

---

## **11 Special instructions**

last modified by Joey

on 2022/06/14 17:35

---

# Table of Contents

PID/PID calculation ..... 3  
CCPID/CCPID calculation ..... 6  
FPID/FPID calculation ..... 8  
CCPID instruction introduction manual ..... 12

## PID/PID calculation

### PID

This instruction is used to perform PID control that changes the output value according to the amount of input change.

-[PID (s1)(s2)(s3)(d)]

#### Content, range and data type

Parameter	Content	Range	Data type	Data type (label)
(s1)	Device number for storing the target value (SV)	-32767 to 32767	Signed BIN 16 bit	ANY16
(s2)	Device number for storing the measured value (PV)	-32767 to 32767	Signed BIN 16 bit	ANY16
(s3)	Device number for storing parameters	1 to 32767	Signed BIN 16 bit	ANY16
(d)	Device number for storing output value (MV)	-32767 to 32767	Signed BIN 16 bit	ANY16

#### Device used

Instruction	Parameter	Devices			Offset modification [D]	Pulse extension XXP
		D	R	SD		
PID	Parameter 1	●	●	●		
	Parameter 2	●	●	●		
	Parameter 3	●	●	●		
	Parameter 4	●	●	●		

#### Features

This instruction is to complete the PID operation and is used to control the parameters of the closed-loop control system. PID control has a wide range of applications in mechanical equipment, pneumatic equipment, constant pressure water supply and electronic equipment, etc. among them:

(S1) is the target value of PID control;

(S2) is the measured feedback value;

(S3) The starting address of the buffer area for setting parameters required for PID operation and saving intermediate results, occupies a total of 26 variable units in the subsequent addresses, the value range is D0 to D7974, it is best to specify the power failure retention area, which will remain after the power is OFF Set the value, otherwise the buffer area needs to be assigned value before starting the operation for the first time. The function and parameter description of each unit are described in this section;

(D) is the storage unit of the PID calculation result. Please designate (D) as a non-battery holding area, otherwise it needs to be initialized and cleared before starting the calculation for the first time.

#### Programming example



The parameter description is as follows:

What is stored in D9 is the target value of PID adjustment, and D10 is the closed-loop feedback value. Note that D9 and D10 must be of the same dimension, such as both 0.01MPa units, or 1°C units, etc.;

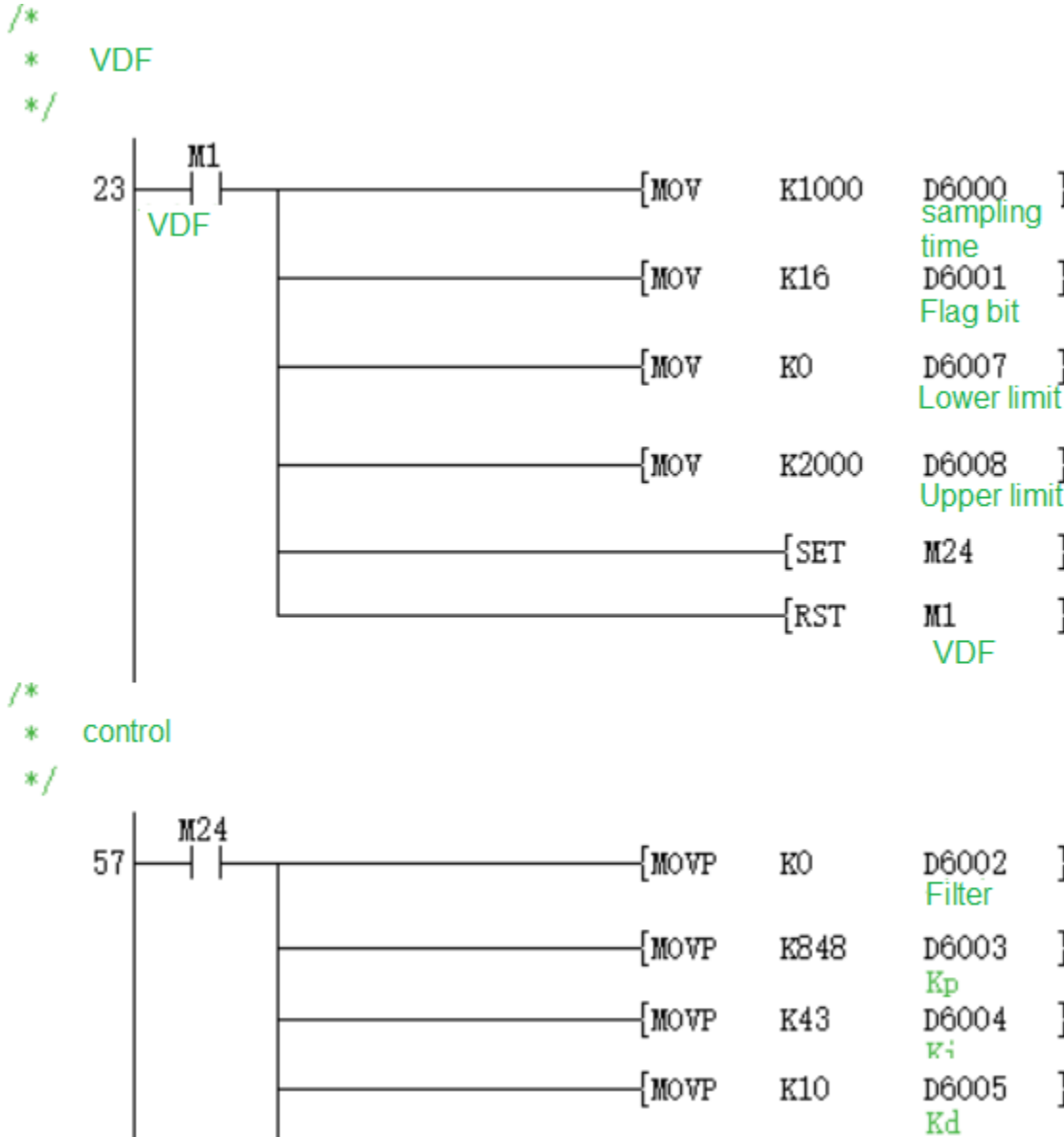
A total of 26 units of D200 to D225 are used to store the set value and process value of PID operation. These values must be set item by item before the first PID calculation;

The D130 unit is used to store the calculated control output value to control the execution of the action.

The function and setting method of the parameter value of each unit about starting of (S3) are described in the following table:

Unit	Features	Setting instructions
(S3)	Sampling time (TS)	The setting range is 1 to 32767 (ms), but it needs to be greater than the PLC program scan period
(S3) <sub>+1</sub>	Action direction (ACT)	bit0: 0 = positive action; 1 = reverse action bit3: 0 = unidirectional; 1 = bidirectional  bit4: 0 = auto-tuning does not work; 1 = auto-tuning is executed, others cannot be used.
(S3) <sub>+2</sub>	Maximum ascent rate (DeltaT)	Setting range 0 to 32000 is the threshold of integral increment
(S3) <sub>+3</sub>	Proportional gain (Kp)	Setting range 0 to 32767, note that this value is enlarged by 256 times, the actual value is Kp/256
(S3) <sub>+4</sub>	Integral gain (Ki)	Setting range 0 to 32767, Ki=16384Ts/Ti, Ti is the integral time
(S3) <sub>+5</sub>	Differential gain (Kd)	Setting range 0 to 32767, Kd≈Td/Ts, Td is the derivative time
(S3) <sub>+6</sub>	Filtering (C0)	Setting range 0 to 1023, integral part filtering
(S3) <sub>+7</sub>	Output lower limit	Recommended setting range -2000 to 2000  When bit3 of S3+1=0, set to 0; When bit3 of S3+1=1, set to -2000;
(S3) <sub>+8</sub>	Output upper limit	Recommended setting value 2000
(S3) <sub>+9</sub>	Reserved	Reserved
:	:	:
(S3) <sub>+25</sub>	Reserved	Reserved

**Auto tuning example**



**#Note:**

- When multiple instructions are used, the device number of (d) cannot be repeated.
- During the execution of auto-tuning, the (s3) parameter space cannot be modified.
- The instruction occupies 26 point devices from the device specified in (s3).
- PID instruction can be used multiple times in the program and can be executed at the same time, but the variable area used in each PID instruction should not overlap; it can also be used in step instructions, jump instructions, timing interrupts, and subroutines, in this case When executing the PID instruction, the (s3)+9 cache unit must be cleared in advance.
- The maximum error of the sampling time Ts is -(1 operation cycle +1ms) +(1 operation cycle). If the sampling time Ts ≤ 1 operation cycle of the programmable controller, the following PID operation error (4D86H) will occur, and the PID operation will be executed with TS = operation cycle. In this case, it is recommended to use constant scan mode or use PID instruction in timer interrupt.

**Error code**

Error code	Content
4085H	When the device specified in the read application instructions (s1), (s2), (s3), (d) exceeds the range of the corresponding device.
4086H	When the device specified in the write application instruction (s3) and (d) exceeds the range of the corresponding device.
4D80H	The sampling time is out of range. $T_s \leq 0$
4D81H	Input filter constant ( $C_o$ ) is out of range ( $C_o < 00$ or $C_o \geq 1025$ )
4D82H	The maximum ascent rate ( $\Delta T$ ) is out of range. $\Delta T < 00$ or $\Delta T > 3200$
4D83H	The proportional gain (Kp) is out of range. $K_p < 0$
4D84H	The integral gain (Ki) is out of range. $K_i < 0$
4D85H	The differential gain (Kd) is out of range. $K_d < 0$
4D86H	The sampling time (Ts) is less than the operation cycle. $T_s < S_{cycle}$

**Example**

See manual.

**CCPID/CCPID calculation**

**CCPID**

This instruction is used to perform PID control that changes the output value according to the amount of input change.

-[CCPID (s1) (s2) (s3) (d)]

**Content, range and data type**

Parameter	Content	Range	Data type	Data type (label)
(s1)	Device number for storing the target value (SV)	-32767 to 32767	Signed BIN 16 bit	ANY16
(s2)	Device number for storing the measured value (PV)	-32767 to 32767	Signed BIN 16 bit	ANY16
(s3)	Device number for storing parameters	1 to 32767	Signed BIN 16 bit	ANY16
(d)	Device number for storing output value (MV)	-32767 to 32767	Signed BIN 16 bit	ANY16

**Device used**

Instruction	Parameter	Devices	Offset modification	Pulse extension
-------------	-----------	---------	---------------------	-----------------

		D	R	SD	[D]	XXP
CCPID	Parameter 1	●	●	●		
	Parameter 2	●	●	●		
	Parameter 3	●	●	●		
	Parameter 4	●	●	●		

**Features**

After setting target value (s1), measured value (s2), parameter (s3) to (s3) +12 and executing the program, the calculation result (MV) will be stored to the output according to the first sampling time (s3) in the parameter Value (d). For details, please refer to the user manual of "Wecon CC Series ccpid Function Description v1.4".

**#Note:**

It can be executed multiple times at the same time (there is no limit to the number of loops), but please note that the device numbers (s3) and (d) used in the calculation cannot be repeated.

The instruction occupies 52 points of devices starting from the device specified in (s3).

During the execution of auto-tuning, the (s3) parameter space cannot be modified.

**Error code**

Error code	Content
4085H	When the device specified in the read application instructions (s1), (s2), (s3), (d) exceeds the range of the corresponding device.
4086H	When the device specified in the write application instruction (s3) and (d) exceeds the range of the corresponding device.
4D80H	The sampling time is out of range. $T_s \leq 0$
4D81H	Input filter constant ( $C_o$ ) is out of range ( $C_o < 00$ or $C_o \geq 102$ )
4D82H	The maximum ascent rate ( $\Delta T$ ) is out of range. $\Delta T < 00$ or $\Delta T > 3200$
4D86H	The sampling time (Ts) is less than the operation cycle. $T_s < S_{cycle}$
4D87H	The proportional gain (Kp) is out of range. $K_p < 10$ or $K_p > 3000$
4D88H	The integral time constant (Ti) is out of range. $T_i < 00$ or $T_i > 360$
4D89H	The differential time constant (Td) is out of range. $T_d < 00$ or $T_d > 100$
4D90H	The upper limit of CCPID output is less than the lower limit.

**Example**

See "[CCPID Instruction Manual](#)".

## FPID/FPID calculation

### FPID

The function of this instruction is to adjust PID control parameters by fuzzy algorithm.

-[FPID (s) (d1) (d2) (d3)]

#### Content, range and data type

Parameter	Content	Range	Data type	Data type (label)
(s)	Store the start number of the device of the fuzzy parameter table (no input required)	-	Signed BIN 16 bit	ANY16
(d1)	Start number of the device storing the initialization parameters	-	Signed BIN 16 bit	ANY16
(d2)	Store the start number of the device of the input PID parameter	-	Signed BIN 16 bit	ANY16
(d3)	The start number of the device that stores the adjusted PID parameters	-	Signed BIN 16 bit	ANY16

#### Device used

Instruction	Parameter	Soft component				Offset modification [D]	Pulse extension XXP
		D	R	SD	LC		
FPID	Parameter 1	●	●	●	●		
	Parameter 2	●	●	●	●		
	Parameter 3	●	●	●	●		
	Parameter 4	●	●	●	●		

#### Features

This instruction needs to be used in conjunction with the PID instruction. It completes the fuzzy calculation of the adjustments of the three parameters of PID, Kp, Ki, and Kd. By passing in the three parameters of the PID, the new three parameters are calculated and substituted into the PID for output control.

#### Parameter Description:

##### S parameter setting

Parameter	Offset address	Name	Format	Instruction	Range
Parameter 1	S	-	-	-	-

##### d1 parameter setting

Parameter	Offset address	Name	Format	Instruction	Range
Parameter 1	d1	em domain	Floating point	Temperature difference	>0
	d1+1				
Parameter 2	d1+2	ecm domain	Floating point	Temperature difference	>0
	d1+3				
Parameter 3	d1+4	kpm coefficient	Floating point	0.5 (fixed) (not set)	-
	d1+5				
Parameter 4	d1+6	kim coefficient	Floating point	1 (fixed) (not set)	-
	d1+7				



Parameter 5	d1+8 d1+9	kdm coefficient	Floating point	1 (fixed) (not set)	-
Parameter 6	d1+10 d1+11	EM	32-bit integer	6 (fixed) (not set)	-
Parameter 7	d1+12 d1+13	ECM	32-bit integer	6 (fixed) (not set)	-
Parameter 8	d1+14 d1+15	UM	32-bit integer	6 (fixed) (not set)	-
Parameter 9	d1+16 d1+17	Size_x	32-bit integer	13 (fixed) (not set)	-
Parameter 10	d1+18 d1+19	Size_y	32-bit integer	13 (fixed) (not set)	-
Parameter 11	d1+20	Kpm reserved for internal use	Reserved	Reserved	-
Parameter 12	d1+21	Kim reserved for internal use	Reserved	Reserved	-
Parameter 13	d1+22	Kdm reserved for internal use	Reserved	Reserved	-
Parameter 14	d1+23	Kukp reserved for internal use	Reserved	Reserved	-
Parameter 15	d1+24	Kuki reserved for internal use	Reserved	Reserved	-
Parameter 16	d1+25	Kukd reserved for internal use	Reserved	Reserved	-
⋮	⋮	⋮	⋮	Reserved	-
Parameter 20	d1+37	Reserved for internal use	Reserved	Reserved	-

**d2 parameter setting**

Parameter	Offset address	Name	Format	Instruction	Range
Parameter 1	d2	Current Temperature	16-bit integer	Current test temperature	-
Parameter 2	d2+1	set temperature	16-bit integer	Set temperature	-
Parameter 3	d2+2	Calculation period	16-bit integer	Take an integer multiple of the pid sampling time, usually the same	-
Parameter 4	d2+3	Kp	16-bit integer	PID initial Kp value	-
Parameter 5	d2+4	KI	16-bit integer	PID initial Ki value	-
Parameter 6	d2+5	KD	16-bit integer	PID initial Kd value	-
Parameter 7	d2+6	Sampling cycle	16-bit integer	No need to enter	-
Parameter 8	d2+7	Initialization flag	16-bit integer	Reserved for internal use	-
Parameter 9	d2+8 d2+9	Last calculation time	32-bit integer	View usage (not operable)	-
Parameter 10	d2+10	Last temperature	16-bit integer	View usage (not operable)	-
Parameter 11	d2+11	Reserved	16-bit integer	Reserved	-

**d3 parameter setting**

Parameter	Offset address	Name	format	Instruction	Range
Parameter 1	d3	Current Temperature	16-bit integer	Current test temperature	-

Parameter 2	d3+1	set temperature	16-bit integer	Set temperature	-
Parameter 3	d3+2	Calculation period	16-bit integer	Take an integer multiple of the pid sampling time, usually the same	-
Parameter 4	d3+3	Kp	16-bit integer	Kp value of PID after adjustment	-
Parameter 5	d3+4	KI	16-bit integer	Ki value of PID after adjustment	-
Parameter 6	d3+5	KD	16-bit integer	Kd value of PID after adjustment	-
Parameter 7	d3+6	Sampling cycle	16-bit integer	No need to enter	-
Parameter 8	d3+7	Reserved	16-bit integer	Reserved	-

**#Note:**

The instruction starts from the device specified in (d1) and occupies 38 points of the device, and initializes the parameters. Normally, it only needs to be initialized once before calling (some parameters are fixed) (occupies 38 words space).

The instruction starts with the device specified in (d2) and occupies 12 points of the device, input parameters, and input the first 6 parameters, where Kp, Ki, Kd are the initial values of the PID control parameters (occupies 12 words space) .

The instruction starts from the device specified in (d3) and occupies 8 points of soft elements and output parameters, among which Kp, Ki, Kd are the parameter values after fuzzy adaptive calculation, which can be input to the designated position of PID (occupy 8 words space).

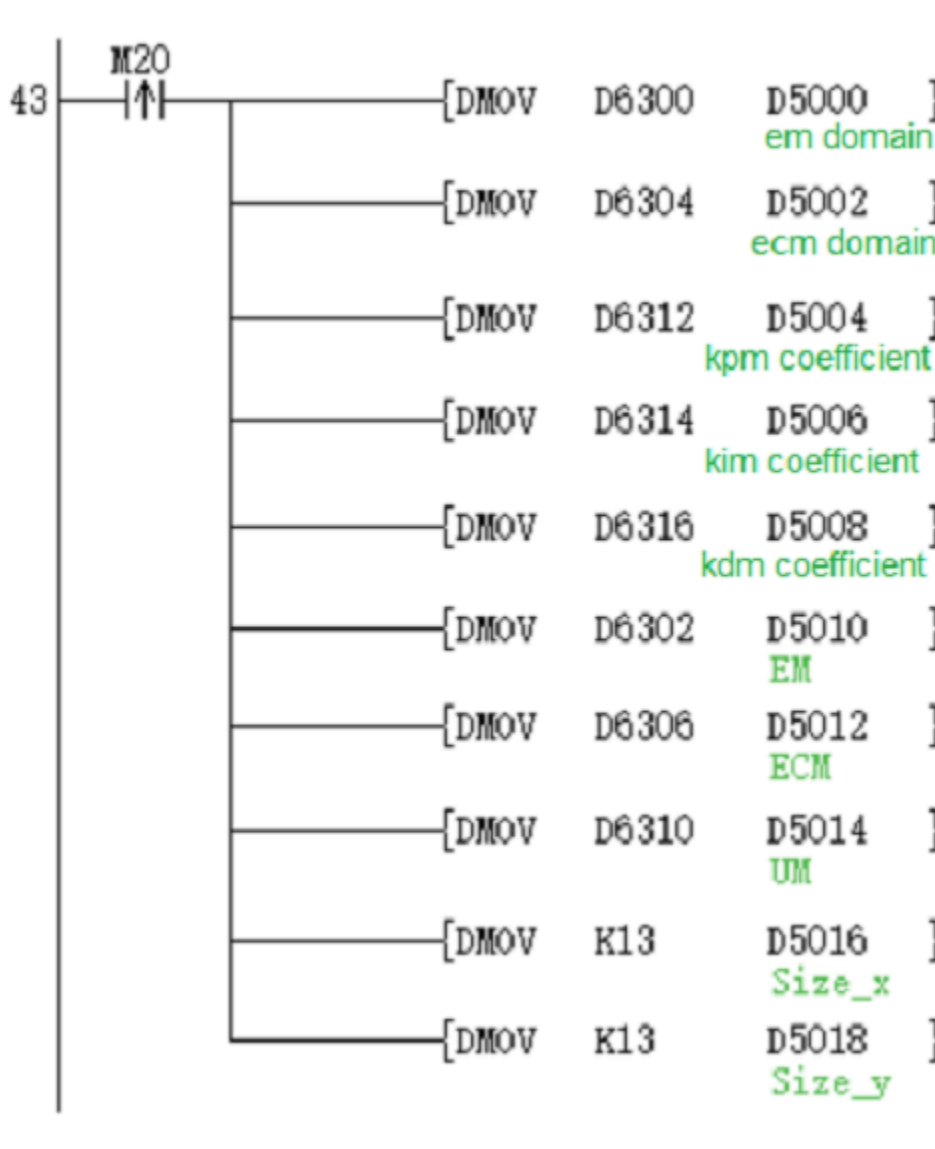
The FPID instruction occupies 58 words. The address of each operand must have a specified interval interval, which cannot be occupied by other instructions.

**Error code**

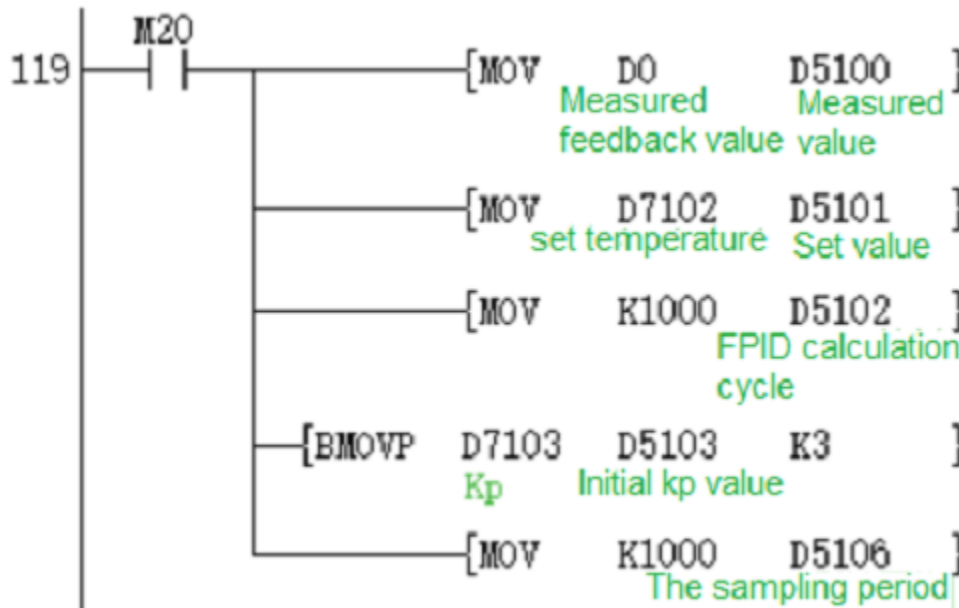
Error code	Content
4085H	When the device specified in the read application instructions (d1), (d2), (d3) exceeds the range of the corresponding device.
4086H	When the device specified in the write application instructions (d1), (d2), (d3) exceeds the range of the corresponding device.
4D91H	FPID calculation cycle is less than or equal to 0
4D92H	FPID parameter range error
4D93H	FPID initial flag error

**Example**

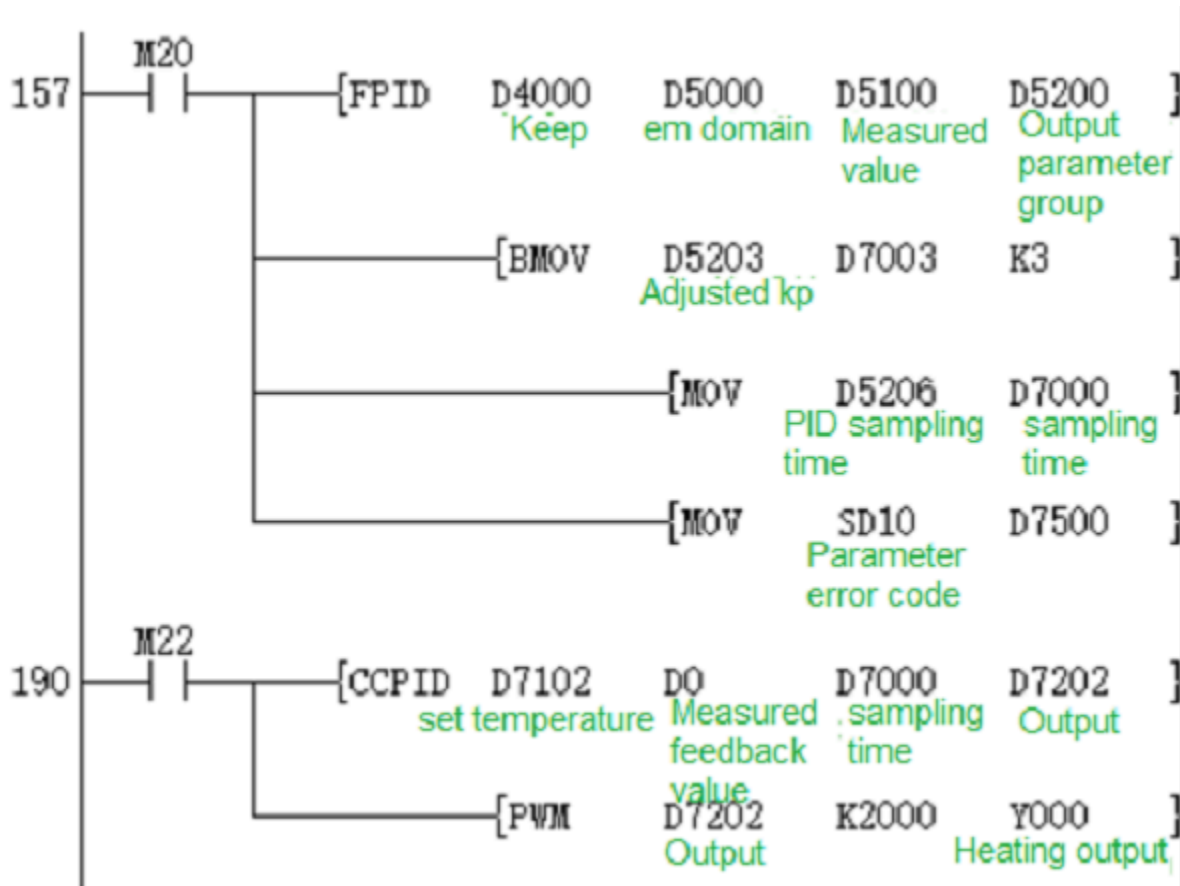
1. Parameter d1



2. Parameter d2



3. Invoke FPID



## CCPID instruction introduction manual

### Background and purpose

(1) Background:

PID (proportion, integral, derivative) controller has been the earliest practical controller for nearly a hundred years, and it is still the most widely used industrial controller. The PID controller is simple and easy to understand, and does not require precise system models and other prerequisites in use, making it the most widely used controller.

(2) Purpose:

You might not be familiar with the parameter settings in the new series of CCPID for the first time, this manual could let you quickly understand the meaning of each parameter in the CCPID and the influence on the control effect, so that you can quickly learn the CCPID.

**Description of the host CCPID instruction**

**Instruction description**

**Content, range and data type**

Name	Features	Bits (bits)	Whether pulse type	Instruction format	Step count
CCPID	PID Operation	16	No	CCPID (S1) (S2) (S3) (D)	9

Instruction	Parameter	Devices	Offset modification	Pulse extension		
		D	R	SD	[D]	XXP
CCPID	Parameter 1	●	●	●		
	Parameter 2	●	●	●		
	Parameter 3	●	●	●		
	Parameter 4	●	●	●		

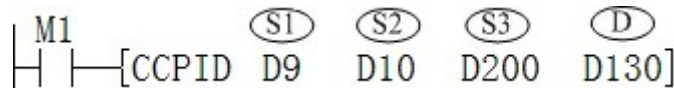
**Device used**

(S1) is the target value (SV) of PID control;

(S2) is the measured feedback value (PV);

(S3) is the start address of the buffer area for setting parameters required for PID operation and saving intermediate results, occupying a total of 52 variable units of subsequent addresses (recommended to reserve 100 continuous spaces).The value range is D0 to D7,948, it is better to specify power failure retention, and the setting value remains after power supply is off. Otherwise,the buffer needs to be assigned value before starting the calculation for the first time. The function and parameter description of each unit are described in this section;

(D) is the storage unit (MV) of the PID calculation result. Please specify it as a non-battery retentive area, otherwise it needs to be initialized and cleared before the first start of calculation.



**Programming example**

The parameter description is as follows:

In D9, the target value of PID adjustment is stored, and D10 is the closed-loop feedback value. Note that D9 and D10 must be of the same dimension, such as both 0.01MPa units, or 1°C units, etc.;

A total of 52 units of D200 to D224 are used to store the set value and process value of PID operation. These values must be set item by item before the first PID calculation;

D130 unit is used to store the calculated control output value to control the execution of the action.

The functions and setting methods of the parameter values of each unit used by **S3** are described in the following table:

**S3** to **S3** +14 is the parameter range that can be set (parameters set when CCPID is executed).

**S3** +15 to **S3** +21 is the space used internally by CCPID control.

**S3** +22 to **S3** +51 is the parameter space used in the auto-tuning process.

Unit	Features	Setting instructions	Supplement
	Sample time (TS)	The set range is 1 to 32,767 (ms), but greater than PLC program scan cycle.	It is how often the instruction calculates and updates the output value (MV). When TS is less than one scan time, PID instruction is executed with one scan time and alarm 4D86H. When TS ≤ 0, alarm 4D80H and no execution.
+1	Action direction (ACT)	bit0: 0=positive action; 1=reverse action bit2: auto-tuning transition zone switch. 0=not open;1=open  bit3: 0=unidirection; 1=bidirection  Bit4: 0=auto-tuning does not execute; 1=execute auto-tuning  [Bit6:0=Two-stage auto-tuning does not execute. 1=Execute two-stage auto-tuning (bit4 must be set to 1).  bit7: 0=Three-stage auto-tuning does not execute. 1=Execute three-stage auto-tuning (bit4 must be set to 1 )]  The Others cannot be used.	bit0: Positive action: similar heating system, when the temperature is lower than the set value, increases the output ; Reverse action: similar cooling system, when the temperature is greater than the set value, increases the output.  bit2: Self-tuning transition zone switch. There is a transition zone size of 1.5°C when opened.  bit3: Bidirection indicates that outputs the positive and negative values to the heating system or the cooling system to control two external systems by one PID.  bit4: #When bit4=1 and bit6 and bit7 are not 1, auto-tuning is not executed. #When bit4=0 and one of bit6 and bit7 is 1, auto-tuning is not executed. #When bit4=1 and bit6 and bit7 are both 1, auto-tuning is executed
+2	Filter coefficient	The first-order inertia filter of feedback amount (0 to 100%) has a range of 0 to100	When the value is greater than or equal to 100, it will be executed as 0, that is, no filtering will be executed;
+3	Proportional gain(Kp)	Set range: 0 to 30,000[%]	Overrun error 4D87H
+4	Integration time (Ti)	Ti is integration time, and the range is 0 to 3,600 (s)	Overrun error 4D88H
+5	Differential time (Td)	Td is derivative time, and the range is 0 to 1,000 (s)	Overrun error 4D89H
+6	Working interval	Operating temperature setting enabled by PID (0 indicates no effect) The range is 0 to 1,000	It is recommended to be greater than 5°C, that is, 50 (precision 0.1 °C). If it exceeds

+7	Output low limit	<p>Range: -10,000 to 10,000.</p> <p>Recommended setting range: -2,000 or 0 (when S3+1 bit3=0, the lower limit = 0; when bit3=1, the lower limit = -2,000)</p>	<p>the range, the boundary value will be taken.</p> <p>1. Self-tuning initialization:</p> <p>① Unidirection control: the lower limit is 0;</p> <p>② Bidirection control: If the lower limit is greater than 0, adjust the lower limit to 0; if the upper limit and the lower limit are equal to 0, the default lower limit is -2,000. #Note: If set to -2,000, and the output value (MV) is less than -2,000, it will output -2,000.</p> <p>2. During the control process, the lower limit is dynamically adjustable. If the lower limit is greater than or equal to the upper limit, error 4D90H will be reported.</p>
+8	Output upper limit	<p>Value range: -10,000 to 10,000.</p> <p>Recommended setting value is 2,000</p>	<p>1. Self-tuning initialization:</p> <p>① Unidirection control: If the upper limit is less than 0, the default upper limit is 2,000;</p> <p>② Bidirection control: If the upper limit is less than 0, adjust the upper limit to 0; if the upper limit and the lower limit are equal to 0, the default upper limit is -2,000. #Note: If set to -2,000 and the output value (MV) is greater than -2,000, it will output 2,000.</p> <p>2. During the control process, the upper limit is dynamically adjustable. If the lower limit is greater than or equal to the upper limit, error 4D90H will be reported.</p>
+9	Mode setting	<p>0: Overshoot allowed</p> <p>1: Slight overshoot or no overshoot</p> <p>2: Dynamic setting</p>	<p>0:Overshoot allowed (ukd = 100)</p> <p>1: Slight overshoot or no overshoot mode (ukd = 300)</p>
+10	Scale factor (ukp)	<p>Typically sets value to 100 (default 100) [enabled when S3+9 is set to 2].The range is 1 to 500.</p>	<p>When the value is less than or equal to 0, or greater than 500, the boundary value will be taken.</p>
+11	Integral coefficient (uki)	<p>Typically sets value to 50 (default 50) [enabled when S3+9 is set to 2]. The range is 1 to 300.</p>	<p>When the value is less than or equal to 0, or greater than 300, the boundary value will be taken.</p>
+12	Differential coefficient (ukd)	<p>Typically sets value to 50 (default 100. 300 to 400 can be set when slight overshoot is required) [Enable when S3+9 is set to 2]. The range is 1 to 500.</p>	<p>When the value is less than or equal to 0, or greater than 500, the boundary value will be taken.</p>

+13	Maximum ascent rate (DeltaT)	The range is 0 to 32,000, which is the threshold of integral increment	Overrun error 4D82H
+14	Filtering (C0)	The range is 0 to 1,023, integral part filtering	Overrun error 4D81H
+15	reserved for internal control	Internal control space occupation	
:			
+21			
+22	used space for self-tuning	New self-tuning space for internal use	
:			
+51			

1) The auto-tuning process occupies the space of S3+22 to S3+51. When the auto-tuning is successful, the adjusted parameters will be written into the space of S3+2 to S3+21.

2) +2 filter coefficient  $\alpha$ : Processing in first-order inertial filter

Formula:  $T_{now}=(100-\alpha)\times T_{\alpha}+\alpha\times T_{old}$

$T_{\alpha}$  is the currently measured temperature.  $T_{old}$  is the temperature that participated in the PID calculation last time.  $T_{now}$  is the temperature used for the current PID calculation.  $\alpha$  is the filter coefficient (when  $\alpha=0$ , no filtering is performed, and the range of  $\alpha$  is 0 to 100.(If there is a temperature with a small overshoot but a long stabilization time, the parameter can be set to 80, and analyze the specific problems in detail)

3) +6 work range:  $T_{work}$ (example: 170 represents 17°C)

Positive action <input type="checkbox"/>	OUT=	$\left\{ \begin{array}{l} 100\% \text{ power output} \\ \text{PidOut} \end{array} \right.$	$PV < SV - T_{work}$
			$PV \geq SV - T_{work}$
Reverse action <input type="checkbox"/>	OUT=	$\left\{ \begin{array}{l} 100\% \text{ power output} \\ \text{PidOut} \end{array} \right.$	$PV < SV - T_{work}$
			$PV \leq SV - T_{work}$

4) +9 working mode:

0: Working mode that allows overshoot

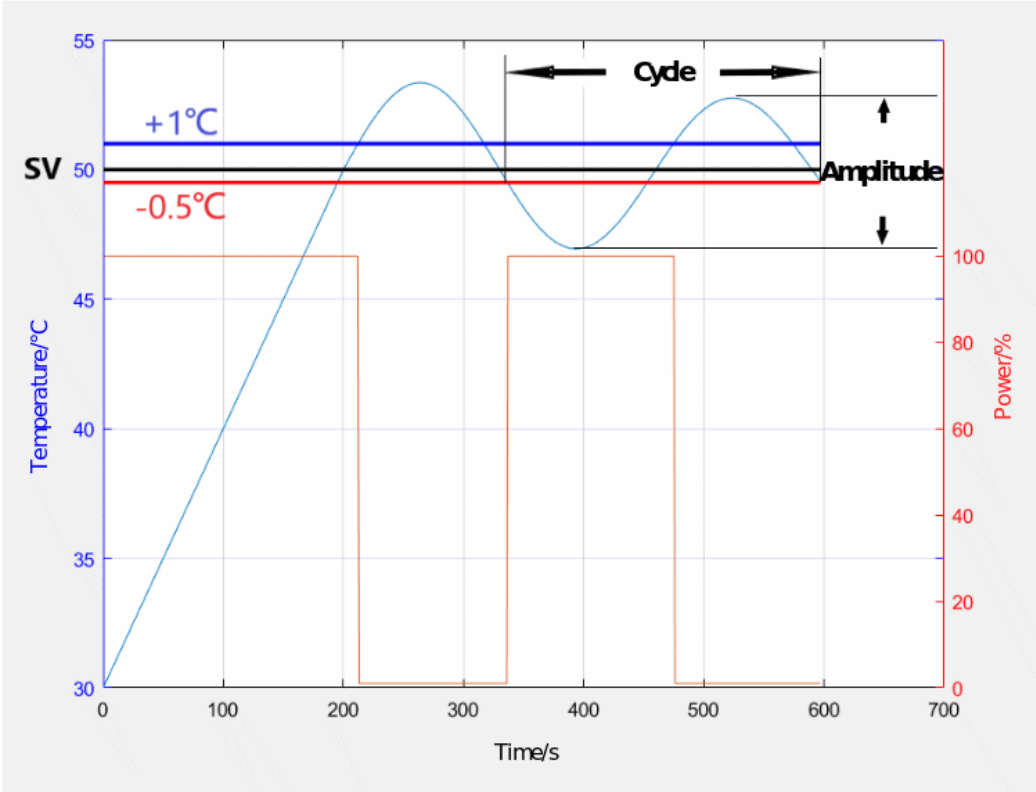
1: Slight overshoot or no overshoot working mode

2: Custom settings; to achieve by setting +10, +11, +12 three coefficients.

5) +1 bit2 self-tuning transition zone switch: (upper limit 1°C, low limit 0.5°C)

The transition zone description in forward control:

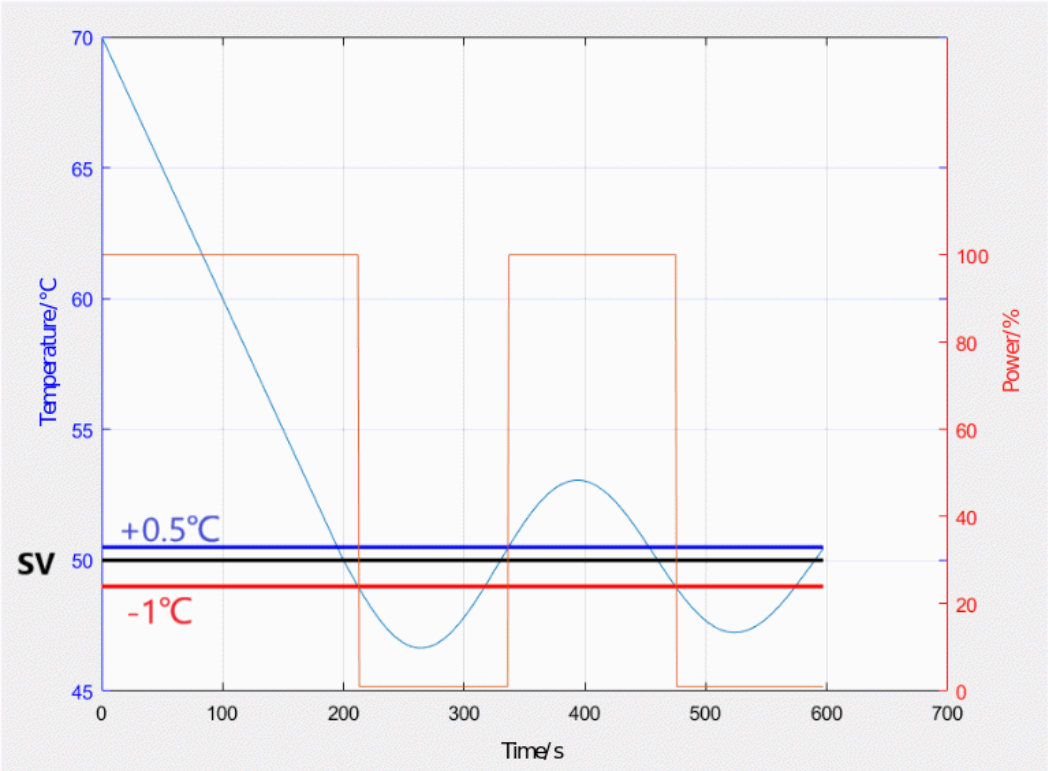




In the heating process, when  $PV \leq SV + 1^\circ\text{C}$ , 100% power output; when  $PV > SV + 1^\circ\text{C}$ , no output.

In the cooling process, when  $PV < SV - 0.5^\circ\text{C}$ , 100% power output; When  $PV \geq SV - 0.5^\circ\text{C}$ , no output.

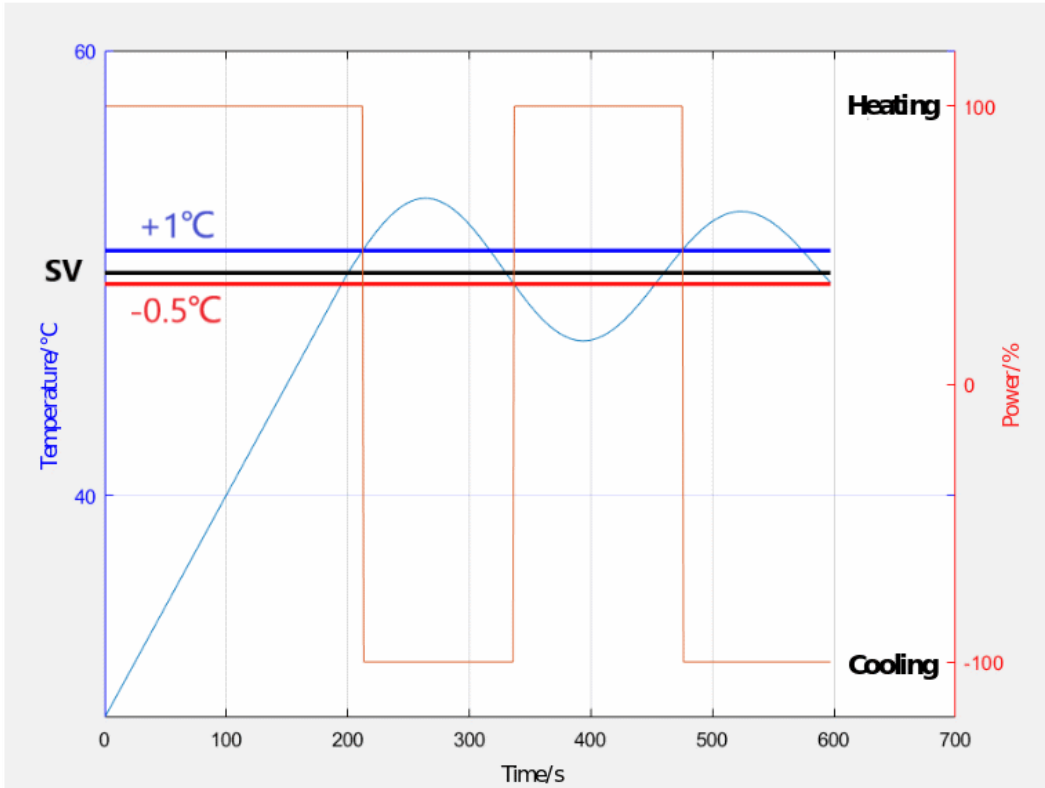
The transition zone description in reverse control:



In the cooling process, when  $PV \geq SV - 1^\circ C$ , 100% power output; when  $PV < SV - 1^\circ C$ , no output.

In the heating process, when  $PV > SV + 0.5^\circ C$ , 100% power output; When  $PV \leq SV + 0.5^\circ C$ , no output.

The transition zone description in bidirectional control:



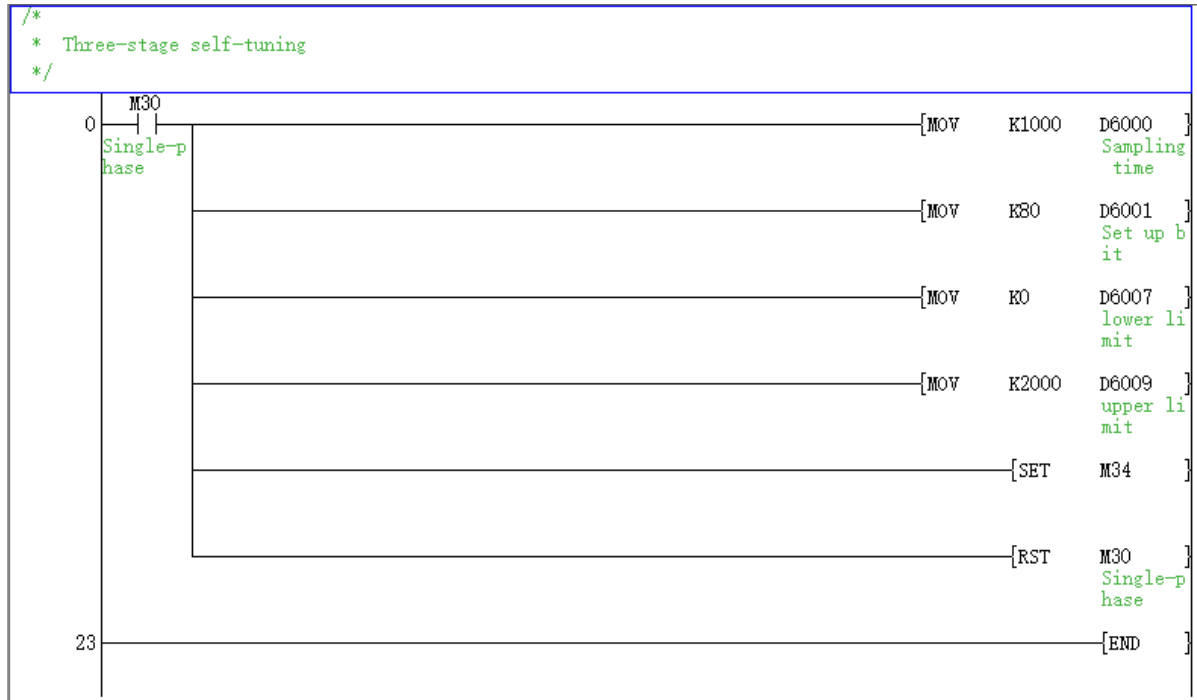
In the heating process, when  $PV \leq SV + 1^\circ\text{C}$ , 100% power heating output; when  $PV > SV + 1^\circ\text{C}$ , 100% power cooling output.

In the cooling process, when  $PV < SV - 0.5^\circ\text{C}$ , 100% power heating output. When  $PV \geq SV - 0.5^\circ\text{C}$ , 100% power cooling output

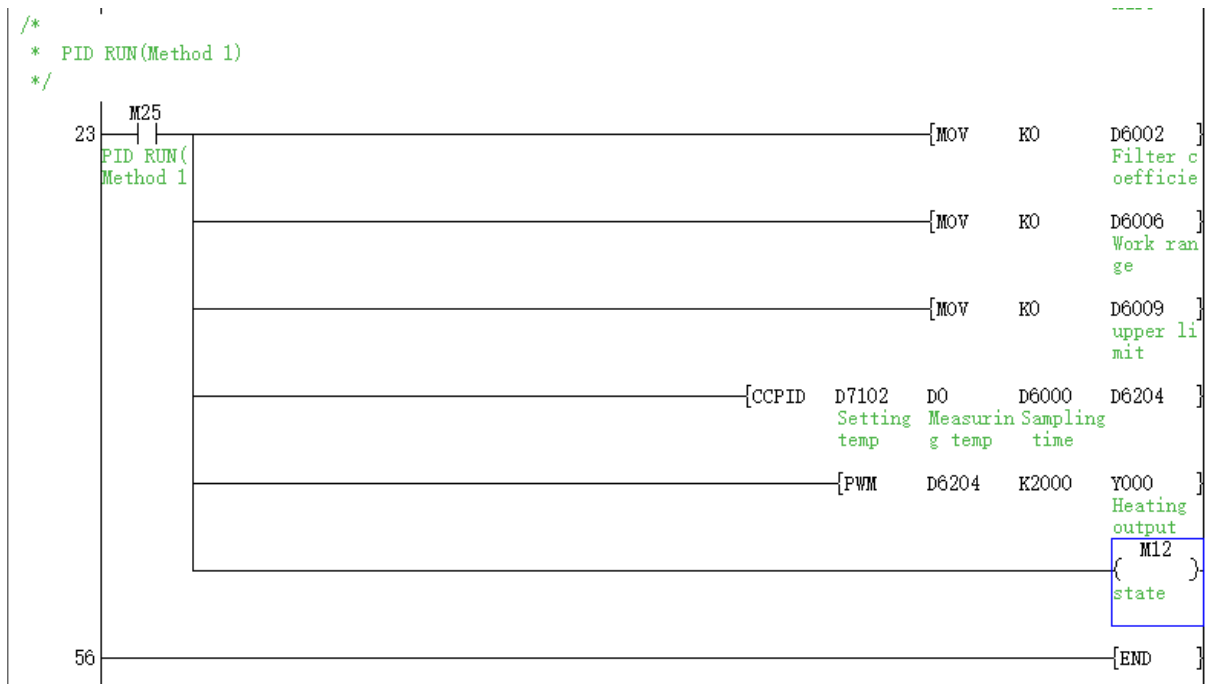
#### Programming case

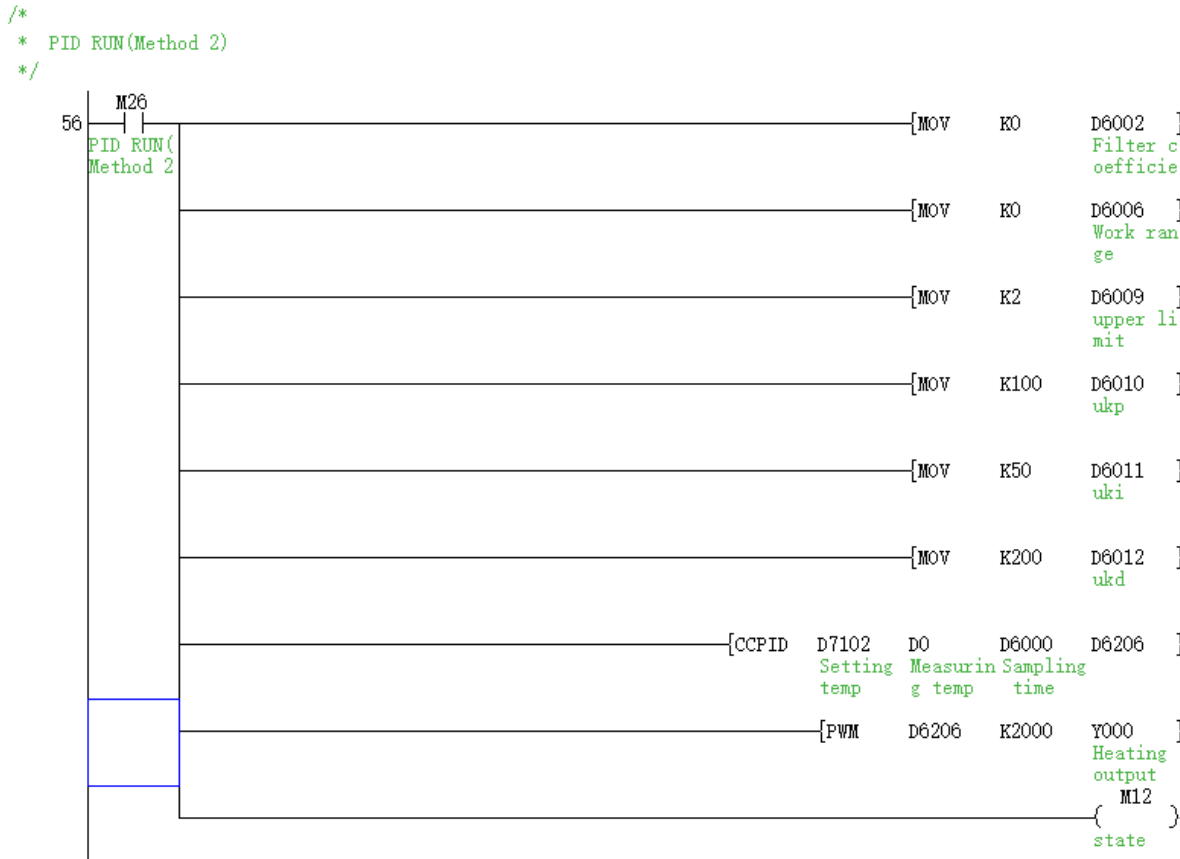
#### CCPID application configuration

(1) Parameter setting

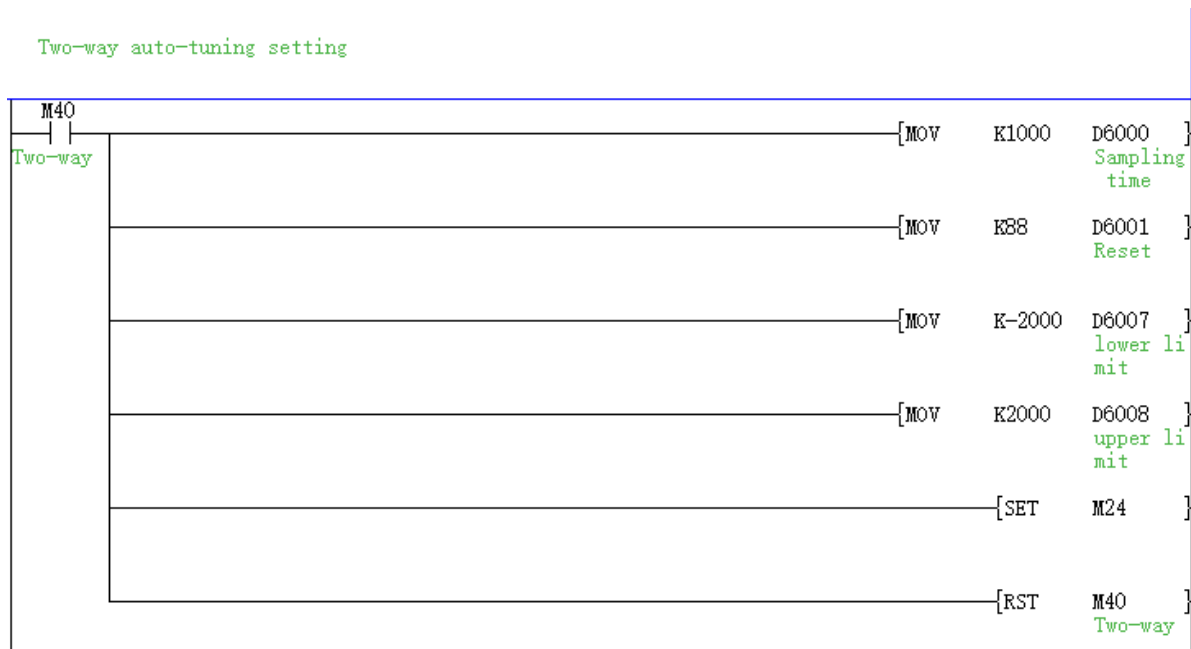


(2) CCPID control process setting





(3) Bidirection control



#Note:

1. CCPID is a special instruction for operation control. CCPID operation will be executed only after the sample time is reached.

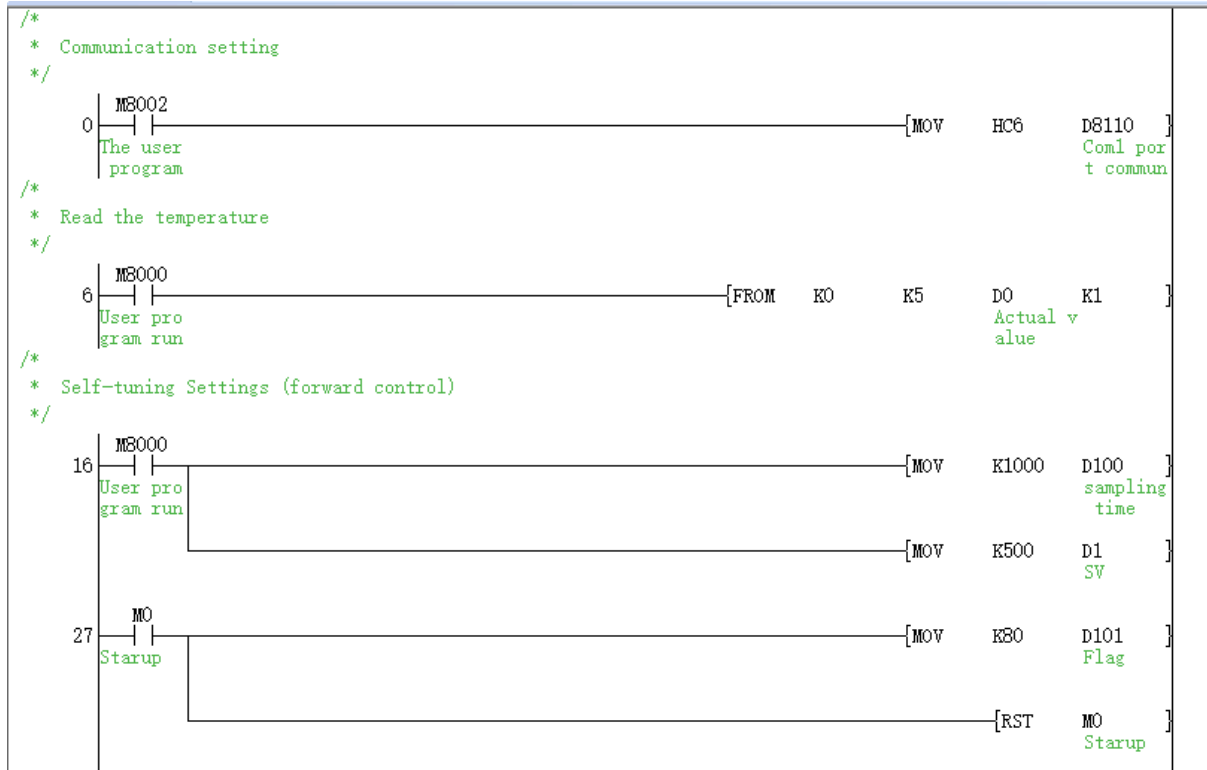
2. There is no limit to the number of times the CCPID instruction can be used, but +51 cannot be repeated.
3. Before CCPID instruction is executed, CCPID parameters need to be set.

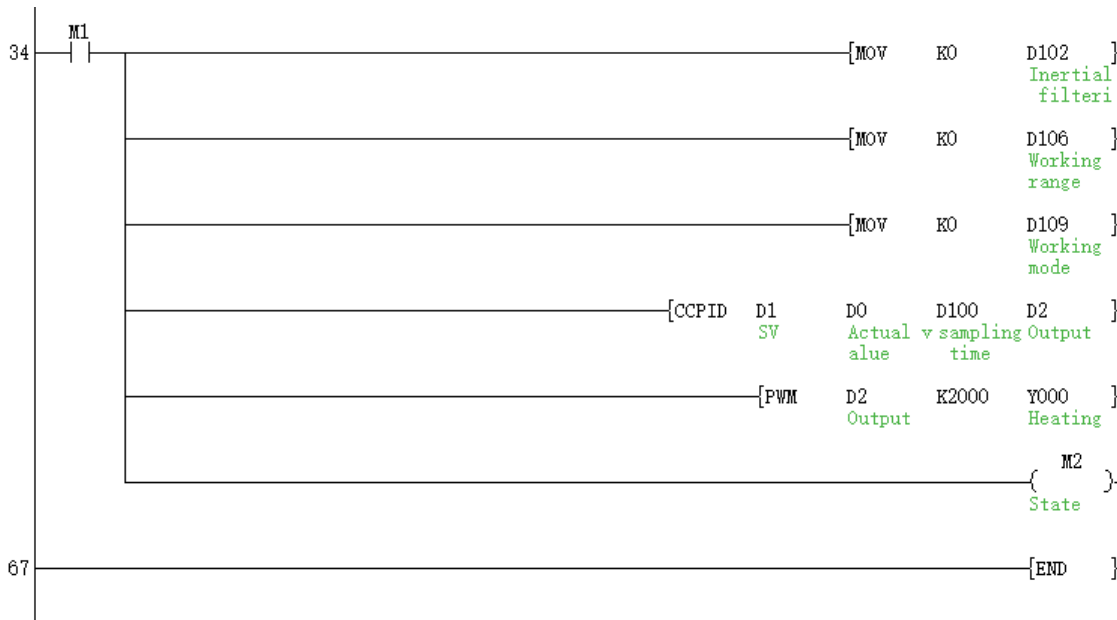
**Case analysis**

**(1) Control requirements**

The control environment of this example is a kettle. The configuration is controlled by PLC-5V2416 host with 4PT module, and PI8070 screen is used for data storage and process curve viewing.

**(2) Sample program**





**(3) Parameter description**

**PLC device**

M0

M1

M2

Y0

D0

D1

D100

D101

D102

D106

D109

**Control instructions**

Set auto tuning

CCPID instruction calculation start

CCPID operating status

Pulse output with adjustable pulse width

Temperature measured value

Temperature setting value

sample time

Control detail settings

First-order inertial filter coefficient

Working interval

Operating mode

**(4) Parameter control effect description**

1) Boiling water experiment

① Auto-tuning process and control process (no transition zone setting), take two-stage auto-tuning as an example

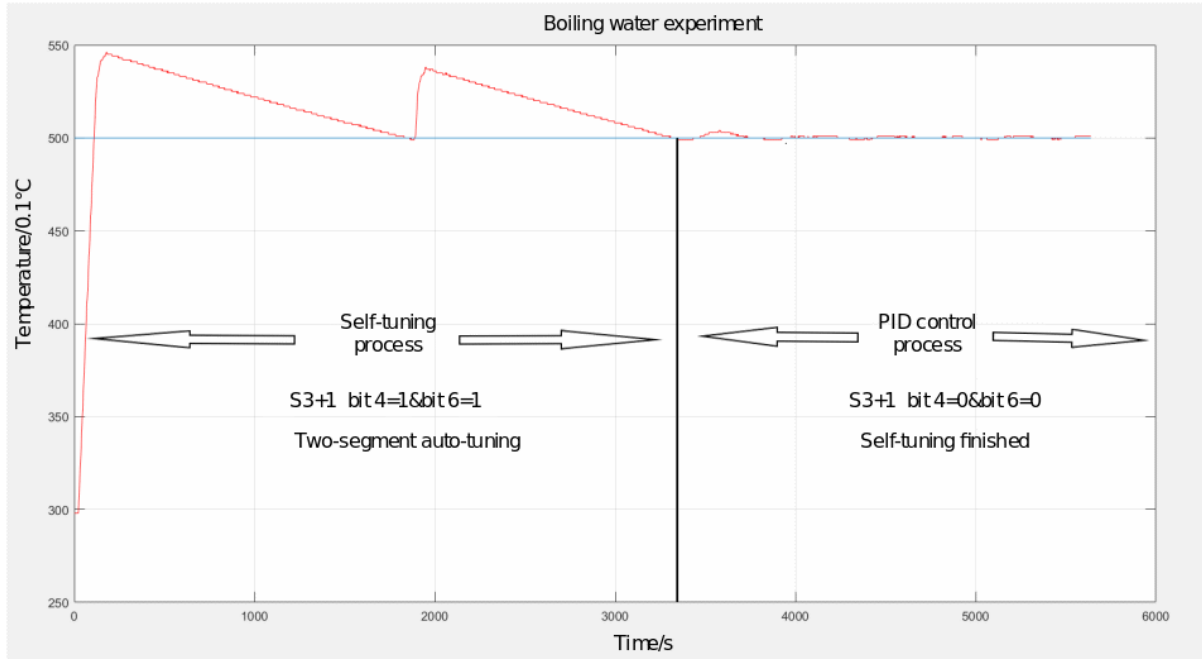


Figure 1 Auto-tuning process curve without transition zone

When the control system is a single temperature control system or a system where environmental interference does not cause large fluctuations. Generally the automatic tuning without transition zone is selected, so that the self-tuning process can be completed more quickly than the method with transition zone.

② Self-tuning process and control process (transition zone setting)

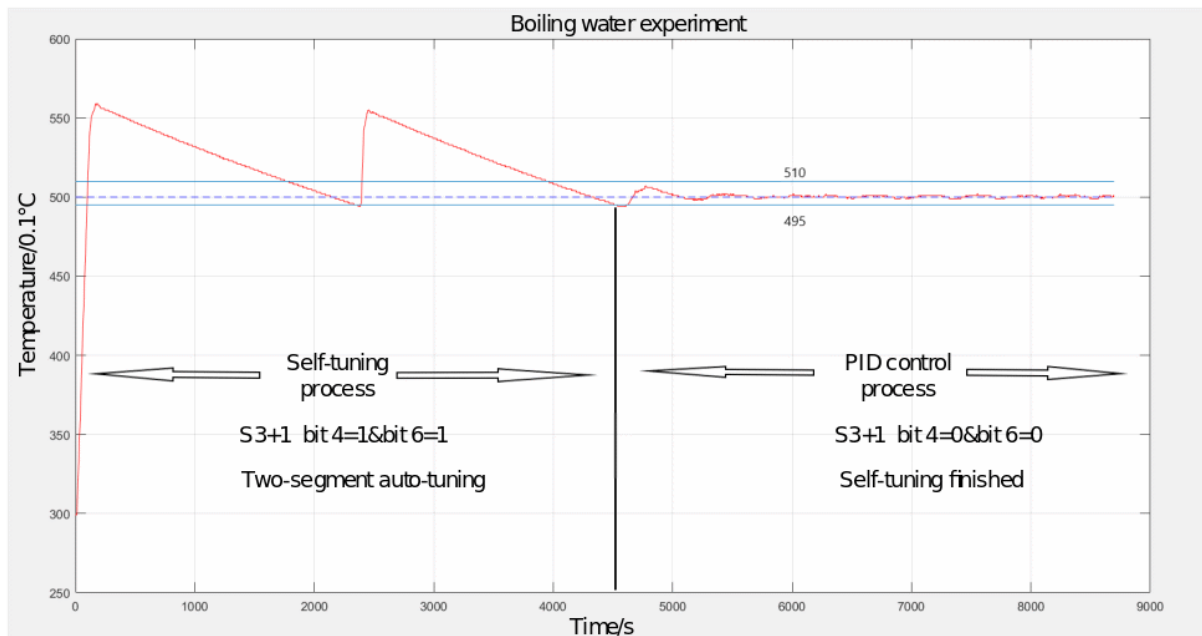


Figure 2 Self-tuning process curve with transition zone

It is more suitable in a two-way control system with transition zone self-tuning process. The transition zone has a range of 1.5°C. The upper limit is 1°C, and the lower limit is 0.5°C.

2) Difference in working interval setting



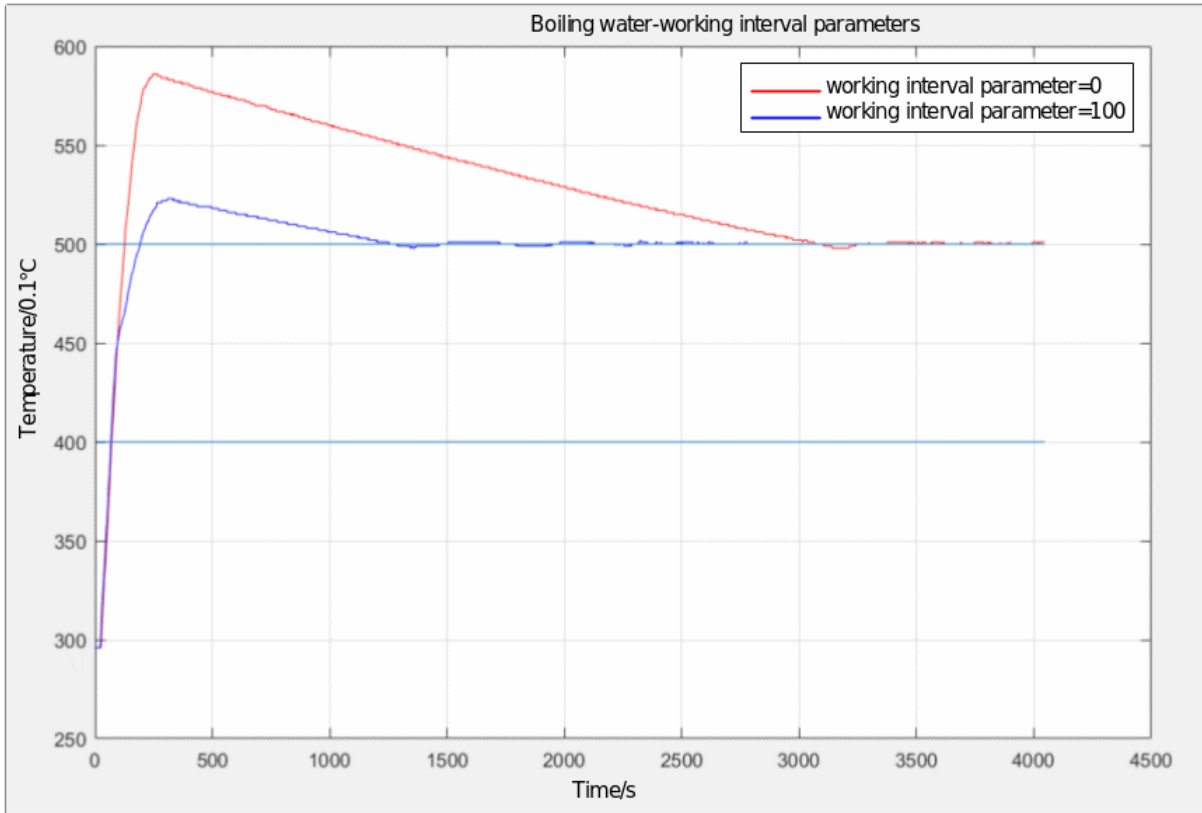


Figure 3 Process curve under different working interval parameters

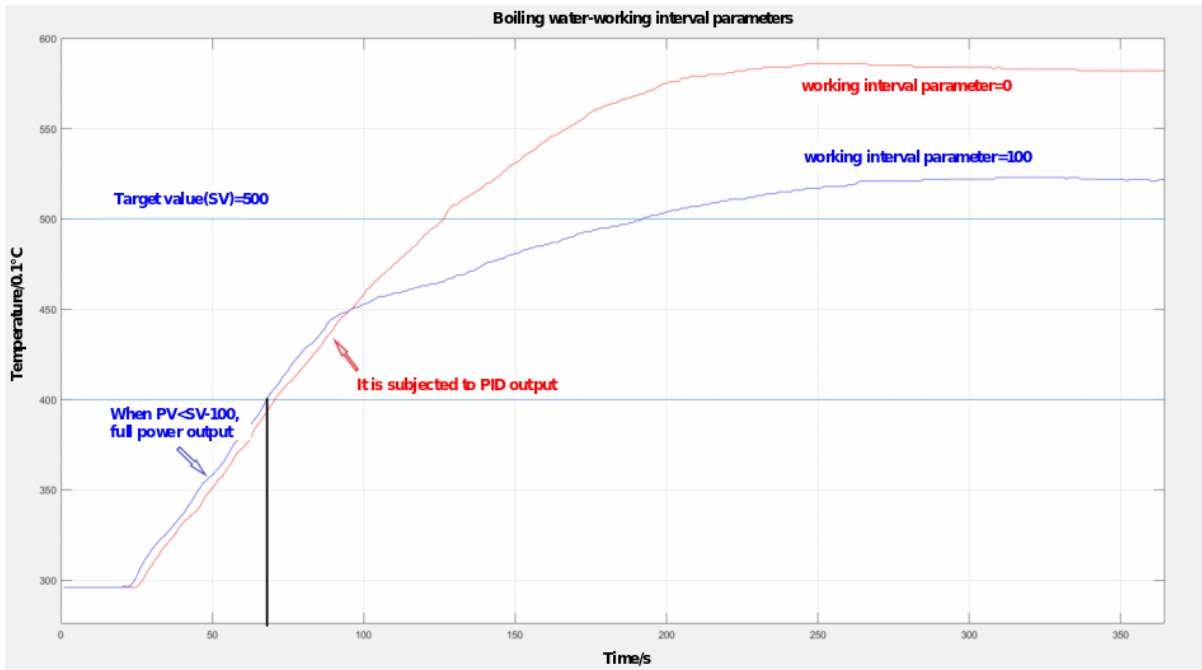


Figure 4 Process curve without different working interval parameters (heating process diagram)

It can be seen from the partially enlarged graph that the parameters of the working interval have a certain influence on the overshoot and the stable time. In the case of allowing overshoot, setting the working interval

parameters can make the overshoot smaller. This is because the deviation E of PID starting to work is relatively small, and the integration accumulation will not quickly saturate.

3) Result of filter coefficient setting

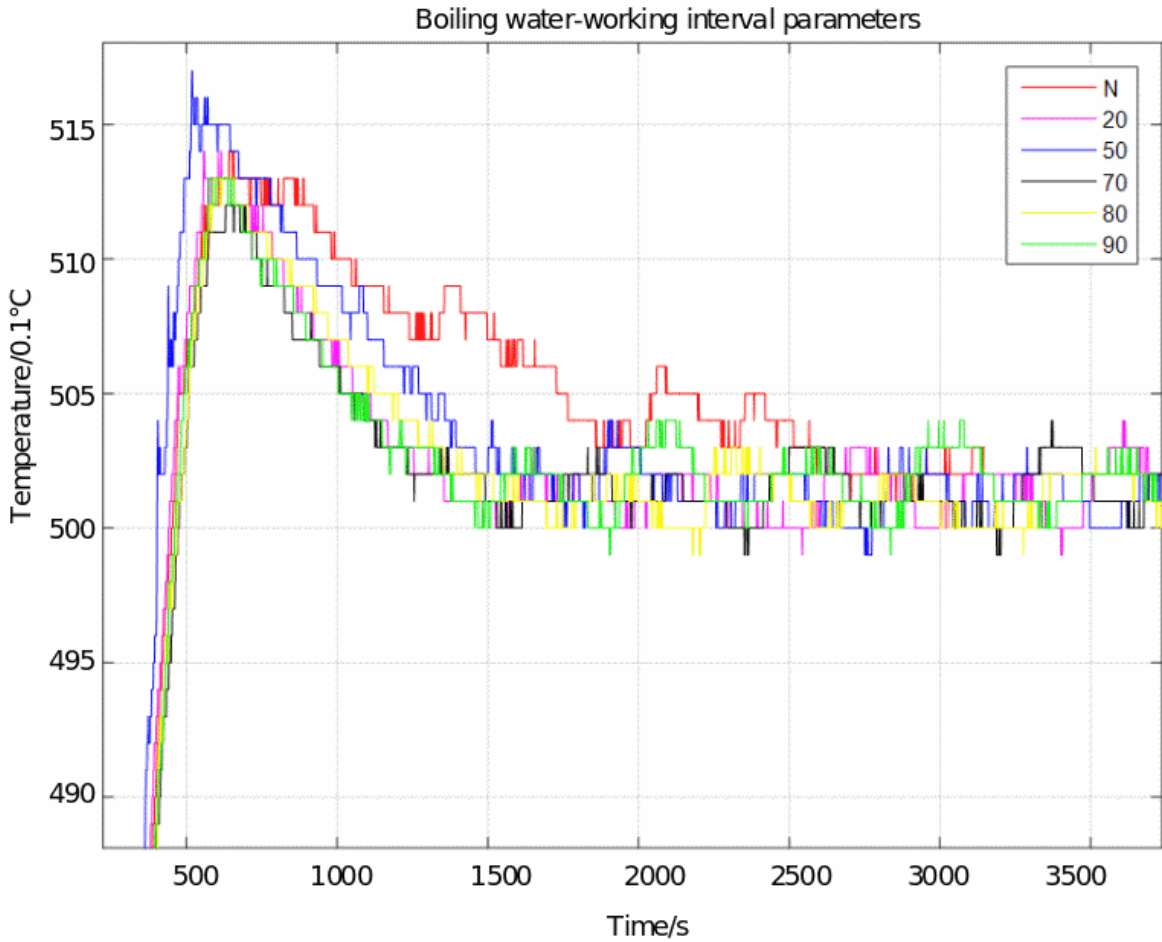


Figure 5 Process curve under different filtering parameters

The figure above is the experimental result under the small overshoot coefficient, the sample time is 1s. The coefficients of the first-order inertial filtering are (20, 50, 70, 80, 90). After adding the inertia coefficient, the stability time of system control is greatly accelerated, and it is increased by about 6 minutes for the boiling water experiment. The overshoot is about 1.2°C to 1.7°C.

Therefore, the introduction of first-order inertial filtering could greatly improve the PID environment where the temperature fluctuates to a certain extent and increase stabilization time.

**#Note:** This parameter of filter coefficient is helpful for systems with not very large hysteresis or the control effect of the phenomenon that the control amount fluctuates back and forth has been greatly improved.

4) The difference in mode selection

0: Overshoot allowed (ukd = 100)

1: Small overshoot or no overshoot (ukd = 300)

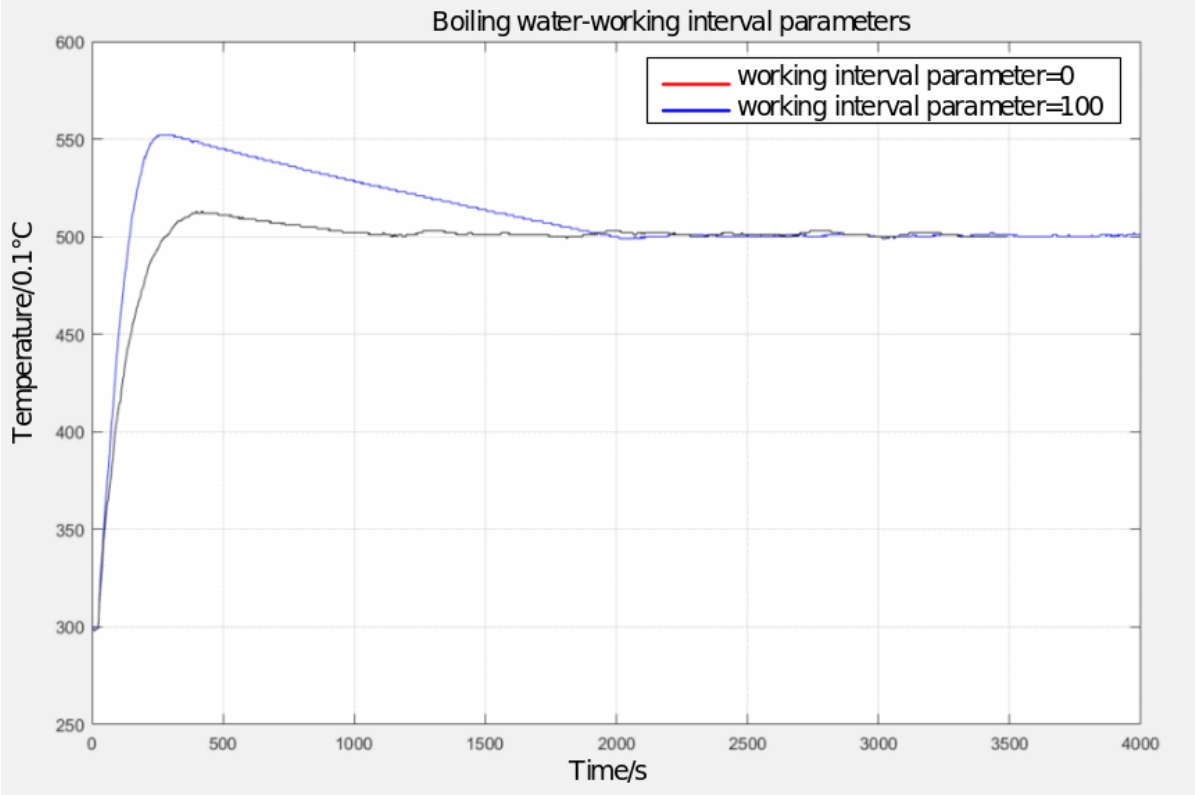


Figure 6 Process curves in different working modes

When selecting mode 1 (small overshoot or no overshoot), the stable temperature may be slightly higher than the set temperature (fluctuates above the set temperature).

5) The function of the coefficient

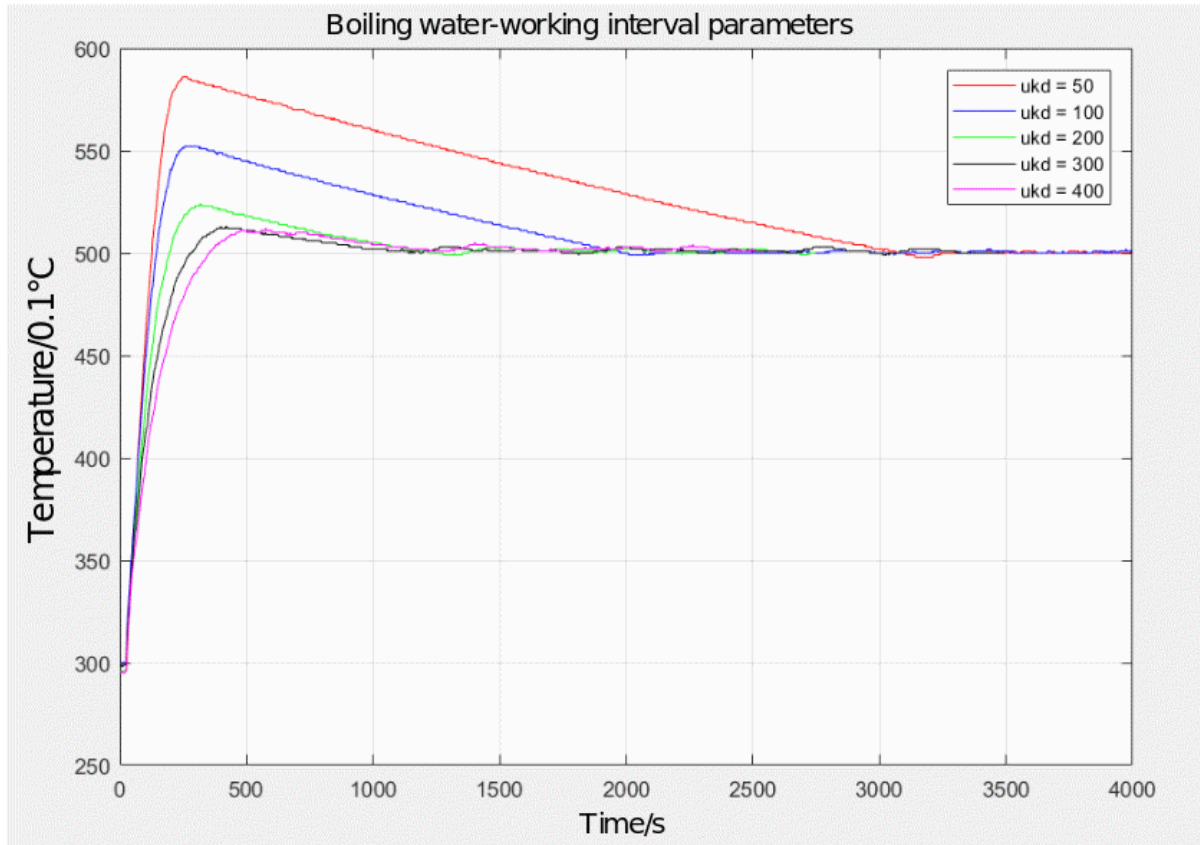


Figure 7 Process curve under dynamic setting

When selecting working mode 2, there are three corresponding adjustable parameters:  $ukp[S3+10]$ ,  $uki[S3+11]$ ,  $ukd[S3+12]$ . Usually, the default parameters can be used for  $ukp$  and  $uki$ . Adjust the value of  $ukd$  could achieve the control effect.

$Ukp$  is adjusted when the value of  $Kp$  reaches the maximum value, and the default value is usually 100.

$Uki$  is adjusted when periodic oscillations occur. Gradually increase the value of  $uki$  to track the control effect.