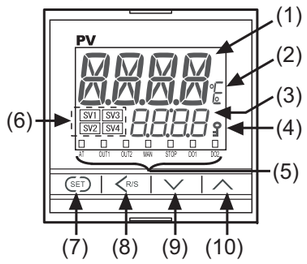
Digital Indicating Controller

# SC-S21 Operation Manual

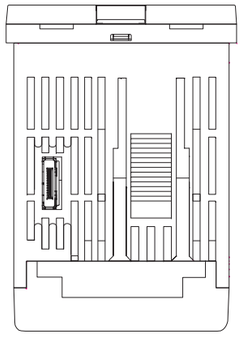
In order to achieve maximum performance and ensure proper operation of your new instrument, carefully read all the instructions in this manual. Please place the manual in a convenient location for easy reference. This manual describes the parts description and basic key operations of the SC-S21.

## 1. PARTS DESCRIPTION

Front view




Bottom view

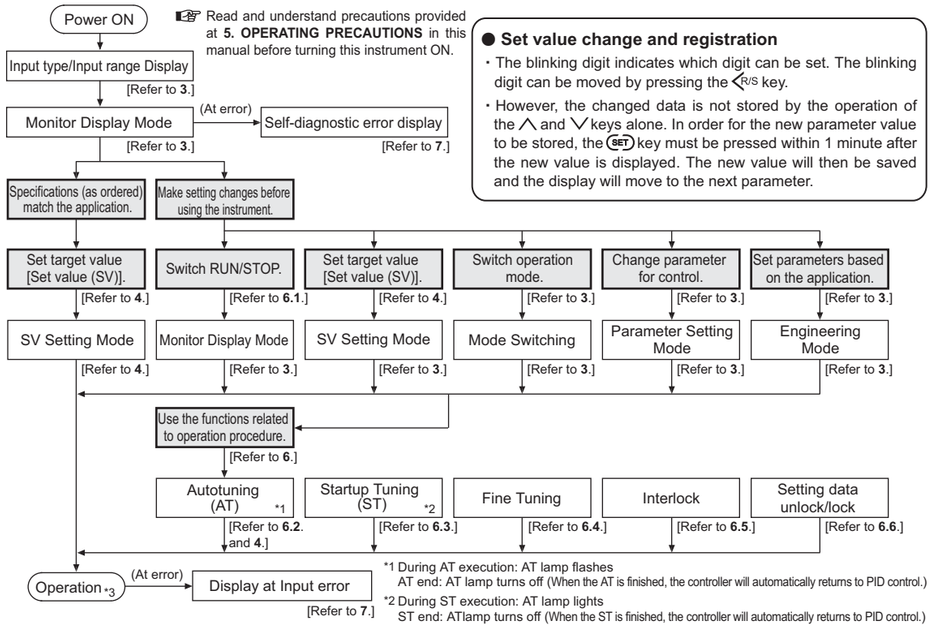


| | | | |
|---|---|---|---|
| (1) | Measured value (PV) display | [Green] | Displays Measured value (PV) or various parameter symbols. |
| (2) | Unit display | [Green] | Displays the temperature units (°C or °F) of displayed data and the units (%) of the Manipulated output value (MV). |
| (3) | Set value (SV) display | [Orange] | Displays Set value (SV), Manipulated output value (MV) or various parameter set values. |
| (4) | Set lock display | [Orange] | Lights when the settings are locked. |
| (5) | AT lamp | [Green] | Flashes when Autotuning is activated.<br>(After Autotuning is completed: AT lamp will go out)<br>Light during Startup tuning (ST) execution. |
| | Output lamp | [Green] | OUT1: Lights when Output 1 is turned on.<br>OUT2: Lights when Output 2 is turned on.<br>Lamp indication becomes as follows for Current output and Voltage output.<br>For an output of less than 0 %: Extinguished<br>For an output of more than 0 %: Lit |
| | MAN mode lamp | [Green] | Lights when operated in Manual (MAN) mode. |
| | STOP lamp | [Green] | Lights when control is stopped (STOP).<br>Blinks when control is stopped (STOP) by the Timer function. |
| | DO (digital output) lamp | [Orange] | Lights when the Event (DO1 to DO3) output corresponding to each lamp is ON. |
| (6) | STEP set value lamp | [Orange] | When the step SV function or the Timer function is used, the lamp corresponding to the currently used Set value (SV1 to SV4) lights. |
| (7) | Set (SET) key | | Used for parameter calling up and set value registration. |
| (8) | Shift key | | Shift digits when settings are changed.<br>Used to switch monitor items, RUN/STOP, and modes. |
| (9) | Down key [1] | | Decrease numerals. |
| (10) | Up key [1] | | Increase numerals. |

[1] Also used to switch items within Mode switching (AUTO/MAN, Set data lock, and Interlock release).

**To avoid damage to the instrument, never use a sharp object to press keys.**

## 2. OPERATION FLOW



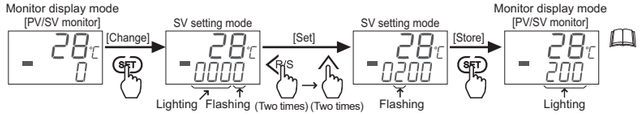

**● Set value change and registration**

- The blinking digit indicates which digit can be set. The blinking digit can be moved by pressing the R/S key.
- However, the changed data is not stored by the operation of the ∧ and ∨ keys alone. In order for the new parameter value to be stored, the SET key must be pressed within 1 minute after the new value is displayed. The new value will then be saved and the display will move to the next parameter.

*3 Adjust the PID constants manually when the optimum PID constants cannot be calculated by AT or ST for characteristic variations of the controlled system.

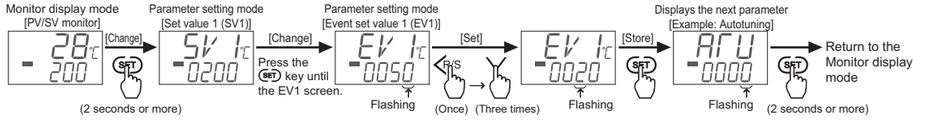
## 4. SETTING EXAMPLE

**● Set Set value 1 (SV1) to 200 °C**

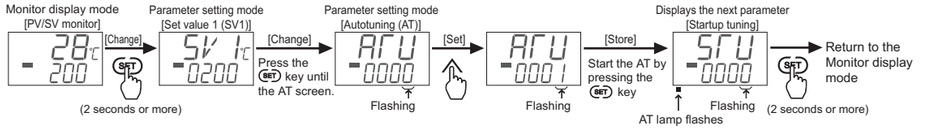



The Set value (SV) can also be set in Parameter setting mode.

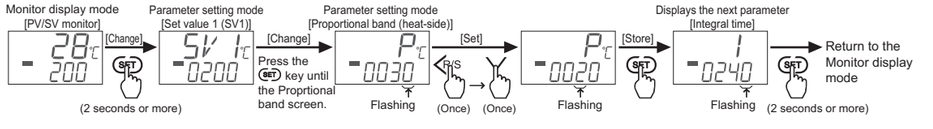
**● Set Event 1 set value (EV1) to 20 °C**




**● Set Autotuning (AT)**

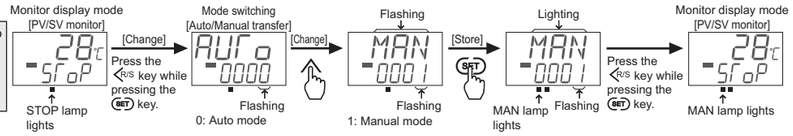



**● Set 20 °C for Proportional band (P) of PID control**



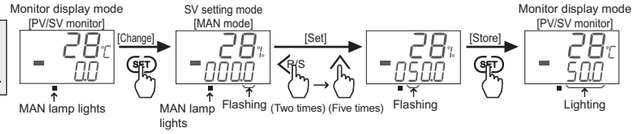

**● Switch from Auto (AUTO) mode to Manual (MAN) mode**

Switch the RUN/STOP mode from RUN to STOP. [Refer to **6.1**.]




**● Set Manipulated output value (MV) to 50 % in the Manual mode**

Switch to the Manual mode by following the procedure above.




## 3. OPERATION MENU

Power ON

Some parameters are not displayed depending on the model and the specifications.

### Input type/Input range Display

Symbol
Input type symbol (Refer to Fig. at the right)
Unit for input and SV display
TC/RTD input: °C or °F
Voltage/Current input: No display
Automatically (in 2 sec.)
Input range high*
Input range low*
* When sensor type is K thermocouple (-200 to +1372 °C)
Automatically (in 2 sec.)

| Symbol | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Input type | TC | | | | | | | | | | W5Re/W26Re |
| | K | J | T | S | R | E | B | N | PL Ⅱ | | |

| Symbol | | | | |
|---|---|---|---|---|
| Input type | RTD | | Voltage | Current |
| | Pt100 | JPt100 | V | mA |

### Monitor Display Mode

- Monitor parameters such as PV, SV and MV.
- Conduct operation in this mode.

[RUN mode (factory shipment)]

(AUTO mode) PV/SV monitor — Unit of PV *
(MAN mode) PV/SV monitor — Unit of PV *, MAN lamp lights

*Temperature input (TC, RTD): °C or °F
Voltage/Current input: No display

R/S
Manipulated output value (MV1) monitor [heat-side]
Within output limiter range
R/S
Manipulated output value (MV2) monitor [cool-side]
Within output limiter range
R/S
Remaining time monitor
0 minutes 00 seconds to 99 minutes 59 seconds or 0 hours 00 minutes to 99 hours 59 minutes
R/S

RUN/STOP transfer
R/S
(2 seconds or more)

[STOP mode]
(AUTO mode) STOP lamp lights
(MAN mode) MAN lamp lights, STOP lamp lights

Even in the STOP state the Set value (SV) and the Parameter setting mode can be set, and Mode switching is possible.

Refer to **6.1 RUN/STOP Transfer** for the state of the controller in STOP mode.

Press the R/S while pressing the SET

### SV Setting Mode

In this mode, control Set value (SV) and Manual output value (MV) in Manual (MAN) mode can be set.

(AUTO mode) PV, Unit of SV *, SV can be changed [Flashing]
*Temperature input (TC, RTD): °C or °F
Voltage/Current input: No display

(MAN mode) PV, Unit of MV : %, MV can be changed [Flashing]
MAN lamp lights

Refer to **4. SETTING EXAMPLE**.

### Mode Switching

In this mode, Auto/Manual transfer, Set data unlock/lock transfer, and Interlock release can be performed.

Auto (AUTO)/Manual (MAN) transfer
Auto (AUTO) ⇄ Manual (MAN)
[Factory shipment: AUTO mode]
Refer to **4. SETTING EXAMPLE**.

Set data unlock/lock transfer
Unlock ⇄ Lock
[Factory shipment: Data lock function OFF (All parameters can be changed)]*
Refer to **6.6 Data Lock Function**.

Interlock release
Interlock state → Interlock release
[Factory shipment: Interlock function OFF]*
Refer to **6.5 Interlock Release**.

* The setting to enable the function is configured in Engineering mode.
Refer to **Parameter List.**

Press the R/S while pressing the SET for 4 seconds
Press the R/S while pressing the SET

SET (2 seconds or more)

### Engineering Mode

In this mode, it is possible to set operating conditions such as the Set lock level, Mode switching, the non-display selection of Parameter setting mode (F01 to F10), etc. according to specific requirements.

For parameters in the Engineering mode, refer to **5. ENGINEERING MODE** in **Parameter list**.

### Parameter Setting Mode

Change parameters related to control such as PID values.

F04 to F09 indicate group numbers used in Non-display of block and Set lock level in Engineering mode.
Parameters in F01 to F03 as well as F10 are not displayed with the factory default setting.

Some parameters are not displayed depending on the model and the specifications.

[Figures on the SV display shows a "factory set value."]

(F04) EV 1 → (F04) EV 1' → (F04) EV2 → (F04) EV2' → (F04) EV3 → (F04) EV3' → (F04) EV4 → (F04) EV4'
(F05) ARU → (F05) SRU → (F06) Pc → (F06) I → (F06) d → (F06) ARW → (F06) Pc → (F06) dbc
(F06) PRU → (F07) HbA1 → (F07) HbA2 → (F07) LbA → (F07) Lbdc → (F08) r → (F08) MR → (F08) oLH
(F08) oLL → (F08) t → (F08) ML → (F09) Pbc → (F09) dF → Return to F04 parameter

For parameters in the Parameter setting mode, refer to **4. PARAMETER SETTING MODE** in **Parameter list**.

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# 5. OPERATING PRECAUTIONS

Read and understand the following precautions before starting operation.

**CAUTIONS**

- There is no power switch on this instrument, so the instrument starts operation immediately following initial power ON (Factory set value: RUN).
- If the input signal wiring is disconnected or short-circuited (RTD input only), the instrument determines that input error (burnout, etc.) has occurred.
  <Burnout direction>
  Thermocouple input*: Upscale or Downscale
  RTD input: Upscale (when input break), Downscale (when short-circuited)
  Voltage input, current input: Downscale or Indicate the value near 0
  * Burnout direction can be selected by Engineering mode. (Factory set value: Upscale)
  <Output at burnout>
  Control output: According to the contents set by Control output at burnout (Factory set value: 0 [Result of control computation])
  Event output: According to the contents set by Event output action at input burnout (Factory set value: 0 [The Event output is not forcibly turned ON when the Burnout function is activated.])
- A power failure of 20 ms[*1] or less will not affect the control action. When a power failure of more than 20 ms[*1] occurs the instrument assumes that the power has been turned off. When power returns the controller will retain the conditions that existed prior to shut down[*2].
  [*1] 10 ms in case of 24 V AC/DC power supply.
  [*2] In case of AUTO mode:
  Output changes from the Output limiter low with control calculation results.
  In case of a Manual (MAN) mode:
  Output status is defined as follows by the Bumpless mode setting in the Engineering mode.

| In case of "0: without bumpless" | In case of "1: with bumpless" |
|---|---|
| Preset manual value is output. | PID control: Output limiter low is output.<br>Heat/Cool PID control: Output is 0 % |

- The Event hold action is activated when the power is turned on or when transferred from STOP mode to RUN mode. (Event type with hold action)
- The Event re-hold action is activated when not only the SV is changed, but also when power is turned on or when transferred from STOP mode to RUN mode. (Event type with re-hold action)

# 6. FUNCTIONS RELATED TO OPERATION

Refer to ● **Set value change and registration** for basic data setting in this manual.
Functions related to operation are explained below.

## 6.1 RUN/STOP Transfer

It is possible to transfer between control start (RUN) and control stop (STOP). RUN/STOP transfer can be performed by key operation, or by using the "RUN/STOP setting" in Engineering mode. These two methods are linked together. For example, if the keys are used to transfer from RUN to STOP, the setting of "RUN/STOP setting" in Engineering mode will also change to "STOP."

**● State of this instrument when set to STOP mode**

| | |
|---|---|
| STOP display | STOP lamp lights (Green). Displays the STOP symbol "STOP" on the SV or PV displays. [Factory shipment: SV display + STOP lamp] |
| Control output | When the time-proportional control output: Output OFF<br>When the continuous control output: Output of -5 % |
| Event output | Output depending on the "Output action at STOP mode" [Factory shipment: Output OFF (Contact open)] |
| Autotuning (AT) | AT canceled (The PID constants are not updated) |
| Parameters | The Set value (SV) and Parameter setting mode can be set, and mode switching can be operated. |

**● State of this instrument when set to RUN mode**

If the instrument is transferred to RUN mode from STOP mode, it performs the same operation (control RUN, event determination start-up) as the power-on.

### ■ RUN/STOP transfer by front key operation

<RUN mode (factory shipment)>

R/S (2 seconds or more)

<STOP mode>

STOP lamp lights

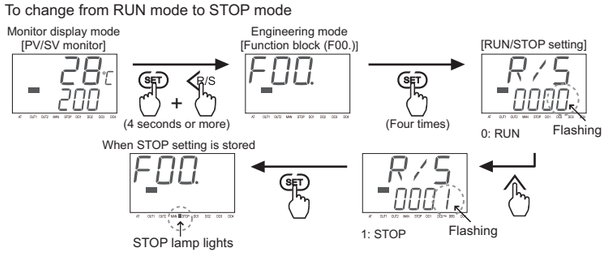
"STOP" character in the STOP mode:

| Character | STOP lamp | Key operation or communication [1] | Digital input (DI) [1,3] | Timer function [2] |
|---|---|---|---|---|
| LSTP | Lighting | STOP | RUN | |
| dSTP | Lighting | RUN | STOP | |
| STOP | Lighting | STOP | STOP | |
| rSTP | Flashing | RUN | RUN | STOP |

[1] Communication, Digital input (DI): Optional function
[2] Factory shipment: Timer function is unused
[3] When no Digital input (DI) is supplied: Only STOP or rSTP is displayed.

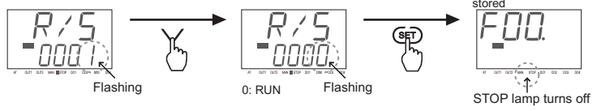
### ■ Performing RUN/STOP transfer in the "RUN/STOP setting"

● To change from RUN mode to STOP mode




● **To change from STOP mode to RUN mode**

***1.*** Follow the steps above to display the RUN/STOP setting screen.
***2.*** Changed to STOP from RUN.




## 6.2 Autotuning (AT) Start/Stop

The AT function automatically measures, computes and sets the optimum PID values.

### ■ Caution for using the Autotuning (AT)

- When a temperature change (UP and/or Down) is 1 ºC or less per minute during AT, AT may not be finished normally. In that case, adjust the PID values manually. Manual setting of PID values may also be necessary if the set value is around the ambient temperature or is close to the maximum temperature achieved by the load.
- If the manipulated output value may be limited by the output limiter setting, the optimum PID values may not be calculated by AT.

### ■ Requirements for Autotuning (AT) start

Start the AT when all following conditions are satisfied:

| | |
|---|---|
| Operation state | PID control |
| | RUN |
| Parameter setting | Output limiter high ≧ 0.1 %, Output limiter low ≦ 99.9 %<br>[Heat/Cool control type: Output limiter high (heat-side) ≧ 0.1 %, Output limiter high ccool-side) ≧ 0.1 %] |
| Input value state | The Measured value (PV) is not underscale or overscale. |

### ■ Requirements for Autotuning (AT) cancellation

If the AT is canceled according to any of the following conditions, the controller immediately changes to PID control. The PID values will be the same as before AT was activated.

| | |
|---|---|
| Operation state | When the PID/AT transfer is changed to the PID control. |
| | When the RUN/STOP mode is changed to the STOP mode. |
| | When the Auto/Manual mode is changed to the Manual mode. |
| Parameter changing | When the Set value (SV) is changed. |
| | When the PV bias or the PV digital filter is changed. |
| | When the Output limiter value is changed. |
| Input value state | When the Measured value (PV) goes to underscale or overscale. |
| AT execution time | When the AT does not end in 9 hours after AT started. |
| Power failure | When the power failure of more than 20 ms occurs.<br>(10 ms or more with 24V AC/DC power supply.) |
| Instrument error | When the instrument is in the FAIL state. |

### ■ Autotuning (AT) Start/Stop operation

The Autotuning function can start from any state after power on, during a rise in temperature or in stable control.

If AT ends normally, the LBA time is automatically set twice as large as the Integral time.

## 6.3 Startup Tuning (ST)

Startup tuning (ST) is a function which automatically computes and sets the PID values (Proportional band: heat-side only) from the response characteristics of the controlled system at power ON, transfer from STOP to RUN, and Set value (SV) change.
As simple autotuning, the PID values can be found in a short time without disturbing controllability for controlled systems with slow response at power ON.

### ■ Caution for using the Startup tuning (ST)

- For ST at power ON or transfer from STOP to RUN, always set the heater power to ON simultaneously with the start of tuning or before the start of tuning.
- Start ST in the state in which the temperature differential of the Measured value (PV) and Set value (SV) at the start of ST is twice the proportional band, or greater.
- When the manipulated output value may be limited by the output limiter setting, the optimum PID values may not be calculated by ST.

### ■ Requirements for Startup tuning (ST) start

Start the ST when all following conditions are satisfied:

| | |
|---|---|
| Operation state | PID control |
| | RUN |
| Parameter setting | ST is set to ON. (Execute once, Execute always) |
| | Output limiter high ≧ 0.1 %, Output limiter low ≦ 99.9 %<br>[Heat/Cool control type: Output limiter high (heat-side) ≧ 0.1 %] |
| Input value state | The Measured value (PV) is not underscale or overscale. |
| | At ST at setting change, the Measured value (PV) shall be stabilized. |
| | Set value (SV) > Measured value (PV) [Heat/Cool PID control] |
| Output value state | At startup, output is changed and saturated at the Output limiter high or the Output limiter low [Heat/Cool control type: Output limiter high (heat-side)]. |

### ■ Requirements for Startup tuning (ST) cancellation

If the ST is canceled according to any of the following conditions, the controller immediately changes to PID control. The PID values will be the same as before ST was activated.

| | |
|---|---|
| Operation state | When the AT is activated. |
| | When the RUN/STOP mode is changed to the STOP mode. |
| | When the Auto/Manual mode is changed to the Manual mode. |
| Parameter changing | When ST is set to "0 (ST unused)." |
| | When the PV bias or the PV digital filter is changed. |
| | When the Output limiter value is changed. |
| Input value state | When the Measured value (PV) goes to underscale or overscale. |
| ST execution time | When the ST does not end in hundred minutes after ST started |
| Power failure | When the power failure of more than 20 ms occurs.<br>(10 ms or more with 24V AC/DC power supply.) |
| Instrument error | When the instrument is in the FAIL state. |

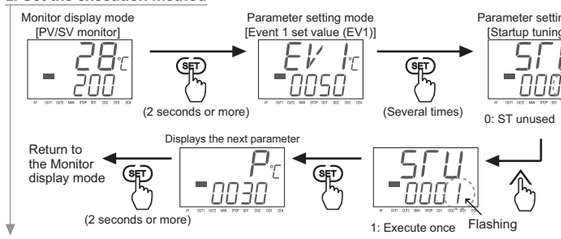
### ■ Startup tuning (ST) setting

Setting example: When executing ST only 1 time at power ON

***1.*** **Check the start condition**

First, make sure that "when the power is turned on" is selected in the ST start condition in Function block F52 of Engineering mode.
Factory set value: 0 (Activate the ST function when the power is turned on; when transferred from STOP to RUN; or when the Set value (SV) is changed.)

***2.*** **Set the execution method**




***3.*** **Start the ST**

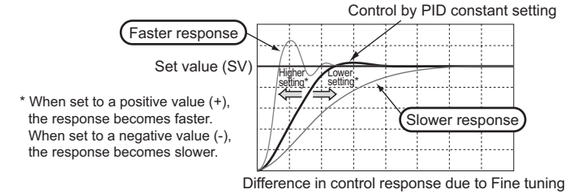
Turn off the power once and turn it on again. The ST will automatically start (During ST execution: AT lamp lights). When the calculation and setting of PID values is completed, setting of the ST screen will automatically change to "0." (ST is completed: AT lamp turns off)

When ST was interrupted, the setting does not change to "0: ST unused." ST starts when the restart conditions are satisfied.

If ST ends normally, the LBA time is automatically set twice as large as the Integral time.

## 6.4 Fine Tuning

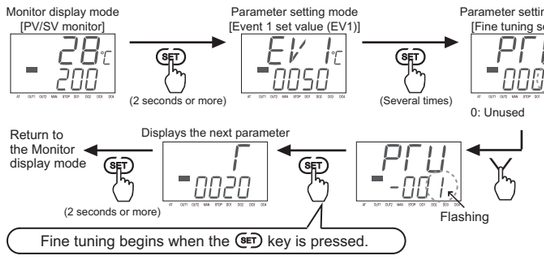
The Fine tuning function allows you to change the response of the set PID constant control. The control response can be made "faster" or "slower" by simply changing the Fine tuning setting (6 levels: -3 to +3) in Parameter setting mode; the PID constant can be kept unchanged.




* When set to a positive value (+), the response becomes faster. When set to a negative value (-), the response becomes slower.

### ■ Fine tuning setting

Setting example: To slow the response (when "-1" is set)




If the set value of Fine tuning is returned to "0: Unused," Fine tuning correction will no longer be applied to control.

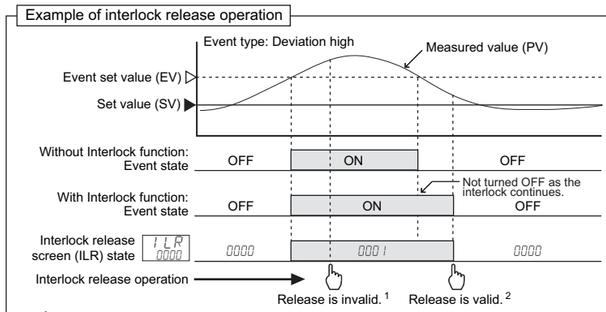
## 6.5 Interlock Release

The Event interlock action holds the event state even if the Measured value (PV) is out of the event zone after it enters the event zone once. The Interlock release can be made by the key operation.

**To validate the Interlock function, it is necessary to set Event interlock (EIL) to "1: Used" in Engineering mode. (Factory shipment: Interlock function OFF)**

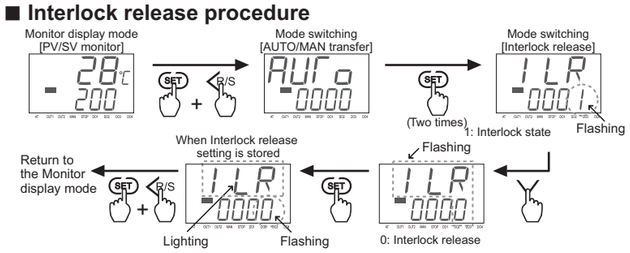
Refer to **Parameter List.**

Example of interlock release operation




[1] Invalid when PV is in the event ON region.
[2] Since the PV is in the event OFF region, Interlock is released and becomes 0000.

### ■ Interlock release procedure




## 6.6 Data Lock Function

The Data lock function limits access of unauthorized personnel to the parameters and prevents parameter change by mistake. The setting of data lock is enabled in Set data unlock/lock of Mode switching. Set the parameters* that you wish to lock in the Set lock level of Engineering mode.

*Only parameter of Parameter setting mode

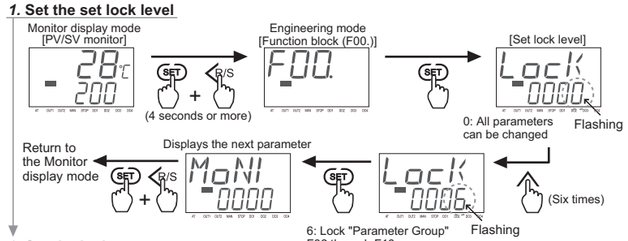
**To validate the Data lock function, settings are required in Set lock level (Lock) of Engineering mode.**
**(Factory shipment: Data lock function OFF [All parameters can be changed])**

Refer to **Parameter List.**

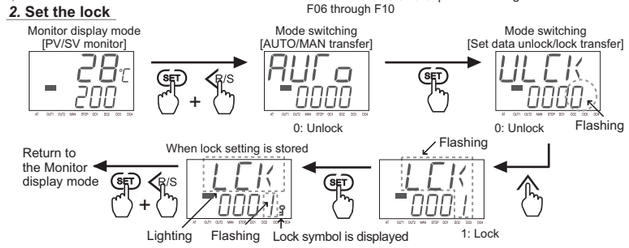
### ■ Data lock setting

Setting example:
Locking parameters from "Parameter Group" F06 through F10 in Parameter setting mode

***1.*** **Set the set lock level**




***2.*** **Set the lock**




The Set lock level (Lock) settings can be changed after lock is executed.

# 7. ERROR DISPLAY

### ■ Display when input error occurs

| Display | Description | Solution |
|---|---|---|
| Measured value (PV) [Flashing] | PV is outside of input range. | **Prior to replacing the sensor, always turn the power OFF or change to STOP with RUN/STOP transfer.**<br>Check input range, sensor and sensor connection. |
| 0000 [Flashing] | Over-scale:<br>PV is above the display range limit high | |
| UUUU [Flashing] | Underscale:<br>PV is below the display range limit low | |

### ■ Self-diagnostic error

If two or more errors occur simultaneously, the total summation of these error codes is displayed.

| Description | Action | Operation at error | Solution |
|---|---|---|---|
| Err 1 Flashing<br>Adjustment data error | Indication lamp: All lamp turns off | Control output:<br>Time-proportional control output: OFF<br>Continuous control output: Output of -5 %<br>Transmission output: Output of -5 %<br>FAIL output: Contact open [When FAIL is selected for the event (EV)] | Turn off the power at once.<br>If an error occurs after the power is turned on again, please contact RKC sales office or the agent. |
| Err 2 Flashing<br>Data back-up error | | | |
| Err 4 Flashing<br>A/D conversion error * | | | |
| Power supply voltage is abnormal | All display is OFF | | |
| Watchdog timer | | | |

* Including temperature compensation error

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