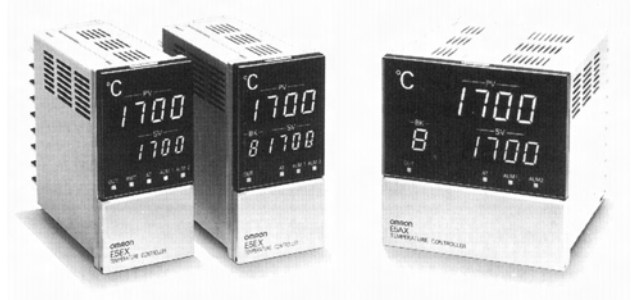


Temperature Controller

E5AX-BA/BAH
E5EX-BA/A02/A03

Compact 96 x 48-mm (DIN) Temperature Controller with Communication Capabilities and 8 Memory Banks

- Advanced PID control with feed-forward circuitry (2-PID) for optimum control.
- Eight memory banks for easy parameter changes.
- Communication capabilities for centralized data management.
- Interchangeable Output Units to expand Controller applicability.
- Input sensor selectable via internal switches.
- Available with heater burnout detection.



Ordering Information

An Output Unit must be connected to all Controllers.

An Output Unit and Current Transformer must also be connected to Controllers with a heater burnout alarm.

Current Output Units and Current Transformer are sold separately.

Current Output Units cannot be used to control the outputs of E5EX models that incorporate a heater burnout alarm.

Be sure to specify Output Unit and Current Transformer as necessary when ordering.

Example: E5EX-BATC, Relay Output Unit E53-R, Current Transformer E54-CT1

■ Temperature Controllers Thermocouple

Item	8 banks		Communications			
	Without heater burnout alarm	With heater burnout alarm	RS-422		RS-485	
			Without heater burnout alarm	With heater burnout alarm	Without heater burnout alarm	With heater burnout alarm
Model	E5AX-BATC E5EX-BATC	E5AX-BAHTC E5EX-BAHTC	E5EX-A02TC	E5EX-AH02TC	E5EX-A03TC	E5EX-AH03TC

Platinum Resistance Thermometer

Item	8 banks		Communications			
	Without heater burnout alarm	With heater burnout alarm	RS-422		RS-485	
			Without heater burnout alarm	With heater burnout alarm	Without heater burnout alarm	With heater burnout alarm
Model	E5AX-BAP E5EX-BAP	E5AX-BAHP E5EX-BAHP	E5EX-A02P	E5EX-AH02P	E5EX-A03P	E5EX-AH03P

■ Current Transformers (CT)

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

Note: The E54-CT2 cannot be used.

■ Temperature Ranges

Thermocouple

Input (switch selectable)	R Platinum vs. platinum. rhodium 13%	S Platinum vs. platinum. rhodium 10%	K (CA) Chromel vs. alumel	J/L (IC) Iron vs. constantan	T/U (CC) Copper vs. constantan	E (CRC) Chromel vs. constantan	B Platinum. rhodium 30% vs. platinum. rhodium 6%	N Nichrosil vs. nisil	
Range	°C	0 to 1,700	0 to 1,700	-200 to 1,300	-100 to 850	-200 to 400	0 to 600	100 to 1,800	0 to 1,300
	°F	0 to 3,000	0 to 3,000	-300 to 2,300	-100 to 1,500	-300 to 700	0 to 1,100	300 to 3,200	0 to 2,300
Resolution (°C/°F) (main settings and alarm)	1								

Platinum Resistance Thermometer

Input (switch selectable)	JPt100/Pt100	
Range	°C	-99.9 to 450.0
	°F	-99.9 to 800.0
Resolution (°C/°F) (main settings and alarm)	0.1	

Specifications

■ Ratings

Supply voltage	100 to 240 VAC, 50/60 Hz
Operating voltage range	85% to 110% of rated supply voltage
Power consumption	Approx. 10 VA (at 100 VAC) to 15 VA (at 24 VAC)
Input	Thermocouple (R/S/K/J/T/E/B/N/L/U) or platinum resistance thermometer (Pt100/JPt 100), selectable
Current Transformer input	Connect an exclusive Current Transformer unit (E54-CT1 or E54-CT3).
Control output	See Control Output Unit Ratings (Control Output Units are sold separately.)
Control mode	PID control with feed-forward circuitry (feed-forward PID) with auto-tuning or ON/OFF
Alarm output	Relay output, 2 independent SPST-NO contacts; 3 A, 250 VAC (resistive load)
Heater burnout alarm output	Relay output, SPST-NO; 1 A, 250 VAC (resistive load)
Setting method	Digital setting via Up and Down Keys
Indication method	Digital indications (character heights: PV: 11 mm, SV: 8 mm, BK: 8 mm) (color PV: red, SV: green, BK: orange)
Bank selection	No voltage, contact signal input; contact impedance: 100 Ω max.
Other functions	Upper and lower limits for set value Key protection Input shift Scale selection (°C/°F) Normal and reverse output selection Bank selection Bank copy Watchdog timer function (Detects failures in the CPU and restores the CPU.)

■ Output Unit Ratings

Relay Output Unit	E53-R	SPDT; 5 A, 250 VAC (resistive load)
SSR Output Unit	E53-S	SPST-NO; 1 A, 75 to 250 VAC; leakage current: 1.5 mA max. (at 200 VAC)
Voltage Output Unit (for driving SSR)	E53-Q	40 mA max., 12 VDC; NPN (with short-circuit protection)
	E53-Q3	20 mA max., 24 VDC; NPN (with short-circuit protection)
	E53-Q4	20 mA max., 24 VDC; PNP (with short-circuit protection)
Current Output Unit*	E53-C	4 to 20 mA, DC: 600 Ω max.; resolution: 212

*Current Output Units cannot be used to control the outputs of E5EX models that incorporate a heater burnout alarm.

■ Current Transformer Ratings

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

■ Controller Characteristics

Setting accuracy*	($\pm 0.3\%$ of set value or $\pm 1^\circ\text{C}$, whichever greater) ± 1 digit max.
Indication accuracy	($\pm 0.3\%$ of indication value or $\pm 1^\circ\text{C}$, whichever greater) ± 1 digit max. (Set value coincides with the indicated value, because no relative error exists between both values.)
Hysteresis	0.0° to 999.9 °C/°F (in units of 0.1°C/°F) (during ON/OFF control action)
Proportional band	0.0° 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: -999° to $9,999^\circ\text{C}/^\circ\text{F}$ (in units of $1^\circ\text{C}/^\circ\text{F}$) Platinum resistance thermometer: -99.9° to $999.9^\circ\text{C}/^\circ\text{F}$ (in units of $0.1^\circ\text{C}/^\circ\text{F}$)
Control period	Pulse output: 1 to 99 s (in units of 1 s)
Sampling period	500 ms
Output refresh period	500 ms
Display refresh period	500 ms
Input shift range	-99.9° to $999.9^\circ\text{C}/^\circ\text{F}$ (in units of $1^\circ\text{C}/^\circ\text{F}$)
Insulation resistance	20 M Ω min. (at 500 VDC) (measured with a Control Output Unit attached)
Dielectric strength	2,000 VAC, 50/60 Hz for 1 minute between terminals of different polarities (measured with a Control Output Unit attached)
Vibration resistance	Malfunction: 2 to 55 Hz, 2G 10 minutes each in X, Y, and Z directions Destruction: 10 to 55 Hz, 0.75-mm double amplitude 2 hours each in X, Y, and Z directions
Shock resistance	Malfunction: 200 m/s ² 3 times each in 6 directions Destruction: 300 m/s ² 3 times each in 6 directions
Ambient temperature	Operating: -10° to 55°C (with no icing) Storage: -25° to 65°C (with no icing)
Ambient humidity	Operating: 35% to 85%
Memory protection	Non-volatile memory
Enclosure ratings	Front panel: IEC standard IP50 Rear case: IEC standard IP20 Terminals: IEC standard IP00
Weight	Approx. 310 g; mounting bracket: approx. 50 g

*The accuracy of U thermocouples under temperatures from -150° to 400°C (-240° to 700°F) is $\pm 2^\circ\text{C}$ ($\pm 3.6^\circ\text{F}$) ± 1 digit. Accuracy is reduced below -150°C (-240°F). The accuracy of R and S thermocouples under 0° to 200°C (0° to 400°F) is $\pm 3^\circ\text{C}$ ($\pm 5.4^\circ\text{F}$) ± 1 digit. The accuracy of the B thermocouple below 400°C (750°F) is not guaranteed.

■ Output Unit Characteristics

Relay unit life expectancy	Mechanical: 10,000,000 operations min. Electrical: 100,000 operations min.
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■ Heater Burnout Detection Characteristics

Max. heater current	50 A, single-phase
Monitor accuracy of input current	±5% of full scale ±1 digit max.
Heater burnout detection setting range	0.1 to 49.9 A (in units of 0.1 A)*
Heater current monitor range	0.0 to 50.0 A
Min. detectable ON time	200 ms**

*Heater burnout is not detected when current is set to 0.0 A; the burnout alarm will be automatically turned ON when current is set to 50.0 A.

**When the control output is ON for less than 200 ms, heater burnout is not detected and heater current is not measured.

■ Communications

Protocol		RS-422	RS-485
Transmission method		4-wire, half-duplex	2-wire, half-duplex
Synchronization method		Start-stop synchronization	
Baud rate		150/300/600/1,200/2,400/4,800/9,600 bps	
Transmission code		ASCII (7-bit)	
Communications	Write to Temperature Controller	Main setting, set alarm value, proportional band, integral time, derivative time, Auto-tuning (AT) start/stop, heater burnout alarm set value	
	Read from Temperature Controller	Main setting, set alarm value, proportional band, integral time, derivative time, process temperature, heater burnout alarm set value, Current Transformer input value, etc.	

Note: 1. The maximum total cable length must not exceed the following limits.

RS-422: 500 m, RS-485: 500 m

2. A maximum of 32 Temperature Controllers can be connected to one host computer using serial communications (RS-422). In the case of the RS-485 serial communications, however, a maximum of 31 Temperature Controllers can be connected to one host computer.

Nomenclature

E5AX-BA/BAH

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

Bank Number Display
Displays the present bank number.

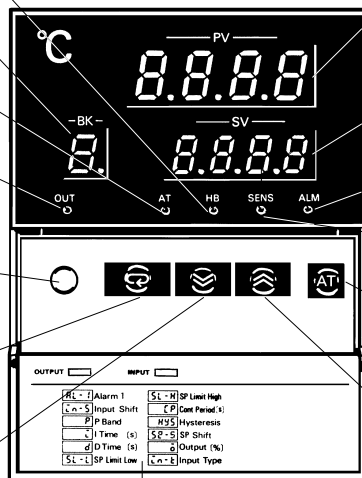
Auto-tuning Indicator
Flashes on and off every second when auto-tuning is taking place.

Output Indicator
Lights when the control output is ON. Turns off when the current output unit is used.

Level Key
Press for 2 seconds minimum to change levels to set different groups of parameters.

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

Down Key
Press to decrease the main setting or other parameters. Successively decrease the value when held down.



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

Set Value (SV) Display
Displays the main setting and other parameters.

Alarm Indicator
Lights when alarm output is ON.

Sensor Error Indicator
Lights when sensor error is detected.

Auto-tuning Key
Press for 1 second minimum to start auto-tuning. Press for 1 second minimum during auto-tuning to stop auto-tuning.

UP Key
Press to increase the main setting or other parameters. Successively increases the value when held down.

E5EX-BA

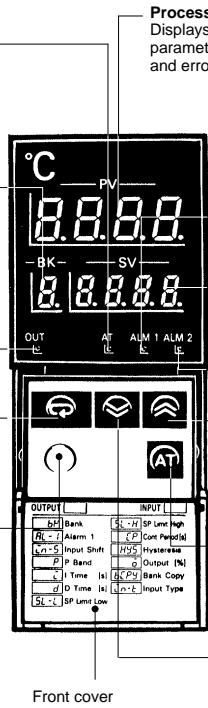
Auto-tuning Indicator
Flashes on and off every second when auto-tuning is taking place.

Bank Number Display
Displays the present bank number.

Output Indicator
Lights when the control output is ON. Turns off when the current output unit is used.

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

Level Key
Press for 2 seconds minimum to change levels to set different groups of parameters.



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

Alarm 1 Indicator
Lights when alarm output 1 is ON.

Set Value (SV) Display
Displays the main setting and other parameters.

Alarm 2 Indicator
Lights when alarm output 2 is ON.

UP Key
Press to increase the main setting or other parameters. Successively increases the value when held down.

Auto-tuning Key
Press for 1 second minimum to start auto-tuning. Press for 1 second minimum during auto-tuning to stop auto-tuning.

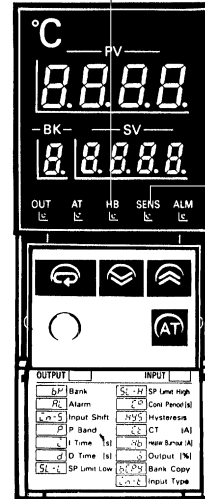
Down Key
Press to decrease the main setting or other parameters. Successively decrease the value when held down.

Front cover

E5EX-BAH

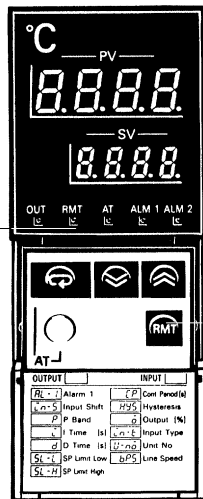
Heater Burnout Indicator
Lights when a heater burnout is detected and stays lit until reset.

Sensor Error Indicator
Lights when sensor error is detected.



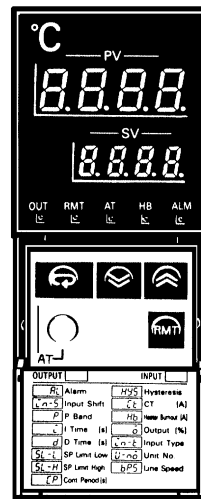
E5EX-A02/A03

Remote Indicator
Lights in the remote mode. The indicator is off in the local mode.



Remote Key
Press to communicate in the remote mode. Press again to set parameters with the keys in the local mode.

E5EX-AH02/AH03



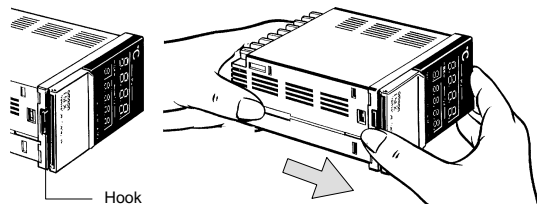
Note: Press both the Display Key and Level Key for 1 second minimum to start auto-tuning. Press both the Display Key and Level Key for 1 minimum during auto-tuning to stop auto-tuning.

Operation

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

■ Settings

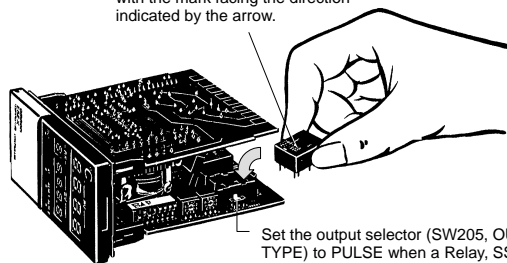
1. Remove the internal mechanism from the housing. Lift the internal mechanism while pressing the hook at the bottom of the front panel.



Pull out the internal mechanism while holding down the hook with your finger.

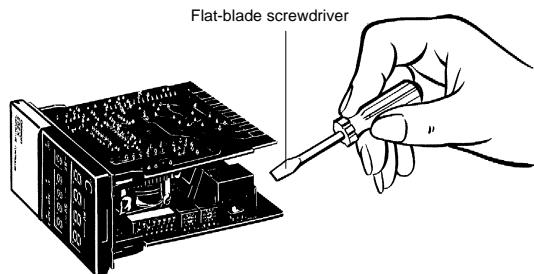
2. Connect a Control Output Unit to the vacant socket on the printed circuit board as shown below.

Mount the Control Output Unit with the mark facing the direction indicated by the arrow.



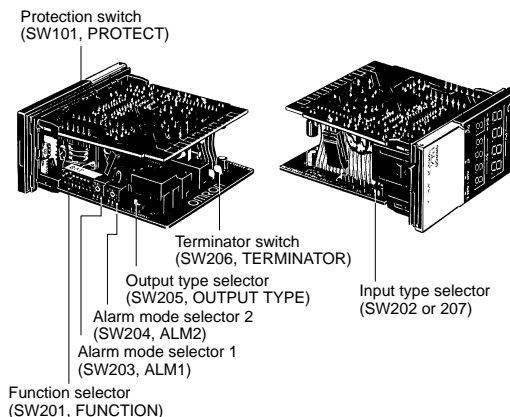
Set the output selector (SW205, OUTPUT TYPE) to PULSE when a Relay, SSR, or Voltage Output Unit is mounted. Set the output selector to CURRENT when a Current Output Unit is mounted.

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



3. Six internal switches must be set on the E5EX: the function selector, the alarm mode selectors 1 and 2, the output selector, terminator switch, and the input type selector.

The figures show the locations of these switches and the protection switch on the internal mechanisms. The protection switch can be used to disable key operation.



Output Selector (SW204, OUTPUT)

OFF ON
PULSE ↔ CURRENT

Output	Setting (factory-set to OFF)
Current	ON
Pulse	OFF

Input Type Selector

Thermocouple Selector (SW202, 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.

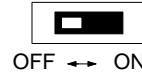
The scale displayed ($^{\circ}\text{C}$ or $^{\circ}\text{F}$) is selected by the function selector (SW201).



Switch setting	Temperature sensor code	Temperature range	
		$^{\circ}\text{C}$	$^{\circ}\text{F}$
0	R	0 to 1,700	0 to 3,000
1	S	0 to 1,700	0 to 3,000
2	K	-200 to 1,300	-300 to 2,300
3	J	-100 to 850	-100 to 1,500
4	T	-200 to 400	-300 to 700
5	E	0 to 600	0 to 1,100
6	B	100 to 1,800	300 to 3,200
7	N	0 to 1,300	0 to 2,300
8	L	-100 to 850	-100 to 1,500
9	U	-200 to 400	-300 to 700

Platinum Resistance Thermometer Selector (SW207, INPUT)

This selector is factory-set to OFF to designate a JPt100-type temperature sensor. The settings and applicable ranges are shown in the following table.



Switch setting	Temperature sensor code	Temperature range	
		$^{\circ}\text{C}$	$^{\circ}\text{F}$
OFF	JPt100	-99.9 to 450.0	-99.9 to 800.0
ON	Pt100	-99.9 to 450.0	-99.9 to 800.0

Note: JPt100: 100 $^{\circ}\text{C}$ /139.16 Ω
PT100: 100 $^{\circ}\text{C}$ /138.50 Ω

■ Function Selector (SW201, FUNCTION)

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



Controllers with Memory Banks

Function	Pin number	Pin setting	Setting
Control mode	1	ON	ON/OFF operation
		OFF	Feed-forward PID operation
Control output	2	ON	Normal (cooling)
		OFF	Reverse (heating)
Input shift (see Note 2)	3	ON	Enabled
		OFF	Disabled
SP (set point) protection cancel	4	ON	Enabled
		OFF	Disabled
Scale	5	ON	°F
		OFF	°C
PID display	6	ON	Enabled
		OFF	Disabled
Bank No. selection	7	ON	Terminal input
		OFF	Key input
Not used.	8	Leave turned OFF.	

Note:

1. The set temperature value can be changed regardless of the position of the key protection switch (SW101, PROTECT) when pin 4 is set to the ON position.
2. The input shift function will be disabled regardless of the pin position when an input shift value of 0 is set.

Controllers with Communications Capability

Function	Pin number	Pin setting	Setting
Control mode	1	ON	ON/OFF operation
		OFF	Feed-forward PID operation
Control output	2	ON	Normal (cooling)
		OFF	Reverse (heating)
Input shift	3	ON	Enabled
		OFF	Disabled
SP (set point) protection cancel	4	ON	Enabled
		OFF	Disabled
Scale	5	ON	°F
		OFF	°C
PID display	6	ON	Enabled
		OFF	Disabled
Not used.	7	Leave turned OFF.	
Loop back test	8	ON	Test
		OFF	Normal

Note:

1. The set temperature value can be changed regardless of the position of the key protection switch (SW101, PROTECT) when pin 4 is set to the ON position.
2. The input shift function will be disabled regardless of the pin position when an input shift value of 0 is set.

■ Alarm Mode Selectors (SW203: ALM1; SW204: ALM2)

Alarm mode selectors are provided on all Temperature Controllers. 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 output		Setting range
	Alarm operation	Display	When X is positive	When X is negative	
0	No alarm	No display	OFF		---
1	Upper- and lower-limit alarm]--[---	Thermocouple: 0° to 9,999°C/°F Platinum resistance thermometer: 0° to 999.9°C/°F
2	Upper-limit alarm	---[Thermocouple: -999° to 9,999°C/°F
3	Lower-limit alarm]----			Platinum resistance thermometer: -99.9° to 999.9°C/°F
4	Upper- and lower-limit range alarm	-[]-		---	Thermocouple: 0° to 9,999°C/°F
5	Upper- and lower-limit range alarm with standby sequence]--E		---	Platinum resistance thermometer: 0° to 999.9°C/°F
6	Upper-limit alarm with standby sequence	---E			Thermocouple: -999° to 9,999°C/°F
7	Lower-limit alarm with standby sequence]----			Platinum resistance thermometer: -99.9° to 999.9°C/°F
8	Absolute-value upper-limit alarm	!-[
9	Absolute-value lower-limit alarm]--!			

■ Key Protection Switch (SW101, PROTECT)

The key protection switch is factory-set to the OFF position. When the key protection switch is ON, the Level Key, Up and Down Keys, and Auto-tuning Key cannot be operated. In effect, the E5EX is write-protected and the set values (such as the alarm value) can be only read out. However, when pin 4 of the function selector (SW201, FUNCTION) is set to the ON position (i.e., SP (set point) protection is cancelled), only the set temperature value can be changed.

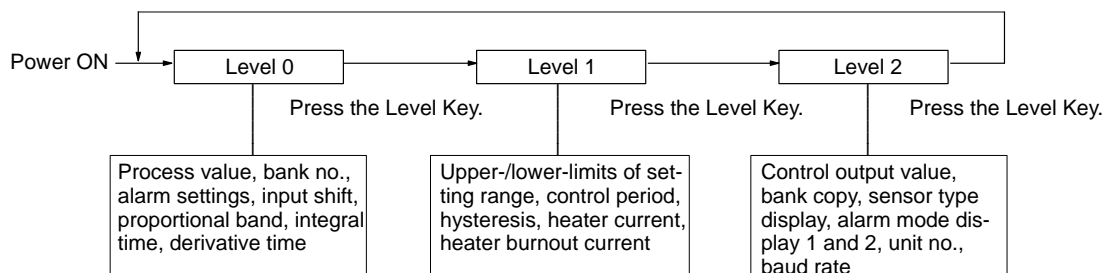
■ Terminator Switch (SW206, TERMINATOR)

The terminator switches of all the Temperature Controllers on a network must be set to the OFF position, except the terminator switch of the Temperature Controller working as the end unit (i.e. the Temperature Controller farthest from the host computer on a network). The terminator switch is factory-set to the OFF position.

Note: If the terminator is not designated correctly, the total current consumption will increase and communications errors could result.

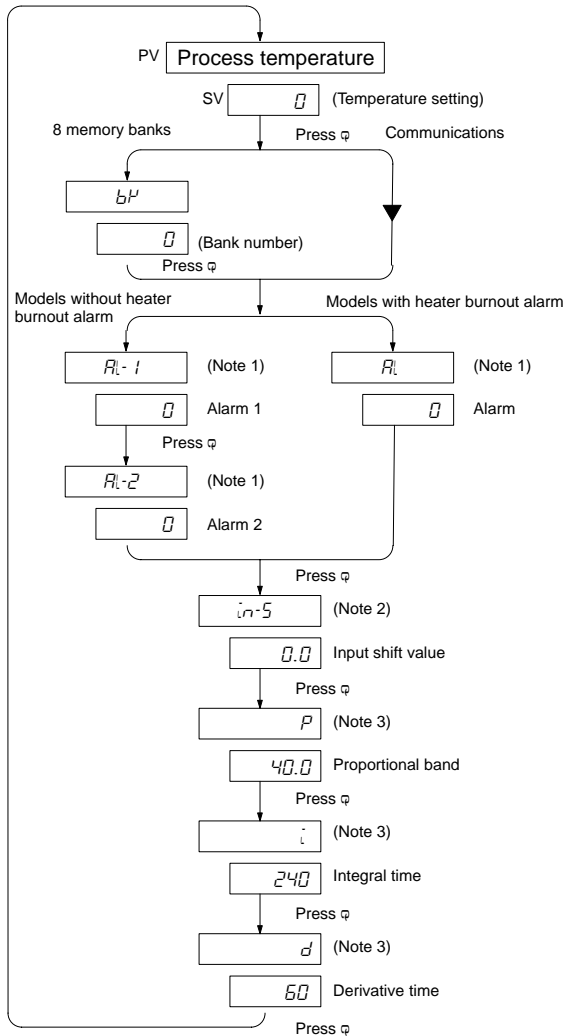
■ Inputting Parameters

The Temperature Controller has three display levels 0, 1, and 2, in which only specific parameters can be set. Level 0 is the initial level and is automatically entered at power application. To change the mode to set or change a different group of parameters, hold down the Level Key for 2 seconds 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.



Level 0

In this level, parameters such as the alarm setting, input shift values can be set or changed. When these parameters are being set or changed, the new values are displayed on the SV display. The parameter to be set or changed is selected by pressing the Display Key the required number of times.



- Note:**
1. Displayed only when the alarm function is selected.
 2. Displayed only when the input shift display function is selected.
 3. Displayed only when the PID constant display function is selected.

Process Value

While the process temperature is displayed, the desired temperature can be set with Up and Down Keys. The value is factory-set to 0°C/°F.

Bank No.: bP

When “bP” is displayed on the PV display, the memory bank number can be set with Up and Down Keys. The memory bank number is factory-set to 0. This means the E5AX-BA/E5EX-BA operates with the values set in memory bank 0 if the memory bank number is not reset before use.

Alarm 1, 2: RL-1, RL-2

Alarm: RL

When “RL” is displayed on the PV display, the alarm value for alarm output can be set on the SV display with Up and Down Keys. Usually, the alarm value is set as a deviation from the main setting, but it can also be set as an absolute value when the absolute value alarm mode is selected. The message is not displayed if the alarm mode selector is set to position 0. The value is factory-set to 0°C/°F.

Input Shift: in-5

When “in-5” is displayed on the PV display, the input shift value can be set on the SV display with Up and Down Keys. When a platinum resistance thermometer is used, the range is from -99.9° to 999.9°C/°F in units of 0.1°C/°F. If the displayed temperature does not need to be shifted, set 0°C/°F. This function is used to shift the temperature display from the measured value by a desired value, as shown by the examples in the following table:

Input shift value	Temperature measured by sensor	Displayed temperature
0 (without shift)	100°C	100°C
10 (offset by 10°C)	100°C	110°C
-10 (offset by -10°C)	100°C	90°C

Proportional Band: P

When the character “P” is displayed on the PV display, the proportional band (P constant) can be changed using the Up and Down Keys. The new value will be displayed on the SV display. It can be set in a range from 0.1° to 999.9°C/°F in units of 0.1°C/°F. The value is factory-set to 40°C/°F.

Integral Time : I

When the character “I” is displayed on the PV display, the integral time (I constant) can be changed using the Up and Down Keys. It can be set in a range from 0 to 3,999 seconds in units of 1 second. The value is factory-set to 240 seconds.

Derivative Time : d

When the character “d” is displayed on the PV display, the derivative time (D constant) can be changed using the Up and Down Keys. It can be set in a range from 0 to 3,999 seconds in units of 1 second. The value is factory-set to 60 seconds.

Memory Bank Function

The E5AX-BA/E5EX-BA has 8 memory banks (memory bank 0 through 7) where parameters such as main setting, alarm values, PID constants, and input shift values can be preset. By switching from a memory bank to another, different parameters can be selected at a time with ease.

Memory Configuration of the E5AX-BA/E5EX-BA Memory Bank 0 to 7

The following parameters are set separately for each bank. Main setting, alarms 1 and 2, input shift, proportional band, integral time, derivative time, and hysteresis.

Common Data

The same values are used for the following parameters, regardless of the bank setting. Upper-/lower-limit values of the setting range, and control period.

Bank Number Display

The selected memory bank number is displayed on the bank number display and the control operation is effected according to the parameters preset in the selected memory bank.

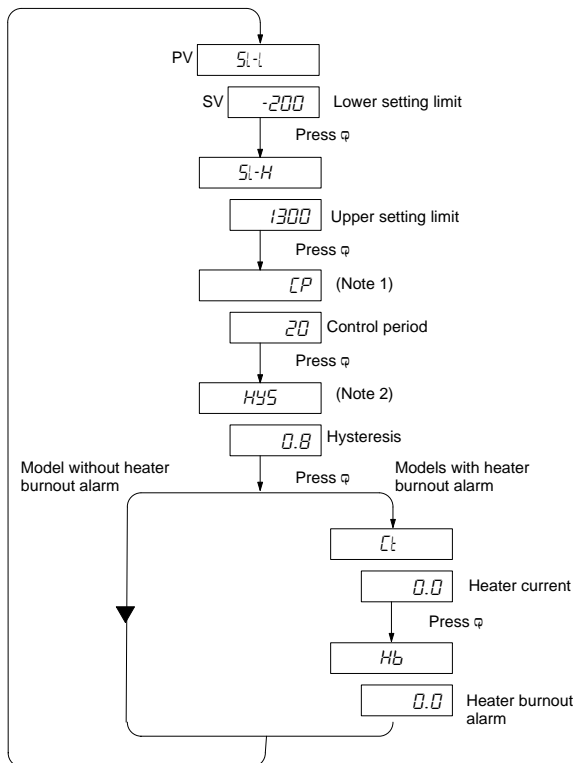
Selection of Bank Number

- To select the bank number with key input, set pin 7 of the function selector to the OFF position first. Select display level 1 with the Level Key and press the Display Key. Then select the bank number with the Up and Down Keys. The selected bank number will appear on the SV Display.
- To select the bank number with the bank selection terminal input, set pin 7 of the function selector to the ON position first. Then connect (short-circuit) or disconnect (open) the following bank terminals to the SG terminal (terminal 1):

Bank	Terminals
0	Disconnect all terminals.
1	Connect only Bank terminal 0 to SG.
2	Connect only Bank terminal 1 to SG.
3	Connect Bank terminals 0 and 1 to SG.
4	Connect Bank terminal 2 to SG.
5	Connect Bank terminals 0 and 2 to SG.
6	Connect Bank terminals 1 and 2 to SG.
7	Connect Bank terminals 0, 1, and 2 to SG.

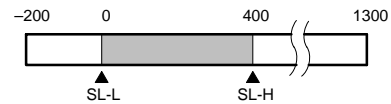
Level 1

In this level, parameters such as upper- and lower-limit values of the setting limit, control period, hysteresis, heater current, and heater burnout alarm are set.



- Note:**
- Not displayed in the ON/OFF control mode or when the output switch (SW205 OUTPUT TYPE) is set to CURRENT.
 - Not displayed when the PID control with feed-forward circuitry is ON (when P is set to 0).

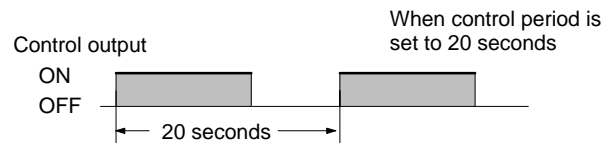
Lower/Upper Limits of Setting Range: $SL-L$, $SL-H$



Basically, the temperature range that can be measured is determined by the temperature sensor to be used. For example, when a K-type (chromel-alumel thermocouple) temperature sensor is selected, the measurable range is from -200°C to $1,300^{\circ}\text{C}$. However, this temperature range can be narrowed, for example, to 0° to 400°C . To do this, set the lower-limit value of the temperature setting range, in this case to 0°C , on the SV display by using the Up and Down Keys while " $SL-L$ " is displayed on the PV display. Similarly, set the upper-limit value, 400°C , while " $SL-H$ " is displayed. If the process temperature falls below the set lower-limit value or exceeds the set upper-limit value, it is displayed on the PV display within the temperature range of the temperature sensor.

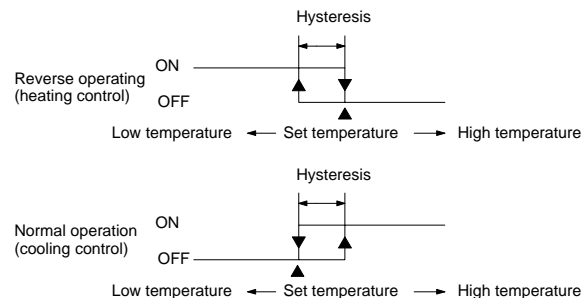
Control Period: CP

When " CP " is displayed on the PV display, the control period can be set or changed in a range from 1 to 99 seconds in units of 1 second. The factory setting is 20 seconds. When a Voltage Output Unit is used, it is recommended that the control period be set to 20 seconds or less (ideally, about 2 seconds), so that the control operation can be performed more accurately.



Hysteresis: HYS

The hysteresis value for the ON/OFF control can be set in a range from 0.0° to $999.9^{\circ}\text{C}/^{\circ}\text{F}$ while " HYS " is displayed on the PV display using the Up and Down Keys. The value is factory-set to $0.8^{\circ}\text{C}/^{\circ}\text{F}$.



Heater Burnout Alarm: Hb

A burnout current value can be set to detect heater failure. First, the current measured in the heater current value mode will be displayed in amperes. The normal current value is the current value with the control output ON. Disconnect the heater and read the current value and obtain the set value from the following:

$$\frac{\text{Normal current value} + \text{Current value with disconnected heater}}{2}$$

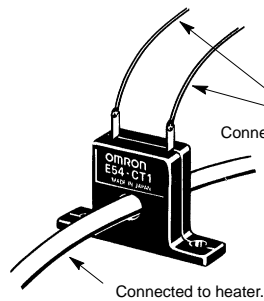
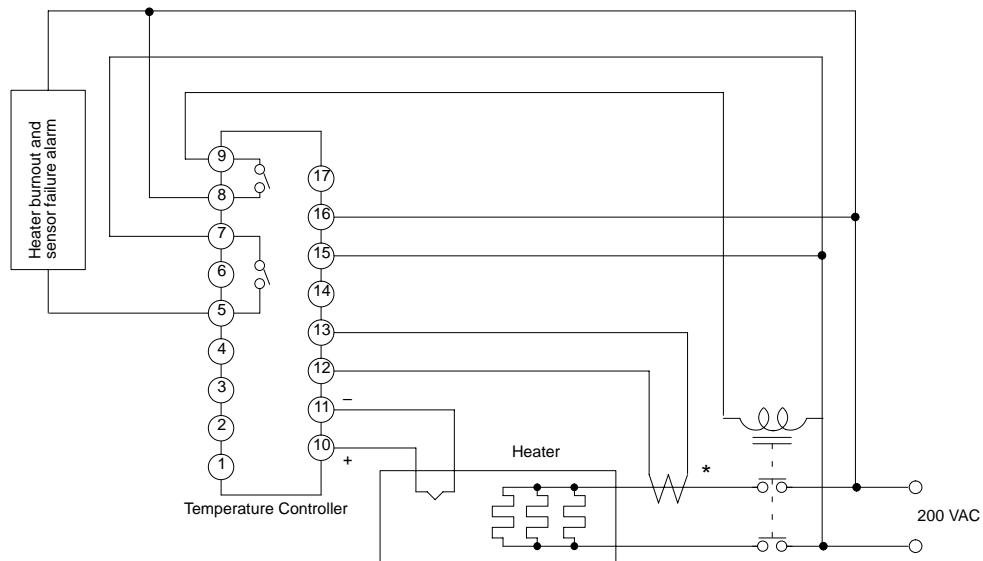
Use the Display Key and set the PV display to Hb . The difference between the normal current and the one with a disconnected heater should be 2.5 A minimum. If it is less than 2.5 A, the operation to detect heater disconnection will not be stable. The value can be set in a range of 0.1 to 49.9 A in units of 0.1 A.

- Note:**
- Do not allow a current exceeding 50 A to flow in the Controller; the maximum continuous heater current is 50 A.
 - Set the value to 0.0 A if the heater burnout alarm is not used, in which case the alarm will not function at all.

Heater Burnout Alarm and Sensor Failure Alarm

Alarm	Heater burnout alarm	Sensor failure alarm
Output terminal	Output to heater burnout alarm output terminals.	
Output ON	Alarm output turns ON when heater burnout is detected.	Alarm output turns ON when sensor failure is detected.
Output display monitor	HB on front panel is lit.	SENS on front panel is lit. (Not incorporated by the model with a communications function)
Output retention function	Yes	No
Output retention reset	Set heater burnout alarm value to 0.0 A or switch power OFF and then ON again.	Output turns OFF when sensor failure condition is removed.
Influence on control output/alarm output	No	Yes (see page 15 5. Err flushing)

Connections to Temperature Controller



* Wire through the hole of the Current Transformer. The Current Transformer and the Temperature Controller can be connected regardless of polarity.

Connected to Temperature Controller.

Connected to heater.

Level 2

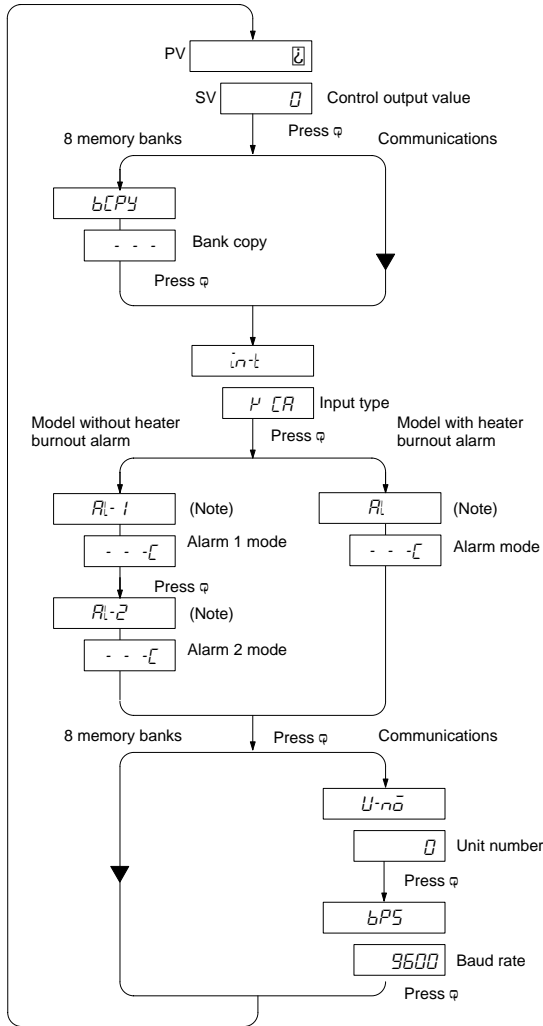
Level 2 is used both to display switch settings, to copy bank settings, and to set the unit number and baud rate for communications. When the Level Key is pressed for 2 seconds minimum after power application, "5.L" is displayed on the PV display. When the Level Key is held down for another 2 seconds "5.L" appears, "0" will be displayed on the PV display, and you will be in setting level 2 and can use the features described below.

Control Output Value: 0

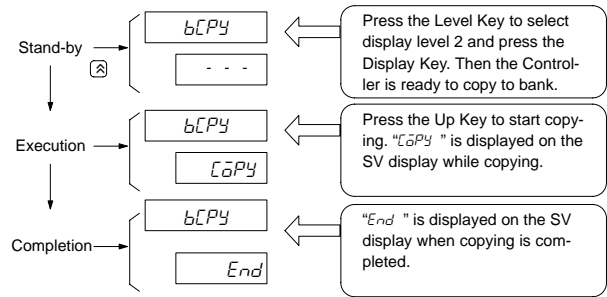
When the Temperature Controller enters level 2, the control output value is displayed on the SV display in a range of 0.0% to 100%.

Bank Copy Function: bCPy

The bank copy function makes it possible to copy the parameters other than the main setting that have been stored in bank 0 to any other bank(s) (banks 1 through 7), which require the following steps:



Note: Displayed only when the alarm function is selected.



- Note:**
1. The parameters stored in bank 0 can be copied to banks 1 through 7.
 2. When the parameters of bank 0 are copied, the old parameters of other banks are replaced with the parameters of bank 0.

Input Type: i.n.t

When "i.n.t" is displayed on the PV display, the present setting of the input type selector (SW202) is displayed on the SV display. The following table shows the messages that may be displayed:

Thermocouple Type (SW202, INPUT)

Display	Sensor
r Pr	R
s Pr	S
P CR	K
J CR	J
t CR	T
E CR	E
b Pr	B
n	N
L CR	L
U CR	U

Platinum Resistance Thermometer Type (SW207, INPUT)

Display	Sensor
JPt	JPt100
Pt	Pt100

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

AL (Alarm Mode): R_L (SW203, ALM2)

When " R_L " is displayed on the PV display in level 2, alarm output mode or the present setting of the corresponding alarm mode selector (SW203, ALM1/SW204, ALM2) is displayed on the SV display. The following table shows the messages that may be displayed.

Display	Alarm mode
No display	No alarm
]--[Upper- and lower-limit alarm
---[Upper-limit alarm
]---	Lower-limit alarm
-[]-	Upper- and lower-limit range alarm
∃--E	Upper- and lower-limit alarms with standby sequence
---E	Upper-limit alarm with standby sequence
∃---	Lower-limit alarm with standby sequence
!--[Absolute-value upper-limit alarm
]--!	Absolute-value lower-limit alarm

Unit No.: $U-n\bar{0}$

Each Temperature Controller must have a unit number to communicate with the host computer. When " $U-n\bar{0}$ " is displayed on the PV display, use the Up and Down Keys to set an integral number of 0 through 99 as the unit number. The selected unit number will appear on the SV display. The unit number of each Temperature Controller must be different from one another or an error will result. The unit number is factory-set to 0.

Baud Rate: $bP5$

Each Temperature Controller must have a baud rate of 150, 300, 600, 1200, 2400, 4800 or 9600 bps to communicate with the host computer. When " $bP5$ " is displayed on the PV display, use the Up and Down Keys to set a baud rate on the Temperature Controller. The selected baud rate will appear on the SV display, which, however, will be effective only after the power to Temperature Controller is turned off once and turned on again. The baud rate is factory-set to 9600 bps.

■ Starting Control Operation

The E5EX will start control operations as soon as power is turned on until power is turned off. Turn off the power and then turn it back on after setting the desired parameters.

Auto-tuning

When the Auto-tuning Key is pressed for 1 second minimum, the Temperature Controller automatically starts tuning the PID constants. While auto-tuning is in operation, the auto-tuning indicator on the front panel will flash. The Temperature Controller executes control based on the set PID constants (factory-set to P = 40°C/°F, I = 240 seconds, and D = 60 seconds) until the temperature of the controlled system reaches the main setting. After that, the Temperature Controller automatically adjusts the PID constants using the limit cycle method.

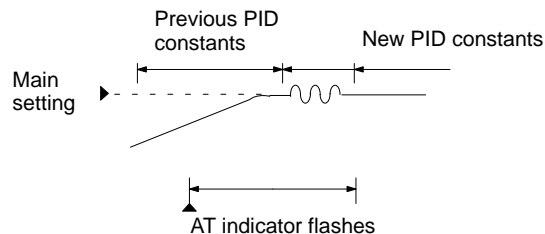
When the auto-tuning indicator turns off, the auto-tuning is terminated and PID constants are renewed.

Auto-tuning can be carried out regardless of whether the Temperature Controller is performing reverse (heating) or normal (cooling)

operation. To stop auto-tuning, press the Auto-tuning Key again for 1 second minimum. Auto-tuning can be executed at any time: at power application, while the temperature is rising, or after the control action has stabilized.

Limit Cycle Method

The optimum PID constants are calculated by varying the control output value and generating external oscillation.



■ Error Messages

The Temperature Controller is provided with self-diagnostic functions, and will display an error message on the PV display when an error is detected.

Message	Cause	Control output		Alarm output
		Pulse output	Current output*	
FFFF	Input temperature has exceeded the upper limit of the temperature range by more than 20°C	OFF during reverse (heating) operation ON during normal (cooling) operation	4 mA during reverse (heating) operation 20 mA during normal (cooling) operation	Sends alarm signal in accordance with the set alarm mode.*
----	Input temperature has fallen below the lower limit of the temperature range by more than 20°C.*	ON during reverse (heating) operation OFF during normal (cooling) operation	20 mA during reverse (heating) operation 4 mA during normal (cooling) operation	Sends alarm signal in accordance with the set alarm mode.*
5.Err3. (flashes)	The thermocouple has burned out or short-circuit bar has been removed. The platinum resistance thermometer has burned out or A and B terminals have been short-circuited.	OFF	Approx. 1 mA	Sends alarm signal in accordance with the set alarm mode.
E111 (flashes) E333 (flashes)	Memory failure (E111) or A/D converter failure (E333) has occurred. Temperature Controller must be repaired if recovery is not made by turning power off once and on again.**	OFF	Approx. 1 mA	OFF

*When the temperature resistance thermometer is used, this message is displayed when the temperature has fallen below -99.9°C.

**E333 also appears if a PT platinum resistance thermometer is connected to E5EX thermocouple models.

■ Connection with G3PX Power Controller

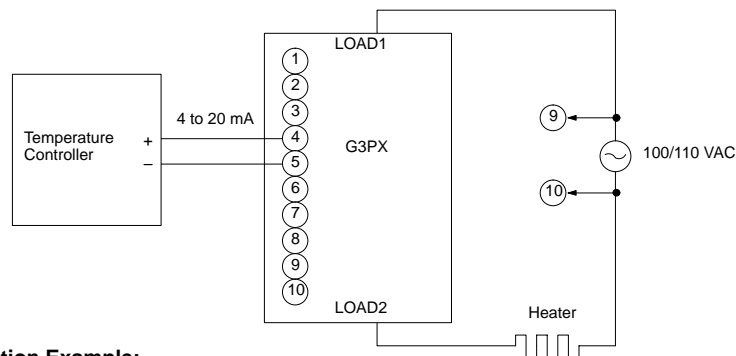
Refer to the G3PX data sheet for the details of the G3PX Power Controller.

The following is possible by connecting the E5AX/E5BX to the G3PX:

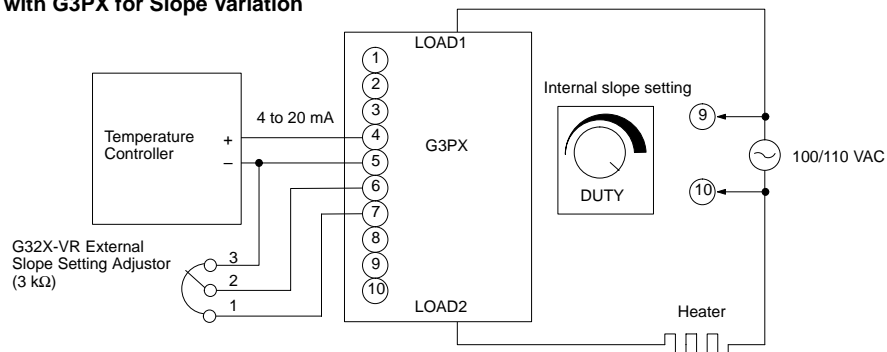
Using the current output, more precise temperature control will be performed.

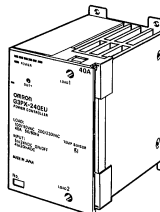
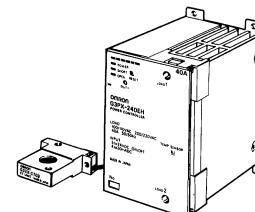
The life of the heater will be prolonged.

Connection Example: Current Output (4 to 20 mA) Model with G3PX

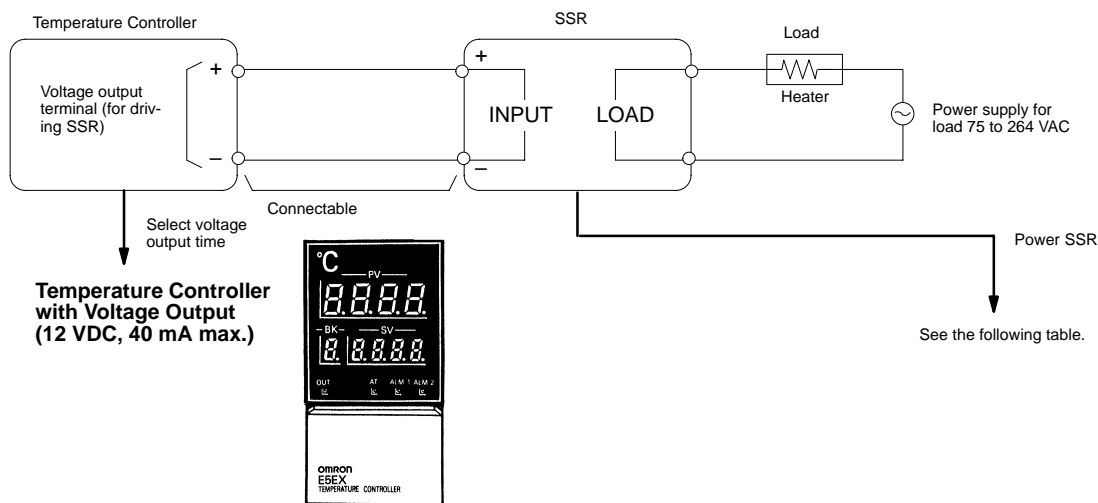


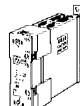
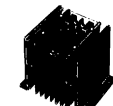
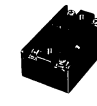
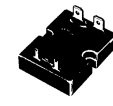

Connection Example: Current Output (4 to 20 mA) Model with G3PX for Slope Variation



Classification	Basic model			High performance model		
Model	G3PX-220EU	G3PX-240EU	G3PX-260EU	G3PX-220EH-CT03/-CT10	G3PX-240EH-CT03/-CT10	G3PX-260EH-CT03/-CT10
Appearance	 (40-A type)			 (40-A type)		
Phase	Single-phase					
Applicable load	Resistive or inductive load					
Output display	Yes (level indicator)					
Heater burnout/short-mode failure detection	No			Yes		
Rated output	20 A	40 A	60 A	20 A	40 A	60 A
	100/110/200/220 VAC					
Frequency	50/60 Hz					
Input signal for control	Current input (analog control output signal): 4 to 20 mA Voltage input (ON/OFF control input signal): 5 to 24 VDC 3 kΩ (B type, 2 W min.)					
External slope setting	3 kΩ (B type)					
Alarm relay output	SPDT , 250 VAC; 8 A at 30 VDC					

■ Connection Example of Temperature Controller and SSR

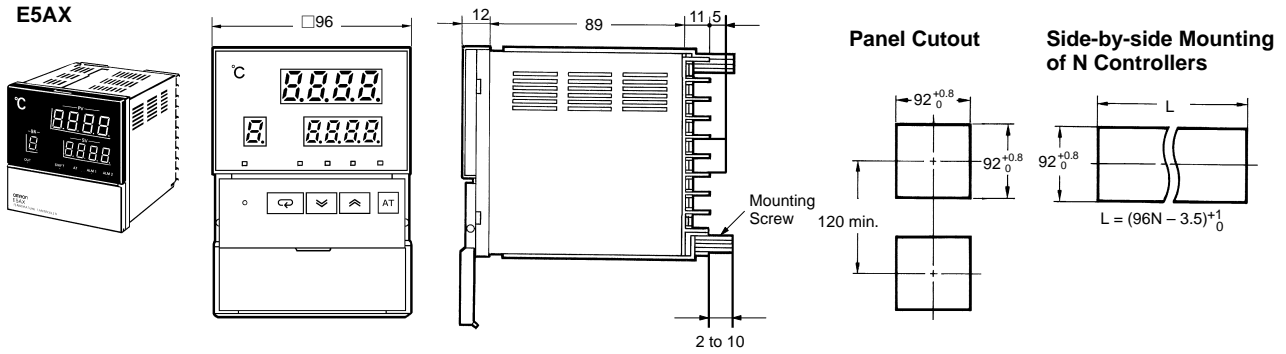


Model	G3PA	G3NH	G3N	G3NE	G3B
Appearance					
SSRs connected in parallel	12 pcs.	8 pcs.	6 pcs.	2 pcs.	6 pcs.
Rated input voltage	5 to 24 VDC	5 to 24 VDC	5 to 24 VDC	5/12 VDC	5 to 24 VDC
Features	Thin, monoblock construction with heat sink	For high-power heater control	Standard model with screw terminals	Compact, low-cost model with tab terminals	Socket, model with 5-A switching capacity

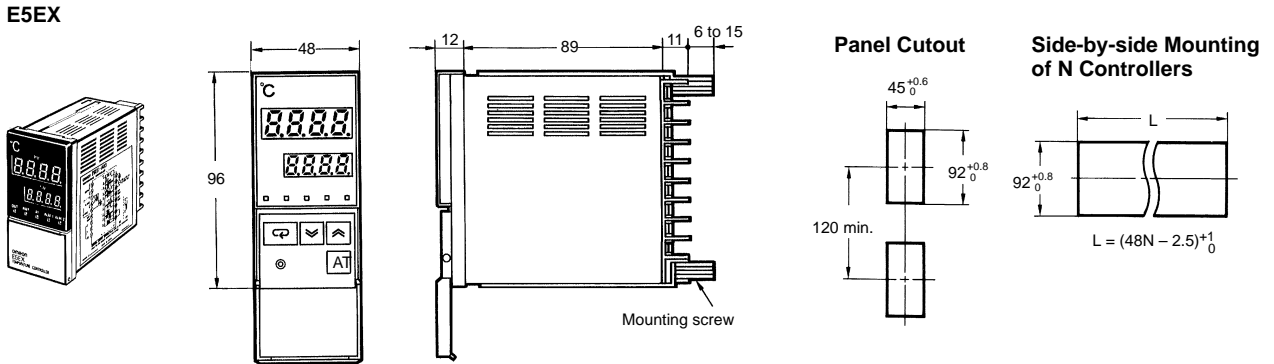
Dimensions

Note: All units are in millimeters unless otherwise indicated.

E5AX

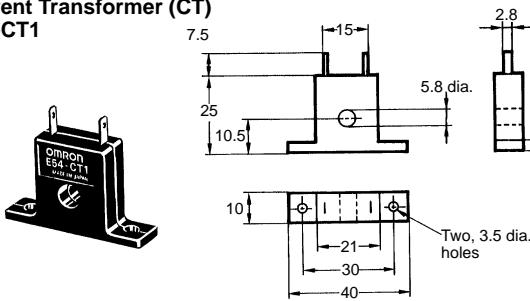


E5EX

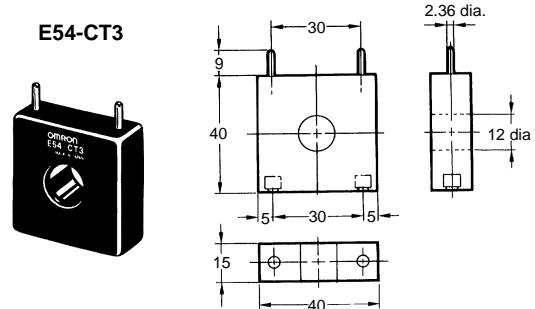


Current Transformer (CT)

E54-CT1

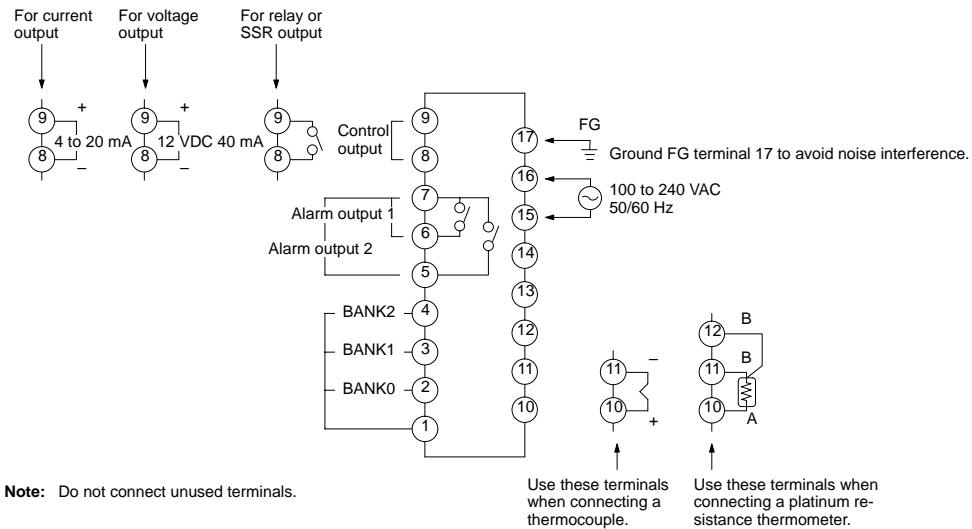


E54-CT3

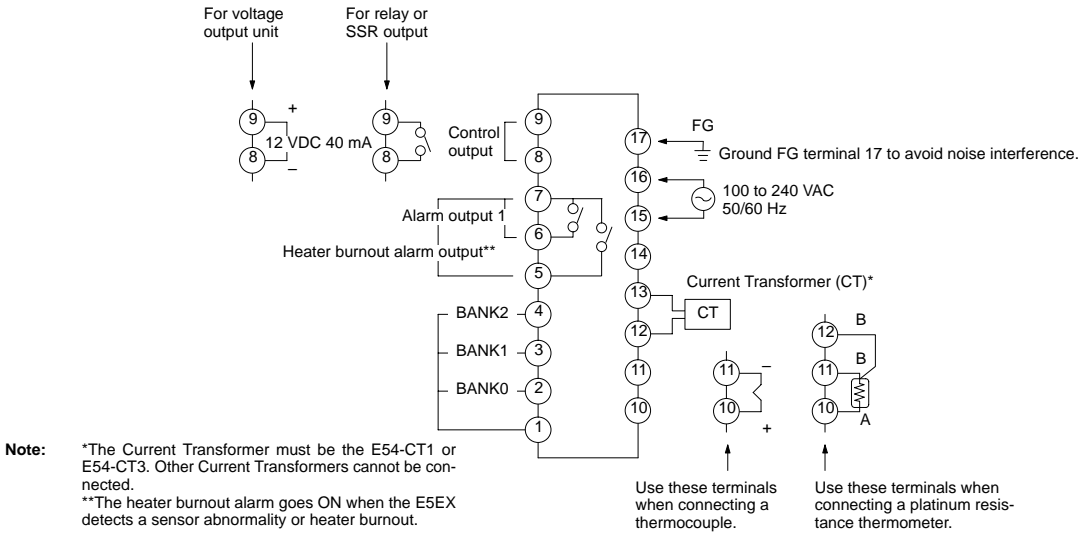


Installation

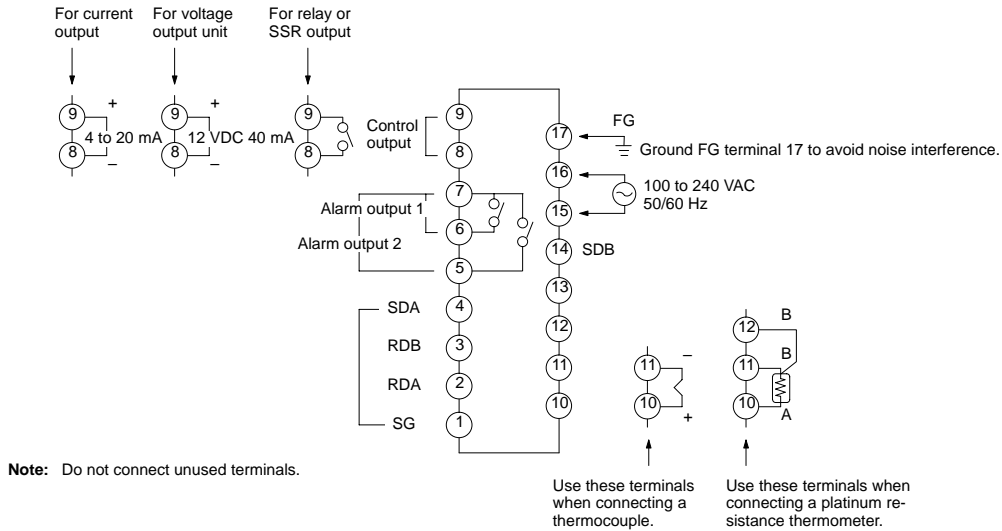
E5AX-BA/E5EX-BA (with 8 Memory Banks)



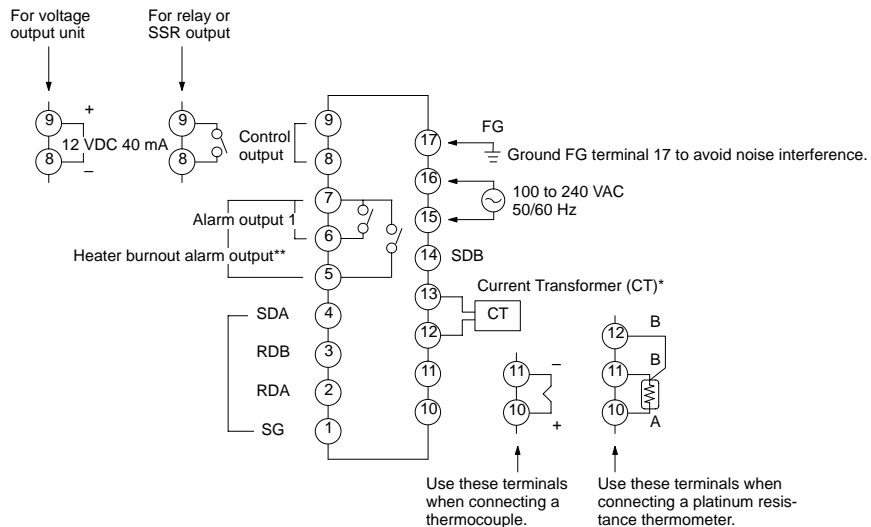
E5AX-BAH/E5EX-BAH (with Heater Burnout Alarm)



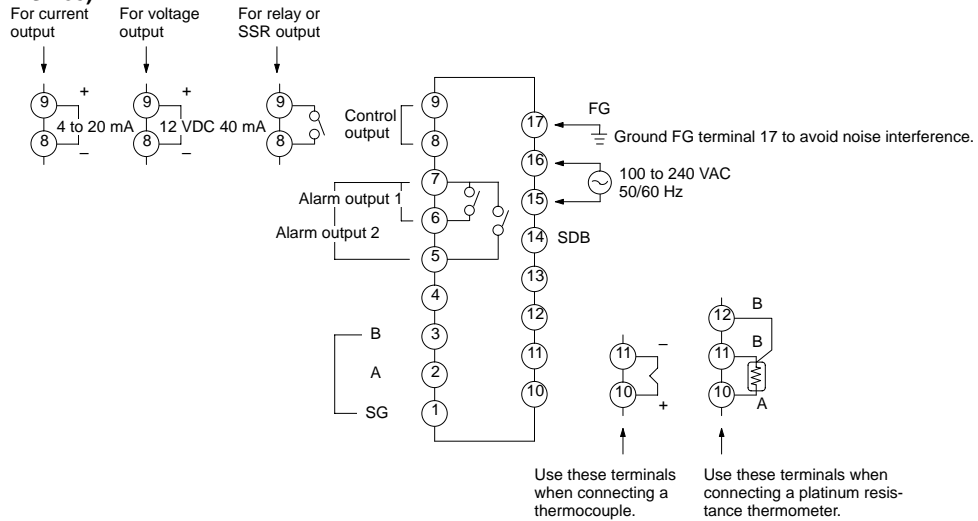
E5EX-A02 (with RS-422)



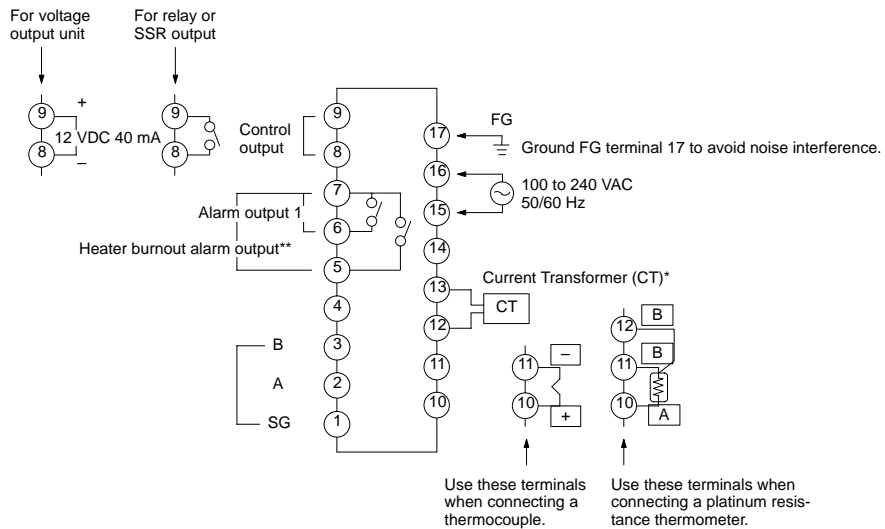
E5EX-AH02 (with RS-422 and Heater Burnout Alarm)



E5EX-A03 (with RS-485)



E5EX-AH03 (with RS-485 and Heater Burnout Alarm)



Precautions

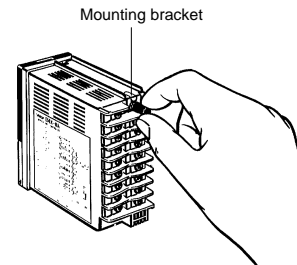
Mounting

The dimensions of the Temperature Controller conform to DIN 43700. Recommended panel thickness is 1 to 8 mm.

Do not install the Temperature Controller in a location exposed to excessive dust or corrosive gases. Moreover, avoid locations subject to heavy vibration or shock, water or oil spray, or high temperatures. Any of these condition will affect product life.

Isolate the Temperature Controller from equipment that generates strong, high-frequency noises such as high-frequency welders, because such equipment may prevent proper operation.

Attach the two mounting brackets supplied with E5EX on the top and bottom of the Temperature Controller. Tighten the screws of the mounting brackets with your fingers.



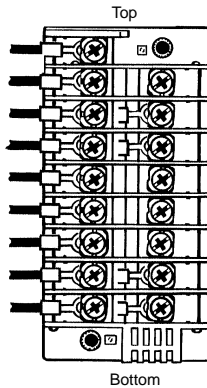
Connection Examples

With Solderless Terminal

Use M3.5 solderless terminals with the Temperature Controller's M3.5 self-rising pressure plate screws.

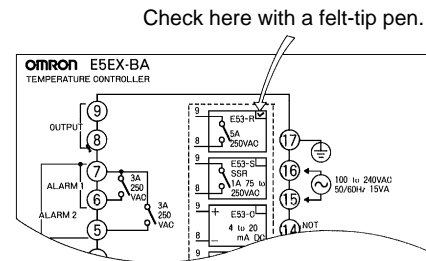
Solder-dipped Leads

Strip 6 to 12 mm of the lead wires and carefully arrange the wire tips. Do not tighten the terminal screw with excessive force, because doing so may damage them. The terminal block of the Temperature Controller is constructed so that the lead wires can be connected to all the terminals from the same direction.



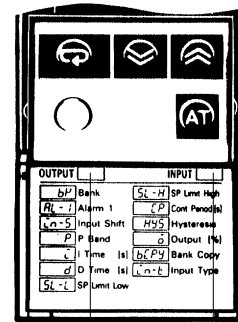
Terminal Arrangement Diagram on the Housing

The Temperature Controller allows the input and output devices to be freely selected. Use the terminal arrangement diagram shown on the housing of the Temperature Controller to identify the output device mounted on the Temperature Controller by marking the diagram as follows:



Stickers Inside Frontcover

Stickers indicating the input type (R, S, K, J, etc.) and Control Output Unit (R, S, Q, and C) are supplied with the Temperature Controller. Attach the proper stickers to the front panel as shown below, allowing the input type and Control Output Unit mounted in the Temperature Controller to be easily identified.



Sticker identifying input type

Sticker identifying Control Output Unit
(The above is the E5EX-BA.)

Input Type Connection

To reduce inductive noise influence, the lead wires connecting the input type to the Temperature Controller must be separated from the power lines and load lines.

Use the specified compensating conductors for thermocouples. Use lead wires having a small resistance for platinum resistance thermometers.

Sequenced Circuits

Several seconds are required until the relay is turned ON after power has been supplied to the Temperature Controller. Therefore, take this time delay into consideration when designing sequenced circuits which incorporate a Temperature Controller.

ALL DIMENSIONS SHOWN ARE IN MILLIMETERS.

To convert millimeters into inches, multiply by 0.03937. To convert grams into ounces, multiply by 0.03527.

Cat. No. H38-E1-3 In the interest of product improvement, specifications are subject to change without notice.

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