

MAC3 Series

Digital controller Instruction Manual

Thank you for purchasing SHIMAX product. Please check that the product is the one you ordered.

Please operate after you read the instruction manual and fully understand it.

Notice

Please ensure that this manual is given to the final user of the instrument.

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Preface

This instruction manual is intended for those who will be involved in wiring, installation, operation and routine maintenance of the MAC3.

This manual describes the care, installation, wiring, function, and proper procedures regarding the operation of MAC3.

Keep this manual on hand while using this device. Please follow the provided guidance.

1. Matters regarding safety

For matters regarding safety, potential damage to equipment and/or facilities and additional instructions are indicated as follows:

- * This mark indicates hazardous conditions that could cause injury or death of personnel. Exercise extreme caution as indicated.

⚠ **WARNING**

- * □ This mark indicates hazardous conditions that could cause damage to equipment and/or facilities. Exercise extreme caution as indicated.

⚠ **CAUTION**

- * This mark indicates additional instructions and/or notes.

NOTE

⚠ **WARNING**

MAC3 is designed for controlling temperature, humidity, and other physical subjects in general industrial facilities. It must not be used in any way that may adversely affect safety, health, or working conditions.

⚠ **CAUTION**

To avoid damage to the connected equipment, facilities or the product itself due to a fault of this instrument, safety countermeasures must be taken before usage, such as proper installation of the fuse and the overheating protection device. No warranty, expressed or implied, is valid in the case of usage without having implemented proper safety countermeasures.

⚠ **CAUTION**

- The ⚠ mark on the plate affixed to the instrument:
On the terminal nameplate affixed to the case of your instrument, the ⚠ mark is printed. This is to warn you of the risk of electrical shock which may result if the charger is touched while it is energized.
- The external power circuit connected to the power terminal of this instrument must have a means of turning off the power, such as a switch or breaker. Install the switch or breaker adjacent to the instrument in a position which allows it to be operated with ease, and with an indication that it is a means of turning off the power. Use a switch or breaker, which meets the requirements of IEC127.
- Fuse:
Since the instrument does not have a built-in fuse, do not forget to install a fuse in the power circuit to be connected to the power terminal. The fuse should be positioned between the switch or breaker and the instrument and should be attached to the L side of the power terminal.
Fuse Rating: 250V AC 0.5A / medium lagged or lagged type.
Use a fuse which meets the requirements of IEC127
- Load voltage/current to be connected to the output terminal and the alarm terminal should be within the rated range. Otherwise, the temperature will rise and shorten the life of the product and/or result in problems with the product.
- Voltage/current that differs from input specification should not be connected to the input terminal. It may shorten the life of the product and/or result in problems with the product.
- Input, output of voltage pulse, and output of electric current are not insulated. Therefore, do not ground an adjusted power terminal when a ground sensor is employed.
- A signal wire's common mode voltage to ground (signal wires other than contact output including power supply and event) should be less than 30V rms, 42.4V peak, and 60 VDC.
- This instrument has basic insulation between the power supply and the secondary circuit. If accessible Safety Extra Low Voltage (SELV) circuits are to be connected to Signalinput/output terminals (Input, Output (SSR, Current, Voltage), DI, CT, Analog output, Communication, and other secondary circuit), ensure to provide a basic insulation between the SELV circuits and these terminals (For example, use transformer which has a basic insulation or higher degree of insulation). The basic insulation requires a clearance at least 1.5mm and a creepage of at least 3.0mm.
- All the wires for the interior distribution, except for communication and contact output (including power supply and event), should be less than 30m in length. When the wire's length is 30m or more, or in the case of outdoor wiring, the suitable measure against a lightning surge is required.
- EMC standard (IEC61326) classifies MAC3 into Class A apparatus. Electromagnetic interference may occur when MAC3 is used at a business district or in the home. Please use after taking sufficient measures.

2. Introduction

2-1. Check before use

Before using MAC3, please check the model code, the exterior appearance and accessories. Also, make sure that there are no errors, impairs and shortages.

Confirmation of model code: Check that the product you ordered is being delivered properly.

Check the model code of the main body case against the following code table.

Example of model code

MAC3A-	M	C	F-	E	C-	D	H	T	R	N
1	2	3	4	5	6	7	8	9	10	11

Item

- Series MAC3A-96×96mm size digital controller
MAC3B-48×96mm size digital controller
- Input M:multi, V:voltage, I:current
- Control Output 1 C:contact, S:voltage pulse, I:current(4~20mA), V: Voltage(0~10V)
- Power Supply F-:90-264V AC, L-:21.6-26.4V DC/AC
- Event Output N:none, E:Event Output 1·2 (two points)
- Control Output 2·Event Output·Optional Selection of DI
N:none, C:contact, S:voltage pulse, I:current (4~20mA), V: Voltage(0~10V)
E: Event Output 3(one point), D: external control input (DI4) one point
- DI N:none, D: external control input (DI 1,2) two points
- CT Input N: none, H: CT Input one points
- Analog Output N: none, I: current (4~20mA), V: Voltage(0~5V)
- Communication N: none, R: RS485
- Program Function N: none, P: equipped

Example of model code

MAC3D-	M	C	F-	E	C-	D	T	N
1	2	3	4	5	6	7	8	9

Items

- Series MAC3C-: 72×72mm size digital controller
MAC3D-: 48×48mm size digital controller
- Input M:multi, V: voltage, I:current
- Control Output 1 C:contact, S:voltage pulse, I:current(4~20mA), V: Voltage(0~10V)
- Power Supply F-:90-264V AC, L-:21.6-26.4V DC/AC
- Event Output N:none, E:Event Output 1·2 (two points)
- Control Output 2·Event Output·Optional Selection of DI
N:none, C:contact, S:voltage pulse, I:current (4~20mA), V: Voltage(0~10V)
E: Event Output 3(one point), D: external control input (DI4) one point
- DI·CT Input N: none, D: external control input (DI1,2) two points, H:CT Input one points
- Analog Output·Communication N: none, T: current (4~20mA), V: Voltage(0~5V) R: RS485
- Program Function N: none, P: equipped

Check of accessories

Instruction manual: 1 set

NOTE : Please contact our agencies or business offices if you have any problem.
We welcome any kind of inquiry such as defect of the product, shortage of accessory and so on.

2-2. Caution for use

- (1) Do not operate the front panel keys with hard or sharp objects.
Do not fail to touch keys lightly with a fingertip.
- (2) Wipe gently with a dry rag and avoid using solvents such as thinner.

3. Installation and wiring

3-1. Installation site (environmental conditions)

⚠ **CAUTION**

Do not use this product under the following conditions.
Otherwise, failure, damage and fire may occur.

- (1) Where flammable gas, corrosive gas, oil mist or dust generate or grow rife.
- (2) Where the temperature is below -10°C or above 55°C.
- (3) Where the humidity is over 90%RH or where condensation occurs.
- (4) Where high vibration or impact occurs
- (5) Where inductive interference may easily affect the operation.
Or, in the region of strong electric circuit area.
- (6) Where waterdrops or direct sunlight exists.
- (7) Where the altitude is above 2,000m.

NOTE : The environmental conditions comply with the IEC664.
Installation category is II and the pollution degree is 2.

3-2. Mounting

- (1) Machine the mounting hole by referring to the panel-cut illustration in Section 3-3.
- (2) Applicable thickness of the mounting panel is 1.2~2.8mm.
- (3) As this product provides mounting fixture, insert the product into the panel.

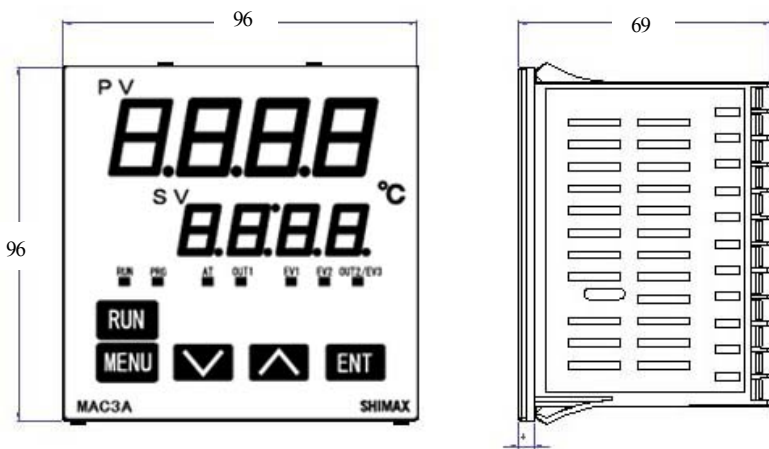
「NOTE」:MAC 3 is a panel set-up type.

Please use the product after setting up to the panel.

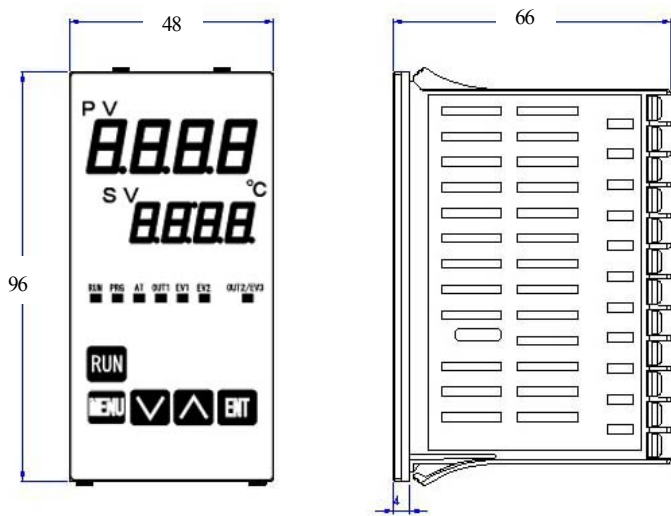
3-3. External dimension and panel cutout

MAC3 external dimensions (unit: mm)

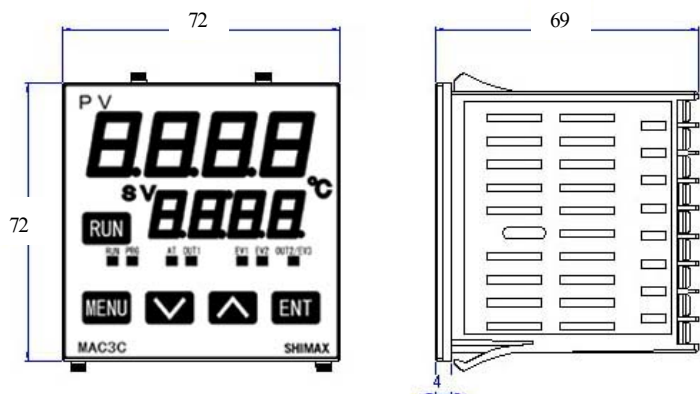
MAC 3A



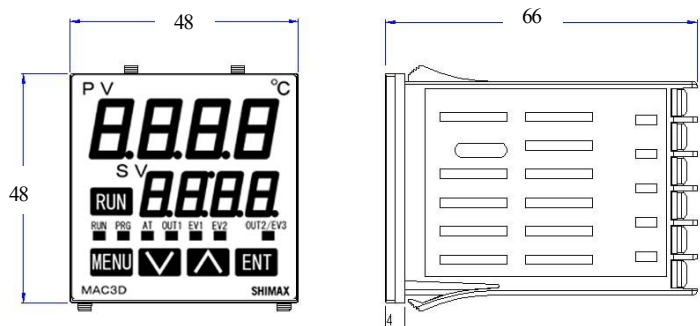
MAC 3B



MAC 3C

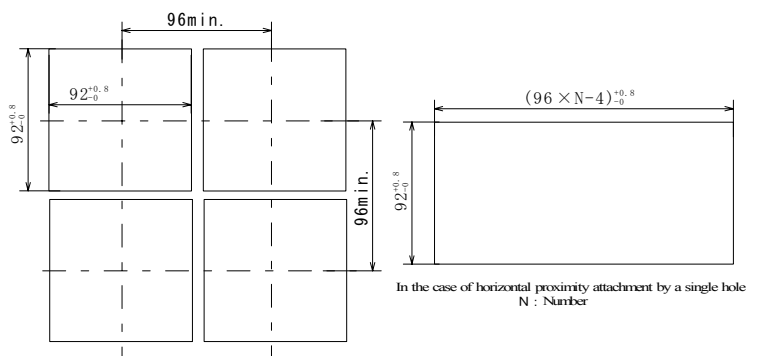


MAC 3D

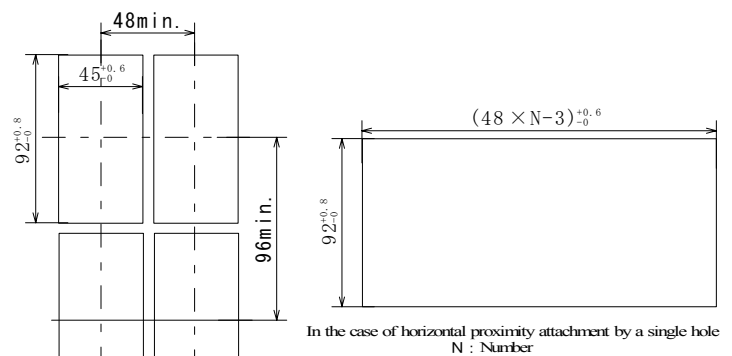


MAC3 panel cutout (unit: mm)

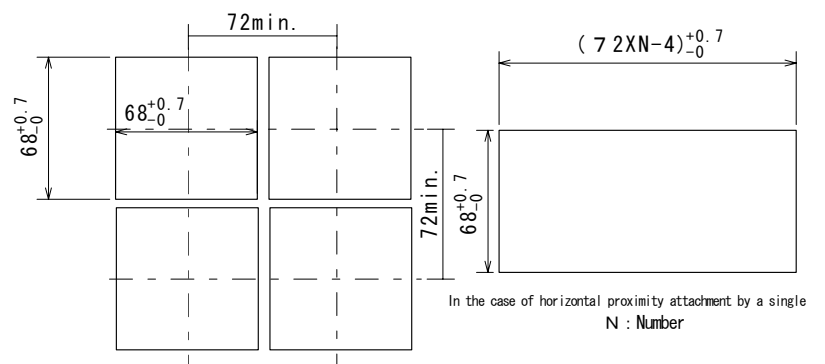
MAC3A (96×96 size)



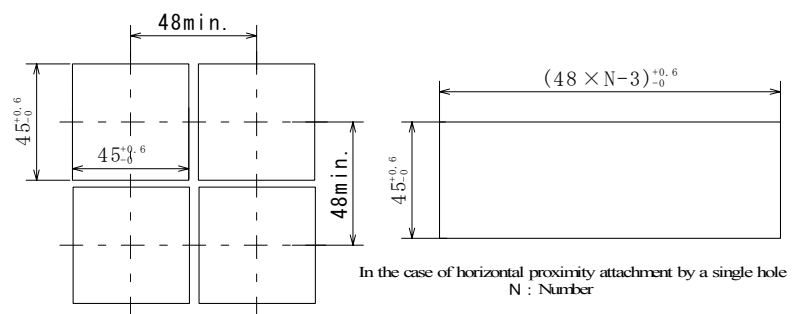
MAC3B 48×96 size



MAC3C 72×72 size



MAC3D 48×48 size



Note: Proximity attachment by a single hole is possible only in the case of horizontal direction.

When an apparatus that was attached in vertical direction is removed, a dedicated detachment tool is required.

3-4. Wiring

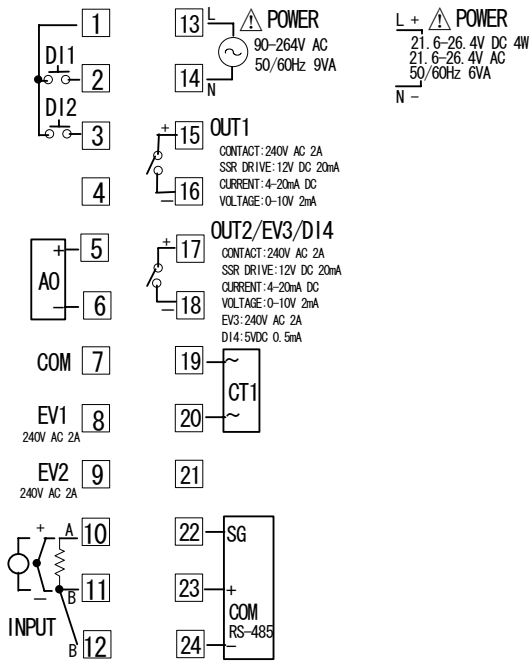
「WARNING」

- ⊙ Do not turn on electricity while wiring to avoid an electric shock.
- ⊙ Do not touch a terminal or live part while turning on electricity.

- (1) Make sure that wiring operation is properly done in line with a terminal wire diagram of section 3-5.
- (2) Choose a suitable compensation lead wire in the case of thermocouple input.
- (3) In the case of resistance bulb input, resistance value of each lead wire must be less than 5Ω and that of three lead wires must be equal.
- (4) Do not wire an input signal line inside of an electric wire pipe or a duct same with the high voltage line.
- (5) Shield wiring (single point grounding) is effective against static induction noise.
- (6) Wiring twisted at equal short intervals is effective against electromagnetic induction noise.

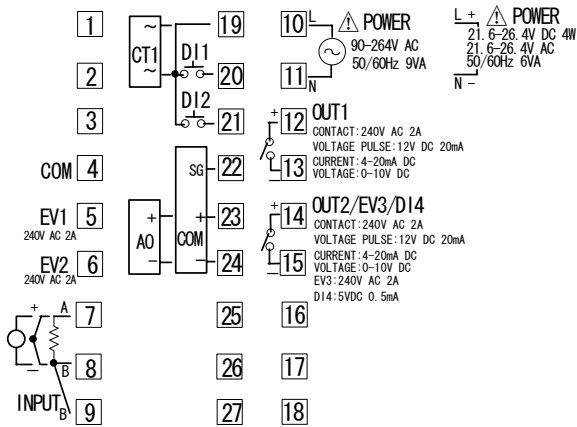
3-5. Terminal arrangement diagram

3-5. Terminal arrangement plan of MAC3A and MAC3B



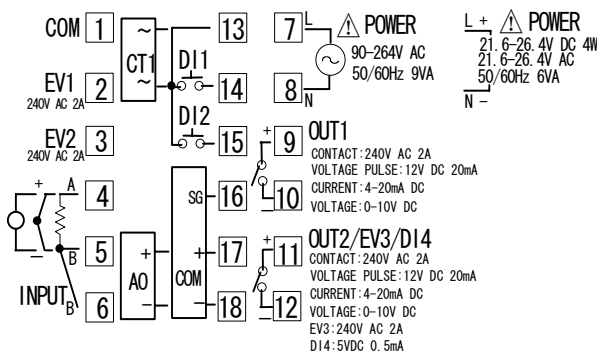
[Note] : If input type is thermocouple or voltage, errors may occur when terminal 11 and terminal 12 terminal are short-circuited

Terminal arrangement plan of MAC3C



[Note] : If input type is thermocouple or voltage, errors may occur when terminal 8 and terminal 9 terminal are short-circuited

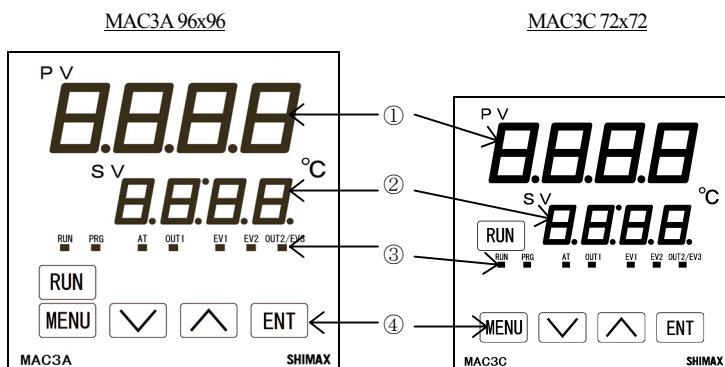
Terminal arrangement plan of MAC3D



[Note] : If input type is thermocouple or voltage, errors may occur when terminal 5 and terminal 6 terminal are short-circuited

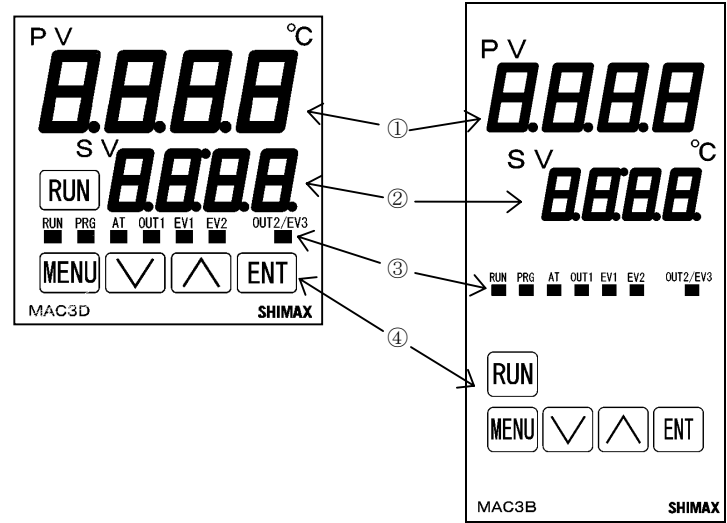
4. Description of front panel

4-1. Names of front panel.



MAC3D 48x48

MAC3B 48x96



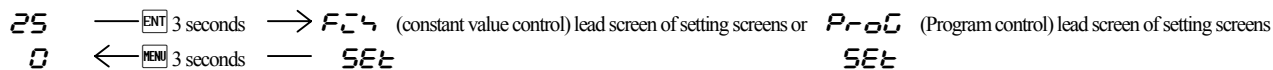
4-2. Explanation of front panel section

- ① : Display of measured value (PV) (red)
Measured value (PV) and type of setting is displayed on each setting screen.
- ② : Display of target value (SV) (green)
Target value and set value are displayed on each setting screen.
- ③ : Monitor LED
 - (1) RUN monitor LED RUN (green)
If RUN is performed with RUN key, operation mode 1 screen, external control input (DI), and communication, it lights up, and put out by standby (reset). It blinks, if a manual output is chosen in output monitoring screen or external control input (DI).
 - (2) Program functional monitor LED PRG (green)
Lights up at the time of program control's standby or flat part control. Puts out at the time of FIX control selection.
 - (3) Auto tuning operation monitor LED AT (green)
If AT is chosen in ON or external control input (DI), blinks during AT execution. Lights up when AT is on standby, and puts out with AT automatic termination or release.
 - (4) control out put 1 monitor LED OUT (green)
At the time of a contact or a voltage pulse output, the it lights up with ON and lights off with OFF. Lights off with 0% power output, and lights up with 100% power. And blinks in intermediate ratio.
 - (5) Event output monitors LED EV1 and EV2 (yellow)
Lights up when the allotted event output turns to ON.
 - (6) Control out put 2/event output 3 monitors LED OUT2/EV3 (yellow)
When control output 2 is chosen, it operates like control output 1 monitor LED does. When event output 3 is chosen, it operates like event output monitor LED does.
- ④ : Key-switch section
 - (1) **MENU** (MENU)key
Press this key to move onto the next screen among the screens.
Press **MENU**(MENU) key for three seconds on the basic screen, then it jumps to the lead screen of Mode 1. Press **MENU** key for three seconds on the lead screen of each Mode screens, then it jumps to the basic screen.
Press **MENU** key for three seconds on the lead screen of FIX or PROG, then it jumps to the basic screen.
When a program control option is added, press **MENU** (MENU) key for three seconds on the screen of operation mode 2, then it jumps to the screen of operation Mode 1.
 - (2) **DOWN** (DOWN)key
Press **DOWN** (DOWN) key one time, and the shown value decreases by one numerical value.
One time press of **DOWN** key decreases by one numerical value. By pressing the key continuously, the value as well consecutively decreases. A decimal point of the smallest digit blinks at this time. This shows that a setting change is in progress.
In PROG, used as a shift key between each step setting screens(Steps 1-25),lead screen. Also used as a shift key between lead screen in each mode screens.
 - (3) **UP** (UP) key
Press **UP** (UP) key one time, and the shown value increases by one numerical value.
By pressing continuously, the value By pressing the key continuously, the value consecutively increases. A decimal point of the smallest digit blinks at this time. This shows that a setting change is in progress.
In PROG, used as a shift key between each step setting screens (Steps 1-25), lead screen. Also used as a shift key between lead screen in each mode screens.
 - (4) **ENT** (ENTRY/REGISTER)key
The setting data changed on each screen is determined (the decimal point of the minimum digit is also lighted off).
When a program control option is added, press **ENT** (ENT) key for three seconds on the screen of operation mode 1, then it jumps to the screen of operation Mode 2.
Press **ENT** key for 3 seconds on the output monitoring screen,then the shift between manual output and automatic output is carried out.
Press the key for 3 seconds on the basic screen, then it shifts to FIX or PROG head screen. Push at FIX-PROG and each mode screens' lead screen, then shifts to setting screen.
 - (5) **RUN** (RUN OPERATION/STOP)key
Push for 3 seconds at STBY (control stop), then FIX or PROG control starts.
Push for 3 seconds while FIX or PROG is in operation, then control is stopped.

5. Description of screens

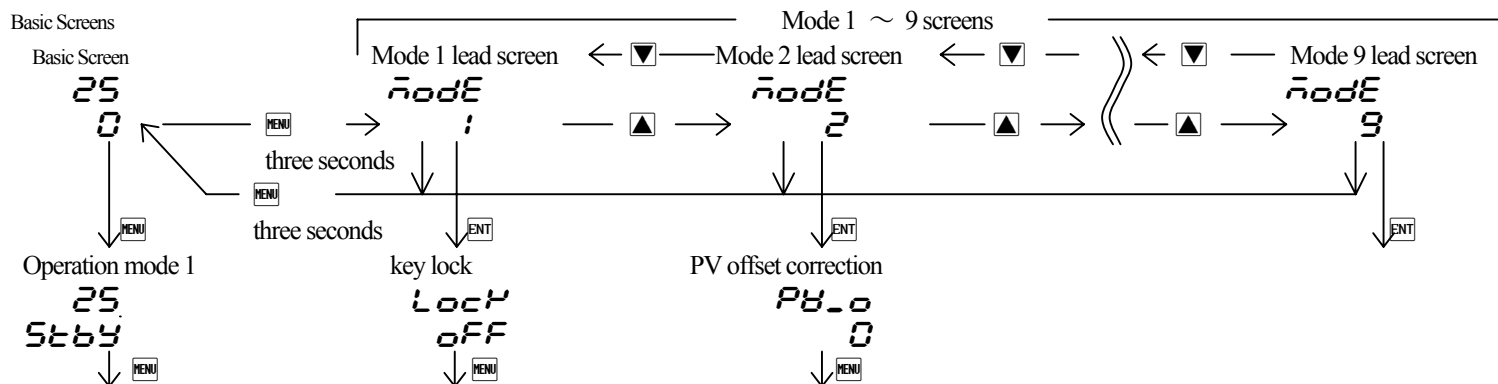
5-1. How to move to another screen

Basic Screen



Press the **ENT** key for 3 seconds on a basic screen, then it shifts to the lead screen of **FIX** (constant value control) setting screens, or to the lead screen of **PROG** (program control) setting screens.

Press the **MENU** key for 3 seconds on **FIX** or **PROG** the lead screen of setting screens, then it shifts to the basic screen. The shift is also possible when the program option is added and **FIX** is chosen on the operation mode 2 screen. The shift is possible when the program option is added and **PROG** is chosen on the operation mode 2 screen.



Every time you press the **MENU** key on a basic screen, it shifts to each screen of the basic screens.

Press the **MENU** key for 3 seconds on a basic screen, then it shifts to the lead screen of mode 1 screens.

Press the **▲** key on the lead screen of mode 1 screens, then it further advances to mode 2, and mode 3. (Notes: If no corresponding option is found, the mode 4 - 9 is skipped)

Press the **▼** key on the lead screen of mode 1 screens, then it further advances to mode 9, and mode 8. (Notes: If no corresponding option is found, the mode 4 - 9 is skipped)

Press the **MENU** key for 3 seconds on the lead screen of mode 1 to 9 screens, then it shifts to the basic screen.

Press the **ENT** key on the lead screen of mode 1 to 9 screens, then it shifts to the first setting screen of each screens.

Press the **MENU** key on the first setting screen of each screens, then it shifts to the next screen. Every time you press the **MENU** key, it shifts to the next setting screen.

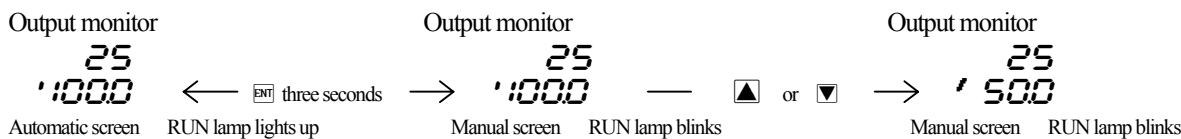
5-2. Setting Method

To change settings, display an appropriate screen and change the setting (value or function) by pressing **▲** or **▼** key.

On the output monitor screen of basic screens, you can change the control output from "Automatic" to "manual", and save its change of setting. Display the output monitor screen, and then press **ENT** key for three seconds to shift from Automatic to Manual. Then by pressing **▲** or **▼** key, you can adjust to the desirable output value. In this case, no need to press **ENT** key in order to determine the change of setting.

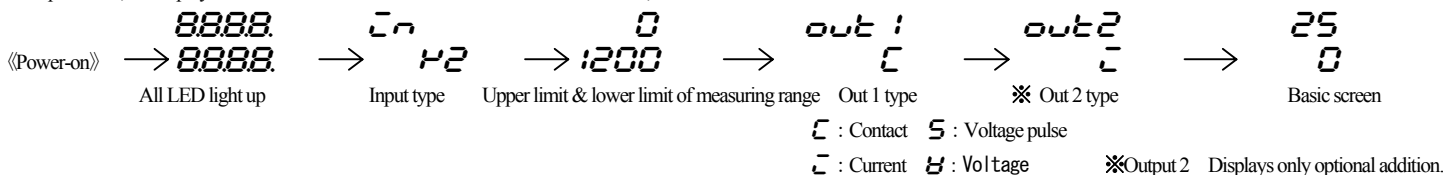
Press **ENT** key for three seconds as well to shift back to Automatic. Excluding when a keylock is OFF, Automatic⇔Manual switchover does not work while STBY<RST> and AT are in operation.

In the case of two-output type, the switchover between automatic and manual is operatable through output 1 and output 2. The setting is altered simultaneously.



5-3. Power-on and initial screen display

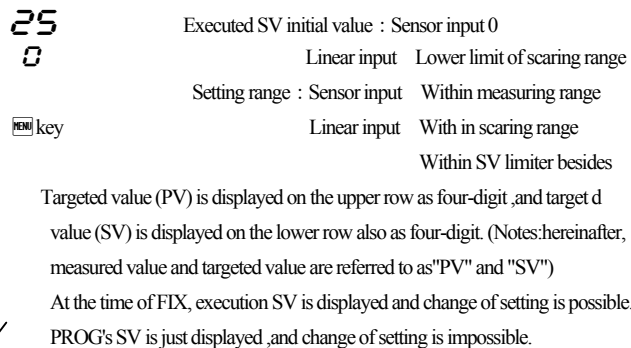
At power-on, the display section shows each screen of initial screens for one second, then moves on to the basic screen.



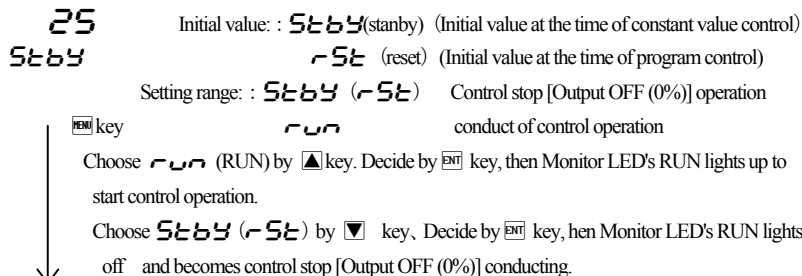
5-4. Explanation of each screen

(1) Basic Screens

Basic Screen



Action Mode 1 screen



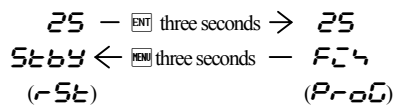
Priority is given to DI when RUN is allotted to external control input. DI. Key operation cannot be performed unless allotment is canceled.

When measuring range, a unit, scaling, and output characteristics are changed it is initialized and **Stby (rSt)** is displayed.

Press **ENT** key for 3 seconds, then it shifts to Action mode 2 screen, when the program control option is added on this screen, **FIX** (constant value control) ← **PROG** (program control) switchover is possible choose.

Choose a program, then Monitor LED's PRG lights up.

Action mode 1 screen Action mode 2 screen



Press **MENU** key for 3 seconds on Action mode 2 screen, then it returns to Action mode 1 screen.

Action mode 2 screen is not displayed without a program option.

When PROG is allotted to DI, DI is given priority. Key operation cannot be performed unless allotment is canceled.

Press **MENU** key on Action mode 1 screen, then it shifts to output 1 monitoring screen.

Output 1 monitoring screen

25 manual output setting range: :0.0-100.0% (within output limiter)
 '1000 At the time of automatic output,monitor display only.
 [F5] key Refer to Item 5-2 about automatic ↔ manual switchover,and setting method at the time of manual operation.
 A manual output is canceled when an operation mode is made into *Stby (rSt)*.
 When a power source is intercepted and re-switched on, it returns to the condition just before intercepting.
 When *PROG* is allotted to DI, DI is given priority. Automatic ma ↔ manual switchover is not performed with key operation,and only the output value at the time of manual operation can be changed.

Output 2 monitoring screen

25
 '1000 Contents are the same with that of an output 1.
 [F5] key Output 2 monitoring screen displays only when output 2 option is added.

CT1 current monitoring-screen

25 Current display range: 0.0-55.0A
 '500 Displays at the time of CT input option addition, and the current value detected by CT sensor is displayed.
 [F5] key Current value is displayed.

CT2 current monitoring screen

25
 -300 Contents are the same with that of an CT 1.
 [F5] key

Monitoring screen of step's remaining time period

25
 99:59 Displays while program is in operation if program option is added.
 [F5] key Step № in progress and remaining time are displayed by turns.
 (In ∞ setting, step № and 00 are displayed by turns)
 A remaining time and an elapsed time is switchable by pressing the [F5] key for 3 seconds. (Switchover is interlocked with the number of times of next screen pattern.)
 Decimal point of the minimum digit lights up in displaying elapsed time,
 This screen is not displayed without a program option.Not displayed in the state of program RST and FIX neither.

Monitoring screen for the remaining repeating time of pattern

25
 9999 Being displayed while program is in operation, when the program option is added,
 On-going step № and the remaining repeating time of pattern are displayed by turns.
 [F5] key (In ∞ setting, step № and 00 are displayed by turns)
 A remaining time and actually performed times are switchable by pressing the [F5] key for 3 seconds. (Switchover is interlocked with front screen step time.)
 The decimal point of the minimum digit lights up when actually performed times being displayed.
 This screen is not displayed without a program option.Not displayed in the state of Program RST and FIX neither.

PID № monitoring screen

25
 P2_1 Chosen PID № is displayed when FIX is in operation.
 [F5] key PID № chosen at each step and on-going step № are displayed by turns when PROG is in operation.
 PID № of output 1 is displayed in the first digital, and PID № of output 2 is displayed in the third digital. The third digital is shown as _ when there is no output 2 option.
 This screen is not displayed in the state of STBY (RST).

HOLD (temporary stopping) execution screen

Hold Initial value: : *OFF*
OFF Setting range: : *OFF*, *ON*
 While HOLD is executed, on the basic screen,SV value and *Hold* is displayed by turns .
 If switched *ON* while PROG is in operation , the operation temporary stops with as of then step time and SV value. While HOLD is in execution , SV value and *Hold* is displayed by turns in basic screen.,
 HOLD is used in order to perform AT in the middle of an inclination step or to compensate the insufficient time of flat step.
 Controls is performed with SV value at the time of stopping,while HOLD is in execution
 HOLD is canceled if *OFF* is chosen while HOLD is in execution. The remaining time of

the step is performed based on a program.

SKIP (skip)is unable to perform while HOLD is in execution.
 When *Hold* is allotted to DI, DI is given priority.
 Execution and release of HOLD with key operation is unable to perform.
 This screen is not displayed without a program option.Not displayed in the state of program *rSt* and FIX neither.

SKIP (skip) execution screen

SKIP Initial value: : *OFF*
OFF Setting range: : *OFF*, *ON*
 SKIP (skip) is the function that makes to end the on-going step compulsorily, and is to shift to the following step. The next step starts instantly, if performed.
 When SKIP is continuously performed, about 1 second interval is required from execution to the next one.
 Even if SKIP is allotted to DI, execution is able to perform with DI and key operation.
 [F5] key SKIP cannot be performed while HOLD is in operation.
 This screen is not displayed without a program option. Not displayed in the state of program *rSt* and FIX neither.

AT (Auto Tuning) execution screen

AT Initial value: : *OFF*
OFF Setting range: : *OFF*, *ON*
 [F5] key
 AT is performed by ON selection ,and canceled by OFF selection.
 Not displayed at the time of STBY(RST), a manual output, and P(proportional band)=OFF.
 Except in the setting of keylock OFF, AT is unable to perform in scale over.
 (At the time of DI allotment,execution of AT by DI can be performed.)
 Even in such a case,halfway release is performed on this screen.
 Release of AT, STBY(RST), EV operating point, setting of keylock, and mode 5 ~ 9screen are operateable with key.
 Except in th setting of AT normal end, execution of AT is canceled compulsorily at the time of STBY(RST) selection and AT release setup.

EV1 (event 1) operating-point setting screen

EV1 Initial value: upper limit absolute value measuring range Scaling upper limit
1200 lower limit absolute value measuring range Scaling lower limit
 [F5] key upper limit deviation *2000*
 lower limit deviation *-1999*
 within deviation *0*
 outside deviation *2000*
 CT1 or CT2 *00*
 guarantee *0*
 Setting range: upper limit absolute value within measuring range within scaling limit
 lower limit absolute value within measuring range within scaling limit
 upper limit deviation *-1999~2000* unit
 lower limit deviation *-1999~2000* unit
 within upper-lower limit deviation *0~2000* unit
 outside upper-lower limit deviation *0~2000* unit
 CT1 or CT2 *0~500*A
 The operating point of the alarm type allotted to EV1 is set up.
 No option, No display when *non*, *So*, *run*, *StP*, *P_E*, *End*, *Hold*, *ProG*, *d_SL*, and *u_SL* are allotted to EV1.
 The operation mode of each deviation alarm is *run*.
 Effective at the time of automatic output.
 Each deviation alarm serves as PV's deviation to Execution SV.
 Event operation other than each deviation alarm is always effective.

EV2 (event 2) operating-point setting screen

EV2 Initial value,setting range, contents are the same with EV1
0
 [F5] key

EV3 (event 3) operating-point setting screen

EV3 Initial value,setting range, contents are the same with EV1
0
 [F5] key
 When EV3 option is added, event 3 is displayed as the same contents with EV 1 and 2, irrespective of EV 1 and 2.

Latching release screen

LArch Initial value: : **rSt :**
rSt : Setting range: : **rSt :** release EV1
rSt2 release EV2
rSt3 release EV3
ALL release all EVs at a time

On the latching setting screen of each EV mode, **rSt** No. and **ALL** which chose **on** are displayed. If latching is **on**, once EV is outputted, EV output state is maintained even if EV is in the state of OFF. When EV is in a latching state, decimal point of the minimum digit blinks, and it shows that release of EV is possible. If **ENT** key is pressed, EV is released and a decimal point lights off.

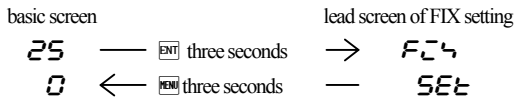
However, release is impossible when a state is in EV power range.

Return to basic screen

(2) FIX (constant value control) setting screens

At the time of no program option and with program option and **FC4** is chosen on Action mode2 screen of basic screens, lead screen of FIX setting screens is displayed when **ENT** key is pressed for 3 seconds.

If **ENT** key is pressed for 3 seconds on lead screen, it returns to basic screen.



FIX lead screen

FC4
SEt No setting on this screen.
ENT key Press **ENT** key, then it shifts to the first setting screen SV1 setting screen.

SV1 setting screen

SV : Initial value : At the time of sensor input 0
0 linear input time scaling lower limit
Setting range: sensor input time within measuring range
ENT key linear input time within scaling range
Moreover, within limit of SV limiter.
When SV1 is Execution SV, being reflected in basic screen.
Being initialized when measuring range, unit, and scaling are changed.

SV1 output1 PID No. setting screen

io iP Initial value : 1
: Setting range: 1, 2, 3
ENT key When SV1 is Execution SV, PIDNo. that will be used for control of output 1 is chosen from 1~3.

SV1 output2 PID No. setting screen

io2P Initial value:1
: Setting range:1,2,3
ENT key When SV1 is Execution SV, PIDNo. that will be used for control of output 2 is chosen from 1~3.
Displayed when output 2 option is added.

SV2 setting screen

SV2 Initial value: same with SV1
0 Setting range: same with SV1
ENT key Displayed when SV2 is allotted to DI. When terminal of allotted DI short-circuits, it becomes Execution SV.
When SV2 is Execution SV, it is reflected in basic screen.
Being initialized when measuring range, unit, and scaling are changed.

SV2 output 1 PIDNo. setting screen

2o iP Initial value:1
: Setting range:1,2,3
ENT key Displayed when SV2 is allotted to DI.
ENT key When SV2 is Execution SV, PIDNo. that will be used for control of output 1 is chosen from 1~3.

SV2 output 2 PIDNo. setting screen

2o2P Initial value:1
: Setting range:1,2,3
ENT key Displayed when SV2 is allotted to DI.
When SV2 is Execution SV, PIDNo. that will be used for control of output 2 is chosen from 1~3.
Displayed when output 2 option is added.

SV3 setting screen

SV3 Initial value: same with SV1
0 Setting range: same with SV1
ENT key Displayed when SV3 is allotted to DI. When terminal of allotted DI short-circuits, it becomes Execution SV.
When SV3 is Execution SV, it is reflected in basic screen.
Being initialized when measuring range, unit, and scaling are changed.

SV3 output 1 PIDNo. setting screen

3o iP Initial value:1
: Setting range:1,2,3
ENT key Displayed when SV3 is allotted to DI.
When SV3 is Execution SV, PIDNo. that will be used for control of output 1 is chosen from 1~3.

SV3 output 2 PIDNo. setting screen

3o2P Initial value:1
: Setting range:1,2,3
ENT key Displayed when SV3 is allotted to DI.
When SV3 is Execution SV, PIDNo. that will be used for control of output 2 is chosen from 1~3.
Displayed when output 2 option is added.

SV4 setting screen

SV4 Initial value: same with SV1
0 Setting range: same with SV1
ENT key Displayed when SV4 is allotted to DI.
When terminal of allotted DI short-circuits, it becomes Execution SV.
When SV4 is Execution SV, it is reflected in basic screen.
Being initialized when measuring range, unit, and scaling are changed.

SV4 output 1 PIDNo. setting screen

4o iP Initial value:1
: Setting range:1,2,3
ENT key Displayed when SV4 is allotted to DI.
When SV4 is Execution SV, PIDNo. that will be used for control of output 1 is chosen from 1~3.

SV4 output 2 PIDNo. setting screen

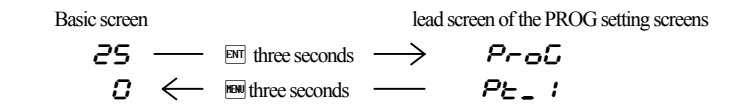
4o2P Initial value:1
: Setting range:1,2,3
ENT key Displayed when SV4 is allotted to DI.
When SV4 is Execution SV, PIDNo. that will be used for control of output 2 is chosen from 1~3.
Displayed when output 2 option is added.

Return to FIX lead screen

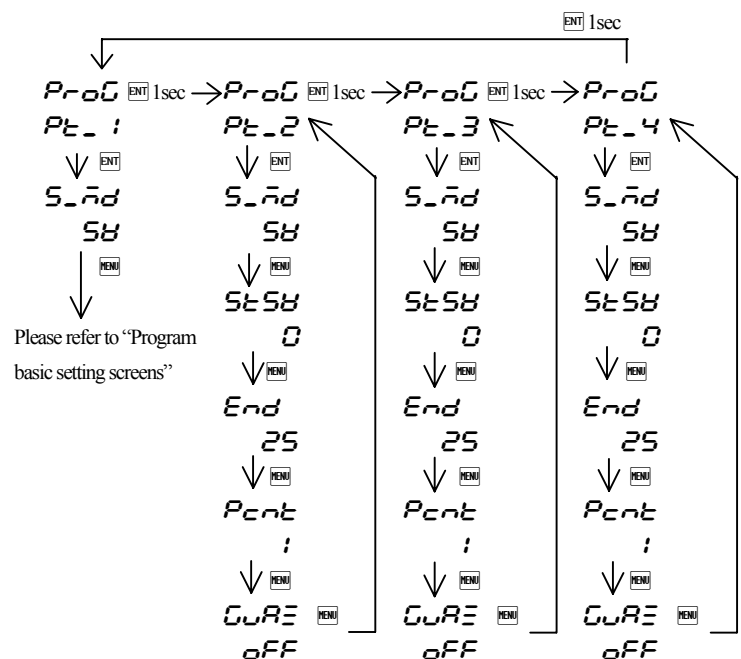
(3) PROG (program control) setting screens

Press **ENT** key for 3 seconds, lead screen of the PROG setting screens is displayed, When program option is added and **Prog** is chosen on Action mode2 screen of basic screens.

If **ENT** key is pressed for 3 seconds on lead screen, it returns to basic screen.



Pattern setting screens overview



Program basic setting screens

Program basic setting screens Lead screen

Prog No setting on this screen

Pt_ : Press **▲** key to shift to step 1 lead screen.

Press **▼** key to shift to step 40 lead screen.

ENT key Press **ENT** key to shift to the first setting screen start mode setting screen.

Start mode setting screen

S_ā Initial value: **PV** (PV)
SB Setting range: **SB** (SV), **PB**

This setting screen can decide if the start set point of program control should be PV, or should be the start SV which is set on the next screen.

When PV is chosen, and when PV is closer to the set point of Step1 than start wasting SV,time is omissible.

Start SV setting screen

StSB Initial value : At the type of sensor input 0
0 linear input type scaling lower limit
Setting range: sensor input type within measuring range
ENT key linear input type within scaling range
Moreover, within limit of SV limiter.

When SV is chosen on start mode setting screen, this screen's set value becomes start set point.

The basic screen SV display at the time of Program RST is the value set on this screen.

Termination step setting screen

End Initial value: 40
40 Setting range: 1~40(1ptn), 1~20(2ptn), 1~10(4ptn)
ENT key Pattern termination step No of program control is set.

Number of execution Setting screen for repeating of program pattern

Pcnt Initial value:1
: Setting range:1~9999 times, ∞
ENT key The number of execution of a program pattern is set.

Guarantee soak zone setting screen

GuRE Initial value : OFF
OFF Setting range : OFF, 1 to 2000 unit
ENT key During program operation, the SV value on program step proceed to flat step from ramp step, the PV value some time delay from the SV value and the flat step become shorter than the step. This function avoid and assuring the time of flat step.

Time unit setting screen (Displayed only for the pattern 1 setting screen group)

t_ūn Initial value: **āā** : **SS**(minute:second)
āā : SS Setting range: **āā** : **SS**, **HH** : **āā**, **HHH.H**
ENT key This decides if unit of the execution time set up at each step is minute: second ,hour: minute,or hour.

Number of patterns setting screen (Displayed only for the pattern 1 setting screen group)

Ptn Initial value : 1
: Setting range : 1, 2, 4
ENT key Set the number of patterns.

To program basic setting screens Lead screen

About PV start

In start mode,when PV is chosen, and when PV is closer to the set point of Step1 than start SV, wasting time is omissible.

example : PV at the time of "RST is 30°C, Start SV is 0 °C, Step 1's attainment SV 100 °C, Execution time of Step1 is 60 minutes. Start at start SV,attainment time is 60 minutes.

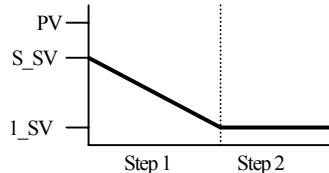
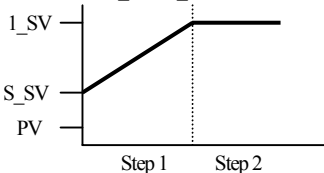
When starts at PV, 100-30=70°C ,therefore 60 minutes x70%=42 minutes= 18 minutes' shortening

However, depending on the spatial relationship between PV, Start SV, and attainment SV, it may become SV start or Step1 may be skipped.

(1) case of SV start

$PV \leq S_SV(\text{start SV}) < 1_SV(\text{step1 attainment SV})$

$PV \geq S_SV > 1_SV$

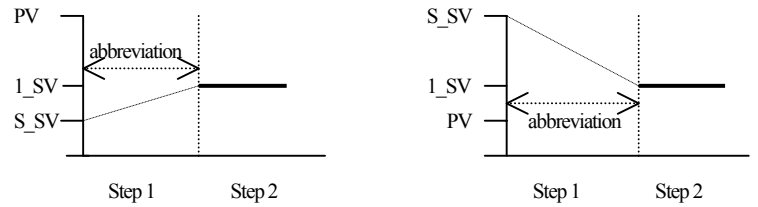


(2)When Step 1 is skipped and progresses to Step 2

$S_SV < 1_SV < PV$

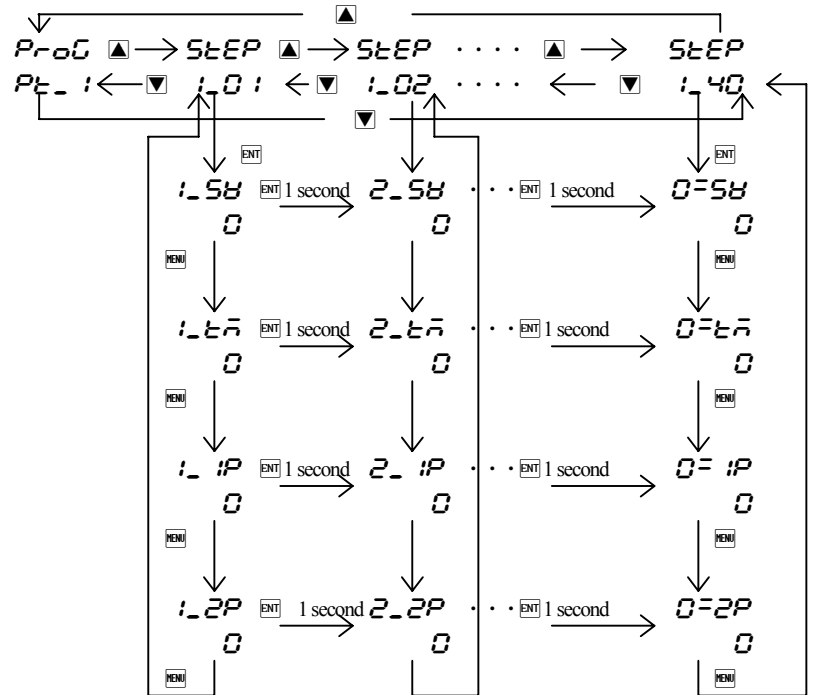
$S_SV > 1_SV > PV$

$PV = 1_SV$



Step 1 setting screens ~ Step 40 setting screens

Screen sequence of step 1 setting screens ~ step 40 setting screens are as follows.



In each step setting screen, next to number, **_** for Steps 1~9, **-** for 10~ 19, **ˉ** for 20~ 29, **ˉˉ** for 30~ 39, **ˉˉˉ** for 40, are assigned to distinguish each of them.

(Example : Step1SV = **1_ SB**, step 12SV = **2- SB** and step 23SV = **3ˉ SB**)

If the **ENT** key is pressed at each step lead screen, it shifts to SV setting screen of each step.

If the **ENT** key is pressed on SV setting screen, it shifts to execution time setting screen of each step.

After that, if **ENT** key is pressed, then it shifts to output 1PIDNo, output 2PIDNo, and lead screen.

Moreover, it is if **ENT** key is pushed for 1 second on each setting screen, it advances to the next Step No's same setting item screen. ($1_SV \rightarrow 2_SV \dots \rightarrow 0 = SV \rightarrow 1_SV$)

Step 1 is explained, since all the setting content of each step are same.

Step1 SV setting screen

1_SB Initial value : At the time of sensor input 0
0 At the time of linear input scaling lower limit
ENT key Setting range : At the time of sensor input within measuring range
At the time of linear input scaling within the limits
Within limit of SV limiter, and yet
Attainment set value of Step 1 is set.
Being initialized when measuring range, unit, and scaling are changed.

Step 1 execution-time setting screen

1_tā Initial value: 00:01
9999 Setting range: 00:00 to 99:59 (minute: second, hour: minute)
0.1-999.9 (hour) and ∞(infinity)
ENT key Execution time of Step 1 is set.

Step1 output 1 PIDNo. setting screen

1_ IP Initial value:1
: Setting range:1~3
ENT key PIDNo used in Step1's control output 1 is chosen.

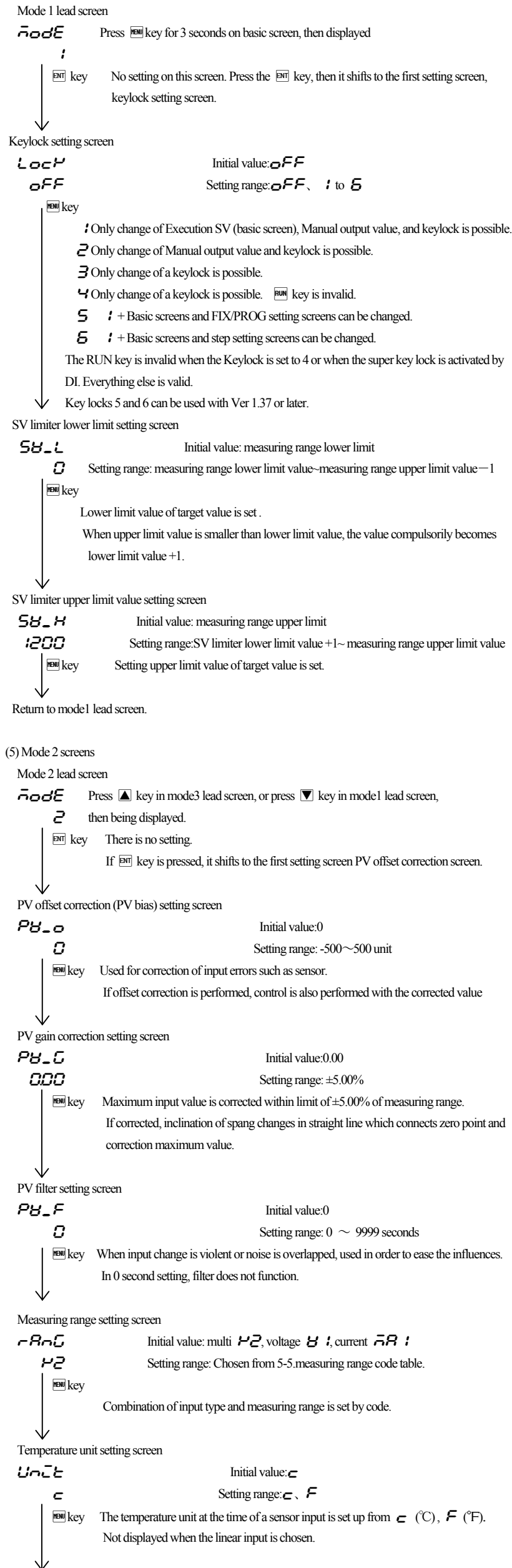
Step1 output 2 PIDNo. setting screen

1_ 2P Initial value:1
: Setting range:1~3
ENT key PIDNo used in Step1's control output 2 is chosen.

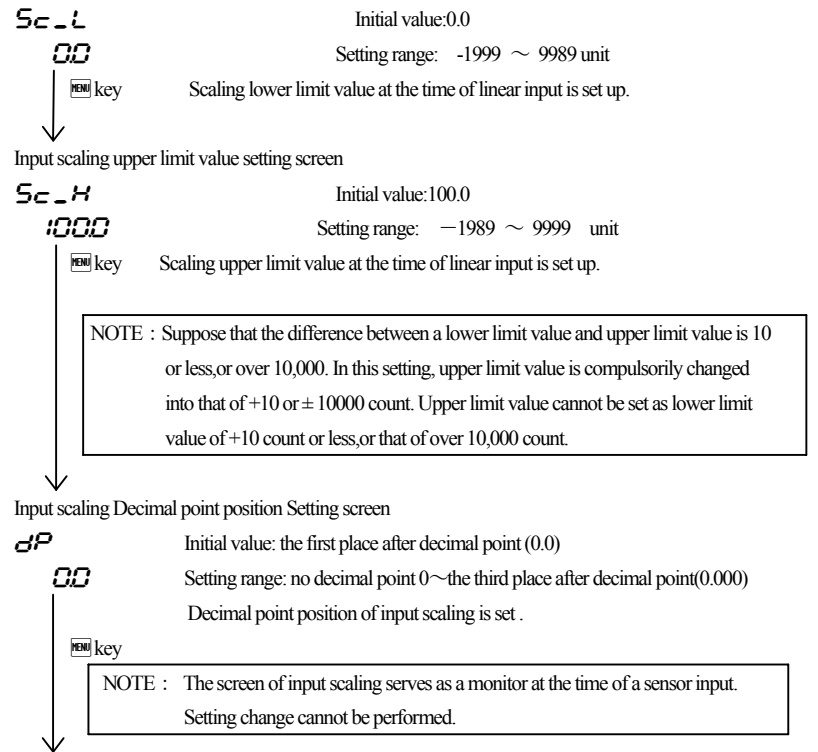
Displayed when output 2 option is added.

To step1 lead screen

(4) Mode 1 screens

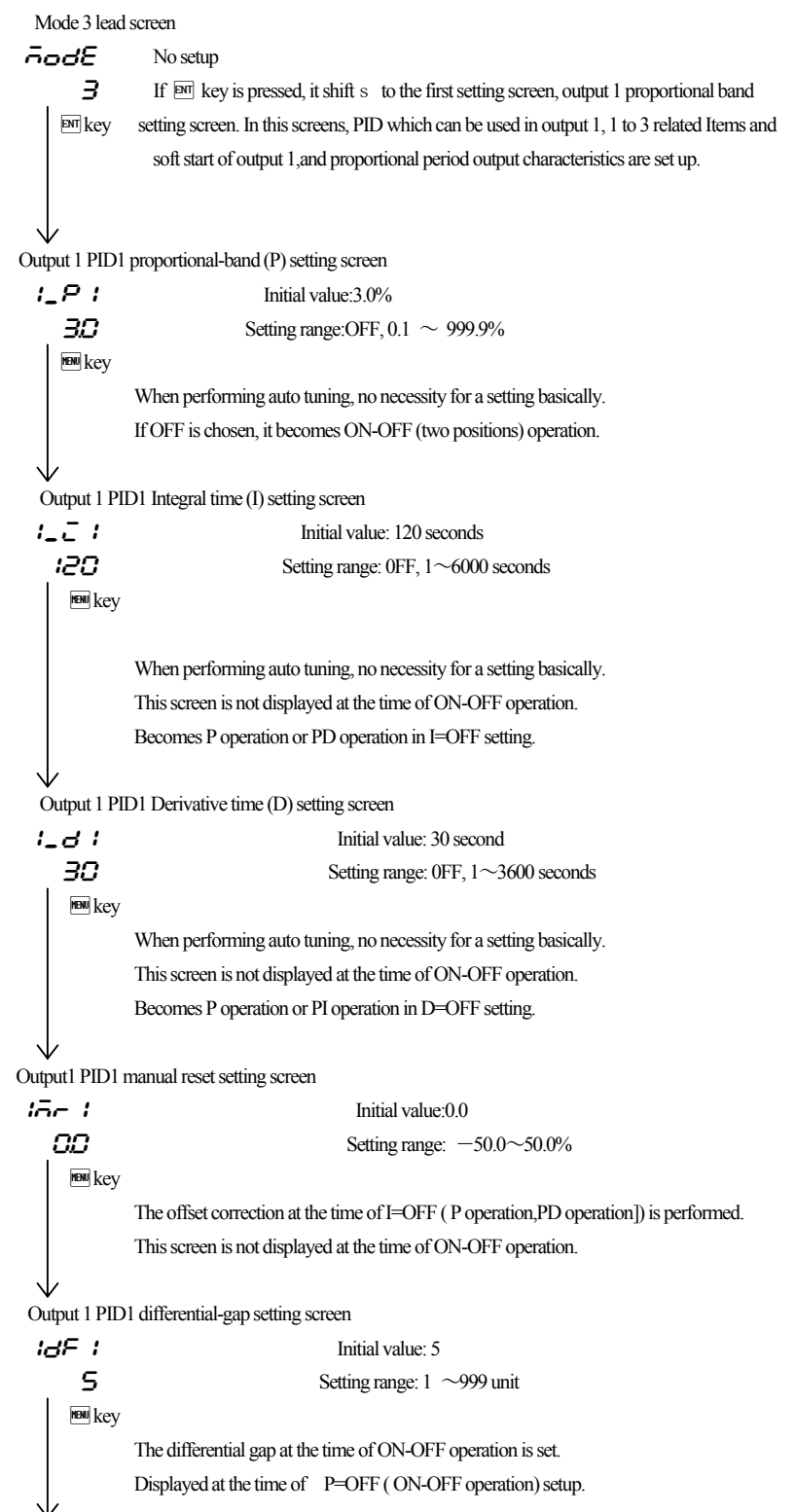


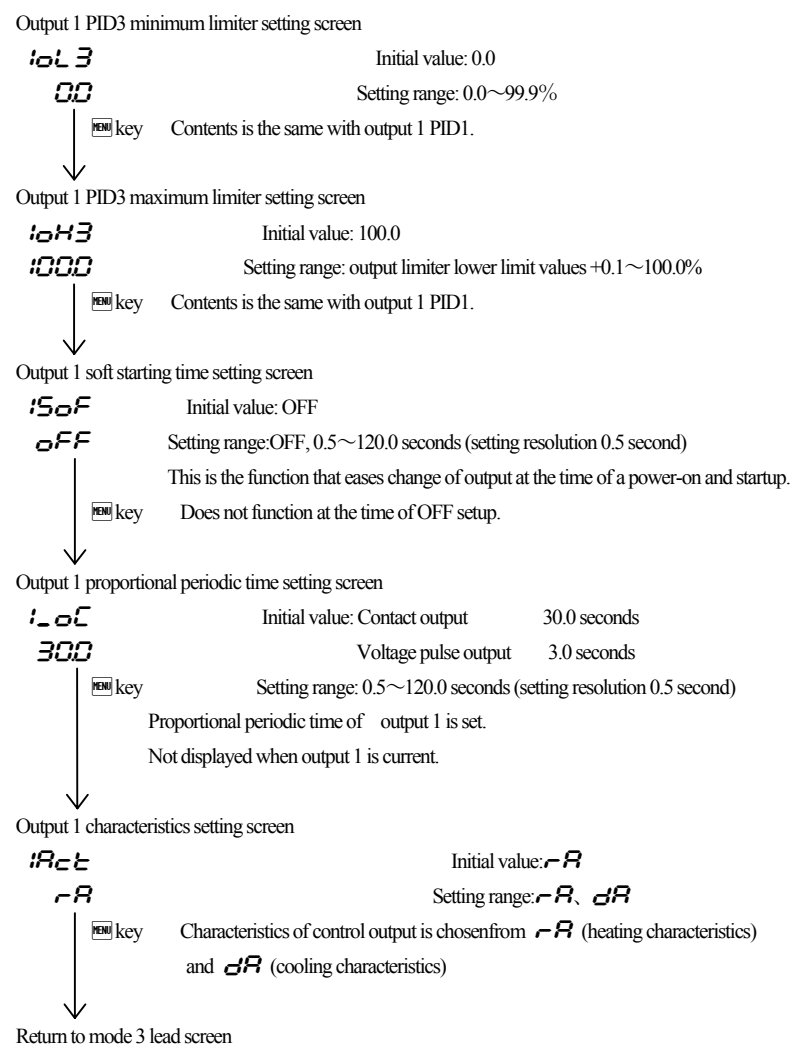
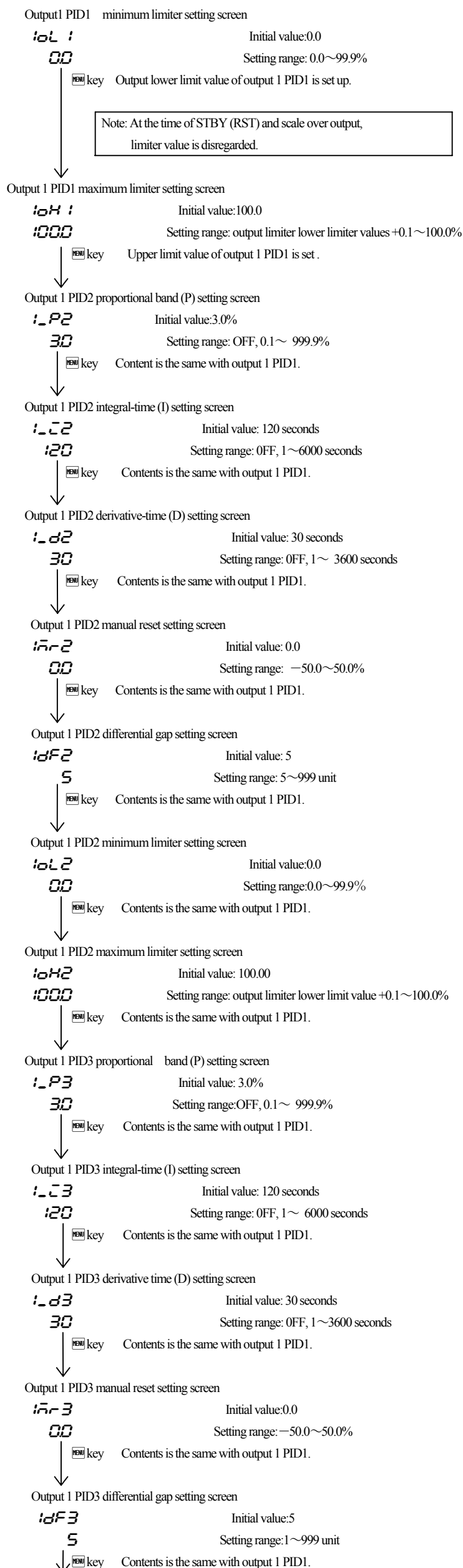
Input scaling lower limit value setting screen



Return to mode 2 lead screen.

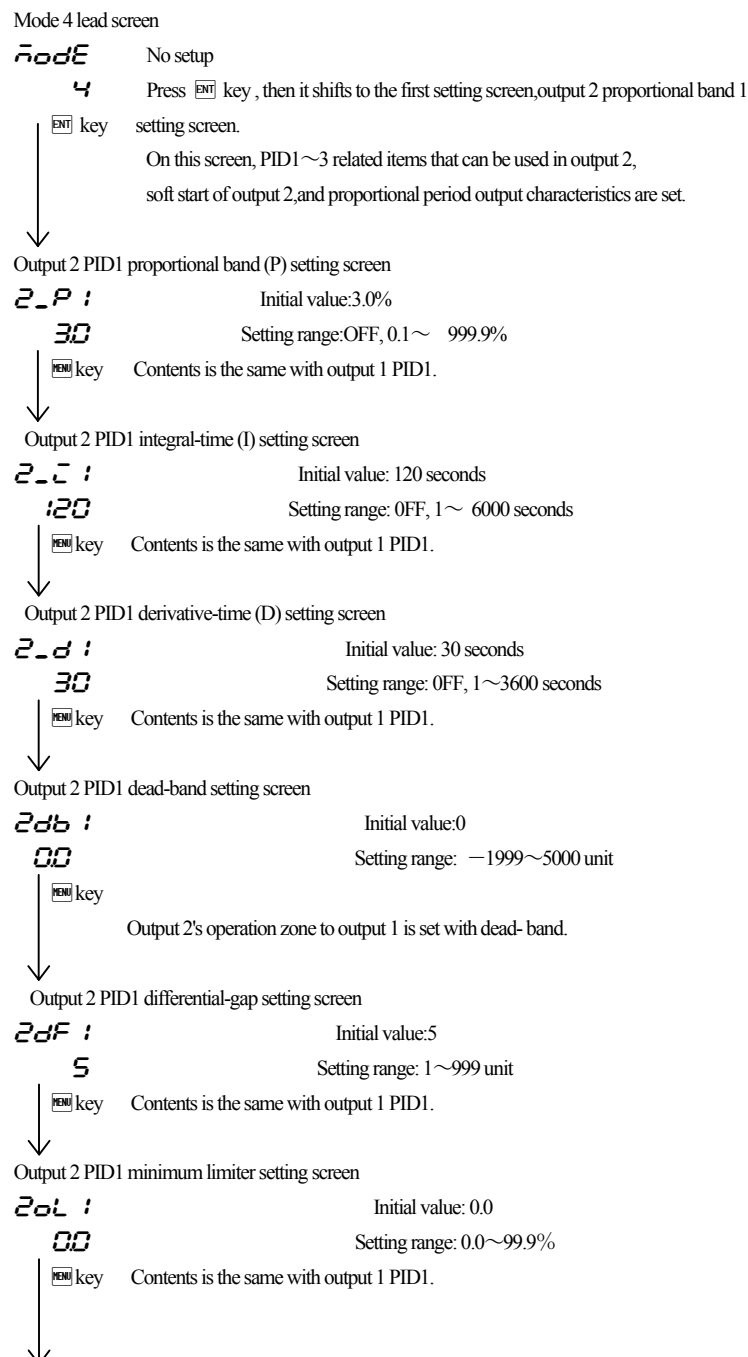
(6) Mode 3 screens

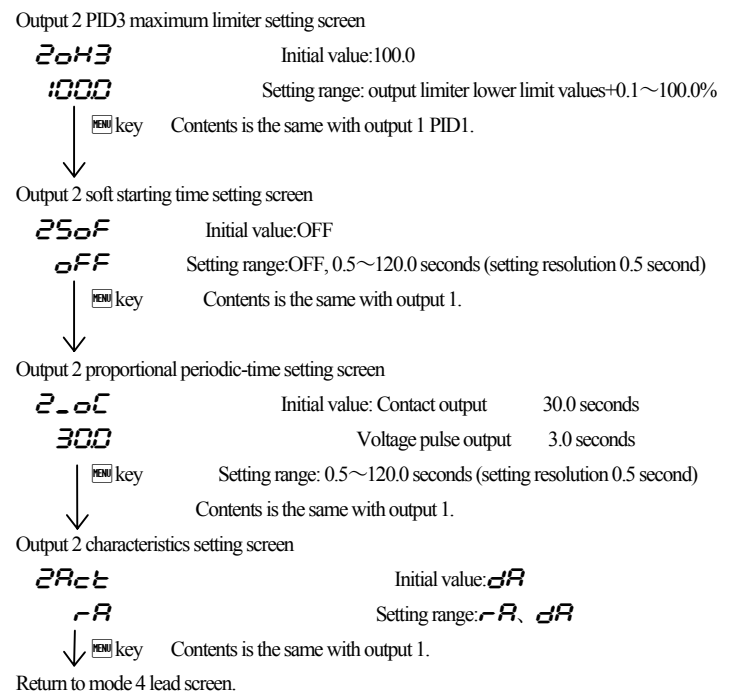
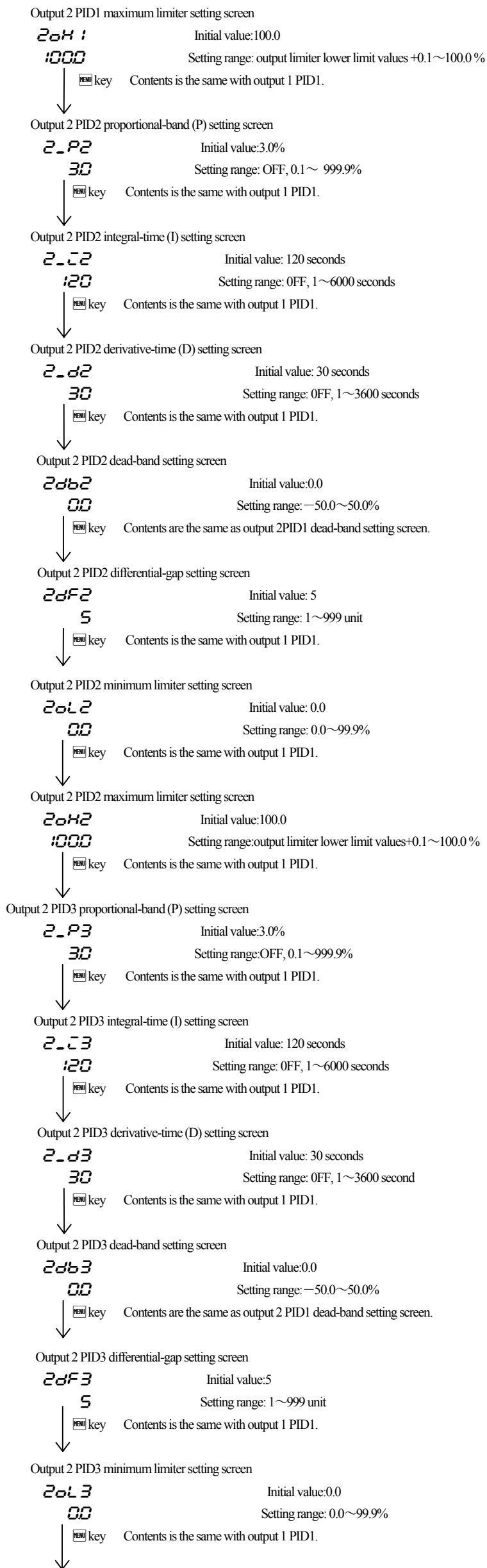




(7) Mode 4 screens

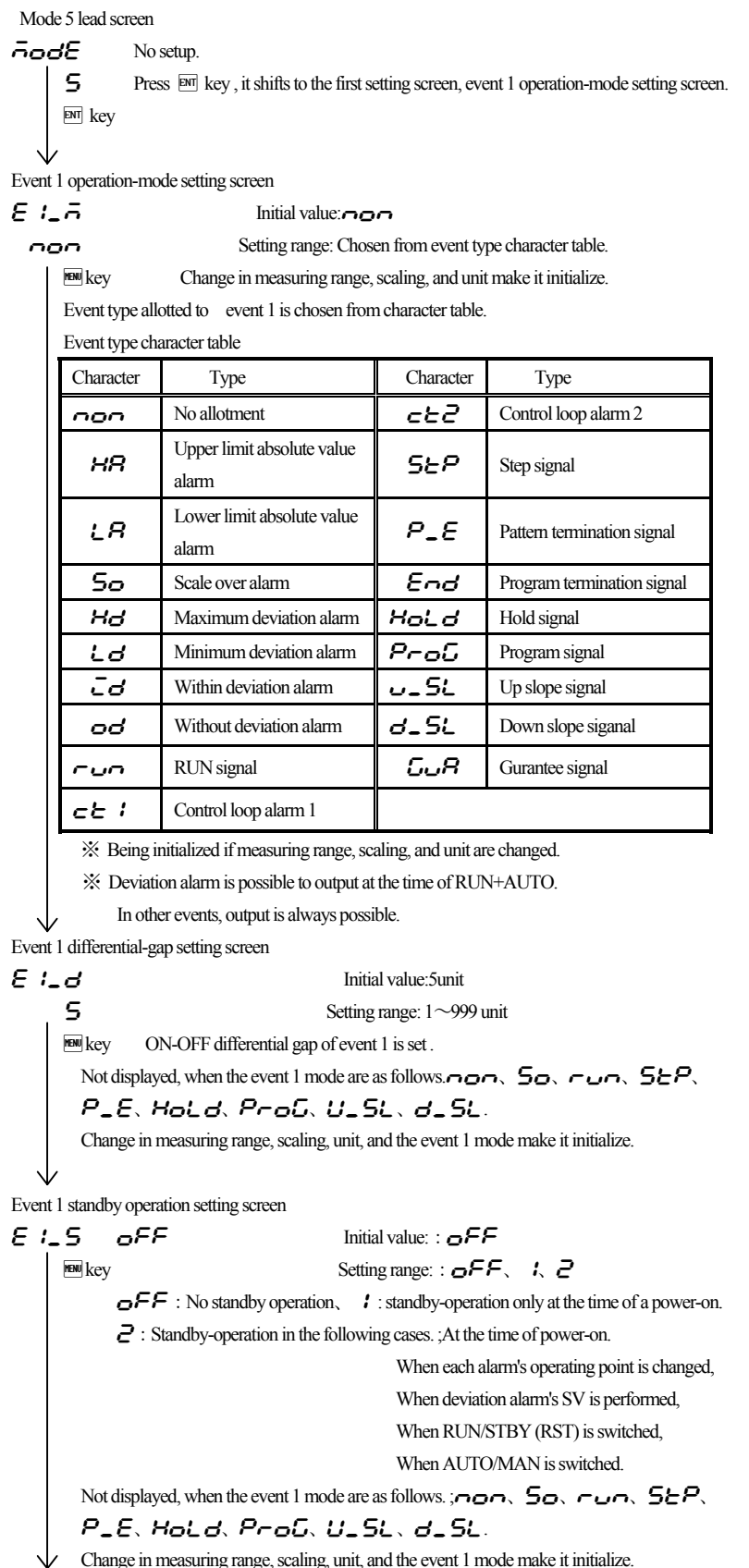
Mode 4 screens is the setup screens of output 2 option. Not displayed when option is not added.



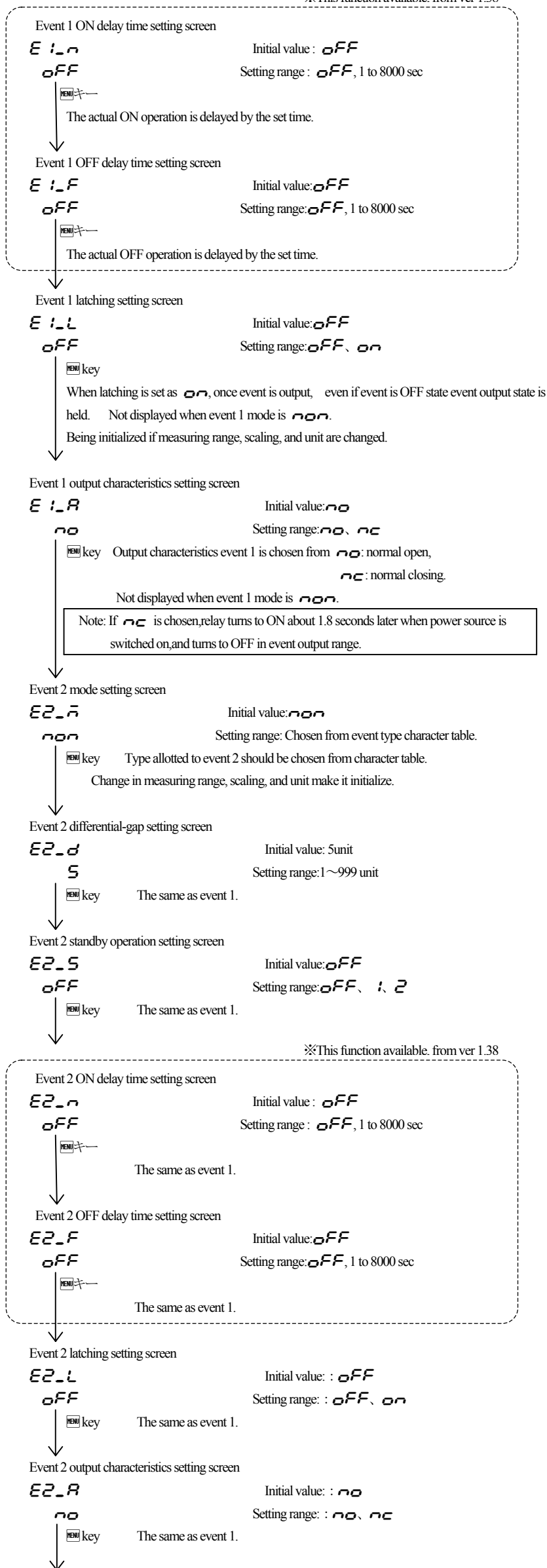


(8) Mode 5 screens

Mode 5 screens is the setup screens of event option. Not displayed when option is not added.



※This function available. from ver 1.38



Event 3 mode setting screen

Notes: Apart from event 1 and 2, event 3 is displayed when being added as additional option.
E3_n Initial value: *NON*
NON Setting range: Chosen from event type character table.
 Type allotted to event 3 should be chosen from character table.
 Change in measuring range, scaling, and unit make it initialize.
 The following screens are the same as for events 1 and 2.
 Return to mode 5 lead screen

(9) Mode 6 screens

Mode 6 screens is the setup screens of external control input (DI) option.
 Not displayed when option is not added.
 DI input is a no-voltage contact or open collector

Mode 6 lead screen

modeE No setup.
E Press **ENT** key, it shifts to the first setting screen, DI1 mode setting screen.
 In MAC 3D (48x48), when option of CT OUTPUT is added, DI 1~DI3 cannot be chosen and not displayed.

DI 1 mode setting screen

d1_n Initial value: *NON*
NON Setting range: chosen from DI operation character table
 Choose DI operation that is allotted to DI 1 from character table.

DI 2 mode setting screen

d2_n Initial value: *NON*
NON Setting range: chosen from DI operation character table
 Choose DI operation that is allotted to DI 2 from character table.

DI 3 mode setting screen

d3_n Initial value: *NON*
NON Setting range: Chosen from DI operation character table.
 Choose DI operation that is allotted to DI 3 from character table.

DI 4 mode setting screen

Notes: Apart from DI 1-3, DI 4 is displayed when being added as additional option.
d4_n Initial value: *NON*
NON Setting range: Chosen from DI operation character table.
 Choose DI operation that is allotted to DI 4 from character table.
 Return to mode 6 lead screen

DI operation character table and restrictions concerning DI

DI character	Operation type	Input detection	Contents
<i>NON</i>	No allotment		
<i>SV1</i>	1st SV	level	With closed DI terminal Execution SV = 1st SV
<i>SV2</i>	2nd SV	level	With closed DI terminal Execution SV = 2nd SV
<i>SV3</i>	3rd SV	level	With closed DI terminal Execution SV = 3rd SV
<i>SV4</i>	4th SV	level	With closed DI terminal Execution SV = 4th SV
<i>RUN</i>	control RUN	level	RUN with closed DI terminal, STBY with open one.
<i>PROG</i>	program	level	Program with closed DI terminal. Constant value with opened.
<i>MAN</i>	manual input	level	Manual with closed DI terminal, auto with open one.
<i>AT</i>	auto tuning	edge	AT-start with rise edge.
<i>HOLD</i>	hold	level	Program's time stops temporarily.
<i>SKIP</i>	skip	edge	Shift to the next program's step.
<i>PT_1</i>	Pattern 1	level	With closed DI terminal, Execution pattern = 1
<i>PT_2</i>	Pattern 2	level	With closed DI terminal, Execution pattern = 2
<i>PT_3</i>	Pattern 3	level	With closed DI terminal, Execution pattern = 3
<i>PT_4</i>	Pattern 4	level	With closed DI terminal, Execution pattern = 4
<i>LRS</i>	latching release	edge	All latching are released by rise edge.
<i>LOCK</i>	super key lock	level	Super keylock with closed DI terminal. Release with opened.

- When **SB 1** to **SB 4** are conducted during AT execution, they are performed at the time of AT termination.
- If each DI is assigned **SB 1** to **SB 4**, or **PE 1** to **PE 4** and more than one DI is turned on at the same time, the one with the lowest number has priority.
- **PE** can be performed at the time of a RUN-automatic output.
- When **PE** is allotted to, release in the middle of AT operation is carried out by off-key operation chosen in AT screen.
- While AT is performed, if STBY (RST) or a manual output is performed, AT is released.
- Even when a keylock is not OFF, conducting of DI is effective.
- The same operation other than **non** is impossible to allot to DI1-DI4 at a time.
- Operation allotted to DI takes priority over DL. Key operation cannot be performed.
- Execution of DI operation is possible to perform. But neither release of AT nor numerical change of SV and manual output is possible to perform.
- In DI input, 5VDC 0.5mA per point is impressed. Use durable switch, transistor and so on.
- Wiring distance of DI should be less than **30m**.

(10) Mode 7 screens

The Mode 7 screens is the setup screens of analog output option.

Not displayed when option is not added.

In MAC 3D (48x48), when communication option is added, it is impossible to choose and display.

Mode 7 lead screen

mode No setup
 ? When **ENT** key is pressed, it shifts to the first setting screen, analog output mode setin screen.

Analog output mode setting screen

Ro_n Initial value: **non** (does not output)
non Setting range: **PV** PV
SB execution SV
out 1 control out put 1
out 2 control out put 2
ct 1 CT OUTPUT 1
ct 2 CT OUTPUT 2

out 2, ct 1, ct 2 is displayed when option is added.
 Data type allotted to analog output are chosen.

Analog output scaling lower limit value setting screen

AS_L Initial value: the following table
0 Setting range: the following table
 Lower limit value of range allotted to analog output is set up.
 However, **AS_L < AS_H** Lower limit value is given priority

MODE		Setting range	Initial value
PV	sensor input	within measuring range	measuring range lower limit value
	linear input	within scaling range	scaling lower limit value
OUT1, OUT2		0.0~99.9	0.0
CT1, CT2		0.0~49.9	0.0

Analog output scaling upper limit value setting screen

AS_H Initial value: the following table
100 Setting range: the following table
 Upper limit value of range allotted to analog output is set up.
 However, **AS_L < AS_H** Lower limit value is given priority

MODE		Setting range	Initial value
PV	sensor input	within measuring range	measuring range upper limit value
	linear input	within scaling range	scaling upper limit value
OUT1, OUT2		0.1~100.0	100.0
CT1, CT2		0.1~ 50.0	50.0

Lower limit value takes priority, therefore upper limit value cannot be set below the value of lower limit value +1. When a lower limit value is set more than upper limit value, upper limit value is push to the level of lower limit value +1.

Analog output limiter lower limit value setting screen

AL_L Initial value: 0.0
00 Setting range: 0.0~100.0%

The lower limit value of analog output value (4-20mA) is set up by %.
 For example, output value of a lower limit value in each setup are: 8mA(25.0), 12mA(50.0), 16mA(75.0) and 20mA(100.0) respectively.

Analog output limiter upper limit value setting screen

AL_H Initial value: 100.0
100 Setting range: 0.0~100.0%

Upper limit value of analog output value (4-20mA) is set up by %.
 If set as the same value as **AL_L** and **AL_H**, it is fixed to the value.

Return to mode 7 lead screen

Note: An analog output limiter can be made into reverse scaling.
 Example: Output range :0°C (4mA)~ 1200°C (20mA) can be 0°C (20mA) ~ 1200°C (4mA).
 Set AL_L as 100% and AL_H as 0.0%.

(11) Mode 8 screens

Mode 8 screens is the setup screens of CT OUTPUT option.

Not displayed when option is not added.

In MAC 3D (48x48), when DI 1~3 are added, it is impossible to choose and display.

Mode 8 lead screen

node No setup
8 Press **ENT** key, it shifts to the first setting screen, CT1 mode setting screen.

CT_n

non Initial value: **non**
 Setting range: **non, out 1, out 2, EB 1, EB 2, EB 3**
 Object detected by CT (current) sensor is chosen.
 In the case of a current output, **out 1** is not displayed.
out 2 is not displayed without current output or output 2 option.
EB 1, 2 and **3** are not displayed without any option, respectively.

CT1 delay time setting screen

CT_n Initial value: 0.5
05 Setting range: 0.5~30.0 seconds
 When control loop abnormal alarm is allotted to event, delay time from switchover of operation (ON-OFF) to detection start is set up.

CT2 mode setting screen

CT_n Initial value: **non**
non Setting range: **non, out 1, out 2, EB 1, EB 2, EB 3**
 The same as CT1 mode setting screen.

CT2 delay time setting screen

CT_n Initial value: 0.5
05 Setting range: 0.5~30.0 seconds
 The same as CT1 delay time setting screen

Return to mode 8 lead screen

About control loop abnormal alarm

When the targeted output of a control loop abnormal alarm is ON, if current detected by CT is lower than the allotted event's operating point (Setting Value of a basic screens, event operating point setting screen) alarm output is issued as breaking alarm.

When the targeted output is OFF, if detected current is higher than the allotted event's operating point (short-circuit, earth fault, etc.)

(12) Mode 9 screens

Mode 9 screens is the setup screens of communication (RS-485) option.

Not displayed when it is not added. See the attached Communication Instruction Manual (in the appendix: "at the time of communication option added") about communication,

5-5. measuring range code table

Input type		code	Measuring Range		
			unit code C ($^{\circ}C$)	unit code F ($^{\circ}F$)	
Thermo couple	R	$r1$	0 ~ 1700	0 ~ 3100	
	K	$k1$	-199.9 ~ 400.0	-300 ~ 700	
	K	$k2$	0 ~ 1200	0 ~ 2200	
	K	$k3$	0.0 ~ 300.0	0 ~ 600	
	K	$k4$	0.0 ~ 800.0	0 ~ 1500	
	J	$j1$	0 ~ 600	0 ~ 1100	
	J	$j2$	0.0 ~ 600.0	0 ~ 1100	
	T	$t1$	-199.9 ~ 200.0	-300 ~ 400	
	E	$e1$	0 ~ 700	0 ~ 1300	
	S	$s1$	0 ~ 1700	0 ~ 3100	
	*5 U	$u1$	-199.9 ~ 200.0	-300 ~ 400	
	N	$n1$	0 ~ 1300	0 ~ 2300	
	*1 B	$b1$	0 ~ 1800	0 ~ 3300	
	*3 WreS-26	s_{26}	0 ~ 2300	0 ~ 4200	
	*4 PL II	$pl2$	0 ~ 1300	0 ~ 2300	
Multi Input	Resistance bulb Pt100	$p1$	-200 ~ 600	-300 ~ 1100	
		$p2$	-100.0 ~ 200.0	-150.0 ~ 400.0	
		*6 $p3$	0.0 ~ 100.0	0.0 ~ 200.0	
		*6 $p4$	-50.0 ~ 50.0	-60.0 ~ 120.0	
		$p5$	-100.0 ~ 300.0	-150.0 ~ 600.0	
		$p6$	-200.0 ~ 300.0	-300 ~ 600	
		$p7$	-199.9 ~ 600.0	-300 ~ 1100	
		$p8$	0 ~ 250	0 ~ 500	
		$jp1$	-200 ~ 500	-300 ~ 900	
		$jp2$	-100.0 ~ 200.0	-150.0 ~ 400.0	
		*6 $jp3$	0.0 ~ 100.0	0.0 ~ 200.0	
		*6 $jp4$	-50.0 ~ 50.0	-60.0 ~ 120.0	
		$jp5$	100.0 ~ 300.0	-150.0 ~ 600.0	
		$jp6$	-200.0 ~ 300.0	-300 ~ 600	
		$jp7$	-199.9 ~ 500.0	-300 ~ 900	
		$jp8$	0 ~ 250	0 ~ 500	
		Nickel 120	$nc1$	0 ~ 230	0 ~ 450
		Voltage (mV)	*7 0 ~ 10	$v1$	Scaling range : -1999~9999 count Span : 10~10000 count
0 ~ 100	$v2$				
*7 -10 ~ 10	$v3$				
0 ~ 20	$v4$				
0 ~ 50	$v5$				
Voltage (V)	1 ~ 5	$v1$	Possible to change decimal point position (No Decimal point, 0.1, 0.01, 0.001)		
	0 ~ 5	$v2$			
	-1 ~ 1	$v3$			
	0 ~ 1	$v4$			
	0 ~ 2	$v5$			
	0 ~ 10	$v6$			
Current (mA)	4 ~ 20	$ca1$	Possible to change decimal point position (No Decimal point, 0.1, 0.01, 0.001)		
	0 ~ 20	$ca2$			

Thermo couple B,R,S,K,E,J,T,N:JIS/IEC

Resistance bulb Pt100:JIS/IEC

JPt100: former JIS

*1 Thermo couple Accuracy is not guaranteed below B:400 $^{\circ}C$ (752 $^{\circ}F$).

*2 Thermo couple In K, T, U, accuracy is $\pm 0.5\%$ FS for 0~100 $^{\circ}C$ (-148 $^{\circ}F$) and $\pm 1.0\%$ FS if it is below -100 $^{\circ}C$

*3 Thermo couple Wre 5-26: Product of Hoskins Mfg. Co.

*4 Thermo couple P L II : Platinel

*5 Thermo couple U:DIN43710

*6 Resistance bulb Accuracy of Pt/JPt $\pm 50.0^{\circ}C$, 0.0~100.0 $^{\circ}C$ is $\pm 0.3\%$ FS.

*7 Voltage (mV) 0~10mV, Accuracy of 0~10mV is $\pm 0.3\%$ of input range.

* Setup of factory shipment is Multi input: Thermo couple $k2$ 0-1200 $^{\circ}C$

Voltage input :1-5V $v1$ 0.0-100.0

Current input :4-20mA $ca1$ 0.0-100.0

6. Supplementary Explanation of Function

6-1. Auto return function

When there is no key operation 3 minutes or more, on the screen except for basic screen and each monitoring screen, screen automatically shifts to basic screen. (Auto return).

6-2. Output Soft Start Function

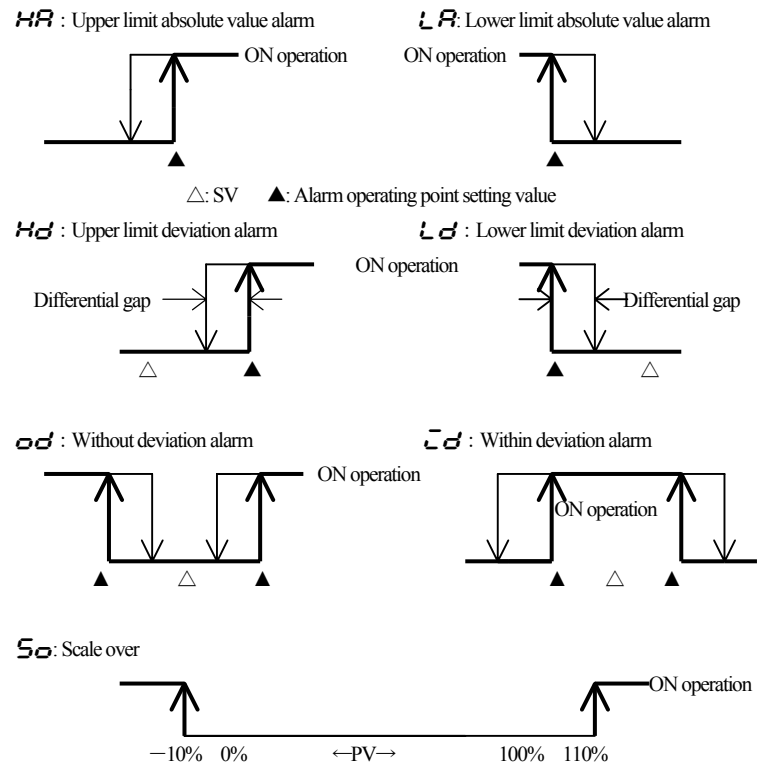
This is the function to increase the control output gradually with set-up time at the time of power-on, STBY \rightarrow RUN, and normal return from scale over. This is effective for controlling the excessive current to loads, such as a heater.

1) Soft-start functions in the following conditions.

- At the time of the power-on in automatic operation, STBY(RST) \rightarrow RUN, and normal return from scale over.
- Setup of proportional band (P) is other than OFF
- Soft starting time is not OFF

6-3. Event Selection Alarm Operation Figure

The figure of alarm operation figure allotted to event 1~3 is shown.



6-4. AT (Auto Tuning)

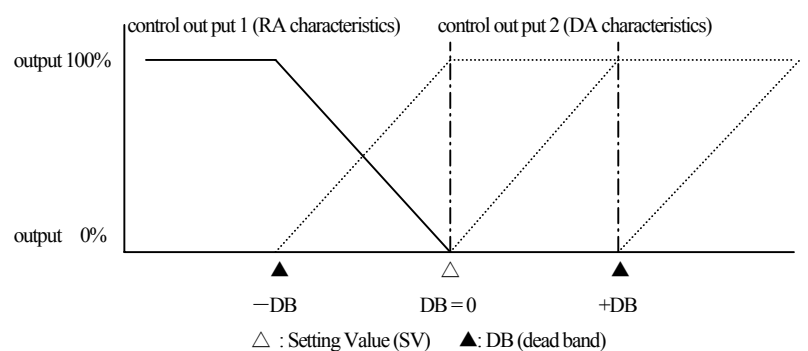
- If AT is performed by FIX (constant value control), AT monitor LED blinks and light is put out by termination or intermediate release.
 - When auto tuning is ended in inclination step or chosen all PID(s), it is in standby state until one pattern is completed. then lights up, then puts out when one pattern is completed.
 - When AT is not completed within 1 pattern, AT conducting is released when one pattern is completed.
 - Even in inclination step, AT is performed if it is in HOLD state.
 - AT at the time of 2 output specification is as follows.
- At the time of heating / cooling operation and cooling / heating operation = OUT1, OUT2 common - PID value
- At the time of heating / heating operation and cooling / cooling operation, only OUT1 performs AT.
- OUT 2 output while performing AT is 0% or output limiter lower limit value.

6-5. 2 output-characteristics figure

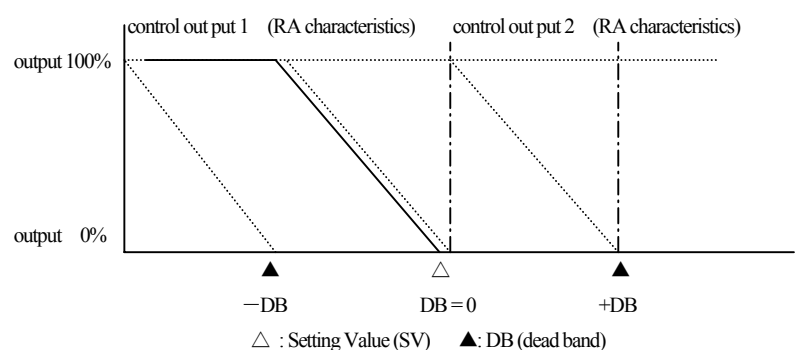
2-output-characteristics is shown in the following figure.

⊙ Conditions: P operation, manual reset ($\bar{r}r$) -50.0%

1) OUT 1 RA (heating) • OUT 2 DA (cooling)



2) OUT 1 RA (heating) • OUT 2 RA (heating)

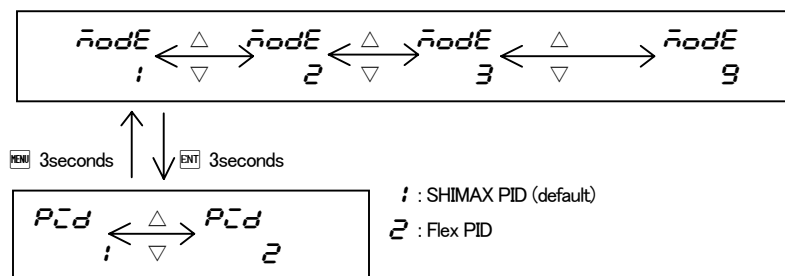


6-6 PID control method (Flex PID Method add from Ver 1.20)

MAC3 equipped with flex PID which can be suited SV (target value) change followingness as a disturbance in addition to the usual type SHIMAX PID which can be suited for a few target of a disturbance element (factory setting)

This is explanation a modification method of two types PID method both SHIMAX PID method and Flex PID method.

(1) Setting of PID method



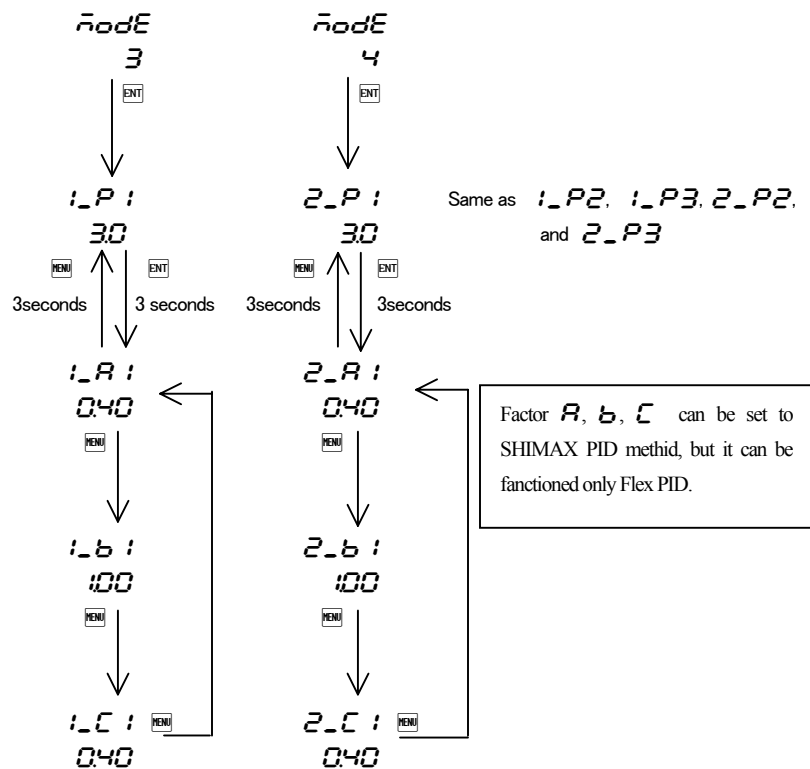
Press **ENT** key 3seconds at each setting lead screen from Mode 1 to Mode 9, it move to the screen that can be choosen both SHIMAX PID or Flex PID.

(2) About the factor used for Flex PID

There are a factor ζ for SV change followingness and a disturbance response factor R and b in addition to the SHIMAX PID method, P (proportional band), I (integration time) and D (derivative time) in flex PID, and it's possible to set from 1 to 3 at PID setting screen of output 1 and 2.

At PID setting screen it can be moved to R setting screen by pressing **ENT** key for 3seconds.

Move to b setting screen by pressing **MEM** key, move to ζ setting screen by pressing **MEM** key, move to R setting screen by pressing **MEM** key, move to PID setting screen by pressing **MEM** key 3 seconds at R setting screen.



(3) Adjustment of each Factor

Auto tuning function calculates standard PID for the turbulence response but best value is not necessarily obtained for all applications.

When the auto tuning function finished, it should be confirmed whether the auto tuning result is excellent by giving turbulence by intention while checking the control result.

The integration limitation coefficient is trimmed ζ as an adjustment of the overshoot and undershoots. When ζ is enlarged, it becomes easy for the overshoot and undershoot to go out though the restoration speed quickens.

ζ setting range : 0.00 to 1.00

Initial value : 0.4 (When the control characteristics of OUT1 and 2 are the same (RA&RA, or DA&DA))

0.8 (When the control characteristics of OUT1 and 2 are different (RA&DA, or DA&RA))

Adjustment of follow for Start up and SV change

The turbulence response and the SV change follow can be individually set by Flexible PID method in MAC3. It already set up the turbulence response, and now set it according to the purpose based on the table below.

R	b	Control method	Features	Remarks
1	1	I-PD (Measurements proportion differentiation early type)	For fixation control	1 flexible PID control
1	0	ID-P (Measurements proportionally early type)	The kickback due to the change in the SV value is small, but the target value tracking ability is slightly inferior.	
0	1	IP-D (Measurements differentiation early type)	For lamp control	
0	0	PID (Deflection PID)	For target value follow valuing and cascade regulation	
Any	0	P-I-PD (P Flex type)	Turbulence response and target value follow	Like 2 flexible PID control
Any	Any	PD-I-PD (PD Flex type)		

R, b Setting range : 0.00 to 1.00

Default value : FIX : $R = 0.40$ $b = 1.00$

PROG : $R = 0.20$ $b = 0.20$

R should be reduced when you want to improve the step response at the SV change and the start-up, R should be expanded when you wants to reduce the overshoot at the step responds and to reduce the output change.

b should be reduced when you want to improve the follow performance at the lamp control, b should be expanded When you wants to reduce the overshoot at the lamp ends and to reduce the output change

(4) Dual output control

• When using for heating & cooling:

If $SV > PV$ when both output 1 and output 2 are left at 0%, assign heating to output 1. If $SV < PV$, assign cooling to output 1.

• In the following cases, depending on the load condition, the dead band (DB) setting may be temporarily ignored and the control output may operate.

- ① When the set values of proportional band (P) and derivative (D) of output 1 and output 2 are different.
- ② When the proportional period of output 1 and output 2 is different.

7. Trouble Shooting

7-1. Cause and Treatment of Main Defects

Contents of defects	Cause	Treatment
Error message display	Refer to cause and treatment of error display	Refer to cause and treatment of error display
PV display is not normal	Mismatch of instrument and input. Fault in the wiring.	Type code, check of specification. Check of wiring.
Display disappeared and does not operate	Power is not supplied. Abnormality of instrument.	Check of a power supply (voltage of terminal, switch, fuse, wiring).
Key operation impossible	Keylocked. Abnormality of instrument.	Release of keylock. Check of instrument, repair, exchange.

7-2. Cause and Treatment of Error Display

(1) Abnormality Display of Measurement Input






Error display	Contents	Cause	Treatment
HHHH (HHHH)	Scale over in upper limit	1.wire breaking of thermocouple input 2.wire breaking of resistance bulb input A 3.when input exceeds upper limit of measuring range by 10%	1.wire breaking check of thermocouple input wiring, replacement of thermocouple 2.check of resistance bulbA wiring, replacement of resistance bulb 3.check of input voltage value and current value, input transmitter and specification (matching of incoming signal and meter specification)
LLLL (LLLL)	Scale over in lower limit	1.when input exceeds lower limit of measuring range by 10% 2.wire breaking of resistance bulb input B	1.polarity of input is everse, check of wiring and an input transmitter 2.check of resistance bulb B wiring, replacement of resistance bulb
(B: Wiring of MAC3A, 3B's terminal No.11, Wiring of MAC 3C's terminal No.8, Wiring of MAC 3D's terminal No.5)			
b--- (B---)	Breaking of resistance bulb input	1.wire breaking of b (b: Wiring of MAC 3A, 3B's terminal No.12, Wiring of MAC 3C's terminal No.9, wiring of MAC 3D's terminal No.6)	1.check of resistance bulb wiring
		2.multiple wire breaking combinations in A, B, b (A and B, A and b, B and b, all of ABb)	2.replacement of resistance bulb
CJHH (C J HH)	Cold junction (CJ) temperature of thermocouple input is scale over in upper limit side	When ambient temperature of a meter exceeds 80°C	1.make Ambient temperature of meter within use environment condition temperature 2. Check the meter when ambient temperature is not over 80°C
CJLL (C J LL)	Cold junction (CJ) temperature of thermocouple input is scale over in lower limit side	When ambient temperature of meter becomes less than -20°C	1.make Ambient temperature of meter within use environment condition temperature 2. Check the meter when ambient temperature is not less than -20°C


8. Specification

Display

Display method	Digital display: MAC3A (96 x 96 size) PV red 7 segment LED 4 figure (height of character about 20mm) SV green 7 segment LED 4 figure (character quantity about 13mm)
	MAC3B(48x96 size) PV red 7 segment LED 4 figure (height of character about 12mm) SV green 7 segment LED 4 figures (height of character about 9 mm)
	MAC3C(72x72 size) PV red 7 segment LED 4 figure (height of character about 16mm) SV green 7 segment LED 4 figures (height of character about 11mm)
	MAC3D(48x48 size) PV red 7 segment LED 4 figure (height of character about 12mm) SV green 7 segment LED 4 figures (height of character about 9mm)
Status display:	RUN (green), PRG (green), AT (green), OUT 1(green) EV1 (yellow), EV2 (yellow), OUT2 /EV3 (yellow)
Display accuracy	: ±(0.25%FS+1digit) CJ errors not included, B thermo couple below 400°C is not guaranteed. Display accuracy during EMC examination is ±5%FS.
Accuracy maintenance range	: 23±5°C
Display range	: -10%~110% of measuring range, but Pt100's -200~600°C is -240~680°C
Display resolution	: Changes with measuring range and scaling.
Input scaling	: Possible at the time of voltage input and current input -1999 to 9999 (spang 10 to 10000 count, decimal point position no decimal point 0.1, 0.01, 0.001)

Setting

Setting system	: By five front keys (    )
SV setting range	: Same with measuring range
Key lock	: Communication and key setting (six levels), DI (one level)

Operations	Level	Lock Content
Communication & Key setting	OFF	No lock
	1	Possible to change Execution SV, manual output value, and a keylock level.
	2	Possible to change manual output value and keylock level.
	3	Possible to change keylock level.
	4	Possible to change keylock level.  key is invalid.
	5	In addition to the contents of Level 1, Basic screens and FIX/PROG setting screens can be changed.
DI Setting		Super Key Lock (Shift between screens prohibited. Fixed only to the basic screen.)

The RUN key is invalid when the Keylock is set to 4 or when the super key lock is activated by DI. Everything else is valid.

SV setting limiter	: Same with measuring range (lower limit < upper limit)
Unit setting	: Settable at the time of sensor input °C, °F

Input

Multi input

Thermocouple

- Input resistance : 500k Ω or more
- External resistance tolerance level : 100 Ω or less
- Influence of lead-wire resistance : $1.2 \mu V / 10 \Omega$
- Burnout : Standard equipment (Up Scale only)
- Measuring range : Item 5-5. Refer to measuring range code table.
- Compensation accuracy
 - of reference junction : $\pm 1^\circ C$ (ambient temperature 18 to 28 $^\circ C$) At the time of vertical plural proximity attachment $\pm 2^\circ C$
 $\pm 2^\circ C$ (ambient temperature 0 to 50 $^\circ C$) At the time of vertical plural proximity attachment $\pm 3^\circ C$
Several minutes after power-on, accuracy is not guaranteed. Reaches the accuracy level within 5 minutes after power-on.

Tracking of a reference

- junction : Below the ambient temperature of 0.5 $^\circ C / \text{min}$, compensation accuracy of reference junction $\pm 1^\circ C$

Resistance bulb

- Stipulated current : Approx. 0.25mA
- Lead wire resistance tolerance level : 5 Ω or less per wire (Resistance of three lines should be equal)
- Influence of lead-wire resistance
 - : 5 Ω or less per wire 0.2%FS
 - 10 Ω or less per wire 0.5%FS
 - 20 Ω or less per wire 1.0%FS
- Measuring range : Item 5-5. Refer to measuring range code table.

Voltage (mV) Input resistance : 500k Ω or more

- Input voltage range : Item 5-5. Refer to measuring range code table.

Voltage input (V) Input resistance : 500k Ω or more

- Input voltage range : Item 5-5. Refer to measuring range code table.

Current input (mA) reception

- Resistance : 250 Ω (built-in)
- Input range : Item 5-5. Refer to measuring range code table.

- Sampling period : 0.25 second
- PV filter : 0 to 9999 second
- PV offset compensation : ± 500 unit
- PV gain correction : $\pm 5.00\%$ PV filter

Control

- Control system : PID control with an auto tuning function or ON-OFF operation
- Proportional band (P) : OFF and 0.1 to 999.9% of measuring range (ON-OFF operation by OFF setting)
- ON-OFF Differential-gap (DF) : 1 to 999 unit
- Integration time (I) : OFF, 1 to 6000 seconds (PD operation by OFF setting)
- Derivative time (D) : OFF, 1 to 3600 seconds (PI operation by OFF setting)
- Manual Reset (MR) : $\pm 50.0\%$ (effective when set as I = OFF)
- Output 2 dead band : -1999 to 5000 unit
- Output limiter (OL, OH) : 0.0 to 100.0% (OL<OH) (set resolution 0.1)
- Soft start : OFF, 0.5 to 120.0 seconds (set resolution 0.5)
- Proportional period : 0.5 to 120.0 seconds (set resolution 0.5)
- Control output characteristic : Output 1, output 2. Possible to choose either RA (heating) or DA (cooling).
- Manual output : 0.0 to 100.0% (set resolution 0.1)

* Each parameter, (P, I, D, DF, MR, OL, and OH) of Outputs 1 and Outputs 2, belongs to 1~3 categories.

Control output 1

- Contact : normal open (1a) 240V AC 2A (resistance load)
- Voltage pulse (SSR drive) : 12V (-1.5 to +1.0V) DC MAX 20mA
- Current : 4 to 20mA DC load resistance 500 Ω or less Display accuracy $\pm 1\%$ (accuracy maintenance range 23 $^\circ C \pm 5^\circ C$)
Load regulation $\pm 0.2\%$, resolution approx. 1/12000
- Voltage : 0 to 10VDC MAX 2mA Display accuracy $\pm 1\%$ (accuracy maintenance range 23 $^\circ C \pm 5^\circ C$)
Load regulation $\pm 0.2\%$, resolution approx. 1/12000

Control output 2 (option) : Control output 2 is exclusive option of event 3 and DI4.

- Contact : normal open (1a) 240V AC 2A (resistance load)
- Voltage pulse (SSR drive) : 12V (-1.5 to +1.0V) DC MAX 20mA
- Current : 4 to 20mA DC load resistance 500 Ω or less, display accuracy $\pm 1\%$ (accuracy maintenance range 23 $^\circ C \pm 5^\circ C$)
Load regulation $\pm 0.2\%$, resolution approx. 1/200
- Voltage : 0 to 10VDC MAX 2mA Display accuracy $\pm 1\%$ (accuracy maintenance range 23 $^\circ C \pm 5^\circ C$)
Load regulation $\pm 0.2\%$, resolution approx. 1/200

Program function (option) (40step function add from ver1.30)

- Number of pattern : 1, 2, and 4
- Maximum Number of steps : 40(1 pattern), 20(2 pattern), 10(4 pattern)
- PID selection : Each output has three kinds. PID1, PID2, and PID3.
- Time setting : 0 minute 0 second~99 minutes 59 seconds or 0 hour 0 minute~99 hours 59 minutes or 0.0 - 999.9 hours ,and ∞ (infinity)
- Time setup resolution : 1 second or 1 minute or 0.1 hour
- Time accuracy : ± (Setup time × 0.005 +0.25 second)
- In a step Setting parameter : SV, time, PIDNo
- Number of repeats : 1 to 9999 times, and ∞
- Time signal : Possible to allot to Event (1 second for changeover, 3 seconds for pattern end, 3 seconds for program end)
- PV start function : With
- Guarantee soak function : With
- Time hold facility : Possible at front key, DI allotment, or communication
- Step skip : Possible at front key, DI allotment, or communication
- Power failure compensation : Without (setting contents being held.However, elapsed time, execution step, and number of execution are reset.)

Event 1・2 (option)

- : 2 sets
- Output rating : Contact Normal open (1a) 240V AC 2A (resistance load) EV1・EV2 and common
- Kind of event : Refer to following table.

Function	Character	Note
No allotment	<i>non</i>	
Upper limit absolute value Alarm	<i>HR</i>	
Lower limit absolute value alarm	<i>LR</i>	
Scale over alarm	<i>So</i>	HHHH, LLLL, B---- Operates, when displayed.
Upper limit deviation value Alarm	<i>Hd</i>	
Lower limit deviation value alarm	<i>Ld</i>	
Within deviation alarm	<i>cd</i>	
Without deviation alarm	<i>od</i>	
RUN signal	<i>run</i>	Operates during PROG and FIX in operation.
Control loop alarm (Heater breaking / loop)	<i>ct1</i>	When contact/voltage pulse output is ON Breaking alarm, when it is below EV set.
	<i>ct2</i>	When contact/voltage pulse output is OFF Loop alarm, when it is more than EV set.
Step signal	<i>StP</i>	Operate for 1 second at the time of step switchover
Pattern end signal	<i>P_E</i>	Operate for 3 seconds at the time of pattern end
Program end signal	<i>End</i>	For 3 seconds at the time of program end
Hold signal	<i>Hold</i>	Operates during time hold.
Program signal	<i>Prog</i>	Operates by program selection
Upslope signal	<i>u_SL</i>	Operates when the inclination of program control rises (including Hold status)
Downslope signal	<i>d_SL</i>	Operates when the inclination of program control descends (including Hold status)
Guarantee signal	<i>GUR</i>	Operates when approaches the targeted value exceeding the EV value.

- Setting range : Upper limit absolute value alarm, Lower limit absolute value alarm within measuring range
- Upper limit deviation alarm, Lower limit deviation alarm -1999 - 2000 unit
- Within deviation alarm, without deviation alarm 0 - 2000unit
- Control loop alarm 0.0-50.0A

- Standby operation : OFF No standby operation
- 1 Only at the Time of Power-on, standby operation
- 2 At the Time of power switch on, each alarm operating point is changed, deviation alarm's execution SV is changed, and RUN/STBY (RST) is switched over standby operation, at the time of AUTO/MAN switchover

- ON/OFF delay : OFF, 1 to 8000 second (This function available, from ver 1.38)
- Latching : Alarm operation maintenance function(Release is done by key operation, DI, or power OFF.
In the case of release by DI and power OFF, all alarms are called off simultaneously)

- Differential gap : 1 to 999 unit
- Output characteristic : Choose from normal open (NO) or normal closing (NC).
If NC is chosen and power is turned on, relay becomes ON about 1.8 seconds and becomes OFF at event power range.

- Event3 (Option) : Event3 is exclusive selection option of control out put 2 and DI4.
- : Item and contents are same with event 1 and 2.

- DI 1-2 (option) : In MAC3C and MAC3D, exclusive selection option with CT1 input.
 Input rating : 5V DC 0.5mA
 Allotment function : Refer to following table.

Character	Kinds of operation	Input detection	Contents
<i>non</i>	No allotment	level	
<i>SV1</i>	1st SV	level	With closed DI terminal, Execution SV = 1st SV
<i>SV2</i>	2nd SV	level	With closed DI terminal, Execution SV = 2nd SV
<i>SV3</i>	3rd SV	level	With closed DI terminal, Execution SV = 3rd SV
<i>SV4</i>	4th SV	level	With closed DI terminal, Execution SV = 4th SV
<i>run</i>	Control RUN	level	RUN with closed DI terminal. STBY(RST) with opened.
<i>Prog</i>	Program	level	Program with closed DI terminal. Constant value with opened.
<i>MAN</i>	Manual output	level	Manual with closed DI terminal. Auto with opened.
<i>At</i>	Auto tuning	edge	AT starts with rise edge.
<i>Hold</i>	Hold	level	Program time stops temporary.
<i>SKIP</i>	Skip	edge	Shifts to the following step of program.
<i>Pat_1</i>	Pattern 1	level	With closed DI terminal, Execution pattern = 1
<i>Pat_2</i>	Pattern 2	level	With closed DI terminal, Execution pattern = 2
<i>Pat_3</i>	Pattern 3	level	With closed DI terminal, Execution pattern = 3
<i>Pat_4</i>	Pattern 4	level	With closed DI terminal, Execution pattern = 4
<i>LRS</i>	Latching release	edge	With rise edge, all latching released
<i>LOCK</i>	Super keylock	level	Super keylock with closed DI terminal. Release with opened.

- Input minimum retention time : 0.25 second
 Input of operation : Non-voltage contact or open collector

- DI4 (option) : DI4 is exclusive selection option with control output 2, Event3
 Number of input : One
 : Item and contents are same with DI 1 and DI 2.

- Communication function(option) : In MAC3C and MAC3D, exclusive selection option with Analog output function
 Read attached communication instructions manual that detailed about communication function.
- Communicative type : EIA standard RS-485
 Communication system : Two-wire system half duplex multi-drops (bus) system
 Synchro system : Asynchronous system
 Communication distance : Maximum 500m (depend s on conditions)
 Communication Speed : 1200, 2400, 4800, 9600, 19200 or 38400bps
 Data format : Start 1bit, Stop 1-2 bits, Data length 7 or 8 bits, Parity without, odd number, even number
 Master function : Chooses from SV, OUT1, OUT2 (1:n number of slaves maximum 31)
 ※ When MAC3 is a master, slave address range must be continuation.
 ※ When MAC3 is a master, bus connection with other host PCs is not allowed.
 ※ Input range of master machine and slave machine should be equal, at the time of cascade control
- Slave address : 1 to 255
 Parameter preservation mode : Choose from RAM, MIX and EEP mode.
 Error detection : None, Choose from ADD, complement of ADD +2, exclusive OR, CRC-16 and LRC
 Flow control : none
 Delay : 1 to 500ms (resolution 1ms)
 Communication code : ASCII code or binary code
 Protocol : SHIMAX Standard or MODBUS ACII, MODBUS RTU protocol
 Termination resistance : 120Ω (external connection)
 Number of connection : Maximum 32 sets (depends on conditions, host is included)

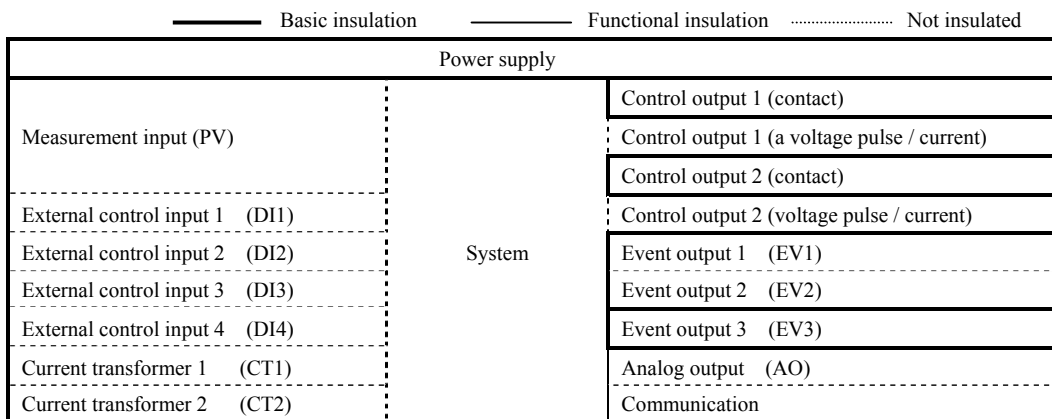
- Analog output(AO) : In MAC3C and MAC3D, exclusive selection option with communication function
 Output kind : Choose from PV, SV, OUT1, OUT2, CT1, and CT2.
 Output rating : 4-20mA DC 300Ω or less, Display accuracy ±0.3% (accuracy maintenance range 23°C±5°C)
 Load regulation±0.05%, Resolution approx 1/50,000
 Scaling function : with (range depends on output type) analog output lower limit value < analog output upper limit value
 Output limiter : 0.0 to 100.0% (reverse setting is possible)

- CT 1 input : In MAC3C and MAC3D, exclusive selection option with DI1 · DI2.
 Detection method : Current judging system by CT sensor
 Detection range : 0.0 to 55.0A
 Sampling period : 125ms
 Detection accuracy : ±5%FS
 Detection delay time : 0.5 to 30.0 seconds
 Alarm output : Assigned to event
 Detection Objects : Assigned to OUT1, OUT2, EV1, EV2, and EV3.
 Alarm operating point setting range : 0.0 to 50.0A
 Recommended CT sensors : Products of U_RD co., CTL-6-L, CTL-6-V, CTL-6-P-H, CTL-6-S-H, CTL-12L-8

General specification

- Data save : Nonvolatile memory (EEPROM)
- Temporary dead time : No influence within 0.02 second 100% dip
- Use environmental condition : Temperature: -10 to 55 °C
- Humidity : Below 90%RH (no dew condensation)
- Hight : Altitude of 2000m or less
- Category : II
- Contamination degree : 2
- Storage temperature Conditions : -20 to 65 °C
- Supply voltage : 90 to 264V AC 50/60Hz or 21.6 to 26.4V AC (50/60Hz)/DC
- Power consumption : 90 to 264V AC maximum 9VA 21.6 to 26.4V AC maximum 6 VA 21.6 to 26.4V DC maximum 4W
- Applicable standard : EU CE marking directives compliant (EMC : Class A)
- Oscillation : IEC60068-2-6
- Insulated class : Class I apparatus
- Input noise removal ratio : Normal 50dB or higher
- Impulse-proof noise : Power-source Normal 100ns/1 μ s±1500V
- Insulation resistance : Between input/output terminal and power supply terminal 500V DC 20Ω or higher
: Between analog output or communication and other input/output terminals 500V DC 20Ω or higher
- Withstand voltage : Between input/output terminal and power supply terminal 1500V AC 1 minute or 1800V AC 1 second
: Between analog output or communication and other input/output terminals 500V AC 1 minute or 600V AC 1 second
- Resistance to vibration : Frequency 10~55~10Hz, amplitude 0.75mm (one side amplitude) · · · 100m/S² Direction 3 directions
Sweep speed 1 octave/minute (about 5 minutes for both-way/cycle) Number of sweep 10 times
- Case material : PC or PPE
- Case color : Light gray
- Outside dimension MAC3 A : H96×W96×D69mm (depth in panel 65mm)
MAC3 B : H96×W48×D66mm (depth in panel 62mm)
MAC3 C : H72×W72×D69mm (depth in panel 65mm)
MAC3 D : H48×W48×D66mm (depth in panel 62mm)
- Thickness of applied panel : 1.2-2.8mm
- Size of attachment hole
MAC3A : H92×W92mm Attachment hole size of horizontal plural proximity attachment W(96×N-4) mm H92mm
MAC3B : H92×W45mm N=number of equipment W(48×N-3) mm H92mm
MAC3C : H68×W68mm W(72×N-4) mm H68mm
MAC3D : H45×W45mm W(48×N-3) mm H45mm
- Weight MAC3A : About 220g
MAC3B : About 160g
MAC3C : About 150g
MAC3D : About 120g
- Isolation : Except for input, system and contact, all control output are no-isolation
Between event output EV1 and EV2 1 is not insulated
Others are basic insulation or functional insulation.
Refer to the following insulation block chart.

Insulation block chart



RoHS information

中华人民共和国中国电子行业标准 SJ/T11364-2014
People's Republic of China Electronic Industry Standard SJ/T 11364-2014

产品 / Product	MAC3/5/50 Series Digital Controller					
零件名称 / Part Name	有毒有害物质或元素 / Hazardous Substances					
	铅/Pb	汞/Hg	镉/Cd	六价铬/Cr6+	多溴联苯/PBB	多溴二苯醚/PBDE
电路模块 / PCB Assembly	X	0	0	0	0	0
壳体 / Enclosure	0	0	0	0	0	0
包装 / Packaging	0	0	0	0	0	0
0	指明产品所有均质材料包含的有害物质要低于GB/T26572限定的要求 Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.					
X	指明产品所用的至少一种均质材料包含的有害物质高于GB/T26572限定的要求 Indicates that said hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572.					



标识中央的数字表示适用于中华人民共和国销售的电子信息产品的“环保使用期限”。
本公司生产的产品的环保使用期限为10年。但是，此环保使用期限不是产品保证期限。

9. Program pattern setting table

Please copy and use this table according to need.

Start mode	SV, PV																		
End step	1-40																		
Number of pattern execution	1~9999, ∞																		
Time unit	min.: sec., hour: min., or hour																		
Output 1 PID No. 1																			
P=	%																		
I=	second																		
D=	second																		
Differential gap =																			
Manual reset =	%																		
Output limiter																			
	OL= %																		
	OH= %																		
Output 1 PID No. 2																			
P=	%																		
I=	second																		
D=	second																		
Differential gap =																			
Manual reset =	%																		
Output limiter																			
	OL= %																		
	OH= %																		
Output 1 PID No. 3																			
P=	%																		
I=	second																		
D=	second																		
Differential gap =																			
Manual reset =	%																		
Output limiter																			
	OL= %																		
	OH= %																		
Output 2 PID No. 1																			
P=	%																		
I=	second																		
D=	second																		
Differential gap =																			
Manual reset =	%																		
Output limiter																			
	OL= %																		
	OH= %																		
Output 2 PID No. 2																			
P=	%																		
I=	second																		
D=	second																		
Differential gap =																			
Manual reset =	%																		
Output limiter																			
	OL= %																		
	OH= %																		
Output 2 PID No. 3																			
P=	%																		
I=	second																		
D=	second																		
Differential gap =																			
Manual reset =	%																		
Output limiter																			
	OL= %																		
	OH= %																		
Step No.																			
SV (target setting value)																			
Time																			
Output 1 PID No.																			
Output 2 PID No.																			

The contents of this instruction are subject to change without notice.

SHIMAX CO., LTD.

190 Shimoniyaichi, Aza, Yotsuya, Daisen-shi, Akita 014-0102, Japan

URL <http://www.shimax.co.jp>

Phone: +81-187-86-3400 FAX: +81-187-62-6402

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