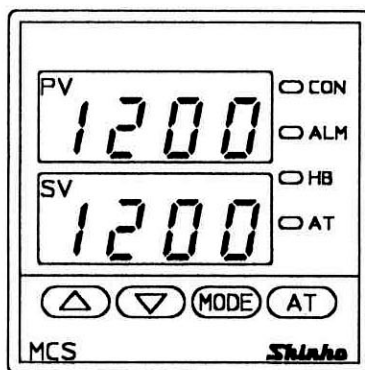


INSTRUCTION MANUAL
FOR
MICROCOMPUTER BASED
TEMPERATURE INDICATING CONTROLLER
MCS-300 SERIES



Thank you for your purchase of our Microcomputer based Temperature Indicating Controller **MCS-300 Series**.

This controller is delivered after its production and inspection on the basis of severe quality control in our factory.

Further to your confirmation of the model and specifications of the controller, peruse this instruction manual before starting operation.

Note:

Please arrange to give this manual into the hands of the operator who actually uses our product.

Warning

Turn the power supplied to the instrument OFF before wiring or checking. If working or touching the terminal on the power ON status, there is a possibility of Electric Shock which can cause severe injury or death.

Notice

In warmup status, avoid key operations, and do not turn the power supply ON while the key is operated. (There is a possibility of changing of the specification.)

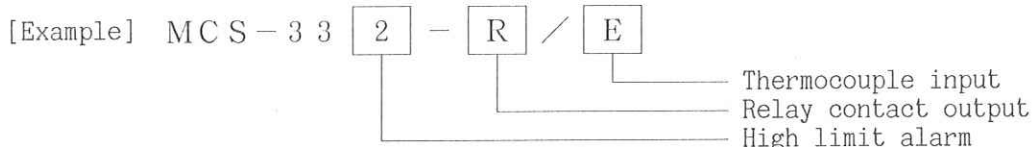
— CONTENTS —

1. Model names	3
1.1 Model names	3
1.2 How to indicate the Model nameplate	4
2. Name of the sections	5
2.1 Explanations for displays	5
2.2 Explanations for keys	6
3. Mounting to control panel	7
3.1 Site selection	7
3.2 External dimension	7
3.3 Panel cutout	7
4. Wiring connection	8
4.1 Terminal arrangements	8
4.3 Wiring example	9
5. Operations	10
5.1 Operation flow chart	10
5.2 Operations	11
(1) PV/SV display mode	11
(2) Main setting mode	11
(3) Sub-setting mode	12
(4) Auxiliary function setting mode	16
6. Control actions	21
6.1 Explanation of PID	21
6.2 Explanation of PID auto-tuning	22
6.3 Performance of PID auto-tuning	23
7. Other functions	24
8. Running	25
9. Action drawings	25
10. Specifications	28
11. Character table	30

1. Model names

1.1 Model names

* Described mark "□" in this manual such as -R/□ or -□/□ means an alphanumerical character which shows various functions or the kinds. (e.g. R/E or S/R)



Standard models

MCS-3	□	□	□	□	Series name: MCS-300 series
Control action	3				PID action
Temperature alarm action	0				No alarm action
	2				High limit alarm
	3				Low limit alarm
	4				High/low limits alarm
	6				High/low limit range alarm
	8				Process value alarm
Output		R			Relay contact
		S			Non-contact voltage
		A			DC current
Input		E			Thermocouple K, J, N
		R			RTD Pt100, JPt100

Optional specifications

Optional name	Code	Description
Temperature alarm with standby function	H	The standby alarm function disables alarm action until the temperature passes over the alarm setpoint on initial start.
Heater burnout alarm function.	W	It watches the heater current through current transformer, and when the heater current falls to the setting value, it gives alarm.
Function selection	F	A function to designate or set the Sensor, Temperature scale, Control action, Temperature alarm and Differential (Dead band) value.
Specified dead band	S K	The product is shipped setting the differential (dead band between ON and OFF point of main control action) to the specified value.
Control type	P D	It makes the main control action to PD action.
Heating and Cooling control output	D□	It is the most suitable control output to the control object which has a self-heating such as Mold temperature controller for Extruder or Injection molding machine. The output type is selectable from Relay contact (DR) or Non-contact voltage (DS).
Cooling control action	C M	OFF in the range in which the input value is lower than the setting value, ON in the range higher than that.
Color Black	B K	Face plate: Dark gray Case, Base: Black
Screw type mounting bracket	B L	Mounting Panel thickness 1 to 8 mm. (Standard is One-touch type mounting bracket.)

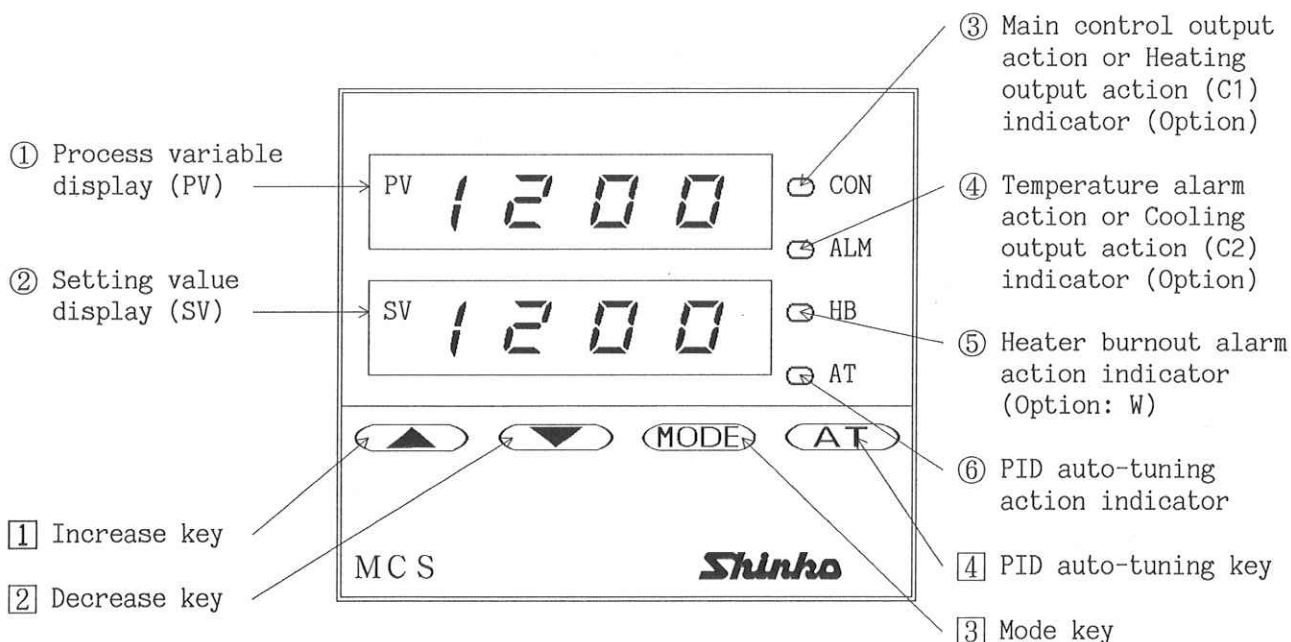
1.2 How to indicate the Model nameplate

The model nameplate is put on the right side (when observed from the front) of the instrument and the inner assembly.

	Model nameplate	<u>Example</u>
Standard model name	3 3 0 - R / E	Relay output/Thermocouple input
Option codes, Special order No., etc. {	F	Function selection
	W (1 0 A)	Heater burnout alarm action 10A
Serial No. (Indicated only on the inner equipment)	No.	

- ◆ Optional specifications are specified by the option code (described in the preceding page) besides the model name. When plural functions are specified, they are delimited with comma.
- ◆ As to specified Heater burnout alarm action W, etc. the specified value is to be indicated following to the option code in ().

2. Name and functions of the sections



◆ The code [ALM] is changed to [C2] when the option Heating/Cooling control output is applied.

2.1 Explanations of display

- ① Process variable (PV) display
Indicates the process variable with the red LED.
- ② Setting value(SV) display
Indicates the setting value with the green LED.
- ③ CON Main control output action indicator
Green LED lights when the control output is ON or heating output (C1) is ON.
(With the current output type [-A/[]], it lights while the power supplied to the instrument is ON, no connection with the output.)
(Heating output [C1] is option.)
- ④ ALM Temperature alarm action indicator
Red LED lights when temperature alarm output is ON or cooling output (C2) is ON.
(Cooling output [C2] is option.)
- ⑤ HB Heater burnout alarm action indicator
Red LED lights when heater burnout alarm output is ON or Sensor burnout action.
(Heater burnout alarm is option.)
- ⑥ AT PID auto-tuning indicator
Yellow LED blinks when PID auto-tuning is performing.
(Yellow LED blinks when PD auto-reset [offset correction] is performing.)

2.2 Explanations of the keys

Main functions are described here, however, they make other functions depending on the mode, refer to [5. Operations] on and after page 10 for the detail.

- ① **▲** Increase key: • Increases the setting value (SV) being displayed. [If the key is held causes setting value to change faster.]
- If the **MODE** key is pressed while the **▲** key is being pressed, the Sub-setting mode will be selected.
 - If the **MODE** key is pressed for approx. 3 sec. while the **▲** key is being pressed, the Control output OFF function will work.*
- * Character [**F**] Sub-setting mode will be displayed for a while, though keep pressing until [**OFF**] is displayed.
- ② **▼** Decrease key: • Decreases the setting value (SV) being displayed. [If the key is held causes setting value to change faster.]
- If the **MODE** key is pressed for approx. 3 sec. while the **▼** key is being pressed, the Auxiliary function setting mode will be selected.
- ③ **MODE** Mode key : • Changes the mode.
- In PV/SV display mode,
 - If the **MODE** key is pressed, main setting mode will be selected.
 - If the **MODE** key is pressed while **▲** key is being pressed, the Sub-setting mode will be selected.
 - If the **MODE** key is pressed for approx. 3 sec. while the **▲** key is being pressed, the Control output OFF function will work.
 - If the **MODE** key is pressed for approx. 3 sec. while the **▼** key is being pressed, the Auxiliary function setting mode will be selected.
- ④ **AT** PID auto-tuning key: Performs or cancels the PID auto-tuning.

PD auto-

reset key: When the controlling value is within the proportional band, it starts the offset correction if this key is pressed 1second or greater.

- ◆ The PD auto-reset key will function only when the control type is designated to [PD].
(Option)

Notice

In warmup status, avoid key operations, and do not turn the power supply ON while the key is operated. (There is a possibility of changing of the specification.)

3. Mounting to control panel

3.1 Site selection

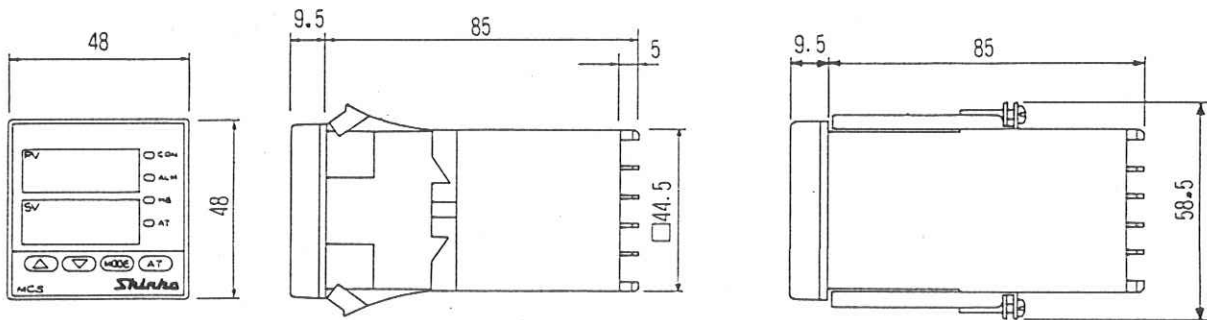
Mount the controller in a place with:

- (1) A minimum of dust, and an absence of corrosive gases.
- (2) An ambient humidity is 85%RH or less, non-condensing and no water or oil including their vapor directly splash.
- (3) No exposure to direct sunlight, and an ambient temperature is within 0°C (32°F) to 50°C (122°F).
- (4) No mechanical vibrations or shocks.
- (5) The controller should be away from the electromagnetic switch of large capacity, or cables through which large current flows.

3.2 External dimension drawing

* When one-touch mounting bracket is used:
Mounting panel thickness 1 to 3mm.

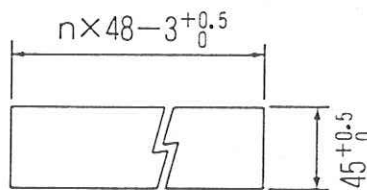
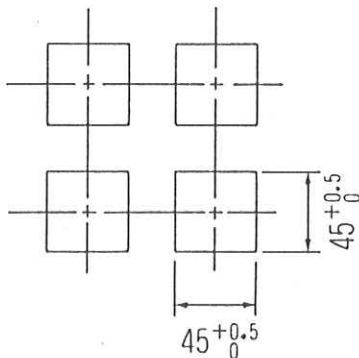
* When screw type mounting bracket is used:
Mounting panel thickness 1 to 8mm.



- Mount one-touch mounting bracket to the body in advance, and then insert MCS-300 from the front of panel.
- Soft front cover (FC-48-S) to protect drip and dust is provided by extra charge. When used the soft front cover, the panel thickness to be mounted should be 1 to 2.5mm for one-touch type, and 1 to 7.5mm for screw type.

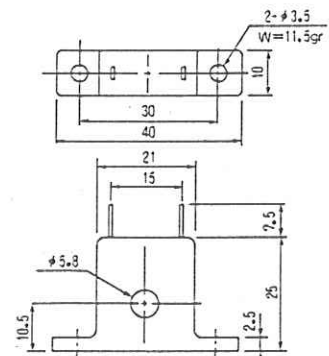
Notice
Do not screw with excessive force, or the case may be bent, since it is made of resin.

3.3 Panel cutout



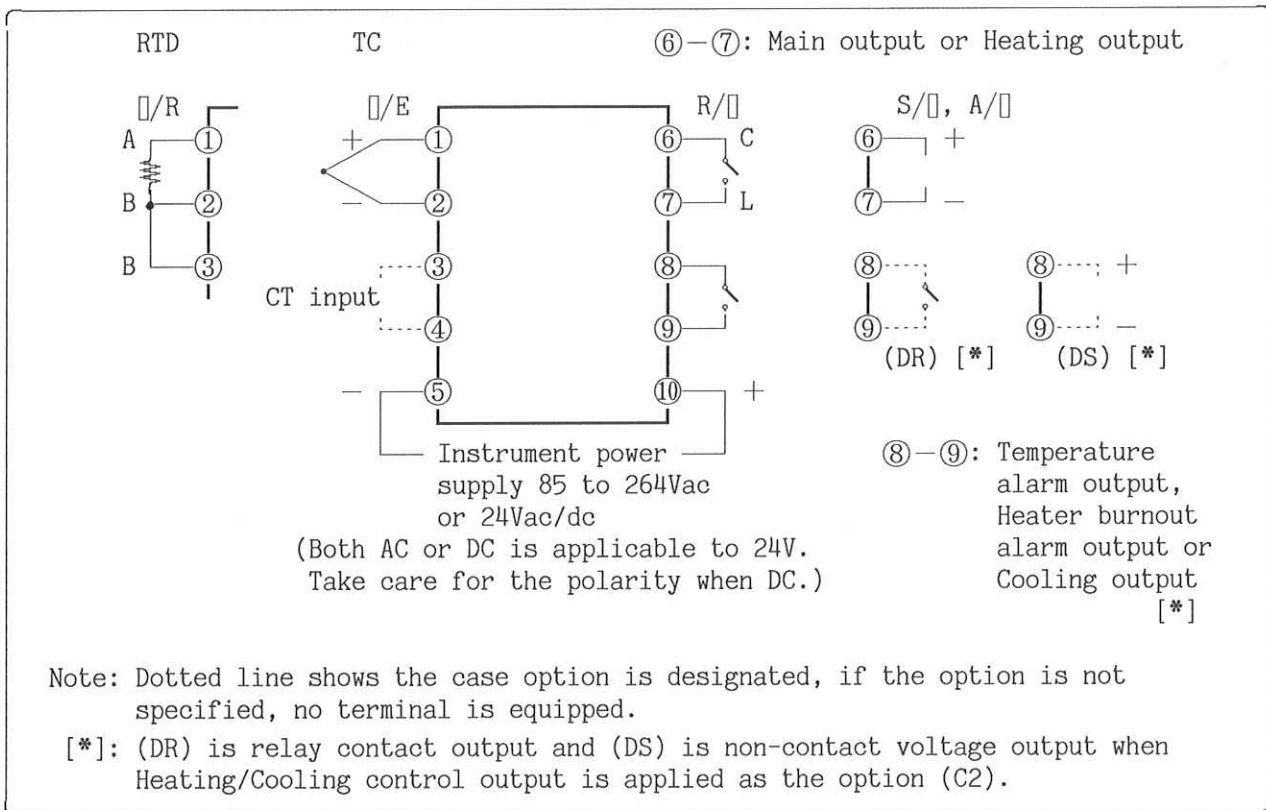
Lateral close mounting
n: Number of units mounted

Current transformer
Dimensional drawing
[Optional accessory for option W]



4. Wiring connection

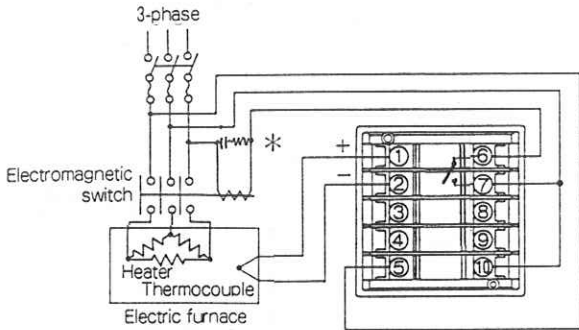
4.1 Terminal arrangements



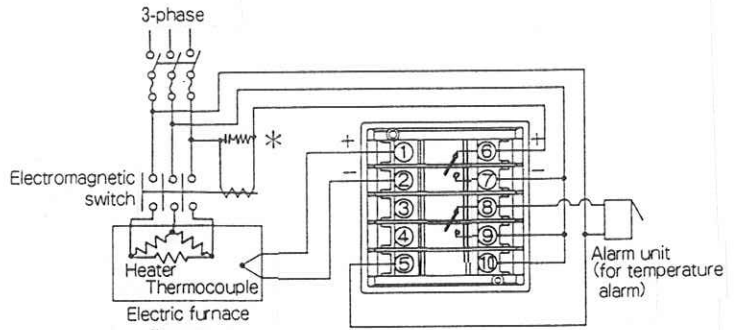
- ① For the product of the supply voltage is 24V, the voltage (24V) is indicated. Be careful about the wiring not to apply the other voltage.
 - ② The terminal block of this instrument is designed to wire from the left side. Lead wire must be inserted from the left side of the terminal, and fasten by the terminal screw.
 - ③ Use a thermocouple and compensating lead wire applicable to the input specification (K, J, etc.) of this controller.
 - ④ Use a 3-wire system of RTD applicable to the input specifications (Pt100) of this controller.
 - ⑤ This controller has no built-in power switch nor fuse. It is therefore recommended to provide them in the circuit near the external controller.
 - ⑥ When wiring, keep input wire (Thermocouple, RTD, etc.) away from AC source and load wire to avoid external interference.
 - ⑦ With relay output type of controller, it is suggested to provide proper relay to protect the built-in relay contact, even if the load capacity is smaller than the built-in contact capacity (considering rush current).
- [Option W: Heater burnout alarm function]
- ① This alarm is not available for detecting current under phase control.
 - ② When using Current transformer (CT), select an accessory one.
 - ③ Pass a lead wire of heater circuit into the hole of the CT.
 - ④ When wiring, keep CT wire away from AC source and load wire.

4.2 Wiring connection examples

MCS-330-R/E

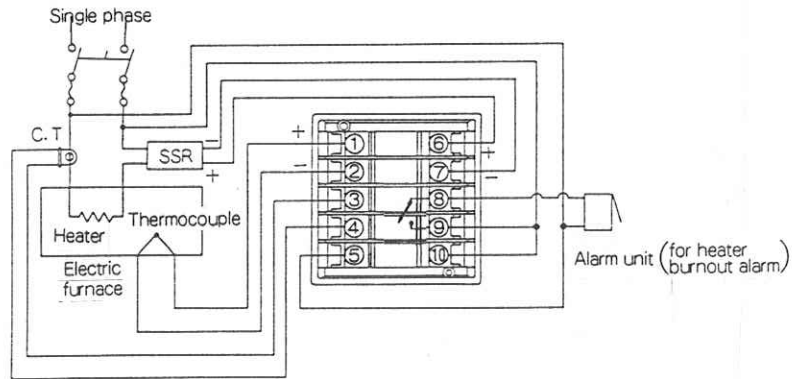


MCS-332-R/E

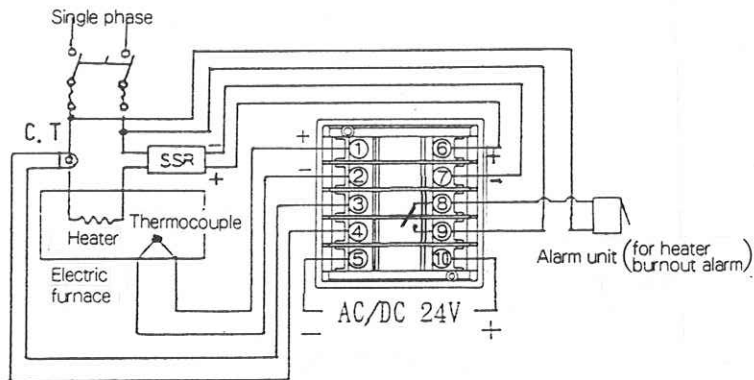


*To prevent the instrument from a bad influence owing to the unexpected level noise, it is recommended that the surge absorber be provided between the coil of the external relay.

MCS-330-S/E,W Heater burnout alarm action [Option]

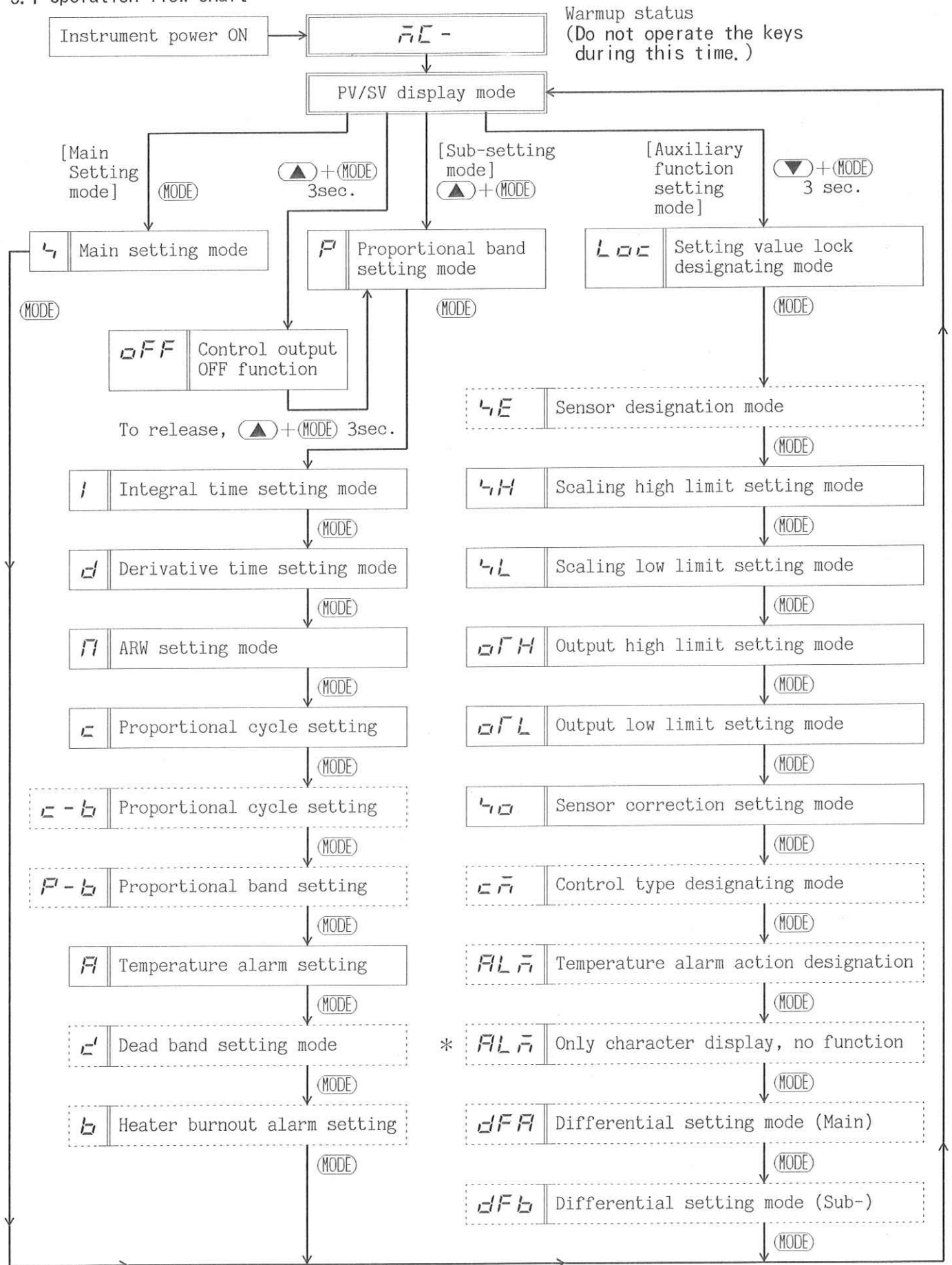


MCS-330-S/E,W Supply voltage 24V



Whichever type of the power source, AC or DC can be used. However, in case of DC, be careful about the polarity.

5. Operations
5.1 Operation flow chart



Notes: (for preceding page)

- ① Dotted line means in case of option specification.
(If the options are not designated, the modes cannot be selected.)
- ② $\triangle + \text{MODE}$ and $\nabla + \text{MODE}$ mean that press MODE key while the \triangle or ∇ key is being pressed. (i.e. Press \triangle or ∇ key first.)
- ③ $\triangle + \text{MODE}$ 3 sec. and $\nabla + \text{MODE}$ 3 sec. mean that press them until the character [OFF] or [Loc] is indicated on PV display.
- ④ *: Characters are indicated on PV display only when option F is designated, however, the functions are not applied.

1. In any mode, if the AT key is pressed, auto-tuning will be started. However, if lock function is specified, the auto-tuning cannot work. (See page 16.)

2. The indicated value selected by \triangle and ∇ keys is registered after pressing the MODE key. If the key operation is ended after the numeric value is set, approx. 30 seconds later the mode is automatically changed to PV/SV display mode and the setting values are registered.

5.2 Operations

Process variable display (PV) indicates [$\overline{r} \overline{c} -$] for approx. 8 seconds after the power turned ON. During this time, all outputs, digital displays and LED indicators are in their off status. After that, it displays actual temperature on the PV display, the setting value on the SV display and starts control.

Notice

When displaying [$\overline{r} \overline{c} -$], avoid key operations, and do not turn the power supply ON while the key is operated. (There is a possibility of changing of the specification.)

(1) PV/SV display mode

A mode to indicate a status of control.

PV display	SV display	No contents of setting items nor setting values can be changed.
Actual temperature	Main setting value	

(2) Main setting mode

In PV/SV display mode, if the MODE key is pressed, [\overline{L}] is displayed on PV display, and main setting mode is selected.

① \overline{L} Main setting mode

A mode to set a setting value of the main control.
The setting range covers the scaling low to high limit setting values.
The setting value is registered when MODE key is pressed.

PV display	SV display	Change of setting value
\overline{L}	Main setting value	The value can be increased or decreased by pressing the \triangle or ∇ key.

(3) Sub-setting mode

In PV/SV display mode, if the (MODE) key is pressed while the (▲) key is being pressed, Sub-setting mode will be selected, and the mode turns to the Proportional band setting mode indicating [P] on the PV display. Further, each pressing only the (MODE) key, the mode is changed and the desired setting value can be set for each mode.

① [P] Proportional band setting mode

A mode to set a proportional band of main control.
 [If the PID auto-tuning is performed, it is automatically set.]
 Setting range is 0.1 to 200.0% Setting the proportional band to 0.0 causes the instrument to act as an ON/OFF controller. At this time, if the option [F] is specified, differential (dead band of ON and OFF action points) can be set in the differential setting mode of the auxiliary function setting mode. (Factory adjusted as 2.5%.)

PV display	SV display	Change of setting value
P	Proportional band setting value	The value can be increased or decreased by pressing the (▲) or (▼) key.

② [I] Integral time setting mode

A mode to set an integral time value.
 [If the PID auto-tuning is performed, it is automatically set.]
 Setting range is 1 to 3600 seconds.
 Setting the integral to 0 disables the function. (Factory adjusted as 200 seconds.)

PV display	SV display	Change of setting value
I	Integral time setting value	The value can be increased or decreased by pressing the (▲) or (▼) key.

③ [D] Derivative time setting mode

A mode to set a derivative time value.
 [If the PID auto-tuning is performed, it is automatically set.]
 Setting range is 1 to 1800 seconds.
 Setting the derivative to 0 disables the function. (Factory adjusted as 50 seconds.)

PV display	SV display	Change of setting value
D	Derivative time setting value	The value can be increased or decreased by pressing the (▲) or (▼) key.

④ [N] ARW (Anti-Reset Windup) setting mode

A mode to set an ARW value.
 [If the PID auto-tuning is performed, it is automatically set.]
 Setting range is 0 to 100%. (Factory adjusted as 50%.)

PV display	SV display	Change of setting value
N	ARW value	The value can be increased or decreased by pressing the (▲) or (▼) key.

⑤ C Proportional cycle setting mode.

A mode to set a proportional cycle.

Setting range is 1 to 120 seconds. (Factory adjusted as 30 sec. for R/□, 3 sec. for S/□.)

PV display	SV display	Change of setting value
C	Proportional cycle setting value	The value can be increased or decreased by pressing the ▲ or ▼ key.

Notice

With relay output type (R/□), if the time of proportional cycle is set shorter, the relay action becomes too much and the life may be shorten.

⑥ A Temperature alarm setting mode

A mode to set a temperature alarm setting value. (This mode is not available if no temperature alarm is selected.)

Setting ranges are as follows. (Setting ranges differ from the type of alarm action.)
(Factory adjusted as 0°C, 0°F.)

- No alarm action (MCS-330-): This mode is not available.
- High limit alarm (MCS-332-): -100 to 100°C, -200 to 200°F
- Low limit alarm (MCS-333-): -100 to 100°C, -200 to 200°F
- * High/Low limits alarm (MCS-334-): ±(1 to 100°C), ±(1 to 200°F)
- * High/Low limit range alarm (MCS-336-): ±(1 to 100°C), ±(1 to 200°F)
- Process value alarm (MCS-338-): Scaling low to high limit setting value
- In case the input is RTD, and decimal point is applied.
 - High limit alarm (MCS-332-□/R): -100.0 to 100.0°C, -199.9 to 200.0°F
 - Low limit alarm (MCS-333-□/R): -100.0 to 100.0°C, -199.9 to 200.0°F
 - * High/Low limits alarm (MCS-334-□/R): ±(1.0 to 100.0°C), ±(1.0 to 200.0°F) **
 - * High/Low limit range alarm (MCS-336-□/R): ±(0.1 to 100.0°C), ±(0.1 to 200.0°F)
 - Process value alarm (MCS-338-□/R): Scaling low to high limit setting value

* Both (+) and (-) values will be simultaneously set when applied only one value.

** Avoid setting the value 0.9 or less, since it prevents proper action related to the dead band.

Setting the alarm value to 0 disables the temperature alarm function.
(However, in case of Process value alarm, it works even if 0 is set.)

[Option code: H, Standby function]

This standby function holds the alarm output until the input value reaches within alarm setting range after power ON, or if main setting is changed during control, and in case the deviation becomes larger than alarm setting range.

High limit alarm with standby function (MCS-332-□/□,H): -100 to 100°C, -200 to 200°F

Low limit alarm with standby function (MCS-333-□/□,H): -100 to 100°C, -200 to 200°F

* High/Low limits alarm w/standby function (MCS-334-□/□,H): ±(1 to 100°C), ±(1 to 200°F)

• In case the input is RTD, and decimal point is applied.

High limit alarm with standby function (MCS-332-□/□,R,H): -100.0 to 100.0°C,
-199.9 to 200.0°F



Low limit alarm with standby function (MCS-333-□/□,R,H): -100.0 to 100.0°C,
-199.9 to 200.0°F

* High/Low limits alarm w/standby function (MCS-334-□/□,R,H): ±(1.0 to 100.0°C), **
±(1.0 to 200.0°F) **

* Both (+) and (-) values will be simultaneously set when applied only one value.

** Avoid setting the value 0.9 or less, since it prevents proper action related to the dead band.

Setting the alarm value to 0 disables the temperature alarm function.

PV display	SV display	Change of setting value
A	Temperature alarm setting value	The value can be increased or decreased by pressing the  or  key.

⑦ b Heater burnout alarm setting mode (Option)

A mode to set a heater current, and is applied when option Heater burnout alarm output (Option code: W) is specified.

The setting value is calculated as:



$$[\text{Action point (setting value)\%} = \frac{\text{Heater current}}{\text{Rated value}} \times 100\%]$$

Heater current: Maximum current during control
 Rated value : Specified value, 5A, 10A or 20A

However, considering the voltage fluctuation, it is recommended to set the value approx. 80% of the setting value.

Setting range is 0 to 100%. (Factory adjusted as 0%)
 Once alarm action operates, the output is held. To release the output, turn the output OFF, and ON again or set the value to 0.

Setting this value to 0, heater burnout function will not work.
 (However, the sensor burnout function works.)

PV display	SV display	Change of setting value
b	Heater current setting value	The value can be increased or decreased by pressing the  or  key.

Heating/Cooling control output (Option code: D□)

- ⑧ c - b Cooling control Proportional cycle setting mode
- ⑨ P - b Cooling control Proportional band setting mode
- ⑩ c' Overlap, Dead band setting mode

These modes are applied when the option Heating/Cooling control output [Option code: D□] is specified, and the controller performs the Heating/Cooling control with Cooling control output (Sub-output [C2]) besides Heating control output (Main output [C1]).

- Cooling control Proportional cycle: 1 to 120sec.
(Factory adjusted as 30sec. [Relay contact output], 3sec. [Non-contact voltage output])
- Cooling control proportional band : 0.1 to 10 times of Heating control proportional band
(Factory adjusted as 1)
- Overlap, Dead band setting range : -10.0 to 10.0% of scaling range full scale.
(+): setting for dead band, and (-): setting for overlap (Factory adjusted as 0.0%)
(The value is indicated corresponding to the temperature.)
- The value for Integral time and Derivative time follow the setting values of main control action.

◇ Example to set the Sub proportional band

In case of, Rated scale: 0 to 400°C, Main proportional band: 10.0% (40°C)
Desired, Sub-proportional band: 10°C

[Formula] Sub-P-band value = Main P-band value × Sub-P-band multiplying factor
(Sub-P-band setting value)

[Example] 10°C = 40°C × 1/4 (-4) [See below table]

Sub-proportional band is set within the range of -10 to 10, however, if the main proportional band is changed, the sub-proportional band is also changed even if it is the same value. With the above example, that is,

If the main proportional band is 5.0% (20°C),
the sub-proportional band should be 5°C 5°C = 20°C × 1/4 (-4)

If desired the sub-proportional band 10°C,
set the value to -2 (1/2) 10°C = 20°C × 1/2 (-2)

Sub control Proportional band setting value	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
Sub control Proportional band multiplying factor	1/10	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1/1	0
Sub control Proportional band value (°C) *	4.0	4.4	5.0	5.7	6.7	8.0	10.0	13.3	20.0	40.0	0

Sub control Proportional band setting value	0	1	2	3	4	5	6	7	8	9	10
Sub control Proportional band multiplying factor	0	1	2	3	4	5	6	7	8	9	10
Sub control Proportional band value (°C) *	0	40	80	120	160	200	240	280	320	360	400

* The value in case the rated scale is 0 to 400°C.

PV display	SV display	Change of setting value
c - b	Cooling control output, proportional cycle setting value	Increase or decrease the numerical value operating (▲) or (▼) keys.
P - b	Cooling control output, proportional band setting value	
c'	Overlap or dead band setting value	

⑧ **OFF** Control output OFF function

A function to stop the control output. (The function will not be released even if the power supplied to the instrument is turned off and on again.)

Notice

In PV/SV display mode, if the **(MODE)** key is pressed while the **(▲)** key is being pressed, the mode turns to the Sub-setting mode and the character **[P]** will be displayed for a while. Though the character is displayed, keep pressing until **[OFF]** is displayed. (Approx. 3sec.) To release the function, the same key operation will do it.

PV display	SV display	Change of the function
0	OFF	In PV/SV display mode, press the (MODE) key for approx. 3 seconds while the (▲) key is being pressed. To release the function, carry out the same key operation, however, it selects the proportional band setting mode [P] .

(4) Auxiliary function setting mode

In PV/SV display mode, if the **(MODE)** key is pressed for approx. 3 seconds while the **(▼)** key is being pressed, the mode turns to the Auxiliary function setting, and it selects the Setting value lock designation mode showing **[Loc]** on PV display.

Further, each pressing only the **(MODE)** key, the mode is changed, and the desired setting value can be set for each mode.

① **Loc** Setting value lock designating mode

A mode to designate the Setting value lock function to prevent from wrong setting. The setting items to be locked are different from the designating status.

[Factory adjusted as unlock status (- -)]

Character	Function
- -	Lock cancelled status. All setting values can be changed.
LcA	Lock status for the all setting values in Main and Sub setting mode. No values in Main and Sub setting mode can be changed.
Lc4	Only main setting value is changeable in the locking items [LcA] , and others are unchangeable.

PV display	SV display	Change of status
LcC	- -	With (▲) key <div style="display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; padding: 2px 5px; margin: 0 5px;">- -</div> ⇒ <div style="border: 1px solid black; padding: 2px 5px; margin: 0 5px;">LcA</div> ⇒ <div style="border: 1px solid black; padding: 2px 5px; margin: 0 5px;">Lc4</div> </div>
	LcA	
	Lc4	With (▼) key <div style="display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; padding: 2px 5px; margin: 0 5px;">Lc4</div> ⇒ <div style="border: 1px solid black; padding: 2px 5px; margin: 0 5px;">LcA</div> ⇒ <div style="border: 1px solid black; padding: 2px 5px; margin: 0 5px;">- -</div> </div>

PID auto-tuning cannot work in the lock status **LcA, Lc4**.

② **4E** Sensor designating mode (Option)

A mode to change the input type, available to 6 kinds of thermocouples -[]/E and 8 kinds of RTDs -[]/R, to be applied to option [F].

Character	Input	Scaling range	Applicable model
$\bar{n}t$	K	0 to 1200°C	-[]/E Thermocouple
$\bar{n}tF$	K	0 to 2400°F	
$\bar{n}d$	J	0 to 800°C	
$\bar{n}dF$	J	0 to 1600°F	
$\bar{n}n$	N	0 to 1300°C	
$\bar{n}nF$	N	0 to 2300°F	
Pd	JPt100	-200 to 400°C	-[]/R RTD
PdF	JPt100	-200 to 1000°F	
Pd	Pt100	-200 to 400°C	
PdF	Pt100	-200 to 1000°F	
$Pdc.$	JPt100	-199.9 to 400.0°C	
$PdF.$	JPt100	-199.9 to 999.9°F	
$Pdc.$	Pt100	-199.9 to 400.0°C	
$PdF.$	Pt100	-199.9 to 999.9°F	

Notice

Do not change the designation between the input type thermocouple and RTD, or the accuracy will come off from the guarantee range owing to the difference of the terminal parts.

PV display	SV display	Change of setting
4E	$\bar{n}t$	With \blacktriangle key $\bar{n}t \Rightarrow \bar{n}tF \Rightarrow \bar{n}d \Rightarrow \bar{n}dF \Rightarrow$ $\Rightarrow \bar{n}n \Rightarrow \bar{n}nF \Rightarrow Pd \Rightarrow PdF \Rightarrow$ $\Rightarrow Pd \Rightarrow PdF \Rightarrow Pdc. \Rightarrow PdF. \Rightarrow$ $\Rightarrow Pdc. \Rightarrow PdF.$ With \blacktriangledown key $PdF. \Rightarrow Pdc. \Rightarrow PdF. \Rightarrow Pdc. \Rightarrow$ $\Rightarrow PdF \Rightarrow Pd \Rightarrow PdF \Rightarrow Pd \Rightarrow$ $\Rightarrow \bar{n}nF \Rightarrow \bar{n}n \Rightarrow \bar{n}dF \Rightarrow \bar{n}d \Rightarrow$ $\Rightarrow \bar{n}tF \Rightarrow \bar{n}t$
	$\bar{n}tF$	
	$\bar{n}d$	
	$\bar{n}dF$	
	$\bar{n}n$	
	$\bar{n}nF$	
	Pd	
	PdF	
	Pd	
	PdF	
	$Pdc.$	
	$PdF.$	
	$Pdc.$	
	$PdF.$	

Keep pressing the \blacktriangle or \blacktriangledown key, and the setting changes continuously.

③ **4H** Scaling high limit setting mode

A mode to set the high limit of the scaling value.
 Setting range is different from the kind of sensor.
 (Factory adjusted as specified rated value)

PV display	SV display	Change of setting value
4H	Scaling high limit value	The value can be increased or decreased by pressing the ▲ or ▼ key.

④ **4L** Scaling low limit setting mode

A mode to set the low limit of the scaling value.
 Setting range is different from the kind of sensor.
 (Factory adjusted as specified rated value)

PV display	SV display	Change of setting value
4L	Scaling low limit value	The value can be increased or decreased by pressing the ▲ or ▼ key.

⑤ **oFH** Output high limit setting mode

A mode to set the high limit of the control output. Effective to only main output.
 Setting range is from output low limit value to 100%. [Indication: to 110 (%)]
 (With Current output type, it is from output low limit value to 110%.)
 (Factory adjusted as 100%)

PV display	SV display	Change of setting value
oFH	Output high limit value	The value can be increased or decreased by pressing the ▲ or ▼ key.

⑥ **oFL** Output low limit setting mode

A mode to set the low limit of the control output. Effective to only main output.
 Setting range is from 0% to output high limit value. [Indication: from -10 (%)]
 (With Current output type, it is from -10% to output high limit value.)
 (Factory adjusted as 0%)

PV display	SV display	Change of setting value
oFL	Output low limit value	The value can be increased or decreased by pressing the ▲ or ▼ key.

⑦ **40** Sensor correction setting mode

A mode to set the sensor correction value.
 Setting range is from -30.0 to +30.0°C (-50.0 to +50.0°F)
 (Factory adjusted as 0.0°C[°F])

PV display	SV display	Change of setting value
40	Sensor correction value	The value can be increased or decreased by pressing the ▲ or ▼ key.

◆ Explanation of sensor correction function

It corrects the input value from the sensor. When a sensor cannot be set at a location where control is desired, the sensor measuring temperature may deviate from the temperature in the controlled location, and when controlling with plural controllers, the accuracy of sensors or the difference of load capacities have influence on the control. Therefore, sometimes measuring temperature (input value) does not accord with the same setting value. In such a case, the control can be accorded with desired temperature by shifting the input value of sensors.

⑧ **cā** Control type designating mode (Option)

A mode to designate the control type (Heating [reverse] or Cooling [direct]), and is applied to the option [F].

PV display	SV display	Control type	Change of setting
cā	HE	Heating (reverse) action	Heating (reverse) action with ▲ key
	CO	Cooling (direct) action	Cooling (direct) action with ▼ key

⑨ **ALā** Temperature alarm action designating mode (Option)

A mode to select the temperature alarm action mentioned below, and is applied to the option [F].

Character	Temperature alarm action	Setting range
--	No alarm action	—
H	High limit alarm action	-100 to 100°C [-200 to 200°F]
L	Low limit alarm action	-100 to 100°C [-200 to 200°F]
HL	High/Low limits alarm action	* ±(1 to 100°C) [±(1 to 200°F)]
ūī d	High/Low limit range alarm action	* ±(1 to 100°C) [±(1 to 200°F)]
Hū	High limit alarm action w/standby	-100 to 100°C [-200 to 200°F]
Lū	Low limit alarm action w/standby	-100 to 100°C [-200 to 200°F]
HLū	Hi/Lo limits alarm action w/standby	* ±(1 to 100°C) [±(1 to 200°F)]
Ab4	Process value alarm action	Scaling low to high limit setting value

* Both (+) and (-) values will be simultaneously set when applied only one value.

● In case the input is RTD, and decimal point is applied, refer to page 13 and 14 for the setting range.

Setting the alarm value to 0 disables the temperature alarm function.
(However, in case of Process value alarm, it works even if 0 is set.)

PV display	SV display	Change of the setting
ALā	--	With ▲ key -- ⇒ H ⇒ L ⇒ HL ⇒ ūī d ⇒ Hū ⇒ Lū ⇒ HLū ⇒ Ab4 With ▼ key Ab4 ⇒ HLū ⇒ Lū ⇒ Hū ⇒ ūī d ⇒ HL ⇒ L ⇒ H ⇒ --
	H	
	L	
	HL	
	ūī d	
	Hū	
	Lū	
	HLū	
Ab4		

Keep pressing the **▲** or **▼** key, and the setting changes continuously.

- ⑩ **dFA** Differential setting mode [Main control output (C1)] (Option)
- ⑪ **dFb** Differential setting mode [Sub-control output (C2)] (Option)

In case the controller acts ON/OFF action, differential (Dead band of ON and OFF action) can be set in this mode. [**dFA**] is applicable only when the option Function selection (code: F) is specified, and [**dFb**] is applicable only when the options both Function selection (code: F) and Heating/Cooling control output (code: D□) are specified. [**dFA**] is the mode to change the differential for the main control and [**dFb**] is for sub-control.

Setting range is 0.0 to 10.0°C(20.0°F) (Factory adjusted as 1.0°C[°F])

This action is effective only when the controller acts ON/OFF action (P = 0.0%).

PV display	SV display	Change of setting value
dFA	Differential setting value for main control output (C1)	The value can be increased or decreased by pressing the (▲) or (▼) key.
dFb	Differential setting value for sub-control output (C2)	

6. CONTROL ACTIONS

6.1 Explanation of PID

(1) Proportional band (P)

Proportional action is the action of which the control output varies in proportion to the deviation between setting value and processing temperature. If the proportional band is narrowed, the output changes according to even by a slight variation of the processing temperature, and good control result can be obtained since the offset decreases. However, if when the proportional band is extremely far too narrowed, it may cause variation in the processing temperature even by slight disturbance, and turns into control such as ON/OFF action of the so called hunting phenomenon.

Therefore, when the processing temperature comes to the balanced position near the setting value and a constant temperature is maintained, the most suitable value is selected by gradually narrowing the proportional band while observing the control results.

(2) Integral time (I)

Integral action is to eliminate offset. When the integral time is shortened, the returning speed to the setting point is quickened. However, the cycle of vibration is also quickened and stability becomes unfavorable.

(3) Derivative time (D)

Derivative action is to restore the change of processing temperature according to the changing speed. It reduces overshoot and vibration width.

If the derivative time is shortened, restoring value comes small, and if it is adjusted longer, a phenomenon of returning too much may occur and the control system may vibrate.

(4) Anti-reset windup (ARW)

ARW prevents overshoot caused due to the integral action. If operating by manual, duty factor of load for the setting is of standard value, to fix controlling aim. The less ARW value is, the less excess integral action becomes at transition status, however, it needs time till stabilized.

* How to get the duty factor for ARW when manual controlling.

$$\text{Duty factor(\%)} = \frac{\text{ON action time}}{\text{Proportional cycle}} \times 100(\%)$$

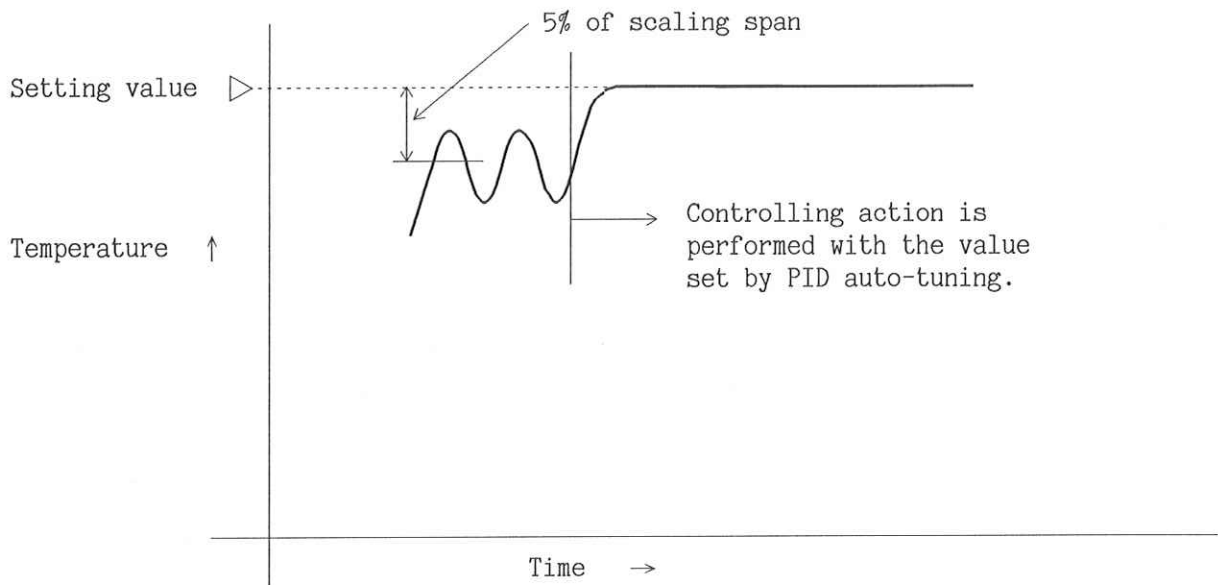
Set to 50% (factory adjusted value) on trial run, if duty factor is unknown.

The values P, I, D and ARW are automatically set by performing PID auto-tuning.

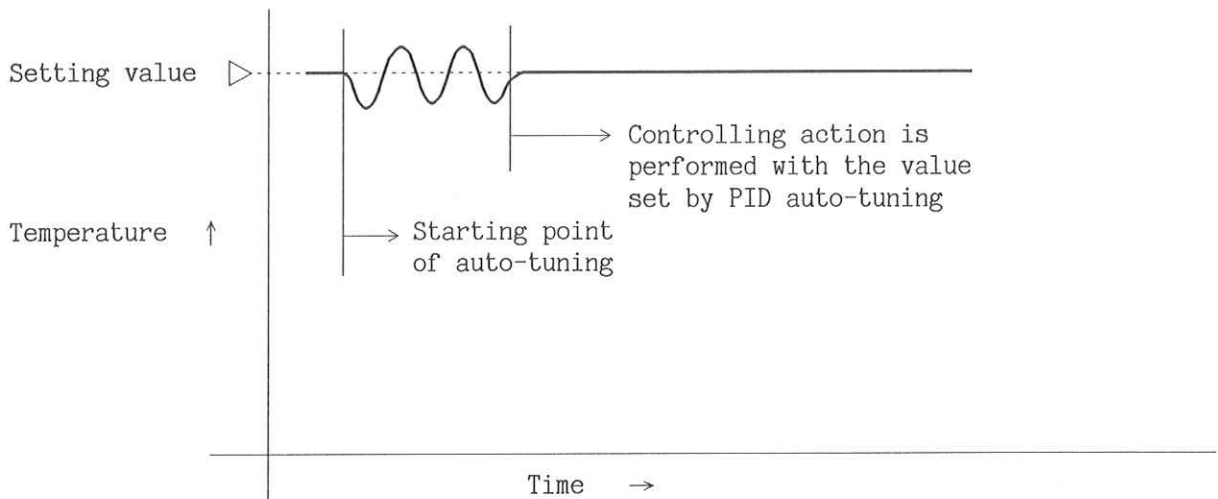
6.2 Explanations of PID auto-tuning

In order to decide each value of P, I, D and ARW automatically, this system gives the fluctuation to the control object by force. Three kinds of undermentioned systems are automatically selected by an instrument.

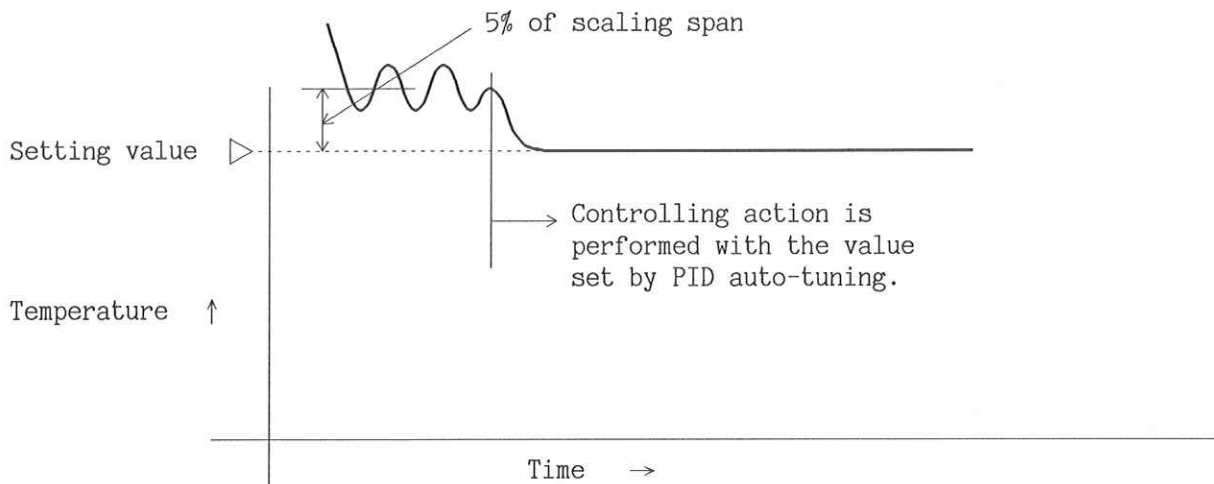
- (1) In case the difference between setting value and processing temperature is large when the temperature rises. Fluctuation is given at the temperature 5% of scaling span less than the setting value.



- (2) In case of the stable situation during control or when control temperature is within $\pm 10\%$ of scaling span. Fluctuation is given at the setting value.



- (3) In case control temperature is 10% or more of scaling span. Fluctuation is given at the temperature 5% of scaling span higher than the setting value.



* The methods (1) to (3) are automatically selected by the relation between control temperature and setting value. However, according to the process, if selected the timing to start auto-tuning, the merits mentioned below is applicable effectively.

- The method (1) prevents control temperature from exceeding setting value during auto-tuning. This method is suitable to the system high process gain such as process has high rise rate or the process have short lagged time.
- The method (2) is possible to measure with small fluctuation, specially, suitable to the process of long lagged time.
- The method (3) is suitable to be used as cooling (direct) action. It has no objection using to heating (reverse) action, however, hunting may often occur depending on the process.

6.3 PID auto-tuning performance

Auto-tuning starts by pressing the **(AT)** key in PV/SV display mode, Main setting mode, Sub-setting mode or Auxiliary function setting mode. During auto-tuning is operated, auto-tuning indicator blinks. At this time, the **(MODE)** key becomes null, and other settings cannot be operated.

Auto-tuning is released when the **(AT)** key is pressed again while the auto-tuning is operated. However, proper values (P, I, D and ARW) cannot be set, but the former values will be kept, because the tuning is finished during the process.

After auto-tuning is ended, the indicator goes off and the values Proportional band, the Integral time, the Derivative time and the ARW are set automatically.

The setting values (P, I, D and ARW) can be confirmed at each setting item in Sub-setting mode.

Auto-tuning will not function if lock is specified with the setting value lock designation mode. (See page 16)

7. Other functions

(1) Tamper-proof function

In any mode excepting PV/SV display mode, if no keys are pressed for 30 seconds, the controller will automatically return to PV/SV display mode.

(2) Burnout alarm (upscale)

When the thermocouple or RTD (between A and B) burns out, or the input value exceeds 1.125 times of the maximum rated value, PV display will blink [- - - -], and HB indicator (red LED) lights.

At this time, in case the main control output is reverse action (heating), the output becomes OFF status, and in case it is direct action (cooling), the output becomes ON.

In case the Heater burnout alarm function (Option) is specified, the alarm output turns ON along with the above action.

(3) Self-diagnostic function

Watches the CPU by watchdog timer, and when occurred any abnormal status on the CPU, it makes the controller to initial status making the all output off.

(4) Automatic cold junction temperature compensation (-[]/E)

Detects the temperature at the connecting terminal between thermocouple and instrument, and always makes it the same status at which the reference junction located at 0°C [32°F].

(5) Power failure back up

In case the power failure time exceeds 30ms, the data are kept with non-volatile IC memory.

8. RUNNING

After completion of the mounting to the control panel and wiring connections, start running in the following manner:

- (1) Turn the power supplied to this instrument ON.
(Do not turn the power on while pressing the key, or the specification contents of the instrument may be changed.)
- (2) Instrument (warmup status)
For approx. 8 seconds after power on, [\overline{FL} -] is displayed on process variable display. During this time, all output, digital display and LED indicators are in their OFF status. (Key operations must not be executed during this time, or the specification of the instrument will have a possible to change.)
After that, it displays actual temperature on the process variable display, setting value on the display, and starts control.
- (3) Input the setting value, referring to [5. OPERATIONS page 10].
- (4) Turn the control circuit power ON.
- (5) The controller starts the following control action so as to maintain the controlled object at the setting value.

Note: It is recommended to make the PID auto-tuning on trial run.

9. Action drawings

o Heating (reverse) and Cooling (direct) action drawings

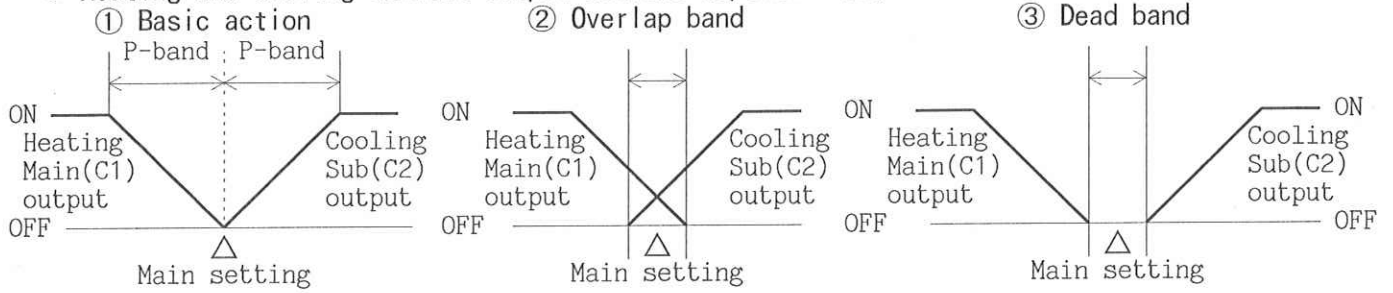
Action		Heating (Reverse) action [\overline{HE}]			Cooling (Direct) action [\underline{CO}]		
Main control action							
Relay contact	Output						
	Indication (Green)						
Non-contact voltage	Output						
	Indication (Green)						
Current	Output						
	Indication (Green)						

○ Temperature alarm actions

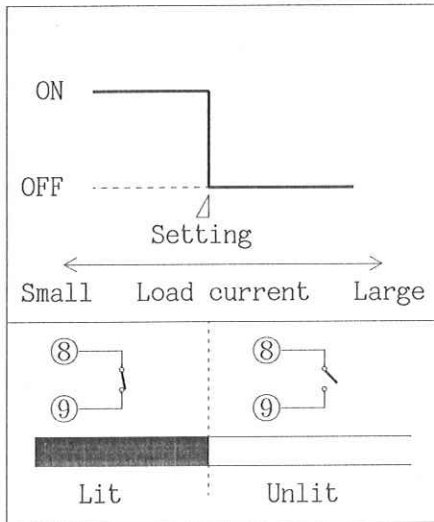
	High limit alarm action (-332)	Low limit alarm action (-333)
Alarm action		
Output indication		
	High limit alarm w/standby (-332-, H)	Low limit alarm w/standby (-333-, H)
Alarm action		
Output indication		
	High/Low limits alarm action (-334)	Hi/Lo limit range alarm action (-336)
Alarm action		
Output indication		
	Hi/Lo limits alarm w/standby (-334, H)	Process value alarm action (-338)
Alarm action		
Output indication		

The standby function works at part.

○ Heating and Cooling control output actions (Option: D□)



○ Heater burnout alarm action (Option: W)



○ ON/OFF action (the proportional band is set to 0.0)

Main control action		ON	Dead band	OFF	Setting
Relay contact	Output	⑥	⑦	⑥	⑦
	Indication	Green	Lit	Unlit	
Non-contact voltage	Output	⑥ + 15Vdc	⑦ -	⑥ + 0Vdc	⑦ -
	Indication	Green	Lit	Unlit	
Current	Output	⑥ + 20mA dc	⑦ -	⑥ + 4mA dc	⑦ -
	Indication	Green	Lit		

10. Specifications

- Mounting : Flush
- Setting : Input system using membrane sheet key
- Display : Process variable display: Red LED, 4 digits, Size 8(H)×4(W)mm
Setting value display: Green LED, 4 digits, Size 8(H)×4(W)mm
- Rated scale : Thermocouple K, J 0 to 800°C (0 to 1600°F)
K 0 to 1200°C (0 to 2400°F)
N 0 to 1300°C (0 to 2300°F)
RTD Pt100, JPt100 -199.9 to 400.0°C (-199.9 to 999.9°F)
-200 to 400°C (-200 to 1000°F)
- Accuracy : Within ±0.3% of scaling range full scale ±1 digit, or
within ±2°C (±4°F) [whichever is greater]
Minimum scale span to guarantee the accuracy, 300°C(600°F)
: Within ±0.3% of scaling range full scale ±1 digit, or
within ±1°C (±2°F) [whichever is greater]
(In case of -199.9 to 999.9°F, within ±0.3% of full scale ±3 digit)
Minimum scale span to guarantee the accuracy, 100°C(200°F)
- Input : Thermocouple K, J, N (100Ω or less)
: RTD Pt100, Pt100 (3-wire system, resistance per wire 4Ω maximum)
- Output : Relay contact 1a 220Vac 3A (resistive load)
220Vac 1A (inductive load cos φ=0.4)
: Non-contact voltage (for SSR drive)
15 ±3Vdc (at load resistance 1.5k Ω)
20mA (short-circuit protected)
: DC current 4 to 20mAdc (Isolated type)
Load resistance, 600 Ω maximum
Temperature alarm: Relay contact 1a 220Vac 1A (resistive load)
220Vac 0.4A (inductive load cos φ=0.4)
- Control system : PID action (with auto-tuning function)
Proportional band 0.1 to 200.0% (acts ON/OFF when set to 0.0,
the dead band: 1°C[1°F])
Integral time 1 to 3600 seconds (off when set to 0)
Derivative time 1 to 1800 seconds (off when set to 0)
Anti-reset windup 0 to 100%
Proportional cycle 1 to 120 seconds
Temperature alarm ON/OFF action Dead band 1°C(1°F)
- Supply voltage : 85 to 264Vac 50/60Hz, 24Vac 50/60Hz or 24Vdc
- Voltage fluctuation : In case of 24V, the allowable range is 20 to 28V
- Ambient temperature : 0 to 50°C (32 to 122°F)
- Ambient humidity : 35 to 85%RH (non-condensing)
- Power consumption : Approx. 2.2W
- Weight : Approx. 150g
- Materials and Color : Frame and case, Polycarbonate resin. Light-gray
- Insulation resistance: 10MΩ or greater at 500Vdc (However, voltage must not be applied to
the CT input terminal and for the type
-S/□, -A/□.)
- Dielectric strength : Input terminal - Power terminal and Ground: 500Vac for 1 minute
Power terminal - Ground : 1.5kVac for 1 minute
Output terminal - Power terminal and Ground: 1.5kVac for 1 minute *
(* Do not apply the voltage to the terminal
non-contact voltage output and current output.)

Attached functions : Scaling function (scaling high limit and low limit setting)
 Sensor correcting function
 Setting value lock function
 Power failure back-up (data back-up by non-volatile IC memory)
 Self-diagnostic function (watchdog timer, instrument source abnormal watch, RAM check)
 Automatic cold junction temperature compensation (-□/E),
 Burnout function (upscale)
 Output limit function
 Control output OFF function.

Accessories : Mounting brackets 1 set
 Instruction manual 1 copy
 Current transformer, Model CTL-6-S 1 set [when the option W is applied]

[Optional specifications]

Temperature alarm : [Code: H] Temperature alarm (applicable to High limit, Low limit w/standby function and High/Low limits alarm) with standby function.

Heater burnout alarm : [Code: W]
 output
 Setting 0 to 100% (current 5A, 10A or 20A, specified)
 Setting accuracy $\pm 5\%$
 Action ON/OFF action
 Output Relay contact 1a (common to temperature alarm)
 220Vac 1A (resistive load)
 220Vac 0.4A (inductive load $\cos\phi=0.4$)

Function selection : [Code: F] A function to designate or set the Sensor, Temperature scale Control type, Temperature alarm and Differential value.

Specified dead band : [Code: SK] Designation of dead band (main control ON and OFF) (Range, 0.0 to 10.0°C [0.0 to 20.0°F])

Heating/Cooling control output : [Code: D□]
 Output
 Relay contact 1a [DR], 220Vac 3A (resistive load)
 220Vac 1A (inductive load $\cos\phi=0.4$)
 Non-contact voltage (for SSR drive) [DS],
 15Vdc $\pm 3V$ (load resistance 1.5k Ω)
 20mA (short circuit protected)
 Cooling (sub-) proportional cycle: 1 to 120sec.
 Cooling (sub-) proportional band : 0.1 to 10 times of Main P-band
 Overlap/Dead band setting value : -10.0 to 10.0% of scaling range full scale
 The values of Integral time (I) and Derivative time (D) follow the main control one.

Cooling control action : [Code: CM] OFF in the range in which the input value is lower than the setting value, ON in the range higher than that.

PD control system : [Option: PD]
 The main control action consists of Proportional (P) and Derivative (D) actions. (PD auto-reset function is attached.)
 Proportional band (P): 0.1 to 200.0%
 (Factory adjusted as 2.5%, [ON/OFF action when set to 0.0.])
 Derivative time (D): 1 to 3600sec.
 (Factory adjusted as 50sec., [OFF when set to 0.])
 Proportional cycle : 1 to 120sec.
 (Factory adjusted as 3sec. -S /□, 30sec. -R/□, not available -A/□.)

Color Black : [Code: BK] Face plate: Dark gray, Case: Black

Screw type mounting bracket : [Code: BL] Mounting Panel thickness 1 to 8 mm

11. CHARACTER TABLE

Character	Description	Character	Description
$\bar{a}C-$	Warmup status	$PJc. *$	Pt100(old JIS), -199.9 to 400.0°C
$\bar{4}$	Main setting mode	$PJF. *$	Pt100(old JIS), -199.9 to 999.9°F
\bar{P}	Proportional band setting mode	$Pdc. *$	Pt100(JIS, IEC), -199.9 to 400.0°C
\bar{I}	Integral time setting mode	$PdF. *$	Pt100(JIS, IEC), -199.9 to 999.9°F
\bar{d}	Derivative time setting mode	$\bar{4}H$	Scaling high limit setting mode
\bar{n}	ARW setting mode	$\bar{4}L$	Scaling low limit setting mode
\bar{c}	Proportional cycle setting mode	$\bar{o}FH$	Output high limit setting mode
\bar{c}_b**	Prop. cycle setting (cooling)	$\bar{o}FL$	Output low limit setting mode
\bar{P}_b**	Prop. band setting (cooling)	$\bar{4}o$	Sensor correction setting mode
\bar{A}	Temperature alarm setting mode	$\bar{c}\bar{n} **$	Control type designating mode
$\bar{A}.$	Only display, no function	$\bar{H}E *$	Heating (reverse) action
$\bar{c}' **$	Overlap Dead band setting mode	$\bar{c}o *$	Cooling (direct) action
$\bar{b} **$	Heater burnout alarm setting	$\bar{A}L\bar{n}**$	Temperature alarm designation
$\bar{o}FF *$	Control output OFF status	$\bar{A}L\bar{n}.$	Only display, no function
$\bar{L}oc$	Setting value lock designation	$- - *$	No alarm action
$- - *$	Lock is not designated	$\bar{H} *$	High limit alarm action
$\bar{L}c\bar{A} *$	All setting value lock	$\bar{L} *$	Low limit alarm action
$\bar{L}c\bar{4} *$	Lock excepting main setting	$\bar{H}L *$	High/Low limits alarm action
$\bar{4}E **$	Sensor designating mode	$\bar{u}l\bar{d} *$	Hi/Lo limit range alarm action
$\bar{n}\bar{t} *$	K, 0 to 1200°C	$\bar{H}\bar{u} *$	Hi limit alarm action w/standby
$\bar{n}\bar{t}F *$	K, 0 to 2400°F	$\bar{L}\bar{u} *$	Lo limit alarm action w/standby
$\bar{n}\bar{J} *$	J, 0 to 800°C	$\bar{H}L\bar{u} *$	Hi/Lo limits alarm with standby
$\bar{n}\bar{J}F *$	J, 0 to 1600°F	$\bar{A}b\bar{4} *$	Process value alarm action
$\bar{n}\bar{n}$	N, 0 to 1300°C	$\bar{d}F\bar{A}**$	Differential setting mode
$\bar{n}\bar{n}F$	N, 0 to 2300°F	$\bar{d}F\bar{b}**$	Differential setting mode (cool)
$\bar{P}\bar{J} *$	Pt100(old JIS), -200 to 400°C	$- - - -$	Sensor burnout status (upscale)
$\bar{P}\bar{J}F *$	Pt100(old JIS), -200 to 1000°F		
$\bar{P}\bar{d} *$	Pt100(JIS, IEC), -200 to 400°C		
$\bar{P}\bar{d}F *$	Pt100(JIS, IEC), -200 to 1000°F		

*: They are displayed on the SV display (Green) and others are on the PV display (Red).
 **: They show the case of options.

MEMO

4		PdF	
P		PJc.	
l		PJF.	
d		Pdc.	
n		PdF.	
c		4H	
c_b		4L	
P_b		oFH	
A		oFL	
d'		4o	
b		HE	
oFF		co	
--		--	
LcA		H	
Lc4		L	
āt		HL	
ātF		ūl d	
āJ		Hū	
āJF		Lū	
ān		HLū	
ānF		Ab4	
PJ		dFA	
PJF		dFb	
Pd			

• • • Inquiry • • •

For any inquiry of this controller, after checking the following as to the controller, please contact your shop where purchased, or our agent.

[Example]

- Model MCS-330-R/E
- Temperature specification 0 to 1200°C
- Type of input K

In addition to the above, let us know the details of malfunction, if any, and the operating conditions specifically on job site.

SHINKO TECHNOS CO., LTD.
OVERSEAS DIVISION

Reg Office : 2-48, 1-Chome, Ina, Minoo, Osaka, Japan
Mail Address: P.O.Box 17, Minoo, Osaka, Japan
Telephone : (0727)21-2781 & 2782

Telex: 5324127 (SHINKO J)
Cable: SHINKO MINOO JAPAN
FAX : (0727) 24-1760