# OMRON

Digital Controller	E5AK/E5EK

Advanced Digital Controllers Ideal for Worldwide Use

- Modular structure, one-stock type
- High-accuracy: 100 ms sampling (for analog input)
- Advanced tuning which includes fuzzy self-tuning
- Conforms to international EMC and safety standards.
- IP66/NEMA4 (indoor use) front face
- Remote set point
- Serial communications (RS-232C, RS-422 and RS-485) and transfer output (4 to 20 mA)
- Position-proportional control model
- Heat/Cool control

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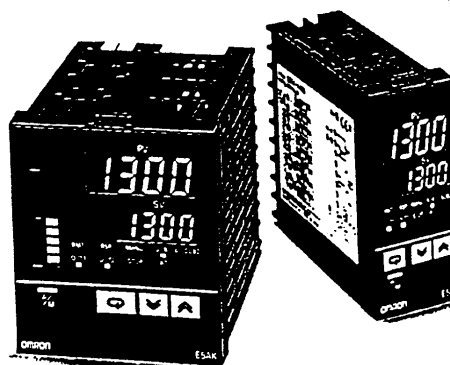
Ordering Information

Description	Model	Specification
Base Unit	E5AK-AA2	Standard model
	E5AK-AA2-500	Standard model with terminal cover
	E5AK-PRR2	Position-proportional model
	E5AK-PRR2-500	Position-proportional model with terminal cover
	E5EK-AA2	Standard model
	E5EK-AA2-500	Standard model with terminal cover
	E5EK-PRR2	Position-proportional model
	E5EK-PRR2-500	Position-proportional model with terminal cover

Note: 1. When using the heater burnout alarm function with a standard model, the Linear Output Unit cannot be used for the control outputs (heat). The Digital Controller provides transfer outputs at 4 to 20 mA for the PV and other values and control outputs at 4 to 20 mA for the current outputs.

2. Be sure to specify the Current Transformer, Output Unit, and Option Unit when ordering.

Description	Model	Specification
Output Unit	E53-R	Relay
	E53-S	SSR
	E53-Q	Pulse (NPN) 12 VDC
	E53-Q3	Pulse (NPN) 24 VDC
	E53-Q4	Pulse (PNP) 24 VDC
	E53-C3	Linear (4 to 20 mA)

Description	Model	Specification
Option Unit	E53-AKB	Event input
	E53-AK01	Communication (RS-232C)
	E53-AK02	Communication (RS-422)
	E53-AK03	Communication (RS-485)
	E53-AKF	Transfer output

- **Note:** 1. The Option Unit can be used either by the E5AK or E5EK.

    2. The E5AK allows a maximum of three Option Units to be mounted. Refer to page 7 for mounting combinations.
    The E5EK allows only one Option Unit to be mounted.

Inspection Report

The Digital Controller can be provided together with an inspection report.

Refer to the following legend with the suffix "K" when ordering a model provided together with an inspection report.
    E5□K-AA2-K, E5□K-PRR2-K, E53-AKF-K

■ Accessories (Order Separately)

Name	Model	Hole diameter
Current Transformer	E54-CT1	5.8 mm
	E54-CT3	12.0 mm

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

Name	Model	Connectable models
Terminal Cover	E53-COV0809	E5AK
	E53-COV08	E5EK

■ Ranges

Platinum Resistance Thermometer

Input (switch selectable)		JPt100	Pt100
Range	°C	–199.9 to 650.0	–199.9 to 650.0
	°F	–199.9 to 999.9	–199.9 to 999.9
Resolution (°C/°F) (main setting and alarm)		0	1

Thermocouple

Input (switch selectable) (see note)		K1	K2	J1	J2	T	E	L1	L2	U	N	R	S	B	W	PLI
Range	°C	–200 to 1,300	0.0 to 500.0	–100 to 850	0.0 to 400.0	–199.9 to 400.0	0 to 600	–100 to 850	0.0 to 400.0	–199.9 to 400.0	–200 to 1,300	0 to 1,700	0 to 1,700	100 to 1,800	0 to 2,300	0 to 1,30
	°F	–300 to 2,300	0.0 to 900.0	–100 to 1,500	0.0 to 750.0	–199.9 to 700.0	0 to 1,100	–100 to 1,500	0.0 to 750.0	–199.9 to 700.0	–300 to 2,300	0 to 3,000	0 to 3,000	300 to 3,200	0 to 4,100	0 to 2,30
Resolution (°C/°F) (main setting and alarm)		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Note: Setting number is factory-set to 2 (K1).
    Thermocouple W is W/Re5-26 (tungsten rhenium 5, tungsten rhenium 26).

Current/Voltage

Input (switch selectable)	Current input		Voltage input		
	4 to 20 mA	0 to 20 mA	1 to 5 V	0 to 5 V	0 to 10 V
Range	One of following ranges depending on results of scaling –1999 to 9999 –199.9 to 999.9 –19.99 to 99.99 –1.999 to 9.999				
Resolution (°C/°F) (main setting and alarm)	17	18	19	20	21

Specifications

■ Ratings

Supply voltage	AC100–240V∿, 50/60 Hz
Operating voltage range	85% to 110% of rated supply voltage
Power consumption	E5AK: 16 VA E5EK: 15 VA
Input	Thermocouple: K, J, T, E, L, U, N, R, S, B, W, PLII Platinum resistance thermometer: JPt100, Pt100 Current input: 4 to 20 mA, 0 to 20 mA (Input impedance: 150 Ω) Voltage input: 1 to 5 V, 0 to 5 V, 0 to 10 V (Input impedance: 1 MΩ)
Control output	<u>Standard Model</u> According to Output Unit (see "Output Unit Ratings and Characteristics") <u>Position-proportional Model</u> 2 Relay outputs: SPST-NO, 1 A at 250 VAC (including inrush current) (see note 1)
Auxiliary output	SPST-NO, 3 A at 250 VAC (resistive load)
Control method (see note 2)	ON/OFF or advanced PID control (with auto-tuning)
Setting method	Digital setting using front panel keys
Indication method	7-segment digital display and LEDs
Potentiometer	100 Ω to 2.5 kΩ
Event input	Contact input: ON: 1 kΩ max., OFF: 100 kΩ min. No-contact input: ON: residual voltage: 1.5 V max., OFF: leakage current: 0.1 mA max.
Transmission output	4 to 20 mA, permissible load impedance: 600 Ω max., resolution: approx. 2,600
Remote SP input	Current input: 4 to 20 mA (Input impedance: 150 Ω)
Current Transformer input	Connect an exclusive Current Transformer (E54-CT1 or E54-CT3)
Other functions	<u>Standard</u> Manual output, heating/cooling control, SP limiter, loop burnout alarm, SP ramp, MV limiter, MV change rate limiter, input digital filter, input shift, run/stop, protect functions <u>Option</u> Multiple SP, run/stop selection, transfer output functions
Enclosure ratings	Conforms to IEC IP66 and NEMA4 (Indoor use)

Note: 1. All control outputs are insulated from the input circuit.

2. Fuzzy self-tuning is available using the Digital Controller in standard control operation with temperature input.

■ Characteristics

Indication accuracy (see note 1)	Thermocouple: (±0.3% of indication value or ±1°C, whichever greater) ±1 digit max. Platinum resistance thermometer: (±0.2% of indication value or ±0.8°C, whichever greater) ±1 digit max. Analog input: ±0.2% FS ±1 digit max.
Hysteresis	0.01% to 99.99% FS (in units of 0.01% FS)
Proportional band (P)	0.1% to 999.9% FS (in units of 0.1% FS)
Integral (reset) time (I)	0 to 3,999 s (in units of 1 s)
Derivative (rate) time (D)	0 to 3,999 s (in units of 1 s)
Control period	1 to 99 s (in units of 1 s)
Manual reset value	0.0% to 100.0% (in units of 0.1%)
Alarm setting range	−1,999 to 9,999 or −199.9 or 999.9 (decimal point position dependent on input type or result of scaling)
Sampling period (see note 2)	Temperature input: 250 ms Analog input: 100 ms
Insulation resistance	20 MΩ min. (at 500 VDC)
Dielectric strength	2,000 VAC, 50/60 Hz for 1 min between terminals of different polarities
Vibration resistance	Malfunction: 10 to 55 Hz, 10 m/s² (approx. 1G) for 10 min each in X, Y, and Z directions Destruction: 10 to 55 Hz, 20 m/s² (approx. 2G) for 2 hrs each in X, Y, and Z directions
Shock resistance	Malfunction: 200 m/s² min. (approx. 20G), 3 times each in 6 directions (100 m/s² (approx. 10G) applied to the relay) Destruction: 300 m/s² min. (approx. 30G), 3 times each in 6 directions
Ambient temperature	Operating: −10°C to 55°C (with no icing)/3-year warranty period: −10°C to 50°C Storage: −25°C to 65°C (with no icing)
Ambient humidity	Operating: 35% to 85%
Enclosure ratings	Front panel: NEMA4 for indoor use (equivalent to IP66) Rear case: IEC standard IP20 Terminals: IEC standard IP00

■ Output Unit Ratings and Characteristics

Relay output	5 A at 250 VAC (resistive load)
SSR output	1 A at 75 to 250 VAC (resistive load)
Voltage output	NPN: 40 mA at 12 VDC (with short-circuit protection) NPN: 20 mA at 24 VDC (with short-circuit protection) PNP: 20 mA at 24 VDC (with short-circuit protection)
Linear current output	4 to 20 mA, permissible load impedance: 600 Ω max., resolution: approx. 2,600 0 to 20 mA, permissible load impedance: 600 Ω max., resolution: approx. 2,600
Linear voltage output	0 to 10 VDC, permissible load impedance: 1 kΩ max., resolution: approx. 2,600 0 to 5 VDC, permissible load impedance: 1 kΩ max., resolution: approx. 2,600

Note: An output relay (1 A at 250 VAC) is mounted on the position-proportional model. (When replacing, use the E53-R.)

■ Option Unit Ratings and Characteristics

Event inputs	Contact input: ON: 1 kΩ max., OFF: 100 kΩ min. No-contact input: ON: residual voltage 1.5 V max., OFF: leakage current 0.1 mA max.
Communications	Interface: RS-232C, RS-422 or RS-485 Transmission method: Half-duplex Synchronization method: Start-stop synchronization (asynchronous method) Baud rate: 1.2/2.4/4.8/9.6/19.2 kbps
Transfer output	4 to 20 mA: Permissible load impedance: 600 Ω max. Resolution: approx. 2,600

■ Current Transformer Ratings

Dielectric strength	1,000 VAC (for 1 min)
Vibration resistance	50 Hz, 98 m/s^2 (10G)
Weight	E54-CT1: approx. 11.5 g; E54-CT3: approx. 50 g
Accessories (E54-CT3 only)	Armature: 2; Plug: 2

■ Heater Burnout Alarm

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

Note: 1. Use the K2CU-F☐☐A-☐GS (with gate input terminals) for the detection of three-phase heater burnout.

2. The heater burnout alarm is always OFF if the alarm is set to 0.0 A and always ON if the alarm is set to 50.0 A.

3. No heater burnout detection or heater current value measurement is possible if the control output (heat) is ON for less than 190 ms.
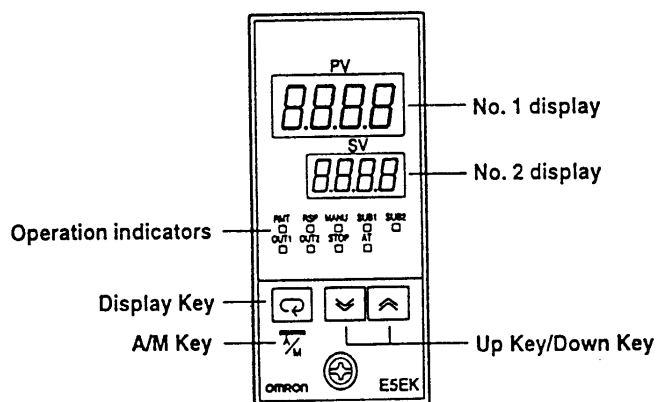
Nomenclature

E5AK

Operation Indicators

- **OUT1**
  Lit when the pulse output function assigned to control output 1 turns ON.

- **OUT2**
  Lit when the pulse output function assigned to control output 2 turns ON.

- **SUB1**
  Lit when the output function assigned to auxiliary output 1 turns ON.

- **SUB2**
  Lit when the output function assigned to auxiliary output 2 turns ON.

- **MANU**
  Lit when the manual operation mode.

- **STOP**
  Lit during operation has stopped.

- **RMT**
  Lit during remote operation.

- **AT**
  Flashes during auto-tuning.

- **RSP**
  Lit during remote SP operation.

- **Bar Graph**
  On a standard model (E5AK-AA2), this bar graph indicates the manipulated variable (heat) in 10% increments per single segment. On a position-proportional model (E5AK-PRR2), this bar graph indicates the valve opening in 10% increments per single segment.

No. 1 Display

Displays the process value or parameter symbols.

No. 2 Display

Displays the set point, manipulated variable, or parameter settings.

Up Key/Down Key

Press to increase or decrease the value on the No.2 display.

Display Key

Press for less than 1 s to shift the display to the next parameter. When this key is pressed for 1 s or more, the menu screen will be displayed in any case.

A/M Key

Press to select the auto operation or manual operation.

E5EK

Operation indicators

No. 1 display

No. 2 display

Display Key

A/M Key

Up Key/Down Key

Operation ———————————————————————

Note: Always turn off the power supply to the Digital Controller before changing any switch settings.

■ Settings

On a standard model, set up the Output Units for control outputs 1 and 2 before mounting the Controller.

On a position-proportional model, the Relay Output Unit is already set. Therefore, this setup operation is unnecessary. (Do not replace with other Output Units.)

When setting up the Output Units, draw out the internal mechanism from the housing and insert the Output Units into the sockets for control outputs 1 and 2.

Setting Up the Output Unit
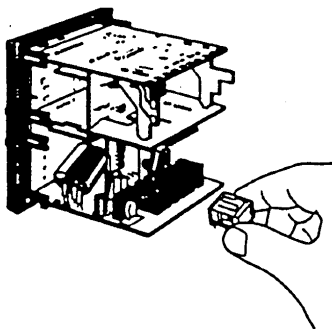
Removing the Output Unit

To replace the Output Unit, use a flat-blade screwdriver to push up the Output Unit.
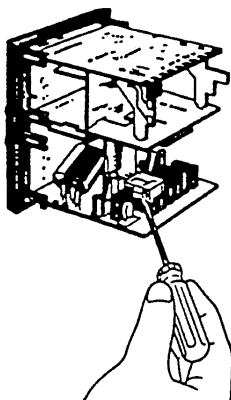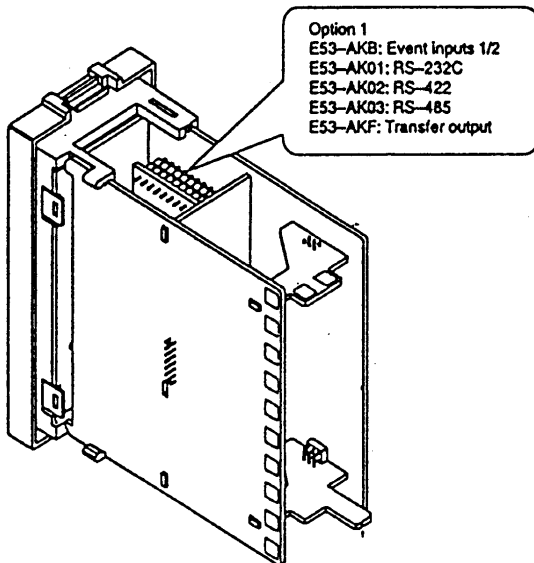

Setting Up the Option Unit

● **E5AK**

1. Remove the power board and option boards in the order shown in the following diagram.
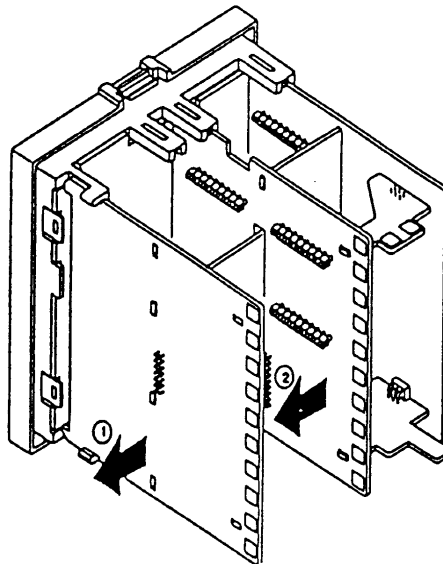
2. Insert the Option Units into the sockets for options 1 to 3. The following diagram shows the relationship between the Option Units and mounting positions.


Option 1
E53-AKB: Event Inputs 1/2
E53-AK01: RS-232C
E53-AK02: RS-422
E53-AK03: RS-485

Option 2
E53-AKF: Transfer output

Option 3
E53-AKB: Event Inputs 3/4
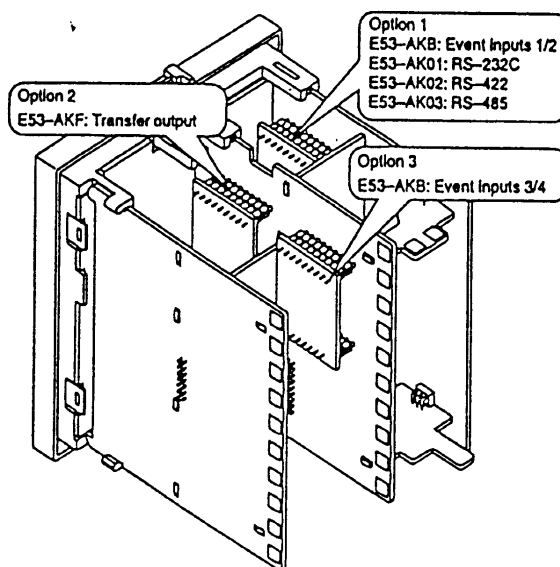
3. Mount the option boards and the power board in the order shown.

● **E5EK**

1 Remove the power board and option boards in the order

Draw-out

To draw out the internal mechanism from the housing, use a Phillips screwdriver matching the screw on the lower part of the front panel.

the upper part of the front panel.

Hook

2. Draw out the internal mechanism while holding the left and right sides of the front panel.

Mounting

1. Insert the E5AK Controller into the panel's mounting hole at the position shown in the figure below.

2. Fit the mounting bracket (accessory) into the fixing slots on the top and bottom of the rear case.


2. Insert the Option Unit into the socket for option 1. The following diagram shows the relationship between the Option Unit and mounting position.

Option 1
E53–AKB: Event inputs 1/2
E53–AK01: RS–232C
E53–AK02: RS–422

● E5EK

1. Remove the power board and option boards in the order shown in the following diagram.

2. Insert the Option Unit into the socket for option 1. The following diagram shows the relationship between the Option Unit and mounting position.

Option 1
E53–AKB: Event inputs 1/2
E53–AK01: RS–232C
E53–AK02: RS–422
E53–AK03: RS–485
E53–AKF: Transfer output

3. Mount the option board and the power board in the order shown.

Draw-out

To draw out the internal mechanism from the housing, use a Phillips screwdriver matching the screw on the lower part of the front panel.

1. Turn the screw counterclockwise while pressing the hook on the upper part of the front panel.
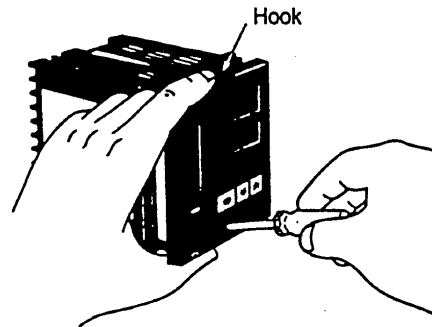
Hook

2. Draw out the internal mechanism while holding the left and right sides of the front panel.

Mounting

1. Insert the E5AK Controller into the panel's mounting hole at the position shown in the figure below.

2. Fit the mounting bracket (accessory) into the fixing slots on the top and bottom of the rear case.
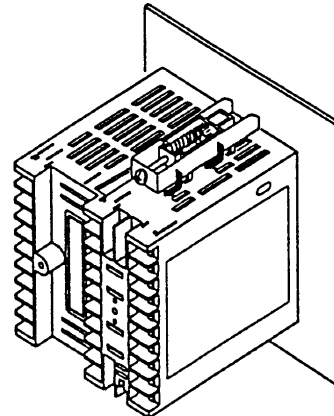
3. Tighten the mounting bracket screws on the upper and lower parts of the E5AK in small increments alternately and equally until the ratchet start to slide.
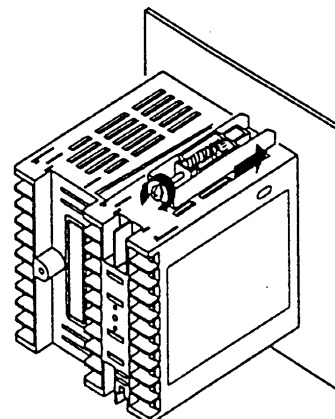
E53-COV0809, E53-COV08 Terminal Cover (Sold Separately)

Fasten the terminals covers as follows by using the snap pins. Snap
pins are provided with the terminal covers.
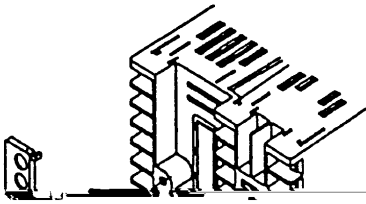
fter Turning Power ON

termine the I/O specifications of the Digital Controller in setup
de.

```
      ┌──────────────┐
      │  Power ON    │
      └──────────────┘
              ↓
      ┌──────────────┐
      │ Process value│
      │      0       │
      └──────────────┘
              ↓
          [⟳] 1 s min.
              ↓
      ┌──────────────┐
      │   n̄EnU       │
      │    Lu-0      │
      └──────────────┘
              ↓
          [⟰]
              ↓
      ┌──────────────┐
      │   n̄EnU       │
      │    Lu-l      │
      └──────────────┘
              ↓
          [⟰]
              ↓
      ┌──────────────┐
      │   n̄EnU       │
      │    Lu-2      │
      └──────────────┘
              ↓
          [⟰]
              ↓
      ┌──────────────┐
      │   n̄EnU       │
      │    SEt       │
      └──────────────┘
              ↓
          [⟳] 1 s min.
              ↓
      ┌──────────────┐
      │   ιn-t       │  Input type
      │     2        │
      └──────────────┘
              ↓
 Temperature input  [⟳]  Current/Voltage input
```
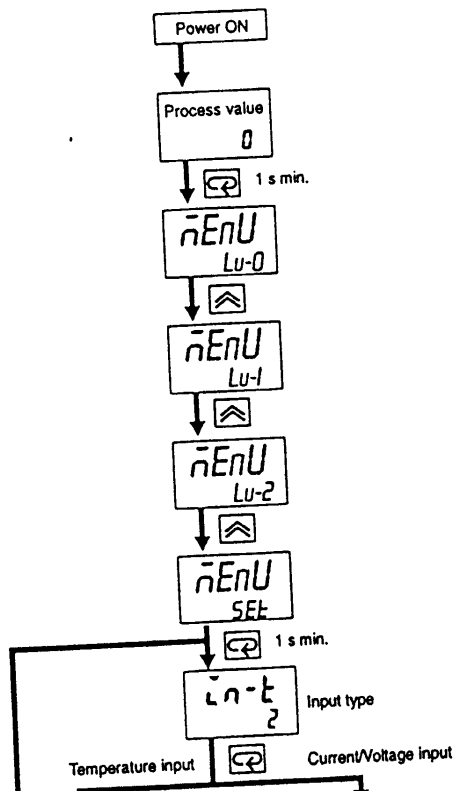
■ Input Type

Set the code according to the following table. Default is "2: K1 thermocouple."

Platinum Resistance Thermometer

Set value	Input type		
0	JPt100	−199.9 to 650.0 (°C) /−199.9 to 999.9 (°F)	Platinum resistance thermometer
1	Pt100	−199.9 to 650.0 (°C) /−199.9 to 999.9 (°F)	
2	K1	−200 to 1,300 (°C) /−300 to 2,300 (°F)	Thermocouple
3	K2	0.0 to 500.0 (°C) /0.0 to 900.0 (°F)	
4	J1	−100 to 850 (°C) /−100 to 1,500 (°F)	
5	J2	0.0 to 400.0 (°C) /0.0 to 750.0 (°F)	
6	T	−199.9 to 400.0 (°C) /−199.9 to 700.0 (°F)	
7	E	0 to 600 (°C) /0 to 1,100 (°F)	
8	L1	−100 to 850 (°C) /−100 to 1,500 (°F)	
9	L2	0.0 to 400.0 (°C) /0.0 to 750.0 (°F)	
10	U	−199.9 to 400.0 (°C) /−199.9 to 700.0 (°F)	
11	N	−200 to 1,300 (°C) /−300 to 2,300 (°F)	

oUt 1
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Control output 1 assignment (Not displayed by the E5□K-PRR2)

oUt 2

Control output 2 assignment (Not
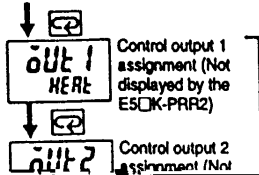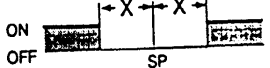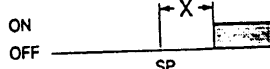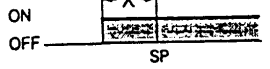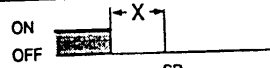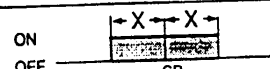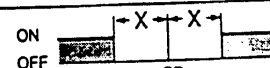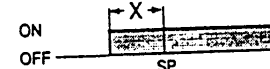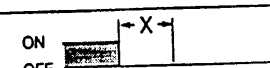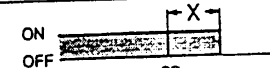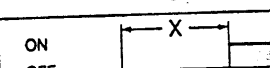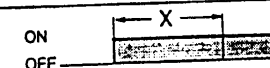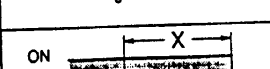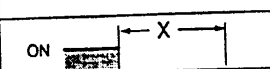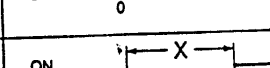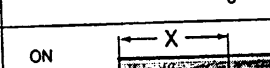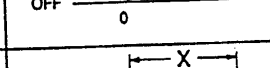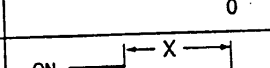
Standard Models

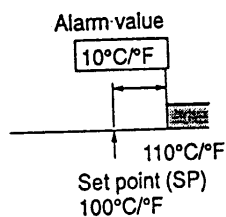|	Assignment destination	Control output		Auxiliary output	
Output function		1	2	1	2
Control output (heat)		Yes	Yes	---	---
Control output (cool)		Yes	Yes	---	---

■ Alarm Mode Selectors

Alarm outputs are available if they are allocated as outputs. Factory setting is "2: Upper-limit alarm (deviation)."

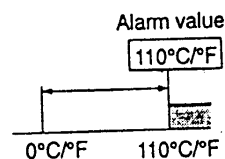| Switch setting	Alarm operation	Alarm output	
		When X is positive	When X is negative
1	Upper- and lower-limit alarm (deviation)		Always ON
2	Upper-limit alarm (deviation)		
3	Lower-limit alarm (deviation)		
4	Upper- and lower-limit range alarm (deviation)		Always OFF
5	Upper- and lower-limit alarm with standby sequence (deviation)		Always OFF
6	Upper-limit alarm with standby sequence (deviation)		
7	Lower-limit alarm with standby sequence (deviation)		
8	Absolute-value upper-limit alarm		
9	Absolute-value lower-limit alarm		
10	Absolute-value upper-limit alarm with standby sequence		
11	Absolute-value lower-limit alarm with standby sequence		

Deviation Alarm

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

Alarm value
10°C/°F
110°C/°F
Set point (SP)
100°C/°F

When selecting a control method, refer to the following table for correct parameter setting.

Control method	Control output 1 assignment	Control output 2 assignment	Operation
Heat	Control output (heat)	---	Reverse
Cool	Control output (heat)	---	Direct
Heat/Cool	Control output (heat)	Control output (cool)	Reverse

Absolute Alarm

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

Alarm value
110°C/°F
0°C/°F   110°C/°F

■ Close in Alarm/Open in Alarm

When the Controller is set to "close in alarm," the status of the alarm output function is output as it is. When set to "open in alarm," the status of the alarm output function is output inverted.

| Condition	Alarm	Output	Output LED
Close in alarm	ON	ON	Lit
	OFF	OFF	Not lit
Open in alarm	ON	OFF	Lit
	OFF	ON	Not lit

Alarm type and close in alarm (normally open)/open in alarm (normally close) can be set independently from each alarm.

Close in alarm/Open in alarm is set in the "alarm 1 to 3 open in alarm" parameters (setup mode). Factory setting is "close in alarm" [n-o].

■ Parameter Operation List

Switching to modes other than manual or protect mode is carried out using the mode selection in the menu display.

The figure below shows all parameters in the order that they are displayed. Some parameters are not displayed depending on the protect mode setting and conditions of use.
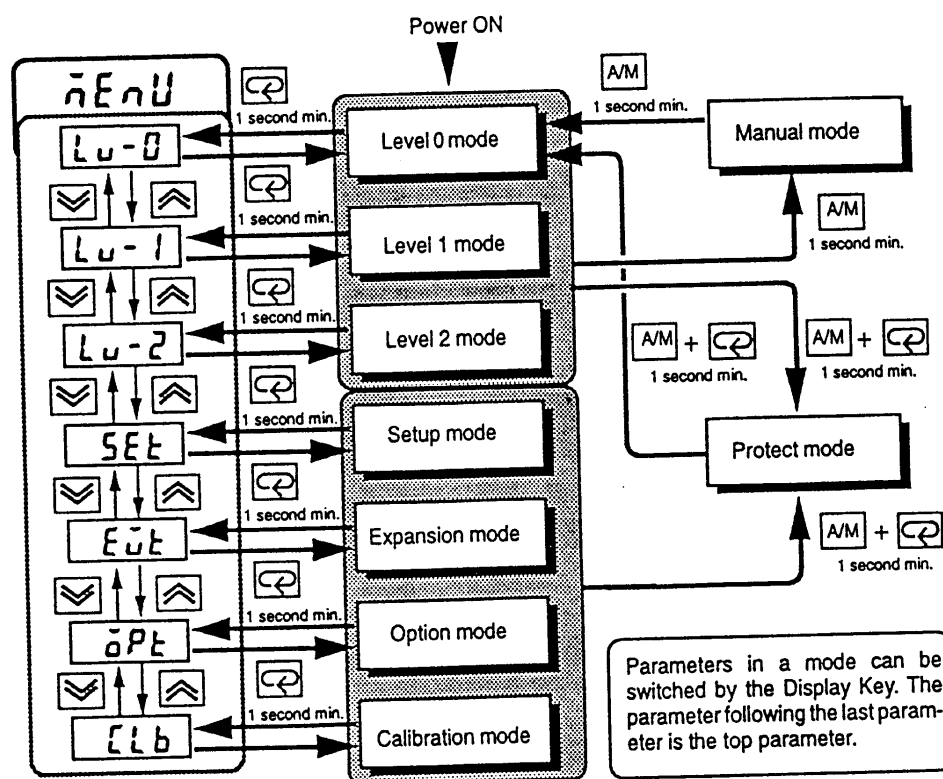
Note: The control of the Digital Controller is reset when the Digital Controller is in setup, expansion, option, or calibration mode, in which case the control and auxiliary outputs are OFF. The reset condition will be canceled when the Digital Controller is in any mode other than the above.

■ Parameters and Menus

Note: For more details on the functions of each part and display contents, refer to the *E5AK/E5EK User's Manual (H83/H85)*. All functions selected with the Digital Controller in setup or expansion mode or all optional functions of the Digital Controller may not be displayed.

Protect Mode
Limits use of the menu and A/M Keys. The protect function prevents unwanted modification of parameters and switching between the auto and manual operation.

Manual Mode
The Controller can be switched to manual operation. The manipulated variable can be manipulated manually only in this mode.

Level 0 Mode
Set the Controller to this mode during normal operation. In this mode, change the set point during operation, and start or stop Controller operation. The process value, ramp SP, and manipulated variable can only be monitored in this mode.

Level 1 Mode — The main mode for adjusting control. In this mode, execute AT (auto-tuning), and set alarm values, the control period, and PID parameters.

Level 2 Mode — The auxiliary mode for adjusting control. In this mode, set the parameters for limiting the manipulated variable and set point, switch between the remote and local modes; switch between the SP mode, and set the loop break alarm (LBA), alarm hysteresis, and the digital filter value of inputs.

Setup Mode — The mode for setting the basic specifications. In this mode, set parameters that must be checked or set before operation such as the input type, scaling, output assignments and direct/reverse operation.

Expansion Mode — The mode for setting expanded functions. In this mode, set ST (self-tuning), SP setting limiter, select advanced PID or ON/OFF control, specify the standby sequence resetting method, and set the time for automatic return to the monitoring display.

Option Mode — The mode for setting option functions. Select this mode only when the Option Unit is set in the Controller. In this mode, set the communications conditions, transfer output and event input parameters to match the type of Option Unit set in the Controller. Heater burnout latch function, position-proportional travel time, and remote SP scaling parameter are also located in this mode.
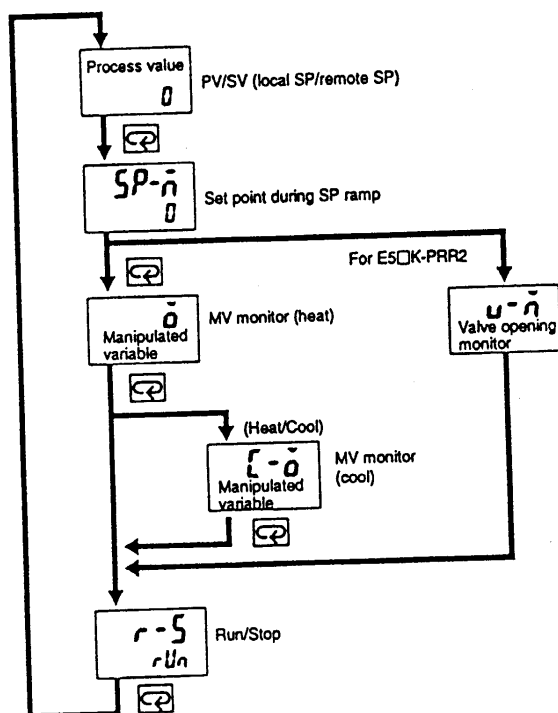
Calibration Mode — The mode for calibrating inputs and transfer output. When calibrating input, the selected input type is calibrated. Whereas, transfer output can be calibrated only when the Communications Unit (E53-CKF) is set in the Controller.

■ Parameter Operation

Refer to the *E5AK/E5EK User's Manual (H83/H85)* for each parameter and the calibration mode in detail.

Refer to page 7 for the setting in detail.

Level 0 Mode

SP Ramp

With the SP ramp function, the Controller operates according to the value (set point during SP ramp) limited by a change rate, instead of the changed set point when the set point is changed. The interval in which the set point during SP ramp is limited is referred to as the "SP ramp."
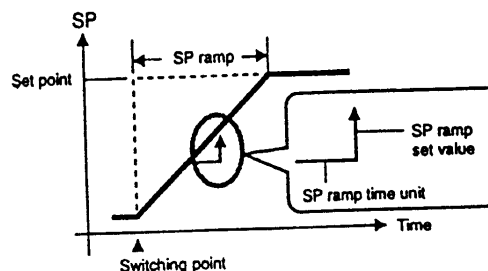
The change rate during the SP ramp is specified by the "SP ramp set value" and "SP ramp time unit" parameters. At the "SP ramp set value" default "0," the SP ramp function is disabled.

The set point changing in SP ramp can be monitored in the "Set point during SP ramp" parameter (level 0 mode).

PV/SV
The process value is displayed on the No.1 display and the set point is displayed on the No.2 display.

When the multi-SP function is in use, the value of whichever is set, set point 0 or 1, is linked.
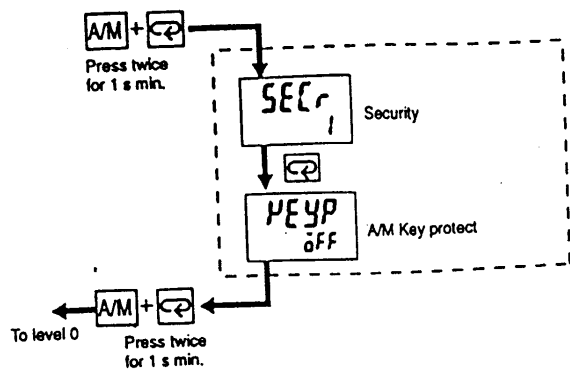
Remote SP Monitor
Monitors remote SP in the local SP mode.

Set Point During SP Ramp

Protect Mode

Press twice
for 1 s min.

SECr / — Security

PEYP oFF — A/M Key protect

To level 0 — A/M + ⏎ — Press twice for 1 s min.

Manual Mode

A/M 1 s min.

388 — Process value
16.0 — Manipulated variable/ Valve opening
— MANU indicator
— Bar graph (see note)

A/M 1 s min.

Note: Only for E5AK

Security

Any mode marked with "X" in the following table is not displayed on the menu when this parameter is set to "0" to "3."

Mode	Set value				
	0	1	2	3	4
Calibration	---	x	x	x	x
Option	---	---	x	x	x
Expansion	---	---	x	x	x
Setup	---	---	x	x	x
Level 2	---	---	---	x	x
Level 1, 0	---	---	---	---	x

The Unit will be in only level 0 mode and the menu will not be available when this parameter is set to "4" to "6."
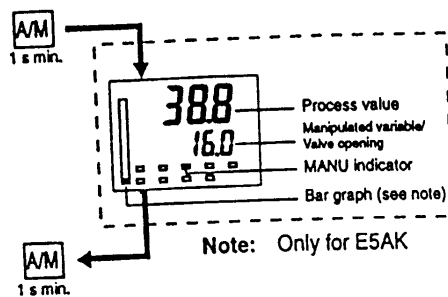
Only the "PV/SP" parameter in the level 0 mode can be used when this parameter is set to "5."

Only the "PV/SP" parameter in the level 0 mode can be used when this parameter is set to "6."
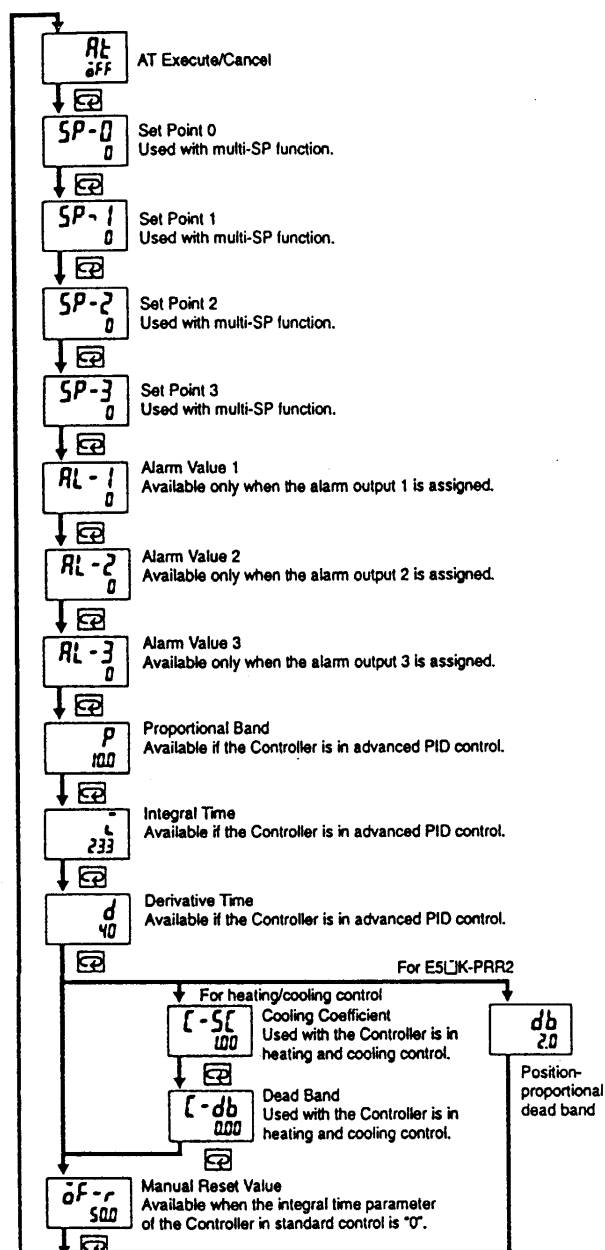
A/M Key Protect
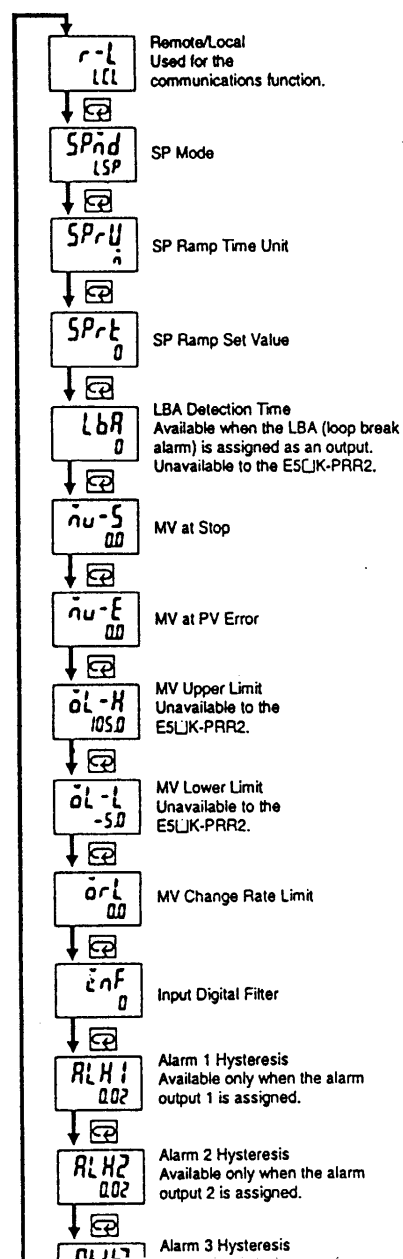
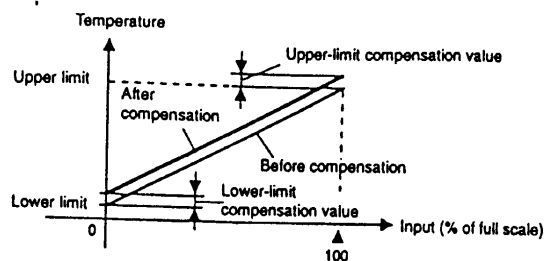Invalidate the function of the A/M Key.

15

Level 1 Mode

AT
off — AT Execute/Cancel

↓

SP-0
0 — Set Point 0
Used with multi-SP function.

↓

SP-1
0 — Set Point 1
Used with multi-SP function.

↓

SP-2
0 — Set Point 2
Used with multi-SP function.

↓

SP-3
0 — Set Point 3
Used with multi-SP function.

↓

AL-1
0 — Alarm Value 1
Available only when the alarm output 1 is assigned.

↓

AL-2
0 — Alarm Value 2
Available only when the alarm output 2 is assigned.

↓

AL-3
0 — Alarm Value 3
Available only when the alarm output 3 is assigned.

↓

P
10.0 — Proportional Band
Available if the Controller is in advanced PID control.

↓

i
233 — Integral Time
Available if the Controller is in advanced PID control.

↓

d
40 — Derivative Time
Available if the Controller is in advanced PID control.

↓

For E5☐K-PRR2

For heating/cooling control

C-SC
1.00 — Cooling Coefficient
Used with the Controller is in heating and cooling control.

↓

C-db
0.00 — Dead Band
Used with the Controller is in heating and cooling control.

↓

db
2.0 — Position-proportional dead band

oF-r
50.0 — Manual Reset Value
Available when the integral time parameter of the Controller in standard control is "0".

↓

Level 2 Mode

r-L
LCL — Remote/Local
Used for the communications function.

↓

SPmd
LSP — SP Mode

↓

SPrU
n — SP Ramp Time Unit

↓

SPrt
0 — SP Ramp Set Value

↓

LbA
0 — LBA Detection Time
Available when the LBA (loop break alarm) is assigned as an output.
Unavailable to the E5☐K-PRR2.

↓

mu-S
0.0 — MV at Stop

↓

mu-E
0.0 — MV at PV Error

↓

oL-H
105.0 — MV Upper Limit
Unavailable to the E5☐K-PRR2.

↓

oL-L
-5.0 — MV Lower Limit
Unavailable to the E5☐K-PRR2.

↓

orL
0.0 — MV Change Rate Limit

↓

inF
0 — Input Digital Filter

↓

ALH1
0.02 — Alarm 1 Hysteresis
Available only when the alarm output 1 is assigned.

↓

ALH2
0.02 — Alarm 2 Hysteresis
Available only when the alarm output 2 is assigned.

↓

ALH3 — Alarm 3 Hysteresis

Input Shift

When temperature input is selected, scaling is not required. This is because input is treated as the "temperature" as it is matched to the input type. However, note that the upper- and lower-limit values of the sensor can be shifted. For example, if both the upper- and lower-limit values are shifted by 1.2°C, the process value (before shift) is regarded as 201.2°C after shift when input is 200°C before shift.
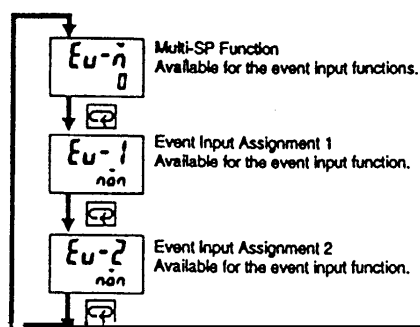
To set the input shift, set shift values in the "input shift upper limit" and "input shift lower limit" parameters (level 2 mode).

Expansion Mode

5L-H
13
Set point
Upper Limit

5L-L
200
Set point
Lower Limit

CntL
Pid
PID/ON/OFF
Unavailable to the
E5□K-PRR2.

Option Mode

Eu-n
0
Multi-SP Function
Available for the event input functions.

Eu-1
non
Event Input Assignment 1
Available for the event input function.

Eu-2
non
Event Input Assignment 2
Available for the event input function.
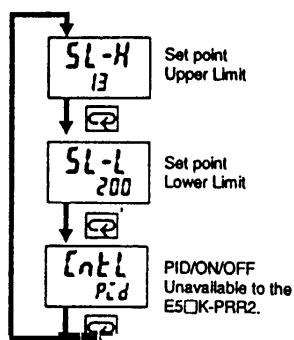
■ How to Use the Error Display

When an error has occurred, the No.1 display alternately indicates error codes together with the current display item.
This section describes how to check error codes on the display, and the actions that must be taken to remedy the problem.

| $5.E \ r \ r$ | Input Error |

Meaning	Input is in error.
Action	Check the wiring of inputs, disconnections, and shorts, and check the input type and the input type jumper connector.
Operation at Error	For control output functions, output the manipulated variable matched to the setting of the "MV at PV ~~~~~~~~~~ (level 2 mode). Alarm output functions are activated when the upper limit is~~~~~~~~~

| $E \ 111$ | Memory Error |

Meaning	Internal memory operation is in error
Action	First, turn the power OFF then back ON again. If the display remains the same, the E5AK/E5EK Controller must be repaired. If the display is restored to normal, the probable cause may be external noise affecting the control system. Check for external noise.
Operation at Error	Control output functions turn OFF (2 mA max. at 4 to 20 mA output, and output equivalent to 0% in case of other outputs). Alarm output functions turn OFF.

| $E \ 333$ | A/D Converter Error |

Meaning	Internal circuits are in error.
Action	First, turn the power OFF then back ON again. If the display remains the same, the E5AK/E5EK Controller must be repaired. If the display is restored to normal, the probable cause may be external noise affecting the control system. Check for external noise.
Operation at Error	Control output functions turn OFF (2 mA max. at 4 to 20 mA output, and output equivalent to 0% in case of other outputs). Alarm output functions turn OFF.

| $R.E \ r \ r$ | Calibration Data Error |

■ Fuzzy Self-tuning

Fuzzy self-tuning is a function that enables the E5AK/E5EK to calculate the most suitable PID constants for the controlled object.

Features

● The E5AK/E5EK determines by itself when to perform fuzzy self-tuning.

Fuzzy Self-tuning Function

The fuzzy self-tuning function has three modes.

In SRT (step response tuning) mode, the PID constants are tuned using a step response method at the time the set point is changed.

In DT (disturbance tuning) mode, the PID constants are amended so that the controlled temperature will be within the target range set in advance when there is external disturbance.

In HT (hunting tuning) mode, when hunting occurs, the PID constants are amended to suppress the hunting.

Note: Be sure to turn on the power supply to the load either before or simultaneously with the start of Temperature Controller operation.
Dead time will be measured from the time the Temperature Controller starts operating. If a load such as a heater is turned on after the Temperature Controller is turned on, dead time longer than the actual value will be measured and inappropriate PID constants will be obtained. If an extremely large amount of dead time is measured, the control amount will be set to 0% for a short period of time before being returned to 100%, and the constants will then be re-tuned. Retuning is performed only for large amounts of dead time, so be sure to follow the precaution given above when starting operation.

Startup Conditions of SRT

SRT will start if the following conditions are satisfied simultaneously when the E5AK/E5EK is turned on or the set point is changed.

At the time the E5AK/E5EK starts operating	At the time set point is changed
1. The set point at the time the E5AK/E5EK starts operating is different from the set point used at the time SRT was last executed (see note). 2. The difference between the set point and the process value at the time the E5AK/E5EK starts operating is larger than the present proportional band value (P) x 1.27+4. 3. The process value at the time the E5AK/E5EK starts operating is smaller than the set point in reverse operation and larger than the set point in normal operation.	1. The new set point is different from the set point used at the time SRT was last executed (see note). 2. The set point changing range is larger than the present proportional band value (P) x 1.27+4. 3. The process value is in stable condition before the set point is changed. 4. A larger set point value is set in reverse operation and a smaller set point is set in normal operation.

Note: The last SRT-executed set point is set to 0 before shipping and when changing from advanced PID control to advanced PID control with fuzzy self-tuning.

Imposition Completion Condition of Step Control Amount

In order to prevent overshooting, the step controlled amount must be imposed continuously only while the present deviation is the same as or greater than the value obtained from the proportional band (P) x 1.27. The step control will not be applied when the deviation becomes smaller than this value.

PID Constant Refreshing Conditions

If the step control amount is applied before the maximum temperature slope (R) is obtained, SRT will not renew any PID constant. If the proportional band obtained from the R and L values that were measured before the imposition had been completed is larger than the present proportional band, the PID constants will be renewed because the measured value is in the direction towards the suitable proportional band value, and the set point at that time will be the SRT-executed set point.
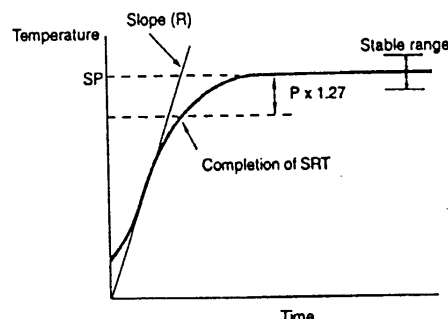
Stable Temperature Status

If the temperature is within the stable range for a certain time, it is deemed that the temperature is stable. This time is called stability judgement time. Like PID constants, stability judgement time is adjusted with fuzzy self-tuning according to the characteristics of the object to be controlled. Fuzzy self-tuning will not be activated if the temperature is stable because the Temperature Controller deems that temperature control is smooth.
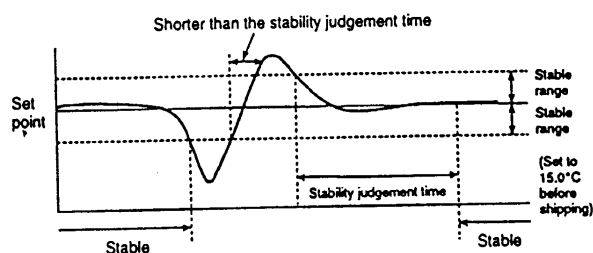

Balanced Status

If the process value is within the stable range for 60 s when there is no output, it is deemed that the the temperature is balanced.

Startup Conditions of DT

1. DT will start if the temperature that has been stable varies due to external disturbance and the deflection of the temperature exceeds the stable range, and then the temperature becomes stable, provided that the number of maximum temperature values is less than four.

2. DT will start if the set point is changed under the condition that SRT does not start and the temperature becomes stable, provided that the number of maximum temperature values is less than four.
If there are four or more maximum temperature values, HT will start.
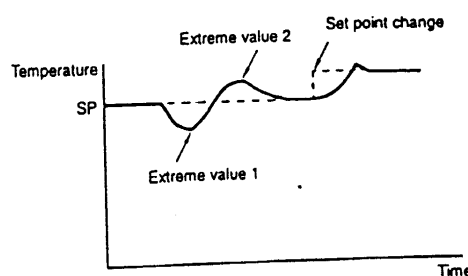
Startup Conditions of HT

HT will be ON when there is hunting with four or more maximum temperature values (extreme values) while SRT is not being executed.
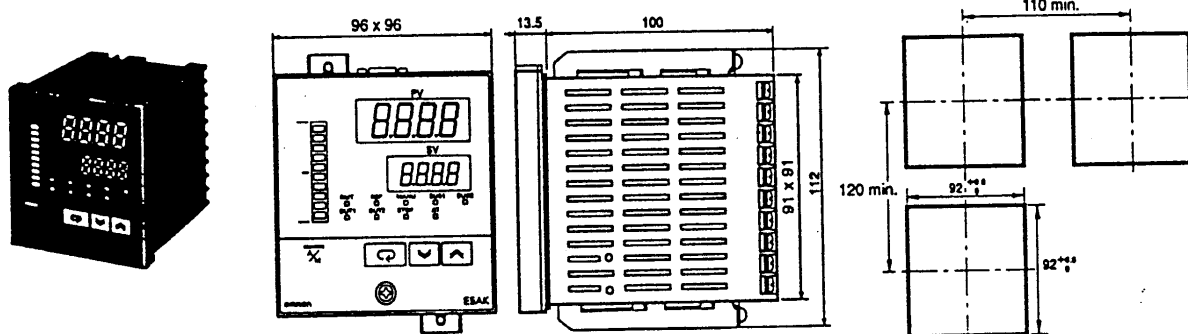
Note: In specific applications where temperature varies periodically due to disturbance, internal parameters need to be adjusted. For details, refer to the *E5AK/E5EK User's Manual (H83/H85)*.
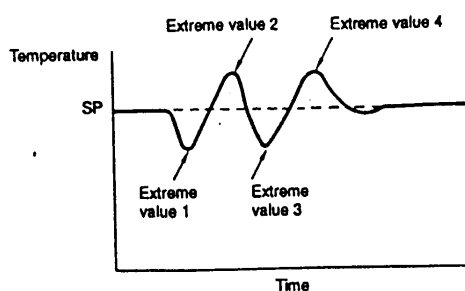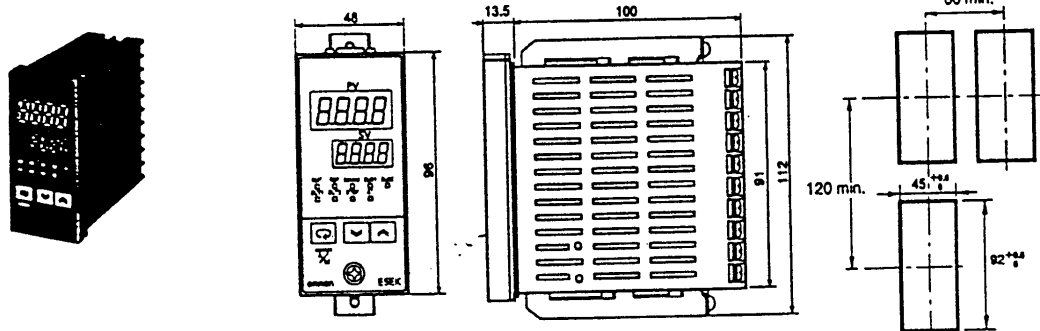

Dimensions

Note: All units are in millimeters unless otherwise indicated.

E5AK

Panel Cutouts

Note: 1. Recommended panel thickness is 1 to 8 mm.

2. Maintain the specified vertical and horizontal mounting space between each Unit. Units must not be closely mounted vertically or horizontally.

E5EK

Panel Cutouts

Note: 1. Recommended panel thickness is 1 to 8 mm.

2. Maintain the specified vertical and horizontal mounting space between each Unit. Units must not be closely mounted vertically or horizontally.

Accessories (Order Separately)

Terminal Cover

E53-COV0809
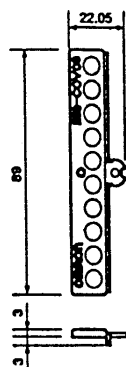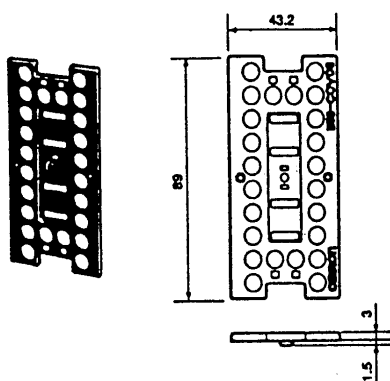
E53-COV08
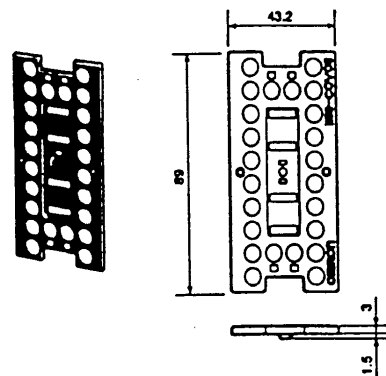
Current Transformer
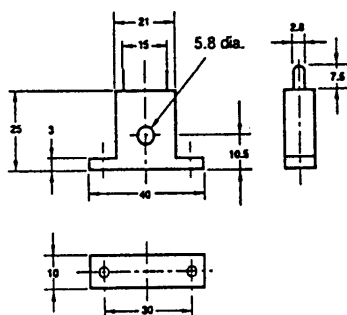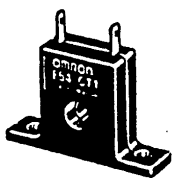
E54-CT1

E54-CT3

Installation

■ Wiring Terminals for E5AK
Terminal Arrangement

AC100–240V∿
50/60 Hz

	10	TRSF	30	31	32	20	EV1/2 RS232C RS422 RS485
	9		29			19	
OUT1	8		28			18	
	7		27			17	CT PTMR
OUT2	6	EV3/4	26			16	
	5		25			15	
SUB1	4		24			14	TC Pt I V
	3		23			13	
SUB2	2	RSP	22			12	
	1		21	33		11	

TRSF: Transfer output
EV1 to 4: Event input
PTMR: Potentiometer
RSP: Remote SP input

Wiring

In the following wiring diagrams, the left side of the terminal numbers indicate the inside of the Controller.

Power Supply

Input power to terminal numbers 9 and 10. Power specifications are as follows: 100 to 240 VAC, 50/60 Hz, approx. 16 VA

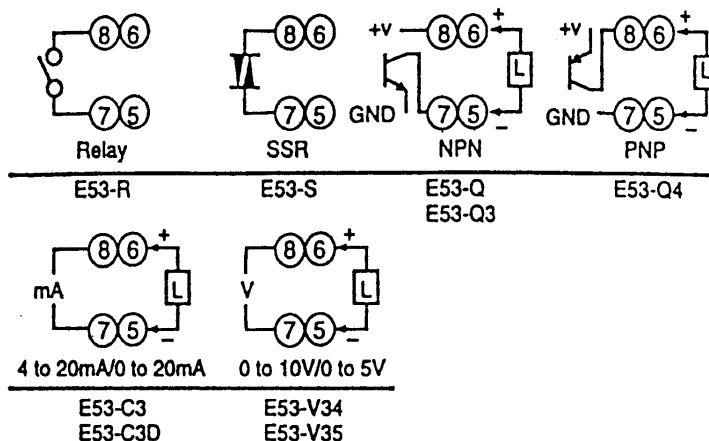|				
10	30	31	32	20
9	29			19
8	28			18
7	27			17
6	26			16
5	25			15
4	24			14
3	23			13
2	22			12
1	21	33		11

Sensor Input

Connect the sensor input to terminal numbers 11 to 14 and 33 as follows according to the input type.

10	30	31	32	20
9	29			19
8	28			18
7	27			17
6	26			16
5	25			15
4	24			**14**
3	23			**13**
2	22			**12**
1	21	**33**		**11**

Thermocouple	Platinum resistance thermometer	Voltage Input	Current Input

Installation

■ Wiring Terminals for E5AK
Terminal Arrangement

TRSF: Transfer output
EV1 to 4: Event input
PTMR: Potentiometer
RSP: Remote SP input

Wiring
In the following wiring diagrams, the left side of the terminal numbers indicate the inside of the Controller.

Power Supply
Input power to terminal numbers 9 and 10. Power specifications are as follows: 100 to 240 VAC, 50/60 Hz, approx. 16 VA

Sensor Input
Connect the sensor input to terminal numbers 11 to 14 and 33 as follows according to the input type.

Thermocouple   Platinum resistance thermometer   Voltage Input   Current Input

Control Output

Terminal numbers 7 and 8 are for control output 1 (OUT1), and terminal numbers 5 and 6 are for control output 2 (OUT2). The following diagrams show the available Output Units and their internal equalizing circuits.

Relay	SSR	NPN	PNP
E53-R	E53-S	E53-Q / E53-Q3	E53-Q4

4 to 20mA/0 to 20mA	0 to 10V/0 to 5V
E53-C3 / E53-C3D	E53-V34 / E53-V35

With E53-V□□ Output Units, approx. 2 V is output for one second after the power is interrupted.

The following table shows the specifications for each Output Unit.

Model	Output type	Specifications
E53-R	Relay	5 A at 250 VAC
E53-S	SSR	1 A at 75 to 250 VAC
E53-Q E53-Q3 E53-Q4	Voltage (NPN) Voltage (NPN) Voltage (PNP)	NPN: 40 mA at 12 VDC (with short-circuit protection) NPN: 20 mA at 24 VDC (with short-circuit protection) PNP: 20 mA at 24 VDC (with short-circuit protection)
E53-C3 E53-C3D	4 to 20 mA 0 to 20 mA	4 to 20 mA; permissible load impedance: 600 Ω max.; resolution: approx. 2600 0 to 20 mA; permissible load impedance: 600 Ω max.; resolution: approx. 2600
E53-V34 E53-V35	0 to 10 V 0 to 5 V	0 to 10 VDC; permissible load impedance: 1 kΩ min.; resolution: approx. 2600 0 to 5 VDC; permissible load impedance: 1 kΩ min.; resolution: approx. 2600

With E5AK-PRR2 Controllers, the relay output (1 A at 250 VAC) is fixed.

When replacing the Output Unit, use the E53-R. The following diagrams show the relationship between terminals and open/close relay settings.

Open   Close

Auxiliary Output

Terminal numbers 3 and 4 are for auxiliary output 1 (SUB1) and terminal numbers 1 and 2 are for auxiliary output 2 (SUB2). The following diagrams show the internal equalizing circuits for the auxiliary outputs:

Auxiliary output 1   Auxiliary output 2

Output specifications are as follows:
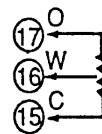
SPST-NO, 3 A at 250 VAC

CT Input/Potentiometer

When using the HBA function on the E5AK-AA2 Controller, connect CT input (CT) to terminal numbers 15 to 17. When monitoring the valve opening on the E5AK-PRR2 Controller, connect the potentiometer (PTMR) to terminal numbers 15 to 17. Connect each of these inputs as follows:
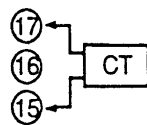
CT input   Potentiometer

For details on CT inputs, refer to *Appendix, About Current Transformer* in the *E5AK/E5EK User's Manual (H83/H85)*. For details on the potentiometer, refer to the *Instruction Manual* for the valve connected to the Controller. The variable resistance range is 100 Ω to 2.5 kΩ.

Remote SP Input

Connect the input (RSP) to be used as the remote SP to terminal numbers 21 and 22. Only 4 to 20 mA inputs can be connected. Connect the input as follows:

4 to 20 mA
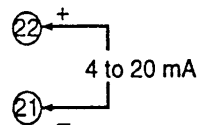
Event Input
Connect event inputs 1 and 2 (EV1/2) to terminal numbers 18 to 20, and event events 3 and 4 (EV3/4) to terminal numbers 24 to 26. However, note that terminal numbers 18 to 20 cannot be used on Controllers with a communications function. Connect the event inputs as follows:


Event input 1 and 2   Event input 3 and 4
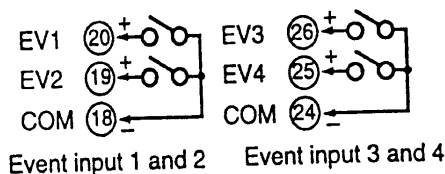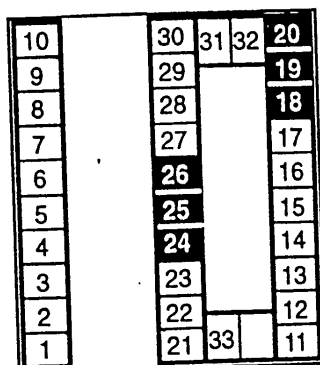
Terminals 18 and 24 (COM) are connected internally.

Use event inputs under the following conditions:

Contact input	ON: 1 kΩ max. OFF: 100 kΩ min.
No-contact input	ON: Residual voltage 1.5 V max., OFF: Leakage current 0.1 mA max.

Polarities during no-contact input are as follows:

Event input 1 and 2   Event input 3 and 4
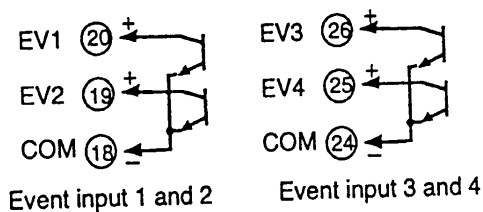
Transfer Output
Connect transfer output (TRSF) to terminal numbers 29 and 30. The internal equalizing circuit for transfer output is as follows:
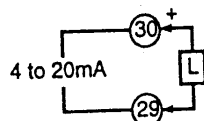
4 to 20mA

Transfer output specifications are as follows: 4 to 20 mA,
Permissible load impedance: 600 Ω max.,
Resolution: Approx. 2600

Communications
Terminal numbers 18 to 20, 31 and 32 can be used only on Controllers with Communications Units (E53-AK01/02/03). For details on wiring, refer to *Chapter 6, Using the Communications Function* in the *E5AK/E5EK User's Manual (H83/H85)*.

# ■ Wiring Terminals for E5EK

Terminal Arrangement

AC100–240V∿
50/60 Hz

10	21	22	20
9			19
8			18
7			17
6			16
5			15
4			14
3			13
2			12
1	23		11

EV1/2
TRSF
RS232C
RS422
RS485

RSP
CT
PTMR

TC
Pt
I
V

OUT1
OUT2
SUB1
SUB2
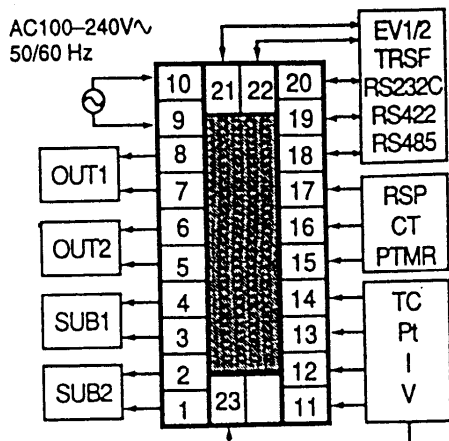
TRSF: Transfer output
EV1/2: Event input
PTMR: Potentiometer
RSP: Remote SP input

Wiring

In the following wiring diagrams, the left side of the terminal numbers indicate the inside of the Controller.

Power Supply

Input power to terminal numbers 9 and 10. Power specifications are as follows: 100 to 240 VAC, 50/60 Hz, approx. 15 VA

10	21	22	20
9			19
8			18
7			17
6			16
5			15
4			14
3			13
2			12
1	23		11
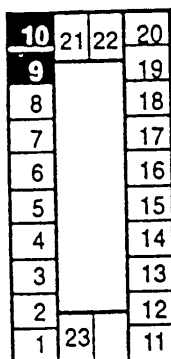
Sensor Input

Sensor input to terminal numbers 11 to 14 and 33 as follows according to the input type.

10	21	22	20
9			19
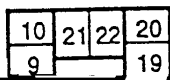
(14)   (14)   (14)   (14)

Control Output
Terminal numbers 7 and 8 are for control output 1 (OUT1), and terminal numbers 5 and 6 are for control output 2 (OUT2). The following diagrams show the available Output Units and their internal equalizing circuits.
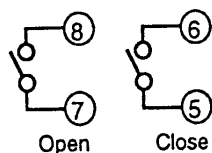

Relay	SSR	NPN	PNP
E53-R	E53-S	E53-Q E53-Q3	E53-Q4

4 to 20mA/0 to 20mA	0 to 10V/0 to 5V
E53-C3 E53-C3D	E53-V34 E53-V35

With E53-V□□ Output Units, approx. 2 V is output for one second after the power is interrupted.

The following table shows the specifications for each Output Unit.

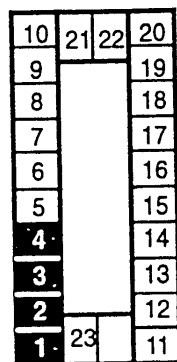| Model	Output type	Specifications
E53-R	Relay	5 A at 250 VAC
E53-S	SSR	1 A at 75 to 250 VAC
E53-Q E53-Q3 E53-Q4	Voltage (NPN) Voltage (NPN) Voltage (PNP)	NPN: 40 mA at 12 VDC (with short-circuit protection) NPN: 20 mA at 24 VDC (with short-circuit protection) PNP: 20 mA at 24 VDC (with short-circuit protection)
E53-C3 E53-C3D	4 to 20 mA 0 to 20 mA	4 to 20 mA, permissible load impedance: 600 Ω max., resolution: approx. 2600 0 to 20 mA, permissible load impedance: 600 Ω max., resolution: approx. 2600
E53-V34 E53-V35	0 to 10 V 0 to 5 V	0 to 10 VDC, permissible load impedance:1 kΩ min., resolution: approx. 2600 0 to 5 VDC, permissible load impedance: 1 kΩ min., resolution: approx. 2600

With E5EK-PRR2 Controllers, the relay output (1 A at 250 VAC) is fixed.

When replacing the Output Unit, use the E53-R. The following diagrams show the relationship between terminals and open/close relay settings.

Open   Close

Auxiliary Output
Terminal numbers 3 and 4 are for auxiliary output 1 (SUB1) and terminal numbers 1 and 2 are for auxiliary output 2 (SUB2). The following diagrams show the internal equalizing circuits for the auxiliary outputs:


Auxiliary output 1   Auxiliary output 2

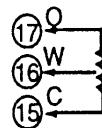Output specifications are as follows:
SPST-NO, 3A at 250 VAC

CT Input/Potentiometer

When using the HBA function on the E5EK-AA2 Controller, connect CT input (CT) to terminal numbers 15 to 17. When monitoring the valve opening on the E5EK-PRR2 Controller, connect the potentiometer (PTMR) to terminal numbers 15 to 17. Connect each of these inputs as follows:
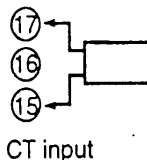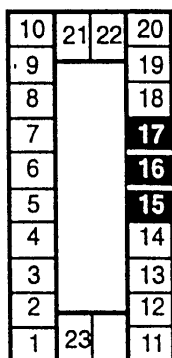

CT input   Potentiometer

For details on CT inputs, refer to *Appendix, About Current Transformer* in the *E5AK/E5EK User's Manual (H83/H85)*. The potentiometer cannot be used simultaneously with remote SP input. For details on the potentiometer, refer to the *Instruction Manual* for the valve connected to the Controller. The variable resistance range is 100 Ω to 2.5 kΩ.

Remote SP Input

Connect the input (RSP) to be used as the remote SP to terminal numbers 15 and 16. However, note that the potentiometer cannot be used simultaneously with remote SP input. Only 4 to 20 mA inputs can be connected. Connect the input as follows:

4 to 20 mA
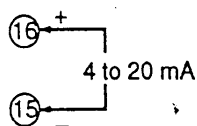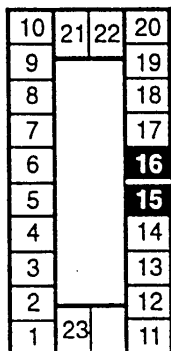
Event Input

Connect event inputs 1 and 2 (EV1/2) to terminal numbers 18 to 20. However, note that terminal numbers 18 to 20 cannot be used on Controllers with a communications function. Connect the event inputs as follows:
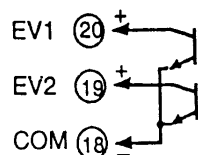

EV1   ⑳
EV2   ⑲
COM   ⑱
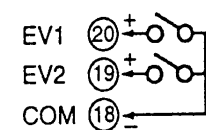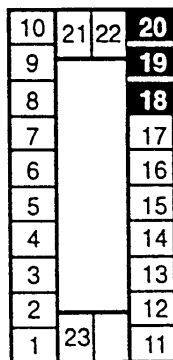
Event input 1 and 2

Use event inputs under the following conditions:

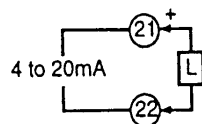| Contact input	ON: 1 kΩ max., OFF: 100 kΩ min.
No-contact input	ON: Residual voltage 1.5 V max., OFF: Leakage current 0.1 mA max.

Polarities during no-contact input are as follows:

EV1 ⑳ ±
EV2 ⑲ ±
COM ⑱ −

Event input 1 and 2

Transfer Output

Connect transfer output (TRSF) to terminal numbers 21 and 22. The internal equalizing circuit for transfer output is as follows:

4 to 20mA ㉑ + L ㉒ −

Transfer output specifications are as follows: 4 to 20 mA,
Permissible load impedance: 600 Ω max.,
Resolution: Approx. 2600

Communications

Terminal numbers 18 to 22 can be used only on controllers with Communications Units (E53-AK01/02/03). For details on wiring, refer to *Chapter 6, Using the Communications Function* in the *E5AK/E5EK User's Manual (H83/H85)*.

■ Precautions when Wiring

Use ducts to separate input leads and power lines in order to protect the Controller and its lines from external noise.

Solderless terminals are recommended when wiring the Controller.

Tighten the terminal screws using a torque no greater than 0.78 N • m, or 8 kgf • cm max. Take care not to tighten the terminal screws too tightly.
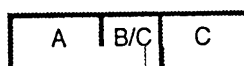
Power Blocks

The E5AK/E5EK has independent power supplies for each of the terminal blocks shown below.

E5AK

| A | B | C |

E5EK

| A | B/C | C |

Precautions

General Precautions

Operating Environment

Keep within the rated ambient operating temperature, ambient operating humidity, and storage temperature ranges.

Use the Unit according to the vibration resistance, shock resistance, and enclosure ratings.

Do not use the Unit in places with corrosive gas or excessive dust.

Do not use the Unit nearby machines generating high-frequency noise.

Correct Use

Mounting

The dimensions of the Digital Controller conform to DIN 43700.

Recommended panel thickness is 1 to 8 mm.

Mount the Unit horizontally.

Connection

To reduce inductive noise influence, the lead wires connecting the input type to the Digital 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.

Connection Example

Wire the terminals of the Unit using solderless terminals.

The tightening torque applied to the terminal screws of the Unit must be approximately 0.78 N • m or 8 kgf • cm.

Use the following type of solderless terminals for M3.5 screws.
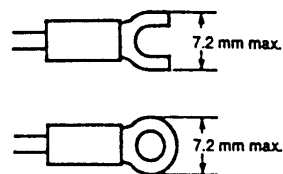
Operation

The alarm outputs of a model with an alarm function may not turn ON properly when the model malfunctions. The use of alarm equipment with the model is recommended.

The parameters and internal switch are set before shipping so that the Unit will function normally. Change the settings of the parameters and internal switch according to the application if necessary.

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

Do not use excessive force when drawing out the internal mechanism from the housing. Protect the internal connector or electronic parts of the Unit from shock. Protect against static discharge when changing the settings of the internal switch. Changing the settings on a grounded conductive mat is recommended.

When connecting the Control Output Unit to the Temperature Controller or Digital Controller, make sure that the Control Output Unit is a suitable type. The use of an improper type of Control Output Unit may cause the system to malfunction.

The heater burnout alarm will not be available if the Linear Output Unit is used.

■ Period and Scope of Guarantee
Unit with Standard Specifications

Scope of Guarantee

Should the Unit malfunction during the guarantee period, OMRON shall repair the Unit or replace any parts of the Unit at the expense of OMRON.

The above does not apply in the following cases.

1. Any malfunction of the Unit due to the incorrect use or improper handling of the Unit.

2. Any malfunction of the Unit not originating from the Unit.

3. Any malfunction of the Unit due to a modification of the Unit or repairs to the Unit carried out by any person not authorized by OMRON.

4. Any malfunction of the Unit due to any natural disaster.

OMRON shall not be responsible for any damage or loss induced by

Three-year Guarantee

■ SSR

Connection Example of Digital Controller and SSR

Digital Controller SSR Load