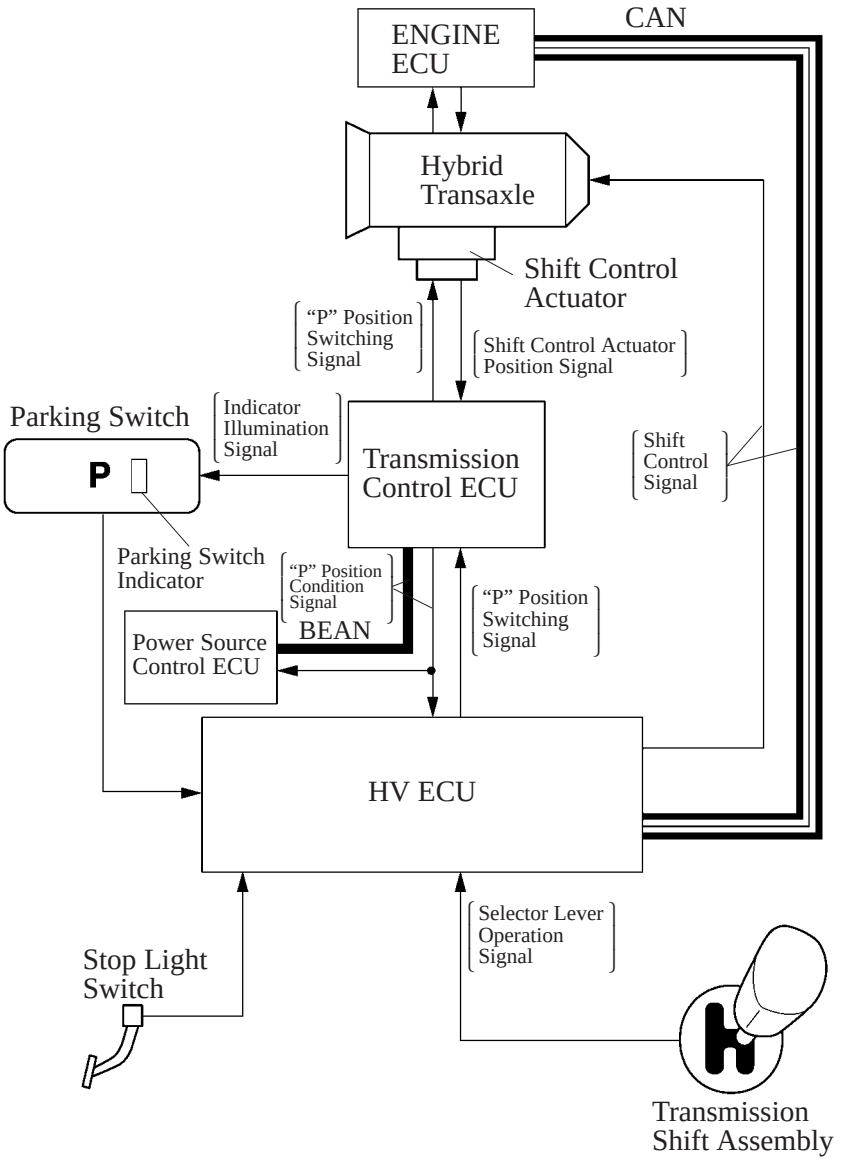
■SHIFT CONTROL SYSTEM

1. General

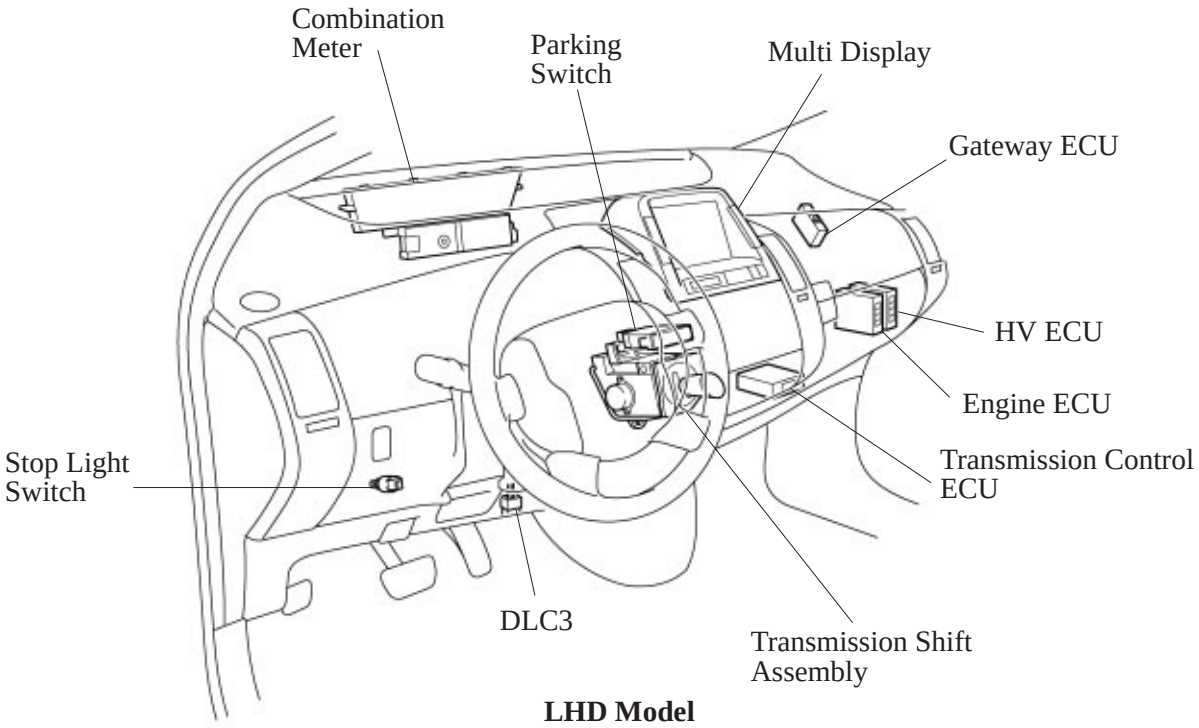
- A compact selector lever (transmission shift assembly), which has been designed under a new concept, has been adopted in the instrument panel. It is a momentary shift type that returns to the home position when the driver's hand is released from the shift knob after a shifting operation. It can be shifted with a fingertip, and the ergonomically designed shifting pattern offers excellent ease of operation.
- A shift-by-wire technology has been adopted. A shift position sensor provided in the transmission shift assembly detects the shift position ("R", "N", "D", or "B") and sends a corresponding signal to the HV ECU. The HV ECU controls the speed of the engine, MG1, and MG2, in order to produce an optimal gear ratio.
- The parking lock mechanism of the previous Prius is operated through a linkage. In contrast, the new Prius has adopted an electrical control in the same way as the shift control.
  With this mechanism, when the driver presses the Parking switch located on the top of the transmission shift assembly, the "P" position control actuates the shift control actuator located in the hybrid transaxle in order to mechanically lock the counter driven gear, which engages the parking lock.

▶ System Diagram ◀

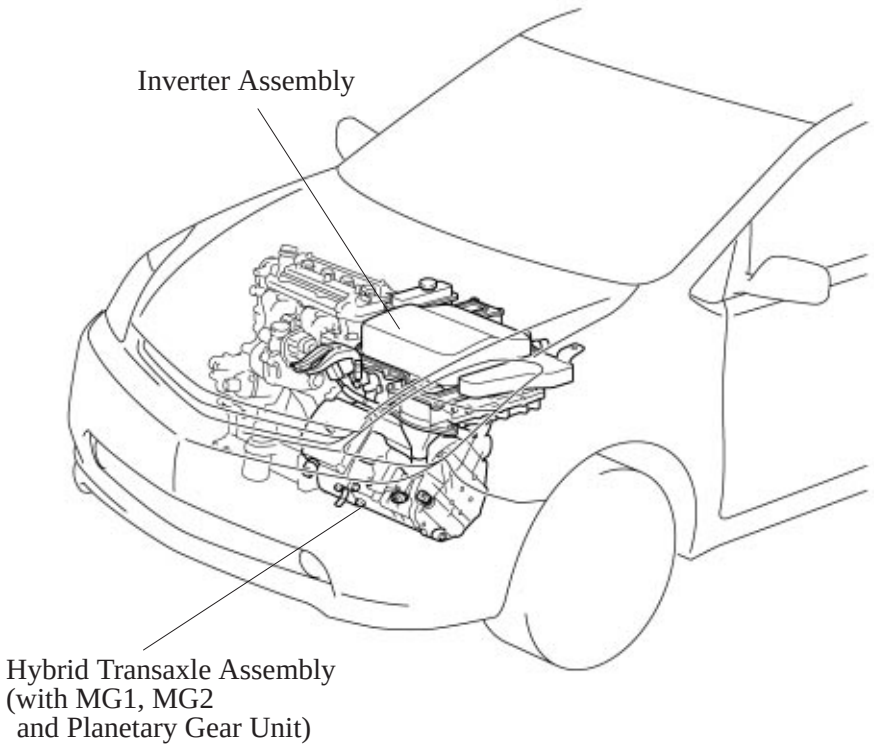


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2. Layout of Main Components



LHD Model

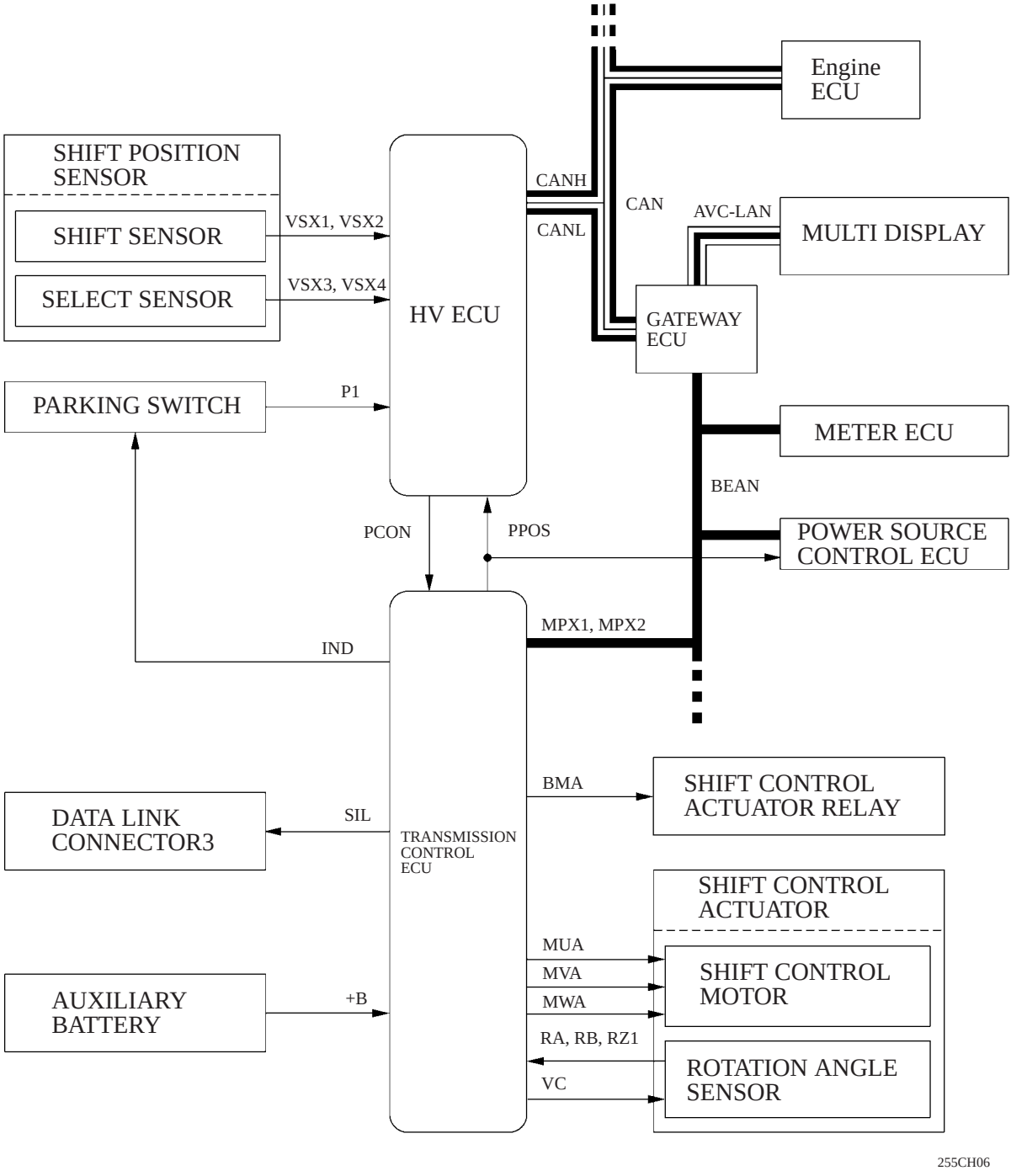


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3. Construction

The configuration of the shift control system in the '04 Prius is shown in the following chart.



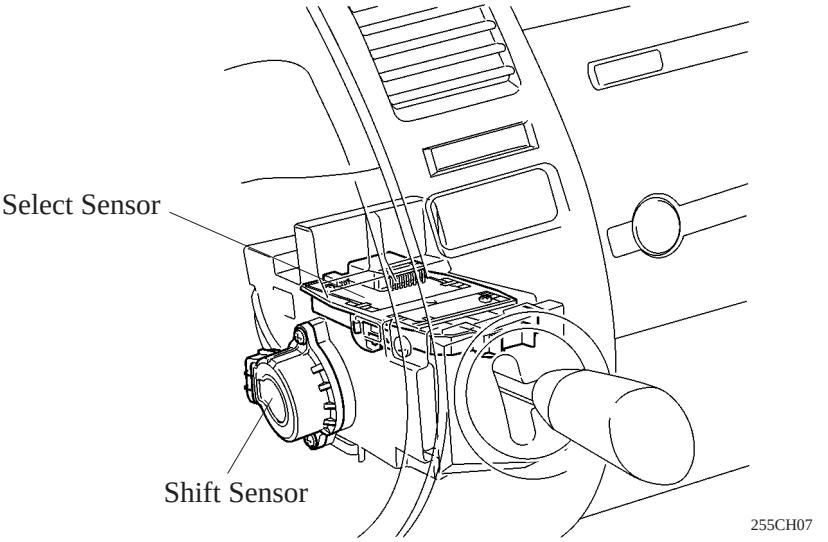
4. Function of Main Components

Item	Outline
Shift Position Sensor	This sensor, which is installed in the transmission shift assembly, detects the shift positions (“R”, “N”, “D”, and “B”), and transmits the positions to the HV ECU.
Shift Control Actuator	• When the Parking switch is pressed, the shift control actuator operates to engage the parking lock in the hybrid transaxle. • When the shift position is in the “P” and the brake pedal is pressed, if the driver operates the selector lever, this actuator operates to unlock the parking lock in the hybrid transaxle.
Parking Switch	• As this switch turns ON or OFF, it detects the driver’s operation of the P position, and sends it to the HV ECU. • This is a momentary type switch, and indicates a status whether the parking lock is applied or not with an indicator light on the switch.
Transmission Control ECU	• Transmission Control ECU, Upon receiving an ON signal of the Parking switch from the HV ECU, the transmission control ECU actuates the shift control actuator. • It illuminates the P position indicator light in accordance with the switching condition of the P position.
HV ECU	• Upon receiving an ON signal from the Parking switch, the HV ECU determines whether the conditions for shifting into the P position have been met, and transmits a shift control actuator control signal to the transmission control ECU. • The shift position sensor installed on the transmission shift assembly detects the shift position (“R”, “N”, “D”, or “B”) and sends a signal to the HV ECU. The HV ECU produces an optimal gear ratio by controlling the speeds of the engine, MG1, and MG2. • If the HV ECU receives a vehicle power supply OFF signal from the power supply ECU when the parking lock in the hybrid transaxle is not engaged, the HV ECU transmits a P position switching signal to the transmission control ECU in order to engage the parking lock.
Engine ECU	The engine ECU receives from the HV ECU an engine control signal that suits the shift position that the driver has selected, in order to optimally control the engine.
Power Source Control ECU	• Transmits a signal to the HV ECU, indicating that the vehicle power supply has been turned OFF. • Transmits a request signal to the transmission control ECU, commanding that changes the shift position to the “P” position. This signal is transmitted only if the shift position is in other than the “P” position when the POWER switch is turned OFF.
Stop Light Switch	Detects the brake pedal depressing signal.
Combination Meter	• Illuminates the shift position indicator, which the driver has selected, in accordance with the signal from the HV ECU. • Illuminates the master warning light if abnormality has occurred in the transmission control ECU.
Multi-Display	Displays a warning message to alert the driver in accordance with a signal provided by the transmission control ECU.

5. Transmission Shift Assembly

General

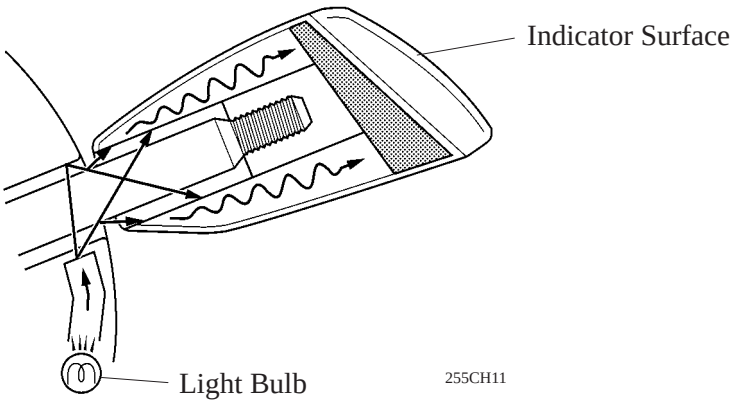
- A compact selector lever, which has been designed under a new concept, has been adopted. It is a momentary shift type in which the reactive force of a spring returns the lever to its home position when the driver's hand is released from it after a shifting operation.
- The transmission shift assembly has built-in shift position sensors (select sensor and shift sensor) to detect the shift position ("R", "N", "D", and "B").
- When the taillights are turned ON, a light bulb that is provided in the housing indirectly illuminates the shift knob indicator surface, in order to enhance its nighttime visibility.



LHD Model

Shift Knob Indicator

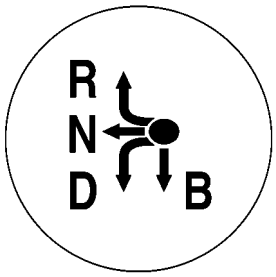
The shift knob indicator is constructed in such a way that when a light bulb that is provided in the housing illuminates, its light beam passes through a light guide housing and is reflected on the selector lever's pole and the light transmission area, thus illuminating the indicator surface from underneath the knob.



Shift Position Sensor

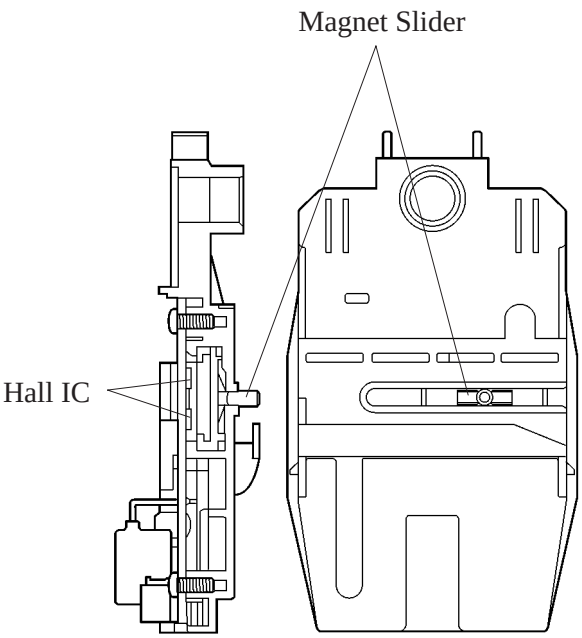
- The shift position sensors consist of a select sensor that detects the lateral movement of the selector lever, and a shift sensor that detects the longitudinal movement. A combination of these signals is used to detect the shift position.
- The sensor portion of both the select and shift sensors contains a Hall IC.

Select Sensor Detection Position (Lateral Direction)	Shift Sensor Detection Position (Longitudinal Direction)	Selected Shift Position
R, N, D	Up	R
	Center	N
	Down	D
B, Center	Down	B



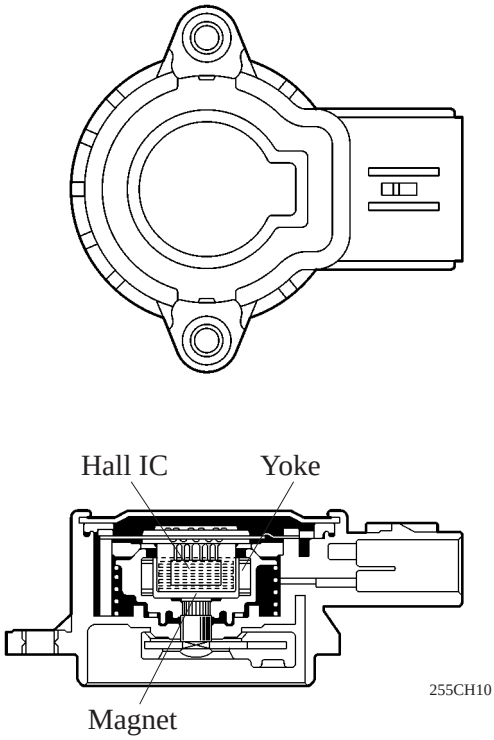
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Shift Pattern (LHD)



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Select Sensor



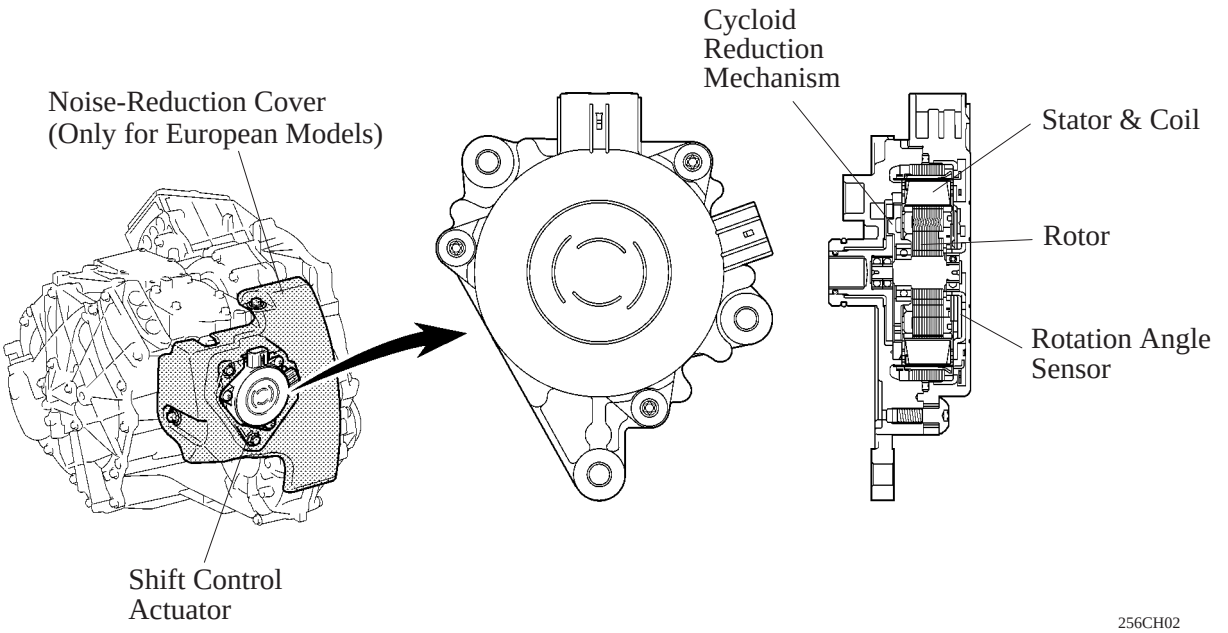
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Shift Sensor

6. Shift Control Actuator

General

- The shift control actuator is mounted on the side of the hybrid transaxle. Upon receiving an actuation signal from the transmission control ECU, the motor in the actuator rotates to move the parking lock rod, which slides the parking lock pawl, thus causing the parking lock pawl to engage with the parking gear that is installed on the counter driven gear. As a result, the hybrid transaxle is locked or unlocked mechanically.
- The shift control actuator mainly consists of a brush-less motor and a cycloid reduction mechanism. The motor mainly consists of a rotation angle sensor, coil, stator, and a rotor.
- The rotation angle sensor consists of three Hall ICs. The two of them, called phases A and B, are used to detect the rotation angle of motor. The rest, called phase Z, is used to correct the rotation angle detection control.

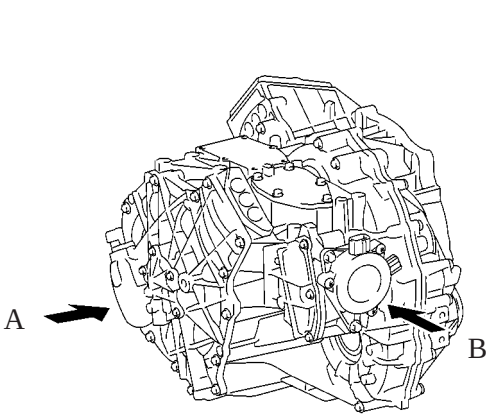


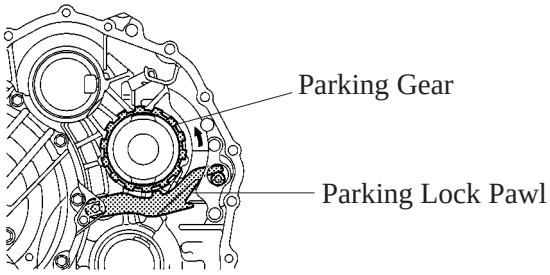
Service Tip

- This actuator is a precision instrument. Do not strike it with a plastic hammer or the like during installation.
- This actuator detects its own position when a battery is reinstalled. Thus, it does not require initialization.

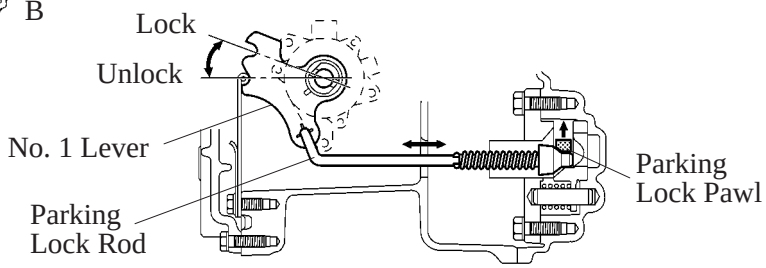
Parking Lock Mechanism

- A mechanical parking lock mechanism has been provided in the counter driven gear. The engagement of the parking lock pawl with the parking gear that is integrated with the counter driven gear locks the movement of the vehicle.
- Upon receiving a lock or unlock signal from the transmission control ECU, the shift control actuator rotates the No. 1 lever to slide the parking lock rod, which pushes on the parking lock pawl. As a result, the parking lock pawl meshes with the parking gear, thus engaging the parking lock.





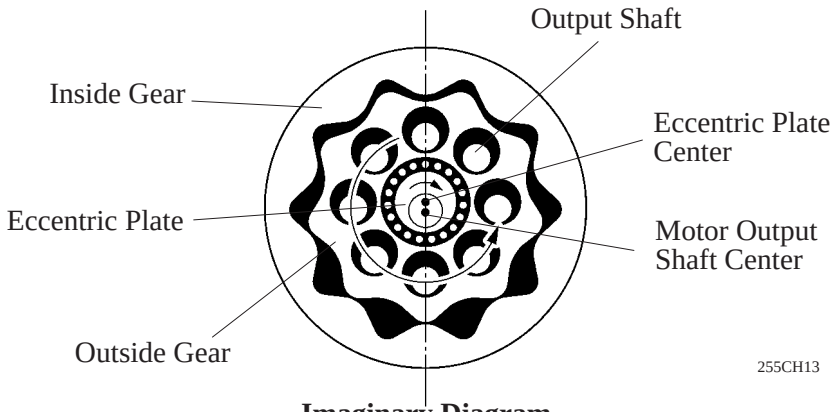
Cross Section of View from A



Cross Section of View from B

Cycloid Reduction Mechanism

- The cycloid reduction mechanism ensures the complete releasing operation for the parking lock when the vehicle is parked on a sloping road in which requires a high torque, since it amplifies the torque of the motor output shaft.
- This mechanism consists of an eccentric plate that is mounted on the motor output shaft, an inside gear (61 teeth) that is secured to the housing, an outside gear (60 teeth), and an output shaft that rotates in unison with the outside gear.
- Along with the rotational movement of the eccentric plate, which rotates in unison with the motor output shaft, the inside gear pushes against the outside gear, while meshing. The outside gear, which has 1 tooth less than the inside gear, rotates 1 tooth less per rotation of the eccentric plate. As a result, the output shaft, which rotates in unison with the outside gear, outputs the rotational movement of the motor at a reduction ratio of 61.



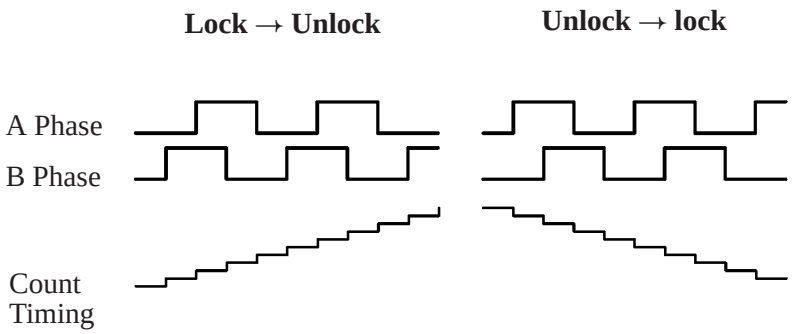
Imaginary Diagram

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Motor Control

- This motor rotates to lock or unlock parking. The transmission control ECU detects the present shift position (Parking locked or unlocked) in accordance with the rotation angle sensor signal, which detects the extent of rotation of the motor.
- The transmission control ECU detects the direction of the motor rotation, the extent of the rotation, and its moving range through the combination of the pulses and the counting of the two Hall ICs with staggered phases (A phase and B phase), which are located in the rotation angle sensor.
  Once the moving range is detected, it is stored in the ECU memory. However, it will be deleted if a battery terminal is disconnected.

Item	Pulse Changes	
	A Phase	B Phase
Count-up (Lock → Unlock)	OFF → OFF	OFF → ON
	OFF → ON	ON → ON
	ON → ON	ON → OFF
	ON → OFF	OFF → OFF
Countdown (Unlock → Lock)	OFF → ON	OFF → OFF
	OFF → OFF	ON → OFF
	ON → ON	OFF → ON
	ON → OFF	ON → ON



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- The parking lock position and unlock position, which provide the values to establish control criteria, are detected and stored in memory at the time the transmission control ECU is started or the battery is reconnected. Initially, the transmission control ECU causes the motor to rotate to the position that engages the lock, in order to store the parking lock position in memory. Then, the ECU causes the motor to rotate in reverse, in order to store the unlock position in memory. However, if the ECU has stored the moving range of the previous operation in its memory, it detects one of the present positions, and calculates the other position from the moving range stored in memory. These processes make it unnecessary for the system to be initialized after the actuator or the ECU is replaced or the battery terminal is reconnected.

7. Shift Control

General

- In this system, the HV ECU determines the general conditions of the vehicle and switches the shift position and lock or unlock parking
- This system contains a reject function. When the vehicle is being driven under normal conditions, the shift position can be moved to all positions, provided that the reject function has not been tripped.
- The table below shows how the selector lever operation and the Parking switch operation are controlled at each shift position.

Power Supply Status	Operation	Shift Position				
		P	R	N	D	B
ACC (not drivable)	Selector Lever	●	×	×	×	×
	Parking Switch	◄	◄	●		
IG-ON (not drivable)	Selector Lever	●	►	►		
	Parking Switch	◄	◄	●		
READY (drivable)	Selector Lever	● ►	►	● ►	● ►	●
			● ►	●	●	●
			◄	◄	●	●
	Parking Switch	◄ ●	◄	◄	◄	◄ ●

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- In this system, when the power supply to the transmission control ECU is restored, the ECU starts the control by estimating the present shift position (Parking lock or unlock) based on the previous shift position that is stored in memory.
  If a previous shift position is unavailable, the control will start in accordance with the position determined by the HV ECU through the vehicle speed.

Previous Parking Lock Condition		Value Determined by HV ECU	Estimated Value
Parking Lock		—	Parking Lock
Parking Unlock		—	Parking Unlock
Unavailable	Vehicle was stopped	Parking Lock	Parking Lock
	Vehicle was running	Parking Unlock	Parking Unlock

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Reject Function

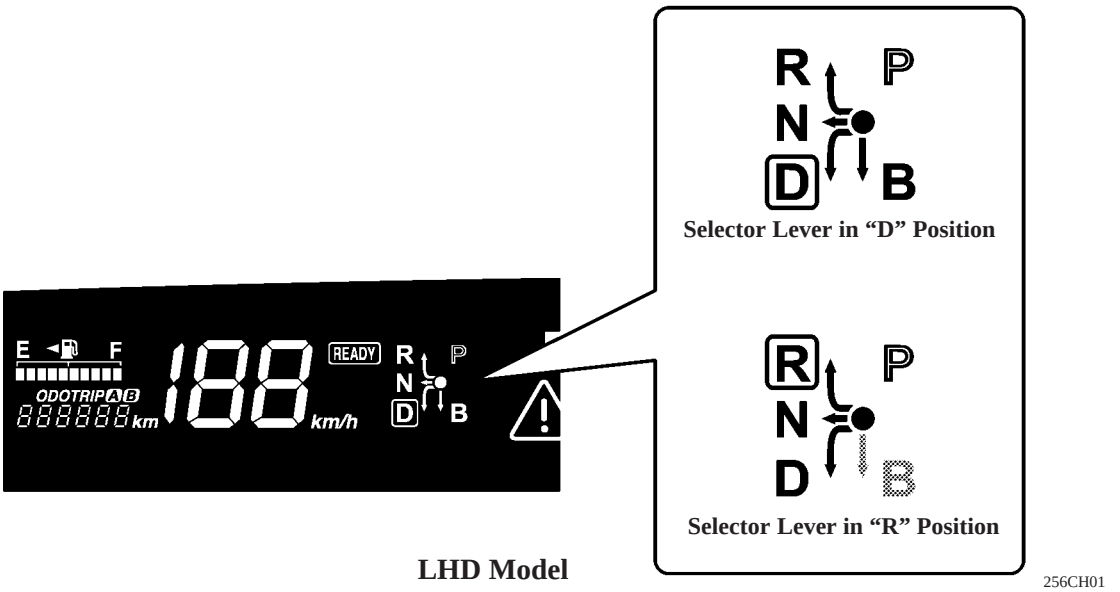
To ensure safety, this system might not change the shift position even if the driver operates the selector lever or parking switch. In that case, it sounds a buzzer to alert the driver. The table below shows the situations that trip the reject function.

Operation Causing the Reject Function to Trip	Corresponding Operation of HV ECU
During system operation, the driver changes the shift position out of the "P" position without pressing the brake pedal.	Maintains the "P" position.
While driving, the driver changes the shift position to the "P" position with the parking switch operation.	Shifts to the "N" position.
While driving, the driver changes the shift position from the "D" to "R" position, or from the "R" to "D" position.	
The driver changes the shift position to the "B" position from a position other than "D".*	

*: In this system, the "B" position operates in the engine brake range. Therefore, the shifting to the "B" position from a position other than "D" is prohibited.

Shift Position Indicator

- The selector lever is designed to always return to its home position. Therefore, the shift position that is currently selected can be checked on the shift position indicator, which is provided in the combination meter.
- In this system, the "B" position operates in the engine brake range. Therefore, the shifting to the "B" position from a position other than "D" is prohibited. Accordingly, if the selector lever is in a position other than "D" or "B", the "B" position indicator will turn OFF to prevent the driver from inadvertently shifting into the "B" position.



LHD Model

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