MELSEC-Q/L PID Control FB Library Reference Manual

Target Module:
MELSEC-Q/L CPU Module

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REFERENCE MANUAL RECISIONS

Reference Manual No.	Date	Revision
FBM-M202-A	2017/05	New Create

1. OVERVIEW

1.1. FB Library Overview

This FB library is an FB library for PID control.

1.2. FB Library Function Content

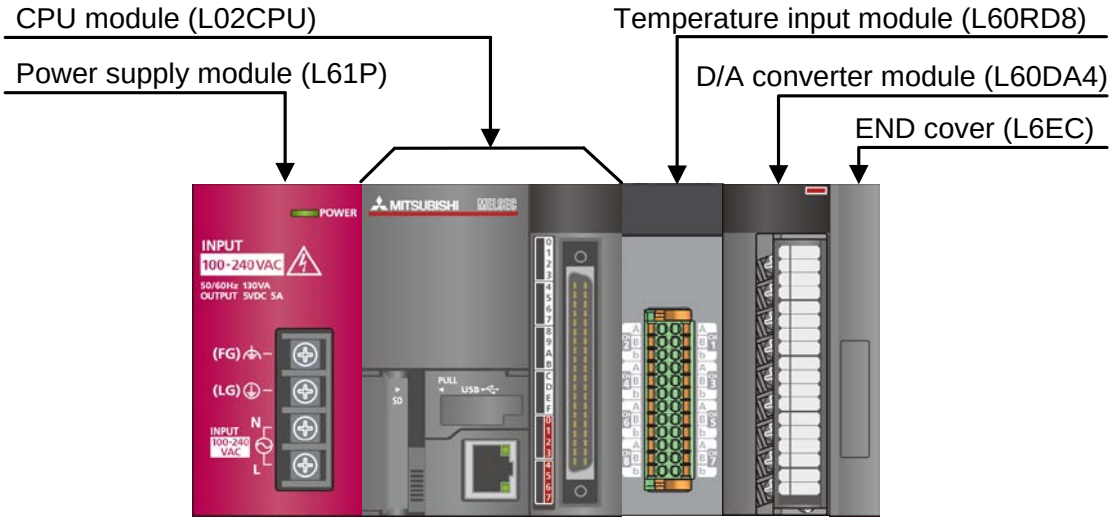
Item	Description
M+CPU-PID_PIDControl	Perform auto tuning, calculate PID constant, and perform PID control.
M+CPU-PID_PIDOperation	Perform auto tuning, calculate PID constant, and perform PID operation.

1.3. System Configuration Examples

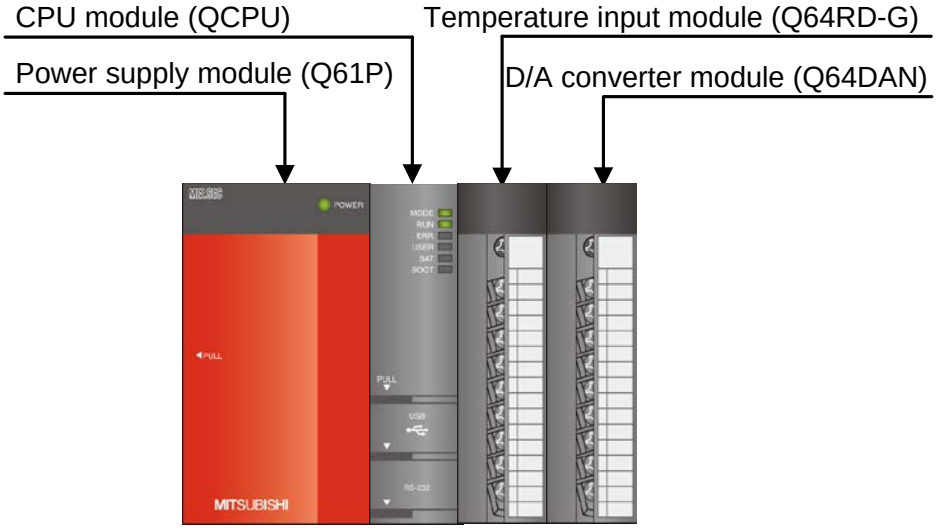
Examples for the system configuration when PID control is performed with the following combination are shown below.

(1) SCR (Thyristor) is used

a) System configuration of L series

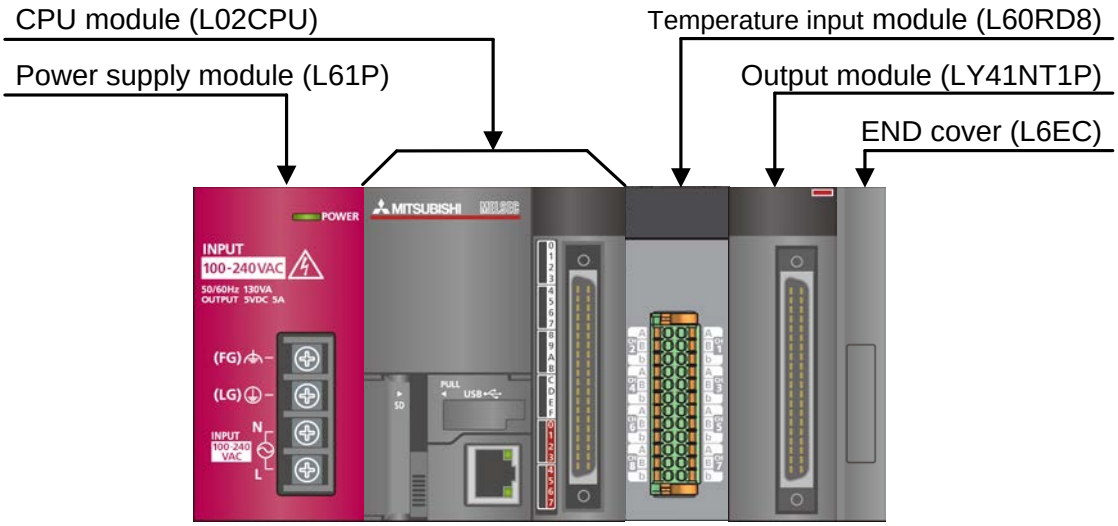


b) System configuration of Q series

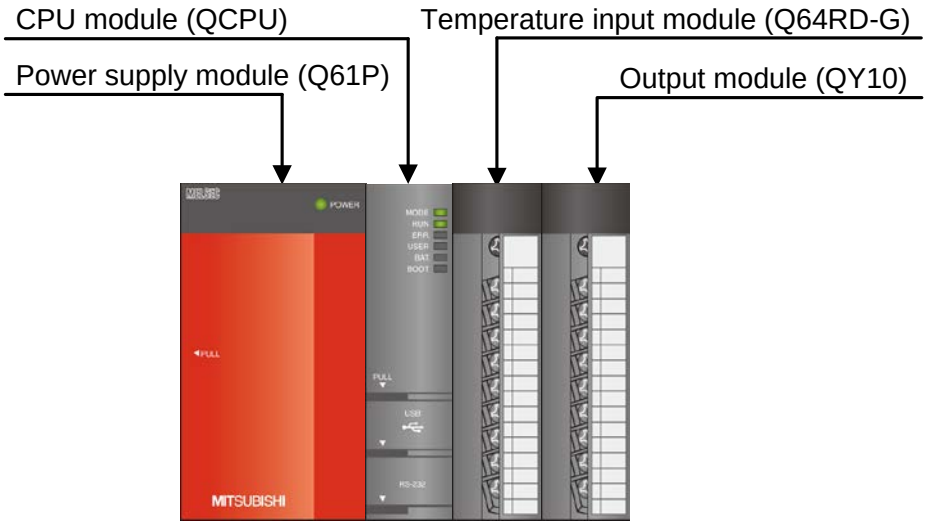


(2) SSR (Solid State Relay) is used

a) System configuration of L series



b) System configuration of Q series



1.4. Relevant Manuals

MELSEC-L RTD Input Module User's Manual

MELSEC-L Digital-Analog Converter Module User's Manual

MELSEC-L I/O Module User's Manual

MELSEC-L CPU Module User's Manual (Hardware Design, Maintenance and Inspection)

MELSEC-L CPU Module User's Manual (Function Explanation, Program Fundamentals)

MELSEC-Q/L Programming Manual (Common Instruction)

RTD Input Module/Channel Isolated RTD Input Module User's Manual (Details)

Digital-Analog Converter Module User's Manual (Details)

I/O Module Type Building Block User's Manual

QCPU User's Manual (Hardware Design, Maintenance and Inspection)

QnUCPU User's Manual (Function Explanation, Program Fundamentals)

GX Works2 Version 1 Operating Manual (Common)

GX Works2 Version 1 Operating Manual (Simple Project, Function Block)

1.5. Please

Please read the user's manual of the product carefully before working on the target product.

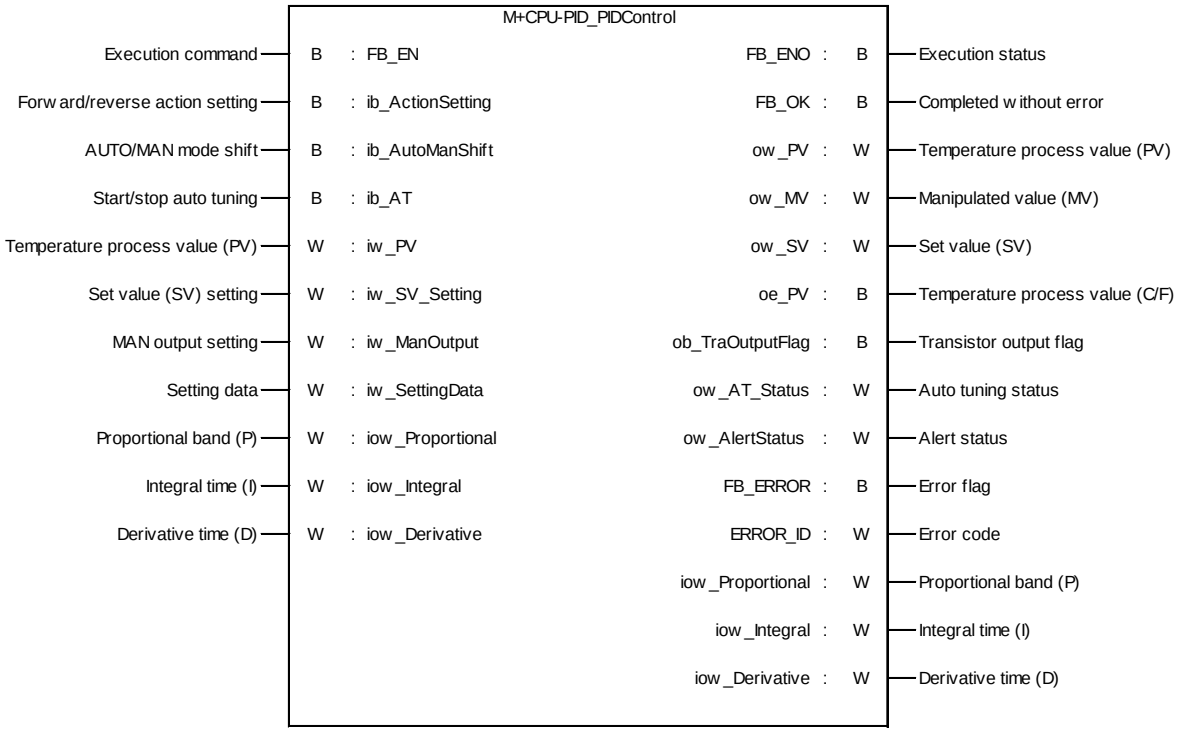
2. FB LIBRARY DETAILS

2.1. M+CPU-PID_PIDControl (PID Control)

Name

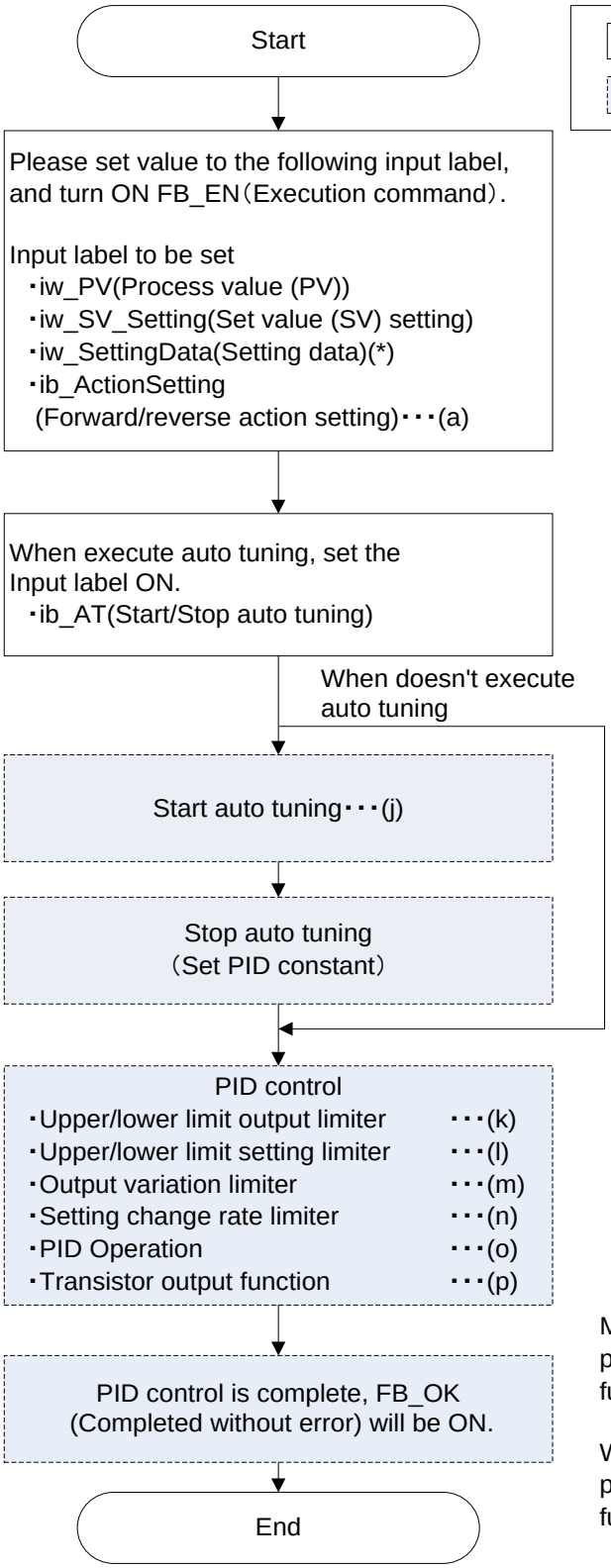
M+CPU-PID_PIDControl

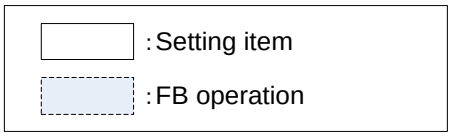
Function description

Item	Description	
Function Overview	Perform auto tuning, calculate PID constant, and perform PID control.	
Symbol		
Target Module	CPU Module	Series: MELSEC-Q series — Model: High-Speed Universal Model*1 Series: MELSEC-L series — Model: LCPU *2 *1 First five digits of serial No. are “19012” or later can be used *2 First five digits of serial No. are “18102” or later can be used

<table>
<tr><th>Item</th><th colspan="2">Description</th></tr>
<tr><td></td><td>Engineering tool</td><td>GX Works2 *1
<table>
<tr><th>Language</th><th>Supported Software Version</th></tr>
<tr><td>Japanese version</td><td>Version 1.560J or later</td></tr>
<tr><td>English version</td><td>Version 1.560J or later</td></tr>
<tr><td>Chinese (Simplified) version</td><td>Version 1.560J or later</td></tr>
<tr><td>Chinese (Traditional) version</td><td>Version 1.560J or later</td></tr>
<tr><td>Korean version</td><td>Version 1.560J or later</td></tr>
</table>
*1 For software versions applicable to the modules used, refer to "Relevant manuals".</td></tr>
<tr><td>Description Language</td><td colspan="2">ST (closed program)</td></tr>
<tr><td>Number Of Steps</td><td colspan="2">3646 Step (for MELSEC-Q series universal model CPU)
* The number of steps of the FB in a program depends on the CPU model that is used and input and output definition.</td></tr>
</table>

Item	Description
Functional Description	1) PID control is realized as shown below in this FB.





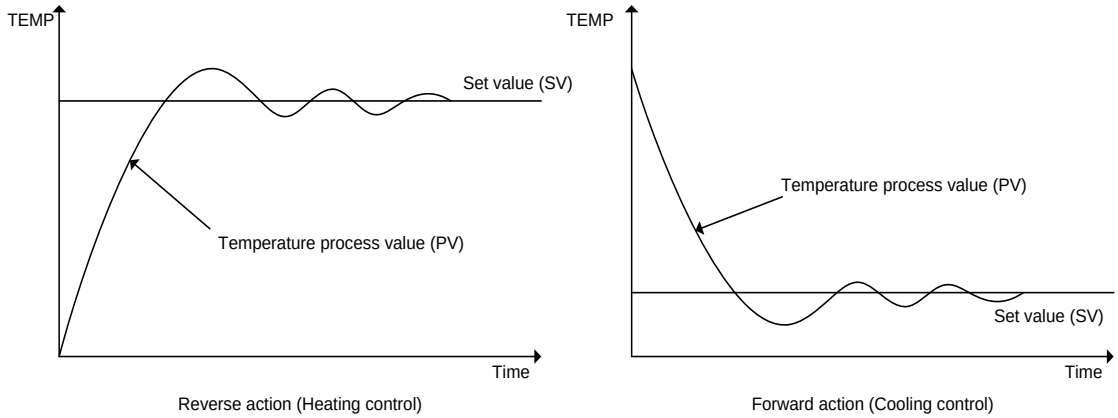
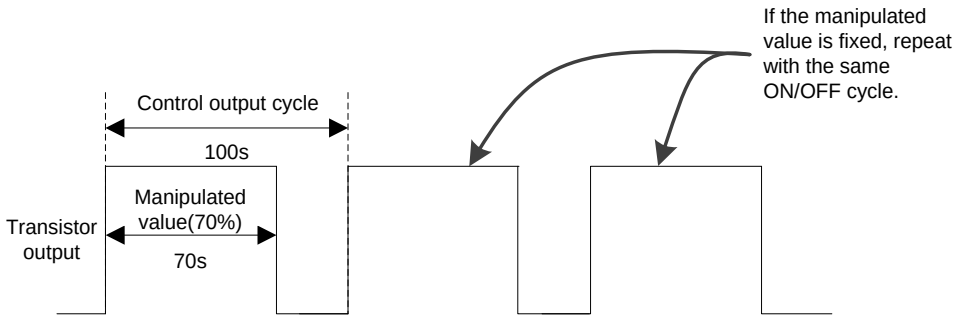
(*)Setting data to be set

Control output cycle setting・・・(b)
Input range upper limit
Input range lower limit
Upper limit output limiter
Lower limit output limiter
Upper limit setting limiter
Lower limit setting limiter
Output variation limiter
Setting change rate limiter
Alert 1 mode setting
Alert 2 mode setting
Alert 3 mode setting
Alert 4 mode setting
Alert set value 1
Alert set value 2
Alert set value 3
Alert set value 4
Alert dead band setting・・・(h)
AT timeout time
Auto tuning control type setting
Two-degree-of-freedom parameter α
Two-degree-of-freedom parameter β
Decimal point position
Timer Limit Setting
Using timer divice setting

More information of functions a)～p), please refer to “4) Explanation of each function”.

When use MAN output function, please refer to “4) Explanation of each function q”.

Item	Description
	2) When FB_EN (Execution command) is ON, ib_ActionSetting (Forward/reverse action setting) and iw_SettingData (Setting data) are read. Therefore, even if setting data is changed while FB_EN is ON, the value will be disabled. 3) If the setting value of the following data of iw_SettingData (Setting data) is out of range, FB_ERROR (Error flag) turns ON and processing of FB is interrupted. In addition, the error code corresponding to the error of each setting data is stored in ERROR_ID (Error code). For the error code, refer to the explanation of the error code. •Control output cycle setting •Upper limit output limiter •Lower limit output limiter •Output variation limiter •Setting change rate limiter •Alert 1 mode setting •Alert 2 mode setting •Alert 3 mode setting •Alert 4 mode setting •Alert set value1 •Alert set value2 •Alert set value3 •Alert set value4 •Alert dead band setting •AT timeout time •Auto tuning control type setting •Two-degree-of-freedom parameter α •Two-degree-of-freedom parameter β •Decimal point position •Timer Limit Setting 4) Explanation of each function a) Switch between forward action and reverse action i) It is a function to set which to use between forward action and reverse action. ii) Perform the following operations based on the setting value. •The forward action is an operation to increase the manipulated value (MV) when the temperature process value (PV) is higher than the set value (SV).Forward action is used for cooling control. •The reverse action is an operation to increase the manipulated value (MV) when the temperature process value (PV) is lower than the set value (SV). Reverse action is used for heating control.

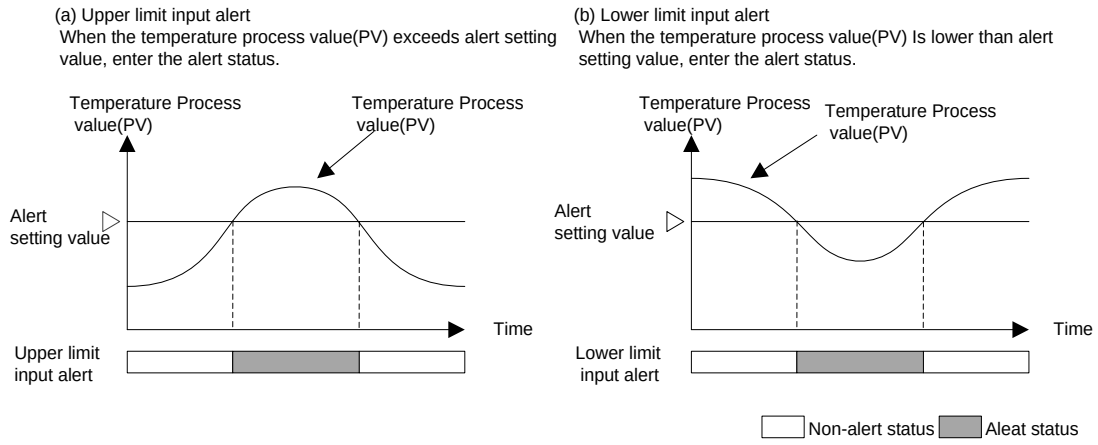
Item	Description
	 iii) When ib_ActionSetting (Forward/reverse action setting) is ON, the forward action is performed, and when it is OFF, the reverse action is performed. b) Control output cycle setting Set the pulse cycle (ON/OFF cycle) of the transistor output. Ex.) The control output cycle is set to 100s, and the manipulated value is 70%. Repeat the operation that turns ON for 70s every 100s and turns OFF for the remaining 30s. 

Item	Description

c) Upper limit input alert/Lower limit input alert

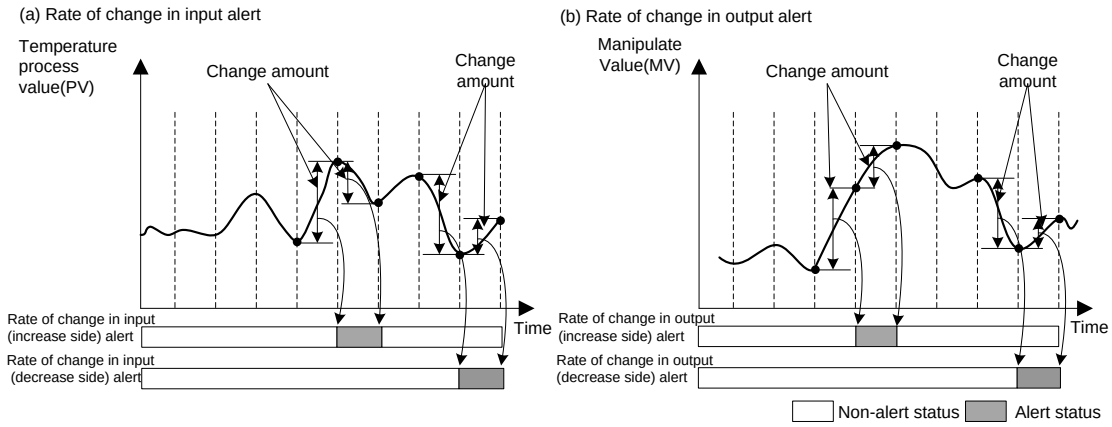
i) When iw_PV (Temperature process value (PV)) is out of the range of alert set value of iw_SettingData (Setting data), the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON.

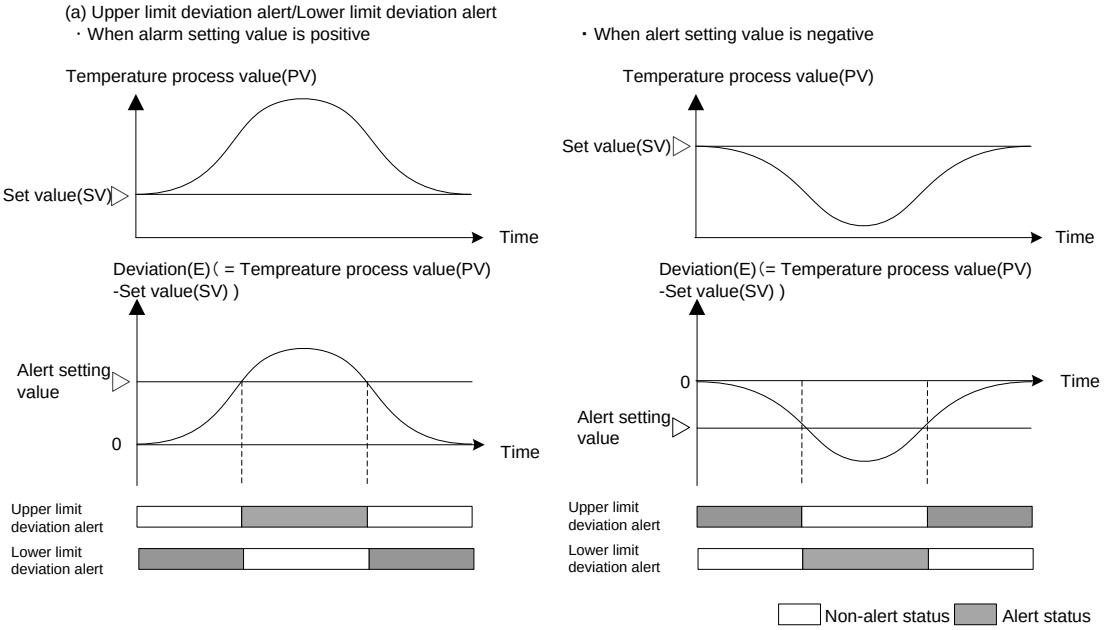
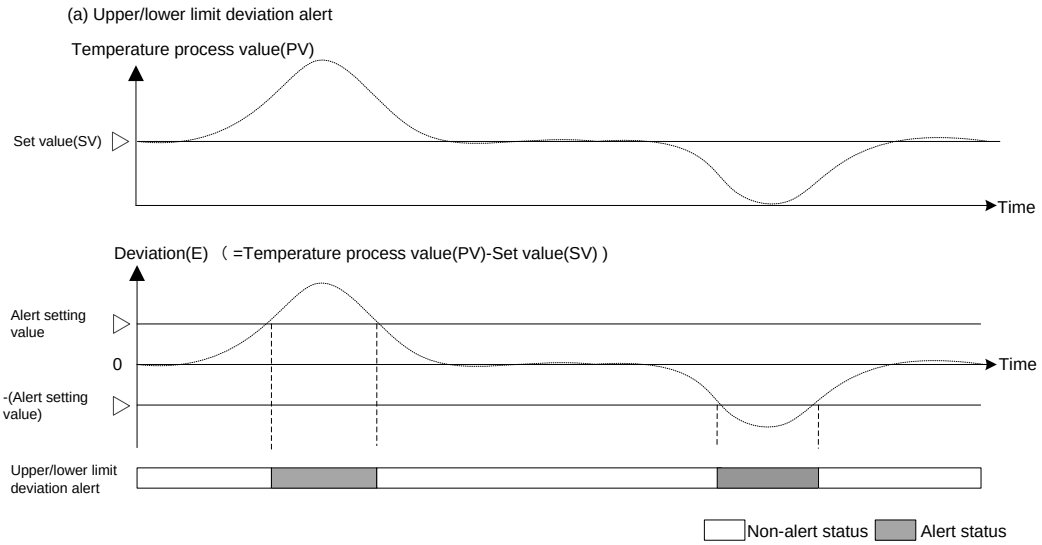
ii) When iw_PV (Temperature process value (PV)) returns to the range, the alert status automatically turns OFF.

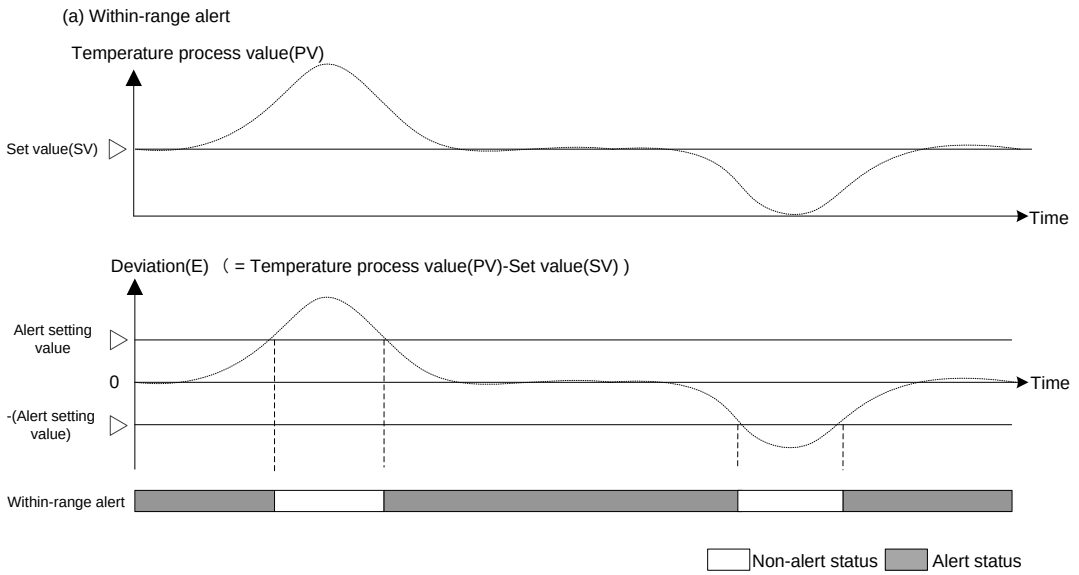
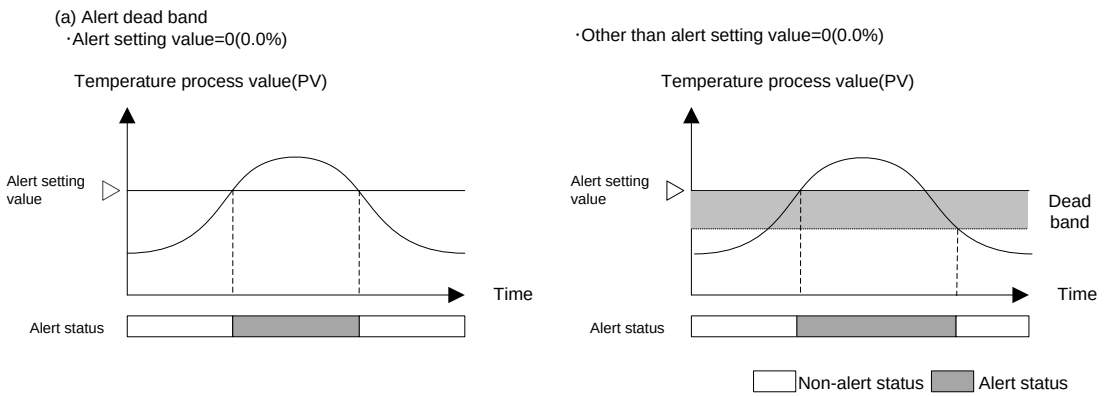


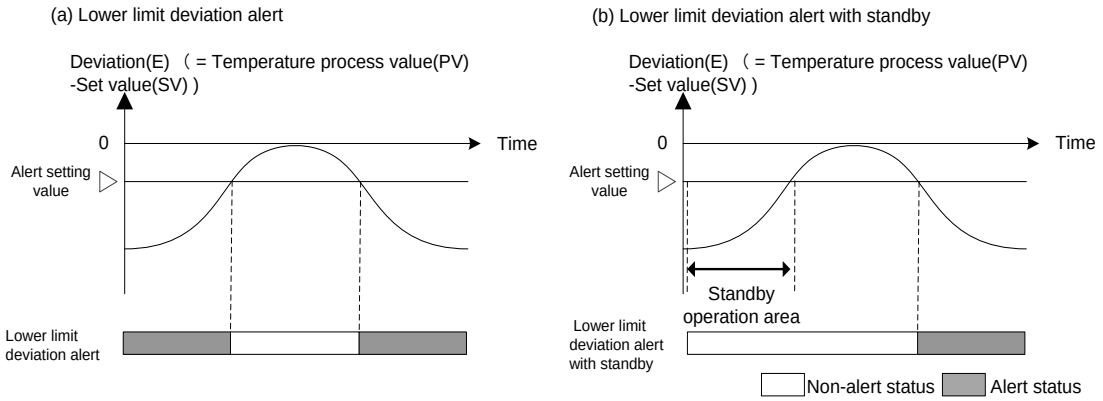
d) Rate of change in input alert/Rate of change in output alert

When iw_PV (Temperature process value (PV)) or manipulate (MV) exceeds the change amount which has been set in alert set value of iw_SettingData (Setting data), the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON.

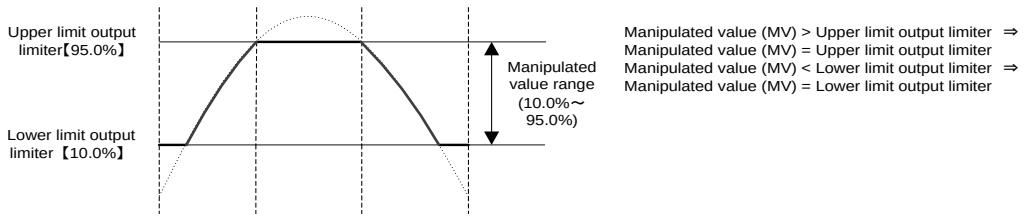


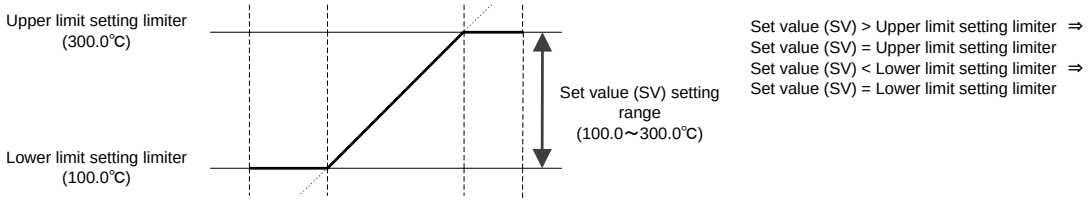
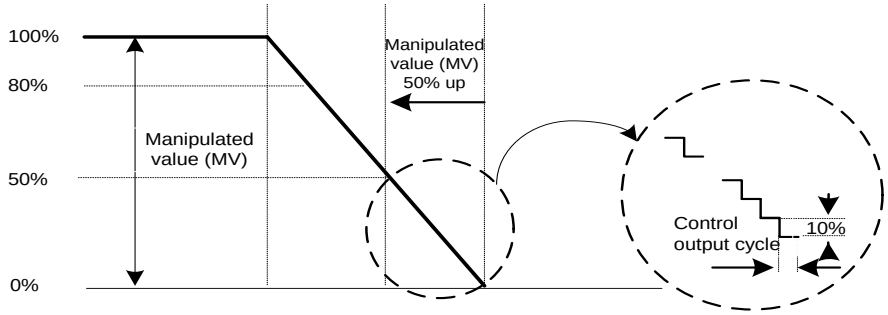
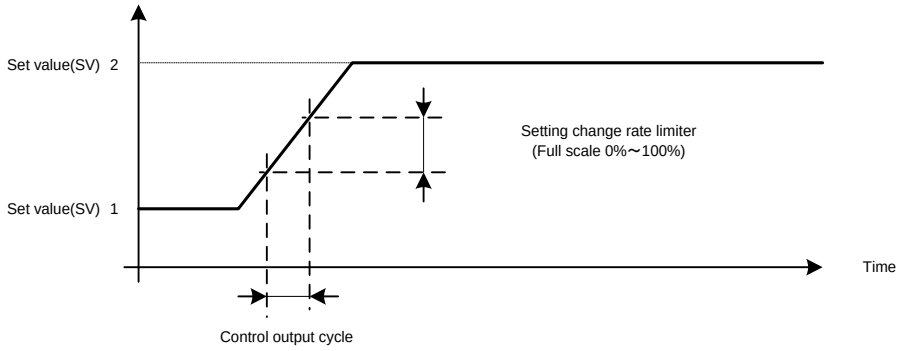
Item	Description
	e) Upper limit deviation alert/Lower limit deviation alert When the deviation (E) exceeds the alert set value of iw_SettingData (Setting data), the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON.  f) Upper/lower limit deviation alert When the deviation (E) exceeds the alert set value of iw_SettingData (Setting data), the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON. 

Item	Description
	g) Within-range alert When the deviation (E) exceeds the alert set value of iw_SettingData (Setting data), the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON.  h) Alert dead band When iw_PV (Temperature process value (PV)) or deviation (E) exceeds the alert set value of iw_SettingData (Setting data), the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON. If it falls below the alert dead band, it becomes non-alert status and the corresponding bit of ow_AlertStatus (Alert status) turns OFF. 

Item	Description
	i) Standby function When the FB_EN (Execution command) is turned ON, even if the process value (PV) or the deviation (E) is in the alert status, it is ignored and does not alert. Alert function is disabled until the temperature process value (PV) or the deviation (E) once escapes from the alert status.  j) Auto tuning i) This is a function automatically sets the optimum PID constant. For the calculation method of PID constant, please set by auto tuning control type setting of iw_SettingData (Setting data). The control type is shown in the table below. <table><tr><th>Setting value</th><th>Control type</th><th>Feature</th></tr><tr><td>0</td><td>Fixed value PI control</td><td rowspan="2">It improves responsiveness to external disturbances.</td></tr><tr><td>1</td><td>Fixed value PID control</td></tr><tr><td>2</td><td>Follow-up PI control</td><td rowspan="2">Suppress overshoot when changing the set value.</td></tr><tr><td>3</td><td>Follow-up PID control</td></tr></table>ii) When ib_AT (Start/stop auto tuning) is ON, execute the auto tuning. At this time, ow_AT_status (Auto tuning status) changes from “0” (Auto tuning not in progress) to “1” (Auto tuning in progress). After that, when auto tuning is completed, it becomes “2” (Auto tuning completed) regardless of normal end/error end. iii) Outputs the optimum iow_Proportional (Proportional band (P)), iow_Integral (Integration time (I)), and iow_Derivative (Derivative time (D)) when auto tuning is completed. iv) During auto tuning, PID control and manual output are not executed. v) If an error is detected during auto tuning, the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON. For the turned ON bit, refer to the explanation of ow_AlertStatus (Alert status) of the used label.

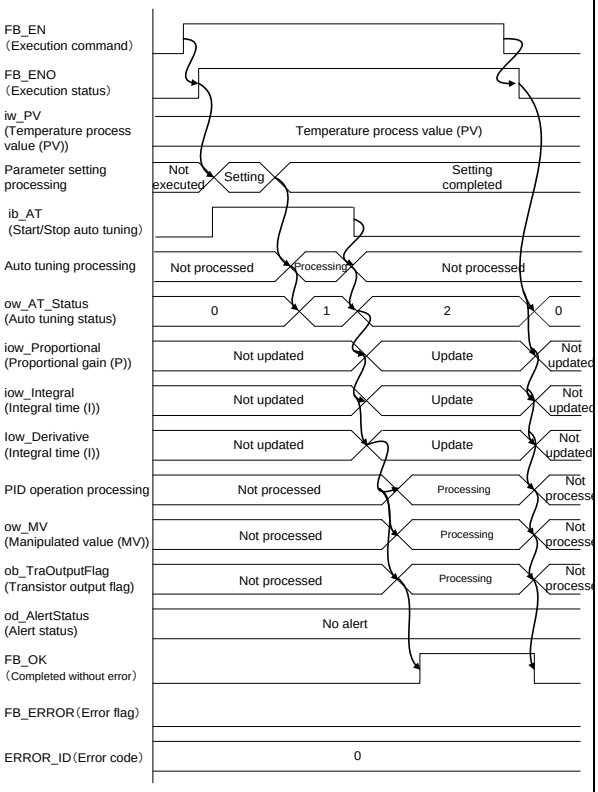
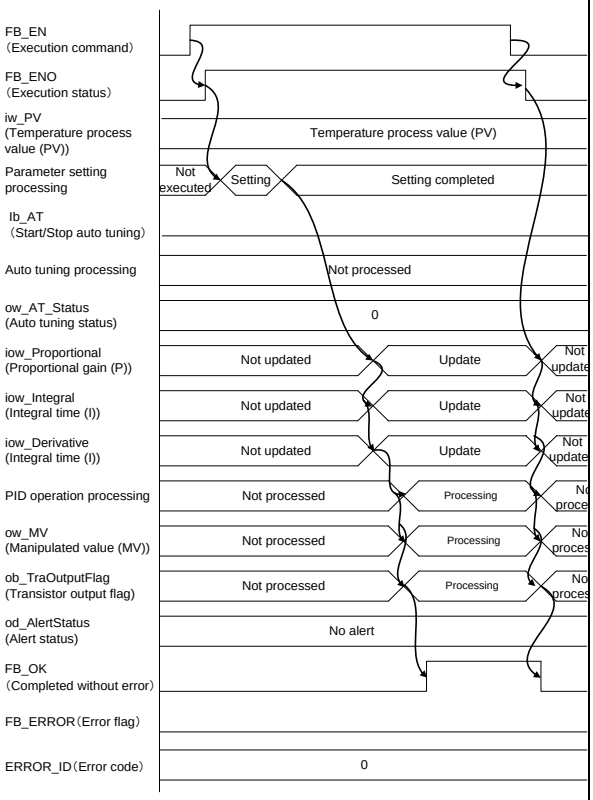
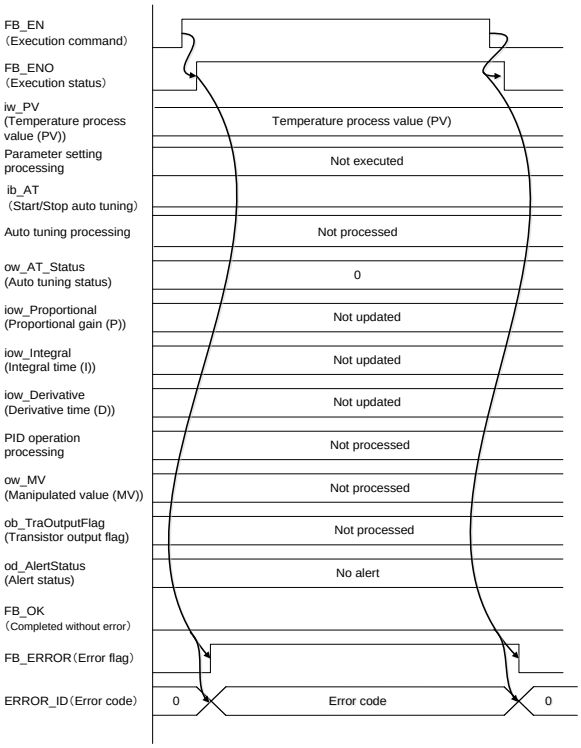
Item	Description
	vi) When auto tuning execution time exceeds the AT timeout time, b14 of ow_AlertStatu (Alert status) turns ON. Under this status, set a longer AT timeout time, then execute auto tuning again. Also check the following. ■Temperature process value (PV) does not reach the set value (SV) when the output is ON •Make sure that the heater power is on. •Check the value of the upper limit output limiter. If it is less than 100%, please check and correct the value. ■The temperature process value (PV) does not reach the set value (SV) when the output is OFF •Check the value of the lower limit output limiter. If it is larger than 0%, please check and correct the value. •As there is a possibility that the temperature of the control object may not be lowered due to the impact of the surrounding environment, stop the control of the adjacent control object and excute auto tuning individually for the control object. If the problem is not solved in the above, please set the PID constant manually. Or check and correct the heater capacity. vii) After executing auto tuning, if the calculated PID constant is out of the range, b15 of ow_AlertStatu (Alert status) turns ON. In this status, please check the following. ■When the proportional band <1 Reason for alert occurrence: The amplitude of control response during auto tuning execution is small. •Check the value of the upper limit output limiter. If it is less than 100%, please check and correct the value. •Check the value of the lower limit output limiter. If it is larger than 0%, please check and correct the value. •Change the input range lower limit and input range upper limit to narrow the measurement temperature range. ■Proportional band ≥ Input range lower limit to input range upper limit , Proportional band ≥ 10001 Reason for alert occurrence: The amplitude of control response during auto tuning execution is big.

Item	Description
	•In order to smaller the amplitude of the control response during auto tuning execution, please change the value of the upper limit output limiter and the value of lower limit output limiter. ■When integration time < 1 Reason for alert occurrence: The vibration cycle of control response during auto tuning execution is short. •Please increase the upper limit output limiter and decrease the lower limit output limiter. ■When integration time ≥3601 Reason for alert occurrence: The vibration cycle of control response during auto tuning execution is long. •Check the value of moving average and correct it. Temperature [When the temperature process value (PV) does not decrease after the temperature process value (PV) exceeds the set value (SV)] •Check the value of the lower limit output limiter. If it is larger than 0%, please check and correct the value. •As there is a possibility that the temperature of the control object may not be lowered due to the impact of the surrounding environment, stop the control of the adjacent control object and excute AT individually for the control object. [When the temperature process value (PV) does not increase after the Temperature process value (PV) exceeds the set value (SV)] •Check the value of the upper limit output limiter. If it is less than 100%, please check and correct the value. ■When derivative time ≥3601 Reason for alert occurrence: The vibration cycle of control response during auto tuning execution is long. •Please set the integration time to 3600 or less. k) Upper/lower limit output limiter It can limit the upper and lower limits of ow_MV (Manipulated value (MV)). When the manipulated value (MV) exceeds the upper limit output limiter or lower than the lower limit output limiter, it is corrected to the upper/lower limit output limiter value. 

Item	Description
	l) Upper/lower limit setting limiter When the iw_SV_Setting (Set value (SV) setting) exceeds the upper limit setting limiter of iw_SettingData (Setting data) or lower than the lower limit setting limiter, it is corrected to the upper/lower limit setting limiter value. Ex.) In the diagram, the setting range is 100.0℃ to 300.0℃.  m) Output variation limiter Set the limit of the rate of change in output per control output cycle and suppress rapid change of the manipulated value (MV). Ex.) When the output variation limiter is set to 10%, even if the manipulated value (MV) suddenly changes by 50%, the change amount is suppressed to 10% per control output cycle.  n) Setting change rate limiter Set the change range rate of the set value (SV) per control output cycle and suppress rapid change of the set value (SV). 

Item	Description
	o) PID operation Perform the PID operation based on the values of iw_SV_Setting (Set value (SV) setting), iw_PV (Temperature process value (PV)), iow_Proportional (Proportional band (P)), iow_Integral (Integral time (I)), iow_Derivative (Differential time (D), and store the ow_MV (Manipulated value (MV)). When the iow_Proportional (Proportional band (P)), iow_Integral (Integral time (I)) and iow_Derivative (Differential time (D)) are out of the respective ranges, the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON. When returning to the range, the alert status automatically turns OFF. p) Transistor output function Based on the control output cycle, ow_MV (Manipulated value (MV)), ob_TraOutputFlag (Transistor output flag) is transistor output to the output device. q) Manual output function i) It is a function to set the manipulated value (MV) manually without calculating it automatically by PID control opration. When ib_AutoManShift (AUTO/MAN mode shift) is set to “ON” (MAN (Manual) mode), manual output is executed according to iw_ManOutput (MAN output setting), and the user's setting value enters ow_MV (Manipulated value (MV)). When iw_ManOutput (MAN output setting) is out of the upper/lower limit output limiter or 0(0.0%) to 1000(100.0%), the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON. When returning to the range, the alert status automatically turns OFF.
FB Compilation Method	Macro type
Restrictions And Precautions	1) This FB does not include the error recovery processing. Prepare the error recovery processing separately to fit the user’s system and the required operation. 2) The FB cannot be used in an interrupt program. 3) Using the FB in a program that is executed only once (such as a subroutine program or a FOR ... NEXT) has a problem that FB_EN (Execution command) can not be turned off, so normal operation can not be performed, please use a program that is capable of turning off the FB_EN (Execution command). 4) When using multiple FB, be careful not to use the same target CH.

Item	Description
	5) When the CPU stops, the Y signal is turned off. For Y signal operated with ob_TraOutputFlag (Transistor output flag), create a program to avoid the malfunction of the control object device. Set the operation when CPU STOP → RUN in [STOP-> RUN output mode] from GX Works2 project window → [Parameter] → [PC Parameter] → [PC system setting]. 6) When this FB is used in two or more places, a duplicated coil warning may occur during compile operation due to the timer (T) device being operated by index modification. However this is not a problem and the FB will operate without error. 7) Set the output operation when a CPU stop error occurs in [Error output mode] from GX Works2 project window →[Parameter] →[PC Parameter] →[I/O Assignment] →[Detail Setting]. Set the operation when a CPU module error occurs in [Error Time Output Mode] from GX Works2 project window →[Parameter] →[PC Parameter] →[PC RAS Setting]. 8) For this FB, it is necessary to set the circuits for all input labels. 9) Please make settings by the parameter setting of GX Works2 according to the connected equipment/system. For more information about the usage of parameter setting, please refer to GX Works2 Operating Manual (Common). 10) In this FB, use the timer (T) device which specified in using timer device setting of iw_SettingData (Setting data). Do not use the timer (T) device specified outside the FB during FB execution. Also, specify the used timer (T) within the range of assigned device for timer (T) from GX Works2 project window →[Parameter] →[PC Parameter] →[Device Setting]. 11) The ON time of the transistor output is measured according to the setting value of the timer time limit setting (High speed) for timer (T) device which specified by using timer device setting of iw_SettingData (Setting data). To set Timer Limit Setting of iw_SettingData (Setting data), please set the same value as the timer limit setting (High speed) of GX Works2 Project window →[Parameter] →[PC parameter] →[PC system setting].
FB Operation Type	Real-time execution
Examples	Please refer to “Appendix1. FB LIBRARY EXAMPLES”.

Item	Description
Operation Of Input/Output Signals	[When operation completes without error] •Auto tuning is used  •Auto tuning is not used  [When an error occurs] 

Item	Description
Relevant Manuals	MELSEC-L RTD Input Module User's Manual MELSEC-L Digital-Analog Converter Module User's Manual MELSEC-L I/O Module User's Manual MELSEC-L CPU Module User's Manual (Hardware Design, Maintenance and Inspection) MELSEC-L CPU Module User's Manual (Function Explanation, Program Fundamentals) MELSEC-Q/L Programming Manual (Common Instruction) RTD Input Module/Channel Isolated RTD Input Module User's Manual (Details) Digital-Analog Converter Module User's Manual (Details) I/O Module Type Building Block User's Manual QCPU User's Manual (Hardware Design, Maintenance and Inspection) QnUCPU User's Manual (Function Explanation, Program Fundamentals) GX Works2 Version 1 Operating Manual (Common) GX Works2 Version 1 Operating Manual (Simple Project, Function Block)

Error code

●Error code list

Error Code	Description	Corrective Action
10(Decimal)	Control output cycle setting is out of the range. A value other than 5 to 1000(0.5s to 100.0s) is set in control output cycle.	Check and correct the setting and excute FB again.
11(Decimal)	Upper limit output limiter is out of the setting range. A value other than -50 to 1050(-5.0% to 105.0%) is set in upper limit output limiter.	Check and correct the setting and excute FB again.
12(Decimal)	Lower limit output limiter is out of the setting range. A value other than -50 to 1050 (-5.0% to 105.0%) is set in lower limit output limiter.	Check and correct the setting and excute FB again.
13(Decimal)	Output variation limiter is out of the setting range. A value other than 0 to 1000 is set in output variation limiter.	Check and correct the setting and excute FB again.
14(Decimal)	Setting change rate limiter is out of the setting range. A value other than 0 to 1000 is set in setting change rate limiter.	Check and correct the setting and excute FB again.
15(Decimal)	Alert 1 mode setting is out of the range. A value other than 0 to 11, 25 to 32 is set in alert 1 mode setting.	Check and correct the setting and excute FB again.
16(Decimal)	Alert 2 mode setting is out of the range. A value other than 0 to 11, 25 to 32 is set in alert 2 mode setting.	Check and correct the setting and excute FB again.
17(Decimal)	Alert 3 mode setting is out of the range. A value other than 0 to 11, 25 to 32 is set in alert 3 mode setting.	Check and correct the setting and excute FB again.
18(Decimal)	Alert 4 mode setting is out of the range. A value other than 0 to 11, 25 to 32 is set in alert 4 mode setting.	Check and correct the setting and excute FB again.
19(Decimal)	Alert set value1 is out of the range. If alert 1 mode setting is 5, 6, 11, 25 to 32, the alert set value1 is set to other than 0 to 32767.	Check and correct the setting and excute FB again.
20(Decimal)	Alert set value2 is out of the range. If alert 2 mode setting is 5, 6, 11, 25 to 32, the alert set value2 is set to other than 0 to 32767.	Check and correct the setting and excute FB again.

Error Code	Description	Corrective Action
21(Decimal)	Alert set value3 is out of the range. If alert 3 mode setting is 5, 6, 11, 25 to 32, the alert set value3 is set to other than 0 to 32767.	Check and correct the setting and excute FB again.
22(Decimal)	Alert set value4 is out of the range. If alert 4 mode setting is 5, 6, 11, 25 to 32, the alert set value4 is set to other than 0 to 32767.	Check and correct the setting and excute FB again.
23(Decimal)	Alert dead band setting is out of the range. A value other than 0 to 100(0.0% to 10.0%) is set in alert dead band setting.	Check and correct the setting and excute FB again.
24(Decimal)	AT timeout time is out of the setting range. A value other than 0 to 7200(0s to 7200s) is set in AT timeout time.	Check and correct the setting and excute FB again.
25(Decimal)	Auto tuning control type setting is out of the range. A value other than 0 to 3 is set in auto tuning control type setting.	Check and correct the setting and excute FB again.
26(Decimal)	Two-degree-of-freedom parameter α is out of the setting range. A value other than 0 to 100(0.00 to 1.00) is set in two-degree-of-freedom parameter α.	Check and correct the setting and excute FB again.
27(Decimal)	Two-degree-of-freedom parameter β is out of the setting range. A value other than 0 to 100(0.00 to 1.00) is set in two-degree-of-freedom parameter β.	Check and correct the setting and excute FB again.
28(Decimal)	Decimal point position is out of the range. Decimal point position is set other than -1,0,1.	Check and correct the setting and excute FB again.
29(Decimal)	Timer Limit Setting is out of the setting range. A value other than 1 to 10000(0.01ms to 100.00ms) is set in Timer Limit Setting.	Check and correct the setting and excute FB again.
30(Decimal)	Upper limit output limiter ≤lower limit output limiter is set.	Set the value as below: Upper limit output limiter >lower limit output limiter.
31(Decimal)	Upper limit setting limiter ≤lower limit setting limiter is set.	Set the value as below: Upper limit setting limiter >lower limit setting limiter.

Error Code	Description	Corrective Action
32(Decimal)	Input range upper limit ≤input range lower limit is set.	Set the value as below: Input range upper limit >input range lower limit.
33(Decimal)	Input range upper limit <set value (SV) is set.	Set the value as below: Input range upper limit ≥set value (SV).
34(Decimal)	Input range lower limit >set value (SV) is set.	Set the value as below: Iput range lower limit ≤set value (SV).

Labels to use

●Input label

Name (Comment)	Label Name	Data Type	Scope	Description
Execution command	FB_EN	bit	ON,OFF	ON: Start FB. OFF: Do not start FB.
Forward/reverse action setting	ib_ActionSetting	bit	ON,OFF	To use with forward action or reverse action. Set forward action when it is used for cooling control. Set reverse action when it is used for heating control. ON: Forward action (Cooling control) OFF: Reverse action (Heating control)
AUTO/MAN mode shift	ib_AutoManShift	bit	ON,OFF	To select the manipulated value (MV) calculated by PID operation or set by the user. OFF: AUTO (Automatic) mode The manipulated value (MV) is calculated by PID operation in the FB. ON: MAN (Manual) mode The manipulated value (MV) is set in iw_ManOutput (MAN output setting) by the user.
Start/stop auto tuning	ib_AT	bit	ON,OFF	ON: Start auto tuning. OFF: Stop auto tuning.

Name (Comment)	Label Name	Data Type	Scope	Description
Temperature process value (PV)	iw_PV	word	-32768 to 32767	Set the temperature process value detected by the analog input module. (Ex.) In the following setting, please set "U3 ¥ G11". •Used module : "L60RD8" •Start I/O No. : "H30" •Temperature process value used for control: "CH1 temperature process value" * The measurement range varies depending on the input range setting, input type/range setting, and Celsius/Fahrenheit display setting of the used module. For more information, please refer to the user's manual of the module.
Set value (SV) setting	iw_SV_Setting	word	-32768 to 32767	Set the set value of the PID control. Please set it within the range of "upper limit setting limiter" and "lower limit setting limiter" of iw_SettingData (Setting data).
MAN output setting	iw_ManOutput	word	0 to 1000 (0.0% to 100.0%)	Set the manipulated value (MV) in MAN mode. * This setting is enable when ib_AutoManShift (AUTO/MAN mode shift) is set to "ON: MAN mode".
Setting data	iw_SettingData	word	*Refer to the setting data in the table below	Specify the start address where setting data is stored. Set the parameter necessary for PID operation and auto tuning.

●Setting data

Name	Offset	Data Type	Scope	Description
Control output cycle setting	+0	word	5 to 1000 (0.5s to 100.0s)	Set the pulse cycle (ON/OFF cycle) of the transistor output. The ON time of the control output cycle is the value obtained by multiplying the control output cycle by the manipulated value (MV) (%) calculated with PID operation. If the manipulated value (MV) is fixed, pulses of the same cycle are repeatedly output.
Input range upper limit	+1	word	-32768 to 32767	Set the upper limit value of the input range for the control object. (Ex.) In the following setting, set a value less than ontrol •Used module: “L60RD8” •Input range: “2: Pt100(-200 to 850°C)” •Celsius/Fahrenheit display setting: “0: Celsius [°C]” * The measurement range varies depending on the input range setting, input type/range setting, and Celsius/Fahrenheit display setting of the used module. For more information, please refer to the user’s manual of the module.

Name	Offset	Data Type	Scope	Description
Input range lower limit	+2	word	-32768 to 32767	Set the lower limit value of the input range for the control object. (Ex.) In the following setting, please set a value of ange setting, inp •Used module: “L60RD8” •Input range: “2: Pt100 (-200 to 850°C)” •Celsius/Fahrenheit display setting:“0: Celsius [°C]” * The measurement range varies depending on the input range setting, input type/range setting, and Celsius/Fahrenheit display setting of the used module. For more information, please refer to the user’s manual of the module.
Upper limit output limiter	+3	word	-50 to 1050 (-5.0% to 105.0%)	Set the upper limit value when actually outputting the manipulated value (MV) calculated by the PID operation to the external device. Set the value as below: Lower limit output limiter value <upper limit output limiter value.
Lower limit output limiter	+4	word	-50 to 1050 (-5.0% to 105.0%)	Set the lower limit value when actually outputting the manipulated value (MV) calculated by the PID operation to the external device. Set the value as below: Lower limit output limiter value <upper limit output limiter value.

Name	Offset	Data Type	Scope	Description
Upper limit setting limiter	+5	word	-32768 to 32767	Set the upper limit of the set value (SV) setting range. Set the value as below: Lower limit setting limiter value <upper limit setting limiter value. * The measurement range varies depending on the input range setting, input type/range setting, and Celsius/Fahrenheit display setting of the used module. For more information, please refer to the user's manual of the module.
Lower limit setting limiter	+6	word	-32768 to 32767	Set the lower limit of the set value (SV) setting range. Set the value as below: Lower limit setting limiter value <upper limit setting limiter value. * The measurement range varies depending on the input range setting, input type/range setting, and Celsius/Fahrenheit display setting of the used module. For more information, please refer to the user's manual of the module.
Output variation limiter	+7	word	0,1 to 1000 (0.1% control output cycle to 100% control output cycle)	Set the limit of the rate of change in output per control output cycle and suppress rapid change of the manipulated value (MV). When it is 0, adjustment of rate of change in output can not be performed.
Setting change rate limiter	+8	word	0,1 to 1000 (0.1% control output cycle to 100% control output cycle)	Set the change rate of the set value (SV) per control output cycle.Suppresses rapid changes in manipulated value (MV). When it is 0, adjustment of setting change rate can not be performed.

Name	Offset	Data Type	Scope	Description
Alert 1 mode setting	+9	word	0 to 11, 25 to 32	Set the alert mode of alert1. 0: No alert 1: Upper limit input alert 2: Lower limit input alert 3: Upper limit deviation alert 4: Lower limit deviation alert 5: Upper/lower limit deviation alert 6: Within-range alert 7: Upper limit input alert with standby 8: Lower limit input alert with standby 9: Upper limit deviation alert with standby 10: Lower limit deviation alert with standby 11: Upper/lower limit deviation alert with standby 25: Rate of change in input (increase side) alert 26: Rate of change in input (decrease side) alert 27: Rate of change in output (increase side) alert 28: Rate of change in output (decrease side) alert 29: Rate of change in input (increase side) alert with standby 30: Rate of change in input (decrease side) alert with standby 31: Rate of change in output (increase side) alert with standby 32: Rate of change in output (decrease side) alert with standby

Name	Offset	Data Type	Scope	Description
Alert 2 mode setting	+10	word	0 to 11, 25 to 32	Set the alert mode of alert2. 0: No alert 1: Upper limit input alert 2: Lower limit input alert 3: Upper limit deviation alert 4: Lower limit deviation alert 5: Upper/lower limit deviation alert 6: Within-range alert 7: Upper limit input alert with standby 8: Lower limit input alert with standby 9: Upper limit deviation alert with standby 10: Lower limit deviation alert with standby 11: Upper/lower limit deviation alert with standby 25: Rate of change in input (increase side) alert 26: Rate of change in input (decrease side) alert 27: Rate of change in output (increase side) alert 28: Rate of change in output (decrease side) alert 29: Rate of change in input (increase side) alert with standby 30: Rate of change in input (decrease side) alert with standby 31: Rate of change in output (increase side) alert with standby 32: Rate of change in output (decrease side) alert with standby

Name	Offset	Data Type	Scope	Description
Alert 3 mode setting	+11	word	0 to 11, 25 to 32	Set the alert mode of alert 3. 0: No alert 1: Upper limit input alert 2: Lower limit input alert 3: Upper limit deviation alert 4: Lower limit deviation alert 5: Upper/lower limit deviation alert 6: Within-range alert 7: Upper limit input alert with standby 8: Lower limit input alert with standby 9: Upper limit deviation alert with standby 10: Lower limit deviation alert with standby 11: Upper/lower limit deviation alert with standby 25: Rate of change in input (increase side) alert 26: Rate of change in input (decrease side) alert 27: Rate of change in output (increase side) alert 28: Rate of change in output (decrease side) alert 29: Rate of change in input (increase side) alert with standby 30: Rate of change in input (decrease side) alert with standby 31: Rate of change in output (increase side) alert with standby 32: Rate of change in output (decrease side) alert with standby

Name	Offset	Data Type	Scope	Description
Alert 4 mode setting	+12	word	0 to 11, 25 to 32	Set the alert mode of alert 4. 0: No alert 1: Upper limit input alert 2: Lower limit input alert 3: Upper limit deviation alert 4: Lower limit deviation alert 5: Upper/lower limit deviation alert 6: Within-range alert 7: Upper limit input alert with standby 8: Lower limit input alert with standby 9: Upper limit deviation alert with standby 10: Lower limit deviation alert with standby 11: Upper/lower limit deviation alert with standby 25: Rate of change in input (increase side) alert 26: Rate of change in input (decrease side) alert 27: Rate of change in output (increase side) alert 28: Rate of change in output (decrease side) alert 29: Rate of change in input (increase side) alert with standby 30: Rate of change in input (decrease side) alert with standby 31: Rate of change in output (increase side) alert with standby 32: Rate of change in output (decrease side) alert with standby

Name	Offset	Data Type	Scope	Description
Alert set value1	+13	word	When alert 1 mode setting is 1 to 4, 7 to 10: -32768 to 32767 When alert 1 mode setting is 5,6,11,25 to 32: 0 to 32767	Set the alert set value of alert1. In alert status, bit 0 of ow_AlertStatus (Alert status) turns ON.
Alert set value2	+14	word	When alert 2 mode setting is 1 to 4, 7 to 10: -32768 to 32767 When alert 2 mode setting is 5,6,11,25 to 32: 0 to 32767	Set the alert set value of alert2. In alert status, bit 1 of ow_AlertStatus (Alert status) turns ON.
Alert set value3	+15	word	When alert 3 mode setting is 1 to 4, 7 to 10: -32768 to 32767 When alert 3 mode setting is 5,6,11,25 to 32: 0 to 32767	Set the alert set value of alert3. In alert status, bit 2 of ow_AlertStatus (Alert status) turns ON.
Alert set value4	+16	word	When alert 4 mode setting is 1 to 4, 7 to 10: -32768 to 32767 When alert 4 mode setting is 5,6,11,25 to 32: 0 to 32767	Set the alert set value of alert4. In alert status, bit 3 of ow_AlertStatus (Alert status) turns ON.

Name	Offset	Data Type	Scope	Description
Alert dead band setting	+17	word	0,1 to 100 (0.1% to 10.0%)	This is the setting of the dead band when using the alert function. Please use it when operating the danger signal of the equipment or safety device. When it is 0, alert dead band setting is not performed.
AT timeout time	+18	word	0 to 7200 (0s to 7200s)	Set the auto tuning timeout time.
Auto tuning Control type setting	+19	word	0 to 3	Determine calculate method of the PID control parameter during auto tuning execution. 0: fixed value PI control 1: fixed value PID control 2: follow-up PI control 3: follow-up PID control
Two-degree-of-freedom parameter α	+20	word	0 to 100 (0.00 to 1.00)	In 2-degree-of freedom PID control, set the feed forward proportional value. As α is increased, the effect of proportional on the change of the set value is reduced.
Two-degree-of-freedom parameter β	+21	word	0 to 100 (0.00 to 1.00)	In 2-degree-of freedom PID control, set the feed forward differentiation value. As β is decreased, the effect of differentiation on the change of the set value is increased.

Name	Offset	Data Type	Scope	Description
Decimal point position	+22	word	-1,0, 1	Set the decimal point position. 0: Set the temperature process value (PV) without decimal point. When temperature process value (PV) is “10”, oe_PV (Temperature process value (C/F)) is “10”. 1: Set the temperature process value (PV) with one decimal place. When temperature process value (PV) is “10”, oe_PV (Temperature process value (C/F)) is “1.0”. -1: It does not correspond to decimal point position setting. When set to -1, 0 (Fixed value) is stored in oe_PV (Temperature process value (C/F)). (Ex.) In the following setting, please set pl. •Used module: “L60RD8” •Input type: “2: Pt100(-200 to 850°C)”
Timer Limit Setting	+23	word	1 to 10000 (0.01ms to 100.00ms)	Set the unit of transistor output timer. (Ex.) In the following setting, please set “1000”. •Timer Limit Setting(High speed) of PC system setting: “10.00ms”
Using timer device setting	+24	word	Device scope (*1) (*1): Scope varies depending on the device setting of the PC parameter.	Set the number of the used timer (T) device. (Ex.) In the following setting, please set “3”. •Used timer: “T3”

●Output label

Name (Comment)	Label Name	Data Type	Initial Value	Description
Execution status	FB_ENO	bit	OFF	ON: Execution command is ON OFF: Execution command is OFF
Completed without error	FB_OK	bit	OFF	When ON, PID control is in progress.
Temperature process value (PV)	ow_PV	word	0	The temperature process value is stored.
Manipulated value (MV)	ow_MV	word	0	The result of the PID operation based on the temperature process value (PV) is stored. *When ib_AutoManShift (AUTO/MAN mode shift) is set to "ON: MAN mode", it becomes the manipulated value (MV) set by iw_ManOutput (MAN output setting).
Set value (SV)	ow_SV	word	0	The set value is stored.
Temperature process value (C/F)	oe_PV	Single precision real number	0	The temperature process value is stored. The value stored is varies with the decimal point position setting of iw_SettingData (Setting data). (Ex.) •When "0" is set to the decimal point position: When the temperature process value (PV) is 10, "10" is stored in oe_PV (Temperature process value (C/F)). •When "1" is set to the decimal point position: When the temperature process value (PV) is 10, "1.0" is stored in oe_PV (Temperature process value (C/F)). •When "-1" is set to the decimal point position: When the temperature process value (PV) is 10, "0" (Fixed) is stored in oe_PV (Temperature process value (C/F)).

Name (Comment)	Label Name	Data Type	Initial Value	Description
Transistor output flag	ob_TraOutputFlag	bit	OFF	Store the ON/OFF status of transistor output. (Ex.) In the following setting, please set “Y41”. •Used module : “LY41NT1P” •Start I/O No. : “H40” •Signals used for control : “B19”
Auto tuning status	ow_AT_status	word	0	Execution status of the auto tuning. 0: Auto tuning is unprocessed 1: Auto tuning is in process 2: Auto tuning is completed
Alert status	ow_AlertStatus	word	0	The bit corresponding to the detected alert turns ON. b0: When alert1 occurs. b1: When alert2 occurs. b2: When alert3 occurs. b3: When alert4 occurs. b4: When the temperature process value (PV) exceeds the setting value of the input range upper limit of iw_SettingData (Setting data) which has been set. b5: When the temperature process value (PV) lower than the setting value of the input range lower limit of iw_SettingData (Setting data) which has been set. b6: When iw_ManOutput (MAN output setting) is set to 1000(100.0%) or exceeds the upper limit output limiter of the iw_SettingData (Setting data) which has been set. b7: When iw_ManOutput (MAN output setting) is set to 0(0.0%) or lower than the lower limit output limiter of the iw_SettingData (Setting data) which has been set. (Continue to next page)

Name (Comment)	Label Name	Data Type	Initial Value	Description
				(Continue from the previous page) b8: When iow_Proportional (Proportional band (P)) exceeds 10000(1000.0%). b9: When iow_Proportional (Proportional band (P)) falls below 1(0.1%). b10: When iow_Integral (Integration time (I)) exceeds 3600(3600s). b11: When iow_Integral (Integration time (I)) falls below 0(0s). b12: When iow_Derivative (Derivative time (D)) exceeds 3600(3600s). b13: When iow_Derivative (Derivative time (D)) falls below 0(0s). b14: When auto tuning execution time exceeds the AT timeout time of iw_SettingData (Setting data) which has been set. b15: When auto tuning is executed but the calculated value of PID constant is out of the range.
Error flag	FB_ERROR	bit	OFF	When ON, it indicates that an error has occurred.
Error code	ERROR_ID	word	0	FB error code output.

●I/O label

Name	Label Name	Data Type	Scope	Description
Proportional band (P)	iow_Proportional	word	1 to 10000 (0.1% to 1000.0%)	Set the proportional band (P) for PID control. * When auto tuning is executed with this FB and the calculated PID constant is used, specify the same device for input and output.
Integral time (I)	iow_Integral	word	0 to 3600 (0s to 3600s)	Set the integral time (I) for PID control. * When auto tuning is executed with this FB and the calculated PID constant is used, specify the same device for input and output.
Derivative time (D)	iow_Derivative	word	0 to 3600 (0s to 3600s)	Set the derivative time (D) for PID control. * When auto tuning is executed with this FB and the calculated PID constant is used, specify the same device for input and output.

FB Version History

Version	Date	Description
1.00A	2017/05	New create

PLEASE

This chapter explains the function block function.

Restrictions on using of the module and programmable controller CPU, restrictions on combination, etc. are not given.

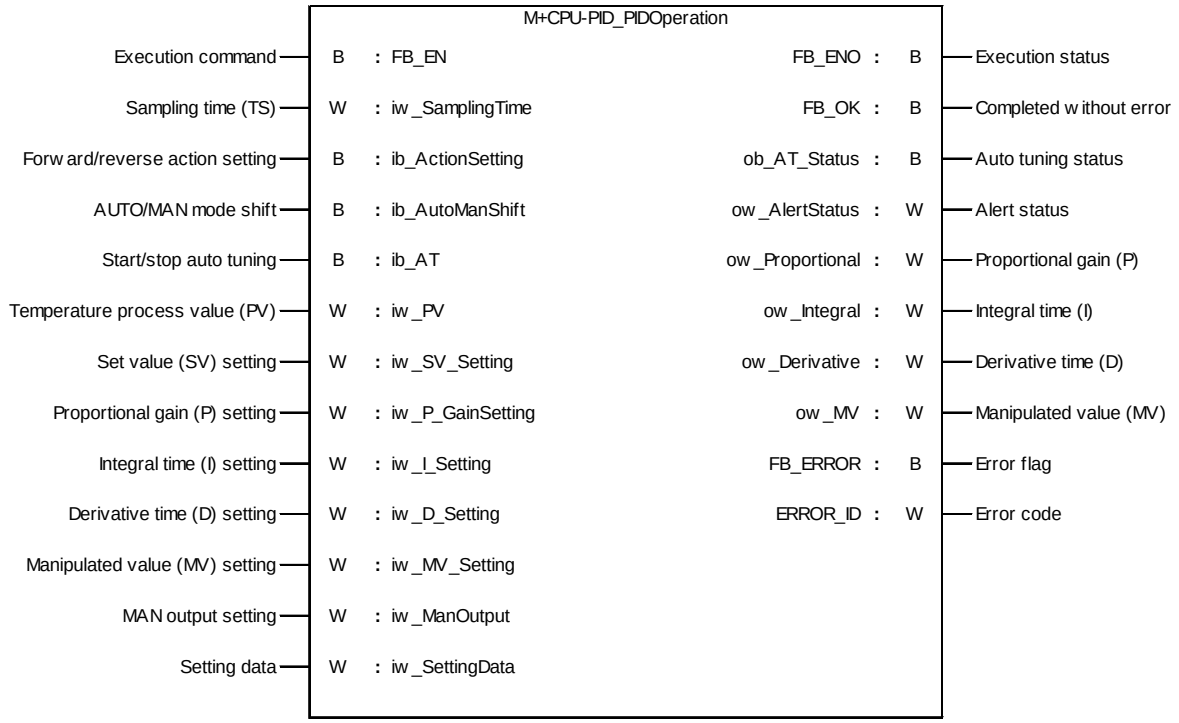
Please read the user's manual of the product carefully before working on the target product.

2.2. M+CPU-PID_PIDOperation (PID Operation)

Name

M+CPU-PID_PIDOperation

Function description

Item	Description
Function Overview	Perform auto tuning, calculate PID constant, and perform PID operation.
Symbol	
Target Module	CPU Module

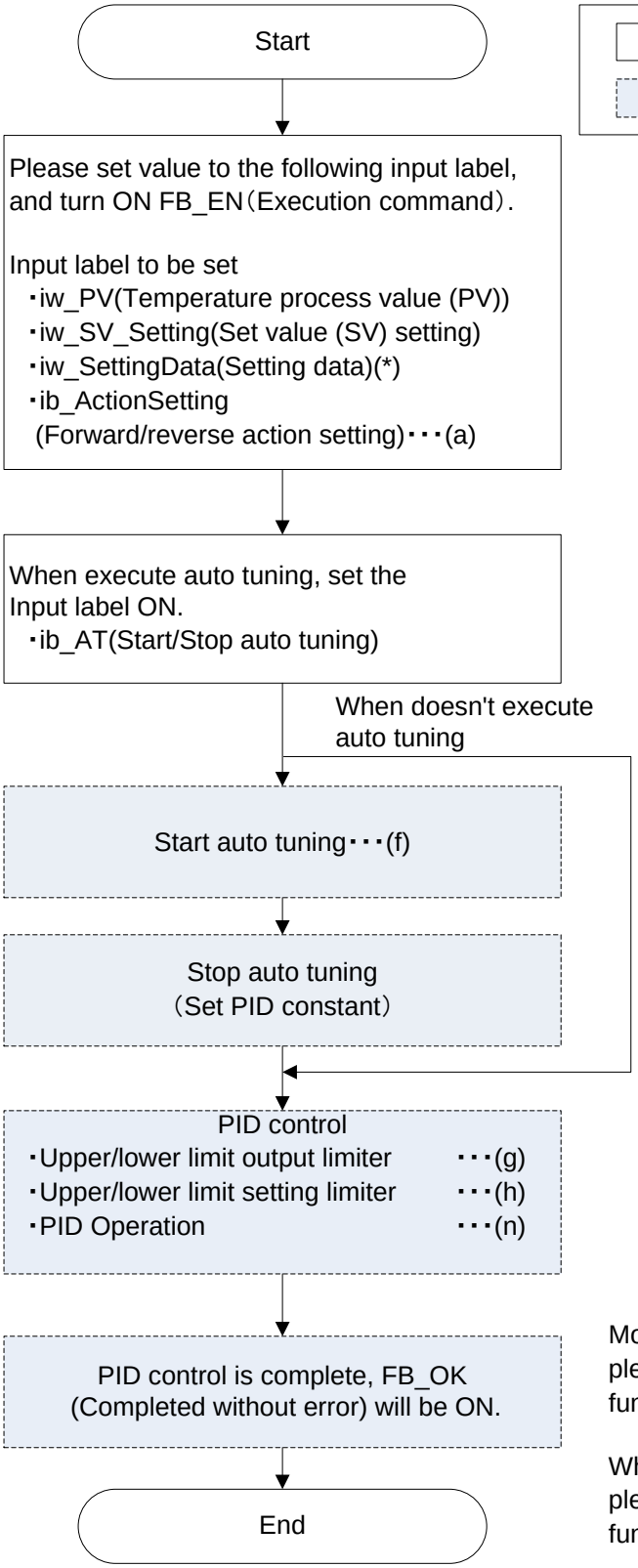
Series	Model
MELSEC-Q series	High-Speed Universal Model*1
MELSEC-L series	LCPU *2

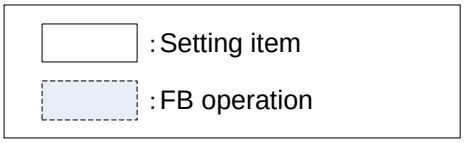
*1 First five digits of serial No. are “19012” or later can be used

*2 First five digits of serial No. are “18102” or later can be used

<table>
<tr><th>Item</th><th colspan="2">Description</th></tr>
<tr><td></td><td>Engineering tool</td><td>GX Works2 *1
<table>
<tr><th>Language</th><th>Supported Software Version</th></tr>
<tr><td>Japanese version</td><td>Version 1.560J or later</td></tr>
<tr><td>English version</td><td>Version 1.560J or later</td></tr>
<tr><td>Chinese (Simplified) version</td><td>Version 1.560J or later</td></tr>
<tr><td>Chinese (Traditional) version</td><td>Version 1.560J or later</td></tr>
<tr><td>Korean version</td><td>Version 1.560J or later</td></tr>
</table>
*1 For software versions applicable to the modules used, refer to "Relevant manuals".</td></tr>
<tr><td>Description Language</td><td colspan="2">Ladder(closed program)</td></tr>
<tr><td>Number Of Steps</td><td colspan="2">1460 Step (for MELSEC-Q series universal model CPU)
* The number of steps of the FB in a program depends on the CPU model that is used and input and output definition.</td></tr>
</table>

Item	Description
Functional Description	1) PID operation is realized as shown below in this FB.



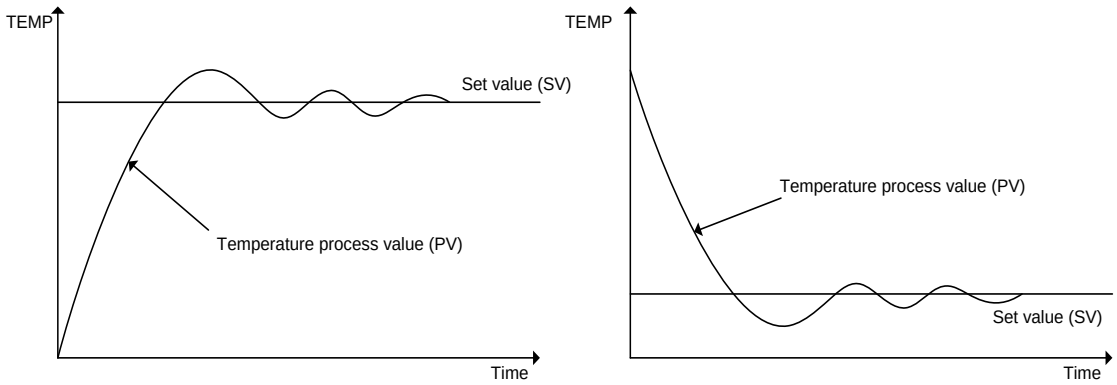


(*)Setting data to be set

Operation setting(ACT)
Input filter constant (α)・・・(i)
Derivative gain (KD)・・・(j)
Rate of change in input (increase side) alert setting value・・・(d)
Rate of change in input (decrease side) alert setting value・・・(d)
Rate of change in output (increase side) alert setting value・・・(e)
Rate of change in output (decrease side) alert setting value・・・(e)
Uper limit output limiter・・・(g)
Lower limit output limiter・・・(g)
Upper limit setting limiter・・・(h)
Lower limit setting limiter・・・(h)
Threshold value (hysteresis)・・・(f)
AT upper limit output limiter (ULV) ・・・(f)
AT lower limit output limiter (LLV) ・・・(a)
Wait setting parameter (KW)・・・(f)

More information of functions a)～o), please refer to “4) Explanation of each function”.

When use MAN output function, please refer to “4) Explanation of each function o”.

Item	Description
	2) When FB_EN (Execution command) is ON, iw_MV_Setting (Manipulated value (MV) setting), ib_ActionSetting (Forward/reverse action setting) and iw_SettingData (Setting data) are read. Therefore, even if setting data is changed while FB_EN is ON, the value will be disabled. 3) When the setting value is out of range or a PID operation error occurs, an error code is stored in ERROR_ID (Error code). For the error code, refer to the explanation section for the error code. 4) Explanation of each function a) Switch between forward action and reverse action i) It is a function to set which to use between forward action and reverse action. ii) Perform the following operations based on the setting value. • The forward action is an operation to increase the manipulated value (MV) when the temperature process value (PV) is higher than the set value (SV).Forward action is used for cooling control. • The reverse action is an operation to increase the manipulated value (MV) when the temperature process value (PV) is lower than the set value (SV). Reverse action is used for heating control.  Reverse action (Heating control) Forward action (Cooling control) iii) When ib_ActionSetting (Forward/reverse action setting) is ON, the forward action is performed, and when it is OFF, the reverse action is performed. iv) In the case of auto tuning (limit cycle method), the forward action or reverse action needs to be set as the PID operation direction. v) In the case of auto tuning (step response method), the forward action or reverse action is automatically set regardless of the direction of the auto tuning.

Item	Description

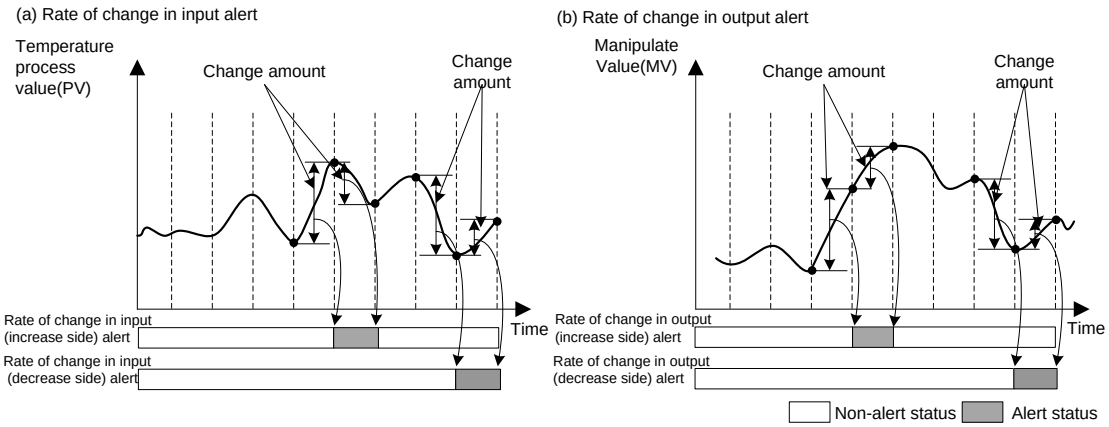
b) Sampling time (TS)

Set the cycle (ms) for PID operation.

- For the PID control or auto tuning (limit cycle method), set the time corresponding to "Operation cycle of programmable controller < Sampling time". When the sampling time is shorter than one operation cycle of programmable controller, the error code is stored in ERROR_ID (Error code).
- For auto tuning (step response method), set 1000 ms (1s) or longer.

c) Rate of change in input alert/Rate of change in output alert

When iw_PV (Temperature process value (PV)) or manipulate (MV) exceeds the change amount which has been set in alert set value of iw_SettingData (Setting data), the alert status is entered and the corresponding bit of ow_AlertStatus (Alert status) is turned ON.



d) Rate of change in input alert

To use this function, set the operation setting (ACT) and the rate of change in input alert set value, as shown below.

The change amount equals to "Previous temperature process value (PV) - Current temperature process value (PV)".

Setting item		Description
Operation setting (ACT)	iw_SettingData (Setting data) Offset +0 (bit 0)	ON: Rate of change in input alert enabled
Rate of change in input (increase side) alert setting value	iw_SettingData (Setting data) Offset +3	0 to 32767
Rate of change in input (decrease side) alert setting value	iw_SettingData (Setting data) Offset +4	0 to 32767

Item	Description

e) Rate of change in output alert

To use this function, set the operation setting (ACT) and the rate of change in output alert set value, as shown below.

The change amount equals to "Previous manipulated value (MV) - Current manipulated value (MV)".

Setting item		Description
Operation setting (ACT)	iw_SettingData (Setting data) Offset +0 (bit 1)	ON: Rate of change in output alert enabled
	iw_SettingData (Setting data) Offset +0 (bit 2)	OFF
Rate of change in output (increase side) alert set value	iw_SettingData (Setting data) Offset +5	0 to 32767
Rate of change in output(decrease side) alert set value	iw_SettingData (Setting data) Offset +6	0 to 32767

f) Auto tuning

i) This function sets the optimal PID constant automatically. To calculate the PID constant, the operation setting (ACT) is required.

Setting item		Description
Operation setting (ACT)	iw_SettingData (Setting data) Offset +0 (bit 4)	OFF: Step response method ON: Limit cycle method

ii) When ib_AT (Start/stop auto tuning) is ON, execute the auto tuning.
ob_AT_Status (Auto tuning status) turns ON.
After the auto tuning is completed, ob_AT_Status (Auto tuning status) turns OFF.

iii) Outputs the optimum ow_Proportional (Proportional gain (P)), ow_Integral (Integration time (I)), and ow_Derivative (Derivative time (D)) when auto tuning is completed.

iv) During auto tuning, PID control and manual output are not executed.

v) Threshold value (hysteresis)
To use the auto tuning (limit cycle method), set this value.
Set the threshold value (hysteresis), depending to the fluctuation of temperature process value (PV).

Item	Description

vi) AT upper/lower limit output limiter (ULV, LLV)

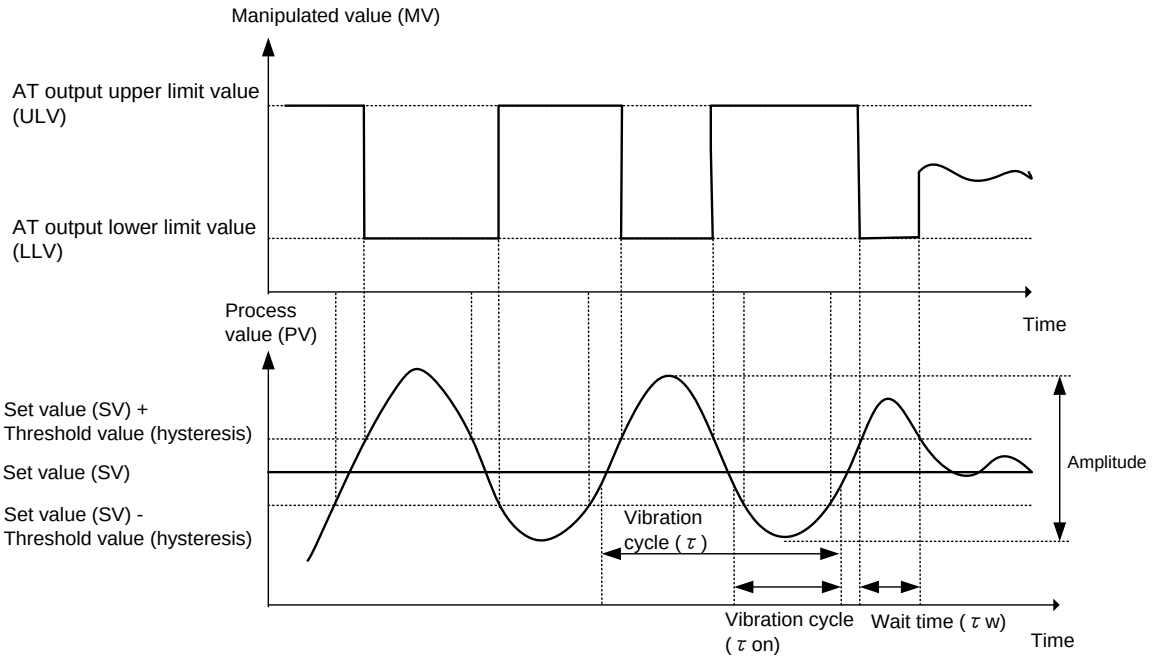
To use the auto tuning (limit cycle method), set this value.

During the auto tuning, set the AT upper limit output limiter (ULV) and the AT lower limit output limiter (LLV) to be output to the manipulated value (MV).

vii) Wait setting parameter (KW)

To use the auto tuning (limit cycle method), set this value.

Set the wait setting parameter (KW) from the end of auto tuning to the start of PID operation.

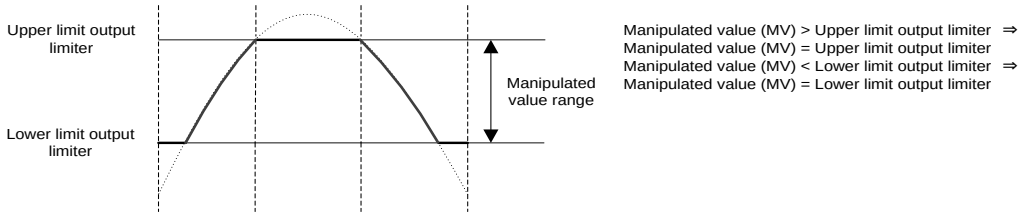


Wait time (τ w) = (50 - Wait setting parameter (KW)) / 100 × (Vibration cycle (τ - τ on))

g) Upper/lower limit output limiter

i) It can limit the upper and lower limits of ow_MV (Manipulated value (MV)).

When the manipulated value (MV) exceeds the upper limit output limiter or lower than the lower limit output limiter, it is corrected to the upper/lower limit output limiter value.



Item	Description

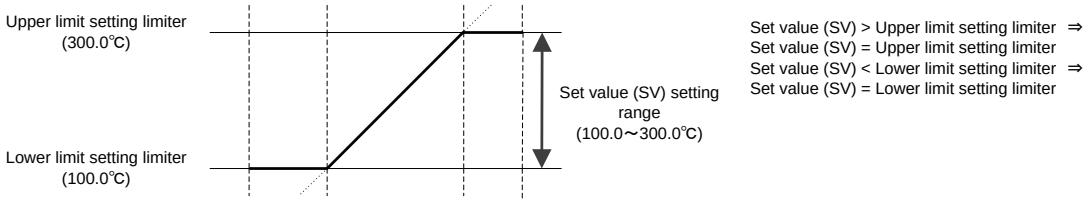
ii) To use this function, set the operation setting (ACT) and the upper/lower limit output limiter, as shown below.

Setting item		Description
Operation setting (ACT)	iw_SettingData (Setting data) Offset +0 (bit 1)	OFF
	iw_SettingData (Setting data) Offset +0 (bit 2)	ON: Upper/lower limit output limiter enabled
Upper limit output limiter	iw_SettingData (Setting data) Offset +5	-32768 to 32767
Lower limit output limiter	iw_SettingData (Setting data) Offset +6	-32768 to 32767

h) Upper/lower limit setting limiter

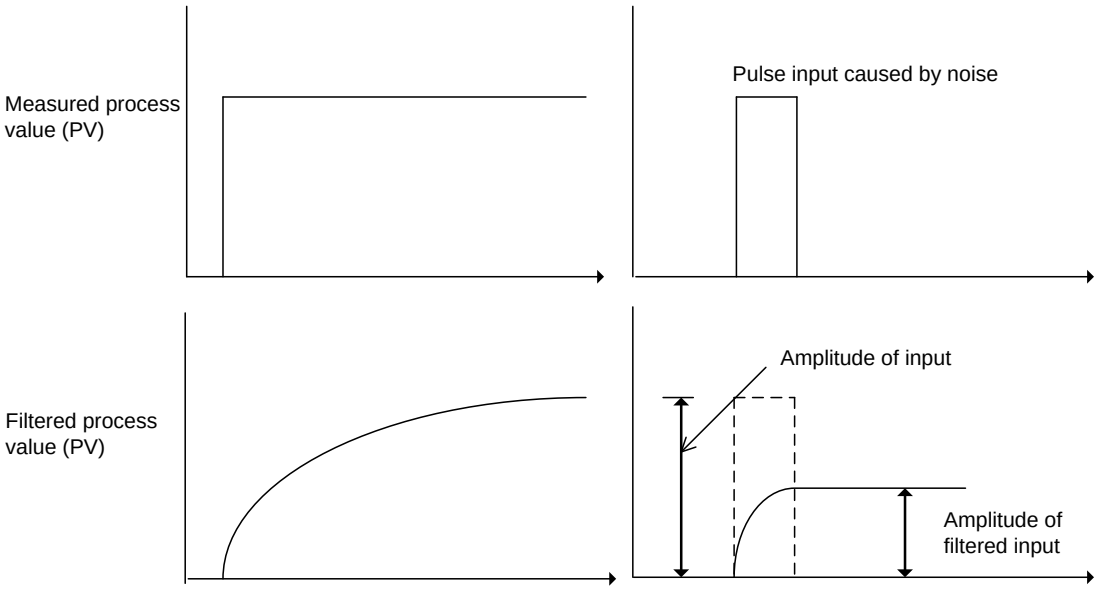
i) Set the upper limit and lower limit of iw_SV_Setting (Set value (SV) setting). When the iw_SV_Setting (Set value (SV) setting) exceeds the upper limit setting limiter of iw_SettingData (Setting data) or lower than the lower limit setting limiter, it is corrected to the upper/lower limit setting limiter value.

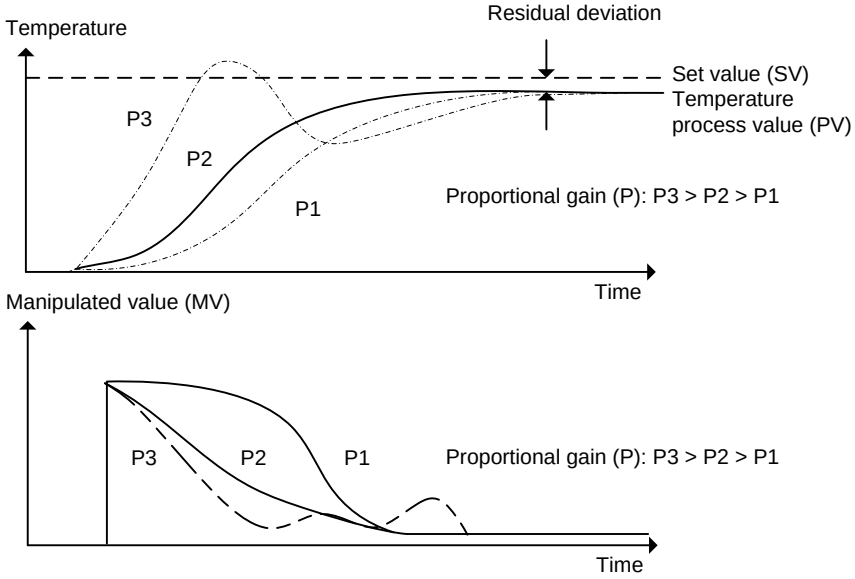
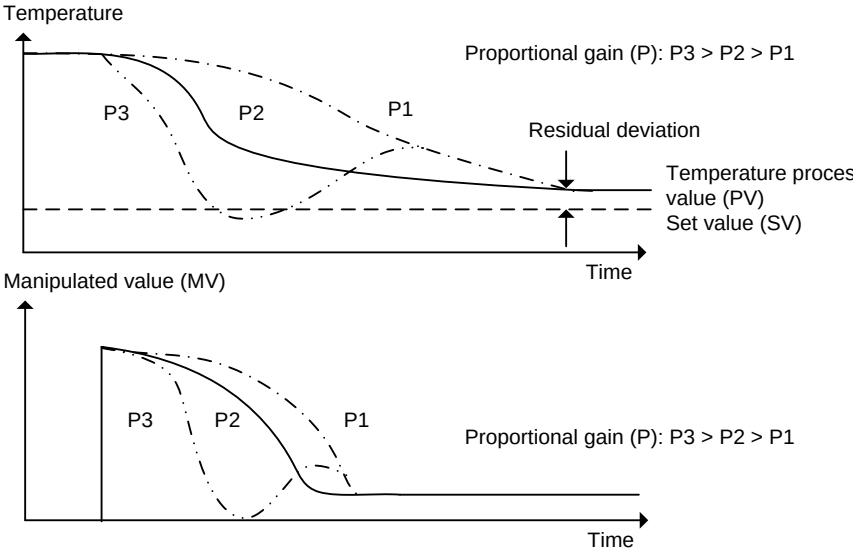
Ex.) In the diagram, the setting range is 100.0 C to 300.0 C.

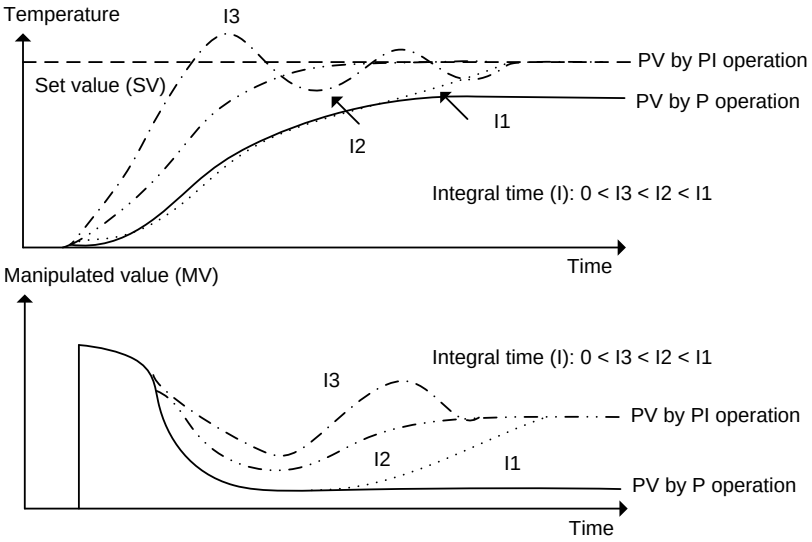
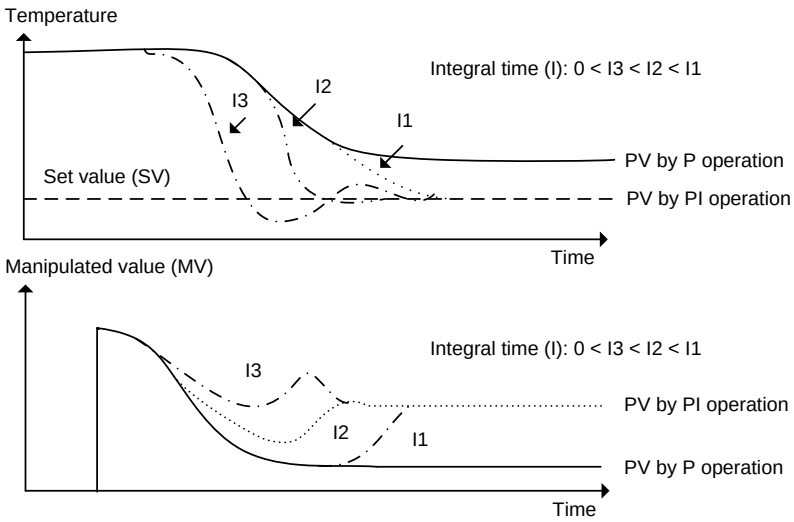


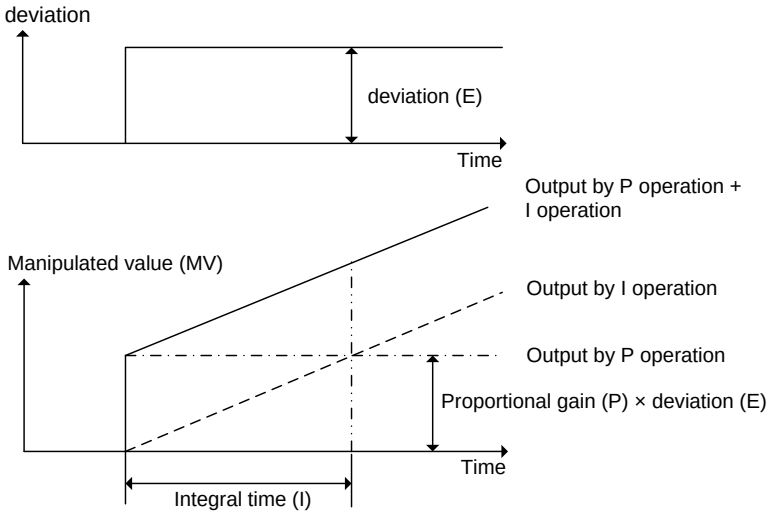
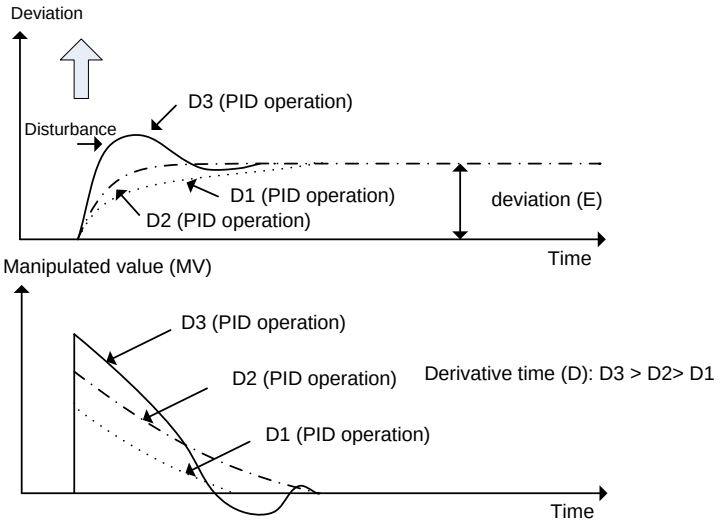
ii) To use this function, set the operation setting (ACT) and the upper/lower limit setting limiter, as shown below.

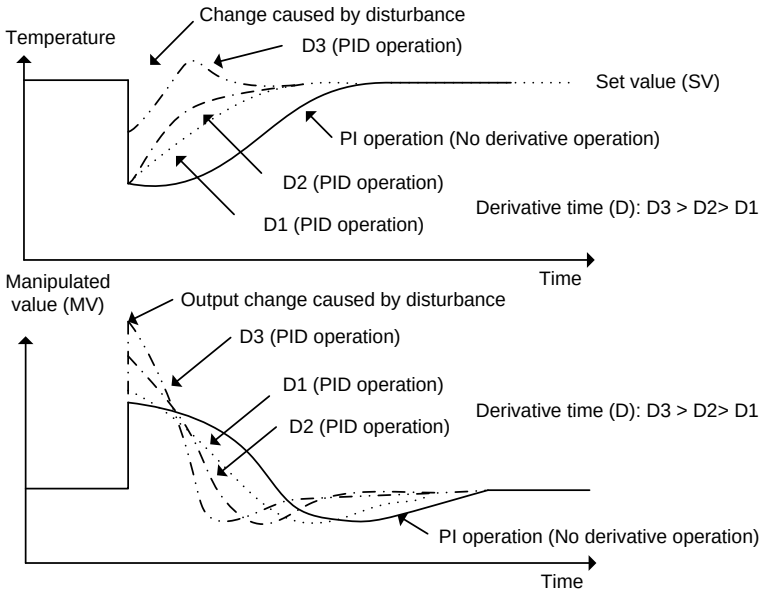
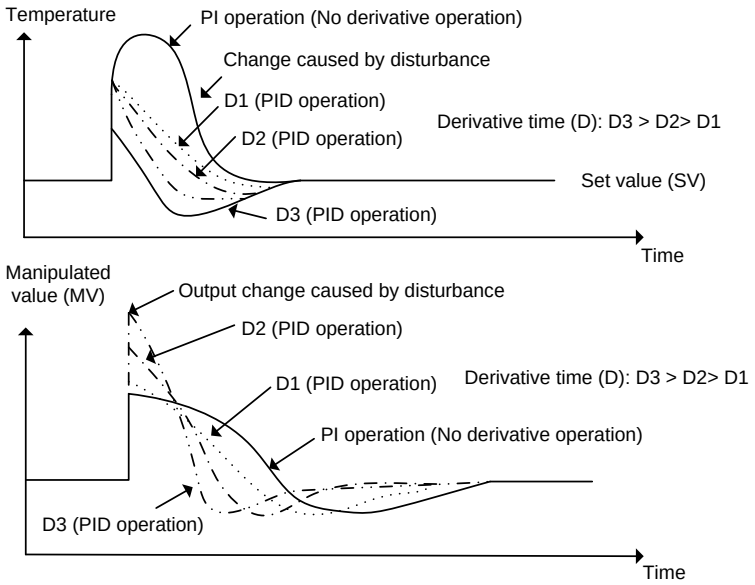
Setting item		Description
Operation setting (ACT)	iw_SettingData (Setting data) Offset +0 (bit 3)	ON: Upper/lower limit setting limiter enabled
Upper limit setting limiter	iw_SettingData (Setting data) Offset +7	-32768 to 32767
Lower limit setting limiter	iw_SettingData (Setting data) Offset +8	-32768 to 32767

Item	Description
	i) Input filter constant (α) i) The input filter constant (α) is a software filter that reduces variations caused by noise of temperature process value (PV). Influences of noise can be suppressed by setting the time constant of this filter according to the characteristics and noise level of the control target. • When the constant is too small, effects of the filter is reduced. • When the constant is too large, the responsiveness of input is reduced. ii) The input filter constant (α) is applied on the set value (SV) and accordingly affects the proportional operation, integral operation, and derivative operation.  j) Proportional gain (P) setting i) The manipulated value (MV) increases in proportion to the error (difference between the set value (SV) and temperature process value (PV)) in the proportional operation. This proportion is called the proportional gain (P) and is expressed in the following relational expression. • Manipulated value (MV) = Proportional gain (P) × Deviation (E) ii) The reciprocal of the proportional gain (P) is called the proportional band. As the proportional gain (P) increases, the movement of getting the temperature process value (PV) closer to the set value (SV) becomes stronger.

Item	Description
	Ex.) Proportional operation (P operation) in reverse action (heating control)  Ex.) Proportional operation (P operation) in forward action (cooling control) 

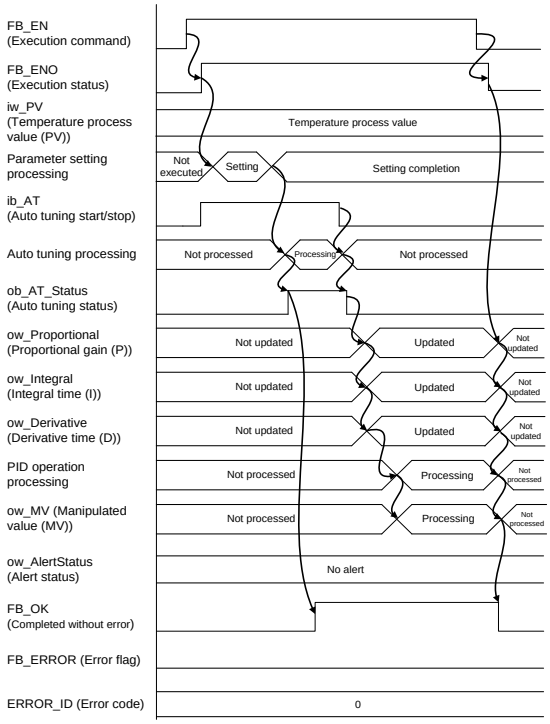
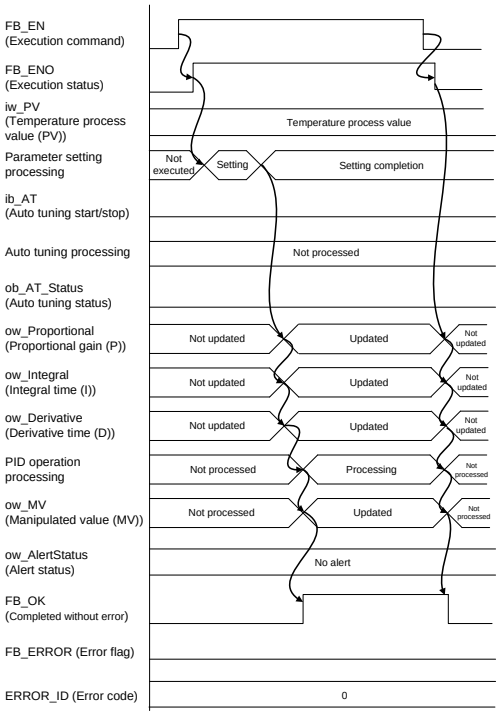
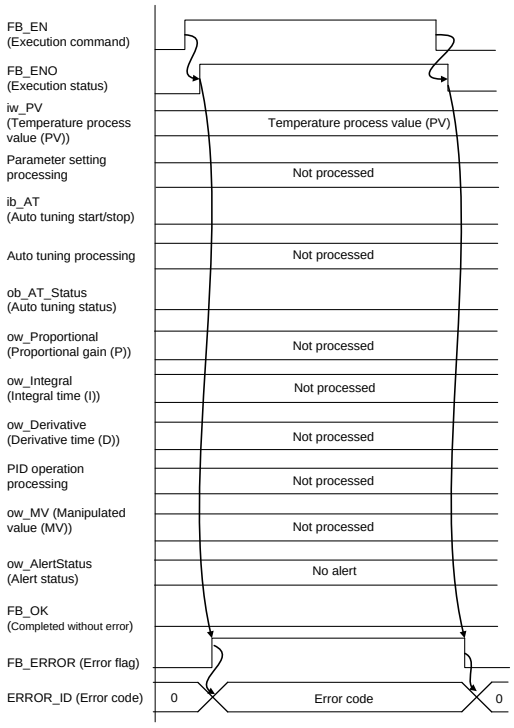
Item	Description
	k) Integral time (I) setting i) The integral time is a time from when an error occurs to when the integral operation output reaches the proportional operation output. As the integral time gets shorter, the integral operation becomes stronger. Ex.) PI operation in reverse action (heating control)  Ex.) PI operation in forward action (cooling control) 

Item	Description
	ii) The integral operation changes the output to eliminate an error generated in succession.Therefore, the residual error, which is generated in the proportional operation, can be eliminated.  l) Derivative time (D) setting i) This setting is used to sensitively reacting to changes, which is caused by disturbance, in the temperature process value (PV) and minimizing the changes. • As the derivative time (D) gets longer, the movement of preventing a significant change caused by disturbance becomes stronger. • Use the derivative time (D) as needed. Use this setting when small disturbance occurs. 

Item	Description
	Ex.) PID operation in reverse operation (heating control)  Ex.) PID operation in forward operation (cooling control) 

Item	Description
	m) Derivative gain (KD) i) A filter is applied to the output by the derivative operation. The derivative gain (KD) affects the derivative operation. • As the derivative gain (KD) gets smaller, output immediately responds specifically to a change in the temperature process value caused by disturbance. • As the derivative gain (KD) gets larger, output takes time to respond to a change in the temperature process value (PV) caused by disturbance. ii) Set the derivative gain (KD) to 0, and then adjust the value with the input filter (α). When output greatly responds to a change caused by disturbance, set a larger value. n) PID operation Perform the PID operation based on the values of iw_SV_Setting (Set value (SV) setting), iw_PV (Temperature process value (PV)), iw_P_GainSetting (Proportional gain (P) setting), iw_I_Setting (Integral time (I) setting), iw_D_Setting (Derivative time (D) setting), and store the ow_MV (Manipulated value (MV)). o) Manual output function i) It is a function to set the manipulated value (MV) manually without calculating it automatically by PID control opration. When ib_AutoManShift (AUTO/MAN mode shift) is set to “ON” (MAN (Manual) mode), manual output is executed according to iw_ManOutput (MAN output setting), and the user's setting value enters ow_MV (Manipulated value (MV)).
FB Compilation Method	Macro type
Restrictions And Precautions	1) This FB does not include the error recovery processing. Prepare the error recovery processing separately to fit the user’s system and the required operation. 2) The FB cannot be used in an interrupt program. 3) Using the FB in a program that is executed only once (such as a subroutine program or a FOR ... NEXT) has a problem that FB_EN (Execution command) can not be turned off, so normal operation can not be performed, please use a program that is capable of turning off the FB_EN (Execution command). 4) When using multiple FB, be careful not to use the same target CH. 5) For this FB, it is necessary to set the circuits for all input labels. 6) Please make settings by the parameter setting of GX Works2 according to the connected equipment/system. For more information about the usage of parameter setting, please refer to GX Works2 Operating Manual (Common).

Item	Description
FB Operation Type	Real-time execution
Examples	Please refer to “Appendix1. FB LIBRARY EXAMPLES”.

Item	Description
Operation Of Input/Output Signals	[When operation completes without error] • Auto tuning is used  • Auto tuning is not used  [When an error occurs] 

Item	Description
Relevant Manuals	MELSEC-L RTD Input Module User's Manual MELSEC-L Digital-Analog Converter Module User's Manual MELSEC-L I/O Module User's Manual MELSEC-L CPU Module User's Manual (Hardware Design, Maintenance and Inspection) MELSEC-L CPU Module User's Manual (Function Explanation, Program Fundamentals) MELSEC-Q/L Programming Manual (Common Instruction) RTD Input Module/Channel Isolated RTD Input Module User's Manual (Details) Digital-Analog Converter Module User's Manual (Details) I/O Module Type Building Block User's Manual QCPU User's Manual (Hardware Design, Maintenance and Inspection) QnUCPU User's Manual (Function Explanation, Program Fundamentals) GX Works2 Version 1 Operating Manual (Common) GX Works2 Version 1 Operating Manual (Simple Project, Function Block)

Error code

●Error code list

Error Code	Description	Corrective Action
30(Decimal)	The upper limit output limiter is equal to or smaller than the lower limit output limiter.	Check and correct the setting and excute FB again.
31(Decimal)	The upper limit setting limiter is equal to or smaller than the lower limit setting limiter.	Check and correct the setting and excute FB again.
35(Decimal)	The sampling time is out of the setting range. A value other than 1 to 32767 is set as the sampling time.	Check and correct the setting and excute FB again.
36(Decimal)	The proportional gain (P) is out of the setting range. A value other than 1 to 32767 (1 to 32767%) is set as the proportional gain (P).	Check and correct the setting and excute FB again.
37(Decimal)	The integral time (I) is out of the setting range. A value other than 0 to 32767 (0 to 32767 × 100 ms) is set as the integral time (I).	Check and correct the setting and excute FB again.
38(Decimal)	The derivative time (D) is out of the setting range. A value other than 0 to 32767 (0 to 32767% × 10 ms) is set as the derivative time (D).	Check and correct the setting and excute FB again.
39(Decimal)	The input filter constant is out of the setting range. A value other than 0 to 99 (0 to 99%) is set as the input filter constant (α).	Check and correct the setting and excute FB again.
40(Decimal)	The derivative gain (KD) is out of the setting range. A value other than 0 to 100 (0 to 100%) is set as the derivative gain (KD).	Check and correct the setting and excute FB again.
41(Decimal)	The rate of change in input alert set value is out of the setting range. A value other than 0 to 32767 (0 to 32767 × 100 ms) is set as the rate of change in input (increase/Decrease side) alert set value.	Check and correct the setting and excute FB again.
42(Decimal)	The rate of change in output alert set value is out of the setting range. A value other than 0 to 32767 is set as the rate of change in output (increase/Decrease side) alert set value.	Check and correct the setting and excute FB again.
43(Decimal)	The threshold value (hysteresis) is out of the setting range. A value other than 0 to 32767 is set as the threshold value (hysteresis).	Check and correct the setting and excute FB again.

Error Code	Description	Corrective Action
44(Decimal)	The wait setting parameter (KW) is out of the setting range. A value other than -50 to 32717 is set as the wait setting parameter (KW).	Check and correct the setting and excute FB again.
45(Decimal)	The rate of change in output alert and the upper/lower output limiter are simultaneously set.	Check and correct the setting and excute FB again.
46(Decimal)	The AT upper limit output limiter (ULV) is equal to or smaller than the AT lower limit output limiter (LLV).	Check and correct the setting and excute FB again.
Error codes other than above	The error codes are for the PID operation instruction (PID) which performs PID operation.	For the detail of the error codes, refer to the explanation of the PID operation instruction on the MELSEC-Q/L Programming Manual (Common Instruction).

Labels to use

●Input label

Name (Comment)	Label Name	Data Type	Scope	Description
Execution command	FB_EN	bit	ON,OFF	ON: Start FB. OFF: Do not start FB.
Sampling time (TS)	iw_SamplingTime	word	1 to 32767 (1 to 32767 ms)	Set the cycle (ms) for PID operation. The PID operation cannot be performed with a cycle which is smaller than that of the programmable controller.
Forward/reverse action setting	ib_ActionSetting	bit	ON,OFF	To use with forward action or reverse action. Set forward action when it is used for cooling control. Set reverse action when it is used for heating control. ON: Forward action (Cooling control) OFF: Reverse action (Heating control)
AUTO/MAN mode shift	ib_AutoManShift	bit	ON,OFF	To select the manipulated value (MV) calculated by PID operation or set by the user. OFF: AUTO (Automatic) mode The manipulated value (MV) is calculated by PID operation in the FB. ON: MAN (Manual) mode The manipulated value (MV) is set in iw_ManOutput (MAN output setting) by the user.
Start/stop auto tuning	ib_AT	bit	ON,OFF	ON: Start auto tuning. OFF: Stop auto tuning.

Name (Comment)	Label Name	Data Type	Scope	Description
Temperature process value (PV)	iw_PV	word	-32768 to 32767	Set the temperature process value detected by the analog input module. (Ex.) In the following setting, please set "U3 ¥ G11". •Used module : "L60RD8" •Start I/O No. : "H30" •Temperature process value used for control: "CH1 temperature process value" * The measurement range varies depending on the input range setting, input type/range setting, and Celsius/Fahrenheit display setting of the used module. For more information, please refer to the user's manual of the module.
Set value (SV) setting	iw_SV_Setting	word	-32768 to 32767	Set the set value of PID operation. When the set values for auto tuning and PID control are different in the limit cycle method, set a value obtained by adding a bias value and store the actual set value of when ob_AT_Status (Auto tuning status) turns OFF.
Proportional gain (P) setting	iw_P_GainSetting	word	1 to 32767 (1 to 32767%)	Set the proportional gain (P) for PID operation.
Integral time (I) setting	iw_I_Setting	word	0 to 32767 (0 to 32767 × 100 ms)	Set the integral time (I) for PID operation. When 0 is specified, it is handled as ∞. (No integral operation)
Derivative time (D) setting	iw_D_Setting	word	0 to 32767 (0 to 32767% × 10 ms)	Set the derivative time (D) for PID operation. When 0 is specified, no derivative operation is performed.

Name (Comment)	Label Name	Data Type	Scope	Description
Manipulated value (MV) setting	iw_MV_Setting	word	-32768 to 32767	Set the initial manipulated value for PID operation. When normal processing is performed, set the initial manipulated value. When the step response method is used, set the step manipulated value.
MAN output setting	iw_ManOutput	word	-32768 to 32767	Set the manipulated value (MV) in MAN mode. * This setting is enable when ib_AutoManShift (AUTO/MAN mode shift) is set to “ON: MAN mode”.
Setting data	iw_SettingData	word	*Refer to the setting data in the table below	Specify the start address where setting data is stored. Set the parameter necessary for PID operation and auto tuning.

●Setting data

Name	Offset	Data Type	Scope	Description
Operation setting (ACT)	+0	Bit 0	ON,OFF	Set the rate of change in input alert. OFF: Rate of change in input alert disabled ON: Rate of change in input alert enabled
		Bit 1	ON,OFF	Set the rate of change in output alert. OFF: Rate of change in output alert disabled ON: Rate of change in output alert enabled Do not set bits 1 and 2 to ON simultaneously.
		Bit 2	ON,OFF	Set the upper/lower limit output limiter. OFF: Upper/lower limit output limiter disabled ON: Upper/lower limit output limiter enabled Do not set bits 1 and 2 to ON simultaneously.
		Bit 3	ON,OFF	Set the upper/lower limit setting limiter. OFF: Upper/lower limit setting limiter disabled ON: Upper/lower limit setting limiter enabled
		Bit 4	ON,OFF	Select the auto tuning mode. OFF: Step response method ON: Limit cycle method
		Bit 5 to 15	-	Unused area
Input filter constant (α)	+1	word	0 to 99 (0 to 99%)	Set the input filter constant. When 0 is specified, no input filter is applied.
Derivative gain (KD)	+2	word	0 to 100 (0 to 100%)	Set the derivative gain (KD) for PID control. When 0 is specified, no derivative gain is applied.
Rate of change in input (increase side) alert setting value	+3	word	0 to 32767 (0 to 32767 × 100 ms)	Set the rate of change in input (increase side) alert setting value. This setting is enabled when bit 0 of the operation setting (ACT) is ON.
Rate of change in input (decrease side) alert setting value	+4	word	0 to 32767 (0 to 32767 × 100 ms)	Set the rate of change in input (decrease side) alert setting value. This setting is enabled when bit 0 of the operation setting (ACT) is ON.

Name	Offset	Data Type	Scope	Description
Rate of change in output (increase side) alert	+5	word	0 to 32767	Set the rate of change in output (increase side) alert set value. This setting is enabled when bit 1 of the operation setting (ACT) is ON and bit 2 is OFF.
Upper limit output limiter			-32768 to 32767	Set the upper limit of the manipulated value (MV). This setting is enabled when bit 1 of the operation setting (ACT) is OFF and bit 2 is ON.
Rate of change in output (decrease side) alert	+6	word	0 to 32767	Set the rate of change in output (decrease side) alert set value. This setting is enabled when bit 1 of the operation setting (ACT) is ON and bit 2 is OFF.
Lower limit output limiter			-32768 to 32767	Set the lower limit of the manipulated value (MV). This setting is enabled when bit 1 of the operation setting (ACT) is OFF and bit 2 is ON.
Upper limit setting limiter	+7	word	-32768 to 32767	Set the upper limit of the set value (SV) setting range. Set the value as below: Lower limit setting limiter value <upper limit setting limiter value. * The measurement range varies depending on the input range setting, input type/range setting, and Celsius/Fahrenheit display setting of the used module. For more information, please refer to the user's manual of the module.

Name	Offset	Data Type	Scope	Description
Lower limit setting limiter	+8	word	-32768 to 32767	Set the lower limit of the set value (SV) setting range. Set the value as below: Lower limit setting limiter value <upper limit setting limiter value. * The measurement range varies depending on the input range setting, input type/range setting, and Celsius/Fahrenheit display setting of the used module. For more information, please refer to the user's manual of the module.
Threshold value (hysteresis)	+9	word	0 to 32767	To prevent chatter, set the threshold value (hysteresis) for the temperature process value (PV) on which the auto tuning (limit cycle method) is being performed.
AT upper limit output limiter (ULV)	+10	word	-32768 to 32767	Set the upper limit of the manipulated value (MV) on which the auto tuning (limit cycle method) is being performed.
AT lower limit output limiter (LLV)	+11	word	-32768 to 32767	Set the lower limit of the manipulated value (MV) on which the auto tuning (limit cycle method) is being performed.
Wait setting parameter (KW)	+12	word	-50 to 32717 (-50 to 32717%)	Set the wait setting parameter (KW) from the end of auto tuning (limit cycle method) to the start of PID operation. The AT lower limit output limiter (LLV) is stored in Manipulated value (MV) during the wait.

●Output label

Name (Comment)	Label Name	Data Type	Initial Value	Description
Execution status	FB_ENO	bit	OFF	ON: Execution command is ON OFF: Execution command is OFF
Completed without error	FB_OK	bit	OFF	When ON, the PID operation is being performed.
Auto tuning status	ob_AT_Status	bit	OFF	Execution status of the auto tuning. OFF: Auto tuning not performed/completed ON: Auto tuning being performed
Alert status	ow_AlertStatus	word	0	The bit corresponding to the detected alert turns ON. Bit 0 Rate of change in input (increase side) alert Bit 1 Rate of change in input (decrease side) alert Bit 2 Rate of change in output (increase side) alert Bit 3 Rate of change in output (decrease side) alert Bit 4 to bit 15 Unused
Proportional gain (P)	ow_Proportional	word	0	Return the proportional gain (P) for PID operation.
Integral time (I)	ow_Integral	word	0	Return the integral time (I) for PID operation.
Derivative time (D)	ow_Derivative	word	0	Return the derivative time (D) for PID operation.

Name (Comment)	Label Name	Data Type	Initial Value	Description
Manipulated value (MV)	ow_MV	word	0	The result of the PID operation based on the temperature process value (PV) is stored. [Limit cycle method] The AT upper limit output limiter (ULV) or the AT lower limit output limiter (LLV) is automatically output during the auto tuning, and the specified manipulated value is set after the completion of the auto tuning. [Step response method] The manipulated value is not changed in the FB during the auto tuning. [Manual mode] The manipulated value (MV) which is set in iw_ManOutput (MAN output setting) is applied.
Error flag	FB_ERROR	bit	OFF	When ON, it indicates that an error has occurred.
Error code	ERROR_ID	word	0	FB error code output.

FB Version History

Version	Date	Description
1.00A	2017/05	New create

PLEASE

This chapter explains the function block function.

Restrictions on using of the module and programmable controller CPU, restrictions on combination, etc. are not given.

Please read the user's manual of the product carefully before working on the target product.

Appendix1. FB LIBRARY EXAMPLES

Appendix1.1. PID Control FB Examples

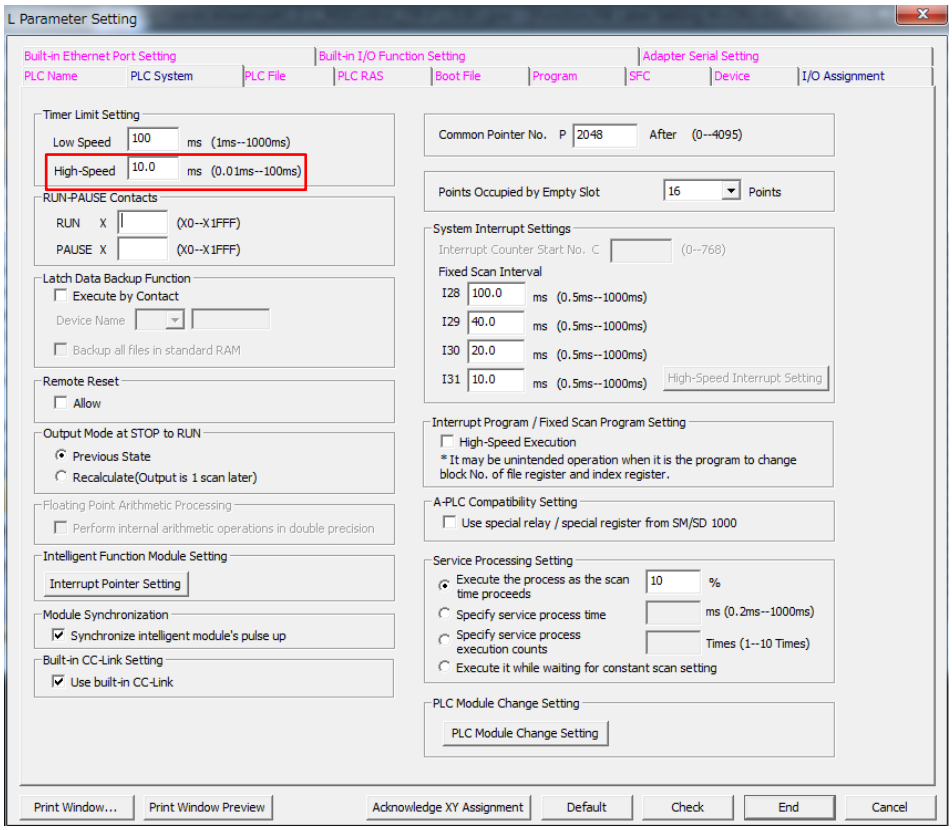
Examples for using PID control FB is shown below.

Global label setting

None

Examples of setting

a) Common setting

I/O Item	Value	Description
Mounted XY address on module	0	Specify the start XY address mounted on the target module.
PC system setting	10.00ms	Specify the Timer Limit Setting. From [parameter]-[PC parameter]-[PC system setting], set the high speed of the Timer Limit Setting.  	

Available devices list

a) External input (Command)

Device	FB Name	Application (Contents When ON)
M0	M+CPU-PID_PIDControl	PID control execution command
M1		Forward/reverse action setting
M2		AUTO/MAN mode switching
M3		Start/stop auto tuning
M4		Start/stop auto tuning2

b) External output (Confirmation)

Device	FB Name	Application (Contents When ON)
M5	M+CPU-PID_PIDControl	Execution status
M6		Completed without error
M7		Transistor output flag
M8		Execution status2
M9		Completed without error2
M10		Transistor output flag2
F0		Error flag
F1		Error flag2

c) Data register

Device	FB Name	Application	
D0	M+CPU-PID_PIDControl	Temperature process value (PV)	
D1		Set value (SV) setting	
D2		MAN output setting	
D3		Setting data	Control output cycle setting
D4			Input range upper limit
D5			Input range lower limit
D6			Upper limit output limiter
D7			Lower limit output limiter
D8			Upper limit setting limiter
D9			Lower limit setting limiter
D10			Output variation limiter
D11			Setting change rate limiter
D12			Alert 1 mode setting
D13			Alert 2 mode setting
D14			Alert 3 mode setting
D15			Alert 4 mode setting

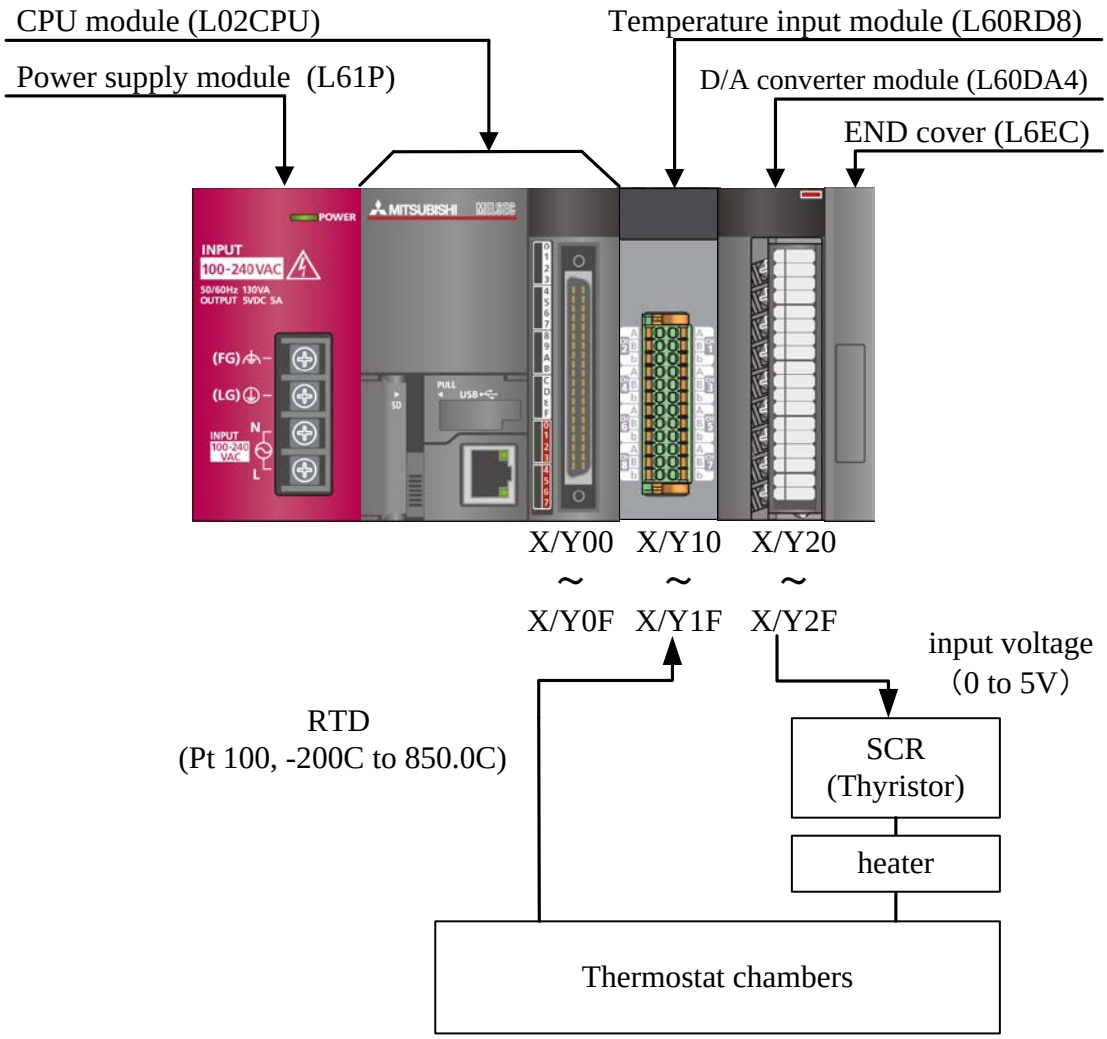
Device	FB Name	Application	
D16			Alert set value1
D17			Alert set value2
D18			Alert set value3
D19			Alert set value4
D20			Alert dead band setting
D21			AT timeout time
D22			Auto tuning control type setting
D23			2-degree-of-freedom parameter a
D24			2-degree-of-freedom parameter b
D25			Decimal point position
D26			Timer Limit Setting
D27			Using timer device setting
D28		Temperature process value (PV)	
D29		Manipulated value (MV)	
D30		Set value (SV)	
D31,D32		Temperature process value (C/F)	
D33		Auto tuning status	
D34		Alert status	
D35		Error code	
D36		Proportional band (P)	
D37		Integral time (I)	
D38		Derivative time (D)	
D39		Set value (SV) setting2	
D40		MAN output setting2	
D41		Setting data	Control output cycle setting
D42			Input range upper limit
D43			Input range lower limit
D44			Upper limit output limiter
D45			Lower limit output limiter
D46			Upper limit setting limiter
D47			Lower limit setting limiter
D48			Output variation limiter
D49			Setting change rate limiter
D50			Alert 1 mode setting
D51			Alert 2 mode setting
D52			Alert 3 mode setting

Device	FB Name	Application	
D53			Alert 4 mode setting
D54			Alert set value1
D55			Alert set value2
D56			Alert set value3
D57			Alert set value4
D58			Alert dead band setting
D59			AT timeout time
D60			Auto tuning control type setting
D61			2-degree-of-freedom parameter a
D62			2-degree-of-freedom parameter b
D63			Decimal point position
D64			Timer Limit Setting
D65			Using timer device setting
D66		Temperature process value (PV)2	
D67		Manipulated value (MV)2	
D68		Set value (SV)2	
D69,D70		Temperature process value(C/F)2	
D71		Auto tuning status2	
D72		Alert status2	
D73		Error code2	
D74		Proportional band (P)2	
D75		Integral time (I)2	
D76		Derivative time (D)2	
D77		Range width	
D78 to D81		Setting value calculation value	

Appendix 1.1.1 When SCR (Thyristor) is used

Examples when using SCR (Thyristor) are shown below.

1) System configuration



Point

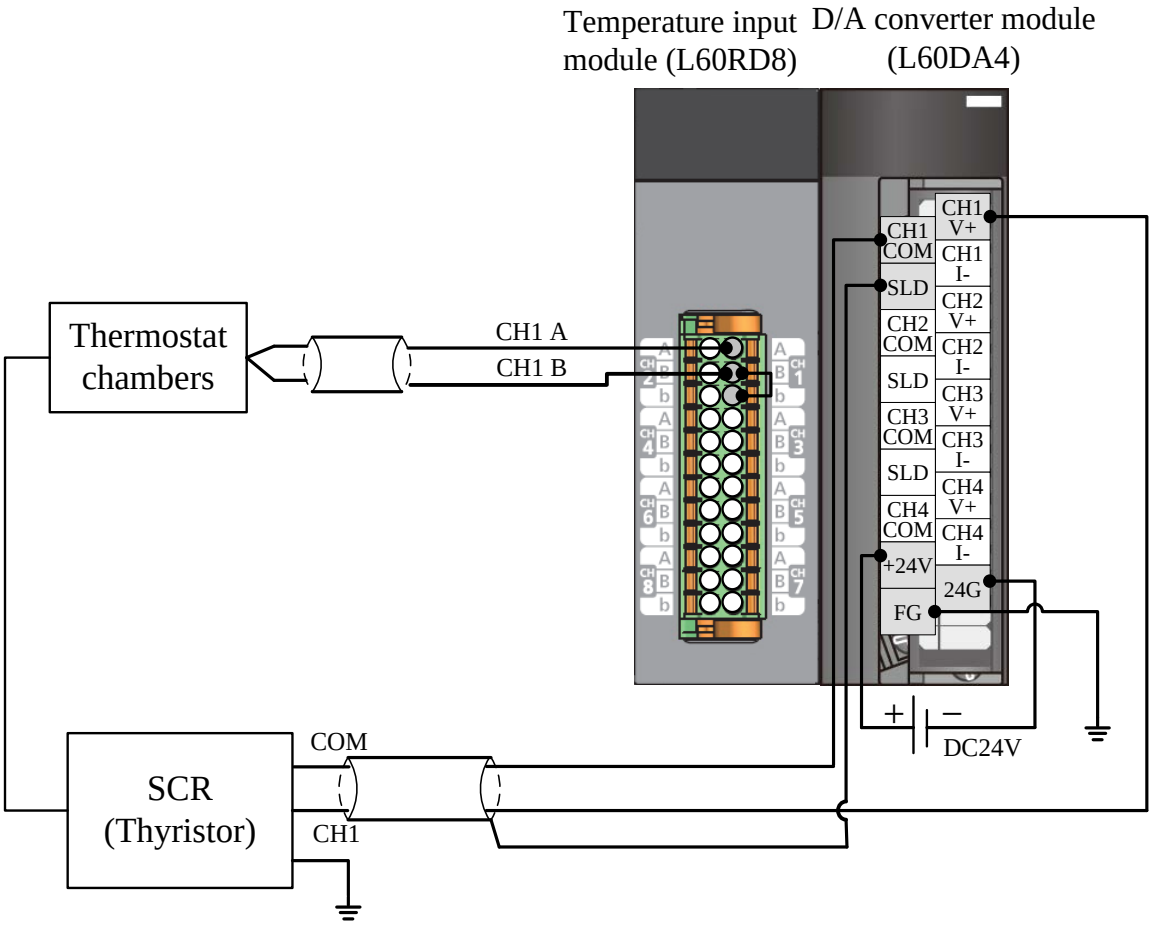
•Circuit settings are required for all input labels. If it is not set, it becomes indefinite value.

•Depending on the number of characters that GX Works2 can display, label comments may be described in abbreviated form.

2) Programming conditions

This is a program for PID control. It reads the temperature measured by RTD (Pt 100, -200°C to 850.0°C) connected to CH1 of L60RD8, outputs DC voltage (0 to 5V) from CH1 of L60DA4, and excute the PID control.

3) Wiring examples



4) Examples of setting

a) Parameter setting of temperature input module

Display Filter: Display All

Item	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
Basic setting	**Set the conversion system.**							
Input range setting	2:Pt100 (-200 to 850°C)	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion
Celsius/Fahrenheit display setting	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]
Averaging process setting	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing
Time Average/ Count Average/Moving Average	0	0	0	0	0	0	0	0
Sensor compensation function	**Set value for sensor compensation when the conversion is executed.**							
Sensor compensation valid/invalid setting	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable
Shifting amount to conversion value	0	0	0	0	0	0	0	0
Disconnection detection function	**Set value to store into measured temperature value when the disconnection is detected.**							
Conversion setting for disconnection detection	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks
Conversion setting value for disconnection detection	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C
Scaling function	**Set value for scaling function when the conversion is executed.**							
Scaling enable/disable setting	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid
Scaling upper limit value	0	0	0	0	0	0	0	0
Scaling lower limit value	0	0	0	0	0	0	0	0
Waning output function	**Set value for warnings when the conversion is executed.**							
Process alarm output setting	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable

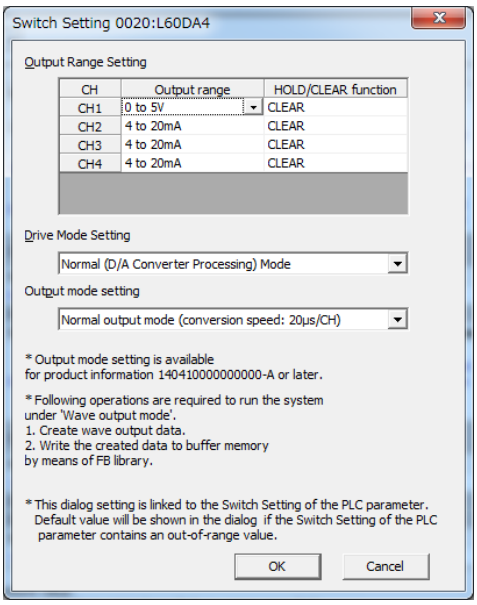
Set the lower lower limit of the measured temperature value.
An error will occur unless lower lower limit <= lower upper limit <= upper lower limit <= upper upper limit.
When the Scaling enable/disable setting is set as 'Enable', please set the value in consideration of scaling calculation.

When 'Disable' is selected in the 'Scaling enable/disable setting' for the relevant CH:

Setting Item		CH1
Basic setting	Input range setting	2: Pt100(-200 to 850°C)

*Settings other than the above are default values

(b) Switch setting of D/A conversion module



•Please check the input voltage specification of the SCR (Thyristor) before setting the output range of the D/A conversion module.

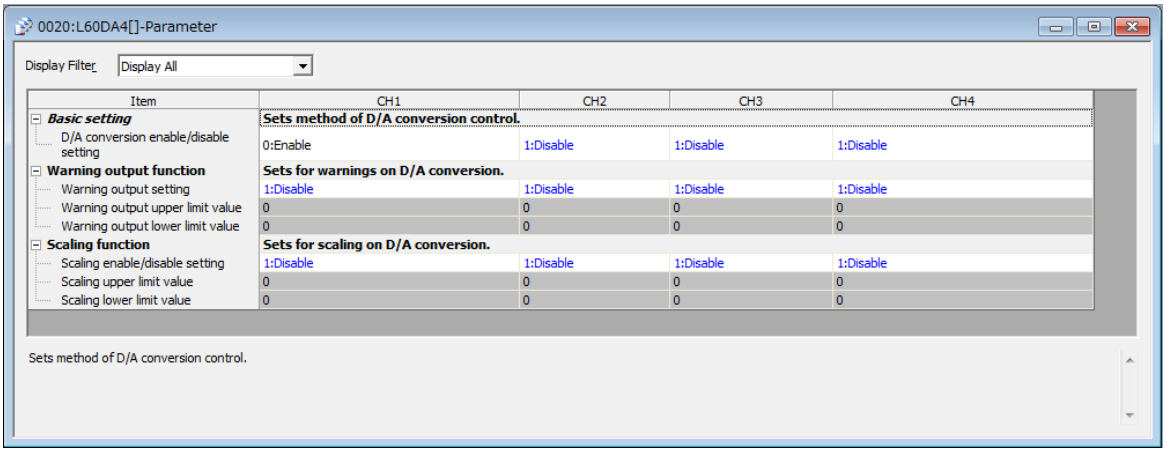
•Please check the digital value of the set output range before setting the output upper/lower limit of the manipulated value (MV).

Output Range	Digital Value	Resolution
0 to 5V	0 to 20000	250uV
1 to 5V		200uV
-10 to 10V	-20000 to 20000	500uV
User range setting		333uV

Setting Item		CH1
Output range setting	CH1	0 to 5V

*Settings other than the above are default values

(c) Parameter setting of D/A conversion module



Setting Item		CH1
Basic setting	D/A conversion enable/disable setting	0: enable

*Settings other than the above are default values

M+CPU-PID_PIDControl (PID Control)

Label Name	Setting Value	Description
ib_ActionSetting	OFF	Specify the reverse action for PID control direction by turning it OFF.
ib_AutoManShift	OFF	Specify AUTO/MAN mode switching to AUTO mode.
ib_AT	ON	Start auto tuning by turning it ON.
iw_PV	U1¥G11	Enter the measured temperature from the control object (Sensor).
iw_SV_Setting	K1000	Specify the set value (SV) setting to 100.0°C.
iow_Proportional	K100	Specify the proportional band (P) setting to 10.0%.
iow_Integral	K240	Specify the integral time (I) setting to K240.
iow_Derivative	K60	Specify the derivative time (D) setting to K60.
iw_ManOutput	K500	Specify the MAN output setting to 50.0%.
iw_SettingData[Offset+0]	K100	Specify the control output cycle setting to 10.0.
iw_SettingData[Offset+1]	K4000	Specify the input range upper limit to 400.0°C.
iw_SettingData[Offset+2]	K0	Specify the input range lower limit to 0.0°C.
iw_SettingData[Offset+3]	K1000	Specify the upper limit output limiter to 100.0%.
iw_SettingData[Offset+4]	K0	Specify the lower limit output limiter to 0.0%.
iw_SettingData[Offset+5]	K4000	Specify the upper limit setting limiter to 400.0°C.
iw_SettingData[Offset+6]	K0	Specify the lower limit setting limiter to 0.0°C.
iw_SettingData[Offset+7]	K500	Specify the output variation limiter to 50.0%.
iw_SettingData[Offset+8]	K500	Specify the setting change rate limiter to 50.0%.
iw_SettingData[Offset+9]	K1	Specify the alert 1 mode setting to 1 (Upper limit input alert).
iw_SettingData[Offset+10]	K2	Specify the alert 2 mode setting to 2 (Lower limit input alert).
iw_SettingData[Offset+11]	K0	Specify the alert 3 mode setting to 0 (No alert is executed).
iw_SettingData[Offset+12]	K0	Specify the alert 4 mode setting to 0 (No alert is executed).
iw_SettingData[Offset+13]	K4000	Specify the alert set value1 to 400.0°C.
iw_SettingData[Offset+14]	K0	Specify the alert set value2 to 0.0°C.
iw_SettingData[Offset+15]	K0	Do not use.
iw_SettingData[Offset+16]	K0	Do not use.
iw_SettingData[Offset+17]	K0	Specify the alert dead band setting to 0 (Do not use).
iw_SettingData[Offset+18]	K1000	Specify the AT timeout time to 1000s.
iw_SettingData[Offset+19]	K1	Specify the auto tuning control type setting to 1: fixed value PID control.
iw_SettingData[Offset+20]	K0	Specify the two-degree-of-freedom parameter α to 0.00.
iw_SettingData[Offset+21]	K100	Specify the two-degree-of-freedom parameter β to 1.00.
iw_SettingData[Offset+22]	K1	Specify the decimal point position to 1 (One decimal place).
iw_SettingData[Offset+23]	K1000	Specify the Timer Limit Setting to 10.00ms.
iw_SettingData[Offset+24]	K3	Specify the using timer device setting to 3 (T3).

i) Initial setting

Set the initial value after the CPU RUN.

(For the rest, please refer to the next page.)

```
<Set K0 as input range low limit >
[MOV    K0      D5   ]
                 Input ra
                 nge lowe
                 r limit

<Set K1000 as up lim out limiter >
[MOV    K1000   D6   ]
                 Upper li
                 mit outp
                 ut limit
                 er

<Set K0 as lower lim out limiter >
[MOV    K0      D7   ]
                 Lower li
                 mit outp
                 ut limit
                 er

<Set K4000 as up lim set limiter >
[MOV    K4000   D8   ]
                 Upper li
                 mit sett
                 ing limi
                 ter

<Set K0 as lower lim set limiter >
[MOV    K0      D9   ]
                 Lower li
                 mit sett
                 ing limi
                 ter

<Set K500 as out variation limit >
[MOV    K500    D10  ]
                 Output v
                 ariation
                  limiter
```

(For the rest, please refer to the next page.)

```
<Set K500 as set change rate lim >
[MOV    K500    D11   ]
                Setting
                change r
                ate limi
                ter

<Set K1 as alert 1 mode setting >
[MOV    K1      D12   ]
                Alert 1
                mode set
                ting

<Set K2 as alert 2 mode setting >
[MOV    K2      D13   ]
                Alert 2
                mode set
                ting

<Set K0 as alert 3 mode setting >
[MOV    K0      D14   ]
                Alert 3
                mode set
                ting

<Set K0 as alert 4 mode setting >
[MOV    K0      D15   ]
                Alert 4
                mode set
                ting

<Set K4000 as up lim input alert >
[MOV    K4000   D16   ]
                Alert se
                t value1

<Set K0 as lower lim input alert >
[MOV    K0      D17   ]
                Alert se
                t value2
```

(For the rest, please refer to the next page.)

```
<Set 1000s as AT timeout time >
[MOV    K1000    D21 ]
                  AT timeo
                  ut time

<Set AT type to fixed value PID >
[MOV    K1       D22 ]
                  Auto tun
                  ing cont
                  rol type
                   setting

<Set K0 as 2-degree-of-freedom a >
[MOV    K0       D23 ]
                  2-degree
                  -of-free
                  dom para
                  meter a
<Set K0 as 2-degree-of-freedom b >
[MOV    K100     D24 ]
                  2-degree
                  -of-free
                  dom para
                  meter b

<Set K1 decimal point position >
[MOV    K1       D25 ]
                  Decimal
                  point po
                  sition

<Set K1000 timer limit setting >
[MOV    K1000    D26 ]
                  Timer Li
                  mit Sett
                  ing

<Set T3 as using timer device >
[MOV    K3       D27 ]
                  Using ti
                  mer devi
                  ce setti
                  ng
```

(For the rest, please refer to the next page.)

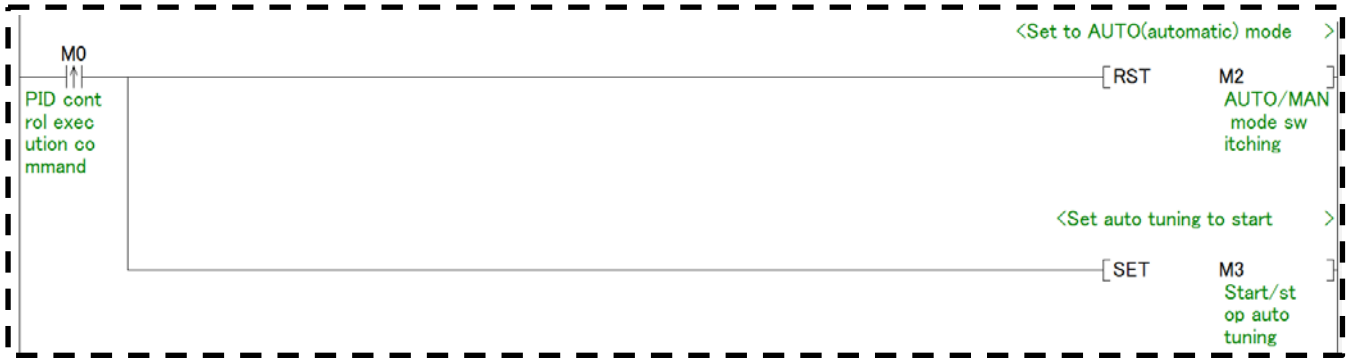
ii) PID control

Perform auto tuning and calculate PID constant, then perform PID control on temperature process value acquired on CH1.

*If calculation of PID constant by auto tuning is unnecessary, set M3 to OFF and execute.

In addition, automatic control/manual control can be switched by M2 ON/OFF.

*1



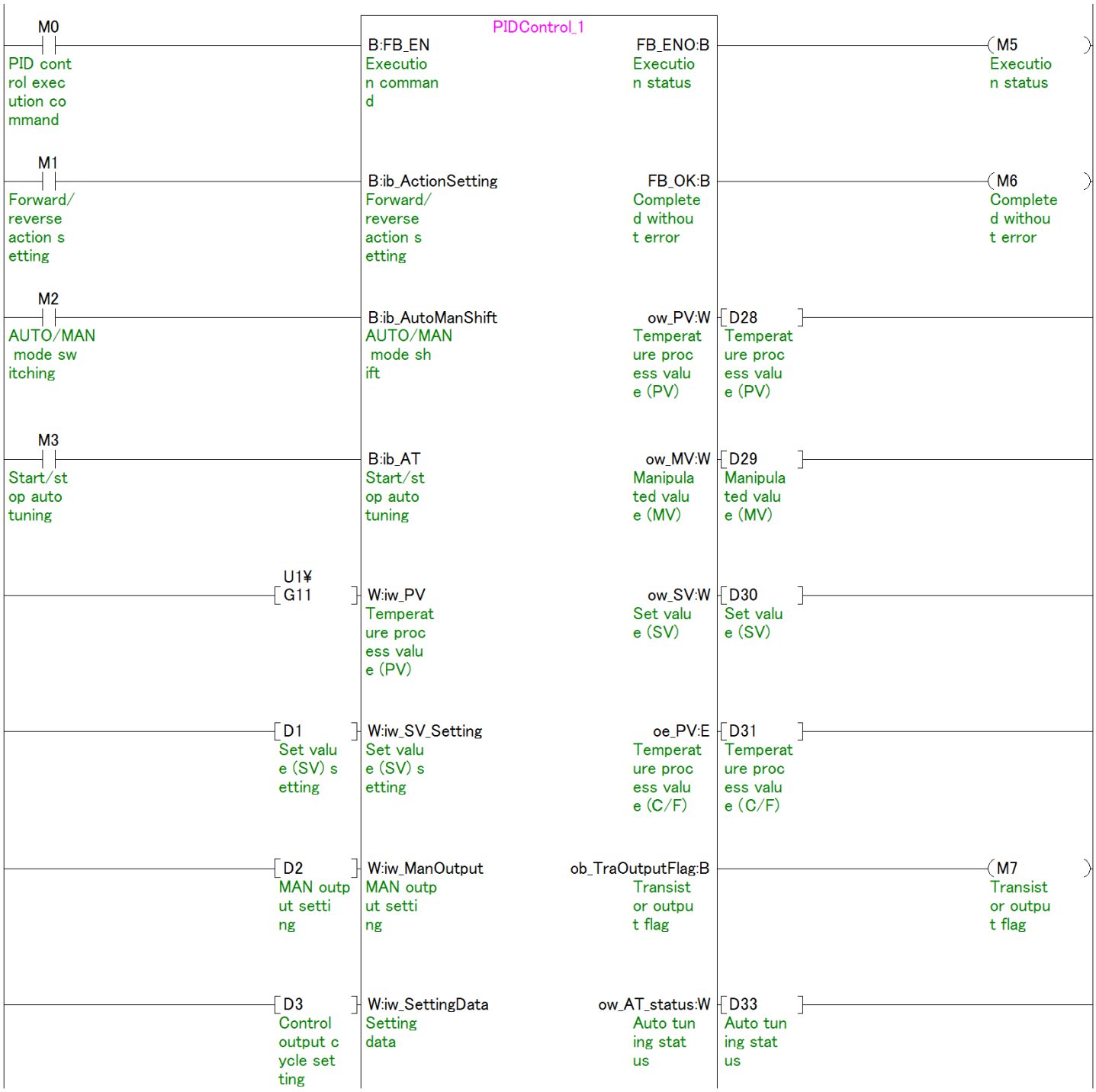
*2

*1,2

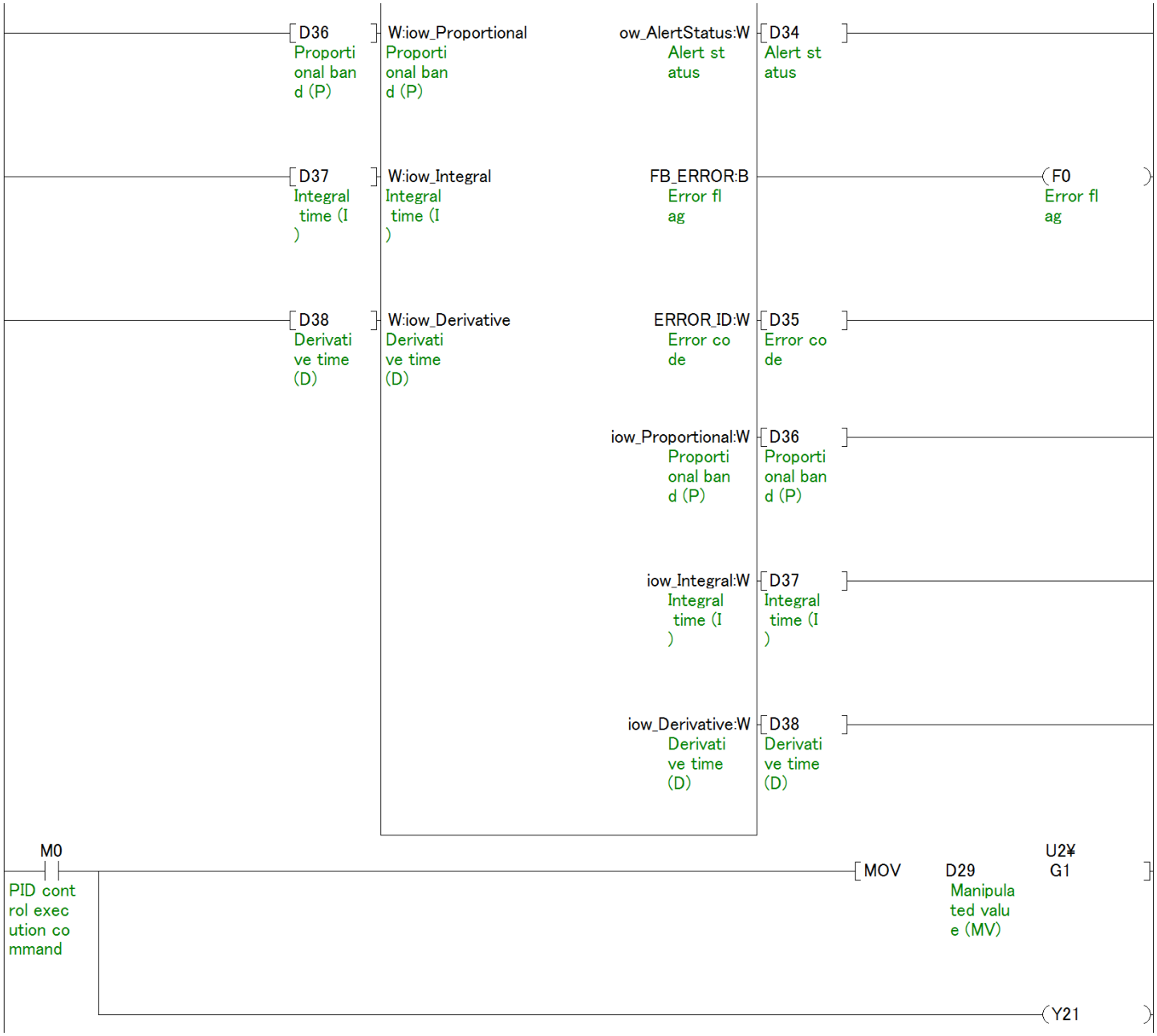
*1 Please set it when automatic control is performed.

*2 Please set it when manual control is performed.

(For the rest, please refer to the next page.)



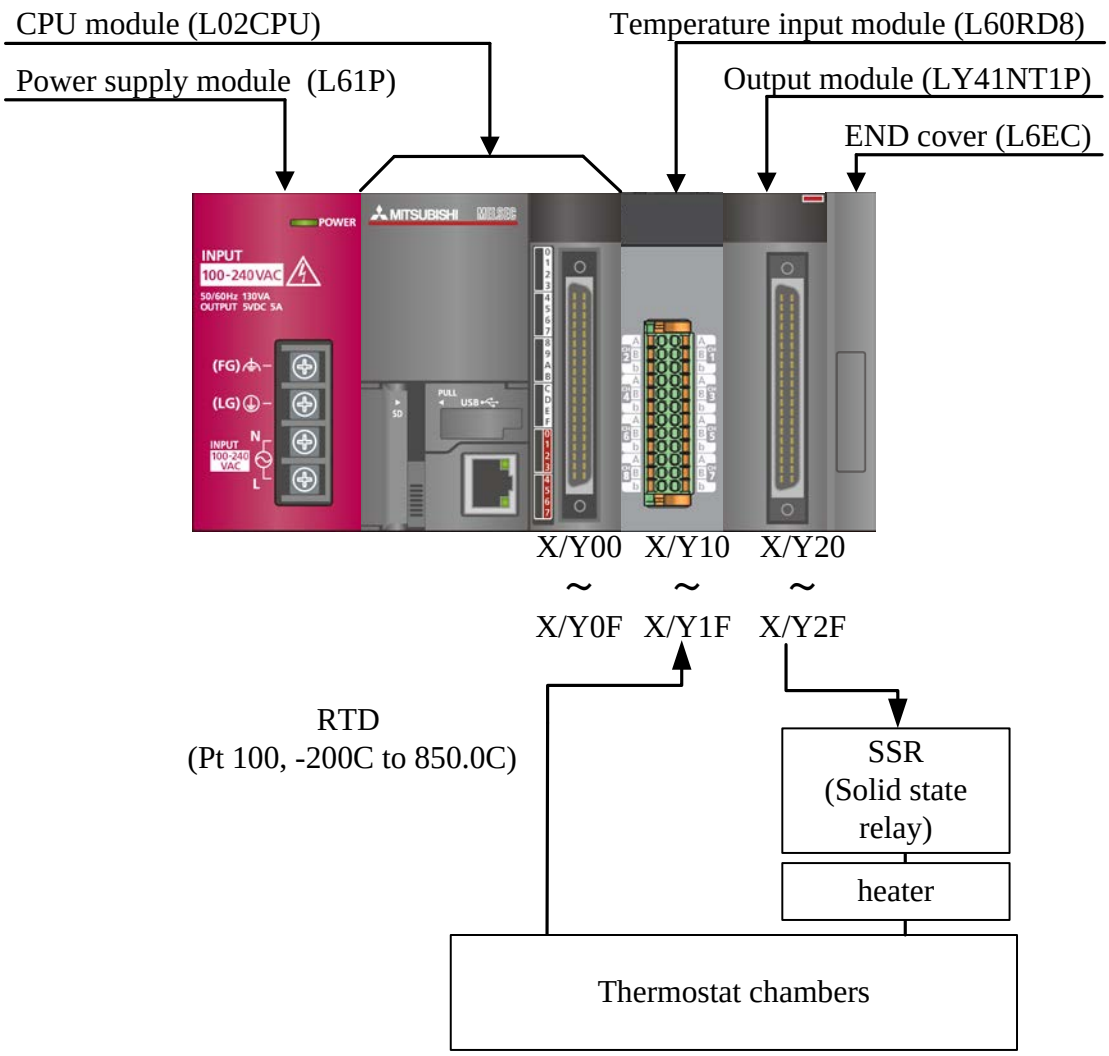
(For the rest, please refer to the next page.)


D36
Proporti
onal ban
d (P)
W:iow_Proportional
Proporti
onal ban
d (P)
ow_AlertStatus:W
Alert st
atus
D34
Alert st
atus
D37
Integral
time (I
)
W:iow_Integral
Integral
time (I
)
FB_ERROR:B
Error fl
ag
F0
Error fl
ag
D38
Derivati
ve time
(D)
W:iow_Derivative
Derivati
ve time
(D)
ERROR_ID:W
Error co
de
D35
Error co
de
iow_Proportional:W
Proporti
onal ban
d (P)
D36
Proporti
onal ban
d (P)
iow_Integral:W
Integral
time (I
)
D37
Integral
time (I
)
iow_Derivative:W
Derivati
ve time
(D)
D38
Derivati
ve time
(D)
M0
PID cont
rol exec
ution co
mmand
MOV
D29
Manipula
ted valu
e (MV)
U2¥
G1
Y21

Appendix 1.1.2 When SSR (Solid state relay) is used

Examples when using SSR (Solid state relay) are shown below.

1) System configuration



Point

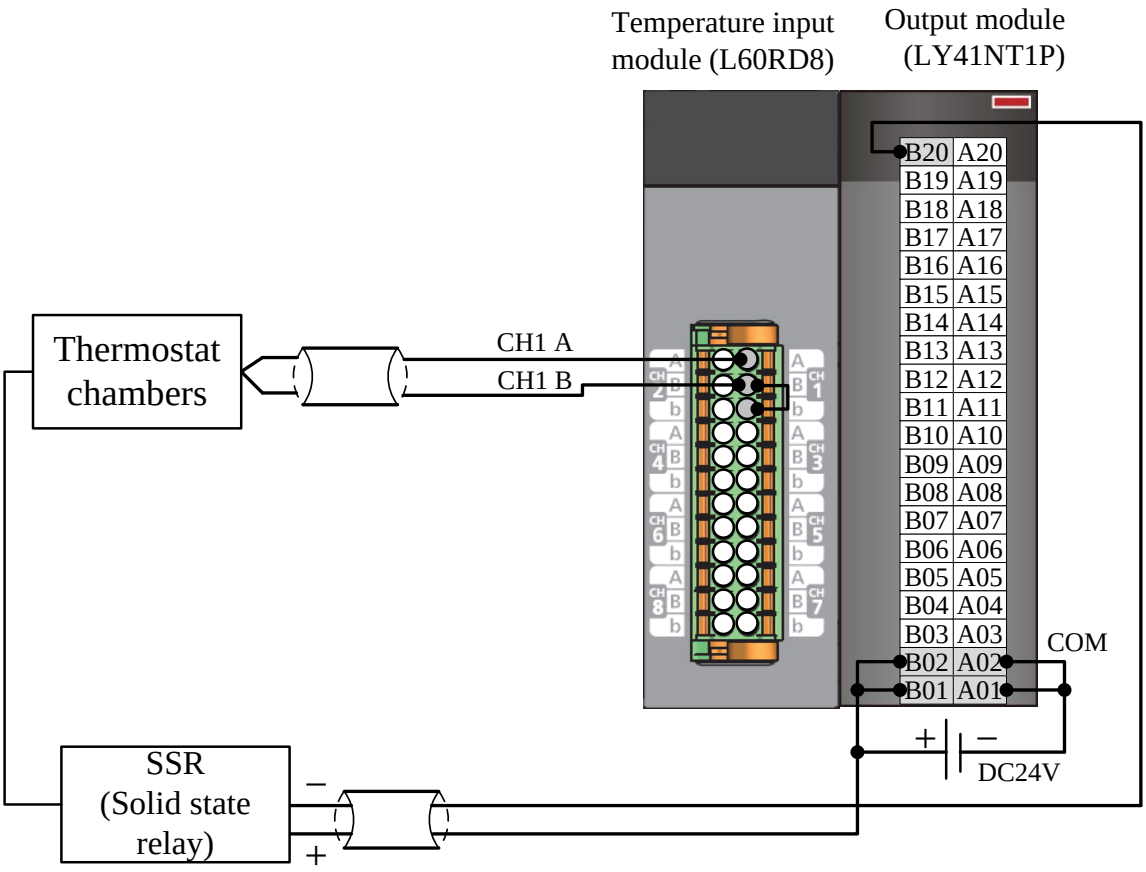
·Circuit settings are required for all input labels. If it is not set, it becomes indefinite value.

·Depending on the number of characters that GX Works2 can display, label comments may be described in abbreviated form.

2) Programming conditions

This is a program for PID control. It reads the temperature measured by RTD (Pt 100, -200°C to 850.0°C) connected to CH1 of L60RD8, and excute the PID control.

3) Wiring examples



4) Examples of setting

a) Parameter setting of temperature input module

Display Filter: Display All

Item	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
Basic setting	**Set the conversion system.**							
Input range setting	2:Pt100 (-200 to 850°C)	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion
Celsius/Fahrenheit display setting	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]
Averaging process setting	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing
Time Average/ Count Average/Moving Average	0	0	0	0	0	0	0	0
Sensor compensation function	**Set value for sensor compensation when the conversion is executed.**							
Sensor compensation valid/invalid setting	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable
Shifting amount to conversion value	0	0	0	0	0	0	0	0
Disconnection detection function	**Set value to store into measured temperature value when the disconnection is detected.**							
Conversion setting for disconnection detection	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks
Conversion setting value for disconnection detection	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C
Scaling function	**Set value for scaling function when the conversion is executed.**							
Scaling enable/disable setting	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid
Scaling upper limit value	0	0	0	0	0	0	0	0
Scaling lower limit value	0	0	0	0	0	0	0	0
Waning output function	**Set value for warnings when the conversion is executed.**							
Process alarm output setting	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable

Set the lower lower limit of the measured temperature value.
An error will occur unless lower lower limit <= lower upper limit <= upper lower limit <= upper upper limit.
When the Scaling enable/disable setting is set as 'Enable', please set the value in consideration of scaling calculation.

When 'Disable' is selected in the 'Scaling enable/disable setting' for the relevant CH:

Setting Item		CH1
Basic setting	Input range setting	2: Pt100(-200 to 850°C)

*Settings other than the above are default values

M+CPU-PID_PIDControl (PID Control)

Label Name	Setting Value	Description
ib_ActionSetting	OFF	Specify the reverse action for PID control direction by turning it OFF.
ib_AutoManShift	OFF	Specify AUTO/MAN mode switching to AUTO mode.
ib_AT	ON	Start auto tuning by turning it ON.
iw_PV	U1¥G11	Enter the measured temperature from the control object (Sensor).
iw_SV_Setting	K1000	Specify the set value (SV) setting to 100.0°C.
iow_Proportional	K100	Specify the proportional band (P) setting to 10.0%.
iow_Integral	K240	Specify the integral time (I) setting to K240.
iow_Derivative	K60	Specify the derivative time (D) setting to K60.
iw_ManOutput	K500	Specify the MAN output setting to 50.0%.
iw_SettingData[Offset+0]	K100	Specify the control output cycle setting to 10.0.
iw_SettingData[Offset+1]	K4000	Specify the input range upper limit to 400.0°C.
iw_SettingData[Offset+2]	K0	Specify the input range lower limit to 0.0°C.
iw_SettingData[Offset+3]	K1000	Specify the upper limit output limiter to 100.0%.
iw_SettingData[Offset+4]	K0	Specify the lower limit output limiter to 0.0%.
iw_SettingData[Offset+5]	K4000	Specify the upper limit setting limiter to 400.0°C.
iw_SettingData[Offset+6]	K0	Specify the lower limit setting limiter to 0.0°C.
iw_SettingData[Offset+7]	K500	Specify the output variation limiter to 50.0%.
iw_SettingData[Offset+8]	K500	Specify the setting change rate limiter to 50.0%.
iw_SettingData[Offset+9]	K1	Specify the alert 1 mode setting to 1 (Upper limit input alert).
iw_SettingData[Offset+10]	K2	Specify the alert 2 mode setting to 2 (Lower limit input alert).
iw_SettingData[Offset+11]	K0	Specify the alert 3 mode setting to 0 (No alert is executed).
iw_SettingData[Offset+12]	K0	Specify the alert 4 mode setting to 0 (No alert is executed).
iw_SettingData[Offset+13]	K4000	Specify the alert set value1 to 400.0°C.
iw_SettingData[Offset+14]	K0	Specify the alert set value2 to 0.0°C.
iw_SettingData[Offset+15]	K0	Do not use.
iw_SettingData[Offset+16]	K0	Do not use.
iw_SettingData[Offset+17]	K0	Specify the alert dead band setting to 0 (Do not use).
iw_SettingData[Offset+18]	K1000	Specify the AT timeout time to 1000s.
iw_SettingData[Offset+19]	K1	Specify the auto tuning control type setting to 1: fixed value PID control.
iw_SettingData[Offset+20]	K0	Specify the two-degree-of-freedom parameter α to 0.00.
iw_SettingData[Offset+21]	K100	Specify the two-degree-of-freedom parameter β to 1.00.
iw_SettingData[Offset+22]	K1	Specify the decimal point position to 1 (One decimal place).
iw_SettingData[Offset+23]	K1000	Specify the Timer Limit Setting to 10.00ms.
iw_SettingData[Offset+24]	K3	Specify the used timer device setting to 3 (T3).

i) Initial setting

Set the initial value after the CPU RUN.

(For the rest, please refer to the next page.)

```
<Set K0 as input range low limit >
[MOV    K0      D5   ]
                Input ra
                nge lowe
                r limit

<Set K1000 as up lim out limiter >
[MOV    K1000   D6   ]
                Upper li
                mit outp
                ut limit
                er

<Set K0 as lower lim out limiter >
[MOV    K0      D7   ]
                Lower li
                mit outp
                ut limit
                er

<Set K4000 as up lim set limiter >
[MOV    K4000   D8   ]
                Upper li
                mit sett
                ing limi
                ter

<Set K0 as lower lim set limiter >
[MOV    K0      D9   ]
                Lower li
                mit sett
                ing limi
                ter

<Set K500 as out variation limit >
[MOV    K500    D10  ]
                Output v
                ariation
                 limiter
```

(For the rest, please refer to the next page.)

```
<Set K500 as set change rate lim >
[MOV    K500    D11   ]
                Setting change rate limiter

<Set K1 as alert 1 mode setting >
[MOV    K1      D12   ]
                Alert 1 mode setting

<Set K2 as alert 2 mode setting >
[MOV    K2      D13   ]
                Alert 2 mode setting

<Set K0 as alert 3 mode setting >
[MOV    K0      D14   ]
                Alert 3 mode setting

<Set K0 as alert 4 mode setting >
[MOV    K0      D15   ]
                Alert 4 mode setting

<Set K4000 as up lim input alert >
[MOV    K4000   D16   ]
                Alert set value1

<Set K0 as lower lim input alert >
[MOV    K0      D17   ]
                Alert set value2
```

(For the rest, please refer to the next page.)

```
<Set 1000s as AT timeout time >
[MOV    K1000    D21 ]
                 AT timeo
                 ut time

<Set AT type to fixed value PID >
[MOV    K1       D22 ]
                 Auto tun
                 ing cont
                 rol type
                  setting

<Set K0 as 2-degree-of-freedom a >
[MOV    K0       D23 ]
                 2-degree
                 -of-free
                 dom para
                 meter a
<Set K0 as 2-degree-of-freedom b >
[MOV    K100     D24 ]
                 2-degree
                 -of-free
                 dom para
                 meter b

<Set K1 decimal point position >
[MOV    K1       D25 ]
                 Decimal
                 point po
                 sition

<Set K1000 timer limit setting >
[MOV    K1000    D26 ]
                 Timer Li
                 mit Sett
                 ing

<Set T3 as using timer device >
[MOV    K3       D27 ]
                 Using ti
                 mer devi
                 ce setti
                 ng
```

(For the rest, please refer to the next page.)

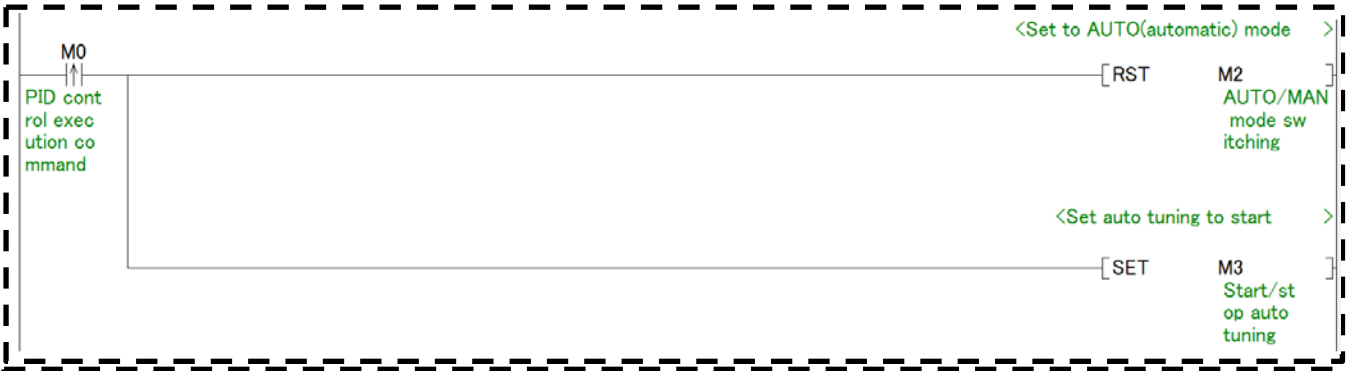
ii) PID control

Perform auto tuning and calculate PID constant, then perform PID control on temperature process value acquired on CH1.

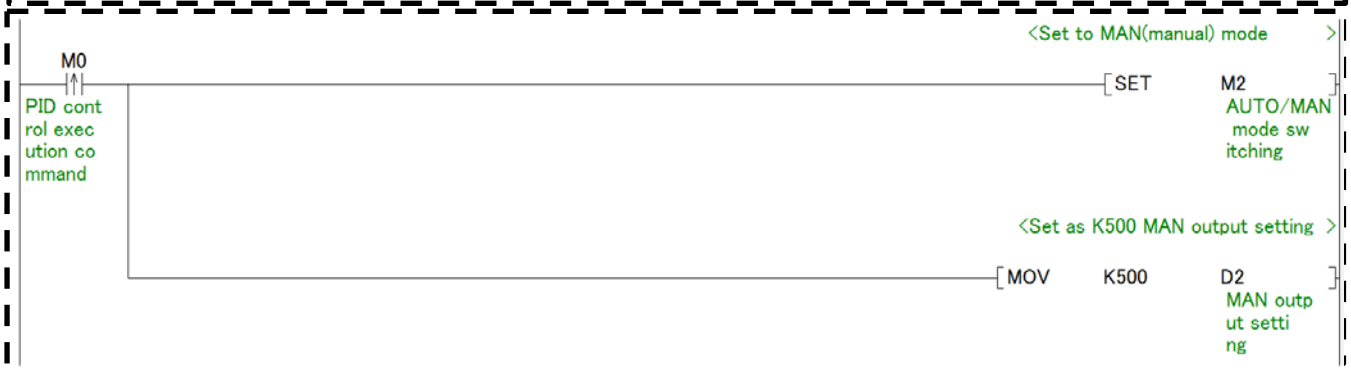
*If calculation of PID constant by auto tuning is unnecessary, set M3 to OFF and execute.

In addition, automatic control/manual control can be switched by M2 ON/OFF.

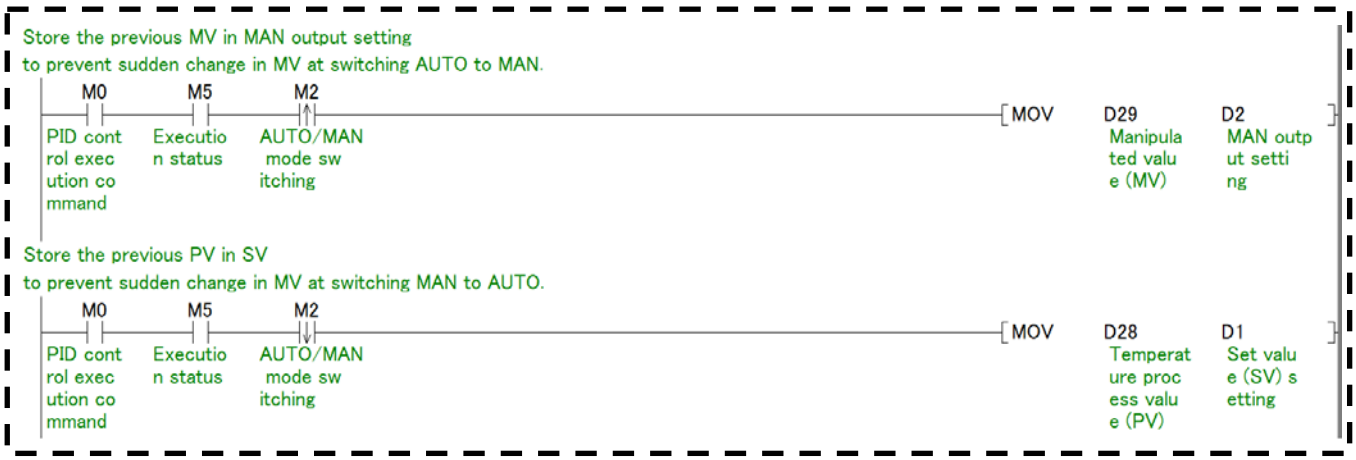
*1



*2



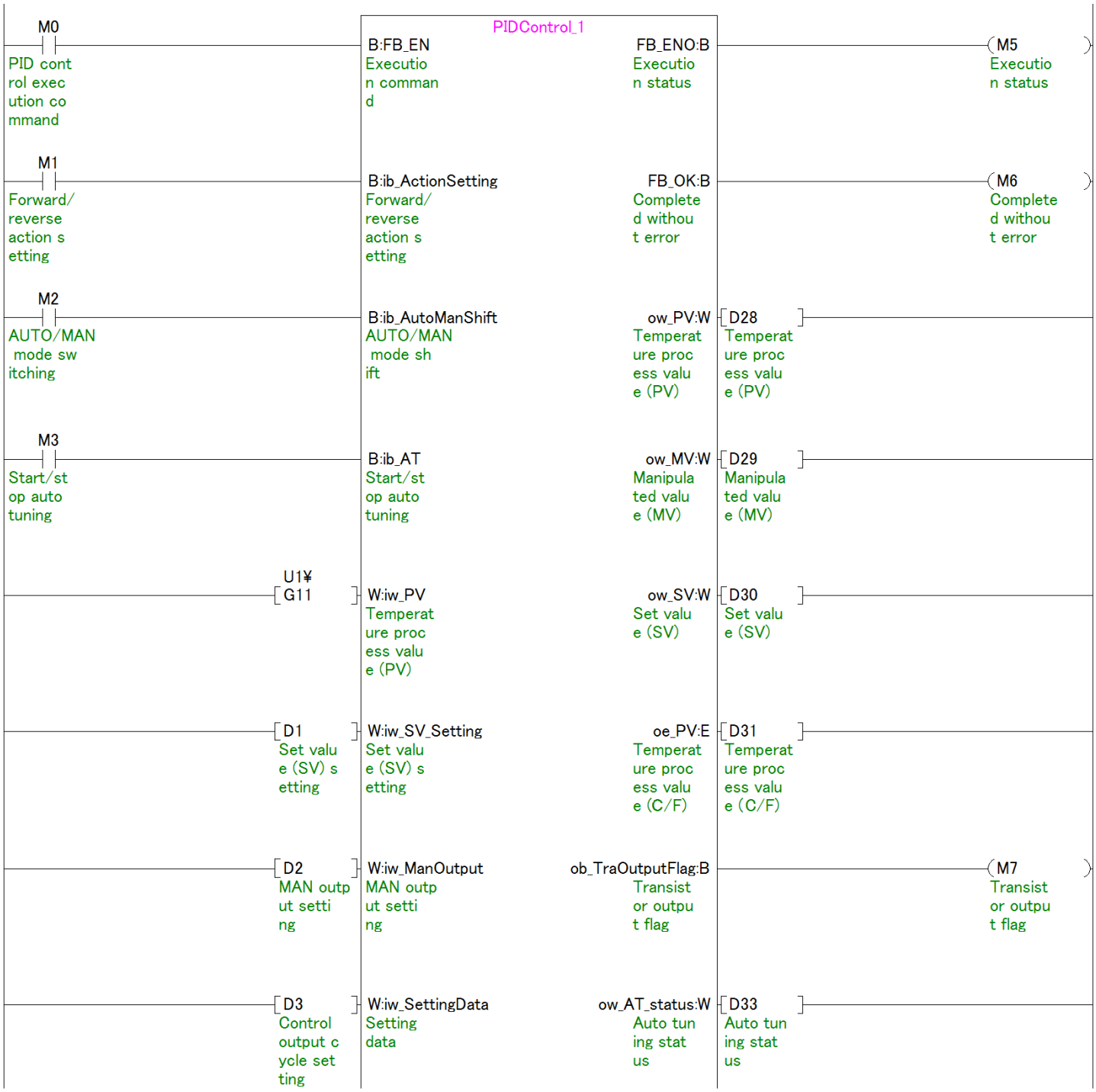
*1,2



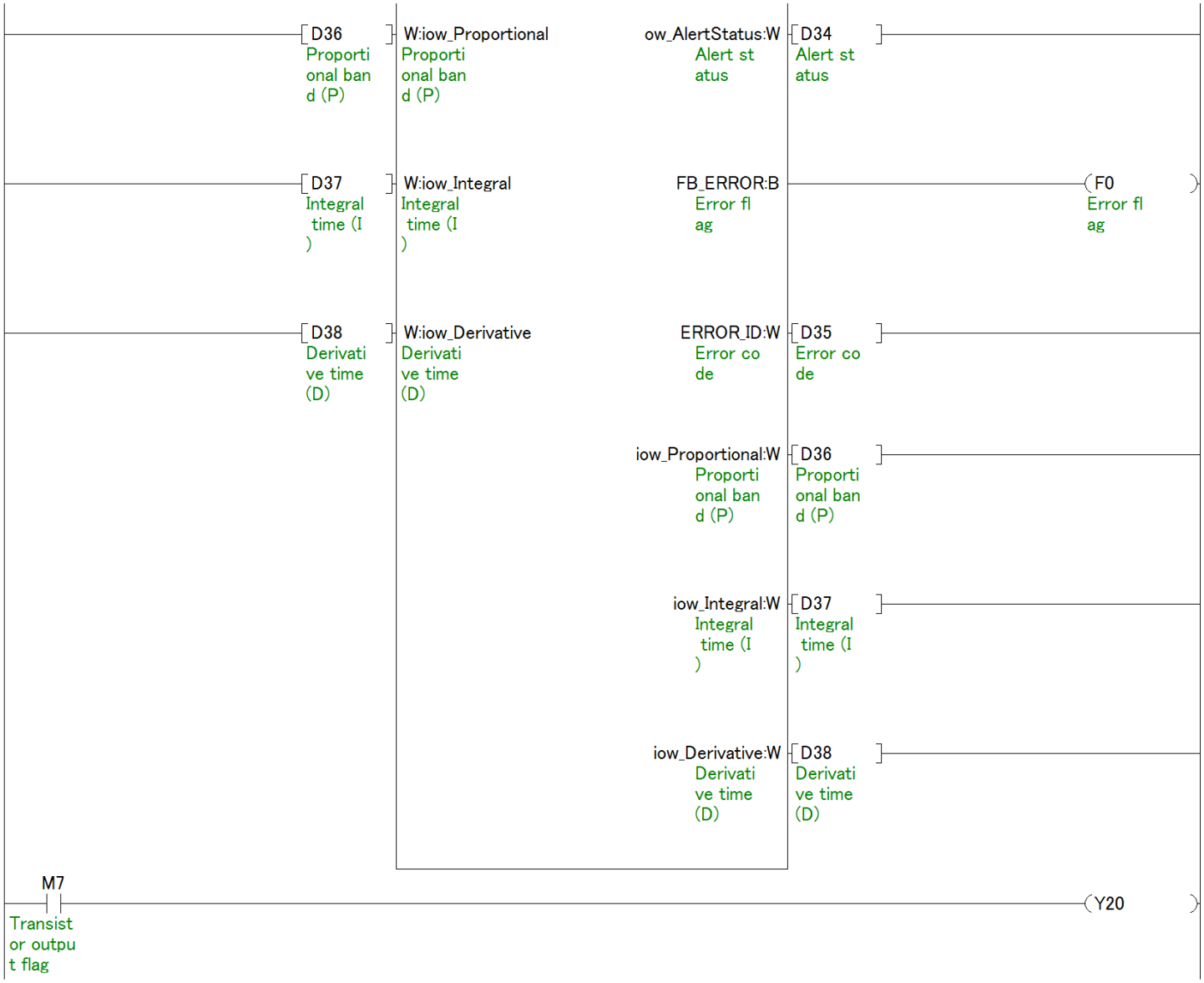
*1 Please set it when automatic control is performed.

*2 Please set it when manual control is performed.

(For the rest, please refer to the next page.)



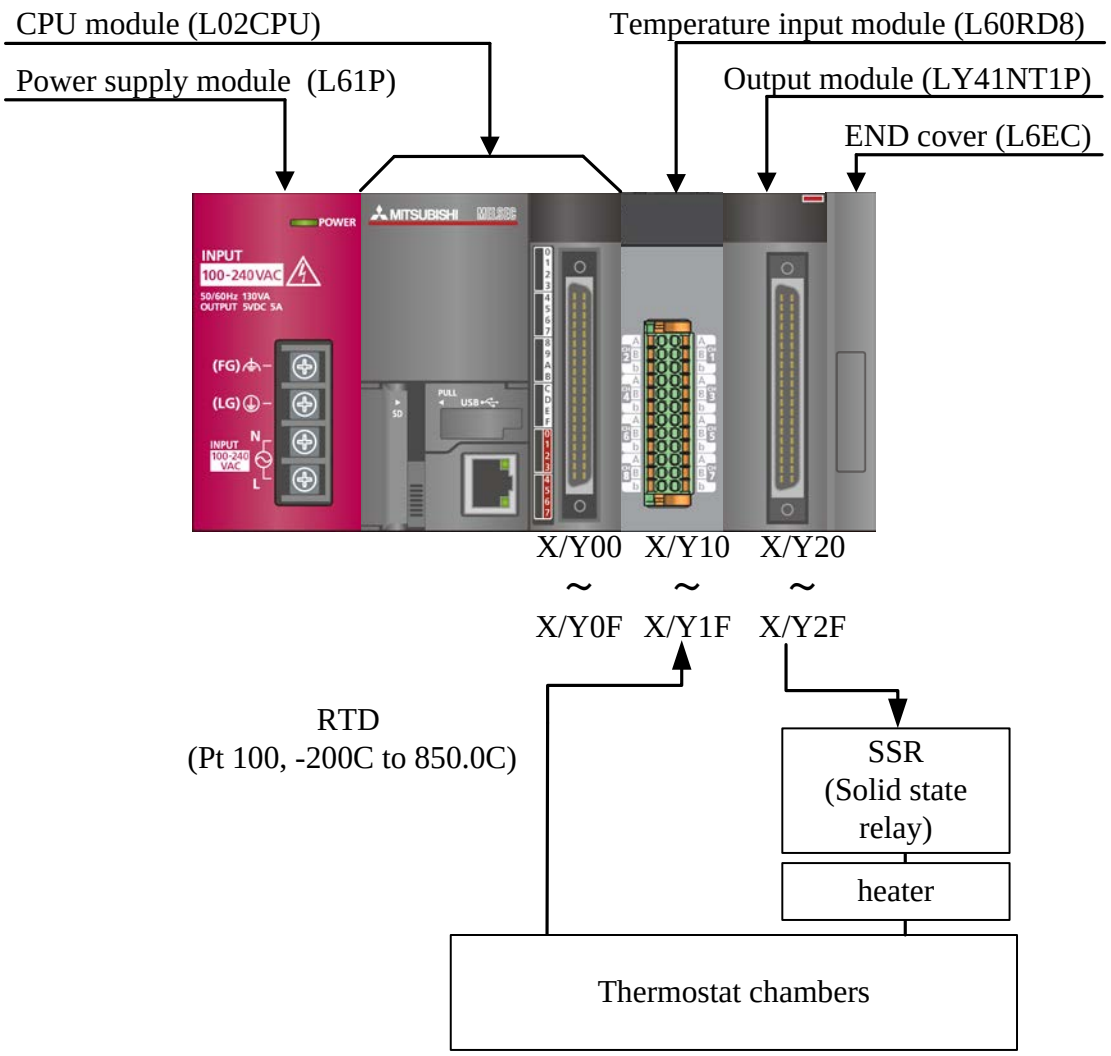
(For the rest, please refer to the next page.)


D36
Proportional band (P)
W:iow_Proportional
Proportional band (P)
ow_AlertStatus:W
Alert status
D34
Alert status
D37
Integral time (I)
W:iow_Integral
Integral time (I)
FB_ERROR:B
Error flag
F0
Error flag
D38
Derivative time (D)
W:iow_Derivative
Derivative time (D)
ERROR_ID:W
Error code
D35
Error code
iow_Proportional:W
Proportional band (P)
D36
Proportional band (P)
iow_Integral:W
Integral time (I)
D37
Integral time (I)
iow_Derivative:W
Derivative time (D)
D38
Derivative time (D)
M7
Transistor output flag
Y20

Appendix 1.1.3 When Cascade control is performed

Examples when cascade control is performed by using multiple FB are shown below.

1) System configuration



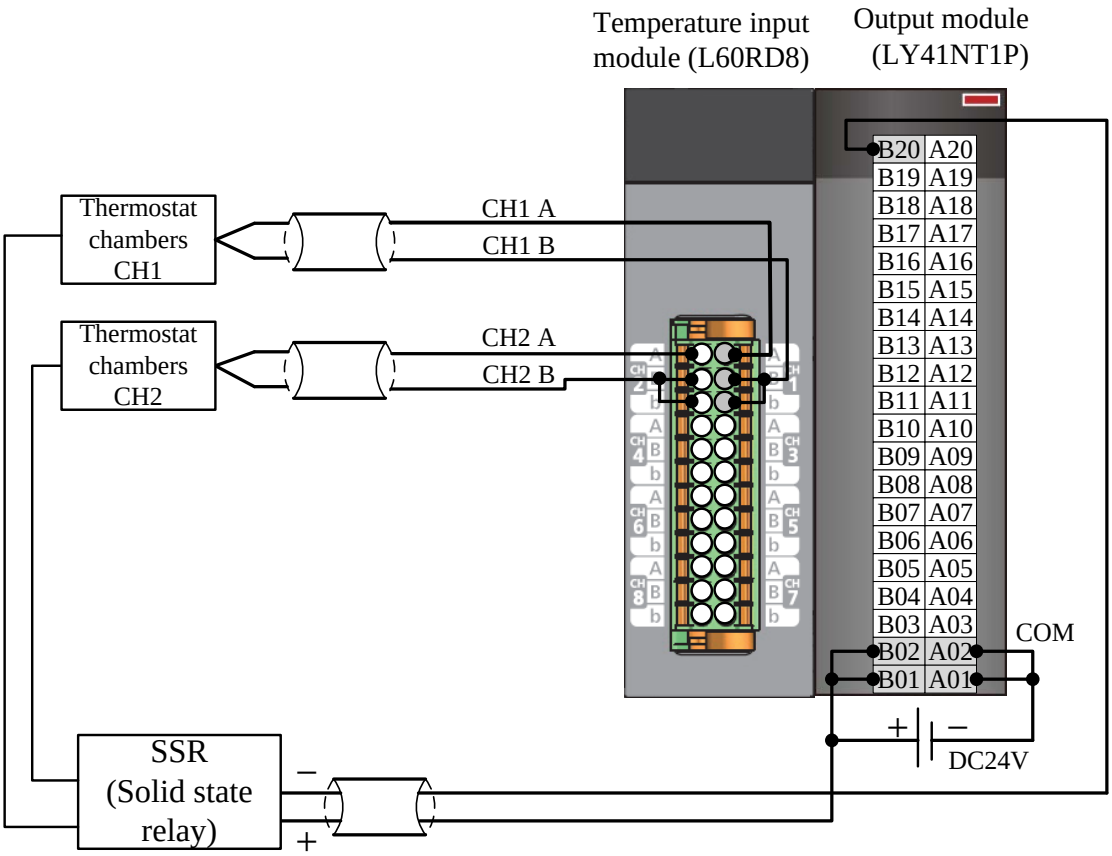
Point

- Circuit settings are required for all input labels. If it is not set, it becomes indefinite value.
- Depending on the number of characters that GX Works2 can display, label comments may be described in abbreviated form.

2) Programming conditions

This is a program for PID control. It reads the temperature measured by RTD (Pt 100, -200°C to 850.0°C) connected to CH1 of L60RD8, and excute the PID control.

3) Wiring example



4) Examples of setting

a) Parameter setting of temperature input module

Display Filter: Display All

Item	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
Basic setting	**Set the conversion system.**							
Input range setting	2:Pt100 (-200 to 850℃)	2:Pt100 (-200 to 850℃)	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion
Celsius/Fahrenheit display setting	0:Celsius [℃]	0:Celsius [℃]	0:Celsius [℃]	0:Celsius [℃]	0:Celsius [℃]	0:Celsius [℃]	0:Celsius [℃]	0:Celsius [℃]
Averaging process setting	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing
Time Average/ Count Average/Moving Average	0	0	0	0	0	0	0	0
Sensor compensation function	**Set value for sensor compensation when the conversion is executed.**							
Sensor compensation valid/invalid setting	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable
Shifting amount to conversion value	0	0	0	0	0	0	0	0
Disconnection detection function	**Set value to store into measured temperature value when the disconnection is detected.**							
Conversion setting for disconnection detection	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks
Conversion setting value for disconnection detection	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃
Scaling function	**Set value for scaling function when the conversion is executed.**							
Scaling enable/disable setting	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid
Scaling upper limit value	0	0	0	0	0	0	0	0
Scaling lower limit value	0	0	0	0	0	0	0	0
Waning output function	**Set value for warnings when the conversion is executed.**							
Process alarm output setting	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable
Process alarm upper upper limit value	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃
Process alarm upper lower limit value	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃
Process alarm lower upper limit value	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃
Process alarm lower lower limit	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃	0.0 ℃

Set the lower lower limit of the measured temperature value.
An error will occur unless lower lower limit <= lower upper limit <= upper lower limit <= upper upper limit.
When the Scaling enable/disable setting is set as 'Enable', please set the value in consideration of scaling calculation.

When 'Disable' is selected in the 'Scaling enable/disable setting' for the relevant CH:

Setting Item		CH1	CH2
Basic setting	Input range setting	2: Pt100(-200 to 850°C)	2: Pt100(-200 to 850°C)

*Settings other than the above are default values

M+CPU-PID_PIDControl (PID Control)

(1) PIDControl_1

Label Name	Setting Value	Description
ib_ActionSetting	OFF	Specify the reverse action for PID control direction by turning it OFF.
ib_AutoManShift	OFF	Specify AUTO/MAN mode switching to AUTO mode.
ib_AT	ON	Start auto tuning by turning it ON.
iw_PV	U1¥G11	Enter the measured temperature from the control object (Sensor).
iw_SV_Setting	K1000	Specify the set value (SV) setting to 100.0°C.
iow_Proportional	K100	Specify the proportional band (P) setting to 10.0%.
iow_Integral	K240	Specify the integral time (I) setting to K240.
iow_Derivative	K60	Specify the derivative time (D) setting to K60.
iw_ManOutput	K500	Specify the MAN output setting to 50.0%.
iw_SettingData[Offset+0]	K100	Specify the control output cycle setting to 10.0.
iw_SettingData[Offset+1]	K4000	Specify the input range upper limit to 400.0°C.
iw_SettingData[Offset+2]	K0	Specify the input range lower limit to 0.0°C.
iw_SettingData[Offset+3]	K1000	Specify the upper limit output limiter to 100.0%.
iw_SettingData[Offset+4]	K0	Specify the lower limit output limiter to 0.0%.
iw_SettingData[Offset+5]	K4000	Specify the upper limit setting limiter to 400.0°C.
iw_SettingData[Offset+6]	K0	Specify the lower limit setting limiter to 0.0°C.
iw_SettingData[Offset+7]	K500	Specify the output variation limiter to 50.0%.
iw_SettingData[Offset+8]	K500	Specify the setting change rate limiter to 50.0%.
iw_SettingData[Offset+9]	K1	Specify the alert 1 mode setting to 1 (Upper limit input alert).
iw_SettingData[Offset+10]	K2	Specify the alert 2 mode setting to 2 (Lower limit input alert).
iw_SettingData[Offset+11]	K0	Specify the alert 3 mode setting to 0 (No alert is executed).
iw_SettingData[Offset+12]	K0	Specify the alert 4 mode setting to 0 (No alert is executed).
iw_SettingData[Offset+13]	K4000	Specify the alert set value1 to 400.0°C.
iw_SettingData[Offset+14]	K0	Specify the alert set value2 to 0.0°C.
iw_SettingData[Offset+15]	K0	Do not use.
iw_SettingData[Offset+16]	K0	Do not use.
iw_SettingData[Offset+17]	K0	Specify the alert dead band setting to 0 (Do not use).
iw_SettingData[Offset+18]	K1000	Specify the AT timeout time to 1000s.
iw_SettingData[Offset+19]	K1	Specify the auto tuning control type setting to 1: fixed value PID control.
iw_SettingData[Offset+20]	K0	Specify the two-degree-of-freedom parameter α to 0.00.
iw_SettingData[Offset+21]	K100	Specify the two-degree-of-freedom parameter β to 1.00.
iw_SettingData[Offset+22]	K1	Specify the decimal point position to 1 (One decimal place).
iw_SettingData[Offset+23]	K1000	Specify the Timer Limit Setting to 10.00ms.

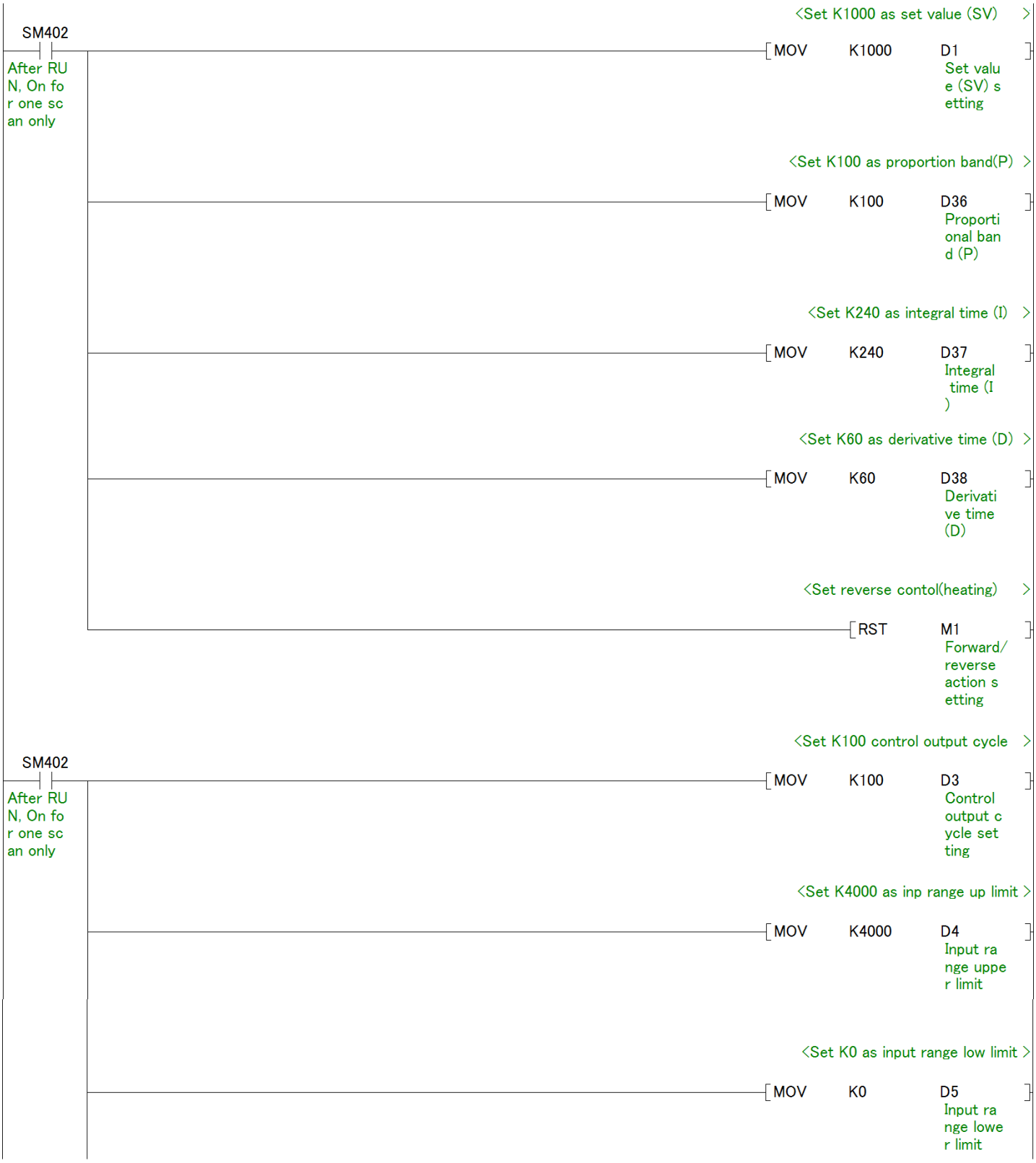
Label Name	Setting Value	Description
iw_SettingData[Offset+24]	K3	Specify the using timer device setting to 3 (T3).

(2) PIDControl_2

Label Name	Setting Value	Description
ib_ActionSetting	OFF	Specify the reverse action for PID control direction by turning it OFF.
ib_AutoManShift	OFF	Specify AUTO/MAN mode switching to AUTO mode.
ib_AT	ON	Start auto tuning by turning it ON.
iw_PV	U1¥G12	Enter the measured temperature from the control object (Sensor).
iw_SV_Setting	K1000	Specify the set value (SV) setting to 100.0°C.
iow_Proportional	K100	Specify the proportional band (P) setting to 10.0%.
iow_Integral	K240	Specify the integral time (I) setting to K240.
iow_Derivative	K60	Specify the derivative time (D) setting to K60.
iw_ManOutput	K500	Specify the MAN output setting to 50.0%.
iw_SettingData[Offset+0]	K100	Specify the control output cycle setting to 10.0.
iw_SettingData[Offset+1]	K4000	Specify the input range upper limit to 400.0°C.
iw_SettingData[Offset+2]	K0	Specify the input range lower limit to 0.0°C.
iw_SettingData[Offset+3]	K1000	Specify the upper limit output limiter to 100.0%.
iw_SettingData[Offset+4]	K0	Specify the lower limit output limiter to 0.0%.
iw_SettingData[Offset+5]	K4000	Specify the upper limit setting limiter to 400.0°C.
iw_SettingData[Offset+6]	K0	Specify the lower limit setting limiter to 0.0°C.
iw_SettingData[Offset+7]	K500	Specify the output variation limiter to 50.0%.
iw_SettingData[Offset+8]	K500	Specify the setting change rate limiter to 50.0%.
iw_SettingData[Offset+9]	K1	Specify the alert 1 mode setting to 1 (Upper limit input alert).
iw_SettingData[Offset+10]	K2	Specify the alert 2 mode setting to 2 (Lower limit input alert).
iw_SettingData[Offset+11]	K0	Specify the alert 3 mode setting to 0 (No alert is executed).
iw_SettingData[Offset+12]	K0	Specify the alert 4 mode setting to 0 (No alert is executed).
iw_SettingData[Offset+13]	K4000	Specify the alert set value1 to 400.0°C.
iw_SettingData[Offset+14]	K0	Specify the alert set value2 to 0.0°C.
iw_SettingData[Offset+15]	K0	Do not use.
iw_SettingData[Offset+16]	K0	Do not use.
iw_SettingData[Offset+17]	K0	Specify the alert dead band setting to 0 (Do not use).
iw_SettingData[Offset+18]	K1000	Specify the AT timeout time to 1000s.
iw_SettingData[Offset+19]	K1	Specify the auto tuning control type setting to 1: fixed value PID control.
iw_SettingData[Offset+20]	K0	Specify the two-degree-of-freedom parameter α to 0.00.
iw_SettingData[Offset+21]	K100	Specify the two-degree-of-freedom parameter β to 1.00.

Label Name	Setting Value	Description
iw_SettingData[Offset+22]	K1	Specify the decimal point position to 1 (One decimal place).
iw_SettingData[Offset+23]	K1000	Specify the Timer Limit Setting to 10.00ms.
iw_SettingData[Offset+24]	K4	Specify the using timer device setting to 4 (T4).

When M0 is turned ON, PID control is performed.



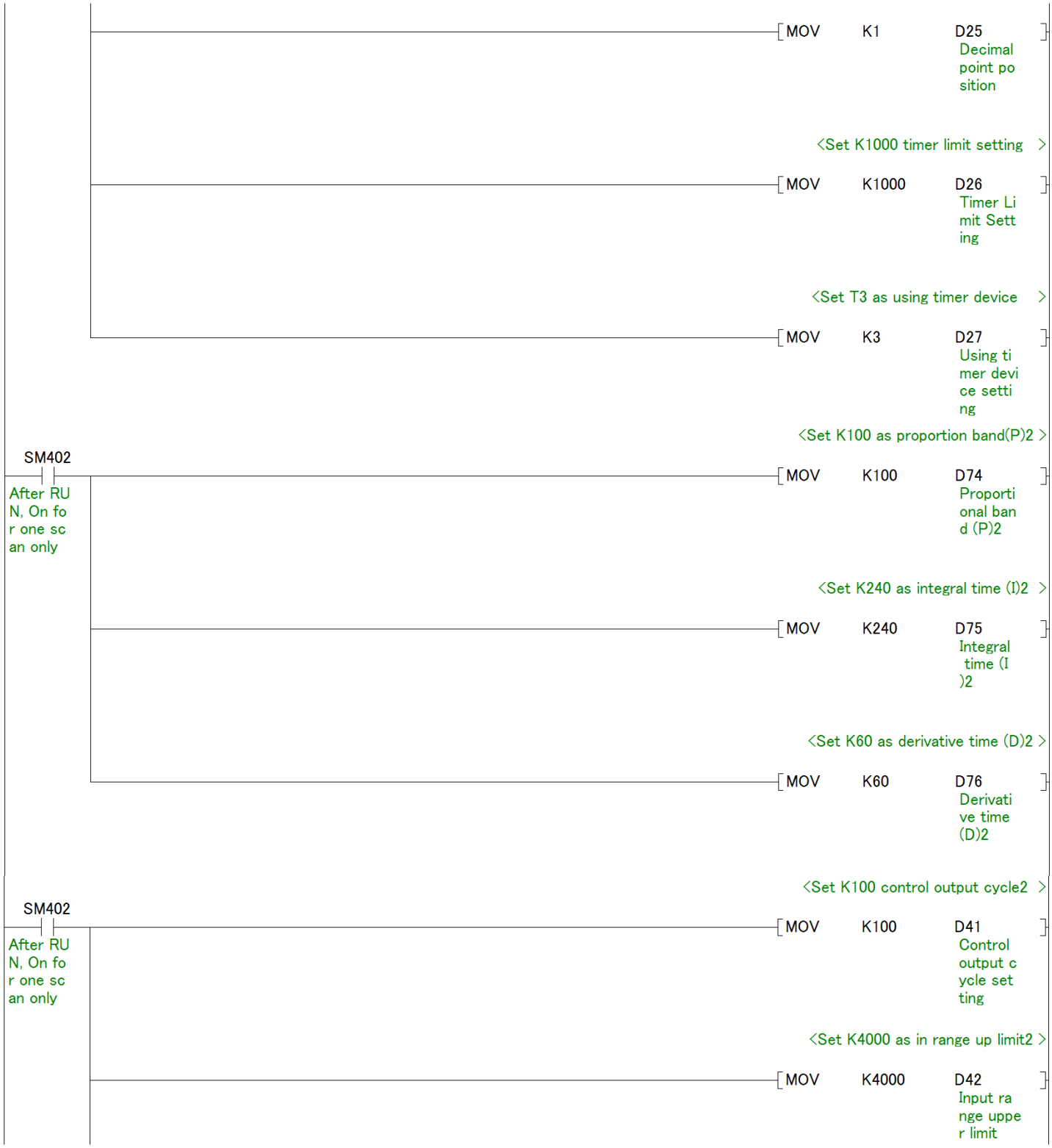
(For the rest, please refer to the next page.)

```
<Set K1000 as up lim out limiter >
[MOV    K1000    D6   ]
                  Upper li
                  mit outp
                  ut limit
                  er

<Set K0 as lower lim out limiter >
[MOV    K0       D7   ]
                  Lower li
                  mit outp
                  ut limit
                  er

<Set K4000 as up lim set limiter >
[MOV    K4000    D8   ]
                  Upper li
                  mit sett
                  ing limi
                  ter

<Set K0 as lower lim set limiter >
[MOV    K0       D9   ]
                  Lower li
                  mit sett
                  ing limi
                  ter

<Set K500 as out variation limit >
[MOV    K500     D10  ]
                  Output v
                  ariation
                   limiter

<Set K500 as set change rate lim >
[MOV    K500     D11  ]
                  Setting
                  change r
                  ate limi
                  ter

<Set K1 as alert 1 mode setting >
[MOV    K1       D12  ]
                  Alert 1
                  mode set
                  ting

<Set K2 as alert 2 mode setting >
[MOV    K2       D13  ]
                  Alert 2
                  mode set
                  ting
```

(For the rest, please refer to the next page.)

```
<Set K0 as alert 3 mode setting >
[MOV    K0      D14 ]
                Alert 3
                mode set
                ting

<Set K0 as alert 4 mode setting >
[MOV    K0      D15 ]
                Alert 4
                mode set
                ting

<Set K4000 as up lim input alert >
[MOV    K4000   D16 ]
                Alert se
                t value1

<Set K0 as lower lim input alert >
[MOV    K0      D17 ]
                Alert se
                t value2

<Set 1000s as AT timeout time >
[MOV    K1000   D21 ]
                AT timeo
                ut time

<Set AT type to fixed value PID >
[MOV    K1      D22 ]
                Auto tun
                ing cont
                rol type
                 setting

<Set K0 as 2-degree-of-freedom a >
[MOV    K0      D23 ]
                2-degree
                -of-free
                dom para
                meter a

<Set K0 as 2-degree-of-freedom b >
[MOV    K100    D24 ]
                2-degree
                -of-free
                dom para
                meter b
```

(For the rest, please refer to the next page.)



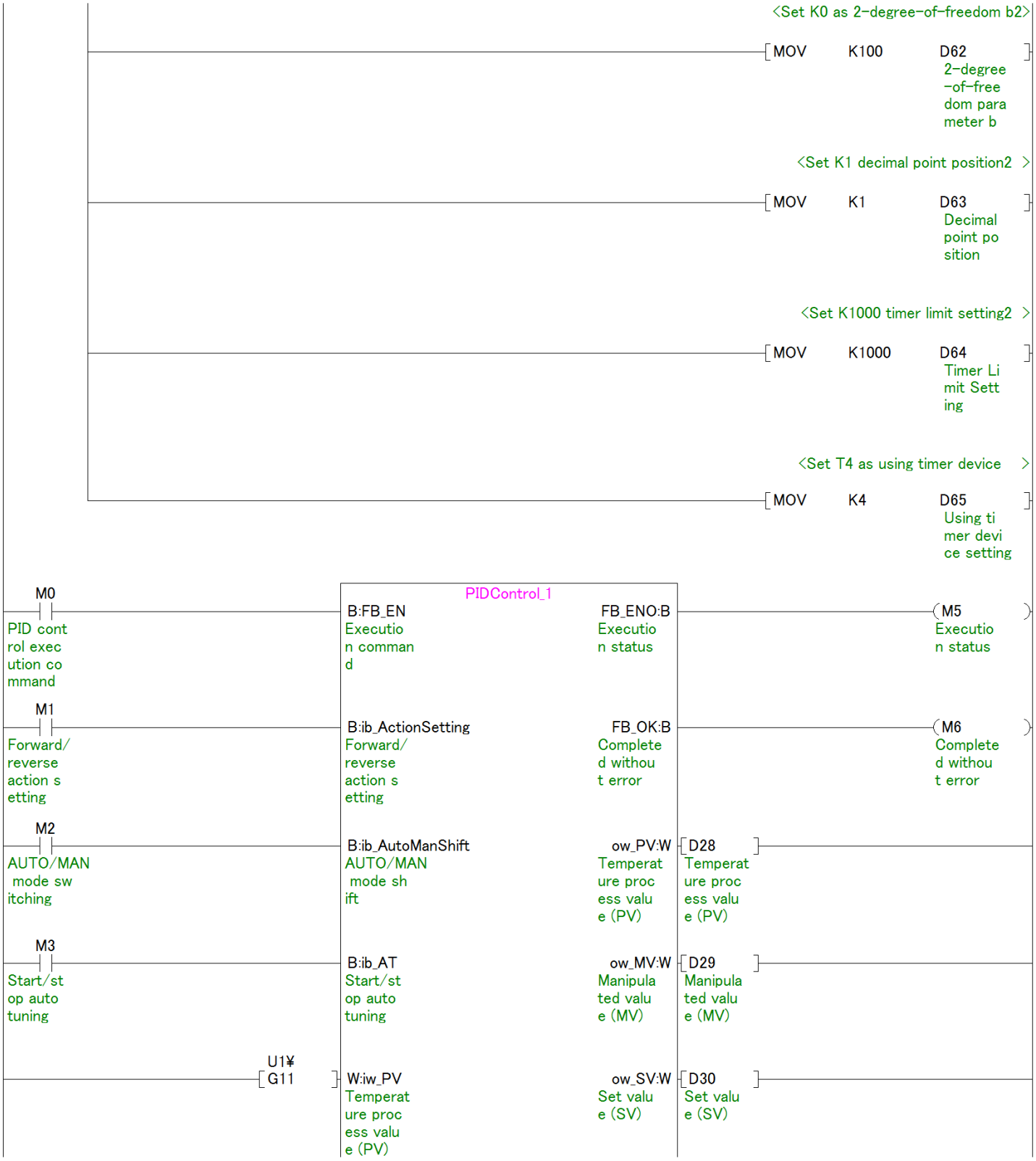
(For the rest, please refer to the next page.)

```
<Set K0 as input range low limit2>
[MOV    K0      D43   ]
                Input ra
                nge lowe
                r limit

<Set K1000 as up lim out limiter2>
[MOV    K1000   D44   ]
                Upper li
                mit outp
                ut limit
                er

<Set K0 as lower lim out limiter2>
[MOV    K0      D45   ]
                Lower li
                mit outp
                ut limit
                er

<Set K4000 as up lim set limiter2>
[MOV    K4000   D46   ]
                Upper li
                mit sett
                ing limi
                ter

<Set K0 as lower lim set limiter2>
[MOV    K0      D47   ]
                Lower li
                mit sett
                ing limi
                ter

<Set K500 as out variation limit2>
[MOV    K500    D48   ]
                Output v
                ariation
                 limiter

<Set K500 as set change rate lim2>
[MOV    K500    D49   ]
                Setting
                change r
                ate limi
                ter

<Set K1 as alert 1 mode setting >
[MOV    K1      D50   ]
                Alert 1
                mode set
                ting
```

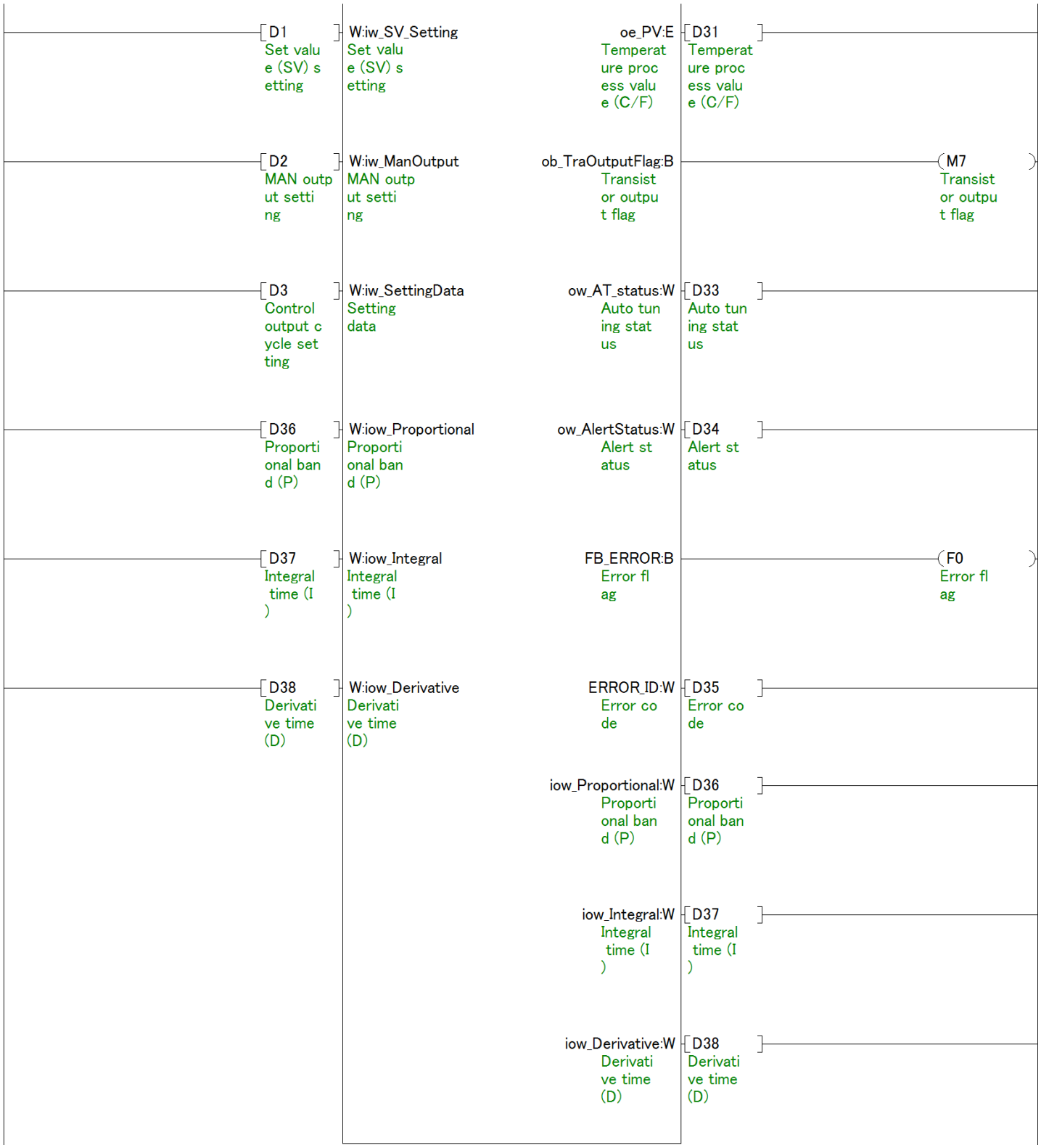
(For the rest, please refer to the next page.)

```
<Set K2 as alert 2 mode setting2 >
[MOV    K2      D51 ]
                 Alert 2
                 mode set
                 ting

<Set K0 as alert 3 mode setting2 >
[MOV    K0      D52 ]
                 Alert 3
                 mode set
                 ting

<Set K0 as alert 4 mode setting2 >
[MOV    K0      D53 ]
                 Alert 4
                 mode set
                 ting

<Set K4000 as up lim input alert2>
[MOV    K4000   D54 ]
                 Alert se
                 t value1

<Set K0 as lower lim input alert2>
[MOV    K0      D55 ]
                 Alert se
                 t value2

<Set 1000s as AT timeout time2  >
[MOV    K1000   D59 ]
                 AT timeo
                 ut time

<Set AT type to fixed value PID2 >
[MOV    K1      D60 ]
                 Auto tun
                 ing cont
                 rol type
                  setting

<Set K0 as 2-degree-of-freedom a2>
[MOV    K0      D61 ]
                 2-degree
                 -of-free
                 dom para
                 meter a
```

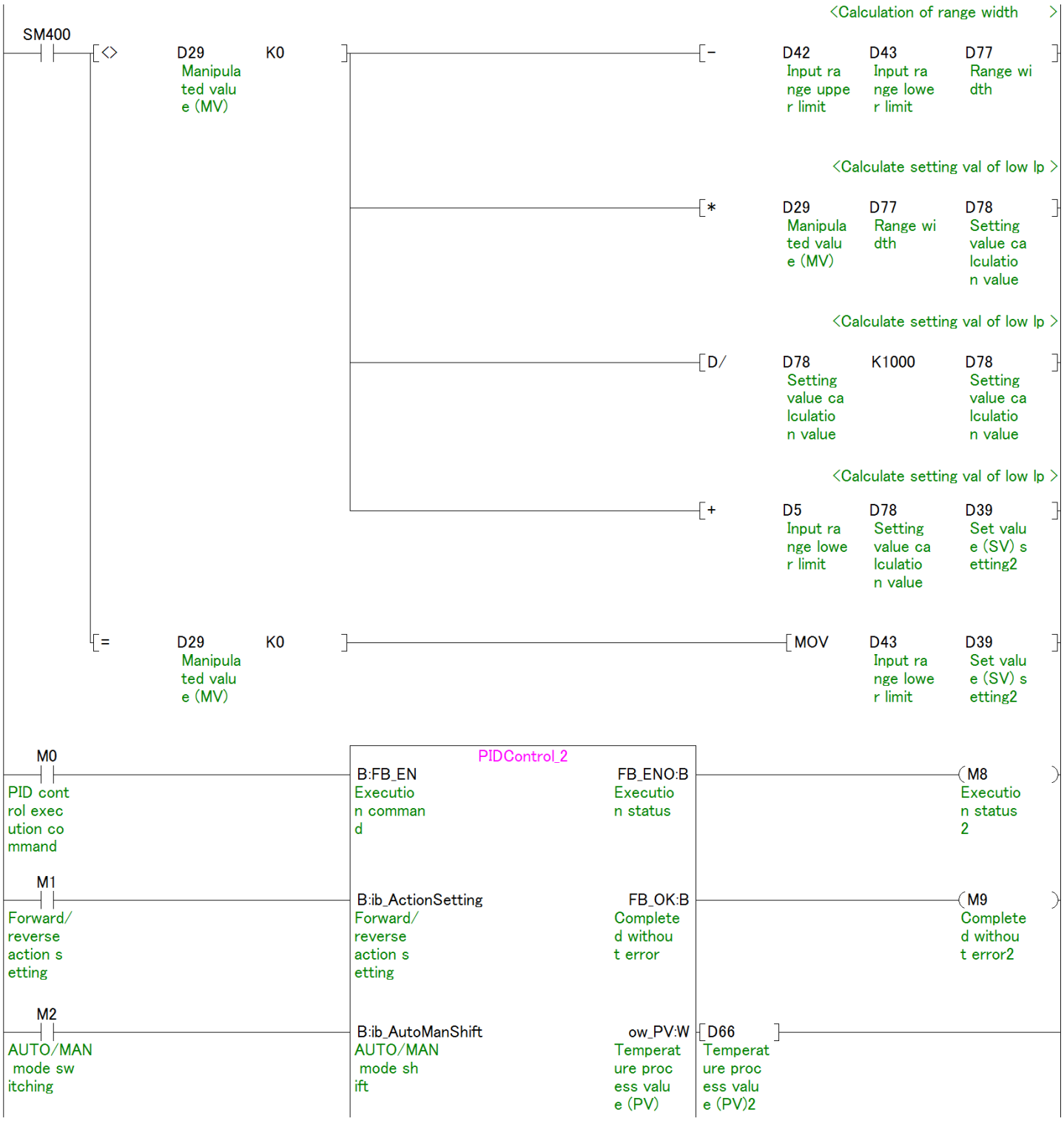
(For the rest, please refer to the next page.)



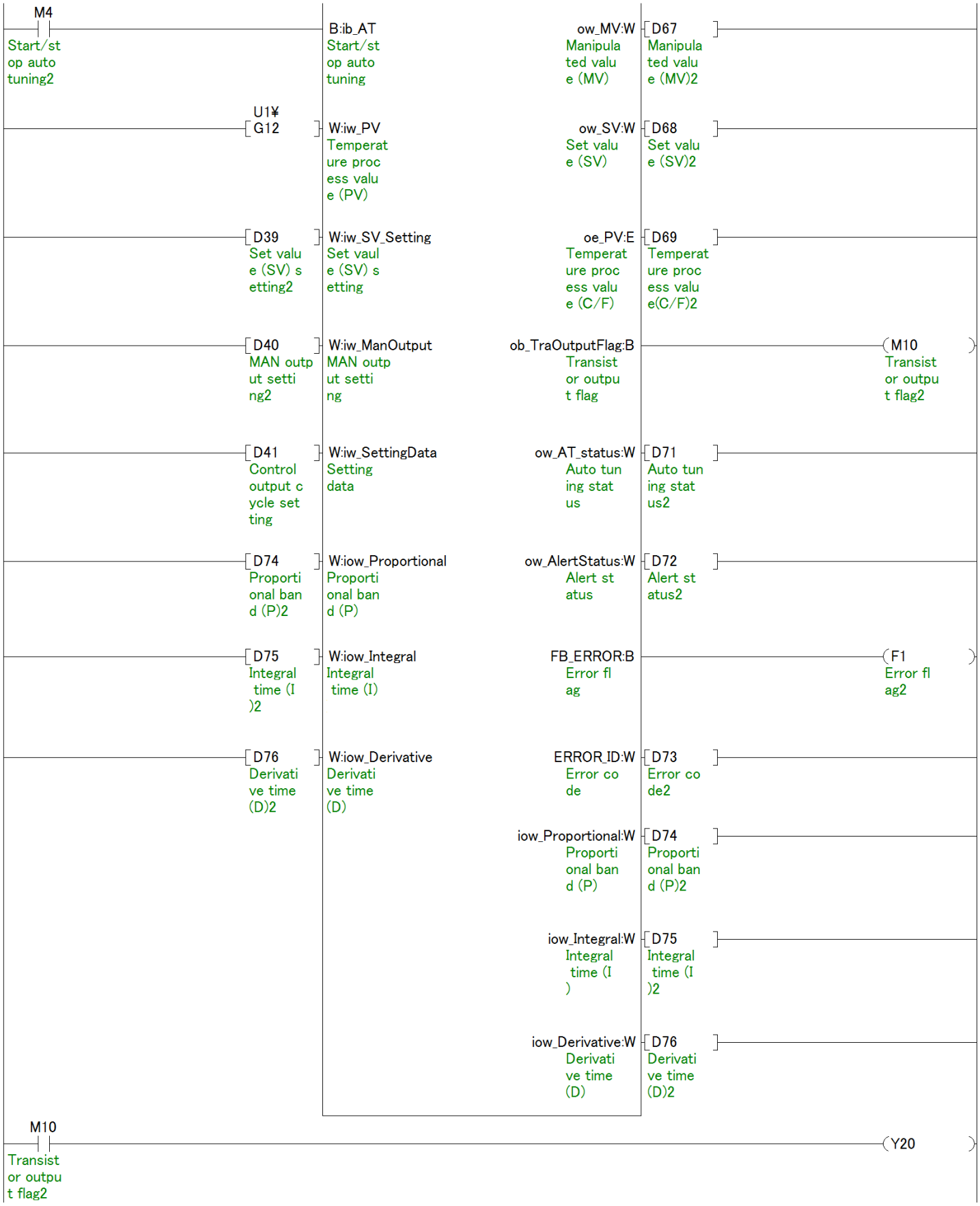
(For the rest, please refer to the next page.)



(For the rest, please refer to the next page.)



(For the rest, please refer to the next page.)


M4
Start/stop auto tuning2
B:ib_AT
Start/stop auto tuning
ow_MV:W
Manipulated value (MV)
D67
Manipulated value (MV)2
U1¥G12
W:iw_PV
Temperature process value (PV)
ow_SV:W
Set value (SV)
D68
Set value (SV)2
D39
Set value (SV) setting2
W:iw_SV_Setting
Set vaul e (SV) setting
oe_PV:E
Temperature process value (C/F)
D69
Temperature process value(C/F)2
D40
MAN output setting2
W:iw_ManOutput
MAN output setting
ob_TraOutputFlag:B
Transistor output flag
M10
Transistor output flag2
D41
Control output cycle setting
W:iw_SettingData
Setting data
ow_AT_status:W
Auto tuning status
D71
Auto tuning status2
D74
Proportional band (P)2
W:iow_Proportional
Proportional band (P)
ow_AlertStatus:W
Alert status
D72
Alert status2
D75
Integral time (I)2
W:iow_Integral
Integral time (I)
FB_ERROR:B
Error flag
F1
Error flag2
D76
Derivative time (D)2
W:iow_Derivative
Derivative time (D)
ERROR_ID:W
Error code
D73
Error code2
iow_Proportional:W
Proportional band (P)
D74
Proportional band (P)2
iow_Integral:W
Integral time (I)
D75
Integral time (I)2
iow_Derivative:W
Derivative time (D)
D76
Derivative time (D)2
M10
Transistor output flag2
Y20

Appendix1.2. PID Operation FB Examples

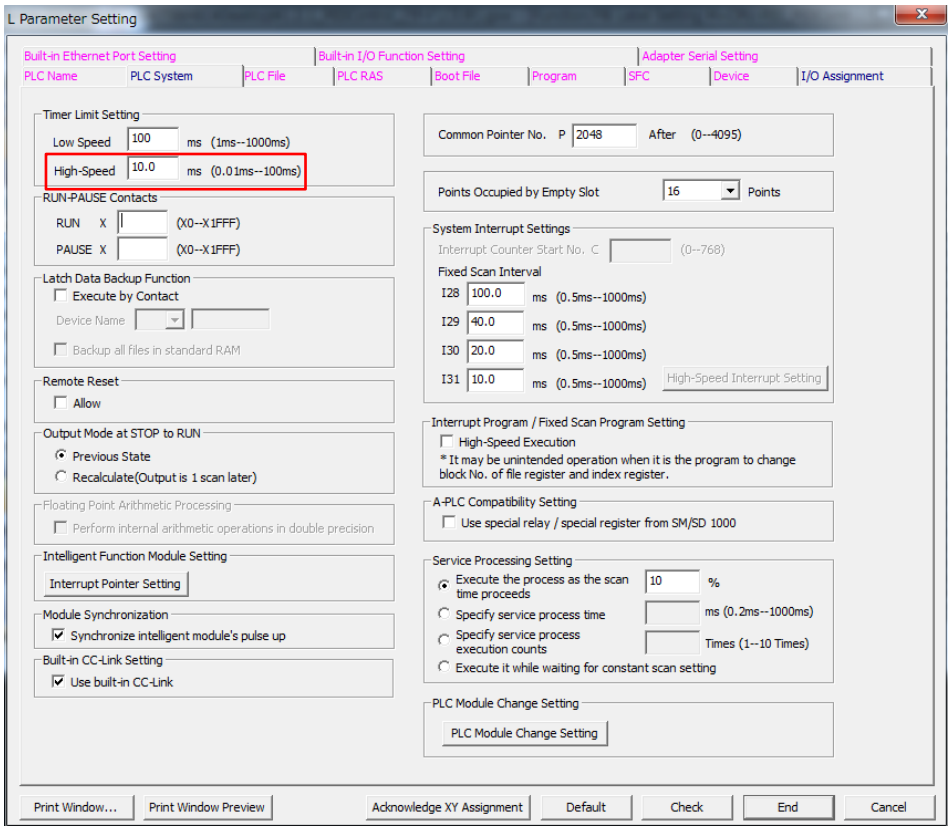
PID operation FB application examples are as follows.

Global label setting

None

Examples of setting

a) Common setting

I/O Item	Value	Description
Module mounting XY address	0	Specify the start XY address mounted on the target module.
PC system setting	10.00ms	Set the Timer Limit Setting. From [parameter]-[PC parameter]-[PC system setting], set the high speed of the Timer Limit Setting. 

Available devices list

a) External input (Command)

Device	FB Name	Application (Contents When ON)
M0	M+CPU-PID_PIDOperation	PID operation execution command
M1		Forward/reverse action setting
M2		AUTO/MAN mode switching
M3		Start/stop auto tuning

b) External output (Confirmation)

Device	FB Name	Application (Contents When ON)
M4	M+CPU-PID_PIDOperation	Execution status
M5		Completed without error
M6		Auto tuning status
F0		Error flag

c) Data register

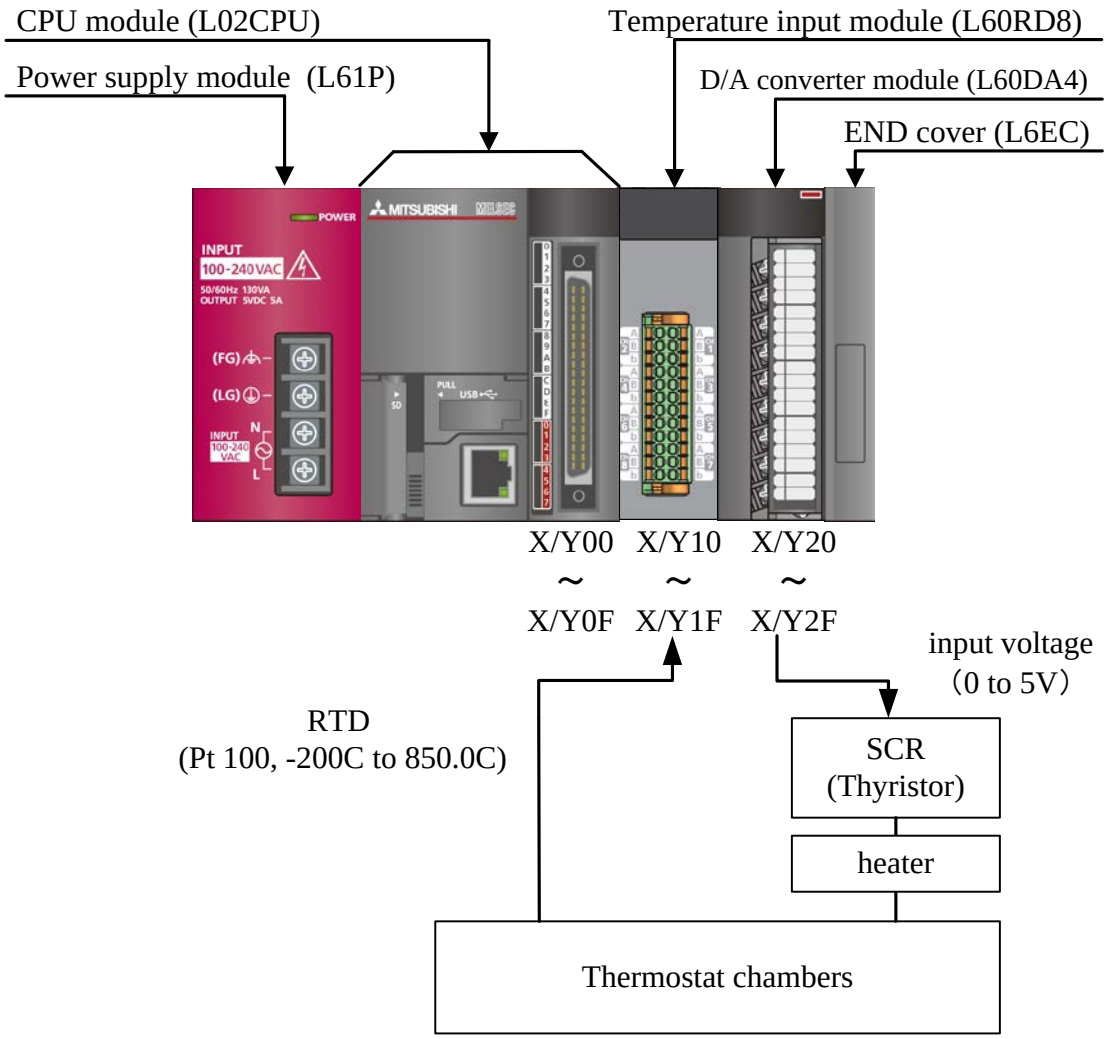
Device	FB Name	Application	
D0	M+CPU-PID_PIDOperation	Sampling time (TS)	
D1		Set value (SV)	
D2		Proportional gain (P) setting	
D3		Integral time (I) setting	
D4		Derivative time (D) setting	
D5		Manipulated value (MV) setting	
D6		MAN output setting	
D7		Operation setting (ACT)	
D8		Input filter constant (a)	
D9		Setting data	Derivative gain (KD)
D10			Rate of change input (Inc) alarm
D11			Rate of change input (Dec) alarm
D12			Upper limit output limiter
D13			Lower limit output limiter
D14			Upper limit setting limiter
D15			Lower limit setting limiter
D16			Threshold value (hysteresis)
D17			AT upper limit output limiter (ULV)
D18			AT lower limit output limiter (LLV)
D19			Wait setting parameter (KW)
D20		Alert status	

Device	FB Name	Application
D21		Proportional gain (P)
D22		Integral time (I)
D23		Derivative time (D)
D24		Manipulated value (MV)
D25		PID operation FB error code
D26		Temperature process value (PV) previous value
D27,D28		Output upper limit (ms)
D29,D30		Manipulated value (ms)

Appendix 1.2.1 When SCR (Thyristor) is used

Examples when using SCR (Thyristor) are shown below.

1) System configuration



Point

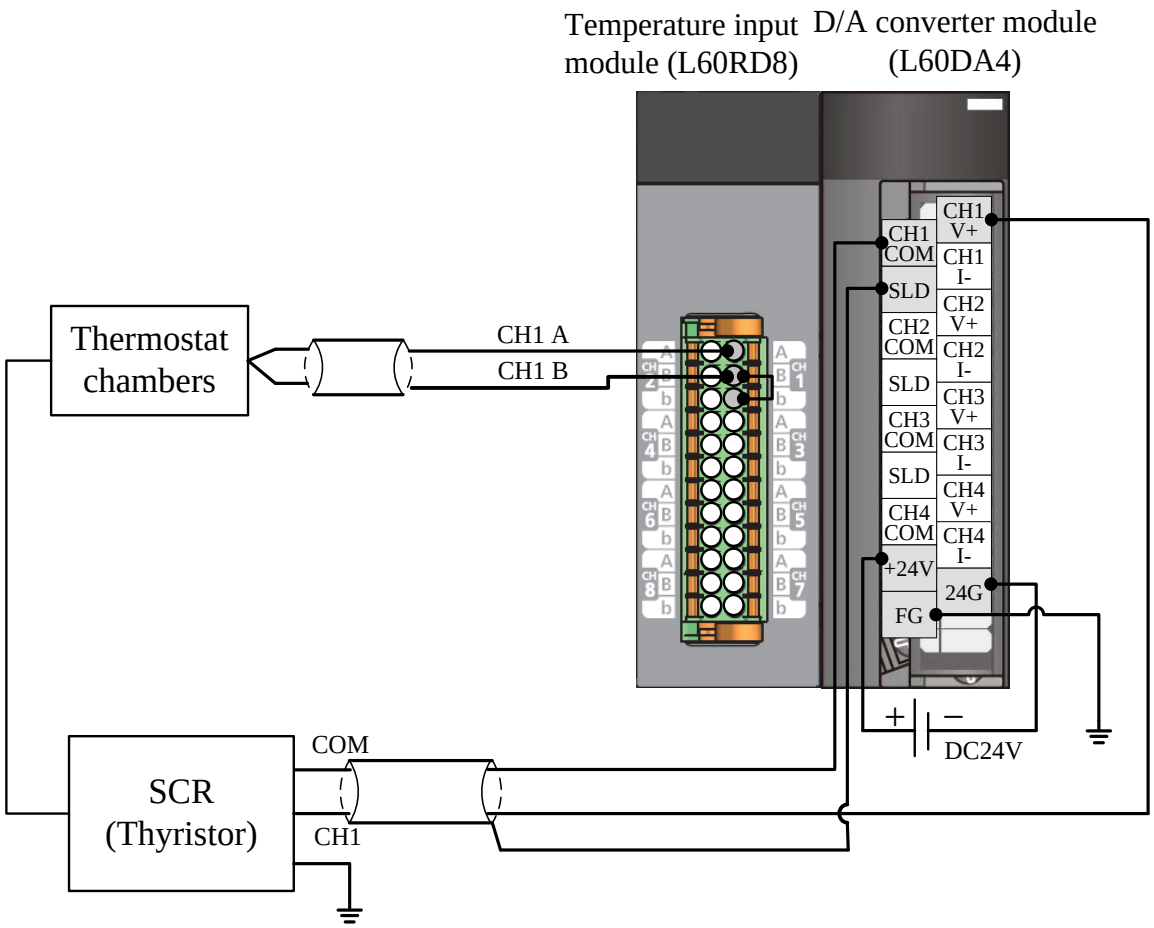
•Circuit settings are required for all input labels. If it is not set, it becomes indefinite value.

•Depending on the number of characters that GX Works2 can display, label comments may be described in abbreviated form.

2) Programming conditions

This is a program for PID control. It reads the temperature measured by RTD (Pt 100, -200°C to 850.0°C) connected to CH1 of L60RD8, outputs DC voltage (0 to 5V) from CH1 of L60DA4, and excute the PID control.

3) Wiring examples



4) Examples of setting

a) Parameter setting of temperature input module

Display Filter: Display All

Item	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
Basic setting	**Set the conversion system.**							
Input range setting	2:Pt100 (-200 to 850°C)	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion
Celsius/Fahrenheit display setting	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]
Averaging process setting	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing
Time Average/ Count Average/Moving Average	0	0	0	0	0	0	0	0
Sensor compensation function	**Set value for sensor compensation when the conversion is executed.**							
Sensor compensation valid/invalid setting	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable
Shifting amount to conversion value	0	0	0	0	0	0	0	0
Disconnection detection function	**Set value to store into measured temperature value when the disconnection is detected.**							
Conversion setting for disconnection detection	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks
Conversion setting value for disconnection detection	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C
Scaling function	**Set value for scaling function when the conversion is executed.**							
Scaling enable/disable setting	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid
Scaling upper limit value	0	0	0	0	0	0	0	0
Scaling lower limit value	0	0	0	0	0	0	0	0
Waning output function	**Set value for warnings when the conversion is executed.**							
Process alarm output setting	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable

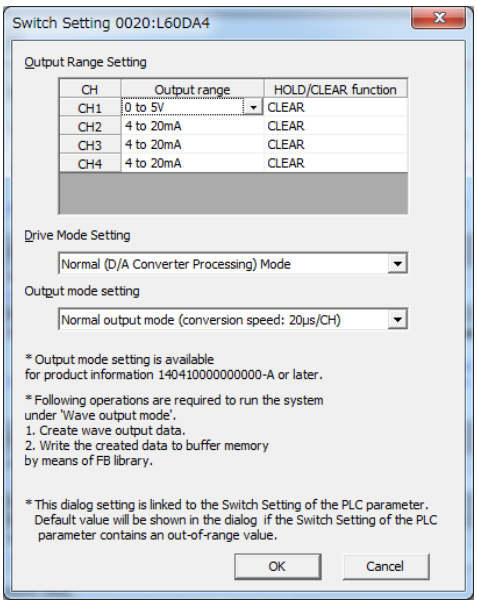
Set the lower lower limit of the measured temperature value.
An error will occur unless lower lower limit <= lower upper limit <= upper lower limit <= upper upper limit.
When the Scaling enable/disable setting is set as 'Enable', please set the value in consideration of scaling calculation.

When 'Disable' is selected in the 'Scaling enable/disable setting' for the relevant CH:

Setting Item		CH1
Basic setting	Input range setting	2: Pt100(-200 to 850°C)

*Settings other than the above are default values

(b) Switch setting of D/A conversion module



•Please check the input voltage specification of the SCR (Thyristor) before setting the output range of the D/A conversion module.

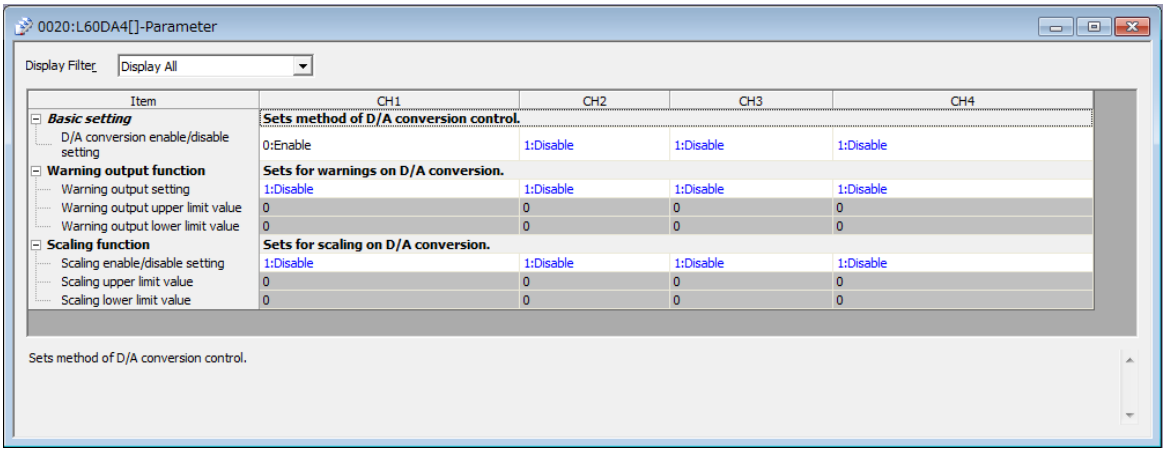
•Please check the digital value of the set output range before setting the output upper/lower limit of the manipulated value (MV).

Output Range	Digital Value	Resolution
0 to 5V	0 to 20000	250uV
1 to 5V		200uV
-10 to 10V	-20000 to 20000	500uV
User range setting		333uV

Setting Item		CH1
Output range setting	CH1	0 to 5V

*Settings other than the above are default values

(c) Parameter setting of D/A conversion module



Setting Item		CH1
Basic setting	D/A conversion enable/disable setting	0: enable

*Settings other than the above are default values

M+CPU-PID_PIDOperation (PID Operation)

Label Name	Setting Value	Description
ib_ActionSetting	OFF	Specify the reverse action for PID control direction by turning it OFF.
ib_AutoManShift	OFF	Specify AUTO/MAN mode switching to AUTO mode.
ib_AT	ON	Start auto tuning by turning it ON.
iw_PV	U1¥G11	Enter the measured temperature from the control object (Sensor).
iw_SV_Setting	K1000	Specify the set value (SV) to 100.0°C.
iw_SamplingTime	K3000 K500	Specify 3 seconds during the auto tuning and 0.5 seconds after the completion of the auto tuning for the sampling time (TS).
iw_P_GainSetting	K10000	Specify K10000 as the proportional gain (P).
iw_I_Setting	K2400	Specify K2400 as the integral time (I) setting.
iw_D_Setting	K600	Specify K600 as the derivative time (D) setting.
iw_MV_Setting	K800	Specify K800 as the manipulated value (MV) during the auto tuning.
iw_ManOutput	-	Unused
iw_SettingData[Offset+0]	H14	Specify "Upper/lower limit output limiter enabled".
iw_SettingData[Offset+1]	K70	Specify 70% as the input filter constant (α).
iw_SettingData[Offset+2]	-	Unused
iw_SettingData[Offset+3]	-	Unused
iw_SettingData[Offset+4]	-	Unused
iw_SettingData[Offset+5]	K1000	Specify K1000 as the upper limit output limiter.
iw_SettingData[Offset+6]	K0	Specify K0 as the lower limit output limiter.
iw_SettingData[Offset+7]	-	Unused
iw_SettingData[Offset+8]	-	Unused
iw_SettingData[Offset+9]	-	Unused
iw_SettingData[Offset+10]	K800	Specify K800 as the AT upper limit output limiter (ULV).
iw_SettingData[Offset+11]	K0	Specify K0 as the AT lower limit output limiter (LLV).
iw_SettingData[Offset+12]	-	Unused

i) Initial setting

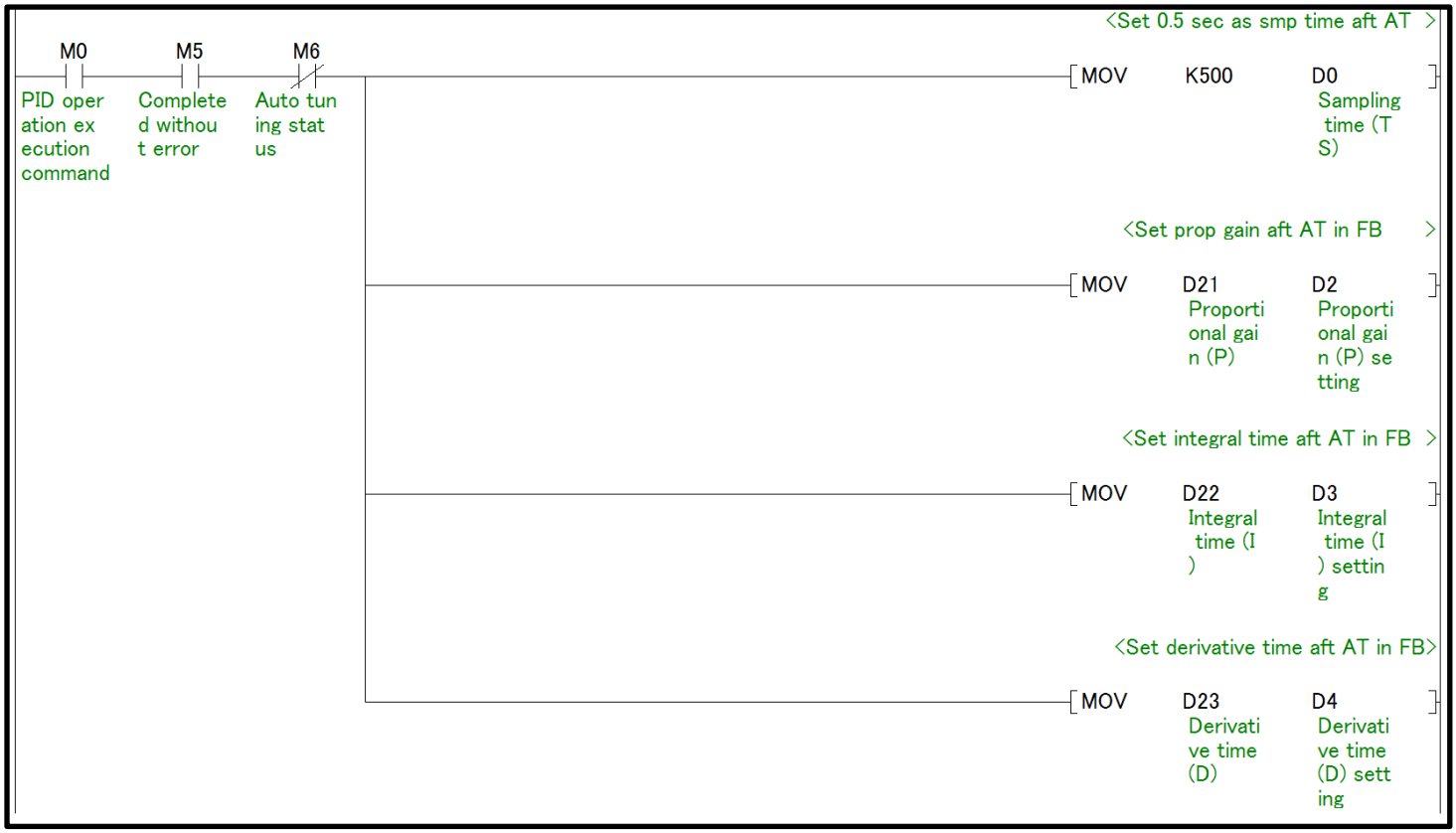
Set the initial value after the CPU RUN.

(For the rest, please refer to the next page.)

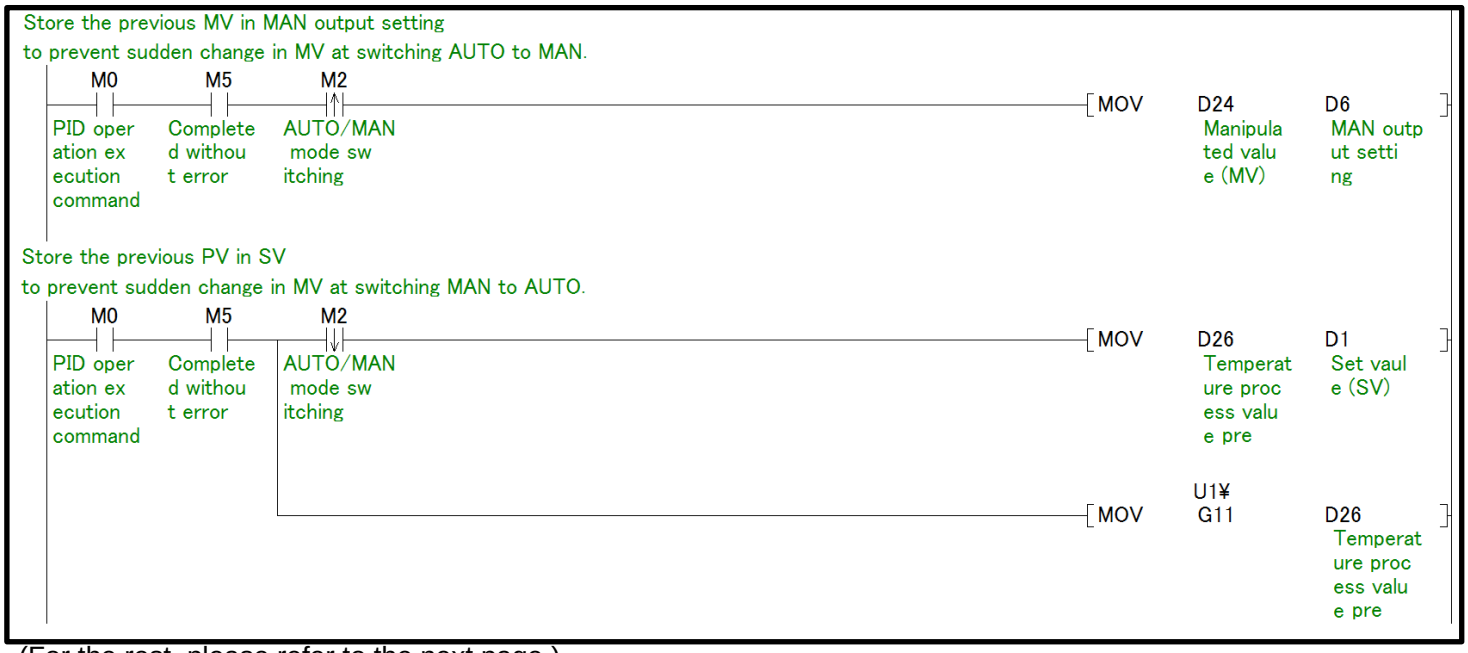
```
<Set K1000 as up lim out limiter >
[MOV    K1000    D12   ]
                  Upper li
                  mit outp
                  ut limit
                  er

<Set K0 as lower lim out limiter >
[MOV    K0       D13   ]
                  Lower li
                  mit outp
                  ut limit
                  er

<Set K800 as AT uplim out limiter>
[MOV    K800     D17   ]
                  AT upper
                   limit o
                  utput li
                  miter

<Set K0 as AT low lim out limiter>
[MOV    K0       D18   ]
                  AT lower
                   limit o
                  utput li
                  miter

[SET    M3       ]
                  Start/st
                  op auto
                  tuning
```

(For the rest, please refer to the next page.)

(Add the following processing, and set the parameter again after the auto tuning is completed.)

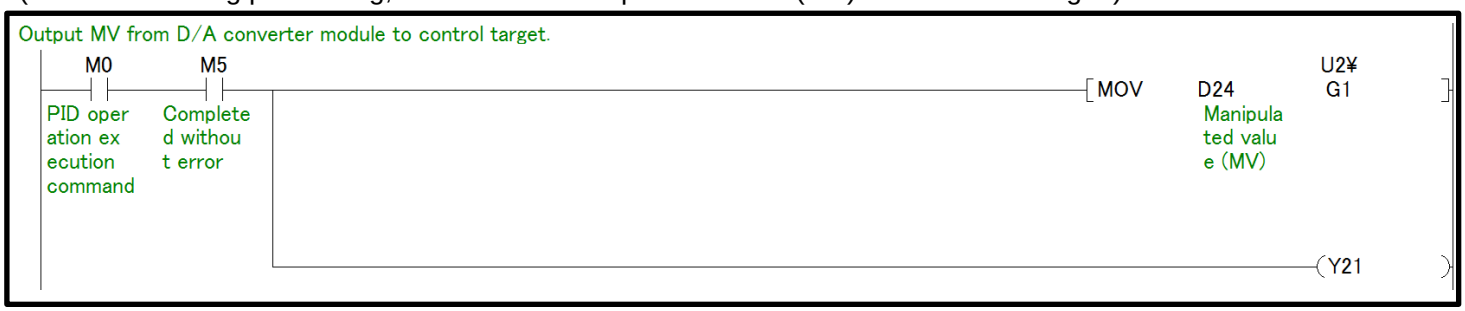


(Add the following processing and prevent a sudden change in the manipulated value (MV) at the AUTO/MAN mode switching.)

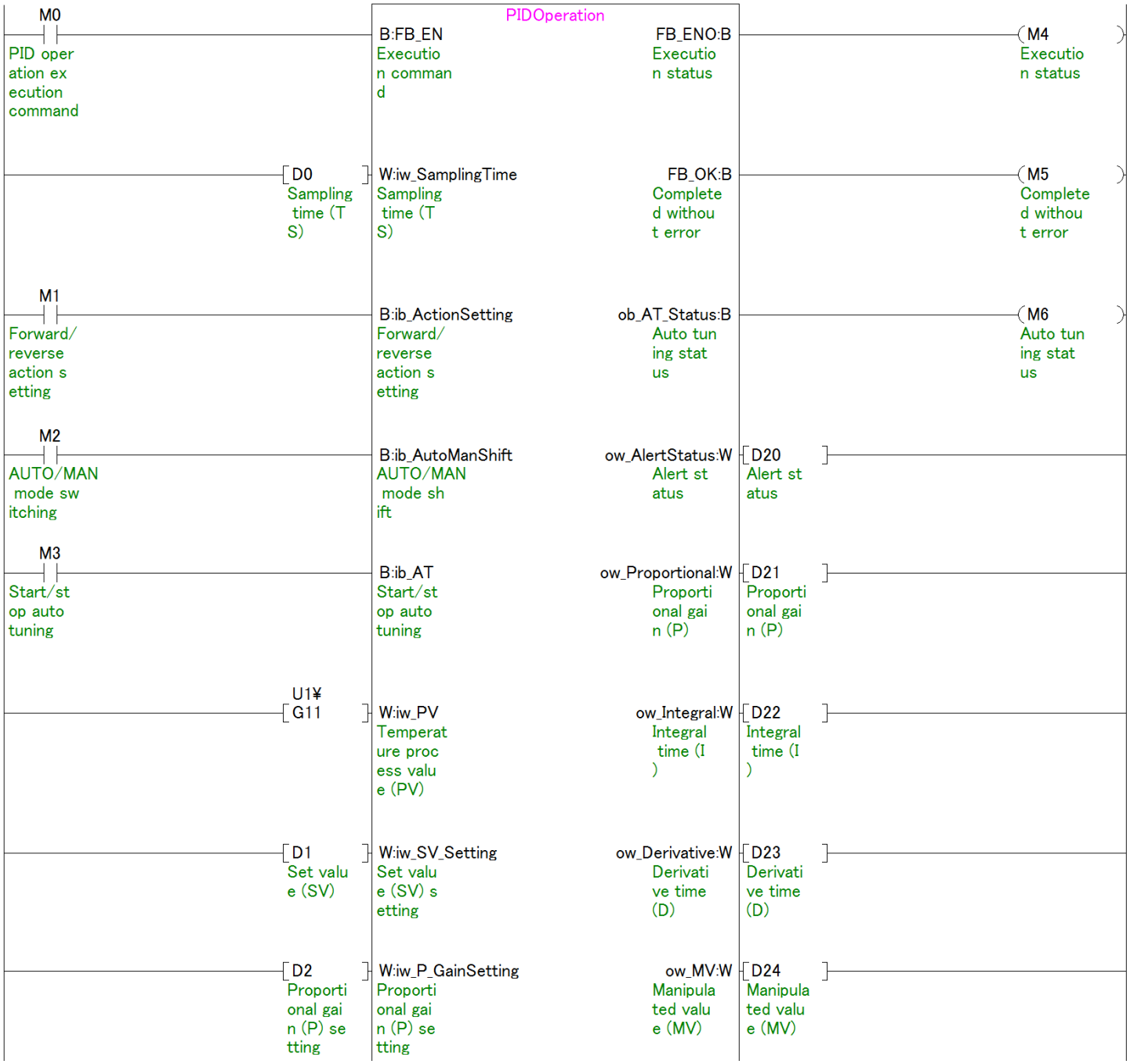


(For the rest, please refer to the next page.)

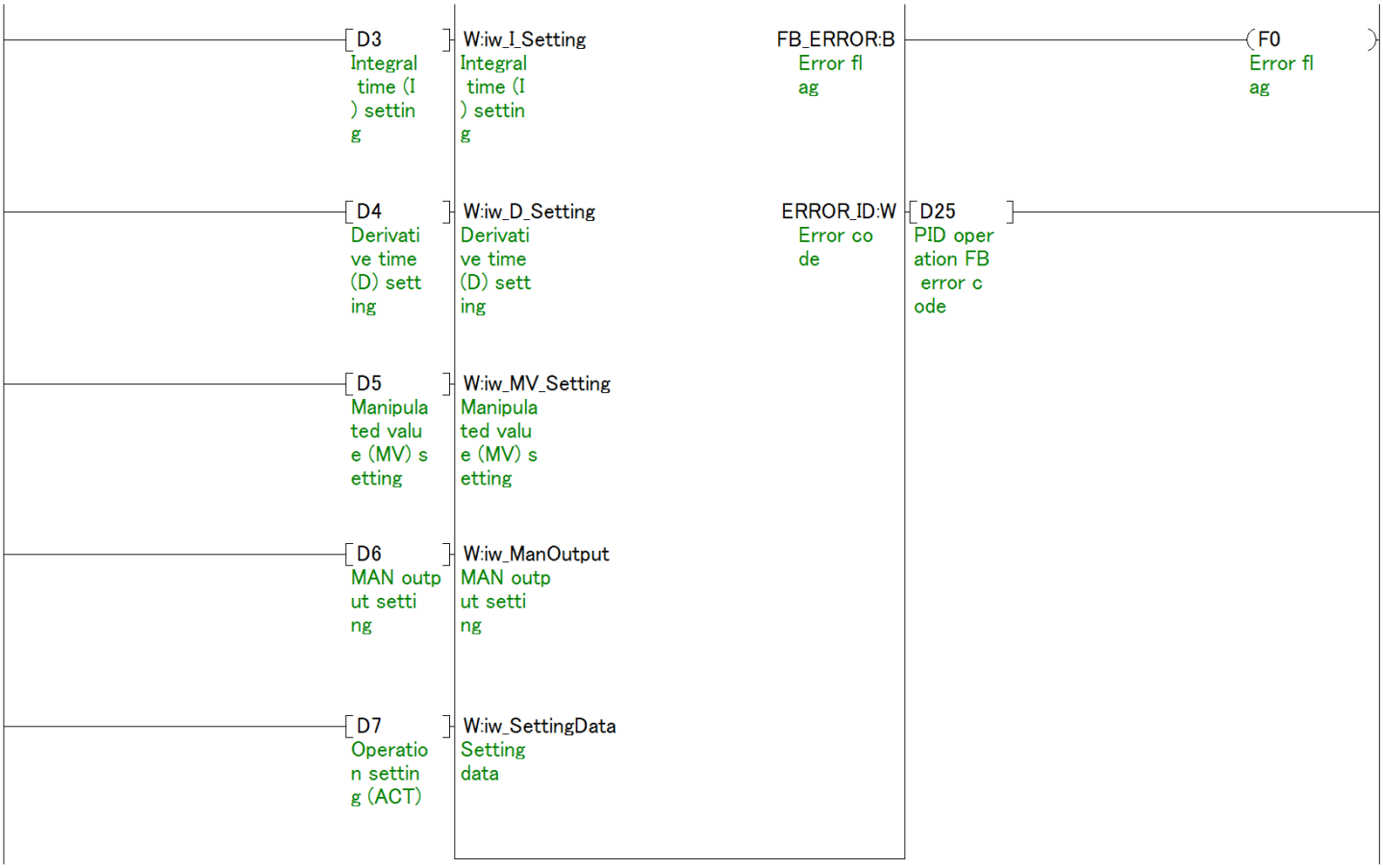
(Add the following processing, and connect Manipulated value (MV) to the control target.)



(For the rest, please refer to the next page.)



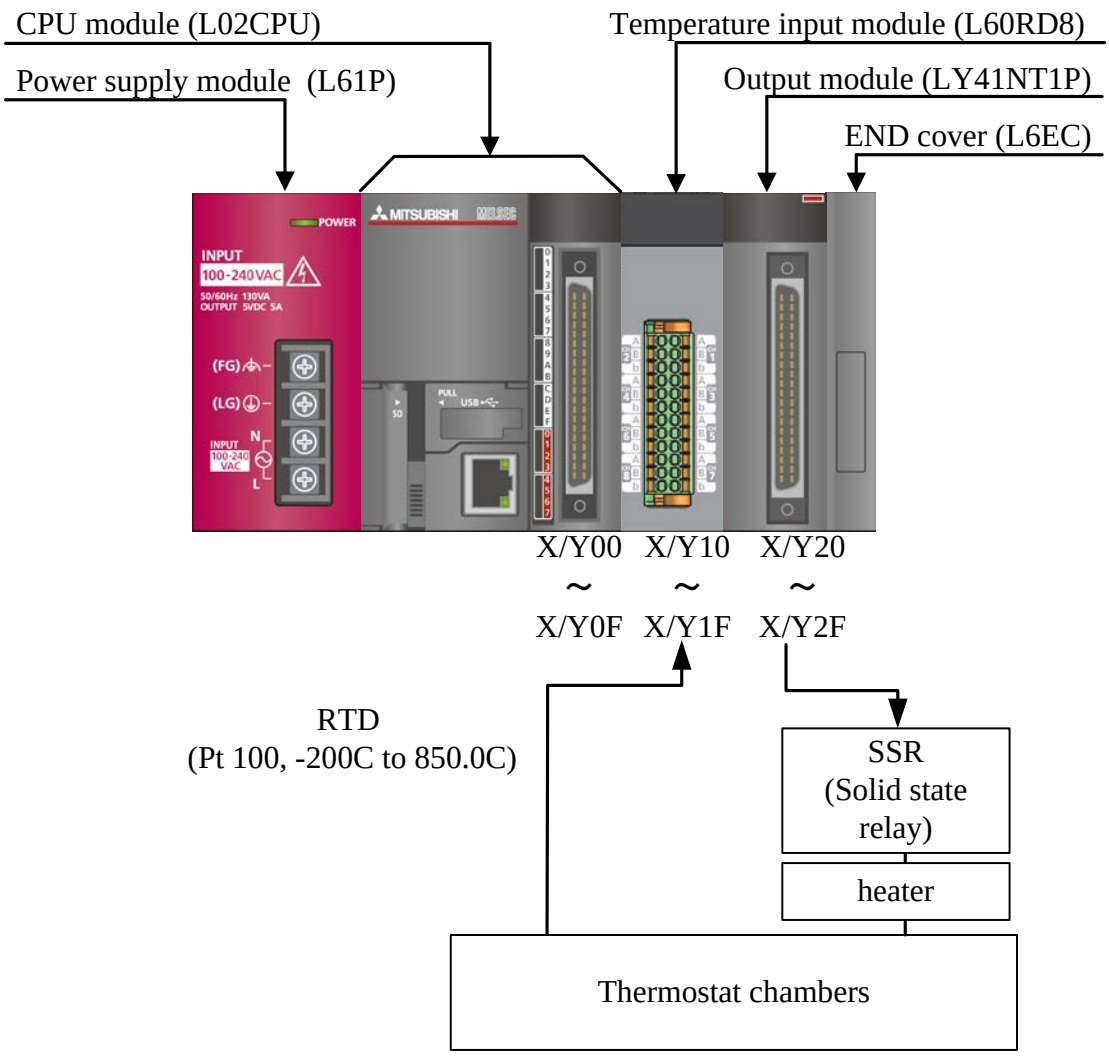
(For the rest, please refer to the next page.)


D3
Integral time (I) setting
W:iw_I_Setting
Integral time (I) setting
FB_ERROR:B
Error flag
F0
Error flag
D4
Derivative time (D) setting
W:iw_D_Setting
Derivative time (D) setting
ERROR_ID:W
Error code
D25
PID operation FB error code
D5
Manipulated value (MV) setting
W:iw_MV_Setting
Manipulated value (MV) setting
D6
MAN output setting
W:iw_ManOutput
MAN output setting
D7
Operation setting (ACT)
W:iw_SettingData
Setting data

Appendix 1.2.2 When SSR (Solid state relay) is used

Examples when using SSR (Solid state relay) are shown below.

1) System configuration



Point

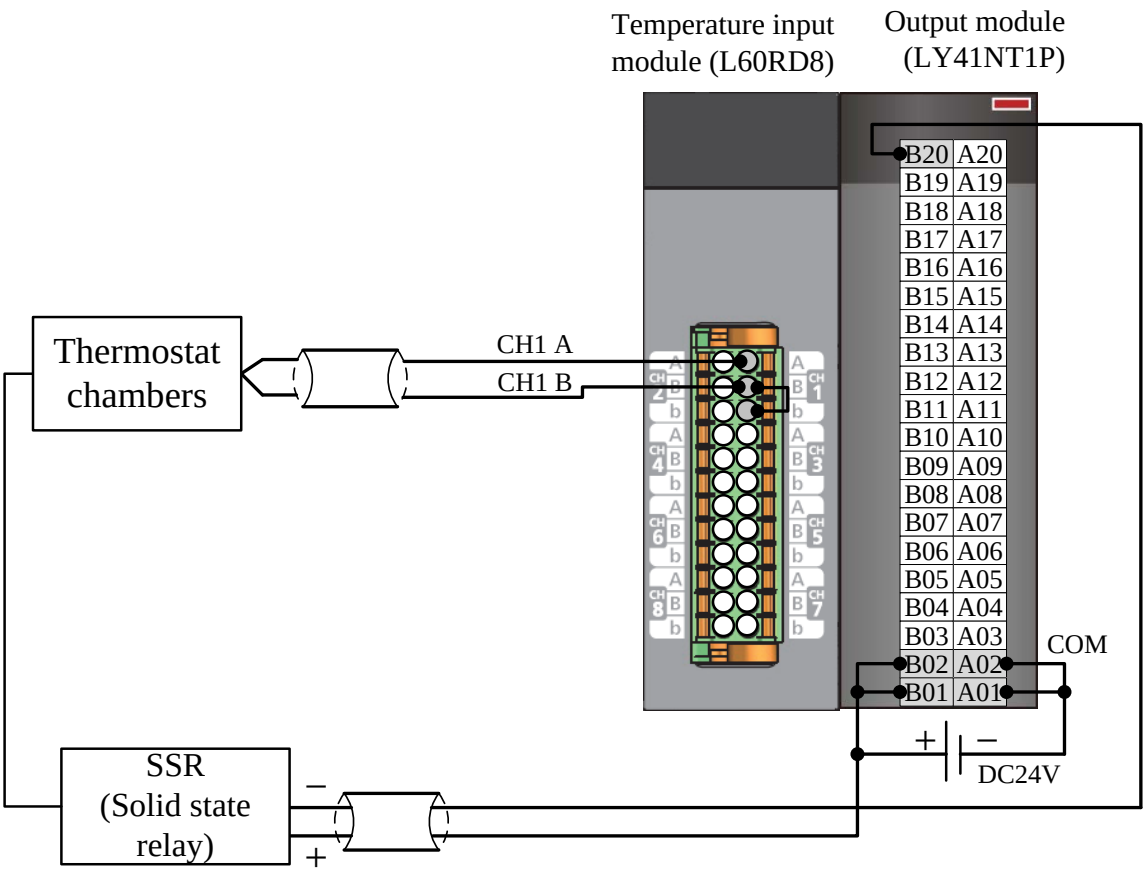
•Circuit settings are required for all input labels. If it is not set, it becomes indefinite value.

•Depending on the number of characters that GX Works2 can display, label comments may be described in abbreviated form.

2) Programming conditions

This is a program for PID control. It reads the temperature measured by RTD (Pt 100, -200°C to 850.0°C) connected to CH1 of L60RD8, and excute the PID control.

3) Wiring examples



4) Examples of setting

a) Parameter setting of temperature input module

Display Filter: Display All

Item	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
Basic setting	**Set the conversion system.**							
Input range setting	2:Pt100 (-200 to 850°C)	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion	0:Disable Conversion
Celsius/Fahrenheit display setting	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]	0:Celsius [°C]
Averaging process setting	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing	0:Sampling Processing
Time Average/ Count Average/Moving Average	0	0	0	0	0	0	0	0
Sensor compensation function	**Set value for sensor compensation when the conversion is executed.**							
Sensor compensation valid/invalid setting	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable	0:Disable
Shifting amount to conversion value	0	0	0	0	0	0	0	0
Disconnection detection function	**Set value to store into measured temperature value when the disconnection is detected.**							
Conversion setting for disconnection detection	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks	0:Value just before wire breaks
Conversion setting value for disconnection detection	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C	0.0 °C
Scaling function	**Set value for scaling function when the conversion is executed.**							
Scaling enable/disable setting	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid	1:Invalid
Scaling upper limit value	0	0	0	0	0	0	0	0
Scaling lower limit value	0	0	0	0	0	0	0	0
Waning output function	**Set value for warnings when the conversion is executed.**							
Process alarm output setting	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable	1:Disable

Set the lower lower limit of the measured temperature value.
An error will occur unless lower lower limit <= lower upper limit <= upper lower limit <= upper upper limit.
When the Scaling enable/disable setting is set as 'Enable', please set the value in consideration of scaling calculation.

When 'Disable' is selected in the 'Scaling enable/disable setting' for the relevant CH:

Setting Item		CH1
Basic setting	Input range setting	2: Pt100(-200 to 850°C)

*Settings other than the above are default values

M+CPU-PID_PIDOperation (PID Operation)

Label Name	Setting Value	Description
ib_ActionSetting	OFF	Specify the reverse action for PID control direction by turning it OFF.
ib_AutoManShift	OFF	Specify AUTO/MAN mode switching to AUTO mode.
ib_AT	ON	Start auto tuning by turning it ON.
iw_PV	U1¥G11	Enter the measured temperature from the control object (Sensor).
iw_SV_Setting	K1000	Specify the set value (SV) to 100.0°C.
iw_SamplingTime	K3000 K500	Specify 3 seconds during the auto tuning and 0.5 seconds after the completion of the auto tuning for the sampling time (TS).
iw_P_GainSetting	K10000	Specify K10000 as the proportional gain (P).
iw_I_Setting	K2400	Specify K2400 as the integral time (I) setting.
iw_D_Setting	K6000	Specify K6000 as the derivative time (D) setting.
iw_MV_Setting	K800	Specify K800 as the manipulated value (MV) during the auto tuning.
iw_ManOutput	-	Unused
iw_SettingData[Offset+0]	H14	Specify "Upper/lower limit output limiter enabled".
iw_SettingData[Offset+1]	K70	Specify 70% as the input filter constant (α).
iw_SettingData[Offset+2]	-	Unused
iw_SettingData[Offset+3]	-	Unused
iw_SettingData[Offset+4]	-	Unused
iw_SettingData[Offset+5]	K1000	Specify K1000 as the upper limit output limiter.
iw_SettingData[Offset+6]	K0	Specify K0 as the lower limit output limiter.
iw_SettingData[Offset+7]	-	Unused
iw_SettingData[Offset+8]	-	Unused
iw_SettingData[Offset+9]	-	Unused
iw_SettingData[Offset+10]	K800	Specify K800 as the AT upper limit output limiter (ULV).
iw_SettingData[Offset+11]	K0	Specify K0 as the AT lower limit output limiter (LLV).
iw_SettingData[Offset+12]	-	Unused

i) Initial setting

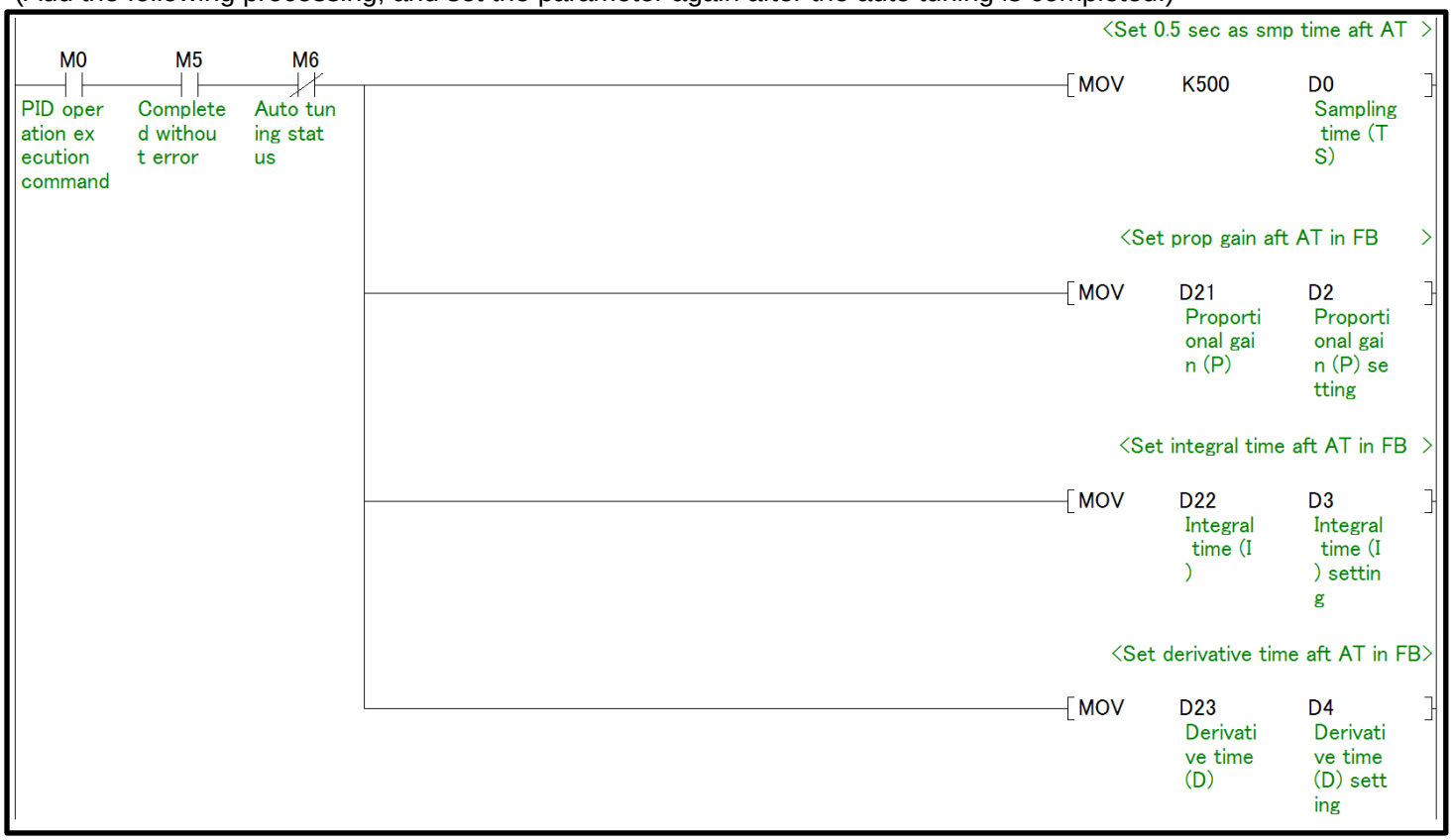
Set the initial value after the CPU RUN.

(For the rest, please refer to the next page.)

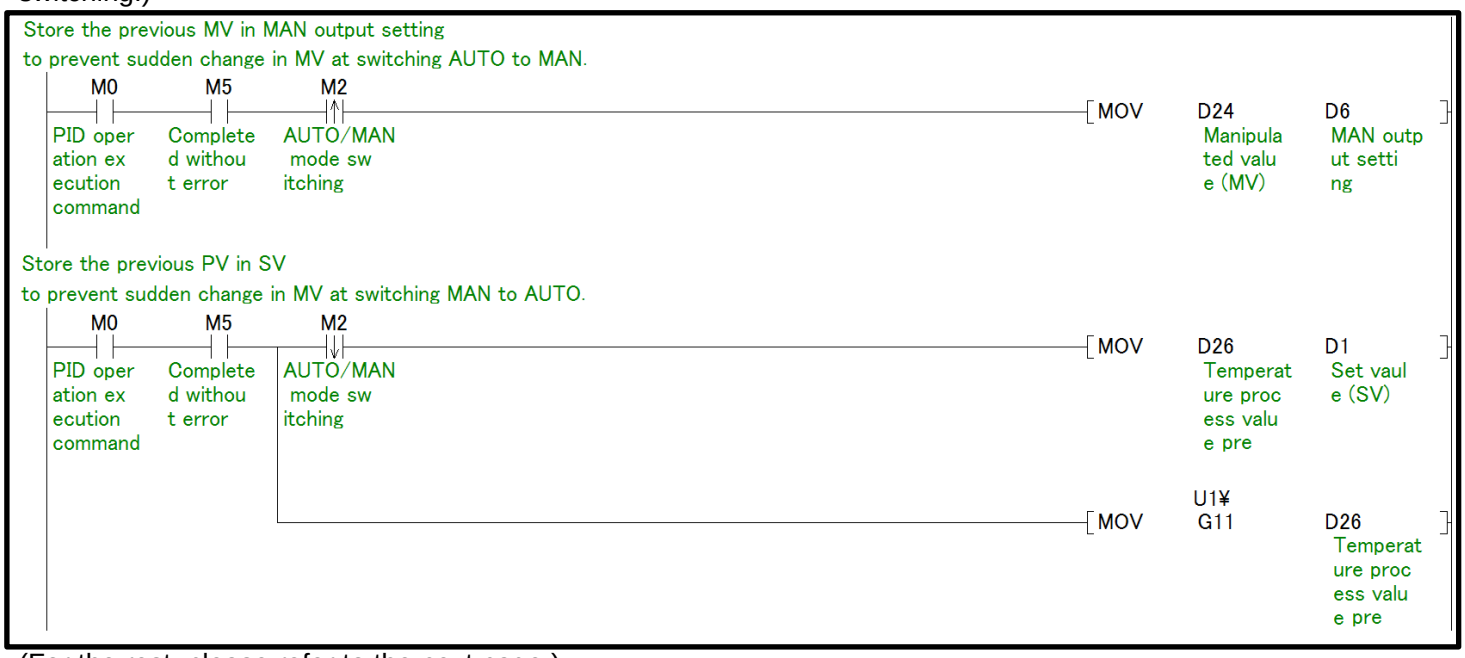
```
<Set K1000 as up lim out limiter >
[MOV    K1000    D12 ]
                  Upper li
                  mit outp
                  ut limit
                  er

<Set K0 as lower lim out limiter >
[MOV    K0       D13 ]
                  Lower li
                  mit outp
                  ut limit
                  er

<Set K800 as AT uplim out limiter>
[MOV    K800     D17 ]
                  AT upper
                   limit o
                  utput li
                  miter

<Set K0 as AT low lim out limiter>
[MOV    K0       D18 ]
                  AT lower
                   limit o
                  utput li
                  miter

[SET    M3       ]
                  Start/st
                  op auto
                  tuning
```

(For the rest, please refer to the next page.)

(Add the following processing, and set the parameter again after the auto tuning is completed.)

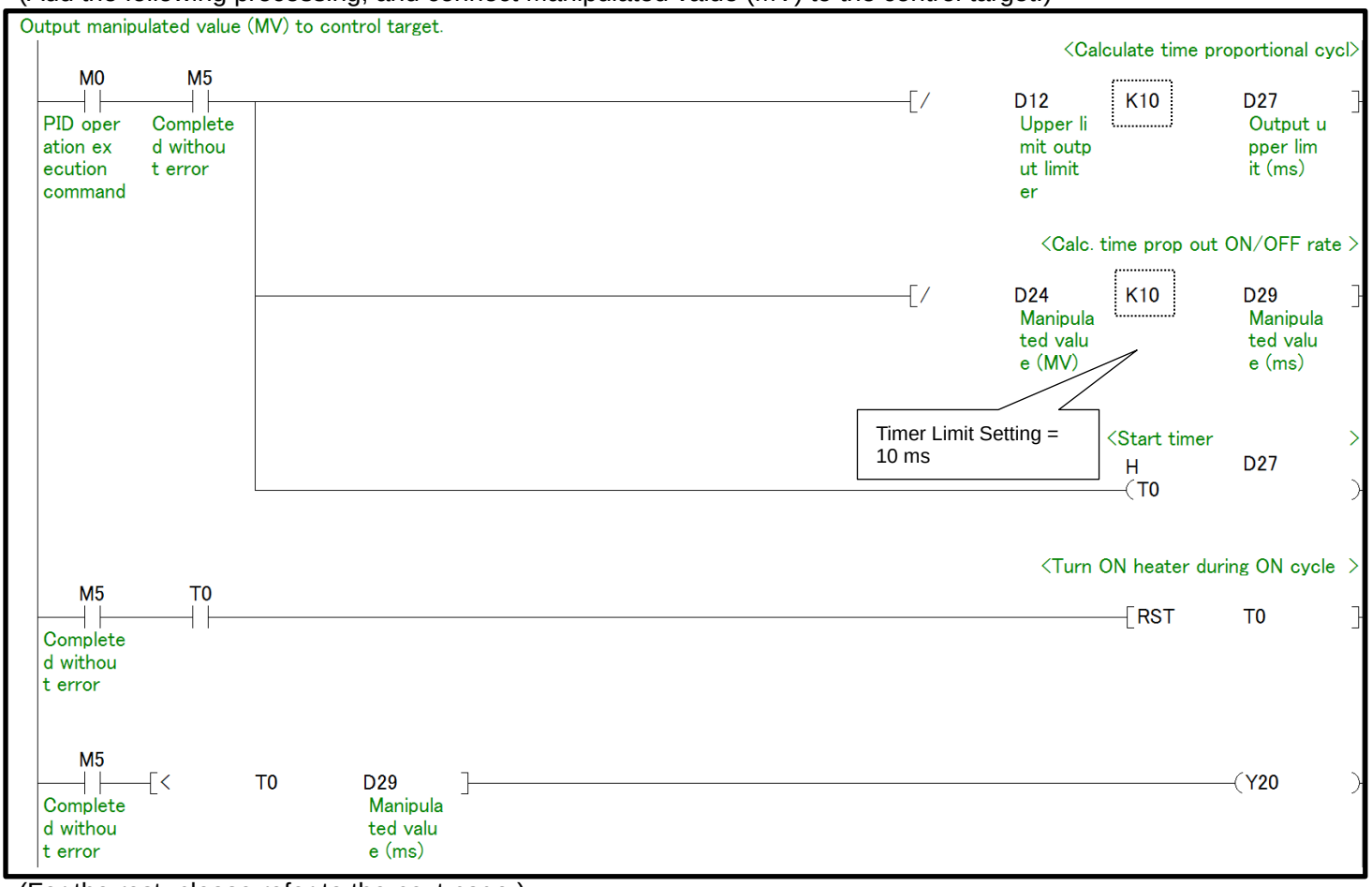


(Add the following processing and prevent a sudden change in the manipulated value (MV) at the AUTO/MAN mode switching.)

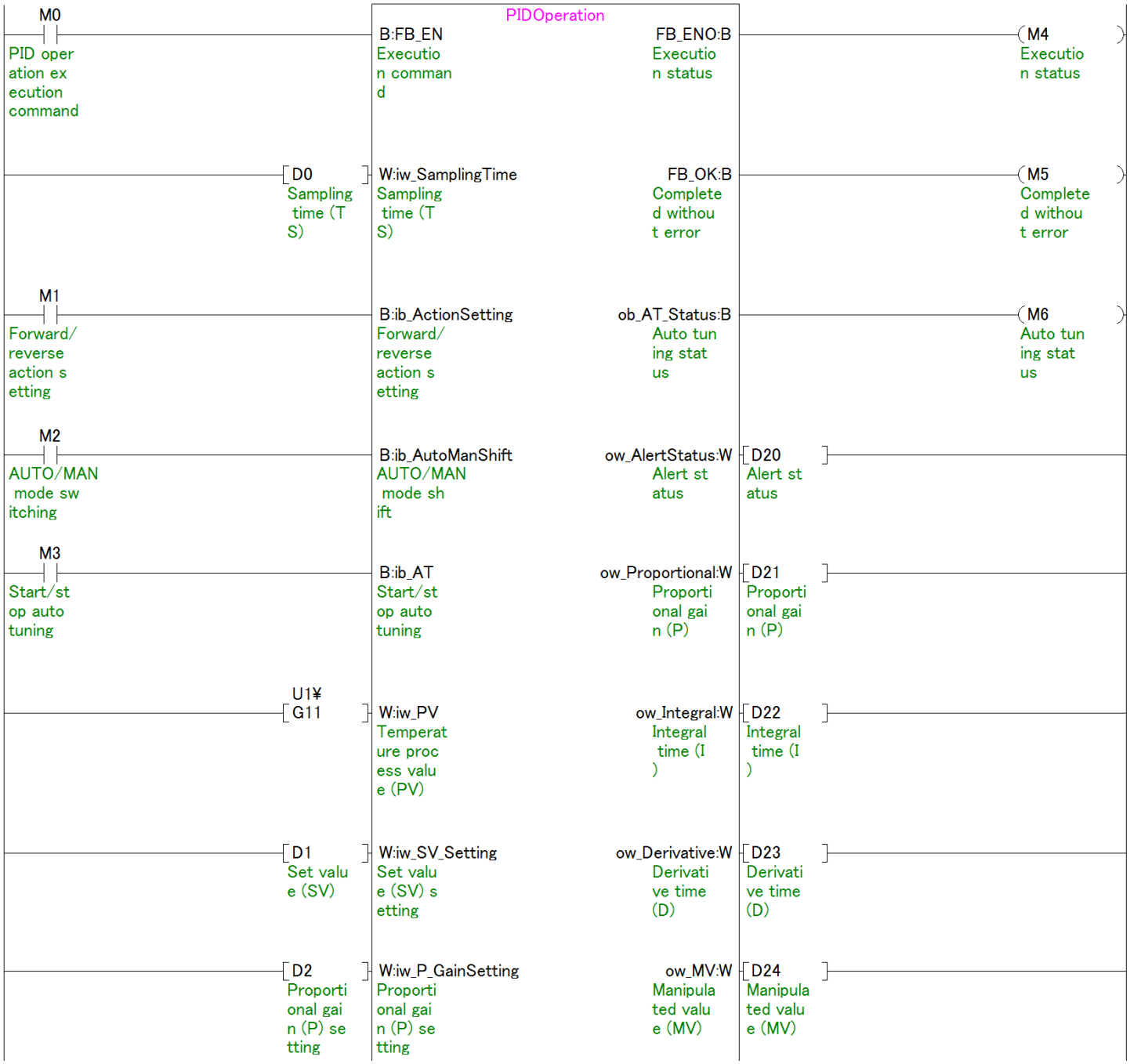


(For the rest, please refer to the next page.)

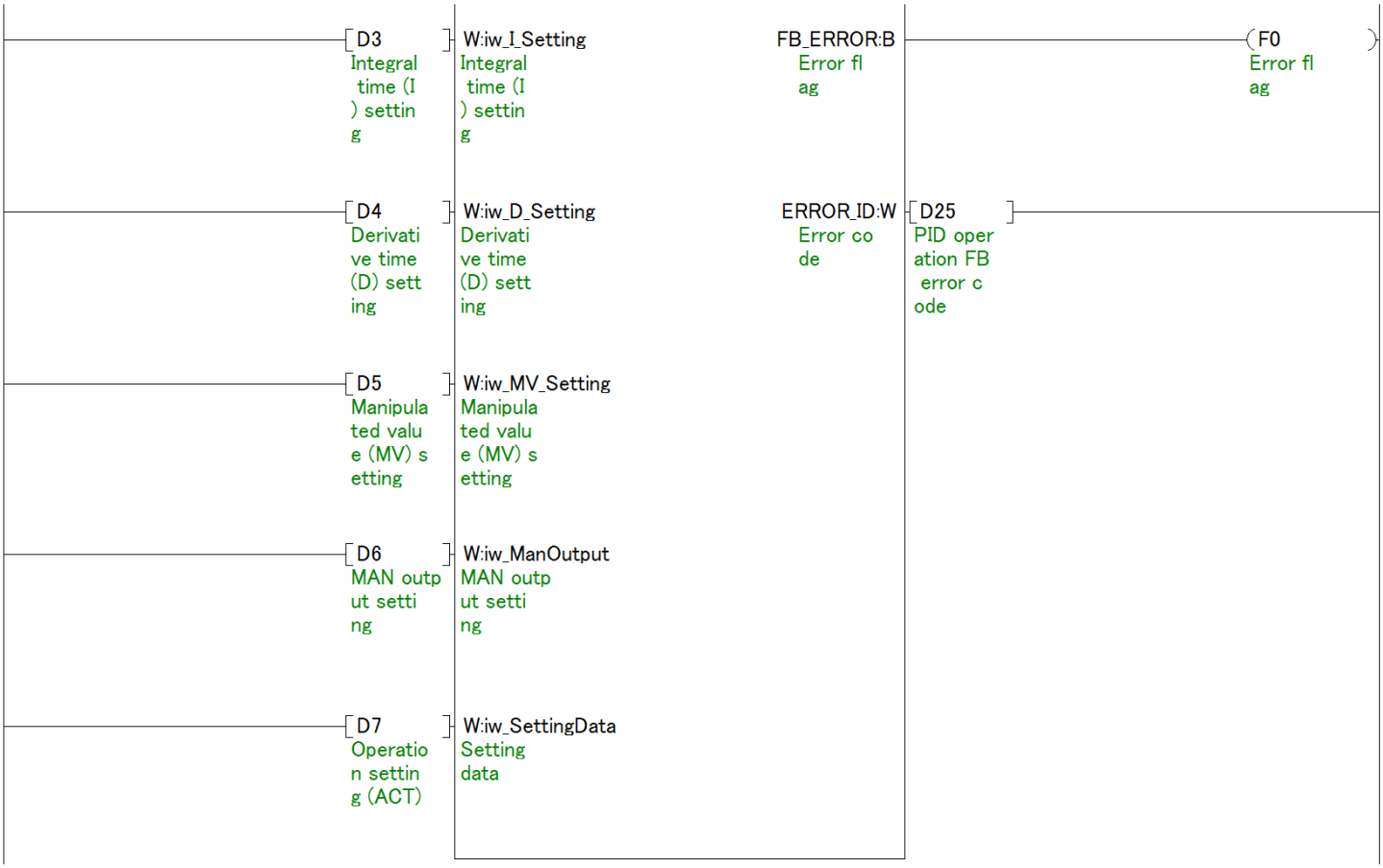
(Add the following processing, and connect Manipulated value (MV) to the control target.)



(For the rest, please refer to the next page.)



(For the rest, please refer to the next page.)


D3
Integral time (I) setting
W:iw_I_Setting
Integral time (I) setting
FB_ERROR:B
Error flag
F0
Error flag
D4
Derivative time (D) setting
W:iw_D_Setting
Derivative time (D) setting
ERROR_ID:W
Error code
D25
PID operation FB error code
D5
Manipulated value (MV) setting
W:iw_MV_Setting
Manipulated value (MV) setting
D6
MAN output setting
W:iw_ManOutput
MAN output setting
D7
Operation setting (ACT)
W:iw_SettingData
Setting data