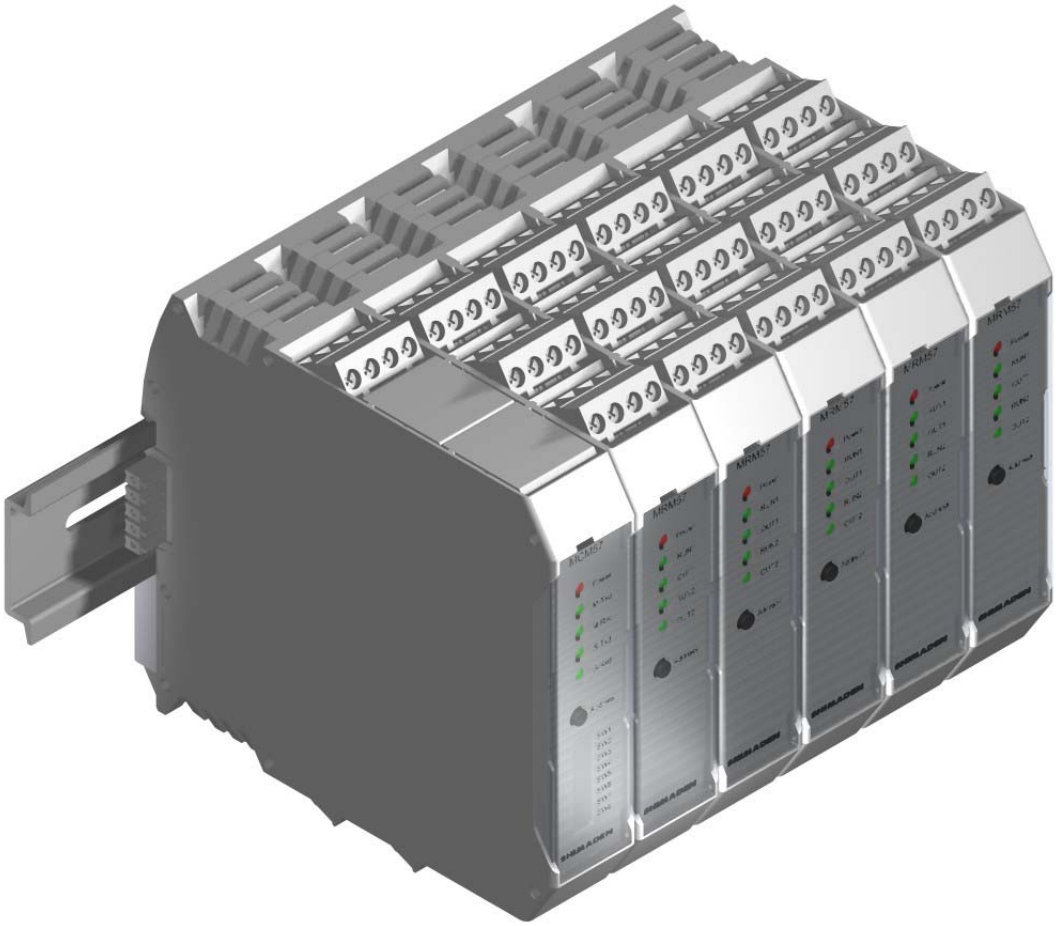
MCM57-MRM57 Series
Module-type Temperature Controller
Instruction Manual
(Detailed Version)



SHIMADEN CO., LED.

MMCM57-E01-A
Nov. 2016

Thank you very much for purchasing this Shimaden product.
Make sure that the delivered product is the one that you ordered. Carefully read and fully understand this Instruction Manual before use.

Notice

Ensure that this manual is handed to the final user of the instrument.

Introduction

This Instruction Manual is intended for personnel engaged in wiring, installation, and regular maintenance of the MCM57-MRM57 Series (personnel with knowledge and experience in electrical work).
This Instruction Manual contains the specifications and the operating and wiring instructions necessary to use the MCM57-MRM57 Series. Keep this manual handy so that it can be consulted by anyone using the MCM57-MRM57 Series.
Always operate the instrument according to the instructions contained in this Instruction Manual.

Table of Contents

1. Important safety instructions

The following symbols appear with instructions for safety and for equipment/facility damage prevention, as well as additional explanations and notes on exceptions:

"Warning": Failure to comply may result in personal injury or death.
"Caution": Failure to comply may result in damage to equipment and/or facilities.
[Note]: Additional explanations, notes on exceptions, and other necessary information

" ⚠ Warning"

The MCM57-MRM57 Series industrial control instruments are designed for the conversion of temperature, humidity, and other physical quantities. Therefore, avoid use for conversion purposes that may cause life-threatening risks. Otherwise, take appropriate safety measures before use.

We shall not be held responsible or liable for any accident that may occur due to the failure of the user to take safety measures.

- Install this instrument in a control panel, etc., to prevent any terminal from physical contact with the operator.
- Be sure to power this instrument off before installing or uninstalling it or before inserting a hand or any conductor into its casing. Failure to comply may result in an electrical shock that may cause serious injury or death.
- Before wiring, be sure to turn the power off. Failure to comply may result in an electrical shock.
- Be sure to de-energize wired terminals or any other live parts before touching them.

"⚠ Caution"

Where the failure of this instrument may cause damage to nearby devices, equipment, products, etc., take safety measures, such as installing a fuse or an anti-overheating device, before use.

We shall not be held responsible or liable for any accident that may occur due to the failure of the user to take safety measures.

- Install a switch or a circuit breaker, as a power-off method, on the external power supply circuit connected to the power terminal of the MCM57.
  The switch or circuit breaker must be installed securely in a location close to this instrument and easily accessible to the operator and must be indicated as the power-off device for this instrument.
- About the fuse
  This instrument has no built-in fuse. Fit a fuse in the external power supply circuit connected to the MCM57 power terminal.
  Standard fuse rating/characteristics: 24 V DC, 150 mA per Temp Control Module
- Before wiring, be sure to tighten the terminal connection.
  Insufficient tightening may cause overheating due to contact resistance, leading to a burning accident.
- Use within the rated supply voltage.
- The user must not make any modification and/or non-standard use.
- It takes 30 minutes for the Module-type Temperature Controller to read the correct temperature after power-on. (Power on this instrument more than 30 minutes before it actually starts control.)

2. Model code check

Check that the delivered product is manufactured to the specifications.

The Module-type Temperature Controller can be configured to consist of a COM Module and a desired number of Temp Control Modules.

2-1. COM Module

ITEM	CODE	SPECIFICATIONS	
Series	MCM57-	DIN rail mountable COM Module	
Master communication method	2	EIA RS-422, 4-wire half-duplex multi-drop (connectable to up to 31 units per group)	
	5	EIA RS-485, 2-wire half-duplex multi-drop (connectable to up to 31 units per group)	
Special notes	0	N/A	
	9	Applicable	

2-2. Temp Control Module

ITEM	CODE	SPECIFICATIONS	
Series	MRM57-	DIN rail mountable Temp Control Module with 2 event output points/CH (4 points in total)	
CH1 input	8	Multi (B, R, S, K, E, J, T, N, PL II, C(WRe5-26), U, L, Pt100, JPt100, ±10mV, 0-10mV, 0-20mV, 0-50mV, 10-50mV, 0-100mV)	
	6	Volt (±1V, 0-1V, 0-2V, 0-5V, 1-5V, 0-10V)	
CH2 input	8-	Multi (B, R, S, K, E, J, T, N, PL II, C(WRe5-26), U, L, Pt100, JPt100, ±10mV, 0-10mV, 0-20mV, 0-50mV, 10-50mV, 0-100mV)	
	6-	Volt (±1V, 0-1V, 0-2V, 0-5V, 1-5V, 0-10V)	
Control outputs (common to both CH1 and CH2)	C-	Transistor open collector/24 V DC, 100 mA	
	P-	SSR drive voltage/12 V DC, 30 mA	
	I-	Amperage/4-20 mA, max. load 500Ω	
	V-	Voltage/0-10 V, max. current 2 mA	
Program	N	N/A	
	P	4 patterns, 32 steps	
Options (common to both CH1 and CH2)	00	3 DI points/CH (6 points in total), no-voltage contact input/5 V, 1 mA [standard] Note that 6 points are usable in the one-input configuration.	
	03	1 analog output point/CH (2 points in total), 0-10 mV, output resistance 10Ω	
	04	1 analog output point/CH (2 points in total), 4-20 mA, max. load 300Ω	
	06	1 analog output point/CH (2 points in total), 0-10 V, max. current 2 mA	
Control modes	0	2-input 2-output (2ch independent two-loop)	
	1	1-input 2-output (1ch heating and cooling, 2 heating stages, 2 cooling stages)	
	2	2-input 1-output (1ch cascade)	
	3	2-input 2-output (1ch PV switchover control)	
Special notes	0	N/A	
	9	Applicable	

2-3. Checking the accessories

Instruction Manual (Basic Edition): 1 copy
Connectors for external connection: 2 to 6 pcs (variable depending on options selected)
Bus connector: 1 pc
Terminal resistor for RS-422 communication (supplied with MCM57): 2 pcs
Terminal resistor for RS-485 communication (supplied with MCM57): 1 pc

[Note]: In case of any defect in the product or any missing accessories, or if you have any questions, contact our distributor or our nearest sales office.

2-4. Precautions for use

Do not use thinner or any other solvent to clean the instrument. Clean it with gentle wiping, using a dry cloth.

3. About installation and wiring

3-1. Installation site (environmental conditions)

Operating environmental conditions

This instrument is manufactured assuming use under the following conditions. Use it within the following environmental conditions:

(1) Indoor use
(2) Altitude: 2,000 m or less above sea level
(3) Operating temperature: -10 to 50°C
(4) Operating humidity: 90%RH or less, no condensation
(5) Transient overvoltage category: I
(6) Contamination level: 2 (IEC 60664)

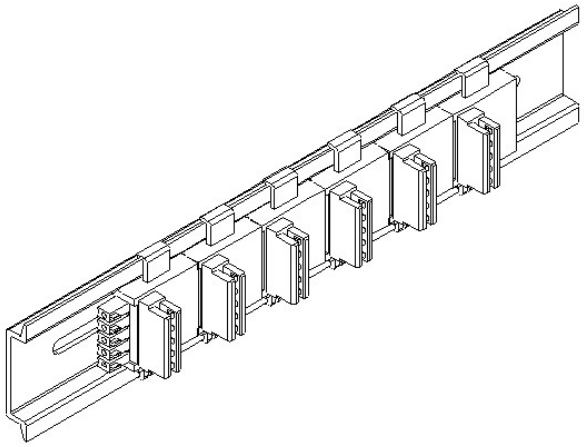
" ⚠ Caution"

Avoid use in any of the places listed below.
Failure to comply may cause malfunction or damage to this instrument and could result in a fire.

- Places where flammable gas, corrosive gas, oil mist, or dust that deteriorates insulation is generated or abundant.
- Places exposed to excessive vibration or impact.
- Places close to a high-voltage circuit or prone to inductive interference.
- Places exposed to water droplets or direct sunlight.
- Places exposed to air blown from a heater or an air conditioner.

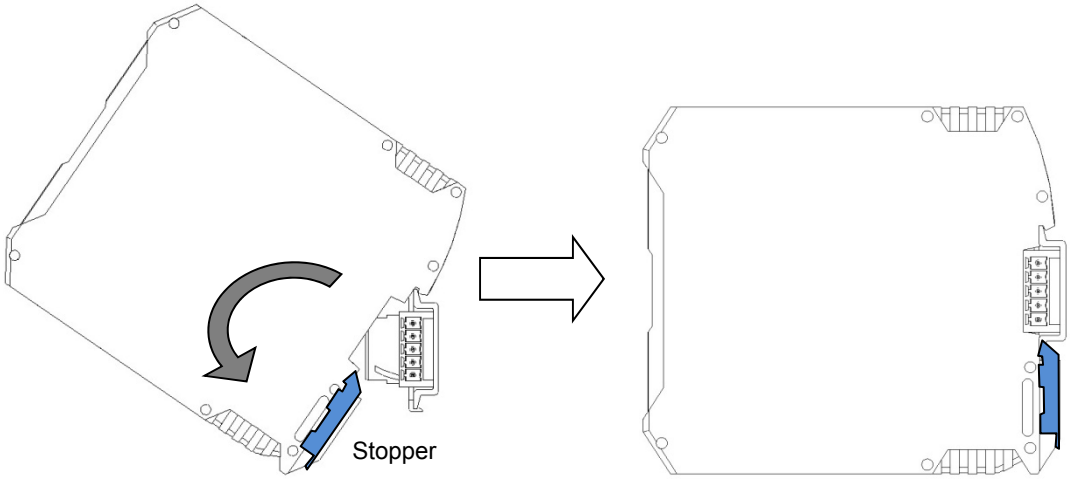
3-2. Installation and uninstallation

(1) Connect a sufficient number of bus connectors for one COM Module and one or more Temp Control Modules and install them on a DIN rail.

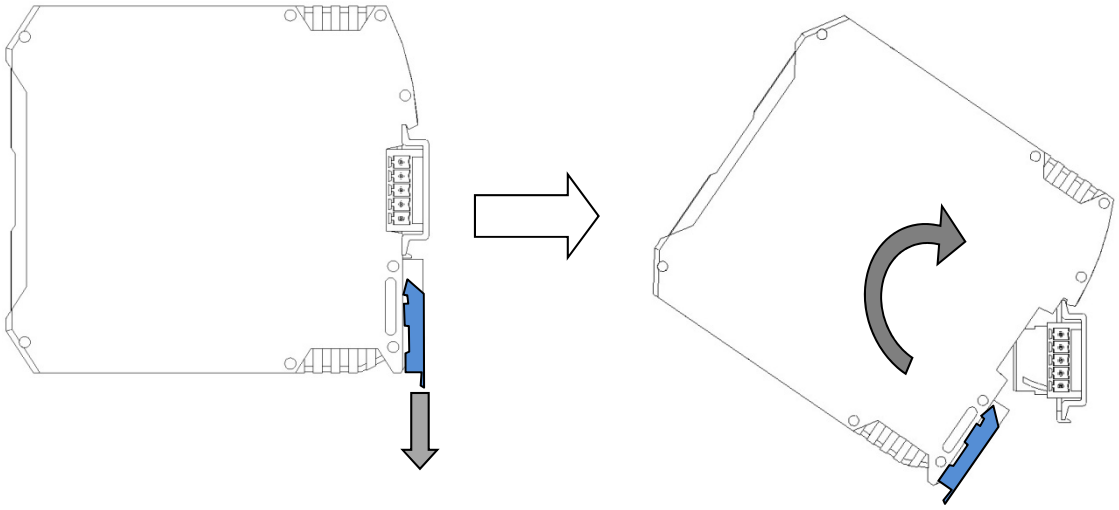


(2) First, engage the upper side of each module (the side without the stopper) with the DIN rail and slide each module diagonally into place.
Push each module in all the way until the stopper snaps into place.

(3) Repeat the above steps to connect and install multiple modules on the DIN rail.



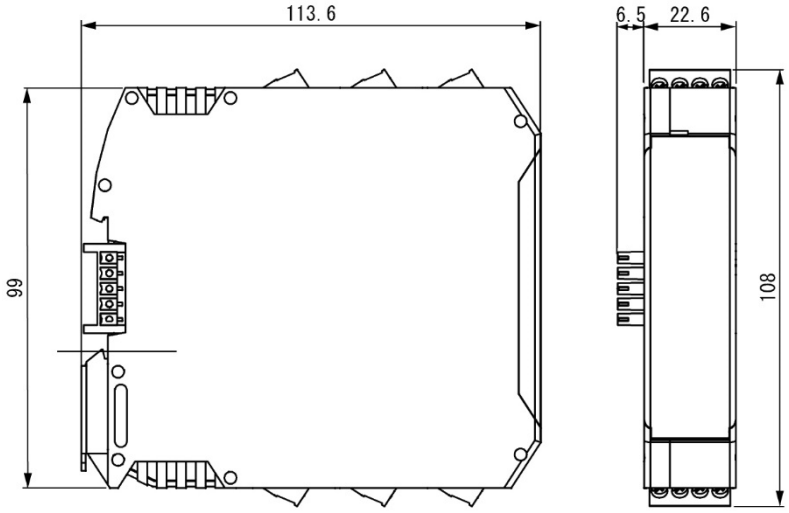
(4) To remove a module, turn its body upward with the stopper pulled down using a screwdriver.



*There is no particular order specified for the installation/uninstallation of the COM Module and Temp Control Module(s).

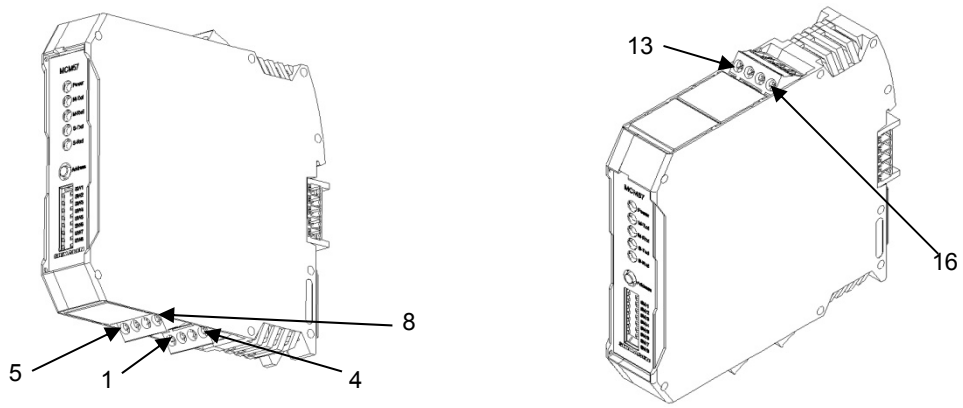
This instrument does not support hot-swapping. A module must be powered off before plugging it into a bus connector (DIN rail). Failure to comply may result in failure or malfunction of the module.

3-3. Outline dimensional drawing



3-4. Terminal number arrangement

(1) COM Module

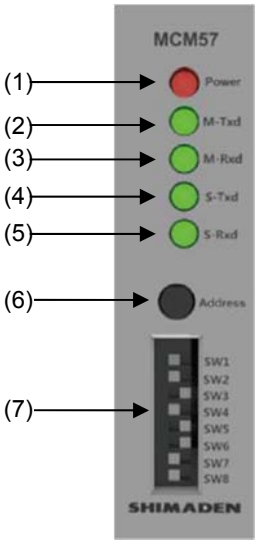


* Terminal Nos. 5 to 8 are absent in the RS-485 version.

(2) Functions of the COM Module terminals

Terminal No.	Name	Description	
		RS-422	RS-485
1	COM	Connects transmission A (+) to master reception A (+).	Connects transmission-reception A (+) to master transmission-reception A (+).
2		Connects transmission B (-) to master reception B (-).	Connects transmission-reception B (-) to master transmission-reception B (-).
3		Connects reception A (+) to master transmission A (+).	Connects transmission-reception A (+) to next group transmission-reception A (+).
4		Connects reception B (-) to master transmission B (-).	Connects transmission-reception B (-) to next group transmission-reception B (-).
5	COM	Connects transmission A (+) to next group transmission A (+).	- - -
6		Connects transmission B (-) to next group transmission B (-).	- - -
7		Connects reception A (+) to next group reception A (+).	- - -
8		Connects reception B (-) to next group reception B (-).	- - -
13	SG	RS-422 COM GND	RS-485 COM GND
14		RS-422 COM GND	RS-485 COM GND
15	Power	24V DC +	24V DC +
16	Power	24V DC -	24V DC -

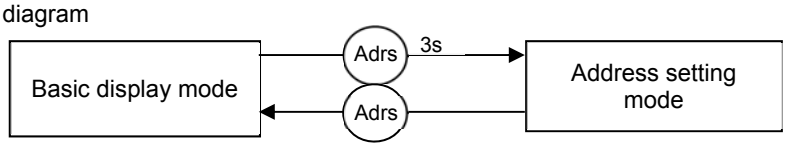
--Front view—



No.	Name	Function	
(1)	Power LED	This LED remains on in the normal mode. It blinks in the address setting mode (address initialization).	
(2)	Master transmission LED	This LED blinks during transmission to the master unit.	
(3)	Master reception LED	This LED blinks during reception from the master unit.	
(4)	Slave transmission LED	This LED blinks during transmission to the Temp Control Module.	
(5)	Slave reception LED	This LED blinks during reception from the Temp Control Module.	
(6)	Address switch (Adrs)	Hold down for 3 seconds to switch from the normal mode to the address setting mode. Push once in the address setting mode to get the slave address.	
(7)	Initialization switch	SW1	Group address setting
		SW2	
		SW3	Protocol selection
		SW4	Communication speed selection
		SW5	
		SW6	Data length selection
		SW7	Parity bit selection
		SW8	Stop bit selection

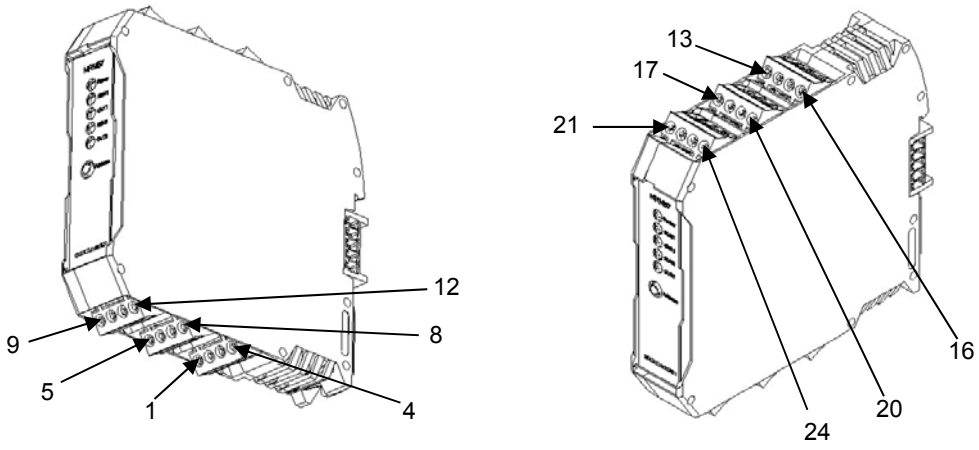
A COM Module uses address switch operations to toggle between the basic display mode and the address setting mode.

COM Module status transition diagram



*For the connection drawing for RS-422/RS485, see 20-2 “Controller-host computer connection.”

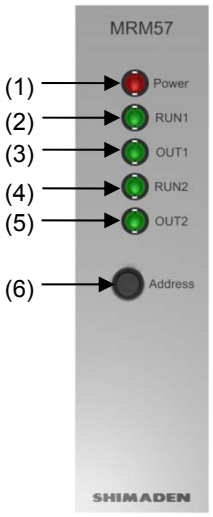
(3) Temp Control Module



(4) Functions of the Temp Control Module terminals

Terminal No.	Name	Description
1	CH1 PV input	+ (TC, mV, V), A (RTD)
2		- (TC, mV, V), B (RTD)
3		B (RTD)
4	CH1 EV_C	CH1 event common
5	CH2 PV	+ (TC, mV, V), A (RTD)
6		- (TC, mV, V), B (RTD)
7		B (RTD)
8	CH2 EV_C	CH2 event common
9	CH1 EV	Event output 1
10		Event output 2
11	CH2 EV	Event output 1
12		Event output 2
13	CH1 DI	External control input common
14		External control input 1
15		External control input 2
16		External control input 3
17	CH2 DI / AO+	CH2 external control input common/CH1 analog output+
18		CH2 external control input 1 / CH1 analog output-
19	CH2 DI / AO+	External control input 2 / CH2 analog output+
20		External control input 3 / CH2 analog output-
21	CH1 OUT	Control output +
22		Control output -
23	CH2 OUT	Control output +
24		Control output -

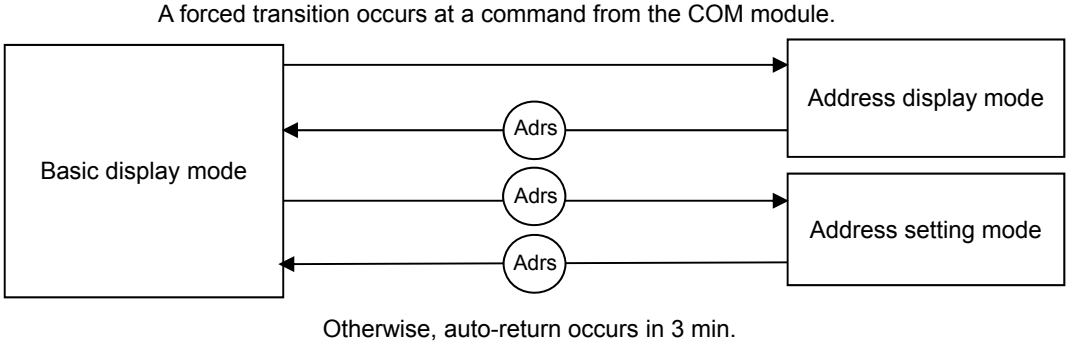
--Front view--



No.	Name	Function
(1)	Power LED	This LED remains on in the normal mode. It blinks in the address setting mode (address initialization). It indicates Bit 5 in the address display mode.
(2)	CH1 RUN LED	This LED remains on during CH1 operation in the normal mode. It indicates Bit 4 in the address display mode.
(3)	CH1 Output LED	This LED indicates CH1 output in the normal mode. It indicates Bit 3 in the address display mode.
(4)	CH2 RUN LED	This LED remains on during CH2 operation in the normal mode. It indicates Bit 2 in the address display mode.
(5)	CH2 Output LED	This LED indicates CH2 output in the normal mode. It indicates Bit 1 in the address display mode.
(6)	Address switch (Adrs)	Push once in the normal mode to switch to the address display mode. Push once in the address setting mode to request the slave address.

A Temp Control Module uses address switch operations to toggle between the basic display mode, the address setting mode, and the address display mode.

Temp Control Module status transition diagram



4. Product profile

This product supports modular configuration, in which a series of slim multi-loop temperature controllers, each having 2 input and 2 output channels, can be installed gap-free (on a DIN rail).

4-1. Advantages

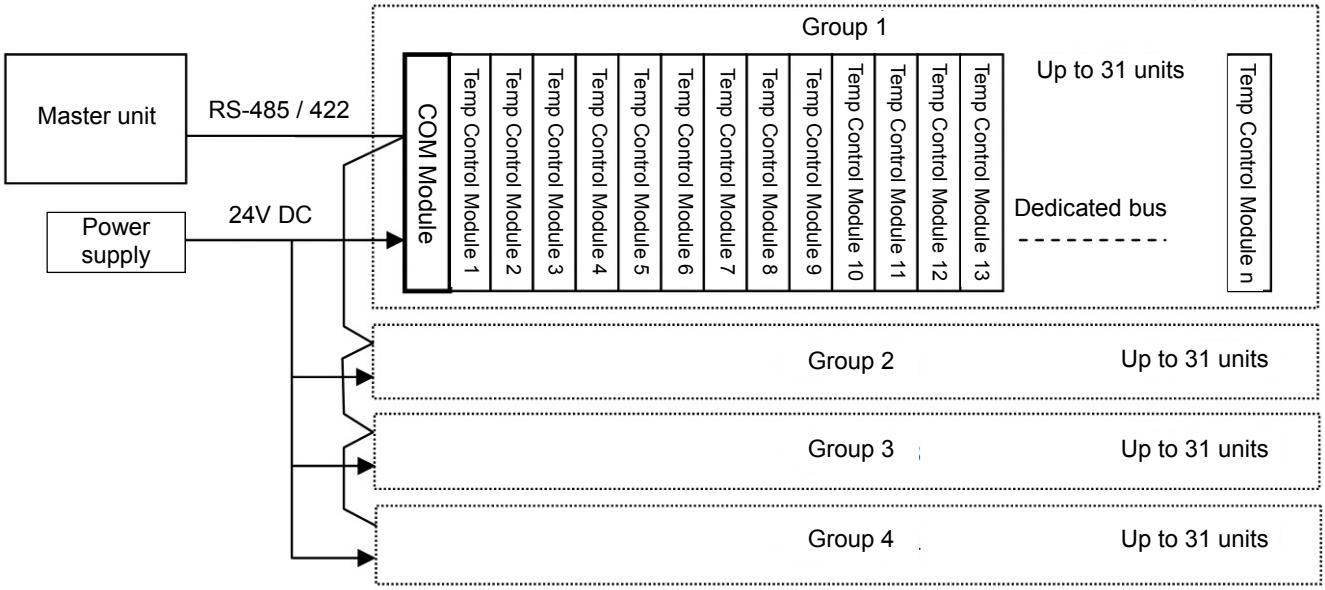
- Various system modes selectable by combinations of 2 inputs and 2 outputs (some modes are optional).
- 4-pattern, 32-step program (option)
- 2 analog output channels (option)
- 3 external control input (DI) points × 2 channels, provided as standard
- Connectable to a bus connector, requiring no external power supply.
- Slim-bodied (22.6 mm)
- Multiple gapless installation
- Easy address setting
- RS-422 or RS-485 communication function
- DIN rail-mountable
- Low cost

4-2. Configuration of this instrument

This instrument consists of a COM Module and one or more Temp Control Modules, allowing two temperature control loops per Temp Control Module. After the initial setting is completed, the Temp Control Module can be operated independently. The COM Module is still necessary to monitor the current value, to change the parameter settings, or to perform any other related operation. The COM Module controls groups and serves as a linkage between a master unit (PLC, PC, etc.) and the Temp Control Module. The COM Module uses an RS-485 or RS-422 bus for communication with a master unit and a dedicated bus for communication with the Temp Control Module.

Each module has a bus connector. When a group of modules are connected to each other on a DIN rail, they are ready to receive power supply and their bus connectors form the dedicated bus. In a group, up to 31 Temp Control Modules can be connected to each other. It is possible to connect up to 4 groups per master unit.

Conceptual diagram of product configuration

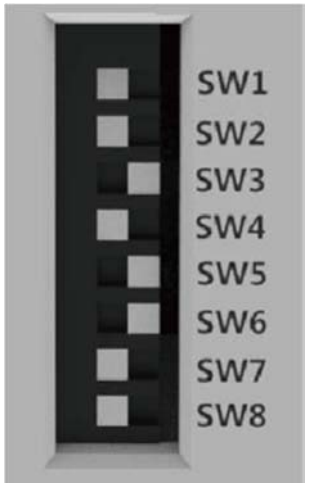


5. Setup before power-on

Use the COM Module DIP switches to set the communication conditions. The switch setting information reflects the state of the COM Module immediately after power-on. This means that any switch operation after power-on will be invalid. Hence, always set the DIP switches before power-on.

DIP switches
Left = OFF
Right = ON

OFF <-> ON



SW1-2: Group address setting
These switches are used for the address setting operation described later for automatic address assignment that determines the slave address range of a group.

SW1	SW2	Slave address range
OFF	OFF	1 to 62
OFF	ON	65 to 126
ON	OFF	129 to 190
ON	ON	193 to 254

SW3: Protocol setting

SW3	Protocol
OFF	SHIMADEN
ON	MODBUS-RTU

SW4-5: Communication speed (baud rate) setting

SW4	SW5	Communication speed
OFF	OFF	4,800 bps
OFF	ON	9,600 bps
ON	OFF	19,200 bps
ON	ON	38,400 bps

SW6: Data length setting (not applicable when the protocol is MODBUS-RTU)

SW6	Data length
OFF	7 bits
ON	8 bits

SW7: Parity bit setting

SW7	Parity bit
OFF	N/A (Non)
ON	Even number (Even)

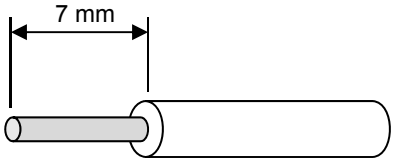
SW8: Stop bit setting

SW8	Stop bit
OFF	1 bit
ON	2 bits

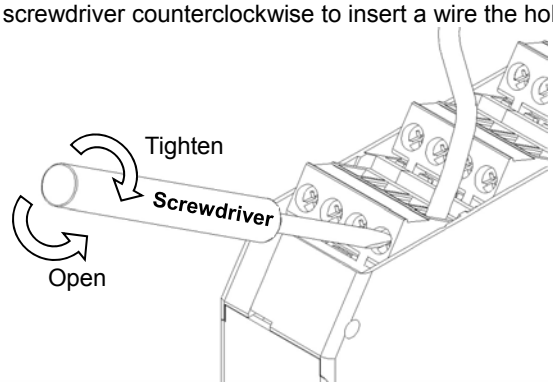
6. Wiring

After installing and connecting all modules to each other, wire them to the power supply, sensors, and peripheral devices.
As illustrated below, open each wire insertion hole fully by turning a screwdriver counterclockwise to insert a wire the hole.

Wire strip length



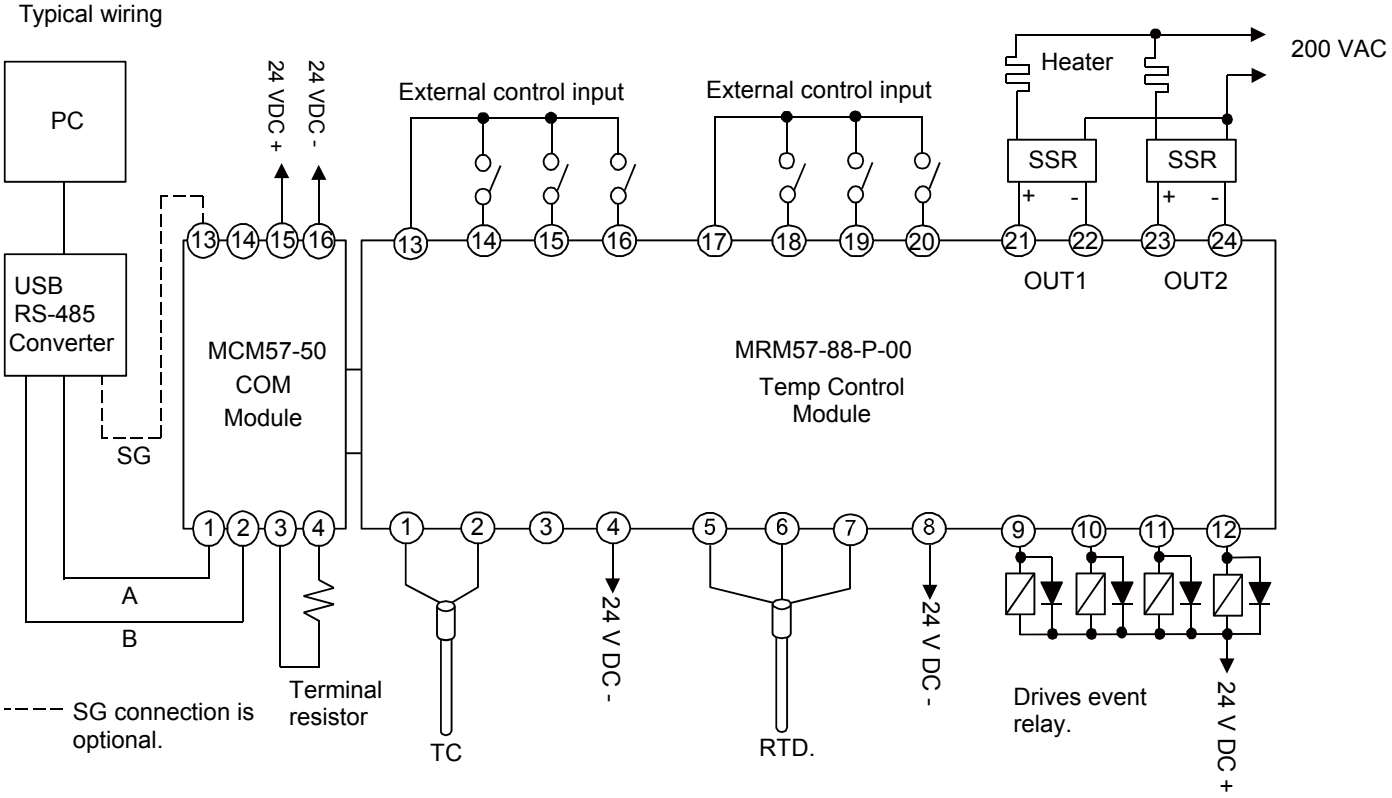
Compatible wire: 0.5 to 2.5mm^2, AWG 30 to 12



Tightening torque: 0.5 to 0.6 N·m

* Use crimp terminals (bar terminals or ferrules) for easier wiring and termination.

Typical wiring

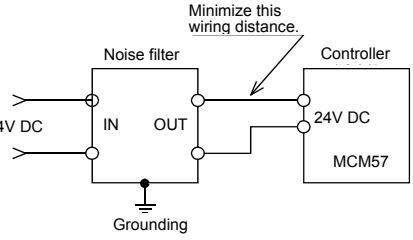


" ⚠ Warning"

- Before wiring, be sure to turn the power off. Failure to comply may result in failure or malfunction.
- Be sure to de-energize wired terminals or any other live parts before touching them. Failure to comply may result in an electrical shock.

Keep the following points in mind during wiring.

(1) According to "Functions of the COM Module terminals" and "Functions of the Temp Control Module terminals," ensure that all the wires are connected correctly.
(2) For thermocouple input, use a compensating conductor compatible with the selected type of thermocouple.
(3) For RTD. input, ensure that each lead wire has a resistance of 5Ω or less and that all the three wires have the same resistance.
(4) Do not run the input signal wiring through the same conduit or duct as a high-voltage circuit.
(5) Use shield wiring (single point grounding), which provides effective protection against static induction noise.
(6) Twist the input wires at short, regular intervals to provide effective protection against electromagnetic induction noise.
(7) For power supply wiring, use a wire or cable 0.5 m^2 or more in cross-sectional area and equivalent or superior in performance to a vinyl insulated wire.
(8) Tighten the terminal screws securely in place.
Tightening torque: 0.5 to 0.6 N·m (5 to 6 kgf·cm)
(9) Use a noise filter to prevent the malfunction of this instrument where it is likely to be affected by power supply noise.
Install the noise filter on a grounded panel and minimize the wiring distance between the noise filter output and the controller's power supply terminal.



7. Power-on

After making sure that the wiring is all correct, supply 24 V DC to COM Module terminals Nos. 15 and 16.
When the power is correctly supplied, the COM Module power LED comes on first. Then, the other Temp Control Module indicator LEDs come on in the following order.

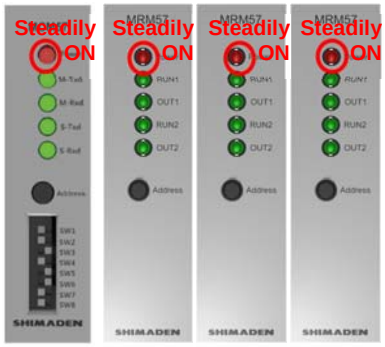
● Power ⇨ ● Power ● RUN1 ⇨ ● Power ● OUT1 ⇨ ● Power ● RUN2 ⇨ ● Power ● OUT2

8. First operations after power-on

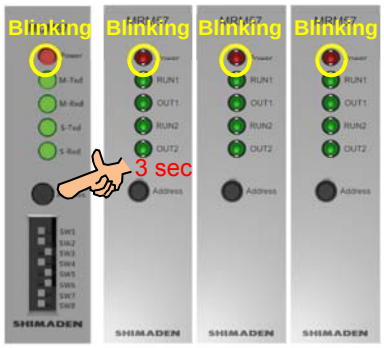
This instrument is used in a multi-drop bus network and uses an RS-485 or RS-422 bus for host-to-COM Module communication and a dedicated bus for COM Module-to-Temp Control Module communication. Each Temp Control Module needs to be assigned an identification number called a slave address. Unlike our conventional products that were set using key or rotary switch operations, this instrument can be easily set using a push-button switch.
Note that a Temp Control Module has a 2-channel, built-in temperature controller. Accordingly, both CH1 and CH2 are assigned a slave address, respectively. The slave addresses in a module are consecutively numbered, with a smaller odd number assigned to CH1.

* The factory-default settings are: CH1 = 01 and CH2 = 02.

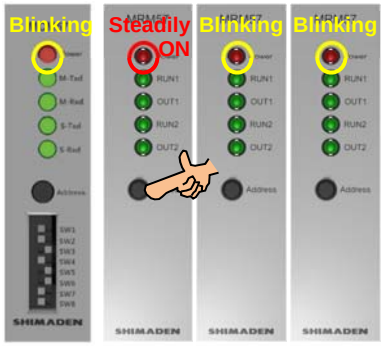
8-1. Address setting procedure



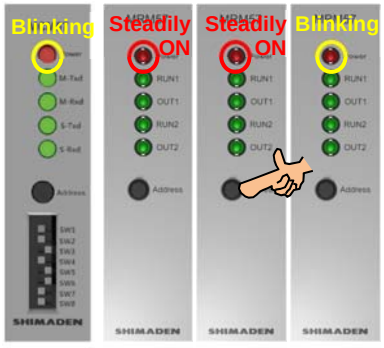
(1) Make sure that each module is correctly connected. Then, turn the power on.
Ensure that the power LED of each module is on.



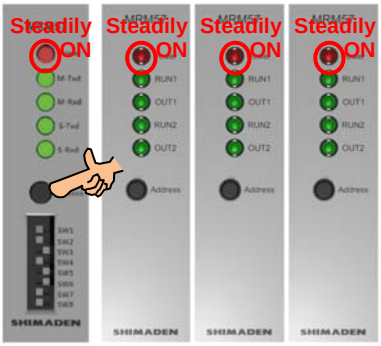
(2) Hold down the COM Module address switch for 3 seconds to select the address setting mode.
When the address setting mode is selected, the power LEDs of all the modules of the group start to blink.
Then, all the Temp Control Modules of the group have their internal addresses initialized (CH 1 = 01 and CH 2 = 02).



(3) When the address switch of a Temp Control Module is pressed, the Module's power LED stops blinking and remains on, indicating the completion of internal address assignment.
Then, the Temp Control Module returns to the basic display mode.



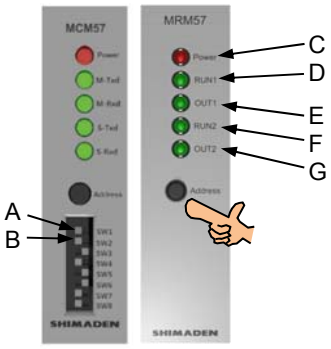
(4) When multiple Temp Control Modules are installed in a group, repeat Step (3) in the order of address assignment. Address assignment occurs in the order of switch pressing.



(5) After assigning addresses to all the Temp Control Modules (switch pressing), push the COM Module address switch.
Exit the address setting mode to go back to the basic display mode.
Make sure that the power LEDs of all the modules are back on again.

* An address assignment operation interrupted due to power loss cannot be resumed, although the addresses already assigned are valid.
  If there is any Temp Control Module left with unassigned addresses, perform the operation all over again from the beginning.
* The order of address assignment (that of switch pressing) need not be the same as the order of modules arranged in a group.

8-2. Address check



Press the address switch of a Temp Control Module in the basic display mode to switch to the address display mode. The 5 indicator LEDs of a Temp Control Module correspond to Bits 1 to 5, which are used in combination with the statuses of the COM Module DIP switches to determine the slave addresses.

Symbol	Name	Constant
A	SW1	128
B	SW2	64
C	Power (Bit 5)	32
D	RUN1 (Bit 4)	16
E	OUT1 (Bit 3)	8
F	RUN2 (Bit 2)	4
G	OUT2 (Bit 1)	2

According to the above table, total the constants of switches and LEDs that are ON. Then, add 1 to determine the CH1 slave address.

Slave address calculation formula: A+B+C+D+E+F+G+1

Example:

A	SW1	ON
B	SW2	OFF
C	Power (Bit 5)	OFF
D	RUN1 (Bit 4)	OFF
E	OUT1 (Bit 3)	OFF
F	RUN2 (Bit 2)	ON
G	OUT2 (Bit 1)	OFF

Address=128+0+0+0+0+4+0+1=133
CH1=133
CH2=134

* When the address switch is pressed again in the address display mode, the Module goes back to the basic display mode.
* The address display mode defaults back to the basic display mode in approximately 3 minutes.
* The CH2 address value is greater by 1 than the CH1 address value.

8-3. Operation

This instrument is shipped disabled (with the outputs turned OFF). Set the parameters listed below one by one in the top-to-bottom order before operating the instrument.
The parameter setting procedures in the table below may include some items necessary only for some customers. Set such items only when necessary.

* The following table assumes that the instrument has been configured and ready for communication.

• Communication memory card setting	0x05B0H
• System mode setting	0x070DH*
• Input range setting	0x0705H
• Input scaling setting	0x0707H…
• SV limiter setting	0x030AH…
• SV setting (including program)	0x0300H…
• Event type setting	0x0500H…
• Event level setting	0x0501H…
• External control input (DI) setting	0x0580H…
• PID setting (may be auto-tuned later)	0x0400H…
• Run operation	0x0190H

* This address is read-only and not editable.

9. Communication address table

Address	Parameter name	Setting range	R / W	OP	Remarks	Section explaining function
0046H	Code selection data 1		R		CH1 / CH2 input selection	
0047H	Code selection data 2		R		Output selection	
0048H	Code selection data 3		R		Optional	
0049H	Code selection data 4		R		Program / system	
005FH	Option info		R		*2 See the bit correspondence table.	11
0100H	PV (measured value)	Within setting range	R		*1	
0101H	Execution SV value	Within set value limiter	R			
0102H	Control output 1	0 to 1,000 (0.0 to 100.0%)	R			12-2 (1)
0103H	Control output 2	0 to 1,000 (0.0 to 100.0%)	R		MODE2 / 4	12-2 (1)
0104H	Action flag	See the detailed description below.	R		*2 See the bit correspondence table.	See the table below.
0105H	Event output flag	See the detailed description below.	R		*2 See the bit correspondence table.	See the table below.
0106H	Execution SV No.	1 to 3	R			17-2
0107H	Execution PID No.		R		0x7FFE when not executed	
010BH	DI input state flag	See the detailed description below.	R		*2 See the bit correspondence table.	See the table below.
010DH	Event latch output flag	See the detailed description below.	R		*2 See the bit correspondence table.	See the table below.
010EH	Event relay ON/OFF flag	See the detailed description below.	R		*2 See the bit correspondence table.	See the table below.
0120H	Program action flag	See the detailed description below.	R		*2 See the bit correspondence table.	See the table below.
0121H	Execution pattern No.		R		*3 0x7FFE if not PROG. RUN	
0123H	Execution pattern count	1 to 10,000	R		0x7FFE if not PROG. RUN	
0124H	Execution step No.	1 to 40	R			
0125H	Execution step remaining time	00:00 to 99:59	R		*3	
0126H	Execution PID No.		R			
0180H	Execution SV No.	1 to 3	R / W			17-2
0182H	Control output 1 manual output value	0 to 1,000 (0.0 to 100.0%)	R / W			12-2 (1)
0183H	Control output 2 manual output value	0 to 1,000 (0.0 to 100.0%)	R / W		MODE2 / 4	12-2 (1)
0184H	AT	0: OFF 1: ON	R / W			17-4
0185H	AUTO <-> MAN switching	0: AUTO 1: MAN	R / W			17-5 (1)
018CH	Communication mode	0: LOC 1: COM	R / W			19-3 (2)
018DH	Event direct output		R / W		*2 See the bit correspondence table.	
0190H	RUN <-> RST switching	0: RST 1: RUN (STBY<->RUN)	R / W			16-4 / 17-1
0191H	Hold (HLD)	0: OFF 1: ON	R / W			18-1
0192H	Advance (AD)	0: OFF 1: ON	R / W			18-2
0198H	Latching alarm reset		R / W		*2 See the bit correspondence table.	
019FH	Parameter initialization	0: No initialization instructed 1: Initialization instructed	W			
0260H	Master's internal cascade	Input unit	R		MODE3	12-4
0261H	Master's internal cascade	Input range	R		MODE3	
0262H	Master's internal cascade	Decimal point position	R		MODE3	12-5
0263H	Master's internal cascade	Measuring range lower limit value	R		MODE3	12-3 (2)
0264H	Master's internal cascade	Measuring range upper limit value	R		MODE3	12-3 (2)
0280H	CH1 PV (measured value)		R			
0281H	CH2 PV (measured value)		R		MODE1 / 3	

The following table shows the details of the action flag, event output flag, and DI input state flag data (RUN_FLG, EV_FLG, DI_FLG):
(When not in action: bit = 0, when in action: bit = 1)

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
RUN_FLG	0	0	0	0	0	0	AT WAIT	COM	0	0	ESV	0	0	STBY	MAN	AT
EV_FLG	0	0	0	0	0	0	0	0	0	0	0	0	EV4	EV3	EV2	EV1
DI_FLG	0	0	0	0	0	0	0	0	0	0	DI6	DI5	DI4	DI3	DI2	DI1

Address	Parameter name	Setting range	R / W	OP	Remarks	Section explaining function
0300H	FIX SV1	Within SV limiter	R / W			16-3 (5)
0301H	FIX SV2	Within SV limiter	R / W			16-3 (5)
0302H	FIX SV3	Within SV limiter	R / W			16-3 (5)
030AH	SV limiter lower limit value	Measuring range lower limit value to measuring range upper limit value -1	R / W			13-1 (1)
030BH	SV limiter upper limit value	Measuring range lower limit value +1 to measuring range upper limit value	R / W			13-1 (1)
0328H	Cascade mode	0: CAS1, 1: CAS2, 2: CAS3	R / W		MODE3	12-3 (1)
0329H	Cascade SV lower limit value	CS_L: SV2_SC_L to SC_H-1	R / W		MODE3	12-3 (2)
032AH	Cascade SV upper limit value	SC_H: CS_L to SV2_SC_H	R / W		MODE3	12-3 (2)
032BH	Cascade deviation value	-2,000 to 2,000 (digit)	R / W		MODE3	12-3 (3)
032CH	Cascade filter	0: OFF, 1 to 100 (seconds)	R / W		MODE3	12-3 (4)
0331H	Switchover point	CH1 PV lower to CH2 PV upper limit value	R / W		MODE4	12-7 (3)
0332H	Switchover hysteresis	0 to 1,000 (digit)	R / W		MODE4	12-7 (4)
0400H	Output 1 proportional band 1	0: OFF, 1 to 10,000 (0.1 to 1,000.0%)	R / W			14-1
0401H	Output 1 integral time 1	0: OFF, 1 to 6,000 (seconds)	R / W			14-2
0402H	Output 1 derivative time 1	0: OFF, 1 to 3,600 (seconds)	R / W			14-3
0403H	Output 1 manual reset 1	-500 to 500 (-50.0 to 50.0%)	R / W			14-4
0404H	Output 1 differential gap 1	1 to 1,000 (digit)	R / W			14-6
0405H	Output 1 output limiter lower limit value 1	0 to 999 (0.0 to 99.9%)	R / W			14-8
0406H	Output 1 output limiter upper limit value 1	Lower limit value + 1 to 1,000 (to 100.0%)	R / W			14-8
0407H	Output 1 SF1	0: OFF, 1 to 100 (0.01 to 1.00)	R / W			14-5
0408H	Output 1 proportional band 2	0: OFF, 0.1 to 10,000 (1 to 1,000.0%)	R / W			14-1
0409H	Output 1 integral time 2	0: OFF, 1 to 6,000 (seconds)	R / W			14-2
040AH	Output 1 derivative time 2	0: OFF, 1 to 3,600 (seconds)	R / W			14-3
040BH	Output 1 manual reset 2	-500 to 500 (-50.0 to 50.0%)	R / W			14-4
040CH	Output 1 differential gap 2	1 to 10,000 (digit)	R / W			14-6
040DH	Output 1 output limiter lower limit value 2	0 to 999 (0.0 to 99.9%)	R / W			14--8
040EH	Output 1 output limiter upper limit value 2	Lower limit value + 1 to 1,000 (to 100.0%)	R / W			14-8
040FH	Output 1 SF2	0: OFF, 1 to 100 (0.01 to 1.00)	R / W			14-5
0410H	Output 1 proportional band 3	0: OFF, 1 to 10,000 (0.1 to 1,000.0%)	R / W			14-1
0411H	Output 1 integral time 3	0: OFF, 1 to 6,000 (seconds)	R / W			14-2
0412H	Output 1 derivative time 3	0: OFF, 1 to 3,600 (seconds)	R / W			14-3
0413H	Output 1 manual reset 3	-500 to 500 (-50.0 to 50.0%)	R / W			14-4
0414H	Output 1 differential gap 3	1 to 1,000 (digit)	R / W			14-6
0415H	Output 1 output limiter lower limit value 3	0 to 999 (0.0 to 99.9%)	R / W			14-8
0416H	Output 1 output limiter upper limit value 3	Lower limit value + 1 to 1,000 (to 100.0%)	R / W			14-8
0417H	Output 1 SF3	0: OFF, 1 to 100 (0.01 to 1.00)	R / W			14-5
0460H	Output 2 proportional band 1	0: OFF, 1 to 10,000 (0.1 to 1,000.0%)	R / W		MODE2 / 4	14-1
0461H	Output 2 integral time 1	0: OFF, 1 to 6,000 (seconds)	R / W		MODE2 / 4	14-2
0462H	Output 2 derivative time	0: OFF, 1 to 3,600 (seconds)	R / W		MODE2 / 4	14-3
0463H	Output 2 dead band	-2,000 to 5,000 (digit)	R / W		MODE2 / 4	14-7
0464H	Output 2 differential gap 1	1 to 1,000 (digit)	R / W		MODE2 / 4	14-6
0465H	Output 2 output limiter lower limit value 1	0 to 999 (0.0 to 99.9%)	R / W		MODE2 / 4	14-8
0466H	Output 2 output limiter upper limit value 1	Lower limit value + 1 to 1,000 (to 100.0%)	R / W		MODE2 / 4	14-8
0467H	Output 2 SF1	0: OFF, 1 to 100 (0.01 to 1.00)	R / W		MODE2 / 4	14-5
0468H	Output 2 proportional band 2	0: OFF, 1 to 10,000 (0.1 to 1,000.0%)	R / W		MODE2 / 4	14-1
0469H	Output 2 integral time 2	0: OFF, 1 to 6,000 (seconds)	R / W		MODE2 / 4	14-2
046AH	Output 2 derivative time 2	0: OFF, 1 to 3,600 (seconds)	R / W		MODE2 / 4	14-3
046BH	Output 2 dead band	-2,000 to 5,000 (digit)	R / W		MODE2 / 4	14-7
046CH	Output 2 differential gap 2	1 to 1,000 (digit)	R / W		MODE2 / 4	14-6
046DH	Output 2 output limiter lower limit value 2	0 to 999 (0.0 to 99.9%)	R / W		MODE2 / 4	14-8
046EH	Output 2 output limiter upper limit value 2	Lower limit value + 1 to 1,000 (to 100.0%)	R / W		MODE2 / 4	14-8
046FH	Output 1 SF2	0: OFF, 1 to 100 (0.01 to 1.00)	R / W		MODE2 / 4	14-5
0470H	Output 2 proportional band 3	0: OFF, 1 to 10,000 (0.1 to 1,000.0%)	R / W		MODE2 / 4	14-1
0471H	Output 2 integral time 3	0: OFF, 1 to 6,000 (seconds)	R / W		MODE2 / 4	14-2
0472H	Output 2 derivative time 3	0: OFF, 1 to 3,600 (seconds)	R / W		MODE2 / 4	14-3
0473H	Output 2 dead band	-2,000 to 5,000 (digit)	R / W		MODE2 / 4	14-7
0474H	Output 2 differential gap 3	1 to 1,000 (digit)	R / W		MODE2 / 4	14-6
0475H	Output 2 output limiter lower limit value 3	0 to 999 (0.0 to 99.9%)	R / W		MODE2 / 4	14-8
0476H	Output 2 output limiter upper limit value 3	Lower limit value + 1 to 1,000 (to 100.0%)	R / W		MODE2 / 4	14-8
0477H	Output 2 SF3	0: OFF, 1 to 100 (0.01 to 1.00)	R / W		MODE2 / 4	14-5
04DFH	Differential gap mode	0: CENTER, 1: SV_OFF	R / W			12-9 (7)

Address	Parameter name	Setting range	R / W	OP	Remarks	Section explaining function
0500H	Event 1 code	See the event (EV) assignment table.	R / W			15-1
0501H	Event 1 level	See the event level value.	R / W			15-1 (1)
0502H	Event 1 differential gap	1 to 1,000 (digit)	R / W			15-1 (2)
0503H	Event 1 standby operation	0 to 3	R / W			15-1 (3)
0505H	Event 1 latching / output characteristics	0: OFF, 1: ON / 0: NO, 1: NC	R / W		*3	15-1(4)/(5)
0508H	Event 2 code	See the event (EV) assignment table.	R / W			15-1
0509H	Event 2 level	See the event level value.	R / W			15-1 (1)
050AH	Event 2 differential gap	1 to 1,000 (digit)	R / W			15-1 (2)
050BH	Event 2 standby operation	0 to 3	R / W			15-1 (3)
050DH	Event 2 latching/output characteristics	0: OFF, 1: ON / 0: NO, 1: NC	R / W		*3	15-1(4)/(5)
0510H	Event 3 code	See the event (EV) assignment table.	R / W		MODE2 / 4	15-1
0511H	Event 3 level	See the event level value.	R / W		MODE2 / 4	15-1 (1)
0512H	Event 3 differential gap	1 to 1,000 (digit)	R / W		MODE2 / 4	15-1 (2)
0513H	Event 3 standby operation	0 to 3	R / W		MODE2 / 4	15-1 (3)
0515H	Event 3 latching/output characteristics	0: OFF, 1: ON / 0: NO, 1: NC	R / W		MODE2 / 4 *3	15-1(4)/(5)
0518H	Event 4 code	See the event (EV) assignment table.	R / W		MODE2 / 4	15-1
0519H	Event 4 level	See the event level value.	R / W		MODE2 / 4	15-1 (1)
051AH	Event 4 differential gap	1 to 1,000 (digit)	R / W		MODE2 / 4	15-1 (2)
051BH	Event 4 standby operation	0 to 3	R / W		MODE2 / 4	15-1 (3)
051DH	Event 4 latching/output characteristics	0: OFF, 1: ON / 0: NO, 1: NC	R / W		MODE2 / 4 *3	15-1(4)/(5)
0580H	DI1 Mode	0: non 1: RUN1 2: RUN2 3: mAn 4: At 5: ESV2 6: ACt1 7: ACt2 8: ProG 9: HLd 10: AdV 11: Ptn2 12: Ptn3 13: L_rS	R / W	DI		19-1 (1)
0581H	DI2 Mode		R / W	DI		19-1 (1)
0582H	DI3 Mode		R / W	DI		19-1 (1)
0583H	DI4 Mode		R / W	DI	MODE2 / 4	19-1 (1)
0584H	DI5 Mode		R / W	DI	MODE2 / 4	19-1 (1)
0585H	DI6 Mode		R / W	DI	MODE2 / 4	19-1 (1)
05A0H	Analog output mode	0: PV, 1: SV, 2: OUT1, 3: OUT2	R / W	AOUT		19-2 (1)
05A1H	Analog output scaling lower limit value	PV, SV: Within measuring range OUT1, OUT2: 0 to 1,000 (0.0 to 100.0%)	R / W	AOUT		19-2 (2)
05A2H	Analog output scaling upper limit value		R / W	AOUT		19-2 (2)
05A4H	Analog 2 output mode	0: PV, 1: SV, 2: OUT1, 3: OUT2	R / W	AOUT	MODE2 / 4	19-2 (1)
05A5H	Analog 2 output scaling lower limit value	PV, SV: Within measuring range OUT1, OUT2: 0 to 1,000 (0.0 to 100.0%)	R / W	AOUT	MODE2 / 4	19-2 (2)
05A6H	Analog 2 output scaling upper limit value		R / W	AOUT	MODE2 / 4	19-2 (2)
05B0H	Communication memory card	0: EEP, 1: rAm, 2: r_E	R / W			19-3 (1)
05B1H	Communication mode type	0: COM1, 1: COM2	R / W			19-3 (3)
05B4H	Analog output limiter lower limit value	0 to 999 (0.0 to 99.9%)	R / W	AOUT		19-2 (3)
05B5H	Analog output limiter upper limit value	Lower limit value + 1 to 1,000 (to 100.0%)	R / W	AOUT		19-2 (3)
05B7H	Analog 2 output limiter lower limit value	0 to 999 (0.0 to 99.9%)	R / W	AOUT	MODE2 / 4	19-2 (3)
05B8H	Analog 2 output limiter upper limit value	Lower limit value + 1 to 1,000 (to 100.0%)	R / W	AOUT	MODE2 / 4	19-2 (3)

Address	Parameter name	Setting range	R / W	OP	Remarks	Section explaining function
0600H	Output 1 output characteristics	0: RA, 1: DA	R / W			12-9 (2)
0601H	Output 1 proportional cycle	1 to 120 (seconds)	R / W			12-9 (3)
0604H	Output 2 proportional cycle	1 to 120 (seconds)	R / W		MODE2 / 4	12-9 (3)
0607H	Output 2 output characteristics	0: RA, 1: DA	R / W		MODE2 / 4	12-9 (2)
060AH	Output 1 soft start	0: OFF, 1 to 120 (seconds)	R / W			12-9 (4)
060BH	Output 2 soft start	0: OFF, 1 to 120 (seconds)	R / W		MODE2 / 4	12-9 (4)
0700H	PV gain correction	-500 to 500 (-5.00 to 5.00%)	R / W			12-8 (1)
0701H	PV bias	-2,000 to 20,000 (digit)	R / W			12-8 (1)
0702H	PV filter	0 to 9,999 (seconds)	R / W			12-8 (1)
0704H	Input unit	0: °C, 1: °F	R / W			12-4 (1)
0705H	Input range	See 12.6 “Measuring range code table.”	R / W			12-1 (1)
0707H	Input scaling decimal point position	0: (0), 1: (0.0), 2: (0.00), 3: (0.000)	R / W			12-5
0708H	Input scaling lower limit value	-2,000 to 9,999 (digit)	R / W			12-1 (2)
0709H	Input scaling upper limit value	SC_L+10 to 10,000 (digit)	R / W			12-1 (2)
0730H	Switchover input 2 input unit	0: °C, 1: °F	R		MODE4	12-7 (2)
0731H	Switchover input 2 input range		R / W		MODE4	12-7 (2)
0733H	Switchover input 2 input scaling decimal point position	With or without decimal point	R		MODE4	12-7 (2)
0734H	Switchover input 2 input scaling lower limit value		R / W		MODE4	12-7 (2)
0735H	Switchover input 2 input scaling upper limit value		R / W		MODE4	12-7 (2)
070DH	System mode	0: 2in2Loop 1: 1in1Loop 2: 2in2LoopCas 3: 2in1LoopSW	R			10-1
0800H	FIX <-> PROG switching	0: PROG 1: FIX	R / W			16-3 (4)
0802H	Start pattern No.	1 to 4 (number of patterns)	R / W			16-3 (1)
0818H	Number of patterns	0: 1, 1: 2, 2: 4	R / W			16-3 (2)
0819H	Time unit	0: HH:MM, 1: MM:SS	R / W			16-3 (3)
0882H	Pattern 1 number of end steps	1 to 32	R / W			16-3 (6)
0883H	Pattern 1 repeat execution count	1 to 10,000	R / W			16-3 (8)
0884H	Pattern 1 start SV value	Within SV limiter	R / W			13-1 (1)
0885H	Pattern 1 guaranteed soak band	0: OFF, 1 to 1,000 (digit)	R / W			18-4 (1)
0887H	Pattern 1 start mode	0: SV, 1: PV	R / W			16-3 (9)
0889H	Pattern 1 alarm 1 level value	See the pattern event level value.	R / W			16-3 (7)
088AH	Pattern 1 alarm 2 level value		R / W			16-3 (7)
088BH	Pattern 1 alarm 3 level value		R / W		MODE2 / 4	16-3 (7)
088CH	Pattern 1 alarm 4 level value		R / W		MODE2 / 4	16-3 (7)
08A0H	Pattern 1 step 1 step SV value	Within SV limiter	R / W			16-5 (1)
08A1H	Pattern 1 step 1 step time	00:00 to 99:59	R / W		*3	16-5 (2)
08A2H	Pattern 1 step 1 step PID No.	0 to 3	R / W			16-5 (3)
08A4H	Pattern 1 step 2 step SV value	Within SV limiter	R / W			16-5 (1)
08A5H	Pattern 1 step 2 step time	00:00 to 99:59	R / W		*3	16-5 (2)
08A6H	Pattern 1 step 2 step PID No.	0 to 3	R / W			16-5 (3)
08A8H	Pattern 1 step 3 step SV value	Within SV limiter	R / W			16-5 (1)
08A9H	Pattern 1 step 3 step time	00:00 to 99:59	R / W		*3	16-5 (2)
08AAH	Pattern 1 step 3 step PID No.	0 to 3	R / W			16-5 (3)
08ACH	Pattern 1 step 4 step SV value	Within SV limiter	R / W			16-5 (1)
08ADH	Pattern 1 step 4 step time	00:00 to 99:59	R / W		*3	16-5 (2)
08AEH	Pattern 1 step 4 step PID No.	0 to 3	R / W			16-5 (3)

Address	Parameter name	Setting range	R / W	OP	Remarks	Section explaining function
08B0H	Pattern 1 step 5 step SV value	Within SV limiter	R / W			16-5 (1)
08B1H	Pattern 1 step 5 step time	00:00 to 99:59	R / W		*3	16-5 (2)
08B2H	Pattern 1 step 5 step PID No.	0 to 3	R / W			16-5 (3)
08B4H	Pattern 1 step 6 step SV value	Within SV limiter	R / W			16-5 (1)
08B5H	Pattern 1 step 6 step time	00:00 to 99:59	R / W		*3	16-5 (2)
08B6H	Pattern 1 step 6 step PID No.	0 to 3	R / W			16-5 (3)
08B8H	Pattern 1 step 7 step SV value	Within SV limiter	R / W			16-5 (1)
08B9H	Pattern 1 step 7 step time	00:00 to 99:59	R / W		*3	16-5 (2)
08BAH	Pattern 1 step 7 step PID No.	0 to 3	R / W			16-5 (3)
08BCH	Pattern 1 step 8 step SV value	Within SV limiter	R / W			16-5 (1)
08BDH	Pattern 1 step 8 step time	00:00 to 99:59	R / W		*3	16-5 (2)
08BEH	Pattern 1 step 8 step PID No.	0 to 3	R / W			16-5 (3)
0902H	Pattern 2 number of end steps	1 to 16	R / W			16-3 (6)
0903H	Pattern 2 repeat execution count	1 to 10,000	R / W			16-3 (8)
0904H	Pattern 2 start SV value	Within SV limiter	R / W			13-1
0905H	Pattern 2 guaranteed soak band	0: OFF, 1 to 1,000 (digit)	R / W			18-4 (1)
0907H	Pattern 2 start mode	0: SV, 1: PV	R / W			16-3 (9)
0909H	Pattern 2 alarm 1 level value	See the pattern event level value.	R / W			16-3 (7)
090AH	Pattern 2 alarm 2 level value		R / W			16-3 (7)
090BH	Pattern 2 alarm 3 level value		R / W		MODE2 / 4	16-3 (7)
090CH	Pattern 2 alarm 4 level value		R / W		MODE2 / 4	16-3 (7)
0920H	Pattern 2 step 1 step SV value	Within SV limiter	R / W			16-5 (1)
0921H	Pattern 2 step 1 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0922H	Pattern 2 step 1 step PID No.	0 to 3	R / W			16-5 (3)
0924H	Pattern 2 step 2 step SV value	Within SV limiter	R / W			16-5 (1)
0925H	Pattern 2 step 2 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0926H	Pattern 2 step 2 step PID No.	0 to 3	R / W			16-5 (3)
0928H	Pattern 2 step 3 step SV value	Within SV limiter	R / W			16-5 (1)
0929H	Pattern 2 step 3 step time	00:00 to 99:59	R / W		*3	16-5 (2)
092AH	Pattern 2 step 3 step PID No.	0 to 3	R / W			16-5 (3)
092CH	Pattern 2 step 4 step SV value	Within SV limiter	R / W			16-5 (1)
092DH	Pattern 2 step 4 step time	00:00 to 99:59	R / W		*3	16-5 (2)
092EH	Pattern 2 step 4 step PID No.	0 to 3	R / W			16-5 (3)
0930H	Pattern 2 step 5 step SV value	Within SV limiter	R / W			16-5 (1)
0931H	Pattern 2 step 5 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0932H	Pattern 2 step 5 step PID No.	0 to 3	R / W			16-5 (3)
0934H	Pattern 2 step 6 step SV value	Within SV limiter	R / W			16-5 (1)
0935H	Pattern 2 step 6 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0936H	Pattern 2 step 6 step PID No.	0 to 3	R / W			16-5 (3)
0938H	Pattern 2 step 7 step SV value	Within SV limiter	R / W			16-5 (1)
0939H	Pattern 2 step 7 step time	00:00 to 99:59	R / W		*3	16-5 (2)
093AH	Pattern 2 step 7 step PID No.	0 to 3	R / W			16-5 (3)
093CH	Pattern 2 step 8 step SV value	Within SV limiter	R / W			16-5 (1)
093DH	Pattern 2 step 8 step time	00:00 to 99:59	R / W		*3	16-5 (2)
093EH	Pattern 2 step 8 step PID No.	0 to 3	R / W			16-5 (3)

Address	Parameter name	Setting range	R / W	OP	Remarks	Section explaining function
0982H	Pattern 3 number of end steps	1 to 8	R / W			16-3 (6)
0983H	Pattern 3 repeat execution count	1 to 10,000	R / W			16-3 (8)
0984H	Pattern 3 start SV value	Within SV limiter	R / W			13-1
0985H	Pattern 3 guaranteed soak band	0: OFF, 1 to 1,000 (digit)	R / W			18-4 (1)
0987H	Pattern 3 start mode	0: SV, 1: PV	R / W			16-3 (9)
0989H	Pattern 3 alarm 1 level value	See the pattern event level value.	R / W			16-3 (7)
098AH	Pattern 3 alarm 2 level value		R / W			16-3 (7)
098BH	Pattern 3 alarm 3 level value		R / W		MODE2 / 4	16-3 (7)
098CH	Pattern 3 alarm 4 level value		R / W		MODE2 / 4	16-3 (7)
09A0H	Pattern 3 step 1 step SV value	Within SV limiter	R / W			16-5 (1)
09A1H	Pattern 3 step 1 step time	00:00 to 99:59	R / W		*3	16-5 (2)
09A2H	Pattern 3 step 1 step PID No.	0 to 3	R / W			16-5 (3)
09A4H	Pattern 3 step 2 step SV value	Within SV limiter	R / W			16-5 (1)
09A5H	Pattern 3 step 2 step time	00:00 to 99:59	R / W		*3	16-5 (2)
09A6H	Pattern 3 step 2 step PID No.	0 to 3	R / W			16-5 (3)
09A8H	Pattern 3 step 3 step SV value	Within SV limiter	R / W			16-5 (1)
09A9H	Pattern 3 step 3 step time	00:00 to 99:59	R / W		*3	16-5 (2)
09AAH	Pattern 3 step 3 step PID No.	0 to 3	R / W			16-5 (3)
09ACH	Pattern 3 step 4 step SV value	Within SV limiter	R / W			16-5 (1)
09ADH	Pattern 3 step 4 step time	00:00 to 99:59	R / W		*3	16-5 (2)
09AEH	Pattern 3 step 4 step PID No.	0 to 3	R / W			16-5 (3)
09B0H	Pattern 3 step 5 step SV value	Within SV limiter	R / W			16-5 (1)
09B1H	Pattern 3 step 5 step time	00:00 to 99:59	R / W		*3	16-5 (2)
09B2H	Pattern 3 step 5 step PID No.	0 to 3	R / W			16-5 (3)
09B4H	Pattern 3 step 6 step SV value	Within SV limiter	R / W			16-5 (1)
09B5H	Pattern 3 step 6 step time	00:00 to 99:59	R / W		*3	16-5 (2)
09B6H	Pattern 3 step 6 step PID No.	0 to 3	R / W			16-5 (3)
09B8H	Pattern 3 step 7 step SV value	Within SV limiter	R / W			16-5 (1)
09B9H	Pattern 3 step 7 step time	00:00 to 99:59	R / W		*3	16-5 (2)
09BAH	Pattern 3 step 7 step PID No.	0 to 3	R / W			16-5 (3)
09BCH	Pattern 3 step 8 step SV value	Within SV limiter	R / W			16-5 (1)
09BDH	Pattern 3 step 8 step time	00:00 to 99:59	R / W		*3	16-5 (2)
09BEH	Pattern 3 step 8 step PID No.	0 to 3	R / W			16-5 (3)
0A02H	Pattern 4 number of end steps	1 to 8	R / W			16-3 (6)
0A03H	Pattern 4 repeat execution count	1 to 10,000	R / W			16-3 (8)
0A04H	Pattern 4 start SV value	Within SV limiter	R / W			13-1
0A05H	Pattern 4 guaranteed soak band	0: OFF, 1 to 1,000 (digit)	R / W			18-4 (1)
0A07H	Pattern 4 start mode	0: SV 1: PV	R / W			16-3 (9)
0A09H	Pattern 4 alarm 1 level value	See the pattern event level value.	R / W			16-3 (7)
0A0AH	Pattern 4 alarm 2 level value		R / W			16-3 (7)
0A0BH	Pattern 4 alarm 3 level value		R / W		MODE2 / 4	16-3 (7)
0A0CH	Pattern 4 alarm 4 level value		R / W		MODE2 / 4	16-3 (7)

Address	Parameter name	Setting range	R / W	OP	Remarks	Section explaining function
0A20H	Pattern 4 step 1 step SV value	Within SV limiter	R / W			16-5 (1)
0A21H	Pattern 4 step 1 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0A22H	Pattern 4 step 1 step PID No.	0 to 3	R / W			16-5 (3)
0A24H	Pattern 4 step 2 step SV value	Within SV limiter	R / W			16-5 (1)
0A25H	Pattern 4 step 2 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0A26H	Pattern 4 step 2 step PID No.	0 to 3	R / W			16-5 (3)
0A28H	Pattern 4 step 3 step SV value	Within SV limiter	R / W			16-5 (1)
0A29H	Pattern 4 step 3 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0A2AH	Pattern 4 step 3 step PID No.	0 to 3	R / W			16-5 (3)
0A2CH	Pattern 4 step 4 step SV value	Within SV limiter	R / W			16-5 (1)
0A2DH	Pattern 4 step 4 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0A2EH	Pattern 4 step 4 step PID No.	0 to 3	R / W			16-5 (3)
0A30H	Pattern 4 step 5 step SV value	Within SV limiter	R / W			16-5 (1)
0A31H	Pattern 4 step 5 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0A32H	Pattern 4 step 5 step PID No.	0 to 3	R / W			16-5 (3)
0A34H	Pattern 4 step 6 step SV value	Within SV limiter	R / W			16-5 (1)
0A35H	Pattern 4 step 6 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0A36H	Pattern 4 step 6 step PID No.	0 to 3	R / W			16-5 (3)
0A38H	Pattern 4 step 7 step SV value	Within SV limiter	R / W			16-5 (1)
0A39H	Pattern 4 step 7 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0A3AH	Pattern 4 step 7 step PID No.	0 to 3	R / W			16-5 (3)
0A3CH	Pattern 4 step 8 step SV value	Within SV limiter	R / W			16-5 (1)
0A3DH	Pattern 4 step 8 step time	00:00 to 99:59	R / W		*3	16-5 (2)
0A3EH	Pattern 4 step 8 step PID No.	0 to 3	R / W			16-5 (3)

- Direct specification of an address other than a predefined address will result in an error. If multiple data read by a read command include any address other than a defined one, the return value will always be 0.

*1 If any measured value error data occurs MODBUS RTU
If PV is overscaled or if wire B is broken →→→→ (7FH FFH) will be returned.
If PV is underscaled, →→→→→→→→→→→→ (80H 00H) will be returned.

*2 Bit correspondence table

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Option info													PROG	OUT2	AOUT	DI
Action flag							AT / W	COM						STBY	MAN	AT
Event flag													EV4	EV3	EV2	EV1
DI input state flag											DI6	DI5	DI4	DI3	DI2	DI1
Event latch output flag															EV2	EV1
EV relay ON/OFF flag															EV2	EV1
EV direct															EV2	EV1
Latching alarm reset															EV2	EV1
Program action flag	PRG					UP	LVL	DW					ADV	GUA	HLD	RUN

*3 Special setting items

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Remaining time for execution step	0 to 9 * 10h (S)				0 to 9 * 1h (S)				0 to 5 * 10m (S)				0 to 9 * 10m (S)			
Latching/output characteristics	Alarm latching, 0x00: N/A, 0x01: Applicable								Output characteristics, 0x00: NO, 0x01: NC							

*4 Step information handling (See 12-2.)

• The step info of which pattern info is to be used may vary depending on the number of patterns.

Number of patterns	Pattern	Pattern info 1	Pattern info 2	Pattern info 3	Pattern info 4
		Step info 1 to 8	Step info 1 to 8	Step info 1 to 8	Step info 1 to 8
1	1	Steps 1 to 8	Steps 9 to 16	Steps 17 to 24	Steps 25 to 32
2	1	Steps 1 to 8	Steps 9 to 16		
	2			Steps 1 to 8	Steps 9 to 16
-					
4	1	Steps 1 to 8			
	2		Steps 1 to 8		
	3			Steps 1 to 8	
	4				Steps 1 to 8

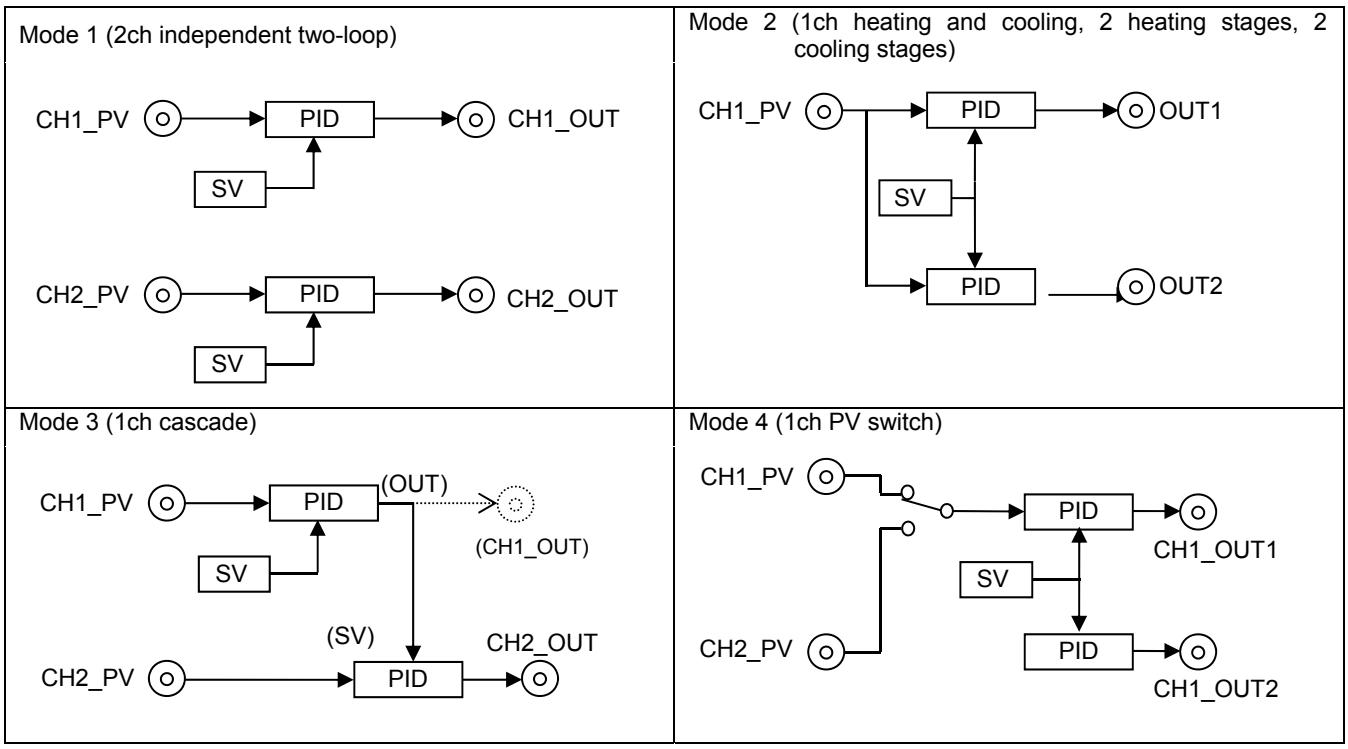
10. Configuration

10-1. System mode

This instrument is a basic independent two-loop temperature controller with 2 inputs and 2 outputs. The following configurations are available for selection at the time of order placement.

Mode 1: 2-input 2-output 2-channel, independent two-loop control
Mode 2: 1-input 2-output 1-channel heating and cooling, 2 heating stages, 2 cooling stages
Mode 3: 2-input 1-output 1-channel cascade control
Mode 4: 2-input 2-output 1-channel PV switchover control

* In Mode 4, assign CH1 to the minimum temperature measuring range.
* In Mode 4, the standard measuring range for the proportional band is the span from the CH1 lower limit value to the CH2 upper limit value.



Setting range: 0: 2in2Loop, 1: 1in1Loop, 2: 2in2LoopCas, 3: 2in1LoopSW
Relevant address: 070DH

11. Checks to be made for the master unit at first power-on

The basic display mode is selected at power-on.
When powering on this instrument for the first time, run a communication test for the instrument to make sure that it is the one that you ordered.

• Optional functions
Make sure that analog outputs, DIs (3 points × 2ch), and EVs (2 points × 2ch) are all provided.

Relevant address: 005FH

Details may vary depending on the specifications or the functional setting specifications.

12. Input and output settings

12-1. Measuring range settings

Set the control action to standby (STBY: ON) before performing this setting/editing operation.
For the details of the operation of the control standby function, see “Control standby (STBY).”

(1) Range setting

Refer to the measuring range code table to set the code No. for the RANGE.
When the current input ranges from 4 to 20 mA or from 0 to 20 mA, select RANGE No. 85 (1-5 V) or 84 (0-5 V) and fit a 250 ohm 0.1 % reception resistor between the input terminals.

Relevant address: 0705H

(2) Range scaling

When selecting a range for the voltage input and the current input (corresponding to code Nos. 71 to 76 and 81 to 86, respectively), set the measuring range (scaling). Sc_L is the PV lower limit side scaling, while Sc_H is the PV upper limit side scaling.
Set the control action to standby (STBY: ON) before performing this setting/editing operation.
For the details of the control standby action, see “Control standby (STBY).”
Inverse scaling is impossible.
The maximum span is (Sc_H − Sc_L) ≤ 10,000.
If the value Sc_L is set so that the span will exceed 10,000, the value Sc_H will, by default, be set so that 10,000 will not be exceeded.

Setting range: See the measuring range code table.
Initial value: 05, 86
Relevant addresses: 0707H, 0708H, 0709H

12-2. Manual setting of the control outputs

(1) AUTO/MAN output switching and setting of the control outputs (OUT1 and OUT2)

Perform AUTO/MAN and MAN/AUTO switching as follows:

(1) If either the OUT1 or OUT2 output action is switched to manual unless system mode 1 is selected, the other will also be switched similarly. Conversely, when either is switched to auto, the other will also be switched to AUTO.
(2) When the output is the SSR drive voltage or open collector, with the proportional band (P) set to OFF, the output value will be 0.0% or 100.0%.
(3) When the output is either voltage or current, with the proportional band (P) set to OFF, the output value will be the upper or lower limit value of the set output limiter.

[Note 1] During auto-tuning (AT), switching to manual output is impossible. Turn AT OFF beforehand.
[Note 2] When MAN is selected, the external control input (DI) takes priority, disabling switching to manual output.

1) Output 1 (OUT1) setting

Manual output setting range: 0 to 1,000 (0.0 to 100.0%)
Relevant address: 0182H

2) Output 2 (OUT2) setting
Valid unless system mode 1 is selected.

Manual output setting range: 0 to 1,000 (0.0 to 100.0%)
Relevant address: 0183H

(2) Supplementary note on the use of manual control output

The relationship between the automatic and manual output modes is as follows (when SHIMADEN-COM is used):
(1) When auto-manual switching is performed, the output will be balanceless-bumpless action. The output value will be the one immediately before the switching. When MAN/AUTO switching is performed, the output will be bumpless action. If the measured value (PV) is outside the proportional band, no bumpless action will occur.
(2) When the power is turned off and back on, the control output action will remain AUTO or MAN, unchanged from when the power is turned off.
(3) When the transition from RUN to STBY (RST) occurs, manual output (MAN) will be released.
• MAN operation is possible only in the RUN state.

12-3. Internal cascade control settings

These settings are for system mode 3.
Usually, two controller meters are used in a pair, with the output of one (master unit) being the SV value of the other (slave unit), to perform cascade control.

When system mode 3 is specified, a single unit can perform this cascade control. This function is called the internal cascade function. SV1 is the master while SV2 is the slave. OUT2 is the final control output.

(1) Cascade mode

A desired cascade mode can be selected.
When mode 2 or 3 is selected, the value of SV2 will be that of SV1 or PV1 with the cascade deviation value added, regardless of the master control output.

Setting range: 0: CAS1, 1: CAS2, 2: CAS3
Initial value: 0
Relevant address: 0328H

CAS1 : SV2 = (OUT1 / 100) × (SC_H2 – SC_L2) + SC_L2
CAS2 : SV2 = CAS DEV + SV1
CAS3 : SV2 = CAS DEV + PV1

(2) Cascade SV scaling

Set the SV scaling for the slave (SV2).
Set the SV range for the slave (SV2) within the control output range for the master (SV1). Use this when cascade 1 (CAS1) is selected.
Inverse scaling is impossible.

Setting range: CS_L : SV2_SC_L to CS_H-1
CS_H : CS_L to SV2_CS_H
Initial value: CS_L : SV2 measuring range lower limit value
CS_H : SV2 measuring range upper limit value
Relevant addresses: 0263H, 0264H, 0329H, 032AH

CS_L : Sets the slave SV lower limit value to the master output lower limit value.
CS_H : Sets the slave SV upper limit value to the master output upper limit value.

(3) Cascade deviation

This is used when cascade 2 (CAS2) or cascade 3 (CAS3) is selected.

Setting range: -2,000 to 2,000 (digit)
Initial value: 0
Relevant address: 032BH

(4) Cascade SV filter

Set a filter for using the master (SV1) control output as the slave (SV2) SV.
A control output is constantly variable. When it is directly entered into the slave and used as an SV, unstable control may result. In such a case, use a filter to stabilize the slave SV.

Setting range: 0: OFF, 1 to 100 (seconds)
Initial value: OFF
Relevant address: 032CH

12-4. Unit setting

Select the unit to be used in the set measuring range. Set the control action to standby (STBY: ON) before performing this setting/editing operation. For the details of the control standby action, see “Control standby (STBY).”

Setting range: 0:°C, 1: ･
Initial value: 0
Relevant addresses: 0260H, 0704H

* Fixed to 2:K when the measuring range code is between 15 and 18 (Kelvin units).

12-5. Decimal point setting

When the measuring range is for the voltage input and the current input (corresponding to code No. 71 to 76 and 81 to 86, respectively), set the decimal point position in the PV indication screen.
Set the control action to standby (STBY: ON) before performing this setting/editing operation. For the details of the control standby action, see “Control standby (STBY).”

Setting range: 0: (0), 1: (0.0), 2: (0.00), 3: (0.000)
Initial value: 0
Relevant addresses: 0262H, 0707H

※ This instrument has no digital indicator on it. In practice, remotely control the decimal point position on the host side.

12-6. Measuring range code table

Select the measuring range from the following table:

<Caution> When any change is made to this code, all data related to the measuring range will be initialized. Settings can only be changed while in the STANDBY state.

Input type			CODE		Measuring range (°C)	Measuring range (·)
Multi-input	Thermocouple	B	01 *1	G0	0 to 1,800 °C	0 to 3,300 ·
		R	02	G1	0 to 1,700 °C	0 to 3,100 ·
		S	03	G0	0 to 1,700 °C	0 to 3,100 ·
		K	04 *2	G0	-200.0 to 400.0 °C	-300 to 750 ·
			05	G1	0.0 to 800.0 °C	0 to 1,500 ·
			06	G1	0 to 1,200 °C	0 to 2,200 ·
		E	07	G1	0 to 700 °C	0 to 1,300 ·
		J	08	G1	0 to 600 °C	0 to 1,100 ·
		T	09 *2	G0	-200.0 to 200.0 °C	-300 to 400 ·
		N	10	G1	0 to 1,300 °C	0 to 2,300 ·
		PLII *3	11	G1	0 to 1,300 °C	0 to 2,300 ·
		C(WRe5-26) *4	12	G1	0 to 2,300 °C	0 to 4,200 ·
		U *5	13 *2	G1	-200.0 to 200.0 °C	-300 to 400 ·
		L *5	14	G1	0 to 600 °C	0 to 1,100 ·
	Kelvin	K	15	G0	10.0 to 350.0 K	10.0 to 350.0 K
		AuFe-Cr	16	G0	0.0 to 350.0 K	0.0 to 350.0 K
		K	17	G0	10 to 350 K	10 to 350 K
		AuFe-Cr	18	G0	0 to 350 K	0 to 350 K
	Resistance thermometer detector	Pt100	30	G1	-100.0 to 350.0 °C	-150.0 to 650.0 ·
			31	G2	-200 to 600 °C	-300 to 1,100 ·
			32	G1	-100.0 to 100.0 °C	-150.0 to 200.0 ·
			33	G1	- 50.0 to 50.0 °C	- 50.0 to 120.0 ·
			34	G1	0.0 to 200.0 °C	0.0 to 400.0 ·
		JPt100	35	G2	-200 to 500 °C	-300 to 1,000 ·
			36	G1	-100.0 to 100.0 °C	-150.0 to 200.0 ·
			37	G1	- 50.0 to 50.0 °C	- 50.0 to 120.0 ·
			38	G1	0.0 to 200.0 °C	0.0 to 400.0 ·
			39	G1	-100.0 to 350.0 °C	-150.0 to 650.0 ·
		Pt100	40	G2	-200.0 to 550.0 °C	-300 to 1,000 ·
			41	G1	0.0 to 350.0 °C	0.0 to 650.0 ·
			42	G2	0.0 to 550.0 °C	0 to 1,000 ·
		JPt100	45	G2	-200.0 to 500.0 °C	-300 to 1,000 ·
			46	G1	0.0 to 350.0 °C	0.0 to 650.0 ·
			47	G2	0.0 to 500.0 °C	0 to 1,000 ·
	mV	-10 to 10mV	71	G0	Initial value : 0.0 to 100.0 Input scaling setting range: -2,000 to 10,000 Span: 10 to 10,000 digit Decimal point position: none, 1st to 3rd decimal places Lower limit value < upper limit value <Caution> If the lower limit value is set to differ from the upper limit value by less than +10 digit or more than +10,000 digit, the upper limit value will default to differ from the lower limit value by +10 or +10,000 digit The upper limit value cannot be set below the lower limit value + 10 digit or above the lower limit value + 10,000 digit. For current input, select a voltage input and fit the specified receiving resistor (250Ω) to the input terminal for use as per code 84 (0 to 20 mA) or 85 (4 to 20 mA).	
		0 to 10mV	72	G0		
		0 to 20mV	73	G1		
		0 to 50mV	74	G1		
		10 to 50mV	75	G1		
		0 to 100mV	76	G2		
Voltage	V	-1 to 1V	81	G0		
		0 to 1V	82	G0		
		0 to 2V	83	G1		
		0 to 5V	84	G1		
		1 to 5V	85	G1		
		0 to 10V	86	G2		

Thermocouple (TC) B, R, S, K, E, J, T, N: JIS/IEC RTD Pt100: JIS/IEC JPt100

*1 TC B: accuracy not guaranteed for 400°C (752°F) or less. *2 If TC K, T, or U reads -100°C or less, the accuracy is ±0.7%FS.

*3 TC PLII: Platinel II *4 TC WRe5-26: ASTM E988-96 *5 TC U or L: DIN 43710

*6 High-accuracy temp. range of TC K (Kelvin) *7 High-accuracy temp. range of TC gold/iron-chromel [AuFe-Cr] (Kelvin)

10.0 to 30.0 K	±(2.0%FS + (CJ error × 20) K + 1K)	0.0 to 30.0 K	±(0.7%FS + (CJ error × 3) K + 1K)
30.0 to 70.0 K	±(1.0%FS + (CJ error × 7) K + 1K)	30.0 to 70.0 K	±(0.5%FS + (CJ error ×1.5) K + 1K)
70.0 to 170.0 K	±(0.7%FS + (CJ error × 3) K + 1K)	70.0 to 170.0 K	±(0.3%FS + (CJ error × 1.2)K + 1K)
170.0 to 270.0 K	±(0.5%FS + (CJ error ×1.5) K + 1K)	170.0 to 280.0 K	±(0.3%FS + (CJ error × 1) K + 1K)
270.0 to 350.0 K	±(0.3%FS + (CJ error × 1) K + 1K)	280.0 to 350.0 K	±(0.5%FS + (CJ error × 1) K + 1K)

[Note] Do not use the above sensors (current sensors, voltage sensors, thermocouples, RTDs) for power-line measurements.

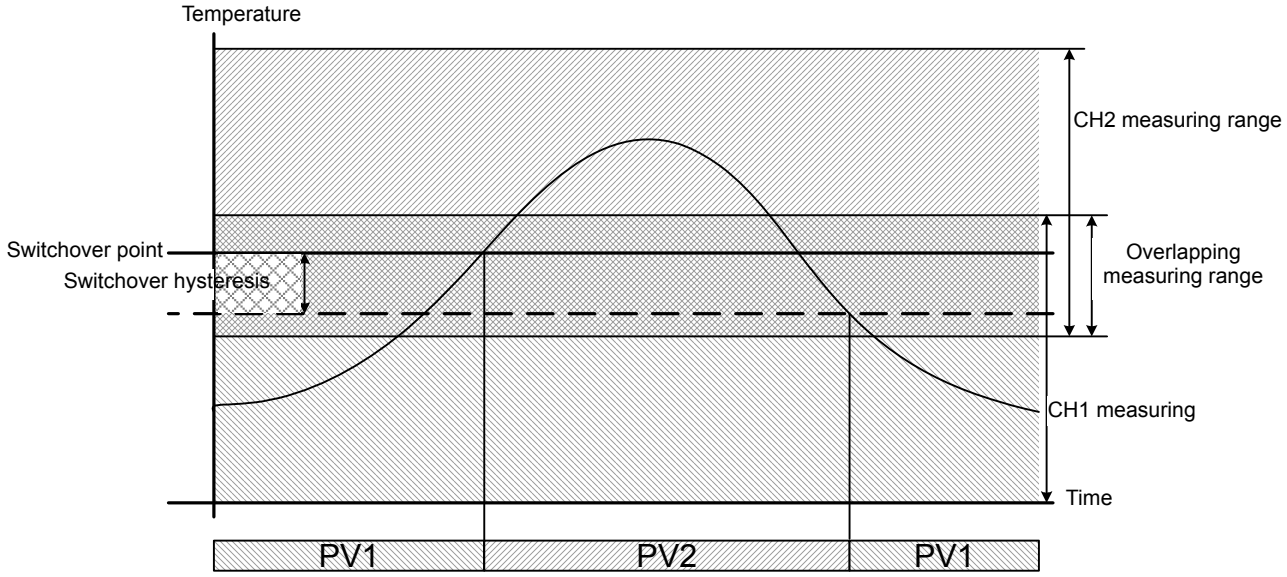
[Note] If unspecified, the instrument is factory-set to the following measuring ranges:

Input	Spec/rating	Measuring range
Multi-input	K thermocouple	0.0 to 800.0°C
Voltage (V)	0 to 10 V DC	0.0 to 100.0 (unitless)

12-7. Switchover control

(1) Principle of operation

Switchover control is a control method that handles the measuring ranges assigned respectively to CH1 and CH2 as a single range to cover a wider measuring range.



(2) Limitations on switchover control

There are the following limitations on the use of switchover control:

(1) Specify the lower measuring range for CH1 and the higher measuring range for CH2.
(2) The decimal point position and the input unit are the same for both CH1 and CH2. (Neither the CH2 decimal point position nor the CH2 input unit can be changed.)
(3) The CH1 and CH2 measuring ranges must share an overlapping part.
(4) When the measuring range and the input unit for CH1 are changed, the same settings will, by default, apply to CH2.
(5) If the decimal point is hidden in a CH1 range other than the linear ranges (mV or V input), CH2 can only be switched to either linear range (mV or V input).
(6) If either CH exceeds the full scale range, switching between PV1 and PV2 will not occur.

Relevant addresses: 0730H, 0731H, 0733H, 0734H, 0735H

(3) Switchover point

Set the temperature at which CH1 switches over to CH2 for the PV in a temperature rising process. (Set this value within the overlapping part of the CH1 and CH2 measuring ranges.)

Setting range:	CH2 PV lower limit value to CH1 PV upper limit value
Initial value:	Midpoint of the overlap between CH1 and CH2 measuring ranges
Relevant address:	0331H

(4) Switchover hysteresis

Based on the value subtracted from the switchover point, specify the temperature at which CH1 switches over to CH2 for the PV in a temperature dropping process. (Set this value within the range of 0 to 1,000 digit.)

Setting range:	0 to 1,000 (digit)
Initial value:	20
Relevant address:	0332H

12-8. Auxiliary input and output settings

(1) PV correction value settings

1) PV bias

This is used to correct errors in sensor- or instrument-temperature readings.

Setting range:	-2,000 to 2,000 (digit)
Initial value:	0
Relevant address:	0701H

2) PV filter

If a PV signal contains noise, the control results may be affected by factors such as the drift of the PV signal. Use a PV filter to reduce such adverse effects and ensure stable control.

Setting range:	0 to 1,000 (seconds)
Initial value:	0
Relevant address:	0702H

PV filtering is performed by first-order lag calculation.
A greater time constant will improve the noise filtering performance but may cause negative effects in rapid response control systems.

3) Gain correction value setting

This is used to correct input gain errors of sensors, etc.
After gain correction, the corrected value will be used for control.

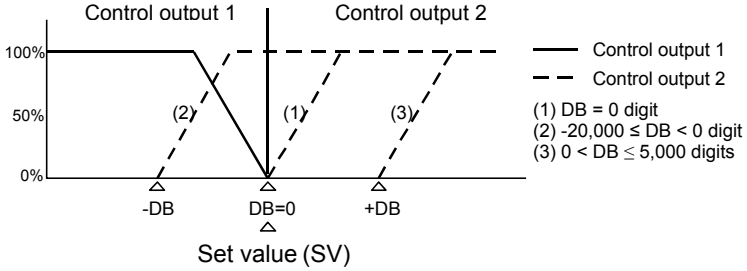
Setting range:	-500 to 500 (-5.00 to 5.00%)
Initial value:	0 (0.00%)
Relevant address:	0700H

12-9. Control output settings

(1) Control output characteristics

In system mode 2, the control output characteristics of output 1 can be set independently from those of output 2 and vice versa. Set the characteristics of heating action to RA (reverse action) and those of cooling action to DA (direct action).

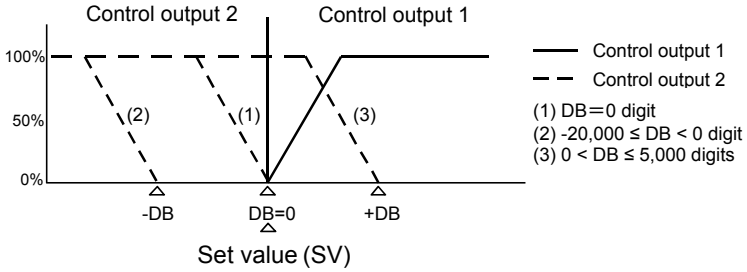
■ Control output 1: RA Control output 2: DA (RA + DA)



Set value (SV)

Low ← Measured value (PV) → High

■ Control output 1: DA Control output 2: RA (RA + DA)



Set value (SV)

Low ← Measured value (PV) → High

(2) Output action characteristics

Select the output characteristics from inverse and direct characteristics:

Setting range:	0: RA, 1: DA
Initial value:	0
Relevant addresses:	0600H, 0607H

RA : An action that generates a greater output as the measured value (PV) becomes smaller than the set value (SV). This is generally used for heating control.

DA : An action that generates a greater output as the measured value (PV) becomes larger than the set value (SV). This is generally used for cooling control.

[Note] During auto-tuning (AT), output characteristics switching is impossible.

(3) Output proportional cycle

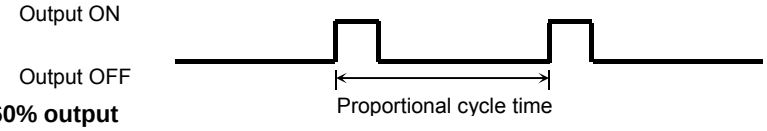
This parameter can only be set for an open collector output (C) or an SSR drive output (P).
Set the output ON-OFF cycle time in seconds.
When this proportional cycle time is set short in a rapid response control system, good control results will result.

Setting range:	1 to 120 (seconds)
Initial value:	SSR: 30 / Open collector: 3
Relevant addresses:	0601H, 0604H

[Note] When a proportional cycle time is set long in a control system with a short delay time, the control results may be affected.
Proportional cycle time setting is impossible during auto-tuning (AT) and during slope control.

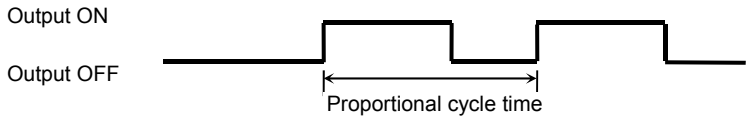
The following figures show typical proportional cycle time-control output relationships. (The following figures show typical cases of heating action.)

(1) 20% output



A time equivalent to 20 % of a proportional cycle time is generated as an ON output, while a time equivalent to the remaining 80 % is generated as an OFF output.

(2) 60% output



A time equivalent to 60 % of a proportional cycle time is generated as an ON output, while a time equivalent to the remaining 40 % is generated as an OFF output.

(4) About soft start

At power-ON, standby OFF, or normal recovery from overrange, this function gradually increases a control output within a set time and can effectively prevent overcurrent to a load such as a heater.

1) Conditions for soft start to function
(1) Power-ON, standby OFF, or normal recovery from overrange in automatic output mode.
(2) P (proportional band) is set to a value other than OFF in “Proportional band setting.”
(3) The soft start time is not set to OFF in “Soft start time setting.”

2) Conditions for soft start to be turned off
(1) The normal soft start time has elapsed.
(2) The soft start output value exceeds the value of the PID calculation output.
(3) The soft start time setting is changed to OFF.
(4) The output mode is changed to MAN.
(5) AT (auto-tuning) is executed.
(6) The P (proportional band) setting is changed to OFF.
(7) One control output characteristic is changed.
(8) A standby state has occurred.

3) Control output soft start time setting
Set the soft start time for a gradual change in the output.
When set to OFF, the soft start function is disabled.

Setting range:	0: OFF, 1 to 120 (seconds)
Initial value:	0
Relevant addresses:	060AH, 060BH

(5) Upper and lower limiter settings

(1) The output limiter is a function that limits the minimum or maximum value of a control output and is effective in, among other things, securing the minimum temperature or preventing control overshoot.

(2) As for the output limiter settings, the lower limit value takes priority. When the lower limit value is set equal to or above the upper limit value, the upper limit value will default to exceed the lower limit value by +1 %. The upper limit value cannot be set to exceed the lower limit value by less than +1 %.

(6) Differential gap mode

Set the differential gap mode for an ON/OFF action selected.
Note that the set mode will be reflected in all of OUT1, OUT2, and PID1 to 3.

Setting range:	0: CENTER, 1: SV_OFF
Initial value:	0
Relevant address:	04DFH

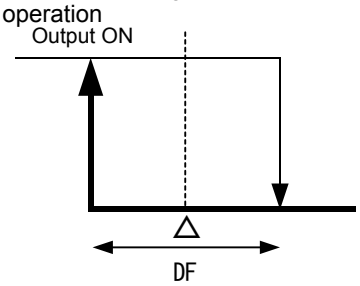
CENTER : A mode that uses the center position in the differential gap as the SV value.
SV_OFF : A mode that uses the differential-gap output OFF position as the SV value.

(7) Two-position action

When performing a two-position action, use the differential gap to prevent frequent on/off of the output.

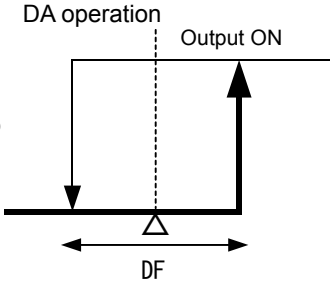
(1) When the differential gap mode is CENTER

RA operation



△: SV value
DF: differential gap

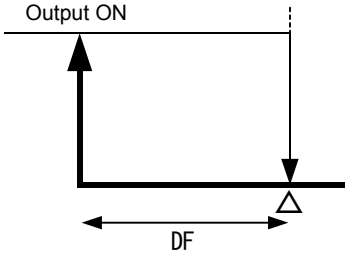
DA operation



△:SV value
DF: differential gap

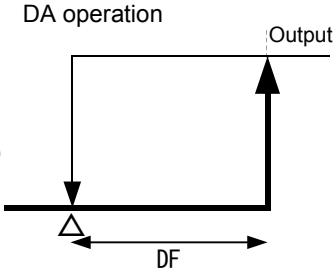
(2) When the differential gap mode is SV_OFF

RA operation



△: SV value
DF: differential gap

DA operation



△:SV value
DF: differential gap

13. SV value settings

13-1. SV value settings

(1) SV limiter

The SV limiter is used to prevent inputs of incorrect target set values.
Set the lower limit (SV L) and upper limit (SV H) for the set-value (SV value) setting range.

Setting range:	Lower limit value: Measuring range lower limit value to measuring range upper limit value - 1 Upper limit value: Measuring range lower limit value + 1 to measuring range upper limit value Note that SV Limit_L < SV Limit_H.
Initial value:	Lower limit value: Measuring range lower limit value Upper limit value: Measuring range upper limit value
Relevant addresses:	030AH, 030BH

The SV limiter set here is valid for any Execution SV.
Any Execution SV is limited by the SV limiter value.

[Note] When any change is made to the SV limiter after SV value setting, SV values falling outside the limiter range may be discarded, invalidating the settings.
To prevent such a state, always perform SV limiter setting before SV value setting.

(2) Start SV

Set the SV value that starts the program.
This value will be the same as the SV limiter value if the SV limiter range is exceeded due to any change made to the SV limiter.

Setting range:	Within SV limiter
Initial value:	0
Relevant addresses:	0884H, 0904H, 0984H, 0A04H

(3) End step

Set the number of steps for use in program patterns.
The maximum number of steps may vary depending on the number of patterns.
If the number of steps is reduced to smaller than the number of the step currently being executed, the program will end or loop back to the first step when the currently executed step ends.

Setting range:	1 to 32
Initial value:	8
Relevant addresses:	0882H, 0902H, 0982H, 0A02H

# of patterns	Max. # of steps
1	32
2	16
4	8

(4) Start mode

Set the program start mode.
When the program start mode is set to SV, the program will start from the start SV value. When the mode is set to PV, the PV start function will become active and eliminate dead time, depending on the conditions.

Setting range:	0: SV, 1: PV
Initial value:	0
Relevant addresses:	0887H, 0907H

14. PID settings

14-1. Proportional band (P) setting

A proportional band is a range in which the amount of control output changes proportionally to the difference (deviation) between a measured value (PV) and a set value (SV). For the purpose here, set the rate of change (%) in control output with respect to the measuring range.

With a wide proportional band, the change in control output will be small relative to the deviation while the offset (steady-state deviation) will be large. With a narrow proportional band, the change in control output will be large while the offset will be small. Note that, with too narrow a proportional band, hunting (vibration) will occur, making the action similar to an ON-OFF control action. When P is set to OFF, the action will be an ON-OFF control action and unable to be auto-tuned.

Setting range:	0: OFF, 1 to 10,000 (0.1 to 1,000.0%)
Initial value:	30 (3.0)
Relevant addresses:	0400H, 0408H, 0410H, 0460H, 0468H, 0470H

14-2. Integral time (I) setting

Integral action is an operation used to correct the offset (steady-state deviation) caused by proportional action.
With a long integral time, integral action will have a weak corrective effect and take a long time to correct the offset.
The shorter the integral time is, the stronger corrective effect integral action has. Too short an integral time will cause hunting (vibration), making the action similar to an ON-OFF control action.

Setting range:	0: OFF, 1 to 6,000 (seconds)
Initial value:	120
Relevant addresses:	0401H, 0409H, 0411H, 0461H, 0469H, 0471H

If auto-tuning is performed with I = OFF, the manual reset (MR) value will be calculated and auto-set.
For MR auto-setting, see “Setting the manual reset (MR).”

14-3. Derivative time (D) setting

Derivative action is an operation that predicts the change in control output to reduce the influence of external disturbances, as well as to reduce overshoot caused by integration in order to improve control stability.
The shorter/longer the derivative time is, the weaker/stronger effect derivative action has. With too long a derivative time, hunting (vibration) will occur, making the action similar to an ON-OFF control action.

Setting range:	0: OFF, 1 to 3,600 (seconds)
Initial value:	30
Relevant addresses:	0402H, 040AH, 0412H, 0462H, 046AH, 0472H

During auto-tuning with D = OFF, calculations will be performed using PI (proportional-integral) values only.

14-4. Manual reset (MR) setting

In PID action, offsets are automatically corrected by integration (I). With I set to OFF, however, offsets will not be corrected. In this case, offsets need to be manually increased or decreased for correction. This method is called manual reset.
This is a manual function used to correct offsets that occur when P or P+D control action is performed with I (integral time) set to OFF. Set the value to the positive (+) or negative (-) side to shift the control result in the positive (+) or negative (-) direction. The amount of shift is proportional to the size of the numerical value.

Setting range:	-500 to 500 (-50.0 to 50.0%)
Initial value:	1 output: 0 2 outputs: -500
Relevant addresses:	0403H, 040BH, 0413H

■ Auto-setting the MR

When auto-tuning is performed, a value corresponding to this manual reset (MR) value will be calculated and auto-set. In PID control, the MR value is used as the target load factor for the initial PID calculation. Accordingly, when required to reduce overshoot at power-ON or at STBY ON/OFF, set a small MR value to reduce the target load factor.
When auto-tuning is performed by PID control in this instrument, load factor calculation is performed to reduce the offset with no I action and to auto-set an MR-value equivalent. This function allows the user to obtain control results better than those achievable with conventional PID control.

14-5. Set point function (SF) setting

This function determines the effect of the overshoot prevention function for expert PID calculation.
Expert PID predicts the amount of change in the PV value up to the target set value (SV) (or proportional band), predicts the amount of overshoot based on the PID value, etc., and then performs calculations to cancel the predicted amount of overshoot and reduce the actual amount of overshoot.
A set point function (SF) is valid only when integral action (PI or PID action) is present.

Setting range:	0: OFF, 1 to 100 (0.01 to 1.00)
Initial value:	40 (0.40)
Relevant addresses:	0407H, 040FH, 0417H, 0467H, 046FH, 0477H

SF = OFF: Expert PID will be disabled and ordinary PID action will be performed.
SF =100 (1.00): Overshoot will be minimized in expert PID control.
SF→Low: The overshoot prevention function has a weak effect.
SF→High: The overshoot prevention function has a strong effect.

14-6. Differential gap (DF) setting

This is an item for setting the differential gap (DF) for an ON-OFF control action with P set to OFF.
When a narrow differential gap is set, output chattering is likely to occur.
When a wide differential gap is set, a stable, chattering-free control action will result. The response time, however, may become longer.

Setting range:	1 to 10,000 (digit)
Initial value:	20
Relevant addresses:	0404H, 040CH, 0414H, 0464H, 046CH, 0474H

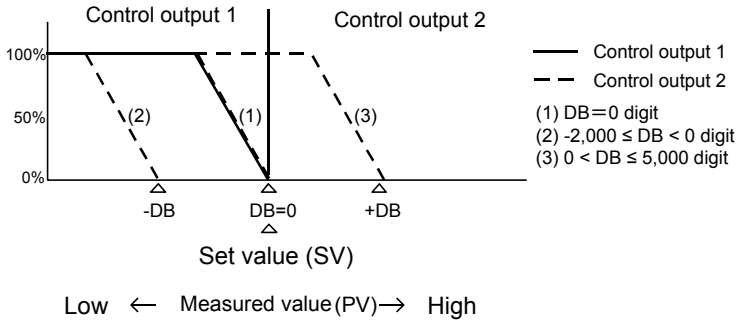
14-7. Dead band (DB) setting

This parameter setting is required only when the instrument is configured for two outputs.
Set the operating range of output 2 (OUT2), taking into account the characteristics and energy efficiency of the controlled system.

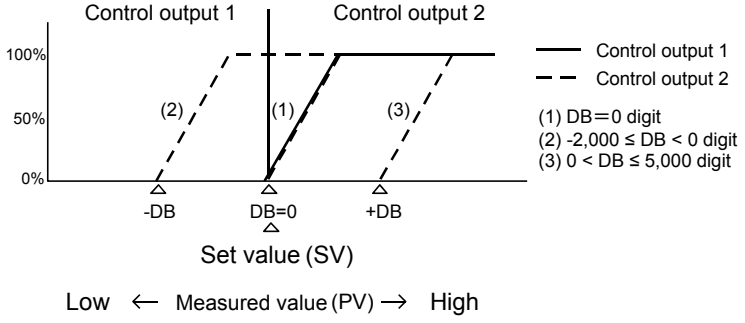
Setting range:	-2,000 to 5,000 (digit)
Initial value:	0
Relevant addresses:	0463H, 046BH, 0473H

The output action-DB relationship is as shown in the following figures:
RA: Reverse Action DA: Direct Action

■ Control Output 1: RA Control Output 2: RA (RA + RA)



■ Control Output 1: DA Control Output 2: DA (DA + DA)



14-8. Output limit value settings (OUT1L and OUT2H)

Set the upper and lower limits for the control output value corresponding to the PID No. The initial values of these parameters should be used for ordinary control. Their values should be changed when the controlled system requires high accuracy control.

When the instrument is configured for use with a heating system and is slow in recovery from upward overshoot, set a lower value for the upper limit. If the controlled system is slow in temperature rise and immediately starts to decrease in temperature when its output is turned down, set a higher value for the lower limit.

Setting range:	Lower limit value: 0 to 999 (0.0 to 99.9%) Upper limit value: Lower limit value +1 to 1,000 (Lower limit value +1 to 100.0%)
Initial value:	Lower limit value: 0 (0.0) Upper limit value: 1,000 (100.0)
Relevant addresses:	0405H, 0406H, 040DH, 040EH, 0415H, 0416H, 0465H, 0466H, 046DH, 046EH, 0475H, 0476H

[Note] When P is set to OFF for ON-OFF control, the output limiter will be invalid for SSR drive voltage output or for open collector output.

15. Event (EV) settings

15-1. Event (EV) action

When the type of any assigned EV is changed, the action set point (SP) and differential gap (DF) parameters will be initialized.

Setting range: See the event (EV) assignment table.
Initial value: 1 (EV1)
2 (EV2)
Relevant addresses: 0500H, 0508H, 0510H, 0518H

■ Event (EV) assignment table

Val	Event action mode type	Remarks
0	None selected	
1	Upper limit deviation (HD)	EV1 initial value
2	Lower limit deviation (LD)	EV2 initial value
3	Outside upper/lower limit deviation (OD)	
4	Within upper/lower limit deviation (ID)	
5	Upper limit absolute value (HA)	
6	Lower limit absolute value (LA)	
7	Overrange (SO)	
8	RUN signal (during execution)	This signal occurs during control operation.
9	Output 1 inverted output (ROT1)	Applicable only to open collector
10	COM direct (COM)	
11	Step signal (STPS)	This signal lasts for one second each time a step ends during program control.
12	Pattern signal (PTNS)	This signal lasts for one second each time a pattern ends during program control.
13	Program end signal (ENDS)	This signal lasts for one second when program control ends. (This signal also occurs when the program is aborted in the middle.)
14	Hold signal (HOLD)	This signal occurs when a hold (a pause of the program) occurs during program control.
15	Program signal (PROG)	This signal occurs when the instrument is set to the program mode.
16	Up-slope signal (U_SL)	This signal occurs during an upward slope step performed by program control.
17	Down-slope signal (D_SL)	This signal occurs during a downward slope step performed by program control.
18	Guaranteed soak (GUA)	This signal occurs when guaranteed soak is enabled.

(1) Event action point setting

The event action point setting is displayed when an alarm is assigned to an event code. This setting sets the event action point at which the program comes into action.

Setting range: See the event level value table.
Initial value: EV1: 2,000
EV2: -2,000
Relevant addresses: 0501H, 0509H, 0511H, 0519H

The event action point setting is disabled when no alarm is assigned.

■ Event level values

Alarm type	Setting range	Initial value
Upper limit absolute value	Within measuring range	Measuring range upper limit value
Lower limit absolute value	Within measuring range	Measuring range lower limit value
Upper limit deviation	-2,000 to 2,000	2,000
Lower limit deviation	-2,000 to 2,000	-2,000
Within upper/lower limit deviation	0 to 2,000	2,000
Outside upper/lower limit deviation	0 to 2,000	2,000

(2) Differential gap setting

The differential gap setting is displayed when one of types (1) through (6) is selected in the event action mode.

Set the differential gap (DF) between ON and OFF actions.
When a wide differential gap is set, a stable, chattering-free control action will result.

Setting range: 1 to 1,000 (digit)
Initial value: 20
Relevant addresses: 0502H, 050AH, 0512H, 051AH

(3) Event standby action selection

Standby action is an item displayed only when one of types (1) to (6) is selected in the EV action mode.
Standby action is a function that does not generate an EV output with the PV value falling in the event action range at power-on, at STBY OFF, or at an SV change but generates an EV output when the PV value falls back in the event action range after falling outside the range.
Taking into account the standby action and the event action during overrange, select one of the following:

Setting range: 0 to 3
Initial value: 0
Relevant addresses: 0503H, 050BH, 0513H, 051BH

■ Standby action code table

CODE	Specifics of standby action
0	No standby
1	Power-ON and STBY(RST) → RUN
2	Power-ON, STBY(RST) → RUN, and SV change
3	Control mode (no standby)

[Note 1] When the setting is changed to 0 during the standby action, the standby action will be immediately cancelled.

[Note 2] Standby action will be cancelled when overrange occurs.

1) Standby action
When event standby action is set to 1 (or 2), no event will be generated with the measured value falling within the alarm action range (ON range) at power-ON or at standby OFF (or at a change of the target set value).
An event will be generated when the measured value falls back in the alarm action range after it falls outside the range (OFF range) and the standby action is cancelled.

2) Non-standby actions
An event will always be generated if the measured value falls within the alarm action range with event standby action set to 0.

(4) Latching setting

The event latching function is used to repetitively generate a type of event even when the event condition is lost after the event is activated. (Self-holding of an event)
This function is enabled when the alarm type code is one of **types (1) to (6).**

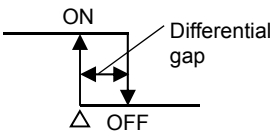
Setting range: 0: OFF, 1: ON
Initial value: 0
Relevant addresses: 0505H, 050DH, 0515H, 051DH

OFF : Latching function disabled
ON : Latching function enabled

(5) Output characteristics selection

Specify the output characteristics.
Select whether the transistor open collector output is in or out of conduction at the occurrence of an event action.
Whether NO or NC is selected, the event output at power-OFF will be out of conduction.

E.g.) PV-Low case



Setting range: 0: NO, 1: NC.
Initial value: 0
Relevant addresses: 0505H, 050DH, 0515H, 051DH

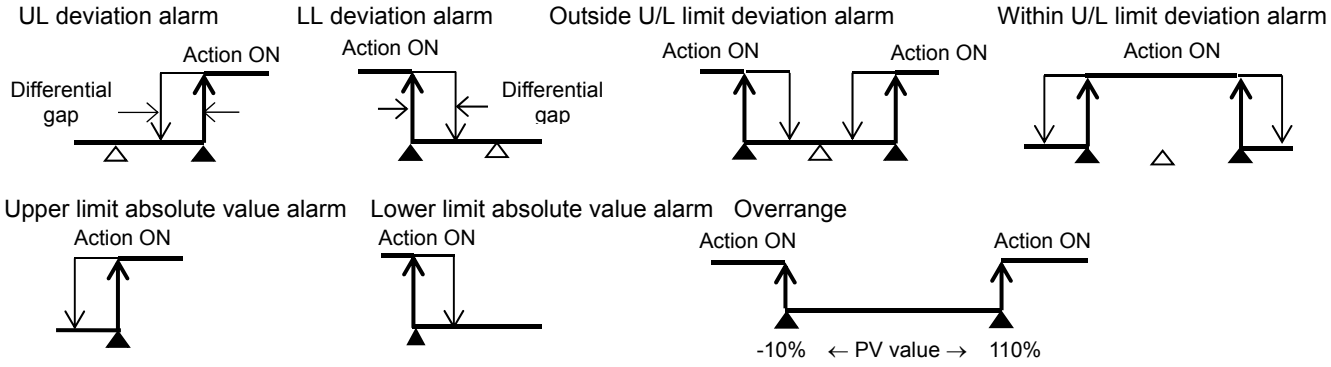
Normally open (NO): The transistor is turned ON when the EV is ON.
Normally close (NC): The transistor is turned OFF when the EV is ON.

(6) Operational diagrams of event selection alarm

Shown below are the operational diagrams of the alarms to be selected as events (EV1 and EV2):

△: SV value

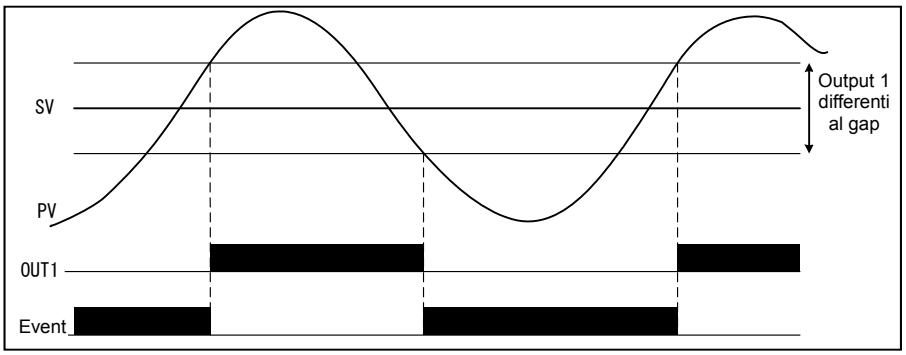
▲: Alarm action point set value



(7) About inverted output from OUT1

When an open collector output is built in as OUT1, select OUT1 inverted output as the event code to invert the output from OUT1. Note, however, that both output 1 and the event output will be OFF at power-OFF.

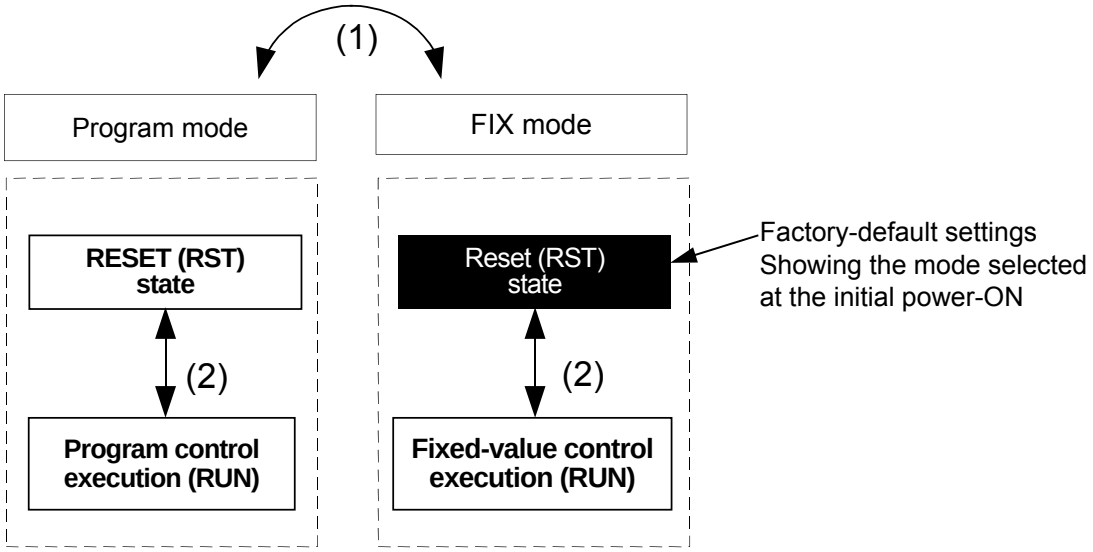
It should also be noted that the output from OUT1 is similarly inverted during standby.



16. Control mode and program

16-1. Control mode

This instrument can perform fixed value control in addition to program control, which is the main mode of control.
The “program mode” is used for program control, while the “FIX mode” is used for fixed value control. The following figure shows the relationship between the two modes and their switching operations:



Set the FIX mode to ON or OFF to toggle between the two modes. Select ON to select the FIX mode (fixed value control) and OFF to select the program mode.

16-2. RESET state

During the RESET state in both the program mode and the FIX mode, no control will occur.
If any of the action modes in the following table is assigned to the event/DO, no output will occur during the RESET state:

■ Events/DO action modes with no outputs generated in reset state

Type	Action
1	Upper limit deviation action
2	Lower limit deviation action
3	Outside upper/lower limit deviation action

Type	Action
4	Within upper/lower limit deviation action
5	PV upper limit absolute value action
6	PV lower limit absolute value action

16-3. Preparations for using the program function

Before using the program function, set the following parameters first:

(1) Start pattern No.

Specify the ordinal number of the pattern to be used.

Setting range: 1 to number of patterns (4 max.)
Initial value: 1
Relevant address: 0802H

In a DI-equipped configuration, the DI function is used to specify the start pattern No.
If assigned to a DI, this function cannot be operated remotely.

* While the program is running, no change can be made to the settings.

(2) Number of patterns

Specify the number of patterns to be used.
Note that the total number of available steps is fixed to 32 steps. The number of steps available per pattern may vary depending on the specified number of patterns.

Setting range: 0: 1, 1: 2, 2: 4
Initial value: 4
Relevant address: 0818H

Number of patterns	Pattern No.	Number of steps	Total number of steps
1	1	1 to 32	32
2	1	1 to 16	32
	2	1 to 16	
4	1	1 to 8	32
	2	1 to 8	
	3	1 to 8	
	4	1 to 8	

* While the program is running, no change can be made to the settings.
It should be noted that if any change is made to the settings, program-related parameters will be initialized.

(3) Time unit

Use the program time unit for setting.

Setting range: 0: HM, 1: MS
Initial value: 0
Relevant address: 0819H

Set the step time unit as the time unit.
The time may be indicated differently depending on the relevant steps (up to the end step).

Time unit	Time	Setting range
HM (0)	Hr, min	00 hr 00 min to 99 hr 59 min
MS (1)	Min, sec	00 min 00 sec to 99 min 59 sec

* While the program is running, no change can be made to the settings.

(4) Switching to the program function

When required to switch to the program mode, short-circuit the DI to which the program function is assigned. Release to switch to the FIX mode.
The program signal will continue to occur as long as the program mode is selected. Note that a one-second program end signal will occur when program execution ends.

Select the desired mode by toggling ON / OFF of FIX control.

Setting range: 0: ON, 1: OFF
Initial value: 0
Relevant address: 0800H

Set FIX to OFF to switch to the program function.
If PROG is assigned to the DI, it is impossible to switch between PROG and FIX.
When FIX is switched to PROG or vice versa, the RUN or STANDBY state will remain unchanged.

(5) Setting the start SV

Set the SV value that starts the program.
This value will be the same as the SV limiter value if the SV limiter range is exceeded due to any change made to the SV limiter.

Setting range: Within SV limiter
Initial value: 0
Relevant addresses: 0884H, 0904H, 0984H, 0A04H

(6) End step setting

Set the number of steps for use in program patterns.

Setting range: 1 to 32
Initial value: 8
Relevant addresses: 0882H, 0902H, 0982H, 0A02H

The maximum number of steps may vary depending on the number of patterns.

Number of patterns	Max. number of steps
1	32
2	16
4	8

If the number of steps is reduced to smaller than the number of the step currently being executed, the program will end or loop back to the first step when the currently executed step ends.

(7) Pattern event action point setting

The pattern event action point setting is displayed when an alarm is assigned to an event code. This setting sets the event action point at which the program comes into action.

Setting range: See the pattern event level value table.
Initial value: EV1: 2,000
EV2: -2,000
Relevant addresses: 0889H, 088AH, 088BH, 088CH, 0909H, 090AH, 090BH, 090CH, 0989H, 098AH, 098BH, 098CH, 0A09H, 0A0AH, 0A0BH, 0A0CH

The pattern event action point setting is disabled when no alarm is assigned.

■ Pattern event level values

Alarm type	Setting range	Initial value
Upper limit absolute value	Within measuring range	Measuring range upper limit value
Lower limit absolute value	Within measuring range	Measuring range lower limit value
Upper limit deviation	-2,000 to 2,000	2,000
Lower limit deviation	-2,000 to 2,000	-2,000
Within upper/lower limit deviation	0 to 2,000	2,000
Outside upper/lower limit deviation	0 to 2,000	2,000

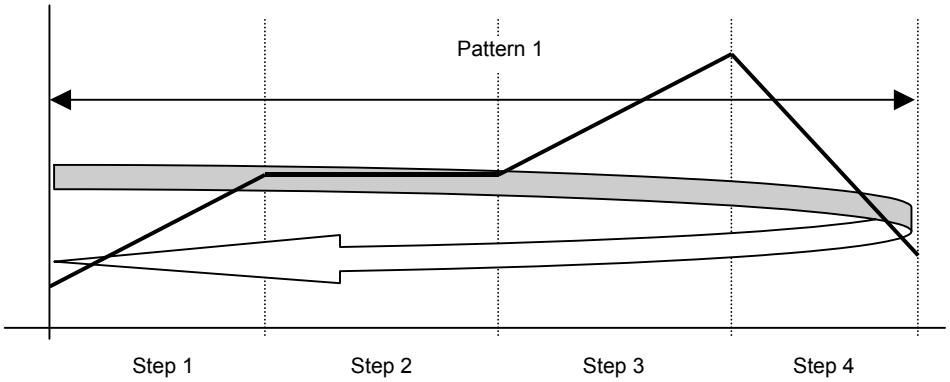
(8) Pattern execution count setting

Specify the number of times for the execution of the relevant pattern.
If a numerical value smaller than the number of the current run is set during the execution of the program, the program will end after the execution of the end step.

Setting range: 1 to 10,000
Initial value: 1
Relevant addresses: 0123H, 0883H, 0903H, 0983H, 0A03H

■ Pattern RUN function

This function is used to repeat the execution of a desired pattern once to 10,000 times.



(9) Start mode setting

Set the program start mode.
When the program start mode is set to SV, the program will start from the start SV value. When the mode is set to PV, the PV start function will become active and eliminate dead time, depending on the conditions. (See 13-3. “About PV start.”)

Setting range: 0: SV, 1: PV
Initial value: 0
Relevant addresses: 0887H, 0907H, 0987H, 0A07H

16-4. Start pattern setting and execution

Specify the number of the pattern to be executed and execute the pattern as follows.
Note that similar operations can be performed for DIs.
This instrument can memorize up to 8 steps × 4 patterns.

(1) RUN Start/Stop

Use this function to start or stop program execution.
If assigned to the DI function, this function cannot be operated remotely.
It should also be noted that the program will not be executed if all the step times of the pattern set on the Program Start Pattern monitor are set to “00:00.”

Setting range:	0: RST, 1: RUN
Initial value:	0
Relevant address:	0190H

The RUN state and the RESET state can be switched by a DI to which this function is assigned. Select from two options: RUN1 and RUN2.

(1) When RUN1 (level) is selected
- The RUN state will continue as long as the DI is short-circuited.
- If the program ends normally, the transition to the RUN state will occur only after the DI is released once and short-circuited again.
- If the DI is short-circuited at power-ON, the transition to the RUN state will occur immediately after power-ON.

(2) When RUN2 (edge) is selected
- Each time the DI is short-circuited, the RUN state and the RESET state will toggle each other.
- When the program ends normally, the DI will be short-circuited again for transition to the RUN state.
- If the DI is short-circuited at power-ON, the transition to the RUN state will not occur immediately after power-ON.

16-5. Descriptions and settings of step info

(1) Setting the step SV

Set the SV value of a relevant step.
This value will be the same as the SV limiter value if the SV limiter range is exceeded due to any change made to the SV limiter.

Setting range:	Within SV limiter
Initial value:	0
Relevant addresses:	08A0H, 08A4H, 08A8H, 08ACH, 08B0H, 08B4H, 08B8H, 08BCH, 0920H, 0924H, 0928H, 092CH, 0930H, 0934H, 0938H, 093CH, 09A0H, 09A4H, 09A8H, 09ACH, 09B0H, 09B4H, 09B8H, 09BCH, 0A20H, 0A24H, 0A28H, 0A2CH, 0A30H, 0A34H, 0A38H, 0A3CH

(2) Step time setting

Set the relevant step time. The time unit will be the one set by the user.

Setting range:	0x0000 (00:00) to 0x9959 (99:59)
Initial value:	0000
Relevant addresses:	08A1H, 08A5H, 08A9H, 08ADH, 08B1H, 08B5H, 08B9H, 08BDH, 0921H, 0925H, 0929H, 092DH, 0931H, 0935H, 0939H, 093DH, 09A1H, 09A5H, 09A9H, 09ADH, 09B1H, 09B5H, 09B9H, 09BDH, 0A21H, 0A25H, 0A29H, 0A2DH, 0A31H, 0A35H, 0A39H, 0A3DH

(3) Step PID No. setting

Set the PID No. of a relevant step.
Select 0 to continue using the PID No. from the previous step. When 0 is set for Step 1, the action will occur with PID No. 1.

Setting range:	0 to 3
Initial value:	0
Relevant addresses:	08A2H, 08A6H, 08AAH, 08AEH, 08B2H, 08B6H, 08BAH, 08BEH, 0922H, 0926H, 092AH, 092EH, 0932H, 0936H, 093AH, 093EH, 09A2H, 09A6H, 09AAH, 09AEH, 09B2H, 09B6H, 09BAH, 09BEH, 0A22H, 0A26H, 0A2AH, 0A2EH, 0A32H, 0A36H, 0A3AH, 0A3EH

17. Operations during control

17-1. Control standby (STBY)

This is a wait-and-see function used to set the control output and the event output to standby and to start control when the input, etc., are stabilized.
The analog outputs operate regardless of run/standby.
The standby control output will be 0%.
Assign “control run/standby switching” to a DI to enable run/standby switching by an external contact.

Setting range: 0: OFF, 1: ON
Initial value: 0
Relevant address: 0190H

ON : The instrument stops control action and switches over to the standby output (0%).
OFF : The instrument performs normal control.

[Note] This instrument turns power off when set to standby (STBY=ON) and remains on standby when powered ON again.

17-2. Execution SV No. switching

When the internal cascade function is selected, the CH2 SV value will be the CH1 output, making SV No. setting impossible.
If the SV No. switching operation is set to external switching, SV No. cannot be changed remotely.

Setting range: 1 to 3
Initial value: 1
Relevant address: 0180H

17-3. External SV No. switching

When required to use more than one target set value (SV), use an external contact to perform Execution SV No. selection and switching.

[Note] If there is no input to any DI, SV No. 1 will be the Execution SV. If a device such as a decimal switch is used to perform this switching, instantaneous switching to an unexpected SV No. may occur at the timing of contact switching. Set the DIs of this instrument to be switched within the response time (250 ms).

17-4. Auto-tuning

(1) Auto-tuning ON/OFF

This function toggles ON and OFF of PID auto-tuning (AT).
During AT, optimum PID constants are determined by the limit cycle method. These values are used to perform control action automatically.
During AT, hunting occurs near the SV value due to the limit cycle.
During AT, changes can be made only to AT, HLD, and ADV.

Setting range: 0: OFF, 1: ON
Initial value: 0
Relevant address: 0184H

Set AT to ON to perform auto-tuning.
Assign “AT ON/OFF switching” to a DI to enable AT by an external contact.
To perform AT, all the following conditions must be met:

- The instrument is NOT in the manual output (MAN) state.
- P is NOT set to OFF (ON-OFF control).
- The instrument is NOT in the standby state (STBY: ON, ACTION PAUSED).
- The PV value has not exceeded the full-scale range (SO).

[Note] ● Depending on the controlled system or the control loop dead time, better results may be achieved by correcting the auto-tuned PID constants.

● If required to use the output limit function, set the upper and lower limits for the control output value before performing AT.

● Auto-tuning action stops in any of the following cases:
(1) Overrange occurs.
(2) A power failure occurs.
(3) Approximately 200 minutes of ON or OFF time have elapsed.
(4) The instrument is set to standby (STBY).

17-5. Control output (MAN) setting

Use this function to toggle the control output between AUTO and MAN.
Usually, the instrument is automatically operated. This function is used to set the control output manually for purposes such as commissioning.
During manual output, a set value will continue to be generated without feedback control.

(1) AUTO/MAN switching

Assign “control output AUTO/MAN switching” to a DI to enable AUTO/MAN switching by an external contact.
In a 2-loop configuration, each channel can be toggled independently between AUTO and MAN.

Setting range:	0: AUTO, 1: MAN
Initial value:	0
Relevant address:	0185H

[Note]: During AT, changes can be made only to AT, HLD, ADV, and key lock.

(2) Output value

This operation can be performed for OUT1/OUT2 set to manual output.

17-6. Tuning function

(1) Tuning function

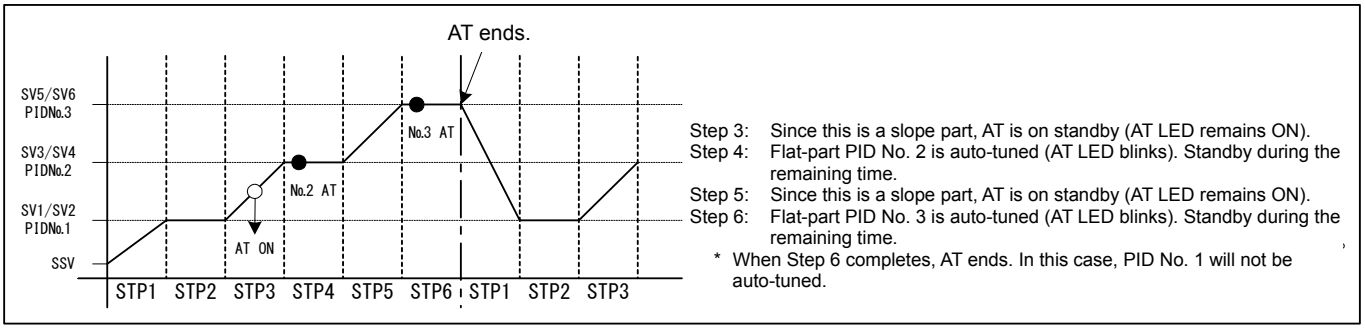
This section explains the PID constants tuning function.
Adjustment of PID constants used for PID control (P: proportional band, I: integral time, and D: derivative time) is generally called tuning. Automatic tuning of PID constants is called auto-tuning.

(2) Auto-tuning (AT)

Auto-tuning is performed to determine optimum PID values for PID calculation control.

During the program mode, AT is not performed while a slope step is being executed. Note, however, that the above does not apply when HOLD action is ON even if a slope step is being executed.
Even if the program execution count is set to 2 or more, AT will end at the end step.
If auto-tuning of all PID Nos. completes before the end step, AT will end at that point.

E.g.) When the end step is set to Step No. 6 and the pattern execution count is set to 2 or more, the following sequence of actions will occur:

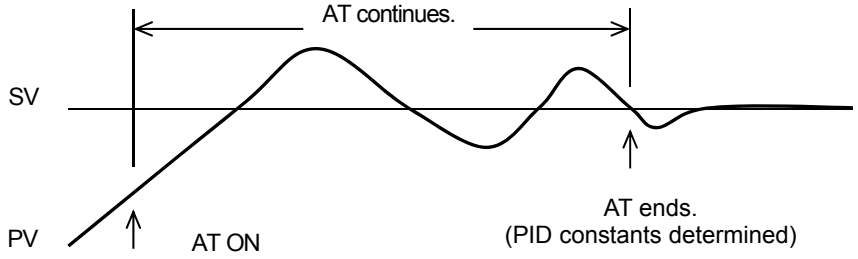


Step 3: Since this is a slope part, AT is on standby (AT LED remains ON).
Step 4: Flat-part PID No. 2 is auto-tuned (AT LED blinks). Standby during the remaining time.
Step 5: Since this is a slope part, AT is on standby (AT LED remains ON).
Step 6: Flat-part PID No. 3 is auto-tuned (AT LED blinks). Standby during the remaining time.
* When Step 6 completes, AT ends. In this case, PID No. 1 will not be auto-tuned.

Once DI input is ON, auto-tuning will start.
If the SV No. is changed by means of DI during AT, the change will not be reflected until AT ends.
AT cannot be aborted by means of DI. AT can only be aborted remotely.

■ Auto-tuning system operation

Auto-tuning is performed by the limit cycle method.
The limit cycle method turns ON/OFF the control output to measure the measured value (PV) amplitude or the dead time and calculate the PID constants.



■ AT will fail to start if:
- The instrument is set to standby (STBY).
- The instrument is in the manual output (MAN) state.
- P = OFF (ON-OFF control)
- The PV value has exceeded the full-scale range (SO).

■ Auto-tuning will be aborted if:
- AT is set to OFF (remotely).
- More than 200 minutes have elapsed with the output value standing at 0% or 100%.
- The instrument is set to standby (STBY).
- The PV value has exceeded the full-scale range (SO).
- A power failure occurs.

[Note] If the measured value (PV) contains noise and is unstable, AT may not be performed accurately. Perform AT after stabilizing the measurement input or after stabilizing the measured value using a PV filter, etc.
If required to use an output limiter, set it before performing AT. It should be noted, however, that when the control output is either a transistor open collector output or an SSR drive voltage output open collector output, the control output will operate at 0 or 100% (ON/OFF) regardless of the output limiter.
Depending on the controlled system, no optimum PID constants may be obtained. In such a case, better results may be achieved by correcting the auto-tuned PID constants.

18. Program function settings

18-1. HLD (hold)

This function is used to pause program execution remotely. This is a level action.

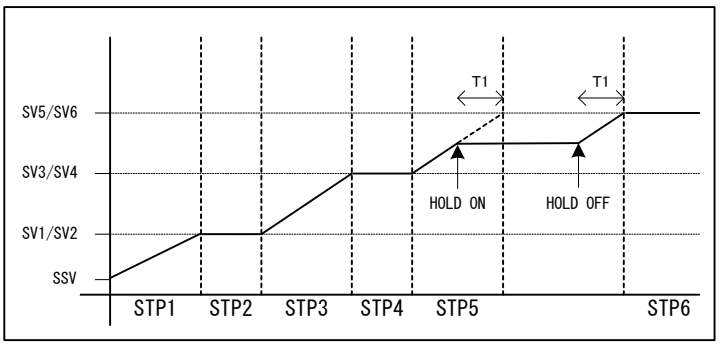
Setting range: 0: OFF, 1: ON
Initial value: 0
Relevant address: 0191H

When DI input ON: The program step time will be stopped.

The program will be paused by turning the DI input ON. Only the program execution time will be stopped; the control action will not. This is fixed-value-controlled. In a DI-equipped configuration, the HLD function can be assigned to the DI function. If assigned to a DI, this function cannot be operated remotely. When HLD is OFF, the stopped time will start counting up again.

The HLD function can be turned on by short-circuiting a DI to which it is assigned. During short-circuiting, the time is stopped and the SV value is fixed.

(1) If assigned to a DI, HLD cannot be operated remotely.
(2) When RUN is executed with HLD ON, a HLD state will occur at the start SV value.
(3) If the start SV value, the step SV value, the step time, or the step PID No. is changed during HLD, the change will not be reflected until HLD is OFF.



18-2. ADV (advance)

This is an edge action.

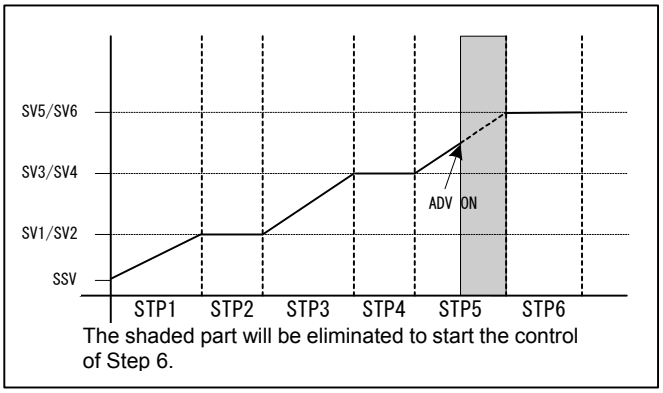
Setting range: 0: OFF, 1: ON
Initial value: 0
Relevant address: 0192H

Once DI input is ON during program control, the current step will be aborted to force transition to the next step.

Turn DI input ON to abort a currently executed step to go to the next step.
In a DI-equipped configuration, the ADV function can be assigned to the DI function.

The ADV function can be turned ON by short-circuiting a DI to which it is assigned. One action occurs per short-circuit.
ADV is impossible during HLD. If short-circuiting occurs during HLD, the ADV function will be ignored.

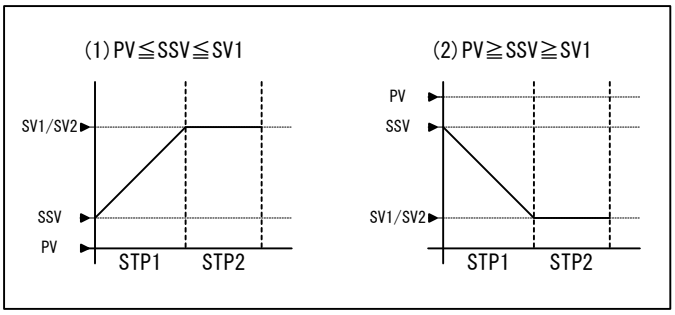
(1) As soon as an ADV input occurs, the next step will be executed.
(2) Each time ADV is executed, ADV input will be disabled for approximately 2 seconds.
(3) After a transition occurs from one step to the next, ADV input will be disabled for approximately one second.



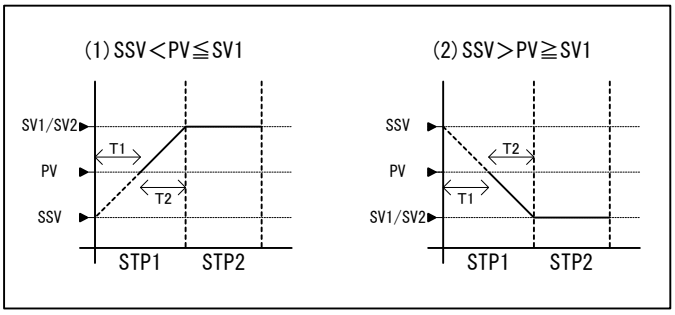
18-3. About PV start

If the program operation start step is slope-controlled and the start SV value and the PV value differ significantly from each other, some of the operating time may be wasted.
To eliminate this dead time, set the PV value as the start SV value to start program operation.
This function is enabled when setting the “start mode” to PV.

1) Case where PV start fails
If the PV value does not fall between the start SV value (SSV) and the relevant step 1SV value (SV1), the PV start function will fail to work.

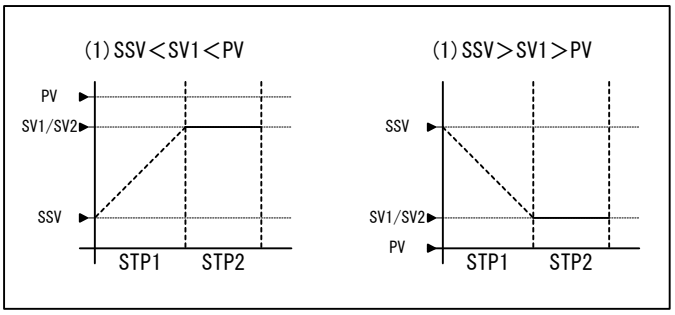


2) Case where PV start works and saves time
If the PV value falls between the start SV value (SSV) and the relevant step 1SV value (SV1), the PV start function will work and time-saving will occur.



T1: Saved time
T2: Execution time

3) Case where PV start works and omits a step.
If the PV value exceeds the relevant step 1 SV value (SV1), the PV start function will work and step 1 will be skipped.



The transition to Step 2 will occur, skipping Step 1.

Setting range: 0: SV, 1: PV
Initial value: 0
Relevant addresses: 0887H, 0907H, 0987H, 0A07H

18-4. About guaranteed soak (GUA)

(1) Guaranteed soak band (GUA band) setting

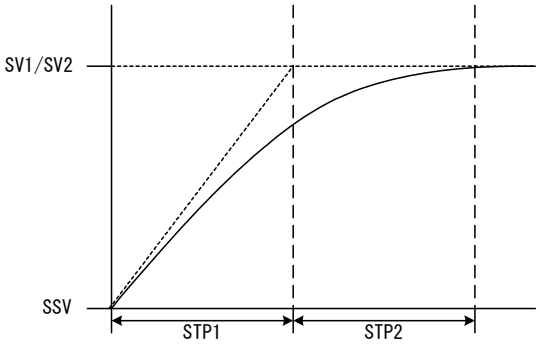
Set a guaranteed soak band (GUA band).
If set to OFF, guaranteed soak will not work.

Setting range:	0: OFF, 1 to 1,000
Initial value:	0
Relevant addresses:	0885H, 0905H, 0985H, 0A05H

If the PV falls outside the specified guaranteed soak band (GUA band) at the transition from the slope step to the flat step, no transitions to the subsequent steps will occur. This function remains disabled except during a transition from a slope step to a flat step.

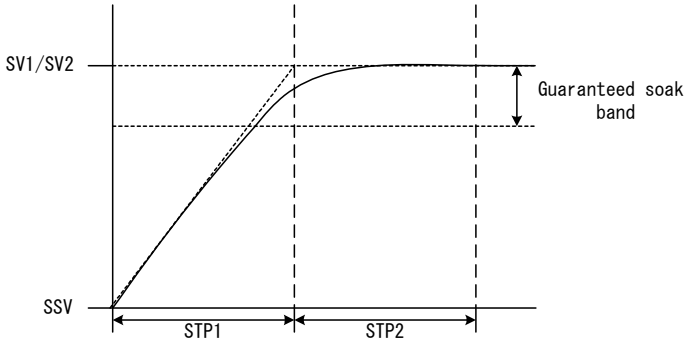
(2) When OFF

Even if the PV has not reached SV1 after the elapse of step 1 time, the transition to step 2 will occur.

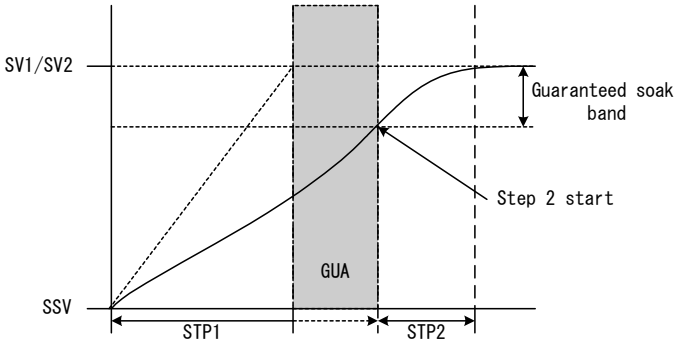


(3) When a guaranteed soak band (GUA band) is set

a. When the PV delay is small relative to the SV slope
If the guaranteed soak band (GUA band) is reached after the elapse of step 1 time, the transition to step 2 will occur.



b. When the PV delay is large relative to the SV slope
If the guaranteed soak band (GUA band) is not reached even after the elapse of step 1 time, guaranteed soak will be performed until the guaranteed soak band (GUA band) is reached.



* Even when step 1 is flat (SSV = SV1), guaranteed soak will be performed.
Even when the step time is set to 00:00, guaranteed soak will be performed if the conditions are met.
During guaranteed soak, the decimal point for the left two digits of the PV indicator blinks on the Basic screen, the RUN Step No. monitor screen, the Step Remaining Time monitor screen, the Pattern Execution Count monitor screen, and the Execution PID No. monitor screen.

19. DI and AO settings

19-1. About external control input (DI)

The MRM57 Series requires a minimum input hold time of 250 ms or more to load an external control input.
Functions assigned to any DI cannot be operated remotely (DI input takes priority.).
Note, however, that AT and unlatching allow remote operation if assigned to a DI.

(1) DI mode setting

Setting range: 0 to 13
Initial value: 0
Relevant addresses: 0580H, 0581H, 0582H, 0583H, 0584H, 0585H

Select and set external inputs (DI) for the intended use.

DI mode assignment type code table

CODE	Symbol	External control input assignment type	Assignable DI No.	Detection
0	non	None assigned		
1	RUN1	RUN1 control ON/OFF	1, 2, 3, 4, 5, 6	Level
2	RUN2	RUN2 control ON/OFF	1, 2, 3, 4, 5, 6	Edge
3	mAn	MAN manual output	1, 2, 3, 4, 5, 6	Level
4	At	AT auto-tuning execution	1, 2, 3, 4, 5, 6	Edge
5	ESV2	ESV2 external selection-2 bit	1, 2	Level
6	ACt1	ACT1 OUT1 output characteristics (RA/DA)	1, 2, 3, 4, 5, 6	Level
7	ACt2	ACT2 OUT2 output characteristics (RA/DA)	1, 2, 3, 4, 5, 6	Level
8	ProG	PROG program	1, 2, 3, 4, 5, 6	Level
9	HLd	HOLD hold signal	1, 2, 3, 4, 5, 6	Level
10	AdV	ADV advance	1, 2, 3, 4, 5, 6	Edge
11	Ptn2	PTN2 start pattern selection-2 bit	1, 2	Level
12	Ptn3	PTN3 start pattern selection-3 bit	1	Level
13	L_rS	L_RS total unlatching	1, 2, 3, 4, 5, 6	Edge

When ESV2 and Ptn2 are assigned to DI1, no settings can be made to DI2.
When Ptn3 is assigned to DI1, no settings can be made to DI2 and DI3.
It is impossible to assign a single type of code to more than one DI.
When ESV2 and Ptn2 are assigned to DI2, no settings can be made to DI3.

(2) Temperature controller action ON - RUN1

This is used to toggle ON and OFF of a controller meter action. This is a level action.

When DI input OFF: The transition to standby (reset) will occur, causing the MRM57 to stop its action.
When DI input ON: The transition to the RUN state, namely PID calculation RUN (program control RUN) state, will occur.

[Note] If the DI is ON at power-ON, the transition to the RUN state will occur immediately after power-ON.

(3) Temperature controller action ON - RUN2

This is used to toggle between the RUN state and the stop state each time DI input is ON. (Edge action)

[Note] If the DI is ON at power-ON, the transition to the RUN state will not occur immediately after power-ON.

(4) Manual output (MAN)

This is used to switch over to manual output. This is a level action.

When DI input OFF: A normal feedback control action will occur.
When DI input ON: The control output will be a manual action. No feedback control will occur.

(5) Auto-tuning execution (AT)

Use this to execute auto-tuning remotely. This is an edge action.

(6) External SV selection (ESV2)

Use this to switch the set values SV1 to SV3 to Execution SV. Two DI points are used for a level action. External SV selection can be assigned to DI1 or DI2.

When external SV selection is assigned to DI1, the same will automatically occur to DI2, making DI2 unselectable.

When external SV selection is assigned to DI2, the same will automatically occur to DI3, making DI3 unselectable.

When assigned to DI1

DI2	DI1	Selected SV No.
0	0	1
0	1	1
1	0	2
1	1	3

When assigned to DI2

DI3	DI2	Selected SV No.
0	0	1
0	1	1
1	0	2
1	1	3

An Execution SV No. and an execution PID No. correspond to each other as in SV1/PID1, SV2/PID2, and SV3/PID3.

(7) OUT1 output characteristics (ACT1)

This switches the output characteristics (RA/DA) of control output 1.

When DI input OFF: RA (heating)
When DI input ON: DA (cooling)

(8) OUT2 output characteristics (ACT2)

This switches the output characteristics (RA/DA) of control output 2.

When DI input OFF: RA (heating)
When DI input ON: DA (cooling)

(9) Program (PROG)

Toggle between the FIX (fixed value control) mode and the program mode. This is a level action.

When DI input OFF: Fixed value control (FIX mode)
When DI input ON: Program (PROG mode)

(10) External start pattern selection-2 bit (PTN2)

The user can select a program start pattern. Two DI points are used for a level action. External start pattern selection can be assigned to DI1 or DI2.

When external start pattern selection is assigned to DI1, the same will automatically occur to DI2, making DI2 unselectable.

When external start pattern selection is assigned to DI2, the same will automatically occur to DI3, making DI3 unselectable.

When assigned to DI1

DI2	DI1	Start pattern No.
0	0	1
0	1	1
1	0	2
1	1	3

When assigned to DI2

DI3	DI2	Start pattern No.
0	0	1
0	1	1
1	0	2
1	1	3

When the number of patterns is set to 2 and start pattern No. 3 is selected, start pattern No. 2 will be executed.

(11) External start pattern selection-3 bit (PTN3)

The user can select a program start pattern. Three DI points are used for a level action. Only DI1 allows assignment.

When external start pattern selection-3 bit is assigned to DI1, the same will automatically occur to DI2 and DI3, making DI2 and DI3 unselectable.

DI3	DI2	DI1	Start pattern No.
0	0	0	1
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	*	*	4

* Start pattern No. 4 will be selected whether ON or OFF.
When the number of patterns is set to 2 and either start pattern No. 3 or No. 4 is selected, start pattern No. 2 will be executed.

(12) Total unlatching (L_RS)

This function is used to unlatch events remotely. This is an edge action.

Once DI input is ON, all event outputs will be unlatched. Note, however, that event outputs meeting event output conditions cannot be unlatched.

19-2. Analog output settings (Ao1 and Ao2)

This instrument can be equipped with two optional analog output points (Ao1 and Ao2).
The following settings apply only to instruments equipped with these optional analog outputs:

(1) Analog output type selection

Select the type of analog output to be assigned.

Setting range: 0: PV, 1: SV, 2: OUT1, 3: OUT2
Initial value: 0
Relevant addresses: 05A0H, 05A4H,

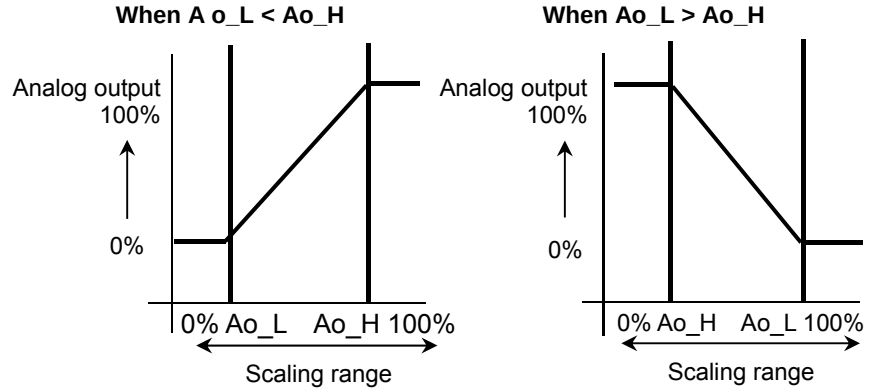
PV: Measured value (CH1)
SV: Set value (CH1)
OUT1: Control output 1
OUT2: Control output 2

(2) Analog output scaling

Set the minimum values (0 mV, 4 mA, and 0 V) of the analog output signal as the scaling lower limits for the desired output values.

Setting range: PV, SV: within measuring range
OUT1 and OUT2: 0 (0.0%) to 1,000 (100.0%)
Initial value: Analog scaling lower limit: Measurement lower limit
Analog scaling upper limit: Measurement upper limit
Relevant addresses: 05A1H, 05A2H, 05A5H, 05A6H

Inverse scaling (Ao_L > Ao_H) is also allowed. (H-L = ±1 count or more)
The following figures show the characteristics of the analog output after inverse scaling:



(3) Analog output limiter settings

Set the upper and lower limits for the analog output.

Setting range: Lower limit: 0 (0.0%) to 999 (99.9%)
Upper limit: AL_L + 1 to 1,000 (100.0%)
Initial value: Lower limit: 0
Upper limit: 1,000
Relevant addresses: 05B4H, 05B5H, 05B7H, 05B8H

19-3. Communication function (COM)

(1) Communication memory card settings screen

Set up a communication memory card as follows.

Setting range: 0: EEP, 1: rAm, 2: r_E
Initial value: 0
Relevant address: 05B0H

When required to write data remotely, select from the table below the method of writing data to EEPROM and RAM.

CODE	Type	Description of the write process
0	EEP	Write all to EEPROM
1	rAm	Write all to RAM
2	r_E	SV, OUT1, and OUT2 data are written to RAM, and other data are written to EEPROM.

*** Precautions for using RAM as the communication memory card**

When RAM is set as the communication memory card, all settings made using the communication function will be written to RAM.

Hence, be aware that inconsistencies may occur in the settings depending on the operating method.

(2) Communication mode selection

Select from the following to set the communication mode.

Setting range: 0: LOCAL, 1: COM
Initial value: 0
Relevant address: 018CH

CODE	Type	Valid command	
		COM1	COM2
0	LOCAL	READ and WRITE	READ
1	COM	READ and WRITE	READ and WRITE

Even during local operation, the communication function allows the user to send a command from the host to this instrument to switch from LOCAL to COM.

LOCAL: During LOCAL operation, settings can be read but cannot be written or changed.
COM: In this mode, settings can be read and changed remotely.

For more details of the communication function, see “Communication function.”

(3) Communication mode type setting

Select the type of communication mode.

Setting range: 0: COM1, 1: COM2
Initial value: 0
Relevant address: 05B1H

To enable remote operation during a remote write process performed remotely, select COM1.

Type of COM mode	COM1		COM2	
COM mode	COM	LOC	COM	LOC
Remote operation	Enabled	Enabled	Disabled	Enabled
COM writing	Enabled	Enabled	Enabled	Disabled

When the “communication modes” are rewritten by communication commands, the results will be as follows:

COM mode	LOC	COM
COM writing	COM1 => COM2 enabled	COM1 => COM2 enabled
	COM2 => COM1 disabled	COM2 => COM1 enabled

20. Communication function

20-1. Overview of communication

(1) Communication interface

The MCM57 Series supports the RS-422 and RS-485 communication protocols and uses RS-422 and RS-485 communication interfaces to perform the setting, reading, and writing of various data from personal computers and other external devices.
RS-422 and RS-485 are data communication standards specified by the Electronic Industries Association (EIA). These standards specify requirements applicable only to hardware and do not define any software-related parts of data transmission procedures. Even RS-422/RS-485-compliant devices with identical interfaces cannot communicate with each other without meeting additional conditions. Accordingly, the customer must have sufficient prior knowledge about data transmission specifications and transmission procedures.

The use of RS-422/RS-485 allows parallel connection of a multiple number of MCM57 Series units.
Currently, few models of personal computers support RS-422/RS-485 interfaces. Use a commercially available "RS-422/RS-485 converter" for RS-422/RS-485 communication.

(2) Communication protocols and their specifications

The MCM57 Series supports the Shimaden protocol and the MODBUS protocol.

■ Common to both protocols

Signal level	EIA-RS-422/RS-485-compliant
Communication method	RS-485: 2-wire half-duplex multi-drop connection RS-422: 4-half-duplex multi-drop connection
Synchronization method	Half-duplex, asynchronous
Communication distance	500 m max., total length (variable depending on connection conditions)
Communication speed	4,800 / 9,600 / 19,200 / 38,400 bps
Transmission procedure	Dumb-terminal procedure
Communication delay time	Approx. 10 msec
Number of connectable units	4 groups max., 31 units per group
Communication address	1 to 255
Communication memory card	EEP / RAM / R_E
Protocol	Shimaden Standard / MODBUS-RTU
Data length	Data length, 7 or 8 bits (8 bits for MODBUS-RTU)
Stop bit	Stop bits 1 and 2
Control code	STX (02H) / ETX (03H) / CR (ODH)
Error detection	Checksum (Shimaden Standard) / CRC-16 (MODBUS)

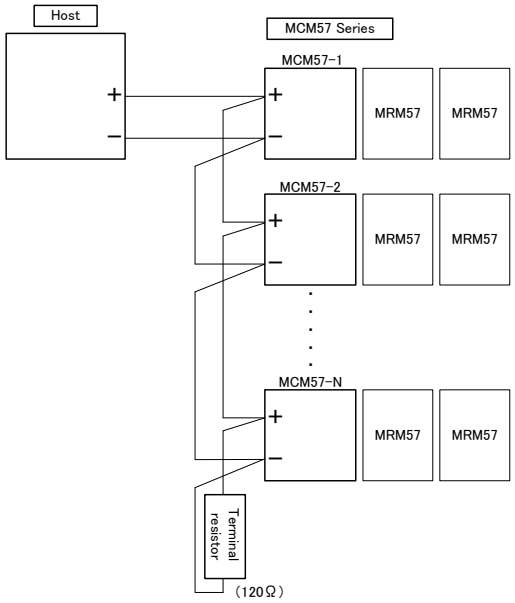
20-2. Controller-to-host computer connection

(1) RS-422 / RS-485

Basically, the MCM57 Series has the following input and output logic levels:
Mark state -terminal < +terminal
Space state -terminal > +terminal

Note, however, that the +/- controller terminals have a high impedance until immediately before the start of transmission and that the above levels are produced as outputs immediately before the start of transmission. (See (2) 3 "About state output control.")
An "RS-422/RS-485 converter" may be necessary to use a generic personal computer as the host computer.
For more details, refer to the manuals supplied with the personal computer and RS-422/RS-485 converter to be used.

Typical RS-485 wiring



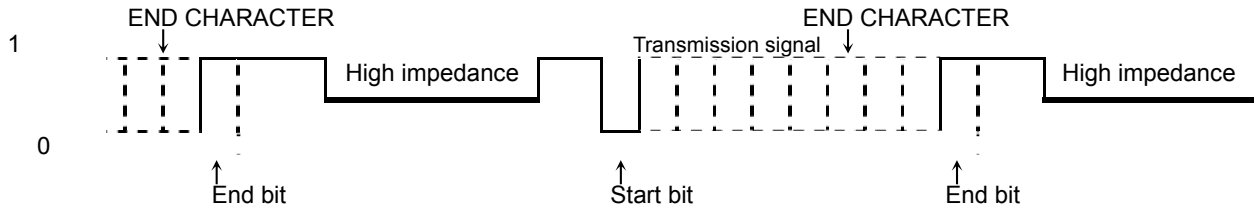
Note 1: Install the supplied 1/2W 120 Ω resistor between the terminals (+ and - terminals) as necessary for use in an RS-422/RS-485 system.
The terminal resistor should be fitted only on one controller, which is the end station.
Normal operation cannot be guaranteed if two or more units are fitted with a terminal resistor.

MCM57 Series terminal number

	MCM57
+	1
-	2

(2) About tri-state output control

RS-485 is a multi-drop system. Therefore, the transmission output always has a high impedance to prevent transmission signal collision during no communication activity or during reception. The tri-state output shifts from the high-impedance state to the normal state immediately before transmission. As soon as the transmission ends, the tri-output is controlled to the high-impedance state again.
In tri-state output control, an approx. 1 msec delay occurs after the transmission of the end bit of an end character. Provide a several-msec delay time when required to start transmission immediately after the host completes reception.



20-3. Overview of the Shimaden communication protocol

The MCM57 Series uses the Shimaden communication protocol.
Accordingly, when connected to Shimaden communication protocol-compliant devices of a different series, they can receive and change data in the same message format.

(1) Communication procedure

1) About master-slave relationship
- A personal computer or a PLC (host) is the master.
- An MCM57-Series unit is the slave.
- A communication session starts with a command from the master and ends with a response message from the slave. Note, however, that no response message will occur if any error such as a message format error or a BCC error is detected. Similarly, no response message will occur when a broadcast command is issued.

2) Communication procedure
The communication procedure is such that the master and the slave exchange tokens as they respond to each other.

3) About time-out
When failing to complete end character reception within one second after start character reception, the Controller Meter will time out and wait for another command (new start character).
Therefore, when required to set a host timeout time, set it to one second or longer.

(2) Message formats

The MCM57 Series is multi-protocol-compatible and allows various selections of message format (control code, BCC calculation method) and message data format (data bit length, parity presence/absence, stop bit length).
It is recommended, however, to use the following formats for user-friendliness and as a precaution against incorrect communication settings.

	Recommended format	
Control code	STX_ETX_CR	
BCC calculation method	ADD	
Message data formats	7 data bits, even parity, 1 stop bit	8 data bits, none, 1 stop bit

1) Overview of the message formats

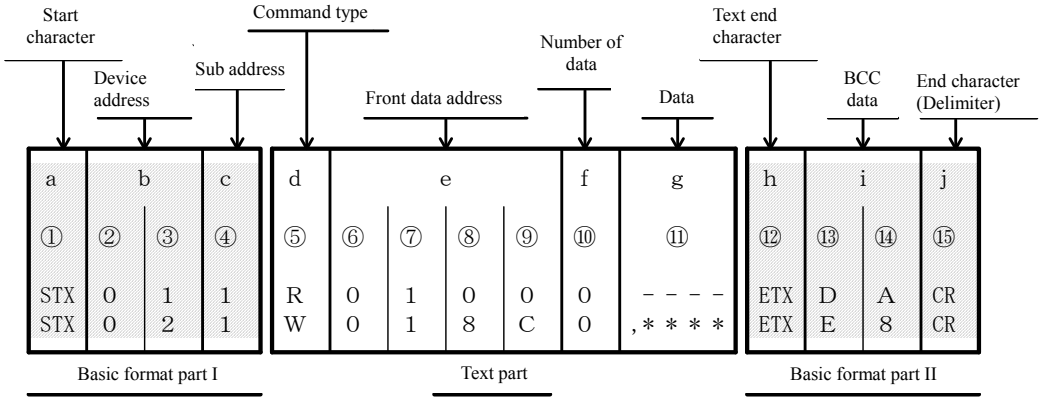
The command message format for transmissions from the master and the response message format for transmissions from the slave consist respectively of three blocks: basic format block I, text block, and basic format block II.

The basic format blocks I and II are common in read commands (R), write commands (W), and response messages.

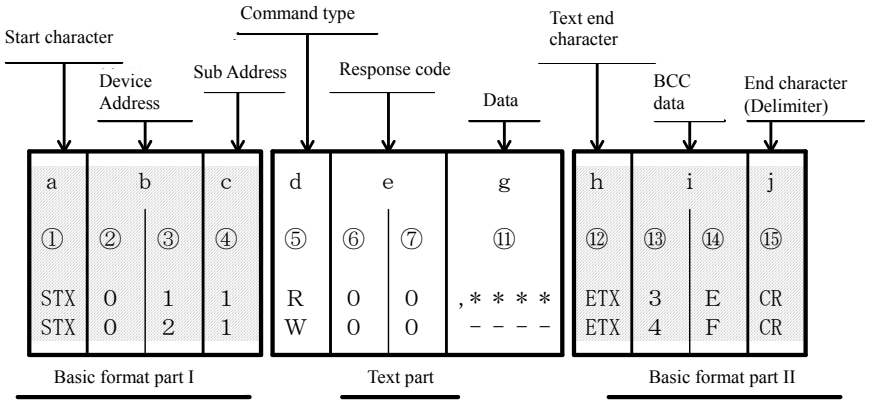
Note, however, that the BCC data in item i ((13) and (14)) contain calculation result data that may differ each time.

The text block may vary depending on, among other things, the command type, the data address, and the response message.

■ Command message format



■ Response message format



2) Details of basic format block I

a: Start character [(1): 1 digit / STX (02H) or “@”(40H)]

- Marks where the text of a message begins.
- When a start character is received, it is determined as the first character of the text of a new message.
- A start character is selected in a pair with a text end character as follows:

STX (02H) - - - ETX (03H)
“@” (40H) - - - “:” (3AH)

b: Device address [(2) and (3): 2 digits]

- Specifies the destination device.
- This address needs to be specified within the range of 1 to 255 (decimal number).
- The 8-bit binary datum (1: 0000 0001 to 255: 1111 1111) is divided into the high-order 4 bits and the low-order 4 bits for conversion into ASCII.
  (2): High-order 4-bit data converted into ASCII
  (3): Low-order 4-bit data converted into ASCII
- The device address = 0 (30H, 30H) is used in broadcast commands.
  The MRM57 Series supports broadcast commands.
  Note, however, that no response occurs to a broadcast command, whether normal or not.

c: Sub-address [(4): 1 digit]

- An MRM57 Series unit is a multi-temperature controller but is handled as a single loop. Hence, its sub-address is fixed to 1(31H).
  If any other sub-address is used, no response will occur due to a sub-address error.

3) Details of basic format block II

h: Text end character [(12): 1 digit / ETX(03H) or ":" (3AH)]
- Occurs immediately after the end of the text block of a message.

i: BCC data [(13) and (14): 2 digits]
- The block check character (BCC) data are used to check for any errors in the message data.
- If a BCC calculation results in a BCC error, no response will occur.
- The BCC calculation method is fixed to ADD.

I) ADD
Performs the addition of all the characters, from the start character (1) to the text end character (12), handling them as single ASCII data characters (1 byte per character).
- The addition is performed in bytes (8 bits per byte), regardless of the data bit length (7 or 8 bits).
- The lower 1-byte data of the above calculation result is divided into the high-order 4 bits and the low-order 4 bits for conversion into ASCII.
  (13): High-order 4-bit data converted into ASCII
  (14): Low-order 4-bit data converted into ASCII

E.g.) Typical read command (R) with BCC set to Add

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(14)	(15)
STX	0	1	1	R	0	1	0	0	0	ETX	D	A	CR

02H + 30H + 31H + 31H + 52H + 30H + 31H + 30H + 30H + 30H + 03H = 1DAH

The lower 1 byte of the addition result (1DAH) = DAH
(13): "D" = 44H, (14): "A" = 41H

j: End character (delimiter) [(15): 1 digit / CR]
- Marks where the text of a message ends.

Note No response will occur when any errors such as the following are detected in the basic format block:

- A hardware error has occurred.
- The device address or the sub-address is set to the address of the specified device.
- Any of the characters defined in the above-mentioned message format are not in the specified position.
- The BCC calculation result differs from the BCC data.

In data conversion, binary data are converted every 4 bits into ASCII.
The hexadecimal characters <A> to <F> are converted into uppercase ASCII data.

4) Overview of the text block
The text block may vary depending on the command type and the response message. For the details of text blocks, see "Details of read command (R)," "Details of write command (W)," and "Details of broadcast command (B)."

d: Command type [(5): 1 digit]

- "R" (52H / uppercase):
  Indicates a read command or a read command response.
  "R" is used to read various data from a master such as a personal computer or a PLC to an MCM57 Series unit.
- "W" (57H / uppercase):
  Indicates a write command or a write command response.
  "W" is used to write various data from a master such as a personal computer or a PLC to an MCM57 Series unit.
- "B" (42H / uppercase):
  Indicates a broadcast command.
  "B" is used to write data from the master such as a personal computer or a PLC to all the MCM57 Series units.
- No response will occur if any abnormal character other than "R," "W," and "B" is detected.

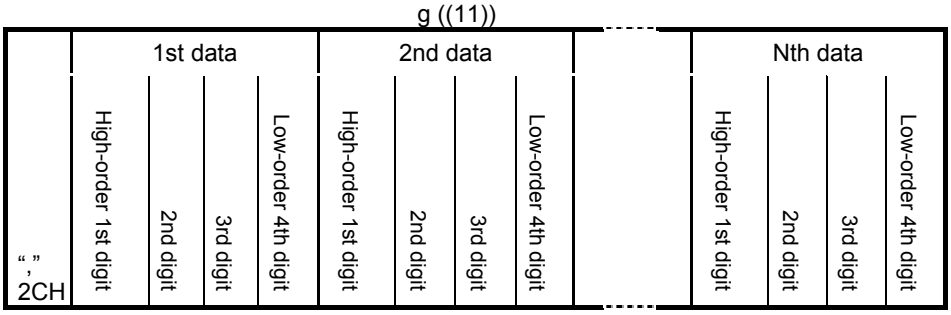
e: Start data address [(6), (7), (8), and (9): 4 digits] (command message format)
- Specifies the read start data address of a read command (R) or the write start data address of a write command (W).
- A start data address is specified by 16-bit binary data (1 word / 0 to 65535).
- A 16-bit datum is divided every 4 bits for conversion into ASCII.

Binary number (16 bits)	D15,D14,D13,D12	D11,D10,D9, D8	D7, D6, D5, D4	D3, D2, D1, D0
	0 0 0 0	0 0 0 1	1 0 0 0	1 1 0 0
Hexadecimal number (Hex)	0H	1H	8H	CH
	"0"	"1"	"8"	"C"
ASCII data	30H	31H	38H	43H
	(6)	(7)	(8)	(9)

- For data addresses, see "Communication Address table."

f: Number of data [(10): 1 digit]
- Specifies the number of data to be read per read command (R) or the number of data to be written per write command (W) or broadcast command (B).
- These numbers of data are specified by converting 4-bit binary data into ASCII.
- A read command (R) can specify a number of data within the range of 1: "0" (30H) to 10: "9" (39H).
  Note, however, that the number of data consecutively readable per MCM57/MRM57 Series unit is 10 max.: "9" (39H).
- The number of data per write command (W) is fixed to 1: "0" (30H).
- The number of data per broadcast command (B) is fixed to 1: "0" (30H).
- The actual number of data is the "number of data = specified number of data + 1."

g: Data [(11): The number of digits is determined by the number of data.]
- Specifies the write data (change data) per write command (W) or broadcast command (B) or the read data per read command (R).
- The data format is parsed as follows:



- A comma ("," 2CH) is always added to the beginning of a data string to mark where the data string begins.
  No data delimiters are used.
- The number of data is as per the number of data (f: (10)) in the command message format.
- Each datum consists of 16 binary bits (1 word), excluding the decimal-point bit. The position of the decimal point is determined for each datum.
- A 16-bit datum is divided every 4 bits, each of which is converted into ASCII.
- For the details of the data format, see "Details of read command (R)" and "Details of write command (W)."

e: Response codes [(6) and (7): 2 digits] (response message format)
- Specify the response code for a read command (R) and a write command (W).
  The 8-bit binary datum (0 to 255) is divided into the high-order 4-bit datum and the low-order 4-bit datum, both of which are converted into ASCII.
  (6): High-order 4-bit data converted into ASCII
  (7): Low-order 4-bit data converted into ASCII

- "0" (30H) and "0" (30H) are specified for a normal response.
  An error code No. converted into ASCII is specified for an error response.
  For the details of response codes, see "Details of response codes."

(3) Details of read command (R)

The read command (R) is used to read (load) various data from a master such as a personal computer or a PLC into an MCM57 Series unit.

1) Read command format

• The text block format for read commands is shown below.
Note that the basic format block I and the basic format block II are common in all commands and command responses.

Text block

d	e				f
(5)	(6)	(7)	(8)	(9)	(10)
R	0	4	0	0	4
52H	30H	34H	30H	30H	34H

• d ((5)): Indicates a read command.
Fixed to “R” (52H).
• e ((6) to (9)): Specifies the start data address of the data to be read.
• f ((10)): Specifies the number of data (words) to be read.

• The above command is parsed as follows:

Readout start data address = 0400H (Hexadecimal number)
= 0000 0100 0000 0000 (Binary number)
Number of readout data =4H (Hexadecimal number)
=0100 (Binary number)
=4 (Decimal number)
(Actual number of data) = 5 (4 + 1)

In other words, the five consecutive data from data address 0400H are designated for readout.

2) Format for normal responses to read commands

• Shown below is the format of a normal response (text block) to a read command.
Note that the basic format block I and the basic format block II are common in all commands and command responses.

Text block

d	e		g													
(5)	(6)	(7)	(11)													
				1st data				2nd data					5th data			
R	0	0	,	0	0	1	E	0	0	7	8		0	0	0	3
52H	30H	30H	2CH	30H	30H	31H	45H	30H	30H	37H	38H		30H	30H	30H	33H

• d ((5)): <R(52H)> is inserted here to indicate a response to a read command.
• e ((6) and (7)): A response code <00 (30H, 30H)> is inserted to indicate a normal response to the read command.
• g ((11)): Response data to a read command are inserted here.
1. <“,” (2CH)> is inserted at the beginning of the data description to indicate the beginning of the response data.
2. Then inserted consecutively are an equal number of data to the <number of readout data> from the <data of the readout start data address>.
3. Nothing is inserted in between the data.
4. Each datum consists of 16-bit binary data (1 word), excluding the decimal point. This datum is converted every 4 bits into ASCII for insertion.
5. The decimal point position is determined for each datum.
6. The number of characters per response datum is the “number of characters = 1 + 4 × number of readout data.”

• More specifically, the following data are returned consecutively as the response data to the read command.

	Data address 16 bits (1 word)	Data 16 bits (1 word)	
	Hexadecimal number	Hexadecimal number	Decimal number
Readout start data address (0400H) → 0	0400	001E	30
1	0401	0078	120
Number of readout data (4H: 5 data) 2	0402	001E	30
3	0403	0000	0
4	0404	0003	3

3) Format for error responses to read commands

• Shown below is the format of an error response (text block) to a read command.
Note that the basic format block I and the basic format block II are common in all commands and command responses.

Text block

d	e	
(5)	(6)	(7)
R	0	7
52H	30H	37H

• d (5): <R(52H)> is inserted here to indicate a response to a read command.
• e ((6) and (7)): A response code is inserted to indicate an error response to a read command.
• No response data are inserted for an error response.
• For the details of error codes, see “Details of response codes.”

(4) Details of write command (W)

The write command (W) is used to write (rewrite) various data from a master such as a personal computer or a PLC to an MCM57 Series unit.

CAUTION

It is necessary to switch the communication mode from LOC to COM to use a write command.
Send the following command from the master to perform the switching.

- The above operation is required when the type of communication mode is COM2.
- The above operation is not required when the type of communication mode is COM1.

■ Command format

When ADDR = 1, CTRL = STX_ETX_CR, and BCC = ADD

STX	0	1	1	W	0	1	8	C	0	,	0	0	0	1	ETX	E	7	CR
02H	30H	31H	31H	57H	30H	31H	38H	43H	30H	2CH	30H	30H	30H	31H	03H	45H	37H	0DH

When the above command is sent and a normal response is returned, the front COM LED will come ON, indicating the switching of the communication mode to COM.

1) Write command format

Shown below is the text block format for write commands.
Note that the basic format block I and the basic format block II are common in all commands and command responses.

Text block

d	e				f	g				
(5)	(6)	(7)	(8)	(9)	(10)	(11)				
						Write data				
W	0	4	0	0	0	,	0	0	2	8
57H	30H	34H	30H	30H	30H	2CH	30H	30H	32H	38H

• d ((5)): Indicates a write command.
Fixed to “W” (57H).
• e ((6) to (9)): Specifies the start data address of write (change) data.
• f ((10)): Specifies the number of write (change) data.
The number of write data is fixed to 1: “0” (30H).
• g ((11)): Specifies the write (change) data.
1. <“,” (2CH)> is inserted at the beginning of the data description to mark where it begins.
2. Then, the write data are inserted.
3. Each datum consists of 16-bit binary data (1 word), excluding the decimal point. This datum is converted every 4 bits into ASCII for insertion.
4. The decimal point position is determined for each datum.

The command is parsed as follows:

Write start data address	= 0400H	(Hexadecimal number)
	= 0000 0100 0000 0000	(Binary number)
Number of write data	= 0H	(Hexadecimal number)
	= 0000	(Binary number)
	=0	(Decimal number)
(Actual number of data)	= 1 (0 + 1)	
Write data	=0028H	(Hexadecimal number)
	= 0000 0000 0010 1000	(Binary number)
	= 40	(Decimal number)

In other words, the data address 0400H is specified for the writing (changing) of a datum (40: decimal number).

Write start data Address (400H) → 0
Number of write data 1 (01)

Data Address 16 bits (1 word)	Data 16 bits (1 word)	
Hexadecimal number	Hexadecimal number	Decimal number
0400	0028	40
0401	0078	120
0402	001E	30

2) Format for normal responses to write commands
- Shown below is the format (text block) of a normal response to a write command.
  Note that the basic format block I and the basic format block II are common in all commands and command responses.

Text block

d	e	
(5)	(6)	(7)
W	0	0
57H	30H	30H

- d ((5)): <W(57H)> is inserted here to indicate a write command.
- e ((6) and (7)): A response code <00 (30H, 30H)> is inserted to indicate a normal response to the write command.

3) Format for error responses to write commands
- Shown below is the format (text block) of an error response to a write command.
  Note that the basic format block I and the basic format block II are common in all commands and command responses.

Text block

d	e	
(5)	(6)	(7)
W	0	9
57H	30H	39H

- d ((5)): <W(57H)> is inserted here to indicate a write command.
- e ((6) and (7)): A response code is inserted to indicate an error response to the write command.
- For the details of error codes, see “Details of response codes.”

(5) Details of broadcast command (B)

The broadcast command (B) is used to write (rewrite) various data from a master such as a personal computer or a PLC to all devices that support broadcast commands.
Broadcast commands are not responded to.
Broadcast commands are supported by the Shimaden protocol, but not by the MODBUS protocol.
Broadcast commands can be used to write data to write (W) data addresses.

1) Broadcast command format

Shown below is the text block format for broadcast commands.
Note that the device address of the basic format block I is fixed to "00."

Text block

d	e				f	g				
(5)	(6)	(7)	(8)	(9)	(10)	(11)				
							Write data			
B	0	4	0	0	0	,	0	0	2	8
42H	30H	34H	30H	30H	30H	2CH	30H	30H	32H	38H

- d ((5)): Indicates a broadcast command.
  Fixed to "B" (42H).
- e ((6) to (9)): Specifies the start data address of write (change) data.
- f ((10)): Specifies the number of write (change) data.
  The number of write data is fixed to 1: "0" (30H).
- g ((11)): Specifies the write (change) data.
  1. <"," (2CH)> is inserted at the beginning of the data description to mark where it begins.
  2. Then, the write data are inserted.
  3. Each datum consists of 16-bit binary data (1 word), excluding the decimal point. This datum is converted every 4 bits into ASCII for insertion.
  4. The decimal point position is determined for each datum.

The above command is parsed as follows for all devices that support broadcast commands:

Write start data address	= 0400H	(Hexadecimal number)
	= 0000 0100 0000 0000	(Binary number)
Number of write data	= 0H	(Hexadecimal number)
	= 0000	(Binary number)
	= 0	(Decimal number)
(Actual number of data)	= 1 (0 + 1)	
Write data	= 0028H	(Hexadecimal number)
	= 0000 0000 0010 1000	(Binary number)
	= 40	(Decimal number)

In other words, the data address 0400H is specified for the writing (changing) of a datum (40: decimal number).

Write start data Address (400H) → 0
Number of write data 1 (01)

Data address 16 bits (1 word)	Data 16 bits (1 word)	
Hexadecimal number	Hexadecimal number	Decimal number
0400	0028	40
0401	0078	120
0402	001E	30

(6) Details of response codes

1) Types of response codes
A response message to a read command (R) or a write command (W) always contains a response code.
Response codes fall into two types, i.e., normal and error response codes.
Response codes are 8-bit binary data (0 to 255), the details of which are as shown in the following table:

Response code table

Response code		Code type	Description of the code
Binary number	ASCII		
0000 0000	"0", "0":30H, 30H	Normal response	Normal response code that occurs as a read command (R) or a write command (W) is received.
0000 0001	"0", "1" : 30H, 31H	Text block hardware error	A hardware error such as framing overrun error or parity error is detected in the text block data.
0000 0111	"0", "7" : 30H, 37H	Text block format error	The text block format differs from the prescribed format.
0000 1000	"0", "8" : 30H, 38H	Text block error in data format, data address, or number of data	The text block format differs from the prescribed format. The data address or the number of data differs from the prescribed one.
0000 1001	"0", "9" : 30H, 39H	Data error	A write data exceeds the settable range for the data.
0000 1010	"0", "A" : 30H, 41H	Execution command error	An execution command (such as MAN command) is received when it cannot be.
0000 1011	"0", "B" : 30H, 42H	Write mode error	When a type of data should not be rewritten, a write command containing the data is received.
0000 1100	"0", "C" : 30H, 43H	Specification/option error	A write command is received which contains the data of a specification or an option not added to the instrument.

2) About the priority among response codes
A response code has a higher priority when it has a smaller value.
When more than one response code occurs, the response code with the highest priority will be returned.

20-4. Overview of the MODBUS protocol

The MODBUS protocol supports ASCII and RTU modes as its two transmission modes. The MCM57 Series supports the RTU mode only.

(1) Overview of the transmission mode

Eight-bit binary data contained in commands are transmitted as they are.

■ Data configuration

Data format:	Selectable from 8E1, 8E2, 8N1, and 8N2
Error check method:	CRC-16 (cyclic redundancy check)
Data transmission interval:	3.5-character transmission time or less

(2) Message configuration

Configured to start after an idle period of 3.5-character transmission time or more and end after the elapse of an idle period of 3.5-character transmission time or more.

Idle 3.5 characters	Slave address	Function code	Data	Error check CRC	Idle 3.5 characters

(3) Slave address

A slave address is a device number assigned to each slave within the range of 1 to 247. (The MCM57 Series allows the assignment of up to 255 slave addresses.)
The master uses request messages to specify slave addresses for the identification of individual slaves.
A slave sends a response message with its own address set in it to identify itself to the master.

(4) Function codes

The function codes are used to instruct slaves of the type of action.

Function code	Details
03 (03H)	Set value and information reading by slave
06 (06H)	Writing by slave

These function codes are also used by slaves to indicate whether their response message to the master is a normal response (ACK) or indicates that an error of some kind (NAK) has occurred.

A positive acknowledgement is returned with the original function code set in it.

A negative acknowledgement is returned with the highest-order bit of the original function code set to 1.
For example, when a request message with a function code set incorrectly to 10H is sent to a slave, the slave will return a response message with the highest-order bit of 90H set to 1 because 10H is a non-existent function code.
When a negative acknowledgment occurs, the response message is returned with an error code set in its data to inform the master which type of error has occurred.

Error code	Details
1 (01H)	Illegal function (non-existent function)
2 (02H)	Illegal data address (non-existent data address)
3 (03H)	Illegal data value (overrange value)

(5) Data

Data may vary in configuration depending on the function code.
A request message from a master consists of data items, the number of data, and settings data.
A response message from a slave consists of the number of requested bytes and data, among other things, as well as an error code that may accompany a NAK.
The effective data range is from -32768 to 32767.

(6) Error check

An RTU mode error check calculates CRC-16 from the slave address to the end of the data and sets the obtained 16-bit data in low-to-high order to the end of the data.

■ CRC-16 calculation method

In the CRC method, the data to be transmitted are divided by a generator polynomial and transmitted with the resulting remainder added to the end of the data.

Generator polynomial: X16+X15+X2+1

1. CRC data (X) are initialized. (FFFFH)
2. The exclusive logical sum (XOR) of the first datum and X is taken and substituted into X.
3. X is shifted rightward by 1 bit for substitution into X.
4. If a carry occurs as the result of the shift, an XOR of the X resulting from Step 3 and the fixed value (A001H) is taken and substituted into X.
   If no carry occurs, the calculation proceeds to Step 5.
5. Steps 3 and 4 are repeated until 8 shifts are made.
6. An XOR of the next data and X is taken and substituted into X.
7. Steps 3 to 5 are repeated.
8. Steps 3 to 5 are repeated until the last datum is processed.

The obtained X's are set as CRC-16 data in low-to-high order to the end of the data of the message.

(7) Typical message

■ Reading of device number 1 and SV

• Request message from master

Idle 3.5 characters	Slave address (01H)	Function code (03H)	Data address (0300H)	Number of data (0001H)	Error check CRC (844EH)	Idle 3.5 characters
	1	1	2	2 2	⟵	Number of characters (8)

• Normal-state slave response message (SV=10.0°C)

Idle 3.5 characters	Slave address (01H)	Function code (03H)	Response Number of bytes (02H)	Data (0064H)	Error check CRC (B9AFH)	Idle 3.5 characters
	1	1	1	2	2	⟵ Number of characters (7)

• Abnormal-state slave response message (wrong data item)

Idle 3.5 characters	Slave address (01H)	Function code (83H)	Error code (02H)	Error check CRC (C0F1H)	Idle 3.5 characters
	1	1	1	2	⟵ Number of characters (5)

In a response message transmitted when an error has occurred, the highest-order bit of the function code is set to 1 (83H). As a response message for an error, error code 02H (non-existent data address) is returned.

■ Settings of device number 1 SV = 10.0°C

• Request message from master

Idle 3.5 characters	Slave address (01H)	Function code (06H)	Data Address (0300H)	Data (0064H)	Error check CRC (8865H)	Idle 3.5 characters
	1	1	2	2	2	⟵ Number of characters (8)

• Normal-state slave response message (SV=10.0°C)

Idle 3.5 characters	Slave address (01H)	Function code (06H)	Data Address (0300H)	Data (0064H)	Error check CRC (8865H)	Idle 3.5 characters
	1	1	2	2	2	⟵ Number of characters (8)

• Abnormal-state slave response message (when an out of range value is set)

Idle 3.5 characters	Slave address (01H)	Function code (86H)	Error code (03H)	Error check CRC (0261H)	Idle 3.5 characters
	1	1	1	2	⟵ Number of characters (5)

In a response message transmitted when an error has occurred, the highest-order bit of the function code is set to 1 (86H). As a response message for an error, error code 03H (out of range value) is returned.

20-5. Communication data address

(1) Details of communication data address

[Note] Error response codes are explained above in the section on the codes used with the Shimaden protocol.

1) About data addresses and read/write
- A data address expresses every 4 bits of a binary number (16-bit data) as one number in hexadecimal.
- R/W is readable/writable data.
- R … is read-only data.
- W … is write-only data.
- When a write-only data address is specified by a read command (R) or when a read-only data address is specified by a write command (W) or a broadcast command (B), a data address error will occur and error response codes “0” and “8” (30H and 38H) will be returned as “text block error in data format, data address, or number of data.”

2) About data addresses and numbers of data
- If any data address not listed as one for MCM57/MRM57 is specified as a start data address, a data address error will occur and error response codes “0” and “8” (30H, 38H) will be returned as “text block error in data format, data address, or number of data.”
- If the start data address of a read command is within the listed one but the data address with the number of data added is outside the listed one, the read data will be “0.”

3) About data
- Each data is a binary number without a decimal point (16-bit data) and hence needs to be checked for the data type, decimal point presence/absence, etc.
- The decimal point position for data for which the unit is digits depends on the measuring range.
- Data are handled as signed binary numbers (16-bit data: -32768 to 32767).

E.g.) Expressing data with a decimal point

				Hexadecimal data
20.0%	→	200	→	00C8
100.00°C	→	10,000	→	2710
-40.00°C	→	-4,000	→	F060

E.g.) 16-bit data representation method

Signed data	
Decimal number	Hexadecimal number
0	0000
1	0001
to	to
32767	7FFF
-32768	8000
-32767	8001
to	to
-2	FFFE
-1	FFFF

4) About <spare> in the parameter block
When a <spare> part is read out by a read command (R) or written by a write command (W), normal response codes “0” and “0” (30H and 30H) will be returned.

5) About option-related parameters
If a data address of a parameter not added is specified as an option by a read command (R) or a write command (W), error response codes “0” and “C” (30H and 43H) “specification/option error” will be returned.

6) About parameters hidden depending on the operating and/or setting specifications
Even parameters hidden (unused) depending on the operating and/or setting specifications can be read out/written in COM mode.

20-6. ASCII code table

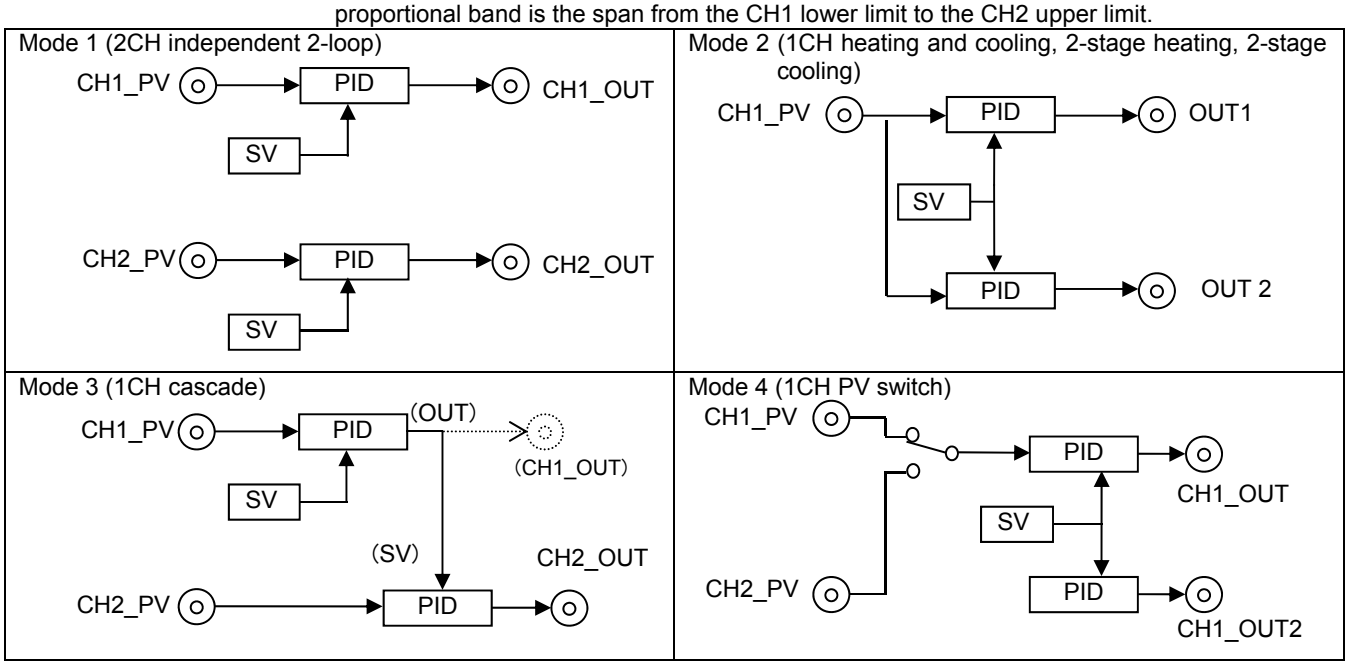
b7b6b5	000	001	010	011	100	101	110	111
b4 to b1	0	1	2	3	4	5	6	7
0000	NUL	TC7(DLE)	SP	0	@	P	`	p
0001	TC1(SOH)	DC1	!	1	A	Q	a	q
0010	TC2(STX)	DC2	”	2	B	R	b	r
0011	TC3(ETX)	DC3	#	3	C	S	c	s
0100	TC4(EOT)	DC4	$	4	D	T	d	t
0101	TC5(ENQ)	TC8(NAK)	%	5	E	U	e	u
0110	TC6(ACK)	TC9(SYN)	&	6	F	V	f	v
0111	BEL	TC10(ETB)	’	7	G	W	g	w
1000	FE0(BS)	CAN	(	8	H	X	h	x
1001	FE1(HT)	EM	)	9	I	Y	i	y
1010	FE2(LF)	SUB	*	:	J	Z	j	z
1011	FE3(VT)	ESC	+	;	K	[	k	{
1100	FE4(FF)	IS4(FS)	,	<	L	¥	l	|
1101	FE5(CR)	IS3(GS)	-	=	M	]	m	}
1110	SO	IS2(RS)	.	>	N	^	n	to
1111	SI	IS1(US)	/	?	O	_	o	DEL

21. Specifications

21-1. Configuration

• System mode: This instrument is basically an independent two-loop temperature controller with 2 inputs and 2 outputs.
Its flexible settings allow the following system configurations:

Mode 1: 2-input 2-output 2-channel, independent two-loop control
Mode 2: 1-input 2-output 1-channel heating and cooling, 2-stage heating, 2-stage cooling
Mode 3: 2-input 1-output 1-channel cascade control
Mode 4: 2-input 2-output 1-channel PV switchover control
* In mode 4, assign CH1 to the lowest temperature measuring range.
* In mode 4, the measuring range used as the reference for the proportional band is the span from the CH1 lower limit to the CH2 upper limit.



21-2. Indicators

· Status indicators: LED indicators
Red: Power
Green: CH1-RUN, CH2-RUN, CH1-OUT, and CH2-OUT

21-3. Setting

· Address setting: Pushbutton switch-operated automatic assignment of 2 consecutive addresses per unit

21-4. Inputs

· Input type: Selectable from multi (TC/Pt/mV) and voltage (V) at order placement
· Thermocouple: B, R, S, K, E, J, T, N, PLII, WRe5-26, {U, L (DIN 43710)}
Gold/iron-chromel (AuFe-Cr)
Input resistance: 500 kΩ or more
Tolerance for external resistance: 100 Ω or less
Burnout function: equipped as standard (upscale burnout)
Reference junction compensation accuracy: ±3°C (ambient temperature: 5 to 45°C)
• Resistance thermometer detector: Pt100 / JPt100, 3-wire type
Specified current: 0.25 mA
Wire resistance tolerance: 5 Ω or less per wire (3 wires with equal resistance)
• Voltage mV: -10 to 10, 0 to 10, 0 to 20, 0 to 50, 10 to 50, 0 to 100 mVDC
V: -1 to 1, 0 to 1, 0 to 2, 0 to 5, 1 to 5, 0 to 10 VDC
Input resistance: 500 kΩ or more
External receiving resistor (250 Ω) to be used for current input (0 to 20, 4 to 20 mADC).
· Input scaling function: Scaling available for voltage (mV, V) input
Scaling range: -2,000 to 10,000 digit
Span: 10 to 10,000 digit
Decimal point position: None, 1st to 3rd decimal places (decimal point optional in sensor input range)
• Sampling period: 0.5 seconds
• PV bias: -2,000 to 2,000 digit
• PV filter: 0 to 10,000 seconds
• PV gain: -5.00 to +5.00%
• Isolation: To be isolated from control outputs and AOs. Not to be isolated from other inputs and outputs, power supply, and system.

21-5. Control

- Controlling method: Expert PID control with auto-tuning function
- Control output type/rating: Transistor open collector/24 VDC, 100 mA
  SSR drive voltage / 12 V ± 1.5 V DC (max. load current 30 mA)
  Current / 4 to 20 mA DC (max. load resistance 500 Ω)
  Voltage / 0 to 10 V DC (max. load current 2 mA)
- Output resolution: Approx. 0.008% (1/13,000)
- Output accuracy: ±1.0%FS (5 to 100% output)
- Control parameters
  - Proportional band (P): OFF, 0.1 to 1,000.0%FS (ON-OFF action when OFF)
  - Integral time (I): OFF, 1 to 6,000 seconds (P or PD action when OFF)
  - Derivative time (D): OFF, 1 to 3,600 seconds (P or PI action when OFF)
  - Set point function (SF): OFF, 0.01 to 1.00
  - Differential gap mode: Selectable from the following two modes:
    CENT mode and SVOF mode
  - ON-OFF differential gap: 1 to 999 digit (enabled when P = OFF)
  - Manual reset: -50.0 to 50.0% (enabled when I = OFF)
  - Upper & lower output limiters: Lower limit 0.0 to 99.9%, upper limit 0.1 to 100.0% (lower limit < upper limit)
  - Proportional cycle: 1 to 120 seconds (for transistor open collector output and SSR drive voltage output)
  - Dead band: -2,000 to 5,000 digit (with overlapping upper and lower limits if negative)
  - Cascade mode: Cascade mode selectable from 3 different calculation methods:
    - Mode 1: SV2 = (OUT1/100) × (Scale_H-Scale_L) + Scale_L
    - Mode 2: SV2 = SV + Bias
    - Mode 3: SV2 = PV1 + Bias
  - Cascade scale: CH2 measuring range
  - Switchover point: Temperature at which PV switches from CH1 to CH2 in a temp. rising process
    (To be set within the overlapping part of the CH1 and CH2 measuring ranges)
  - Switchover hysteresis: Temp. at which PV is switched from CH1 to CH2 in a temp. dropping process should be specified based on the value subtracted from the switchover point.
    (To be set within the range of 0 to 1,000 digit)
- Manual control
  - Output setting range: 0.0 to 100.0%, setting resolution 0.1%
  - MAN-AUTO switching: Balanceless-bumpless (within proportional band)
- Soft start: To be set individually for CH1 and CH2
  OFF, 1 to 120 seconds
- AT point: Execution SV value
- Control output characteristics: RA (inverse characteristics) / DA (direct characteristics) switchable remotely
  To be set individually for CH1 and CH2
  RA (inverse characteristics) for heating action
  DA (direct characteristics) for cooling action
- Isolation: Not to be isolated from other control outputs and AOs. To be isolated from other inputs and outputs, power supply, and system.
- Other: Do not select different output types for CH1 and CH2 in a single module.

21-6. Event output

- Number of output points: 2 points per channel (EV1, EV2), 4 points in total
- Event types: Selectable for each EV from the following types:

NON	(None assigned)
HD	(Upper limit deviation alarm)
LD	(Lower limit deviation alarm)
OD	(Outside upper/lower limit deviation alarm)
ID	(Within upper/lower limit deviation alarm)
HA	(Upper limit absolute value alarm)
LA	(Lower limit absolute value alarm)
SO	(Overrange)
RUN	(RUN signal)
ROT1	(Output 1 inverted output (during transistor open collector output only))
COM	(COM direct operation)
STPS	(Step signal)
PTNS	(Pattern signal)
ENDS	(Program end signal)
HOLD	(Hold signal)
PROG	(Program signal)
U_SL	(Up-slope signal)
D_SL	(Down-slope signal)
GUA	(Guaranteed soak signal)

- Event setting ranges
  - Absolute value: Within measuring range (both upper and lower limits)
  - Deviation: -2,000 to 2,000 digit (both upper and lower limits)
    Upper/lower limit deviation: 0 to 2,000 digit (within/outside measuring range)

- Event action: ON-OFF action
- Differential gap: 1 to 1,000 digit
- Standby actions: Selectable from the following four types:
  No standby
  Standby 1 (at power-ON, and at STBY (RST) → RUN)
  Standby 2 (at power-ON, at STBY (RST) → RUN, and at execution SV change)
  Control mode (no standby: no alarm occurrence at input error)
- Output type/rating: Transistor open collector/24 VDC, 100 mA
- Output update cycle: 0.5 seconds
- Latching function: Alarm action holding function (assignable to deviation alarm/absolute value alarm)
  Selectable from ON (enable) and OFF (disable).
  Latching can be undone via DI or remotely.
- Output characteristics: Selectable from NO and NC
- Isolation: To be isolated from control outputs and AOs. Not to be isolated from other inputs and outputs, power supply, and system.

21-7. Program function

- Number of patterns: 4 max. (can be set to 1, 2, or 4)
- Number of steps: 8 max. (# of patterns = 4), 16 (# of patterns = 2), and 32 (# of patterns = 1)
  Total number of steps = 32
- Number of PID types: 3 max.
- Time setting: 0 min 0 sec to 99 min 59 sec per step, or 0 hr 0 min to 99 hr 59 min per step
- Setting resolution: 1 minute or one second
- Time accuracy: ± (setting time × 0.005 + 0.5 sec)
- Parameters can be set per step: SV, step time, and PID No.
- Pattern execution count: 10,000 times max.
- PV start: ON / OFF
- Guaranteed soak: OFF / 1 to 1,000 digit
- Hold: Operable either by external control input or remotely
- Advance: Operable either by external control input or remotely
- Power interruption backup: N/A (settings will be retained, while elapsed time, execution step, and execution count will be reset.)

21-8. External control input (DI)

- Number of input points: 3 points (DI1, DI2, DI3) exclusive-ORed with AO inputs
- DI assignment types: Selectable for each DI from the following types:

None assigned	
RUN1 (control ON/OFF)	Level action
RUN2 (control ON/OFF)	Edge action
MAN (manual output)	Level action
AT (auto-tuning)	Edge action
ESV2 (external SV selection 2)	Level action
ACT1 (output 1 output characteristics)	Level action
ACT2 (output 2 output characteristics)	Level action
PROG (program)	Level action
HLD (hold)	Level action
ADV (advance)	Edge action
PTN2 (start pattern selection-2 bit)	Level action
PTN3 (start pattern selection-3 bit)	Level action
L_RS (unlatching)	Edge action

  * For a level action to function when communication contention occurs, priority is given to DI. Meanwhile, both the up-edge and down-edge will remain enabled when communication contention occurs.
- Action input: No-voltage contact or open collector, approx. 5 VDC, 1 mA or less
- Min. input holding time: 0.5 seconds
- Isolation: To be isolated from control outputs and AOs. Not to be isolated from other inputs and outputs, power supply, and system.

21-9. Analog outputs (option)

- Number of output points: 1 point per channel
- Output type: Selectable from measured value, set value (execution SV), and control output
- Output specifications/rating: Current 4 to 20 mADC (max. load resistance 300 Ω)
  Voltage 0 to 10 VDC (max. load current 2 mA)
  Voltage 0 to 10 mVDC (output resistance 10 Ω)
- Output scaling: Within measuring range or within output range (inverse scaling allowed)
- Output accuracy: ±0.3%FS (relative to indicated value)
- Output resolution: Approx. 0.008% (1/13,000)
- Output update cycle: 0.5 seconds
- Output limiter: Upper and lower limit (0.0 to 100.0%) can be set. Lower limit< upper limit.
- Isolation: Not to be isolated from other AOs and control outputs. To be isolated from other inputs and outputs, power, and system.

21-10. COM Module

• Indication

Status indicators:LED indicators
Red: Power
Green: M-TXD, M-RXD, S-TXD, and S-RXD

• Setting

Indication method:8 front face DIP switches and pushbutton switch

SW1, 2	Slave address (high-order)	OFF, OFF ON, OFF	: 1 to 62 : 129 to 191	OFF, ON ON, ON	: 65 to 127 : 183 to 255
SW3	Protocol	OFF	: SHIMADEN	ON	: MODBUS-RTU
SW4, 5	Baud rate	OFF, OFF ON, OFF	: 4,800 : 19,200 bps	OFF, ON ON, ON	: 9,600 bps : 38,400 bps
SW6	Data length (invalid for MODBUS)	OFF	: 7 bits	ON	: 8 bits
SW7	Parity bit	OFF	: Non	ON	: Even
SW8	Stop bit	OFF	: 1	ON	: 2

• Master communication function

Communication system:EIA standard RS-485 or RS-422 (specified at order placement)
Communication method:Half-duplex, asynchronous
Communication delay time:Approx. 10 msec
Max. number of connectable units:5 units including host
Communication code:SHIMADEN: ASCII code / MODBUS-RTU: Binary code
Protocol:Shimaden standard protocol / MODBUS-RTU
Start / end character:STX(02h), ETX(03h), CR(0Dh) (Shimaden standard protocol)
Error detection:CRC-16 (MODBUS-RTU), checksum (SHIMADEN)
Communication distance:500 m max. (variable depending on conditions)
Termination:External 120 Ω resistor

• Temp. Control Module communication function

Communication system:Dedicated bus
Communication method:Half-duplex, asynchronous
Max. number of connectable units:32 units including COM Module
Communication code:Binary code
Protocol:Dedicated protocol

21-11. General specifications

• Data memory: Non-volatile memory (EEPROM)
• Operating environmental conditions

Temperature:-10 to 50°C
Humidity:90%RH or less (no condensation)
Altitude:2,000 m or less above sea level
Category:I
Contamination level:2

• Operating temperature: -10 to 55°C
• Storage temperature: -20 to 65°C
• Power supply voltage: 24V DC±10%
• Insulation resistance: 500 VDC, 20 MΩ or more, for power supply-to-master communication (RS-485/RS-422)
• Withstand voltage: 500 VAC, 1 min, for power supply-to-master communication (RS-485/RS-422)
• Power consumption

COM Module:1.9 W max. at 24 VDC
Temp. Control Module:2.9 W max. at 24 VDC

• Insulation: Functional insulation for power supply-to-master communication (RS-485/RS-422)
Dedicated bus not to be insulated from power supply and system
• Casing material: PA66 (66 nylon)
• Outline dimensions: H108 × W22.6 × D113.6 mm
• Mass

COM Module:Approx. 120 g
Temp. Control Module:Approx. 150 g

* With regard to the technical details of products, please contact your nearer Shimaden dealer.

The contents of this manual are subject to change without notice.

Temperature and Humidity Control Specialists

SHIMADEN CO., LTD

Head Office: 2-30-10 Kitamachi, Nerima-ku, Tokyo 179-0081 Japan
Phone: +81-3-3931-7891 Fax: +81-3-3931-3089
E-MAIL: exp-dept@shimaden.co.jp URL: http://www.shimade.co.jp

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