FP23 Series

Programmable Controller

Instruction Manual

1-Input, 2-Input Standard Model Version
(excluding Servo Output)

September 5, 2004

Thank you for purchasing the Shimaden FP23 Series Programmable Controller.
Check that the delivered product is the correct item you ordered. Do not begin operating this product until you have read and thoroughly understood the contents of this Instruction Manual.

SHIMADEN CO., LTD.

TFP23F-1AE
September, 2004

Request

Make sure that this instruction manual is given to the final user of the device.
Keep this manual at the work site during operation of the FP23 Series.

Preface

This Instruction Manual describes the basic functions and method of use of the “1-input/2-input models” and “1-output/2-output models” of the FP23 Series Programmable Controller.
For details on the “servo output model,” refer to the separate document “FP23 Series Controller, Instruction Manual, Servo Version (manual No.: 00000-000).

This Instruction Manual is meant for those will be involved in the wiring, installation, operation and routine maintenance of the FP23 Series. This manual describes the handling, installation and wiring procedures for operation.
While using this device, you should always follow the instructions written in this manual. For safety precautions and potential damage to equipment and/or facilities, additional instructions are indicated by the following headings.

Safety Precautions

⚠Warning

The FP23 Series Programmable Controller is designed for controlling temperature, humidity and other physical quantities in general industrial facilities.

It must not be used in any way that may adversely affect the safety, health or working conditions of those who come into contact with the effects of its use.
When used, adequate and effective safety countermeasures must be provided at all times by the user. No warranty, express or implied, is valid when this device is used without the proper safety countermeasures.

⚠Warning

- Before you start to use this device, install it in a control panel or the like and avoid touching the terminals.
- Do not open this device’s case, and touch the boards or inside of the case with your hands or a conductor.
  The user should never repair or modify this device.
  Doing so might cause an accident that may result in death or serious bodily injury from electric shock.

⚠Caution

To avoid damage to connected peripheral devices, facilities or the product itself due to malfunction of this device, safety countermeasures such as proper installation of the fuse or installation of overheating protection must be taken before use. No warranty, express or implied, is valid in the case of use resulting in an accident without having taken the proper safety countermeasures.

⚠Caution

- The warning mark on the plate affixed on the casing of this device warns you not to touch charged parts while this device is powered ON.
  Doing so might cause an electric shock.
- A means for turning the power OFF such as switch or a breaker must be installed on the external power circuit connected to the power terminal on this device.
  Fasten the switch or breaker at a position where it can be easily operated by the operator, and indicate that it is a means for powering this device OFF.
- This device does not have a built-in fuse. Install a fuse that conforms to the following rating in the power circuit connected to the power terminal.

Fuse rating/characteristics: 250 VAC 1.0A/medium lagged or lagged type

- When wiring this device, tighten the terminal connections firmly.
- Use the device with the power voltage and frequency within their rated ranges.
- Do not apply a voltage or current outside of the input rating to the input terminal.
  Doing so might shorten the service life of this device or cause it to malfunction.
- The voltage and current of the load connected to the output terminal should be within the rated range.
  Exceeding this range may cause the temperature to rise which might shorten the service life of this device or cause it to malfunction.
- This device is provided with ventilation holes for heat to escape.
  Prevent metal objects or other foreign matter from entering these ventilation holes as this may cause this device to malfunction.
  Do not block these ventilation holes or allow dirt and dust to stick to these holes.
  Temperature buildup or insulation failure might shorten the service life of this device or cause it to malfunction.
- Repeated tolerance tests on voltage, noise, surge, etc. may cause this device to deteriorate.
- Never remodel this device or use it a prohibited manner.
- To ensure safe and proper use of this device, and to maintain its reliability, observe the precautions described in this manual.
- Do not operate the keys on the front panel of this device with a hard or sharp-tipped object.
  Be sure to operate the keys with your fingertips.
- When cleaning this device, do not use paint thinner or other solvents. Wipe gently with a soft, dry cloth.

Check before use

This device has been fully checked for quality assurance before shipment from the factory. However, you are requested to make sure that there are no errors, damages or shortages in the delivered items by confirming the model code, external appearance of the device and the number of accessories.

Confirmation of model codes

Referring to the table below check the model codes affixed to the case of the product to check if the respective codes indicate what was specified when you ordered the product.

1-input specification

Item	Code	Specification
1. Series	FP23-	MPU-mounted multi-function controller
2. Basic functions	SS	Multi-input, 1-input/1-output control, 3 event outputs
	SD	Multi-input, 1-input/2-output control, 3 event outputs
3. Control output 1	Y	Contact 1c, Contact rating: 240 VAC, 2.5 A/resistive load, 1A/ inductive load
	I	Current 4 to 20 mA DC, Load resistance: 600Ω max.
	P	SSR drive voltage 12 V±1.5 VDC, Load current: 30 mA max.
	V	Voltage 0 to 10 VDC, Load current: 2 mA max.
4. Control output 2 N- selected when basic function SS is used	N-	None
	Y-	Contact 1c, Contact rating: 240 VAC 2.5 A/resistive load, 1A/ inductive load
	I-	Current 4 to 20 mA DC, Load resistance: 600Ω max.
	P-	SSR drive voltage 12 V±1.5 VDC, Load current: 30 mA max.
	V-	Voltage 0 to 10 VDC, Load current: 2 mA max.
5. Heater burnout alarm (for 1-phase) *1	00	None
	31	Heater burnout alarm (heater current 30 A, CT provided)
	32	Heater burnout alarm (heater current 50 A, CT provided)
		Selectable only when Control Output 1 or 2 is Y or P
6. Analog output 1	0	Without
	3	0 to 10 mVDC, Output resistance: 10Ω
	4	4 to 20 mA DC, Load resistance: 300Ω max.
	6	0 to 10 VDC, Load current: 2 mA max.
7. Analog output 2/sensor power supply	0	Without
	3	0 to 10 mVDC, Output resistance: 10Ω
	4	4 to 20 mA DC, Load resistance: 300Ω max.
	6	0 to 10 VDC, Load current: 2 mA max.
	8	Sensor power supply 24 VDC 25mA
8. External I/O control signals (DI/DO) *2	Standard	0 4 DI, 5 DO
		1 10 DI, 9 DO
		2 10 DI, 13 DO
9. Communication interface	0	Without
	5	RS-485
	7	RS-232C
10. Remarks	0	With
	9	Without

*1 When the 2-output specification is used, either of Control Output 1 or Control Output 2 is used as the heater burnout alarm.

*2 Ten DI points (code 1 or 2) are required for switching the start pattern No. by DI.

2-input specification

Item	Code	Specification
1. Series	FP23-	MPU-mounted multi-function controller
2. Basic functions *1	DL	Multi-input, independent 2-channel control, 3 event outputs
	DS	Multi-input, 2-input operation/1-output control, 3 event outputs
	DD	Multi-input, 2-input operation/2-output control, 3 event outputs
3. Control output 1	Y	Contact 1c, Contact rating: 240 VAC, 2.5 A/resistive load, + load 1 A/inductive load
	I	Current 4 to 20 mA DC, Load resistance: 600Ω max.
	P	SSR drive voltage 12 V±1.5 VDC, Load current: 30 mA max.
	V	Voltage 0 to 10 VDC, Load current: 2 mA max.
4. Control output 2 Y- selected when basic function DS is used	Y-	Contact 1c, Contact rating: 240 VAC 2.5 A/resistive load, 1A/ inductive load
	I-	Current 4 to 20 mA DC, Load resistance: 600Ω max.
	P-	SSR drive voltage 12 V±1.5 VDC, Load current: 30 mA max.
	V-	Voltage 0 to 10 VDC, Load current: 2 mA max.
5. Heater burnout alarm (for 1-phase) *2	00	None
	31	Heater burnout alarm (heater current 30 A, CT provided) — Selectable only when Control Output 1 or 2 is Y or P
	32	Heater burnout alarm (heater current 50 A, CT provided) — Selectable only when Control Output 1 or 2 is Y or P
6. Analog output 1	0	Without
	3	0 to 10 mVDC, Output resistance: 10Ω
	4	4 to 20 mA DC, Load resistance: 300Ω max.
	6	0 to 10 VDC, Load current: 2 mA max.
7. Analog output 2/sensor power supply	0	Without
	3	0 to 10 mVDC, Output resistance: 10Ω
	4	4 to 20 mA DC, Load resistance: 300Ω max.
	6	0 to 10 VDC, Load current: 2 mA max.
	8	Sensor power supply 24 VDC 25mA
8. External I/O control signals (DI/DO) *3	Standard 0	4 DI, 5 DO
	1	10 DI, 9 DO
9. Communication interface	0	Without
	3	RS-485 (not insulated) — SHIMADEN standard protocol/ MODBUS communication protocol
	5	RS-485 — SHIMADEN standard protocol/ MODBUS communication protocol
	7	RS-232C — SHIMADEN standard protocol/ MODBUS communication protocol
10. Remarks	0	With
	9	Without

*1 The 2-output specification can support one of independent 2-channel control, 2-input operation/1-output, or 2-input operation/2-output control. This device is set with the function selected in item “2. Basic functions” before it is shipped.
Both Control Outputs 1 and 2 must be selected. If you have no intention of using control outputs and you are unsure, select contact (Y).

*2 When the internal cascade control specification is used, output for control is output to Control Output 2. Select the same specifications as Control Output 2 for Control Output 1.

*3 When the 2-input operation, 1-output control specification is used, output for control is output to Control Output 1. Select the same specifications as Control Output 1 for Control Output 2.

*4 When the 2-output specification is used, either of Control Output 1 or Control Output 2 is used as the heater burnout alarm.

*5 Ten DI points (code 1) are required for switching the start pattern No. by DI.

Checking accessories

Make sure that your product package has all of the following items:

Standard accessories

(1) Instruction Manual (this manual)
(2) LCD Screen Display Parameters Drawing
(3) Mounting fixture (w/ 2 screws)
(4) Terminal cover
(5) Unit decal

Optional accessories

(1) Current transformer (CT) for heater break alarm (when the heater break alarm option is selected)
(2) Communications Interface Instruction Manual
(3) Terminal resistance (when the communication option is selected)

Options (sold separately)

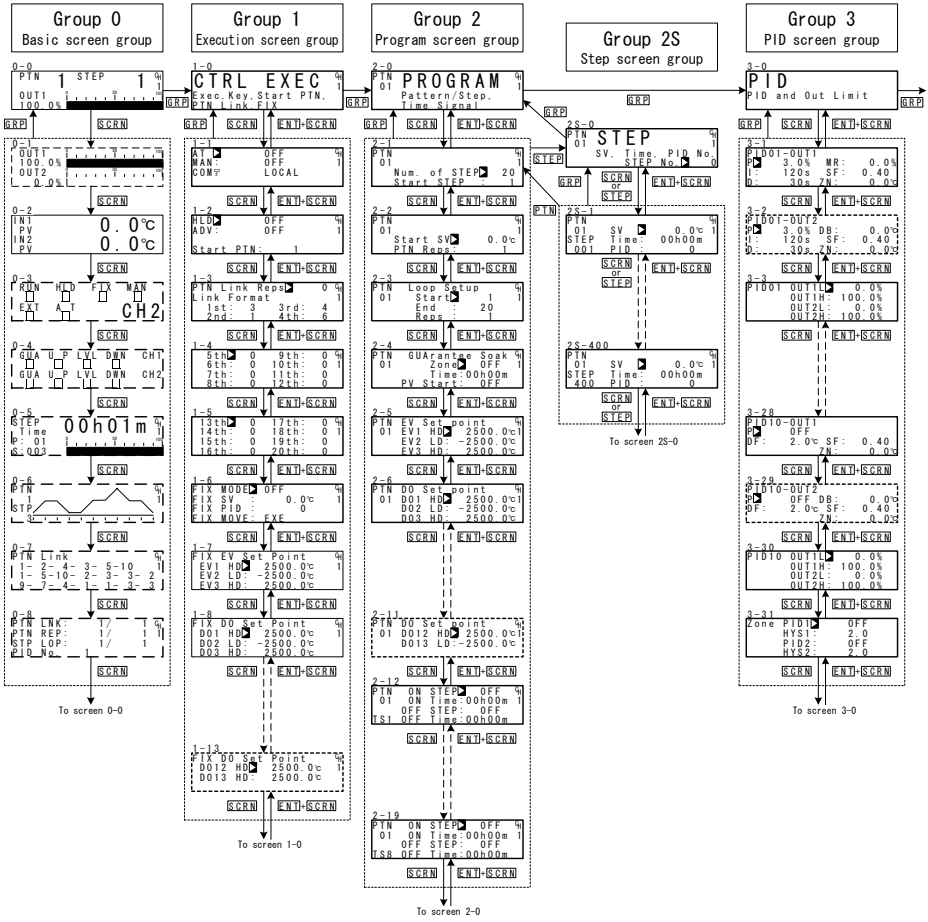
The following table shows the options available for this product.

Model No.	Model No.	Application
Infrared Communication Adapter	S-5004	USB connector cable (2 m) w/ Setup Software (CD-ROM)
Shunt resistance	OCS002	250Ω±0.1%, external receiving resistance at current input
Relay Unit	AP2MC	Converts open collector output to contact output. 2 circuits built-in

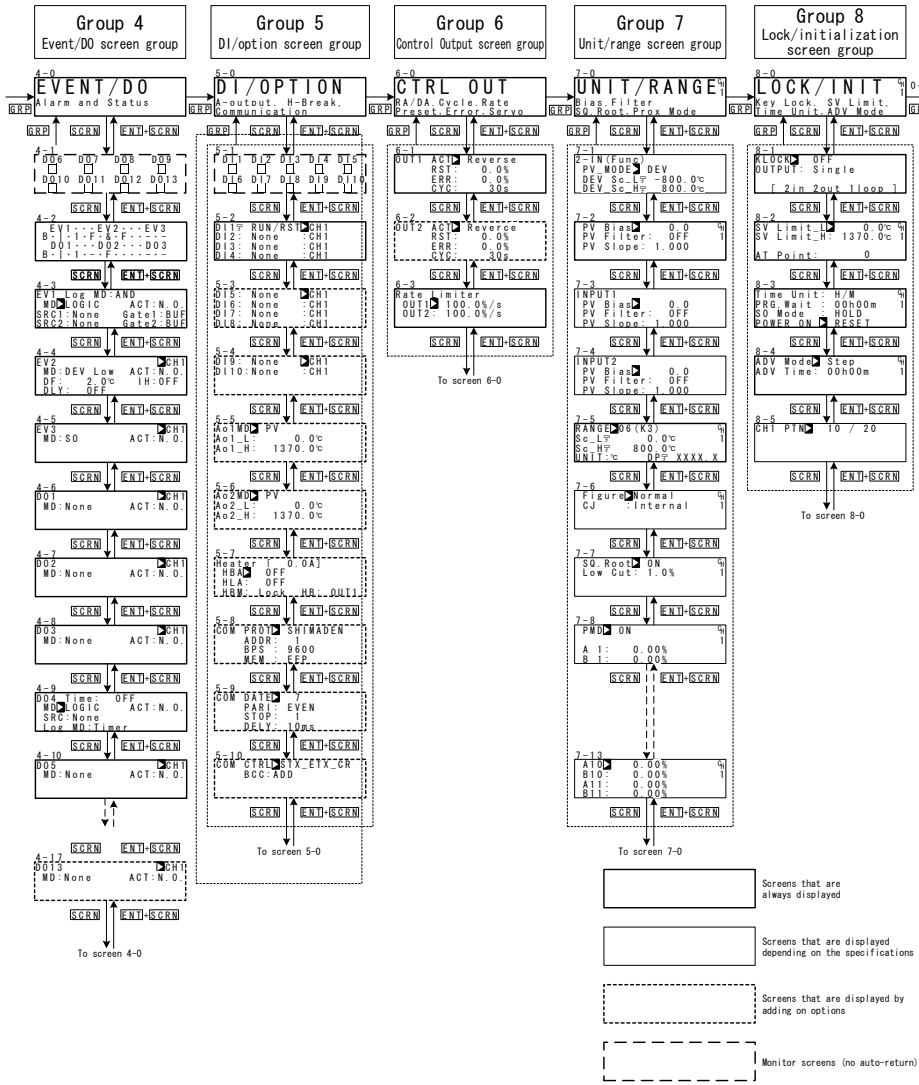
Contents

LCD Screen Index

The following shows how to move between the LCD display screens of this device and the numbers of pages that explain these screens.
For details on the LCD screen display, see the “A3-size LCD Screen Display Parameters Drawing” (provided separately).



When the DISP key is pressed at a screen other than the 0-0 basic screen, the 0-0 basic screen is returned to.


Group 4
Event/DO screen group
Group 5
DI/option screen group
Group 6
Control Output screen group
Group 7
Unit/range screen group
Group 8
Lock/initialization screen group
EVENT/DO
Alarm and Status
DI/OPTION
A-output, H-Break, Communication
CTRL OUT
RA/DA Cycle Rate Preset Error Servo
UNIT/RANGE
Bias Filter SQ Root Prox Mode
LOCK/INIT
Key Lock, SV Limit, Time Unit ADV Mode
GRP
SCRN
ENT+SCRN
To screen 4-0
To screen 5-0
To screen 6-0
To screen 7-0
To screen 8-0
Screens that are always displayed
Screens that are displayed depending on the specifications
Screens that are displayed by adding on options
Monitor screens (no auto-return)

1 INSTALLATION & WIRING

1-1 FP23 Installation Site

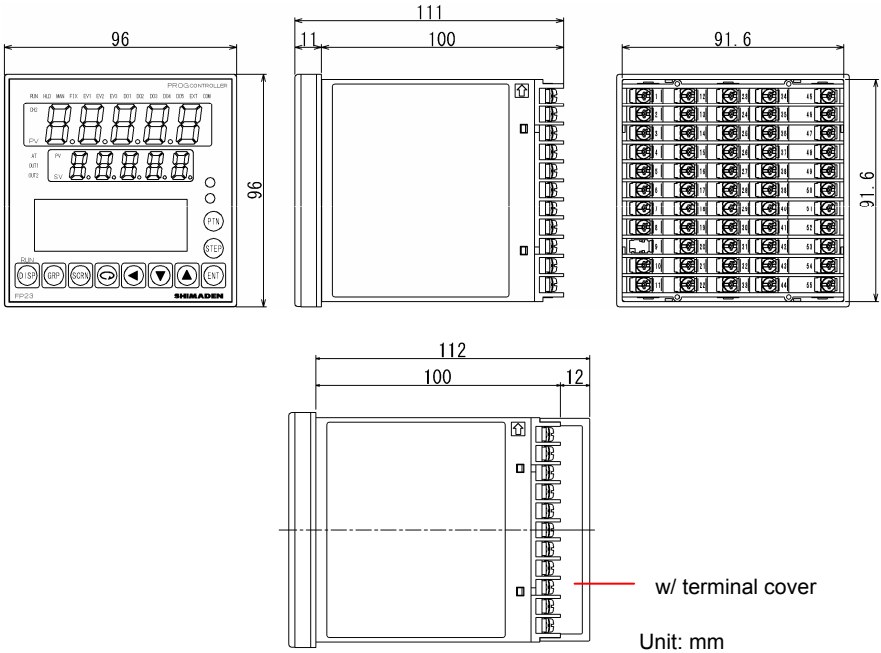
⚠Caution

Do not use this device in the following sites.
Doing so might result in malfunction or damage to this device and in some cases cause fire and/or dangerous situations.

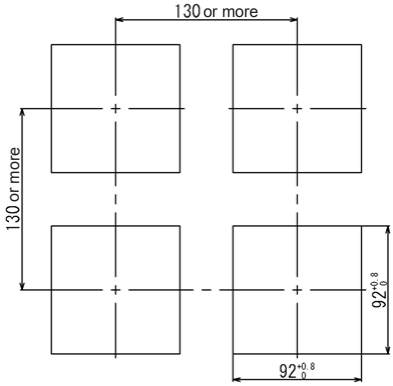
- ●Locations that are filled with or generate inflammable gas, corrosive gas, dirt and dust, smoke, etc.
- ●Locations that are subject to water droplets, direct sunlight or strong radiated heat from other equipment
- ●Locations where the ambient temperature falls below -10°C or rises above 50°C
- ●Locations where condensation forms and the humidity reaches 90% or more
- ●Near equipment that generates high-frequency waves
- ●Near heavy current circuits or locations likely to be subject to inductive interference
- ●Locations subject to strong vibration and impact
- ●Locations exceeding an elevation of 2000 m

1-2 FP23 External Dimensions and Panel Cutout

External dimensions



Panel cutout dimensions and space for gang mounting



Unit: mm

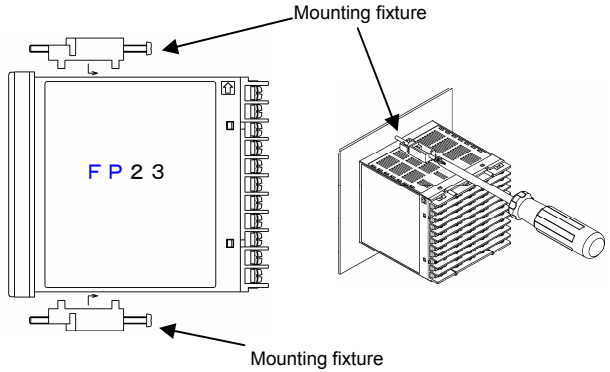
1-3 Mounting the FP23 on a Panel

⚠Caution

To ensure safety and maintain the functions of this device, do not disassemble this device.
If this device must be disassembled for replacement or repair, contact your dealer.

Follow the procedure below to mount this device on a panel.

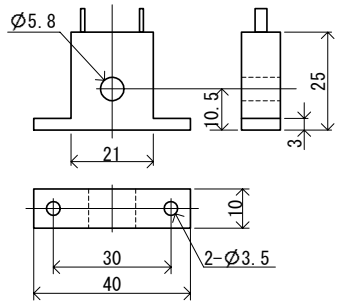
1. Drill mounting holes referring to the panel cutout dimensions described in the previous section.
   The applicable thickness of the mounting panel is 1.0 to 8.0 mm.
2. Press this device into the panel from the front of the panel.
3. Insert the mounting fixtures at the top and bottom of this device, and tighten the screws from behind to fasten the device in place.
4. Over-tightening the screws may deform or damage the device housing.
   Take care not to tighten the screws too tight.
5. After completing wiring after installation, attach the terminal cover.



1-4 Dimensions of Current Transformer (CT) for Heater Burnout Alarm

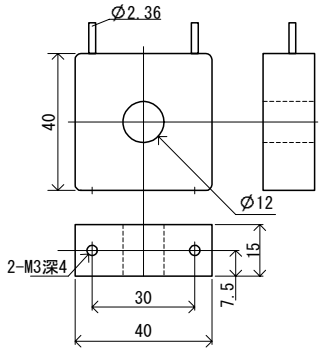
The CT can be used when the heater burnout alarm is selected in the product specifications.
Select either of the following optional CTs.

■For 0 to 30A (CTL-6-S)



Unit: mm

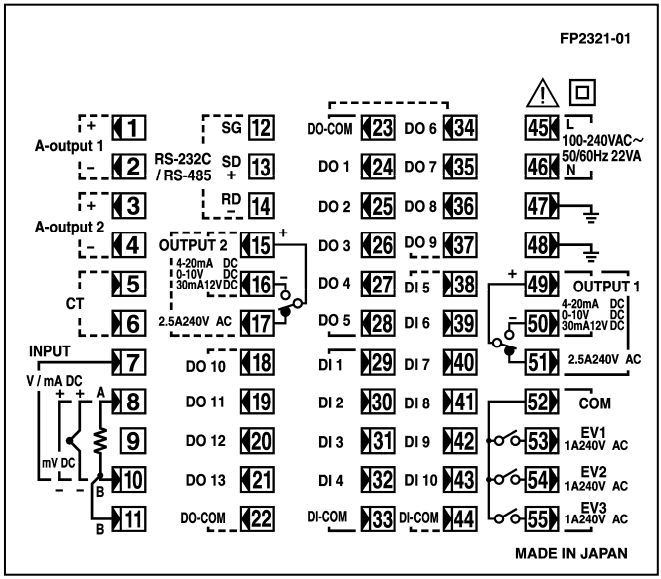
■For 0 to 50A (CTL-12-S36-8)



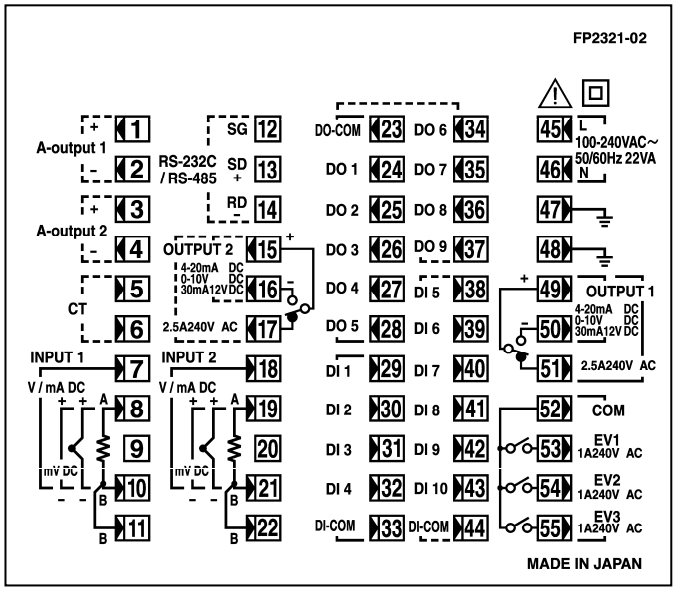
Unit: mm

1-5 FP23 Rear Terminal Arrangement Diagrams

■ **1-input model**



■ **2-input model**



Terminal No.	Symbol	Description	
1 2	+ -	Analog output 1 (option)	
3 4	+ -	Analog output 2 (option)	
5 6	+ -	Heater burnout alarm CT input (option)	
8 10	+ -	mV, thermocouple input	Input 1
8 10 11	A B B	RTD input	
7 10	+ -	V, mA input	
45 46	L N	Power supply	
47 48		Grounding (internal shorting across terminals)	
49 50 51	COM+ NO- NC	Control output 1	
23	COM		
24 25 26	DO1 DO2 DO3	External control output DO (mounted as standard)	Darlington output
27 28	DO4 DO5		Open collector output
29 30 31 32 33	DI1 DI2 DI3 DI4 COM	External control output D1 (mounted as standard)	
34 35 36 37	DO6 DO7 DO8 DO9	External control output DO Open collector output (option)	
Terminal No.	Symbol	Description	
38 39 40 41 42 43 44	DI5 DI6 DI7 DI8 DI9 DI10 COM	External input DI5 to DI10 (option)	

12 13 14	SG SD+ RD-	Communication function (option)
15 16 17	COM+ NO- NC	Control Output 2 (option)

18 19 20 21 22	DO10 DO11 DO12 DO13 DO COM	External Control Output DO10 to DO13 Open collector output 1-input specifications only (option)

19 21	+ -	mV, thermocouple input	Input 2 (option)
19 21 22	A B B	RTD input	
18 21	+ -	V, mA input	

A receiving resistance of 1/2W 250Ω 0.1% is attached across input terminals (7-10 or 8-21) for use for the 0 to 20mA, and 4 to 20mA inputs.

Note

Inputs 1 and 2 on this device are not insulated.
When Inputs 1 and 2 are used on the same common, control accuracy is sometimes impaired when connections are such that the control loop is extended.

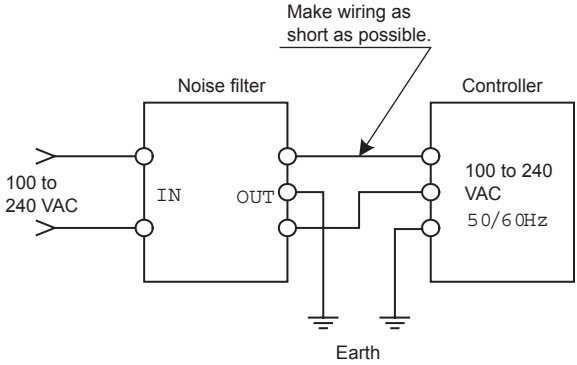
1-6 Wiring

Caution

- To prevent electric shock, always turn off and disconnect this device from the power supply before starting wiring.
- Do not touch wired terminals or charged parts with your hands while the power is supplied.

Pay attention to the following points when performing wiring:

- Check that the wiring is free from mistakes according to "1-5 FP23 Rear Terminal Arrangement Diagrams."
- Use crimped terminals that accommodate an M3 screw and that have a width of 6.2 mm or less.
- For thermocouple input, use a compensation wire compatible with the type of thermocouple.
- For RTC input, leads should be 5Ω or less in resistance per lead, and the three leads should have the same resistance.
- The input signal lead must not be passed along the same piping or duct as that for high-voltage power lines.
- Shield wiring (single point grounding) is effective against static induction noise.
- Short interval twisted pair wiring is effective against electromagnetic induction noise.
- When wiring, use wire or cable (minimum 1 mm^2 cross-sectional area) of 600 V grade PVC insulated wire or equivalent wire having the same rating.
- For wiring the ground, ground the ground terminal with the earth resistance at less than 100Ω and with wire 2 mm^2 or thicker.
- Two earth terminals are provided, each connected internally. One is for the ground connection, and the other is for connecting the shield of the signal lead. Do not use the earth terminals for crossover wiring of the power system ground lead.
- If this device is considered as being susceptible to noise caused by the power supply, attach a noise filter to prevent abnormal functioning.
  Install a noise filter onto a grounded panel, and make the wire connecting the noise filter output and the power supply terminal on the controller as short as possible.



Recommended noise filter: ZMB2203-13

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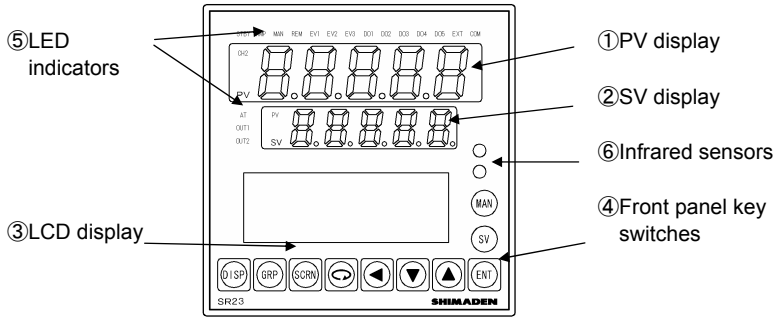
2 NAMES & FUNCTIONS OF PARTS ON FRONT PANEL



①PV display
Displays the current measured value of CH1. (Display Modes 1 and 3)
When the CH2 indicator is lit, displays the measured value (PV) of CH2. (Display Mode 2)
Displays an error message when an error (e.g. scale over) occurs.

②SV display
During execution on CH1, displays the target value of SV No. (Display Mode 1)
When the CH2 indicator is let, displays the target value (SV) of Execution SV No. on CH2. (Display Mode 2)
When the PV indicator is lit, displays the measured value on CH2. (Display Mode 3)

Relationship between display mode, PV display and SV display

- Display Mode 1 is displayed in both a 1-loop specification and a 2-loop specification.
  The PV of CH1 is displayed on the PV display, and the SV of CH1 is displayed on the SV display.
- Display Modes 2 and 3 are displayed only when the 2-loop specification is selected.
  In Display Mode 2 (when CH2 indicator is lit), the PV of CH2 is displayed on the PV display, and the SV of CH2 is displayed on the SV display.
  In Display Mode 3 (when PV indicator is lit), the PV of CH1 is displayed on the PV display, and the PV of CH2 is displayed on the SV display.

③LCD display

・Pattern/step No. display	Displays the pattern/step No. in the program mode. In the FIX mode, “FIX indicating the FIX mode is displayed at the PTN field and “----“ is displayed at the STEP field. ”----“ at the STEP field goes out during control execution (RUN) in the FIX mode.
・Ouput (OUT) display	The control output value is displayed by a numerical value and a bar graph as a percentage (%).

・Channel (CH1, CH2) display	The channel of the screen display parameters and data are displayed. (only in a 2-loop control specification)
・IN1/IN2 PV display:	Displays the PV value of INPUT1/INPUT2 (in 2-input computation specification only).
・CH1/CH2 operation display:	Displays the operation monitor of channels not displayed on the operation display. (2-loop specification only)
・Program mode disaply:	Displays the program status monitor.
・Remaining step time display:	Displays the remaining step time during program operation.
・Pattern graph display:	Displays the pattern (step) graph during program operation.
・Screen title display:	Displays the screen group title in the respective screen group top screen.
・Setup parameter display:	Selected and displayed by front key operation in the parameter setups (21 characters x 4 lines)

④Front panel key switches

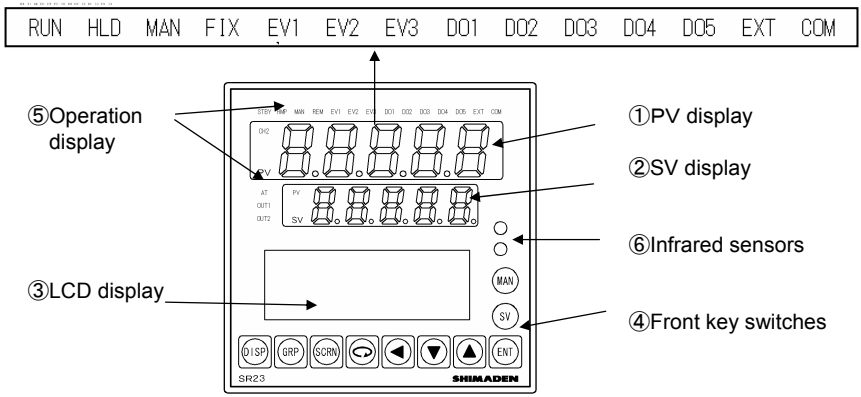
DISP	Display key	Displays the basic screen, and switches between the three basic screen types.
GRP	Group key	Changes the screen group to be displayed. Or, returns to the group title screen.
SCRN	Screen key	Changes the parameter display screen in a group.
↺	Parameter key	Selects the parameter to set up or change. The parameter to be changed is indicated by the cursor (▶). This cursor blinks all the time.
◀	Shift key	Moves the digit in set numerical values.
▼	Down key	Decrements parameters and numerical values during setup.
▲	Up key	Increments parameters and numerical values during setup.
ENT	Entry key	Switches the execution SV No. in the basic screen.
STEP	Step key	Increments the step No. in the basic screen. (ENT must be pressed to fix the step No.)
PTN	Pattern key	Increments the pattern No. in the basic screen. (ENT must be pressed to fix the pattern No.)

⑤Operation display

Monitor indicators

CH2	Green	Lights when the PV and SV of CH2 are displayed on the PV and SV displays.

		When the 2-input specification is used, the monitor indicators display the state (RUN, HLD, MAN, FIX, AT) of CH1 when the CH2 indicator is out. The monitor indicators display the state of CH2 while the CH2 indicator is lit.
PV	Green	Lights when the PV of CH1 is displayed on the SV display.



⑤Operation display (cont'd)

Status indicators

RUN	green	Blinks during program standby, and lights during program execution.
HLD	green	Lights during program pause. Blinks at an input error during program execution.
MAN	green	Blinks when control output is set to manual operation (MAN).
FIX	orange	Lights in the FIX mode.
EV1	orange	Lights during EV1 action.
EV2	orange	Lights during EV2 action.
EV3	orange	Lights during EV3 action.
DO1	orange	Lights during DO1 action.
DO2	orange	Lights during DO2 action.
DO3	orange	Lights during DO3 action.
DO4	orange	Lights during DO4 action.
DO5	orange	Lights during DO5 action.
EXT	green	Lights when start pattern No. selection (PTN 2bit, PTN 3bit, PTN 4bit, PTN 5bit) are set to DI5 to DI8.
COM	green	Lights when setup of parameters, for example, is being performed by communication (COM).
AT	green	Blinks during execution of auto tuning, and lights during standby.
OUT1	orange	During current or voltage output, the brightness of this indicator changes according to fluctuation of Control Output 1, and during contact or SSR drive voltage output, this indicator lights when Control Output 1 is ON and goes out when Control Output 1 is OFF.
OUT2	orange	During current or voltage output, the brightness of this indicator changes according to fluctuation of Control Output 2, and during contact or SSR drive voltage output, this indicator lights when Control Output 2 is ON and goes out when Control Output 2 is OFF.

Note

●For details on the main screen operations on this device, see the following items:

1. FP23 operation at power ON	3-1	p.11
2. Switching LCD screen display and cursor operation	3-2	p.12
3. Entry of numerical values on the LCD screen	3-3	p.13
4. Selection of setting items on the LCD screen	3-3	p.14
5. Operations in basic screen	15-2	p.78
6. Execution and cancellation of auto tuning	16-2	p.83
7. Auto/manul switching of control output	16-3	p.85
8. Temporary hold and resumption of program	16-4	p.86
9. Executing advance	16-5	p.87
10. Verification (monitor) of operation state (control during execution)	16-1	p.81
11. Displaying step No. and SV	15-3	p.80

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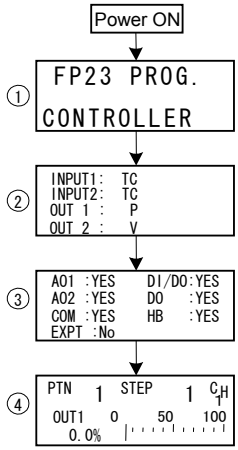
3 OPERATION AT POWER ON, MOVING BETWEEN SCREENS & SETUP

3-1 FP23 Operation at Power ON

When the power is turned ON, the basic screen is displayed after each of the initial screens are displayed on the LCD for about three seconds each.
When the FP23 is powered ON for the first time, check on screen to make sure that this device is the one you ordered.



①The series name is displayed.

②The I/O type is displayed.
The figure shows a thermocouple (TC) set for Input 1, thermocouple (TC) set for Input 2, SSR drive voltage (P) set for Output 1, and output (V) set for Output 2.

③The mounting status of option functions is displayed.
The figure shows that Analog Output 1, Analog Output 2 and the communication function are mounted (YES), DI (10 points) and DO (9 points) are monuted (YES), and DO 13 points and the heater burnout alarm are mounted (YES).

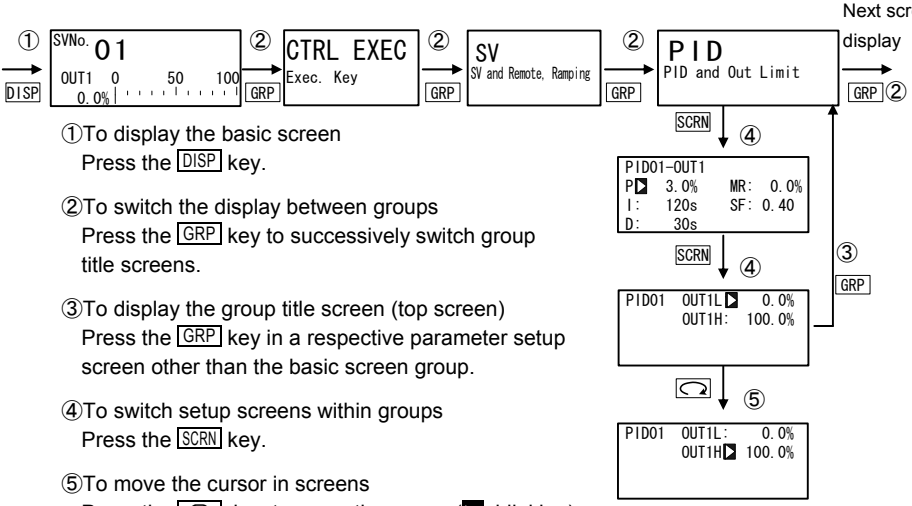
④Basic screen (Monitor Group top screen)
The figure shows that OUT1 of PTN.1 on CH1 is outputting at 0% in the case of a 2-loop (2 channel) specification.

The details displayed on screen vary according to 1-input/2-input and 1-output/2-output specifications, or according to preset function specifications.

3-2 Switching LCD Screen Display and Moving the Cursor

Switching the screen display

For details on moving between screens, see “LCD Screen Index” in the preface.
The operation screens of this device are configured so that screens are displayed in order from the most frequently used screen in regular use.
The following shows an example of screens in the 1-input/1-output specification.



①To display the basic screen
Press the DISP key.

②To switch the display between groups
Press the GRP key to successively switch group title screens.

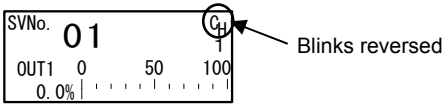
③To display the group title screen (top screen)
Press the GRP key in a respective parameter setup screen other than the basic screen group.

④To switch setup screens within groups
Press the SCRN key.

⑤To move the cursor in screens
Press the ↺ key to move the cursor (▶: blinking) to the next parameter when there are two or more parameters in the same screen.

CH1 and CH2: Switching channels

This operation is required in 2-loop action.
Press the ↺ key to move the (▶: blinking) to CH1, and press the ▼, ▲ keys to switch the channel.



In a 2-loop specification, if you return to the basic screen (group 0) by pressing the GRP key, CH displayed on the basic screen changes to the CH No. for which the PV is displayed.

3-3 Changing and Registering Data

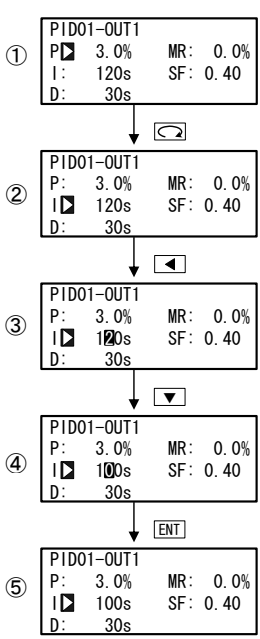
Basically, set up and change parameters while confirming the LCD screen display.

Entering numerical values

1. When there are two or more parameters, press the [↻] key to move the cursor (▶) to the parameter to be changed.
2. Press the [◄] or [▼], [▲] keys. The smallest digit of the numerical value blinks.
3. Press the [◄] key again. Move the blinking section in the numerical value to the digit to be changed, and change the value using the [▼] or [▲] key.
4. Press the [ENT] key. The numerical value is fixed and registered, and stops blinking.

Changing a numerical value setting (example)

The following shows the procedure for changing the value of PID parameter I to 100 s.



①To move between screens
Press the [GRP] key three times in the intial screen to display the top screen of the PID screen (group 3). Next, press the [SCRN] key once.

②To move the cursor from P to I
Press the [↻] key once to move the blinking cursor (▶) to I.

③To make the I numerical value blink and move to the 10's digit
Press the [◄] key twice to move the blinking cursor to the 10's digit.

④To change the numerical value of the 10's digit to 0
Press the [▼] key to change the display from "2" to "0".

⑤To fix and register the setting
Press the [ENT] key to fix the new setting.

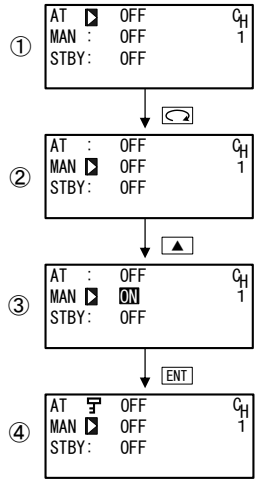
Selecting setup items

The settings of parameters marked by a 🔒 key mark cannot be changed.

1. When there are two or more parameters, press the [↩] key to move the cursor (▶) to the parameter to be changed.
2. Change the parameter settings by the [▼] or [▲] key, check the setting, and press the [ENT] key to fix and register settings. The character stops blinking.

Selecting a parameter (example)

The following shows the procedure for changing control output to manual.



① To move between screens
Press the [GRP] key once in the initial screen to display the top screen of the execution screen (group 1).
Next, press the [SCRN] key once.

②To move the cursor from AT to MAN
Press the [↩] key once to move the blinking cursor (▶) to MAN.

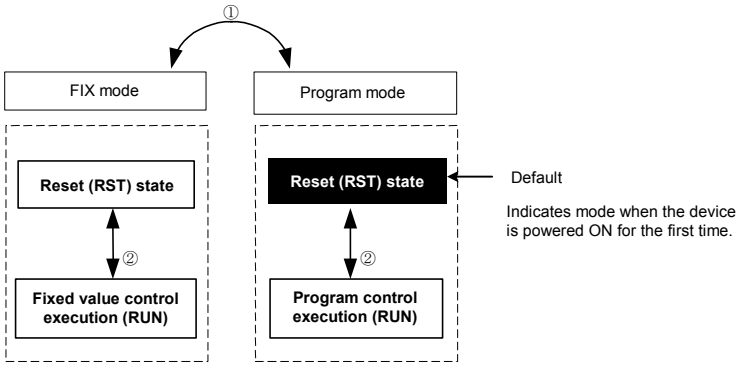
③To change the MAN setting from OFF to ON
Press the [▲] key to change the display from OFF to ON.

④To fix and register the setting
Press the [ENT] key to fix the new setting.

4. CONTROL MODES, PROGRAMS & CONTROL FUNCTION BLOCK DIAGRAMS

4-1 FP23 Control Modes

This device can execute fixed value cont
The FP23 has two control modes.
These are the “program mode” for performing program operation, and the “FIX mode” for performing fixed value control.
The following illustrates the relationship between both of these modes and how to switch to these modes.



① The FIX mode is switched by the FIX mode ON/OFF settings in the FIX MODE screen (No.1 to 6). The mode switches to the FIX (fixed value) mode when ON is set, and to the program mode when OFF is set.

② Switch RST/RUN by the [ENT] + [DISP] keys.

4-2 Reset State

The FP23 does not execute control when it is in a reset state in both the program and FIX modes.
Note, however, that output at reset can be set in advance.
For details, see “8-5 Setting output at reset.”

Also, when the operation modes shown in the table below are assigned to event/DO, event/DO are sometimes not output even if the state returns (moves) to an operation state from a reset state.

Actions that sometimes cannot be restored after a reset is canceled

EV_MD	EV, DO operation modes
DEV Hi	Higher limit deviation value action
DEV Low	Lower limit deviation value action
DEV Out	Outside higher/lower limit deviation
DEV In	Inside higher/lower limit deviation

PV Hi	PV higher limit absolute value
PV Low	PV lower limit absolute value

4-3 Program Functions

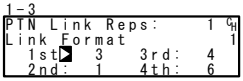
Up to 20 steps x 20 patterns can be stored to memory on this device.
Steps can be freely assigned as long as the total number of steps to assigned to each pattern is within 400 steps.

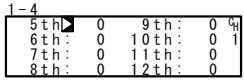
For example, to assign 40 steps to pattern 1 with 20 steps each assigned and set to each of patterns 1 to 20, set the number of steps assigned to unused pattern 20 to “0”, and set the number of steps of pattern 1 to “40”.

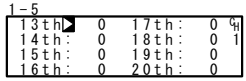
The FP23 is also mounted with various program setup functions such as the pattern link function, pattern execution function, and step loop function.

■Pattern link function

Each of the patterns can be linked.
The pattern link can be set in any order.

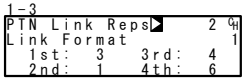


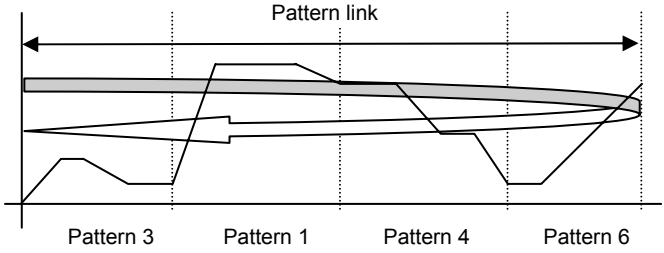




■Pattern link execution function

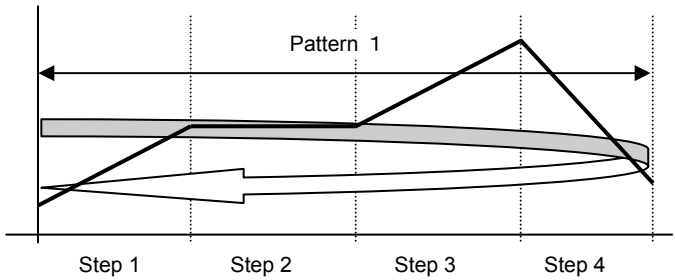
Linked patterns can be executed repeatedly 1 to 9999 times.





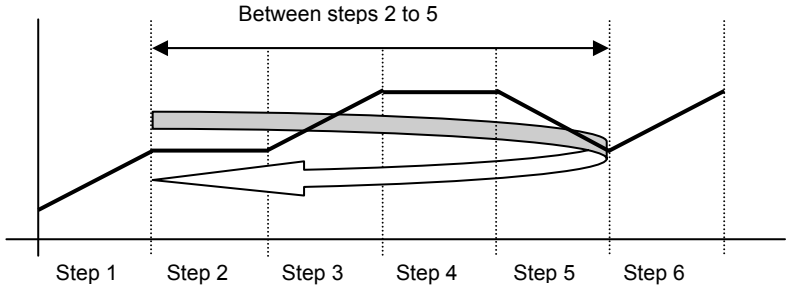
■Pattern execution function

Any pattern can be executed repeatedly 1 to 9999 times.



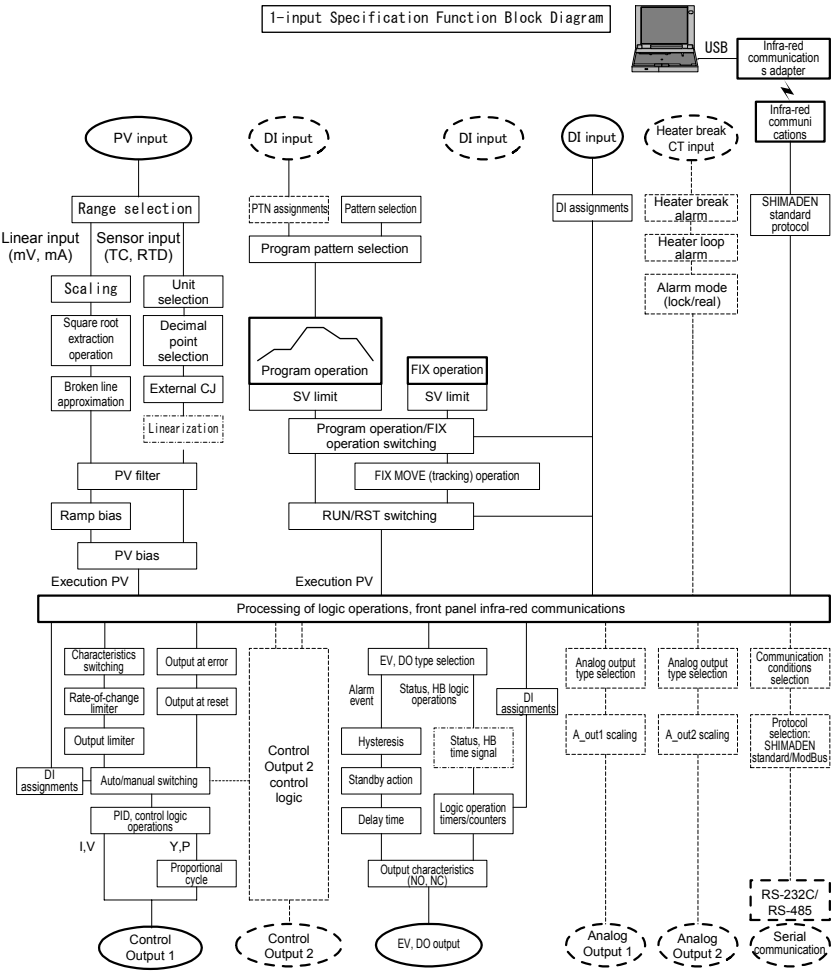
■Step loop function

Any step time can be executed repeatedly 1 to 9999 times.

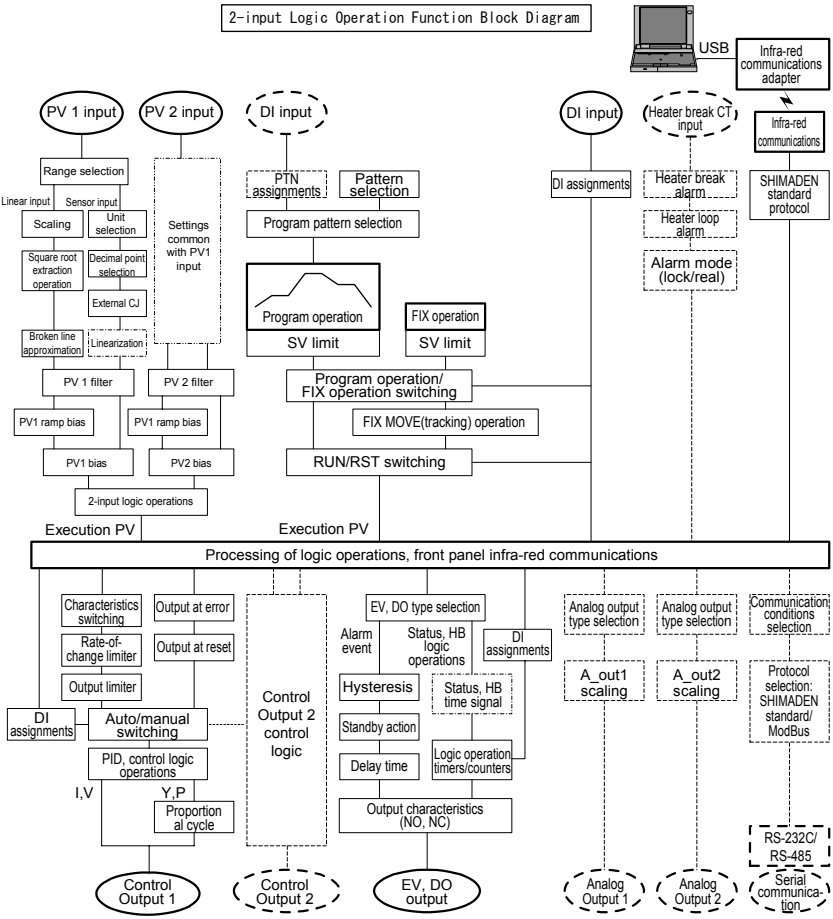


4-4 CONTROL FUNCTION BLOCK DIAGRAMS

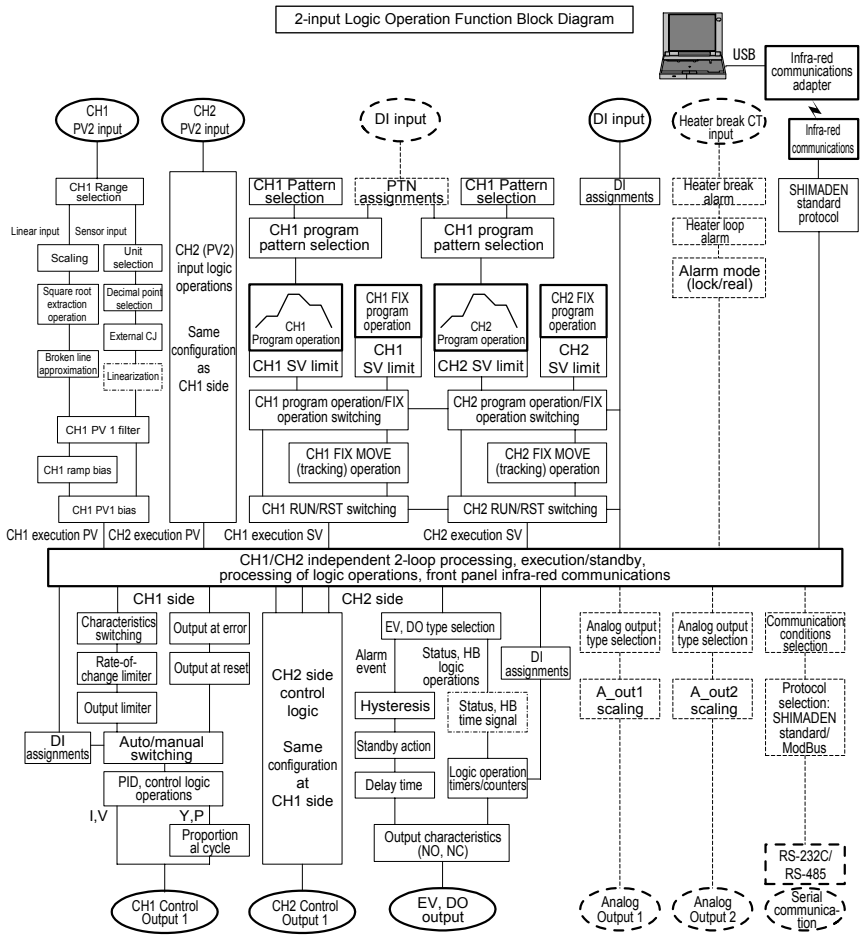
1-input, 1-output/2-output (option)



2-input, 1-output/2-output



2-input, 2-output/2-output independent channels



5 INITIAL SETUP & SETUP BEFORE OPERATION

5-1 Parameter Setup Procedure

Follow the procedure below to set up this device or change device settings when you are to use this device for the first time, change the control mode during use, or the control target device has been changed, for example.

Caution

When you initialize this device, all parameter settings are erased, and settings return to their factory settings.
Before you initialize this device, note down and retain settings as required.

It is assumed that experienced personnel familiar with basic operation of this device will set up this device.
Users other than device manufacturers should thoroughly familiarize themselves with the functions to be used before they start to operate or set up this device.

Basic operations and setup of this device are described in detail from Chapter 6 onwards by following programming procedures.
Some screens and parameters are not displayed when option functions are not added on or when option functions are not selected.
For an overview of operation screens and how to move between screens, see “LCD Screen Index” in the preface. For an overview of setup parameters, see “18. Parameter Lists.”

Set up parameters in the order shown below.

1. Cancel the key lock and the operation mode.
Perform this as necessary.
For details, see “Chapter 6.”
Initialize I/O
For details, see “Chapter 7.”

2. I/O auxiliary settings.
For details, see “Chapter 8.”

3. Set up the program.
Make “program initial settings,” “step-related settings,” “pattern-related settings,” “pattern link-related settings,” and “setup before program operation.”
For details, see “Chapter 9.”

5. Set up FIX.
For details, see “Chapter 10.”

6. Set up PID.
For details, see “Chapter 11.”

7. Set up EV/DO.
For details, see “Chapter 12.”

8. Set up DI and AO.
For details, see “Chapter 13.”

9 Options and other functions
When setup of heater burnout/loop alarm and the communications function is completed, set the key lock as necessary to prevent inadvertent operation.
For details, see “Chapter 14.”

10. Monitor, execute and stop operation.
For details, see “Chapter 15.”

11. Control operations during execution
For details, see “Chapter 16.”

6. OPERATION MODE & CANCELING KEY LOCK

Perform the following as necessary.

6.1 Selecting the Operation Mode in a 2-input Specification

Caution

・On 2-input specification models, all parameters are initialized when the operation modes described in this chapter are changed.
For this reason, parameters must be set again after the operation mode is changed.

The descriptions in this chapter need not be read in the case of a 1-input specification

This chapter describes the functions of the 2-input operation mode and how to set up this mode.
This operation mode is closely related to basic section of control, so fully understand the details of this operation mode. The setup procedure is made deliberately complicated to prevent unnecessary setup or changes.

Before you start using this device, you must select one of the following operation modes on models supporting the optional 2-input specification:

●1-input, 1-output/2-output (1 loop)
●2-input, 1-output/2-output (1 loop)
●2-input, 2-output (2 loops, independent)

2-input, 2-output specification operation mode

There are three 2-input operation modes as follows.
Operation modes for functions that are not mounted as options are not displayed as menu selections in the action setup screen.

1-input
This device operates as a regular 1-loop controller, and Input 2 is disabled.
(1) During 1-input, only OUT1 operates, and OUT2 is disabled.
(2) During 2-output, this device operates as a 1-loop/2-output controller. Combinations of Reverse+Reverse, Direct+Direct, and Reverse+Direct are possible as outputs.
This can be used for 2-stage heating, 2-stage cooling, and heating+cooling, etc.

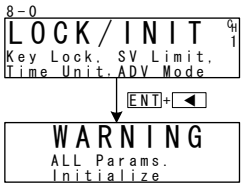
2-input logic operation (1 loop)
This device performs arithmetic operation on two inputs to perform control action by a single SV.
Select from the four input operation methods: maximum PV value (MAX), minimum PV value (MIN), average PV value (AVE) and PV deviation value (DIV). The operation result is displayed as the PV.
(1) During 1-input, only OUT1 operates, and OUT2 is disabled.
(2) During 2-output, this device operates as a 1-loop/2-output controller. Combinations of Reverse+Reverse, Direct+Direct, and Reverse+Direct are possible as outputs.
This can be used for 2-stage heating, 2-stage cooling, heating+cooling, etc.

2-input/2-output (2-in, 2-out: 2 loops)
This device uses the channels independently (CH1: Input 1-OUT1, CH2: Input 2-OUT2), and operates as two controller units.
This operation mode is preset on 2-input/2-output specification models before they are shipped from the factory.
The regular display mainly displays CH1. So, key operation is sometimes required to confirm display of CH2.

2-input specification operation mode settings

This 2-input operation mode cannot be set or changed during control action.

1. Unlock the key lock when the key lock is enabled.
   For details on how to do this, see "6.2 Canceling Key Lock."
2. Stop controller operation (to a reset state), and reset device operation.
   When this device is used in a 2-loop specification, set the reset on both CH1 and CH2.
3. Call the operation mode setup screen.
   Press the [GRP] key in the basic screen to display the top title screen of the LOCK/INIT screen group (group 8).
4. Press the [◄] key for about three seconds with the [ENT] key held down.



A warning is displayed on the LCD screen, and the setup parameters in the table below are displayed on the PV/SV displays.

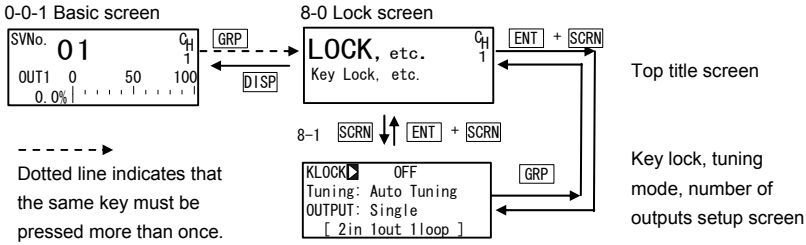
PC Display SV Display	Operation mode	Description
1-1n 1LooP	1-input (1 loop)	1-channel controller Can be switched to 1-output or 2-output for use.
2-1n 1LooP	2-input (1 loop)	Operates as a 2-input operation controller. Can be switched to 1-output or 2-output for use.
2-1n 2LooP	2-input (2 loops)	Operates as two independent controllers CH1: INPUT1, OUT1, CH2: INPUT2 OUT2

5. Press the [▼] or [▲] keys to select the operation mode, and press the [ENT] key to fix and register the mode.
6. When you have finished setting the operation mode, press the [DISP] key.
   This device is reset and starts up again.

6.2 Canceling the Key Lock

Key lock screen display

To call up the LOCK, etc. screen group (group 8) from the basic screen, press the GRP key.
Press the SCRN key in the LOCK, etc. screen group to switch to the screens for making and changing setups.
Select parameters in screens by pressing the ↺ key.
Set parameters by pressing the ◄, ▼ or ▲ key, and press the ENT key to fix and register settings.



Canceling the key lock

When the key lock is applied, the 🔒 (key mark) is displayed at the relevant parameter on the LCD screen indicating that the parameter cannot be set or its settings changed. Here, let's cancel the key lock.

8-1

```
KLOCK▶    OFF
Tuning: Auto Tuning
OUTPUT: Single
  [ 2in 1out 1loop ]
```

Setting range	OFF, LOCK1, LOCK2, LOCK3
Initial value	OFF

LOCK1 Locks parameters other than SV related, AT, MAN, or EV/DO action points
LOCK2 Locks parameters other than SV related
LOCK3 Locks all parameters. (excluding the key lock parameter itself)

For details on parameters that are locked, see "17 List of Parameters."

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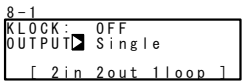
7. INITIALIZING I/O

7.1 Setting the Output Specifications (2-output specification)

This item is set in the case of a single loop in the 2-output specification.
Select whether to set to 1-output or 2-output in the case of a 2-output specification.

In the case of other specifications, proceed to the next items.



Setting range Single, Dual
Initial value Single

Single Control output becomes 1-output.
Dual Control output becomes 2-output.

■Displaying the current operation mode

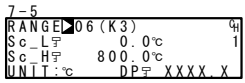
The current operation mode is displayed at the bottom line of the key lock, tuning mode and number of outputs setup screen (8-1).

1in 1out 1loop	1-channel/1-output controller
1in 2out 1loop	1-channel/2-output controller
2in 1out 1loop	2-input operation/1-output controller
2in 2out 1loop	2-input operation/2-output controller
Cascad	Controller that performs cascade operation with CH1 as the master and CH2 as the slave
2in 2out 2loop	Independent 2-channel controller

7.2 Setting the Unit, Measuring Range and Reference Values

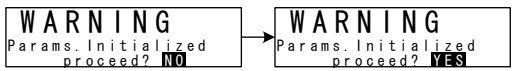
Setting a range

Set the code to the RANGE No. referring to the Measuring Range Code Table below.



Setting range 01 to 87
Initial value 06(K3)

When a range is changed in the above screen, the following confirmation message will be displayed.
Press the ▲ key to select YES, and press the ENT key to apply the setting. The range will be changed.



Note When a range is changed, some of the input-related parameters will be initialized.
For details, see “18 Parameter Lists.”

Measuring Range Code Table

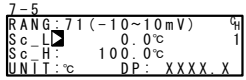
Input Type		Sensor Type	Code	Symbol	Measuring range	Measuring range
Multi Input	Thermocouple	B *1	01	B	0.0 to 1800.0 °C	0 to 3300 °F
		R	02	R	0.0 to 1700.0 °C	0 to 3100 °F
		S	03	S	0.0 to 1700.0 °C	0 to 3100 °F
		K	04	K1	−100.0 to 400.0 °C	−150.0 to 750.0 °F
		K	05	K2	0.0 to 400.0 °C	0.0 to 750.0 °F
		K	06	K3	0.0 to 800.0 °C	0.0 to 1500.0 °F
		K	07	K4	0.0 to 1370.0 °C	0.0 to 2500.0 °F
		K *2	08	K5	−200.0 to 200.0 °C	−300.0 to 400.0 °F
		E	09	E	0.0 to 700.0 °C	0.0 to 1300.0 °F
		J	10	J	0.0 to 600.0 °C	0.0 to 1100.0 °F
		T *2	11	T	−200.0 to 200.0 °C	−300.0 to 400.0 °F
		N	12	N	0.0 to 1300.0 °C	0.0 to 2300.0 °F
		PLII	13	PL Ⅱ	0.0 to 1300.0 °C	0.0 to 2300.0 °F
		PR40-20 *3	14	PR40-20	0.0 to 1800.0 °C	0 to 3300 °F
		WRe5-26	15	WRe5-26	0.0 to 2300.0 °C	0 to 4200 °F
		U	16	U	−200.0 to 200.0 °C	−300.0 to 400.0 °F
		L	17	L	0.0 to 600.0 °C	0.0 to 1100.0 °F
		K *4	18	K	10.0 to 350.0 K	10.0 to 350.0 K
		AuFe−Cr *5	19	AuFe-Cr	0.0 to 350.0 K	0.0 to 350.0 K
	RTD	Pt100 (new) JIS/IEC	31	Pt 1	−200.0 to 600.0 °C	−300.0 to 1100.0 °F
			32	Pt 2	−100.00 to 100.00 °C	−150.0 to 200.0 °F
			33	Pt 3	−100.0 to 300.0 °C	−150.0 to 600.0 °F
			34	Pt 4	−60.00 to 40.00 °C	−80.00 to 100.00 °F
			35	Pt 5	−50.00 to 50.00 °C	−60.00 to 120.00 °F
			36	Pt 6	−40.00 to 60.00 °C	−40.00 to 140.00 °F
			37	Pt 7	−20.00 to 80.00 °C	0.00 to 180.00 °F
			38	Pt 8	0.000 to 30.000 °C	0.00 to 80.00 °F
			39	Pt 9	0.00 to 50.00 °C	0.00 to 120.00 °F
			40	Pt10	0.00 to 100.00 °C	0.00 to 200.00 °F
			41	Pt11	0.00 to 200.00 °C	0.0 to 400.0 °F
			42	Pt12	0.0 to 300.0 °C	0.0 to 600.0 °F
			43	Pt13	0.00 to 300.00 °C	−140.0 to 600.0 °F
			44	Pt14	0.0 to 500.0 °C	0.0 to 1000.0 °F
	RTD	JPt100 (old) JIS	45	JPt 1	−200.0 to 500.0 °C	−300.0 to 900.0 °F
			46	JPt 2	−100.00 to 100.00 °C	−150.0 to 200.0 °F
			47	JPt 3	−100.0 to 300.0 °C	−150.0 to 600.0 °F
			48	JPt 4	−60.00 to 40.00 °C	−80.00 to 100.00 °F
			49	JPt 5	−50.00 to 50.00 °C	−60.00 to 120.00 °F
			50	JPt 6	−40.00 to 60.00 °C	−40.00 to 140.00 °F
			51	JPt 7	−20.00 to 80.00 °C	0.00 to 180.00 °F
			52	JPt 8	0.000 to 30.000 °C	0.00 to 80.00 °F
			53	JPt 9	0.00 to 50.00 °C	0.00 to 120.00 °F
			54	JPt10	0.00 to 100.00 °C	0.00 to 200.00 °F
			55	JPt11	0.00 to 200.00 °C	0.0 to 400.0 °F
			56	JPt12	0.0 to 300.0 °C	0.0 to 600.0 °F
			57	JPt13	0.00 to 300.00 °C	−140.0 to 600.0 °F
			58	JPt14	0.0 to 500.0 °C	0.0 to 900.0 °F
	Voltage (mV)	−10 to 10 mV	71	-10 to 10 mV	Initial value 0.0 to 100.0 Measuring range Any value in the following ranges can be set by the scaling function. Scaling range -19999 to 30000 counts Span 10 to 30000 counts	
		0 to 10 mV	72	0 to 10 mV		
		0 to 20 mV	73	0 to 20 mV		
		0 to 50 mV	74	0 to 50 mV		
		10 to 50 mV	75	10 to 50 mV		
		0 to 100 mV	76	0 to 100 mV		

		−100 to 100 mV	77	-100 to 100 mV	When used with 0 to 20 mA, 4 to 20 mA current input, select either of measuring range codes 84 and 85, and attach a shunt resistance of 250Ω±0.1% to the input terminals.
	Voltage (V)	−1 to 1V	81	-1 to 1V	
		0 to 1V	82	0 to 1V	
		0 to 2V	83	0 to 2V	
		0 to 5V	84	0 to 5V	
		1 to 5V	85	1 to 5V	
		0 to 10V	86	0 to 10V	
		−10 to 10V	87	-10 to 10V	

∗1: Accuracy is not guaranteed at temperatures 400°C and 750°F or below.
∗2: Accuracy is not guaranteed at temperatures -100°C (-148°F) or below ±(0.5%＋1 digit).
∗3: The accuracy is ±(0.3%FS+1°C).
∗4: The accuracy of thermocouple K is ±(0.75%FS+1K)/10.0 to 30.0K, ±(0.30%FS+1K)/30.0 to 70.0K, ±(0.25%FS+1K)/70.0 to 350.0K.
*5: The accuracy is ±(0.25%FS+1K).

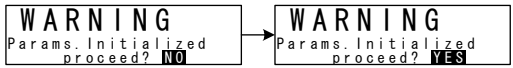
PV scaling

This item is set during linear input, and cannot be set during RTD and TC input.
Set the measurement range (scaling) during voltage and current input.



Settable range	-19999 to 30000 Unit
Measuring range	Minimum span 10 Unit Maximum span 30000 Unit Any setting within the above ranges is possible. (Note that Sc_L<Sc_H)
Initial value	Sc_L;0 Unit, Sc_H;1000 Unit

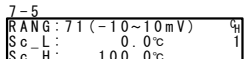
When a range is changed in the above screen, the following confirmation message will be displayed.
Press the ▲ key to select YES, and press the ENT key to apply the setting. The range will be changed.



Note When a range is changed, some of the input-related parameters will be initialized.
For details, see “18 Parameter Lists.”

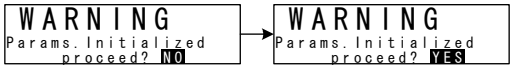
Setting the unit

Set the measurement unit.



Setting range	°C, °F, %, None
Initial value	°C

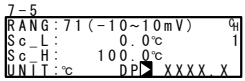
When a range is changed in the above screen, the following confirmation message will be displayed.
Press the ▲ key to select YES, and press the ENT key to apply the setting. The range will be changed.



Note When a range is changed, some of the input-related parameters will be initialized.
For details, see “18 Parameter Lists.”

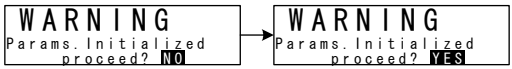
Setting the decimal point position

This item is set during linear input, and cannot be set during RTD and TC input.
Set the measurement range (scaling) during voltage and current input.



Setting range XXXXX to X.XXXX
Initial value XXXX.X

When a range is changed in the above screen, the following confirmation message will be displayed.
Press the ▲ key to select YES, and press the ENT key to apply the setting. The range will be changed.

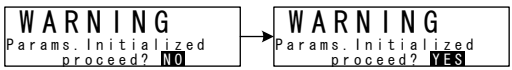


Switching the lowest digit past the decimal point

The lowest digit past the decimal point of measuring ranges determined by the range setting can be set.
Note, however, that this function cannot be used for measurement ranges without digits past the decimal point.
This screen is not displayed in linear ranges.

Setting range Normal, Short
Initial value Normal

When a range is changed in the above screen, the following confirmation message will be displayed.
Press the ▲ key to select YES, and press the ENT key to apply the setting. The range will be changed.



Thermocouple cold junction compensation

Set whether to perform cold junction compensation during TC input internally or externally.
Normally, set to internal compensation. Set to external compensation when greater accuracy is required.

7-6

Setting range	Internal, External
Initial value	Internal

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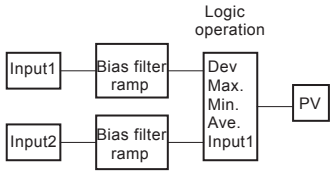
8. I/O AUXILIARY SETTINGS

8-1 Setting 2-input Logic Operation

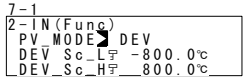
This setting is for the 2-input/1-loop specification.
The setup screen is not displayed in other specifications.

This setting sets processing during input operation or a scale over error.
This function performs deviation, maximum, minimum, average, and other logic operations on two inputs, and takes the result as the execution PV value.
Bias, filter and ramp processing can be set to each of the two inputs.



Selecting the PV mode

Set the computation method for calculating the PV value to be used in control action.



Setting range MAX, MIN, AVE, DEV, PV
Initial value DEV

MAX	Maximum value	Uses the larger value of the inputs as the PV value in control action.
MIN	Minimum value	Uses the smaller value of the inputs as the PV value in control action.
AVE	Average value	Uses the average value of inputs as the PV value in control action.
DEV	Deviation value	Uses (Input 1 – Input 2) as the PV value in control action.
PV		Uses Input 1 as the PV value in control action.

Setting processing at scale over

Set control processing when a PV scale over error occurs in the 2-input, 1-loop specification.
This setup screen is not displayed when PVMODE: DEV is selected.

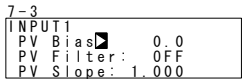
Setting range 0, 1
Initial value 0

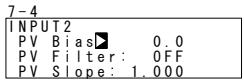
0 Control processing is continued using the PV value on the normal side when a scale over error occurs.
Control action is executed using the PV value in the scale when one of the inputs exceeds the scale and the other is within the scale (only when MAX, MIN or AVE is selected for the operation).

1 Control processing is performed using the selected data as it is.
The preset scale over processing is executed when one of the inputs has exceeded the scale.

Setting bias, filter and ramp

Set the bias, filter and ramp to each of INPUT1 and INPUT2.



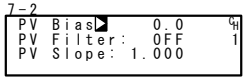


For details of each parameter, see “8-2 Setting the PV Compensation Values.”

8-2 Setting the PV Compensation Value

PV bias

This item is used to compensate for error in the indicated temperature, for example, in a detector or instrument.



Setting range	-10000 to 10000 Unit
Initial value	0 Unit

PV filter

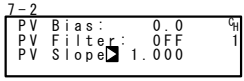
When the PV signal contains noise, the control result sometimes is adversely affected by fluctuation of PV signals.
The PV filter is used to decrease this influence and stabilize control.

Setting range	OFF, 1 to 100s
Initial value	OFF

PV filter computation is performed by primary lag computation. The filter time constant can be set up to 100 seconds.
When a large time constant is set, noise removal performance increases. However, in control systems having a fast response, noise removal is adversely affected when the time constant is too large.

PV slope

This item changes the PV ramp during linear input.
This item is set during linear input, and the screen is not displayed during RTC and TC input.



Setting range	0.500 to 1.500
Initial value	1.000

Execution PV = A x X + B where, A=PV input, X=PV slope, B=Bias

When this item is used in combination with square root extraction operation and broken line approximation, this slope is applied to the result of square root extraction operation and broken line approximation.

8-3 Setting the Square Root Extraction Operation Function

Signals having square root characteristics such as in the measurement of flow rates can be linearized.
This item is set during linear input, and the screen is not displayed during RTC and TC input.

Enabling the square root extraction operation function

The square root extraction operation function is valid when SQ.Root is set to ON.

Setting range OFF, ON
Initial value OFF

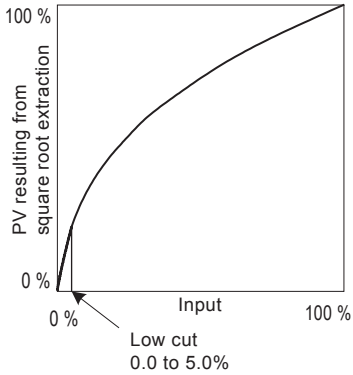
Low cut

This item functions only when the square root extraction operation function is enabled.

Setting range 0.0 to 5.0%
Initial value 1.0%

In square root operation, the PV fluctuates greatly by a slight fluctuation of the input value in the vicinity of signal zero.
”Low cut” is a function for outputting “0” (zero) to PV at the preset input value or lower. Setting low cut prevents action from becoming unstable when there is noise on the input signal line.

The set value of low cut is 0.0 to 5.0% of the PV input range.



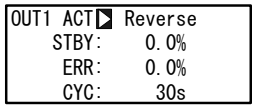
Note Low cut processing is performed on input, and square root extraction processing is performed.

8-4 Setting Control Output

Action characteristics

Select either reverse action (Reverse) or direct action (Direct) as the output characteristics.

6-1



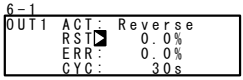
Setting range	Reverse, Direct
Initial value	Reverse

Reverse	By this action, the smaller the measured value (PV) than the set value (SV), the higher output increases. This action is generally used for heating control.
Direct	By this action, the larger the measured value (PV) than the set value (SV), the higher output decreases. This action is generally used for cooling control.

Output at reset

Use this item to maintain control output at a fixed value in a reset state.

6-1



Setting range	0.0 to 100.0%
Initial value	0.0%

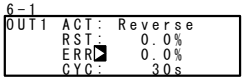
Note 1 In ON-OFF control (P=OFF), when output at error is set to 50% or more, the actual output at reset becomes 100%.
When output at reset is set to 49.99% or less, the actual output at error becomes 0%.

Note 2 Output at a reset is maintained without being affected by whether or not an error has occurred.

Output at error

Set the value to be output when an error occurs.

6-1



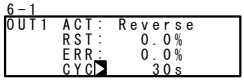
Setting range	0.0 to 100.0%
Initial value	0.0%

Note 1 In ON-OFF control (P=OFF), when output at error is set to 50% or more, the actual output at reset becomes 100%.
When output at reset is set to 49.99% or less, the actual output at error becomes 0%.

Note 2 Output at a reset is given priority and output without being affected by whether or not an error has occurred at reset.

Proportional cycle time

Set the proportional cycle time. (contact/SSR drive output only)
This item is set only in the contact and SSR drive voltage output specification.
The screen is not displayed in the case of the current and voltage output specification.



Setting range	1 to 120s	
Initial value	Contact output (Y)	; 30s
	SSR drive output (P)	; 3s

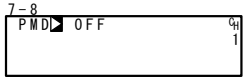
Note 1 If a short time is set as the proportional cycle time in contact output, the contact life of the output relay may be adversely affected.
Pay particular attention to this point when setting the proportional cycle time.

Note 2 If a long time is set as the proportional cycle time is set in a control system with a short delay time, the control result will be adversely affected.

8-5 Setting Broken Line Approximation Computation

Enabling broken line approximation computation

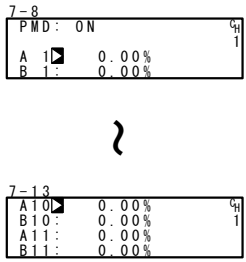
This function performs linearization based upon broken line approximation when the PV input is a non-linear signal.
This item is set during linear input.
The screen is not displayed during RTD and TC input.



Setting range	OFF, ON
Initial value	OFF

Setting broken-line approximation input points

Set the input points in the case of broken line approximation input. Set PV display value (B) to PV input value (A).
When the value of B is smaller than the value of the previous A, values of B from then onwards are invalid.

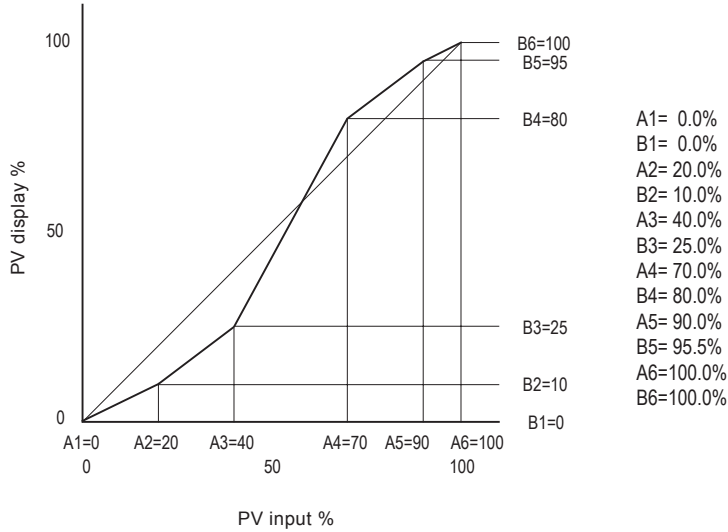


Up to 11 points can be set. 11 points (B1 to B11) can be set for PV display (%) on PV 11 inputs (A1 to A11). For each input point, B1 is set to A1, B2 for A2 and so forth until B11 is set to A11, and linear interpolation is executed between input points.
This item is set during linear input. The screen is not displayed during RTD and TC input.

Setting range	An, Bn: -5.0 to 105.0%
Initial value	An, Bn: 0.0%

Broken line approximation setting (example)

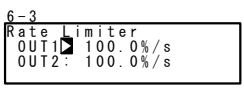
In the following figure, A1, B1 to A6, B6 are used to set input points with four intermediate points.



8-6 Setting the Various Limiters

Output rate-of-change limiter

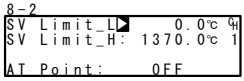
Set this setting item when a control target that is adverse to sudden changes in output is used.
The rate-of-change limiter can be set to each of output 1 (OUT1) and output 2 (OUT2 is displayed only in the 2-output specification only).



Setting range	OUT1, OUT2 : OFF, 0.1 to 100.0 %/s
Setting range	OUT1, OUT2 : OFF

SV limiter

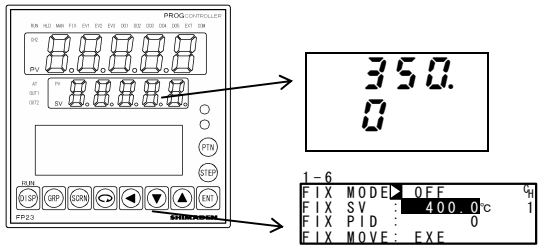
The SV limit is used to prevent a wrongful setting to a dangerous range. Set the lower limit value and higher limit value of the SV value setting range.



Setting range	Within measuring range SV Limit L<SV Limit H
Initial value	SV Limit_L: Lower limit value of measuring range SV Limit_H: Higher limit value of measuring range

Note If the preset SV value (FIX SV, Start SV, STEP SV) exceeded the limiter before the SV limiter is set, the numerical value will be displayed inverted in white as shown below, and the white-inverted SV value will be replaced internally with the limiter value, and the limit-cut SV value will be displayed on the SV display.

Ex:) When FIX SV value is set to 400.0°C with RANGE 04(K1) –100.0 to 400.0°C, and then SV Limit_H is set to 350.0°C



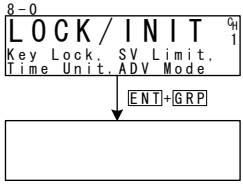
The white-inverted section indicates limit over.

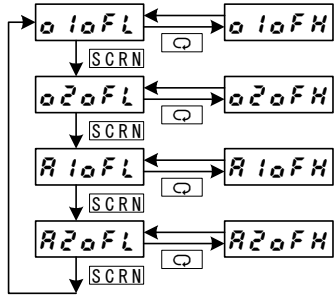
8.7 Compensating Control Output/Analog Output

Error that occurs in control output (at linear output) or analog output can be compensated.

1. Stop control action.
   Control output/analog output cannot be compensated during control action.
   Cancel the key lock if it is applied.
   Set both CH1 and CH2 to a reset state.

2. Set the count value.
   Call up the LOCK/INIT top screen (group 8) from the basic screen by the GRP key. Move to the setup screen by holding the ENT and GRP keys for at least 3 seconds, and select the output to compensate by pressing the SCRN and ENT keys. Set the count value currently displayed on the SV display with the ▼ or ▲ key, and press the ENT key to fix and register settings.





PV Display	Description	PV Display	Description
o1oFL	Control Output 1 lower limit value	o1oFH	Control Output 1 higher limit value
o2oFL	Control Output 2 lower limit value	o2oFH	Control Output 2 higher limit value
A1oFL	Analog output 1 lower limit value	A1oFH	Analog output 1 higher limit value
A2oFL	Analog output 2 lower limit value	A2oFH	Analog output 2 higher limit value

3. When you have finished setting the above, press the DISP key to return to the basic screen.

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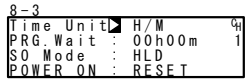
9 PROGRAM SETTINGS

9-1 Program Initial Settings

Time unit

Set the unit of time that is currently used in various items such as step time or time signal time.



Setting range H/M, M/S
Initial value H/M

H/M : hours/minutes
M/S : minutes/seconds

Program control execution delay time

The delay time during program control execution can be set.
The time unit is fixed to H/M.
The RUN indicator blinks while the delay time is active after program control execution is started.
Program control is started, and the RUN indicator lights after the preset delay time has elapsed.

Setting range 00h00m to 99h59m
Initial value 00h00m

Input error mode

Set processing when a sensor breaks or a scale over or other error occurs during program control.

Setting range HLD, RUN, RESET
Initial value HLD

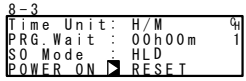
HLD Sets a hold state until the device is restored from scale over or a reset is performed. Note, however, that this differs from a regular hold state in that the setting value of the output at error continues to be output. For details, see “8-5, Setting output at error.”

RUN Runs the program until the program ends or a reset is performed. (time elapses). Note, however, that this differs from a regular hold state in that the setting value of the output at error continues to be output. For details, see “8-5, Setting output at error.”

RESET Cancels and resets program operation.

Power interruption compensation

Set in which state the device is to be restored when the power is turned ON again after a power interruption.



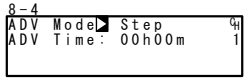
Setting range RESET, CONTINUE
Initial value RESET

RESET During program control, the state that was active before the power interrupt is not held, and the device is reset when the power is turned ON again.

CONTINUE During program input, the state that was active before the power interrupt is held and the device is started up again. (During FIX control, the state that was active before the power interrupt is held at all times.)
Excluding the following:
1. AT execution
2. Change in state of DI input
3. PID No. when the hysteresis of zone PID is taken into consideration

Advance mode

Set the details of advance operation.
For details on advance operation, refer to “15-5 Execution of Advance.”



Setting range Step, Time
Initial value Step

Step Advances the program by steps during advance execution.

Time Advances the program by time during advance execution.
When there is a part that exceeds the step width time in the time set here, that part becomes invalid, and the program advances to the start of the next step immediately when the step width time is exceeded.

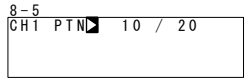
Advance time

Set the advance time when the advance mode is set to [Time].

Setting range 00:00 to 99:59
Initial value 00:00

Number of CH1 patterns

Set the number of patterns to be used on CH1 from among 20 patterns.
The remaining patterns are automatically set to CH2.
This screen is displayed only in a 2-input, 2-loop specification.



Setting range 0 to 20
Initial value 10

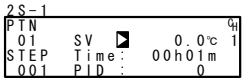
Note: When this parameter is changed, pattern- and step-related settings are initialized.

9-2 Step-related Settings

Make settings for each step.
The following describes setup operation using start pattern 1 and step 1 as an example.

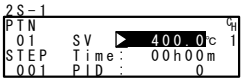
Step SV value

Set the SV value of step 1.



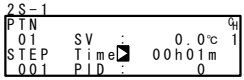
Setting range Within SV limiter setting range
Initial value 0.0

Note When the STEP SV value exceeds the limit, the SV value is displayed reversed in white as shown below. The SV value displayed reversed in white is replaced internally with the limiter value, and the SV value cut by the limiter is displayed on the SV display.
For details, see “8-6, Setting the Various Limiters.”



Step time

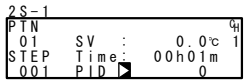
Set the time of step 1.



Setting range 00:00 to 99:59
Initial value 00:01

Step PID No.

Set the PID No. of step 1 execution.



Setting range 0 to 10
Initial value 0

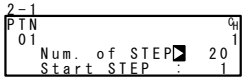
The PID No. becomes as follows when PID=0 is set:

1. The previous execution step PID No. is looked up
2. When PID=0 is set to the start step, the program is executed by PID No.1 at the start of the program.

9-3 Pattern-related Settings

Number of steps

Set the number of steps to be used in the program pattern.



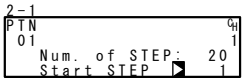
Setting range 0 to 400
Initial value 20

The maximum number of steps is allocated between CH1 and CH2 patterns, and changes according to the number of other pattern steps. For example, when number of CH1 patterns is set to “20” and the number of steps in pattern Nos.2 to 20 is set to “0”, the number of steps of CH1 pattern No.1 can be set to a maximum number of 400 steps.

When a value smaller than the currently executing step No. is set, the program immediately moves to the end of the program or to the start step.
After execution of the currently executing step ends, the program moves to the end or the start step.

Start step

Set the step at program start.



Setting range 0 to number of steps
Initial value 1

Reference This parameter can also be set before execution of program control in the basic screen. For details, see “14-2, Operations in the Basic Screen.”

Start SV

Set the SV value at start of the program.
The start SV function is enabled only when the program is started from step 1.

Setting range Within SV limiter setting range
Initial value 0.0

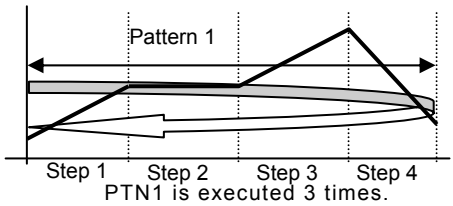
Note: When the Start SV value exceeds the limit, the SV value is displayed reversed in white as shown below. The SV value displayed reversed in white is replaced internally with the limiter value, and the SV value cut by the limiter is displayed on the SV display.
For details, see “8-6, Setting the Various Limiters.”

Pattern execution count

Set the execution count of the program pattern. When a pattern execution count smaller than the current execution count is set during program execution, the program pattern ends after execution up to the end step. (If the pattern is linked, the program moves to the next pattern.)

Setting range 1 to 9999
Initial value 1

Ex) When the pattern execution count is set to “3” at PTN1 (set up to STP4)



Start step No. of step loop

Set the start step No. during step loop.

Setting range 1 to number of steps
Initial value 1

End step No. of step loop

Set the end step No. during step loop.

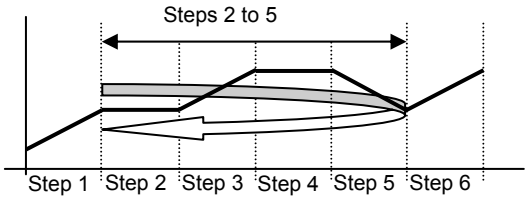
Setting range 1 to number of steps
Initial value 20

Execution count of step loop

Set the execution count of the step loop.

Setting range 1 to 9999
Initial value 1

Ex) When execution count is set to "3" at start step No.2 and end step No.5



Steps 2 to 5 are executed 3 times.

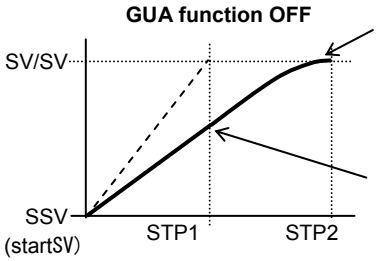
Guarantee soak zone

Set the guarantee soak zone (hysteresis of guarantee soak function).
Set the setting value as a deviation with respect to the SV value of a flat step.

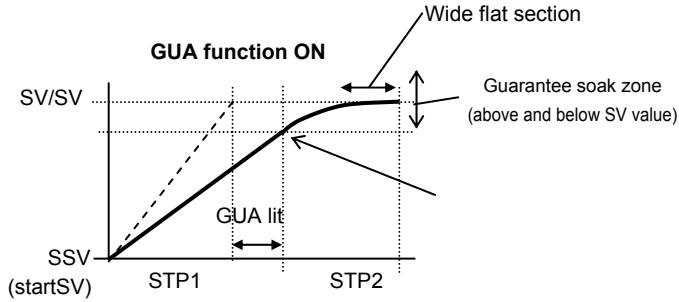
Setting range OFF, 1 to 9999
Initial value OFF

What is the guarantee soak (GUA) function?

During program control, when the SV value migrates from a ramp step to a flat step, the PV value sometimes can no longer track the SV value and the flat step time may become shorter on some control systems.
This function is for avoiding this and assuring the time of the flat step.



Even if SV1 is not reached after step 1 time elapses, control migrates to step 2.



When the deviation between the step SV and PV of the flat step does not enter the guarantee soak zone when the ramp step switches to the flat step, the program does not move to the next step, and stands by until this region is reached or the GUA time ends.
In this standby state, the GUA indicator lights in the status monitor screen (0 to 4).

Note 1 Even if step 1 is flat when the RST mode changes to the PROG mode, guarantee soak is performed. Even in steps where the step time is set to “00:00”, guarantee soak is performed if the guarantee soak conditions are satisfied.

Guarantee soak time

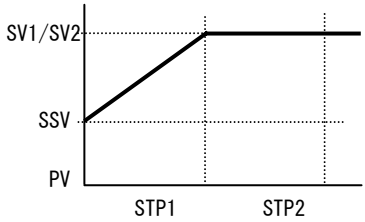
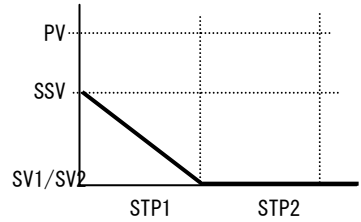
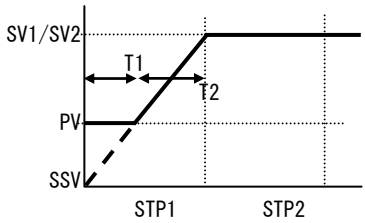
Set the guarantee soak time. Time measurement is performed at the same time that the ramp step time ends, and the program moves to the flat step regardless of whether the PV value is inside or outside the zone when the preset time is reached.
Note, however, that when “00:00” is set, GUA continues until PV reaches the zone.

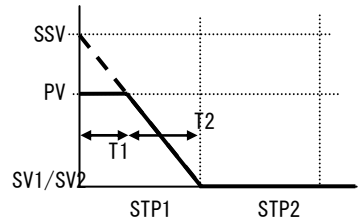
Setting range 00:00 to 99:59
Initial value 00:00

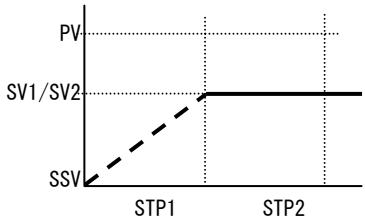
PV start

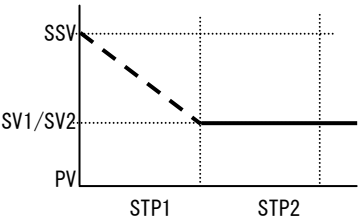
When the start step at program execution is ramp control, and the start SV value and PV value are separated from each other, dead time occurs. To omit this dead time, set the PV value for the purpose of starting as the start SV. When PV start is OFF, execution starts from the start SV at all times.

Setting range ON/OFF
Initial value OFF

<table>
<tr>
<td>① PV≦SSV＜SV1
 
</td>
<td>④ PV≧SSV＞SV1
 
</td>
</tr>
<tr>
<td>② SSV＜PV≦SV1
 

T1: The time in this period is shortened to become PV start.
T2: STP1 time to be executed</td>
<td>⑤ SSV＞PV≧SV1
 

T1: The time in this period is shortened to become PV start.
T2: STP1 time to be executed</td>
</tr>
<tr>
<td>③ SSV＜SV1＜PV
 

In this case, the program advances to step 2, and step 1 is omitted.</td>
<td>⑥ SSV＞SV1＞PV
 

In this case, the program advances to step 2, and step 1 is omitted.</td>
</tr>
</table>

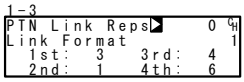
∗1: PV start is enabled only when the start step time is set to “00m01s“ or more.

∗2: Cautions in ② and ⑤ action
Due to the relationship with the device’s internal resolution, an accurate start SV might not be calculated when the PV start function is started up by conditions such as a large step SV rate-of-change.

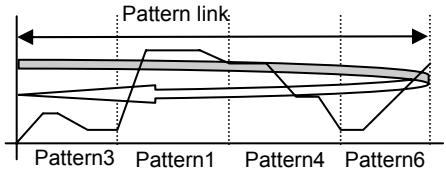
9-4 Pattern Link-related Settings

Setting the pattern link execution count

Set the number of times that pattern link is executed.

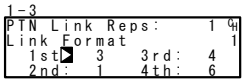


Setting range 0 to 9999
Initial value 0



Pattern link

This setting is for linking (connecting) and operating each pattern by a program.
Set the pattern No. to be linked in order from 1st.
Up to 20 patterns can be linked from 1st to 20th.
The same pattern can also be set repeatedly.



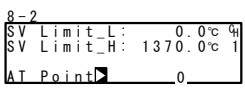
Setting range	0 to upper limit of assigned pattern
Initial value	0

Note 1 When pattern 0 is set, the link to patterns set from then onwards becomes invalid.

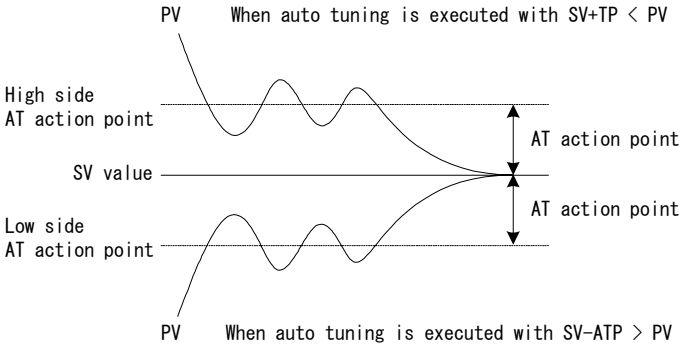
9-5 Settings before Program Operation

Auto-tuning point

To avoid hunting caused by the limit cycle on the SV value when executing auto-tuning, set a virtual SV value (auto tuning point) so that AT action is performed at a point away from the true SV value.



Setting range 0, 1 to 10000 Unit
Initial value 0



Note 1 For ATP (AT points), set the AT action points above and below the SV as a deviation.

Note 2 When auto tuning is executed with PV outside of the preset AT points above and below, auto tuning is performed at an AT point between PV and SV.

Note 3 When auto tuning is executed with the PV value inside the At action points above and below, auto tuning is performed using the SAV value.

Note 4 When ATP is set to “0”, the SV value becomes the AT action points.

Note 5 When zone PID SV is selected, AT points become invalid.

Program EV, DO action points

Set the action points of each of EV and DO in the PROGRAM mode.
This screen is not displayed when a mode other than the six operation modes shown below is set to DO.

2-5
```
PTN EV Set Point     CH
 01 EV1 HD▶  2500.0℃1
    EV2 LD: -2500.0℃
    EV3 HD:  2500.0℃
```

2-6
```
PTN DO Set Point     CH
 01 DO1 HD▶  2500.0℃1
    DO2 LD: -2500.0℃
    DO3 HD:  2500.0℃
```

2-7
```
PTN DO Set Point     CH
 01 DO4 HD▶  2500.0℃1
    DO5 LD: -2500.0℃
```

2-8
```
PTN DO Set Point     CH
 01 DO6 HD▶  2500.0℃1
    DO7 LD: -2500.0℃
```

2-9
```
PTN DO Set Point     CH
 01 DO8 HD▶  2500.0℃1
    DO9 LD: -2500.0℃
```

2-10
```
PTN DO Set Point     CH
 01 DO10 HD▶ 2500.0℃1
    DO11 LD:-2500.0℃
```

2-11
```
PTN DO Set Point     CH
 01 DO12 HD▶ 2500.0℃1
    DO13 LD:-2500.0℃
```

Setting range	HD (DEV Hi)	Higher limit deviation value	-25000 to 25000 Unit
	LD (DEV Low)	Lower limit deviation value	-25000 to 25000 Unit
	OD (DEV Out)	Outside higher/lower limit deviation action	0 to 25000 Unit
	ID (DEV In)	Inside higher/lower limit deviation action	0 to 25000 Unit
	HA (DEV Hi)	PV higher limit absolute value action	Within measuring range
	HL (DEV Low)	PV lower limit absolute value action	Within measuring range
Initial value	HD (DEV Hi)	Higher limit deviation value	25000 Unit
	LD (DEV Low)	Lower limit deviation value	-25000 Unit
	OD (DEV Out)	Outside higher/lower limit deviation action	25000 Unit
	ID (DEV In)	Inside higher/lower limit deviation action	25000 Unit
	HA (DEV Hi)	PV higher limit absolute value action	Within measuring range
	HL (DEV Low)	PV lower limit absolute value action	Within measuring range

Time signal

Eight time signals are available for each pattern.
The following screen descriptions are for time signal 1 (TS1).
To use a time signal as an external output, TS1 to 8 must be assigned to EV1 to 3 and D01 to 13 in the event/DO screen group.

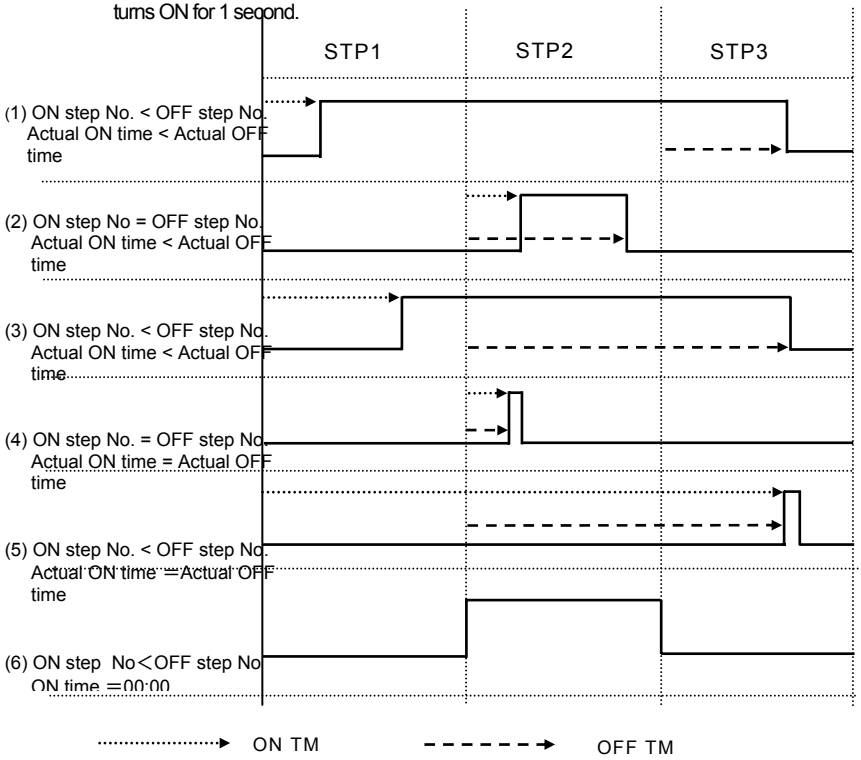
■Time signal (TS) enabling conditions

Though invalid conditions can be assigned, they do not function.

1) The ON step No. must already be set (must not be OFF).

2) The ON step No. must be less than the OFF step No.
Note, however, that the actual ON time must be less than the actual OFF time.

- When the ON step No. = OFF step No., and the actual ON time = actual OFF time, TS turns ON for 1 second.
- When the ON step No. < OFF step No., and the actual ON time = actual OFF time, TS turns ON for 1 second.



〈Other precautions relating to setting〉

(1) The time signal time also is suspended during a hold or guarantee soak.

(2) If TS turns ON when the OFF step assigned is OFF with the ON step and ON time both enabled, TS stays ON until the end of the pattern.

(3) When the OFF step or actual OFF time exceeds the end step time, TS output becomes OFF at the end of the pattern end step.
Note, however, that it becomes ON when the ON time at the next pattern is 00:00.

(4) When the ON time = step time, TS turns ON at the start of the next step. (including OFF time)

(5) When the time signal has been changed in a hold state during program execution, the time signal is reflected after the hold state is canceled.

Note, however, that when a power interruption has occurred while the power interruption compensation setting is set to POWER ON: CONTINUE, the device is restored with the newly changed time signal reflected when it is powered ON again. (This is the equivalent of the change being reflected before a hold state is canceled.)

① Time signal ON step No.

Set the step No. at which time signal 1 (TS1) is to be output.

Setting range OFF, 1 to number of steps
Initial value OFF

② Time signal ON time

Set the time from the start of the step at which time signal 1 (TS1) is to be output up to when the signal is actually output.

Setting range 00:00 to 99:59
Initial value 00:00

③ Time signal OFF step No.

Set the step No. at which time signal 1 (TS1) is to be stopped.

Setting range OFF, 1 to number of steps
Initial value OFF

The actual ON time is the ON time of the total time up to start of the step set at ① + the time set at ②.

④ Time signal OFF time

Set the time from the start of the step at which time signal 1 (TS1) is to be stopped up to when the signal is actually stopped.

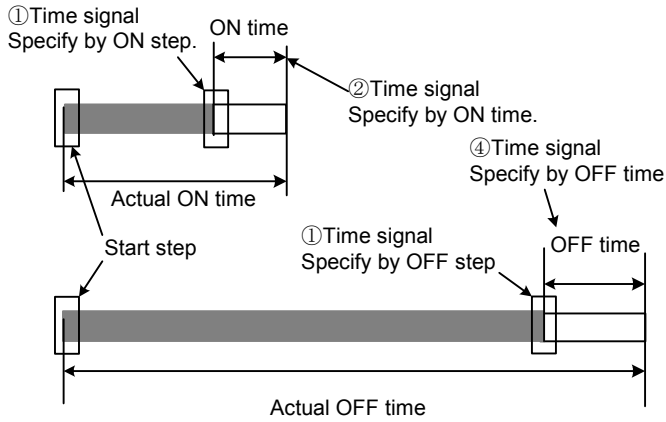
Setting range 00:00 to 99:59
Initial value 00:00

The actual OFF time is the OFF time of the total time up to start of the step set at ③ + the time set at ④.

⑤ Actual ON and OFF times

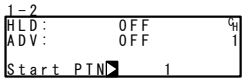
The following shows the relationship between the setting items in ① to ④ above, and the actual ON and OFF times.

■When ON step No. < OFF step No. and actual ON time < actual OFF time



Start pattern No.

Set the start pattern No. when executing a program.
This screen belongs not to PROGRAM (program screen group) but to CTRL EXEC (execution screen group).



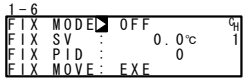
Setting range 1 to 20
Initial value 1

Reference This pattern can also be set before program control execution in the basic screen.
For details, see “14-2 Operations in the Basic Screen.”

10 FIX SETTINGS

10-1 Switching the FIX Mode

The mode can be set to the FIX (fixed value control) mode.
Note that movement to the FIX mode when the program mode is switched to the FIX mode varies according to the FIX MOVE setting.
For details, see “10-4 FIX MOVE Settings.”



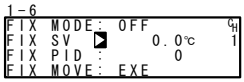
Setting range ON,OFF
Initial value OFF

ON The mode becomes the FIX (fixed value control) mode.
OFF The mode becomes the program mode.

Reference Switching between the program mode and the FIX mode is also possible in the basic screen.
For details, see “14-2, Operations in the Basic Screen.”

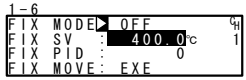
10-2 Setting the FIX SV Value

Set the SV value during fixed value control (FIX mode: ON).



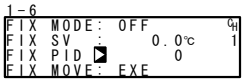
Setting range Within SV limiter setting range
Initial value 0 Unit

Note When the FIX SV value exceeds the limit, the SV value is displayed reversed in white as shown below. The SV value displayed reversed in white is replaced internally with the limiter value, and the SV value cut by the limiter is displayed on the SV display.
For details, see “8-6 Setting the Various Limiters.”



10-3 Setting the FIX PID No.

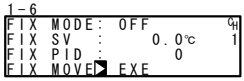
Set the PID No. during fixed value control (FIX mode: ON).
The PID No. cannot be set when zone PID is used. (“Zone” is displayed.)



Setting range 0 to 10
Initial value 0

10-4 FIX MOVE Settings

Make detailed settings for when the mode enters the FIX mode.



Setting range EXE, EXE/STBY, EXE/TRCK
Initial value EXE

EXE The RUN mode is entered when the FIX mode is entered. (same as when the FIX mode is entered in the RUN mode)

EXE/STBY The FIX mode is entered in the current state (reset state or RUN mode).

EXE/TRCK In a reset state, the RUN mode is entered when the FIX mode is entered, In the RUN mode, the FIX mode is entered, the execution PID No. and SV that were executing previously are tracked, and the RUN mode is entered.

FIX MOVE	Before Move		After Move	Remarks
EXE	PRG RST	→	FIX RUN	
	PRG RUN	→	FIX RUN	
EXE/STBY	PRG RST	→	FIX RST	
	PRG RUN	→	FIX RUN	
EXE/TRCK	PRG RST	→	FIX RUN	
	PRG RUN	→	FIX RUN	The execution SV value and execution PID No. are tracked.

Note When the FIX mode moves to the program mode, the mode must be changed in the current state (reset state of RUN state).

10-5 Setting the FIX EV/DO Action Points

Set each of the EV and DO action points in the FIX mode.
This screen is not displayed when a mode other than the six operation modes shown below is set to EV and DO.

1-7
```
FIX EV Set Point      CH
 EV1 HD▶  2500.0℃     1
 EV2 LD:  -2500.0℃
 EV3 HD:   2500.0℃
```

1-8
```
FIX DO Set Point      CH
 DO1 HD▶  2500.0℃     1
 DO2 LD:  -2500.0℃
 DO3 HD:   2500.0℃
```

1-9
```
FIX DO Set Point      CH
 DO4 HD▶  2500.0℃     1
 DO5 HD:   2500.0℃
```

1-10
```
FIX DO Set Point      CH
 DO6 HD▶  2500.0℃     1
 DO7 HD:   2500.0℃
```

1-11
```
FIX DO Set Point      CH
 DO8 HD▶  2500.0℃     1
 DO9 HD:   2500.0℃
```

1-12
```
FIX DO Set Point      CH
 DO10 HD▶ 2500.0℃     1
 DO11 HD:  2500.0℃
```

1-13
```
FIX DO Set Point      CH
 DO12 HD▶ 2500.0℃     1
 DO13 HD:  2500.0℃
```

Setting range Unit	HD (DEV Hi)	Higher limit deviation value	-25000 to 25000
	LD (DEV Low)	Lower limit deviation value	-25000 to 25000 Unit
	OD (DEV Out)	Outside higher/lower limit deviation action	0 to 25000 Unit
	ID (DEV In)	Inside higher/lower limit deviation action	0 to 25000 Unit
	HA (DEV Hi)	PV higher limit absolute value action	Within measuring range
	HL (DEV Low)	PV lower limit absolute value action	Within measuring range
Initial value	HD (DEV Hi)	Higher limit deviation value	25000 Unit
	LD (DEV Low)	Lower limit deviation value	-25000 Unit
	OD (DEV Out)	Outside higher/lower limit deviation action	25000 Unit
	ID (DEV In)	Inside higher/lower limit deviation action	25000 Unit
	HA (DEV Hi)	PV higher limit absolute value action	Within measuring range
	HL (DEV Low)	PV lower limit absolute value action	Within measuring range

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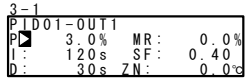
11 SETTING PID

11-1 Setting the Proportional Band (P)

”Proportional band” refers to the measuring range in which the size of the control output changes in proportion to the difference (deviation) between the measured value (SV) and the set value (PV).
When a wide proportional band is set, the change in the control output with respect to deviation decreases, and the offset (steady-state deviation) increases
When a narrow proportional band is set, the change in the control output increases, proportional action becomes stronger, and the offset decreases.

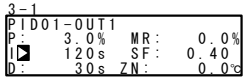
If too narrow a proportional band is set, hunting (vibration) occurs, and action becomes similar to that of ON-OFF control.
When P=OFF is set, control becomes ON-OFF control, and auto tuning cannot be executed.



Setting range OFF, 0.1 to 999.9 %
Initial value 3.0 %

11-2 Setting the Integral Time (I)

When a long integral time is set, offset correction action is weak, and it takes a long time to correct the offset. The shorter an integral time is set, the stronger the correction action becomes. However, if too short an integral time is set, hunting (vibration) occurs, and action becomes similar to that of ON-OFF control.



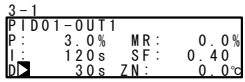
Setting range OFF, 1 to 6000 s
Initial value 120 s

Note When auto tuning is executed with I=OFF, the manual reset (MR) value is computed and automatically set.

11-3 Setting the Differential Time (D)

Differential action functions in two ways. It forecasts changes in the control output to reduce influence caused by external disturbance, and suppresses overshoot caused by integral action to improve control stability.

The shorter a differential time is set, the weaker differential action becomes. Alternatively, the longer a differential time is set, the stronger differential action becomes. However, if too long a differential time is set, hunting (vibration) occurs, and action becomes similar to that of ON-OFF control.

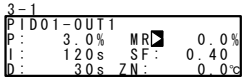


Setting range OFF, 1 to 3600 Sec
Initial value 30 Sec

Note When auto tuning is executed with I=OFF, auto tuning is performed and set by PI (proportional, integral) action.

11-4 Setting the Manual Reset (MR)

This function sets I (integral time) to OFF, and manually corrects offset that occurs when control action is performed by P or P+D.
When a + side MR value is set, the control result shifts to the + side, and when a – MR value is set, the control action shifts to the – side. The amount of shift is proportional to the size of the numerical value that is set.
When auto tuning is executed with I=OFF, the manual reset (MR) value is computed and automatically set.



Setting range	-50.0 to +50.0 %
Initial value	0.0 % (in 1-output specification) -50.0 % (in 2-output specification)

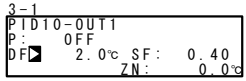
In regular PID control, there are no manual reset setting items, and it takes time to correct offset as correction of offset is dependent only on I (integral time) action.

When auto tuning is performed by PID control on this device, the load ratio is calculated so that the offset decreases even if there is no integral action, and the value equivalent to manual reset is automatically set.

This function enables better control results that those obtained by regular PID control.

11-5 Setting the Action Hysteresis (DF)

This item sets the hysteresis (DF) in ON-OFF control action when P is set to 0 (OFF).
When a narrow hysteresis is set, chattering is more likely to occur on the output.
When a wide hysteresis is set, chattering, etc. can be avoided and stable control action can be obtained.



Setting range	1 to 9999 Unit
Initial value	20 Unit

11-6 Setting the Dead Band (DB)

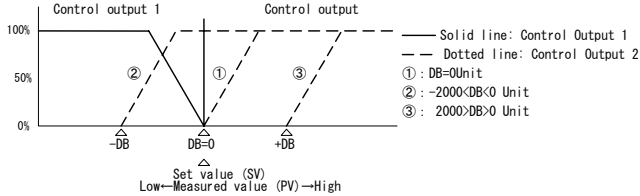
This setting is for only the 1-loop control, 2-output specification. Set the action range of Output 2 (OUT2) taking the characteristics of the control target and energy savings into consideration.

Setting range	-19999 to 20000 Unit
Initial value	0 Unit

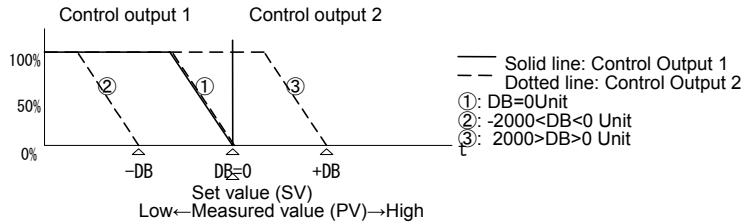
The patterns in the following figures show the relationship between output action and dead band.

RA: Reverse Action, DA: Direct Action

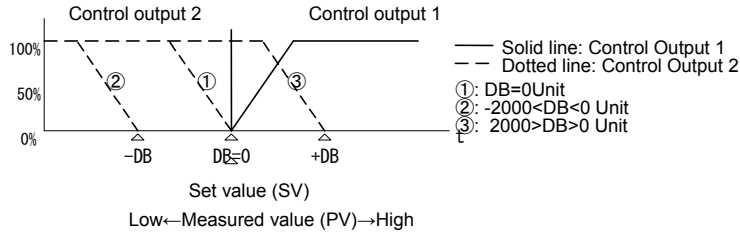
RA+DA



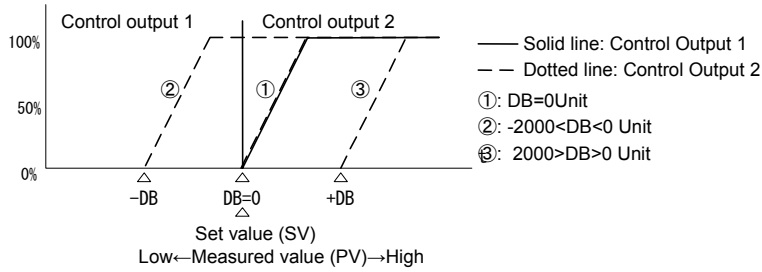
RA+RA



DA+RA



DA+DA



11-7 Setting the Target Value Function (TF)

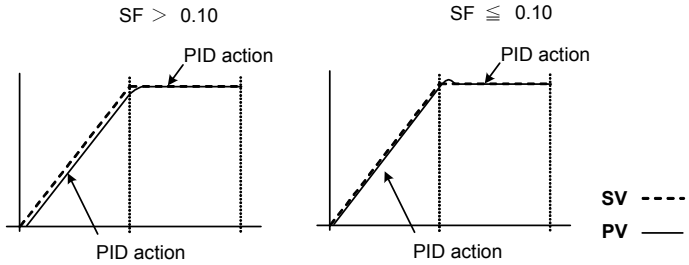
This function corrects overshoot or undershoot that occurs in PID control on this device.
Set this item taking the control result into consideration.
The target value function is valid only when integral action (PI or PID) is set.

Setting range 0.00 to 1.00
Initial value 0.40

SF ＝0.00 Regular PID computation is performed, and the overshoot correction function is not effective.
SF → Small The effect of the overshoot correction function is small.
SF → Large The effect of the overshoot correction function is large.

Reference: About PID action according to set value function (SF)

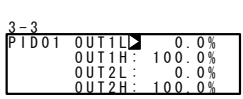
PID and PD action can be switched by the SF value during program control



11-8 Setting the Output Limiter (OUT1L to OUT2H)

This is the screen for setting the lower limit value and higher limit value of the control output value corresponding to the PID No.
Though regular control is performed using the initial values as they are, these lower limit and higher limit values are used for control that requires higher accuracy.
In a heating control specification, set a lower limit value when the return value is slow arriving due to overshoot at the upper side. For control targets whose temperature immediately drops when the temperature rise is slow and output is lowered, set a higher limit value.

Output 2 (OUT2L, OUT2) are displayed only in a 2-output specification.



Setting range Lower limit value ; 0 to 99.9 %
Higher limit value ; 0.0 to 100.0 %
(Lower limit value< Higher limit value)
Initial value Lower limit value ; 0 %
Higher limit value ; 100 %

Note The output limiter is invalid when P=OFF is set and ON-OFF control is selected.

11-9. Setting Zone PID

About the zone PID function

This function sets two or more zones in a measuring range and switches different PID values in each zone for use.
When multiple SVs are used and ramp control is performed, the optimum PID value can be set to each temperature range (zone) so that satisfactory controllability is obtained in a wide temperature range as two or more SVs can be used for performing ramp control.

Selecting the PID zone

Select whether or not to use zone PID.
When this function is used, further select whether to set the zone by SV or by PV.

Setting range OFF, SV, PV
Initial value OFF

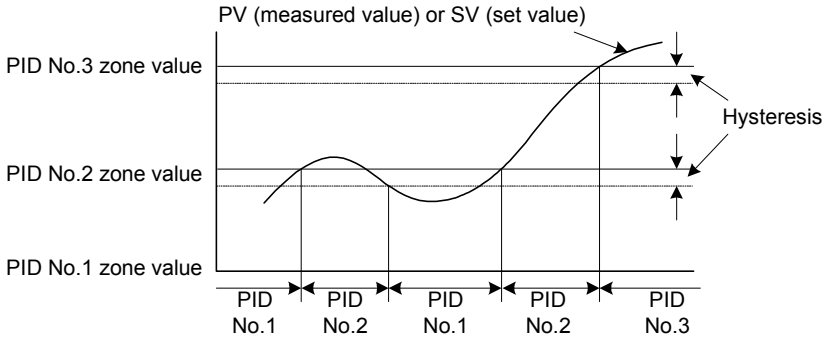
OFF The zone PID function is not used. (The PID No. is switched interlocked with the STEP No.)
SV The zone PID function of SV is used. (The PID No. is not interlocked with the STEP No.)
PV The zone PID function of PV is used. (The PID No. is not interlocked with the STEP No.)

Note 1 Auto tuning cannot be executed when PV is selected.
Note 2 Auto tuning points are invalid when PV is selected.

Zone hysteresis

The hysteresis can be set with respect to the zone set value.
This hysteresis is valid for all zone set values.

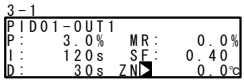
Measuring range 0 to 10000 Unit
Initial value 20 Unit



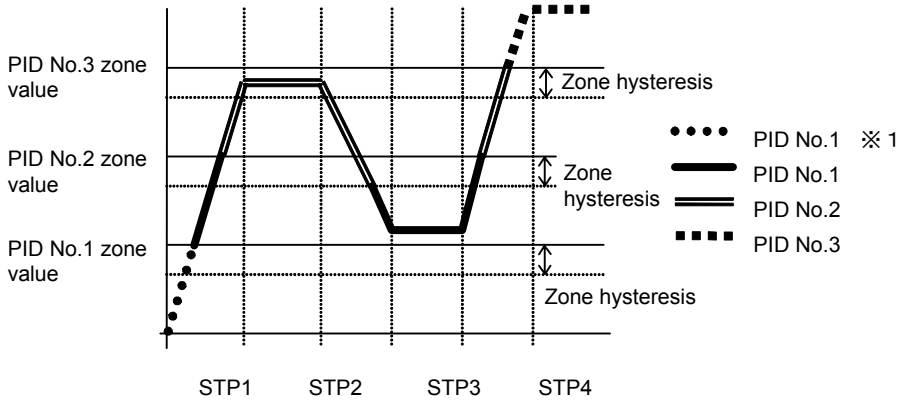
Zone (ZN)

This screen is for setting the zone required for the zone PID function to each PID No. This screen is not displayed when zone PID (ZPID1, ZPID2: parameter No.3 to 31) is OFF.

In areas not set with a zone, the closest PID No. is used.



Setting range	Within measuring range
Initial value	0.0 Unit



Note 1 When the same zone value is set to two or more PID Nos., the PID having the smallest No. is executed.

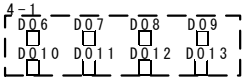
Note 2 The execution PID No. is not changed with the SV value in the zone hysteresis until it leaves the zone hysteresis even if the zone value and zone hysteresis are changed.

12. EV/DO SETTINGS

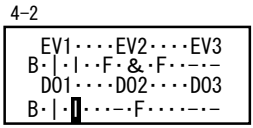
12-1 Monitor Screens

DO monitor

The status of DO can be monitored.
When ☐ is reversed to ■, this shows that DO is being output.



Monitoring logic

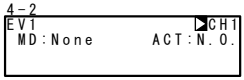


This screen is displayed when even one event DO is assigned.

LOGIC I: OR &: AND ^: XOR
Input B: Buffer F: Flip flop I: Inverse
Becomes white reversed on black in an active state.

12-2 Setting the Channel

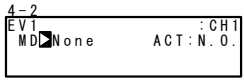
Set the channel to be targeted for event action.
This can be set only in a 2-input, 2-loop specification.



Setting range	CH1, CH2
Initial value	CH1

12-3 Setting Event Action and DO Operation mode

Set the event operation mode.
Note that if you have changed this setting, the action characteristics (ACT), action set points (SP), hysteresis (DF), delay time (DY) and standby action (IH) parameters are initialized.



Setting range	See event (EV, DO) Assignment Table.
Initial value	None

Event (EV/DO) Assignable Types

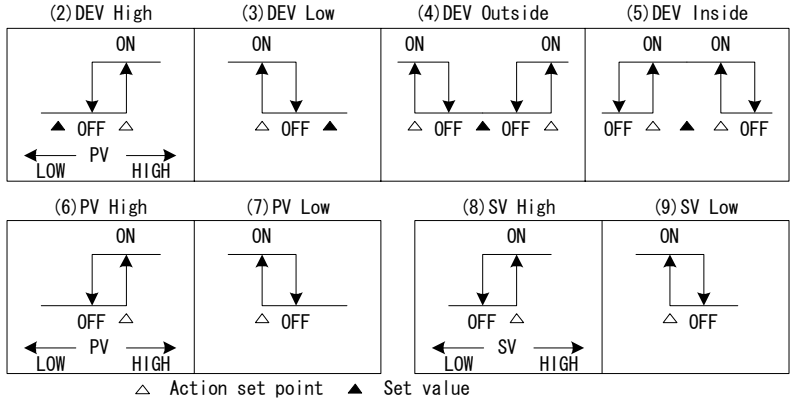
No.	EV_MD	EV, DO Operation mode	No.	EV_MD	EV, DO Operation mode
1	None	No action	12	LOGIC	Logic operation (mode AND, OR, XOR)
2	DEV Hi	Higher limit deviation value action		LOGIC	Logic operation (mode Timer, Count)
3	DEV Low	Lower limit deviation value action		Direct	Direct output
4	DEV Out	Outside higher/lower limit deviation action	13	RUN	Program/FIX execution
5	DEV In	Inside higher/lower limit deviation action	14	HLD	Hold
6	PV Hi	PV higher limit absolute value action	15	GUA	Guarantee soak
7	PV Low	PV lower limit absolute value action	16	STEP	Step signal
8	SO	Scale over	17	PRG.END	End signal
9	FIX	FIX mode	18-25	TS1 to TS8	Time signal 1 to 8
10	AT	Auto tuning execution in progress	26	HBA	Heater burnout alarm output (option)
11	MAN	Manual operation in progress	27	HBL	Heater loop alarm output (option)

*1 LOGIC logic operations (mode AND, OR, XOR) can be assigned only to EV1 to EV3, and DO1 to DO3.

*2 LOGIC logic operations (mode Timer, Count) can be assigned only to DO4 and DO5.

*3 The Direct function can be used when the communication option is added on. For details, refer to the Communication Users Manual.

Event Action Diagrams



Note ON/OFF in the diagrams indicate operation mode.
EV and DO output conforms to the setting (OPEN/CLOSE) of output characteristics.

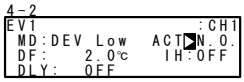
EV/DO Action in RST State

When the actions in the table below are assigned to EV/DO, EV/DO do not function even if an action state is reached in a RST state.

EV_MD	EV/DO Operation mode	EV_MD	EV/DO Operation mode
DEV Hi	Higher limit deviation value action	DEV In	Inside higher/lower limit deviation action
DEV Low	Lower limit deviation value action	PV Hi	PV higher limit absolute value action
DEV Out	Outside higher/lower limit deviation action	PV Low	PV lower limit absolute value action

12-4 Setting Event DO Action

Set the output characteristics



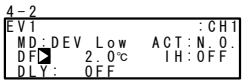
Setting range N.O., N.C.
Initial value N.O

N.O. (normally open) When event/DO action turns OFF, output is contact open or transistor OFF.

N.C. (normally closed) When event/DO action turns OFF, output is contact closed or transistor ON.

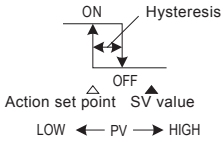
12-5 Setting Hysteresis

Set the hysteresis between ON action and OFF action. Setting hysteresis can avoid chattering, etc., and obtain stable action.
This item is displayed when event types (2) to (7) are selected in the event/tDO operation mode.



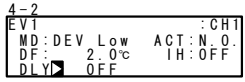
Setting range 1 to 9999 Unit
Initial value 20 Unit

Example) At PV Low



12-6 Setting the Delay Time

This function is for outputting EV after the preset time has elapsed after an event cause has been generated.
This item is displayed when event types (2) to (7) are selected in the event/tDO operation mode.



Setting range OFF, 1 to 9999 Unit
Initial value OFF

Note 1 EV is not output when the cause of the signal output disappears during the delay time. When the cause is generated again, counting of the time is performed from the beginning.

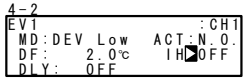
Note 2 When the delay time is set to OFF, EV is output at the same time that the cause of EV output is generated.

Note 3 When an EV output cause is generated within the delay time operation, the delay time can be changed. Note, however, that the delay time is the time not from when measurement is performed from the newly set time but from the time that was measured from when the output cause was generated.

12-7 Setting Standby Action

This function is for outputting EV when the PV value leaves the EV action range and enters the EV action range again without outputting EV even if the PV value is in the EV action range at power ON.
Select this item taking the standby action and event action at scale over into consideration.

This item is displayed when event types (2) to (7) are selected in the event/tDO operation mode.



Setting range OFF, 1, 2, 3
Initial value OFF

IH:OFF Standby action is not performed.

IH:1 Standby action is executed at power ON and when the control state changes from RST to RUN.

IH:2 Standby action is executed at power ON, when the control state changes from RST to RUN, and when the state of SV has changed.

IH:3 Standby action is not performed (action OFF at scale over [input error]).

Note 1 When IH is set to OFF, 1 or 2, EV action turns ON when a scale over error occurs on the EV set side.

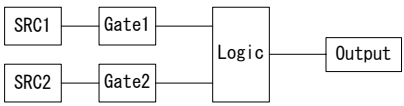
Note 2 When IH is set to 3, EV action turns OFF when a scale over error occurs on the EV set side.

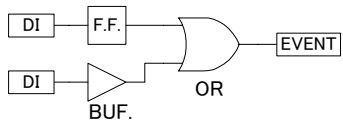
Note 3 To output an alarm when a scale over error occurs with IH set to 3, assign scale over (SO) to other EVs or DOs.

12-8 Event Logic Operations

Event logic operations can be assigned to EV1 to EV3, and DO1 to DO3.
This function performs logic operations on inputs from two DIs or time signals, and outputs the result to EV/DO. The action of sending D signals by communication is also possible. Simple sequences can be combined regardless of combination with timer/counter functions, and control action of the controller.

Event logic operation block diagram and configuration





The screens below are for when [LOGIC] has been assigned to EV1 to EV3 and DO1 to DO3.

Logic operation mode (Log MD)

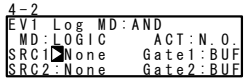
NAND and NOR logic operations are also possible by inverting input logic and output logic.

Setting range AND, OR, XOR
Initial value AND

AND	Logical product of 2 inputs	EV/DO turn ON when both of the two inputs turn ON. (positive logic)
OR	Logical sum of 2 inputs	EV/DO turn ON when either of the two inputs turns ON. (positive logic)
XOR	Exclusive OR of 2 inputs	EV/DO turn ON when one of the two inputs turns ON and the other input turns OFF. (positive logic)

Assigning logic operation input (SRC1, SRC2)

Assign the DI No. or time signal No. to two inputs that undergo logic operation.



Setting range None, TS1 to TS8, TS1-C2 to TS8-C2, DI1 to DI10
Initial value None (no assignment)

Note When a different function is assigned to DI, the function assigned to DI also starts to operate when logic operation functions when that DI signal is input.
When the assignment to DI is set to None, the function does not operate.

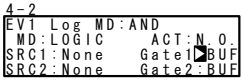
Logic operation input logic (Gate1, Gate2)

Set the logic of the two inputs that undergo logic operation.

BUF (buffer) The input signal is treated as the input logic signal as it is.

INV (inverter) The input signal obtained by inverting the input signal is treated as the input logic signal.

FF(flip-flop) The assigned input becomes the input logic that is inverted each time that this signal turns ON.
By this logic, input logic turns ON when input has turned ON, and is held at ON even if input turns OFF later, and input logic turns OFF when inputs turns ON again.



Setting range BUF, INV, FF
Initial value BUF

Note When the logic operation input is a time signal (TS1 to TS8, TS1-C2 to TS8-C2), FF cannot be set.

12-9 Timers/Counters

Assign timers and counters to DO4 and DO5.

With this timer/counter function, DI or a time signal is taken as input and EV/DO is taken as output, and EV can be output after the preset time has elapsed after generation of an input, or when there was an input of the preset count.

The timers and counters operate regardless of the control action of this device, and output a one-shot pulse of one second.

The following screens are displayed when [LOGIC] has been assigned to DO4 and DO5.

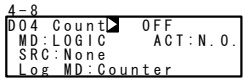
Setting timer time (Time)

The time can be set within the range 1 to 5000 seconds only when the mode is set to timer.

Setting range	OFF, 1 to 5000 s
Initial value	OFF

Setting count (Count)

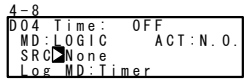
The range can be set within the range 1 to 5000 times only when the mode is set to counter.



Setting range	OFF, 1 to 5000
Initial value	OFF

Input assignment (SRC)

Assign the DI No. or time signal No.

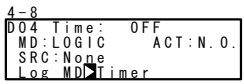


Setting range	None, TS1 to TS8, TS1-C2 to TS8-C2, DI1 to DI10
Initial value	None (no assignment)

Note When a different function is assigned to DI, the function assigned to DI also starts to operate when logic operation functions when that DI signal is input.

Setting the logic operation mode (Log MD)

Select and set timer or counter.



Setting range	MD: Timer, Counter
Initial value	MD: Timer

Timer	Timer function	DO is output after DI is input and a preset time elapses.
Count	Counter function	DO is output when the DI input count reaches the preset count.

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13 SETTING DI & AO

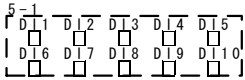
13-1 Setting DI

”DI” is a digital input signal for external control based upon an externally input non-voltage contact signal or an open collector transistor. The function to be executed can be selected, and assigned to DI2 to DI10.

DI5 to DI10 are optional.
DI5 to DI10 are not displayed when they are not mounted.

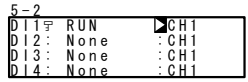
DI monitor screen

The status of the DI terminal can be monitored.
When ☐ is displayed reversed to ■, this indicates that the DI terminal is ON.

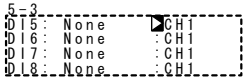


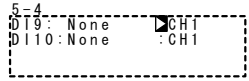
Setting DI assigned channels

This item can be set only in the 2-input, 2-loop specification.
Each DI can be assigned to each channel.
CH1, CH2 or CH1+CH2 can be assigned simultaneously according to the details of action.



Setting range	CH1, CH2, CH1+2
Initial value	CH1





List of DI assignment setup parameters

The following nine parameters can be assigned in the following DI assignment screen.

Restriction conditions when assigning DI

*1 RUN/RST are assigned (fixed) to DI1. These assignments cannot be changed.

*2 PTN2bit and PTN3bit can be assigned only to DI5 and DI8.

*3 PTN4bit and PTN5bit can be assigned only to DI5.

List of DI assignment parameters

Type	Explanation of Action	No-action Conditions	Signal Detection
None	No action (factory setting)	————	Level
RUN/RST	Switching of Run/Reset (when ON: Run execution)	None	Edge
RST	Forced Reset (when ON: Reset state)	None	Level
HLD	Control pause/resume (when ON: Reset state)	None	Level
ADV	Execute advance (when ON: execute advance)	HLD	Edge
FIX	Switchnig of FIX mode/program mode (when ON: FIX mode)	None	Level
MAN	Switching of control output between auto/manual (when ON: manual)	AT	Level
LOGIC	Logic operation input [exclusive port] (when ON: input ON)	None	Level
PTN2bit	Selection of start pattern No. by DI input (selectable from 3 patterns)	FIX	Level
PTN3bit	Selection of start pattern No. by DI input (selectable from 7 patterns)	FIX	Level
PTN4bit	Selection of start pattern No. by DI input (selectable from 15 patterns)	FIX	Level
PTN5bit	Selection of start pattern No. by DI input (selectable from 20 patterns)	FIX	Level

Note 1 The corresponding DI action details cannot be executed while parameters listed in the “No-action Conditions” column in the DI Assignments Table are being executed.

Note 2 Signal detection timing:

Level input Action is maintained with DI input ON.
Edge input Action is executed by DI input ON, and is maintained even if DI input turns OFF. Action is canceled by DI input ON again.

Note 3 DI input must be held at ON or OFF for at least one second to detect DI input.

Note 4 Once functions are assigned a DI, the same function cannot be set by the front panel keys as DI is given priority.

Note 5 When the same action is assigned to two or more DIs, only the DI having the smallest No. is valid under the following conditions, and DIs having a larger No. are invalid:

(1) When the same action is assigned to multiple DIs (however, valid if on different channels)
For example, assignment to DI2 becomes invalid when MAN is assigned to DI1 and DI2.

(2) When action types (PTN2bit, PTN3bit, PTN4bit, PTN5bit) that use multiple DI terminals are assigned to multiple DIs (however, valid if on different channels)
For example, assignment to DI8 becomes invalid when PTN3bit is assigned to DI5 and DI8.

Note 6 When action types (PTN2bit, PTN3bit, PTN4bit, and PTN5bit) that use multiple DI terminals are assigned, the assigned action of the DI to be used will be cleared depending on the assignment.

For example, the assignment of MAN to DI6 is canceled when PTN5bit is assigned to DI5 with MAN assigned to DI6.

Note 7 When a DI assignment is canceled during DI execution, the currently executing action is continued (excluding LOGIC operation).

Note 8 For details on logic operation, see “12-1, Event Logic Operations.”

Note 9 LOGIC cannot be set to CH.

■Selection of start pattern No.

The start pattern No. can be selected by the external input.
To use this function, PTN 2bit, PTN 3bit, PTN 4bit, or PTN 5bit must be assigned to DI5, or PTN 2bit or PTN 3bit must be assigned to DI8, and the EXT indicator must be set to light.

Ex: To assign [PTN 5bit] to DI5, and select start pattern No.5

Short across DI COM (terminal No.44) and DI5 (terminal No.38), and DI7 (terminal No.40) according to the following table.

DI (terminal No.)	Start Pattern No.																			
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DI5(38)		*		*		*		*		*		*		*		*		*		*	
DI6(39)			*	*			*	*			*	*			*	*			*	*	
DI7(40)					*	*	*	*					*	*	*	*					*
DI8(41)									*	*	*	*	*	*	*	*					
DI9(42)																	*	*	*	*	*

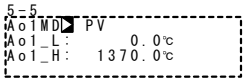
* mark indicates short across DI COM(44).

Note When start pattern No.0 is selected (DI input in OPEN state), the start pattern No. becomes No.1.

13-2 Analog Output

All of the following analog output types can be selected for both Ao1 and Ao2.
All of the following assignments are possible for both Ao1 and Ao2 even in a 2-input, 2-output specification.

Assigning the analog output 1 type

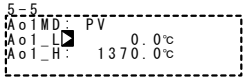


Setting range	Ao1, Ao2：PV, SV, DEV, OUT1, CH2_PV, CH2_SV, CH2_DEV, OUT2, Posi
Initial value	Ao1, Ao2：PV

PV	Input 1 measured value	CH2_PV	Input 1 measured value
SV	Channel 1 set value	CH2_SV	Channel 1 set value
DEV	Deviation value 1 (deviation of PV and SV)	CH2_DEV	Deviation value 2 (deviation of CH2_PV and CH2_SV)
OUT1	Control output 1	OUT2	Control output 1

Setting analog output 1 scaling

Scaling of analog output can be set.



Setting ranges and defaults

	Analog Output Type	Setting Range	Default
Ao1_L analog output 1 lower limit scaling Ao2_L analog output 2 lower limit scaling	PV, SV, CH2_PV, CH2_SV	Within measuring range	Measuring range lower limit value
	DEV, CH2_DEV	-100.0 to 100.0%	
	OUT1, OUT2	0 to 100.0%	0.0%
Ao1_H analog output 1 higher limit scaling Ao2_H analog output 2 higher limit scaling	PV, SV, CH2_PV, CH2_SV	Within measuring range	Measuring range higher limit value
	DEV, CH2_DEV	-100.0 to 100.0%	
	OUT1, OUT2	0 to 100.0%	100.0%

14. OPTIONS & OTHER FUNCTIONS

14-1 Heater Burnout/Heater Loop Alarms

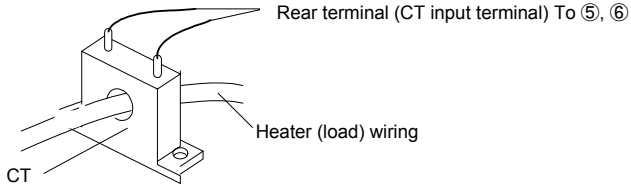
The heater burnout alarm and heater loop alarm can be used when Control Output 1 or Control Output 2 is a contact (Y) or SSR drive voltage (P).
These alarms cannot be used if control output is current (I) or voltage (V).

Pass the load wire through to the CT provided with this device.
Wire from the CT terminal to the CT input terminal on this device. The wire has no polarity.

Connecting the current transformer (CT)

Pass the load wire through the hole of the CT (provided with this device).
Wire from the CT terminal to the CT input terminal on this device.
The wire has no polarity.

For 30A CT CTL－6－S
For 50A CT CTL－12－S36－8



Heater current value monitor

The monitor displays the current value detected by the current transformer (CT).

5-7

```
Heater [  0.0A]
 HBA: OFF
 HLA: OFF
 HBM: Real   HB▶OUT1
```

Display range: 0.0 to 50.0 A

・"HB_HH" is displayed on the CT current display screen when the detection current exceeds 55.0A.
・"HB_LL" is displayed on the CT current display screen when the detection current is less than 0.0A.
・"----" is displayed on the CT current display screen when the current cannot be detected.

Heater burnout alarm current value (HBA)

An alarm is output when the current value of the load wire is detected by CT when Control Output is ON, and the current value of the load wire is smaller than the preset current value.
The alarm output is maintained even if control output turns OFF during alarm output.

Setting range OFF, 0.1 to 50.0A
Initial value OFF

Note To use this heater burnout alarm, HBA must be assigned in the EV/DO action mode settings.

Heater loop alarm current value (HLA)

An alarm is output when the current value of the load wire is detected by CT when Control Output 1 is OFF, and the current value of the load wire is greater than the preset current value. The alarm output is maintained even if control output turns ON during alarm output.

Setting range OFF, 0.1 to 50.0A
Initial value OFF

Note To use this heater loop alarm, HBL must be assigned to event or external output.

Heater burnout/heater loop alarm mode (HBM)

You can select the real mode and the lock mode as the alarm output mode.

Setting range Real, Lock
Initial value Real

Lock Once the alarm is output, alarm output is locked (fixed), and is output continuously even if the heater current value returns to normal.
Alarm output is canceled either when the alarm current value is set to OFF or the power is turned OFF.

Real Alarm output is canceled when the heater current value returns to a normal value after the alarm is output.

Heater burnout detection (HB)

Select the control output at which heater burnout is detected.
This parameter can be selected only for output type Y and P.

Setting range	OUT1, OUT2
Initial value	OUT1

14-2 Communication

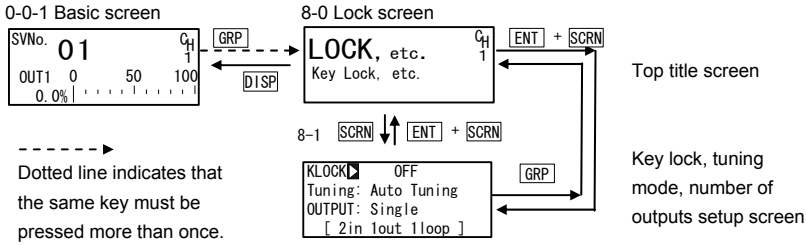
Setting communication

For details on the communication function, refer to the “FP23 Communication Interface Instruction Manual.”

14-3 Setting Key Lock

Displaying the key lock screen

To call up the LOCK, etc. screen group (group 8) from the basic screen, press the GRP key.
Press the SCRN key in the LOCK, etc. screen group to switch to the screens for making and changing setups.
Select parameters in screens by pressing the ↺ key.
Set parameters by pressing the ◄, ▼ or ▲ key, and press the ENT key to fix and register settings.



Key lock

When the key lock is applied, the (key mark) is displayed at the relevant parameter on the LCD screen indicating that the parameter cannot be set or its settings changed. Here, let's turn key lock ON.

8-1

```
KLOCK▶     OFF

OUTPUT: Single
  [ 2in 1out 1loop ]
```

Setting range OFF, LOCK1, LOCK2, LOCK3
Initial value OFF

LOCK1 Locks parameters other than SV-related, AT, MAN, and EV/DO parameters.
LOCK2 Locks parameters other than SV-related parameters.
LOCK3 Locks all parameters. (excluding the key lock parameter itself)

For details on parameters that are locked, see "17 List of Parameters."

15 Monitoring, Executing and Stopping Operation

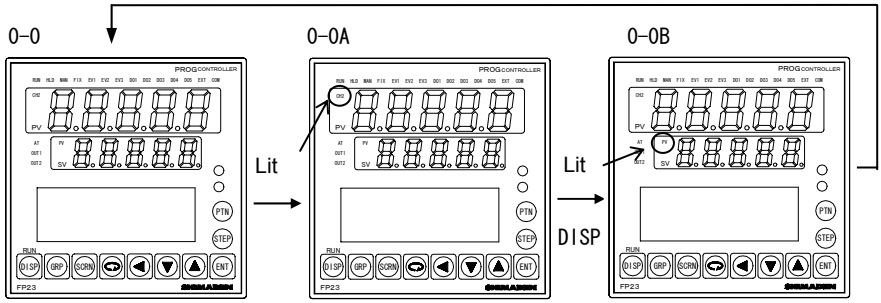
To execute program control or fixed value control, the basic screen (No.0-0) must first be moved to.
When another screen is displayed, press the DISP key to move to the basic screen.

15.1 Flow of Basic Screen in a 2-loop Specification

This section describes the configuration of the basic screen in a 2-loop specification and the flow of the basic screen.
You do not need to read this section in the case of other specifications.

There are three basic screens for the LCD display: CH1 basic screen (.0-0), CH2 basic screen (.0-0A), and PV basic screen (.0-0B).

You can switch to the display of the basic screen of the CH to execute control on by pressing the DISP key in the basic screen.



CH1 basic screen CH2 basic screen PV basic screen

The channel display in these basic screens is interlocked with the PV display, SV display and five status indicators (RUN, HLD, MAN, FIX, EXT). The CH1 is displayed when the CH2 indicator is out, and the CH2 is displayed when the CH1 indicator is out.

The channel in these displays can be switched only by switching the basic screen display.

When the PV basic screen is displayed, the PV value of CH1 is displayed on the PV display and the PV value of CH2 is displayed on the SV display, and the five status indicators show the CH1.

■Status indicator/7-segment LED states

	CH1 Basic Screen	CH2 Basic Screen	PV Basic Screen
Status indicator	CH1	CH2	CH1
7-segment LED upper section	CH1 PV	CH2 PV *1	CH1 PV
7-segment LED lower section	CH1 SV	CH2 SV	CH2 PV *2

*1: CH2 indicator on PV display lights.
*2: PV indicator on SV display lights.

The PV and SV displayed never change even if you press the GRP key to display a different screen group in the displayed basic screen. Also, the basic screen that is displayed by a return by the DISP key is the screen before the GRP key is pressed.

15-2 Operations in Basic Screen

The following operations are possible in the basic screen in a reset state:

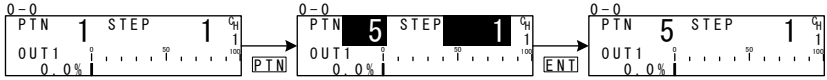
(1) Setting of the start pattern
(2) Setting of the start step
(3) Setting of the FIX mode (move from program mode to FIX mode)
(4) Changing of the FIX SV value
(5) Execution of program control/fixed value control

Setting the start pattern

Set the start pattern before the program is started.

When the PTN key is pressed in the monitor group top screen, the program pattern No. on the LCD display blinks and is incremented. (It can also be changed by the ▲ or ▼ key if it is blinking.)

When you press the ENT key after changing the program pattern No. to fix the setting, blinking stops.

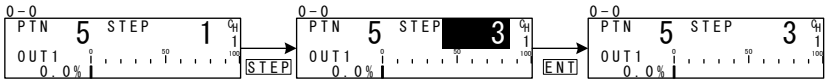


Setting the start step

Set the start step before the program is started.

When the STEP key is pressed in the monitor group top screen, the program step No. on the LCD display blinks and is incremented. (It can also be changed by the ▲ or ▼ key if it is blinking.)

When you press the ENT key after changing the program step No. to fix the setting, blinking stops.

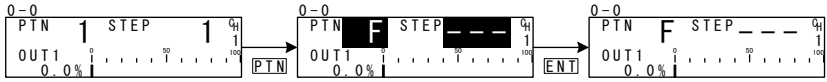


When “0” is set to the start step, control is executed even by pressing the ENT + DISP keys. To execute control, set a value other than “0” to the start step.

Setting the FIX mode

When the PTN key is pressed in the monitor group top screen, the program pattern No. on the LCD display blinks and is incremented. (It can also be changed by the ▲ or ▼ key if it is blinking.)

When “F” is selected, and the ENT key is pressed to fix the setting, blinking stops.



Note When the mode is changed from the program to the FIX mode, the move operation changes depending on the FIX MOVE setting.
For details, see “10-4 FIX MOVE Settings.”

Setting the FIX SV value (only in FIX mode)

In the FIX mode, pressing the ◄ key in the monitor group top screen causes the lowermost digit in the SV display to blink.

Press the ◄ key to move the blinking section on the numerical value to the digit to be changed, and press the ▲ or ▼ key to change the SV No. After changing the SV No., press the ▲ or ▼ key to fix the setting. The blinking section on the numerical value stops.

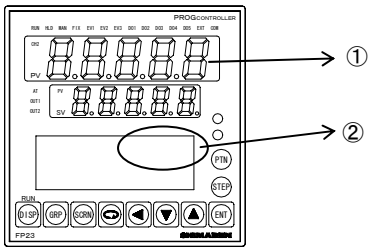
Executing program control/fixed value control

In the basic screen (in the 2-loop specification, the basic screen for the channel to execute control on), execute control by pressing the ENT + DISP keys.

Control can also be stopped during control execution by pressing the ENT + DISP keys.

For details, see “14-4 How to Execute and Stop Control.”

15-3 Displaying the Step No. and SV



The following table shows the relationship between the step No. ((1) in the figure) displayed in the basic screen and the SV ((2) in the figure) displayed in the SV display in a reset state.

Step No.	SV Display	
	PRG Mode	FIX Mode
0	Start SV	
1	Start SV	
2 to 400	Previous step SV	
— — —		FIX SV

15-4 How to Execute and Stop Control

Check the following again before executing control:

1. Is the screen the basic screen (in a 2-loop specification, the basic screen of the channel to be controlled)?
2. Is the control mode the desired control mode (program or FIX)?
3. Is the program at the desired start pattern or start step?

After checking the above, execute control.

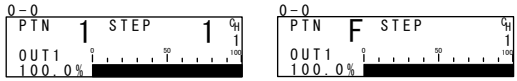
In the basic screen (in a 2-loop specification, the basic screen of the channel to execute control on), press the ENT + DISP keys, and execute control.
Control can also be stopped during control execution by pressing the ENT + DISP keys again.

16 CONTROL OPERATIONS DURING EXECUTION

16-1 Monitoring Control during Execution

Basic screen

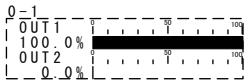
During program control execution, the currently executing pattern and step are displayed. During fixed value control, "F" is displayed on the pattern display, and "- - - " is displayed on the step display indicating that the display is off.
(These are not displayed in the case of a 1-output specification.)



Output value display

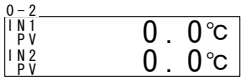
The output values of Control Output 1 (OUT1) and Control Output 2 (OUT2: option) are displayed on the upper and lower sections, respectively, as a % and a bar graph.

During manual output, OUT1 or OUT2 can be selected by the [⟲] key, and output can be adjusted by operating the [◄], [▲] or [▼] key



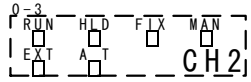
Monitoring PV

There are monitor screens for INPUT1/INPUT2 in addition to a monitor screen for the execution PV value.
This screen is displayed only in a 2-input, 1-loop specification.



Monitoring status

This screen is displayed only in a 2-loop specification.
In a 2-loop specification, the status monitor is for the channel different from that in the basic screen.

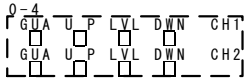


☐ below each indicated parameter inverted to ■ = lit
☐ below each indicated parameter blinks = blinking

RUN	Lights during program execution, and blinks during program execution standby.
HLD	Lights during program pause, and blinks during program error hold.
FIX	Lights in the FIX mode.
MAN	Blinks when control output is set to manual.
EXT	Lights when start pattern No. external selection (PTN2bit to PTN5bit) is assigned to DI.
AT	Blinks during execution of auto tuning, and lit during auto tuning standby.

Monitoring program status

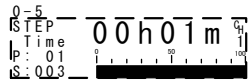
This status display is related to program execution of CH1 and CH2.
The upper section is for CH1, and the lower section is for CH2.



GUA Lights in guarantee soak.
UP Lights at execution of ascending step.
LVL Lights at execution of flat step.
DWN Lights at execution of descending step.

Monitoring the remaining step time

This screen is displayed only during program execution.
The remaining time of the currently executing step is displayed. The display returns to the basic screen when a stop (RST) is input by DI or when the mode has moved to the FIX mode by DI.

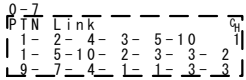


Monitoring the start pattern

This screen graphically displays the start pattern.

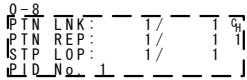
Monitoring the pattern link

This screen is displayed only during program execution.
The pattern link settings and execution state are displayed.
The currently executing pattern No. is displayed blinking.



Monitoring information during control execution

This screen is displayed only during control execution.
The states of the following four parameters are displayed during control execution.
Note, however, that only (4) is displayed during fixed value control (FIX).



PTN LNK	Indicates the pattern link execution count and setting count. (not displayed when a pattern link is not set)
PTN REP	Indicates the pattern execution count and setting count. (not displayed during FIX mode execution)
STP LOP	Indicates the execution count and setting count of the step loop. (not displayed when a step loop is not set)
PID.No	Indicates the PID No. currently in use.

16-2 Executing and Canceling Auto Tuning

Auto tuning (AT) can be executed and stopped.
During execution of auto tuning, the AT monitor indicator and status monitor blink, light during execution standby, and go out when auto tuning ends or stops.

Setting range ON, OFF
Initial value OFF

> What is “auto tuning?”
>
> Auto tuning automatically calculates the optimum PID constants by the limit cycle method so that control action is performed using these values.

Note As auto tuning is affected by the output limiter during execution, set the lower and higher limit values of the control output value before executing auto tuning. (Normally, set the lower limit value to 0% and the higher limit value to 100%.)

■ **Auto tuning cannot be executed (front panel keys)**

	Program Mode	FIX Mode
Reset state (RST)	Auto tuning cannot be executed	Auto tuning cannot be executed
Manual output (MAN)	Auto tuning cannot be executed	Auto tuning cannot be executed
Zone PID set to “PV”	Auto tuning cannot be executed	Auto tuning cannot be executed
PV value scale over	Auto tuning cannot be executed	Auto tuning cannot be executed
PID P=OFF (ON-OFF control)	Auto tuning standby	Auto tuning cannot be executed

■**Auto tuning end conditions**

	Program Mode	FIX Mode
When the RUN state changes to the reset (RST) state	End of auto tuning	End of auto tuning
When output has elapsed for about 200 minutes in a 0% or 100% state	End of auto tuning	End of auto tuning
At power interruption	End of auto tuning	End of auto tuning
When PID operation has ended	- - -	End of auto tuning
When computation of all PID Nos. (No.1 to No.10) has ended	End of auto tuning	- - -
When PV value has exceeded the scale	End of auto tuning	End of auto tuning

■ **About auto tuning during program control**

Once AT has been executed, the program judges whether the ramp is a ramp section or a flat section, and stands by for the next step in an AT standby state (indicator lit) on ramp sections. At flat sections, AT is executed (indicator blinks) using the PID No. of that step. Note, however, that under the following conditions operation sometimes is not performed.

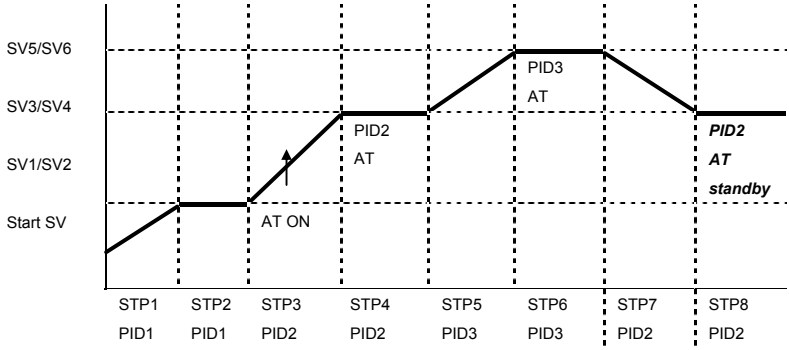
(1) AT is executed if even ramp sections are in a hold state.

(2) AT forcibly ends at PV scale over.

(3) The state changes to the AT standby state when P=OFF (ON-OFF control).

(4) For PID Nos. obtained by AT execution once and set with appropriate PID values, the state is the AT standby state even on flat sections until the program ends, and AT is not executed as long as AT is not performed again.

The following shows an example of AT execution at STP3.



STP3 AT is in a standby state as the section is a ramp section. (AT LED lit)
STP4 AT of flat section PID2 is executed (AT LED blinks), and becomes a standby state at the remaining time (AT LED lit).
STP5 AT is in a standby state as the section is a ramp section. (AT LED lit)
STP6 AT of flat section PID2 is executed (AT LED blinks), and becomes a standby state at the remaining time (AT LED lit).
STP7 AT is in a standby state as the section is a ramp section. (AT LED lit)

STP8 AT is in a standby state (AT LED lit) as computation of PID2 has ended at STP4.

*1 AT also ends (AT LED out) at program end (STP8).
*2 In the case of this example, AT of PID1 is not performed.

Note When there is not enough step execution time at flat sections, and AT does not end, AT execution of that No. is carried out to the next time.

■ **About auto tuning during fixed value control (FIX)**

During FIX control, the AT indicator lights from the moment that AT is started, and AT is executed.
When AT ends, the AT indicator automatically goes out.

16-3 Switching Auto/Manual of Control Output

Switch control output between automatic or manual output.
Normally, automatic operation is performed. However, use this item to manually set control output, for example, during device testing.
During manual output, note that the set value is continually output and feedback control is not performed.
During manual output, the MAN monitor indicator and status monitor are displayed blinking.

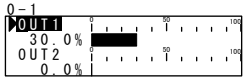
Setting range OFF, ON
Initial value OFF

The manual execution conditions (common to front panel keys and external switch input) are as follows:

(1) Execution of auto tuning must not be in progress (AT=ON).
(2) The state must not be reset (RST).

Manual output operations

In a 1-output specification, the output value of OUT2 and the output bar graph are not displayed on the screen.



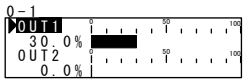
1. In the setup screen (1-1), select MAN (manual) using the cursor, and select ON to register manual output.

2. Next, to perform control output manually, move to the basic screen (group 0) by the DISP key, and move to the output value display (.0-1) screen by the SCRN key.
At this time, make sure that the cursor (▶) is displayed at the top left of the LCD screen.

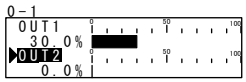
3. You can select OUT1 or OUT2 by the ⟲ key, and adjust the output by the ◀, ▲ or ▼ key.
In manual output, there is no need to register and fix settings by the ENT key.

Simple key-based manual output operations

In the output value display screen (0-1), you can switch OUT1 automatic/manual by pressing the ENT + ▲ keys, and switch OUT2 automatic/manual by pressing the ENT + ▼ keys.



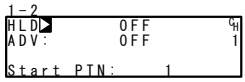
ENT + ▲



ENT + ▼

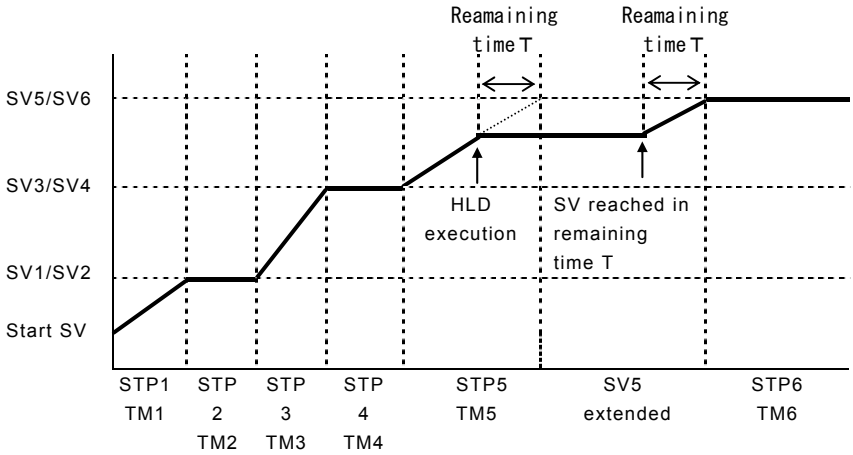
16-4 Temporarily Holding and Resuming Program Execution

Hold is a function for temporarily holding action during program execution. When this function is set to ON, HLD is executed, and when it is set to OFF, HLD is canceled. During HLD execution, the HLD monitor indicator and status monitor are lit.



Setting range OFF, ON
Initial value OFF

As shown below, control is performed on SV5 for the remaining time of TM5 when HLD is canceled.



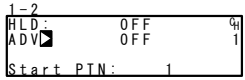
*1 HLD is enabled even in the guarantee soak.
*2 ADV cannot be executed during HLD.
*3 HLD operation by key entry or communication is enabled only when DI is not assigned. (DI input is given priority.)
*4 When a program is executed with HLD DI input ON, program execution is dependent on the SV value of the PV start function.
Ex: When PV start is ON, hold by SV value of PV start
When PV start is OFF, hold by start SV
*5 During HLD, changes to parameters are not reflected until HLD is canceled even if start V, step SV and time signal related parameters are changed.

16-5 Executing Advance

Advance is a function for forcibly moving to the next step (or time) from the current step (or time) during program execution.

①Step move: Program advance in step units (single steps).
②Time move: Program advance in time units.

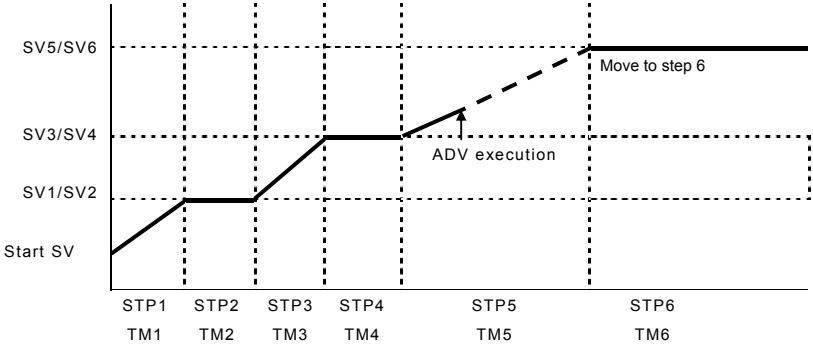
For details on the setting of move action by ADV execution and ADV time when time move is set, see “9-1, Setting the advance mode,” and “9-1 Setting the advance time.”



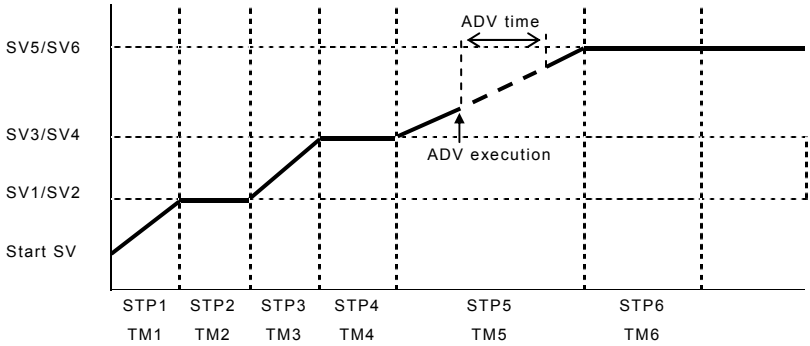
Setting range ON, OFF
Initial value OFF

*1 ADV is disabled for about two second after ADV is executed.
*2 In a guarantee soak (GUA) state, GUA is canceled on both the step and time, and the program only moves to the next step.
*3 Advance cannot be executed during a hold (HLD).

Example 1) Move by step according to ADV (forcibly end step 5 and move to step 6)



Example 2) Move by time according to ADV (move by ADV time only)



*1 In time selection, when the ADV time is greater than the remaining time of that step, advance beyond the next step is not performed, and the program only advances to the next step in the same way as in step selection.

17 ERROR DISPLAYS (PV DISPLAY AREA)

17-1 Operation Check Abnormalities at Power ON

This device displays the following error codes on the PV display when the self-test is automatically executed when the device is powered ON and an error is detected.

Display	Cause	
E-roM	ROM error	In any of the states shown on the left, all outputs turn OFF or become 0%.
E-rAM	RAM error	
E-EEP	EEPROM error	
E-Ad1	Input 1 A/D error	
E-Ad2	Input 2 A/D error	
E-SPc	Hardware error	

Request

・If any of the messages shown in the table are displayed, repair or replacement is required. Immediately turn the power OFF, and contact your dealer.

17-2 PV Input Abnormalities

When a PV input-related abnormality is detected during execution of control on this device, the following error codes are displayed on the PV display.

Display	Cause
Sc_LL	The PV value exceeded the measuring range lower limit (-10%FS).
Sc_HH	The PV value exceeded the measuring range higher limit (+110%FS).
dE_LL	Count value lower limit over
dE_HH	Count value higher limit over
Sc_HH b-----	RTD 1 burnout RTD 2 or 3 burnout, or two or more burnouts
Sc_HH CJ_LL CJ_HH	Thermocouple burnout Reference junction compensation (heater lead) is at the lower limit side in the case of thermocouple input Reference junction compensation (heater lead) is at the higher limit side in the case of thermocouple input
E-Ad1	Input 1 A/D error
E-Ad2	Input 2 A/D error

Request

- Check input or the heater lead when the above messages are displayed. If the input or the heater lead is not in error and there is another probable cause, contact your dealer.
- When an A/D error occurs, the action of both PV is the same as when the higher limit scale over error occurs.

17-3 Heater Lead Abnormalities

When a heater lead abnormality is detected during execution of control on this device the following error codes are displayed on the LCD.

Display	Cause
Hb_LL	The heater lead has fallen to less than 0.0%.
Hb_HH	The heater lead exceeds 55.0.

18 LIST OF PARAMETERS

This chapter lists all of the parameters used by the FP23.
Option functions that are not mounted or parameters that cannot be set by the user are not listed.

No.	Indicates the parameter No.
Display Symbol	Indicates the parameter symbol displayed on the LCD screen.
(CH1), (CH2)	Relevant only in a 2-loop specification
Description of Function	Indicates the display or setup details.
Setting range	Indicates the range of parameters or numerical values that can be set.
Initial Value	Indicates the factory setting. (excluding instances where this device is shipped with values customized to customer specified values)
Lock	Number indicates the level at which key lock is valid.

★ Indicates a parameter that may be initialized when one of a range setting, unit setting or PV scaling setting has been changed. Parameters marked by ★ may need to be confirmed again when the above settings have been changed.

18-1 Execution Screen Group (group 1)

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
AT	Auto tuning execution	ON/OFF	OFF	2
MAN ★	Control output operation switching	ON/OFF	OFF	2
COM	Communication mode	LOC: COM:	LOC	2
HLD	Hold execution	ON/OFF	OFF	1
ADV	Advance execution	ON/OFF	OFF	1
Start PTN	Start pattern No.	1 to 20	1	1
PTN Link Reps	Pattern link execution count	0 to 9999	0	1
Link Format 1st to 20th	Pattern link settings	0 to assigned pattern higher limit	0	1
FIX MODE	FIX mode switching	ON/OFF	OFF	1
FIX SV ★	FIX SV value setting	Within SV limit setting range	0 Unit	3
FIX PID	FIX PID No. selection	0 to 10	0	1
FIX MOVE	FIX move switching	EXE EXE/STBY EXE/TRCKTRCK	EXE	1

FIX EV Set Point EV1 to EV3 ★	FIX EV action point setting	DEV_Hi: -25000 to 25000 Unit DEV_Low: -25000 to 25000 Unit DEV_Out:0 to 25000 Unit DEV_In: 0 to 25000 Unit PV_Hi: Within measuring range PV_Low: Within measuring range	25000 Unit -25000 Unit 25000 Unit 25000 Unit Measuring range higher limit value Measuring range higher limit value	2
FIX DO Set Point DO1 to DO13 ★	FIX DO action point setting	DEV_Hi: -25000 to 25000 Unit DEV_Low: -25000 to 25000 Unit DEV_Out:0 to 25000 Unit DEV_In: 0 to 25000 Unit PV_Hi: Within measuring range PV_Low: Within measuring range	25000 Unit -25000 Unit 25000 Unit 25000 Unit Measuring range higher limit value Measuring range higher limit value	2

18-2 Program Screen Group (group 2)

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
Num.of STEP	Number of steps	0 to assigned pattern higher limit	20	1
Start STEP	Start step	0 to number of steps	1	1
Start SV ★	Start SV	Within SV limiter setting range	0 Unit	3
PTN Reps	Pattern execution count	1 to 9999 times	1	1
Loop Setup				
Start	Start step No.	1 to number of steps	1	1
End	End step No.	1 to number of steps	20	1
Reps	Execution count	1 to 9999 times	1	1
GUArantee Soak				
Zone ★	Guarantee soak zone	OFF, 1 to 9999 Unit	OFF	1
Time ★	Guarantee soak time	00:00 to 99:59	00:01	1
PV Start	PV start	ON/OFF	OFF	1
EV Set Point EV1 to EV3 ★	EV action point setting	DEV_Hi: -25000 to 25000 Unit DEV_Low: -25000 to 25000 Unit DEV_Out:0 to 25000 Unit DEV_In: 0 to 25000 Unit PV_Hi: Within measuring range PV_Low: Within measuring range	25000 Unit -25000 Unit 25000 Unit 25000 Unit Measuring range higher limit value Measuring range higher limit value	2
DO Set Point DO1 to DO13 ★	DO action point setting	DEV_Hi: -25000 to 25000 Unit DEV_Low: -25000 to 25000 Unit DEV_Out:0 to 25000 Unit DEV_In: 0 to 25000 Unit PV_Hi: Within measuring range PV_Low: Within measuring range	25000 Unit -25000 Unit 25000 Unit 25000 Unit Measuring range higher limit value Measuring range higher limit value	2
TS1 to TS8				
ON STEP	Time signal ON step	OFF, 1 to number of steps	OFF	1
ON Time	Time signal ON time	00:00 to 99:59	00:00	1
OFF STEP	Time signal OFF time	OFF, 1 to number of steps	OFF	1
OFF Time	Time signal OFF time	00:00 to 99:59	00:00	1

18-3 Step Screen Group (group 2S)

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
STEP001 to 400				
SV ★	Step SV	Within SV limiter setting range	0 Unit	3
Time	Step time	00: 00 to 99: 59	00: 01	1
PID	Step PID No.	0 to 10	0	1

18-4 PID Screen Group (group 3)

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
PID01-OUT1				
P	No.1 proportional band (OUT1)	OFF, 0.1 to 999.9 %	3.0 %	1
I	No.1 integral time (OUT1)	OFF, 1 to 6000 s	120 s	1
D	No.1 differential time (OUT1)	OFF, 1 to 3600 s	30 s	1
DF ★	No.1 hysteresis (OUT1)	1 to 9999 Unit	20 Unit	1
MR	No.1 manual reset (OUT1)	-50.0 to 50.0 %	0.0 % (1-output specification) -50.0 % (2-output specification)	1
SF	No.1 target value function (OUT1)	0.00 to 1.00	0.40	1
ZN ★	No.1 PID zone (CH1)	Within measuring range	0 Unit	1
PID01-OUT2				
P	No.1 proportional band (OUT2)(CH2)	OFF, 0.1 to 999.9 %	3.0 %	1
I	No.1 integral time (OUT2)(CH2)	OFF, 1 to 6000 s	120 s	1
D	No.1 differential time (OUT2)(CH2)	OFF, 1 to 3600 s	30 s	1
DF ★	No.1 hysteresis (OUT2)(CH2)	1 to 9999 Unit	20 Unit	1
DB ★	No.1 dead band (OUT2)(CH2)	-19999 to 20000 Unit	0 Unit	1
MR	No.1 manual reset (OUT2)(CH2)	-50.0 to 50.0 %	0.0 % (1-output specification) -50.0 % (2-output specification)	1
SF	No.1 target value function (OUT2)(CH2)	0.00 to 1.00	0.40	1
ZN ★	No.1 PID zone (CH2)	Within measuring range	0 Unit	1
PID01 OUT1L	No.1 output limiter lower limit value (OUT1)	0.0 to 100.0 %	0.0 %	1
OUT1H	No.1 output limiter higher limit value (OUT1)	0.0 to 100.0 %	100.0 %	1
OUT2L	No.1 output limiter lower limit value (OUT2)	0.0 to 100.0 %	0.0 %	1
OUT2H	No.1 output limiter higher limit value (OUT2)	0.0 to 100.0 %	100.0 %	1
Zone PID1	Zone 1 PID mode	OFF: Switching OFF PV : PV zone switching SV : SV zone switching	OFF	1
HYS1★	Zone 1 hysteresis	0 to 10000 Unit	20 Unit	1
PID2	Zone 2 PID mode	OFF: Switching OFF PV : PV zone switching SV : SV zone switching	OFF	1
HYS2★	Zone 2 hysteresis	0 to 10000 Unit	20 Unit	1
AT Point	AT point	0 to 10000 Unit	0	?

18-5 Event/DO Screen Group (group 4)

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
EV1 to EV3, DO1 to DO13				
MD	EV1 to 3 DO1 to 13 Operation mode	None : No action DEV Hi : Higher limit deviation action DEV Low: Lower limit deviation action DEV Out : Outside higher/lower limit deviation action DEV In : Inside higher/lower limit deviation action PV Hi : PV higher limit absolute value action PV Low : PV lower limit absolute value action SO : Scale over FIX : In FIX mode AT : Auto tuning execution in progress MAN : Manual action in progress LOGIC : Logic operation (*1 *2) Direct : Direct output (*3) RUN : RUN HLD : Program hold in progress GUA : Guarantee soak zone STEP : Step signal PRG.END: Program end signal TS1 : Time signal 1 TS2 : Time signal 2 TS3 : Time signal 3 TS4 : Time signal 4 TS5 : Time signal 5 TS6 : Time signal 6 TS7 : Time signal 7 TS8 : Time signal 8 HBA: Heater burnout alarm output in progress HBL: Heater loop alarm output in progress	EV1: DEV Hi EV2: DEV Low EV3: RUN DO1 to 13: None	1
ACT	EV1 to EV3 DO1 to DO13 output characteristics	N.O.: Normally open N.C.: Normally closed	N.O.	1
DF ★	EV1 to EV3 DO1 to DO13 hysteresis	1 to 9999 Unit	20 Unit	1
IH	EV1 to EV3 DO1 to DO13 standby action	OFF, 1/2/3	OFF	1
DLY	EV1 to EV3 DO1 to DO13 delay time	OFF, 1 to 9999 s	OFF	1
At EV1 to EV3MD LOGIC				

SRC1, SRC2	Input 1, input 2	None/TS1 to TS8/ TS1-C2 to TS8-C2/DI1 to DI10	None	1
Gate1, Gate2	Input 1, input 2	BUF/INV/FF	BUF	1
Log MD	Logic operation mode	AND/OR/XOR	AND	1
At DO4, DO5MD LOGIC				
SRC	Input	None/TS1 to TS8/ TS1-C2 to TS8-C2/DI1 to DI10	None	1
Log MD	Logic operation mode	Timer/Counter	Timer	1
Time	Time	OFF, 1 to 5000 s	OFF	1
Count	Count	OFF, 1 to 5000	OFF	1

*1: Logic operation (AND, OR, XOR) can be assigned only to LOGIC EV1 to EV3, and DO1 to DO3.
*2: Logic operation (Timer, Count) can be assigned only to DO4 and DO5.
*3: Direct output can be assigned only to DO6 to DO13.

18-6 DI/Option Screen Group (group 5)

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
------	DI assignment channel	CH1, CH2/CH1+2	CH1	1
DI1	DI1 assignment	RUN	RUN	1
DI2	DI2 assignment	CH1, CH2 None CH1, CH2 RUN CH1, CH2 HLD CH1, CH2 ADV CH1, CH2 FIX CH1, CH2 MAN CH1, CH2 LOGIC	None	1
DI3 DI4 DI6 DI7 DI9 DI10	DI3 assignment DI4 assignment DI6 assignment DI7 assignment DI9 assignment DI10 assignment	CH1, CH2 None CH1, CH2 RUN CH1, CH2 HLD CH1, CH2 ADV CH1, CH2 FIX CH1, CH2 MAN CH1, CH2 LOGIC	None	?
DI5	DI5 assignment	CH1, CH2 None CH1, CH2 RUN CH1, CH2 HLD CH1, CH2 ADV CH1, CH2 FIX CH1, CH2 MAN CH1, CH2 LOGIC PTN2bit PTN3bit PTN4bit PTN5bit	NON	1
DI8	DI8 assignment	CH1, CH2 None CH1, CH2 RUN CH1, CH2 HLD CH1, CH2 ADV CH1, CH2 FIX CH1, CH2 MAN CH1, CH2 LOGIC PTN2bit PTN3bit	NON	1
Ao1MD	Analog output 1 type	PV : CH1 measurement value SV : CH1 setting value DEV : CH1 deviation value OUT1 : Output 1 CH2_PV : CH2 measurement value CH2_SV : CH2 setting value CH2_DEV: CH2 deviation value OUT2 : Output 2	PV	1
Ao1_L ★	Analog output 1 lower limit side scaling	PV,SV,CH2_PV,CH2_SV: Within measuring range DEV,CH2_DEV2 : -100.0 to 100.0 % OUT1,OUT2 : 0.0 to 100.0 %	Measuring range lower limit value	1
Ao1_H ★	Analog output 1 higher limit side scaling	PV, SV, CH2_PV,CH2_SV: Within measuring range DEV, CH2_DEV2 : -100.0 to 100.0 % OUT1, OUT2 : 0.0 to 100.0 %	Measuring range higher limit value	1

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
Ao2MD	Analog output 2 type	PV : CH1 measurement value SV : CH1 setting value DEV : CH1 deviation value OUT1 : Output value 1 CH2_PV : CH2 measurement value CH2_SV : CH2 setting value CH2_DEV: CH2 deviation value OUT2 : Output value 2	SV	1
Ao2_L ★	Analog output 2 lower limit side scaling	PV, SV, CH2_PV,CH2_SV: Within measuring range DEV, CH2_DEV2 : -100.0 to 100.0 % OUT1,OUT2 : 0.0 to 100.0 %	Measuring range lower limit value	1
Ao2_H ★	Analog output 2 higher limit side scaling	PV, SV, CH2_PV,CH2_SV: ¥Within measuring range DEV, CH2_DEV2 : -100.0 to 100.0 % OUT1, OUT2 : 0.0 to 100.0 %	Measuring range higher limit value	1
Heater	Heater current value monitor	0.0 to 50.0A	—	—
HBA	Heater burnout alarm	OFF, 0.1 to 50.0 A	OFF	1
HLA	Heater loop alarm	OFF, 0.1 to 50.0 A	OFF	1
HBM	Heater burnout mode	Lock: Lock Real: Real	Lock	1
HB	Heater current detection selection	OUT1: Control Output 1 OUT2: Control Output 2	OUT1	1
COM PROT	Communication protocol	SHIMADEN MOD_ASC MOD_RTU	SHIMADEN	1
ADDR	Communication address	1 to 98	1	1
BPS	Communication speed	2400 bps 4800 bps 9600 bps 19200 bps	9600 bps	1
MEM	Communication memory mode	EEP: Write to EEPROM, RAM RAM: Write to RAM only R_E: Write other than SV to EEPROM	EEP	1
COM DATA	Communication data length	7: 7 bits 8: 8 bit	7	1
PARI	Communication data parity	EVEN/ODD/None	EVEN	1
STOP	Communication stop bit	1/2	1	1
DELY	Communication delay time	1 to 50 ms	10 ms	1
COM CTRL ★	Communication control code	STX_ETX_CR STX_ETX_CRLF @_: _CR	STX_ETX_CR	1
BCC ★	Communication BCC check	ADD ADD two's cmp XOR None	ADD	1

* SHIMADEN standard protocol only

18-7 Control Output Screen Group (group 6)

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
OUT1 ACT	Output 1 control characteristics	Reverse: Reverse characteristics Direct: Direct characteristics	Reverse	1
RST	Output preset value at output 1 reset	0.0 to 100.0 %	0.0 %	
ERR	Output preset value at output 1 error	0.0 to 100.0 %	0.0 %	1
CYC	Output 1 proportional cycle time	1 to 120 s	Contact (Y): 30 s SSR (P): 3 s	1
OUT2 ACT	Output 2 control characteristics	Reverse: Reverse characteristics Direct: Direct characteristics	Reverse	1
RST	Output preset value at output 2 reset	0.0 to 100.0 %	0.0 %	
ERR	Output preset value at output 2 error	0.0 to 100.0 %	0.0 %	1
CYC	Output 2 proportional cycle time	1 to 120 Sec	Contact (Y): 30 Sec SSR (P): 3 Sec	1
Rate Limiter				
Out1	Output 1 rate-of-change limiter	OFF, 0.1 to 100.0 %/s	OFF	1
Out2	Output 2 rate-of-change limiter	OFF, 0.1 to 100.0 %/s	OFF	1

18-8 Unit/Range Screen Group (group 7)

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
2-IN(func)				
PV_MODE	PV1, PV2 input mode	MAX: Maximum value MIN: Minimum value AVE: Average value DEV: Deviation value PV : CH1 PV	DEV	1
SO_MODE	Scale over mode	0/1	0	1
PV Bias ★	PV bias	-10000 to 10000 Unit	0 Unit	1
PV Filter	PV filter	OFF, 1 to 100 Sec	OFF	
PV Slope ★	PV ramp bias	0.500 to 1.500 Unit	1.000	1
INPUT1				
PV Bias ★	PV bias	-10000 to 10000 Unit	0 Unit	1
PV Filter	PV filter	OFF, 1 to 100 Sec	OFF	1
PV Slope ★	PV ramp bias	0.500 to 1.500 Unit	1.000	1
INPUT2				
PV Bias ★	PV bias	-10000 to 10000 Unit	0 Unit	1
PV Filter	PV filter	OFF, 1 to 100 Sec	OFF	1
PV Slope ★	PV ramp bias	0.500 to 1.500 Unit	1.000	1
RANGE	Measuring range	01 to 19: Thermocouple 31 to 58: Resistor 71 to 77: Voltage (mV) 81 to 87: Voltage (V)	06	1
Sc_L ★	PV lower limit side scaling	-19999 to 30000 Unit	0 Unit	?
Sc_H ★	PV higher limit side scaling	-19999 to 30000 Unit	1000 Unit	?
UNIT ★	Measurement unit	˚C: Centigrade ˚F: Fahrenheit % : Percentage None: No unit	˚C	1
DP ★	Decimal point position	XXXXX. XXXX.X XXX.XX XX.XXX X.XXXX	XXXX.X	1
Figure ★	Selection of number of digits past decimal point	Normal: Digits past decimal point Short : No digits past decimal point	Normal	1
CJ	Cold junction compensation	Internal: Internal compensation External: External compensation	Internal	1
SQ.Root ★	Square root extraction operation (at linear output)	OFF: No operation ON : Operation	OFF	1
Low cut	Low cut (at linear output)	1.0 to 5.0 %	1.0 %	1

PMD	Broken line operation mode	OFF: Broken line operation OFF ON : Broken line operation ON	OFF	1
A1 to A11	Broken line approximation input 1 to 11	-5.00 to 105.00 %	0.00 %	1
B1 to B11	Broken line approximation output 1 to 11	-5.00 to 105.00 %	0.00 %	1

18-9 Lock/Initialization Screen Group (group 8)

Display Symbol	Description of Function	Setting Range	Initial Value	Lock
KLOCK	Key lock	OFF : Cancel LOCK1: Other than SV, CONTROL LOCK2: Other than SV LOCK3: All	OFF	
OUTPUT	Output mode	Single: 1-output Dual : 2-output	1-output: Single 2-outputs: Dual	1
IR COM	Front panel communication ON/OFF	ON : Enabled OFF : Disabled	ON	1
SV Limit_L ★	SV limiter lower limit value	Within measuring range. Note that L<H	Measuring range lower limit value	1
SV Limit_H ★	SV limiter higher limit value	Within measuring range. Note that L<H	Measuring range higher limit value	1
Time Unit	Time unit	H/M: Hours/minutes M/S: Minutes/second	H/M	1
PRO.Wait	Program control execution delay time	00h00m to 99h59m	00: 00	1
SO Mode	Input error mode	HOLD : Hold state RUN : RUN continued RESET: Reset state	HOLD	1
POWER ON	Power interruption compensation return action	RESET: Power interrupt compensation restore action CONTINUE: No power interrupt compensation restore action	RESET	1
ADV Mode	Advance mode	Step: Step Time: Time	Step	1
ADV Time	Advance time	00: 00 to 99: 59	00: 00	1
CH1 PTN	CH1 pattern number assignment	0 to 20	10	1

19 PARAMETER SETUP RECORD SHEETS

Lots of parameters are set on this device before use.
Users will find these sheets will come in handy to restore a system in the event of a malfunction, for example, if they keep a detailed record of the product model No. they are using and the values set on this device.

We recommend that you fully utilize these record sheets by making a blank copy of these tables and entering the required values on the copied record sheet.

19-1 Product Model Code

FP23−	□	□−	□□−	□□	□	□	□	□	□

19-2 SV Parameters

Item	CH1	CH2
AT		
MAN		
HLD		
ADV		
Start PTN		
PTN Link Reps		
Link Format		
1st		
2nd		
3rd		
4th		
5th		
6th		
7th		
8th		
9th		
10th		
11th		
12th		
13th		
14th		
15th		
16th		
17th		
18th		
19th		
20th		

Item	CH1	CH2
FIX MODE		
FIX SV		
FIX PID		
FIX MOVE		
FIX EV1 Set Point		
FIX EV2 Set Point		
FIX EV3 Set Point		
FIX DO1 Set Point		
FIX DO2 Set Point		
FIX DO3 Set Point		
FIX DO4 Set Point		
FIX DO5 Set Point		
FIX DO6 Set Point		
FIX DO7 Set Point		
FIX DO8 Set Point		
FIX DO9 Set Point		
FIX DO10 Set Point		
FIX DO11 Set Point		
FIX DO12 Set Point		
FIX DO13 Set Point		

19-3 PROG STEP Parameters

PTN No. ____________

Item	CH1	CH2
Num. of STEP		
Start STEP		
Start SV		
PTN Reps		
Loop setup		
Start		
End		
Reps		
GUArantee Soak		
Zone		
Time		
PV Start		

Item	CH1	CH2
EV1 Set Point		
EV2 Set Point		
EV3 Set Point		
DO1 Set Point		
DO2 Set Point		
DO3 Set Point		
DO4 Set Point		
DO5 Set Point		
DO6 Set Point		
DO7 Set Point		
DO8 Set Point		
DO9 Set Point		
DO10 Set Point		
DO11 Set Point		
DO12 Set Point		
DO13 Set Point		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

PTN No. ____________

Item	CH1	CH2
Num. of STEP		
Start STEP		
Start SV		
PTN Reps		
Loop setup		
Start		
End		
Reps		
GUArantee Soak		
Zone		
Time		
PV Start		

Item	CH1	CH2
EV1 Set Point		
EV2 Set Point		
EV3 Set Point		
DO1 Set Point		
DO2 Set Point		
DO3 Set Point		
DO4 Set Point		
DO5 Set Point		
DO6 Set Point		
DO7 Set Point		
DO8 Set Point		
DO9 Set Point		
DO10 Set Point		
DO11 Set Point		
DO12 Set Point		
DO13 Set Point		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

STEP No.________

Item	CH1	CH2
SV		
Time		
PID		

19-4 PID Parameters

OUT1 (CH1)

PID No.	P	I	D	DF	MR	SF	ZN	OUT1L	OUT1H
01									
02									
03									
04									
05									
06									
07									
08									
09									
10									

OUT2 (CH2)

PID No.	P	I	D	DF	MR /DB	SF	ZN	OUT2L	OUT2H
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Zone PID

Item	Set Value
Zone PID1	
Zone HYS1	
Zone PID2	
Zone HYS2	

19-5 EV/DO Parameters

Item	EV1	EV2	EV3	DO1	DO2	DO3
CH						
MD						
ACT						
DF						
IH						
DLY						
Log MD						
SRC1						
GATE1						
SRC2						
GATE2						

Item	DO4	DO5	DO6	DO7	DO8	DO9
CH						
MD						
ACT						
DF						
IH						
DLY						
Log MD			———	———	———	———
SRC			———	———	———	———
Time /Count			———	———	———	———

Item	DO10	DO11	DO12	DO13		
CH						
MD						
ACT						
DF						
IH						
DLY						

19-6 DI/Options Parameters

Item	Set Value	CH Setting
DI1		
DI2		
DI3		
DI4		
DI5		
DI6		
DI7		
DI8		
DI9		
DI10		
Ao1MD		———
Ao1_L		———
Ao1_H		———
Ao2MD		———
Ao2_L		———
Ao2_H		———

Item		Set Value
HBA		
HLA		
HBM		
HB		
COM	PROT	
	ADDR	
	BPS	
	MEM	
	DATA	
	PARI	
	STOP	
	DELY	
	CTRL	
	BCC	

19-7 Control Output Parameters

Item	OUT1	OUT2
ACT		
RST		
ERR		
CYC		
Rate Limiter		

19-8 Unit Measuring Range Parameters

2-input, 1-loop specification

Item		Set Value
2-IN (FUNC)	PV_MODE	
	SO_MODE	

Item		Set Value
INPUT1	PV Bias	
	PV Filter	
	PV Slope	
INPUT2	PV Bias	
	PV Filter	
	PV Slope	

Input setting

Item	CH1	CH2
PV Bias		
PV Filter		
PV Slope		
RANGE		
Sc_L		
Sc_H		
UNIT		
DP		
Figure		
CJ		
SQ.Root		
Low Cut		
PMD		

Input point set values

Input point No.	CH1		CH2	
n	An	Bn	An	Bn
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

19-9 Lock/etc. Parameters

Item	Set Value
KLOCK	
OUTPUT	

Item	CH1 Set Value	CH1 Set Value
SV Limit_L		
SV Limt_H		
AT Point		
Time Unit		
PRG.Wait		
SO Mode		
POWER ON		
ADV Mode		
ADV Time		
CH1 PTN		

19-10 2-input Setup

Number of inputs, number of loops

20 SPECIFICATIONS

20-1 Display

- LED display

  Measured value (PV): 7-segment red LED 5 digits, height of characters 16 mm

  Set value (SV): 7-segment green LED 5 digits, height of characters 16 mm

- LCD display

  SV No., OUT% graph, control output value, various parameter displays

  128 x 32 dot matrix liquid crystal display with yellow-green LED backlight

- LED indicators

  19 action statuses displayed. Light on or blinking when status is enabled

RUN	Green	When program is running
HOLD	Green	When program operation is paused
FIX	Green	In FIX (fixed value control) mode
COM	Green	In the communication mode
EXT	Green	When start pattern external switching is assigned
MAN	Green	When manual control is in operation
AT	Green	When execution of auto tuning is in progress
EV1 to EV3	Orange	When event output is ON
DO1 to DO5	Orange	When DO output is ON
CH2	Green	When CH2 display is selected
PV	Green	When ChH2 side PV is displayed (on SV display)
OUT1	Green	Control Output 2
OUT2	Green	Control Output 2

- Display accuracy

  ±0.1% of measuring range (See Range Tables for individual ranges.)

TC input	±(0.1% FS + 1°C)
Pt input	±(0.1% FS + 0.1°C)
mV, V input	±(0.1% FS + 1 digit)
mA input	Depends on accuracy of externally attached resistor (±0.1%FS or specified when order is placed)

- Temperature range for maintaining display accuracy

  23°C±5°C

- Display resolution

  0.0001, 0.001, 0.01, 0.1, 1
  (differs depending on measuring range)

- Sampling cycle

  0.1 seconds (100 msec)

20-2 Settings

・Local setting	By 10 front panel key switches
SV setting range	Same as measuring range (within setting limiter)
・Higher/lower setting limiter	Any value in measuring range (lower limit value < higher limit value)

20-3 Input

・Multi-input, multi-range	Thermocouple input, RTD input, voltage input (mV, V), current input (mA),
・Thermocouple (TC) input type	B, R, S, K, E, J, T, N, PLII, PR40-20, WRe5-26, L,U(DIN43710) gold & ion-Chromel (Kelvin scale). For details, see Table of Ranges.
Display range	±10% of measuring range
Allowable range of external resistance	100Ω max.
Input resistance	500 kΩ max.
Cold junction compensation	Selectable between internal and external cold junction compensation
Internal cold junction compensation accuracy	±1°C (in range of 18 to 23°C)
Burnout functions	Standard feature (up scale)
・RTD input type	JIS Pt100 /JPT100 3-wire type. For details, see Table of Ranges.
Display range	±10% of measuring range (not lower than -273.15°C)
Lead wire tolerance	10Ω max. per wire
Prescribed current	Approx. 1.1mA
・Voltage input (mV, V) type	-10 to 10, 0 to 10, 0 to 20, 0 to 50, 10 to 50, 0 to 100, -100 to 100 mV -1 to 1, 0 to 1, 0 to 2, 0 to 5, 1 to 5, 0 to 10, -10 to 10 V Multi-input, programmable scaling For details, see Table of Ranges.
Input resistance	500 kΩ min.
・Current input (mA) type	4 to 20, 0 to 20 mA: multi-input and programmable scaling
Receiving resistance	250Ω by external resistance
・Common functions	
Sampling cycle	0.1 seconds (100 msec)
PV bias/PV ramp	±10000 Unit/input value x 0.5 to 1.5
PV filter	OFF, 1 to 100 seconds
・Input operation	Possible with voltage or current input
Square root extraction operation	Low cut range 0 to 5.0% FS
Broken line approximation	Number of input points: 11
・Isolation	Insulated between input and DI input and various outputs (not insulated between input and system and CT input)

20-4 Control

・Control output:	1-output specification, 2-output specification (optional) In a 2-input (CH1, CH2) specification, Control Output 2 is output on CH2 side. In a 2-input (CH1, CH2) specification, 2-output specification is unavailable.
・Control system (common to Control Output 1 and 2)	W/ auto tuning function Expert PID control, In 2-output specification, expert PID+PID control
Multi-PID	By PID Nos.01 to 10 (10 types) Individual PID set on each step and FIX SV
Zone PID	Selectable between individual PID and zone PID (max. 10 zones)
Proportional band (P)	OFF, 0.1 to 999.9% (OFF: ON-OFF action)
Integral time (I)	OFF, 1 to 6000 seconds (OFF: with manual reset)
Derivative time (D)	OFF, 1 to 3600 seconds
Manual reset (MR)	-50.0 to 50.0% (Control Output 1)
Dead band (DB)	-19999 to 20000 Unit (Control Output 2)
Hysteresis (DF)	1 to 9999 Unit (at ON-OFF action)
Proportional cycle	1 to 120 seconds (at contact or SSR drive voltage output)
・Control output type/rating (common to Control Outputs 1 and 2)	Control output (Y) contact (1c) 240 VAC/2.5A resistive load Current output (I) 4 to 20 mA DC/resistive load 600Ω max. SSR drive voltage output (P) 12 V±1.5 VDC/load current 30 mA max. Voltage output (V) 0 to 10 VDC/load current 2 mA max.
Output accuracy	±0.5% FS (5 to 100% output/within accuracy maintaining temperature range)
Resolution	Approx. 1/14000 (during current or voltage output)
・Operation/output update cycle	0.1 seconds (100 msec)
・Control output characteristics	Reverse (for heating)/Direct (for cooling), Control Outputs 1 and 2 set individually (heating/cooling, 2-stage heating/2-stage cooling selectable in 1-loop, 2-output specification)
・Higher/lower output limiter setting range	Higher limit/lower limit (set individually for each PID No.) 0 to 100.0% (lower limit < higher limit)
・Output rate-of-change limiter	OFF, 0.1 to 100.0%/seconds (set individually for Control Outputs 1 and 2)
・Control output at error	0 to 100.0% (set individually for Control Outputs 1 and 2)
・Control output at standby	0 to 100.0% (set individually for Control Outputs 1 and 2)
・Manual control	
Auto/manual switching	Balanceless/bumpless action (simultaneous for Control Outputs 1 and 2)
Output setting range	0.0 to 100.0% set individually for Control Outputs 1 and 2
Setting resolution	0.1%
・Isolation	Control output insulated from various I/O and system. I, P and V of Control Outputs 1 and 2 not insulated from each other

20-5 Program Function

・Number of patterns	Max. 20 patterns
・Number of steps	Max. 400 steps
・Number of steps	0 minutes 0 seconds to 99 minutes 59 seconds or 0 hours 0 minutes to 99 hours 59 minutes
・Pattern execution count	Repeatable to 9999 times max.
・Step loop count	Repeatable to 9999 times max.
・Pattern link setting	Connectable to 20 patterns max. Executable to 9999 times max.
・Link execution setting	Repeatable to 9999 times max.
・Program settings	By front panel keys or communication
Level	Same as measuring range
Time (1)	0 to 99 hours 59 minutes/step
Time (2)	0 to 99 minutes 59 seconds/step
Ramp settings	Automatic computation by setting time and level Ascend, descend, ramp control
Timer	Sets the delay time for start of program operation 0 minutes 0 seconds to 99 minutes 59 seconds or 0 hours 0 minutes to 99 hours 59 minutes
・Setting resolution	
Level	0.1 or 1 (varies according to measuring range)
Time	1 minute or 1 second
・Advance function	Program moves to next step during operation.
・Hold function	Progress of program time is paused during operation.
・Time signal setting	
Number of registrations	Max. 8 points Assigned to event output and DO
Time (1)	0 to 99 hours 59 minutes
Time (2)	0 to 99 minutes 59 seconds
Resolution	1 minute or 1 second
・Guarantee soak zone	When the program moves from a ramp step to a flat step, the program does not move to the next step if the PV value is not in the set zone range or is not more than the preset time.
Setting resolution	0 to 9999 Unit
Time (1)	0 to 99 hours 59 minutes
Time (2)	0 to 99 minutes 59 seconds

20-6 Event Output

- Number of outputs: Total 3; EV1 to EV3
- Output rating: 240 VAC/1.0A resistive load common to contact outputs (normally open contacts)
- Output update cycle: 0.1 seconds (100 msec)
- Setting/selection: Individual setting (individual output), selectable from 21 types (to designate output)
  Assigned to either of CH1 and CH2 in the case of 2-input (CH1, CH2) specification

Output types

1) None	No action (no assignment)
2) DEV Hi	Higher limit deviation alarm
3) DEV Low	Lower limit deviation alarm
4) DEV Out	Outside higher/lower limit deviation alarm
5) DEV In	Inside higher/lower limit deviation alarm
6) PV Hi	PV higher limit alarm
7) PV Low	PV lower limit alarm
8) SO	ON at scale over
9) FIX	ON in FIX mode
10) AT	ON during execution of auto tuning
11) MAN	ON during manual control
12) LOGIC	ON during logic operation output
13) RUN	ON during control execution
14) HLD	ON during program hold
15) GUA	ON during guarantee soak
16) STEP	ON during step move
17) PRG.END	ON at program end
18) TS1	ON during time signal 1
|	|
25) TS8	ON during time signal 8
26) HBA	ON during heater burnout alarm action
27) HLA	ON during heater loop alarm action

- Setting range

DEV Hi, Low	-25000 to 25000 Unit
DEV Out, In	0 to 20000 Unit
PVHi, Low	Within measuring range

Hysteresis: 1 to 9999 Unit (when DEV, PV or SV is selected)
Action delay time: OFF, 1 to 9999 seconds (when DEV, PV or SV is selected)
Standby action: Selectable from 4 types (when DEV, PV or SV is selected)

OFF	No standby action
1	When RST → RUN at power ON
2	When RST → RUN and when execution SV is changed at power ON
3	At input error (SO), when action is OFF

Output characteristics switching: Selectable between normally open and normally closed

- Isolation: EV outputs insulated from various I/O and system

20-7 External Control Output (DO)

・Number of outputs	13 points in total; standard 5 and 8 optional		
	DO1 to DO3	Darlington output	3 points
	DO4 to DO5	Open collector output	2 points
	DO6 to DO13	Open collector output	8 points (optional)
・Output rating	Open collector output 24 VDC/8 mA max., ON voltage 0.8V or lower		
	Darlington output 24 VDC/50mA max., ON voltage 1.5V or lower		
・Output update cycle	0.1 seconds (100 msec)		
・Setting/selection	Individual setting (individual input), selectable from 27 types		
	Assigned to either of CH1 and CH2 in the case of 2-input (CH1, CH2) specification		
	Details are the same as those for event outputs.		
	(However, LOGIC can be assigned to only DO1 to DO5, and Direct can be assigned to only DO6 to DO13.)		
	Details of setting range, hysteresis, action delay time and standby action are the same as those for event outputs.		
・Output characteristics switching	Normal OFF and normal ON selectable		
・Isolation	DO outputs insulated from various I/O and system		

20-8 External Control Input (DI)

・Number of inputs	10 points in total; standard 4 and 6 optional		
	DI1 to DI4	4 points	
	DI5 to DI10	6 points (optional)	
・Input rating	Non-voltage contact or open collector		
Input specifications	Photocoupler input		
	5 VDC, 1 mA max. voltage application per 1 input		
Minimum input holding time	0.1 seconds (100 msec) min.		
・Setting/selection	Individual setting (individual input), selectable from 9 types		
	Assigned to either or both of CH1 and CH2 in the case of 2-input (CH1, CH2) specification		
Input types	1) None	No action (no assignment)	
	2) RUN/RST	ON during control execution	
		OFF when program is stopped [reset state] (edge input)	
	3) RST	ON when program is stopped [reset state]	
	4) HLD	ON when program control is paused	
		OFF when program control is resumed	
	5) ADV	ON when program is advances by steps (edge input)	
	6) FIX	ON when FIX mode is ON	
		OFF when FIX mode is OFF	
	7) MAN	ON during manual control,	
		OFF during automatic control	

8) LOGIC ”1” when logic operation input is ON, “0” when OFF
9) PTN2bit Start pattern No. selection by DI input (3 patterns max.)
10) PTN3bit Start pattern No. selection by DI input (7 patterns max.)
11) PTN2bit Start pattern No. selection by DI input (15 patterns max.)
12) PTN3bit Start pattern No. selection by DI input (20 patterns max.)

・Isolation DI inputs insulated from various I/O and system

20-9 Logic Operation Functions

- Number of logic operation outputs: Assignable to 8 points in total: EV1 to EV3 3 points, DO1 to DO5 5 points
  DO4 and DO5 are exclusively for timer and counter operation.
- Number of logic operation inputs: 26 external control input points, TS1 to TS8 (CH1), TS1 to TS8 (CH2) and DI1 to DI10, can be assigned individually to cause 1 and cause 2
- Input logic conversion: Input logic conversion possible individually on causes 1 and 2 (EV1 to EV3,DO1 to DO3 output)
  1) BUF By external control input logic
  2) INV Inversion of external control input logic
  3) FF Flip-flop logic operation of external control input
  (When a time signal is assigned to a cause, flip-flop cannot be set.)
- Logic operation (1): Logic operation output by cause 1 and cause 2 (EV1 to EV3, DO1 to DO3 output)
  1) AND Output by logical product
  2) OR Output by logical sum
  3) XOR Output by exclusive OR
- Logic operation (2): Logic operation output by cause 1 (DO4, DO5 output)
  1) Timer operation Comparative operation output with timer preset value
  2) Counter operation Comparative operation output with counter preset value

20-10 2-input Specifications (option)

- Input types: Input 1, Input 2, individual selection and individual setting, multi-input, multi-range
  Thermocouple input, RTD input, voltage input (mV, V), current input (mA)
- Input and control specifications
  1CH specification: Control specification to be determined by combination of input and control output
  1-loop control specification
  1) Input operation, 1-output control specification by 2 inputs (PV1, PV2)
  MAX PV max. value input, 1-output/2-output control specification
  MIN PV min. value input, 1-output/2-output control specification
  AVE PV average value input, 1-output/2-output control specification
  DEV PV deviation value input, 1-output/2-output control Specification
  PV Input 1 is taken as PV value.

	2) Input operation, 2-output control specification by 2 inputs (PV1, PV2)
2CH specification	2-loop control specification 1) 2-channel (2-loop) control specification
・Isolation	Not insulated across Input 1 (standard input) and Input 2. Otherwise, the same as 1-input specification

20-11 Heater Break Alarm (option)

・Alarm action	HB alarm ON when control output is ON and heater burnout is detected HLA alarm ON when control output is OFF and heater loop error is detected
Alarm detection	Heater current at alarm detection ON ≤ set current at heater burnout detection Heater current at OFF ≥ set current at heater loop error detection
Hysteresis at heater burnout or loop error detection	0.2 A
・Current detection	Heater current detection by external CT (supplied CT for exclusive use/1-phase)
Current detection selection	Selectable between Control Output 1 and Control Output 2 only when control output is Y or P
Sampling cycle	0.2 seconds
Minimum action confirmation time	0.2 seconds (200 msec) or longer (regardless of whether control output is ON or OFF)
・Current setting	Heater burnout, heater alarm set individually
Setting range	OFF, 0.1 to 50.0 A (setting OFF sets suspension of alarm action)
Setting resolution	0.1 A
・Current display	0.0 to 55.0 A
Display accuracy	3% FS (sine wave 50 Hz)
Sampling cycle	0.2 seconds
Minimum action confirmation time	0.2 seconds (200 msec) or longer (regardless of whether control output is ON or OFF)
・Output	Assigned to EV, DO output
Output hold	Selectable between Hold mode and Real mode
・Isolation	CT input insulated from DI input and various outputs, CT input not insulated from sensor input, standard remote input and system

20-12 Analog Output (option)

・Number of outputs	Maximum 2, A_o1, A_o2 individual setting, individual output Only A_o1 when sensor power supply (optional) is selected Assigned to either CH1 or CH2 in case of 2-input (CH1, CH2) specification
・Output types	Selectable from 8 types PV, SV, DEV, OUT1, CH2_PV, CH2_SV, CH2_DEV, OUT2
・Output rating	Individual selection (individual output) 0 to 10 mV DC/output resistance 10Ω 0 to 10 VDC/load current 2 mA max. 4 to 20mA DC/load resistance 300Ω max.
・Output accuracy	±0.1% FS (of indicated value)
・Output resolution	Approx. 1/14000
・Output update cycle	0.1 second (100 msec)

・Output scaling	PV, SV, CH"_PV, CH_SV within measuring range DEV, CH2_DEV within -100.0 to 100.0%; OUT1, OUT2 within 0.0 to 100.0%; reverse scaling possible
・Isolation	Analog outputs insulated from various I/O and system Analog outputs (A_o1, A_o2) not insulated from each other

20-13 Sensor Power Supply (option)

- Number of outputs: 1 (1 circuit)
  Output from Analog Output 2 (A_o2) terminal
  When the sensor power supply is selected, Analog Output 2 (A_o2) is unusable.
- Output rating: 24 VDC/25 mA max.
- Isolation: Sensor power supply insulated from various I/O and system

20-14 Communication Function (option)

- Communication type: RS-232C, RS-485
- Communication system: RS-232C 3-line half-duplex system
  RS-485 2-line half-duplex multidrop (bus) system
- Communication distance: RS-232C 15 m max.
  RS-485 500 m. max. (depending on connection conditions)
- Number of connectable devices: RS-232C 1
  RS-485 (differs depending on connection conditions including the host)
- Synchronization system: Start-stop synchronization
- Communication speed: 2400, 4800, 9600, 19200 bps
- Communication (device) address: 1 to 98
- Communication delay time: 0 to 50 msec
- Communication memory mode: EEP, RAM, r_E
- Communication protocol (1): SHIMADEN standard protocol
  Control code: STX_ETX_CR, STX_ETX_CRLF, @_:_CR
  Checksum (BCC): Add, Add two's cmp, XOR, None
  Communication code: ASCII data
- Communication protocol (2): MODBUS ASCII mode
  Control code: CRLF
  Error check: LRC check
  Function code: 03H and 06H (Hex) supported for both ASCII and RTU modes
  1) 03H Read data
  2) 06H Write data
- Communication protocol (3): MODBUS RTU mode
  Control code: None
  Error check: CRC 16
  Function code: 03H and 06H (Hex) supported for both ASCII and RTU modes
  1) 03H Read data
  2) 06H Write data

20-15 Infrared Communication

・Communication system	Direct communication is possible with a PC through the infrared-USB conversion adapter (sold separately)
・Number of connectable devices	1
・Infrared communication specification	
Synchronization system	Start-stop synchronization
Communication speed	9600 bps
Data format	7E1 (7 bits, even parity, stop 1 bit)
Control code	STX_ETX_CR
Checksum (BCC)	Add
Communication code	ASCII data
Communication delay time	0
・Communication protocol	SHIMADEN standard protocol

20-16 General Specifications

・Data storage	Non-volatile memory (EEPROM)	
・Operating environment conditions		
Temperature	-10 to 50°C	
Humidity	90% RH max. (no dew condensation)	
Elevation	2000 m above sea level or lower	
Category	II	
Pollution class	2	
・Storage temperature	-20 to 65°C	
・Power voltage	100 to 240 VAC ±10% 50/60 Hz	
・Power consumption	Max. 15 VA	
・Input noise removal ratio	Normal mode 40 dB min. (50/60 Hz) Common mode 120 dB min. (50/60 Hz)	
・Applicable standards	Safety IEC61010-1 and EN61010-1 EMC EN61326	
・Insulation resistance	Across I/O terminals and power terminal:	500 VDC 20MΩ min.
	Across I/O terminals and protective conductor terminal:	500 VDC 20MΩ min.
・Dielectric strength	Across I/O terminals and power terminal:	2300 VAC 1 minute (faradic current 5mA)
	Across I/O terminals and protective conductor terminal:	1500 VAC 1 minute (faradic current 5mA)
・Protective structure	Front operating panel only is dust-proof and drip-proof. (equivalent to IP66, NEMA4X)	
・Case material	PC resin molding (equivalent to UL94V-1)	
・External dimensions (H x W x D)	96 x 96 x 111 mm (panel depth:100 mm)	

- Mounting Imbedded in panel (using mounting fixtures)
- Thickness of usable panel 1.0 to 4.0 mm
- Size of panel cutout 92 (H) x 92 (W)
- Weight 600 g max.

The contents of this Instruction Manual are subject to change without notice.

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