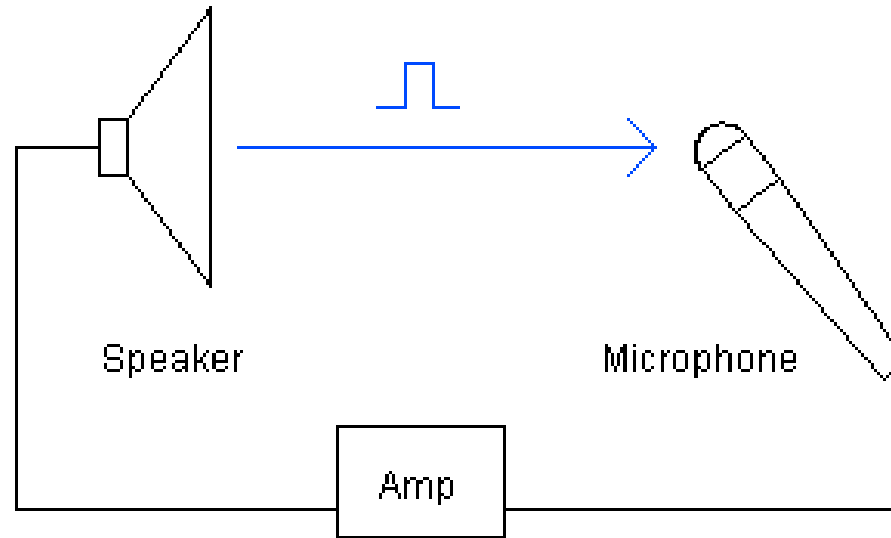




PID Controllers

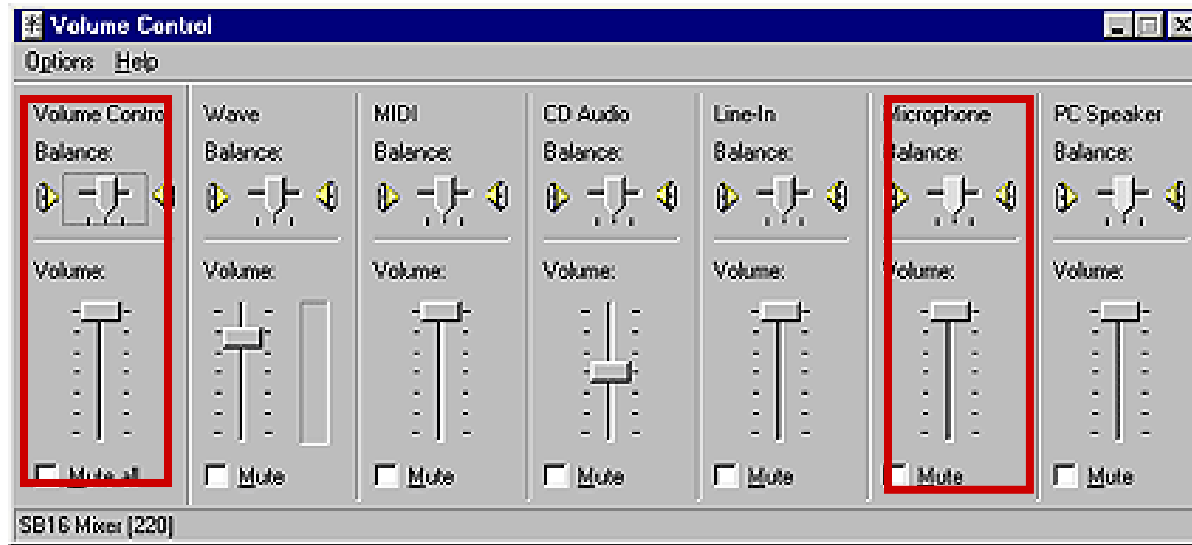
Dedicated Control System

Feedback Control – Why Should You Care?



- Microphone $\Rightarrow$ Amplifier $\Rightarrow$ Speaker $\Rightarrow$ Microphone
- This loop happens so fast that it generates its own frequency
- Microphone-to-speaker distance dictates the frequency
 - Decides how quickly sound “feedback” occurs through the system
- This feedback problem happens in public address systems

Feedback Control – Why Should You Care?



- Attach a set of speakers to your computer
- “Un-mute” and set microphone and speakers to maximum volume
- Tap microphone and hear it in the speakers
- Place speakers near microphone, turn up the volume and hear feedback
- Change distance between microphone and speakers to see the effect
- Caution: Not to be used as revenge on instructors, labmates, etc.

Specification of PID

- Relay Type Output –
DTC 1000R – [Contact]
- Current type Output –
DTC 1000C [4~20 mA]
- Voltage Type Output –
DTC 1000V [0 ~ 10 VDC]



■ Model Name Explanation

DTC 1 2 3 4 5

Series name		DTC: Delta C series temperature controller	
1 Controller position		1: First controller	2: Controller connected in parallel
2 Auxiliary output groups		0: standard, 2 outputs, no auxiliary output 1: 1 auxiliary output. Not available now.	2: 2 auxiliary outputs. Not available now
3 4 Optional		00: Standard 01: CT input	02: EVENT input. Not available now
5 Main output type		R: Relay output SPST, 250VAC, 3A V: Voltage pulse output 12V +10% ~ -20%	C: Current output 4 ~ 20mA L: Linear voltage output 0 ~ 10V

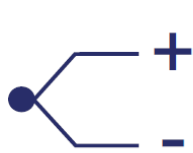
Specification of PID

Input sensors	Thermocouple: K, J, T, E, N, R, S, B, L, U, TXK
	Platinum RTD: Pt100, JPt100
	Linear DC input: 0 ~ 5V, 0 ~ 10V, 0 ~ 20mA, 4 ~ 20mA, 0 ~ 50mV
Sampling rate	Analog input: 0.15 sec. Thermocouple or platinum RTD: 0.4 sec.
Control method	PID , programmable PID, Manual, ON/OFF
Output types	Relay: SPST, Max. load 250VAC, 3A resistive load
	Voltage pulse: 12VDC, Max. output current: 40mA
	Current: DC 4 ~ 20mA (Load resistance: < 500Ω)
	Analog voltage: 0 ~ 10V (Load resistance: > 1,000Ω)



Supports Various Sensors:

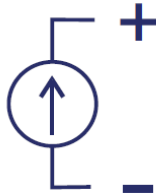
- Built-in various sensor input modes: Thermocouple, platinum RTD or linear voltage/current.



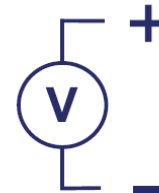
Thermocouple
(TC)



Platinum RTD
(RTD)

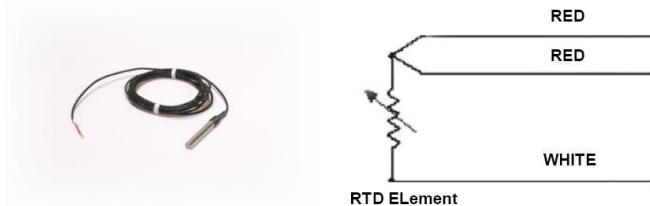


Linear current
(mA)



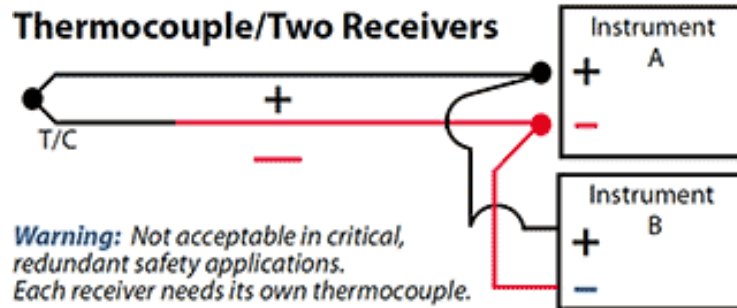
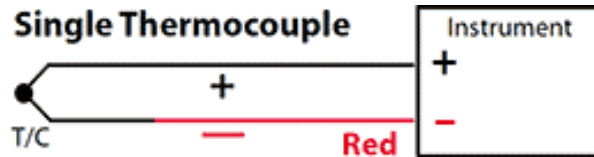
Linear voltage
(V)

Input Sensors

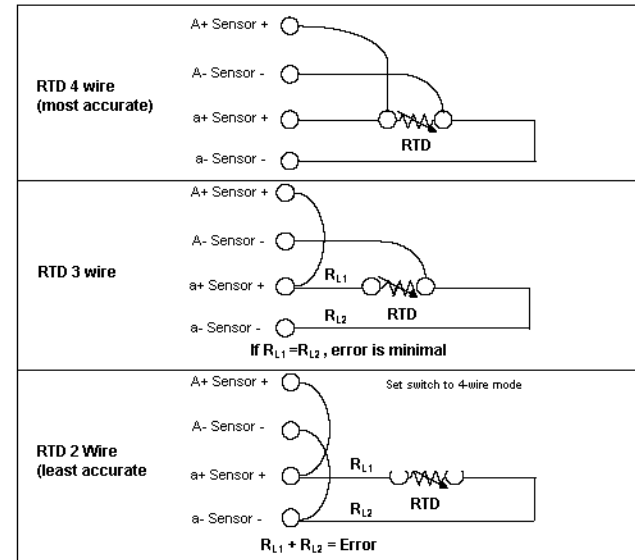
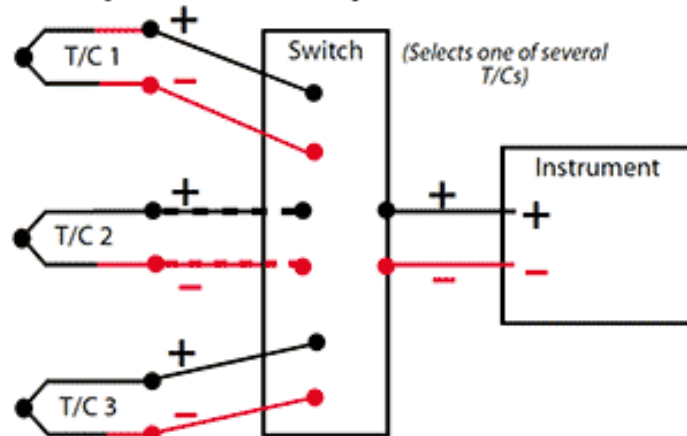


Input Sensor	Register Value	Available Range
0 ~ 50mV linear voltage input	17	0 ~ 50mV
4 ~ 20mA linear current input	16	4 ~ 20mA
0 ~ 20mA linear current input	15	0 ~ 20mA
0 ~ 10V linear voltage input	14	0 ~ 10V
0 ~ 5V linear voltage input	13	0 ~ 5V
Platinum RTD (Pt100)	12	-200 ~ 600°C (-328 ~ 1,112°F)
Platinum RTD (JPt100)	11	-20 ~ 400°C (-4 ~ 752°F)
Thermocouple TXK type	10	-200 ~ 800°C (-328 ~ 1,472°F)
Thermocouple U type	9	-200 ~ 500°C (-328 ~ 932°F)
Thermocouple L type	8	-200 ~ 850°C (-328 ~ 1562°F)
Thermocouple B type	7	100 ~ 1,800°C (212 ~ 3,272°F)
Thermocouple S type	6	0 ~ 1,700°C (32 ~ 3,092°F)
Thermocouple R type	5	0 ~ 1,700°C (32 ~ 3,092°F)
Thermocouple N type	4	-200 ~ 1,300°C (-328 ~ 2,372°F)
Thermocouple E type	3	0 ~ 600°C (32 ~ 1,112°F)
Thermocouple T type	2	-200 ~ 400°C (-328 ~ 752°F)
Thermocouple J type	1	-100 ~ 1,200°C (-148 ~ 2,192°F)
Thermocouple K type	0	-200 ~ 1,300°C (-328 ~ 2,372°F)

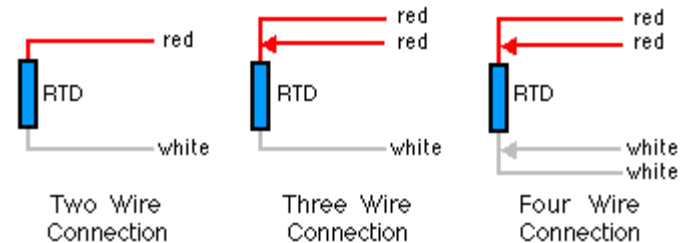
Input Sensors



Multiple Thermocouples/One Receiver

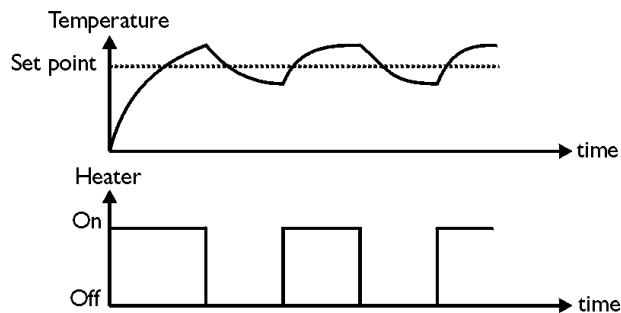


Notes: A refers to sensor, a refers to source

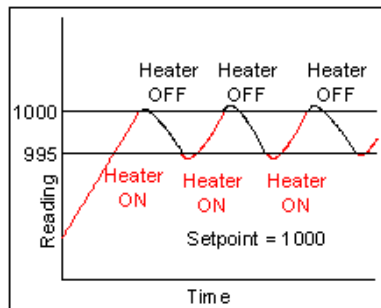


Relay Type Output

On- Off Control



On- Off Control with Hysteresis



Dual Output Control:

- Able to execute heating and cooling controls at the same time, allowing the system to reach the set temperature quickly.

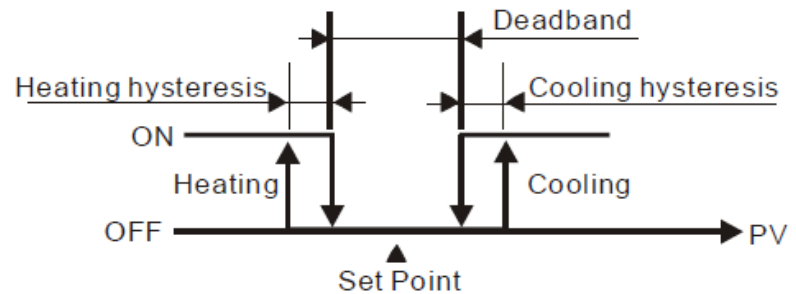
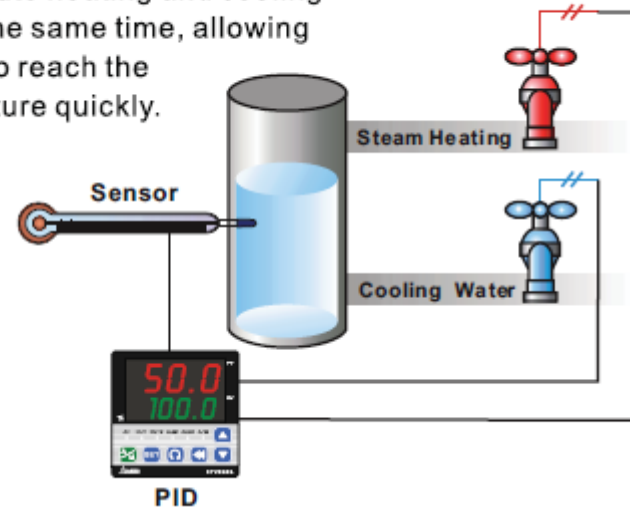


Figure 4: ON/OFF Control

Types of Output Controls

Various Output Modes:

- Relay, voltage pulse, linear voltage, and current



Relay



Voltage pulse
(For driving SSR)



Linear current
(mA)

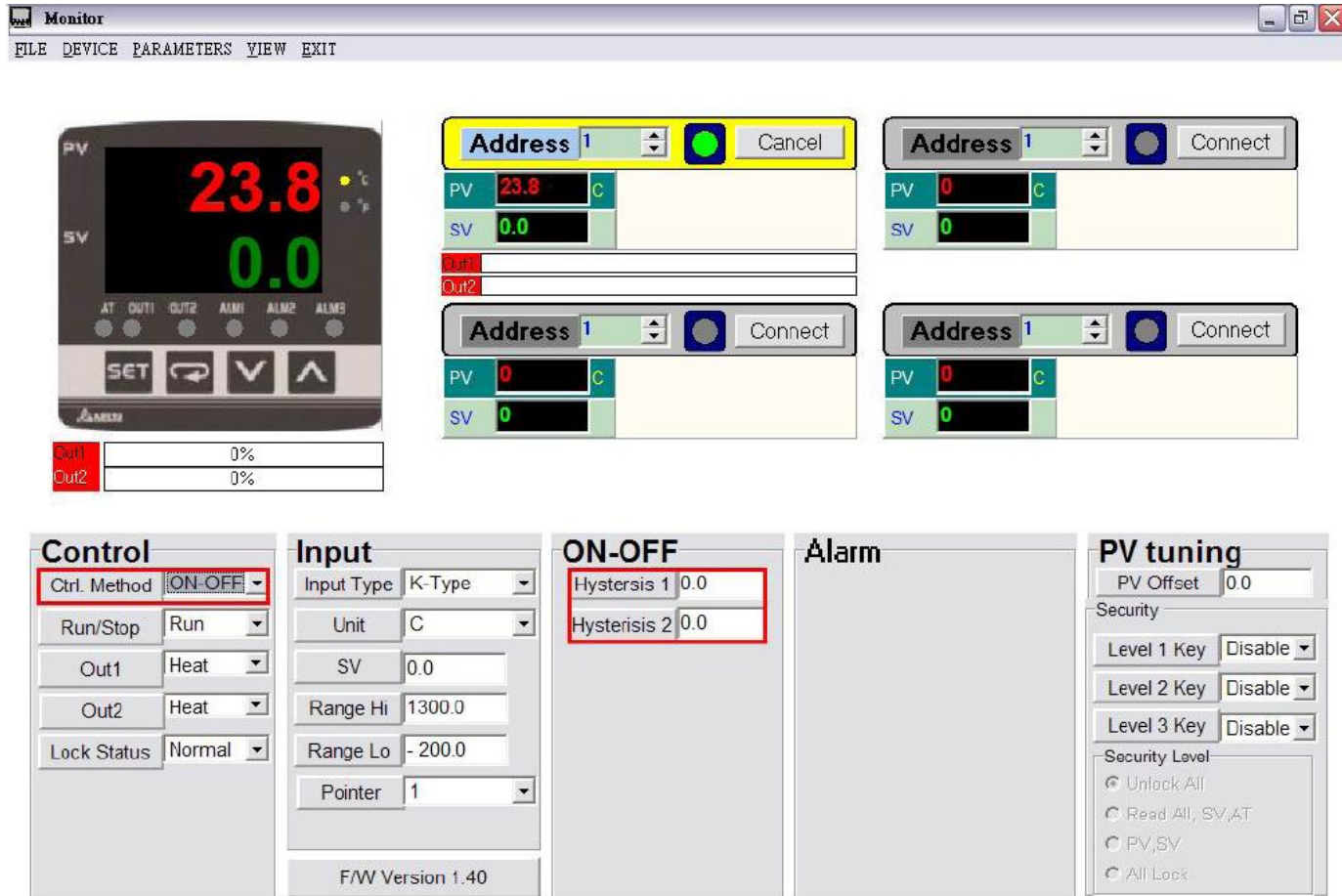


Linear voltage
(V)

Types of Output Controls

On- Off Control

Monitor
FILE DEVICE PARAMETERS VIEW EXIT



The interface displays the following components:

- Digital Display:** Shows PV (Process Variable) as 23.8 and SV (Setpoint) as 0.0. Below the display are buttons for AT, OUT1, OUT2, ALM1, ALM2, and ALM3, along with a SET button and navigation arrows.
- Output Status:** A table showing the status of Out1 and Out2.
- Control Panel:** Contains settings for Ctrl. Method (ON-OFF), Run/Stop (Run), Out1 (Heat), Out2 (Heat), and Lock Status (Normal).
- Input Panel:** Contains settings for Input Type (K-Type), Unit (C), SV (0.0), Range Hi (1300.0), Range Lo (-200.0), and Pointer (1).
- ON-OFF Panel:** Contains settings for Hysteresis 1 (0.0) and Hysteresis 2 (0.0).
- Alarm Panel:** Currently empty.
- PV tuning Panel:** Contains settings for PV Offset (0.0), Security (Level 1 Key, Level 2 Key, Level 3 Key), and Security Level (Unlock All, Read All, PV, SV, All Lock).

Out1	Out2
0%	0%

Ctrl. Method	Run/Stop	Out1	Out2	Lock Status
ON-OFF	Run	Heat	Heat	Normal

Input Type	Unit	SV	Range Hi	Range Lo	Pointer
K-Type	C	0.0	1300.0	-200.0	1

ON-OFF
Hysteresis 1 0.0
Hysteresis 2 0.0

PV tuning
PV Offset 0.0
Security
Level 1 Key Disable
Level 2 Key Disable
Level 3 Key Disable
Security Level
Unlock All
Read All, SV, AT
PV, SV
All Lock

F/W Version 1.40

Manual Control

Monitor FILE DEVICE PARAMETERS VIEW EXIT



Out1 0%
Out2 0%

Address 1 [Green Light] Cancel

PV 23.8 C
SV 0.0

Out1
Out2

Address 1 [Blue Light] Connect

PV 0 C
SV 0

Address 1 [Blue Light] Connect

PV 0 C
SV 0

Address 1 [Blue Light] Connect

PV 0 C
SV 0

Control
Ctrl. Method **ON-OFF**
Run/Stop Run
Out1 Heat
Out2 Heat
Lock Status Normal

Input
Input Type K-Type
Unit C
SV 0.0
Range Hi 1300.0
Range Lo -200.0
Pointer 1
F/W Version 1.40

ON-OFF
Hysteresis 1 0.0
Hysteresis 2 0.0

Alarm

PV tuning
PV Offset 0.0
Security
Level 1 Key Disable
Level 2 Key Disable
Level 3 Key Disable
Security Level
Unlock All
Read All, SV, AT
PV, SV
All Lock

PID Control

PID Control

Monitor FILE DEVICE PARAMETERS VIEW EXIT



Out1 0%
Out2 0%

Address 1

PV 25.1 C
SV 0.0

Out1
Out2

Address 1

PV 0 C
SV 0

Address 1

PV 0 C
SV 0

Address 1

PV 0 C
SV 0

Control

Ctrl. Method PID

Run/Stop Run

Out1 Heat

Out2 Heat

Lock Status Normal

Auto tuning Stop

Input

Input Type K-Type

Unit C

SV 0.0

Range Hi 1300.0

Range Lo -200.0

Pointer 1

F/W Version 1.40

PID Parameter

Pb 47.6

Ti 260

Td 41

Ctrl. Period1 4

I Offset 0.0

Ctrl. Period2 4

Alarm

PV tuning

PV Offset 0.0

Security

Level 1 Key Disable

Level 2 Key Disable

Level 3 Key Disable

Security Level

☒ Unlock All

☐ Read All, SV, AT

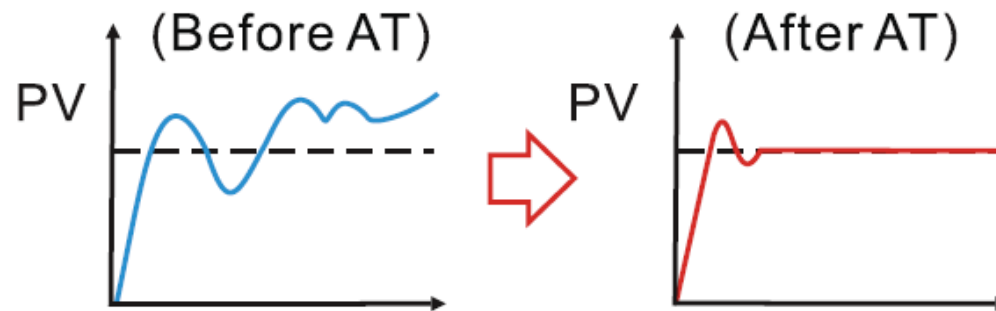
☐ PV, SV

☐ All Lock

PID Control

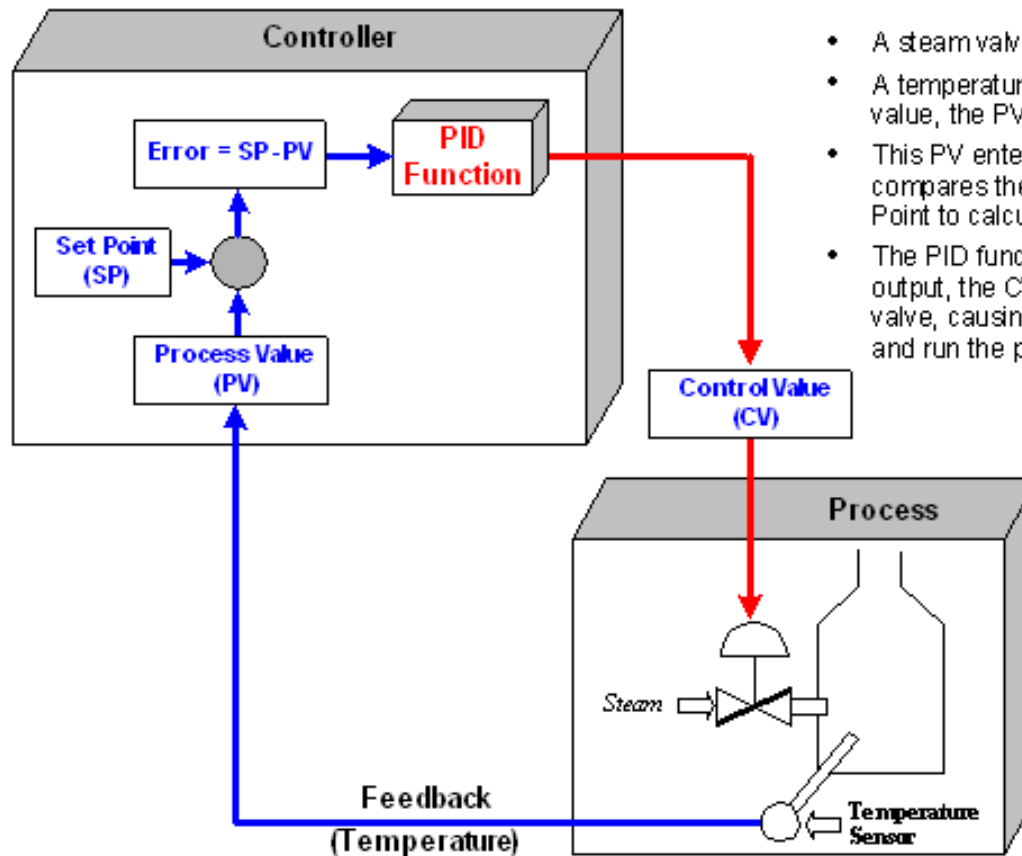
Stable Control:

- Built-in PID control function, with accurate auto-tuning (AT).
- PID parameters are automatically calculated, which enhances the stability of the system and accuracy of control.



Basic PID Control

- Proportional Current/ Voltage Output



- A steam valve releases heat into the system.
- A temperature sensor outputs a temperature value, the PV.
- This PV enters the controller. The PID function compares the temperature value with the Set Point to calculate the Error signal.
- The PID function regulates the controller output, the CV. This output controls the steam valve, causing it to vary the release of steam and run the process at the desired Set Point.

Basic PID Control

- Proportional Current/ Voltage Output

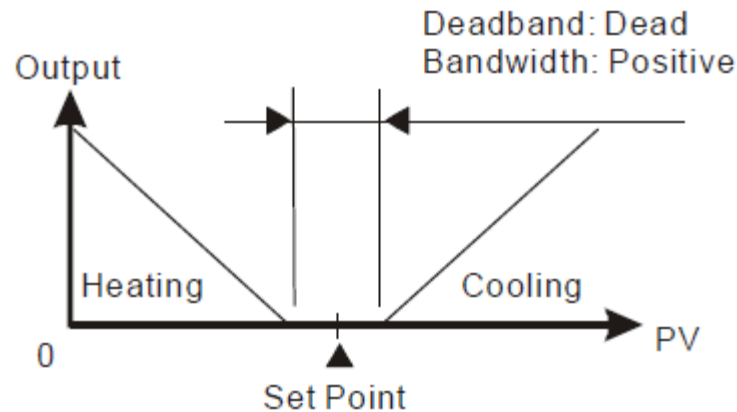


Figure 5: PID control

Automation Studio Example

Robot Simulator

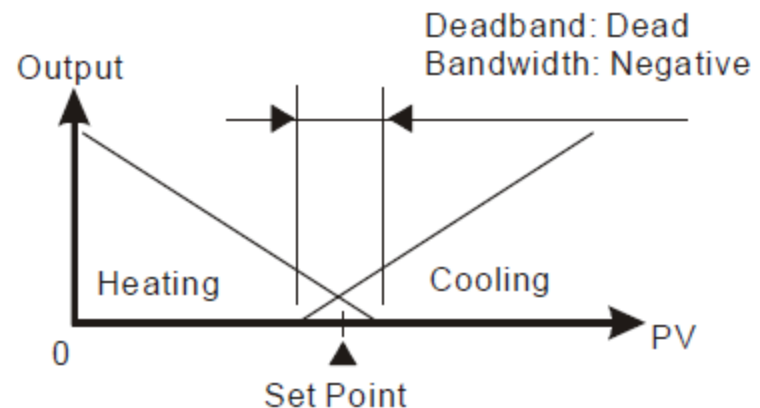


Figure 6: PID Control

Ramp/Soak Control

Monitor
FILE DEVICE PARAMETERS VIEW EXIT



Out1 0%
Out2 0%

Control
Ctrl. Method Ramp Soak
Run/Stop Run
Out1 Heat
Out2 Heat
Lock Status Normal
Auto tuning Stop

Input
Input Type K-Type
Unit C
SV Time Left
Range Hi 1300.0
Range Lo -200.0
Pointer 1
F/W Version 1.40

PID Parameter
Pb 47.6
Ti 260
Td 41
Ctrl. Period1 4
I Offset 0.0
Ctrl. Period2 4

Address 1 Cancel
PV 25.4 C
SV 00:00:00
Out1
Out2
Address 1 Connect
PV 0 C
SV 0

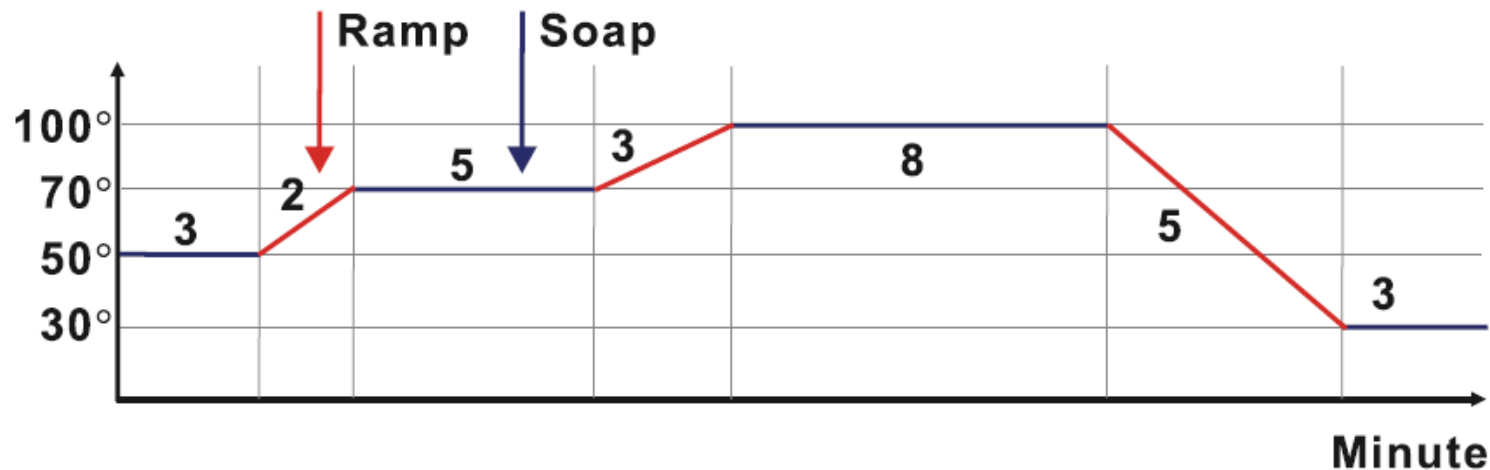
Ramp Soak programmer
Start Pattern
Pattern 0
Read Setting
Read File
Save to ...
Write
Edit
Back

	Pattern 0	Pattern 1	Pattern 2	Pattern 3	Pattern 4
Step Max.	7	7	7	7	7
Set Value 0	0.0	0.0	0.0	0.0	0.0
Execute Time 0	00:00	00:00	00:00	00:00	00:00
Set Value 1	0.0	0.0	0.0	0.0	0.0
Execute Time 1	00:00	00:00	00:00	00:00	00:00
Set Value 2	0.0	0.0	0.0	0.0	0.0
Execute Time 2	00:00	00:00	00:00	00:00	00:00
Set Value 3	0.0	0.0	0.0	0.0	0.0
Execute Time 3	00:00	00:00	00:00	00:00	00:00
Set Value 4	0.0	0.0	0.0	0.0	0.0
Execute Time 4	00:00	00:00	00:00	00:00	00:00
Set Value 5	0.0	0.0	0.0	0.0	0.0
Execute Time 5	00:00	00:00	00:00	00:00	00:00
Set Value 6	0.0	0.0	0.0	0.0	0.0
Execute Time 6	00:00	00:00	00:00	00:00	00:00
Set Value 7	0.0	0.0	0.0	0.0	0.0
Execute Time 7	00:00	00:00	00:00	00:00	00:00
Loop Count	0	0	0	0	0
Link Pattern	Pattern 0	Pattern 0	Pattern 0	Pattern 0	Pattern 0

Ramp/Soak Control

Programmable Control:

- Max. 8 patterns available, with 8 steps in each pattern.
No master controller is required for planning all kinds of temperature control curves.



PID Alarms

• Proportional Current/ Voltage Output

Mode	Alarm Type	Alarm Output Operation
0	No alarm	OFF
1	Alarm output will be enabled when the temperature reaches upper and lower limits. • Alarm will be enabled when the PV exceeds $SV + AL-H$ or falls below $SV - AL-L$.	
2	Alarm output will be enabled when the temperature reaches the upper limit. • Alarm will be enabled when the PV exceeds $SV + AL-H$.	
3	Alarm output will be enabled when the temperature reaches the lower limit. • Alarm will be enabled when the PV falls below $SV - AL-L$.	
4	• Alarm will be enabled when the PV is between $SV + AL-L$ and $SV - AL-L$.	



Thank You
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