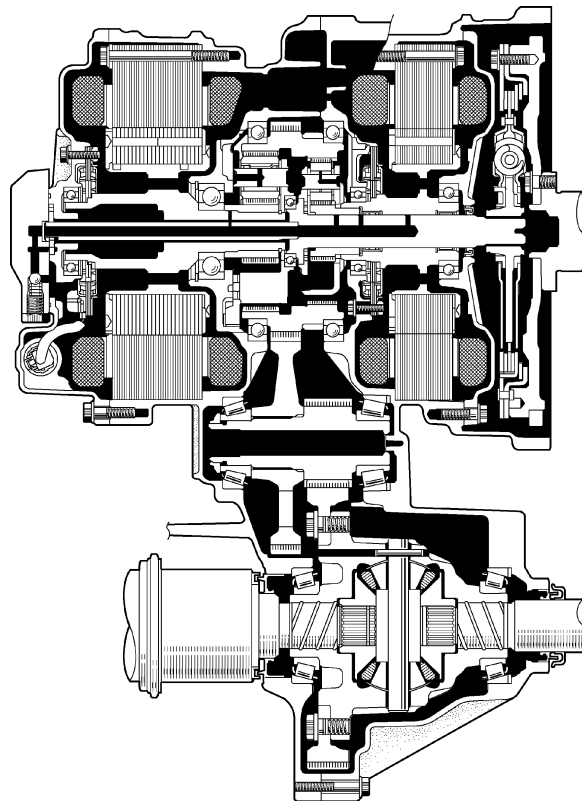


CHASSIS

P310 HYBRID TRANSAXLE

■ DESCRIPTION

- The P310 hybrid transaxle is used on the RX400h.
Containing a MG2 (Motor Generator No.2) for driving the vehicle and a MG1 (Motor Generator No.1) for generating electrical power, this hybrid transaxle uses a continuously variable transmission mechanism with compound gear unit (which consists of a motor speed reduction planetary gear unit and a power split planetary gear unit) that achieve smooth and quiet operation.
- A transaxle damper that consists of a coil spring with low-twist characteristics is used in order to absorb the torque fluctuation in the drive force of the engine.
- This transaxle uses two lubrication mechanisms concurrently: a lubrication mechanism consisting of a trochoid type oil pump placed on the main shaft, and a lubrication mechanism consisting of an oil slinger on the final gear. The concurrent use of the two mechanisms reduces the drive loss of the oil pump.



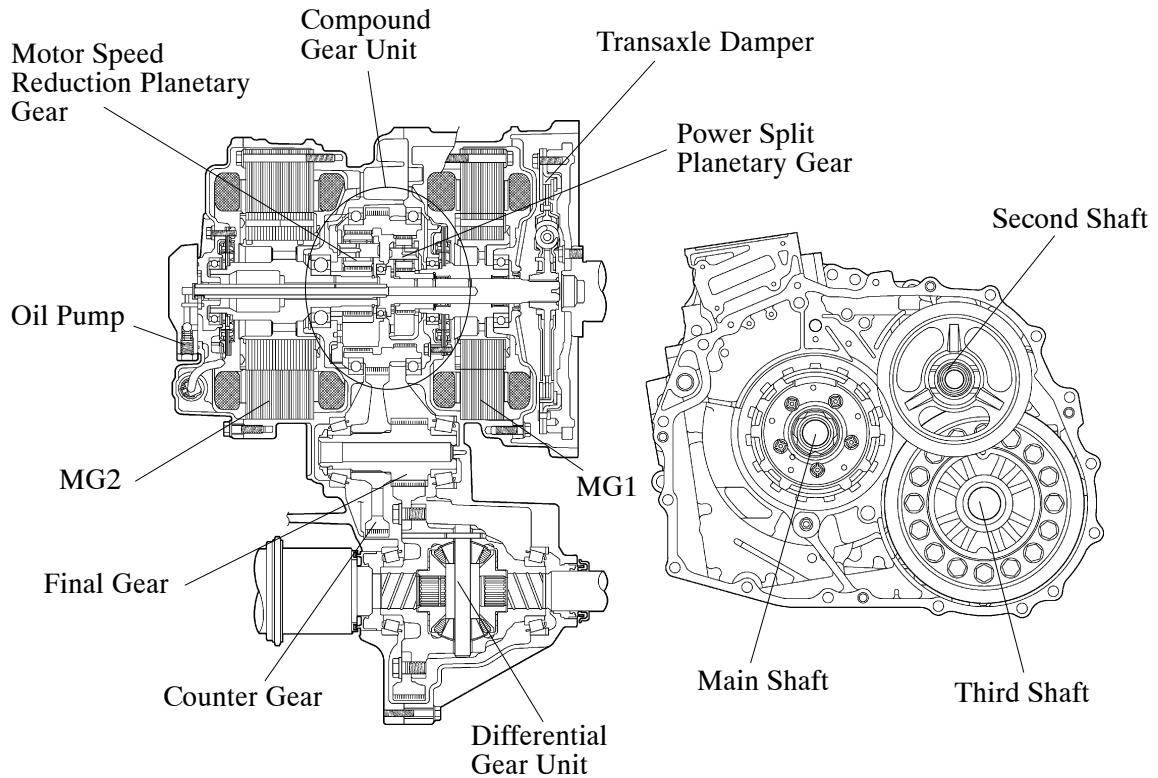
277TH44

► Specifications ◀

Transaxle Type		P310
Power Split Planetary Gear unit	The No. of Ring Gear Teeth	78
	The No. of Pinion Gear Teeth	23
	The No. of Sun Gear Teeth	30
Motor Speed Reduction Planetary Gear unit	The No. of Ring Gear Teeth	57
	The No. of Pinion Gear Teeth	18
	The No. of Sun Gear Teeth	23
Counter Gear	The No. of Drive Gear Teeth	54
	The No. of Driven Gear Teeth	55
Final Gear	The No. of Drive Gear Teeth	25
	The No. of Driven Gear Teeth	77
Total Deceleration Ratio		3.137
Oil Capacity Liters (US qts, Imp.qts)		4.2 (4.4, 3.7)
Oil Type		ATF WS or equivalent
Weight (Reference)* kg (lb)		117 (258)

* : Weight shows the figure with the fluid fully filled.

CH

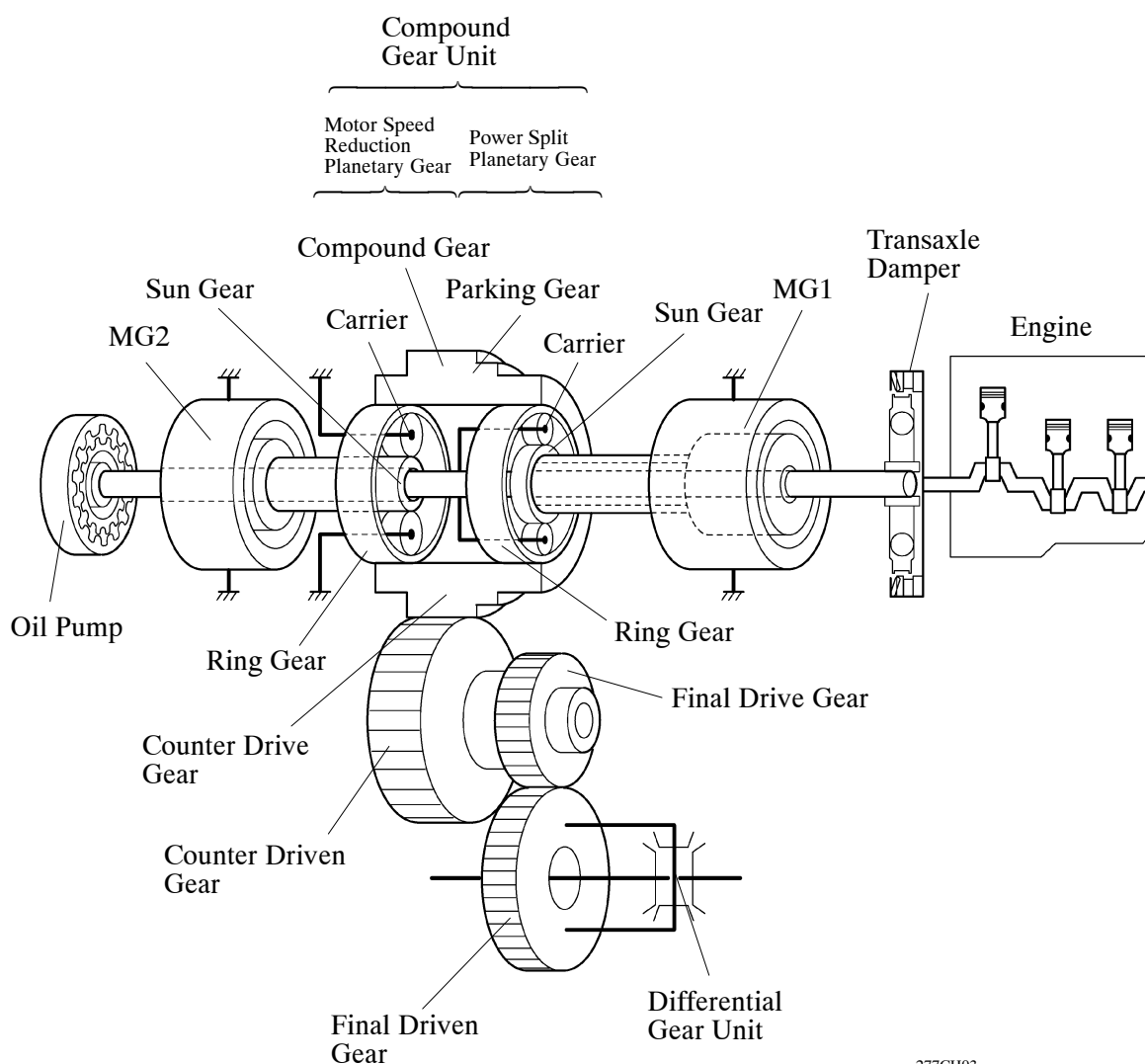


277CH02

■ TRANSAXLE UNIT

1. General

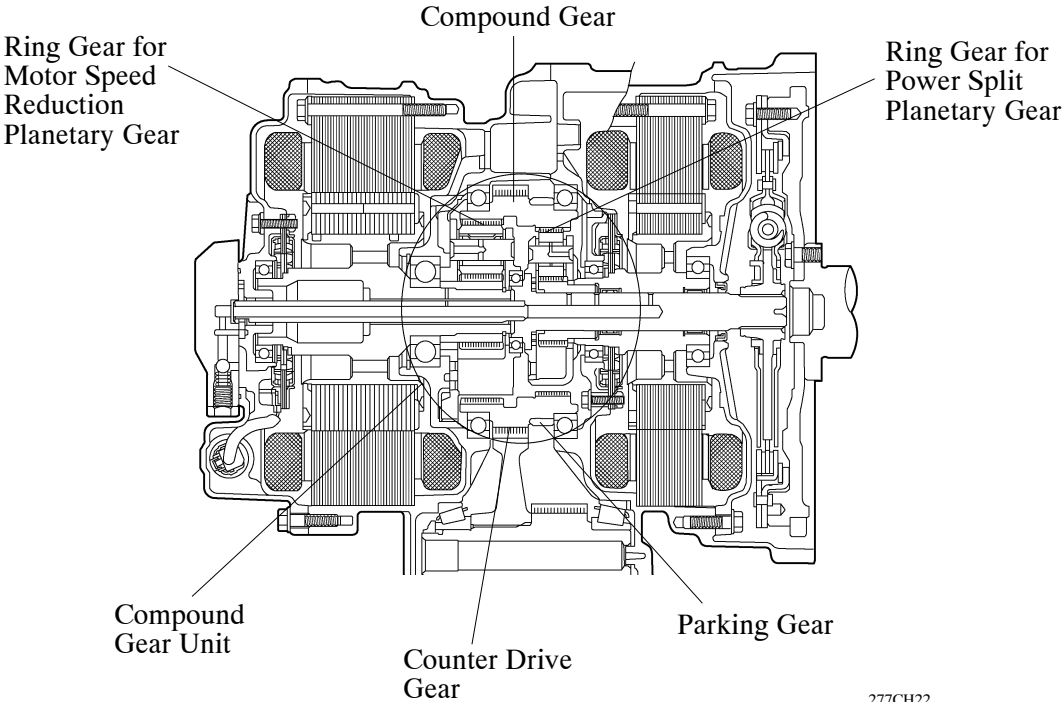
- This hybrid transaxle consists primarily of MG1, MG2, a compound gear unit (which consists of a motor speed reduction planetary gear unit and a power split planetary gear unit), a counter gear unit, and a differential gear unit.
- This transaxle has a three-shaft configuration. The compound gear unit (consisting of the motor speed reduction planetary unit and a power split planetary gear unit), MG1, and MG2 are provided on the main shaft. The counter driven gear and the final gear are provided on the second shaft. The differential ring gear and the differential gear unit are provided on the third shaft.
- The engine, MG1 and MG2 are mechanically joined via the compound gear unit.
- The compound gear unit contains a motor speed reduction planetary gear unit and a power split planetary gear unit. The motor speed reduction planetary gear unit, whose purpose is to reduce motor speed, is used to enable the high-speed, high-output MG2 to adapt optimally to the power split planetary gear unit. The power split planetary gear unit splits the motive force of the engine two ways: one to drive the wheels, and the other to drive the MG1, so that it can function as a generator.
- In the motor speed reduction planetary gear unit, the sun gear is coupled to the output shaft of MG2, and the carrier is fixed.



2. Compound Gear Unit

General

The compound gear unit consists of a motor speed reduction planetary gear, and a power split planetary gear. Each planetary ring gear is integrated with the compound gear. Furthermore, this compound gear is integrated with a counter drive gear and parking gear.



277CH22

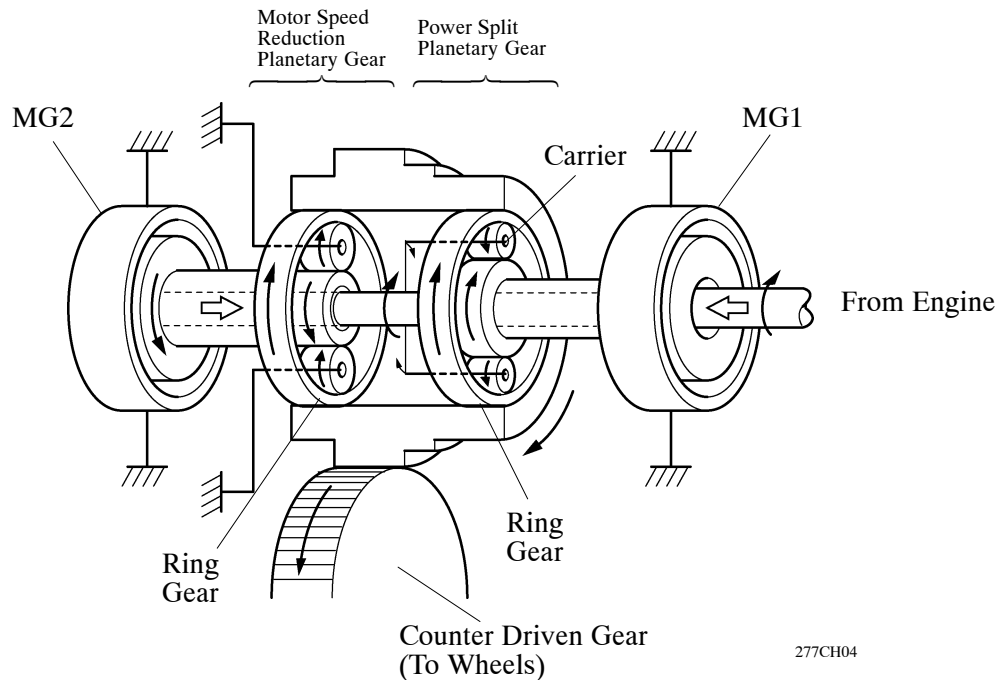
CH

Item		Connection
Power Split Planetary Gear	Sun Gear	MG1
	Ring Gear	Output (Wheels)
	Carrier	Engine Output Shaft
Motor Speed Reduction Planetary Gear	Sun Gear	MG2
	Ring Gear	Output (Wheels)
	Carrier	Fixed

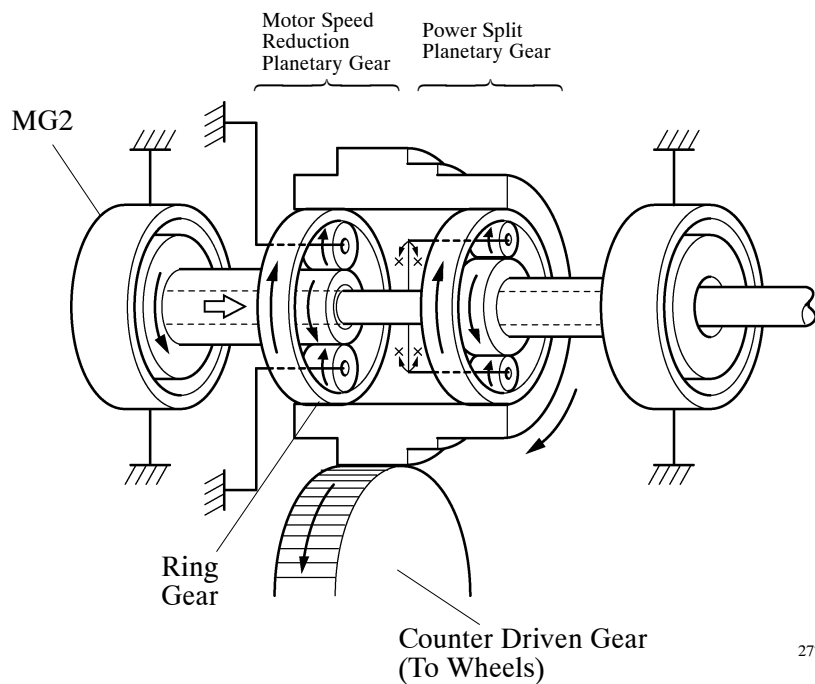
Power Split Planetary Gear

The power split planetary gear in the compound gear unit transmits the motive force in the four ways described below.

- The engine motive force, which is input by the carrier, is output to the ring gear. Furthermore, the MG2 motive force is output to the ring gear via the motor speed reduction planetary gear. The sum of these two motive forces is transmitted in order to drive the wheels.



- The MG2 motive force is output to the ring gear via the motor speed reduction planetary gear, and this motive force is transmitted in order to drive the wheels.



-

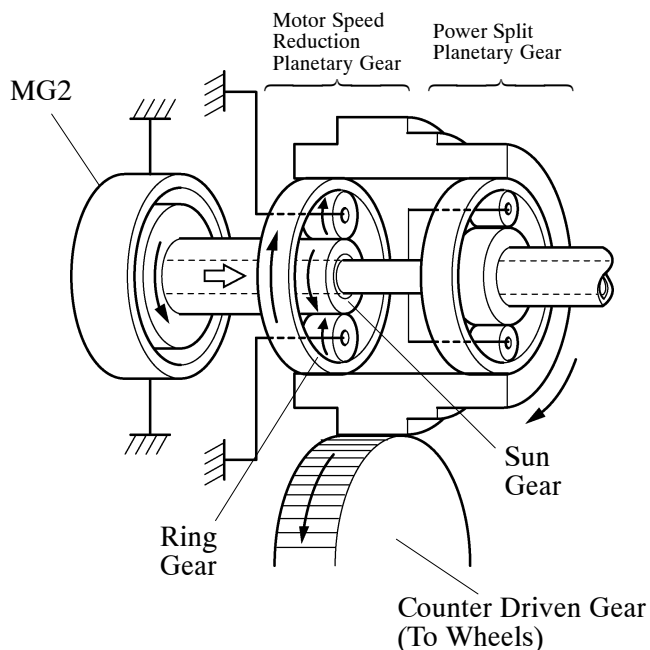
CH

-
- Motor Speed Reduction Planetary Gear
- Power Split Planetary Gear
- Carrier
- Sun Gear
- MG1
- To Engine

277CH28

Motor Speed Reduction Planetary Gear

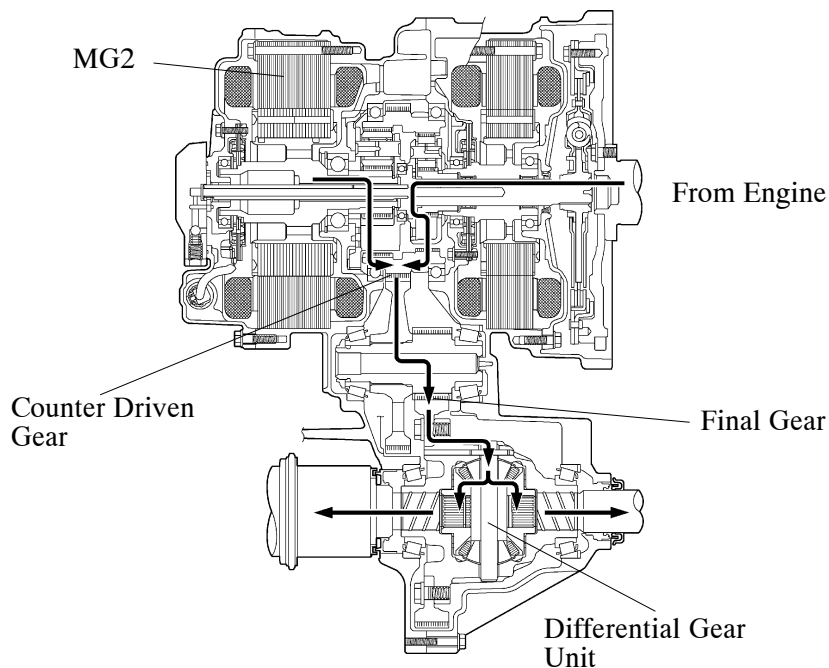
The carrier of the motor speed reduction planetary gear, which is located in the compound gear unit, is fixed. The MG2 motive force is input by the sun gear and is output to the ring gear, in order to drive the wheels. For this reason, the motor speed reduction planetary gear has a function to reduce the speed of MG2 and increase torque, in accordance with a set gear ratio.



277CH29

3. Gear Train

This transaxle transmits the motive force created by the engine and MG2 to the counter drive gear and the counter driven gear of the compound gear unit, via the final gear, and to the differential gear unit, in order to drive the front wheels.



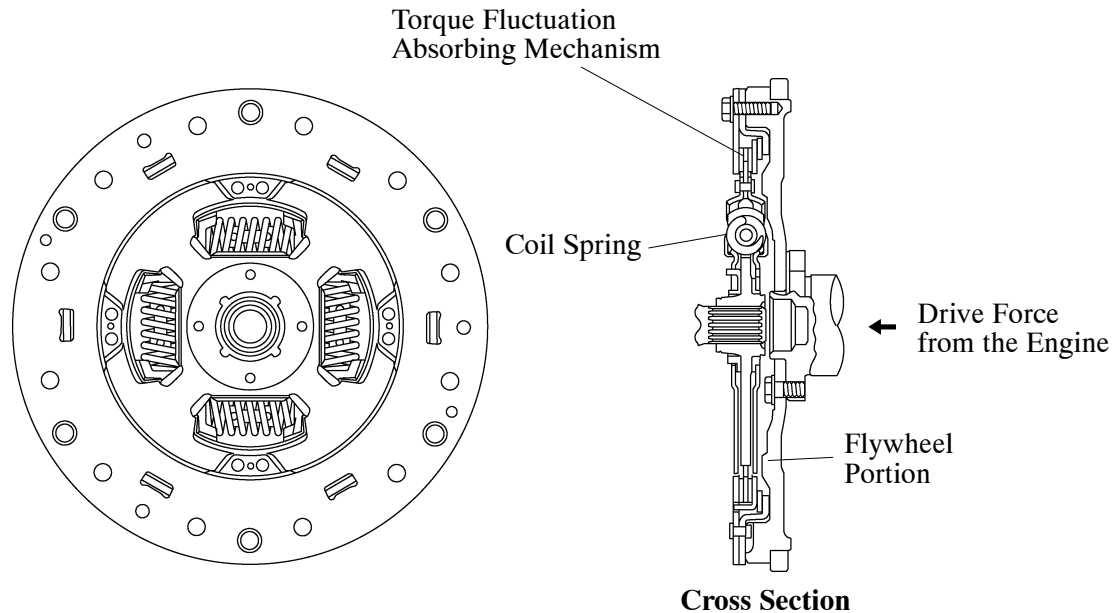
277CH07

4. Differential Gear Unit

For the differential gear unit, a 2-pinion type that is similar to the differential unit of the conventional transaxle is used.

5. Transaxle Damper

A transaxle damper that consists of a coil spring with low-twist characteristics is used in order to absorb the torque fluctuation in the drive force of the engine. Furthermore, a torque fluctuation absorbing mechanism that uses a dry-type, single-plate friction material is used. Through the use of the parts, a damper construction that excels in absorbing the vibrations of the engine motive force has been achieved.



277CH06

6. MG1 and MG2

MG1 and MG2 are located coaxially at each end of the compound gear unit.

MG1 connects to the sun gear of the power split planetary gear, and MG2 connects to the sun gear of the motor speed reduction planetary gear. For detailed characteristics of MG1 and MG2, refer to MG1, MG2 and MGR in [THS-II](#), on [page TH-27](#).

Service Tip

Do not disassemble MG1 or MG2 because they are precision components. If a malfunction is found on either of these components, replace MG1 or MG2 as a complete assembly.

■ LUBRICATION MECHANISM

- This transaxle is lubricated by a trochoid type oil pump placed on the main shaft.
- Furthermore, it uses a final gear with an oil sling type lubrication mechanism. This construction minimizes the drive torque of the oil pump, which reduces the drive loss.
- An oil catch tank is used in this transaxle in order to supply oil in a stable manner. The oil catch tank temporarily stores the oil that is slung up, and supplies oil to each gear train from there. Furthermore, oil holes are provided in the oil catch tanks in order to efficiently supply oil to MG1 and MG2.

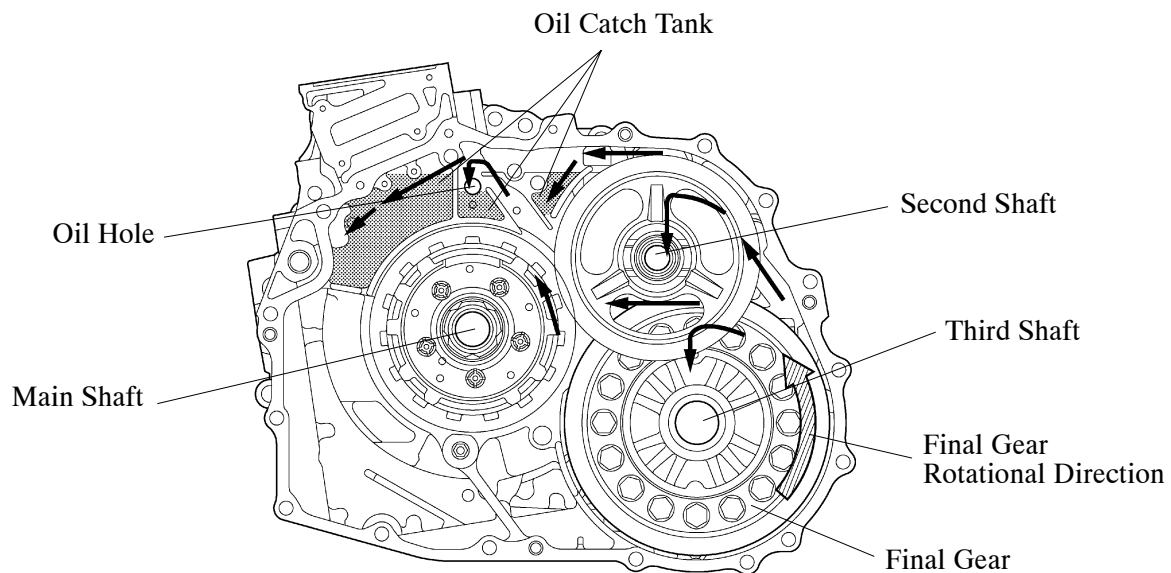


Diagram of Oil Flow

277CH08

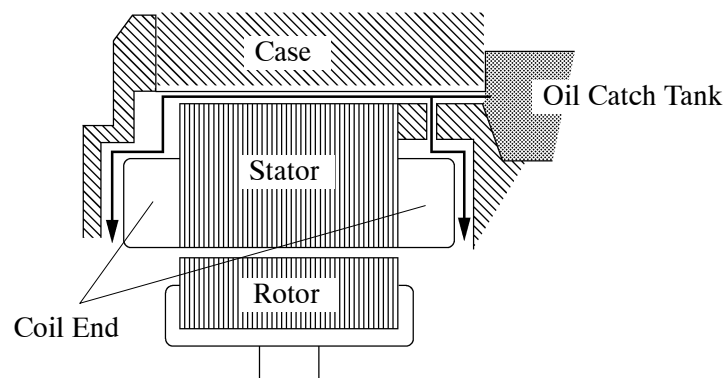
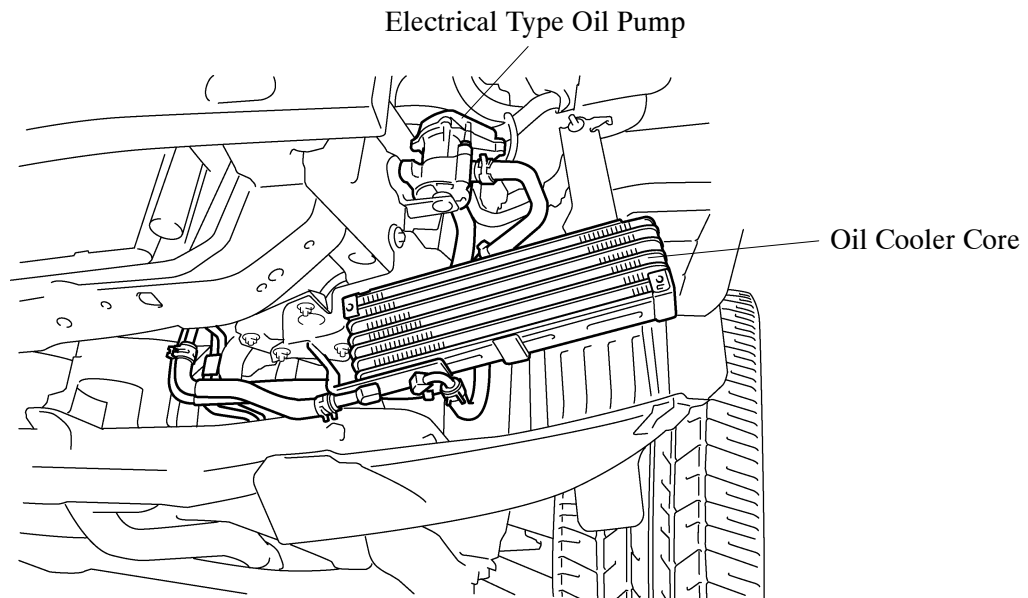


Diagram of Motor Generator Cooling

277CH09

- A transaxle oil cooler is used. This oil cooler is provided on the inside of the LH side of the front bumper. An electrical type oil pump that is provided on top of the oil cooler core circulates oil.



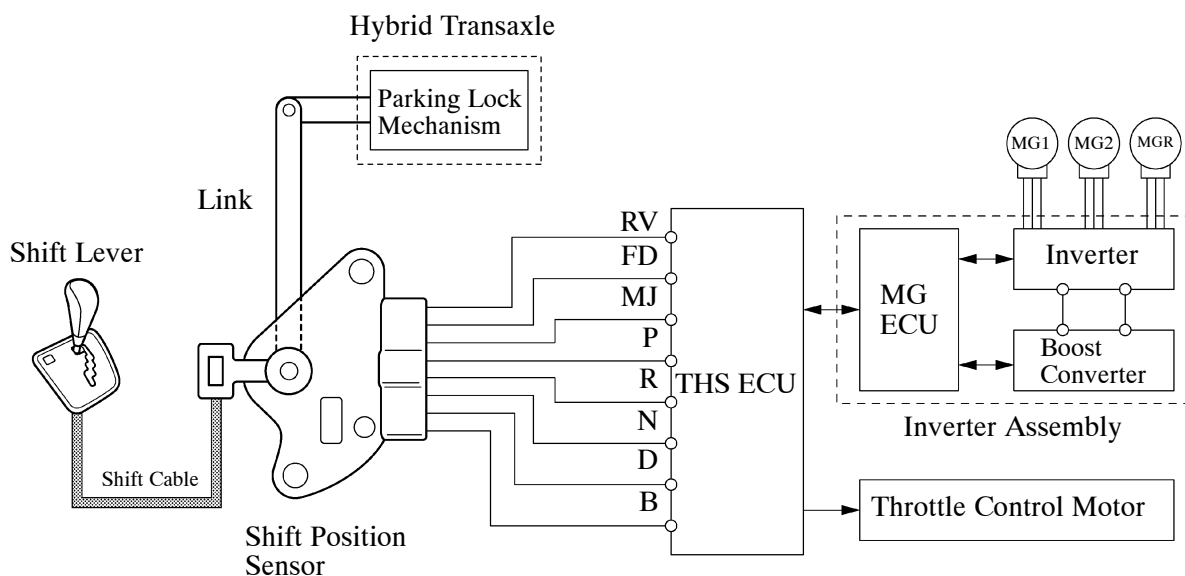
277CH30

■ SHIFT CONTROL SYSTEM

1. Shift Control

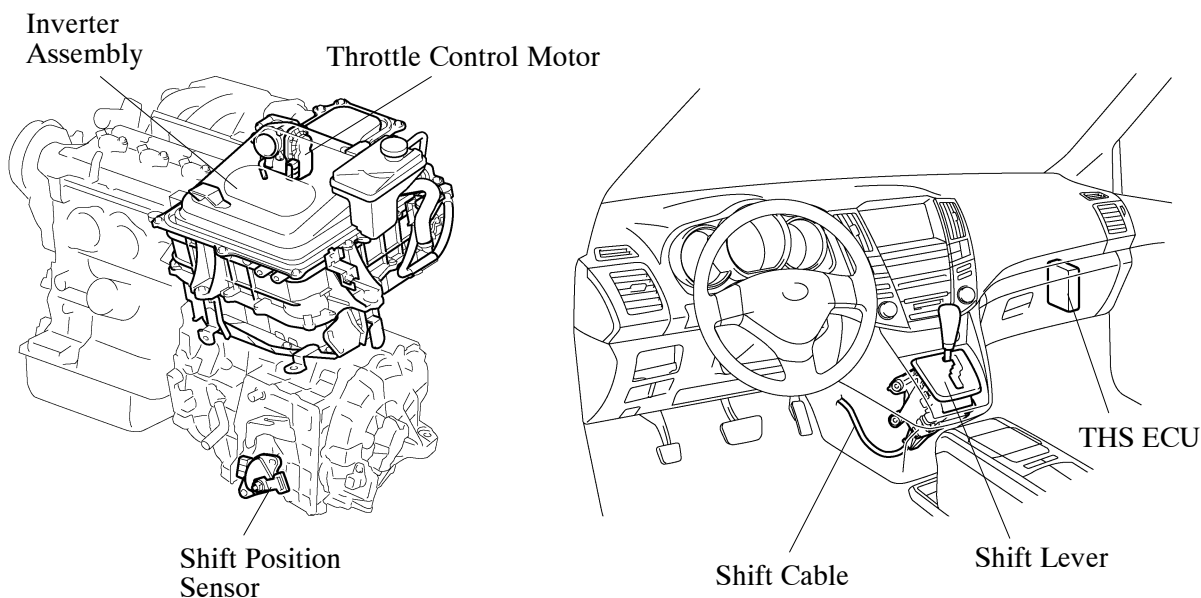
- A shift position sensor is provided in the transaxle to detect the shift position and sends a corresponding signal to the THS ECU. Upon receiving this signal, the THS ECU optimally combines the operation of the engine, MG1, MG2, and MGR in order to produce the respective shift positions (“P”, “R”, “N”, “D”, and “B”).
- However, because the movement of the wheels must be mechanically locked in the P position, a parking lock mechanism is used in the transaxle. Therefore, if the driver operates the shift lever to the P position, a cable and a linkage cause the movement of the transaxle to lock mechanically.

► System Diagram ◀



277CH23

► Layout of Main Components ◀

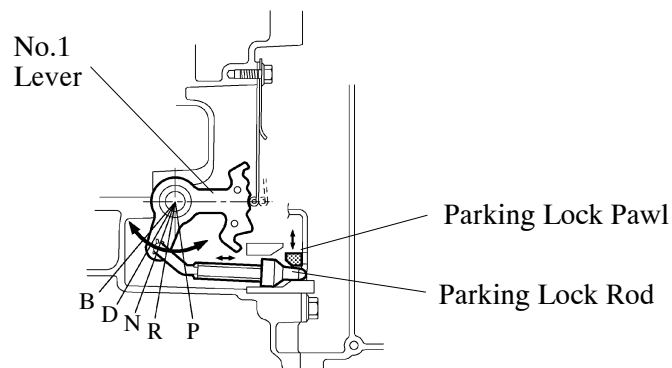
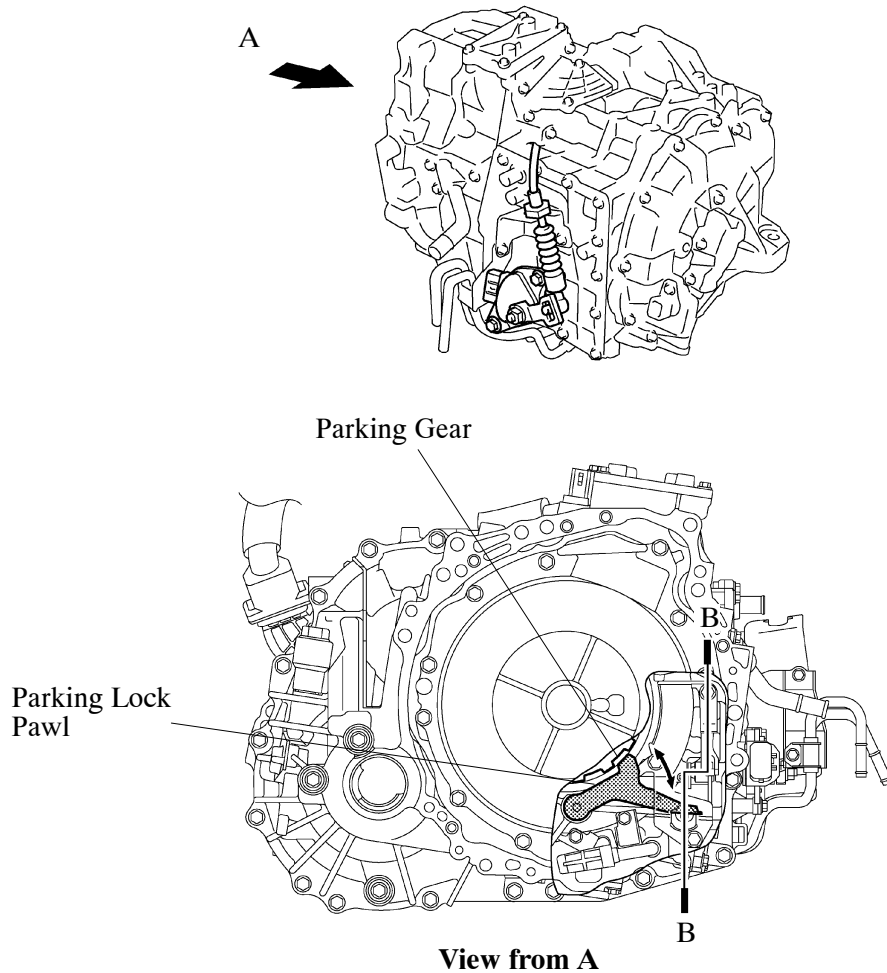


LHD Model

277CH24

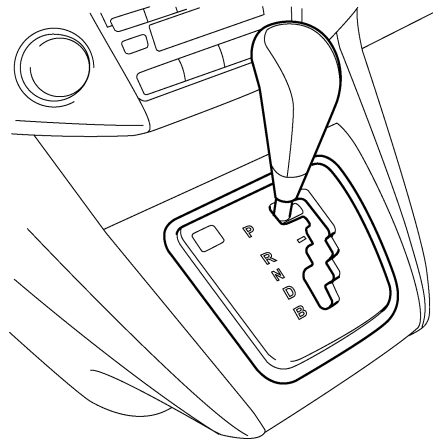
2. Parking Lock Mechanism

- A mechanical parking lock mechanism has been provided in the compound gear. The engagement of the parking lock pawl with the parking gear that is integrated with the compound gear locks the movement of the vehicle.
- When the driver moves the shift lever to the P position, the cable at the shift lever causes the No. 1 lever to rotate. The rotational movement of the No. 1 lever causes the parking lock rod to slide and the parking lock pawl to push up. As a result, the parking lock pawl locks the parking gear.



3. Shift Lever

A 5-position (P, R, N, D, and B) gate type shift lever is used. The gate type shift lever operates on the single-shift operation principle (fore-aft and side-to-side). Therefore, it does not require the use of a shift lever button, which is used on a straight type shift lever. Therefore, it excels in ease of use.



277CH26

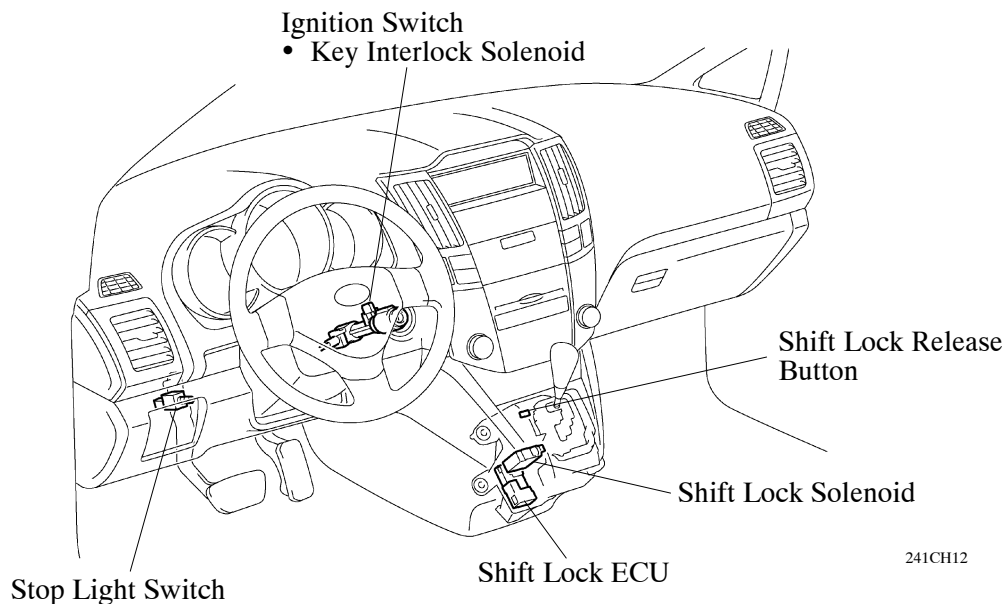
LHD Model

4. Shift Lock System

General

- The key interlock device prevents the key from being pulled out after the ignition switch is turned OFF, unless the shift lever is moved to the P position. Thus, the driver is urged to park the vehicle in the P position.
- The shift lock mechanism prevents the shift lever from being shifted to a position other than the P position, unless the ignition switch is ON and the brake pedal is pressed. It prevents the driver from accidentally releasing the parking lock condition.

Layout of Main Components

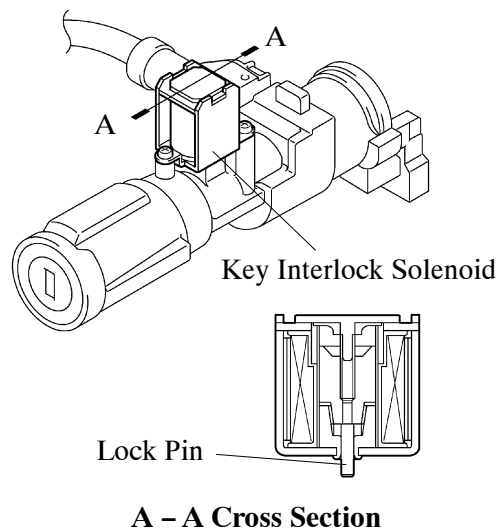


241CH12

LHD Model

Key Interlock Solenoid

The activation of the key interlock solenoid that is mounted on the upper column bracket moves the lock pin to restrict the movement of the key cylinder. Therefore, if the shift lever is shifted to any position other than “P”, the ignition key cannot be moved from “ACC” to the “LOCK” position.



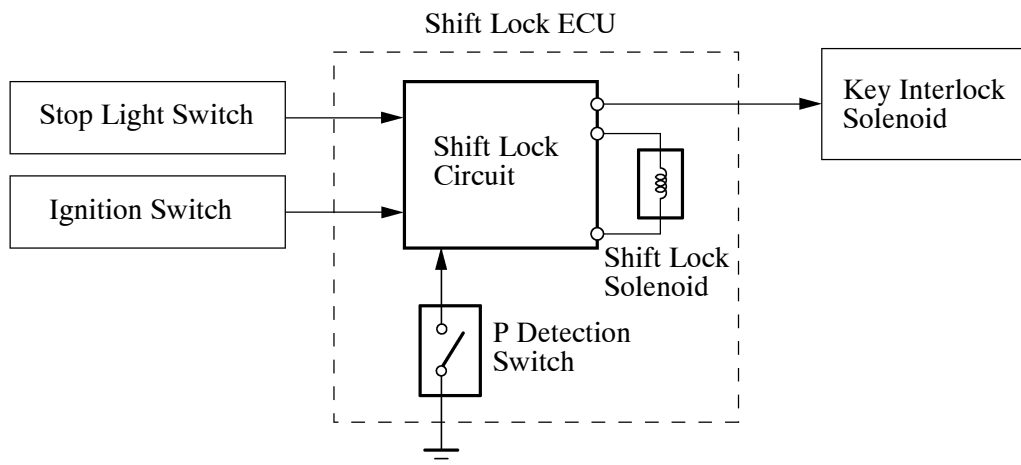
241CH13

System Operation

- The shift lock ECU uses the P detection switch to detect the shift lever position, and receives the inputs of the stop light switch and ignition switch signals. Upon receiving these signals, the shift lock ECU turns ON the key interlock solenoid and the shift lock solenoid in order to release the key interlock and shift lock.
- A shift lock override button, which manually overrides the shift lock mechanism, is provided.

CH

► System Diagram ◀

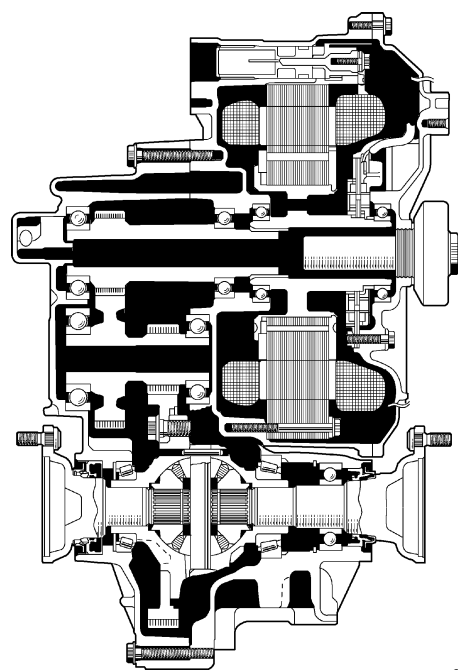


232CH94

Q211 REAR TRANSAXLE

DESCRIPTION

- The Q211 rear transaxle is used. This transaxle has a built-in MGR (Motor Generator Rear), which is used for driving the rear wheels. It consists of a counter drive gear, counter driven gear, and a differential gear unit, which transmit the motive force of MGR.
- A lubrication mechanism, which uses a differential ring gear to sling up the oil, is used.



277CH10

Specifications

Transaxle Type		Q211
Gear Train Type		Three Shaft Counter Type
Total Deceleration Ratio		6.859
Counter Gear	The No. of Drive Gear Teeth	23
	The No. of Driven Gear Teeth	40
Differential Gear	The No. of Drive Pinion Gear Teeth	18
	The No. of Ring Gear Teeth	71
No. of Differential Pinion		2
Oil Capacity Liters (US qts, Imp.qts)		2.0 (2.1, 1.8)
Oil Type		ATF WS or Equivalent
Weight (Reference)* kg (lb)		41.3 (91.1)

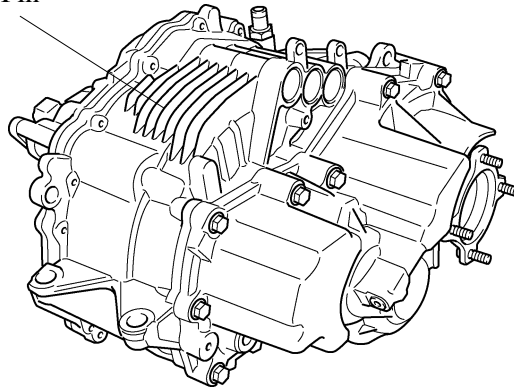
* : Weight shows the figure with the fluid fully filled.

■ TRANSAXLE UNIT

1. General

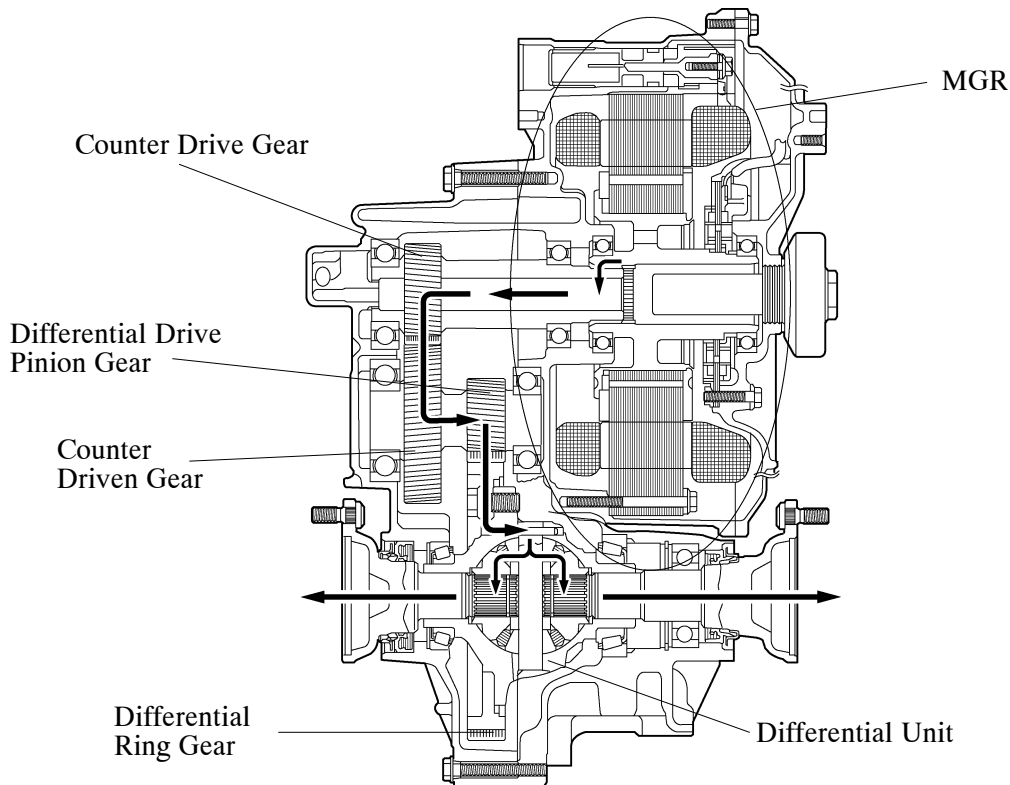
- This transaxle has a three-shaft configuration. MGR and the counter drive gear are provided on the main shaft. The counter driven gear and the differential drive pinion gear are provided on the second shaft. The differential ring gear and the differential gear unit are provided on the third shaft.
- This transaxle transfers the motive force of MGR to the counter drive gear, counter driven gear, differential drive pinion gear, differential ring gear, and differential gear unit, in order to drive the rear wheels.
- The transaxle case and cover are made of aluminum. The shape of the case and the shape of the ribs have been optimized to achieve a highly rigid and lightweight construction. Furthermore, cooling fins have been provided on top of the transaxle case to improve cooling performance.

Cooling Fin



277CH11

CH



Motive Force Transmission Path

277CH12

2. MGR

MGR, which is mounted on the main shaft, directly drives the counter drive gear.

For detailed characteristics of MGR, refer to MG1, MG2 and MGR in THS-II, on page TH-27.

Service Tip

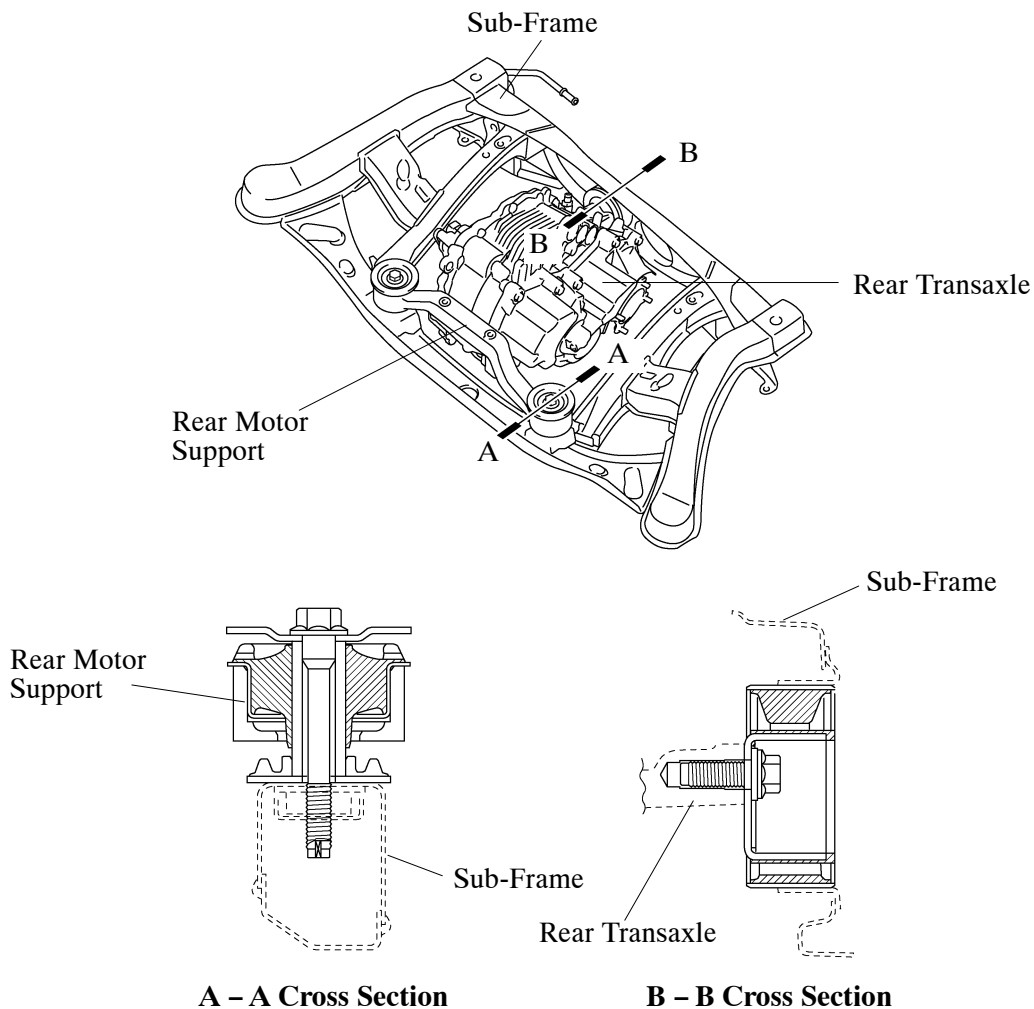
Do not disassemble MGR because it is a precision component. If a malfunction is found, replace it as a rear transaxle assembly.

3. Differential Gear Unit

For the differential gear unit, a 2-pinion type that is similar to the differential unit of the conventional transaxle is used.

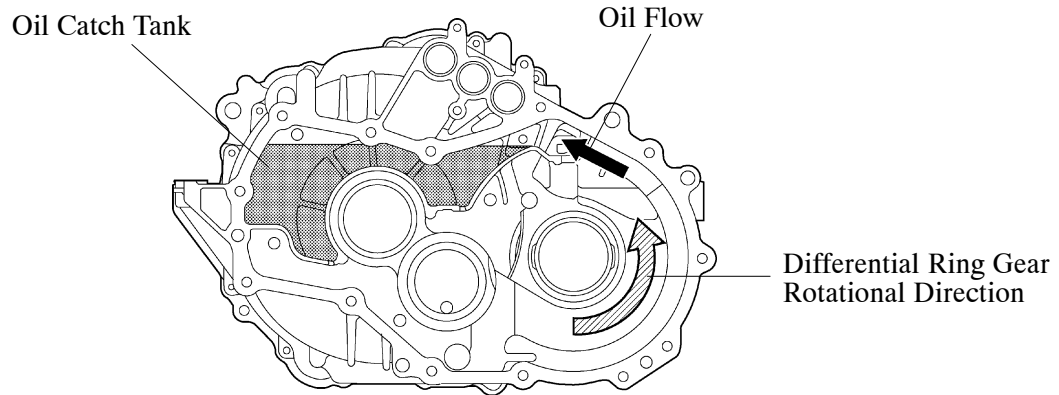
4. Transaxle Mount

The transaxle mount consists of two points at the front, which are supported by the rear motor support, and one point at the rear, which is supported by a mount that is press-fit into the sub-frame.

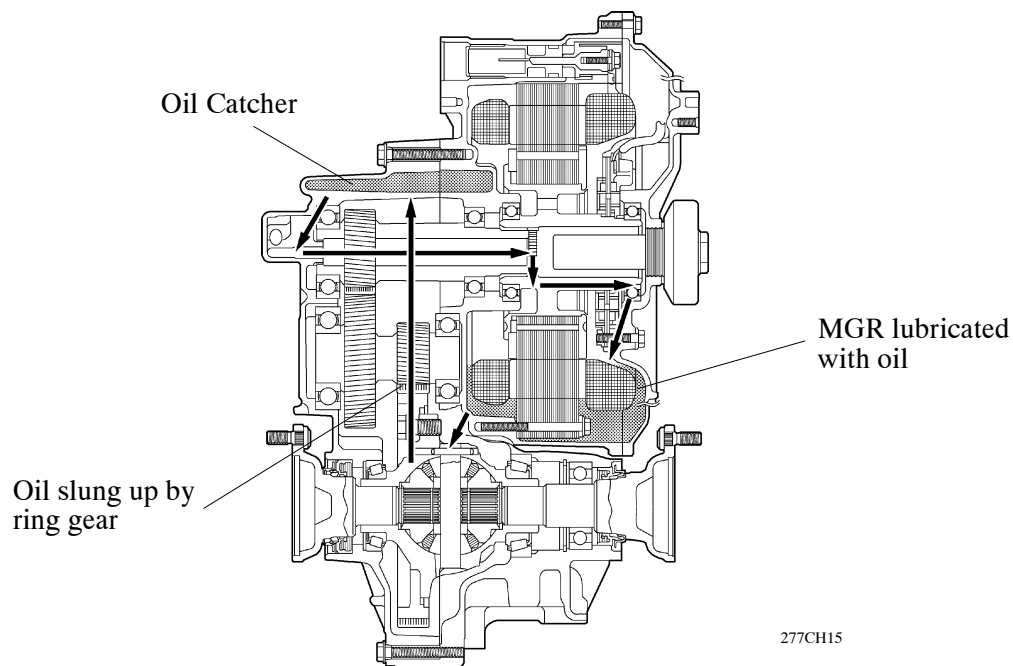


■ LUBRICATION MECHANISM

- A lubrication mechanism, which uses a differential ring gear to sling up the oil, is used.
- An oil catch tank is used in this transaxle in order to supply oil in a stable manner. The oil catch tank temporarily stores the oil that is slung up, and supplies oil in a stable manner to each gear train from there.



277CH14



277CH15

Diagram of Oil Flow

4WD SYSTEM

■ DESCRIPTION

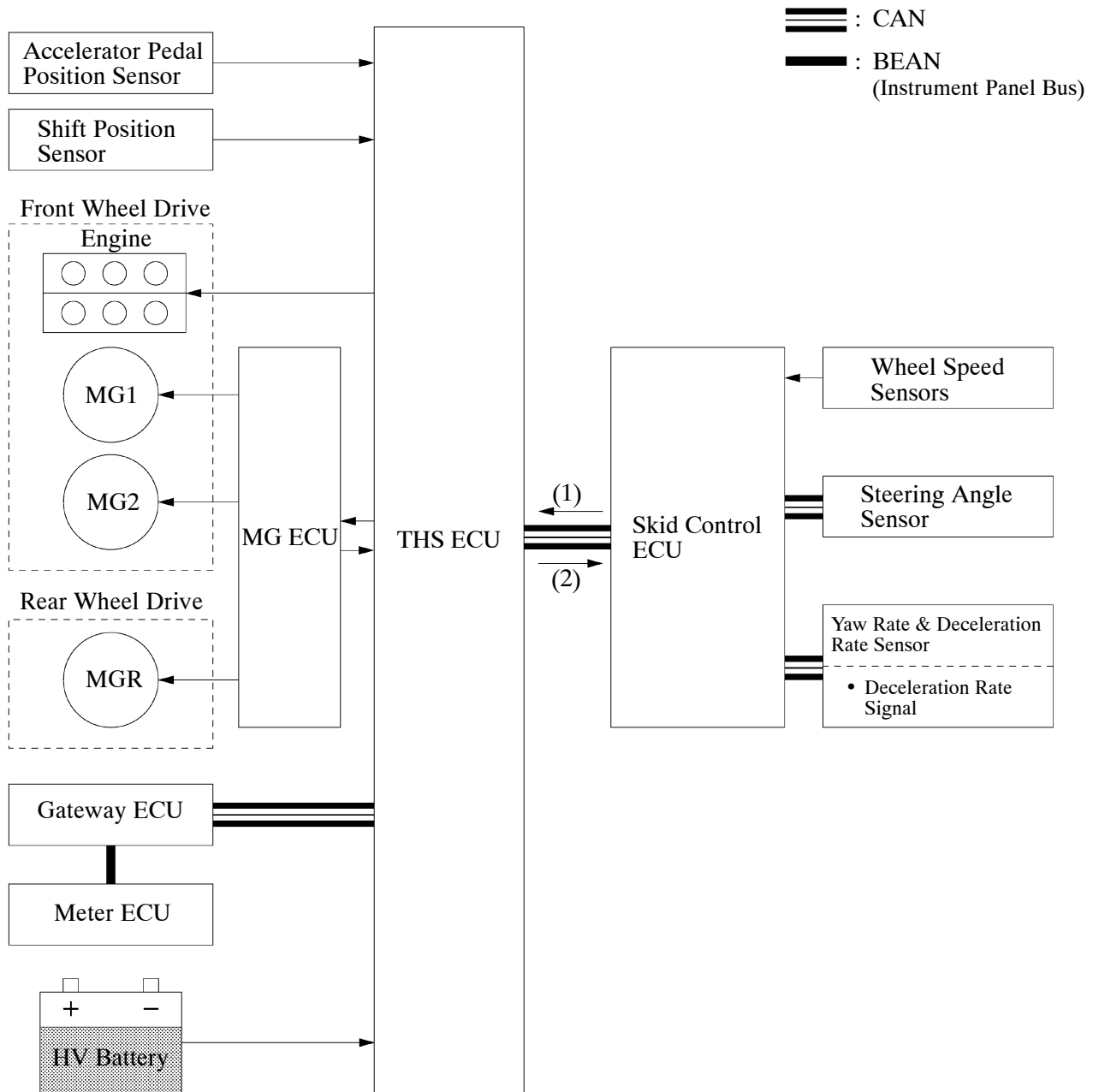
1. General

- The new RX400h uses an electric type 4WD system.
- Under the control of the THS ECU, this system uses an MGR (Motor Generator Rear) in the rear transaxle to directly drive the rear wheels. According to the driving conditions of the vehicle, the THS ECU linearly effects distribution control to attain an optimal front-rear torque distribution that provides the drive force required by the vehicle as a whole. Therefore, this system realizes a high level of fuel economy performance and traction performance under various conditions, thus realizing excellent driving stability.

► Feature of 4WD System ◀

Item	Outline
Starting Off	On a slippery road surface, the skid control ECU calculates the required total motive force and the torque distribution between the front and rear wheels, and transmits the signals to the THS ECU. Upon receiving these signals, the THS ECU appropriately drives the front and rear wheels, in order to achieve traction performance while ensuring driving stability.
Normal Driving	• As a rule, the system stops the driving of the rear wheels during normal driving to ensure fuel economy performance. • If the vehicle is being driven on a slippery road surface, accelerates, or makes a tight turn, the skid control ECU detects the conditions of the vehicle based on the signals provided by the sensors. Then, the skid control ECU calculates the required total motive force and the torque distribution between the front and rear wheels, and transmits the signals to the THS ECU. Upon receiving these signals, the THS ECU appropriately drives the front and rear wheels, in order to achieve traction performance while ensuring driving stability.
Decelerating	When the vehicle is decelerating, the kinetic energy is recovered from the front and rear wheels, converted into electrical energy, and used for recharging the HV battery by means of MG2 and MGR. This contributes to fuel economy performance.

► System Diagram ◀

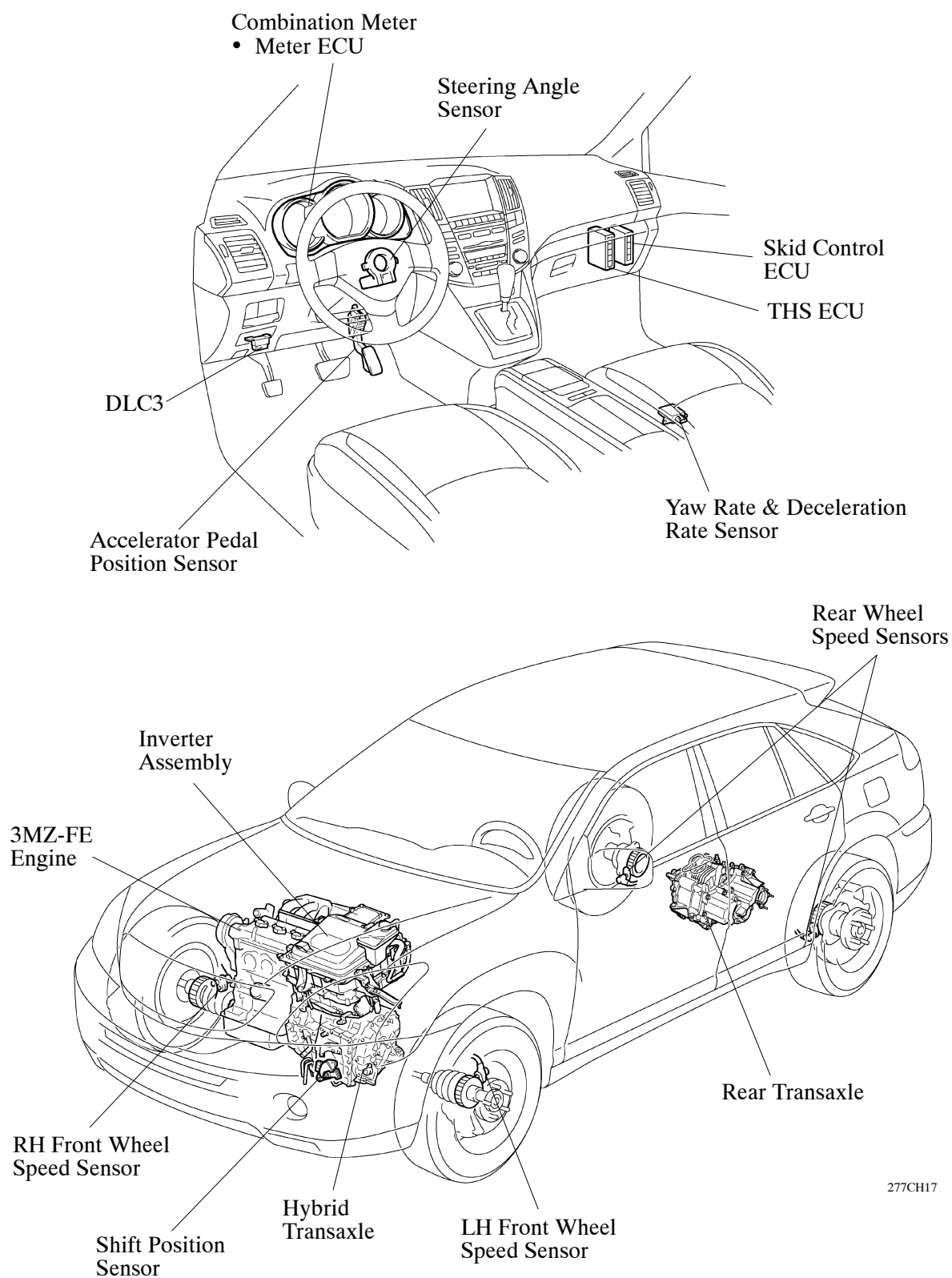


CH

282CH09

- (1) : • Required motive force distribution rate for front and rear wheels
 (2) : • Required total motive force
 • Motive force execution value of front and rear wheels
 • Shift position signal

2. Layout of Main Components



277CH17

LHD Model

■ FUNCTION OF MAIN COMPONENTS

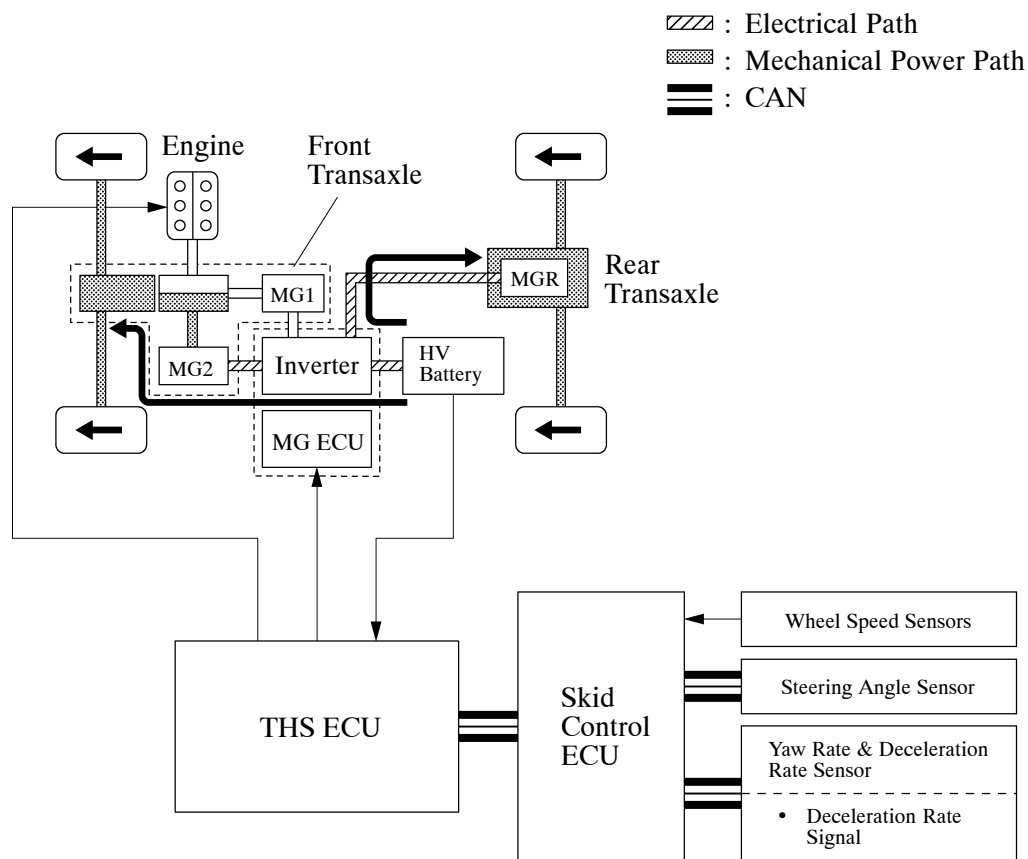
The table below describes the functions of the main components of the 4WD system.

Components	Function
Engine and Front Transaxle	The motive forces of MG2 that is built into the front transaxle and the engine are combined to drive the front wheels.
Rear Transaxle	The motive force of MGR that is built into the rear transaxle is transmitted to drive the rear wheels.
Skid Control ECU	• Detects the conditions of the vehicle based on the signals that are input from the sensors and the THS ECU, calculates the required total motive force and the torque distribution between the front and rear wheels, and transmits the signals to the THS ECU. • If the skid control ECU detects a failure in the system, it transmits a request to the THS ECU to display a 4WD warning on the multi-information display in the combination meter.
THS ECU	• The THS ECU calculates the required motive force based on the amount of effort applied to the accelerator pedal by the driver and the signals from the sensors. Then, the THS ECU transmits the required motive force and the shift position signal to the skid control ECU. • The THS ECU controls the engine, MG2, and MGR based on the required total motive force and the torque distribution between the front and rear wheels, which are transmitted by the skid control ECU, in order to appropriately control the motive force.
Wheel Speed Sensors (FL, FR, RL, RR)	Detects the speed of each wheel, and transmits this signal to the skid control ECU.
Steering Angle Sensor	Detects the steering direction and the angle of the steering wheel, and transmits this signal to the skid control ECU.
Yaw Rate & Deceleration Rate Sensor (Deceleration Rate Signal)	Detects the vehicle's acceleration in the forward, rearward, and lateral directions, and sends these signals to the skid control ECU.
4WD Warning (Multi-Information Display)	The multi-information display in the combination meter displays a 4WD warning in accordance with the illumination request received from the THS ECU, in order to inform the driver. At the same time, the master warning light illuminates and the buzzer sounds.

■ OPERATION

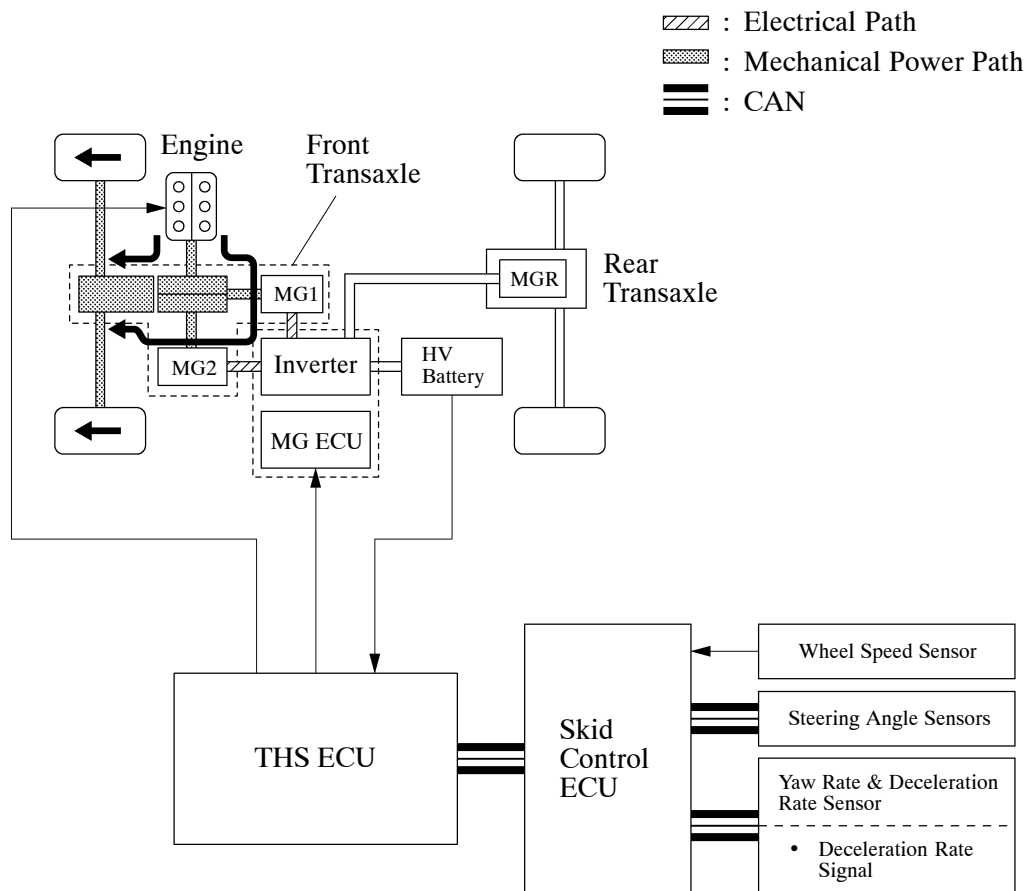
1. Start-off Control

- The THS ECU calculates the required motive force based on the amount of effort applied to the accelerator pedal by the driver and the signals from the sensors. Then, the THS ECU transmits the required motive force and the shift position signal to the skid control ECU.
- The skid control ECU determines that the vehicle is in the start-off state based on the signals from the wheel speed sensors, steering angle sensor, and the yaw rate & deceleration rate sensor (deceleration rate signal). Then, the skid control ECU calculates the torque distribution between the front and rear wheels based on the foregoing signals and the required motive force and the shift position signal from the THS ECU, and transmits them to the THS ECU.
- Upon receiving the signals from the skid control ECU, the THS ECU appropriately controls the motive forces of MG2 and MGR, in order to achieve traction performance while ensuring driving stability.
- The THS ECU constantly monitors the SOC (state of charge) of the HV battery. Thus, it appropriately controls whether to use the electrical power of the HV battery to drive MG2 and MGR, use the electrical power generated by MG1 to drive MG2 and MGR, or use both electrical powers.



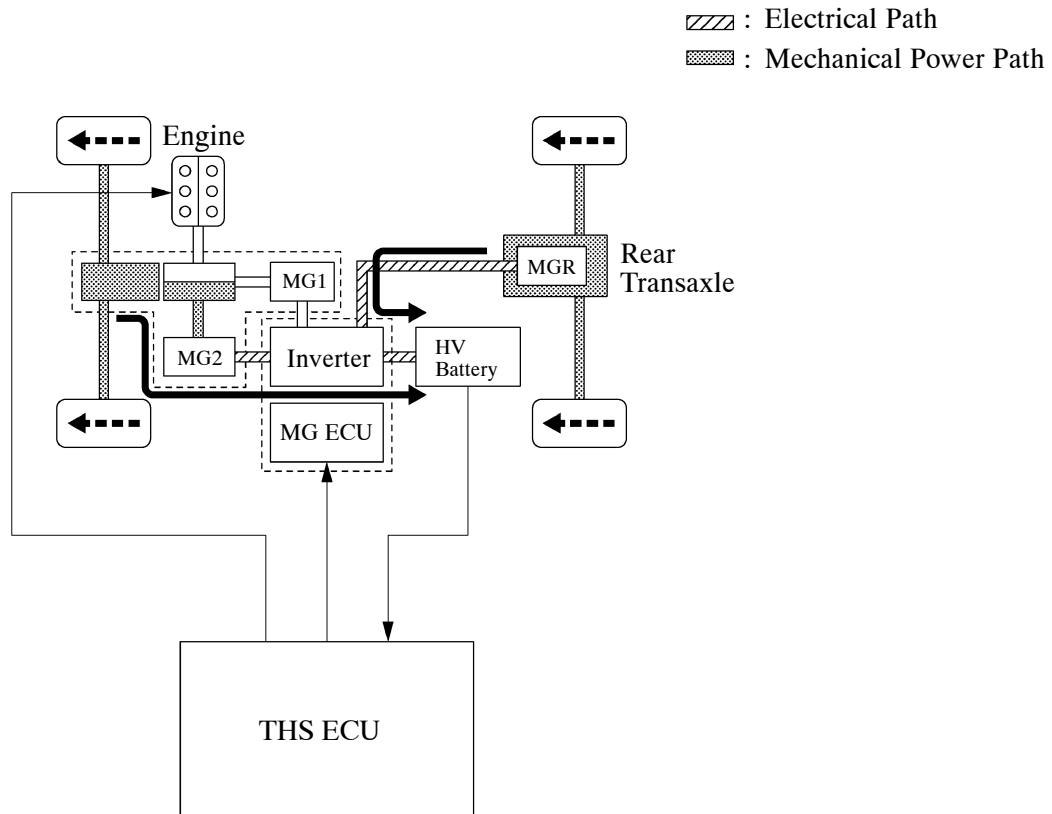
2. Normal Driving

- As a rule, the system stops the driving of the rear wheels during normal driving, to ensure fuel economy performance.
- If the vehicle is being driven on a slippery road surface, accelerates, or makes a tight turn, the skid control ECU detects the conditions of the vehicle based on the signals provided by the wheel speed sensors, steering angle sensor, and the yaw rate & deceleration rate sensor (deceleration rate signal). Then, the skid control ECU calculates the torque distribution between the front and rear wheels, and transmits the signals to the THS ECU.
- Upon receiving the signals from the skid control ECU, the THS ECU appropriately controls the motive forces of the engine, MG2, and MGR, in order to achieve traction performance while ensuring driving stability.
- The THS ECU constantly monitors the SOC (state of charge) of the HV battery. Thus, it appropriately controls whether to use the electrical power of the HV battery to drive MG2 and MGR, use the electrical power generated by MG1 to drive MG2 and MGR, or use both types of electrical power.



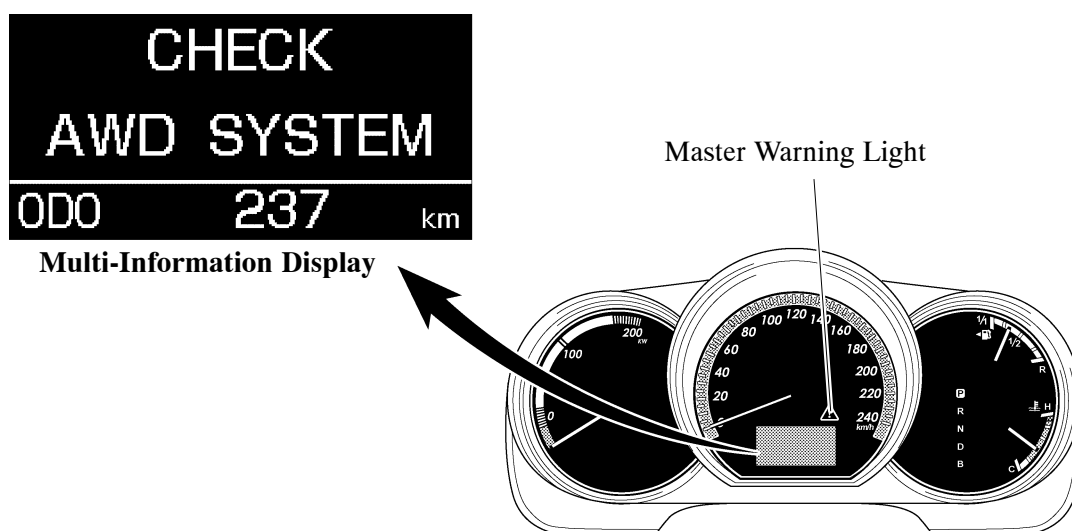
3. Deceleration

- The THS ECU determines that the vehicle is decelerating by way of the required motive force and the shift position signal, and calculates the torque distribution for the front and rear wheels.
- Based on the front and rear wheel torque distribution values that have been calculated, the THS ECU determines the ratio for operating the regenerative brakes of the MG2 and MGR. According to this ratio, the MG2 and MGR charge the HV battery. By converting the kinetic energy of the vehicle into an electrical energy and recovering it in the HV battery, this system contributes to enhancing fuel economy.



■ DIAGNOSIS

- If the THS ECU detects that its function to communicate with the skid control ECU fails, or a function that is related to MGR fails, the ECU performs a diagnosis and memorizes the failed sections. Furthermore, the THS ECU transmits the 4WD warning illumination request signal to the meter ECU. Then, the meter ECU displays the 4WD warning on the multi-information display in the combination meter to inform the driver. Furthermore, the master warning light illuminates and the buzzer sounds simultaneously.
- If the skid control ECU detects a failure in the skid control ECU proper in the function to communicate between the skid control ECU and the THS ECU or in the sensors, the ECU performs a diagnosis and memorizes the failed sections. Furthermore, the skid control ECU transmits the 4WD warning illumination request signal to the THS ECU. The THS ECU transmits this signal to the meter ECU. Then, the meter ECU displays the 4WD warning on the multi-information display in the combination meter to inform the driver. Furthermore, the master warning light illuminates and the buzzer sounds simultaneously.



278CH01

- In both the THS ECU and the skid control ECU, three-digit information codes have been provided in the conventional DTCs as a subset of the primary five-digit code. During troubleshooting, this enables a technician to narrow down the trouble area in order to identify a problem.
 - The DTCs can be accessed through the use of the intelligent tester II.
- For details, refer to the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

■ FAIL-SAFE

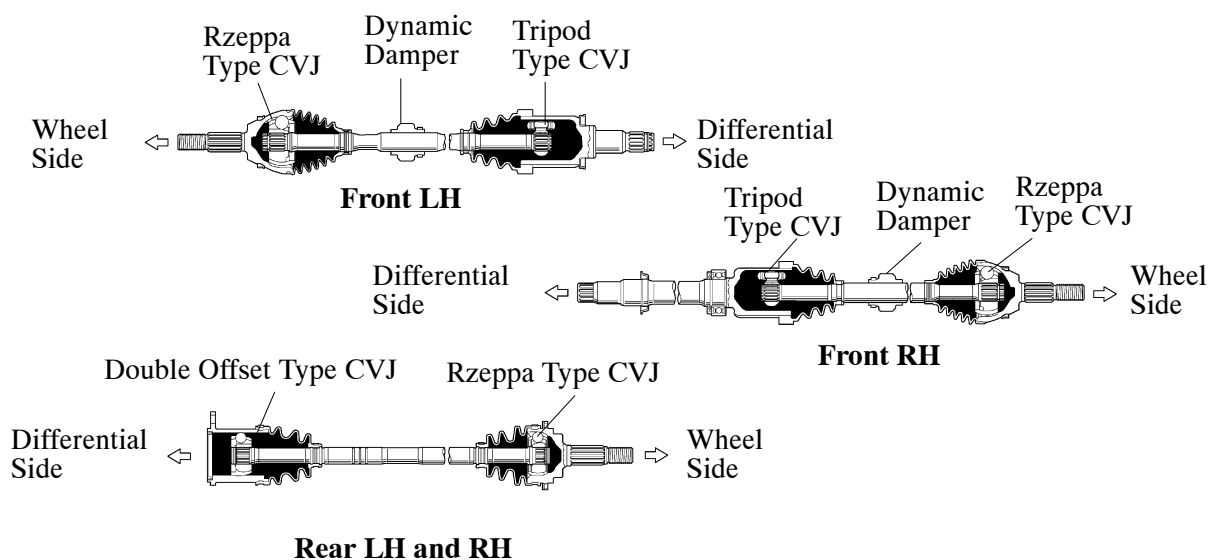
If the THS ECU or skid control ECU detects a malfunction in the 4WD system, it will control the system in accordance with the data that is stored in its memory.

For details, refer to the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

DRIVE SHAFT

DESCRIPTION

- The front drive shaft uses a tripod type CVJ (Constant Velocity Joint) on the front differential side, and Rzeppa type CVJ on the wheel side.
- The rear drive shaft uses a double offset type CVJ on the rear differential side, and Rzeppa type CVJ on the wheel side.

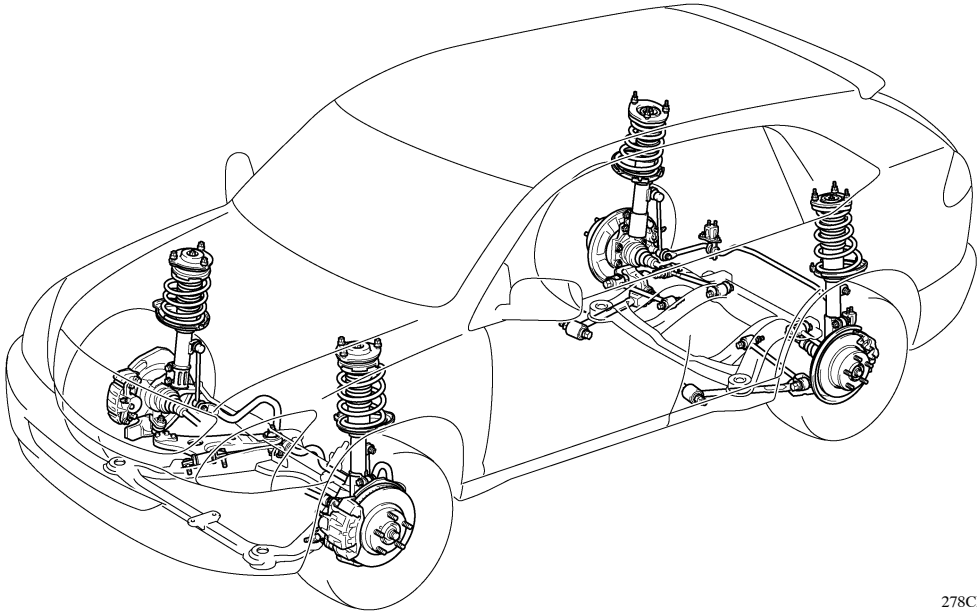


SUSPENSION AND AXLE

■ SUSPENSION

1. General

- A MacPherson strut type independent suspension is used for the front.
- A dual link MacPherson strut type independent suspension is used for the rear.



278CH104

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► Specifications ◀

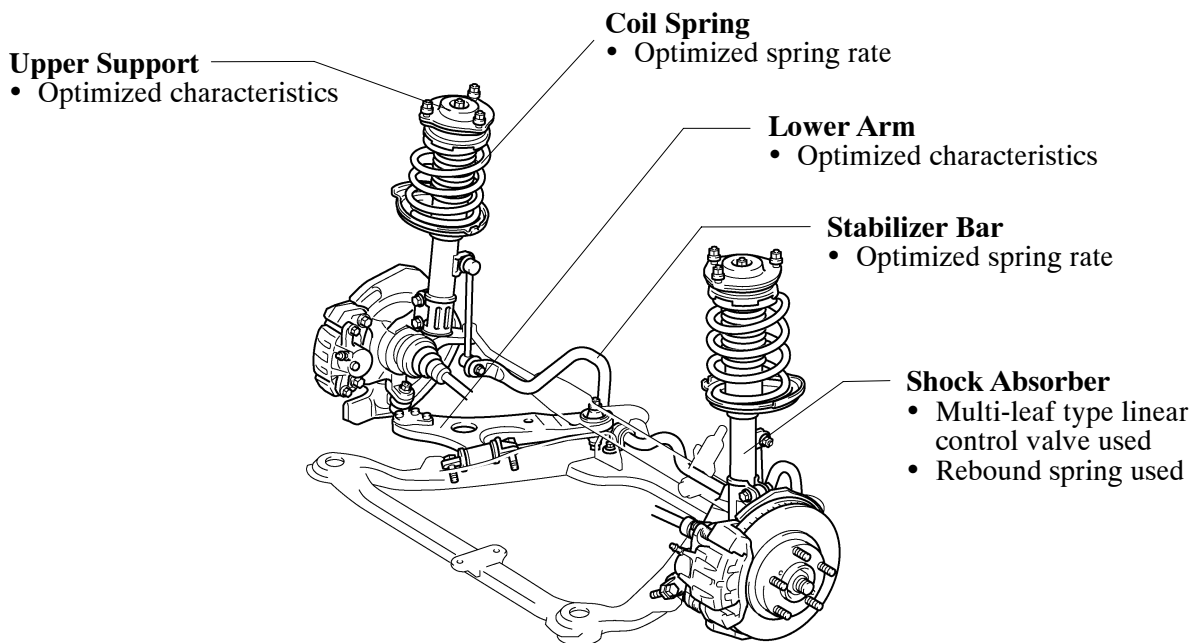
Front Wheel Alignment	Type		MacPherson Strut
	Tread*	mm (in.)	1,575 (62.0)
	Caster*	degrees	2° 25'
	Camber*	degrees	-0° 40'
	Toe-in*	mm (in.)	0
	King Pin Inclination*	degrees	10° 40'
Rear Wheel Alignment	Type		Dual link MacPherson Strut
	Tread*	mm (in.)	1,550 (61.0)
	Camber*	degrees	-0° 35'
	Toe-in*	mm (in.)	3 (0.12)

*: Unload Vehicle Condition

2. Front Suspension

General

Through the optimal location of components, and the use of Nachlauf geometry, the front suspension provides excellent riding comfort and controllability.



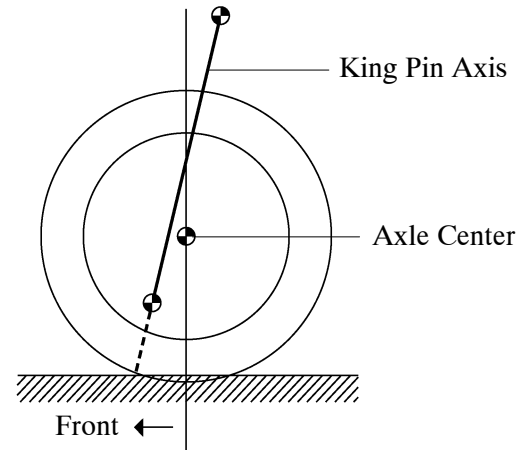
277CH104

Service Tip

- To adjust the camber of the front suspension, change the location of the bolts and nuts fastened onto the lower side of the shock absorber and front axle. For details, see the LEXUS RX400h Repair Manual (Pub. No. RM1139E).
- To prevent injury or hazard when discarding a low-pressure (N₂) gas sealed shock absorber, make sure to remove the gas before disposal. For details, see the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

Nachlauf Geometry

The front suspension uses the Nachlauf geometry in which the king pin axis is located ahead of the axle center. As a result, excellent straightline stability and steering feel has been improved.



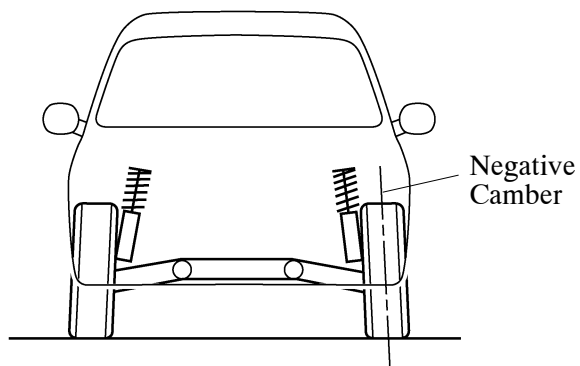
181CH22

Negative Camber

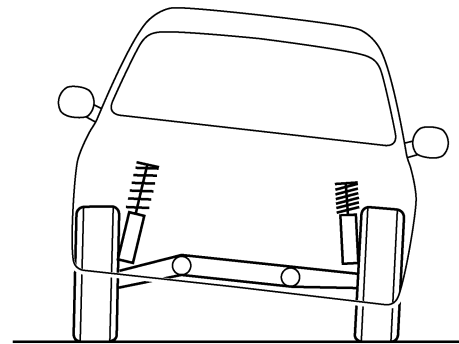
The front suspension uses negative camber to reduce the ground contact camber angle of the outer wheel during of turning (cornering), and provide excellent cornering performance.

► During Cornering ◄

CH



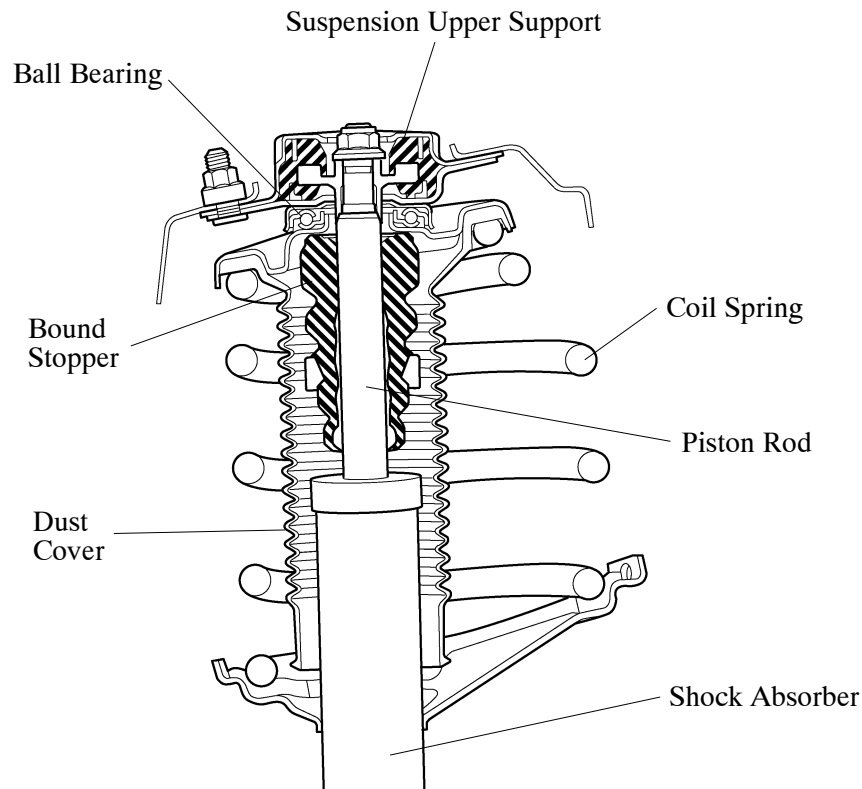
181CH23



181CH24

Suspension Upper Support and Coil Spring

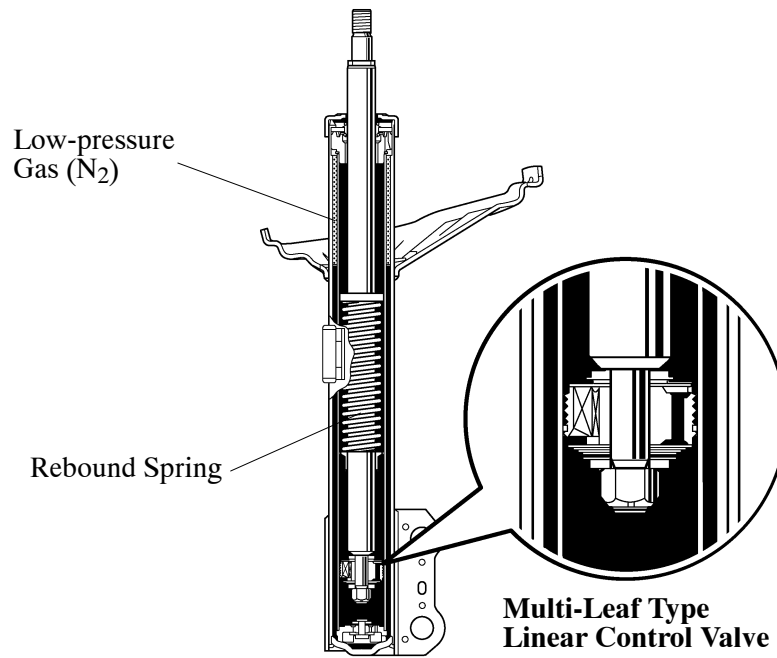
- The suspension upper support transmits the load that is applied via the spring through its metal structure, while the rubber portion receives only the load that is applied through the shock absorber.
- The center axis of the coil spring is slanted toward the outside of the vehicle compared to the center axis of the shock absorber. This reduces the lateral force bearing on the shock absorber piston rod and piston, and prevents increased sliding resistance while helping to maintain riding comfort.
- The dust cover is designed to completely cover the piston rod to reduce the intrusion of dust and improves the durability of the shock absorber.



Shock Absorber

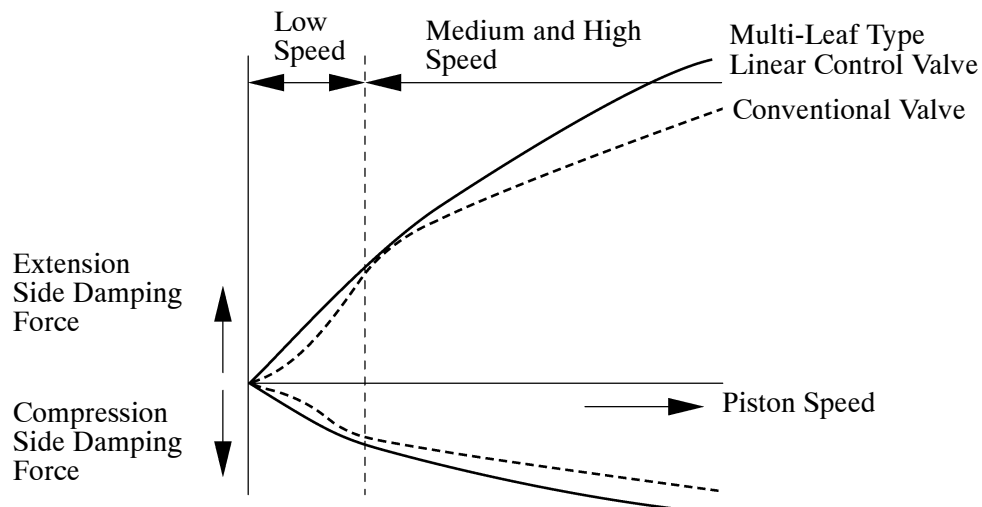
1) General

- Low-pressure (N_2) gas sealed front shock absorbers with a linear control valve are used to realize both driving stability and riding comfort.
- A multi-leaf type linear control valve is used to attain linear damping force characteristics.
- A rebound spring is used to ensure vehicle stability during cornering.



241CH22

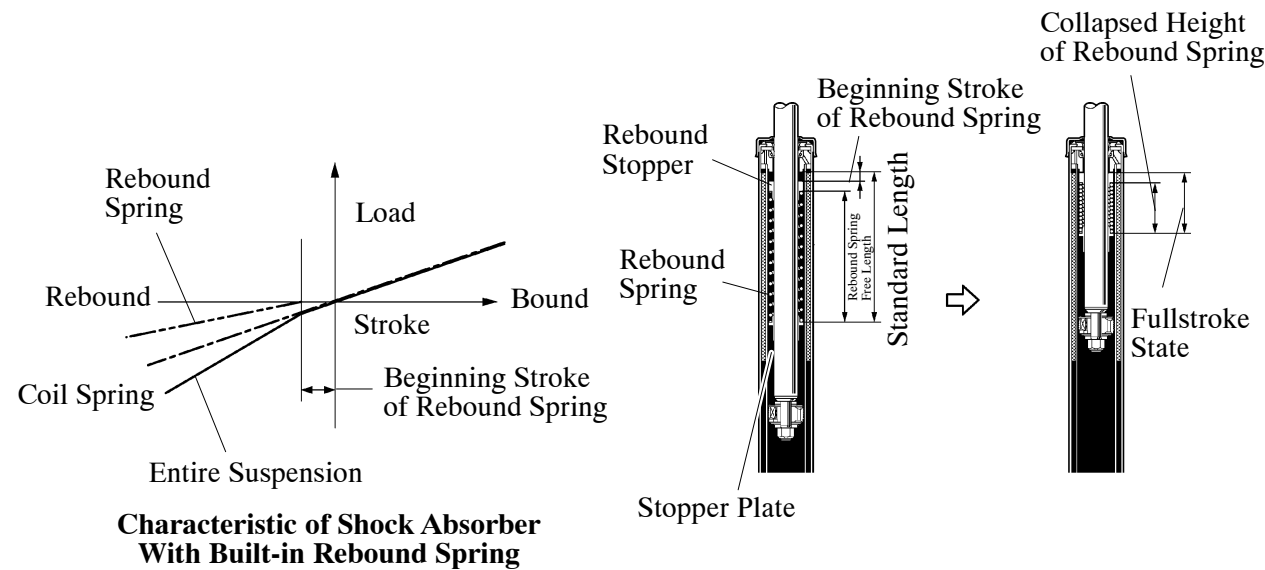
► Multi-Leaf Type Damping Force Characteristics ◀



199CH110

2) Rebound Spring

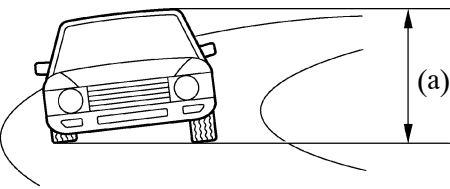
The function of the built-in rebound spring is to combine with the function of the coil spring in order to restrain the elongation of the entire suspension during rebounds. Consequently, only the function of the coil spring is applied when the suspension stroke is small during normal driving, in order to realize a soft and comfortable ride. However, when the inner wheel makes large rebounds, such as when the vehicle is cornering, the functions of both the rebound spring and the coil spring are combined in order to reduce the elongation of the entire suspension. As a result, the vehicle has excellent maneuverability and stability.



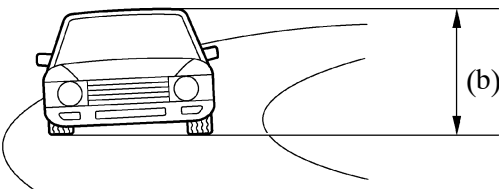
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277CH107

► During Cornering ◀



Without Rebound Spring



With Rebound Spring

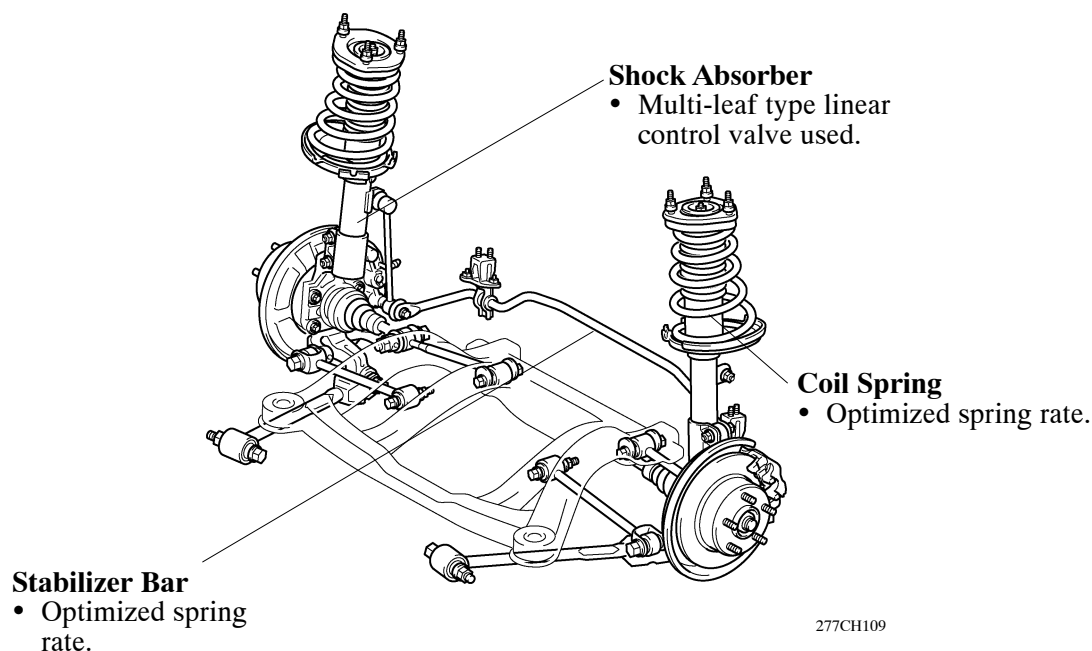
241CH90

(a) > (b)

3. Rear Suspension

General

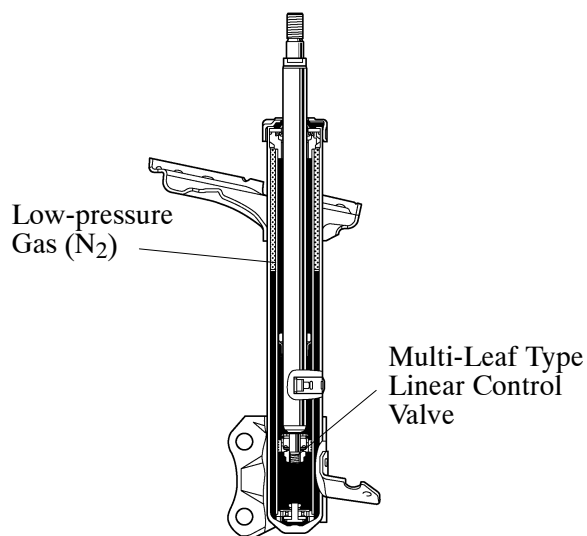
Rear suspension realizes excellent stability and controllability by optimizing the suspension geometry and the allocation of components.



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Shock Absorber

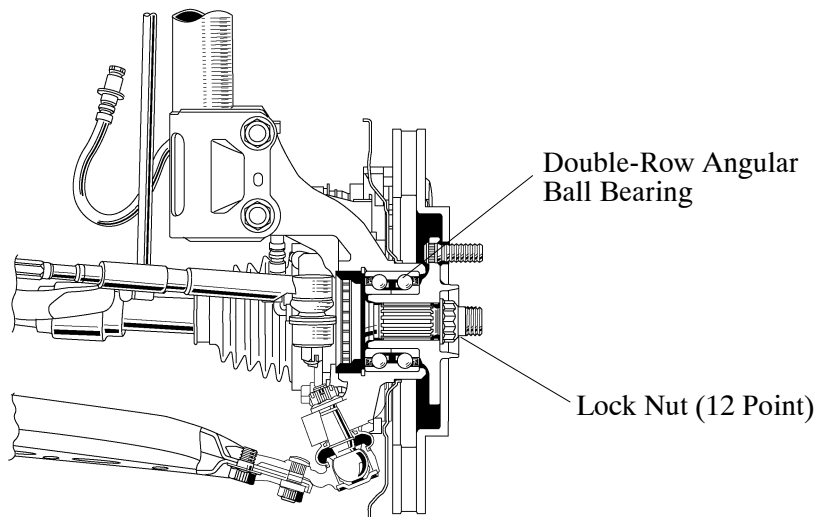
- Low-pressure (N_2) gas sealed front shock absorbers with a linear control valve realize driving stability and riding comfort.
- As with the front shock absorbers, a multi-leaf type linear control valve is used in order to attain the linear damping force characteristics.



■ AXLE

1. Front Axle

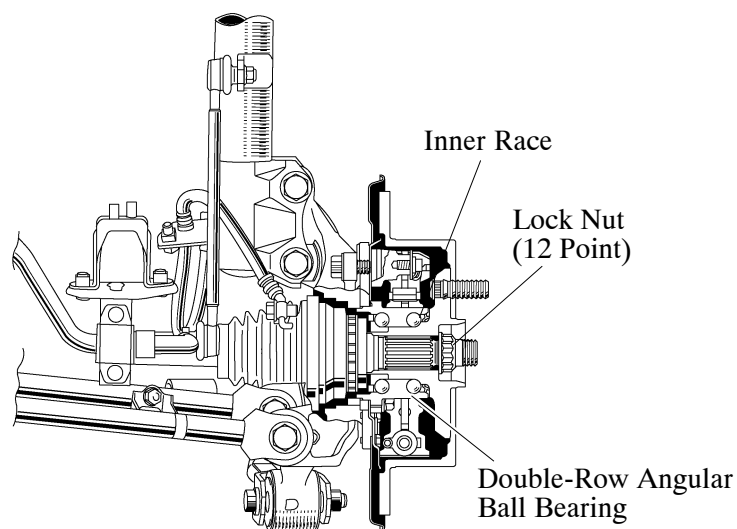
- The front axle use a double-row angular ball bearing which offers low rolling resistance.
- A lock nut (12-point) is staked to secure the axle hub. Once removed, this nut cannot be reused.



241CH51

2. Rear Axle

- The rear axle use a double-row angular ball bearing which offers low rolling resistance.
- Part of the inner race is integrated with the shaft, optimizing rigidity.
- On the 4WD model, a 12-point lock nut is used and staked in order to ensure that the axle hub is properly tightened. Once removed, this nut cannot be reused.



277CH121

BRAKE

■ DESCRIPTION

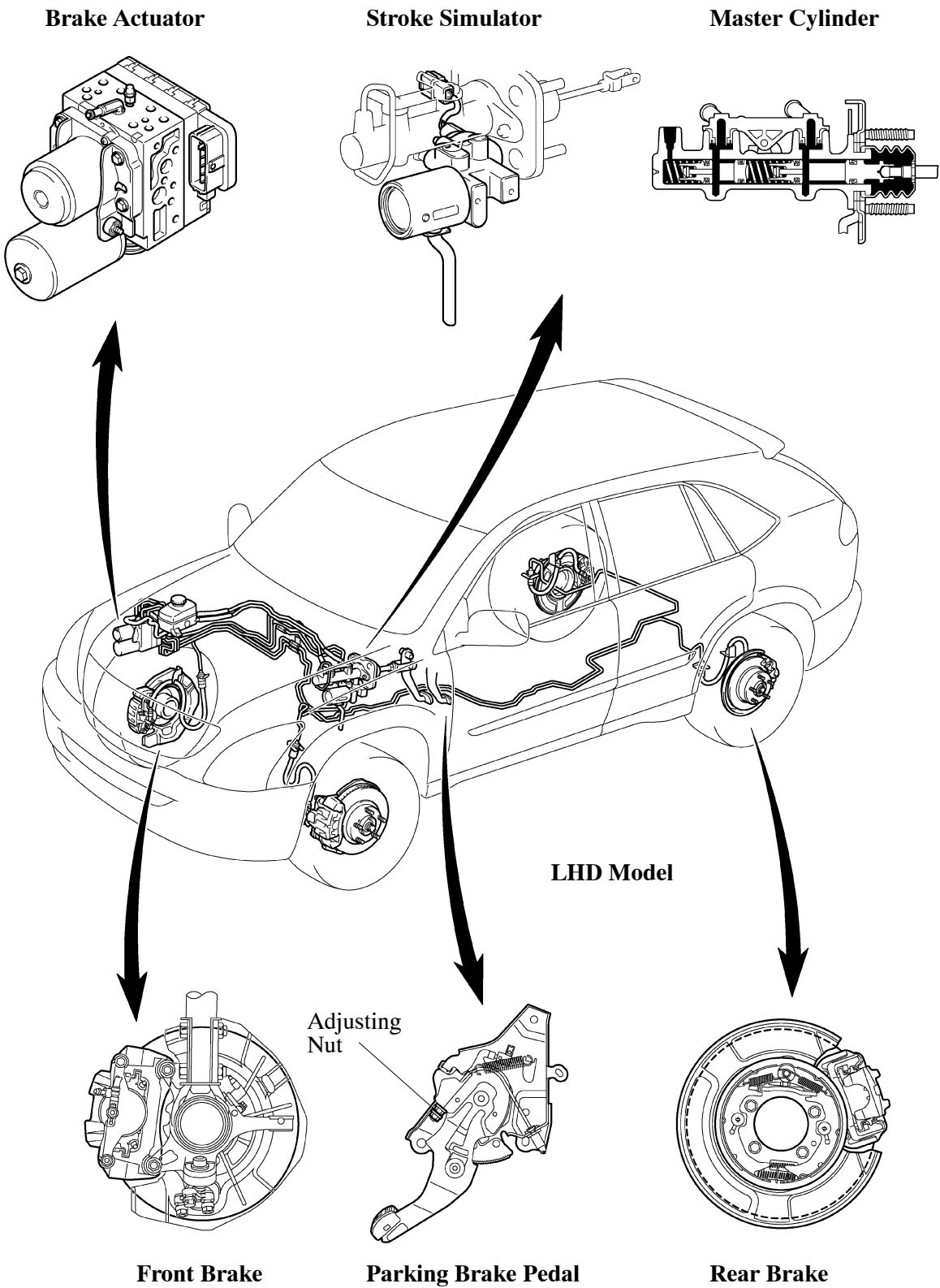
The RX400h has a brake system with the following specifications:

Front Brake	Type	Ventilated Disc
	Rotor Size	for 17 in. wheel
Rear Brake	Type	Solid Disc
	Rotor Size	for 15 in. wheel
• Regenerative Brake Cooperative Control • ECB System (ABS Function, EBD Function, Brake Assist Function, TRC Function and VSC Function)		Standard
Parking Brake Lever Type		Pedal

► Specifications ◀

Master Cylinder	Type	Tandem (Portless + Portless)
	Diameter mm (in.)	19.05 (0.75)
Front Disc Brake	Caliper Type	AXH63
	Wheel Cylinder Dia. mm (in.)	63.5 (2.5)
	Rotor Size (D × T)* mm (in.)	319 × 28 (12.56 × 1.10)
	Pad Material	T4146
Rear Disc Brake	Caliper Type	AXS41
	Wheel Cylinder Dia. mm (in.)	41.3 (1.63)
	Rotor Size (D × T)* mm (in.)	288 × 10 (11.34 × 0.39)
	Pad Material	PS506H
Parking Brake	Type	Duo Servo
	Drum Inner Dia. mm (in.)	190.0 (7.48)
Brake Actuator Manufacturer		TOYOTA (In-house Sourcing Parts)

*: D: Outer Diameter, T: Thickness



■ BRAKE CONTROL SYSTEM

1. General

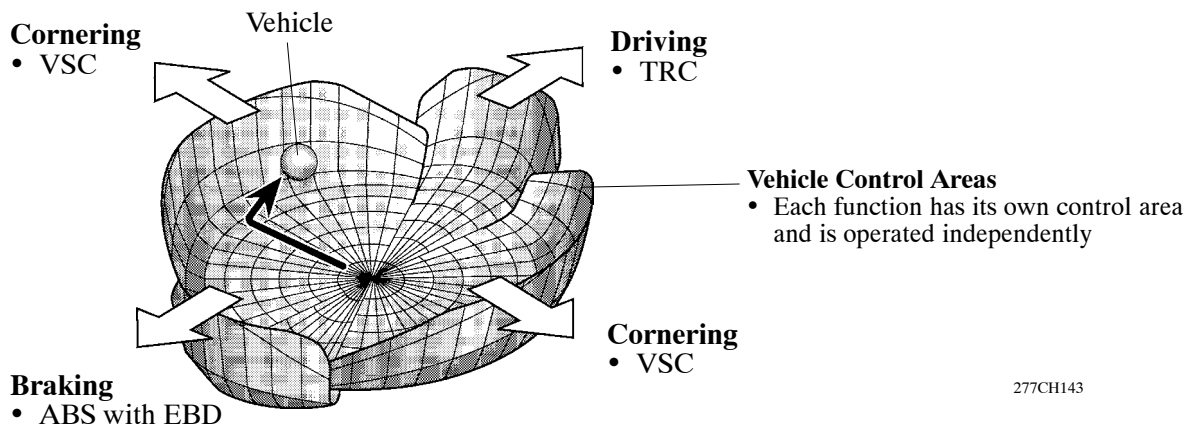
- A brake management function, VDIM (Vehicle Dynamics Integrated Management), which delivers comprehensive vehicle movement control, is new on the RX400h.
- An ECB (Electronically Controlled Brake) system is new on the RX400h.
- The brake control system of the RX400h is controlled by the skid control ECU. This ECU maintains communication with the EPS ECU and the THS ECU via the CAN (Controller Area Network).

2. VDIM (Vehicle Dynamics Integrated Management)

General

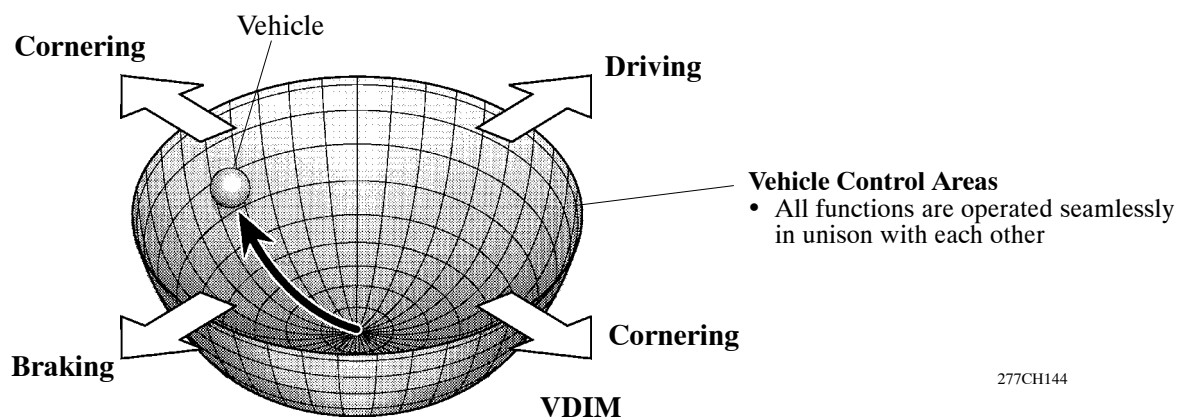
- The VDIM manages all functions, such as the ABS with EBD, the Brake Assist, the TRC, and the VSC. And is operated by the ECB system, which regulates brake fluid pressure. In addition, the regenerative brake cooperative control and power steering cooperative control functions are also available, thus allowing the VDIM to perform the comprehensive management.
- Conventional brake control systems begin to control either the braking or motive force 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, hybrid 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 brake control related functions.

► Conceptual Diagram of Control Management ◀



277CH143

Conventional



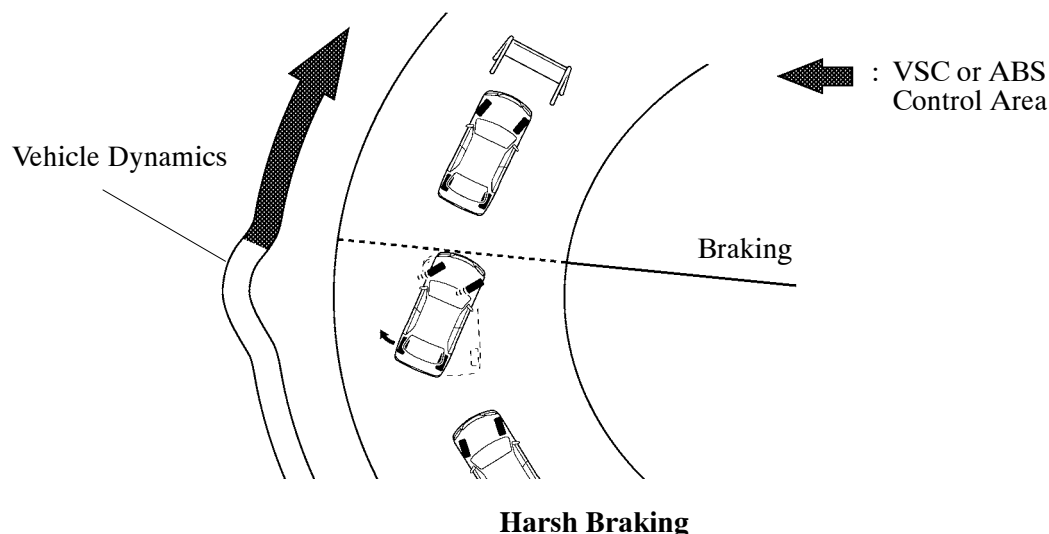
277CH144

► Examples of Control Operation ◀

The difference in vehicle control during harsh braking situations while cornering, with the VDIM and conventional brake control systems, is as follows:

— Conventional —

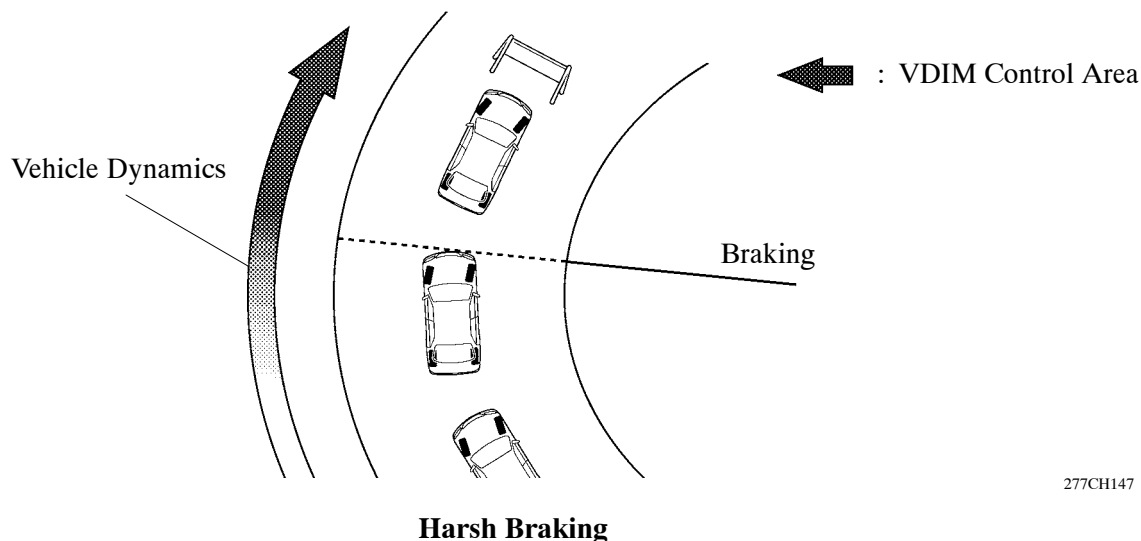
Conventional brake control systems calculate vehicle motion based on signals transmitted by yaw rate and deceleration sensors, the wheel speed sensors and the steering sensor, and activates VSC systems when vehicles are determined to be skidding. If the driver brakes suddenly, brake control systems perform 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.



277CH146

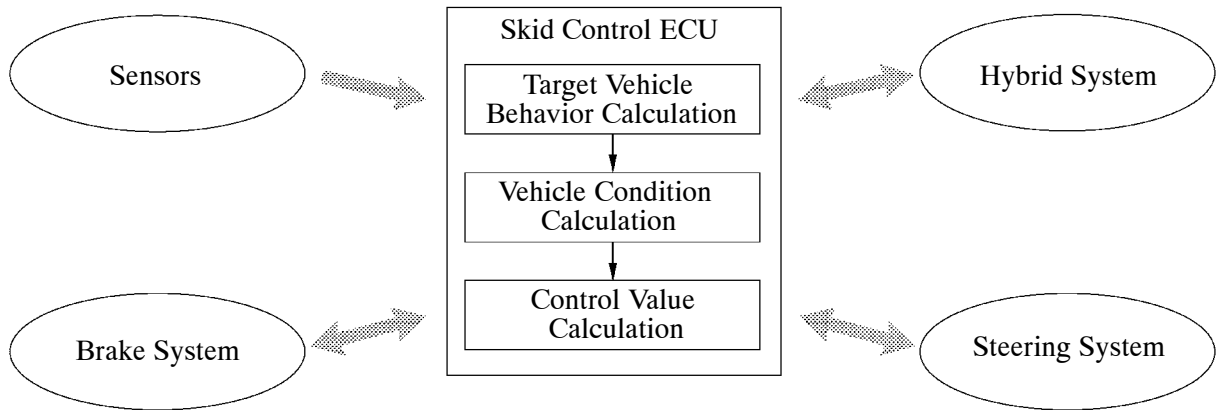
— VDIM —

The VDIM also calculates vehicle motion based on signals from the yaw rate and deceleration sensor, wheel speed sensors 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.



277CH147

► Control Configuration of VDIM ◀



277CH145

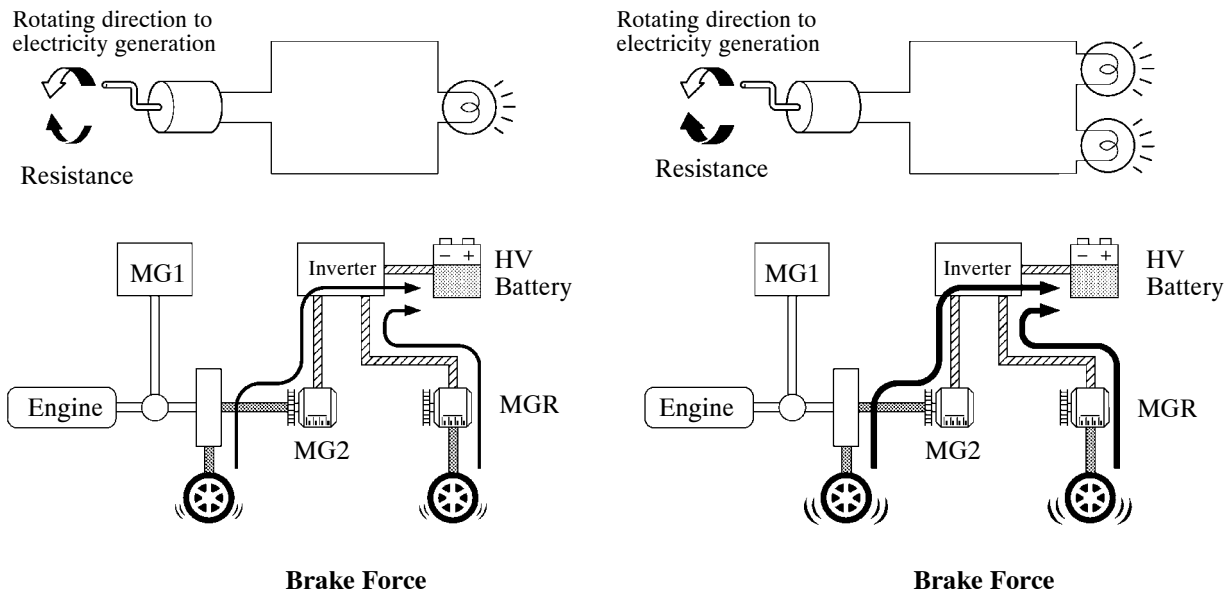
The brake system of the RX400h has a following function:

Brake Control System	Function	Outline
VDIM	Regenerative Brake Cooperative Control	Controls hydraulic braking in order to recover electrical energy by utilizing the regenerative brake of the THS-II system as much as possible.
	Power Steering Cooperative Control	Effects cooperative control with the EPS ECU in order to provide steering assist in accordance with the operating conditions of the vehicle.
	ECB System	- This system electrically detects the operation information for the brake pedal and generates an appropriate amount of hydraulic brake. - Executes the hydraulic control of the brake control functions based on the VDIM.
		VSC (Vehicle Stability Control) The VSC function helps prevent the vehicle from slipping sideways as a result of strong front wheel skid or strong rear wheel skid during cornering.
		TRC (Traction Control) The TRC function helps prevent the drive wheels from slipping if the driver presses the accelerator pedal excessively when starting off or accelerating on a slippery surface.
		ABS (Anti-lock Brake System) The ABS helps prevent the wheels from locking when the brakes are applied firmly or when braking on a slippery surface.
		EBD (Electronic Brake force Distribution) The EBD control utilizes ABS, realizing the proper brake force distribution between front and rear wheels in accordance with the driving conditions. In addition, during cornering braking, it also controls the brake forces of right and left wheels, helping to maintain the vehicle behavior.
	Brake Assist	The primary purpose of the Brake Assist is to provide an auxiliary brake force to assist the driver who cannot generate a large brake force during emergency braking, thus helping the vehicle's brake performance.

Outline of Regenerative Brake Cooperative Control Function

1) General

- Regenerative brake consists of a resistance force that is generated at the rotational axle in the reverse direction of the rotation of the generator (MG2 and MGR) that is generating electricity. The greater the generated amperage (battery charging amperage), the greater will be the resistance force.



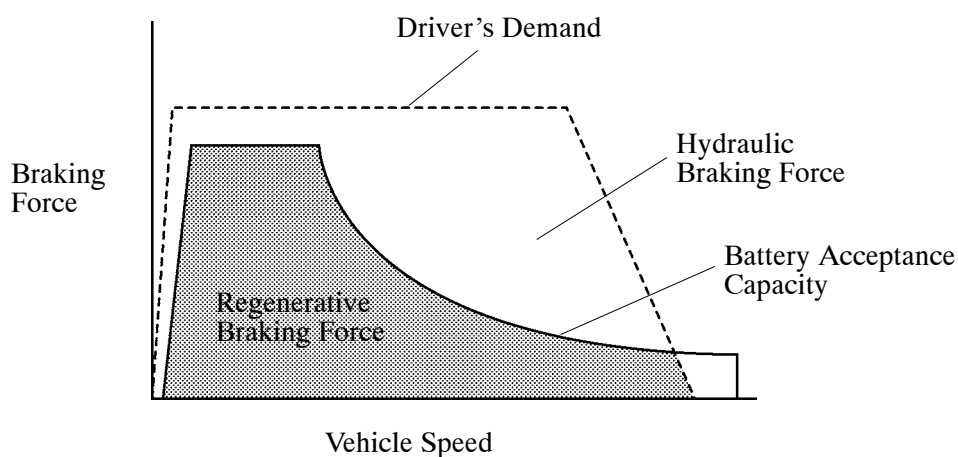
277CH112

- The front and rear drive axles are joined mechanically by the MG2 and MGR generators, which drive the respective axles. The rotational movement of the drive wheels drive MG2 and MGR, causing them to operate as generators, and the generative brake forces of MG2 and MGR are transmitted to the drive wheels. These forces are controlled by the THS-II system, which controls the generation of electricity. The regenerative brake cooperative control does not rely solely on the braking force of the hydraulic brake system to supply the brake force required by the driver. Instead, by effecting cooperative control with the THS-II system, this control provides a joint braking force provided by the regenerative brake and the hydraulic brake. As a result, this control minimizes the loss of the kinetic energy associated with the normal hydraulic brake, and recovers this energy by converting it into electrical energy.

2) Apportioning of the Brake Force

- The apportioning of the brake force between the hydraulic brake and the regenerative brake varies by the vehicle speed and time.
- The apportioning of the brake force between the hydraulic brake and the regenerative brake is accomplished by controlling the hydraulic brake so that the total brake force of the hydraulic brake and the regenerative brake matches the brake force required by the driver.
- If the regenerative brake becomes inoperative due to a malfunction in the THS-II system, the brake system effects control so that the entire brake force required by the driver is supplied with the hydraulic brake system.

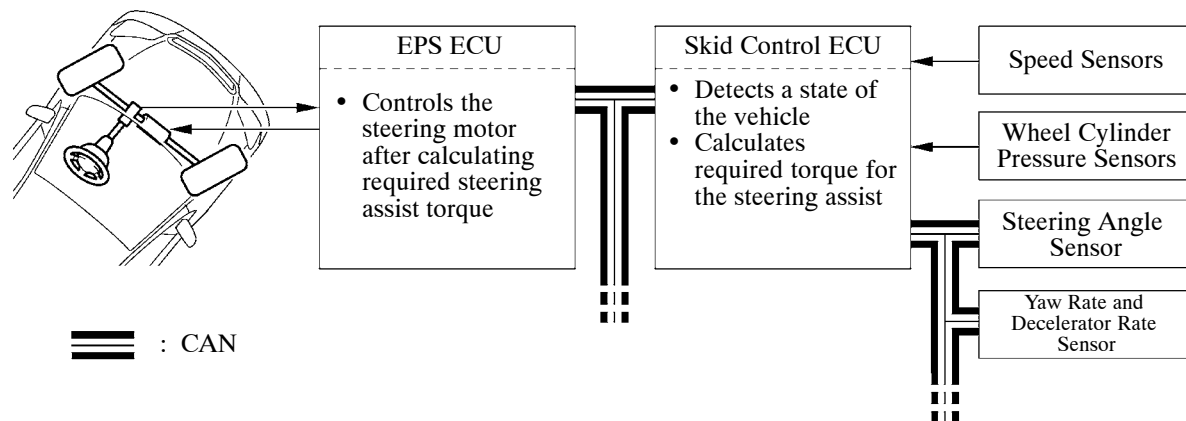
► Imagery Drawing ◀



277CH142

Outline of Power Steering Cooperative Control Function

When the skid control ECU activates the VSC function, this function simultaneously effects the EPS (Electric Power Steering) and cooperative controls. Thus, it controls the EPS system in order to facilitate the driver to operate the steering in a direction that stabilizes the vehicle.



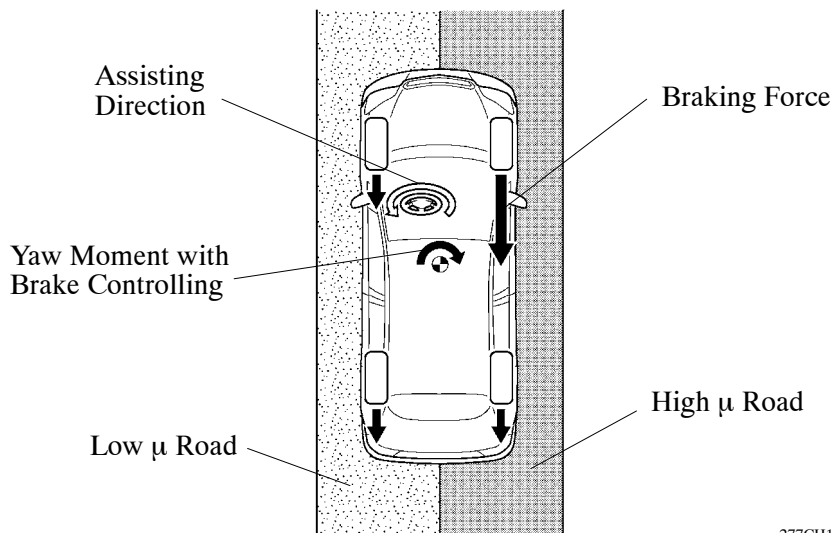
277CH114

1) Operation in a wheel skid tendency

- When the rear wheels lose grip, this function controls the brake force and the motive force. At the same time, the function controls the steering torque to facilitate the steering effort of the driver.
- When the front wheels exhibit the tendency to skid, the driver could turn the steering wheel excessively, which could worsen the situation. To prevent this, power steering torque assist is regulated.

2) Operation in braking when surface resistance differs to both sides of the wheels

If the vehicle is braking while its right and left wheels are on surfaces with a different resistance, a difference will be created in the braking force applied to the right and left wheels, depending on the strength of the braking force. This will generate a yaw moment, which could require a steering maneuver. In this situation, the skid control ECU activates the VSC function, and it simultaneously effects the EPS and cooperative controls. When the driver operates the steering in a direction that cancels out the moment that is generated as requested by the skid control ECU, the EPS ECU controls the assist torque to facilitate the steering maneuver. By operating the EPS in this manner and facilitating the steering effort of the driver, this function helps to make the vehicle stable.



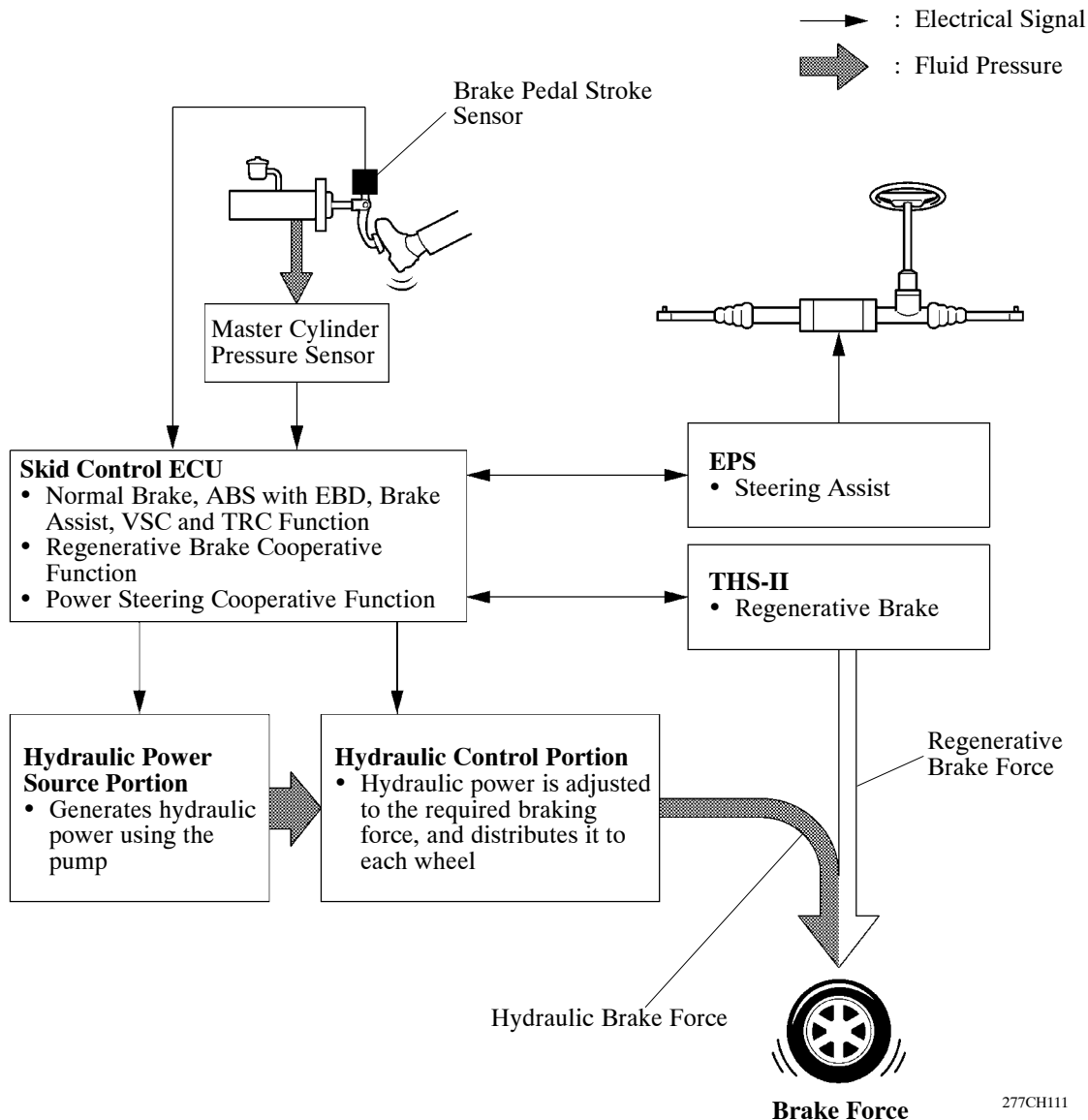
277CH115

3. ECB (Electronically Controlled Brake) System

General

- In this system, the conventional brake booster portion has been discontinued. Instead, it consists of brake input, power supply, and hydraulic pressure control portions.
- During normal braking, the fluid pressure generated by the master cylinder does not directly actuate the wheel cylinders, but serves as a hydraulic pressure signal. Instead, the actual control pressure is obtained by regulating the fluid pressure of the hydraulic power source in the brake actuator, which actuates the wheel cylinders.
- The ECB executes the hydraulic control of the ABS with EBD, brake assist, TRC, and VSC function in accordance with information provided by the sensors and ECUs.
- The power source backup unit is used as an auxiliary power source, to supply power to the brake system in a stable manner.

► Outline of ECB System ◀



Outline of EBD Control Function

1) General

The distribution of the brake force, which was performed mechanically in the past, is now performed under electrical control of the skid control ECU, which precisely controls the braking force in accordance with the vehicle's driving conditions.

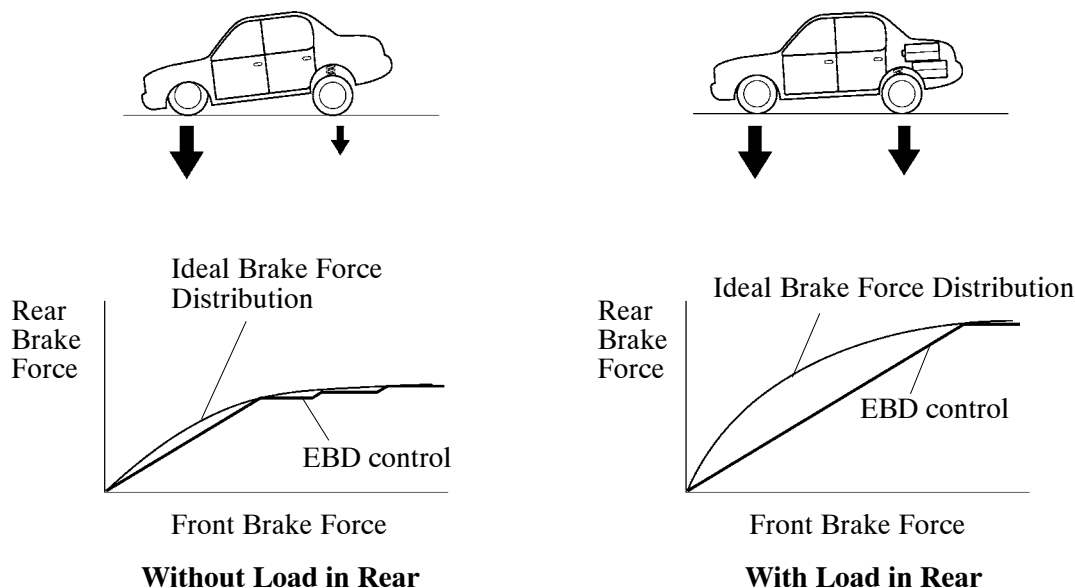
2) Front/Rear Wheels Brake Force Distribution

If the brakes are applied while the vehicle is moving straight forward, the transfer of the road reduces the load that is applied to the rear wheels. The skid control ECU determines this condition by way of the signals from the wheel speed sensors, and the brake actuator regulates the distribution of the brake force of the rear wheels to optimally control.

For example, the amount of the brake force that is applied to the rear wheels during braking varies whether or not the vehicle is carrying a load. The amount of the brake force that is applied to the rear wheels also varies in accordance with the extent of the deceleration.

Thus, the distribution of the brake force to the rear is optimally controlled in order to effectively utilize the braking force of the rear wheels under these conditions.

► EBD Control Concept ◀

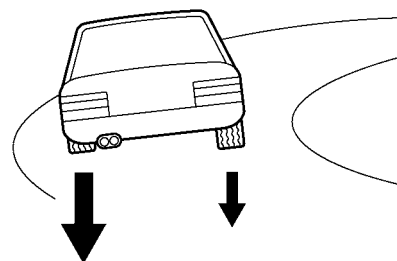


182CH56

Right/Left Wheels Brake Force Distribution (During Cornering Braking)

When the brakes are applied while the vehicle is cornering, the load that applied to the inner wheel decreases and the outer wheel increases.

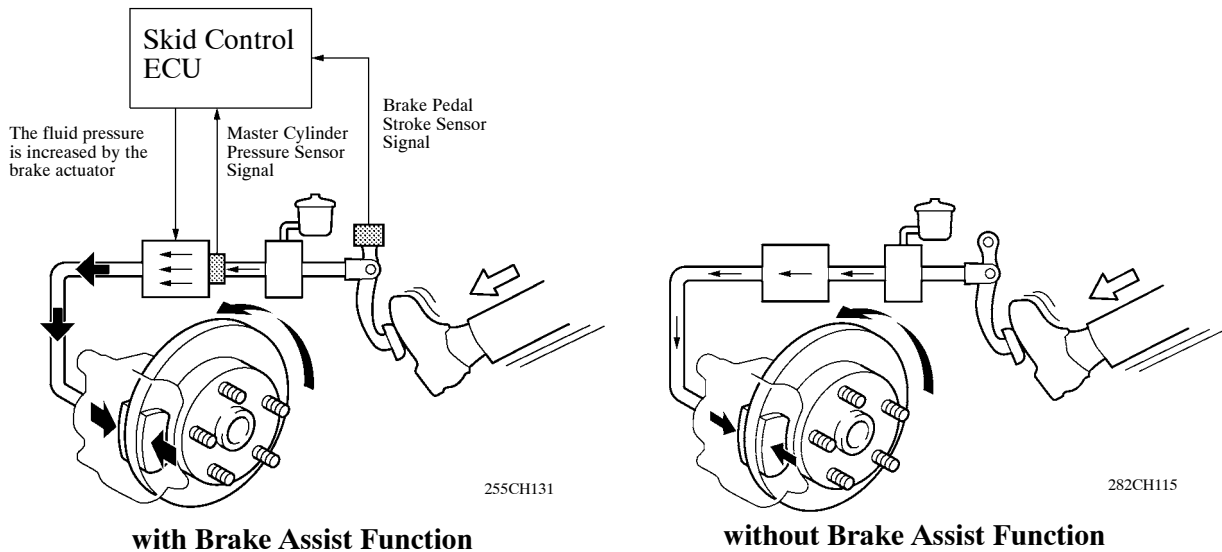
The skid control ECU determines this condition by way of the signals from the wheel speed sensors, and the brake actuator regulates the brake force in order to optimally control the distribution of the brake force to the inner wheel and outer wheel.



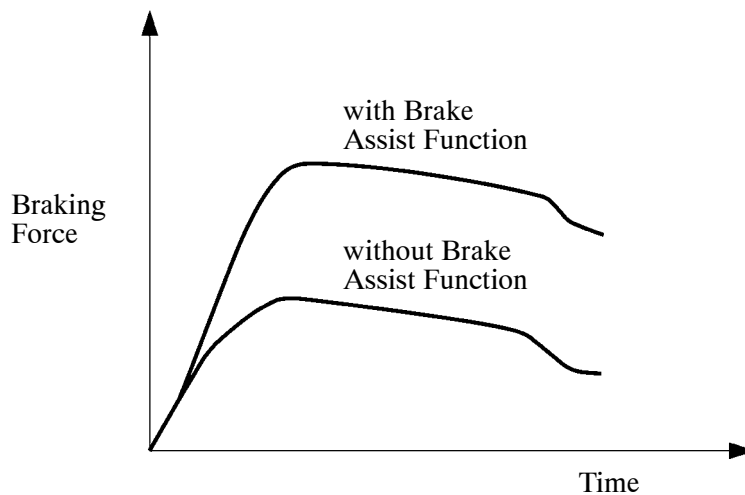
181CH56

Outline of Brake Assist Function

The brake assist function interprets a quick push of the brake pedal as emergency braking and supplements the braking power applied if the driver has not stepped hard enough on the brake pedal. In emergencies, drivers, especially inexperienced ones, often panic and do not apply sufficient pressure on the brake pedal. Based on the signals from the master cylinder pressure sensors and the brake pedal stroke sensor, the skid control ECU calculates the speed and the amount of the brake pedal application and then determines the intention of the driver to make an emergency braking. If the skid control ECU determines that the driver intends emergency braking, the function activates the brake actuator to increase the brake fluid pressure. The brake assist function in combination with ABS helps ensure the vehicle's brake performance. A key feature of brake assist function is that the timing and the degree of braking assistance are designed to ensure that the driver does not discern anything unusual about the braking operation. When the driver intentionally eases up on the brake pedal, the function reduces the amount of assistance it provides.



- ◆ : There is no difference of the maximum brake performance between the vehicles with and without brake assist function.

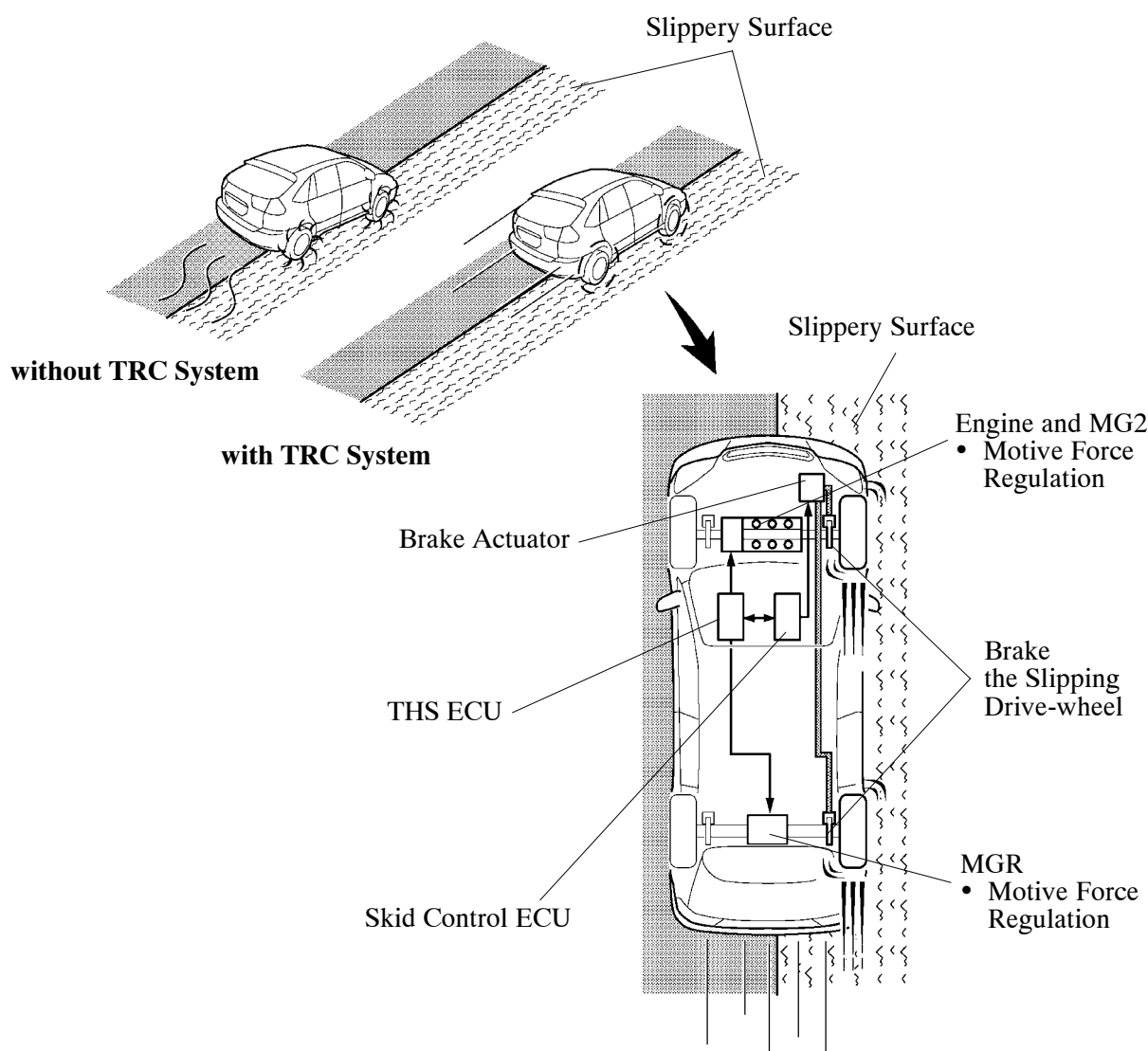


Outline of TRC Function

- If the driver presses the accelerator pedal aggressively when starting off or accelerating on a slippery surface, the drive wheel could slip due to the excessive amount of torque that is generated. The adjustment of the motive force and the control of the hydraulic brakes of the drive wheels accomplished by THS-II allow the TRC function to help minimize the slippage of the drive wheels, and generate the drive force that is appropriate for the road surface conditions.
- For example, a comparison may be made between two vehicles, one with the TRC function and the other without. If the driver of each vehicle operates the accelerator pedal in a rough manner while driving over a surface with different surface friction characteristics, the drive wheel on the slippery surface could slip as illustrated. As a result, the vehicle could become unstable.

However, when the vehicle is equipped with the TRC function, the skid control ECU instantly determines the state of the vehicle and operates the brake actuator in order to apply the brake of the slipping drive wheel. Simultaneously, the skid control ECU effects cooperative control with the THS ECU, in order to adjust the motive force. Thus, this function can constantly maintain a stable vehicle posture.

► Driving condition on road with different surface friction characteristics ◀



277CH113

◆ This case applies only to the 4WD model. On the 2WD model, control is effected on the front wheels, which are the drive wheels.

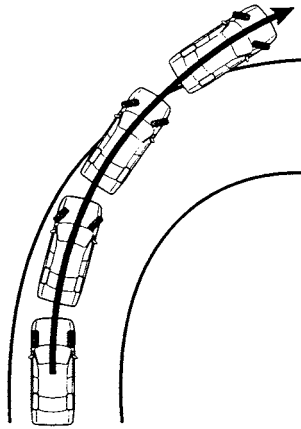
Outline of VSC Function

1) General

The followings are two examples that can be considered as circumstances in which the tires exceed their lateral grip limit.

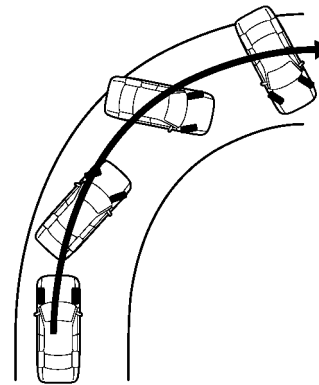
The VSC function is designed to help control the vehicle behavior by controlling the motive force and the brakes at each wheel when the vehicle is under one of the conditions indicated below.

- When the front wheels lose grip in relation to the rear wheels (front wheel skid tendency).
- When the rear wheels lose grip in relation to the front wheels (rear wheel skid tendency).



Front Wheel Skid Tendency

151CH17



Rear Wheel Skid Tendency

189CH100

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2) Method for Determining the Vehicle Condition

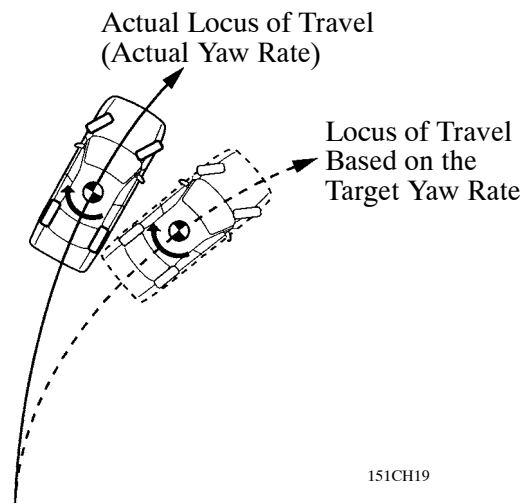
To determine the condition of the vehicle, sensors detect the steering angle, vehicle speed, vehicle's yaw rate, and the vehicle's lateral acceleration, which are then calculated by the skid control ECU.

a. Determining Front Wheel Skid

Whether or not the vehicle is in the state of front wheel skid is determined by the difference between the target yaw rate and the vehicle's actual yaw rate.

When the vehicle's actual yaw rate is smaller than the yaw rate (a target yaw rate that is determined by the vehicle speed and steering angle) that should be rightfully generated when the driver operates the steering wheel, it means the vehicle is making a turn at a greater angle than the locus of travel.

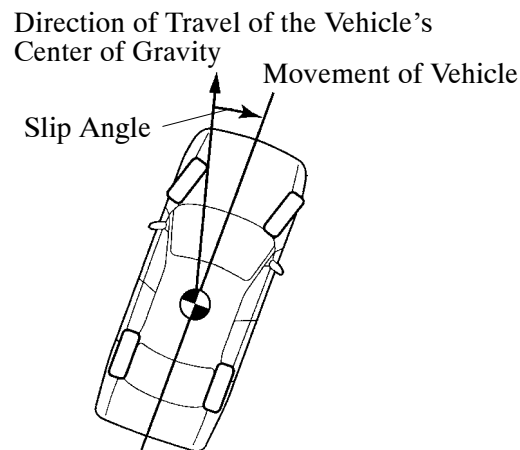
Thus, the skid control ECU determines that there is a large tendency to front wheel skid.



151CH19

b. Determining Rear Wheel Skid

Whether or not the vehicle is in the state of rear wheel skid is determined by the values of the vehicle's slip angle and the vehicle's slip angular velocity (time-dependent changes in the vehicle's slip angle). When the vehicle's slip angle is large, and the slip angular velocity is also large, the skid control ECU determines that the vehicle has a large rear wheel skid tendency.



151CH18

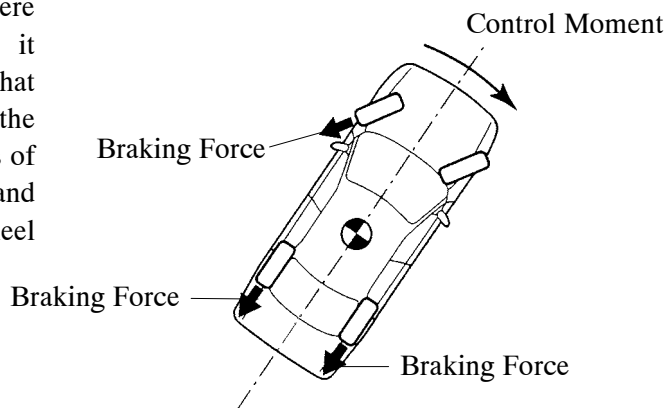
3) Method for VSC Operation

When the skid control ECU determines that the vehicle exhibits a tendency to front wheel skid or rear wheel skid, it decreases the engine output and applies the brake of a front or rear wheel to control the vehicle's yaw moment.

The basic operation of the VSC is described below. However, the control method differs depending on the vehicle's characteristics and driving conditions.

a. Dampening a Front Wheel Skid

When the skid control ECU determines that there is a large front wheel skid tendency, it counteracts in accordance with the extent of that tendency. The skid control ECU controls the motive power output and applies the brakes of the front wheel of the outer circle in the turns and rear wheels in order to restrain the front wheel skid tendency.



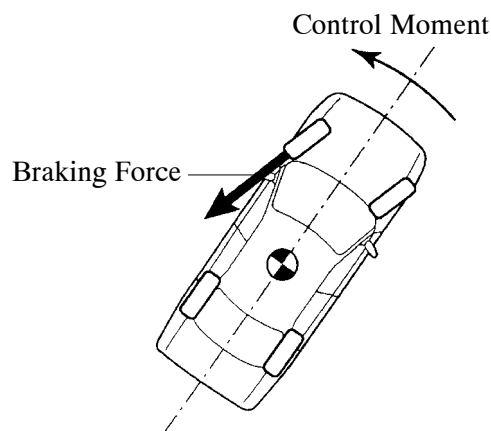
189CH101

Making a Right Turn

b. Dampening a Rear Wheel Skid

When the skid control ECU determines that there is a large rear wheel skid tendency, it counteracts in accordance with the extent of that tendency. It applies the brakes of the front wheel of the outer circle of the turn, and generates an outward moment of inertia in the vehicle, in order to restrain the rear wheel skid tendency. Along with the reduction in the vehicle speed caused by the braking force, the excellent vehicle's stability is ensured.

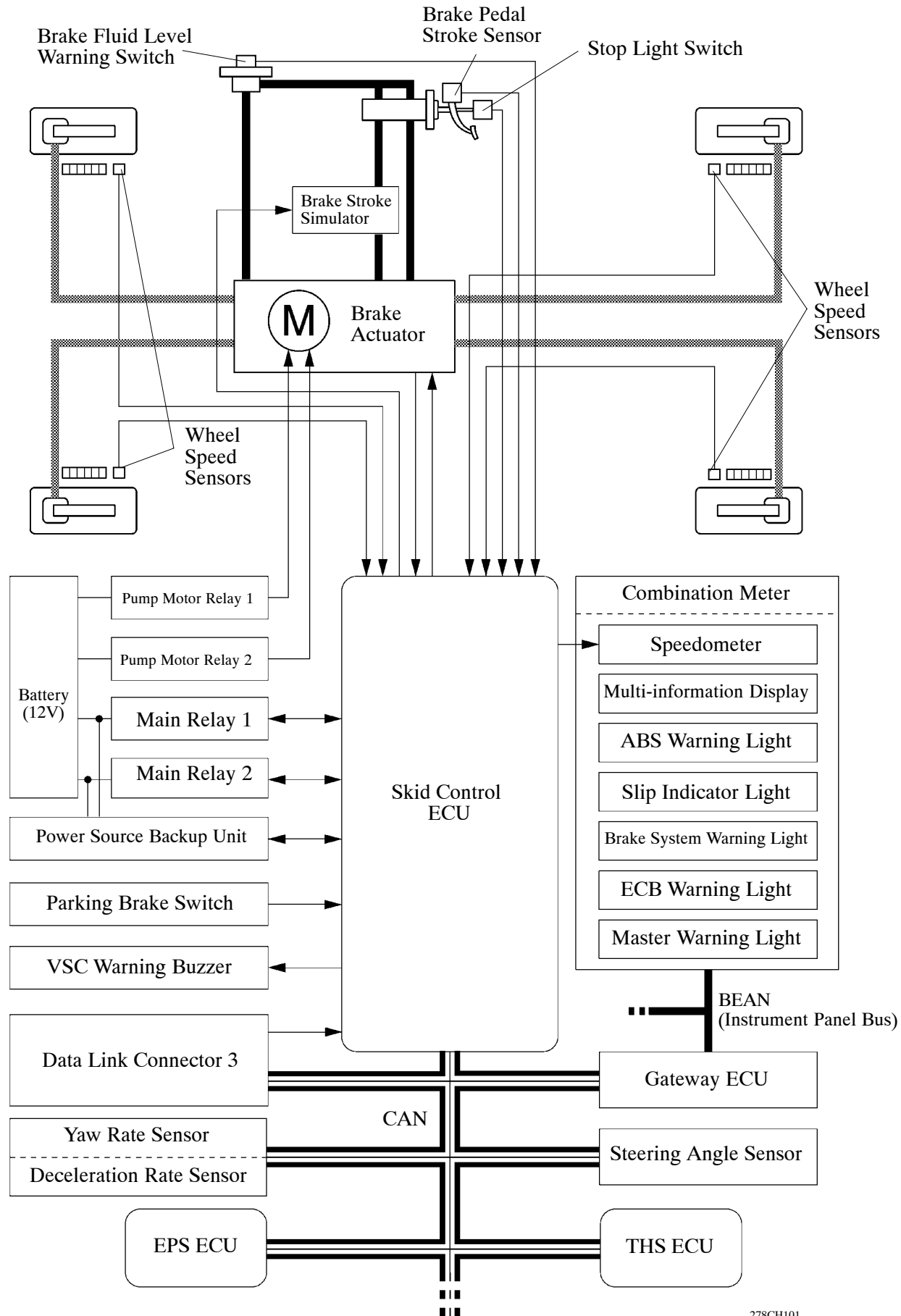
In some cases, the skid control ECU applies the brake of the rear wheels, as necessary.



Making a Right Turn

204CH15

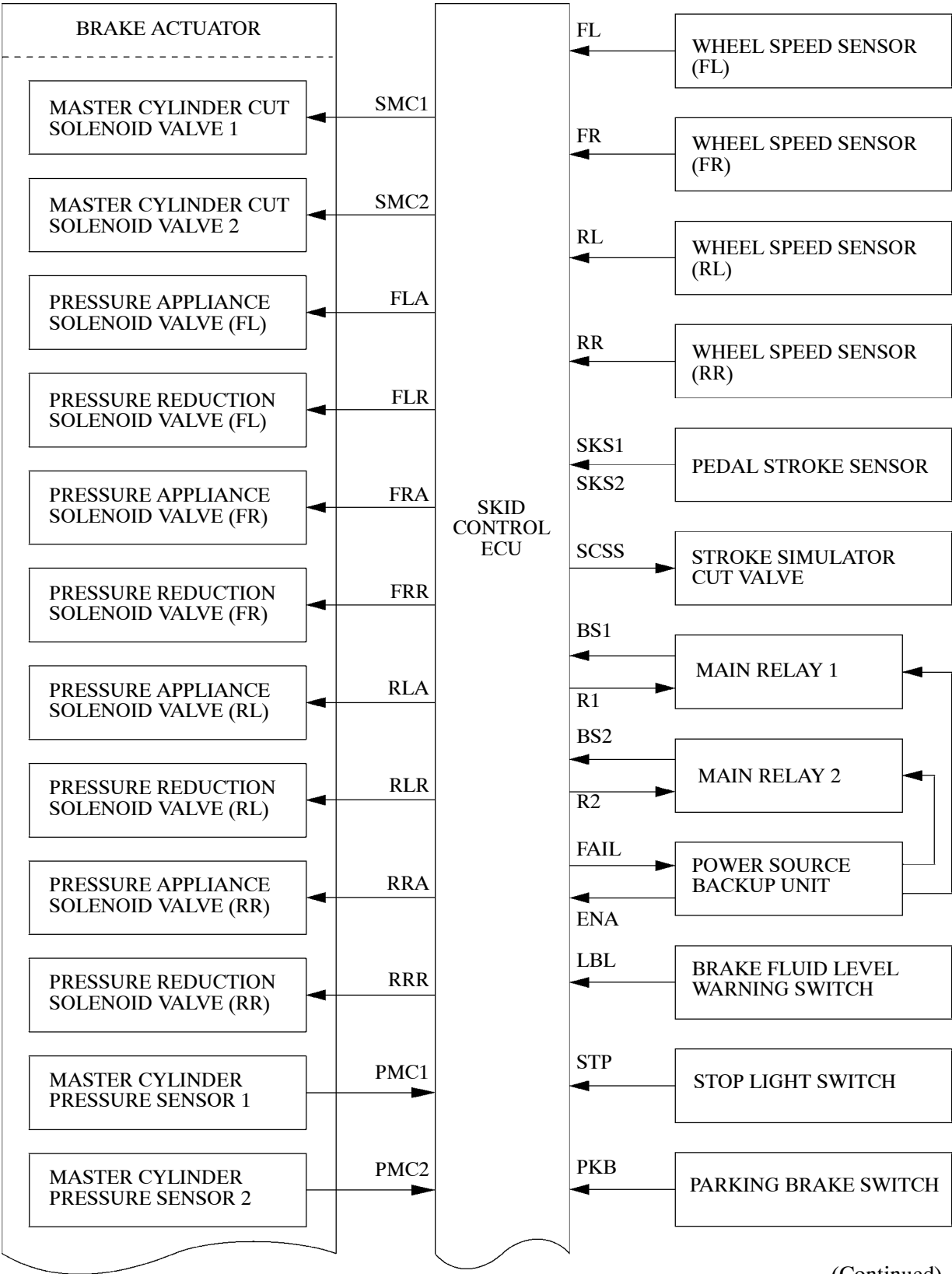
System Diagram



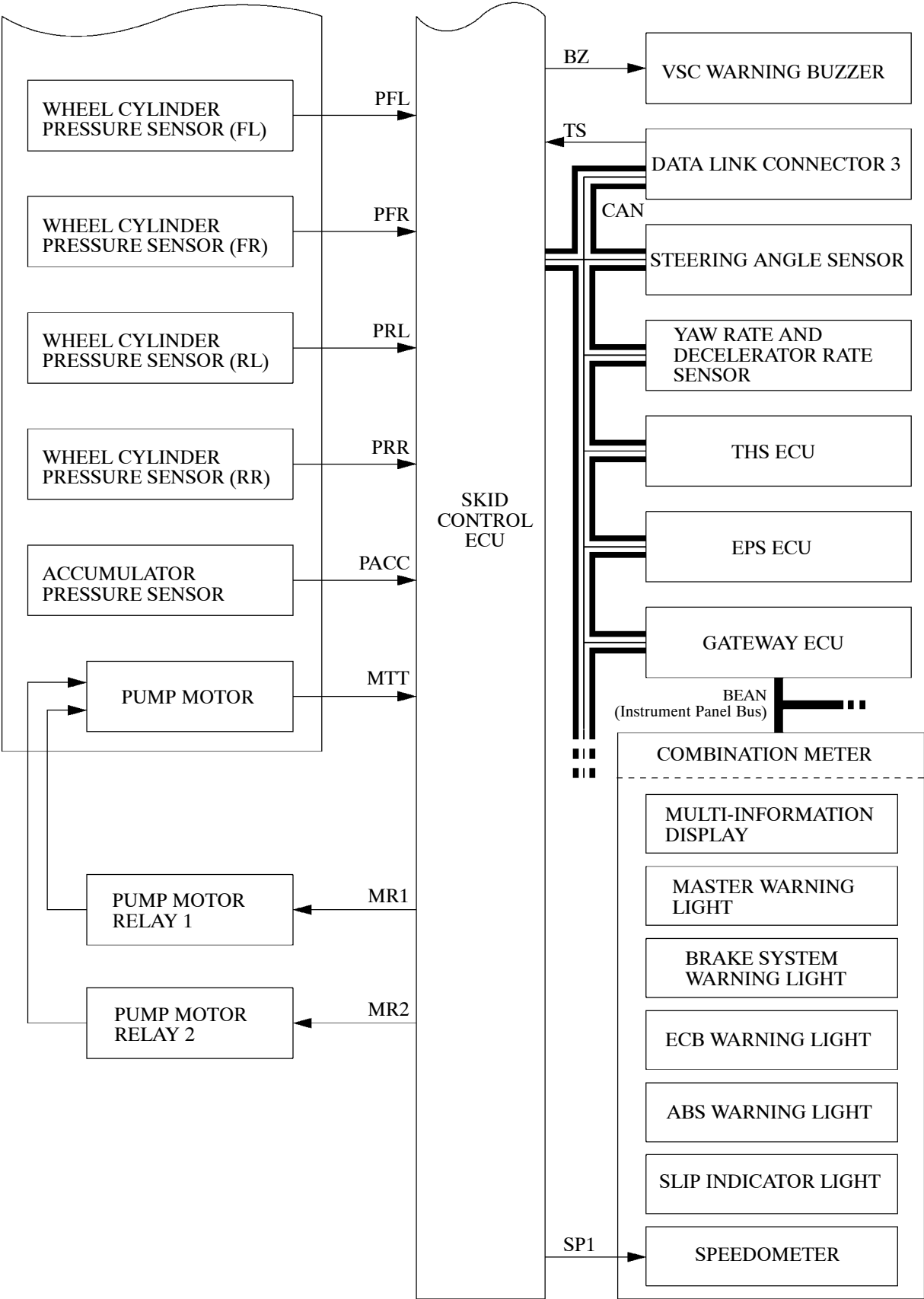
CH

Construction

The configuration of the brake control system on the RX400h is as shown in the following chart.

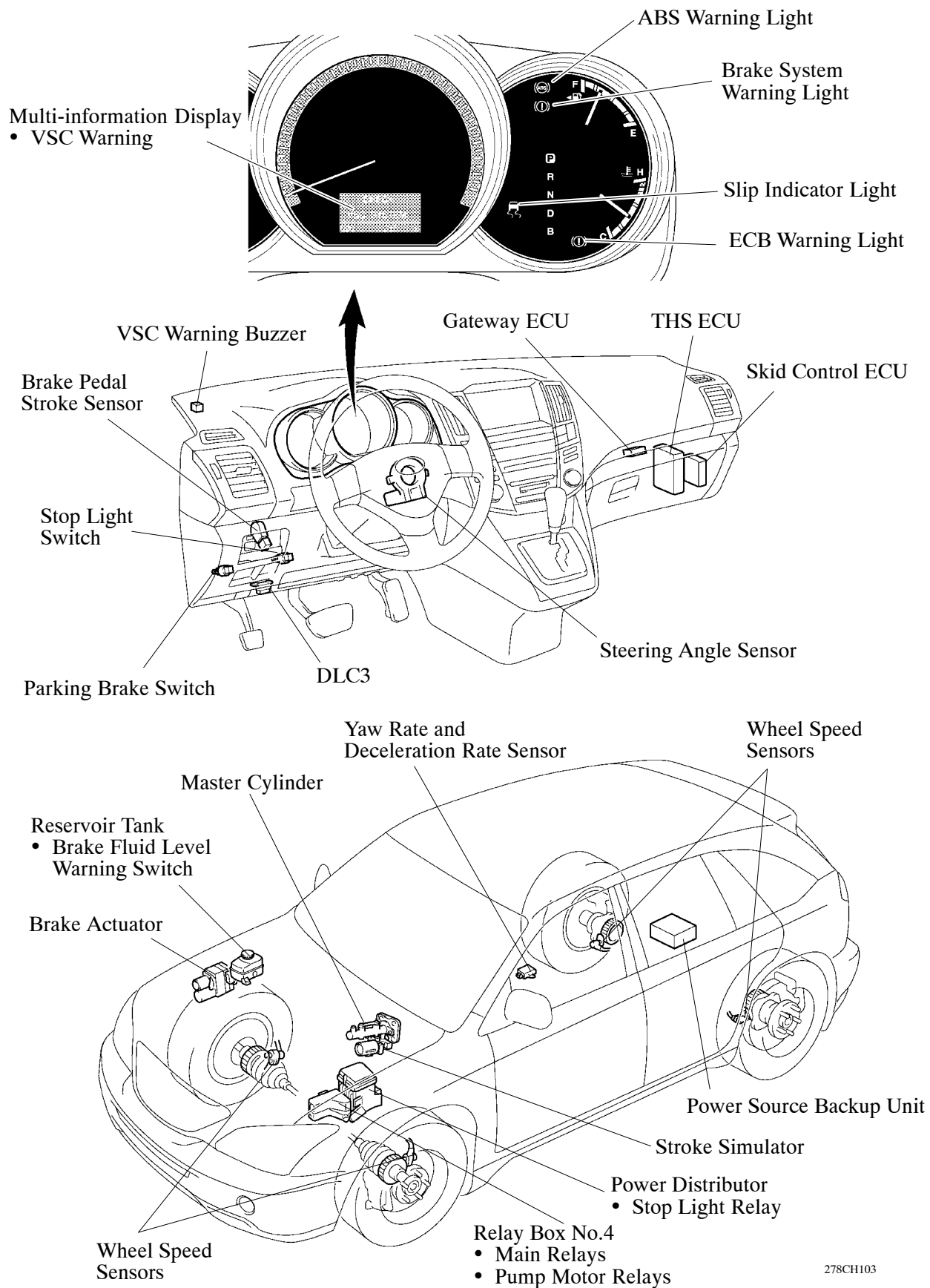


(Continued)



CH

Layout of Main Component



Function of Main Components

Component		Function
Brake Actuator (See Page CH-57)	Hydraulic Power Source Portion	- Consisting of a pump, pump motor, accumulator, relief valve, and accumulator pressure, the hydraulic power source portion generates and stores the hydraulic pressure, which the skid control ECU uses for controlling braking. - The accumulator pressure sensor is installed in the brake actuator.
	Hydraulic Control Portion	- Consists of 2 master cylinder cut solenoid valves, 4 pressure appliance solenoid valves, and 4 pressure reduction solenoid valves. - The 2 master cylinder cut solenoid valves, which are the two-position type, are controlled by the skid control ECU to open and close the passage between the master cylinder and the wheel cylinders. - The 4 pressure appliance solenoid valves and the 4 pressure reduction solenoid valves are the linear type. They are controlled by the skid control ECU to increase and decrease the fluid pressure in the wheel cylinders. - The master cylinder pressure sensors and the wheel cylinder pressure sensors are installed in the brake actuator.
Skid Control ECU		Monitors the driving conditions of the vehicle in accordance with the signals received from the sensors and through cooperative control with the THS ECU and EPS ECU, calculates the required amount of braking force, and controls the brake actuator.
Brake Master Cylinder		- Generates hydraulic pressure in accordance with the amount of effort applied to the brake pedal by the driver. - When a malfunction occurs in the power supply portion, the brake master cylinder supplies the fluid pressure (which is generated by the brake pedal effort) directly to the wheel cylinders.
Stroke Simulator (See Page CH-63)		Generates a pedal stroke during braking in accordance with the driver's pedal effort.
Brake Pedal Stroke Sensor (See Page CH-62)		Directly detects the extent of the brake pedal stroke operated by the driver.
Combination Meter	Multi-information Display and Master Warning Light	Informs the driver of a failure in the VSC function by displaying a message on the multi-information display in the combination meter and blinking the master warning light.
	ABS Warning Light	Lights up to alert the driver when the skid control ECU detects the malfunction in the ABS, EBD, or Brake Assist function.
	Slip Indicator Light	Blinks to inform the driver when the ABS function, the VSC function or the TRC function is operated.
	ECB Warning Light	Lights up to alert the driver when a minor malfunction occurs in the brake system, which does not affect the braking force (such as a malfunction in the regenerative brake).
	Brake System Warning Light	- Lights up to alert the driver when the skid control ECU detect the malfunction in the apportioning of the brake. - Lights up to inform the driver when the parking brake is ON or the brake fluid level is low.

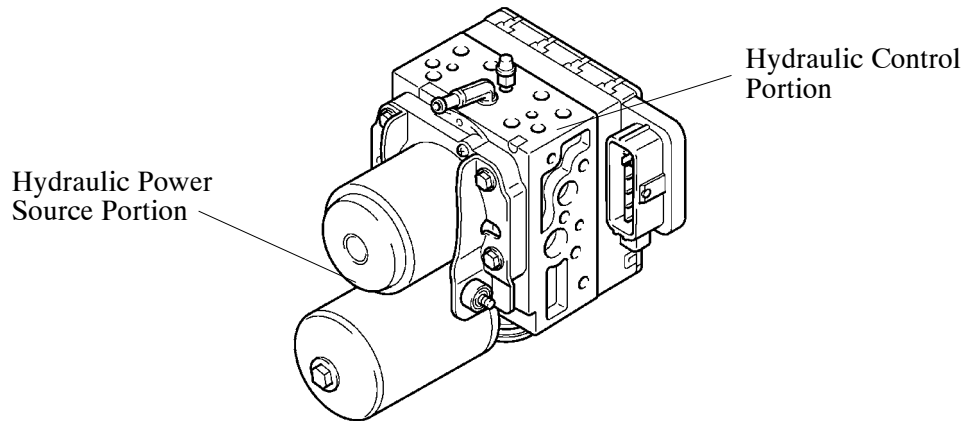
Component		Function
VSC warning buzzer		• This buzzer sounds continuously to inform the driver when there is a malfunction in the hydraulic pressure or a failure in the power supply. • This buzzer sounds intermittently to inform the driver of the vehicle skidding.
THS ECU		• Actuates the regenerative brake on receiving signal from the skid control ECU. • Sends the actual regenerative brake control value to the skid control ECU. • Controls the motive force based on an output control request signal received from the skid control ECU while the VSC function, or TRC function is operating.
Reservoir Tank		Stores the brake fluid.
	Brake Fluid Level Warning Switch	Detects the low brake fluid level.
Stop Light Switch		Detects the brake pedal-depressing signal.
Yaw Rate and Decelerator Rate Sensor (See Page CH-63)		• Detects the vehicle's yaw rate. • Detects the vehicle's acceleration in the forward, rearward, and lateral.
Steering Angle Sensor (See Page CH-64)		Detects the steering direction and angle of the steering wheel.
Pump Motor relay 1,2		• Two types of pump motor relays with different pump actuation speeds. • If one relay fails, the other relay operates to actuate the pump.
Main Relays		Controlled by the skid control ECU, the main relays supply or remove power to the solenoid valves in the brake actuator and the skid control ECU.
Power Source Backup Unit (See Page CH-64)		• An auxiliary power supply to provide stable power to the brake system. • Complements the supply of power to the brake system by discharging the electric charge that is stored in the unit when the voltage of the (12V) power supply of the vehicle is low.

Construction and Operation of Main Component

1) Brake Actuator

a. General

- The brake actuator of the RX400h consists of hydraulic control and hydraulic power source portions.
- The two master cylinder pressure sensors, four wheel cylinder pressure sensors, and an accumulator pressure sensor are installed in the brake actuator.



277CH123

CH

► Function of Main Components ◀

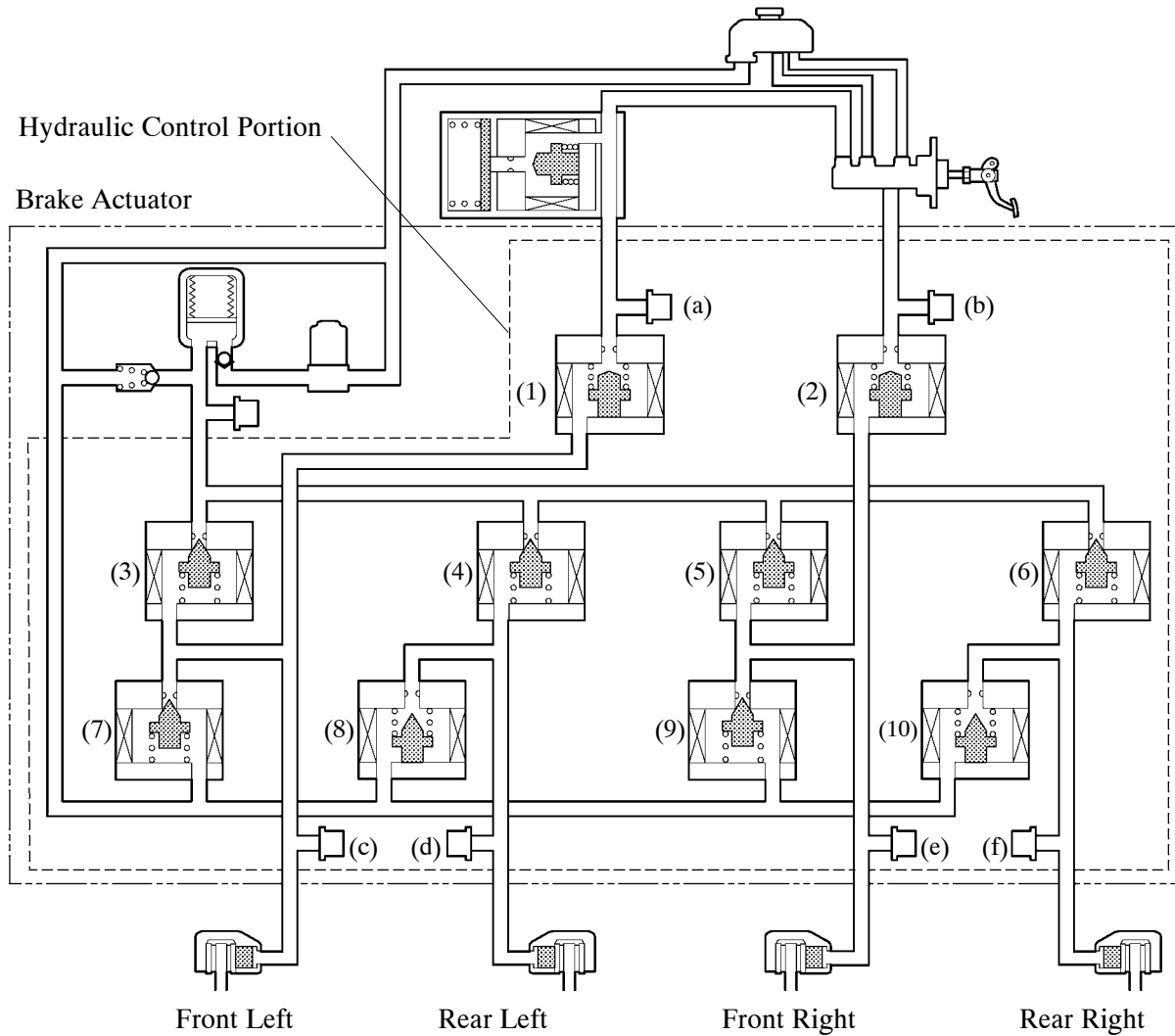
Component	Function
Master Cylinder Cut Solenoid Valve (2-position Type)	• When the brake system is started, this valve cuts the hydraulic passage between the master cylinder and the wheel cylinder. • When the brake system is stopped or a failure occurs in the hydraulic power source portion, the valve opens to maintain the hydraulic passage to the front wheel cylinders and ensure braking. However, a greater effort than normal is required to press the brake pedal.
Pressure Appliance Solenoid Valve (Linear Type)	This valve, which is controlled by the skid control ECU, regulates the fluid pressure from the accumulator in order to amplify the fluid pressure to the wheel cylinder.
Pressure Reduction Solenoid Valve (Linear Type)	This valve, which is controlled by the skid control ECU, regulates the fluid pressure in order to reduce the fluid pressure to the wheel cylinder.
Master Cylinder Pressure Sensors	The master cylinder pressure sensor converts the fluid pressure generated by the master cylinder into electrical signals and transmits them to the skid control ECU. Accordingly, the skid control ECU determines the braking force required by the driver.
Wheel Cylinder Pressure Sensors	These sensors detect the fluid pressure that acts on the respective wheel cylinders and transmits them to the skid control ECU in the form of feedback. Accordingly, the skid control ECU monitors the fluid pressure of the wheel cylinders and controls the pressure appliance solenoid valve and the pressure reduction solenoid valve, in order to achieve the optimal wheel cylinder pressures.
Accumulator Pressure Sensor	The accumulator pressure sensor constantly detects the brake fluid pressure in the accumulator and transmits the signals to the skid control ECU. Accordingly, the skid control ECU controls the pump motor.
Pump and Pump Motor	Draws up the brake fluid from the reservoir tank and provides high hydraulic pressure to the accumulator.
Accumulator	Stores the hydraulic pressure that was generated by the pump. The accumulator is filled with high pressure nitrogen gas.
Relief Valve	Returns the brake fluid to the reservoir tank to prevent excessive pressure if the pump operates continuously due to a malfunction of the accumulator pressure sensor.

b. Hydraulic Control Portion

The 10 solenoid valves and 6-pressure sensors consists of the following:

- 2 master cylinder cut solenoid valves [(1), (2)]
- 4 pressure appliance valves [(3), (4), (5), (6)]
- 4 pressure reduction valves [(7), (8), (9), (10)]
- 2 master cylinder pressure sensor [(a), (b)]
- 4 wheel cylinder pressure sensor [(c), (d), (e), (f)]

► Hydraulic Circuit ◀



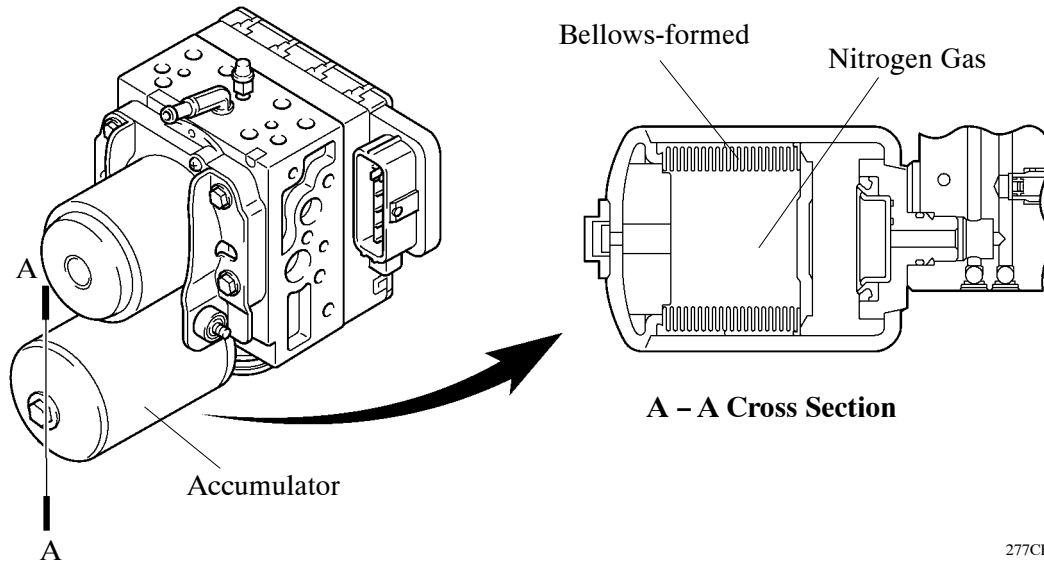
c. Hydraulic Power Source Portion

i) General

The hydraulic power source portion consists of pump, pump motor, accumulator, relief valve, 2 motor relays, and accumulator pressure sensor.

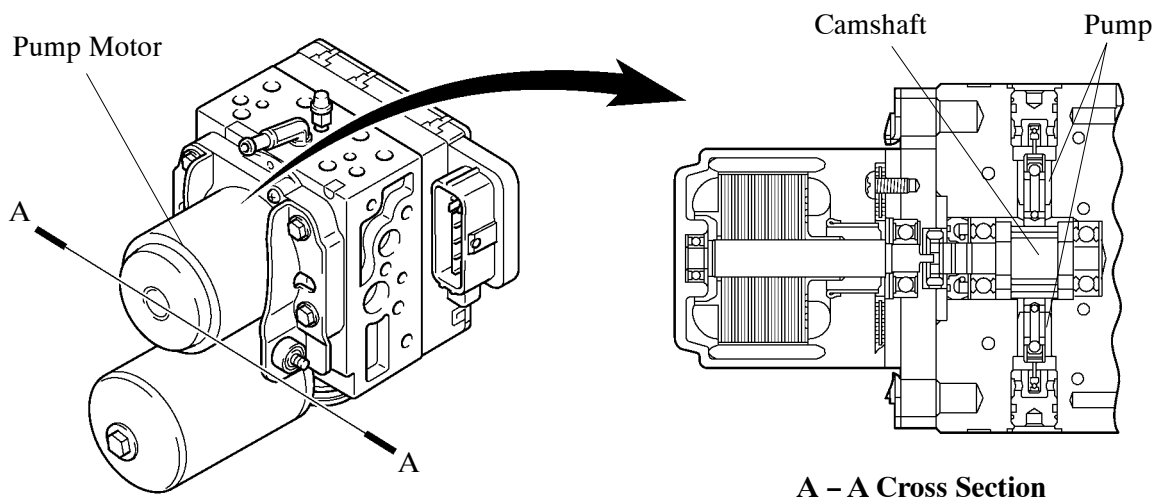
ii) Accumulator

Inside the accumulator of the RX400h, as same as the previous model, the high-pressurized nitrogen gas is charged and sealed. On the RX400h, metallic bellows-formed tube is used, in order to enhance the gastight performance of the accumulator.



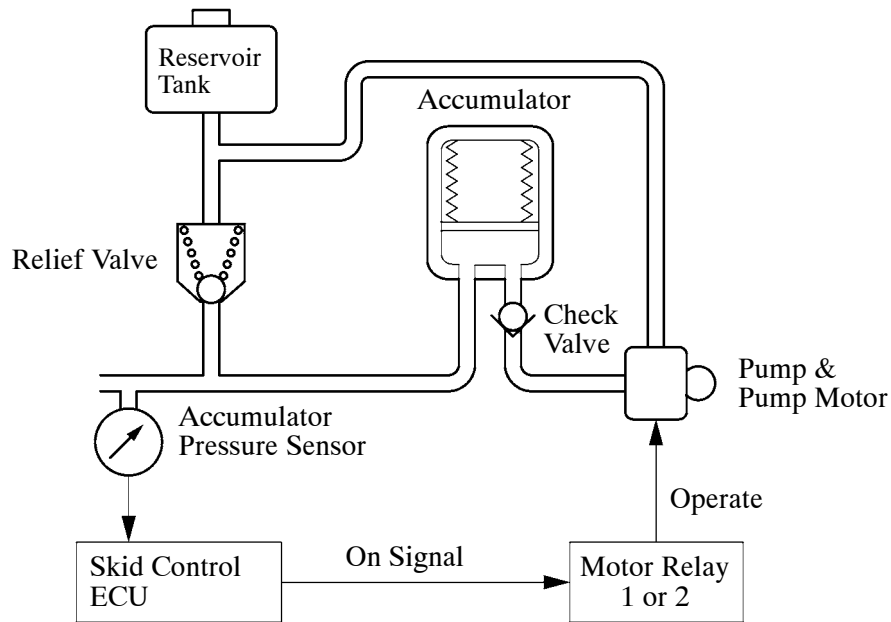
iii) Pump and Pump Motor

A plunger type pump is used. This pump is operated by the rotation of the camshaft driven by the motor, and then supplies high-pressurized fluid to the accumulator.



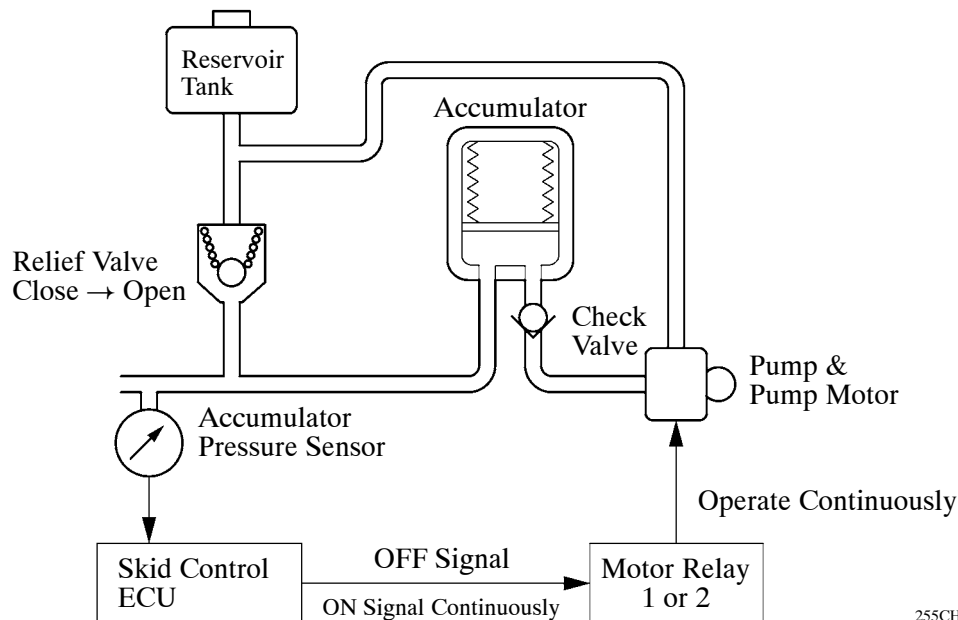
iv) Operation

- The brake fluid that is discharged by the pump passes through the check valve and is stored in the accumulator. The hydraulic pressure that is stored in the accumulator is used for providing the hydraulic pressure that is needed for normal braking and for operating the brake control.
- The motor relays consist of the following relays with different pump actuation speeds: relay 1 (low speed) and relay 2 (high speed). Normally, relay 1 with the slow pump speed is used. When the fluid pressure drops quickly because more fluid pressure is required, such as in ABS fluid pressure control, relay 2 with the fast pump speed is used. If one of the relays malfunctions, the other is used for actuating the pump.
- The accumulator pressure sensor constantly monitors the pressure in the accumulator and transmits it to the skid control ECU. If the accumulator pressure drops below the set pressure, the skid control ECU sends an activation signal to the motor relay in order to actuate the pump motor until the pressure in the accumulator reaches the set pressure.



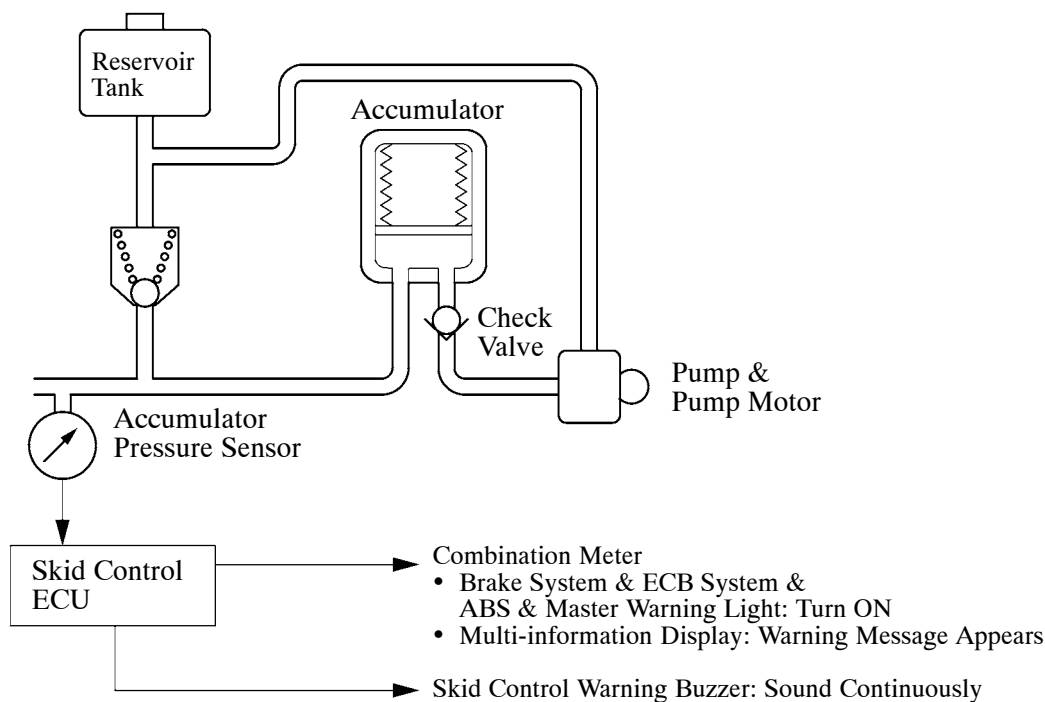
255CH136

- If the pump and the pump motor continue to operate unintendedly and accumulator sensor failed, a high pressure would be created in the accumulator. At this time, the relief valve will open to return the brake fluid to the reservoir tank, in order to reduce the accumulator pressure.



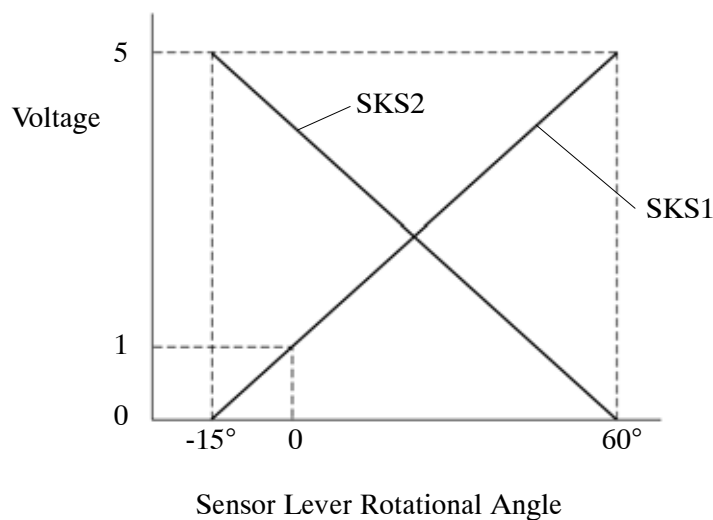
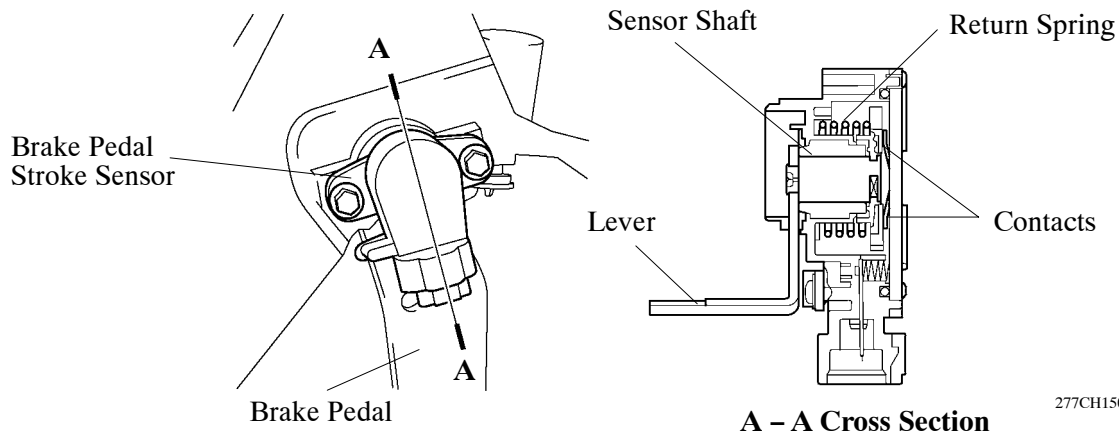
255CH137

- If the accumulator pressure drops abnormally to a level below the pressure set at the ECU, the skid control ECU illuminates the brake system warning light, the ECB warning light, ABS warning light and the master warning light. Then, a warning message appears on the multi-information display in the combination meter, and the skid control warning buzzer sounds to alert the driver of the abnormal hydraulic pressure.



2) Brake Pedal Stroke Sensor

This sensor, which contains a contact type variable resistor, detects the extent of the brake pedal stroke and transmits it to the skid control ECU.



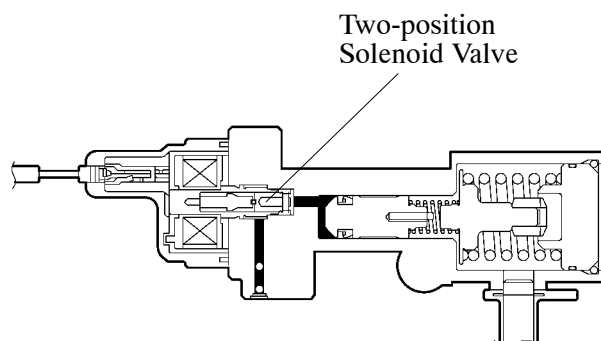
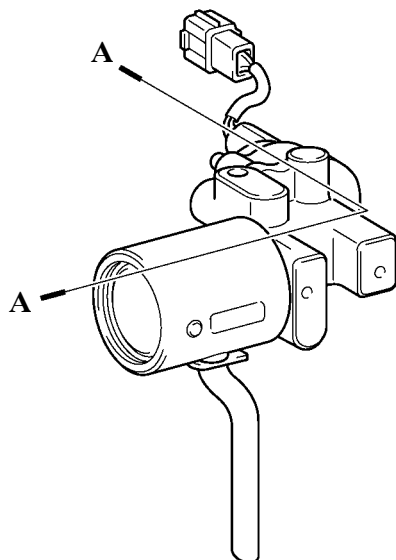
255CH164

Service Tip

- To install a brake pedal stroke sensor, which is available as a service part, perform as follows:
 - The sensor lever is secured with a pin to "0" stroke. (Do not detach the pin until the installation has been completed.)
 - In this state, install the sensor on the brake pedal (in the OFF state) on the vehicle.
 - After completing the installation, firmly press the brake pedal once to break off the pin that is securing the sensor in place.
 - Make sure the broken pin does not remain in the sensor lever.
- After replacing the brake pedal stroke sensor, initialization of brake pedal stroke sensor must be required on the skid control ECU side.
- For the actual procedure, refer to the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

3) Stroke Simulator

The stroke simulator is located between the master cylinder and the brake actuator. It generates a pedal stroke in accordance with the driver's pedal effort during braking. Containing 2 types of coil springs with different spring constants, the stroke simulator provides pedal stroke characteristics in 2 stages in relation to the master cylinder pressure.



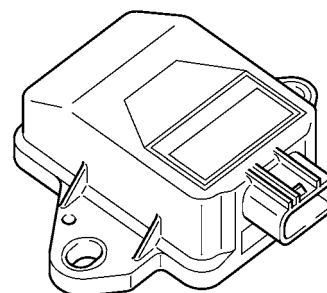
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277CH140

CH

4) Yaw Rate Sensor

A deceleration rate sensor is built into the yaw rate sensor. This sensor detects the yaw rate and lateral acceleration, and sends this signal to the skid control ECU.



255CH141

Service Tip

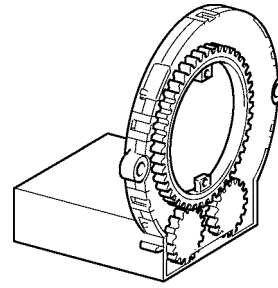
After replacing the yaw rate sensor or the skid control ECU, initialization of the deceleration sensor and yaw rate sensor is required.

For the actual procedure, refer to the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

5) Steering Angle Sensor

This steering angle sensor detects the steering direction and angle, and sends this signal to the skid control ECU.

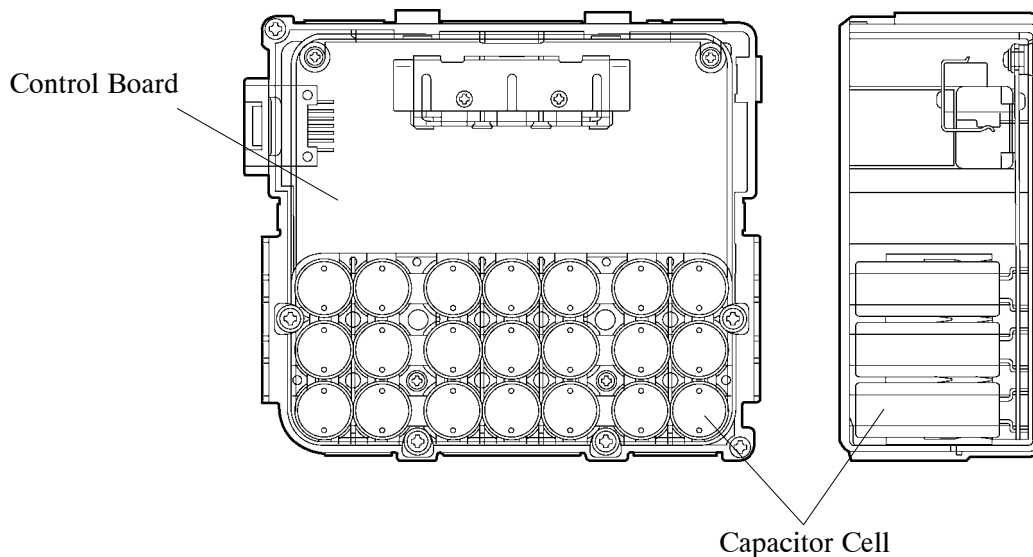
The sensor contains two gears for detecting the rotational movement. The magnetic field of the MRE (Magnetic Resistance Element), which is built into these gears, changes as the gears rotate. The change in the magnetic field causes the resistance of the sensor to change, which is detected by the skid control ECU in the form of the rotational angle of the steering.



277CH126

6) Power Source Backup Unit

- The power source backup unit is used as an auxiliary power source, in order to supply power to the brake system in a stable manner.
- This unit contains 21 capacitor cells, which store an electrical charge provided by the (12V) vehicle power supply. When the voltage of the (12V) vehicle power supply drops, the electrical charge stored in the capacitor cells is used as an auxiliary power supply to the brake system.



277CH127

Service Tip

Immediately after the ignition switch is turned OFF, this unit is in the discharging state, and some voltage remains in the capacitors. Therefore, make sure to check for residual voltage and discharge it if necessary, before removing the power source backup unit from the vehicle or opening and inspecting the inside of the power source backup unit case.

For details, refer to the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

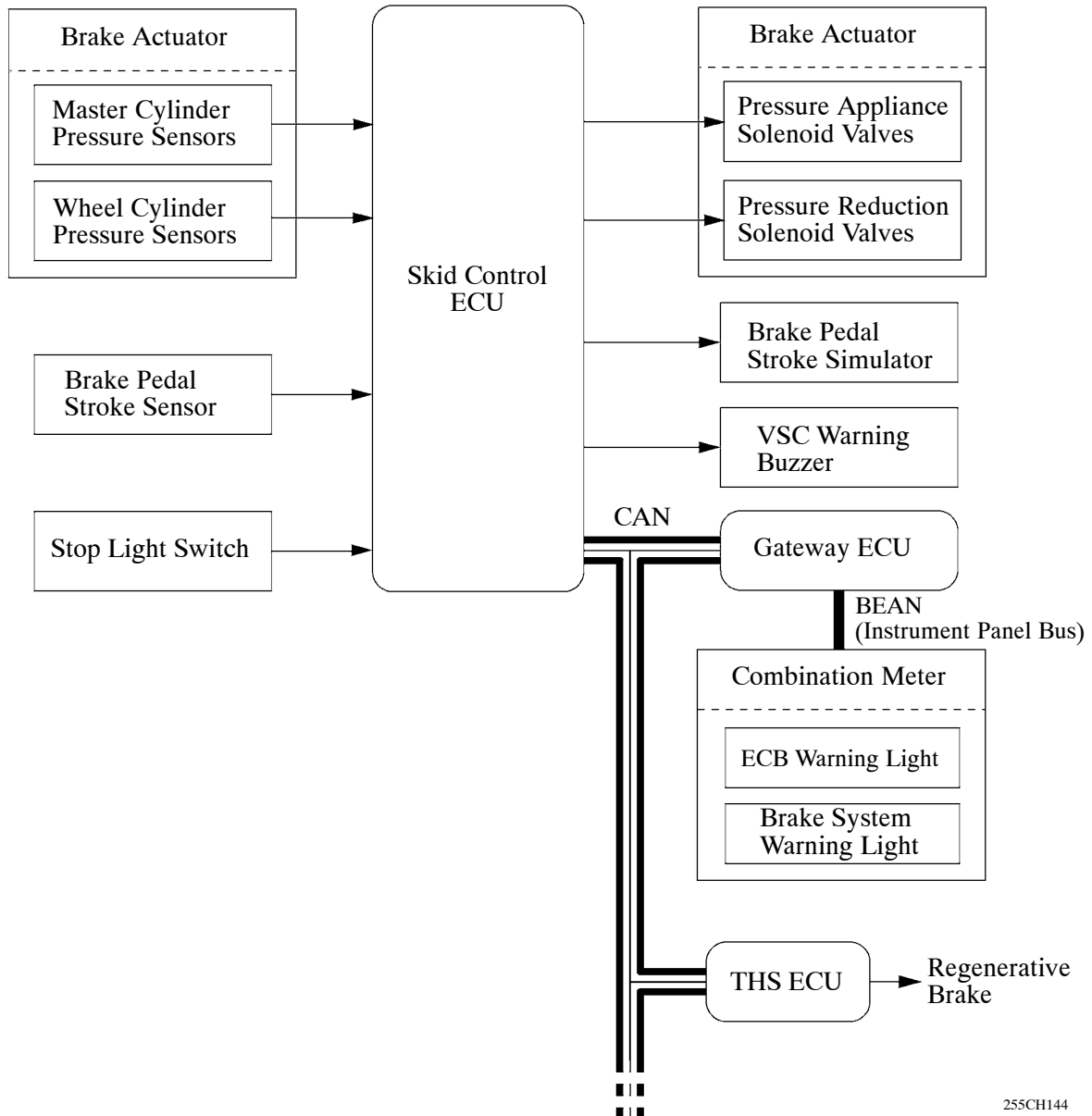
System Operation

1) Normal Brake Operation (With Regenerative Brake Cooperative Control)

a. General

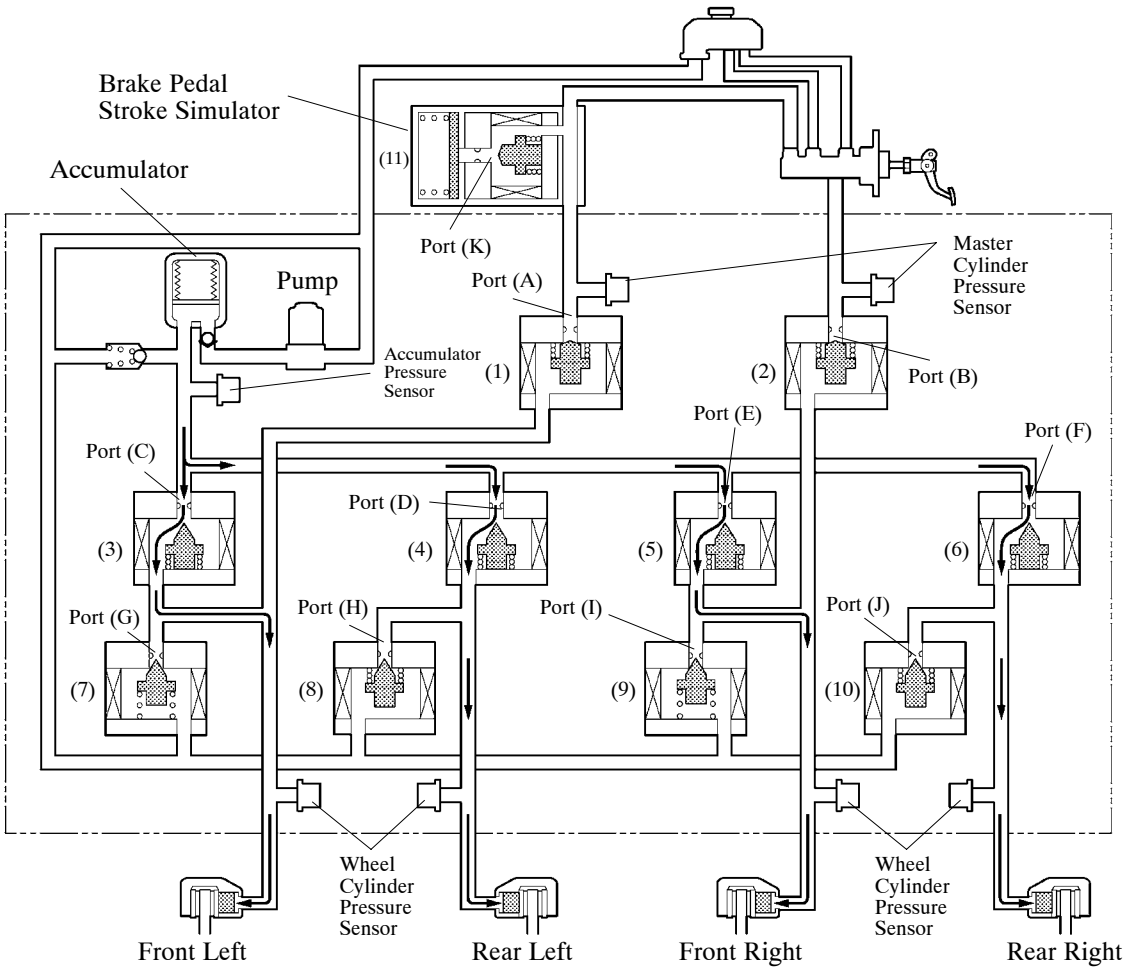
- During normal braking, the master cylinder cut solenoid valves are closed and the fluid pressure circuits to the wheel cylinders remain independent. Accordingly, the fluid pressure generated by the master cylinder will not directly cause the wheel cylinders to actuate.
- The skid control ECU calculates the braking force required by the driver in accordance with the signals received from the master cylinder pressure sensors and the brake pedal stroke sensor. Then, the skid control ECU calculates the regenerative brake force value out of the required brake force and transmits the calculated value to the THS ECU. Upon receiving the value, the THS ECU generates a regenerative brake force. At the same time, the THS ECU transmits the actual regenerative brake force value to the skid control ECU. The skid control ECU controls the solenoid valves in order to cause the hydraulic brake system to generate a brake force value (which is obtained by subtracting the regenerative brake force from the brake force value required by the driver).

► System Diagram ◀



b. Pressure Increase

The skid control ECU calculates the target wheel cylinder pressure (equivalent to the brake force required by the driver) in accordance with the signals received from the master cylinder pressure sensor and the brake pedal stroke sensor. The skid control ECU compares the wheel cylinder pressure sensor signal and the target wheel cylinder pressure. If the target wheel cylinder pressure is lower, the skid control ECU boosts the pressure in the brake actuator. Accordingly, the fluid pressure in the accumulator is fed into the wheel cylinder. Moreover, this operation is the same when the hydraulic brake force must be increased in order to effect cooperative control in accordance with the changes in the regenerative brake force.



256CH108

Item		Normal Braking Increase Mode
(1), (2)	Master Cylinder Cut Solenoid Valve	ON (Close)
	Port: (A), (B)	
(3), (4), (5), (6)	Pressure Appliance Solenoid Valve	ON (Half-Open*)
	Port: (C), (D), (E), (F)	
(7), (9)	Pressure Reduction Solenoid Valve	OFF (Close)
	Port: (G), (I)	
(8), (10)	Pressure Reduction Solenoid Valve	ON (Close)
	Port: (H), (J)	
(11)	Stroke Simulator Cut Solenoid Valve	ON (Open)
	Port: (K)	

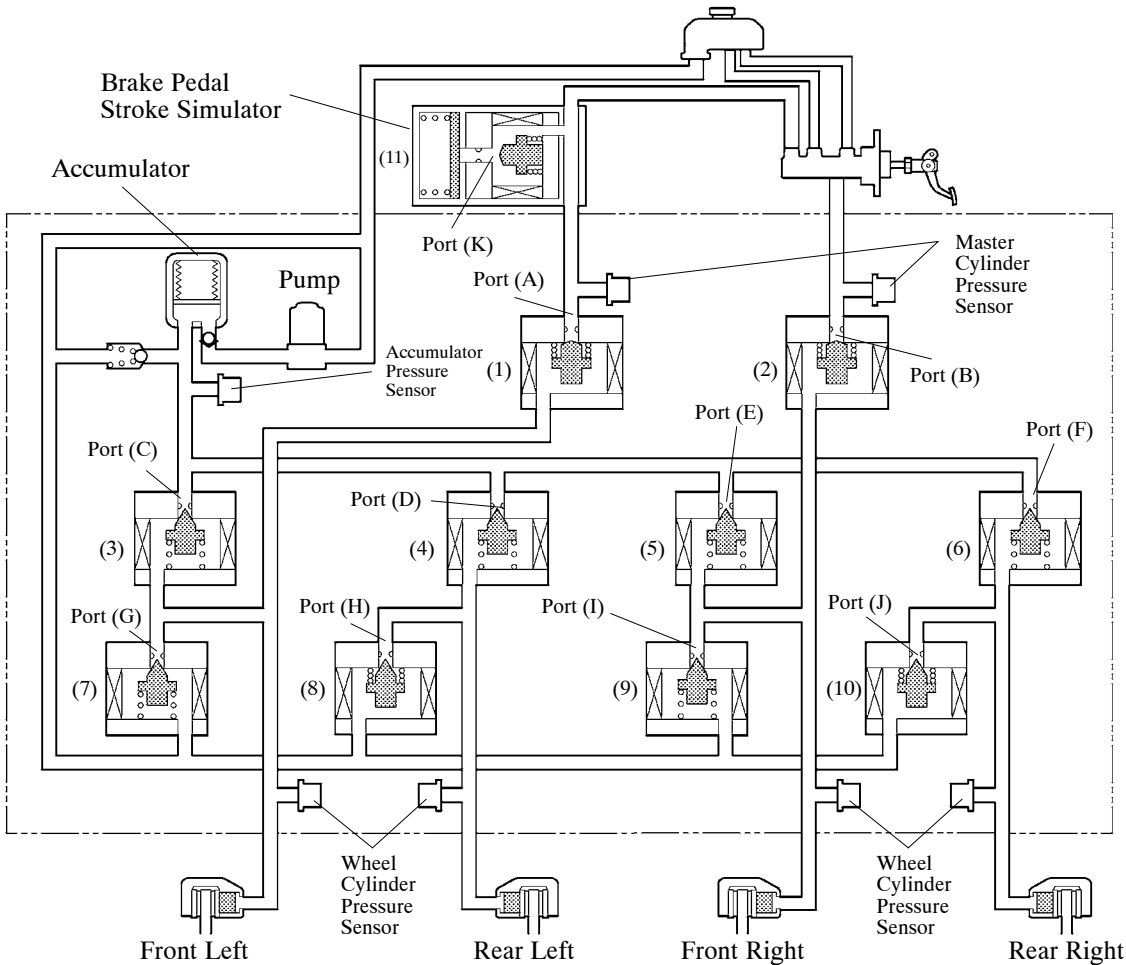
*: The solenoid valve constantly regulates the amount of opening of the port in accordance with the use conditions in order to control the fluid pressure.

c. Holding

The skid control ECU calculates the target wheel cylinder pressure (equivalent to the brake force required by the driver) in accordance with the signals received from the master cylinder pressure sensor and the brake pedal stroke sensor.

The skid control ECU compares the wheel cylinder pressure signal with the target wheel cylinder pressure. If they are equal, the skid control ECU controls the brake actuator in the hold state.

Accordingly, the wheel cylinder will be held at a constant pressure.



256CH109

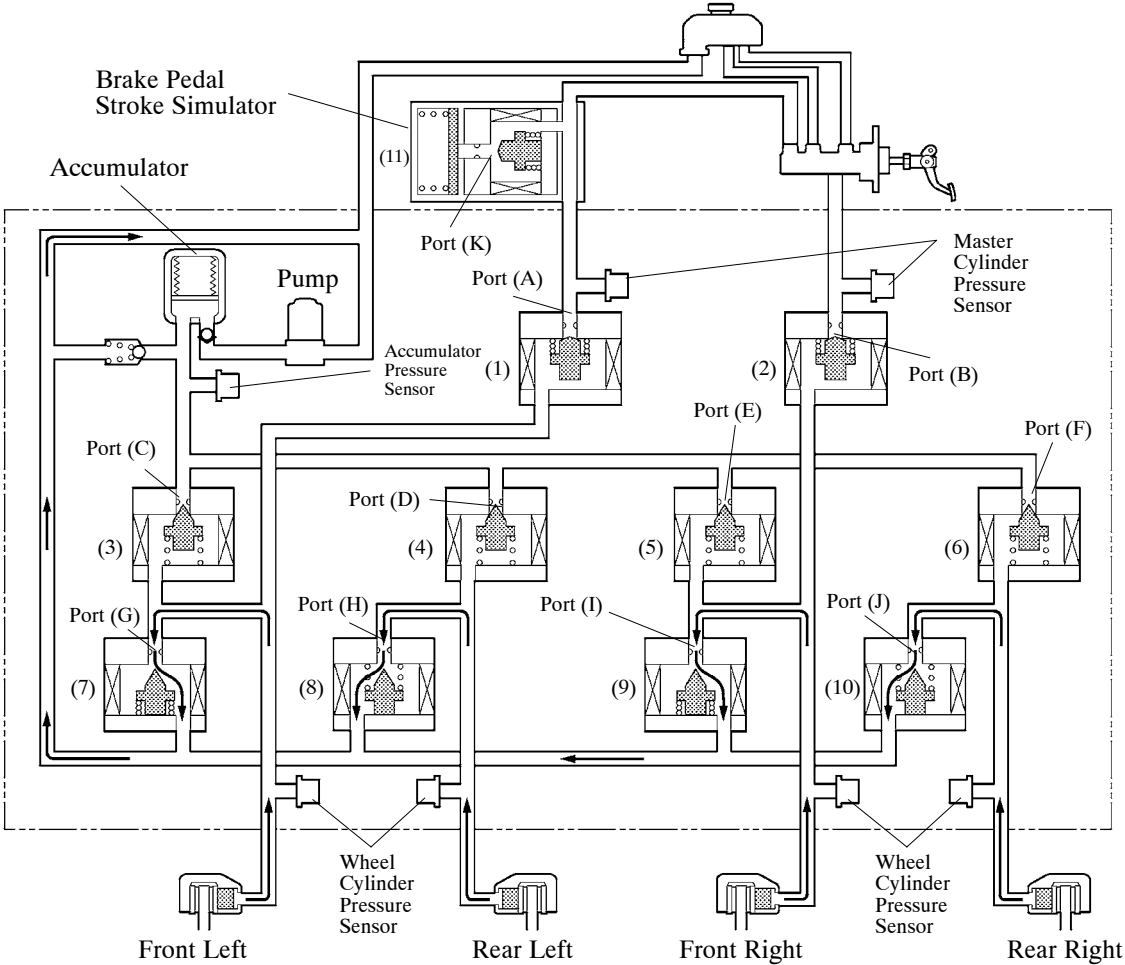
Item		Normal Braking Hold Mode
(1), (2)	Master Cylinder Cut Solenoid Valve	ON (Close)
	Port: (A), (B)	
(3), (4), (5), (6)	Pressure Appliance Solenoid Valve	OFF (Close)
	Port: (C), (D), (E), (F)	
(7), (9)	Pressure Reduction Solenoid Valve	OFF (Close)
	Port: (G), (I)	
(8), (10)	Pressure Reduction Solenoid Valve	ON (Close)
	Port: (H), (J)	
(11)	Stroke Simulator Cut Solenoid Valve	ON (Open)
	Port: (K)	

d. Pressure Reduce

The skid control ECU calculates the target wheel cylinder pressure (equivalent to the brake force required by the driver) in accordance with the signals received from the master cylinder pressure sensor and the brake pedal stroke sensor.

The skid control ECU compares the wheel cylinder pressure signal with the target wheel cylinder pressure. If the target wheel cylinder pressure is higher, the skid control ECU reduces the pressure in the brake actuator. Accordingly, the pressure in the wheel cylinder decreases.

Moreover, this operation is the same when the hydraulic brake force must be decreased in order to effect cooperative control in accordance with the changes in the regenerative brake force.



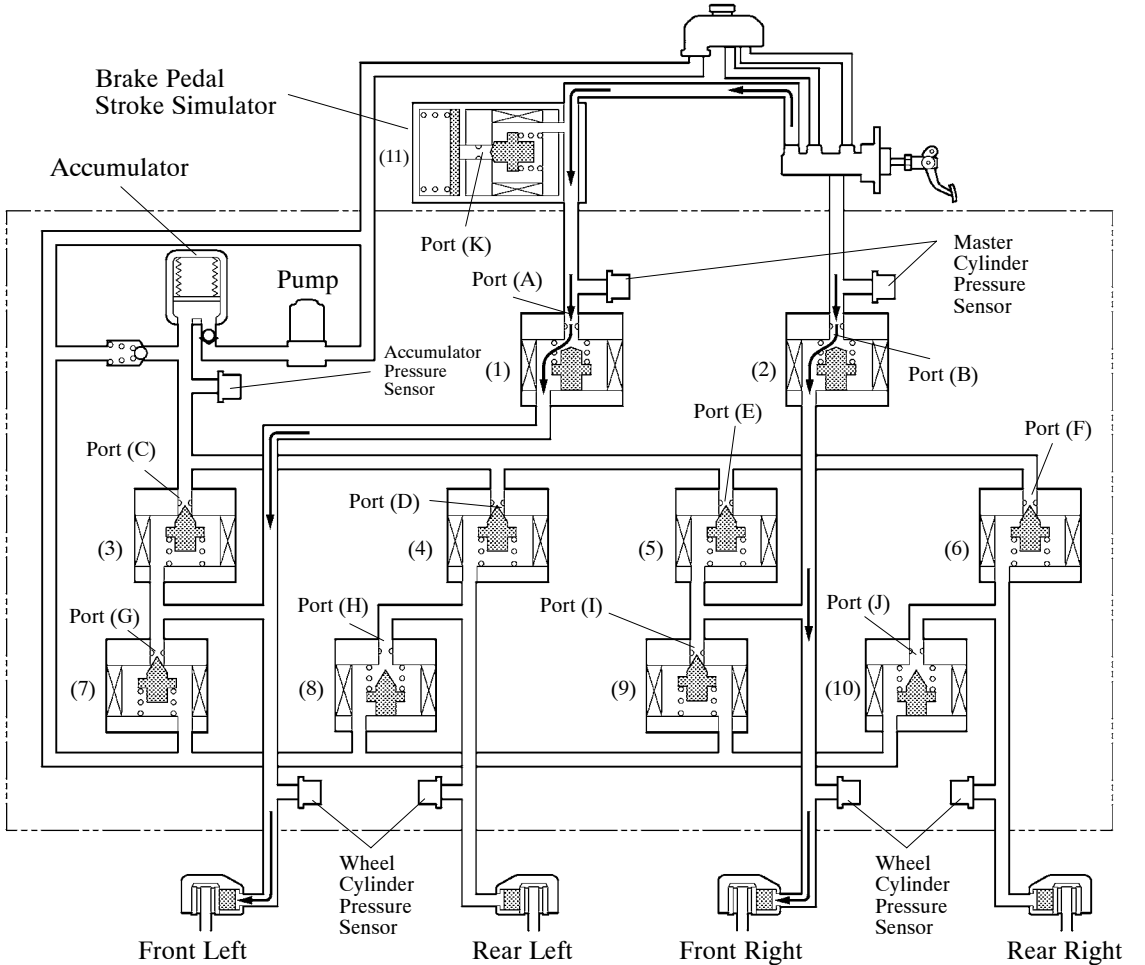
256CH110

Item		Normal Braking Reduce Mode
(1), (2)	Master Cylinder Cut Solenoid Valve	ON (Close)
	Port: (A), (B)	
(3), (4), (5), (6)	Pressure Appliance Solenoid Valve	OFF (Close)
	Port: (C), (D), (E), (F)	
(7), (9)	Pressure Reduction Solenoid Valve	ON (Half-Open*)
	Port: (G), (I)	
(8), (10)	Pressure Reduction Solenoid Valve	ON (Half-Open*)
	Port: (H), (J)	
(11)	Stroke Simulator Cut Solenoid Valve	ON (Open)
	Port: (K)	

*: The solenoid valve constantly regulates the amount of opening of the port in accordance with the use conditions in order to control the fluid pressure.

e. Brake System Stops or During Power Supply Malfunction

If the brake system stops or no accumulator pressure is supplied due to some malfunction, the skid control ECU operates the fail-safe function. This function opens the master cylinder solenoid valve in the brake actuator, in order to secure a fluid passage between the master cylinder and the wheel cylinder. Thus, the brakes can be applied by operating only the front wheel cylinders under the fluid pressure generated by the master cylinder. At this time, port (K) of the stroke simulator cut solenoid valve closes in order to prevent the fluid pressure generated by the master cylinder from being negatively affected by the operation of the stroke simulator.



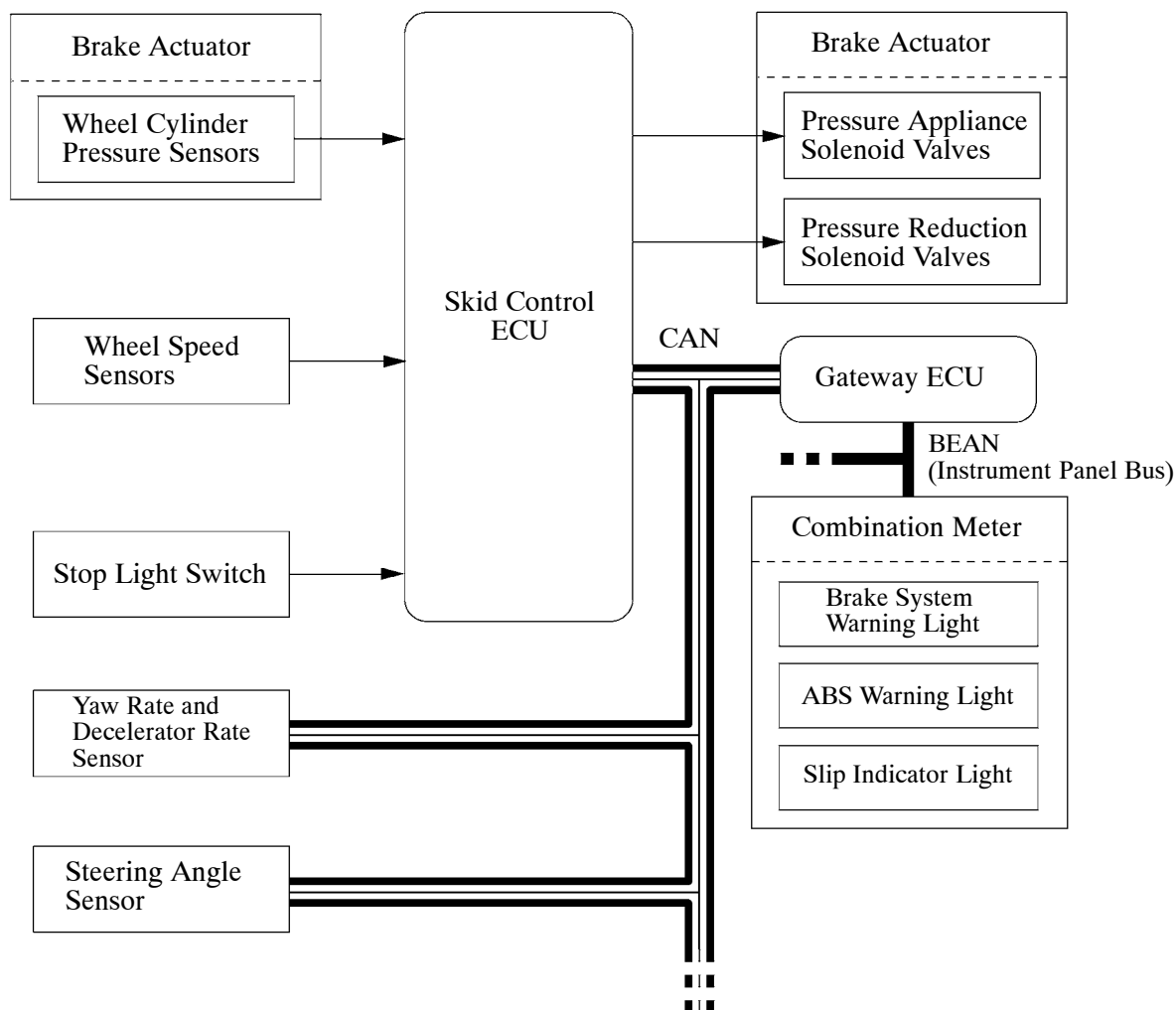
256CH111

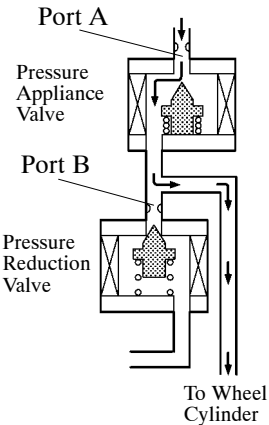
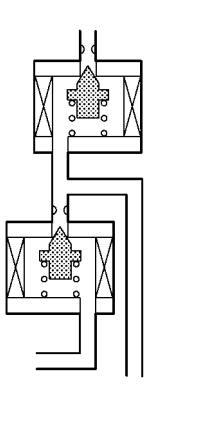
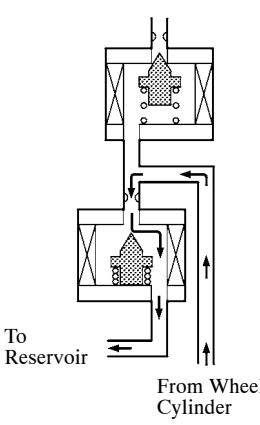
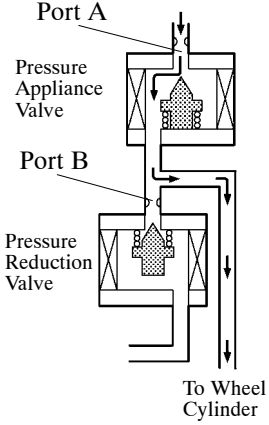
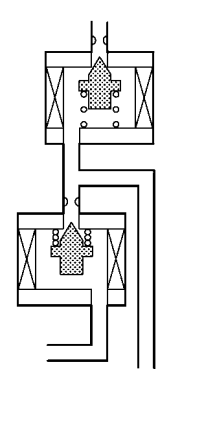
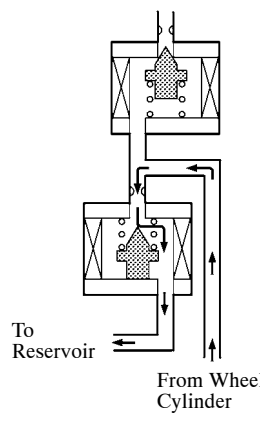
Item		System OFF & Fail-Safe Mode
(1), (2)	Master Cylinder Cut Solenoid Valve	OFF (Open)
	Port: (A), (B)	
(3), (4), (5), (6)	Pressure Appliance Solenoid Valve	OFF (Close)
	Port: (C), (D), (E), (F)	
(7), (9)	Pressure Reduction Solenoid Valve	OFF (Close)
	Port: (G), (I)	
(8), (10)	Pressure Reduction Solenoid Valve	OFF (Open)
	Port: (H), (J)	
(11)	Stroke Simulator Cut Solenoid Valve	OFF (Close)
	Port: (K)	

2) ABS with EBD Operation

Based on the signals received from the four wheel speed sensors, the skid control ECU calculates each wheel speed and deceleration, and checks wheel slipping conditions. And according to the slipping condition, the skid control ECU controls the pressure increase valve and pressure reduction valve in order to adjust the fluid pressure of the each wheel cylinder in the following 3 modes: pressure reduction, pressure holding, pressure increase modes.

► System Diagram ◀



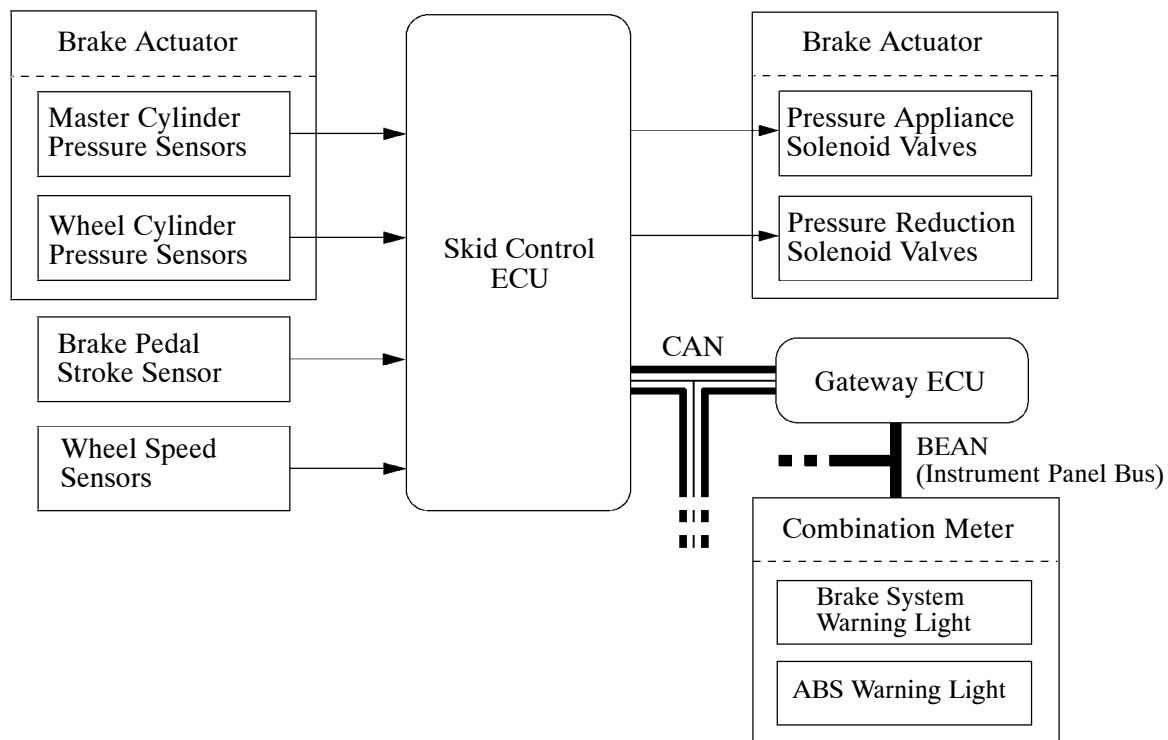
Not Activated		Normal Braking	—	—
Activated		Increase Mode	Holding Mode	Reduction Mode
Hydraulic Circuit		 255CH151	 255CH152	 255CH153
Front	Pressure Appliance Solenoid Valve (Port A)	ON (Half-Open*)	OFF (Close)	OFF (Close)
	Pressure Reduction Solenoid Valve (Port B)	OFF (Close)	OFF (Close)	ON (Half-Open*)
Hydraulic Circuit		 255CH159	 255CH160	 255CH161
Rear	Pressure Appliance Solenoid Valve (Port A)	ON (Half-Open*)	OFF (Close)	OFF (Close)
	Pressure Reduction Solenoid Valve (Port B)	ON (Close)	ON (Close)	ON (Half-Open*)
Wheel Cylinder Pressure		Increase	Hold	Reduction

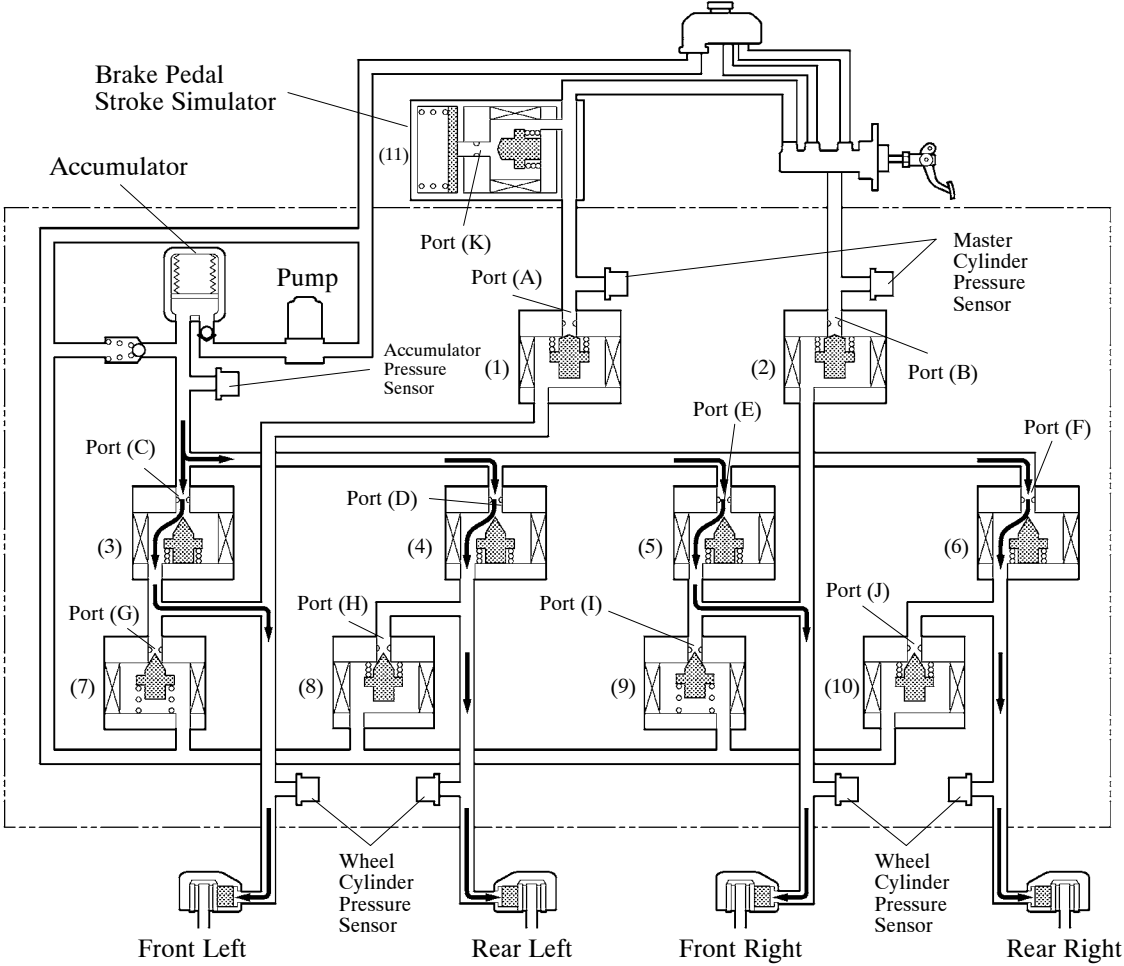
*: The solenoid valve constantly regulates the amount of opening of the port in accordance with the use conditions in order to control the fluid pressure.

3) Brake Assist Operation

In the event of emergency braking, the skid control ECU detects the driver's intention based on the speed of the pressure increase in the master cylinder determined by the pressure sensor signal. If the ECU judges the need for the additional brake assist, additional fluid pressure is generated by the pump in the actuator and directed to the wheel cylinders.

► System Diagram ◀





256CH112

Item		Normal Braking Increase Mode	Brake Assist Activated
(1), (2)	Master Cylinder Cut Solenoid Valve Port: (A), (B)	ON (Close)	ON (Close)
(3), (4), (5), (6)	Pressure Appliance Solenoid Valve Port: (C), (D), (E), (F)	ON (Half-Open*)	ON (Half-Open*)
(7), (9)	Pressure Reduction Solenoid Valve Port: (G), (I)	OFF (Close)	OFF (Close)
(8), (10)	Pressure Reduction Solenoid Valve Port: (H), (J)	ON (Close)	ON (Close)
(11)	Stroke Simulator Cut Solenoid Valve Port: (K)	ON (Open)	ON (Open)

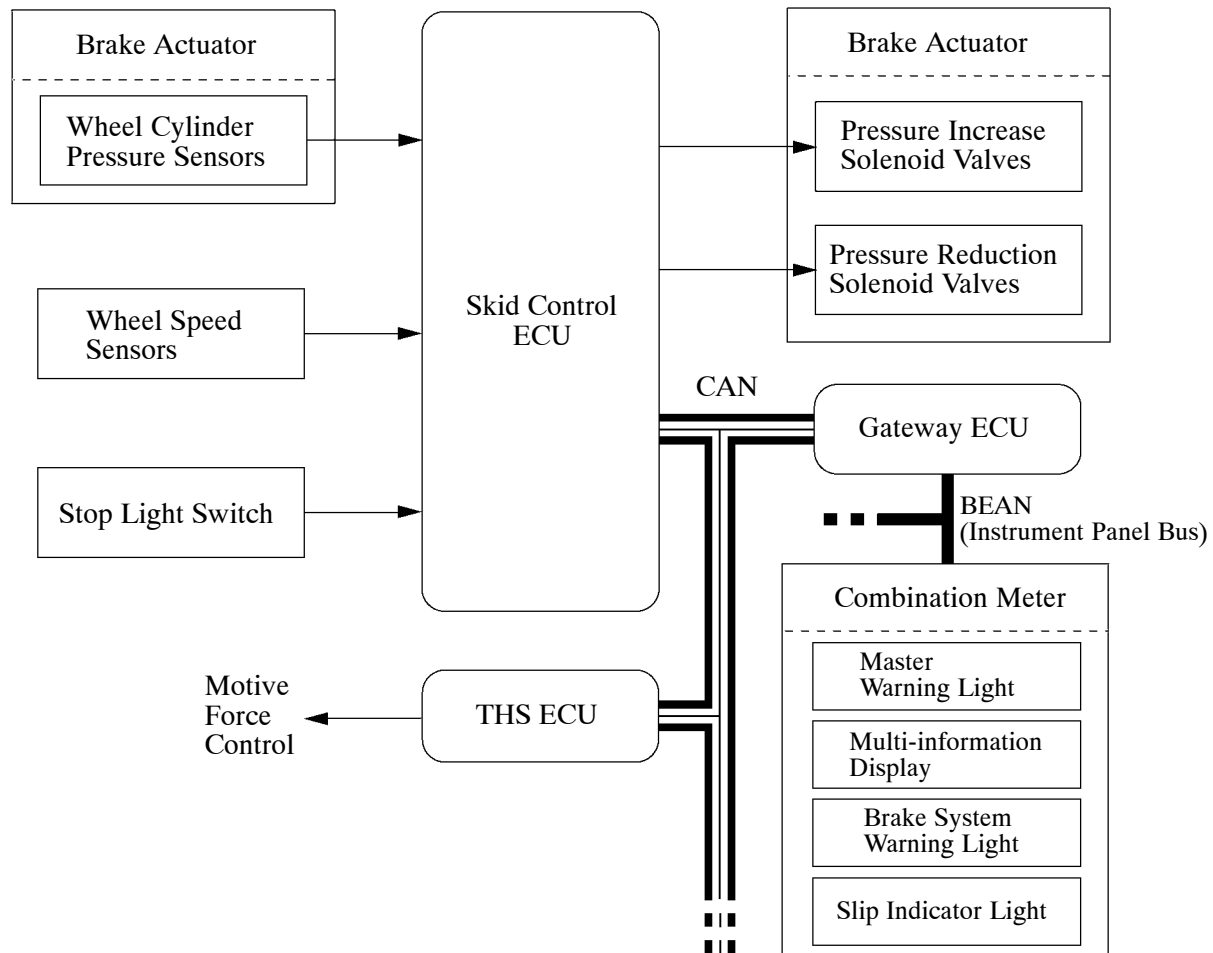
*: The solenoid valve constantly regulates the amount of opening of the port in accordance with the use conditions in order to control the fluid pressure.

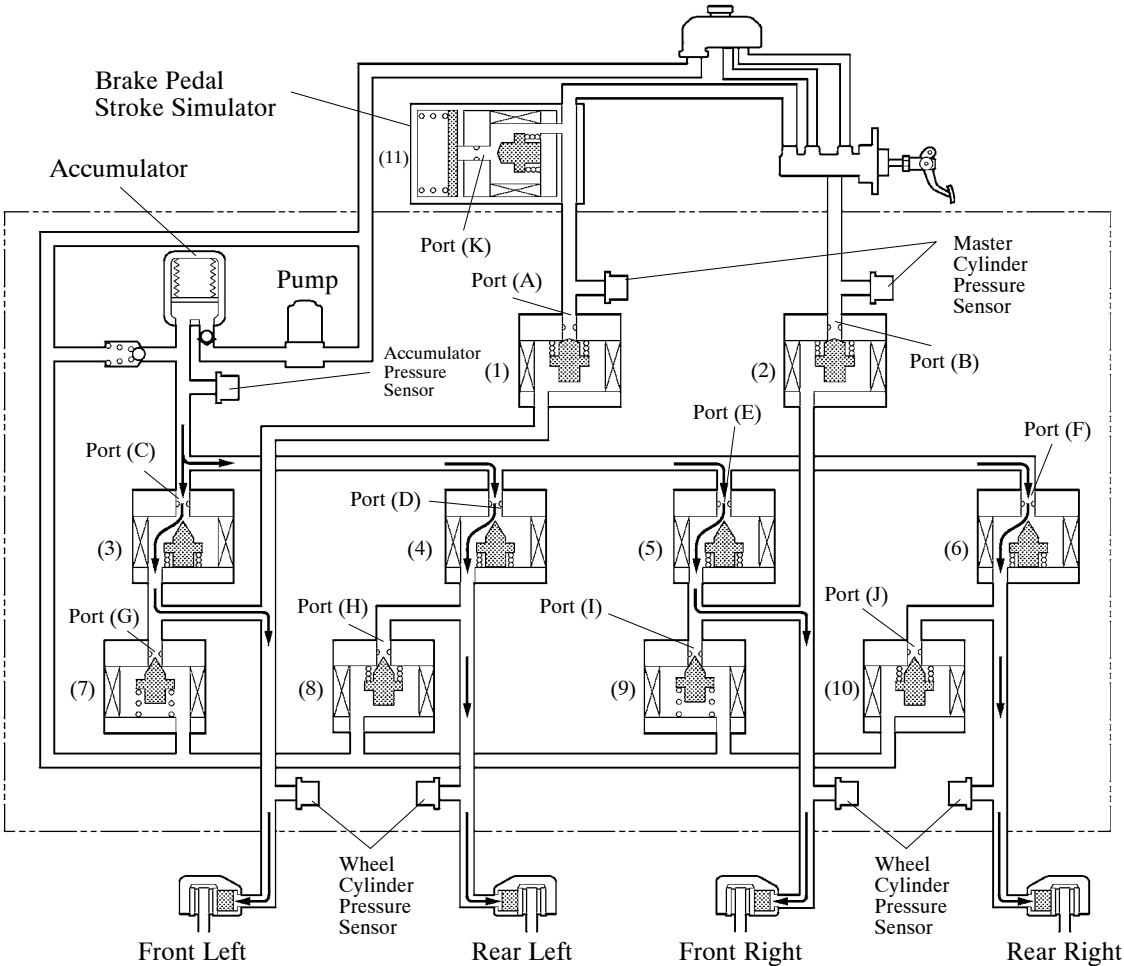
4) TRC Operation

The fluid pressure generated by the pump is regulated by the pressure appliance solenoid valve and pressure reduction solenoid valve to the required pressure. Thus, the wheel cylinders of the drive wheels are controlled in the following 3 modes: pressure reduction, pressure holding, and pressure increase modes, to restrain the slippage of the drive wheels.

The diagram on the next page shows the hydraulic circuit in the pressure increase mode when the TRC system is activated.

► System Diagram ◀





CH

Increase Mode

Item			TRC not Activated	TRC Activated		
				Increase Mode	Hold Mode	Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		ON (Close)	ON (Close)	ON (Close)	ON (Close)
	Port: (A), (B)					
Front Brake	(3), (5)	Pressure Appliance Solenoid Valve	OFF (Close)	ON (Half-Open*)	OFF (Close)	OFF (Close)
		Port: (C), (E)				
	(7), (9)	Pressure Reduction Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Half-Open*)
		Port: (G), (I)				
	Wheel Cylinder Pressure		—	Increase	Hold	Reduction
	Rear Brake	(4), (6)	Pressure Appliance Solenoid Valve	OFF (Close)	ON (Half-Open*)	OFF (Close)
Port: (D), (F)						
(8), (10)		Pressure Reduction Solenoid Valve	OFF (Open)	ON (Close)	ON (Close)	ON (Half-Open*)
		Port: (H), (J)				
Wheel Cylinder Pressure		—	Increase	Hold	Reduction	
(11)	Stroke Simulator Cut Solenoid Valve		ON (Open)	ON (Open)	ON (Open)	ON (Open)
	Port: (K)					

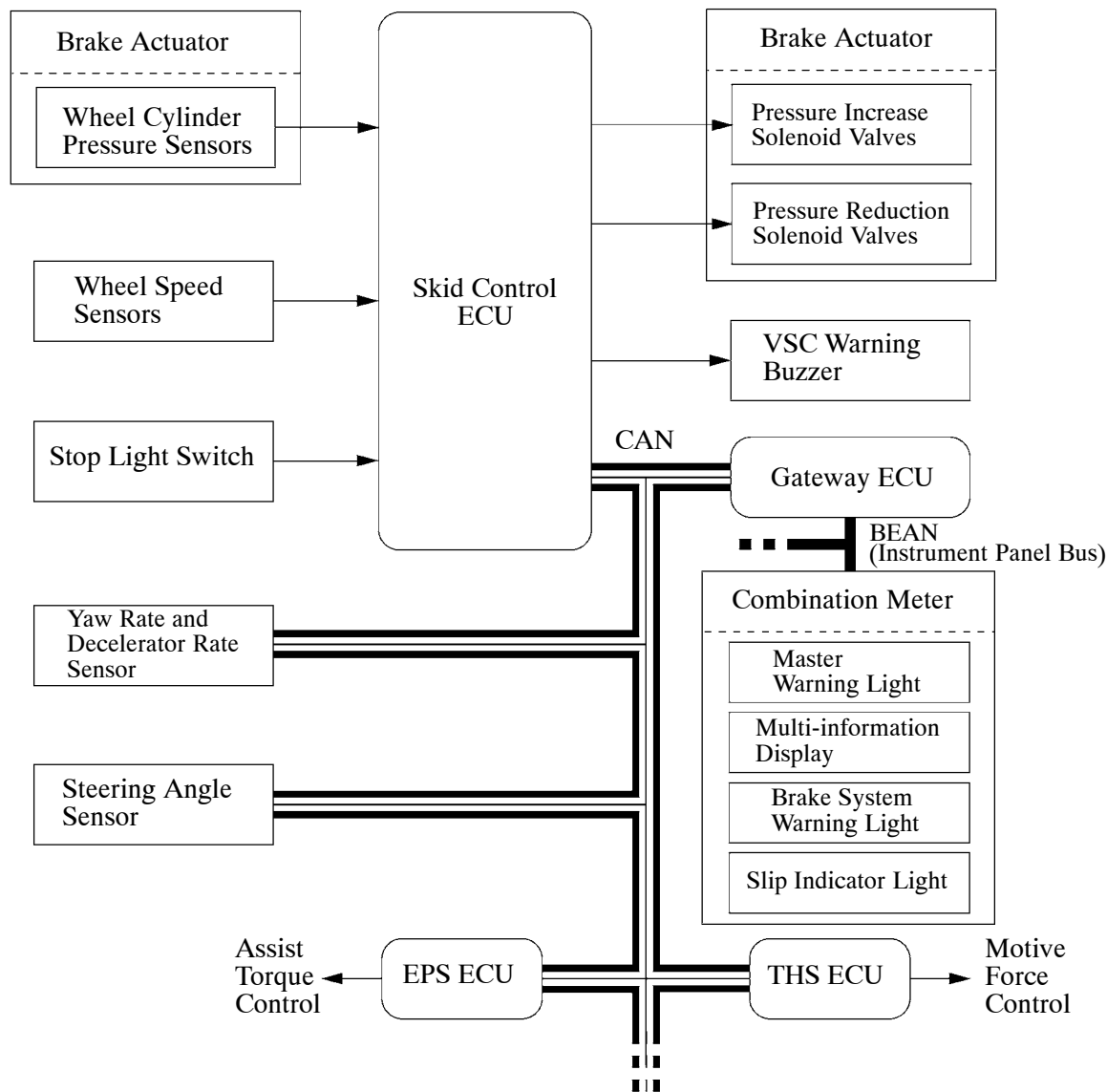
*: The solenoid valve constantly regulates the amount of opening of the port in accordance with the use conditions in order to control the fluid pressure.

5) VSC Operation

a. General

The VSC function controls the solenoid valves in order to send the fluid pressure stored in the accumulator to the brake wheel cylinders at the respective wheels, through routes that are different from those used during normal braking. Thus, the function operates in the following 3 modes: pressure reduction, pressure holding, and pressure increase. As a result, the tendency of the front wheels or the rear wheels to skid is restrained.

► System Diagram ◀



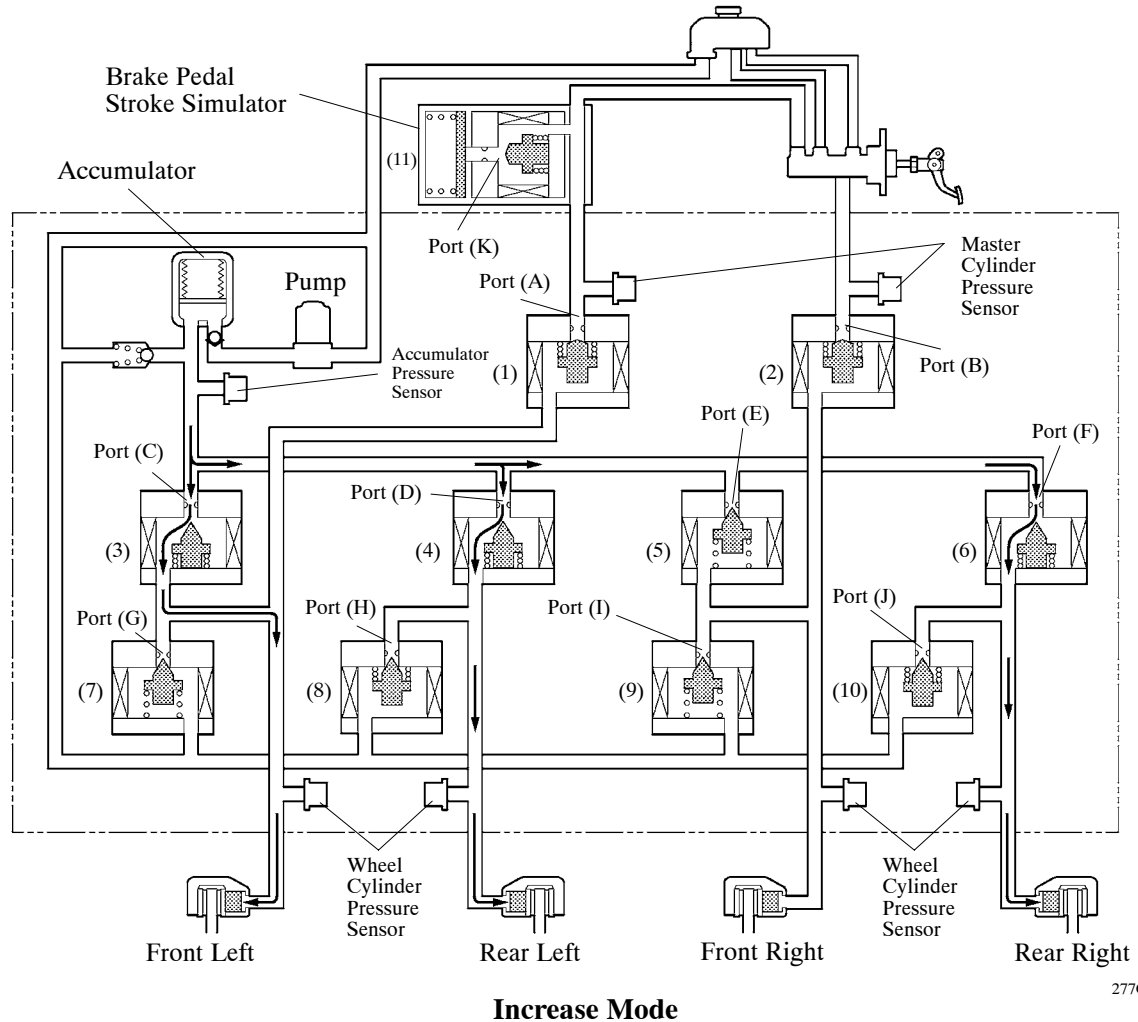
b. Front Wheel Skid Restraint Control (Turning to the Right)

In the front wheel skid tendency, this management function applies the brake of the rear wheels and front wheel of the outer side of the turn.

Also, depending on whether the brake is ON or OFF and the condition of the vehicle, there are circumstances in which the brake might not be applied to the wheels even if those wheels are targeted for braking.

The diagram below shows the hydraulic circuit in the pressure increase mode, as it restrains the front wheel skid condition while the vehicle makes a right turn.

The pressure appliance valve and the pressure reduction valve are turned ON/OFF according to the ABS operation pattern.



277CH153

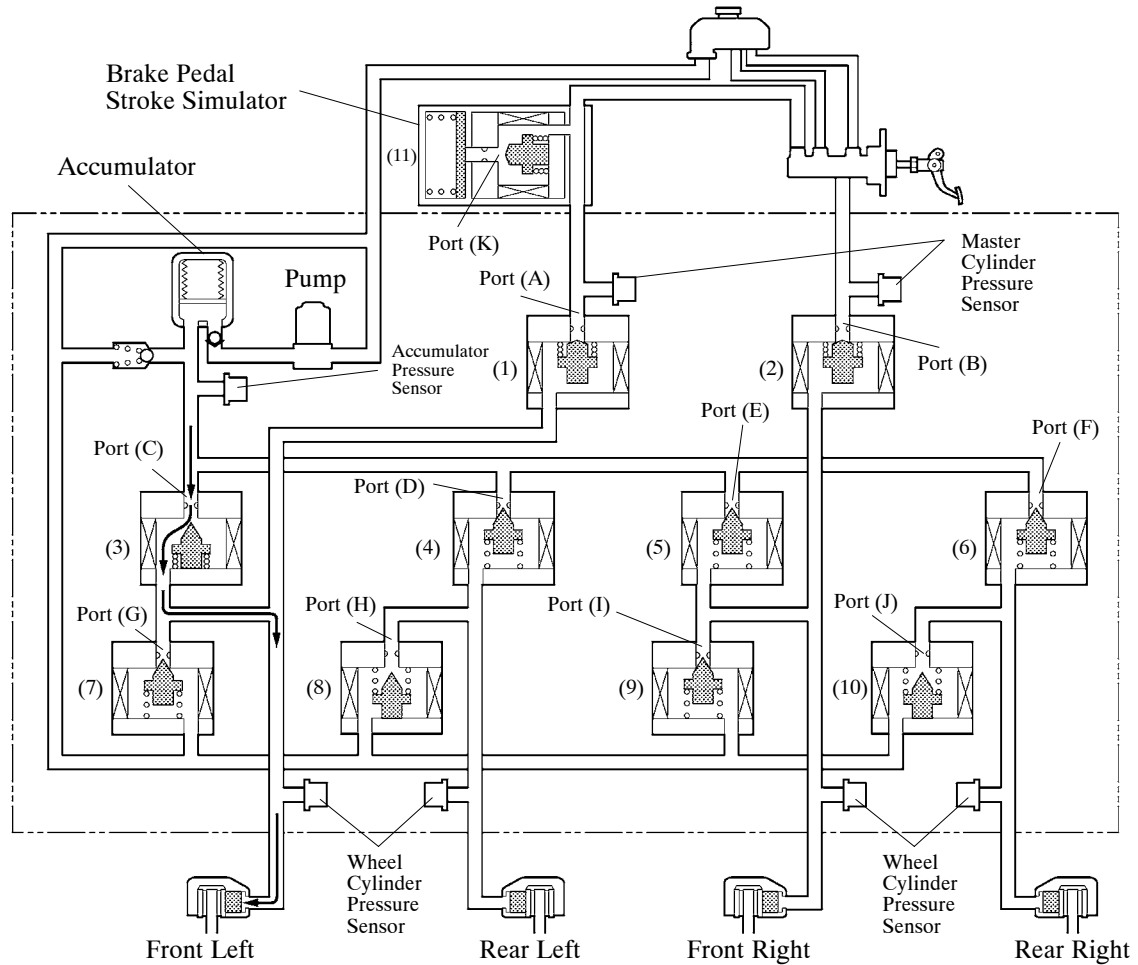
Item			VSC not Activated	VSC Activated		
				Increase Mode	Hold Mode	Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		ON (Close)	ON (Close)	ON (Close)	ON (Close)
	Port: (A), (B)					
Front Brake	(3)	Pressure Appliance Solenoid Valve	OFF (Close)	ON (Half-Open*)	OFF (Close)	OFF (Close)
		Port: (C)				
	(5)	Pressure Appliance Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (E)				
	(7)	Pressure Reduction Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Half-Open*)
		Port: (G)				
	(9)	Pressure Reduction Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (I)				
	Wheel Cylinder Pressure	Right	—	—	—	—
		Left	—	Increase	Hold	Reduction
Rear Brake	(4)	Pressure Appliance Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (D)				
	(6)	Pressure Appliance Solenoid Valve	OFF (Close)	ON (Half-Open*)	OFF (Close)	OFF (Close)
		Port: (F)				
	(8)	Pressure Reduction Solenoid Valve	OFF (Open)	ON (Close)	OFF (Open)	ON (Half-Open*)
		Port: (H)				
	(10)	Pressure Reduction Solenoid Valve	OFF (Open)	ON (Close)	ON (Close)	ON (Half-Open*)
		Port: (J)				
Wheel Cylinder Pressure	Right	—	Increase	Hold	Reduction	
	Left					
(11)	Stroke Simulator Cut Solenoid Valve		ON (Open)	ON (Open)	ON (Open)	ON (Open)
	Port: (K)					

*: The solenoid valve constantly regulates the amount of opening of the port in accordance with the use conditions in order to control the fluid pressure.

c. Rear Wheel Skid Restraint Control (Turning to the Right)

In rear wheel skid tendency, this management function applies the brake of the front and rear wheels of the outer circle of the turn. As an example, the diagram below shows the hydraulic circuit in the pressure increase mode, as it restrains the rear wheel skid condition while the vehicle make a right turn.

As in front wheel skid restrain the pressure appliance valve and the pressure reduction valve are turned ON/OFF according to the ABS operating pattern.



Increase Mode

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Item			VSC not Activated	VSC Activated		
				Increase Mode	Hold Mode	Reduction Mode
(1), (2)	Master Cylinder Cut Solenoid Valve		ON (Close)	ON (Close)	ON (Close)	ON (Close)
	Port: (A), (B)					
Front Brake	(3)	Pressure Appliance Solenoid Valve	OFF (Close)	ON (Half-Open*1)	OFF (Close)	OFF (Close)
		Port: (C)				
	(5)	Pressure Appliance Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (E)				
	(7)	Pressure Reduction Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	ON (Half-Open*1)
		Port: (G)				
	(9)	Pressure Reduction Solenoid Valve	OFF (Close)	OFF (Close)	OFF (Close)	OFF (Close)
		Port: (I)				
	Wheel Cylinder Pressure	Right	—	—	—	—
		Left	—	Increase	Hold	Reduction
Rear Brake	(4)	Pressure Appliance Solenoid Valve	OFF (Close)	OFF (Close) ON (Half-Open*1)*2	OFF (Close)	OFF (Close)
		Port: (D)				
	(6)	Pressure Appliance Solenoid Valve	OFF (Close)	OFF (Close) ON (Half-Open*1)*2	OFF (Close)	OFF (Close)
		Port: (F)				
	(8)	Pressure Reduction Solenoid Valve	OFF (Open)	OFF (Open)	ON (Close)	ON (Close) ON (Half-Open*1)*2
		Port: (H)				
	(10)	Pressure Reduction Solenoid Valve	OFF (Open)	OFF (Open)	ON (Close)	ON (Close) ON (Half-Open*1)*2
		Port: (J)				
	Wheel Cylinder Pressure	Right	—	—	—	—
		Left				
(11)	Stroke Simulator Cut Solenoid Valve		ON (Open)	ON (Open)	ON (Open)	ON (Open)
	Port: (K)					

*1: The solenoid valve constantly regulates the amount of opening of the port in accordance with the use conditions in order to control the fluid pressure.

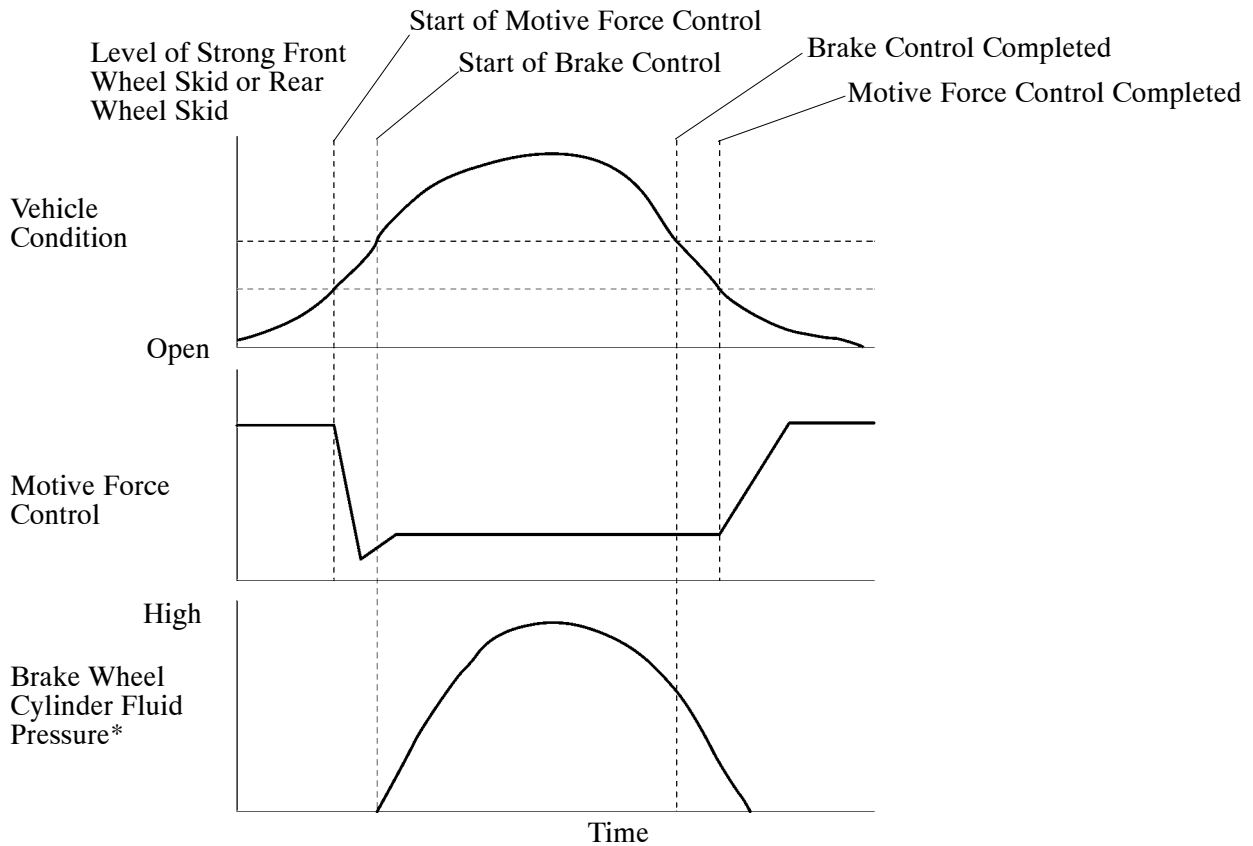
*2: In some cases, the skid control ECU applies the brake of the rear wheel, as necessary.

Skid Control ECU

VSC

Based on the signals received from the wheel speed sensors, yaw rate sensor, deceleration sensor and steering sensor, the skid control ECU calculates the vehicle condition.

If a strong front wheel skid or rear wheel skid tendency is created during an emergency avoidance maneuver or cornering, and the skid control ECU determines that the amount of skid exceeds a prescribed value, and controls the motive force and brake fluid pressure.



151CH31

*: The wheel cylinder that activates varies depending on the condition of the vehicle.

4. Self-Diagnosis

- If a failure occurs in one of the sensors or actuators in the brake system, the skid control ECU informs the driver of the failure in the brake system by illuminating the ECB warning light, brake system warning light, or ABS warning light in the combination meter, or displaying a VSC warning message (on the multi-information display).
- At the same time, a DTC (Diagnostic Trouble Code) is stored in memory. The DTC can be accessed by connecting the SST (09843-18040) between the Tc and CG terminals of the DLC3 connector and checking the blinking of the ABS warning light, ECB warning light, or the “DIAG VSC” that appears on the multi-information display. Another way to access the DTC is to connect an intelligent tester II and read the code that appears on the tester.
- This system has a sensor signal check (test mode) function. This function is activated by connecting the SST (09843-18040) between the Ts and CG terminals of the DLC3 or by connecting an intelligent tester II.
- If the CAN has communication error ECU or sensors, multiple DTCs (Diagnostic Trouble Codes) are output simultaneously to indicate the malfunction location.
- All the DTCs have been made to correspond to the SAE controlled codes. Some of the DTCs have been further divided into smaller detection areas than in the past, and new DTCs have been assigned to them. Additionally, DTCs have been added to corresponding items.
- Three-digit information codes have been provided in the conventional DTC as subset of a primary five-digit code. This enables the troubleshooting procedure to further narrow down a trouble area to identify a problem.

For details on the DTC that are stored in skid control ECU memory and the DTC that are output through the sensor signal check function, see the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

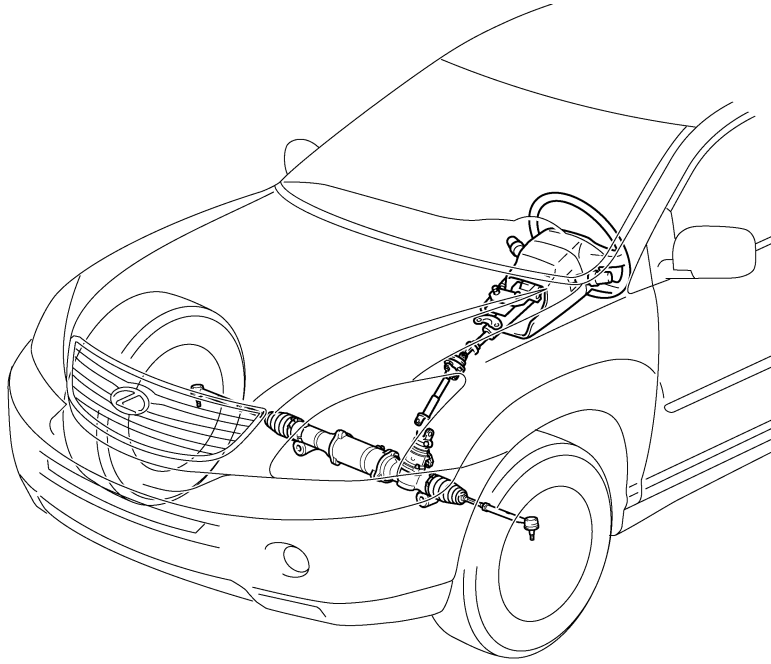
5. Fail-Safe

- If a failure occurs in the skid control ECU, sensors, and/or brake actuators, the system continues effecting brake control by excluding the failed area and using only the areas that are operating normally.
- If the regenerative brake becomes unusable due to a failure in communication with the THS ECU, the skid control ECU uses the hydraulic brake force to control the entire braking force.

STEERING

■ DESCRIPTION

- The new RX400h uses a vehicle-speed sensing type EPS (Electric Power Steering) as standard equipment on all models.
- The manual type tilt mechanism (6-step) is used on all models as standard equipment.
- A power tilt and power telescopic mechanism with memory function is available as optional equipment.
- The steering column uses an energy absorbing mechanism.



LHD Model

277CH133

► Specifications ◀

Gear Ratio		15.6
No. of Turns Lock to Lock		2.90
Rack Stroke	mm (in.)	145.0 (5.71)

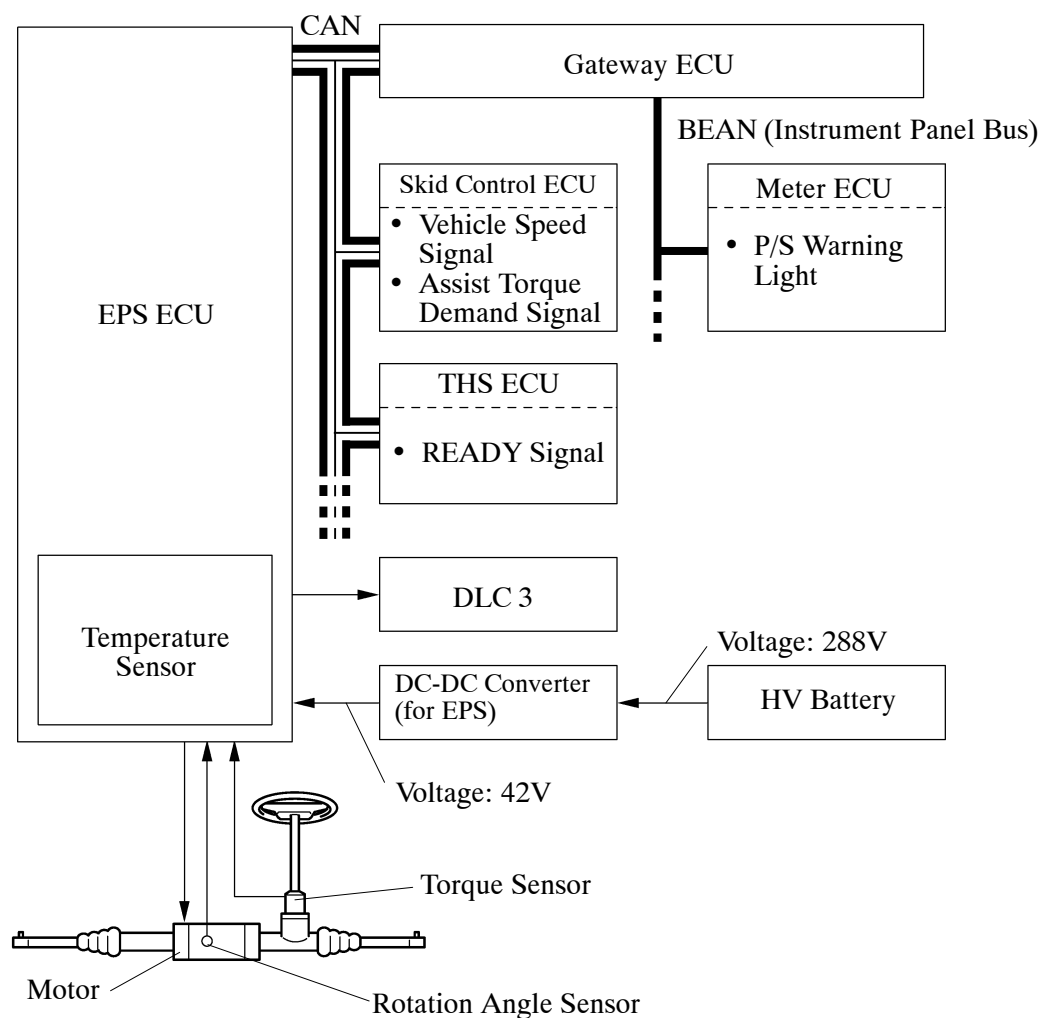
■ EPS (Electric Power Steering)

1. General

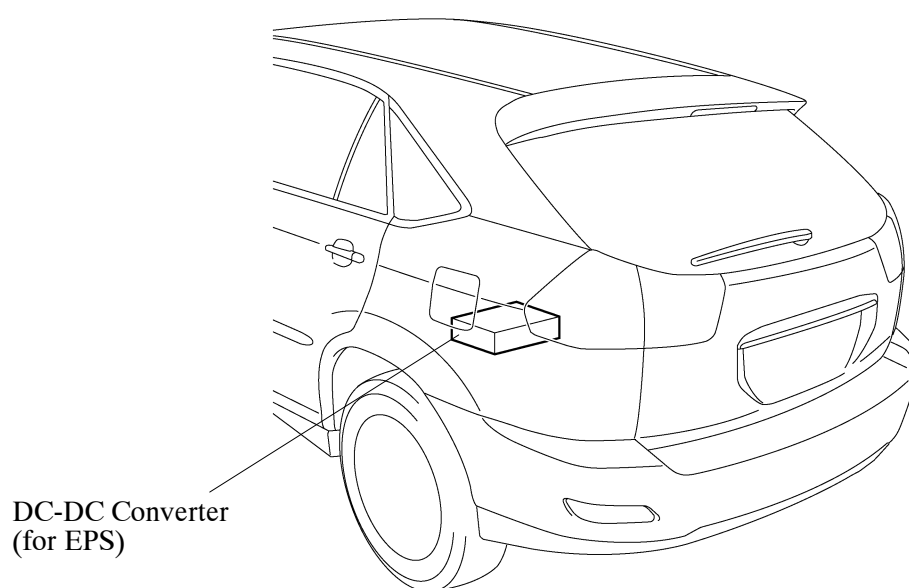
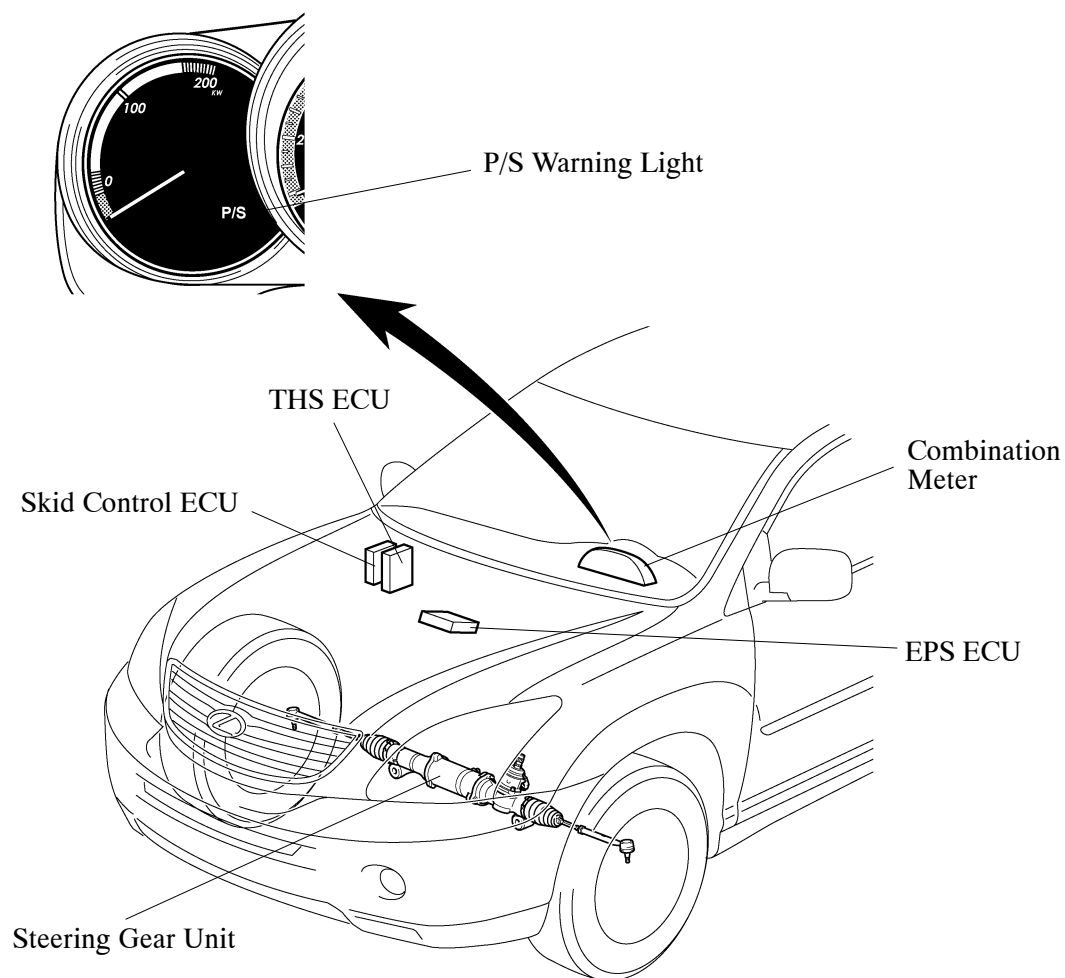
- This system uses a motor and a reduction mechanism that are built into the steering gear housing to generate assist torque, in order to assist the driver's steering effort. The EPS ECU calculates the amount of power assist in accordance with the signals provided by the sensors and the ECUs.
- This system offers excellent fuel economy characteristics because the DC motor, which is built into the steering gear housing to provide power assist, consumes energy only when power assist is required.
- The EPS is driven by a high voltage (42V). A DC-DC converter converts the power of the HV battery (288V) and supplies it to the motor.
- Unlike the conventional hydraulic power steering system, this system excels in serviceability because it does not require pipes, vane pump, pulley and power steering fluid.
- The EPS ECU maintains communication with the skid control ECU, THS ECU, and Gateway ECU via CAN. In addition, the EPS ECU maintains communication with the Meter ECU through the Gateway ECU, via BEAN. For details, refer to Multiplex Communication on page BE-4.
- The new RX400h uses a VDIM (Vehicle Dynamics Integrated Management) to effect the total control of the vehicle. As a result, the brake system and the EPS system effect cooperative control. When the VSC function of the brake control system is activated, the EPS ECU controls the assist torque of the motor upon receiving an assist torque demand signal from the skid control ECU.

For details on the VDIM, see the Brake Control System on page CH-39.

► System Diagram ◀



2. Layout of Main Components



LHD Models

277CH135

3. Function of Main Components

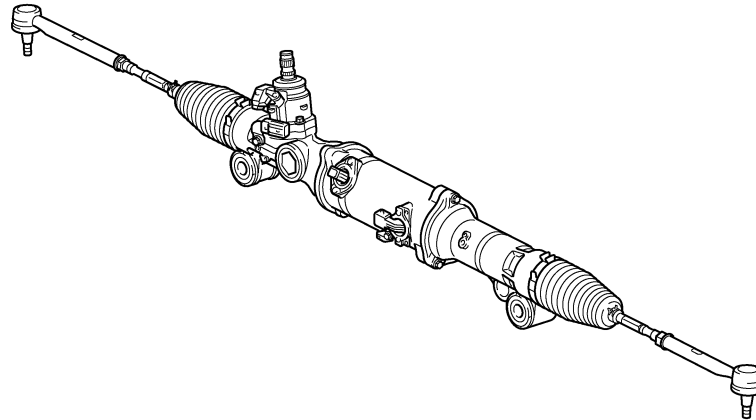
Components		Function
Steering Gear Unit	Torque Sensor	Detects the twist of the torsion bar with this, it calculates the torque that is applied to the torsion bar by changing it into an electrical signal, and outputs this signal to the EPS ECU.
	Motor	Generates power assist in accordance with a signal received from the EPS ECU.
	Reduction Mechanism	Uses a screw mechanism to reduce the speed through a ball screw reduction gear and a rack shaft gear, as well as to convert the rotational movement to a linear movement.
	Rotation Angle Sensor	Outputs the rotation angle of the motor to the EPS ECU.
DC-DC Converter (for EPS)		Converts the voltage of the HV battery from 288V to 42V and supplies this power source to the motor via the EPS ECU.
EPS ECU		In accordance with the signals received from various sensors and the skid control ECU, the EPS ECU operates the motor in the steering gear unit for the purpose of providing power assist.
THS ECU		Transmits a READY signal to the EPS ECU, in order to inform the EPS system that it is ready to generate electricity.
Skid Control ECU		- Vehicle speed signal is outputted to EPS ECU. - When VSC (Vehicle Stability Control) function is operating, the skid control ECU transmits an additional torque signal (which it has calculated in accordance with the signals from the sensors for the purpose of effecting cooperative control) to the EPS ECU.
Meter ECU		Upon receiving a signal from the EPS ECU in the event of a system malfunction, the meter ECU illuminates the P/S warning light.

4. Constructions and Operation

Steering Gear Unit

1) General

A motor, reduction mechanism, and the torque sensor are enclosed in the steering gear unit.



LHD Model

277CH136

CH

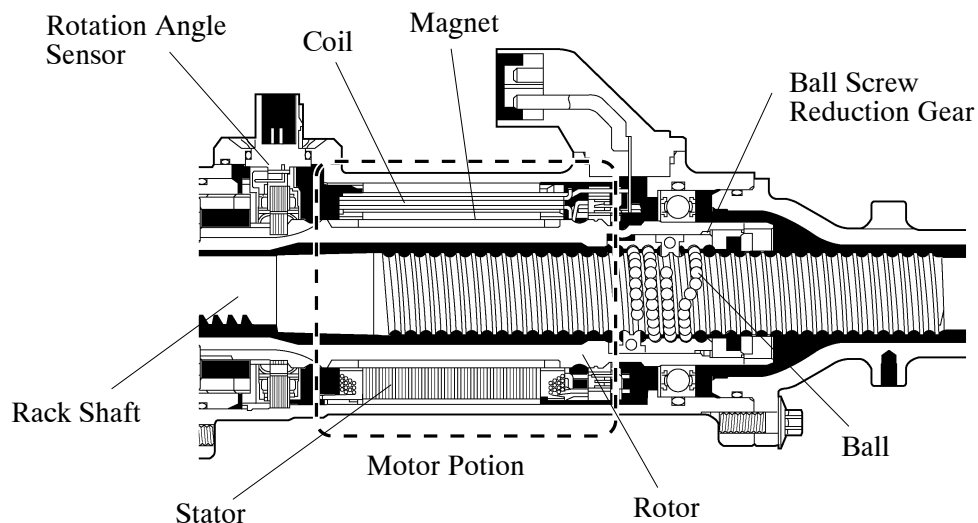
2) Motor

- The motor is a high power output, brushless type motor that is driven by a voltage of 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 reliability and durability. The rotation angle sensor detects the rotation angle of the motor and outputs it to the EPS ECU. As a result, it ensures efficient EPS control.

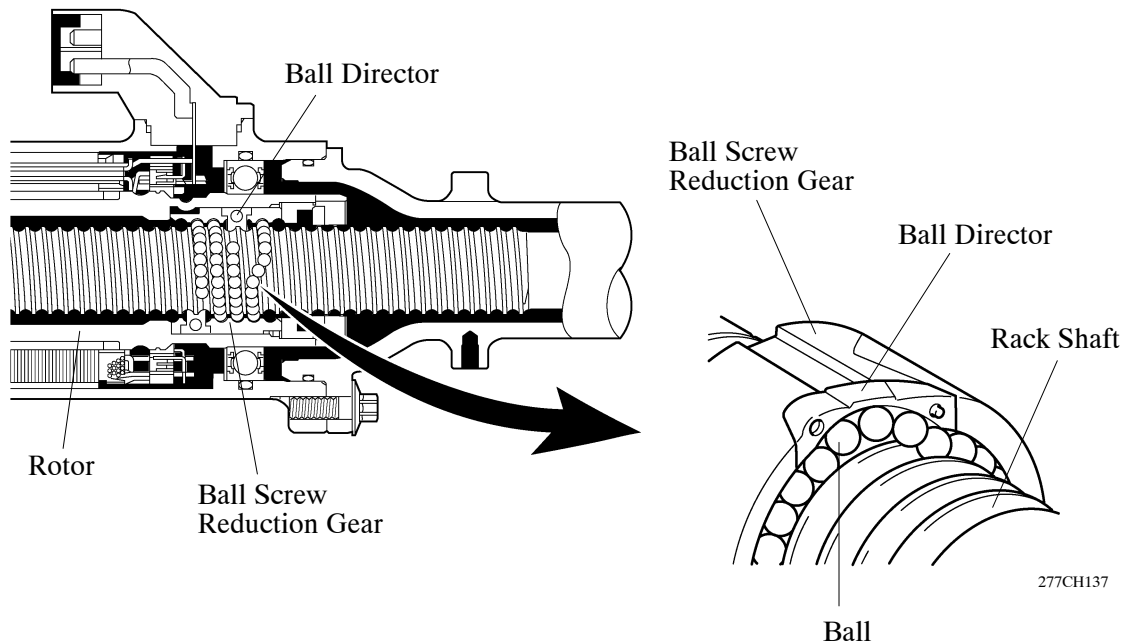


LHD Model

277CH138

3) 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 ball directors, and is fixed to the rotor.
- By the ball director, 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.

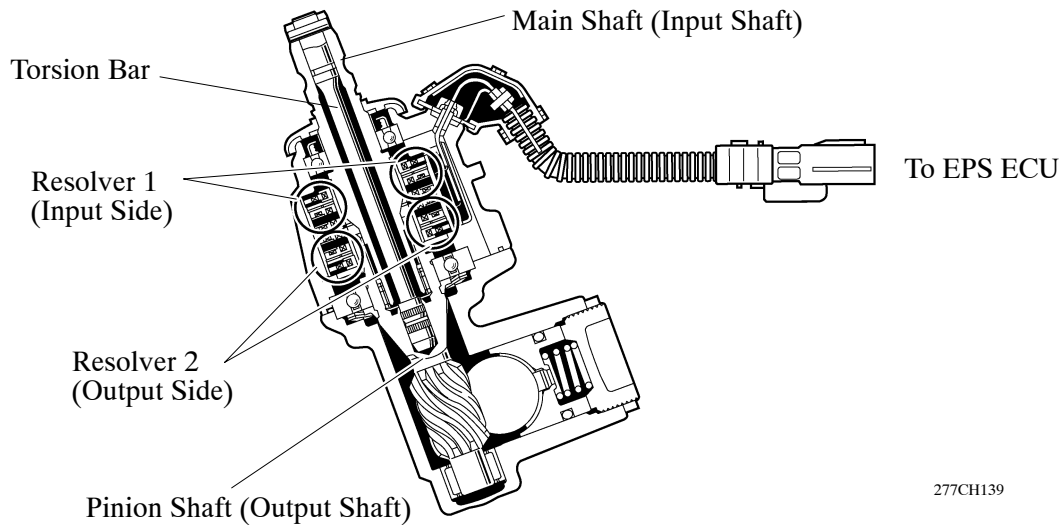


4) Torque Sensor

a. General

The torque sensor consists of two resolvers, a torsion bar, main shaft (input shaft), and pinion shaft (output shaft).

The two resolvers for the torque sensor are mounted to the main shaft (input shaft) and the pinion shaft (output shaft) respectively, which are coupled with the torsion bar. This construction generates a relative angle difference that is equivalent to the twisting of the torsion bar. When the driver turns the steering wheel, this difference is created between the angle that the main shaft (input shaft) transmits to the resolver 1 and the angle that the pinion shaft (output shaft) transmits to the resolver 2.



277CH139

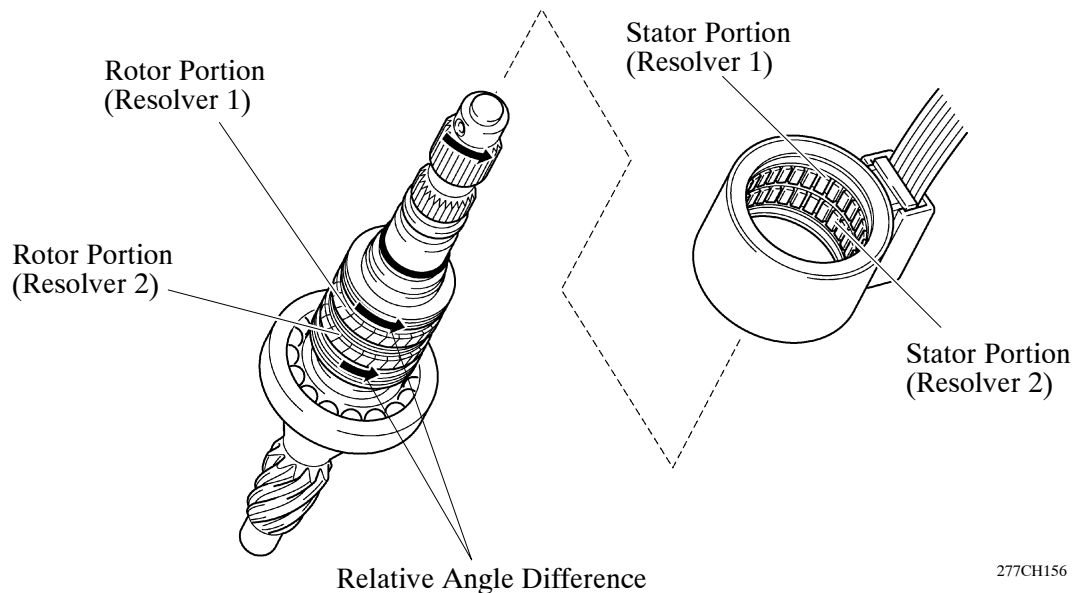
b. Torque Sensor Operation

i) Straight-line Driving

If the vehicle is driven straight and the driver does 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 does not apply current to the motor.

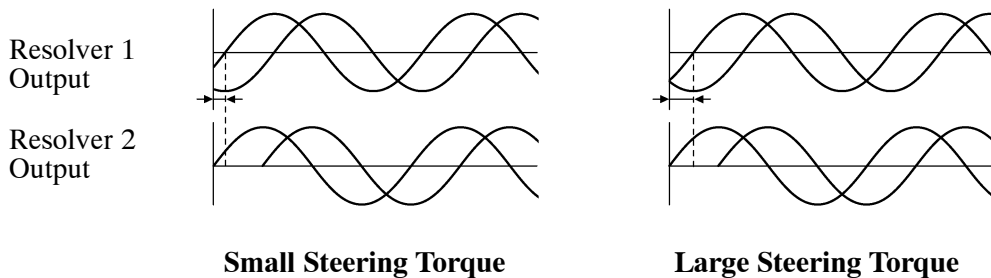
ii) When Steering

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.



277CH156

► Torque Sensor Output Image Diagram ◀

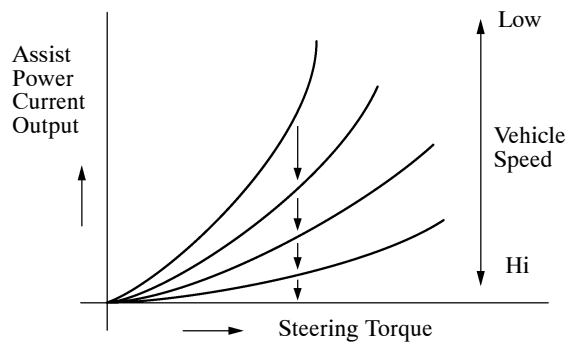


277CH157

5. EPS ECU

1) General

- The EPS ECU receives signals from various sensors, judges the current vehicle condition, and determines the assist current to be applied to the motor accordingly.
- The diagram on the right describes the relationship between the steering torque and the assist power current output.



277CH158

- The EPS ECU of new RX400h has a following function:

Item	Function
Basic Control	Calculates the assist current from the steering torque value and the vehicle speed, and actuates the motor.
Inertia Compensation Control	Improves the starting movement of the motor when the driver starts to turn the steering wheel.
Return Force Compensation Control	During the short interval between the time the driver fully turns the steering wheel and the wheels try to return, this control assists the returning force.
Damping Compensation Control	Regulates the amount of assist when the driver turns the steering wheel while driving at high speeds, thus damping the changes in the yaw rate of the vehicle body.
System Overheat Protection Control	Estimates the motor temperature based on the amperage and the current duration. If the temperature exceeds the standard, it limits the amperage to prevent the motor from overheating.

- The EPS ECU effects cooperative control with the skid control ECU, in order to control the steering assist torque in accordance with information received from the skid control ECU. This facilitates the steering operation of the driver, thus realizing a high level of vehicle stability.

For an outline of Power Steering Cooperative Control Function, refer to CH-44.

2) Diagnosis

- If the EPS ECU detects a problem in the EPS system, the master warning light that corresponds to the function in which the malfunction has been detected light up to alert the driver of the malfunction.
- At the same time, the DTCs (Diagnosis Trouble Codes) are stored in memory. The DTCs can be accessed by using the intelligent tester II.

For details of the DTCs that are stored in EPS ECU memory, see the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

3) Fail-Safe

- If the EPS ECU detects a malfunction in the EPS system, it turns on the P/S warning light in the combination meter to inform the driver and stops the assist control. As a result, the EPS system operates in the same manner as manual steering.
- In case of a malfunction, the fail-safe function activates and the ECU effects various controls. For details refer to the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

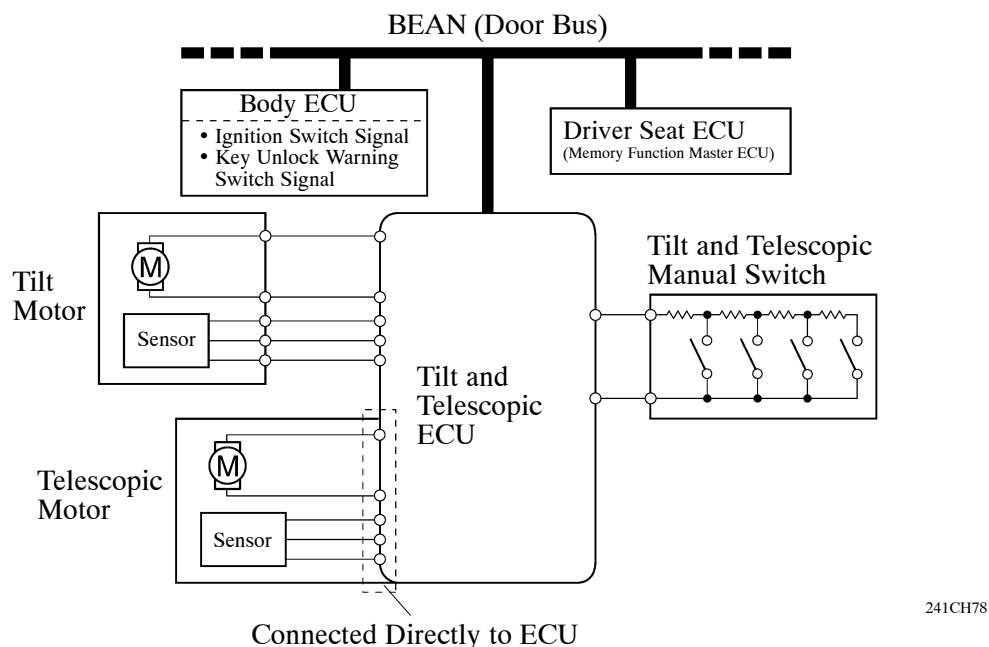
■ STEERING COLUMN

1. Power Tilt and Power Telescopic Steering Column

General

- A compact and lightweight power tilt and power telescopic steering column is used.
- The automatic set (Away and Return) function is used.
- This system is controlled by the tilt and telescopic ECU and the tilt and telescopic ECU maintains communication through the multiplex communication system.
- This steering column contains a driving position memory function, which operates in unison with the driver's seat and the outside rearview mirror. This function memorizes two driving positions.

► System Diagram ◀

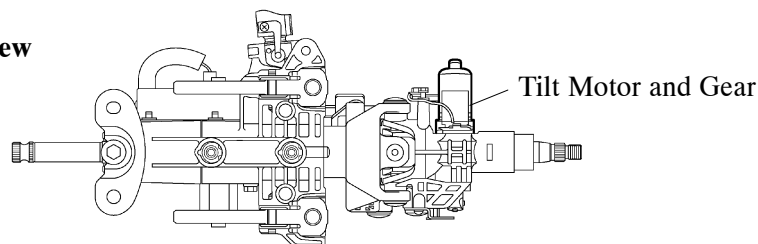


Construction

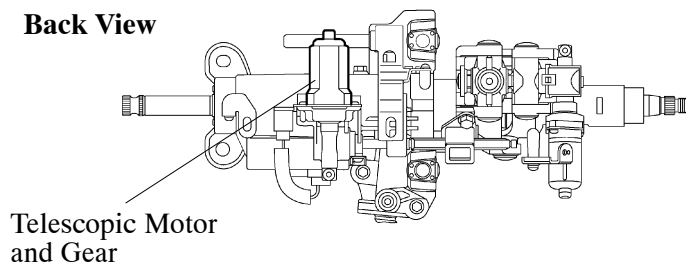
The power tilt and power telescopic steering column consists of the tilt and telescopic ECU, a tilt motor, telescopic motor and gears.

The tilt and telescopic motor contains position sensor that use hall elements.

Top View



Back View

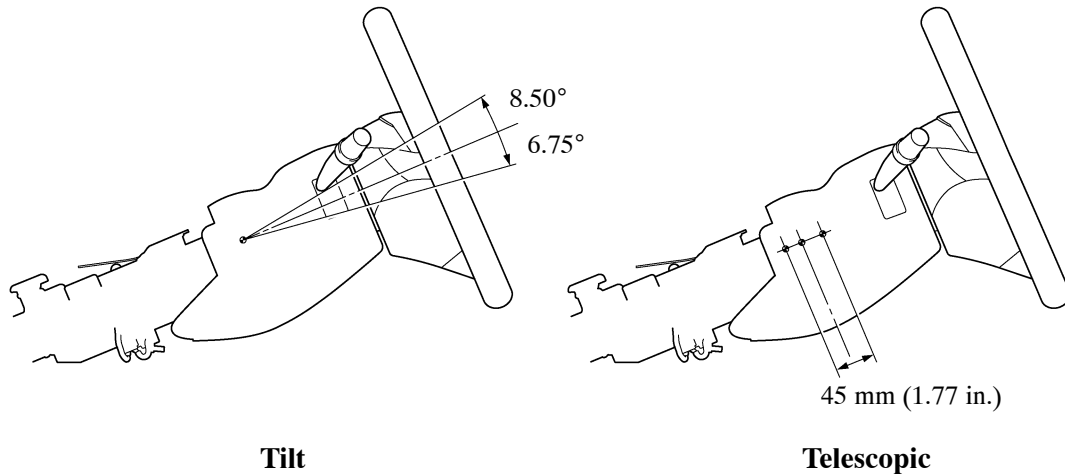


Operation

1) Manual Operation

The tilt position and the telescopic position can be adjusted as desired by operating the tilt and telescopic manual switch.

A stepless adjustment enables the tilt mechanism to be tilted 15.3° vertically, and the telescopic mechanism to be moved 45 mm (1.77 in.) longitudinally.



199CH118

2) Automatic Set (Away and Return) Function

When the ignition key is removed, the steering column moves forward away from the driver and also tilts up for easy exit and entry.

When the ignition key is inserted in the ignition switch, the steering column returns to the previously set position.

The automatic set function can be prohibited by using an intelligent tester II.

3) Driving Position Memory Function

The steering column moves to the position last saved in memory by pressing the driving position memory switch.

4) Position Detection

To detect the position of the tilt and telescopic steering column, a position sensor that uses a hall elements are located in the tilt and telescopic motors to detect the changes in the magnetic field of the magnets, which are attached to the shafts of the motors.

Diagnosis

If the tilt and telescopic ECU detects a malfunction in the power tilt and power telescopic system, the ECU stores the malfunction data in memory. Then, by connecting a hand-held tester to the DLC3 terminal, the DTCs (Diagnostic Trouble Codes) can be accessed and an active test can be performed to verify operation of the tilt motor and the telescopic motor. For details, refer to the LEXUS RX400h Repair Manual (Pub. No. RM1139E).

Fail-Safe

- If a malfunction in the tilt position sensor signal or telescopic position sensor signal occurs while operating the power tilt or power telescopic function, the tilt and telescopic ECU stops the operation of the power tilt and telescopic system.
- If the power voltage to the ECU drops below approximately 8 V while operating the power tilt or power telescopic function, the ECU stops the operation of the power tilt and telescopic system.
- If the tilt and telescopic ECU detects that the motor has locked during the operation of the power tilt or power telescopic function, the ECU stops the operation of the power tilt and telescopic system.
- If the communication of an ECU that is related to the power tilt and power telescopic steering column system is interrupted, the tilt and telescopic ECU effects the controls listed below.

Function	Body ECU Communication Interruption	Driver Seat ECU Communication Interruption	All ECUs*1 Communication Interruption
Manual	x*2	○	x*2
Automatic Away	x	○	x
Automatic Return	x*3	○	x*3
Memory	x	x	x

○: Actuated

x: Not actuated

*1: All ECUs that are related to the power tilt and power telescopic steering column system.

*2: ● The operation is permitted if the ignition switch signal is ON while the signal from Body ECU is interrupting.

● The operation is prohibited if the ignition switch signal is OFF while the signal from Body ECU is interrupting.

*3: ● The operation continues if the ignition switch signal is ON while the signal from Body ECU is interrupting.

● The operation is prohibited if the ignition switch signal is OFF while the signal from Body ECU is interrupting.

For details, refer to the LEXUS RX400h Repair Manual (Pub. No. RM1139E)

2. Energy Absorbing Mechanism

- The energy absorbing mechanism mainly consists of a lower bracket, breakaway bracket, energy absorbing plate, main shaft, and column tube.
- When an impact is transmitted to the steering wheel in a collision (secondary collision), the steering wheel and the steering wheel pad help absorb the impact. In addition, the breakaway bracket and the lower bracket separate, causing the entire steering column to move forward. At this time, the energy absorbing plate becomes deformed to help absorb the impact of the secondary collision.

► Energy Absorbing Mechanism ◀

