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No. CP-SP-1308E

NX Network Instrumentation Module

NX-D15/25 Controller Module

User's Manual

Abridged Version

Thank you for purchasing the NX Network Instrumentation Module NX-D15/25 Controller Module.

This manual contains information for ensuring the correct use of the NX-D15/25. It also provides necessary information for installation, maintenance, and troubleshooting.

This manual should be read by those who design and maintain equipment that uses the NX-D15/25. Be sure to keep this manual nearby for handy reference.

Yamatake Corporation

NOTICE

Be sure that the user receives this manual before the product is used.

Copying or duplicating this user's manual in part or in whole is forbidden. The information and specifications in this manual are subject to change without notice.

Considerable effort has been made to ensure that this manual is free from inaccuracies and omissions. If you should find an error or omission, please contact Yamatake Corporation.

In no event is Yamatake Corporation liable to anyone for any indirect, special or consequential damages as a result of using this product.

Conventions Used in This Manual

■ To prevent injury to the operator and others, and to prevent property damage, the following types of safety precautions are indicated:

⚠**WARNING**	Warnings are indicated when mishandling this product might result in death or serious injury.
⚠**CAUTION**	Cautions are indicated when mishandling this product might result in minor injury to the user, or only physical damage to the product.

■ In describing the product, this manual uses the icons and conventions listed below.


Use caution when handling the product.


The indicated action is prohibited.


Be sure to follow the indicated instructions.

Handling Precautions:
Handling Precautions indicate items that the user should pay attention to when handling the NX-D15/25.

Note: Notes indicate information that might benefit the user.

☞: This indicates the item or page that the user is requested to refer to.

(1), (2), (3): Numbers within parentheses indicate steps in a sequence or parts of an explanation.

Safety Precautions

⚠WARNING

Before removing, mounting, or wiring the NX-D15/25, be sure to turn off the NX and all connected devices. Failure to do so might cause electric shock.
Before starting transmission to the NX-D15/25, be sure to verify that it is wired properly. A wiring mistake can cause faulty operation or a dangerous accident.

⚠CAUTION

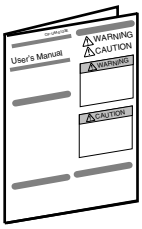
Use a tool such as a screwdriver to mount and remove the DIN rail locking tab.
Do not disassemble the NX-D15/25. Doing so might cause device failure.
Do not block ventilation holes. Doing so might cause fire or device failure.
Do not allow wire clippings, metal shavings or water to enter the controller case. They might cause fire or device failure.
Do not touch electrically charged parts such as the power terminals. Doing so might cause electric shock.
Before wiring the NX-D15/25, be sure to turn off the power. Failure to do so might cause device failure.
Wire the NX-D15/25 properly using the specified types of wire and following recognized installation methods. Failure to do so might cause electric shock, fire or device failure.
Prevent the total power consumption of all linked modules from exceeding 70 W. Failure to do so might cause fire or faulty operation.
Supply power to all linked modules from the same power source. Using two or more power sources can cause fire or faulty operation.
Do not use unused terminals on the NX-D15/25 as relay terminals. Doing so might cause electric shock, fire or device failure.
Do not short-circuit the outputs. Doing so might cause device failure.
Firmly tighten the terminal screws to the torque listed in the specifications. Insufficient tightening of terminal screws might cause electric shock or fire.
Use a surge protector or the like if there is a risk of power surges caused by lightning. Failure to do so might cause fire or faulty operation.
Use the NX-D15/25 within the operating ranges recommended in the specifications (temperature, humidity, voltage, vibration, shock, mounting direction, atmosphere, etc.). Failure to do so might cause fire or device failure.

⚠CAUTION

	**The NX-D15/25 does not operate for about ten seconds after turning on the power. Pay attention to this when using the relay output from the NX-D15/25 as an interlock signal.**
	**When disposing of the NX-D15/25, dispose of it appropriately as industrial waste in accordance with local regulations.**

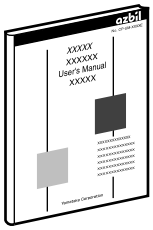
The Role of This Manual

A total of 4 different manuals are available for the NX-D15/25. Read them as necessary for your specific requirements. If a manual you require is not available, contact Yamatake Corporation or its dealer.



NX Network Instrumentation Module
NX-D15/25/35 Controller Module User's Manual for Installation
Manual No. CP-UM-5561JE

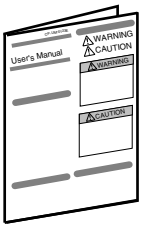
This manual is supplied with the NX-D15/25. Personnel in charge of design and/or manufacture of a system using the NX-D15/25 must thoroughly read this manual. This manual describes safety precautions, installation, wiring, and primary specifications. For further information about operation, refer to Installation and Configuration manual.



NX Network Instrumentation Module
NX-D15/25 Controller Module User's Manual Abridged Version
Manual No. CP-UM-1308E

This Manual.

First-time users of the NX-D15/25, as well as personnel in charge of hardware design involving the NX-D15/25 (such as building it into a control panel) or maintenance of a system using the NX-D15/25 should read this manual thoroughly. This manual describes the hardware, gives an overview of the NX-D15/25, outlines the kinds of products used in combination with the NX-D15/25, describes installation, wiring, maintenance, and troubleshooting, and gives detailed specifications.



NX Network Instrumentation Module
NX-CB1 Communication Box User's Manual for Installation
Manual No. CP-UM-5558JE

This manual is supplied with the NX-CB-1. Personal in charge of design and/or manufacture of a system using the NX-CB-1 must thoroughly read this manual. The manual describes installation of the software into a personal computer, operation of the personal computer, various functions, and setup procedures.

Organization of This User's Manual

This manual is organized as follows:

Chapter 1. OVERVIEW

This chapter describes the overview, features, model selection guide, and part names and functions of the NX-D15/25.

Chapter 2. INSTALLATION

This chapter describes the environmental conditions and installation procedures when installing the NX-D15/25.

Chapter 3. WIRING

This chapter describes the wiring procedures, wiring precautions, and connection examples.

Chapter 4. FUNCTIONS NECESSARY FOR CONTROL

This chapter describes the functions absolutely necessary to operate the control of the NX-D15/25.

Chapter 5. OPERATION AND GENERAL FUNCTIONS

This chapter describes how to set the functions, which are normally used for the NX-D15/25.

Chapter 6. FUNCTIONS OFTEN USED FOR OPERATIONS OTHER THAN CONTROL

This chapter describes how to set the functions, which are used for operations other than the control actions of the NX-D15/25.

Chapter 7. FUNCTIONS USED AS REQUIRED

This chapter describes how to set the functions necessary for convenient operations of the NX-D15/25.

Chapter 8. LIST OF SETTINGS

Refer to: "NX-D15/25 Digital Indicating Controller User's Manual for Displays and Settings (CP-SP-1265E)".

Chapter 9. CPL COMMUNICATIONS FUNCTION

This chapter describes how to communicate the NX-D15/25 with a host unit, such as a personal computer or PLC through Yamatake's standard CPL communication using RS-485.

Chapter 10. MODBUS COMMUNICATIONS FUNCTION

This chapter describes how to communicate the NX-D15/25 with a host unit, such as a personal computer or MODBUS communication using RS-485.

Chapter 11. TROUBLESHOOTING

This chapter describes the troubleshooting of the NX-D15/25.

Chapter 12. MAINTENANCE, INSPECTION, AND DISPOSAL

This chapter describes how to carry out the maintenance and inspection of the NX-D15/25 and how to dispose of the NX-D15/25.

Chapter 13. SPECIFICATIONS

This chapter describes the general specifications, performance specifications, external dimensions, and optional parts of the NX-D15/25.

Appendixes

These appendixes describe the function block diagrams, standard bit codes, standard numerical bit codes, and using characters and terms used in descriptions of this manual.

Contents

Chapter 4. FUNCTIONS NECESSARY FOR CONTROL

Chapter 5. OPERATION

Chapter 6. FUNCTIONS OFTEN USED FOR OPERATIONS OTHER THAN CONTROL

Chapter 7. MV if PV is Abnormal

Chapter 8. CPL COMMUNICATIONS FUNCTION

Chapter 9. MODBUS COMMUNICATIONS FUNCTIONS

Chapter 10. MODBUS/TCP COMMUNICATIONS FUNCTIONS

Chapter 11. TROUBLESHOOTING

Chapter 12. MAINTENANCE, INSPECTION, AND DISPOSAL

Chapter 13. SPECIFICATIONS

APPENDICES

Chapter 1. OVERVIEW

1 - 1 Overview and Features

■ Overview

Linked by Ethernet, NX network instrumentation modules make distributed instrumentation, high-speed communications, and easy installation all possible at the same time. NX also creates value for customers by offering reduced environmental impact, superior product quality, and higher productivity.
The NX-D15/25 is a distributed multi-channel controller that can execute PID control for up to 4 loops.

■ Features

● For high-speed communications

- Standard Ethernet hardware
  Each NX module is equipped for Ethernet communication.
  When NX modules are not only linked but also distributed, greatly reduced wiring is possible by using a daisy chain configuration.
  NX modules are also equipped for RS-485 communication.
  NX modules are capable of high-speed communications with host systems, programmable logic controllers (PLCs), display devices, etc.
  A network equipped with NX modules can be upgraded to use Yamatake's monitoring/control system.

- Distributed layout
  With Ethernet connections, there is no difference in function between distributed and contiguous layouts.

- Redundant communications
  Either non-ring or ring connection is possible on an Ethernet network.

● Hardware

- Compact, with advanced capabilities
  Compact size (30 X 100 X 104 mm)

- Simple assembly
  The NX module consists of a base, body, and terminal block, and can be installed and uninstalled without tools.

- Contiguous modules or distributed layout
  Input/output signals can be shared between modules, whether they are physically contiguous or in a distributed layout.

- Stand-alone modules
  Since each module contains its own power supply, control and communication functions, a single module can be used effectively for applications that do not require many channels, saving space.

● Control functions

- One module can execute PID control for up to 4 loops.
- Full multi-range input provides multiple range selections for thermocouple, resistance temperature detector (RTD), DC, and DC voltage.
- 2-loop control (with RSP) and heat/cool control are available in control mode.
- Control output can be allotted for control of multiple devices.
- As an option, 4-channel models can additionally be equipped for current transformer input, digital input, or digital output.
- NX modules can also provide logical operation processing for digital inputs, digital outputs, internal events, etc.
- Because modules are linked, they can provide input/output for the operation of other modules.

● Engineering tools

The SLP-NX smart loader package (sold separately) is available for use with NX modules.
The SLP-NX allows a PC to access multiple modules simultaneously via Ethernet. Consequently, control/setting/monitoring can be executed for multiple modules at the same time, reducing engineering time.

1 - 2 Model Selection Table

■ Controller module

Basic Model No.	Type	Ring connection	Wiring method	Channels	Output type	Option	Other	Specification
NX-								NX Instrumentation Network Module
	D15							Controller module ±0.3 %FS, 500 ms sampling (SV connection is not possible.)
	D25							Controller module ±0.3 %FS, 200 ms sampling
		N						Non-ring connection
		R						Ring connection
			T					Screw terminal block
				4				4 channels
					T			Transistor output
					C			Analog current output
					D			Analog voltage output
						0		None
						1		Current transformer inputs (with 4 ch.)
						2		Digital outputs (with 4 ch.)
						3		Digital inputs (with 4 ch.)
							0	None
							D	Inspection certificate
							Y	Traceability certification

■ Communications box

Basic model No.	Type	Ring connection 1	Ring connection 2	Number of ports	Option	Other	Specification
NX-							NX Instrumentation Network Module
	CB1						4-port switching hub
		N					Side connector (non-ring connection)
		R					Side connector (ring connection)
			N				Front port (non-ring connection)
			R				Front port (ring connection)
				04			4 ports
					0		RJ-45
						0	None
						D	Inspection certificate

■ Communications adaptor / Terminal adaptor

Basic model No.	Type	Option 1	Option 2	Option 3	Option 4	Other	Specification
NX-							NX Instrumentation Network Module
*1	CL1						Communications adaptor for left side
*1	CR1						Communications adaptor for right side
*1	TL1						Terminal adaptor for left side (for ring connection between chains)
*1	TR1						Terminal adaptor for right side (for ring connection between chains)
		0					None
			0				None
				00			None
					0		None
						0	None
						D	Inspection certificate

*1. Left and right are defined as seen when viewing the front of the unit.

1 - 3 Names and Functions of Parts

■ Controller module

● Body

LED operation indicators (shared)

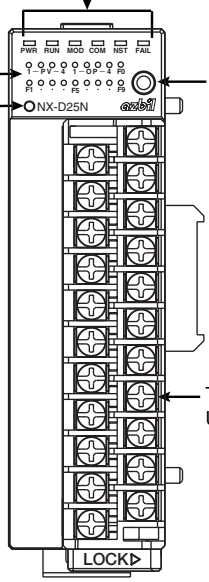
PWR :	Lit	Power is on
	Off	Power is off
RUN :	Lit	RUN mode (normal operation mode)
	Fast blink	Module RUN mode, READY for PID calculation for 1 loop or more
	Off	Operation other than the above
MOD	Fast blink	Downloading configuration data Downloading firmware
	Off	Normal operation mode
COM	Lit	Sending/receiving module's own Ethernet packets
	Off	Not sending/receiving module's own Ethernet packets
NST	Lit	Ring diagnostics function is off
	Fast blink	Ring disconnection (ring disconnected somewhere)
	Slow blink	Ring disconnection between the module and its node or the next node.
	Off	Ring condition normal.
FAIL	Lit	Serious fault
	Slow blink	Minor fault or alarm
	Off	No errors

LED operation indicators (individual)

PV1～4	Fast blink	PV input error
	Off	PV input normal, or not in use
OP1～4	Lit	Control output is on.
	Off	Control output is off.
F0～9	Lit	User definitions 0 to 9 are on.
	Off	User definitions 0 to 9 are off

LED operation can be selected from five types: lit, fast blink, slow blink, off, and reverse.

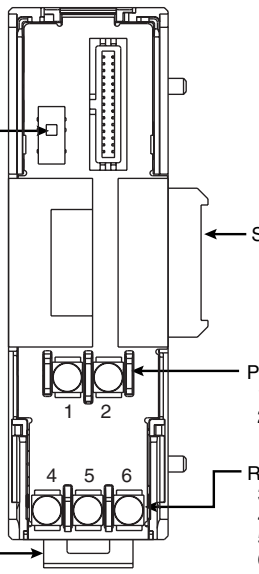
Button



Loader jack:
Used for connecting the cable for the SLP-NX smart loader package (sold separately), for setting/monitoring with the loader.

Terminals:
Used for connecting signal wires.

● Base



RS-485 cutoff switch:
Used to disable RS-485 communications with devices connected on the right side.

Side connector:
Used for connecting modules.

Power supply terminal:
1: 24 Vdc(+)
2: 24 Vdc(-)

DIN rail locking tab:
Used for locking on a DIN rail.

RS-485 communications terminal:
3-lead RS-485 connector terminal
4: DA
5: DB
6: SG

■ Communications box

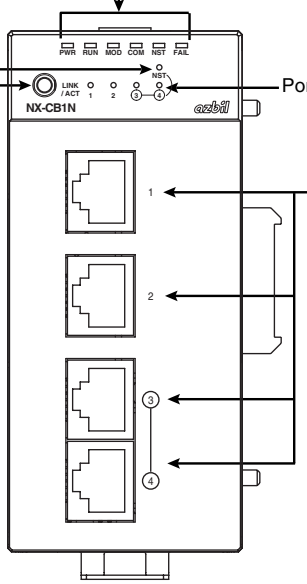
● Body

LED operation indicators (shared)

PWR :	Lit	Power is on
	Off	Power is off
RUN :	Lit	Normal operation
	Flashing	Hardware error
	Off	Hardware error
MOD	Off	Normal
COM	Lit	Sending Ethernet packets to network linked to side connector.
	Off	Not sending Ethernet packets to network linked to side connector.
NST	Lit	Non-ring communications
	Fast blink	Ring disconnection (ring disconnected somewhere)
	Slow blink	Ring disconnection between the module and its node or the next node.
	Off	Normal ring communications
FAIL	Lit	Serious fault
	Blinking	Minor fault
	Off	No errors

Front NST operation indicator

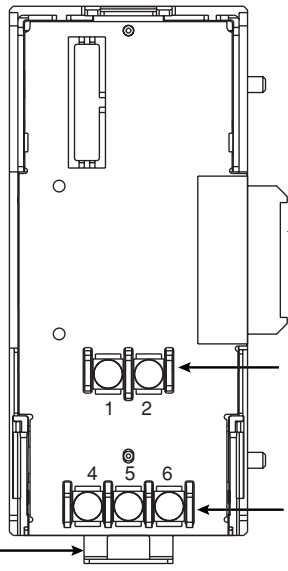
Maintenance jack
(for Yamatake Corp. use only):
Cannot be connected to SLP-NX smart loader package.



Port operation indicators 1 to 4

Ethernet ports 1 to 4:
Used for connecting an Ethernet cable.
For a ring connection, use ports 3 and 4.

● Base



Side connector:
Used for connecting modules.

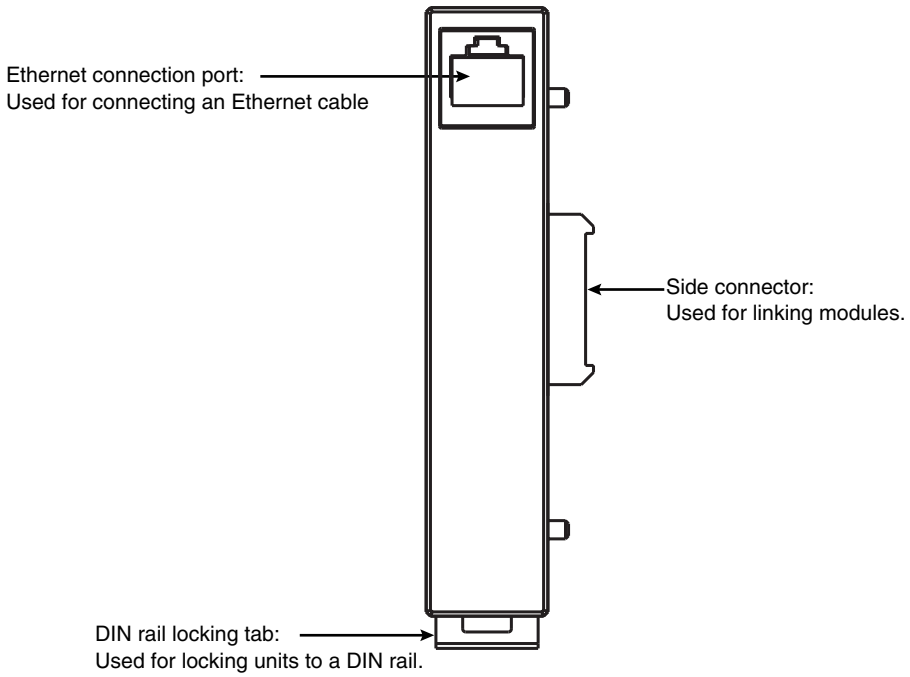
Power supply terminal:
1: 24 Vdc(+)
2: 24 Vdc(-)

DIN rail locking tab:
Used for locking on a DIN rail.

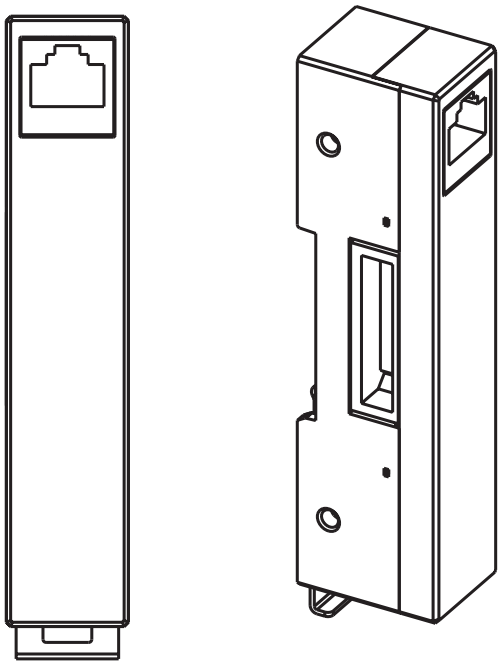
RS-485 communications terminal:
3-lead RS-485 connector terminal
4: DA
5: DB
6: SG

■ Communications adaptor

● Port for left-side connection

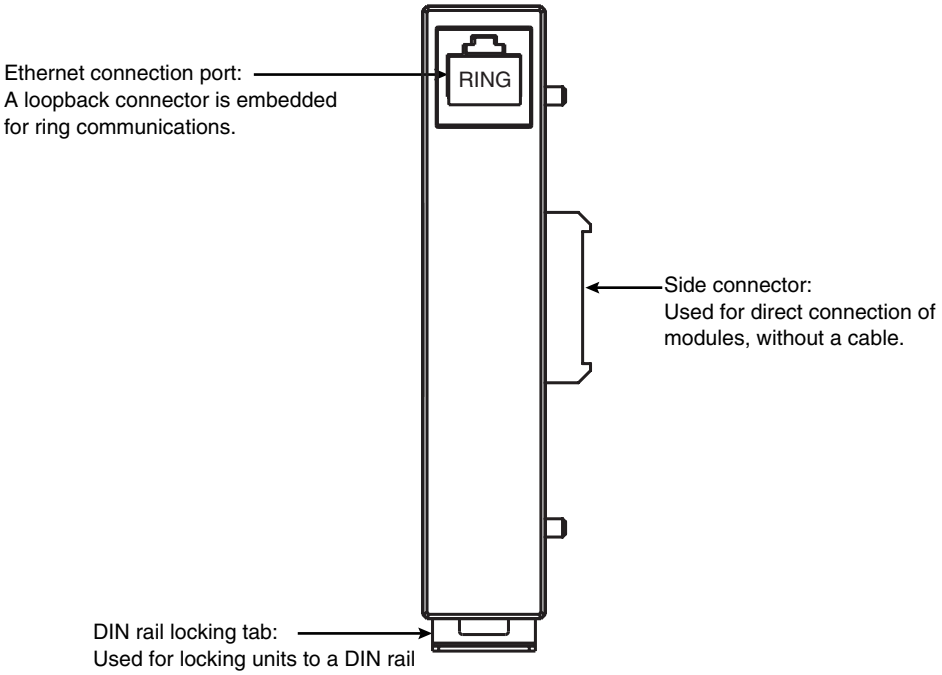


● Port for right-side connection

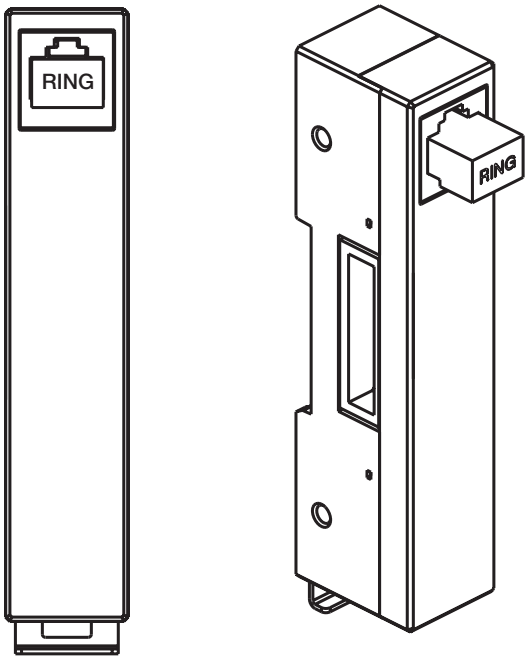


■ Terminal adaptor

● Port for left-side connection

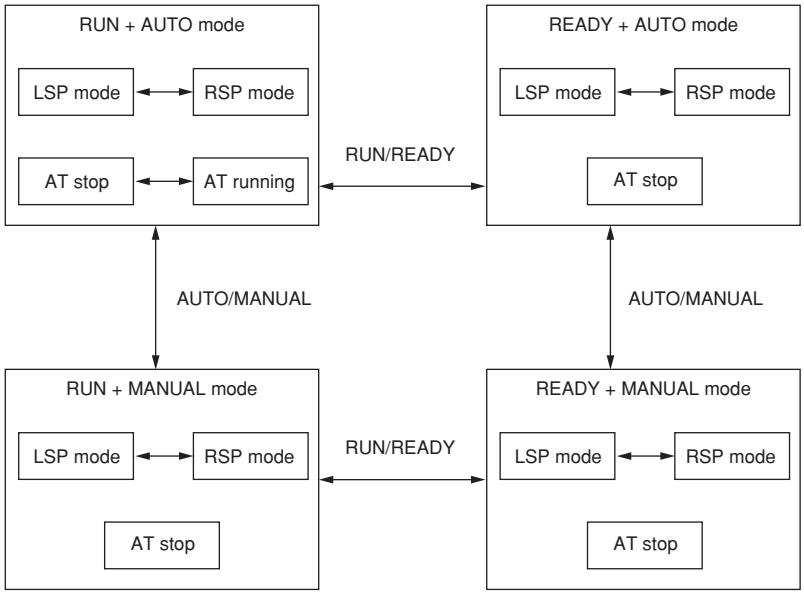


● Port for right-side connection



1 - 4 Operation Modes

The following shows the transition of operation modes:



RUN: Control status

READY: Control stop status

AUTO: Automatic operation (This unit automatically determines the MV values.)

MANUAL: Manual operation (The MV values are operated manually.)

LSP: Local SP (The control is performed using the SP stored in the measuring instrument.)

RSP: Remote SP (The analog input from the external device is used as SP.)

AT: Auto tuning (The PID constants are set automatically using the limit cycle.)

Chapter 2. INSTALLATION

⚠ WARNING

Before removing, mounting, or wiring the NX-D15/25, be sure to turn off the NX and all connected devices. Failure to do so might cause electric shock.

⚠ CAUTION

Use the NX-D15/25 within the operating ranges recommended in the specifications (temperature, humidity, voltage, vibration, shock, mounting direction, atmosphere, etc.).
Failure to do so might cause fire or faulty operation.

Do not block ventilation holes.
Doing so might cause fire or faulty operation.

Do not allow wire clippings, metal shavings or water to enter the controller case.
They might cause fire or device failure.

■ Location

Install the controller in a location that meets the following criteria:

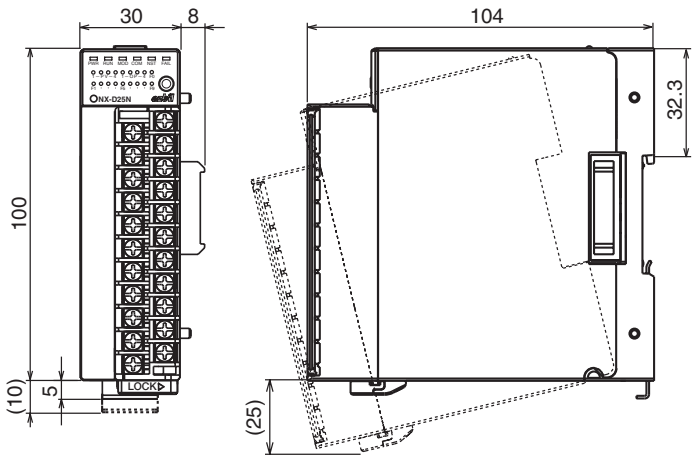
- No high/low temperature/humidity.
- Free from sulfide gas or corrosive gas.
- Not dusty or sooty.
- Protected from direct sunlight, wind, and rain.
- Little mechanical vibration or shock.
- Not close to high voltage line, welding machine or other electrical noise generating source.
- At least 15 meters away from the high voltage ignition device for a boiler.
- No strong magnetic fields.
- No flammable liquid or gas.

■ External dimensions

The diagram below shows the NX-D25, which has the same dimensions as the NX-D15/25.

Unit: mm

● Screw terminal block



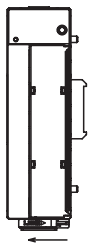
■ Mounting/removing the terminal block

● Removal procedures

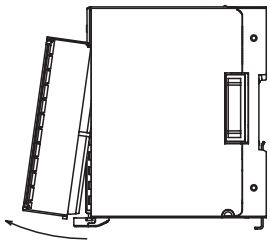
! Handling Precautions

- Removal of the terminal block should be done during wiring before the NX is installed, or during maintenance.

(1) To unlock the terminal block, slide its lock lever to the left.

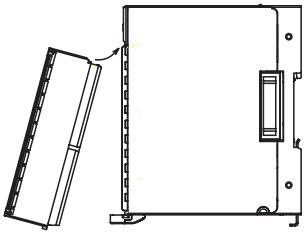


(2) Remove the terminal block by pulling the bottom part toward you.

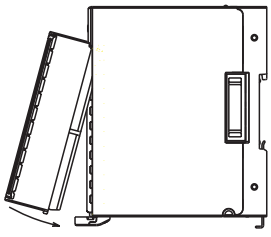


● Mounting procedures

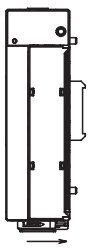
(1) Tilt the terminal block and insert its upper part into the groove on the case.



(2) Push the bottom part of the terminal block into the case.



(3) To lock the terminal block in place, slide its lock lever to the right.



■ Linking modules

The NX-D15/25 can be linked to other modules using the connectors on the left and right of the base. Modules must be linked before the NX-D15/25 is mounted on the DIN rail. When linked, modules share the power supply and RS-485 connection, eliminating the need for wiring. RS-485 communications can be disabled using the communications disconnection switch on the base.

■ Mounting procedure

The NX-D15/25 is used while mounted on a DIN rail.
After mounting the DIN rail and pulling the locking tab completely off, hook the base onto the DIN rail. Then, push the DIN rail locking tab upwards firmly until it clicks into place.

! Handling Precautions

- Install the module so that it is vertical, with the DIN rail locking tab at the bottom.

■ Attaching the main unit to the base

! Handling Precautions

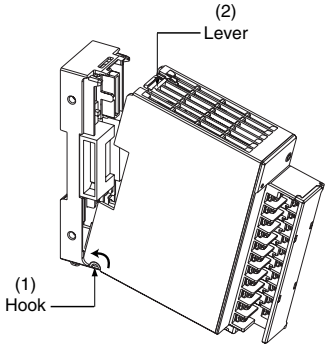
- The included base and main NX unit must be used as a pair.

(1) Fit the hook on the main unit into the base.

! Handling Precautions

- Be sure to fit the hook on the main unit into the base first. If this is not done, the hook might be broken during mounting.

(2) Push the main unit onto the base until it clicks into place.



To remove the main unit from the base, pull it towards you while pressing down on the lever.

Chapter 3. WIRING

3 - 1 Wiring Precautions

⚠ WARNING

- Before removing, mounting, or wiring the NX-D15/25, be sure to turn off the NX and all connected devices. Failure to do so might cause electric shock.
- Before starting transmission to the NX-D15/25, be sure to verify that it is wired properly. A wiring mistake can cause faulty operation or a dangerous accident.

⚠ CAUTION

- Do not disassemble the NX-D15/25. Doing so might cause electric shock or device failure.
- Do not allow wire clippings, chips or water to enter the controller case. They might cause fire or device failure.
- Before wiring the NX-D15/25, be sure to turn off the power. Failure to do so might cause device failure.
- Wire the NX-D15/25 properly using the specified types of wire and following recognized installation methods. Failure to do so might cause electric shock, fire or device failure.
- Firmly tighten the terminal screws to the torque listed in the specifications. Insufficient tightening of terminal screws might cause electric shock or fire.
- Use a surge protector or the like if there is a risk of power surges caused by lightning. Failure to do so might cause fire or faulty operation.
- The NX-D15/25 does not operate for about ten seconds after turning on the power. Pay attention to this when using the relay output from the NX-D15/25 as an interlock signal.

■ Wiring precautions

- Check the model number of the controller and the terminal numbers on the label on the side of the NX to prevent any wiring errors.
- For terminal connections, use crimp terminals that are the correct size for M3 screws.
- Be careful not to allow any crimp-type terminal lugs to touch adjacent terminals.
- The signal wires and power wires of the NX should be at least 60 cm away from other power wires or power sources. Also, do not pass these wires through the same conduit or wiring duct.
- Before connecting the NX-D15/25 to other devices in parallel, check their connection conditions carefully.
- Pass a lead wire for carrying the heater current through the current transformer. Do not use a heater current that exceeds the amount of allowable current stated in the specifications. Doing so might damage the NX-D15/25.
- To ensure stable operation, the NX-D15/25 is designed not to operate for ten seconds after the power is turned ON. It then enters Run mode. However, for satisfaction of the accuracy specifications, allow at least 30 minutes of warm-up time.
- After wiring, check that there are no mistakes before turning the power ON.

3 - 2 Recommended Cables

- Contact the thermocouple wires to the terminals in case of a thermocouple input. When a thermocouple is connected to terminals, or wiring distance is long, connect the wire via a shielded compensating lead wire.
- For input/output other than thermocouples, use a JCS 4364 instrument cable or equivalent (generally called twisted shielded cable for instrumentation use).

  Recommended twisted shielded cables are:

Fujikura Ltd.	2 conductors	IPEV-S-0.9 $mm^2 \times$ 1P
	3 conductors	ITEV-S-0.9 $mm^2 \times$ 1T
Hitachi Cable, Ltd.	2 conductors	KPEV-S-0.9 $mm^2 \times$ 1P
	3 conductors	KTEV-S-0.9 $mm^2 \times$ 1T

- A shielded multiconductor microphone cord (MVVS) may be used, if electromagnetic induction noise is comparatively low.

3 - 3 Terminal Connections

⚠CAUTION

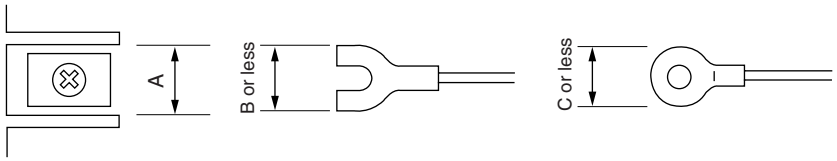
Firmly tighten the terminal screws to the torque listed in the specifications. Insufficient tightening of terminal screws might cause electric shock or fire.

Do not use unused terminals on the NX-D15/25 as relay terminals. Doing so might cause electric shock, fire or device failure.

Do not short-circuit the outputs. Doing so might cause device failure.

NX-D15/25 terminal connections

For wiring of NX-D15/25, use an appropriate crimp type terminal lug suitable for the M3 screw.



Applicable screw size	Terminal dimensions (mm)			Recommended crimp terminal JIS indication	Applicable electrical wire size	JST Mfg. Co. Model No. (Reference)
	A	B	C			
M3	6.1	5.8	5.8	RAV1.25-3	0.3 to 1.3 mm² AWG22 to 16	V1.25-3 V1.25 B3A

Handling Precautions

- When installing this unit in a place where the vibration or impact is large, always use an appropriate round crimp type terminal lug to avoid loose terminal connections.
- Pay special attention so that no crimp type terminal lugs are in touch with adjacent terminals.
- The tightening torque of the terminal screw must be 0.5 to 0.7 N · m or less.

Note

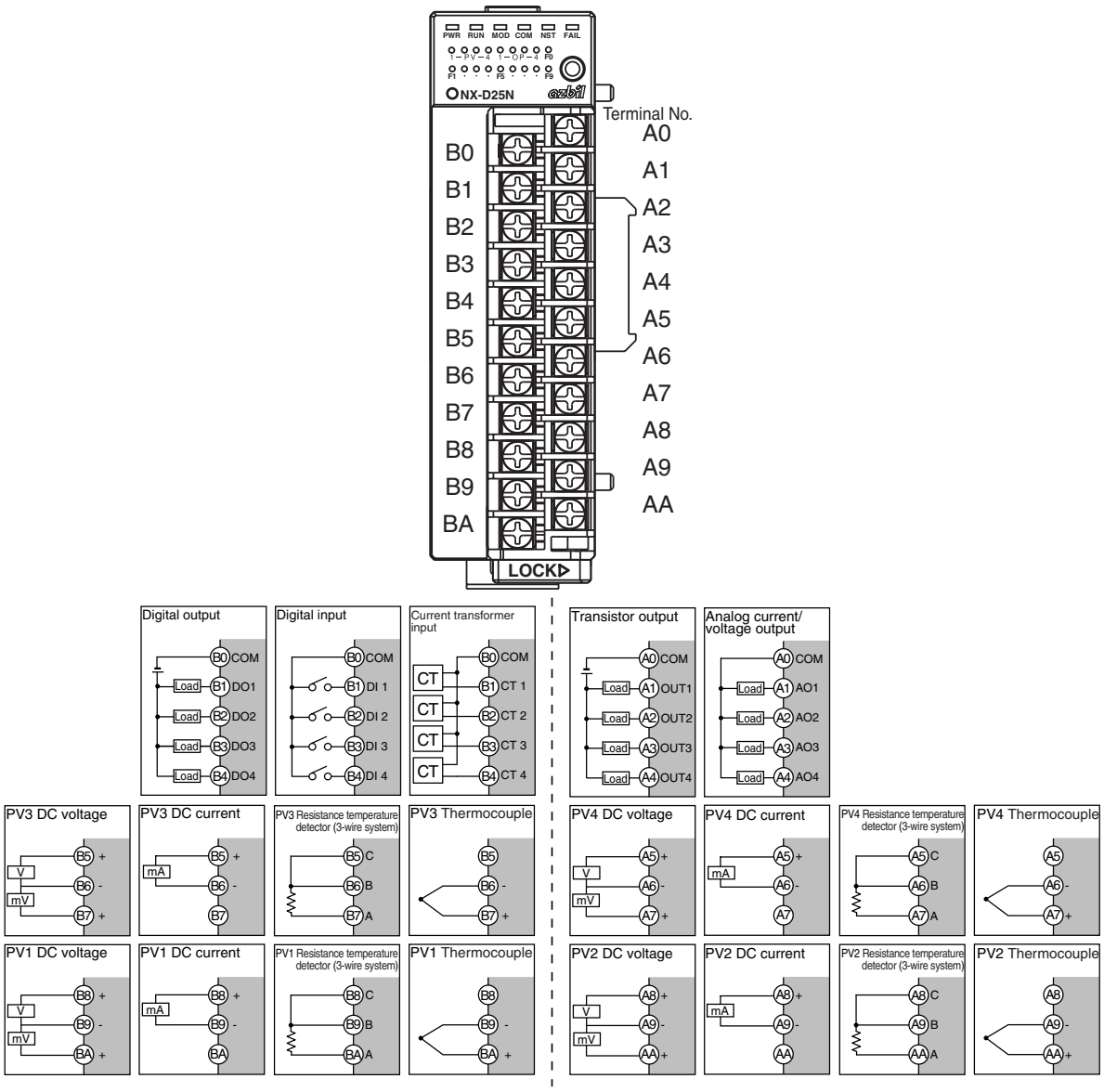
- Crimp terminals

  For marking cables, the sleeve of a crimp terminal is usually used. Crimp terminals that fit the NX-D15/25 connector are shown below for reference.

  Manufacturer: J.S.T. Mfg. Co., Ltd.

  Model No.: VTUB-1.25
  (pack of 1000, with insulation; lead size: 0.25 to 1.65 mm2)
  VTUB-2
  (pack of 1000, with insulation; lead size: 1.04 to 2.63 mm2)
  TUB-1.25
  (pack of 1000, without insulation; lead size: 0.25 to 1.65 mm2)
  TUB-2
  (pack of 1000, without insulation; lead size: 1.04 to 2.63 mm2)

3 - 4 Terminal Wiring Diagram



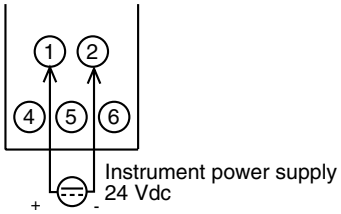
3 - 5 Power Supply Connections and Grounding

■ Power supply connections

⚠WARNING

- Before wiring, removing or mounting the NX-D15/25, be sure to turn the power OFF. Failure to do so might cause electric shock or device failure.
- Prevent the total power consumption of all linked modules from exceeding 70 W. Failure to do so might cause fire or faulty operation.

Connect the power terminals as shown below.



Handling Precautions

- Linked modules supply power to each other.
- Supply power to one of the linked modules.
- Use a power supply that can supply the total power requirement of the linked modules.

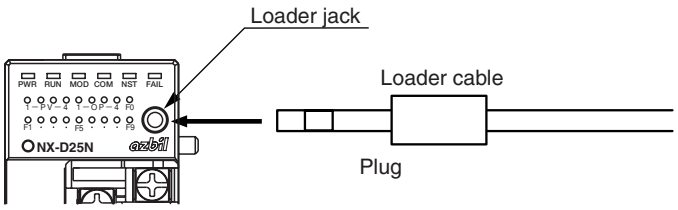
■ Noise-reduction

Obtain the NX-D15/25 power source from a single-phase instrumentation power source not subject to excess noise for AC model.
If the power source generates noise, add an insulation transformer, and use a line filter.
Line filter Yamatake Corporation Model No. 81446364-001
Use a CR filter for fast-rising noise.
CR filter Yamatake Corporation Model No. 81446365-001

Handling Precautions

- After introducing noise-reduction measures, do not bundle cables from the primary and secondary coils of the isolation transformer together. Do not put them in the same conduit or duct.

3 - 6 Loader Cable Connection

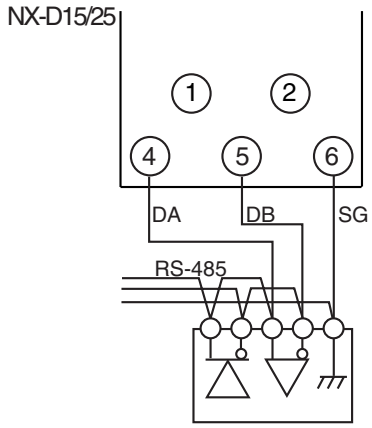


Handling Precautions

- Be sure to insert the plug into the loader jack properly.
- When plugging/unplugging the loader cable, grasp the plug. Do not pull on the cable itself.
- When the loader cable is connected, do not apply force to the cable or plug (side to side or up and down). Doing so may damage the cable or jack, or affect the functions or performance of the unit.

3 - 7 RS-485 Communication Connections

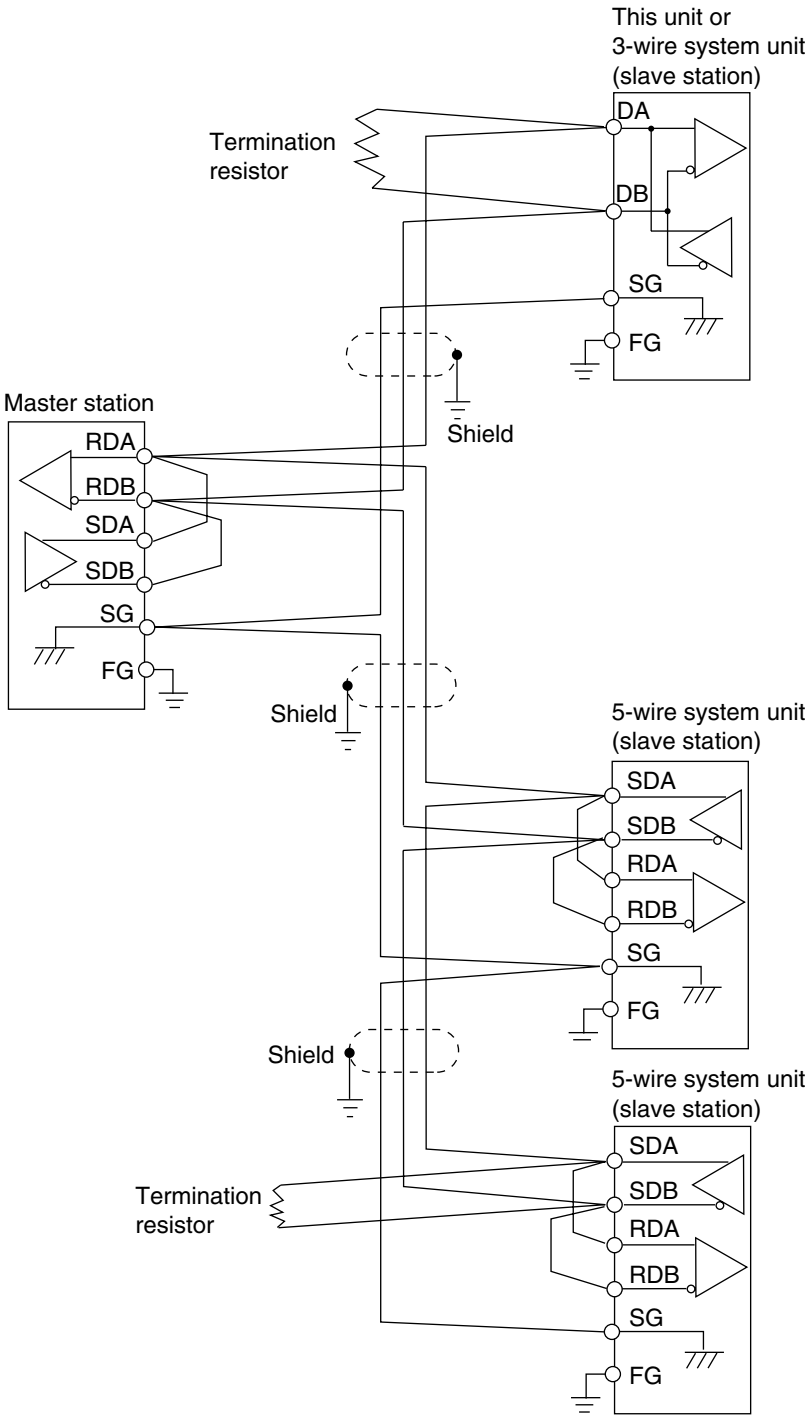
RS-485 communications uses a 3-lead connection.
Connect the communications wiring to any linked module.



Handling Precautions

- 0.5 W or greater terminating resistor of 150 Ω 5 % at each end of the communications lines.
- Be sure to connect the SG terminals each other. Failure to do so might cause unstable communications.
- For communications wiring, use twisted pair cables.

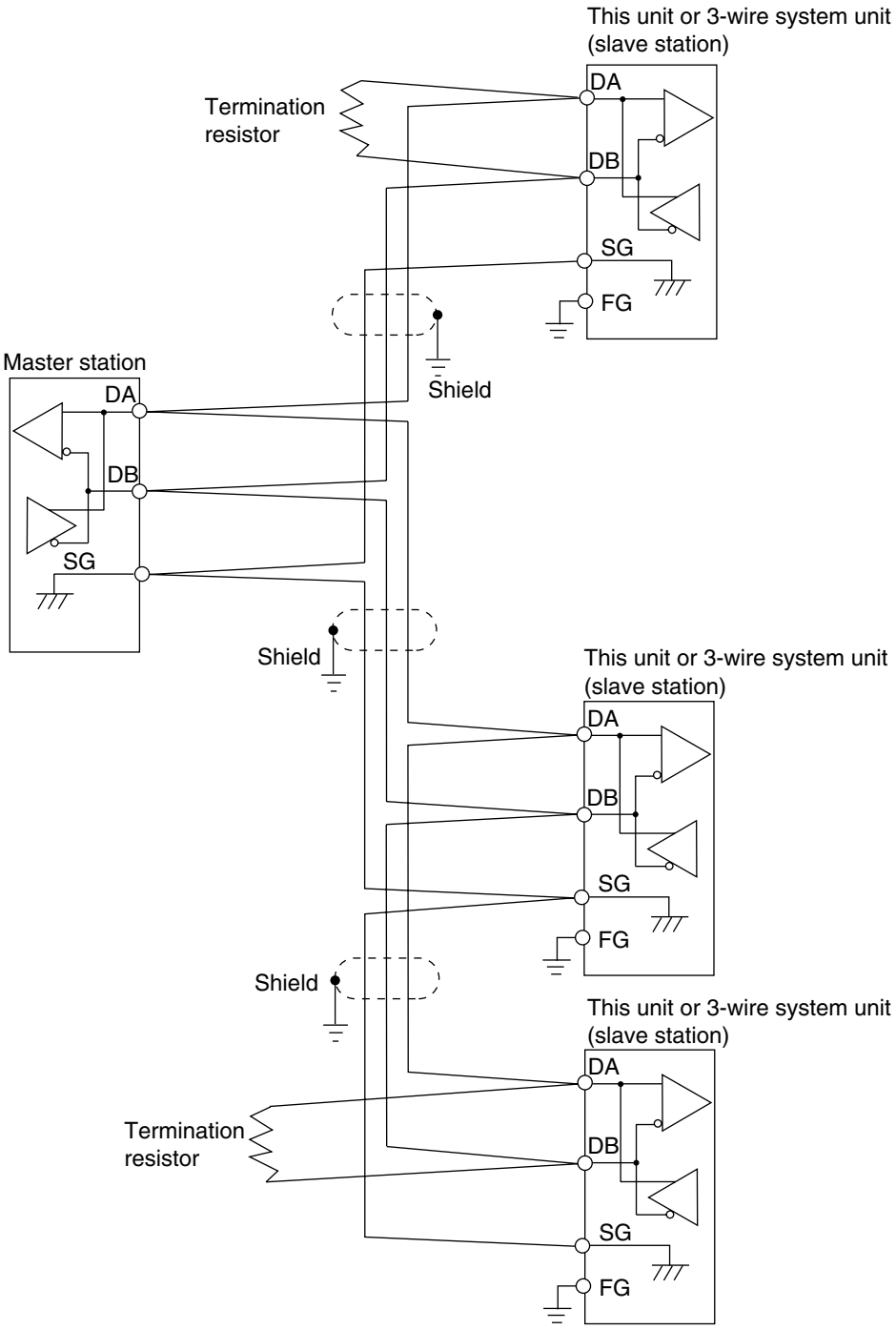
● **Multiple 5-wire system units together**



! Handling Precautions

- If devices to which the connection of a terminating resistor is prohibited (Such as Yamatake SDC15/25/26/35/36 or DMC10) are on the same communications line, do not connect a terminating resistor to the NX-D15/25 or to the communications line.

● **3-wire system**



! Handling Precautions

- If devices to which the connection of a terminating resistor is prohibited (Such as Yamatake SDC15/25/26/35/36 or DMC10) are on the same communications line, do not connect a terminating resistor to the NX-D15/25 or to the communications line.

3 - 8 Noise Generation Sources and Noise Suppression

Generally, it is thought that the following may be noise generation sources:

1. Relays and contacts
2. Solenoid coils and solenoid valves
3. Power lines (higher than 90 Vac, in particular)
4. Inductive loads
5. Motor commutators
6. Phase angle control SCRs
7. Radio communication equipment
8. Welding machines
9. High-voltage ignition devices

The following shows effective measures for noise suppression:

1. A CR filter is effective for quick-rising noises such as impulse noise.
   Recommended CR filter: Yamatake Corporation Model No. 81446365-001
2. A varistor is effective for noises with high crest values.
   Recommended varistor
   Yamatake Corporation Model No. : 81446366-001 (for 100 V)
   81446367-001 (for 200 V)

Handling Precautions

- Take great care when using a varistor since the varistor becomes short-circuited if it is faulty.

3 - 9 I/O Isolation

Items surrounded by solid lines are isolated from other signals.

<table>
<tr><td colspan="2">Power supply</td></tr>
<tr><td rowspan="5">Logic circuits
Loader jack
RS-485, Ethernet communication
Displays (led, switch, etc)
Current transformer inputs (ch1 to 4)</td><td rowspan="5">Transistor outputs (ch1 to 4)
Analog current outputs (ch1 to 4)
Analog voltage outputs (ch1 to 4)
Digital output (ch1 to 4)
Digital input (ch1 to 4)</td></tr>
<tr><td>PV input (ch1)</td></tr>
<tr><td>PV input (ch2)</td></tr>
<tr><td>PV input (ch3)/MFB 1 *1</td></tr>
<tr><td>PV input (ch4)/MFB 2 *1</td></tr>
</table>

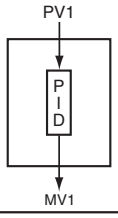
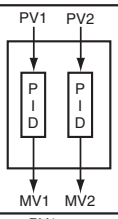
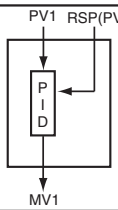
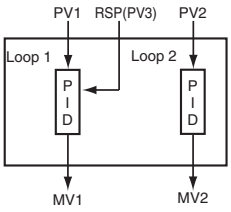
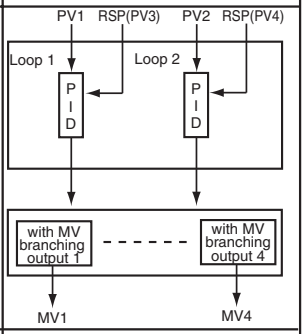
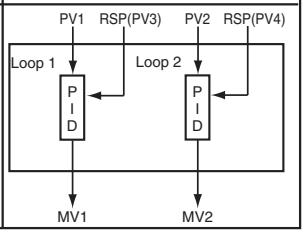
*1: Motor feedback input will be available in the near future.

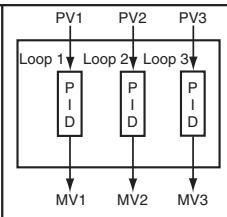
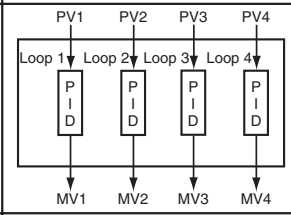
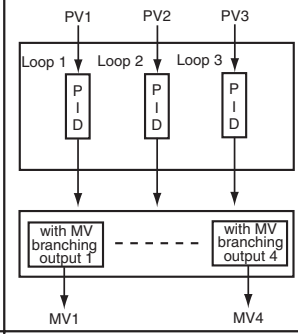
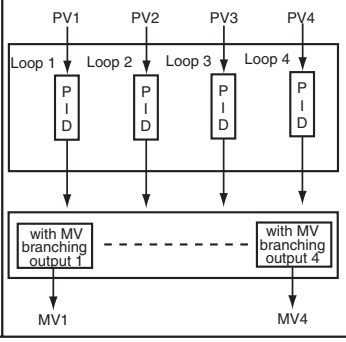
Chapter 4. FUNCTIONS NECESSARY FOR CONTROL

4 - 1 How to Set the Loop Type

■ Bank and settings

Bank	Item name	Settings
Setup (basic function)	Loop type	See below

Loop type	
0: 1 loop	
1: 2 loops (Independent)	
2: 1 loop (RSP)	
5: 2 loops (with an RSP)	
8: 2 loops + with MV branching output	
9: 2 loops (Independent)	

Loop type	
21: 3 loops (Independent)	
22: 4 loops (Independent)	
23: 3 loops + with MV branching output	
24: 4 loops + with MV branching output	

4 - 2 How to Set the Input Type (PV input)

■ Bank and settings

Bank	Item name	Settings
PV input	Range type	See below

■ Input types

● Thermocouple

Range type	Sensor type	Range	Resolution
1	K	-200 to +1200˚C	1˚C
2	K	0 to 1200˚C	1˚C
3	K	0.0 to 800.0˚C	0.1˚C
4	K	0.0 to 600.0˚C	0.1˚C
5	K	0.0 to 400.0˚C	0.1˚C
6	K	-200.0 to +400.0˚C	0.1˚C
7	K	-200.0 to +200.0˚C	0.1˚C
8	J	0 to 1200˚C	1˚C
9	J	0.0 to 800.0˚C	0.1˚C
10	J	0.0 to 600.0˚C	0.1˚C
11	J	-200.0 to +400.0˚C	0.1˚C
12	E	0.0 to 800.0˚C	0.1˚C
13	E	0.0 to 600.0˚C	0.1˚C
14	T	-200.0 to +400.0˚C	0.1˚C
15	R	0 to 1600˚C	1˚C
16	S	0 to 1600˚C	1˚C
17	B	0 to 1800˚C	1˚C
18	N	0 to 1300˚C	1˚C
19	PL II	0 to 1300˚C	1˚C
20	WRe5-26	0 to 1400˚C	1˚C
21	WRe5-26	0 to 2300˚C	1˚C
22	Ni-Ni･Mo	0 to 1300˚C	1˚C
23	PR40-20	0 to 1900˚C	1˚C
24	DIN U	-200.0 to +400.0˚C	0.1˚C
25	DIN L	-100.0 to +800.0˚C	0.1˚C
26	Gold-iron/chromel	0.1 to +360.1K	0.1K

The low limit for B thermocouple indication is 20 °C.

● RTD

Range type	Sensor type	Range	Resolution
41	Pt100	-200.0 to +500.0˚C	0.1˚C
42	JPt100	-200.0 to +500.0˚C	0.1˚C
43	Pt100	-200.0 to +850.0˚C	0.1˚C
44	JPt100	-200.0 to +640.0˚C	0.1˚C
45	Pt100	-100.0 to +300.0˚C	0.1˚C
46	JPt100	-100.0 to +300.0˚C	0.1˚C
47	Pt100	-100.0 to +200.0˚C	0.1˚C
48	JPt100	-100.0 to +200.0˚C	0.1˚C
49	Pt100	-50.0 to +100.0˚C	0.1˚C
50	JPt100	-50.0 to +100.0˚C	0.1˚C
51	Pt100	-20.00 to +60.00˚C	0.01˚C
52	JPt100	-20.00 to +60.00˚C	0.01˚C

● Linear

Range type	Sensor type	Range
81	DC voltage	0 to 10mV
82		-10 to +10mV
83		0 to 100mV
84		0 to 1V
85		-1 to +1V
86		1 to 5V
87		0 to 5V
88		0 to 10V
89		2 to 10V
90	DC electricity	0 to 20mA
91		4 to 20mA

■ Setting procedures

(1) Set the range type.
(2) Set the decimal point position as needed.
(3) Set the temperature unit (Celsius/Fahrenheit/Kelvin) as needed.
(4) Set the alarm point as needed.

🕮 Note

- The input indication accuracy may vary depending on the type of sensor.
  For details, refer to:
  ☞ Chapter 13, PV input (on page 13-1).

[!] Handling Precautions

- If any value not available is set, the input value will be fixed at 0.0.

4 - 3 How to Set Range-Related Items

Each range is set corresponding to the input type set in section 4-2 How to Set the Input Type (on page 4-2).

■ Bank and settings

Bank	Item name	Settings
Loop control (basic setting)	Range low limit for proportional band	Low limit of range used for PID control
	Range high limit for proportional band	High limit of range used for PID control
PV input	Alarm setting low limit	Under-range is detected by the PV below this value.
	Alarm setting high limit	Over-range is detected by the PV exceeding this value.
	Linear scaling low limit	Value when the low limit of the linear signal is input. * This item must be set when the linear input is selected.
	Linear scaling high limit	Value when the high limit of the linear signal is input. * This item must be set when the linear input is selected.

■ How to set the Range for Proportional Band

Range low and high limits for proportional band are used for PID control.
Set the range low and high limits for proportional band as needed according to the PV input range for operation.
Execute PID tuning after setting the range for proportional band. If the range is changed, tune the PID again.

● Setting procedures

Example: K thermocouple range (0.0 to 800.0 °C) used for loop 1 PV
In the loop control (basic setting) bank, set as follows.

Item name	Settings
(Loop 1) Range low limit for proportional band	0.0
(Loop 1) Range high limit for proportional band	800.0

Note

- 4-2 Other than setting the input type as shown in 4-2, "How to Set the Input Type" (page 4-2), set range-related items as needed.
  Since settings are initialized automatically as in the examples shown below, re-setting is usually not necessary other than alarm setting for linear.
  - If the range type is changed to thermocouple/RTD
    Usually, it is not necessary to change settings other than the range type. However, if needed, set the decimal point position, temperature unit, alarm setting high and low limits, range high and low limits for proportional band.
  - If the range type is changed to linear
    Set the high and low limits for the alarm setting, because they are not initialized automatically.
    –1999.9 to +32000.0 is the usual setting range. In the range set by user, an alarm occurs if the input is the allowable minimal input or less, or the allowable maximum input or more.

- Parameter initialization when a range type is set

Input type	Alarm setting low-high limits	Range high and low limits for proportional band	Decimal point position
Thermocouple, RTD	Set *1	Set *1	Set *2
Linear range	Do not set	Do not set	Do not set

*1. The default setting varies depending on the temperature unit (Celsius/Fahrenheit).
*2. The maximum decimal point position is set for the range type and temperature unit (Celsius/Fahrenheit).

- Parameter initialization when a temperature unit is set

Input type	Alarm setting low-high limits	Range high and low limits for proportional band	Decimal point position
Thermocouple, RTD	Set *1	Set *1	Set *2
Linear range	Do not set	Do not set	Do not set

*1. The default setting varies depending on the temperature unit (Celsius/Fahrenheit).
*2. The maximum decimal point position is set for the range type.

- Parameter initialization when linear scaling is set

Input type	Range high and low limits for proportional band
Linear range	Set *1

*1. The linear range high and low limits are set for the range for proportional band.

■ How to set the linear scaling

The high and low limits of the linear range need to be set when the DC voltage or DC current is selected for the input type. Input high and low limit values corresponding to the output range (engineering range) of the connected unit.

● Setting procedures

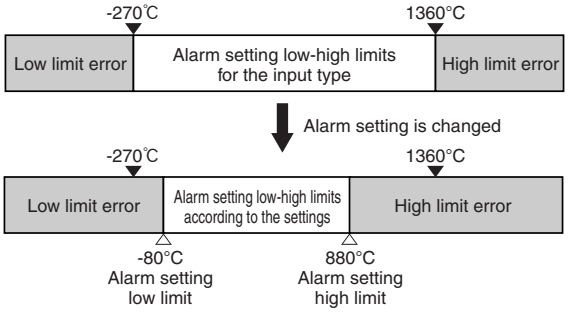
Example: Setting when the pressure transmitter is connected

Specifications of transmitter		Setting of this unit		
Output signal	Output range	Bank	Item name	Settings
4 mA DC	0.0 kPa	PV input	Linear scaling low limit	0.0
20 mA DC	10.0 kPa	PV input	Linear scaling high limit	10.0

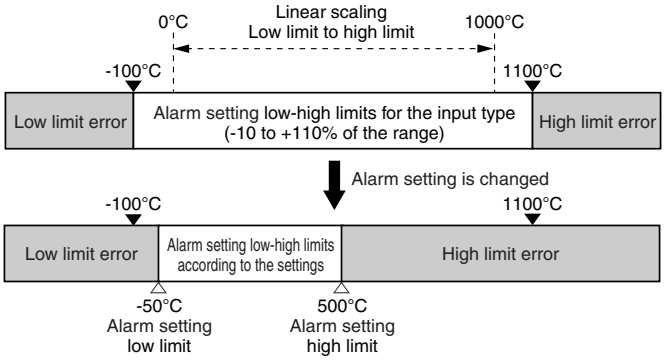
■ How to change the alarm setting

The alarm setting differs for each input type.
By setting the PV input range narrowly, the point at which the alarm is activated can be changed.

● Example: changing the alarm setting for PV1 (K thermocouple, -200 to +1200 °C)

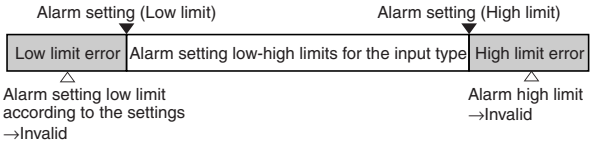


● Example: changing the alarm setting for PV1 (DC voltage, scaling 0 to 1000)



⚠ Handling Precautions

- If the low and high limits of the alarm setting are set outside of the low-high limit alarm setting for the input type, the alarm setting will remain unchanged.



4 - 4 Functions of LSP

Up to 4 SP groups can be selected for a loop.
The number of SP system groups can be changed by setting the SP system group in the setup (basic action) bank.

■ SP system group

Select the number of LSP groups for a loop.
For details, refer to:
☞ 6-3, How to Use the Multi-SP (on page 6-11)

Bank	Item name	Setting
Setup (basic function)	SP system group	1 to 4

■ LSP

Up to 4 LSP groups can be selected for a loop.

Bank	Item name	Setting
LSP	LSP1	SP low and high limits
	LSP2	
	LSP3	
	LSP4	

■ PID group definition

A PID group No. used for LSP/RSP can be set.

Bank	Item name	Setting
LSP	PID group definition 1 (for LSP)	1 to 4
	PID group definition 2 (for LSP)	
	PID group definition 3 (for LSP)	
	PID group definition 4 (for LSP)	
RSP	PID group definition (for RSP)	

■ SP group No.

An LSP group No. can be set for each loop.
The SP group selection can be changed for loops having 2 or more SP system groups.

Bank	Item name	Setting
SP group selection	SP group selection	1 to 4

■ SP high and low limits

The SP high and low limits can be set for each loop in order to specify the SP range.

Bank	Item name	Setting
SP configuration (limit)	SP low limit	-19999 to +32000U (depending on the decimal point position of the loop PV/SP)
	SP high limit	

■ LSP ramp

It is possible to change the SP with a constant SP ramp.
For details, refer to:
☞ 6-4, How to Change the LSP with Constant Ramp (on page 6-13)

■ RSP ramp

When the setting of the RSP is changed, it is possible to change the SP with a constant SP ramp.
For details, refer to:
☞ 6-5, How to Change the RSP with Constant Ramp (on page 6-14)

Note

- LSP (local set point): set point stored in the NX.
  RSP (remote set point): set point given by an external analog input.

4 - 5 How to Set the Decimal Point Position

Apart from the decimal point position for the input range, which is set in the PV bank, the decimal point position for the display can be set.

■ Bank and settings

Bank	Item name	Settings
Loop control (basic function)	Loop PV/SP decimal	0: No decimal point, 1: 1 digit after the decimal point, 2: 2 digits after the decimal point 3: 3 digits after the decimal point 4: 4 digits after the decimal point

Settings for the decimal point position are reflected in the following screens/items.

Bank	Item name	Note
Communications profile (instrument status) Monitor (basic)	PV, SP	Even if the decimal point position is changed, the.settings are unchanged (within the allowable setting range). Example: changing 100 to 100.0 (from no decimal point to 1 digit after the decimal point)
Loop control (basic setting)	Range low and high limits for proportional band	
SP configuration (limit)	SP low and high limits	
SP configuration (ramp and others)	LSP bias	
PID	Differential 1 - Differential 4	
LSP	LSP1 - LSP4	
RSP	RSP	
Communications profile (operation processing)	LSP	

! Handling Precautions

- In the case of a thermocouple or RTD, the maximum number of digits after the decimal point is determined separately for each range type. Set the decimal point position within the appropriate range for the range No.
  For details about ranges for each input type, refer to:
  ☞ ■ Input types (on pages 4-2).

4 - 6 How to Set the Loop Control Action

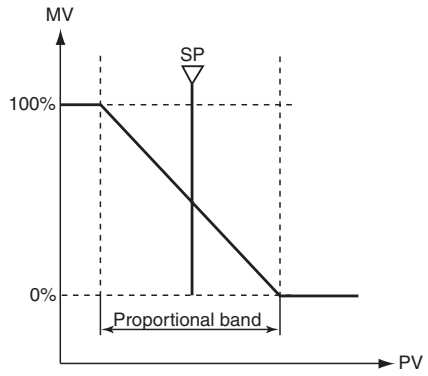
■ Bank and settings

Bank	Item name	Settings
Loop control (basic setting)	Control action	0: Reverse action (heat) 1: Direct action (cool) 2: Heat/Cool 4: Reverse action (on/off) 5: Direct action (on/off)

The basic operation of the PID control is set.

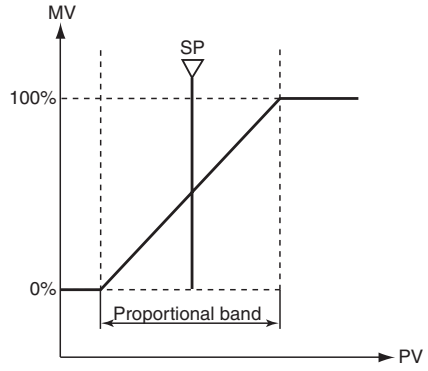
• Heat action: Reverse action

(The MV decreases as the PV increases. Generally, this action is used for heating control.)

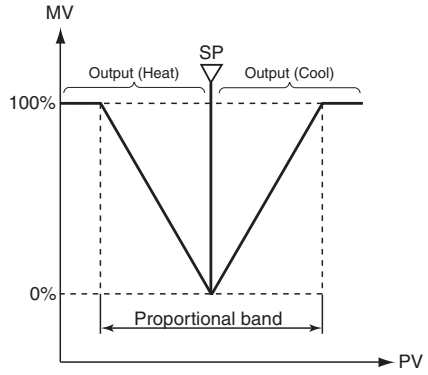


• Cool action: Direct action

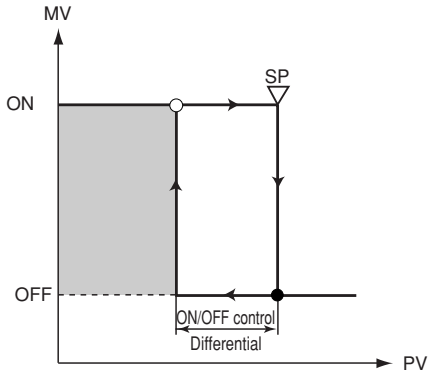
(The MV decreases as the PV increases. Generally, this action is used for cooling control.)



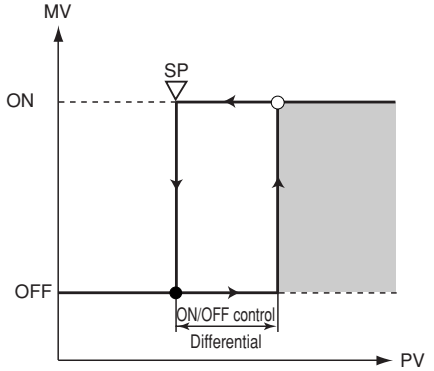
• Heat/Cool action



• ON/OFF action: Reverse action



• ON/OFF action: Direct action



● **Example: Assigning the heat/cool MV to the output.**

The following is an example of how to assign the heat and cool MVs to the analog current outputs 1 and 2 respectively for loop 1 of an analog current output model.

(1) In the loop control (basic setting) bank, make setting as follows.

Item name	Settings
(Loop 1) Control action	2: Heat/Cool
(Loop 1) Heat/cool control dead zone	0.0

(2) In the output (continuous output) bank, set as follows

Item name	Settings
(Analog current output 1) Output range	0: 4 to 20 mA
(Analog current output 1) Output type	2: Heat MV
(Analog current output 1) Loop/channel definition	1: Loop 1
(Analog current output 1) Output decimal position	1: 1 digit after the decimal point
(Analog current output 1) Low limit of output scaling	0.0
(Analog current output 1) High limit of output scaling	100.0
(Analog current output 2) Output range	0: 4 to 20 mA
(Analog current output 2) Output type	3: Cool MV
(Analog current output 2) Loop/channel definition	1: Loop 1
(Analog current output 2) Output decimal position	1: 1 digit after the decimal point
(Analog current output 2) Low limit of output scaling	0.0
(Analog current output 2) Output decimal position	100.0

4 - 7 How to Set Outputs (continuous output and time proportional output)

Setup items of each setting may vary depending on the type of output and operation method.

■ Output types, applications

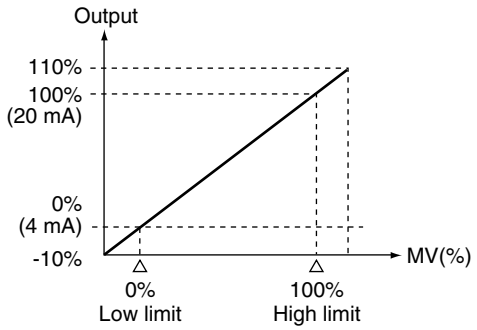
Output type	Application
Transistor	Time proportional output (MV) Alarm output (EV)
Analog current Analog voltage	Continuous output (MV) Transmission output (PV, SP, etc.)

■ Continuous output setup

Bank	Item name	Settings
Output (continuous output)	Output range	At analog current output 0: 4 to 20 mA 1: 0 to 20 mA At analog voltage output 0: 1 to 5 V 1: 0 to 5 V 2: 0 to 10 V 3: 2 to 10 V
	Output type	0: Fixed at 0 % 1: MV 2: Heat MV (for heat/cool control) 3: Cool MV (for heat/cool control) 4: PV (loop) 5: SP 6: Differential (PV-SP) 7: PV (input channel) Others: ☞ Standard numerical codes (on page App.-12)
	Loop/channel definition	0: None 1 to 4: Loop/channel1 to 4
	Output decimal position	0: No decimal point 1: One digit below the decimal point 2: Two digits below the decimal point 3: Three digits below the decimal point 4: Four digits below the decimal point
	Low limit of output scaling	-19999 to +32000 U (Value assigned to the low limit of the output)
	High limit of output scaling	-19999 to +32000 U (Value assigned to the high limit of the output)

Set the output range for analog current and voltage.
Specify the output type and loop/channel definition for the output.
In the output decimal point position, the decimal point position is set for the low limit of the output scaling and the high limit of the output scaling.

With the low limit and high limit settings, output scaling can be applied to the data assigned in the output type.
If the high limit is set smaller than the low limit, reverse scaling is possible.
The figure below shows an example of scaled output applied to the MV for the power supply output (4 to 20 mA).

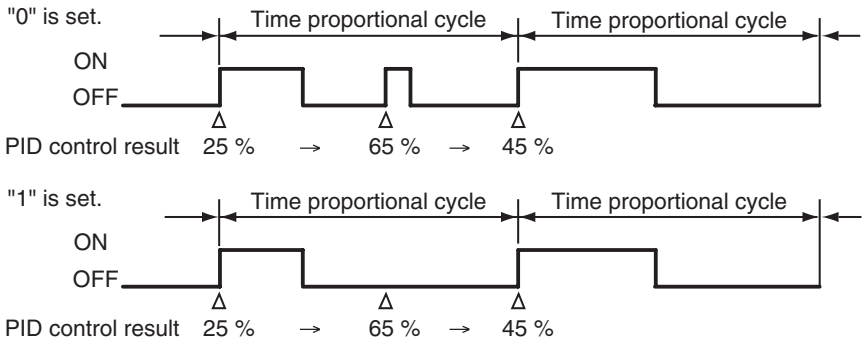


However, when the output range is 0 to 20 mA, 0 to 1 V, 0 to 5 V, or 0 to 10 V, the output becomes 0 to 110 %.

■ Time proportional output setup

Bank	Item name	Settings
OUT/EV output ON/OFF	Output type	1: MV of loop 1 2: Heat MV of loop 1 (for heat/cool control) 3: Cool MV of loop 1 (for heat/cool control) 4: MV of loop 2 5: Heat MV of loop 2 (for heat/cool control) 6: Cool MV of loop 2 (for heat/cool control) 7: MV of loop 3 10: MV of loop 4
	Latch	Invalid setting
	Time proportional operation type	0: Control-oriented 1: Actuator-life-oriented
	Min. ON/OFF time	0 to 300 ms
	Time proportional cycle	0.1 to 120.0 s
	Phase shift	0 to 32000

When the output type is set to 1 to 6, and 10 the time proportional value is output according to the settings of the time proportional cycle.
According to the time proportional operation type, the time proportional output becomes as follows.
When "0: Priority on controllability" is set, the output may be turned ON twice or more within the time proportional cycle. On the contrary, when "1: Priority on device life" is set, the output is turned ON zero time to once within the time proportional cycle.



The min. ON/OFF time is valid. However, even though "0" is set, the min. ON/OFF time becomes 1 ms. The latch becomes invalid.

■ ON/OFF control setup

For an output of the MV of ON/OFF control, make settings as follows.

Bank	Item name	Settings
OUT/EV output ON/OFF	Output type	1: MV of loop 1 4: MV of loop 2 7: MV of loop 3 10: MV of loop 4
	Latch	Invalid setting
	Time proportional operation type	0: Control-oriented
	Min. ON/OFF time	10 ms (or a specific time set by user)
	Time proportional cycle	2.0 s
	Phase shift	0

■ ON/OFF output setup

Bank	Item name	Settings
OUT/EV output ON/OFF	Output type	0: OFF 1024 to 2047: Standard bit ☞ Standard bit codes (on page App.-11)
	Latch	0: No latch 1: Latch when ON 2: Latch when OFF (except before power-on)
	Time proportional operation type	Invalid setting
	Min. ON/OFF time	0 to 300 ms
	Time proportional cycle	Invalid setting
	Phase shift	0

When any of the standard bit Nos. 1024 to 2047 is set in the output type, the ON/OFF status of this standard bit is output.

Chapter 5. OPERATION

5 - 1 Operation Displays

There are LED indicators and a button on the front panel.
There are 2 types of LED blinking: fast blink (0.2 s cycle) and slow blink (1.4 s cycle).

■ PWR, RUN, MOD, COM, NST, FAIL

Lighting patterns of the LEDs on the top row are shown and described in the table below.

LED name	Color	Lighting pattern	Description
PWR	Green	Lit	Power is on
		Off	Power is off
RUN	Green	Lit	RUN mode (normal operation mode)
		Fast blink	Module RUN mode, READY for PID calculation for 1 loop or more
		Off	Operation other than the above
MOD	Orange	Fast blink	Downloading configuration data Downloading firmware
		Off	Normal operation mode
COM	Green	Lit	Sending and receiving the module's own Ethernet packets in progress
		Off	Sending and receiving the module's own Ethernet packets unexecuted
NST	Orange	Lit	Ring diagnostics function is off
		Fast blink	Ring disconnection (ring disconnected somewhere)
		Slow blink	Ring disconnection in this node or the next node
		Off	Ring condition normal
FAIL	Red	Lit	Serious fault
		Slow blink	Minor fault
		Off	No errors

■ PV1-4

Lighting patterns of LEDs PV 1-4 on the middle row are shown and described in the table below.

LED name	Color	Lighting pattern	Description
PV1	Green	Fast blink	Ch. 1 PV input Range high or low limit error
		Off	Ch. 1 PV input Normal, or not in use
PV2	Green	Fast blink	Ch. 2 PV input Range high or low limit error
		Off	Ch. 2 PV input Normal, or not in use
PV3	Green	Fast blink	Ch. 3 PV input Range high or low limit error
		Off	Ch. 3 PV input Normal, or not in use
PV4	Green	Fast blink	Ch. 4 PV input Range high or low limit error
		Off	Ch. 4 PV input Normal, or not in use

■ OP1-4

Lighting patterns of LEDs OP1-4 on the middle row are shown and described in the table below.

LED name	Color	Lighting pattern	Description
OP1	Green	Lit	Ch. 1 transistor output: ON
		Off	Ch. 1 transistor output ch.1: OFF Analog current output ch1. or analog voltage output ch1.
OP2	Green	Lit	Ch. 2 transistor output: ON
		Off	Ch. 2 transistor output: OFF Ch. 2 analog current output or analog voltage output ch2.
OP3	Green	Lit	Ch. 3 transistor output: ON
		Off	Ch. 3 transistor output: OFF Ch. 3 analog current output or analog voltage output ch3.
OP4	Green	Lit	Ch. 4 transistor output: ON
		Off	Ch. 4 transistor output: OFF Ch. 4 analog current output or analog voltage output ch4.

■ F0-9

It is possible to set lighting conditions and patterns only for the normal lighting of LED F0 on the right end of the middle row and LEDs F1-9 on the bottom row.
An initial value is shown as an alarm or event.

LED name	Color	Bank name	Item name	Setting	Initial value
F0	Red	LED lamp	Lighting condition	1024 to 2047: Standard bit code	1792 (Representative alarm)
		LED lamp	Lighting state	0: Off 1: Lit 2: Lit (inversion) 3: Fast blink 4: Fast blink (conditional inversion) 5: Slow blink 6: Slow blink (conditional inversion)	3 (Fast blink)
F1	Green	LED lamp	Lighting condition	1024 to 2047 (same as F0)	1088 (Event 1)
		LED lamp	Lighting state	0 to 6 (same as F0)	1 (Lit)
F2	Green	LED lamp	Lighting condition	1024 to 2047 (same as F0)	1089 (Event 2)
		LED lamp	Lighting state	0 to 6 (same as F0)	1 (Lit)
F3	Green	LED lamp	Lighting condition	1024 to 2047 (same as F0)	1090 (Event 3)
		LED lamp	Lighting state	0 to 6 (same as F0)	1 (Lit)
F4	Green	LED lamp	Lighting condition	1024 to 2047 (same as F0)	1091 (Event 4)
		LED lamp	Lighting state	0 to 6 (same as F0)	1 (Lit)
F5	Green	LED lamp	Lighting condition	1024 to 2047 (same as F0)	1092 (Event 5)
		LED lamp	Lighting state	0 to 6 (same as F0)	1 (Lit)
F6	Green	LED lamp	Lighting condition	1024 to 2047 (same as F0)	1093 (Event 6)
		LED lamp	Lighting state	0 to 6 (same as F0)	1 (Lit)
F7	Green	LED lamp	Lighting condition	1024 to 2047 (same as F0)	1094 (Event 7)
		LED lamp	Lighting state	0 to 6 (same as F0)	1 (Lit)
F8	Green	LED lamp	Lighting condition	1024 to 2047 (same as F0)	1545 (in RS-485 communications)
		LED lamp	Lighting state	0 to 6 (same as F0)	1 (Lit)
F9	Green	LED lamp	Lighting condition	1024 to 2047 (same as F0)	1968 (parameter error)
		LED lamp	Lighting state	0 to 6 (same as F0)	3 (Fast blink)

■ Operation at power-on

When the power is on, first, LEDs are lit as shown in the table below, and then indicate the state of operation.

Order	LED lighting state (❍: Lit, -: Off, ❁: Blinking, ✻: Depends on the state)								State/Processing
	Top LEDs						Middle LEDs	Bottom LEDs	
	PWR	RUN	MOD	COM	NST	FAIL	PV1-4 OP1-4 F0	F1-9	
1	-	-	-	-	-	-	-	-	Power-off
2	❍	❍	❍	❍	❍	❍	-	-	Shortly after power-on
3	❍	-	-	-	-	-	❍	-	LED lighting test (0.5 s)
4	❍	-	-	-	-	-	-	❍	LED lighting test (0.5 s)
5	❍	-	-	-	-	-	-	-	EEPROM read Stabilization
6	❍	✻	✻	✻	✻	✻	❁	❁	Start of operation
7	❍	✻	✻	✻	✻	✻	✻	✻	Operation display

5 - 2 Operation Modes

Banks and settings for operation modes are shown in the table below.
☞ 1-4 Operation Modes (on page 1-8)

■ Banks and settings (operation mode selection)

Bank	Item name	Settings
Loop mode	RUN/READY	0: RUN 1: READY
	AUTO/MANUAL	0: AUTO 1: MANUAL
	AT stop/start	0: AT stop 1: AT start
	LSP/RSP	0: LSP 1: RSP

■ Banks and settings (for MANUAL)

Bank	Item name	Settings
Loop control (extending setting)	Output operation at changing Auto/Manual	0: Bumpless 1: Preset
	Preset MANUAL value	-10.0 to +110.0 (%)

■ Banks and settings (for READY)

Bank	Item name	Settings
Loop output	Output at READY	-10.0 to +110.0 (%)
	Output at READY (Heat)	-10.0 to +110.0 (%)
	Output at READY (Cool)	-10.0 to +110.0 (%)

■ Banks and settings (for RSP)

Bank	Item name	Settings
RSP	RSP	-
	PID group definition (for RSP)	1 to 4 (groups)

5 - 3 How to Change Control Modes and Parameters

To change control modes or parameters, use the SLP-NX (sold separately) or host communications.
This section describes how to change control modes or parameters using the SLP-NX.

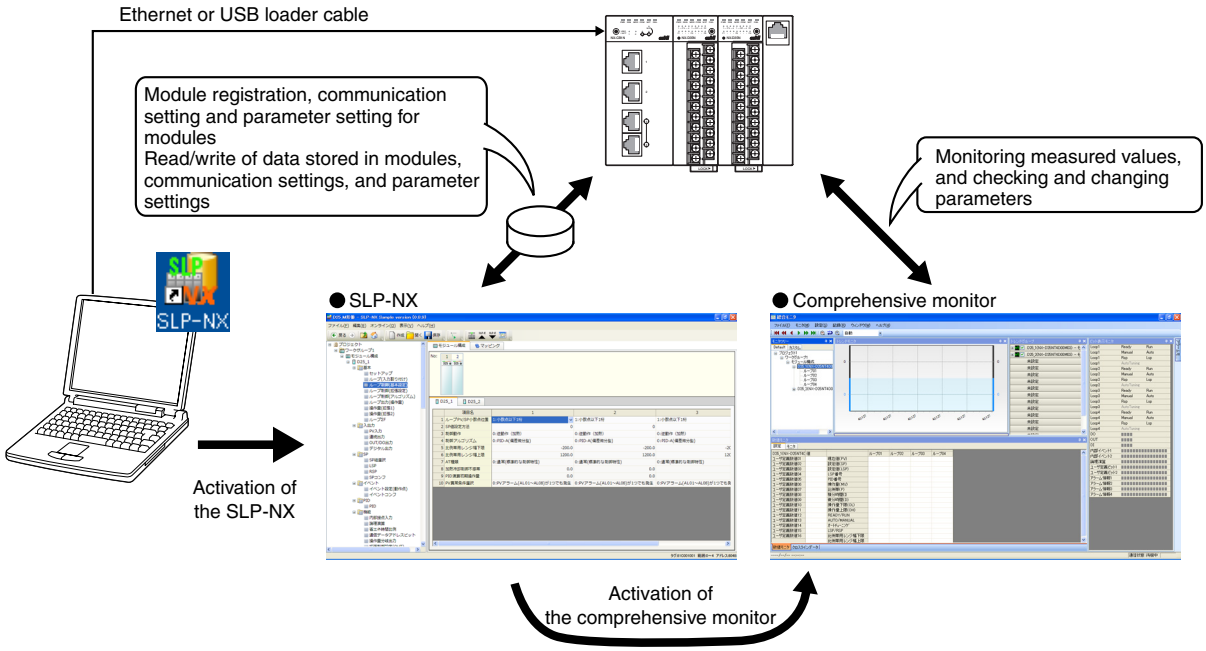
■ Functions of the SLP-NX

The SLP-NX has the following functions.

Function name	Application
SLP-NX	Module registration, communication setting and parameter setting for modules. In addition, read/write of data stored in modules, communication settings, and parameter settings.
Comprehensive monitor	Monitoring measured values, and checking and changing parameters through communications with modules.

■ How to change parameters

The following shows how to use the comprehensive monitor for changing parameters.



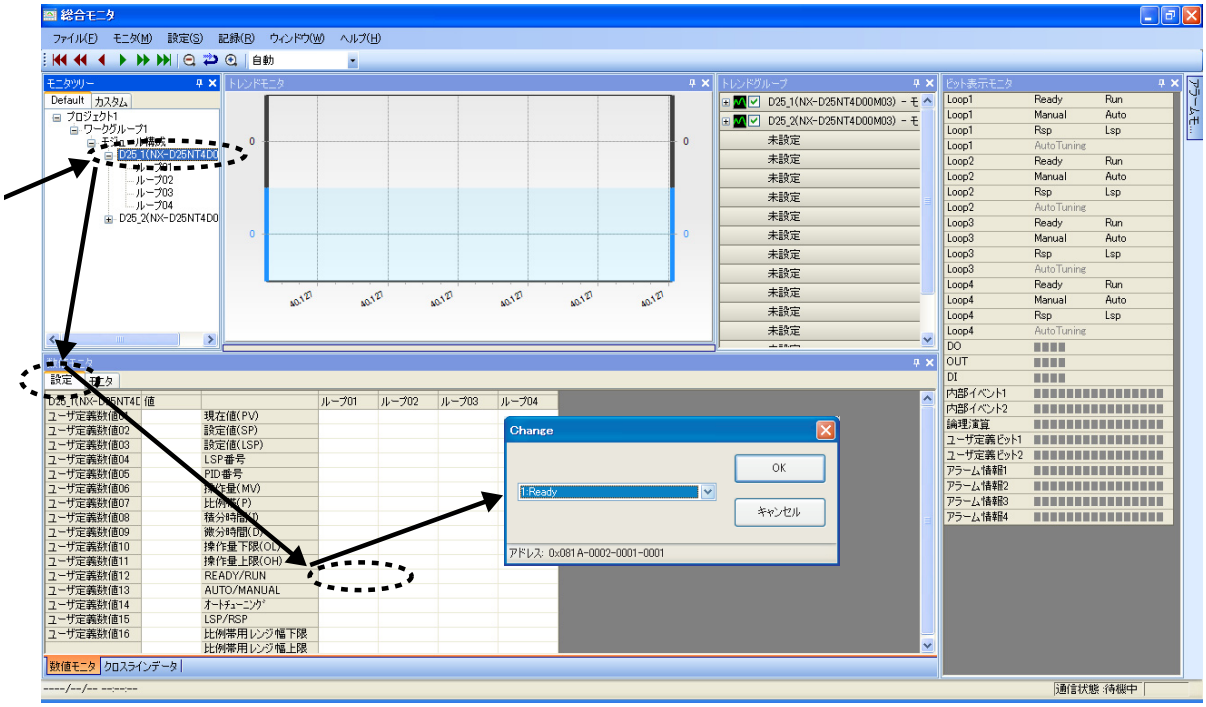
● How to change settings

Example: switching RUN to READY in PID control

Note

• The following is an example. It is not the only way to make the change.

(1) Activate the SLP-NX.
(2) Open the project stored in the PC as backup.
(3) Connect the PC to the NX (via Ethernet).
(4) To activate the comprehensive monitor, click [オンライン]→[モニタ].
(5) Click the module to be modified on the directory tree of the comprehensive monitor.
(6) To activate communications, click [モニタ]→[開始].
(7) To display the dialog box, double-click the [READY/RUN] cell for the desired loop in the 設定 tab of the 数値モニタ部 of the comprehensive monitor.
(8) Change [0: RUN] to [1: READY] using the pull down key and click the [OK] button.



Handling Precautions

- ☞ SLP-NX Smart Loader Package, document No. CP-SP-1312 (for more detail on SLP-NX operation)
  The above example is partly described in the manual.

5 - 4 How to Manually Output the MV (AUTO/MANUAL)

The MV can be manually output to each loop using the comprehensive monitor.

The procedure is as follows.

(1) Display the desired loop using the comprehensive monitor.

(2) Switch AUTO to MANUAL in the 設定 tab of the 数値モニタ部.

(3) Change the MV in the 設定 tab of the 数値モニタ部

5 - 5 How to Change to the Remote SP (RSP/LSP)

For a loop that already has an RSP, it is possible to switch the LSP to RSP or the reverse using the comprehensive monitor.

The procedure is as follows.

(1) Display the desired loop using the comprehensive monitor.

(2) Switch LSP to RSP or the reverse in the 設定 tab of the 数値モニタ部.

5 - 6 How to Stop Control by Switching RUN to READY

It is possible to switch RUN to READY or the reverse using the comprehensive monitor.

The procedure is as follows.

(1) Display the desired loop using the comprehensive monitor.

(2) Switch RUN to READY or the reverse in the 設定 tab of the 数値モニタ部.

5 - 7 How to Start Auto-tuning

It is possible to start/stop auto-tuning (AT) using the comprehensive monitor.

The procedure is as follows.

(1) Display the desired loop using the comprehensive monitor.

(2) Make sure that the PV is correct.
Make sure that the control function is ready to use in both RUN and AUTO modes.

(3) Start the auto-tuning in the 設定 tab of the 数値モニタ部.

(4) The auto-tunning stops automatically.
To stop the AT while it is running, change AT mode to 中止.

5 - 8 How to change the SP

There are several methods to change the SP of any loop.

■ Changing the SP used

It is possible to change the SP of any loop using the comprehensive monitor.

The procedure is as follows.
(1) Display the desired loop using the comprehensive monitor.
(2) Change the LSP in the 設定 tab of the 数値モニタ部.

However, if the SP is in RSP mode, it is not changeable.

■ Changing the SP group selection

The SP group selection can be changed for loops having 2 or more SP system groups using the comprehensive monitor.
However, if the SP group selection is executed by internal contact input, it cannot be changed.

The procedure is as follows.
(1) Display the desired loop using the comprehensive monitor.
(2) Change the LSP No. in the 設定 tab of the 数値モニタ部.

5 - 9 How to Change the PID

There are 2 methods of changing the PID: changing the PID setting and executing auto-tuning.

■ Changing the PID setting

The PID can be changed using the comprehensive monitor.

The procedure is as follows.
(1) Display the desired loop using the comprehensive monitor.
(2) Change the PID 設定 tab of the 数値モニタ部.

■ Executing auto-tuning

☞ 5-7 How to Start Auto-tuning (on page 5-10)

5 - 10 How to Change the Event Operating Point

There are 2 event setting types: event main setting and event sub-setting. Some events have event main setting alone, some have both types.

☞ 6-1 How to Use Events (on page 6-1)

The procedure is as follows.

(1) Display the event setting (operating point) bank using the SLP-NX.

(2) Change event main setting to event sub-setting or the reverse by key operation.

5 - 11 PID Control

If the control action is set to “0: Reverse action” or “1: Direct action,” the control is executed as follows.

When integral time ≠ 0 and derivative time ≠ 0, PID control is executed.
When integral time ≠ 0 and derivative time = 0, PI control is executed.
When integral time = 0 and derivative time = 0, PD control is executed.
When integral time = 0 and derivative time = 0, P control is executed.

■ Banks and settings

Bank	Item name	Settings
Loop control (basic setting)	Control action	0: Reverse action (heat) 1: Direct action (cool) 2: Heat/Cool 4: Reverse action (ON/OFF) 5: Direct action (ON/OFF)
Loop control (extending setting)	Decimal point position for integral time/derivative time	0: No decimal point 1: 1 digit after the decimal point 2: 2 digits after the decimal point
PID	Proportional band 1 (PID1 group)	0.1 to 3200.0 (%)
	Integral time band 1	0 to 32000 (s) 0.0 to 3200.0 (s) 0.00 to 320.00 (s) The range varies depending on the setting of decimal point position for integral time/derivative time.
	Derivative time 1 (PID1 group)	0 to 32000 (s) 0.0 to 3200.0 (s) 0.00 to 320.00 (s) The range varies depending on the setting of decimal point position for integral time/derivative time.
	MV low limit 1 (PID1 group)	-10.0 to +110.0 (%)
	MV high limit 1 (PID1 group)	-10.0 to +110.0 (%)
	Manual reset 1 (PID1 group)	-10.0 to +110.0 (%)
	Settings for PID2 group	Same as settings for PID 1 group
	Settings for PID3 group	
	Settings for PID4 group	

5 - 12 Heat/Cool Control

If the control action is set to "2: Heat/Cool," the heat/cool control is executed.

■ Banks and settings

Bank	Item name	Settings
Loop control (basic setting)	Control action	0: Reverse action (heat) 1: Direct action (cool) 2: Heat/Cool 4: Reverse action (ON/OFF) 5: Direct action (ON/OFF)
	Heat/cool control dead zone	-100.0 to +100.0 (%)
Loop control (extending setting)	Decimal point position for integral time/derivative time	0: No decimal point 1: 1 digit after the decimal point 2: 2 digits after the decimal point
PID	Proportional band 1 (PID1 group)	0.1 to 3200.0 (%)
	Integral time band 1 (PID1 group)	0 to 32000 (s) 0.0 to 3200.0 (s) 0.00 to 320.00 (s) The range varies depending on the setting of decimal point position for integral time/derivative time.
	Derivative time 1 (PID1 group)	0 to 32000 (s) 0.0 to 3200.0 (s) 0.00 to 320.00 (s) The range varies depending on the setting of decimal point position for integral
	MV low limit 1 (PID1 group)	-10.0 to +110.0 (%)
	MV high limit 1 (PID1 group)	-10.0 to +110.0 (%)
	Manual reset 1 (PID1 group)	-10.0 to +110.0 (%)
	Proportional band 1 for cool side 1 (PID1 group)	0.1 to 3200.0 (%)
	Integral time for cool side 1 (PID1 group)	0 to 32000 (s) 0.0 to 3200.0 (s) 0.00 to 320.00 (s) The range varies depending on the setting of decimal point position for integral time/derivative time.
	Derivative time for cool side 1 (PID1 group)	0 to 32000 (s) 0.0 to 3200.0 (s) 0.00 to 320.00 (s) The range varies depending on the setting of decimal point position for integral time/derivative time.
	Output low limit for cool side 1 (PID1 group)	-10.0 to +110.0 (%)
	Output high limit for cool side 1 (PID1 group)	-10.0 to +110.0 (%)
	Settings for PID2 group	Same as settings for PID1 group
	Settings for PID3 group	
	Settings for PID4 group	

5 - 13 ON/OFF Control

If the control action is set to “3: Reverse action (ON/OFF) or “4: Direct action (ON/OFF),” ON/OFF control is executed.
The differential can be changed by switching PID groups.

■ Banks and settings

Bank	Item name	Settings
Loop control (basic setting)	Control action	0: Reverse action (heat) 1: Direct action (cool) 2: Heat/Cool 4: Reverse action (ON/OFF) 5: Direct action (ON/OFF)
PID	Differential 1 (PID1 group)	0.0 to 3200.0
	Differential 2 (PID2 group)	0.0 to 3200.0
	Differential 3 (PID3 group)	0.0 to 3200.0
	Differential 4 (PID4 group)	0.0 to 3200.0

Chapter 6. FUNCTIONS OFTEN USED FOR OPERATIONS OTHER THAN CONTROL

6 - 1 How to Use Events

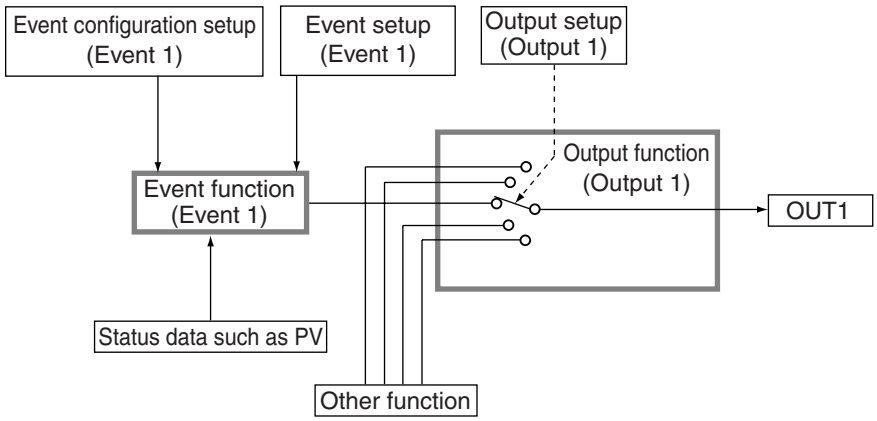
The ON/OFF status of the event is determined according to the conditions for each operation type.
The ON/OFF of the event can be output to the ON/OFF output terminal or digital output terminal.
Additionally, the ON/OFF status of the event can be used as input of the internal contact input function.

■ Setting banks

Event setting (operating point) bank
Event configuration bank
OUT/EV output ON/OFF bank

■ Example: PV high limit alarm (on if an error occurs.)

The following describes an example that the relay of the output 1 is turned ON if the PV of loop 1 exceeds 800 °C. In this example, the event function and output function are used.



(1) Set the event configuration of event 1.
In the event configuration setting bank, set as follows.

Item name	Settings
(Event 1) Operation type	1: PV high limit
(Event 1) Loop/Channel definition	1
(Event 1) Polarity	0: Direct
(Event 1) Standby	0: No standby
(Event 1) Operation at READY	0: Continue
(Event 1) Decimal point position	0: No decimal point
(Event 1) Hysteresis	5
(Event 1) ON delay	0.0 (unit: s)
(Event 1) OFF delay	0.0 (unit: s)

(2) Set the event action point of event 1.
In the event setting (operating point) bank, set as follows.

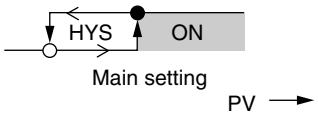
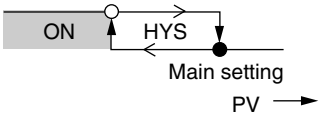
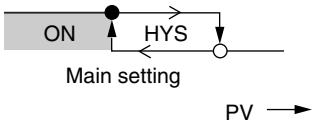
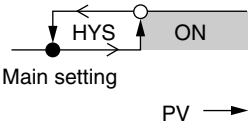
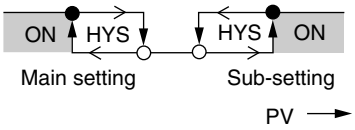
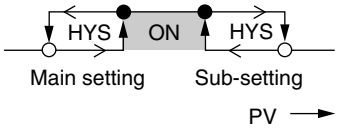
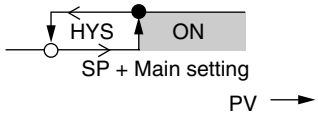
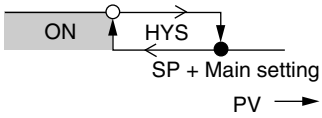
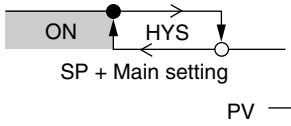
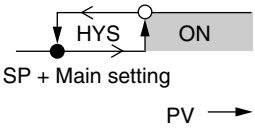
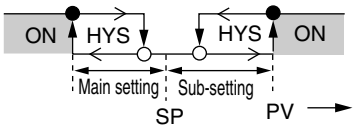
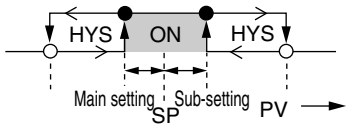
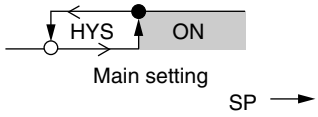
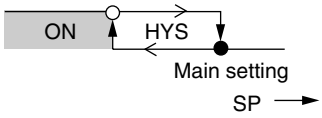
Item name	Settings
(Event 1) Event 1	800
(Event 1) sub-setting	(setting is disabled.)

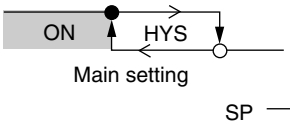
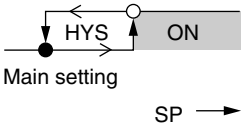
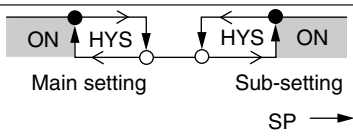
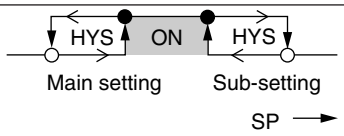
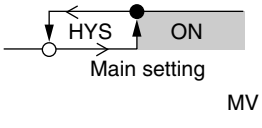
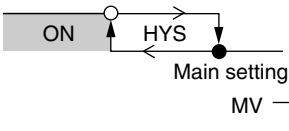
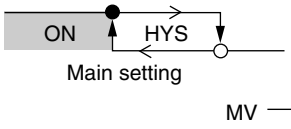
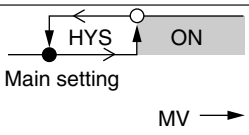
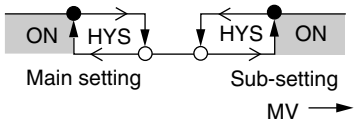
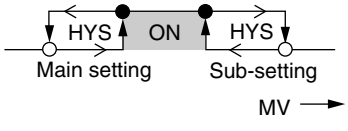
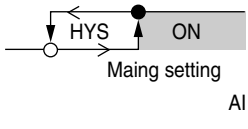
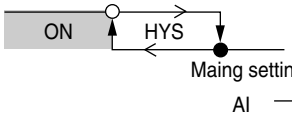
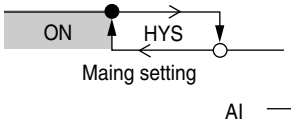
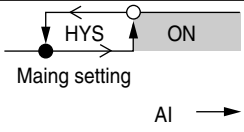
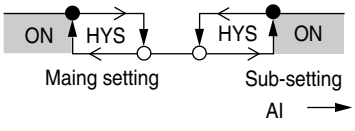
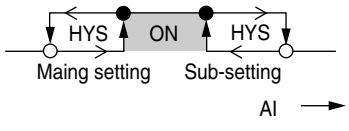
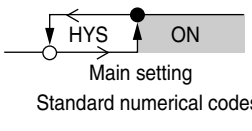
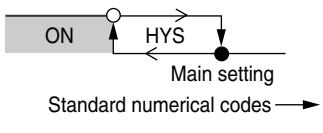
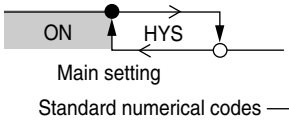
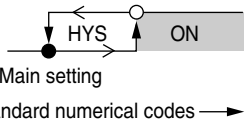
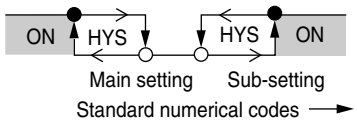
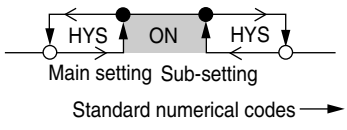
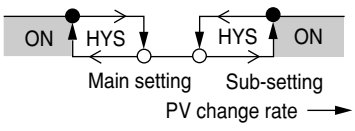
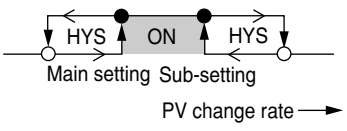
(3) Configure the settings so that the ON/OFF status of event 1 is output from output 1.
In the OUT/EV output ON/OFF bank, set as follows.

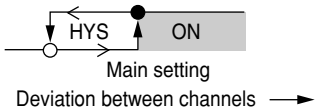
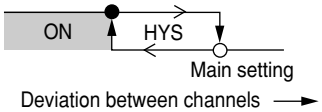
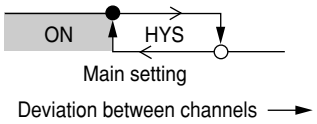
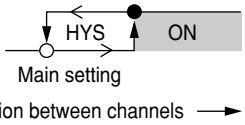
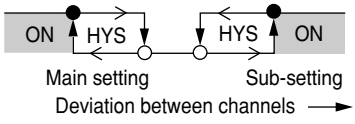
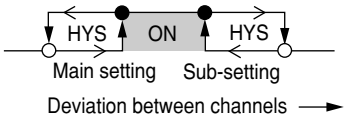
Item name	Settings
Output type	1088: Event 1
Latch	0: No latch
Time proportional operation type	(setting is disabled.)
Min. ON/OFF time	10 (ms)
Time proportioning cycle time	(setting is disabled.)
Phase shift	0

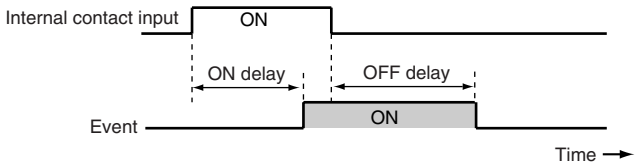
■ Event operation type, polarity, hysteresis, main setting, and sub-setting

According to the operation type, polarity, main setting, sub-setting, hysteresis, and other settings, the operation of the event becomes as follows:

Operation type	Set value of operation type	Direct action ● shows that the ON/OFF is changed at this value. ❍ shows that the ON/OFF is changed at a point that "1U" is added to this value.	Reverse action ● shows that the ON/OFF is changed at this value. ❍ shows that the ON/OFF is changed at a point that "1U" is added to this value.
No event	0	Always OFF	Always OFF
PV high limit	1		
PV low limit	2		
PV high/low limit	3		
Deviation high limit	4		
Deviation low limit	5		
Deviation high/ low limit	6		
Deviation high limit (Final SP reference)	7	Same as the direct action of the deviation high limit when the SP ramp is not used. The difference is that the SP ramp does not use the current SP, but it uses the final SP.	Same as the reverse action of the deviation high limit when the SP ramp is not used. The difference is that the SP ramp does not use the current SP, but it uses the final SP.
Deviation low limit (Final SP reference)	8	Same as the direct action of the deviation low imit when the SP ramp is not used. The difference is that the SP ramp does not use the current SP, but it uses the final SP.	Same as the reverse action of the deviation low limit when the SP ramp is not used. The difference is that the SP ramp does not use the current SP, but it uses the final SP.
Deviation high/ low limit (Final SP reference)	9	Same as the direct action of the deviation high/low limit when the SP ramp is not used. The difference is that the SP ramp does not use the current SP, but it uses the final SP.	Same as the reverse action of the deviation high/low limit when the SP ramp is not used. The difference is that the SP ramp does not use the current SP, but it uses the final SP.
SP high limit	10		

Operation type	Set value of operation type	Direct action ● shows that the ON/OFF is changed at this value. ❍ shows that the ON/OFF is changed at a point that "1U" is added to this value.	Reverse action ● shows that the ON/OFF is changed at this value. ❍ shows that the ON/OFF is changed at a point that "1U" is added to this value.
SP low limit	11		
SP high/low limit	12		
MV high limit	13		
MV low limit	14		
MV high/low limit	15		
AI high limit	18		
AI low limit	19		
AI high and low limits	20		
Upper limit for standard numerical codes	26		
Lower limit for standard numerical codes	27		
Upper/lower limit for standard numerical codes	28		
PV change rate	29		

Operation type	Set value of operation type	Direct action ● shows that the ON/OFF is changed at this value. ❍ shows that the ON/OFF is changed at a point that "1U" is added to this value.	Reverse action ● shows that the ON/OFF is changed at this value. ❍ shows that the ON/OFF is changed at a point that "1U" is added to this value.
High limit of deviation between channels (specified by PV1)	31		
High limit of deviation between channels (specified by PV2)	32		
High limit of deviation between channels (specified by PV3)	33		
High limit of deviation between channels (specified by PV4)	34		
Low limit of deviation between channels (specified by PV1)	35		
Low limit of deviation between channels (specified by PV2)	36		
Low limit of deviation between channels (specified by PV3)	37		
Low limit of deviation between channels (specified by PV4)	38		
High and low limit of deviation between channels (specified by PV1)	39		
High and low limit of deviation between channels (specified by PV2)	40		
High and low limit of deviation between channels (specified by PV3)	41		
High and low limit of deviation between channels (specified by PV4)	42		

<table>
<tr><th>Operation type</th><th>Set value of operation type</th><th>Direct action
● shows that the ON/OFF is changed at this value.
❍ shows that the ON/OFF is changed at a point that "1U" is added to this value.</th><th>Reverse action
● shows that the ON/OFF is changed at this value.
❍ shows that the ON/OFF is changed at a point that "1U" is added to this value.</th></tr>
<tr><td>Alarm
(status)</td><td>61</td><td>ON if alarm occurs (alarm code AL01 to 99).
OFF in other cases.</td><td>OFF if alarm occurs (alarm code AL01 to 99).
ON in other cases.</td></tr>
<tr><td>READY
(status)</td><td>62</td><td>ON in the READY mode.
OFF in the RUN mode.</td><td>OFF in the READY mode.
ON in the RUN mode.</td></tr>
<tr><td>MANUAL
(status)</td><td>63</td><td>ON in the MANUAL mode.
OFF in the AUTO mode.</td><td>OFF in the MANUAL mode.
ON in the AUTO mode.</td></tr>
<tr><td>RSP
(status)</td><td>64</td><td>ON in the RSP mode.
OFF in the LSP mode.</td><td>OFF in the RSP mode.
ON in the LSP mode.</td></tr>
<tr><td>During AT
(Status)</td><td>65</td><td>ON when AT is executed.
OFF when AT is stopped.</td><td>OFF when AT is executed.
ON when AT is stopped.</td></tr>
<tr><td>During SP ramp</td><td>66</td><td>ON during SP ramp.
OFF when SP ramp is not performed or is completed.</td><td>OFF during SP ramp.
ON when SP ramp is not performed or is completed.</td></tr>
<tr><td>Control action
(status)</td><td>67</td><td>ON during direct action (cooling).
OFF during reverse action (heating).</td><td>OFF during direct action (cooling).
ON during reverse action (heating).</td></tr>
<tr><td>Timer
(status)</td><td>70</td><td colspan="2">The direct and reverse action settings are disabled for the timer event.
To use the timer event, it is necessary to set the operation type of the internal contact input to "Timer Stop/Start".
Additionally, multiple timer events can be controlled from individual internal contact input by setting an event No. in the loop/channel definition of the internal contact input.
● Setting items
• ON delay time: A period of time necessary for the event change from OFF to ON after the internal contact input has been changed from OFF to ON.
• OFF delay time: A period of time necessary for the event change from ON to OFF after the internal contact input has been changed from ON to OFF.
● Operation specifications
• The event is turned ON when the internal contact input ON continues for ON delay time or longer.
• The event is turned OFF when the internal contact input OFF continues for OFF delay time.
• In other cases, the current status is continued.
 

● CAUTION
The default settings of the ON delay and OFF delay before shipment are 0.0s.
The default setting of the loop/channel definition of the internal contact input is "0". In this case, all timer events can be stopped or started through one internal contact input.
Additionally, when a value exceeding "1" is set for the loop/channel definition, one specified timer event can be stopped or started through one internal contact input.</td></tr>
</table>

■ Loop/Channel definition

Setting differs depending on the operation type.

Loop/Channel definition	Operation type No.	Operation at READY*1	Standby*2
Loop 1 or 4 for the operation type	1 to 15, 18 to 20, 26 to 28, 31 to 42	❍	❍
	62 to 67	❍	×
Loop 1 or 4 for use of standby or operation at READY	61, 70	❍	×
Standard numerical code (2048 to 3071)	26 to 28	×	×

*1. ❍: Choice of continuation/forced OFF is available. ×: Always continues

*2. ❍: Choice of standby/no standby is available. ×: No standby

■ Event standby and operation at READY

"Standby" is a function that does not turn ON the event even though the event currently used satisfies the ON conditions when this unit is turned ON or when READY mode is changed to RUN mode.

The event is turned ON when the ON conditions are satisfied again once the OFF conditions have been satisfied.

"Standby + Standby at SP change" means that the standby is set again when the SP is changed (SP value and SP group number) in addition to the standby functions. However, when the same SP value is written or when the SP value is not changed even though the SP group number is changed, the unit does not enter standby mode.

	READY		READY→ RUN change	
EVENT state at READY setup / Standby setup	0: Continued	1: Forced OFF	0: Continued	1: Forced OFF
0: None	Usual operation	OFF	Usual operation	Usual operation
1: Standby	OFF	OFF	OFF (standby state)	OFF (standby state)
2: Standby + Standby at SP change	OFF	OFF	OFF (standby state)	OFF (standby state)

■ Event decimal point

The decimal point position of the main setting and sub-setting of the event setup bank (action point) and the hysteresis setting of the event configuration bank can be changed.

■ ON delay and OFF delay

ON delay is a function that delays the timing, at which the event status is changed from OFF to ON. OFF delay is a function that delays the timing, at which the event status is changed from ON to OFF. However, the operation with the operation type set at timer event is performed as described on the previous page.

6 - 2 How to Use Internal Contact Input (digital input)

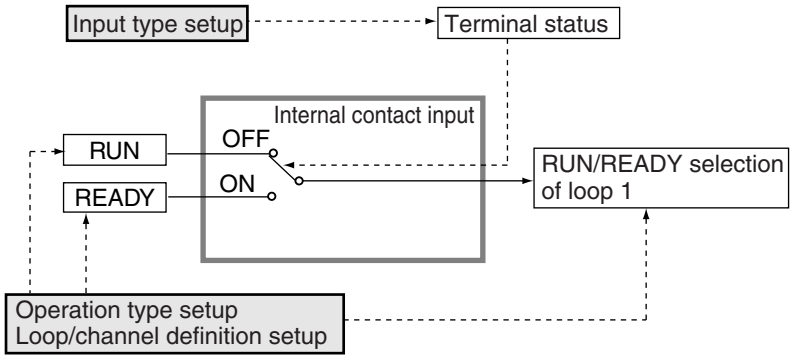
The internal contact input (digital input) can take in the ON/OFF data, which is specified in the input type, as internal contact input inside the instrument.
The change-over operation specified in the operation type can be performed with the ON/OFF data in the specified input type.

■ Setting banks

Internal contact input

■ Example 1: RUN/READY change-over by internal contact input

The following describes an example that the RUN/READY of the loop 1 is changed to READY when the DI 1 terminal status is ON and it is changed to RUN when the DI 1 terminal status is OFF.

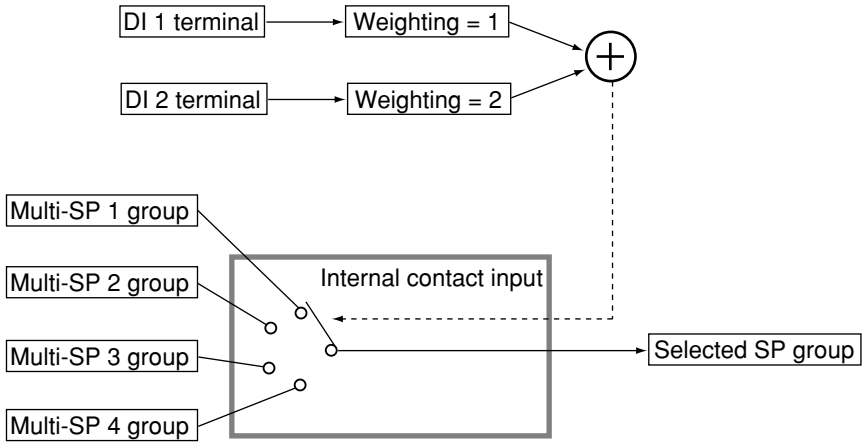


Set RUN/READY to the internal contact 1.
Configure the settings as shown below in the internal contact input bank setup.

Item name	Settings
(Internal contact 1 group) Operation type	21: RUN/READY
(Internal contact 1 group) Input type	1152: DI-C1 terminal status
(Internal contact 1 group) Loop/channel definition	1: Loop 1
(Internal contact 1 group) Weighting	(setting is disabled.)

■ Example 2: SP group selection by internal contact input

The following describes an example that the selection of multi-SP group (1 to 4) in the loop 1 is made enabled using the DI 1 to DI 2 terminals.



DI 1	OFF	ON	OFF	ON
DI 2	OFF	OFF	ON	ON
Sum of the weighting values	0	1	2	3
Selected SP group	SP1	SP2	SP3	SP4

(1) Set the number of SP system groups.

In the setup bank (basic setting), make setting as follows.

Item name	Setting
SP system group	4

(2) Set the SP group selection for the internal contact input 1 and 2 group.

In the internal contact input bank, set the internal contact inputs of the two groups as follows.

Item name	Settings
(Internal contact 1 group) Operation type	1: SP group selection
(Internal contact 1 group) Input type	1152: DI1 terminal status
(Internal contact 1 group) Loop/channel definition	1
(Internal contact 1 group) Weighting	1
(Internal contact 2 group) Operation type	1: SP group selection
(Internal contact 2 group) Input type	1153: DI1 terminal status
(Internal contact 2 group) Loop/channel definition	1
(Internal contact 2 group) Weighting	2

■ Operation type

Select operations, which are to be changed over by internal contact input, from the following table, "Operation Type Settings" and then set them properly.

Set value and meaning of operation type	Set value and meaning of loop/channel definition
0: No function	0 to 127: Invalid
1: SP group selection	0: All loops, 1: Loop 1, 2: Loop 2, 3: Loop 3, 4: Loop 4, 5 to 127: Invalid
2: PID group selection	0: All loops, 1: Loop 1, 2: Loop 2, 3: Loop 3, 4: Loop 4, 5 to 127: Invalid
9: AI group definition	0: All loops, 1: Loop 1, 2: Loop 2, 3: Loop 3, 4: Loop 4, 5 to 127: Invalid
21: RUN/READY mode selection	0: All loops, 1: Loop 1, 2: Loop 2, 3: Loop 3, 4: Loop 4, 5 to 127: Invalid
22: AUTO/MANUAL mode selection	0: All loops, 1: Loop 1, 2: Loop 2, 3: Loop 3, 4: Loop 4, 5 to 127: Invalid
23: LSP/RSP mode selection	0: All loops, 1: Loop 1, 2: Loop 2, 3: Loop 3, 4: Loop 4, 5 to 127: Invalid
24: AT start/stop selection	0: All loops, 1: Loop 1, 2: Loop 2, 3: Loop 3, 4: Loop 4, 5 to 127: Invalid
41: Control operation polarity selection	0: All loops, 1: Loop 1, 2: Loop 2, 3: Loop 3, 4: Loop 4, 5 to 127: Invalid
42: SP RAMP enabled/disabled	0: All loops, 1: Loop 1, 2: Loop 2, 3: Loop 3, 4: Loop 4, 5 to 127: Invalid
46: Timer stop/start selection	0: All timer events 1 to 24: Event No. of timer event 25 to 127: Invalid
47: Release all latches	5 to 127: Invalid

■ Input type

Use to specify the ON/OFF data that the data internal contact input uses as input. This ON/OFF data shows various kinds of instrument statuses and it is called "standard bit".

For details about standard bit numeric values, refer to:

☞ ■ Standard bit codes (on page App.-11).

■ Loop/channel definition

Use to specify a loop or channel is specified that becomes a target operated by the internal contact input. The meaning of the loop/channel definition may vary depending on the operation type.

For details, refer to:

☞ Operation Type Settings on the previous page.

■ Weighting

Use to select a group or number in a specific operation type, such as SP group selection or PID group selection.

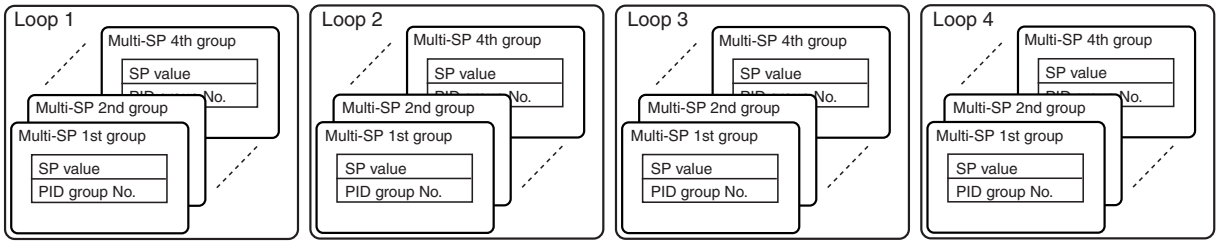
When the input is OFF, the value becomes "0". When the input is ON, the value becomes the set value.

When the operation type and loop/channel definition use the same internal contact input, a selection is determined by the sum of weighting values as shown in the table below.

Sum of weights / Operation type	0	1 or more
SP group selection	1 group	Group with "1" added to the sum of weighting values is selected.
PID group selection	1 group	Group with "1" added to the sum of weighting values is selected.

6 - 3 How to Use the Multi-SP

The multi-SP can be set by combining LSP value and PID group definition on an SP group basis.
Up to 16 SP groups per loop are provided. You can select one group from these groups and use it for control.



■ Setting banks

Setup bank (basic action)
Loop 1 LSP bank
Loop 2 LSP bank
Loop 3 LSP bank
Loop 4 LSP bank
Loop 1 PID bank
Loop 2 PID bank
Loop 3 PID bank
Loop 4 PID bank
SP group selection bank

■ Features

PID constant group separated from the SP group is provided. When selecting an SP group, the constants of the PID group corresponding to the PID group definition set in the SP group are used for the control. When using PID constants common to multiple SP groups, you can configure the settings so that the same PID group can be specified.

■ Example: Multi-SP is used with two LSP groups

The following describes an example that two LSP groups and PID constants of two groups are used with two SP groups in the loop 1:

(1) Set the SP to two groups using the multi-SP.
Configure the settings as shown below in the setup bank (basic action) setup.

Item name	Setting
SP system group	2

(2) Set data for the SP group.
Configure the settings as shown below in the loop 1 LSP bank setup.

Item name	Settings
(Loop 1 SP 1 group) LSP	100.0
(Loop 1 SP 1 group) PID group definition (For LSP)	1
(Loop 1 SP 2 group) LSP	200.0
(Loop 1 SP 2 group) PID group definition (For LSP)	2

(3) Set data for the PID group.

Configure the settings as shown below in the loop 1 PID bank setup.

Item name	Settings
(Loop 1 PID 1 group) Proportional band	5.0
(Loop 1 PID 1 group) Integration time	120
(Loop 1 PID 1 group) Derivative time	30
(Loop 1 PID 1 group) MV low limit	0.0
(Loop 1 PID 1 group) MV high limit	100.0
(Omission)	
(Loop 1 PID 2 group) Proportional band	5.0
(Loop 1 PID 2 group) Integration time	100
(Loop 1 PID 2 group) Derivative time	25
(Loop 1 PID 2 group) MV low limit	0.0
(Loop 1 PID 2 group) MV high limit	100.0
(Others omitted.)	

(4) Select an SP group.

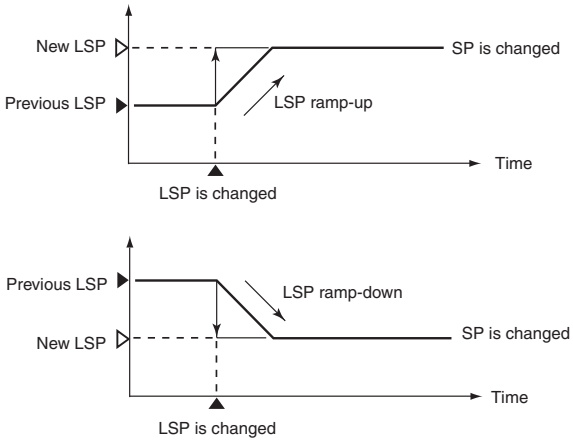
Select an SP group in the SP group selection bank.

To select the SP 2 group, configure the setting as described in the table below.

Item name	Setting
(Loop 1) SP group selection	2: Select the SP 2 group

6 - 4 How to Change the LSP with Constant Ramp

When changing the set value of the LSP or the SP group selection, it is possible to change the SP with a constant SP ramp.



■ Bank and settings

Bank	Item name	Settings
SP configuration (ramp and others)	SP ramp unit	0: No decimal point/s, 1: No decimal point/min, 2: No decimal point/h, 3: 0.1/s, 4: 0.1/min, 5: 0.1/h, 6: 0.01/s, 7: 0.01/min, 8: 0.01/h, 9: 0.001/s, 10: 0.001/min, 11: 0.001/h
	Ramp-up for LSP	0 U (No ramp) 1 to 32000 U (decimal point position may vary depending on the SP ramp unit)
	Ramp-down for LSP	0 U (No ramp) 1 to 32000 U (decimal point position may vary depending on the SP ramp unit)
	PV start for LSP	0: Enabled, 1: Disabled

■ Conditions for ramp start

- LSP value is changed.
- SP group is changed.
- Mode is changed from RSP to LSP.

■ Conditions for ramp start with PV used as start point

If any of the following arises, the ramp is started with PV used as start point instead of the previous SP:

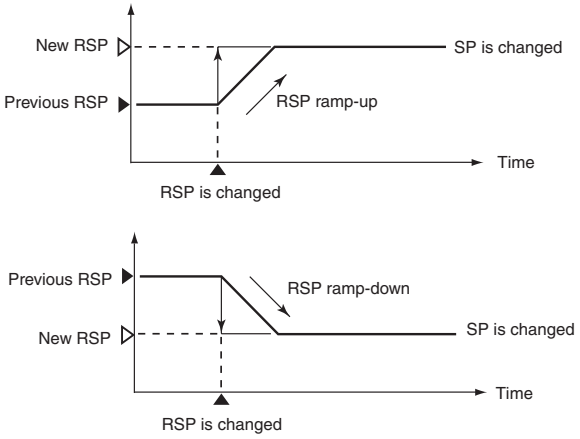
- The power is turned ON.
- The MANUAL mode is changed to the AUTO mode.
- The READY mode is changed to the RUN mode.
- The "Loop type" item of the setup bank is changed.

! Handling Precautions

- In any one of the following situations, NX ramp operation will not begin. Also, if a ramp is in progress and one of these situations occurs, the ramp operation will be halted.
  - In MANUAL mode
  - In READY mode
  - When ramp operations are prohibited by internal contact input
- Under the following circumstances ramp operation cannot be initiated by the PV.
  - If a PV input error occurs
  - If PV start is set to 1 (PV start disabled)

6 - 5 How to Change the RSP with Constant Ramp

When changing the set value of the RSP, it is possible to change the SP with a constant SP ramp.



■ Bank and settings

Bank	Item name	Settings
SP configuration (ramp and others)	SP ramp unit	0: No decimal point/s, 1: No decimal point/min, 2: No decimal point/h, 3: 0.1/s, 4: 0.1/min, 5: 0.1/h, 6: 0.01/s, 7: 0.01/min, 8: 0.01/h, 9: 0.001/s, 10: 0.001/min, 11: 0.001/h
	Ramp-up for RSP	0 U (No ramp) 1 to 32000 U (decimal point position may vary depending on the SP ramp unit)
	Ramp-down for RSP	0 U (No ramp) 1 to 32000 U (decimal point position may vary depending on the SP ramp unit)
	PV start for RSP	0: Enabled, 1: Disabled

■ Conditions for ramp start

- RSP value is changed.
- Mode is changed from LSP to RSP.

■ Conditions for ramp start with PV used as start point

If any of the following arises, the ramp is started with PV used as start point instead of the previous SP:

- The power is turned ON.
- The MANUAL mode is changed to the AUTO mode.
- The READY mode is changed to the RUN mode.
- The "Loop type" item of the setup bank is changed.

! Handling Precautions

- In any one of the following situations, NX ramp operation will not begin. Also, if a ramp is in progress and one of these situations occurs, the ramp operation will be halted.
  - In MANUAL mode
  - In READY mode
  - When ramp operations are prohibited by internal contact input
- Under the following circumstances ramp operation cannot be initiated by the PV.
  - If a PV input error occurs
  - If PV start is set to 1 (PV start disabled)

6 - 6 Current Transformer (CT) Input

On CT input models, current to the heater can be measured by CT input.
Channels 1 and 2 (CH1, CH2) are available for CT input.
There are 3 types of current measurement, as follows. Select the appropriate detection mode.

(1) Measured current output ON when NX output is ON/OFF
(2) Measured current output OFF when NX output is ON/OFF
(3) Measured current output unrelated to NX output ON/OFF

Use (1) for detection of heater line break or overcurrent.
Use (2) for detection of heater short circuit (actuator short circuit).
Use (3) for constant current measurement. The measured value is conveniently shown as output ON current.

- Methods (2) and (3) of current detection can be used if CT operation is set to any value from 1 to 5.
- If CT operation is set to 0, current detection method (1) is available.

■ Bank and settings

Bank	Item name	Settings
CT input	CT operation	0: Current measurement 1: OUT1 heater line break detection 2: OUT2 heater line break detection 3: OUT3 heater line break detection 4: OUT4 heater line break detection
	Waiting time for CT measurement	30 to 300 ms
	The number of CT turns	100 to 4000
	The number of CT power line passes	1 to 6
	Amount of current indicating disconnected heater	0.0 to 350.0 A
	Amount of current indicating overcurrent	0.0 to 350.0 A
	Amount of current indicating short circuit	0.0 to 350.0 A
	Hysteresis	0.0 to 350.0 A
	Delay time	0.0 to 3200.0 s
	Condition for restoring the status before measurement	1024 to 2047 (standard bit codes)

■ CT operation

CT inputs 1 and 2 can be independently set.

- If set to 0 (current measurement), whenever the NX output is ON the value for measured current will be updated, and whenever the NX output is OFF the value for measured current will be fixed at 0.0 amps.

■ Waiting time for CT measurement

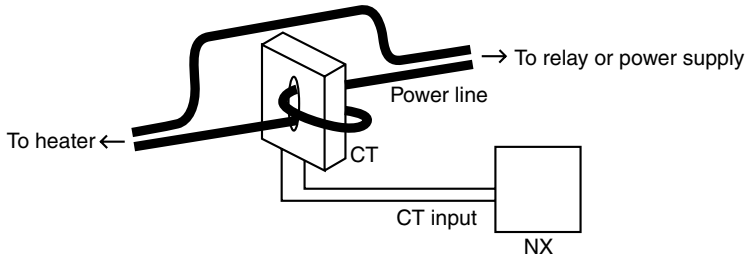
If the CT operation is set to detect a heater line break, the time from the change in output ON/OFF until the start of current measurement can be set.

- Following a change in output ON/OFF, and after the waiting time for CT measurement, current measurement starts. It ends 100 ms later.

■ The number of CT turns/ power line passes

These functions can be set independently for the CTs connected to CT inputs 1 and 2.

- Be sure to enter a setting for the number of turns of the CT connected to the NX.
- For the number of power line passes, count the number of times the power line passes through the CT hole.
  For example, if the power line goes through the hole twice, as shown below, set "2."



■ Amount of current that indicates a disconnected heater

If the current measured by the CT is below the set value when the NX output is ON, a heater line break will be detected.
When set to "0.0," detection is disabled.

■ Amount of current that indicates overcurrent

If the current measured by the CT is above the set value when the NX output is ON, an overcurrent will be detected.
When set to "0.0," detection is disabled.

■ Amount of current indicating short circuit

If the current measured by the CT is above the set value when the NX output is OFF, a short circuit will be detected.
When set to "0.0," detection is disabled.

■ Hysteresis

Applies to the detection of heater line break, overcurrent, and short circuit of the actuator.

■ Delay time

Applies to the detection of heater line break, overcurrent, and short circuit of the actuator.

■ Condition for restoring the status before measurement

A standard bit code can be set as the condition for restoring the status before measurement of current. For example, if the control output is OFF after detection of a line break, use this function to cancel continuing detection of the line break.

! Handling Precautions

- The ON/OFF status of heater line break/overcurrent/short circuit detection is reflected in the standard bit codes.
  ☞ ■ Standard bit codes (on page App.-11).
- If ON/OFF signals for detecting a line break or overcurrent are generated from the relay output or digital output (DO), set the desired CT operation for the output type assignment.

Chapter 7. MV if PV is Abnormal

7 - 1 Loop output (MV) bank

The MV for PID calculation can be set so that it switches to any desired fixed value if a PV input error occurs when the mode is both RUN and AUTO.

■ Setting banks

Loop output (MV) bank

■ Example

The following describes how to configure the MV for PID calculation so that it decreases to 10 % if a PV input error occurs in loop 1.

(1) First, set Output operation at PV error.
In the loop output (MV) bank, set as follows.

Item name	Setting
(Loop 1) Output operation at PV error	1: Output at PV error

(2) Next, set Output at PV error.
In the loop output (MV) bank, set as follows.

Item name	Setting
(Loop 1) Output at PV error	10.0

7 - 2 MV change limit

Handling Precautions

- This function is not available on the NX-D15.

The amount of MV change per second can be limited by setting the MV change limit.

■ Setting banks

Loop control (extended settings) bank

■ Example

The example below shows how to set the loop 1 MV so that when the MV is increasing its amount of change is limited to 10 %.

(1) Set the MV increase change limit.
In the loop control (extended settings) bank, set as follows.

Item name	Setting
(Loop 1) MV increase change limit	10.00

(2) Set the MV decrease change limit.
In the loop control (extended settings) bank, set as follows.

Item name	Setting
(Loop 1) MV decrease change limit	0.00

7 - 3 MV Branching Output

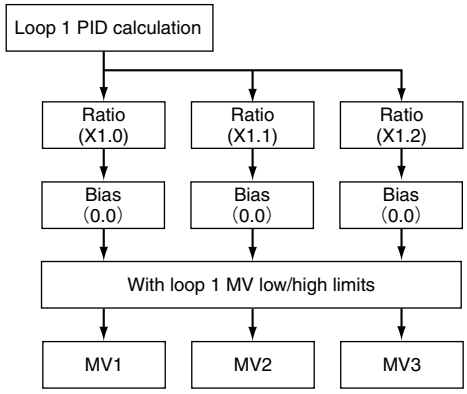
MV branching outputs (up to 4) with ratios or biases can be executed using the MV for PID calculation of any loop.

■ Setting banks

MV branching output bank

■ Example

The following describes how to turn the MV of loop 1 into MV1-MV3 having ratios of 1.0, 1.1, and 1.2 respectively.



(1) Set MV1.

In the MV branching output bank, set as follows.

Item name	Settings
(MV1) Loop No. / Standard numerical code assignment	1
(MV1) Ratio	1.00
(MV1) Bias	0.00

(2) Set MV2.

In the MV branching output bank, set as follows.

Item name	Settings
(MV2) Loop No. / Standard numerical code assignment	1
(MV2) Ratio	1.10
(MV2) Bias	0.00

(2) Set MV3.

In the MV branching output bank, set as follows.

Item name	Settings
(MV3) Loop No. / Standard numerical code assignment	1
(MV3) Ratio	1.20
(MV3) Bias	0.00

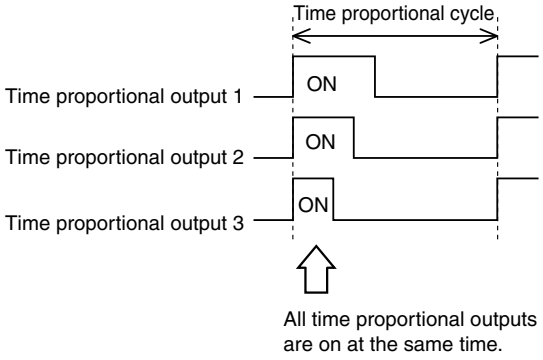
⚠ Handling Precautions

- Ratio and bias do not operate if Loop No. / Standard numerical code assignment is set for one of the following: output at PV error, manual MV, output at READY, or AT output.

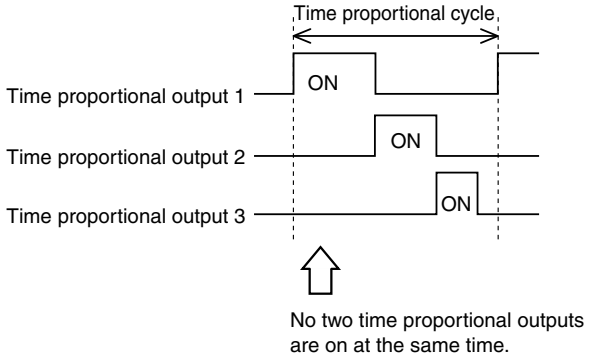
7 - 4 Energy saving time proportional operation

The energy saving time proportional function prevents multiple time proportional outputs from being ON at the same time.

[Example of operation without energy saving time]



[Example of operation without energy saving time]



Up to 8 time proportional outputs can be put into an energy saving time proportioning group.
An energy saving time proportioning group consists of one master output and one or more slave outputs.
Time proportional output 1 represents the master output in the figure on the right above.

- The master output turns on at the beginning of the time proportional cycle.
- The first slave output turns on after the master output turns off.
- The second slave output turns on after the first slave output turns off.
- Likewise, the each following slave output turns on after the previous one turns off.

Handling Precautions

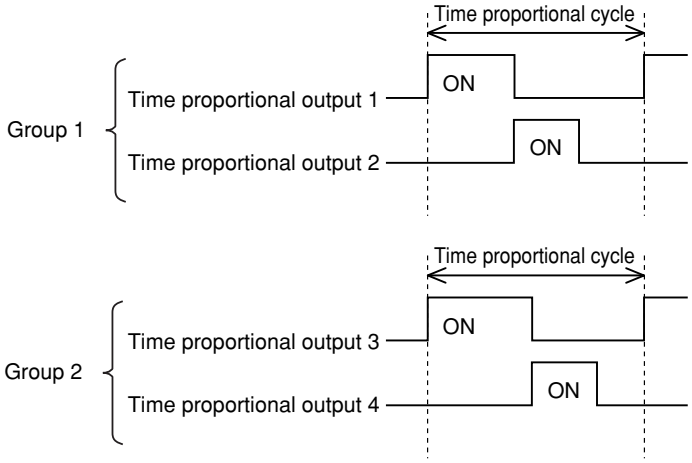
- Set the same time proportional cycle for each output in the group.
- Set the time proportional operation type to 1 (actuator-life-oriented) for each output in the group.

■ Setting banks

Energy saving time proportional bank

■ Example

The following tells how to create two energy saving time proportioning groups and assign outputs 1-2 and 3-4 to group 1 and 2 respectively.



(1) Set output 1.

In the energy saving time proportional bank, set as follows.

Item name	Settings
(Time proportional output 1) Energy saving time proportional operation	1: Enabled
(Time proportional output 1) Energy saving delay time	(Invalid setting)
(Time proportional output 1) Master/Slave selection	0: Master
(Time proportional output 1) Time proportional slave channel	2: Time proportioning 2

(2) Set output 2.

In the energy saving time proportional bank, set as follows.

Item name	Settings
(Time proportional output 2) Energy saving time proportional operation	1: Enabled
(Time proportional output 2) Energy saving delay time	Set the time (in ms) required because of delay in the operation of the actuator.
(Time proportional output 2) Master/Slave selection	1: Other than master
(Time proportional output 2) Time proportional slave channel	2: Time proportioning 2

(3) Set output 3.

In the energy saving time proportional bank, set as follows.

Item name	Settings
(Time proportional output 3) Energy saving time proportional operation	1: Enabled
(Time proportional output 3) Energy saving delay time	(Invalid setting)
(Time proportional output 3) Master/Slave selection	0: Master
(Time proportional output 3) Time proportional slave channel	4: Time proportioning 4

(4) Set output 4.

In the energy saving time proportional bank, set as follows.

Item name	Settings
(Time proportional output 4) Energy saving time proportional operation	1: Enabled
(Time proportional output 4) Energy saving delay time	Set the time (ms) corresponding to the delay in the operation of the actuator.
(Time proportional output 4) Master/Slave selection	1: Other than master
(Time proportional output 4) Time proportional slave channel	4: Time proportioning 4

Note

- Within a group, assign the time proportional slave channel to the last slave output. (In the above examples, slave outputs 2 and 4 are the last ones.)

■ Energy saving delay time

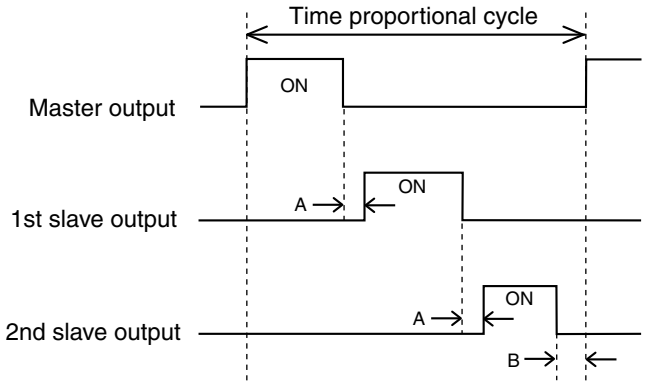
This is set when there are slave outputs.

This setting allows a slave output to turn on after the previous output has turned off and the delay time has passed, so that another output and the actuator are not ON at the same time. In other words, this setting prevents time proportional outputs from being ON at the same time because of delay in the operation of the actuator.

(See A in the chart below.)

At the end of the time proportional cycle, the energy saving delay time is also used to prevent overlapping outputs when the master output turns on.

(See B in the chart below.)



! Handling Precautions

● Before use, make sure to do the following.

- Set the same time proportional cycle for each output in an energy saving group.
- Set to "Actuator-life-oriented."
- For slave channels, be sure to set the energy saving delay time as appropriate for the amount of delay in the operation of the actuator.

● Observe the following limitations on use.

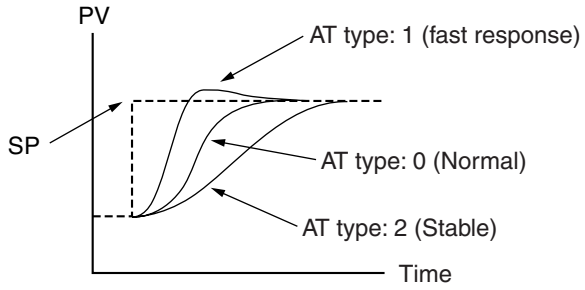
- If the output of the master channel is so large that the output time of the slave channel cannot fit within the time proportional cycle, the slave output is aborted at the end of the cycle. Therefore, the control output result may not be properly output.
- Even in MANUAL or READY mode, or during a PV alarm, the energy saving time proportional output results have priority. Therefore, the set MV may not be output, depending on the MV determined by the master channel.
- For a stable state where PV = SP, the total length of time for control outputs and delay time in each channel must be equal to or less than 100% of the cycle time. If the total time exceeds the cycle time, the slave channels cannot be controlled by the settings.
- Controllability may vary significantly depending on whether energy saving time proportioning is used or not.

7 - 5 AT (Auto-Tuning)

When using AT, select the proper AT type in order to achieve successful AT that fits the control characteristics of the target application. The AT type can be selected from the following 3 types:

0: Normal (regular control characteristics)
1: Fast response (reaction to disturbance)
2: Stable (minimal up/down PV fluctuation)

The figure below illustrates the differences in control results using the PID constants generated by each AT type.



Differences in SPs

■ Setting banks

Bank	Item name	Settings
Loop control (basic configuration)	AT type	0: Normal (regular control characteristics) 1: Fast response (reaction to disturbance) 2: Stable (minimal up/down PV fluctuation)
Loop control (extended settings)	MV low limit at AT	-10.0 to +110.0
	MV high limit at AT	-10.0 to +110.0
Loop control (algorithm)	AT adjustment factor, proportional band	0.00 to 320.00
	AT adjustment factor, integral time	0.00 to 320.00
	AT adjustment factor, derivative time	0.00 to 320.00

■ Example 1

The following describes how to set the AT type of loop 1 to "Fast response."

Set the AT type.
In the loop control (basic setting) bank, set as follows.

Item name	Setting
(Loop 1) AT type	1: Fast response (reaction to disturbance)

■ Example 2

The following describes how to configure the loop 1 auto tuning so that the AT result for derivative time is always 0.0.

Set the AT adjustment factor.
In the loop control (algorithm) bank, set as follows.

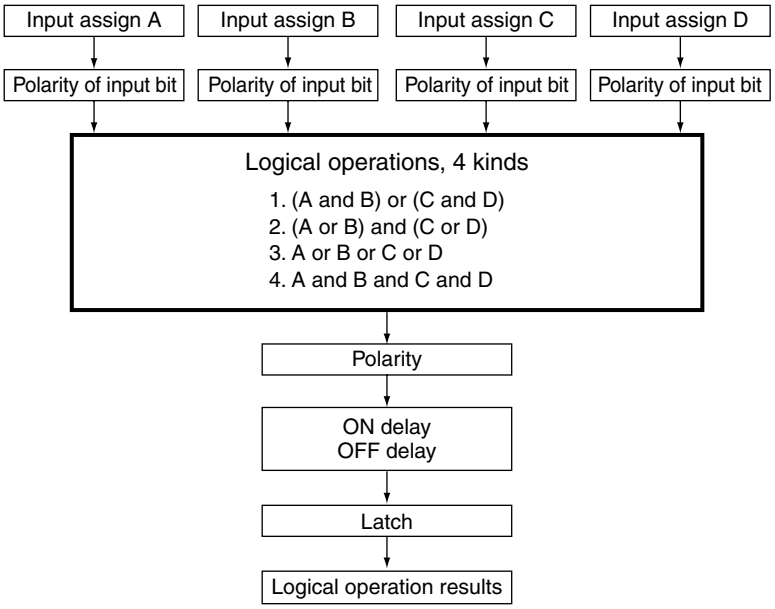
Item name	Settings
(Loop 1) AT adjustment factor, proportional band	1.00
(Loop 1) AT adjustment factor, integral time	1.00
(Loop 1) AT adjustment factor, derivative time	0.00

Note

- If an AT adjustment factor is set, the PID constant resulting from AT is multiplied by the adjustment factor and the result is used as the PID constant setting.
  It is not necessary to set an AT adjustment factor if the PID constant resulting from AT is to be used as is. Use the default setting (1.00).

7 - 6 Logical Operations

This unit can perform the logical operation (Boolean operation consisting of "0" and "1") corresponding to various instrument statuses and can use the logical operation results as ON/OFF outputs or internal contact inputs.
16 groups of logical operations are provided. One operation group consists of four inputs and one output.
Four kinds of logical operations are provided. Furthermore, the input or output logic can be inverted.



■ Processing sequence for logical operations

Certain logical operation results can be used as inputs of the logical operation in the same group or different group. The operating process of the logical operation is performed at intervals of sampling cycles in the group No. order.
Therefore, the logical operation results of a smaller group No. can be used in the same sampling cycle. The logical operation results of the same group No. or a lager group No. are used in the next sampling cycle.

Note

- Logical operations 1-4 are executed before PID calculation and 5-16 are executed afterwards.

■ Example

The following describes the settings required so that digital output 1 turns on using logical operation group 1 when any of event 1 event 2, or "representative of all alarms" is in the ON state.

(1) Set the logical operation.
In the logical operation bank, set as follows.

Item name	Settings
(Logical operation group 1) Operation type	3: Operation 3 (A or B or C or D)
(Logical operation group 1) Input assign A	1088: Event 1
(Logical operation group 1) Input assign B	1089: Event 2
(Logical operation group 1) Input assign C	1792: Representative of all alarms
(Logical operation group 1) Input assign D	1024:OFF
(Logical operation group 1) Input bit polarity A	0: Direct
(Logical operation group 1) Input bit polarity B	0: Direct
(Logical operation group 1) Input bit polarity C	0: Direct
(Logical operation group 1) Input bit polarity D	0: Direct
(Logical operation group 1) ON delay time	0.0 (unit: s)
(Logical operation group 1) OFF delay time	0.0 (unit: s)
(Logical operation group 1) Reverse	0: Direct
(Logical operation group 1) Latch	0: Not latched.

(2) Set the results of the logical operation 1 for the output 1.
In the OUT/EV output ON/OFF bank, set as follows.

Item name	Settings
(OUT/EV output 1) Output type	1088: Event 1
(OUT/EV output 1) Latch	0: Not latched.
(OUT/EV output 1) Time proportional operation type	(Invalid setting)
(OUT/EV output 1) Min. ON/OFF time	10 (ms)
(OUT/EV output 1) Time proportional cycle	(Invalid setting)
(OUT/EV output 1) Phase shift	(Invalid setting)

7 - 7 User-Defined Bit

Instead of digital input, user-defined bits can be used. User-defined bits are 32 ON/OFF variables that can be read and written using communications.

■ Example

The following describes the settings required so that when user-defined bit 1 is turned ON or OFF the mode of loop 1 is switched to READY or RUN respectively.

(1) Set the RUN/READY mode selection to internal contact 1.
In the internal contact input bank, set as follows.

Item name	Settings
(Internal contact 1 group) Operation type	21: RUN/READY mode selection
(Internal contact 1 group) Input type	1408: User-defined bit 1
(Internal contact 1 group) Loop/channel definition	1: Loop 1
(Internal contact 1 group) Weighting	(Setting is invalid.)

(2) Change the value of user-defined bit 1 using communications.
Input 0 (RUN) or 1 (READY) to the data address of user-defined bit 1 in the user-defined bit bank.

7 - 8 User-defined Numerical Codes

User-defined numerical codes are 16 numerical variables that can be read and written using communications.

■ Example

The NX receives the MV from the host device via communications and outputs it. The following describes the settings required so that the MV of the host device is output from analog current output 1 using user-defined numerical code 1.

(1) Assign user-defined numerical code 1 to analog current output 1.
In the output (continuous output) bank, set as follows.

Item name	Settings
(Analog current output 1) Output range	0: 4 to 20 mA
(Analog current output 1) Output type	2111: User-defined numerical code 1
(Analog current output 1) Loop/channel definition	(Invalid setting)
(Analog current output 1) Output decimal point position	0: No decimal point
(Analog current output 1) Output scaling low limit	0
(Analog current output 1) Output scaling high limit	1000

(2) Change the value of user-defined numerical code 1 using communications.
Multiply the MV from the host device by 10 and input the result into the data address of user-defined numeral code 1 in the user-defined numeral code bank. (If the MV is 50.0 %, input 500 into the address.)

Chapter 8. CPL COMMUNICATIONS FUNCTION

8 - 1 Overview of Communications

If the model is provided with the optional RS-485 communication function, communication with a PC, PLC or other host devices is available using a user-configured program.
The communication protocol of this unit can be selected from the Controller Peripheral Link (CPL) communication (Yamatake's host communication protocol) and the MODBUS communication.
This chapter describes the CPL communications.

■ Features

The features of the NX-D15/25's communication function are as follows:

- Up to 31 units can be connected to a single master station as a host device.
- When the communication specifications of the host device conform to the RS-232C interface, the communication converter CMC10L (sold separately) is required. The CMC10L allows conversion between RS-232C and RS-485.
- Almost all of the device parameters can be communicated.
  For details on communication parameters, refer to:
  ☞ LIST OF COMMUNICATION DATA.
- Random access commands are available.
  Two or more parameters at separated addresses can be read or written by a single command.

■ Setup

The following settings are required for CPL communications.

Item name	Contents of setup	Initial value
CPL/MODBUS	0: CPL 1: MODBUS ASCII format 2: MODBUS RTU format	0
Station address	0: Does not communicate 1 to 127	127
Transmission speed	0: 4800 bps 1: 9600 bps 2: 19200 bps 3: 38400 bps 4: 57600 bps 5: 115200 bps	2
Data format (Data length)	0: 7 bits 1: 8 bits	1
Data format (Parity)	0: Even parity 1: Odd parity 2: No parity	0
Data format (Stop bit)	0: 1 stop bit 1: 2 stop bits	0
Response time-out	1 to 250 ms	3

[!] Handling Precautions

- However, they cannot be performed via RS-485 communications.
- If you use the Yamatake CMC10L as an RS-232C/RS-485 converter, set the response time-out to 3 ms or longer.
  The supported transmission speed of the CMC10L is up to 38400 bps.

■ Communication procedures

The communication procedure is as follows:

(1) The instruction message is sent from the host device (master station) to one unit (slave station) to communicate with.

(2) The slave station receives the instruction message, and performs read or write processing according to the content of the message.

(3) The slave station sends a message corresponding to the processing content as a response message.

(4) The master station receives the response message.

! Handling Precautions

- Two or more protocols cannot be used together on a single RS-485 transmission line (such as CPL, MODBUS ASCII format, or MODBUS RTU format).

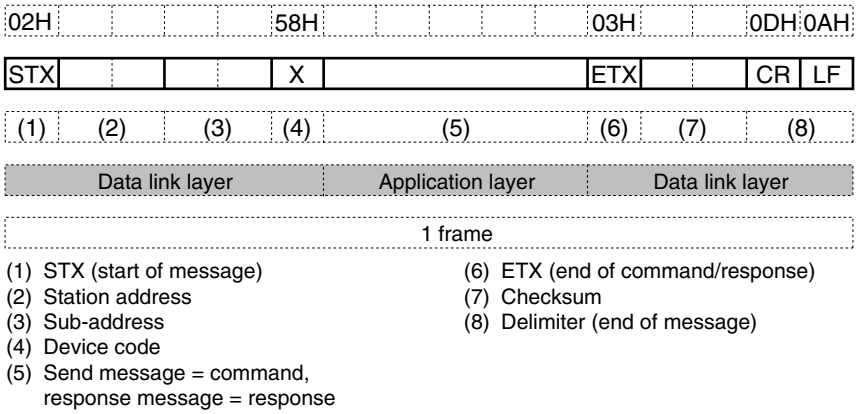
8 - 2 Message Structure

■ Message structure

The following shows the message structure.
Messages are broadly classified into two layers: the data link layer and the application layer.

- Data link layer
  This layer contains the basic information required for the communication such as the destination of the communication message and the check information of the message.
- Application layer
  Data is read and written in this layer. The content of the layer varies according to the purpose of the message.

Messages comprise parts (1) to (8) as shown in the figure below.
The command (details sent from the master station) and the response (details returned from the slave station) are stored in the application layer.



(1) STX (start of message)
(2) Station address
(3) Sub-address
(4) Device code
(5) Send message = command, response message = response
(6) ETX (end of command/response)
(7) Checksum
(8) Delimiter (end of message)

■ Data link layer

● Outline

The data link layer is of a fixed length. The position of each data item and the number of its characters are already decided. Note, however, that the data positions of the data link layer from ETX onwards shift according to the number of characters in the application layer.

● Response start conditions

- The device sends the response message only when message structure in the data link layer is all correct. If even one of these is incorrect, no response messages are sent, and the device waits for new message.

● List of data link layer data definitions

The following list shows the definitions for data in the data link layer:

Data name	Character code	Number of characters	Meaning of data
STX	02H	1	Start of message
Station address	0 to 7FH are expressed as hexadecimal character codes.	2	Identification of device to communicate with
Sub-address	"00" (30H, 30H)	2	No function
Device code	"X" (58H) or "x" (78H)	1	Device type
ETX	03H	1	End position of the application layer
Checksum	00H to FFH are expressed as two-digit hexadecimal character codes.	2	Checksum of message
Delimiter	CR(0DH), LF(0AH)	2	End of message

● Description of data items

- STX(02H)
  When it receives an STX, the NX regards it as the start of a transmitted message, even if no delimiter for the previous STX has been received. In this way, if electrical noise (etc.) causes an error in a message, the NX can respond properly when the next message from the master station is received.
- Station address
  The NX creates a response message only when the station address on the received message is that of the NX. The station address consists of two hexadecimal characters.
  The NX returns the same station address as that of the received message. However, if the station address is set to "0" (30H 30H), the NX makes no response even if the station addresses match.
- Sub-address
  Two hexadecimal characters between "00" (30H 30H) and "FF" (46H 46H) can be used. The NX returns the same sub-address as that of the received message.
- Device code
  "X" (58H) or "x" (78H) can be used. Because the device code is fixed for each device series, other codes cannot be used. The NX returns the same device code as that of the received message. As an example of use, "X" (58H) can be used as the default code, while "x" (78H) is used for resent messages.
- ETX
  ETX indicates the end of the application layer.
- Checksum
  This value is for checking whether or not some abnormality (e.g. noise) causes the message content to change during communications.
  The checksum is expressed as two hexadecimal characters.
  - How to calculate a checksum
    (1) Add the character codes in the message from STX through ETX in single byte units.
    (2) Take two's complement of the low-order one byte of the addition result.
    (3) Convert the obtained two's complement to a two-byte ASCII code.

The following is a sample checksum calculation for a sample message:

STX: 02H
'0': 30H (first byte of the station address)
'1': 31H (second byte of the station address)
'0': 30H (first byte of the sub-address)
'0': 30H (second byte of the sub-address)
'X': 58H (device code)
'R': 52H (first byte of the command)
'D': 44H (second byte of the command)
(omitted)
ETX: 03H

(1) Add the character codes in the message from STX through ETX in single byte units.
The addition operation in single byte units is as follows:
02H + 30H + 31H + 30H + 30H + 58H + 52H + 53H + • • • + 03H.
Assume that the result is 376H.
(2) The low-order one byte of the addition result 376H is 76H. The two's complement of 76H is 8AH.
(3) Convert the obtained 8AH to a two-byte ASCII code.
The result is:
'8': 38H
'A': 41H,
and the two bytes, '8'(38H) and 'A'(41H), are the checksum.

- Delimiter (CR/LF)
This indicates the end of the message. Immediately after LF is received, the device enters a state allowed to process the received message.

■ Application layer

The table below shows the configuration of the application layer.

Item	Description
Command	"RS" (decimal format continuous address data read command)
	"WS" (decimal format continuous address data write command)
	"RD" (hex format continuous address data read command)
	"WD" (hex format continuous address data write command)
	"RU" (hex format random address data read command)
	"WU" (hex format random address data write command)
Data delimiter	RS, WS command: "," (comma) Other commands: none
Word address	RS, WS command: Base 10 numbers + W (501W, etc.) Other commands: Numeric value in hex notation, such as "01F5".
Read count	RS, WS command: Base 10 numbers (1, etc.) Other commands: Numeric value in hex notation, such as "0001".
Numerical value to be written	RS, WS command: Base 10 numbers (100, etc.) Other commands: Numeric value in hex notation, such as "0064".

The number of addresses accessible by a single command and response message.

Command	RAM	EEPROM
RD	28	28
WD	28	28
RU	28	28
WU	16	16
RS	16	16
WS	16	16

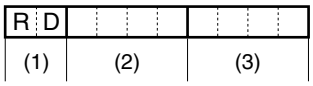
8 - 3 Description of Commands

■ Fixed length continuous data read command (RD command)

Reads data from contiguous data addresses in hexadecimal format.

● Command message

Specify the starting data address and the number of words. The format for the application layer of command messages is shown below.

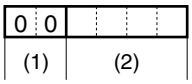


(1) Fixed length continuous data read command
(2) Starting data address
(3) Number of read data

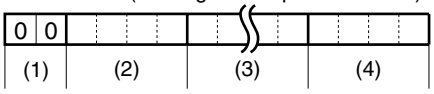
● Response message

The format for the application layer of response messages is shown below.

• Normal termination (reading of single data item)



• Normal termination (reading of multiple data items)



• Abnormal termination

The abnormal termination code is entered at XX.
For details of codes, refer to:
☞ 8-6, List of Termination Codes (on page 8-15).

(1) Termination code
(2) Data
(3) Data 2 to data (n-1)
(4) Data n

🕮 Note

For details on hexadecimal number format, refer to:
☞ 8-5 Numeric Representation in the Application Layer ■ Hexadecimal numbers (on page 8-13).

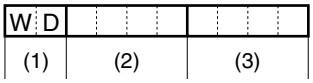
■ Fixed length continuous data write command (WD command)

Writes data to continuous data addresses in hexadecimal format.

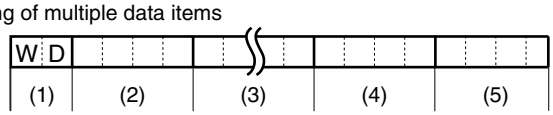
● Command message

Specify the starting data address and 1 word or more. The format for the application layer of command messages is shown below.

• Writing of single data item



• Writing of multiple data items



(1) Fixed length continuous data write command
(2) Starting data address
(3) Data 1
(4) Data 2 to data (n-1)
(5) Data n

● Response message

The format for the application layer of response messages is shown below.

• Normal termination

• Abnormal termination

The abnormal termination code is entered at XX.
For details of codes, refer to:
☞ 8-6, List of Termination Codes (on page 8-15).

(1) Termination code

🕮 Note

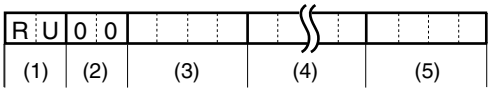
For details on hexadecimal number format, refer to:
☞ 8-5 Numeric Representation in the Application Layer ■ Hexadecimal numbers (on page 8-13).

■ Fixed length random data read command (RU command)

Reads data from "random" (non-continuous) data addresses in hexadecimal format.

● Command message

Specify 1 or more data addresses. The format for the application layer of command messages is shown below.

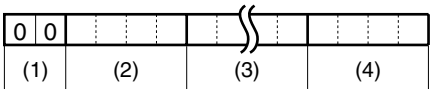


(1) Fixed length random data read command
(2) Sub-command: fixed to "00".
(3) Data address 1
(4) Data address 2 to data address (n-1)
(5) Data address n

● Response message

The format for the application layer of response messages is shown below.

• Normal termination



• Abnormal termination

The abnormal termination code is entered at XX.
For details of codes, refer to:
☞ 8-6, List of Termination Codes (on page 8-15).

(1) Termination code
(2) Data 1
(3) Data 2 to data (n-1)
(4) Data n

🕮 Note

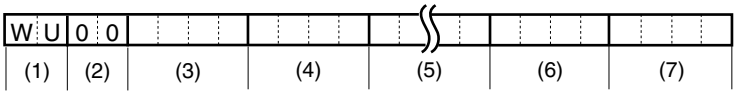
For details on hexadecimal number format, refer to:
☞ 8-5 Numeric Representation in the Application Layer ■ Hexadecimal numbers (on page 8-13).

■ Fixed length random data write command (WU command)

Writes data to "random" (non-continuous) data addresses in hexadecimal format.

● Command message

Make a set of data address and data, and specify 1 group or more. The format for the application layer of command messages is shown below.



(1) Fixed length random data write command
(2) Sub-command: fixed to "00".
(3) Data address 1
(4) Write data 1
(5) Data address, write data 2 to write data (n-1)
(6) Data address n
(7) Write data n

● Response message

The format for the application layer of response messages is shown below.

• Normal termination

• Abnormal termination

The abnormal termination code is entered at XX.
For details of codes, refer to:
☞ 8-6, List of Termination Codes (on page 8-15).

(1) Termination code

🕮 Note

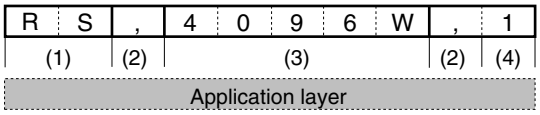
For details on hexadecimal number format, refer to:
☞ 8-5 Numeric Representation in the Application Layer ■ Hexadecimal numbers (on page 8-13).

■ Continuous data read command (RS command)

Reads data is read from continuous data addresses in decimal format.

● Command message

Specify the starting data address and number of words. The format for the application layer of command messages is shown below.

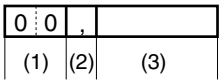


(1) Command
(2) Data delimiter
(3) Starting data address (“W” is necessary)
(4) Number of words

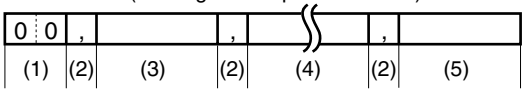
● Response message

The format for the application layer of response messages is shown below.

• Normal termination (reading of single data item)



• Normal termination (reading of multiple data items)



• Abnormal termination

The abnormal termination code is entered at XX.
For details of codes, refer to:
☞ 8-6, List of Termination Codes (on page 8-15).

(1) Termination code
(2) Data delimiter
(3) Data
(4) Data 2 to data (n-1)
(5) Data n

🕮 Note

For details on decimal number format, refer to:
☞ 8-5 Numeric Representation in the Application Layer ■ Decimal numbers (on page 8-14).

■ Continuous data write command (WS command)

Writes data to continuous data addresses in decimal format.

● Command message

Specify the starting data address and 1 word or more. The format for the application layer of command messages is shown below.

W	S	,	4	0	9	6	W	,	1	,	6	5
(1)		(2)	(3)					(2)	(4)	(2)	(5)	

(1) Command
(2) Data delimiter
(3) Starting data address (“W” is necessary)
(4) Data 1
(5) Data 2

● Response message

The format for the application layer of response messages is shown below.

• Normal termination

0	0
(1)	

• Abnormal termination

X	X
(1)	

The abnormal termination code is entered at XX.
For details of codes, refer to:
☞ 8-6, List of Termination Codes (on page 8-15).

(1) Termination code

🕮 Note

For details on decimal number format, refer to:
☞ 8-5 Numeric Representation in the Application Layer ■ Decimal numbers (on page 8-14).

8 - 4 Definition of Data Addresses

● RAM and EEPROM areas of data addresses

Data addresses are categorized as follows:

Data address Hexadecimal notation	Data address Decimal notation	Name	Remarks
1000 to 4FFF	4096 to 20479	RAM access data address	Reading and writing of these addresses are both performed in RAM. Since writing is not performed to EEPROM, the value returns to that stored in EEPROM after restarting.
5000 to 8FFF	20480 to 36863	EEPROM access data address	Writing is performed to both RAM and EEPROM; reading is only from RAM. Since writing is also performed to EEPROM, the value does not change even after restarting.

! Handling Precautions

- EEPROM's erase/write cycles are limited.
  Accordingly, it is recommended that very frequently written parameters be written to RAM, which does not have a limitation on cycles. Note that with regard to the data written to RAM area, that data is saved to EEPROM area when the power is turned ON again.

● Write data range

If the write value exceeds the range determined by parameters, writing is not performed and an abnormal termination code is returned.

● Write conditions

An abnormal termination code is also returned when the writing is not possible due to the conditions.

● Reading an undefined address

If an undefined address is read, the end code does not indicate an error or alarm because there is no data.

8 - 5 Numeric Representation in the Application Layer

Numeric values in the application layer include data addresses, the number of words, and data values. Hexadecimal or decimal numbers are used depending on the command. Command and response messages both use the same format.

■ Hexadecimal numbers

Specifications for hexadecimal numbers are shown below.
If values do not meet the specifications, the NX will send an abnormal termination code and abort command message processing.

Item	Specification	Illegal formats
Command name	RD WD RU WU	RS command (no hexadecimal numbers) WS command (no hexadecimal numbers)
Usable characters	0(30H) to 9(39H) A(41H) to F(46H)	1 2 3 a (“a” cannot be used) - 1 2 3 (“-” cannot be used) ␣ 1 2 3 (space cannot be used)
Number of characters	4	1 2 3 (3 characters) 0 1 2 3 4 (5 characters)
Usable values	8000H to 7FFFH (signed data) 0000H to FFFFH (unsigned data)	
Typical character strings	0 0 0 0 1 2 A B 0 1 2 3 F F F F	

■ Decimal numbers

Specifications for decimal numbers are shown below.
For data addresses, and "W" (57H) to the end of the decimal numeral.
If values do not meet the specifications, the NX will send an abnormal termination code and abort command message processing.

Item	Specification	Illegal formats
Command	RS WS	RD command (no decimal numbers) WD command (no decimal numbers)
Usable characters	0(30H) to 9(39H) -(2DH)	1 2 3 A (“A” cannot be used) + 1 2 3 (“+” cannot be used) ␣ 1 2 3 (space cannot be used)
Delimiter	,(2CH) The delimiter is put between values	
Number of digits	Positive numbers: 1 to 5 digits Negative numbers: 2 to 6 digits Zero: 1 digit	Nothing (between delimiters) 1 2 3 4 5 6 (6 positive numbers)
Usable values	-32768 to +32767 (signed data) 0 to 65535 (unsigned data)	
Format for positive numbers	First digit must be from 1(31H) to 9(39H)	0 1 (0 cannot be the first digit)
Format for negative numbers	First character must be "-" (2DH) followed by 1(31H) to 9(39H)	- 0 1 (0 cannot be the second character)
Format for 0	0	- 0 ("-" cannot be used) 0 0 (1 digit only)
Typical character strings	1 3 2 7 6 7 - 1 2 - 3 2 7 6 8	

8 - 6 List of Termination Codes

The outcome of processing the application layer of the command message is indicated in the termination code of the response message. In addition to the normal termination code, there are abnormal termination codes (no processing was done) and warning termination codes (processing may have been done).

■ Termination codes for read commands

Termination code	Description	Processing by NX
00 (normal)	Normal termination	Read-out value was returned
99 (abnormal)	Undefined command	Only termination code was returned (without data)
10 (abnormal)	Parameter error*	Only termination code was returned (without data)
40 (abnormal)	Word count error	Only termination code was returned (without data)
21 (warning)	Data address error	Data from this address was returned as "0"
22 (warning)	Data range error	Data read from this address was returned as 8000 or 7FFF (hex), or as -32768 or +32767 (decimal)
23 (warning)	Impossible due to device conditions	Data from this address was returned as "0"

*: The following are parameter errors
- Incorrect numerical representation
- Incorrect command message format

■ Termination codes for write commands

Termination code	Description	Processing by NX
00 (normal)	Normal termination	All data was written
99 (abnormal)	Undefined command	No data was written
10 (abnormal)	Parameter error*	No data was written
40 (abnormal)	Word count error	No data was written
21 (warning)	Data address error	There was at least one data address where nothing was written
22 (warning)	Data range error	There was at least one data address where nothing was written
23 (warning)	Impossible due to device conditions	There was at least one data address where nothing was written

*: The following are parameter errors
- Incorrect numerical representation
- Incorrect command message format
- Unnecessary data at the end of the frame.

8 - 7 Reception and Transmission Timing

■ Timing specifications for instruction and response message

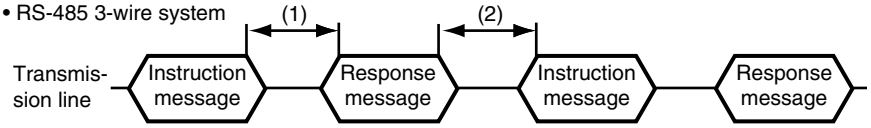
The cautions below are required with regard to the timing to transmit a instruction message from the master station and a response message from the slave station.

● Response monitor time

The maximum response time from the end of the instruction message transmission by the master station until when the master station receives a response message from the slave station is two seconds ((1) in the figure below). So, the response monitor time should be set to two seconds.
Generally, when a response time-out occurs, the instruction message is resent.

● Transmission start time

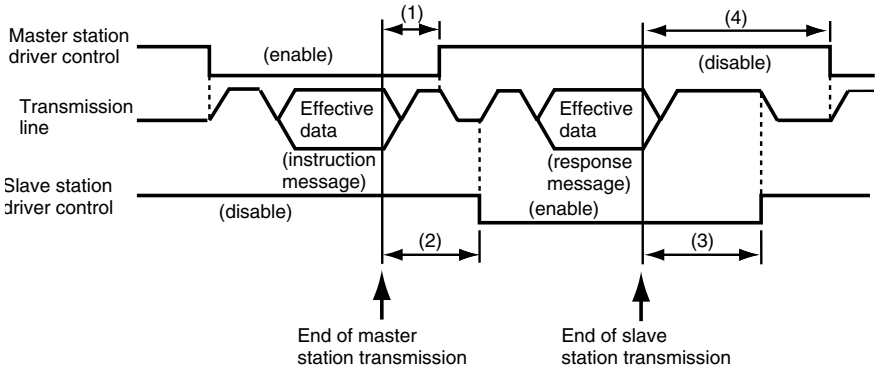
A wait time of 10 ms is required before the master station starts to transmit the next instruction message (to the same slave station or a different slave station) after the end of receiving response message ((2) in the figure below).



(1) End of master station transmission -
Transmission start time of slave station = Max. 2000 ms
(2) End of slave station transmission -
Transmission start time of master station = Min. 10 ms

■ RS-485 driver control timing specifications

When the transmission/reception on the RS-485 3-wire system is directly controlled by the master station, care should be paid to the following timing



(1) End of master station transmission - Driver disable time = Max. 500 μs
(2) End of slave station reception - Driver enable time = Response time-out
(3) End of slave station transmission - Driver disable time = Max. 10 ms
(4) End of master station reception - Driver enable time = Min. 10 ms

Chapter 9. MODBUS COMMUNICATIONS FUNCTIONS

9 - 1 Overview of Communications

If the optional model is provided with the RS-485 communications function, communication with a PC, PLC or other host devices are available using a user-configured program.
The communication protocol can be selected from the Controller Peripheral Link (CPL) communication (Yamatake's host communication protocol) and the MODBUS communication. This chapter describes the MODBUS communications.

■ Features

The features of the NX-D15/25's communication function are as follows:

- Up to 31 units can be connected to a single master station as a host device.
- When the communication specifications of the host device conform to the RS-232C interface, the communication converter CMC10L (sold separately) is required. The CMC10L allows the conversion between RS-232C and RS-485.
- Almost all of the device parameters can be communicated.
  For details on communication parameters, refer to;
  ☞ LIST OF COMMUNICATION DATA.

■ Setup

The following settings are required for MODBUS communications.

Item name	Contents	Initial value
CPL/MODBUS	0: CPL 1: MODBUS ASCII 2: MODBUS RTU	0
Station address	0: No communications 1～127	127
Transmission speed	0: 4800 bps 1: 9600 bps 2: 19200 bps 3: 38400 bps 4: 57600 bps 5: 115200 bps	2
Data format (data length)	0: 7 bits 1: 8 bits	1
Data format (parity)	0: Even parity 1: Odd parity 2: No parity	0
Data format (stop bit)	1: 2 bits	0
Response time-out	1 to 250 ms	3

- If the communications type is set to MODBUS RTU format, data format (data length) cannot be displayed nor set up, and the action is fixed to 8-bit data.

[!] Handling Precautions

- However, they cannot be performed via RS-485 communications.
- If you use the Yamatake CMC10L as an RS-232C/RS-485 converter, set the response time-out to 3ms or longer.
  The supported transmission speed of the CMC10L is up to 38400 bps.

■ Communication procedures

The communication procedure is as follows:

(1) The instruction message is sent from the host device (master station) to one unit (slave station) to communicate with.

(2) The slave station receives the instruction message, and performs read or write processing according to the content of the message.

(3) The slave station sends a message corresponding to the processing content as a response message.

(4) The master station receives the response message.

Handling Precautions

- Two or more protocols cannot be used together on a single RS-485 transmission line (such as CPL, MODBUS ASCII format, or MODBUS RTU format).

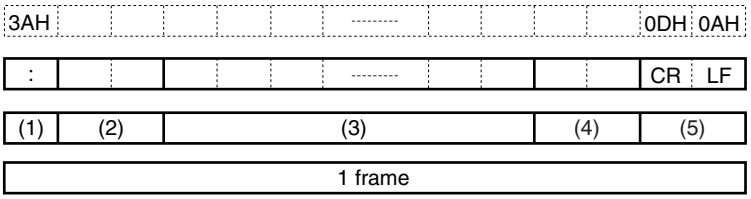
9 - 2 Message Structure

■ Message structure

This section describes the message structure.

● MODBUS ASCII

All messages other than delimiters are written in hexadecimal ASCII codes.
A message of MODBUS ASCII consists of (1) to (5) below.
The part of (3) stores commands, which are transmission contents from the master station and responses, which are transmission contents from the slave station.
All messages use ASCII codes. (Each slot below corresponds to one character.)



(1) Start code (1 byte)
(2) Station address (2 bytes)
(3) Send message, response message
(4) Check code (2-byte LRC)
(5) End code (2 bytes)

- Start code
  The start code is a colon (3AH). Whenever it receives the start code, the NX judges that it is the start of a sent message, even if no end code for the previous start code has been received. In this way, even if electrical noise (etc.) causes an error in a message, the NX can respond properly when the next message from the master station is received.

- Station address
  The NX creates a response message only when the station address on the received message is the same as that of the NX. The station address consists of two hexadecimal characters.
  However, if the station address is set to “0” (30H 30H), the NX makes no response even if the station addresses match. The NX returns the same station address as that of the received message.

- Check code (LRC)
  This code, consisting of two hexadecimal characters, is used to check whether or not some problem (such as electrical noise) has corrupted the message during transmission. The method used to create the check code is described below.

  (1) Data from the beginning of the station address up to just before the check code is added. Note that the values added are not those of the pairs of ASCII numerals in the sent message that express the hex values, but rather the one-byte binary data converted from the two ASCII characters.

  (2) Take two's complement of the addition result is taken.

  (3) The low-order byte of the addition result is converted to two hexadecimal characters.

- End code (CR/LF)
  This indicates the end of the message. As soon as LF is received, processing of the received message can begin.

Note

- A sample check code (LRC) calculation is shown below.

[Sample message]

:	: 3AH (start of the message)
'0'	: 30H (first byte of the station address)
'A'	: 41H (second byte of the station address)
'0'	: 30H (first byte of the read command)
'3'	: 33H (second byte of the read command)
'0'	: 30H (first byte of the start data address)
'3'	: 33H (second byte of the start data address)
'E'	: 45H (third byte of the start data address)
'9'	: 39H (fourth byte of the start data address)
'0'	: 30H (first byte of the number of read data)
'0'	: 30H (second byte of the number of read data)
'0'	: 30H (third byte of the number of read data)
'2'	: 32H (fourth byte of the number of read data)

(1) Add the data from the top up to just before the checksum.
The add operation is as follows:
0AH + 03H + 03H + E9H + 00H + 02H
The result is FBH.

(2) The low-order byte of the addition result FBH is FBH as is. The two's complement of FBH is 05H.

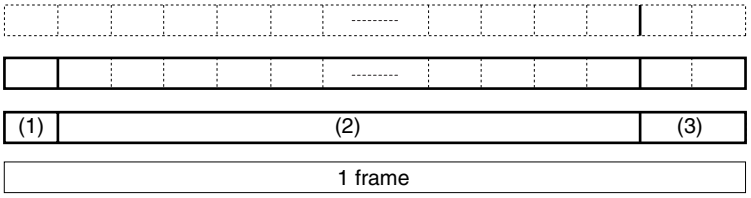
(3) Convert the obtained 05H to a two-byte ASCII code.
The result is:

'0'	: 30H
'5'	: 35H,

and the two bytes, '0' (30H) and '5' (35H), are the check code.

● MODBUS RTU

All messages are written in binary data.
A MODBUS RTU message consists of (1) to (3) below.
The part of (2) stores commands, which are transmission contents from the master station and responses, which are transmission contents from the slave station.
All messages use binary data. (Each slot below corresponds to one character.)



(1) Station address (1 byte)
(2) Send message, response message
(3) Checksum (2 bytes)

- Station address
  The NX creates a response message only when the station address of the received message is the same as that of the NX. The station address in a message is expressed as 1 byte. However, when the station address is set to "0," the NX makes no response even if the station addresses match.The NX returns the same station address as that of the received message.
- Check code (CRC)
  This code is used for checking whether or not some abnormality (e.g., electrical noise) causes the message to change during transmission. The check code is expressed as 2 bytes.

The CRC check code creation method is shown below.
The section of the message from the station address until just before the check code is used in the calculation. For the calculation, the binary data in the message is used. The check code is 16 bit data and can be calculated by using the C-language function "get_crc16()" shown below. In the message, the low-order byte comes first, and then the high-order byte. The opposite order is used in other 16 bit data.

```
[Description]      16-bit CRC is calculated.
[Argument 1]       Length of character string (number of bytes)
[Argument 2]       Pointer for start of character string
[Function value]   Calculation result

unsigned short get_crc16(signed int len, const unsigned char *p)
{
    unsigned short crc16;
    unsigned short next;
    unsigned short carry;
    signed int i;
    crc16 = 0xffff;

    while (len > 0)
    {
        next = (unsigned short)*p;
        crc16 ^= next;
        for (i = 0; i < 8; i++)
        {
            carry = crc16 & 0x0001;
            crc16 >>= 1;
            if (carry != 0)
            {
                crc16 ^= 0xa001;
            }
        }
        p++;
        len--;
    }

    return crc16;
}
```

- 1-frame end judgment
  A message end (1-frame end) is determined when a time period specified for each transmission speed has passed during which no character is received. It is considered that 1 frame has ended when the next character is not received before the time-out time shown below passes.
  However, the time-out time has a fluctuation of ±1ms from the values in the table below.

Set transmission speed (bps)	Time-out time transmission speed (bps)
4800	9 ms or more
9600	5 ms or more
19200	3 ms or more
38400	2 ms or more
57600	2 ms or more
115200	2 ms or more

■ Command type

The following types of command (send message) are compatible with the NX.

Command type	Description		Conformance class
	ASCII	RTU (binary)	
Multiple word read-out	"03" (2-byte)	03H (1-byte)	class 0
Multiple word write	"10" (2-byte)	10H (1-byte)	class 0
Single word write	"06" (2-byte)	06H (1-byte)	class 1 *

* The NX is not compliant with class 1 commands other than single word write.

■ Exception codes

If the response message is abnormal, it will have one of the exception codes below after the function code.

Type of Error	Exception Code		Description
	ASCII	RTU (binary)	
Function code error	"01" (2-byte)	01H (1-byte)	Function code not supported by NX
Data address error	"02" (2-byte)	02H (1-byte)	Cannot read/write at data address
Data error	"03" (2-byte)	03H (1-byte)	Error other than the above

■ Number of words

In a 1-frame message, the amount of data read or written is shown below.

Command type (function code)	Amount of data			
	ASCII		RTU	
	RAM	EERROM	RAM	EERROM
Multiple data read-out (03)	1 to 16	1 to 6	1 to 32	1 to 32
Multiple data write (10)	1 to 16	1 to 6	1 to 32	1 to 32
Single word write (06)	1	1	1	1

🕮 Note

- For the details of MODBUS specifications, refer to;
  ☞ Modicon Modbus Protocol Reference Guide (PI-MBUS-300 Rev.J) by MODICON, Inc.
  ☞ OPEN MODBUS/TCP SPECIFICATION (Release 1.0) by Schneider Electric

9 - 3 Description of Commands

■ Multiple data read-out command (03H)

Data of contiguous data addresses is read out in hexadecimal.

● Command message

Specify the start data address and number of data. The command message structure is shown below.

MODBUS ASCII

3AH	30H	41H	30H	33H	30H	33H	45H	39H	30H	30H	30H	32H	30H	35H	0DH	0AH
:	0	A	0	3	0	3	E	9	0	0	0	2	0	5	CR	LF
(1)	(2)		(3)		(4)				(5)				(6)		(7)	

(1) Start code
(2) Station address
(3) Function code
(4) Starting data address
(5) Number of words
(6) Check code (LRC)
(7) End code

MODBUS RTU

0AH	03H	03H	E9H	00H	02H	14H	C0H
(1)	(2)	(3)		(4)		(5)	

(1) Station address
(2) Function code
(3) Starting data address
(4) Number of read-out words
(5) Check code (CRC)

● Response Message

The structure of a response message is shown below.

MODBUS ASCII

- Example in case of normal reception

3AH	30H	41H	30H	33H	30H	34H	30H	33H	30H	31H	30H	30H	30H	33H	45H	38H	D0H	0AH
:	0	A	0	3	0	4	0	3	0	1	0	0	0	3	E	8	CR	LF
(1)	(2)		(3)		(4)		(5)				(6)				(7)		(8)	

(1) Start code
(2) Station address
(3) Function code
(4) Number of read data X 2
(5) Read data 1
(6) Read data 2
(7) Check code (LRC)
(8) End code

• Example in case of error

3AH	30H	41H	38H	34H	30H	31H	37H	31H	0DH	0AH
:	0	A	8	4	0	1	7	1	CR	LF
(1)	(2)		(3)		(4)		(5)		(6)	

(1) Start code
(2) Station address
(3) Function code (If an abnormality occurs, set the MSB of the function code in the sent message to 1. In this case, since undefined “04” is sent as a command with a sent message, “84” is sent back.)
(4) Abnormal termination code (☞ refer to page 9-6)
(5) Check code (LRC)
(6) End code

MODBUS RTU

• Example in case of normal reception

0AH	03H	04H	03H	01H	00H	03H	51H	76H
(1)	(2)	(3)	(4)		(5)		(6)	

(1) Station address
(2) Function code
(3) Number of read data X 2 (bytes)
(4) Read data 1
(5) Read data 2
(6) Check code (CRC)

• Example in case of error

0AH	84H	01H	F3H	02H
(1)	(2)	(3)	(4)	

(1) Station address
(2) Error flag (since undefined "04H" is sent as a command with a send message, the most significant bit is turned ON and sent back as "84H".)
(3) Abnormal termination code (☞ refer to page 9-6)
(4) Check code (CRC)

■ Multiple data write command (10H)

Data is written to data with contiguous data addresses in hexadecimal.

● Command message

Specify the start data address and 1 word or more. The structure of the application layer of a command message is shown below.

(Example) 01A0H and 0E53H are written to 2 contiguous data addresses starting at 05DDH.

MODBUS ASCII

3AH	30H	31H	31H	30H	30H	35H	44H	44H	30H	30H	30H	32H	30H	34H
:	0	1	1	0	0	5	D	D	0	0	0	2	0	4
(1)	(2)		(3)		(4)				(5)				(6)	

30H	31H	41H	30H	30H	45H	35H	33H	30H	35H	0DH	0AH
0	1	A	0	0	E	5	3	0	5	CR	LF
(7)				(8)				(9)		(10)	

(1) Start of message
(2) Station address
(3) Write command 10H
(4) Starting write data address
(5) Number of write data
(6) Number of write data X 2
(7) Write data 1
(8) Write data 2
(9) Check code (LRC)
(10) End code

MODBUS RTU

01H	10H	05H	DDH	00H	02H	04H	01H	A0H	0EH	53H	45H	B9H
(1)	(2)	(3)		(4)		(5)	(6)		(7)		(8)	

(1) Station address
(2) Write command 10H
(3) Starting write data address
(4) Number of write data
(5) Number of write data X 2
(6) Write data 1
(7) Write data 2
(8) Check code (CRC)

● Response Message

The structure of the application layer of a response message is shown below.

MODBUS ASCII

3AH	30H	31H	31H	30H	30H	35H	44H	44H	30H	30H	30H	32H	30H	42H	0DH	0AH
:	0	1	1	0	0	5	D	D	0	0	0	2	0	B	CR	LF
(1)	(2)		(3)		(4)				(5)				(6)		(7)	

(1) Start code
(2) Station address
(3) Function code
(4) Starting write data address 1
(5) Number of write data
(6) Check code
(7) End code

MODBUS RTU

01H	10H	05H	DDH	00H	02H	D1H	3EH
(1)	(2)	(3)		(4)		(5)	

(1) Station address
(2) Function code
(3) Starting write data address
(4) Number of write data
(5) Check code (CRC)

🕮 Note

- The response message at the time of abnormal termination is the same as that for abnormal termination of the multiple-data read command.

■ Single data write command (06H)

One data address of data is written in hexadecimal.

● Command message

Specify the data address and data. The command message structure is shown below.

(Example) The value of 01A0H is written to data address 05DDH.

MODBUS ASCII

3AH	30H	31H	30H	36H	30H	35H	44H	44H	30H	31H	41H	30H	37H	36H	0DH	0AH
:	0	1	0	6	0	5	D	D	0	1	A	0	7	6	CR	LF
(1)	(2)		(3)		(4)				(5)				(6)		(7)	

(1) Start of message
(2) Station address
(3) Function code
(4) Data address
(5) Write data
(6) Check code (LRC)
(7) End code

MODBUS RTU

01H	06H	05H	DDH	01H	A0H	18H	D4H
(1)	(2)	(3)		(4)		(5)	

(1) Station address
(2) Function code
(3) Data address
(4) Write data
(5) Check code (CRC)

● Response Message

Normally the response message is the same as the command.

Note

- If an error has occurred, the response message is the same as when the multiple data read command results in an error.

9 - 4 Numeric Representation

Numerical values include data addresses, numbers specifying the number of data words, and data values, all of which are hexadecimal numbers.
Numeric representation varies depending on whether the communications type is Modbus ASCII or Modbus RTU. This applies to both command and response messages.

■ ASCII hexadecimal numbers

Specifications for ASCII hexadecimal numbers are shown in the table below.
If values do not meet these specifications, the NX will send an abnormal termination code, aborting command message processing.

Item	Specification	Illegal formats
Usable characters	0(30H) to 9(39H) A(41H) to F(46H)	1 2 3 a (“a” cannot be used) - 1 2 3 (“-” cannot be used) ␣ 1 2 3 (space cannot be used)
Number of characters	4 or 2	1 2 3 (3 characters) 0 1 2 3 4 (5 characters)
Usable values (4 characters)	8000H to 7FFFH (signed data) 0000H to FFFFH (unsigned data)	
Usable values (2 characters)	00H to FFH (unsigned data)	
Typical character strings	0 0 0 0 1 2 A B 0 1 2 3 F F F F 0 1 1 0	

■ RTU hexadecimal numbers

Specifications for RTU hexadecimal numbers are shown in the table below.
If values do not meet these specifications, the NX will send an abnormal termination code, aborting command message processing.

Item	Specification	Illegal formats
Usable characters	00H to FFH (all)	
Number of characters	2 or 1	00H 01H 02H (3 characters)
Usable values (2 characters)	8000H to 7FFFH (signed data) 0000H to FFFFH (unsigned data)	
Usable values (1 character)	00H to FFH (unsigned data)	
Typical character strings	00H 00H 12H ABH 01H 23H FFH FFH 10H 04H	

9 - 5 CPL Communication Function and Common Specifications

■ Definition of Data Address

Refer to;

☞ Section 8-4, Definition of Data Address, on page 8-12

■ RS-485 Driver Control Timing Specifications

Refer to;

☞ Section 8-7, Reception and Transmission Timing, on page 8-16.

Chapter 10. MODBUS/TCP COMMUNICATIONS FUNCTIONS

10 - 1 Overview of Communications

The NX can communicate with the host device using the MODBUS/TCP protocol, which is compliant with Ethernet TCP/IP.

■ Features

The features of the NX-D15/25's communication function are as follows:

- The NX can access all modules in the linked block when an Ethernet interface is connected to the left or right sides, consisting of either a communication adaptor (1 port) or a communication box (4 ports; left side only) attached by Ethernet cable.
- Host devices can communicate with the NX via Ethernet using the IP address of the NX.
- Almost all of the device parameters can be communicated.
  For details on communication parameters, refer to;
  ☞ LIST OF COMMUNICATION DATA.

■ Setup

To activate MODBUS/TCP communications with the NX, set as follows.

Item	Initial value
IP address	192.168.255.254
Netmask	255.255.255.0
Default gateway	None

- The netmask and default gateway can be set separately for each chain when "全体" is selected for "実モジュール構成画面" in the SLP-NX (sold separately).
- The port No. for MODBUS/TCP is 502. However, it can be changed if necessary.

■ Communication procedures

The communication procedure is as follows:

(1) The instruction message is sent from the host device (master station) to one unit (slave station) to communicate with.
(2) The slave station receives the instruction message, and performs read or write processing according to the content of the message.
(3) The slave station sends a message corresponding to the processing content as a response message.
(4) The master station receives the response message.

[!] Handling Precautions

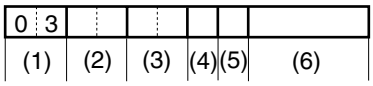
- For MODBUS/TCP, up to 2 TCP connections are available. However, check for any restrictions by other communications or communications functions.

10 - 2 Message Structure

■ Message structure

Uses a TCP/IP frame. A MODBUS/TCP message is shown in the TCP data section of the frame.

● MODBUS TCP



(1)Transaction Identifier (2 bytes)	No particular definition
(2)Protocol Identifier (2 bytes)	0x0000 is for the MODBUS protocol.
(3)Length (2 bytes)	The No. of bytes in 4-6
(4)Unit Identifier (1 byte)	Specify 0xFF or 0x00.
(5)Function (1 byte)	Specify the function code.
(6)Data (n byte)	Data column depending on the function code

● Detailed data

- Transaction Identifier
  A request and its response have the same value.
  The host station can use the transaction identifier to confirm that the data is the response to the request.

- Protocol Identifier
  Specify 0x0000 for the MODBUS protocol.

- Length
  Shows the data length in bytes based on the unit identifier.

- Unit Identifier
  Specify 0xFF or 0x00.

- Function
  Specify the function code.

- Data
  Communications data

● Frame detection method

A TCP frame is equivalent to a MODBUS/TCP frame.

● Port

The TCP port No. for MODBUS/TCP is 502 (changeable).

● Function codes

Supports Function Code 3 (0x03), 16 (0x10), (0x06).

■ Exception codes

If the response message is abnormal, it will have one of the exception codes below after the function code.

Type of Error	Exception Code	Description
Function code error	"01" (2-byte)	Function code not supported by NX
Data address error	"02" (2-byte)	Cannot read/write at data address
Data error	"03" (2-byte)	Error other than the above
Busy	"06" (2-byte)	Cannot process data. Please send again.

■ Number of words

In a 1-frame message, the amount of data read or written is shown below.

Command type (function code)	Amount of data	
	RAM	EEPROM
Multiple data read-out (03)	1 to 64	1 to 64
Multiple data write (10)	1 to 32	1 to 32
Single word write (06)	1	1

Note

- For the details of MODBUS specifications, refer to;
  - ☞ Modicon Modbus Protocol Reference Guide (PI-MBUS-300 Rev.J) by MODICON, Inc.
  - ☞ OPEN MODBUS/TCP SPECIFICATION (Release 1.0) by Schneider Electric

10 - 3 Description of Commands

■ Application section

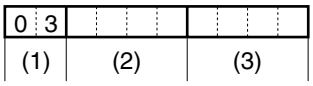
Following data representation

1 byte in hex notation. (High nibble on the left.)

■ Read Holding Registers (FC=0x03)

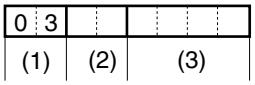
● For 1-word data

- Request



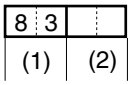
(1) Function code (Read Holding Registers)
(2) Station address
(3) Number of words

- Normal response



(1) Function code (Read Holding Registers)
(2) No. of bytes
(3) Read data

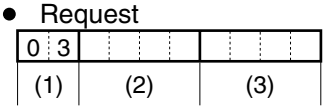
- Abnormal response



(1) Error code (Read Holding Registers)
(2) Exception code (= 01/02/03/06)

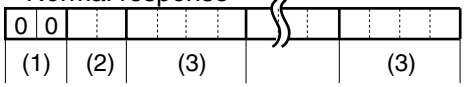
● For multiple-word data

- Request



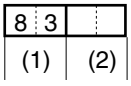
(1) Function code (Read Holding Registers)
(2) Station address
(3) Number of words

- Normal response



(1) Function code (Read Holding Registers)
(2) No. of bytes
(3) Read data (continuous series of all Read data)

- Abnormal response

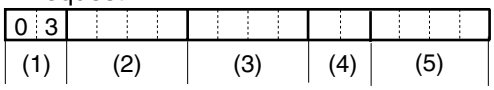


(1) Error code (Read Holding Registers)
(2) Exception code (= 01/02/03/06)

■ Write Multiple Registers (FC=0x10)

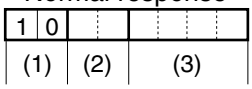
● For 1-word data

- Request



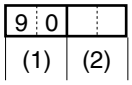
(1) Function code (Write Multiple Registers)
(2) Station address
(3) Number of words (=1)
(4) No. of bytes (= No. of data words X 2)
(5) Write data

- Normal response



(1) Function code (Write Multiple Registers)
(2) Station address
(3) Number of words (=1)

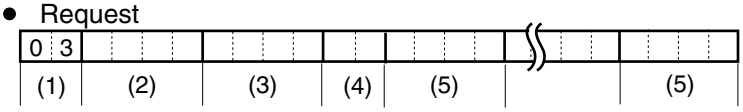
- Abnormal response



(1) Error code (Write Multiple Registers)
(2) Exception code (= 01/02/03/06)

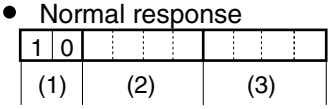
● For multiple-word data

- Request



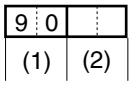
(1) Function code (Write Multiple Registers)
(2) Station address
(3) Number of words
(4) No. of bytes (= No. of data words X 2)
(5) Write data

- Normal response



(1) Function code (Write Multiple Registers)
(2) Station address
(3) Write data

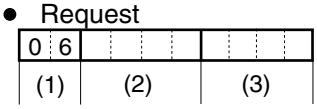
- Abnormal response



(1) Error code (Write Multiple Registers)
(2) Exception code (= 01/02/03/06)

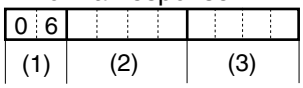
■ Write Single Register (FC=0x06)

- Request



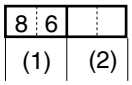
(1) Function code (Write Single Register)
(2) Write address
(3) Write data

- Normal response



(1) Function code (Write Single Register)
(2) Write address
(3) Write data (echo back)

- Abnormal response



(1) Error code (Write Single Register)
(2) Exception code (= 01/02/03/06)

Chapter 11. TROUBLESHOOTING

■ Alarm codes and corrective actions

Alarm codes and countermeasures in case of abnormal operation of this controller.

Alarm code	Problem	Cause	Corrective action
AL01	PV1 high limit error	Sensor disconnection, incorrect wiring, Incorrect settings for input voltage, current, or resistance. Input exceeding upper and lower limit settings for alarm.	Check the PV wiring. Check the input voltage, current, and resistance.
AL02	PV1 low limit error		
AL03	PV2 high limit error		
AL04	PV2 low limit error		
AL05	PV3 high limit error		
AL06	PV3 low limit error		
AL07	PV4 high limit error		
AL08	PV4 low limit error		
AL25	CT1 input error	CT input over range Incorrect setting for CT input AD error	Check the CT input. Change the CT input setting. If there is an AD error replace the unit.
AL26	CT2 input error		
AL27	CT3 input error		
AL28	CT4 input error		
AL71	CJ1 error	Abnormal terminal temperature AD error	Check the ambient temperature. If there is an AD error replace the unit.
AL72	CJ2 error		
AL73	CJ3 error		
AL74	CJ4 error		
AL83	EEPROM not initialized	EEPROM read error	Turn the power off and back on. Replace the unit.
AL85	RAM read/write error	RAM read/write error	
AL86	EEPROM read/write error	EEPROM read/write error	
AL87	Base EEPROM read/write error	Base EEPROM read/write error	
AL88	Base EEPROM error	Base EEPROM error	
AL94	RAM error (parameter data)	ROM error	
AL95	RAM error (adjustment data)		
AL97	EEPROM error (parameter data)	EEPROM read error	
AL98	EEPROM error (adjustment data)		
AL99	ROM error	Faulty ROM (memory)	

Chapter 12. MAINTENANCE, INSPECTION, AND DISPOSAL

12 - 1 Maintenance and Inspection

Cleaning: When removing dirt from the instrument, wipe it off with a soft cloth rag.

Part replacement: Do not replace any parts of this unit.

Fuse replacement: When replacing the fuse connected to the electric wiring, always use the specified standard fuse.
Standard IEC127
Shut-down speed Slow-action type (T)
Rated voltage 250V
Rated current 1.0A

12 - 2 Disposal

When discarding the NX-D15/25, dispose of it appropriately as industrial waste in accordance with local regulations.

Chapter 13. SPECIFICATIONS

13 - 1 Specifications

■ PV input

Input points: 4

Thermocouple: K, E, J, T, B, R, S, N (JIS C 1602-1995)
WRe5-26(ASTM E988-96 (reapproved 2002))
PR40-20 (ASTM E1751-00), Ni-Ni•Mo (ASTM E1751-00),
PL II (ASTM E1751-00), DIN U, DIN L (DIN 43710-1985)
Gold-iron/Chromel (ASTM E1751-00)

Resistance: Pt100 (JIS C 1604-1997), JPt100 (JIS C 1604-1989)

DC voltage (mV range): 0 to 10 mV, -10 to +10 mV, 0 to 100 mV

DC voltage (V range): 0 to 1 V, -1 to +1 V, 1 to 5 V, 0 to 5 V, 0 to 10 V, 2 to 10 V

DC current: 4 to 20 mA, 0 to 20 mA

Sampling cycle: 500 ms (NX-D15), 200 ms (NX-D25)

Input impedance: 150 Ω max. (DC current input), 1 MΩ min. (DC voltage input)

Indication accuracy: ±0.3 % FS ±1 digit

• Thermocouple input

Indication accuracy (under standard conditions):

Range type	Sensor type	Range	Accuracy
1	K	-200 to +1200 °C	±0.3 % FS (±0.6 % FS below 0 °C)
2	K	0 to 1200 °C	±0.3 % FS
3	K	0.0 to 800.0 °C	±0.3 % FS
4	K	0.0 to 600.0 °C	±0.3 % FS
5	K	0.0 to 400.0 °C	±0.3 % FS
6	K	-200.0 to +400.0 °C	±0.3 % FS (±0.6 % FS below 0 °C)
7	K	-200.0 to +200.0 °C	±0.3 % FS (±0.6 % FS below 0 °C)
8	J	0 to 1200 °C	±0.3 % FS
9	J	0.0 to 800.0 °C	±0.3 % FS
10	J	0.0 to 600.0 °C	±0.3 % FS
11	J	-200.0 to +400.0 °C	±0.3 % FS (±0.6 % FS below 0 °C)
12	E	0.0 to 800.0 °C	±0.3 % FS
13	E	0.0 to 600.0 °C	±0.3 % FS
14	T	-200.0 to +400.0 °C	±0.3 % FS (±0.6 % FS below 0 °C)
15	R	0 to 1600 °C	±0.4 % FS (±6.4 °C)
16	S	0 to 1600 °C	±0.4 % FS (±6.4 °C)
17	B	0 to 1800 °C	800 °C to 1800 °C : ±0.4 % FS (±7.2 °C) 260 °C to 800 °C : ±0.8 % FS (±14.4 °C) 0 to 260 °C : ±4 % FS (±72 °C) Low limit for indication: 20 °C
18	N	0 to 1300 °C	±0.3 % FS
19	PL II	0 to 1300 °C	±0.3 % FS
20	WRe5-26	0 to 1400 °C	±0.3 % FS
21	WRe5-26	0 to 2300 °C	±0.3 % FS
22	Ni-Ni•Mo	0 to 1300 °C	±0.3 % FS
23	PR40-20	0 to 1900 °C	800 to 1900 °C: ±1.0 % FS (±19.0 °C) 300 to 800 °C: ±1.5 % FS (±28.5 °C) 0 to 300 °C: ±2.5 % FS (±47.5 °C)
24	DIN U	-200.0 to +400.0 °C	±0.3 % FS (±0.6 % FS below 0 °C)
25	DIN L	-100.0 to +800.0 °C	±0.3 % FS (±0.6 % FS below 0 °C)
26	Gold-iron/Chromel	0.1 to +360.1 K	±3.0 K

■ Transistor output

Output points: 4

Output type: Transistor (sink type)

Load voltage: 5 to 24 Vdc

Load current: 100 mA max.

OFF-state leakage current: 100 μA max.

ON-state residual voltage: 0.5 V max.

■ Analog current output

Output current:	4 to 20 mAdc (2.4 to 21.6 mA)
	0 to 20 mAdc (0 to 22 mA)
Allowable load resistance:	300 Ω max.
Output accuracy:	±0.3 % FS max.
	But 1 % FS for 0 to 0.2 mA
Output resolution:	1/10000 (4 to 20 mA range), 1/12500 (0 to 20 mA range)
Open voltage:	10 Vdc

■ Analog voltage output

Output voltage:	0 to 5 Vdc (0 to 5.5 Vdc)
	1 to 5 Vdc (0.6 to 5.4 Vdc)
	0 to 10 Vdc (0 to 11 Vdc)
	2 to 10 Vdc (1.2 to 10.8 Vdc)
Allowable load resistance:	4 kΩ min.
Output accuracy:	±0.3 % FS max.
	But 1 % FS for 0 to 0.1 V
Output resolution:	1/8000 (1 to 5 V range)
	1/10000 (0 to 5 V range)
	1/16000 (2 to 10 V range)
	1/20000 (0 to 10 V range)

■ Current transformer input (optional)

Compatible current transformers:	QN206A (hole diameter: 5.8 mm, 800 turns)
	QN212A (hole diameter: 12 mm, 800 turns)
Current measurement range:	0.4 to 50.0 Aac
Maximum allowable current:	60 A (with 1 through-turn)
Indication accuracy:	±5 % FS ±1 digit
Indication resolution:	0.1 A

■ Digital output (optional)

Output points:	4
Output type:	Transistor (sink type)
Load voltage:	5 to 24 Vdc
Load current:	100 mA max.
OFF-state leakage current:	100 μA max.
ON-state residual voltage:	0.5 V max.

■ Digital input (optional)

Output points:	4
Connectable output:	Non-voltage contacts or transistor (sink type)
Open terminal voltage:	5 Vdc ±10 %
ON resistance:	250 Ω max.
OFF resistance:	100 kΩ min.
Allowable ON-state residual voltage:	1 V max.
Allowable OFF-state leakage current:	0.1 mA max.

■ Standard conditions

Ambient temperature:	23 ±2 °C
Ambient humidity:	60 ±5 % RH (without condensation)
Rated power supply voltage:	24 Vdc
Vibration resistance:	0 m/s^2
Shock resistance:	0 m/s^2
Mounting angle:	Reference plane ±3 °

■ Operating conditions

Ambient temperature:	0 to 50 °C (below the installed NX)
Ambient humidity:	10 to 90 % RH (without condensation)
Allowable power supply voltage for operation:	21.6 to 26.4 Vdc
Vibration resistance:	0 to 3.2 m/s^2 (10 to 150 Hz for 2 h each in x, y, and z directions)
Shock resistance:	0 to 9.8 m/s^2
Mounting angle:	Reference plane ±3 °
Dust:	0.3 mg/m^3 max.
Corrosive gas:	None
Altitude:	2000 m max.

■ Transportation conditions

Ambient temperature:	-20 to +70 °C
Ambient humidity:	5 to 95 % RH (without condensation)
Vibration resistance:	0 to 9.8 m/s^2 (10 to 150 Hz for 2 h each in x, y, and z directions)
Shock resistance:	0 to 300 m/s^2 (vertically 3 times while on DIN rail)
Package drop test:	Drop height 60 cm (free fall on 1 corner, 3 sides, 6 planes)

■ Other specifications

Memory type:	Nonvolatile
Insulation resistance:	20 MΩ min.
Dielectric strength:	500 Vac for 1 min (between power supply terminals and I/O terminals isolated from the power supply terminals)
Power consumption:	4W max. (under operating conditions)
Power ON inrush current:	20 A max. (under operating conditions)
Case material, color:	Modified PPO resin, black
Mounting method:	DIN rail
Terminal screw tightening torque:	0.6 ±0.1 N·m

■ Communications

- Ethernet

protocol:	MODBUS/TCP

- RS-485

protocol:	MODBUS (RTU/ASCII), CPL
Signal level:	RS-485 compliant
Communication/ synchronization type:	Half-duplex, start/stop synchronization
Maximum cable length:	500 m
Terminating resistor:	External (150 Ω, 1/2 W min.)
Transmission speed:	115200 bps max.

■ Communications box (sold separately, model No. NX-CB1****)

Communication path type:	• Ports 1, 2 IEEE802.3/IEEE802.3u 10BASE-T/100BASE-TX (with auto-negotiation and Auto-MDI/MDI-X) • Ports 3, 4 IEEE802.3u 100BASE-TX (with full duplex and Auto-MDI/MDI-X.)
Connector:	RJ-45
Cable:	UTP cable (4P) Category 5e min. (straight) (EIA/TIA568)

■ Communications adaptor (sold separately, models NX-CL1****, NX-CR1****)

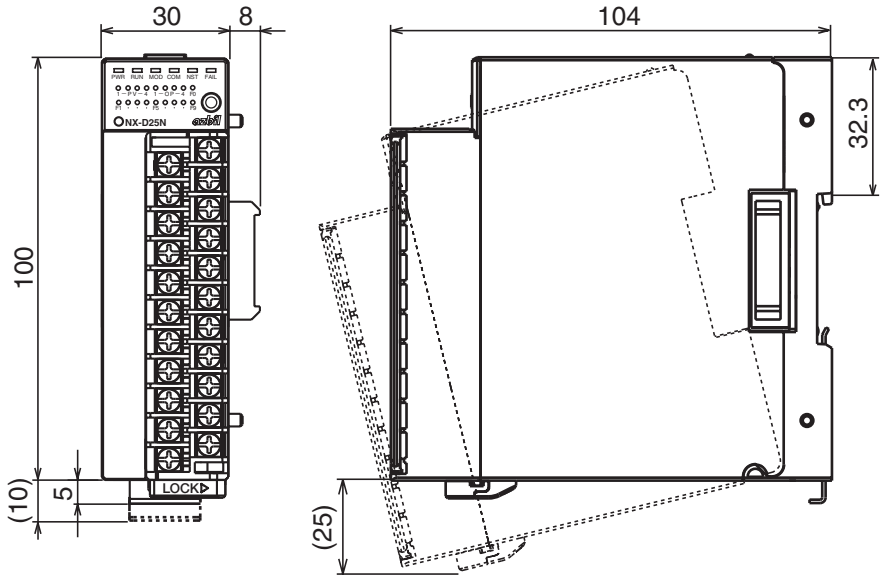
Communication path type:	IEEE802.3u 100BASE-TX (with full duplex and Auto-MDI/MDI-X.)
Connector:	RJ-45
Cable:	UTP cable (4P) Category 5e min. (straight) (EIA/TIA568)

13 - 2 External Dimensions

■ Controller module

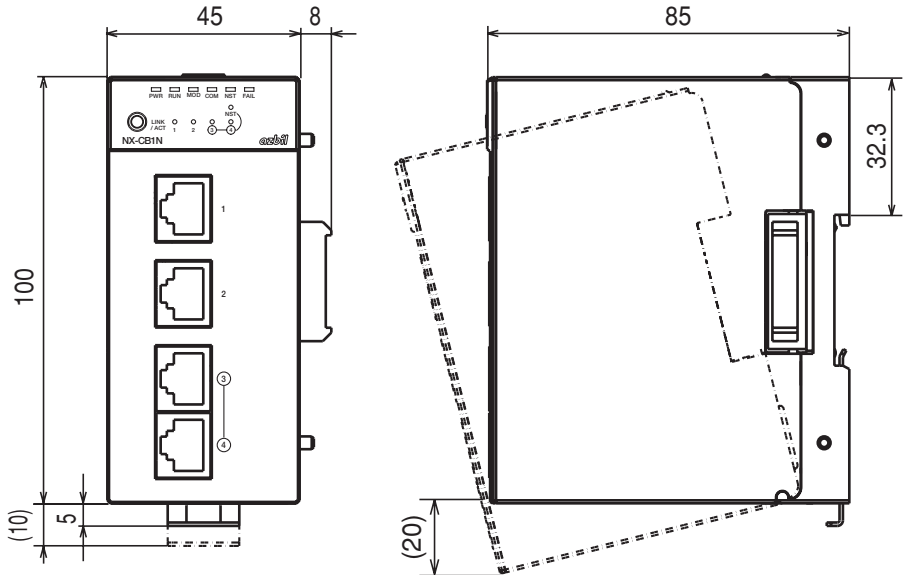
The diagram below shows the NX-D25, which has the same dimensions as the NX-D15/25.

Unit: mm



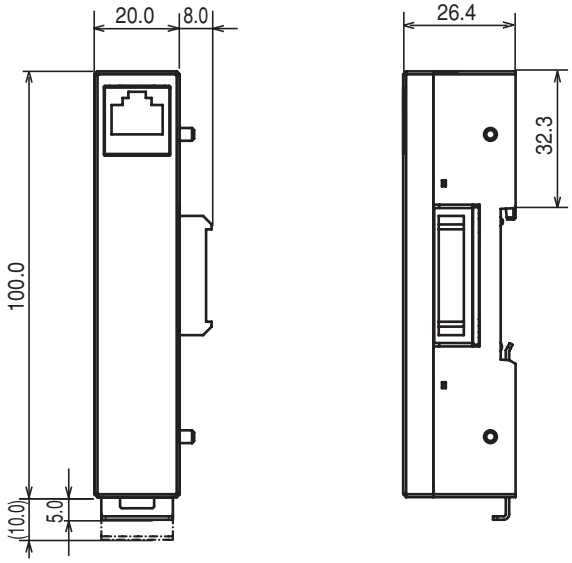
■ Communications box

Unit: mm

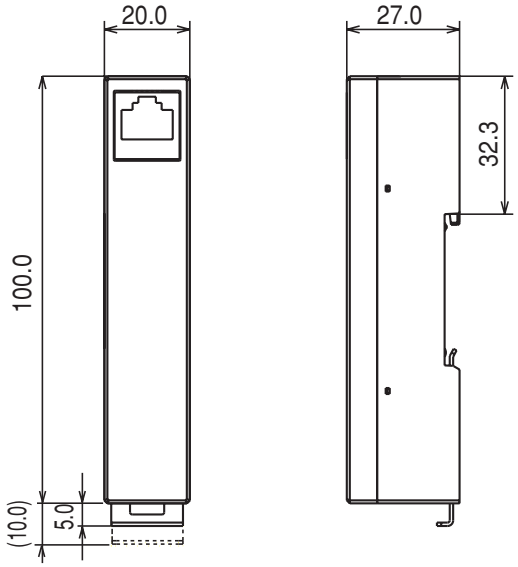


■ Communications adaptor

● **Port for left-side connection** Unit: mm

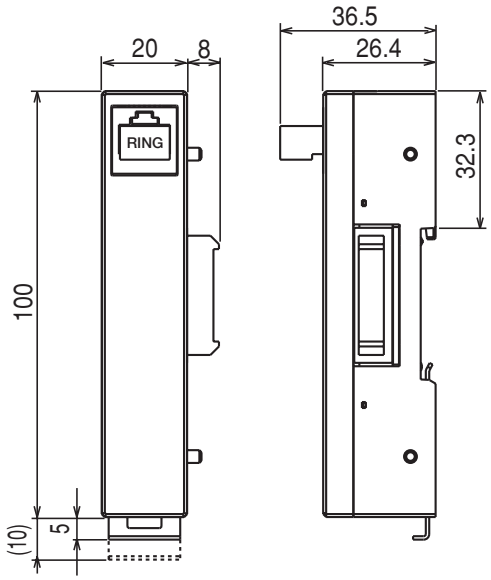


● **Port for right-side connection** Unit: mm

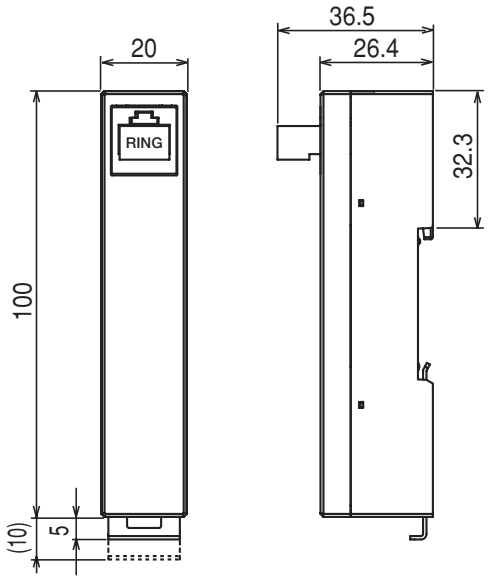


■ Terminal adaptor

● **Port for left-side connection** Unit: mm



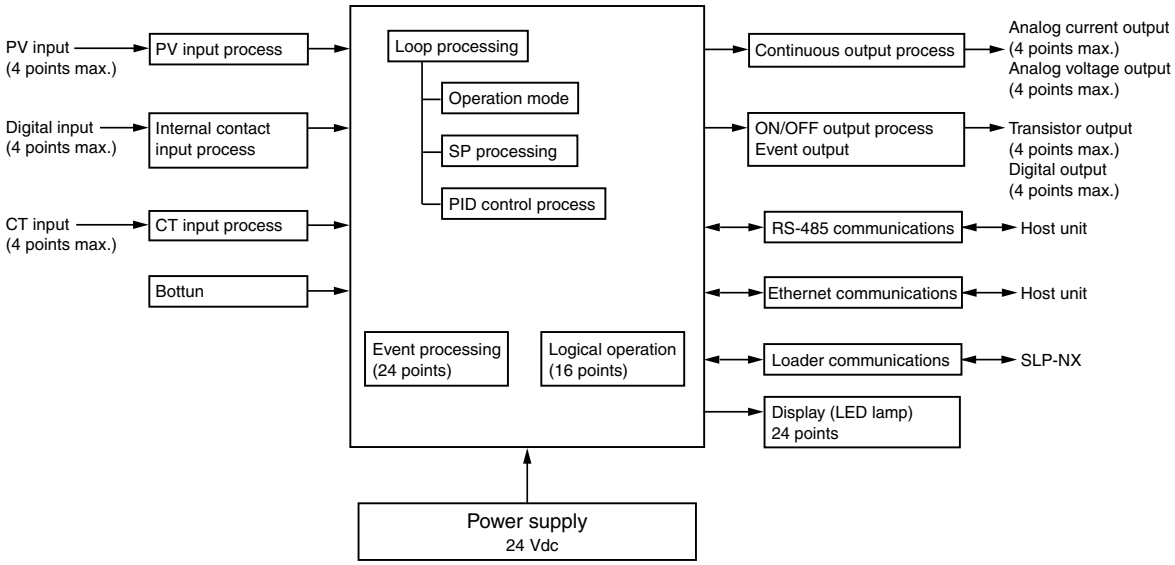
● **Port for right-side connection** Unit: mm



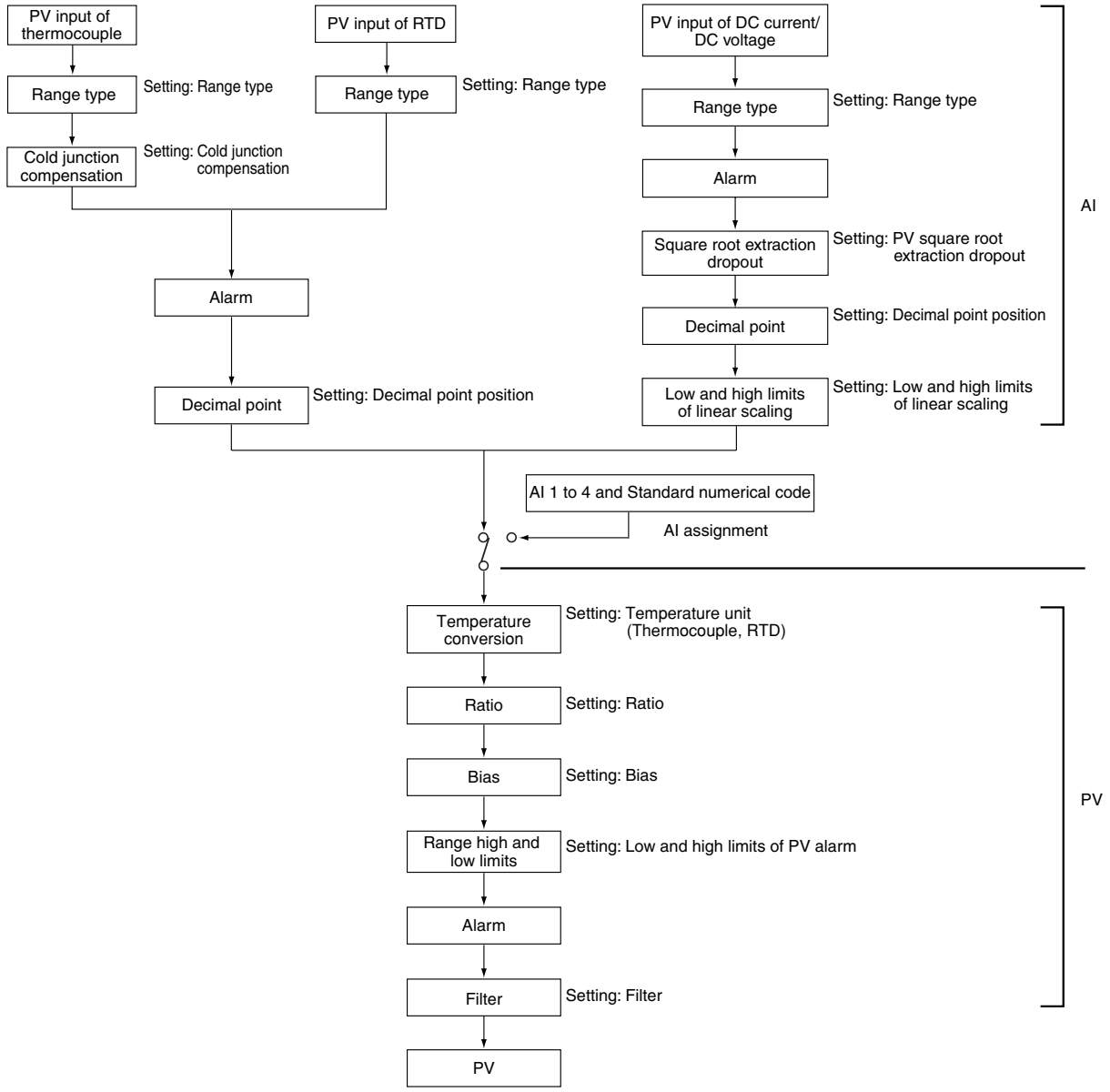
APPENDICES

Appendix 1 Function Block Diagrams

■ Basic function block diagram

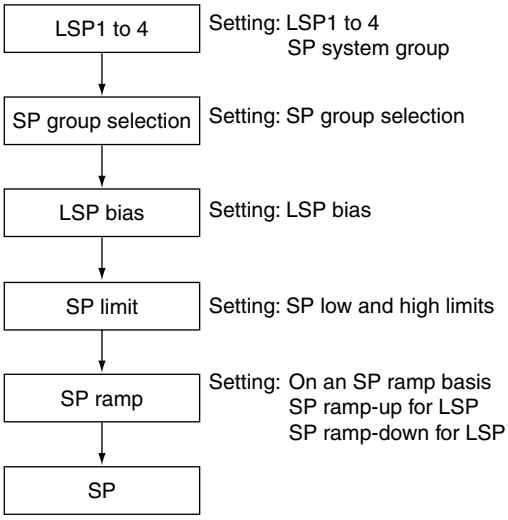


■ PV input process block diagram



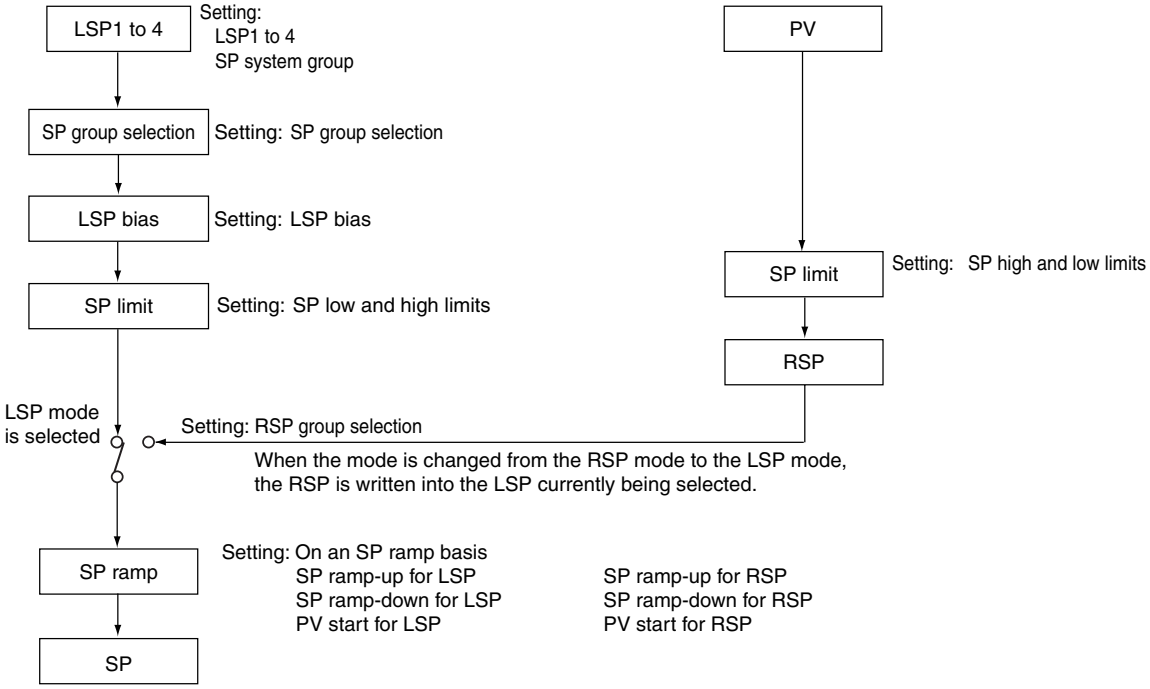
■ SP process block diagram

SP process without an RSP.

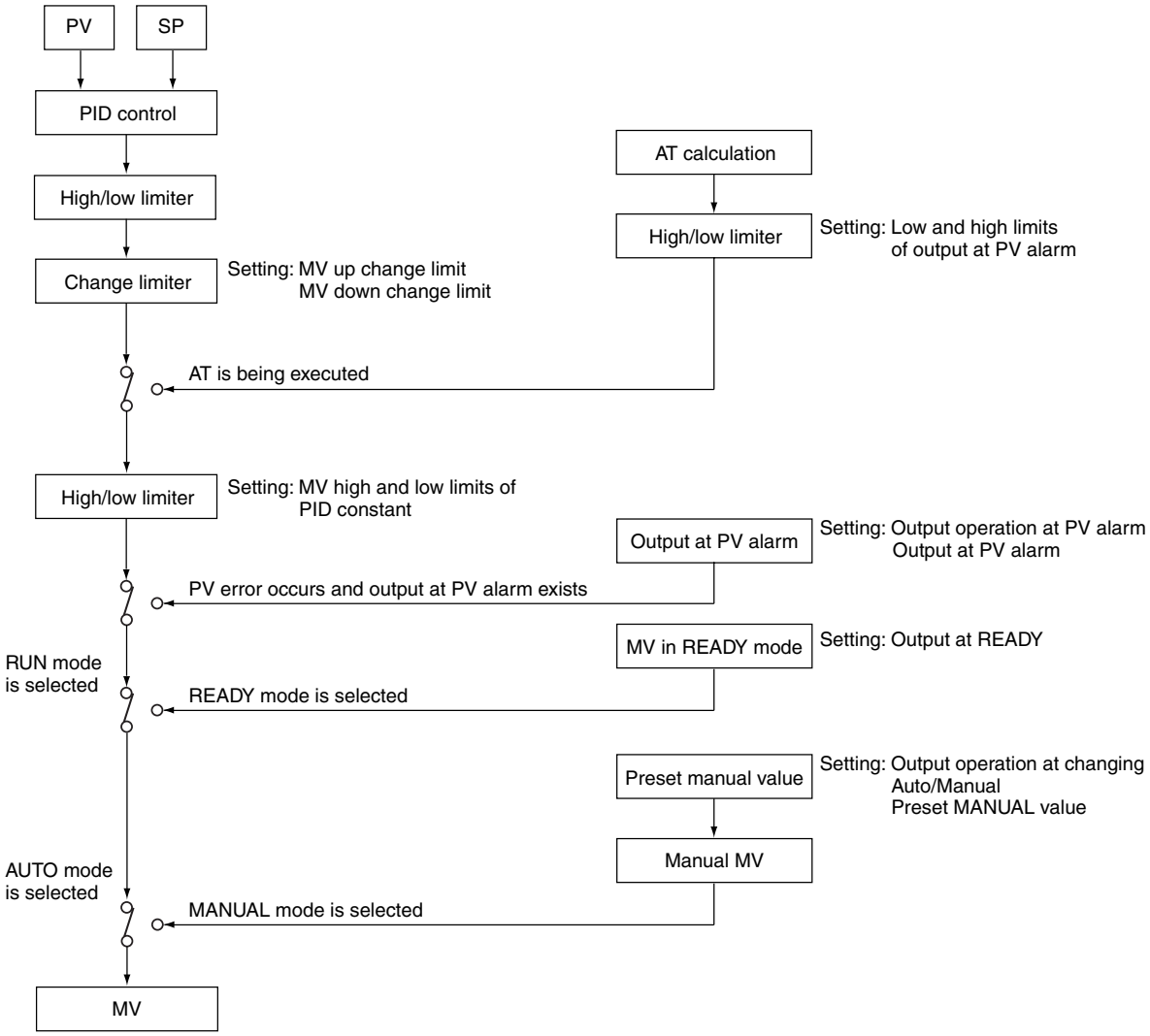


■ SP process block diagram (with RSP)

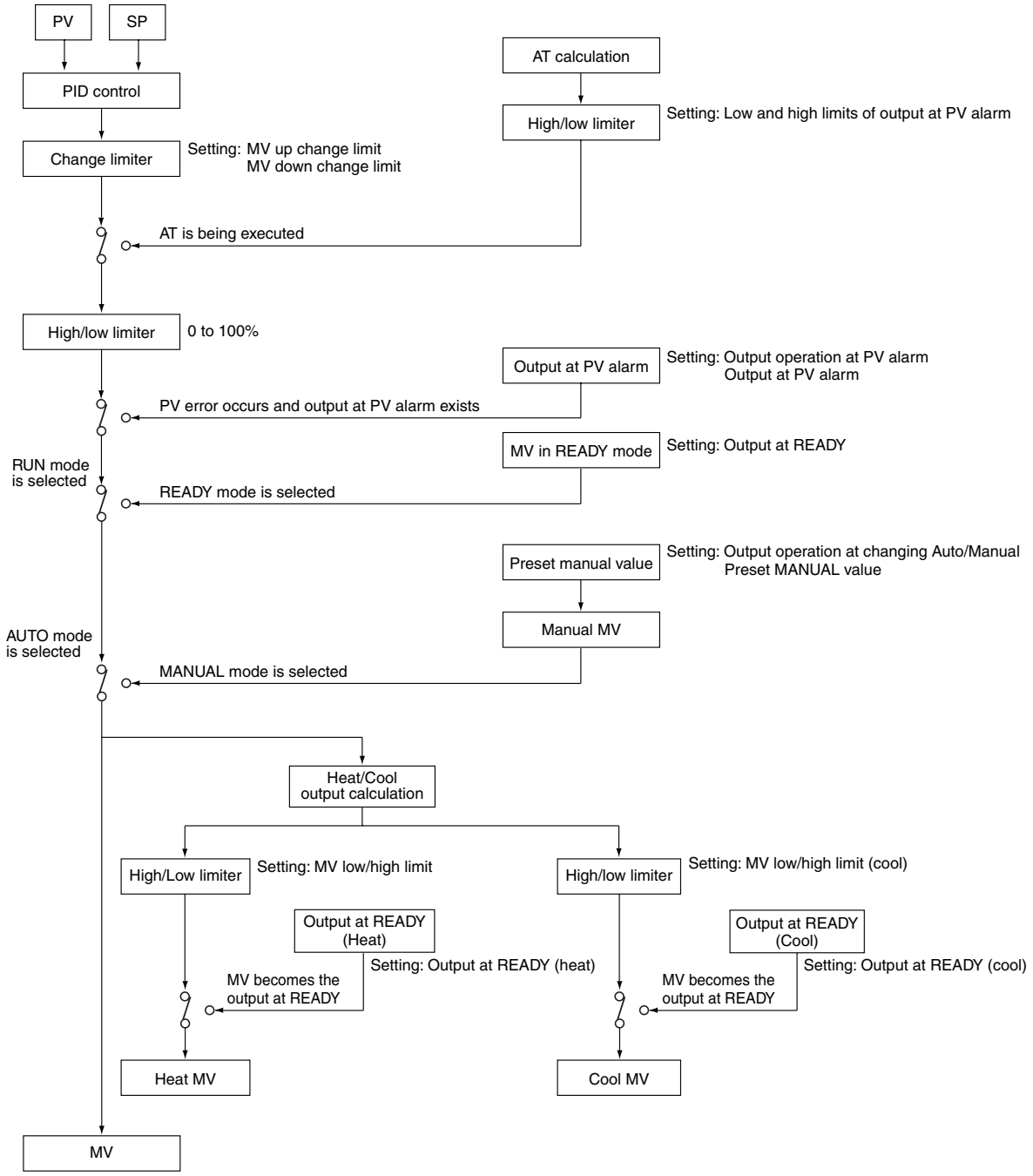
SP process with an RSP.



■ Control process block diagram (direct or reverse action)

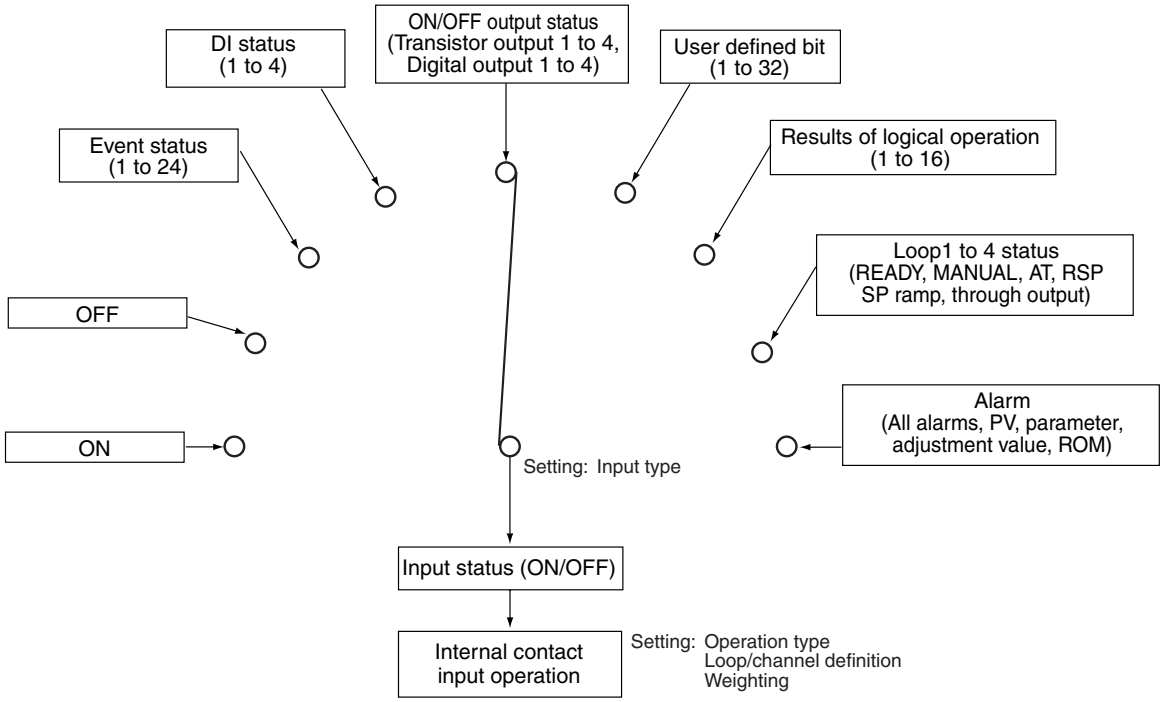


■ Control process block diagram (heat/cool control)



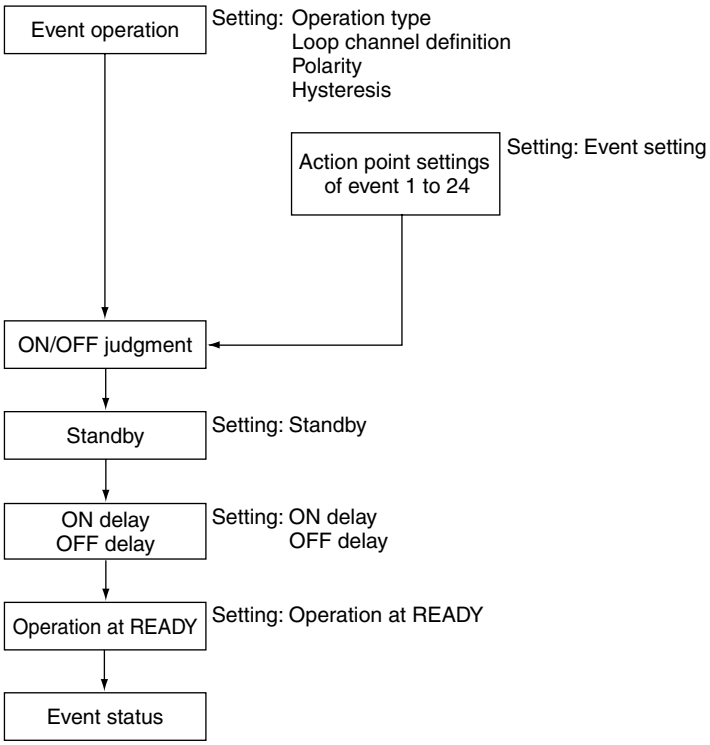
■ Internal contact input process block diagram

There are 16 groups of internal contact input processes. All groups use the same process. Settings are provided for each group.



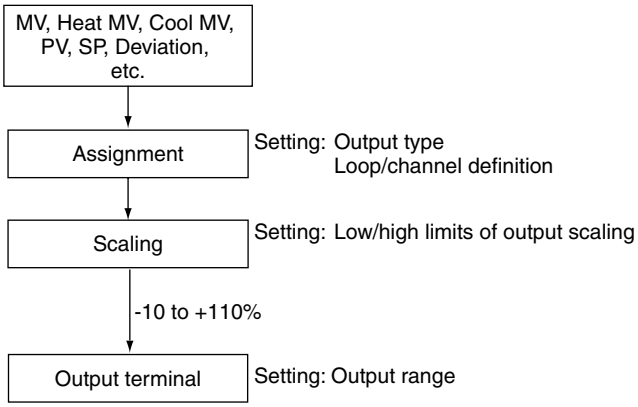
■ Event process block diagram

There are 24 groups of event processes. All groups use the same process. Settings are provided for each group.



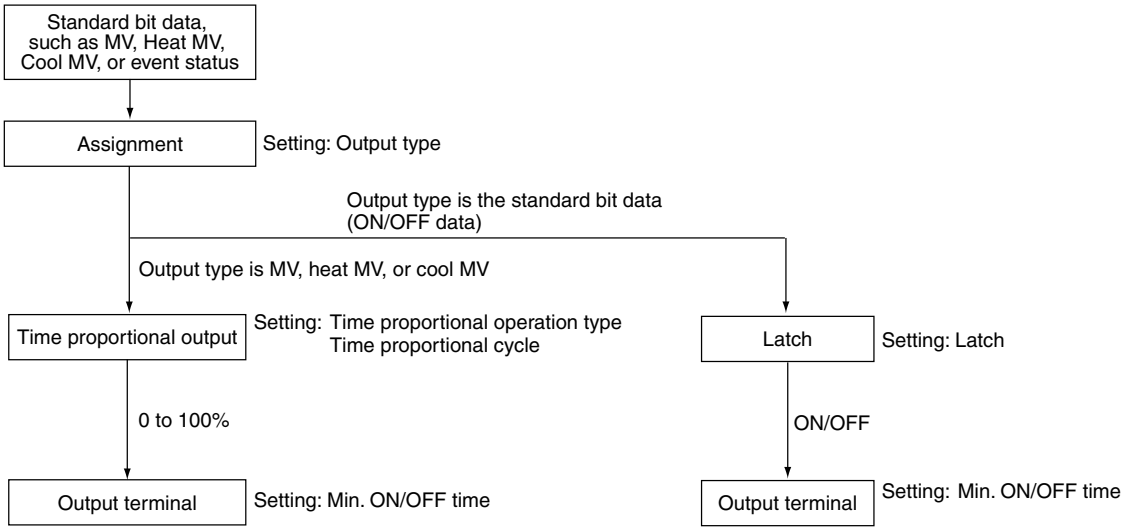
■ Continuous output process block diagram

The following shows the analog current output and analog voltage output processes:



■ ON/OFF output process block diagram

The following shows the transistor output and digital output processes:



Appendix 2 Standard Bit codes and Standard Numerical Codes

■ Standard bit codes

The range of standard bit codes is 1024 to 2047.

Codes not stated in the list are undefined. Therefore, do not use such codes.

Standard bit code	Meaning of standard bit
1024	All the time 0 (OFF)
1025	All the time 1 (ON)
1088	Event 1
1089	Event 2
1090	Event 3
1091	Event 4
1092	Event 5
1093	Event 6
1094	Event 7
1095	Event 8
1096	Event 9
1097	Event 10
1098	Event 11
1099	Event 12
1100	Event 13
1101	Event 14
1102	Event 15
1103	Event 16
1104	Event 17
1105	Event 18
1106	Event 19
1107	Event 20
1108	Event 21
1109	Event 22
1110	Event 23
1111	Event 24
1120	CT1 Heater burnout detection
1121	CT2 Heater burnout detection
1122	CT3 Heater burnout detection
1123	CT4 Heater burnout detection
1124	CT1 Over-current detection
1125	CT2 Over-current detection
1126	CT3 Over-current detection
1127	CT4 Over-current detection
1128	CT1 Short-circuit detection
1129	CT2 Short-circuit detection
1130	CT3 Short-circuit detection
1131	CT4 Short-circuit detection
1152	Terminal status of DI1
1153	Terminal status of DI2
1154	Terminal status of DI3
1155	Terminal status of DI4
1280	Terminal status of OUT1
1281	Terminal status of OUT2
1282	Terminal status of OUT3
1283	Terminal status of OUT4
1284	Terminal status of EV1
1285	Terminal status of EV2
1286	Terminal status of EV3
1287	Terminal status of EV4
1312	Status of time proportioning 1
1313	Status of time proportioning 2
1314	Status of time proportioning 3
1315	Status of time proportioning 4
1408	User-defined bit 1
1409	User-defined bit 2
1410	User-defined bit 3
1411	User-defined bit 4
1412	User-defined bit 5
1413	User-defined bit 6

Standard bit code	Meaning of standard bit
1414	User-defined bit 7
1415	User-defined bit 8
1416	User-defined bit 9
1417	User-defined bit 10
1418	User-defined bit 11
1419	User-defined bit 12
1420	User-defined bit 13
1421	User-defined bit 14
1422	User-defined bit 15
1423	User-defined bit 16
1424	User-defined bit 17
1425	User-defined bit 18
1426	User-defined bit 19
1427	User-defined bit 20
1428	User-defined bit 21
1429	User-defined bit 22
1430	User-defined bit 23
1431	User-defined bit 24
1432	User-defined bit 25
1433	User-defined bit 26
1434	User-defined bit 27
1435	User-defined bit 28
1436	User-defined bit 29
1437	User-defined bit 30
1438	User-defined bit 31
1439	User-defined bit 32
1440	Results of logical operation 1
1441	Results of logical operation 2
1442	Results of logical operation 3
1443	Results of logical operation 4
1444	Results of logical operation 5
1445	Results of logical operation 6
1446	Results of logical operation 7
1447	Results of logical operation 8
1448	Results of logical operation 9
1449	Results of logical operation 10
1450	Results of logical operation 11
1451	Results of logical operation 12
1452	Results of logical operation 13
1453	Results of logical operation 14
1454	Results of logical operation 15
1455	Results of logical operation 16
1504	Key status (push switch)
1545	Communication status (Normal receipt on a byte basis)
1547	Communication status (Normal receipt on a byte basis)
1548	Communication status (An error received)
1568	RUN/READY status of loop 1
1569	RUN/READY status of loop 2
1570	RUN/READY status of loop 3
1571	RUN/READY status of loop 4
1584	AUTO/MANUAL status of loop 1
1585	AUTO/MANUAL status of loop 2
1586	AUTO/MANUAL status of loop 3
1587	AUTO/MANUAL status of loop 4
1600	AT stop/ AT status of loop 1
1601	AT stop/ AT status of loop 2
1602	AT stop/ AT status of loop 3
1603	AT stop/ AT status of loop 1

Standard bit code	Meaning of standard bit
1616	LSP/RSP status of loop 1
1617	LSP/RSP status of loop 2
1618	LSP/RSP status of loop 3
1619	LSP/RSP status of loop 4
1648	During SP ramp of loop 1 (ramp-up)
1649	During SP ramp of loop 2 (ramp-up)
1650	During SP ramp of loop 3 (ramp-up)
1651	During SP ramp of loop 4 (ramp-up)
1664	During SP ramp of loop 1 (ramp-down)
1665	During SP ramp of loop 2 (ramp-down)
1666	During SP ramp of loop 3 (ramp-down)
1667	During SP ramp of loop 4 (ramp-down)
1792	Alarm representative (logical OR of alarms to be displayed)
1808	Error in AD1 for PV
1809	Error in AD2 for PV
1810	Error in AD3 for PV
1811	Error in AD4 for PV
1824	PV input high limit alarm (PV1)
1825	PV input high limit alarm (PV2)
1826	PV input high limit alarm (PV3)
1827	PV input high limit alarm (PV4)
1840	PV input low limit alarm (PV1)
1841	PV input low limit alarm (PV2)
1842	PV input low limit alarm (PV3)
1843	PV input low limit alarm (PV4)
1856	CJ input alarm (PV1)
1857	CJ input alarm (PV2)
1858	CJ input alarm (PV3)
1859	CJ input alarm (PV4)
1920	Reception monitoring 1
1921	Reception monitoring 2
1922	Reception monitoring 3
1923	Reception monitoring 4
1924	Reception monitoring 5
1925	Reception monitoring 6
1926	Reception monitoring 7
1927	Reception monitoring 8
1928	Reception monitoring 9
1929	Reception monitoring 10
1930	Reception monitoring 11
1931	Reception monitoring 12
1932	Reception monitoring 13
1933	Reception monitoring 14
1934	Reception monitoring 15
1935	Reception monitoring 16
1952	CT1 input alarm
1953	CT2 input alarm
1954	CT3 input alarm
1955	CT4 input alarm
1968	Parameter error
1969	Adjustment value error
1970	EEPROM not initialized
1972	ROM error
1974	EEPROM read/write error
1978	External A/D error (representative)
1979	Reception monitoring (representative of 1-16)
1980	Time out
1981	EEPROM writing in progress

■ Standard numerical codes

The range of standard bit codes is 2048 to 3071.

Codes not stated in the list are undefined. Therefore, do not use such codes.

Standard numerical code	Meaning of standard bit
2111	User-defined numerical code 1
2112	User-defined numerical code 2
2113	User-defined numerical code 3
2114	User-defined numerical code 4
2115	User-defined numerical code 5
2116	User-defined numerical code 6
2117	User-defined numerical code 7
2118	User-defined numerical code 8
2119	User-defined numerical code 9
2120	User-defined numerical code 10
2121	User-defined numerical code 11
2122	User-defined numerical code 12
2123	User-defined numerical code 13
2124	User-defined numerical code 14
2125	User-defined numerical code 15
2126	User-defined numerical code 16
2304	PV1
2305	PV2
2306	PV3
2307	PV4
2312	AI value 1
2313	AI value 2
2314	AI value 3
2315	AI value 4
2320	PV of loop 1 (used for PID control)
2321	PV of loop 2 (used for PID control)
2322	PV of loop 3 (used for PID control)
2323	PV of loop 4 (used for PID control)
2328	Zener barrier adjustment monitor 1
2329	Zener barrier adjustment monitor 2
2330	Zener barrier adjustment monitor 3
2331	Zener barrier adjustment monitor 4
2336	SP of loop 1 (in use)
2337	SP of loop 2 (in use)
2338	SP of loop 3 (in use)
2339	SP of loop 4 (in use)
2352	SP of loop 1 (finally attained value)
2353	SP of loop 2 (finally attained value)
2354	SP of loop 3 (finally attained value)
2355	SP of loop 4 (finally attained value)
2384	SP output of loop 1
2385	SP output of loop 2
2386	SP output of loop 3
2387	SP output of loop 4

Standard numerical code	Meaning of standard bit
2416	MV of loof 1
2417	MV of loof 2
2418	MV of loof 3
2419	MV of loof 4
2432	Heat MV of loof 1
2433	Heat MV of loof 2
2448	Cool MV of loof 1
2449	Cool MV of loof 2
2496	CT1 current when output ON
2497	CT2 current when output ON
2498	CT3 current when output ON
2499	CT4 current when output ON
2512	CT1 current when output OFF
2513	CT2 current when output OFF
2514	CT3 current when output OFF
2515	CT4 current when output OFF
2528	Deviation of loop 1 (PV-SP)
2529	Deviation of loop 2 (PV-SP)
2530	Deviation of loop 3 (PV-SP)
2531	Deviation of loop 4 (PV-SP)
2656	Event 1 timer remaining time
2657	Event 2 timer remaining time
2658	Event 3 timer remaining time
2659	Event 4 timer remaining time
2660	Event 5 timer remaining time
2661	Event 6 timer remaining time
2662	Event 7 timer remaining time
2663	Event 8 timer remaining time
2664	Event 9 timer remaining time
2665	Event 10 timer remaining time
2666	Event 11 timer remaining time
2667	Event 12 timer remaining time
2668	Event 13 timer remaining time
2669	Event 14 timer remaining time
2670	Event 15 timer remaining time
2671	Event 16 timer remaining time
2672	Event 17 timer remaining time
2673	Event 18 timer remaining time
2674	Event 19 timer remaining time
2675	Event 20 timer remaining time
2676	Event 21 timer remaining time
2677	Event 22 timer remaining time
2678	Event 23 timer remaining time
2679	Event 24 timer remaining time

Appendix 3 Abbreviations and Terms

Abbreviations are used in descriptions, tables, and illustrations of this manual. The following describes major abbreviations.

AT:	Auto Tuning. The PID is automatically adjusted at an optimal numeric value.
DI:	Digital input
DO:	Digital output (control output of relay and voltage pulse, and event output)
OL:	Output Low. Output low limit, a minimum limit level of the output, is set.
OH:	Output High. Output high limit, a maximum limit level of the output, is set.
PID :	PID has the following meanings.
	P (Proportioning). Proportional operation.
	I (Integral). Integral operation or reset operation.
	D (Derivative). Derivative operation or rate operation.
PV:	Process Variable. Measured values of the thermocouple, RTD, and linear input.
SP:	Set value of Set Point. For example, set point to control the temperature.
LSP :	Local Set Point. A set value stored in the controller.
RSP:	Remote Set Point. A set value given from the outside by the analog signal.
MV:	Manipulated Variable. An output of the instrument to be controlled. This output shows the PID control results.
Setup:	Setup is a setting operation corresponding to how to use a unit that incorporates operating conditions, such as control action.
Hysteresis:	An operation gap during event operation. A difference between the value at which the event OFF is changed to ON and the value at which the event ON is changed to OFF.
	Hysteresis is shown as "HYSR" in the Figs. in this manual.
EV:	Event. EV shows a set value of the event function. The event function is the ON/OFF signal function, which is output in the control status.
	EV with numeric values added, like EV1 or EV2 shows an event function. A numeric value shows relevant event No.
U:	An abbreviation of "Unit". This shows the minimum unit of the setting. When the number of digits below the decimal point of the set value is "0", "1", "2", "3", and "4", 1U=1, 1U=0.1, 1U=0.01, 1U=0.001, and 1U=0.0001, respectively.
Heat/cool output:	Control output, which is output when the heat output is related with the cool output within one controller.
AUTO:	Auto operation status that the PID control result is used as MV.
MANUAL:	Manual operation status that a value manually set by the operator is used as MV.
READY:	Standby status, in which the control calculation is stopped.
RUN:	Status, in which the control calculation is executed.

Revision History

Printed date	Manual Number	Edition	Revised pages	Description
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We would like to express our appreciation for your purchase and use of Yamatake products.
You are required to acknowledge and agree upon the following terms and conditions for your purchase of Yamatake products (field instruments, control valves, and control products), unless otherwise stated in any separate document, including, without limitation, estimation sheets, written agreements, catalogs, specifications and instruction manuals.

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   In the event that Yamatake product has any failure attributable to Yamatake during the aforementioned warranty period, Yamatake shall, without charge, deliver a replacement for the said product to the place where you purchased, or repair the said product and deliver it to the aforementioned place. Notwithstanding the foregoing, any failure falling under one of the following shall not be covered under this warranty:
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   (2) Failure caused for other reasons than Yamatake product;
   (3) Failure caused by any modification or repair made by any person other than Yamatake or Yamatake's subcontractors;
   (4) Failure caused by your use of Yamatake product in a manner not conforming to the intended usage of that product;
   (5) Failure that the state-of-the-art at the time of Yamatake's shipment did not allow Yamatake to predict; or
   (6) Failure that arose from any reason not attributable to Yamatake, including, without limitation, acts of God, disasters, and actions taken by a third party.
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   Yamatake products other than those explicitly specified as applicable (e.g. Yamatake Limit Switch For Nuclear Energy) shall not be used in a nuclear energy controlled area (radiation controlled area). Any Yamatake products shall not be used for/with medical equipment.
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   * Transportation equipment
   [Railway, aircraft, vessels, vehicle equipment, etc.]
   * Antidisaster/crime-prevention equipment
   * Burning appliances
   * Electrothermal equipment
   * Amusement facilities
   (3) Supply systems such as electricity/gas/water supply systems, large-scale communication systems, and traffic/air traffic control systems requiring high reliability
   (4) Facilities that are to comply with regulations of governmental/public agencies or specific industries
   (5) Machinery or equipment that may affect human lives, human bodies or properties
   (6) Other machinery or equipment equivalent to those set forth in items (1) to (5) above which require high reliability and safety

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   Mechanical components, such as relays and switches, used for Yamatake products will reach the end of their life due to wear by repetitious open/close operations.

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   For field instruments, we may not be able to undertake parts replacement for similar reasons.

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