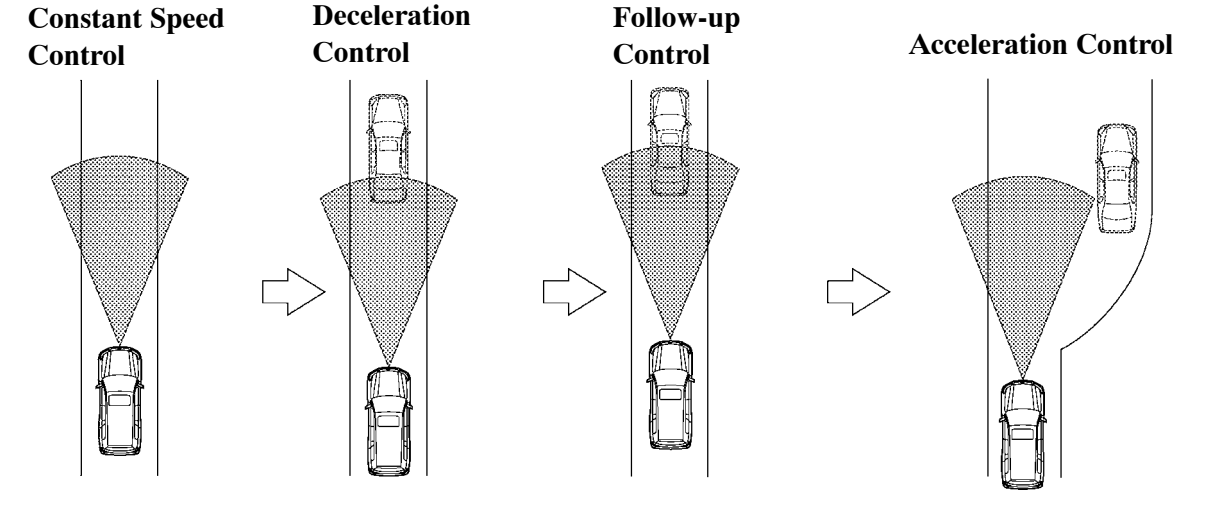
■ DYNAMIC RADAR CRUISE CONTROL SYSTEM

1. General

The dynamic radar cruise control system is newly available as optional equipment on models for Australia and G.C.C. countries.
The dynamic radar cruise control system has 2 cruise control modes: constant speed control mode and vehicle-to-vehicle distance control mode.

- The cruise control switch is used for switching between the 2 modes. The mode in which the cruise control system starts is the vehicle-to-vehicle distance control mode.
- The dynamic radar cruise control system is controlled by the distance control ECU, millimeter wave radar sensor and ECM.
- The combination meter informs the driver of the control conditions.

Mode	Outline
Constant Speed Control Mode	The constant speed control mode is the same as in the cruise control system.
Vehicle-to-vehicle Distance Control Mode	In the vehicle-to-vehicle distance control mode, the system recognizes and determines the lane in which the driver's own vehicle and the vehicle ahead are traveling. Thus, the system is able to maintain the proper vehicle-to-vehicle distance in accordance with the vehicle speed, and allows the vehicle to be driven under follow-up control. ● The driver can operate the distance control switch on the steering wheel to select the vehicle-to-vehicle distance in three stages: long, middle and short. ● This mode consists mainly of four controls: constant speed control, deceleration control, follow-up control and acceleration control. ● The illustrations below show control examples while the driver's own vehicle is operating at 100 km/h (62 mph) and the vehicle ahead is operating at 80 km/h (50 mph). ● The distance control ECU increases and decreases the vehicle speed by controlling the engine and brakes through transmitting the target acceleration rate, target deceleration rate and brake request signals to the skid control ECU and ECM.

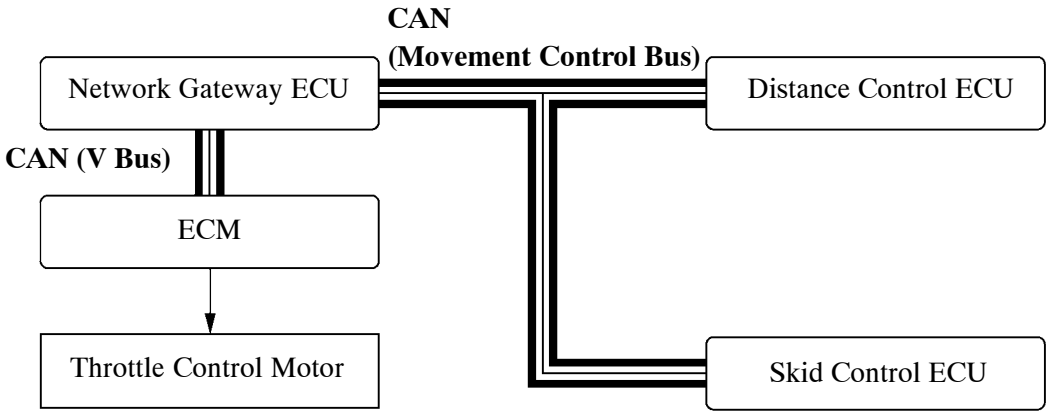


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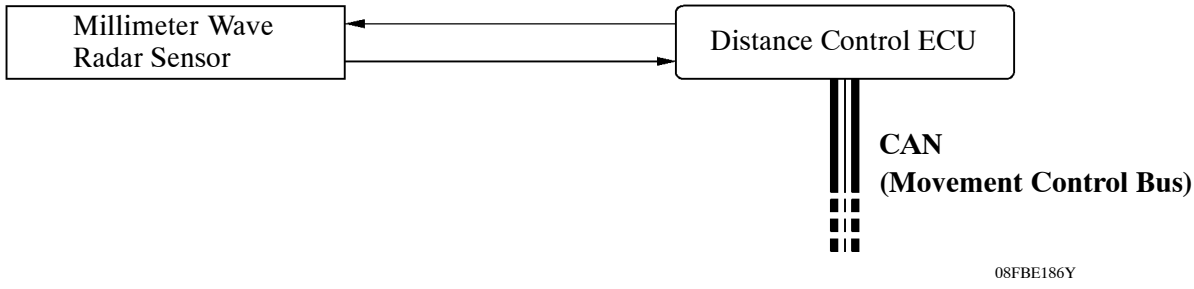
Service Tip

When either the distance control ECU or the ECM is replaced, the millimeter wave radar sensor information stored in the replaced ECU must be initialized. For details, see the Repair Manual.

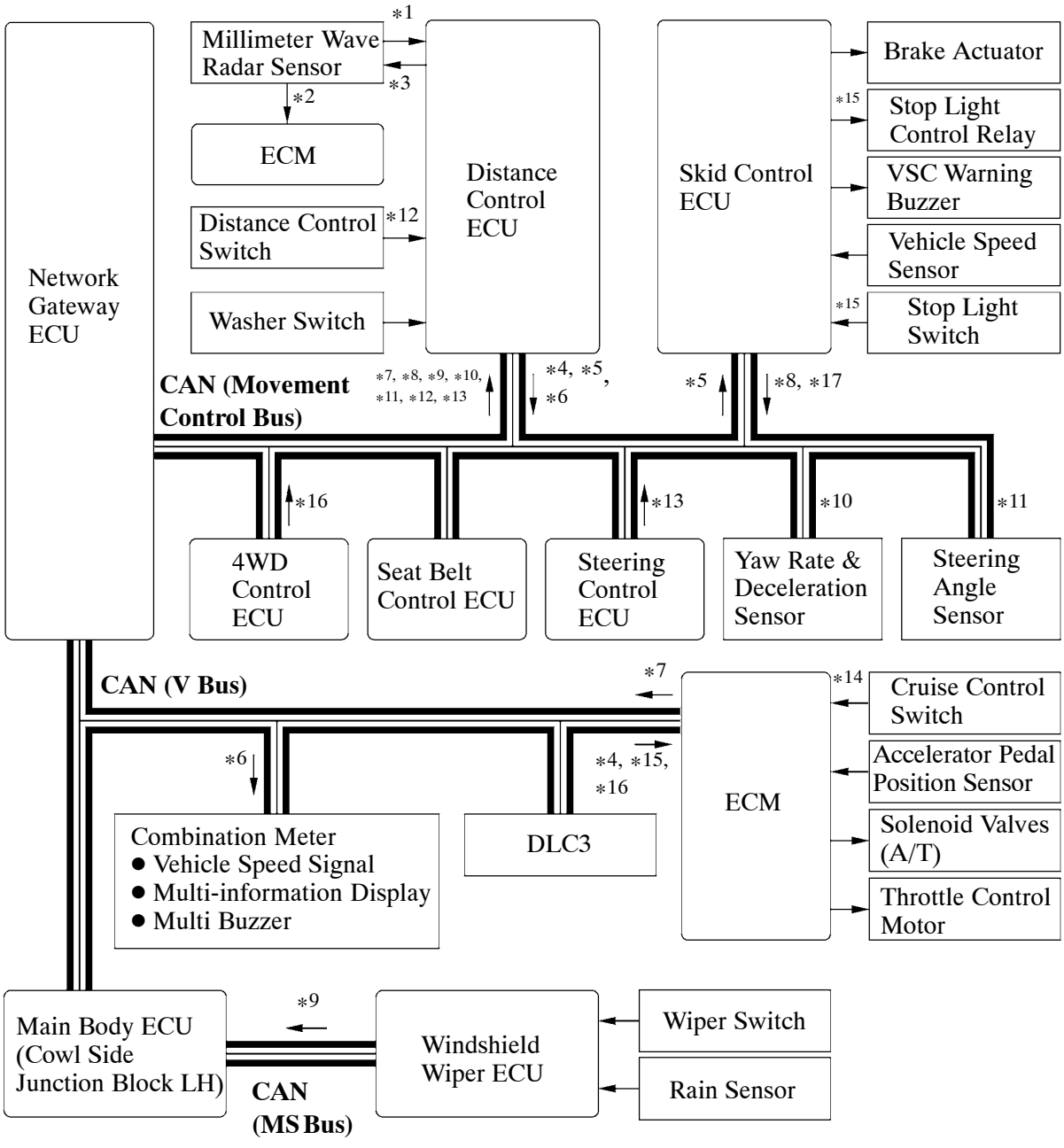
- As in the cruise control system, the constant speed control mode is controlled by the distance control ECU, which outputs signals to the skid control ECU and the ECM.



- The vehicle-to-vehicle distance control mode is controlled by the millimeter wave radar sensor and distance control ECU. Thus, the signals are output to the actuators and the ECU while exchanging data as indicated below:



2. System Diagram



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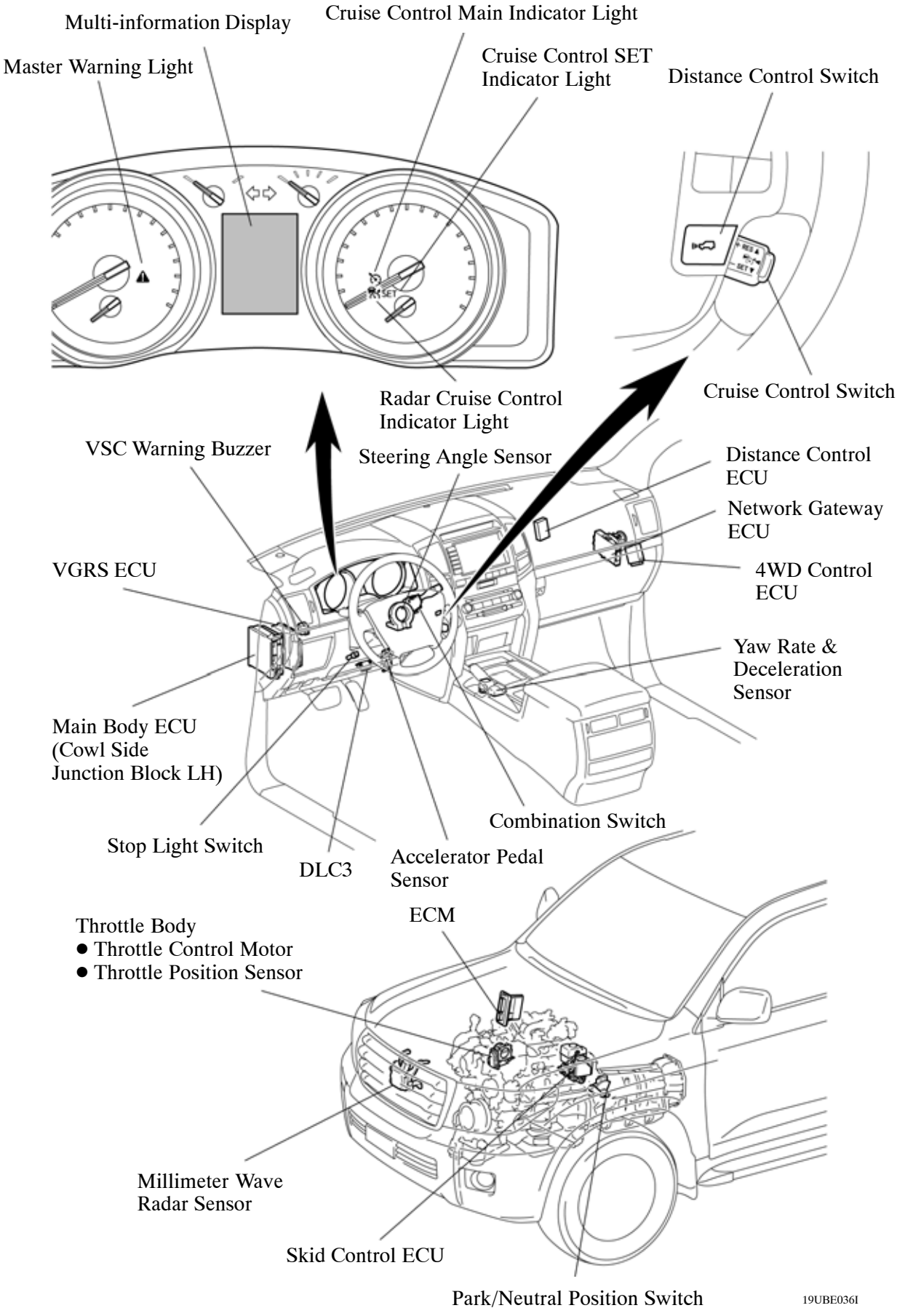
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No.	Transmit	Receive	Data List	Communication
∗1	Millimeter Wave Radar Sensor	Distance Control ECU	● Information about Vehicle Ahead (Distance, Relative Speed, etc.) ● Diagnostic Data	Serial
∗2		ECM	Millimeter Wave Radar Sensor Operation Signal	Wire
∗3	Distance Control ECU	Millimeter Wave Radar Sensor	● Actual Vehicle Speed ● Estimated Curve Radius ● Set Distance	Serial
∗4		ECM	● Cruise Control Status ● ETC Control Request ● Target Acceleration Rate ● Vehicle-to-vehicle Distance ● Brake Request ● Poor Weather Detection ● Millimeter Wave Radar Sensor Dirtiness Detection ● Diagnosis Data	CAN
∗5		Skid Control ECU	● Warning Request ● Cruise Control Status ● Brake Request ● Target Deceleration Rate ● Target Deceleration Rate Gradient	CAN
∗6		Combination Meter	● Display Request ● Warning Request	CAN
∗7	ECM	Distance Control ECU	● Cruise Control Status ● Accelerator Pedal Idle ● Set Vehicle Speed ● Actual Vehicle Speed ● Set Distance ● Cruise Control Switch ● Brake Request Response ● Stop Light Signal	CAN
∗8	Skid Control ECU		● Wheel Speed ● Brake System Malfunction Flag ● Zero Point Information of Yaw Rate ● Buzzer Malfunction Flag	CAN
∗9	Windshield Wiper ECU		Wiper Status	CAN
∗10	Yaw Rate & Deceleration Sensor		Yaw Rate	CAN
∗11	Steering Angle Sensor		Angle and Direction of Steering	CAN
∗12	Distance Control Switch		Select Vehicle-to-vehicle Distance	Wire
∗13	Steering Control ECU		VGRS Control Status	CAN

(Continued)

No.	Transmit	Receive	Data List	Communication
∗14	Cruise Control Switch	ECM	Set Vehicle Speed	Wire
∗15	Stop Light Switch		Stop Light Switch On/Off	Wire
∗16	4WD Control ECU		Cruise Control Cancel Request	CAN
∗17	Skid Control ECU	Stop Light Control Relay	Stop Light Illumination Signal	Wire

3. Layout of Main Components



4. Function of Main Components

Item		Outline
Cruise Control Switch	ON/OFF Button	Turns ON/OFF the power to the cruise control system.
	MODE Switch	Switches the control mode, between the constant speed control mode and vehicle-to-vehicle distance mode.
	CANCEL Switch	A cancel signal can be output to the ECM through the operation of this switch.
	+RES Switch	The acceleration function and resumption of a preset speed can be performed by operating this switch. A signal is output to the ECM when this switch is operated.
	–SET Switch	The deceleration function and vehicle speed setting resume signals are output to the ECM due to operation of this switch.
Distance Control Switch		While the system is in the vehicle-to-vehicle distance control mode, the driver can operate the distance control switch to select the vehicle-to-vehicle distance in three stages: long, middle, and short.
Stop Light Switch		Detects the pressing of the brake pedal and transmits a signal to the ECM.
Combination Switch	Wiper Switch	Transmits wiper switch information to the wiper ECU.
Millimeter Wave Radar Sensor		Radiates millimeter waves forward, uses the reflected millimeter waves for detecting the presence of a vehicle being driven ahead, the vehicle-to-vehicle distance and the relative speed, and transmits these pieces of information to the distance control ECU. This sensor is also used in the pre-crash safety system. For details, refer to page 280.
Distance Control ECU		While the system is in the vehicle-to-vehicle distance control mode, the distance control ECU detects the vehicle being followed based on signals from the millimeter wave radar sensor. Then, the distance control ECU calculates the acceleration or deceleration rate required in order to attain the target vehicle-to-vehicle distance, and outputs a request signal to the ECM and/or skid control ECU.
Combination Meter	Cruise control Main Indicator Light	● Illuminates when the constant speed mode is on. ● If the distance control ECU detects a malfunction, this light turns off.
	Radar Cruise Control Indicator Light	● Illuminates when the vehicle-to-vehicle distance control mode is on. ● If the distance control ECU detects a malfunction, this light turns off.
	Cruise SET Indicator Light	Illuminates when the constant speed control mode or the vehicle-to-vehicle distance control mode is set.
	Master Warning Light	Illuminates when there is a malfunction in the system.
	Multi Buzzer	If the ECM and distance control ECU detect automatic cancel or warning signals while the vehicle is operating under cruise control, the buzzer sounds to inform the driver.
	Multi-information Display	During the dynamic radar cruise control, the multi-information display receives signals from the distance control ECU in order to display the system conditions.
Steering Angle Sensor		Detects the angle and direction of steering and transmits signals to the skid control ECU and distance control ECU.

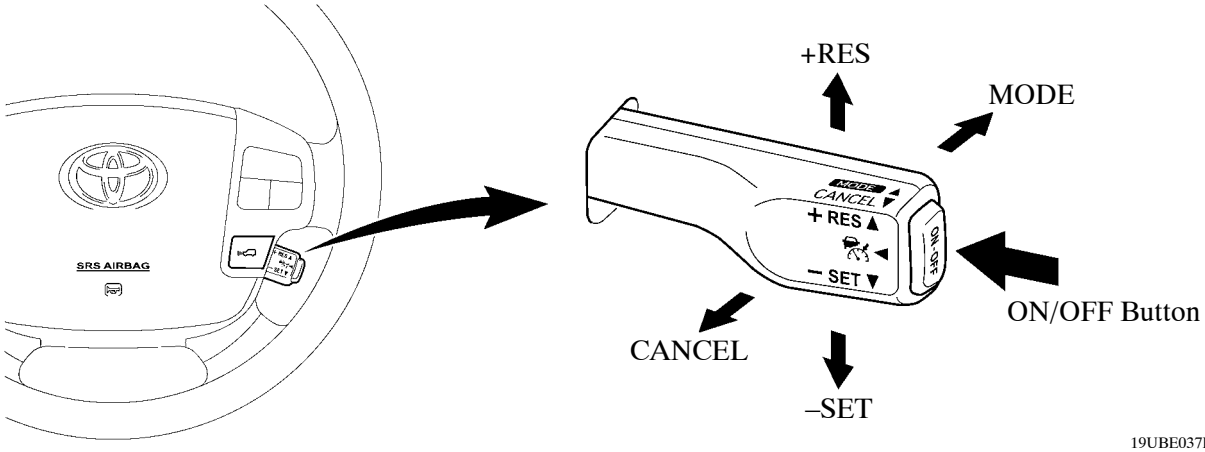
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Item	Outline
Yaw Rate & Deceleration Sensor	Detects the yaw rate of the vehicle and transmits signals to the skid control ECU and distance control ECU.
Skid Control ECU	While the system is operating in vehicle-to-vehicle distance control mode, the skid control ECU actuates the brake actuator in accordance with the brake request signal received from the distance control ECU. In addition, the skid control ECU transmits signals such as a wheel speed and estimated vehicle acceleration speed to the distance control ECU.
VSC Warning Buzzer	Sounds on receiving a signal from the skid control ECU assembly and alerts the driver that the distance between vehicles is short.
Brake Actuator	Actuates the brakes in accordance with the signals from the skid control ECU.
Stop Light Control Relay	Illuminates the stop light in accordance with the stop light illumination request signal from the skid control ECU.
ECM	● Controls the cruise control system in accordance with signals from the switches, sensors, skid control ECU and distance control ECU. ● If the ECM detects a malfunction in the cruise control system, it will store a Diagnostic Trouble Code (DTC).
Accelerator Pedal Sensor	Detects the amount of pedal effort applied to the accelerator pedal and transmits signals to the ECM.
Park/Neutral Position Switch	Detects the shift position and transmits signals to the ECM.
Throttle Body	Adjusts the throttle valve opening angle in accordance with signals from the ECM.
VGRS ECU	Transmits the VGRS condition signal to the distance control ECU.
4WD Control ECU	Transmits the transfer condition signal to the distance control ECU.
Network Gateway ECU	Transmits the CAN communication signal.
DLC3	The 5-digit DTCs can be read by connecting an intelligent tester II to the DLC3.

5. Construction and Operation

Cruise Control Switch

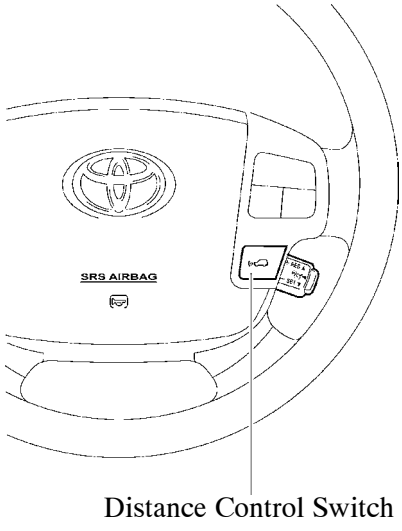
- The cruise control switch consists of the ON/OFF button, +RES, MODE, –SET and CANCEL switches. The +RES, MODE, –SET and CANCEL switches are a lever that operates in four directions.
- The cruise control switch is an automatic reset (normally open) type that turns on only when the switch is being operated and turns off as soon as the driver releases the switch. Furthermore, the functions of the control switch are active only when the cruise control system has been turned on using the ON/OFF button on the cruise control switch.



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Distance Control Switch

- While the vehicle is being driven in vehicle-to-vehicle distance control mode, the vehicle-to-vehicle distance setting can be changed each time the distance control switch is pressed as follows; long → middle → short.
- If the engine switch is turned off and back to on (IG), the system will be set to long.
- The vehicle-to-vehicle distance is set as follows:



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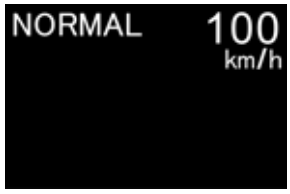
Mode	Vehicle-to-vehicle Distance*
Long	Approx. 50 m (164 ft.)
Middle	Approx. 40 m (131 ft.)
Short	Approx. 30 m (98 ft.)

*: While driving at 80 km/h (50 mph).

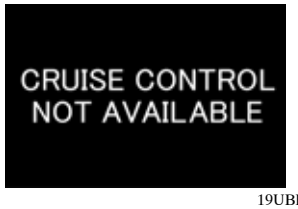
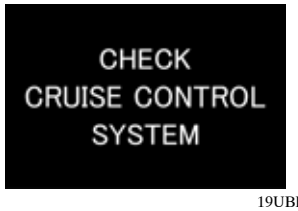
Combination Meter

The combination meter assembly provides a master warning light, cruise control main indicator light, radar cruise control indicator light, cruise control SET indicator light, multi buzzer, and multi-information display to provide warnings and messages regarding the dynamic radar cruise control system.

- The multi-information display displays the set vehicle speed, vehicle ahead mark, and warning message.
- Examples are shown below for the illumination or display of each indicator light, warning light or multi-information display.

Mode	Condition	Multi-information Display	Indicator Light	Cruise Control SET Indicator	Master Warning Light	Multi Buzzer
Constant Speed Control	Being Controlled	 19UBE039I	Cruise Control Main Indicator Light Illuminates	Illuminates	—	—
	System Check*	 19UBE040I	—	—	Illuminates	Sounds Once
Vehicle-to-vehicle Distance Control	Set Standby	 19UBE041I	Radar Cruise Control Indicator Light Illuminates	—	—	—
	Under Constant Speed Control (No Vehicle Ahead)	 19UBE042I	Radar Cruise Control Indicator Light Illuminates	Illuminates	—	—
	Under Follow-up Control (Vehicle Ahead)	 19UBE043I	Radar Cruise Control Indicator Light Illuminates	Illuminates	—	—

(Continued)

Mode	Condition	Multi-information Display	Indicator Light	Cruise Control SET Indicator	Master Warning Light	Multi Buzzer
Vehicle-to-vehicle Distance Control	Deceleration Control (Proximity Warning)	 19UBE044I Flashes the road in the display are highlighted.	Radar Cruise Control Indicator Light Illuminates	Illuminates	—	Sounds Continuously (VSC Warning Buzzer)
System Failure	Millimeter Wave Radar Sensor is Dirty.	 19UBE045I	—	—	Illuminates	Sounds Once
System Failure	Poor Weather Condition	 19UBE046I	—	—	Illuminates	Sounds Once
	System Check*	 19UBE040I	—	—	Illuminates	Sounds Once

*: When a Diagnostic Trouble Code (DTC) is memorized.

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6. System Control

General

The control of the dynamic radar cruise control system varies depending on the mode:
A: Constant Speed Control Mode
B: Vehicle-to-vehicle Distance Control Mode

Control	Outline	Mode	
		A	B
Constant Speed Control [See page 313]	The ECM compares the actual vehicle speed and the set speed. If the vehicle speed is higher than the set speed, the ECM uses the throttle control motor to decrease the throttle opening. If the actual vehicle speed is lower than the set speed, the ECM uses the throttle control motor to increase the throttle opening.	○	○
Deceleration Control [See page 314]	Effects throttle control and brake control in order to decelerate the vehicle so that the vehicle-to-vehicle distance between the driver's own vehicle and the vehicle ahead equals the set distance.	—	○
Follow-up Control [See page 315]	After effecting deceleration control, the vehicle follows the vehicle ahead in order to maintain the proper vehicle-to-vehicle distance in accordance with the vehicle speed.	—	○
Acceleration Control [See page 316]	Accelerates the vehicle in order to attain the set vehicle speed if the vehicle ahead or the driver's own vehicle has changed lanes.	—	○
Set Control	While this system fulfills the following conditions, the cruise control switch is pressed to the –SET side and released when the ON/OFF button on the cruise control switch has been pressed to turn the system on, the ECM stores the vehicle speed, illuminates the cruise control SET indicator light on the combination meter assembly, and maintains the vehicle constantly at that speed. ● The shift lever is in D. ● The shift lever is moved to the S mode, and shift range is 4th, 5th or 6th.	○	○
	The vehicle is running within the following speed range: ● Approx. 50 to 200 km/h (30 to 125 mph)	○	—
	The vehicle is running within the following speed range: ● Approx. 50 to 170 km/h (30 to 105 mph)	—	○
Low Speed Limit Control	The low speed limit is the lowest speed that cruise control can be set at and it is designed to be approx. 40 km/h (25 mph). The cruise control cannot be set below that speed. If the vehicle speed drops below that speed while running in the cruise control, the cruise control will be canceled automatically. However, the set vehicle speed in the memory is kept.	○	○

(Continued)

Control	Outline	Mode	
		A	B
Coast Switch Control	While the cruise control switch is held to the -SET side, the vehicle speed and the set speed change, in accordance with the mode as follows:	○	○
	● The vehicle decelerates constantly. ● The set speed changes to the speed at which the switch was turned off.	○	—
	● The vehicle setting speed decreases in increments of 5 km/h or 5 mph. [Example: 57 → 55 → 50 km/h, 57 → 55 → 50 mph] ● The vehicle decelerates rapidly due to ETCS-i.	—	○
Tap-down Control	When the cruise control switch is pushed momentarily (approx. 0.6 sec.) to the –SET side, the vehicle speed and the set speed change, in accordance with the mode as follows:	○	○
	● The vehicle will decelerate in increments of approx. 1.6 km/h (1 mph) for each time the switch was pressed. ● However, if the difference between the actual vehicle speed and the set speed is greater than 5 km/h (3 mph), the set speed will change to the speed at which the vehicle was being driven at the time the switch was operated.	○	—
	● The vehicle will decelerate in increments of approx. 5 km/h (5 mph) for each time the switch was pressed.	—	○
Accelerator Control	When the cruise control switch is pushed to the +RES side and held, the vehicle speed and the set speed change, in accordance with the mode as follows:	○	○
	● The vehicle will accelerate constantly. ● The set speed changes to the speed at which the switch was turned off.	○	—
	● The set speed increases in increments 5 km/h or 5 mph. [Example: 52 → 55 → 60 km/h, 52 → 55 → 60 mph] ● The vehicle will accelerate to the speed that was set at the time the switch was released. However, only the set speed will change during follow-up control.	—	○
Resume Control	When the driver pushes the cruise control switch to the +RES side after the vehicle speed has exceeded the low speed limit, the cruise control resumes operation to reach the vehicle speed that was set at the time the driver canceled cruise control.	○	○
	● Even if the vehicle speed drops below the low speed limit, resume can be performed when the vehicle speed exceeds the low speed limit. ● If the vehicle ahead changes driving lanes during follow-up control, the vehicle speed is gradually increased to the set speed. At this time, the vehicle speed can be increased promptly by pushing the cruise control switch to the +RES side.	—	○

(Continued)

Control	Outline	Mode	
		A	B
Tap-up Control	When the cruise control switch is pushed momentarily (approx. 0.6 sec.) to the +RES side, the vehicle speed and the set speed change in accordance with the mode as follows:	○	○
	● The vehicle will accelerate in increments of approx. 1.6 km/h (1 mph) for each time the switch was pressed. ● However, if the difference between the actual vehicle speed and the set speed is greater than 5 km/h (3 mph), the set speed changes to the speed as which the vehicle was being driven at the time the switch was operated.	○	—
	● The vehicle will accelerate in increments of approx. 5 km/h (5 mph) for each time the switch was pressed.	—	○
Shift Down Control	When the vehicle is cruising uphill, shift down control may be performed by the Electronic Control Transmission (ECT). The ECM transmits the shift up request signal to the ECT ECU when the ECM judges the end of cruising uphill based on the throttle valve angle.	○	○
Manual Cancel Control	If any of the following conditions is met, the cruise control will be canceled: ● A stop light switch on signal is sent to the ECM (the brake pedal is depressed). ● The shift lever is moved from D to N. ● The 1st, 2nd or 3rd range is selected in the S mode position. ● A CANCEL switch on signal is sent to the ECM (the cruise control switch is moved to the CANCEL side). ● An ON/OFF button off signal is sent to the ECM. ● A VSC operation signal is sent to the ECM.	○	○
Automatic Cancel Control [See page 317]	When an automatic cancel signal is sent to the ECM, the cruise control operation is canceled. At this time, the warning method and the control resumption condition vary in accordance with the cancel signal.	○	○
Mode Switching Control	The following operations switch the modes: 1) ON/OFF button on the cruise control switch is on (starts in the vehicle-to-vehicle distance control mode). 2) Cruise control switch is held to the MODE side (approx. 1 second or more). If the switch is pushed to any other side before switching modes, switch the cruise control system off, then perform steps 1) and 2) again.	○	○
Diagnosis [See page 318]	If a malfunction occurs in the dynamic radar cruise control system during cruise control operation, the ECM cancels cruise control and diagnoses and memorizes the faults related to the malfunction.	○	○

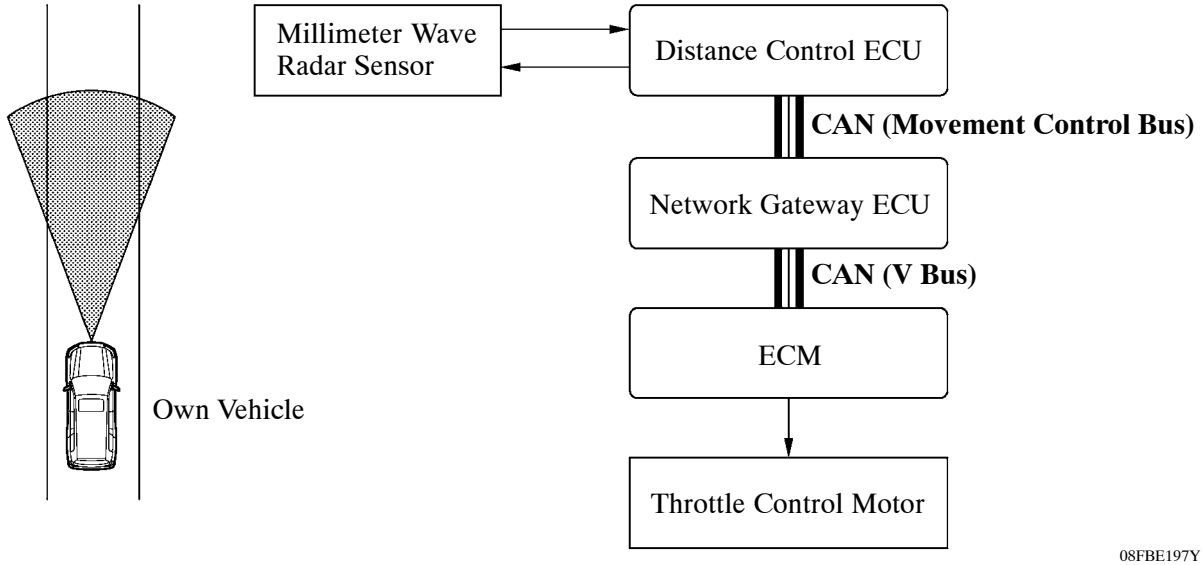
Constant Speed Control

1) General

- In the constant speed control mode, the constant speed control is effected by the ECM.
- In the vehicle-to-vehicle distance control mode, the constant speed control is effected by the millimeter wave radar sensor and distance control ECU.

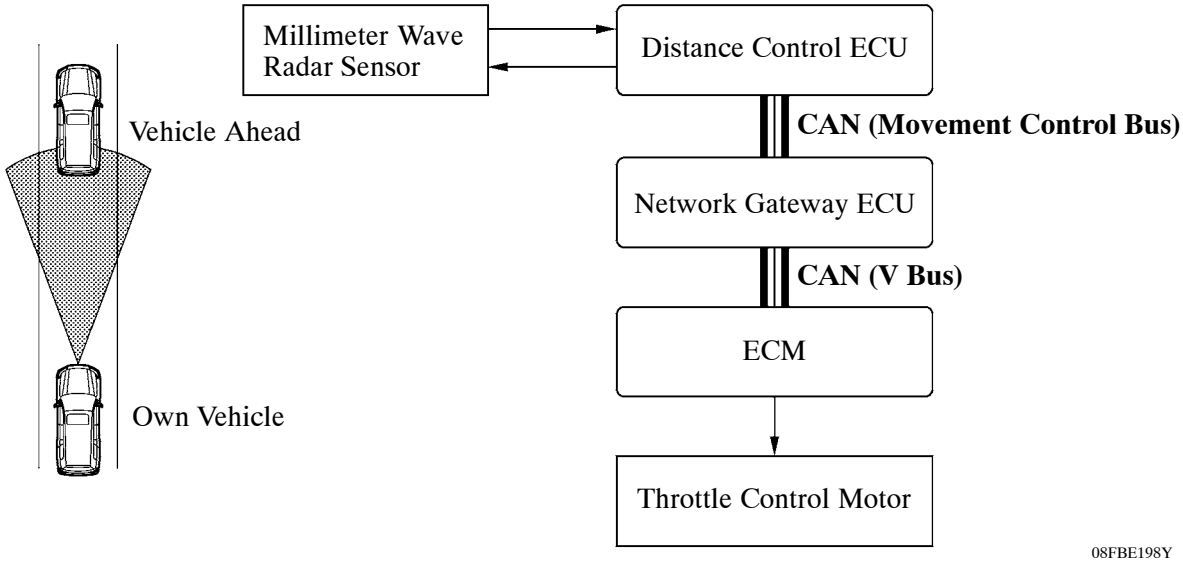
2) Constant Speed Control in Vehicle-to-vehicle Distance Control Mode

The millimeter wave radar sensor transmits the information about the vehicle ahead to the distance control ECU and also transmits a millimeter wave radar sensor operation signal to the ECM. The distance control ECU transmits this signal to the ECM. The ECM compares the set speed and the actual vehicle speed, and effects constant speed control by regulating the throttle control in order to attain the set speed.

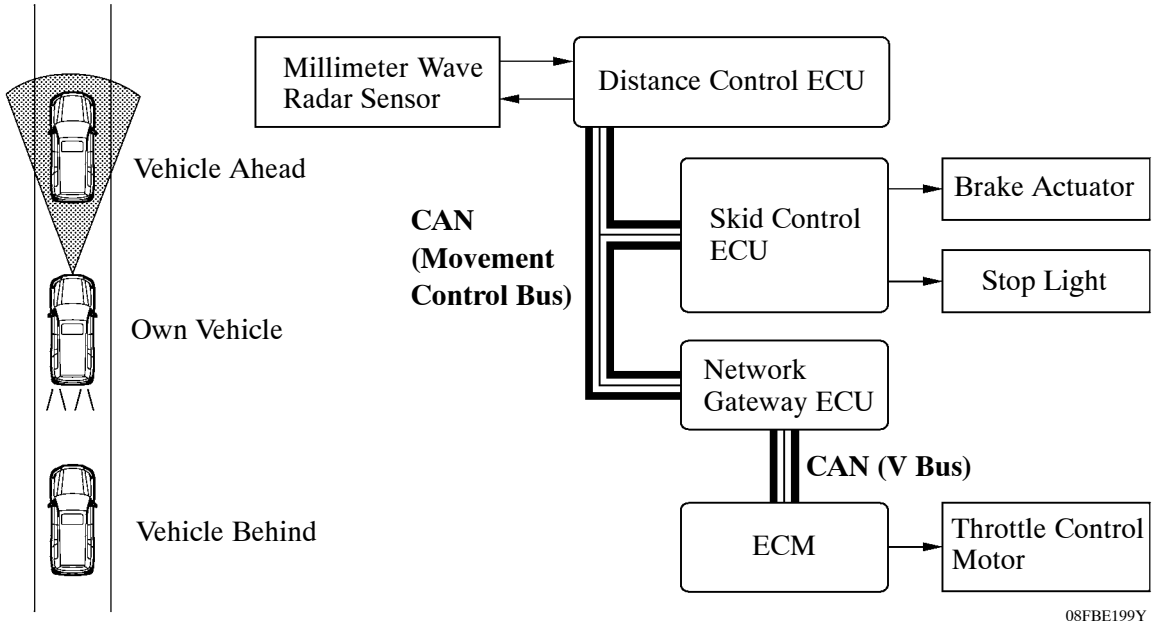


Deceleration Control

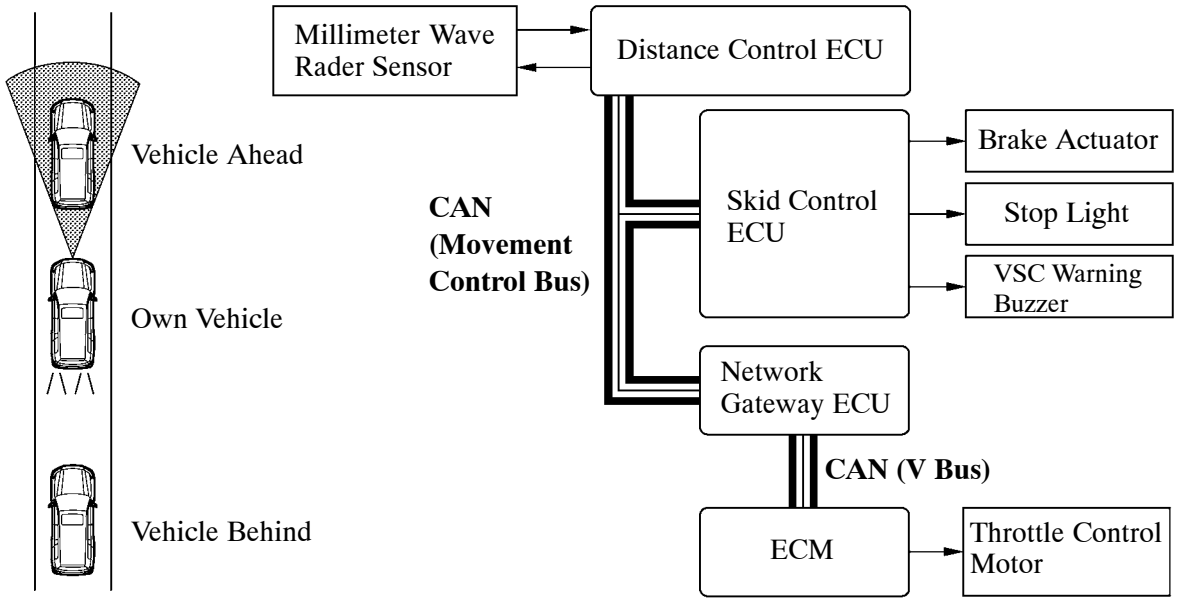
- The distance control ECU calculates the target deceleration rate in accordance with signals from the millimeter wave radar sensor, and transmits a deceleration request signal to the ECM. Upon receiving this signal, the ECM closes the throttle valve in order to cause the vehicle to decelerate.
- This control is not effected in the presence of a parked vehicle or object, or below the settable vehicle speed range.



- If the distance control ECU determines that further deceleration is necessary, it transmits a brake request signal to the ECM. Upon receiving this signal, the ECM transmits a brake request signal to the skid control ECU. The skid control ECU then controls the brake actuator to apply the brakes.
- At this time, if the deceleration rate is higher than a predetermined value, the skid control ECU outputs a stop light illumination request signal to the stop light control relay, in order to inform anyone who might be following the vehicle.

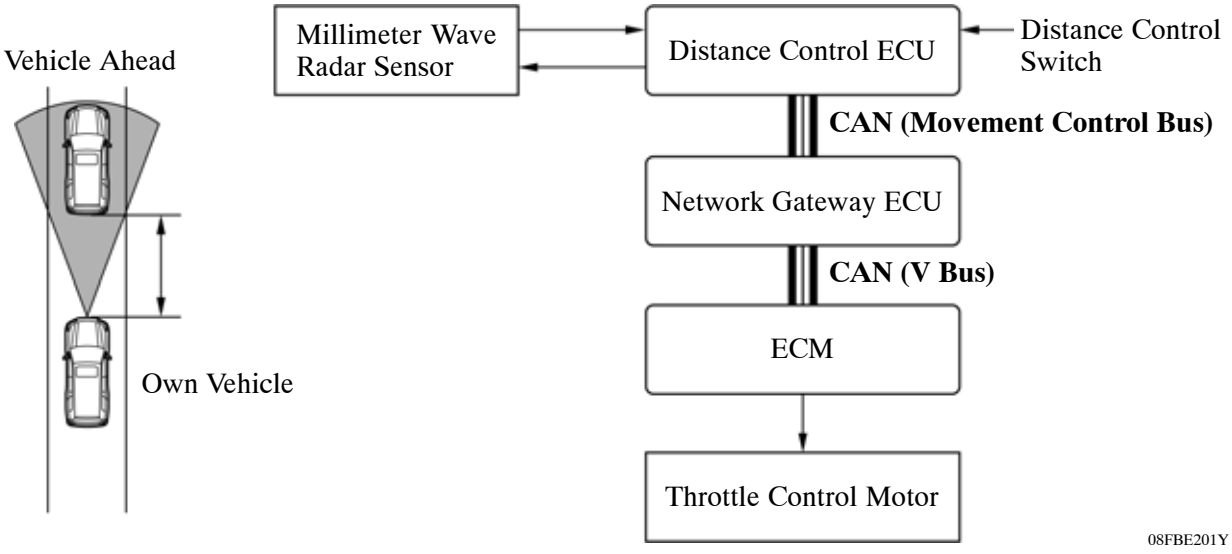


- If further deceleration is necessary after the stop light is illuminated, the skid control ECU sounds the VSC warning buzzer based on the request signal from the distance control ECU to urge the driver to depress the brake pedal.



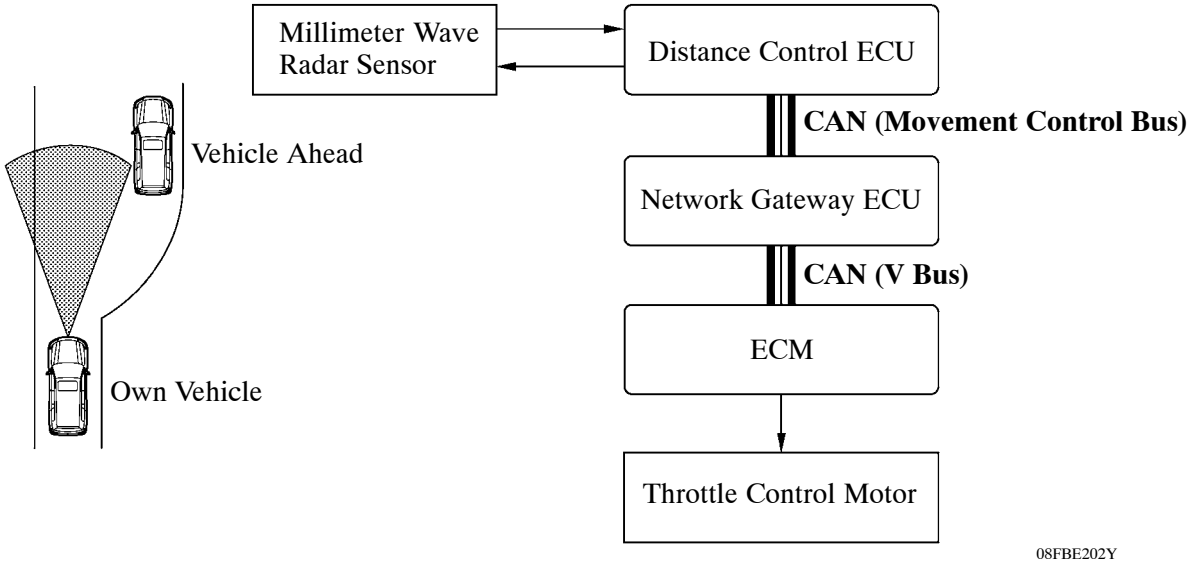
Follow-up Control

- After effecting deceleration control, the distance control ECU transmits a request signal to the ECM so that the vehicle can follow the vehicle ahead while maintaining the proper vehicle-to-vehicle distance in accordance with the vehicle speed. Upon receiving this signal, the ECM regulates the throttle in order to effect follow-up control.
- Three stages (long, middle, and short) of vehicle-to-vehicle distance can be selected by operating the distance control switch.



Acceleration Control

If the distance control ECU detects (based on the millimeter wave radar sensor) that either the vehicle ahead or own vehicle has changed lanes, an acceleration request signal is transmitted to the ECM in order to attain the set vehicle speed. Upon receiving this signal, the ECM regulates the throttle in order to effect acceleration control.



Automatic Cancel Control

If any of the conditions listed below occurs while the vehicle is in cruise control (A: constant speed control mode, B: vehicle-to-vehicle distance control mode), the cruise control will be canceled. Then, the following warning will be issued:

1) Warning message is displayed on the multi-information display.

2) Master warning light illuminates.

3) Multi buzzer sounds.

4) Cruise control main indicator light turns off.

Mode	Description of Malfunction	Warning
A and B	If any of the conditions listed below occurs, the ECM clears the set speed and cancels the cruise control: ● Malfunction of the vehicle speed signal ● An open or short circuit in the stop light switch The cruise control is prohibited until the conditions are restored or the cruise control system is turned off and back on again using the ON/OFF button on the cruise control switch.	1) "CHECK CRUISE CONTROL SYSTEM" 2) Illuminates 3) Sounds Once 4) Turns Off
	If the condition below occurs, the ECM clears the set speed and cancels the cruise control: ● Malfunction in the ETCS-i The cruise control is prohibited until the condition is restored or the cruise control system is turned off and back on again using the ON/OFF button on the cruise control switch.	1) — 2) — 3) — 4) Turns Off
	If any of the conditions listed below occurs, the ECM clears the set speed and cancels the cruise control: ● Malfunction of the stop light switch input signal circuit ● Malfunction of the cancel circuit The cruise control is prohibited until the power source is turned on again.	1) "CHECK CRUISE CONTROL SYSTEM" 2) Illuminates 3) Sounds Once 4) Turns Off
A	If the condition below occurs, the ECM cancels the cruise control while retaining the set speed in its memory: ● The vehicle speed drops below low speed limit [approx. 40 km/h (25 mph)].	1) — 2) — 3) — 4) Turns Off
B	If the condition below occurs, the ECM cancels the cruise control while retaining the set speed in its memory: ● The vehicle speed drops below low speed limit [approx. 40 km/h (25 mph)].	1) — 2) — 3) Sounds Twice 4) Turns Off
A	If the condition below occurs, the ECM clears the set speed and cancels the cruise control: ● The vehicle speed drops more than 16 km/h (10 mph) below the set speed.	1) — 2) — 3) — 4) Turns Off

(Continued)

Mode	Description of Malfunction	Warning
B	If any of the conditions listed below occurs, the ECM clears the set speed and cancels the cruise control: ● Malfunction of the millimeter wave radar sensor ● Displacement of the axis of the millimeter wave radar sensor ● Malfunction in the dynamic radar cruise control system other than those given above The cruise control is prohibited until the engine switch is turned on (IG) again.	1) "CHECK CRUISE CONTROL SYSTEM" 2) Illuminates 3) Sounds Once 4) Turns Off
	If the condition below occurs, the ECM cancels the cruise control while retaining the set speed in its memory: ● The millimeter wave radar sensor is dirty. The cruise control is prohibited until the condition is remedied or the cruise control system is turned off and back on again using the ON/OFF button on the cruise control switch.	1) "CLEAN RADAR SENSOR" 2) Illuminates 3) Sounds Once 4) Turns Off
	If any of the conditions listed below occurs, the ECM cancels the cruise control while retaining the set vehicle speed in its memory: ● The wipers operate at high speed (including AUTO mode). ● When the 2nd start control mode is selected. The cruise control is prohibited until the conditions are remedied or the cruise control system is turned off and back on again using the ON/OFF button on the cruise control switch.	1) "CRUISE CONTROL NOT AVAILABLE" 2) Illuminates 3) Sounds Once 4) Turns Off

Diagnosis

If a malfunction occurs in the dynamic radar cruise control system, the ECM actuates the automatic cancel control and turns off the cruise main indicator light or the radar cruise indicator light. Then, the multi-information display in the combination meter displays "**CHECK CRUISE CONTROL SYSTEM**" warning message to inform the driver of a malfunction during cruise control. At this time, the ECM memorizes the malfunction in the form of 5-digit Diagnostic Trouble Codes (DTCs).

- The 5-digit DTCs can be read by connecting an intelligent tester II to the DLC3.

  For details, see the Repair Manual.