

# Chapter 6 TUNING

## 6-1 Selecting the Control Method

The UDC900 is provided with three types of tuning. Select the desired tuning method according to the  $\zeta \tau \zeta$  (control method) setup in parameter items.

0. ON/OFF control

1. Self-tuning : This control method automatically changes control constants when SP is changed, or disturbance load changes occur.

2. Control by PID fixed values : Control follows fixed PID values set by auto-tuning or manual operation.

## 6-2 Self-tuning

The controller can be self-tuned by setting the control method to self-tuning ( $\zeta \tau \zeta = 1$ ).

Tuning is automatically started and control constants are changed by the following operation or when a change in state occurs in this state.

### ① Start by SP change

Start conditions

- Initial start (\*1) SP change of  $\pm 10\%$ FS (\*2) or more
- 2nd start onwards SP change of  $\pm 5\%$ FS or more

\*1 "Initial start" refers to initial tuning after the  $\zeta \tau \zeta$  setting is set to 1.

\*2 "FS (full-scale)" refers to the width between the upper and lower temperatures set by range code (setup item C04).

Example:  $\pm 10\%$ FS when the range is  $-200$  to  $400^\circ\text{C}$  becomes:  
 $600 (^\circ\text{C}) \times 10 (\%) = 60 (^\circ\text{C})$

### ② Start by disturbance

Start conditions

- When the difference between SP and PV is  $\pm 2^\circ\text{C}$  or more

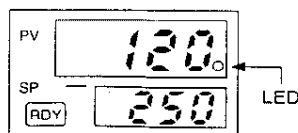
### ③ Start by power ON or mode change from READY to RUN

Start conditions

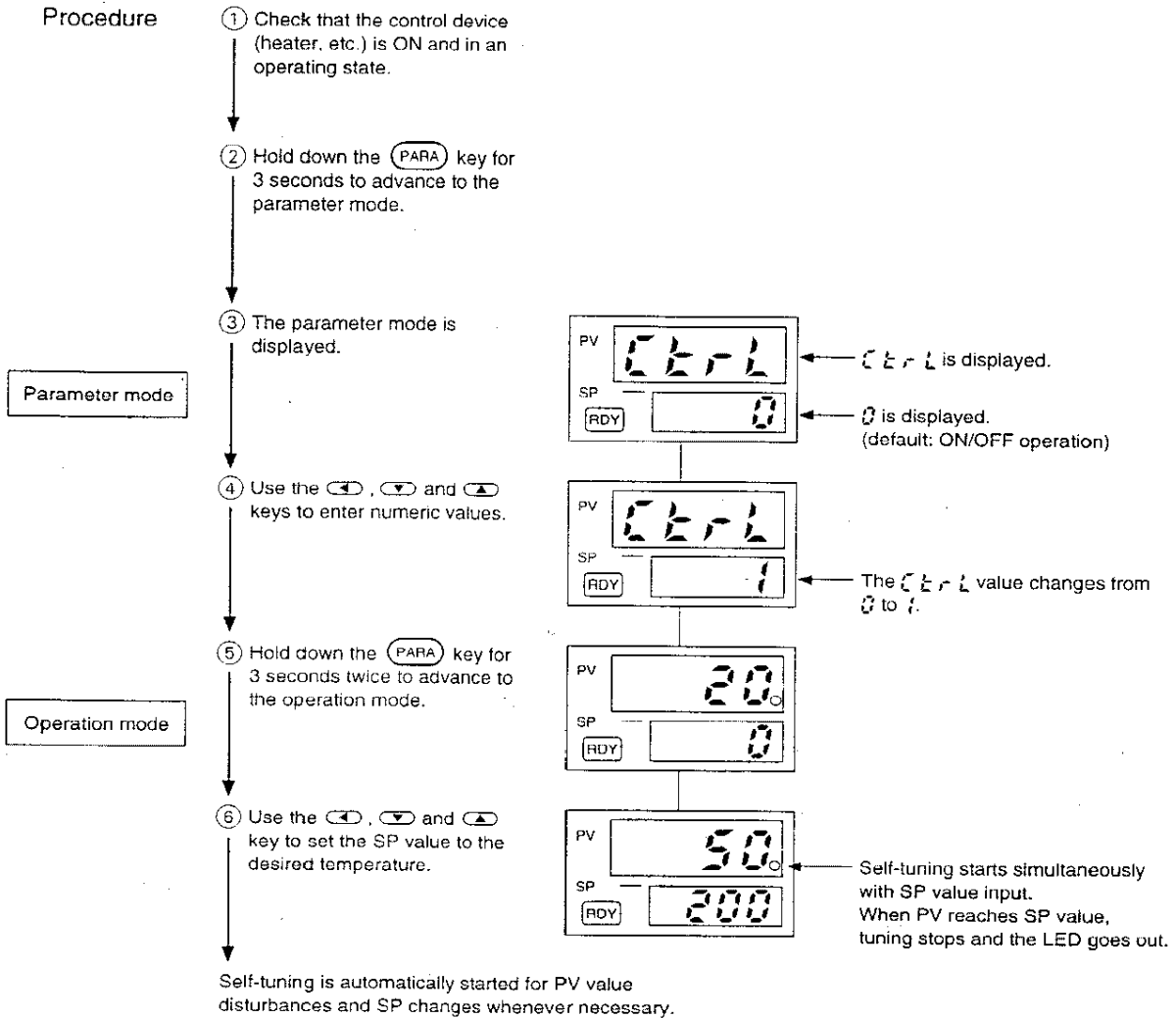
- When the power is turned ON with the difference between SP and PV at  $\pm 2^\circ\text{C}$  or more, or the mode is changed from READY to RUN

### Self-tuning display

The lower right LED after the 1st digit in the upper display blinks when the self-tuning function is ON. The LED goes out when the learning process ends and control constants are stored.



## ● Startup method



## ● Stop method

Changing **C E F L** from 1 to 2 (step 4) fixes the PID values. This fixes the PID values. PID values can also be changed by key entry.

## 6-3 Cautions During Self-tuning

- Turn heaters or other control devices ON before turning the controller ON.
- Set the controller to the ready mode before turning the heaters or other control device OFF. When turning a control device back ON again, set the controller to RUN mode simultaneously.
- If power is turned OFF during self-tuning while the LED is blinking, the control constants used during tuning will not be stored in controller memory.

If any of the above errors have been made, unsuitable control constants may be stored to memory, which may result in unexpected control action. If this happens, follow the procedure below to reset the controller.

- Use auto-tuning.  
For details on how to use auto-tuning, see 6-4 Auto-tuning.

- Reset the PID values, and resume self-tuning.
  - ① Set parameter item  $\zeta \xi r \xi$  (control method) to 2.
  - ② Reset the PID values to the factory settings ( $P = 5.0, I = 120, D = 30$ ).
  - ③ Set  $\zeta \xi r \xi$  to 1, and resume self-tuning.

### ! HANDLING PRECAUTIONS

#### In the Case of Control Interference

Interference may cause control targets to be less than optimum for the process order control resulting in slow response.

If this happens, use the fixed PID values by setting  $\zeta \xi r \xi$  to 2.

## 6-4 Auto-tuning

Use the auto-tuning function in the following instances.

- To automatically calculate PID constants and control with fixed PID values ( $\zeta \xi r \xi = 2$ )
- When startup is slow in self-tuning control
- When response startup is slow in self-tuning control

The auto-tuning function can be used in either self-tuning control ( $\zeta \xi r \xi = 1$ ) or control by fixed PID values ( $\zeta \xi r \xi = 2$ ).

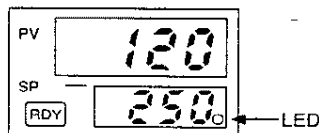
### ● Procedure

- ① Hold the **PARA** key down for at least 3 seconds in the RUN mode and with the SP value set.
- ② Press the **PARA** key with  $\zeta \xi r \xi$  set to 1 or 2.
- ③  $\overline{A} \xi$  (auto-tuning) is displayed. Set 1.  
If 1 is already set, set to 0 then back to 1.

Auto-tuning can also be stopped by using the external contact input function. To forcibly cancel auto-tuning midway, either set  $\overline{A} \xi$  to 0, or set the controller to the READY mode.

#### Auto-tuning indication

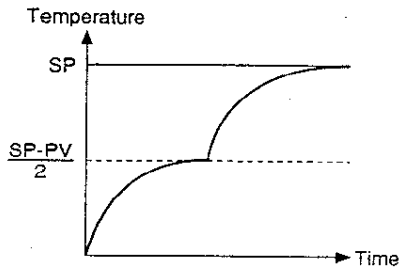
The lower right LED after the 1st digit in the lower display blinks when the auto-tuning function is ON. The LED goes out when tuning ends.



### ! HANDLING PRECAUTIONS

- Auto-tuning does not function normally unless the control target is connected.
- The auto-tuning time from start to finish varies according to the control target.
- When auto-tuning is executed, control is suspended, and 0 to 100% output is repeated several times. If this hinders operation, manually set the PID values.
- Sometimes suitable PID values cannot be obtained according to the control target. If this happens, manually set the PID values.

The following describes auto-tuning operation.

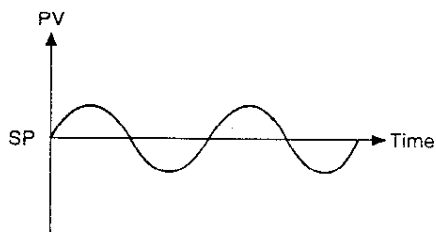


- ① Operation when the difference between SP and PV values is 10% FS or more and  $SP > PV$

At startup, operation stabilizes at a temperature of approximately  $(SP - PV)/2$

↓  
The temperature rises again and reaches SP.

↓  
Auto-tuning ends when stability is achieved.



- ② Operation when the difference between SP and PV values is 10% FS or less and  $SP < PV$

Cycling is repeated around the SP value.

↓  
Auto-tuning ends when stability is achieved.

## 6-5 Control Troubleshooting

Refer to the following table when the control result is not as expected, and remedy according to the phenomenon.

| Phenomenon   |      | Remedy  |
|--|------|---|
| Slow startup time  | ①②   | ① Execute auto-tuning.  |
| Slow response  | ①②   | ② Set $\zeta \tau L$ to 2, reset PID values to factory settings, and set $\zeta \tau L$ to 1 to execute self-tuning.  |
| PV value fluctuates  | ①②③④ | ③ Reduce the value of time-proportional cycle ( $\zeta \tau L$ ).   |
| Tuning does not end. PV value fluctuates with a 2°C or more error between SP and PV value. | ①②③④ | ④ Set the value of PV filter (parameter item) to 1.0 to 2.0.  |
| Tuning does not end. PV value is stable but PV does not end.                               | ⑤    | ⑤ Operation ends though it takes a long time. The slower the response of the control target, the longer tuning takes. |
| Large overshoot  | ①②   |   |
| Control signals repeatedly turn ON and OFF more than necessary.                            | ④    |   |