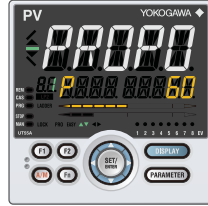


6.4 Adjusting PID Manually

Setting Display

Parameter Setting Display Operation Display > **PARAMETER** or **PARA** key for **3 seconds** (to [MODE] Menu Display) > **Right arrow** key (to [PID] Menu Display) > **SET/ENTER** key (The setting parameter is displayed.) > **Down arrow** key (The setting parameter is displayed.)



In the Setting Display for the PID parameters, Displays can be arbitrarily switched using the Up, Down, Left or Right arrow key. Pressing the Left or Right arrow key changes the group. (The group number is displayed on Group display.)

Setting Details

Parameter symbol	Name	Display level	Setting range	Menu symbol
P	Proportional band Heating-side proportional band (in Heating/cooling control)	EASY	0.0 to 999.9% When 0.0% is set, it operates as 0.1%. Heating-side ON/OFF control applies when 0.0% in Heating/ cooling control	PID Ope
I	Integral time Heating-side integral time (in Heating/cooling control)	EASY	OFF: Disable 1 to 6000 s	
D	Derivative time Heating-side derivative time (in Heating/cooling control)	EASY	OFF: Disable 1 to 6000 s	
Pc	Cooling-side proportional band	EASY	0.0 to 999.9% Cooling-side ON/OFF control applies when 0.0% in Heating/ cooling control	
Ic	Cooling-side integral time	EASY	OFF: Disable 1 to 6000 s	
Dc	Cooling-side derivative time	EASY	OFF: Disable 1 to 6000 s	
PIDN	PID number selection	EASY	1 to 8	SP Ope
PIDG.	Number of PID groups	STD	1 to 8	CTL Set

Note1: In Cascade control, the LP2 lamp is lit while the Loop-2 parameter is displayed.

Note

When changing the setpoint of the parameter PIDG., if the setpoint of the parameter PIDN which belongs to the SP menu is larger than that of the parameter PIDG., the PIDN setpoint is changed to the PIDG. setpoint.

There are eight groups of PID parameters.
In Cascade control, both Loop 1 and Loop 2 have eight groups.

The PID parameters can be selected by using the following two methods:

(1) SP group number selection

The PID group which is set in the PID number selection (PIDN) of each SP group is used.

SP number (SPNO)	Target setpoint (SP)	Setting range of PID number selection (PIDN)
1	SP	1 to 8
2	SP	1 to 8
3	SP	1 to 8
4	SP	1 to 8
5	SP	1 to 8
6	SP	1 to 8
7	SP	1 to 8
8	SP	1 to 8

When the SP parameter is displayed, the SP number is shown on Group display.

When the PID parameters are displayed, the PID number is shown on Group display.

- ▶ Selection by keystroke: [6.6 Selecting Target Setpoint Number \(SPNO\)](#)
- ▶ Selection by contact input: [12.1 Setting Contact Input Function](#)

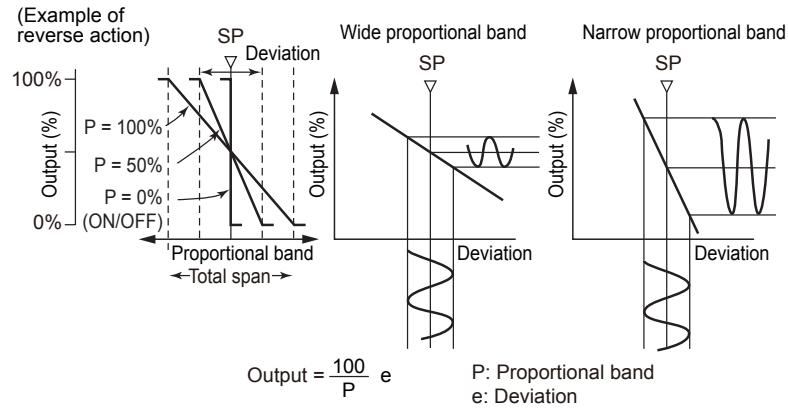
(2) Zone PID selection

- ▶ Selection by each Zone: [8.4 Switching PID](#)

Description

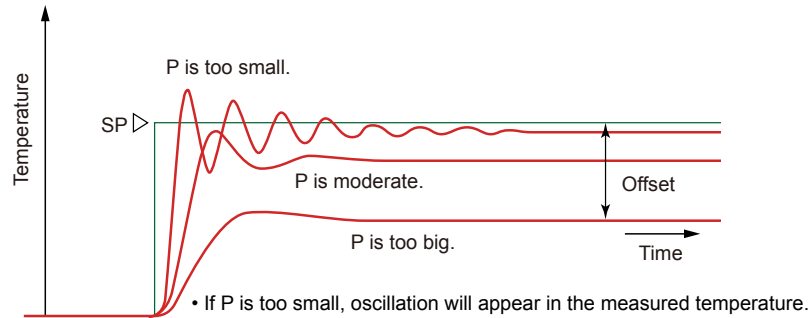
Description and Tuning of Proportional Band

The proportional band is defined as the amount of change in input (or deviation), as a percent of span, required to cause the control output to change from 0% to 100%. Because a narrower proportional band gives greater output change for any given deviation, it therefore also makes the control performance more susceptible to oscillation. At the same time, a narrower proportional band reduces the offset. Reducing the proportional band to its smallest limit (proportional band = 0%) results in ON/OFF control.



To fine-tune a proportional band obtained using auto-tuning, or to manually tune the proportional band:

- Work from larger to smaller numbers (wider to narrower).
- If cycling appears, that means that the proportional band is too narrow.
- Proportional band tuning cannot cancel an offset.



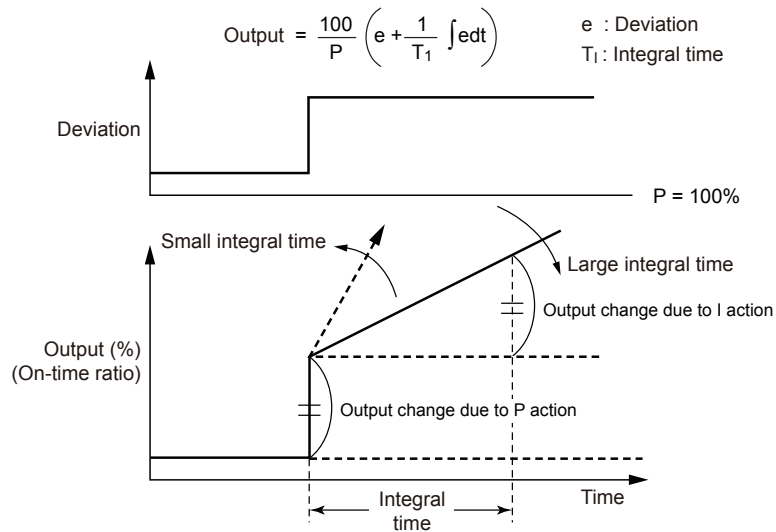
► Offset: 10.8 Canceling Offset of PV and SP (Manual Reset)

Description and Tuning of Integral Time

The integral action (I action) is a function that will automatically diminish the offset (steady-state deviation) that is inherently unavoidable with proportional action alone. The integral action continuously increases or decreases the output in proportion to the time integral of the deviation (the product of the deviation and the time that the deviation continues.)

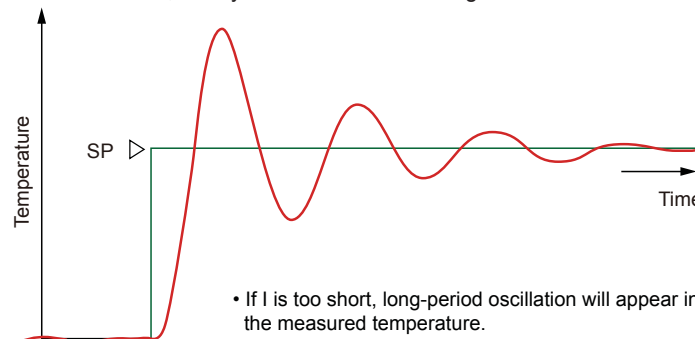
The integral action is normally used together with proportional action as proportional-plus-integral action (PI action).

The integral time (I) is defined as the time required to develop, when a stepwise change in deviation is imposed, an output change due to integral action that is exactly equal to the change due to proportional action. The longer the integral time set, the slower the change in output; the smaller the time, the faster the output changes.



To manually tune the integral time

- The main goal is to reduce the offset.
- Adjust from longer time to shorter time.
- If you see an oscillation at a longer period than that seen when the proportional band is too narrow, then you have made the integral time too short.



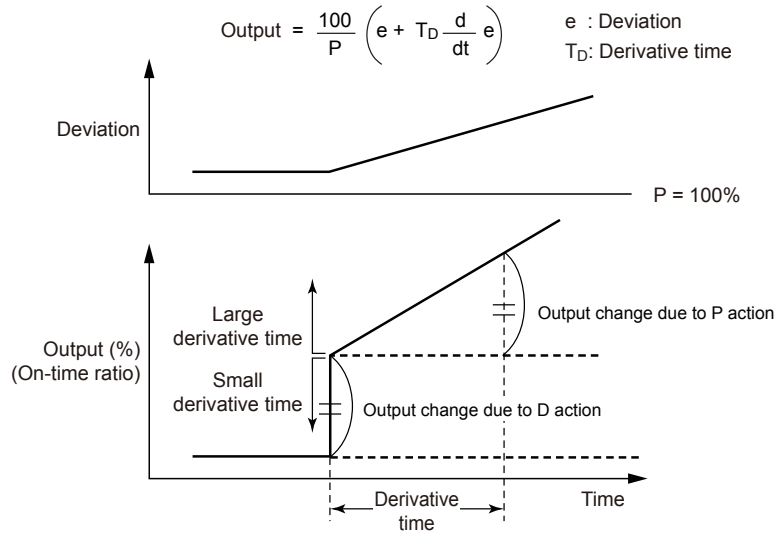
Use the manual reset (MR) to cancel an offset when the integral action is disabled.

- ▶ [Manual reset: 10.8 Canceling Offset of PV and SP \(Manual Reset\)](#)

Description and Tuning of Derivative Time

If the control object has a large time constant or dead time, the corrective action will be too slow with proportional action or proportional-plus-integral action alone, causing overshoot. However, even just sensing whether the deviation is on an increasing or a decreasing trend and adding some early corrective action can improve the controllability. Thus the derivative action (D action) is action that changes the output in proportion to the deviation derivative value (rate-of-change).

The derivative time is defined as the time required with PD action to develop, when a constant-slope change in deviation is imposed, an output change due to derivative action that is exactly equal to the change due to proportional action.

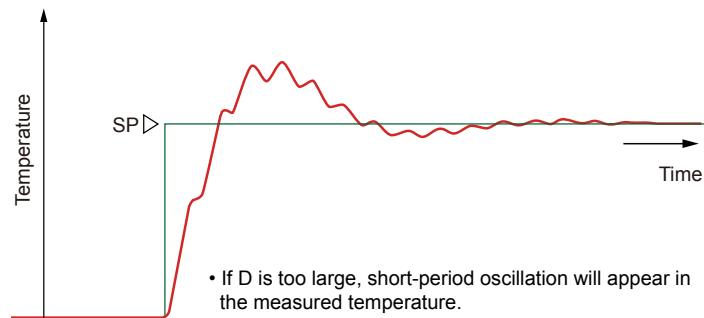


To manually tune the derivative time

- Adjust from shorter time to longer time.
- If you see a short-period oscillation, the time is too long.

The longer the derivative time set, the stronger the corrective action, and the more likely the output will become oscillatory. Oscillations due to derivative action are characterized by a short period.

D = OFF should always be used when controlling fast-responding inputs such as pressure and flow rate, or inputs characterized by rapid fluctuation, such as optical sensors.



Manual PID Tuning Procedure

- (1) In principle, auto-tuning must be used.
- (2) Tune PID parameters in the order of P, I, and D. Adjust a numeric slowly by observing the result, and keep notes of what the progress is.
- (3) Gradually reduce P from a larger value. When the PV value begins to oscillate, stop tuning and increase the value somewhat.
- (4) Also gradually reduce I from a larger value. When the PV value begins to oscillate (with long period), stop tuning and increase the value somewhat.
- (5) Gradually increase D from a smaller value. When the PV value begins to oscillate (with short period), stop tuning and lower the value slightly.

Reference Values for Manual Tuning of Temperature, Pressure, and Flow Rate

		Setting range (reference)	Initial value for tuning (reference)
Pressure	P	100 to 300%	200%
	I	5 to 30 s	15 s
	D	OFF	OFF
Flow rate	P	100 to 240%	150%
	I	8 to 30 s	20 s
	D	OFF	OFF
Temperature (electric furnace)	P	1 to 20%	5%
	I	180 to 600 s	240 s
	D	1/4 to 1/6 of I	60 s