

AIR CONDITIONING

DESCRIPTION

1. General

The air conditioner is a fully automatic type controlled by an ECU that is integrated into the control panel, as in the LS400. Its basic function is the same as in the LS400.

The air conditioning system in the SC400 has the following features.

- The blower, heater and cooler units are integrated for improved quietness.
- Opening and closing of the water valve that controls circulation of the engine coolant in the heater core is accomplished by the VSV (Vacuum Switching Valve) turning on and off.
- A newly-developed dome type solar sensor, which detects solar radiation accurately even if the sun's position in the sky is low, is used.
- A manual control adjusts the blower speed over 5 steps for precise control.
- The “bi-level” mode during automatic control has 5 steps and abrupt changes in blower output when switching between “face” and “foot” have been eliminated.
- A hydraulic driven fan is used to cool the condenser. For details about this fan, see page 50.

►Performance◀

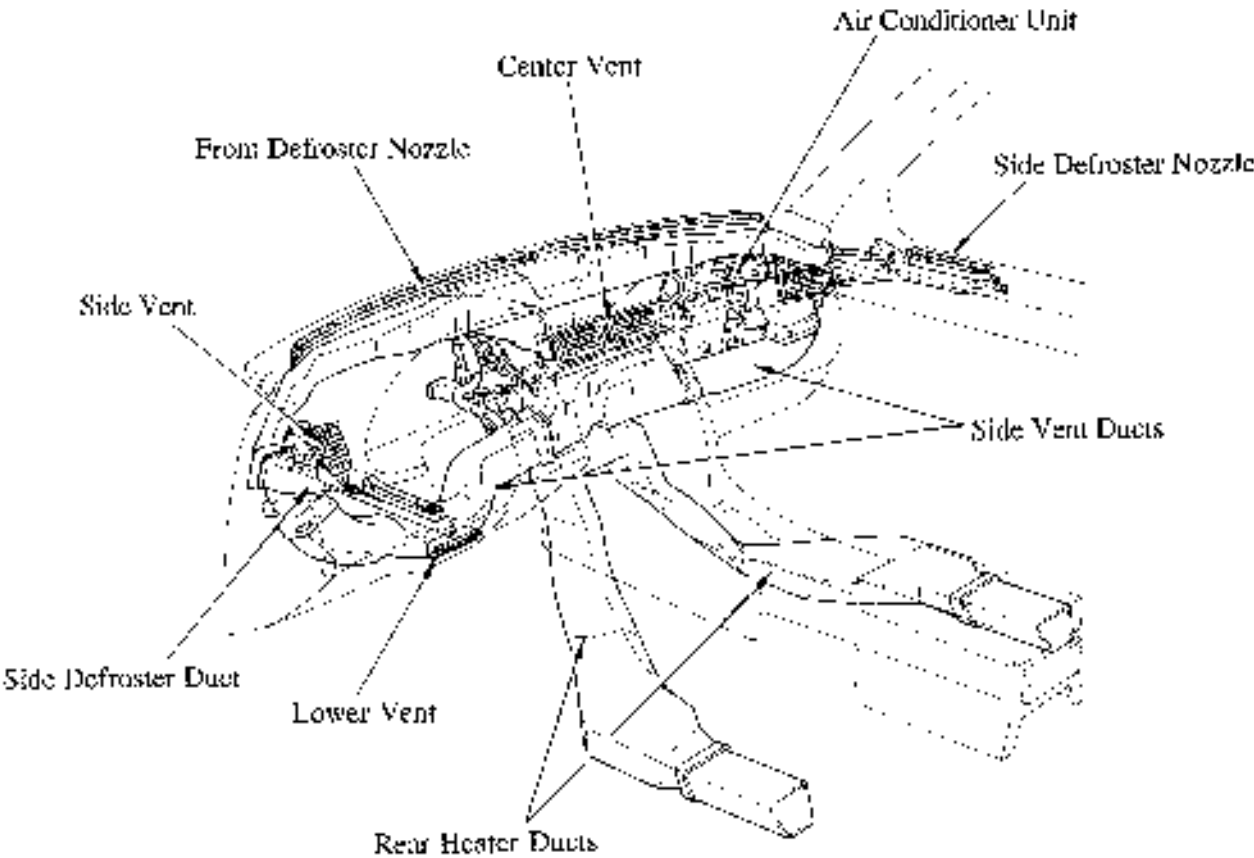
Model		SC400	LS400
Item			
Heater	Heat Output (MJ/h [Kcal/h])	18.00 [4300]	18.42 [4400]
	Air Flow Volume (m³/h)	360	390
	Power Consumption (W)	210	220
Air Conditioner	Heat Output (MJ/h [Kcal/h])	19.26 [4600]	22.60 [5400]
	Air Flow Volume (m³/h)	530	640
	Power Consumption (W)	260	280
Defroster	Air Flow Volume (m³/h)	360	420

►Specifications◀

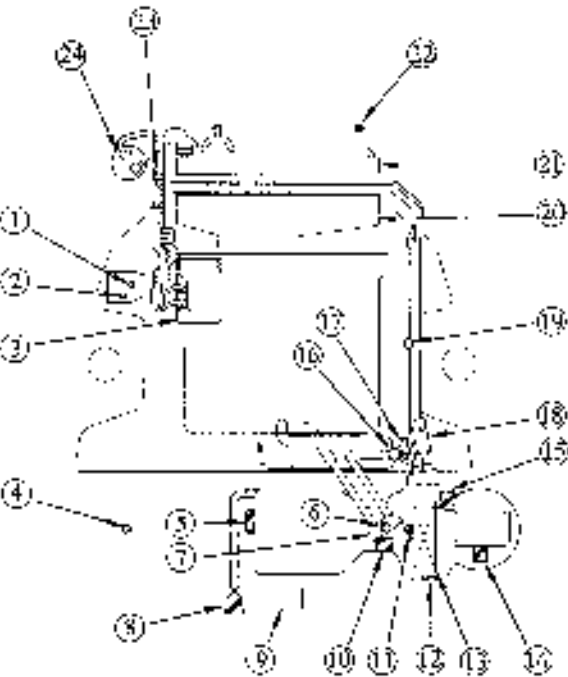
Model					SC400	LS400
Item						
Ventilation and Heater	Heater Core	Type			Flat Tube Type	Dimpled Tube Type
		Size	W x H x L	mm (in.)	160 x 200 x 49 (6.3 x 7.9 x 1.9)	159.5 x 200 x 49 (6.3 x 7.9 x 1.9)
		Fin Pitch	mm (in.)		2.7 (0.11)	←
	Blower	Motor Type			S80F 11T	S80F 11.5T
		Fan Size	Dia. x H	mm (in.)	150 x 65 (5.9 x 2.6)	150 x 85 (5.9 x 3.3)
Air Conditioning	Condenser	Type			Corrugated Fin and Serpentine Tube Type	←
		Size	W x H x L	mm (in.)	686 x 435 x 22 (27.0 x 17.1 x 0.9)	706 x 346.2 x 32 (27.8 x 13.6 x 1.3)
		Fin Pitch	mm (in.)		4.5 (0.18)	4.0 (0.16)
	Evaporator	Type			Drawn Cup Type	←
		Size	W x H x L	mm (in.)	292.9 x 210 x 90 (11.5 x 8.3 x 3.5)	286 x 240 x 105 (11.3 x 9.4 x 4.1)
		Fin Pitch	mm (in.)		4.0 (0.16)	←
	Compressor	Type			10PA20	←
	Electric Fan				—	Forced Fan x 2

2. Layout of Components

Unit, Ducts and Vents

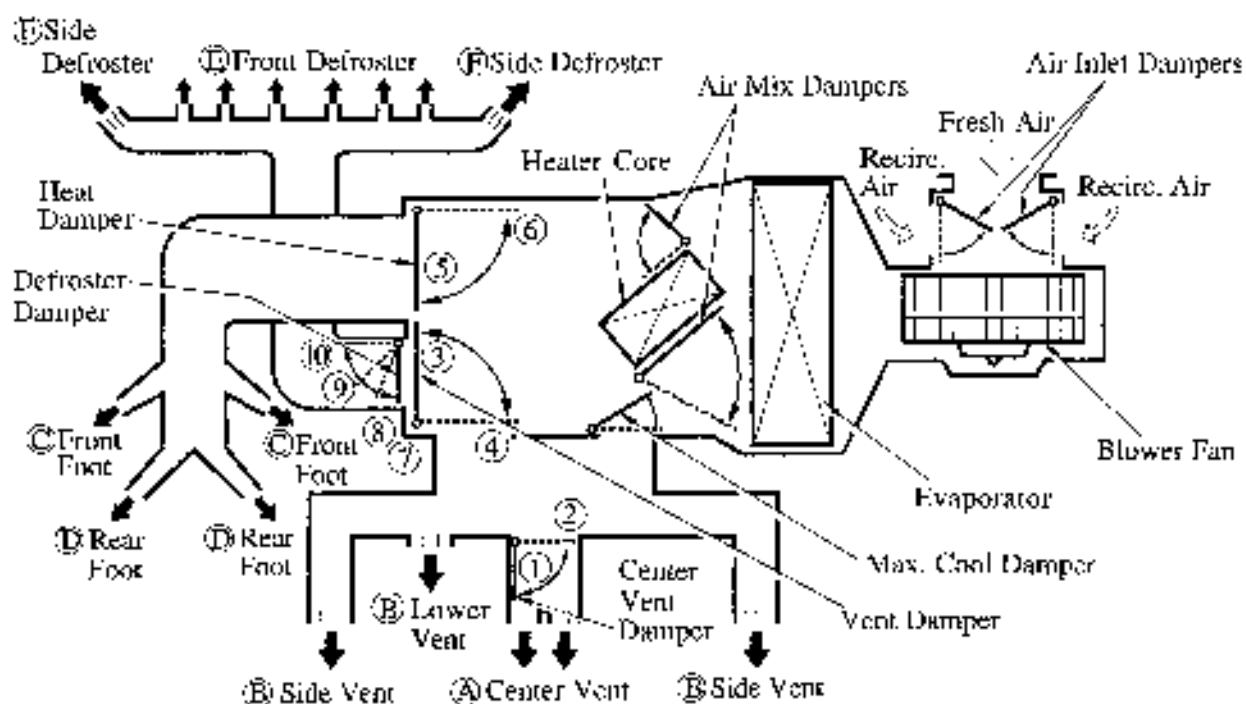


Functional Parts



No.	Part Name	No.	Part Name
①	Magnetic Clutch Relay	⑬	Evaporator
②	Heater Relay	⑭	Air Inlet Servomotor
③	Compressor	⑮	Power Transistor
④	Solar Sensor	⑯	Water Valve
⑤	Air Outlet Servomotor	⑰	Water Valve VSV
⑥	Water Temperature Sensor	⑱	EPR (Evaporator Pressure Regulator)
⑦	Heater Core	⑲	Pressure Switch (for Cooling Fan Control and High & Low Pressure Cut Control for Magnetic Clutch)
⑧	Room Temperature Sensor		
⑨	Air Conditioner Control Assembly with built-in ECU	⑳	Cooling Fan
⑩	Air Mix Servomotor	㉑	Condenser
⑪	Evaporator Temperature Sensor	㉒	Ambient Temperature Sensor
⑫	Blower Resistor	㉓	Sight Glass
		㉔	Receiver

3. Damper Position and Air Flow Relationship



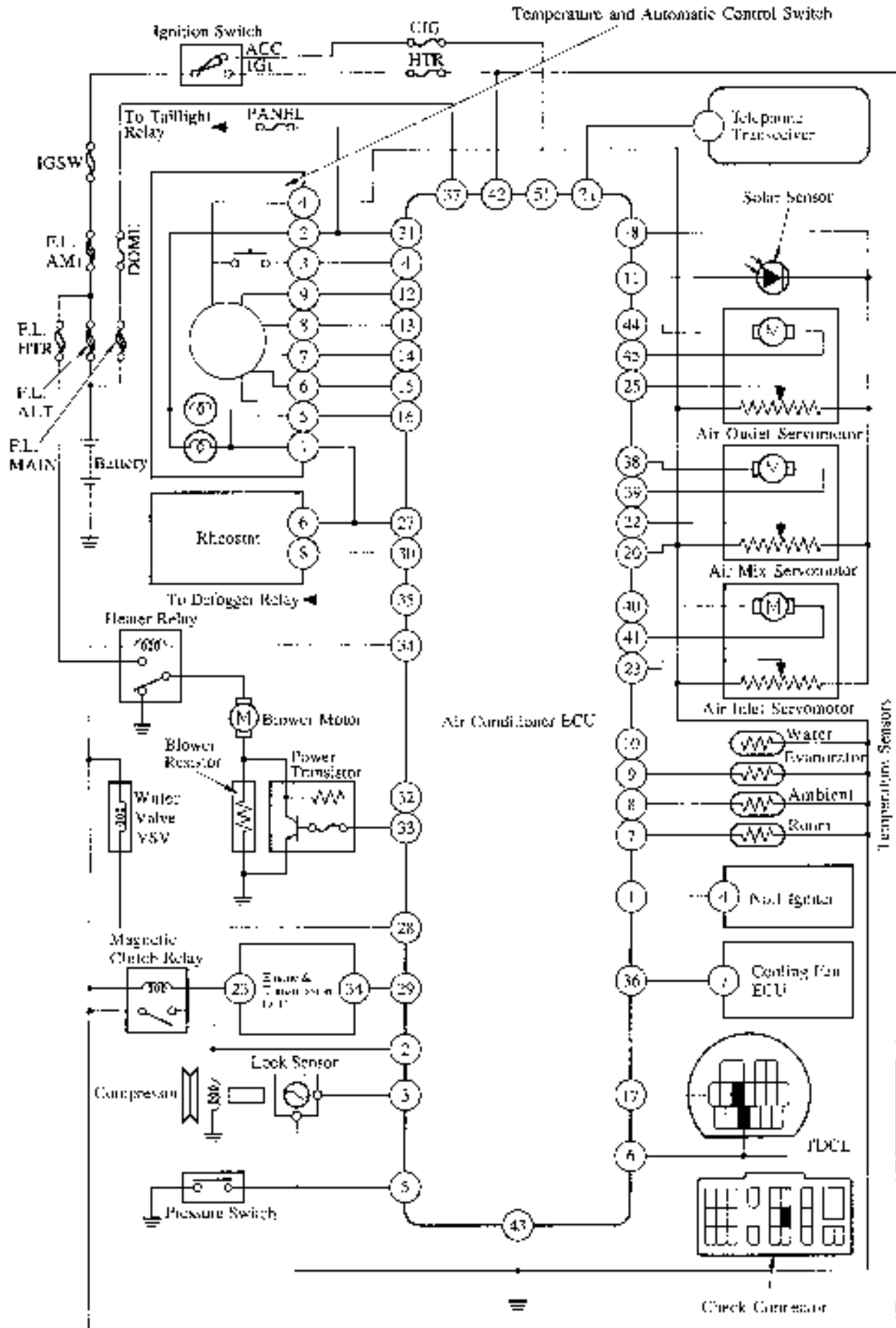
Air Outlet Mode		Mode Control Damper Position	Vent		Foot		Defroster	
			(A) Center	(B) Side	(C) Front	(D) Rear	(E) Front	(F) Side
Face		① ③ ⑤ ⑦	○	○				
Bi-level		① ③ ⑥ ⑦	○	○	○	○		
Foot*	I	② ④ ⑥ ⑧		○	○	○	○	○
	II	② ④ ⑥ ⑦		○	○	○		
Foot./Defroster		② ④ ⑥ ⑨		○	○	○	○	○
Defroster		② ④ ⑤ ⑩		○			○	○

The size of the circle ○ indicates the proportion of air flow volume.

* Foot I indicates the status during automatic control and Foot II indicates the status during manual control.

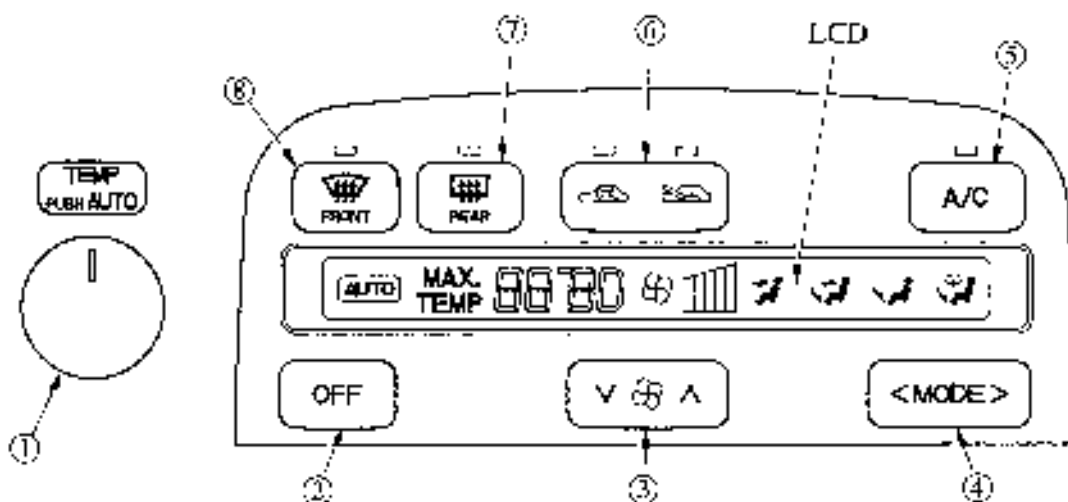
NOTE: In the “bi-level” mode during automatic control, the positions of the center vent, vent and heat dampers can be adjusted to 5 steps. The damper position and proportion of the air flow volume in the above table shows automatic control while in the 3rd step and while under manual control.

4. Wiring Diagram



5. Air Conditioning Switches

- The TEMP and AUTO switch is positioned on the console upper panel separate from the control panel. This location makes it easier for the driver to reach and operate the switch. The switch operating condition is shown by the LCD (Liquid Crystal Display) in the control panel.
- The blower and mode select switches are rocker type switches. The blower speed and air outlet mode are displayed in the LCD.



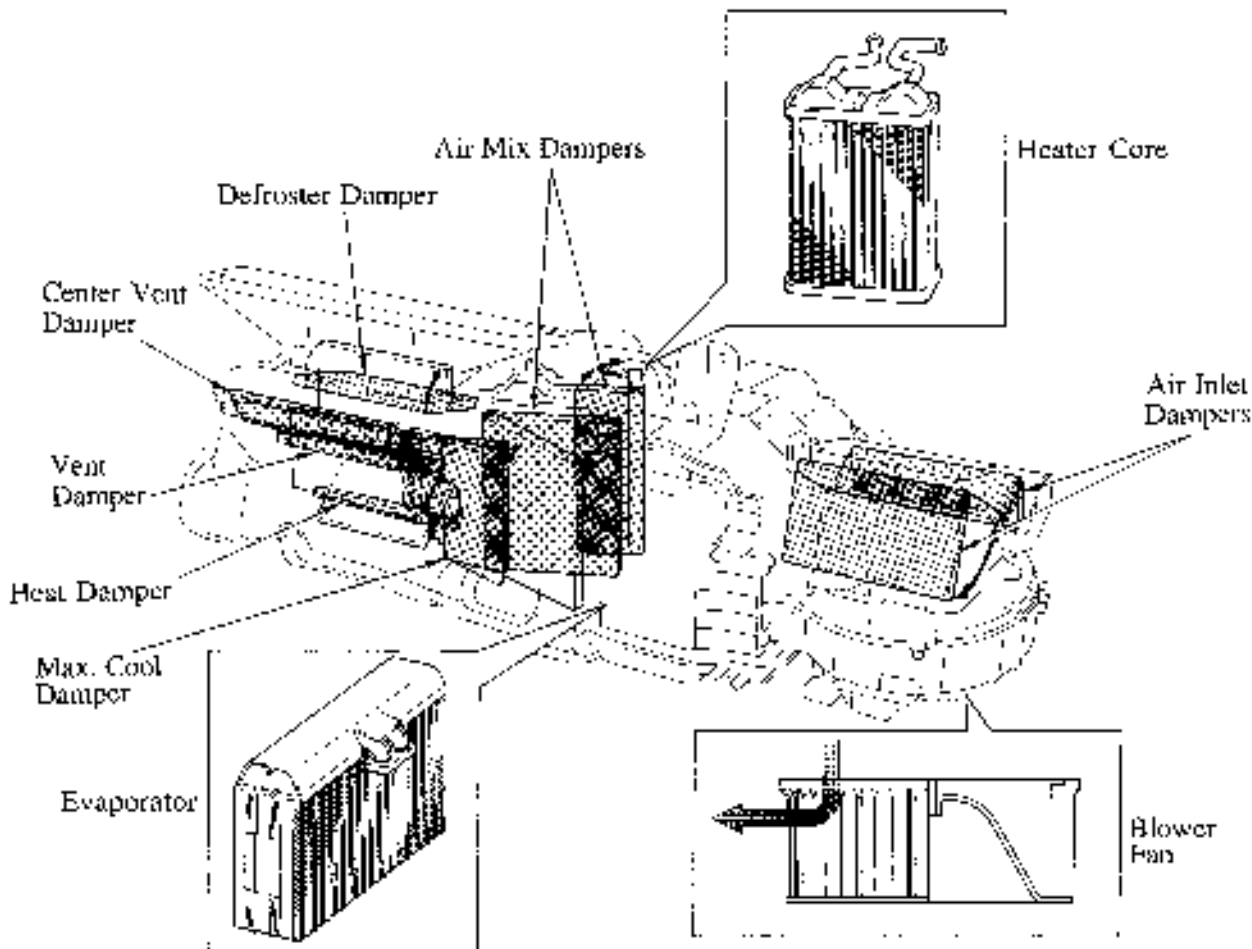
►Functions◀

No.	Switch	Function
①	Temperature and Automatic Control	<ul style="list-style-type: none"> By turning the dial, the set temperature can be raised or lowered by gradations of 1°F (or 0.5°C). If the dial is turned fully in either direction, the LCD display changes to MAX COLD or MAX HOT. This not only switches the air mix damper to the maximum cool or hot position, it also causes the blower to run at its maximum speed. Pushing the dial starts fully automatic control of the blower speed, air inlet mode, air outlet mode and compressor operation.
②	OFF	This switches off all controls, causing the LCD temperature, blower speed and AUTO displays to go off.
③	Blower	The blower speed can be set to 5 steps.
④	Mode Select	The air outlet mode can be set to “face”, “bi-level”, “foot”, or “foot/def.”.
⑤	A/C	Turns compressor on and off. This switch will not activate when the blower is stopped.
⑥	Air Inlet Control	Sets air inlet to Fresh or Recirculation mode.
⑦	Rear Defogger	Turns rear window defogger and mirror heaters on and off. The defogger and mirror heaters automatically turn off approx. 15 minutes after the switch is turned on.
⑧	Front Defroster	Fixes air outlet mode to “defroster” and also turns on blower and compressor.

■ CONSTRUCTION AND OPERATION

1. Air Conditioner Unit

The air conditioner unit incorporates a blower, heater and cooler units. This provides high rigidity and low ventilating resistance and improves quietness.



Blower Fan

The blower fan is large to ensure a large air flow volume (Diameter: 150 mm [5.91 in.]).

Heater Core

This is a large capacity type heater core with good heat radiation efficiency. It varies from the radiator in the LS400 in that a flat tube type is used.

Evaporator

This is the same type of drawn cup type evaporator, with high heat exchange efficiency, which is used in the LS400. In the SC400, a service hole is provided in the air conditioner unit case to remove and install the evaporator, improving serviceability.

Air Flow Control Dampers

The air flow mode and proportions of air flow volume are adjusted by 7 dampers.

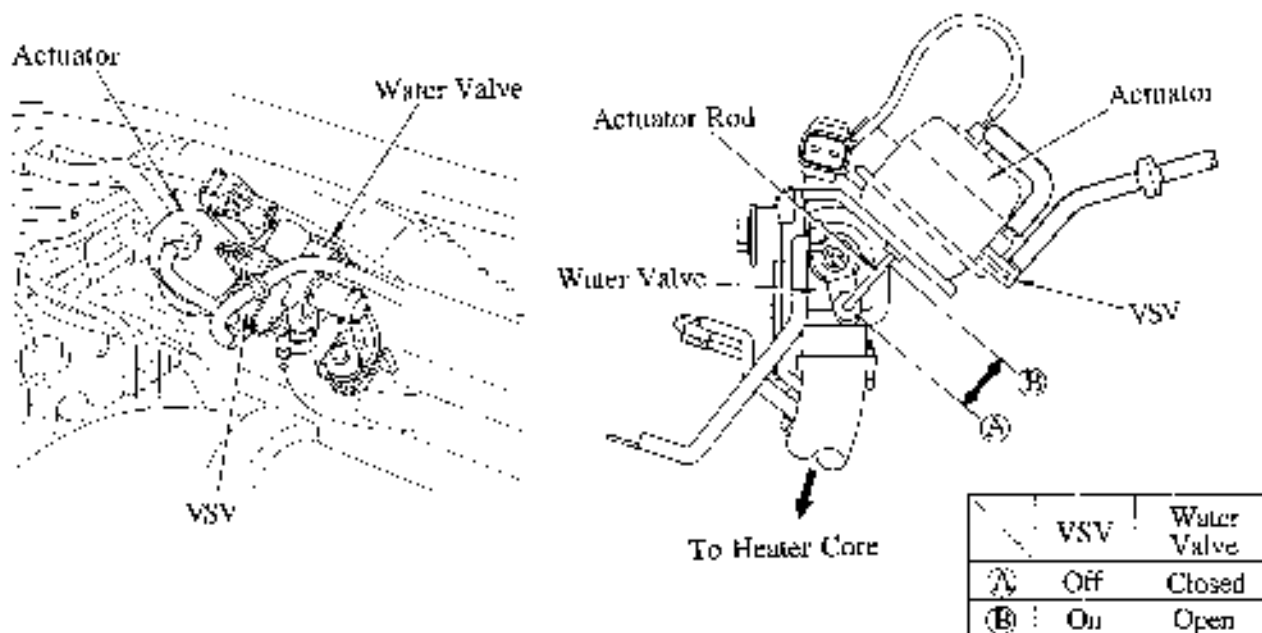
Servomotors

These change the position of the air flow control dampers using three servomotors. The basic construction of the servomotors is the same as in the LS400. For details, see NCF054U, page 417.

2. Water Valve

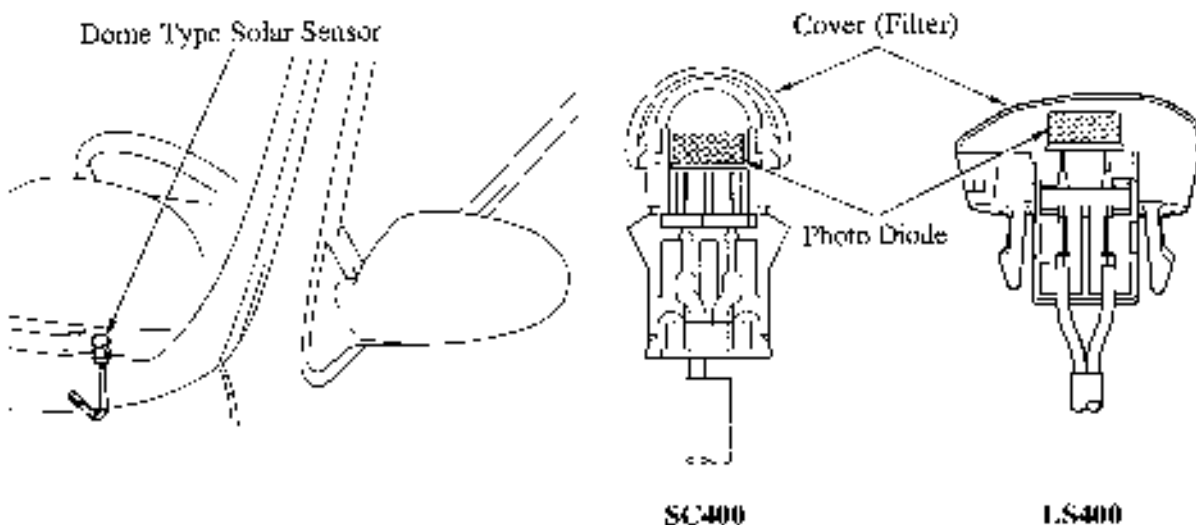
The construction of the water valve is the same as in the LS400, but in the SC400 it is opened and closed by a VSV switching on and off.

The valve in the water valve is connected to an actuator rod. While the engine is running and the VSV is on, a vacuum acts on the diaphragm chamber of the actuator, attracting the diaphragm. This pulls on the actuator rod, opening the water valve. If the VSV goes off or the engine stops, atmospheric pressure acts on the diaphragm chamber. The result is that the diaphragm is turned by spring force and the water valve closes.



3. Solar Sensor

The solar sensor detects solar radiation using a photo diode as in the LS400. The basic construction and operation of this sensor is the same as in the LS400. The cover of the photo diode, however, has been given a dome shape. This improves its detection accuracy when the sun is low in the sky.



4. Air Conditioner ECU

The ECU is integrated into the control panel as in the LS400.

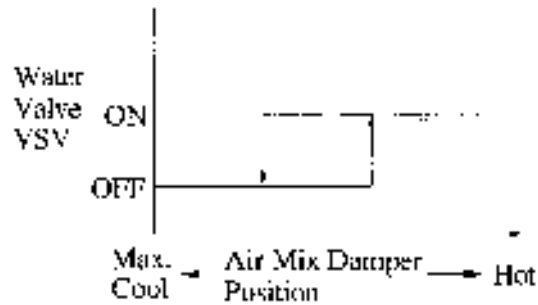
The following table is a comparison of the air conditioner ECU functions between the SC400 and LS400:

System	Function	SC400	LS400
Calculation of Required Outlet Air Temperature	Calculates the required outlet air temperature based on the set temperature, room air temperature, ambient air temperature and solar radiation.	○	○
Temperature Control	Drives the air mix servomotor in accordance with the required outlet air temperature, the air temperature after the air passes through the evaporator and the engine coolant temperature and controls the outlet air temperature (Air Mix Damper Control).	○	○
	If the target air mix damper position is on the cool side beyond a predetermined level, the water valve VSV is turned off and the circulation of coolant to the heater core is stopped, thus improving the cooling performance (Water Valve Control).	○	—
	Switches the air mix dampers to the maximum cool or hot position when the temperature control switch is turned fully to the cool or hot side (Max. Control).	○	—
Blower Control	Sets the blower speed according to operation of the blower switch (Manual Control).	○ (5-step)	○ (3-step)
	When the automatic control or front defroster switch is turned on, the blower starts. Then the blower speed that is appropriate for the required outlet air temperature is compared with the blower speed that is appropriate for solar radiation, and the blower is controlled at the faster of the two speeds (Automatic Control). However, when the coolant temperature is below a predetermined level and the air outlet is in the “foot” or “bi-level” mode, the blower will not operate (Warm-Up Control). In addition, when the air outlet mode is on “face” and the required outlet air temperature is below a predetermined level, in order to prevent hot air from being blown out suddenly right after the engine is started, the blower is set to operate after a time lag (Time-Lagged Air Flow Control).	○	○
	When the temperature control switch is turned fully to the cool or hot side, it runs the blower at maximum speed regardless of the operation of the blower switch (Max. Control).	○	—
	When the mobile telephone is being used, the blower speed is slowed down to reduce blower noise (Telephone Control).	○	—
Air Inlet 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 (Manual Control).	○	○
	Switches the damper position between “fresh”, “fresh and recirc. mix” or “recirc.” according to the required outlet air temperature (Automatic Control).	○	○
	Fixes the damper position on “fresh” if the front defroster switch is turned on during automatic control (Forced Fresh Air Intake Control).	—	○
Air Outlet Control	Drives the air outlet servomotor in accordance with the operation of the Mode select and front defroster switches and fixes the dampers in the “face”, “bi-level”, “foot”, “foot and def.” or “def.” position (Manual Control).	○	○
	Switches the damper position between “face”, “bi-level” or “foot” according to the required outlet air temperature (Automatic Control).	○	○

System	Function	SC400	LS400
Air Outlet Control	Switches the proportion of the air flow volume for vent and foot in 5 steps in accordance with the required outlet air temperature in the “bi-level” mode during automatic control (5-Step Bi-Level Control).	○	—
	When the air outlet mode is set to “face”, it drives the max. cool servomotor at one of 2 steps in accordance with the required outlet air temperature, and opens and closes the max. cool damper to increase or decrease the air outlet volume from the vents (Max. Cool Control).	—	○
	Opens and closes the max. cool damper steplessly in response to operation of the air mix servomotor in order to increase or decrease the air outlet volume from the vents (Max. Cool Control).	○	—
	When the air outlet is in the “foot” mode and the blower is under warm-up control, this drives the air outlet servomotor, switches the dampers to the “def.” position and prevents cool air from leaking from the foot vent (Def.-Foot Control).	—	○
	If the blower is under warm-up control when the air outlet mode is in “bi-level” or “foot” mode, the LCD display remains as it is while the air outlet servomotor is driven and the dampers are switched to the “def.” position, preventing cool air from leaking from the foot vent (Def.-Foot Control).	○	—
Compressor Control	If the A/C switch is switched on while the blower is turned on, this turns on the magnetic clutch relay and operates the compressor (Manual Control).	○	○
	Turns the magnetic clutch relay on or off according to the air inlet mode and ambient temperature and controls the compressor’s operation (Automatic Control).	○	○
	Switches the magnetic clutch relay off when the engine speed is below 300 rpm, when the blower is turned off by the warm-up control, or when the refrigerant pressure is abnormally high or low (Abnormal Condition Detection).	○	○
	Switches the magnetic clutch relay on regardless of the operating condition of the A/C and automatic control switches if the front defroster switch and blower are turned on (Def. Linked Control).	○	○
	Compares the engine speed and compressor speed. If it is judged that the compressor is locked, the magnetic clutch relay goes off and the A/C switch indicator light blinks to warn the driver (Compressor Lock Detection).	○	○
Cooling Fan Control	Sends signals to the cooling fan ECU in accordance with the compressor’s operation and the required outlet air temperature.	○	—
Electric Fans Control	Switches the three fan relays on and off in accordance with compressor operation, coolant temperature and refrigerant pressure and operates the fan in 3 steps (stop, low speed, high speed).	—	○
Rear 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.	○	○
Self-Diagnosis	Checks the sensors in accordance with operation of the air conditioning switches, then displays a code No. and sounds a buzzer to indicate if there is a malfunction or not (Sensor Check Function).	○ (13 items)	○ (10 items)
	Drives the actuators through a predetermined sequence in accordance with the operation of the air conditioner switches (Actuator Check Function).	○ (6 items)	○ (5 items)

Temperature Control

As in the LS400, the air mix damper position is determined by the required outlet air temperature, the air temperature after passing through the evaporator and the engine coolant temperature. In the SC400, if the air mix damper position is further to the cool side than a predetermined level, the water valve VSV is turned off and the circulation of coolant through the heater core is stopped to improve the cooling performance.

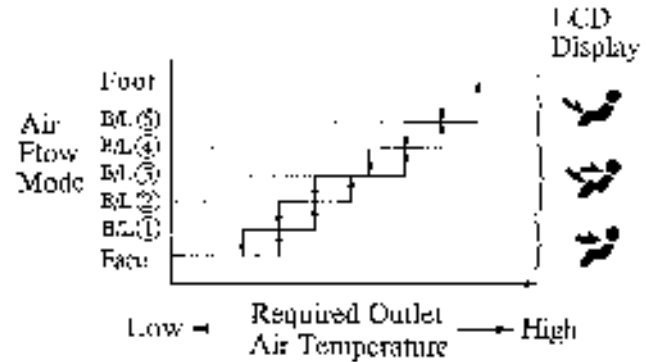


Air Outlet Control

1) 5-Step Bi-Level Control

The “bi-level” has 5 steps which gradually change the proportion of the air flow volume blown to the vent and to the foot in accordance with the required outlet air temperature during automatic control in the air outlet mode. As a result, it eliminates abrupt changes when switching between “face” and “foot”.

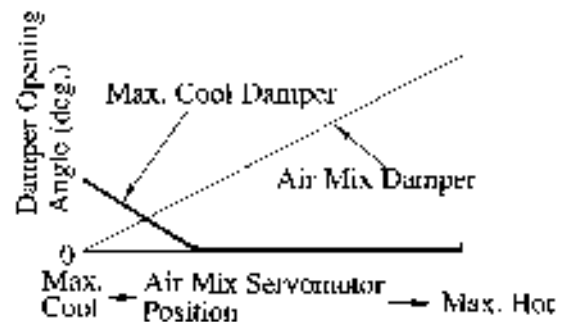
The LCD display in the air outlet mode indicates “face” while in bi-level ① and indicates “foot” while in bi-level ⑤. At other times, the system indicates at “bi-level”.



2) Max. Cool Control

The max. cool damper differs from the LS400 in that it is opened and closed by the air mix servomotor.

The position of the air mix servomotor is determined by the temperature control system. As shown in the graph at right, the max. cool damper opens when the opening angle of the air mix damper is small, that is, when the outlet air temperature is in the low range. This increases the air flow volume to the center and side vents and improves cooling performance.





Cooling Fan Control

If the magnetic clutch relay is on and the required outlet air temperature is below the predetermined level, signals are sent to the cooling fan ECU. The cooling fan ECU then raises the fan speed as necessary and improves the condenser's cooling performance.


For details of cooling fan operation, see page 54.

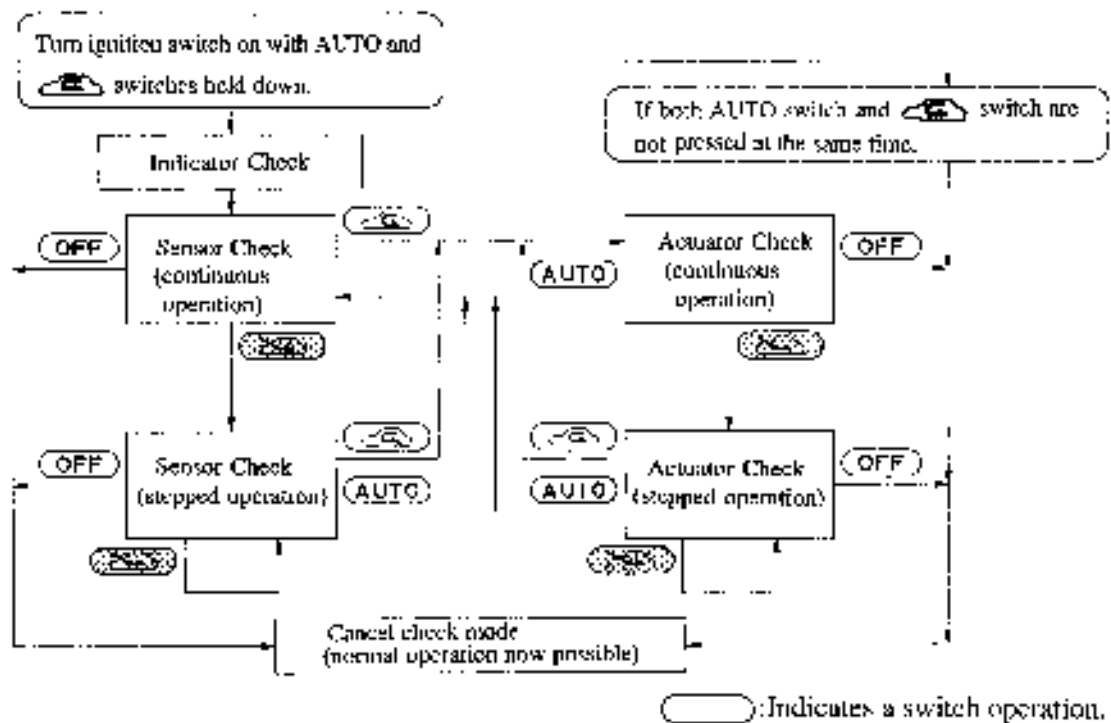
Self-Diagnosis

The basic functions are the same as in the LS400, but the following points differ.


- The switches used to advance through the steps of the sensor and actuator checks have been changed (LS400 :  : → SC400 : )
- The number of sensor check items has been changed to 13.
- With the increase in the number of actuator check items to 6 items, the driving patterns for actuators have been changed to 8 patterns.

1) Sensor and Actuator Checking Procedure

The procedure is basically the same as in the LS400. Portions marked  are different from the LS400.



2) Sensor Check Function















Portions marked with  are additions to the diagnosis system now in use for the LS400. The code No. display and the sounding of the buzzer are the same as with the LS400, except for LS400 codes No. 33 and No. 34, which correspond to SC400 codes No. 41 and No. 42, respectively.


Display	Diagnosis
00	All sensors are normal
11	Open or short circuit in room temperature sensor circuit
12	Open or short circuit in ambient temperature sensor circuit
13	Open or short circuit in evaporator temperature sensor circuit
14	Open or short circuit in water temperature sensor circuit
21*	Open or short circuit in solar sensor circuit
22*	Compressor lock detected
23*	Refrigerant pressure is either too high or too low
31	Abnormal air mix servomotor potentiometer output voltage
32	Abnormal air inlet servomotor potentiometer output voltage
33	Abnormal air outlet servomotor potentiometer output voltage
41	Abnormal air mix servomotor operation
42	Abnormal air inlet servomotor operation
43	Abnormal air outlet servomotor operation

* Only present malfunctions are displayed. When checking the solar sensor, do it while shining a light at the sensor.

3) Actuator Check Function

The water valve VSV has been added to the check items, changing the number of checks to 8 patterns.

Step No.	Display Code	Conditions					
		Blower Speed	Air Flow Vent	Air Inlet	Air Mix Damper Position	Magnetic Clutch	Water Valve VSV
1	20	OFF ()	Face ()	Fresh ()	Cool side (0% open)	OFF	OFF
2	21	① ()	↑	Fresh/Recirc.*	↑	↑	↑
3	22	↑	↑	Recirc. ()	↑	ON	↑
4	23	③ ()	Bi-Level ()	Fresh ()	Cool/Hot (50% open)	↑	ON
5	24	↑	Foot II ()	↑	↑	↑	↑
6	25	④ ()	Foot I ()	↑	Hot side (100% open)	↑	↑
7	26	↑	Foot/Def. ()	↑	↑	↑	↑
8	27	⑤ ()	Def. ()	↑	↑	↑	↑

* Indicator light for "fresh ()" mode goes on.