
LANE-KEEP ASSIST SYSTEM

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Purpose

- The lane-keep assist system detects the white lines (yellow lines) of the vehicle lane using the forward sensing camera (FSC) installed to the windshield, and alerts the driver that the vehicle may be deviating from its lane and it provides steering assistance to help the driver stay within the vehicle lanes.

Warning

- The lane-keep assist system is a supplementary system which helps the driver stay within the vehicle lanes, but it is not an automatic driving system. If the driver takes his or her hands off the steering wheel, the lane-keep assist system will not operate. In all situations, always make it your responsibility as a driver to check the vehicle's surroundings and drive the vehicle correctly.
- The detection ability of the lane-keep assist system is limited. Over reliance on the lane-keep assist system leading to the steering wheel being mistakenly operated could result in an accident and serious injury or death. Do not rely completely on the lane-keep assist system and always stay on course using the steering wheel.
- The lane-keep assist system may not operate normally under the following conditions.
 - Poor vehicle lane line visibility due to adverse weather (rain, snow, fog)
 - Poor vehicle lane line visibility due to backlight, snow on the road, water puddles, road ruts
 - Poor vehicle lane line visibility due to cracks and fissures in the vehicle lane
 - Vehicle lane lines intersect with complexity due to additions or reductions of travel lanes
 - Vehicle lane marking is not completely erased after road maintenance, two or more lane lines next to each other
 - Vehicle lane lines not recognized due to vehicle ahead
 - Vehicle is driven on sharp curve
 - Vehicle is Driven on slippery road
 - Driving on road with extremely narrow/wide driving lanes
 - Tire pressure is not adjusted to specified value
 - Tires other than specified size installed
 - No vehicle lane lines

Caution

- If the forward sensing camera (FSC) aiming is not completed correctly, the forward sensing camera (FSC) cannot record the camera shooting angle and the lane-keep assist system may not operate normally. When performing the following servicing, always perform the forward sensing camera (FSC) aiming. In addition, for the FSC aiming procedure, refer to the [FORWARD SENSING CAMERA (FSC) AIMING] in the Workshop Manual.
 - Forward sensing camera (FSC) replacement
 - Windshield replacement

Note

- If a malfunction occurs in the EPS system, the lane-keep assist system will not operate.

Functions

- The forward sensing camera (FSC) performs the steering wheel operation assist and activates the lane-keep assist system warning based on the white lines (yellow lines) recognized by the camera. For details on the forward sensing camera (FSC), refer to the [FORWARD SENSING CAMERA (FSC)]. (See FORWARD SENSING CAMERA (FSC).)
- With the lane-keep assist system, operation of the steering assist sensitivity (intervention frequency of driver's steering wheel operation) and the steering wheel operation assist can be turned on or off. (See i-ACTIVSENSE PERSONALIZATION.)

Steering wheel operation assist

- If the possibility of a lane departure increases due to the driver's carelessness, the system assists the driver in preventing a lane departure by operating the steering wheel.

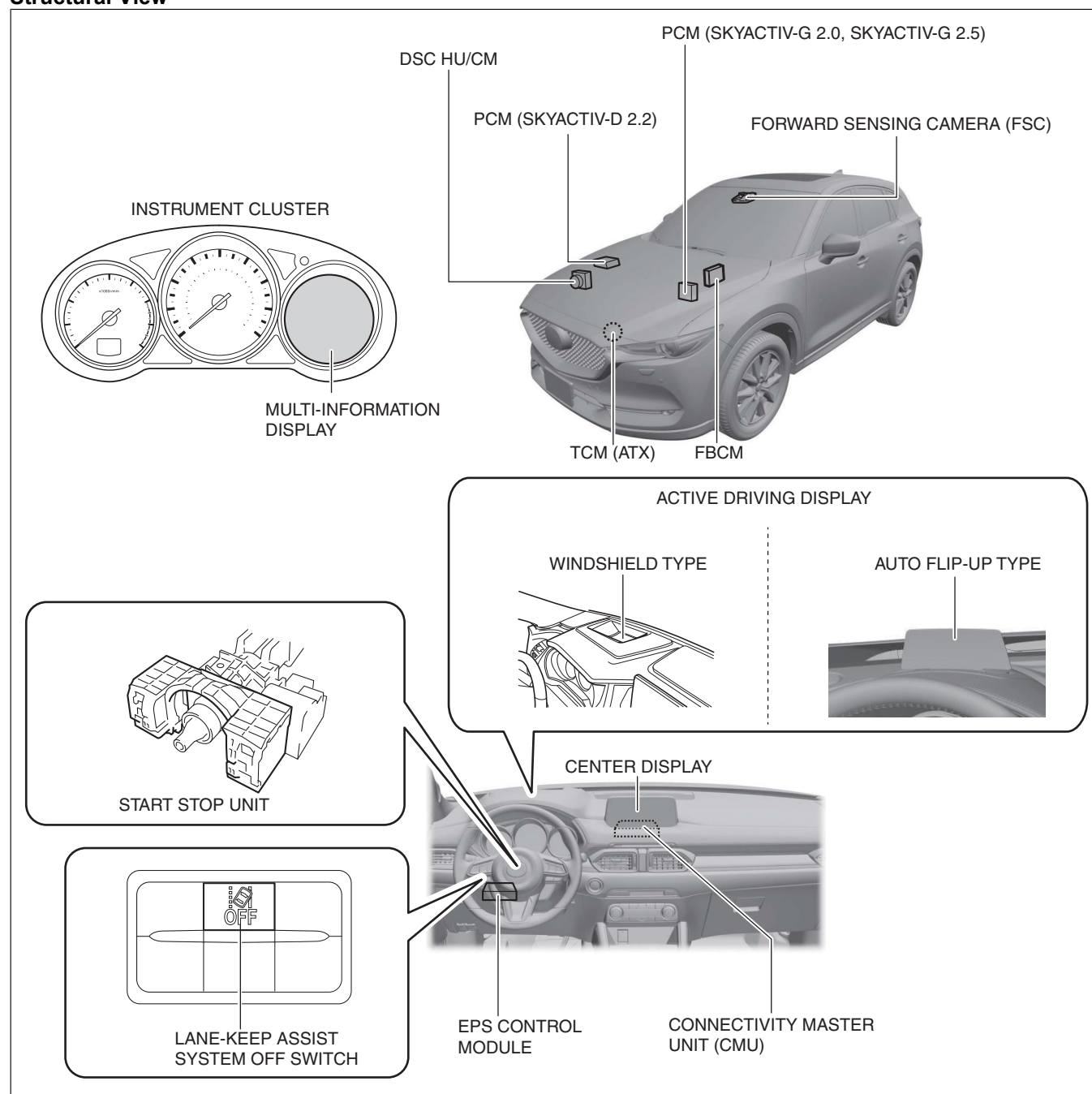
Lane-keep assist system warning

- Steering wheel vibration or a warning sound activates and the warning screens are indicated in the multi-information display or the active driving display to warn the driver.
- The following lane-keep assist warning settings can be changed. (See i-ACTIVSENSE PERSONALIZATION.)
 - Operation/non-operation (during steering wheel operation assist)
 - Warning activation timing (during steering wheel operation assist non-operation)
 - Warning sensitivity (during steering wheel operation assist non-operation)
 - Type of warning (steering wheel vibration/rumble strip sound^{*1}/beep sound)

— Strong/weak steering wheel vibration or warning sound volume

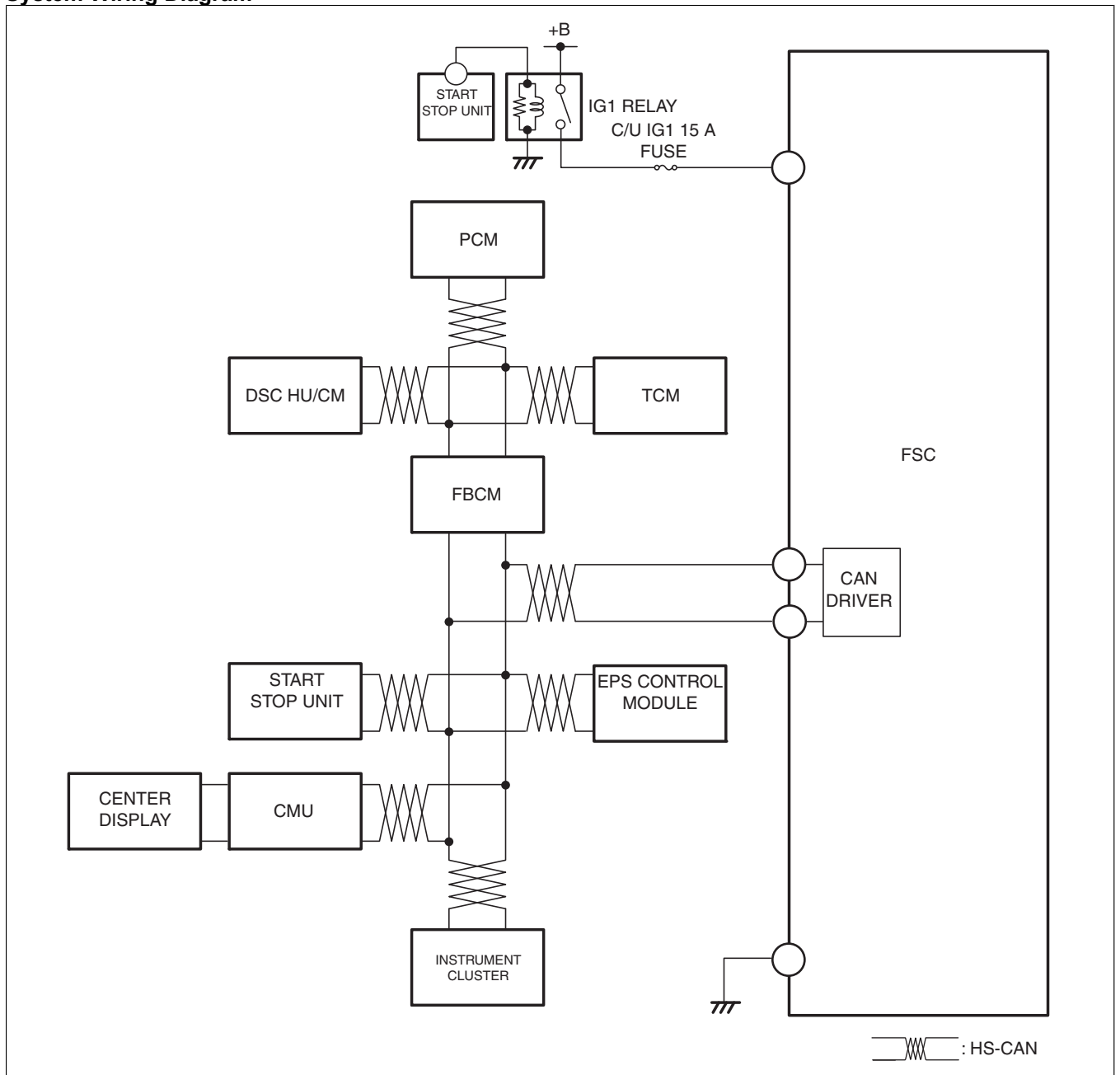
*1 : A rumble strip is a series of grooves in the road surface positioned at specific intervals, and when the vehicle passes over them a rumble sound is produced and an uncomfortable vibration can be felt which alerts the driver that the vehicle is departing from the lane lines. The rumble strip sound is a reproduction of the sound which occurs when a vehicle passes over a rumble strip.

Construction Structural View

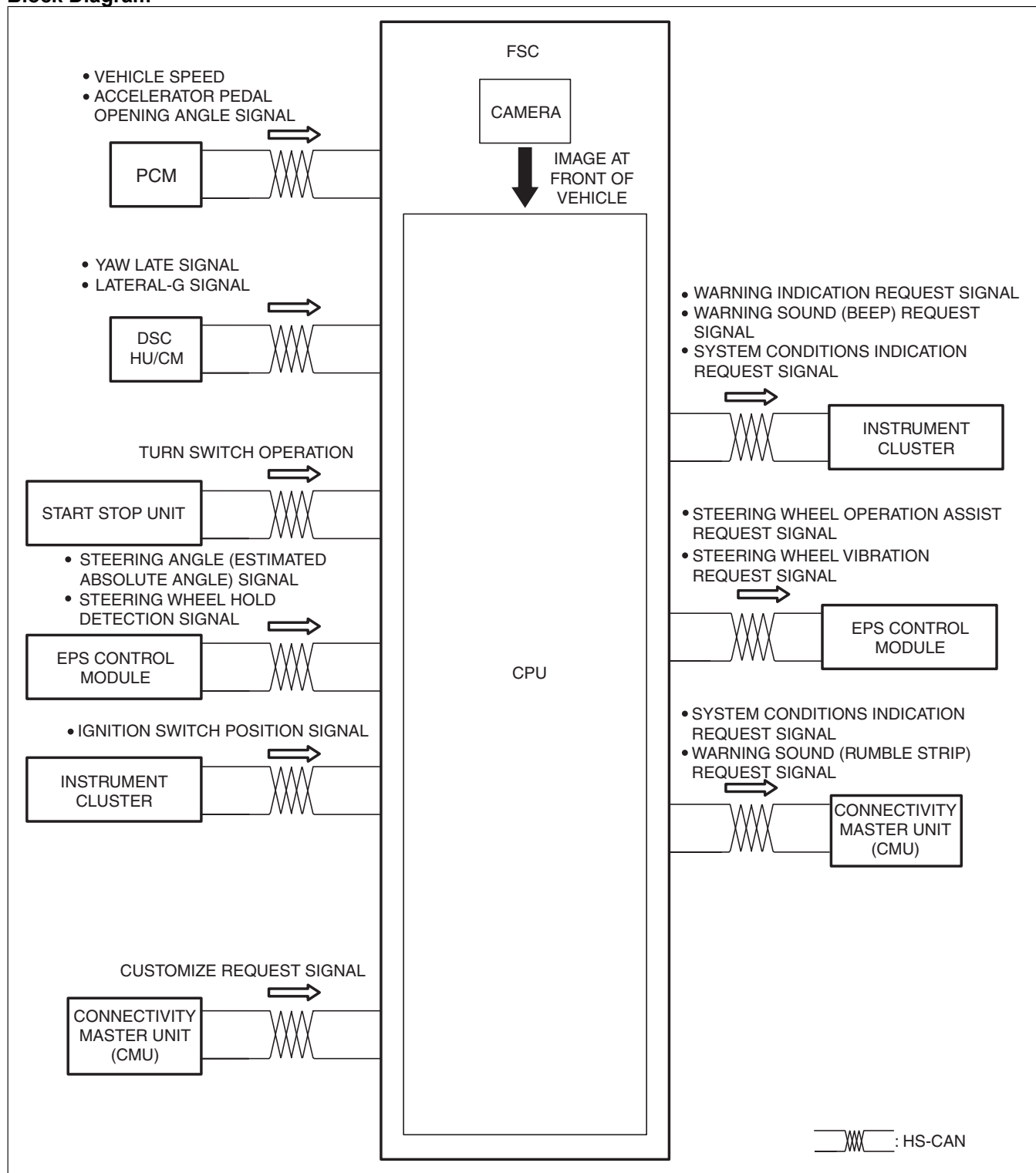


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System Wiring Diagram



Block Diagram



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Operation

- The lane-keep assist system operates when all of the following conditions are met. An indication indicating the system operation condition is visible in the active drive display and the multi-information display, and the lane-keep assist system indication (green) is displayed in the multi-information display.
 - Lane-keep assist system ON
 - Driving at vehicle speed of **approx. 60 km/h {37 mph} or more**
 - Forward sensing camera (FSC) detects white lines (yellow lines) on both the right and left sides
 - Driver is operating steering wheel

Note

- When the ignition is switched OFF, the system status before it was turned off is maintained. For example, if the ignition is switched OFF with the lane-keep system operable, the system will be operable when the ignition is switched ON the next time.
- Even if the lane-keep assist system switch is turned on, the lane-keep assist system goes on stand-by under any of the following conditions. An indication indicating the system stand-by condition is displayed in the active drive display and the multi-information display, and the lane-keep assist system indication (white) is displayed in the multi-information display.

Note

- When all of the operation conditions are met, the lane-keep assist system is enabled automatically.
- Forward sensing camera (FSC) cannot detect white lines (yellow lines)
 - Forward sensing camera (FSC) detects only a white line (yellow line) on either the left or right
 - Vehicle speed is **less than approx. 60 km/h {37 mph}**
 - ABS/DSC is operating
 - TCS is off
 - Vehicle is driven on sharp curve
 - Driving on winding roads
 - Driver takes his or her hands off steering wheel

Note

- The forward sensing camera (FSC) determines if the driver has taken his or her hands off the steering wheel based on the signal from the torque sensor. A torque sensor signal is output to CAN via the TCM.
 - While the driver is not operating the steering wheel, an uneven road is input from the tires to the torque sensor. The forward sensing camera (FSC) determines that the driver has taken his or her hands off the steering wheel based on the sudden increase in torque or input of a minute, irregular signal at that time.
 - If this condition continues for the preset period, the forward sensing camera (FSC) displays the warning indication in the display to warn the driver.
- The lane-keep assist system determines that the driver is performing the following driving operations, and suppresses the steering wheel operation assist and the lane-keep assist system warning activation.
 - The turn switch is operated. (the steering wheel operation assist on)
 - After the turn switch is operated, the vehicle lane is changed **within 3 s.** (the steering wheel operation assist off)
 - The steering wheel is turned at a certain angle or more, and an avoidance maneuver is performed or the vehicle lane is changed.
 - The accelerator pedal is depressed a certain amount or more.
 - The brake pedal is depressed.

Note















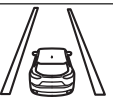










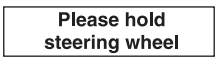
- When all of the operation conditions are met after driving, the lane-keep assist system is enabled automatically.
- If there is a malfunction in the lane-keep assist system or forward sensing camera (FSC), the lane-keep assist system turns off.
- When the lane-keep assist system is operated with the lane-keep assist system turned on, the lane-keep assist system turns off.

Note

- When the lane-keep assist system is off, the lane-keep assist system OFF indicator light is turned on.

System conditions display table

Lane-keep assist system condition	Condition	Lane-keep assist system indication	Multi-information display indication	Active driving display indication (With auto flip-up type)	Active driving display indication (With windshield type)
OFF	System off	No display	No display	No display	No display

Lane-keep assist system condition	Condition	Lane-keep assist system indication	Multi-information display indication	Active driving display indication (With auto flip-up type)	Active driving display indication (With windshield type)
ON	Vehicle lane lines are recognized on both sides at a vehicle speed of approx. 60 km/h {37 mph} or more	 GREEN			
	While warning is triggered*	 GREEN	 RIGHT SIDE  LEFT SIDE	 RIGHT SIDE  LEFT SIDE	 RIGHT SIDE  LEFT SIDE
	Vehicle speed is approx. 60 km/h {37 mph} or less	 WHITE		No display	No display
	Vehicle lane lines are not recognized or vehicle lane line is recognized on either left or right side at a vehicle speed of approx. 60 km/h {37 mph} or more	 WHITE	 BOTH SIDES  LEFT SIDE ONLY  RIGHT SIDE ONLY	No display	No display
	Forward sensing camera (FSC) detects camera fogging	 AMBER	 Front camera blocked Defog windshield completely	No display	No display
	Forward sensing camera (FSC) detects that the camera is dirty	 AMBER	 Clear outside of windshield completely	No display	No display
	Malfunction in lane-keep assist system occurred	 AMBER	Lane-keep Assist System Deactivated	No display	No display
	Malfunction in forward sensing camera (FSC) occurred	 AMBER	Front camera sensor system malfunction	No display	No display
	Driver takes his or her hands off steering wheel	 RED	Lane-keep Assist System on Hold the steering wheel		

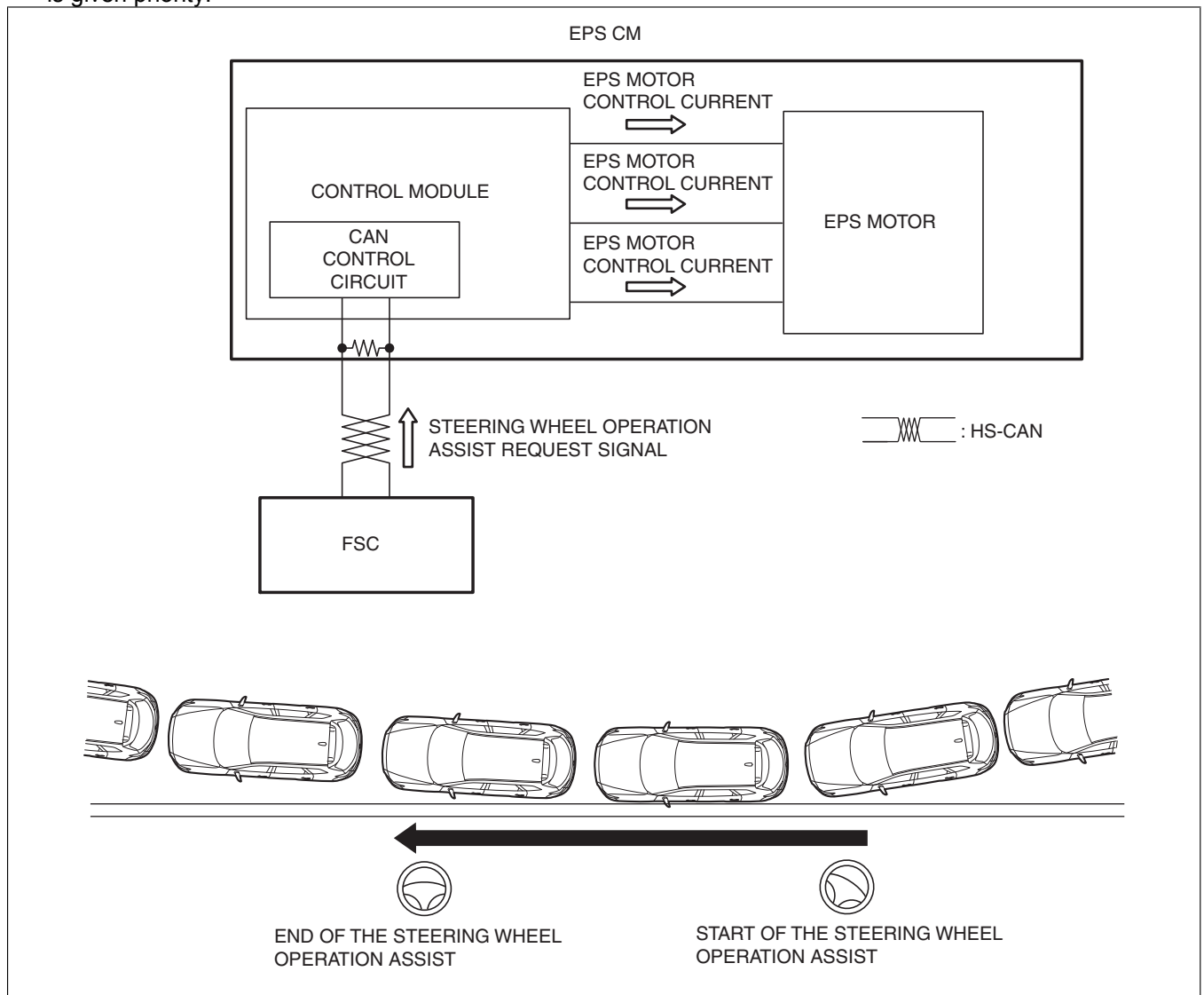
* : If the system determines that the vehicle may deviate from its lane, the color of the line on side being detected by the system changes from white to amber, and flashes.

Note

- A warning message in the center display and multi-information display are displayed. For the message content and verification method of the center display, refer to the CENTER DISPLAY. (See CENTER DISPLAY [WITH CENTER DISPLAY].)

Steering wheel operation assist

- When the vehicle approaches to white lines (yellow lines), the forward sensing camera (FSC) calculates the steering angle required for the prevention of a lane departure and outputs a steering wheel operation assist request signal to the EPS CM.
- The EPS CM energizes the EPS motor to generate assist torque (maximum 5 N·m {51 kgf·cm, 44 in·lbf}) and supplement the insufficient steering angle for the prevention of a lane departure based on the steering wheel operation assist request signal.
- When the driver performs the prevention operation during steering wheel operation assist, the driver's operation is given priority.

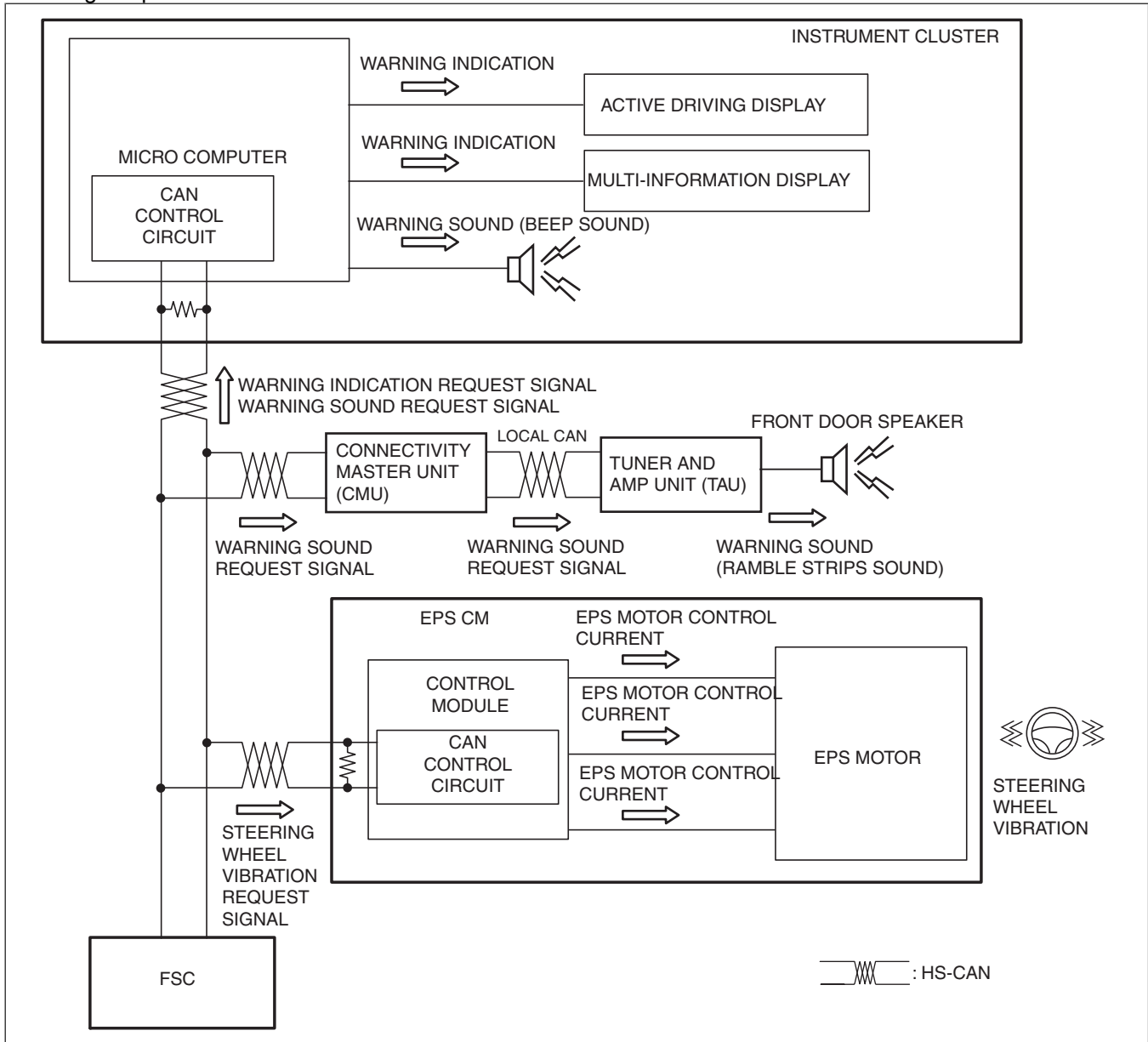


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Lane departure warning

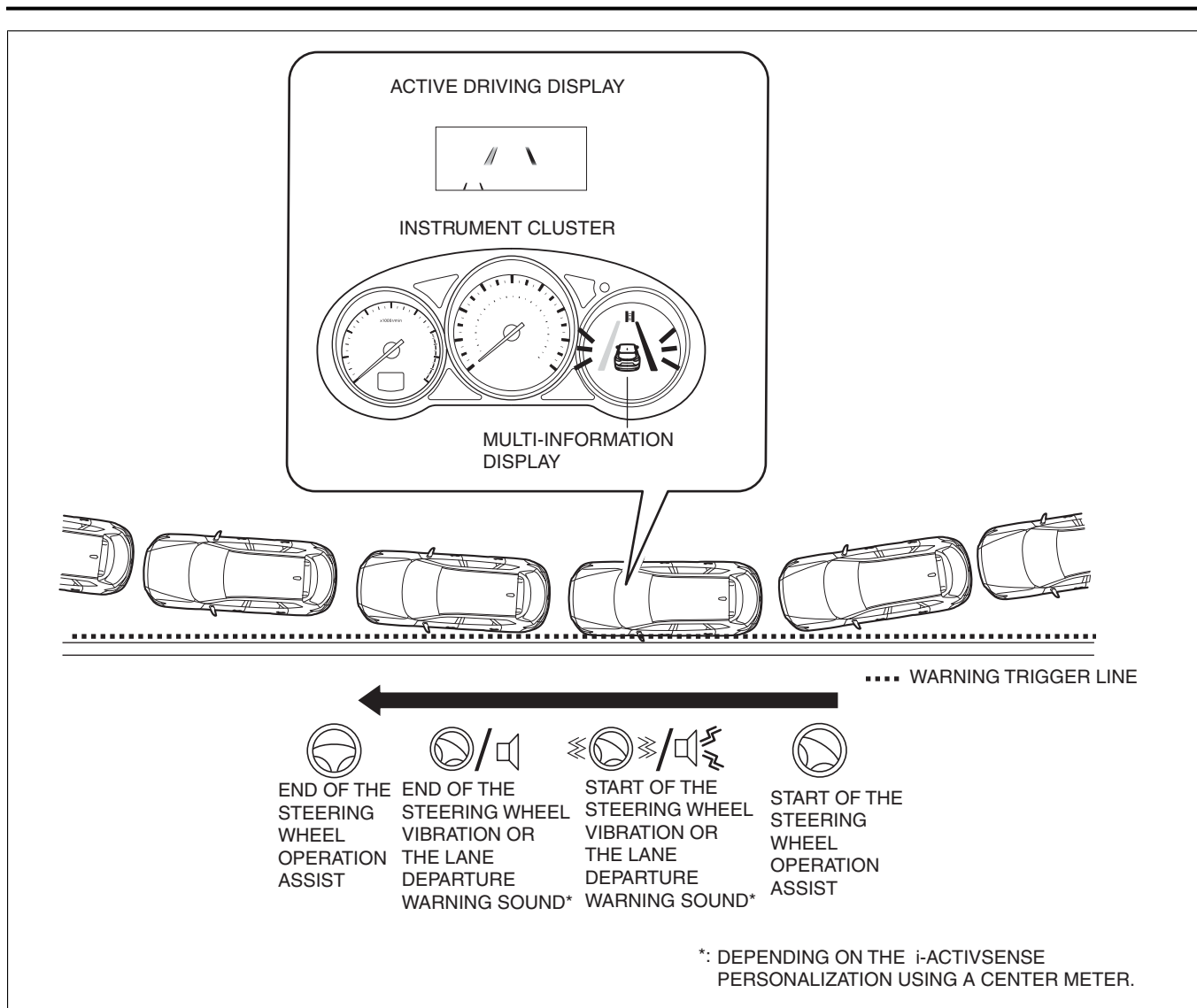
- When the vehicle contacts warning-trigger line, a lane departure warning triggers for **0.5 s**. For details on the warning-trigger line, refer to the [FORWARD SENSING CAMERA (FSC)]. (See FORWARD SENSING CAMERA (FSC).)
- If the warning is triggered one time, the warning will not trigger again until the vehicle travels within the warning-trigger lines for a period of 3 s (If steering wheel operation assist is turned off, the warning will not trigger again until the vehicle travels within the warning-trigger lines for a period of 1.5 s.).
- If the forward sensing camera (FSC) determines that the vehicle has contacted a warning-trigger line, it sends a warning indication request signal to the instrument cluster.

- When the instrument cluster receives the warning indication request signal, it displays the warning screen in the active driving display or the multi-information display.
- The forward sensing camera (FSC) sends the following signals according to the type of the warning-trigger set using the personalization feature.



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- Steering wheel vibration
 - A steering wheel vibration request signal is sent to the EPS CM.
 - When the EPS CM receives the steering wheel vibration request signal, it energizes the EPS motor to vibrate the steering wheel.
- Rumble strip sound
 - A warning sound request signal is sent to the connectivity master unit (CMU).
 - When the CMU receives the warning sound request signal, it sends the warning sound request signal to the tuner and amp unit (TAU). The TAU outputs the rumble strip sound from the front left or right door speaker.
- Beep sound
 - A warning sound request signal is sent to the instrument cluster.
 - When the instrument cluster receives the warning sound request signal, it operates the buzzer built into the instrument cluster. For the buzzer operation, refer to the [LANE DEPARTURE WARNING SOUND]. (See LANE DEPARTURE WARNING SOUND.)



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Note

- When the forward sensing camera (FSC) can detect either left or right white line (yellow line), the lane-keep assist system is performed. However, the steering wheel operation assist and warning cannot be activated only when the vehicle deviates on the side where the white line (yellow line) is being detected.
- The timing at which the steering wheel operation assist is performed and the lane-keep assist system warning is activated varies.
- If the driver takes his or her hands off the steering wheel, alarm sound is activated and a message is indicated in the multi-information display. For the message, refer to the system conditions indication table.