Cat. No. H08E-EN-01

E5CN
E5AN
E5EN
E5GN

Digital Temperature Controllers

Getting Started Manual

OMRON

E5CN/E5AN/E5EN/E5GN
Digital Temperature Controllers

Getting Started Manual

Basic Type

Revised August 2010

This manual needs the H04E+E5CN(-U) and H03E+E5EN/AN datasheet for selection and installation. (This manual is a selection from the full manual H156)

Preface

The E5CN, E5CN-U, E5AN, E5EN, and E5GN are Digital Temperature Controllers. The E5CN and E5CN-U are both compact temperature controllers, with the E5CN featuring screw terminal connections, and the E5CN-U featuring socket pin connections. The E5GN can be connected using screw terminals or screwless clamp terminals. The main functions and characteristics of these Digital Temperature Controllers are as follows:

- Any of the following types of input can be used: thermocouple, platinum resistance thermometer, infrared sensor, analog voltage, or analog current.
- Either standard or heating/cooling control can be performed.
- Both auto-tuning and self-tuning are supported.
- Event inputs can be used to switch set points (multi-SP function), switch between RUN and STOP status, switch between automatic and manual operation, start/reset the simple program function, and perform other operations. (Event inputs are not applicable to the E5CN-U.)
- Heater burnout detection, heater short (HS) alarms, and heater overcurrent (OC) functions are supported. (Applicable to E5CN, E5AN, E5EN, and E5GN models with heater burnout detection function.)
- Communications are supported. (Applicable to E5CN, E5AN, E5EN, and E5GN models with communications.)
- User calibration of the sensor input is supported.
- The structure is waterproof (IP66). (Not applicable to the E5CN-U.)
- Conforms to UL, CSA, and IEC safety standards and EMC Directive.
- The PV display color can be switched to make process status easy to understand at a glance.

This manual describes the E5CN, E5CN-U, E5AN, E5EN, and E5GN for basic functions. Read this manual thoroughly and be sure you understand it before attempting to use the Digital Temperature Controller and use the Digital Temperature Controller correctly according to the information provided. Keep this manual in a safe place for easy reference. Refer to the full manual for advanced settings: *E5CN/E5AN/E5EN/E5GN Digital Temperature Controllers User's Manual* (Cat. No. H156).
Refer to the following manual for further information on communications: *E5CN/E5AN/E5EN/E5GN Digital Temperature Controllers Communications Manual Basic Type* (Cat. No. H158).
Refer to the following manual for information on the Advanced Type Controllers: *E5CN/E5AN/E5EN-H Digital Temperature Controllers User's Manual Advanced Type* (Cat. No. H157).

Visual Aids

The following headings appear in the left column of the manual to help you locate different types of information.

Note Indicates information of particular interest for efficient and convenient operation of the product.

1,2,3... 1. Indicates lists of one sort or another, such as procedures, checklists, etc.

Precautions for Operation

1) It takes approximately two seconds for the outputs to turn ON from after the power supply is turned ON. Due consideration must be given to this time when incorporating Temperature Controllers into a control panel or similar device.
2) Make sure that the Temperature Controller has 30 minutes or more to warm up after turning ON the power before starting actual control operations to ensure the correct temperature display.
3) When executing self-tuning, turn ON power for the load (e.g., heater) at the same time as or before supplying power to the Temperature Controller. If power is turned ON for the Temperature Controller before turning ON power for the load, self-tuning will not be performed properly and optimum control will not be achieved. When starting operation after the Temperature Controller has warmed up, turn OFF the power and then turn it ON again at the same time as turning ON power for the load. (Instead of turning the Temperature Controller OFF and ON again, switching from STOP mode to RUN mode can also be used.)
4) Avoid using the Controller in places near a radio, television set, or wireless installing. The Controller may cause radio disturbance for these devices.

Shipping Standards

The E5CN, E5CN-H, E5AN, E5AN-H, E5EN, and E5EN-H comply with Lloyd's standards. When applying the standards, the following installation and wiring requirements must be met in the application.

■ Application Conditions

1) Installation Location

The E5CN, E5CN-H, E5AN, E5AN-H, E5EN, and E5EN-H comply with installation category ENV1 and ENV2 of Lloyd's standards. Therefore, they must be installed in a location equipped with air conditioning. They must therefore be installed in a location equipped with air conditioning. They cannot be used on the bridge or decks, or in a location subject to strong vibration.

2) Wiring Conditions

Install the recommended ferrite core and wrap the line around it three turns for the applicable lines (e.g., power supply cable line and signal lines) of the models listed in the following table. (See illustrations.) Install the ferrite cores as close to the terminal block of the E5□N as possible. (As a guideline, the ferrite core should be within 10 cm of the terminal block.)

● Lines Requiring Ferrite Cores

Model	Signal and power lines provided with ferrite cores
E5CN, E5CN-U, or E5CN-H	Input power supply
E5EN, E5AN, E5EN-H, or E5AN-H	Input power supply and I/O lines (control outputs (1 and 2), communications, event inputs (1 to 4), transfer output, and external power supply (Advanced Type models do not have an external power supply.)

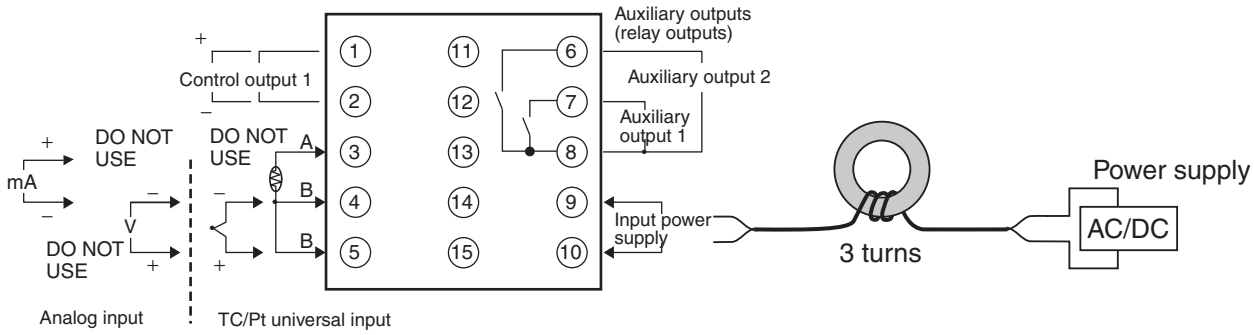
● Recommended Ferrite Core

Manufacturer	Seiwa Electric Mfg. Co., Ltd.
Model	E04RA310190100

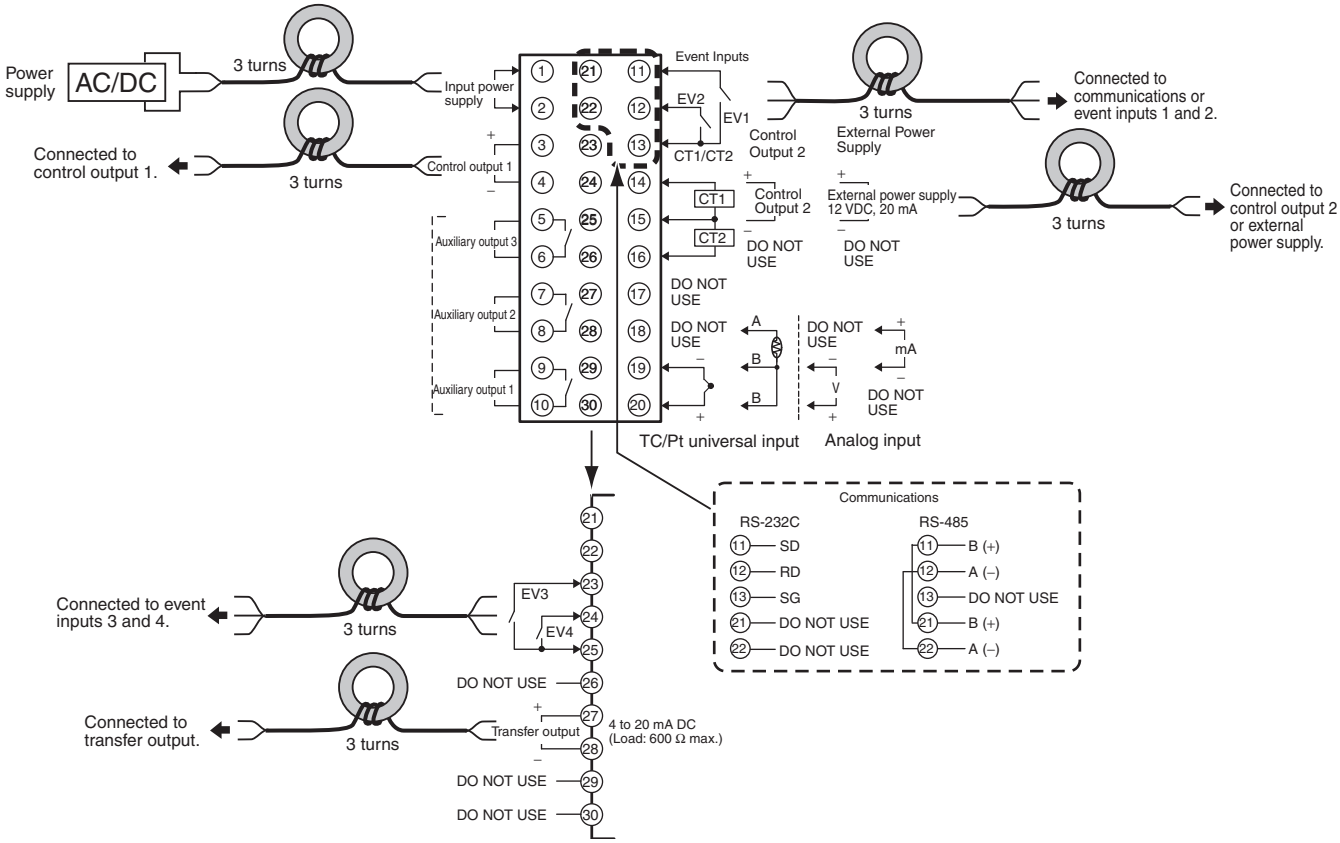
Note This part is available from Omron stock.

● Ferrite Core Connection Examples

1. E5CN/E5CN-H



2. E5AN/E5EN/E5AN-H/E5EN-H



Preparations for Use

Be sure to thoroughly read and understand the manual provided with the product, and check the following points.

Timing	Check point	Details
Purchasing the product	Product appearance	After purchase, check that the product and packaging are not dented or otherwise damaged. Damaged internal parts may prevent optimum control.
	Product model and specifications	Make sure that the purchased product meets the required specifications.
Setting the Unit	Product installation location	Provide sufficient space around the product for heat dissipation. Do not block the vents on the product.
Wiring	Terminal wiring	Do not subject the terminal screws to excessive stress (force) when tightening them. Make sure that there are no loose screws after tightening terminal screws to the specified torque of 0.74 to 0.90 N·m (see note).
		Be sure to confirm the polarity for each terminal before wiring the terminal block and connectors.
	Power supply inputs	Wire the power supply inputs correctly. Incorrect wiring will result in damage to the internal circuits.
Operating environment	Ambient temperature	The ambient operating temperature for the product is –10 to 55°C (with no condensation or icing). To extend the service life of the product, install it in a location with an ambient temperature as low as possible. In locations exposed to high temperatures, if necessary, cool the products using a fan or other cooling method.
	Vibration and shock	Check whether the standards related to shock and vibration are satisfied at the installation environment. (Install the product in locations where the conductors will not be subject to vibration or shock.)
	Foreign particles	Install the product in a location that is not subject to liquid or foreign particles entering the product.

Note The tightening torque is 0.5 N·m for the E5CN-U and 0.43 to 0.58 N·m for the E5GN. The terminal torque is 0.5 to 0.6 N·m for auxiliary output 2 on the E5GN.

Conventions Used in This Manual

Model Notation

The E5CN-□□□, E5CN-□□□U, E5AN-□□□, E5EN-□□□, and E5GN-□□□ are given as the E5CN, E5CN-U, E5AN, E5EN, and E5GN when they share functionality.
The following notation is used when specifying differences in functionality.

Notation	Options
E5□N-□□□B	Two event inputs
E5□N-□□□03	RS-485 communications
E5□N-□□H	One of HB, HS, and heater overcurrent detection
E5□N-□□HH	Two of HB, HS, and heater overcurrent detection (See note 1.)
E5□N-□Q	Control output 2 (voltage output) (See note 1.)
E5□N-□□P	External power supply to ES1B (See note 1.)
E5□N-□□□01	RS-232C communications (See note 2.)
E5□N-□□F	Transfer output (See note 3.)

Note: (1) Excluding the E5GN.

(2) Excluding the E5CN.

(3) The E5AN and E5EN only.

Meanings of Abbreviations

The following abbreviations are used in parameter names, figures and in text explanations. These abbreviations mean the following:

Symbol	Term
PV	Process value
SP	Set point
SV	Set value
AT	Auto-tuning
ST	Self-tuning
HB	Heater burnout
HS	Heater short (See note 1.)
OC	Heater overcurrent
LBA	Loop burnout alarm
EU	Engineering unit (See note 2.)

Note: (1) A heater short indicates that the heater remains ON even when the control output from the Temperature Controller is OFF because the SSR has failed or for any other reason.

(2) "EU" stands for Engineering Unit. EU is used as the minimum unit for engineering units such as °C, m, and g. The size of EU varies according to the input type.
For example, when the input temperature setting range is –200 to +1300°C, 1 EU is 1°C, and when the input temperature setting range is –20.0 to +500.0°C, 1 EU is 0.1°C.
For analog inputs, the size of EU varies according to the decimal point position of the scaling setting, and 1 EU becomes the minimum scaling unit.

TABLE OF CONTENTS

About this Manual:

This manual describes the E5CN/CN-U/AN/EN Digital Temperature Controllers and includes the sections described below.

Please read this manual carefully and be sure you understand the information provided before attempting to set up or operate an E5CN/CN-U/AN/EN Digital Temperature Controller.

• Overview

Section 1 introduces the features, components, and main specifications of the E5CN/CN-U/AN/EN/GN Digital Temperature Controllers.

• Setup

Section 2 describes the work required to prepare the E5CN/CN-U/AN/EN/GN Digital Temperature Controllers for operation, including installation and wiring.

• Basic Operations

Section 3 describes the basic operation of the E5CN/CN-U/AN/EN/GN Digital Temperature Controllers, including key operations to set parameters and descriptions of display elements based on specific control examples.

Section 5 describes the individual parameters used to setup, control, and monitor operation.

• Operations for Applications

Section 4 describes scaling, the SP ramp function, and other special functions that can be used to make the most of the basic functionality of the E5CN/CN-U/AN/EN/GN Digital Temperature Controllers.

⚠ **WARNING** Failure to read and understand the information provided in this manual may result in personal injury or death, damage to the product, or product failure. Please read each section in its entirety and be sure you understand the information provided in the section and related sections before attempting any of the procedures or operations given.

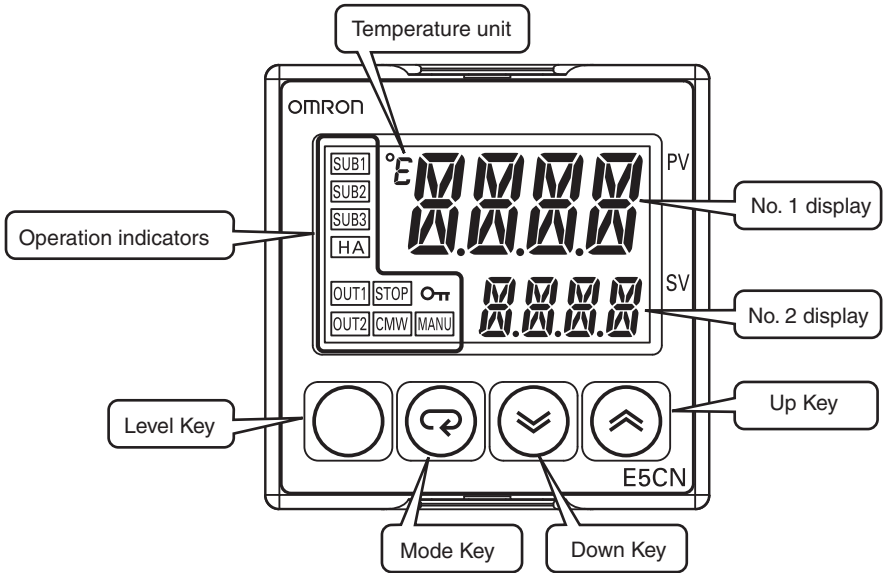
SECTION 1
Introduction

This section introduces the features, components, and main specifications of the E5GN, E5CN, E5EN and E5AN digital temperature controllers.

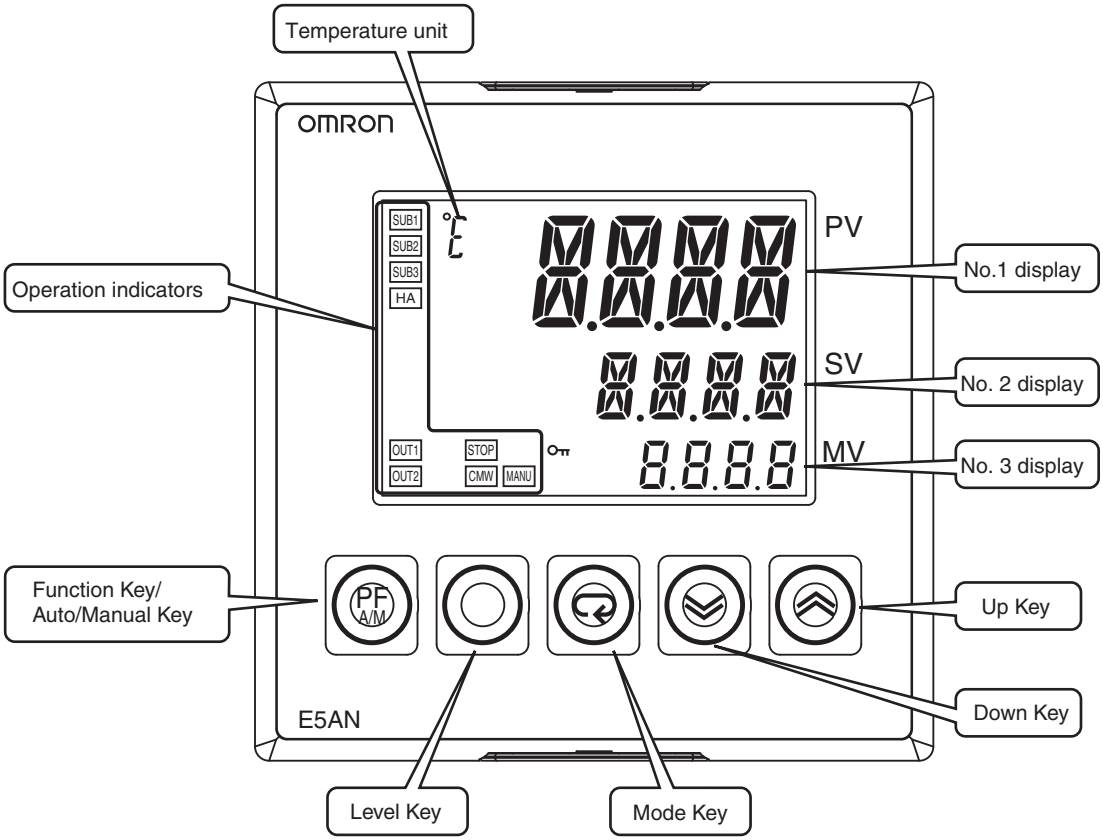
1-1 Names of Parts

1-1-1 Front Panel

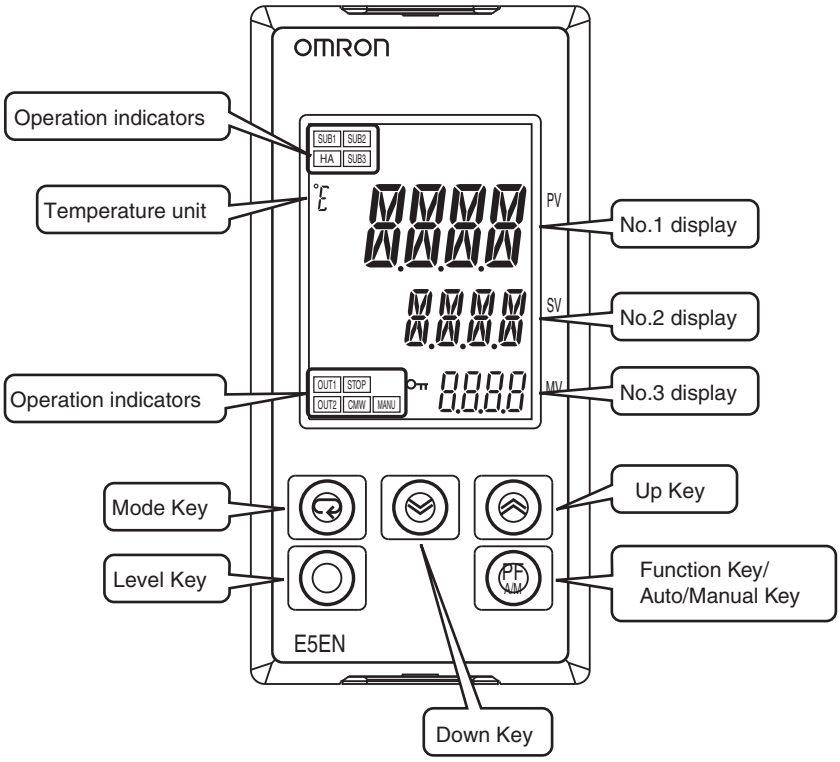
E5CN/CN-U The front panel is the same for the E5CN and E5CN-U.



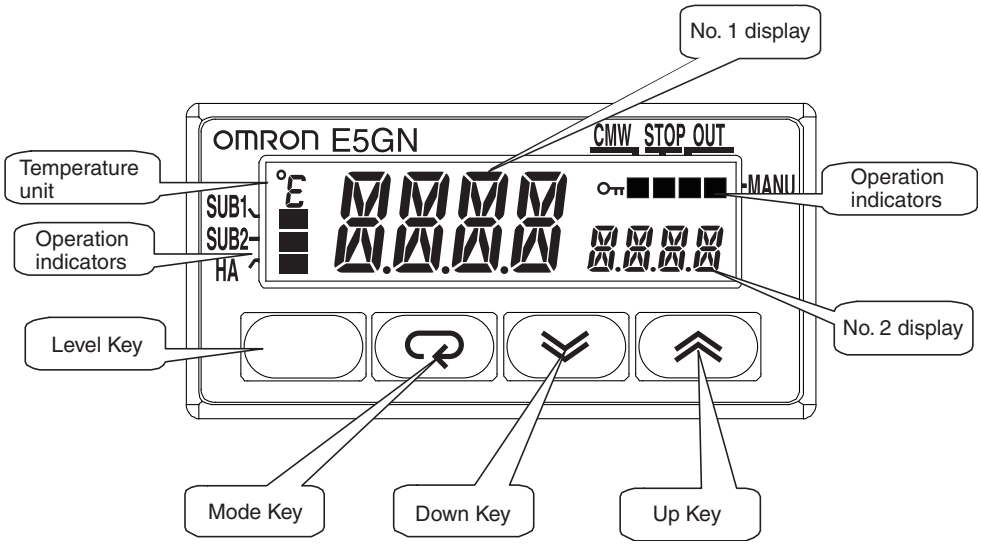
E5AN



E5EN


OMRON
Operation indicators
Temperature unit
Operation indicators
Mode Key
Level Key
Down Key
Up Key
Function Key/
Auto/Manual Key
No.1 display
No.2 display
No.3 display
PV
SV
MV
E5EN

E5GN


No. 1 display
OMRON E5GN
CMW STOP OUT
MANU
Temperature unit
Operation indicators
Operation indicators
Level Key
No. 2 display
SUB1
SUB2
HA
Mode Key
Down Key
Up Key

1-1-2 Explanation of Indicators

No. 1 Display

Displays the process value or parameter name.

Lights for approximately one second during startup.

No. 2 Display

Displays the set point, parameter operation read value, or the variable input value.

Lights for approximately one second during startup.

The set point will flash during autotuning.

No. 3 Display (E5AN/EN Only)

Displays MV, soak time remaining, or multi SP.

Lights for approximately one second during startup.

A 2-level display is set when shipped from the factory.
A 3-level display is activated if parameters are initialized.

Operation Indicators

1,2,3...

1. SUB1 (Sub 1)
   Lights when the function set for the Auxiliary Output 1 Assignment parameter is ON.

   SUB2 (Sub 2)
   Lights when the function set for the Auxiliary Output 2 Assignment parameter is ON.

   SUB3 (Sub 3) (E5AN/EN Only)
   Lights when the function set for the Auxiliary Output 3 Assignment parameter is ON.
2. HA (Heater Burnout, Heater Short Alarm, Heater Overcurrent Detection Output Display)
   Lights when a heater burnout, heater short alarm, or heater overcurrent occurs.
3. OUT1 (Control Output 1)
   Lights when the control output function assigned to control output 1 turns ON. For a current output, however, OFF for a 0% output only.

   OUT2 (Control Output 2) (Excluding the E5GN)
   Lights when the control output function assigned to control output 2 turns ON. For a current output, however, OFF for a 0% output only.
4. STOP
   Lights when operation is stopped.

   During operation, this indicator lights when operation is stopped by an event or by key input using the RUN/STOP function.
5. CMW (Communications Writing)
   Lights when communications writing is enabled and is not lit when it is disabled.
6. MANU (Manual Mode)
   Lights when the auto/manual mode is set to manual mode.
7. (Key)
   Lights when settings change protect is ON (i.e., when the and Keys are disabled by protected status.)

Temperature Unit

The temperature unit is displayed when parameters are set to display a temperature. The display is determined by the currently set value of the Temperature Unit parameter. °C indicates °C and °F indicates °F.

This indicator flashes during ST operation. It is OFF on models with linear inputs.

1-1-3 Using the Keys

This section describes the basic functions of the front panel keys.

PF (Function (Auto/ Manual)) Key (E5AN/EN Only)

This is a function key. When it is pressed for at least 1 second, the function set in the PF Setting parameter will operate.

Example: When A-M (auto/manual) is selected in the PF Setting parameter (initial value: A-M), the key operates as an auto/manual switch, switching between Auto Mode and Manual Mode. If the key is pressed for more than 1 second (regardless of key release timing), the mode will switch.

O Key

Press this key to move between setting levels. The setting level is selected in the following order: operation level: adjustment level, initial setting level, communications setting level.

R Key

Press this key to change parameters within a setting level.

The parameters can be reversed by holding down the key (moving one per second in reverse order).

U Key

Each press of this key increments the value displayed on the No. 2 display or advances the setting. Holding the key down speeds up the incrementation.

D Key

Each press of this key decrements values displayed on the No. 2 display or reverses the setting. Holding the key down speeds up the incrementation.

O + R Keys

Press these keys to change to the protect level. For details on operations involving holding these keys down simultaneously, refer to *1-3 Setting Level Configuration and Key Operations*.

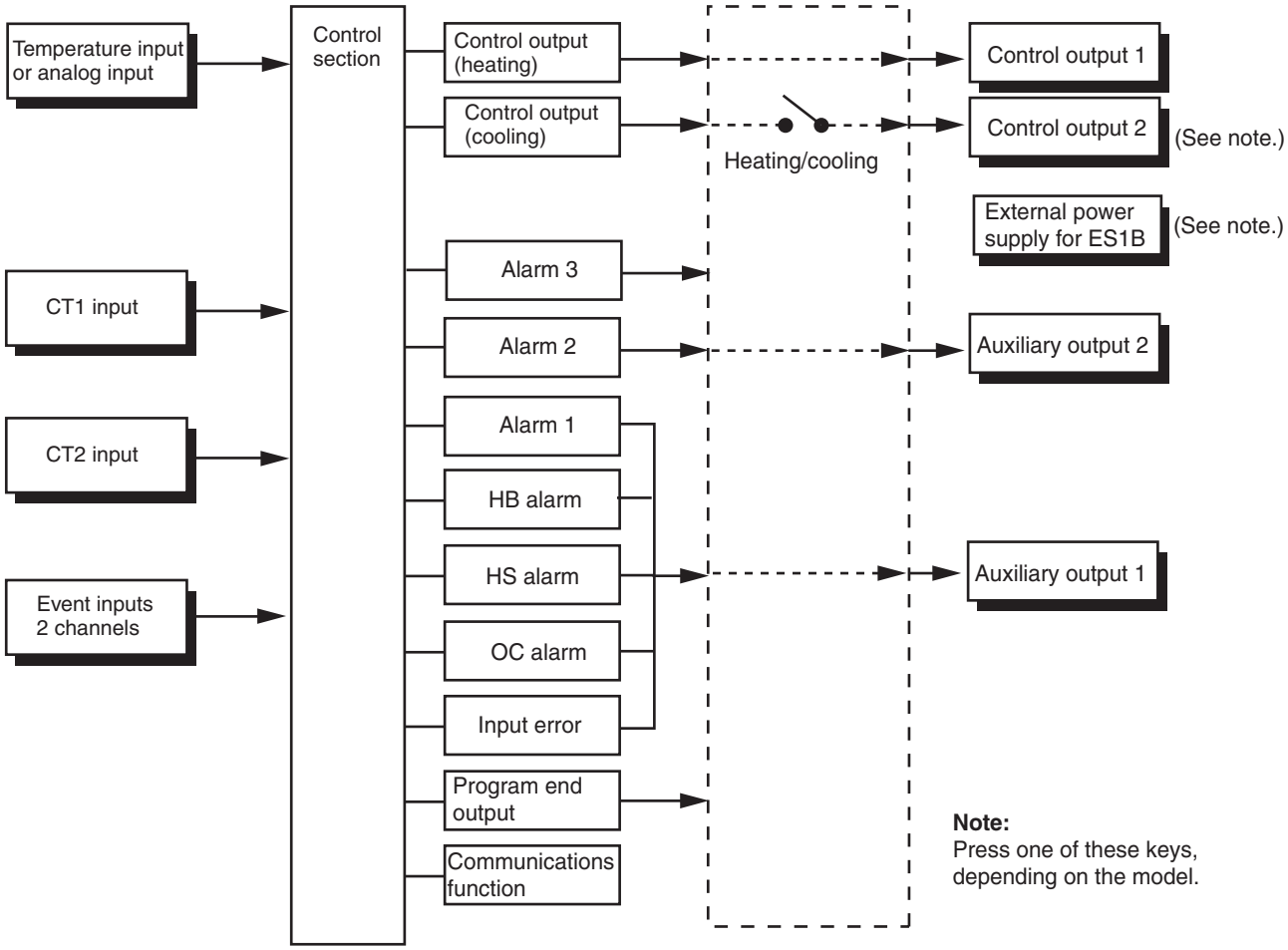
O + U Keys
O + D Keys

To restrict set value changes (in order to prevent accidental or incorrect operations), these key operations require simultaneously pressing the O key along with U or D key. This applies only to the parameter for the password to move to protect level.

1-2 I/O Configuration and Main Functions

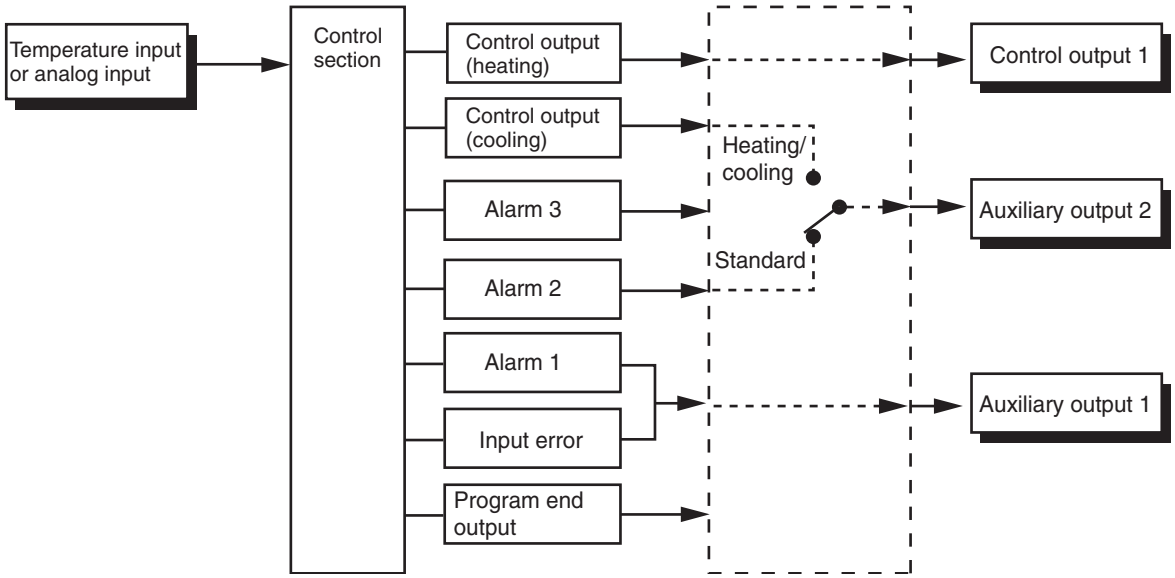
1-2-1 I/O Configuration

E5CN



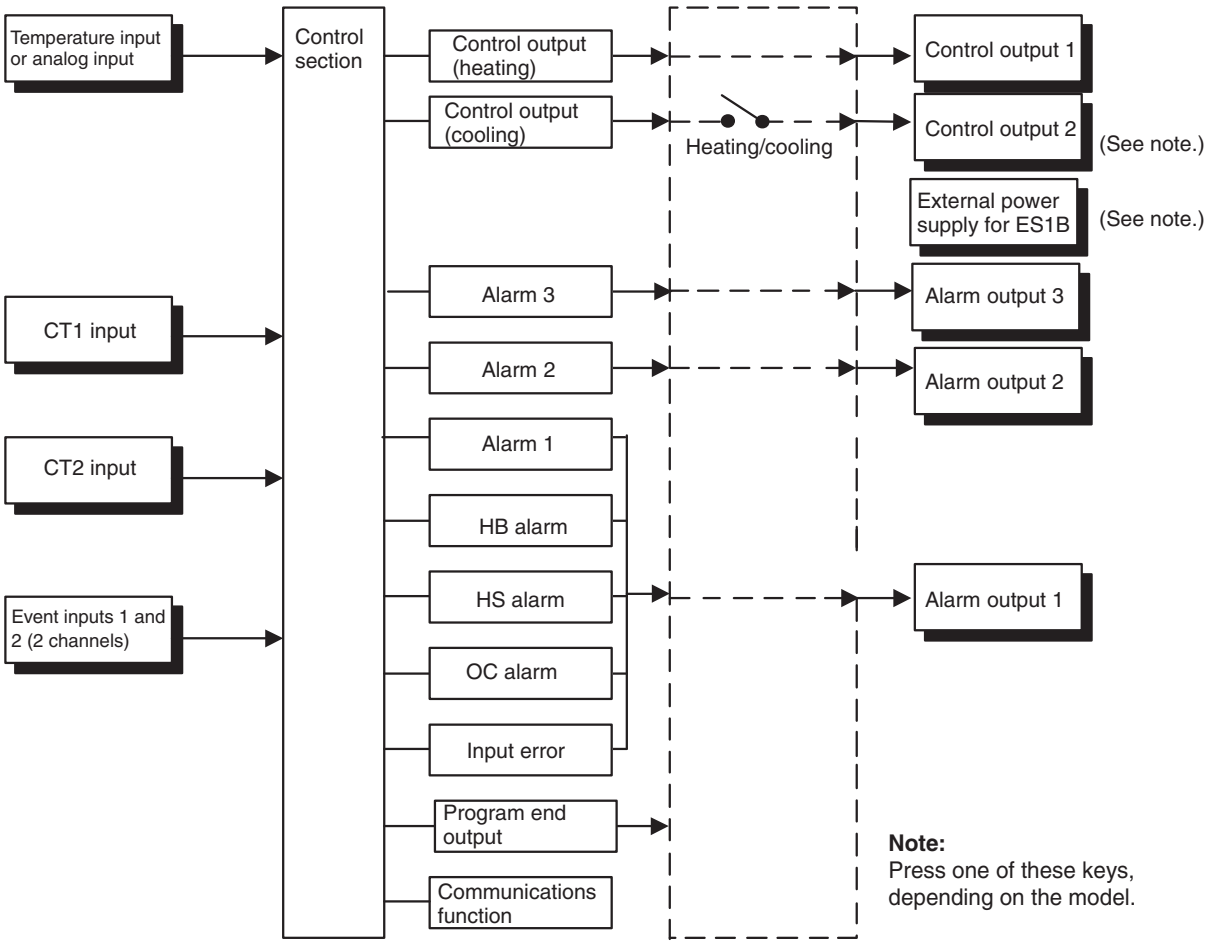
Note Functions can be assigned individually for each output by changing the set values for the Control Output 1 Assignment, the Control Output 2 Assignment, the Auxiliary Output 1 Assignment, and the Auxiliary Output 2 Assignment parameters in the advanced function setting level.

E5CN-U



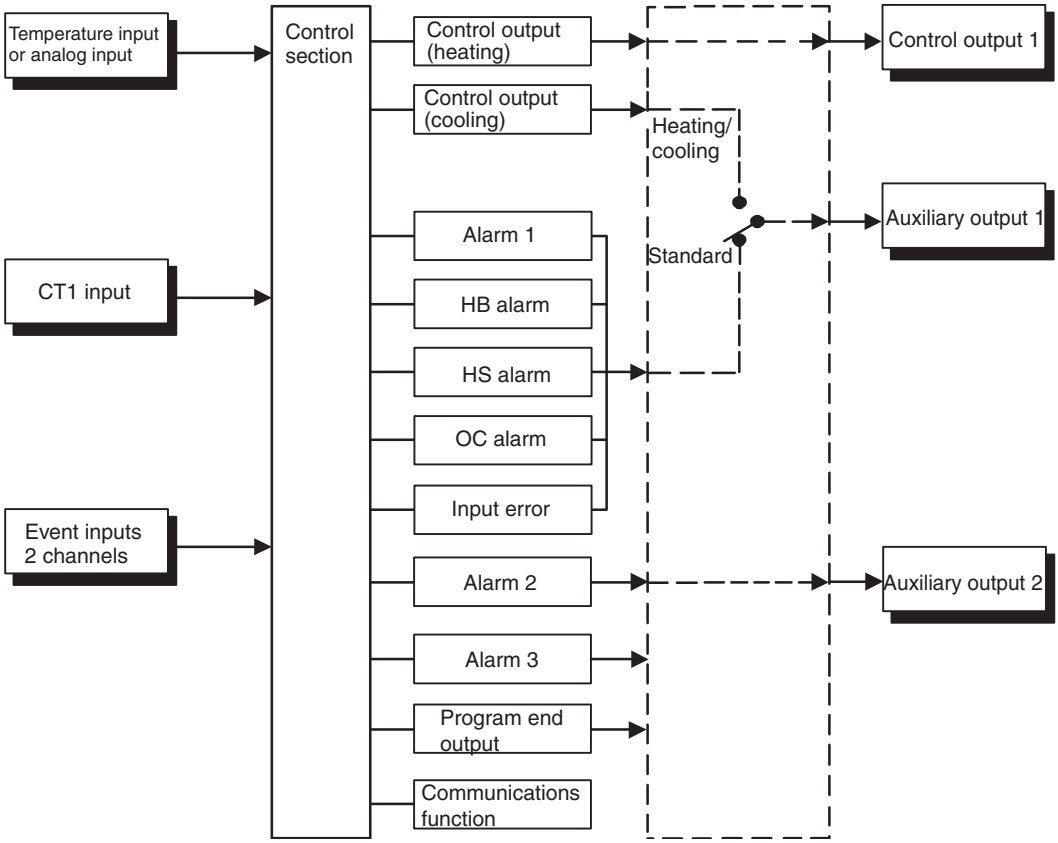
Note Functions can be assigned individually for each output by changing the set values for the Control Output 1 Assignment, the Auxiliary Output 1 Assignment, and the Auxiliary Output 2 Assignment parameters in the advanced function setting level.

E5AN/EN



Note Functions can be assigned individually to each output by changing the set values for the Control Output 1 Assignment, Control Output 2 Assignment, Auxiliary Output 1 Assignment, Auxiliary Output 2 Assignment, and Auxiliary Output 3 Assignment parameters in the advanced function setting level.

E5GN



Note Functions can be assigned individually for each output by changing the set values for the Control Output 1 Assignment, the Auxiliary Output 1 Assignment, and the Auxiliary Output 2 Assignment parameters in the advanced function setting level.

1-2-2 Main Functions

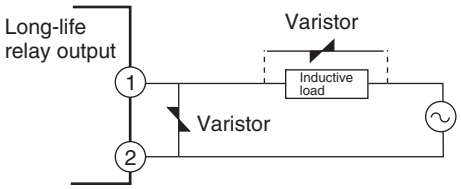
This section introduces the main E5CN/CN-U/AN/EN/GN functions. For details on particular functions and how to use them, refer to *SECTION 3 Basic Operation* and following sections.

Input Sensor Types

- The following input sensors can be connected for temperature input (i.e., E5_N-□□□□T):
  Thermocouple: K, J, T, E, L, U, N, R, S, B, W, PLII
  Infrared temperature sensor: ES1B
  10 to 70°C, 60 to 120°C, 115 to 165°C, 140 to 260°C
  Platinum resistance thermometer: Pt100, JPt100
  Analog input: 0 to 50 mV
- Inputs with the following specifications can be connected for analog input (i.e., E5_N-□□□□L):
  Current input: 4 to 20 mA DC, 0 to 20 mA DC
  Voltage input: 1 to 5 VDC, 0 to 5 V DC, 0 to 10 V DC

Control Outputs

- A control output can be a relay, voltage (for driving SSR), or current output, depending on the model.
- Long-life relay outputs (see note) use semiconductors for switching when closing and opening the circuit, thereby reducing chattering and arcing and improving durability. However, if high levels of noise or surge are imposed between the output terminals, short-circuit faults may occasionally occur. If the output becomes permanently shorted, there is the danger of fire due to overheating of the heater. Design safety into the system, including measures to prevent excessive temperature rise and spreading of fire. Take countermeasures such as installing a surge absorber. As an additional safety measure, provide error detection in the control loop. (Use the Loop Burnout Alarm (LBA) and HS alarm that are provided for the E5□N.)



Select a surge absorber that satisfies the following conditions.

Voltage used	Varistor voltage	Surge resistance
100 to 120 VAC	240 to 270 V	1,000 A min.
200 to 240 VAC	440 to 470 V	

- Always connect an AC load to a long-life relay output (see note). The output will not turn OFF if a DC load is connected.

Note Long-life relay outputs are not supported for the E5GN.

Alarms

- Set the alarm type and alarm value or the alarm value upper and lower limits.
- If necessary, a more comprehensive alarm function can be achieved by setting a standby sequence, alarm hysteresis, auxiliary output close in alarm/open in alarm, alarm latch, alarm ON delay, and alarm OFF delay.
- If the Input Error Output parameter is set to ON, the output assigned to alarm 1 function will turn ON when an input error occurs.

Control Adjustment

- Optimum PID constants can be set easily by performing AT (auto-tuning) or ST (self-tuning).

Event Inputs

- With the E53-CN□B□N2 for the E5CN or the E5AN/EN-□M□-500-N with the E53-AKB for the E5AN/EN, the following functions can be executed using event inputs: switching set points (multi-SP, 4 points max.), switching RUN/STOP, switching between automatic and manual operation, starting/resetting the program, inverting direct/reverse operation, 100% AT execute/cancel, 40% AT execute/cancel, setting change enable/disable, and canceling the alarm latch.

Heater Burnout, HS Alarm, and Heater Overcurrent

- With the E53-CN□H□N2 or E53-CN□HH□N2 for the E5CN, or the E5AN/EN-□□H□-500-N or E5AN/EN-□□HH□-500-N, the heater burnout detection function, HS alarm function, and heater overcurrent detection function can be used.

Communications Functions

- Communications functions utilizing CompoWay/F (See note 1.), SYSWAY (See note 2.), or Modbus (See note 3.) can be used.

  RS-485 Interface

  Use the E53-CN□03N2 for the E5CN or the E53-EN03 for the E5AN/EN.

  RS-232C Interface

  Use the E53-EN01 for the E5AN/EN.

Note

(1) CompoWay/F is an integrated general-purpose serial communications protocol developed by OMRON. It uses commands compliant with the well-established FINS, together with a consistent frame format on OMRON Programmable Controllers to facilitate communications between personal computers and components.

(2) SYSWAY communications do not support alarm 3.

(3) Modbus is a communications control method conforming to the RTU Mode of Modbus Protocol. Modbus is a registered trademark of Schneider Electric.

(4) The E5CN and E5CN-U do not support the RS-232C interface.

External Power Supply for ES1B

The E5AN-□P□-N or E5EN-□P□-N with the E53-CN□P□N2 can be used as the power supply for ES1B Infrared Temperature Sensors.

Note

The E5GN does not provide a power supply for an ES1B Infrared Temperature Sensor.

Transfer Output

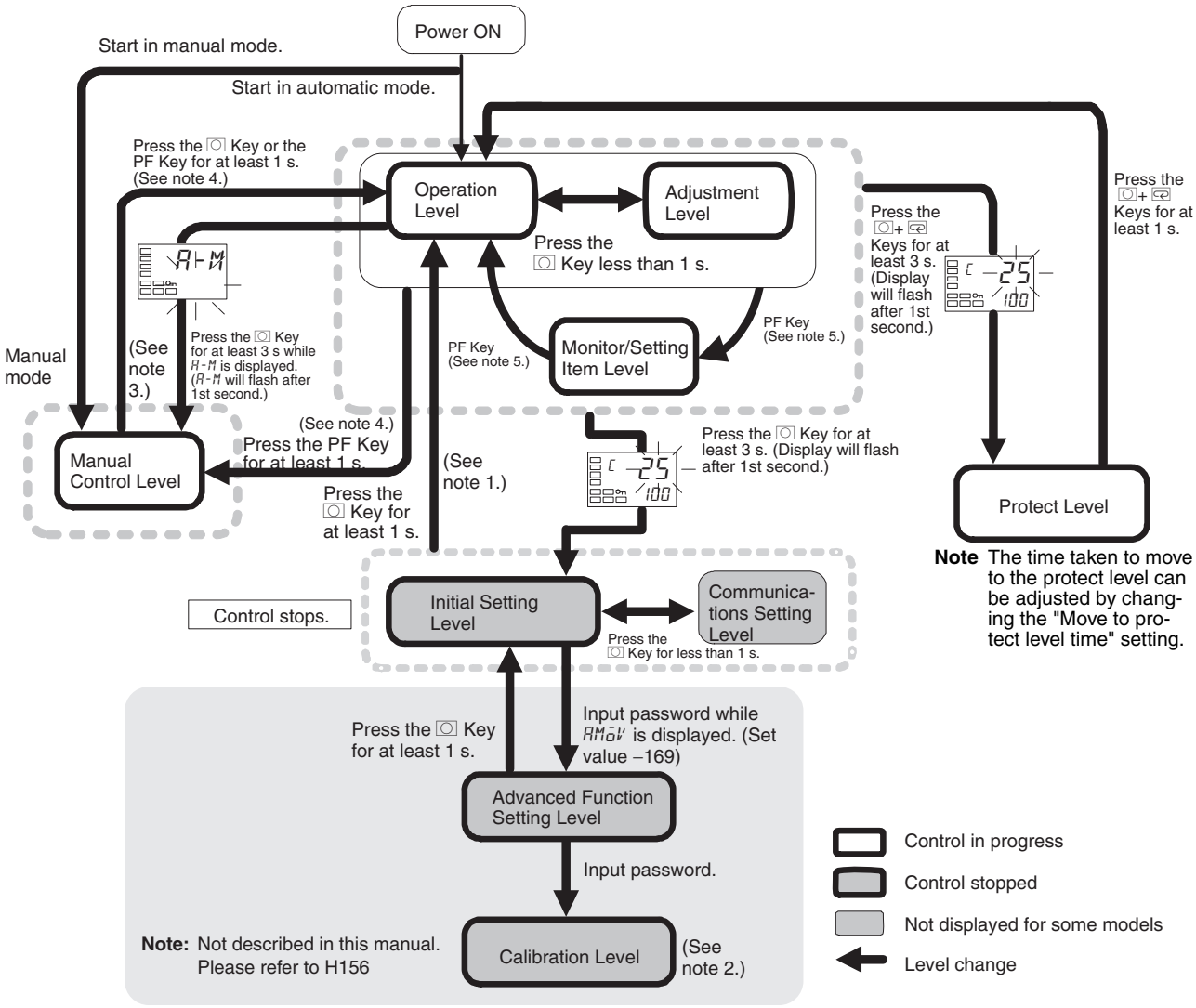
A transfer output for 4 to 20 mA can be used with the E5AN/E5EN-□□F.

For E5□N-C□□ models (models without “F” in the model number), the current output can be used as a simple transfer output.

1-3 Setting Level Configuration and Key Operations

Parameters are divided into groups, each called a level. Each of the set values (setting items) in these levels is called a parameter. The parameters on the E5CN/CN-U/AN/EN/GN are divided into the following 9 levels.

When the power is turned ON, all of the display lights for approximately one second.



Note (1) You can return to the operation level by executing a software reset.

(2) You cannot move to other levels by operating the keys on the front panel from the calibration level. You must turn OFF the power supply.

(3) From the manual control level, key operations can be used to move to the operation level only.

Level	Control in progress	Control stopped
Protect level	Can be set.	---
Operation level	Can be set.	---
Adjustment level	Can be set.	---
Manual control level	Can be set.	---
Monitor/setting item level	Can be set.	---
Initial setting level	---	Can be set.

Level	Control in progress	Control stopped
Advanced function setting level	---	Can be set.
Calibration level	---	Can be set.
Communications setting level	---	Can be set.

Of these levels, the initial setting level, communications setting level, advanced function setting level, and calibration level can be used only when control is stopped. Control outputs are stopped when any of these four levels is selected.

(4) When the PF Setting is set to A-M in models with a PF Key (E5AN/EN)

(5) When the PF Setting is set to PFDP in models with a PF Key (E5AN/EN)

Protect Level

- To switch to the protect level from the operation level, the adjustment level, or the monitor/setting item level, simultaneously hold down the ○ and ⊂⊃ Keys for at least 3 seconds. (See note.) This level is for preventing unwanted or accidental modification of parameters. Protected levels will not be displayed, and so the parameters in that level cannot be modified.

  Note The key pressing time can be changed in Move to Protect Level parameter (advanced function setting level).

Operation Level

- The operation level is displayed when the power is turned ON. You can move to the protect level, initial setting level, or adjustment level from this level.
- Normally, select this level during operation. While operation is in progress, items such as the PV and manipulated variable (MV) can be monitored, and the set points, alarm values, and alarm upper and lower limits can be monitored and changed.

Adjustment Level

- To move to the adjustment level, press the ○ Key once (for less than 1 s).
- This level is for entering set values and offset values for control. In addition to AT (auto-tuning), communications write enable/disable switching, hysteresis settings, multi-SP settings, and input offset parameters, it includes HB alarm, HS alarm, OC alarm, and PID constants. From the adjustment level, it is possible to move to the top parameter of the initial setting level, protect level, or operation level.

Monitor/Setting Item Level

- To switch to the monitor/setting item level, press the PF Key from the operation level or adjustment level. The contents set for monitor/setting items 1 to 5 can be displayed. You can move from the monitor/setting item level to the operation level or initial setting level. (This level is supported by the E5AN and E5EN only.)

Manual Control Level

- When the ○ Key is pressed for at least 3 seconds from the operation level's auto/manual switching display, the manual control level will be displayed. (The MANU indicator will light.)
- When the PF Setting is set to A-M (auto/manual) and the PF Key is pressed for more than one second from the operation level or adjustment level, the manual control level will be displayed (E5AN and E5EN only.)
- This is the level for changing the MV in manual mode.
- To return to the operation level, press the ○ Key for at least one second. It is also possible to return to the operation level by pressing the PF Key for more than one second when the PF Setting is set to A-M.

Initial Setting Level

- To move to the initial setting level from the operation level or the adjustment level, press the ○ Key for at least 3 seconds. The PV display flashes after one second. This level is for specifying the input type and selecting the control method, control period, setting direct/reverse operation, setting the alarm types, etc. You can move to the advanced function setting level or communications setting level from this level. To return to the operation level, press the ○ Key for at least one second. To move to the communications setting level, press the ○ Key for less than one second.
  (When moving from the initial setting level to the operation level, all the indicators will light.)

  Note Pressing the ○ Key for at least 3 seconds in the operation level's auto/manual switching display will move to the manual control level, and not the initial setting level.

Advanced Function Setting Level

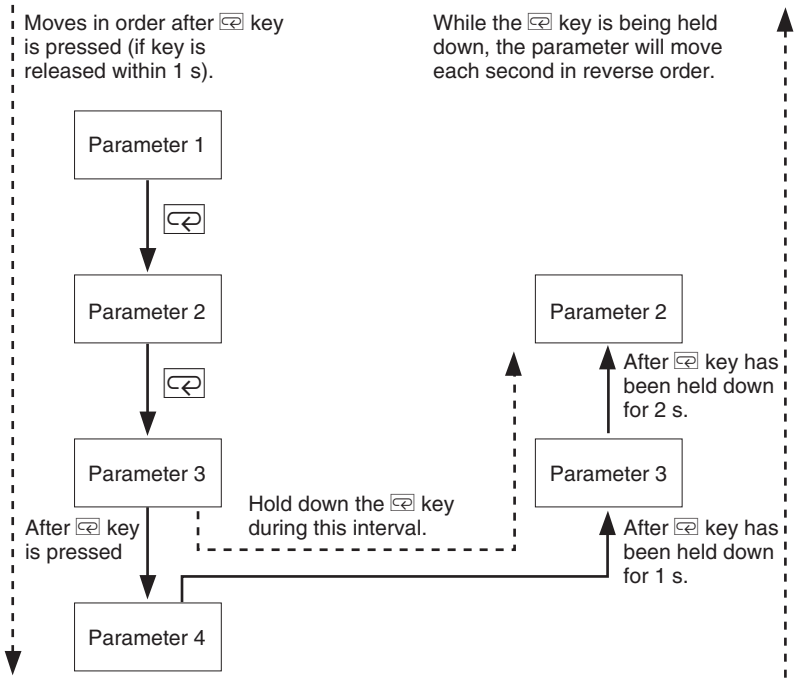
- To move to the advanced function setting level, set the Initial Setting/Communications Protect parameter in the protect level to 0 and then, in the initial setting level, input the password (–169).
- From the advanced function setting level, it is possible to move to the calibration level or to the initial setting level.
- This level is for setting the automatic display return time and standby sequence, and it is the level for moving to the user calibration and other functions.

Communications Setting Level

- To move to the communications setting level from the initial setting level, press the ○ Key once (for less than 1 s). When using the communications function, set the communications conditions in this level. Communicating with a personal computer (host computer) allows set points to be read and written, and manipulated variables (MV) to be monitored.

1-3-1 Selecting Parameters

- Within each level, the parameter is changed in order (or in reverse order) each time the ⊏↵ Key is pressed. (In the calibration level, however, parameters cannot be changed in reverse order.)



1-3-2 Saving Settings

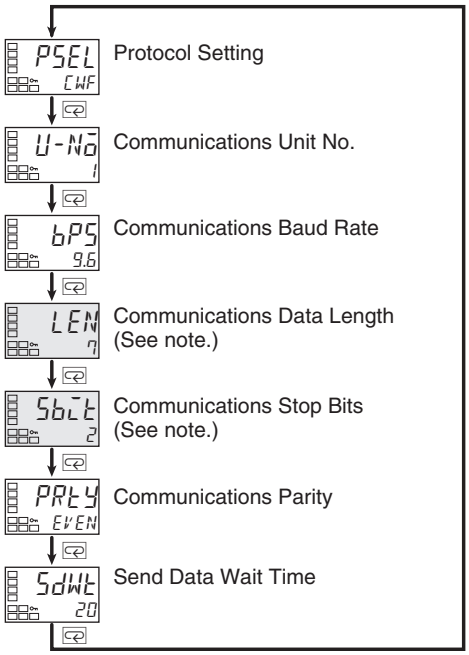
- If you press the Key at the final parameter, the display returns to the top parameter for the current level.
- To change parameter settings, specify the setting using the or Key, and either leave the setting for at least two seconds or press the Key. This saves the setting.
- When another level is selected after a setting has been changed, the contents of the parameter prior to the change is saved.
- When you turn the power OFF, you must first save the settings (by pressing the Key). The settings are sometimes not changed by merely pressing the or Keys.

1-4 Communications Function

The E5CN/AN/EN/GN are provided with a communications function that enables parameters to be checked and set from a host computer. If the communications function is required, use the E53-CN□03N2 with the E5CN, or the E53-EN03 or E53-EN01 with the E5AN/EN/GN. For details on the communications function, see the separate *Communications Manual Basic Type*. Use the following procedure to move to the communications setting level.

1,2,3...

1. Press the Key for at least three seconds to move from the operation level to the initial setting level.
2. Press the Key for less than one second to move from the initial setting level to the communications setting level.
3. Select the parameters as shown below by pressing the Key.
4. Press the or Key to change the parameter setting.



Note The Protocol Setting parameter is displayed only when CompoWay/F communications are being used.

Setting Communications Data

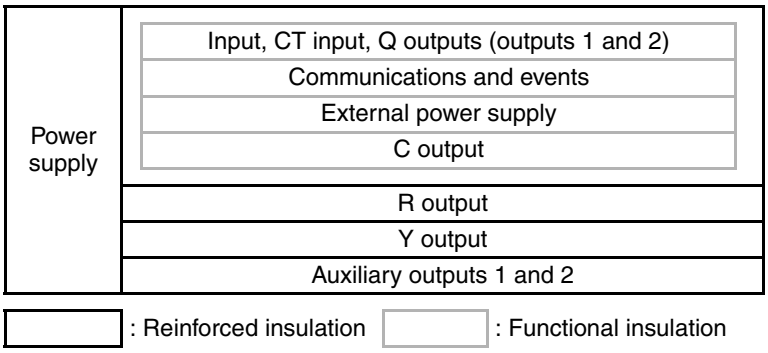
Match the communications specifications of the E5CN/AN/EN/GN and the host computer. If a 1:N connection is being used, ensure that the communications specifications for all devices in the system (except the communications Unit No.) are the same.

Parameter name	Symbol	Setting (monitor) value	Selection symbols	Default	Unit
Protocol Setting	PSEL	CompoWay/F (SYSWAY), Modbus	CWF, Mod	CompoWay/F (SYSWAY)	None
Communications Unit No.	U-No	0 to 99		1	None
Communications Baud Rate	bPS	1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6	1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6	9.6	kbps
Communications Data Length	LEN	7, 8		7	Bits
Communications Stop Bits	Sbit	1, 2		2	Bits
Communications Parity	PRTY	None, Even, Odd	NONE, EVEN, odd	Even	None
Send Data Wait Time	SdWE	0 to 99		20	ms

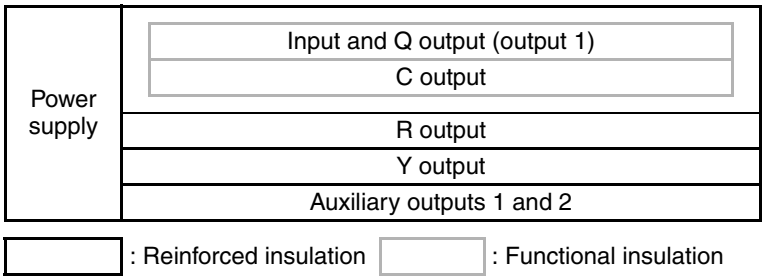
1-5 Insulation Block Diagrams

The insulation block diagrams for the E5CN, E5AN, E5EN, and E5GN are provided in this section.

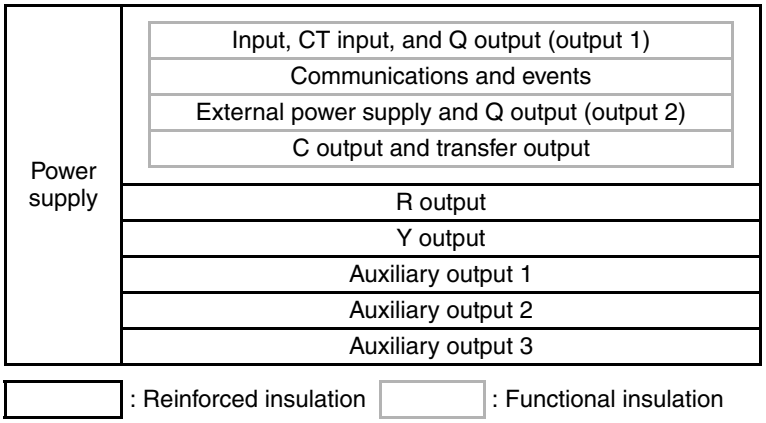
E5CN



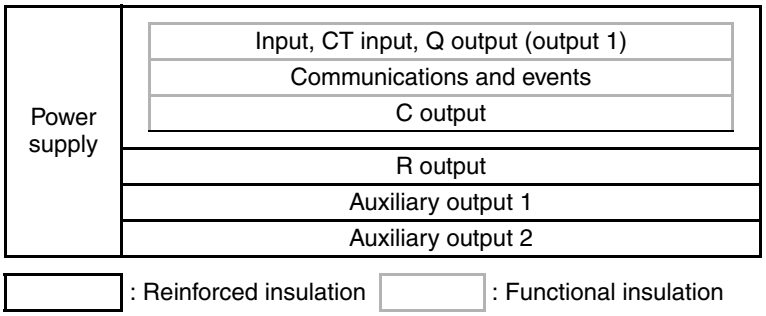
E5CN-U



E5AN/EN



E5GN



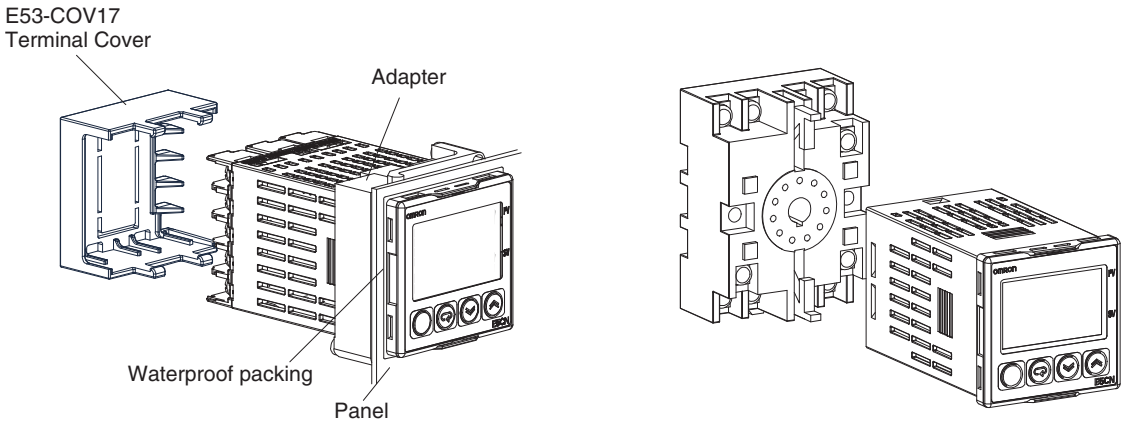
SECTION 2
Preparations

This section describes the work required to prepare the E5GN, E5CN, E5EN and E5AN Digital Temperature Controllers for installation. For operation and wiring details refer to the datasheet (H03E and H04E).

2-1 Installation

2-1-1 Mounting

E5CN/CN-U



E5CN E5CN-U

For the Wiring Socket for the E5CN-U, order the P2CF-11 or P3GA-11 separately.

Mounting to the Panel

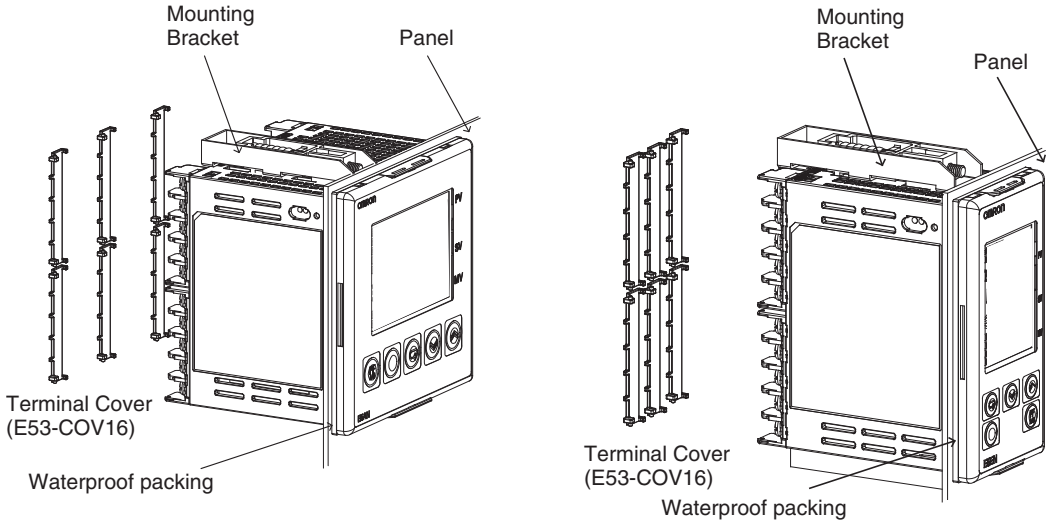
1,2,3...

1. For waterproof mounting, waterproof packing must be installed on the Controller. Waterproofing is not possible when group mounting several Controllers. Waterproof packing is not necessary when there is no need for the waterproofing function. There is no waterproof packing included with the E5CN-U.
2. Insert the E5CN/E5CN-U into the mounting hole in the panel.
3. Push the adapter from the terminals up to the panel, and temporarily fasten the E5CN/E5CN-U.
4. Tighten the two fastening screws on the adapter. Alternately tighten the two screws little by little to maintain a balance. Tighten the screws to a torque of 0.29 to 0.39 N·m.

Mounting the Terminal Cover

For the E5CN, make sure that the “UP” mark is facing up, and then attach the E53-COV17 Terminal Cover to the holes on the top and bottom of the Temperature Controller.

E5AN/EN



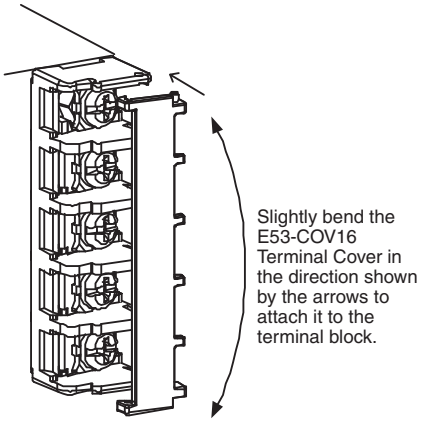
Mounting to the Panel

1,2,3...

1. For waterproof mounting, waterproof packing must be installed on the Controller. Waterproofing is not possible when group mounting several Controllers. Waterproof packing is not necessary when there is no need for the waterproofing function.
2. Insert the E5AN/E5EN into the square mounting hole in the panel (thickness: 1 to 8 mm). Attach the Mounting Brackets provided with the product to the mounting grooves on the top and bottom surfaces of the rear case.
3. Use a ratchet to alternately tighten the screws on the top and bottom Mounting Brackets little by little to maintain balance, until the ratchet turns freely.

Mounting the Terminal Cover

Slightly bend the E53-COV16 Terminal Cover to attach it to the terminal block as shown in the following diagram. The Terminal Cover cannot be attached in the opposite direction.



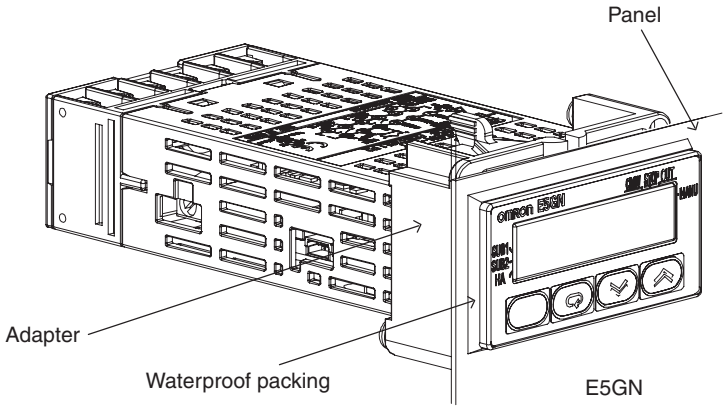
Enlarged Illustration of Terminal Section

E5GN

Mounting to the Panel

1,2,3...

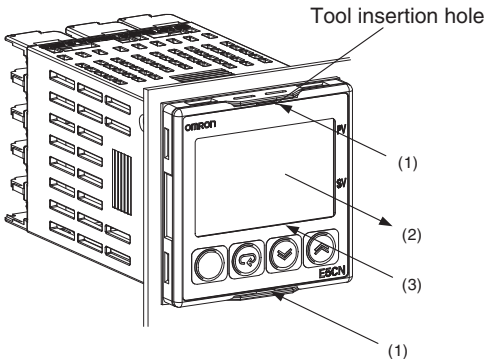
1. For waterproof mounting, waterproof packing must be installed on the Controller. Waterproofing is not possible when group mounting several Controllers.
   Waterproof packing is not necessary when there is no need for the waterproofing function.
2. Insert the E5GN into the mounting hole in the panel.
3. Push the adapter from the terminals up to the panel, and temporarily fasten the E5GN.
4. Tighten the two fastening screws on the adapter. Alternately tighten the two screws little by little to maintain a balance.Tighten the screws to a torque of 0.29 to 0.39 N·m.

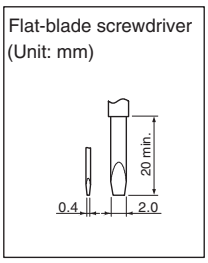


2-1-2 Removing the Temperature Controller from the Case

The Temperature Controller can be removed from the case to perform maintenance without removing the terminal leads. This is possible for only the E5CN, E5AN, and E5EN, and not for the E5CN-U or E5GN. Check the specifications of the case and Temperature Controller before removing the Temperature Controller from the case.

E5CN

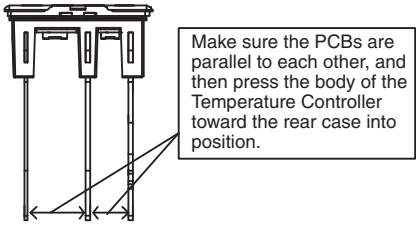




1,2,3...

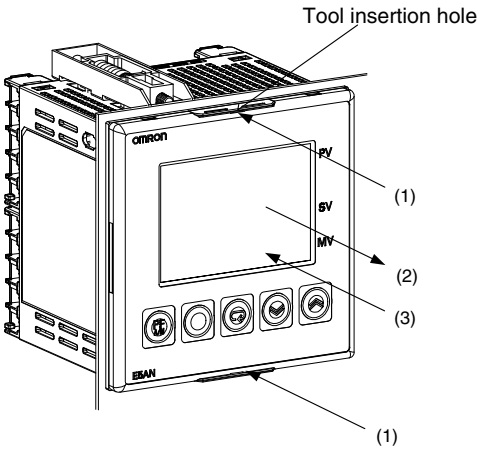
1. Insert a flat-blade screwdriver into the two tool insertion holes (one on the top and one on the bottom) to release the hooks.
2. Insert the flat-blade screwdriver in the gap between the front panel and rear case, and pull out the front panel slightly. Hold the top and bottom of the front panel and carefully pull it out toward you, without applying unnecessary force.

3. When inserting the body of the Temperature Controller into the case, make sure the PCBs are parallel to each other, make sure that the sealing rubber is in place, and press the E5CN toward the rear case into position. While pushing the E5CN into place, push down on the hooks on the top and bottom surfaces of the rear case so that the hooks are securely locked in place. Be sure that electronic components do not come into contact with the case.

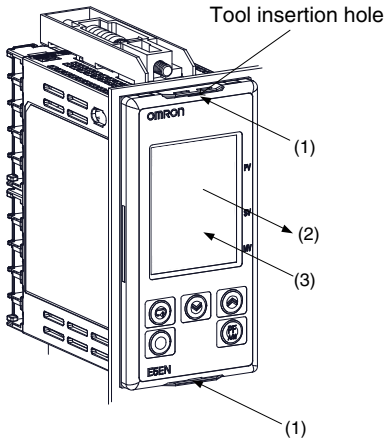


Bottom View of the E5CN

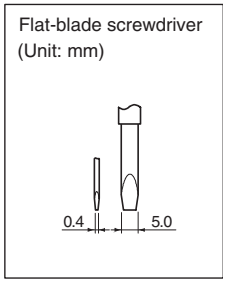
E5AN/EN



E5AN

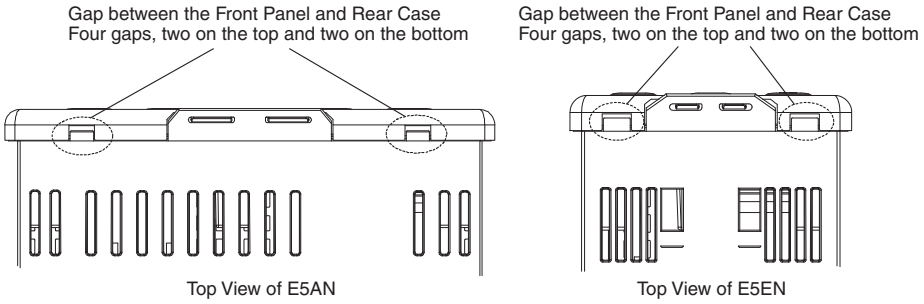


E5EN



1,2,3...

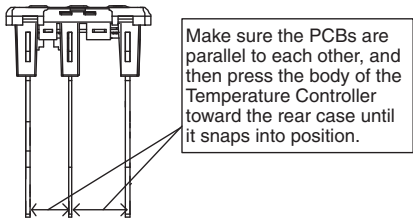
1. Insert a flat-blade screwdriver into the two tool insertion holes (one on the top and one on the bottom) to release the hooks.
2. Insert the flat-blade screwdriver in the gap between the front panel and rear case (two on the top and two on the bottom), and use it to pry and pull out the front panel slightly. Then, pull out on the front panel gripping both sides. Be sure not to impose excessive force on the panel.



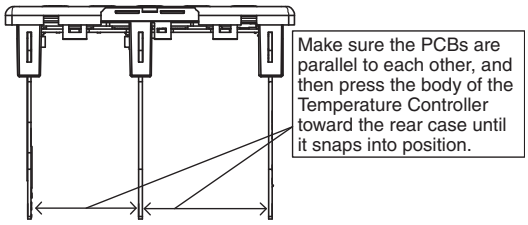
Top View of E5AN

Top View of E5EN

3. When inserting the body of the Temperature Controller into the case, make sure the PCBs are parallel to each other, make sure that the sealing rubber is in place, and press the E5AN/EN toward the rear case until it snaps into position. While pressing the E5AN/EN into place, press down on the hooks on the top and bottom surfaces of the rear case so that the hooks securely lock in place. Make sure that electronic components do not come into contact with the case.



Bottom View of the E5EN



Bottom View of the E5AN

Removing the Terminal Block

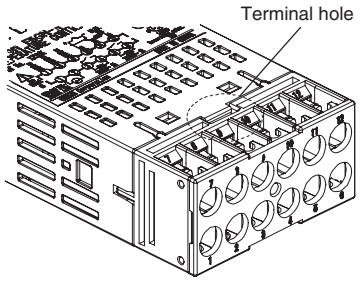
The terminal block can be removed from the E5GN. It is not possible for the E5CN, E5AN, E5EN, and E5CN-U.

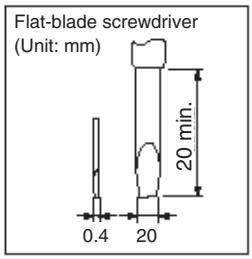
E5GN

The body of the Controller can be replaced by removing the terminal block from the E5GN.

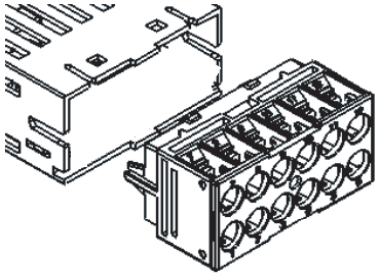
1,2,3...

1. Insert a flat-blade screwdriver into the tool holes (one on the top and one on the bottom) to release the hooks. Do not apply excessive force.





2. Pull the terminal block out while the hooks are released.



Note The method for removing the terminal block is the same for both screw terminal blocks and screwless clamp terminal blocks.
Do not connect a different type of terminal block to a Controller. For example, do not replace a screw terminal block with a screwless clamp terminal block. The temperature indication accuracy will decrease.

2-2 Using the Support Software Port

Use the communications port for Support Software to connect the personal computer to the Temperature Controller when using EST2-2C-MV4 CX-Thermo or a version of CX-Thermo higher than 4.00, or other Support Software. The E5GN is supported from CX-Thermo version 4.2. The E58-CIFQ1 USB-Serial Conversion Cable is required to make the connection.

For information concerning the models that can be used with CX-Thermo, contact your OMRON sales representative.

Procedure

Use the following procedure to connect the Temperature Controller to the personal computer using the USB-Serial Conversion Cable. The USB-Serial Conversion Cable is used to communicate with the COM port of the personal computer. To perform communications using USB-Serial Conversion Cable, set the communications port (COM port) number to be used for the software to the COM port assigned to the Cable.

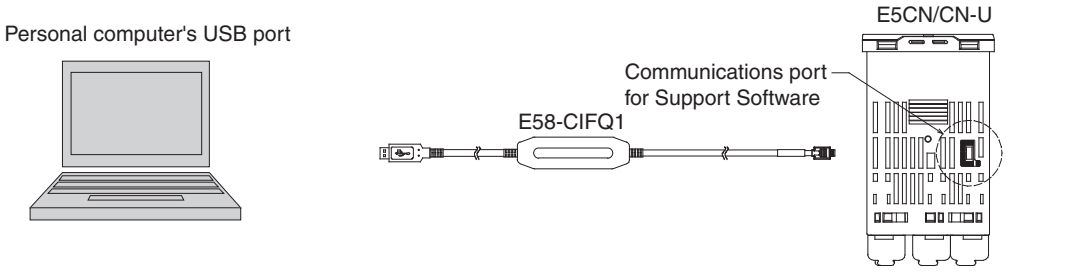
1,2,3...

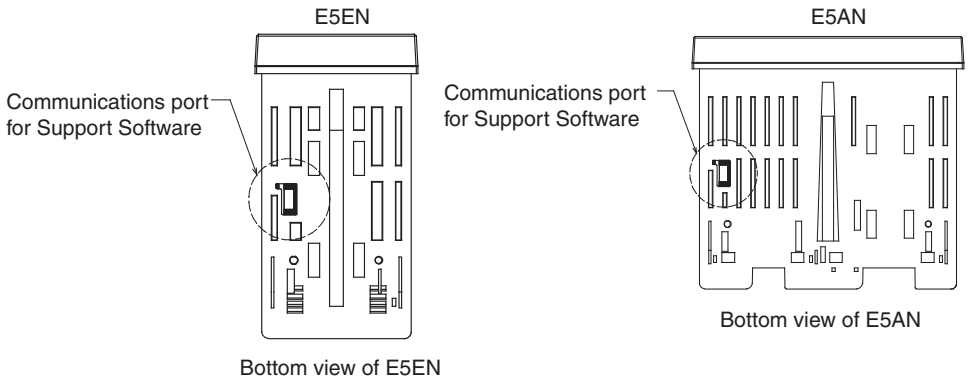
1. Turn ON the power to the Temperature Controller.

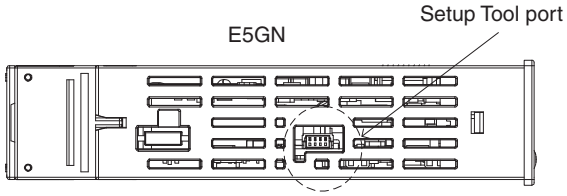
   Note If the Cable is connected when the power to the Temperature Controller is OFF, power will be supplied from the personal computer and impose a load on the internal circuits of the Temperature Controller.

2. Connect the Cable.
   Connect the personal computer's USB port with the Support Software port on the Temperature Controller using the Cable.

   • Temperature Controller Connection Method







Side View of the E5GN

Note Hold the connector when inserting or disconnecting the Cable.

3. Install the driver.
   Install the driver to enable the Cable to be used with the personal computer.
   - Installation
     When the Cable is connected with the personal computer, the OS detects the product as a new device. At this time, install the driver using the installation wizard. For details on installation methods, refer to the user's manual for the E58-CIFQ1 USB-Serial Conversion Cable.
4. Setting Setup Tool Communications Conditions
   Set the communications port (COM port) number to be used for the CX-Thermo Setup Tool to the COM port number assigned to the USB-Serial Conversion Cable.
   Refer to the E58-CIFQ1 USB-Serial Conversion Cable *Instruction Manual* and *Setup Manual* for details on how to check the COM port assigned to the USB-Serial Conversion Cable.
   The communications conditions for Setup Tool COM ports are fixed as shown in the table below. Set the communications conditions for the CX-Thermo Setup Tool according to the following table.

Parameter	Set value
Communications Unit No.	01
Communications baud rate	38.4 (kbps)
Communications data length	7 (bits)
Communications stop bits	2 (bits)
Communications parity	Even

SECTION 3
Basic Operation

This section describes the basic operation of the E5GN, E5CN, E5EN and E5AN Digital Temperature Controllers, including key operations to set parameters and descriptions of display elements based on specific control examples.

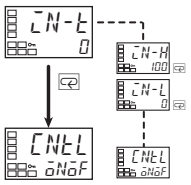
3-1 Initial Setting Examples

Initial hardware setup, including the sensor input type, alarm types, control periods, and other settings, is done using parameter displays. The ○ and ↵ Keys are used to switch between parameters, and the amount of time that you press the keys determines which parameter you move to.

This section describes two typical examples.

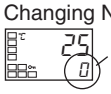
Explanation of Examples

Changing Parameters



A ▭ image means that there are parameters. Continue pressing the ↵ key to change parameters until you reach the intended parameter.

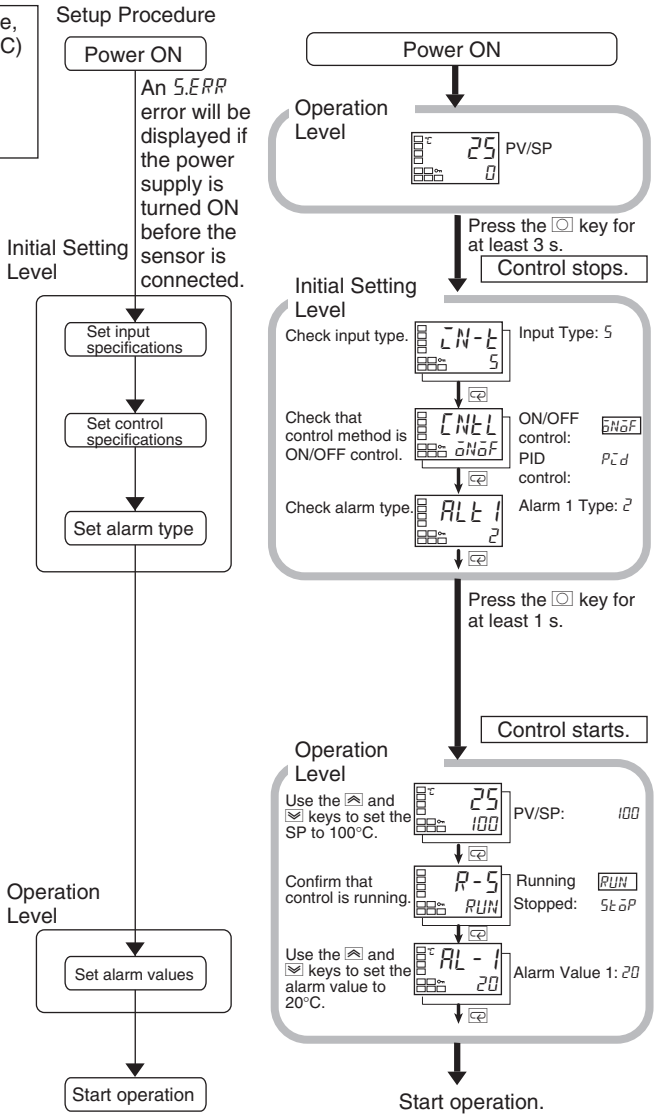
Changing Numbers



Numeric data and selections in each screen can be changed by using the ∧ and ∨ keys.

Example 1

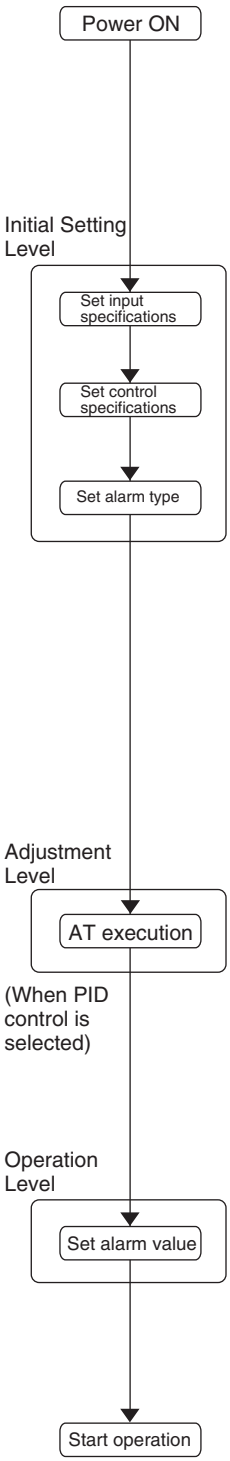
Input type:	5 (K thermocouple, –200°C to 1,300°C)
Control method:	ON/OFF control
Alarm type:	2 (upper limit)
Alarm value 1:	20°C (deviation)
Set point:	100°C

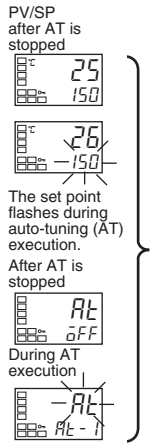


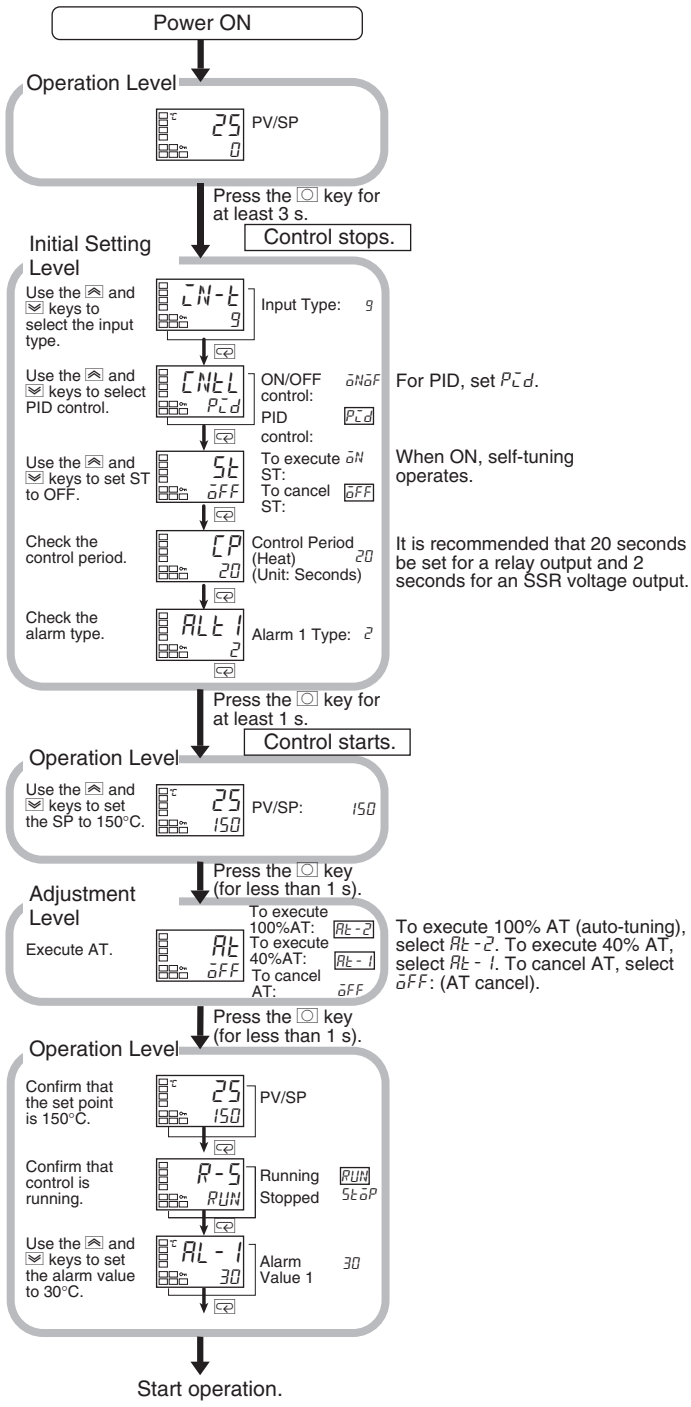
Example 2

Input type:	9 (T thermocouple, –200°C to 400°C)
Control method:	PID control
PID constants found using auto-tuning (AT).	
Alarm type:	2 upper limit
Alarm value 1:	30°C
Set point:	150°C

Setup Procedure







3-2 Setting the Input Type

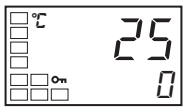
The Controller supports four input types: platinum resistance thermometer, thermocouple, infrared temperature sensor, and analog inputs. Set the input type that matches the sensor that is used. In the product specifications, there are models with thermocouple/resistance thermometer inputs (universal inputs) and models with analog input. The settings differ depending on the model. Check to make sure which model you are using.

3-2-1 Input Type

The following example shows how to set a K thermocouple for –20.0 to 500.0°C.

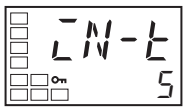
Operating Procedure

Operation Level

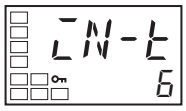


1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

Initial Setting Level



Input Type



2. Press the ^ Key to enter the set value of the desired sensor.
   When you use a K thermocouple (–20.0 to 500.0°C), enter 6 as the set value.

Hint: The key operation is saved two seconds after the change, or by pressing the ○ or ↵ Key.

List of Input Types

	Input type	Specifications	Set value	Input temperature setting range
Controllers with Thermocouple/ Resistance Thermometer Multi-input	Platinum resistance thermometer	Pt100	0	–200 to 850 (°C)/–300 to 1,500 (°F)
			1	–199.9 to 500.0 (°C)/–199.9 to 900.0 (°F)
			2	0.0 to 100.0 (°C)/0.0 to 210.0 (°F)
		JPt100	3	–199.9 to 500.0 (°C)/–199.9 to 900.0 (°F)
			4	0.0 to 100.0 (°C)/0.0 to 210.0 (°F)
	Thermocouple	K	5	–200 to 1,300 (°C)/–300 to 2,300 (°F)
			6	–20.0 to 500.0 (°C)/0.0 to 900.0 (°F)
		J	7	–100 to 850 (°C)/–100 to 1,500 (°F)
			8	–20.0 to 400.0 (°C)/0.0 to 750.0 (°F)
		T	9	–200 to 400 (°C)/–300 to 700 (°F)
			10	–199.9 to 400.0 (°C)/–199.9 to 700.0 (°F)
		E	11	–200 to 600 (°C)/–300 to 1,100 (°F)
		L	12	–100 to 850 (°C)/–100 to 1,500 (°F)
		U	13	–200 to 400 (°C)/–300 to 700 (°F)
			14	–199.9 to 400.0 (°C)/–199.9 to 700.0 (°F)
		N	15	–200 to 1,300 (°C)/–300 to 2,300 (°F)
		R	16	0 to 1,700 (°C)/0 to 3,000 (°F)
		S	17	0 to 1,700 (°C)/0 to 3,000 (°F)
		B	18	100 to 1,800 (°C)/300 to 3,200 (°F)
	Infrared temperature sensor ES1B	10 to 70°C	19	0 to 90 (°C)/0 to 190 (°F)
		60 to 120°C	20	0 to 120 (°C)/0 to 240 (°F)
		115 to 165°C	21	0 to 165 (°C)/0 to 320 (°F)
		140 to 260°C	22	0 to 260 (°C)/0 to 500 (°F)
	Analog input	0 to 50 mV	23	Either of the following ranges, by scaling: –1,999 to 9,999 –199.9 to 999.9
	Thermocouple	W	24	0 to 2,300 (°C)/0 to 3,200 (°F)
		PLII	25	0 to 1,300 (°C)/0 to 2,300 (°F)

- The default is 5.
- If a platinum resistance thermometer is mistakenly connected while a setting for other than a platinum resistance thermometer is in effect, S.ERR will be displayed. To clear the S.ERR display, check the wiring and then turn the power OFF and back ON. Make sure that the setting of the input type parameter agrees with the sensor that is connected.

	Input type	Specifications	Set value	Input temperature setting range
Models with analog input	Current input	4 to 20 mA	0	Either of the following ranges, by scaling: –1,999 to 9,999 –199.9 to 999.9 –19.99 to 99.99 –1.999 to 9.999
		0 to 20 mA	1	
	Voltage input	1 to 5 V	2	
		0 to 5 V	3	
		0 to 10 V	4	

- The default is 0.

3-3 Selecting the Temperature Unit

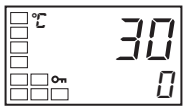
3-3-1 Temperature Unit

- Either °C or °F can be selected as the temperature unit.
- Set the temperature unit in the Temperature Unit parameter of the initial setting level. The default is C (°C).

Operating Procedure

The following example shows how to select °C as the temperature unit.

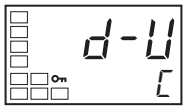
Operation Level



1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

Initial Setting Level

2. Select the Temperature Unit parameter by pressing the ↵ Key. Press the ∧ or ∨ Key to select either °C or °F.
   C: °C
   F: °F



3. To return to the operation level, press the ○ Key for at least one second.

3-4 Selecting PID Control or ON/OFF Control

Two control methods are supported: 2-PID control and ON/OFF control. Switching between 2-PID control and ON/OFF control is executed by means of the PID ON/OFF parameter in the initial setting level. When this parameter is set to PID, 2-PID control is selected, and when set to ONOF, ON/OFF control, is selected. The default is ONOF.

2-PID Control

PID control is set by AT (auto-tuning), ST (self-tuning), or manual setting.

For PID control, set the PID constants in the Proportional Band (P), Integral Time (I), and Derivative Time (D) parameters.

ON/OFF Control

In ON/OFF control, the control output is turned ON when the process value is lower than the current set point, and the control output is turned OFF when the process value is higher than the current set point (reverse operation).

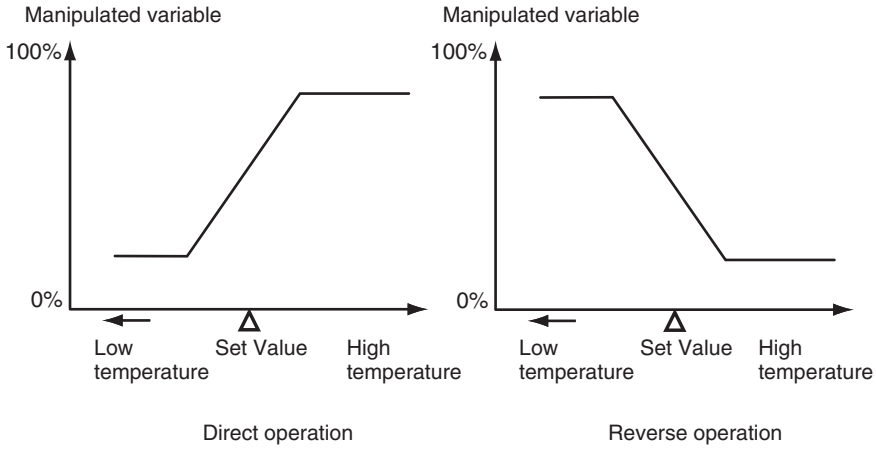
3-5 Setting Output Specifications

3-5-1 Control Periods

- Set the output periods (control periods). Though a shorter period provides better control performance, it is recommended that the control period be set to 20 seconds or longer for a relay output to preserve the service life of the relay. After the settings have been made in the initial setup, readjust the control period, as required, by means such as trial operation.
- Set the control periods in the Control Period (Heating) and Control Period (Cooling) parameters in the initial setting level. The default is 20 seconds.
- The Control Period (Cooling) parameter is used only for heating/cooling control.
- When control output 1 is used as a current output, Control Period (Heating) cannot be used.

3-5-2 Direct and Reverse Operation

- Direct operation increases the manipulated variable whenever the process value increases. Reverse operation decreases the manipulated variable whenever the process value increases.



For example, when the process value (PV) is lower than the set point (SP) in a heating control system, the manipulated variable increases according to the difference between the PV and SP. Accordingly, reverse operation is used in a heating control system. Direct operation is used in a cooling control system, in which the operation is the opposite of a heating control system. The Control Output 1 Assignment is set to $\bar{o}$ (control output (heating)) for either direct or reverse operation.

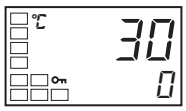
- Direct/reverse operation is set in the Direct/Reverse Operation parameter in the initial setting level. The default is $\bar{o}R\text{-}R$ (reverse operation).

Operating Procedure

In this example, the input type, temperature unit, direct/reverse operation, and control period (heat) parameters are checked.

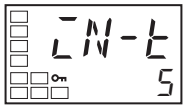
Input type = 5 (K thermocouple)
Temperature unit = C (°C)
Direct/reverse operation = $\bar{o}R\text{-}R$ (reverse operation)
Control period (heat) = 20 (seconds)

Operation Level



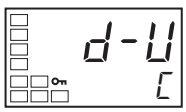
1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

Initial Setting Level



Input Type

2. The input type is displayed. When the input type is being set for the first time, 5 (K thermocouple) is set. To select a different sensor, press the ▲ or ▼ Key.



Temperature Unit

3. Select the Temperature Unit parameter by pressing the ↵ Key. The default is C (°C). To select F (°F), press the ▲ Key.

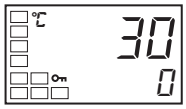
Control Period (Heating)

4. Select the Control Period (Heating) parameter by pressing the ↵ Key. The default is 20.

Direct/Reverse Operation

5. Select the Direct/Reverse Operation parameter by pressing the Key. The default is oR-R (reverse operation). To select oR-d (direct operation), press the Key.

Operation Level



PV/SP

6. To return to the operation level, press the Key for at least one second.

Move to Advanced Function Setting Level

7. Select the Move to Advanced Function Setting Level parameter by pressing the Key.

3-5-3 Assigned Output Functions

- Function assignments can be changed by changing the settings for control and auxiliary output assignments.
- The default function assignments for each output are shown below.

Parameter name	Symbol	Initial status
Control Output 1 Assignment	out1	Control output (heating)
Control Output 2 Assignment	out2	Not assigned.
Auxiliary Output 1 Assignment	sub1	Alarm 1
Auxiliary Output 2 Assignment	sub2	Alarm 2
Auxiliary Output 3 Assignment (E5AN/EN only)	sub3	Alarm 3

- Refer to pages 240 to 242 of H156 for the functions that can be assigned to the outputs.
- Each output is automatically initialized as shown below by changing the control mode.

Example: E5CN

Parameter name	Symbol	Without control output 2		With control output 2	
		Standard	Heating/cooling	Standard	Heating/cooling
Control Output 1 Assignment	out1	Control output (heating)	Control output (heating)	Control output (heating)	Control output (heating)
Control Output 2 Assignment	out2	Not assigned. (See note 1.)	Not assigned. (See note 1.)	Not assigned.	Control output (cooling)
Auxiliary Output 1 Assignment	sub1	Alarm 1 (See note 2.)	Alarm 1 (See note 2.)	Alarm 1 (See note 2.)	Alarm 1 (See note 2.)
Auxiliary Output 2 Assignment	sub2	Alarm 2 (See note 3.)	Control output (cooling) (See note 3.)	Alarm 2	Alarm 2

Example: E5GN

Parameter name	Symbol	Standard	Heating/cooling
Control Output 1 Assignment	out1	Control output (heating)	Control output (heating)
Auxiliary Output 1 Assignment	sub1	Alarm 1 (See note 2.)	Control output (cooling)
Auxiliary Output 2 Assignment	sub2	Alarm 2	Alarm 2

Note

(1) There is no control output 2 and no parameter assignment is displayed for that output.

(2) The Auxiliary Output 1 Assignment parameter becomes the program end output unless the Program Pattern parameter is set to OFF.

(3) For the E5AN/EN, the Auxiliary Output 3 Assignment parameter is set as the control output for cooling. (The Auxiliary Output 2 Assignment parameter is set for alarm 2).

■ **Alarms**

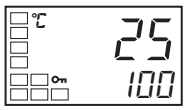
It will be specified in this section when an alarm must be assigned, i.e., when an alarm must be set for the Control Output 1 or 2 Assignment parameters, or for the Auxiliary Output 1 to 3 Assignment parameters. For example, if alarm 1 is set for the Control Output 1 Assignment parameter, then alarm 1 has been assigned.

Assigning a work bit to either control output 1 or 2 or to auxiliary output 1 to 3 is also considered to be the same as assigning an alarm. For example, if work bit 1 is set for the Auxiliary Output 1 Assignment parameter, then alarms 1 to 3 have been assigned.

Operating Procedure

This procedure sets the following control and auxiliary output assignments.
Control output 1: Control output (heating); Control output 2: Control output (cooling); Auxiliary output 1: Alarm 1; Auxiliary output 2: Alarm 2

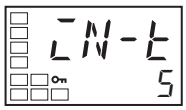
Operation Level



PV/SP

1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

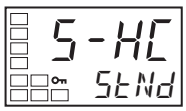
Initial Setting Level



Input Type

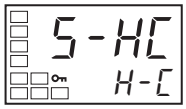
2. Select the Standard or Heating/Cooling parameter by pressing the ↵ Key.

Initial Setting Level



Standard or Heating/Cooling

Initial Setting Level



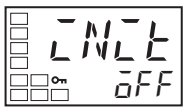
3. Press the ↑ Key to set the parameter to H-C.

Note The following output assignments do not need to be set because they are set automatically by changing the control mode, but they are shown here as a reference for checking the assignments for each output.

Move to Advanced Function Setting Level

4. Select the Move to Advanced Function Setting Level parameter by pressing the ↵ Key. (For details on moving between levels, refer to *1-3* (page 14) *Moving to the Advanced Function Setting Level.*)

Advanced Function Setting Level



Parameter Initialization

5. Press the ↓ Key to enter the password ("–169"), and move from the initial setting level to the advanced function setting level.

Advanced Function Setting Level

Control Output 1 Assignment

6. Select the Control Output 1 Assignment parameter by pressing the Key.

7. Press the or Key to set o.
(The default is o.)

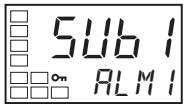
Advanced Function Setting Level

Control Output 2 Assignment

8. Select the Control Output 2 Assignment parameter by pressing the Key.

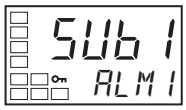
9. Press the or Key to set C-o.
(When H-C is selected for the Standard or Heating/Cooling parameter, the setting will be C-o.)

Advanced Function Setting Level



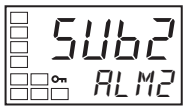
Auxiliary Output 1 Assignment

10. Select the Auxiliary Output 1 Assignment parameter by pressing the Key.



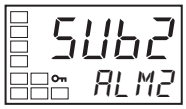
11. Press the or Key to set ALM 1.
(The default is ALM 1.)

Advanced Function Setting Level



Auxiliary Output 2 Assignment

12. Select the Auxiliary Output 2 Assignment parameter by pressing the Key.



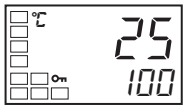
13. Press the or Key to set ALM2.
(The default is ALM2.)

Initial Setting Level

Input Type

14. Press the Key for at least one second to move from the advanced function setting level to the initial setting level.

Operation Level



PV/SP

15. Press the Key for at least one second to move from the initial setting level to the operation level.

Auxiliary Output Opening or Closing in Alarm

- When “close in alarm” is set, the status of the auxiliary output is output unchanged. When “open in alarm” is set, the status of the auxiliary output function is reversed before being output.
- Each auxiliary output can be set independently.
- These settings are made in the Auxiliary Output 1 to 3 Open in Alarm parameters (advanced function setting level).
- The default is N-o: Close in Alarm.

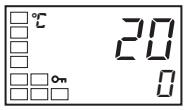
- When “open in alarm” is set for the alarm 1 output, the open in alarm status is also applied to heater burnout, HS alarm, heater overcurrent, and input error outputs.

	Auxiliary output functions 1 to 3	Auxiliary output	Indicators (SUB1 to SUB3)
Close in Alarm	ON	ON	Lit
	OFF	OFF	Not lit
Open in Alarm	ON	OFF	Lit
	OFF	ON	Not lit

- The alarm output will turn OFF (i.e., the relay contacts will open) when power is interrupted and for about two seconds after the power is turned ON regardless of the setting of the Auxiliary Output 1 to 3 Open in Alarm parameter.

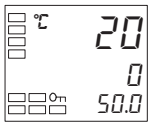
3-6 Setting the Set Point (SP)

Operation Level



The operation level is displayed when the power is turned ON. The process value (PV) is at the top of the display, and the set point (SP) is at the bottom.

Operation Level



For Controllers that support a No. 3 display (E5AN/E5EN), the contents set in the PV/SP Display Screen Selection parameter (advanced function setting level) are displayed below the PV and SP.
The MV is displayed as the default. For details, refer to *3-11 Setting the No. 3 Display*.

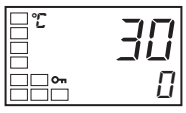
3-6-1 Changing the SP

- The set point cannot be changed when the Operation/Adjustment Protect parameter is set to 3. For details, refer to *4-9* of H156 *Using the Key Protect Level*.
- To change the set point, press the ▲ or ▼ Key in the Process Value/Set Point parameter (in the operation level), and set the desired set value. The new set point is selected two seconds after you have specified the new value.
- Multi-SP is used to switch between two or four set points. For details, refer to *4-5* of H156 *Using Event Inputs* for details.

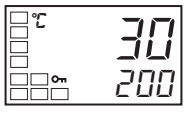
Operating Procedure

In this example, the set point is changed from 0°C to 200°C.

Operation Level



1. Normally, the Process Value/Set Point parameter is displayed. The set point is 0°C.



2. Use the ▲ and ▼ Keys to set the set point to 200°C.

3-7 Using ON/OFF Control

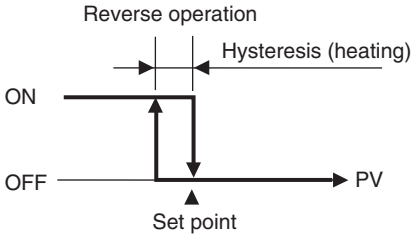
In ON/OFF control, the control output turns OFF when the temperature being controlled reaches the preset set point. When the manipulated variable turns OFF, the temperature begins to fall and the control turns ON again. This operation is repeated over a certain temperature range. At this time, how much the temperature must fall before control turns ON again is determined by the Hysteresis (Heating) parameter. Also, what direction the manipulated variable must be adjusted in response to an increase or decrease in the process value is determined by the Direct/Reverse Operation parameter.

3-7-1 ON/OFF Control

- Switching between 2-PID control and ON/OFF control is performed using the PID ON/OFF parameter in the initial setting level. When this parameter is set to $\bar{P}\bar{i}\bar{d}$, 2-PID control is selected, and when it is set to $\bar{o}\bar{N}\bar{o}\bar{F}$, ON/OFF control is selected. The default is $\bar{o}\bar{N}\bar{o}\bar{F}$.

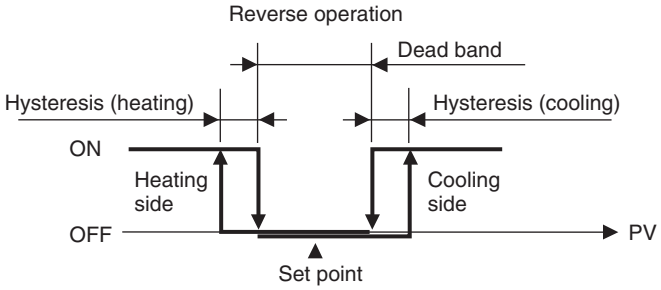
Hysteresis

- With ON/OFF control, hysteresis is used to stabilize operation when switching between ON and OFF. The control output (heating) and control output (cooling) functions are set in the Hysteresis (Heating) and Hysteresis (Cooling) parameters, respectively.
- In standard control (heating or cooling control), the setting of the Hysteresis (Heating) parameter in the adjustment level is used as the hysteresis regardless of whether the control type is heating control or cooling control.



Three-position Control

- In heating/cooling control, a dead band (an area where both control outputs are 0) can be set to either the heating or cooling side. This makes it possible to use 3-position control.



Parameters

Symbol	Parameter: level	Application
5-HC	Standard or Heating/Cooling: Initial setting level	Specifying control method
CNTL	PID ON/OFF: Initial setting level	Specifying control method
oREV	Direct/Reverse Operation: Initial setting level	Specifying control method
C-db	Dead Band: Adjustment level	Heating/cooling control
HYS	Hysteresis (Heating): Adjustment level	ON/OFF control
CHYS	Hysteresis (Cooling): Adjustment level	ON/OFF control

3-7-2 Settings

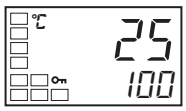
To execute ON/OFF control, set the Set Point, PID ON/OFF, and Hysteresis parameters.

Setting the PID ON/OFF Parameter

Operating Procedure

Confirm that the PID ON/OFF parameter is set to oNOF in the initial setting level.

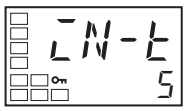
Operation Level



PV

1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

Initial Setting Level



Input Type

2. The Input Type parameter is displayed in the initial setting level.

PID ON/OFF

3. Select the PID ON/OFF parameter by pressing the ↵ Key.
4. Check that the set value is oNOF (i.e., the default).
5. To return to the operation level, press the ○ Key for at least one second.

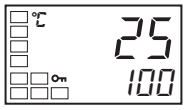
Next, set the set point value.

Setting the SP

Operating Procedure

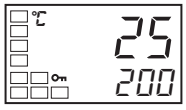
In this example, the set point is set to 200. The set value (i.e., the SP) is shown at the bottom of the display.

Operation Level



PV/SP

1. Select the Process Value/Set Point parameter in the operation level.



2. Use the ∧ and ∨ Keys to set the SP. (In this example, it is set to 200.) The new set value can be saved by pressing the ↵ Key, or it will go into effect after two seconds have elapsed.

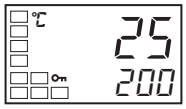
Next, set the hysteresis.

Setting the Hysteresis

Operating Procedure

Set the hysteresis to 2.0°C.

Operation Level



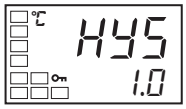
PV

1. Press the O Key to move from the operation level to the adjustment level.

Adjustment Level

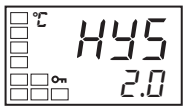
Adjustment Level Display

2. The Adjustment Level Display parameter will be displayed in the adjustment level.



Hysteresis (Heating)

3. Select the Hysteresis (Heating) parameter by pressing the ↵ Key.

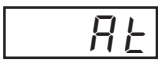


4. Press the ↑ and ↓ Keys to set the hysteresis (2.0 in this example). Either press the ↵ Key or wait for at least two seconds after setting the hysteresis value to confirm the setting.

5. To return to the operation level, press the O Key.

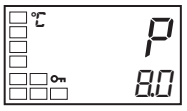
3-8 Determining PID Constants (AT, ST, Manual Setup)

3-8-1 AT (Auto-tuning)

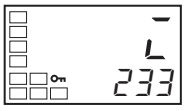


- When AT is executed, the optimum PID constants for the set point at that time are set automatically. A method (called the limit cycle method) for forcibly changing the manipulated variable and finding the characteristics of the control object is employed.
- Either 40% AT or 100% AT can be selected depending on the width of MV variation in the limit cycle. In the AT Execute/Cancel parameter, specify AT-2 (100% AT) or AT-1 (40% AT). To cancel AT, specify OFF (AT cancel).
- Only 100% AT can be executed for heating and cooling control.
- AT cannot be executed when control has stopped or during ON/OFF control.
- The results of AT are reflected in the Proportional Band (P), Integral Time (I), and Derivative Time (D) parameters in the adjustment level.

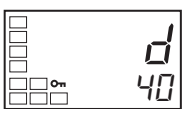
Adjustment Level



Proportional Band



Integral Time



Derivative Time

AT Operations

AT is started when either AT-2 (100% AT) or AT-1 (40% AT) is specified for the AT Execute/Cancel parameter. During execution, the AT Execute/Cancel parameter on the No. 1 display flashes. When AT ends, the AT Execute/Cancel parameter turns OFF, and the No. 1 display stops flashing.

100% AT execution in progress

If you move to the operation level during AT execution, the No. 2 display flashes to indicate that AT is being executed.

AT execution in progress

Only the Communications Writing, RUN/STOP, AT Execution/Cancel, and Program Start parameters can be changed during AT execution. Other parameters cannot be changed.

AT Calculated Gain

The AT Calculated Gain parameter sets the gain for when PID values are calculated using AT. When emphasizing response, decrease the set value. When emphasizing stability, increase the set value.

AT Hysteresis

The AT Hysteresis parameter sets the hysteresis when switching ON and OFF for the limit cycle operation during auto-tuning.

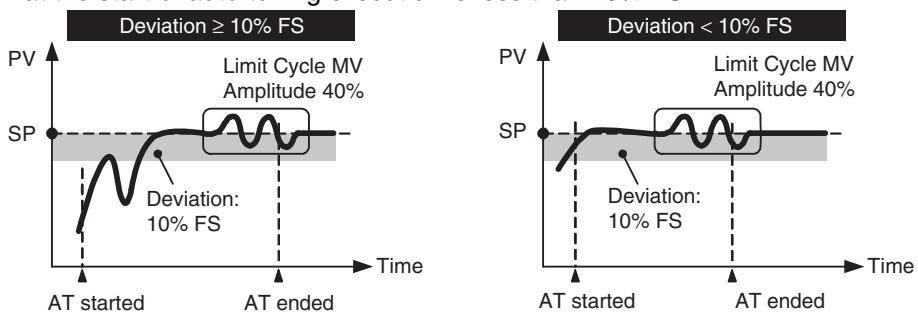
Limit Cycle MV Amplitude

The Limit Cycle MV Amplitude parameter sets the MV amplitude for limit cycle operation during auto-tuning.

Note This setting is disabled for 100% AT.

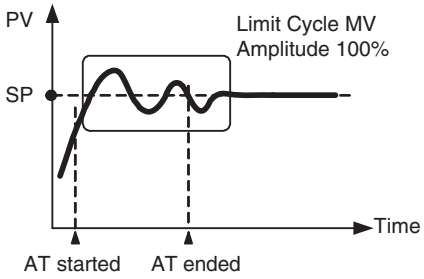
■ 40% AT

The width of MV variation in the limit cycle can be changed in the Limit Cycle MV Amplitude parameter, but the AT execution time may be longer than for 100% AT. The limit cycle timing varies according to whether the deviation (DV) at the start of auto-tuning execution is less than 10% FS.



■ **100% AT**

Operation will be as shown in the following diagram, regardless of the deviation (DV) at the start of AT execution. To shorten the AT execution time, select 100% AT.

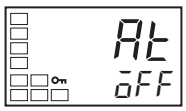


Note The Limit Cycle MV Amplitude parameter is disabled.

Operating Procedure

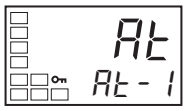
This procedure executes 40%AT.

Adjustment Level

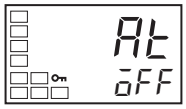


AT Execute/ Cancel

1. Press the ○ Key to move from the operation level to the adjustment level.



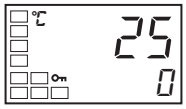
2. Press the ^ Key to select AT-1. The No. 1 display for AT Execute/Cancel will flash during AT execution.



3. oFF will be displayed when AT ends.

Operation Level

4. To return to the operation level, press the ○ Key.



PV

3-8-2 ST (Self-tuning)

ST (self-tuning) is a function that finds PID constants by using step response tuning (SRT) when Controller operation begins or when the set point is changed.

Once the PID constants have been calculated, ST is not executed when the next control operation is started as long as the set point remains unchanged.

ST (self-tuning) is enabled when the ST parameter is set to ON in the initial setting level.

When the ST function is in operation, be sure to turn the power supply of the load connected to the control output ON simultaneously with or before starting Controller operation.

When executing self-tuning, turn ON power for the load (e.g., heater) at the same time as or before supplying power to the Digital Temperature Controller. If power is turned ON for the Digital Temperature Controller before turning ON power for the load, self-tuning will not be performed properly and optimum control will not be achieved.

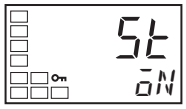
Note PID Constants
When control characteristics are already known, PID constants can be set directly to adjust control. PID constants are set in the Proportional Band (P), Integral Time (I), and Derivative Time (D) parameters in the adjustment level.

Operating Procedure

This procedure executes self-tuning (ST).

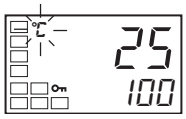
Initial Setting Level

1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.



2. Select the ST parameter by pressing the ↩ Key.
3. Press the ∧ Key to select ON. ON is the default.

Operation Level



4. To return to the operation level, press the ○ Key for at least one second. The temperature display flashes during self-tuning (ST) execution.

Startup Conditions

Self-tuning by step response tuning (SRT) is started when the following conditions are met after program execution is started and the set point is changed.

At start of operation	When set point is changed
1. The set point at the start of operation differs from the set point when the previous SRT was executed. (See note 1.) 2. The difference between the temperature at the start of operation and the set point is greater both of the following: (Present proportional band × 1.27 + 4°C) and the ST stable range. 3. The temperature at the start of operation is lower than the set point during reverse operation, and is larger than the set point during direct operation. 4. There is no reset from input errors.	1. The new set point differs from the set point used when the previous SRT was executed. (See note 1.) 2. The set point change width is greater both of the following: (Present proportional band × 1.27 + 4°C) and the ST stable range. 3. During reverse operation, the new set point is larger than the set point before the change; and during direct operation, the new set point is smaller than the set point before the change. 4. The temperature is stable. (See note 2.) (Equilibrium with the output amount at 0% when the power is turned ON is also all right.) (See note 3.)

Note

(1) The previous SRT-implemented set point is the set point that was used for calculating the PID constants for the previous SRT.

(2) In this state, the measurement point is within the ST stable range.

(3) In this state, the change width of the PV every 60 seconds is within the ST stable range or less.

In the following instances, PID constants are not changed by self-tuning (ST) for the present set point.

1,2,3...

1. When the PID constants have been changed manually with ST set to ON.
2. When auto-tuning (AT) has been executed.

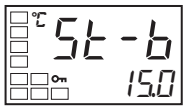
ST Stable Range

Operating Procedure

The ST stable range determines the condition under which ST (self-tuning) functions.

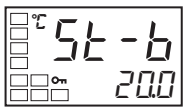
This procedure sets the ST stable range to 20.0°C.

Advanced Function Setting Level



ST Stable Range

1. Select the ST Stable Range parameter by pressing the ↵ Key in the advanced function setting level.



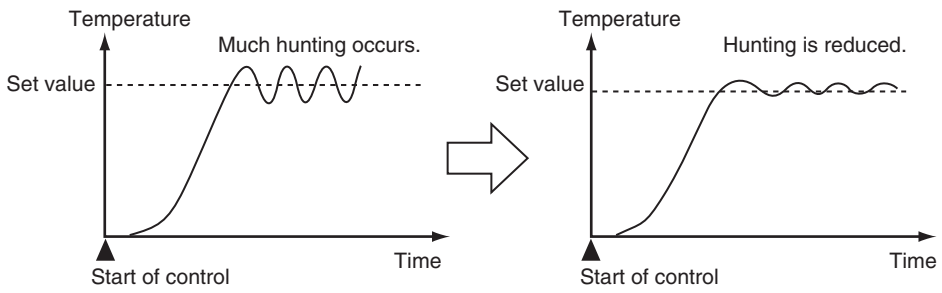
2. Use the ↑ Key to set the parameter to 20.0°C.

3-8-3 RT (Robust Tuning)

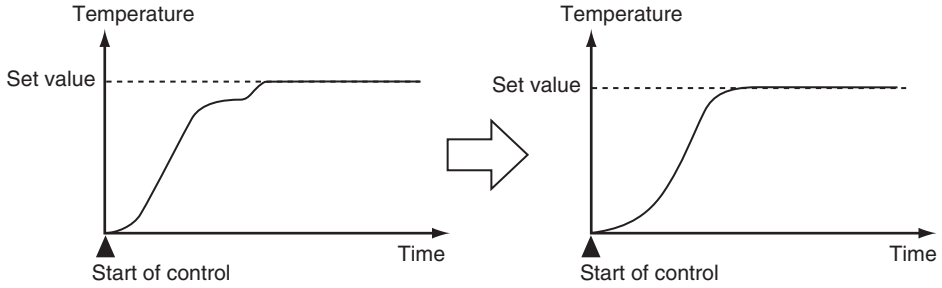
- When AT or ST is executed with RT selected, PID constants are automatically set that make it hard for control performance to degenerate even when the characteristics of the controlled object are changed.
- RT can be set in the advanced function setting level when PID control has been set.
- The RT mode cannot be selected while an analog input is set.
- Selecting the RT mode in the following cases will help to prevent hunting from occurring.
  - When the set temperature is not constant and is changed in a wide range
  - When there are large variations in ambient temperatures due to factors such as seasonal changes or differences between day and night temperatures
  - When there are large variations in ambient wind conditions and air flow
  - When heater characteristics change depending on the temperature
  - When an actuator with disproportional I/O, such as a phase-control-type power regulator, is used
  - When a rapidly heating heater is used
  - When the control object or sensor has much loss time
  - When hunting occurs in normal mode for any reason
  - PID constants are initialized to the factory settings by switching to RT mode.
  - When the RT mode is selected, the derivative time setting unit becomes the second.

RT Features

- Even when hunting occurs for PID constants when AT or ST is executed in normal mode, it is less likely to occur when AT or ST is executed in RT mode.



- When the temperature (PV) falls short of the set point for the PID constants when using AT or ST in normal mode, executing AT or ST in RT mode tends to improve performance.

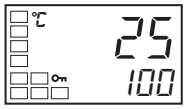


- When the manipulated variable (MV) is saturated, the amount of overshooting may be somewhat higher in comparison to PID control based on AT or ST in normal mode.

Operating Procedure

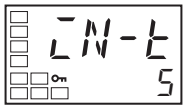
This procedure selects RT mode.

Operation Level



1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

Initial Setting Level

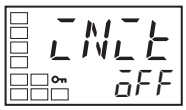


2. Select the Move to Advanced Function Setting Level parameter by pressing the ↵ Key.

Initial Setting Level

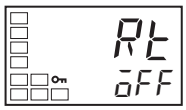
3. Use the ↓ Key to enter "–169" (the password).

Advanced Function Setting Level

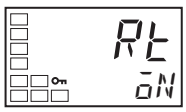


It is possible to move to the advanced function setting level by pressing the ↵ Key or leaving the setting for at least two seconds.

Advanced Function Setting Level

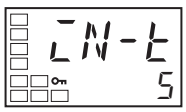


4. Press the ↵ Key to select *RT*.



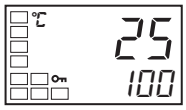
5. Press the ↑ Key to select *ON*. *OFF* is the default.

Initial Setting Level



6. To return to the initial setting level, press the ○ Key for at least one second.

Operation Level



PV/SP

7. To return to the operation level, press the ○ Key for at least one second.

3-8-4 Manual Setup

Individual PID constants can be manually set in the Proportional Band, Integral Time, and Derivative Time parameters in the adjustment level.

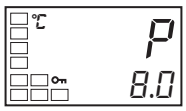
Operating Procedure

In this example, the Proportional Band parameter is set to 10.0, the Integral Time parameter to 250, and the Derivative Time parameter to 45.

Adjustment Level

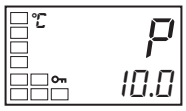
Adjustment Level Display

1. Press the ○ Key to move from the operation level to the adjustment level.

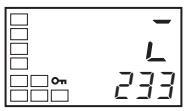


Proportional Band

2. Press the ↵ Key to select the proportional band" parameter.



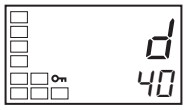
3. Use the ∧ and ∨ Keys to set 10.0.



Integral Time

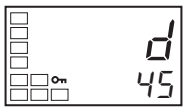
4. Press the ↵ Key to select the Integral Time parameter.

5. Use the ∧ and ∨ Keys to set 250.



Derivative Time

6. Select the Derivative Time operation by pressing the ↵ Key.

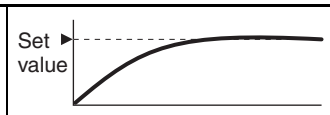
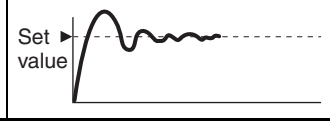


7. Use the ∧ and ∨ Keys to set 45.

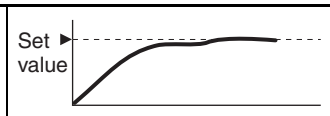
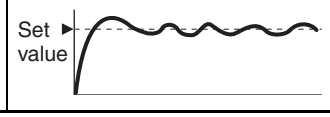
8. To return to the operation level, press the ○ Key.

Note Proportional Action
When PID constants I (integral time) and D (derivative time) are set to 0, control is executed according to proportional action. As the default, the center value of the proportional band becomes the set point.
Related parameter: Manual reset value (adjustment level)

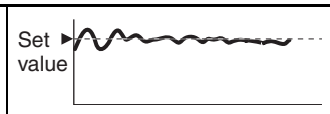
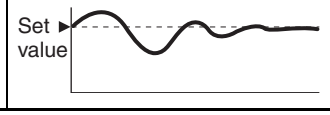
When P (Proportional Band) Is Adjusted

Increased		The curve rises gradually, and a long stabilization time is created, but overshooting is prevented.
Decreased		Overshooting and hunting occur, but the set value is quickly reached and the temperature stabilizes.

When I (Integral Time) Is Adjusted

Increased		It takes a long time to reach the set point. It takes time to achieve a stable state, but overshooting, undershooting, and hunting are reduced.
Decreased		Overshooting and undershooting occur. Hunting occurs. The Controller starts up faster.

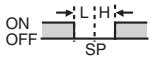
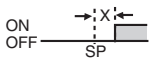
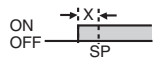
When D (Derivative Time) Is Adjusted

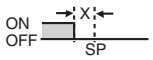
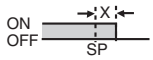
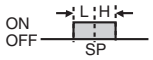
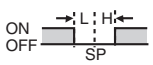
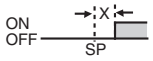
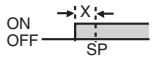
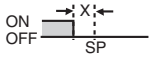
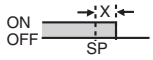
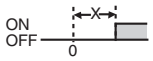
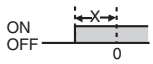
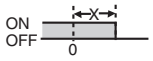
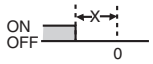
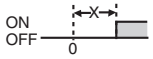
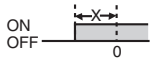
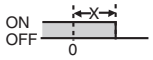
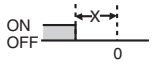
Increased		Overshooting, undershooting, and stabilization times are reduced, but fine hunting occurs on changes in the curve itself.
Decreased		Overshooting and undershooting increase, and it takes time to return to the set point.

3-9 Alarm Outputs

- Alarms can be used by the E5CN-□2□□□ (2 auxiliary outputs), E5AN/E5EN-□1□□□ (1 auxiliary output), E5AN/E5EN-□3□□□ (3 auxiliary outputs), the E5CN-□1□□□U (1 auxiliary output), the E5CN-□2□□□U (2 auxiliary outputs), E5GN-□1□□□ (1 auxiliary output), and E5GN-□2□□□ (2 auxiliary outputs).
  Alarms can also be used by setting the Control Output 1 Assignment or Control Output 2 Assignment parameter to any of the alarms from alarm 1 to 3. The alarm output condition is determined by a combination of the alarm type, alarm value, alarm hysteresis, and the standby sequence.
  For details, refer to *4-2 Alarm Hysteresis*.
- This section describes the Alarm Type, Alarm Value, Upper-limit Alarm and Lower-limit Alarm parameters.

3-9-1 Alarm Types

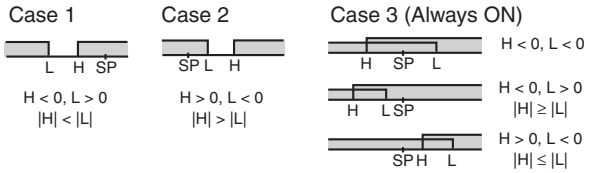
Set value	Alarm type	Alarm output operation		Description of function
		When alarm value X is positive	When alarm value X is negative	
0	Alarm function OFF	Output OFF		No alarm
1 (See note 1.)	Upper- and lower-limit		See note 2.	Set the deviation in the set point by setting the alarm upper limit (H) and alarm lower limit (L).
2	Upper-limit			Set the upward deviation in the set point by setting the alarm value (X).

Set value	Alarm type	Alarm output operation		Description of function
		When alarm value X is positive	When alarm value X is negative	
3	Lower-limit			Set the downward deviation in the set point by setting the alarm value (X).
4 (See note 1.)	Upper- and lower-limit range		See note 3.	Set the deviation in the set point by setting the alarm upper limit (H) and alarm lower limit (L).
5 (See note 1.)	Upper- and lower-limit with standby sequence	 See note 5.	See note 4.	A standby sequence is added to the upper- and lower-limit alarm (1). (See note 6.)
6	Upper-limit with standby sequence			A standby sequence is added to the upper-limit alarm (2). (See note 6.)
7	Lower-limit with standby sequence			A standby sequence is added to the lower-limit alarm (3). (See note 6.)
8	Absolute-value upper-limit			The alarm will turn ON if the process value is larger than the alarm value (X) regardless of the set point.
9	Absolute-value lower-limit			The alarm will turn ON if the process value is smaller than the alarm value (X) regardless of the set point.
10	Absolute-value upper-limit with standby sequence			A standby sequence is added to the absolute-value upper-limit alarm (8). (See note 6.)
11	Absolute-value lower-limit with standby sequence			A standby sequence is added to the absolute-value lower-limit alarm (9). (See note 6.)
12	LBA (alarm 1 type only)	---		(See note 7.)
13	PV change rate alarm	---		Refer to page 52. (See note 8.)

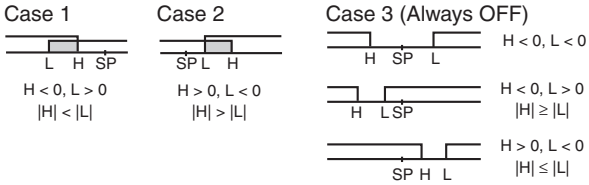
Note

(1) With set values 1, 4, and 5, the upper- and lower-limit values can be set independently for each alarm type, and are expressed as “L” and “H.”

(2) Set value: 1 (Upper- and lower-limit alarm)



(3) Set value: 4 (Lower limit range)



(4) Set value: 5 (Upper- and lower-limit with standby sequence)

- For the lower-limit alarms in cases 1 and 2 above, the alarm is always OFF if upper- and lower-limit hysteresis overlaps.
- In case 3, the alarm is always OFF.

(5) Set value: 5 (Upper- and lower-limit with standby sequence)
- The alarm is always OFF if upper- and lower-limit hysteresis overlaps.

(6) Refer to *4-2-1 Standby Sequence* for information on the operation of the standby sequence.

(7) Refer to *4-12* of H156: *Loop Burnout Alarm (LBA)*.

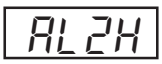
(8) Refer to *PV Change Rate Alarm* on page 52.

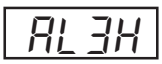
- Set the alarm type independently for each alarm in the Alarm 1 to 3 Type parameters in the initial setting level. The default is 2 (Upper-limit alarm).

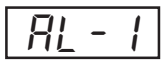
3-9-2 Alarm Values

Alarm Lower Limit Value

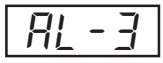
Alarm Upper Limit Value







Alarm Value



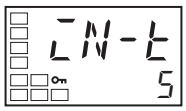
- Alarm values are indicated by “X” in the table on the previous page. When the upper and lower limits are set independently, “H” is displayed for upper limit values, and “L” is displayed for lower limit values.
- To set the alarm value upper and lower limits for deviation, set the upper and lower limits in each of the Alarm 1 to 3 Upper Limit, and Alarm 1 to 3 Lower Limit parameters in the operation level.

Operating Procedure

This procedure sets alarm 1 as an upper-limit alarm. The related parameters and settings are shown below. The alarm is output when the set point exceeds 10°C. (In this example, the temperature unit is °C.)

Alarm 1 type = 2 (Upper-limit alarm)
Alarm value 1= 10

Initial Setting Level

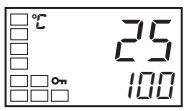


Input Type

1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

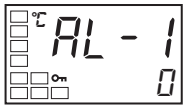
Alarm 1 Type

2. Select the Alarm 1 Type parameter by pressing the ⊏↵ Key. Confirm that the set value is 2. The default value is 2 (Upper-limit alarm).



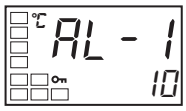
PV/SP

3. To return to the operation level, press the ○ Key for at least one second.



Alarm Value 1

4. Select the Alarm Value 1 parameter by pressing the ↩ Key.



5. Use the ∧ Key to set the parameter to 10.

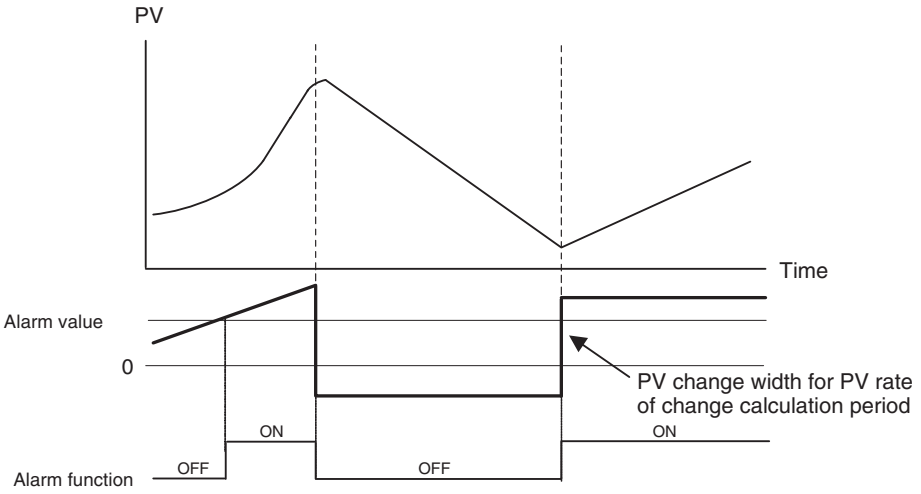
PV Change Rate Alarm

The change width can be found for PV input values in any set period. Differences with previous values in each set period are calculated, and an alarm is output if the result exceeds the alarm value. The PV rate of change calculation period can be set in units of 250 ms.

If a positive value is set for the alarm value, the PV will operate as a change rate alarm in the rising direction. If a negative value is set, the PV will operate as a change rate alarm in the falling direction.

Precaution

If a shorter PV rate of change calculation period is set, outputs set for the PV change rate alarm function may repeatedly turn ON and OFF for a short period of time. It is therefore recommended that the PV change rate alarm be used with the alarm latch turned ON.



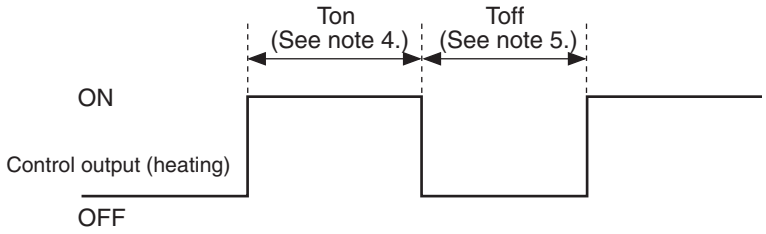
Parameter name	Setting range	Unit	Default
PV Rate of Change Calculation Period	1 to 999	Sampling cycle	4 (1 s)

3-10 Using Heater Burnout, Heater Short, and Heater Overcurrent Alarms

3-10-1 Heater Burnout, Heater Short, and Heater Overcurrent Alarm Operations

- Heater burnout detection and heater overcurrent detection are executed by measuring heater current while the control output (heating) is ON, and heater short detection is executed by measuring heater current while it is OFF. For details, refer to the following table. (Heater burnout detection, heater short detection, and heater overcurrent detection cannot be used with the control output for cooling.)

Control output (heating) status		Power to heater	HB alarm output	HS alarm output	Heater overcurrent alarm output
Control output (heating)	Operation indicator				
ON	Lit	Yes (Normal) (See note 1.)	OFF	---	---
		No (Heater burnout)	ON	---	---
OFF	Not lit	Yes (HS alarm)	---	ON	---
		No (Normal) (See note 2.)	---	OFF	---
ON	Lit	Normal	---	---	OFF
		Heater overcurrent status (See note 3.)	---	---	ON



Note

(1) In the above diagram, power is considered to be ON (normal) if the heater current is greater than the heater burnout detection current during the Ton interval. If the heater is burned out, the measured current decreases and falls below the heater burnout detection value. The output is then activated as the heater burnout alarm.

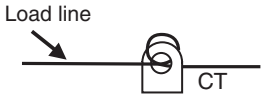
(2) In the above diagram, power is considered to be OFF (normal) if the leakage current is less than the HS alarm current during the Toff interval. If the SSR output is short-circuited, the measured current increases beyond the HS alarm value. The output is then activated as the HS alarm.

(3) In the above diagram, it is regarded as normal when the heater current is less than the heater overcurrent detection current during the Ton period. Current is increased when excessive current flows to the heater, causing the heater overcurrent detection value to be exceeded and an OC (heater overcurrent) alarm to be output.

(4) Heater burnout and heater overcurrent are not detected if the control output (heating) ON time (Ton) is 100 ms or less.

(5) HS alarms are not detected if the control output (heating) OFF time (Toff) is 100 ms or less.

- For Controllers with heater burnout, HS, and heater overcurrent alarms, an OR output is established between the ALM 1 function and the alarms. If the ALM1 function is to be used for the heater burnout, HS, and heater overcurrent alarms only, set 0 as the alarm 1 type (i.e., do not use ALM1).
- Turn the heater power ON simultaneously or before turning ON the E5□N power. If the heater power is turned ON after turning ON the E5AN power, the HB alarm will be activated.
- Control is continued even when the heater burnout, HS, or heater overcurrent alarm is active.
- The rated current value may sometimes differ slightly from the actual current flowing to the heater.
  Use the Heater Current 1 Value Monitor, Heater Current 2 Value Monitor, Leakage Current 1 Monitor, and Leakage Current 2 Monitor parameters to check the actual current being used.
- If there is little difference between the current in normal and abnormal states, detection may become unstable. To stabilize detection, set a current value difference of at least 1.0 A for heaters of less than 10.0 A, and at least 2.5 A for heaters of 10.0 A or more. If the heater current is too low, loop the load line several times through a CT, as shown in the diagram below. Looping it through once will double the detection current.

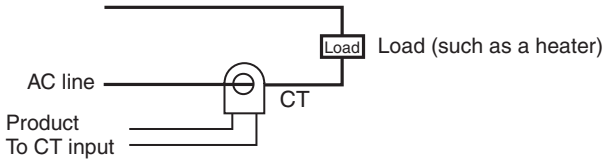


3-10-2 Installing Current Transformers (CT)

- This function can be used with E5□N models that have the HB alarm, HS alarm, and OC alarm.
  For the E5CN, connect the CT in advance to terminals 14 and 15 (CT1), or 13 and 15 (CT2). For the E5AN/E5EN, connect the CT in advance to terminals 14 and 15 (CT1) or 15 and 16 (CT2). For the E5GN, connect the CT in advance to terminals 7 and 8 (CT1). Then pass the heater power line through the CT's hole. For specifications, models and dimensions of current transformers that can be used with this Controller, refer to *Appendix Current Transformer (CT)* on page 279 of H156 .

Single-phase Heaters

For single-phase heaters, install the CT in the position shown in the following diagram.

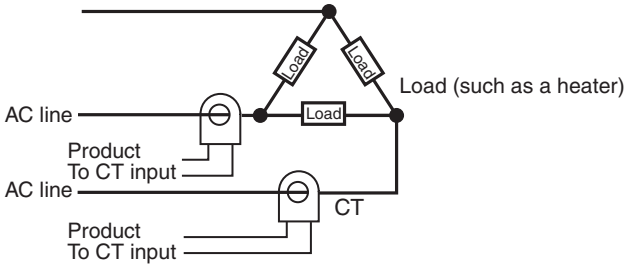


Three-phase Heaters (E5AN-□□HH□-N, E5EN-□□HH□-N, and E53-CN□□HHN2 (for E5CN) 3-phase Heater Detection Models)

When a 3-phase power supply is used, regardless of the types of connecting lines, two current transformers (CTs) are required to detect heater burnout, HS, and OC.

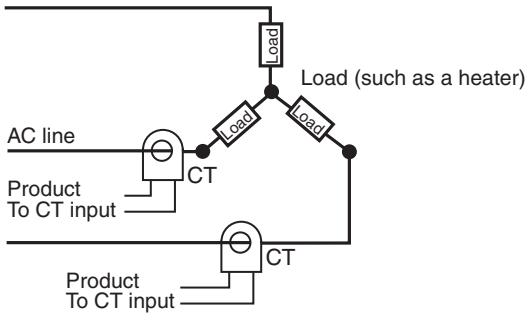
1,2,3... 1. Delta connecting lines: Refer to the following diagram for CT installation positions.

Note Heater voltage fluctuations are not considered here, so be take that into account when setting the detection current.



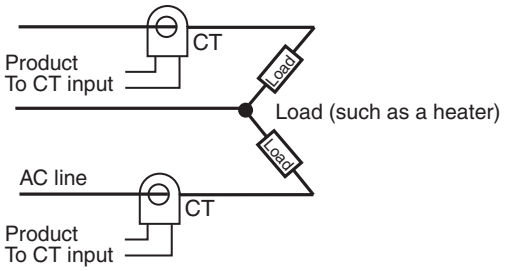
2. Star connecting lines: Refer to the following diagram for CT installation positions.

   Note Heater voltage fluctuations are not considered here, so be take that into account when setting the detection current.



3. V connecting lines: Refer to the following diagram for CT installation positions.

   Note Heater voltage fluctuations are not considered here, so be take that into account when setting the detection current.



3-10-3 Calculating Detection Current Values

- Calculate the set value using the following equation:

$$\text{Heater Burnout Detection 1/2 set value} = \frac{\text{Normal current value + Burnout current value}}{2}$$

$$\text{HS Alarm 1/2 set value} = \frac{\text{Leakage current value (output OFF) + HS current value}}{2}$$

$$\text{Heater overcurrent 1/2 set value} = \frac{\text{Normal current value + Overcurrent value}}{2}$$

- To set the current for heater burnout when two or more heaters are connected through the CT, use the value from when the heater with the smallest current burns out. If all of the heaters have the same current, use the value from when any one of them burns out.

- Make sure that the following conditions are satisfied:
  Heater with a current of less than 10.0 A:
  (Current value at normal operation) − (Current value at heater burnout) ≥ 1 A
  When the difference is less than 1 A, detection is unstable.
  Heater with a current of 10.0 A or more:
  (Current value at normal operation) − (Current value at heater burnout) ≥ 2.5 A
  When the difference is less than 2.5 A, detection is unstable.
- The setting range is 0.1 to 49.9 A. Heater burnout, HS, and heater overcurrent are not detected when the set value is 0.0 or 50.0. When the set value is 0.0, the heater burnout alarm is always OFF, the HS alarm is always ON, and the heater overcurrent alarm is always ON. When the set value is 50.0, the heater burnout alarm is always ON, the HS alarm is always OFF, and the heater overcurrent alarm is always OFF.
- Set the total current value for normal heater operation to 50 A or less. When a current value of 55.0 A is exceeded, FFFF is displayed in the Heater Current 1 (or 2) Value Monitor and Leakage Current 1 (or 2) Monitor parameters.

Note For application examples see H156 section 3-10-4

3-10-4 Settings: HB Alarm

To activate the heater burnout alarm, set the HB ON/OFF parameter to ON in the advanced function setting level and set the Heater Burnout Detection 1 and Heater Burnout Detection 2 parameters in the adjustment level.

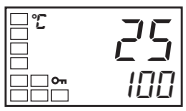
Operating Procedure

This procedure sets the Heater Burnout Detection 1 parameter to 2.5.

■ Moving to the Advanced Function Setting Level

The Heater Burnout Detection parameter setting is already ON by default, so set the Heater Burnout Detection 1 parameter.

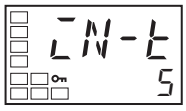
Operation Level



PV/SP

1. Move to the advanced function setting level.
Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

Initial Setting Level



Input Type

2. Select Move to Advanced Function Setting Level by pressing the ↩ Key. (For details on moving between levels, refer to *4-8* of H156 *Moving to the Advanced Function Setting Level*.)

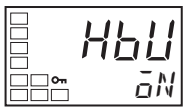
Initial Setting Level

3. Press the ≫ Key to enter the password (−169), and move from the initial setting level to the advanced function setting level.

Advanced Function Setting Level

Moves to Advanced Function Setting Level

The top parameter in the advanced function setting level is displayed.

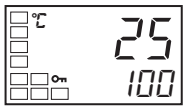


Heater Burnout Detection

4. Select the Heater Burnout Detection parameter by pressing the ↩ Key. Check that this parameter is set to ON (the default).
Next, set the Heater Burnout Detection 1 parameter.

■ Setting Heater Burnout Detection

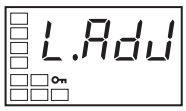
Operation Level



PV/SP

5. Press the ○ Key for at least one second to move from the advanced function setting level to the initial setting level. Press the ○ key again for at least one second to move to the operation level.

Adjustment Level



Adjustment Level Display

6. Press the ○ Key for less than one second to move from the operation level to the adjustment level.

Heater Current 1 Value Monitor

7. Select the Heater Current 1 Value Monitor parameter by pressing the ↩ Key. Check the current value. Next, set the Heater Burnout Detection 1 parameter.

Heater Burnout Detection 1

8. Select the Heater Burnout Detection 1 parameter by pressing the ↩ Key. Refer to *Calculating Detection Current Values* on page 55 on when making the settings.

9. For this example, set 2.5. To return to the operation level, press the ○ Key for less than one second.

3-10-5 Settings: Heater Short Alarm

To activate the HS alarm, set the HS Alarm Use parameter to ON in the advanced function setting level and set the HS Alarm 1 and HS Alarm 2 parameters in the adjustment level.

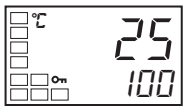
Operating Procedure

This procedure sets the HS Alarm 1 parameter to 2.5.

■ Moving to the Advanced Function Setting Level

The HS Alarm Use parameter setting is already ON by default, so set the HS Alarm 1 parameter.

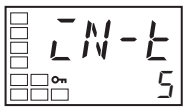
Operation Level



PV/SP

1. Move to the advanced function setting level.
Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

Initial Setting Level



Input Type

2. Select Move to Advanced Function Setting Level by pressing the ⊡ Key. (For details on moving between levels, refer to *4-8* of H156 *Moving to the Advanced Function Setting Level.*)

Initial Setting Level

3. Press the ⊻ Key to enter the password (–169), and move from the initial setting level to the advanced function setting level.

Advanced Function Setting Level

The top parameter in the advanced function setting level is displayed.

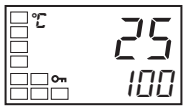
Move to the Advanced Function Setting Level

HS Alarm Use

4. Select the HS Alarm Use parameter by pressing the ⊡ Key.
Check that this parameter is set to ON (the default).
Next, set the HS Alarm 1 parameter.

■ HS Alarm Settings

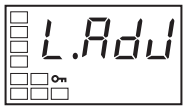
Operation Level



PV/SP

5. Press the ○ Key for at least one second to move from the advanced function setting level to the initial setting level. Press the ○ key again for at least one second to move to the operation level.

Adjustment Level



Adjustment Level Display

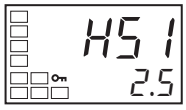
6. Press the ○ Key for less than one second to move from the operation level to the adjustment level.

Leakage Current 1 Monitor

7. Select the Leakage Current 1 Monitor parameter by pressing the ⊏↵ Key. Check the current value. Next, set the HS Alarm 1 parameter.

HS Alarm 1

8. Select the HS Alarm 1 parameter by pressing the ⊏↵ Key. Refer to *Calculating Detection Current Values* on page 55 when setting the values.



9. For this example, set 2.5. To return to the operation level, press the ○ Key for less than one second.

3-10-6 Settings: Heater Overcurrent Alarm

To activate heater overcurrent alarm, set the Heater Overcurrent Use parameter to ON in the advanced function setting level and set the Heater Overcurrent Detection 1 and Heater Overcurrent Detection 2 parameters in the adjustment level.

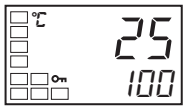
Operating Procedure

This procedure sets the Heater Overcurrent Detection 1 parameter to 20.0.

■ Moving to the Advanced Function Setting Level

The default setting for the Heater Overcurrent Use parameter is ON, so set the Heater Overcurrent Detection 1 parameter.

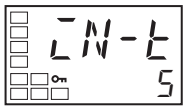
Operation Level



PV/SP

1. Move to the advanced function setting level.
   Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

Initial Setting Level



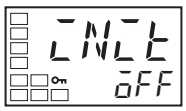
Input Type

2. Press the ⊏↵ Key to select the Move to Advanced Function Setting Level parameter. (For details on moving between levels, refer to *4-8* of H156 *Moving to the Advanced Function Setting Level*.)

Initial Setting Level

3. Press the ∨ Key to enter the password (–169), and move from the initial setting level to the advanced function setting level.

Advanced Function Setting Level



Move to the Advanced Function Setting Level

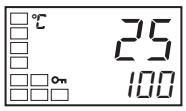
The top parameter in the advanced function setting level is displayed.

Heater Overcurrent Use

4. Press the ↵ Key to select the Heater Overcurrent Use parameter. Check that this parameter is set to ON (the default), and then set the Heater Overcurrent Detection 1 parameter.

■ Setting Heater Overcurrent Detection

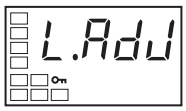
Operation Level



PV/SP

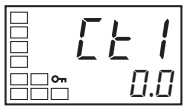
5. Press the ○ Key for at least one second to move from the advanced function setting level to the initial setting level. Press the ○ key again for at least one second to move to the operation level.

Adjustment Level



Adjustment Level Display

6. Press the ○ Key for less than one second to move from the operation level to the adjustment level.

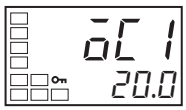


Heater Current 1 Value Monitor

7. Press the ↵ Key to select the Heater Current 1 Value Monitor parameter. Check the current value, and then set the Heater Overcurrent Detection parameter.

Heater Overcurrent Detection 1

8. Press the ↵ Key to select the Heater Overcurrent Detection 1 parameter. Refer to *Calculating Detection Current Values* on page 55 when setting the values.



9. For this example, set 20.0. To return to the operation level, press the ○ Key for less than one second.

3-11 Setting the No. 3 Display

This section describes how to set the No. 3 Display (E5AN/EN). The Multi-SP, MV, or soak time remain can be displayed on the No. 3 display.

3-11-1 PV/SP Display Selection

The following table shows the set values and display contents for the PV/SP Display selection.

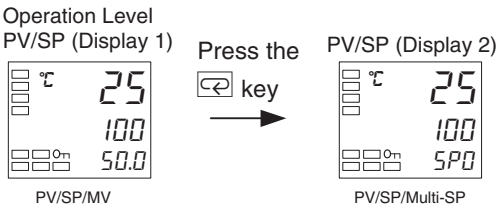
Set value	Display contents
0	Only PV/SP is displayed (with no No. 3 display.)
1	PV/SP/Multi-SP and PV/SP/MV are displayed in order. (See note.)
2	PV/SP/MV and PV/SP/Multi-SP are displayed in order. (See note.)
3	Only PV/SP/Multi-SP is displayed.
4	Only PV/SP/MV is displayed. (See note.)
5	PV/SP/Multi-SP and PV/SP/Soak time remain are displayed in order.
6	PV/SP/MV and PV/SP/Soak time remain are displayed in order. (See note.)
7	Only PV/SP/Soak time remain is displayed.

- A 2-level display is set when shipped from the factory. (set value: 0)
  A 3-level display is activated if parameters are initialized. (set value: 4)

Note For details on setting the MV for heating and cooling control, refer to *MV Display for Heating and Cooling Control* below.

When 1, 2, 5, or 6 is selected, press the ↵ Key to display the next value set for the PV/SP display (display 2).

Example: When the PV/SP Display Screen Parameter Is Set to 2



MV Display for Heating and Cooling Control

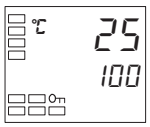
Select either the manipulated variable (heating) or manipulated variable (cooling) as the MV to be displayed for PV/SP/MV during heating and cooling control. The MV Display Selection parameter is displayed only when heating/cooling control is being performed and PV/SP/MV is selected in the PV/SP Display Screen parameter or a Monitor/Setting Item Display parameter.

Parameter name	Set value	Symbol	Display contents
MV Display Selection	O	o	Manipulated variable (heating)
	C-O	C-o	Manipulated variable (cooling)

Operating Procedure

This procedure displays PV/SP/MV and PV/SP/Multi-SP on the Process Value/Set Point display. The PV/SP Display Screen Selection parameter is set to 2.

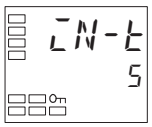
Operation Level



PV/SP

1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

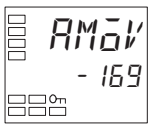
Initial Setting Level



Input Type

2. Press the ↵ Key to select the Move to Advanced Function Setting Level parameter.

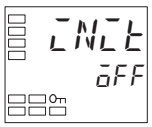
Initial Setting Level



Move to Advanced Function Setting Level

3. Use the ▼ Key to enter the password ("–169").
It is possible to move to the advanced function setting level by either pressing the ↵ Key or waiting two seconds without pressing any key.

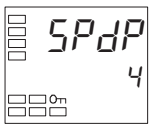
Advanced Function Setting Level



Parameter Initialization

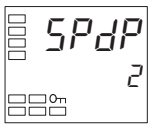
4. Press the ↵ Key to select the PV/SP Display Screen Selection parameter.

Advanced Function Setting Level



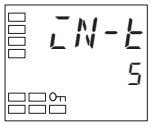
PV/SP Display Screen Selection

5. Use the ▲ and ▼ Keys to set 2.



6. Press the ○ Key for at least one second to move from the advanced function setting level to the initial setting level.

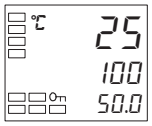
Initial Setting Level



Input Type

7. Press the ○ Key for at least one second to move from the initial setting level to the operation level.
The MV will be displayed on the No. 3 display.

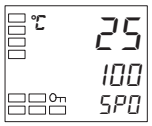
Operation Level



PV/SP

8. Press the ↵ Key to confirm that the Multi-SP is displayed on the No. 3 display.

Operation Level



PV/SP

SECTION 4
Applications Operations

This section describes scaling, the SP ramp function, and other special functions that can be used to make the most of the functionality of the E5GN, E5CN, E5AN, and E5EN Digital Temperature Controllers.

4-1 Shifting Input Values

4-1-1 Shifting Inputs

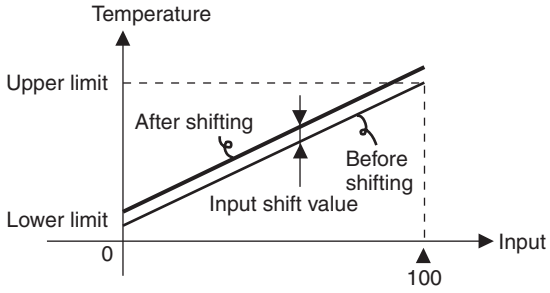
The input shift matched to the sensor currently selected in the Input Type parameter is displayed.

- A 2-point shift is applied for infrared temperature sensors. A 2-point shift can also be used if the Input Shift Type parameter (advanced function setting level) is set to INS2 for a thermocouple or platinum resistance thermometer.
- There is no shift for analog inputs. Use scaling for fine adjustments.

One-point shift

Temperature Input Shift

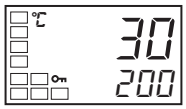
- With a 1-point shift, the value set for the Temperature Input Shift parameter (adjustment level) is applied to each point in the entire temperature input range. For example, if the input shift value is set to 1.2°C, the process value is treated as 201.2°C after the input shift is applied when the measured process value is 200°C.



Operating Procedure

In this example, the input from a K sensor is shifted by 1°C using a 1-point input shift.

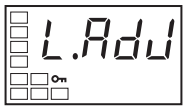
Operation Level



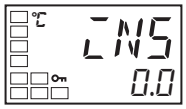
Operation Level

1. Press the ○ Key to move from the operation level to the adjustment level.

Adjustment Level

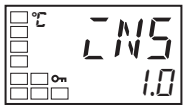


Adjustment Level Display



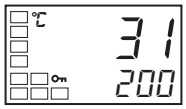
Temperature Input Shift

2. Select the Temperature Input Shift parameter by pressing the ↵ Key.



3. Press the ∧ or ∨ Key to set 1.0.

Operation Level

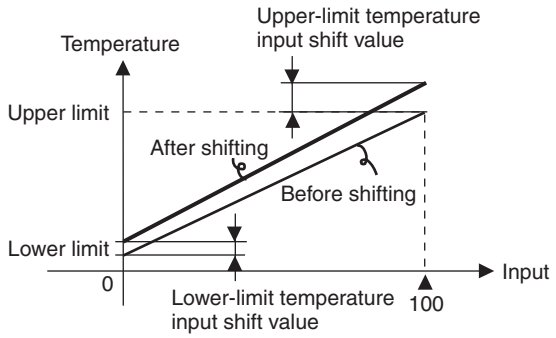


4. To return to the operation level, press the ○ Key. The process value is 1°C larger than before the shift was applied.

Two-point shift

1NSH	Upper-limit Temperature Input Shift Value
1NSL	Lower-limit Temperature Input Shift Value

- Separate shift values can be set for the upper limit and lower limit of the sensor input range for an infrared sensor as well as for a thermocouple or platinum resistance thermometer with the Input Shift Type parameter set to INS2. If different shift values are set for the upper limit and lower limit, then the slope of the line will be different before and after applying the input shift. For example, if the upper-limit value is set to 2°C and the lower-limit value is set to 1°C, the input temperature will be shifted by 1.5°C for a 50% input, i.e., by the average of the upper-limit and lower-limit values.
- Set the upper-limit value in the Upper-limit Temperature Input Shift Value parameter and the lower-limit value in the Lower-limit Temperature Input Shift Value parameter.



4-1-2 How to Calculate Input Shift Values for a 2-point Shift

When an ES1B Infrared Temperature Sensor is connected to the E5CN, an offset of several degrees to several tens of a degree can occur.

For this reason, offset the readout value using a 1-point or 2-point shift as described in this section. This offset occurs because a bias current for detecting a Controller sensor error flows to the output impedance of the infrared temperature sensor.

Preparations

1,2,3...

1. Set a temperature range matching the input specifications of the infrared temperature sensor. (The ES1B can be used with the E5□N only for a thermocouple/resistance thermometer universal input.)
2. Prepare a thermometer capable of measuring the temperature of the control target as shown in *Figure 1* so that a 1-point shift or 2-point shift can be carried out.
3. The E53-CN□□P□N2 (for E5CN), E5AN-□□P□-N, or E5EN-□□P□-N has a built-in external power supply for ES1B Infrared Temperature Sensors. These E5CN models can be used as the power supply when using ES1B. When ES1B are used with other E5CN models, provide a separate power supply for the Infrared Temperature Sensors.

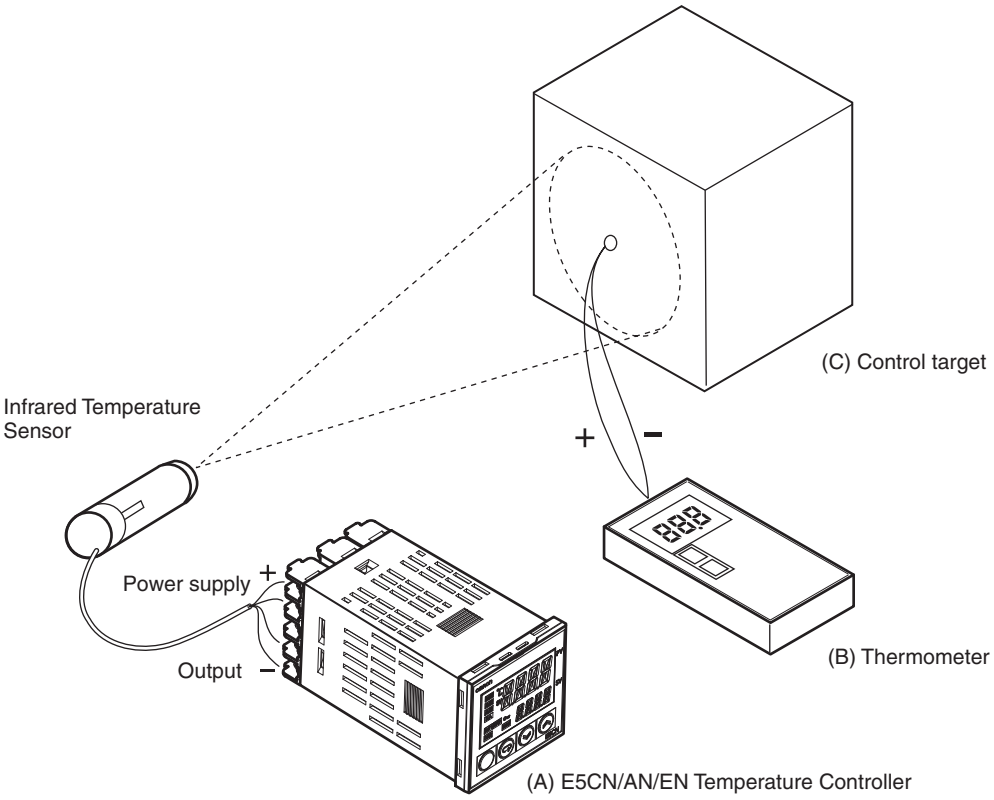
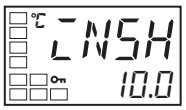


Figure 1 Offset Configuration for an Infrared Temperature Sensor

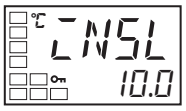
Method for a 1-point Shift

1,2,3...

1. In the configuration shown in *Figure 1*, bring the set point to near the value at which the temperature of the control target is to be controlled. Assume that the control target temperature (C) and the thermometer temperature (B) are the same.



Upper-limit Temperature Input Shift Value



Lower-limit Temperature Input Shift Value

2. Check the thermometer temperature (B) and the Controller readout (A). Subtract the Controller readout temperature (A) from the thermometer temperature (B), and set $\overline{\text{INSL}}$ and $\overline{\text{INSH}}$ to the result as the input shift value. The shift is illustrated in *Figure 2*.
3. After setting the input shift values, check the Controller readout (A) and the thermometer temperature (B). If they are almost the same, this completes shifting the temperature input.

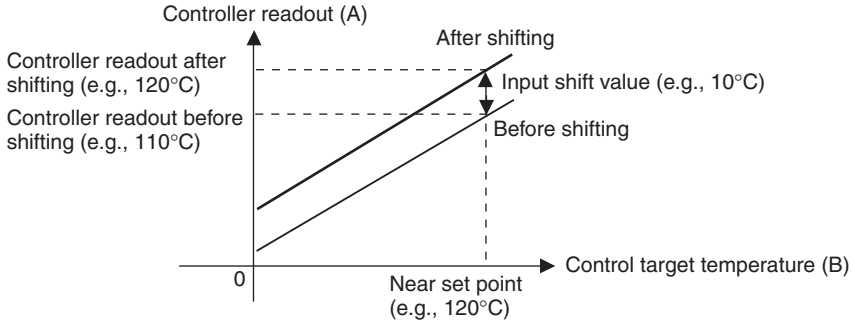


Figure 2 Illustration of 1-Point Shift

Method for a 2-point Shift

Use a 2-point input shift if you want to increase the accuracy of the readout values across the range of the Sensor.

1,2,3...

1. Shift the Controller readout at two points, near room temperature and near the value at which the temperature of the control target is to be controlled. For this reason, check the thermometer temperature (B) and Controller readout (A) with the thermometer temperature near room temperature and near the set point.
2.
   - Y1 is the Controller readout at room temperature before shifting and X1 is the Controller readout at room temperature after shifting.
   - Y2 is the Controller readout at the set temperature before shifting and X2 is the Controller readout at the set temperature after shifting.
   - Set the upper-limit temperature input shift and the lower-limit temperature input shift using the following formulas based on the temperatures before shifting (Y1 and Y2), the temperatures after shifting (X1 and X2), the set temperature upper limit (YH), and the set temperature lower limit (YL). The shift is illustrated in *Figure 3*.

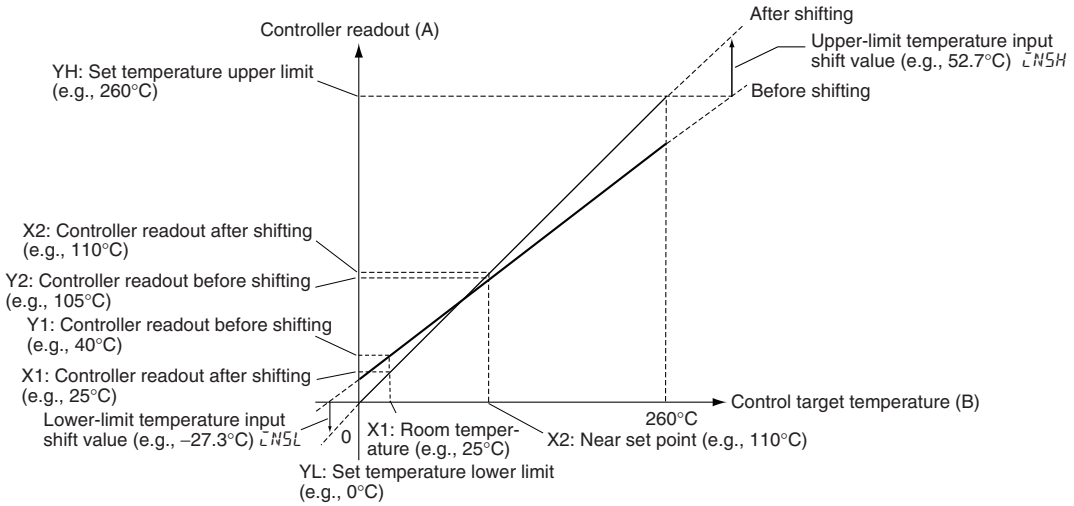


Figure 3 Illustration of 2-Point Shift

a. Lower-limit temperature input shift value

$$ĿNSL = \frac{YL - Y1}{Y2 - Y1} \times \{(X2 - Y2) - (X1 - Y1)\} + (X1 - Y1)$$

b. Upper-limit temperature input shift value

$$ĿNSH = \frac{YH - Y1}{Y2 - Y1} \times \{(X2 - Y2) - (X1 - Y1)\} + (X1 - Y1)$$

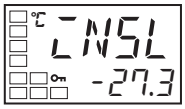
3. After setting the calculated values to ĿNSL and ĿNSH, check the Controller readout (A) and thermometer temperature (B).
4. Here, offsets are set at two points, near room temperature and near the set point. To improve accuracy within the measurement temperature range, another point in the measurement temperature range other than the set point should be set instead of room temperature.

Example of a 2-point Temperature Input Shift

In this example, we use the ES1B K 0 to 260°C specification. In equations 1 and 2, the set temperature lower limit YL is 0°C and the set temperature upper limit YH is 260°C. Check the temperature of the control target.

The temperature input offset values can be calculated as shown below when the Controller readout Y1 is 40°C for a room temperature X1 of 25°C and when the Controller readout Y2 is 105°C for a set point temperature X2 of 110°C.

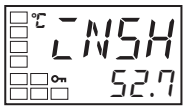
Lower-limit Temperature Input Shift Value



Lower-limit Temperature Input Shift Value

$$\text{L-SL} = \frac{0 - 40}{105 - 40} \times \{(110 - 105) - (25 - 40)\} + (25 - 40) = -27.3\ (°C)$$

Upper-limit Temperature Input Shift Value

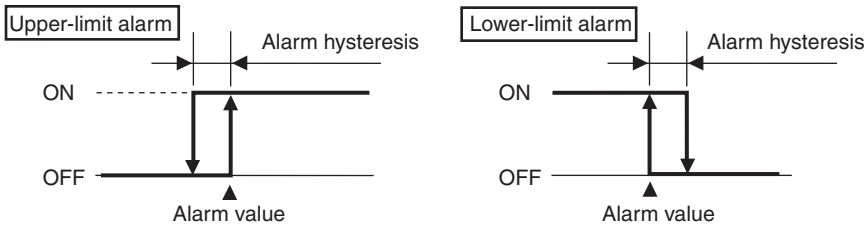


Upper-limit Temperature Input Shift Value

$$\text{L-SH} = \frac{260 - 40}{105 - 40} \times \{(110 - 105) - (25 - 40)\} + (25 - 40) = 52.7\ (°C)$$

4-2 Alarm Hysteresis

- The hysteresis of alarm outputs when alarms are switched ON/OFF can be set as follows:



- Alarm hysteresis is set independently for each alarm in the Alarm Hysteresis 1 to Alarm Hysteresis 3 parameters (initial setting level).
- The default is 0.2 (°C/°F) for Controllers with Thermocouple/Resistance Thermometer Universal Inputs and 0.02% FS for Controllers with Analog Inputs.

4-2-1 Standby Sequence

- The standby sequence can be used so that an alarm will not be output until the process value leaves the alarm range once and then enters it again.
- For example, with a lower limit alarm, the process value will normally be below the set point, i.e., within the alarm range, when the power supply is turned ON, causing an alarm to be output.
  If the lower limit alarm with a standby sequence is selected, an alarm will not be output until the process value increases above the alarm set value, i.e., until it leaves the alarm range, and then falls back below the alarm set value.

Restart

- The standby sequence is canceled when an alarm is output. It is, however, restarted later by the Standby Sequence Reset parameter (advanced function setting level). For details, refer to the Standby Sequence Reset parameter in *SECTION 5* of H156 *Parameters*.

4-2-2 Alarm Latch

- The alarm latch can be used to keep the alarm output ON until the latch is canceled regardless of the temperature once the alarm output has turned ON.

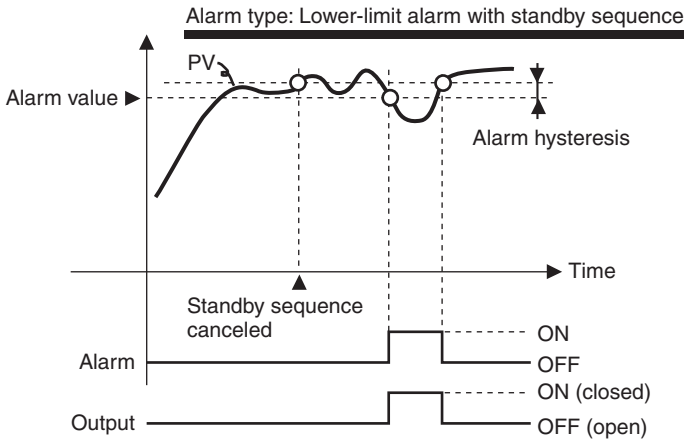
Any of the following methods can be used to clear the alarm latch.

- Turn OFF the power supply. (The alarm latch is also cleared by switching to the initial setting level, communications setting level, advanced function setting level, or calibration level.)
- Use the PF Key.
- Use an event input.

For details on setting the PF Key, refer to *4-19* of H156: *Setting the PF Key*. For details on setting events, refer to *4-5 Using Event Inputs*.

Summary of Alarm Operation

The following figure summarizes the operation of alarms when the Alarm Type parameter is set to “lower-limit alarm with standby sequence” and “close in alarm” is set.



Parameters

Symbol	Parameter: level	Description
ALH*	Alarm 1 to 3 Hysteresis: Initial setting level	Alarm
RESt	Standby Sequence: Advanced function setting level	Alarm

Note * = 1 to 3

4-3 Setting Scaling Upper and Lower Limits for Analog Inputs

4-3-1 Analog Input

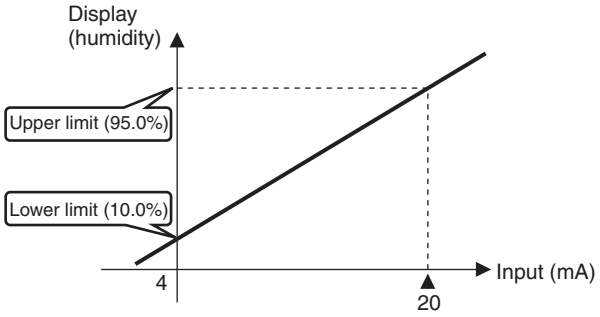
SCN-H Scaling Upper Limit

SCN-L Scaling Lower Limit

dP Decimal Point

- When an analog input is selected, scaling can be performed as needed by the control application.
- Scaling is set in the Scaling Upper Limit, Scaling Lower Limit, and Decimal Point parameters (initial setting level). These parameters cannot be used when a temperature input is selected.
- The Scaling Upper Limit parameter sets the physical quantity to be expressed by the upper limit value of input, and the Scaling Lower Limit parameter sets the physical quantity to be expressed by the lower-limit value of input. The Decimal Point parameter specifies the number of digits below the decimal point.

- The following figure shows a scaling example for a 4 to 20 mV input. After scaling, the humidity can be directly read. Here, one place below the decimal point is set.



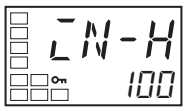
Operating Procedure

In this example scaling is set to display 4 to 20 mA as 10.0% to 95.0%.

Initial Setting Level

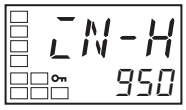
Input Type

1. Press the ○ Key for three seconds to move from the operation level to the initial setting level.

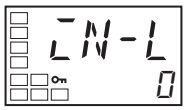


Scaling Upper Limit

2. Select Scaling Upper Limit parameter by pressing the ↵ Key.

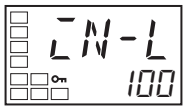


3. Use the ∧ and ∨ Keys to set the parameter to 950.

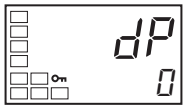


Scaling Lower Limit

4. Select the Scaling Lower Limit parameter by pressing the ↵ Key.

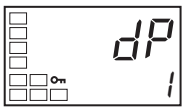


5. Press the ∧ and ∨ Keys to set 100.



Decimal Point

6. Select the Decimal Point parameter by pressing the ↵ Key.



7. Press the ∧ and ∨ Keys to set 1.

8. To return to the operation level, press the ○ Key for one second.

4-4 Executing Heating/Cooling Control

4-4-1 Heating/Cooling Control

Heating/cooling control can be used on the E5CN-□M□-500 (with an E53-CNQ□□N2), E5CN-□2M□-500, E5AN-□3□M□-500-N or E5EN-□3□M□-500-N. Heating/cooling control operates when H-C (heating/cooling) is selected for the Standard or Heating/Cooling parameter.

The following functions are assigned to outputs in the initial status.

Parameter name	Symbol	Initial status
Control Output 1 Assignment	oUt1	Control output for heating
Control Output 2 Assignment	oUt2	Not assigned.
Auxiliary Output 1 Assignment	Sub1	Alarm 1
Auxiliary Output 2 Assignment	Sub2	Alarm 2
Auxiliary Output 3 Assignment (E5AN/EN only)	Sub3	Alarm 3

Each output assignment is automatically initialized as shown below when the control mode is changed.

Example: E5CN

Parameter name	Symbol	Without control output 2		With control output 2	
		Standard	Heating/cooling	Standard	Heating/cooling
Control Output 1 Assignment	oUt1	Control output (heating)	Control output (heating)	Control output (heating)	Control output (heating)
Control Output 2 Assignment	oUt2	Not assigned. (See note 1.)	Not assigned. (See note 1.)	Not assigned.	Control output (cooling)
Auxiliary Output 1 Assignment	Sub1	Alarm 1 (See note 2.)	Alarm 1 (See note 2.)	Alarm 1 (See note 2.)	Alarm 1 (See note 2.)
Auxiliary Output 2 Assignment	Sub2	Alarm 2 (See note 3.)	Control output (cooling) (See note 3.)	Alarm 2	Alarm 2

Example: E5GN

Parameter name	Symbol	Standard	Heating/cooling
Control Output 1 Assignment	oUt1	Control output (heating)	Control output (heating)
Auxiliary Output 1 Assignment	Sub1	Alarm 1 (See note 2.)	Control output (cooling)
Auxiliary Output 2 Assignment	Sub2	Alarm 2	Alarm 2

Note

(1) No parameter assignment is displayed because there is no control output 2.

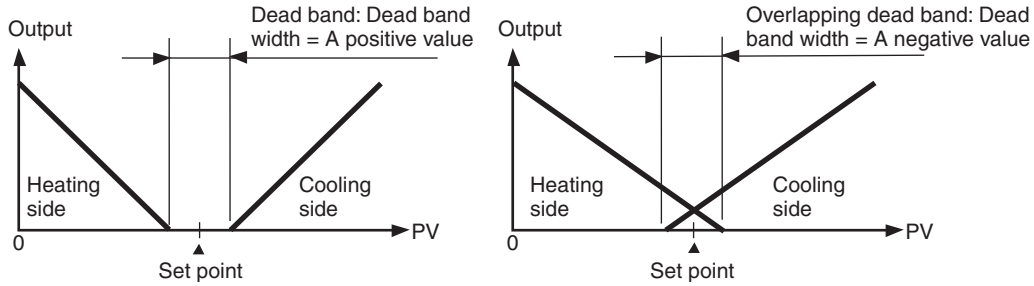
(2) The output set for the Auxiliary Output 1 Assignment parameter becomes the program END output unless the program pattern is OFF.

(3) For the E5AN/EN, the Auxiliary Output 3 Assignment parameter is set for control output (cooling) (the Auxiliary Output 2 Assignment parameter is set for alarm 2).

- The heating/cooling operation of the control outputs will switch when the Direct/Reverse Operation parameter is set to “direct.”
- When DRS (Invert Direct/Reverse Operation) is assigned for an Event Input Assignment (1 or 2), control will start with the contents set for the Direct/Reverse Operation parameter inverted when the event input turns ON, and with the contents left according to the setting when the event input turns OFF. For details on event inputs and control combined with the Direct/Reverse Operation parameter, refer to *Control by Inverting Direct/Reverse Operation* on page 78.
- When heating/cooling control is selected, the Dead Band and Cooling Coefficient parameters can be used.

Dead Band

- For heating/cooling control, the dead band is set with the set point as its center. The dead band width is the set value of the Dead Band parameter (adjustment level). Setting a negative value produces an overlapping band.
- If an overlapping band is set, the bumpless function may not operate when switching between manual operation and automatic operation.
- The default is 0.0 EU for Controllers with Thermocouple/Resistance Thermometer Universal Inputs and 0.00% FS for Controllers with Analog Inputs.



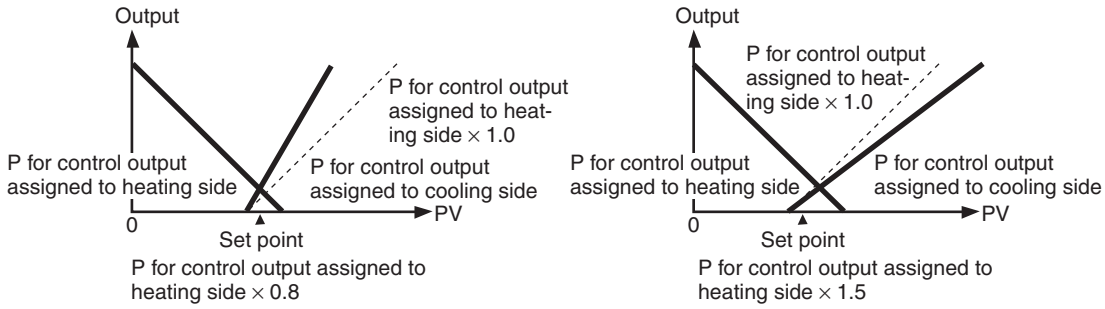
Cooling Coefficient

If the heating characteristics and cooling characteristics of the control object are very different and good control characteristics cannot be achieved with the same PID constants, the cooling coefficient can be used to adjust the proportional band (P) for the control output assigned to the cooling side. Use this to achieve balanced control between the heating side and cooling side. The proportional bands (P) for the control outputs assigned to the heating/cooling sides can be calculated using the following equations.

P for control output assigned to heating side = P

P for control output assigned to cooling side = P for control output assigned to heating side × cooling coefficient

The cooling coefficient is multiplied by the P for the control output assigned to the heating side to obtain control with characteristics that differ from those of the control output assigned to the heating side.



Automatic Cooling Coefficient Adjustment

By executing AT during heating/cooling control, the cooling coefficient can be automatically calculated along with the PID parameters.

Parameter name	Setting rage	Default
Automatic Cooling Coefficient Adjustment	OFF: Disabled, ON: Enabled	OFF

Note If there is strong non-linear gain for the cooling characteristics, such as when cooling water boils for cooling control, it may not be possible to obtain the optimum cooling coefficient at the Controller, and control may take the form of

oscillating waves. If that occurs, increase the proportional band or the cooling coefficient to improve control.

4-4-2 Settings

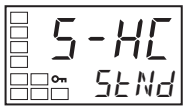
To set heating/cooling control, set the Standard or Heating/Cooling, Dead Band, and Cooling Coefficient parameters.

Setting Heating/Cooling Control

Operating Procedure

Standard or heating/cooling = Heating/cooling

Initial Setting Level



Standard or Heating/ Cooling

1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

2. Select “heating/cooling control” in the initial setting level.
   StNd: Standard control
   H-C: Heating/cooling control

Setting the Cooling Coefficient

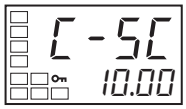
Operating Procedure

Cooling Coefficient = 10

Adjustment Level

Cooling Coefficient

1. Select the Cooling Coefficient parameter in the adjustment level.



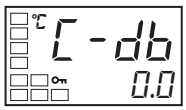
2. Use the ^ Key to set the parameter to 10.00.

Setting the Dead Band

Operating Procedure

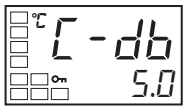
Dead Band = 5

Adjustment Level



Dead Band

1. Select the Dead Band parameter in the adjustment level.



2. Use the ^ Key to set the parameter to 5.0.

4-5 Using Event Inputs

4-5-1 Event Input Settings

- Event inputs can be used for Multi-SP, RUN/STOP, Auto/Manual Switch, Program Start, Invert Direct/Reverse Operation, 100% AT Execute/Cancel, 40% AT Execute/Cancel, Setting Change Enable/Disable, and Alarm Latch Cancel.
- Of these, only the number of event inputs (0 to 2) set in the Number of Multi-SP Uses parameter (initial setting level) are used for the multi-SP function.
- Of these, only the number of event inputs (0 to 2) set in the Number of Multi-SP Uses parameter (initial setting level) are automatically assigned by the multi-SP function. Displays for event input assignments will not be displayed for inputs that are automatically assigned by the multi-SP function. Event inputs 1 and 2 are used for the multi-SP function by models with four event inputs.
- Event inputs can be used on the following models:
  E5CN-□M□-500 with the E53-CN□B□N2 for the E5CN
  E5AN/EN-□M□-500-N with the E53-AKB for the E5AN/EN
- When using event inputs to switch the multi-SP, the event input assignment display will not appear. Whether the set value and event input assignments 1 and 2 will be displayed or hidden is shown in the tables below.
- Do not connect the contacts from the same switch to more than one E5□N Controllers.

Models with Two Event Inputs, 1 and 2

		Event input assignment 1	Event input assignment 2	Description of EV1 and EV2 operation
Number of Multi-SP Uses	0	Displayed (Multi-SP not used).		EV1 and EV2 will perform the operation command assigned using the Event Input Assignment 1 and 2 parameters.
	1	Not displayed (Operation performed with two Multi-SP points.)	Displayed (Event input 2 not used as multi-SP switch).	EV1 will be used for the Multi-SP function to switch between set points 0 and 1. EV2 will perform the operation command assigned using the Event Input Assignment 2 parameter.
	2	Not displayed (Operation performed with four Multi-SP points.)		EV1 and EV2 will be used for the Multi-SP function to switch between set points 0, 1, 2, and 3.

Models with Two Event Inputs, 3 and 4

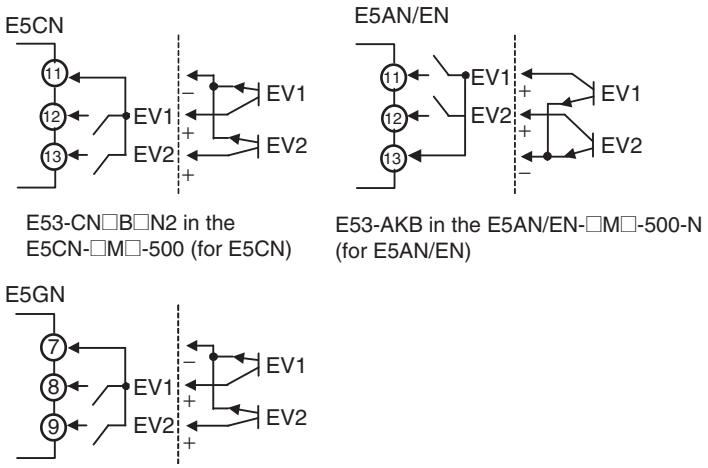
		Event input assignment 3	Event input assignment 4	Description of EV3 and EV4 operation
Number of Multi-SP Uses	0	Displayed (Multi-SP not used).		EV3 and EV4 will perform the operation command assigned using the Event Input Assignment 3 and 4 parameters.
	1	Not displayed (Operation performed with two Multi-SP points.)	Displayed (Event input 4 not used as multi-SP switch).	EV3 will be used for the Multi-SP function to switch between set points 0 and 1. EV4 will perform the operation command assigned using the Event Input Assignment 2 parameter.
	2	Not displayed (Operation performed with four Multi-SP points.)		EV3 and EV4 will be used for the Multi-SP function to switch between set points 0, 1, 2, and 3.

Models with Four Event Inputs, 1 to 4

		Event input assignment 1	Event input assignment 2	Event input assignment 3	Event input assignment 4	Description of EV1, EV2, EV3, and EV4 operation
Number of Multi-SP Uses	0	Displayed (Multi-SP not used).				EV1, EV2, EV3, and EV4 will perform the operation command assigned using the Event Input Assignment 1, 2, 3, and 4 parameters.
	1	Not displayed (Operation performed with two Multi-SP points.)	Displayed (Event inputs 2, 3, and 4 cannot be used for multi-SP switching.)			EV1 will be used for the Multi-SP function to switch between set points 0 and 1. EV2, EV3, and EV4 will perform the operation command assigned using the Event Input Assignment 2, 3, and parameters.
	2	Not displayed (Operation performed with four Multi-SP points.)		Displayed (Event inputs 3 and 4 cannot be used for multi-SP switching.)		EV1 and EV2 will be used for the Multi-SP function to switch between set points 0, 1, 2, and 3. EV3 and EV4 will perform the operation command assigned using the Event Input Assignment 3 and 4 parameters.

Two set points are set externally by using the Number of Multi-SP Uses parameter.

- Switching is possible between two set points (0 and 1) by setting the Number of Multi-SP Uses parameter to 1. The default setting is 1 and does not need to be changed to switch between two set points. Set points 0 and 1 are specified by the status of event input 1.



E53-CN□B□N2 in the E5CN-□M□-500 (for E5CN)

E53-AKB in the E5AN/EN-□M□-500-N (for E5AN/EN)

4-5-2 How to Use the Multi-SP Function

The multi-SP function allows you to set up to four set points (SP 0 to 3) in the adjustment level. The set point can be switched by operating the keys on the front panel or by using external input signals (event inputs).

Using Event Inputs

■ Two Event Inputs: Event Inputs 1 and 2

The following tables show the relationship between the ON/OFF combinations of event inputs 1 and 2 and the selected set points.

Number of Multi-SP Uses = 1

Event input 1	Selected set point
OFF	Set point 0
ON	Set point 1

Number of Multi-SP Uses = 2

Event input 1	Event input 2	Selected set point
OFF	OFF	Set point 0
ON	OFF	Set point 1
OFF	ON	Set point 2
ON	ON	Set point 3

Using Key Operations

You can select any of the set points 0 to 3 by changing the set value of the Multi-SP Uses parameter. The Multi-SP Uses parameter display conditions are as follows:

- If the Controller does not support event inputs, the Multi-SP Uses parameter must be set to ON.
- If the Controller supports event inputs, the Number of Multi-SP Uses parameter must be set to 0 and the Multi-SP Uses parameter must be set to ON.

The following table shows the relationship between the Multi-SP Uses parameter set value and the selected set point.

Multi-SP	Selected set point
0	Set point 0
1	Set point 1
2	Set point 2
3	Set point 3

Note The set point can also be switched using communications.

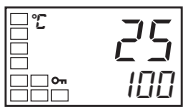
4-5-3 Settings

Switching between Set Points 0, 1, 2, and 3

Operating Procedure

The following example sets the Number of Multi-SP Uses parameter to 2.

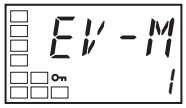
Operation Level



PV/SP

1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.

Number of Multi-SP Uses Setting

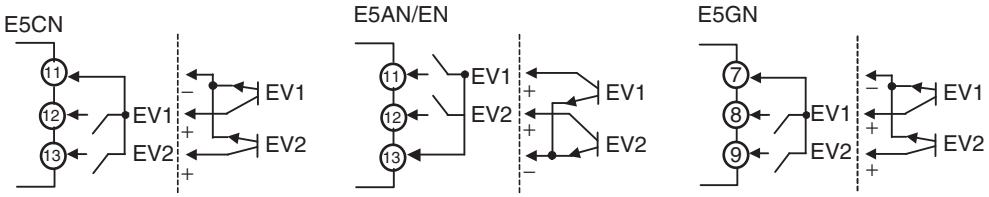


Number of Multi-SP Uses

2. Select the Number of Multi-SP Uses parameter by pressing the ↵ Key.

3. Use the ^ Key to set the parameter to 2.

Set points 0, 1, 2 and 3 will be set according to the ON/OFF states of event inputs 1 and 2.



4-5-4 Operation Commands Other than Multi-SP

The following table shows the functions assigned when an Event Input Assignment (1 or 2) is displayed.

Setting	Function
NONE	None
STOP	RUN/STOP
MANU	Auto/Manual
PRST	Program Start (See note 1.)
dRS	Invert Direct/Reverse Operation
AT-2	100% AT Execute/Cancel
AT-1	40% AT Execute/Cancel (See note 2.)
WTPT	Setting Change Enable/Disable
LAT	Alarm Latch Cancel

Note

(1) PRST (Program Start) can be set even when the Program Pattern parameter is set to OFF, but the function will be disabled.

(2) This function can be set for heating/cooling control, but the function will be disabled.

When any of the following functions is set for an Event Input Assignment parameter, the same function cannot be set for another Event Input Assignment parameter: STOP (RUN/STOP), MANU (Auto/Manual Switch), PRST (Program Start), DRS (Invert Direct/Reverse Operation), AT-2 (100% AT Execute/Cancel), AT-1 (40% AT Execute/Cancel), WTPT (Setting Change Enable/Disable), or LAT (Alarm Latch Cancel). Turn event inputs ON and OFF while the power is being supplied. Event input ON/OFF changes are detected for inputs of 50 ms or longer. (However, inputs of 250 ms or longer is determined using logic operations.)

The functions are described in detail below. Event inputs 1 and 2 are taken as examples.

Executing Run/Stop Control

When the Event Input Assignment 1 or Event Input Assignment 2 parameter is set to STOP (RUN/STOP), control is started when event input 1 or 2 turns OFF. Control is stopped when the input turns ON. Alarm outputs, however, will be according to the process value.

The STOP indicator will light while control is stopped.

Setting	Input contact	Status
Event input 1 or 2	ON	STOP
Event input 1 or 2	OFF	RUN

Switching between Auto and Manual Control

When the Event Input Assignment 1 or Event Input Assignment 2 parameter is set to MANU (auto/manual), manual control will start when event input 1 or 2 turns ON. Auto control will start when the input turns OFF.

The MANU indicator will light during manual control.

Setting	Input contact	Status
Event input 1 or 2	OFF	Automatic
Event input 1 or 2	ON	Manual

Controlling the Start of the Simple Program Function

When the Event Input Assignment 1 or Event Input Assignment 2 parameter is set to PRST (program start), the program will start when event input 1 or 2 turns ON. The program will be reset when the input turns OFF and the RUN/STOP status will automatically switch to STOP mode. If the program END output is ON, the program END output will turn OFF.

Setting	Input contact	Status
Event input 1 or 2	OFF	Reset
Event input 1 or 2	ON	Start

Control by Inverting Direct/Reverse Operation

When DRS (Invert Direct/Reverse Operation) is set for the Event Input Assignment 1 or Event Input Assignment 2 parameter and the Direct/Reverse Operation parameter is set for reverse operation, control starts with direct operation (cooling control) when event input 1 or 2 turns ON and control starts with reverse operation (heating control) when the event input turns OFF.

Setting	Input contact	Direct/Reverse Operation parameter	Status
Event input 1 or 2	OFF	Direct operation (cooling)	Direct operation (cooling)
		Reverse operation (heating)	Reverse operation (heating)

Setting	Input contact	Direct/Reverse Operation parameter	Status
Event input 1 or 2	ON	Direct operation (cooling)	Reverse operation (heating)
		Reverse operation (heating)	Direct operation (cooling)

Switching 100% AT Execute/Cancel

When AT-2 (100% AT Execute/Cancel) is set for either the Event Input Assignment 1 or Event Input Assignment 2 parameter, 100% AT will be executed when event input 1 or 2 turns ON and will be cancelled when the input turns OFF.

Setting	Input contact	Status
Event input 1 or 2	OFF	100% AT cancelled
Event input 1 or 2	ON	100% AT executed

Switching 40% AT Execute/Cancel

When AT-1 (40% AT Execute/Cancel) is set for either the Event Input Assignment 1 or Event Input Assignment 2 parameter, 40% AT will be executed when event input 1 or 2 turns ON and will be cancelled when the input turns OFF.

Setting	Input contact	Status
Event input 1 or 2	OFF	40% AT cancelled
Event input 1 or 2	ON	40% AT executed

Switching Setting Change Enable/ Disable

When WTPT (Setting Change Enable/Disable) is set for either the Event Input Assignment 1 or Event Input Assignment 2 parameter, the setting change will be disabled when event input 1 or 2 turns ON and will be enabled when the input turns OFF.

Setting	Input contact	Status
Event input 1 or 2	OFF	Enabled
Event input 1 or 2	ON	Disabled

Switching Alarm Latch Cancel

When LAT (Alarm Latch Cancel) is set for either the Event Input Assignment 1 or Event Input Assignment 2 parameter, all alarm latches (alarms 1 to 3, heater burnout, HS alarm, and heater overcurrent latch) will be cancelled when event input 1 or 2 turns ON.

Setting	Input contact	Status
Event input 1 or 2	OFF	---
Event input 1 or 2	ON	Cancelled

Parameters

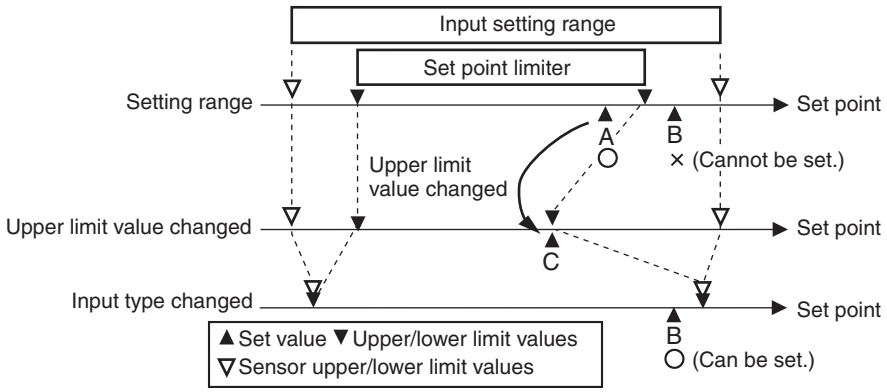
Symbol	Parameter: level	Description
EV-1	Event Input Assignment 1: Initial setting level	Function of event input function
EV-2	Event Input Assignment 2: Initial setting level	
EV-M	Number of Multi-SP Uses: Initial setting level	

4-6 Setting the SP Upper and Lower Limit Values

4-6-1 Set Point Limiter

The setting range of the set point is limited by the set point limiter. This function can be used to prevent setting incorrect process values. The set point limiter is used to prevent the control target from reaching abnormal temperatures. If the set point is not within the range set for the set point limiter as the result of changes to the Set Point Upper Limit or Set Point Lower Limit parameter, the set point will automatically be change to a value within the set

range. The upper- and lower-limit values of the set point limiter are set using the Set Point Upper Limit and Set Point Lower Limit parameters in the initial setting level. When the set point limiter is reset, the set point is forcibly changed to the upper- or lower-limit value of the set point limiter if the set point is out of the limiter range. Also, when the input type and the temperature unit, scaling upper-limit value, or lower-limit value are changed, the set point limiter is forcibly reset to the input setting range or the scaling upper- or lower-limit value.

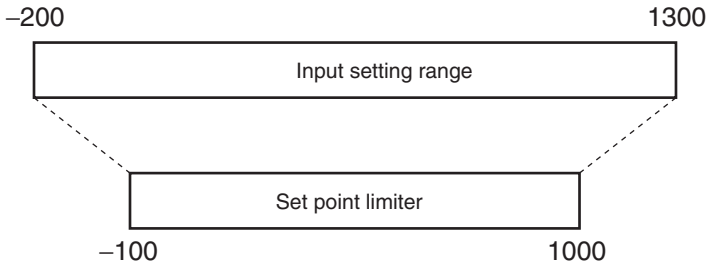


Parameters

Symbol	Parameter: level	Description
SL-H	Set Point Upper Limit: Initial setting level	To limit the SP setting
SL-L	Set Point Lower Limit: Initial setting level	To limit the SP setting

4-6-2 Setting

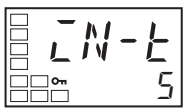
Set the set point upper and lower limits in the Set Point Upper Limit and Set Point Lower Limit parameters in the initial setting level. In this example, it is assumed that the input type is set to a K thermocouple with a temperature range of –200 to 1300°C.



Setting the Set Point Upper-limit Value

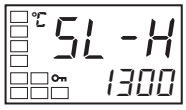
Operating Procedure

Set Point Upper Limit = 1000



Input Type

1. Press the ○ Key for at least three seconds to move from the operation level to the initial setting level.



Set Point Upper-limit

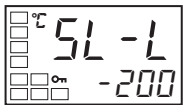
2. Select the Set Point Upper Limit parameter.

3. Use the ▲ and ▼ Keys to set the parameter to 1000.

Setting the Set Point Lower-limit Value

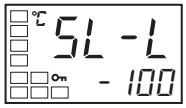
Operating Procedure

Set Point Lower Limit = −100



Set Point Lower Limit

1. Select the Set Point Lower Limit parameter in the initial setting level.



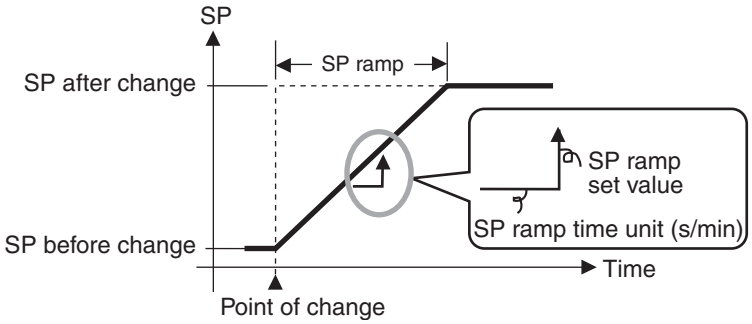
2. Use the ▲ and ▼ Keys to set the parameter to −100.

4-7 Using the SP Ramp Function to Limit the SP Change Rate

4-7-1 SP Ramp

The SP ramp function is used to restrict the width of changes in the set point as a rate of change. When the SP ramp function is enabled and the change width exceeds the specified rate of change, an area where the set point is restricted will be created, as shown in the following diagram.

During the SP ramp, control will be performed not for the specified set point but rather for the set point restricted by the rate of change set for the SP ramp function.



The rate of change during SP ramp is specified using the SP Ramp Set Value and SP Ramp Time Unit parameters. The SP Ramp Set Value parameter is set to OFF by default, i.e., the SP ramp function is disabled.

Changes in the ramp set point can be monitored in the Set Point During SP Ramp parameter (operation level). Use this parameter when monitoring SP ramp operation.

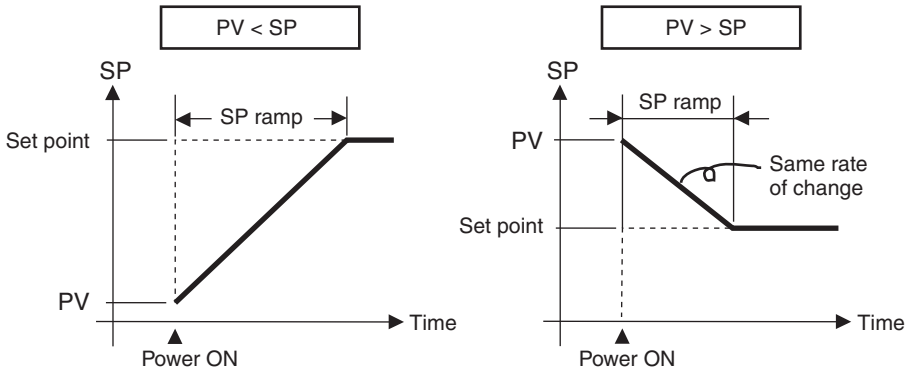
The SP ramp function operates in the same way when switching the set point using the multi-SP function.

Parameters

Symbol	Parameter: level	Description
oL-H	MV Upper Limit: Adjustment level	To limit the manipulated variable
oL-L	MV Lower Limit: Adjustment level	To limit the manipulated variable
SL-H	Set Point Upper Limit: Initial setting level	To limit the SP setting
SL-L	Set Point Lower Limit: Initial setting level	To limit the SP setting
SPRt	SP Ramp Set Value: Adjustment level	To limit the SP rate of change
SPRU	SP Ramp Time Unit: Advanced function setting level	Unit for setting the SP
ALSP	Alarm SP Selection: Advanced function setting level	Alarm SP selection

Operation at Startup

If the SP ramp function is enabled when the Controller is turned ON or when switching from STOP to RUN mode, the process value reaches the set point using the SP ramp function in the same way as when the set point is changed. In this case, operation is carried out with the process value treated as the set point before the change was made. The direction of the SP ramp changes according to the relationship between the process value and the set point.



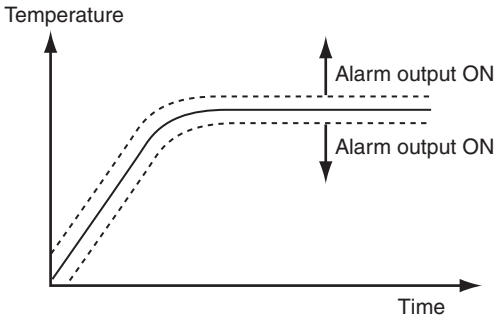
Restrictions during SP Ramp Operation

- Execution of auto-tuning starts after the end of the SP ramp.
- When control is stopped or an error occurs, the SP ramp function is disabled.

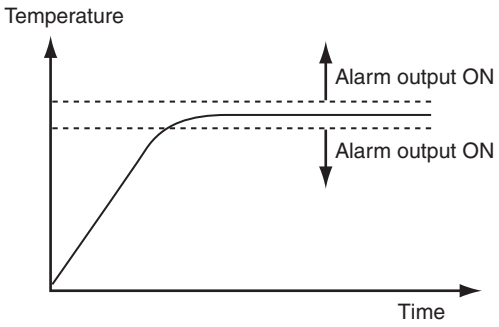
Alarms during SP Ramp Operation

The operation of alarms during SP ramp operation depends on whether alarms are set to be based on the ramp set point or the target set point (refer to the following diagrams). The set point to be used is set in the Alarm SP Selection parameter. (Refer to page 244 of H156.)

Alarm SP Selection = Ramp SP (Alarm Type: 1 (Upper/Lower Limits))



Alarm SP Selection = Target SP (Alarm Type: 1 (Upper/Lower Limits))



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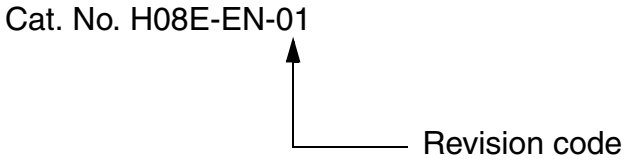
Revision History

A manual revision code appears as a suffix to the catalog number on the front cover of the manual.



The following table outlines the changes made to the manual during each revision. Page numbers refer to the previous version.

Revision code	Date	Revised content
01	August 2010	Original production