05IN6–01

DESCRIPTION

1. GENERAL

The following changes have been made to the air conditioner system:

- An ES18 type Electric Inverter Compressor has been newly adopted. This compressor is driven by an alternating current provided by the A/C inverter, which is built into the inverter of the hybrid system. As a result, the air conditioning system is actuated without depending on the operation of the engine, thus realizing a comfortable air conditioning system and low fuel consumption.
- A blower motor controller, which regulates the speed of the blower motor by controlling the output voltage in accordance with the duty cycle signal provided by the A/C amplifier, has been newly adopted. As a result, the power loss associated with the heat generation of the conventional blower linear controller has been reduced, thus realizing low fuel consumption.
- A humidity sensor function has been added to the room temperature sensor in order to optimize the amount of dehumidification effort during the operation of the air conditioning system.
- A compact, lightweight, and highly efficient SFA–II (Straight Flow Aluminum–II) heater core has been adopted on the RHD models. As in the past, the LHD models use the SFA (Straight Flow Aluminum) heater core.
- A compact, lightweight and highly efficient RS (Revolutionary Slim) evaporator has been adopted.
- A compact, lightweight and highly efficient MF–IV (Multi Flow–IV) condenser has been adopted.
- A compact, lightweight, and highly efficient electrical water pump has been adopted in order to ensure the proper heater performance while the engine is stopped.
- Fuzzy control has been adopted for calculating the required outlet air temperature (TAO: Temperature Air Outlet) and the blower volume in the automatic air conditioning control system. Accordingly, the air conditioning ECU is able to calculate the outlet air temperature, blower volume, air outlet, and compressor speed that is suited to the operating environment. As a result, the comfort level of the occupants has been improved.
- On the previous model, the air conditioner was controlled at the heater control panel. This control operation has been changed to the air conditioner screen display on the multi display and the steering pad switch, in order to improve the case of use.

2. AIR CONDITIONING OPERATION

- On the previous Prius, the air conditioner was controlled at the air conditioner control panel. On the new Prius, this control operation has been changed to the switches that appear on the air conditioner screen display of the multi display and the switches provided on the steering pad.
- In addition to the air conditioner screen display, the operating conditions of the AUTO, RECIRCULATION, front DEF, and rear DEF switches are indicated by the indicator lights in the combination meter.

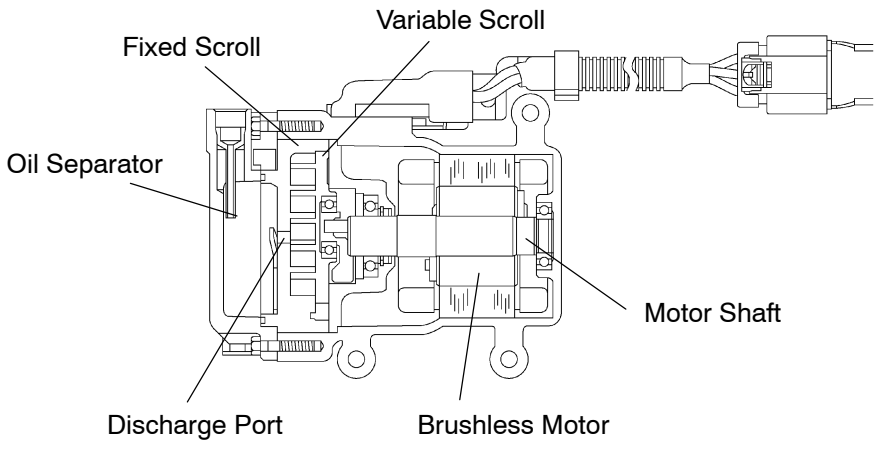
3. HEATER CORE AND PTC HEATER

- A compact, lightweight, and highly efficient SFA–II (Straight Flow Aluminum–II) heater core has been adopted on the RHD models. As in the past, the LHD models use the SFA (Straight Flow Aluminum) heater core.
- The SFA–II heater core is the same straight flow (full–path flow) type heater core as the conventional SFA heater core. However, the SFA–II heater core has adopted a close–packed heater core structure to realize a compact and high–performance heater core.
- The two PTC (Positive Temperature Coefficient) heaters have been built into the heater core, and this heater core is offered as and option on the European LHD models.
- The PTC heater contains electrodes that are interposed with a PTC element, to which current is applied in order to warm the air that passes thought the fin. For details, PTC heater control on see page 05–1139.
- As optional equipment on the European LHD models, PTC heater has been provided in the air duct at the footwell outlet in front of the air conditioner unit. This PTC heater, which is a honeycombshaped PTC thermistor, directly warms the air that flows in the duct.

4. COMPRESSOR

- Instead of the SCS06 scroll compressor that is actuated by the engine on the previous Prius, the new Prius has newly adopted and ES18 Electric Inverter Compressor that is actuated by a built–in electric motor. Except for the portion that is actuated by the electric motor, the basic construction and operation of this compressor are the same as in the scroll compressor used on the previous Prius.
- The electric motor is actuated by the alternating current power (201.6 V) supplied by the A/C inverter, which is integrated in the hybrid system inverter. As a result, the air conditioning control system on the new Prius is actuated without depending on the operation of the engine, thus realizing a comfortable air conditioning system and low fuel consumption.
- Due to the adoption of an electrical inverter compressor, the compressor speed can be controlled at the required speed calculated by the A/C amplifier. Thus, the cooling and dehumidification performance and power consumption have been optimized.
- Low–moisture permeation hoses have been adopted for the suction and discharge hoses at the compressor in order to minimize the entry of moisture into the refrigeration cycle.
- The compressor uses high–voltage alternating current. If a short or open circuit occurs in the compressor wiring harness, the hybrid control ECU will cut off the A/C inverter circuit in order to stop the power supply to the compressor.
- For details on the electric compressor control effected by the A/C amplifier.
- The Electric Inverter Compressor consists of a spirally wound fixed scroll and variable scroll that form a pair, a brushless motor, an oil separator, and a motor shaft.
- The fixed scroll is integrated with the housing. Because the rotation of the shaft causes the variable scroll to revolve while maintaining the same posture, the volume of the space that is partitioned by both scrolls varies to perform the suction, compression, and the discharge of the refrigerant gas.
- Locating the suction port directly above the scrolls enables direct suction, thus realizing improved suction efficiency.
- Containing a built–in oil separator, this compressor is able to separate the compressor oil that is intermixed with the refrigerant and circulates in the refrigeration cycle, thus realizing a reduction in the oil circulation rate.

HINT:
In order ensure the proper insulation of the internal high–voltage portion of the compressor and the compressor housing, the new Prius has adopted a compressor oil (ND–OIL11) with a high level of insulation performance. Therefore, never use a compressor oil other than the ND–OIL11) type compressor oil or its equivalent.



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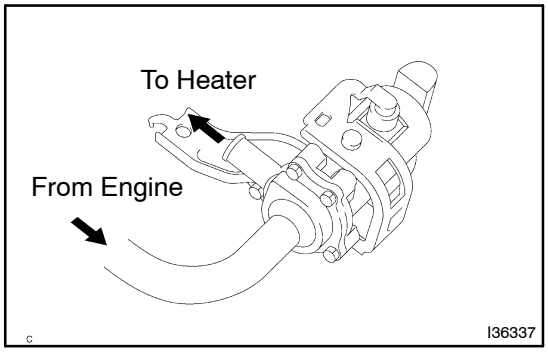


5. WATER PUMP

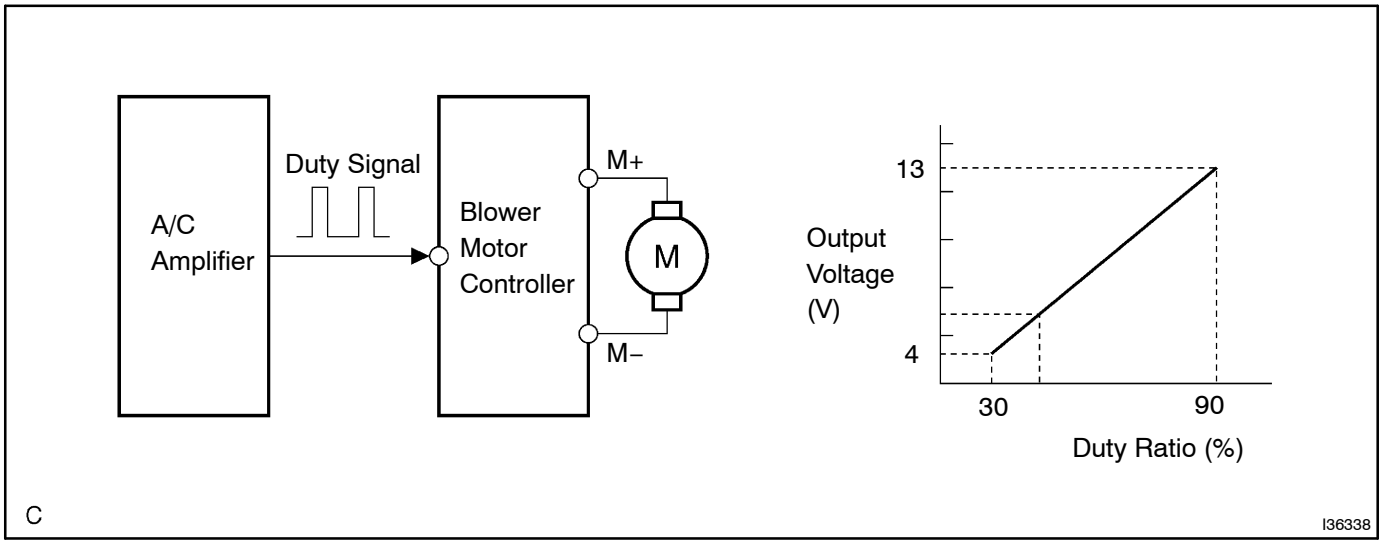
- Same as the previous Prius, an electrical water pump has been adopted. This provides a stable heater performance even if the engine is stopped because of a function of the THS–II.
- The New Prius has adopted a new type of electrical water pump in which the water flow resistance has been reduced. As a result, the bypass valve that was used on the previous Prius has been discontinued.

6. ROOM TEMPERATURE SENSOR AND HUMIDITY SENSOR

- A humidity sensor function has been added to the room temperature sensor. By enabling the detection of humidity in the vehicle interior, this function optimizes the amount of dehumidification effort during the operation of the air conditioning system. As a result, the power consumption of the compressor has been reduced and a comfortable level of humidity has been realized in the vehicle interior.
- The humidity–sensing resistance film that is built into the humidity sensor absorbs and releases the humidity in the vehicle interior. During the absorption and releasing processes, the humidity–sensing resistance film expands (during the absorption of humidity) and contracts (during drying). The clearance between the carbon particles in the humidity–sensing resistance film expands and contracts during absorption and drying, thus changing the resistance between the electrodes. The A/C amplifier determines the humidity in the vehicle interior through the changes in the output voltage of the humidity sensor that are caused by the resistance between the electrodes.

7. BLOWER MOTOR CONTROLLER

The blower pulse controller controls the voltage that is output to the blower motor in accordance with the duty cycle signals that are input by the A/C amplifier. It is characterized by a smaller amount of heat generation than the blower controller used on the previous model. As a result, the power loss associated with the heat generation of the conventional blower linear controller has been reduced, thus realizing low fuel consumption.



8. A/C AMPLIFIER

The A/C amplifier has the following controls.

Control		Outline
Fuzzy Control		The fuzzy control determines the conformity levels of the temperature deviation, ambient temperature, and solar radiation by defining their respective mathematical functions. In addition by defining their respective mathematical functions. In addition, a fuzzy calculation method is used to calculate the required outlet air temperature (TAO) and the blower volume. Based on these calculations, the A/C amplifier effects the respective controls for the outlet air temperature, blower volume, compressor, and air outlet.
Outlet Air Temp. Control	Air Mix Damper Control	In response to the temperature control switch setting, the required outlet air temperature, evaporator temperature sensor, and engine coolant temperature sensor compensations are used by the air mix control damper control to calculate a tentative damper opening angle, through an arithmetic circuit in the air mix damper, to arrive at a target damper opening angle.
Blower Control	Blower Motor Start Up Control	When the blower motor is started up, the A/C amplifier transmits a blower motor actuation signal with a low duty cycle ratio to the blower pulse controller, which applies a low voltage to the blower motor, in order to operate the blower motor for 3 seconds at a low speed. This is designed to protect the blower pulse controller from a sudden start–up voltage surge.
	Manual Control	Sets the blower speed according to operation of the blower switch.
	Automatic Control	**Step Less Air Volume Control:** • When the AUTO switch located on the steering pad switch is pushed, or the air conditioning screen display of the multi display is touched, the A/C amplifier automatically regulates the duty ratio to the blower pulse controller in accordance with a calculation result by the fuzzy control in order to deliver step less air volume. **Warm–up Control:** • When the air outlet is in the FOOT, BI–LEVEL, or FOOT/DEF mode, the blower will not operate until the engine coolant temperature increases above a prescribed value. When the temperature increases above a prescribed value, the blower motor operates at the LO speed. **Time–Lagged Air Flow Control:** • 2 types of time–lagged air flow control (in accordance with the detected by the evaporator temperature sensor) help prevent hot air from being emitted from FACE or BI–LEVEL vent. **Sunlight Air Flow Control:** • Controls the blower speed in accordance with the intensity of the sunlight when the air outlet mode is at FACE or BI–LEVEL. The blower speed can be adjusted in response to the signal received from the solar sensor.
Air Outlet Control	Manual Control	Changes the air outlet in accordance with the selected position of the mode select switch.
	Automatic Control	**Mode Damper Switching Servomotor Control:** • When the AUTO switch is pushed, automatic control causes the mode servomotor to rotate to a desired position in accordance with the target damper opening, which is based on the calculation of the TAO. **Low–Temperature FOOT/DEF Control:** • In accordance with the engine coolant temperature, ambient temperature, amount of sunlight, required outlet temperature (TAO), and vehicle speed conditions, this control automatically switches the blower outlet between the FOOT/DEF modes to prevent the window from becoming fogged when the outside air temperature is low.

(Continued)

Control		Outline
Air Inlet Control	Manual Control	Drives the air inlet servomotor according to the operation of the air inlet control switch and fixes the dampers in the FRESH or RECIRC position.
	Automatic Control	**Automatic RECIRC/FRESH control:** • When the AUTO switch is pressed, the system controls the servo motor in order to achieve the air inlet that has been calculated in accordance with the TAO. **DEF Mode Control:** • When switching the mode switching switch to DEF mode, A/C amplifier turns A/C mode ON forcibly and switched to FRESH mode when the ambient temperature is less than the specified temperature.
2–Way Flow Mode Control		At the time of selecting FRESH mode, A/C amplifier will judge it as 2–way flow mode when the blower outlet is selected to FOOT or FOOT/DEF, the tentative air mix damper opening angle is above the specified value (MAX HOT), and either the blower volume is more than the specified volume or the vehicle speed is less than the specified speed.
Half Inlet Air Mode Control		At the time of selecting FRESH mode, A/C amplifier will judge it as half inlet air mode when the blower outlet mode is selected to FACE or BI–LEVEL and TAO is more than the specified temperature, and operates both outlet air introduction and inlet air circulation at the same time.
Electric Inverter Compressor Control	Electric Inverter Compressor Speed Control	• The A/C amplifier calculates target compressor speed of the compressor based on the target evaporator temperature (which is calculated by the room temperature sensor, humidity sensor, ambient temperature sensor, and the solar sensor) and the actual evaporator temperature that is detected by the evaporator temperature sensor in order to control the compressor speed. • The A/C amplifier calculates the target evaporator temperature, which includes corrections based on the vehicle interior humidity (which is obtained from the humidity sensor) and the windshield glass inner surface humidity (which is calculated from the humidity sensor, solar sensor, room temperature sensor, mode damper position, and wiper operation condition). Accordingly, the A/C amplifier controls the compressor speed to an extent that would not inhibit the proper cooling performance or defogging performance.
Electrical Water Pump Control		When the blower motor is ON and the engine has been stopped by the hybrid control, the A/C amplifier turns ON the Electric water pump in accordance with the judgment of the air mix damper opening.
Engine Start Request Control		To ensure the proper heater performance when the hybrid system is started at low temperatures, the A/C amplifier transmits an engine start request to the hybrid control ECU in accordance with the TAO, engine coolant temperature sensor signal, and ambient temperature sensor signal.

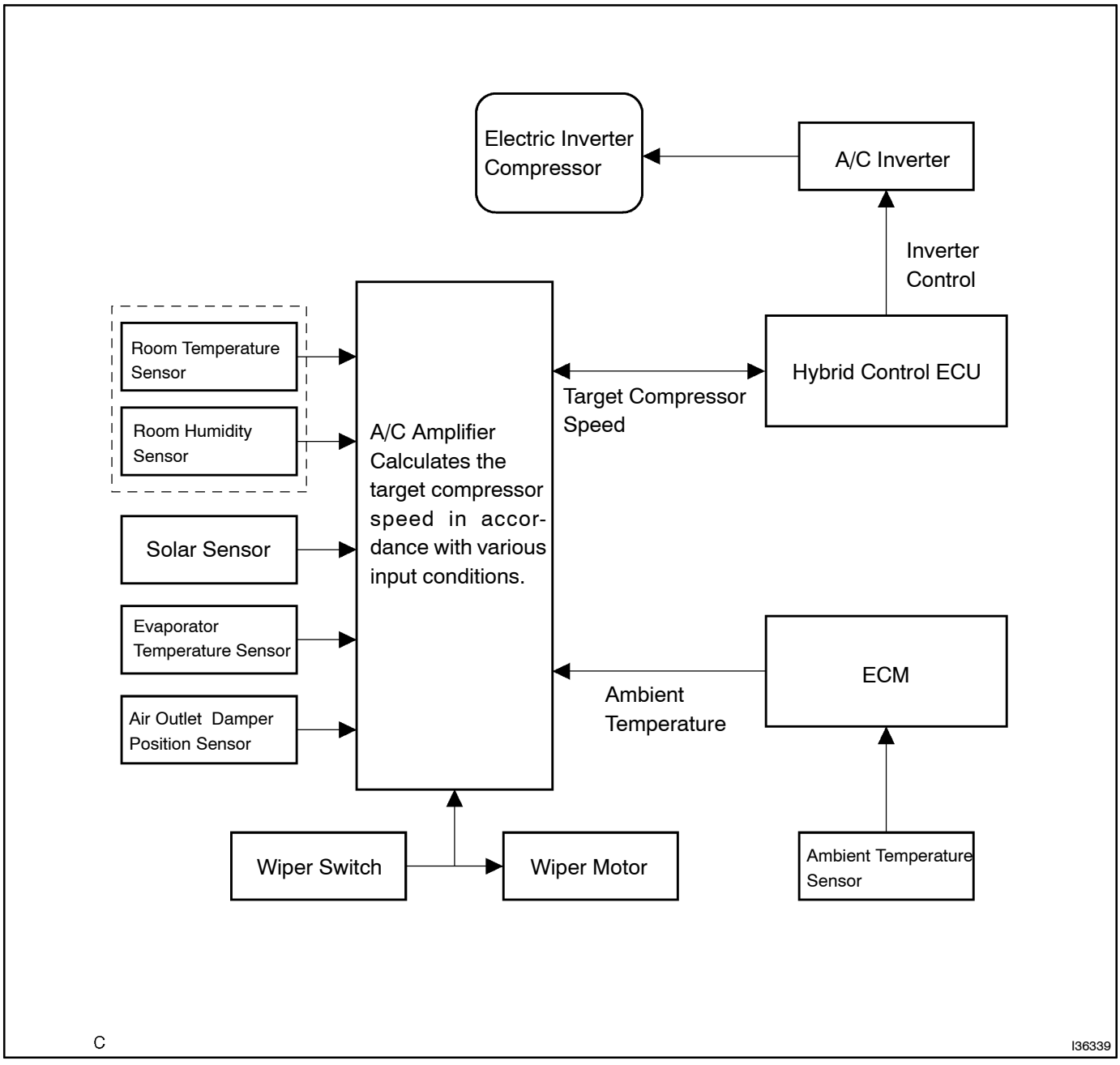
(Continued)

Control	Outline
PTC Heater Control (*1)	When the hybrid system is operating (READY) and the blower motor is turned ON, the A/C amplifier turns on the PTC heater if the conditions listed below are met. **Heater core integrated PTC Heater** • Air outlet is in the FOOT, FOOT/DEF or DEF mode. • Engine coolant temperature is below specified temperature. • Ambient temperature is below specified temperature. (DEF mode) • Tentative air mix damper opening angle is above the specified value. (MAX HOT) **Footwell air duct integrated PTC heater** • Air outlet is in the FOOT or FOOT/DEF mode. • Engine coolant temperature is below specified temperature. • Tentative air mix damper opening angle is above the specified value. (MAX HOT)
Electric Cooling Fan Control	The A/C amplifier controls the cooling fan in accordance with the vehicle speed signal, and compressor speed signal.
Rear Window Defogger Control	Switches the rear defogger and outside rear view mirror heaters on for 15 minutes when the rear defogger switch is switched on. Switches them off if the switch is pressed while they are operating.
Outer Temperature Indication Control	Based on the signals from the ambient temperature sensor, this control calculates the outside temperature, which is then corrected in the air conditioning ECU, and shown in the multi display.
Self–Diagnosis	Checks the sensor and A/C inverter in accordance with operation of the air conditioning switches, then heater control panel display portion display portion a DTC (Diagnosis Trouble Code) to indicate if there is a malfunction or not. (sensor check function)
	Drives the actuators through a predetermined sequence in accordance with the operation of the air conditioner switches. (actuator check function)

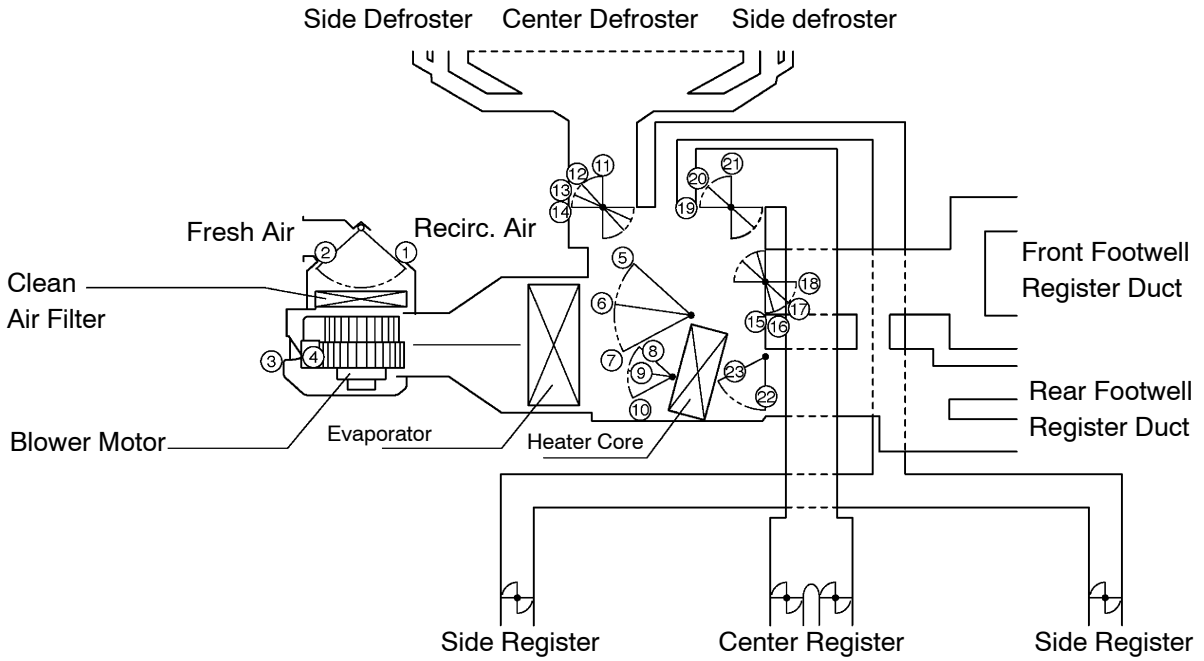
(*1): Optional equipment for Europe LHD models

9. ELECTRIC INVERTER COMPRESSOR CONTROL

- The A/C amplifier calculates the target compressor speed based on the target evaporator temperature (calculated from the room temperature sensor, humidity sensor, ambient temperature sensor, and solar sensor) and the actual evaporator temperature detected by the evaporator temperature sensor. Then, the A/C amplifier transmits the target speed to the hybrid control ECU. The hybrid control ECU controls the A/C inverter based on the target speed data in order to control the compressor to a speed that suits the operating condition of the air conditioning system.
- The A/C amplifier calculates the target evaporator temperature, which includes corrections based on the vehicle interior humidity (which is obtained from the humidity sensor) and the windshield glass inner surface humidity (which is calculated from the humidity sensor, solar sensor, room temperature sensor, mode damper position, and wiper operation condition). Accordingly, the A/C amplifier controls the compressor speed to an extent that does not inhibit the proper cooling performance or defogging performance. As a result, comfort and low fuel consumption can be realized.



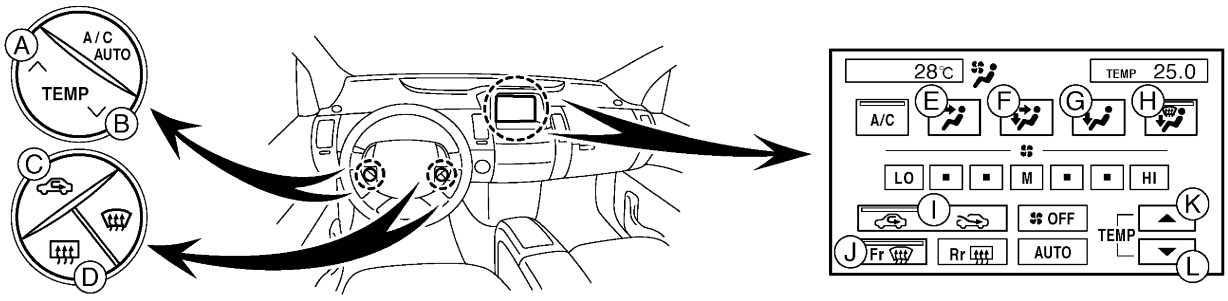
10. MODEL POSITION AND DAMPER OPERATION



Control Damper	Control Position	Damper Position	Operation
Air Inlet Control Damper	Ⓒ or Ⓘ Indicator OFF	① ③	Brings in fresh air.
		② ④	Brings in fresh air while circulating internal air.
	Ⓒ or Ⓘ Indicator ON	② ④	Circulates internal air.
Air Mix Control Damper	ⒶⒷ or ⓀⓁ	⑤ ⑧ to ⑥ ⑨ to ⑦ ⑩	Varies the mix ratio of warm and cool air in order to regulate the temperature continuously from WARM to COOL.
Mode Control Damper	Ⓓ or Ⓙ (DEF)	⑪ ⑰ ⑲ ㉒	Defrosts the window through the front defroster, side defrosters and side registers.
	Ⓗ (F / D)	⑫ ⑰ ⑲ ㉒ (⑪ ⑮ ⑲ ㉓) *1	Defrosts the window through the front defroster, side defrosters and side registers while warm air is also blown out to warm the footwell area.
	Ⓖ (FOOT)	⑬ ⑱ ⑲ ㉒ (⑫ ⑰ ⑲ ㉓) *1	Air is blown out of the footwell ducts and side registers.
	Ⓕ (B / L)	⑭ ⑰ ⑳ ㉒	Air is blown out of the footwell ducts and center and side registers.
	Ⓔ (FACE)	⑭ ⑮ ㉑ ㉒ (⑭ ⑯ ㉑ ㉒) *2	Air is blown out of the center and side registers.

*1: During 2–way flow control

*2: Early stage of COOL during AUTO



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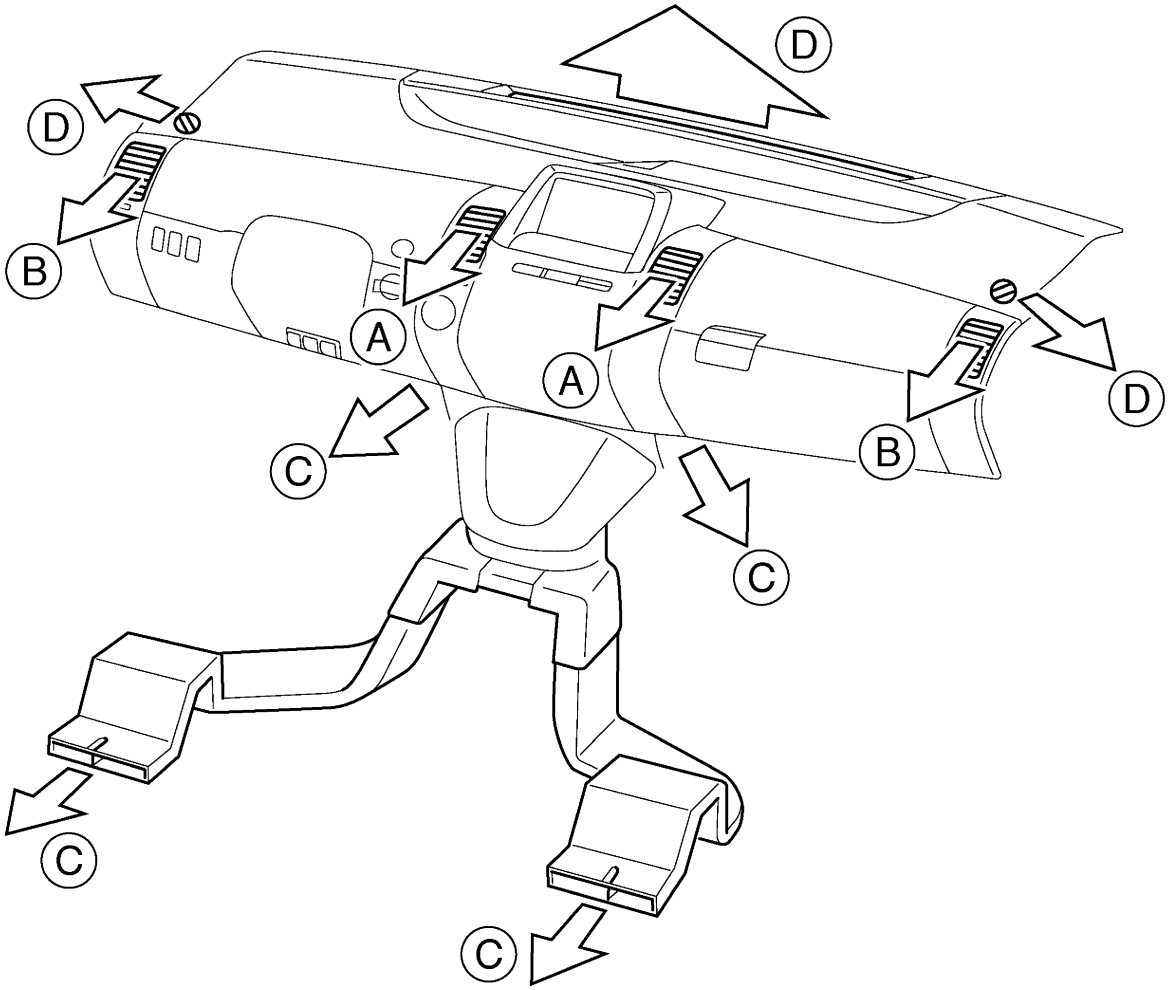
11. AIR OUTLETS AND AIR VOLUME RATIONS



AIR OUTLET / MODE	A Center Face	B Side Face	C Foot	D Defroster
FACE	○	○	— (○) *1	—
B / L	○	○	○	—
FOOT	—	○	○	○ (—) *2
F / D	—	○	○	○
DEF	—	○	—	○

HINT:

1. (○) indicates airflow and its size indicates the proportion of airflow volume.
2. (–) indicates that air is not blown out.
3. *1: Early stage of COOL during AUTO
4. *2: On Australia models, the defroster does blow air if FOOT is manually selected.

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