AIR CONDITIONING

■ DESCRIPTION

1. General

The air conditioning system in the RAV4 EV has the following features.

- A gas injection type heat pump air conditioning system, which is clean, highly efficient, and provides excellent cooling performance, has been adopted.
- A vertical, dual flow air conditioning unit has been adopted.
- To prevent damage to the ozone layer, a refrigerant HFC134a (R134a) is used.

▶ Performance ◀

Item			Performance
Heater	Heat Output	W (Kcal/h)	4000 (3440)
	Air Flow Volume	m^3/h	300
	Power Consumption	W	3000
Air Conditioner	Heat Output	W (Kcal/h)	3000 (2580)
	Air Flow Volume	m^3/h	380
	Power Consumption	W	1400

▶ Specifications ◀

Item			Specifications
Interior Condenser	Size	W × H × L mm (in.)	242.6 × 165.2 × 18.8 (9.5 × 6.5 × 0.7)
	Fin Pitch	mm (in.)	3.2 (0.13)
Blower	Motor Type		S70F15T
	Fan Size	Dia. × H mm (in.)	140 × 65 (5.5 × 2.6) × 2
Exterior Heat Exchanger	Size	W × H × L mm (in.)	710 × 397.3 × 16 (28.0 × 15.6 × 0.6)
	Fin Pitch	mm (in.)	3.25 (0.13)
Interior Evaporator	Size	W × H × L mm (in.)	253 × 260 × 60 (10.0 × 10.2 × 2.4)
	Fin Pitch	mm (in.)	3.5 (0.14)
Compressor	Type		Seal Type Scroll
Refrigerant	Type		HFC134a

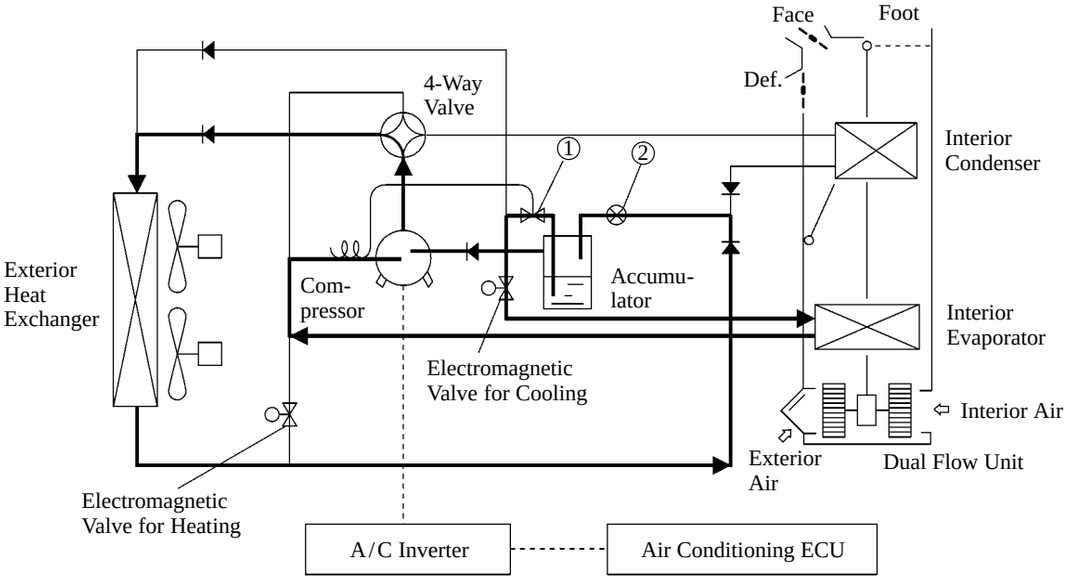
■CONSTRUCTION AND OPERATION

1. Heat Pump Air Conditioning System

A heat pump air conditioning system has been adopted on the RAV4 EV. Through the operation of the electromagnetic valve and the 4-way valve in accordance with the position of the temperature selector lever in the heater control panel, this system switches the refrigerant passage, thus changing the operation mode into 3 modes: cooling, heating, and defogging.

During Cooling

When the temperature selector lever in the heater control panel is moved to the cool position, the electromagnetic valve for cooling and the 4-way valve operate to establish the refrigeration circuit for cooling. Consequently, the refrigerant that is discharged by the compressor passes through the 4-way valve and flows to the exterior heat exchanger, where it becomes condensed and liquefied.
Thereafter, the refrigerant passes through the intermediate pressure control expansion valve, accumulator, super heat control expansion valve, and electromagnetic valve for cooling, and flows into the interior evaporator in the cooler unit. The refrigerant becomes gasified in the interior evaporator and cools and dehumidifies the air around the evaporator. The cooled and dehumidified air is then blown into the cabin through the blower fan.



①: Super Heat Control Expansion Valve
②: Intermediate Pressure Control Expansion Valve

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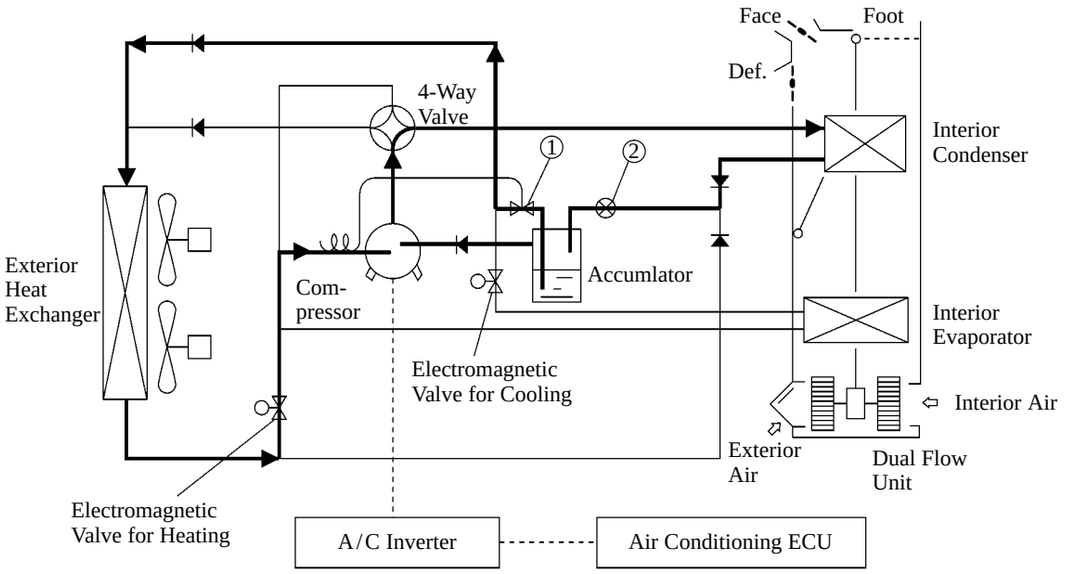
During Heating

When the temperature selector lever in the heater control panel is moved to the heat position, the electromagnetic valve for heating and the 4-way valve operate to establish the refrigerant circuit for heating. Consequently, the refrigerant that is discharged by the compressor passes through the 4-way valve and flows into the interior condenser in the heater unit, where it becomes condensed and liquefied. The heat that is generated at this time heats the air around the condenser. The heated air then blows into the cabin through the blower fan.
The condensed and liquefied refrigerant passes through the intermediate pressure control expansion valve, accumulator, super heat control expansion valve, and flows into the exterior heat exchanger. During heating, the exterior heat exchanger functions as an exterior condenser, and because the gasified refrigerant causes the surrounding air to cool, the heat exchanger could become frosted. If the heat exchanger becomes frosted, it becomes defrosted automatically when the traction batteries are charged.



①: Super Heat Control Expansion Valve
②: Intermediate Pressure Control Expansion Valve

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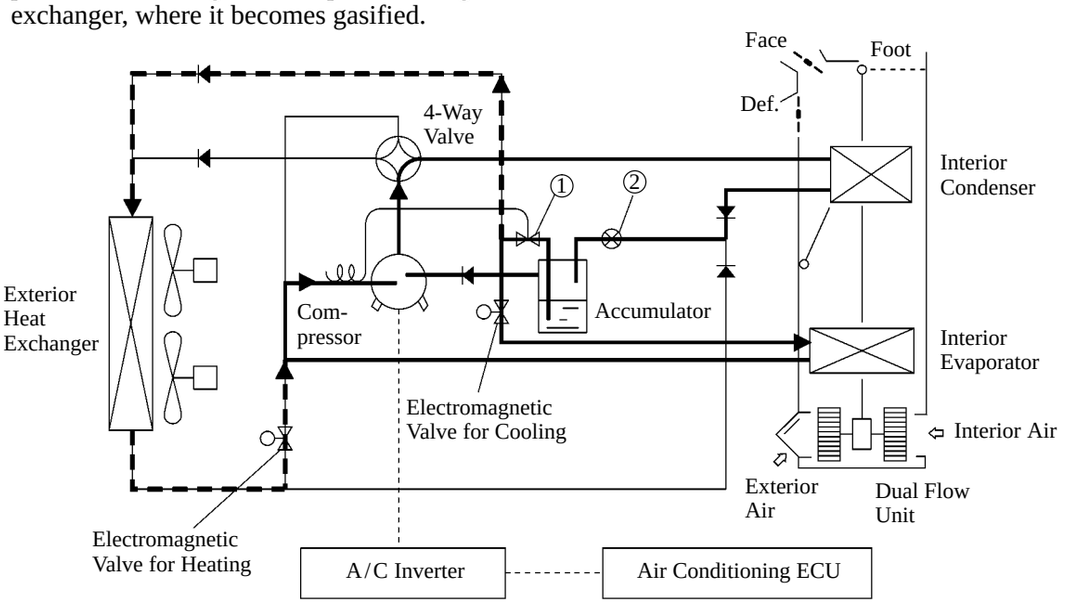
Defogging

When the temperature selector lever in the heater control panel is moved to the defrost position, the electromagnetic valve for cooling and the 4-way valve operate to establish the refrigerant cycle for defogging. Consequently, the refrigerant that is discharged by the compressor passes through the 4-way valve and flows into the interior condenser in the heater unit where it becomes condensed and liquefied, and generates heat. The refrigerant that has been liquefied in the interior condenser passes through the intermediate pressure control expansion valve, accumulator, super heat control expansion valve, and electromagnetic valve for cooling, and flows into the interior evaporator of the cooler unit. The refrigerant becomes gasified in the interior evaporator and cools and dehumidifies the air around the evaporator. In this manner, during defogging, the air that flows from the blower fan is initially cooled and dehumidified in the cooler unit; it is then heated in the heater unit and is blown into the cabin.

Furthermore, even during the operation in the defogging mode, the vent outlet temperature rises or lowers according to the position of the temperature selector lever. When the vent outlet temperature is high, the electromagnetic valve for heating also operates simultaneously with the operation described above, and a portion of the refrigerant that passes through the interior condenser accumulator flows into the exterior heat exchanger, where it becomes gasified.



①: Super Heat Control Expansion Valve
②: Intermediate Pressure Control Expansion Valve

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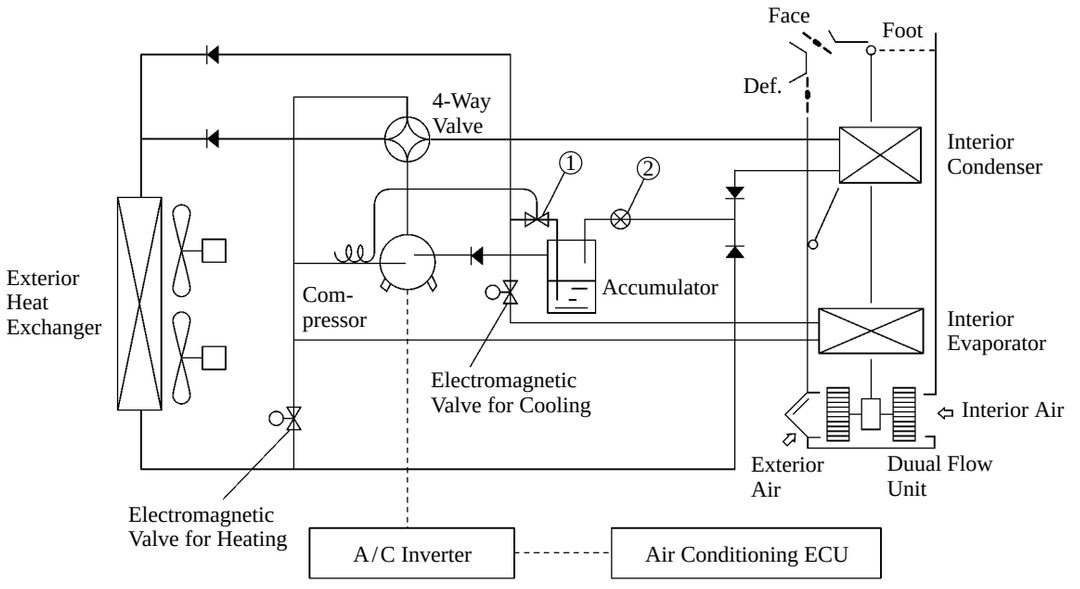
2. Functional Parts

The functional parts of the air conditioning system are shown below.



①: Super Heat Control Expansion Valve
②: Intermediate Pressure Control Expansion Valve

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Exterior Heat Exchanger

The function of the exterior heat exchanger varies according to the operating mode of the air conditioning system. During cooling, it functions as a condenser; during heating, as an evaporator; and during defogging, as an evaporator or a condenser.

Electromagnetic Valve

There are 2 types of electromagnetic valves: for cooling and for heating. These electromagnetic valves receive signals from the air conditioning ECU in order to open and close the refrigerant passage.

4-Way Valve

4-way valve varies the passages through which the refrigerant flows during cooling and heating.

Compressor

Compresses the refrigerant in the low-temperature, low-pressure gasified state.

Electronic Expansion Valve

There are 2 types of electronic expansion valves: the super heat control expansion valve and the intermediate pressure control expansion valve. These electronic expansion valves expand the liquid refrigerant and converts it into a low-temperature, low-pressure atomized refrigerant. At the same time, they regulate the amount of refrigerant to be supplied to the interior evaporator or to the exterior heat exchanger.

Accumulator

The accumulator stores the refrigerant momentarily and removes the moisture from the refrigerant.

Interior Condenser

During heating and defogging, the interior condenser condenses and liquefies the refrigerant that is discharged by the compressor. The heat that is generated at this time is used to heat the air around the condenser.

Interior Evaporator

During heating and defogging, the interior evaporator gasifies the refrigerant in order to cool and dehumidify the air around the evaporator.

Air Conditioning Inverter

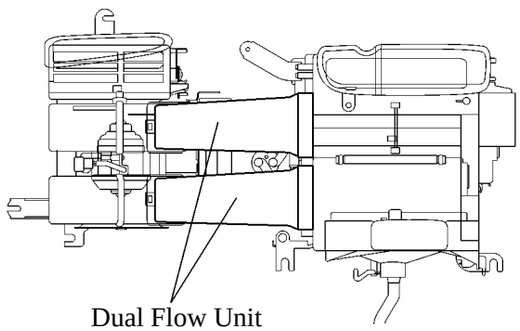
The air conditioning inverter varies the frequency of the alternate current to the compressor motor to control the rpm of the compressor motor.

Air Conditioning ECU

The air conditioning ECU operates the air conditioning system in the operating mode that has been selected by switching the refrigerant circuits based on the signals received from the various types of temperature sensors and heater control panel.

Air Conditioning Unit

A dual-flow type unit, in which the air conditioning unit is separated into 2 vertical portions, has been adopted.



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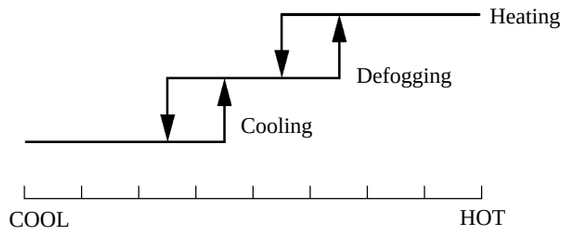
■CONTROL FUNCTIONS

1. Vent Outlet Temperature Control

Varies the vent outlet temperature in accordance with the air conditioning system's operating mode (cooling, heating, defogging).



Temperature Selector Lever Positions

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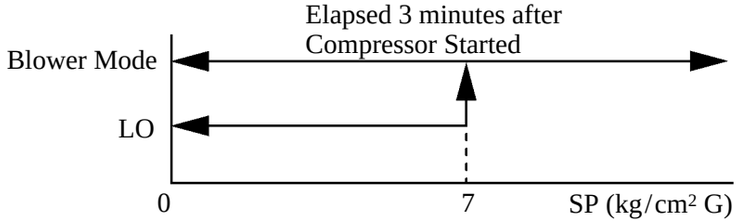
2. Blower Flow Rate Control

Controls the blower flow rate as described in the table below in accordance with the air conditioning system's operating mode (cooling, heating, defogging, defrosting) and the respective condition.

Mode	Blower Switch Position / Condition	OFF	LO	M1	M2	HI
Heating	Basic Operation	OFF	LO	M1	M2	HI
	Pre-Conditioning (for heating)	OFF	OFF	OFF	OFF	M2
Cooling	Basic Operation	OFF	LO	M1	M2	HI
	Pre-Conditioning (for cooling)	OFF	OFF	OFF	OFF	M2
	Defrosting	HI	HI	HI	HI	HI
Defogging	—	OFF	LO	M1	M2	HI
OFF	—	OFF	LO	M1	M2	HI

Defogging Cool Air Prevention Control

When the air conditioning system is operating in the defogging mode, provided that it is within 3 minutes after the compressor started operating, this function controls the blower motor to operate at a low flow rate until the refrigerant pressure surpasses the specified value. As a result, the cool air is prevented from being blown into the cabin. When the refrigerant pressure surpasses the specified value or when 3 minutes have elapsed since the compressor started operating, the blower motor operates at a flow rate in accordance with the selected position of the blower switch.



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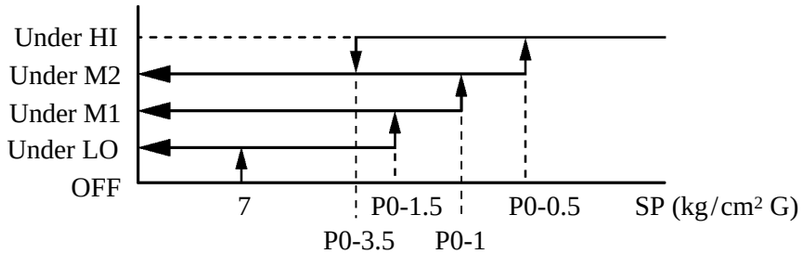
Low Outside Air Temperature Cool Air Prevention Control

When the outside air temperature is under 10°C (50°F) and the refrigerant pressure is lower than the specified value, this function automatically switches the blower's flow rate in accordance with the refrigerant pressure value, as shown in the diagram below. Thus, this function prevents cool air from being suddenly blown into the cabin when the outside air temperature is low.



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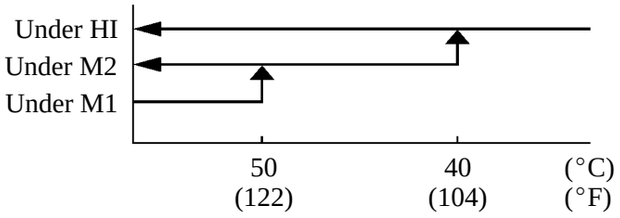
Cooler Starting Control

When the air conditioning system is started in the cooling mode, this function automatically switches the blower flow rate regardless of the selected position of the blower switch, in accordance with the "post-evaporator air temperature" as shown in the diagram below.



Air Temperature after Passage through the Evaporator

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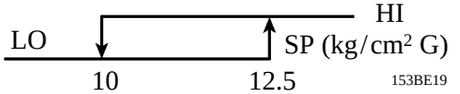
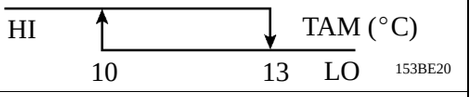
3. Electric Fan Control

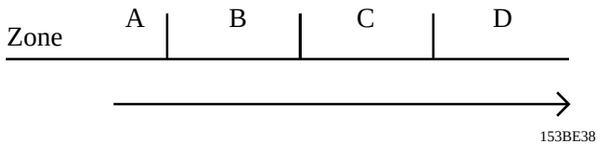
This function switches the operating condition of the electric fan of the exterior heat exchanger in accordance with the air conditioning system's operating mode, outside air temperature, and refrigerant pressure.

Mode	Condition	Operation
Cooling	During Normal Operation	 153BE19
	Pre-Conditioning (for cooling)	LO
Heating Defogging	During Normal Operation	 153BE20
	Pre-Conditioning (for cooling)	LO
Heat Pump OFF	—	OFF

4. Protection Control

To control the compressor rpm, this function classifies the compressor control into 4 zones as described below, in accordance with the air conditioning inverter input current, compressor discharge pressure, compressor discharge temperature, air conditioning inverter temperature, and post-evaporator air temperature (during cooling or defrosting).

- A: Controlled to the target rpm
- B: Controlled to the present rpm
- C: Compressor rpm reduced
- D: Compressor stopped



- Air conditioning inverter input current
- Air conditioning inverter temperature
- Compressor discharge pressure
- Compressor discharge temperature
- Post-evaporator air temperature (during cooling or defrosting)

5. Pre-Conditioning Control

By setting the charge ending time for the timer charge, this function operates the air conditioner in accordance with the operation of the charger control panel and the heater control panel while the traction batteries are being charged. As a result, the vehicle interior is maintained at a comfortable temperature even before entering the vehicle.

6. Defrosting Control

When the air conditioning system is operating in the heating mode and the frost that develops on the exterior heat exchanger must be removed, this function automatically defrosts while the traction batteries are being charged.