OMRON

Temperature Controller

E5□J

Fuzzy Self-tuning Temperature Controller with Advanced PID (2-PID) Control

- DIN-size:
  96 x 96 mm (E5AJ), 72 x 72 mm (E5BJ),
  48 x 48 mm (E5CJ), 48 x 96 mm (E5EJ)
- Fuzzy self-tuning and Auto-tuning optimize temperature control.
- Minimal user setup.
- Dual set point, selectable by external input.
- RUN/STOP operation (E5AJ/E5EJ) by external input.
- Front panel protection conforming to IP54 on E5AJ/E5EJ/E5BJ (IP66/NEMA4 with optional cover). E5CJ conforms to IP50 (IP66/NEMA4 with optional cover).
- Serial communications models (E5AJ/E5EJ).
- Relay, voltage or linear outputs.
- Conforms to international EMC and safety standards.

Ordering Information

■ Temperature Controllers

E5AJ/EJ/BJ

Item	Standard type Two alarm outputs; two event inputs (with heater burnout alarm)	Communications type			Communications Board add-on type
		RS-232C	RS-422	RS-485	
Model	E5AJ-A2HB E5EJ-A2HB E5BJ-A2HB	E5AJ-A2H01 E5EJ-A2H01	E5AJ-A2H02 E5EJ-A2H02	E5AJ-A2H03 E5EJ-A2H03	E5AJ-A2HM E5EJ-A2HM

Note: 1. Be sure to specify Control Output Unit and Current Transformer as necessary when ordering.
Example: E5AJ-A2HB, Relay Output Unit E53-R, Current Transformer E54-CT1

2. The heater burnout alarm is not available when the E5□J is used with Linear Output Units.
3. Ask your OMRON representative for the *E5AJ/E5EJ Communications Manual (Z102)* when using a model incorporating a communications function.
4. Be sure to specify Communications Boards as necessary when ordering E5AJ/EJ-A2HM Communications Board add-on types.

Control Output Unit (Required for E5AJ, E5BJ, and E5EJ)

Type	Relay Output Unit	Voltage Output Unit (for SSR drive)	Current Output Unit
Model	E53-R	E53-Q	E53-C3

Communications Boards

When communications capability is required, mount one of the following Boards on the E5AJ-A2HM or E5EJ-A2HM.

Communications	RS-232C	RS-422	RS-485
Model	E53-J01	E53-J02	E53-J03

Note: For details, refer to the *E5AJ/E5EJ Communications Manual (Z102)*.

E5CJ

Item	Standard type			Single-function type					
	Two alarm points; one event input			Two alarm points; without event input			Without alarm and event input		
	Relay output	Voltage output	Current output	Relay output	Voltage output	Current output	Relay output	Voltage output	Current output
Model	E5CJ-R2HB	E5CJ-Q2HB	E5CJ-C2B	E5CJ-R2	E5CJ-Q2	E5CJ-C2	E5CJ-R	E5CJ-Q	E5CJ-C

Note: Be sure to specify Current Transformer as necessary when ordering E5CJ-R2HB and E5CJ-Q2HB.
The heater burnout alarm is not available for models other than E5CJ-R2HB and E5CJ-Q2HB.

■ Current Transformers (CT) (Order Separately)

Hole diameter	5.8 mm	12.0 mm
Model	E54-CT1	E54-CT3

Note: No CT is required unless the heater burnout alarm function is used.

■ Terminal Covers (Order Separately)

Model	E5AJ	E5EJ	E5CJ
Connectable models	E53-COV02	E53-COV03	E53-COV04

■ Temperature Ranges

Input (switch selectable)		Temperature-resistance thermometer		Thermocouple					
		JPt100 Platinum resistance thermometer	Pt100 Platinum resistance thermometer	K (CA) Chromel vs. alumel	J (IC) Iron vs. constantan	T (CC) Copper vs. constantan	L Iron vs. constantan	U Copper vs. constantan	N Nichrosil vs. nisil
Built-in switch  Default setting; 2(K)	°C 1,300 900 800 600 400 300 200 100 0 –100 –200 Temperature range	650.0 –199.9	650.0 –199.9	1,300 –200	850 –100	400.0 –199.9	850 –100	400.0 –199.9	1,300 –200
	Setting No.	0	1	2	3	4	5	6	7
Minimum setting unit	**Target value**	0.1°C		1°C	1°C	0.1°C	1°C	0.1°C	1°C
	Alarm	0.1°C		1°C	1°C	0.1°C	1°C	0.1°C	1°C

Note: Default setting: 2 (K).

Specifications

■ Ratings

Supply voltage			100 to 240 VAC, 50 or 60 Hz	24 V AC/DC, 50 or 60 Hz
Operating voltage range			85% to 110% of rated supply voltage	
Power consumption			E5AJ/E5EJ: 10 VA (at 100 VAC) to 14 VA (at 240 VAC) E5BJ/E5CJ: 10 VA (at 100 VAC) to 12 VA (at 240 VAC)	10 VA (at 24 VAC) 6 W (at 24 VDC)
Input			Thermocouple (K/J/T/L/U/N) or platinum resistance thermometer (JPt100/Pt100), selectable	
Current Transformer input			Connect an exclusive Current Transformer unit (E54-CT1 or E54-CT3)	
Control output	**E5AJ/E5BJ/E5EJ**		Replaceable Output Unit (sold separately)	
	E5CJ	**Relay output**	SPST-NO, 3 A at 250 VAC (resistive load)	
		Voltage output	20 mA at 12 VDC (with short-circuit protection)	
		Current output	4 to 20 mA DC with a load of 600 Ω max. and a resolution of approx. 2600	
Control mode			ON/OFF or PID control (2-PID) with fuzzy self-tuning and auto-tuning	
Alarm output			E5AJ/E5EJ: Relay output, 2 independent SPST-NO contacts; 3 A, 250 VAC E5BJ/E5CJ: Common 2 outputs, 2 independent SPST-NO contacts; E5CJ: 1 A, 250 VAC; E5BJ: 3 A, 250 VAC	
Setting method			Digital setting via Up and Down Keys	
Indication method			Digital indications Character heights: E5AJ: PV: 15 mm, SV: 10.5mm E5EJ/E5BJ: PV: 14 mm, SV: 9.5 mm E5CJ: PV: 12 mm, SV: 8 mm	
Event input			Contact input: ON: 1 kΩ max., OFF: 100 kΩ min. No-contact input: ON: residual voltage: 3 V max., OFF: leakage current: 1 mA max.	
Other functions			Key protection Direct and reverse output selection Multiple SP (four set points; up to four set points available on E5AJ/E5EJ by engineering level) RUN/STOP (selected via external terminals) (E5AJ, E5EJ) Heater burnout detection	

Note: It is possible to add other functions from the engineering level. Refer to the *E5□J Operation Manual*, obtainable from your OMRON representative, for details.

■ Characteristics

Indication accuracy (see note 1)	(±0.5% of indication value or ±1°C, whichever greater) ±1 digit max.
Hysteresis	0.1° to 999.9°C/°F (in units of 0.1°C/°F) (during ON/OFF control action)
Proportional band	0.1° to 999.9°C/°F (in units of 0.1°C/°F)
Integral (reset) time	0 to 3,999 s (in units of 1 s)
Derivative (rate) time	0 to 3,999 s (in units of 1 s)
Alarm output setting range	Thermocouple (K/J/L/N): –1,999° to 9,999°C/°F (in units of 1°C/°F) Platinum resistance thermometer, thermocouple (T/U): –199.9° to 999.9°C/°F (in units of 0.1°C/°F)
Control period	Pulse output: 1 to 99 s (in units of 1 s)
Sampling period	500 ms
Output refresh time	500 ms
Display refresh time	500 ms
Insulation resistance (see note 2)	20 MΩ min. (at 500 VDC)
Dielectric strength	2,000 VAC, 50/60 Hz for 1 min between terminals of different polarities
Vibration resistance	Malfunction: 10 to 55 Hz, 9.8 m/s^2 (1G) for 10 min each in X, Y, and Z directions Destruction: 10 to 55 Hz, 19.6 m/s^2 (2G) for 2 hrs each in X, Y, and Z directions
Shock resistance	Malfunction: 196 m/s^2 (20G), 3 times each in 6 directions (98 m/s^2 (10G) applied to the relay) Destruction: 294 m/s^2 (30G), 3 times each in 6 directions
Life expectancy	Mechanical: 10,000,000 operations (relay alarm output) Electrical: 100,000 operations (relay alarm output)
Ambient temperature	Operating: –10°C to 55°C (with no icing) Storage: –25°C to 65°C (with no icing)
Ambient humidity	Operating: 35% to 85%
Memory protection	Non-volatile memory (number of write operations: 100,000)
Enclosure ratings	Front panel: E5AJ/E5EJ/E5BJ: IEC standard IP54 E5CJ: IEC standard IP50 (see note 3) Rear case: IEC standard IP20 Terminals: IEC standard IP00
Weight	E5AJ: Approx. 360 g, E5EJ: Approx. 280 g, E5BJ: Approx. 240 g, E5CJ: Approx. 170 g; Mounting adapter for E5CJ: approx. 10 g; Mounting bracket for E5AJ, E5BJ, and E5EJ: Approx. 65 g
EMC	Emission Enclosure: EN55011 Group 1 class A Emission AC Mains: EN55011 Group 1 class A Immunity ESD: EN61000-4-2: 4-kV contact discharge (level 2) 8-kV air discharge (level 3) Immunity RF-interference: ENV50140: 10 V/m (amplitude modulated, 80 MHz to 1 GHz) (level 3) 10 V/m (pulse modulated, 900 MHz) Immunity Conducted Disturbance: ENV50141: 10 V (0.15 to 80 MHz) (level 3) Immunity Burst: EN61000-4-4: 2-kV power-line (level 3) 2-kV I/O signal-line (level 4)
Approved standards	UL1092, CSA C22.2 No. 142 Conforms to EN50081-2, EN50082-2, EN61010-1 (IEC1010-1) (see note 4) Conforms to VDE0106/part 100 (Finger Protection), when the separately-ordered terminal cover is mounted.

Note: 1. The indication accuracy of the K, T, and N thermocouples at a temperature of –100°C or less is ±2°C±1 digit maximum. The indication accuracy of the U thermocouple at any temperature is ±2°C±1 digit maximum.

2. The insulation resistance was measured with a Control Output Unit attached.

3. The model numbers of the exclusive watertight covers conforming to IP66, NEMA4 are as follows:
For E5AJ: Y92A-96N; For E5BJ: Y92A-72N; For E5CJ: Y92A-48N; For E5EJ: Y92A-49N

4. Basic insulation is between the input and output.

■ Output Unit Ratings

No event input is photoelectrically insulated from the voltage or current output.

Relay Output Unit (see note 2)	**E53-R**	SPDT, 5 A at 250 VAC (resistive load)
Voltage Output Unit (for driving SSR)	**E53-Q**	NPN, 40 mA at 12 VDC (with short-circuit protection)
	E53-Q3	NPN, 20 mA at 24 VDC (with short-circuit protection)
	E53-Q4	PNP, 20 mA at 24 VDC (with short-circuit protection)
Linear Output Unit (see note 1 and 3)	**E53-C3**	4 to 20 mA; DC: 600 Ω max.; resolution: approx. 2,600
	E53-C3D	0 to 20 mA; DC: 600 Ω max.; resolution: approx. 2,600
	E53-V34	0 to 10 V; DC: 1 kΩ min.; resolution: approx. 2,600
	E53-V35	0 to 5 V; DC: 1 kΩ min.; resolution: approx. 2,600

Note: 1. The current output is not a transmission output.
The heater burnout alarm cannot be used with the E53-C Current Output Units.
2. The contact configuration will be SPST-NO when used with the E5□J.
3. No heater burnout alarm is available if the Linear Output Unit is used with the E5□J.

■ Heater Burnout Alarm

Max. heater current	Single-phase 50 A VAC (see note 1)
Heater current value display accuracy	±5% FS ±1 digit max.
Heater burnout alarm setting range	0.1 to 49.9 A (in units of 0.1 A) (see note 2)
Min. detection ON time	190 ms (see note 3)

Note: 1. Use the K2CU-F□□A-□GS (with gate input terminals) for the detection of three-phase heater burnout.
2. The heater burnout alarm is always OFF if the alarm is set to 0.0 A and always ON if the alarm is set to 50.0 A.
3. No heater burnout detection or heater current value measurement is possible if the control output is ON for less than 190 ms.

■ Current Transformer Ratings

Max. continuous heater current	50 A
Dielectric strength	1,000 VAC
Vibration resistance	50 Hz, 98 m/s^2 (10G)
Weight	E54-CT1: Approx. 11.5 g; E54-CT3: Approx. 50 g
Accessories (E54-CT3 only)	Contact: 2; Plug: 2

■ Output Unit Characteristics

Relay unit life expectancy	Mechanical: 10,000,000 operations min. Electrical: 100,000 operations min.

■ Communications (E5AJ/E5EJ)

Protocol		**RS-232C, RS-422, RS-485**
Transmission method		Half-duplex
Synchronization method		Start-stop synchronization (asynchronous method)
Baud rate		1,200/2,400/4,800/9,600/19,200 bps
Transmission code		ASCII
Communications	**Write to Temperature Controller**	Set point, alarm value, remote/local selection etc. (proportional band, integral time, derivative time)
	Read from Temperature Controller	Process value, output value, set point, alarm value, heater current value, initial status, etc. (proportional band, integral time, derivative time)

Note: 1. The maximum total cable length must not exceed the following limits.
RS-422: 500 m, RS-232C: 15 m, RS-485: 500 m
2. The number of connecting Units including the host computer via RS-485 is 32. The number of connecting Units via RS-422 is 32.

Nomenclature

E5CJ

Set Value (SV) Display
Displays the set temperature and set value of each setting item.

Process Value (PV) display
Displays the process value, the character for the parameter being displayed on the SV display, and error messages.

Output Indicator
Lights when the control output is ON. In current output mode, however, the output indicator will not be lit.

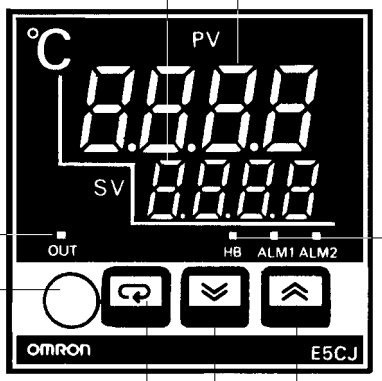
Heater Burnout Indicator
Lights when a heater burnout is detected and stays lit until reset.

Level Key
Press for 1 second minimum to change levels to set different groups of parameters.

Alarm 1 Indicator
Lights when alarm output 1 is ON.

Display Key
Press to shift the display to the next parameter.

Alarm 2 Indicator
Lights when alarm output 2 is ON.



Down and Up Keys
Press to increase or decrease the value on the SV display. Successively increases or decreases the value when held down for 1 s or more. The value set will be effective automatically in 2 s or immediately after pressing the Display Key or Level Key.

Note: There are models that do not incorporate HB, ALM1, and ALM2 indicators.

E5AJ/E5BJ/E5EJ

Process Value (PV) display
Displays the process value, the character for the parameter being displayed on the SV display, and error messages.

Stop Indicator
Lights when the Temperature Controller is not in operation. The E5BJ or any other E5□J model with a communications function does not incorporate a stop indicator.

Set Value (SV) Display
Displays the set temperature and set value of each setting item.

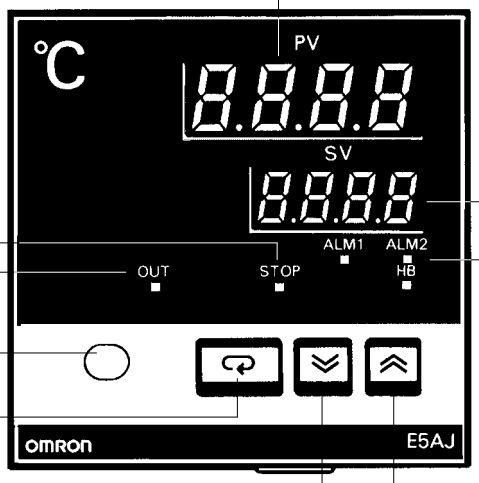
Output Indicator
Lights when the control output is ON. In current output mode, however, the output indicator will not be lit.

Level Key
Press for 1 second minimum to change levels to set different groups of parameters.

Alarm 1 Indicator
Lights when alarm output 1 is ON.

Display Key
Press to shift the display to the next parameter.

Alarm 2 Indicator
Lights when alarm output 2 is ON.



Down and Up Keys
Press to increase or decrease the value on the SV display. Successively increases or decreases the value when held down for 1 s or more. The value set will be effective automatically in 2 s or immediately after pressing the Display Key or Level Key.

Heater Burnout Indicator
Lights when a heater burnout is detected and stays lit until reset.

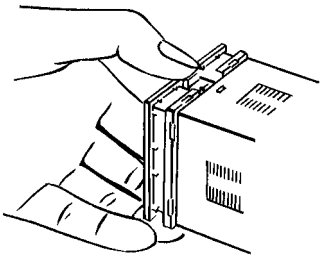
Operation

NOTICE: Always turn off the power supply to the Temperature Controller before changing any switch settings.

■ Settings

E5CJ

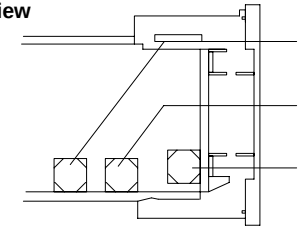
Remove the internal mechanism from the housing. Pull out the internal mechanism while pressing the hook at the bottom of the front panel.



Internal Switches

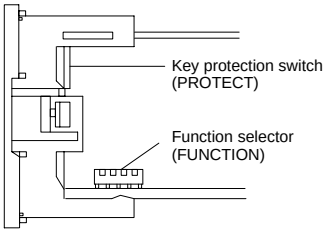
E5CJ

Top View



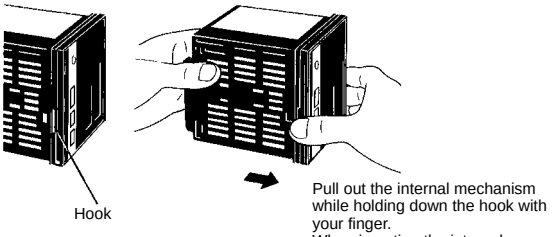
Note: A model with no alarm does not incorporate an alarm mode selector.

Bottom View

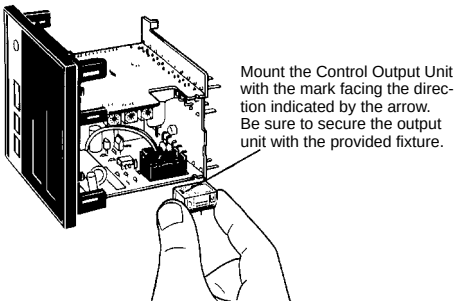


E5AJ/E5BJ/E5EJ

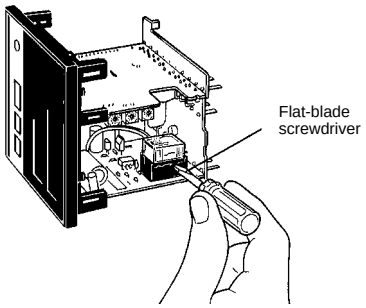
1. Remove the internal mechanism from the housing. Pull out the internal mechanism while pressing the hook at the bottom of the front panel.



2. Connect a Control Output Unit to the vacant socket on the printed circuit board as shown below.



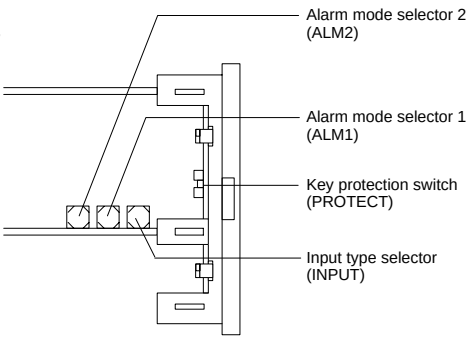
To remove a Control Output Unit, push it up with the tip of a flat-blade screwdriver as shown below.



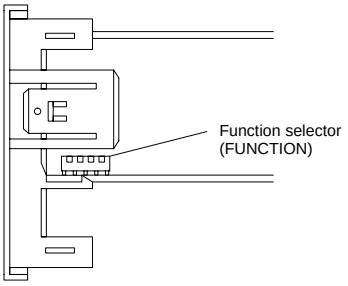
Internal Switches

E5AJ

Top View

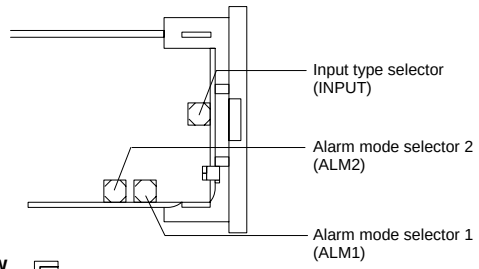


Bottom View

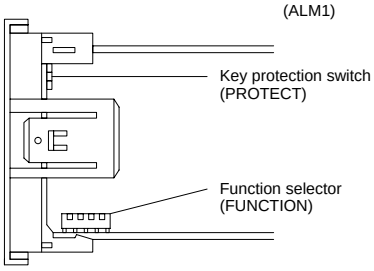


E5BJ

Top View

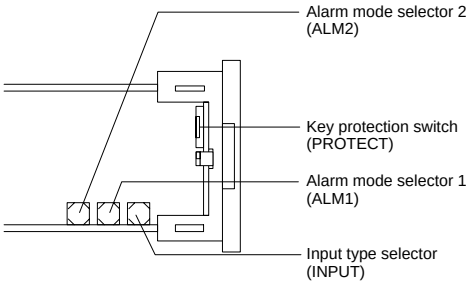


Bottom View

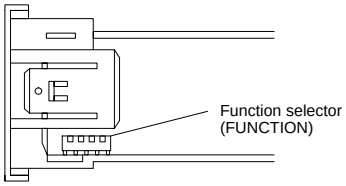


E5EJ

Top View



Bottom View



■ Input Type Selector (INPUT)

This selector selects the temperature sensor to be used. It is factory-set to position 2 to designate a K-type (chromel-alumel thermocouple) temperature sensor. The following table lists the other possible settings for temperature sensors. Refer to temperature range charts under *Ordering Information* for further information.

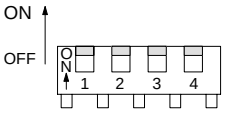
Switch setting	Temperature sensor code	Temperature range	
		°C	°F
0, 8	JPt100	–199.9 to 650.0	–199.9 to 999.9
1, 9	Pt100	–199.9 to 650.0	–199.9 to 999.9
2	K	–200 to 1,300	–300 to 2,300
3	J	–100 to 850	–100 to 1,500
4	T	–199.9 to 400.0	–199.9 to 700.0
5	L	–100 to 850	–100 to 1500
6	U	–199.9 to 400.0	–199.9 to 700.0
7	N	–200 to 1,300	–300 to 2,300

Note: JPt100: 139.16 Ω at 100°C
Pt100: 138.50 Ω at 100°C

Temperature Control in Fahrenheit

1. After setting all internal switch settings, set pin number 4 of the function switch to ON. This pin is normally set to OFF.
2. Insert the internal mechanism into the housing and turn on the Temperature Controller.
3. *adjU* will be displayed. Then press the Up Key to change the set value display into Fahrenheit "*F*."
4. Turn off the power 2 s after the set value display has changed to Fahrenheit.
5. Remove the internal mechanism from the housing, set pin number 4 of the function switch to OFF, replace it and turn on the power.

■ Function Selector (FUNCTION)



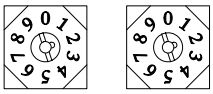
The DIP switch sets the operating parameters listed in the following table. All pins are factory-set to OFF.

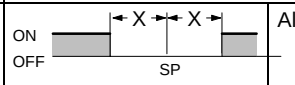
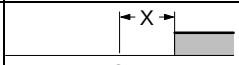
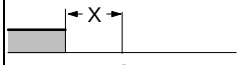
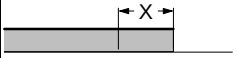
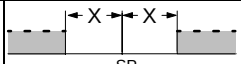
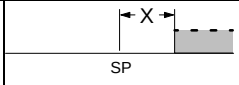
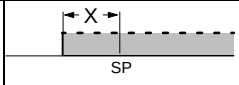
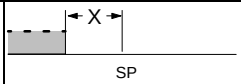
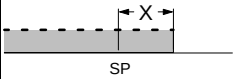
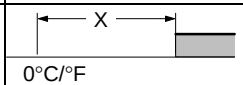
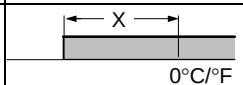
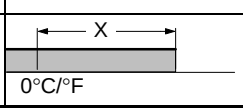
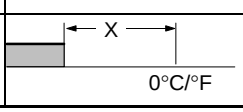
Function selector pin number		1	2	3	4
Output operation	**Normal (see note 1)**	ON	---	---	---
	Reverse (see note 1)	OFF	---	---	---
Control mode	**ON/OFF**	---	ON	---	---
	Advanced PID	---	OFF	---	---
PID tuning mode	**With auto-tuning (see note 2)**	---	---	ON (see note 3)	---
	With fuzzy self-tuning	---	---	OFF (see note 3)	---
Level	**Engineering level**	---	---	---	ON
	Normal operation	---	---	---	OFF
Factory setting		OFF	OFF	OFF	OFF

Note: 1. For heating applications, use the reverse operation mode. For cooling applications use the normal operation mode. (In other cases, select the desired setting.)
2. To start auto-tuning, press the Level and Display Keys simultaneously, for 1 s or longer to start auto-tuning. During auto-tuning, the set value display flashes. (The display will stop flashing after tuning is finished.)
3. If the control mode is ON/OFF, pin 3 can be set ON or OFF. (Pin 3 is not important in case of ON/OFF control.)

■ Alarm Mode Selectors (ALM1, ALM2)

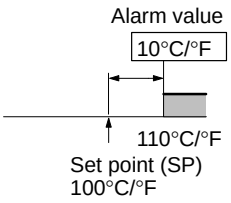
Alarm modes, listed in the following table, can be selected using this switch. The switch is factory-set to position 2, i.e., the upper-limit alarm mode.



Switch setting	Mode Alarm operation	Alarm output When X is positive	 When X is negative	Setting range
0	No alarm	OFF		---
1	Upper- and lower-limit alarm (deviation)		Always ON	–1999 to 9999, or –199.9 to 999.9 (The decimal position varies with the input type.)
2	Upper-limit alarm (deviation)			
3	Lower-limit alarm (deviation)			
4	Upper- and lower-limit alarm (deviation)		Always OFF	
5	Upper- and lower-limit alarm with standby sequence (deviation)		Always OFF	
6	Upper-limit alarm with standby sequence (deviation)			
7	Lower-limit alarm with standby sequence (deviation)			
8	Absolute-value upper-limit alarm			
9	Absolute-value lower-limit alarm			

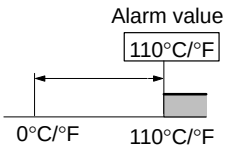
Deviation Alarm

If the alarm mode selector is set to a number between 1 to 7, alarm values are set to the width deviated from the set point as shown in the following illustration.



Absolute Alarm

If the alarm mode selector is set to 8 or 9, alarm values are set to the absolute value based on 0°C/°F as shown in the following illustration.



■ Key Protection Switch (PROTECT)

The key protection switch is factory-set to the OFF position.

$\overline{SP}$ → OFF → ALL

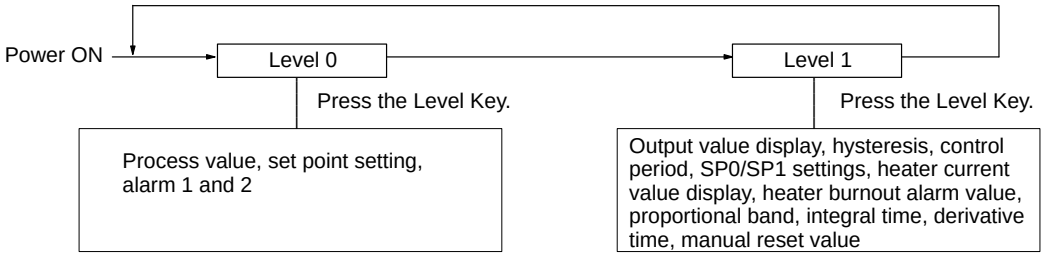
To write-protect set values, the settings of the protect modes must be changed.

Mode	Protection
$\overline{SP}$	All set values other than the set point will be write-protected.
	The Level Key will not be valid. The Down and Up Keys will not be valid except set point setting.
OFF	No key protection will be valid.
	All keys will work normally.
ALL	All set values will be write-protected.
	The Level, Down, and Up Keys will not be valid.

■ Inputting Parameters

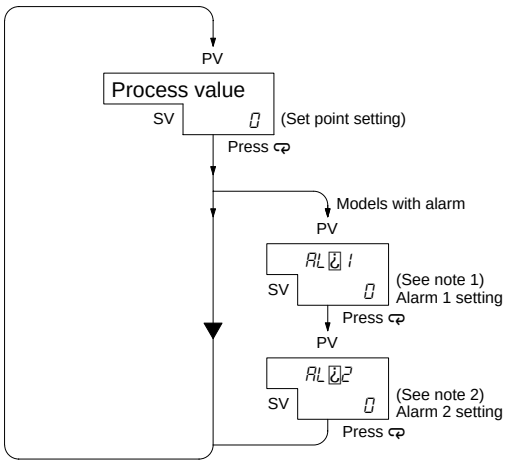
The temperature Controller has two display levels 0 and 1, in which only specific parameters can be set. Level 0 is the initial level and is automatically entered upon power application. To change the mode to set or change a different group of parameters, hold down the Level Key for 1 second minimum. The display level mode changes as shown below. Actual displays vary with models and switch settings. If a display does not appear as expected, check your switch settings.

Besides the functions explained here, the Temperature Controller incorporates an alarm hysteresis function, set point limit function, automatic return of display mode function, input shift function, and event input 2 type selection (incorporated by the E5AJ and E5EJ only). Refer to the *E5□J Operation Manual (Z103)*, which can be obtained from your OMRON representative, for details on these functions.



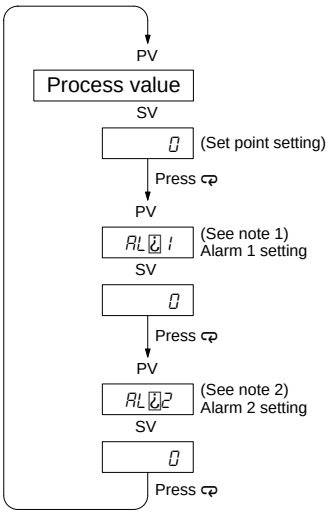
Level 0

E5CJ



Note: 1. Nothing is displayed if ALM1 is set to 0 (i.e., no alarm function is ON).
2. Nothing is displayed if ALM2 is set to 0 (i.e., no alarm function is ON).

E5AJ/E5BJ/E5EJ



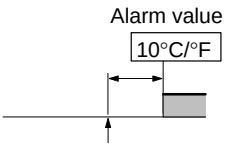
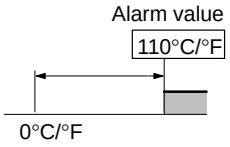
Note: 1. Nothing is displayed if ALM1 is set to 0 (i.e., no alarm function is ON).
2. Nothing is displayed if ALM2 is set to 0 (i.e., no alarm function is ON).

Set Point Setting (°C or °F)

Use the Down and UP Keys to set the set point. A model with event input allows the change of the set point (SP0 or SP1) that has been selected.

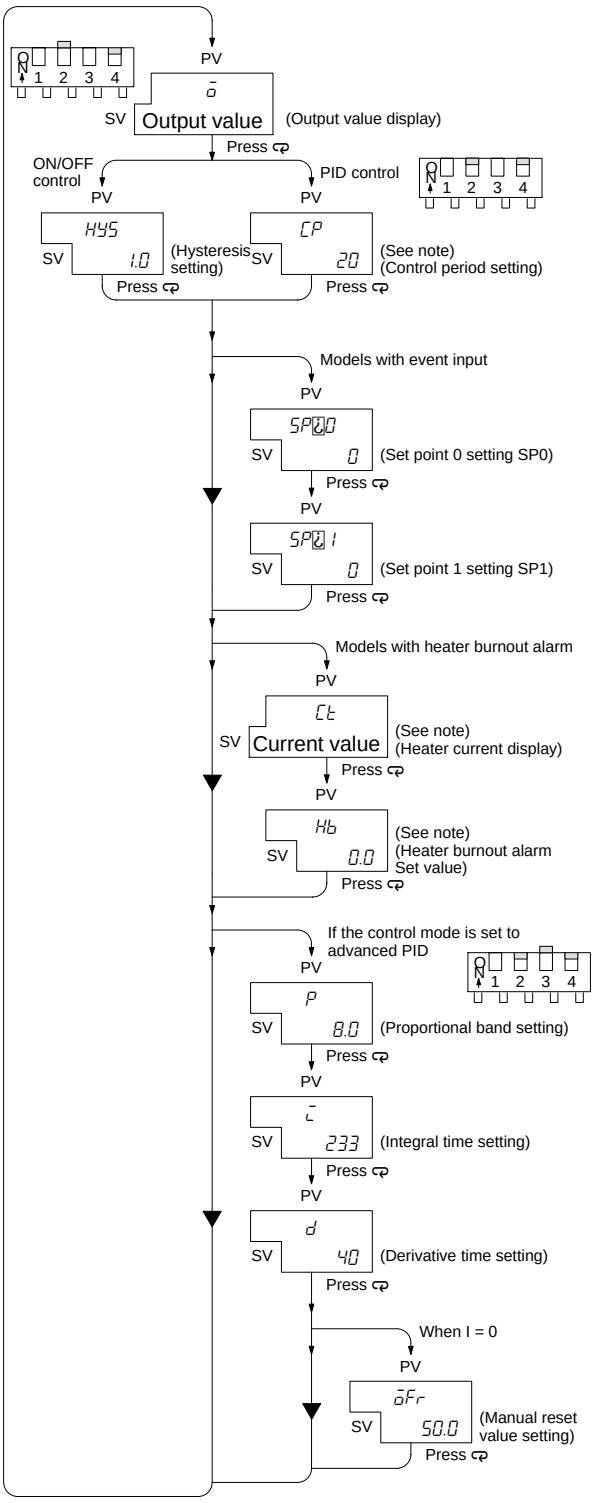
Alarm 1, 2: AL□1, AL□2 (°C or °F)

Alarm values can be set with Down and Up Keys. The alarm mode is factory set to upper-limit alarm (deviation) mode.
The alarm mode can be changed with the alarm mode selector.
An alarm value can be set to the deviation width or absolute value according to the alarm mode.

Deviation alarm	Absolute-value alarm
Upper- and lower-limit alarm, upper-limit alarm, lower-limit alarm, upper- and lower-limit range alarm	**Absolute-value upper-limit alarm, absolute-value lower-limit alarm**
Set to the width deviated from the set point.  	Set to the absolute value based on 0°C/ °F. 

Level 1

E5CJ



Note: Nothing is displayed in current output model.