damping force to a corresponding level will lead to a poor ride comfort. For this reason, repercussion control utilizing a nonlinear H∞ control logic is used in order to realize both a comfortable ride comfort and a high level of damping performance.
- This control uses three acceleration sensors to detect the sprung acceleration rate that corresponds to the bumps on the road surface and applies the modern control logic to calculate the condition of the stroke of the suspension. Based on these conditions, it uses the H∞ control logic to calculate the target damping force and controls the damping force independently at four wheels.
- By setting a frequency weight function to the sprung acceleration rate in the vibration frequency band of the repercussion, the damping performance can be raised positively in the target frequency band. In that case, this function controls the sprung acceleration rate by varying the damping force so as to suppress the energy ratio of the sprung acceleration rate (which counters the input from the road surface) below a predetermined value.



- If the vehicle posture is controlled only by controlling the damping force of the shock absorbers, the sprung acceleration rate is likely to be disturbed when the damping force is changed significantly.
- Even in this case, a natural and smooth repercussion damping can be achieved through the application of the nonlinear H∞ control logic.

Comparison of Sprung Vibration Dampening While Passing Through an Offset



Comparison of Sprung Vibration Dampening While Passing Through an Offset

A4270062C

❖REFERENCE❖

*1 : Generally speaking, H∞ control is a logic used for designing a controller that meets the control specifications represented by the H∞ norm (a standard for measuring the communication speed of a system), which was brought to completion in 1989.

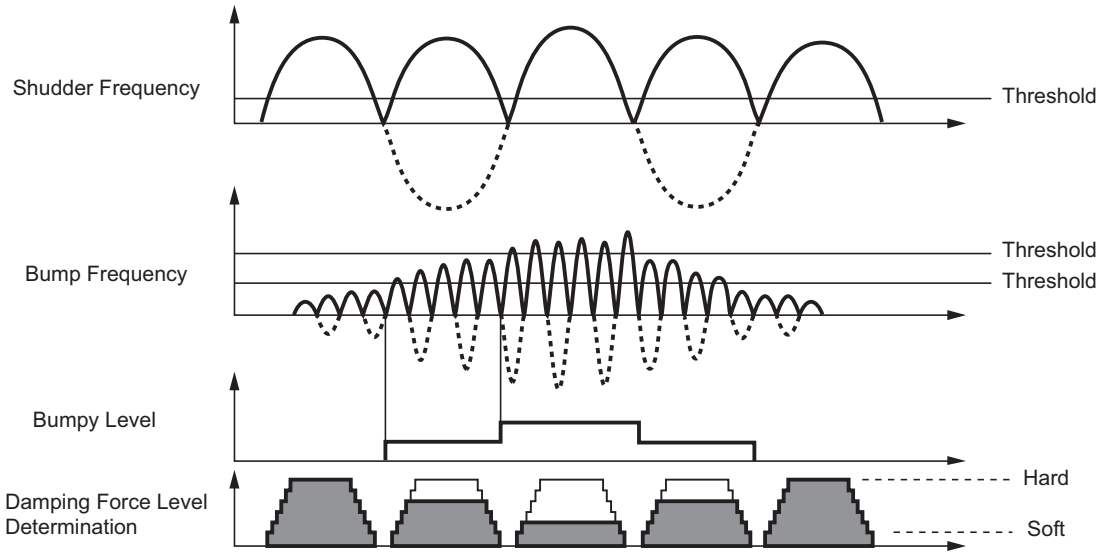
*2 : In the 1990s, this has been expanded for nonlinear systems, resulting in the nonlinear H∞ control. In the past, this control was considered difficult to use and its application examples were few. However, we have succeeded in its application on the damping force suspension control, and put it into practical use.

*3 : The letter "H" stands for the name of the mathematician Hardy (Godfrey Harold Hardy: a researcher of stability of control systems), who advocated the mathematical space that is applied in this control logic. The "∞" symbol represents the ∞ norm, which is one of the mathematical evaluation standards for measuring the size of a signal.

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Roughness Sensing Control

• If the absorber control ECU detects a frequency between the sprung vibration and unsprung vibration (roughness frequency) from the acceleration sensor signals while the vehicle is being driven on a rough road surface that generates both repercussions and roughness, the system sets the damping force slightly low. Thus, the vehicle is able to realize a flat feel without impairing the ride comfort.



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Unsprung Damping Control

• If the absorber control ECU detects unsprung vibration based on the data from the wheel speed sensors, it sets the damping force slightly high for a certain length of time, in order to suppress the unsprung vibration. Thus, the vehicle is able to realize a high level of ground holding performance without impairing the ride comfort.

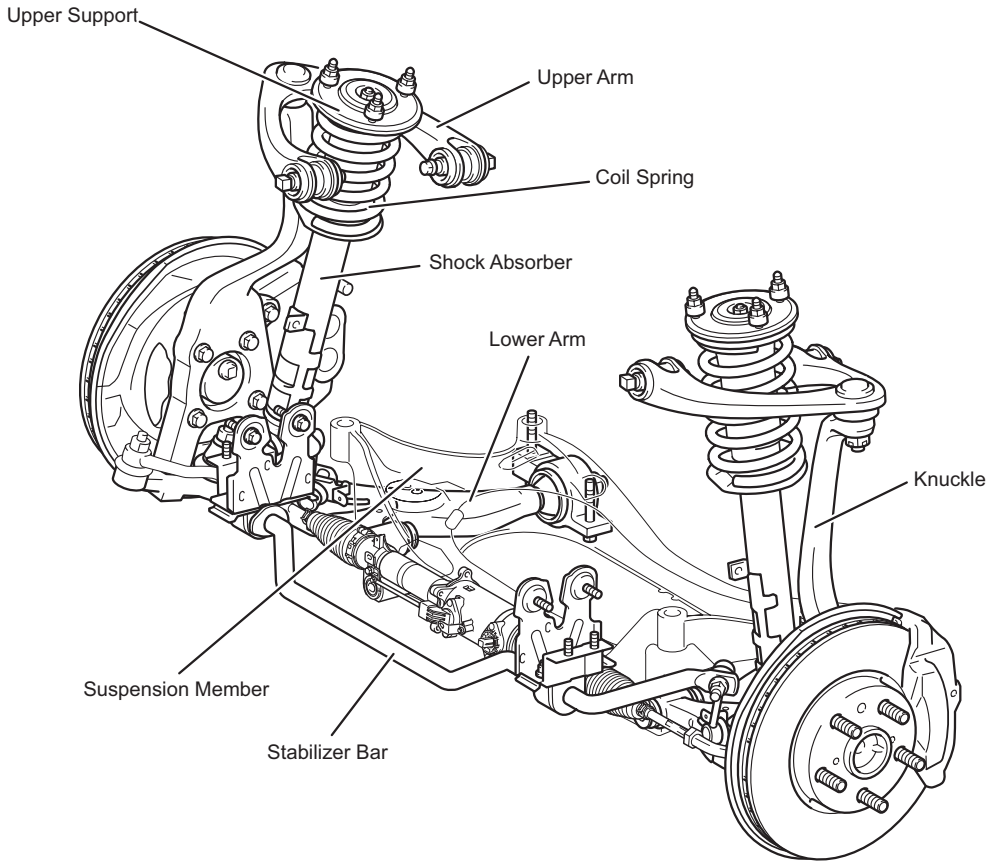
VDIM (VSC) Cooperative Control

• Based on the signals received from the skid control ECU, this control appropriately changes the damping force to suit the state of the lateral slippage of the vehicle or the changes in the slippage of the road surface, in order to maximize the effects of the VDIM (VSC).

SUSPENSION

Front Suspension Outline

- All models use a high-mount, upper arm, double-wishbone type suspension.
- Arms made of high-strength sheet steel and aluminum alloy are used for weight reduction.
- The steering gear has been placed forward of the axle. During cornering, this changes the steering angle to toe-out in accordance with the lateral force. As a result, a smoother response has been realized during high-speed driving.
- The suspension components have been optimally allocated to increase the steering angle of the wheels. As a result, the minimum turning radius has been reduced and excellent maneuverability has been realized.
- The wheel stroke has been increased, urethane bound stoppers are used, and various components have been optimized to ensure excellent ride comfort.
- A large, liquid-filled bushing is used at the rear of the lower arm to optimize vibration and harshness.



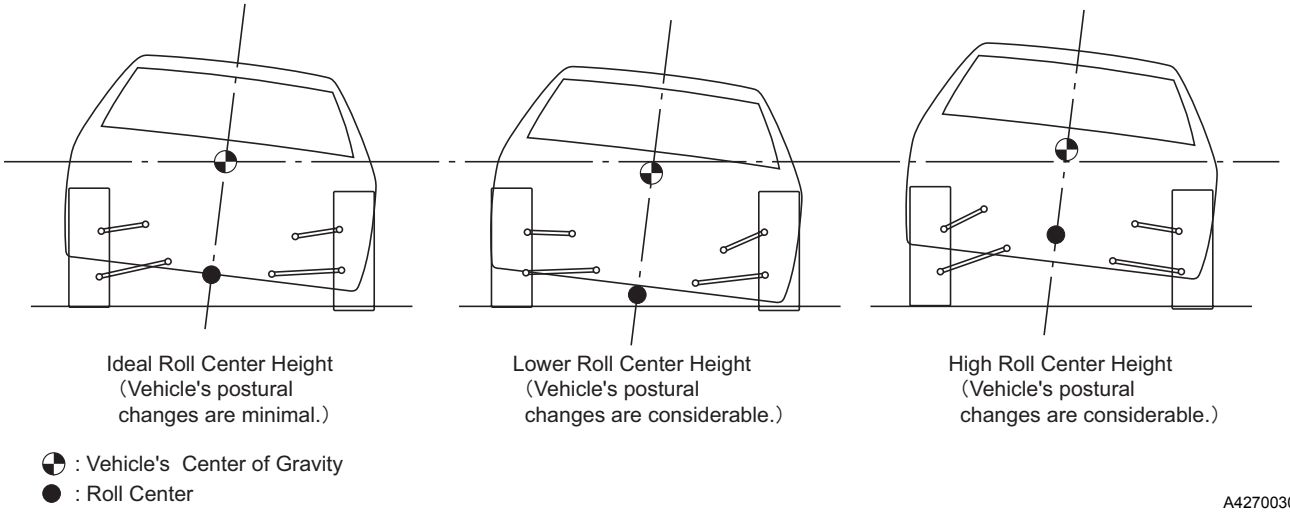
A4270024C

Alignment Specification

		GS300	GS430
Camber	Degrees	-0°23'	-0°26'
Caster	Degrees	7°23'	7°26'
King Pin Inclination	Degrees	9°23'	9°26'
Toe-in	mm(in.)	1(0.04)	←

Optimized Roll Center

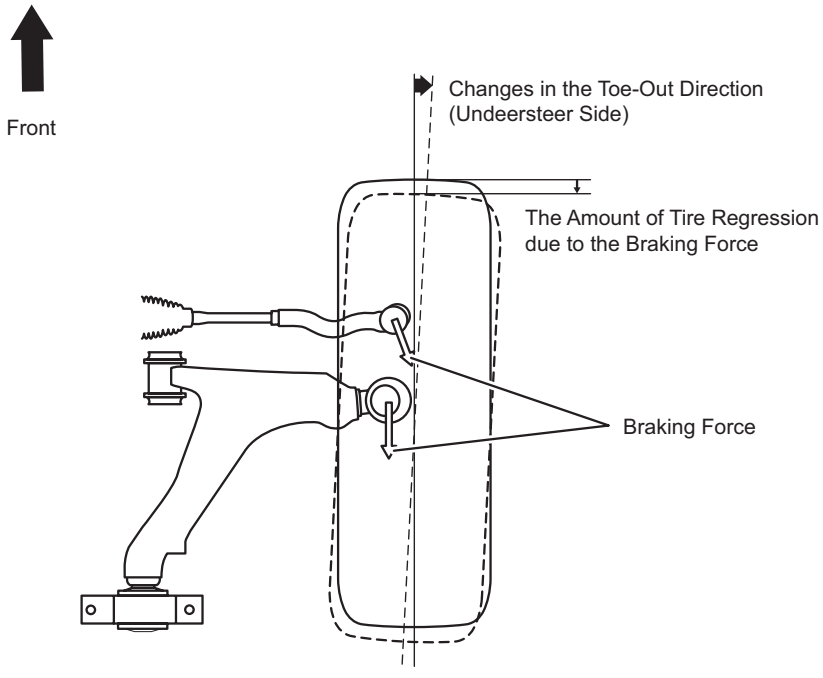
• A Vehicle with a roll center that is set low has a tendency to dip during a roll. Conversery,if its roll center is set high,the vehicle has a tendency to rise during a roll. In either case,the vehicle undergoes a considerable amount of the vehicle.



Braking Understeer

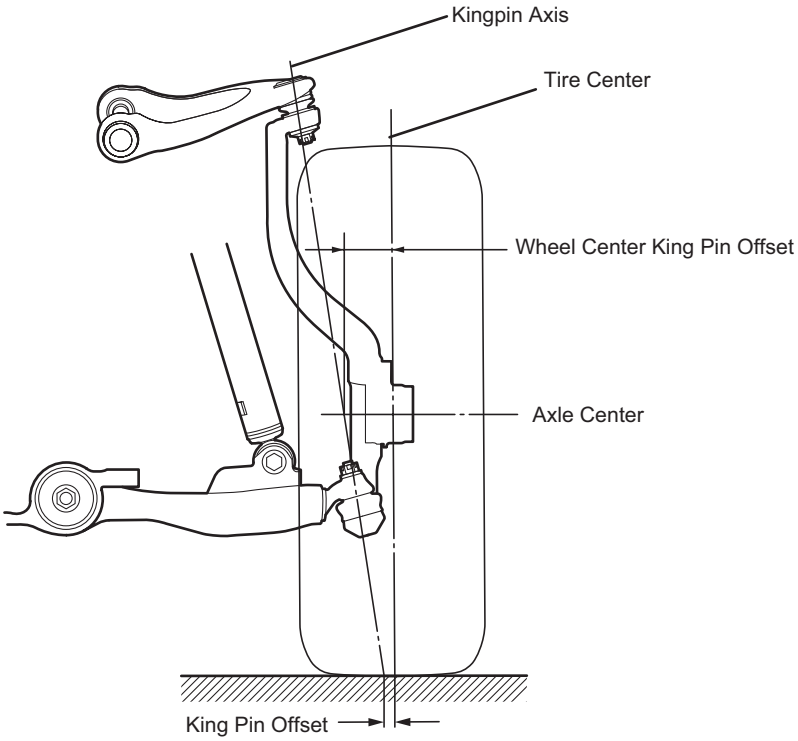
• During braking, the load of the vehicle moves to the front wheels. If the direction of the wheels during a turn is constant, the vehicle will exhibit the behavior of rolling inward of the turn, due to the nature of the wheels. To gain the appropriate understeer (thus reducing the steering angle of the wheels) during braking, the components have been appropriately allocated so that the wheels will change to toe out during braking.

• This ensures the proper stability and longitudinal compliance, as well as superior ride comfort.



Optimized Kingpin Offset

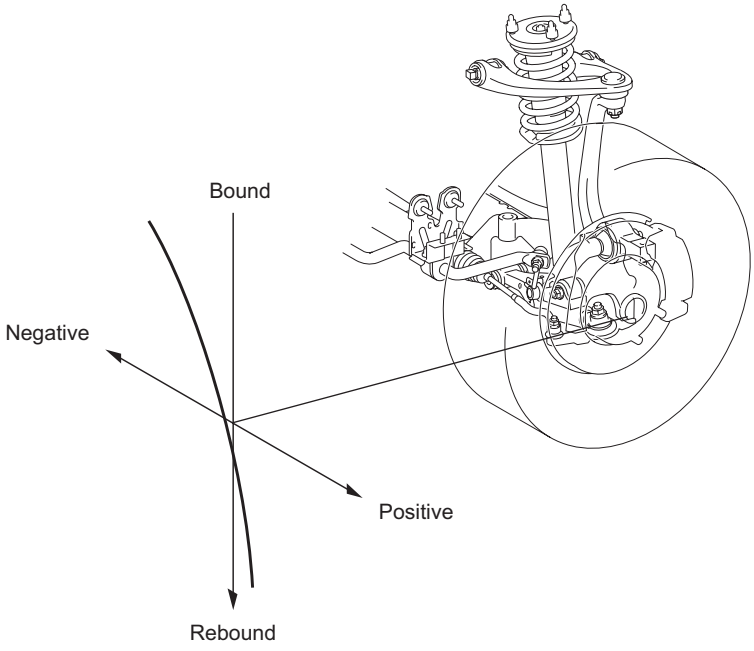
• By adopting the high-mount type upper arms, the offset between the tire center and the king pin is reduced at the axle center height. This reduces the moment around the king pin and suppresses the generation of flutter.



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Optimized Camber

• Both the initial camber and the camber change rate have been optimized to ensure excellent driving stability.

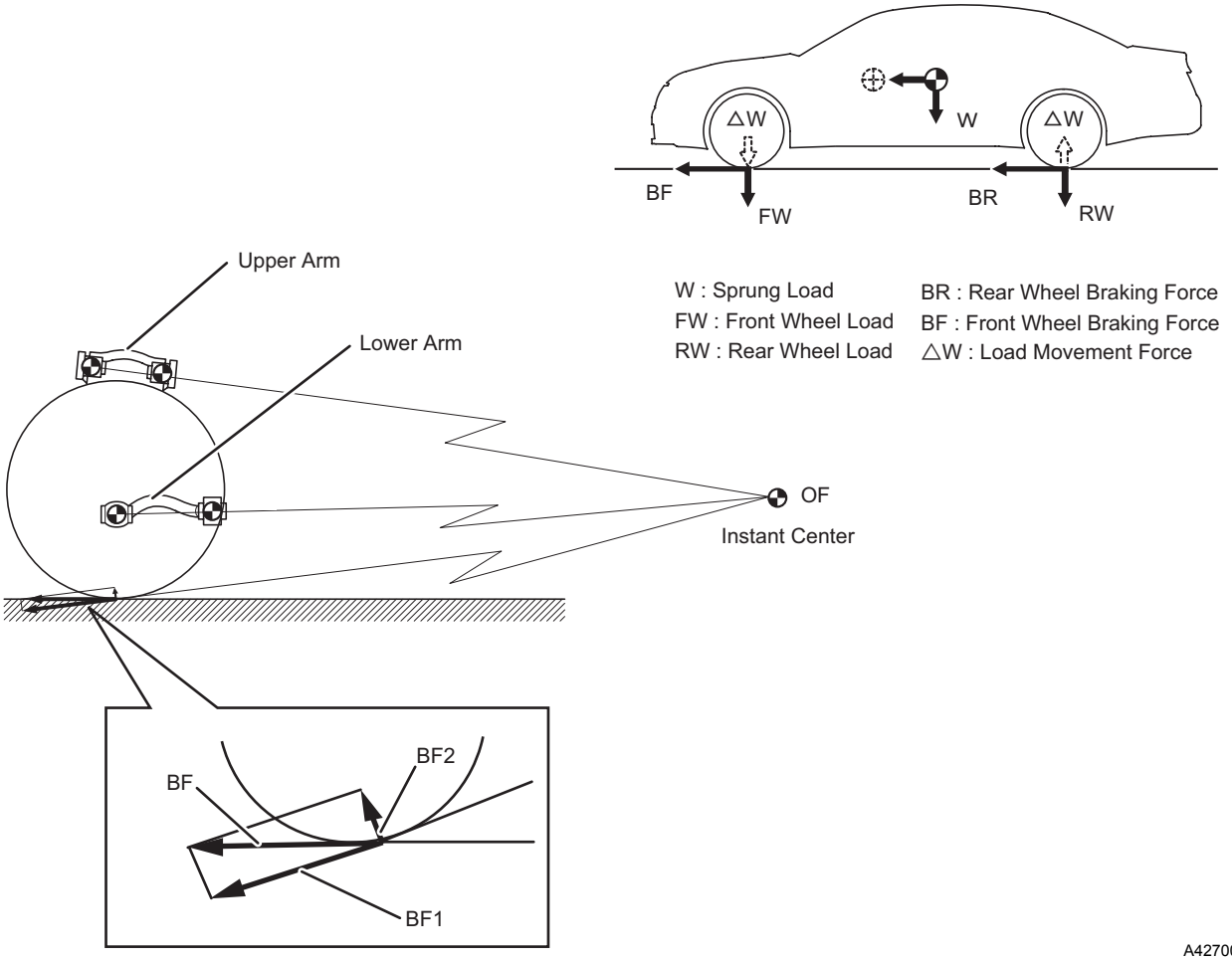


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Anti-Dive

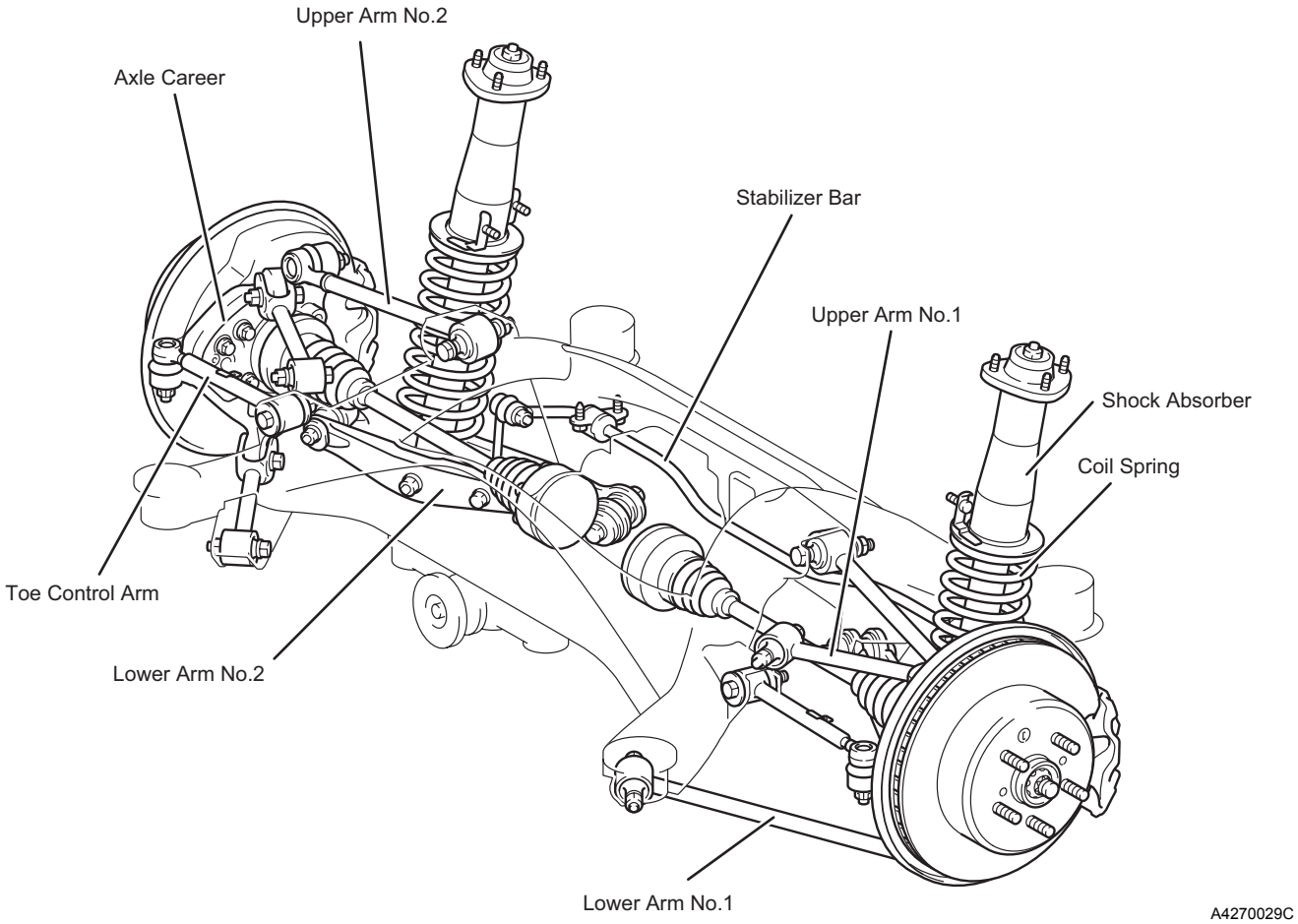
- The lower arm is mounted to the body higher at the back than at the front, and the rear of the upper arm is set lower. As a result, the intersecting point OF, to which the lines extend geometrically from the lower and upper arms, has been set higher than the road surface.
- The intersecting point OF is in a position in which the vehicle body sustains the braking force BF that acts on the front wheels during braking. For this reason, the braking force BF generates the following components: the force BF1 that acts on the intersecting point OF, and the force BF2 that acts in the direction of the ground surface. The direction and the intensity of the force BF2 that acts in the direction of the ground surface vary by the position of the intersecting point OF. Thus, by setting the intersecting point OF at a position higher than the road surface, the increase in the front wheel load that is increased by the inertia during braking can be suppressed geometrically.



A4270028C

Rear Suspension Outline

- All models use a multi-link type suspension that consists of two upper arms, lower arms, and toe control arms.
- Through the use of the double-link upper arms, the suspension changes to a linear alignment in order to ensure the proper sprung stability during a thrust-up input or the cornering of the vehicle.
- Cast-aluminum carriers are used for weight reduction.
- The coil springs have been placed downward to ensure ample luggage space.
- The roll center height and its change rate have been optimized to minimize the changes in the center of gravity during a roll, thus ensuring a stable roll posture.
- The arms have been optimally allocated and the bushing characteristics have been optimized to ensure the proper ride comfort performance. At the same time, the proper behavioral stability has been ensured during braking and driving, realizing ride comfort, drivability, and stability at high levels.

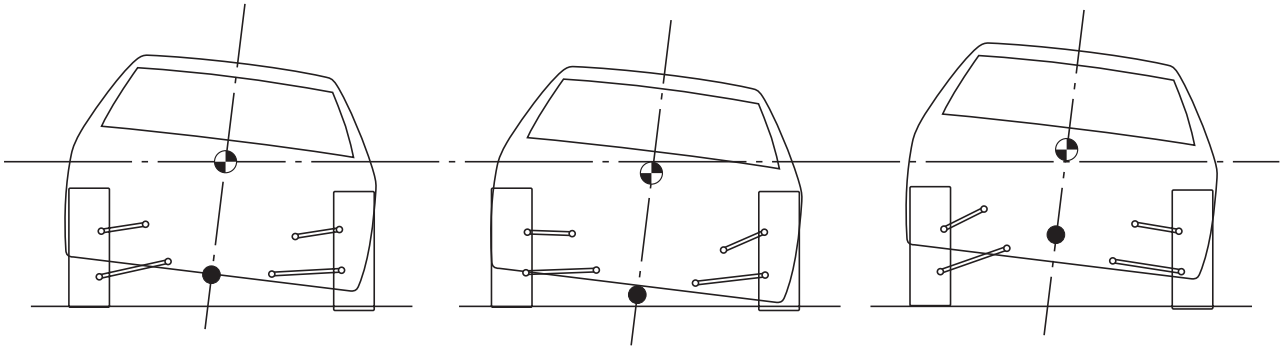


Alignment Specification

	GS300	GS430
Camber Degrees	-1°10'	-1°19'
Toe—in mm(in.)	3(0.12)	←

Optimized Roll Center

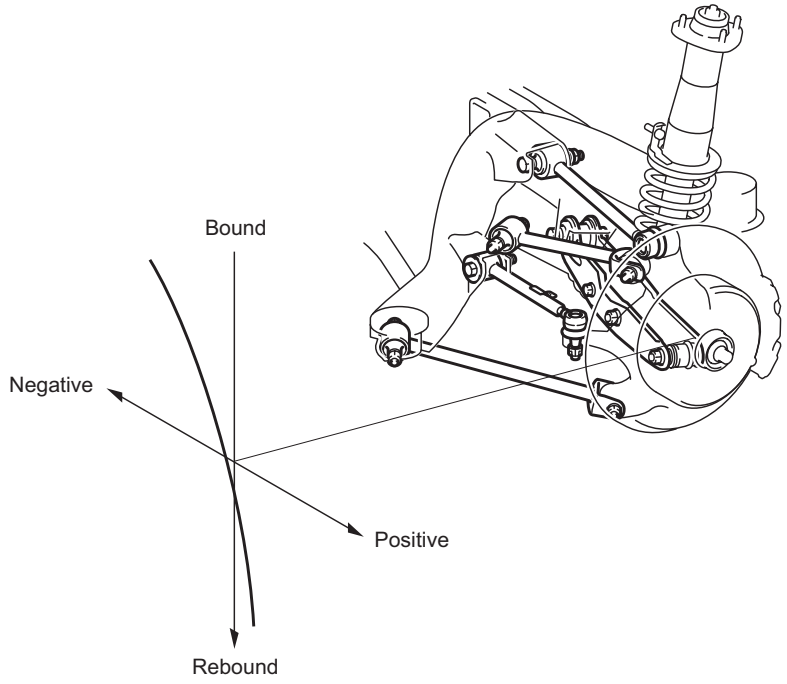
• A Vehicle with a roll center that is set low has a tendency to dip during a roll. Conversery,if its roll center is set high,the vehicle has a tendency to rise during a roll. In either case,the vehicle undergoes a considerable amount of the vehicle.



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Optimized Camber

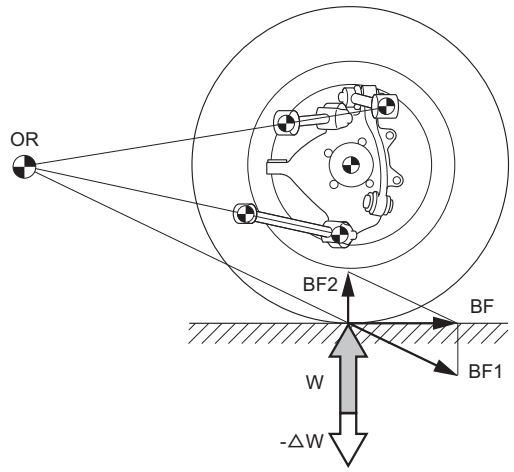
• Both the initial camber and the camber change rate have been optimized to ensure excellent driving stability.



A4270031C

Anti-Lift

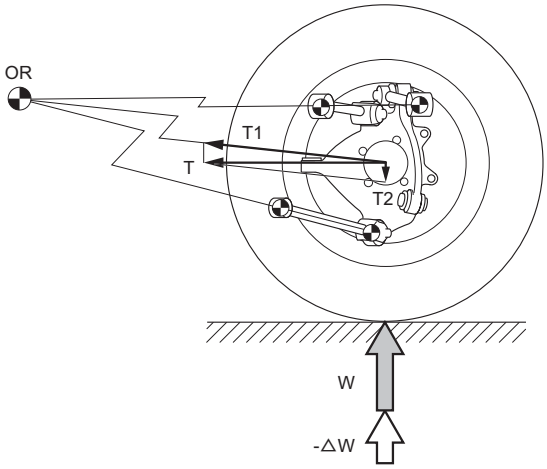
- During braking, the inertial force causes the center of gravity of the vehicle body to move, and reduces the load on the rear wheels. As a result, the rear end of the vehicle lifts up.
- The vehicle body attempts to use the geometric intersecting point OR of the suspension to sustain the braking force that is generated at the road surface. Then, the braking force BF generates the following components: the force BF1 that acts on the intersecting point OF, and the force BF2 that acts in the direction of the ground surface.
- The direction and the intensity of this force, which acts in the direction of the ground surface, can be changed by changing the height of the intersecting point OR. Thus, by setting it at a position higher than the road surface, it acts in the opposite direction of the load movement ΔW, and suppresses the lifting of the rear end of the vehicle.



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Anti-Squat

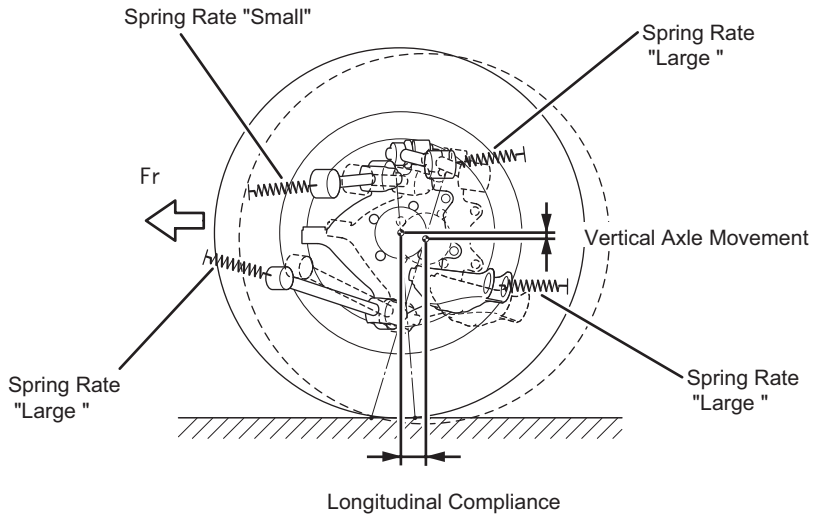
- During a start off or acceleration, the inertial force causes the center of gravity of the vehicle body to move. This increases the load on the rear wheels, causing the rear end of the vehicle to squat.
- The vehicle body uses the geometric intersecting point OR of the suspension to sustain the drive force that acts on the axle center as well as during anti-lift. Then, the drive force T generates the following components: the force T1 that acts in the direction of the intersecting point, and the force T2 that acts in the direction of the ground surface. By setting the intersecting point OR at a position higher than the axle center, the force that acts in the direction of the ground surface will cancel out the load ΔW that increases with the start off or acceleration. As a result, it suppresses the squatting of the rear end of the vehicle.



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Optimizing Longitudinal Compliance and Ensuring Braking Stability

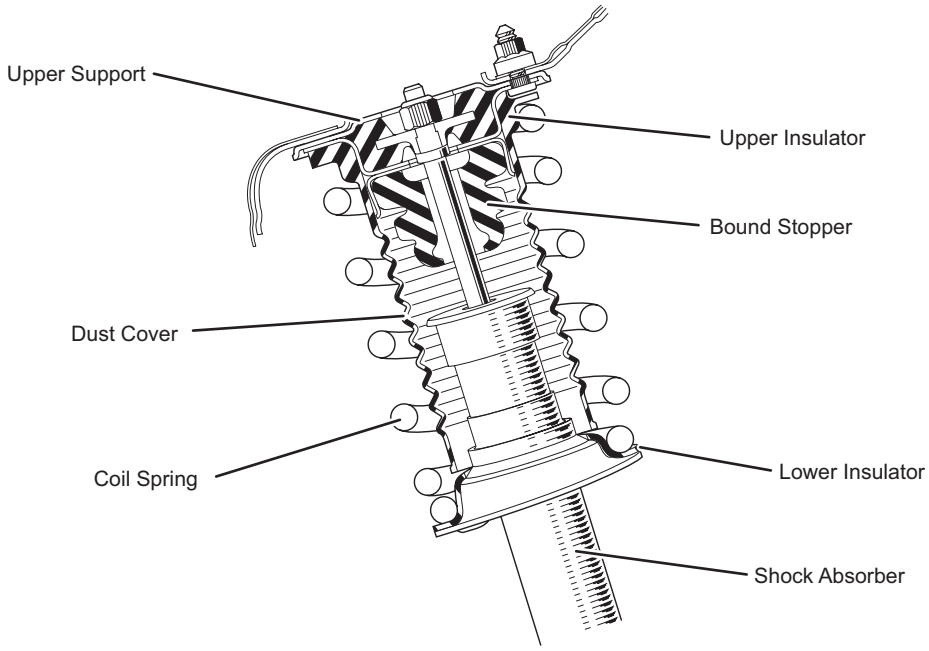
- When the vehicle goes over a bump on the road, a load is input to the axle center in the rear direction of the vehicle. The longitudinal movement of the axle in response to the load that is input from the road surface at this time is called "longitudinal compliance". The ride comfort can be improved by setting a large compliance. For this reason, the spring constant of the bushing in upper arm No. 1, which bears a small input load during braking, has been reduced to ensure ample longitudinal compliance. Furthermore, the spring constant of the lower arm bushing has been increased to suppress the changes in the toe angle during a braking load. As a result, both excellent ride comfort and driving stability have been realized at high levels.



A4270032C

Front Upper Support & Coil Spring

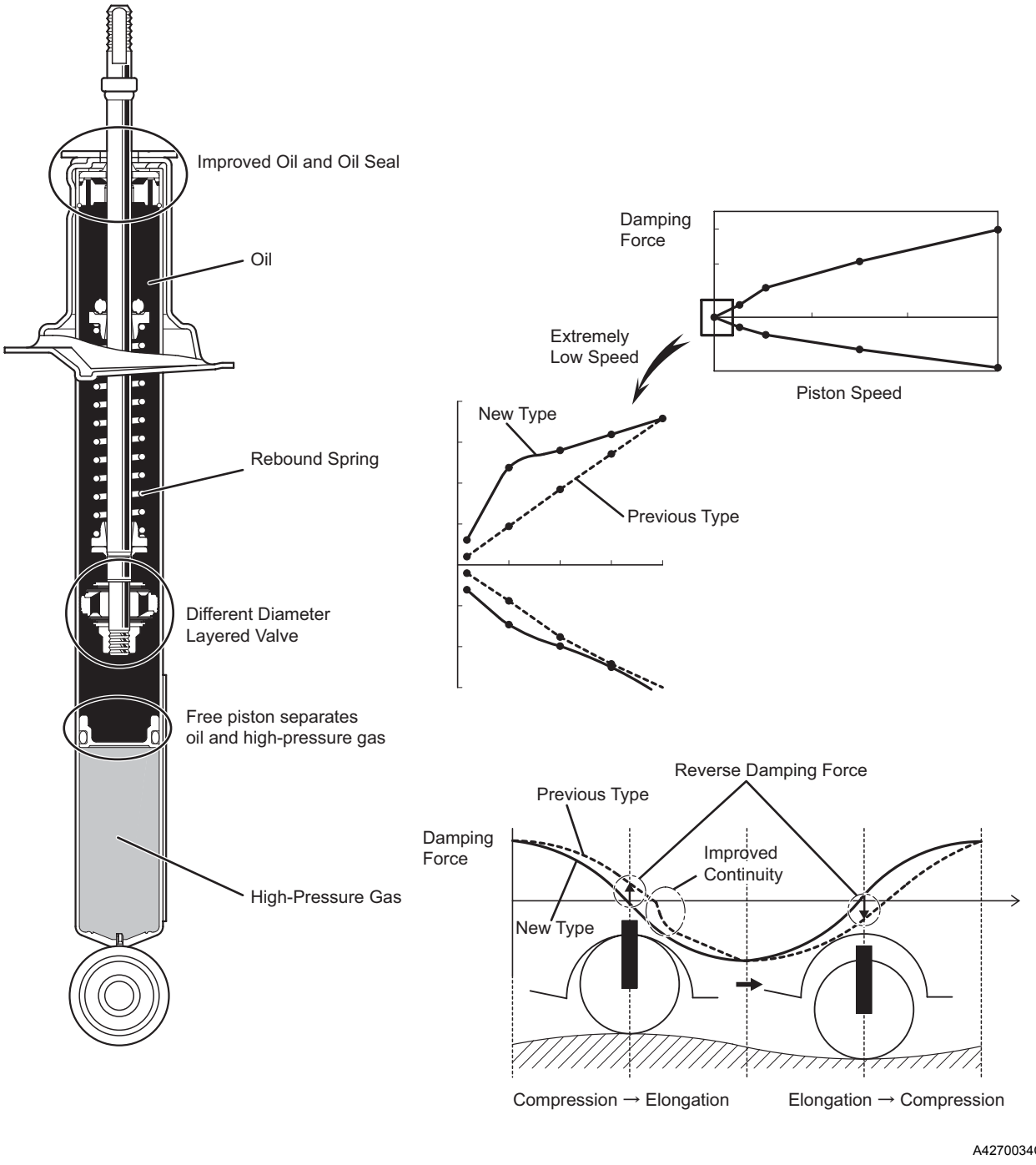
- A bound stopper made of urethane is used to reduce the shock feel when the shock absorber comes in contact with the stopper. Together with the increased wheel stroke, this ensures the proper ride comfort by countering repercussions.
- The stopper acts positively at an early stage of a bound, thus reducing the nose dive during braking and the roll angle during cornering.
- An upper insulator is provided in the upper spring area to ensure stability to counter disturbance.
- A lower insulator is provided in the lower spring area to reduce noise and vibration.



A4270033C

Front Shock Absorber

- A mono-tube type shock absorber with a rebound spring and different diameter layered valve is used.
- A mono-tube type shock absorber generates a damping force starting with an extremely low piston speed range. Thus, it realizes a natural and linear vehicle behavior in response to driving maneuvers and a flat ride comfort. Furthermore, the proper response and continuity of the shock absorber damping force have been ensured. This minimizes useless unsprung movement to ensure the proper road tracking capability and ride comfort.



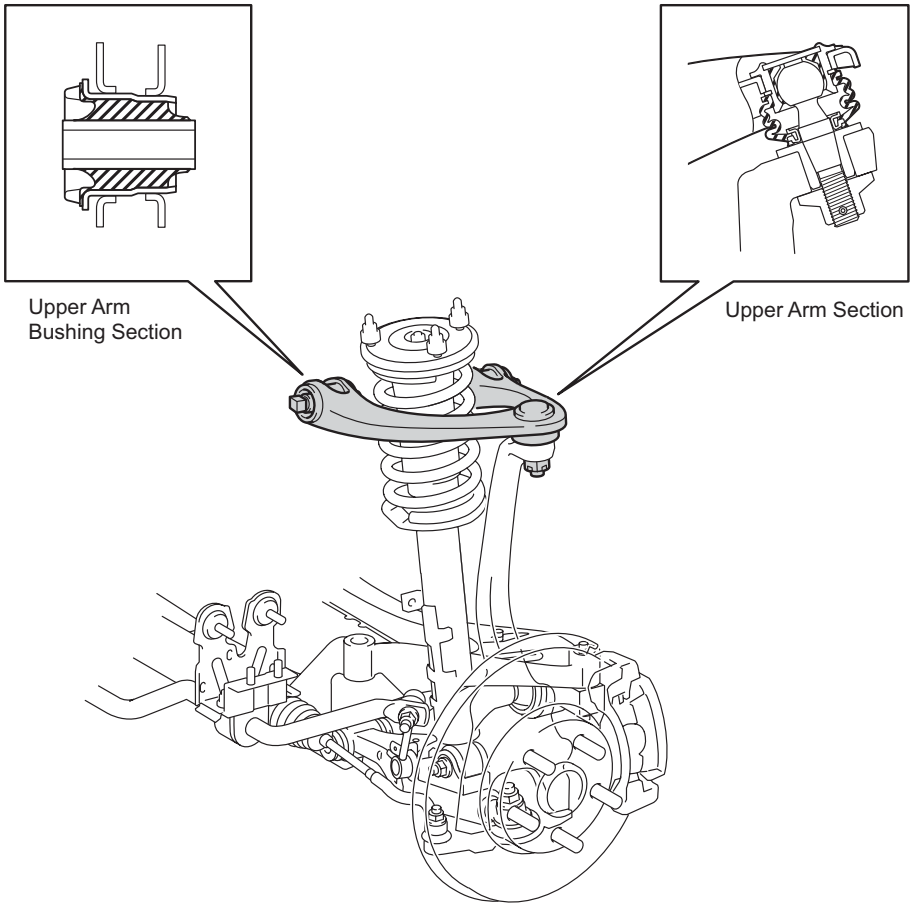
A4270034C

Front Upper Arm & Bushing

● The upper arm is made of high-strength sheet steel for weight reduction. The area that fits into the bushing has been burred*, without a weld, to simplify the construction and reduce the weight.

❖REFERENCE❖

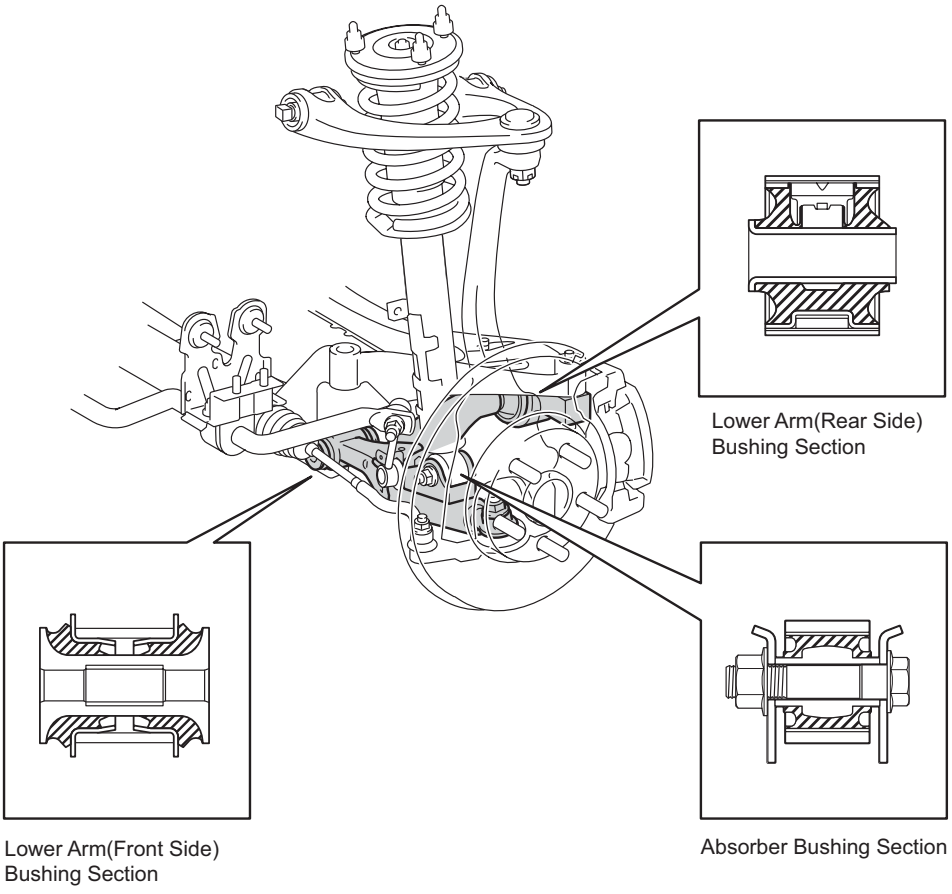
* : The area around the hole is raised.



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Front Lower Arm, Knuckle & Bushing

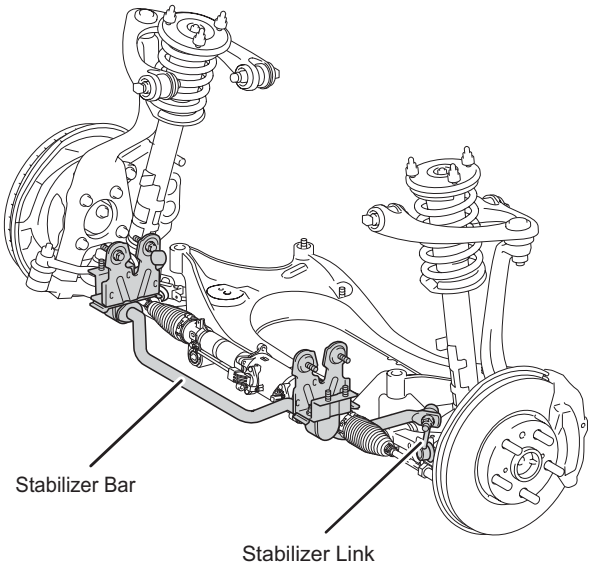
- The lower arms are made of high tensile sheet steel for weight reduction.
- The rear lower arm uses a large, liquid-filled bushing, which increases the linear range of the longitudinal compliance. Thus, it ensures a favorable ride comfort with a minimal amount of harshness and shocks, regardless of the size of the bumps on the road surface. In addition, to reduce vibrations such as flutters and shakes, the length of the orifice has been extended, thus enhancing the effectiveness of the liquid-filled bushing.
- The front lower arm uses a bushing with a two-way split construction in order to enhance the effectiveness of the rear lower arm bushing. This construction uses compressed rubber at the flange to enhance rigidity in the longitudinal direction of the vehicle.
- The knuckle is made of forged aluminum for weight reduction.In addition, the tie-rod ball joint & lower ball joint are integrated at the knuckle to achieve a simple construction.
- A compression type lower ball joint is used.



A4270038C

Front Suspension Stabilizer

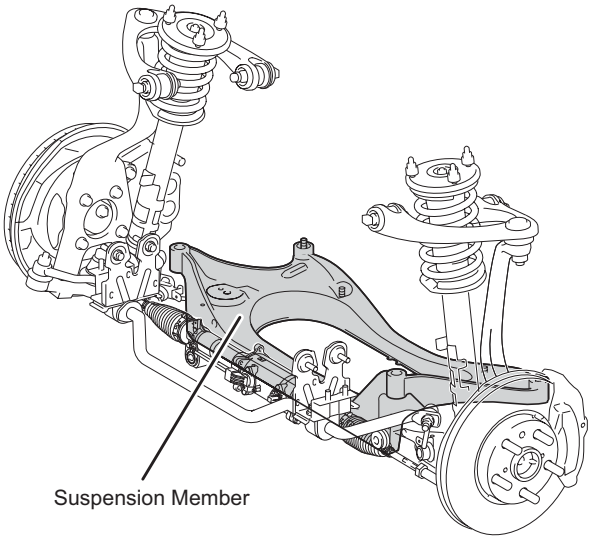
- All models use a lightweight, hollow type stabilizer.
- A ball-joint type stabilizer link is used to ensure excellent rigidity.



A4270041C

Front Suspension Member

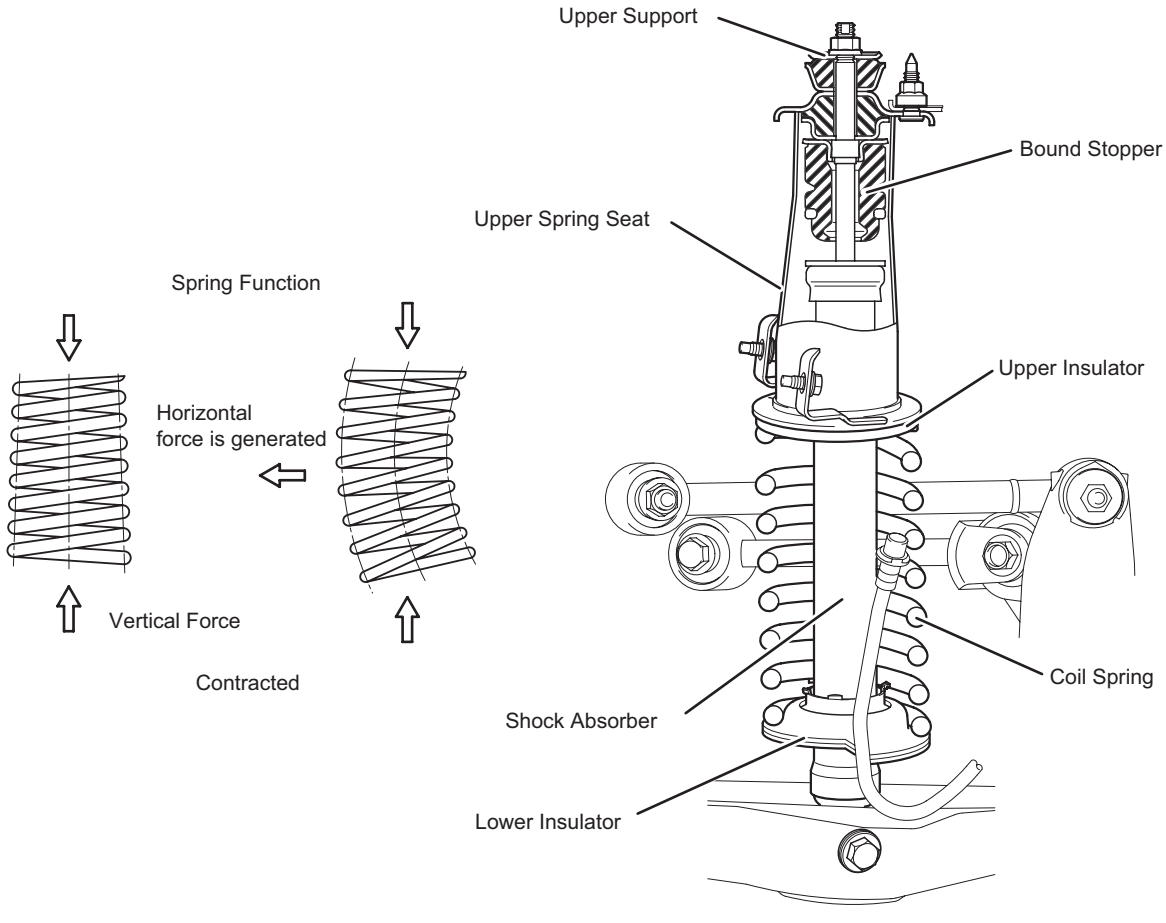
- All models use a suspension member made of aluminum for weight reduction.
- An excellent body rigidity is ensured, including the suspension member, to reduce noise and vibration.



A4270043C

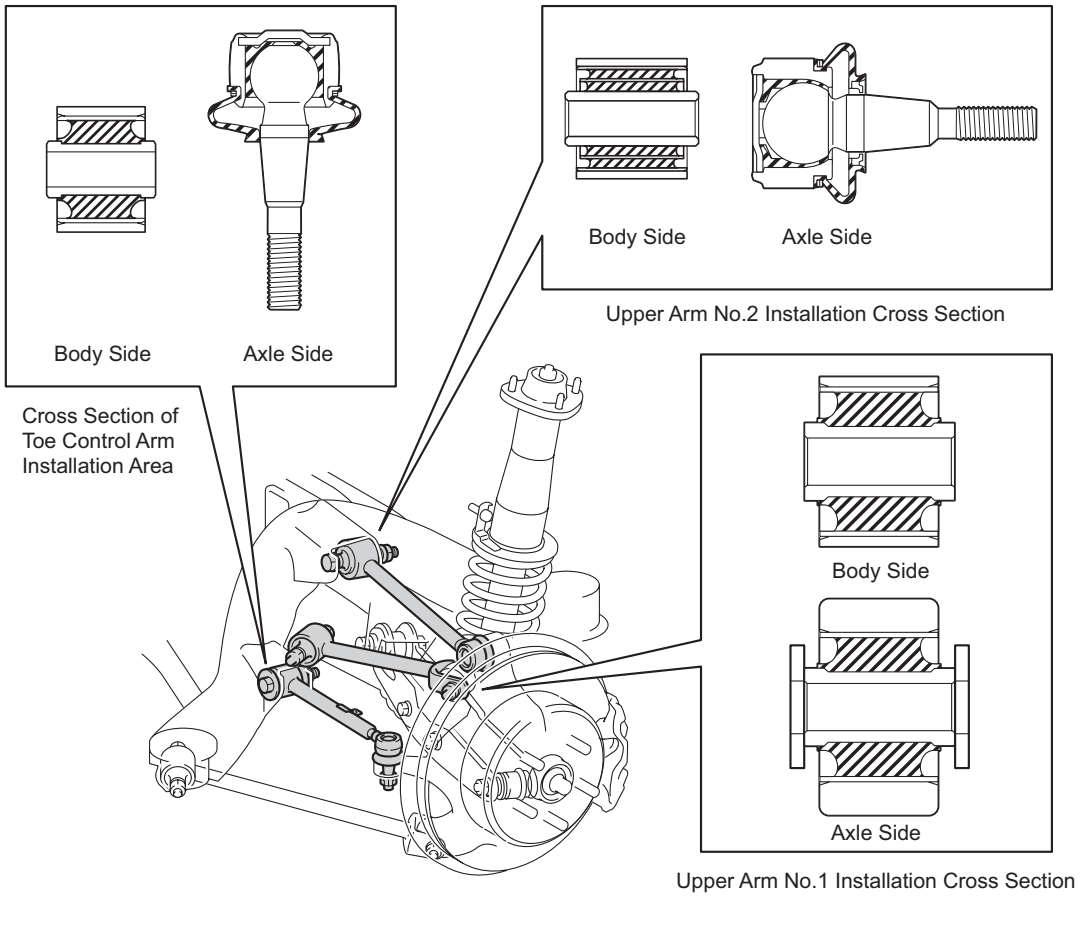
Rear Upper Support, Coil Spring & Shock Absorber

- An upper support with separate inputs is used to realize both excellent ride comfort and driving stability.
- The coil spring is located below the shock absorber. A horizontal force is created by the deviation of the center axis at the landing point or the angle of the spring seat during the contraction or elongation of the coil spring. This force is separate from the vertical force, which is the primary movement of the spring. Thus, by positioning the spring seat in the lower area of the shock absorber, the shock absorber can slide smoothly to ensure excellent ride comfort.
- Along with the lowered position of the coil spring, a cylindrical, upper spring seat is used. Furthermore, the shape of the bound stopper made of urethane has been optimized to realize both excellent ride comfort and driving stability.
- A mono-tube type shock absorber is used to optimize the damping characteristics.
- An upper insulator is provided in the upper spring area to ensure stability to counter disturbance.
- A lower insulator is provided in the lower spring area to reduce noise and vibration.



Rear Upper Arm, Toe Control Arm & Bushing

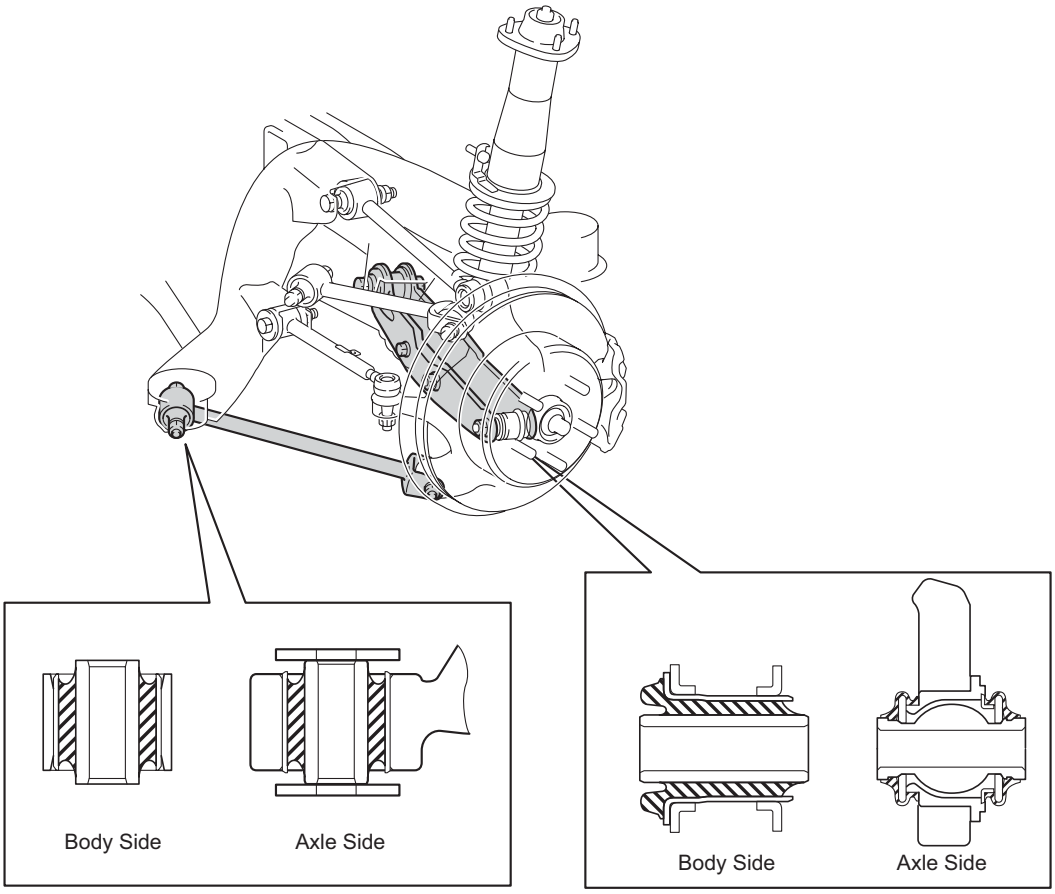
- An upper arm No. 1 and lower arm No. 1 made of high-strength pipe material are used to ensure high rigidity and weight reduction.
- A toe control arm and an upper arm No. 2 made of high-strength pipe material and a ball joint at one end are used to ensure high rigidity and weight reduction.



A4270045C

Rear Lower Arm & Bushing

- A lower arm No. 2 made of stamped high-strength sheet steel is used to ensure high rigidity. On the body side, a bushing with an external cylinder is used, and on the axle side, a pillow ball bushing is used to realize high support rigidity and excellent ride comfort.
- Excellent ride comfort, drivability, and stability have been ensured through the optimization of these bushing characteristics.



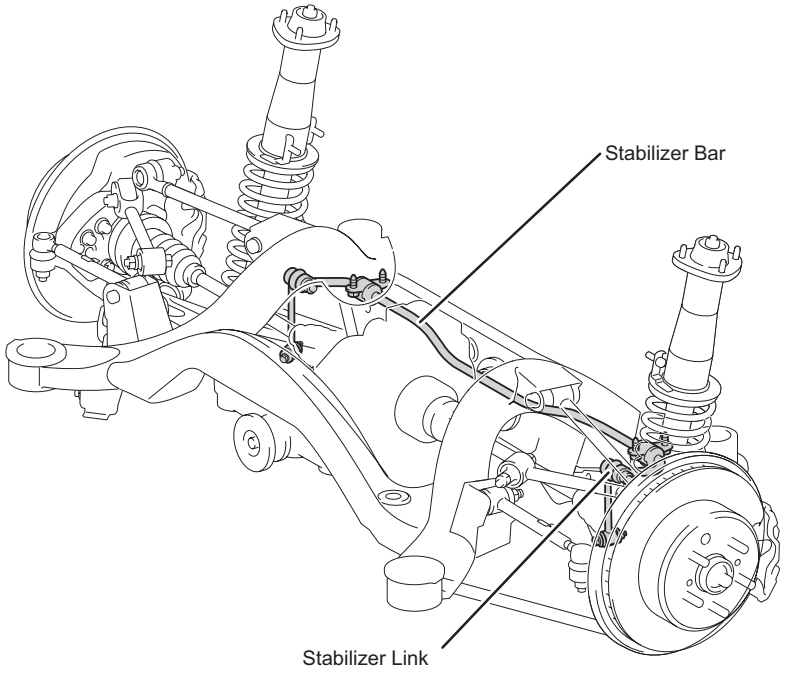
Lower Arm No.1 Installation Cross Section

Lower Arm No.2 Installation Cross Section

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Rear Suspension Stabilizer

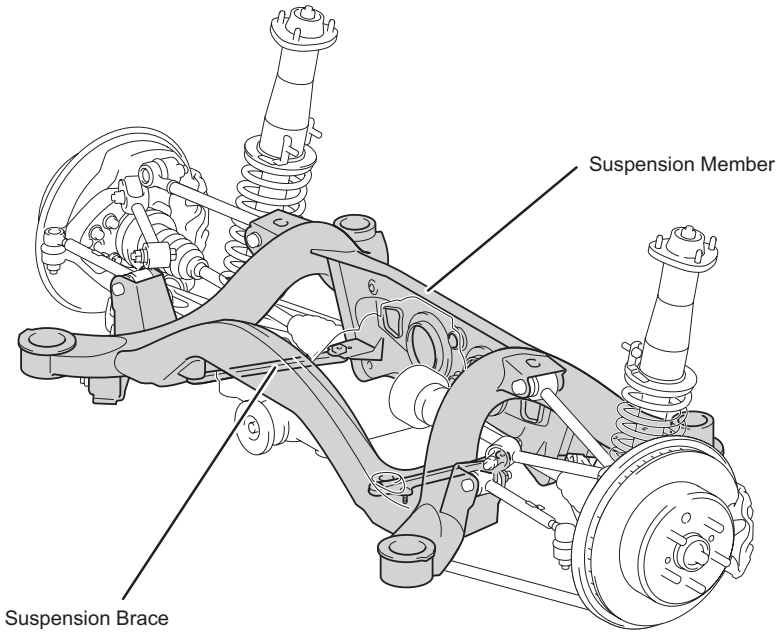
- A highly rigid, solid type stabilizer bar is used.
- A ball-joint type stabilizer link is used to ensure excellent response and rigidity.



A4270047C

Rear Suspension Member

- A rear suspension member shaped like a # is used.
- Its components consist of pipes and stamped sheet steel to ensure the proper torsional rigidity and weight reduction.
- The positions of the body mounts have been optimized and a suspension brace has been provided to ensure the proper support rigidity and excellent drivability and stability.

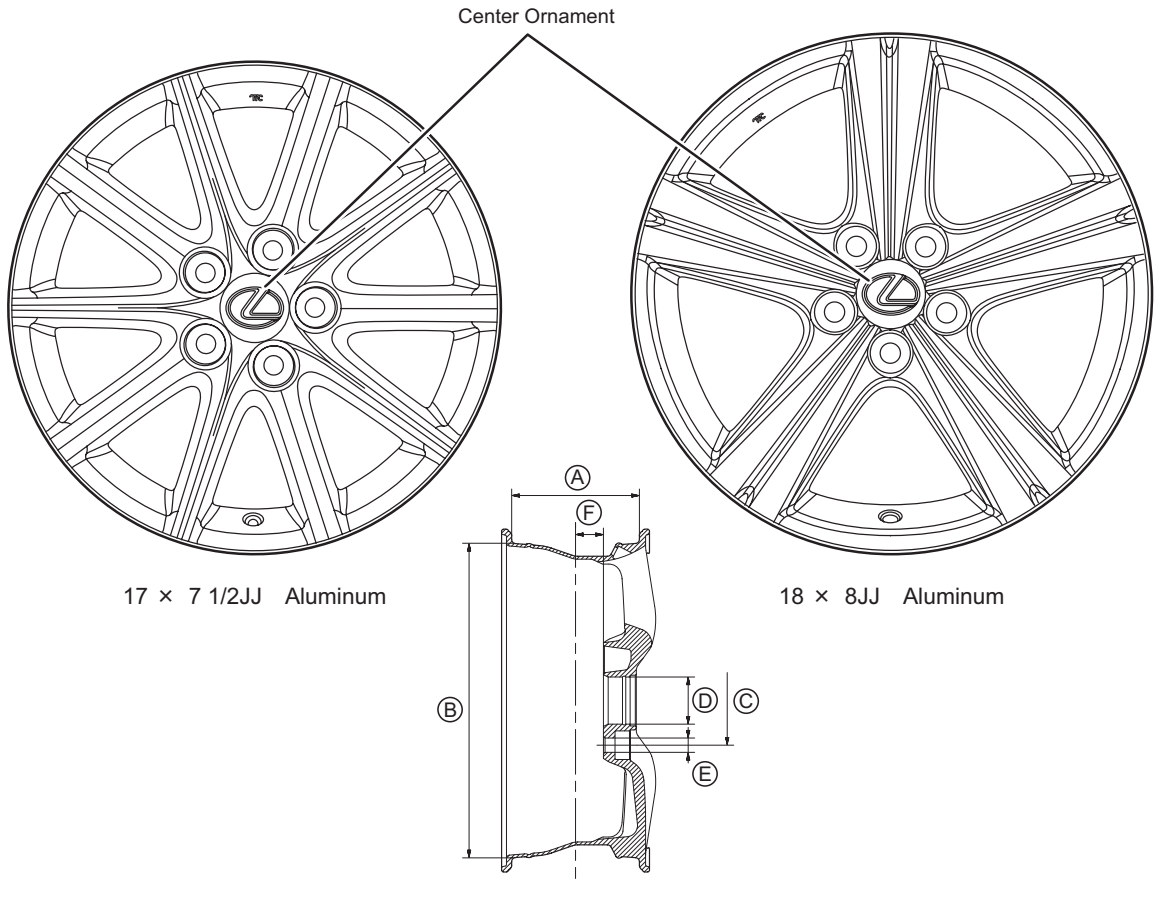


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TIRE & WHEEL

Tire & Disc Wheel

- The models with the 3UZ-FE engine use 245/40R18 size tires and 18 x 8JJ size aluminum wheels.In addition, the same size run-flat tires and the same size aluminum wheels are available as a optional equipment (only for European model).
- The models with the 3GR-FSE and 3GR-FE engines use 225/50R17 size tires and 17 x 7 1/2JJ size aluminum wheels. In addition, 245/40R18 size tires and 18 x 8JJ size aluminum wheels are available as a optional equipment (only for European model).
- The run flat tire is constructed to enable the vehicle to be driven up to approx. 100 miles (approx.160 km) under approx. 55mph(approx.90km/h) even if the tire is flat*1 (these values are approximate and could differ depending on the condition of the tire.)
- European model vehicle's with the optional run-flat tires are not equipped with a spare tire, so larger luggage room space is available.



Disc Wheel Size

	A:Rim Width	B:Rim Diameter	C:P.C.D*2	D:Hub Diameter	E:Bolt Hole Diameter	F:Off Set
17×7 1/2JJ Aluminum	190.5	436.6	114.3	60	19	45
18×8JJ Aluminum	203	462	114.3	60	19	45

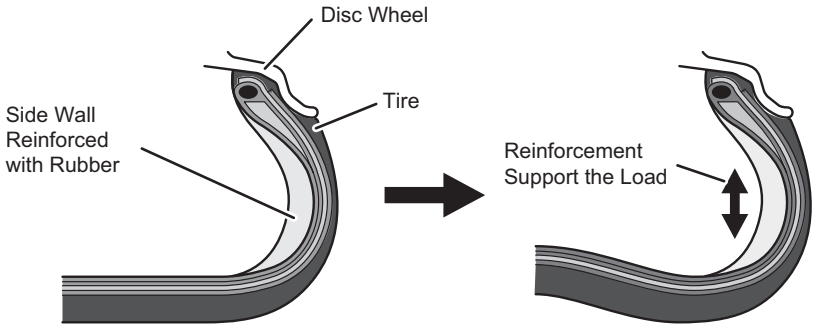
❖REFERENCE❖

*1 : Tire inflation pressure below approx. 100kPa.

*2 : Pitch Circle Diameter

Run-Flat Tire

- The run-flat tires have the inside of its sidewalls reinforced with rubber, which can sustain the load even if the tire inflation pressure is below the specified value.



❒ **NOTICE**

Do not mount a run-flat tire on a wheel other than the dedicated disc wheel that is provided as standard equipment, or use it concurrently with normal tires because it might not be possible to fully realize its performance.

Spare Tire

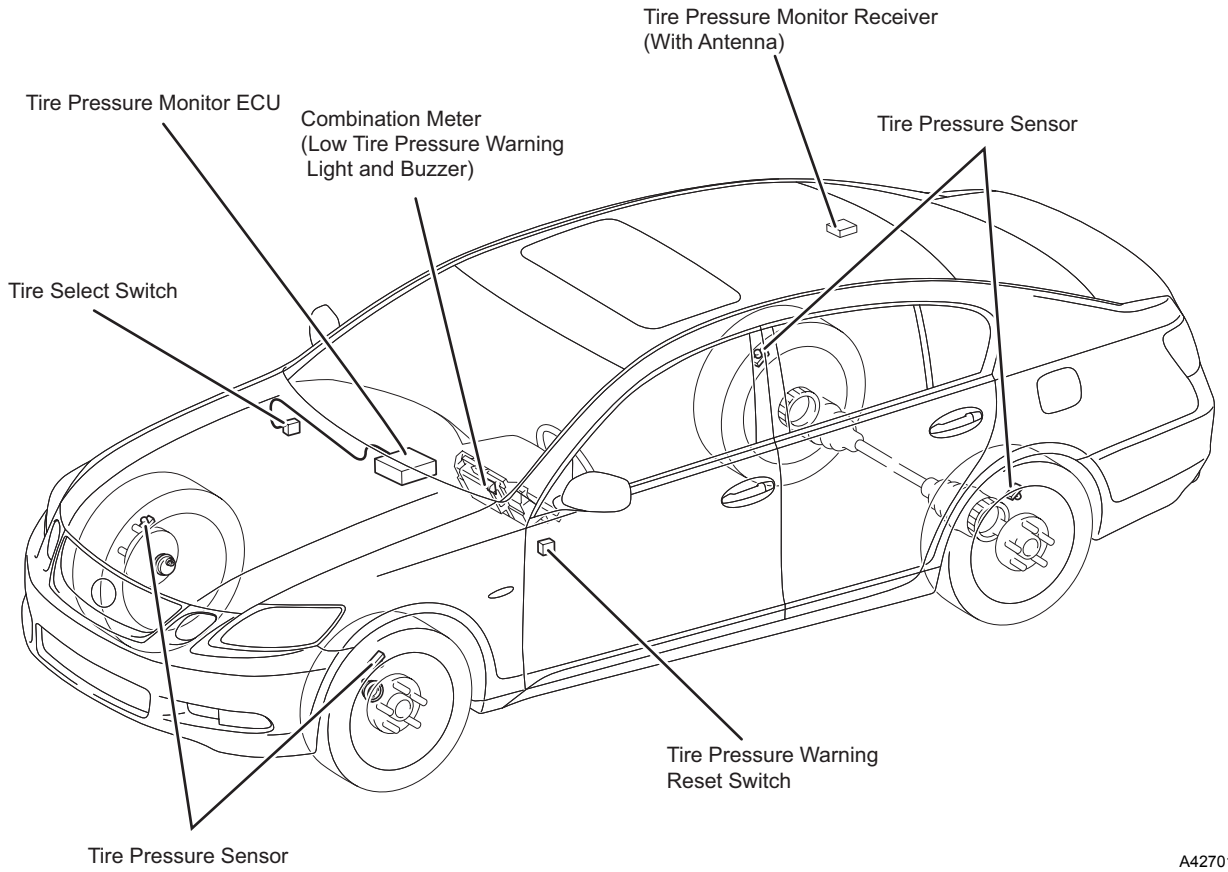
- On the models for Europe, a 155/70D17 size temper tire is used. However, models equipped with run-flat tires are not provided with a spare tire.
- On the models for certain destinations, such as the G.C.C. countries and General Countries, a ground tire is provided.

Tire Pressure Warning System

- A direct-sensing type tire pressure warning system has been newly adopted as standard equipment on all '04 GS430/300 models.
- If the vehicle continues to be driven with one or more of the four tires inflated to a low air pressure that could cause problems in driving,this system will illuminate the tire pressure warning light to inform the driver of the low air pressure.
- Furthermore,this system directly senses the air pressure of each tire through a tire pressure sensor that is attached to each wheel.

Effectiveness of Tire Pressure Warning System

Effectiveness	Effect of continued driving with low pressure tires
Economy	Reduced fuel economy due to increased rolling resistance of the tires
	Reduced service life of the tires due to uneven wear
Vehicle Characteristics	Reduced drivability and stability
Other	Need for replacing flat tires on highways



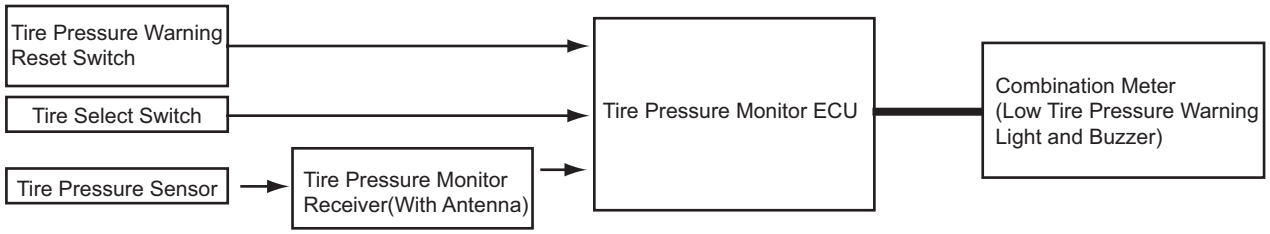
Main Components and Functions

Components	Functions
Tire Pressure Sensor	Integrated in the air valve on the disc wheel, this sensor measures the tire pressure and transmits the measured value and an ID for identifying the wheel.
Tire Pressure Monitor Receiver (with Antenna)	Located inside the roof, it receives signals from the transmitters, and transmits them to the tire pressure monitor ECU.

Components	Functions
Tire Pressure Monitor ECU	Recognizes that the signals are from the vehicle's own wheels, based on the received ID signals. If the measured values exceed a specified value, this ECU transmits signals to illuminate the pressure warning light in the combination meter.
Tire Select Switch	If transmitter IDs for two sets of tires are registered in the control ECU, the driver uses this switch to select one of the sets.
Low Tire Pressure Warning light	Located in the combination meter, this light informs the driver of a low tire pressure or a system failure.
Tire Pressure Warning Reset Switch	If this switch is pressed continuously for 3 seconds, the system will accept initialization.

Tire Pressure Warning System Composition

- The tire pressure warning system consists of pressure sensors & transmitters, reception antenna, receiver, tire pressure monitor ECU, tire selector switch, and warning light.
- The four pressure sensors & transmitters measure the pressure of the respective tires, and transmit the ID of the transmitter and the measurement results through radiowave signals. The transmitted signals are received by a receiver (with a built-in antenna), which is mounted inside the roof. The receiver checks whether the received IDs match those that are pre-registered. If the IDs match, the ECU compares the measurement results against the standard values, and illuminates the tire pressure warning light in the combination meter if the pressures are below the standard values. If the pressure drops further, the ECU simultaneously causes the tire pressure warning light to blink and the buzzer to emit a warning sound at regular intervals.

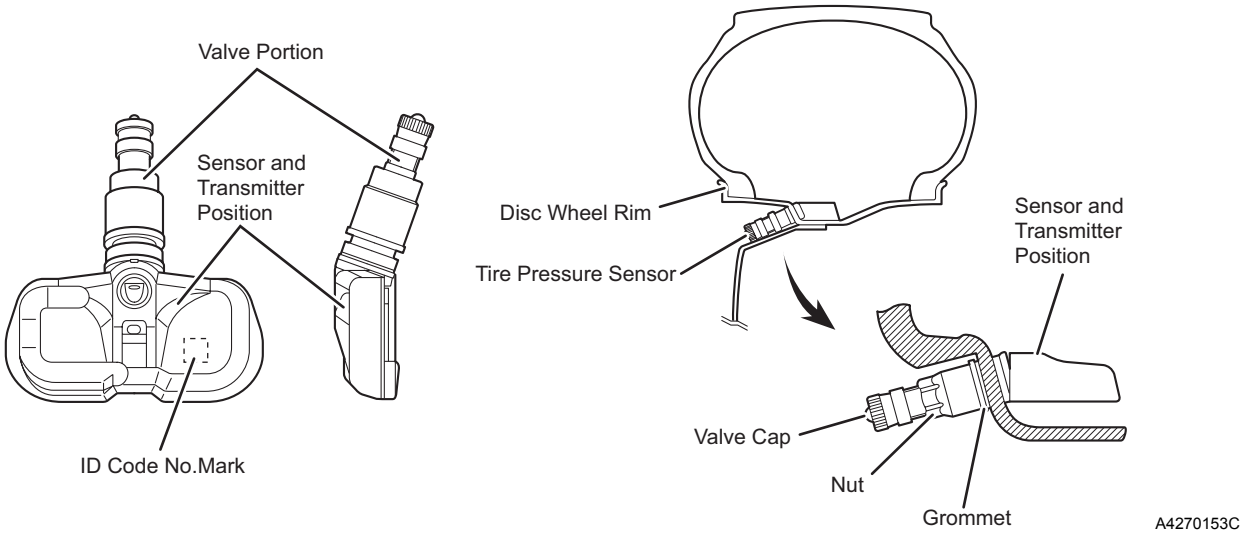


Stricture of Air Pressure Sensor & Transmitter

- The tire pressure sensor is integrated in the air valve of a disc wheel.
- This sensor operates with a lithium battery,which lasts approx.10 years.If the battery voltage drops,the tire pressure monitor receiver stores the DTC (Diagnostic Trouble Code)in its memory. If the voltage drops even further and the sensor stops working,it stores the DTC in memory and illuminates the tire pressure warning light to alert the driver.
- Sensors with four different ID code range are used on one vehicle.
- Each sensor has a built-in semi-conductor to directly measure the inflation pressure of the tire.
- In addition to the measured pressure,the identification data of the tire pressure sensor is included in the data that is transmitted to the tire pressure monitor receiver. This is to enable the tire pressure monitor receiver to determine that the received data came from its own tires.
- Frequency of the this sensor is 433.92 MHz.

❖REFERENCE❖

*1 : Make sure to install the tire pressure sensors to the disc wheels in accordance with the prescribed procedure. Failure to do so could result in the incorrect measurement of the tire air inflation pressure.
*2 : Make sure to replace the tires in accordance with the prescribed procedure. Failure to do so could damage the pressure sensors.
*3 : For further details regarding the above, refer to the LEXUS GS430/300 Repair Manual.



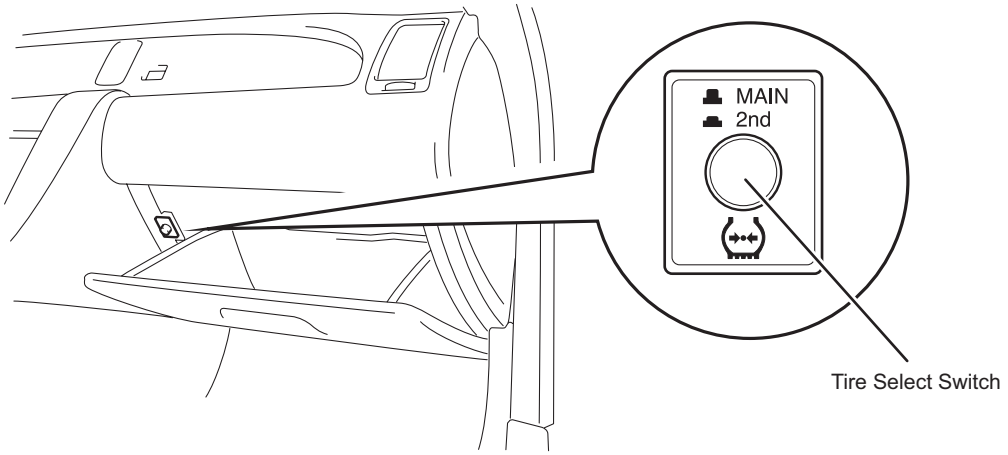
SA

■ **Service Tip** ■

- If the lithium battery is depleted,replace the entire tire pressure sensor assembly.
- When replacing the tire pressure sensors, select them so that all the four sensors will have different identification marks.
- A new tire pressure sensor that is available as a service part is in the sleep mode in its initial state to prevent the battery from depleting. After the sensor and the tire are correctly mounted on the disc wheel, inflating the tire to the specified pressure causes the sleep mode to cancel.
- For further details regarding the above, refer to the LEXUS GS430/300 Repair Manual.

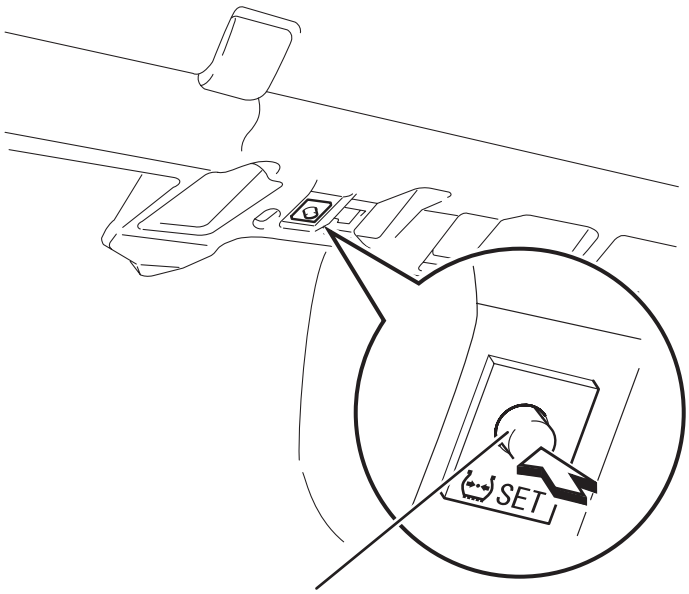
Tire Select Switch

- This switch is located in the lower area of the instrument panel on the front passenger side.
- The transmitter IDs for two sets of tires can be registered in the control ECU. The driver can operate the tire selector switch to select one of the sets. Therefore, it is unnecessary to register the IDs each time tires are replaced.
- The IDs must be registered at a dealer.



Tire Pressure Warning Reset Switch

- The initialization switch is located in the lower area of the instrument panel on the driver's side.
- After adjusting the tire pressure to a set value, press the initialization switch. This will enable the system to issue a warning at a pressure in accordance with the set pressure.



Tire Pressure Warning Reset Switch

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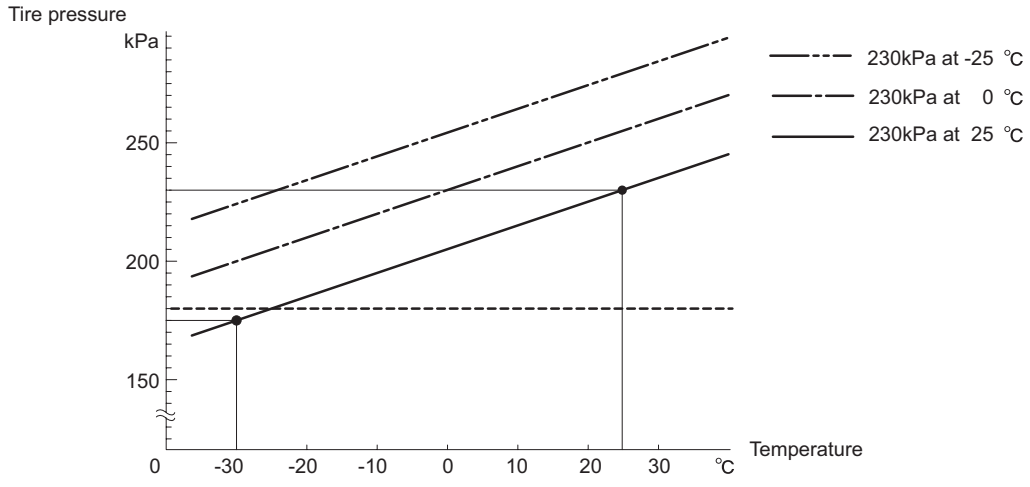
Conditions requiring initialization:

At the time of new car delivery, change in tire size, replacement of pressure sensors, or driving with boosted pressure

■ **Service Tip** ■

- The tire inflation pressure normally changes depending on the ambient temperature, as shown in the graph below.
- When adjusting the tire inflation pressure on GS430/300, it is possible to turn on the low pressure warning indicator light if you do not take if you do not take into consideration the ambient temperature.
- The tire pressure should be adjusted considering the ambient temperature (actual use condition) when it is adjusted in the workshop.

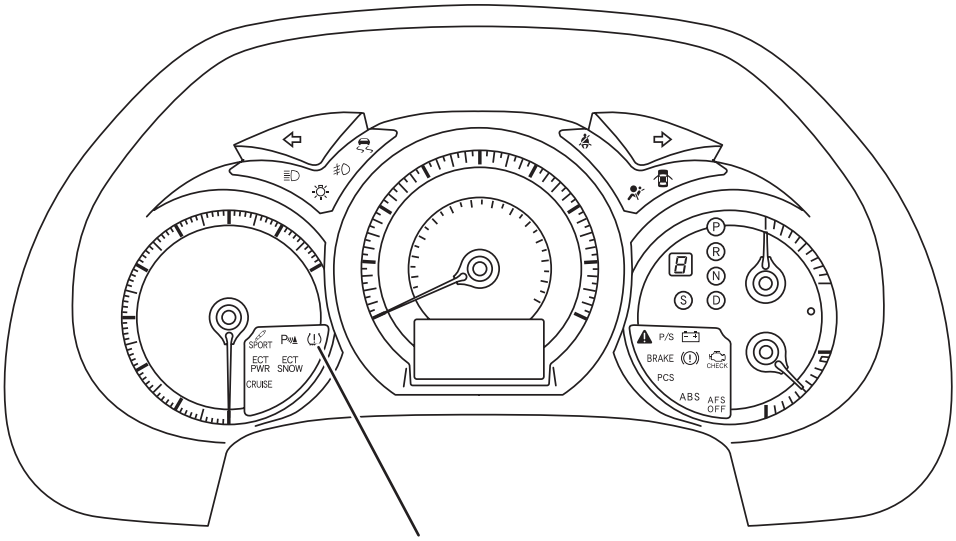
Relationship between Tire Pressure and Temperature



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Tire Pressure Warning Light

- The low tire pressure warning light is located in the combination meter.
- This warning light illuminates or blinks in accordance with signals from the tire pressure monitor receiver if the vehicles own tires are inflated with low pressure or if malfunction occurs in the system.



Light Illumination Pattern

System Check (when system is normal)	Illuminates 3 seconds immediately after the ignition is ON; then it turns OFF.
Low Pressure Warning Illuminates	Illumination
System Failure	Blinks (or illuminates if there is an open circuit in the warning light)

Diagnosis

- The new diagnostic system features improved serviceability. For details on the diagnostic methods and diagnostic items, refer to the repair manual.

Fail Safe

- If a system failure occurs, the tire pressure warning light in the combination meter illuminates to inform the driver of the failure.

Precautions on Tire Pressure Warning System

- If the tire pressure warning light illuminates, reduce the vehicle speed as soon as possible.
- Avoid making sudden steering or braking maneuvers because low-pressure tires could negatively affect handling and braking performance.
- The spare tire does not have a pressure sensor. The tire pressure warning light will remain illuminated when the spare tire is used.
- Make sure to use only the supplied valve caps (made of aluminum) on the pressure sensors & transmitters. If a metal cap (made of brass) is used, the cap could become seized.
- Do not use a flat tire sealant as it could cause the pressure sensor to malfunction.
- To protect the pressure sensor from damage, make sure to follow the instructions in the repair manual to dismount a tire from a wheel.
- Perform pre-driving inspections and regular inspections in the same manner as for ordinary vehicles.
- The system may not operate normally under the following conditions.

Conditions in which the system may not operate normally:

The vehicle is using tires that are not equipped with pressure sensors.
The vehicle is using tires equipped with pressure sensors, but the tire selector switch is selecting a different set of tires.
The batteries of the sensors are depleted.
The vehicle is located in the vicinity of a facility or equipment using a similar wireless frequency.
A large amount of snow or ice is attached to the vehicle, particularly around the wheels or wheel housings.
The vehicle is using non-genuine wheels.
Tire chains are attached to the tires.

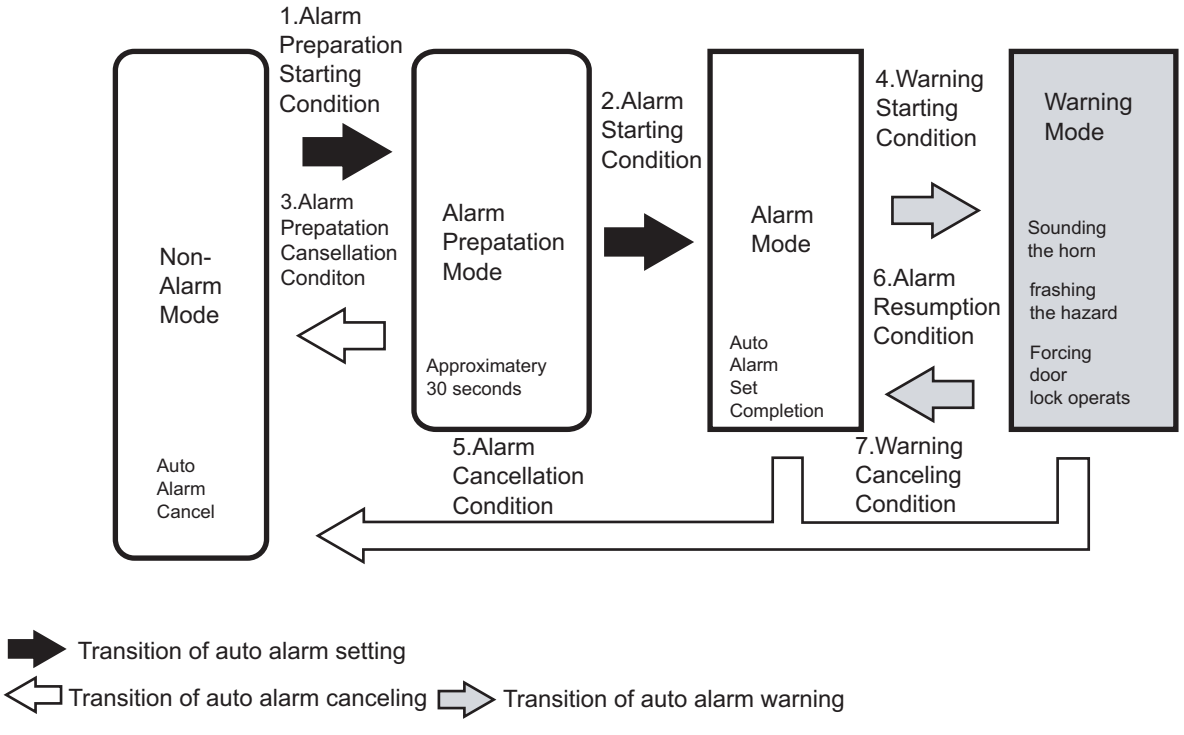
THEFT DETERRENT SENSOR

Theft Deterrnet System Outline

- If there is a possibility of theft, such as the engine hood or a door being unlocked or opened improperly, an "auto alarm" function issues a warning by sounding the horns and flashing the hazard warning light. If a key other than the legitimate key that is registered on the vehicle is used in an attempt to start the engine, an "engine immobilizer" prohibits the engine from starting. Both of these features are provided as standard equipment on all models.
- A security indicator light is used to indicate the operation and control mode of the entire security system. This light is located in the bottom right area of the multi-display.

Auto Alarm System

- When the engine hood, the individual doors, and the luggage door are all closed and locked, the vehicle automatically sets itself on guard against theft.
- When the vehicle is on guard, if there is a possibility of vehicle theft, such as the engine hood, an individual door, or the luggage door being unlocked or forced open through an improper means, the system performs a warning operation (by forcing the door locks to operate, sounding the horns intermittently, and flashing the hazard warning lights). Thus, the system prevents the doors from being unlocked through improper means.
- The auto alarm system automatically determines the state of the vehicle in accordance with the conditions of the electronic key, engine hood, individual doors, and luggage door.As shown in the diagram below, this system transfers the set, cancel, and warning controls of the alarm in accordance with various conditions. Furthermore, the security indicator light turns ON, OFF, or flashes to indicate these control states.



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Non-Alarm Mode

• Transfers to the alarm preparation mode while the IG and ACC are OFF, and any one of the conditions described in "1." below is met.

Transition Conditions

No.	Condition name	Description of Condition	Transition of Function
1.	Alarm Preparation Starting Condition	• While all the doors, the engine hood, and the luggage door are closed, a key is used to lock all the doors. (General Countries, and Australia) • While all the doors, the engine hood , and the luggage door are closed, the wireless or SMART ACCESS SYSTEM with PUSH-BUTTON START function is used to lock all the doors. • While all the doors are locked, any one of the doors, the engine hood , or the luggage door is operated from open to close. Then, all the doors, the engine hood , and the luggage door are closed and all the doors are locked. (General Countries, and Australia)	From the non-Alarm Mode to the Alarm Preparation Mode

Alarm Preparation Mode

• Transfers to the alarm mode when the conditions described in "2." below are met. • Transfers to the non-alarm mode when the conditions described in "3." below are met.

Transition Conditions

No.	Condition name	Description of Condition	Transition of Function
2.	Alarm Starting Condition	• While all the doors, the engine hood , and the luggage door are closed, and all the doors are locked, 30 seconds have elapsed.	From the Alarm Preparation Mode to the Alarm Mode
3.	Alarm Preparation Cancellation Condition	• A key is used to operate a door from lock to unlock, or the luggage door from close to open. (General Countries, and Australia) • The wireless or SMART ACCESS SYSTEM with PUSH-BUTTON START function is used to operate a door from lock to unlock, or the luggage door from close to open. • The push start switch is pushed. • The battery is reconnected. • IG or ACC is ON.	From the Alarm Preparation Mode to the Non-Alarm Mode

Alarm Mode

- Transfers to the warning mode when the conditions described in "4." below are met.
- Transfers to the non-alarm mode when any one of the conditions described in "5." below is met.

Transition Conditions

No.	Condition name	Description of Condition	Transition of Function
4.	Warning Starting Condition	• Any door is operated from close to open. • Any door is operated from lock to unlock by ameans other than a key or the wireless or SMART ACCESS SYSTEM with PUSH-BUTTON START function. (On the models for Europe, any means other than the wireless or SMART ENTRY & START SYSTEM function.) • The luggage door is operated from close to open by a means other than a key or the wireless or SMART ACCESS SYSTEM with PUSH-BUTTON START function. (On the models for Europe, any means other than the wireless or SMART ACCESS SYSTEM with PUSH-BUTTON START function.) • The engine hood is operated from close to open. • The battery is reconnected.(The self-powered siren sounds a warning when the battery is disconnected [Europe].) • After 5 seconds or longer have elapsed without the push start switch being pressed, and a remote engine start is not being implemented, the system allows the IG to turn ON.	From the Alarm Mode to the Warning Mode
5.	Alarm Cancellation Condition	• A key is used to operate the door from lock to unlock or the luggage door from close to open. (General Countries, and Australia) • The wireless or SMART ACCESS SYSTEM with PUSH-BUTTON START function is used to operate the door from lock to unlock or the luggage door from close to open. • With IG ON, an engine speed of 550 rpm or above has continued for the duration of the engine start judgment time (2 seconds).	From the Alarm Mode to the Non-alarm mode

SE

❒ **NOTICE**

On the models for Europe, if a key is used to unlock a door after the security system has been set through the wireless or SMART ENTRY & START SYSTEM function, the system will transfer to the warning mode.

Warning Mode

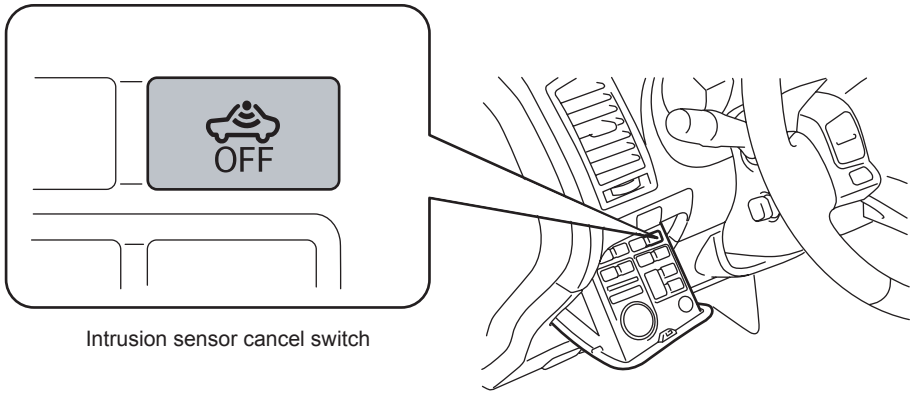
- Transfers to the alarm mode when the conditions described in "6." below are met.
- Transfers to the non-alarm mode when the conditions described in "7." below is met.

Transition Conditions

No.	Condition name	Description of Condition	Transition of Function
6.	Alarm Resumption Condition	• The warning duration (approximately 30 seconds) has elapsed.	From the Warning Mode to the Alarm Mode
7.	Warning Cancellation Condition	• Same as "5. Alarm Cancellation Condition".	From the Alarm Mode to the Non-Alarm Mode.

Intrusion Sensor

- The intrusion sensor, which is linked to the auto alarm system, sets automatically when the system transfers to the alarm mode (and the setting of the auto alarm is completed). When the intrusion sensor detects a moving object in the vehicle interior, the system transfers to the warning mode. Then, the system sounds the horn intermittently and blinks the hazard warning light for approximately 30 seconds and performs a forced locking operation.
- The operation of the intrusion sensor can be canceled temporarily by pressing the intrusion sensor cancel switch, which is provided on the module switch. (It will set automatically the next time the setting of the auto alarm is completed.) The security indicator light blinks with short intervals during the intrusion sensor OFF mode.



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❒ **NOTICE**

- If the vehicle is continuously exposed to abnormal shocks such as a hail or lightning, the system can improperly perform a warning operation.
- The system can improperly perform a warning operation if a mascot is suspended from the inner rearview mirror or a clothes hanger is hung in the vehicle interior.
- Set the intrusion sensor in the OFF mode before leaving a moving object, such as a pet, in the vehicle.
- Set the intrusion sensor in the OFF mode before using a high-pressure or automatic car washer.

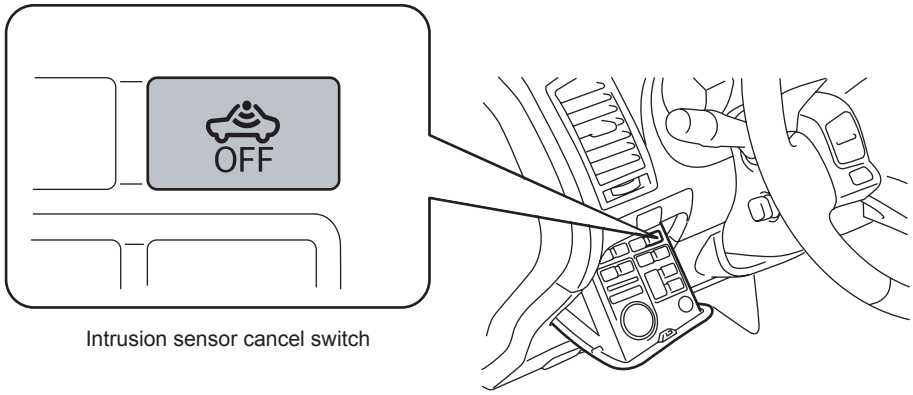
SE

Security Horn

- The security horn, which sounds only during the auto alarm warning control, is a compact, lightweight, flat-shaped horn(excluding the Europe and China).
- It is mounted on the engine compartment room.

Intrusion Sensor

- The intrusion sensor, which is linked to the auto alarm system, sets automatically when the system transfers to the alarm mode (and the setting of the auto alarm is completed). When the intrusion sensor detects a moving object in the vehicle interior, the system transfers to the warning mode. Then, the system sounds the horn intermittently and blinks the hazard warning light for approximately 30 seconds and performs a forced locking operation.
- The operation of the intrusion sensor can be canceled temporarily by pressing the intrusion sensor cancel switch, which is provided on the module switch. (It will set automatically the next time the setting of the auto alarm is completed.) The security indicator light blinks with short intervals during the intrusion sensor OFF mode.



A4270636B

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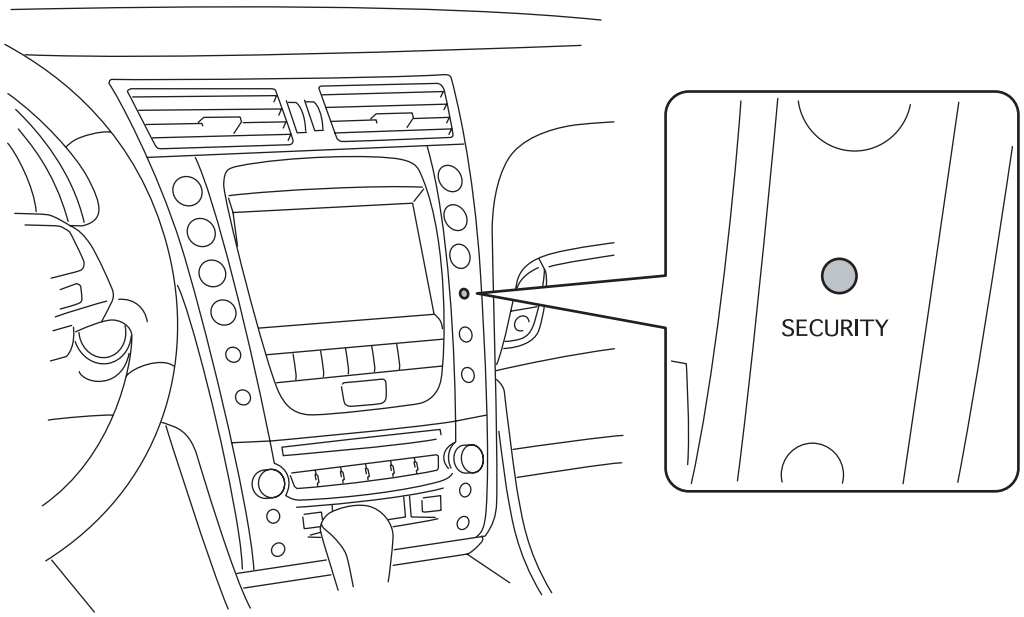
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Security Horn

- The security horn, which sounds only during the auto alarm warning control, is a compact, lightweight, flat-shaped horn(excluding the Europe and China).
- It is mounted on the engine compartment room.

Security Indicator Light

- A security indicator light is located in the right bottom area of the multi-display. This light indicates the alarm state of the auto alarm system.
- When either the auto alarm system or the engine immobilizer system is set, the security indicator light starts flashing at approximately 2.0-second cycles (0.2 seconds ON, 1.8 seconds OFF). If the auto alarm is during a set preparation or warning stage, the light will illuminate.
- The light uses an LED (Light Emitting Diode) with a lower electric power consumption.
- Right side J/B ECU controls the security indicator light for the auto alarm system. The certificate ECU controls the security indicator light for the engine immobilizer system.



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Security indicator lamp and auto alarm, engine immobilizer system status list

Security indicator light	Auto alarm condition
Non-Alarm Mode	OFF or blinking
Alarm Preparation Mode	ON
Alarm Mode	Blinking
Warning Mode	ON

ENGINE IMMOBILIZER

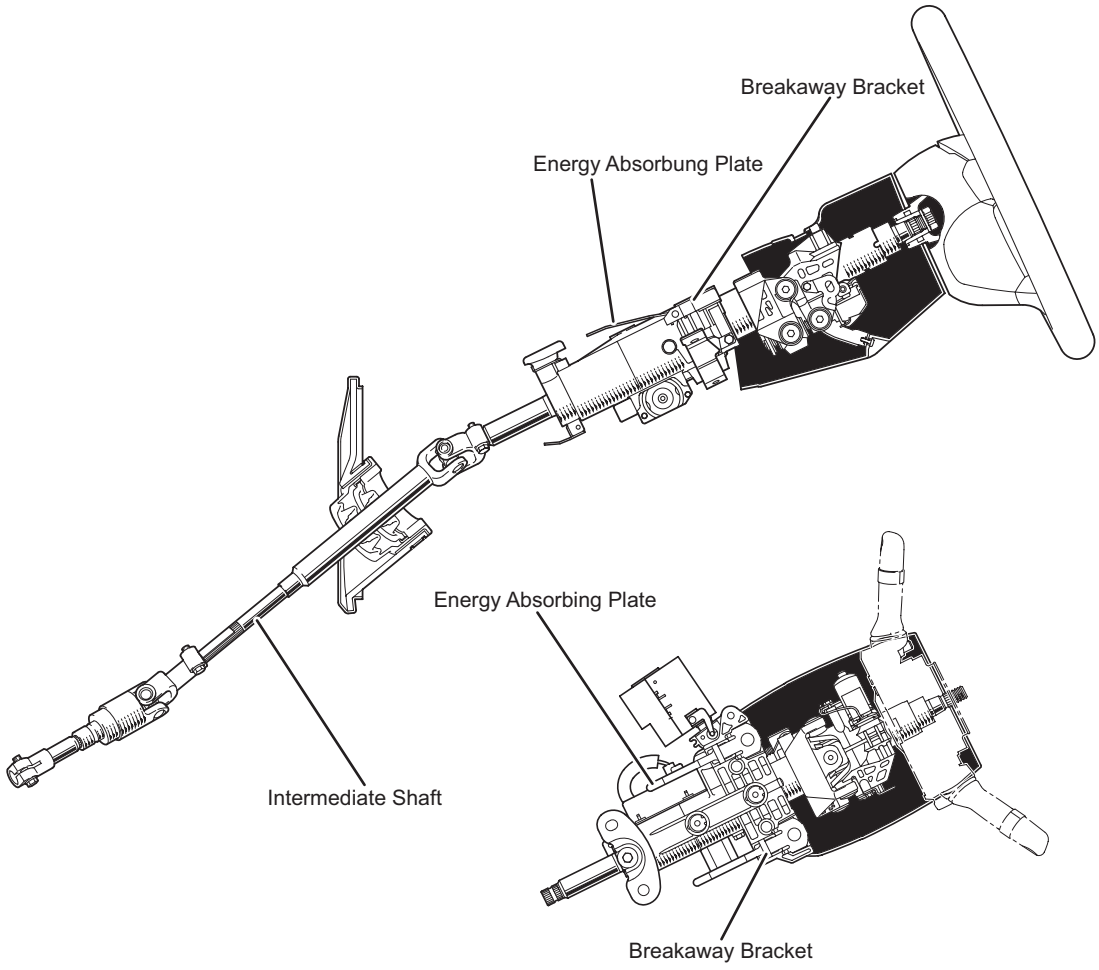
Engine Immobilizer

- When the driver stops the vehicle and stops the engine, the security indicator light at the bottom right area of the multi-display flashes constantly at approximately 2.0-second cycles (0.2 seconds ON, 1.8 seconds OFF). This indicates that the immobilizer system is set.
- Only if the results of the check indicate that the ID codes match, the system cancels the immobilizer function. The system turns OFF the security indicator light and authorizes the engine to start. For this reason, if the system is unable to read the ID code transmitted by the key or if the ID codes do not match, the system will prohibit the engine from starting.

OPEN STEERING COLUMN

Steering Column Outline

- A preset microprocessor steering column is used on all models. It consists of an auto-away, power tilt & telescopic function with memory, which enables the driver to adjust the steering column to a desired position.
- Along with the use of the smart entry & start system, an electronic steering lock system is used to prevent the engine from being started before the steering lock is unlocked.
- An energy absorbing mechanism and an intermediate shaft contraction mechanism are used to ensure driver safety in the event of a collision.

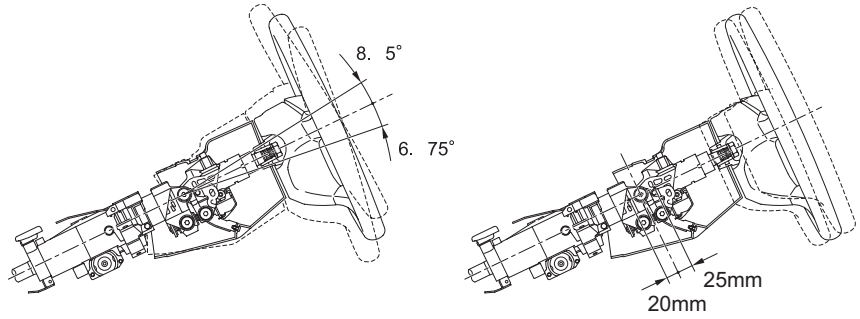


Power Tilt and Power Telescopic Steering Column

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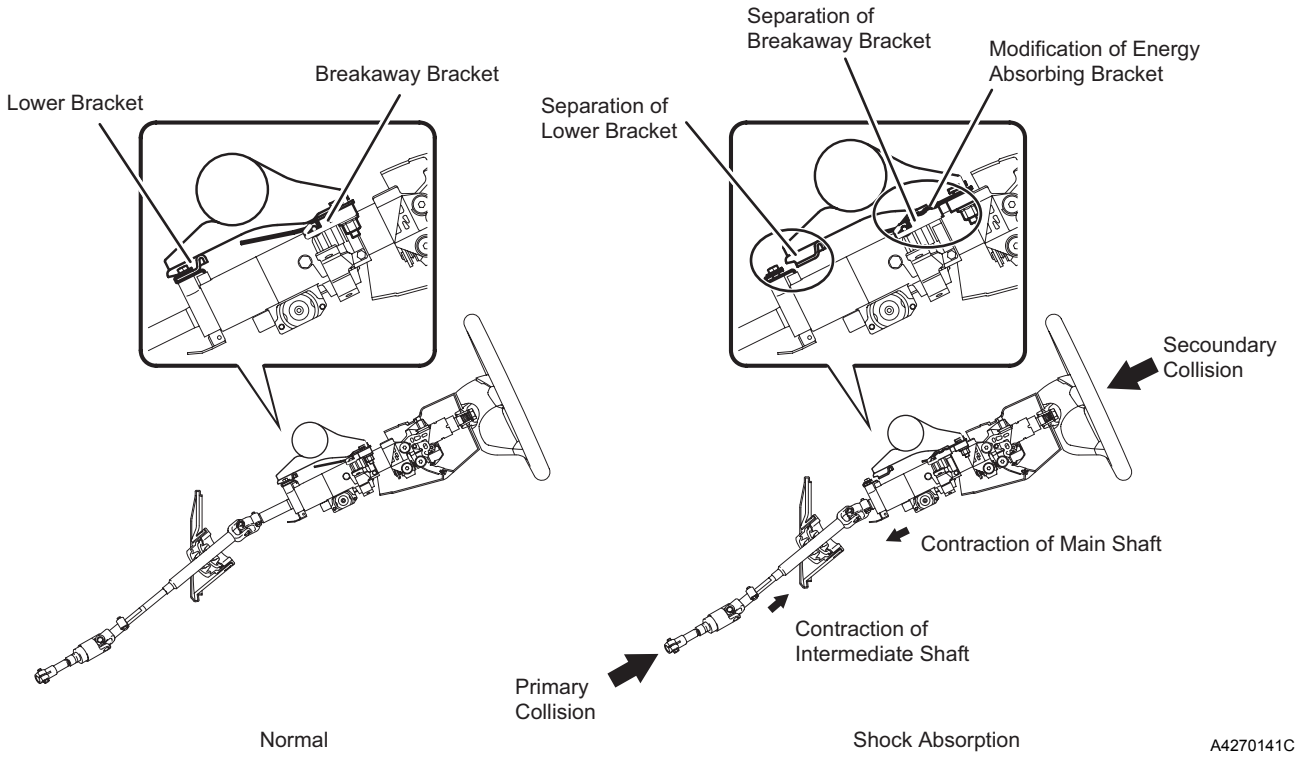
Tilt & Telescopic Mechanism Construction and Operation

- A motor is provided in the tilt & telescopic mechanism, and is controlled with a computer to ensure excellent maneuverability.
- Auto-away and auto-return controls that operate with the engine switch ensure the excellent ease of in-and-out access by the driver. A tilt & telescopic switch is provided on the left side of the steering column cover to enable the driver to adjust the steering column to the desired position.
- The tilt movement ranges from the neutral position to 8.5° upward and 6.75° downward, for a total setting range of 15.25°. The telescopic movement ranges from the neutral position to 20mm forward and 25mm backward, for a total setting range of 45mm.



Energy Absorbing Mechanism

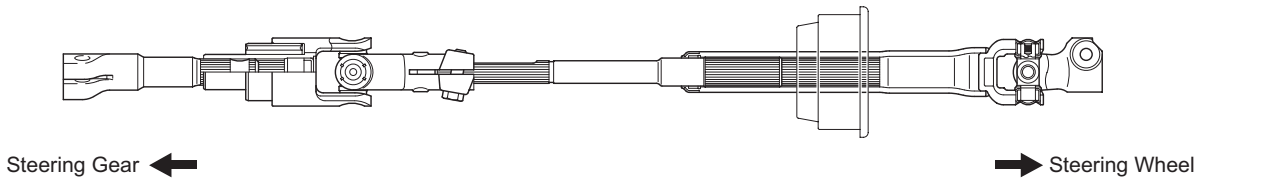
- The steering column is secured to the body by the capsule portion of the breakaway bracket (in which a split lower bracket and a column tube are integrated) with bolts and nuts. When the energy is input from the steering gearbox during a collision, the main shaft and the intermediate shaft contract to absorb the impact, thus preventing the steering column and the steering wheel from being pushed into the cabin.
- If the steering wheel receives an impact, the steering wheel absorbs the energy, and the entire steering column moves forward, leaving the capsule and the split lower bracket behind. At this time, the EA (Energy Absorbing) plate becomes deformed to absorb the energy.



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Intermediate Shaft

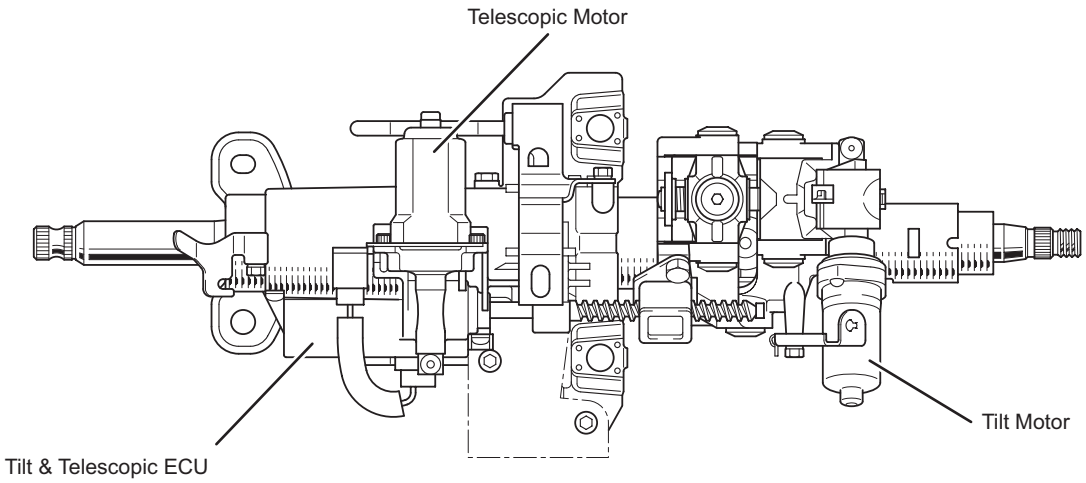
● A stroke mechanism is used to enable the shaft to contract and elongate axially, in order to ensure safety during a collision.



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Tilt & Telescopic Motor

● A DC motor is used in the power tilt & telescopic mechanism.



Bottom view

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Tilt & Telescopic ECU

- Based on the signals received from various sensors and the switch, the tilt & telescopic ECU transmits control signals to the tilt & telescopic motor.
- Auto-away and auto-return controls that operate with the engine switch are used to ensure excellent ease of in-and-out access of the driver.

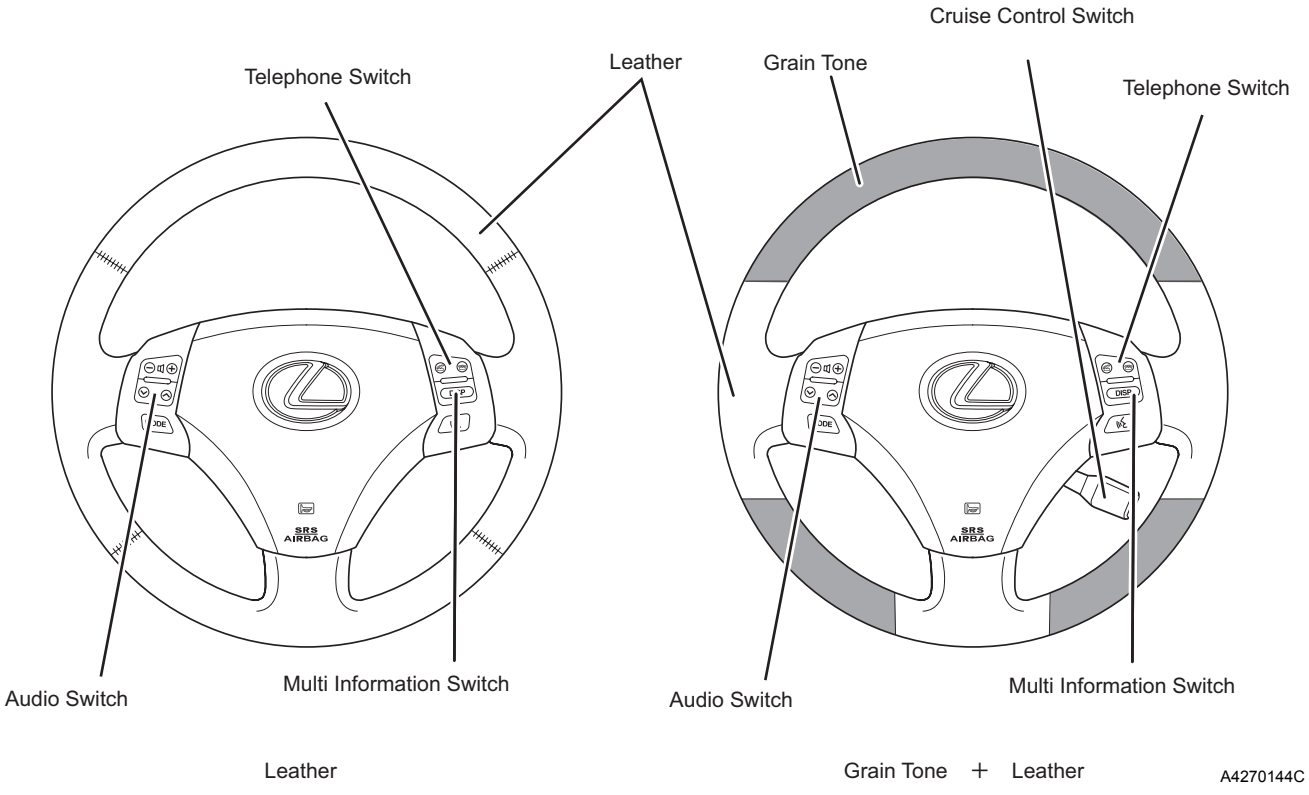
Control Function

Auto Control(Auto-Away)	When the driver presses the engine switch (with the engine stopped) or pulls the smart key out, this function moves the steering wheel to the highest tilt step and the most contracted telescopic position.
Auto Control(Auto-Return)	When the driver presses the engine switch (at ACC or with the engine running) or inserts the smart key, this function returns the steering wheel to the position at which the driver had previously exited the vehicle (tilt & telescopic memory position).
Manual Control	By operating the tilt & telescopic switch, the driver can adjust the tilt & telescopic positions at will.
Memory and Retrieval Control	By operating the memory switch, the driver can make the system memorize and retrieve the steering and seat positions.

Steering Wheel

- All models use a 3-spoke steering wheel made of real wood wrapped with real leather.
- Steering switches for operating the audio and other functions are provided on the steering wheel pad for convenience and ease of use.
- A steering wheel that contains an SRS airbag is used for safety.

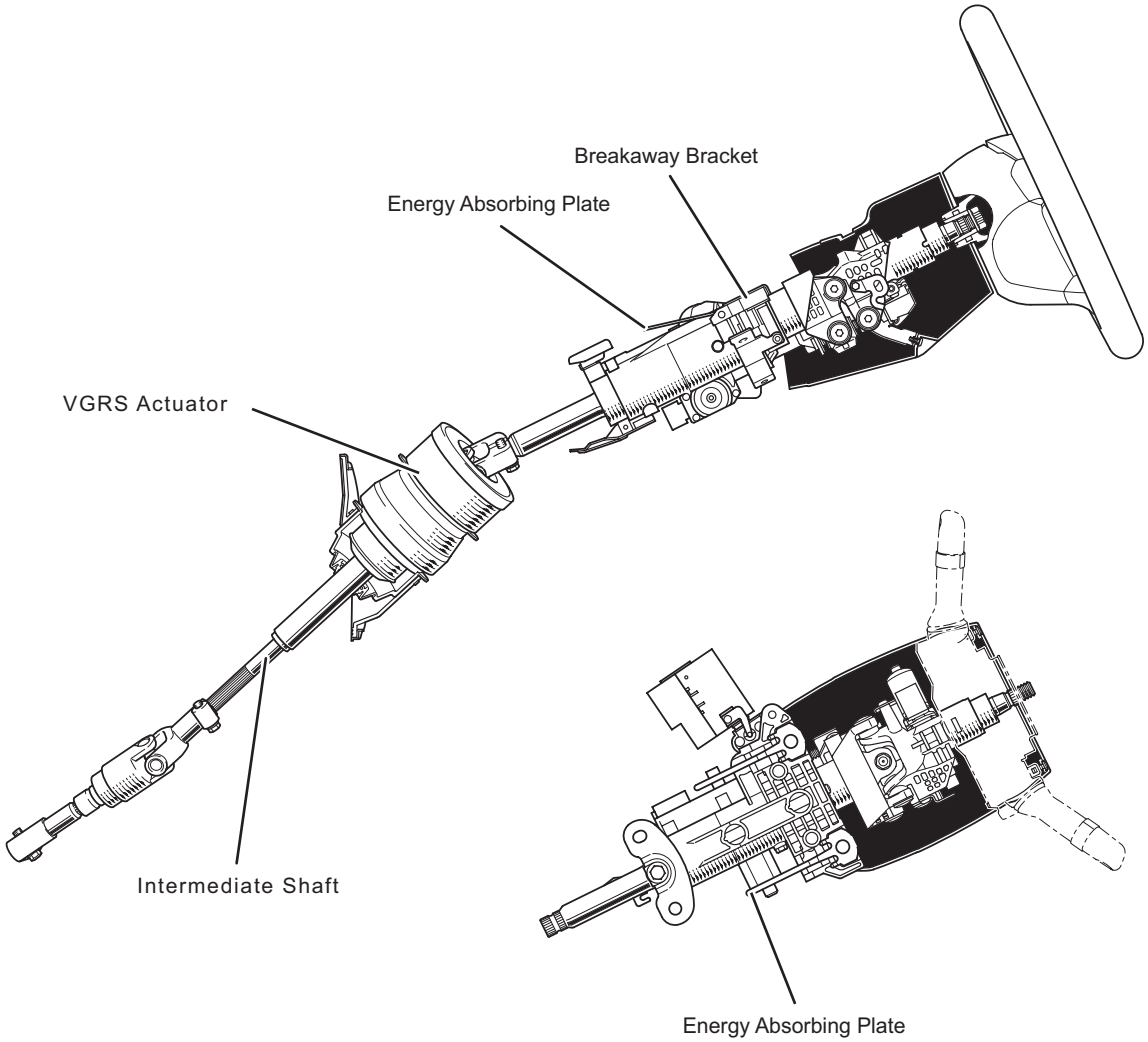
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VGRS STEERING COLUMN

VGRS Outline

- The models with the 3UZ-FE engine uses a Variable Gear Ratio Steering (hereafter referred to as "VGRS") system. This system controls the turning angle of the wheels in accordance with the vehicle's driving speed, in order to achieve higher levels of steering maneuverability and vehicle stability from the low-speed to the high-speed driving range.
- The tilt & telescopic motor, tilt & telescopic ECU, and the steering wheel are the same as those used in the models without the VGRS.



Steering Column with VGRS System

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VGRS Aims

• At very low speeds, this system reduces the amount of steering effort of the driver. At high speeds, it gradually varies the amount of steering effort. Thus, it realizes maneuverability and stability at high levels, while supporting the driver with the proper driving feel.

List of VGRS Objectives

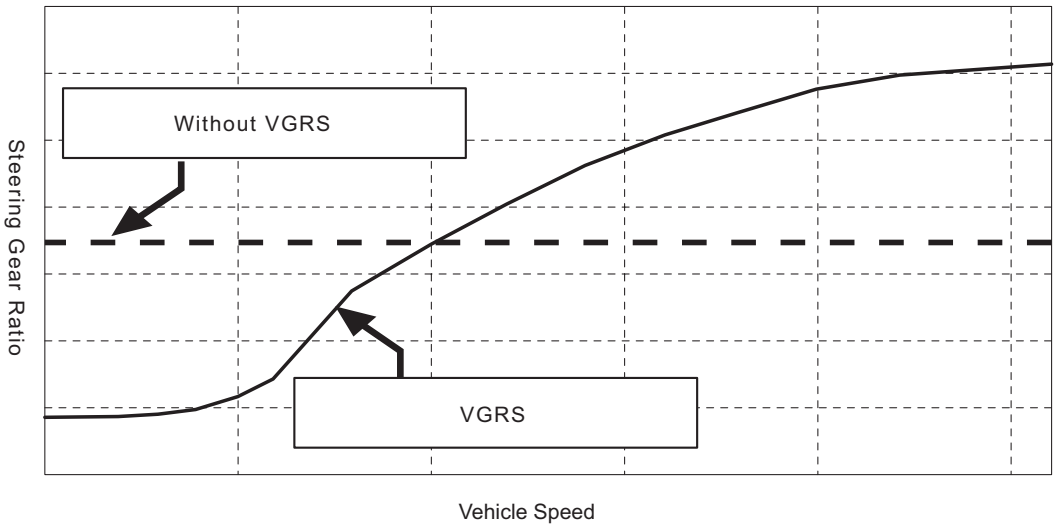
Driving Condition	Effectiveness
Very low speeds, steering at a standstill, and U-turns	Reduces the turning angle of the steering
Low to medium speeds	Continuously changes the steering gear ratio to suit the vehicle speed
High-speed driving	Provides a gentle steering feel

Steering Gear Ratio Changed to Suit Vehicle Speed

• In the conventional steering system, the steering gear ratio is set to enable the vehicle to respond gently to the amount of steering effort, with high-speed driving in mind. This requires the driver to increase the amount of steering effort while driving at low speeds. Because the VGRS can change the steering gear ratio at will, it is able to optimize the steering gear ratio in accordance with the driving conditions.

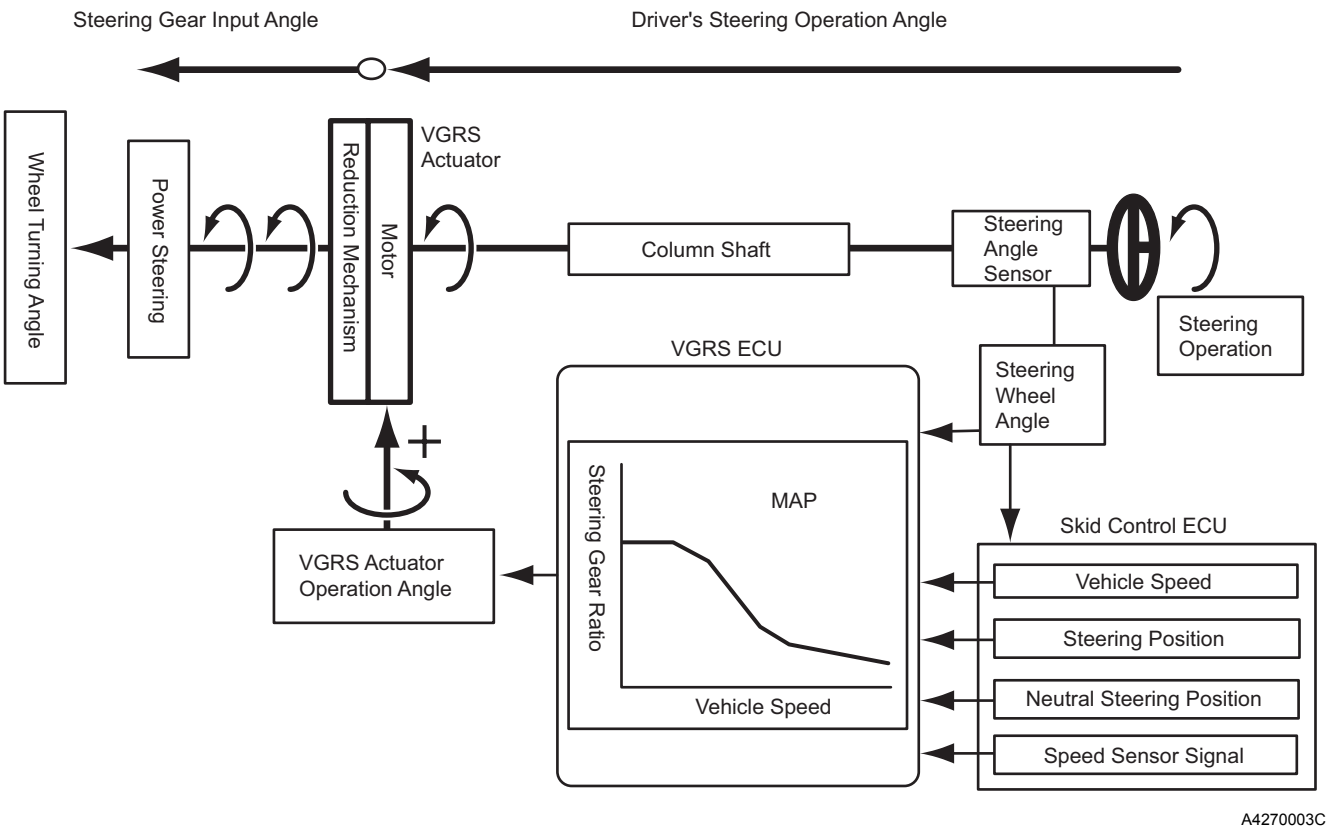
VGRS Functions

Reducing the steering angle in the very low speed range, steering at a standstill, and U-turns	• This is the quickest gear ratio setting. It takes 2.7 turns (or 3.2 turns on non-VGRS models) of the steering wheel for lock-to-lock. Thus, it significantly reduces the amount of effort to turn the steering wheel back and forth at a standstill. • At very low speeds, the gear ratio is close to the quick gear ratio setting, which reduces the number of back-and-forth turns.
Lightening the handling in the low- to medium-speed range	• This function adjusts the gear setting between quick and slow to suit the vehicle speed. Thus, it provides a steering feel that is comfortable and easy to handle in urban areas or on mountain roads that require frequent turns.
Handling at high speeds	• This is the slowest gear ratio setting. It provides a gentle and stable steering feel in the same way as the conventional steering mechanism.



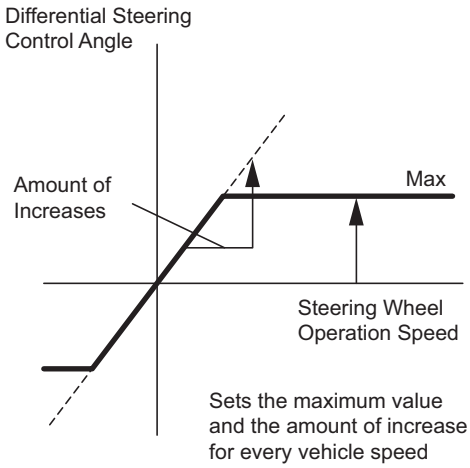
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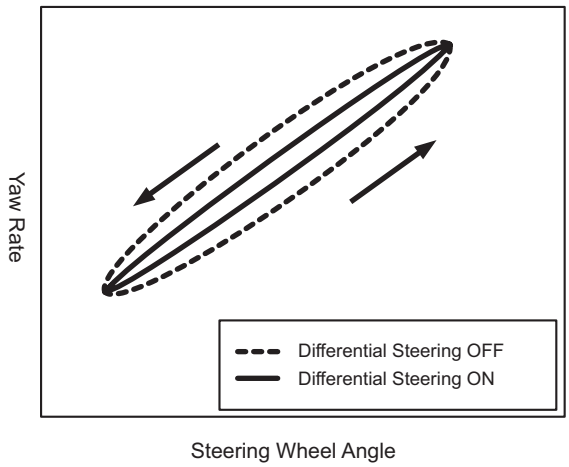


Driving Feel Through Differential Steering Control

- The system controls the VGRS actuator with very small angles in accordance with the speed of the driver's steering maneuver (differential of the steering turning angle), in order to correct the response delay of the vehicle. Thus, it supports the vehicle with the proper driving feel during lane changes or while driving on a winding road.



Differential Steering Control Outline

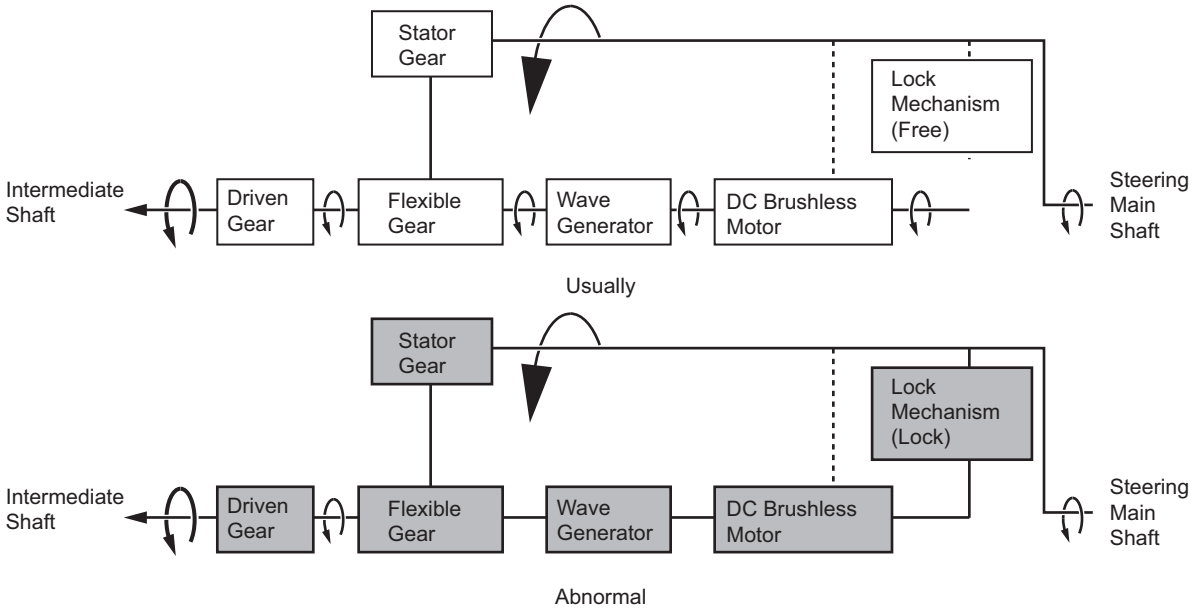


Conceptual Image of
Vehicle Response During Lane Change

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Fail Safe

• In case of a failure in the VGRS system or actuator, the actuator function stops and the lock mechanism renders the internal workings of the actuator in the directly coupled state, thus reverting to the same state as the conventional intermediate shaft. Thus, the proper steering function is ensured.



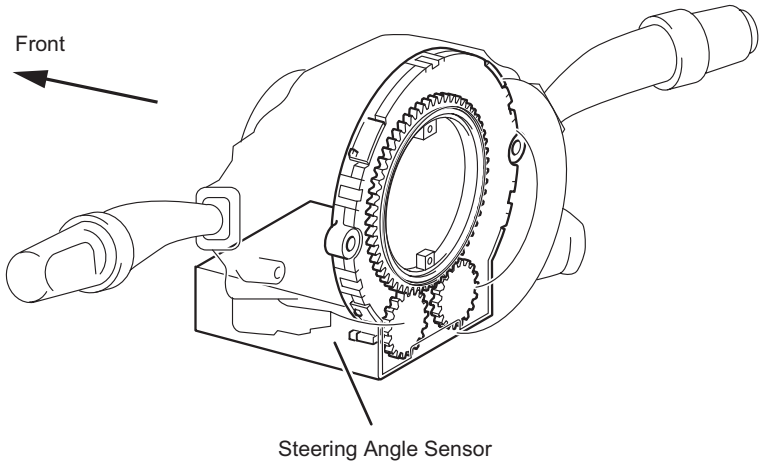
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Steering Angle Sensor

● A steering angle sensor is provided in the combination switch area. This sensor detects the amount of steering effort and the direction of steering and inputs them in the skid control ECU.

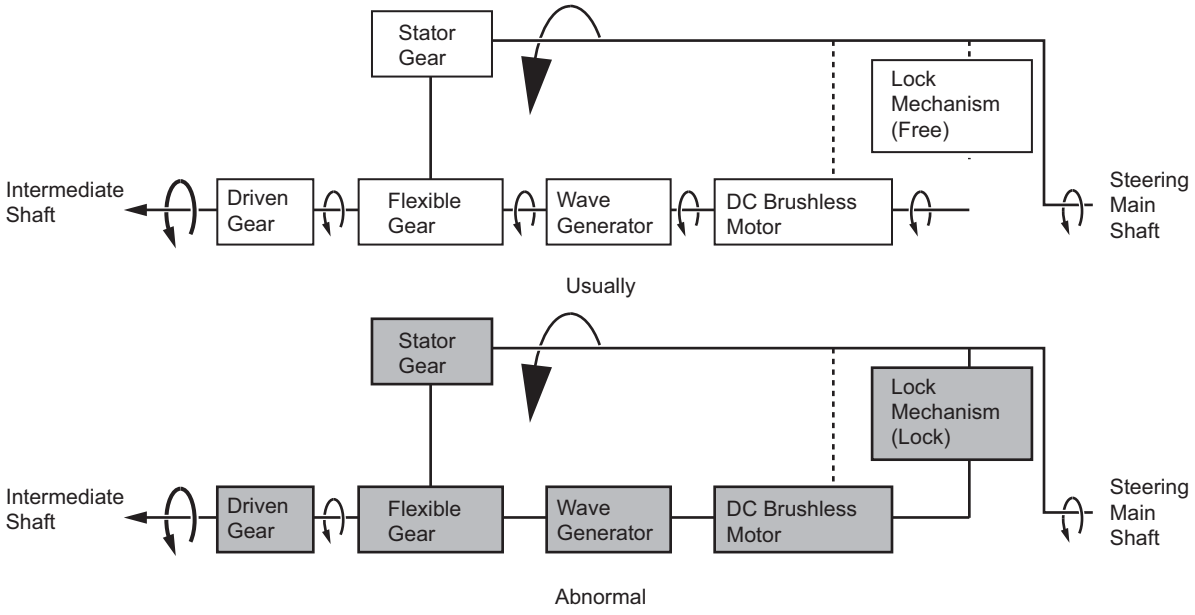
● The sensor assembly contains two sets of magnetic reluctance elements that detect the rotational movement of a magnet that is built into the detection gear. Thus, the sensor detects the changes that occur in the magnetic reluctance along with the rotational movement of the detection gear, in order to detect the rotational movement of the steering wheel.



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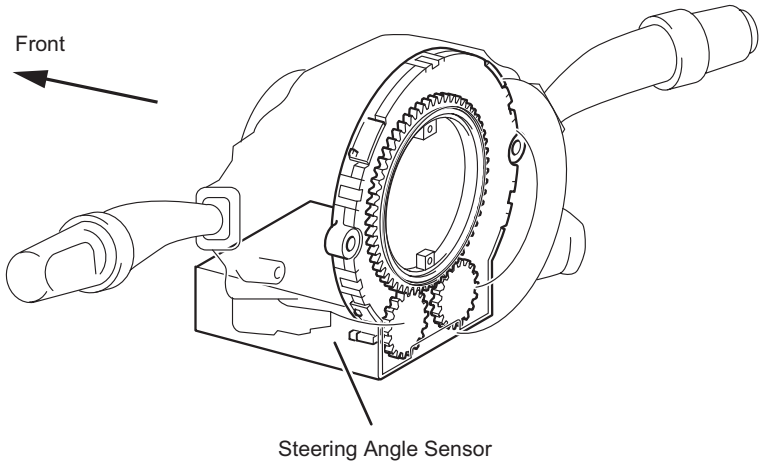
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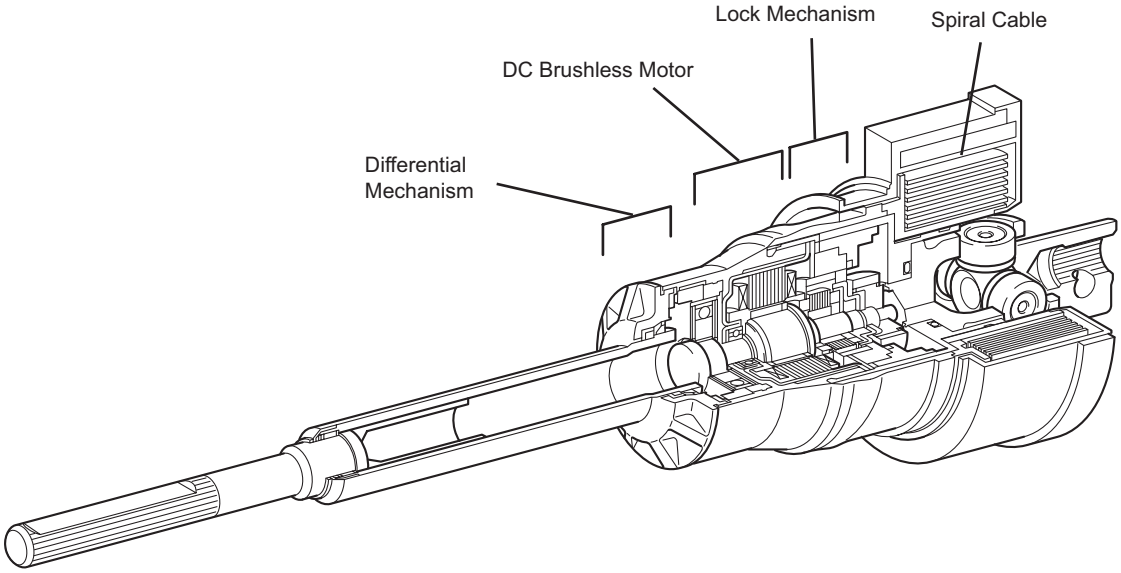
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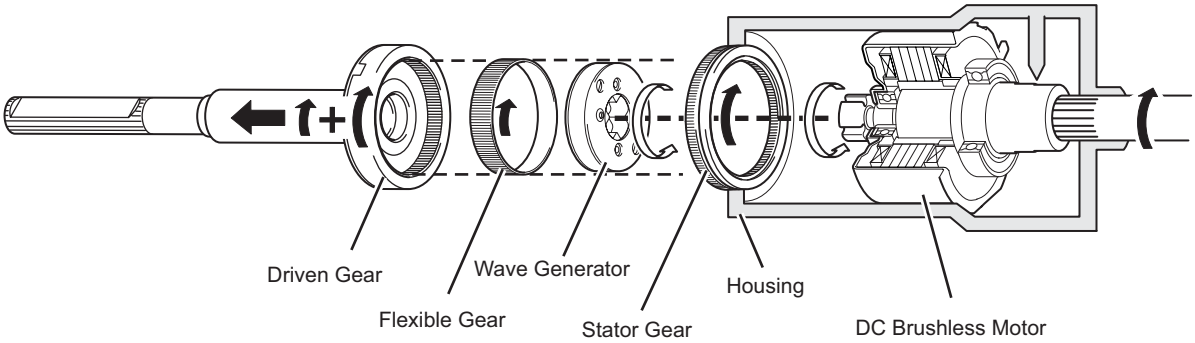
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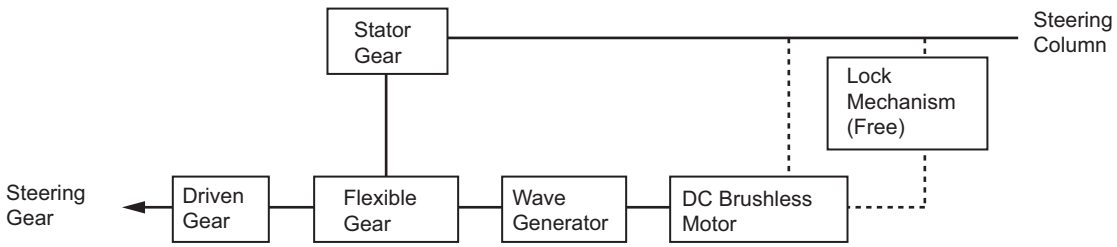
VGRS Actuator

- The VGRS actuator consists of a reduction mechanism, DC brushless motor, lock mechanism, and spiral cable.
- The rotational movement of the steering wheel travels via a rubber coupling to the housing of the VGRS actuator. The cases of the DC brushless motor and the stator gear are secured to the housing.
- The VGRS ECU outputs control signals and supplies power to the DC brushless motor, causing the motor to rotate. This causes the cam of the wave generator in the reduction mechanism to rotate, causing the flexible gear to rotate. The flexible gear rotates inside the stator gear and causes the driven gear, which is located coaxially, to rotate.
- Due to the foregoing operations, the VGRS actuator generates a wheel turning angle that is greater than the amount of steering effort.



VGRS Actuator



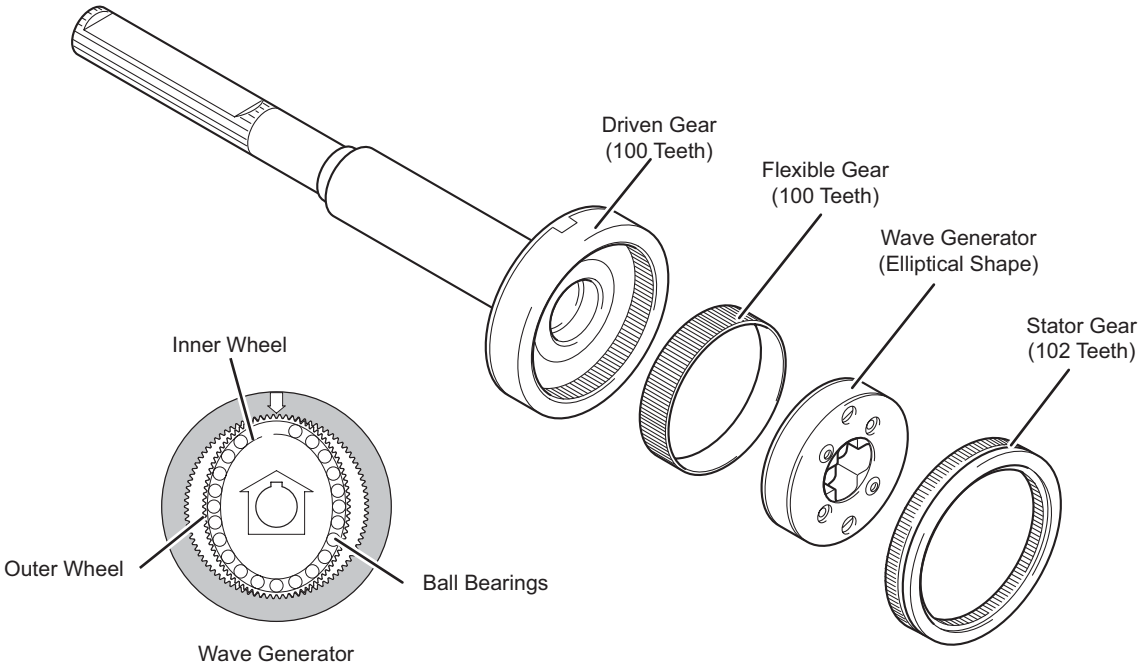


Transfer Course

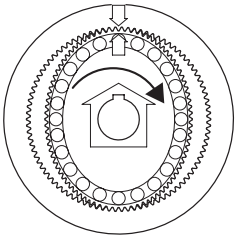
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Reduction Mechanism

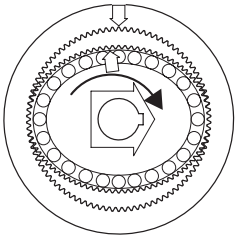
- The reduction mechanism uses Strain Wave Gearing, which is compact and highly accurate, and creates a large reduction ratio using a small number of components.
- The strain wave gearing consists of a stator gear, driven gear, flexible gear, and wave generator. The rotational movement of the wave generator causes the flexible gear to deform and create a rotational difference between the stator gear and the driven gear.
- The stator gear has 102 teeth, and the driven gear has 100 teeth, therefore, the stator gear has two more teeth than the driven gear.
- The flexible gear consists of an elastic metal body that is shaped into a thin belt.
- The wave generator consists of an oval cam, an inner ring that is secured to the cam, ball bearings, and an outer ring that can undergo elastic deformation.



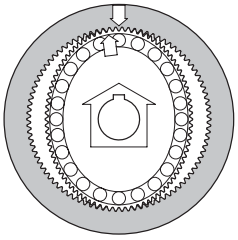
Speed Reduction Mechanism (Strain Wave Gearing)



The wave generator deforms the flexible gear into an oval shape. The teeth at the major axis of the oval shape mesh with the teeth of the stator gear. The minor axis is completely separated from the teeth of the stator gear.



When the wave generator (input) rotates clockwise while the stator gear remains stationary, the flexible gear undergoes elasticity deformation. This causes the position in which it meshes with the teeth of the stator gear to move.



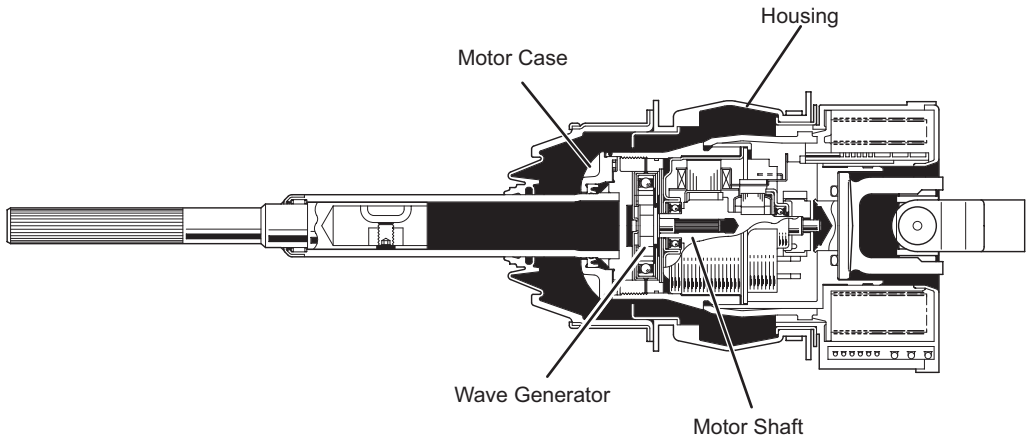
When the wave generator makes one complete revolution, the driven gear will rotate counterclockwise (opposite of the rotational direction of the wave generator) by two teeth. This is because the driven gear has two fewer teeth than the stator gear. The resulting rotational difference is produced as an output.

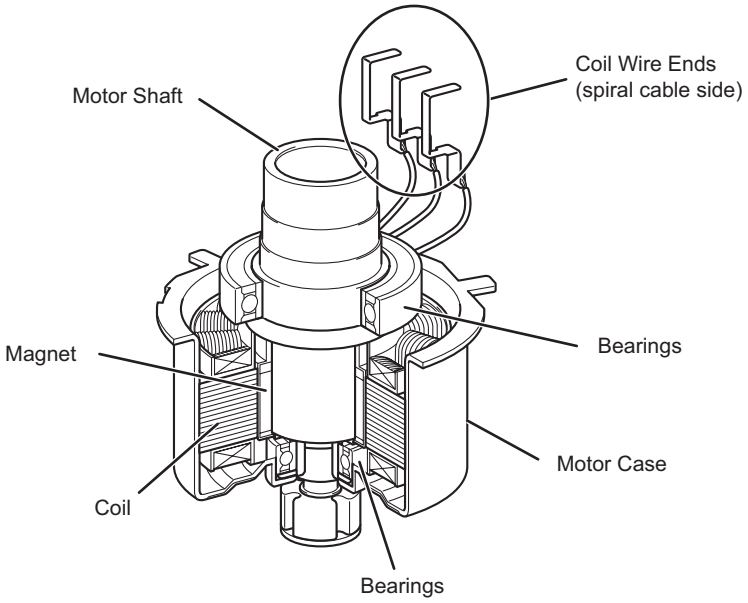
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Structure of DC Brushless motor

- A DC motor that is compact, has high power output, generates less noise, and is brushless, is used.
- This DC motor mainly consists of a coil, magnet, and motor shaft.
- The DC brushless motor is installed in the steering wheel end of the housing. The motor shaft is coupled to the wave generator of the reduction mechanism.

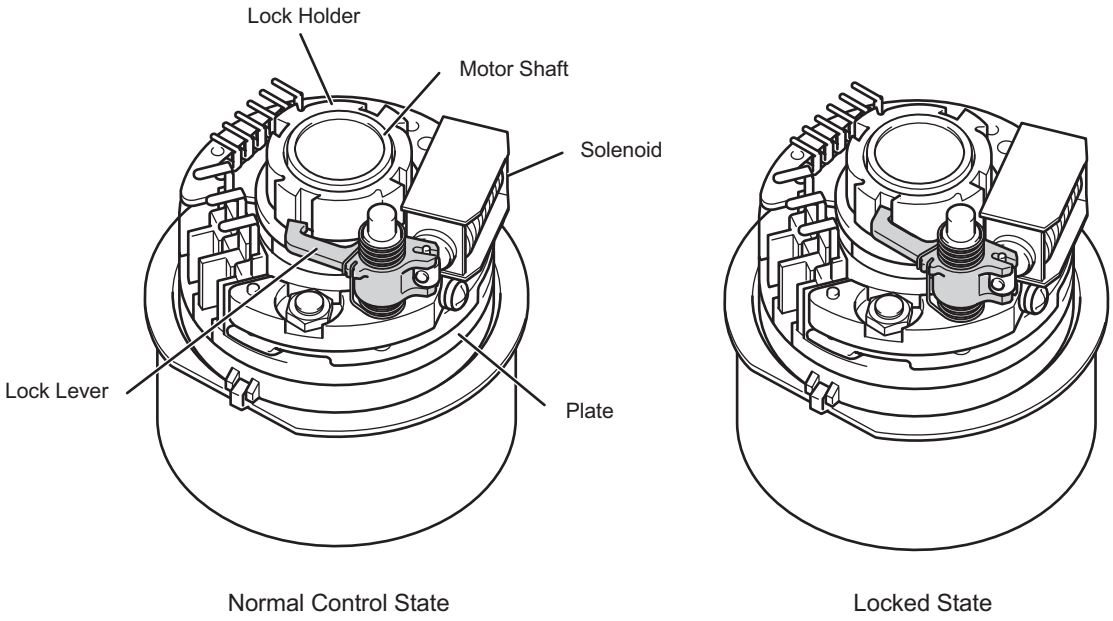




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Lock Mechanism

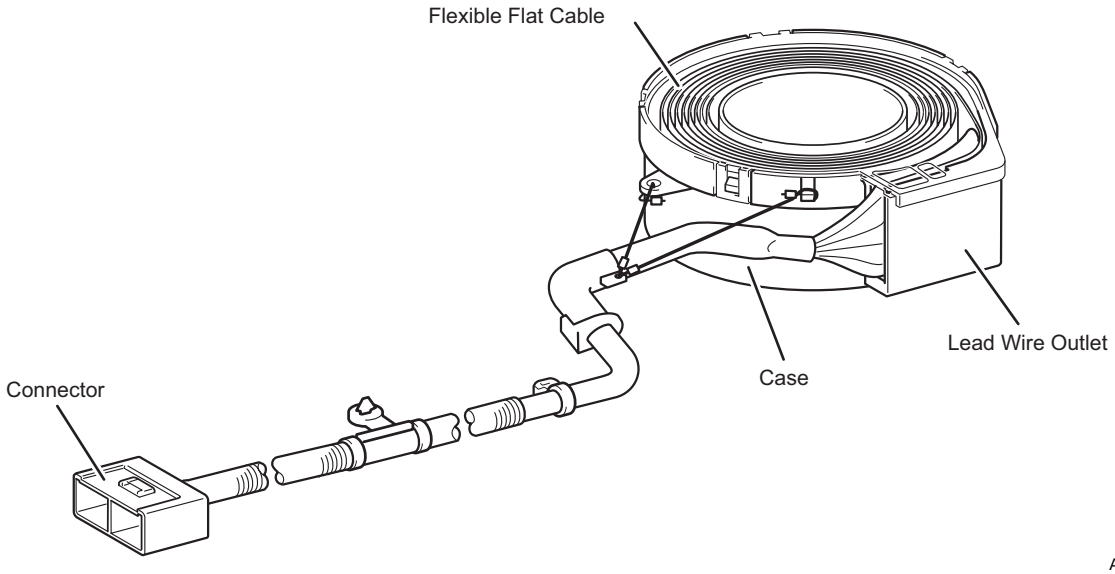
- The lock mechanism consists of a solenoid, lock lever, and lock holder, and is secured to the motor shaft.
- In case of a system failure, or when the ignition switch is OFF, the lock mechanism locks the motor shaft and prevents it from rotating, in order to enable the same steering operation as the conventional steering.



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Spiral Cable

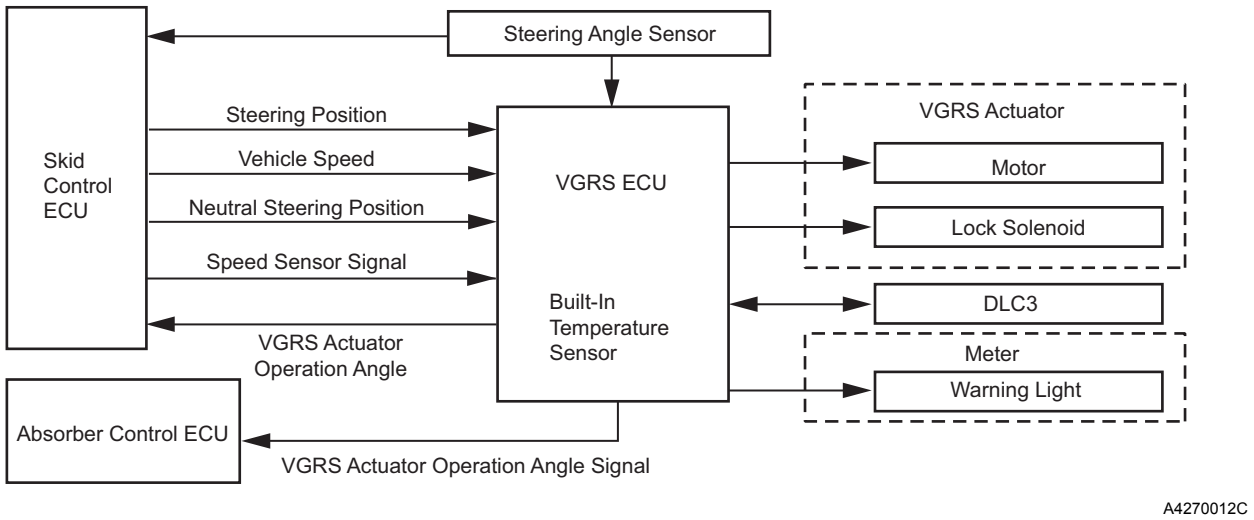
- A dedicated spiral cable is used for the VGRS actuator.
- The flexible flat cable has a dual construction, consisting of a power supply system for driving the motor, and a signal system.



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VGRS ECU

● Based on the signals from the steering sensor and the vehicle speed sensor, this ECU calculates the target wheel steering angle in order to control the motor in the VGRS actuator.



Fail Safe

ST

• If abnormalities occur to a system, Driver will be told by the "CHECK VGRS" display on lighting and the multi information display of master warning. Moreover, VGRS control is suspended and an input axis (motor) is made to lock.

Malfunction and Description of control

Malfunction Item	Description of Control
Steering Angle Sensor Malfunction	Stops the control
DC Motor Malfunction	Stops the control
Motor Drive Circuit	Stops the control
Motor Overheat	The control is stopped; then, the control resumes after the system resumes its normal operation.
Lock Drive Circuit	Stops the control
VGRS ECU Malfunction	Stops the control
Vehicle Speed Signal Malfunction	Stops the control
Skid Control ECU Communication Signal Malfunction	Stops the control
VGRS Actuator Malfunction	The control is stopped; then, the control resumes after the system resumes its normal operation.
VGRS ECU Overheat	The control is stopped; then, the control resumes after the system resumes its normal operation.
PIG Power Source Drop Voltage Malfunction	The control is stopped; then, the control resumes after the system resumes its normal operation.

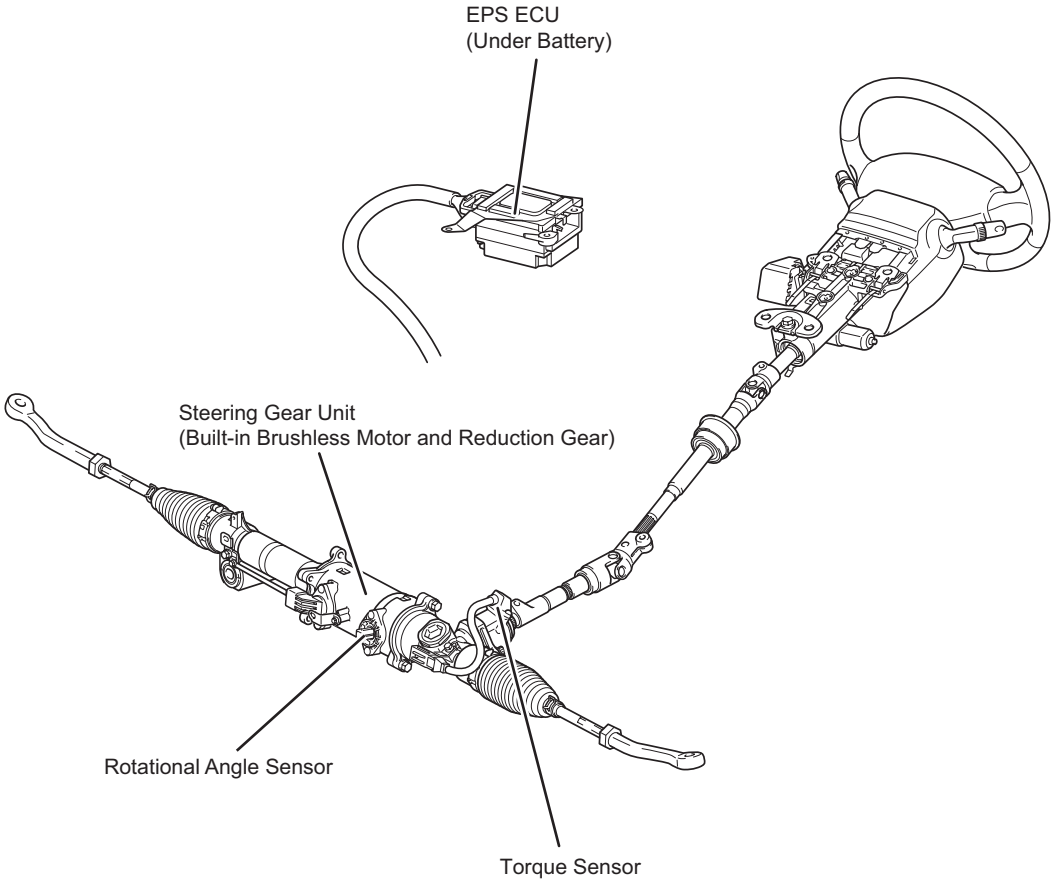
Diagnosis Function

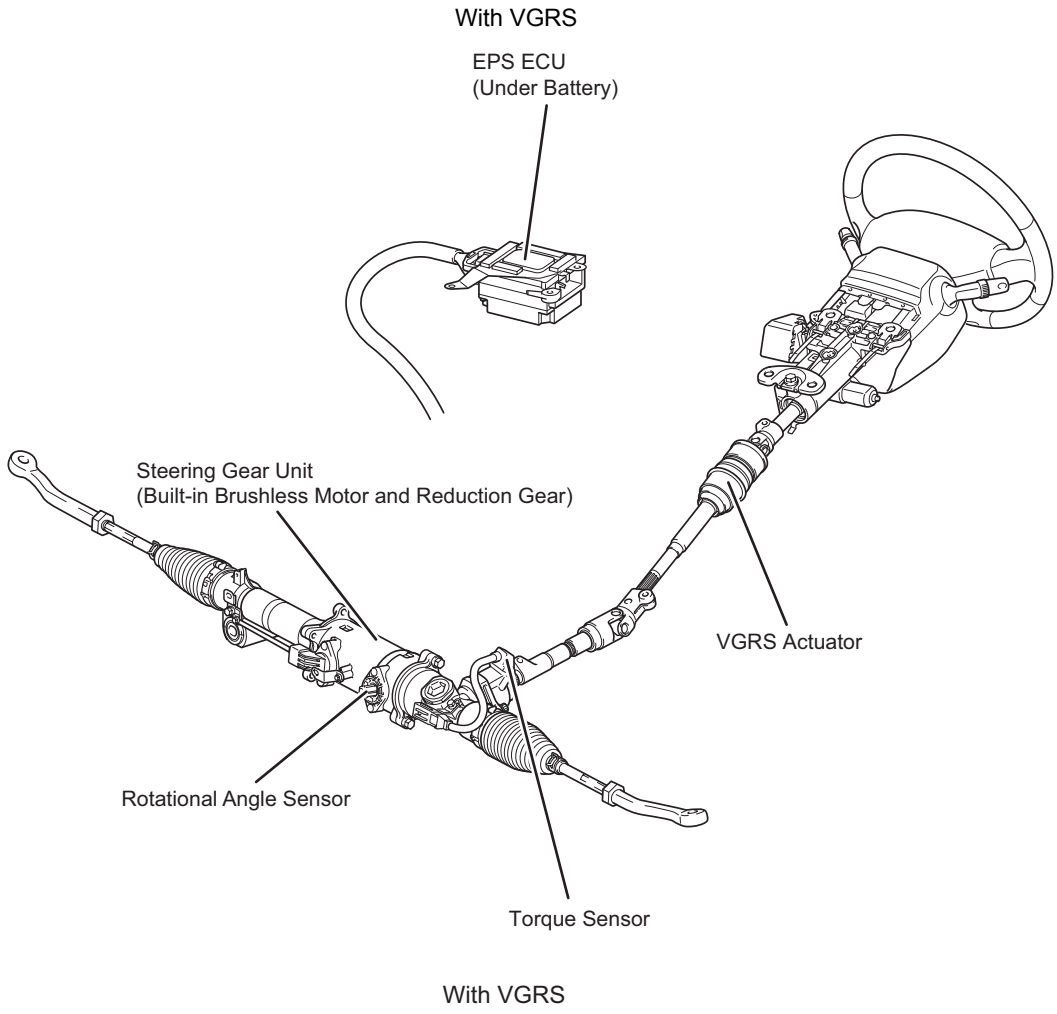
- In case of a system failure, the warning light illuminates to indicate the items on which control will be stopped. Also, the new diagnostic system features improved serviceability. For details on the diagnostic methods and diagnostic items, refer to the repair manual.

POWER STEERING

Power Steering Outline

- All models use a rack assist type EPS (Electric Power Steering) system.
- The rack assist type EPS system uses a brushless motor and a reduction gear that are installed in the steering gear unit. This system generates assist torque during a steering operation to reduce the driver's steering effort.





Main Components and Functions

Component	Function
EPS(Electric Power Steering) ECU	Calculates the assist current based on the torque sensor signal and the vehicle speed signal and outputs it to the motor.
Torque Sensor	Outputs steering torque to the EPS ECU.
Rotational Angle Sensor	Outputs the rotational angle of the motor to the EPS ECU.
Brushless Motor	Generates an assist torque based on the assist current provided by the EPS ECU.
Reduction Gear	Reduces the rotation of the brushless motor and transmits it to the steering gear.
Combination Meter	Illuminates the P/S warning light in the combination meter in case of a system failure.
DLC3	Enables access to the DTC (Diagnostic Trouble Code) and ECU data when a diagnosis tool (Intelligent Tester II) is connected to this connector and operated.

Electric Power Steering Characteristics

● EPS has the following features.

Features

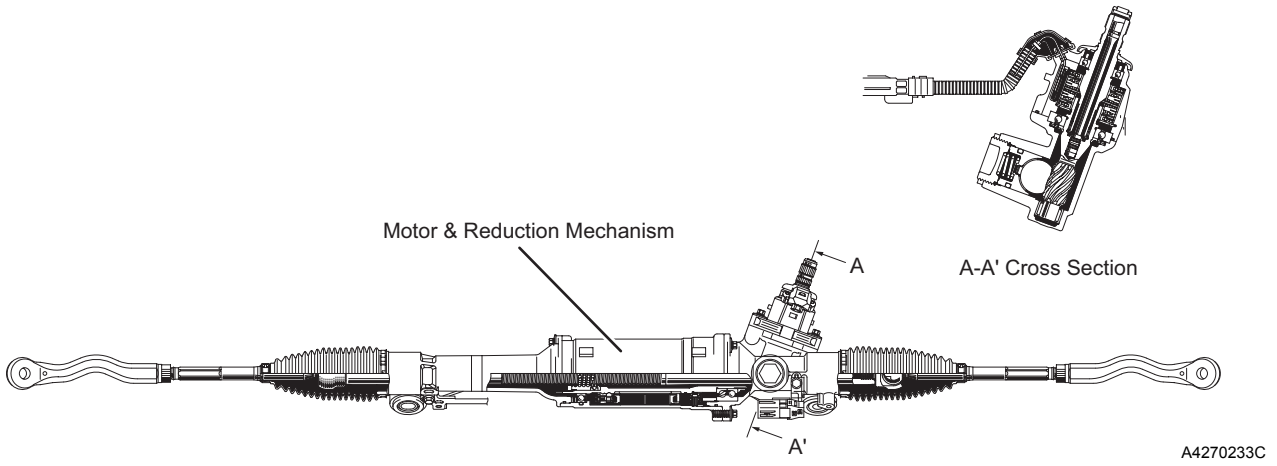
Item	Features
Fuel Economy Characteristics	Hydraulic power steering uses the drive force of the engine to constantly operate a hydraulic pump. In contrast, the EPS drives the motor only during a steering operation that requires assist torque. Accordingly, this power steering does not consume energy during straightline driving at high speeds, and realizes excellent fuel economy characteristics.
Simpler Construction	A simple and compact construction has been achieved by integrating the brushless motor and the reduction gear (the main components of the rack type EPS) in the steering gear unit, and using a compact and lightweight EPS ECU.
Discontinued Hydraulic System	The electric power steering does not need the hydraulic pipes and the oil that are required for driving the hydraulic power steering. Therefore, the steering gear can be easily removed and reinstalled.
Lightweight	It has been made lightweight, along with the discontinuance of the pipe system and the compact configuration of the system.
Steering Feel	This system optimizes the assist characteristics based on the signals provided by the vehicle speed sensor. Thus, it reduces the steering effort at low speeds, and realizes a responsive steering feel at high speeds.

ST

Steering Gear

● A lightweight and compact rack & pinion type steering gear that excels in ease of use is used.

● The brushless motor and the reduction gear (the main components of the rack type EPS) have been integrated in the steering gear unit.

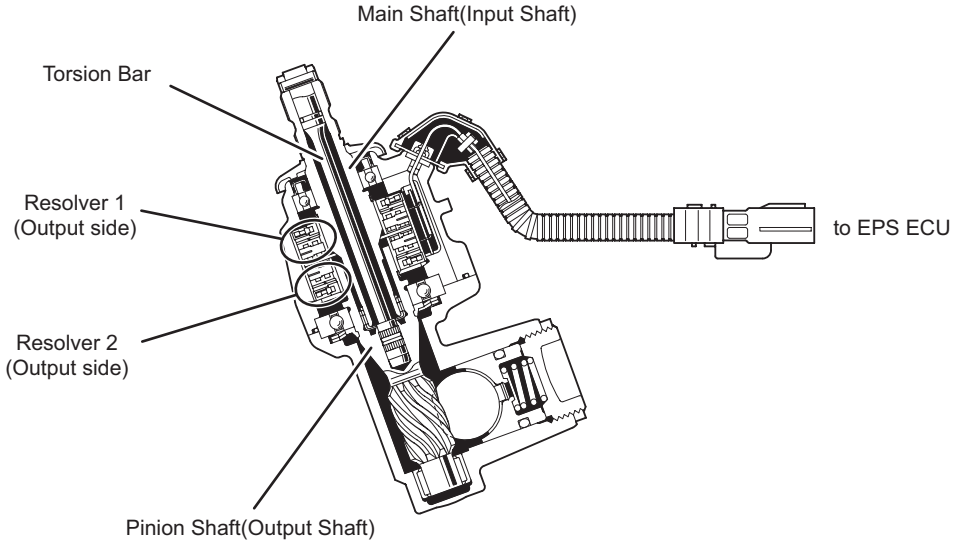


Steering Gear Specification

	GS300	GS430
Gear Ratio(Overall)	14.6	12.4~17.2
Type	Rack & Pinion	←
No. of Turns Lock to Lock	3.2	2.7
Rack Stroke [mm]	158	←

Torque Sensor

- The torque sensors consist of two resolver sensors. One is secured to the input shaft, which is coupled to the steering wheel; the other is secured to the output shaft, which is coupled to the pinion shaft. The two resolver sensors are connected by the torsion bar.
- When the driver turns the steering wheel, it causes the torsion bar to become twisted. This creates a relative difference in the angles detected by the two resolver sensors. The controller calculates the torque value based on this difference.



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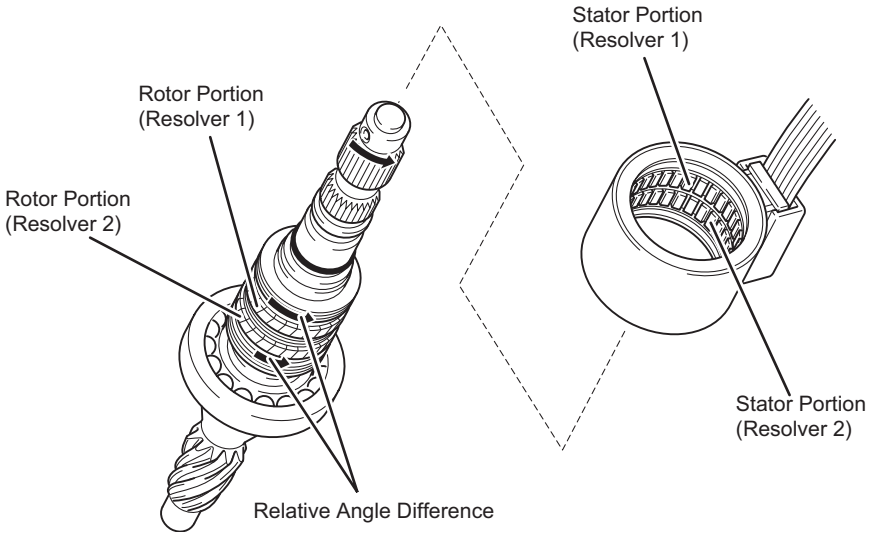
Torque Sensor Operation

- Straight-line Driving

  If the vehicle is driven straight and the driver dose not turn the steering wheel, the specified voltage that is output at this time is determined by the ECU to indicate the neutral position of the steering. Therefore, it dose not apply current to the motor.

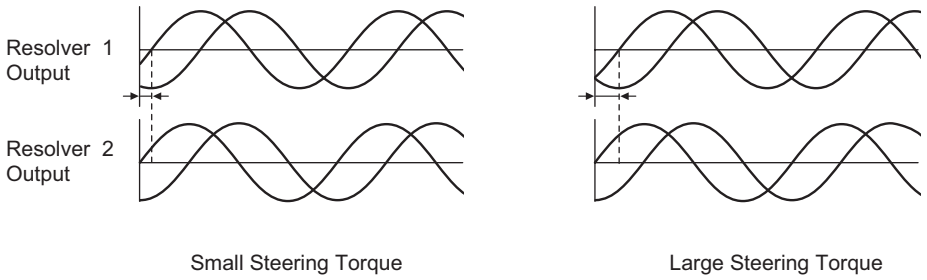
- When Steering

  When the driver turns the steering wheel, a relative angle difference is created between the rotor portions of the resolvers 1 and 2, only in the amount that is equivalent to the twisting of the torsion bar. The stator portions of the resolvers 1 and 2 receive the angles of the rotors in the form of electric signals and output them to the EPS ECU. Based on these input signals, the EPS ECU calculates the relative angle difference between the angles detected by the two resolvers. The EPS ECU calculates the torque value based on that difference. Then, the EPS ECU calculates the assist current based on the calculated torque value and vehicle speed. Based on the information obtained from the rotation angle sensor, the EPS ECU actuates the motor at a predetermined current.



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Torque Sensor Output Image Diagram



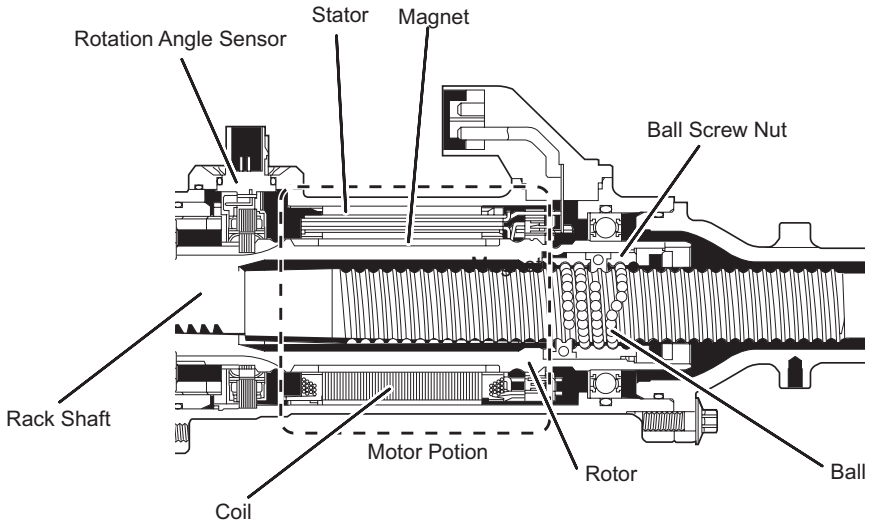
Small Steering Torque

Large Steering Torque

A4270205C

Motor & Reduction Mechanism

- The Motor is a high power output, brushless type motor that is driven by a voltage of 27V~42V.
- The motor, which is mounted coaxially to the rack shaft, consists of a rotation angle sensor, stator, and rotor. A ball screw reduction gear, which consists of a reduction mechanism, is installed on the rotor. The balls Transmit the rotational torque of the motor to the rack shaft in the form of axial force.
- The rotation angle sensor consists of resolver sensors, which excel in to the EPS ECU. As a result, it ensures efficient EPS control.

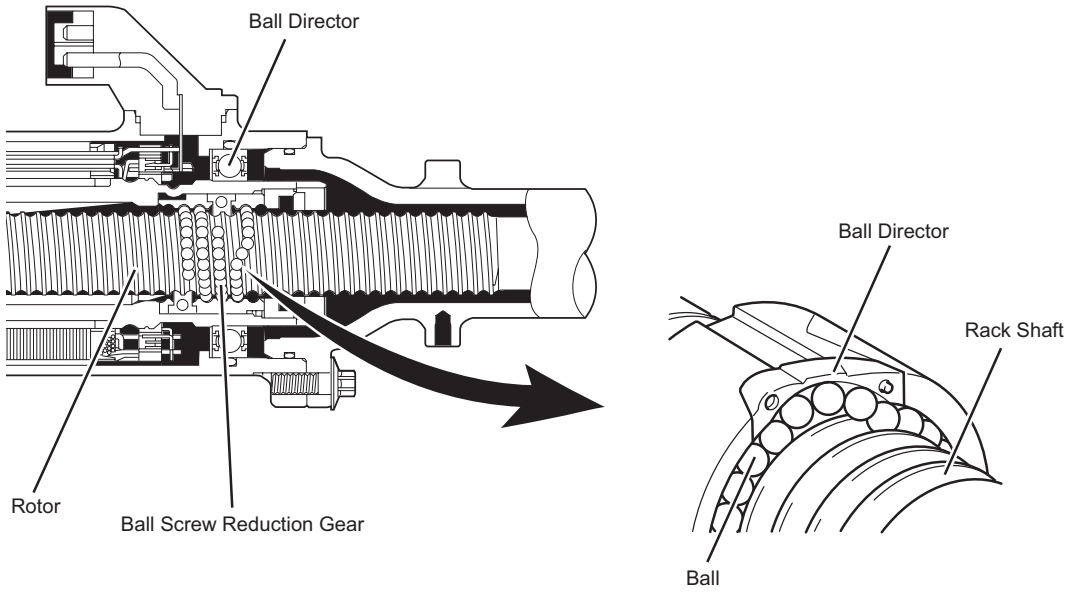


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ST

Structure of Reduction Mechanism

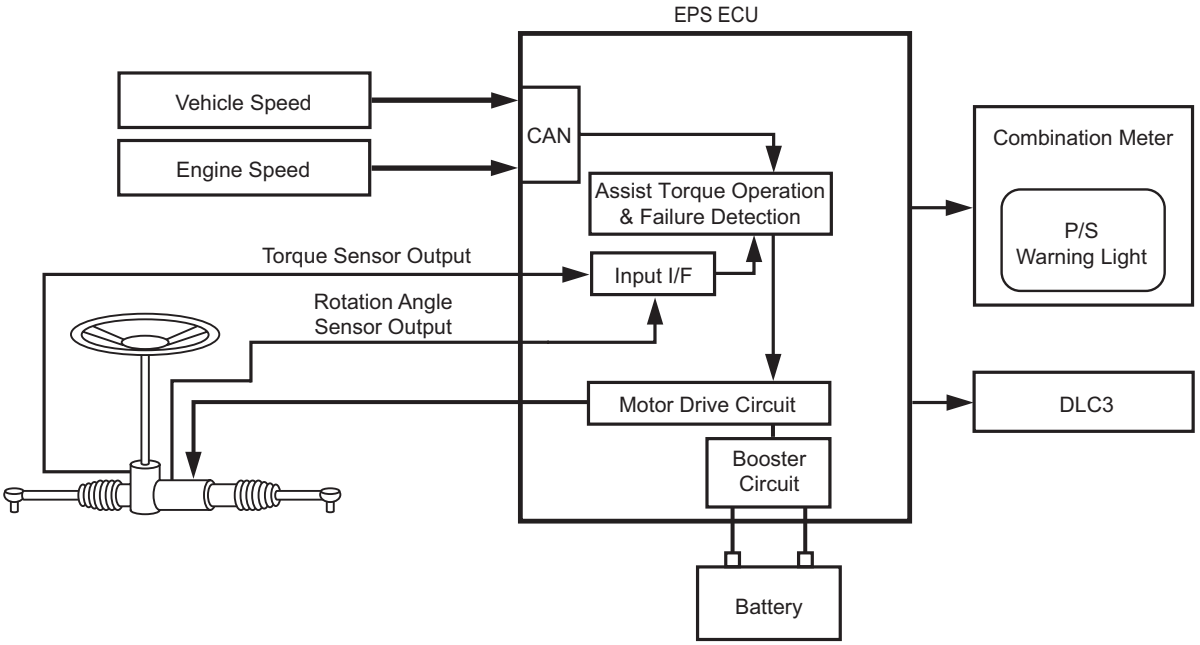
- The reduction mechanism consists of a high-precision rolled ball thread with a smooth surface, which realizes high efficiency and low noise.
- The ball screw reduction gear has four directions, and is fixed to the rotor.
- By the ball deflector, the ball is circulated endlessly the inside of the ball screw reduction gear.
- The motor operates to rotate the rotor. Then, the rotational torque of the motor travels from the ball screw reduction gear via the balls, thus transmitting a direct axial force to the rack shaft.



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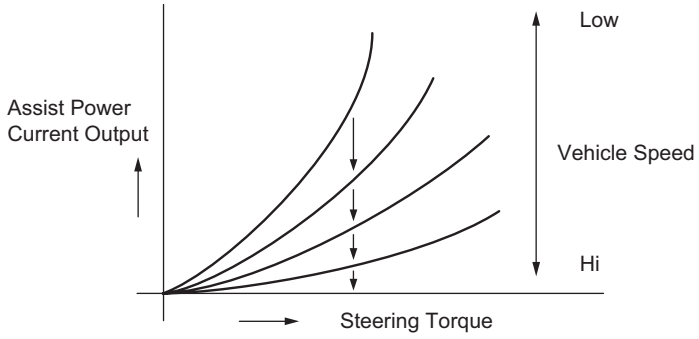
EPS ECU

- Based on the steering torque and vehicle speed, this ECU calculates the assist current, and drives the motor based on the data obtained from the rotational angle sensor.
- It contains a failsafe function and a diagnostic function in case of a failure in the system.



A4270150C

- The EPS ECU receives signals from various sensors, judges the current vehicle condition, and determines the relationship between the steering torque and the assist power current output.



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ST

Assist Control function

• The power assist control consists of the following functions

List of Power Steering Control

Item	Function
Basic Control	Calculates the assist current based on the steering torque and vehicle speed, and controls the drive circuit based on the data obtained from the rotational angle sensor, in order to drive the motor with a specified current.
Inertia Correction Control	Reduces the drag feel of the motor at the start of a steering movement.
Return Control	Ensures the return characteristics during a steering operation.
Damper Control	Ensures the convergence of steering during high speed driving.
Boost Control	Boosts the battery voltage to create a voltage that is necessary for driving the motor.
System Overheat Protection Control	Uses the motor and controller under optimal conditions.

Fail Safe

• If a failure occurs in the system, the failsafe function operates to illuminate the P/S warning light in the combination meter. Then, it gradually cuts off or reduces the output current to allow the system to operate in the manual steering mode or maintain the output current in the limited state.

List of Fail Safe

Item	Fail Safe Function
Torque Sensor System Failure b/ Prohibits assist.	Assist is prohibited.
Motor Rotational Angle Sensor System Failure	Assist is prohibited.
Motor Overheat	Limits the assist force.
Motor Short (including drive system failure)	Assist is prohibited.
Motor overcurrent	Assist is prohibited.
Electric Power Steering ECU Overheat	Limits the assist force.
Electric Power Steering ECU Internal Temperature Sensor Failure	Limits the assist force.
Electric Power Steering ECU System Failure (including boost circuit system failure)	Assist is prohibited.
Vehicle Speed System Failure	Limits the assist force.
Power Supply Voltage Failure	Interrupts assist (reverts to the normal assist after the voltage is restored)

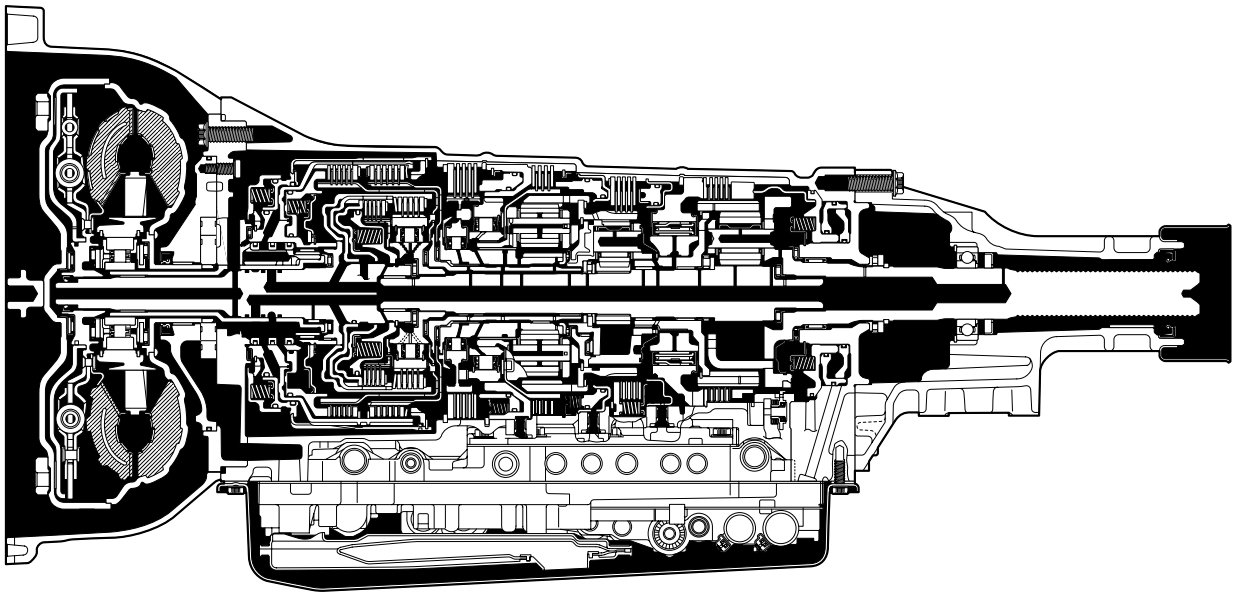
Diagnosis Function

• A diagnostic function is provided to facilitate the inspection of the system. The results of the diagnosis can be obtained by using a service tool to access the output DTCs (Diagnostic Trouble Codes).

OUTLINE

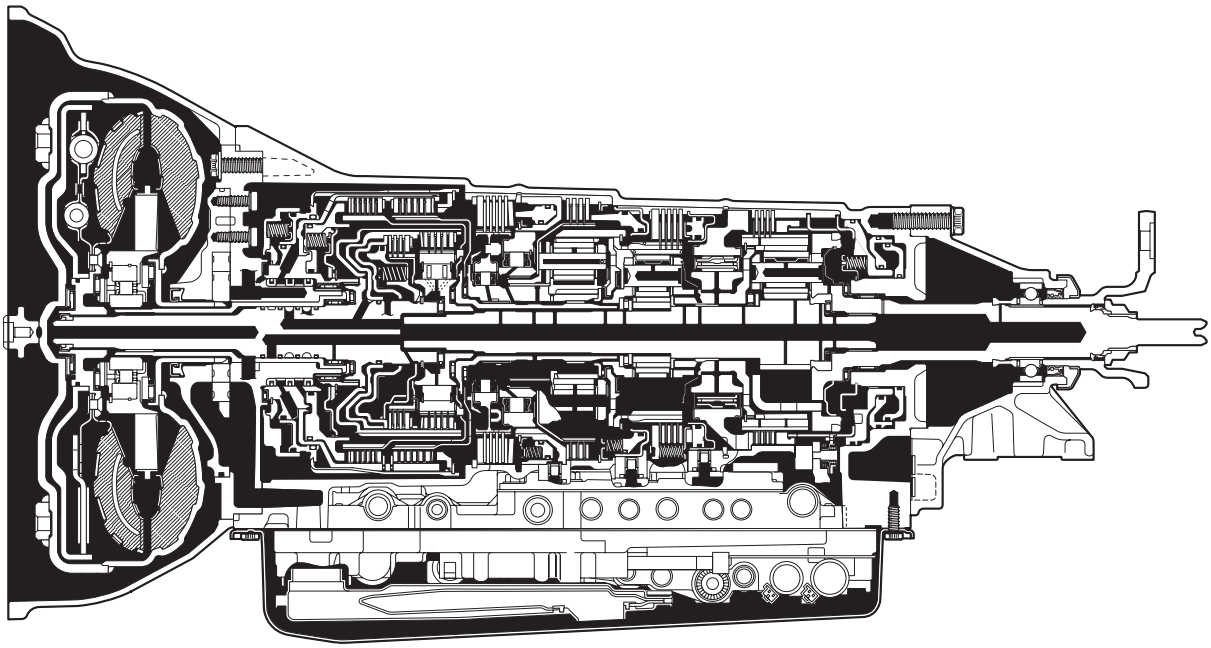
Automatic Transmission Outline

- The following types of 6-speed automatic transmission (6 Super ECT) are used: A761E on the 3UZ-FE engine models, A960E on the 3GR-FSE engine models, and A760E on the 3GR-FE engine models.
- These transmissions contain higher capacity gear trains and hydraulic control mechanisms and use the latest electronic control technology in order to realize both smooth shifting characteristics and superior fuel economy performance.
- They use a new, WS genuine Toyota automatic transmission fluid. This fluid has the same high-temperature viscosity as the conventional ATF to ensure the proper durability of the automatic transmission. Meanwhile, its viscosity in the actual operating temperature range has been lowered to reduce drag loss and improve fuel economy.
- They have discontinued the use of the automatic transmission oil filler tube and the level gauge. Instead, they use a oil level detection mechanism called an "overflow system".

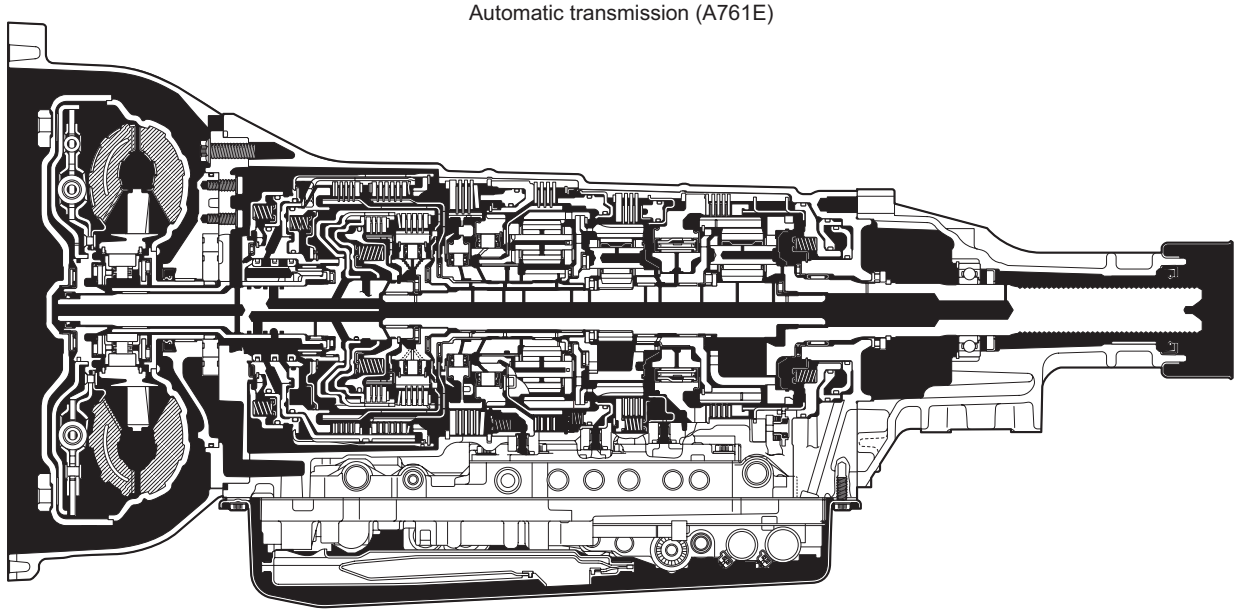


Automatic transmission (A960E)

A4270303P



Automatic transmission (A761E)



Automatic transmission (A760E)

A4270421P

Torque converter specifications

Transmission Model	A761E (6 Super ECT)	A760E(6 Super ECT)	A960E(6 Super ECT)
Engine	3UZ-FE	3GR-FE	3GR-FSE
Type	3-Elemeny,1-Step,2-phase(with lock-up mecha-nism)	←	←
Stall torque ratio	1.85	1.90	1,85

Transmission specifications

Transmission type		A761E (6 Super ECT)	A760E(6 Super ECT)	A960E (6 Super ECT)
Engine		3UZ-FE	3GR-FE	3GR-FSE
Format		Electronically Controlled Planetary Gear Type	←	←
Gear ratio	1st	3.296	3.520	3.538
	2nd	1.958	2.042	2.060
	3rd	1.348	1.400	1.404
	4th	1.000	1.000	1.000
	5th	0.725	0.716	0.713
	6th	0.582	0.586	0.582
	Reverse	2.951	3.224	3.168
Fluid type		Toyota Genuine WS automatic transmission fluid	←	←

Planetary gear specifications

Transmission type		A761E (6 Super ECT)	A760E (6 Super ECT)	A960E (6 Super ECT)
Engine		3UZ-FE	3GR-FE	3GR-FSE
Front planetary gear	The No of Sun gear	43	40	33
	The No of Pinion gear (inner)	22	22	19
	The No of Pinion gear (outer)	21	21	18
	The No of Ring gear	91	91	75
Center planetary gear	The No of Sun gear	33	31	26
	The No of Pinion gear	23	23	20
	The No of Ring gear	78	77	66
Rear planetary gear	The No of Sun gear	27	25	26
	The No of Pinion gear	18	19	20
	The No of Ring gear	62	63	66

Clutch specifications

Transmission type		A761E (6 Super ECT)	A760E (6 Super ECT)	A960E (6 Super ECT)
Engine		3UZ-FE	3GR-FE	3GR-FSE
One-way clutch No.1	F1	18	←	21
One-way clutch No.2	F2	25	←	22
One-way clutch No.3	F3	26	←	22
One-way clutch No.4	F4	27	←	25

Friction element specifications

Transmission type		A761E (6 Super ECT)	A760E (6 Super ECT)	A960E (6 Super ECT)
Engine		3UZ-FE	3GR-FE	3GR-FSE
Clutch No.1	C1	4	←	←
Clutch No.2	C2	5	4	5
Clutch No.3	C3	5	←	←
Clutch No.4	C4	3	←	4
Brake No.1	B1	3	←	←
Brake No.2	B2	4	←	←
Brake No.3	B3	4	4	4
Brake No.4	B4	4	←	5

Development Objectives

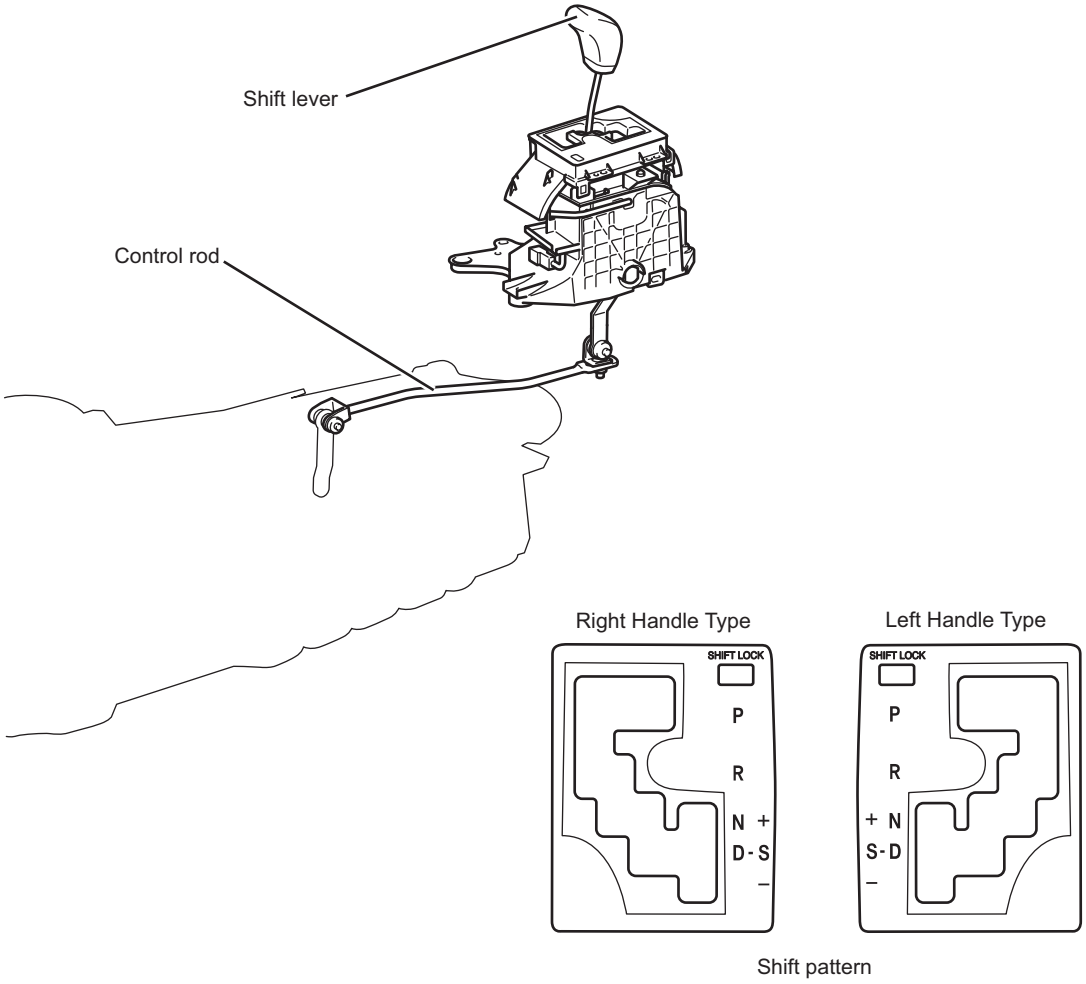
Revolutionary improvement of dynamic performance
Excellent fuel economy in various driving conditions
Top-level compact and lightweight package in the class
A fluid and smooth shift feel
Superior drivability
Overwhelming quietness during high-speed driving

List of development items

Item	Dynamic Performance	Fuel Economy	Compact & Lightweight	Shift Feel	Drivability	Maneuverability	Quietness	Quality
6-Speed Gear Train	❍	❍	❍	❍	❍	-	❍	-
Newly Developed Torque Converter	❍	❍	❍	-	-	-	-	-
Use of Aluminum Alloy Carrier (front planetary)	-	-	❍	-	-	-	-	-
Use of New Friction Material	-	❍	-	-	-	-	-	-
Use of cage & roller bearings	-	❍	-	-	-	-	-	-
Use of Non-Crescent Type Oil Pump	-	❍	❍	-	-	-	-	-
Use of Aluminum Oil Pump Cover	-	-	❍	-	-	-	-	-
Use of Compact Transmission Solenoids	-	-	❍	-	-	-	-	-
Use of Plastic Accumulator	-	-	❍	-	-	-	-	-
Use of Felt Strainer	-	-	❍	-	-	-	-	❍
Use of High-Precision Fluid Control System	-	-	❍	❍	-	-	-	-
Deceleration Downshift Control	-	❍	-	-	-	-	-	-
Lockup Control	-	❍	-	-	-	-	-	-
Flex Lockup Control	-	❍	-	-	-	-	-	-
AI-Shift Control	-	-	-	-	❍	-	-	-
AI-Shift Sport Driving Support Control	❍	-	-	-	❍	-	-	-
Lubrication Orifice Selector Control	-	-	-	-	-	-	-	❍
Use of New ATF	-	❍	-	-	-	-	-	-
Multi-mode Automatic Transmission	-	-	-	-	-	❍	-	-
Use of Oil Level Detection Mechanism	-	-	-	-	-	-	-	❍

Shift Control

● Multi-mode Automatic Transmission is used on all models.



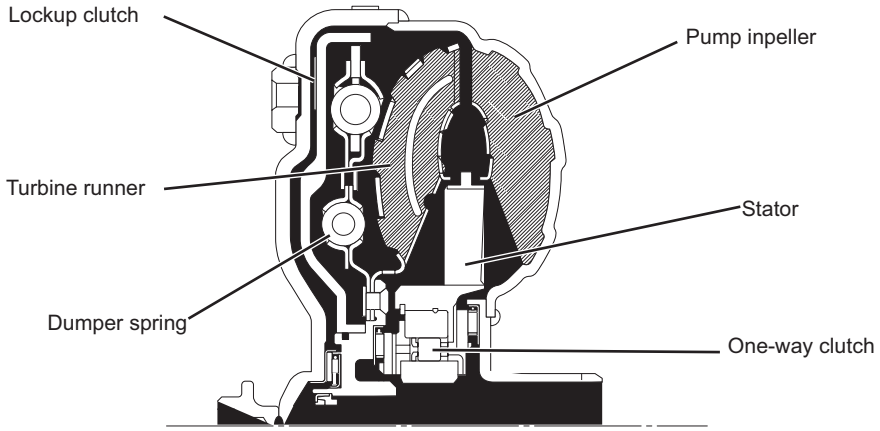
Shift pattern

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A761E/A760E AUTOMATIC TRANSMISSION

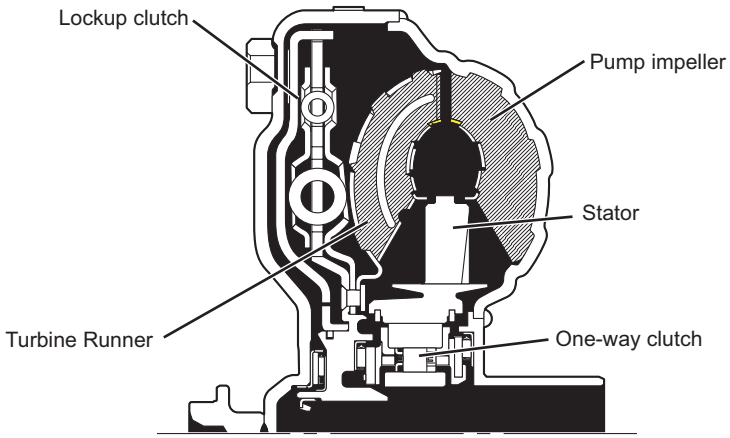
Torque Converter

● A newly developed small-sized and lightweight torque converter is used.



Torque converter (A761E)

A4270373P

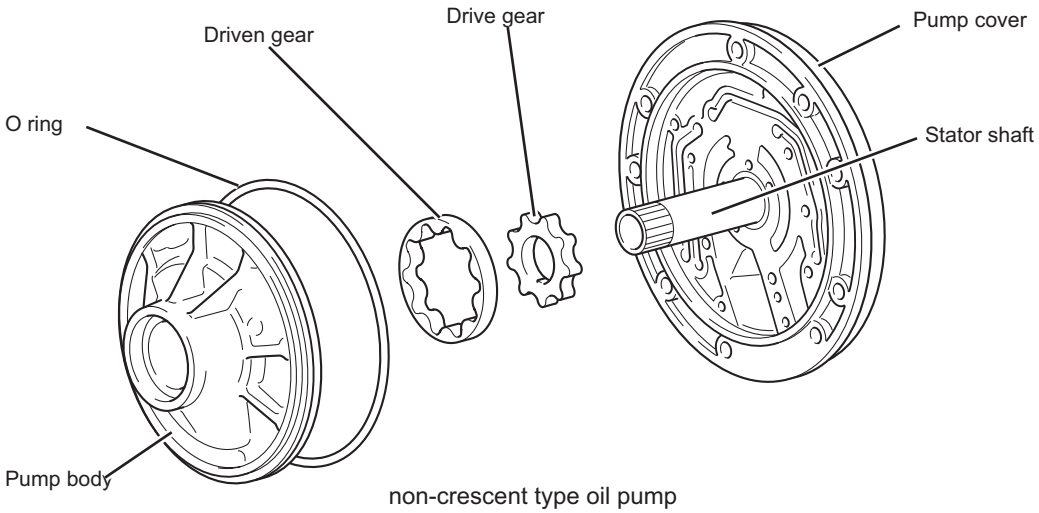


Torque converter (A760E)

A4270423P

Oil Pump

- A non-crescent type oil pump is used. The non-crescent type oil pump has been made compact and lightweight due to the discontinued use of the crescent gears. Also, the volumetric efficiency of the pump at low speeds has been improved, and its drive torque has been reduced.
- A pump cover made of aluminum alloy is used. As a result, an approximate weight reduction of 40% has been realized as compared to the ordinary oil pump made of cast iron.

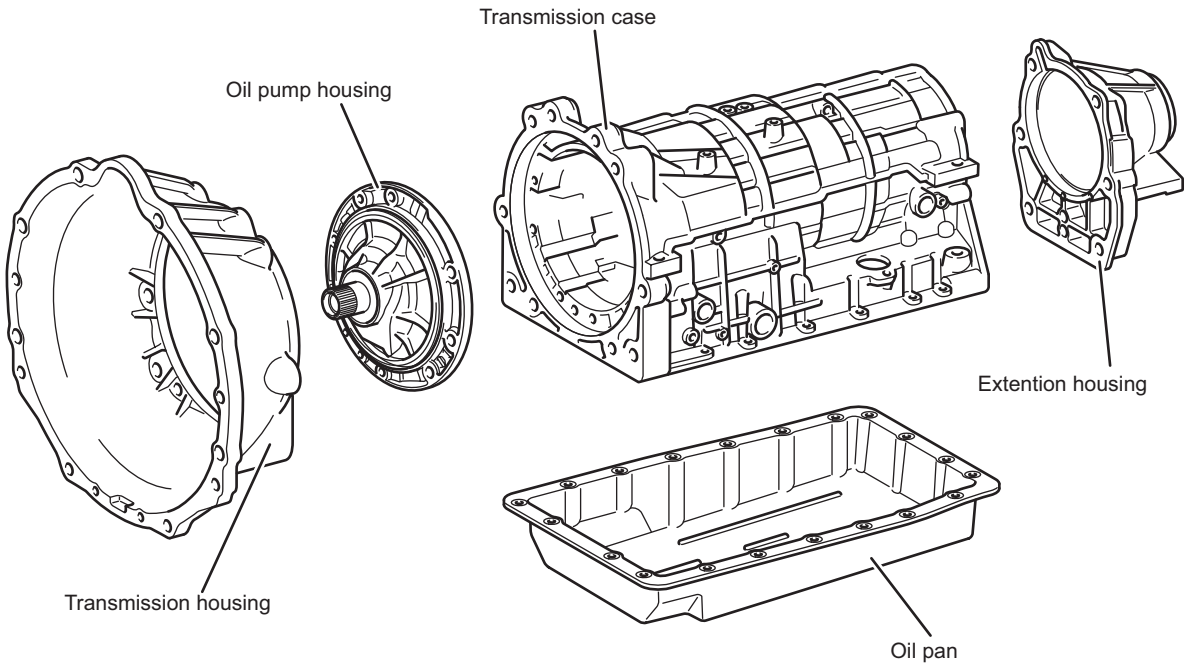


non-crescent type oil pump

A4270329P

Housing

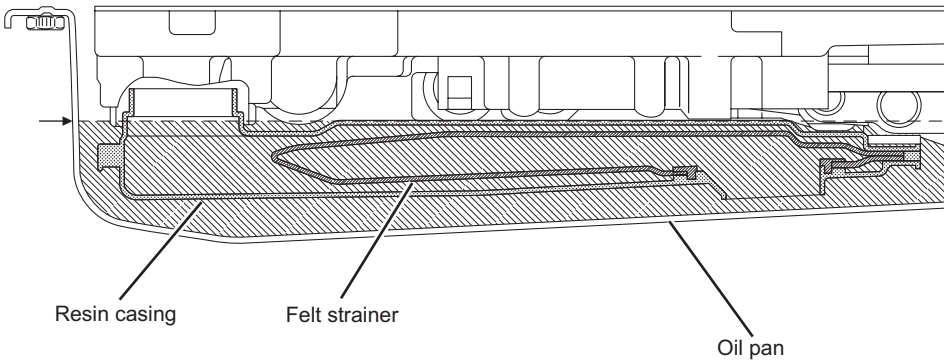
- A transmission housing, transmission case, and extension housing made of aluminum alloy are used for weight reduction. Through FEM (finite element method) analysis, efficient allocation of ribs and optimal shaping of the case have been achieved, thus ensuring weight reduction and rigidity.



A4270355P

Felt Strainer

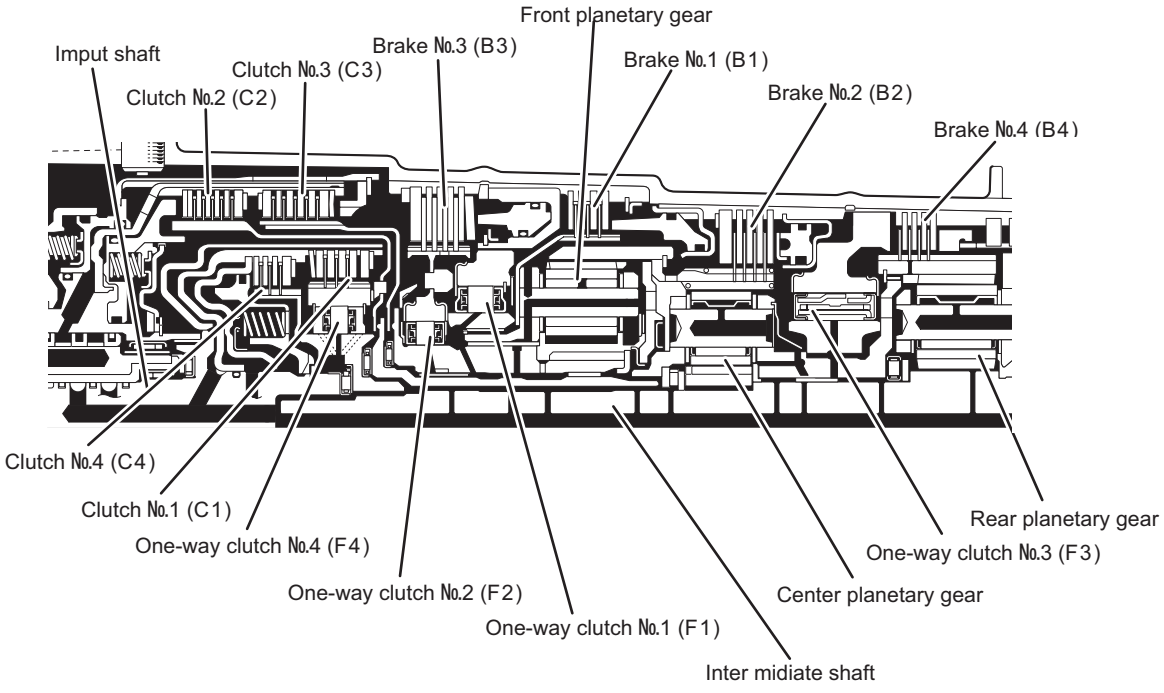
- A felt strainer (with a plastic case) is used. This results in an approximate weight reduction of 40%, as compared to an ordinary metal mesh strainer.
- The felt strainer excels in capturing minute particles of foreign matter, thus improving the reliability of the transmission. Also, the felt strainer counters the flaking of gears and shafts, thus ensuring a longer life.



A4270330P

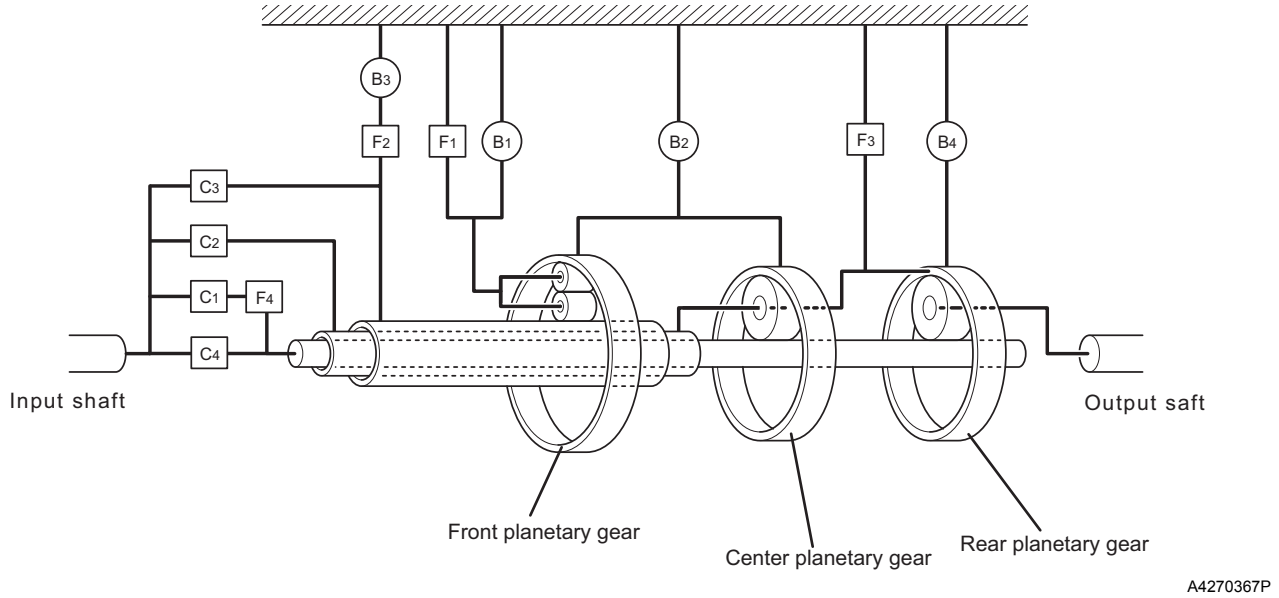
Planetary Gear Unit

- The gear train consists of four sets of multi-disc brakes, four sets of multi-disc clutches, four one-way clutches, and three sets of planetary gears comprising a sun gear, pinion gear, and ring gear.
- The material of the front planetary gear carrier has been changed from the ordinary iron to composite-molded aluminum alloy. As a result, the weight of the gear carrier has been reduced to approximately one-half of an ordinary gear carrier, thus realizing a considerable weight reduction.



A4270366P

A761E/A760E Gear Train Operation



Components and Their Operations

Component		Function
No.1 Clutch	C1	Connect input shaft and intermediate shaft.
No.2 Clutch	C2	Connects input shaft and Center planetary gear carrier.
No.3 Clutch	C3	Connects input shaft and front sun gear.
No.4 Clutch	C4	Connects input shaft and intermediate shaft.
No.1 Brake	B1	Lock the front planetary gear carrier.
No.2 Brake	B2	Lock the front ring gear and center ring gear rotation.
No.3 Brake	B3	Lock the one-way clutch No.2(F2).
No.4 Brake	B4	Lock the ring gear rotation.
No.1 One-way clutch	F1	Prevent front planetary carrier from turning counterclockwise.
No.2 One-way clutch	F2	During operation brake No.3, prevent fronts sun gear turning from counterclockwise.
No.3 One-way clutch	F3	Prevents ring gear from turning counterclockwise. Prevents center planetary carrier from turning counterclockwise.
No.4 One-way clutch	F4	During operation clutch No.1(C1), prevent intermediate shaft from turning counterclock wise.

Components and Their Operating Conditions

		C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio (A761E)	Gear Ratio (A760E)
P														-	-
R				❍		(❍)			❍	❍				2.951	3.224
N														-	-
D	1st	❍			(❍)				(❍)			❍	❍	3.296	3.520
	2nd	❍			(❍)		(❍)	❍		❍	❍		❍	1.958	2.042
	3rd	❍		❍	(❍)	(❍)		Δ		❍			❍	1.348	1.400
	4th	❍	❍	Δ	(❍)			Δ					❍	1.000	1.000
	5th	Δ	❍	❍		❍		Δ						0.725	0.716
	6th	Δ	❍			Δ	❍	Δ						0.582	0.586

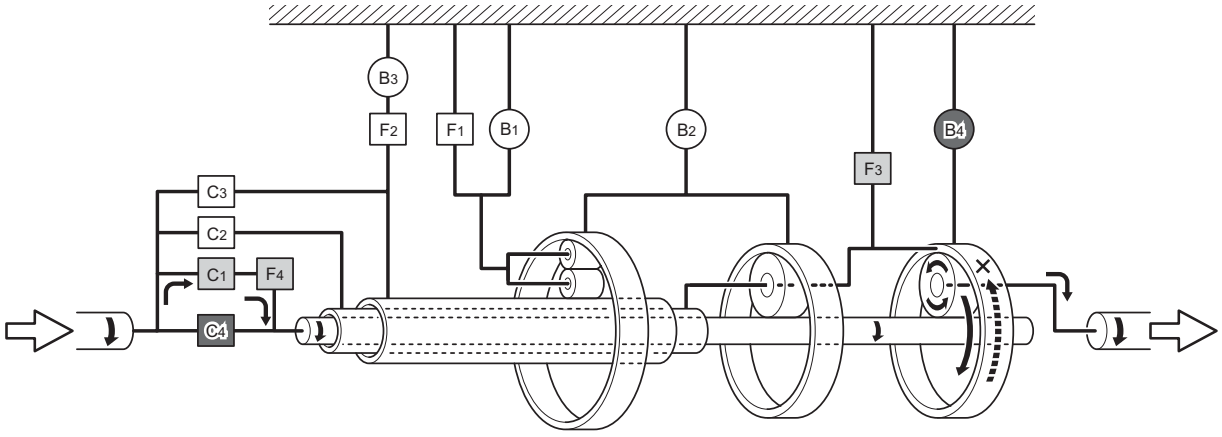
❖REFERENCE❖
❍:Operation

(❍):During engine braking

Δ :Operate but is not related to power transmission

A761E/A760E Gear Train Structure

1st Gear(D or S-1⇔S-6 Position)



: Operation
: Operation during engine braking

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Operating Conditions of Clutches and Brakes

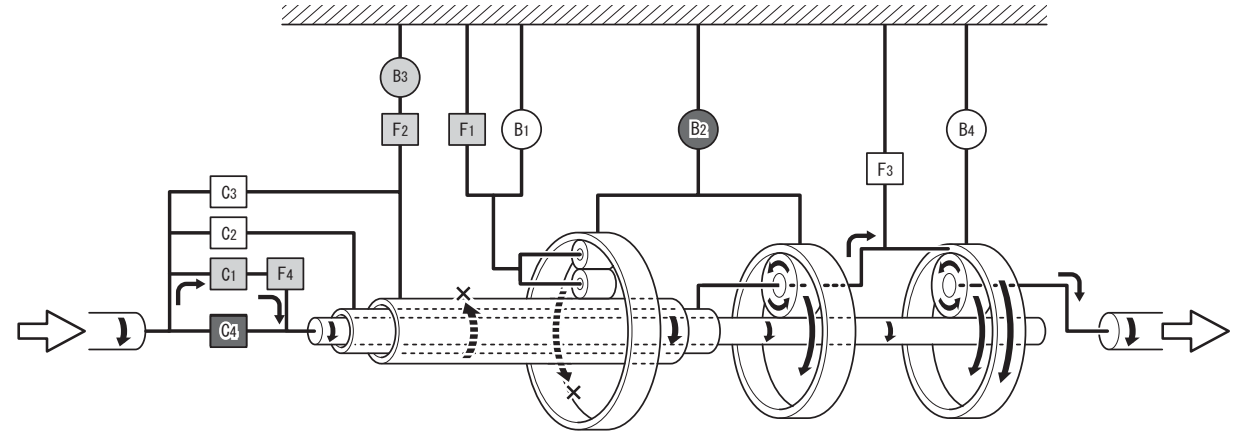
	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio (A761E)	Gear Ratio (A760E)
1st Gear	❍			(❍)				(❍)			❍	❍	3.296	3.520

❖REFERENCE❖
❍:Operation

(❍):During engine braking

Δ :Operate but is not related to power transmission

2nd Gear (D or S-2⇔S-6 Position)



: Operation
: Operation durikng enjine braking

A4270327P

Operating Conditions of Clutches and Brakes

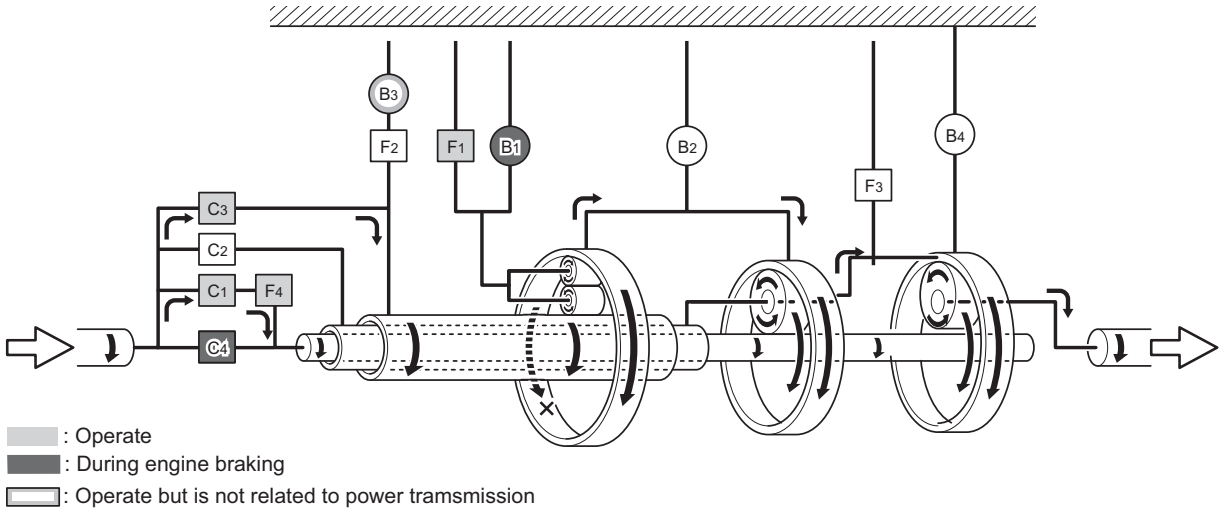
	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio	
													(A761E)	(A760E)
2nd Gear	❍			(❍)		(❍)	❍		❍	❍		❍	1.958	2.042

❖REFERENCE❖
❍:Operation

(❍):During engine braking

Δ :Operate but is not related to power transmission

3rd Gear(D,S-3⇔S-6 Position)



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Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio	
													(A761E)	(A760E)
3rd Gear	❍		❍	(❍)	(❍)		Δ		❍			❍	1.348	1.400

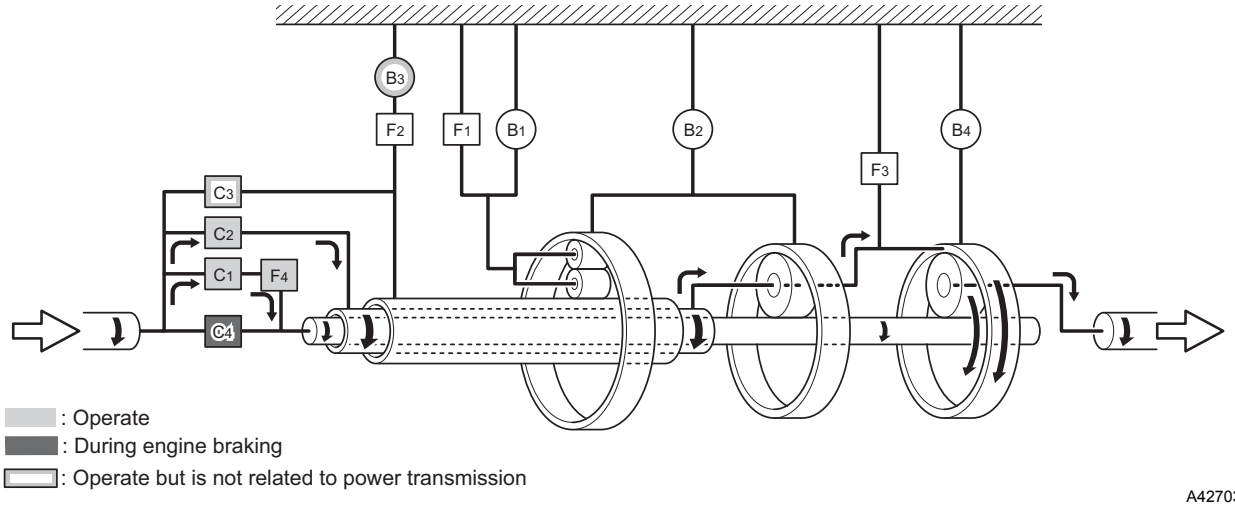
❖REFERENCE❖

❍ :Operation

(❍):During engine braking

Δ :Operate but is not related to power transmission

4th Gear(D,S-4⇔S-6 Position)



A4270370P

Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio	
													(A761E)	(A760E)
4th Gear	❍	❍	Δ	(❍)			Δ					❍	1.000	1.000

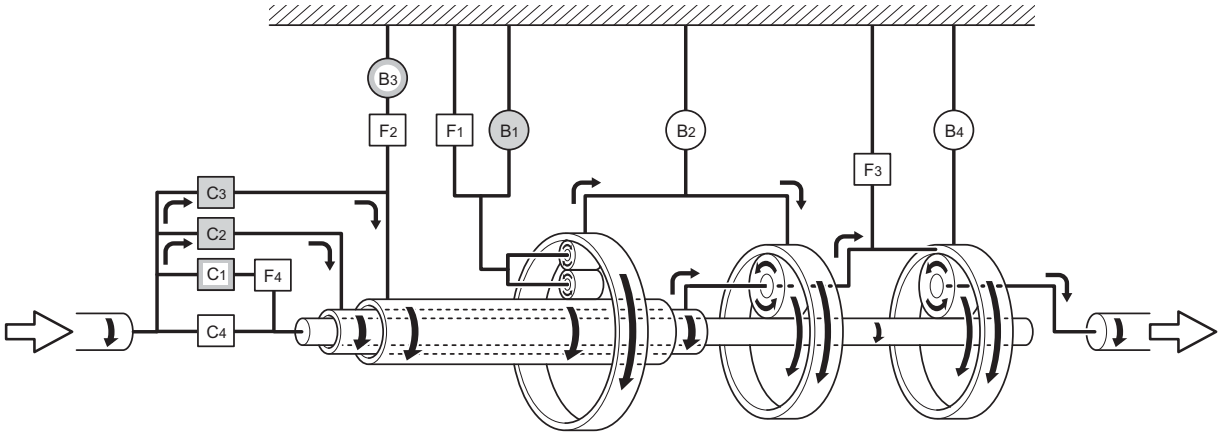
❖REFERENCE❖

❍:Operation

(❍):During engine braking

Δ :Operate but is not related to power transmission

5th Gear(D,S-5⇔S-6 Position)



: Operate

: Operate but is not related to power transmission

A4270371P

Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio	
													(A761E)	(A760E)
5th Gear	Δ	❍	❍		❍		Δ						0.725	0.716

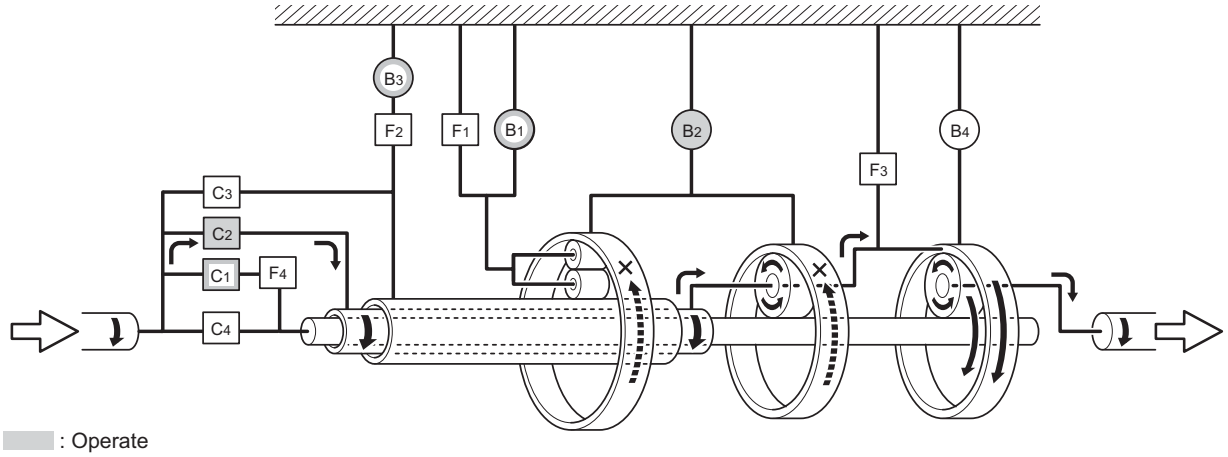
❖REFERENCE❖

❍:Operation

(❍):During engine braking

Δ :Operate but is not related to power transmission

6th Gear(D,S-6)



: Operate
: Operate but is not related to power transmission

A4270372P

Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio	
													(A761E)	(A760E)
6th Gear	Δ	❍			Δ	❍	Δ						0.582	0.586

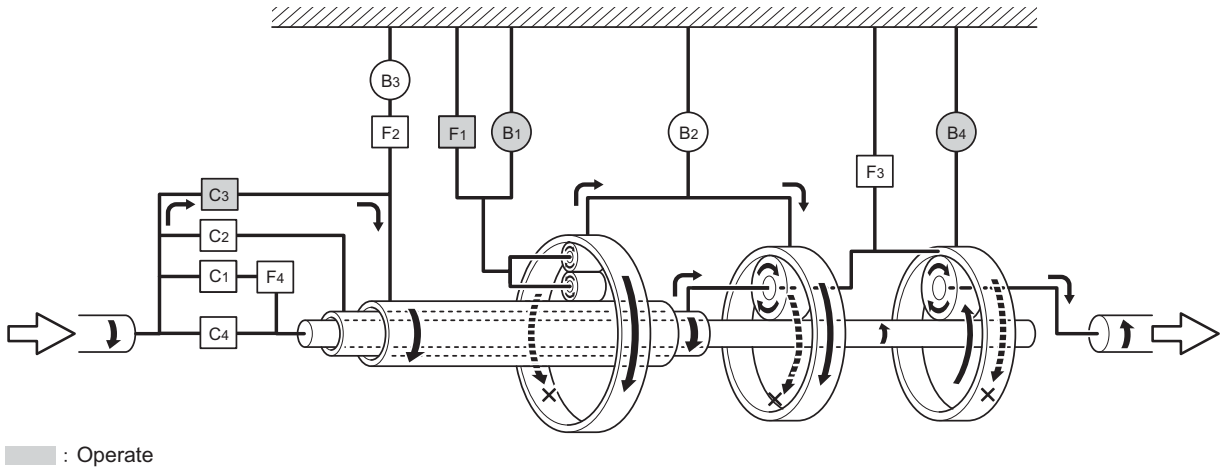
❖REFERENCE❖

❍:Operation

(❍):During engine braking

Δ :Operate but is not related to power transmission

Reverse Gear(R Position)



: Operate

A4270337P

Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio	
													(A761E)	(A760E)
Reverse			❍		(❍)			❍	❍				2.951	3.224

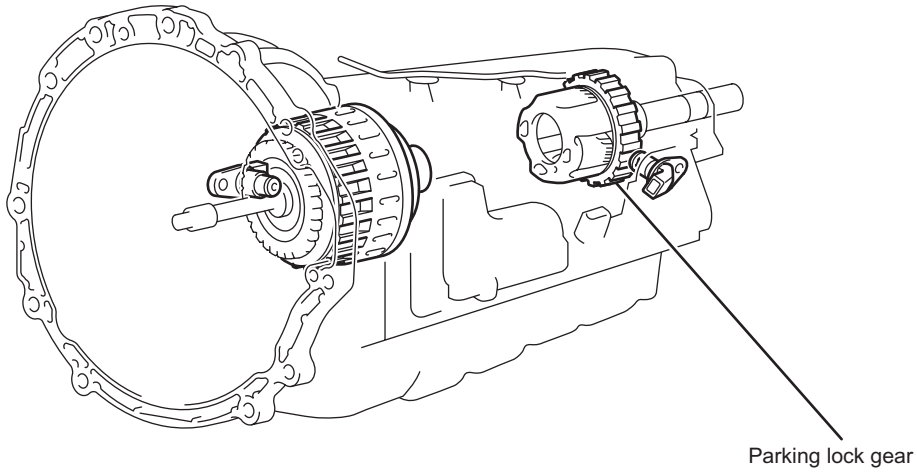
❖REFERENCE❖
❍ :Operation

(❍):During engine braking

Δ :Operate but is not related to power transmission

Parking Lock Mechanism

● A parking lock gear is provided in the rear planetary gear carrier area. A parking lock pawl meshes with the parking lock gear, thus locking the rotational movement of the output shaft.



A4270339P

Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio	
													(A761E)	(A760E)
Reverse			❍		(❍)			❍	❍				2.951	3.224

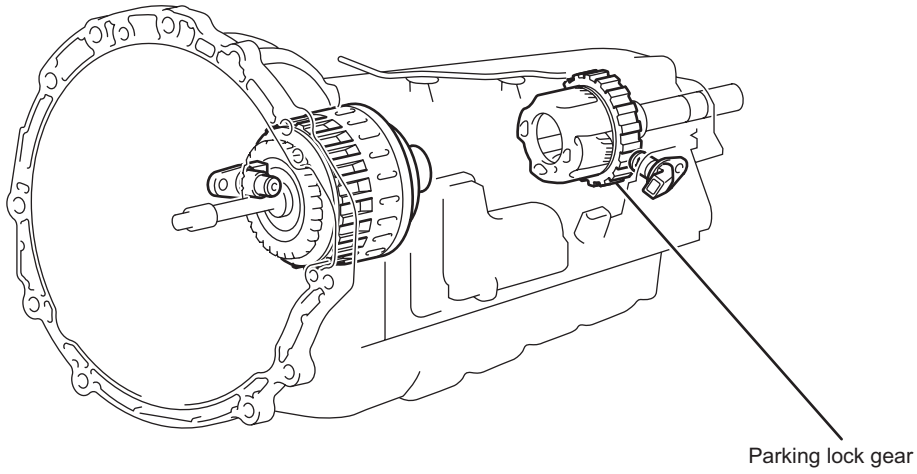
❖REFERENCE❖
❍ :Operation

(❍):During engine braking

Δ :Operate but is not related to power transmission

Parking Lock Mechanism

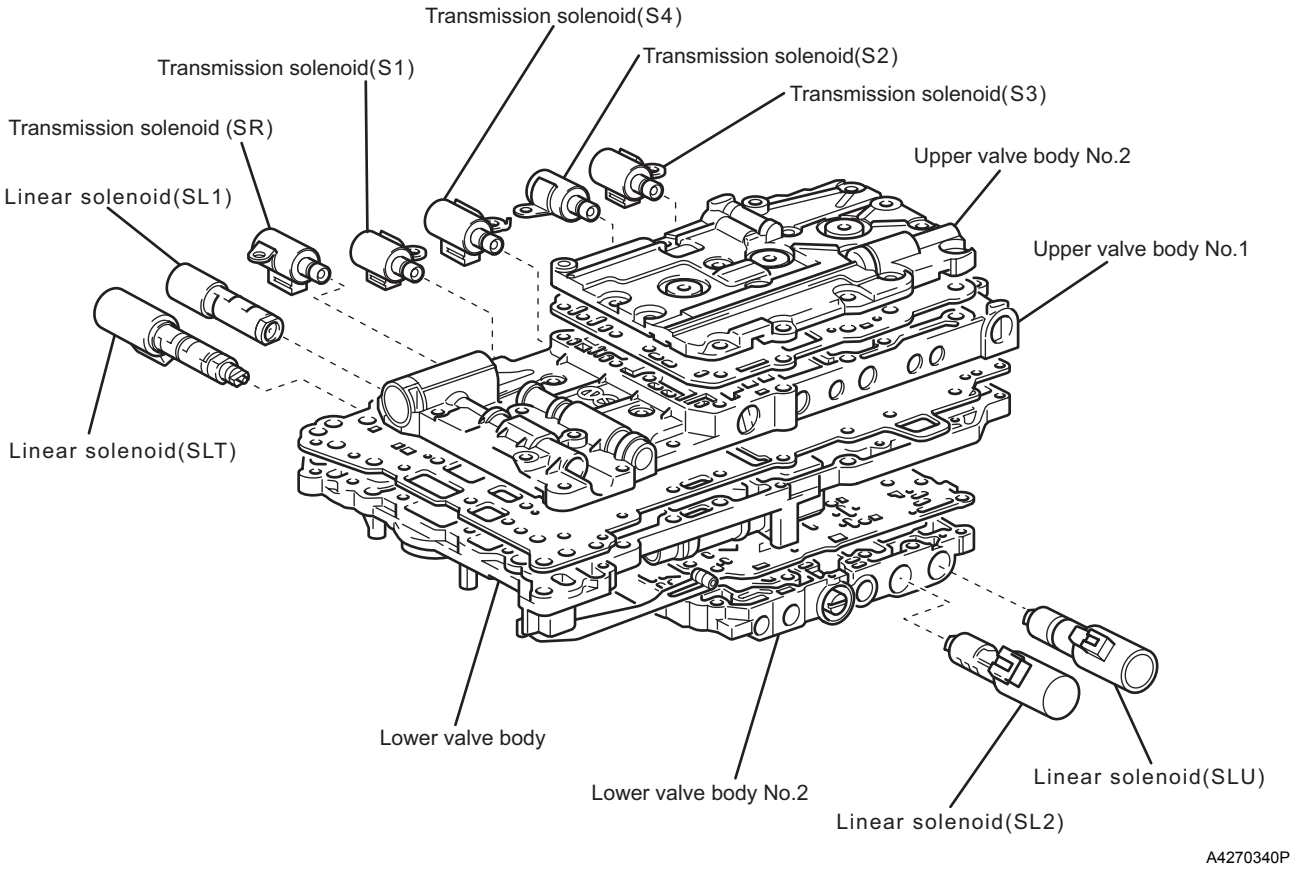
● A parking lock gear is provided in the rear planetary gear carrier area. A parking lock pawl meshes with the parking lock gear, thus locking the rotational movement of the output shaft.



A4270339P

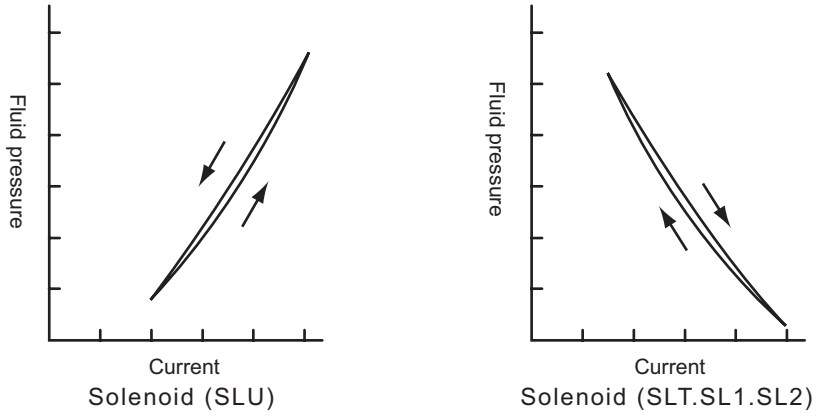
Valve Body Unit

- A valve body made of a lightweight aluminum alloy is used. It consists of a vertical, four-way split construction. The transmission solenoids and linear solenoids are installed on the lower valve body.
- A strainer is provided at each end of the transmission solenoid valves S1, S2, S3, S4, and SR in the unlikely event foreign matter enters the valve body.



Linear Solenoid Valve

- Linear solenoid valves have been provided for the following purposes: to control the fluid pressure for clutch engagement, to control the lockup clutch, to control the line fluid pressure, and to control the fluid pressure for brake engagement.
- The electromagnetic portions of SLT, SLU, SL1, and SL2 have been made compact, lightweight, and low cost, without reducing their attraction.



A4270338P

Function

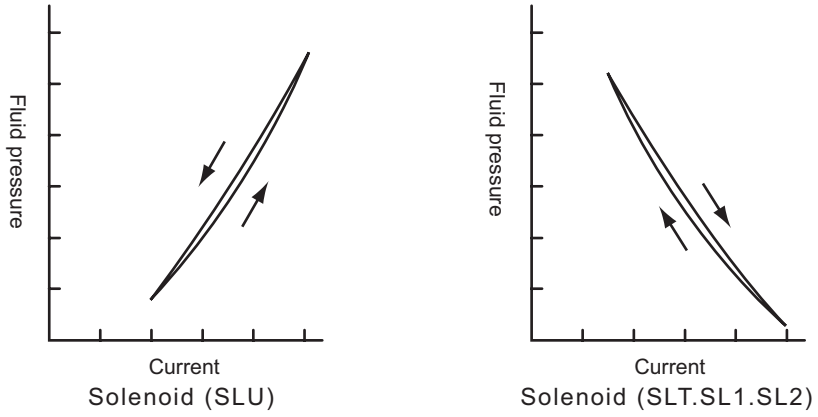
Linear Solenoid Valve	Function
Solenoid valve No. 1 (SL1) for controlling fluid pressure for clutch engagement	·Accumulator back pressure control ·Clutch pressure control
Solenoid valve (SLU) for controlling lockup clutch	·Lockup clutch pressure control ·Flex lockup pressure control
Solenoid valve (SLT) for line fluid pressure control	·Line pressure control ·Accumulator back pressure control
Solenoid valve No. 2 (SL2) for controlling fluid pressure for brake engagement	·Brake pressure control

Transmission Solenoid Valve

- Transmission solenoid valves S1, S2, S3, and S4 are provided for switching the gears, and transmission solenoid valve SR is provided for switching the orifices.
- Each transmission solenoid valve is a three-way solenoid valve that is more compact and lightweight than the previous type. They provide superior response even at low fluid temperatures.
- A strainer is provided at the end of each solenoid valve to realize superior reliability.

Function

Transmission solenoid valves	Type	Function
Transmission solenoid valves (S1)	3-way	·Switches the 1-2 shift valve •Switches the SL1 relay valve
Transmission solenoid valves (S2)	3-way	·Switches the 2-3 shift valve ·Switches the 5-6 shift valve
Transmission solenoid valves (S3)	3-way	·Switches the 3-4 shift valve
Transmission solenoid valves (S4)	3-way	·Switches the 4-5 shift valve
Transmission solenoid valves (SR)	3-way	·Switches the C4 relay valve ·Switches the B1 relay valve



A4270338P

Function

Linear Solenoid Valve	Function
Solenoid valve No. 1 (SL1) for controlling fluid pressure for clutch engagement	·Accumulator back pressure control ·Clutch pressure control
Solenoid valve (SLU) for controlling lockup clutch	·Lockup clutch pressure control ·Flex lockup pressure control
Solenoid valve (SLT) for line fluid pressure control	·Line pressure control ·Accumulator back pressure control
Solenoid valve No. 2 (SL2) for controlling fluid pressure for brake engagement	·Brake pressure control

Transmission Solenoid Valve

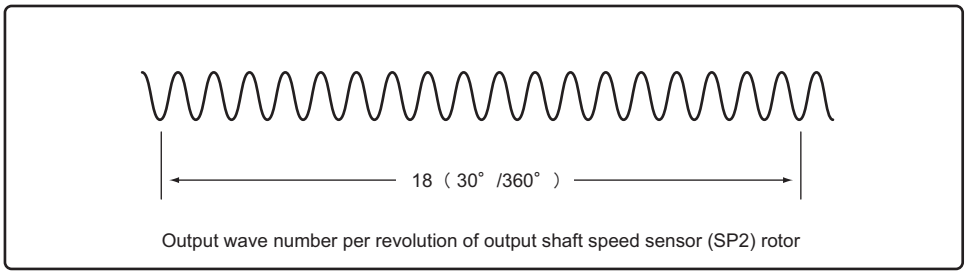
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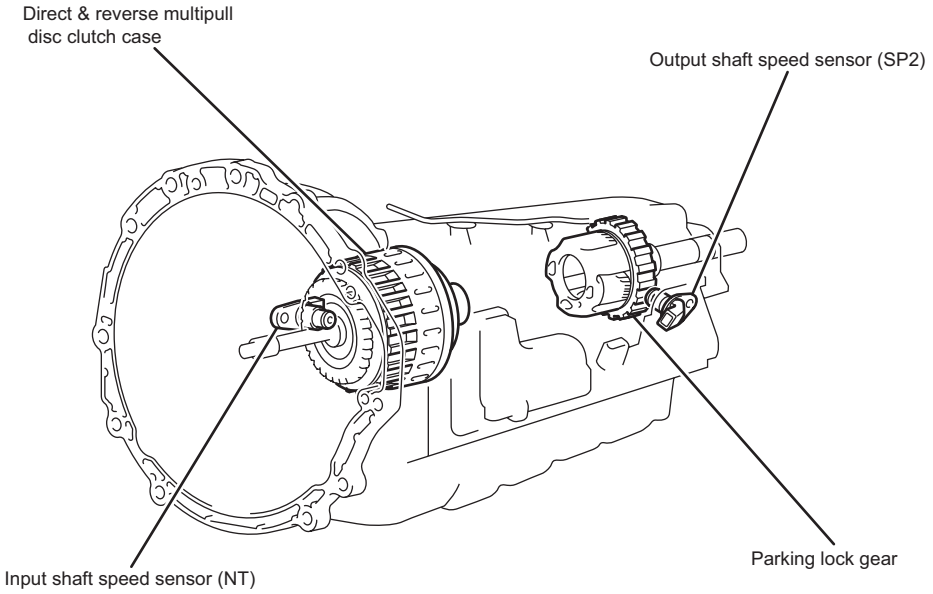
Function

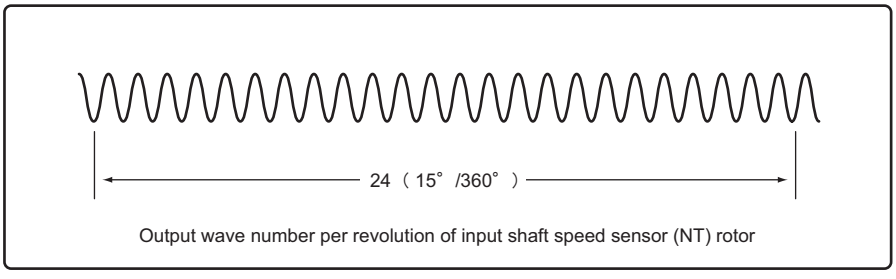
Transmission solenoid valves	Type	Function
Transmission solenoid valves (S1)	3-way	·Switches the 1-2 shift valve •Switches the SL1 relay valve
Transmission solenoid valves (S2)	3-way	·Switches the 2-3 shift valve ·Switches the 5-6 shift valve
Transmission solenoid valves (S3)	3-way	·Switches the 3-4 shift valve
Transmission solenoid valves (S4)	3-way	·Switches the 4-5 shift valve
Transmission solenoid valves (SR)	3-way	·Switches the C4 relay valve ·Switches the B1 relay valve

Input Shaft Speed Sensor

- A rotor, which is used by an input shaft speed sensor, is provided in the clutch case area for the purpose of detecting the input speed of the transmission. The sensor is provided on the left side of the transmission case in order to output the NT speed signals of the input shaft to the Engine ECU.
- A rotor, which is used by an output shaft speed sensor, is provided in the transmission. The output shaft speed sensor is provided on the right side of the transmission case in order to output the SP2 output shaft speed signals to the Engine ECU.
- These sensors are electromagnetic pickup sensors that offer a high level of detection accuracy. As the rotor makes a rotational movement, the air gap between a protrusion (which is provided for detection purposes) and the sensor changes. This causes the magnetic flux that passes through the coil of the sensor to increase and decrease, thus generating an electromotive force in the coil. Depending on whether the protrusion and the sensor approach or separate from each other, this force generates voltage in opposite directions, thus creating an alternating current force.



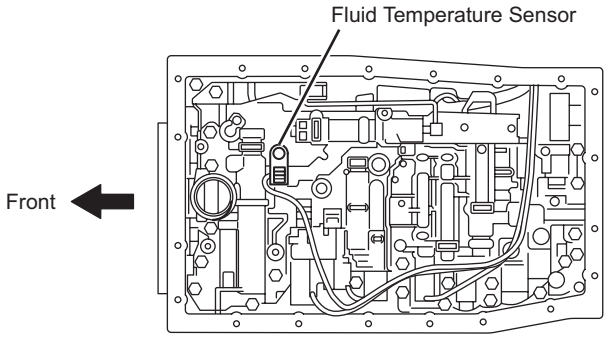




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Fluid Temperature Sensor

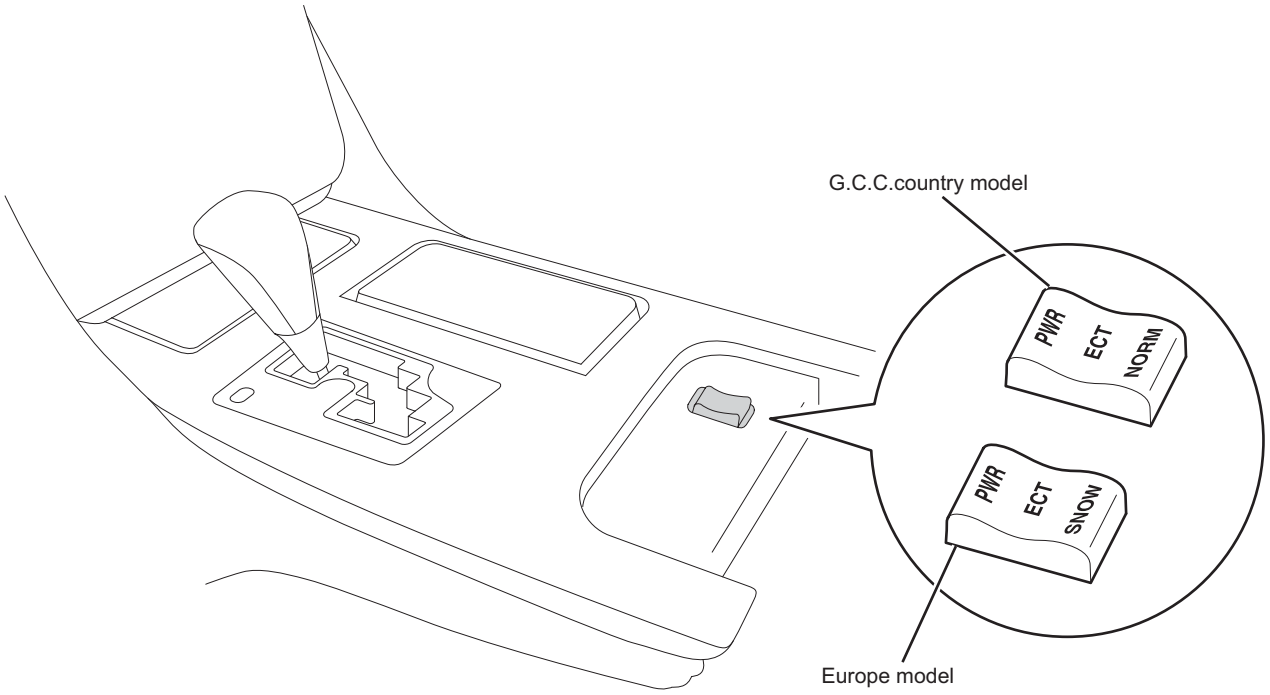
- A fluid pressure sensor for controlling the fluid pressure during shifting is installed inside the valve body.
- The Fluid temperature sensor is located at the discharge outlet of the oil pump where the temperature rise is stable, in order to directly measure the oil temperature in the oil passage. Thus, it is able to detect the oil temperature more accurately.



A4270331P

ECT Pattern Select Switch

- An ECT pattern select switch is located behind the shift lever. The driver can select between the POWER and SNOW and NORMAL modes by turning the switch ON or OFF.(The SNOW mode is Europe model only)

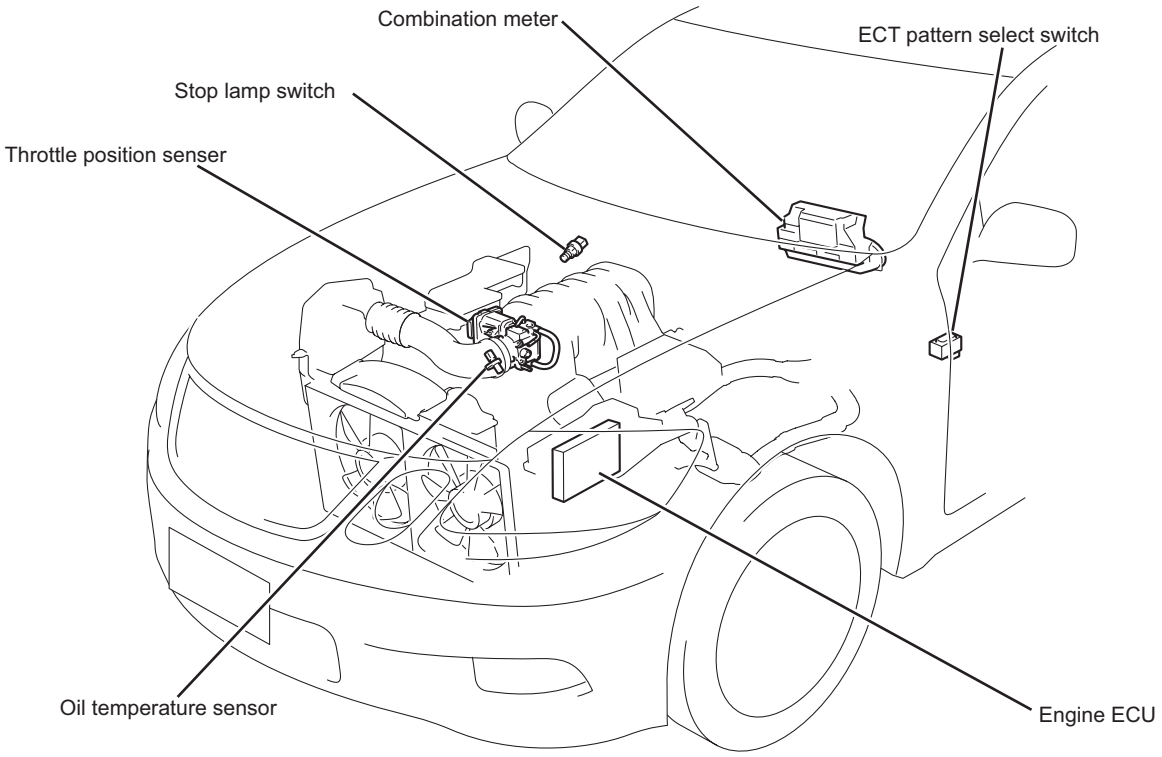


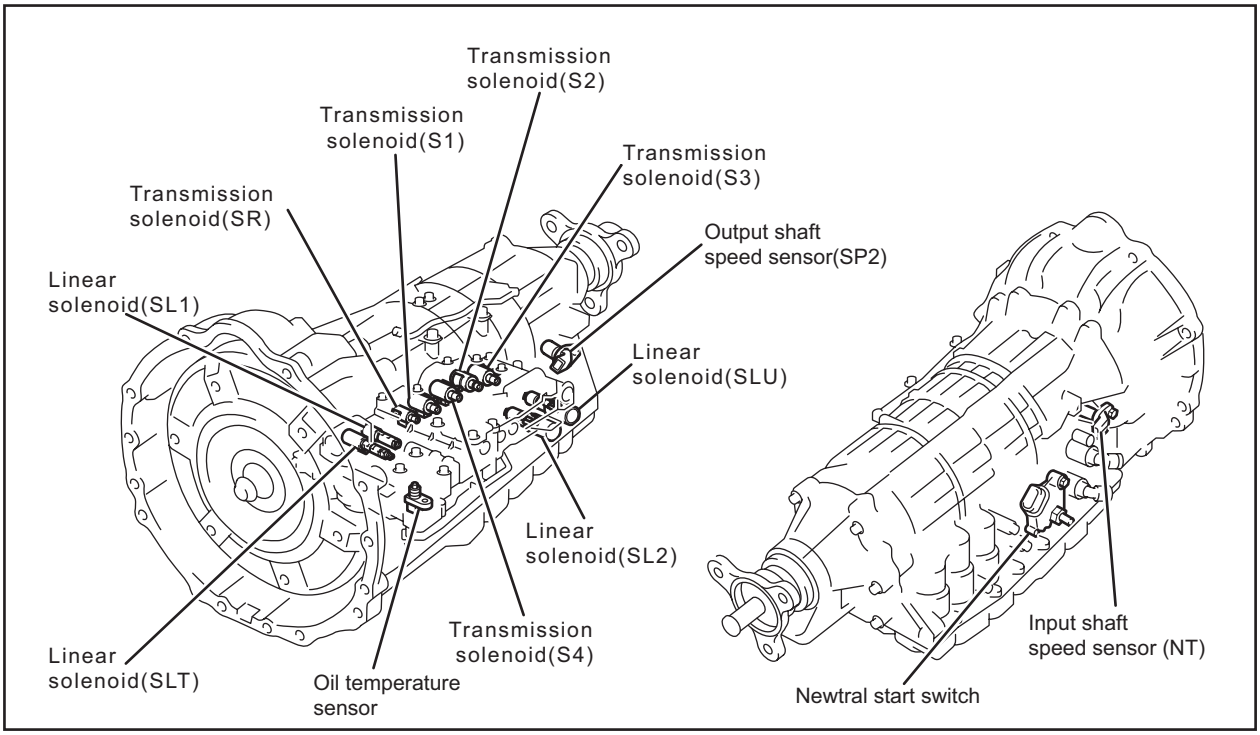
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ECT Control

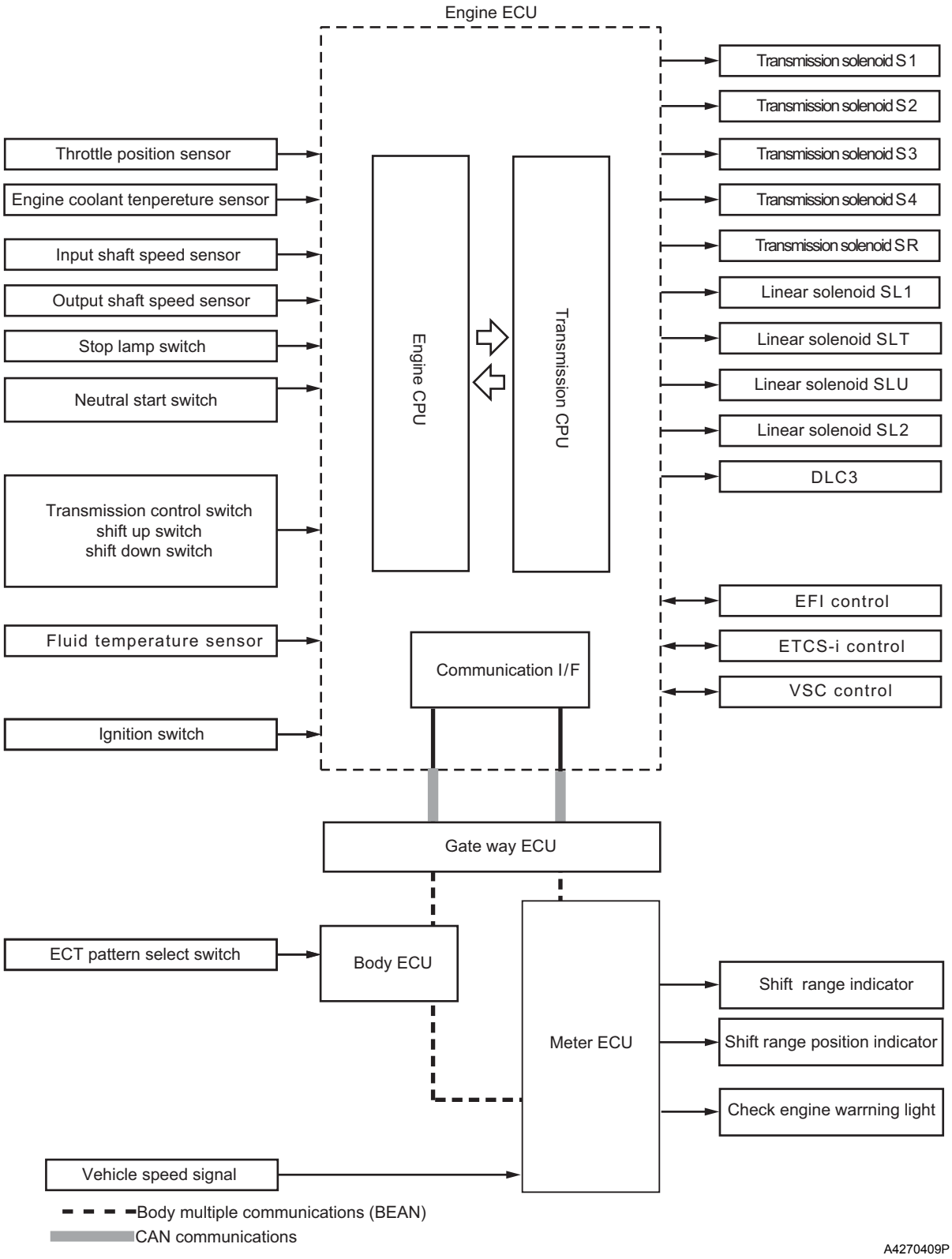
- A transmission control computer that is integrated with the engine control computer is used.
- Based on the signals from each of the sensors, the latest control, such as AI-SHIFT control, is administered to achieve smooth gear shifting.





A4270402P

Engine ECU


Engine ECU
Throttle position sensor
Engine coolant tenpereture sensor
Input shaft speed sensor
Output shaft speed sensor
Stop lamp switch
Neutral start switch
Transmission control switch
shift up switch
shift down switch
Fluid temperature sensor
Ignition switch
Engine CPU
Transmission CPU
Communication I/F
Transmission solenoid S1
Transmission solenoid S2
Transmission solenoid S3
Transmission solenoid S4
Transmission solenoid SR
Linear solenoid SL1
Linear solenoid SLT
Linear solenoid SLU
Linear solenoid SL2
DLC3
EFI control
ETCS-i control
VSC control
Gate way ECU
ECT pattern select switch
Body ECU
Meter ECU
Shift range indicator
Shift range position indicator
Check engine warrning light
Vehicle speed signal
Body multiple communications (BEAN)
CAN communications
A4270409P

Component & Function

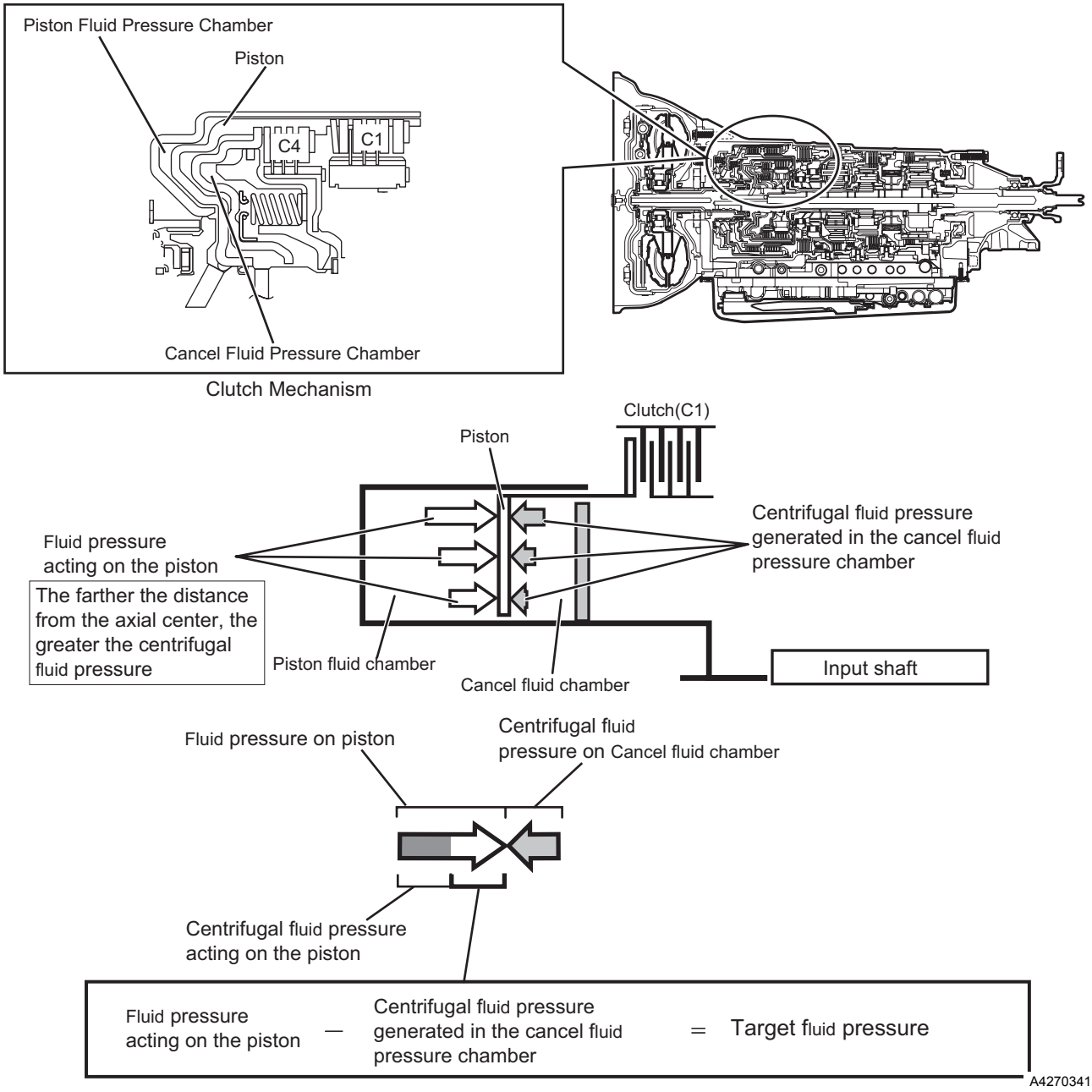
Component	Function
Transmission solenoid S1	Operates when shifting between first and second gears. Switches the oil path of SL1 pressure.
Transmission solenoid S2	Operates when shifting between second and third gears, and fifth and sixth gears.
Transmission solenoid S3	Operates when shifting between third and four theaters.
Transmission solenoid S4	Operates when shifting between fourth and fifth gears. Switches the oil path of SL1 pressure. Switches the reverse sequence valve.
Transmission solenoid SR	Performs switching between C4 clutch and B1 brake.
Linear solenoid SLT	Performs line hydraulic control and accumulator back pressure control.
Linear solenoid SLU	Performs lock-up control.
Linear solenoid SL1	Performs clutch hydraulic control and accumulator back pressure control.
Linear solenoid SL2	Performs brake hydraulic control.
Input shaft speed sensor	Detects the rotation speed of the transmission input shaft.
Output shaft speed sense	Detects the rotation speed of the transmission output shaft.
Oil temperature sensor	Detects the temperature of the oil in the transmission hydraulic control circuit.
Water temperature sensor	Detects the engine water temperature.
Throttle position sensor	Detects the opening of the throttle valve.
Stop lamp switch	Detects depression and non-depression of the brake pedal.
Neutral start switch	Detects the transmission shift lever position.
ECT pattern selector switch	Selects either SNOW mode or POWER mode.
Shift lever position indicator (built into the combination meter)	Notifies driver of the current shift ever position by lighting the corresponding lamp.
Sequential shift indicator (built into the combination meter)	Notifies the driver by displaying the shift lever position (1st to 6th) in sequential mode.
PWR indicator (built in to the combination meter)	Notifies the driver the ECT pattern select or switches in POWER mode by lighting the corresponding lamp.
SNOW indicator (built in to the combination meter)	Notifies the driver the ECT pattern select or switch is in SNOW mode by lighting the corresponding lamp.
Cruise control indicator (built into the combination meter)	Notifies the driver that cruise control is activated by lighting the corresponding lamp.
Engine ECU (integrated with transmission control computer)	Performs overall control of engine transmission and transmission control based on the signals from each of the sensors. Equipped with diagnosis mode and fail safe function for better serviceability when amal function has occurred.
DLC3	By connecting a diagnostic tool and operating it, the diagnosis code and computer data can be readout.

❖REFERENCE❖

*:SNOW mode is Europe model only

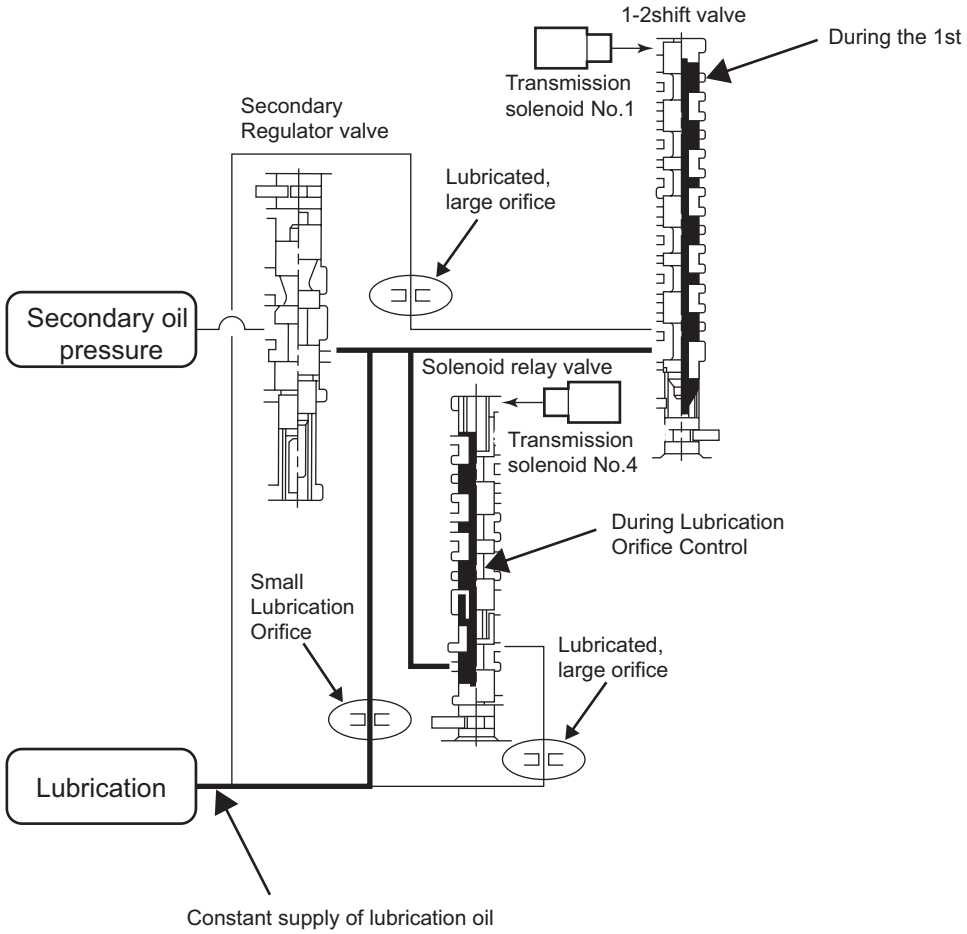
Centrifugal Fluid Pressure Canceling Mechanism

- For operations that require a high level of response while the transmission shifts 2-3, 3-4, 4-5, or 5-6, a centrifugal fluid pressure cancel mechanism is used to engage and disengage the C1, C2, C3, and C4 clutch mechanisms. As a result, a high level of response and smooth shifting characteristics are realized.
- Along with the increase in the speed of the clutch, a centrifugal force acts on the oil in the clutch, which increases the fluid pressure and accelerates the engagement of the clutch. In addition, a shift shock could be created by the rotational difference between the input and output shafts. For this reason, a cancel fluid pressure chamber is provided opposite the piston fluid pressure chamber in the clutch mechanism. The cancel fluid pressure chamber applies an equal amount of centrifugal fluid pressure force to the piston, in the opposite direction. Thus, it cancels out the influences of the centrifugal force.



Apply Orifice Control

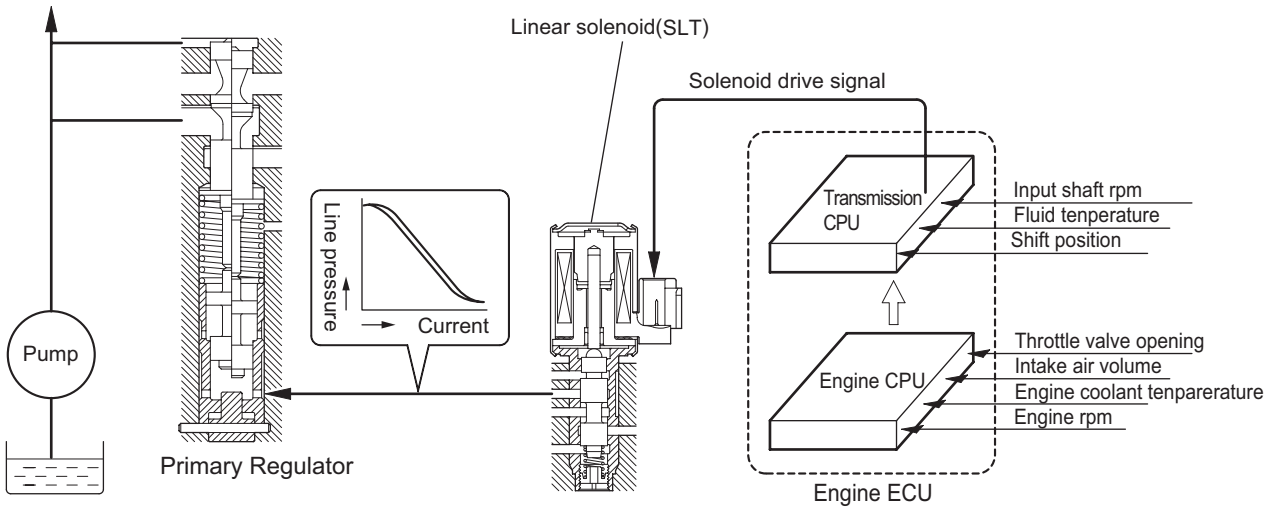
- A new lubrication orifice switching control is used in order to counter the suction of air at extremely low temperatures. This control reduces the volume of the lubrication oil when the vehicle is stopped in 1st gear, in a shift position other than reverse.
- When the vehicle is stopped in 1st gear, the transmission uses only the small lubrication orifice. At other times, one of the two lubrication orifices, or both orifices are used for supplying lubrication oil.



A4270334P

Line Pressure Optimal Control

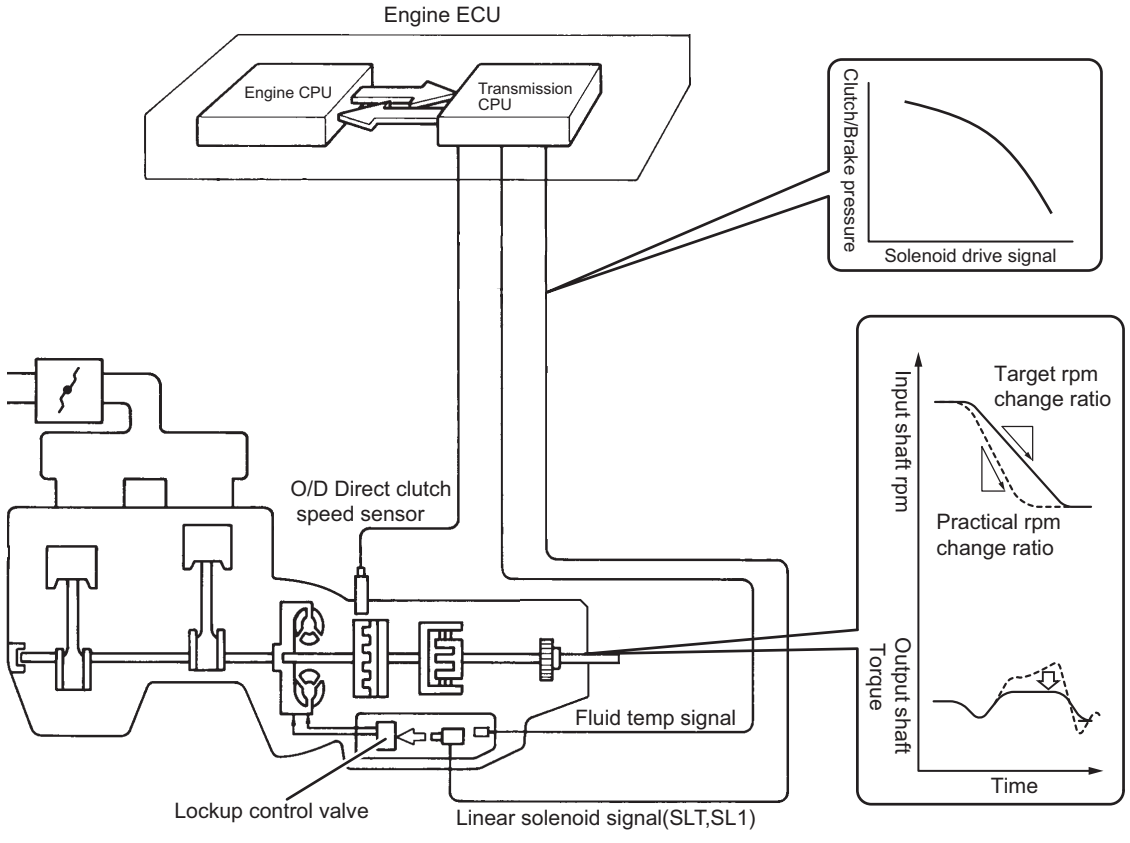
- Controls the line pressure to an optimal value based on real-time engine torque information provided by the engine.
- This enables the line pressure to e finely controlled at a high rate of precision in accordance with the engine output and conditions, thus realizing smooth shift characteristics.



A4270404P

Clutch Pressure Optimal Control

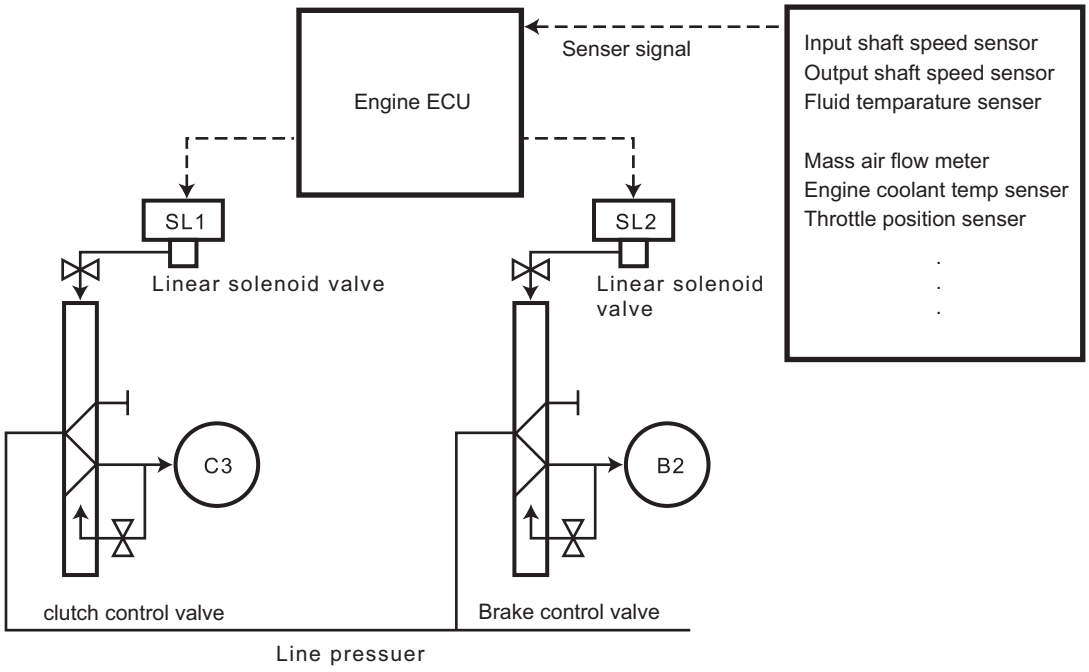
- The ECU actuates the SLT and SL1 linear solenoid valves based on the signals provided by various sensors, such as the input shaft speed sensor. Thus, it precisely controls the clutch hydraulic pressure in accordance with the engine power output and driving conditions, in order to ensure smooth shifting.



A4270405P

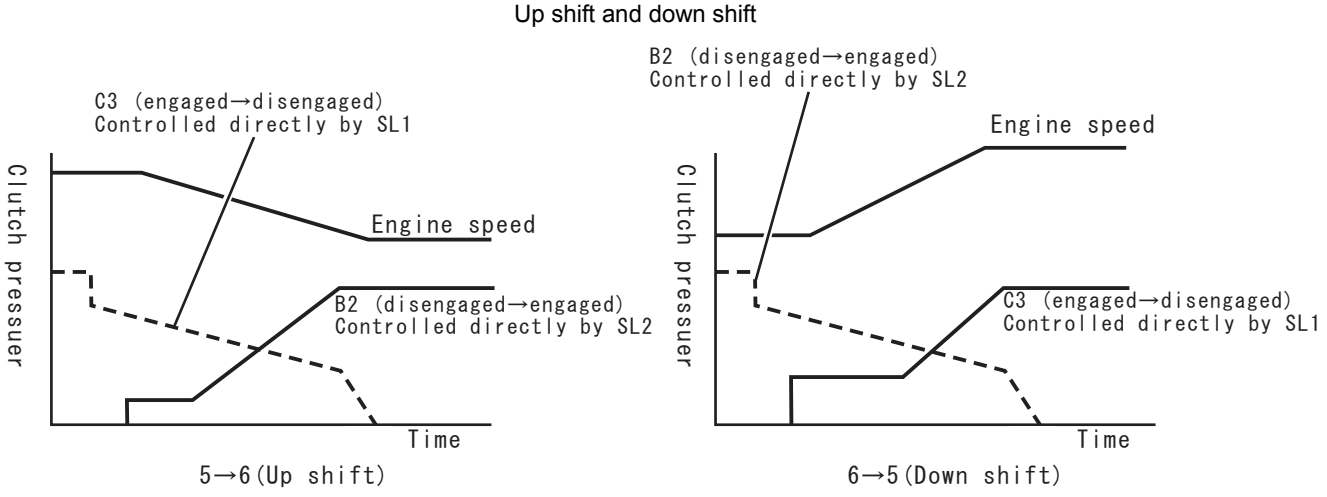
Clutch to Clutch Pressure Control

- Clutch-to-clutch shift control is used for controlling the shifting between the 5th and 6th gears. This has enabled the transmission to discontinue the use of a one-way clutch for shifting between 5th and 6th gears, and realize a compact and lightweight construction.
- The engine and transmission ECUs output signals to control the output hydraulic pressures of the linear solenoid valves SL1 and SL2. These pressures control the control valves in order to directly control the hydraulic pressures of the C3 clutch and the B2 brake.



A4270410P

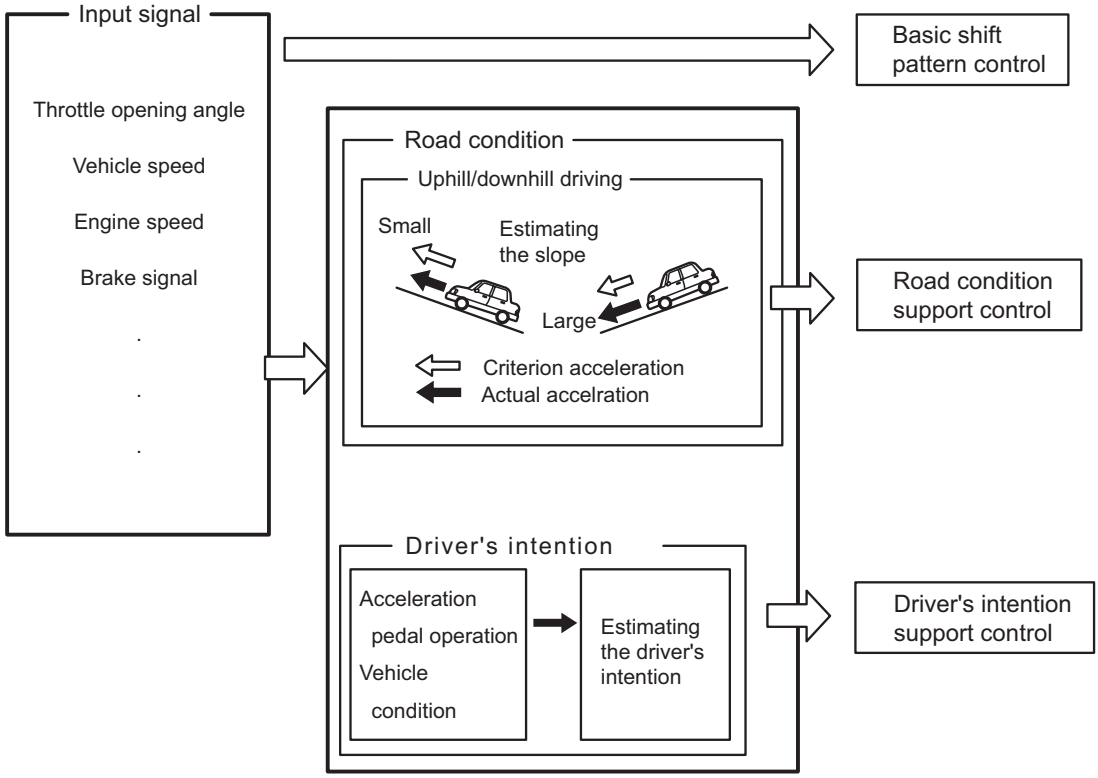
- Up-Downshift: Based on data such as the input and output shaft speeds and engine torque, the ECU controls the clutch to be disengaged and the clutch to be engaged at an optimal hydraulic pressure and timing. Thus, superior shift characteristics have been realized under all possible driving conditions.



A4270352P

AI-Shift Control

- In addition to the aforementioned selection of shift patterns through the operation of the switch, the AI-Shift control automatically changes the shift patterns to suit the "road condition" or "driver's intention". As a result, a comfortable driving experience is realized at high levels.
- The AI-Shift control is effected only with the shift lever in the D position, based on accelerator and brake operation data. The AI-Shift control will be canceled when the driver selects the S mode.



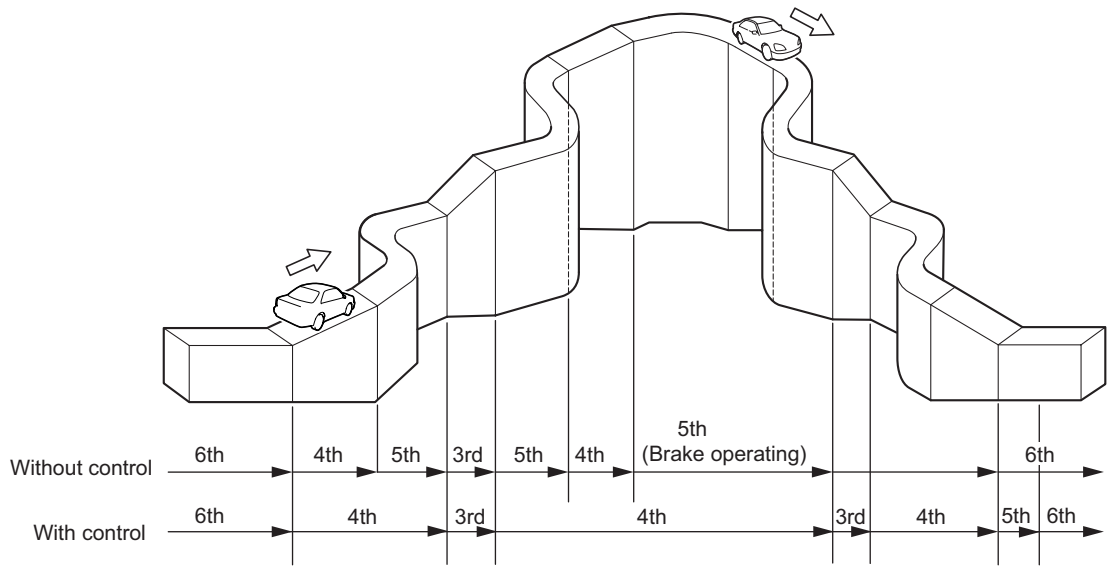
A4270353P

Driver's Intention Support Control

- Estimates the driver's intention based on the accelerator operation and vehicle condition to switch to a shift pattern that is well-suited to each driver, without the need to operate the shift pattern select switch.

Shifting Control in Uphill / Downhill Traveling

- In the conventional automatic transmission, if the vehicle is accelerated or decelerated while driving uphill, depending on the circumstances, the transmission shifted up or down frequently. While driving downhill, because the transmission is upshifted when the throttle valve is almost completely closed, the transmission upshifted quickly even at low driving speeds, occasionally creating a condition in which it was difficult to apply the engine brake.
- In the road condition support control, the uphill or downhill driving conditions are assessed through the throttle opening angle, vehicle speed, etc. to achieve an optimal and constant driving force by restraining the transmission from upshifting while driving uphill (ascent of approximately 5 % or more). The transmission automatically downshifts with brake signal ON so that an optimal engine brake can be achieved while driving downhill (ascent of approximately 6 % or more).



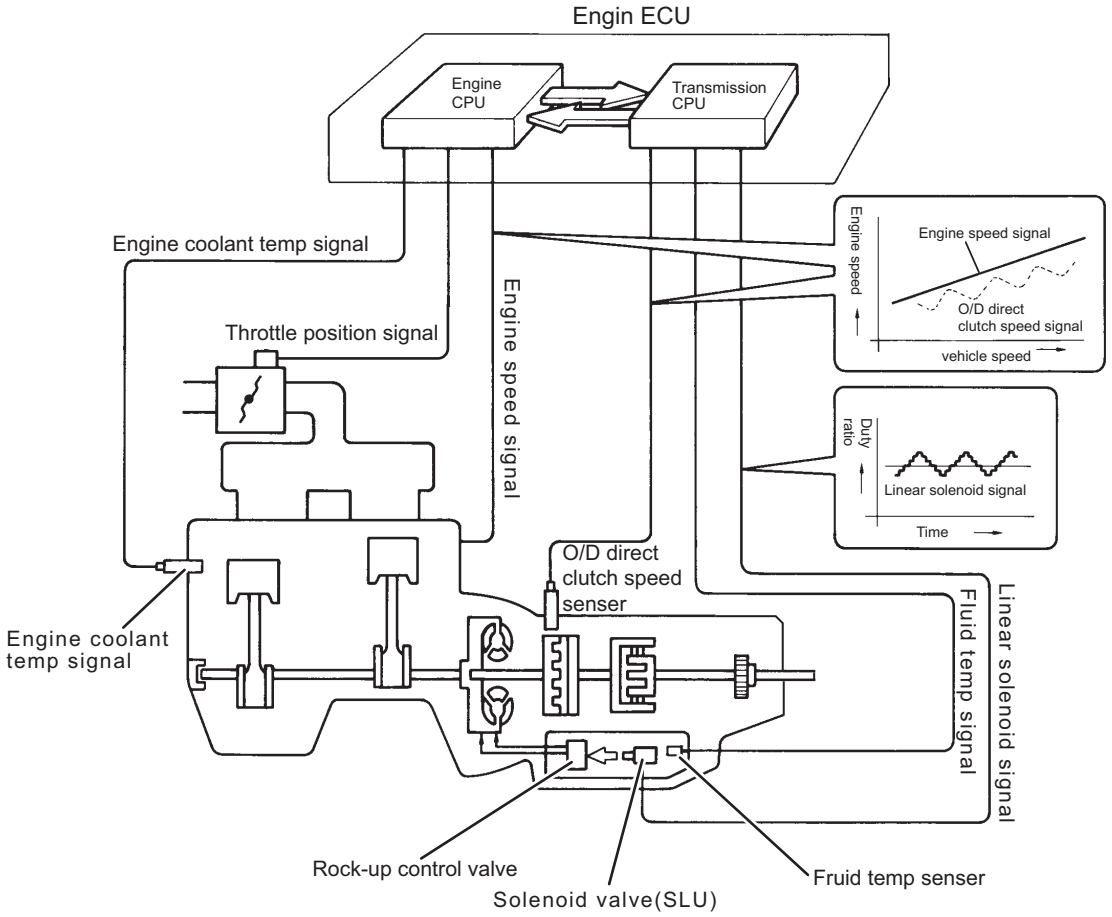
Sport Driving Support Control (AI-SHIFT)

- A type of AI-Shift that excels in acceleration response and thus is suitable for sporty driving, it is used when the POWER pattern is selected.

		Operation	Control Shift Gear
TA Control	Sudden Open Control	When the driver operates the accelerator quickly, this control downshifts rapidly to improve acceleration response.	4th to 6th
	Sudden Close Control	When the driver releases (turns OFF) the accelerator quickly, this control makes it easy for the transmission to hold the gear, which improves engine braking force and re-acceleration response.	2nd to 5th
Sudden Deceleration Downshift Control		When the driver decelerates the vehicle suddenly, this control downshifts rapidly, which improves engine braking force and re-acceleration response.	4th to 6th

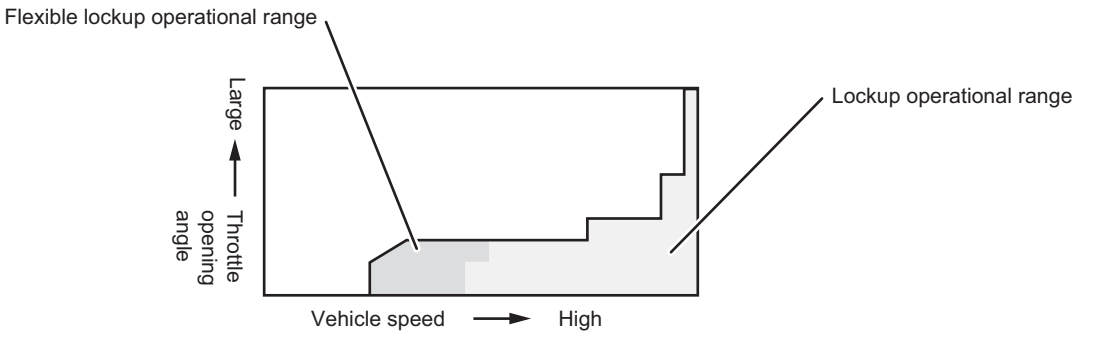
Flex Lockup Clutch Control

- Flex lockup control is used on the models equipped with the 3GR-FSE and 3GR-FE engine.
- Through the use of a leading-edge H∞ (H infinity) control logic, it has become possible to continuously provide the lockup clutch with a subtle slippage in a stable manner. As a result, it has become possible to apply a lockup in a wide range of operations, thus realizing superior fuel economy characteristics.
- The flex lockup operation ranges from 6th to 3rd.



A4270406P

- In the low- to medium-speed range, this control applies a very small specified amount of slippage rotation to the lockup clutch, thus ensuring the transmission efficiency of the torque converter and realizing superior fuel economy characteristics.
- When the accelerator is OFF, this control subtly slips the lockup clutch in the same manner as when the accelerator is ON, thus enabling the engine to expand its fuel cut range.



TM

Flex lock-up operation table(A761E)

Shift Range	1st	2nd	3rd	4th	5th	6th
D,S-6	×	×	❍	❍	❍	❍
S-5	×	×	❍	❍	❍	
S-4	×	×	❍	❍		

❖REFERENCE❖
❍:Operation

×:non-operation

Flex lock-up operation table(A760E)

Shift Range	1st	2nd	3rd	4th	5th	6th
D,S-6	×	×	❍	<❍>	<❍>	<❍>
S-5	×	×	❍	<❍>	<❍>	
S-4	×	×	❍	❍		

❖REFERENCE❖
❍:Operation

×:non-operation

<>:deceleration flex lockup operation

Gear Shift and Lockup Control

• This control effects shift point control (including AI-Shift control) and lockup control (including flex lockup control) in accordance with the shift position, vehicle speed, and throttle position.

Shift Positions, Gears, and Lockup Patterns

Shift position	Gear change pattern
6	1st←→2nd←→3rd*1←→4th*1←→5th*2←→6th*2
5	1st←→2nd←→3rd*1←→4th*1←→5th*2
4	1st←→2nd←→3rd*1←→4th*2
3	1st←→2nd←→3rd
2	1st←→2nd

Shift position	Gear change pattern
1	1st

❖REFERENCE❖

*1Flex lockup operation (on 3rd, flex lockup operation during acceleration only)

*2Lockup or flexible lockup operation

Gear, Lockup, and AI-Shift Control Operating Conditions(A761E)

		4th	5th	6th	Lockup	AI-SHIFT
Shift position		4,5,6,D	5,6,D	6,D	4,5,6,D	D
Engine coolant temperature	47°C maximum	49km/h minimum	51km/h minimum	51km/h minimum	×	51km/h minimum
	47°C minimum	❍	51km/h minimum	51km/h minimum	×	51km/h minimum
	55°C minimum	❍	❍	❍	×	❍
	60°C minimum	❍	❍	❍	❍	❍

Gear, Lockup, and AI-Shift Control Operating Conditions(A760E)

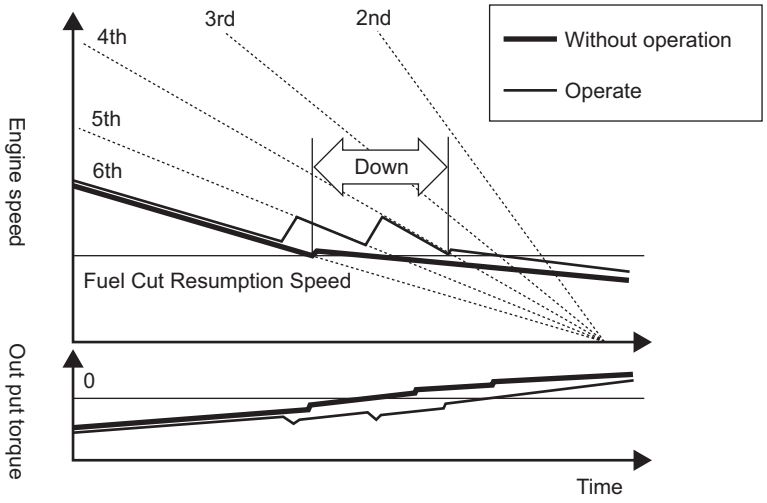
		4th	5th	6th	Lockup	AI-SHIFT
Shift position		4,5,6,D	5,6,D	6,D	4,5,6,D	D
Engine coolant temperature	40°C maximum	45km/h minimum	51km/h minimum	55km/h minimum	×	55km/h minimum
	40°C minimum	❍	51km/h minimum	55km/h minimum	×	55km/h minimum
	55°C minimum	❍	❍	55km/h minimum	×	55km/h minimum
	60°C minimum	❍	❍	❍	❍	❍

❖REFERENCE❖

* : No operation restriction to shift from 1st to 3rd

Downshift Control At Deceleration

- Deceleration downshift control, which maintains the fuel cut control at the maximum possible limit to realize fuel economy, is used on the models equipped with the 3GR-FSE and 3GR-FE engine.
- While in 6th gear, the deceleration downshift control downshifts from 6th to 5th, and 5th to 4th, before fuel delivery is resumed from the fuel cut state. By maintaining the fuel cut state in this manner, this control realizes fuel economy.



A4270347P

Diagnosis

- If this function detects a failure in the speed sensor or any of the solenoids, it alerts the driver by illuminating the check engine warning light in the combination meter assembly.
- The troubleshooting of the entire vehicle is made possible through the use of a diagnostic tool. For details, refer to the repair manual. (This vehicle supports the intelligent Tester II diagnostic tool.)

Fail Safe

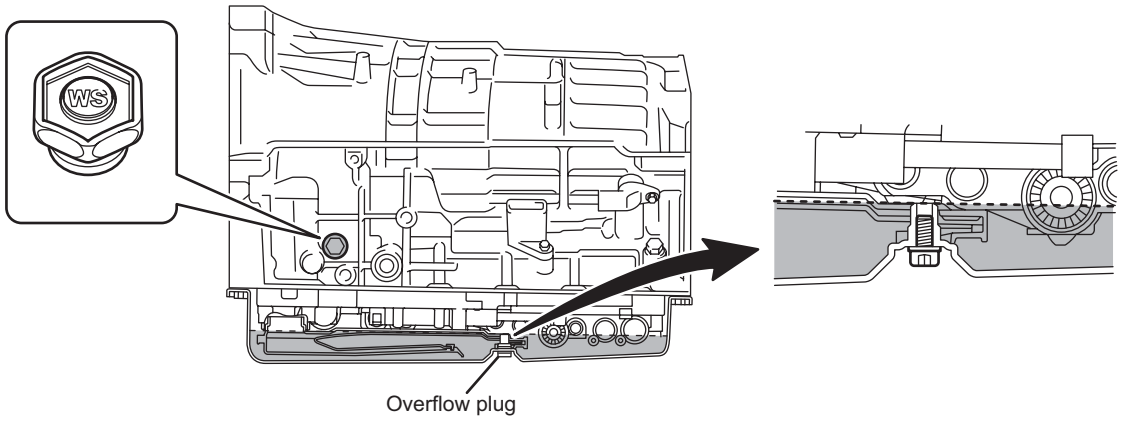
- This function prevents a failure in any of the sensors or solenoids from drastically affecting drivability. For details, refer to the repair manual.List of Failsafe Functions

Failsafe table

Location of malfunction	Function
Output Shaft Speed Sensor(SP2)	If the output shaft speed sensor (SP2) malfunctions, the system uses the NT signals of the input shaft speed sensor to effect shift control.
Transmission Solenoid	The system stops the current to the malfunctioning solenoid and turns the normal solenoids ON or OFF to effect shift control. If all solenoids fail, the system will shift gears through a mechanical fluid pressure circuit.
Fluid Temperature Sensor	The system prohibits shifting into 5th or 6th, and prohibits flex lockup control.
Linear Solenoid (SLU)	The system stops the control current to the solenoid to interrupt lockup control.
Linear Solenoid (SLT)	The system stops the control current to the solenoid. It effects shift control in the normal manner.

Oil Level Detection Mechanism

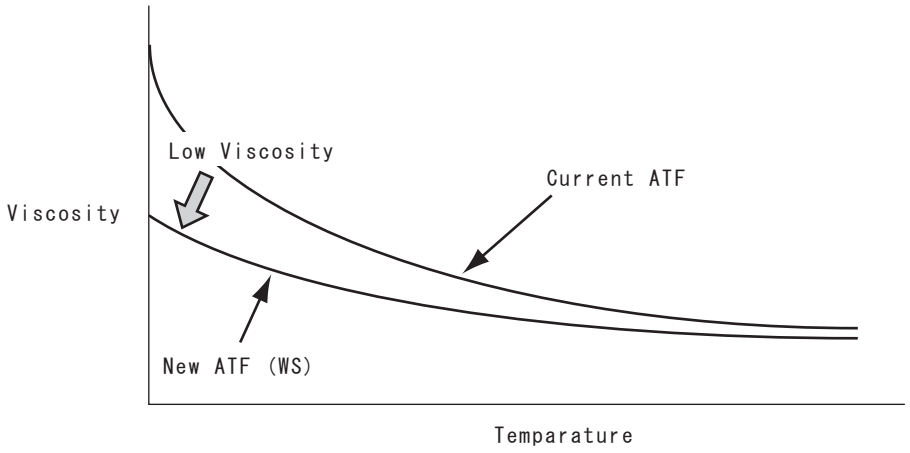
- The transmission has discontinued the use of the automatic transmission oil filler tube and the level gauge. Instead, it uses a oil level detection mechanism called an "overflow system".
- The manufacturer of the automatic transmission guarantees the proper oil level. This prevents the transmission from being contaminated with the wrong type of oil, or being overfilled or underfilled. Thus, a maintenance-free transmission has been realized.
- During a repair or replacement, the oil level can be adjusted mechanically through the overflow system. Thus, the control accuracy of the oil level has been improved. For detailed oil replenishment and adjustment procedures, refer to the repair manual.



A4270345P

Automatic Transmission Fluid

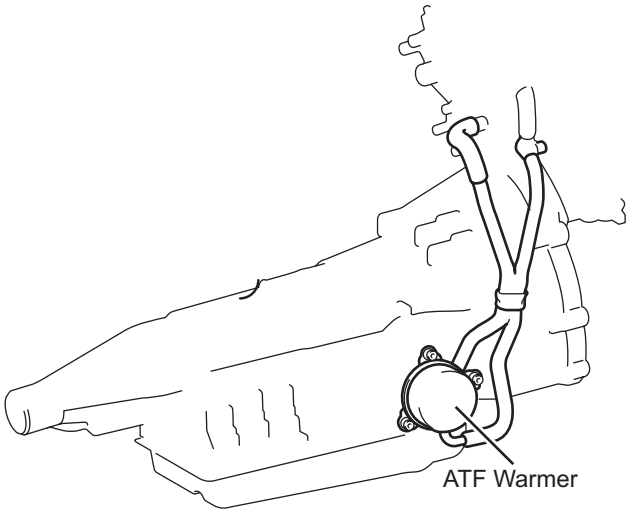
- A newly developed, WS genuine Toyota automatic transmission fluid is used.
- Its viscosity in the actual operating temperature range has been lowered to reduce drag loss and improve fuel economy.
- It has the same high-temperature viscosity as the conventional ATF. This maintains the proper formation of the oil film on the surfaces of the parts to prevent wear and seizure.



A4270346P

ATF Warmer

- An automatic transmission fluid (ATF) warmer is used on the models equipped with the 3GR-FSE and 3GR-FE engine.
- Because this construction does not use the ordinary oil cooler that is built into the radiator, it accelerates the warming of ATF when it is cold, thus shortening the time in which the flex lockup control starts. During normal operation, the ATF warmer keeps the ATF oil temperature high to reduce friction loss. Thus, it ensures superior fuel economy characteristics.



A4270363P

Effect

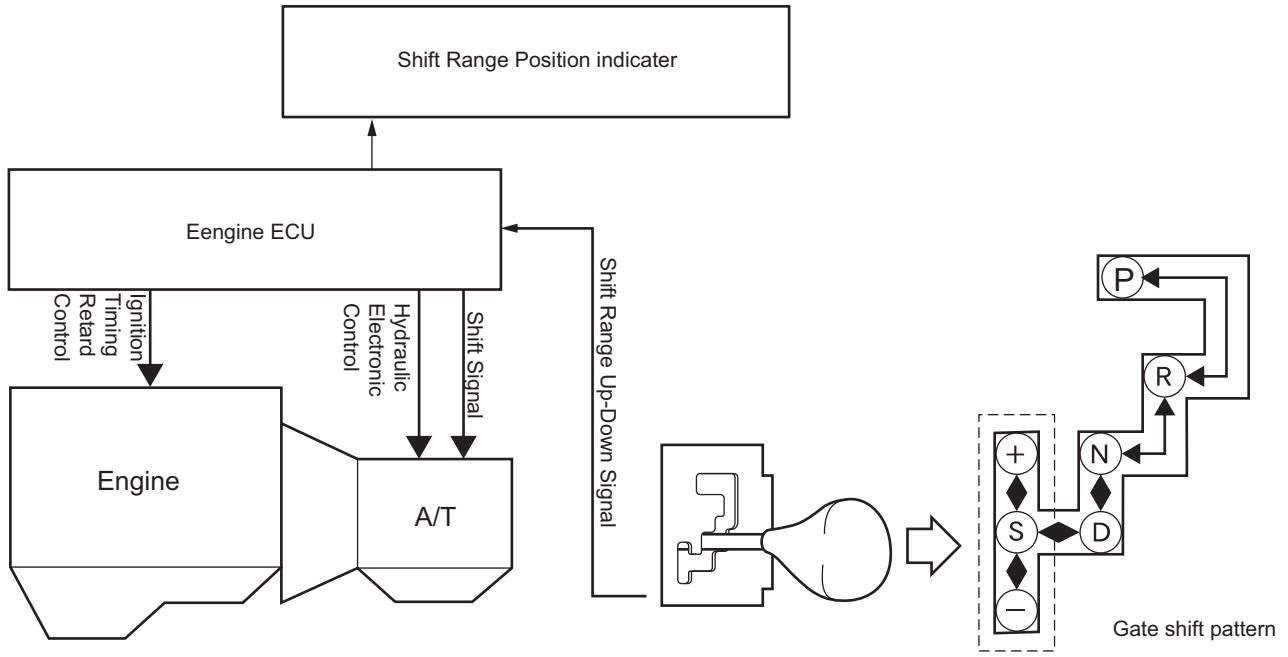
State of ATF		Heat Exchange Method	Effect
Warming Up		Coolant → ATF	Accelerates the warming of ATF and shortens the flex lockup starting time. Accelerates the reduction of the friction loss of the automatic transmission.
After Warm-Up	Low- to Medium-Load	Coolant ←→ ATF	Maintains the ATF at a higher temperature than an oil cooler that is built into the radiator, thus reducing friction loss.
	High Load	Coolant ← ATF	Uses the same heat exchanger to cool the ATF if it is necessary to cool the ATF, thus reducing the deterioration of the ATF.

Specifications

Core Type	Multiplate Aluminum Water-Cooled Type
Core specification	ϕ 90×6 gears
Oil Capacity [L]	0.06
Dry Weight [Kg(lb)]	0.48 (1.05)

Muti-mode Automatic Transmission

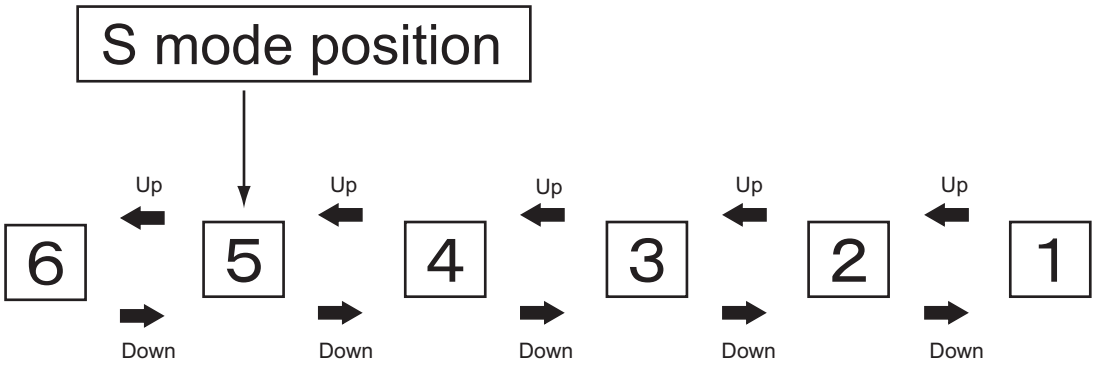
- When the driver moves the shift lever to the S position, the Multi-mode transmission changes the transmission from the automatic shift mode to the multi-mode. This enables the driver to operate the vehicle in the shift range that the driver has selected with the shift lever. In addition, this mechanism enables the vehicle to provide an engine brake force that suits all shift ranges.



A4270407P

Change The Multi-mode Automatic Transmission

- The driver can operate the multi-mode automatic transmission by moving the shift lever to the S position. At the same time, this movement causes the transmission to engage in the 5th range. (During AI-Shift control, the display will show the maximum range that is being controlled.)
- When the driver operates the shift lever, the shift up switch or the shift down switch (the "+" or "-" switch in the shift lever assembly) turns ON. This causes a shift signal to be transmitted to the engine ECU (with built-in transmission ECU), thus changing the shift ranges within the 6th to 1st range.

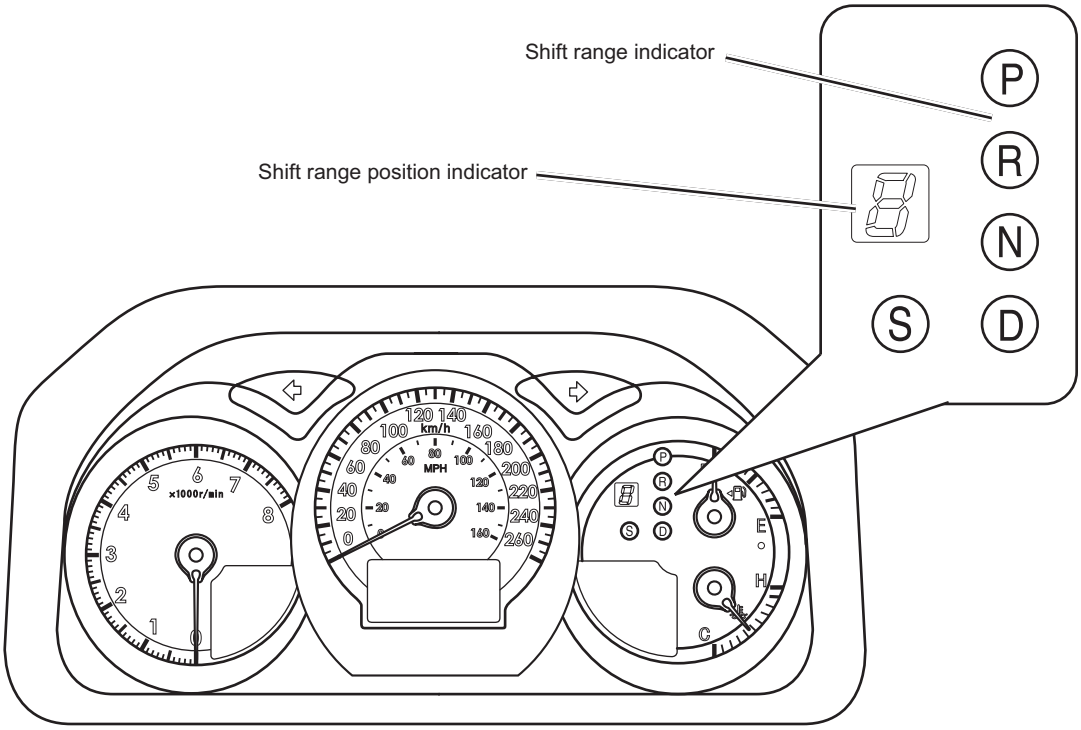


A4270344P

TM

Multi-mode Automatic Transmission Indicator

- Shift range position indicator and a shift range indicator are provided in the combination meter.
- Shift range position indicator illuminates when the driver moves the shift lever to the S position.
- When the shift lever is in the S position, the shift range indicator shows the shift range that is selected at that time. It does not appear in the P, R, N, or D range.



A4270379P

Shift Gears That Can Use the Multi-mode Automatic Transmission

- When the shift lever is in the S mode position, the transmission fixes the gear to the selected shift range. Thus, the driver will be able to operate the vehicle with a manual transmission-like feel.

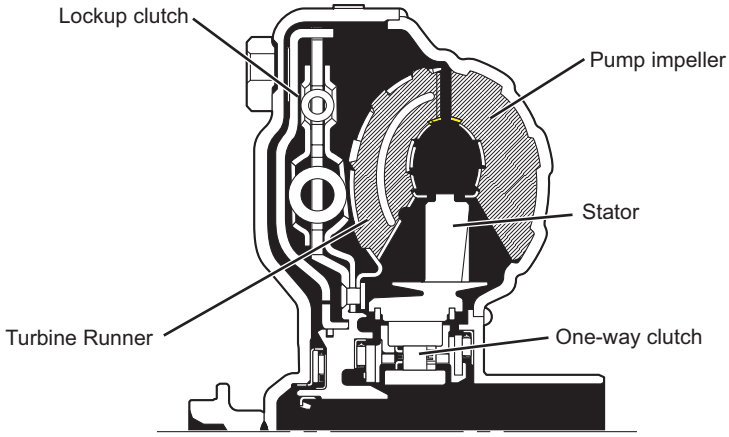
Shift Range Operation

Shift lever position	Shift operation	Shift range position indicator	Shift range
D	Impossible	Putting out lights	6,5,4,3,2,1(Automatic)
S	Possible	6	6,5,4,3,2,1(Automatic)
		5	5,4,3,2,1(Automatic)
		4	4,3,2,1(Automatic)
		3	3,2,1(Automatic)
		2	2,1(Automatic)
		1	1(Automatic)

A960E AUTOMATIC TRANSMISSION

Torque Converter

- A newly developed torque converter that is compact and lightweight is used.

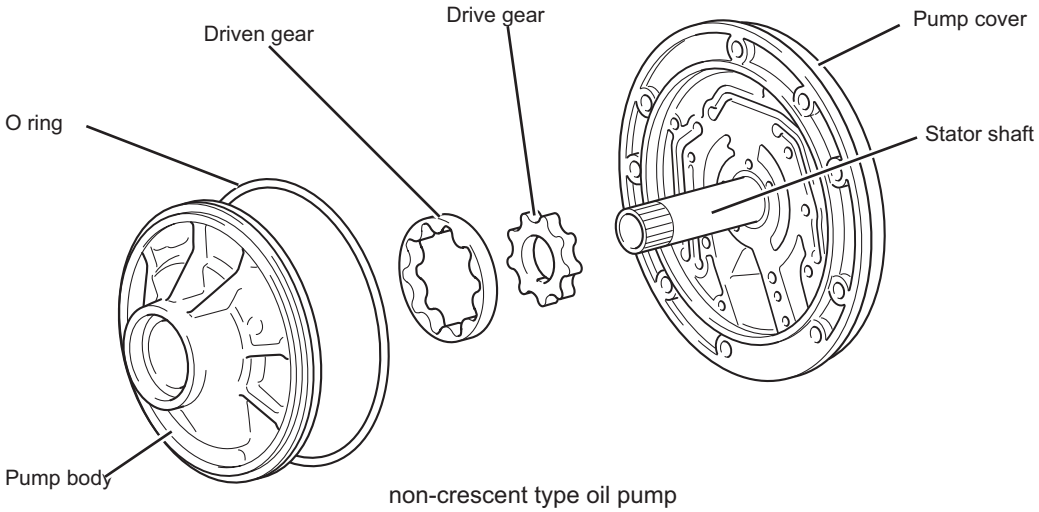


Torque converter (A960E)

A4270422P

Oil Pump

- A non-crescent type oil pump is used. The non-crescent type oil pump has been made compact and lightweight due to the discontinued use of the crescent gears. Also, the volumetric efficiency of the pump at low speeds has been improved, and its drive torque has been reduced.
- A pump cover made of aluminum alloy is used. As a result, an approximate weight reduction of 40% has been realized as compared to the ordinary oil pump made of cast iron.

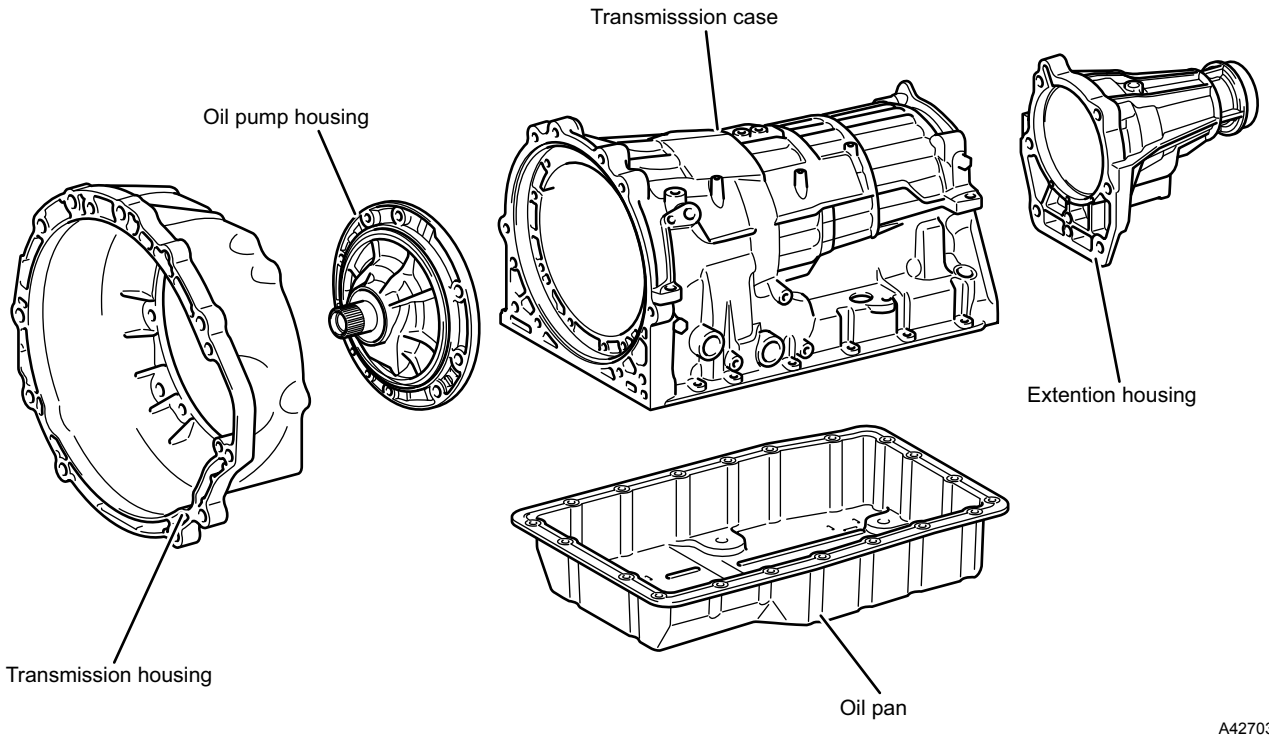


non-crescent type oil pump

A4270329P

Housing

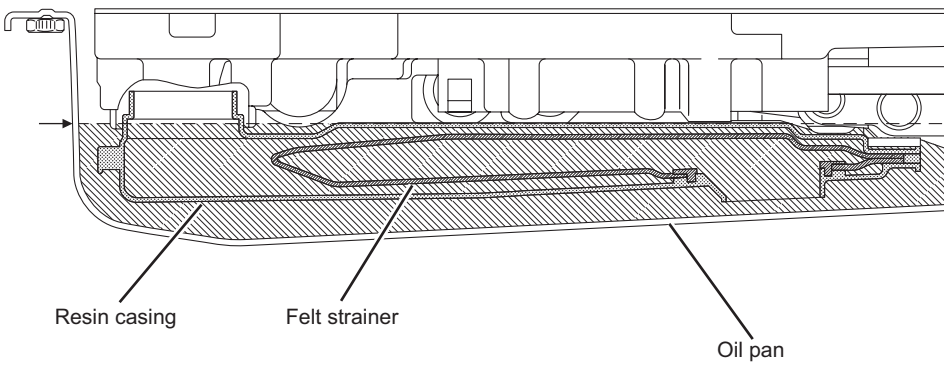
- A transmission housing, transmission case, and extension housing made of aluminum alloy are used for weight reduction. Through FEM (finite element method) analysis, efficient allocation of ribs and optimal shaping of the case have been achieved, thus ensuring weight reduction and rigidity.



A4270389P

Felt Strainer

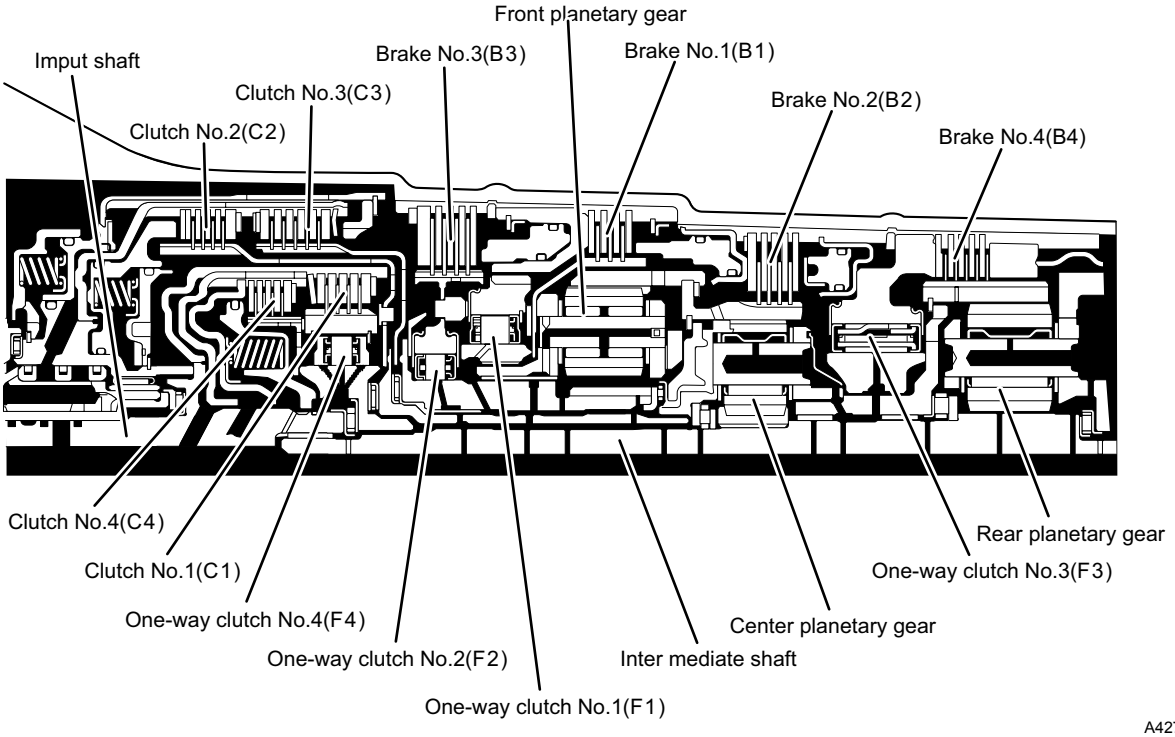
- A felt strainer (with a plastic case) is used. This results in an approximate weight reduction of 40%, as compared to an ordinary metal mesh strainer.
- The felt strainer excels in capturing minute particles of foreign matter, thus improving the reliability of the transmission. Also, the felt strainer counters the flaking of gears and shafts, thus ensuring a longer life.



A4270330P

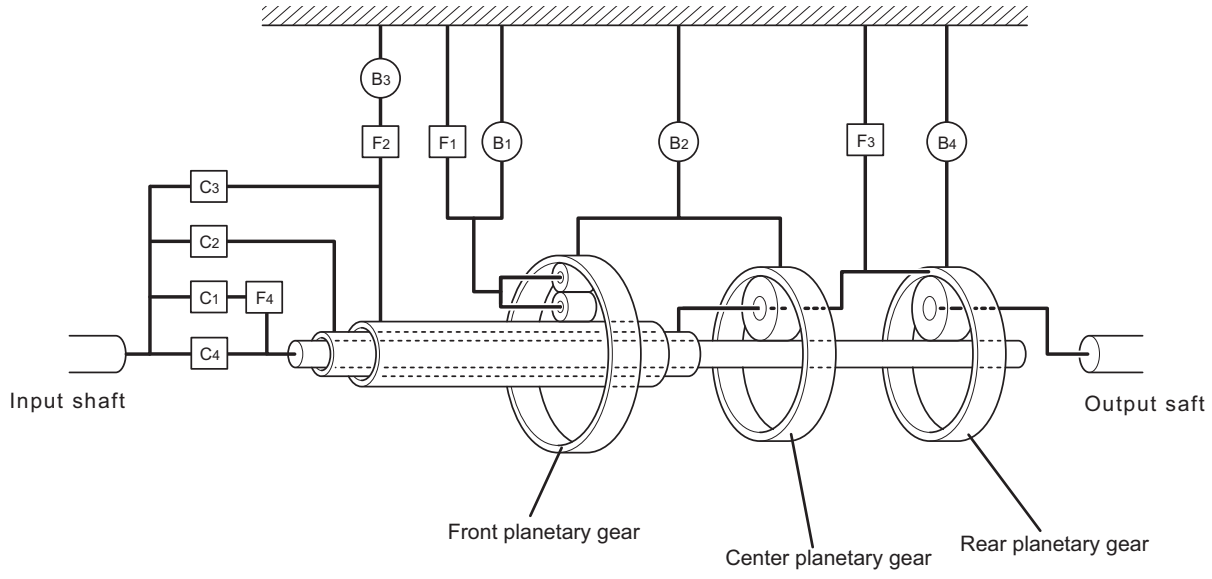
Planetary Gear Unit

- The gear train consists of four sets of multi-disc brakes, four sets of multi-disc clutches, four one-way clutches, and three sets of planetary gears comprising a sun gear, pinion gear, and ring gear.
- The material of the front planetary gear carrier has been changed from the ordinary iron to composite-molded aluminum alloy. As a result, the weight of the gear carrier has been reduced to approximately one-half of an ordinary gear carrier, thus realizing a considerable weight reduction.



A4270381P

A960E Gear Train Operation



A4270367P

Components and Their Operations

Component		Function
No.1 Clutch	C1	Connects input shaft and intermediate shaft.
No.2 Clutch	C2	Connects input shaft and center planetary gear carrier.
No.3 Clutch	C3	Connects input shaft and front sun gear.
No.4 Clutch	C4	Connects input shaft and intermediate shaft.
No.1 Brake	B1	Lock the front planetary gear carrier.
No.2 Brake	B2	Lock the front ring gear and center ring gear.
No.3 Brake	B3	Lock the one-way clutch No.2(F2).
No.4 Brake	B4	Lock the rear ring gear.
No.1 One-way clutch	F1	Prevents front planetary carrier from turning counterclockwise.
No.2 One-way clutch	F2	During operation brake No.3, prevents front sun gear turning from counterclockwise.
No.3 One-way clutch	F3	Prevents rear ring gear from turning counerclockwise. Prevents center planetary carrier from turning counterclockwise.
No.4 One-way clutch	F4	During operation clutch No.1(C1),prevents intermediate shaft from turning counterclockwise.

Components and Their Operating Conditions

		C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio
P														-
R				❍		(❍)			❍	❍				3.168
N														-
D	1st	❍			(❍)				(❍)			❍	❍	3.538
	2nd	❍			(❍)		(❍)	❍		❍	❍		❍	2.060
	3rd	❍		❍	(❍)	(❍)		Δ		❍			❍	1.404
	4th	❍	❍	Δ	(❍)			Δ					❍	1.000
	5th	Δ	❍	❍		❍		Δ						0.713
	6th	Δ	❍			Δ	❍	Δ						0.582

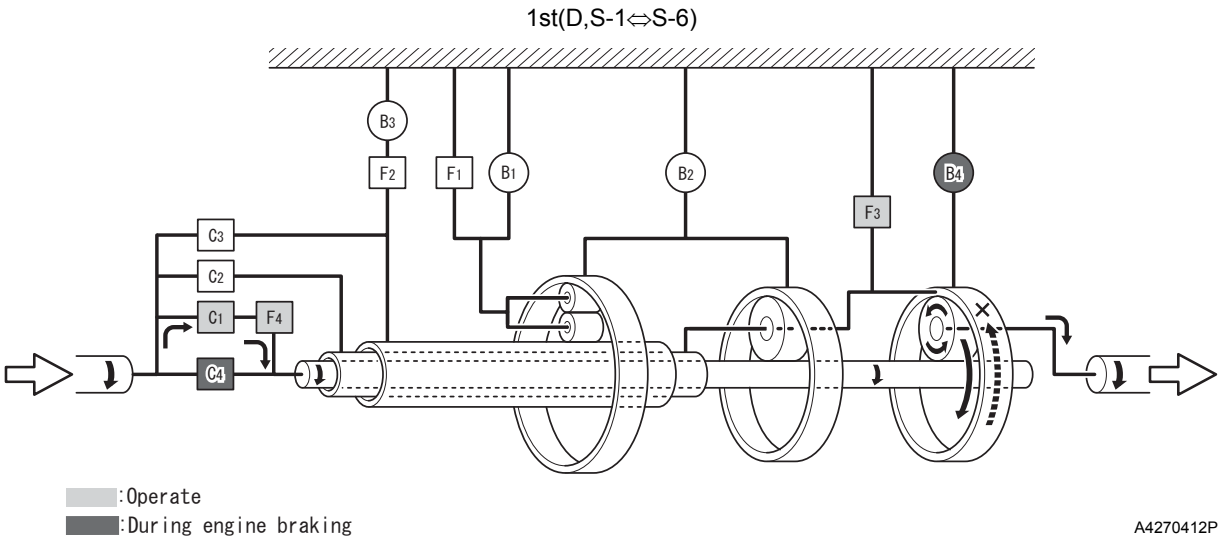
❖REFERENCE❖

❍:operation

(❍):During engine braking

Δ:Operate but is not related to power transmission

A960E Gear Train Structure



Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio
1st	❍			(❍)				(❍)			❍	❍	3.538

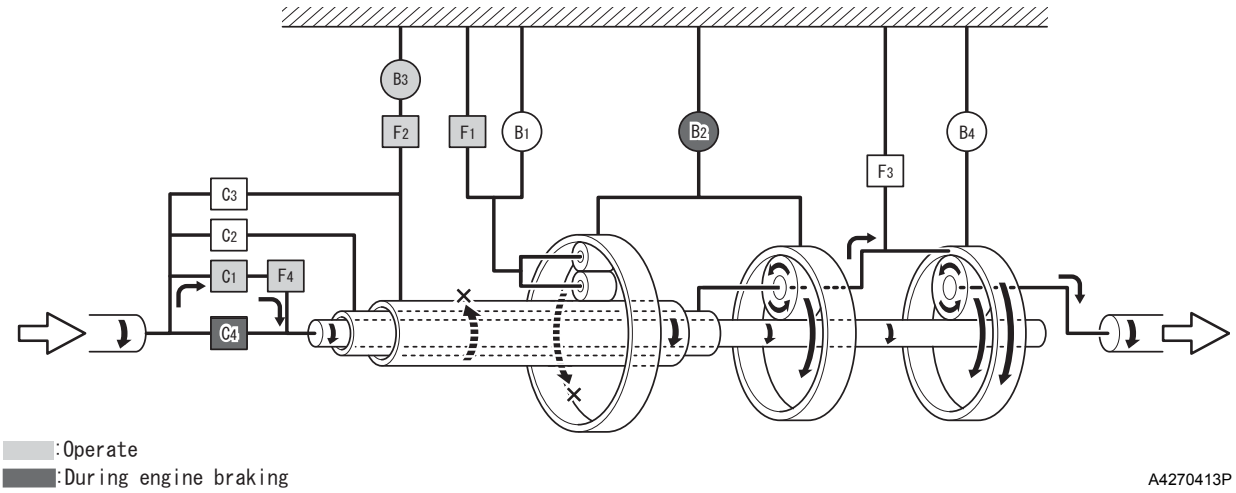
❖REFERENCE❖

❍:Operation

(❍):During engine braking

Δ:Operate but is not related to power transmission

2nd((D,S-2⇔S-6)



Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio
2nd	❍			(❍)		(❍)	❍		❍	❍		❍	2.060

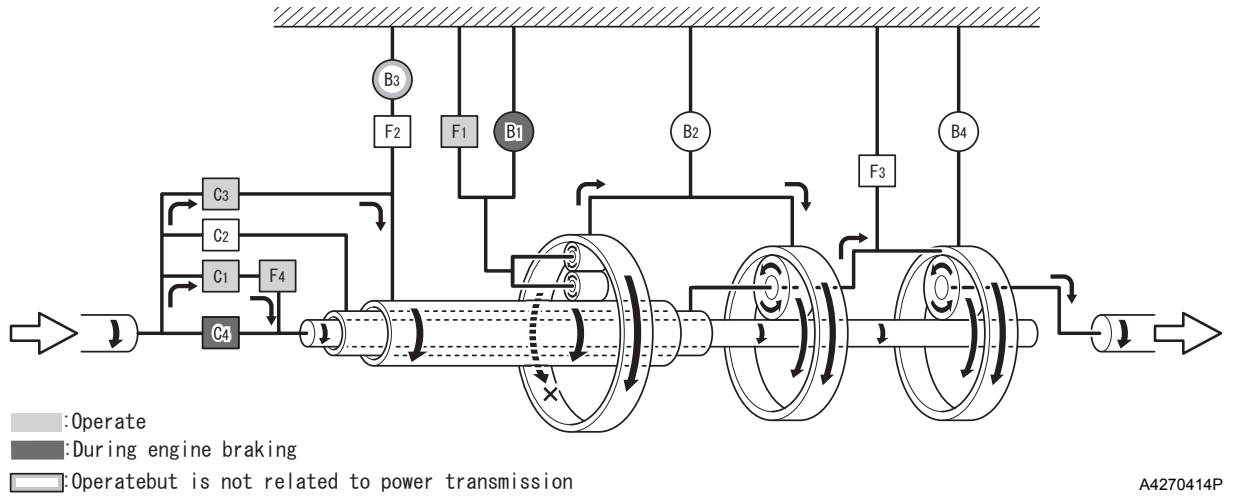
❖REFERENCE❖

❍:Operation

(❍):During engine braking

Δ:Operate but is not related to power transmission

3rd(D,S-3⇔S-6)



Operating Conditions of Clutches and Brakes

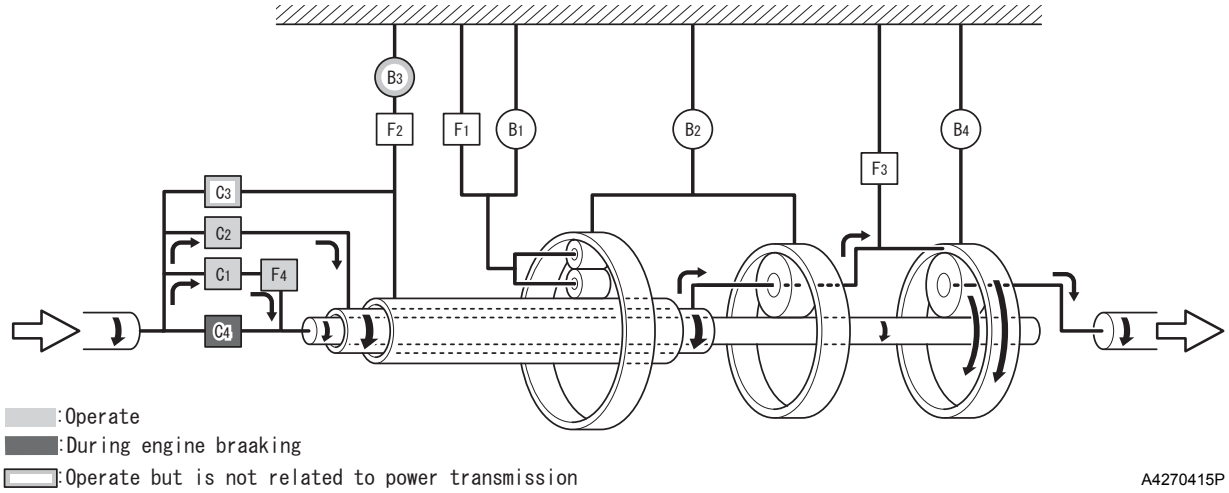
	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio
3rd	❍		❍	(❍)	(❍)		Δ		❍			❍	1.404

❖REFERENCE❖
❍:Operation

(❍)During engine braking

Δ:Operate but is not related to power transmission

4th(D,S-4⇔S-6)



Operating Conditions of Clutches and Brakes

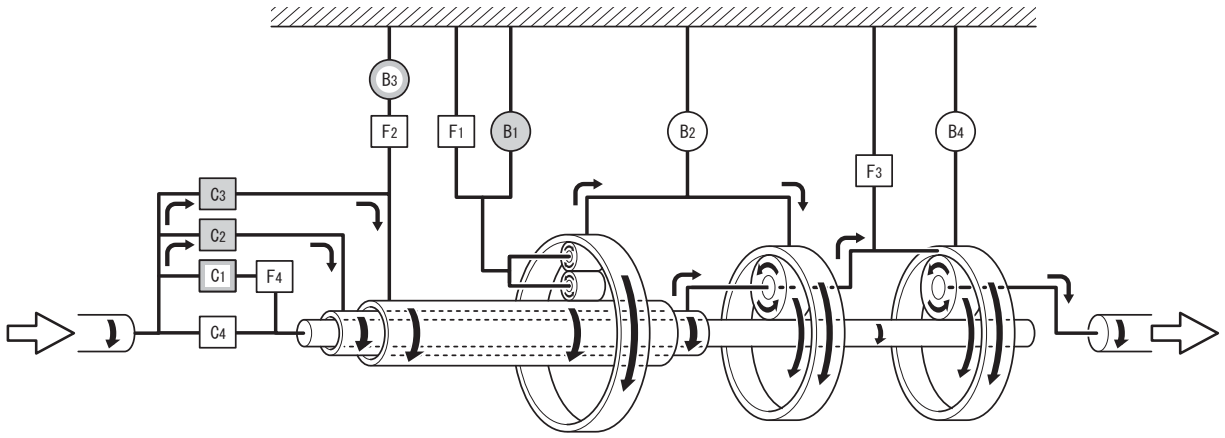
	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio
4th	❍	❍	Δ	(❍)			Δ					❍	1.000

❖REFERENCE❖
❍:Operation

(❍):During engine braking

Δ:Operate but is not related to power transmission

5th(D,S-5⇔S-6)



:Operate
:Operate but is not related to power transmission

A4270416P

Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio
5th	Δ	❍	❍		❍		Δ						0.713

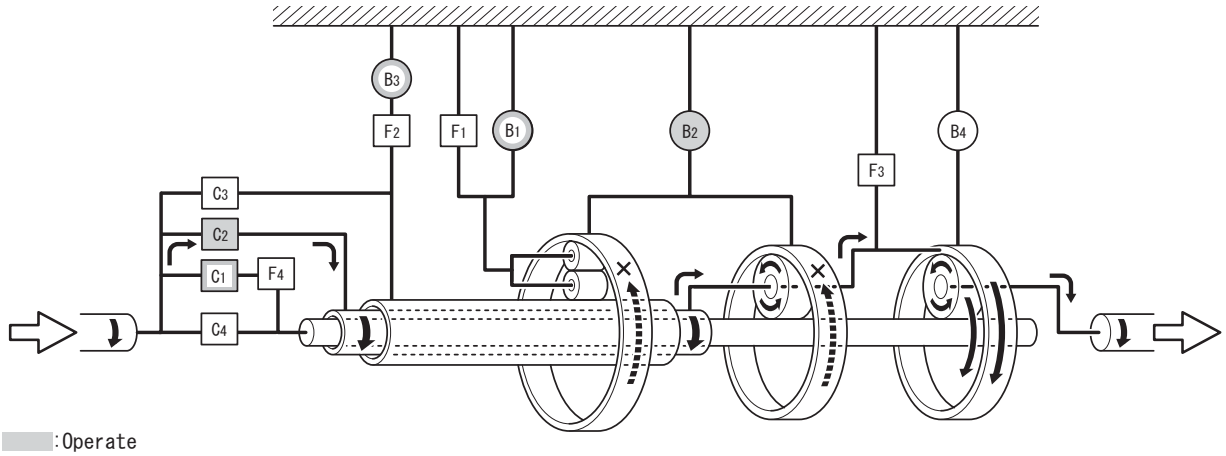
❖REFERENCE❖

❍:Operation

(❍):During engine braking

Δ:Operate but is not related to power transmission

6th(D,S-6)



:Operate
:Operate but is not related to power transmission

A4270417P

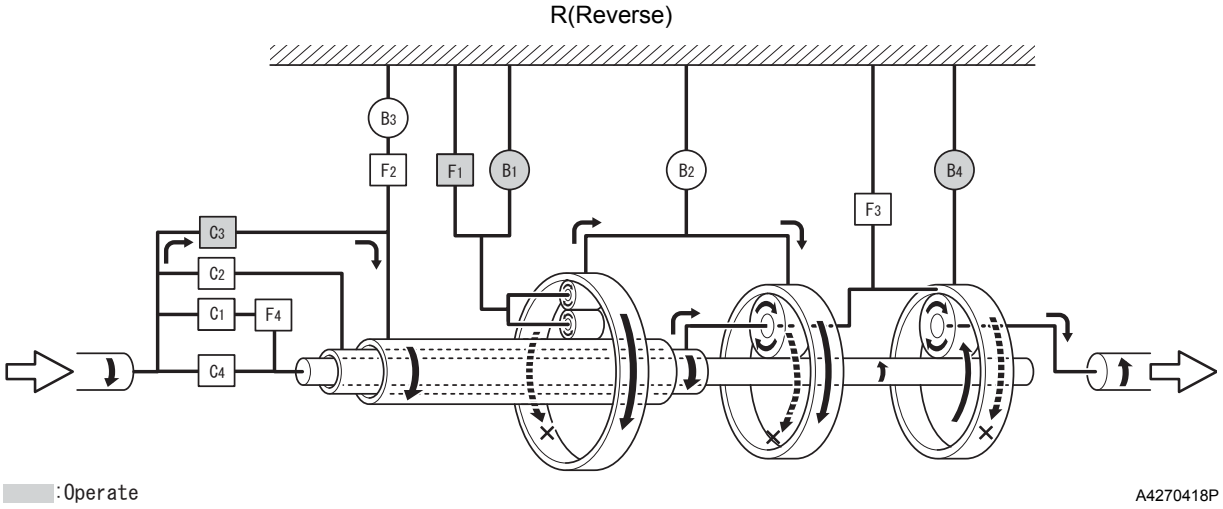
Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio
6th	Δ	❍			Δ	❍	Δ						0.582

❖REFERENCE❖
❍:Operation

(❍):During engine braking

Δ:Operate but is not related to power transmission



Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio
R			❍		(❍)			❍	❍				3.168

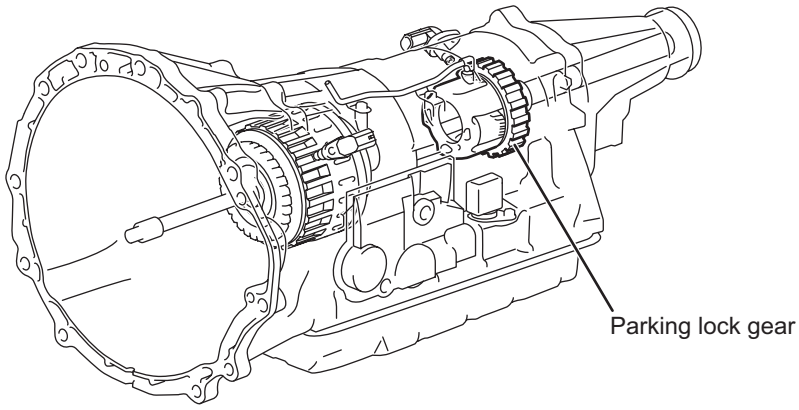
❖REFERENCE❖
❍:Operation

(❍):During engine braking

Δ:Operate but is not related to power transmission

Parking Lock Mechanism

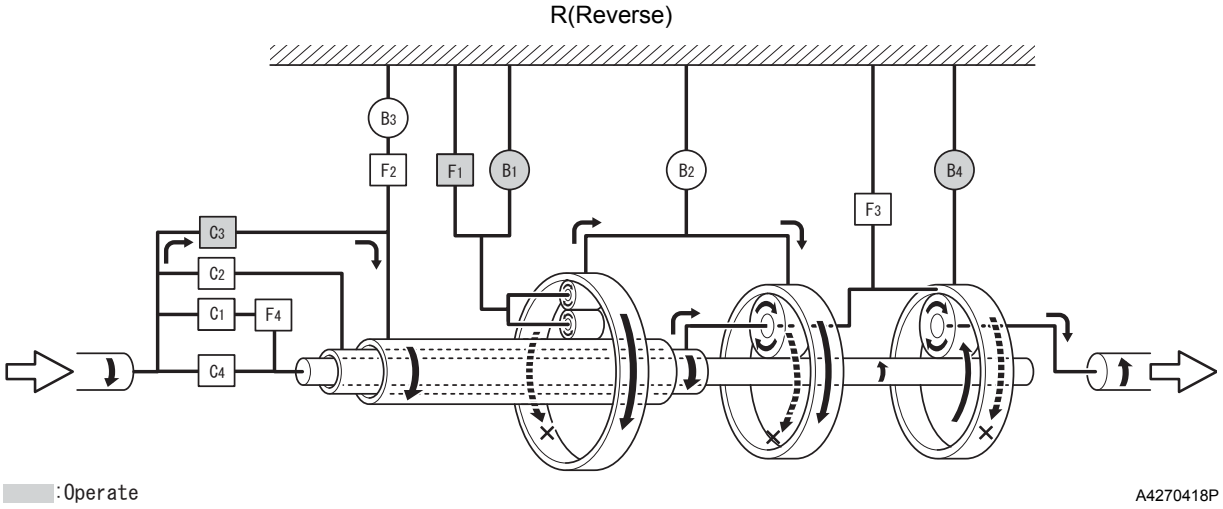
● A parking lock gear is provided in the rear planetary gear carrier area. A parking lock pawl meshes with the parking lock gear, thus locking the rotational movement of the output shaft.



❖REFERENCE❖
❍:Operation

(❍):During engine braking

Δ:Operate but is not related to power transmission



Operating Conditions of Clutches and Brakes

	C1	C2	C3	C4	B1	B2	B3	B4	F1	F2	F3	F4	Gear Ratio
R			❍		(❍)			❍	❍				3.168

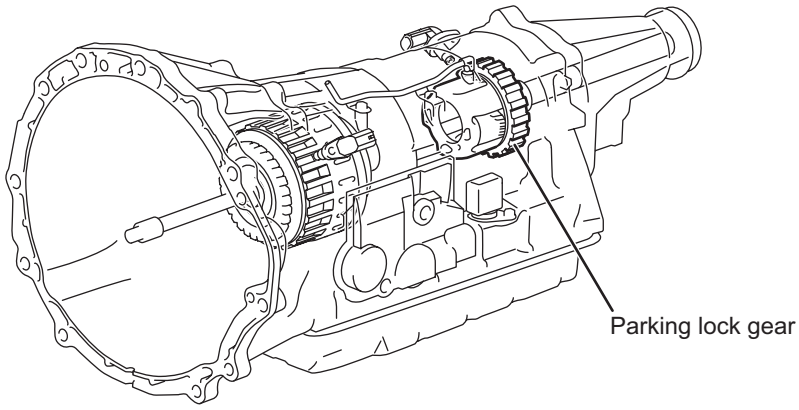
❖REFERENCE❖
❍:Operation

(❍):During engine braking

Δ:Operate but is not related to power transmission

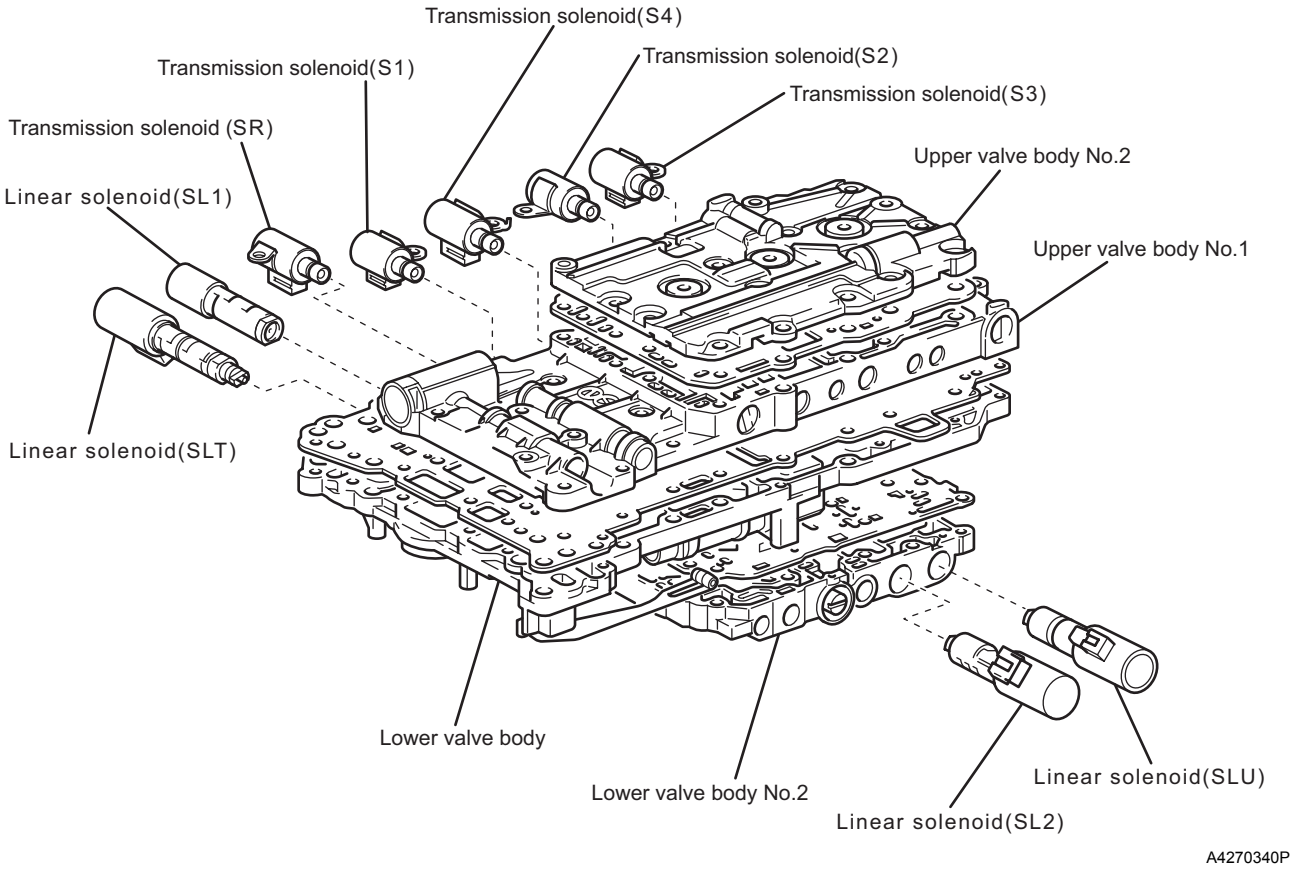
Parking Lock Mechanism

● A parking lock gear is provided in the rear planetary gear carrier area. A parking lock pawl meshes with the parking lock gear, thus locking the rotational movement of the output shaft.



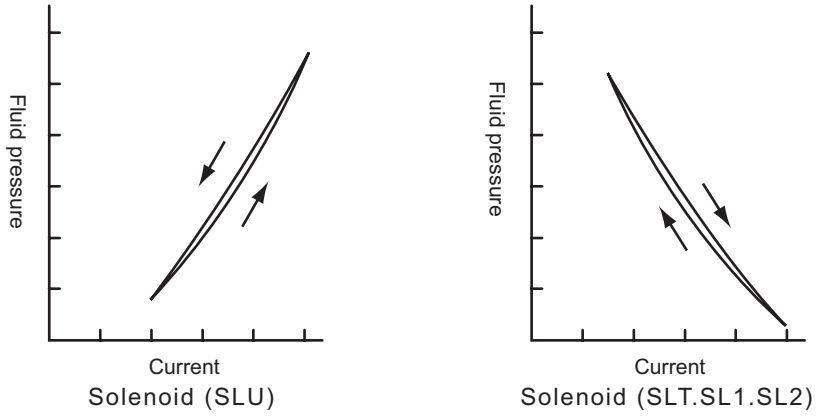
Valve Body Unit

- A valve body made of a lightweight aluminum alloy is used. It consists of a vertical, four-way split construction. The transmission solenoids and linear solenoids are installed on the lower valve body.
- A strainer is provided at each end of the transmission solenoid valves S1, S2, S3, S4, and SR in the unlikely event foreign matter enters the valve body.



Linear Solenoid Valve

- Linear solenoid valves have been provided for the following purposes: to control the hydraulic pressure for clutch engagement, to control the lockup clutch, to control the line hydraulic pressure, and to control the fluid pressure for brake engagement.
- The electromagnetic portions of SLT, SLU, SL1, and SL2 have been made compact, lightweight, and low cost, without reducing their attraction.



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Function

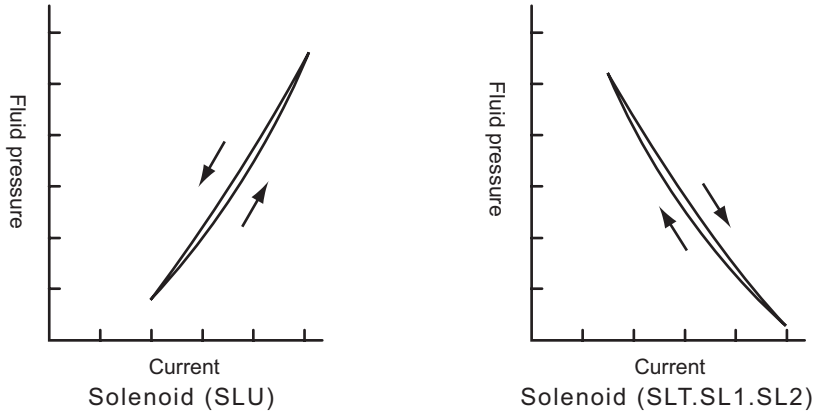
Linear Solenoid Valve	Function
Solenoid valve No. 1 (SL1) for controlling fluid pressure for clutch engagement	• Accumulator back pressure control • Clutch pressure control
Solenoid valve (SLU) for controlling lockup clutch	• Lockup clutch pressure control • Flex lockup pressure control
Solenoid valve (SLT) for line fluid pressure control	• Line pressure control • Accumulator back pressure control
Solenoid valve No. 2 (SL2) for controlling fluid pressure for brake engagement	• Brake pressure control

Transmission Solenoid Valve

- Transmission solenoid valves S1, S2, S3, and S4 are provided for switching the gears, and transmission solenoid valve SR is provided for switching the orifices.
- Each transmission solenoid valve is a three-way solenoid valve that is more compact and lightweight than the previous type. They provide superior response even at low fluid temperatures.
- A strainer is provided at the end of each solenoid valve to realize superior reliability.

Function

Transmission solenoid valves	Type	Function
Transmission solenoid valve (S1)	3-way	• Switches the 1-2 shift valve • Switches the SL1 relay valve
Transmission solenoid valve (S2)	3-way	• Switches the 2-3 shift valve • Switches the 5-6 relay valve
Transmission solenoid valve (S3)	3-way	• Switches the 3-4 shift valve
Transmission solenoid valve (S4)	3-way	• Switches the 4-5 shift valve
Transmission solenoid valve (SR)	3-way	• Switches the C4 relay valve • Switches the B1 relay valve



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Function

Linear Solenoid Valve	Function
Solenoid valve No. 1 (SL1) for controlling fluid pressure for clutch engagement	• Accumulator back pressure control • Clutch pressure control
Solenoid valve (SLU) for controlling lockup clutch	• Lockup clutch pressure control • Flex lockup pressure control
Solenoid valve (SLT) for line fluid pressure control	• Line pressure control • Accumulator back pressure control
Solenoid valve No. 2 (SL2) for controlling fluid pressure for brake engagement	• Brake pressure control

Transmission Solenoid Valve

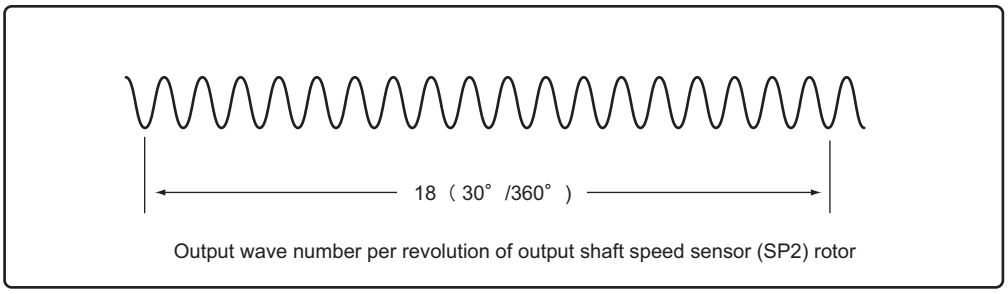
- Transmission solenoid valves S1, S2, S3, and S4 are provided for switching the gears, and transmission solenoid valve SR is provided for switching the orifices.
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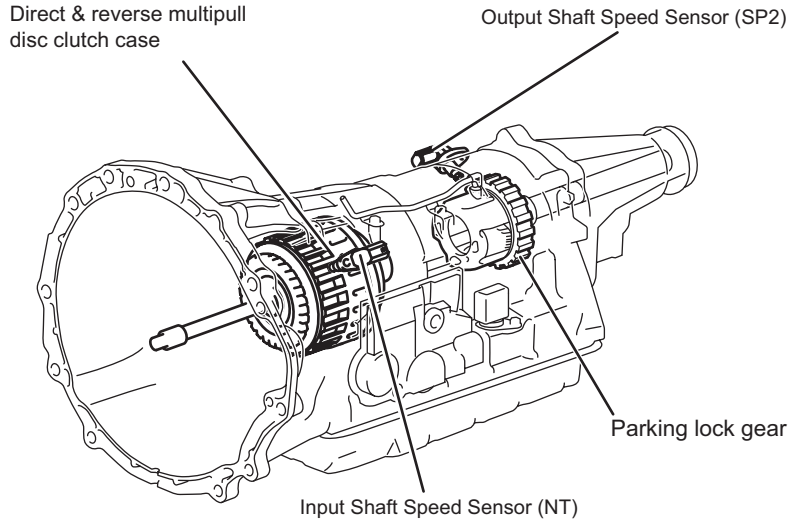
Function

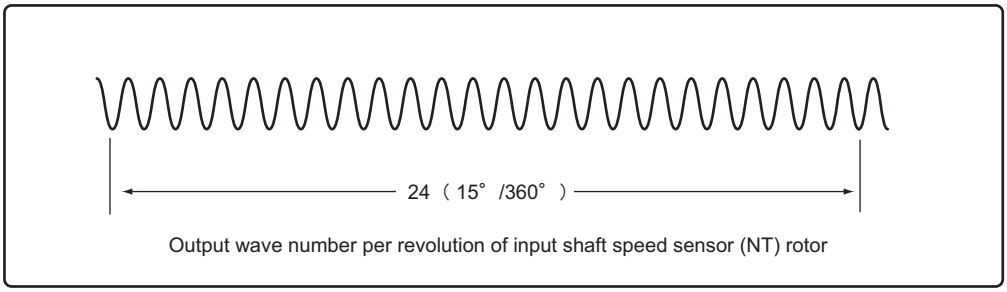
Transmission solenoid valves	Type	Function
Transmission solenoid valve (S1)	3-way	• Switches the 1-2 shift valve • Switches the SL1 relay valve
Transmission solenoid valve (S2)	3-way	• Switches the 2-3 shift valve • Switches the 5-6 relay valve
Transmission solenoid valve (S3)	3-way	• Switches the 3-4 shift valve
Transmission solenoid valve (S4)	3-way	• Switches the 4-5 shift valve
Transmission solenoid valve (SR)	3-way	• Switches the C4 relay valve • Switches the B1 relay valve

Input Shaft Speed Sensor

- A rotor, which is used by an input shaft speed sensor, is provided in the clutch case area for the purpose of detecting the input speed of the transmission. The sensor is provided on the left side of the transmission case in order to output the NT speed signals of the input shaft to the engine ECU.
- A rotor, which is used by an output shaft speed sensor, is provided in the transmission. The output shaft speed sensor is provided on the right side of the transmission case in order to output the SP2 output shaft speed signals to the engine ECU.
- These sensors are electromagnetic pickup sensors that offer a high level of detection accuracy. As the rotor makes a rotational movement, the air gap between a protrusion (which is provided for detection purposes) and the sensor changes. This causes the magnetic flux that passes through the coil of the sensor to increase and decrease, thus generating an electromotive force in the coil. Depending on whether the protrusion and the sensor approach or separate from each other, this force generates voltage in opposite directions, thus creating an alternating current force.



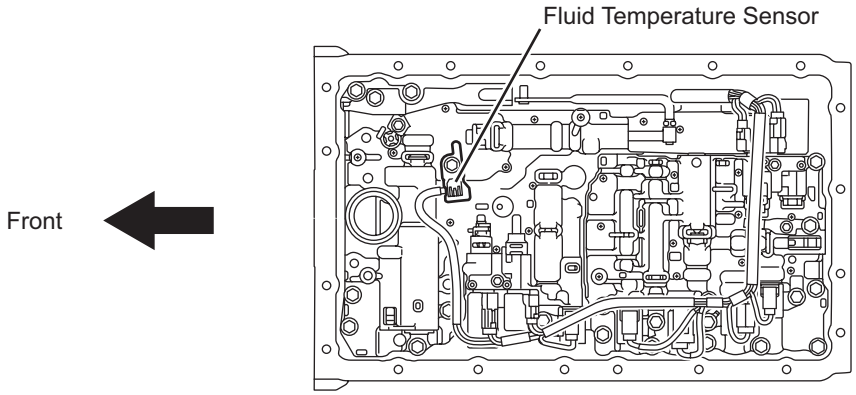




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Fluid Temperature Sensor

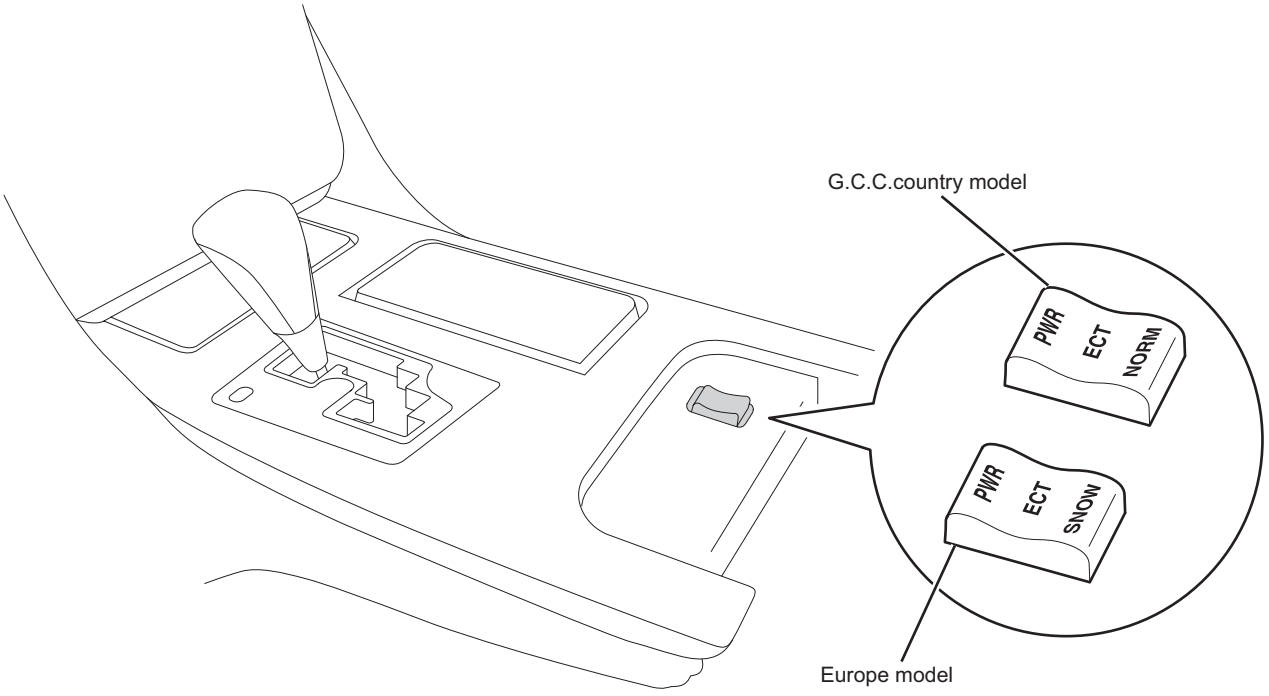
- A fluid pressure sensor for controlling the fluid pressure during shifting is installed inside the valve body.
- The fluid temperature sensor is located at the discharge outlet of the oil pump where the temperature rise is stable, in order to directly measure the fluid temperature in the oil passage. Thus, it is able to detect the oil temperature more accurately.



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ECT Pattern Select Switch

- An ECT pattern select switch is located behind the shift lever. The driver can select between the POWER and SNOW and NORMAL modes by turning the switch ON or OFF.(The SNOW mode is Europe model only)



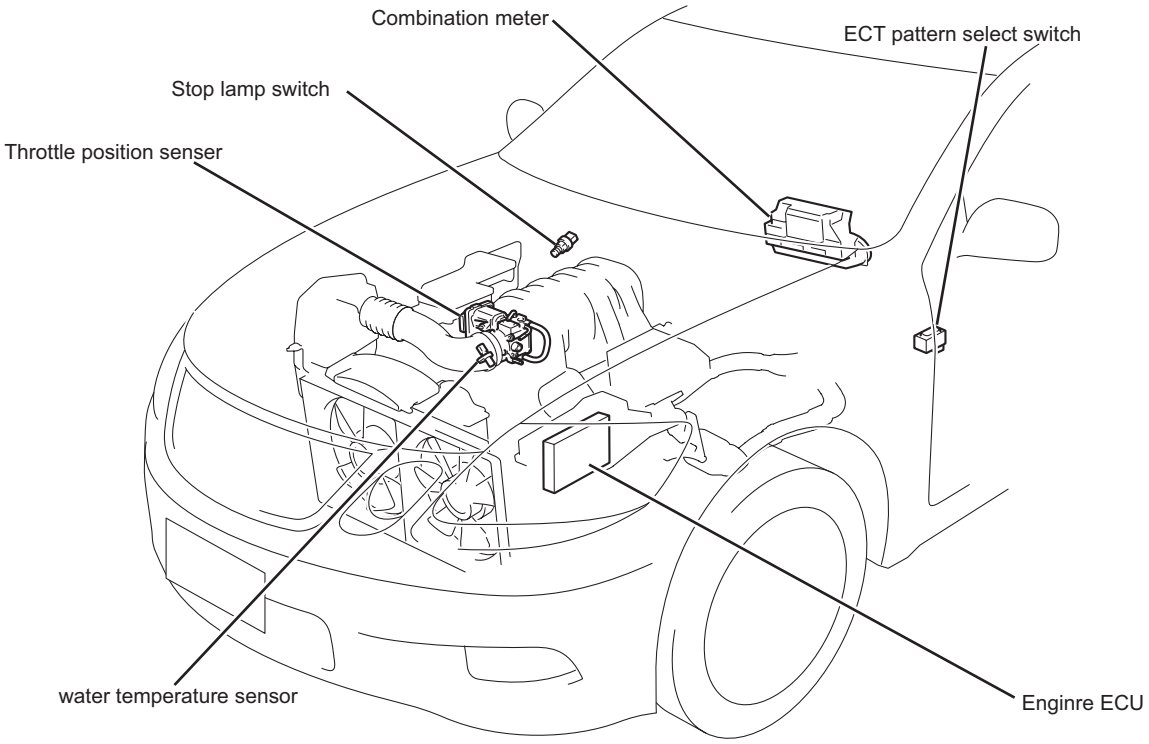
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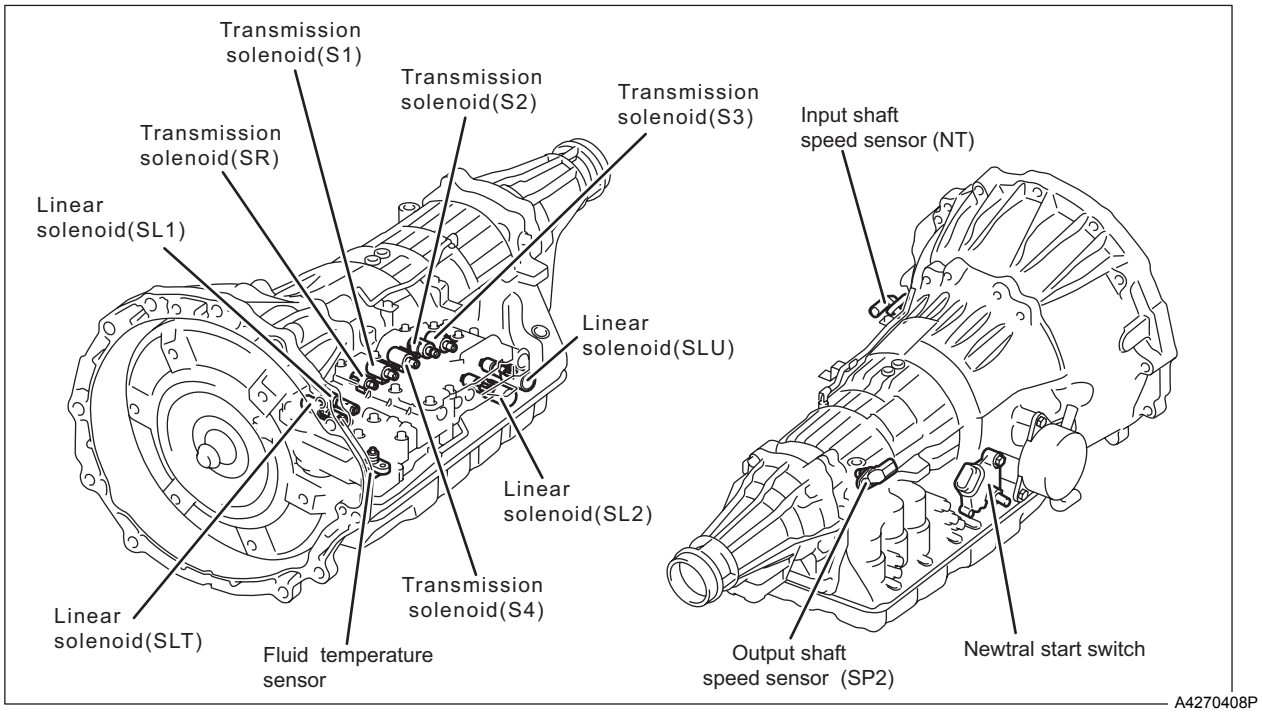
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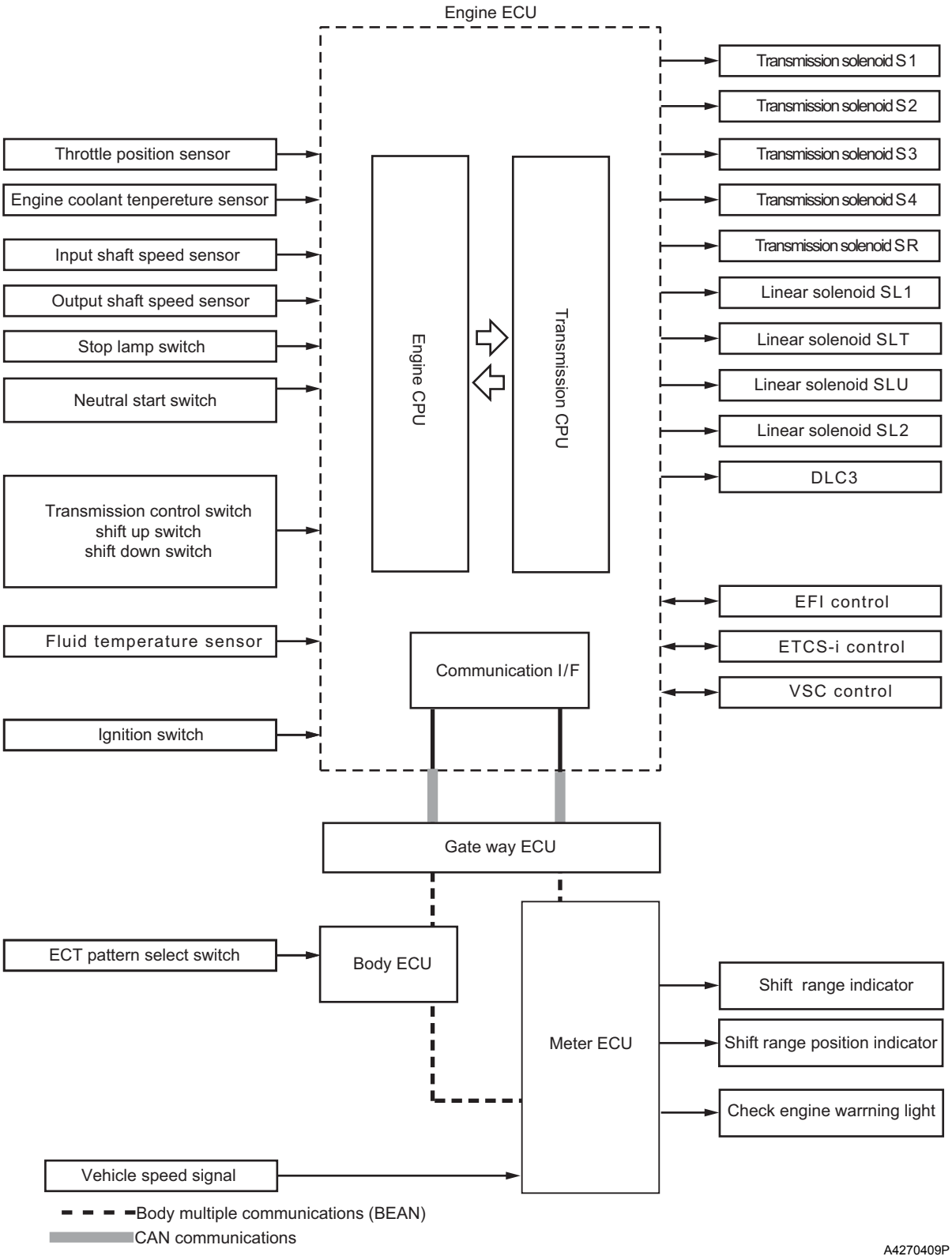
ECT Control

- A transmission control computer that is integrated with the engine control computer is used.
- Based on the signals from each of the sensors, the latest control, such as AI-SHIFT control, is administered to achieve smooth gear shifting.





Engine ECU



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Component & Function

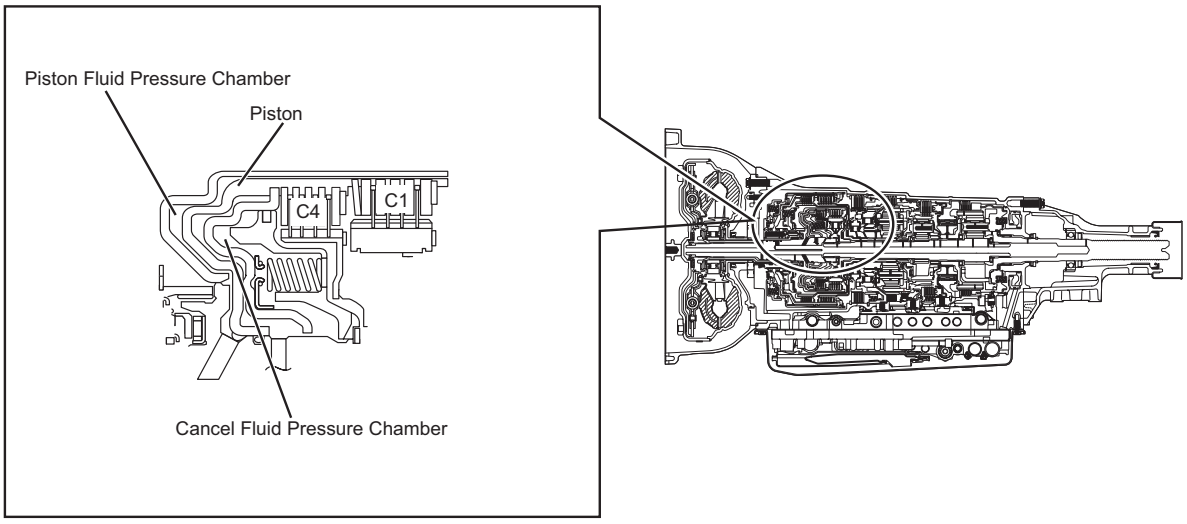
Component	Function
Transmission solenoid S1	Operates when shifting between first and second gears. Switches the oil path of SL1 pressure.
Transmission solenoid S2	Operates when shifting between second and third gears, and fifth and sixth gears.
Transmission solenoid S3	Operates when shifting between third and fourth gears.
Transmission solenoid S4	Operates when shifting between fourth and fifth gears. Switches the oil path of SL1 pressure. Switches the reverse sequence valve.
Transmission solenoid SR	Performs switching between C4 clutch and B1 brake.
Linear solenoid SLT	Performs line hydraulic control and accumulator back pressure control.
Linear solenoid SLU	Performs lock-up control.°
Linear solenoid SL1	Performs clutch hydraulic control and accumulator back pressure control.
Linear solenoid SL2	Performs brake hydraulic control.
Input shaft speed sensor	Detects the rotation speed of the transmission input shaft.
Output shaft speed sensor	Detects the rotation speed of the transmission output shaft.
Oil temperature sensor	Detects the temperature of the oil in the transmission hydraulic control circuit.
Water temperature sensor	Detects the engine water temperature.
Throttle position sensor	Detects the opening of the throttle valve.
Stop lamp switch	Detects depression and non-depression of the brake pedal.
Neutral start switch	Detects the transmission shift lever position.
ECT pattern selector switch	Selects either SNOW mode* or POWER mode.
Shift lever position indicator (built into the combination meter)	Notifies driver of the current shift lever position by lighting the corresponding lamp.
Shift range position indicator (built into the combination meter)	Notifies the driver by displaying the shift lever position (1st to 6th) in sequential mode.°
PWR indicator(built into the combination meter)	Notifies the driver the ECT pattern selector switch is in POWER mode by lighting the corresponding lamp.
SNOW indicator*(built into the combination meter)	Notifies the driver the ECT pattern selector switch is in SNOW mode by lighting the corresponding lamp(SNOW mode is Europe model only).
Cruise control indicator (built into the combination meter)	Notifies the driver that cruise control is activated by lighting the corresponding lamp.
Engine ECU (integrated with transmission control computer)	Performs overall control of engine transmission and transmission control based on the signals from each of the sensors. Equipped with diagnosis mode and failsafe function for better serviceability when a malfunction has occurred.
DLC3	By connecting a diagnostic tool and operating it, the diagnosis code and computer data can be read out.

❖REFERENCE❖

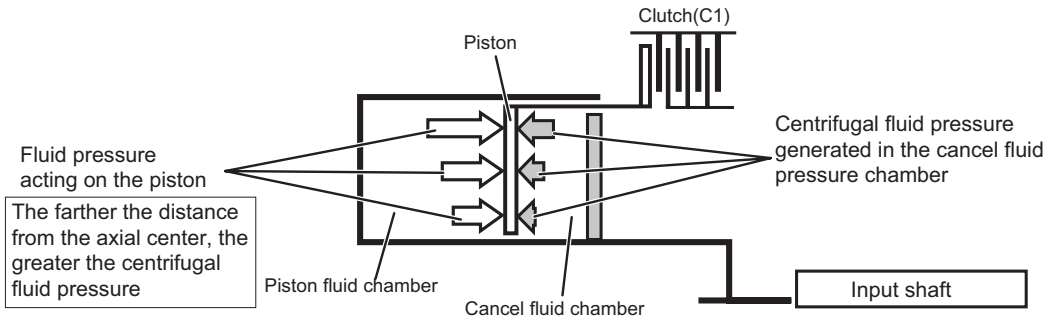
* : SNOW mode is Europe model only

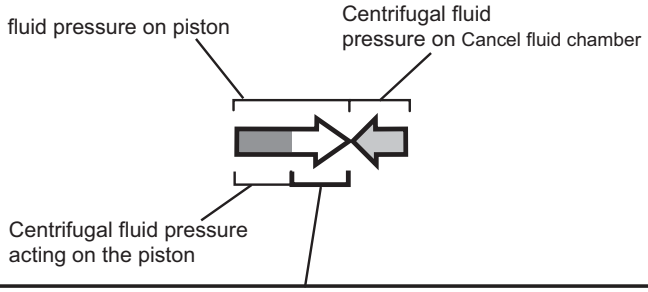
Centrifugal Fluid Pressure Canceling Mechanism

- For operations that require a high level of response while the transmission shifts 2-3, 3-4, 4-5, or 5-6, a centrifugal fluid pressure cancel mechanism is used to engage and disengage the C1, C2, C3, and C4 clutch mechanisms. As a result, a high level of response and smooth shifting characteristics are realized.
- Along with the increase in the speed of the clutch, a centrifugal force acts on the oil in the clutch, which increases the fluid pressure and accelerates the engagement of the clutch. In addition, a shift shock could be created by the rotational difference between the input and output shafts. For this reason, a cancel fluid pressure chamber is provided opposite the piston fluid pressure chamber in the clutch mechanism. The cancel fluid pressure chamber applies an equal amount of centrifugal fluid pressure force to the piston, in the opposite direction. Thus, it cancels out the influences of the centrifugal force.



Clutch Mechanism



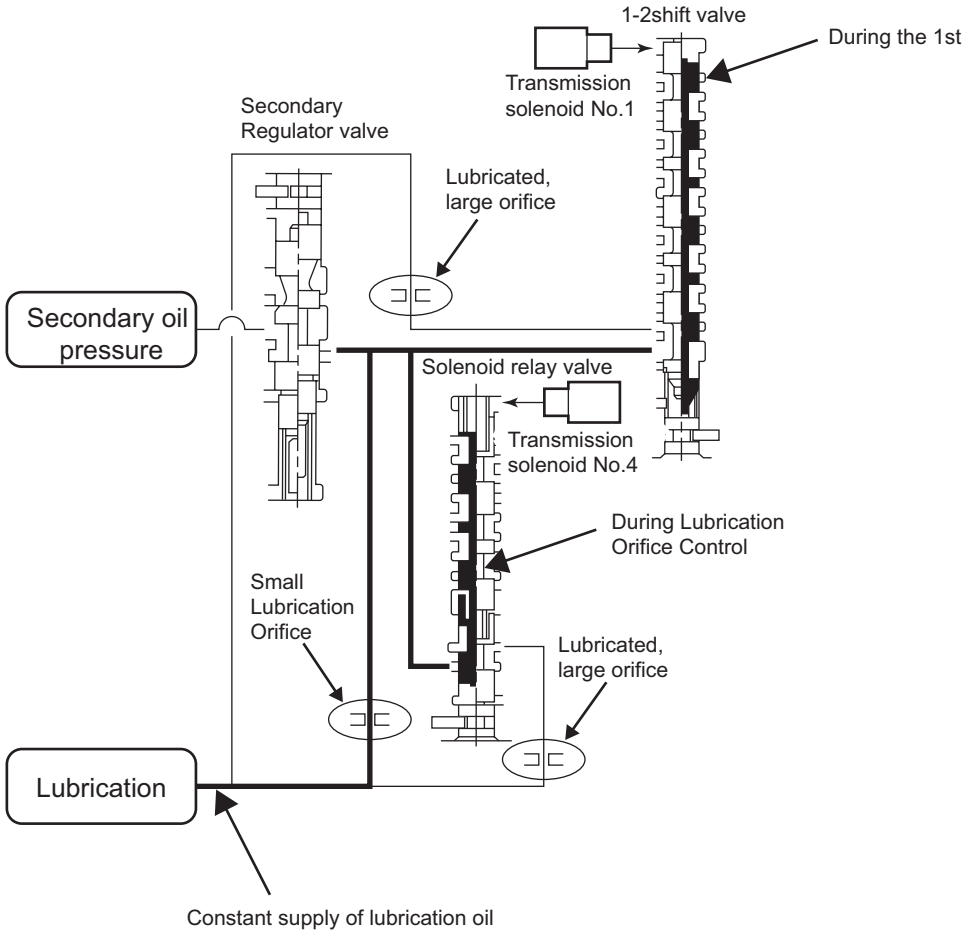


Fluid pressure acting on the piston — Centrifugal fluid pressure generated in the cancel fluid pressure chamber = Target fluid pressure

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Apply Orifice Control

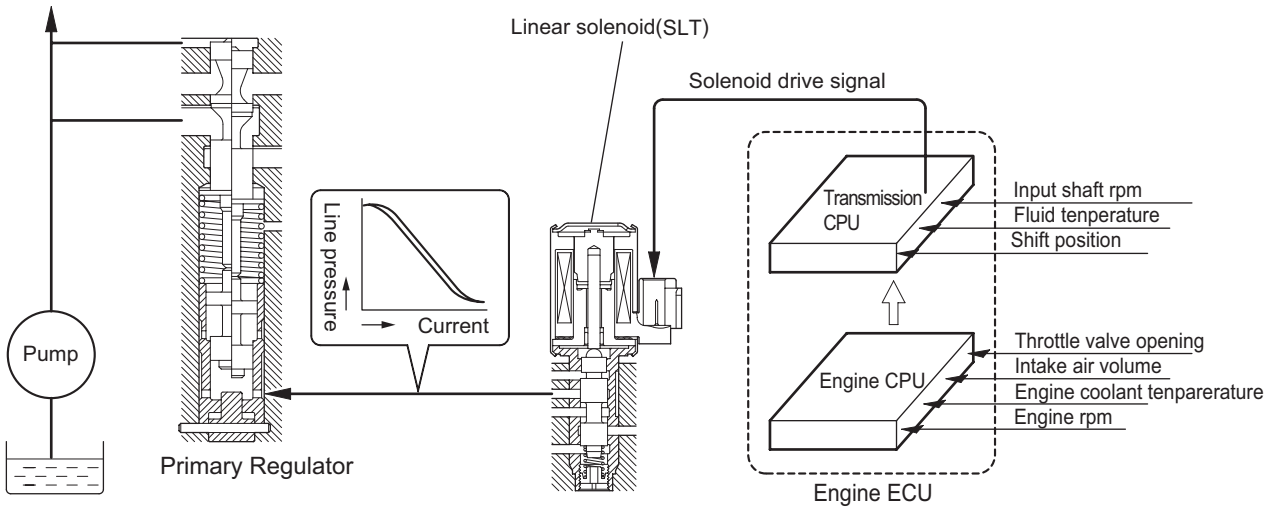
- A lubrication orifice switching control is used in order to counter the suction of air at extremely low temperatures. This control reduces the volume of the lubrication oil when the vehicle is stopped in 1st gear, in a shift position other than reverse.
- When the vehicle is stopped in 1st gear, the transmission uses only the small lubrication orifice. At other times, one of the two lubrication orifices, or both orifices are used for supplying lubrication oil.



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Line Pressure Optimal Control

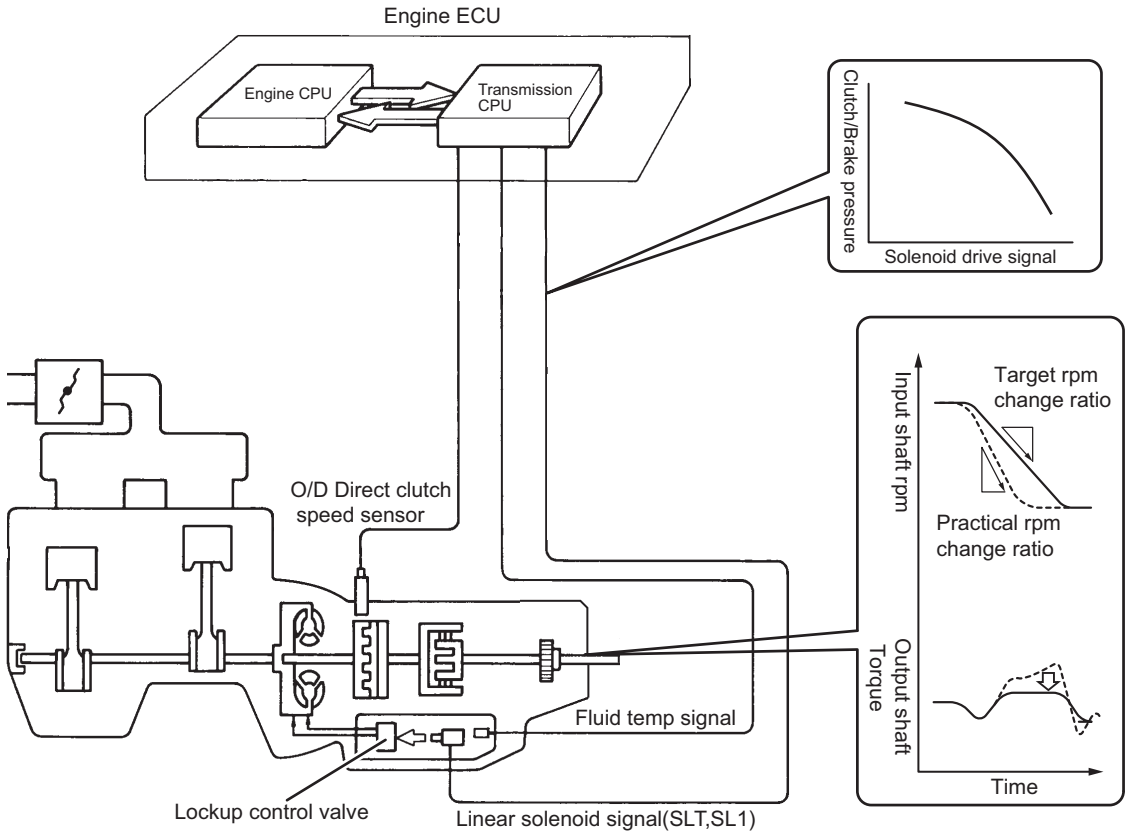
- Controls the line pressure to an optimal value based on real-time engine torque information proved by the engine
- This enables the line pressure to finely controlled at a high rate of precision in accordance with the engine output and conditions, thus realizing smooth shift characteristics.



A4270404P

Clutch Pressure Optimal Control

• Based on the signals from the input shaft speed and other sensors, clutch hydraulics are finely controlled by the linear solenoid valves (SLT and SL1) in line with engine output and driving conditions to achieve even smoother gear shifting.

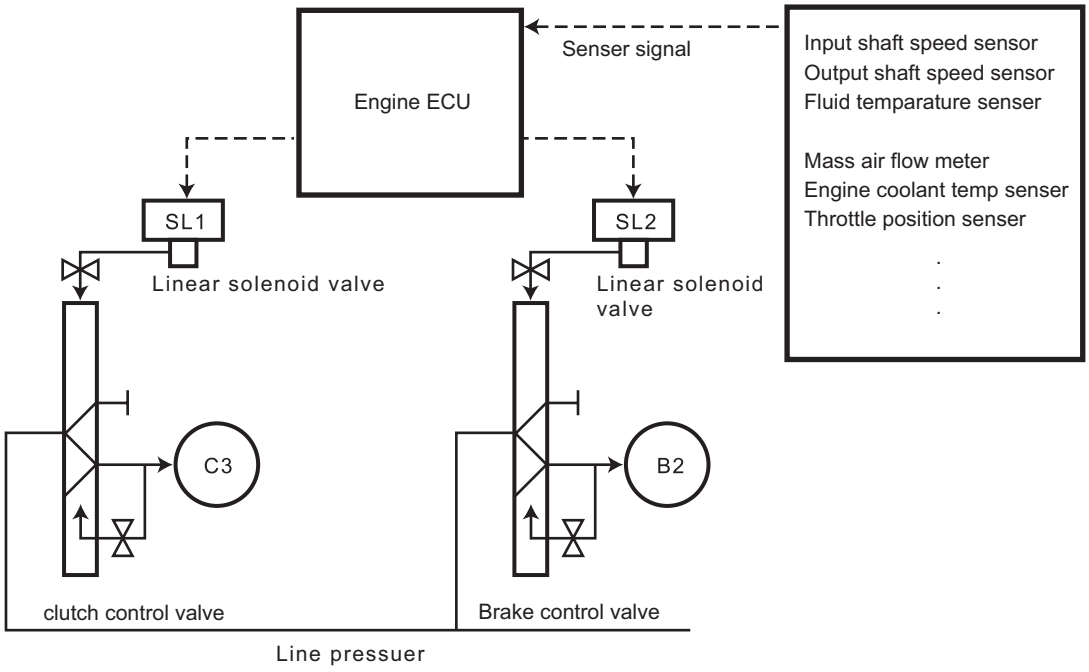


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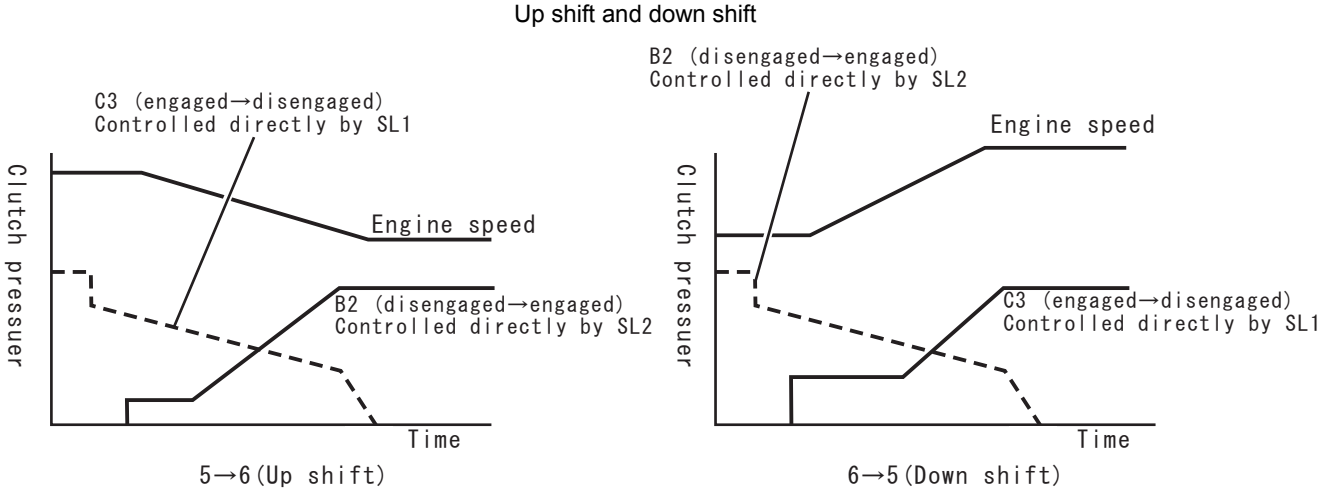
Clutch to Clutch Pressure Control

- Clutch-to-clutch shift control is used for controlling the shifting between the 5th and 6th gears. This has enabled the transmission to discontinue the use of a one-way clutch for shifting between 5th and 6th gears, and realize a compact and lightweight construction.
- The engine and transmission ECUs output signals to control the output fluid pressures of the linear solenoid valves SL1 and SL2. These pressures control the control valves in order to directly control the fluid pressures of the C3 clutch and the B2 brake.



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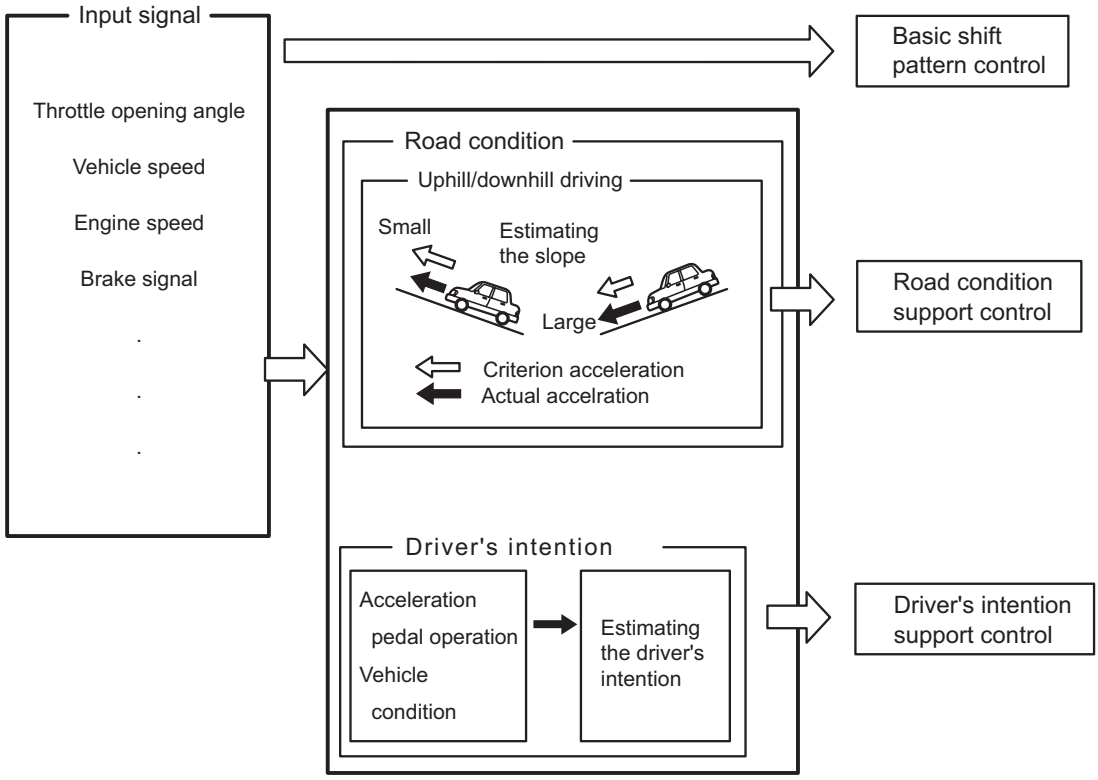
- Up-Downshift: Based on data such as the input and output shaft speeds and engine torque, the ECU controls the clutch to be disengaged and the clutch to be engaged at an optimal fluid pressure and timing. Thus, superior shift characteristics have been realized under all possible driving conditions.



A4270352P

AI-Shift Control

- The shifting of the gears in the automatic transmission is determined by a shift pattern consisting of vehicle speeds and the engine throttle position as parameters. To switch between the shift lines, the driver operates a switch to change a shift pattern, such as NORMAL, POWER, or SNOW.(SNOW mode is Europe model only)
- In addition to the aforementioned selection of shift patterns through the operation of the switch, the AI-Shift control automatically changes the shift patterns to suit the "road condition" or "driver's intention". As a result, a comfortable driving experience is realized at high levels.
- The AI-Shift control is effected only with the shift lever in the D position, based on accelerator and brake operation data. The AI-Shift control will be canceled when the driver selects the S (sequential) mode.



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Driver's Intention Support Control

- Estimates the driver's intention based on the accelerator operation and vehicle condition to switch to a shift pattern that is well-suited to each driver, without the need to operate the shift pattern select switch.

Sport Driving Support Control (AI-SHIFT)

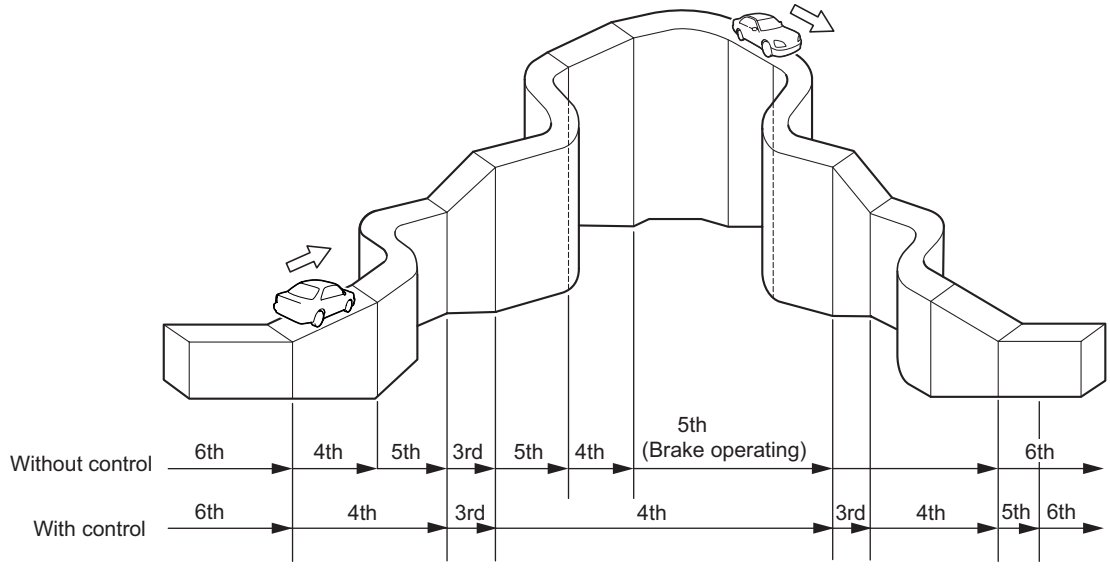
• A type of AI-Shift that excels in acceleration response and thus is suitable for sporty driving, it is used when the POWER pattern is selected.

		Operation	Control Shift Gear
TA Control	Sudden Open Control	When the driver operates the accelerator quickly, this control downshifts rapidly to improve acceleration response.	4th to 6th
	Sudden Close Control	When the driver releases (turns OFF) the accelerator quickly, this control makes it easy for the transmission to hold the gear, which improves engine braking force and re-acceleration response.	2nd to 5th
Sudden Deceleration Downshift Control		When the driver decelerates the vehicle suddenly, this control downshifts rapidly, which improves engine braking force and re-acceleration response.	4th to 6th

Shifting Control in Uphill / Downhill Traveling

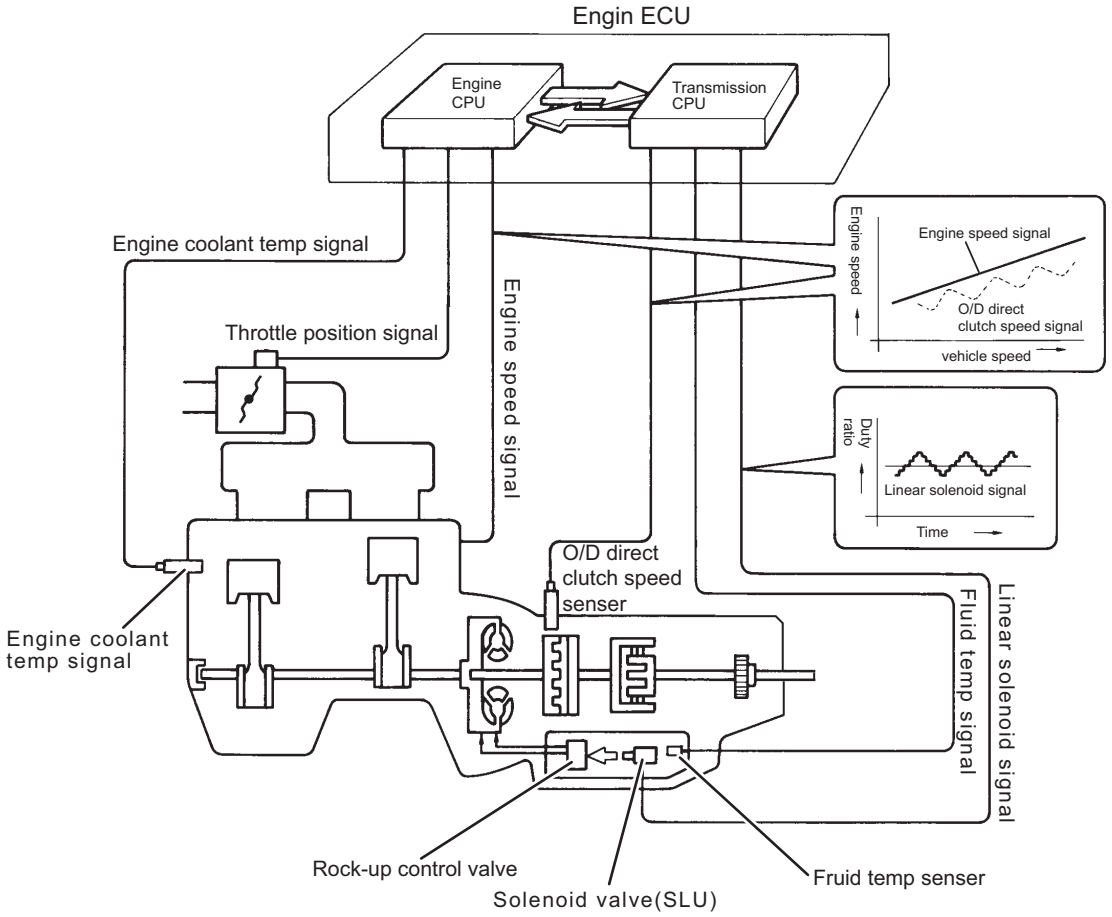
• In the conventional automatic transmission, if the vehicle is accelerated or decelerated while driving uphill, depending on the circumstances, the transmission shifted up or down frequently. While driving downhill, because the transmission is upshifted when the throttle valve is almost completely closed, the transmission upshifted quickly even at low driving speeds, occasionally creating a condition in which it was difficult to apply the engine brake.

• In the road condition support control, the uphill or downhill driving conditions are assessed through the throttle opening angle, vehicle speed, etc. to achieve an optimal and constant driving force by restraining the transmission from upshifting while driving uphill (ascent of approximately 5% or more). The transmission automatically downshifts with brake signal ON so that an optimal engine brake can be achieved while driving downhill (ascent of approximately 6% or more).



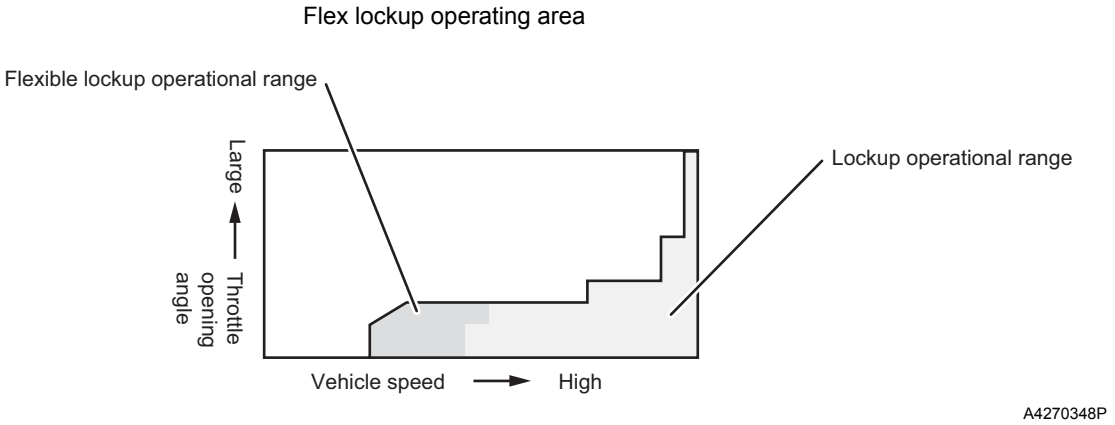
Flex Lockup Clutch Control

- Flex lockup control is used on the models equipped with the 3GR-FSE and 3GR-FE engine.
- Through the use of a leading-edge H∞ (H infinity) control logic, it has become possible to continuously provide the lockup clutch with a subtle slippage in a stable manner. As a result, it has become possible to apply a lockup in a wide range of operations, thus realizing superior fuel economy characteristics.
- The flex lockup operation ranges from 6th to 3rd.



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- In the low- to medium-speed range, this control applies a very small specified amount of slippage rotation to the lockup clutch, thus ensuring the transmission efficiency of the torque converter and realizing superior fuel economy characteristics.
- When the accelerator is OFF, this control subtly slips the lockup clutch in the same manner as when the accelerator is ON, thus enabling the engine to expand its fuel cut range.



Flex lockup operation table

Range	1st	2nd	3rd	4th	5th	6th
D,S-6	×	×	❍	❍	<❍>	<❍>
S-5	×	×	❍	❍	<❍>	
S-4	×	×	❍	❍		

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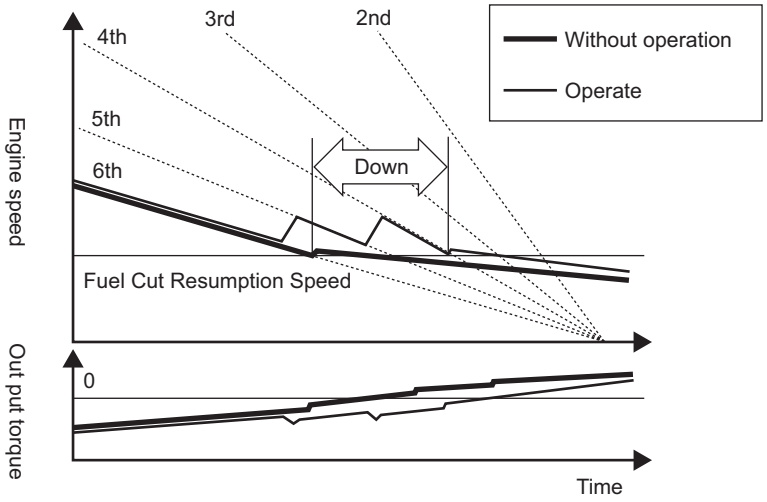
❍:Operation

×:non-operation

<>:deceleration flex lockup operation

Downshift Control At Deceleration

- Deceleration downshift control, which maintains the fuel cut control at the maximum possible limit to realize fuel economy, is used on the models equipped with the 3GR-FSE and 3GR-FE engine.
- While in 6th gear, the deceleration downshift control downshifts from 6th to 5th, and 5th to 4th, before fuel delivery is resumed from the fuel cut state. By maintaining the fuel cut state in this manner, this control realizes fuel economy.



Gear Shift and Lockup Control

• This control effects shift point control (including AI-Shift control) and lockup control (including flex lockup control) in accordance with the shift position, vehicle speed, and throttle position.

Shift Positions, Gears, and Lockup Patterns

Shift position	Gear change pattern
D,6	1st←→2nd←→3rd*1←→4th*1←→5th*2←→6th*2
5	1st←→2nd←→3rd*1←→4th*1←→5th*2
4	1st←→2nd←→3rd*1←→4th*2
3	1st←→2nd←→3rd
2	1st←→2nd
1	1st

❖REFERENCE❖

*1Flex lockup operation (on 3rd, flex lockup operation during acceleration only)

*2Lockup or flex lockup operation

Gear, Lockup, and AI-Shift Control Operating Conditions(A960E)

		4th	5th	6th	Lock-up	AI-SHIFT
Shift position		4,5,6,D	5,6,D	6,D	4,5,6,D	D
Engine coolant temperature	40°C maximum	45km/h minimum	51km/h minimum	55km/h minimum	×	55km/h minimum
	40°C minimum	❍	51km/h minimum	55km/h minimum	×	55km/h minimum
	55°C minimum	❍	❍	55km/h minimum	×	55km/h minimum
	60°C minimum	❍	❍	❍	❍	❍

❖REFERENCE❖

* : No operation restriction to shift from 1st to 3rd

Diagnosis

• If this function detects a failure in the speed sensor or any of the solenoids, it alerts the driver by illuminating the check engine warning light in the combination meter assembly.

• The troubleshooting of the entire vehicle is made possible through the use of a diagnostic tool. For details, refer to the repair manual. (This vehicle supports the intelligent Tester II diagnostic tool .)

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Fail Safe

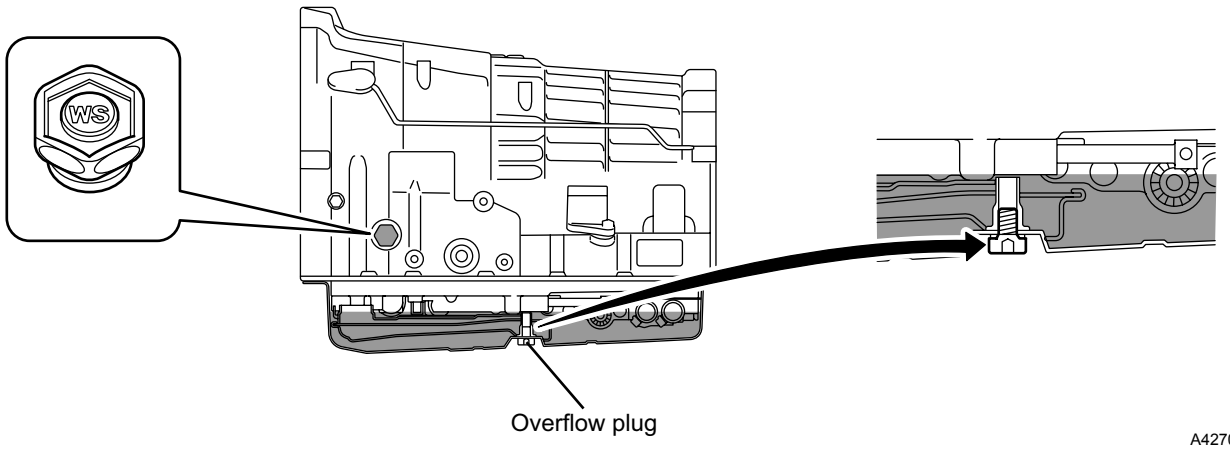
• This function prevents a failure in any of the sensors or solenoids from drastically affecting drivability. For details, refer to the repair manual.

List of Failsafe Functions

Failure Location	Function
Output Shaft Speed Sensor (SP2)	If the output shaft speed sensor (SP2) malfunctions, the system uses the NT signals of the input shaft speed sensor to effect shift control.
Transmission Solenoid	The system stops the current to the malfunctioning solenoid and turns the normal solenoids ON or OFF to effect shift control. If all solenoids fail, the system will shift gears through a mechanical fluid pressure circuit.
Fluid Temperature Sensor	The system prohibits shifting into 5th or 6th, and prohibits flex lockup control.
Linear Solenoid (SLU)	The system stops the control current to the solenoid to interrupt lockup control.
Linear Solenoid (SLT)	The system stops the control current to the solenoid. It effects shift control in the normal manner.

Oil Level Detection Mechanism

- The transmission has discontinued the use of the automatic transmission oil filler tube and the level gauge. Instead, it uses a oil level detection mechanism called an "overflow system".
- The manufacturer of the automatic transmission guarantees the proper oil level. This prevents the transmission from being contaminated with the wrong type of oil, or being overfilled or underfilled. Thus, a maintenance-free transmission has been realized.
- During a repair or replacement, the oil level can be adjusted mechanically through the overflow system. Thus, the control accuracy of the oil level has been improved. For detailed oil replenishment and adjustment procedures, refer to the repair manual.



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Fail Safe

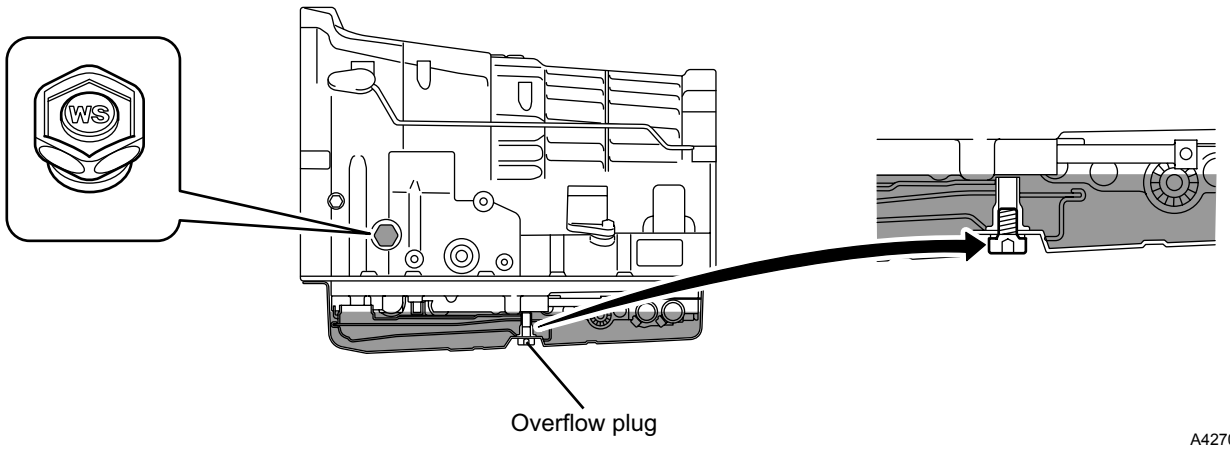
• This function prevents a failure in any of the sensors or solenoids from drastically affecting drivability. For details, refer to the repair manual.

List of Failsafe Functions

Failure Location	Function
Output Shaft Speed Sensor (SP2)	If the output shaft speed sensor (SP2) malfunctions, the system uses the NT signals of the input shaft speed sensor to effect shift control.
Transmission Solenoid	The system stops the current to the malfunctioning solenoid and turns the normal solenoids ON or OFF to effect shift control. If all solenoids fail, the system will shift gears through a mechanical fluid pressure circuit.
Fluid Temperature Sensor	The system prohibits shifting into 5th or 6th, and prohibits flex lockup control.
Linear Solenoid (SLU)	The system stops the control current to the solenoid to interrupt lockup control.
Linear Solenoid (SLT)	The system stops the control current to the solenoid. It effects shift control in the normal manner.

Oil Level Detection Mechanism

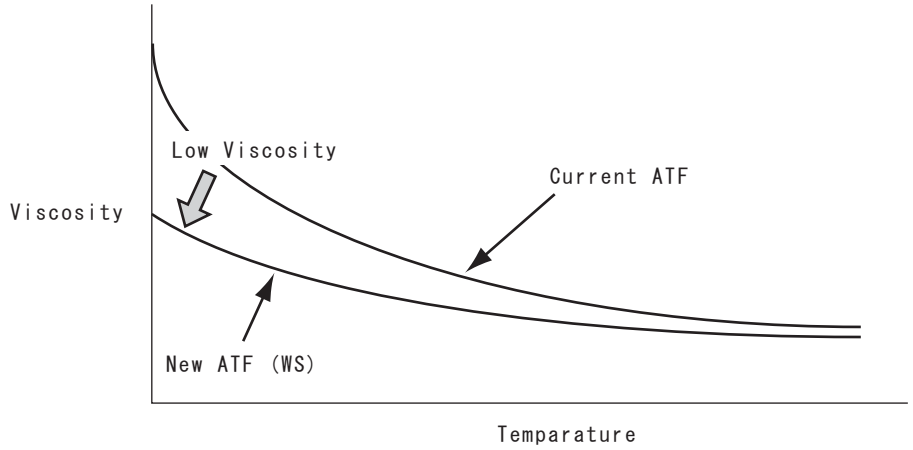
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Automatic Transmission Fluid

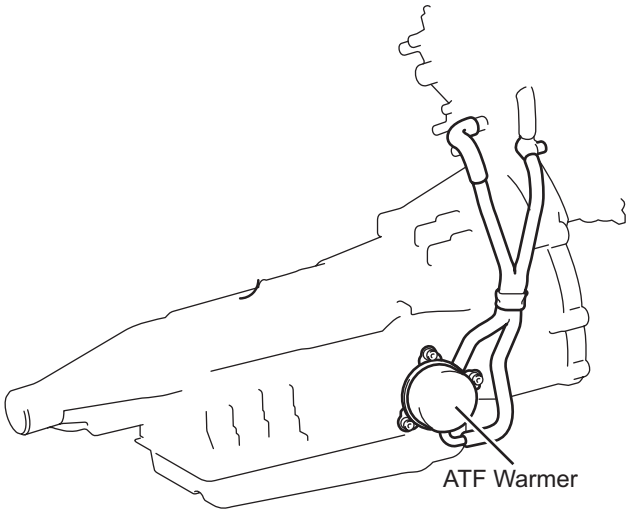
- A newly developed, WS genuine Toyota automatic transmission fluid is used.
- Its viscosity in the actual operating temperature range has been lowered to reduce drag loss and improve fuel economy.
- It has the same high-temperature viscosity as the conventional ATF. This maintains the proper formation of the oil film on the surfaces of the parts to prevent wear and seizure.



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ATF Warmer

- An automatic transmission fluid (ATF) warmer is used on the models equipped with the 3GR-FSE and 3GR-FE engine.
- Because this construction does not use the ordinary oil cooler that is built into the radiator, it accelerates the warming of ATF when it is cold, thus shortening the time in which the flex lockup control starts. During normal operation, the ATF warmer keeps the ATF oil temperature high to reduce friction loss. Thus, it ensures superior fuel economy characteristics.



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Effect

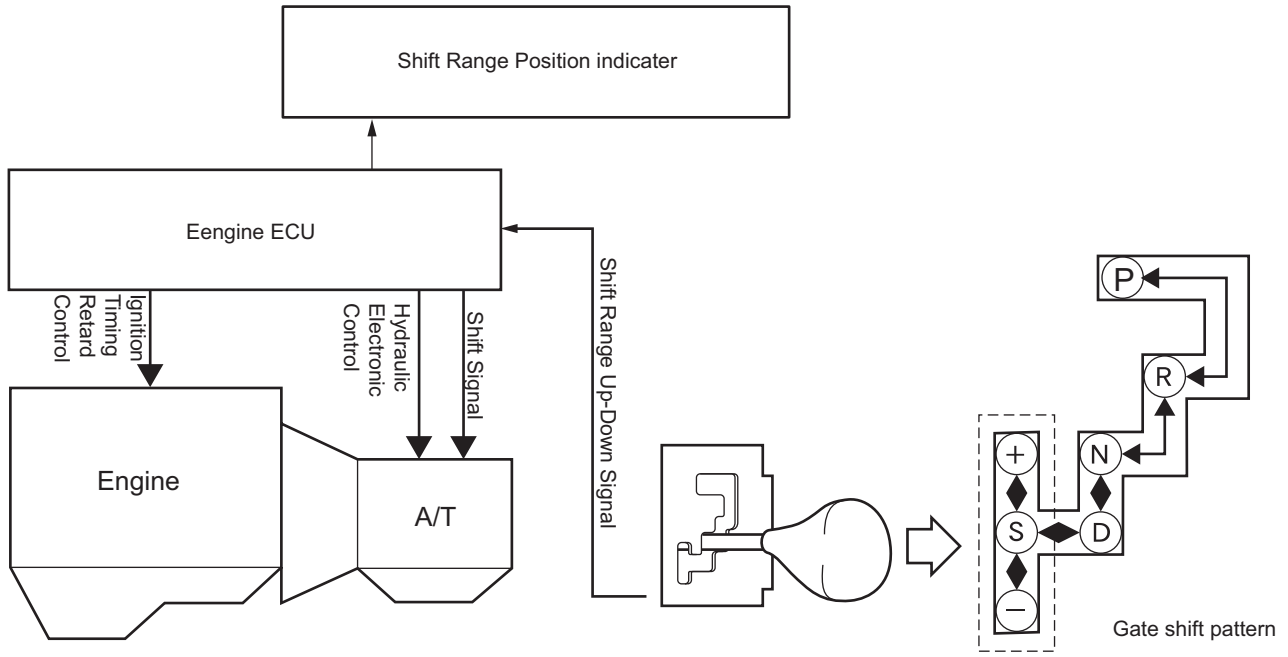
Warming Up		Heat Exchange Method	Effect
When warming up		Coolant → ATF	Accelerates the warming of ATF and shortens the flex lockup starting time. Accelerates the reduction of the friction loss of the automatic transmission.
After Warm-Up	Low- to Medium-Load	Coolant ←→ ATF	Maintains the ATF at a higher temperature than an oil cooler that is built into the radiator, thus reducing friction loss.
	High Load	Coolant ← ATF	Uses the same heat exchanger to cool the ATF if it is necessary to cool the ATF, thus reducing the deterioration of the ATF.

Specifications

Core Type	Multiplate Aluminum Water-Cooled Type
Core specification	ϕ 90×6 gears
Oil Capacity [L]	0.06
Dry Weight [Kg]	0.48

Multi-mode Automatic Transmission

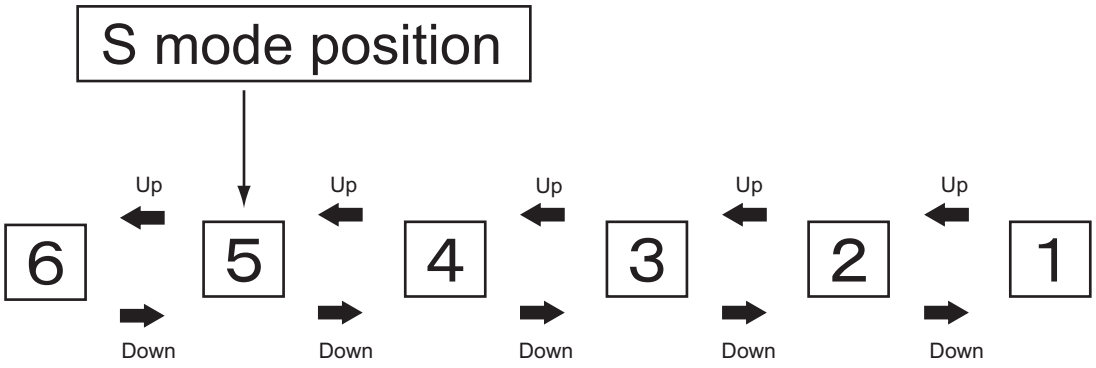
● When the driver moves the shift lever to the S position, the Multi-mode automatic transmission changes the transmission from the automatic shift mode to the multi-mode. This enables the driver to operate the vehicle in the shift range that the driver has selected with the shift lever. In addition, this mechanism enables the vehicle to provide an engine brake force that suits all shift ranges.



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Change The Multi-mode Automatic Transmission

- The driver can operate the multi-mode automatic transmission by moving the shift lever to the S position. At the same time, this movement causes the transmission to engage in the 5th range. (During AI-Shift control, the display will show the maximum range that is being controlled.)
- When the driver operates the shift lever, the shift up switch or the shift down switch (the "+" or "-" switch in the shift lever assembly) turns ON. This causes a shift signal to be transmitted to the engine ECU (with built-in transmission ECU), thus changing the shift ranges within the 6th to 1st range.

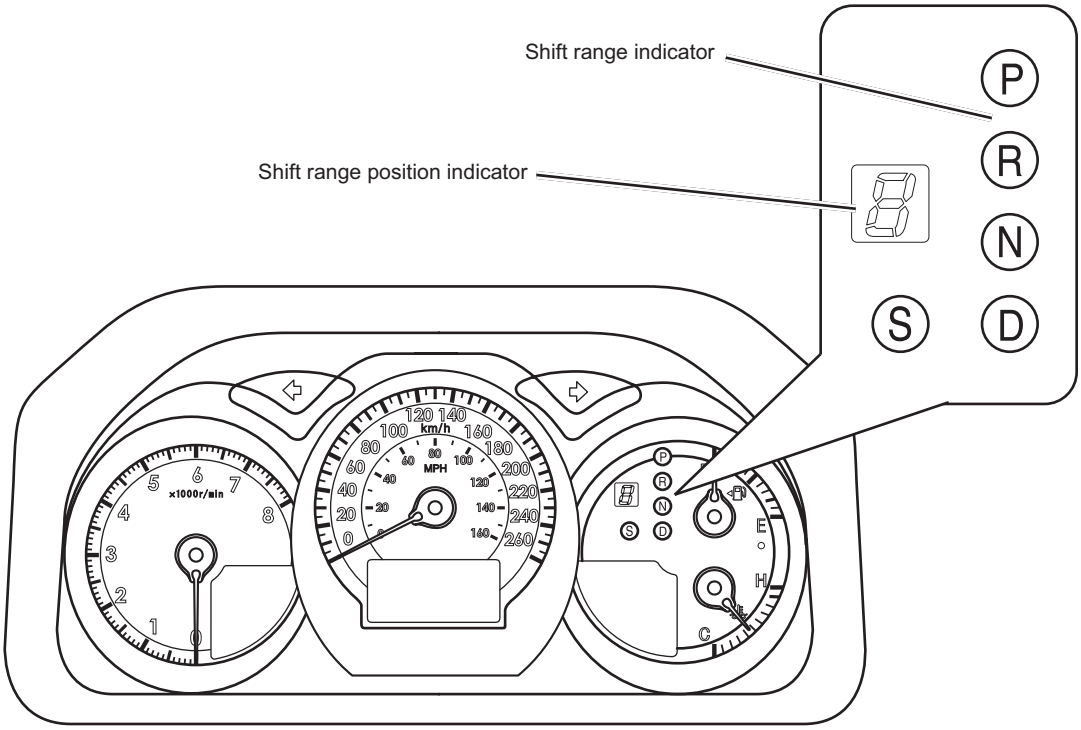


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TM

Multi-mode Automatic Transmission Indicator

- Shift range position indicator and a shift range indicator are provided in the combination meter.
- Shift magic position indicator illuminates when the driver moves the shift lever to the S position.
- When the shift lever is in the S position, the shift range indicator shows the shift range that is selected at that time. It does not appear in the P, R, N, or D range.



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Shift Gears That Can Use the Multi-mode Automatic Transmission

- When the shift lever is in the S mode position, the transmission fixes the gear to the selected shift range. Thus, the driver will be able to operate the vehicle with a manual transmission-like feel.

Shift Range Operation

Shift lever position	Shift operation	Shift range position indicator	Shift range
D	Impossible	Putting out lights	6,5,4,3,2,1(Automatic)
S	Possible	6	6,5,4,3,2,1(Automatic)
		5	5,4,3,2,1(Automatic)
		4	4,3,2,1(Automatic)
		3	3,2,1(Automatic)
		2	2,1(Automatic)
		1	1(Automatic)