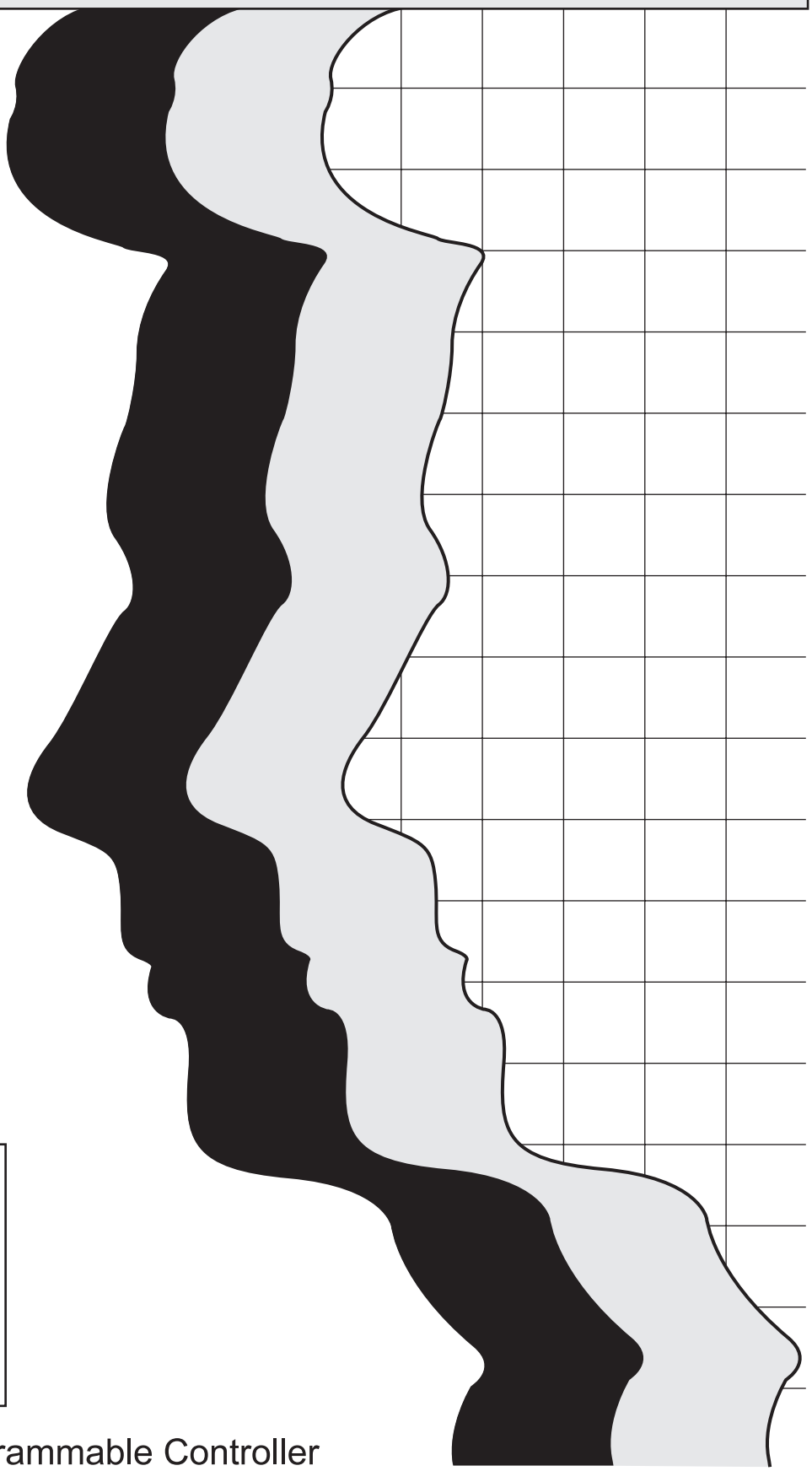
MITSUBISHI

Temperature Control Module Type A1S64TCTRT/Temperature Control Module with Disconnection Detection Function Type A1S64TCTRTBW

User's Manual



MELSEC

Mitsubishi Programmable Controller

• SAFETY PRECAUTIONS •

(Always read these instructions before using this equipment.)

Before using this product, please read this manual and the relevant manuals introduced in this manual carefully and pay full attention to safety to handle the product correctly.
The instructions given in this manual are concerned with this product only. For the safety instructions of the programmable controller system, please read the CPU module User's Manual.
In this manual, the safety instructions are ranked as "DANGER" and "CAUTION".

⚠ DANGER	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠ CAUTION	Indicates that incorrect handling may cause hazardous conditions, resulting in medium or slight personal injury or physical damage.

Note that the ⚠CAUTION level may lead to a serious consequence according to the circumstances. Always follow the instructions of both levels because they are important to personal safety.

Please save this manual to make it accessible when required and always forward it to the end user.

[Design precautions]

⚠ DANGER

- Configure a safety circuit outside the programmable controller so that the entire system operates safety even if there is an external power error or if the programmable controller is malfunctioning.
  (1) The output status to the outside varies, depending on the output status setting in the external-output control setting mode: Please be careful when performing the setting.Refer to the Section 3.3.9 of this manual for details on the output status.
  (2) Due to malfunction of the output element or its internal circuit, normal output may not be obtained or erroneous output may be performed. For output signals that may cause a severe accident, set an external circuit to monitor the output.

⚠ CAUTION

- Do not bundle the control cables and communication cables with the main circuit and power cables. Keep a distance of least 100mm (3.94inch) between them. Noise may cause erroneous operation.

[Installation precautions]

⚠ CAUTION
• Use the programmable controller in the environment given in the general specifications of the this manual. Using the programmable controller outside the range of the general specifications may result in electric shock, fire or malfunction, or may damage or degrade the module. • Insert the tabs at the bottom of the module into the mounting holes in the base unit to install the module, and tighten the module fixing screws with the specified torque. Failure to do so may result in malfunction, failure or drop of the module. • Do not directly touch the module's conductive parts or electronic components. Doing so could cause malfunction or failure in the module.

[Wiring precautions]

⚠ CAUTION
• Do not grab on the cable when removing the communication or power cable connected to the module. When disconnecting a cable without a connector, first loosen the screws on the terminal block. Pulling the cable when it is still connected to the module may cause damage to the module or cable, or malfunction. • Be sure to ground the shield wire to the protective ground conductor. Not doing so could result in an electric shock or malfunction. • Connect the cables to the programmable controller correctly, checking the product's rated voltage and the terminal layout. Connecting a power supply that has a different rating or incorrect wiring could result in fire or failure. • Tighten the terminal screws within the specified torque range. Loose terminal screws may cause a short circuit, fire, or malfunction. Tightening the terminal screws too far may cause damage to the screw and/or the module, resulting in short circuit, or malfunctions. • Be sure that cuttings, wire chips, or other foreign matter do not enter the module. Foreign matter may cause a fire, failure or malfunctions.

[Starting and maintenance precautions]

⚠ CAUTION
• Do not touch the terminal while the power is on. It may cause malfunction. • Make sure to switch all phases of the external power supply off before cleaning or re-tightening the terminal screws. Failure to do so will cause failure or malfunction of the module. • Never disassemble or remodel the module. This may cause failure, malfunction, injury and/or fire. • Make sure to switch all phases of the external power supply off before mounting or removing the module. Failure to do so will cause failure or malfunction of the module. • Do not install/remove the terminal block more than 50 times after the first use of the product. (IEC 61131-2 compliant) • Always touch a grounded metal object to discharge the static electricity from the human body before handling the module. Failure to do so may cause a failure or malfunctions of the module.

[Disposal precaution]

⚠ CAUTION
• When disposing of this product, handle it as an industrial waste.

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REVISIONS

* The manual number is given on the bottom left of the back cover.

Print Date	* Manual Number	Revision
Nov., 2006	SH(NA)-080549ENG-A	First edition
Apr., 2008	SH(NA)-080549ENG-B	Partial Correction SAFETY PRECAUTIONS, INTRODUCTION, CONTENTS, Chapter 1, Section 1.1, 2.1, 3.1, 3.2.1, 3.3.1, 3.3.3, 3.3.6, 3.3.7, 3.3.8, 3.3.9, 3.3.15, 3.5, 3.5.1, 3.5.2, 3.5.3, 3.7.2, 3.7.7, 3.7.11, 3.7.16, 3.7.18, 3.8.10, 3.8.13, 3.10.1, 3.10.7, 4.4.1, 5.2.1, 6.2, 6.3, 6.5

Japanese Manual Version SH-080548-B

INTRODUCTION

Thank you for purchasing the MELSEC-A series programmable controller.
Before using the programmable controller, please read this manual carefully to develop full familiarity with the functions and performance of the A series programmable controller you have purchased, so as to ensure correct use.

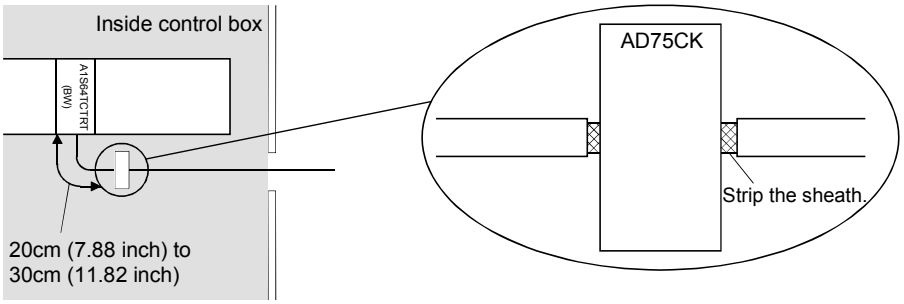
CONTENTS

Conformance with the EMC and Low Voltage Directives

When incorporating a Mitsubishi programmable controller that is compliant with the EMC and low voltage directives into any other product and ensuring compliance with these directives, refer to Chapter 3 “EMC and Low Voltage Directives” of the User's Manual (Hardware) for the programmable controller CPU included with the CPU module or base unit.
The CE logo is printed on the rating plate on the main body of the programmable controller that conforms to the EMC directive and low voltage instruction.

The following wiring is required for conformance of this product with the EMC Directive and Low Voltage Directive.

(1) Use shielded cables for all external wiring and use the AD75CK cable clamp to ground this product to an enclosure.



(2) Using the AD75CK, you can tie four cables of about 7mm outside diameter together for grounding.

(3) The following number of AD75CKs will be needed.
(Assuming that 7mm-diameter cables are used for all wiring)

Number of AD75CKs needed		Number of channels used			
		1	2	3	4
Number of CT channels used	0	1	1	2	2
	1	1	2	2	3
	2	1	2	2	3
	3	2	2	3	3
	4	2	2	3	3

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About the Generic Terms and Abbreviations

Unless otherwise specified, this manual uses the following generic terms and abbreviations to describe the Temperature control module.

Generic term/abbreviation	Description
A1S64TCTRT	Abbreviation of the A1S64TCTRT temperature control module
A1S64TCTRTBW	Abbreviation of the A1S64TCTRTBW temperature control module with disconnection detection function
A1S64TCTRT(BW)	Generic term for the A1S64TCTRT and A1S64TCTRTBW
Standard control	Control method by which either of heating or cooling controls is performed.
Heating-cooling control	Control method by which heating and cooling controls can be performed at the same time.
A1S64TCTT-S1	Abbreviation of the A1S64TCTT-S1 temperature control module
A1S64TCTTBW-S1	Abbreviation of the A1S64TCTTBW-S1 temperature control module with disconnection detection function
A1S64TCTT(BW)-S1	Generic term for the A1S64TCTT-S1 and A1S64TCTTBW-S1
A1S64TCRT-S1	Abbreviation of the A1S64TCRT-S1 temperature control module
A1S64TCRTBW-S1	Abbreviation of the A1S64TCRTBW-S1 temperature control module with disconnection detection function
A1S64TCRT(BW)-S1	Generic term for the A1S64TCRT-S1 and A1S64TCRTBW-S1
A1S62TCTT-S2	Abbreviation of the A1S62TCTT-S2 temperature control module
A1S62TCTTBW-S2	Abbreviation of the A1S62TCTTBW-S2 temperature control module with disconnection detection function
A1S62TCTT(BW)-S2	Generic term for the A1S62TCTT-S2 and A1S62TCTTBW-S2
A1S62TCRT-S2	Abbreviation of the A1S62TCRT-S2 temperature control module
A1S62TCRTBW-S2	Abbreviation of the A1S62TCRTBW-S2 temperature control module with disconnection detection function
A1S62TCTRT(BW)-S2	Generic term for the A1S62TCRT-S2 and A1S62TCRTBW-S2
Existing model	Generic term for A1S64TCTT(BW)-S1, A1S64TCRT(BW)-S1, A1S62TCTT(BW)-S2, and A1S62TCRT(BW)-S2
Temperature sensor	Generic term for thermocouples and platinum RTDs

Product Structure

The product structure of the product is given in the table below.

Model code	Product name	Quantity
A1S64TCTRT	The A1S64TCTRT temperature control module	1
A1S64TCTRTBW	The A1S64TCTRTBW temperature control module with disconnection detection function	1
Disconnection detector connector	Included with the A1S64TCTRTBW	1

1 OVERVIEW

This manual deals with the specifications, handling instructions,and wiring and programming methods of the following temperature control modules used with the MELSEC-A series PLC CPU module (hereafter abbreviated to the PLC CPU).

- The A1S64TCTRT temperature control module (hereinafter referred to as the A1S64TCTRT)
- The A1S64TCTRTBW temperature control module with disconnection detection function (hereinafter referred to as the A1S64TCTRTBW)

A generic term of A1S64TCTRT(BW) is used for the A1S64TCTRT and A1S64TCTRTBW hereinafter.

(1) What is the A1S64TCTRT?

(a) The A1S64TCTRT is a temperature control module, which converts input data from external temperature sensors (thermocouple/platinum RTD) to 16-bit signed binary data, performs PID operations for the set-point temperature, and outputs the resulted data to the control target with transistor output.

(b) The A1S64TCTRT have an auto tuning function which automatically sets the proportional band (P), integral time (I) and derivative time (D) for PID operations.

(c) Thermocouples of K, J, T, B, S, E, R, N, U, L, PL Ⅱ, W5Re/W26Re types, or Pt100 or JPt100 type platinum RTDs (Resistance Temperature Detectors) can be connected to the A1S64TCTRT.

(d) The A1S64TCTRT has Standard and Heating-cooling control modes that can be changed with the switch.

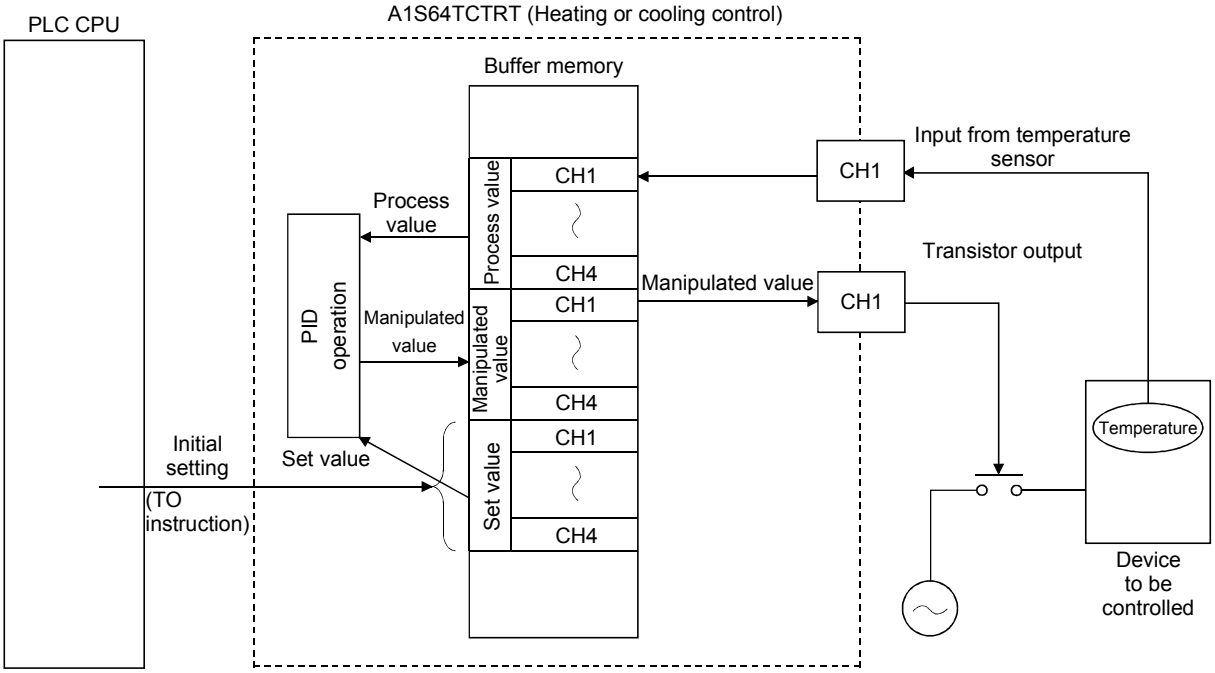

Fig.1.1 Processing of A1S64TCTRT (Heating or cooling control)

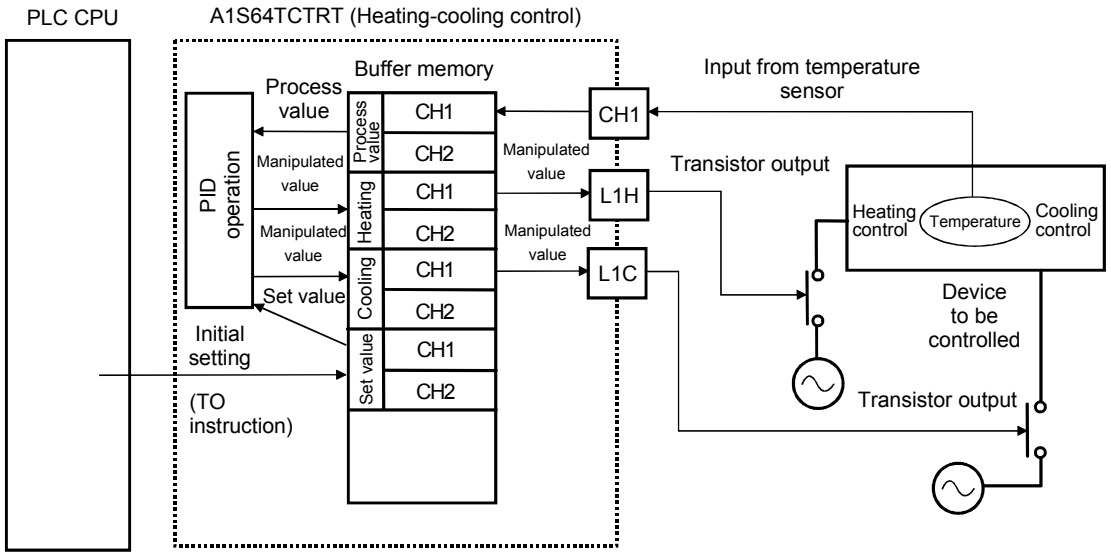

Fig.1.2 Processing of A1S64TCTRT (Heating-cooling control)

(2) What is the A1S64TCTRTBW?

In addition to the features of the A1S64TCTRT, the A1S64TCTRTBW has a function which allows detection of heater disconnection by an input signal from an external current sensor.

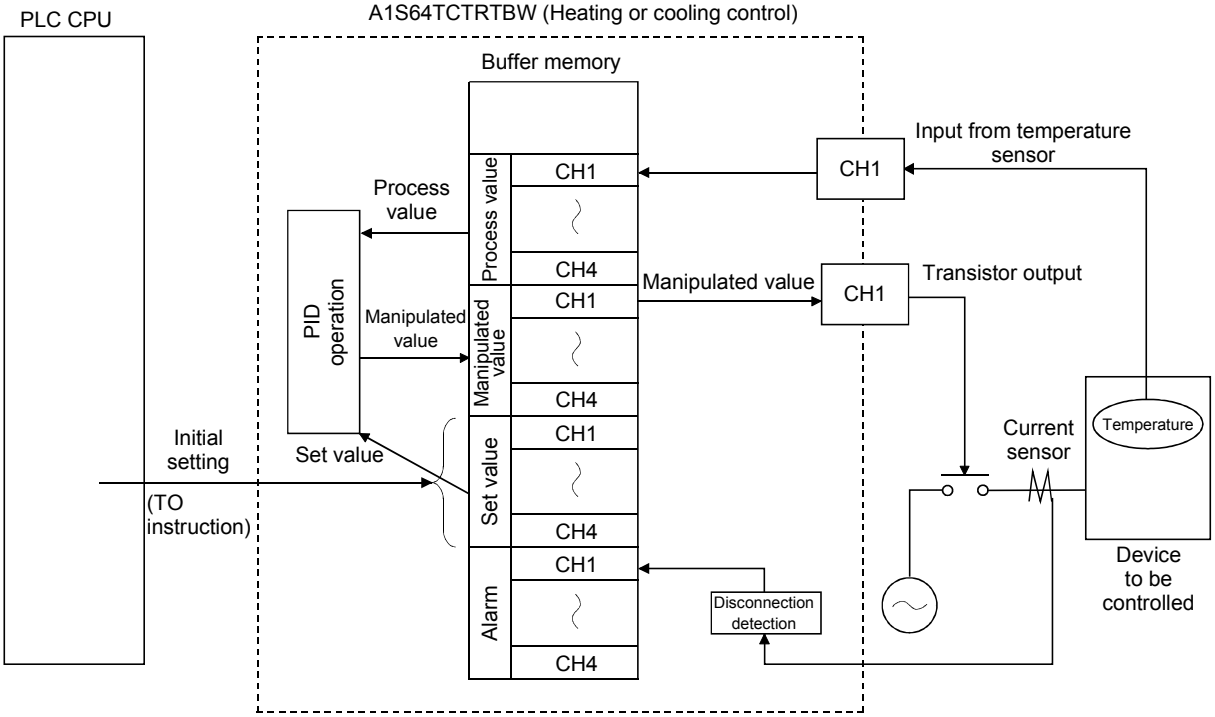

Fig.1.3 Processing of A1S64TCTRTBW (Heating or cooling control)

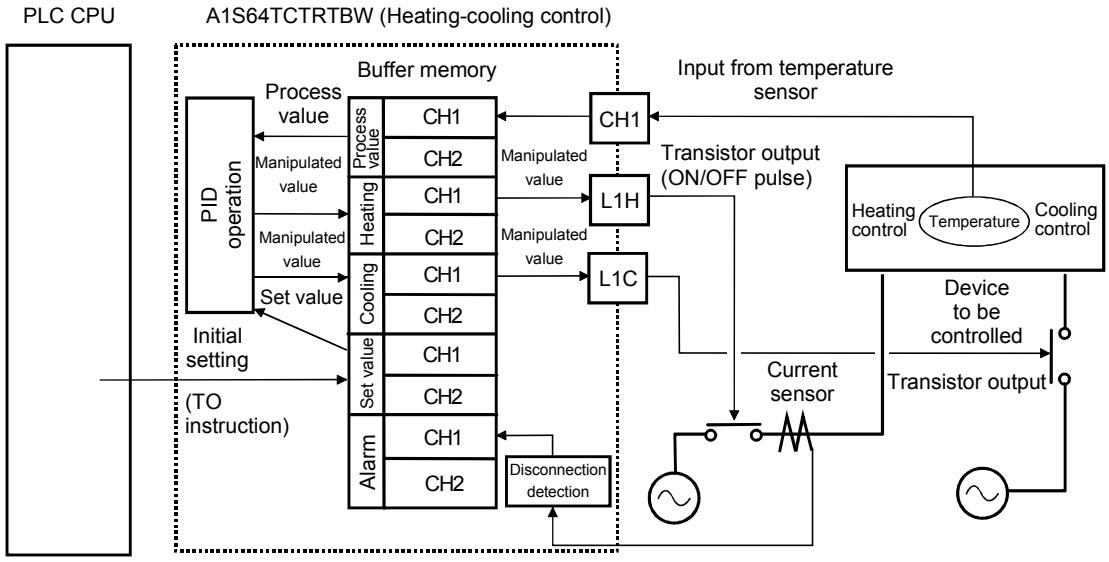

Fig.1.4 Processing of A1S64TCTRTBW (Heating-cooling control)

1.1 Features

The A1S64TCTRT(BW) has the following features.

(1) Optimum temperature adjustment control (PID control)

(a) Simply by setting PID constants required for PID operations (Proportional band (P), Integral time (I), and Derivative time (D)) and the set-point value to the A1S64TCTRT(BW), automatic temperature adjustment control is available.
No special instructions are needed for PID controls.

(b) Using the auto tuning function enables the PID constants to be set automatically by the A1S64TCTRT(BW).
Hence, you can use the equipment without being conscious of cumbersome PID operation expressions to find the PID constants.

(2) Four-loop (Standard control) or two-loop (Heating-cooling control) control

Temperature control is available with up to four loops (Standard control) or two loops (Heating-cooling control) at the same time.

(3) PID control for heating and cooling (Heating-cooling control)

Having two PID outputs (heating and cooling) for one temperature sensor input, the A1S64TCTRT(BW) offers highly reliable temperature control even for a self-heating control target.

(4) RFB limiter function

The RFB (Reset FeedBack) limiter suppresses overshooting which is liable to occur at a startup or when a temperature set value (SV) is increased.

(5) Sensor compensation function

By setting a sensor compensation value, the sensor compensation function eliminates a difference between a temperature process value (PV) and an actual temperature, if any.

(6) Thermocouples or platinum RTDs are connectable as temperature sensors.

Thermocouples or platinum RTDs can be connected. Also, the measurement range suitable for each operating temperature can be set. (Refer to Section 3.7.7.)

(7) Selectable temperature measurement unit and control temperature range

The temperature measurement unit can be set in units of 0.1°C or 1°C (centigrade) or 0.1 °F or 1 °F (Fahrenheit) for each loop, allowing selection of the resolution suitable for the control.

(8) FeRAM for backing up set values

The set values in buffer memory can be stored into FeRAM for data backup. Since data are directly written to the buffer memory using the test function of GX Developer, writing only "LD＊＊" + "OUT Yn1" to the program in the PLC CPU is needed.

(9) Detection of disconnection

The A1S64TCTRTBW can detect disconnection of a heater.

(10) Transition from existing models is possible.

Transition from existing models (A1S64TCTT(BW)-S1, A1S64TCRT(BW)-S1, A1S62TCTT(BW)-S2, A1S62TCRT(BW)-S2) is possible. New models have additional temperature conversion function and self-tuning function.

1.2 The PID Control System

(1) The PID control system

Figure 1.5 indicates the system configuration when performing PID control.

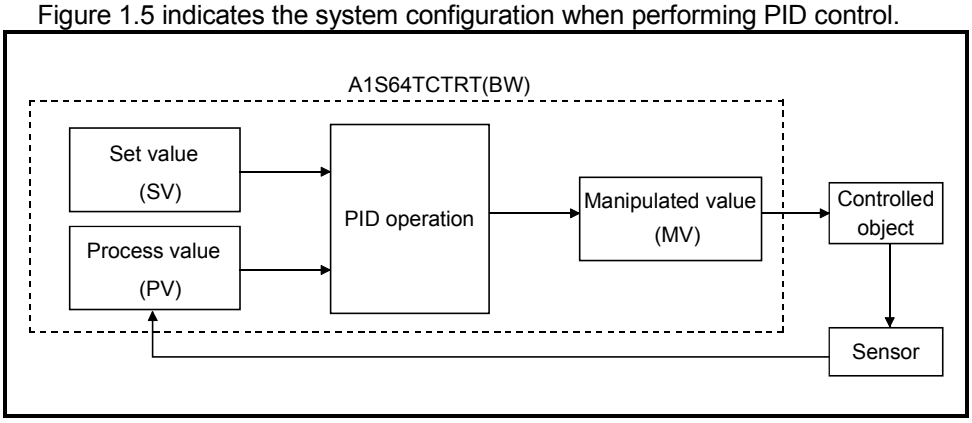

Fig. 1.5 The PID control system

(2) PID control procedure

The PID control is performed in the procedure shown in Figure 1.6 below:

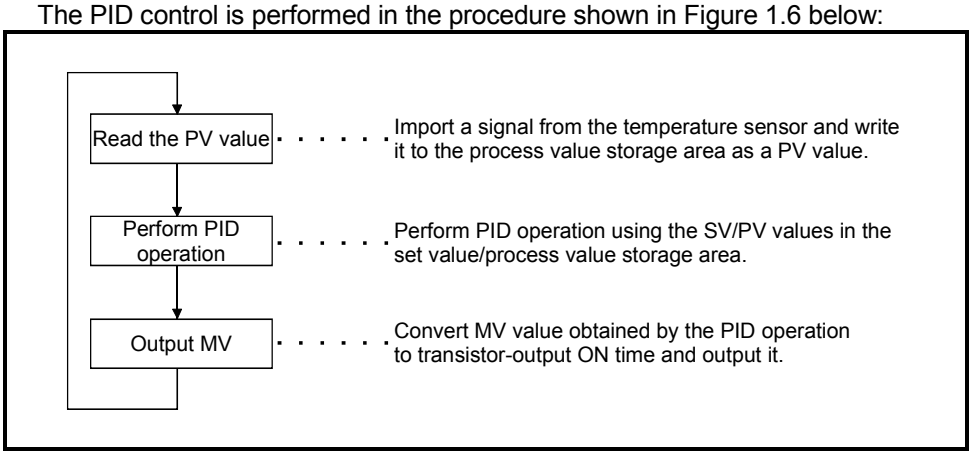

Fig. 1.6 PID control procedure

(3) PID control (simplified two-level response selection)

In general, when the P, I, and D constants that improve the "response to the setting" are set, the "response to the disturbance" degrades by the PID control. Conversely, when the P, I, and D constants that improve the "response to the disturbance" are set, the "response to the setting" degrades by the PID control. In the PID control (simplified two-level response selection) of this module, "fast", "normal", or "slow" can be selected for the "response to the setting" while the P, I, and D constants for better "response for the disturbance" are selected.

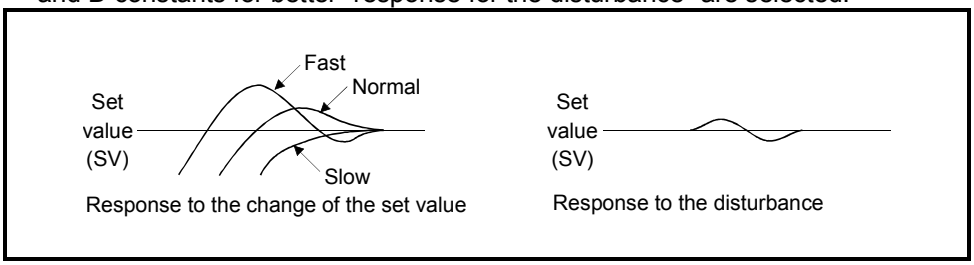

Fig. 1.7 Simplified two-level response selection

1.3 About the PID Operation

The A1S64TCRT(BW) can perform PID control in process-value incomplete differentiation.

1.3.1 Operation method and formula

The PID control in process-value incomplete differentiation is an operation method which puts the first-order delay filter as the input for derivative control action, and performs PID operation with the error value (E) after deleting the high-frequency noise component.

(1) The algorithm of the PID control in process-value incomplete differentiation is shown in Figure 1.8.

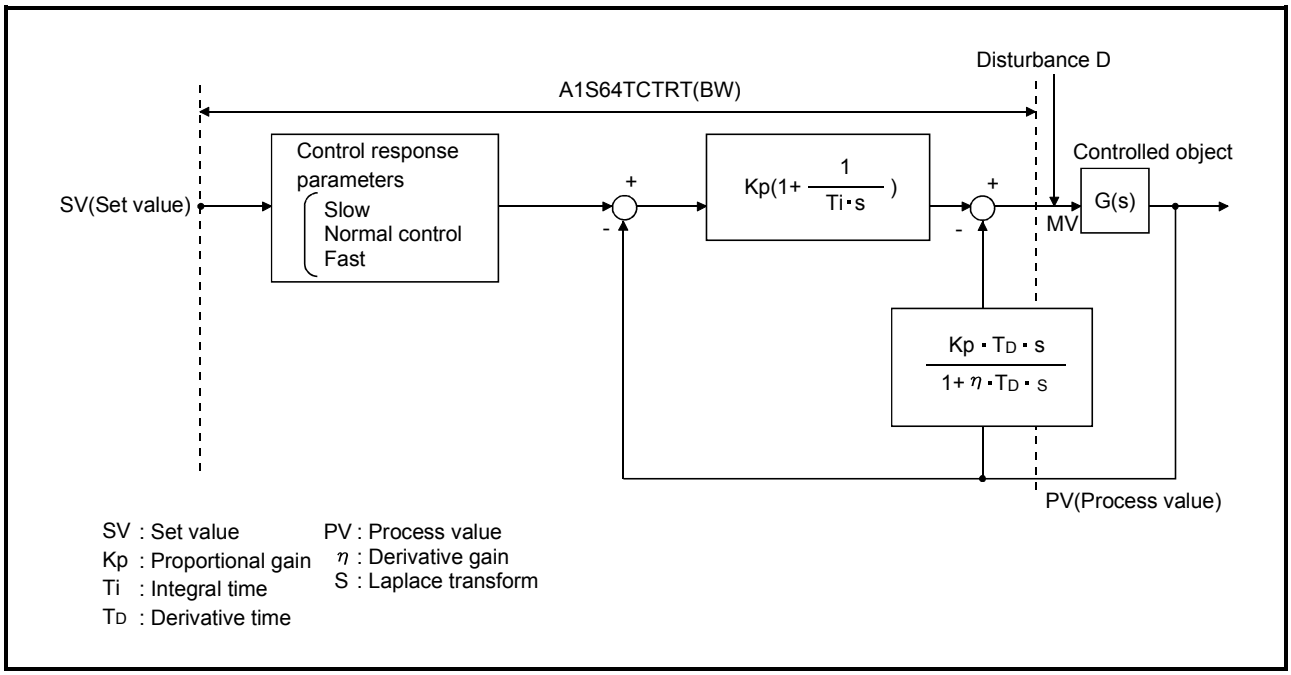

Fig. 1.8 Algorithm of PID control in process-value incomplete differentiation

(2) The formula used for A1S64TCRT(BW) is shown below:

$$MV_n = MV_{n-1} + \frac{T_D}{\tau + \eta \cdot T_D}\left\{(PV_{n-1} - PV_n) - \frac{\tau}{T_D} \cdot MV_{n-1}\right\}$$

τ : Sampling period

MV : Incomplete derivative output

PV : Process value

TD : Derivative time

$\frac{1}{\eta}$: Derivative gain

1.3.2 Proportional action (P-action)

(1) The proportional action is an action to obtain the manipulation value proportional to the deviation (difference between the set value and the process value).

(2) With the proportional action, the relationship between the changes in the deviation and manipulation value can be expressed in the following formula:

$$MV = K_P \cdot E$$

where Kp is a proportional constant and is called the proportional gain.

(3) The proportional action for the step response when the error value is constant is shown in Figure 1.9.

(4) The manipulation value changes between -5.0% and 105.0 %. As the Kp increases, the manipulation value for the same error value becomes larger, and the corrective action becomes stronger.

(5) The proportional action will generate an offset (remaining deflection).

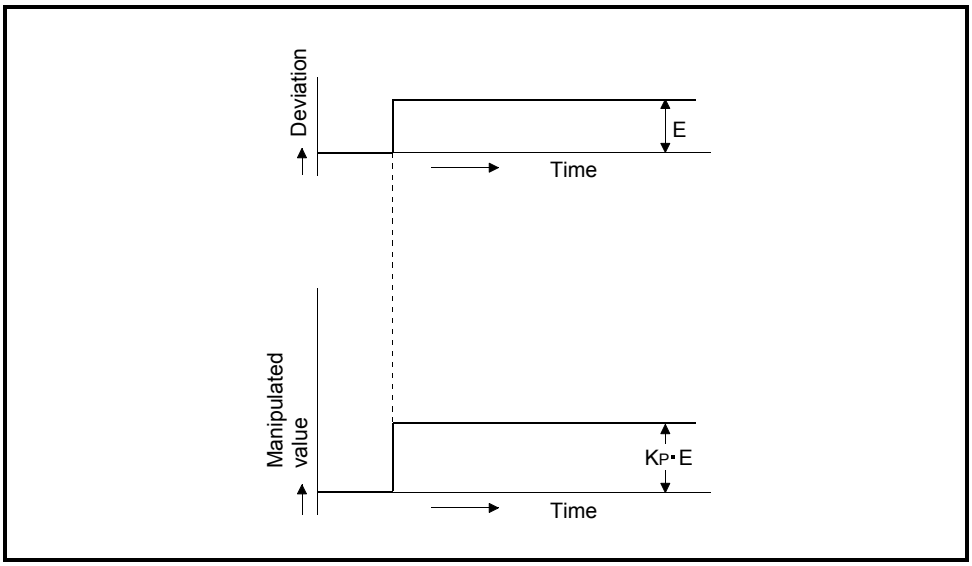

Fig. 1.9 Proportional action for step response

1.3.3 Integral action (I-action)

(1) The integral action is an action which continuously changes the manipulation value to eliminate the deviation when there is an deviation.
The offset produced by the proportional action can be eliminated.

(2) In the integral action, the time from the deviation occurrence until the manipulation value of the integral action becomes that of the proportional control action is called the integral time, and is indicated by T_I.

(3) The integral action for the step response when the error value is constant is shown in Figure 1.10.

(4) The integral action is used as a PI action in combination with the proportional action, or PID action in combination with the proportional and derivative actions.
The integral action cannot be used alone.

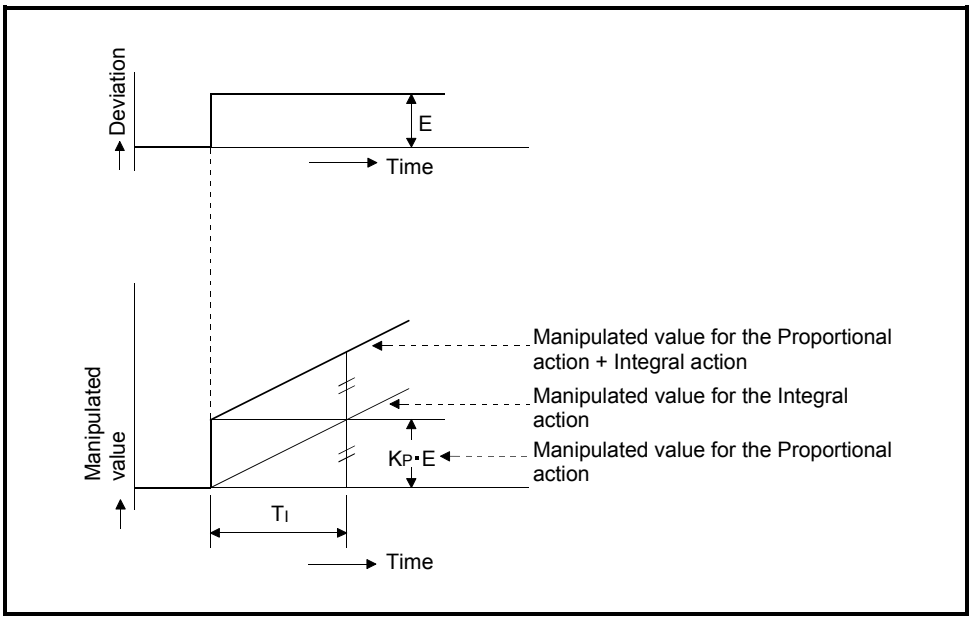

Fig. 1.10 Integral action for step response

1.3.4 Derivative action (D-action)

(1) The derivative action adds the manipulation value proportional to the change speed to eliminate error when an deviation occurs.
The derivative control action can prevent the control target from changing significantly due to disturbance.

(2) In the derivative action, the time from the deviation occurrence until the manipulation value of the derivative action becomes that of the proportional action is called the derivative time, and is indicated by T_D.

(3) The derivative action for the step response when the deviation is constant is shown in Figure 1.11.

(4) The derivative action is used as a PD action in combination with the proportional action, or PID action in combination with the proportional and integral actions.
The derivative action cannot be used alone.

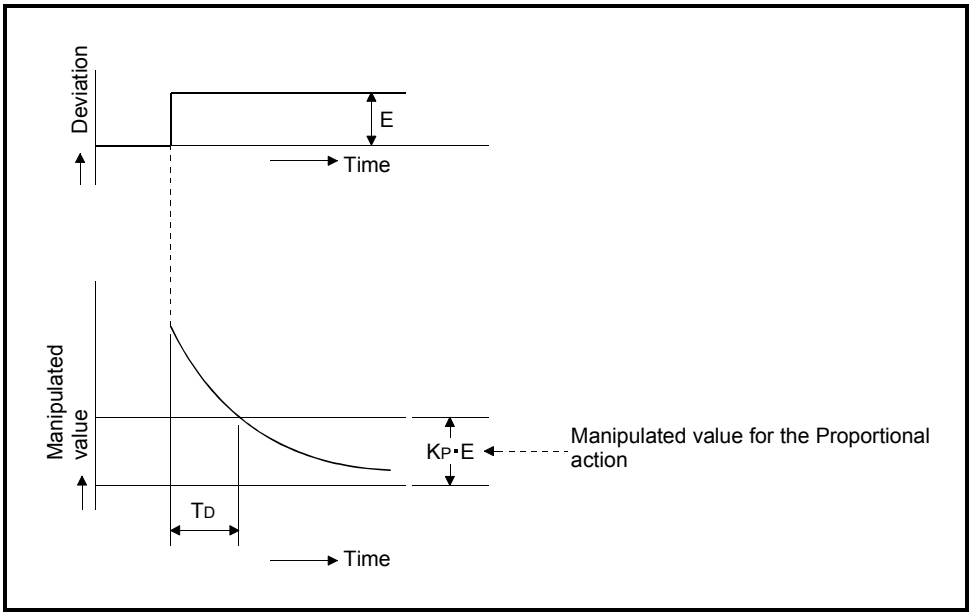

Fig. 1.11 Derivative action for step response

1.3.5 PID action

(1) The PID action performs control using the manipulation value obtained by merging proportional action, integral action and derivative action.

(2) The PID action for the step response when the deviation is constant is shown in Figure 1.12.

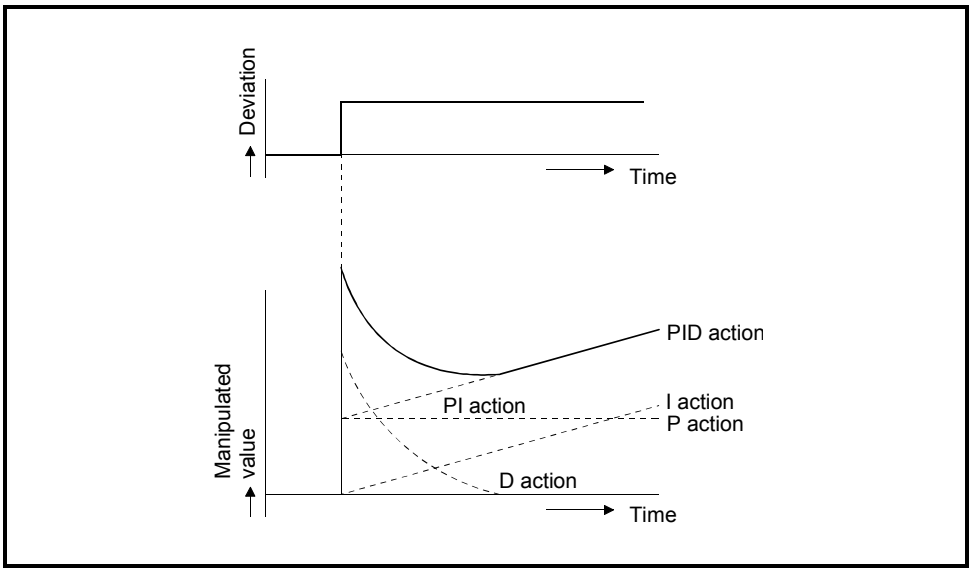

Fig. 1.12 PID action for step response

1.4 Temperature Control Modes

Either of Standard control or Heating-cooling control can be selected as a control mode of the A1S64TCTRT(BW).

1.4.1 Differences between the control modes

(1) Standard control

(a) Heating control (Reverse action)

This is performed when the Direct/reverse action setting (buffer memory address: 36H, 56H, 76H, 96H) has been set to "1: Reverse action", with "Standard control" selected by the control mode switch.

As the manipulated value (MV) increases, the process value (PV) increases and comes close to the set value (SV).

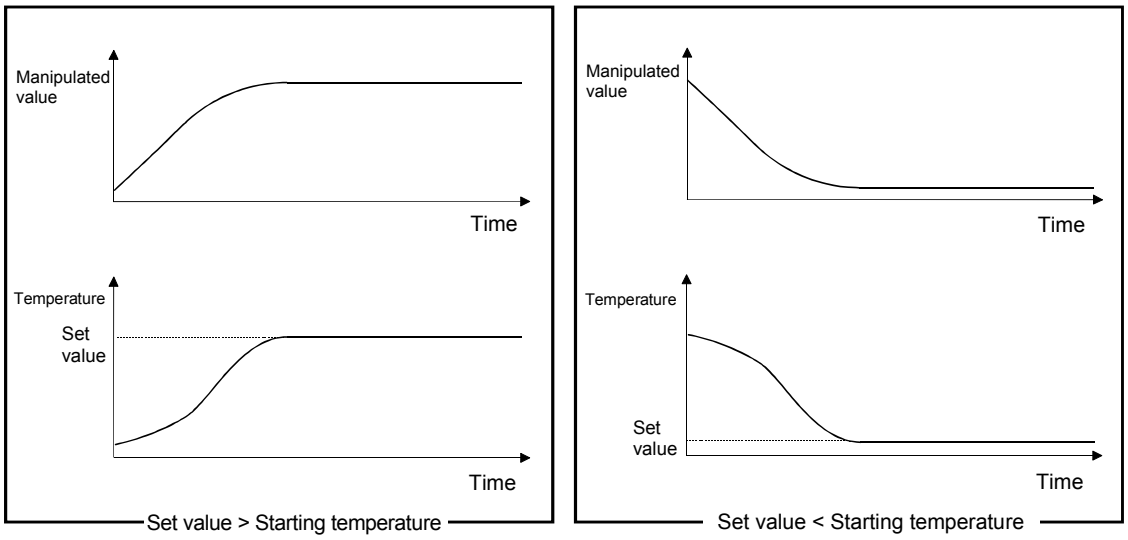

Fig.1.13 Example of process control by reverse action (heating control)

(b) Cooling control (Direct action)

This is performed when the Direct/reverse action setting (buffer memory address: 36H, 56H, 76H, 96H) has been set to "0: Direct action", with "Standard control" selected by the control mode switch.
As the manipulated value (MV) increases, the process value (PV) decreases and comes close to the set value (SV).

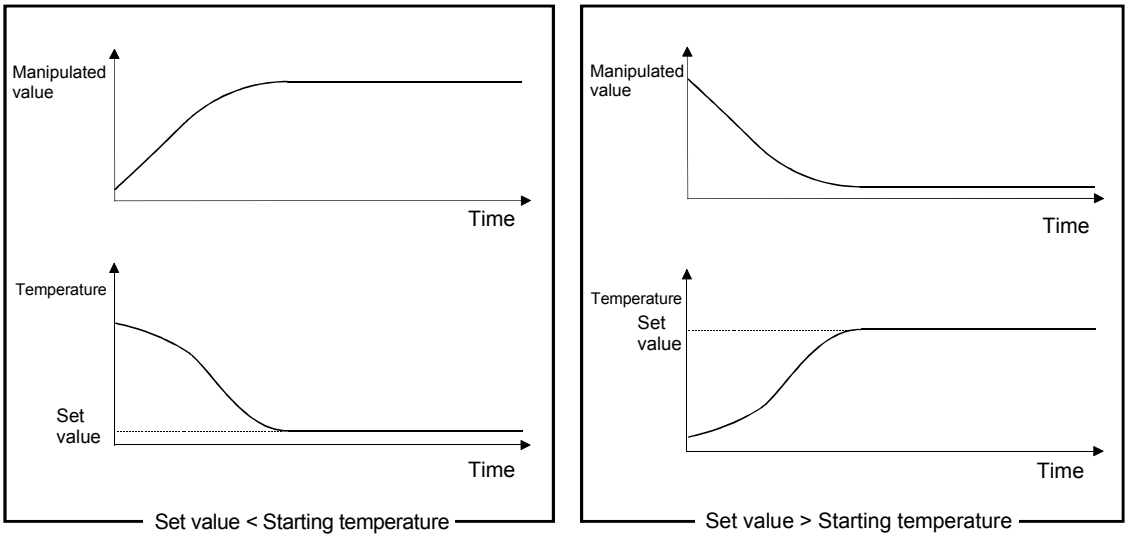

Fig.1.14 Example of process control by direct action (cooling control)

(2) Heating-cooling control

The following shows the operations when "Heating-cooling control" has been selected with the control mode switch.

The module performs arithmetic operations to derive a deviation between the process value (PV) and the set value (SV), and outputs a manipulated value for heating (MVh) or cooling (MVc) to bring the process value close to the set value (SV).

This feature offers reliable control for the control target such as a cylinder of an extruding machine for which both heating and cooling are required. By the Overlap/dead band setting (buffer memory address: D3H, E3H), the user can set a region where both or none of the manipulated values for heating (MVh) and cooling (MVc) are output. (Refer to Section 3.3.13.)

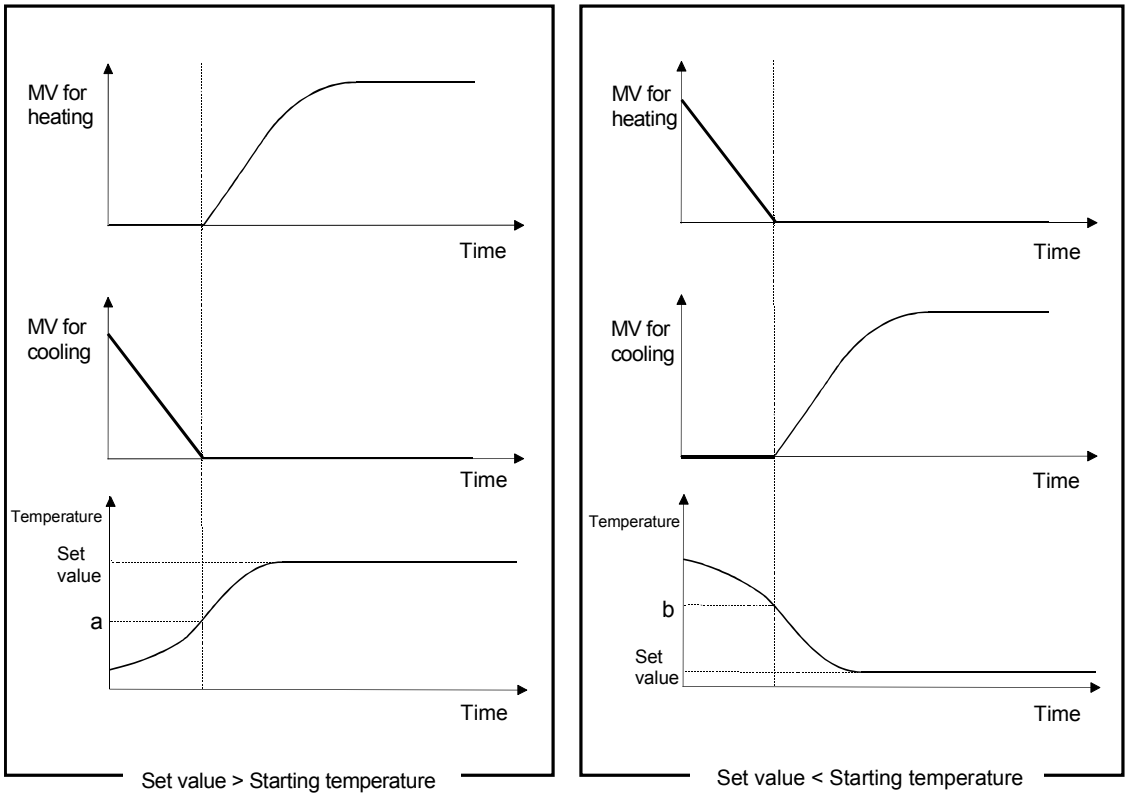

Fig.1.15 Example of process control by heating-cooling control

*1 The Overlap/dead band setting is not made for this example. Depending on the relation between the set value (SV) and process value (PV), either of the manipulated value for heating (MVh) or the manipulated value for cooling (MVc) will be output. (In Fig.1.15, when the starting temperature is higher than point "a" or lower than point "b", only MVh or MVc is output accordingly.)

2 SYSTEM CONFIGURATIONS

2.1 Applicable Systems

(1) Applicable CPU

- A1SJCPU(S3)
- A1SJHCPU(S8)
- A1SCPU(S1)
- A1SCPUC24-R2
- A1SHCPU
- A2SCPU
- A2SHCPU
- A2ASCPU(S1/S30)
- A2USHCPU-S1
- Q2ASCPU(S1)
- Q2ASHCPU(S1)
- A52GCPU
- Q02CPU-A
- Q02HCPU-A
- Q06HCPU-A

(2) Number of mountable A1S64TCTRT(BW)s

Any number of A1S64TCTRT(BW)s can be mounted as long as the number of I/O points of the applicable PLC CPU is not exceeded.

(3) Loading slot

Except in the following cases, an A1S64TCTRT(BW) can be loaded in any slot of a base unit.

If it is installed on an extension base unit without power supply module (A1S52B(S1), A1S55B(S1) or A1S58B(S1)), the power capacity may be insufficient.

If such installation is unavoidable, select a proper power supply module, main and extension base units and extension cables, taking the following factors into consideration:

(a) capacity of the power supply module on the main base unit,
(b) voltage drop in the main base unit,
(c) voltage drop in the extension base unit, and
(d) voltage drop in the extension cable.

(4) Data link system

The A1S64TCTRT(BW) can be loaded on any of the master, local and remote I/O stations in a data link system. For examples of remote I/O station programs, refer to the MELSECNET and MELSECNET/B Data Link System Reference Manuals.

REMARK

For I/O point ranges and calculation of voltage drop, refer to the following manuals:

- A1SJCPU(S3) User's Manual..... IB(NA)66446
- A1S/A1SC24-R2/A2SCPU(S1) User's Manual ..... IB(NA)66320
- A2ASCPU(S1/S30) User's Manual ..... IB(NA)66455
- A2USHCPU-S1 User's Manual ..... IB(NA)66789
- A1SJH(S8)/A1SH/A2SHCPU(S1) User's Manual ..... IB(NA)66779
- Q2AS(H)CPU(S1) User's Manual ..... SH(NA)3599
- QCPU-A(A mode) User's Manual
  Q02CPU-A/Q02HCPU-A/Q06HCPU-A..... SH(NA)080065

3 SPECIFICATIONS

This chapter describes the general specifications, performance specifications, I/O conversion characteristics, and buffer memory specifications of the A1S64TCTRT(BW).

3.1 General Specifications

Table 3.1 shows the general specifications of the A1S64TCTRT(BW).

Table 3.1 General Specifications

<table>
<tr><th>Item</th><th colspan="6">Specifications</th></tr>
<tr><td>Operating ambient temperature</td><td colspan="6">0 to 55°C</td></tr>
<tr><td>Storage ambient temperature</td><td colspan="6">-20 to 75°C</td></tr>
<tr><td>Operating ambient humidity</td><td colspan="6">10 to 90%RH, non-condensing</td></tr>
<tr><td>Storage ambient humidity</td><td colspan="6">10 to 90%RH, non-condensing</td></tr>
<tr><td rowspan="5">Vibration resistance</td><td rowspan="5">Conforming to JIS B 3502, IEC 61132-2</td><td></td><td>Frequency</td><td>Acceleration</td><td>Amplitude</td><td>Sweep Count</td></tr>
<tr><td rowspan="2">When there is Intermittent vibration</td><td>10 to 57 Hz</td><td>—</td><td>0.075mm (0.0030inch)</td><td rowspan="4">10 times each in X, Y and Z axis (80 minutes)</td></tr>
<tr><td>57 to 150 Hz</td><td>9.8m/s^2</td><td>—</td></tr>
<tr><td rowspan="2">When there is continuous vibration</td><td>10 to 57 Hz</td><td>—</td><td>0.035mm (0.0013inch)</td></tr>
<tr><td>57 to 150 Hz</td><td>4.9m/s^2</td><td>—</td></tr>
<tr><td>Shock resistance</td><td colspan="6">Conforming to JIS B 3502, IEC 61132-2 (147m/s^2, 3 times each in 3 directions)</td></tr>
<tr><td>Operating environment</td><td colspan="6">No corrosive gas present</td></tr>
<tr><td>Operating height</td><td colspan="6">2000 m (6562 it) or less</td></tr>
<tr><td>Installation area</td><td colspan="6">On the control panel</td></tr>
<tr><td>Over-voltage category*1</td><td colspan="6">II or less</td></tr>
<tr><td>Pollution rate*2</td><td colspan="6">2 or less</td></tr>
</table>

*1: Indicates the distribution area where the device is assumed to be connected, from the public power distribution network to the local machine device.
Category II is applied to the devices to which the power is supplied from a fixed equipment
The surge resistance voltage of a rated 300 V device is 2500 V.

*2: This is an index which Indicates the occurrence rate of the conductive object in the environment where the device is used.
Pollution rate II indicates that only non-conductive pollution may occur with a possibility of generating temporary conductivity due to accidental condensation.

*3: Do not operate or store the programmable controller in the environment where the pressure applied is equal to greater than the atmospheric pressure at the altitude of 0m.
Doing so may cause a malfunction. Please consult our branch office when the programmable controller is to be operated under such a pressure.

3.2 Performance Specifications

3.2.1 Performance specifications of the A1S64TCTRT (BW)

(1) Common specifications

Table 3.2 Common specifications of the A1S64TCTRT (BW)

Item		Specifications	
		A1S64TCTRT	A1S64TCTRTBW
Control output		Transistor output	
Applicable temperature sensor		Refer to Section 3.5, 3.6	
Specification accuracy[*1]	Ambient temperature :25°C ± 5°C	Full scale × (±0.3%)±1 digit[*2]	
	Ambient temperature : 0°C to 55°C	Full scale × (±0.7%)±1 digit[*2]	
Control output period		1 to 100s	
Input filter		0 to 100s (0: input filter off)	
Sensor compensation value setting		-50.00 to 50.00%	
Set value setting range		Within the temperature range set by the temperature sensor to be used.	
Dead zone setting range		0.1 to 10.0%	
Transistor output	Output signal	ON/OFF Pulse	
	Rated load voltage	10.2 to 30.0VDC (Peak voltage 30.0V)	
	Maximum load current	0.1A/point 0.4A/common	
	Maximum inrush current	0.4A 10ms	
	Maximum leakage current when OFF	0.1mA or less	
	Maximum voltage drop when ON	1.0VDC (TYP) 0.1A 2.5VDC (MAX) 0.1A	
	Response time	OFF → ON: 2ms or less ON → OFF: 2ms or less	
No. of reads/writes to FeRAM[*3]		Up to 10^{12} times	
Insulation system		Between the input terminal and programmable controller power supply:Transformer isolation Between input channels : Transformer isolation	
Dielectric withstand voltage		Between the input terminal and programmable controller power supply :500VAC, 1min. Between input channels : 500VAC, 1min.	
Insulation resistance		Between the input terminal and programmable controller power supply :500VDC 10MΩ or more Between input channels : 500VDC 10MΩ or more	
Heater disconnection detection specifications	Current sensor	—	The following current sensor made by URD Co., Ltd.Input accuracy • CTL-12-S36-8(0.0 to 100.0A) • CTL-6-P-H(0.00 to 20.00A)
	Input method		Multiplexer method A/D conversion
	Input accuracy		Full scale × (±1.0%)
	Alarm delay count		3 to 255
I/O occupied points		32 points (I/O assignment : special 32 points)	
Connection terminal		20-point terminal block	
Supported cable size		0.75 to 1.5 [mm^2]	
Supported solderless terminal		R1.25-3,1.25-YS3,RAV1.25-3,V1.25-YS3A	
Internal current consumption		0.33A (0.19A)[*4]	0.39A (0.25A)[*4]
Weight		0.26kg	0.28kg
External dimensions (mm) [inch]		130 (H) × 34.5 (W) × 93.6 (D) [5.12 × 1.36 × 3.69]	

*1: Accuracy is calculated as follows:
(Accuracy) = (Specification accuracy) + (Cold junction compensation accuracy)
Example) The accuracy for input range setting "38 (Thermocouple K -200.0 to 400.0°C, units of 0.1°C)", operating ambient temperature of 35°C, measured temperature value of 300°C
[Full scale] x [±0.7%] + [±1digit] + [Cold junction compensation accuracy]
= {400.0 - (-200.0)} x (±0.007) + (±0.1) + (±0.1) = ±5.3°C
*2: The value for "±1digit" varies depending on the input range used.
When the setting unit is 1°C, it is "±1°C", and "±0.1°C" for "0.1°C".
*3: This is the total number of times that reading and writing can be performed.
Reading or writing are executed at the following timing:
(1) Read timing
1) Power-ON
2) PID control start from stop status
(2) Write timing
1) When writing initial setting data
2) When the module writes the manipulated value (MV) every sampling cycle (0.5s).
*4: These are current values applied when not using the temperature conversion function for unused channels in Heating-cooling control mode.
*5: For the noise resistance, dielectric withstand voltage, and insulation resistance for the programmable controller system which uses this module, refer to the power supply module specifications given in the CPU Module User's Manual.

(2) Specifications by application (temperature sensor)

Table 3.3 The A1S64TCTRT (BW) specifications by application (temperature sensor)

Item		Specifications	
		Thermocouple	Platinum RTD
Effect of external resistance		0.35 μV/ Ω	—
Input impedance		1M Ω	—
Sensor current		—	Approx. 0.3mA
Allowable input wire resistor effects		—	10 Ω or less
When sensor input is disconnected		Up-scale processing	Up-scale processing
When sensor input is short-circuited		—	Down-scale processing
Cold junction compensation accuracy (Ambient temperature: 0 to 55°C)	Measured temperature: -100°C or more	Within ±1.0°C	—
	Measured temperature: -150 to -100°C	Within ±2.0°C	—
	Measured temperature: -200 to -150°C	Within ±3.0°C	—

(3) Specifications by application (control mode)

Table 3.4 The A1S64TCTRT (BW) specifications by application (control mode)

Item		Specifications	
		Standard control	Heating/cooling control
Temperature input points		4-channel/module	2-channel/module
Sampling cycle		0.5s/4 channels (Constant regardless of the number of channels used)	0.5s/2 channels (Constant regardless of the number of channels used)
Temperature control method		PID ON/OFF pulse or 2-position control	PID ON/OFF pulse
PID constant range	PID constant setting	Auto-tuning or Self-tuning setting is possible.	Auto-tuning setting is possible.
	Proportional region (P)	0.0 to 1000.0% (0.0: 2-position control)	0.1 to 1000.0%
	Integral time (I)	1 to 3600 s	
	Derivative time (D)	0 to 3600 s	
Cooling type setting		—	Air-cooling/Water-cooling
Dead zone setting range		0.0 to 10.0%	—

3.2.2 Applicable temperature sensor types, measured temperature ranges, and data resolutions

(1) When using a thermocouple

Table 3.5 List of thermocouple types, measured temperature ranges, and data resolutions

Thermocouple Type	°C		°F	
	Measured temperature range	Data resolution	Measured temperature range	Data resolution
R	0 to 1700	1	0 to 3000	1
K	0 to 500 0 to 800 0 to 1300	1	0 to 1000 0 to 2400	1
	-200.0 to 400.0 0.0 to 400.0 0.0 to 500.0 0.0 to 800.0	0.1	0.0 to 1000.0	0.1
J	0 to 500 0 to 800 0 to 1200	1	0 to 1000 0 to 1600 0 to 2100	1
	0.0 to 400.0 0.0 to 500.0 0.0 to 800.0	0.1	0.0 to 1000.0	0.1
T	-200 to 400 -200 to 200 0 to 200 0 to 400	1	0 to 700 -300 to 400	1
	-200.0 to 400.0 0.0 to 400.0	0.1	0.0 to 700.0	0.1
S	0 to 1700	1	0 to 3000	1
B	400 to 1800	1	800 to 3000	1
E	0 to 400 0 to 1000	1	0 to 1800	1
	0.0 to 700.0	0.1	—	—
N	0 to 1300	1	0 to 2300	1
U	0 to 400 -200 to 200	1	0 to 700 -300 to 400	1
	0.0 to 600.0	0.1	—	—
L	0 to 400 0 to 900	1	0 to 800 0 to 1600	1
	0.0 to 400.0 0.0 to 900.0	0.1	—	—
PL II	0 to 1200	1	0 to 2300	1
W5Re/W26Re	0 to 2300	1	0 to 3000	1

(2) When using a platinum RTD

Table 3.6 List of applicable platinum RTDs, measured temperature ranges, and data resolutions

Platinum RTD Type	°C		°F	
	Measured temperature range	Data resolution	Measured temperature range	Data resolution
Pt100	-200.0 to 600.0	0.1	-300 to 1100	1
	-200.0 to 200.0		-300.0 to 300.0	0.1
JPt100	-200.0 to 500.0	0.1	-300 to 900	1
	-200.0 to 200.0		-300.0 to 300.0	0.1

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3.3 Function Summary

The functions of the A1S64TCTRT(BW) are listed in Table 3.7 to Table 3.10.

(1) Common functions

Table 3.7 Common functions list

Item	Specification	Reference
Auto-tuning function	• The temperature control module automatically sets the optimal PID constants.	3.3.1
Self-tuning function	• The temperature control module constantly monitors the control status, and if the control is affected by disturbance, automatically changes and/or sets PID constants for the optimum control.	3.3.2
Alert alarm	• Monitors the process value (PV) and alerts the user.	3.3.3
RFB limiter function *1	• Suppresses the manipulation value overshoot which frequently occurs when the set value (SV) is changed or the control target is changed.	3.3.4
Sensor compensation function	• Reduces the difference between the measured value and actual temperature to zero when these two are different due to measurement conditions, etc.	3.3.5
Unused channel setting	• Sets inexecution of the PID operation for channels that do not perform temperature adjustment.	3.3.6
Forced PID control stop	• Stops the PID operation for channels that is performing temperature adjustment.	3.3.7
Data storage in FeRAM	• By backing up the buffer memory contents to FeRAM, the load of sequence program can be reduced.	3.3.8
A1S64TCTRT(BW) control function	• The A1S64CTTRT(BW) can be controlled by output signals of A1S64TCTRT(BW) and the settings in the buffer memory.	3.3.9

*1 Since the RBF limiter function is automatically activated in the PID control, no setting is needed.

(2) Functions for Standard control

Table 3.8 List of functions for Standard control

Item	Specification	Reference
Direct/reverse action selection	• Heat control (reverse action) or cooling control (direct action) can be selected and controlled.	3.3.10
Loop disconnection detection function	• Detects errors in the control system (control loop) caused by a load (heater) disconnection, abnormal external operation device (such as magnet relay), or sensor disconnection.	3.3.11

(3) Functions for Heating-cooling control

Table 3.9 List of functions for Heating-cooling control

Item	Specification	Reference
Cooling type setting function	• This function allows setting of an auto-tuning operation formula according the capacity of the selected cooling system (water- or air-cooling).	3.3.12
Overlap/dead band function	• To a temperature region where output is going to be switched between heating and cooling, whether to output both (overlap) or none of them (dead band) can be set.	3.3.13
Temperature conversion function (utilizing unused channels)	• Utilizing input channels that are not used for the control (monitor channel 1, 2), temperature conversion can be performed.	3.3.14

(4) Functions for heater disconnection detection

Table 3.10 List of functions for heater disconnection detection

Item	Specification	Reference
Heater disconnection detection function	• Measures the current that flows in the heater main circuit and detects disconnection when the A1S64TCTRTBW is used.	3.3.15
Current error detection function when output is off	• When the A1S64TCTRTBW is used, this function measures the current in the heater's main circuit while the transistor's output is off, and checks if there is a current error when output is off.	3.3.16

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3.3.1 Auto tuning function

(1) What is the auto tuning function?

The auto tuning function is designed for the A1S64TCTRT(BW) to set the optimum PID constants automatically.
In auto tuning, the PID constants are calculated according to the hunting cycle and amplitude which take place when a manipulated value turned on/off alternates between overshooting and undershooting a set value.
The auto tuning is executable if data given in Table 3.11 have been set up. *1
Note that, because actual control is performed upon completion of auto tuning, other data must have been set to values for actual operation.

*1 In Standard control, the auto tuning is not executed if 0 is set for the proportional band (P).

Table 3.11 Data to be set before auto tuning

Setting item					Setting item is: ○: Present — : None	
Buffer memory name	Buffer memory address					
	CH1	CH2	CH3	CH4	Standard control	Heating-cooling control
Input range	20H	40H	60H	80H	○	○
Set value (SV) setting	22H	42H	62H	82H	○	○
Upper output limiter	2AH	4AH	6AH	8AH	○	—
Lower output limiter	2BH	4BH	6BH	8BH	○	—
Output variation limiter	2CH	4CH	6CH	8CH	○	—
Sensor compensation value setting	2DH	4DH	6DH	8DH	○	○
Control/Heating output period setting	2FH	4FH	6FH	8FH	○	○
Primary delay digital filter setting	30H	50H	70H	90H	○	○
AUTO/MAN mode switching	32H	52H	72H	92H	○	—
AT bias	35H	55H	75H	95H	○	—
Direct/reverse action setting	36H	56H	76H	96H	○	—
Cooling type setting	CFH		—	—	—	○
Cooling output period setting	D2H	E2H	—	—	—	○

After completion of the auto tuning, calculated values are stored in the buffer memory shown in Table 3.12.

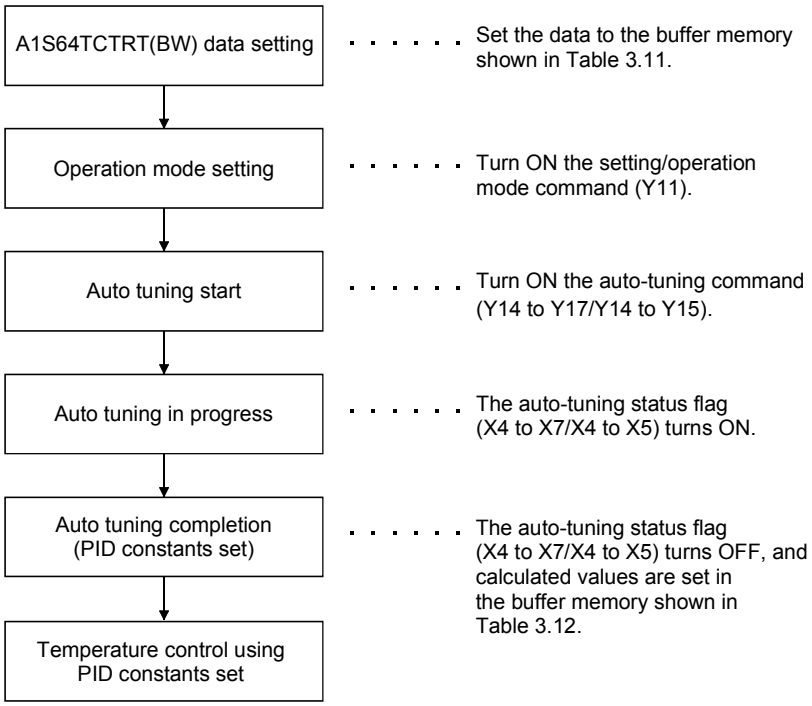
Table 3.12 Data updated after auto tuning

Setting item					Setting item is ○: Present — : None	
Buffer memory name	Buffer memory address					
	CH1	CH2	CH3	CH4	Standard control	Heating-cooling control
Proportional band (P) setting	23H	43H	63H	83H	○	○
Integral time (I) setting	24H	44H	64H	84H	○	○
Derivative time (D) setting	25H	45H	65H	85H	○	○
Loop disconnection detection judgment time	3BH	5BH	7BH	9BH	○*2	—
Cooling proportional band (Pc) setting	D0H	E0H	—	—	—	○

*2 In the case of Standard control, a value twice the calculated integral time is set for the loop disconnection detection judgment time.
If "0" was set for the loop disconnection detection judgment time at start of the auto tuning, however, the value "0" remains unchanged.

(2) Executing auto-tuning

Auto tuning is performed in the following procedure.



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(3) Auto-tuning operation

The auto-tuning operation is as shown in Fig. 3.1 or Fig.3.2.

(a) Output is performed based on the auto tuning.

(b) Data acquisition is started at the time point that the process value reached the set value after the first overshoot.

(c) Different processing is performed depending on whether the auto tuning completed successfully or failed.
For causes of abnormal termination, refer to section (4).

[When normally completed]

After the data acquisition, the following processing is performed to terminate the auto tuning.

1) PID constants are set.
2) In the case of Standard control, the loop disconnection detection judgment time (buffer memory address: 3BH, 5BH, 7BH, 9BH) is set. However, no value is set if the auto tuning starts with "0" set in the setting area.
3) The tuning status flag (X4 to X7/X4 to X5) turns OFF.

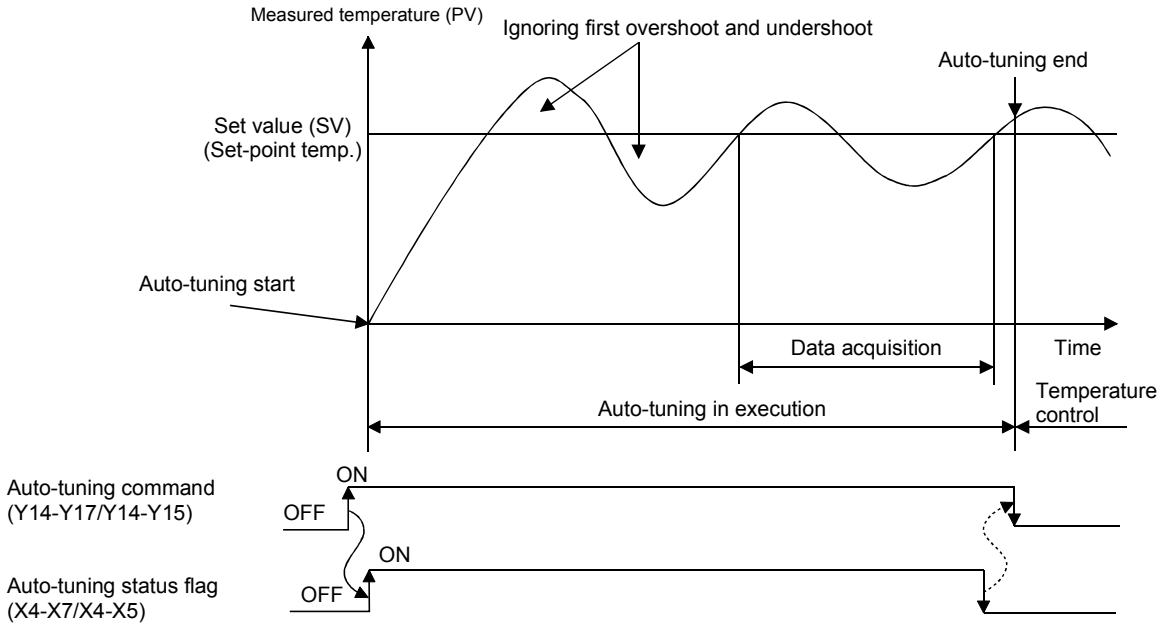

Fig.3.1 Auto-tuning operation (When normally completed)

[When failed]

Data acquisition is stopped and the auto tuning is terminated.

1) The tuning status flag (X4 to X7/X4 to X5) turns OFF.
2) PID constants and the loop disconnection detection judgment time (buffer memory address: 3BH, 5BH, 7BH, 9BH) are not set.

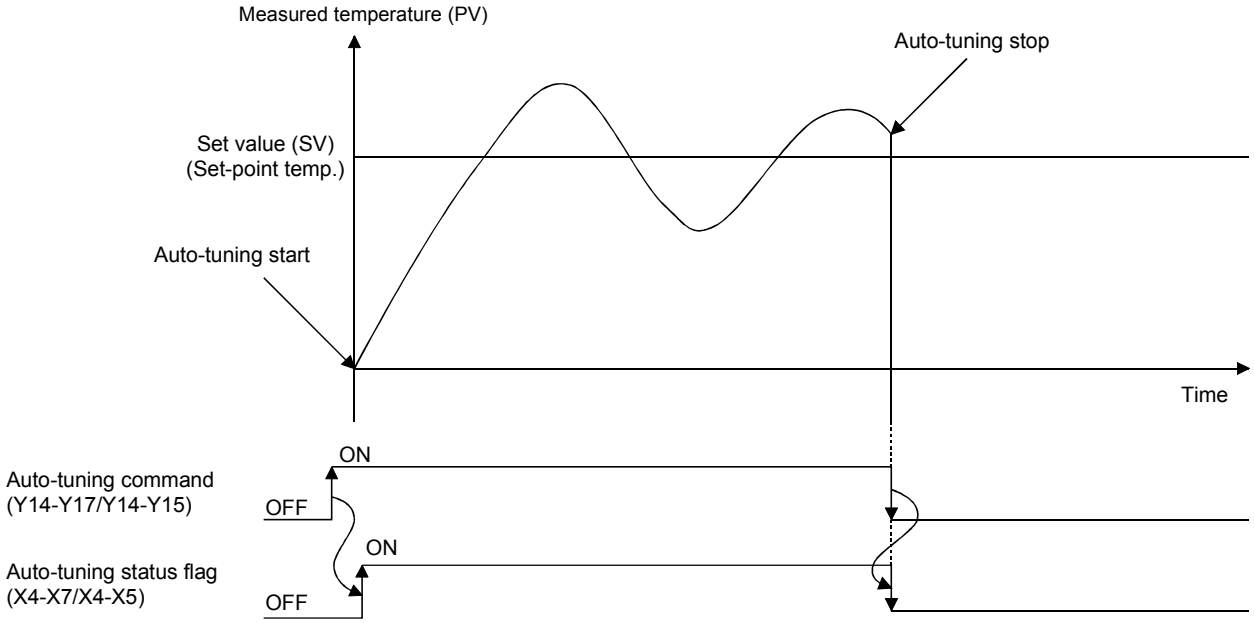

Fig.3.2 Auto-tuning operation (When failed)

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(4) Conditions for auto-tuning start and causes of error termination

Auto tuning is not executable when any of the conditions listed below is met at its start. In such a case, although the tuning status flag (X4 to X7/X4 to X5) turns OFF from ON, it does not mean completion of the auto tuning. Therefore, PID constants, the loop disconnection detection judgment time is not changed.

(a) The Setting mode (Y11: OFF) is active.
(b) In Standard control, 0 is set in the Proportional band (P) setting (buffer memory address: 23H, 43H, 63H, 83H). (Two-position control)
(c) The AUTO/MAN setting (buffer memory address: 32H, 52H, 72H, 92H) is set to 1 (Manual).
(d) In the Unused channel setting (buffer memory address: 3DH, 5DH, 7DH, 9DH/3DH, 5DH), the channel to be used is set to 1 (Unused).
(e) The forced PID control stop command (Y1A to Y1D/Y1A to Y1B) is ON.
(f) Hardware failure (The "RUN" LED flashes at 1s intervals.)
(g) The temperature process value (PV) (buffer memory address: 9H to CH/9H to AH) is out of the measurement range (Refer to Section 3.7.3.)
(h) The temperature sensor is not connected properly.

If any of the conditions shown below is met during auto-tuning execution, the auto-tuning will fail. In such a case, although the tuning status flag (X4 to X7/X4 to X5) turns OFF from ON, the auto-tuning has failed. Therefore, PID constants and the loop disconnection detection judgment time are not changed.
Also, an error code is stored in the Error code (buffer memory address: 0H). (Refer to Section 6.1.)

(a) The setting/operation mode command (Y11) was turned OFF. (Except for the case where the PID continuation flag (buffer memory address: A9H) is set to "Continue".)
(b) Any value in the buffer memory shown in Table 3.13 was changed during auto-tuning execution.

Table 3.13 Data not to be changed during auto-tuning

Setting item	Buffer memory address (HEX)			
	CH1	CH2	CH3	CH4
Set value (SV) setting	22_H	42_H	62_H	82_H
Upper output limiter	$2A_H$	$4A_H$	$6A_H$	$8A_H$
Lower output limiter	$2B_H$	$4B_H$	$6B_H$	$8B_H$
Sensor compensation value setting	$2D_H$	$4D_H$	$6D_H$	$8D_H$
Primary delay digital filter setting	30_H	50_H	70_H	90_H
AUTO/MAN mode switching	32_H	52_H	72_H	92_H
AT bias	35_H	55_H	75_H	95_H
Direct/reverse action setting	36_H	56_H	76_H	96_H
Unused channel setting	$3D_H$	$5D_H$	$7D_H$	$9D_H$

(c) The temperature process value (PV) (buffer memory address: 9H to CH/9H to AH) is out of the measurement range (Refer to Section 3.7.3.)
(d) The forced PID control stop command (Y1A to Y1D/Y1A to Y1B) was turned ON.
(e) A hardware error has occurred.
(f) In Standard control, the value in the Proportional band (P) setting (buffer memory address: 23H, 43H, 63H, 83H) was changed to zero (0). (Two-position control)

(g) The set value (SV) fell out of the setting range by changing the upper setting limiter (buffer memory address: 37H, 57H, 77H, 97H / 37H, 57H) or lower setting limiter (buffer memory address: 38H, 58H, 78H, 98H /38H, 58H).

(h) The value in the AUTO/MAN setting (buffer memory address: 32H, 52H, 72H, 92H) was changed to 1 (Manual).

(5) Adjustment after auto-tuning

(a) The PID constants calculated by the auto-tuning need not be specially readjusted.

(b) To change the control response without changing the PID constants calculated by the auto-tuning, set up the Control response parameter (buffer memory address: 31H, 51H, 71H, 91H /31H, 51H).

REMARK

1) The auto-tuning time elapsed from start to end varies depending on the control target.
2) The completion of the auto-tuning can be confirmed by the fact that the tuning status flag (X4 to X7/X4 to X5) turns OFF from ON.
3) To use the PID constants calculated by the auto-tuning after turning off the programmable controller CPU, perform the following:
   • Write them to the buffer memory with the sequence program.
   • Back them up to the FeRAM and transfer them to the buffer memory at power-ON of the programmable controller CPU.
4) If the auto-tuning is not complete after a long time has elapsed, check the following:
   • Check for incorrect connection of the loads and externally operating devices. If incorrectly connected, correct it and execute the auto-tuning.
   • When using the reverse action, check if the set value is different from the actual control temperature (if it is lower than the measured temperature value). If it is different, correct the set value and execute the auto-tuning.
   • When the response from the control target is slow, wait until the auto-tuning is completed. (Up to two hours)
5) After completion of the auto-tuning, if the PID constants were not changed, check if they were written from the sequence program. If so, modify the program so that the related program part will not be executed.

3.3.2 Self-tuning function

(1) What is the self-tuning function?

The self-tuning function allows the A1S64TCTRT(BW) to constantly monitor the control status, and to change or set PID constants automatically when the measured value of the control target goes erratic due to power-on, change of the set value (SV), or characteristic change of the control target device.
In the self-tuning, unlike in the auto-tuning, the module observes the normal control response waveform to automatically calculate and set PID constants. Therefore, the optimal PID constants can be always used for control without affecting the control.
Table 3.14 shows the differences between the auto-tuning and self-tuning.

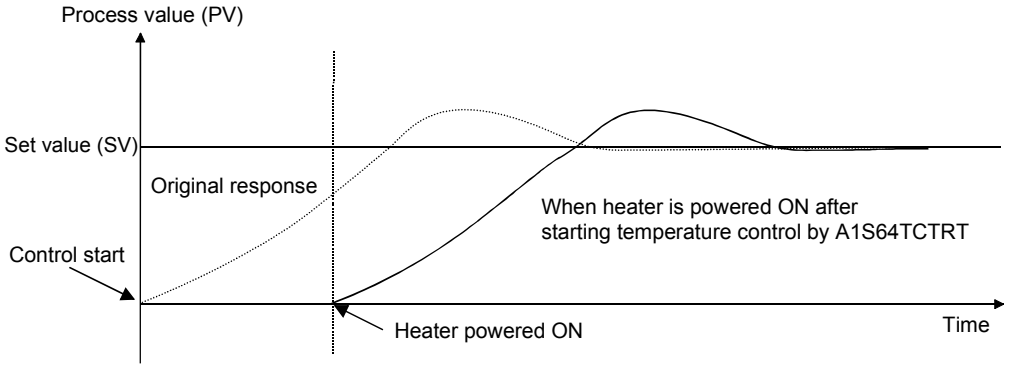
Table 3.14 Differences between auto-tuning and self-tuning

	Auto-tuning	Self-tuning
PID constant calculation	Turns ON/OFF the manipulated value, and calculates PID constants from the hunting cycle and amplitude between the set value and the measured value.	When the control response is oscillatory due to power-ON, change of the set value (SV), or characteristic change of the control target, calculates PID constants by the oscillation.
Execution method	Starts by turning ON the auto-tuning command (Y14 to Y17/Y14 to Y15), and changes the PID constants upon completion.	The A1S64TCTRT(BW) constantly monitors the control response, and when the response is slow, automatically calculates PID constants to change.
Control response	Because PID constants are calculated from the control response at the time of turning ON/OFF the manipulated value, the control could become erratic.	The control is stable because PID constants are calculated from the control response under temperature control.
Calculation result	The optimum PID constants are calculated from one tuning. In Standard control, the loop disconnection detection judgment time is also calculated.	The optimum PID constants could not be obtained by one tuning. The loop disconnection detection judgment time is not calculated.
PID constant setting at characteristic change of the control target	The user must perform auto-tuning again to change the PID constants.	The A1S64TCTRT(BW) automatically changes the PID constants.
Available control method	Both Standard control and Heating-cooling control	Standard control only

(2) Self-tuning setting

To use the self-tuning, set "1 (Used)" in the self-tuning setting (buffer memory address: 3EH, 5EH, 7EH, 9EH).
If the self-tuning setting is changed to "0 (Not used)" during self-tuning execution (while the tuning status flag (X4 to X7) is ON), the self-tuning being executed is stopped and will not be executed. (No error occurs.)

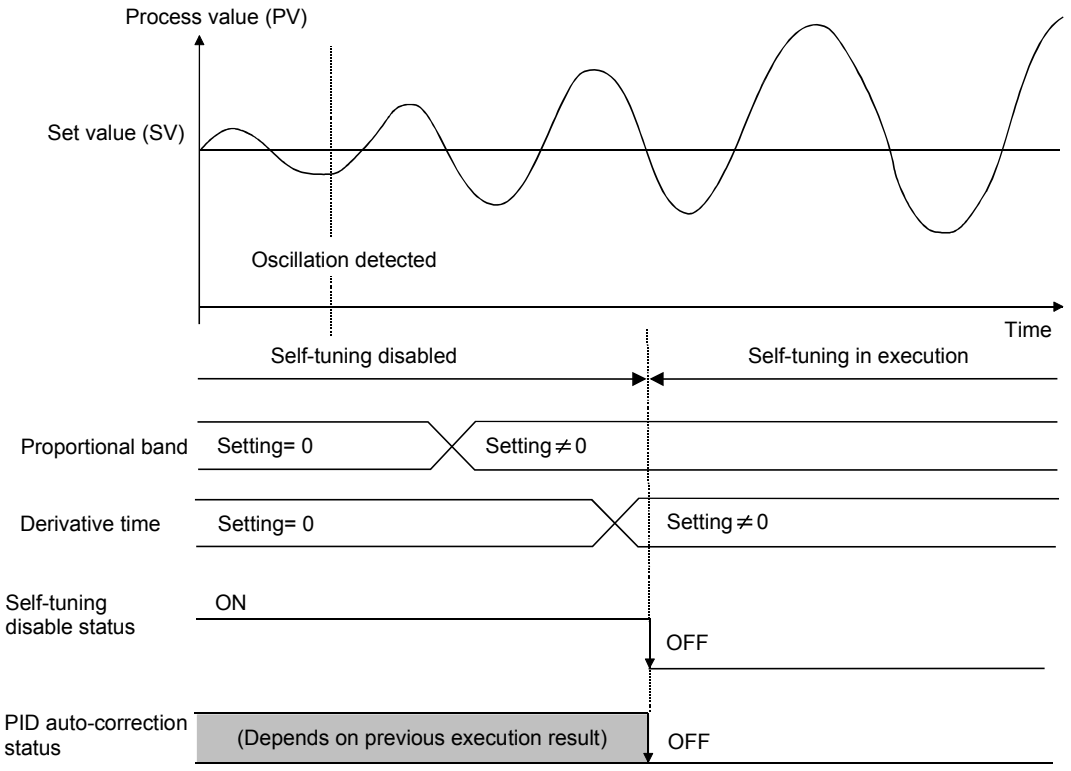
(a) Before starting temperature control using the A1S64TCTRT(BW), power up the control target such as a heater in advance. Failure to do so may cause the self-tuning function to calculate PID constants for control different from the original characteristics.



(b) Do not use the self-tuning function for a control target device where a large disturbance (uncontrollable disturbance) will occur periodically because improper PID constants may be calculated by the self-tuning. If this function is used for such control target, inexact PID constants will be set and the response to a set value (SV) change or disturbance will be slow.
Example) Temperature control of an injection mold, temperature control of a hot plate of a semiconductor manufacturing equipment

(c) The following describes the case where the self-tuning is not executed.

1) When the proportional band (P) or derivative time (D) is 0 (Two-position control or PI control)
The self-tuning disable status bit of the self-tuning flag (buffer memory address: 3FH, 5FH, 7FH, 9FH) turns ON.
At the time that all the PID constants for the target channel change to any other than zero, the self-tuning function is enabled.



2) During auto-tuning execution
No error occurs. Upon completion of the auto-tuning, the self-tuning is enabled.

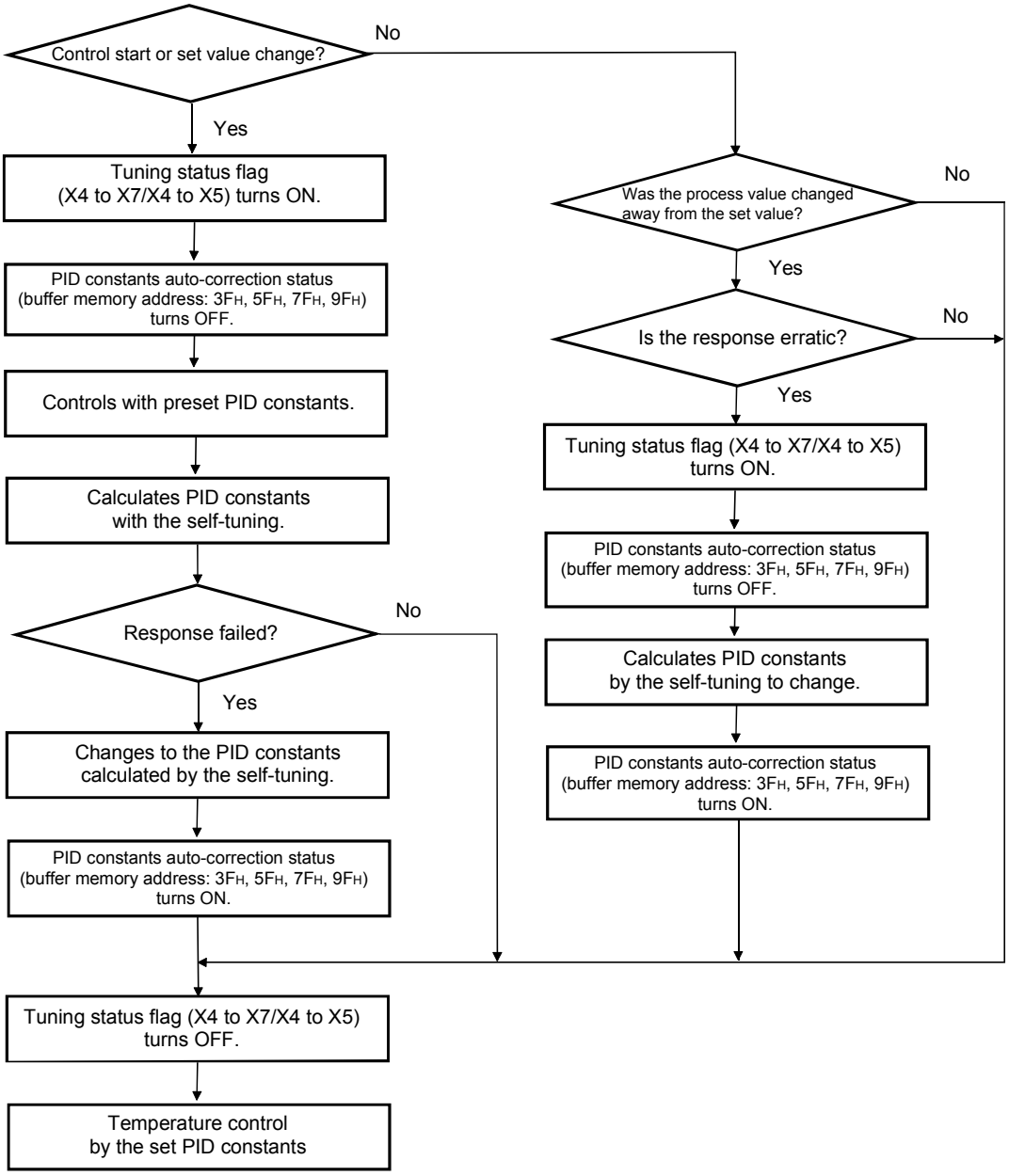
3) When the time for the manipulated value of 100% is insufficient at the time of temperature control start or set value (SV) change
At the time that control response oscillates, the self-tuning is enabled.

4) When the control mode is Heating-cooling control

(d) Do not change PID constants during the self-tuning execution. Failure to do so will cause an error (error code: 70EH).

(3) Self-tuning execution

When the self-tuning is executed, the A1S64TCTRT(BW) performs the following.



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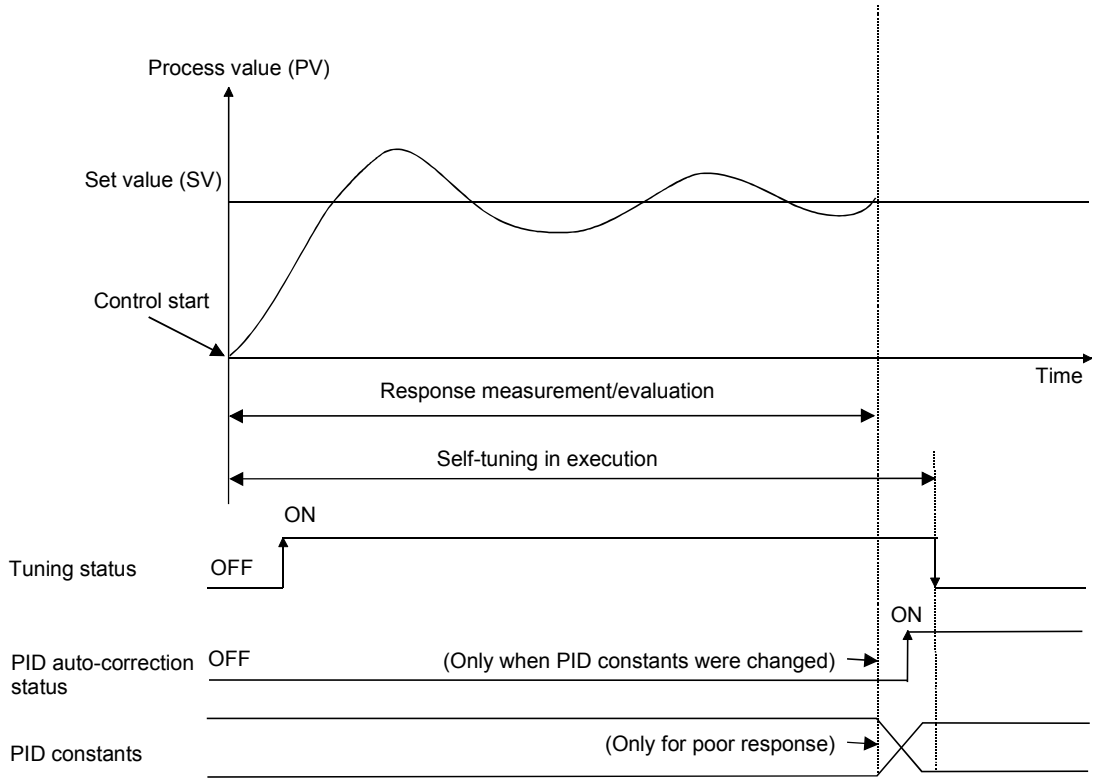
(4) Self-tuning operation

(a) Operation at the time of temperature control start or set value (SV) change

The response waveform of the measured temperature value at the time of temperature control start or set value (SV) change is monitored, and PID constants are automatically corrected. The following describes the internal self-tuning operation.

1) The PID auto-correction status bit of the Self-tuning flag (buffer memory address: 3FH, 5FH, 7FH, 9FH) turns OFF, and the Tuning status flag (X4 to X7) turns ON.
2) Temperature is controlled with the preset PID constants.
3) When the response is poor, the PID auto-correction status bit of the Self-tuning flag (buffer memory address: 3FH, 5FH, 7FH, 9FH) turns ON, and the calculated PID constants are set in the buffer memory. When the response is normal, PID constants are not changed with the PID auto-correction status bit of the Self-tuning flag (buffer memory address: 3FH, 5FH, 7FH, 9FH) remaining OFF.
4) The Tuning status flag (X4 to X7) turns OFF.



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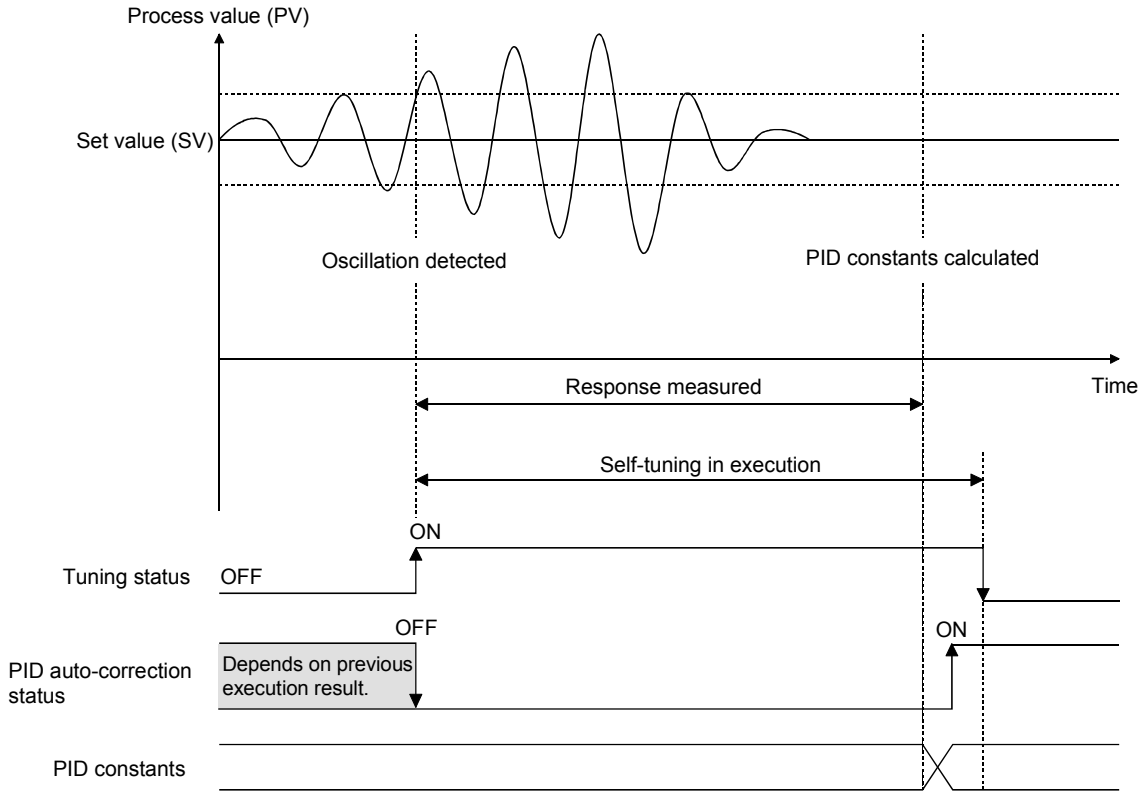
(b) When the control response oscillates

When the control response oscillates due to a reason such as change of the control target characteristics or operating conditions, the self-tuning function automatically corrects the PID constants to suppress the oscillation.

During the self-tuning, the Tuning status flag (X4 to X7) turns ON. After change of the PID constants, the PID auto-correction status bit of the Self-tuning flag (buffer memory address: 3FH, 5FH, 7FH, 9FH) turns ON.

1) Temperature is controlled with the preset PID constants.
2) When an oscillation is observed, the following processing is performed.
   a) The PID auto-correction status bit of the Self-tuning flag (buffer memory address: 3FH, 5FH, 7FH, 9FH) turns OFF, and the Tuning status flag (X4 to X7) turns ON.
   b) PID constants are calculated from the response waveform.
   c) The calculated PID constants are set in the buffer memory, and the PID auto-correction status bit of the Self-tuning flag (buffer memory address: 3FH, 5FH, 7FH, 9FH) turns ON.
   d) The Tuning status flag (X4 to X7) turns OFF.



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3.3.3 Alert alarms

(1) Alert alarms

The alert alarm is a function which sets the system in an alert status when the process value (PV) or deviation reaches the alert set value. It is used to turn on the device's hazard signal or operate the safety device.

The alert alarm is classified as follows:

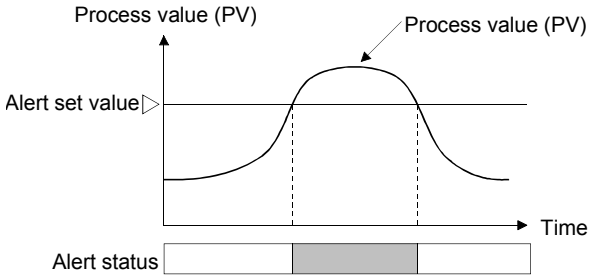
- Input alerts ..... Upper limit input alert, lower limit input alert
- Deviation alerts ..... Upper limit deviation alert, lower limit deviation alert, upper/lower limit deviation alert, within-range alert

(a) Input alerts

1) Upper limit input alert

When the process value (PV) is equal to or greater than the alert set value, the system is put in an alert status.

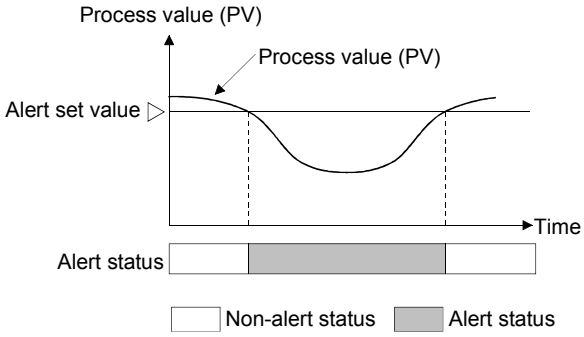
The setting must be within the input range.



2) Lower limit input alert

When the process value (PV) is equal to or less than the alert set value, the system is put in an alert status.

The setting must be within the input range.



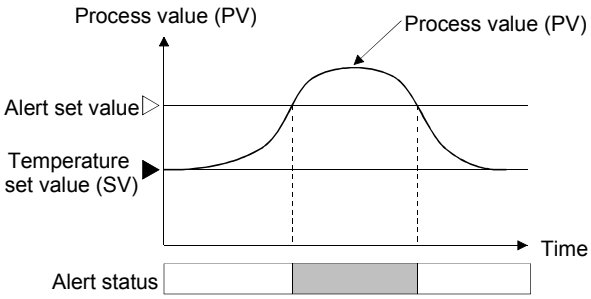
(b) Deviation alerts

1) Upper limit deviation alert

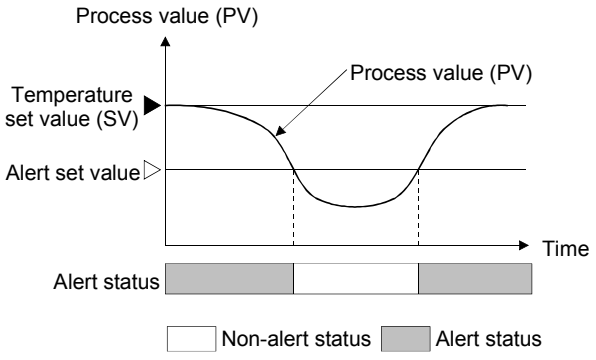
When the deviation [process value (PV) - set value (SV)] is equal to or greater than the alert set value, the system is put in an alert status.

The setting must be within the positive and negative full-scale ranges.

[When alert set value is positive]

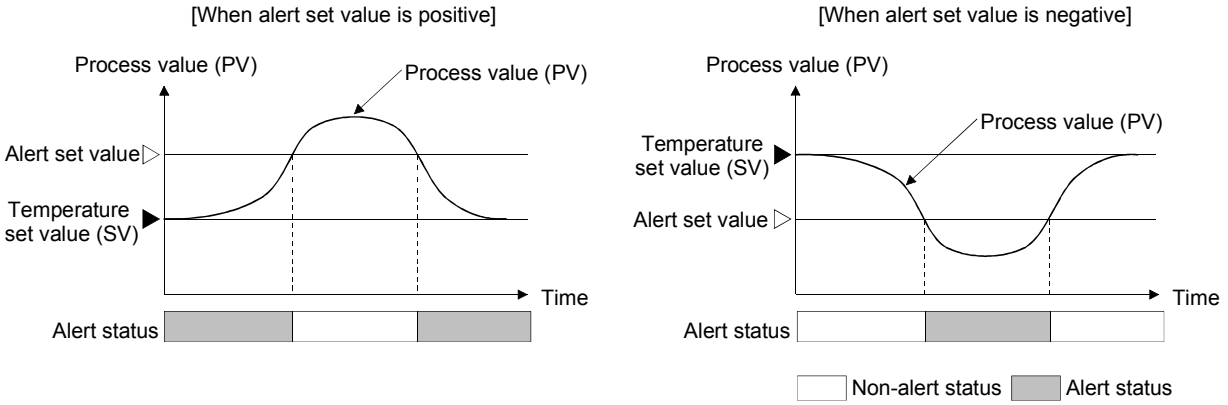


[When alert set value is negative]



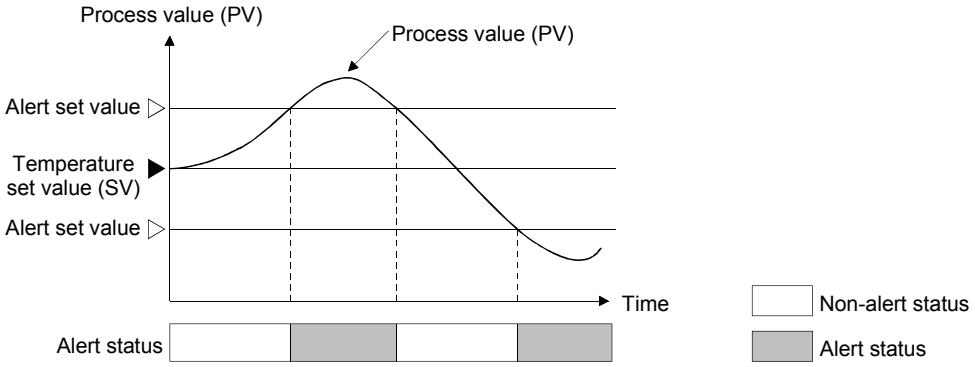
2) Lower limit deviation alert

When the deviation [process value (PV) - set value (SV)] is equal to or less than the alert set value, the system is put in an alert status.
The setting must be within the positive and negative full-scale ranges.



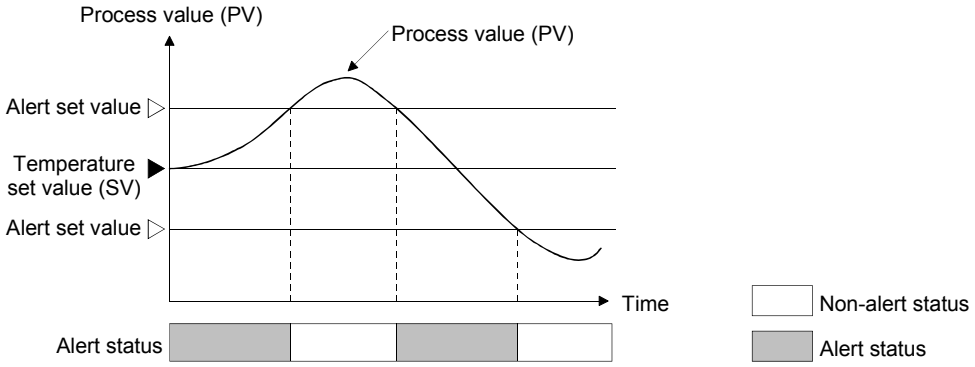
3) Upper/lower limit deviation alert

When the absolute value of deviation [process value (PV) - set value (SV)] is equal to or greater than the alert set value, the system is put in an alert status.
The setting must be within the positive full-scale range including 0.



4) Within-range alert

When the absolute value of deviation [process value (PV) - set value (SV)] is equal to or less than the alert set value, the system is put in an alert status.
The setting must be within the positive full-scale range including 0.



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(2) Alert dead band, alert delay count, wait and re-wait alert alarm

The settings of the alert dead band, the alert delay count, and the wait and re-wait alert alarm are available for the alert alarm of the A1S64TCTRT(BW), which is described in (1).

The table below shows applicable combinations.

Alert alarm		Dead band setting	Alert delay count	Wait	Re-wait
Input alert	Upper limit alert	○	○	○	——
	Lower limit alert	○	○	○	——
Deviation alert	Upper limit deviation alert	○	○	○	○
	Lower limit deviation alert	○	○	○	○
	Upper/lower limit deviation alert	○	○	○	○
	Within-range alert	○	○	——	——

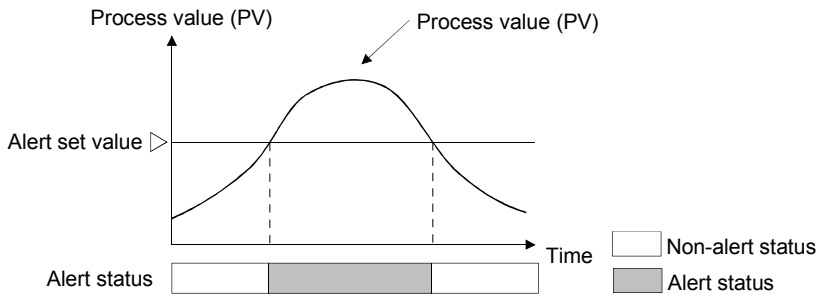
(a) Alert dead band setting

When the measured temperature value (PV)/deviation is close to the alert set value, the alert status may alternate with the non-alert status due to input instability.

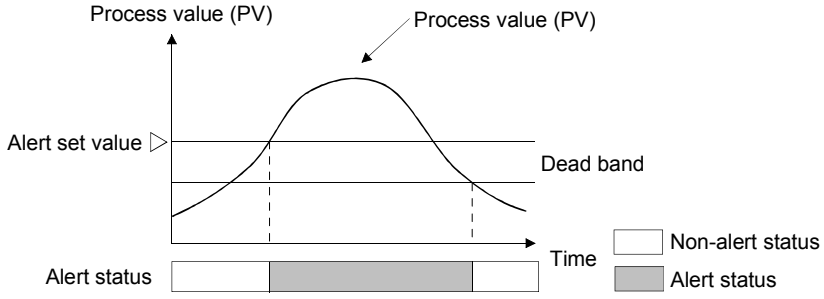
Setting the alert dead band prevents this kind of symptom.

Example: When a dead band value is set for the upper limit alert, the system enters the alert status if the input rises and reaches the set alert value or higher, and enters the non-alert status if it falls below the alert dead band.

[When alert dead band value is not set]



[When alert dead band value is set]



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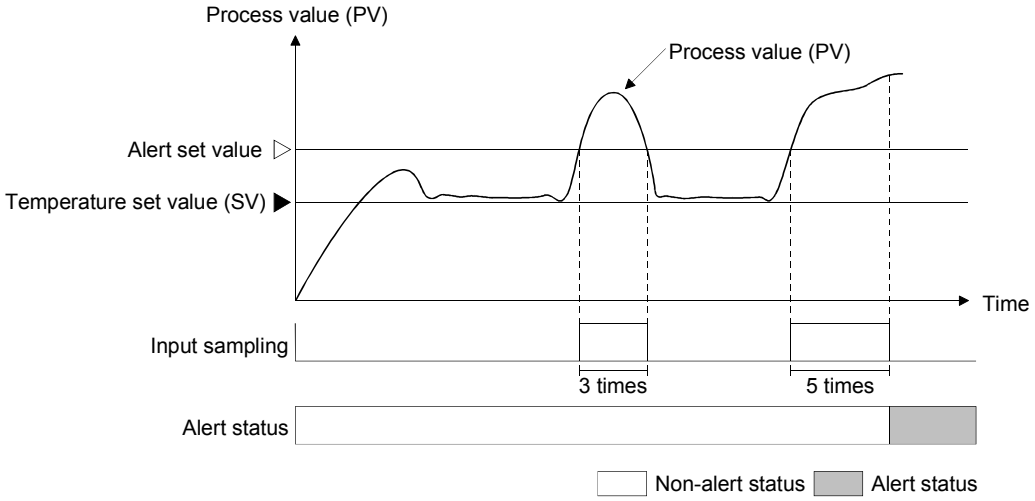
(b) Alert delay count setting

The system is set in the alert status when the process value (PV) that has reached the alert set value remains in the alert range until the sampling count becomes equal to or greater than the preset number of alert delays.

Example: When the number of alert delays set to the input upper limit alert is 5, the system is not placed in the alert status if the sampling count is 4 or less.



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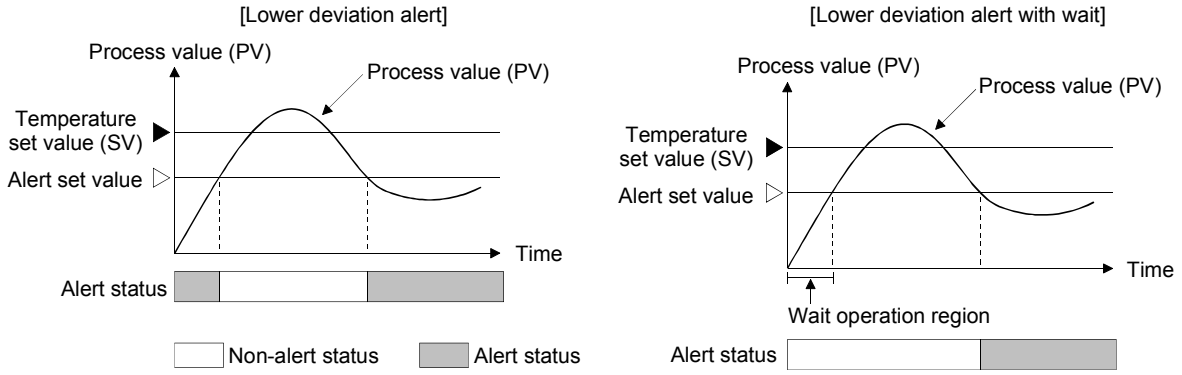
(c) Wait alert

Choosing the wait alert ignores the alert status if the process value (PV)/deviation is in that status when the setting mode is changed to the operation mode, and makes the alert function invalid until the process value comes out of the alert status once.

Example: Selecting the lower limit deviation alert with wait makes the alert function invalid until the process value exceeds the alert set value.



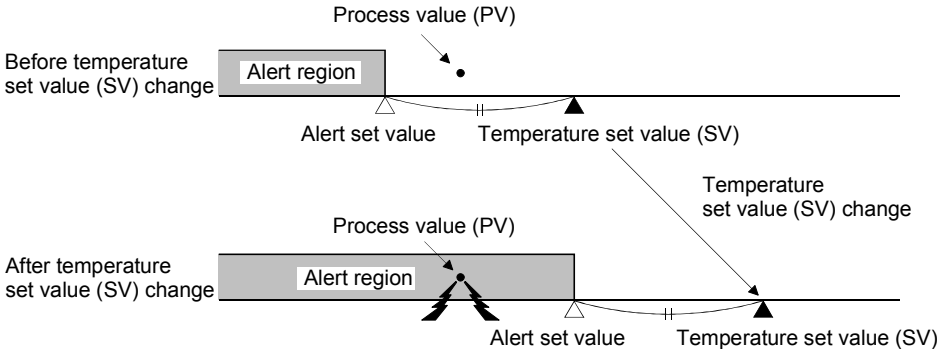
POINT

When the system has reached the non-alert status even once after an alert judgment start following the setting of the alert mode, the alert function with wait will be invalid if you choose the mode with wait.

(d) Re-wait alert

The re-wait alert is a wait alert-based feature which has the additional function to make the alert function invalid again when the set value (SV) is changed.
For set value changing control, choosing the re-wait alert avoids the alarm status reached when the set value is changed.

Example: If the process value (PV) is at the position as shown below before the setting is changed, changing the temperature set value (SV) for deviation alert will put the process value in the alert region and turn on the alert. To prevent this, the function makes the alert wait operation valid and the alert output to wait.



(3) Alert alarm setting

The A1S64TCTRT(BW) allows use of four alert alarms (Alert alarm 1 to 4) selected from Alert alarm, Wait alarm, and Re-wait alarm.
These alert alarms are set in the following buffer memory areas.

Buffer memory name	CH1	CH2	CH3	CH4
Alert alarm 1	A0H			
Alert alarm 2	A1H			
Alert alarm 3	A2H			
Alert alarm 4	A3H			

The alert set value, alert dead band value, and alert delay count are set in the following buffer memory areas.

Buffer memory name	CH1	CH2	CH3	CH4
Alert set value	26H to 29H	46H to 49H	66H to 69H	86H to 89H
Alert dead band value	A4H			
Alert delay count	A5H			

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3.3.4 RFB limiter function

When there has been a deviation for a long period, the RFB (Reset FeedBack) limiter function prevents the PID operation result (manipulated value: MV) from exceeding the valid range by the integral action.
If a PID operation result exceeds the upper/lower output limiter value in Standard control, or exceeds the upper output limiter value in Heating-cooling control, the excess value is fed back to the integral value, holding the PID operation result to the limit value.
Since this function is automatically activated during PID control execution, there is no need to be set.

3.3.5 Sensor compensation function

When a difference between the measured temperature value and actual temperature exists, the sensor compensation function compensates for the difference.

(1) Sensor compensation value setting

When there is a difference between the measured temperature value and actual temperature, set a full-scale percent value of the input range (-50.00 to 50.00%) to the sensor compensation value setting area of the buffer memory (2DH, 4DH, 6DH, 8DH/2DH, 4DH).

Example: In the input range setting of –200°C to 200°C, when the measured temperature value (PV) is 102°C and the actual temperature is 100°C, compensation of –2°C is performed for the measured temperature value.

Temperature sensor error
= Actual temperature – Measured temperature value (PV)
= 100°C - 102°C
= -2°C

Full scale of input range = Highest value – Lowest value
= 200°C - (-200°C)
= 400°C

Sensor compensation value = Temperature sensor error/Full scale of input range x 100
= -2°C /400°C x 100
= -0.5% (Set "-50" in the buffer memory.)

3.3.6 Unused channel setting

When no sensor is connected to a channel, the A1S64TCTRT(BW) performs upscale processing for the channel.
Therefore, for such a channel that does not perform temperature control, the module determines that the measured temperature value (PV) exceeds the input range and the "ALM" LED flashes at 2-second intervals.

(1) Unused channel setting

Set "1" for a channel not to be used and "0" for a channel to be used in the Unused channel setting area (buffer memory address: 3DH, 5DH, 7DH, 9DH/3DH, 5DH).
The default is set to "0: Used".
Once this setting is made, no alarm will occur even for a channel that does not connect a temperature sensor.

3.3.7 Forced PID control stop

This function allows a temporary stop of the PID operation from a programmable controller CPU.
The A1S64TCTRT(BW) behavior at the PID operation stop varies depending on the Stop mode setting (buffer memory address: 21H, 41H, 61H, 81H /21H, 41H). For details, refer to Section 3.3.9.

(1) Execution of forced PID control stop

To execute the forced PID control stop, turn ON the Forced PID control stop command (Y1A to Y1D/Y1A to Y1B).
At this time, the manipulated value and the control output monitor value are as shown below.

Control mode	Buffer memory name	Buffer memory address	Value
Standard control	Manipulated value (MV)	DH to 10H	-50 (-5.0%)
	Control output monitor	B1H to B4H	0
Heating-cooling control	Manipulated value for heating (MV)	DH to EH	-50 (-5.0%)
	Manipulated value for cooling (MV)	C0H to C1H	-50 (-5.0%)
	Heating control output monitor	B1H to B2H	0
	Cooling control output monitor	C2H to C3H	0

(2) Canceling the forced PID control stop

Turning OFF the Forced PID control stop command (Y1A to Y1D/Y1A to Y1B) cancels the forced PID control stop, which restarts PID operation from the manipulated value that was output during the forced stop.

POINT
Setting the programmable controller CPU to the STOP status turns off the forced PID control stop command, "canceling the forced PID control stop".

3.3.8 Storing data in FeRAM

(1) Storing data in FeRAM

(a) Buffer memory data of the A1S64TCTRT(BW) can be stored in the FeRAM as backup data.
Data of the entire writable buffer memory area can be backed up. For the buffer memory details, refer to Section 3.6 to 3.10.
Writing to FeRAM allows backup of the PID constants set by the auto-tuning and the data directly written to the buffer memory.
Using this function eliminates the need of a program for setting data to the A1S64TCTRT(BW).

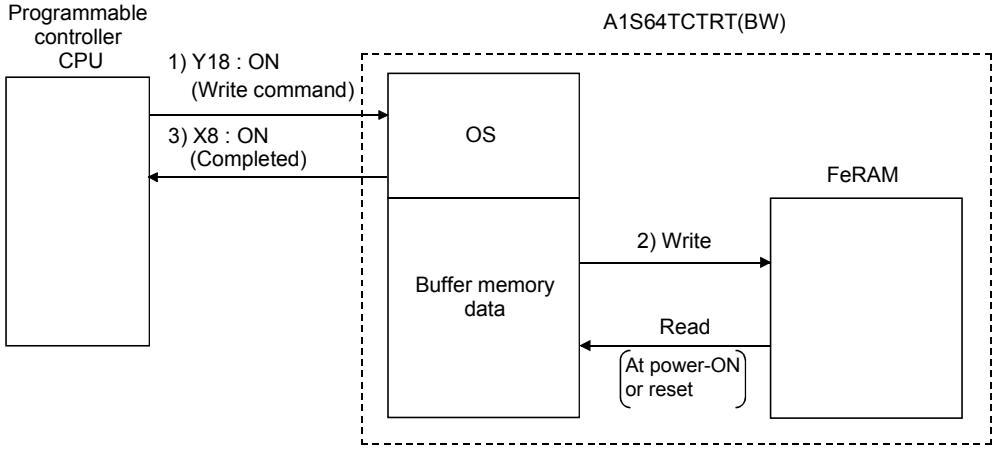
(b) The backup data are transferred from the FeRAM to the buffer memory when the programmable controller CPU is started up (power-ON) or reset. Therefore, temperature control is executable without data writing at startup or reset of the programmable controller CPU.

(2) Writing data to FeRAM

(a) To write data to the FeRAM, turn ON the FeRAM backup command (Y18). Upon completion of writing to the FeRAM, the FeRAM write complete flag (X8) turns ON.
If the writing fails, the FeRAM write failure flag (XA) turns ON.

(b) When changing the buffer memory, the FeRAM write complete flag (X8) must be OFF.

(c) While an error exists, data cannot be written to the FeRAM.
Make sure that the value in the Error code area (buffer memory address: 0H) is "0" before writing data to the FeRAM.



3.3.9 Control function of the A1S64TCTRT(BW)

The A1S64TCTRT(BW) has the output signals (Y) and buffer memory used to set the control status. This section explains the control status set by the output signals and buffer memory.

- Turning ON the Setting/operation mode command allows PID temperature control.
- The PID continuation flag is enabled when the operation mode is changed to the setting mode.
- If the programmable controller CPU is stopped during PID control stop by the Forced PID control stop command, because the command turns OFF, PID control will start.

(1) Unused channel setting

Unused channel setting (Refer to Section 3.7.17.)	Control status		
	PID control	Temperature detection	Alert detection
3DH, 5DH, 7DH, 9DH			
Unused	—	—	—
Used	Depends on the control status of other setting items		

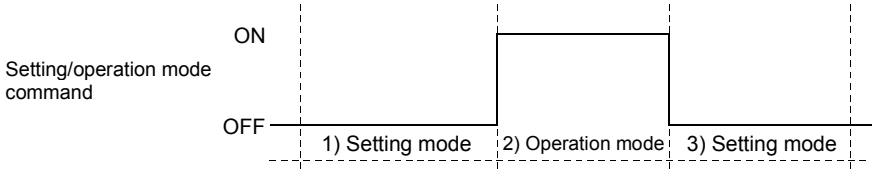
○: Execute, —: Not execute

(2) Other settings

Setting/operation mode command (Refer to 3.5.3.)*	PID continuation flag (Refer to 3.7.23.)	Forced PID control stop command (Refer to 3.5.3.)	Stop mode setting (Refer to 3.7.8.)	Control status		
				PID control	Temperature detection	Alert detection
Y11	A9H	Y1A to Y1D	21H,41H,61H,81H,			
1) Setting mode (at power-ON)	Stop/Continue	OFF/ON	Stop	—	—	—
			Monitor	—	○	—
			Alert	—	○	○
2) Operation mode (during operation)	Stop/Continue	OFF	Stop/Monitor/ Alert	○	○	○
		ON	Stop	—	—	—
			Monitor	—	○	—
			Alert	—	○	○
3) Setting mode (after operation)	Stop	OFF/ON	Stop	—	—	—
			Monitor	—	○	—
			Alert	—	○	○
	Continue	OFF	Stop/Monitor/ Alert	○	○	○
		ON	Stop	—	—	—
			Monitor	—	○	—
			Alert	—	○	○

○: Execute, —: Not execute

*: The Setting/operation mode command settings are classified into the following three types.



3.3.10 Selection of reverse/direct action

In the case of Standard control, whether to perform PID operations by "reverse action" or "direct action" can be selected.

(1) Reverse/direct action controls

(a) Reverse action: Used for heating control that raises the temperature.

(b) Direct action: Used for cooling control that lowers the temperature.

(2) Reverse/direct action setting

In the Reverse/direct action setting area (buffer memory address: 36H, 56H, 76H, 96H), set "1" for reverse action and "0" for direct action. The default is set as "1: Reverse action".

3.3.11 Loop disconnection detection function

(1) Loop disconnection detection function

This function is used in the Standard control and detects disconnection of the load (heater), failure of an external device (e.g. magnet relay) or an error occurred in the control system (control loop) due to an interrupted input.
From the time point that the PID operation value reaches 100% or 0%, the amount of change in the measured value is monitored at intervals set in the Loop disconnection detection judgment time area (buffer memory address: 3BH, 5BH, 7BH, 9BH) to detect disconnection of a heater or input.
Detection conditions for the reverse action (heating control) are shown below. For the direct action (cooling control), the description of the phenomena (rise/fall in temperature) is reversed.

(a) Disconnection of a heater, open or short circuit of the input, or failure to turn ON an external device contact is detected as an error because the temperature does not increase in spite of continuous control output.
After control output of 100%, if rise in temperature of 2°C or more is not detected within the preset loop disconnection detection judgment time, an alert will be output.

(b) Input interruption or fixation of an external device contact is regarded as an error because the temperature increases with no control output.
After control output is reduced to 0%, if drop in temperature of 2°C or more is not detected within the preset loop disconnection detection judgment time, an alert will be output.
Even if an alert due to open-loop detection occurs, the control output will not automatically stop. If forced stop of the output is desired, turn ON the Forced PID control stop command (Y1A to Y1D/Y1A to Y1B).

(2) Loop disconnection detection setting

Set a time (0 to 7200 seconds) in the loop disconnection detection judgment time area (buffer memory address: 3BH, 5BH, 7BH, 9BH). When not using the loop disconnection detection function, set "0".
Setting the loop disconnection detection dead band (buffer memory address: 3CH, 5CH, 7CH, 9CH) disables the detection even if temperature change is less than 2°C near the set value at the time of 100% or 0% control output. (Refer to Section 3.8.13.)

3.3.12 Cooling system setting function

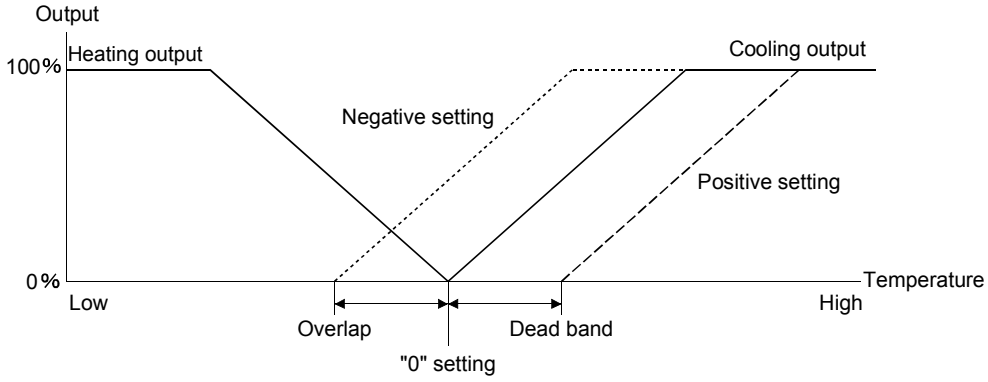
In the case of the heating-cooling control, select a cooling type: "Air-cooling" or "Water-cooling".
Generally, the cooling capacity of the air-cooling system is higher than that of the water-cooling system. Because of this, if PID constants suitable for the air-cooling are used in the water-cooling system, it will result in excessive cooling and require time to stabilize the temperature in the case of initial startup, disturbance or setting change. Therefore, for the auto-tuning of the water-cooling setting, calculate PID constants greater than those for the air-cooling.

(1) Cooling type setting

Set "0" for air-cooling and "1" for water-cooling in the Cooling type setting area (buffer memory address: CFH).
Not that if use of the air-cooling system may result in excessive cooling, set it to "Water-cooling". In the same way, if use of the water-cooling system may have difficulty in cooling, set it to "Air-cooling".
The default value is "0: Air-cooling".

3.3.13 Overlap/dead band function

Under the heating-cooling control, while the self-heating of the control target and natural cooling is balanced, a slight heating or cooling output could greatly change the measured temperature value (PV), resulting in an excessive output.
The Overlap/dead band setting (buffer memory address: D3H, E3H) can change the point at which the cooling control output starts, leading to a tendency toward control stability or energy saving.



(1) Overlap setting

The overlap range is a temperature region where both heating and cooling powers are output. Since heating and cooling counteract the effects each other, the control gain changes smoothly.
The amount of change in the measured temperature value will be reduced and thereby the control stability can be increased.
An overlap value is set in the Overlap/dead band setting area (buffer memory address: D3H, E3H) as a percent of the input range to the full scale (-10.0 to - 0.1%).

(2) Dead band setting

The dead band is a temperature region where neither of heating nor cooling power is output. If the measured temperature value (PV) is stable within this region, output will not be performed for a slight temperature change and this is effective for energy saving.
A dead band value is set in the Overlap/dead band setting area (buffer memory address: D3H, E3H) as a percent of the input range to the full scale (0.1 to 10.0%).

3.3.14 Temperature conversion function (Utilizing unused channels)

(1) Temperature conversion function

In Heating-cooling control, this function allows temperature monitoring using temperature input terminals that are not be used for the control. (Because of one input and two outputs, unused two input terminals can be used.)
Alert detection and temperature control are not available.
Use a terminal whose signal name is shown as "MT1 □" (Monitor channel 1) or "MT2 □" (Monitor channel 2) in the table below.

Terminal No.	Signal name	
	Using thermocouple	Using platinum RTD
1	L1H	L1H
2	L1C	L1C
3	L2H	L2H
4	L2C	L2C
5	COM -	COM -
6	Unused	CH1 A
7	Unused	MT1 A
8	CH1 +	CH1 B
9	MT1 +	MT1 B
10	CH1 -	CH1 b
11	MT1 -	MT1 b
12	CJ	Unused
13	Unused	Unused
14	CJ	Unused
15	Unused	MT2 A
16	Unused	CH2 A
17	MT2 +	MT2 B
18	CH2 +	CH2 B
19	MT2 -	MT2 b
20	CH2 -	CH2 b

The temperature conversion function uses the following buffer memory.

Setting item	Buffer memory address	
	MT1(CH3)	MT2(CH4)
Decimal point position	3H	4H
Alert detail	7H	8H
Measured temperature value (PV)	BH	CH
Input range	60H	80H
Sensor compensation value setting	6DH	8DH
Temperature conversion setting	B8H	B9H

(2) Temperature conversion function setting

Set "1" or "0" in the Temperature conversion setting area (buffer memory address: B8H, B9H) to enable or disable this function accordingly.
The default is set to "0: Not used".
For 9 seconds after changing the setting from "0: Not used" to "1: Used", temperature conversion is not available because the measured temperature value is 0.

(3) Current consumption for the temperature conversion function

Current consumption varies depending on whether to use the temperature conversion function or not.

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3.3.15 Heater disconnection detection function

The A1S64TCTRTBW has a function by which disconnection of a heater can be detected based on the input from the external current sensor.
To use this function, set the following items.

Buffer memory name	Buffer memory address		Description
	Standard control	Heating-cooling control	
CT selection	39H,59H,79H,99H	39H,59H	Specify a current sensor to be used for detecting heater disconnection. 0: CTL-12-S36-8 (0.0 to 100.0A) 1: CTL-6-P-H (0.00 to 20.00A)
CT monitoring method switching	B0H		Set a method for heater current measurement. 0: ON current/OFF current 1: ON current
Heater current reference value	ABH,ACH,ADH,AEH	ABH,ACH	Set a current value, based on which heater disconnection is detected.
Heater disconnection alert setting	3AH,5AH,7AH,9AH	3AH,5AH	Set a percent (%) of heater disconnection detection value to the Heater current reference value. No heater disconnection detection when 0 is set.
Heater voltage compensation setting	AAH		Set whether to use the heater voltage compensation function or not. 0: Use this function 1: Not use this function
Current error detection count during heater disconnection/output OFF	A6H		Set a number of times of consecutive heater disconnection detection before alert occurrence.

(1) Heater disconnection detection function

This function checks for heater disconnection by the heater current reference value (a load current value detected by a current sensor (CT)) with the transistor output ON.
Heater disconnection is detected when the measured heater current value (buffer memory address: 19H to 1CH) is equal to the heater disconnection alert value or less.
The heater disconnection alert value is calculated by the following formula.

Heater disconnection alert value
= Heater current reference value x Heater disconnection alert setting
Heater current reference value: Buffer memory address ABH to AEH
Heater disconnection alert setting: Buffer memory address 3AH, 5AH, 7AH, 9AH

Note that heater disconnection is not detected when the heater disconnection alert setting is "0" or when ON time of transistor output is 0.3 seconds or less. (The alert status is held. (Refer to Section 3.7.3.))
When an alert has occurred by heater disconnection detection, the control output will not automatically stop. If forced stop of the output is desired, turn ON the Forced PID control stop command (Y1A to Y1D/Y1A to Y1B)

By clearing the disconnection status, the alert detail (bit 12 of buffer memory address: 5H, 6H, 7H, and 8H) turns from "1: ON" to "0: OFF".
However, when the CT monitor method switch (buffer memory address: B0H) is set to "1: ON current", disconnection detection does not turn OFF unless the heater turns ON (the "OUT" LED on the front of the module turns on).
Heater-ON timing varies depending on the control output period setting (buffer memory address: 2FH, 4FH, 6FH, and 8FH).

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(2) Heater disconnection compensation function

(a) Heater disconnection compensation

Since the A1S64TCTRTBW measures the heater current to determine whether disconnection has occurred or not, if the heater voltage drops, an erroneous alert could occur due to the voltage fluctuation. (As the heater voltage drops, the heater current also drops.)
Therefore, if the heater current drops, the amount of the drop is compensated to prevent disconnection detection.
When the heater voltage compensation function setting (buffer memory address: AAH) is 0, however, heater disconnection compensation is not performed.

(b) Heater disconnection compensation method

By calculating "(Heater current of each channel) – (Heater current reference value)", obtain the largest positive value as a compensation value.
If no positive value exists, choose a value of the smallest difference as a compensation value.
The compensation value is used to compensate for a heater current error of each channel, and when the compensated value exceeds the specified heater disconnection alert set value, heater disconnection is detected.

Example 1: In heating control, the differences from the heater current reference value are as follows: Channel 1: -2%, Channel 2: 5%, Channel 3: -1%, Channel 4: -17%

Since the compensation value should be 5%, the compensated values for heater disconnection detection are: Channel 1: -7%, Channel 2: 0%, Channel 3: -6%, Channel 4: -22%.
When the heater disconnection alert setting is set to 80%, for example, heater disconnection is detected only on Channel 4.

Channel No.	Heater disconnection alert set value	Difference from heater current reference value	Compensation value	Difference from heater current reference value after compensation	Disconnection
1	80%	-2%	5%	-7%	None
2		5%		0%	None
3		-1%		-6%	None
4		-17%		-22%	Detected

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Example 2: In heating control, the differences from the heater current reference value are as follows: Channel 1: -16%, Channel 2: -17%, Channel 3: -22%, Channel 4: -19%

Since the compensation value should be -16%, the compensated values for heater disconnection detection are: Channel 1: 0%, Channel 2: -1%, Channel 3: -6%, Channel 4: -3%.
When the heater disconnection alert setting is set to 80%, for example, no heater disconnection is detected on all channels.

Channel No.	Heater disconnection alert set value	Difference from heater current reference value	Compensation value	Difference from heater current reference value after compensation	Disconnection
1	80%	-16%	-16%	0%	None
2		-17%		-1%	None
3		-22%		-6%	None
4		-19%		-3%	None

Example 3: In heating-cooling control, the differences from the heater current reference value are as follows: Channel 1: 5%, Channel 2: -17%

Since the compensation value should be 5%, the compensated values for heater disconnection detection are: Channel 1: 0%, Channel 2: -22%.
When the heater disconnection alert setting is set to 80%, for example, heater disconnection is detected only on Channel 2.

Channel No.	Heater disconnection alert set value	Difference from heater current reference value	Compensation value	Difference from heater current reference value after compensation	Disconnection
1	80%	5%	5%	0%	None
2		-17%		-22%	Detected

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Example 4: In heating-cooling control, the differences from the heater current reference value are as follows: Channel 1: -16%, Channel 2: -17%

Since the compensation value should be -16%, the compensated values for heater disconnection detection are: Channel 1: 0%, Channel 2: -1%.
When the heater disconnection alert setting is set to 80%, for example, no heater disconnection is detected on both channels.

Channel No.	Heater disconnection alert set value	Difference from heater current reference value	Compensation value	Difference from heater current reference value after compensation	Disconnection
1	80%	-16%	-16%	0%	None
2		-17%		-1%	None

(c) Restrictions

- When using one channel only, the heater disconnection compensation function is not enabled.
- When using multiple channels, if heater ON status on only one channel is maintained with the other channels placed in heater-OFF status, the heater disconnection compensation function is not activated. Because of this, disconnection may be detected even without actual disconnection.
- The heater disconnection alert compensation value is up to 20%.
  If 40% or more voltage drop occurs, disconnection will be detected even by compensation of 20%.

(3) Heater disconnection detection delay function

This function allows an alert to occur when conditions for the heater disconnection detection have been satisfied for a certain period of time.
The time is calculated by the following formula.

Delay time = Heater disconnection detection delay count setting x Sampling period
Heater disconnection detection delay count setting: Buffer memory address A6H
Sampling period: 0.55s regardless of the number of channels being used

Heater disconnection detection delay count setting uses the same buffer memory as of the Output-off-time current error detection delay count setting.
This means that the same time is used for the heater disconnection detection and the output-off-time current error detection.

3.3.16 Output-off-time current error detection

The A1S64TCTRTBW has a function by which presence of a current error is checked based on the input from the external current sensor.

(1) Output-off-time current error detection

This function checks for presence of any abnormal current using the heater current reference value (a load current value detected by a current sensor (CT)) when the transistor output is OFF.
An output-off-time current error is detected when the measured heater current value (buffer memory address: 19H to 1CH) is equal to the heater disconnection alert value or greater.
The heater disconnection alert value is calculated by the following formula.

Heater disconnection alert value
= Heater current reference value x Heater disconnection alert setting
Heater current reference value: Buffer memory address ABH to AEH
Heater disconnection alert setting: Buffer memory address 3AH, 5AH, 7AH, 9AH

Note that no output-off-time current error is detected when the heater disconnection alert setting is "0" or when OFF time of the transistor output is 0.3 seconds or less.
When an alert has occurred by the output-off-time current error detection, the control output will not automatically stop. If forced stop of the output is desired, turn ON the Forced PID control stop command (Y1A to Y1D/Y1A to Y1B).

(2) Output-off-time current error detection delay function

This function allows an alert to occur when conditions for the output-off-time current error detection have been satisfied for a certain period of time.
The time is calculated by the following formula.

Delay time = Output-off-time current error detection delay count setting x Sampling period
Output-off-time current error detection delay count setting: Buffer memory address A6H
Sampling period: 0.55s regardless of the number of channels being used

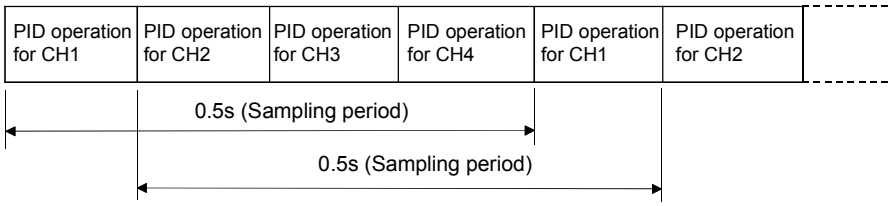
Output-off-time current error detection delay count setting uses the same buffer memory as of the Heater disconnection detection delay count setting.
This means that the same time is used for the heater disconnection detection and the output-off-time current error detection.

3.4 Sampling Period and Control Output Period

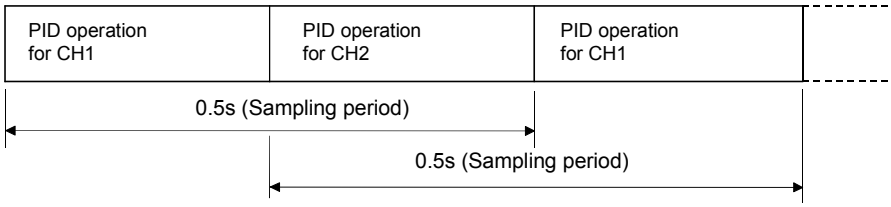
(1) Sampling period

(a) In Standard control, PID operations are executed in the following order: CH1 → CH2 → CH3 → CH4 → CH1→ CH2 → …
In Heating-cooling control, they are executed alternately: CH1 → CH2 → CH1 → CH2 → …
The time interval from execution start of PID operations for a channel (CHn) until restart of that for the same channel is defined as a sampling period.

(b) The sampling period is 0.5s regardless of the number of channels being used or the control method.
Since unused channels also perform processing such as error checking, the sampling period does not change even if the unused channel setting is done.



[Standard control]



[Heating-cooling control]

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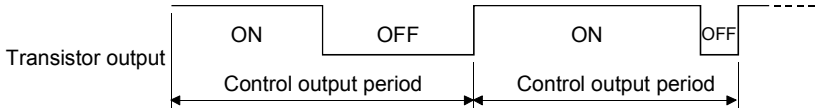
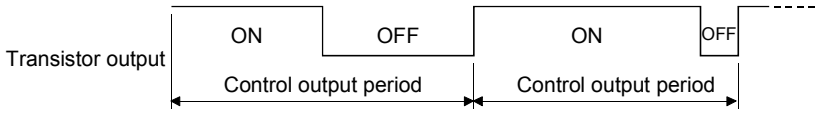
(2) Control output period, heating/cooling control output period

(a) In Standard control, the control output period means the transistor output ON/OFF cycle.



The manipulated value (MV) is a percentage of the ON time in this control output period. (Refer to Section 3.9.1.)

(b) In Heating/cooling control, the heating/cooling control output period indicates the ON/OFF cycle of the transistor output for heating/cooling.



The manipulated value heating/cooling (MV) represents the ON time in this control output period and is shown as a percent or a digital output value. (Refer to Section 3.9.1.)

(c) For Standard control, set a value in the Control output period setting area (buffer memory address: 2FH, 4FH, 6FH, 8FH) within the range from 1s to 100s.
For Heating/cooling control, set respective values in the Heating control output period setting area (buffer memory address: 2FH, 4FH) and the Cooling control output period setting area (buffer memory address: D2H, E2H) within the range from 1s to 100s.

3.5 I/O Signals Transferred to/from the programmable controller CPU

The following explains the I/O signal allocation and the various functions.

3.5.1 I/O signal list

The A1S64TCTRT(BW) uses 32 points for input and 32 points for output for sending and receiving signals with the programmable controller CPU. Table 3.15 shows the I/O signal allocation and each signal's name. Device X means the input signal from the programmable controller CPU to the A1S64TCTRT(BW), an device Y means the output signal from the programmable controller CPU to the A1S64TCTRT(BW). Hereafter in this chapter the I/O signal X, Y, and I/O adress will be shown for when the A1S64TCTRT(BW) is installed in the basic base unit I/O slot 0.

Table 3.15 I/O signal list

Input signal (Signal direction: A1S64TCTRT(BW) → programmable controller CPU)			Output signal (Signal direction: A1S64TCTRT(BW) ← programmable controller CPU)		
Device No.	Signal name		Device No.	Signal name	
	Standard control	Heating-cooling control		Standard control	Heating-cooling control
X0	Watchdog timer error flag		Y00 to Y10	Unusable	
X1	Temperature control module READY flag		Y11	Setting/operation mode command	
X2	Write error flag		Y12	Error reset command	
X3	Hardware error flag		Y13	Unusable	
X4	CH1 tuning status flag		Y14	CH1 Auto-tuning command	
X5	CH2 tuning status flag		Y15	CH2 Auto-tuning command	
X6	CH3 tuning status flag	Unusable	Y16	CH3 Auto-tuning command	Unusable
X7	CH4 tuning status flag	Unusable	Y17	CH4 Auto-tuning command	Unusable
X8	FeRAM write complete flag		Y18	FeRAM backup command	
X9	Default value write complete flag		Y19	Default setting registration command	
XA	FeRAM write incomplete flag		Y1A	CH1 Forced PID control stop command	
XB	Unusable		Y1B	CH2 Forced PID control stop command	
XC	CH1 Alert occurrence flag		Y1C	CH3 Forced PID control stop command	Unusable
XD	CH2 Alert occurrence flag		Y1D	CH4 Forced PID control stop command	Unusable
XE	CH3 Alert occurrence flag	Unusable	Y1E	Unusable	
XF	CH4 Alert occurrence flag	Unusable	Y1F	Unusable	
X10 to X1F	Unusable		—	—	

POINT

(1) When the unusable area in Table 3.15 are turned on/off by a sequence program, the function of the A1S64TCTRT(BW) are not guaranteed. However, when the A1S64TCTRT(BW) is used with the remote I/O station, Y0E and Y0F can be reset from a user program. Refer to the Data Link System Reference Manual for details.

3.5.2 Input signal function

(1) Watchdog timer error flag (X0)

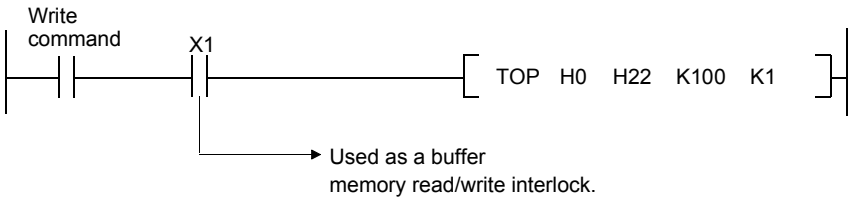
(a) This flag turns on when the watchdog timer error is detected from the A1S64TCTRT(BW) self-diagnosis function.

(b) When the watchdog timer error flag turns on, the A1S64TCTRT(BW) stops the temperature control operation, and turns off the output.

(2) Temperature control module READY flag (X1)

(a) This flag turns on when the A1S64TCTRT(BW) is ready when the power for programmable controller CPU is turned on or reset.

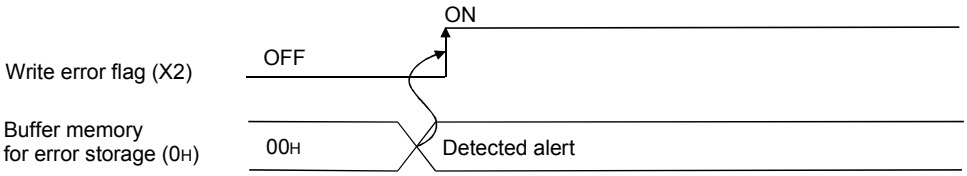
(b) Perform read/write in the A1S64TCTRT(BW) buffer memory from the programmable controller CPU while this ready flag is on.



(3) Write error flag (X2)

This signal turns on when a write error occurs.
A write error occurs under any of the following conditions.

- When data is set to the reserved area.
- When a setting change is made in the operation mode to the area write- enabled in the setting mode only.
- When data outside the setting range is set.
- When data setting is changed during default redistration.



(4) Hardware (H/W) error flag (X3)

This flag turns on when the temperature control module results in a hardware error.

(5) Tuning status flag (X4 to X7)

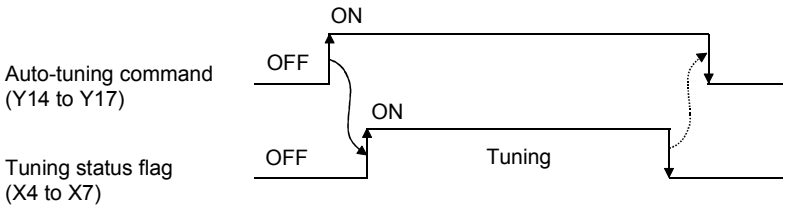
(a) Each channel flag is ON during execution of auto-tuning or self-tuning.

Channel	Tuning status flag		ON/OFF status
	Standard control	Heating-cooling control	
1	X4	X4	ON: Tuning in execution OFF: Tuning not in execution or complete
2	X5	X5	
3	X6	—	
4	X7	—	

(b) The auto-tuning is performed with the auto-tuning commands (Y14 to Y17).

(c) The self-tuning is set from the Self-tuning setting (buffer memory address: 3EH, 5EH, 7EH, 9EH). The self-tuning is available only when Standard control is active. (Refer to Section 3.3.2.)

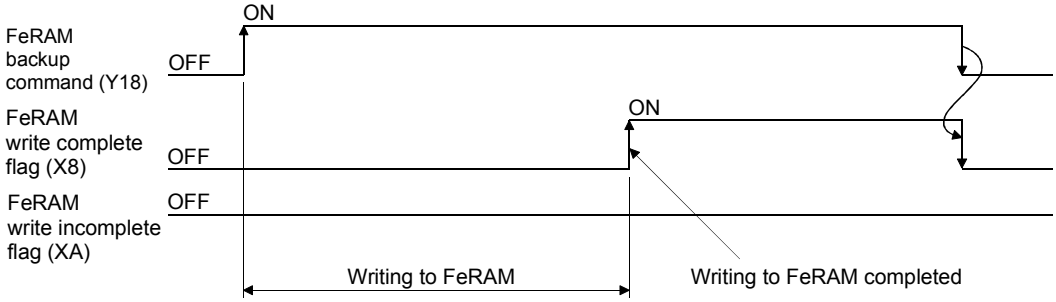
(d) Each of these flags is "ON" during tuning, and automatically turns "OFF" when the tuning is completed.



(6) FeRAM write complete flag (X8)

(a) When the FeRAM backup command (Y18) turns ON, the buffer memory data are written to the FeRAM. Upon completion of the writing, this flag turns ON.

(b) Turning OFF the FeRAM backup command also turns OFF the FeRAM write complete flag.

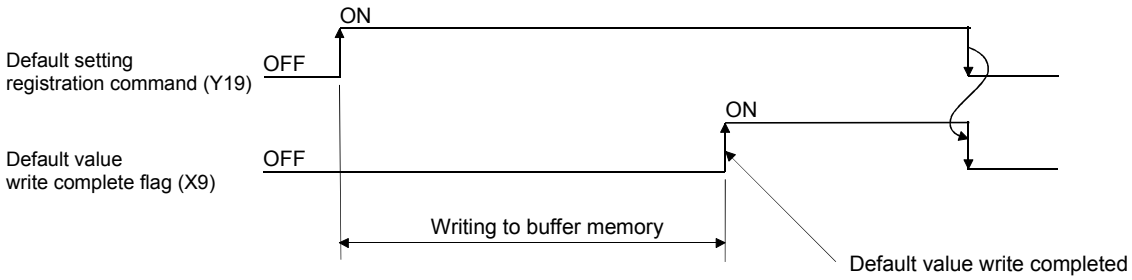


(7) Default value write complete flag (X9)

(a) When the Default setting registration command (Y19) turns ON, default values of the A1S64TCTRT(BW) are written to the buffer memory. Upon completion of the writing, this flag turns ON.

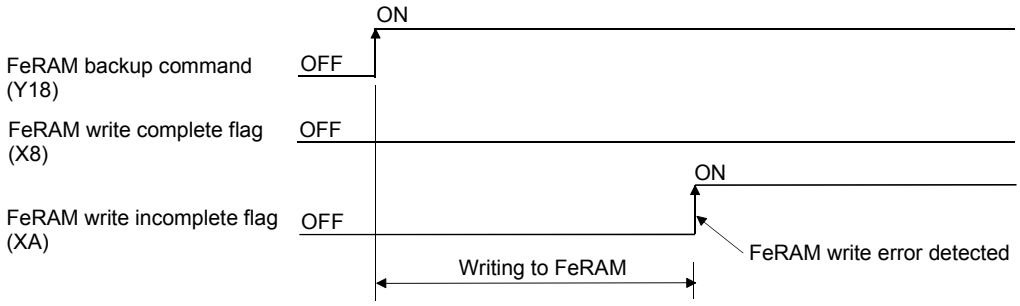
(b) Turning OFF the Default setting registration command (Y19) also turns OFF the Default value write complete flag (X9).

(c) For unused channels, perform the unused channel setting after completing the default value writing.
Failure to do so will cause the "ALM" LED on the A1S64TCTRT(BW) to flash.



(8) FeRAM write incomplete flag (XA)

(a) When the FeRAM backup command (Y18) is ON, and if writing the buffer memory data to the FeRAM fails, this flag turns ON.
- OFF: Writing to FeRAM completed
- ON : Writing to FeRAM not completed (Failed to write data)



(b) The FeRAM write incomplete flag turns OFF when writing to the FeRAM is normally completed.

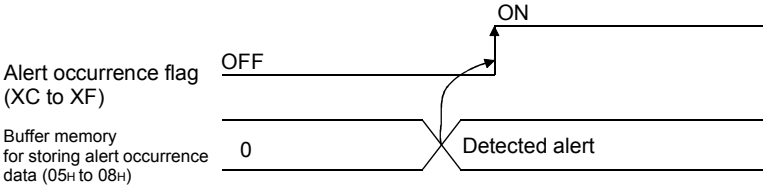
(c) While this flag is ON, the FeRAM data are erratic. If reapplying power to the programmable controller CPU or resetting it with this flag set to ON will cause erratic buffer memory data. To prevent this, in such a case, the A1S64TCTRT(BW) will use its default values.

(9) Alert occurrence flag (XC to XF)

(a) The flag for each channel turns ON when an alert occurs.

Channel	Alert occurrence flag		ON/OFF status	Buffer memory address for storing alert occurrence data	
	Standard control	Heating-cooling control		Standard control	Heating-cooling control
1	XC	XC	OFF: No alert ON: Alert occurred	5H	5H
2	XD	XD		6H	6H
3	XE	—		7H	—
4	XF	—		8H	—

(b) If an alert occurs, alert occurrence data is stored in the buffer memory (05H to 08H) and the relevant alert occurrence flag turns ON.



3.5.3 Output signal function

(1) Setting/operation mode command (Y11)

(a) This signal is used to set the mode of the temperature control.
- OFF: Setting mode
- ON : Operation mode

(b) All channels (four channels for Standard control and two channels for Heating-cooling control) can be set at a time.

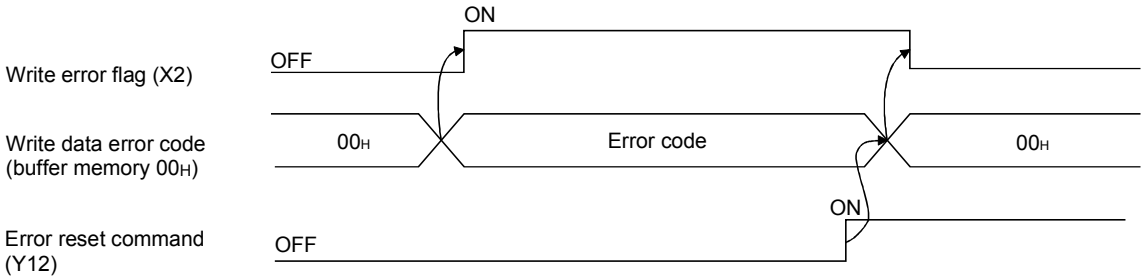
(c) If the input range and alert mode have been changed, move to operation mode after 1.5 seconds or more have passed.

(d) For information on how the A1S64TCTRT(BW) behaves by ON/OFF of this command, refer to Section 3.3.9.

(2) Error reset command (Y12)

(a) This signal is used to turn OFF the Write error flag (X2) to clear (reset) the buffer memory for error code storage.

(b) When this Error reset command turns ON, the "RUN" LED on the A1S64TCTRT(BW) front face stops flashing and stays ON.



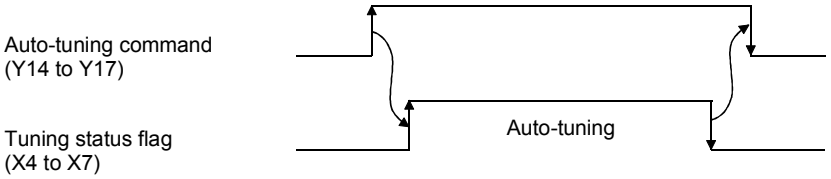
(3) Auto-tuning command (Y14 to Y17)

(a) This signal is used to start the auto-tuning.

(b) When the Auto-tuning command (Y14 to Y17) turns ON, the auto-tuning starts and the Tuning status flag (X4 to X7) turns ON. Upon completion of the auto-tuning, the Tuning status flag (X4 to X7) turns OFF.

(c) Keep the ON status of the Auto-tuning command signal during execution of auto-tuning, and turn it OFF upon completion of the execution.

(d) If the auto-tuning command is turned OFF during execution of auto-tuning, the execution is stopped. In such a case, PID constants in the buffer memory do not change.



(e) In Standard control, the auto-tuning is not performed when "0" is set in the buffer memory for proportional band (P) setting (23H, 43H, 63H, 83H).

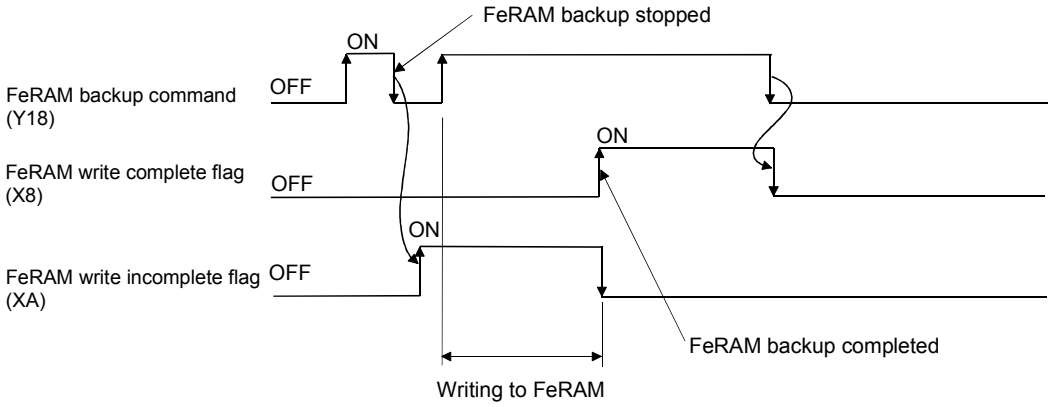
(4) FeRAM backup command (Y18)

(a) This signal is used to write buffer memory data to the FeRAM.

(b) When the FeRAM backup command turns ON, buffer memory data are written to the FeRAM.

1) Upon normal completion of the writing, the FeRAM write complete flag (X8) turns ON.

2) When failed, the FeRAM write incomplete flag (XA) turns ON.
If this occurs, turn ON the FeRAM backup command again to write the data to the FeRAM.



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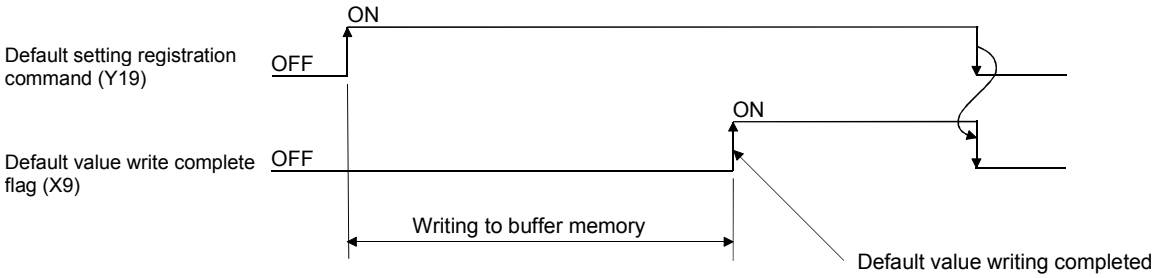
(5) Default setting registration command (Y19)

(a) This signal is used to return the buffer memory data back to the default values.
When the Default setting registration command (Y19) turns ON, default values of the A1S64TCTRT(BW) are written to the buffer memory. Upon completion of the writing, the Default value write complete flag (X9) turns ON.

(b) Set default values in Setting mode (Y11: OFF).
The default setting is not available in Operation mode (Y11:ON).



(6) Forced PID control stop command (Y1A to Y1D)

(a) This signal is used to forcibly stop PID operations of each channel.

(b) The mode that is active at PID operation stop depends on the Stop mode setting (buffer memory address: 21H, 41H, 61H, 81H).

⚠ DANGER	Even when PID operation has been stopped by turning ON the Forced PID control stop command (Y1A to Y1D), if the programmable controller CPU is stopped, the channel where the PID operation was forced to stop will execute the PID operation. Before changing the programmable controller CPU status to STOP, set the channel, where the Forced PID control stop command is ON, to "Unused".

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3.6 Buffer Memory List

Table 3.16 Buffer memory list (1/3)

Addresses (Hexadecimal) *3				Buffer memory address name	Monitoring/setting/ selection range	Default value (Decimal) *7	Availability *4		Condition for write *5		
CH1	CH2	CH3	CH4				Standard control	Heating-cooling control	Con-stantly	In setting mode	N/A
0H				Error code	(Refer to the error codes.)	—	○		—	—	○
1H	2H	3H	4H	Decimal point position	0,1	1	○		—	—	○
5H	6H	7H	8H	Alert detail	(Refer to the alert occurrence data.)	—	○		—	—	○
9H	AH	BH	CH	Temperature process value (PV)	Depends on the input range setting.	—	○		—	—	○
DH	EH	FH	10H	Manipulated value (MV)	-50 to 1050 (-5.0 to 105.0%)	—	○	—	—	—	○
DH	EH	—	—	Manipulated value for heating (MV)	-50 to 1050 (-5.0 to 105.0%)	—	—	○	—	—	○
11H	12H	13H	14H	Temperature rise judgment flag	0, 1	—	○		—	—	○
15H	16H	17H	18H	Transistor output flag	(Refer to the transistor output flag.)	—	○	—	—	—	○
15H	16H	—	—	Heating transistor output flag	(Refer to the transistor output flag.)	—	—	○	—	—	○
19H	1AH	1BH	1CH	Measured heater current value *1	0 to 105.0A 0.00 to 21.00 A	—	○		—	—	○
1DH				Cold junction temperature process value *2	-10 to 100°C, °F	—	○		—	—	○
1EH				MAN mode shift completion flag	(Refer to MAN mode shift completion flag.)	—	○	—	—	—	○
20H	40H	60H	80H	Input range	Depends on the input range setting.	7	○		—	○	—
21H	41H	61H	81H	Stop mode setting	0: Stop, 1: Monitor, 2: Alert	1	○		○	—	—
22H	42H	62H	82H	Set value (SV) setting	Within the upper/lower setting limiter	0	○		○	—	—
23H	43H	63H	83H	Proportional band (P) setting	0 to 10000(0.0 to 1000.0%)	30	○	—	○	—	—
23H	43H	—	—	Heating proportional band (Ph) setting	1 to 10000 (0.1 to 1000.0%)	30	—	○	○	—	—
24H	44H	64H	84H	Integral time (I) setting	1 to 3600 (s)	240	○		○	—	—
25H	45H	65H	85H	Derivative time (D) setting	0 to 3600 (s)	60	○		○	—	—
26H	46H	66H	86H	Setting of Alert alarm 1	Depends on the input range setting.	0	○		○	—	—
27H	47H	67H	87H	Setting of Alert alarm 2							
28H	48H	68H	88H	Setting of Alert alarm 3							
29H	49H	69H	89H	Setting of Alert alarm 4							
2AH	4AH	6AH	8AH	Upper output limiter	-50 to 1050 (-5.0 to 105.0%)	1000	○	—	○	—	—
2AH	4AH	—	—	Heating upper output limiter	-50 to 1050 (-5.0 to 105.0%)	1000	—	○	○	—	—
2BH	4BH	6BH	8BH	Lower output limiter	-50 to 1050 (-5.0 to 105.0%)	0	○	—	○	—	—
2CH	4CH	6CH	8CH	Output variation limiter	0 to 1000 (0.0 to 100.0%/s)	0	○	—	○	—	—
2DH	4DH	6DH	8DH	Sensor compensation value setting	-5000 to 5000 (-50.00 to 50.00%)	0	○		○	—	—
2EH	4EH	6EH	8EH	Adjustment sensitivity (dead band) setting	1 to 100 (0.1 to 10.0%)	5	○	—	○	—	—
2FH	4FH	6FH	8FH	Control output period setting	1 to 100(s)	30	○	—	○	—	—
2FH	4FH	—	—	Heating control output period setting	1 to 100 (s)	30	—	○	○	—	—

*1: Available for the A1S64TCTRTBW only.

*2: Available only when the type of the connected temperature sensor is thermocouple.

*3: Up to four channels are available for Standard control, and channels 1 and 2 only for Heating-cooling control.

*4: Shows whether the area is available for each of the control methods. (○: Available, —: N/A)

*5: Shows conditions for writing. Reading is always possible.

*6: "0" (Slow) is set for Standard control, and "2" (Fast) is set for Heating-cooling control.

*7: The default value of the item, for which "-" is shown in Availability column, is 0.

Table 3.16 Buffer memory list (2/3)

Addresses (Hexadecimal) *3				Buffer memory address name	Monitoring/setting/ selection range	Default value (Decimal) *7	Availability *4		Condition for write *5		
CH1	CH2	CH3	CH4				Standard control	Heating-cooling control	Con-stantly	In setting mode	N/A
30H	50H	70H	90H	Primary delay digital filter setting	0 to 100(s)	0	○		○	—	—
31H	51H	71H	91H	Control response parameter	0: Slow, 1: Normal, 2: Fast	*6	○		○	—	—
32H	52H	72H	92H	AUTO/MAN mode switching	0: Auto (AUTO), 1: Manual (MAN)	0	○	—	○	—	—
33H	53H	73H	93H	MAN output setting	Within the upper/lower limiter range	0	○	—	○	—	—
34H	54H	74H	94H	Setting change rate limiter	0 to 1000(0.0 to 100.0%/min)	0	○		○	—	—
35H	55H	75H	95H	AT bias	+/- full scale (°C, °F)	0	○	—	○	—	—
36H	56H	76H	96H	Direct/reverse action setting	0: Direct action, 1: Reverse action	1	○	—	○	—	—
37H	57H	77H	97H	Upper setting limiter	Lower limit to upper limit within the input range	6000	○		○	—	—
38H	58H	78H	98H	Lower setting limiter	Lower limit to upper limit within the input range	-2000	○		○	—	—
39H	59H	79H	99H	CT selection *1	0: 0.0 to 100.0A 1: 0.00 to 20.00A	0	○		○	—	—
3AH	5AH	7AH	9AH	Heater disconnection alert setting *1	0 to 100%	0	○		○	—	—
3BH	5BH	7BH	9BH	Loop disconnection detection judgment time	0 to 7200s	480	○	—	○	—	—
3CH	5CH	7CH	9CH	Loop disconnection detection dead band	Full scale (°C, °F)	0	○	—	○	—	—
3DH	5DH	7DH	9DH	Unused channel setting	0: Used, 1: Unused	0	○		○	—	—
3EH	5EH	7EH	9EH	Self-tuning setting	0: Not use, 1: Use	0	○	—	○	—	—
3FH	5FH	7FH	9FH	Self-tuning flag	(Refer to the self-tuning.)	0	○	—	—	—	○
A0H				Mode setting for Alert alarm 1	0 to 14	0	○		—	○	—
A1H				Mode setting for Alert alarm 2							
A2H				Mode setting for Alert alarm 3							
A3H				Mode setting for Alert alarm 4							
A4H				Alert dead band setting	0 to 100(0.0 to 10.0%)	5	○		○	—	—
A5H				Alert delay count	0 to 255 (times)	0	○		○	—	—
A6H				Heater disconnection/output off-time current error detection delay count *1	3 to 255 (times)	3	○		○	—	—
A7H				Temperature rise completion range setting	1 to 10 (°C)	1	○		○	—	—
A8H				Temperature rise completion soak time setting	0 to 3600 (min)	0	○		○	—	—
A9H				PID continuation flag	0: Stop, 1: Continue	0	○		○	—	—
AAH				Heater voltage compensation setting *1	0: OFF, 1: ON	0	○		○	—	—
ABH	ACH	ADH	AEH	Heater current reference value *1	0 to 100.0A 0.00 to 20.00A	0	○		○	—	—
AFH				Transistor output monitor ON delay time setting	0 to 50(0 to 500ms)	0	○		○	—	—

*1: Available for the A1S64TCTRTBW only.

*2: Available only when the type of the connected temperature sensor is thermocouple.

*3: Up to four channels are available for Standard control, and channels 1 and 2 only for Heating-cooling control.

*4: Shows whether the area is available for each of the control methods. (○: Available, —: N/A)

*5: Shows conditions for writing. Reading is always possible.

*6: "0" (Slow) is set for Standard control, and "2" (Fast) is set for Heating-cooling control.

*7: The default value of the item, for which "-" is shown in Availability column, is 0.

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Table 3.16 Buffer memory list (3/3)

Addresses (Hexadecimal) *3				Buffer memory address name	Monitoring/setting/ selection range	Default value (Decimal) *7	Availability *4		Condition for write *5		
CH1	CH2	CH3	CH4				Standard control	Heating-cooling control	Con-stantly	In setting mode	N/A
B0H				CT monitor method switching *1	0: ON/OFF current, 1: ON current	0	○		○	—	—
B1H	B2H	B3H	B4H	Control output monitor	0 to 4000	—	○	—	○	—	—
B1H	B2H	—	—	Heating control output monitor	0 to 4000	—	—	○	○	—	—
B7H				Control switching monitor	0: Standard control, 1: Heating-cooling control	0	○		—	—	○
—	—	B8H	B9H	Temperature conversion setting	0: Unused, 1: Used	0	—	○	○	—	—
C0H	C1H	—	—	Manipulated value for cooling (MV)	-50 to 1050 (-5.0% to 105.0%)	—	—	○	—	—	○
C2H	C3H	—	—	Cooling control output monitor	0 to 4000	—	—	○	—	—	○
C4H	C5H	—	—	Cooling transistor output flag	(Refer to the transistor output flag.)	—	—	○	—	—	○
CFH		—	—	Cooling type setting	0: Air-cooling, 1: Water-cooling	0	—	○	○	—	—
D0H	E0H	—	—	Cooling proportional band (Pc) setting	1 to 10000 (0.1% to 1000.0%)	30	—	○	○	—	—
D1H	E1H	—	—	Cooling upper output limiter	0 to 1050 (0.0% to 105.0%)	1000	—	○	○	—	—
D2H	E2H	—	—	Cooling control output period setting	1 to 100s	30	—	○	○	—	—
D3H	E3H	—	—	Overlap/dead band	-100 to 100 (-10.0% to 10.0%)	0	—	○	○	—	—

*1: Available for the A1S64TCTRTBW only.

*2: Available only when the type of the connected temperature sensor is thermocouple.

*3: Up to four channels are available for Standard control, and channels 1 and 2 only for Heating-cooling control.

*4: Shows whether the area is available for each of the control methods. (○: Available, —: N/A)

*5: Shows conditions for writing. Reading is always possible.

*6: "0" (Slow) is set for Standard control, and "2" (Fast) is set for Heating-cooling control.

*7: The default value of the item, for which "-" is shown in Availability column, is 0.

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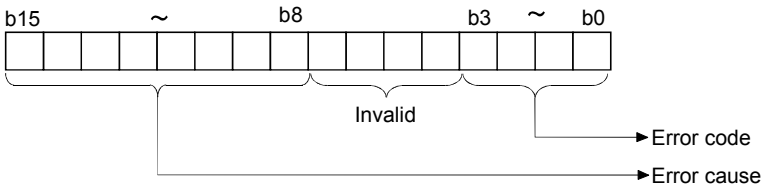
3.7 Common Buffer Memory

This section explains the buffer memory used common to Standard control and Heating-cooling control.

3.7.1 Error code (buffer memory address: 0H)

(1) When any of the following errors occurs, an error code and an error cause are stored in the lower 4-bit and the higher 8-bit areas respectively.
For details of the error codes and error causes, refer to Section 6.1.
• Write data error
• Tuning abend error
• Hardware error



(2) For a write data error, the following is performed.
• Storing an error code (For error codes details, refer to Section 6.1.)
• Flashing of the "RUN" LED on the front face of the module
• Turning ON the Write error flag (X2)

(3) For a tuning abend error, the following is performed.
• Storing an error code

(4) For a hardware error, the following is performed.
• Storing an error code (For error code details, refer to Section 6.1.)
• Flashing of the "RUN" LED on the front face of the module
• Turning ON the Hardware error flag (X3)

(5) When multiple errors have occurred, an error code and an error source address of the highest priority error are stored.

(6) For how to clear the error, refer to Section 6.1.

3.7.2 Decimal point position (buffer memory address: 1H to 4H)

(1) The decimal point position for the following data is stored according to the input range setting which determines the measured temperature range.
- Temperature process value (PV)
- Set value (SV)
- Alert set value
- Upper setting limiter
- Lower setting limiter
- AT bias
- Loop disconnection detection dead band

"1" is stored if the input range of the measured temperature range with a decimal point was set.
"0" is stored if the input range of the measured temperature range without a decimal point was set.

(2) Refer to the following table when performing write/read of the above data from the programmable controller CPU.

Decimal point position	For read	For write
0	Buffer memory data is read as is and used in sequence programs, etc.	The specified value is written as is.
1	One/tenth of the value read from a sequence program or the like is used as the actual value.	The value 10 times the specified value is written.

(3) When Heating-cooling control is used, the buffer memory addresses 3H and 4H can be used for the temperature conversion function. (Refer to Section 3.3.14.)

3.7.3 Alert detail (buffer memory address: 5H to 8H)

(1) A bit corresponding to the alert detected on each channel turns to "1".

Bit No.	Alert detail
b0	The PV rises above the temperature measurement range set for the input range. *1
b1	The PV falls below the temperature measurement range set for the input range. *1
b2	Hardware error has occurred.
b3	
b4	
b5	Unused
b6	
b7	
b8	Alert alarm 1 turned ON.
b9	Alert alarm 2 turned ON.
b10	Alert alarm 3 turned ON.
b11	Alert alarm 4 turned ON.
b12	Heater disconnection detected.
b13	Loop disconnection detected. *2
b14	Electric current error with output OFF detected.
b15	Unused

(2) In Heating-cooling control, when the temperature conversion function is used in unused channels, a bit corresponding to the alert detected on each channel turns to "1".

Bit No.	Alert detail
b0	The PV rises above the temperature measurement range set for the input range. *1
b1	The PV falls below the temperature measurement range set for the input range. *1
b2	Hardware error has occurred
b3	
b4	
b5	Unused
b6	
b7	
b8	
b9	
b10	
b11	
b12	
b13	
b14	
b15	

*1: The temperature measurement range represents the range from the lower limit - 5% to the upper limit + 5% to the full scale of the input range.

Example) When the input range is 38

Input range: -200.0 to 400.00

Temperature measurement range: -230.0 to 430.0

(An alert will occur at -230.0°C or lower, or at 430.0°C or higher.)

*2: Available for Standard control only.

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3.7.4 Temperature process value (PV) (buffer memory address: 9H to CH)

(1) The temperature value detected by the A1S64TCTRT(BW) is processed by the following and stored.
- Linearization
- Sensor compensation (buffer memory address: 2DH, 4DH, 6DH, 8DH)
- Cold junction compensation *1

*1: Available only when the type of the connected temperature sensor is thermocouple.

(2) The value is stored as follows according to the Decimal point position (buffer memory address: 1H to 4H).
- When 0 is set in Decimal point position, the value is stored as it is.
- When 1 is set in Decimal point position, the value is multiplied by 10 and stored.

POINT
If the temperature measured by the temperature sensor exceeds the measurement range, the following value is stored. • Above the temperature measurement range: Upper limit of input range + 5% of full scale • Below the temperature measurement range: Lower limit of input range - 5% of full scale

(3) In Heating-cooling control, buffer memory addresses, BH and CH can be used for the temperature conversion function. (Refer to Section 3.3.14.)

3.7.5 Temperature rise judgment flag (buffer memory address: 11H to 14H)

(1) This flag checks whether the temperature process value (PV) is within the temperature rise completion range or not.

(2) This flag turns to "1" when the temperature process value (PV) is within the temperature rise completion range.
Setting the temperature rise completion soak time (buffer memory address: A8H) will cause this flag to turn to "1" when the temperature process value remains within the temperature rise completion range of the preset temperature rise completion soak time.

3.7.6 Cold junction temperature process value (buffer memory address: 1DH)

(1) This area stores a measured temperature of the cold junction compensation resistor that is connected to the A1S64TCTRT (BW).
It is available only when the type of the connected temperature sensor is thermocouple.

3.7.7 Input range setting (buffer memory address: 20H, 40H, 60H, 80H)

(1) The following table lists the types and input range settings for the temperature sensors connectable to the A1S64TCTRT(BW).
Set an input range setting value suitable for the temperature sensor and temperature range to be used.
The input range must be set in Setting mode (Y11:OFF).
The default value is "7: Pt100 (-200.0 to 600.0°C)".

Table 3.17 Input range setting

Temperature sensor type		°C			°F		
		Measured temperature range	Input range setting	Setting increments	Measured temperature range	Input range setting	Setting increments
Thermocouple	R	0 to 1700	1	1	0 to 3000	105	1
	K	0 to 500	11	1	0 to 1000	100	1
		0 to 800	12	1	0 to 2400	101	1
		0 to 1300	2	1	0.0 to 1000.0	130	0.1
		-200.0 to 400.0	38	0.1	—	—	—
		0.0 to 400.0	36	0.1			
		0.0 to 500.0	40	0.1			
		0.0 to 800.0	41	0.1			
	J	0 to 500	13	1	0 to 1000	102	1
		0 to 800	14	1	0 to 1600	103	1
		0 to 1200	3	1	0 to 2100	104	1
		0.0 to 400.0	37	0.1	0.0 to 1000.0	131	0.1
		0.0 to 500.0	42	0.1	—	—	—
		0.0 to 800.0	43	0.1			
	T	-200 to 400	4	1	0 to 700	109	1
		-200 to 200	21	1	-300 to 400	110	1
		0 to 200	19	1	0.0 to 700.0	132	0.1
		0 to 400	20	1	—	—	—
		-200.0 to 400.0	39	0.1			
		0.0 to 400.0	45	0.1			
	S	0 to 1700	15	1	0 to 3000	106	1
	B	400 to 1800	16	1	800 to 3000	107	1
	E	0 to 400	17	1	0 to 1800	108	1
		0 to 1000	18	1	—	—	—
		0.0 to 700.0	44	0.1			
	N	0 to 1300	22	1	0 to 2300	111	1
	U	0 to 400	25	1	0 to 700	114	1
		-200 to 200	26	1	-300 to 400	115	1
		0.0 to 600.0	46	0.1	—	—	—
	L	0 to 400	27	1	0 to 800	116	1
		0 to 900	28	1	0 to 1600	117	1
		0.0 to 400.0	47	0.1	—	—	—
		0.0 to 900.0	48	0.1			
	PLII	0 to 1200	23	1	0 to 2300	112	1
	W5Re/ W26Re	0 to 2300	24	1	0 to 3000	113	1
Platinum RTD	Pt100	-200.0 to 600.0	7	0.1	-300 to 1100	141	1
		-200.0 to 200.0	8	0.1	-300.0 to 300.0	143	0.1
	JPt100	-200.0 to 500.0	5	0.1	-300 to 900	140	1
		-200.0 to 200.0	6	0.1	-300.0 to 300.0	142	0.1

(2) If the input range have been changed, move to operation mode after 1.5 seconds or more have passed. If the move is made in less than 1.5 seconds, a write error (error code 3) will be generated.
(3) For about nine seconds after change of the input range setting value, the measured temperature value becomes 0 and temperature control is not available.
(4) When changing the input range, be sure that the upper and lower setting limiter values are within the temperature measurement range.
(5) In Heating-cooling control, buffer memory addresses, 60H and 80H can be used for the temperature conversion function. (Refer to Section 3.3.14.)

3.7.8 Stop mode setting (buffer memory address: 21H, 41H, 61H, 81H)

(1) Set a mode to be active when PID operation is stopped.
The default value (initial value) is set to "1: Monitor".

(2) Each mode setting and its operation behavior are as follows:

Mode	Set value	Operation behavior		
		PID operation	Temperature detection	Alert detection
Stop	0	×	×	×
Monitor	1	×	○	×
Alert	2	×	○	○

○: Execute
×: Not execute

Note that the operation behavior differs depending on the unused channel setting, setting/operation mode setting, PID continuation flag, or forced stop command setting. (Refer to Section 3.3.9.)

(a) Temperature detection: Inputs temperature data from the temperature sensor and check if it is within the allowable input range.
(b) Alert detection : Performs Alert alarm 1 to 4 described in Section 3.7.3.

POINT

The default value (initial value) for the Stop mode is set to "1: Monitor".
Therefore, a channel that does not connect a temperature sensor will be regarded as a sensor-input-disconnected channel, the "ALM" LED will flash at 2s intervals.
Such a channel must be set to "1 (Unused)" in the Unused channel setting (buffer memory address: 3DH, 5DH, 7DH, 9DH).

3.7.9 Set value (SV) setting (buffer memory address: 22H, 42H, 62H, 82H)

(1) Set a target temperature for PID operation.

(2) The setting must be within the temperature range that is set by the Upper setting limiter (buffer memory address: 37H, 57H, 77H, 97H) and Lower setting limiter (buffer memory address: 38H, 58H, 78H, 98H).

(3) Setting a value outside the setting range will cause a write error, turning ON the Write error flag (X2) and storing error code "4" in the Error code area (buffer memory address: 0H).

3.7.10 PID constants setting (buffer memory address: 23H to 25H, 43H to 45H, 63H to 65H, 83H to 85H)

(1) Set values of the proportional band (P), integral time (I) and derivative time (D) for PID operations.

(2) In Standard control, set proportional band (P), integral time (I) and derivative time (D) values within the range shown below.

Item	Address (Hex.)				Setting range	Constant in PID operation
	CH1	CH2	CH3	CH4		
Proportional band (P) setting	23H	43H	63H	83H	0 to 10000	0.0 to 1000.0%
Integral time (I) setting	24H	44H	64H	84H	1 to 3600	1 to 3600s
Derivative time (D) setting	25H	45H	65H	85H	0 to 3600	0 to 3600s

(a) The proportional band (P) is set as a percent (%) of the preset input range to the full scale.
For example, in the case of the input range setting 38 (-200.0 to 400.0°C) and the proportional band 10.0%, 60°C is set for the proportional band.

(b) For the two-position control [*1], set the proportional band to "0".

(c) For the PI control, set the derivative time to "0".

(d) For execution of the auto-tuning, do not set "0" for the proportional band. If the set value is "0", the auto-tuning is not performed.

(3) In Heating-cooling control, set heating proportional band (Ph), cooling proportional band (Pc), integral time (I) and derivative time (D) values within the range shown below.

Item	Address (Hex.)		Setting range	Constant in PID operation
	CH1	CH2		
Heating proportional band (Ph) setting	23H	43H	0 to 10000	0.1 to 1000.0%
Cooling proportional band (Pc) setting	D0H	E0H		
Integral time (I) setting	24H	44H	1 to 3600	1 to 3600s
Derivative time (D) setting	25H	45H	0 to 3600	0 to 3600s

(a) Each of the heating proportional band (Ph) and the cooling proportional band (Pc) is set as a percent (%) of the preset input range to the full scale.
For example, in the case of the input range setting 38 (-200.0 to 400.0°C) and the heating proportional band 10.0%, 60°C is set for the heating proportional band.

(b) For the PI control, set the derivative time to "0".

REMARK

*1: The two-position control is a control system used to keep the temperature constant, in which the manipulated value is alternately changed to either 0% (OFF) or 100% (ON), depending on whether the process value is greater or less than the set value.

3.7.11 Settings of Alert alarm 1 to 4 (buffer memory address: 26H to 29H, 46H to 49H, 66H to 69H, 86H to 89H)

(1) Sets conditions to turn on alerts from 1 to 4.

(2) Alert alarms 1 to 4 are set in the following buffer memory.

Alert	Alert alarm mode setting	CH1 set value	CH2 set value	CH3 set value	CH4 set value
Alert 1	A0H	26H	46H	66H	86H
Alert 2	A1H	27H	47H	67H	87H
Alert 3	A2H	28H	48H	68H	88H
Alert 4	A3H	29H	49H	69H	89H

(3) The setting value depends on alert type.
Before making this setting, refer to Section 3.2.11.

1) Input alert (upper limit input alert, lower limit input alert)
Setting value····Process value (PV)

2) Deviation alert (upper limit deviation alert, lower limit deviation alert)
Setting value····Deviation [Process value (PV) – Set value (SV)]

3) Deviation alert (upper/lower limit deviation alert, within-range alert)
Setting value····Absolute value of deviation [Process value (PV) – Set value (SV)]*1

*1 A value less than 0 cannot be set to the Alert set value 1 to 4.
The setting range varies depending on the input range setting (Refer to Section 3.7.7.) and the alert mode as shown below.

Alert mode						Setting range
1	Upper limit input alert	7	Upper limit input alert with wait	—	—	Same as input range
2	Lower limit input alert	8	Lower limit input alert with wait	—	—	Same as input range
3	Upper limit deviation alert	9	Upper limit deviation alert with wait	12	Upper limit deviation alert with re-wait	- full scale to + full scale
4	Lower limit deviation alert	10	Lower limit deviation alert with wait	13	Lower limit deviation alert with re-wait	- full scale to + full scale
5	Upper/lower limit deviation alert	11	Upper/lower limit deviation alert with wait	14	Upper/lower limit deviation alert with re-wait	0 to + full scale
6	Within-range alert	—	—	—	—	0 to + full scale

(4) If a value outside the setting range is specified or if the setting range is set to any value other than 0 with the mode setting 0, a write error occurs and the Write error flag (X2) turns ON. Then, error code "4" is stored in the Error code area (buffer memory address: 0H).

(5) For the alert alarm function, refer to Section 3.3.3.

(6) The value stored varies with the decimal point position (buffer memory address: 1H to 4H) as indicated below:

0: The specified value is written as is.
1: The value 10 times the specified value is written.

3.7.12 Sensor compensation value setting (buffer memory address: 2DH, 4DH, 6DH, 8DH)

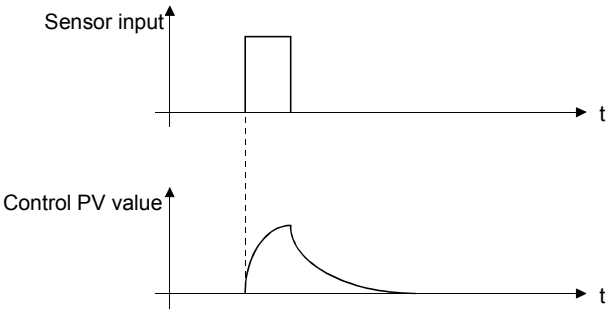
(1) Set a compensation value for the case where some error may be observed between the temperature measured by the sensor and the actual temperature. (Refer to Section 3.3.5.)

(2) Set a value within the range from –5000 to 5000 (-50.00% to 50.00% to the full scale of the set input range).

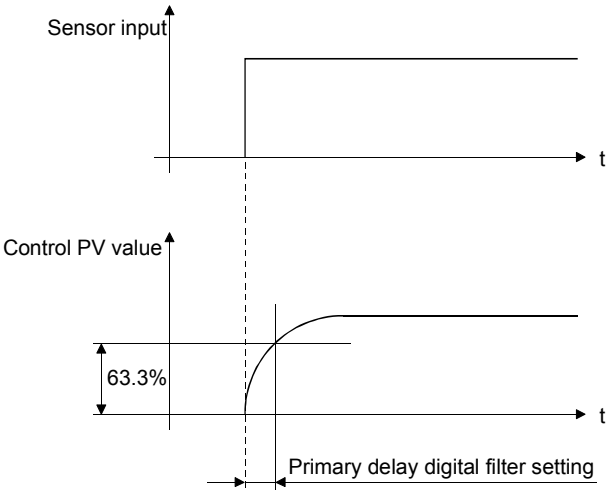
(3) In Heating-cooling control, buffer memory addresses 6DH and 8DH can be used for the temperature conversion function.
(Refer to Section 3.3.14.)

3.7.13 Primary delay digital filter setting (buffer memory address: 30H, 50H, 70H, 90H)

(1) The primary delay digital filter is designed to absorb sudden changes when the mesured value (PV) is input in a pulse format.



(2) As the primary delay digital filter setting (filter setting time), specify the time for the PV value to change 63.3%.



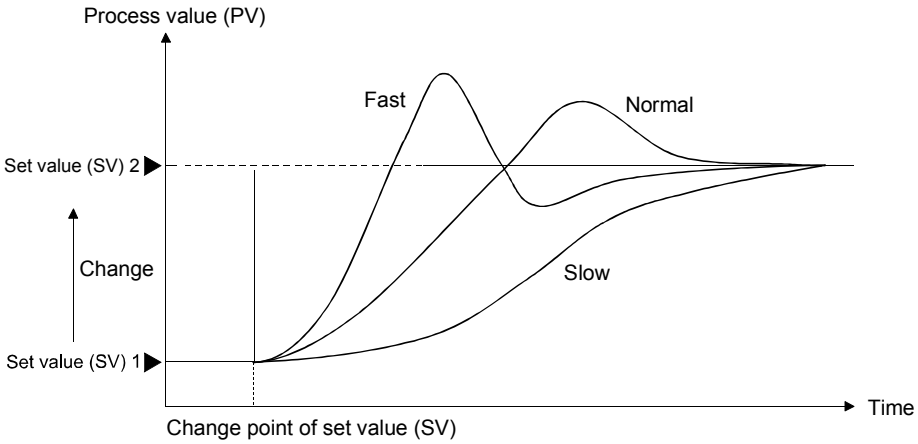
3.7.14 Control response parameter setting (buffer memory address: 31H, 51H, 71H, 91H)

(1) The control response parameter is provided for selection of three kinds of levels (Fast, Normal, Slow) for response to a set value (SV) change in PID control. The default value is set to "0 (Slow)" for Standard control, and "2 (Fast)" for Heating control.

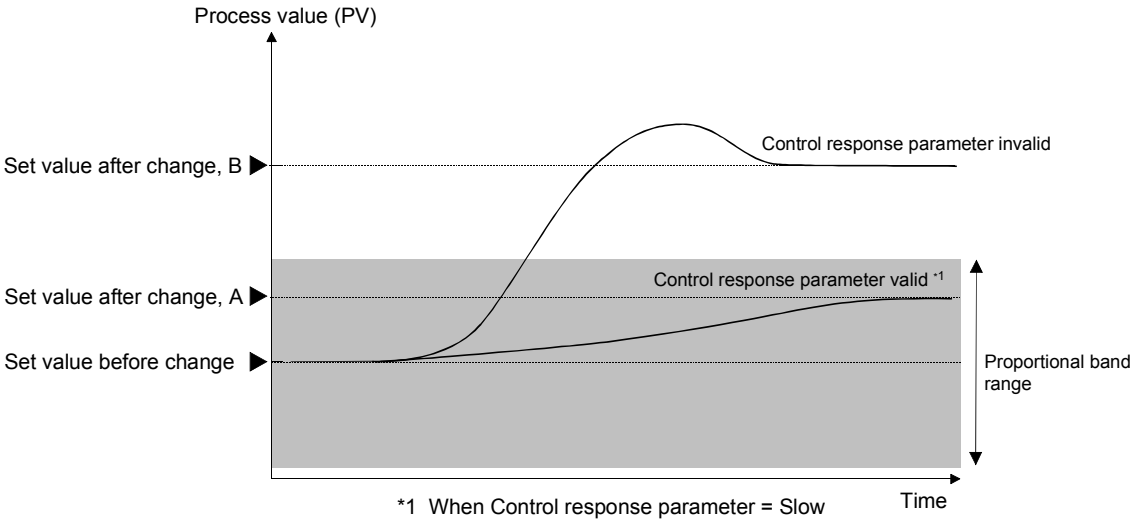
(a) Fast : Choose this level to give faster response to a set value change. Note that the setting of "Fast" will increase overshooting.

(b) Slow : Choose this level to suppress the overshooting of a set value change. Note that this will increase the settling time.

(c) Normal : Provides the intermediate characteristic between "Fast" and "Slow".

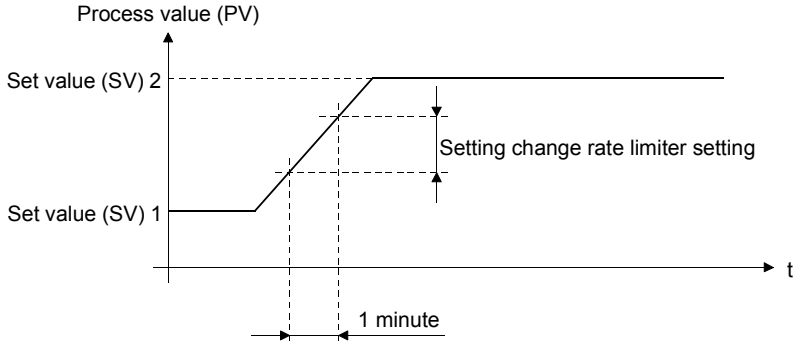


(2) The control response parameter is valid only when the changed set value (SV) is within the proportional band range.
Proportional band range = Full scale x Proportional band P



3.7.15 Setting change rate limiter setting (buffer memory address: 34H, 54H, 74H, 94H)

(1) This setting is made to set the variation of the set value per minute to a set value (SV) change. This will suppress a derivative kick (sudden change in the manipulated value).

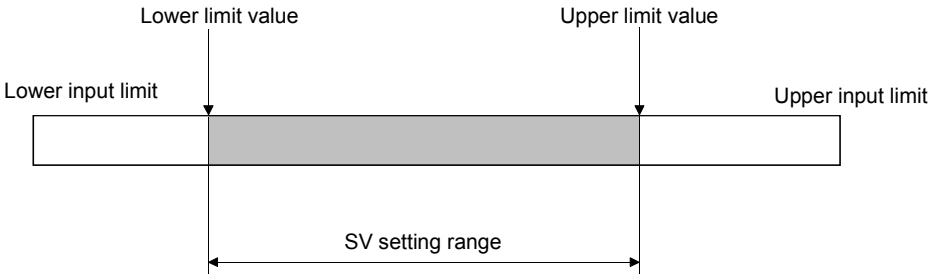


(2) Make this setting as a percentage of the input range setting (buffer memory address: 20H, 40H, 60H, 80H) to the full scale.
The setting range is 0 to 1000 (0 to 100.0%/min).

3.7.16 Upper/lower setting limiter (buffer memory address: 37H, 38H, 57H, 58H, 77H, 78H, 97H, 98H)

(1) This area is used for setting the upper/lower limit of the set value (SV).

(2) Set a value within the measurement range set for the input range.
Make the setting so that (Lower setting limiter value) < (Upper setting limiter value).



(3) Setting a value outside the setting range will cause a write error, turning ON the Write error flag (X2) and storing error code "4" in the Error code area (buffer memory address: 0H).

(4) In the case of (Lower setting limiter value) ≧ (Upper setting limiter value), a write error is detected, which turns ON the Write error flag (X2) and stores error code "5" in the Error code area (buffer memory address: 0H).

(5) The value stored varies with the decimal point position (buffer memory address:1H to 4H) as indicated below:
0: The specified value is written as is.
1: The value 10 times the specified value is written.

3.7.17 Unused channel setting (buffer memory address: 3DH, 5DH, 7DH, 9DH)

(1) A channel that is not used for temperature control or that has no temperature sensor connected can be set as an unused channel. (Refer to Section 3.3.6.) The default (initial) value is set to "0: Used".

(2) The "ALM" LED does not turn ON for any "Unused" channel even if no temperature sensor is connected to it.

(3) Default setting registration (Y19: ON) will clear the unused channel setting. If there is any channel that is not used for temperature control or that has no temperature sensor connected, make the unused channel setting again after completion of the default setting registration.

3.7.18 Mode settings for Alert alarm 1 to 4 (buffer memory address: A0H to A3H)

(1) Set the alert modes.
When "0" is set in the buffer memory for Alert alarm (1 to 4) mode settings (A0H to A3H), no alert alarm occurs.

(2) Set Alert alarm 1 to 4 in the following buffer memory.

Alert	Alert alarm mode setting	CH1 set value	CH2 set value	CH3 set value	CH4 set value
Alert 1	A0H	26H	46H	66H	86H
Alert 2	A1H	27H	47H	67H	87H
Alert 3	A2H	28H	48H	68H	88H
Alert 4	A3H	29H	49H	69H	89H

(3) The following table indicates the alert modes and set values.
Refer to Section 3.3.3 for the alert alarms of the A1S64TCTRT(BW).

Alert mode	Setting	Alert mode	Setting	Alert mode	Setting
Upper limit input alert	1	Upper limit input alert with wait	7	—	—
Lower limit input alert	2	Lower limit input alert with wait	8	—	—
Upper limit deviation alert	3	Upper limit deviation alert with wait	9	Upper limit deviation alert with re-wait	12
Lower limit deviation alert	4	Lower limit deviation alert with wait	10	Lower limit deviation alert with re-wait	13
Upper/lower limit deviation alert	5	Upper/lower limit deviation alert with wait	11	Upper/lower limit deviation alert with re-wait	14
Within-range alert	6	—	—	—	—

(4) If the alert mode have been changed, move to operation mode after 1.5 seconds or more have passed. If the move is made in less than 1.5 seconds, a write error (error code 3) will be generated.

3.7.19 Alert dead band setting (buffer memory address: A4H)

The dead band for alerts is set.
Set it within the range 0 to 100 (0.0% to 10.0%) to the full scale of the set input range.
Example) When the input range 2 (0 to 1300°C) and alert dead band setting 5 (0.5%) are selected

$$\frac{(\text{Full scale}) \times (\text{Alert dead band})}{1000} = \frac{(1300-0) \times 5}{1000} = 6.5\,^{\circ}\mathrm{C}$$

For details, refer to Section 3.3.3.

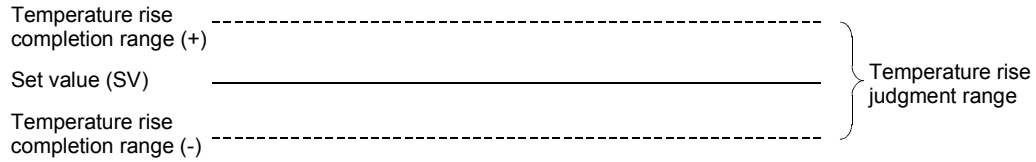
3.7.20 Alert delay count setting (buffer memory address: A5H)

(1) The sampling count for judging an alert is set.
When the number of alert delay times has been set, the system is placed in an alert status if the process value (PV) remains within the alert range until the sampling count reaches or exceeds the number of alert delay times.
Refer to Section 3.3.3 for details.

(2) The setting range is 0 to 255.

3.7.21 Temperature rise completion range setting (buffer memory address: A7H)

(1) Set the temperature rise/fall values, at which a temperature rise will be judged as completed, relative to the set value.



(2) The setting range is 1 to 10°C.

3.7.22 Temperature rise completion soak time setting (buffer memory address: A8H)

(1) Set a delay from when a temperature rise is completed until the temperature rise completion judgment flag is turned on (1).

(2) The setting range is 0 to 3600 (min).

3.7.23 PID continuation flag (buffer memory address: A9H)

(1) Set the operation mode to be entered when the setting mode/operation mode command (Y11) turns off.
- 0: Stop (default)
- 1: Continue

(2) Refer to Section 3.3.9 for the control status operated by ON/OFF of the PID continuation flag.

3.7.24 Transistor output monitor ON delay time setting (buffer memory address: AFH)

(1) In Standard control, set a timing at which ON delay output of the Transistor output flag (buffer memory address: 15H to 18H, b8) turns ON.
Set this when heater disconnection detection is performed using an input module.

(2) In Heating-cooling control, set a timing at which ON delay output of the Heating transistor output flag (buffer memory address: 15H to 16H, b8) turns ON.
Set this when heater disconnection detection is performed using an input module.

(3) The setting range is 0 and 1 to 50 (10 to 500ms).
If "0" is set, the Transistor output flag or Heating transistor output flag (buffer memory address: 15H to 18H or 15H to 16H, b8) does not turn ON (1).

3.7.25 Control switching monitor (buffer memory address: B7H)

(1) The control mode switch setting status is stored.
- 0: Standard control (The Control mode switch is set to S.)
- 1: Heating-cooling control (The Control mode switch is set to HC.)

3.8 Buffer Memory for Standard Control

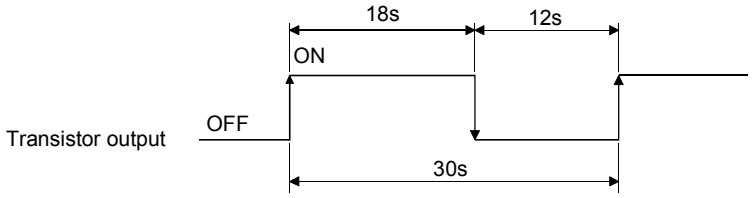
This section explains the buffer memory related to Standard control.

3.8.1 Manipulated value (MV) (buffer memory address: DH to 10H)

(1) This area stores the result of PID operation performed on the basis of the temperature value imported from the temperature sensor.

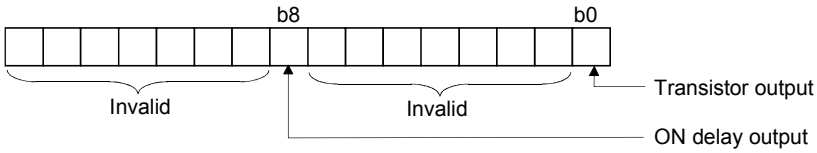
(2) The value stored is in the range -50 to 1050 (-5.0% to 105.0%).
However, the value must be in the range 0% to 100% for external output.
• 0% or less : 0%
• 100% or more : 100%

(3) The manipulated value represents the ON time of the control output period (buffer memory address: 2FH, 4FH, 6FH, 8FH) as a percentage.
At the control output period of 30s (seconds) and the manipulated value of 600 (60.0%), the pulse turns on for 18 seconds and turns off for 12 seconds.



3.8.2 Transistor output flag (buffer memory address: 15H to 18H)

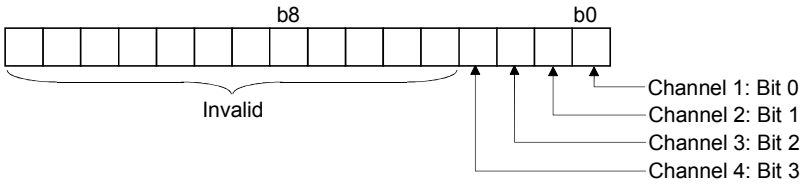
(1) This area stores ON/OFF states of the transistor output and the ON delay output.



(2) The following values are stored for the ON/OFF of the transistor output and the ON delay output.
• ON: 1
• OFF: 0

3.8.3 MAN mode shift completion flag (buffer memory address: 1EH)

(1) This flag checks whether switching from the automatic mode (AUTO) to the manual mode (MAN) has been completed or not.
The bit corresponding to the channel turns to "1" on completion of switching to the manual mode.



(2) When setting the manipulated value (MV) in the manual mode, make setting after confirming that the manual mode shift completion flag has turned to "1".

3.8.4 Upper/lower output limiter setting (buffer memory address: 2AH, 2BH, 4AH, 4BH, 6AH, 6BH, 8AH, 8BH)

(1) Set the upper and lower limit values for actually outputting the manipulated value (MV) calculated by PID operation to an external device.

(2) The setting range is -50 to 1050 (-5.0% to 105.0%).
Make setting so that the (lower output limiter value) is less than the (upper output limiter value).

(3) Setting a value outside the setting range will cause a write error, turning ON the Write error flag (X2) and storing error code "4" in the Error code area (buffer memory address: 0H).

(4) In the case of (Lower setting limiter value) ≧ (Upper setting limiter value), a write error is detected, which turns ON the Write error flag (X2) and stores error code "5" in the Error code area (buffer memory address: 0H).

(5) For the two-position control, the upper/lower output limiter setting is ignored.

3.8.5 Output variation limiter setting (buffer memory address: 2CH, 4CH, 6CH, 8CH)

(1) This function suppresses the variation of the manipulated value updated every 0.5 seconds.

(2) The setting range is 1 to 1000 (0.1 to 100.0%).
For example, when the output variation limiter is set to 10 (1.0%), the output variation will be 1% per second at a sudden manipulated value change of 50%, and it will take 50 seconds until the output value actually changes to 50%.

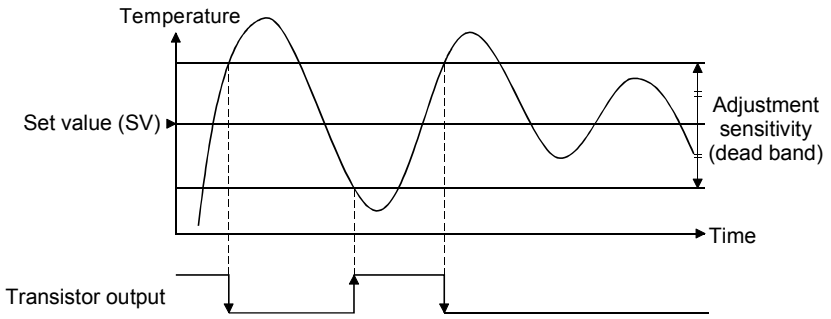
(3) Setting 0 disables the output variation limiter function.

(4) For the two-position control, the output variation limiter function setting is ignored.

3.8.6 Adjustment sensitivity (dead band) setting (buffer memory address: 2EH, 4EH, 6EH, 8EH)

(1) Set the adjustment sensitivity for the set value to prevent chattering of the transistor output.

(2) Set the sensitivity within the range 1 to 100 (0.1% to 10.0%) relative to the full scale of the preset input range.



$$\frac{(\text{Full scale}) \times (\text{adjustment sensitivity})}{1000} = \frac{(400 - (-200)) \times 10}{1000} = 6.0\,℃$$

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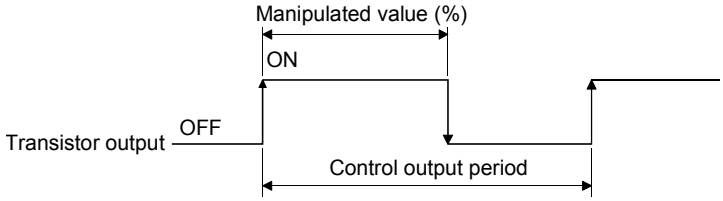
3.8.7 Control output period setting (buffer memory address: 2FH, 4FH, 6FH, 8FH)

(1) Set the pulse cycle (ON/OFF cycle) of the transistor output.



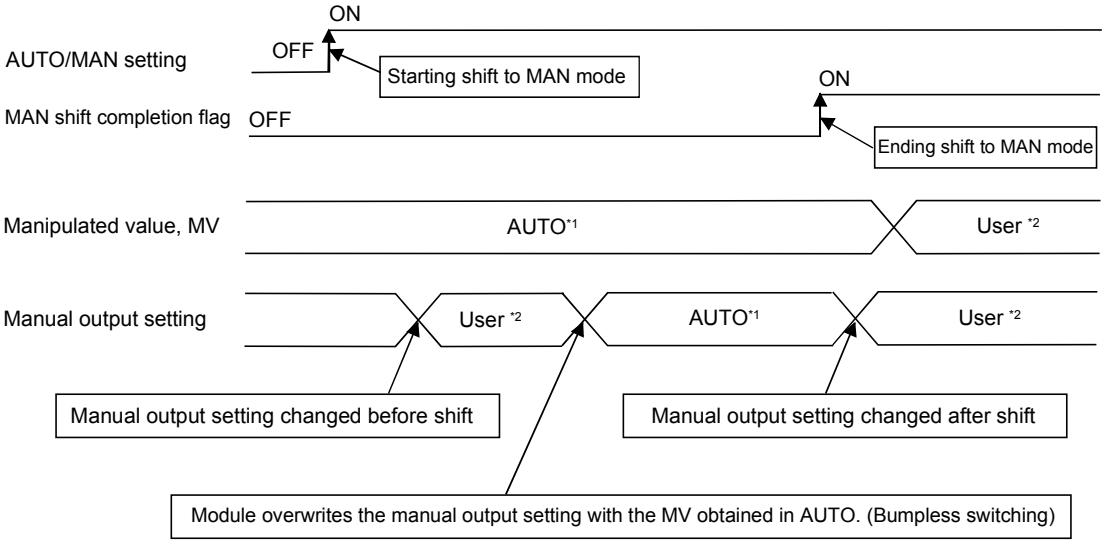
(2) The setting range is 1 to 100 (1 to 100s).

(3) The ON time of the control output period is found by multiplying the control output period by the manipulated value (%) calculated by PID operation. (Refer to Section 3.8.1.)

3.8.8 AUTO/MAN setting (buffer memory address: 32H, 52H, 72H, 92H)

(1) Select whether to use a manipulated value calculated by PID operation or the one set by the user.
- 0 (AUTO) : Use a PID-calculated manipulated value to calculate the ON time of the control cycle.
- 1 (MAN) : Use a manipulated value written to the buffer memory for manual output setting (33H, 53H, 73H, 93H) to calculate the ON time of the control cycle.

(2) When the setting is changed from AUTO to MAN, to prevent rapid change of the manipulated value, the PID-calculated manipulated value is transferred to the buffer memory's manual output setting area. (Bumpless switching)
Upon completion of switching to the manual mode, the corresponding bit of the MAN mode shift completion flag (buffer memory address: 1EH) turns ON (1). Make sure that this bit is ON before setting a manipulated value in the MAN mode.



*1 Manipulated value in AUTO mode (PID operation)
*2 Manipulated value set by the user (manual output)

(3) When executing the auto-tuning, set this to "0: AUTO".
If "1: MAN" is set, the auto-tuning is not executed.

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3.8.9 Manual output setting (buffer memory address: 33H, 53H, 73H, 93H)

(1) This area is provided for setting the manipulated value in "MAN" mode.

(2) Confirm that the corresponding bit of the MAN mode shift completion flag (buffer memory address: 1EH) has turned to 1 (ON) before writing data to this buffer memory area.
Data set with the MAN mode shift completion flag OFF are overwritten with a manipulated value calculated through PID operation by the system. (Refer to Section 3.8.8.)

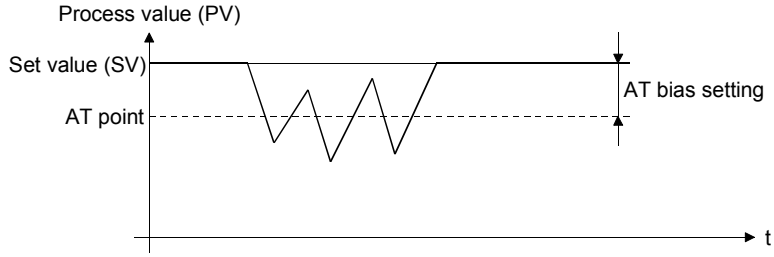
(3) The setting must be made within the range set by the upper/lower output limiter setting (buffer memory address: 2AH, 2BH, 4AH, 4BH, 6AH, 6BH, 8AH, 8BH).

3.8.10 AT bias (buffer memory address: 35H, 55H, 75H, 95H)

(1) The set value (SV) can be changed to another point during the auto-tuning. Make this setting when the measured temperature value may exceed the set value in the auto-tuning and it is not desired.

(2) Set a proper range so that variation in PID operation will be small and the control will not be affected.
Depending on the control target, accurate PID constants may not be obtained.

[When setting the AT bias on the negative side (reverse action)]



(3) The setting can be made within both positive and negative full-scale ranges.

(4) The value stored varies with the decimal point position (buffer memory address:1H to 4H) as indicated below:
0: The specified value is written as is.
1: The value 10 times the specified value is written.

3.8.11 Direct/reverse action setting (buffer memory address: 36H, 56H, 76H, 96H)

(1) Set whether to use a direct or reverse action for each channel of the A1S64TCTRT(BW). (Refer to Section 3.3.10.) The default (initial) value is "Reverse action (Heating control)".
• Direct action (Cooling control): 0
• Reverse action (Heating control): 1

3.8.12 Loop disconnection detection judgment time setting (buffer memory address: 3BH, 5BH, 7BH, 9BH)

(1) The loop disconnection detection function detects errors in the control system due to a load disconnection, external operation device fault, sensor disconnection and the like. (Refer to Section 3.3.11.)
No temperature change of greater than 2°C (2°F) within the loop disconnection detection judgment time is judged as a loop disconnection.

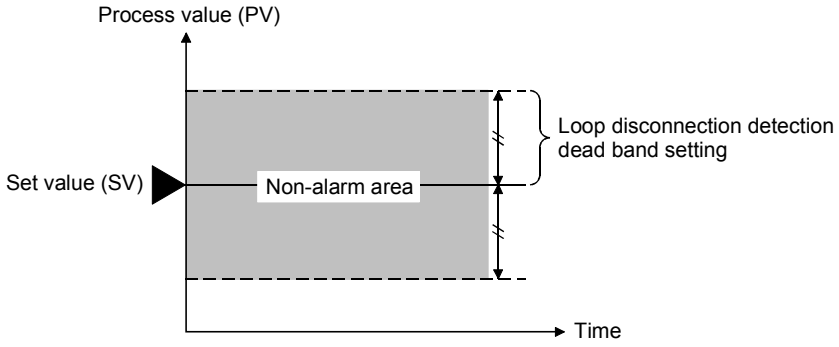
(2) As the loop disconnection detection judgment time, set a value longer than the time taken for temperature to change 2°C (2°F).

(3) Performing auto tuning automatically sets a value twice longer than the integral time as the loop disconnection detection judgment time.
However, if the loop disconnection detection judgment time was set to 0 at the auto tuning, the loop disconnection detection judgment time is not stored.

(4) The setting range is 0 to 7200s.
When "0" is set, the loop disconnection is not detected.

3.8.13 Loop disconnection detection dead band setting (buffer memory address: 3CH, 5CH, 7CH, 9CH)

(1) To prevent the false alarm of loop disconnection detection, set the non-alarm area (temperature width where loop disconnection will not be detected) around the set value. (Refer to Section 3.3.11.)



(2) The setting range is within the temperature setting range defined by the input range setting (refer to Section 3.7.7).
For example, if the loop disconnection detection dead band setting is "50" at the input range setting of 38, loop disconnection detection judgment is not made within the set value ± 5.0°C range.

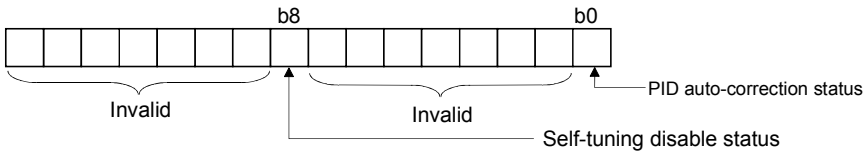
(3) The value stored varies with the decimal point position (buffer memory address:1H to 4H) as indicated below:
0: The specified value is written as is.
1: The value 10 times the specified value is written.

3.8.14 Self-tuning setting (buffer memory address: 3EH, 5EH, 7EH, 9EH)

(1) Set whether to use the self-tuning function or not. (Refer to Section 3.3.2.)
The default (initial) value is "0: Not used".
• 0: Not used
• 1: Used

3.8.15 Self-tuning flag (buffer memory address: 3FH, 5FH, 7FH, 9FH)

(1) The PID auto-correction status and the self-tuning disable status are stored. (Refer to Section 3.3.2.)



(2) Either of the following values is stored as the PID auto-correction status.
• 0 (Uncorrected): PID constants were not corrected in the last self-tuning.
• 1 (Corrected): PID constants were corrected in the last self-tuning.
This bit is initialized to "0: Uncorrected" at start of self-tuning, and on completion of the self-tuning after automatic correction of the PID constants, it changes to "1: Corrected".

(3) Either of the following values is stored as the self-tuning disable status.
• 0 (OFF): Self-tuning is set, and it is executable.
Self-tuning is not set up.
• 1 (ON): Although self-tuning is set, it is not executable in the following condition:
Proportional band, P (buffer memory address: 23H, 43H, 63H, 83H) or
Derivative time, D (buffer memory address: 25H, 45H, 65H, 85H) is 0.

3.8.16 Control output monitor (buffer memory address: B1H to B4H)

(1) This area stores values that are equivalent to manipulated values (buffer memory address: DH to 10H) and that are output to a digital-to-analog converter module.

(2) The value to be stored is within the range of 0 to 4000 (MV of –5.0 to 0.0% is shown as "0", and 100.0 to 105.0% as "4000".)

(3) When heating or cooling is performed by an analog input unit, output the values to a digital-to-analog converter module and convert them to analog values.

3.9 Buffer Memory for Heating-Cooling Control

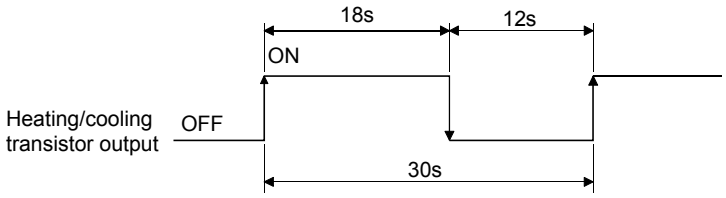
This section explains the buffer memory related to Heating-cooling control.

3.9.1 Manipulated value for heating/cooling (MV) (buffer memory address: DH, EH/C0H, C1H)

(1) This area stores a result of the PID operation performed with a temperature value obtained from a temperature sensor.

(2) The stored value must be within the range of –50 to 1050 (-5.0% to 105.0%). Note that a range of 0% to 100% is used for external output.
• 0% or less: 0%
• 100% or more: 100%

(3) The manipulated value for heating/cooling is a percentage of the ON time out of the heating/cooling control output period (buffer memory address: 2FH, 4FH/D2H, E2H). When the control output period is 30s and the manipulated value is 600 (60%), the pulse turns ON for 18s and OFF for 12s.



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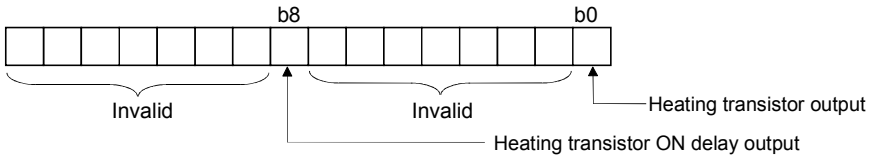
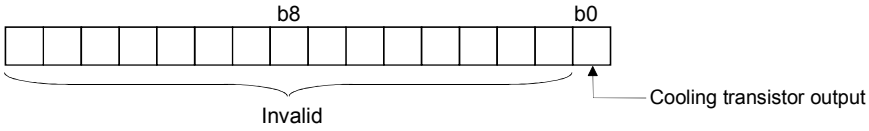
3.9.2 Heating/cooling transistor output flag (buffer memory address: 15H, 16H /C4H, C5H)

(1) The ON/OF states of the heating transistor output and the ON delay output are stored.



(2) The ON/OFF state of the cooling transistor output is stored.



(3) Either of the following values is stored for the heating/cooling transistor output and the heating transistor ON delay output.
- ON: 1
- OFF: 0

3.9.3 Heating/cooling upper output limiter setting (buffer memory address: 2AH, 4AH/D1H, E1H)

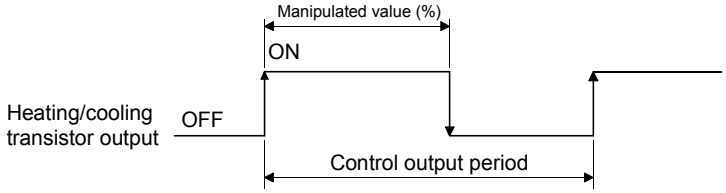
(1) Set an upper limit value when actually outputting the PID calculated manipulated value for heating/cooling (MV) to an external device.
This setting is ignored when the auto-tuning is ON.

(2) The setting range is 0 to 1050 (0.0% to 105.0%).

(3) Setting a value outside the setting range will cause a write error, turning ON the Write error flag (X2) and storing error code "4" in the Error code area (buffer memory address: 0H).

3.9.4 Heating/cooling control output period setting (buffer memory address: 2FH, 4FH/D2H, E2H)

(1) Set a pulse cycle of the heating/cooling transistor output (ON/OFF cycle).



(2) The setting must be within the range of 1 to 100 (1 to 100s).

(3) The ON time in the control output period is obtained by multiplying the control output period by the manipulated value (%) that is calculated from the PID operation. (Refer to Section 3.9.1.)

3.9.5 Heating/cooling control output monitor (buffer memory address: B1H, B2H /C2H, C3H)

(1) This area stores values that are equivalent to the manipulated value for heating/cooling (buffer memory address: DH, EH/C0H, C1H) and that are output to a digital-to-analog converter module.

(2) The value to be stored is within the range of 0 to 4000 (MV of –5.0 to 0.0% is shown as "0", and 100.0 to 105.0% as "4000".)

(3) When heating or cooling is performed by an analog input unit, output the value to a digital-to-analog converter module and convert it to an analog value.

3.9.6 Temperature conversion setting (buffer memory address: B8H, B9H)

(1) Set whether to use the temperature conversion function of unused channels or not.
The default (initial) value is "0: Not used".
• 0: Not used
• 1: Used

3.9.7 Cooling type setting (buffer memory address: CFH)

(1) An auto-tuning operation formula is set according to the cooling performance of the selected cooling type.
• 0: Air-cooling (Weak cooling performance)
• 1: Water-cooling (Strong cooling performance)

(2) Set this before execution of the auto-tuning because this setting may affect the PID operation result for the auto-tuning. (Refer to Section 3.3.12.)

3.9.8 Overlap/dead band setting (buffer memory address: D3H, E3H)

(1) Set the overlap or dead band to the point switching between the heating and cooling control outputs as a percentage of the input range to the full-scale range. (Refer to Section 3.3.13.)

(2) The setting range is -100 to 100 (-10.0% to 10.0%).

Setting value	Description
-100 to -1 (-10.0% to -0.1%)	Overlap (the temperature region where both heating and cooling is output) is set.
0	Overlap/dead band is not set.
1 to 100 (1 to 10.0%)	Dead band (the temperature region where neither heating nor cooling is output) is set.

3.10 Buffer Memory for Heater Disconnection Detection

This section explains the buffer memory related to the heater disconnection detection function.

3.10.1 Heater current process value (buffer memory adress: 19H to 1CH)

(1) The heater current detected by the A1S64TCTRTBW is stored.

(2) This area stores a value within the range specified by the CT selection (buffer memory adress: 39H, 59H, 79H and 99H).
Hold at the upper limit value if the heater current value exceeds the upper limit value of the measurement range.

3.10.2 CT selection (buffer memory address: 39H, 59H, 79H, 99H)

(1) Select a current sensor used for heater disconnection detection. (Refer to Section 3.3.15.)
• 0: CTL-12-S36-8 (0 to 100.0A) (Default)
• 1: CTL-6-P-H (0 to 20.00A) (The existing CTL-6-P is also applicable.)

POINT

Only the current sensors manufactured by URD International, Ltd. can be used for the A1S64TCTRTBW.
Sales channels for current sensors manufactured by URD International, Ltd.are listed as follows

U.S.A	Julia Industries Inc. Tel: 949-831-0111	KOREA	Joyang Trading Co. Tel: 02-521-2294
BRAZIL	Ananda Industial Ltda. Tel: 011-5584-0959		Sewon Tech Co., Ltd. Tel: 02-868-9355/9356
UNITED KINGDOM	Omni Components Tel: 024-7622-5757		Keum Ho Corporation Tel: 51-319-4155/4156
GERMANY	Allied Electronics GmbH Tel: 0221-497-3084	HONG-KONG	Weltronics Components Ltd. Tel: 2410-0623
FRANCE	Diltronic S.A. Tel: 01-34-51-33-00	TAIWAN	Tope Co., Ltd. Tel: 886-2-8228-0658
ITALY	ELNET s.n.c Tel: 041-50-19-939	INDIA	Amtech Electronics PVT.Ltd. Tel: 02712-25324

Operation using other current sensors (CT) are not guaranteed.

3.10.3 Heater disconnection alert setting (buffer memory address: 3AH, 5AH, 7AH, 9AH)

(1) Set the value set for heater disconnection detection or output off-time current error detection as a percentage (%) of the heater current reference value. (Refer to Section 3.3.15.)

(2) The setting range is 0 to 100%.
When the value is 0, heater disconnection detection and output off-time current error detection are not performed.

3.10.4 Heater disconnection/output-off-time current error detection delay count setting (buffer memory address: A6H)

(1) Set a number of times that heater disconnection detection or output-off-time current detection is to be counted before determination of an alert. (Refer to Section 3.3.15, or 3.3.16.) The default (initial) value is "3".

(2) The setting range is 3 to 255.

3.10.5 Heater voltage compensation function selection (buffer memory address: AAH)

Whether to use the heater voltage compensation function or not is set in this area. (Refer to Section 3.3.15.)
The default (initial) value is “0: Not used”.
• 0: Heater voltage compensation function not used
• 1: Heater voltage compensation function used

3.10.6 Heater current reference value (buffer memory address: ABH to AEH)

(1) This value is a current value, which is used as a criterion for heater disconnection detection.
Set a heater current value (buffer memory address: 19H to 1CH) measured while the heater is normally operating. (Refer to Section 3.3.15.)

(2) The setting range varies depending on the setting of CT selection (buffer memory address: 39H, 59H, 79H, 99H).

CT selection (buffer memory address: 39H, 59H, 79H, 99H)		Heater current reference value (buffer memory address: ABH to AEH)
0	CTL-12-S36-8	0 to 1000 (0 to 100.0A)
1	CTL-6-P(-H)	0 to 2000 (0 to 20.00A)

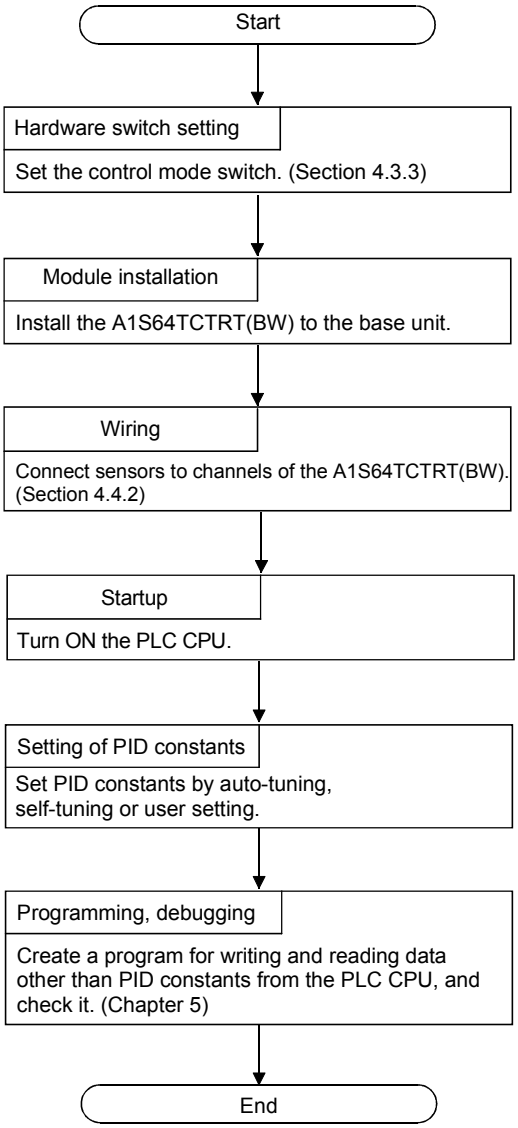
3.10.7 CT monitoring method switching (buffer memory address: B0H)

(1) Set a method for heater current measurement.
When "ON/OFF current" is selected, the present electric current of the CT is measured.
When "ON current" is selected, the module holds the value of the electric current measured at the previous time that the heater was ON. (Refer to Section 3.3.15.)
The default (initial) value is "0: ON/OFF current".
• 0: ON/OFF current
• 1: ON current

4 SETUP AND PROCEDURE BEFORE STARTING THE OPERATION

4.1 Procedure Before Starting the Operation

This section describes the setup and procedure for starting the operation of the A1S64TCTRT(BW).



4.2 Handling Instructions

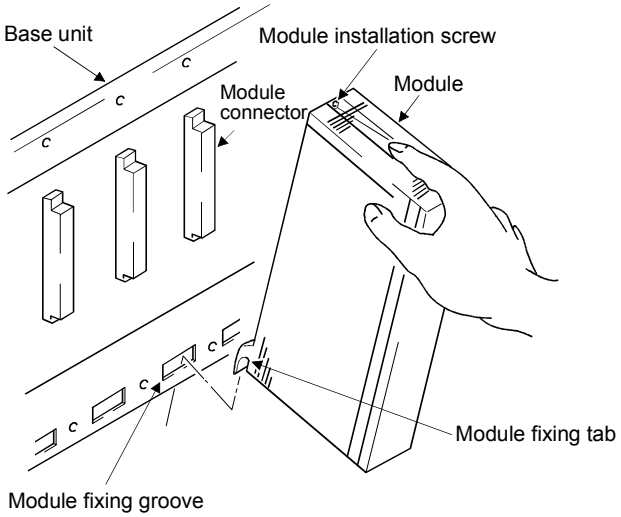
Precautions when handling the A1S64TCTRT(BW) are described below :

(1) The module case and terminal block are made of plastic. Be sure not to drop it or subject it to strong vibration.
(2) Do not remove the module printed circuit boards from the case.
It may cause trouble.
(3) When connecting the wiring, do not allow wire cuttings or other foreign matter to enter from the top of the module. Remove any foreign matter from the module.
(4) Tighten the module installation screws within the following tightening torque range.

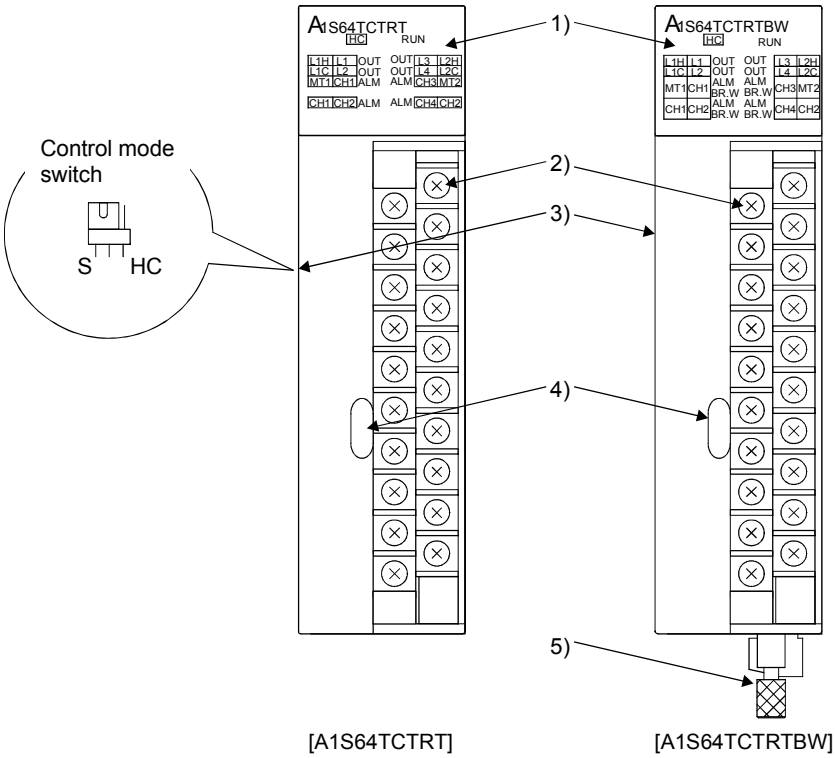
Screw	Tightening torque range
Module installation screw (M4 screw)	78 to 118N • cm
Terminal block screw (M3.5 screw)	59 to 88N • cm
Terminal block installation screw (M4 screw)	78 to 118N • cm
Disconnection detector connector installation screw (M2.6 screws)*	15 to 30N • cm
Cable fixing screw (M2 screws)*	11 to 14N • cm

*: Use only for A1S64TCTRTBW.

(5) When installing the module to the base, always tighten the module screws after inserting the module fixing tab to the module fixing groove. When removing, always remove the module installation screws first, then remove the module fixing tab from the groove.



4.3 Name of Each Part

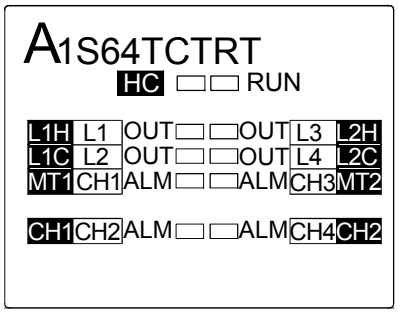


Number	Name and Appearance	Description
1)	LED	Indicate the operating, error or alert status of the A1S64TCTRT (BW). (Refer to Section 4.3.1.)
2)	Terminal block	Used for temperature sensor input, transistor output and current sensor (CT) input. (Refer to Section 4.3.2.)
3)	Control mode switch	Switches the mode between the standard and heating/cooling controls. (Refer to Section 4.3.3.)
4)	Cold junction temperature compensation resistor	When a thermocouple is used as a temperature sensor, this must be connected. (Connected to the terminal block as factory default)
5)	Disconnection detector connector	Connected to the current sensor. Used for the A1S64TCTRTBW only. (Refer to Section 4.3.4.)

4.3.1 LED indication

This section explains the meaning of each LED indication of the A1S64TCTRT(BW).

(1) When the A1S64TCTRT is in Standard control mode



Name	Function	LED indication	Description
RUN	A1S64TCTRT operation status indication	ON	Normal operation
		Flashing (2s. ON, 2s. OFF)	Write data error occurred.
		Flashing (1s. ON, 1s. OFF)	Hardware failure (Including the case where no cold junction temperature compensation resistor is connected.)
		OFF	5V power OFF, or watchdog timer error
HC	Control mode indication	ON	Heating-cooling control
		OFF	Standard control
L1 OUT	Transistor output status indication (L1 to L4 correspond to CH1 to CH4 respectively.)	ON	Transistor output ON
L2 OUT			
L3 OUT		OFF	Transistor output OFF
L4 OUT			
CH1 ALM	Alert alarm status indication	ON	• The alert alarm turned ON. • Loop disconnection detected.
CH2 ALM		Flashing	• Measured temperature range exceeded. • Temperature sensor not connected. • Temperature sensor cable disconnected.
CH3 ALM			
CH4 ALM		OFF	Disconnection alarm turned OFF.

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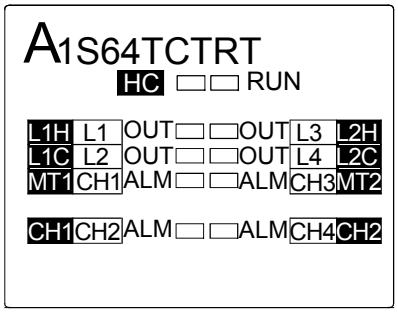
(2) When the A1S64TCTRT is in Heating-cooling control mode



Name	Function	LED indication	Description
RUN	A1S64TCTRT operation status indication	ON	Normal operation
		Flashing (2s. ON, 2s. OFF)	Write data error occurred.
		Flashing (1s. ON, 1s. OFF)	Hardware failure (Including the case where no cold junction temperature compensation resistor is connected.)
		OFF	5V power OFF, or watchdog timer error
HC	Control mode indication	ON	Heating-cooling control
		OFF	Standard control
L1H OUT	Heating transistor output status indication (L1H and L2H correspond to CH1 and CH2 respectively.)	ON	Transistor output ON
L2H OUT		OFF	Transistor output OFF
L1C OUT	Cooling transistor output status indication (L1C and L2C correspond to CH1 and CH2 respectively.)	ON	Transistor output ON
L2C OUT		OFF	Transistor output OFF
MT1 ALM	Alert alarm status indication (Temperature measurement alert status)	ON	• Loop disconnection detected.
MT2 ALM		Flashing	• Measured temperature range exceeded. • Temperature sensor not connected. • Temperature sensor cable disconnected.
		OFF	Disconnection alarm turned OFF.
CH1 ALM	Alert alarm status indication	ON	• The alert alarm turned ON. • Loop disconnection detected.
CH2 ALM		Flashing	• Measured temperature range exceeded. • Temperature sensor not connected. • Temperature sensor cable disconnected.
		OFF	Disconnection alarm turned OFF.

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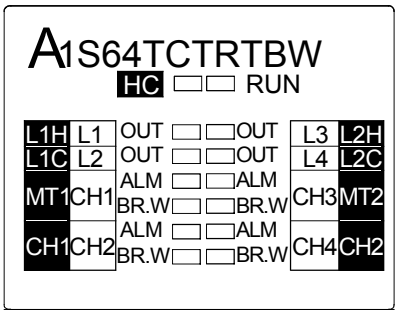
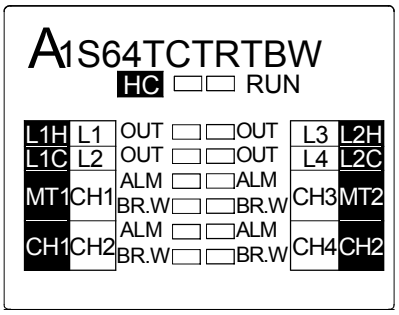
(3) When the A1S64TCTRTBW is in Standard control mode



Name	Function	LED indication	Description
RUN	A1S64TCTRTBW operation status indication	ON	Normal operation
		Flashing (2s. ON, 2s. OFF)	Write data error occurred.
		Flashing (1s. ON, 1s. OFF)	Hardware failure (Including the case where no cold junction temperature compensation resistor is connected.)
		OFF	5V power OFF, or watchdog timer error
HC	Control mode indication	ON	Heating-cooling control
		OFF	Standard control
L1 OUT	Transistor output status indication (L1 to L4 correspond to CH1 to CH4 respectively.)	ON	Transistor output ON
L2 OUT			
L3 OUT		OFF	Transistor output OFF
L4 OUT			
CH1 ALM	Alert alarm status indication	ON	• The alert alarm turned ON. • Loop disconnection detected.
CH2 ALM		Flashing	• Measured temperature range exceeded. • Temperature sensor not connected. • Temperature sensor cable disconnected.
CH3 ALM			
CH4 ALM		OFF	Disconnection alarm turned OFF.
CH1 BR.W	Heater disconnection detection status indication	ON	Heater disconnection is detected.
CH2 BR.W			
CH3 BR.W		OFF	Heater disconnection is not detected.

(4) When the A1S64TCTRTBW is in Heating-cooling control mode



Name	Function	LED indication	Description
RUN	A1S64TCTRTBW operation status indication	ON	Normal operation
		Flashing (2s. ON, 2s. OFF)	Write data error occurred.
		Flashing (1s. ON, 1s. OFF)	Hardware failure (Including the case where no cold junction temperature compensation resistor is connected.)
		OFF	5V power OFF, or watchdog timer error
HC	Control mode indication	ON	Heating-cooling control
		OFF	Standard control
L1H OUT	Heating transistor output status indication (L1H and L2H correspond to CH1 and CH2 respectively.)	ON	Transistor output ON
L2H OUT		OFF	Transistor output OFF
L1C OUT	Cooling transistor output status indication (L1C and L2C correspond to CH1 and CH2 respectively.)	ON	Transistor output ON
L2C OUT		OFF	Transistor output OFF
MT1 ALM	Alert alarm status indication (Temperature measurement alert status)	ON	• Loop disconnection detected.
MT2 ALM		Flashing	• Measured temperature range exceeded. • Temperature sensor not connected. • Temperature sensor cable disconnected.
		OFF	Disconnection alarm turned OFF.
CH1 ALM	Alert alarm status indication	ON	• The alert alarm turned ON. • Loop disconnection detected.
CH2 ALM		Flashing	• Measured temperature range exceeded. • Temperature sensor not connected. • Temperature sensor cable disconnected.
		OFF	Disconnection alarm turned OFF.
MT1 BR.W	Not used	—	—
MT2 BR.W			
CH1 BR.W	Heater disconnection detection status indication	ON	Heater disconnection is detected.
CH2 BR.W		OFF	Heater disconnection is not detected.

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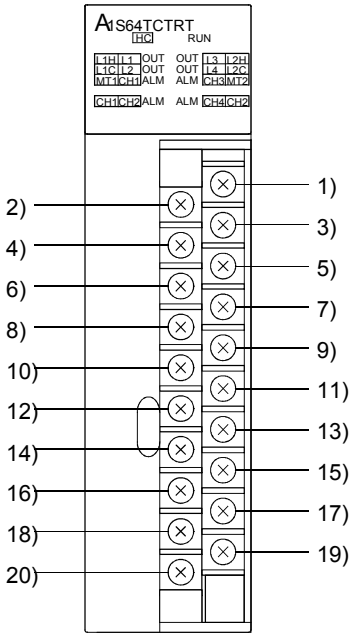
4.3.2 Signal names of the terminals on the terminal block

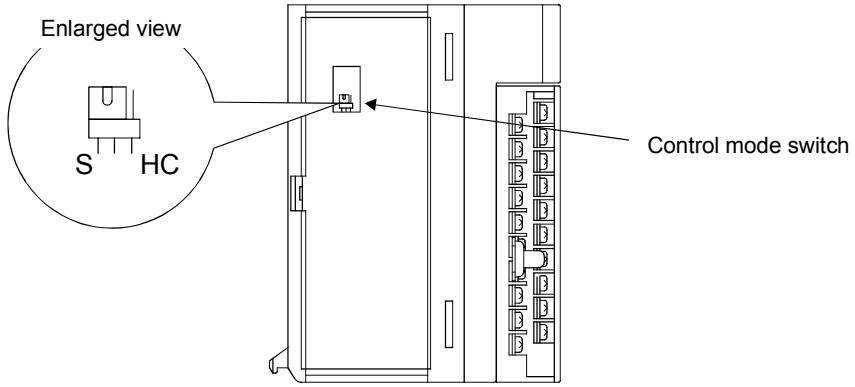
This section lists signal names and corresponding terminals on the A1S64TCTRT(BW) terminal block.



Terminal number	Signal name			
	Standard control mode		Heating-cooling control mode	
	Thermocouple	Platinum RTD	Thermocouple	Platinum RTD
1	L1	L1	L1H	L1H
2	L2	L2	L1C	L1C
3	L3	L3	L2H	L2H
4	L4	L4	L2C	L2C
5	COM-	COM-	COM-	COM-
6	Unused	CH2 A	Unused	CH1 A
7	Unused	CH1 A	Unused	MT1 A
8	CH2+	CH2 B	CH1+	CH1 B
9	CH1+	CH1 B	MT1+	MT1 B
10	CH2-	CH2 b	CH1-	CH1 b
11	CH1-	CH1 b	MT1-	MT1 b
12	CJ	Unused	CJ	Unused
13	Unused	Unused	Unused	Unused
14	CJ	Unused	CJ	Unused
15	Unused	CH3 A	Unused	MT2 A
16	Unused	CH4 A	Unused	CH2 A
17	CH3+	CH3 B	MT2+	MT2 B
18	CH4+	CH4 B	CH2+	CH2 B
19	CH3-	CH3 b	MT2-	MT2 b
20	CH4-	CH4 b	CH2-	CH2 b

4.3.3 Control mode switch

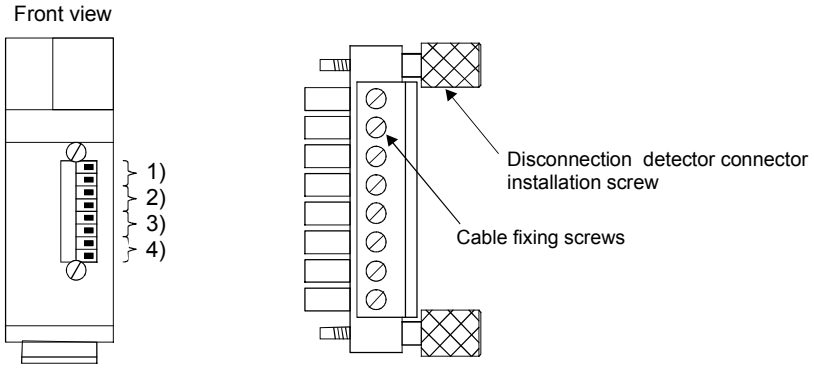
This section explains the control mode switch.
The control mode switch changes the mode between the standard and heating-cooling controls. This is preset to "S: Standard control" as factory default.
The setting status of the control mode switch can be confirmed by the Control switching monitor (buffer memory address: B7H).



Switch setting	Description
Set to S side	Standard control is selected.
Set to HC side	Heating-cooling control is selected.

4.3.4 Disconnection detector connector

The disconnection detector connector is explained below.
The disconnection detector connector is available for the A1S64TCTRTBW only.



Terminal No.		Signal name	
		Standard control	Heating-cooling control
1)	1	BW1 (CH1)	BW1 (CH1)
	2		
2)	3	BW2 (CH2)	BW2 (CH2)
	4		
3)	5	BW3 (CH3)	Not used
	6		
4)	7	BW4 (CH4)	Not used
	8		

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4.4 WIRING

The precautions for wiring and module connection examples are shown below.

4.4.1 Precautions for wiring

In order to have the best result from the A1S64TCTRT(BW) functions and to make the system highly reliable, an external cabling with low noise effects are necessary.
The external wiring precautions are shown below:

(1) Use separate cables for the alternating current and A1S64TCTRT(BW) external input signals to avoid A/C surges and induction effects.

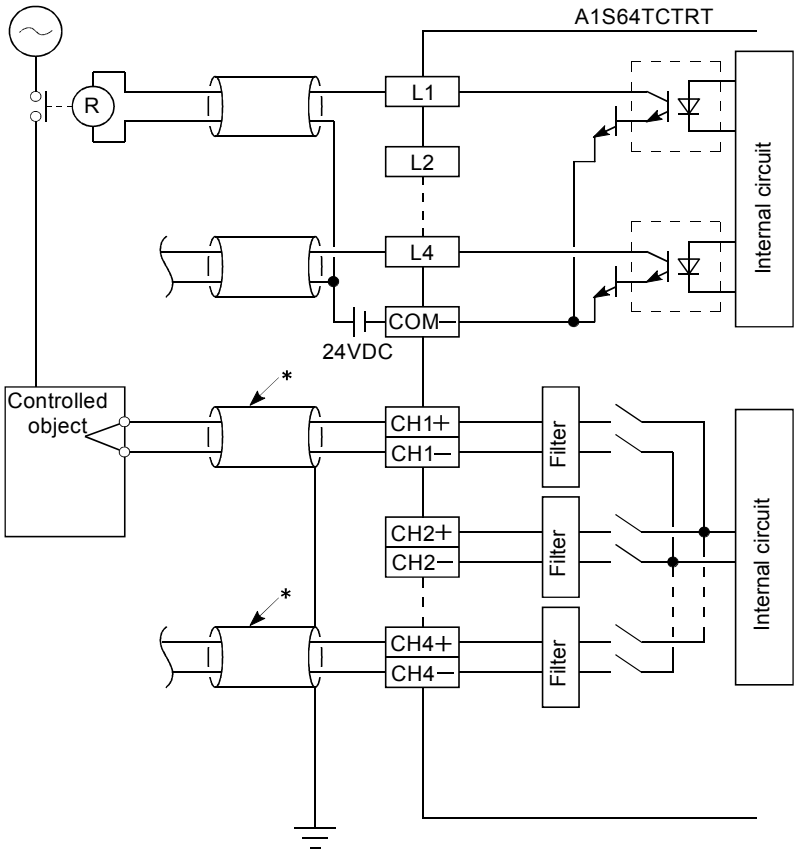
(2) Do not bunch the cables with the main circuit, high-voltage cable or load cables from other than PLC, or install them close to each other.
Install the cables far apart from high-frequency circuits, such as the high-voltage cable and inverter load main circuit, as much as possible.
This increases the noises, surges, and induction.

(3) Ground the shield line or shielded cable at one end on the PLC side. However, depending on the external noise condition, it should be grounded externally.

4.4.2 Module wiring example

(1) A1S64TCTRT

(a) When using thermocouples in Standard control mode



*: Please use shielded compensation conductors.

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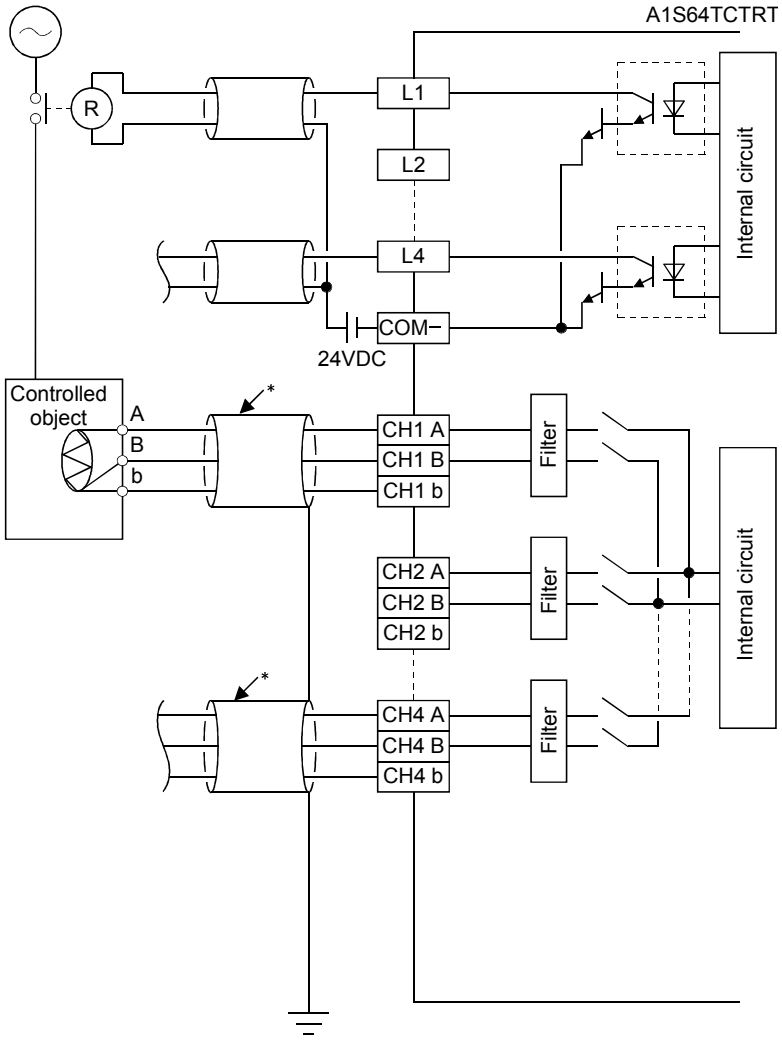
(b) When using platinum RTDs in Standard control mode



*: Please use shielded cables.

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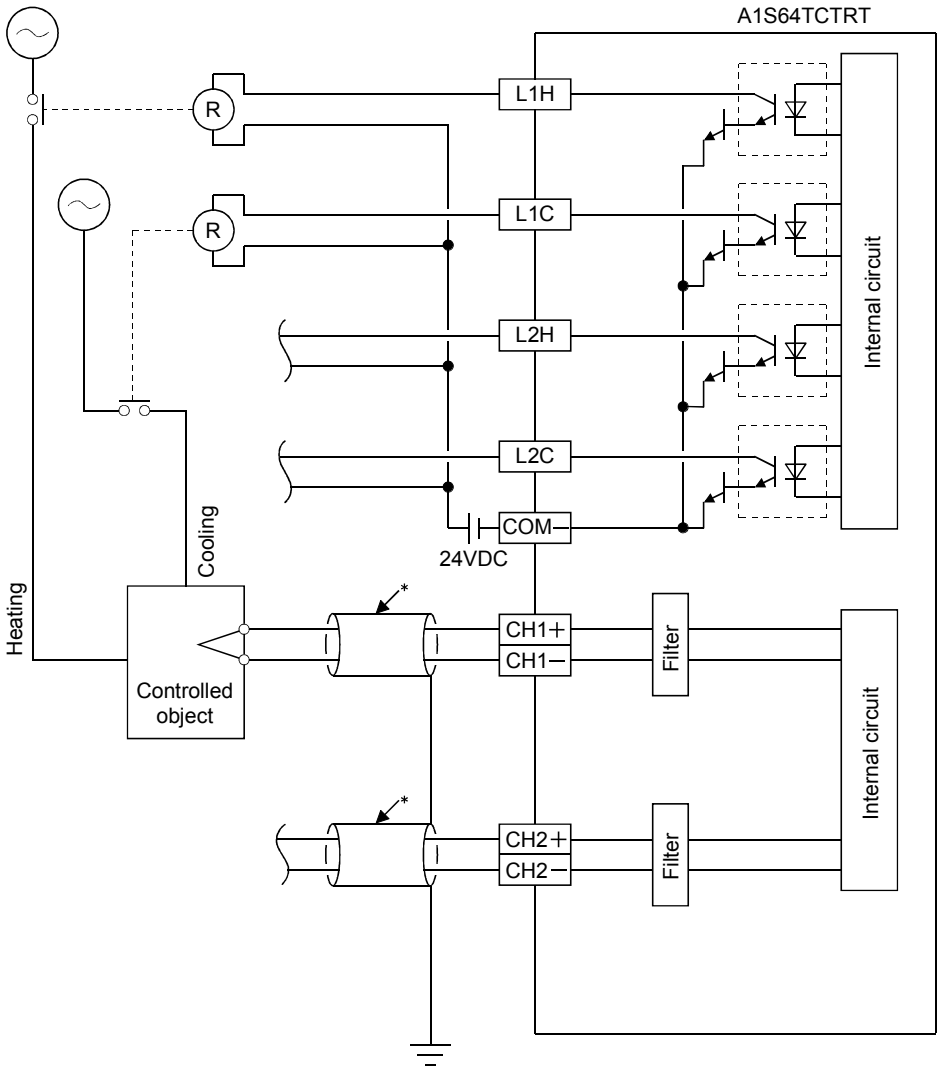
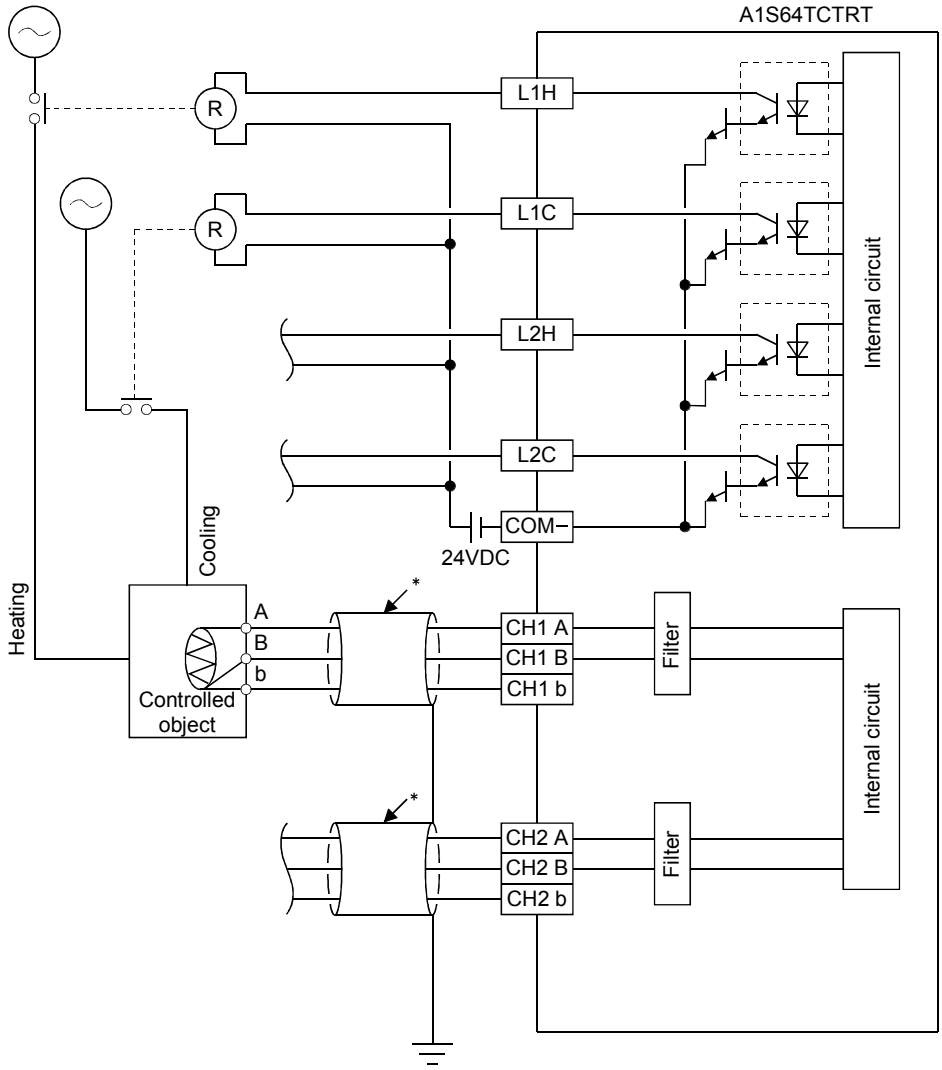
(c) When using thermocouples in Heating-cooling control mode



*: Please use shielded compensation conductors.

4 - 14

(d) When using platinum RTDs in Heating-cooling control mode



*: Please use shielded cables.

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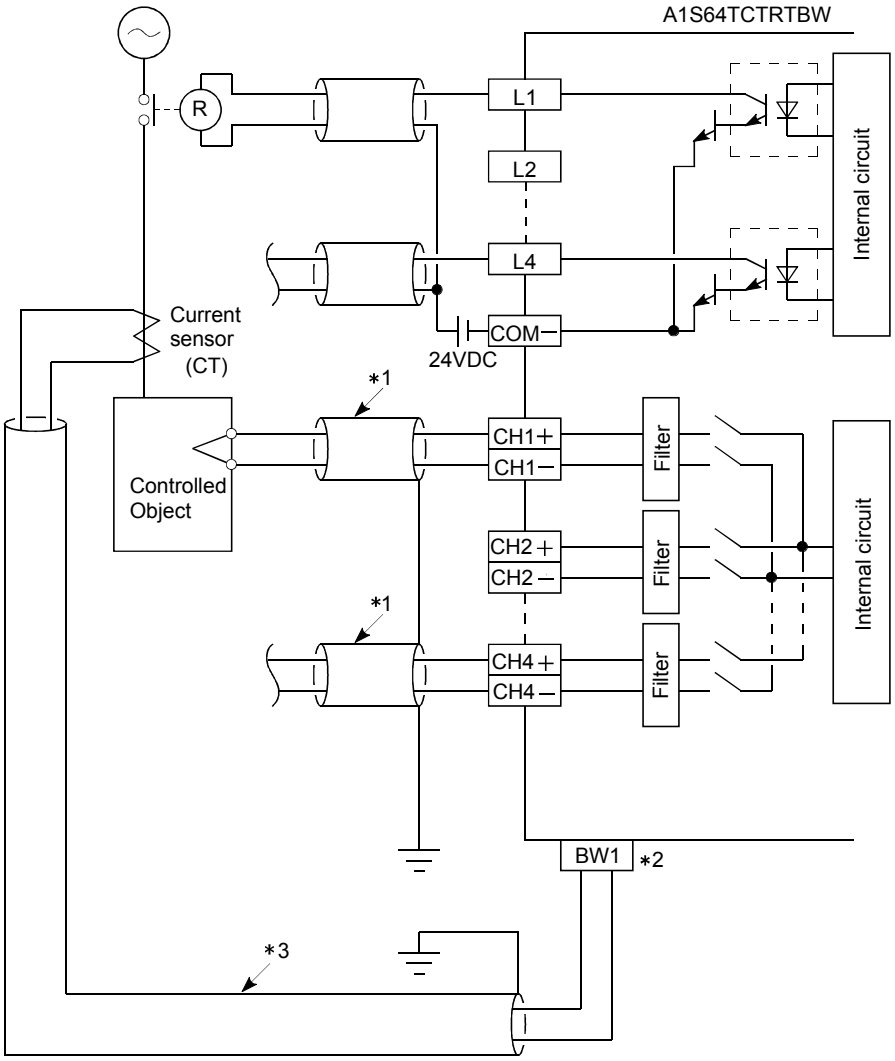
(2) A1S64TCTRTBW

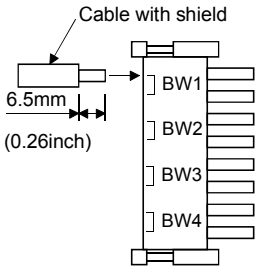
(a) When using thermocouples in Standard control mode

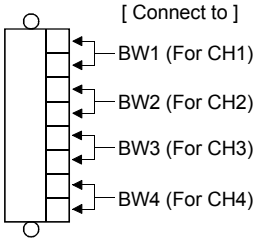


*1:Please use shielded compensation conductors.

*2: Refer to the following for the connection of the disconnection detector connector.

*3: Please use shielded cables.





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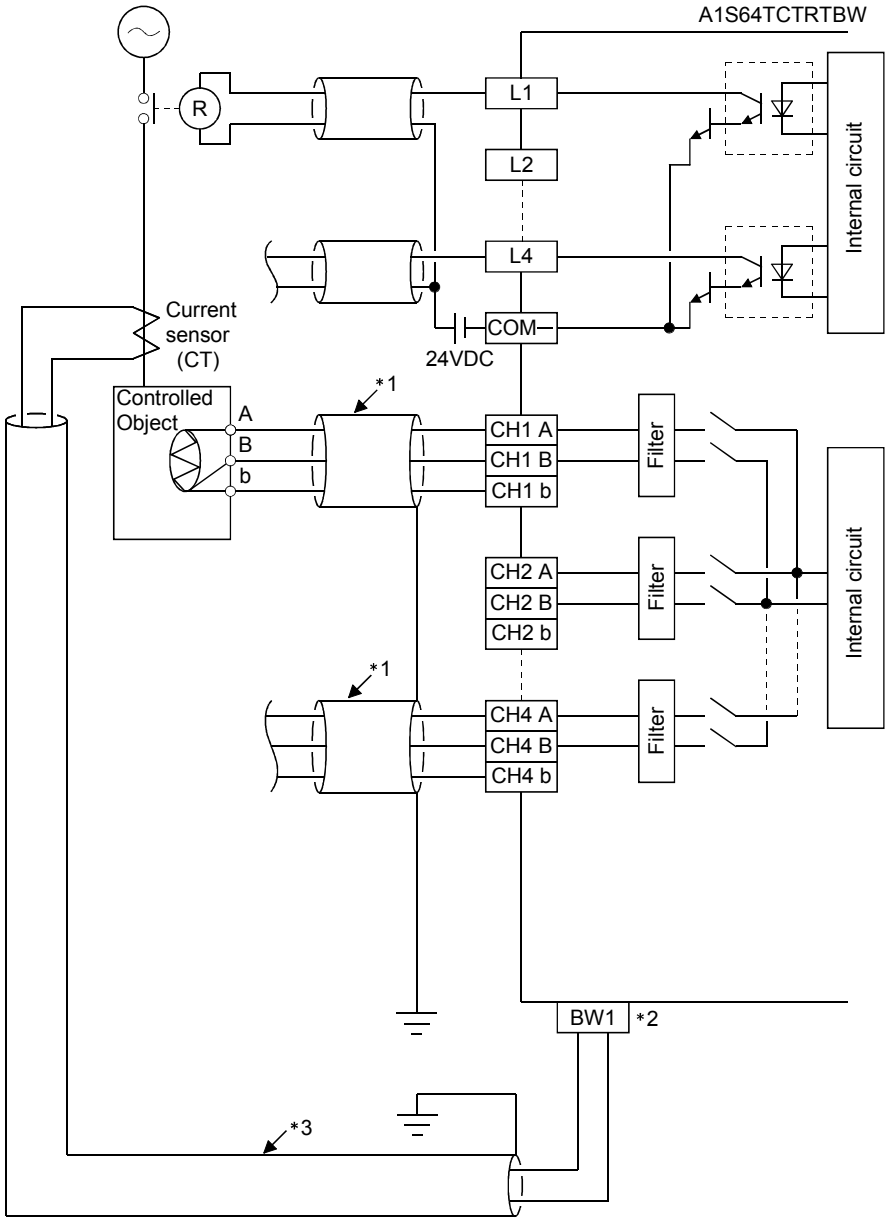
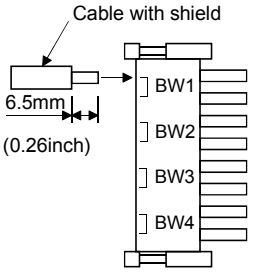
(b) When using platinum RTDs in Standard control mode

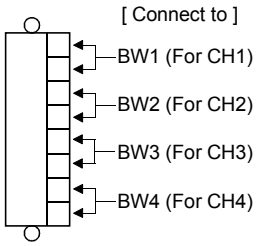


*1: Please use shielded cables.

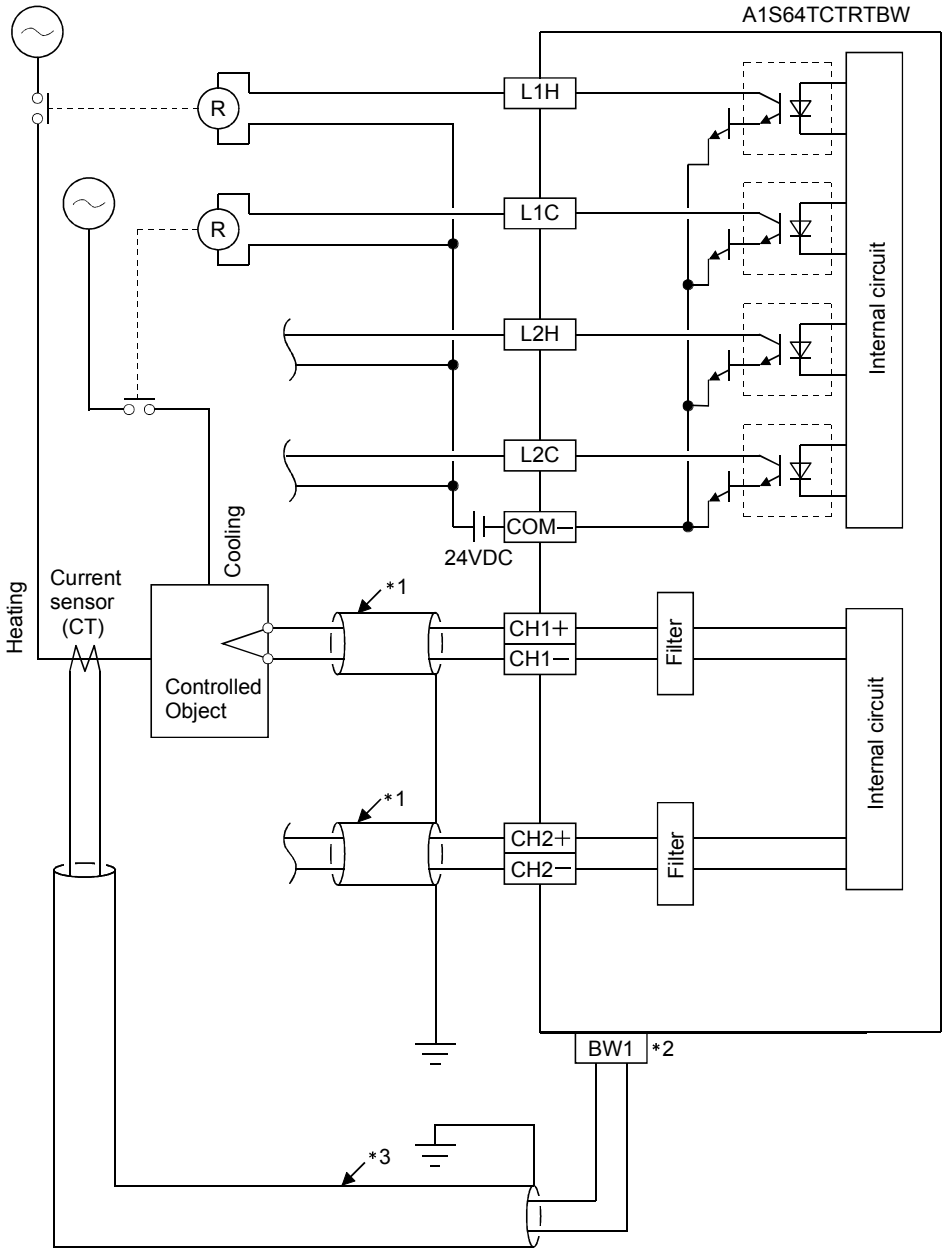
*2: Refer to the following for the connection of the disconnection detector connector.

*3: Please use shielded cables.





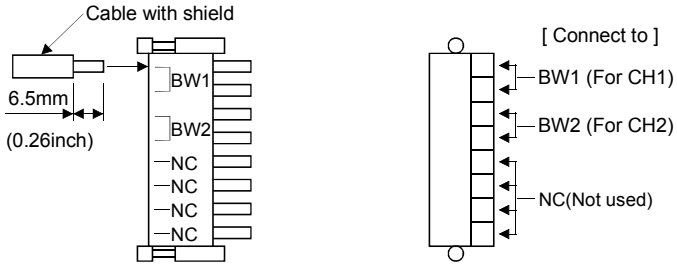
(c) When using thermocouples in Heating-cooling control mode



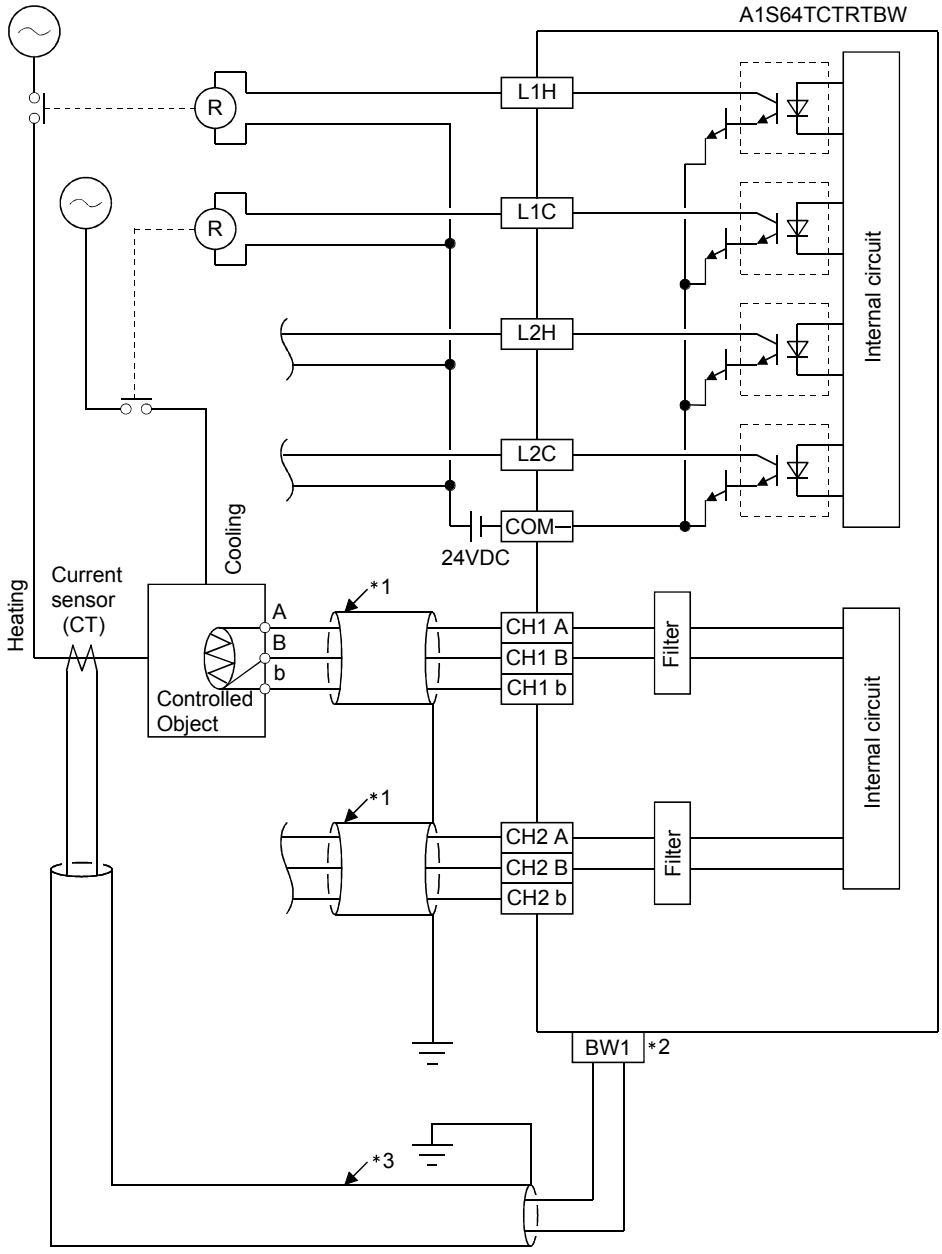
*1: please use shielded compensation conductors.

*2: Refer to the following for the connection of the disconnection detector connector.

*3: Please use shielded cables.



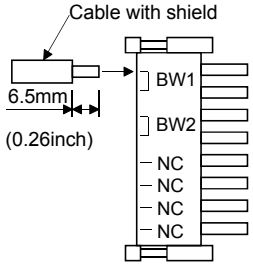
(d) When using platinum RTDs in Heating-cooling control mode

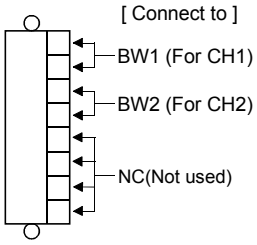


*1: Please use shielded cables.

*2: Refer to the following for the connection of the disconnection detector connector.

*3: Please use shielded cables.





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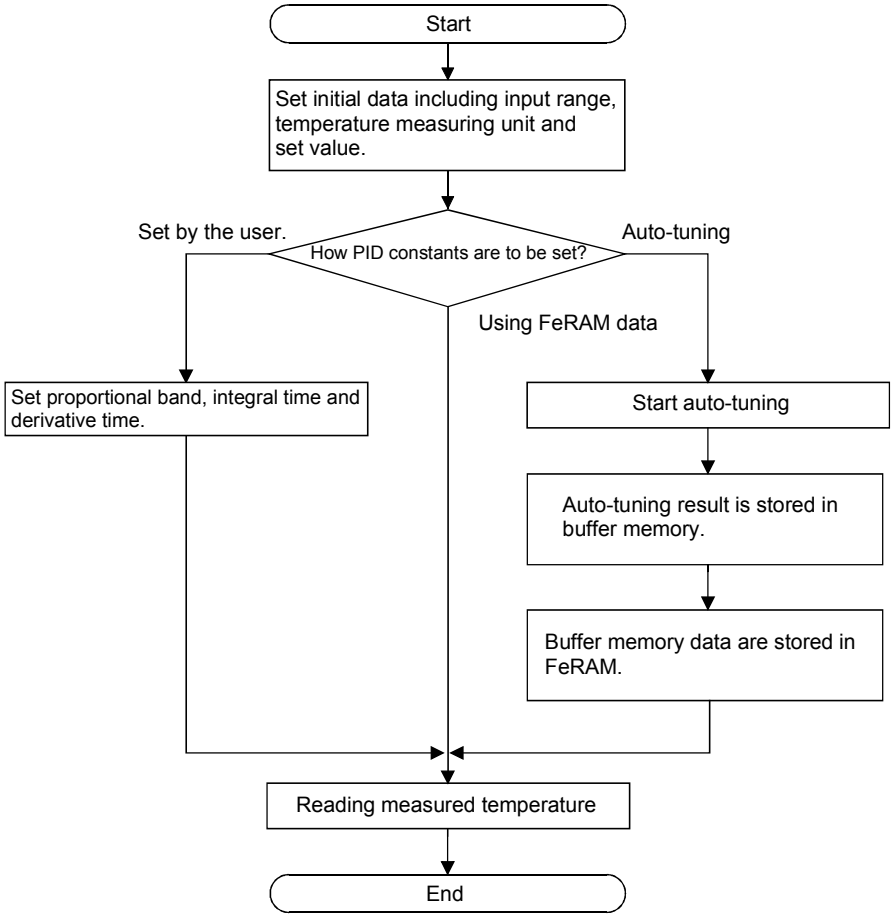
5 PROGRAMMING

This chapter explains the programming procedure, basic read and write programs and programming examples of the A1S64TCTRT(BW).
When applying any of the program examples introduced in this chapter to the actual system, verify the applicability and confirm that no problems will occur in the system control.

5.1 Programming Procedure

Create the programs for running the A1S64TCTRT(BW) to exercise temperature control in the following procedure.



5.2 Program Example

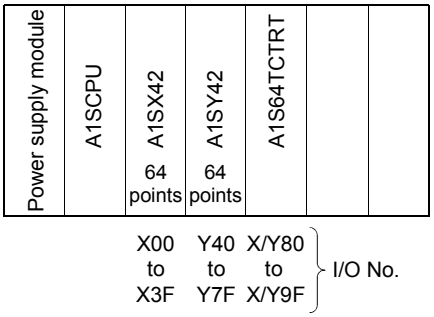
This section explains the programming to use the A1S64TCTRT(BW).

5.2.1 Programs for initial setting and detected temperature value reading

The program reads the measured temperature after executing auto-tuning with a thermocouple (type K) connected to Channel 1.
It includes programs for error code reading and error code reset.

(1) Conditions for the program example

(a) System configuration

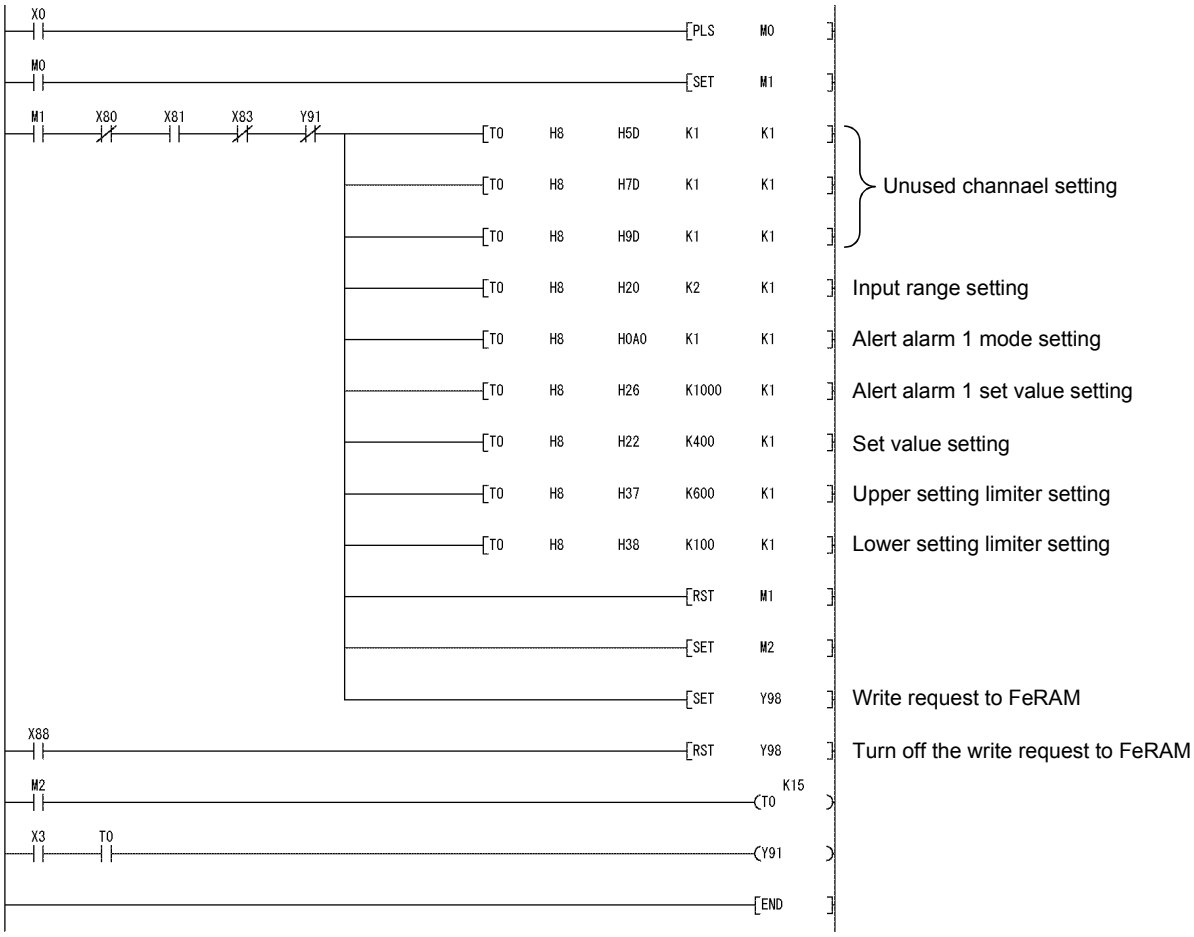


(b) Specification

- Set value write command X0
- Auto-tuning execution command X1
- Reset error code command X2
- Operation mode setting command X3
- Write-data error-code output (BCD 2 digits) Y40 to Y47
- Temperature-detection value output (BCD 4 digits) Y50 to Y5F
- Register for storing write-data error code D50
- Register for storing temperature-detection value read D51

(2) Program example

(a) Unused channel, input range, alert alarm 1, and set value, upper/lower setting limiter setting

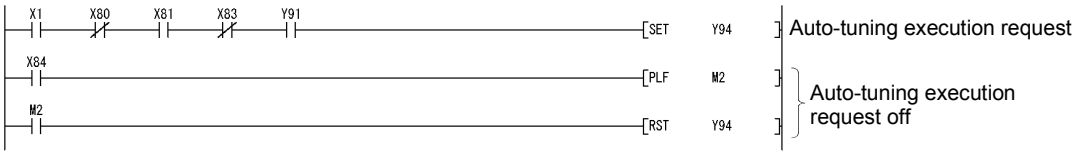


*: Necessary to register the set input range, alert setting, and set value etc. to the FeRAM.
When writing the input range, alert setting, or set value etc. using the sequence program during power startup, it is not necessary to write to the FeRAM.

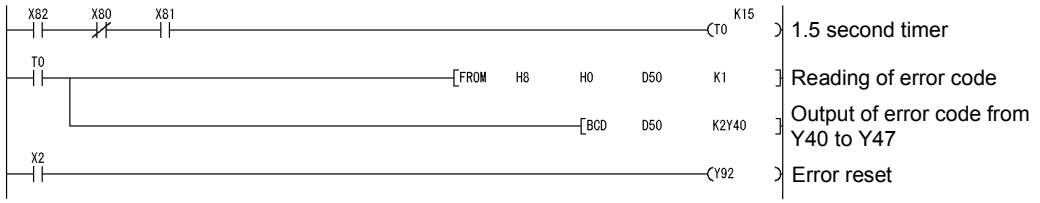
Point

If the input range and alert mode have been changed, move to operation mode after 1.5 seconds or more have passed. If the move is made in less than 1.5 seconds, a write error (error code 3) will be generated.

(b) Executing auto-tuning



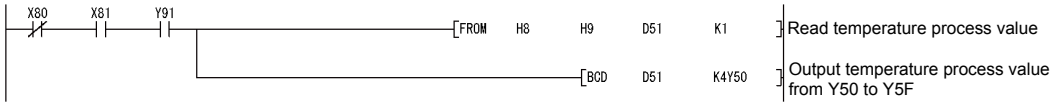
(c) Error code output and error reset



Point

If there have been multiple changes to the setting value, 1.5 second write errors may occur even if the correct value is written due to the checking of the adjustability with the data before changing.
If the set value has been changed, perform the writing error check after 1.5 seconds or more have passed.
Perform error reset have the occurring error has been cleared.

(d) Channel 1 temperature process value output



6 TROUBLESHOOTING

6.1 Error Code List

An error code and an error cause of the A1S64TCTRT(BW) are stored in the lower 4 bits and upper 8 bits of the buffer memory of address 0 accordingly.
There are various kinds of errors such as write errors, tuning abend errors, and hardware errors.
In the case of a write error, the buffer memory address corresponding to the error detection is stored in the error cause area.
For a tuning abend error or a hardware error, a cause code is stored in the error cause area.

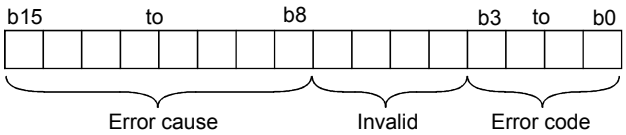


Table 6.1 Error code list (1/2)

Error code (HEX.)	Error type	Cause	Actions taken when an error occurs	Corrective action
1H	Write data error	• Write was executed to the area where write is not allowed (read only).	• The address where the error occurred is stored. • When data were written to multiple areas, the error data of the smallest address is retained.	• Execute the error reset (Y12: ON). • Delete the write program which in an area where write is not allowed (read only).
2H		• Write was executed to the unusable area.	• The written data is retained as is. • The address where the error occurred is stored. • When data were written to multiple areas, the error data of the smallest address is retained.	• Write 0 to the address where the error occurred. (The error is reset when 0 is written.) • Delete the write program which writes in the unusable area.
3H		• Write was executed to the area during the operation mode where write is allowed only in the setting mode. (Operation mode: When Y11 is on. When Y11 is off and the PID continuous setting (buffer memory A9H: 1) is being executed.)	• The written data is retained as is. • The operation is continued with the data prior to the write operation. • The address where the error occurred is stored. • When data were written to multiple areas, the error data of the smallest address is retained.	• Execute the error reset by the following procedure: 1) Change to the setting mode. 2) Write the correct value. 3) Execute the error reset (Y12: ON). • In order to change from the operation mode to the setting mode, turn off Y11 after setting the PID stop. • When the error reset is executed before modifying the value of the area where write is allowed only in the setting mode, it is modified to the contents of the buffer memory.
4H		• Data outside the allowable setting range were written. • The alert alarm was set to any other than 0 with the alert alarm mode set to 0.	• The written data is retained as is. • In case of the mode select item, the operation is executed using the data prior to the write operation. • When the value exceeds the upper or lower limit in temperature, time, or percentage setting, the control is performed with the upper/lower limit value. • The address where the error occurred is stored. • When data were written to multiple areas, the error data of the smallest address is retained.	• Write data within the allowed setting range. (The error is reset when the data within the allowed setting range is written.)

Table 6.1 Error code list (2/2)

Error code (HEX.)	Error type	Cause	Actions taken when an error occurs	Corrective action
5H	Write data error	• Setting of the upper/lower output limiter or the upper/lower setting limiter is invalid.	• The written data is retained as is. • Allowed upper and lower values are used for the control. • The address where the error occurred is stored. • When data were written to multiple areas, the error data of the smallest address is retained.	• Modify the upper/lower output limiter and the upper/lower setting limiter so that the lower limit value is less than the upper limit value
6H		• The set value was modified during the default setting registration.	• The written data is ignored. • Modification of the set value is not allowed until the error is reset. • The address where the error occurred is stored. • When another write error occurs, the error code does not change but the error address is overwritten by the address of the new write error.	• Modify the set value after the error reset (Y12: ON).
EH	Tuning abend error	• Cause code: 1 to 5	• After turning ON Auto-tuning command (Y14 to Y17), Tuning status (X14 to 17) turns OFF. • PID constants and loop disconnection detection judgment time are not changed.	• After resetting the error (Y12: ON) and removing the error cause, turn OFF Auto-tuning command (Y14 to Y17) and then ON again.
		• Cause code: 6	• Temperature control is performed. • Self-tuning is not executed.	• Set 0 in Self-tuning setting (buffer memory address: 3EH, 5EH, 7EH, 9EH) to disable self-tuning.
		• Cause code: 7	• Temperature control is performed with the changed PID constants. • Self-tuning in execution is cancelled and will not be executed until vibration is detected again.	• Modify the sequence program so that PID constants will not be changed during self-tuning.
FH	Hardware error	• Cause code: 101 to 103	• Depends on the symptom of the hardware error.	• For a temperature compensation error (cause code 103), check the terminal block or cold junction compensation resistor for disconnection. • Replace the module. • Please consult your local Mitsubishi representative, explaining a detailed description of the problem.

Table 6.2 List of error causes

Error type	Cause code	Error cause
Tuning abend error	1	A measured value fell outside the input range during auto-tuning.
	2	During auto-tuning, the mode was changed to the following: • Two-position control mode • MAN mode • Setting mode (Except for the case where PID continuation flag is "Continue") • Forced PID control stop command was turned ON.
	3	During auto-tuning, the following buffer memory of the relevant channel was changed. • Set value (SV) • Upper output limiter • Lower output limiter • Output variation limiter • Sensor compensation value setting • Primary delay digital filter setting • AT bias • Direct/reverse action setting During auto-tuning, the following buffer memory of the relevant channel was changed and the set value fell outside the range. • Upper setting limiter • Lower setting limiter
	4	During auto-tuning, the following time exceeded 2 hours. • Time taken from the start of auto-tuning until the set value is reached first time • Half of the hunting cycle
	5	PID constants calculated through auto-tuning exceeded the allowable range.
	6	During self-tuning, change of the following buffer memory was made or attempted. • Proportional band • Integral time • Derivative time • Upper output limiter • Lower output limiter • Output variation limiter • Control output period • Sensor compensation setting value • Primary delay digital filter • AUTO/MAN mode switching • Direct/reverse action setting
	7	Auto-tuning start was attempted under any of the following conditions: • The channel is set as an unused channel. • Setting mode, MAN mode, or Two-position control mode (Proportional band = 0) • Forced PID control stop command is ON. • A hardware error has occurred. • Input value error status (overscale, underscale)
Hardware error	101	Hardware error
	102	
	103	

REMARK

1) When data outside the setting range is written to the input range area or the alert mode setting area in Setting mode, error code "4" is stored.
   If it is changed to Operation mode without resetting the error, the error code will change to "3".
   In this case, take corrective actions for error code "3".
2) The priority of the error types is as shown below.
   If a high-priority error occurs during occurrence of a low-priority error, the error code and error address of the high-priority error are written over the existing ones.
   When multiple errors of the same type, hardware errors or tuning abend errors, have occurred, the error code of the first detected error is retained.

   [Priority]

   Hardware error ← Tuning abend error ← Write data error
   High Low

3) The priority of write data errors is as shown below.
   If a high-priority error occurs during occurrence of a low-priority error, the error code and error address of the high-priority error are written over the existing ones.

   [Priority]

   6 ← 1 ← 3 ← 5 ← 2/4

   High Low

   In the case of the same error codes, the error of the smallest error address has a priority.

6.2 Error Handling of A1S64TCTRT(BW)

The following explains the processing of the A1S64TCTRT(BW) performed when an error has occurred and the PLC CPU is switched from RUN to STOP.

<table>
<tr><td colspan="2" rowspan="3">Status</td><td colspan="2">Processing</td></tr>
<tr><td colspan="2">PID continuation flag (buffer memory address: A9H)</td></tr>
<tr><td>Stop</td><td>Continue</td></tr>
<tr><td>A1S64TCTRT(BW) unit error occurred</td><td>An error such as write data error, which keeps operation continued, occurred</td><td colspan="2">Continues the operation and outputs data to the outside. However, the behavior varies depending on the error type. (Refer to Table 6.1.)</td></tr>
<tr><td colspan="2">Resetting PLC CPU</td><td colspan="2" rowspan="2">Stops the operation and turns OFF the external output.</td></tr>
<tr><td rowspan="2">PLC CPU error occurred</td><td>An error, which causes the PLC CPU to stop the operation, occurred</td></tr>
<tr><td>An error, which allows the PLC CPU to continue the operation, occurred</td><td colspan="2">Continues the operation and outputs data to the outside.</td></tr>
<tr><td colspan="2">PLC CPU switched from RUN to STOP</td><td rowspan="2">Stops the operation and turns OFF the external output.</td><td rowspan="2">Continues the operation and outputs data to the outside.</td></tr>
<tr><td colspan="2">Link error status of a remote I/O station (when mounted on the remote I/O station)</td></tr>
</table>

POINT

- Be extremely careful when setting the PID continuation flag which controls the external output.
- Abnormal output may be provided due to a failure of an output element or its internal circuit.
  Install an external monitoring circuit for the output signals which may lead to serious accidents.

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6.3 When the A1S64TCTRT(BW) RUN LED Flashes or Turns OFF

(1) When flashing

Check item	Corrective action
2 s on/ 2s off Isn't the write data error flag (X2) on?	• Check the error code list in Section 6.1 and correct the sequence program.
1 s on/ 1 s off Is the cold junction compensation resistor disconnected?	• Connect the cold junction compensation resistor. • If the "RUN" LED flashes even with the cold junction compensation resistor connected, the hardware may be faulty. Please consult your local Mitsubishi representative.

(2) When turned off

Check item	Corrective action
Is the 5VDC supplied?	• Check the power module. • Install the module securely.
Confirm if the current capacity total of the modules installed to the base unit is below the power supply module's current capacity.	• Set the current capacity total of the modules installed to the base unit below the current capacity of the power supply module.
Isn't the watchdog timer error (X0) on?	• Perform a reset or restart power supply again for the PLC CPU. • Replace the A1S64TCTRT(BW)

6.4 When the A1S64TCTRT(BW) ALM LED Turns ON or Flashes

(1) When turned on

Check item	Corrective action
Check if the alert flag (XC to XF) is turned on.	• Check buffer memory addresses 5_H to 8_H, then take steps depending on the contents.
Has loop disconnection been detected?	• Check for disconnection of the loads or sensors, or failure of external devices.

(2) When flashing (ON for one second and OFF for one second)

Check item	Corrective action
Check if the process value exceeds the measurement temperature range specified in the input range setting.	• Change the input range setting to the temperature range in use.
Is there any channel to which no temperature sensor is connected?	• Set the channel, to which no temperature sensor is connected, as an unused channel at the buffer memory address $3D_H$, $5D_H$, $7D_H$ or $9D_H$.

6.5 When the Temperature Adjustment Ready Flag (X1) is not Turned ON

Check item	Corrective action
Check if the watchdog timer error (X0) is on.	• Reset the PLC CPU or turn the power off and on. • Replace the A1S64TCTRT(BW)
Check if there is an error in the PLC.	• Take steps by referring to the user's manual of the used CPU.

6.6 When the Write Data Error Flag (X2) is ON

Check item	Corrective action
Check if a write data error has occurred.	• Check the error code summary in Section 6.1, then modify the sequence program.

6.7 When the H/W (hardware) Error Flag (X3) is ON

Check item	Corrective action
Is the cold junction compensation resistor disconnected?	• Connect the cold junction compensation resistor.
—	• Hardware error of the A1S64TCTRT(BW). Please return it to the nearest dealer or branch office.

6.8 When the Alert flag (XC to XF) in ON

Check item	Corrective action
Check if the measurement temperature error/alert set value is exceeded the allowable range.	• Check the buffer memory addresses 5H to 8H, then take steps depending on the contents.
Check if a wire breakage is detected.	

APPENDICES

Appendix 1 Precautions for Replacement

This section explains the precautions for replacing an existing model.

Appendix 1.1 Precautions for module replacement

The control mode switch of the A1S64TCTRT(BW) is factory-set to "S: Standard control" and its input range is defaulted to "7: Pt100, -200.0 to 600.0°C".

(1) When replacing the A1S64TCTT(BW)-S1

1) Confirm that the control mode switch of the A1S64TCTRT(BW) is set to "S: Standard control", which is the factory default setting.
2) The default value of the input range setting (buffer memory address: 20H, 40H, 60H, 80H) has been changed from "2: K, 0 to 1300°C" to "7: Pt100, -200.0 to 600.0°C". Therefore, to use the default value, modify the existing program.

(2) When replacing the A1S64TCRT(BW)-S1

1) Confirm that the control mode switch of the A1S64TCTRT(BW) is set to "S: Standard control", which is the factory default setting.

(3) When replacing the A1S62TCTT(BW)-S2

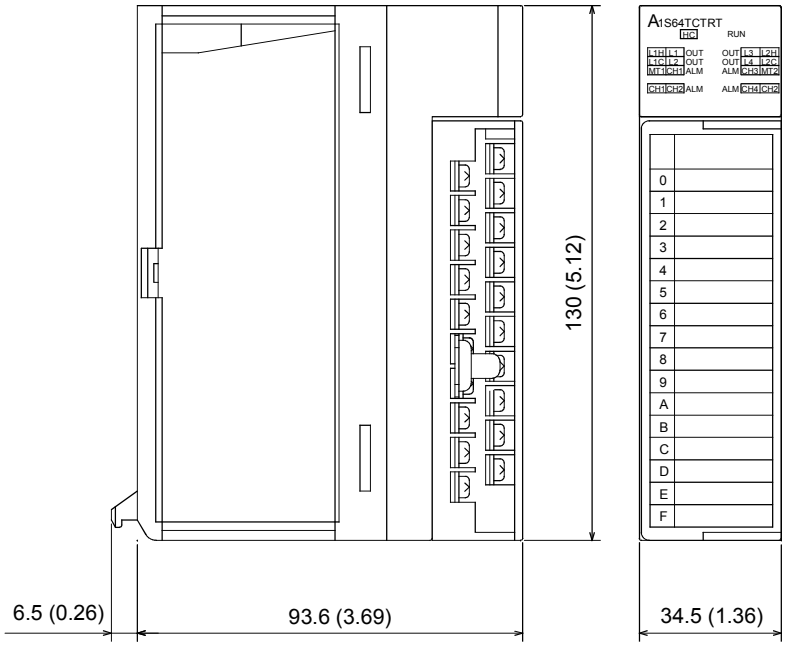
1) Confirm that the control mode switch of the A1S64TCTRT(BW) is set to "HC: Heating-cooling control". The factory default setting is "S: Standard control".
2) The default value of the input range setting (buffer memory address: 20H, 40H) has been changed from "2: K, 0 to 1300°C" to "7: Pt100, -200.0 to 600.0°C". Therefore, to use the default value, modify the existing program.
3) When the temperature conversion function is used, the internal current consumption increases by approx. 0.14A. Because of this, pay attention to the current consumption so that the current capacity of the power supply module will not be exceeded.

(4) When replacing the A1S62TCRT(BW)-S2

1) Confirm that the control mode switch of the A1S64TCTRT(BW) is set to "HC: Heating-cooling control". The factory default setting is "S: Standard control".
2) When the temperature conversion function is used, the internal current consumption increases by approx. 0.14A. Because of this, pay attention to the current consumption so that the current capacity of the power supply module will not be exceeded.

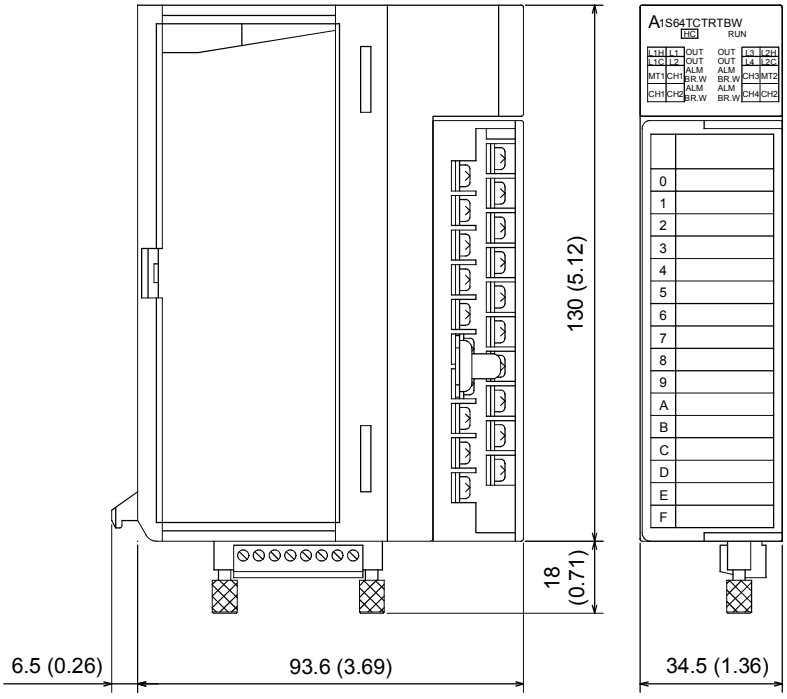
Appendix 2 External Dimensions

(1) A1S64TCTRT



Unit: mm (inch)

(2) A1S64TCTRTBW



Unit: mm (inch)

MEMO

App - 3

WARRANTY

Please confirm the following product warranty details before using this product.

1. Gratis Warranty Term and Gratis Warranty Range

If any faults or defects (hereinafter "Failure") found to be the responsibility of Mitsubishi occurs during use of the product within the gratis warranty term, the product shall be repaired at no cost via the sales representative or Mitsubishi Service Company.
However, if repairs are required onsite at domestic or overseas location, expenses to send an engineer will be solely at the customer's discretion. Mitsubishi shall not be held responsible for any re-commissioning, maintenance, or testing on-site that involves replacement of the failed module.

[Gratis Warranty Term]

The gratis warranty term of the product shall be for one year after the date of purchase or delivery to a designated place.
Note that after manufacture and shipment from Mitsubishi, the maximum distribution period shall be six (6) months, and the longest gratis warranty term after manufacturing shall be eighteen (18) months. The gratis warranty term of repair parts shall not exceed the gratis warranty term before repairs.

[Gratis Warranty Range]

(1) The range shall be limited to normal use within the usage state, usage methods and usage environment, etc., which follow the conditions and precautions, etc., given in the instruction manual, user's manual and caution labels on the product.
(2) Even within the gratis warranty term, repairs shall be charged for in the following cases.
1. Failure occurring from inappropriate storage or handling, carelessness or negligence by the user. Failure caused by the user's hardware or software design.
2. Failure caused by unapproved modifications, etc., to the product by the user.
3. When the Mitsubishi product is assembled into a user's device, Failure that could have been avoided if functions or structures, judged as necessary in the legal safety measures the user's device is subject to or as necessary by industry standards, had been provided.
4. Failure that could have been avoided if consumable parts (battery, backlight, fuse, etc.) designated in the instruction manual had been correctly serviced or replaced.
5. Failure caused by external irresistible forces such as fires or abnormal voltages, and Failure caused by force majeure such as earthquakes, lightning, wind and water damage.
6. Failure caused by reasons unpredictable by scientific technology standards at time of shipment from Mitsubishi.
7. Any other failure found not to be the responsibility of Mitsubishi or that admitted not to be so by the user.

2. Onerous repair term after discontinuation of production

(1) Mitsubishi shall accept onerous product repairs for seven (7) years after production of the product is discontinued. Discontinuation of production shall be notified with Mitsubishi Technical Bulletins, etc.
(2) Product supply (including repair parts) is not available after production is discontinued.

3. Overseas service

Overseas, repairs shall be accepted by Mitsubishi's local overseas FA Center. Note that the repair conditions at each FA Center may differ.

4. Exclusion of loss in opportunity and secondary loss from warranty liability

Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation of damages caused by any cause found not to be the responsibility of Mitsubishi, loss in opportunity, lost profits incurred to the user by Failures of Mitsubishi products, special damages and secondary damages whether foreseeable or not , compensation for accidents, and compensation for damages to products other than Mitsubishi products, replacement by the user, maintenance of on-site equipment, start-up test run and other tasks.

5. Changes in product specifications

The specifications given in the catalogs, manuals or technical documents are subject to change without prior notice.

6. Product application

(1) In using the Mitsubishi MELSEC programmable controller, the usage conditions shall be that the application will not lead to a major accident even if any problem or fault should occur in the programmable controller device, and that backup and fail-safe functions are systematically provided outside of the device for any problem or fault.
(2) The Mitsubishi programmable controller has been designed and manufactured for applications in general industries, etc. Thus, applications in which the public could be affected such as in nuclear power plants and other power plants operated by respective power companies, and applications in which a special quality assurance system is required, such as for Railway companies or Public service purposes shall be excluded from the programmable controller applications.
In addition, applications in which human life or property that could be greatly affected, such as in aircraft, medical applications, incineration and fuel devices, manned transportation, equipment for recreation and amusement, and safety devices, shall also be excluded from the programmable controller range of applications.
However, in certain cases, some applications may be possible, providing the user consults their local Mitsubishi representative outlining the special requirements of the project, and providing that all parties concerned agree to the special circumstances, solely at the users discretion.

Temperature Control Module Type A1S64TCTRT/Temperature Control Module with Disconnection Detection Function Type A1S64TCTRTBW

User's Manual

MODEL	A1S64TCTRT-U-SY-E
MODEL CODE	13JR79
SH(NA)-080549ENG-B(0804)MEE	

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