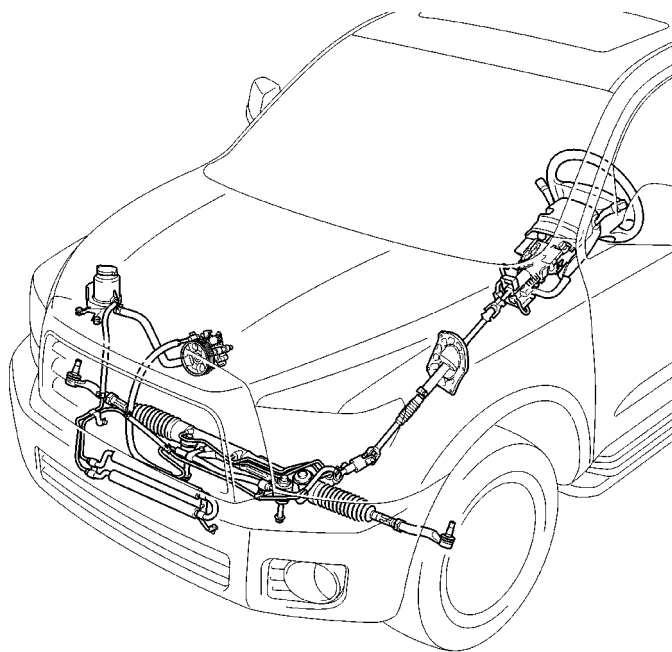


STEERING

■ DESCRIPTION

- A rack and pinion type steering gear with a hydraulic power steering assist is used.
- On the '08 Sequoia, the hydraulic power steering uses a VFC (Variable Flow Control) power steering that controls the discharge flow rate in accordance with the steering angle, vehicle speed, and engine speed.
- The steering column uses an energy absorbing mechanism.
- A tilt and telescopic mechanism is provided as follows.

Grade		SR5	Limited	Platinum
Tilt and Telescopic Mechanism	Power Type	—	Option	Standard
	Manual Type	Standard	Standard	—



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► Specifications ◀

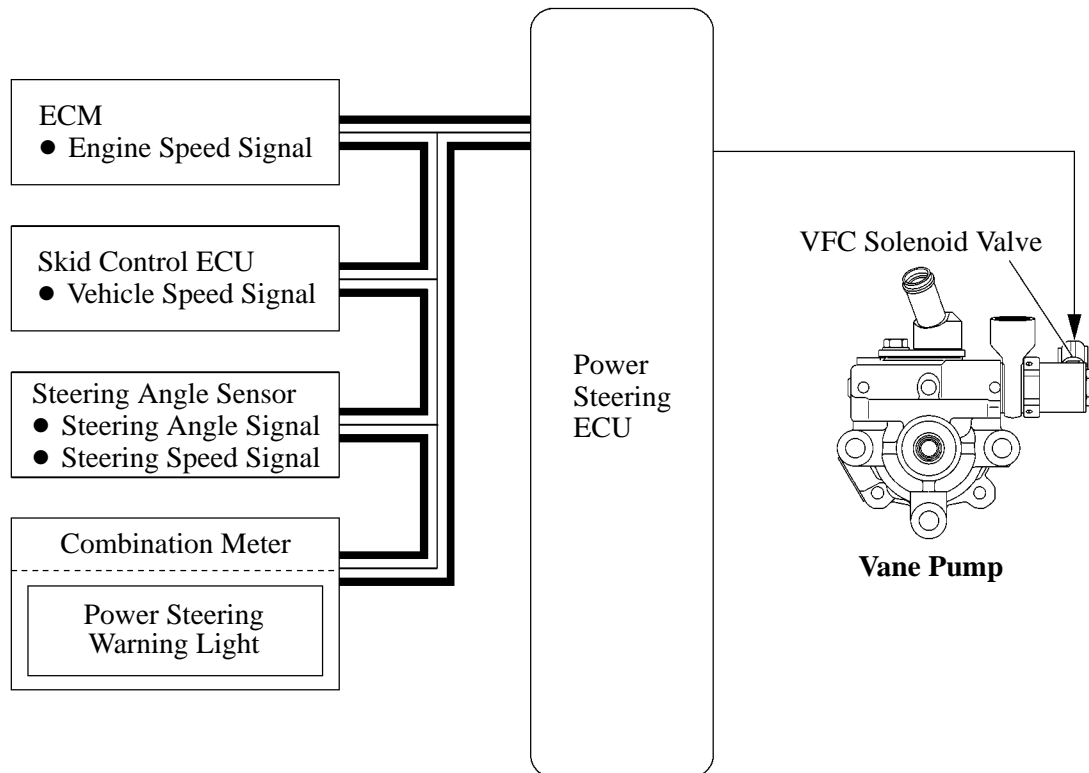
Gear Ratio (Overall)		18.0
No. of Turns Lock to Lock		3.71
Rack Stroke	mm (in.)	198 (7.8)
Fluid Type		ATF Type DEXRON® II or III

■ VFC (VARIABLE FLOW CONTROL) POWER STEERING

1. General

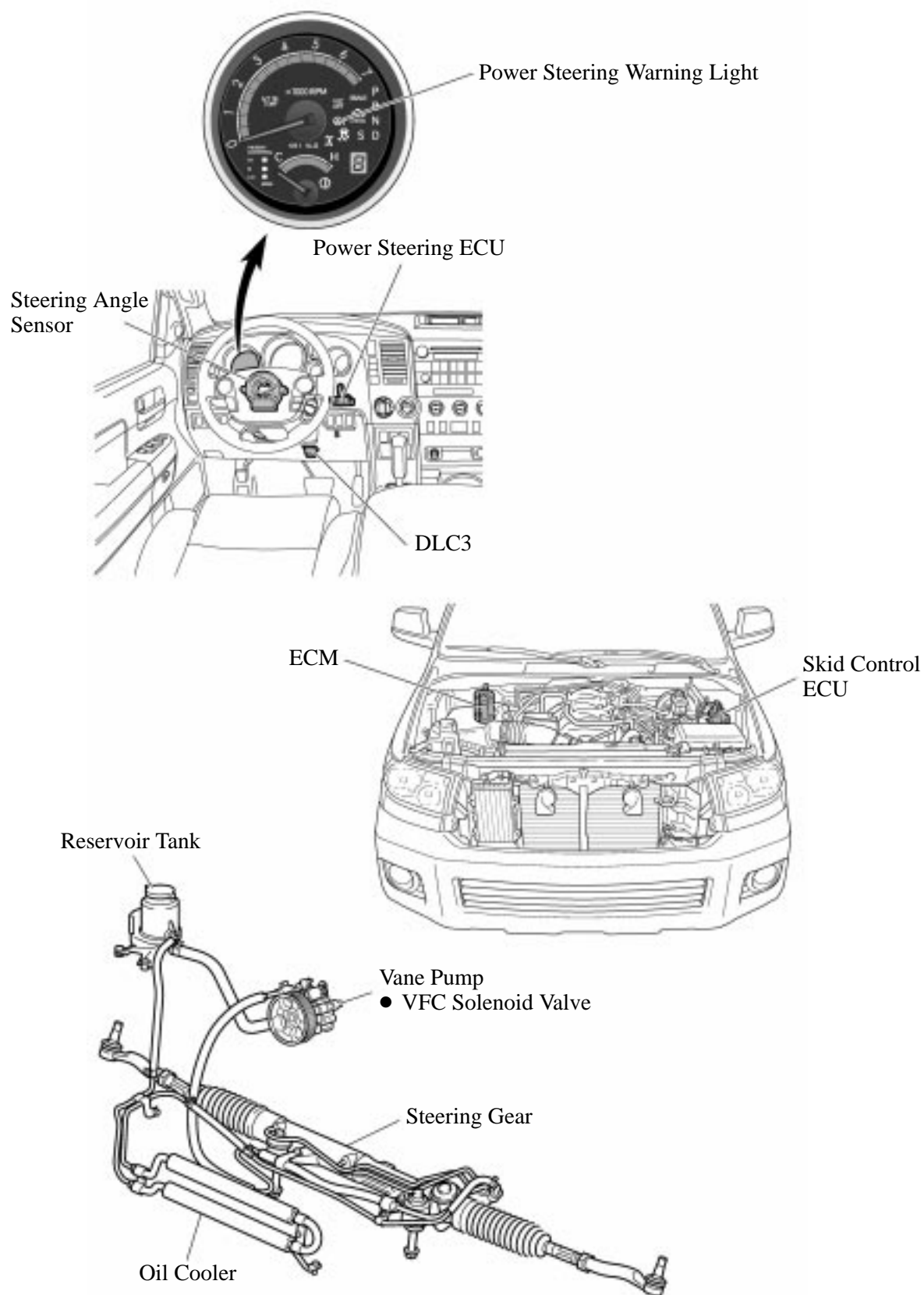
The VFC power steering is provided with a solenoid valve, which is controlled by the power steering ECU, in the vane pump. The solenoid valve controls the discharge flow rate of the power steering fluid in accordance with the operating conditions of the steering wheel, vehicle speed, and engine speed. Thus, it reduces the load on the engine applied by the actuation of the vane pump, and improves fuel economy.

► System Diagram ◀



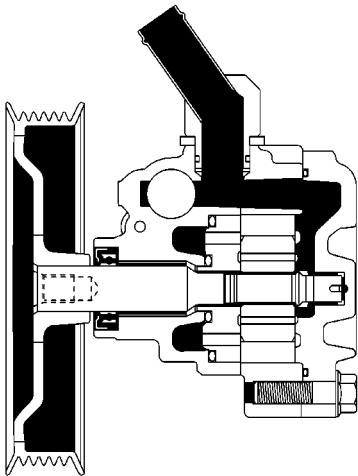
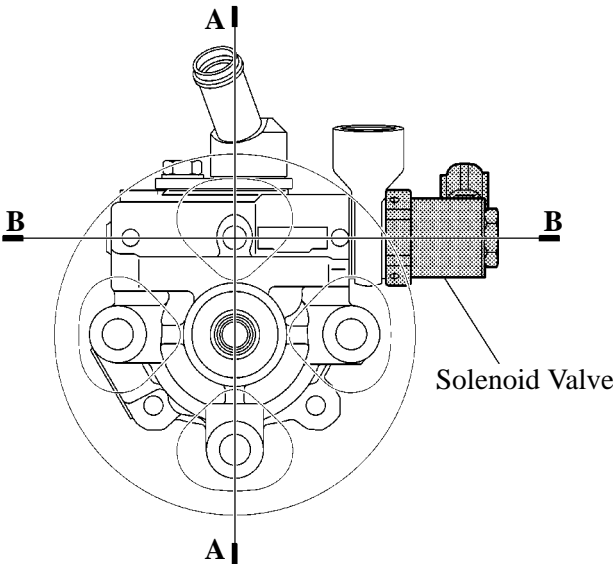
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2. Layout of Main Components



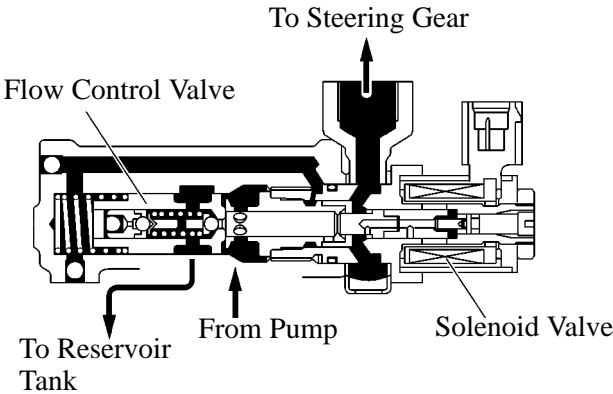
3. Vane Pump

- A compact and lightweight vane pump is used.
- A solenoid valve is provided to control the discharge flow rate.



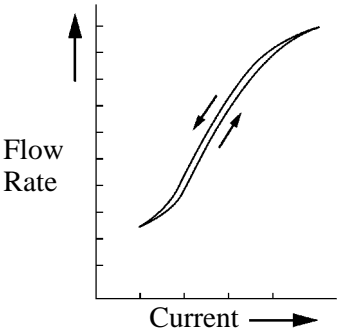
A – A Cross Section

08LCH186Y



B – B Cross Section

08LCH187Y



Flow Rate Characteristic of Solenoid Valve

08LCH188Y

► Specifications ◀

Theoretical Discharge Rate	l/min	15
Relief Pressure	MPa (kgf/cm ² , psi)	10 (102, 1450)

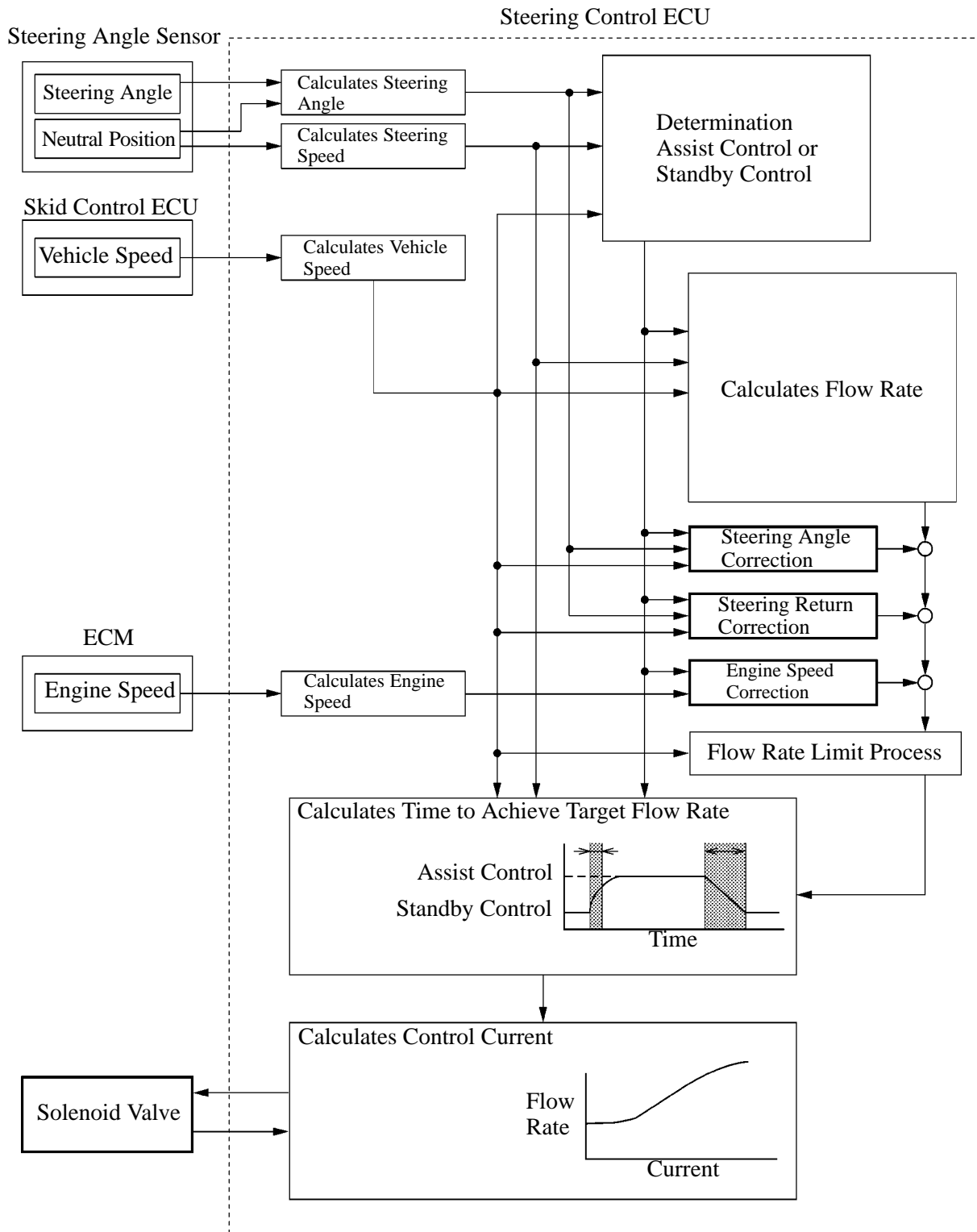
4. System Operation

General

The power steering ECU effects the following controls:

Control	Function
Flow Rate Control	It effects control in accordance with the vehicle speed, steering angle, and steering speed conditions. It effects assist control when the steering wheel is being operated and standby control when the steering wheel is not being operated. Thus, it prevents the vane pump from discharging excessive flow, which lightens the load on the engine and improves fuel economy. Also, the following corrections are made to determine an optimal discharge flow rate.
	Steering Angle Correction Determines the discharge flow rate in accordance with driving conditions, such as steering at standstill, cornering, or straightline driving.
	Steering Return Correction Determines the discharge flow rate for returning the steering wheel to its neutral position after the steering wheel is operated.
	Engine Speed Correction Determines the discharge flow rate in accordance with the engine speed.
Fail-safe	If the steering control ECU detects a malfunction in the VFC power steering system, it makes the steering feel heavier than normal, in order to inform the driver of a system failure.

► Control Diagram ◀



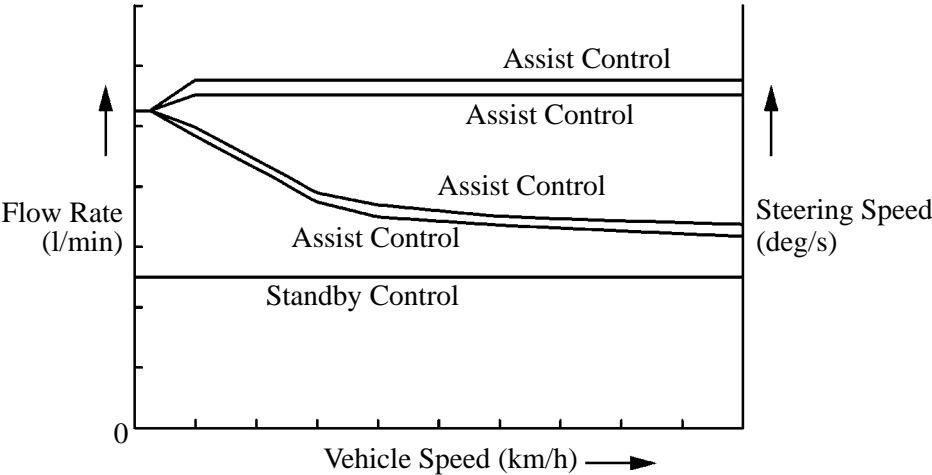
Flow Rate Control

1) Standby Control or Assist Control

- The standby control or assist control is performed in accordance with vehicle condition such as a vehicle speed, a steering angle, and a steering speed.

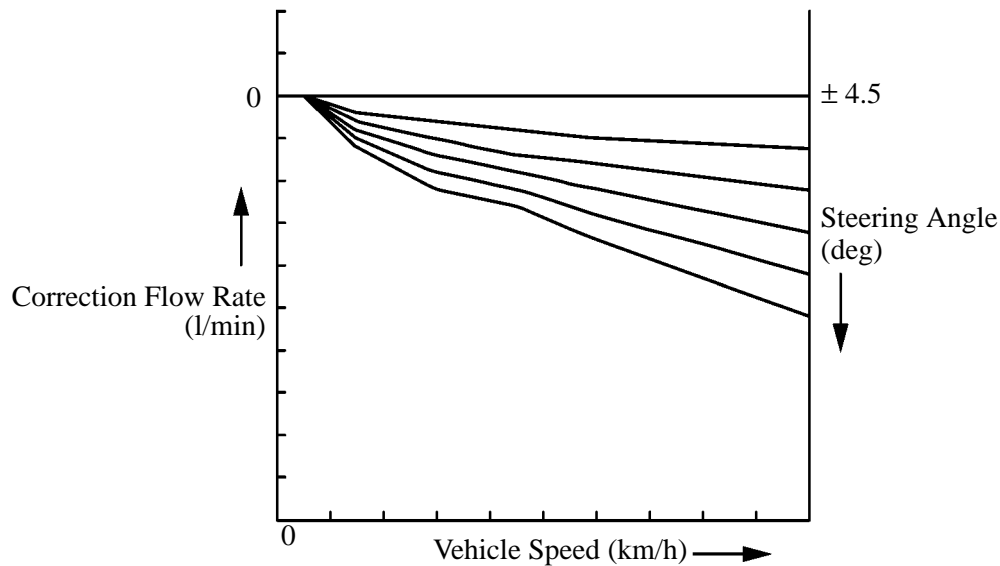
Control		Standby Control	Assist Control
Vehicle Condition	Vehicle speed 0 km/h (0 mph)	Steering Speed = 0 deg/s (For 10 seconds or more)	Steering Speed > 0 deg/s
	Vehicle speed more than 0 km/h (0 mph)	Steering Angle < 4.5° (For 10 seconds or more)	Steering Angle ≥ 4.5°

- The assist flow rate is determined in accordance with the vehicle speed and steering speed.
- For 3 seconds after the ignition switch is turned ON, the flow rate is controlled at 10.5 l/min. After that, the flow rate is controlled as shown in the graph below.



2) Steering Angle Correction

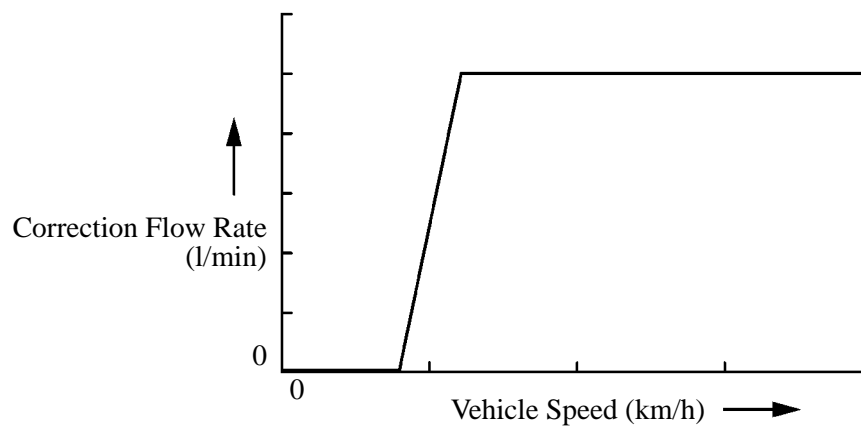
- Based on the steering angle and vehicle speed signals, this function corrects the flow rate in accordance with the driving conditions. Thus, it ensures an optimal steering feeling for every steering condition, such as steering at standstill, cornering, or straightline driving.
- The correction flow rate is 0 l/min while the steering is operated with the vehicle at standstill or driving straight (steering angle is $\pm 4.5^\circ$ or less).
- The correction flow rate decreases when the vehicle speed and steering angle increase.



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3) Steering Return Correction

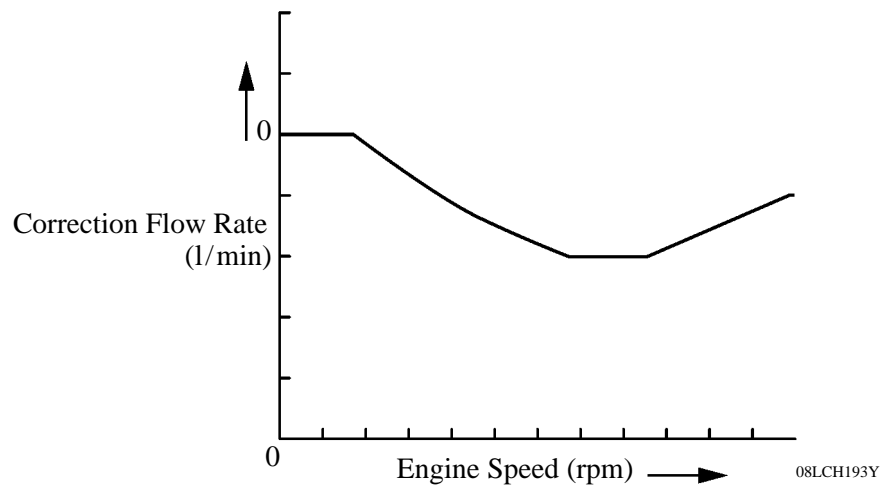
To return the steering wheel to the neutral position quickly after a sudden lane change, the ordinary flow rate is insufficient, as it makes the steering feel heavy. The steering return correction increases the correction flow rate in accordance with the steering speed and vehicle speed, in order to ensure an optimal steering force and vehicle stability.



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4) Engine Speed Correction

With the conventional vane pump, the flow rate increases when engine speed increase. The engine speed correction reduces the correction flow rate in accordance with the engine speed. This ensures optimal steering force, reduces engine load, and improves fuel economy.



Fail-safe

- If the power steering control ECU detects a malfunction in this system, it illuminates the power steering warning light to alert the driver of the malfunction.
- If a malfunction occurs in any of the sensors, the power steering control ECU effects the following fail-safe control.

► Fail-safe Control List ◀

Malfunction	Control			
	Flow Rate Control*	Correction		
		Steering Angle	Steering Return	Engine Speed
Steering Angle Signal	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes steering speed at 360 deg/s ● Effects control when steering speed is 360 deg/s 	×	×	○
Neutral Position Signal	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Effects normal control 	×	×	○
Vehicle Speed Signal	<ul style="list-style-type: none"> ● Fixes vehicle speed at 2 km/h (1.2 mph) ● Effects control when vehicle speed is 2 km/h (1.2 mph) 	○	○	○
Engine Speed Signal	<ul style="list-style-type: none"> ● Fixes engine speed at 0 rpm ● Effects normal control 	○	○	×
Steering Angle and Neutral Position Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes steering speed at 360 deg/s ● Effects control when steering speed is 360 deg/s 	×	×	○
Steering Angle and Vehicle Speed Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes steering speed at 360 deg/s ● Fixes vehicle speed at 2 km/h (1.2 mph) ● Controls flow rate at 8.5 l/min constantly 	×	×	×
Steering Angle and Engine Speed Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes steering speed at 360 deg/s ● Fixes engine speed at 0 rpm ● Effects control when steering speed is 360 deg/s 	×	×	×
Neutral Position and Vehicle Speed Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes vehicle speed at 2 km/h (1.2 mph) ● Effects control when vehicle speed is 2 km/h (1.2 mph) 	×	×	○
Neutral Position and Engine Speed Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes engine speed at 0 rpm ● Effects normal control 	×	×	×
Vehicle Speed and Engine Speed Signals	<ul style="list-style-type: none"> ● Fixes vehicle speed at 2 km/h (1.2 mph) ● Fixes engine speed at 0 rpm ● Effects control when vehicle speed is 2 km/h (1.2 mph) 	○	○	×

*: Fixes at assist control during fail-safe.

(Continued)

Malfunction	Control			
	Flow Rate Control*	Correction		
		Steering Angle	Steering Return	Engine Speed
Neutral Position, Vehicle Speed and Engine Speed Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes vehicle speed at 2 km/h (1.2 mph) ● Fixes engine speed at 0 rpm ● Effects control when vehicle speed is 2 km/h (1.2 mph) 	×	×	×
Steering Angle, Vehicle Speed and Engine Speed Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes steering speed at 360 deg/s ● Fixes vehicle speed at 2 km/h (1.2 mph) ● Fixes engine speed at 0 rpm ● Controls flow rate at 8.5 l/min constantly 	×	×	×
Steering Angle, Neutral Position and Engine Speed Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes steering speed at 360 deg/s ● Fixes engine speed at 0 rpm ● Effects control when steering speed is 360 deg/s 	×	×	×
Steering Angle, Neutral Position and Vehicle Speed Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes steering speed at 360 deg/s ● Fixes vehicle speed at 2 km/h (1.2 mph) ● Controls flow rate at 8.5 l/min constantly 	×	×	×
Steering Angle, Neutral Position, Vehicle Speed and Engine Speed Signals	<ul style="list-style-type: none"> ● Fixes steering angle at 0° ● Fixes steering speed at 360 deg/s ● Fixes vehicle speed at 2 km/h (1.2 mph) ● Fixes engine speed at 0 rpm ● Controls flow rate at 8.5 l/min constantly 	×	×	×

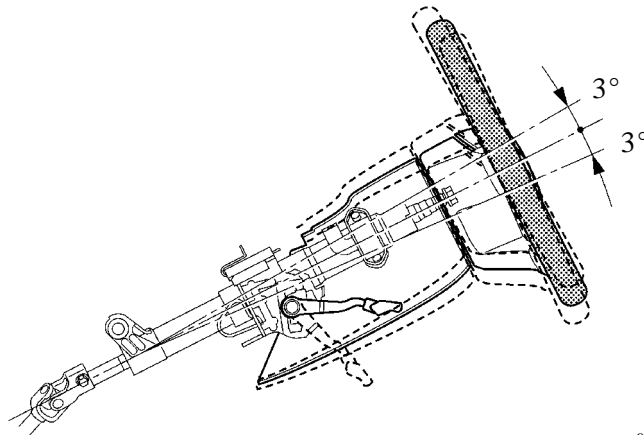
*: Fixes at assist control during fail-safe.

■ STEERING COLUMN

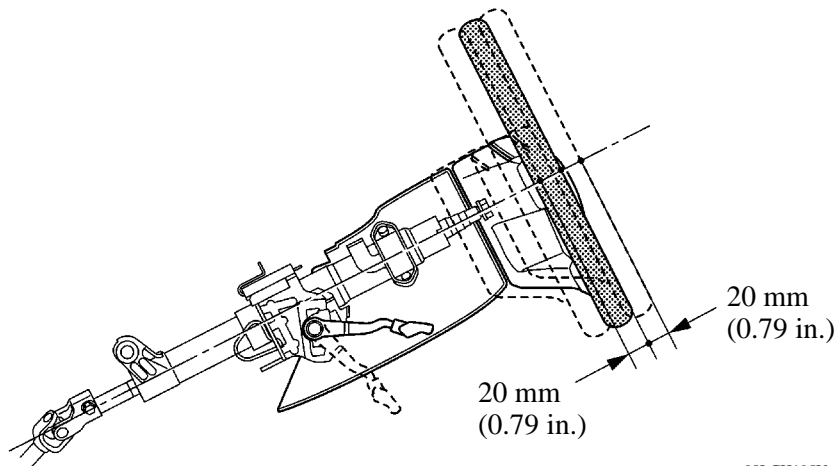
1. Manual Tilt and Telescopic Mechanism

The manual tilt and telescopic mechanism allows adjustment of the steering wheel position in the vertical and longitudinal (extending and retracting) directions through lever operation. This provides the driver with the most comfortable driving position.

- The tilt and telescopic mechanism is locked using the tilt and telescopic lever.
- The tilt adjustment range is 6° .
- The telescopic adjustment range is 40 mm (1.58 in.).



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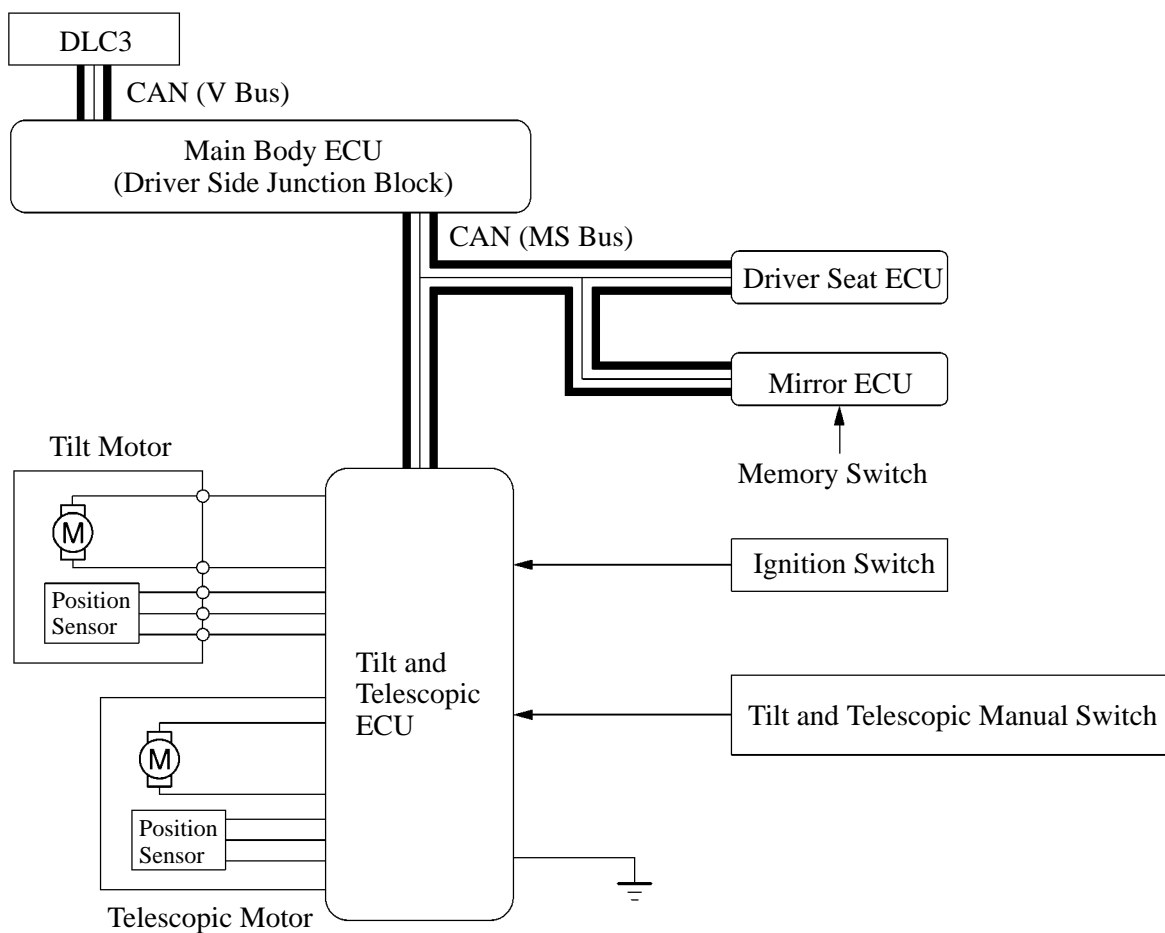
2. Power Tilt and Power Telescopic Mechanism

General

The power tilt and power telescopic system consists of the tilt and telescopic ECU, tilt and telescopic manual switch, tilt motor, and telescopic motor.

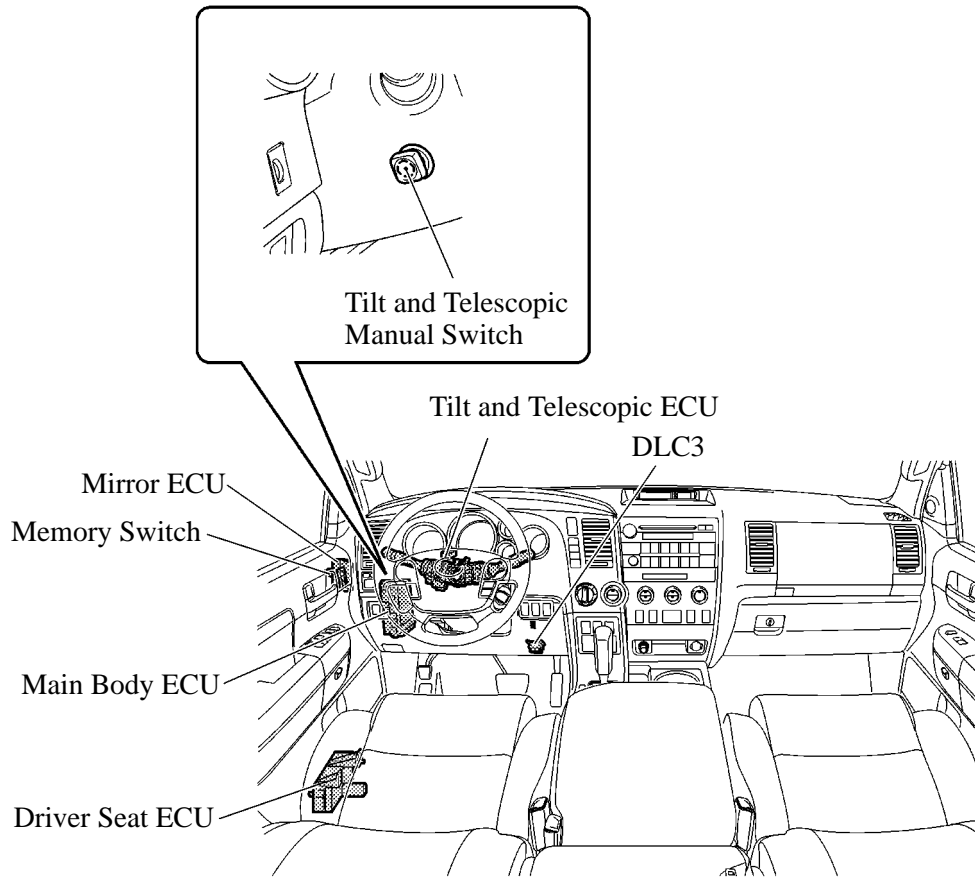
- The tilt and telescopic ECU controls this system.

► System Diagram ◀



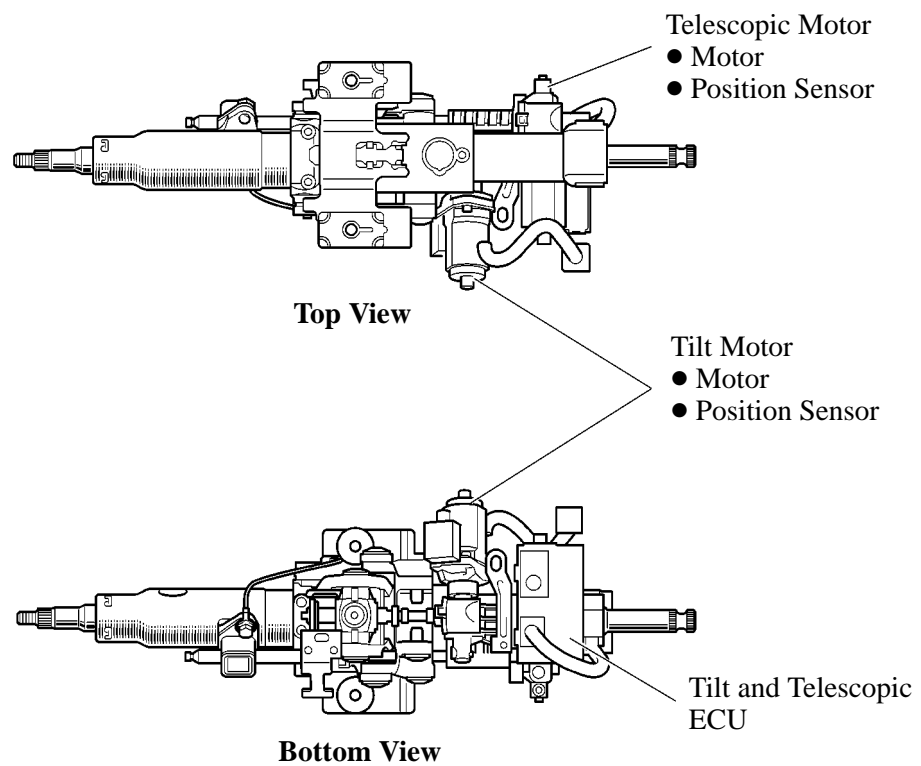
08LCH196Y

Layout of Main Components



08LCH197Y

► Steering Column Assembly ◀



08LCH198Y

System Control

1) General

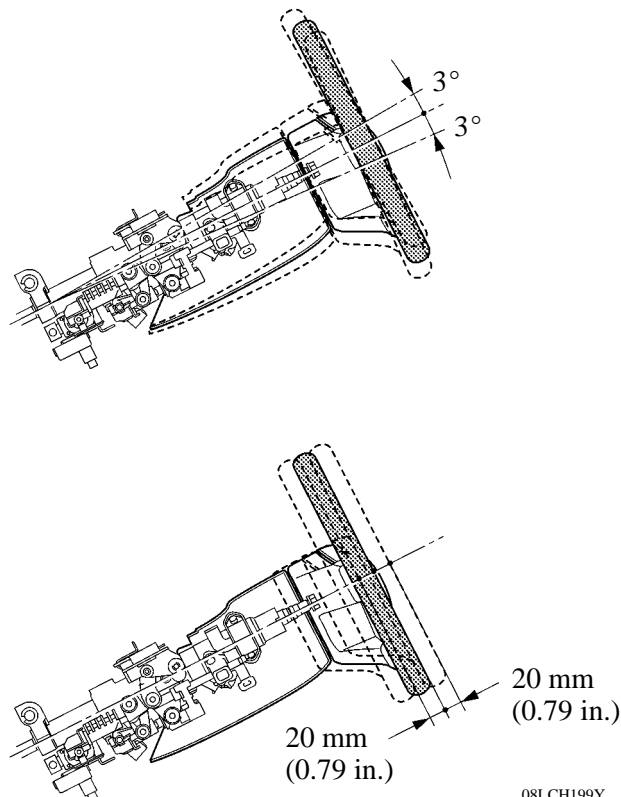
This system has the following control functions, thus providing excellent ease of operation and entry/exit.

Control		Outline
Manual		The tilt and telescopic positions can be adjusted using the tilt and telescopic manual switch.
Automatic*	Auto Away	The steering wheel automatically tilts up and retracts all the way when the ignition switch is changed from ACC or ON to OFF.
	Auto Return	When the ignition switch is changed from OFF to ACC or ON, the steering wheel automatically returns to the previous position which was set before the ignition switch was turned OFF.
Memory		Two steering wheel positions can be memorized, allowing different positions to be restored by the memory system.
Fail-safe		When the tilt & telescopic ECU detects a malfunction in the power tilt and telescopic system, the ECU switches to a fail-safe mode.
Diagnosis		When the tilt & telescopic ECU detects a malfunction in the power tilt and telescopic system, the ECU stores the malfunction data in memory.

*: Customization settings can be changed.

2) Manual Control

A stepless tilt adjustment allows the steering wheel to be tilted 6° vertically, and the telescopic mechanism allows it to be moved in and out 40 mm (1.58 in.).



3) Fail-safe

- When the tilt and telescopic ECU detects a malfunction in the power tilt and telescopic system, the ECU changes the control mode to a fail-safe mode as follows:

Detection Item	Fail-safe
Tilt Position Sensor or Tilt Motor Circuit Malfunction	The tilt operation is suspended.
Telescopic Position Sensor or Telescopic Motor Circuit Malfunction	The telescopic operation is suspended.
ECU Power Source Circuit Malfunction	The tilt and telescopic operations are suspended.

- The table below shows operations that are possible even when there is a problem with communication among ECUs related to the tilt and telescopic ECU and the power tilt and telescopic system.

×: Not Possible ○: Possible

Operation	ECU or Switch for which Communication is Lost			
	Main Body ECU (Ignition Signal)	Driver Seat ECU	Mirror ECU	Related ECU and Switch
Manual	×*	○	○	×*
Automatic Away	×	○	○	×
Automatic Return	×*	○	○	×*
Memory	×	×	×	×
Recall	×*	×	×	×

*: When the power (ignition switch signal) for the tilt and telescopic ECU is ON, the operation is possible. When it is OFF, the operation is not possible.

4) Diagnosis

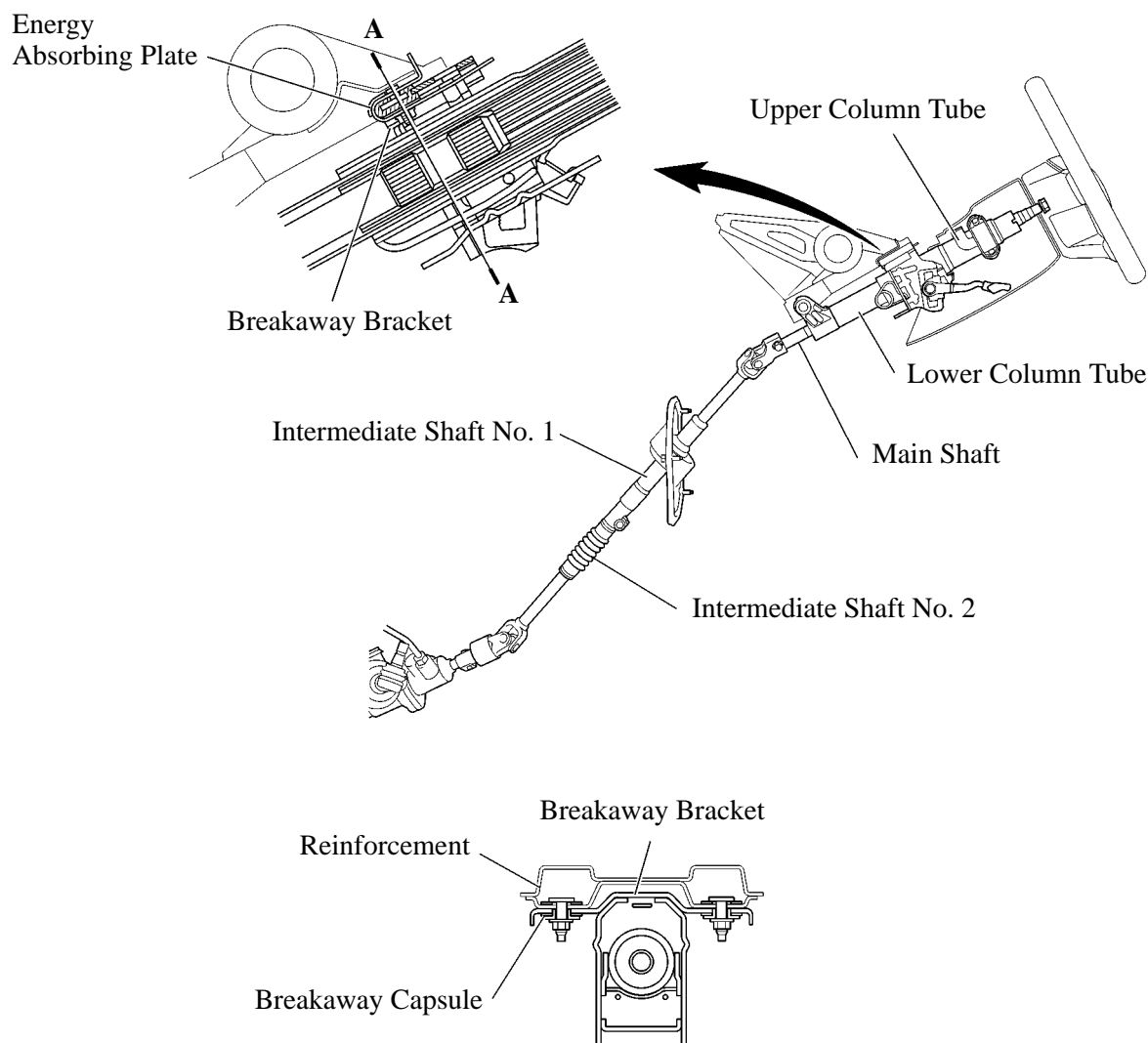
If the tilt and telescopic ECU detects a malfunction in the power tilt and telescopic system, the ECU stores the malfunction data in memory. Then, by connecting a Techstream to the DLC3 terminal, the DTCs (Diagnostic Trouble Codes) can be accessed and an active test can be performed to test the operation of the tilt motor and the telescopic motor.

For details, see the 2008 Sequoia Repair Manual (Pub. No. RM08L0U).

■ ENERGY ABSORBING MECHANISM

- The energy absorbing mechanism consists of a breakaway bracket, breakaway capsule, energy absorbing plate, main shaft, upper column tube and lower column tube.
- When the steering rack moves in toward the cabin during a collision (primary collision), the intermediate shaft and main shaft contract, thus helping prevent the steering column and the steering wheel from moving into the cabin.
- When an impact is transmitted to the steering wheel during a collision (secondary collision), the steering wheel and the steering wheel pad help absorb the impact. In addition, the energy absorbing plate helps absorb the impact and the breakaway capsule is disconnected from the column set bolt, the breakaway bracket and the reinforcement separate, and the space between the upper and lower column tubes contracts.

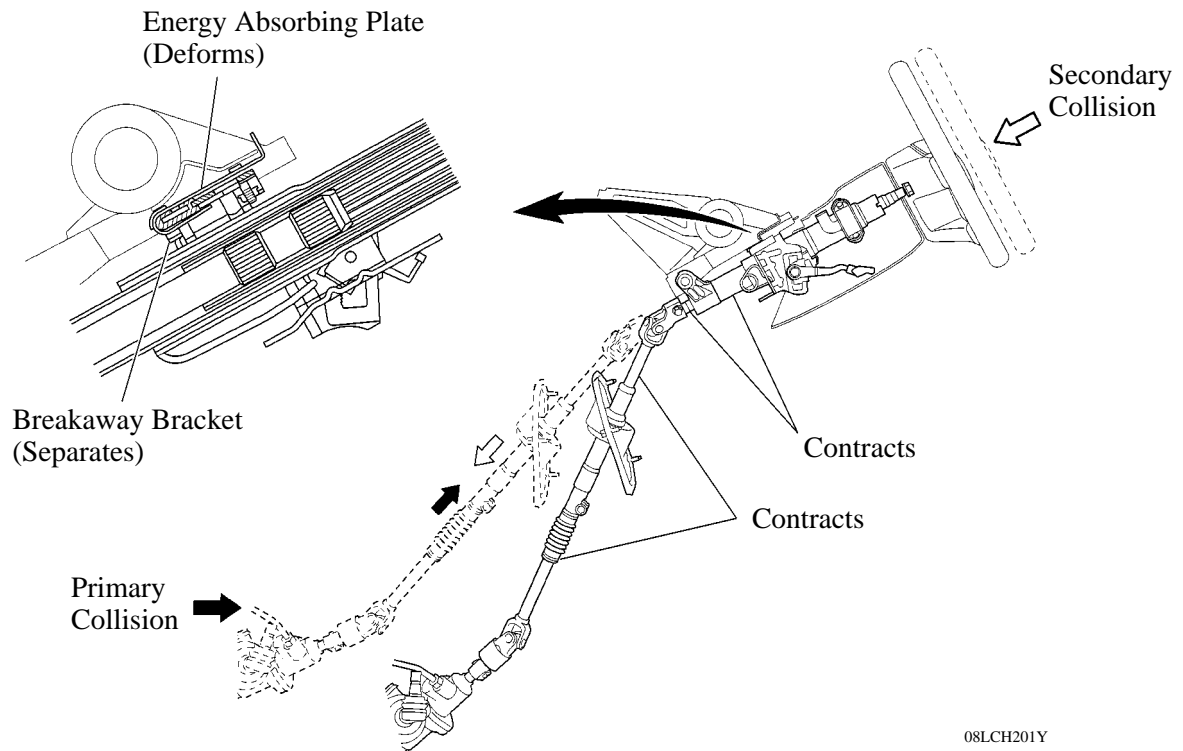
► Before Collision ◀



A – A Cross Section

08LCH200Y

► After Collision ◀



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– MEMO –