T-solution Leader in Electrics & Automation

User Manual

GLOFA G3F-PIDB G4F-PIDB

LS Programmable Logic Controller

Safety Instructions

- Read this manual carefully before installing, wiring, operating, servicing or inspecting this equipment.
- Keep this manual within easy reach for quick reference.

LS Industrial Systems
www.lsis.biz

SAFETY PRECAUTIONS

Be sure to read carefully the safety precautions given in data sheet and user's manual before operating the module and follow them.

The precautions explained here only apply to the G3F-PIDB and G4F-PIDB.

For safety precautions on the PLC system, see the GLOFA GM3/4 User's Manuals.

A precaution is given with a hazard alert triangular symbol to call your attention, and precautions are represented as follows according to the degree of hazard.

! WARNING	If not provided with proper prevention, it can cause death or fatal injury or considerable loss of property.
! CAUTION	If not properly observed, it can cause a hazard situation to result in severe or slight injury or a loss of property.

However, a precaution followed with ! CAUTION can also result in serious conditions.

Both of two symbols indicate that an important content is mentioned, therefore, be sure to observe it.

Keep this manual handy for your quick reference in necessary.

Installation Precautions

CAUTION

- Operate the PLC in the environment conditions given in the general specifications.
- If operated in other environment not specified in the general specifications, it can cause an electric shock, a fire, malfunction or damage or degradation of the module
- Make sure the module fixing projections is inserted into the module fixing hole and fixed.
- Improper installation of the module can cause malfunction, disorder or falling.

Test Run and Maintenance Precautions

CAUTION

- Do not separate the module from the printed circuit board(PCB), or do not remodel the module.
  They can cause disorder, malfunction, damage of the module or a fire.
  When mounting or dismounting the module, perform them after the power has been turned off.
- Do not perform works while the power is applied, which can cause disorder or malfunction.

Waste Disposal Precautions

CAUTION

- When disposing the module, do it as an industrial waste.

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Chapter 7. DEDICATED INSTRUCTIONS FOR SPECIAL MODULES

Chapter 8. PROGRAMMING

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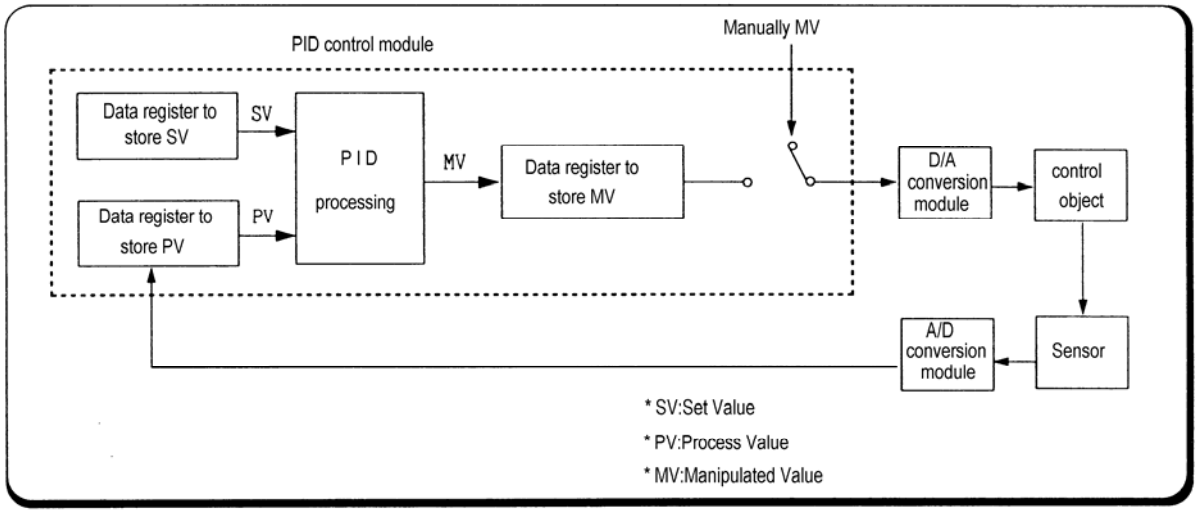
Chapter 1. INTRODUCTION

These two modules are called G3F-PIDB and G4F-PIDB. The G3F-PIDB is used with the CPU of GLOFA PLC GM1.2.3 series and MASTER-K 1000S series , The G4F-PIDB is used with the CPU of GM4 series and MASTER-K 300S series. Hereafter, the two modules will be commonly called the PID control module.

PID control means a control action that in order to keep the object at a value set beforehand (SV), it compares the SV with a sensor-measured value (PV) and when a difference between them is detected the controller makes PV come to be SV by adjusting output to eliminate the difference. The PID control is composed of combinations of Proportional (P), Integral (I) and Derivative (D) actions.

When a difference between SV and PV occurs, proportional, integral, differential quantities are calculated upon that difference and a MV(Manipulated Value) is output.



1.1 Features

The features of the PID control module are as follows.

1) One module can control various processes separately and at the same time.
2) Forward/reverse action selection is available.
3) Manually manipulated out (forced to be output by the user), not operation processing output, is available.
4) The number of modules available on one base unit is unlimited.
5) auto-tuning function finds the value of P,I,D constant automatically

Chapter 2. SPECIFICATIONS

2.1 General Specifications

Table 2.1 shows the general specifications of GLOFA GM series and MASTER-K series.

<table>
<tr><th>No</th><th>Items</th><th colspan="6">Specifications</th><th>Standard</th></tr>
<tr><td>1</td><td>Operating ambient temperature</td><td colspan="6">0 ~ 55℃</td><td></td></tr>
<tr><td>2</td><td>Storage ambient temperature</td><td colspan="6">-25 ~ 75℃</td><td></td></tr>
<tr><td>3</td><td>Operating ambient humidity</td><td colspan="6">5 ~ 95%RH, non-condensing</td><td></td></tr>
<tr><td>4</td><td>Storage ambient humidity</td><td colspan="6">5 ~ 95%RH, non-condensing</td><td></td></tr>
<tr><td rowspan="8">5</td><td rowspan="8">Vibration</td><td colspan="5">Occasional vibration</td><td rowspan="8">10 times in each direction for X, Y, Z</td><td rowspan="8">IEC 61131-2</td></tr>
<tr><td>Frequency</td><td>Acceleration</td><td colspan="2">Amplitude</td></tr>
<tr><td>10≤f∠57 Hz</td><td>-</td><td colspan="2">0.075 mm</td></tr>
<tr><td>57 ≤f≤150 Hz</td><td>9.8㎨ {1G}</td><td colspan="2">-</td></tr>
<tr><td colspan="5">Continuous vibration</td></tr>
<tr><td>Frequency</td><td>Acceleration</td><td colspan="2">Amplitude</td></tr>
<tr><td>10≤f∠57 Hz</td><td>-</td><td colspan="2">0.035 mm</td></tr>
<tr><td>57≤f≤150 Hz</td><td>4.9㎨ {0.5G}</td><td colspan="2">-</td></tr>
<tr><td>6</td><td>Shocks</td><td colspan="6">*Maximum shock acceleration: 147 ㎨ {15G}
*Duration time :11 ms
*Pulse wave: half sine wave pulse(3 times in each of X, Y and Z directions)</td><td>IEC 61131-2</td></tr>
<tr><td rowspan="6">7</td><td rowspan="6">Noise immunity</td><td colspan="2">Square wave impulse noise</td><td colspan="4">±1,500 V</td><td>LGIS Standard</td></tr>
<tr><td colspan="2">Electrostatic discharge</td><td colspan="4">Voltage :4kV(contact discharge)</td><td>IEC 61131-2
IEC1000-4-2</td></tr>
<tr><td colspan="2">Radiated electromagnetic field</td><td colspan="4">27 ~ 500 MHz, 10 V/m</td><td>IEC 61131-2
IEC 1000-4-3</td></tr>
<tr><td rowspan="2">Fast transient burst noise</td><td>Severity Level</td><td>All power modules</td><td>Digital I/Os (Ue ≥ 24 V)</td><td>Digital I/Os (Ue < 24 V) Analog I/Os communication I/Os</td><td rowspan="2">IEC 61131-2
IEC1000-4-4</td></tr>
<tr><td>Voltage</td><td>2 kV</td><td>1 kV</td><td>0.25 kV</td></tr>
<tr><td>8</td><td>Operating atmosphere</td><td colspan="6">Free from corrosive gases and excessive dust</td><td></td></tr>
<tr><td>9</td><td>Altitude for use</td><td colspan="6">Up to 2,000m</td><td></td></tr>
<tr><td>10</td><td>Pollution degree</td><td colspan="6">2 or lower</td><td></td></tr>
<tr><td>11</td><td>Cooling method</td><td colspan="6">Self-cooling</td><td></td></tr>
</table>

[Table 2.1] General specifications

REMARK

1) IEC(International Electrotechnical Commission)

: The international civilian organization which produces standards for electrical and electronics industry.

2) Pollution degree

: It indicates a standard of operating ambient pollution level.

The pollution degree 2 means the condition in which normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

2.2 Performance Specifications

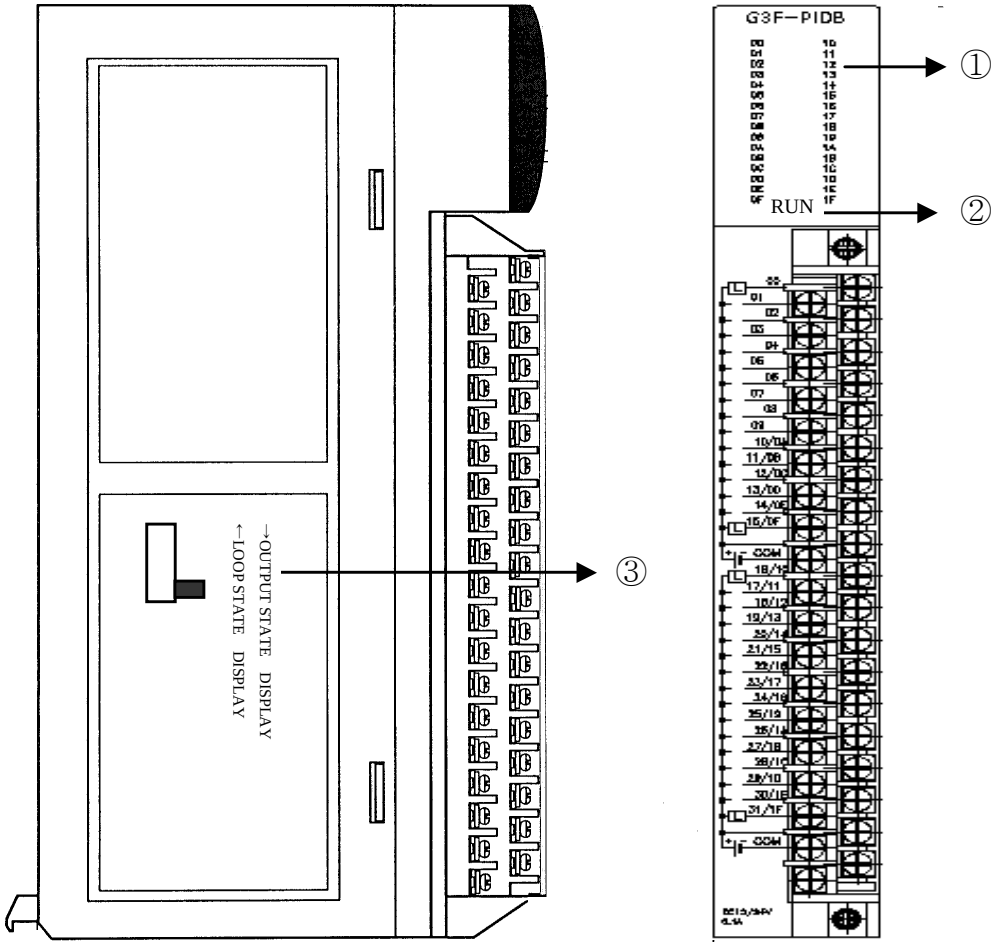
Table. 2.2 shows performance specifications of the high speed PID control module.

Item		Specification	
		G3F-PIDB	G4F-PIDB
I/O Points		16 Points	
Setting range of PID constants	Proportional constant (P)	0.01 ~ 100.00[%] (When the integral and derivative constants are set to 0.0 sec, the proportional action is applied.)	
	Integral constant (I)	0.0 ~ 3000.0 sec (When the integral constant is set to 0.0 sec, the integral action is not applied.)	
	Derivative constant (D)	0.0 ~ 3000.0 sec (When the derivative constant is set to 0.0 sec, the derivative action is not applied.)	
Setting range: SV (Set Value)		0 ~ 16,000	
Input range: PV (Process Value)		0 ~ 16,000	
Output range: MV (Manipulated Value)		0 ~ 16,000	
Setting range: M_MV (Manually Manipulated value)		0 ~ 16,000	
Number of PID control loops		32	16
Control action		PID Control (Auto-tuning function) ON/OFF Control Manual output	
Control cycle		0.01~99.99 sec	
Control type		Measured value derivative type (Pre-derivative type)	
Output	Type	Open Collector (Sink type)	
	Points		
	Output control cycle	1 ~ 100 sec	
	Rated load voltage	DC12/24V	
	Voltage range	DC10.2~26.4V	
	Maximum load current	0.1A/1 point, 1.5A/1 COM	
	Response time	2 ㎳	
	Common type	16point/1COM	
	Minimum pulse output	1 ㎳(1/1000:1 ㎳ unit output)	
LED 표시	RUN / STOP	▶ stop : RUN LED Off ▶ Run : Run LED→ RUN LED On Output display→RUN LED flickering ▶Auto- tuning : RUN LED On Run or Output display are selecting by switch on product	
	NORMAL/ERROR	Normal: RUN LED ON Error: RUN LED flickering	
Internal current consumption		0.7 A	0.6 A
Weight		510 g	300 g

[Table 2.2] Performance specifications

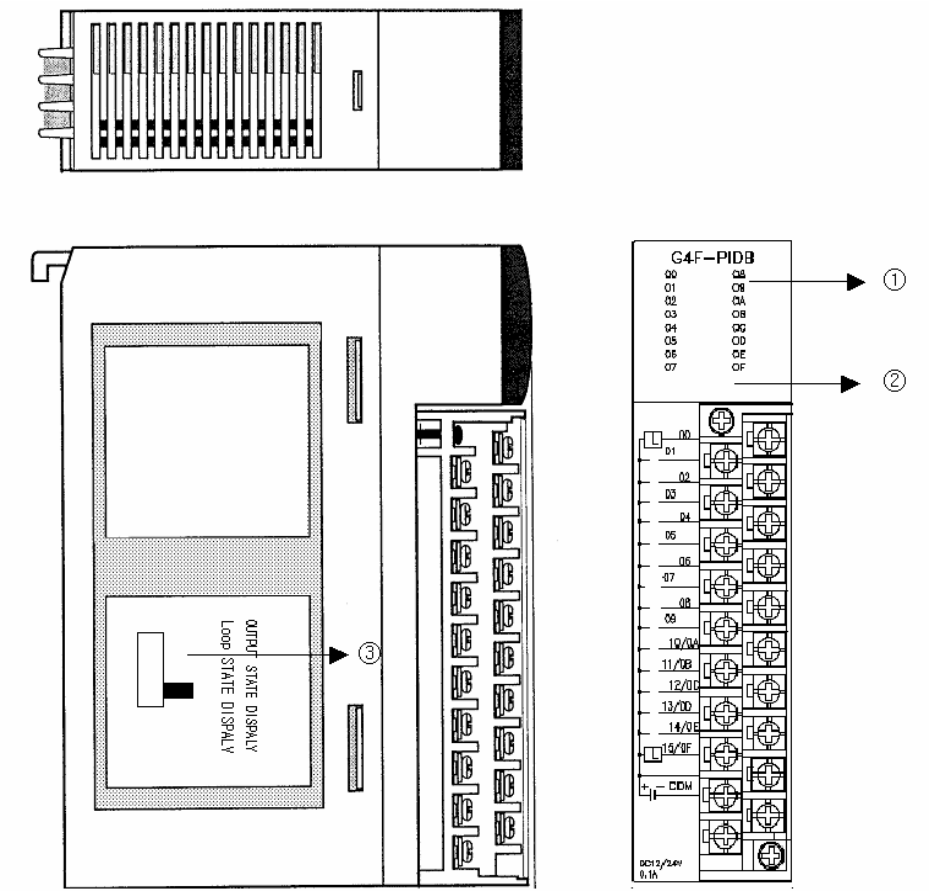
2.3 Names of Parts and Functions

Following gives names of parts.
1)G3F-PIDB



No.	Descriptions
①	Loop Run LED It shows the PID control module run status. ON : The corresponding loop is running OFF : The corresponding loop is stopping
②	RUN LED It shows the PID module Operating status.. ON: Normal, Running the Auto-tuning Flickering : Error ,LED display switch is selecting output state
③	LED display switch Loop State Display : Display Loop Running state Output State Display : Display TR Output(PWM Output)

2)G4F-PIDB



No.	Descriptions
①	Loop Run LED It shows the PID control module run status. ON : The corresponding loop is running OFF : The corresponding loop is stopping
②	RUN LED It shows the PID module Operating status.. ON: Normal, Running the Auto-tuning Flickering : Error ,LED display switch is selecting output state
③	LED display switch Loop State Display : Display Loop Running state Output State Display : Display TR Output(PWM Output)

2.4 PID Control Action

2.4.1 Processing type

1) Velocity type

Velocity type is a processing that in PID processing, the process Manipulated Value(MV) is obtained by adding the calculated variation of MV (ΔMV) to the previous MV

$$MV_n = MV_{n-1} + \Delta MV_n$$

MV_n : Present Manipulated Value

MV_{n-1} : Previous Manipulated Value

ΔMV_n : Variation of the Previous Manipulated Value

2) Measured Value Derivative Type (Pre-derivative)

Measured value derivative processing, in PID processing, uses the process value(PV) for the derivative term. Generally, PID processing, when a deviation occurs, operates toward the direction in which the deviation will be reduced.
The deviation occurs due to alteration of set value(SV) or outside disturbances. Therefore, if the deviation is used in the derivative processing, the output of the derivative term changes rapidly when the deviation occur due to alteration of set value (SV). So, to prevent raid changes like that, this processing uses the process value(PV) for the derivative term.

$$MV_n = MV_{n-1} + K_p \cdot (E_n - E_{n-1}) + K_p \cdot S/K_I \cdot E_n + K_p \cdot K_d/S \cdot (2PV_n - PV_{n-1} - PV_{n-2})$$

MV_n : Manipulated Value

MV_{n-1} : Previous Manipulated Value

ΔMV_n : Variation of the Previous Manipulated Value

E_n : present Deviation

E_{n-1} : Previous Deviation

K_p : Proportional Constant

K_i : Integral Constant

K_d : Derivative Constant

S : Control Cycle (100ms)

PV_n : present Process Value

PV_{n-1} : One-step previous Process Value

PV_{n-2} : Two-step previous Process Value

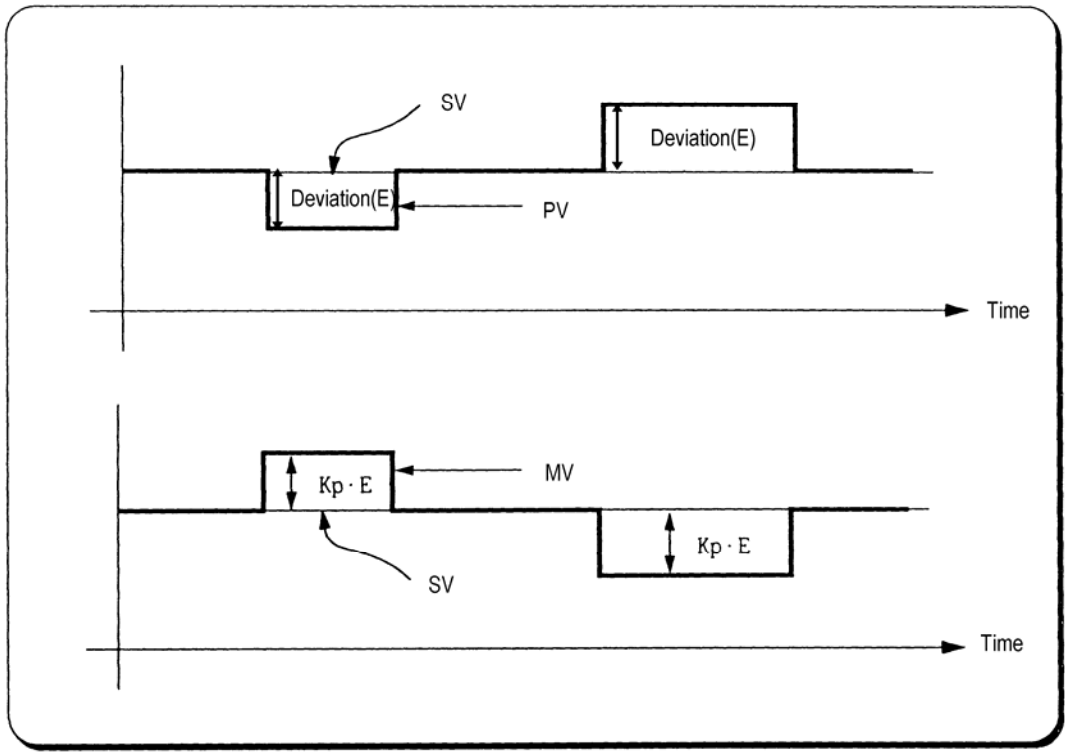
2.4.2 Control Action

1) Proportional Action (P Action)

(1) P action means a control action that obtains a MV which is proportional to the deviation (E: the difference between SV and PV).
(2) The expression which denotes the change relationship of E to MV in P action is shown as follows:

$$MV = Kp \times E$$

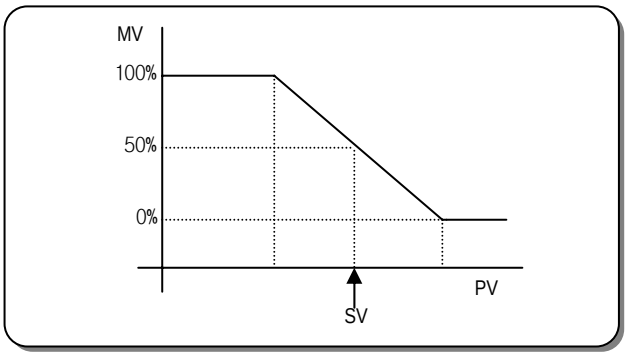
where Kp is a proportional constant and means gain.
(3) When deviation occurs, the MV by P action is shown in Fig. 2.1.



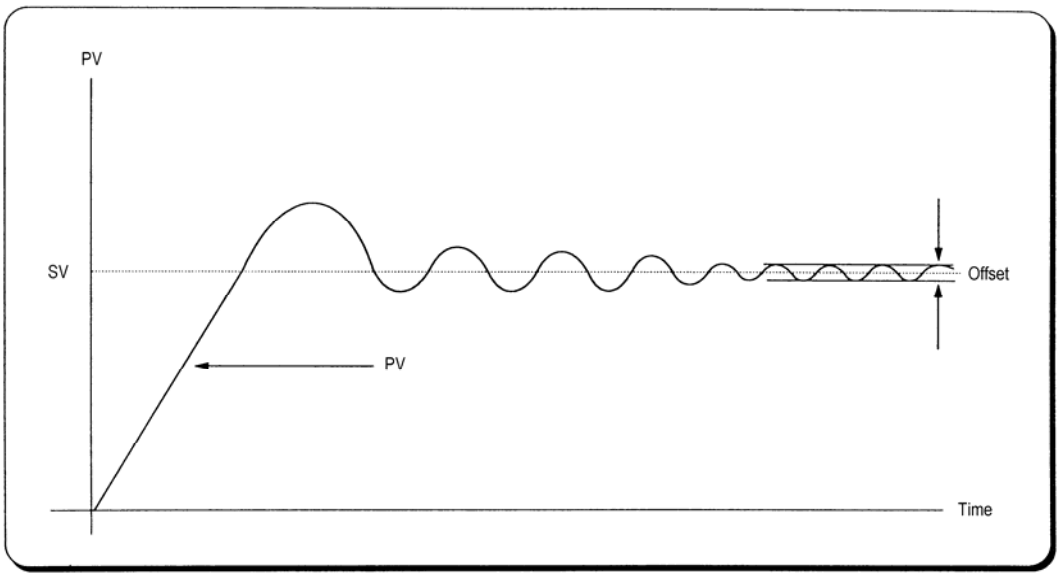
[Fig. 2.1] MV with the proportional action

(4) As shown in Fig. 2.1, the larger the proportional constant Kp the larger the MV, that is, the stronger the P action when the deviation(E) is same . Also, the smaller the Kp the smaller the MV after P action.
(5) If the Kp is too large, PV reaches SV swiftly but can make bad effects like oscillations shown in Fig. 2.3 and cause damage in control stability.
(6) If the Kp is too small, oscillations do not occur but the velocity with which PV reaches SV slows down and offset can happen as shown in Fig. 2.4.
(7) Manipulated Value varies within 0 to 16,000.

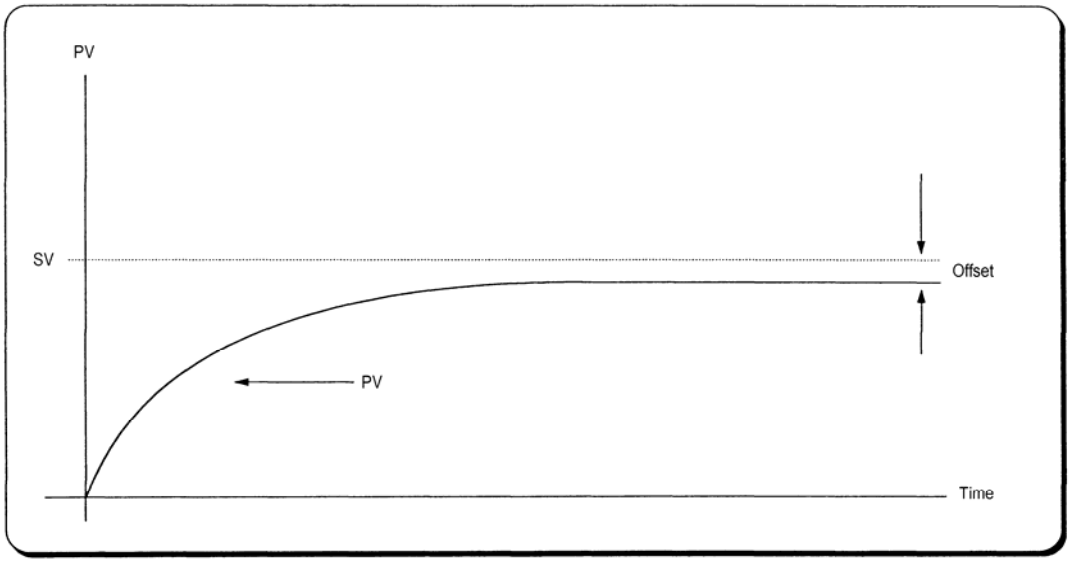
(8) P action MV Output graph for forward action



[Fig. 2.2] P Action MV output graph



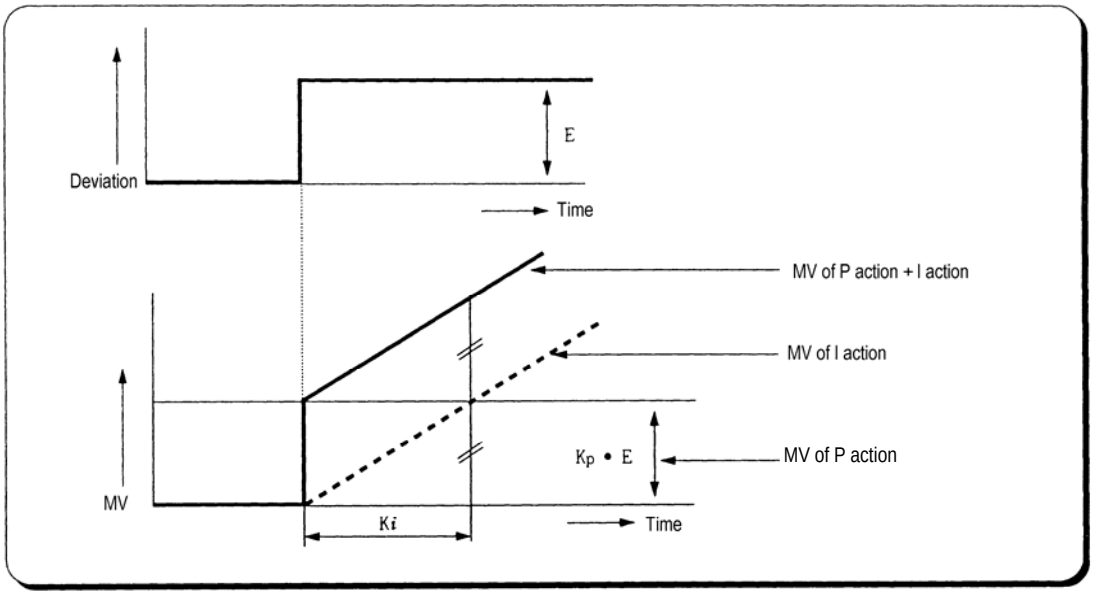
[Fig. 2.3] When the proportional constant Kp is large.



[Fig. 2.4] When the proportional constant Kp is small.

2) Integral Action (I Aaction)

(1) When a deviation(E) occurs between SV and PV, Integral action continuously adds the deviation to or subtracts it from the MV in accordance time in order to eliminate the deviation
When a deviation is small it is not expected that the MV will be changed by P action but I action will eliminate it.
Therefore, the offset which occurs in P action can be eliminated by I action.
(2) The period of the time from when the deviation has occurred in I action to when the MV of I action become that of P action is called Integration time and represented as Ki.
(3) Integral action when a given deviation has occurred is shown as the following Fig. 2.5.

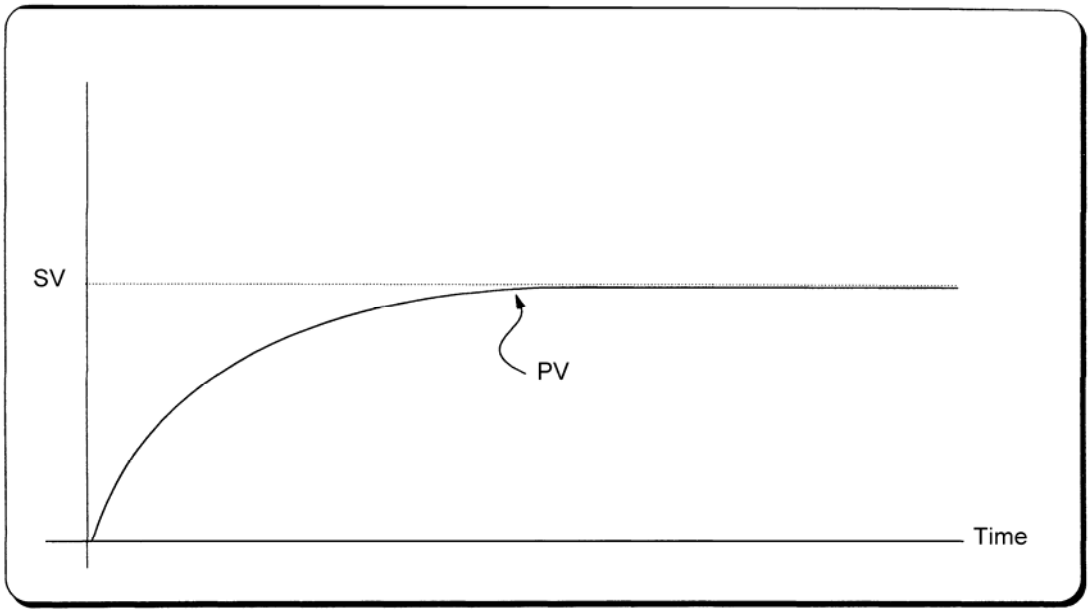


[Fig. 2.5] Integral action at a constant deviation

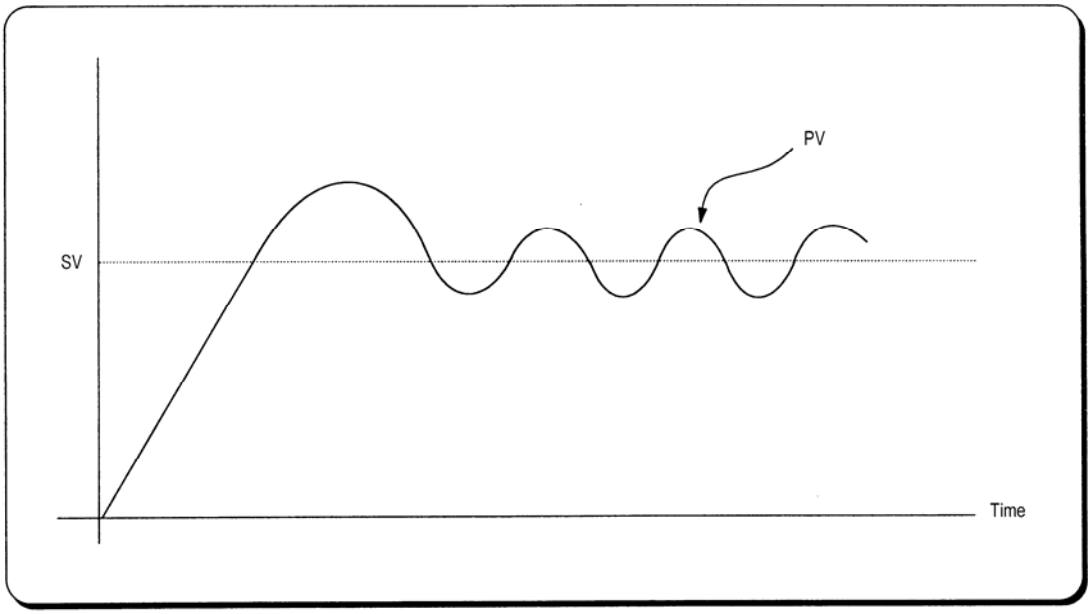
(4) Expression of Integral Action is as follows:

$$MV = P \times E + P \times \frac{1}{Ki} \times \int Edt$$

As shown in the expression, Integral action can be made stronger or weaker by adjusting integration time (Ki) in I action.
That is, the more the integration time (the longer the integration time) as shown in Fig. 2.6, the lesser the quantity added to or subtracted from the MV and the longer the time needed for the PV to reach the SV.
As shown in Fig. 2.7, when the integration time given is short the PV will approach the SV in short time since the quantity added or subtracted become increased. But, If the integration time is too short then oscillations occurs, therefore, the proper P.I value is requested.
(5) Integral action is used in either PI action in which P action combines with I action or PID action in which P and D actions combine with I action.



[Fig. 2.5] When a long integration time is given.



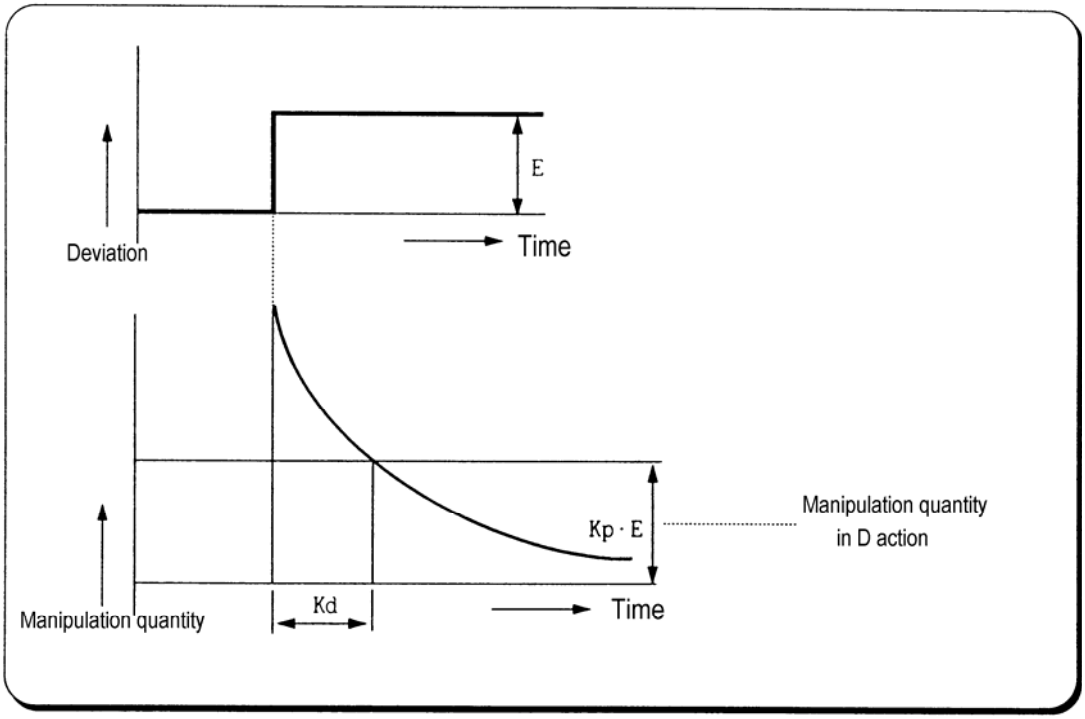
[Fig. 2.6] When a short integration time is given.

3) Derivative Action (D Action)

(1) When a deviation occurs due to alteration of SV or external disturbances, D action restrains the changes of the deviation by producing MV which is proportioned with the change velocity (a velocity whose deviation changes at every constant interval) in order to eliminate the deviation.
- D action gives quick response to control action and has an effect to reduce swiftly the deviation by applying a large control action (in the direction that the deviation will be eliminated) at the earlier time that the deviation occurs.
- D action can prevent the large changes of control object due to external conditions.

(2) The period of time from when the deviation has occurred to when the MV of D action become the MV of P action is called derivative time and represented as Kd.

(3) The D action when a given deviation occurred is shown as Fig. 2.8



[Fig. 2.8] Derivative action at a constant deviation

(4) The expression of D action is represented as follows:

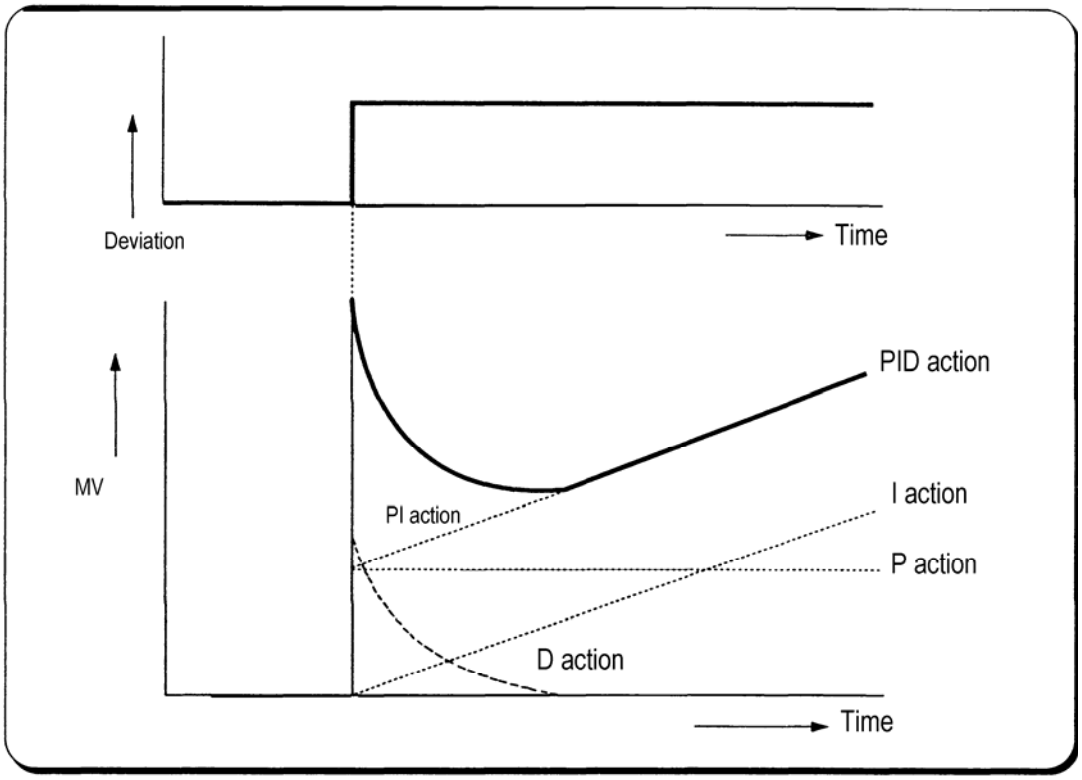
$$MV = K_p \times E + K_p \times \frac{dE}{dt}$$

- In this expression, an output proportional with the variation rate of deviation is added to P action quantity.
- If the derivative time is increased then P action is strengthened.
- D action is applied when a change of deviation occurs and the deviation at normal state become 0. D action, therefore, do not reduce offset.

(5) D action is used in either PD action in which P action combines with D action or PID action in which P and I actions combine with D action.

4) PID Action

(1) PID action controls the control object with the manipulation quantity produced by (P+I+D) action.
(2) PID action when a given deviation has occurred is shown as the following Fig. 2.9



[Fig. 2.9] PID action at a constant deviation

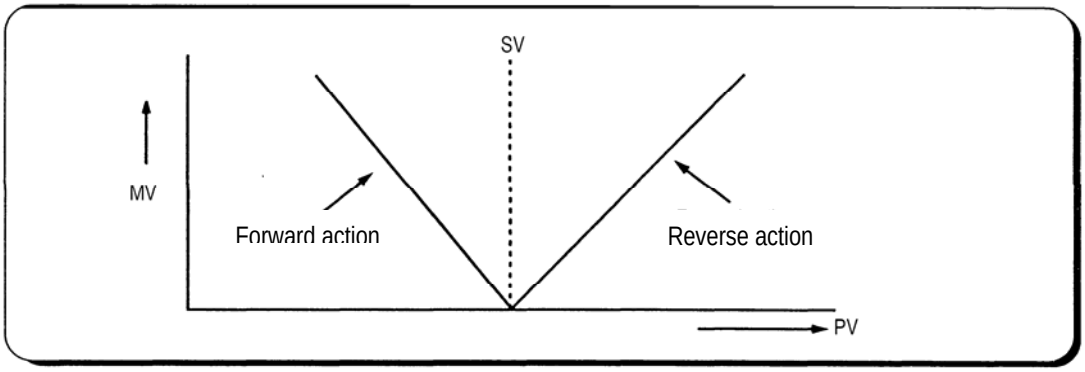
5) PID Processing Expression

PID expressions are of measured value derivative type.

Expressions	Parameters names
$E_n = SV - PV_n$ $MV_n = MV_{n-1} + K_p \times (E_n - E_{n-1})$ $+ K_p \times S/K_i \times E_n$ $+ K_p \times K_d/S \times (2PV_{n-1} - PV_n - PV_{n-2})$	MVn : Present Manipulated Value MVn-1 : One-step-previous Manipulated Value En : Process deviation En-1 : Previous deviation Kp : Proportional constant Ki : Integral constant Kd : Derivative constant S : Control cycle (100 ms) PVn : Process value PVn-1 : One-step-previous Process Value PVn-2 : Two-step-previous Process value

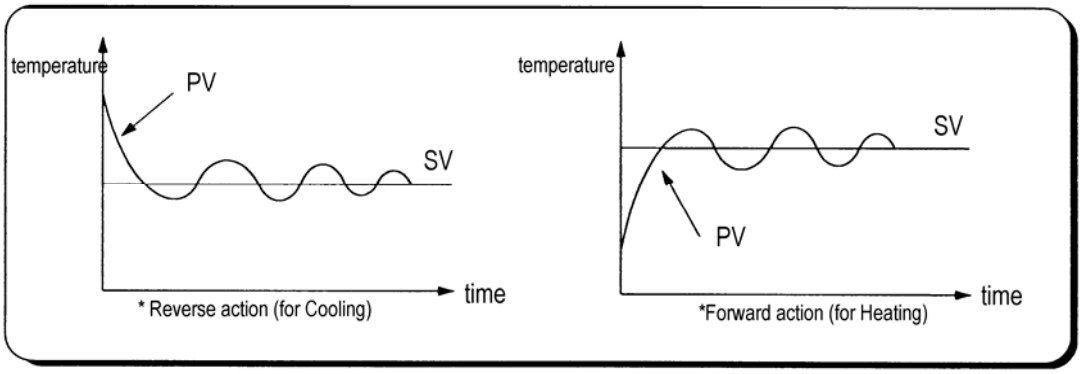
6) Forward/Reverse Actions

(1) PID control has two kinds of action, forward action and reverse action.
a) Forward action makes PV reach SV by outputting MV when PV is less than SV.
b) Reverse action makes PV reach SV by outputting MV when PV is more than SV.
(2) A diagram in which forward and reverse actions are drawn using MV, PV and SV is shown as Fig. 2.10



[Fig. 2.10] Forward and reverse action with MV, PV and SV

(3) Fig 2.11 shows examples of process control by forward and reverse actions, respectively.

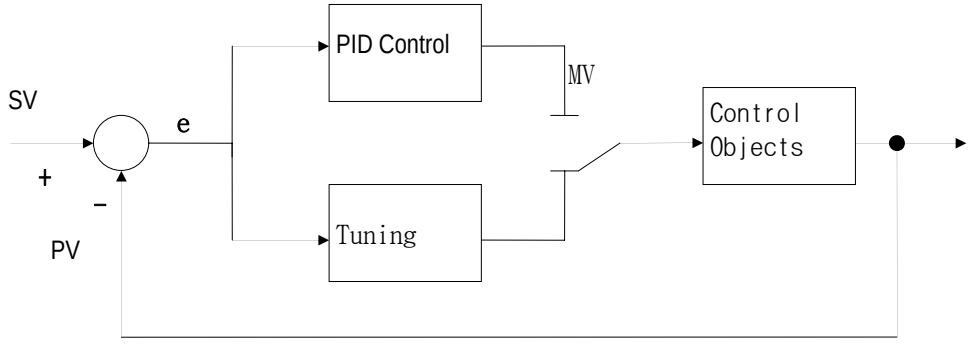


[Fig. 2.11] Examples of process control by forward and reverse actions

2.5 Auto-tuning

2.5.1 Auto-Tuning block Diagram

▶ Appropriate P, I, D constant shall be set to perform optimal control when PID control is applied. The function to find these parameters automatically is called Auto-Tuning.
▶ If Auto-Tuning command starts, PID control module stops PID calculation and moves to start Auto-Tuning.

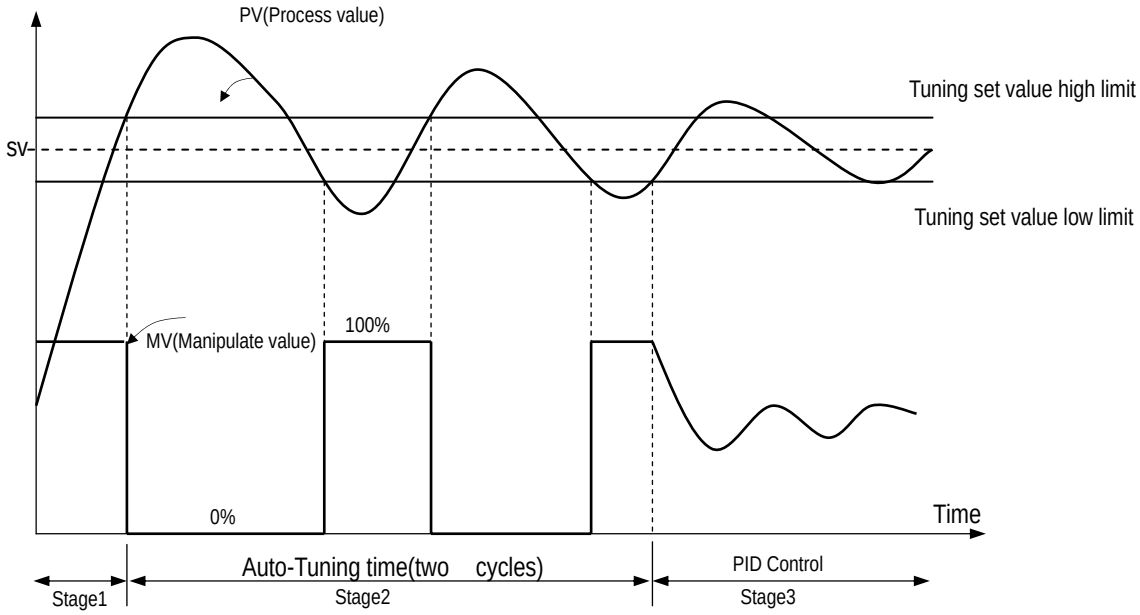


[Fig 2.12] Auto-Tuning block diagram

2.5.2 Sequence of Auto-Tuning

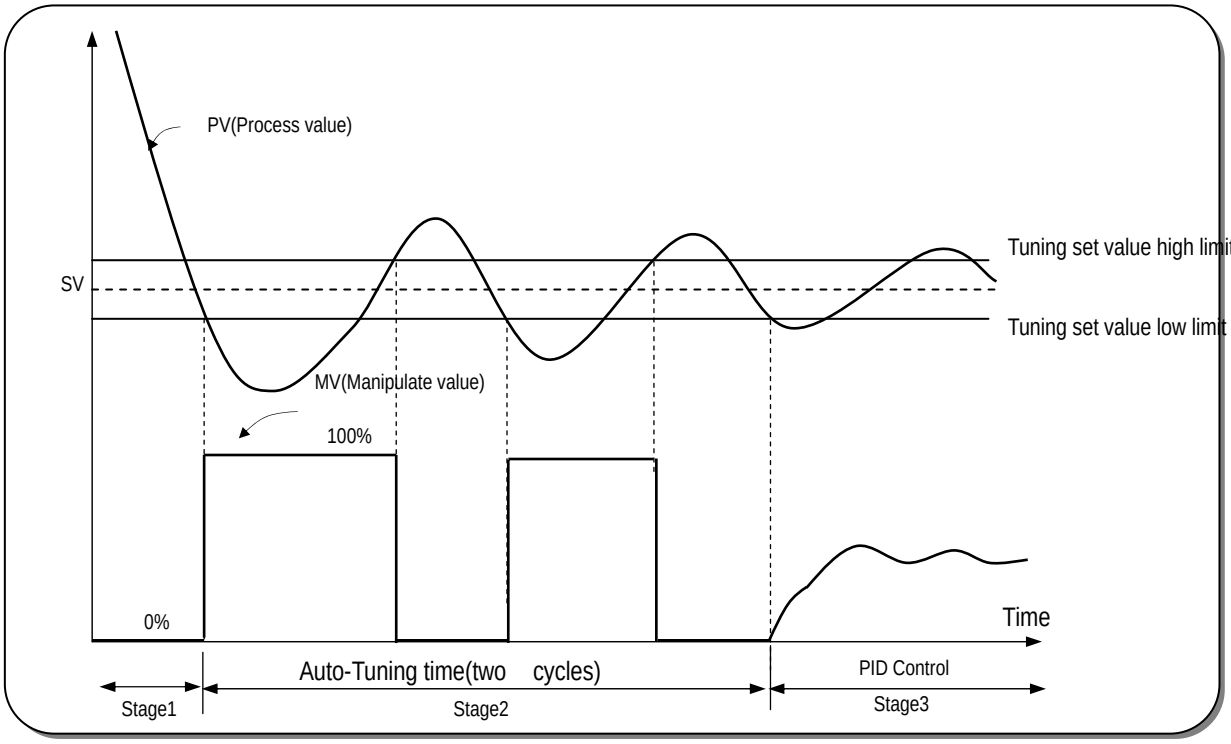
▶ Relay control method is applied to Auto-Tuning in PID module, which finds and selects P, I, D constant value of itself while watching the transition of the object to control using relay output.

(1) Forward action (if PV<SV)



[Fig1.13] Auto-Tuning Algorithm for Forward action

2) Reverse action (if PV<SV)



[Fig1.14] Auto-Tuning Algorithm for Reverse action

Stage 1) Distinction of forward/reverse

▶ By comparison between Process value(PV) and Tuning setting value(Set value:SV)
Forward : if the process value is lower than the tuning setting value
Reverse : if the process value is higher than the tuning setting value

Stage 2) Auto-tuning operation

Forward : Manipulated value is repeatedly output 2 cycles in order of min.(0% : 0) to max.(100% : 16000).
Reverse : Manipulated value is repeatedly output 2 cycles in order of max.(100% : 16000) to min.(0% : 0).

▶ If auto-tuning operation is complete as repeated as above, output variable END of auto-tuning value Read function block(PIDBAAT, PIDBAT) changes "0 ⇒ 1".
Thus, when output variable END of auto-tuning value Read function block changes "0 ⇒ 1" in program, P, I, D constant value shall be moved to input variable P, I, D of module initializing function block (PIDBAINI, PIDBINI)

Stage 3) PID calculation

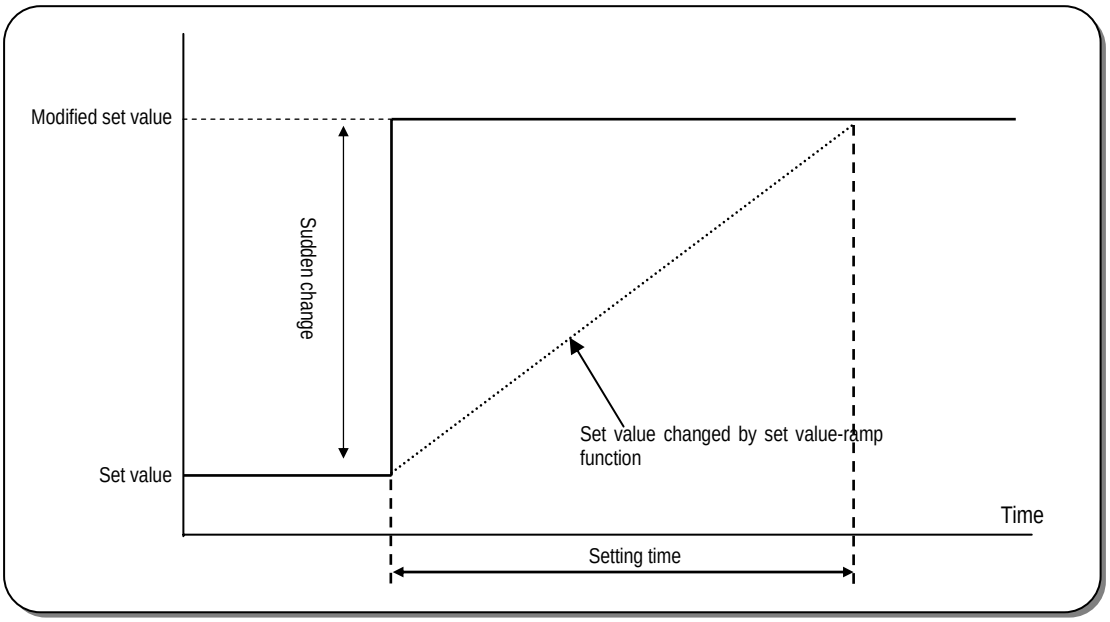
2.6 Set Value(SV) – Ramp function (Set value inclination function)

▶ Manipulated value changes by the change of difference the present value to the Manipulated value or by the change of Manipulated value if PID control is used. Thus, sudden change of the set value leads to sudden change of the manipulated value causing damage on the control object.

▶ Staged increasing or decreasing function of set value (SV) is the set value-ramp function to prevent set value setting from suddenly changed when modified.

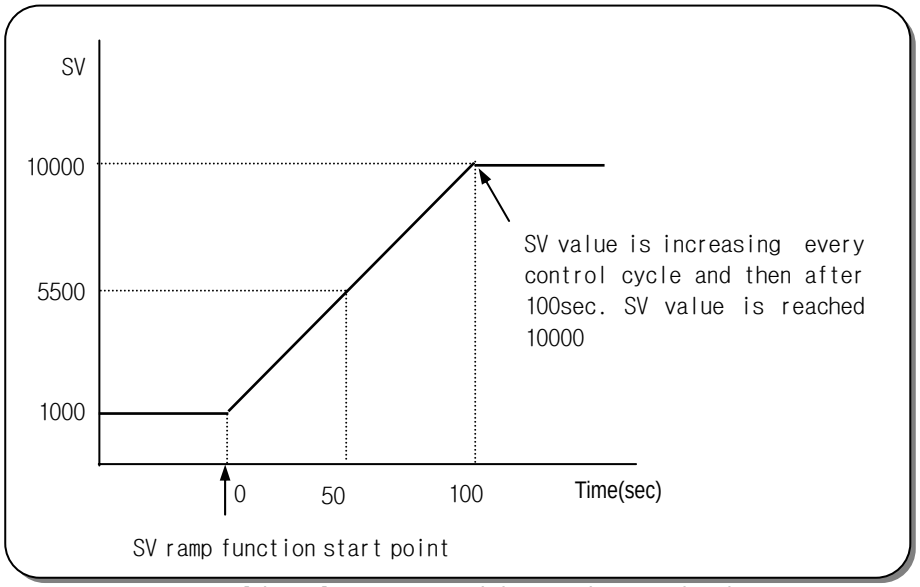
▶ Set value-ramp function setting time: 0 ~ 65,535(Unit:sec)

▶ Related function block: PIDBINI



[Fig1.15] Set value ramp function

▶ For example, SV_UP value of PIDBINI function block are setting 100 sec, Display SV value graph for Initial SV value is change from 1000 to 10000



[Fig1.16] SV output graph for set value ramp function

2.7 PWM control output

- ▶ PID Module has Tr output for PWM in every loop.
  Tr output drives SSR for PWM (ON/OFF Control for Pulse width)
- ▶ Control cycle varies within 1 to 100sec

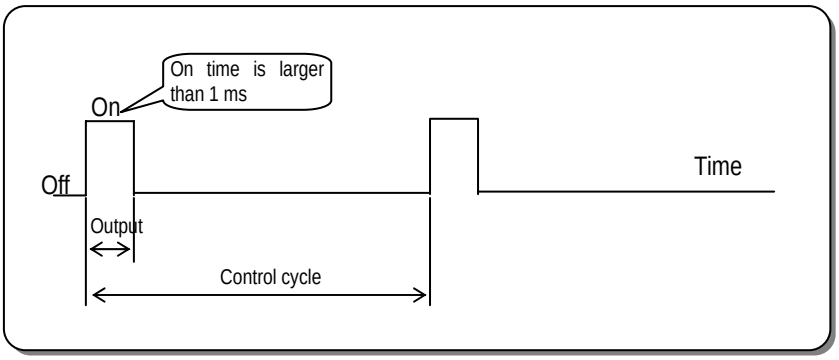
- ▶ Minimum pulse time is 1ms

$$ON\ \ time\ (\text{ms}) = \frac{Output\ \ Range\ (1000)}{MV\ \ Range\ (16000)} \times MV\ \ output\ \ value \times Output\ \ control\ \ cycle\ (S)$$

However pulse ON time round off the numbers to one decimal place

For example if the output control cycle is 1sec, MV 200 the output is 12.5.
In this case On time is 3ms and 987ms is OFF. Although MV is changed during the control cycle the output is not changed and PWM pulse is changed with the MV of the next 1s.

$$ON\ \ time\ (\text{ms}) = 1/16 \times 200 \times 1(S) = 12.5$$

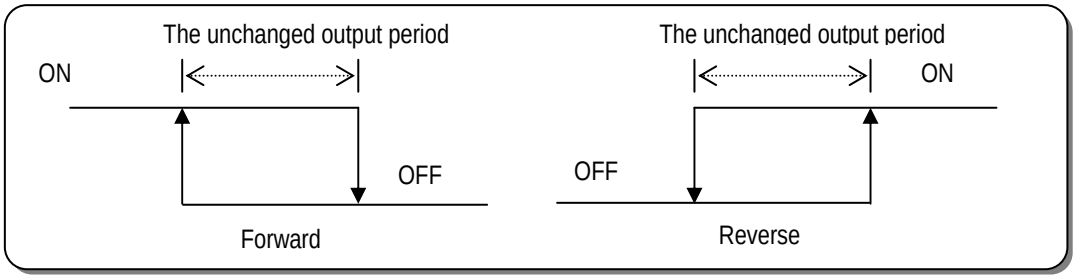


[Fig1.17] PWM Control output

- ▶ PWM control is one of the PID control.
- ▶ To use PWM control,TR output can be used by setting the function blocks as follows..
  OUT_EN of PIDBINI → 1
  OUT_PERD of PIDINI → Setting between 1~100 sec,(Control cycle)

2.8 ON/OFF Control

- ON/OFF control is a method controlling the output by comparing SV and MV.
  The unchanged output period is used to prevent the rapid variety of the output.
- In forward action, if PV is less than SV ON operation is executed and if PV is higher than SV OFF operation is executed.
  During OFF operation,if PV is decreased, MV is repeated ON/OFF near SV.
  It makes the operation unstable, the unchanged output period is used to be stable the output.

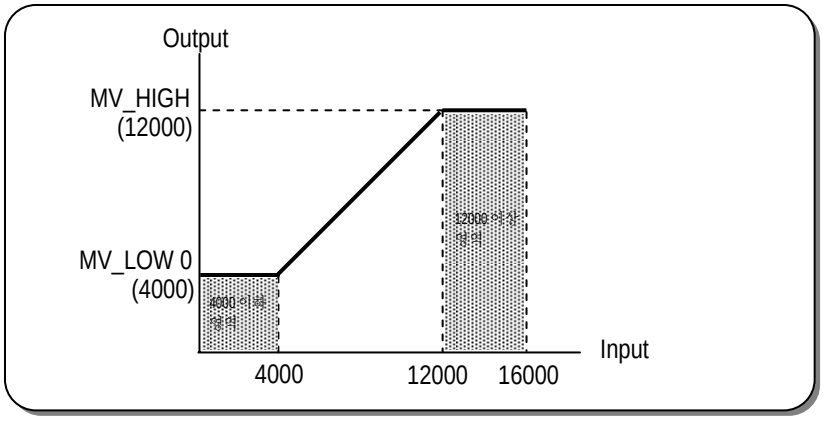


[Fig1.18] ON/OFF control by setting the The unchanged output period.

Example)When SV is 8000 in the forward action and ONOFF_HYS is 100.
If PV is increased and higher than 8000, the output is OFF and the cooling is processed.
If PV is less than 7900, the output is ON and the heating is processed.
Like the above, ON/OFF is not run between 7900~8000 and ON/OFF is run when the PV is out of the value(7900~8000). This area is called the unchanged output period.

2.9 Manipulated value upper/Lower LIMIT function

- The MV upper/lower limit function is executed with the default value(upper:16000,lower:0) although it's not set.
- If MV_HIGH is set at 12000 and MV_LOW 4000, MV is out 4000 when MV is less than 4000, 12000 when MV is higher than 12000, and if MV is 4000~12000 the same value is out.



[Fig1.19] MV value upper/lower limit

2.10 MV value output limit function

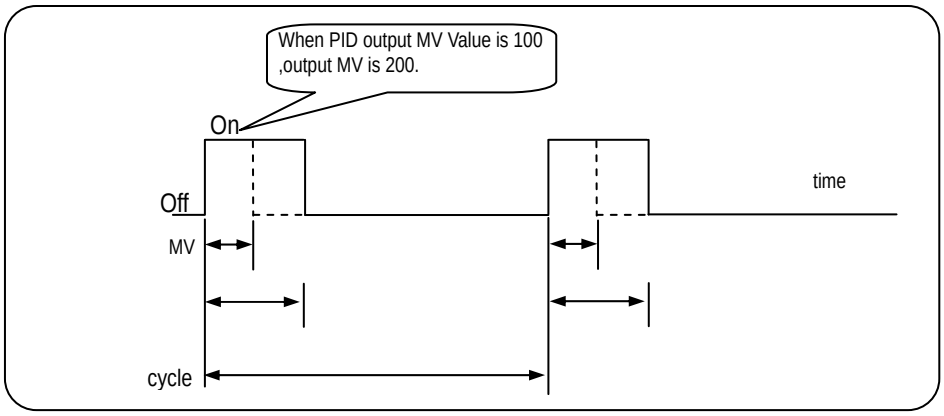
- MV value output limit function is executed with the default value(16000) although it's not set.
- When DELTA_MV is 12000, ΔMV_n is limited by 12000 according the following equation.

MV_n (MV output value) = MV_{n-1} (Previous MV value) + ΔMV_n(Varied MV value)

- According the above equation MV value is out and ΔMV_n is limited to 0~16000 to prevent the rapid variation.
  But if this value is limited so small, the time to reach at SV is needed more.

2.11 Output upper/lower limit function

- Output upper/lower limit function is executed with the default value(upper:1000,lower:0) although it's not set.
- Output upper/lower limit function is used to control PWM output value when MV's output is used as PWM control.
  If PWM control value is less than 200 it PWM is limited at 200, and the value is higher than 800 it PWM is limited at 800.
  If MV is 200~800 the same value is out.



[Fig1.20] PWM control output

2.12 Change from Manual control mode to PID control mode

- When Control mode changes from manual control mode to PID control mode, MV output Value starts manual MV value.

Chapter 3. INSTALLATION

3.1 Installation Ambience

This module has high reliability regardless of its installation ambience. But be sure to check the following for system in higher reliability and stability.

1) Ambience Requirements

Avoid installing this module in locations, which are subjected or exposed to:

- Water leakage and dust a large amount of dust, powder and other conductive power, oil mist, salt, of organic solvent exists.
- Mechanical vibrations of impacts are transmitted directly to the module body.
- Direct sunlight.
- Dew condensation due to sudden temperature change.
- High or low temperatures (outside the range of 0-55℃)

2) Installing and Wiring

- During wiring or other work, do not allow any wire scraps to enter into the PLC
- Install it on locations that are convenient for operation.
- Make sure that it is not located near high voltage equipment on the same panel.
- Make sure that the distance from the walls of duct and external equipment be 50 mm or more.
- Be sure to be grounded to locations that have good noise immunity.

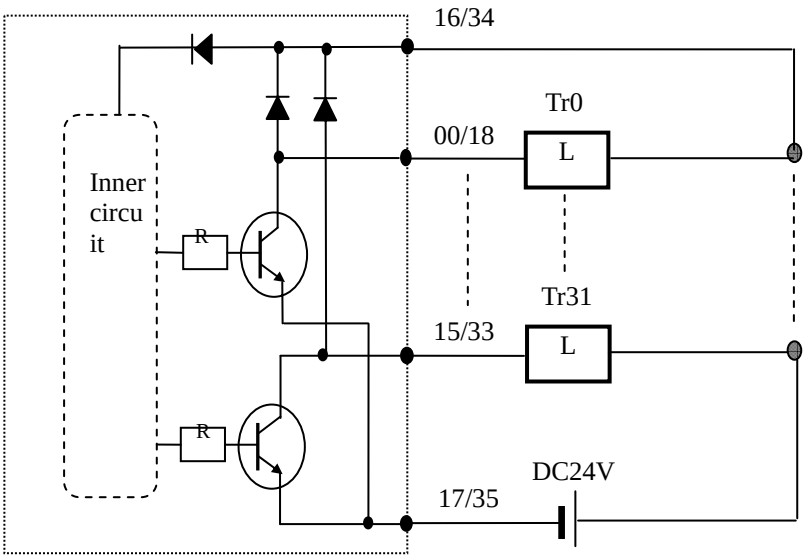
3.2 Handling Precautions

From unpacking to installing the PID control module, be sure to check the following:

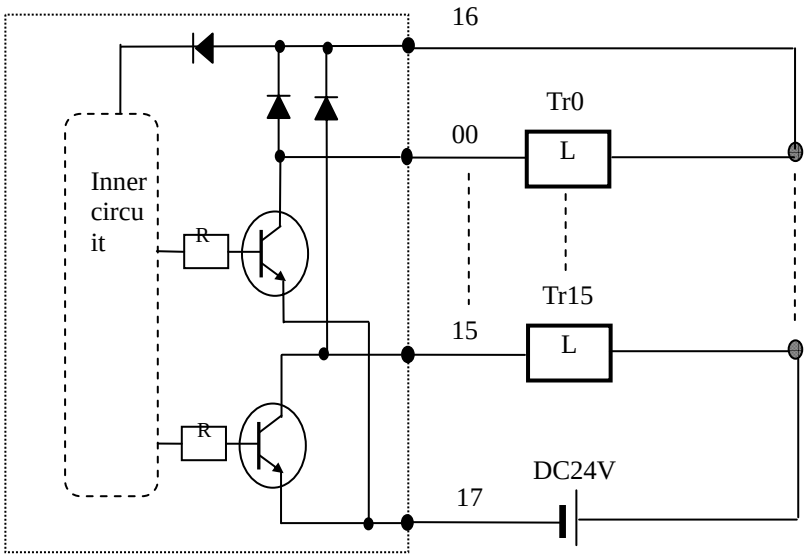
1) Do not drop it off, and make sure that strong impacts should not be applied.
2) Do not dismount printed circuit boards from the case. It can cause malfunctions.
3) During wiring, be sure to check any foreign matter like wire scraps should not enter into the upper side of the PLC, and in the event that foreign matter entered into it, always eliminate it.
4) Be sure to disconnect electrical power before mounting or dismounting the module.

Array of tremial block

1) G3F-PIDB



2) G4F-PIDB



Chapter 4 FUNCTION BLOCK

▶PID control module function blocks used in GMWIN are described below.

NO	G3F-PIDB	G4F-PIDB	Description
1	PIDBAINI	PIDBAINI	Module initialization (Array type)
2	PIDBINI	PIDBINI	Module initialization (Single type)
3	PIDBACAL	PIDBACAL	PID calculation (Array type)
4	PIDBCAL	PIDBCAL	PID calculation (Single type)
5	PIDBAAT	PIDBAAT	Auto Tuning (Array type)
6	PIDBAT	PIDBAT	Auto Tuning (Single type)

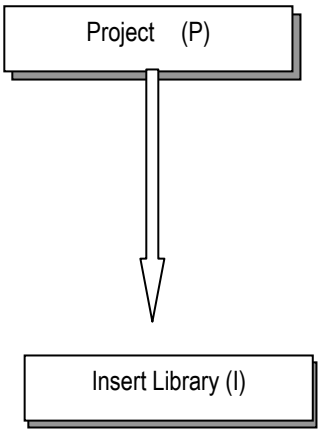
Remark

1. To operate PID calculation FB and Auto tuning FB simultaneously causes the malfunction.
2. Array number of 4.2※1 is G3F- PIDB :32, G4F-PIDB: 16.

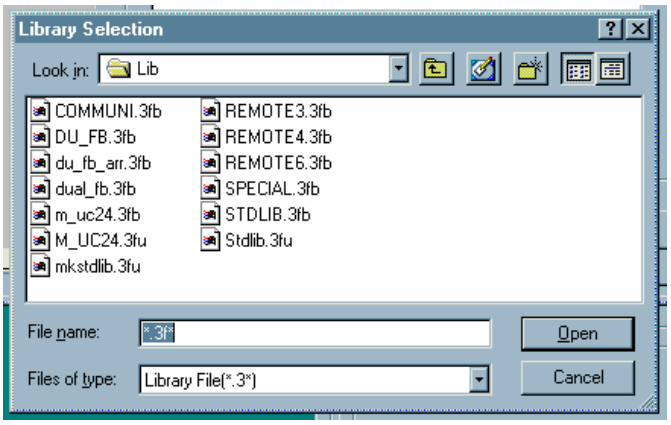
4.1 Insertion of the function blocks for the PID control module on the GMWIN

▶Function blocks can be inserted with the following procedures while the GMWIN is running.

▶ Inserting a function block is only possible when a project is open.



■GMWIN V4.0



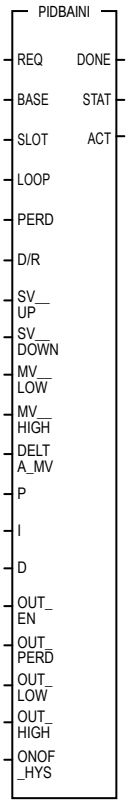
G3F-PIDB
1. Special.3fb
2. Remote3.3fb
3. Remote4.3fb
4. Remote6.3fb

G4F-PIDB
1. Special.4fb
2. Remote3.4fb
3. Remote4.4fb
4. Remote6.4fb

4.2 Function block used in PID control module

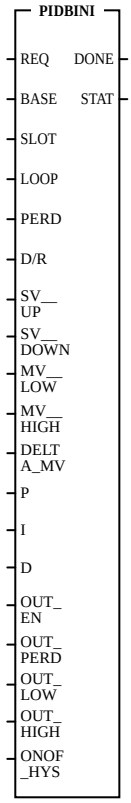
4.2.1Module initialization for array type (PIDBAINI)

Module initialization function block specifies PID control module base location, slot location, run loop enable/disable and forward/reverse action, and sets MV, M_MV and P.I.D constants for use in program so on.

Function Block	I/O	Variable	Data Type	Descriptions
	Input	REQ	BOOL	Function block execution request area ● Used to request an execution of the initialization function block ● If the conditions connected with this area are established while program is running and “0” changes into “1”, the initialization function block is executed
		BASE	USINT	Base location No. ● Used to write the base No. where the PID control module is mounted. ● Setting range: GM1 series (0~31), GM2 series (0~7), GM3/4 series (0-3)
		SLOT	USINT	Slot location No. ● Used to write slot No. where the PID control module is mounted. ● Setting range: 0~7
		LOOP	BOOL [ARRAY]*1	Run loop enable/disable specification ● Used to enable or disable a loop for run. ● Specify “1” for enabling, and “0” for disabling
		PERD	UINT [ARRAY]*1	Run loop control cycle (0.01 ~ 99.99sec) ● Setting range: 1 ~ 9999 ● If this value is not set or set as “0” this value is initialized as “1”.
		D/R	BOOL [ARRAY]*1	Forward/Reverse action specification for a run loop. ●Specify “0” for forward action and “1” for reverse action.
		SV_UP	UINT [ARRAY]*1	Setting a time until a run loop reaches at the target value when the target value rises. ●Setting range: 0~65535sec
		SV_DOWN	UINT [ARRAY]*1	Setting a time until a run loop reaches at the target value when the target value falls. ●Setting range: 0~65535sec
		MV_LOW	UINT [ARRAY]*1	Setting the low limit for the run loop ● Setting range: 0 ~ 16000 (The range should be within the high limit) [Refer 2.9]
		MV_HIGH	UINT [ARRAY]*1	Setting the high limit for the run loop ●Setting range: 1 ~ 16000 (The range should be within the high limit) ● If this value is not set or set as “0” this value is initialized as “16000”. (Refer 2.9)
		DELTA_MV	UINT [ARRAY]*1	Setting for the variable quantity limit of the control value ● Setting range: 1 ~ 16000 ● If this value is not set or set as “0” this value is initialized as “16000”. (Refer 2.10)
		P	UINT [ARRAY]*1	Setting a proportional constant (0.01 ~ 100.00) for a run loop ●Setting range: 1~10000 ● If this value is not set or set as “0” this value is initialized as “1”
		I	UINT [ARRAY]*1	Setting an integral constant (0.0 ~3000.0 sec) for a run loop ● Setting range: 0~30000 ● Integral action not executed if the integral constant is set to ‘0’.
		D	UINT [ARRAY]*1	Setting a derivative constant (0.0 ~3000.0 sec) for a run loop ● Setting range: 0~30000 ● Derivative action not executed if the derivative constant is set to ‘0’.
		OUT_EN	BOOL [ARRAY]*1	Run roop output enable, disable (Transistor output) ● “0” disable. ● “1” enable.
		OUT_PERD	UINT [ARRAY]*1	Run roop output enable/disable set in OUT_EN (1 ~ 100s) ● Setting range: 1 ~ 100 ● If this value is not set or set as “0” this value is initialized as “1”
		OUT_LOW	UINT [ARRAY]*1	Setting the output low limit of the run roop set in OUT_EN ● Setting range: 0 ~ 16000 (The range should be within the high limit) [Refer 2.11]
		OUT_HIGH	UINT [ARRAY]*1	Setting the output high limit of the run roop set in OUT_EN ● Setting range: 0 ~ 16000 (The range should be within the high limit) [Refer 2.11] ● If this value is not set or set as “0” this value is initialized as “1”
		ONOF_HYS	UINT [ARRAY]*1	Setting the run interval for the run roop ON/OFF ● Setting range: 0 ~ 8000 [Refer 2.8]
	Output	DONE	BOOL	Function block finished execution status ● “1” is output when the initialization function block is finished with no error and “1” remains until next execution. If an error occurs, ‘0’ is displayed and the operation enters into the stop state.
		STAT	USINT	Error status indication area ● Used to output the number of an error when it occurs during initialization function block execution. ● For description of errors, see GM Section 6.3
		ACT	BOOL [ARRAY]*1	Run loop status indication area ● After the initialization function block is finished with no error, “1” is output if the loop is in normal state. But “0” is output for the disabled loops.

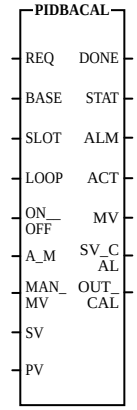
4.2.2 Module initialization for single type (PIDBINI)

Module initialization function block specifies PID control module base location, slot location, run loop enable/disable and forward/reverse action, and sets MV, M_MV and P.I.D constants for use in program so on.

Function Block	I/O	Variable	Data Type	Descriptions
	Input	REQ	BOOL	Function block execution request area ● Used to request an execution of the initialization function block ● If the conditions connected with this area are established while program is running and “0” changes into “1”, the initialization function block is executed
		BASE	USINT	Base location No. ● Used to write the base No. where the PID control module is mounted. ● Setting range: GM1 series (0~31), GM2 series (0~7), GM3/4 series (0-3)
		SLOT	USINT	Slot location No. ● Used to write slot No. where the PID control module is mounted. ● Setting range: 0~7
		LOOP	USINT	Run loop enable/disable specification ● Used to enable or disable a loop for run. ● Specify “1” for enabling, and “0” for disabling
		PERD	UINT	Run loop control cycle (0.01 ~ 99.99sec) ● Setting range: 1 ~ 9999 ● If this value is not set or set as “0” this value is initialized as “1”.
		D/R	BOOL	Forward/Reverse action specification for a run loop. ●Specify “0” for forward action and “1” for reverse action.
		SV_UP	UINT	Setting a time until a run loop reaches at the target value when the target value rises. ●Setting range: 0~65535sec
		SV_DOWN	UINT	Setting a time until a run loop reaches at the target value when the target value falls. ●Setting range: 0~65535sec
		MV_LOW	UINT	Setting the low limit for the run loop ● Setting range: 0 ~ 16000 (The range should be within the high limit) [Refer 2.9]
		MV_HIGH	UINT	Setting the high limit for the run loop ●Setting range: 1 ~ 16000 (The range should be within the high limit) ● If this value is not set or set as “0” this value is initialized as “16000”. (Refer 2.9)
		DELTA_MV	UINT	Setting for the variable quantity limit of the control value ● Setting range: 1 ~ 16000 ● If this value is not set or set as “0” this value is initialized as “16000”. (Refer 2.10)
		P	UINT	Setting a proportional constant (0.01 ~ 100.00) for a run loop ●Setting range: 1~10000 ● If this value is not set or set as “0” this value is initialized as “1”
		I	UINT	Setting an integral constant (0.0 ~3000.0 sec) for a run loop ● Setting range: 0~30000 ● Integral action not executed if the integral constant is set to ‘0’.
		D	UINT	Setting a derivative constant (0.0 ~3000.0 sec) for a run loop ● Setting range: 0~30000 ● Derivative action not executed if the derivative constant is set to ‘0’.
		OUT_EN	BOOL	Run roop output enable, disable (Transistor output) ● “0” disable. ● “1” enable.
		OUT_PERD	UINT	Run roop output enable/disable set in OUT_EN (1 ~ 100s) ● Setting range: 1 ~ 100 ● If this value is not set or set as “0” this value is initialized as “1”
		OUT_LOW	UINT	Setting the output low limit of the run roop set in OUT_EN ● Setting range: 0 ~ 16000 (The range should be within the high limit) [Refer 2.11]
		OUT_HIGH	UINT	Setting the output high limit of the run roop set in OUT_EN ● Setting range: 0 ~ 16000 (The range should be within the high limit) [Refer 2.11] ● If this value is not set or set as “0” this value is initialized as “1”
		ONOF_HYS	UINT	Setting the run interval for the run roop ON/OFF ● Setting range: 0 ~ 8000 [Refer 2.8]
	Output	DONE	BOOL	Function block finished execution status ● “1” is output when the initialization function block is finished with no error and “1” remains until next execution. If an error occurs, ‘0’ is displayed and the operation enters into the stop state.
		STAT	USINT	Error status indication area ● Used to output the number of an error when it occurs during initialization function block execution. ● For description of errors, see GM Section 6.3

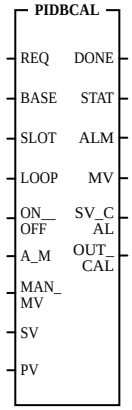
4.2.3 Controlling calculation for array type (PIDBACAL)

PIDBACAL control PID whole loops and specifies ON/OFF enable or disable, auto/manual run enable or disable, manually controlled value, target value and current value, PID calculated value etc.

Function Block	I/O	Variable	Data Type	Descriptions
	Input	REQ	BOOL	Function block execution request area ● Used to request an execution of the initialization function block ● If the conditions connected with this area are established while program is running and "0" changes into "1", the initialization function block is executed
		BASE	USINT	Base location No. ● Used to write the base No. where the PID control module is mounted. ● Setting range: GM1 series (0~31), GM2 series (0~7), GM3/4 series (0-3)
		SLOT	USINT	Slot location No. ● Used to write slot No. where the PID control module is mounted. ● Setting range: 0~7
		LOOP	BOOL [ARRAY]*1	Run loop enable/disable specification ● Used to enable or disable a loop for run. ● Specify "1" for enabling, and "0" for disabling
		ON_OFF	BOOL [ARRAY]*1	ON/OFF control enable/ disable for the run loop. ● "0": ON/OFF control enable. ● "1": ON/OFF control disable.
		A_M	BOOL [ARRAY]*1	Auto/Manual control enable/ disable for the run loop. ● "0": Auto-calculation selection. ● "1": Manual control selection.
		MAN_MV	INT [ARRAY]*1	Manual control value for the run loop. ● Range : 0 ~ 16000
		SV	INT [ARRAY]*1	Target value for the run loop. ● Range: 0 ~ 16000
		PV	INT [ARRAY]*1	Current value for the run loop. ● Range: 0 ~ 16000
	Output	DONE	BOOL	Function block finished execution status ● "1" is output when the initialization function block is finished with no error and "1" remains until next execution. If an error occurs, '0' is displayed and the operation enters into the stop state.
		STAT	USINT	Error status indication area ● Used to output the number of an error when it occurs during initialization function block execution. ● For description of errors, see GM Section 6.3
		ALM	USINT [ARRAY]*1	Alarm status ● If an alarm happened the alarm number is displayed during the function block execution. ●For description of alarms, see section 4.4.
		ACT	BOOL [ARRAY]*1	Run loop status indication area ● After the initialization function block is finished with no error, "1" is output if the loop is in normal state. But "0" is output for the disabled loops.
		MV	INT [ARRAY]*1	MV data for the enabled run loops ● Range: 0 ~ 16000
		SV_CAL	INT [ARRAY]*1	Calculated SV value for the enabled run loops. ● Range: 0 ~ 16000
		OUT_CAL	INT [ARRAY]*1	Output value for the enabled run loops (0.0 ~ 100.0%) ● PWM range: 0 ~ 1000

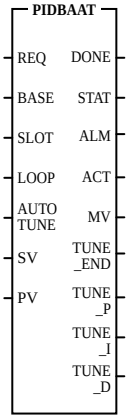
4.2.4 Controlling calculation for single type (PIDBCAL)

PIDBCAL control PID whole loops and specifies ON/OFF enable or disable, auto/manual run enable or disable, manually controlled value, target value and current value, PID calculated value etc.

Function Block	I/O	Variable	Data Type	Descriptions
	Input	REQ	BOOL	Function block execution request area ● Used to request an execution of the initialization function block ● If the conditions connected with this area are established while program is running and "0" changes into "1", the initialization function block is executed
		BASE	USINT	Base location No. ● Used to write the base No. where the PID control module is mounted. ● Setting range: GM1 series (0~31), GM2 series (0~7), GM3/4 series (0-3)
		SLOT	USINT	Slot location No. ● Used to write slot No. where the PID control module is mounted. ● Setting range: 0~7
		LOOP	USINT	Run loop enable/disable specification ● Used to enable or disable a loop for run. ● Specify "1" for enabling, and "0" for disabling
		ON_OFF	BOOL	ON/OFF control enable/ disable for the run loop. ● "0": ON/OFF control enable. ● "1": ON/OFF control disable.
		A_M	BOOL	Auto/Manual control enable/ disable for the run loop. ● "0": Auto-calculation selection. ● "1": Manual control selection.
		MAN_MV	INT	Manual control value for the run loop. ● Range : 0 ~ 16000
		SV	INT	Target value for the run loop. ● Range: 0 ~ 16000
		PV	INT	Current value for the run loop. ● Range: 0 ~ 16000
	Output	DONE	BOOL	Function block finished execution status ● "1" is output when the initialization function block is finished with no error and "1" remains until next execution. If an error occurs, '0' is displayed and the operation enters into the stop state.
		STAT	USINT	Error status indication area ● Used to output the number of an error when it occurs during initialization function block execution. ● For description of errors, see GM Section 6.3
		ALM	USINT	Alarm status ● If an alarm happened the alarm number is displayed during the function block execution. ●For description of alarms, see section 4.4.
		MV	INT	MV data for the enabled run loops ● Range: 0 ~ 16000
		SV_CAL	INT	Calculated SV value for the enabled run loops. ● Range: 0 ~ 16000
		OUT_CAL	INT	Output value for the enabled run loops (0.0 ~ 100.0%) ● PWM range: 0 ~ 1000

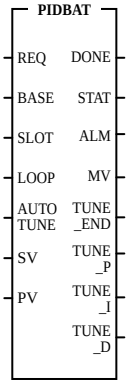
4.2.5 Auto Tuning for array type (PIDBAAT)

PIDBAAT specifies base number, slot number, run loop selection, auto tuning start/stop selection for the enabled loop and displays MV, and auto-tuned value.

Function Block	I/O	Variable	Data Type	Descriptions
	Input	REQ	BOOL	Function block execution request area ● Used to request an execution of the initialization function block ● If the conditions connected with this area are established while program is running and "0" changes into "1", the initialization function block is executed
		BASE	USINT	Base location No. ● Used to write the base No. where the PID control module is mounted. ● Setting range: GM1 series (0~31), GM2 series (0~7), GM3/4 series (0-3)
		SLOT	USINT	Slot location No. ● Used to write slot No. where the PID control module is mounted. ● Setting range: 0~7
		LOOP	BOOL [ARRAY]*1	Run loop enable/disable specification ● Used to enable or disable a loop for run. ● Specify "1" for enabling, and "0" for disabling
		AUTO TUNE	BOOL [ARRAY]*1	Auto tuning start/stop selection for the enabled loops. ● "0": Auto Tuning stop. ● "1": Auto Tuning start [See section 2.5.2]
		SV	INT [ARRAY]*1	Target value for the run loops. ● Range: 0 ~ 16000
		PV	INT [ARRAY]*1	Current value for the run loops. ● Range: 0 ~ 16000
	Output	DONE	BOOL	Function block finished execution status ● "1" is output when the initialization function block is finished with no error and "1" remains until next execution. If an error occurs, '0' is displayed and the operation enters into the stop state.
		STAT	USINT	Error status indication area ● Used to output the number of an error when it occurs during initialization function block execution. ● For description of errors, see GM Section 6.3
		ALM	USINT [ARRAY]*1	Alarm status ● If an alarm happened the alarm number is displayed during the function block execution. ●For description of alarms, see section 4.4.
		ACT	BOOL [ARRAY]*1	Run loop status indication area ● After the initialization function block is finished with no error, "1" is output if the loop is in normal state. But "0" is output for the disabled loops.
		MV	INT [ARRAY]*1	MV data for the enabled run loops ● Range: 0 ~ 16000
		TUNE_END	BOOL [ARRAY]*1	Auto Tuning status. ● "0": Auto Tuning is not completed or canceled. ● "1": Auto Tuning is completed.
		TUNE_P	UINT [ARRAY]*1	P value obtained by Auto Tuning. ● Range: 1 ~ 10000
		TUNE_I	UINT [ARRAY]*1	I value obtained by Auto Tuning. ● Range: 0 ~ 30000 (I value: 0.0 ~ 3000.0 sec)
		TUNE_D	UINT [ARRAY]*1	D value obtained by Auto Tuning. ● Range: 0 ~ 30000 (D value: 0.0 ~ 3000.0 sec)

4.2.6 Auto Tuning for single type (PIDBAT)

PIDBAT specifies base number, slot number, run loop selection, auto tuning start/stop selection for the enabled loop and displays MV, and auto-tuned value.

Function Block	I/O	Variable	Data Type	Descriptions
	Input	REQ	BOOL	Function block execution request area ● Used to request an execution of the initialization function block ● If the conditions connected with this area are established while program is running and "0" changes into "1", the initialization function block is executed
		BASE	USINT	Base location No. ● Used to write the base No. where the PID control module is mounted. ● Setting range: GM1 series (0~31), GM2 series (0~7), GM3/4 series (0-3)
		SLOT	USINT	Slot location No. ● Used to write slot No. where the PID control module is mounted. ● Setting range: 0~7
		LOOP	USINT	Run loop enable/disable specification ● Used to enable or disable a loop for run. ● Specify "1" for enabling, and "0" for disabling
		AUTO TUNE	BOOL	Auto tuning start/stop selection for the enabled loops. ● "0": Auto Tuning stop. ● "1": Auto Tuning start [See section 2.5.2]
		SV	INT	Target value for the run loop. ● Range: 0 ~ 16000
		PV	INT	Current value for the run loop. ● Range: 0 ~ 16000
	Output	DONE	BOOL	Function block finished execution status ● "1" is output when the initialization function block is finished with no error and "1" remains until next execution. If an error occurs, '0' is displayed and the operation enters into the stop state.
		STAT	USINT	Error status indication area ● Used to output the number of an error when it occurs during initialization function block execution. ● For description of errors, see GM Section 6.3
		ALM	USINT	Alarm status ● If an alarm happened the alarm number is displayed during the function block execution. ●For description of alarms, see section 4.4.
		MV	INT	MV data for the enabled run loop. ● Range: 0 ~ 16000
		TUNE_END	BOOL	Auto Tuning status. ● "0": Auto Tuning is not completed or canceled. ● "1": Auto Tuning is completed.
		TUNE_P	UINT	P value obtained by Auto Tuning. ● Range: 1 ~ 10000
		TUNE_I	UINT	I value obtained by Auto Tuning. ● Range: 0 ~ 30000 (I value: 0.0 ~ 3000.0 sec)
		TUNE_D	UINT	D value obtained by Auto Tuning. ● Range: 0 ~ 30000 (D value: 0.0 ~ 3000.0 sec)

4.3 Errors on function block

Errors indicated by an output variable STAT and their corrective actions are explained.

STAT No.	Item	Descriptions	Function block						Corrective Action
			Initialization		Calculation		Auto Tuning		
			Array	Single	Array	Single	Array	Single	
0	Local	Normal Run status							-
		Base location No. outside the setting range							Adjust it within the setting range (See Section 4.2, 4.3)
2		The corresponding base module hardware defect	O	O	O	O	O	O	Contact a service station
3		Slot location No. outside the setting range	O	O	O	O	O	O	Specify correctly the slot No. where the PID control module is mounted.
4		The specified slot has no PID control module	O	O	O	O	O	O	Mount the PID control module on the specified slot.
5		A module other than the PID control module is loaded on.	O	O	O	O	O	O	Mount the PID control module on the specified slot.
6		Loop No. outside the setting range			-	O	-	O	Specify correctly the No. of the run loop.
7		PID control Module hardware Defect	O	O	O	O	O	O	Contact a service station.
8		PID control module shared memory defect	O	O	O	O	O	O	Contact a service station.
9		The run loop was not specified in the Initialization function block.	-	-	O	O	O	O	Specify correctly run loops in the initialization function block.
10		Inputs outside the setting range	O	O	O	O	O	O	One or more of SV, M_MV, P, I, D and PV outside the setting range, adjust it/them within its/their setting range.

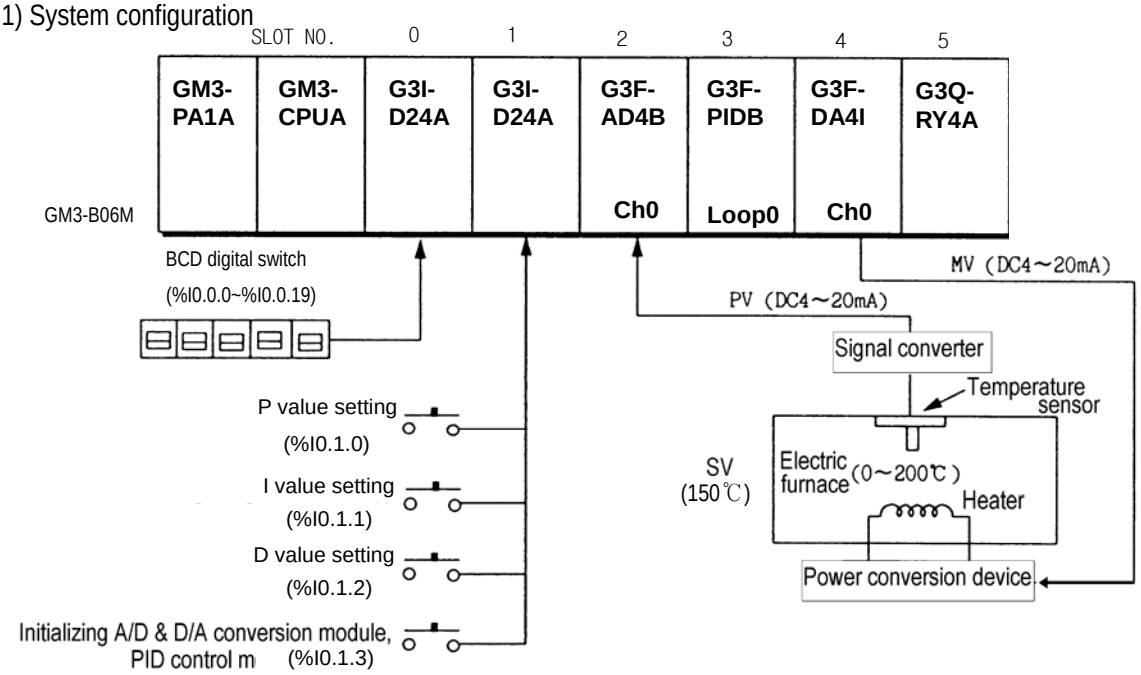
4.4 Alarms on function block

ALM No.	Description	Run status	Corrective Action
0	Normal Run status	Normal run	-
1	Auto Tuning execution during ON/OFF operation.	ON/OFF operation executed.	Stop Auto Tuning operation.
2	ON/OFF operation during Auto Tuning execution.	Auto Tuning operation executed.	Stop ON/OFF operation.
3	SV change during Auto Tuning	Run with the SV value before changing.	The alarm is executed only during Auto Tuning.
4	SV value over	Run with Low limit (0) or High limit (16000)	Specify correctly the value.
5	PV value over	Run with Low limit (0) or High limit (16000)	Specify correctly the value.
6	MV value over	Run with Low limit (0) or High limit (16000)	Specify correctly the value.

Chapter5 GM PROGRAMS

5.1 Program example using G3F-AD4B module

1) System configuration



2) Initial value

(1) PID module
- A) Used loop : Loop 0
- B) Control cycle : 10ms
- C) Forward, reverse action : Forward action
- D) SV value : 12000
- E) Auto/Manual calculation selection : Auto calculation
- F) Initial PID constants : P=200,I=500,D=500

(2) A/D module
- A) Channel : 0
- B) Output data type : 0 ~ 16000
- C) Average calculation : 20 times
- D) Signal converter specification : Input 0~200℃, Output 4~20mA

(3) D/A module
- A) Channel : 0
- B) Input data type selection : -192 ~ 16191
- C) Output status when a channel is not used or CPU stops : Mid-value of the output range.

3) Program descriptions

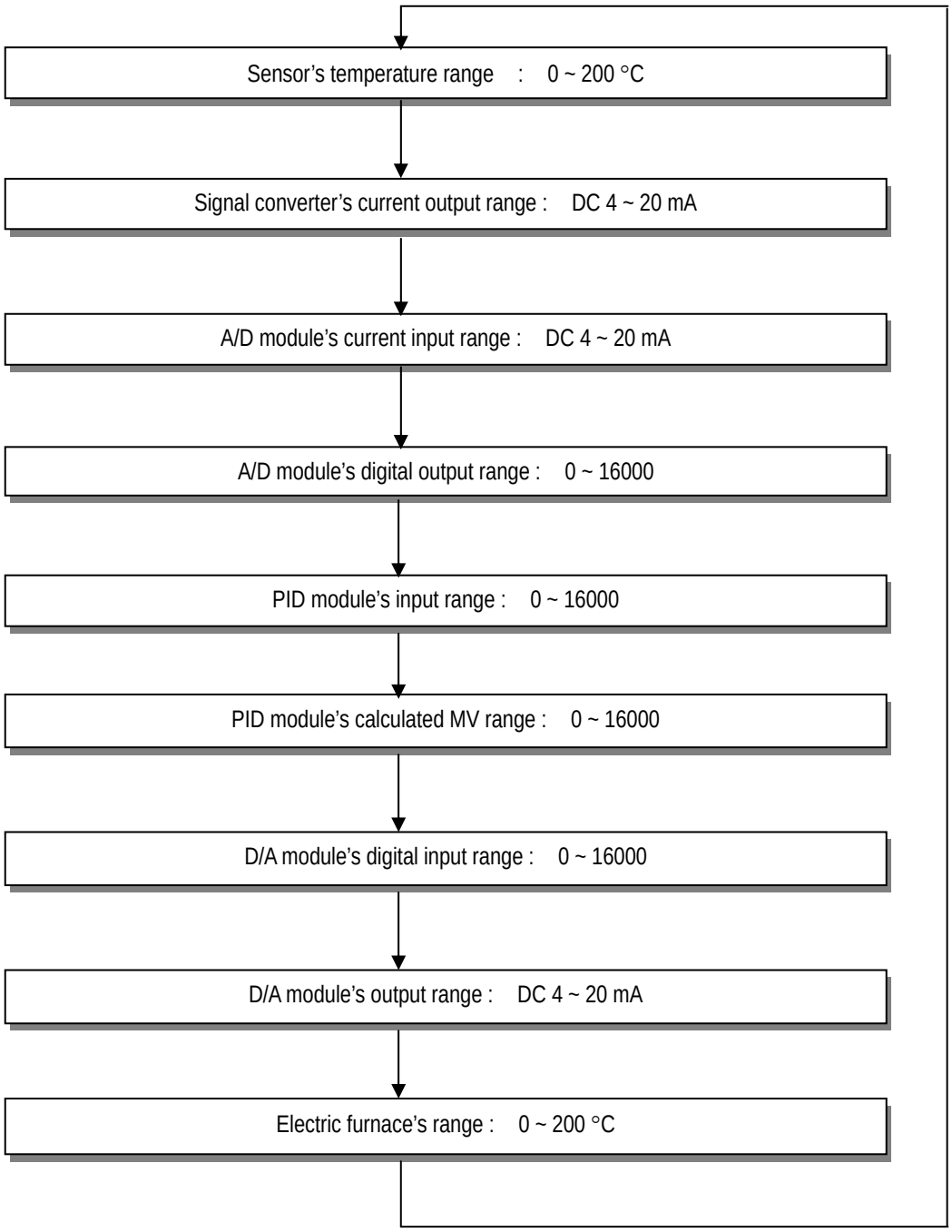
A)Temperature 0 ~ 200°C from sensor is transferred to 4 ~ 20 mA and the current is input to A/D module to convert to digital value.

B) 150°C(The signal converter's output is 16mA, Target value 12000) is set with MV value in PID and P,I,D constants are controlled with the initialized value.
- If %I0.1.0 is On the modified value by BCD switch is set with MV.
- If %I0.1.1 is On the modified value by BCD switch is set with I.
- If %I0.1.2 is On the modified value by BCD switch is set with D.

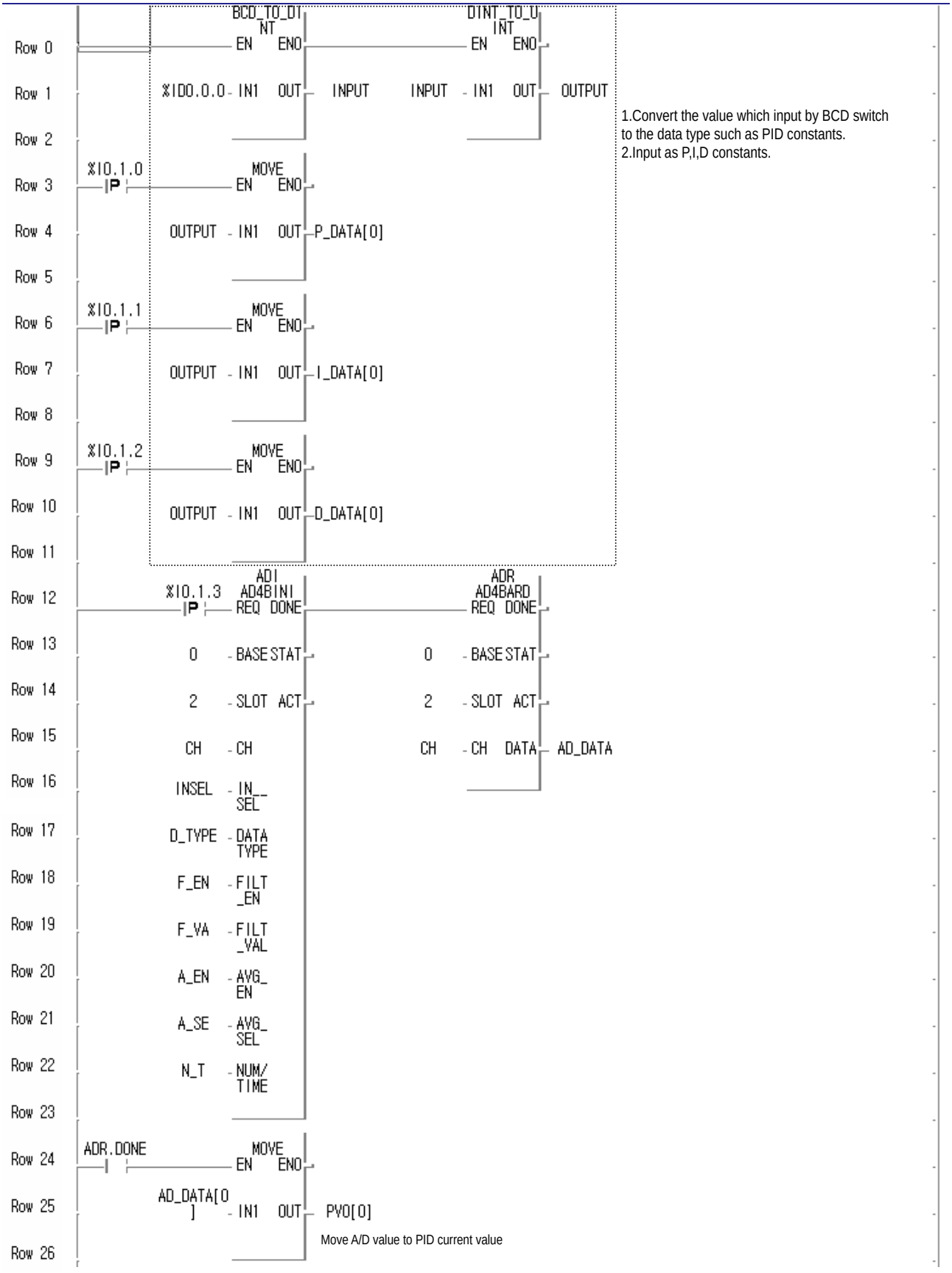
C)PID calculated value is output on D/A module's channel 0.

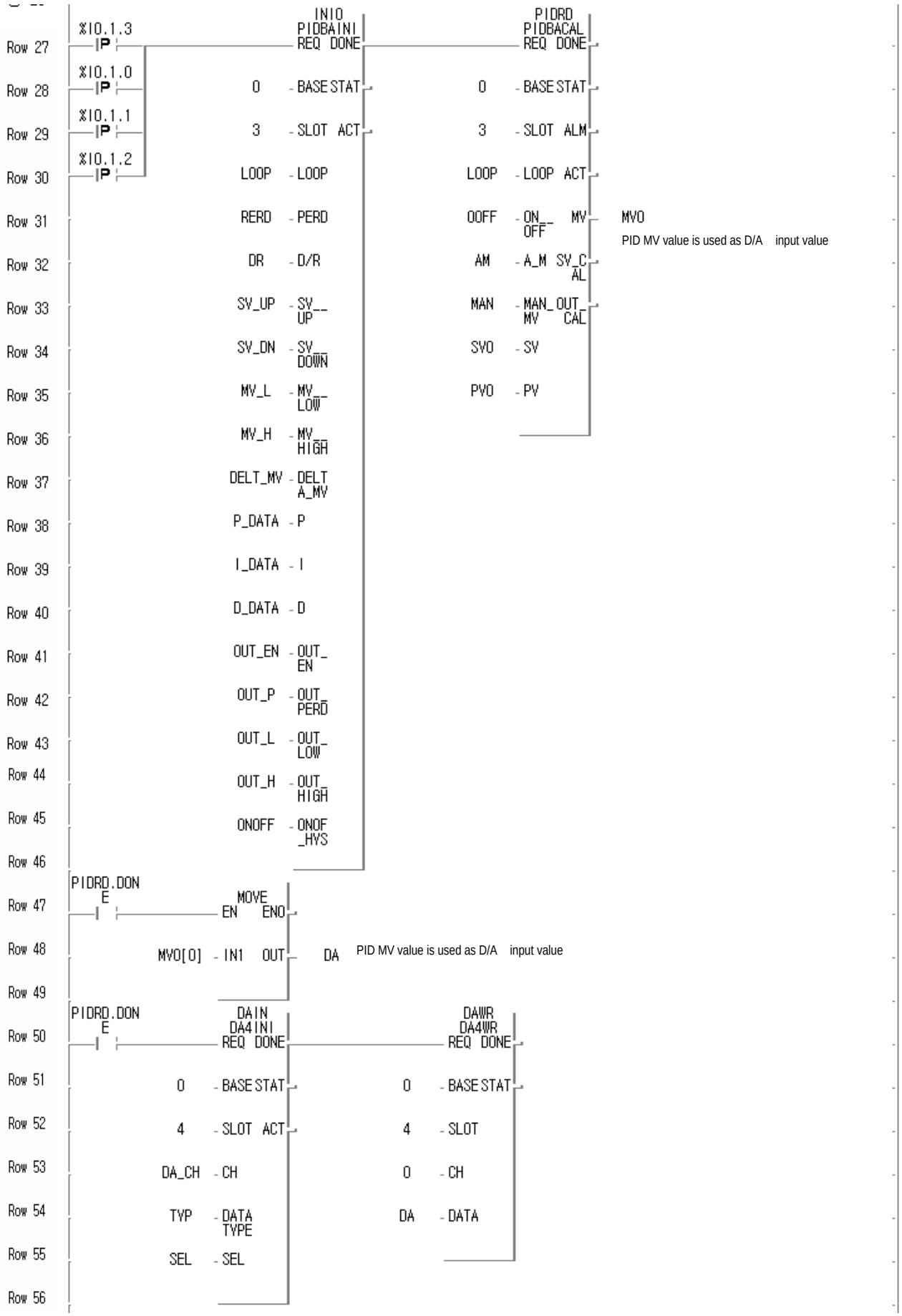
D)If %I0.1.3 is On A/D,PID,D/A modules are initialized.

4) Signal processing relation with each modules



5) Program


BCD_TO_DINT
EN ENO
%ID0.0.0 IN1 OUT INPUT
DINT_TO_UINT
INPUT IN1 OUT OUTPUT
1.Convert the value which input by BCD switch to the data type such as PID constants.
2.Input as P,I,D constants.
%I0.1.0 |P|
MOVE
OUTPUT IN1 OUT P_DATA[0]
%I0.1.1 |P|
MOVE
OUTPUT IN1 OUT I_DATA[0]
%I0.1.2 |P|
MOVE
OUTPUT IN1 OUT D_DATA[0]
%I0.1.3 |P|
ADI
AD4BINI
REQ DONE
0 BASE STAT
2 SLOT ACT
CH CH
INSEL IN_SEL
D_TYPE DATA TYPE
F_EN FILT_EN
F_VA FILT_VAL
A_EN AVG_EN
A_SE AVG_SEL
N_T NUM/TIME
ADR
AD4BARD
REQ DONE
0 BASE STAT
2 SLOT ACT
CH CH DATA AD_DATA
ADR.DONE
MOVE
AD_DATA[0] IN1 OUT PV0[0]
Move A/D value to PID current value

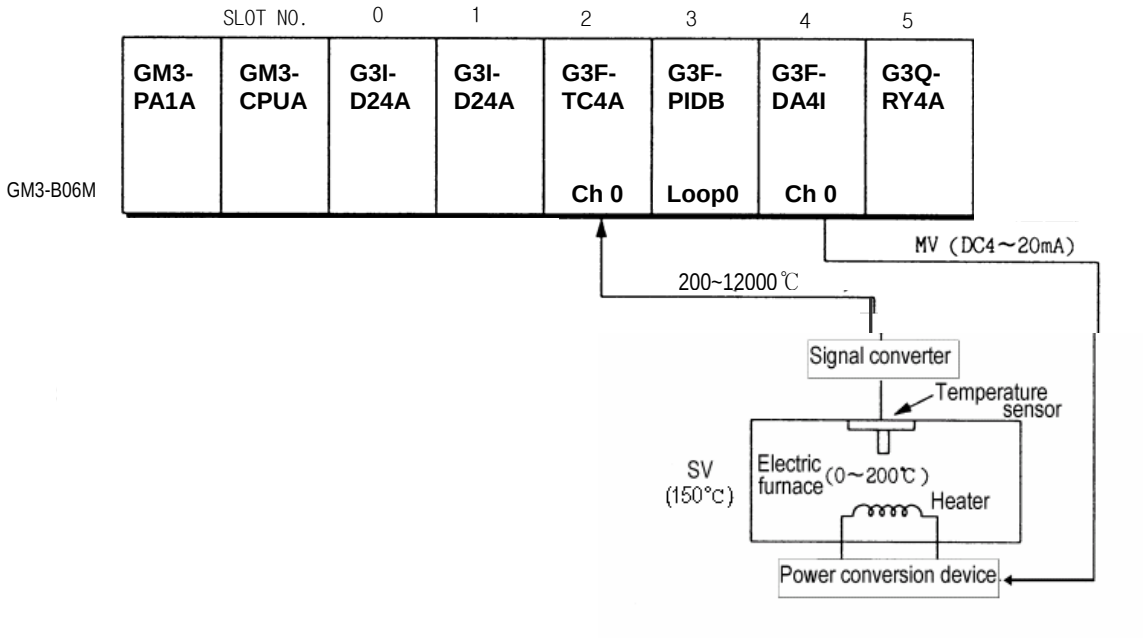

Row 27
%I0.1.3
INIO
PIDBAINI
REQ DONE
PIDRD
PIDBACAL
REQ DONE
Row 28
%I0.1.0
0 - BASE STAT
0 - BASE STAT
Row 29
%I0.1.1
3 - SLOT ACT
3 - SLOT ALM
Row 30
%I0.1.2
LOOP - LOOP
LOOP - LOOP ACT
Row 31
RERD - PERD
OOFF - ON_OFF MV
MVO
PID MV value is used as D/A input value
Row 32
DR - D/R
AM - A_M SV_CAL
Row 33
SV_UP - SV_UP
MAN - MAN_MV OUT_CAL
Row 34
SV_DN - SV_DOWN
SVO - SV
Row 35
MV_L - MV_LOW
PVO - PV
Row 36
MV_H - MV_HIGH
Row 37
DELT_MV - DELTA_MV
Row 38
P_DATA - P
Row 39
I_DATA - I
Row 40
D_DATA - D
Row 41
OUT_EN - OUT_EN
Row 42
OUT_P - OUT_PERD
Row 43
OUT_L - OUT_LOW
Row 44
OUT_H - OUT_HIGH
Row 45
ONOFF - ONOF_HYS
Row 46
Row 47
PIDRD.DONE
MOVE
EN ENO
Row 48
MVO[0] - IN1 OUT - DA
PID MV value is used as D/A input value
Row 49
Row 50
PIDRD.DONE
DAIN
DA4INI
REQ DONE
DAWR
DA4WR
REQ DONE
Row 51
0 - BASE STAT
0 - BASE STAT
Row 52
4 - SLOT ACT
4 - SLOT
Row 53
DA_CH - CH
0 - CH
Row 54
TYP - DATA TYPE
DA - DATA
Row 55
SEL - SEL
Row 56

6) Input/Output variables used in this program.

	Variable name	Data Kind	Memory allocation	Used	Data Type	Initial Value	Comments
1	A_EN	VAR	<Auto>	*	ARRAY[16] OF BOOL		
2	A_SE	VAR	<Auto>	*	ARRAY[16] OF BOOL		
3	AD_DATA	VAR	<Auto>	*	ARRAY[16] OF INT		
4	ADI	VAR	<Auto>	*	FB Instance		
5	ADR	VAR	<Auto>	*	FB Instance		
6	AM	VAR	<Auto>	*	ARRAY[32] OF BOOL		
7	CH	VAR	<Auto>	*	ARRAY[16] OF BOOL	Setting	
8	D_DATA	VAR	<Auto>	*	ARRAY[32] OF UINT		
9	D_TYPE	VAR	<Auto>	*	ARRAY[16] OF BOOL		
10	DA	VAR	<Auto>	*	INT		
11	DA_CH	VAR	<Auto>	*	ARRAY[16] OF BOOL	Setting	
12	DAIN	VAR	<Auto>	*	FB Instance		
13	DAWR	VAR	<Auto>	*	FB Instance		
14	DELT_MV	VAR	<Auto>	*	ARRAY[32] OF UINT		
15	DR	VAR	<Auto>	*	ARRAY[32] OF BOOL		
16	F_EN	VAR	<Auto>	*	ARRAY[16] OF BOOL	Setting	
17	F_VA	VAR	<Auto>	*	ARRAY[16] OF USINT	Setting	
18	I_DATA	VAR	<Auto>	*	ARRAY[32] OF UINT	Setting	
19	INI0	VAR	<Auto>	*	FB Instance		
20	INPUT	VAR	<Auto>	*	DINT		
21	INSEL	VAR	<Auto>	*	ARRAY[16] OF BOOL	Setting	
22	LOOP	VAR	<Auto>	*	ARRAY[32] OF BOOL	Setting	
23	MAN	VAR	<Auto>	*	ARRAY[32] OF INT		
24	MV_H	VAR	<Auto>	*	ARRAY[32] OF UINT		
25	MV_L	VAR	<Auto>	*	ARRAY[32] OF UINT		
26	MV0	VAR	<Auto>	*	ARRAY[32] OF INT		
27	N_T	VAR	<Auto>	*	ARRAY[16] OF UINT		
28	ONOFF	VAR	<Auto>	*	ARRAY[32] OF UINT		
29	OOFF	VAR	<Auto>	*	ARRAY[32] OF BOOL		
30	OUT_EN	VAR	<Auto>	*	ARRAY[32] OF BOOL		
31	OUT_H	VAR	<Auto>	*	ARRAY[32] OF UINT		
32	OUT_L	VAR	<Auto>	*	ARRAY[32] OF UINT		
33	OUT_P	VAR	<Auto>	*	ARRAY[32] OF UINT		
34	OUTPUT	VAR	<Auto>	*	UINT		
35	P_DATA	VAR	<Auto>	*	ARRAY[32] OF UINT	Setting	
36	PIDRD	VAR	<Auto>	*	FB Instance		
37	PV0	VAR	<Auto>	*	ARRAY[32] OF INT		
38	RERD	VAR	<Auto>	*	ARRAY[32] OF UINT	Setting	
39	SEL	VAR	<Auto>	*	ARRAY[16] OF USINT		
40	SV_DN	VAR	<Auto>	*	ARRAY[32] OF UINT		
41	SV_UP	VAR	<Auto>	*	ARRAY[32] OF UINT		
42	SV0	VAR	<Auto>	*	ARRAY[32] OF INT	Setting	
43	TYP	VAR	<Auto>	*	ARRAY[16] OF BOOL		

5.2 Program using the auto tunning function (TC module used)

1) System configuration



2) Initial value

(1) PID module

A) Loop : Loop 0

B) Cycle : 50ms

C) Forward/reverse action : Forward action

D) MV value : 8000(700℃)

E) Auto/Manual calculation selection : After synchronization, auto operation with P,I,D constants.

(2) A/D module

A) Channel : 0

B) Input sensor type : K TYPE(-200~1200℃)

(3) D/A module

A) Channel : 0

B) Input data type : 0 ~ 16000

C) Output status when a channel is not used or CPU stops : Mid-value of the output range.

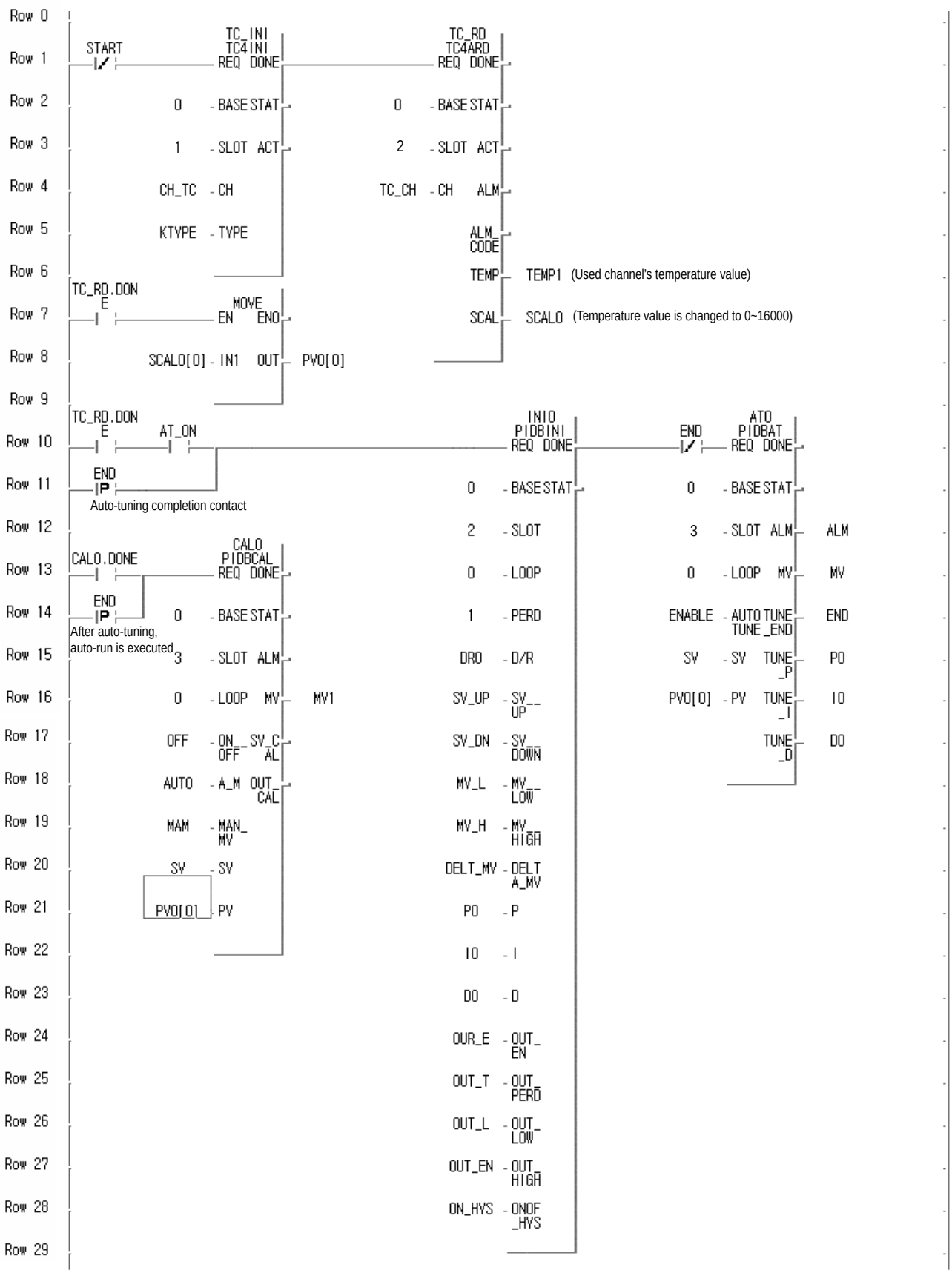
2) Program descriptions

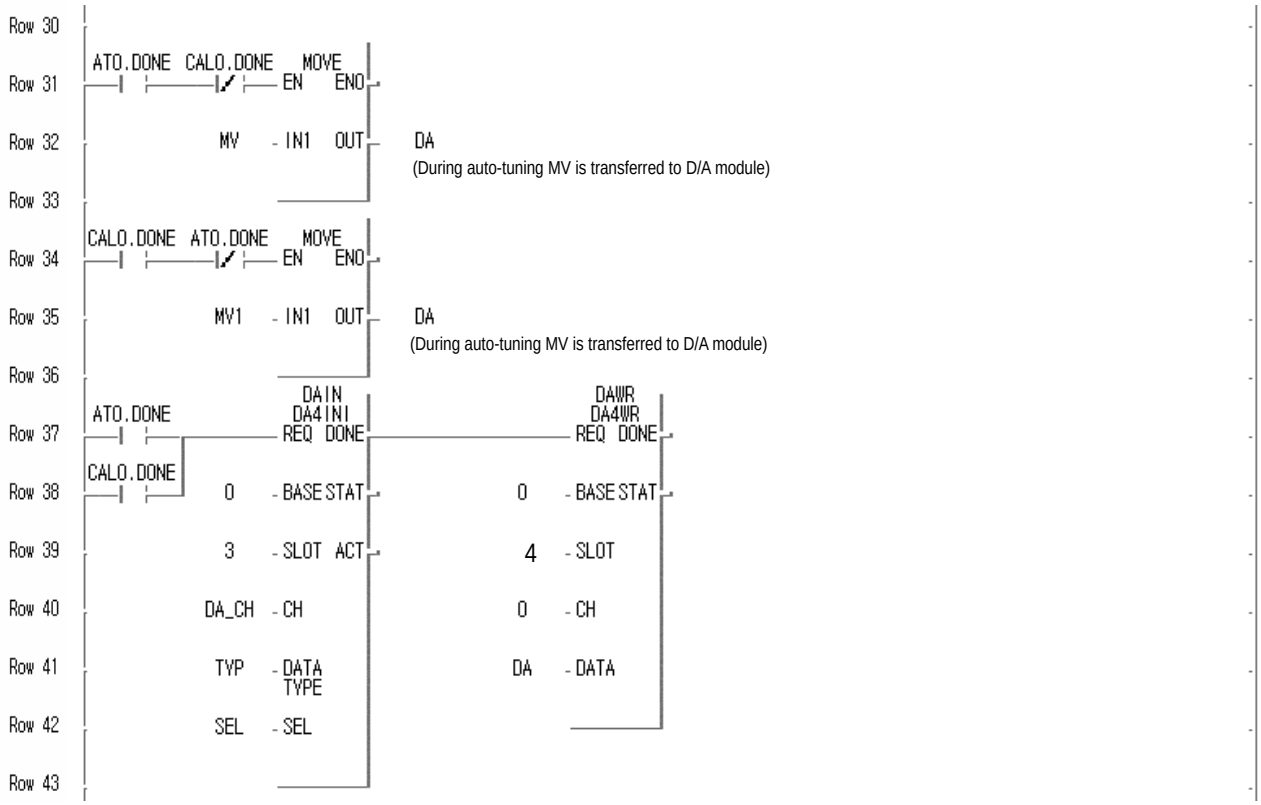
(1) The converted temperature value is transferred 0~16000 and input as a current value..

(2) PID is set MV as 700°C and P,I,D constants are calculated by auto-tuning.
PID control is executed with this calculated value.

(3) PID calculated values are output to D/A module' ch0.

3) Program


Row 0
Row 1
START
TC_INI
TC4INI
REQ DONE
TC_RD
TC4ARD
REQ DONE
Row 2
0 - BASE STAT
0 - BASE STAT
Row 3
1 - SLOT ACT
2 - SLOT ACT
Row 4
CH_TC - CH
TC_CH - CH ALM
Row 5
KTYPE - TYPE
ALM_CODE
Row 6
TEMP
TEMP1 (Used channel's temperature value)
Row 7
TC_RD.DONE
MOVE
EN ENO
SCAL
SCALO (Temperature value is changed to 0~16000)
Row 8
SCALO[0] - IN1 OUT - PVO[0]
Row 9
Row 10
TC_RD.DONE
AT_ON
INIO
PIDBINI
REQ DONE
END
ATO
PIDBAT
REQ DONE
Row 11
END
Auto-tuning completion contact
0 - BASE STAT
0 - BASE STAT
Row 12
2 - SLOT
3 - SLOT ALM
ALM
Row 13
CALO.DONE
CALO
PIDBCAL
REQ DONE
0 - LOOP
MV
MV
Row 14
END
After auto-tuning, auto-run is executed
1 - PERD
ENABLE - AUTO TUNE
TUNE_END
END
Row 15
3 - SLOT ALM
D/R
SV - SV
TUNE_P
P0
Row 16
0 - LOOP MV - MV1
SV_UP - SV_UP
PVO[0] - PV
TUNE_I
I0
Row 17
OFF - ON_OFF
SV_DN - SV_DOWN
TUNE_D
D0
Row 18
AUTO - A_M
OUT_CAL
MV_L - MV_LOW
Row 19
MAM - MAN_MV
MV_H - MV_HIGH
Row 20
SV - SV
DELT_MV - DELTA_MV
Row 21
PVO[0] - PV
P0 - P
Row 22
I0 - I
Row 23
D0 - D
Row 24
OUR_E - OUT_EN
Row 25
OUT_T - OUT_PERD
Row 26
OUT_L - OUT_LOW
Row 27
OUT_EN - OUT_HIGH
Row 28
ON_HYS - ONOF_HYS
Row 29

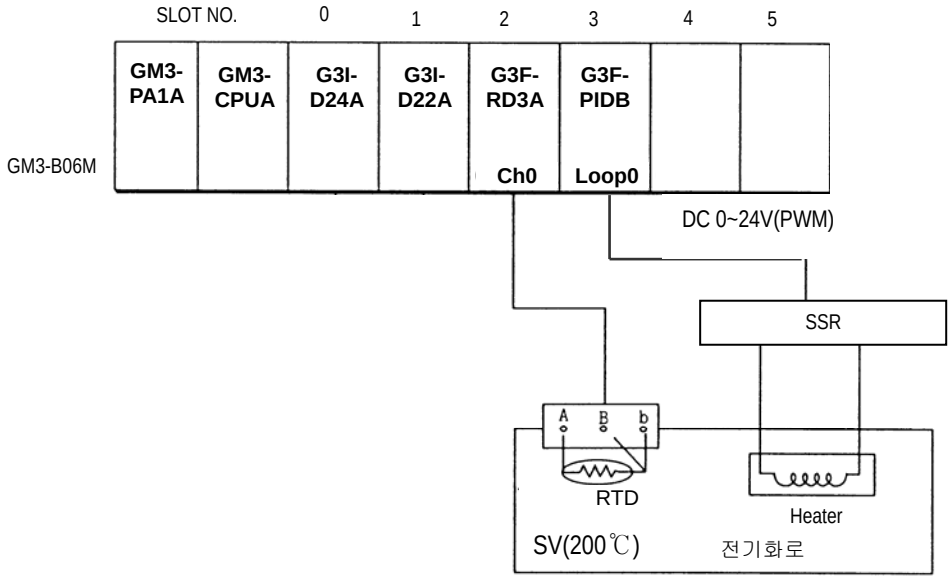

Row 30
Row 31
ATO.DONE CALO.DONE MOVE
EN ENO
Row 32
MV IN1 OUT DA
(During auto-tuning MV is transferred to D/A module)
Row 33
Row 34
CALO.DONE ATO.DONE MOVE
EN ENO
Row 35
MV1 IN1 OUT DA
(During auto-tuning MV is transferred to D/A module)
Row 36
Row 37
ATO.DONE
DAIN DA4INI
REQ DONE
DAWR DA4WR
REQ DONE
Row 38
CALO.DONE
0 BASE STAT
0 BASE STAT
Row 39
3 SLOT ACT
4 SLOT
Row 40
DA_CH CH
0 CH
Row 41
TYP DATA TYPE
DA DATA
Row 42
SEL SEL
Row 43

5) Input/Output variables used in this program.

	Variable name	Data Kind	Memory allocation	Used	Data Type	Initial Value	Comments
1	ALM	VAR	<Auto>	*	USINT		
2	AT_ON	VAR	<Auto>	*	BOOL		
3	AT0	VAR	<Auto>	*	FB Instance		
4	AUTO	VAR	<Auto>	*	BOOL		
5	CAL0	VAR	<Auto>	*	FB Instance		
6	CH_TC	VAR	<Auto>	*	ARRAY[16] OF BOOL		
7	D0	VAR	<Auto>	*	UINT		
8	DA	VAR	<Auto>	*	INT		
9	DA_CH	VAR	<Auto>	*	ARRAY[16] OF BOOL	Setting	
10	DAIN	VAR	<Auto>	*	FB Instance		
11	DAWR	VAR	<Auto>	*	FB Instance		
12	DELT_MV	VAR	<Auto>	*	UINT		
13	DR0	VAR	<Auto>	*	BOOL		
14	ENABLE	VAR	<Auto>	*	BOOL	1	
15	END	VAR	<Auto>	*	BOOL		
16	I0	VAR	<Auto>	*	UINT		
17	INI0	VAR	<Auto>	*	FB Instance		
18	KTYPE	VAR	<Auto>	*	ARRAY[16] OF USINT		
19	MAM	VAR	<Auto>	*	INT		
20	MV	VAR	<Auto>	*	INT		
21	MV_H	VAR	<Auto>	*	UINT		
22	MV_L	VAR	<Auto>	*	UINT		
23	MV1	VAR	<Auto>	*	INT		
24	OFF	VAR	<Auto>	*	BOOL		
25	ON_HYS	VAR	<Auto>	*	UINT		
26	OUR_E	VAR	<Auto>	*	BOOL		
27	OUT_EN	VAR	<Auto>	*	UINT		
28	OUT_L	VAR	<Auto>	*	UINT		
29	OUT_T	VAR	<Auto>	*	UINT		
30	P0	VAR	<Auto>	*	UINT		
31	PV0	VAR	<Auto>	*	ARRAY[32] OF INT		
32	SCAL0	VAR	<Auto>	*	ARRAY[16] OF INT		
33	SEL	VAR	<Auto>	*	ARRAY[16] OF USINT		
34	START	VAR	<Auto>	*	BOOL		
35	SV	VAR	<Auto>	*	INT	10000	
36	SV_DN	VAR	<Auto>	*	UINT		
37	SV_UP	VAR	<Auto>	*	UINT		
38	TC_CH	VAR	<Auto>	*	ARRAY[16] OF BOOL		
39	TC_INI	VAR	<Auto>	*	FB Instance		
40	TC_RD	VAR	<Auto>	*	FB Instance		
41	TEMP1	VAR	<Auto>	*	ARRAY[16] OF INT		
42	TYP	VAR	<Auto>	*	ARRAY[16] OF BOOL		

5.3 Program using PWM

1) System configuration



2) Initial value

(1) PID module

A) Loop : 0

B) Cycle : 50ms

C) Forward/reverse action : Forward action

D) SV: 8000

E) PID constants: P,I,D constants by Auto-tuning

F) Auto calculation/manual calculation : Auto – In case that RTD doesn't have an error.
Manual – In case that RTD has an error.

G) Output :PWM

H) Output cycle:10 ㎳

(2) RTD module

A) Channel : 0

B) RTD module's sensor : Pt100

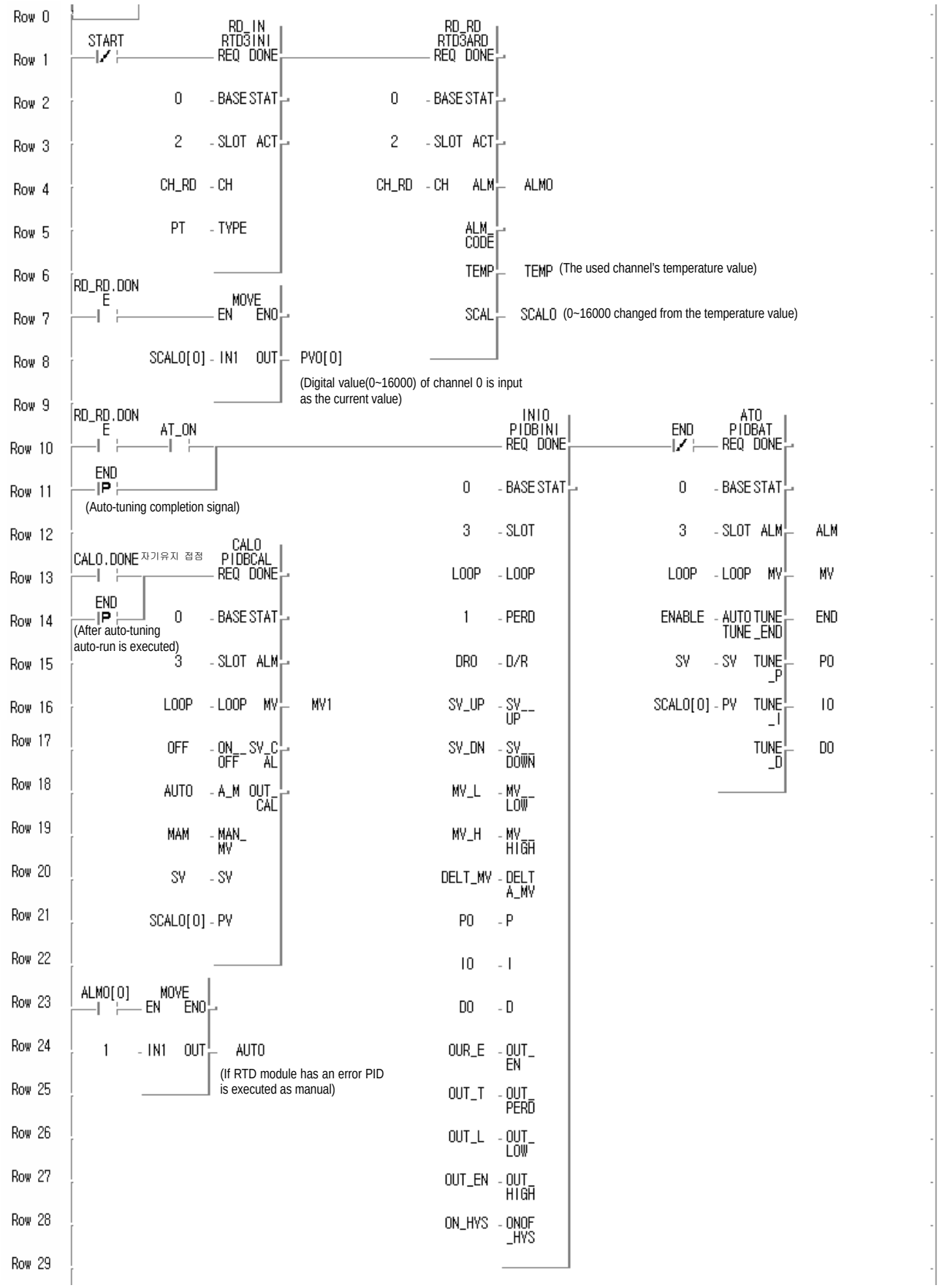
C) Input temperature range: - 200~600℃(SCAL:0~16000)

3) Program description

(1) RTD module detects the heater's temperature with Pt100 and the detected value is changed to the digital value.

(2) MV value is set as 8000(Temperature 200°C) and PID is executed with auto-tuned P,I,D
If PID module has an error (by RTD module's disconnection) PID is run with SV(0).

4) Program


Row 0
Row 1
START
RD_IN
RTD3INI
REQ DONE
RD_RD
RTD3ARD
REQ DONE
Row 2
0 - BASE STAT
0 - BASE STAT
Row 3
2 - SLOT ACT
2 - SLOT ACT
Row 4
CH_RD - CH
CH_RD - CH ALM - ALMO
Row 5
PT - TYPE
ALM_CODE
Row 6
TEMP - TEMP (The used channel's temperature value)
Row 7
RD_RD.DONE
MOVE
EN ENO
SCAL - SCALO (0~16000 changed from the temperature value)
Row 8
SCALO[0] - IN1 OUT - PV0[0]
(Digital value(0~16000) of channel 0 is input as the current value)
Row 9
Row 10
RD_RD.DONE
AT_ON
INIO
PIDBINI
REQ DONE
END
ATO
PIDBAT
REQ DONE
Row 11
END
(Auto-tuning completion signal)
0 - BASE STAT
0 - BASE STAT
Row 12
3 - SLOT
3 - SLOT ALM - ALM
Row 13
CALO.DONE 자기유지 접점
CALO
PIDBCAL
REQ DONE
LOOP - LOOP
LOOP - LOOP MV - MV
Row 14
END
(After auto-tuning auto-run is executed)
1 - PERD
ENABLE - AUTO TUNE TUNE_END - END
Row 15
0 - BASE STAT
DRO - D/R
SV - SV TUNE_P - PO
Row 16
3 - SLOT ALM
SV_UP - SV_UP
SCALO[0] - PV TUNE_I - IO
Row 17
LOOP - LOOP MV - MV1
SV_DN - SV_DOWN
TUNE_D - DO
Row 18
OFF - ON_OFF SV_CAL
MV_L - MV_LOW
Row 19
AUTO - A_M OUT_CAL
MV_H - MV_HIGH
Row 20
MAM - MAN_MV
DELT_MV - DELTA_MV
Row 21
SV - SV
PO - P
Row 22
SCALO[0] - PV
IO - I
Row 23
ALMO[0]
MOVE
EN ENO
DO - D
Row 24
1 - IN1 OUT - AUTO
OUR_E - OUT_EN
(If RTD module has an error PID is executed as manual)
Row 25
OUT_T - OUT_PERD
Row 26
OUT_L - OUT_LOW
Row 27
OUT_EN - OUT_HIGH
Row 28
ON_HYS - ONOF_HYS
Row 29

5) Input/Output variables used in this program.

	Variable name	Data Kind	Memory allocation	Used	Data Type	Initial Value	Comments
1	ALM	VAR	<Auto>	*	USINT		
2	ALM0	VAR	<Auto>	*	ARRAY[8] OF BOOL		
3	AT_ON	VAR	<Auto>	*	BOOL		
4	AT0	VAR	<Auto>	*	FB Instance		
5	AUTO	VAR	<Auto>	*	BOOL		
6	CAL0	VAR	<Auto>	*	FB Instance		
7	CH_RD	VAR	<Auto>	*	ARRAY[8] OF BOOL	Setting	
8	D0	VAR	<Auto>	*	UINT		
9	DELT_MV	VAR	<Auto>	*	UINT		
10	DR0	VAR	<Auto>	*	BOOL		
11	ENABLE	VAR	<Auto>	*	BOOL	1	
12	END	VAR	<Auto>	*	BOOL		
13	I0	VAR	<Auto>	*	UINT		
14	INI0	VAR	<Auto>	*	FB Instance		
15	LOOP	VAR	<Auto>	*	USINT	7	
16	MAM	VAR	<Auto>	*	INT	0	
17	MV	VAR	<Auto>	*	INT		
18	MV_H	VAR	<Auto>	*	UINT		
19	MV_L	VAR	<Auto>	*	UINT		
20	MV1	VAR	<Auto>	*	INT		
21	OFF	VAR	<Auto>	*	BOOL		
22	ON_HYS	VAR	<Auto>	*	UINT		
23	OUR_E	VAR	<Auto>	*	BOOL	1	
24	OUT_EN	VAR	<Auto>	*	UINT		
25	OUT_L	VAR	<Auto>	*	UINT		
26	OUT_T	VAR	<Auto>	*	UINT	1	
27	P0	VAR	<Auto>	*	UINT		
28	PT	VAR	<Auto>	*	ARRAY[8] OF BOOL		
29	PV0	VAR	<Auto>	*	ARRAY[32] OF INT		
30	RD_IN	VAR	<Auto>	*	FB Instance		
31	RD_RD	VAR	<Auto>	*	FB Instance		
32	SCAL0	VAR	<Auto>	*	ARRAY[8] OF INT		
33	START	VAR	<Auto>	*	BOOL		
34	SV	VAR	<Auto>	*	INT	5600	
35	SV_DN	VAR	<Auto>	*	UINT		
36	SV_UP	VAR	<Auto>	*	UINT		
37	TEMP	VAR	<Auto>	*	ARRAY[8] OF INT		

Chapter6 BUFFER MEMORY CONFIGURAGION AND FUNCTIONS

The PID control module has the PLC CPU and the buffer memories for communications.

6.1 Buffer memory configuration

The followings describe buffer memory configuration

6.1.1 G3F-PIDB Buffer memory

Address (Decimal)	Function	Descriptions	Default Setting	Read / Write
0	Loop enable/disable Specification area (loop 0 to 15)	Bit On(1): Enabled Bit Off(0): Disabled	Disabled	R/W
1	Loop enable/disable Specification area (loop 16 to 31)			
2~ 33	Control cycle of each loop	Range:1~9999 (0.01~99.99 sec)	10	"
34	Forward/Reverse action Specification area (loop 0 to 15)	Bit On(1): Reverse Bit Off(0): Forward	0: Forward	"
35	Forward/Reverse action Specification area (loop 16 to 31)			
36~ 67	SV-ramp of each loop(rising) *1	Setting range :0 to 65535 sec) [See section 2.6]	0:SV reaching Immediately.	"
68~ 99	SV-ramp of each loop(falling) *2		0:SV reaching Immediately	"
100~ 131	MV low limit of each loop	Setting range :0~16000 (It should be set lower than MV higher limit) [See section 2.9]	0	"
132~ 163	MV higher limit of each loop	Setting range:1~16000 (It should be set higher than MV higher limit) [See section 2.9]	16000	"
164~ 195	△MV Limit of each loop	Setting range:1~16000 [See section 2.10]	16000	"
196~ 227	P of each loop	Setting range:1~10000	1	"
228~ 259	I of each loop	Setting range:0~30000	0	"
260~ 291	D of each loop	Setting range:0~30000	0	"
292	Output enable/ disable (loop 0~15)	Bit On(1):Enable, Bit Off(0):Disable	0:Disable	"
293	Output enable/ disable (loop 16~31)			
294~ 325	Output control cycle of each loop	Setting range :1~100 see (It should be higher than the loop control cycle)	10	"
326~ 357	Output lower limit of each loop (It should be lower than the upper limit)	Setting range:0~16000 [see section 2.11]	0	"
358~ 389	Output upper limit of each loop (It should be lower than the lower limit)	Setting range:1~16000 [see section 2.11]	16000	"
390~ 421	ON/OFF interval of each loop	Setting range:0~8000 [see section 2.8]	100	"
422	SET DATA enable/disable (loop 0~15)	Bit On(1): Set address 0~421,424~493to a new SV value Bit Off(0): Set address 0~421,424~493to a previous value	0	"
423	SET DATA enable/disable (loop16~31)			
424	ON/OFF enable/disable (loop0~15)	Bit On(1):ON/OFF enable Bit Off(0):ON/OFF disable [see section 2.8]	0	"
425	ON/OFF enable/disable (loop16~31)			
426	Auto Tuning enable/ disable (loop 0~15)	Bit On(1):Auto Tuning enable Bit Off(0):Auto Tuning disable [see section 2.5.2]	0	"
427	Auto Tuning enable/ disable (loop 16~31)			

Address (Decimal)	Function	Descriptions	Default Setting	Read / Write
428~459	Manual MV of each loop	Setting range :0~16000	0	"
460	Auto/Manual operation enable/disable (loop 0~15)	Bit On(1): Manual operation Bit Off(0):Auto operation	0	R/W
461	Auto/Manual operation enable/disable (loop 16~31)			
462~493	SV of each loop	Setting range :0~16000	0	"
494~525	PV of each loop	Setting range :0~16000	0	"
526~557	MV of each loop	Setting range :0~16000	0	읽기
558~589	Calculated SV of each loop *3	Setting range :0~16000	-	"
590~621	Output value of each loop	Setting range :0~1000(0.0~100.0%)	-	"
622	Auto Tuning completion(loop 0~15)	Bit On(1):Auto Tuning completion Bit Off(0):Auto Tuning running or PID controlling	-	"
623	Auto Tuning completion(loop 16~31)			
624~655	Auto Tuned P value of each	Range :1~10000	-	"
656~687	Auto Tuned I value of each	Range :0~30000	-	"
688~719	Auto Tuned D value of each	Range :0~30000	-	"
720	Status information (loop 0~15)	Bit On(1):Run Bit Off(0):Stop	-	"
721	Status information (loop 16~31)			
722~753	Alarm information of each loop	Bit0 :During ON/OFF, Auto Tuning executed → ON/OFF hold. Bit1 : During Auto Tuning, ON/OFF command → Auto Tuning hold Bit2 : During Auto Tuning, SV changed → Run with the previous SV Bit3 : Manual MV OVER → Run with the limit value (0 or 16000) Bit4 : SV setting OVER → Run with the limit value (0 or 16000) Bit5 : PV setting OVER → Run with the limit value (0 or 16000)	-	"
754~785	Setting error information of each loop	Bit 0 : Control cycle setting error Bit 1 : MV upper/lower Limit setting error Bit 2 : △MV Limit setting error Bit 3 : P gain setting error Bit 4 : I gain setting error Bit 5 : D gain setting error Bit 6 : Output control cycle setting error Bit 7 : Output control cycle < Control cycle Bit 8 : Output MV upper/lower limit setting error Bit 9 : ON/OFF interval setting error	-	"

6.1.2 G4F-PIDB buffer memory

Address (Decimal)	Function	Descriptions	Default Setting	Read / Write
0	Loop enable/disable Specification area (loop 0~15)	Bit On(1):Enable, Bit Off(0):Disable	Disable	R/W
1~ 16	Control cycle of each loop	Range :1~9999 (0.01~99.99 see)	10	"
17	Forward/Reverse action Specification area (loop 0~15)	Bit On(1):Reverse, Bit Off(0):Forward	0: Forward	"
18~ 33	SV-ramp of each loop(rising) *1	Setting range :0 to 65535 sec [see section 2.6]	0:SV reaching Immediately	"
34~ 49	SV-ramp of each loop(falling) *2		0:SV reaching Immediately	"
50~ 65	MV low limit of each loop	Setting range :0~16000 (Under MV upper limit) [see section 2.9]	0	"
66~ 81	MV higher limit of each loop	Setting range :1~16000 (Over MV low limit) [see section 2.9]	16000	"
82~ 97	△MV limit of each loop	Setting range :1~16000 [see section 2.10]	16000	"
98~ 113	P of each loop	Setting range :1~10000	1	"
114~ 129	I of each loop	Setting range :0~30000	0	"
130~ 145	D of each loop	Setting range :0~30000	0	"
146	Output enable/disable (loop 0~15)	Bit On(1):Enable, Bit Off(0):Disable	Disable	"
147~ 162	Output control cycle of each loop	Setting range:1~100 sec (It should be higher than the loop control cycle)	10	"
163~ 178	Output low limit of each loop (It should be lower than the output upper limit)	Setting range :0~16000 [see section 2.11]	0	"
179~ 194	Output upper limit (It should be lower than the output lower limit)	Setting range :1~16000 [see section 2.11]	16000	"
195~ 210	ON/OFF interval of each loop	Setting range :0~8000 [see section 2.8]	100	"
211	SET DATA enable/disable (loop 0~15)	Bit On(1): Set address 0~210,212~246 to a new SV value Bit Off(0): Set address 0~210,212~246to a previous value	0	"
212	ON/OFF enable/disable (loop 0~15)	Bit On(1):ON/OFF enable Bit Off(0):ON/OFF disable [see section 2.8]	0	"
213	Auto Tuning enable/disable (loop 0~15)	Bit On(1):Auto Tuning enable Bit Off(0):Auto Tuning disable [see section 2.5.2]	0	"
214~ 229	Manual MV of each loop	Setting range :0~16000	0	"

Address (Decimal)	Function	Descriptions	Default Setting	Read / Write
230	Auto/Manual operation enable/disable (loop 0~15)	Bit On(1): Manual operation Bit Off(0): Auto operation	0	"
231~246	SV of each loop	Setting range :0~16000	0	"
247~262	PV of each loop	Setting range :0~16000	0	"
263~278	MV of each loop	Setting range :0~16000	0	읽기
279~294	Calculated SV of each loop *3	Range :0~16000	-	읽기
295~310	Output value of each loop	Range:0~1000(0.0~100.0%)	-	"
311	Auto Tuning completion (loop 0~15)	Bit On(1):Auto Tuning completion Bit Off(0):Auto Tuning running or PID controlling	-	"
312~327	Auto Tuned P value of each loop	Range :1~10000	-	"
328~343	Auto Tuned I value of each loop	Range :0~30000	-	"
344~359	Auto Tuned D value of each loop	Range :0~30000	-	"
360	Status information (loop0~15)	Bit On(1):Run Bit Off(0):Stop	-	"
361~376	Alarm information of each loop	Bit 0 : During ON/OFF, Auto Tuning executed → ON/OFF hold Bit 1 : During Auto Tuning, ON/OFF command → Auto Tuning hold Bit 2 : During Auto Tuning, SV changed → Run with the previous SV Bit 3 : Manuel MV setting OVER → Run with the limit value (0 or 16000) Bit 4 : SV setting OVER → Run with the limit (0 or 16000) Bit 5 : PV setting OVER → Rung with the limit (0 or 16000)	-	"
377~392	Setting error information of each loop	Bit 0 : Control cycle setting error Bit 1 : MV upper/lower limit setting error Bit 2 : △MV Limit setting error Bit 3 : P gain setting error Bit 4 : I gain setting error Bit 5 : D gain setting error Bit 6 : Our control cycle setting error Bit 7 : Output control cycle < Control cycle Bit 8 : Output MV upper/lower limit setting error Bit 9 : ON/OFF interval setting error	-	"

*1 : If SV is modified higher than the current SV during PID operation, specify the rising ramp time for the system to be stable .
*2 : If SV is modified lower than the current SV during PID operation, specify the falling ramp time for the system to be stable .
*3 : The changed value of SV is shown in proportion to the rising ramp time or the falling ramp time.

6.2 Functions of buffer memory

Each address in the buffer memory occupies one word and it is represented with 16 bits.
In the 16 bits which compose an address, every bit can be set to either “1” when it should be turned On or “0” when Off in order to implement the function of each bit.

6.2.1 Specifying loop enable/disable (G3F-PIDB : Address 0, 1, G4F-PIDB : Address 0)

1) Loop enable/disable specification is possible on every channel.
2) Disabled loops will not be used in processing.
3) The followings show the bit corresponding to each loop.

(1) G3F－PIDB

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "0"	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0
Address "1"	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

Loop enable/disable specification [Bit On(1): Enabled, Bit Off(0): Disabled]

(2) G4F－PIDB

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address "0"	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

6.2.2 Specifying Forward/Reverse action (G3F-PIDB : Address 34, 35, G4F-PIDB : Address 17)

1) Turns the corresponding bit Off(0) for forward action processing and On (1) for reverse action processing.
2) Default is forward action.
3)The following show the bit corresponding to each loop.

(1) G3F-PIDB

ON[1]:Reverse action, OFF[0]:Forward action

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AAddress “34”	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0
AAddress “35”	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

(2) G4F-PIDB

ON[1]: Reverse action, OFF[0]:Forward action

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AAddress “17”	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

6.2.3 Specifying Output enable/disable(G3F-PIDB : Address 292, 293, G4F-PIDB :Address 146)

1) If the bit of the output enable/disable area is set as “1” the output of PID module is allowed and in case of “0” the output is prohibited.
2) The followings show the bit corresponding to each loop.

.

(1) G3F-PIDB

ON[1]:Output enable, OFF[0]:Output disable

AAddress “292”

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

AAddress “293”

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

(2) G4F-PIDB

ON[1]: Output enable, OFF[0]: Output disable

AAddress “146”

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

6.2.4 Specifying Set data enable/disable (G3F-PIDB : Address 422, 423, G4F-PIDB : Address 211)

1) If a bit, corresponding to each loop, in Set data specification area is turned On(1), then the PID processing is executed with new user-defined data due to loop enable/disable specification, forward/reverse action specification, setting SV, setting M_MV, and change of P.I.D constants.
2) If the bit corresponding to each loop is not turned On(1), then the PID processing is executed not with the new user-defined data but with the previous Setting range.
3) The followings show the bit corresponding to each loop.

(1) G3F-PIDB

ON[1]:Set data enable, OFF[0]: Set data disable

AAddress “422”

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

AAddress “423”

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

(2) G4F-PIDB

ON[1]: Set data enable, OFF[0]: Set data disable

AAddress “211”

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

6.2.5 Specifying ON/OFF action(G3F-PIDB : Address 424, 425, G4F-PIDB : Address 212)

1) If the bit of ON/OFF specification area is set as “1” ON/OFF action is enabled and set as “0” ON/OFF is disabled.
2) The following show the bit corresponding to each loop.

(1) G3F-PIDB

ON[1]:ON/OFF action enable, OFF[0]:ON/OFF action disable

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AAddress “424”	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0
AAddress “425”	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

(2) G4F-PIDB

ON[1]:ON/OFF action enable, OFF[0]:ON/OFF action disable

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AAddress “212”	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

6.2.6 Auto –tuning operation enable/disable (G3F-PIDB : Address 426, 427, G4F-PIDA :Address 213)

1) Proportional constant(P) ,integral constant(I) ,derivative constant(D) of the system to control can be automatically set.
2) Since P,I,D constant decided by auto tuning not to be optimal for the system to control ,the P,I,D constant needs adjustment a little
3) Loop setting is as specified below.

(1) G3F-PIDB

ON[1]:Auto tuning operation enable, OFF[0]: Auto tuning operation disable

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AAddress “426”	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0
AAddress “427”	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

(2) G4F-PIDB

ON[1]:Auto tuning operation enable, OFF[0]: Auto tuning operation disable

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AAddress “213”	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

6.2.7 Specifying auto/manual operation enable/disable(G3F-PIDB:Address460, 461,G4F-PIDB :Address 230)

1) Turn the corresponding bit Off(0) if a loop runs with auto processing. Turn the corresponding bit On if a loop runs with manual MV set before by the user.
3) The followings show the bit corresponding to each loop.

(1) G3F-PIDB

ON[1]:Manual operation, OFF[0]: Auto operation

AAddress "460"

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

AAddress "461"

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

(2) G4F-PIDB

ON[1]: Manual operation, OFF[0]: Auto operation

AAddress "230"

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

6.2.8 Auto tuning complete (G3F-PIDB : Address 622,623, G4F-PIDB : Address 311)

1) If auto tuning is complete ,each of loop bit is turned on(1).
2) The followings show the bit corresponding to each loop.

(1) G3F-PIDB

ON[1]: auto tuning completion, OFF[0]: auto tuning running or PID controlling

AAddress "622"

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

AAddress "623"

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

(2) G4F-PIDB

ON[1]: auto tuning completion, OFF[0]: auto tuning running or PID controlling

AAddress "311"

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

6.2.9 Status information (G3F-PIDB : Address 720, 721, G4F-PIDB : Address 360)

1) Area for storing the each loop's status.
2) Bit"1" means on running and bit "0" means stop.
3) The followings show the bit corresponding to each loop.

(1) G3F-PIDB

ON[1]:Run, OFF[0]:Stop

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AAddress "720"	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AAddress "721"	loop 31	loop 30	loop 29	loop 28	loop 27	loop 26	loop 25	loop 24	loop 23	loop 22	loop 21	loop 20	loop 19	loop 18	loop 17	loop 16

(2) G4F-PIDB

ON[1]:Run, OFF[0]:Stop

	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
AAddress "360"	loop 15	loop 14	loop 13	loop 12	loop 11	loop 10	loop 9	loop 8	loop 7	loop 6	loop 5	loop 4	loop 3	loop 2	loop 1	loop 0

6.2.10 Setting PID control data

1) The addresses for PID control data and their setting range are given as follows.

Address (10 decimal)		Item	Setting range	Default
G3F-PIDB	G4F-PIDB			
2~33	1~16	Control cycle	1 ~ 9999	"10"
36~67	18~33	Rising ramp of SV	0 ~ 65535	"0"
68~99	34~49	Falling ramp of SV		
100~131	50~65	Low limit of MV	0 ~ 16000	"0"
132~163	66~81	Upper limit of MV		"16000"
164~195	82~97	△MV Limit		"16000"
196~227	98~113	P	1 ~ 10000	"1"
228~259	114~129	I	0 ~ 30000	"0"
260~291	130~145	D		
294~325	147~162	Output control cycle	1 ~ 100	"10"
326~357	163~178	Output low limit	0 ~ 16000	"0"
358~389	179~194	Output upper limit		"16000"
390~421	195~210	ON/OFF interval	0 ~ 8000	"100"
428~459	214~229	Manual MVs	0 ~ 16000	"0"
462~493	231~246	SV		
494~525	247~262	PV		
526~557	263~278	MV		
558~589	279~294	Calculated SV		-
590~621	295~310	Output value	0 ~ 1000	-
624~655	312~327	Auto Tuned P	1 ~ 10000	-
656~687	328~343	Auto Tuned I	0 ~ 30000	-
688~719	344~359	Auto Tuned D		-

2) If PID data is out of range, PID runs with the previous SV.
3) If PID data is out of range, the error number is displayed on the error information.

6.2.11 Alarm information (G3F-PIDB : Address 722~753, G4F-PIDB : Address 361~376)

1) Bit0~Bit5 for the alarm information is used and if the each bit is "ON" a user can see the alarm information.

Bit	Description	Remark
0	During ON/OFF action ,Auto Tuning executed → ON/OFF action hold	
1	During Auto Tuning, ON/OFF command → Auto Tuning hold	
2	During Auto Tuning, SV changed → Run with the previous SV	
3	Out of range manual MV → Run with the limit value (0 or 16000)	
4	Out of range SV → Run with the limit (0 or 16000)	
5	Out of range SP → Run with the limit (0 or 16000)	
6~15	Ignored	

6.2.12 Setting error information (G3F-PIDB : Address 754~785, G4F-PIDB : Address 377~392)

1) When setting the control data for each loop, if any setting exceeds its range the error information is indicated on this area.
2) Bit 0 to 9 are used to indicate error information for each loop. The following shows the error information indicated by each bit when it turns On(1).

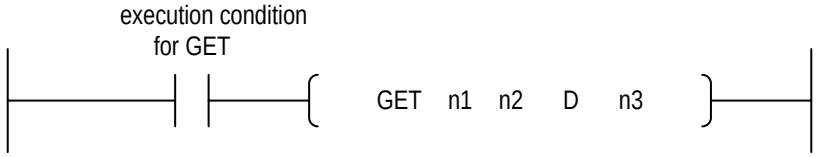
Bit	Description	Remark
0	Control cycle setting error(1~9999)	
1	MV Upper/Lower limit setting error (0~16000)	
2	△MV Limit setting error (0~16000)	
3	P gain setting error (1~10000)	
4	I gain setting error (0~30000)	
5	D gain setting error (0~30000)	
6	Output control cycle setting error (1~100)	
7	Output control cycle < Control cycle	
8	Output MV upper/lower Limit setting error (0~16000)	
9	ON/OFF interval setting error (0~8000)	
10~15	Ignored	

Chapter 7. DEDICATED INSTRUCTIONS FOR SPECIAL MODULES (Read from /Write to buffer memory)

The PID module is available only for local and occupies 16 I/O points.

7.1 Read from buffer memory · · · GET, GETP

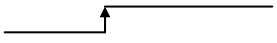
<Format>



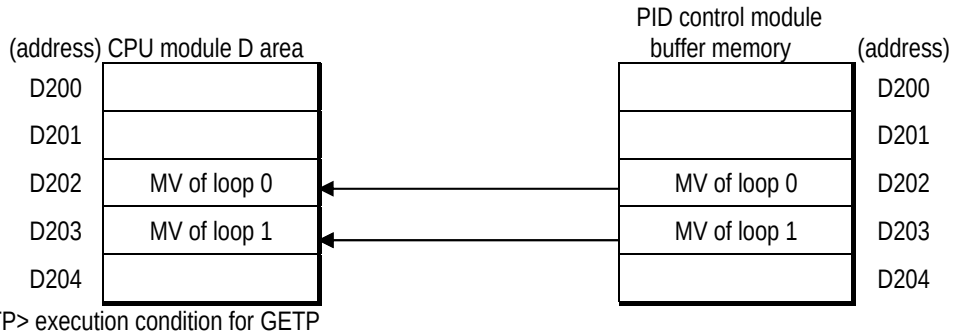
Format	Descriptions	Available Data Type
n1	The slot No. where a special module is mounted	Integer
n2	Head address of the special module buffer memories from which the data will be read.	Integer
D	Head address of the device to store the data read.	M,P,K,J,T,C,D,#D
n3	Number of data to be read .	Integer

<The difference between GET and GETP>

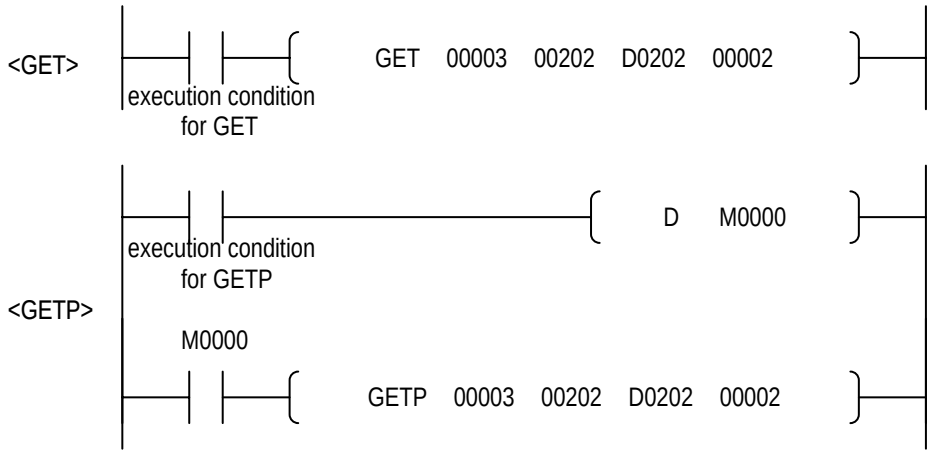
GET: Always executed if the execution condition turns on.()

GETP : Executed if the execution condition is triggered. ()

Example 1) In this example, the PID control module is mounted on the slot 3 in the base unit and the data of buffer memory addresses 202 and 203 will be read to the CPU module addresses D202 and D203.

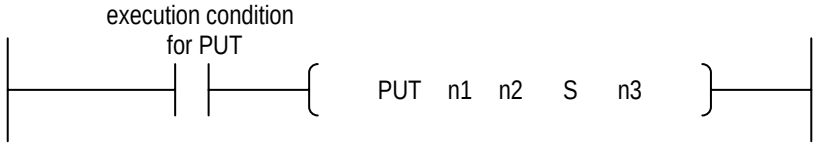


<GETP> execution condition for GETP



7.2 Write to buffer memory · · · PUT, PUTP

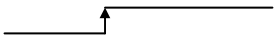
<Format>



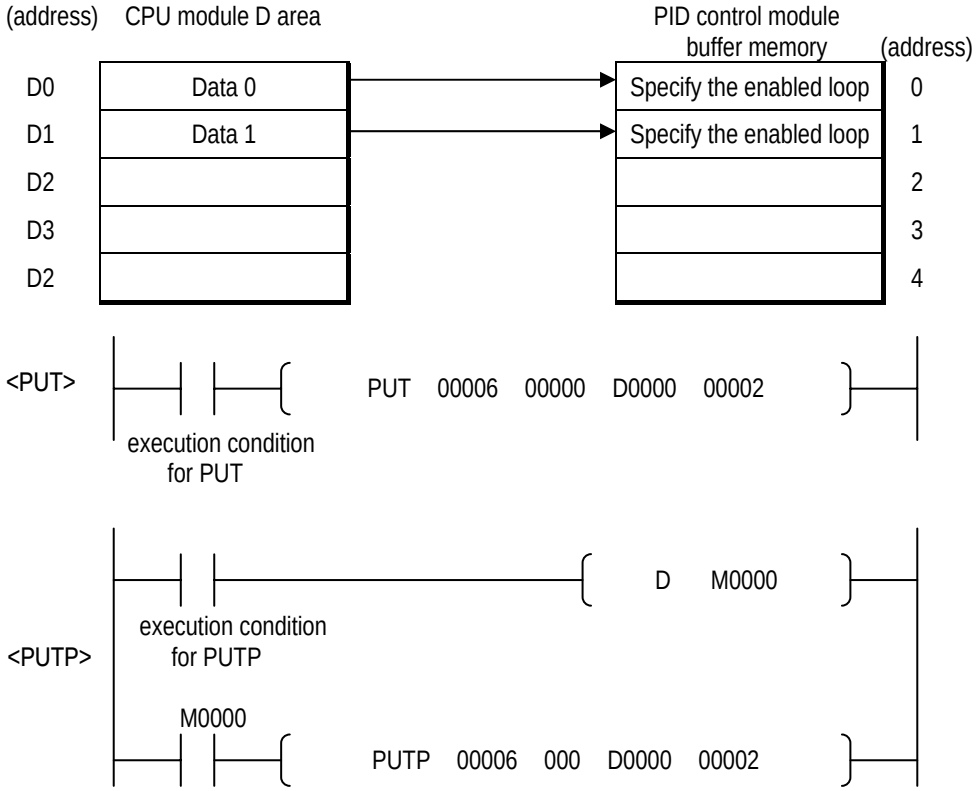
Format	Descriptions	Available Data Type
n1	The slot No. where a special module is mounted.	Integer
n2	Head address of the special module buffer memories to which the data will be written..	Integer
D	Head address of the device where the data to be written has been stored, or an integer	M,P,K,L,T,C,D,#D
n3	Number of data to be written.	Integer

<The difference between PUT and PUTP>

PUT: always executed if the execution condition turns on. ()

PUTP : executed if the execution condition is triggered. ()

Example 1) In this example, the PID control module is mounted on the slot 6 in the base unit and the data of CPU module addresses D0 and D1 will be written to the buffer memory addresses D0 and D1.

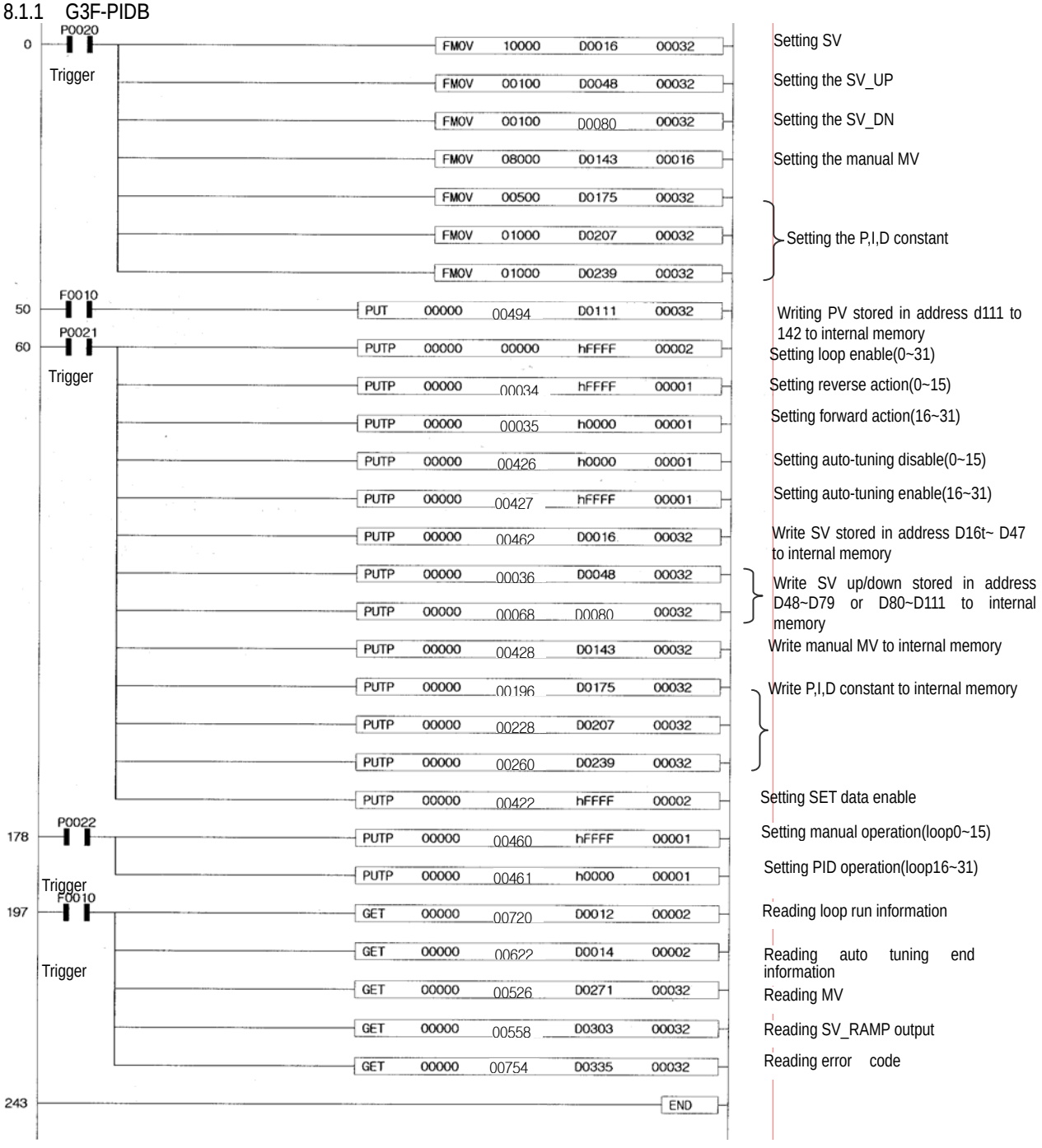


Chapter 8. PROGRAMMING

8.1 Basic programming

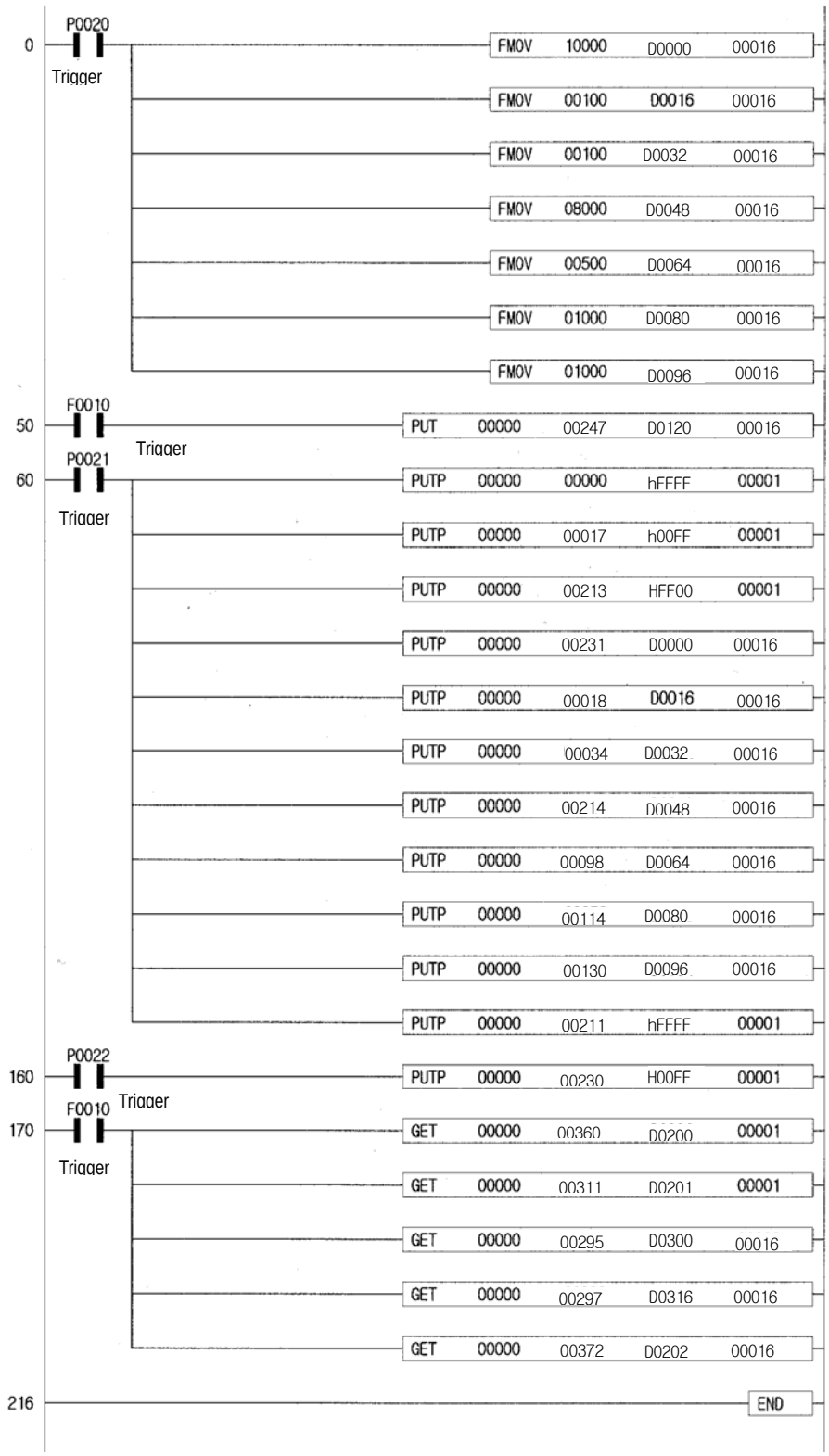
σ The following describes the method to set the running conditions in the buffer memories of the PID control module.
σ The PID control module is already mounted on the slot 0.
σ The PID control module occupies 16 I/O points.

8.1.1 G3F-PIDB



Storing digital conversion value of TC Module to D0000

8.1.2 G4F-PIDB



Setting SV

Setting the SV_UP

Setting the SV_DN

Setting the manual MV

Setting the P,I,D constant

Writing PV stored in address D120~D135 to internal memory

Setting loop enable(loop0~15)

Setting reverse action(loop0~7) and forward action(loop8~15)

Setting auto-tuning enable(loop8~15)

Write SV to internal memory

Write SV up rising time to internal memory

Write SV down falling time to internal memory

Write manual MV to internal memory

Write P,I,D constant to internal memory

Setting SET data enable

Setting manual operation(loop0~7) and PID operation(loop8~15)

Reading loop run information

Reading auto tuning end information

Reading MV

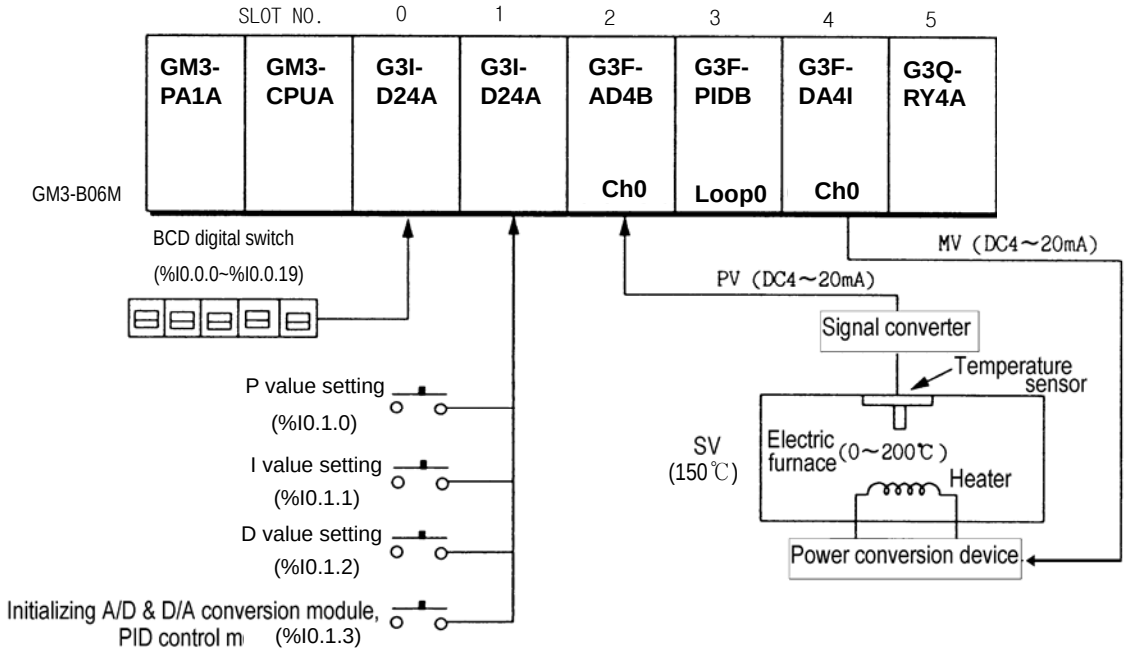
Reading SV_RAMP output

Reading error code

8.2 Application programming

8.2.1 Program example using G3F-AD4B module

1) System configuration



2) Initial value

(1) PID module
- A) Used loop : Loop 0
- B) Control cycle : 10ms
- C) Forward, reverse action : Forward action
- D) SV value : 12000
- E) Auto/Manual calculation selection : Auto calculation
- F) Initial PID constants : P=200,I=500,D=500

(2) A/D module
- A) Used channel : 0
- B) Output data type : 0 ~ 16000
- C) Average calculation : 20 times
- D) Signal converter specification : Input 0~200℃, Output 4~20mA

(3) D/A module
- A) Use channel : 0
- B) Input data type selection : -192 ~ 16191
- C) Output status when a channel is not used or CPU stops : Mid-value of the output range.

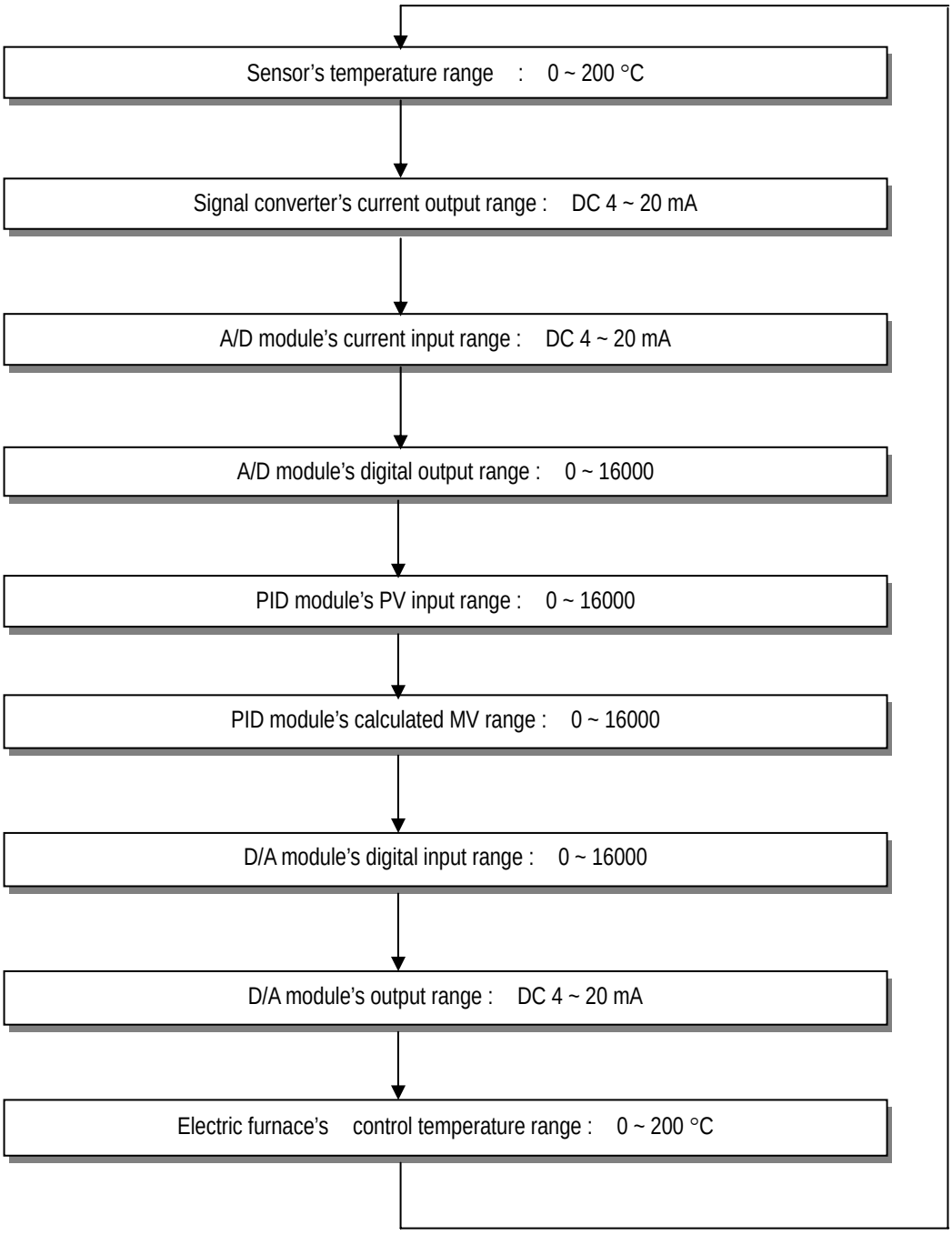
3) Program descriptions

A) Temperature 0 ~ 200°C from sensor is transferred to 4 ~ 20 mA and the current is input to A/D module to convert to digital value.

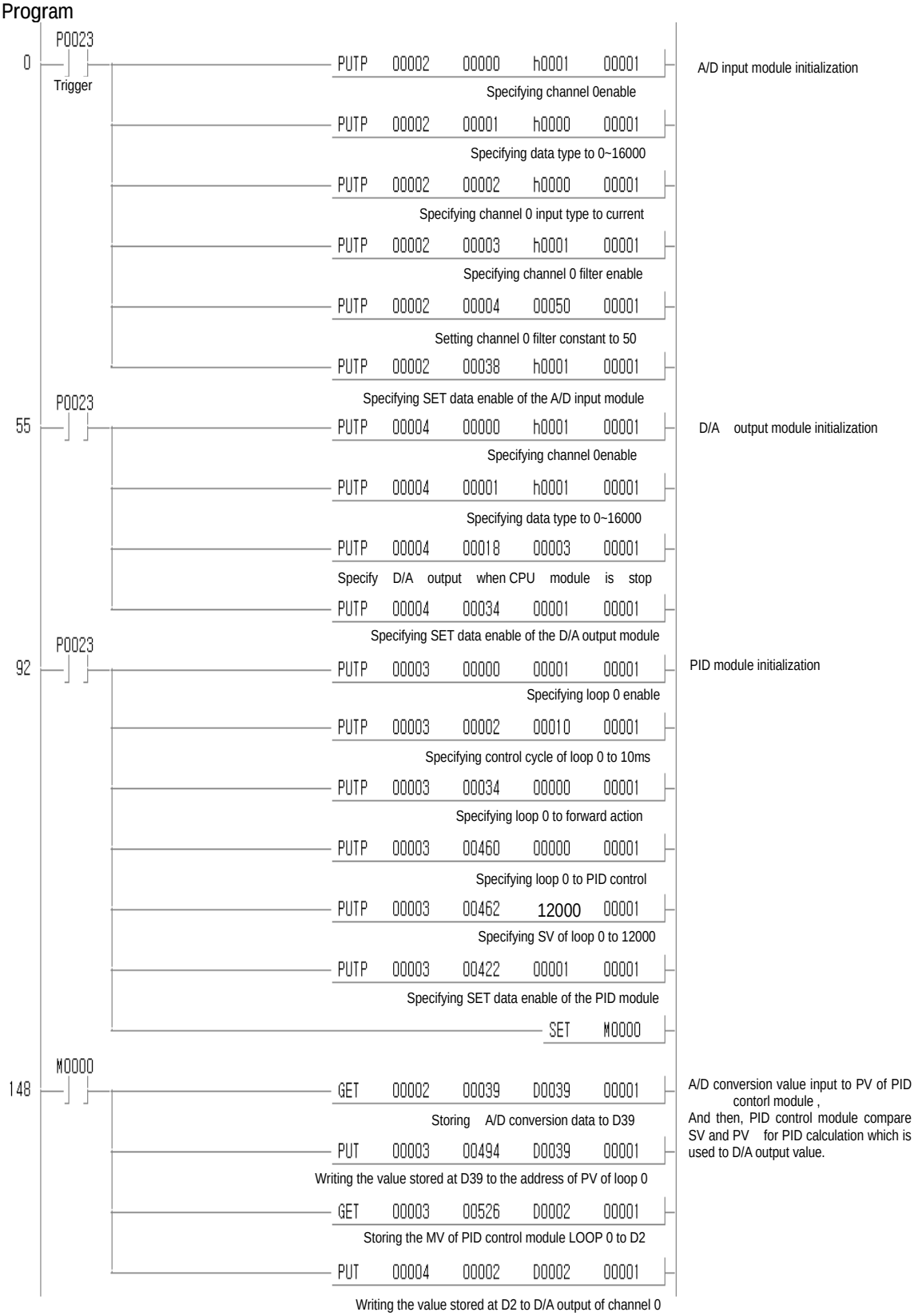
B) 150°C(The signal converter's output is 16mA, Target value 12000) is set with SV value in PID and P,I,D constants are controlled with the initialized value.
If %I0.1.0 is On the modified value by BCD switch is set with P.
If %I0.1.1 is On the modified value by BCD switch is set with I.

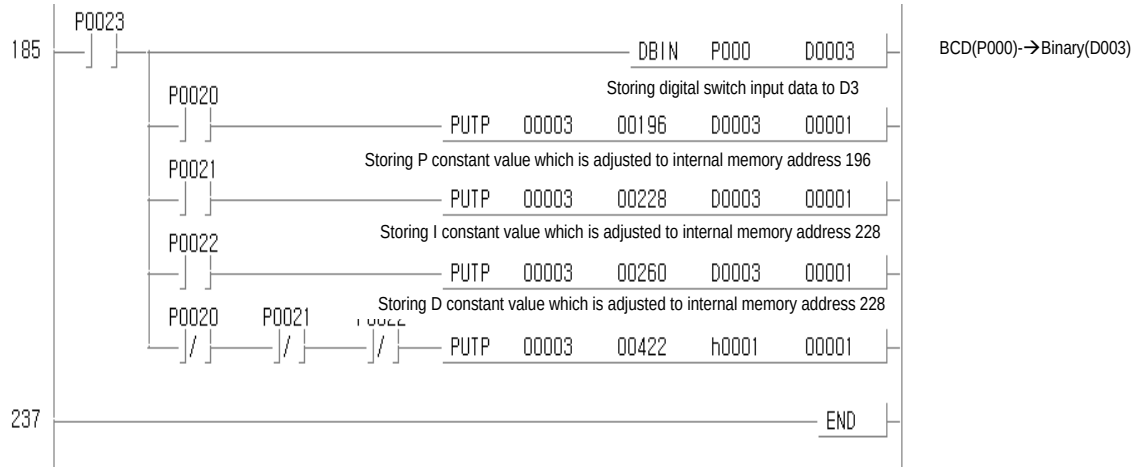
If %I0.1.2 is On the modified value by BCD switch is set with D.
C)PID calculated MV value is output on D/A module's channel 0.
D)If %I0.1.3 is On A/D,PID,D/A modules are initialized.

1) Modules and their signal processing



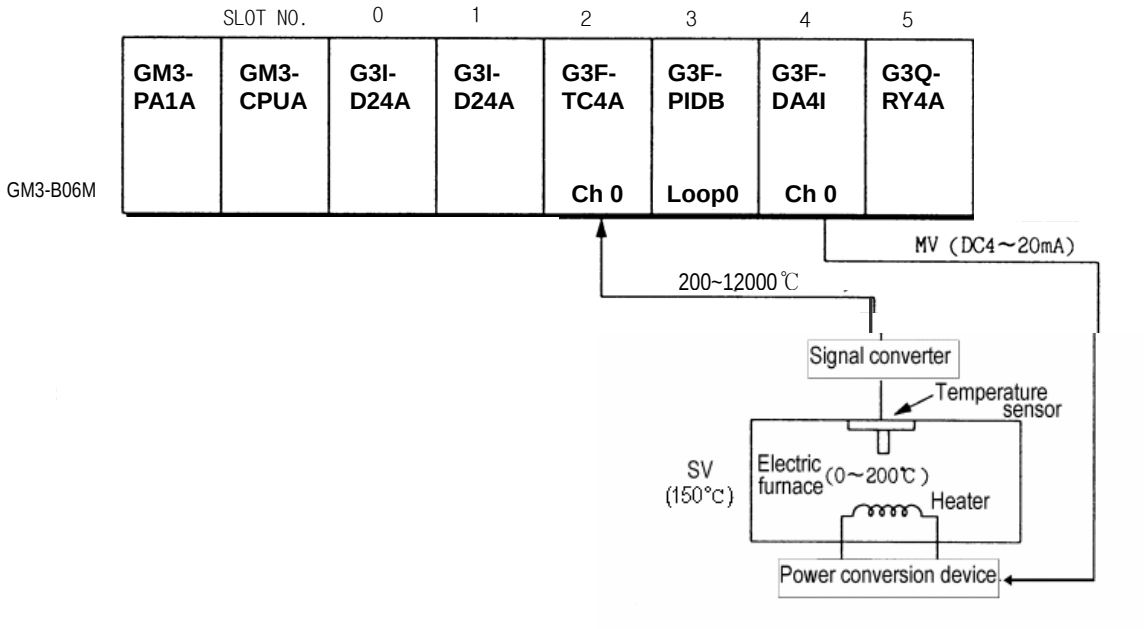
2) Program


P0023
0
Trigger
PUTP U0002 U0000 h0001 U0001
A/D input module initialization
Specifying channel 0enable
PUTP U0002 U0001 h0000 U0001
Specifying data type to 0~16000
PUTP U0002 U0002 h0000 U0001
Specifying channel 0 input type to current
PUTP U0002 U0003 h0001 U0001
Specifying channel 0 filter enable
PUTP U0002 U0004 U0050 U0001
Setting channel 0 filter constant to 50
PUTP U0002 U0038 h0001 U0001
Specifying SET data enable of the A/D input module
P0023
55
PUTP U0004 U0000 h0001 U0001
D/A output module initialization
Specifying channel 0enable
PUTP U0004 U0001 h0001 U0001
Specifying data type to 0~16000
PUTP U0004 U0018 U0003 U0001
Specify D/A output when CPU module is stop
PUTP U0004 U0034 U0001 U0001
Specifying SET data enable of the D/A output module
P0023
92
PUTP U0003 U0000 U0001 U0001
PID module initialization
Specifying loop 0 enable
PUTP U0003 U0002 U0010 U0001
Specifying control cycle of loop 0 to 10ms
PUTP U0003 U0034 U0000 U0001
Specifying loop 0 to forward action
PUTP U0003 U0460 U0000 U0001
Specifying loop 0 to PID control
PUTP U0003 U0462 12000 U0001
Specifying SV of loop 0 to 12000
PUTP U0003 U0422 U0001 U0001
Specifying SET data enable of the PID module
SET M0000
M0000
148
GET U0002 U0039 D0039 U0001
A/D conversion value input to PV of PID contorl module ,
And then, PID control module compare SV and PV for PID calculation which is used to D/A output value.
Storing A/D conversion data to D39
PUT U0003 U0494 D0039 U0001
Writing the value stored at D39 to the address of PV of loop 0
GET U0003 U0526 D0002 U0001
Storing the MV of PID control module LOOP 0 to D2
PUT U0004 U0002 D0002 U0001
Writing the value stored at D2 to D/A output of channel 0


185
P0023
DBIN P000 D0003
BCD(P000)-→Binary(D003)
Storing digital switch input data to D3
P0020
PUTP 00003 00196 D0003 00001
Storing P constant value which is adjusted to internal memory address 196
P0021
PUTP 00003 00228 D0003 00001
Storing I constant value which is adjusted to internal memory address 228
P0022
PUTP 00003 00260 D0003 00001
Storing D constant value which is adjusted to internal memory address 228
P0020
P0021
PUTP 00003 00422 h0001 00001
237
END

8.2.2 Program using the auto tunning function (TC module used)

1)System configuration



2) Initial Settings

(1) PID module

A) Loop : Loop 0

B) Control cycle : 50ms

C) Forward/reverse action : Forward action

D) SV value : 8000(700℃)

E) Auto/Manual calculation selection : After synchronization, auto operation with P,I,D constants.

(2) A/D module

A) Channel : 0

B) Input sensor type : K TYPE(-200~1200℃)

(3) D/A module

A) Channel : 0

B) Input data type : 0 ~ 16000

C) Output status when a channel is not used or CPU stops : Mid-value of the output range.

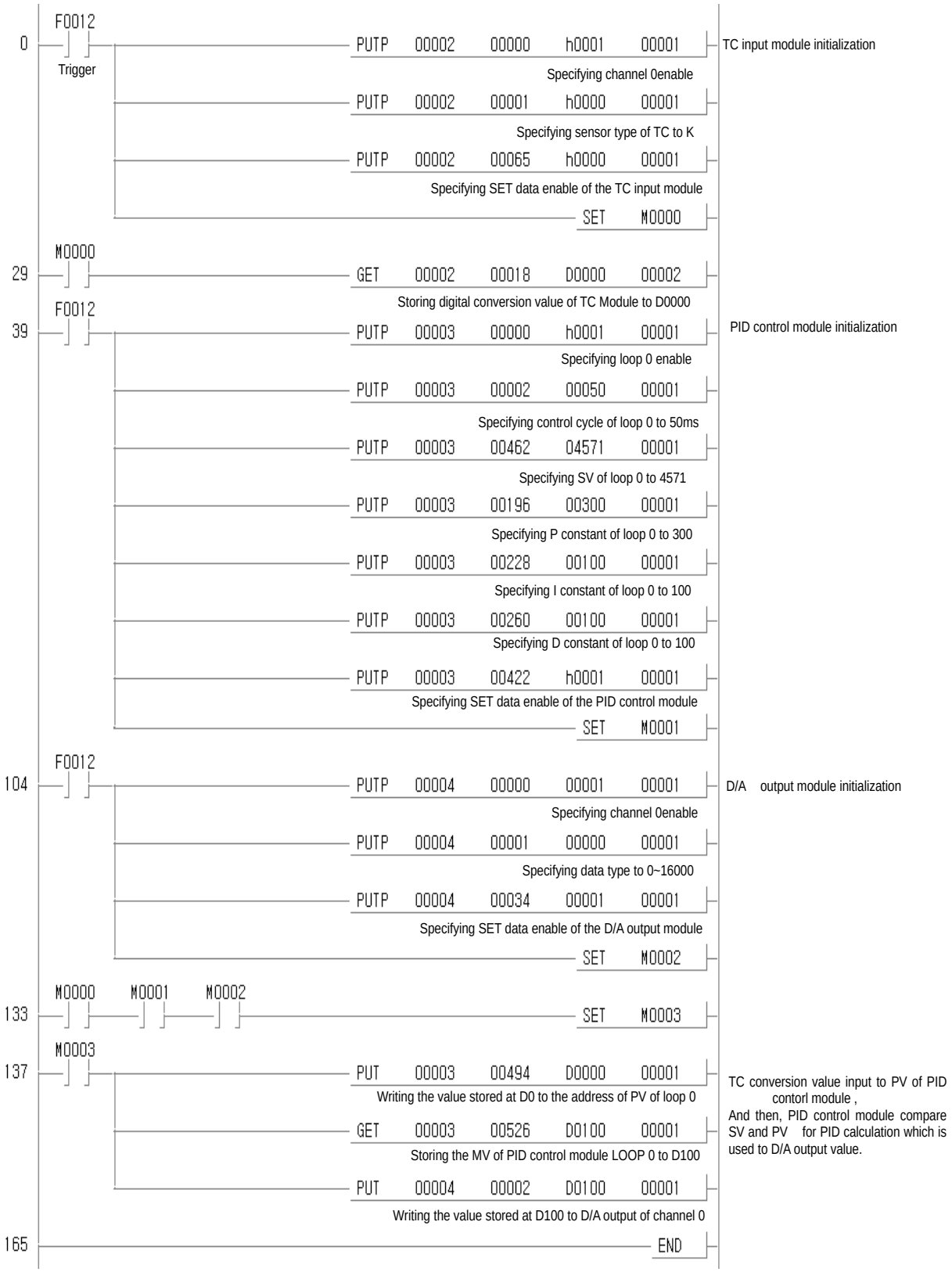
3) Descriptions of the program

(1) The converted temperature value is transferred 0~16000 and input as a current value..

(2) PID is set SV as 700°C and P,I,D constants are calculated by auto-tuning.
PID control is executed with this calculated value.

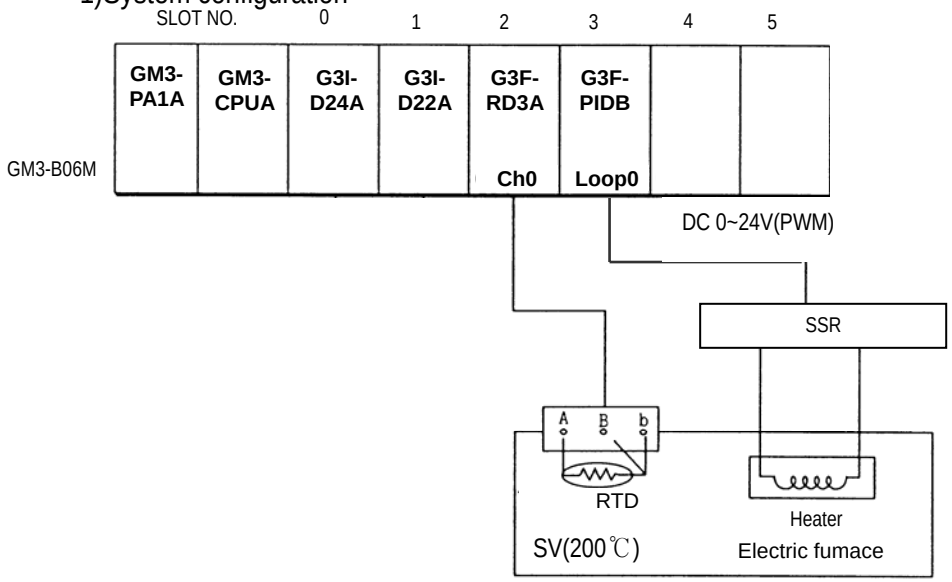
(3) PID calculated values are output to D/A module' ch0..

4) Program


0
F0012
Trigger
PUTP 00002 00000 h0001 00001
TC input module initialization
Specifying channel 0enable
PUTP 00002 00001 h0000 00001
Specifying sensor type of TC to K
PUTP 00002 00065 h0000 00001
Specifying SET data enable of the TC input module
SET M0000
29
M0000
GET 00002 00018 D0000 00002
Storing digital conversion value of TC Module to D0000
39
F0012
PUTP 00003 00000 h0001 00001
PID control module initialization
Specifying loop 0 enable
PUTP 00003 00002 00050 00001
Specifying control cycle of loop 0 to 50ms
PUTP 00003 00462 04571 00001
Specifying SV of loop 0 to 4571
PUTP 00003 00196 00300 00001
Specifying P constant of loop 0 to 300
PUTP 00003 00228 00100 00001
Specifying I constant of loop 0 to 100
PUTP 00003 00260 00100 00001
Specifying D constant of loop 0 to 100
PUTP 00003 00422 h0001 00001
Specifying SET data enable of the PID control module
SET M0001
104
F0012
PUTP 00004 00000 00001 00001
D/A output module initialization
Specifying channel 0enable
PUTP 00004 00001 00000 00001
Specifying data type to 0~16000
PUTP 00004 00034 00001 00001
Specifying SET data enable of the D/A output module
SET M0002
133
M0000 M0001 M0002
SET M0003
137
M0003
PUT 00003 00494 D0000 00001
Writing the value stored at D0 to the address of PV of loop 0
TC conversion value input to PV of PID contorl module ,
And then, PID control module compare SV and PV for PID calculation which is used to D/A output value.
GET 00003 00526 D0100 00001
Storing the MV of PID control module LOOP 0 to D100
PUT 00004 00002 D0100 00001
Writing the value stored at D100 to D/A output of channel 0
165
END

8.2.3 Program using PWM

1)System configuration



2) Initial value

(1) PID module

A) Loop : 0

B) Control cycle : 50ms

C) Forward/reverse action : Forward action

D) SV: 8000(200℃)

E) PID constants: P,I,D constants by Auto-tuning

F) Auto calculation/manual calculation : Auto – In case that RTD doesn't have an error.
Manual – In case that RTD has an error.

G) Output :PWM

H) Output cycle:10 ㎳

(2) RTD module

A) Channel : 0

B) RTD module's sensor : Pt100

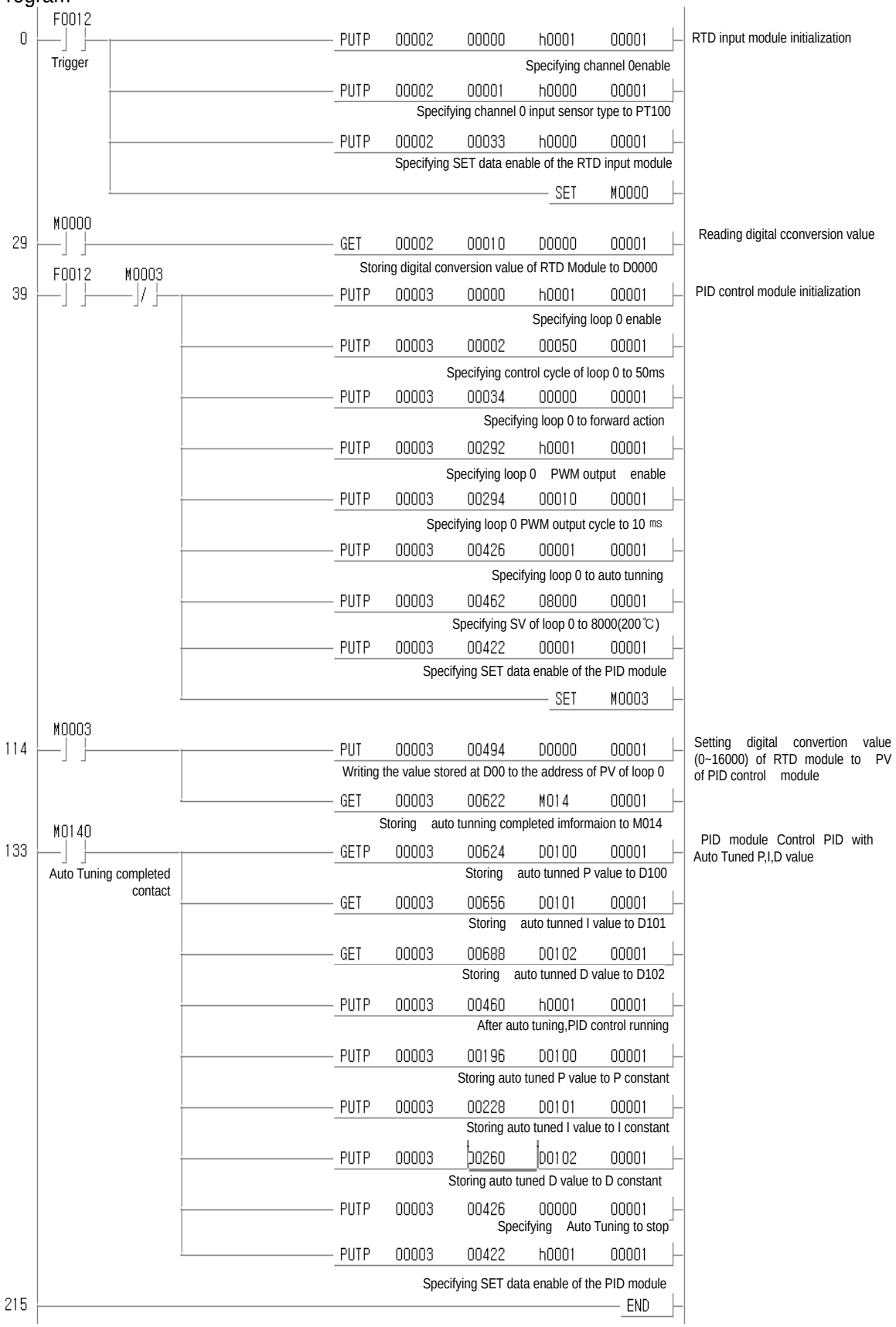
C) Input temperature range: - 200~600℃(SCAL:0~16000)

3) Program description

(1) RTD module detects the heater's temperature with Pt100 and the detected value is changed to the digital value.

(2) SV value is set as 8000(Temperature 200°C) and PID is executed with auto-tuned P,I,D
If PID module has an error (by RTD module's disconnection) PID is run with SV(0).

4) Program


F0012
0
Trigger
PUTP 00002 00000 h0001 00001
RTD input module initialization
Specifying channel 0enable
PUTP 00002 00001 h0000 00001
Specifying channel 0 input sensor type to PT100
PUTP 00002 00033 h0000 00001
Specifying SET data enable of the RTD input module
SET M0000
M0000
29
GET 00002 00010 D0000 00001
Reading digital cconversion value
Storing digital conversion value of RTD Module to D0000
F0012 M0003
39
PUTP 00003 00000 h0001 00001
PID control module initialization
Specifying loop 0 enable
PUTP 00003 00002 00050 00001
Specifying control cycle of loop 0 to 50ms
PUTP 00003 00034 00000 00001
Specifying loop 0 to forward action
PUTP 00003 00292 h0001 00001
Specifying loop 0 PWM output enable
PUTP 00003 00294 00010 00001
Specifying loop 0 PWM output cycle to 10 ms
PUTP 00003 00426 00001 00001
Specifying loop 0 to auto tunning
PUTP 00003 00462 08000 00001
Specifying SV of loop 0 to 8000(200℃)
PUTP 00003 00422 00001 00001
Specifying SET data enable of the PID module
SET M0003
M0003
114
PUT 00003 00494 D0000 00001
Setting digital convertion value (0~16000) of RTD module to PV of PID control module
Writing the value stored at D00 to the address of PV of loop 0
GET 00003 00622 M014 00001
Storing auto tunning completed imformaion to M014
M0140
133
Auto Tuning completed contact
GETP 00003 00624 D0100 00001
PID module Control PID with Auto Tuned P,I,D value
Storing auto tunned P value to D100
GET 00003 00656 D0101 00001
Storing auto tunned I value to D101
GET 00003 00688 D0102 00001
Storing auto tunned D value to D102
PUTP 00003 00460 h0001 00001
After auto tuning,PID control running
PUTP 00003 00196 D0100 00001
Storing auto tuned P value to P constant
PUTP 00003 00228 D0101 00001
Storing auto tuned I value to I constant
PUTP 00003 00260 D0102 00001
Storing auto tuned D value to D constant
PUTP 00003 00426 00000 00001
Specifying Auto Tuning to stop
PUTP 00003 00422 h0001 00001
Specifying SET data enable of the PID module
215
END

Chapter 9. TROUBLESHOOTING

The followings explain errors that could occur during operating the PID control module and their troubleshooting.

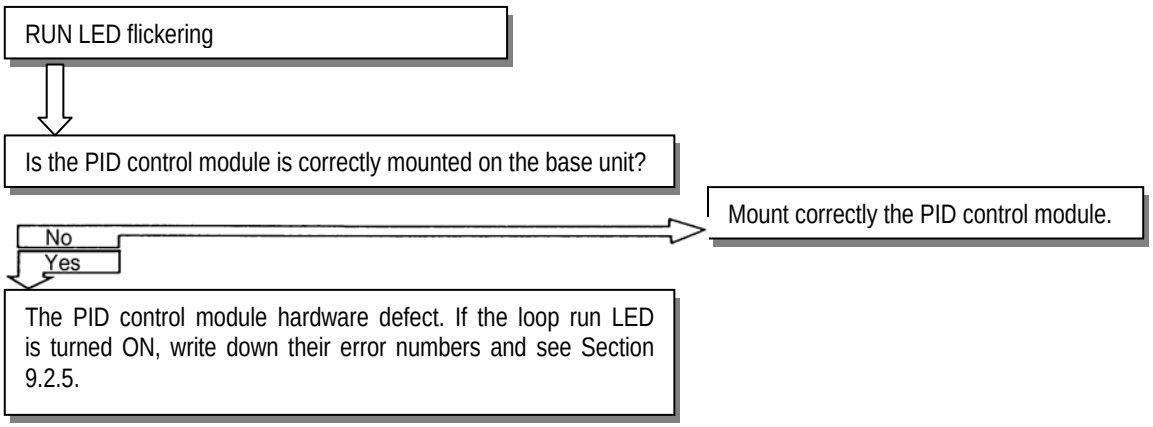
9.1 Errors indicated by RUN LED flickering

Errors indicated by PID control module RUN LED flickering are given below.

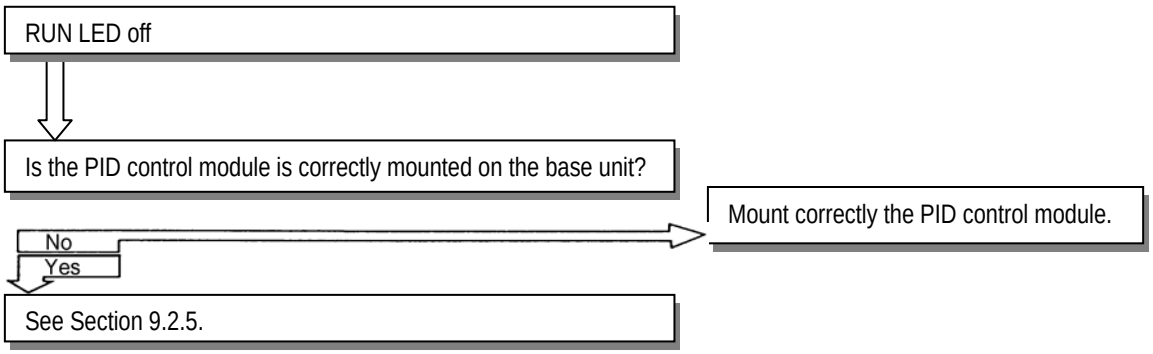
RUN LED Status	Error Type	Remark
Turn on	Normal operation	
Flickering (cycle: 0.2 sec)	WDT Error	
	System Error	
	Buffer Memory Error	

9.2 Troubleshooting procedure

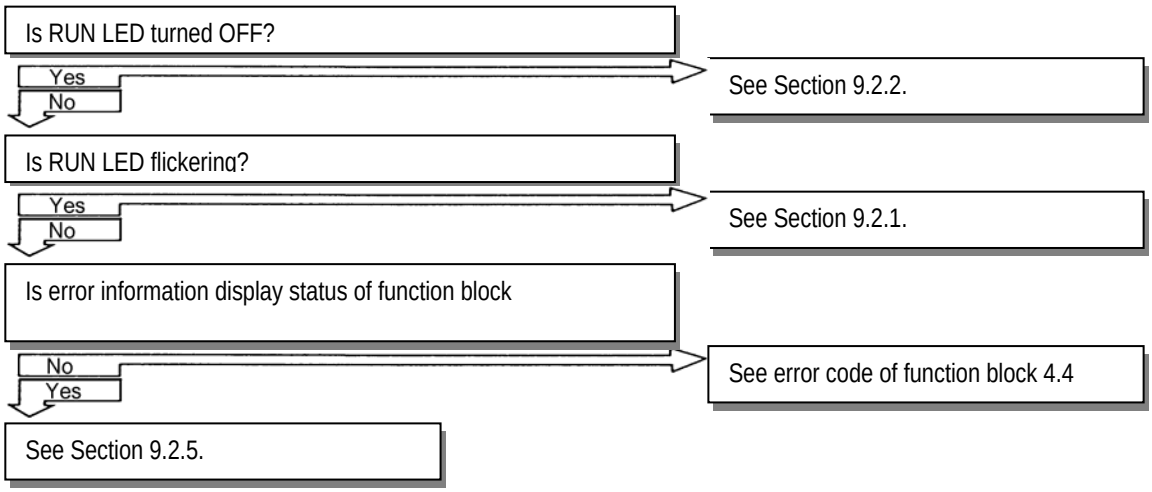
9.2.1 RUN LED flickering



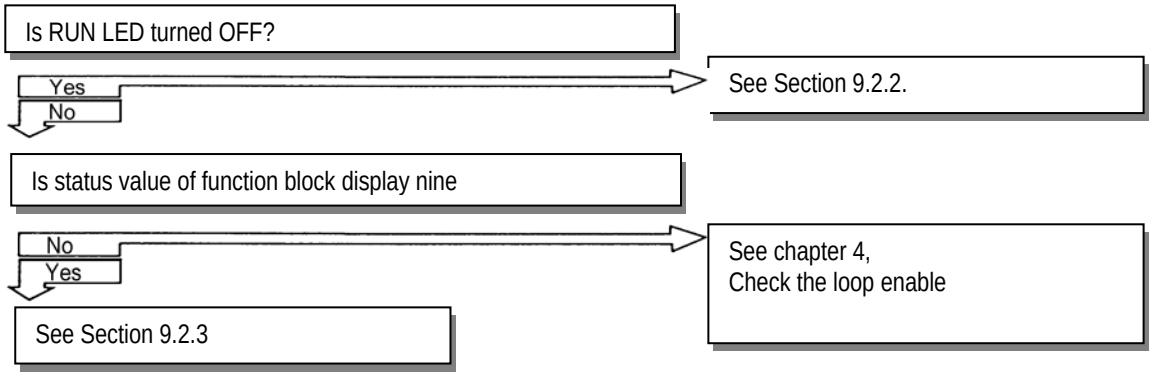
9.2.2 RUN LED off



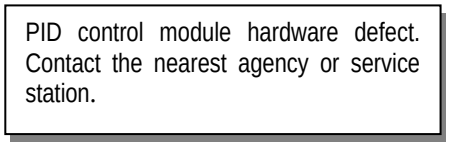
9.2.3 Unreadable processing result of PID control module



9.2.4 Run LED of enabled loops off



9.2.5 PID control module hardware defect



Warranty

1. Warranty Period
   The product purchased will be guaranteed for a period of 18 months upon manufactured.

2. Warranty Coverage
   Against the defect found during the Warranty Period specified above, this product will be repaired or exchanged partially. However, please understand that such cases as described below will be excluded from the Warranty Coverage.

   (1) If the defect is caused by unsuitable condition, environment and treatment or other reason than specified in the user's manual.
   (2) If the defect is caused by other parts than LS product.
   (3) If the product is remodeled or repaired by others than LS or its designated service center
   (4) If the product is used with other procedures than originally intended.
   (5) If the defect is caused by a reason unexpected under the scientific and technical standard when released from LS.
   (6) If the defect is caused by a natural calamity or fire which LS is not responsible for.

3. Since the warranty details above are to guarantee the PLC unit only, the customers are strongly recommended to use the product after due consideration of safety for system configuration or product application.