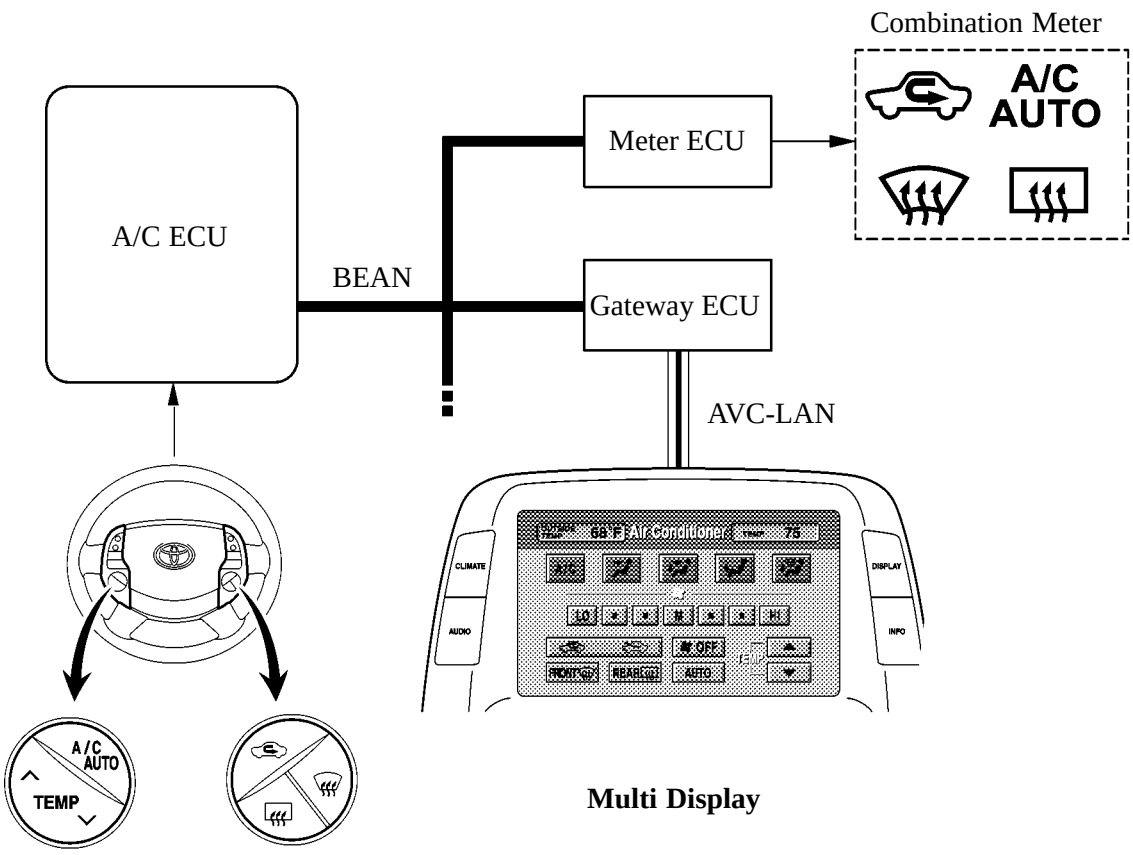
■CONSTRUCTION AND OPERATION

1. Air Conditioning Operation

- On the ’03 Prius, the air conditioning was controlled at the air conditioning control panel. On the ’04 Prius, this control operation has been changed to the switches that appear on the air conditioning screen display of the multi display and the switches provided on the steering pad.
- In addition to the air conditioning 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.



Steering Pad Switch **Multi Display**

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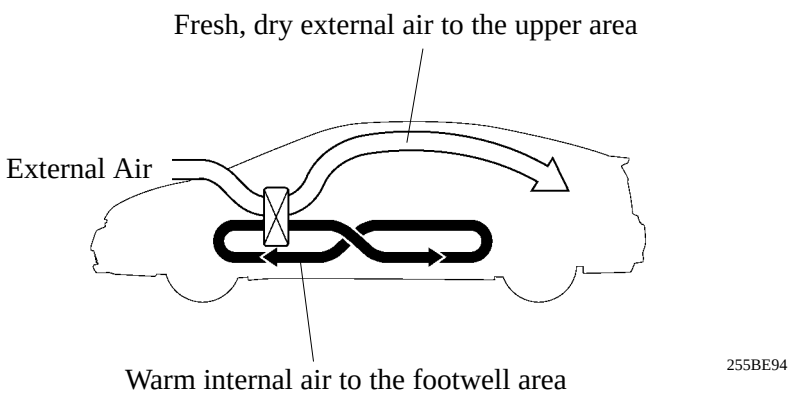
2. Air Conditioning Unit

General

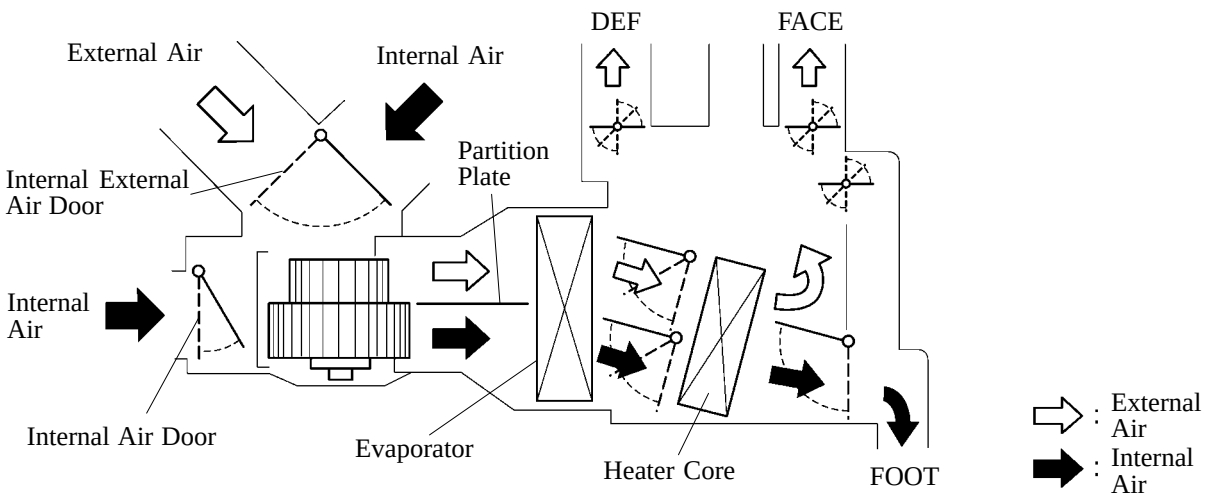
- A semi-center location air conditioning unit, in which the evaporator and heater core are placed in the vehicle's longitudinal direction, has been adopted.
- A 2-way flow type air conditioning unit that changes the 2-way flow operation if specified conditions are met, is adopted. Under 2-way flow operation, the system introduces external air and internal air simultaneously, discharges warm internal air to the foot area, and the fresh, dry external air to the upper area. Thus, it realizes both excellent heating performance and demisting performance. For details, 2-way flow control on see page BE-107.



Construction

A partition plate divides the inside of the air conditioning unit into two (External and internal air passages) parts. Thus, by controlling the external air door and the internal air door separately, the external and internal airs are introduced into the cabin in the following three modes.

- FRESH AIR
- RECIRC AIR
- BI-LEVEL, FRESH AIR/ RECIRC AIR (2-way flow)

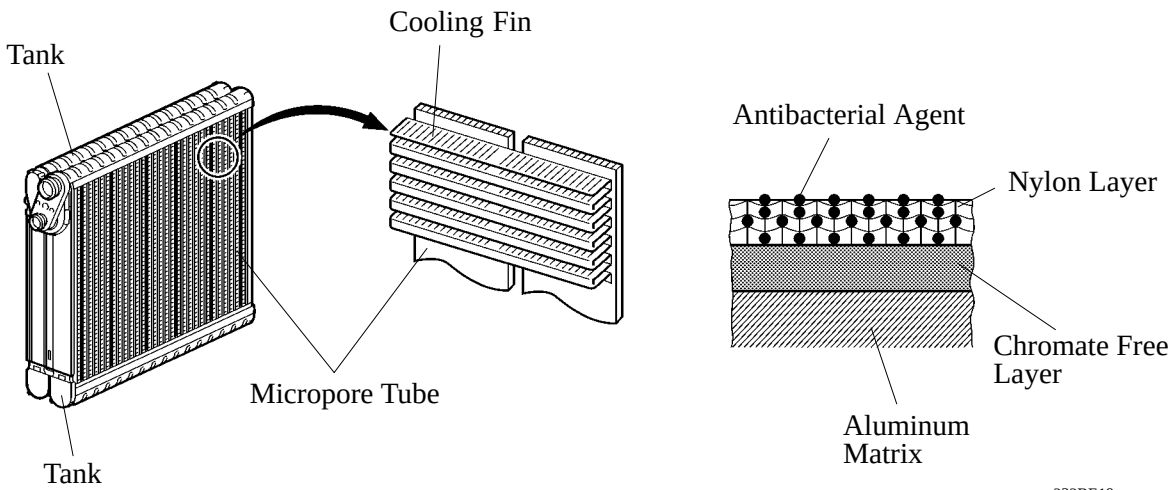


Evaporator

- An RS (Revolutionary Slim) evaporator has been adopted.
- By placing the tanks at the top and the bottom of the evaporator unit and adopting a micropore tube construction, the following effects have been realized:

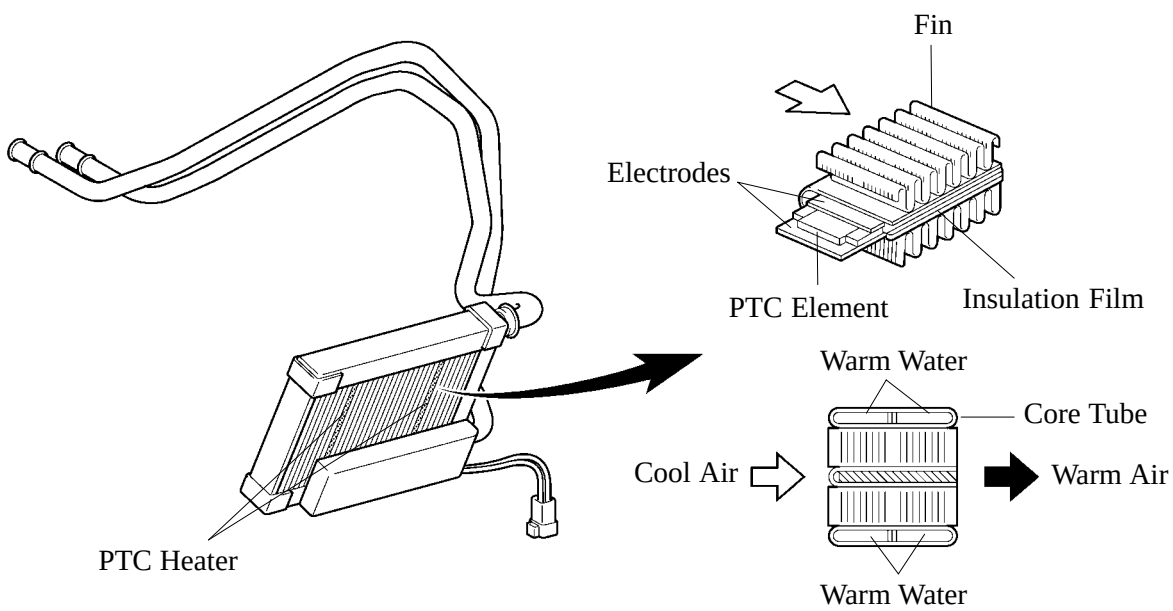
  a) The heat exchanging efficiency has been improved.
  b) The temperature distribution has been made more uniform.
  c) The evaporator has been made thinner. 58 mm (2.3 in.) → 38 mm (1.5 in.)

- The evaporator body has been coated with a type of resin that contains an antibacterial agent in order to minimize the source of foul odor and the propagation of bacteria. The substrate below this coating consists of a chromate-free layer to help protect the environment.



Heater Core and PTC Heater

- A compact, lightweight, and highly efficient straight flow (full-path flow) aluminum heater core is used. A PTC (Positive Temperature Coefficient) heater has been built into the heater core tube.
- 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 through the fin. For details, PTC heater control on see page BE-108.



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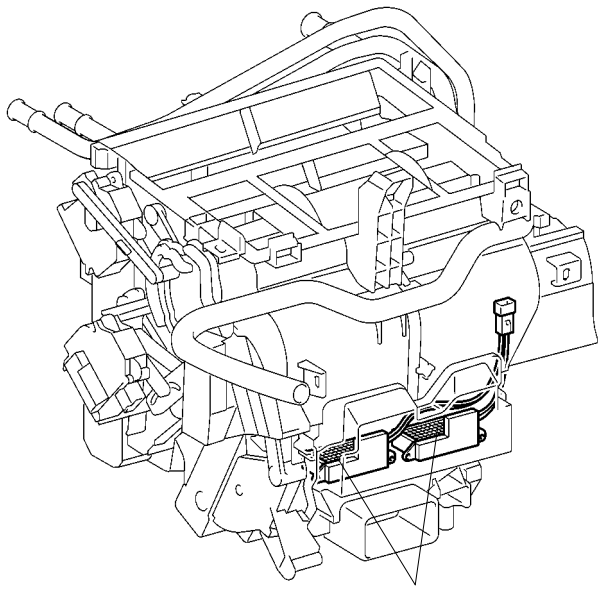
- PTC heater has been provided in the air duct at the footwell outlet in front of the air conditioning unit. This PTC heater, which is a honeycombshaped PTC thermistor, directly warms the air that flows in the duct.



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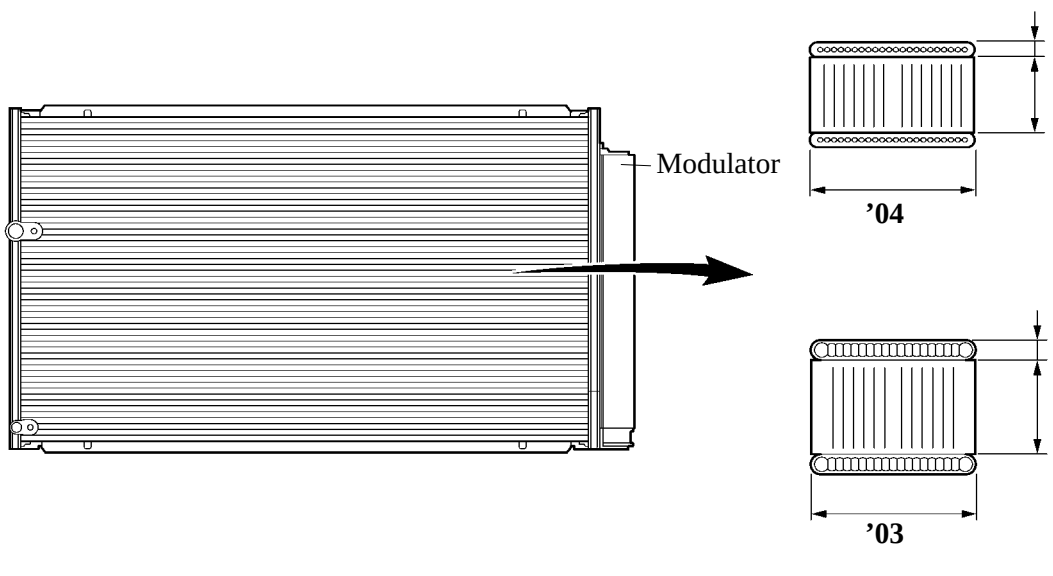
PTC Heaters

3. Condenser

General

- The ’04 Prius retains the sub-cool condenser from the ’03 Prius. However, in the ’04 Prius the condenser core has been made more minute and the refrigerant volume reduced.
- This condenser has adopted a sub-cool cycle for its cooling cycle system to improve heat-exchanging efficiency.



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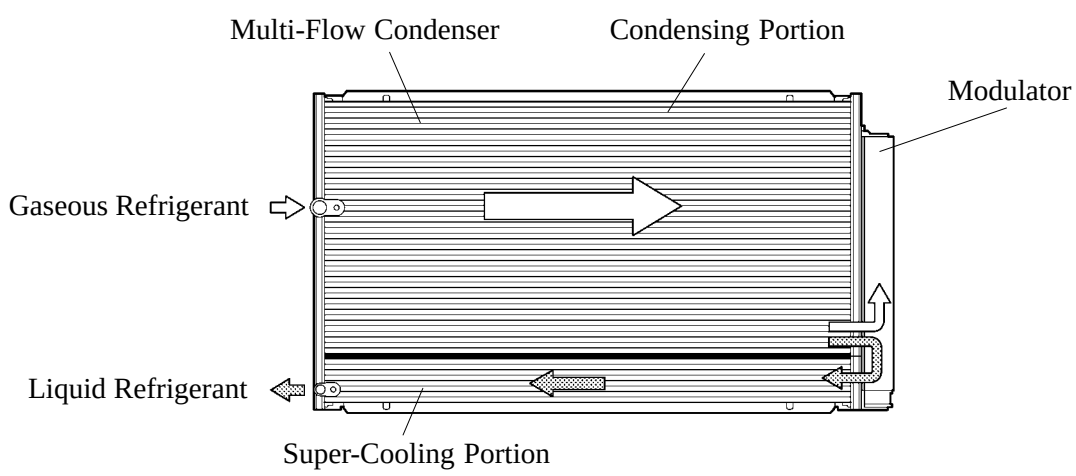
Sub-Cool Cycle

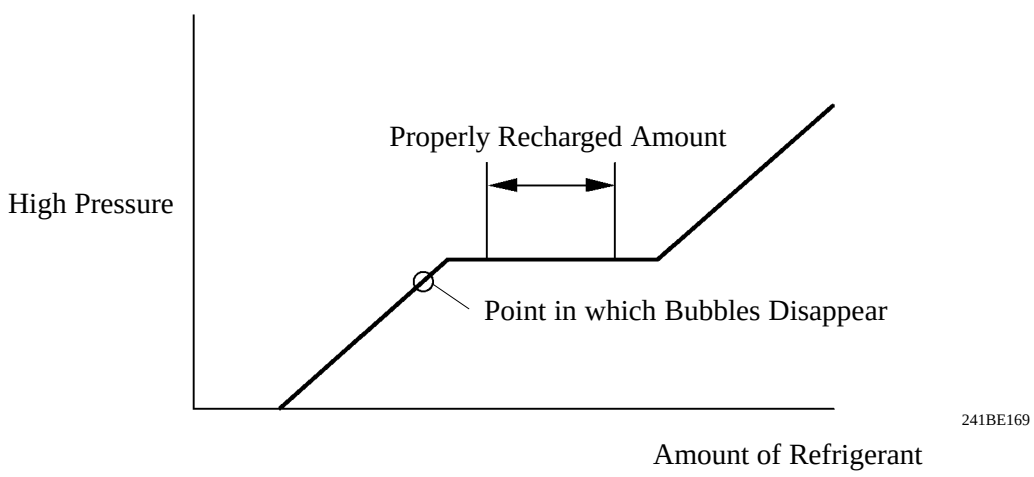
The sub-cool cycle consists of the condensing portion and the super-cooling portion, and has the gas-liquid separator (modulator) located between the two portions. A liquid refrigerant passed though the modulator is cooled again in the super-cooling portion to increase energy of the refrigerant itself, thus high-efficiency of the cooling performance is provided.



Service Tip

The point at which the air bubbles disappear in the refrigerant of the sub-cool cycle is lower than the proper amount of refrigerant with which the system must be filled. Therefore, if the system recharged with refrigerant based on the point at which the air bubbles disappear, the amount of refrigerant would be insufficient. As a result, the cooling performance of the system will be affected. If the system is overcharged with refrigerant, this will also lead to a reduced performance.

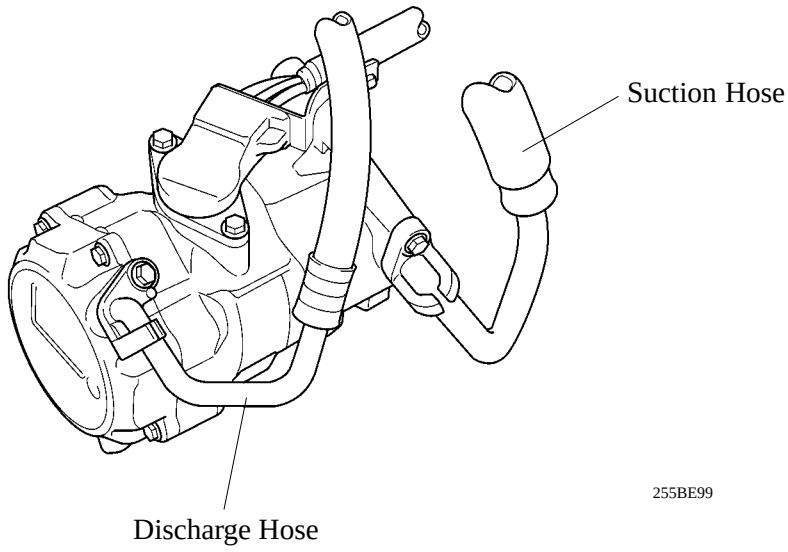
For the proper method of verifying the amount of the refrigerant and to recharge the system with refrigerant, see the 2004 Prius Repair Manual (Pub. No. RM1075U).



4. Compressor

General

- Instead of the SCS06 scroll compressor that is actuated by the engine on the ’03 Prius, the ’04 Prius has newly adopted an 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 ’03 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 ’04 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 electric inverter compressor, the compressor speed can be controlled at the required speed calculated by the A/C ECU. 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 HV ECU will cut off the A/C inverter circuit in order to stop the power supply to the compressor.
- For details on the Electric Inverter Compressor control effected by the A/C ECU, see page BE-110.

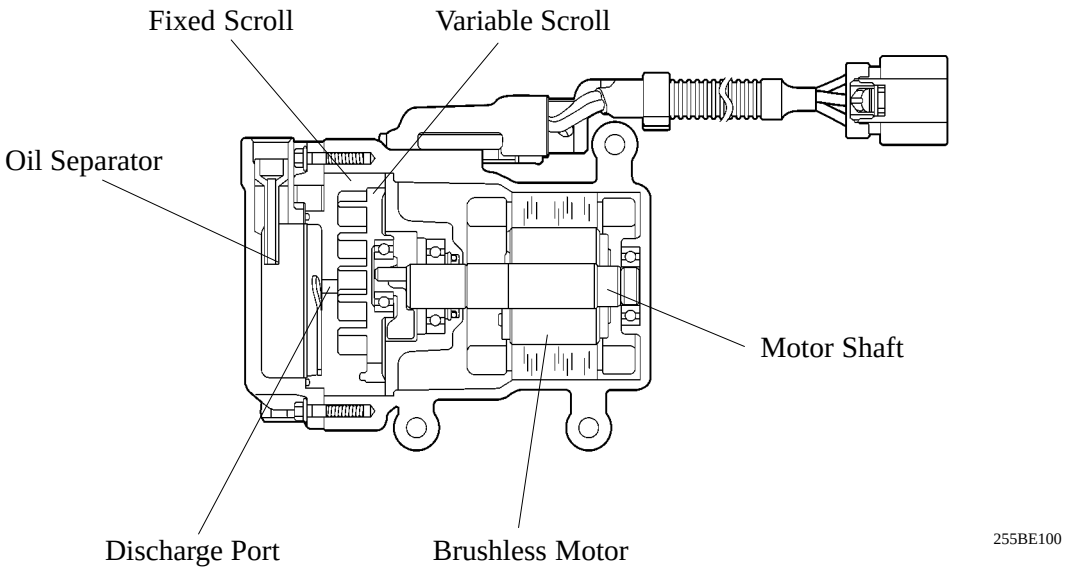


Service Tip

In order ensure the proper insulation of the internal high-voltage portion of the compressor and the compressor housing, the ’04 Prius has adopted a compressor oil (ND11) with a high level of insulation performance. Therefore, never use a compressor oil other than the ND11 type compressor oil or its equivalent.

Construction

- 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.



Operation

1) Suction

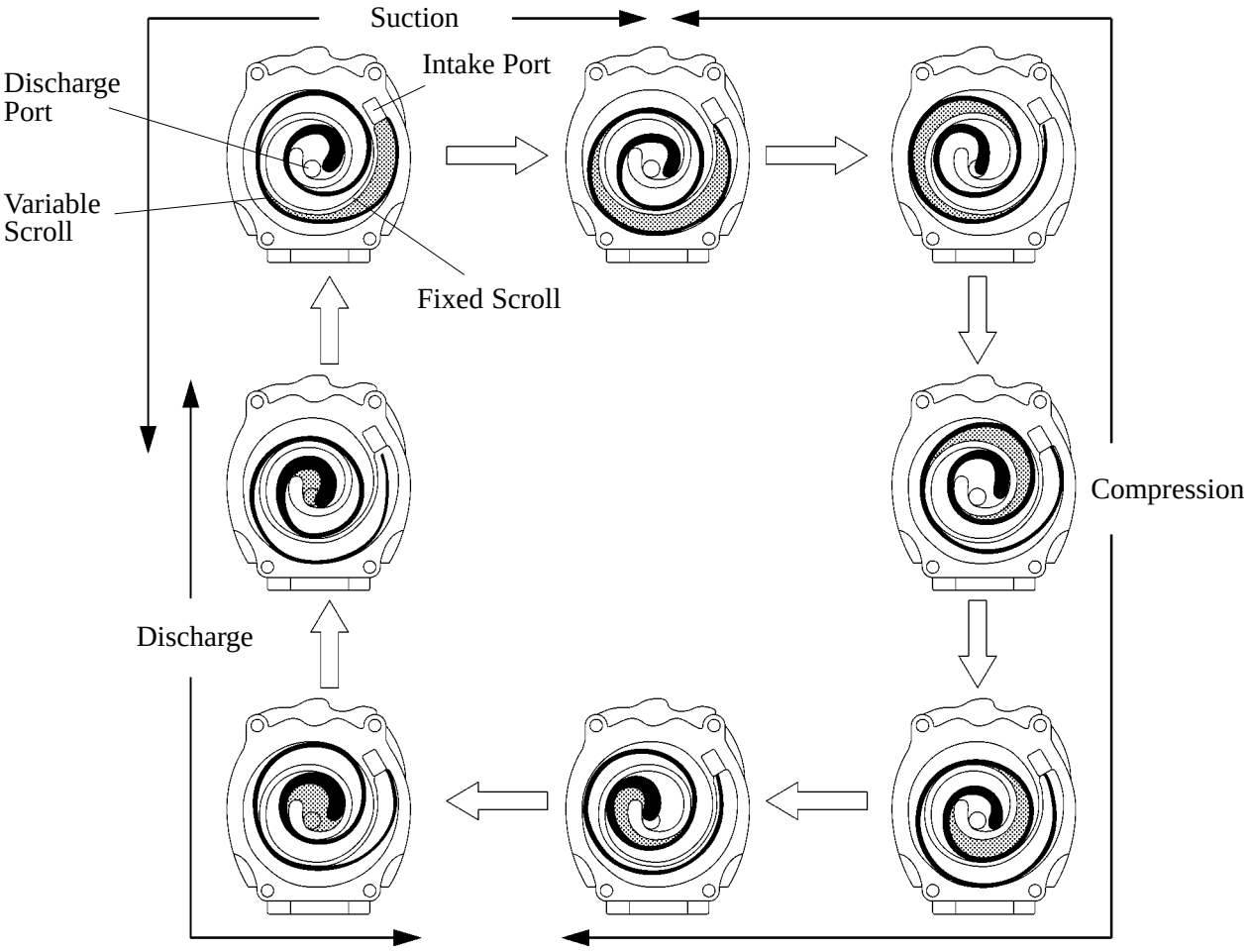
As the capacity of the compression chamber, which is created between the variable scroll and the fixed scroll, increases in accordance with the revolution of the variable scroll, refrigerant gas is drawn in from the intake port.

2) Compression

From the state at which the suction process has been completed, as the revolution of the variable scroll advances further, the capacity of the compression chamber decreases gradually. Consequently, the refrigerant gas that has been drawn in becomes compressed gradually and is sent to the center of the fixed scroll. The compression of the refrigerant gas is completed when the variable scroll completes approximately 2 revolutions.

3) Discharge

When the compression of the refrigerant gas is completed and the refrigerant pressure becomes high, the refrigerant gas discharges through the discharge port located in the center of the fixed scroll by pushing the discharge valve.



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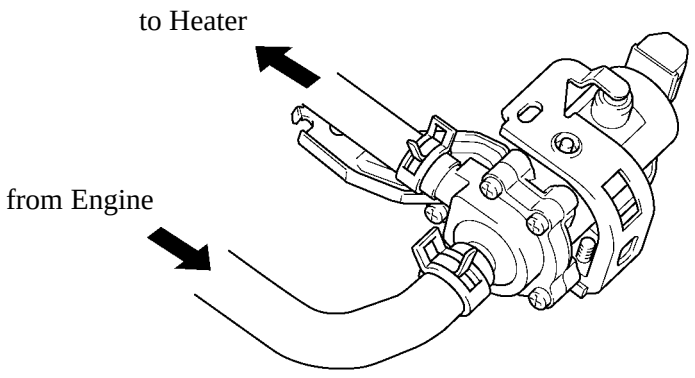
5. Water Pump

- Same as the ’03 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 ’04 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 ’03 Prius has been discontinued.



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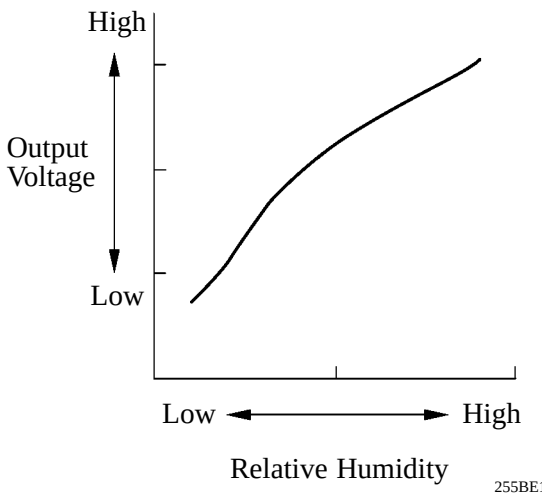
6. Room Temp. and Humidity Sensor

- 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 ECU 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.



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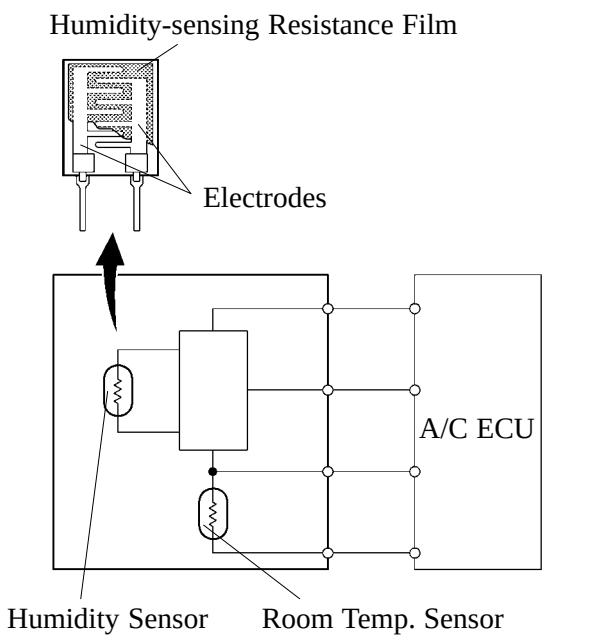

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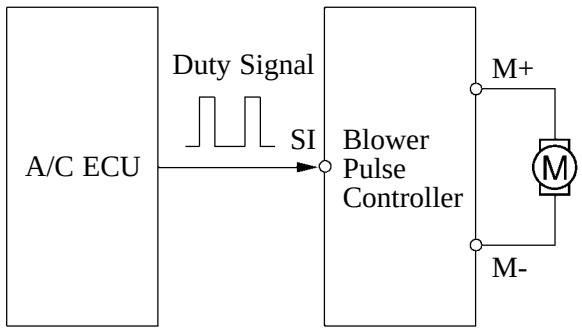
7. Blower Pulse Controller

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 ECU. 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.



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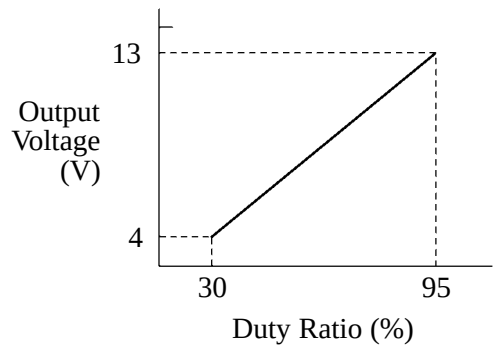

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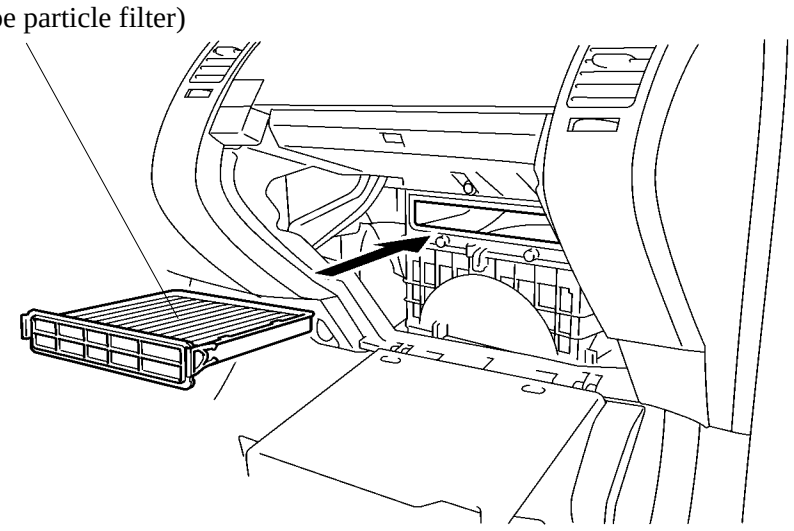
8. Clean Air Filter

- A clean air filter (Standard type Particle Filter) that excels in the removal of dust and pollen, located in the blower unit is provided.
- This filter, which cleans the air in the cabin, is made of polyester. Thus, it can be disposed of easily as a combustible material, a feature that is friendly the environment.

Clean Air Filter
(standard type particle filter)



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Service Tip

The clean air filter (standard type particle filter) on U.S.A. model should be changed at 30,000 miles. On Canada model, it should be changed at 16,000 km. However, it varies with the use conditions (or environment).

9. Air Conditioning ECU

General

The air conditioning ECU has following control.

Control		Outline
Fuzzy Control (see page BE-109)		The fuzzy control determines the conformity levels of the temperature deviation, ambient temperature, and solar radiation 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 ECU 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 ECU 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 ECU 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.

(Continued)

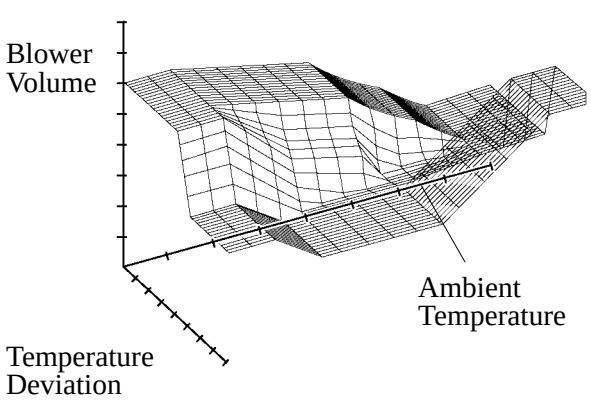
Control		Outline
Air Outlet Control	Manual Control	Changes the air outlet in accordance with the selected position of the mode select switch.
	Automatic Control	**Mode Damper Switching Servomotor Control:** • When the AUTO switch is pushed, automatic control causes the mode servomotor to rotate to a 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.
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 ECU turns MAX mode ON forcibly and switches to FRESH mode. • When switching the mode switching switch to FOOT/DEF mode, A/C ECU switches to FRESH mode.
2-Way Flow Mode Control		At the time of selecting FRESH mode, A/C ECU 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 ECU 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 (see page BE-110)	Compressor Speed Control	• The A/C ECU calculates the target 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 ECU 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 ECU controls the compressor speed to an extent that would not inhibit the proper cooling performance or defogging performance.
Electric Water Pump Control		When the blower motor is ON and the engine has been stopped by the hybrid control, the A/C ECU turns ON the electric water pump in accordance with the judgment of the air mix damper opening.

(Continued)

Control	Outline
Engine Start Request Control	To ensure the proper heater performance when the hybrid system is started at low temperatures, the A/C ECU transmits an engine start request to the HV ECU in accordance with the TAO, engine coolant temperature sensor signal, and ambient temperature sensor signal.
PTC Heater Control	When the hybrid system is operating (READY), and the blower motor is turned ON, the A/C ECU 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 ECU control 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 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 conditioning switches (actuator check function).

Fuzzy Control

- In the conventional automatic air conditioning control system, the A/C ECU calculates the required outlet air temperature (TAO: Temperature Air Outlet) for the set temperature in accordance with a prescribed calculation formula based on the temperature information obtained from the sensors. By automatically controlling the servo motors and the blower motors in order to achieve the TAO that has thus been calculated, this system maintains a stable temperature in the vehicle interior and ensures the comfort of the occupants. However, the conventional automatic air conditioning control system that univocally determines all controls based on the TAO offers a low level of freedom of control (as it was an aggregation of linear systems). Therefore, the '04 Prius has adopted fuzzy control (for non linear control) in order to achieve fine-tuned 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, it uses a fuzzy calculation method (algebraic product addition center of gravity method) to calculate the required outlet air temperature (TAO) and the blower volume. Based on these calculations, the A/C ECU effects the respective controls for the outlet air temperature, blower volume, compressor, and air outlet.
- The conformity levels for the temperature deviations are defined in 9 levels in accordance with the actual room temperature and the set temperature, for the solar radiation in 4 levels (low, medium low, medium, and high) in accordance with the solar sensor, and for the ambient temperatures in 6 levels (midwinter, winter, spring-autumn, spring-summer, and midsummer) in accordance with the ambient temperature sensor.



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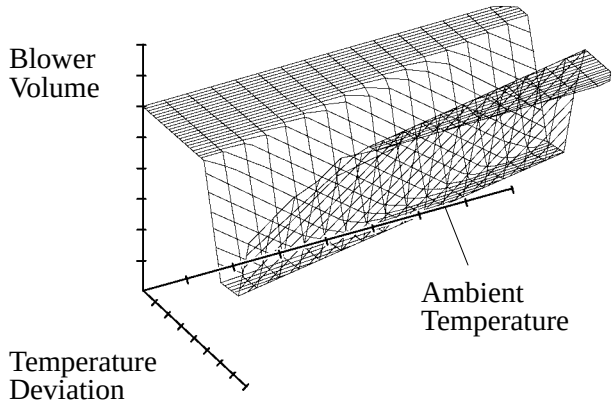
Non-Linear Control (Fuzzy Control)



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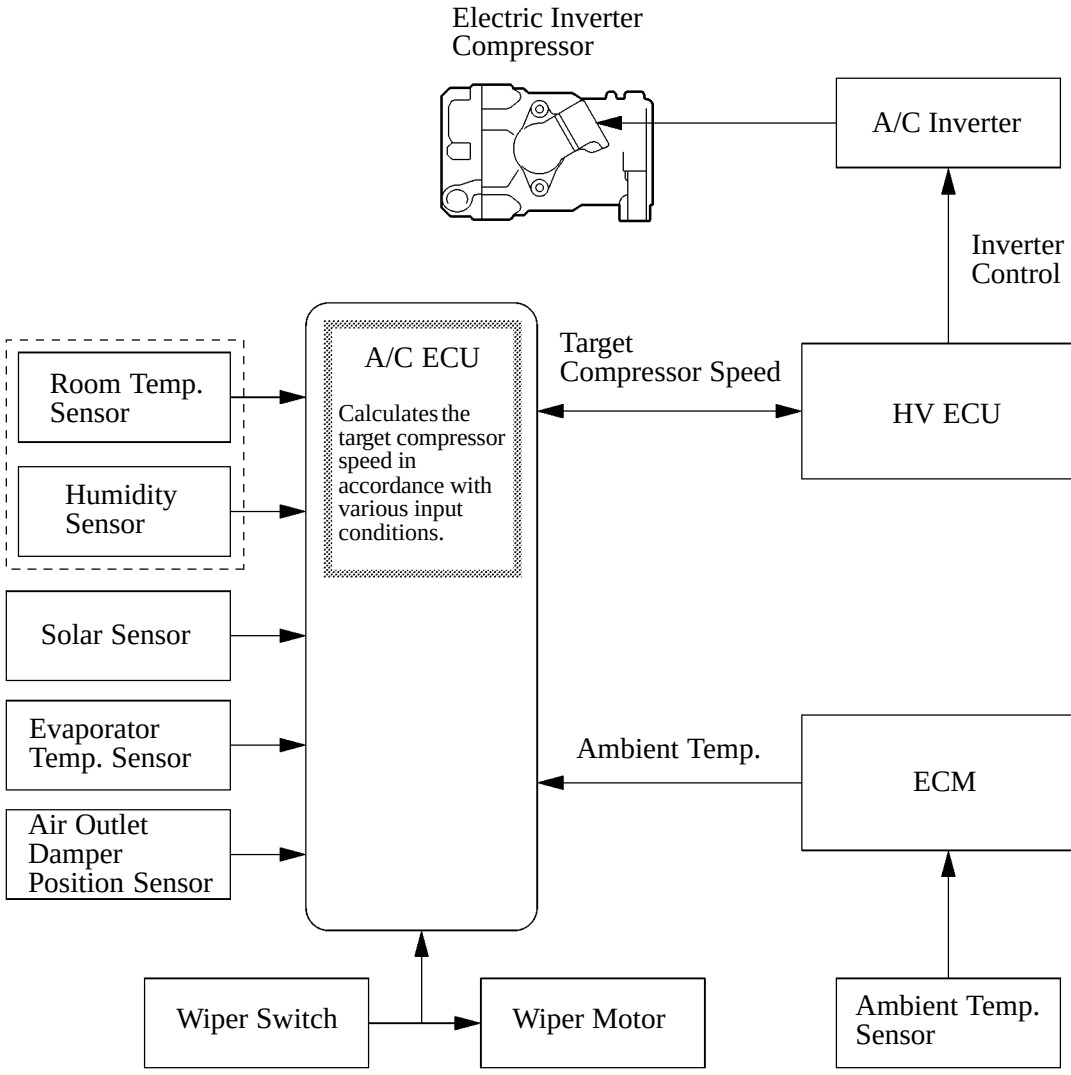
Conventional

Electric Inverter Compressor Control

1) Compressor Speed Control

- The A/C ECU 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 ECU transmits the target speed to the HV ECU. The HV 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 ECU 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 ECU 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.



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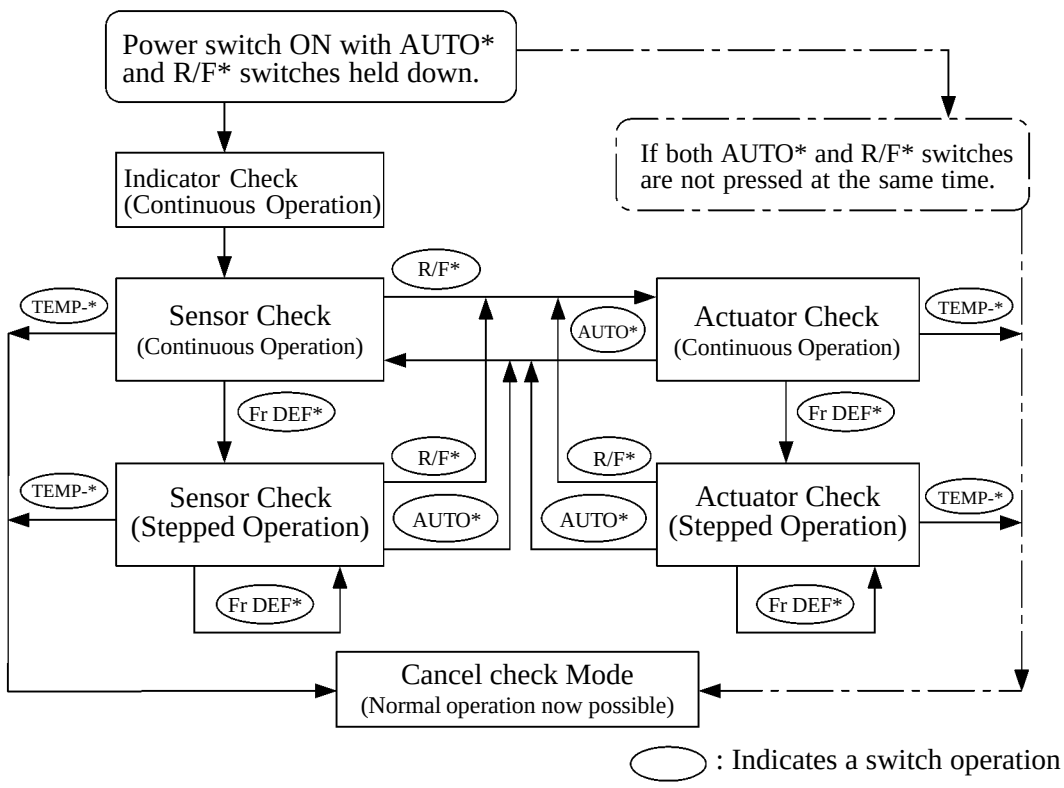
Self-Diagnosis

- The air conditioning ECU has a self-diagnosis function. It stores any operation failures in the air conditioning system memory in the form of a malfunction code. By operating the air conditioning control switches, the stored malfunction codes are displayed on the multi display. Since diagnostic results are stored directly by electric power from the battery, they are not cleared even when the ignition switch is turned off.

▶ Functions ◀

Function	Outline
Indicator Check	Checks mode and temperature setting display.
Sensor Check	Checks the past and present malfunctions of the sensors and A/C inverter, and clearing the past malfunction data.
Actuator Check	Checks against actuator check pattern if blower motor, servomotors and magnetic clutch are operating correctly according to signals from ECU.

- The check function can be started by the following procedure shown below.



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*: Use the switches that are provided on the steering pad switch.

- For details on the indicator check, sensor check, actuator check function, and clearing DTC of this system, refer to the 2004 Prius Repair Manual (Pub. No. RM1075U).