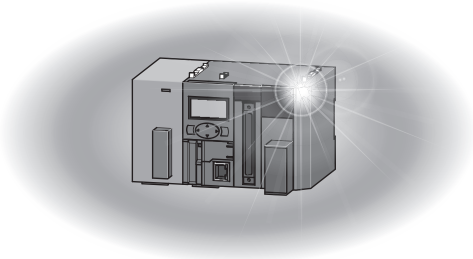
MITSUBISHI
ELECTRIC

Programmable Controller

MELSEC *L* series

MELSEC-L Analog Input/Output Module User's Manual

-L60AD2DA2



●SAFETY PRECAUTIONS●

(Read these precautions before using this product.)

Before using this product, please read this manual and the relevant manuals carefully and pay full attention to safety to handle the product correctly.
The precautions given in this manual are concerned with this product only. For the safety precautions of the programmable controller system, refer to the user's manual for the CPU module used.

In this manual, the safety precautions are classified into two levels: "⚠WARNING" and "⚠CAUTION".

⚠WARNING	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠CAUTION	Indicates that incorrect handling may cause hazardous conditions, resulting in minor or moderate injury or property damage.

Under some circumstances, failure to observe the precautions given under "⚠CAUTION" may lead to serious consequences.
Observe the precautions of both levels because they are important for personal and system safety.

Make sure that the end users read this manual and then keep the manual in a safe place for future reference.

[Design Precautions]

⚠WARNING

- Analog outputs may remain on due to a failure of the module. Configure an external interlock circuit for output signals that could cause a serious accident.
- Do not write any data to the "system area" and "write-protect area" (R) of the buffer memory in the intelligent function module.
  Also, do not use any "use prohibited" signals as an output signal from the programmable controller CPU to the intelligent function module.
  Doing so may cause malfunction of the programmable controller system.

[Design Precautions]

⚠CAUTION

- Do not install the control lines or communication cables together with the main circuit lines or power cables. Keep a distance of 100mm or more between them. Failure to do so may result in malfunction due to noise.
- At power-on, a voltage may occur or a current may flow between output terminals for a moment. In this case, start the control after analog outputs become stable.
- Power on or off the external power supply while the programmable controller is on. Failure to do so may result in incorrect output or malfunction.

[Installation Precautions]

⚠WARNING

- Shut off the external power supply (all phases) used in the system before mounting or removing a module. Failure to do so may result in electric shock or cause the module to fail or malfunction.

[Installation Precautions]

⚠CAUTION

- Use the programmable controller in an environment that meets the general specifications in the Safety Guidelines provided with the CPU module or head module. Failure to do so may result in electric shock, fire, malfunction, or damage to or deterioration of the product.
- To interconnect modules, engage the respective connectors and securely lock the module joint levers until they click. Incorrect interconnection may cause malfunction, failure, or drop of the module.
- Tighten the screws within the specified torque range. Undertightening can cause drop of the screw, short circuit, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, or malfunction.
- Do not directly touch any conductive parts and electronic components of the module. Doing so can cause malfunction or failure of the module.

[Wiring Precautions]

⚠WARNING

- After installation and wiring, attach the included terminal cover to the module before turning it on for operation. Failure to do so may result in electric shock.

[Wiring Precautions]

⚠CAUTION

- Individually ground the FG terminal of the programmable controller with a ground resistance of 100 ohms or less. Failure to do so may result in electric shock or malfunction.
- Tighten the terminal block screws within the specified torque range. Undertightening can cause short circuit, fire, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, or malfunction.
- Prevent foreign matter such as dust or wire chips from entering the module. Such foreign matter can cause a fire, failure, or malfunction.
- A protective film is attached to the top of the module to prevent foreign matter, such as wire chips, from entering the module during wiring. Do not remove the film during wiring. Remove it for heat dissipation before system operation.
- Mitsubishi Electric programmable controllers must be installed in control panels. Connect the main power supply to the power supply module in the control panel through a relay terminal block. Wiring and replacement of a power supply module must be performed by qualified maintenance personnel with knowledge of protection against electric shock. For wiring methods, refer to the MELSEC-L CPU Module User's Manual (Hardware Design, Maintenance and Inspection).

[Startup and Maintenance Precautions]

⚠WARNING
● Do not touch any terminal while power is on. Doing so will cause electric shock or malfunction. ● Shut off the external power supply (all phases) used in the system before cleaning the module or retightening the terminal block screws. Failure to do so may result in electric shock.

[Startup and Maintenance Precautions]

⚠CAUTION
● Do not disassemble or modify the module. Doing so may cause failure, malfunction, injury, or a fire. ● Shut off the external power supply (all phases) used in the system before mounting or removing a module. Failure to do so may cause the module to fail or malfunction. ● Tighten the terminal block screws within the specified torque range. Undertightening can cause drop of the screw, short circuit, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, or malfunction. ● After the first use of the product (module, display unit, and terminal block), the number of connections/disconnections is limited to 50 times (in accordance with IEC 61131-2). Exceeding the limit may cause malfunction. ● Before handling the module, touch a conducting object such as a grounded metal to discharge the static electricity from the human body. Failure to do so may cause the module to fail or malfunction.

[Disposal Precautions]

⚠CAUTION
● When disposing of this product, treat it as industrial waste.

●CONDITIONS OF USE FOR THE PRODUCT●

(1) Mitsubishi programmable controller ("the PRODUCT") shall be used in conditions;
i) where any problem, fault or failure occurring in the PRODUCT, if any, shall not lead to any major or serious accident; and
ii) where the backup and fail-safe function are systematically or automatically provided outside of the PRODUCT for the case of any problem, fault or failure occurring in the PRODUCT.

(2) The PRODUCT has been designed and manufactured for the purpose of being used in general industries.
MITSUBISHI SHALL HAVE NO RESPONSIBILITY OR LIABILITY (INCLUDING, BUT NOT LIMITED TO ANY AND ALL RESPONSIBILITY OR LIABILITY BASED ON CONTRACT, WARRANTY, TORT, PRODUCT LIABILITY) FOR ANY INJURY OR DEATH TO PERSONS OR LOSS OR DAMAGE TO PROPERTY CAUSED BY the PRODUCT THAT ARE OPERATED OR USED IN APPLICATION NOT INTENDED OR EXCLUDED BY INSTRUCTIONS, PRECAUTIONS, OR WARNING CONTAINED IN MITSUBISHI'S USER, INSTRUCTION AND/OR SAFETY MANUALS, TECHNICAL BULLETINS AND GUIDELINES FOR the PRODUCT.
("Prohibited Application")
Prohibited Applications include, but not limited to, the use of the PRODUCT in;
- Nuclear Power Plants and any other power plants operated by Power companies, and/or any other cases in which the public could be affected if any problem or fault occurs in the PRODUCT.
- Railway companies or Public service purposes, and/or any other cases in which establishment of a special quality assurance system is required by the Purchaser or End User.
- Aircraft or Aerospace, Medical applications, Train equipment, transport equipment such as Elevator and Escalator, Incineration and Fuel devices, Vehicles, Manned transportation, Equipment for Recreation and Amusement, and Safety devices, handling of Nuclear or Hazardous Materials or Chemicals, Mining and Drilling, and/or other applications where there is a significant risk of injury to the public or property.

Notwithstanding the above, restrictions Mitsubishi may in its sole discretion, authorize use of the PRODUCT in one or more of the Prohibited Applications, provided that the usage of the PRODUCT is limited only for the specific applications agreed to by Mitsubishi and provided further that no special quality assurance or fail-safe, redundant or other safety features which exceed the general specifications of the PRODUCTs are required. For details, please contact the Mitsubishi representative in your region.

INTRODUCTION

Thank you for purchasing the Mitsubishi Electric MELSEC-L series programmable controllers.
This manual describes the functions and programming of an analog input/output module.
Before using this product, please read this manual and the relevant manuals carefully and develop familiarity with the functions and performance of the MELSEC-L series programmable controller to handle the product correctly.
When applying the program examples introduced in this manual to an actual system, ensure the applicability and confirm that it will not cause system control problems.

■ Relevant module: L60AD2DA2

Remark

- Unless otherwise specified, this manual describes the program examples in which the I/O numbers of X/Y00 to X/Y0F are assigned for an analog input/output module.
  For I/O number assignment, refer to the following.
  MELSEC-L CPU Module User's Manual (Function Explanation, Program Fundamentals)
- Operating procedures are explained using GX Works2. When using GX Developer, refer to the following.
  - When Using GX Developer (Page 449, Appendix 9)

COMPLIANCE WITH EMC AND LOW VOLTAGE DIRECTIVES

(1) Method of ensuring compliance

To ensure that Mitsubishi Electric programmable controllers maintain EMC and Low Voltage Directives when incorporated into other machinery or equipment, certain measures may be necessary. Please refer to one of the following manuals.

- MELSEC-L CPU Module User's Manual (Hardware Design, Maintenance and Inspection)
- MELSEC-L CC-Link IE Field Network Head Module User's Manual
- Safety Guidelines (This manual is included with the CPU module or head module.)

The CE mark on the side of the programmable controller indicates compliance with EMC and Low Voltage Directives.

(2) Additional measures

No additional measures are necessary for the compliance of this product with the EMC and Low Voltage Directives.

RELEVANT MANUALS

(1) CPU module user's manual

Manual name <manual number (model code)>	Description
MELSEC-L CPU Module User's Manual (Hardware Design, Maintenance and Inspection) <SH-080890ENG, 13JZ36>	Specifications of the CPU modules, power supply modules, display unit, branch module, extension module, SD memory cards, and batteries, information on how to establish a system, maintenance and inspection, and troubleshooting
MELSEC-L CPU Module User's Manual (Function Explanation, Program Fundamentals) <SH-080889ENG, 13JZ35>	Functions and devices of the CPU module, and programming

(2) Head module user’s manual

Manual name <manual number (model code)>	Description
MELSEC-L CC-Link IE Field Network Head Module User's Manual <SH-080919ENG, 13JZ48>	Specifications, procedures before operation, system configuration, installation, wiring, settings, and troubleshooting of the head module

(3) Operating manual

Manual name <manual number (model code)>	Description
GX Works2 Version 1 Operating Manual (Common) <SH-080779ENG, 13JU63>	System configuration, parameter settings, and online operations of GX Works2, which are common to Simple projects and Structured projects
GX Developer Version 8 Operating Manual <SH-080373E, 13JU41>	Operating methods of GX Developer, such as programming, printing, monitoring, and debugging
GX LogViewer Version1 Operating Manual <SH-080915ENG, 13JU68>	System configuration, functions, and operating methods of GX LogViewer

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MANUAL PAGE ORGANIZATION

In this manual, pages are organized and the symbols are used as shown below.

The following illustration is for explanation purpose only, and should not be referred to as an actual documentation.

"" is used for screen names and items.

1. shows operating procedures.

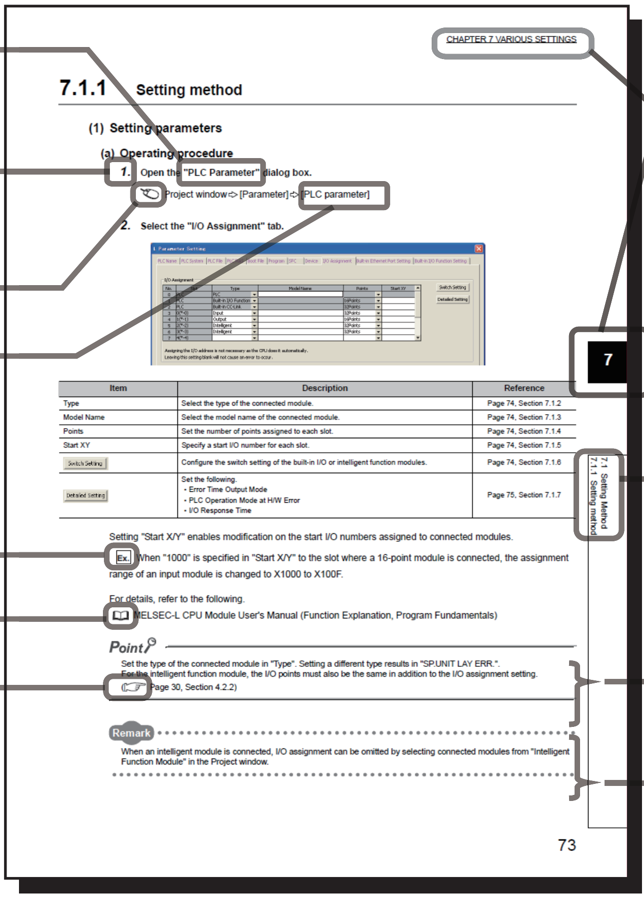
shows mouse operations.*1

[ ] is used for items in the menu bar and the project window.

Ex. shows setting or operating examples.

shows reference manuals.

shows reference pages.



The chapter of the current page is shown.

The section of the current page is shown.

Point shows notes that requires attention.

Remark shows useful information.

*1 The mouse operation example (for GX Works2) is provided below.

Menu bar

Ex. [Online] ⇨ [Write to PLC...]

Select [Online] on the menu bar, and then select [Write to PLC...].

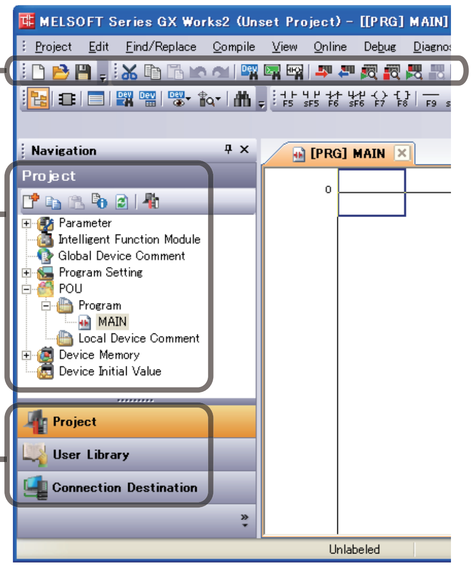
A window selected in the view selection area is displayed.

Ex. Project window ⇨ [Parameter] ⇨ [PLC Parameter]

Select [Project] from the view selection area to open the Project window.

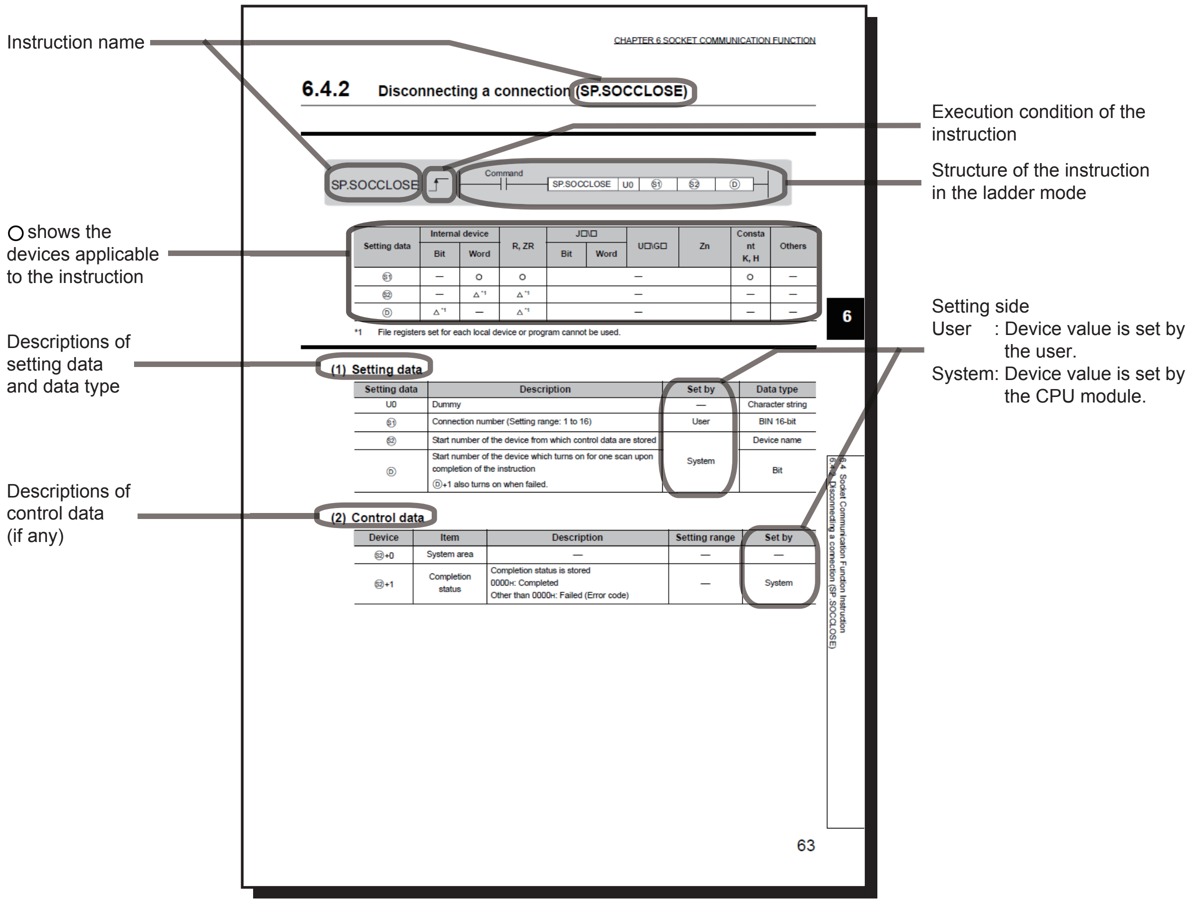
In the Project window, expand [Parameter] and select [PLC Parameter].

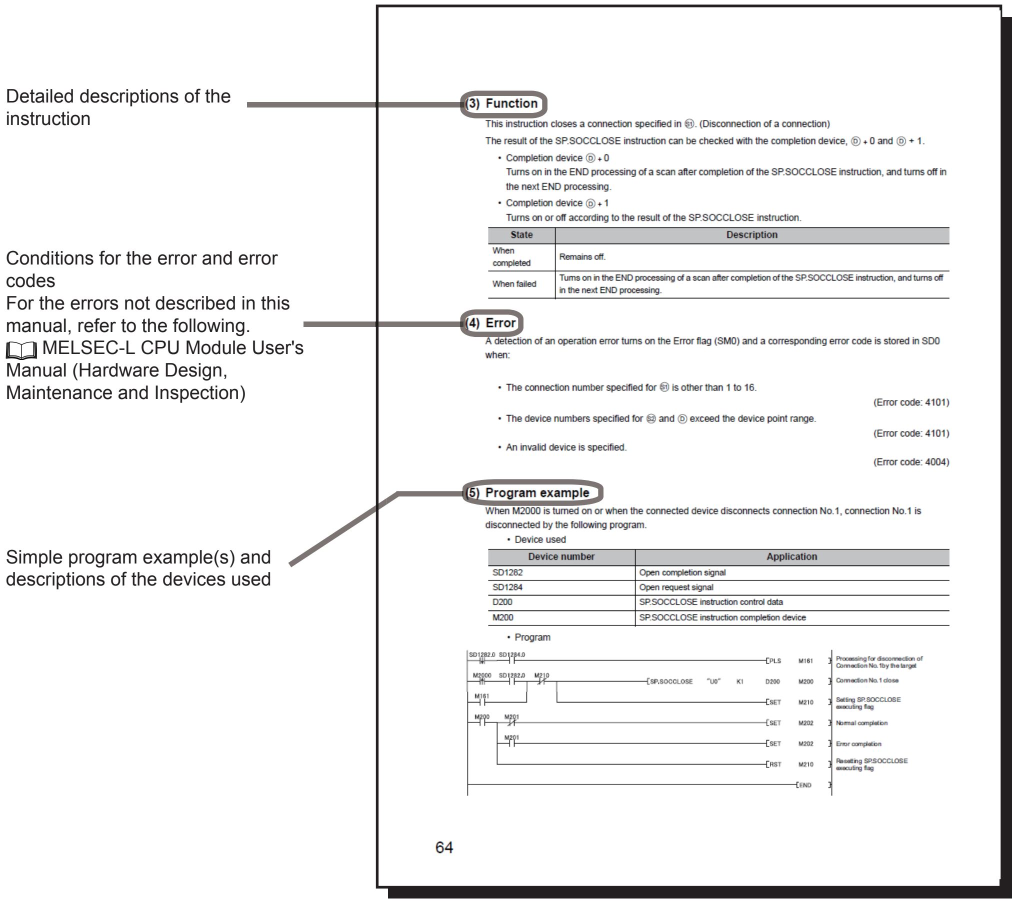
View selection area



Pages describing instructions are organized as shown below.

The following illustration is for explanation purpose only, and should not be referred to as an actual documentation.





(3) Function

This instruction closes a connection specified in ⓢ1. (Disconnection of a connection)

The result of the SP.SOCCLOSE instruction can be checked with the completion device, ⓓ + 0 and ⓓ + 1.

- Completion device ⓓ + 0
  Turns on in the END processing of a scan after completion of the SP.SOCCLOSE instruction, and turns off in the next END processing.
- Completion device ⓓ + 1
  Turns on or off according to the result of the SP.SOCCLOSE instruction.

State	Description
When completed	Remains off.
When failed	Turns on in the END processing of a scan after completion of the SP.SOCCLOSE instruction, and turns off in the next END processing.

(4) Error

A detection of an operation error turns on the Error flag (SM0) and a corresponding error code is stored in SD0 when:

- The connection number specified for ⓢ1 is other than 1 to 16. (Error code: 4101)
- The device numbers specified for ⓢ2 and ⓓ exceed the device point range. (Error code: 4101)
- An invalid device is specified. (Error code: 4004)

(5) Program example

When M2000 is turned on or when the connected device disconnects connection No.1, connection No.1 is disconnected by the following program.

- Device used

Device number	Application
SD1282	Open completion signal
SD1284	Open request signal
D200	SP.SOCCLOSE instruction control data
M200	SP.SOCCLOSE instruction completion device

- Program

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- Instructions can be executed under the following conditions.

Execution condition	Any time	During on	On the rising edge	During off	On the falling edge
Symbol	No symbol				

- The following devices can be used.

Setting data	Internal device (system, user)		File register	Link direct device J□\□		Intelligent function module U□\G□	Index register Zn	Constant[*3]	Others[*3]
	Bit	Word		Bit	Word				
Applicable device[*1]	X, Y, M, L, SM, F, B, SB, FX, FY[*2]	T, ST, C, D, W, SD, SW, FD, @□	R, ZR	—		U□\G□	Z	K, H, E, $	P, I, J, U, D, X, DY, N, BL, TR, BL\S,V

*1 For details on each device, refer to the following.
MELSEC-L CPU Module User's Manual (Function Explanation, Program Fundamentals)

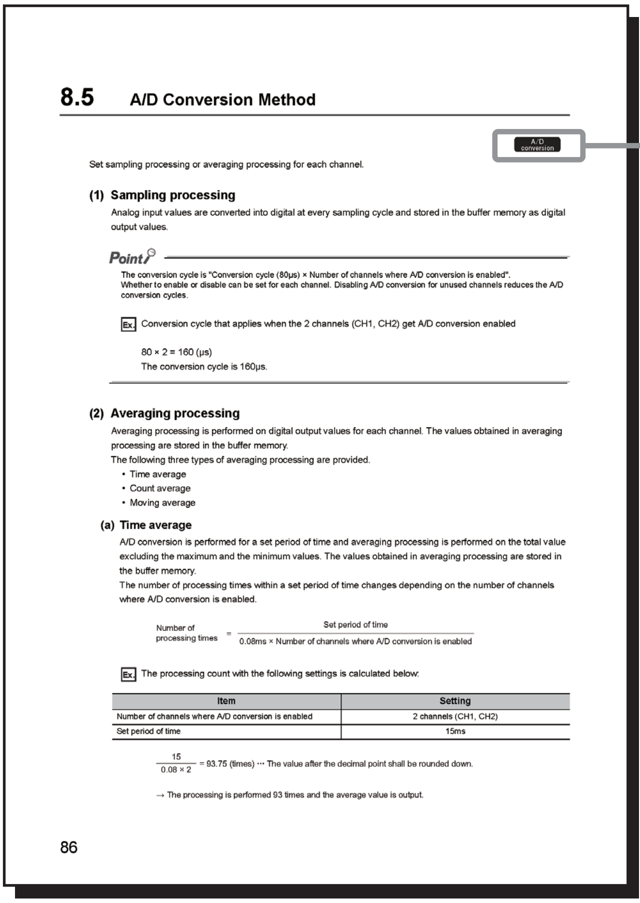
*2 FX and FY can be used for bit data only, and FD for word data only.

*3 In the "Constant" and "Others" columns, a device(s) that can be set for each instruction is shown.

- The following data types can be used.

Data type	Description
Bit	Bit data or the start number of bit data
BIN 16-bit	16-bit binary data or the start number of word device
BIN 32-bit	32-bit binary data or the start number of double-word device
BCD 4-digit	Four-digit binary-coded decimal data
BCD 8-digit	Eight-digit binary-coded decimal data
Real number	Floating-point data
Character string	Character string data
Device name	Device name data

Pages describing functions, I/O signals, and buffer memory areas are organized as shown below.
The following illustration is for explanation purpose only, and should not be referred to as an actual documentation.



8.5 A/D Conversion Method

A/D conversion

Set sampling processing or averaging processing for each channel.

(1) Sampling processing

Analog input values are converted into digital at every sampling cycle and stored in the buffer memory as digital output values.

Point

The conversion cycle is "Conversion cycle (80μs) × Number of channels where A/D conversion is enabled".
Whether to enable or disable can be set for each channel. Disabling A/D conversion for unused channels reduces the A/D conversion cycles.

Ex. Conversion cycle that applies when the 2 channels (CH1, CH2) get A/D conversion enabled

80 × 2 = 160 (μs)
The conversion cycle is 160μs.

(2) Averaging processing

Averaging processing is performed on digital output values for each channel. The values obtained in averaging processing are stored in the buffer memory.
The following three types of averaging processing are provided.

- Time average
- Count average
- Moving average

(a) Time average

A/D conversion is performed for a set period of time and averaging processing is performed on the total value excluding the maximum and the minimum values. The values obtained in averaging processing are stored in the buffer memory.
The number of processing times within a set period of time changes depending on the number of channels where A/D conversion is enabled.

$$\text{Number of processing times} = \frac{\text{Set period of time}}{0.08\text{ms} \times \text{Number of channels where A/D conversion is enabled}}$$

Ex. The processing count with the following settings is calculated below:

Item	Setting
Number of channels where A/D conversion is enabled	2 channels (CH1, CH2)
Set period of time	15ms

$\frac{15}{0.08 \times 2} = 93.75$ (times) ··· The value after the decimal point shall be rounded down.

→ The processing is performed 93 times and the average value is output.

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The icon shows an available conversion method.

The meaning of each icon is as follows.

Icon	Description
Common	The corresponding buffer memory area, I/O signal, or function is for both A/D conversion and D/A conversion.
A/D conversion	The corresponding buffer memory area, I/O signal, or function is for A/D conversion.
D/A conversion	The corresponding buffer memory area, I/O signal, or function is for D/A conversion.
Variable arithmetic	The corresponding buffer memory area, I/O signal, or function is for the variable arithmetic function.
Variable conversion	The corresponding buffer memory area, I/O signal, or function is for the variable conversion characteristics function.
PID control	The corresponding buffer memory area, I/O signal, or function is for the PID control function.

TERMS

Unless otherwise specified, this manual uses the following terms.

Term	Description
Analog I/O module	The abbreviation for the MELSEC-L series analog input/output module
Buffer memory	A memory in an intelligent function module, where data (such as setting values and monitoring values) exchanged with a CPU module are stored
Display unit	A liquid crystal display to be attached to the CPU module
Factory default setting	A generic term for analog input/output ranges of 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V, -10 to 10V, and 0 to 10V
GX Developer	The product name of the software package for the MELSEC programmable controllers
GX LogViewer	Software to display data collected by the logging function
GX Works2	The product name of the software package for the MELSEC programmable controllers
Head module	The abbreviation for the LJ72GF15-T2 CC-Link IE Field Network head module
Normal mode	A drive mode set in the switch setting window. Note that the normal mode is displayed as "Normal (A/D Converter Processing, D/A Converter Processing) Mode" on the programming tool.
Offset/gain setting mode	A drive mode set in the switch setting window.
Programming tool	A generic term for GX Works2 and GX Developer
Switch setting	A generic term for the setting items in the window that is displayed by double-clicking "Switch Setting" of the specified module on the project window of GX Works2
User range setting	An analog input or output range where a user can set any values. To use this range, the offset and gain values have to be set.
Watchdog timer error	An analog I/O module monitors its own internal processing by using the watchdog timer. The module generates this error if the internal processing fails.

PACKING LIST

The following items are included in the package of this product. Before use, check that all the items are included.

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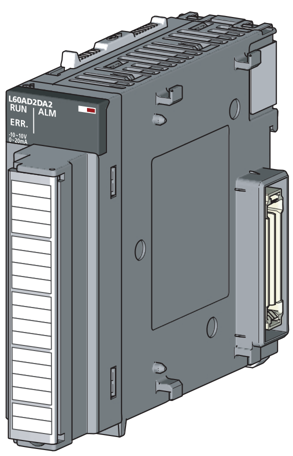

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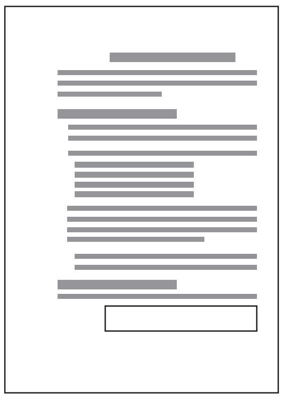


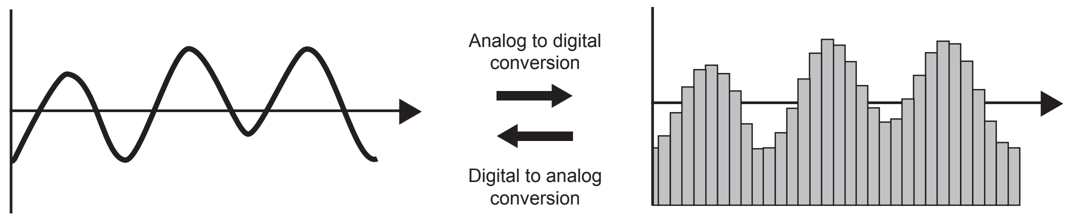
Before Using the Product

CHAPTER 1 ANALOG I/O MODULE

This chapter describes the applications and features of the analog I/O module.

1.1 Application

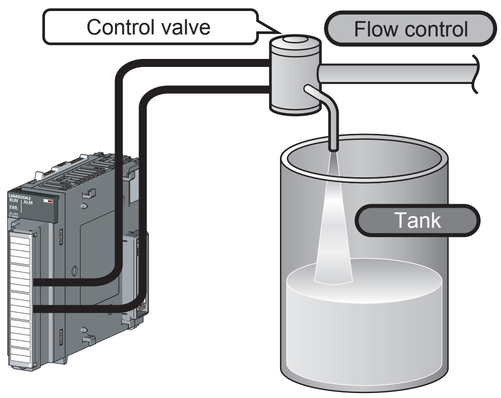
An analog I/O module has two sets of A/D conversion channels and D/A conversion channels.
The fewer number of analog I/O points reduces the required number of analog modules, resulting in the cost reduction and space saving on the system.



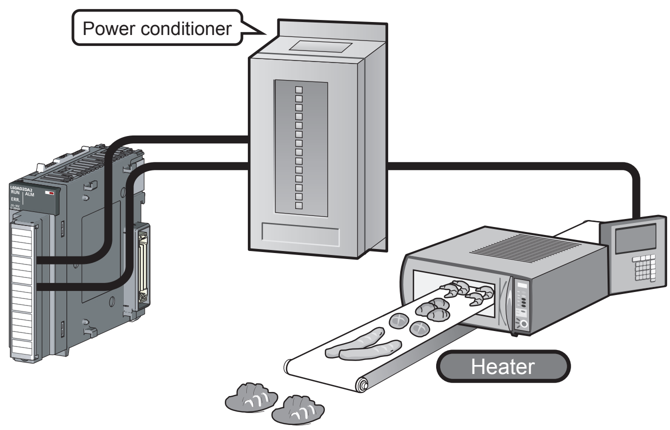
Analog signal (continuous signal) Digital signal (discrete signal)

With the analog I/O module, the following applications are possible.

Measuring and controlling the flow in the connection with a control valve



Measuring and controlling the heat from a heater or other devices in the connection with a power conditioner



1.2 Features

(1) Scale conversion

This function converts a digital output value (A/D conversion) and a digital input value (D/A conversion) to the ratio value (%) in any width to represent the digital value in a numeric value easy to understand.

(2) Comparing and monitoring an object

The input signal error detection function and the input range extension function allow the status of the connected device to be easily monitored.

(3) Logging function

An analysis of the collected data through the logging function improves maintainability of the system in use.

(4) Wave output function

This function outputs any points from 50000 points of the wave data (digital input value) in analog by executing the D/A conversion sequentially. The conversion cycle in the wave output function can be set for each channel. A control with the conversion faster than that of a program control is enabled by the registration of the control wave data to the analog I/O module and the analog output from the module. And this method is useful for an analog (torque) control of equipments such as pressing machines and injection molding units. Because the update of the analog output value of the wave output function is not affected by the scan time of the CPU module, a faster and smoother analog control is available.

(5) Variable arithmetic function

This function executes polynomial operations in the analog I/O module. For the polynomial expressions, any combination of parentheses, operators, constants set by users, and data stored in the buffer memory can be used. Up to two polynomial expressions can be registered. When conversion is enabled for a D/A conversion channel, operation results are output in analog.
Only by registering arithmetic expression data in the analog I/O module, polynomial operations can be executed. Thus, no programs for the operation are required on the CPU module and the man-hour for creating programs can be reduced. In addition, advanced operations independent of the scan time of the CPU module can be executed.

(6) Variable conversion characteristics function

Conventionally, the I/O conversion characteristic of the analog I/O module (A/D conversion and D/A conversion) is indicated with a straight line connecting the offset value and the gain value. However, with this function, the conversion characteristic can be set by users.
Only by registering a conversion characteristics table in this module, values are converted according to the conversion characteristics. Thus, no programs for the operation are required on the CPU module and the man-hour for creating programs can be reduced. With high-speed performance that the analog I/O module has, analog input, analog output, and analog input/output can be performed with the variable conversion characteristic created by users.

(7) Variable conversion characteristics function + variable arithmetic function

The variable conversion characteristics function and the variable arithmetic function can be used together. Because the operation for digital values converted according to variable conversion characteristics can be executed with polynomial expressions registered by users, more advanced control compared to using only the variable conversion characteristics function is available.

(8) PID control function

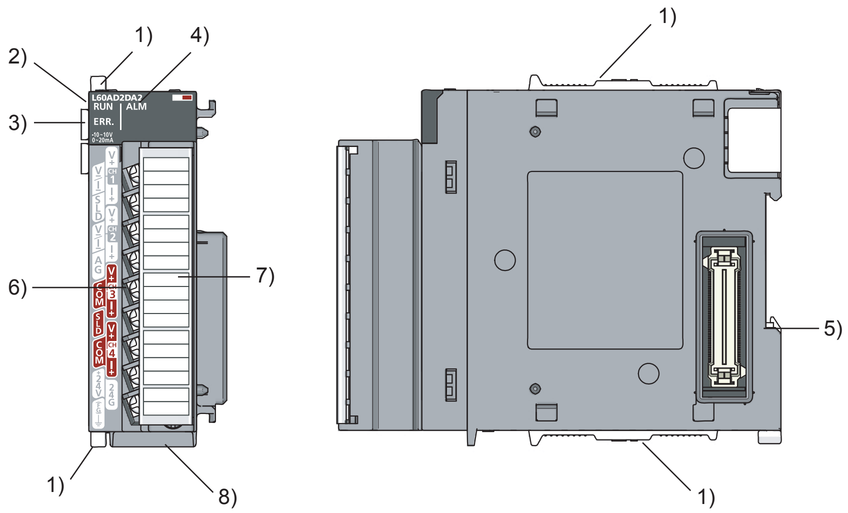
Using this function, an analog input signal from a sensor (such as pressure and flow rate) is input to the module as the process value (PV) (16-bit signed binary) and the PID operation is performed in the module so that the input value reaches the set value (SV). The manipulated value (MV) calculated in the PID operation is output to an external operation device as an analog value of current or voltage.
Because the PID control is performed with the operation cycle of 200μs/CH, the control can be applied to a field which requires high-speed control such as the forming field.

(9) Easy setting with GX Works2

Programming is reduced because the initial setting or auto refresh setting can be configured on the screen. In addition, setting status and operating status of modules can be checked easily. With the wave output function, wave data can be created easily by using "Create Wave Output Data".

CHAPTER 2 PART NAMES

The following table shows part names of the analog I/O module.



No.	Name	Description
1)	Module joint levers	Levers for connecting modules
2)	RUN LED (green)	Indicates the operating status of the analog I/O module. ON: The module is operating normally. Flashing: In the offset/gain setting mode OFF: The 5V power off or watchdog timer error has occurred.
3)	ERR. LED (red)	Indicates the error status of the analog I/O module. ON: An error has occurred except for error code: 112*1 Flashing: Error code: 112 has occurred.*1 OFF: The module is operating normally.
4)	ALM LED (red)	Indicates the alarm occurrence of the analog I/O module. ON: An input signal error and another alarm*2 have occurred at the same time. Flashing (1s intervals): An alarm other than the input signal error has occurred.*2 Flashing (0.5s intervals): Input signal error detection is occurring.*2 OFF: The module is operating normally.
5)	DIN rail hook	A hook used to mount the module to a DIN rail
6)	Terminal Block*3	A 18-point screw terminal block for connecting input signal lines and output signal lines of external devices
7)	Terminal block cover	A cover for preventing electric shock while the power is on
8)	Serial number display	Displays the serial number printed on the rating plate.

*1 For details, refer to Error Code List (☞ Page 315, Section 11.4).
*2 For details, refer to Alarm Code List (☞ Page 324, Section 11.5).
*3 For the signal assignment for the terminal block, refer to (☞ Page 49, Section 6.2).

Memo

CHAPTER 3 SPECIFICATIONS

This chapter describes general specifications, performance specifications, function list, list of I/O signals, and list of buffer memory addresses.

3.1 General Specifications

For the general specifications of the analog I/O module, refer to the following.

📖 The manual "Safety Guidelines" included with the CPU module or head module

3.2 Performance Specifications

The following table lists the performance specifications of the analog I/O module.

(1) A/D conversion part

Item		Model			
		L60AD2DA2			
Number of analog input channels		2 channels			
Analog input	Voltage	-10 to 10VDC (input resistance 1MΩ)			
	Current	0 to 20mADC (input resistance 250Ω)			
Digital output		-16384 to 16383 (with the scaling function used: -32768 to 32767)			
I/O characteristics, resolution[*1]		Analog input range		Digital output value	Resolution
		Voltage	0 to 10V	0 to 16000	625μV
			0 to 5V	0 to 12000	416μV
			1 to 5V		333μV
			-10 to 10V	-16000 to 16000	625μV
			1 to 5V (Extended mode)	-3000 to 13500	333μV
			User range setting (Voltage)	-12000 to 12000	321μV[*2]
		Current	0 to 20mA	0 to 12000	1666nA
			4 to 20mA		1333nA
			4 to 20mA (Extended mode)	-3000 to 13500	1333nA
			User range setting (Current)	-12000 to 12000	1287nA[*2]
Accuracy (accuracy of the maximum digital output value)[*3]		Analog input range		Ambient temperature	
				25±5℃	0 to 55℃
		Voltage	0 to 10V	Within ±0.2% (±32 digit)	Within ±0.3% (±48 digit)
			-10 to 10V		
			0 to 5V	Within ±0.2% (±24 digit)	Within ±0.3% (±36 digit)
			1 to 5V		
			1 to 5V (Extended mode)		
		Current	0 to 20mA		
			4 to 20mA		
			4 to 20mA (Extended mode)		
Conversion speed[*4]	Logging function	80μs/channel			
	Wave output function				
	Variable conversion characteristics function	100μs/channel			
	Variable arithmetic function	160μs/channel			
	Variable conversion characteristics function + variable arithmetic function				
	PID control function	200μs/channel			
Absolute maximum input		Voltage: ±15V, Current: 30mA[*5]			

*1 For details on the I/O conversion characteristic, refer to the following.
I/O conversion characteristic of A/D conversion (☞ Page 425, Appendix 3.1)
*2 Maximum resolution in the user range setting
*3 Except when receiving noise influence.
*4 For details on the conversion speed, refer to the following.
Enable/Disable Setting and Conversion Speed of A/D and D/A Conversion (☞ Page 81, Section 8.2)
*5 A momentary current value which does not cause damage to internal resistors of the module. The maximum input current value for constant application is 24mA.

(2) D/A conversion part

<table>
<tr><th colspan="2" rowspan="2">Item</th><th colspan="4">Model</th></tr>
<tr><th colspan="4">L60AD2DA2</th></tr>
<tr><td colspan="2">Number of analog output channels</td><td colspan="4">2 channels</td></tr>
<tr><td colspan="2">Digital input</td><td colspan="4">-16384 to 16383
(with the scaling functions used: -32768 to 32767)</td></tr>
<tr><td rowspan="2">Analog output</td><td>Voltage</td><td colspan="4">-10 to 10VDC (external load resistance value 1kΩ to 1MΩ)</td></tr>
<tr><td>Current</td><td colspan="4">0 to 20mADC (external load resistance value 0 to 600Ω)</td></tr>
<tr><td colspan="2" rowspan="8">I/O characteristics, resolution[*1]</td><td colspan="2">Analog output range</td><td>Digital input value</td><td>Resolution</td></tr>
<tr><td rowspan="4">Voltage</td><td>0 to 5V</td><td rowspan="2">0 to 12000</td><td>416μV</td></tr>
<tr><td>1 to 5V</td><td>333μV</td></tr>
<tr><td>-10 to 10V</td><td>-16000 to 16000</td><td>625μV</td></tr>
<tr><td>User range setting (Voltage)</td><td>-12000 to 12000</td><td>319μV[*2]</td></tr>
<tr><td rowspan="3">Current</td><td>0 to 20mA</td><td rowspan="2">0 to 12000</td><td>1666nA</td></tr>
<tr><td>4 to 20mA</td><td>1333nA</td></tr>
<tr><td>User range setting (Current)</td><td>-12000 to 12000</td><td>696nA[*2]</td></tr>
<tr><td colspan="2" rowspan="7">Accuracy
(accuracy of the maximum analog output value)[*3]</td><td colspan="2" rowspan="2">Analog output range</td><td colspan="2">Ambient temperature</td></tr>
<tr><td>25±5℃</td><td>0 to 55℃</td></tr>
<tr><td rowspan="3">Voltage</td><td>0 to 5V</td><td rowspan="2">Within ±0.2% (±10mV)</td><td rowspan="2">Within ±0.4% (±20mV)</td></tr>
<tr><td>1 to 5V</td></tr>
<tr><td>-10 to 10V</td><td>Within ±0.2% (±20mV)</td><td>Within ±0.4% (±40mV)</td></tr>
<tr><td rowspan="2">Current</td><td>0 to 20mA</td><td rowspan="2">Within ±0.2% (±40μA)</td><td rowspan="2">Within ±0.4% (±80μA)</td></tr>
<tr><td>4 to 20mA</td></tr>
<tr><td rowspan="6">Conversion speed[*4]</td><td>Normal output</td><td colspan="4" rowspan="2">80μs/channel</td></tr>
<tr><td>Wave output function</td></tr>
<tr><td>Variable conversion characteristics function</td><td colspan="4">100μs/channel</td></tr>
<tr><td>Variable arithmetic function</td><td colspan="4" rowspan="2">320μs/2 channels[*5]</td></tr>
<tr><td>Variable conversion characteristics function + variable arithmetic function</td></tr>
<tr><td>PID control function</td><td colspan="4">200μs/channel</td></tr>
<tr><td colspan="2">Output short protection</td><td colspan="4">Protected</td></tr>
</table>

*1 For details on the I/O conversion characteristic, refer to the following.
I/O conversion characteristic of D/A conversion (☞ Page 428, Appendix 3.2)

*2 Maximum resolution in the user range setting.

*3 Except when receiving noise influence.

*4 For details on the conversion speed, refer to the following.
Enable/Disable Setting and Conversion Speed of A/D and D/A Conversion (☞ Page 81, Section 8.2)

*5 When the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function is used, the operation speed for polynomial expressions is 320μs. Since each operation result of two polynomial expressions is output on each D/A conversion channel, D/A conversion is executed at intervals of 320μs regardless of the number of conversion enabled channels. For details, refer to the following.
Variable Arithmetic Function (☞ Page 192, Section 8.19)

(3) Common part

Item	Model
	L60AD2DA2
Number of offset/gain settings, number of arithmetic expression data settings[*1] (Flash memory write count)	Up to 100000 counts
Insulation method	Between I/O terminals and programmable controller power supply: photocoupler isolation Between I/O channels: no isolation Between the external power supply and analog I/O channels: transformer isolation
Withstand voltage	Between I/O terminals and programmable controller power supply: 500VACrms for 1 minute Between the external power supply and analog I/O: 500VACrms for 1 minute
Insulation resistance	Between I/O terminals and programmable controller power supply: 500VDC 10MΩ or higher
Number of occupied I/O points	16 points (I/O assignment: 16 points for intelligent)
External interface	18-point terminal block
Applicable wire size	0.3 to 0.75mm^2
Applicable solderless terminal	R1.25-3 (solderless terminals with sleeve are not usable)
External power supply	24VDC +20%, -15%
	Ripple, spike 500mVP-P or lower
	Inrush current: 5.0A, 1000μs or shorter
	Current consumption: 0.12A
Internal current consumption (5VDC)	0.17A
Weight	0.22kg

*1 If the number of offset/gain settings exceeds 100000 times, an error (error code: 170) occurs.

3.2.1 Number of parameter settings

Set the initial settings of the analog I/O module and the parameter settings of the auto refresh setting so that the number of parameters, including those of other intelligent function modules, does not exceed the number of parameters that can be set in a CPU module.
For the maximum number of parameters that can be set in a CPU module (maximum number of parameter settings), refer to the following.
MELSEC-L CPU Module User's Manual (Hardware Design, Maintenance and Inspection)
MELSEC-L CC-Link IE Field Network Head Module User's Manual

(1) Number of parameters of the analog I/O module

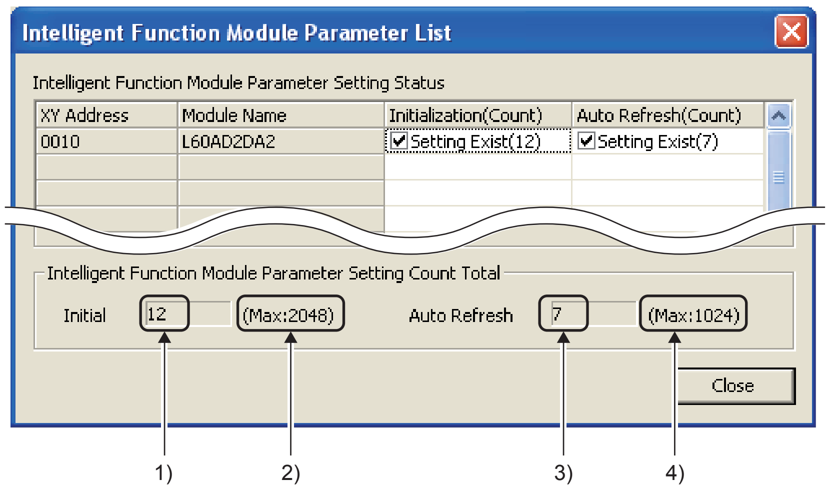
The following number of parameters can be set in a single analog I/O module.

Target module	Initial setting	Auto refresh setting
L60AD2DA2	12	31 (maximum)

(2) Checking method

The maximum number of the parameter settings and the number of the parameter settings set for an intelligent function module can be checked with the following operation.

Project window ⇨ [Intelligent Function Module] ⇨ right-click
⇨ [Intelligent Function Module Parameter List]



No.	Description
1)	The total number of the parameters in the initial settings selected on the window
2)	The maximum number of the parameter settings in the initial settings
3)	The total number of the parameters in the auto refresh settings selected on the window
4)	The maximum number of the parameter settings in the auto refresh settings

3.3 Function List

The following table lists the functions of the analog I/O module.

(1) Functions of A/D conversion

Item			Description	Reference
A/D conversion enable/disable function			This function sets whether to enable or disable the A/D conversion for each channel. Disabling the A/D conversion for unused channels reduces the A/D conversion cycle.	Page 85, Section 8.4
A/D conversion method	Sampling processing		Analog input values are converted into digital at every sampling cycle and stored in the buffer memory as digital output values.	Page 86, Section 8.5 (1)
	Averaging processing	Time average	A/D conversion is performed for a set period of time and averaging processing is performed on the total value excluding the maximum and the minimum values. The values obtained in averaging processing are stored in the buffer memory. The number of processing times within a set period of time changes depending on the number of channels where A/D conversion is enabled.	Page 86, Section 8.5 (2) (a)
		Count average	A/D conversions are performed a set number of times and averaging processing is performed on the total value excluding the maximum and the minimum values. The values obtained in averaging processing are stored in the buffer memory. The time taken for the mean value calculated through average processing to be stored in the buffer memory changes depending on the number of channels where A/D conversion is enabled.	Page 87, Section 8.5 (2) (b)
		Moving average	The average of a specified number of digital output values is calculated at every sampling cycle and is stored in the buffer memory. Because the target set of values for averaging processing shifts to another to involve a subsequent value at every sampling processing, the latest digital output values can be always obtained.	Page 88, Section 8.5 (2) (c)
Range switching function			The input range to use can be selected from the following ranges: • Industrial shipment range (4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V, -10 to 10V, 0 to 10V) • User range setting (Current), user range setting (Voltage) • Extended mode range (4 to 20mA (Extended mode), 1 to 5V (Extended mode))	Page 55, Section 7.2
Input range extension function			This function extends the input range of 4 to 20mA and that of 1 to 5V. By combining this function with the input signal error detection function, simple disconnection detection can be executed.	Page 91, Section 8.6
Maximum value/minimum value hold function			This function stores the maximum digital value and minimum digital output value in the buffer memory for each channel. When the scaling function (A/D conversion) is used, the maximum scaling value and minimum scaling value are stored.	Page 92, Section 8.7
Input signal error detection function			This function outputs an alarm when the analog input value exceeds a preset range.	Page 93, Section 8.8
Scaling function (A/D conversion)			This function performs scale conversion on the digital output values. The values are converted within the range between a specified A/D conversion scaling upper limit value and A/D conversion scaling lower limit value. The program for scale conversion can be omitted.	Page 100, Section 8.9
Logging function			This function can log (record) 10000 digital output values or the scaling values for each channel.	Page 106, Section 8.10

(2) Functions of D/A conversion

Item	Description	Reference
D/A conversion enable/disable function	This function sets whether to enable or disable D/A conversion for each channel. Disabling the D/A conversion for unused channels reduces the D/A conversion cycle.	Page 125, Section 8.12
D/A output enable/disable function	This function sets whether to output the D/A converted value or the offset value, for each channel. The conversion speed is a constant, regardless of the output enable/disable status.	Page 126, Section 8.13
Range switching function	The output range to use can be selected from the following ranges: • Industrial shipment range (4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V, -10 to 10V) • User range setting (Current), user range setting (Voltage)	Page 55, Section 7.2
Analog output HOLD/CLEAR function	This function sets whether to hold the output analog value (HOLD) or clear the output analog value (CLEAR) when the CPU module operating status is RUN, STOP, or stop error.	Page 127, Section 8.14
Analog output test when CPU module is in STOP status	When the CPU module is in STOP operation status, forcibly turning on CH□ Output enable/disable flag (Y3, Y4) outputs the D/A-converted analog value.	Page 132, Section 8.15
Scaling function (D/A conversion)	This function performs scale conversion on the digital output values. The values are converted within the range between a specified D/A conversion scaling upper limit value and D/A conversion scaling lower limit value. The program for scale conversion can be omitted.	Page 134, Section 8.16
Warning output function	This function outputs a warning when the digital input value exceeds the warning output upper limit value or becomes less than the warning output lower limit value.	Page 141, Section 8.17
Wave output function	This function imports the prepared wave data (digital input value) and outputs the data (analog value) in the set conversion cycle. A faster and smoother control than a program is achieved by the automatic output of the control wave data registered in the analog I/O module for the analog (torque) control such as pressing machines and injection molding units. The control can be executed only by registering the wave data to the analog I/O module. Therefore, the program-less control is available for the repeat control such as the line control, and man-hours for programming can be reduced.	Page 144, Section 8.18
Wave output step action function	This function changes addresses and data values to be output to change the analog output flexibly at any timing when the wave output function is used. This function is useful for the analog output test when the wave output function is used and for debugging the wave output function.	Page 183, Section 8.18.4

(3) Common functions

Item	Description		Reference
Free Operation Function	This function executes polynomial operations in the analog I/O module. For the polynomial expressions, any combination of parentheses, operators, constants set by users, and data stored in the buffer memory can be used. When conversion is enabled for a D/A conversion channel, operation results are output in analog.		Page 192, Section 8.19
Variable conversion characteristics function	Conventionally, the I/O conversion characteristic of the analog I/O module (A/D conversion and D/A conversion) is indicated with a straight line connecting the offset value and the gain value. However, with this function, the conversion characteristic can be set by users.		Page 212, Section 8.20
Variable conversion characteristics function + variable arithmetic function	This function executes the operation for digital values converted according to variable conversion characteristics with polynomial expressions registered by users.		Page 239, Section 8.21
PID control function	Using this function, an analog input signal from a sensor (such as pressure and flow rate) is input to the module as the process value (PV) (16-bit signed binary) and the PID operation is performed in the module so that the input value reaches the set value (SV). The manipulated value (MV) calculated in the PID operation is output to an external operation device as an analog value of current or voltage.		Page 246, Section 8.22
External power supply READY flag (X7)	This signal turns on when the external power supply 24VDC is supplied. When External power supply READY flag (X7) is off, A/D conversion processing and D/A conversion processing are not performed. The following operations are performed.		Page 345, Appendix 1.1 (3)
	A/D conversion	The digital output value and the scaling value stored before External power supply READY flag (X7) turns off are held.	
	D/A conversion	The analog output value becomes 0V/0mA regardless of other settings.	
Error log function	This function stores errors and alarms that occurred in the analog I/O module in the buffer memory. A total of 16 errors and alarms can be stored.		Page 269, Section 8.23
Module error collection function	This function collects errors and alarms that occurred in the analog I/O module and stores them to the CPU module.		Page 272, Section 8.24
Error clear function	This function clears errors that occur using the system monitor.		Page 273, Section 8.25
Save/restoration of offset/gain value	This function can save and restore the offset/gain value of the user range setting.		Page 274, Section 8.26
Offset/gain setting	This function compensates for errors in analog output values and digital output values.		Page 61, Section 7.5

(4) Use of functions with the variable arithmetic function, variable conversion characteristics function, or PID control function

When the variable arithmetic function, variable conversion characteristics function, or PID control function is used, the following functions cannot be used. Or, there are the following conditions for the use.

○: Available, △: Available with conditions, ×: Not available

Unavailable function or function available with conditions		Free Operation Function	Free Conversion Characteristics Function	Variable conversion characteristics function + variable arithmetic function	PID control function
A/D conversion	Range switching function	△ (The user range cannot be used.)	△ (The user range cannot be used.)*1	△ (The user range cannot be used.)*1	△ (The user range cannot be used.)
	A/D conversion method	○	○	○	△ (The time average and count average cannot be used.)
	Scaling function (A/D conversion)	○	△*2	△*2	○
	Logging function	×	×	×	×
D/A conversion	Range switching function	△ (The user range cannot be used.)	△ (The user range cannot be used.)*1	△ (The user range cannot be used.)	△ (The user range cannot be used.)
	Scaling function (D/A conversion)	×	△*2	×	×
	Wave Output Function	×	×	×	×
	Wave output step action function	×	×	×	×
Common	Offset/gain setting	×	×	×	×
	Save/restoration of offset/gain value	×	×	×	×

*1 The following user ranges are available according to the set value of Variable conversion characteristics table selection (Un\G4100).
- Analog input (0): The user range of D/A conversion is available.
- Analog output (1): The user range of A/D conversion is available.

*2 The following functions are available according to the set value of Variable conversion characteristics table selection (Un\G4100).
- Analog input (0): The scaling function (D/A conversion) is available.
- Analog output (1): The scaling function (A/D conversion) is available.

3.4 I/O Signal List

The following table lists the I/O signals.
For details of the I/O signals, refer to the following.

• Details of I/O Signals (☞ Page 344, Appendix 1)

Input signal		Output signal	
Device number	**Signal name**	**Device number**	**Signal name**
X0	Module READY	Y0	Use prohibited
X1	Use prohibited	Y1	
X2		Y2	
X3		Y3	CH3 Output enable/disable flag
X4		Y4	CH4 Output enable/disable flag
X5		Y5	Use prohibited
X6	Set value change completed flag	Y6	Set value change request
X7	External power supply READY flag	Y7	Use prohibited
X8	Warning output signal	Y8	Warning output clear request
X9	Operating condition setting completed flag	Y9	Operating condition setting request
XA	Offset/gain setting mode flag/Arithmetic expression data write status flag	YA	User range write request/Arithmetic expression data write request
XB	Channel change completed flag	YB	Channel change request
XC	Input signal error detection signal	YC	Use prohibited
XD	Maximum value/minimum value reset completed flag	YD	Maximum value/minimum value reset request
XE	A/D conversion completed flag	YE	Use prohibited
XF	Error flag	YF	Error clear request

Point

- The I/O number (X/Y) described above shows the case that the start I/O number of the analog I/O module is set to "0".
- Do not use the "Use prohibited" signals shown above because the system uses them.
  If users use (turn on) the signals, the functions of the analog I/O module cannot be guaranteed.

3.5 List of Buffer Memory Addresses

The following table lists the buffer memory addresses of the analog I/O module.
For details of the buffer memory, refer to the following.

- Details of Buffer Memory Addresses (☞ Page 354, Appendix 2)

Point

Do not write data to the system areas and read-only areas in the buffer memory.
Writing data to these areas may lead the module to malfunction.

(1) Un\G0 to Un\G4799

Address (decimal)	Address (hexadecimal)	Name	Default*1	Read/Write *2	Item enabled by turning on and off Operating condition setting request (Y9)
0	0H	A/D conversion enable/disable setting	0003H	R/W	○
1	1H	CH1 Time Average/Count Average/Moving Average	0	R/W	○
2	2H	CH2 Time Average/Count Average/Moving Average	0	R/W	○
3 to 9	3H to 9H	System area	—	—	—
10	AH	A/D conversion completed flag	0000H	R	—
11	BH	CH1 Digital output value	0	R	—
12	CH	CH2 Digital output value	0	R	—
13 to 18	DH to 12H	System area	—	—	—
19	13H	Latest error code	0	R	—
20	14H	Setting range	0000H	R	—
21	15H	Function selection monitor	0	R	—
22	16H	Offset/gain setting mode Offset specification	0000H	R/W	—
23	17H	Offset/gain setting mode Gain specification	0000H	R/W	—
24	18H	Averaging process setting	0000H	R/W	○
25	19H	System area	—	—	—
26	1AH				
27	1BH	Input signal error detection setting	0000H	R/W	○
28	1CH	System area	—	—	—
29	1DH				
30	1EH	CH1 Maximum value	0	R	—
31	1FH	CH1 Minimum value	0	R	—
32	20H	CH2 Maximum value	0	R	—
33	21H	CH2 Minimum value	0	R	—
34 to 48	22H to 30H	System area	—	—	—
49	31H	Input signal error detection flag	0000H	R	—
50 to 52	32H to 34H	System area	—	—	—
53	35H	A/D conversion scaling enable/disable setting	0003H	R/W	○
54	36H	CH1 Scaling value	0	R	—
55	37H	CH2 Scaling value	0	R	—
56 to 61	38H to 3DH	System area	—	—	—
62	3EH	CH1 A/D conversion scaling lower limit value	0	R/W	○
63	3FH	CH1 A/D conversion scaling upper limit value	0	R/W	○
64	40H	CH2 A/D conversion scaling lower limit value	0	R/W	○
65	41H	CH2 A/D conversion scaling upper limit value	0	R/W	○
66 to 141	42H to 8DH	System area	—	—	—

Address (decimal)	Address (hexadecimal)	Name	Default*1	Read/Write *2	Item enabled by turning on and off Operating condition setting request (Y9)
142	8EH	CH1 Input signal error detection setting value	50	R/W	○
143	8FH	CH2 Input signal error detection setting value	50	R/W	○
144 to 157	90H to 9DH	System area	—	—	—
158	9EH	Mode switching setting	0	R/W	○
159	9FH				
160 to 199	A0H to C7H	System area	—	—	—
200	C8H	Pass data classification setting	0	R/W	○
201	C9H	System area	—	—	—
202	CAH	CH1 Industrial shipment settings offset value	0	R/W	—
203	CBH	CH1 Industrial shipment settings gain value	0	R/W	—
204	CCH	CH2 Industrial shipment settings offset value	0	R/W	—
205	CDH	CH2 Industrial shipment settings gain value	0	R/W	—
206	CEH	CH3 Industrial shipment settings offset value	0	R/W	—
207	CFH	CH3 Industrial shipment settings gain value	0	R/W	—
208	D0H	CH4 Industrial shipment settings offset value	0	R/W	—
209	D1H	CH4 Industrial shipment settings gain value	0	R/W	—
210	D2H	CH1 User range settings offset value	0	R/W	—
211	D3H	CH1 User range settings gain value	0	R/W	—
212	D4H	CH2 User range settings offset value	0	R/W	—
213	D5H	CH2 User range settings gain value	0	R/W	—
214	D6H	CH3 User range settings offset value	0	R/W	—
215	D7H	CH3 User range settings gain value	0	R/W	—
216	D8H	CH4 User range settings offset value	0	R/W	—
217	D9H	CH4 User range settings gain value	0	R/W	—
218 to 999	DAH to 3E7H	System area	—	—	—
1000	3E8H	CH1 Logging enable/disable setting	1	R/W	○
1001	3E9H	CH2 Logging enable/disable setting	1	R/W	○
1002 to 1007	3EAH to 3EFH	System area	—	—	—
1008	3F0H	CH1 Logging hold request	0	R/W	—
1009	3F1H	CH2 Logging hold request	0	R/W	—
1010 to 1015	3F2H to 3F7H	System area	—	—	—
1016	3F8H	CH1 Logging hold flag	0	R	—
1017	3F9H	CH2 Logging hold flag	0	R	—
1018 to 1023	3FAH to 3FFH	System area	—	—	—
1024	400H	CH1 Logging data setting	1	R/W	○
1025	401H	CH2 Logging data setting	1	R/W	○
1026 to 1031	402H to 407H	System area	—	—	—
1032	408H	CH1 Logging cycle setting value	4	R/W	○
1033	409H	CH2 Logging cycle setting value	4	R/W	○
1034 to 1039	40AH to 40FH	System area	—	—	—
1040	410H	CH1 Logging cycle unit setting	1	R/W	○
1041	411H	CH2 Logging cycle unit setting	1	R/W	○
1042 to 1047	412H to 417H	System area	—	—	—
1048	418H	CH1 Logging points after trigger	5000	R/W	○
1049	419H	CH2 Logging points after trigger	5000	R/W	○

Address (decimal)	Address (hexadecimal)	Name		Default[*1]	Read/Write [*2]	Item enabled by turning on and off Operating condition setting request (Y9)
1050 to 1055	41AH to 41FH	System area		—	—	—
1056	420H	CH1 Level trigger condition setting		0	R/W	○
1057	421H	CH2 Level trigger condition setting		0	R/W	○
1058 to 1063	422H to 427H	System area		—	—	—
1064	428H	CH1 Trigger data		54	R/W	○
1065	429H	CH2 Trigger data		55	R/W	○
1066 to 1071	42AH to 42FH	System area		—	—	—
1072	430H	Level data 0		0	R/W	—
1073	431H	Level data 1		0	R/W	—
1074	432H	Level data 2		0	R/W	—
1075	433H	Level data 3		0	R/W	—
1076	434H	Level data 4		0	R/W	—
1077	435H	Level data 5		0	R/W	—
1078	436H	Level data 6		0	R/W	—
1079	437H	Level data 7		0	R/W	—
1080	438H	Level data 8		0	R/W	—
1081	439H	Level data 9		0	R/W	—
1082	43AH	CH1 Trigger setting value		0	R/W	○
1083	43BH	CH2 Trigger setting value		0	R/W	○
1084 to 1089	43CH to 441H	System area		—	—	—
1090	442H	CH1 Head pointer		0	R	—
1091	443H	CH2 Head pointer		0	R	—
1092 to 1097	444H to 449H	System area		—	—	—
1098	44AH	CH1 Latest pointer		0	R	—
1099	44BH	CH2 Latest pointer		0	R	—
1100 to 1105	44CH to 451H	System area		—	—	—
1106	452H	CH1 Number of logging data		0	R	—
1107	453H	CH2 Number of logging data		0	R	—
1108 to 1113	454H to 459H	System area		—	—	—
1114	45AH	CH1 Trigger pointer		0	R	—
1115	45BH	CH2 Trigger pointer		0	R	—
1116 to 1121	45CH to 461H	System area		—	—	—
1122	462H	CH1 Logging cycle monitor value	(s)	0	R	—
1123	463H		(ms)	0	R	—
1124	464H		(μs)	0	R	—
1125	465H	CH2 Logging cycle monitor value	(s)	0	R	—
1126	466H		(ms)	0	R	—
1127	467H		(μs)	0	R	—
1128 to 1145	468H to 479H	System area		—	—	—
1146	47AH	CH1 Logging status monitor value		000FH	R	—
1147	47BH	CH2 Logging status monitor value		000FH	R	—
1148 to 1153	47CH to 481H	System area		—	—	—

Address (decimal)	Address (hexadecimal)	Name			Default*1	Read/Write *2	Item enabled by turning on and off Operating condition setting request (Y9)
1154	482H	CH1 Trigger detection time	First two digits of the year	Last two digits of the year	0	R	—
1155	483H		Month	Day	0	R	—
1156	484H		Hour	Minute	0	R	—
1157	485H		Second	Day of the week	0	R	—
1158	486H	CH2 Trigger detection time	First two digits of the year	Last two digits of the year	0	R	—
1159	487H		Month	Day	0	R	—
1160	488H		Hour	Minute	0	R	—
1161	489H		Second	Day of the week	0	R	—
1162 to 1999	48AH to 7CFH	System area			—	—	—
2000	7D0H	D/A conversion enable/disable setting			000CH	R/W	○
2001	7D1H	System area			—	—	—
2002	7D2H						
2003	7D3H	CH3 Digital input value			0	R/W	—
2004	7D4H	CH4 Digital input value			0	R/W	—
2005 to 2012	7D5H to 7DCH	System area			—	—	—
2013	7DDH	CH3 Set value check code			0000H	R	—
2014	7DEH	CH4 Set value check code			0000H	R	—
2015 to 2023	7DFH to 7E7H	System area			—	—	—
2024	7E8H	Offset/gain adjustment value specification			0	R/W	—
2025	7E9H	System area			—	—	—
2026	7EAH	HOLD/CLEAR function setting			0000H	R	—
2027 to 2046	7EBH to 7FEH	System area			—	—	—
2047	7FFH	Warning output setting			000CH	R/W	○
2048	800H	Warning output flag			0000H	R	—
2049 to 2052	801H to 804H	System area			—	—	—
2053	805H	D/A conversion scaling enable/disable setting			000CH	R/W	○
2054 to 2057	806H to 809H	System area			—	—	—
2058	80AH	CH3 D/A conversion scaling lower limit value			0	R/W	○
2059	80BH	CH3 D/A conversion scaling upper limit value			0	R/W	○
2060	80CH	CH4 D/A conversion scaling lower limit value			0	R/W	○
2061	80DH	CH4 D/A conversion scaling upper limit value			0	R/W	○
2062 to 2089	80EH to 829H	System area			—	—	—
2090	82AH	CH3 Warning output upper limit value			0	R/W	○
2091	82BH	CH3 Warning output lower limit value			0	R/W	○
2092	82CH	CH4 Warning output upper limit value			0	R/W	○
2093	82DH	CH4 Warning output lower limit value			0	R/W	○
2094 to 3001	82EH to BB9H	System area			—	—	—
3002	BBAH	CH3 Wave output start/stop request			0	R/W	—
3003	BBBH	CH4 Wave output start/stop request			0	R/W	—
3004 to 3009	BBCH to BC1H	System area			—	—	—
3010	BC2H	CH3 Output setting during wave output stop			1	R/W	○
3011	BC3H	CH4 Output setting during wave output stop			1	R/W	○

Address (decimal)	Address (hexadecimal)	Name	Default*1	Read/Write *2	Item enabled by turning on and off Operating condition setting request (Y9)
3012 to 3017	BC4H to BC9H	System area	—	—	—
3018	BCAH	CH3 Output value during wave output stop	0	R/W	○
3019	BCBH	CH4 Output value during wave output stop	0	R/W	○
3020 to 3027	BCCH to BD3H	System area	—	—	—
3028	BD4H	CH3 Wave pattern start address setting (L)	5000	R/W	○
3029	BD5H	CH3 Wave pattern start address setting (H)			
3030	BD6H	CH4 Wave pattern start address setting (L)	5000	R/W	○
3031	BD7H	CH4 Wave pattern start address setting (H)			
3032 to 3043	BD8H to BE3H	System area	—	—	—
3044	BE4H	CH3 Wave pattern data points setting (L)	0	R/W	○
3045	BE5H	CH3 Wave pattern data points setting (H)			
3046	BE6H	CH4 Wave pattern data points setting (L)	0	R/W	○
3047	BE7H	CH4 Wave pattern data points setting (H)			
3048 to 3057	BE8H to BF1H	System area	—	—	—
3058	BF2H	CH3 Wave pattern output repetition setting	1	R/W	○
3059	BF3H	CH4 Wave pattern output repetition setting	1	R/W	○
3060 to 3065	BF4H to BF9H	System area	—	—	—
3066	BFAH	CH3 Constant for wave output conversion cycle	1	R/W	○
3067	BFBH	CH4 Constant for wave output conversion cycle	1	R/W	○
3068 to 3071	BFCH to BFFH	System area	—	—	—
3072	C00H	Step action wave output request	0	R/W	—
3073 to 3081	C01H to C09H	System area	—	—	—
3082	C0AH	CH3 Wave output step action movement amount	0	R/W	—
3083	C0BH	CH4 Wave output step action movement amount	0	R/W	—
3084 to 3101	C0CH to C1DH	System area	—	—	—
3102	C1EH	CH3 Wave output status monitor	0	R	—
3103	C1FH	CH4 Wave output status monitor	0	R	—
3104 to 3111	C20H to C27H	System area	—	—	—
3112	C28H	CH3 Wave output conversion cycle monitor (L)	0	R	—
3113	C29H	CH3 Wave output conversion cycle monitor (H)			
3114	C2AH	CH4 Wave output conversion cycle monitor (L)	0	R	—
3115	C2BH	CH4 Wave output conversion cycle monitor (H)			
3116 to 3125	C2CH to C35H	System area	—	—	—
3126	C36H	CH3 Wave pattern output count monitor	0	R	—
3127	C37H	CH4 Wave pattern output count monitor	0	R	—
3128 to 3135	C38H to C3FH	System area	—	—	—
3136	C40H	CH3 Wave output current address monitor (L)	0	R	—
3137	C41H	CH3 Wave output current address monitor (H)			
3138	C42H	CH4 Wave output current address monitor (L)	0	R	—
3139	C43H	CH4 Wave output current address monitor (H)			
3140 to 3149	C44H to C4DH	System area	—	—	—
3150	C4EH	CH3 Wave output current digital value monitor	0	R	—

Address (decimal)	Address (hexadecimal)	Name	Default[*1]	Read/Write [*2]	Item enabled by turning on and off Operating condition setting request (Y9)
3151	C4FH	CH4 Wave output current digital value monitor	0	R	—
3152 to 3159	C50H to C57H	System area	—	—	—
3160	C58H	CH3 Wave output digital value outside the range Address monitor (L)	0	R	—
3161	C59H	CH3 Wave output digital value outside the range Address monitor (H)			
3162	C5AH	CH4 Wave output digital value outside the range Address monitor (L)	0	R	—
3163	C5BH	CH4 Wave output digital value outside the range Address monitor (H)			
3164 to 3175	C5CH to C67H	System area	—	—	—
3176	C68H	CH3 Wave output warning Address monitor (L)	0	R	—
3177	C69H	CH3 Wave output warning Address monitor (H)			
3178	C6AH	CH4 Wave output warning Address monitor (L)	0	R	—
3179	C6BH	CH4 Wave output warning Address monitor (H)			
3180 to 3999	C6CH to F9FH	System area	—	—	—
4000	FA0H	Arithmetic expression1 Variable arithmetic value (L)	0	R	—
4001	FA1H	Arithmetic expression1 Variable arithmetic value (H)	0	R	—
4002	FA2H	Arithmetic expression1 Variable arithmetic decimal point monitor	0	R	—
4003	FA3H	Arithmetic expression1 Variable arithmetic value for analog output	0	R	—
4004	FA4H	Arithmetic expression2 Variable arithmetic value (L)	0	R	—
4005	FA5H	Arithmetic expression2 Variable arithmetic value (H)	0	R	—
4006	FA6H	Arithmetic expression2 Variable arithmetic decimal point monitor	0	R	—
4007	FA7H	Arithmetic expression2 Variable arithmetic value for analog output	0	R	—
4008 to 4097	FA8H to 1001H	System area	—	—	—
4098	1002H	Arithmetic expression data write setting	0	R/W	—
4099	1003H		0	R/W	—
4100	1004H	Variable conversion characteristics table selection	0	R/W	○
4101	1005H	Variable conversion characteristics range setting	0	R/W	○
4102 to 4109	1006H to 100DH	System area	—	—	—
4110	100EH	Route1 Variable conversion characteristics conversion value monitor	0	R	—
4111	100FH	Route1 Variable conversion characteristics digital value monitor	0	R	—
4112	1010H	Route1 Variable conversion characteristics digital value outside the range address monitor (L)	0	R	—
4113	1011H	Route1 Variable conversion characteristics digital value outside the range address monitor (H)	0	R	—
4114	1012H	Route1 Variable conversion characteristics warning address monitor (L)	0	R	—
4115	1013H	Route1 Variable conversion characteristics warning address monitor (H)	0	R	—
4116 to 4119	1014H to 1017H	System area	—	—	—

Address (decimal)	Address (hexadecimal)	Name	Default[*1]	Read/Write [*2]	Item enabled by turning on and off Operating condition setting request (Y9)
4120	1018H	Route2 Variable conversion characteristics conversion value monitor	0	R	—
4121	1019H	Route2 Variable conversion characteristics digital value monitor	0	R	—
4122	101AH	Route2 Variable conversion characteristics digital value outside the range address monitor (L)	0	R	—
4123	101BH	Route2 Variable conversion characteristics digital value outside the range address monitor (H)	0	R	—
4124	101CH	Route2 Variable conversion characteristics warning address monitor (L)	0	R	—
4125	101DH	Route2 Variable conversion characteristics warning address monitor (H)	0	R	—
4126 to 4299	101EH to 10CBH	System area	—	—	—
4300	10CCH	Loop1 Control mode monitor	0	R	—
4301	10CDH	Loop1 Manipulated value (MV)	0	R	—
4302	10CEH	Loop1 Output conversion value	0	R	—
4303	10CFH	Loop1 Auto-tuning status	0	R	—
4304 to 4319	10D0H to 10DFH	System area	—	—	—
4320	10E0H	Loop1 Control mode switching	0	R/W	—
4321	10E1H	Loop1 Control cycle setting	10	R/W	○
4322	10E2H	Loop1 Set value (SV) setting	0	R/W	—
4323	10E3H	Loop1 Proportional gain (P) setting	100	R/W	—
4324, 4325	10E4H, 10E5H	Loop1 Integral time (I) setting	1000	R/W	—
4326	10E6H	Loop1 Derivative time (D) setting	0	R/W	—
4327	10E7H	Loop1 Gap width setting	0	R/W	○
4328	10E8H	Loop1 Gap gain setting	100	R/W	○
4329	10E9H	Loop1 Two-degree-of-freedom parameter alpha setting	0	R/W	○
4330	10EAH	Loop1 Two-degree-of-freedom parameter beta setting	100	R/W	○
4331	10EBH	Loop1 Derivative gain setting	800	R/W	○
4332	10ECH	Loop1 Variable speed integral judgment value A setting	0	R/W	○
4333	10EDH	Loop1 Variable speed integral judgment value B setting	10500	R/W	○
4334	10EEH	Loop1 Forward/reverse action setting	0	R/W	○
4335	10EFH	Loop1 Filter coefficient	0	R/W	○
4336	10F0H	Loop1 Upper limit output limiter setting	10000	R/W	○
4337	10F1H	Loop1 Lower limit output limiter setting	0	R/W	○
4338	10F2H	Loop1 Output variation limiter setting	0	R/W	○
4339	10F3H	Loop1 MAN output setting	0	R/W	—
4340	10F4H	Loop1 Output shifting amount to conversion value	0	R/W	—
4341	10F5H	Loop1 PID continuation flag on HOLD	0	R/W	○
4342 to 4359	10F6H to 1107H	System area	—	—	—
4360	1108H	Loop1 Auto-tuning execution command	0	R/W	—
4361	1109H	Loop1 Auto-tuning timeout time	100	R/W	○
4362	110AH	Loop1 Auto-tuning hysteresis	100	R/W	○
4363	110BH	Loop1 Auto-tuning output upper limit value	10000	R/W	○
4364	110CH	Loop1 Auto-tuning output lower limit value	0	R/W	○
4365	110DH	Loop1 Auto-tuning control type setting	0	R/W	○
4366 to 4379	110EH to 111BH	System area	—	—	—
4380	111CH	Loop2 Control mode monitor	0	R	—

Address (decimal)	Address (hexadecimal)	Name	Default[*1]	Read/Write [*2]	Item enabled by turning on and off Operating condition setting request (Y9)
4381	111DH	Loop2 Manipulated value (MV)	0	R	—
4382	111EH	Loop2 Output conversion value	0	R	—
4383	111FH	Loop2 Auto-tuning status	0	R	—
4384 to 4399	1120H to 112FH	System area	—	—	—
4400	1130H	Loop2 Control mode switching	0	R/W	—
4401	1131H	Loop2 Control cycle setting	10	R/W	○
4402	1132H	Loop2 Set value (SV) setting	0	R/W	—
4403	1133H	Loop2 Proportional gain (P) setting	100	R/W	—
4404, 4405	1134H, 1135H	Loop2 Integral time (I) setting	1000	R/W	—
4406	1136H	Loop2 Derivative time (D) setting	0	R/W	—
4407	1137H	Loop2 Gap width setting	0	R/W	○
4408	1138H	Loop2 Gap gain setting	100	R/W	○
4409	1139H	Loop2 Two-degree-of-freedom parameter alpha setting	0	R/W	○
4410	113AH	Loop2 Two-degree-of-freedom parameter beta setting	100	R/W	○
4411	113BH	Loop2 Derivative gain setting	800	R/W	○
4412	113CH	Loop2 Variable speed integral judgment value A setting	0	R/W	○
4413	113DH	Loop2 Variable speed integral judgment value B setting	10500	R/W	○
4414	113EH	Loop2 Forward/reverse action setting	0	R/W	○
4415	113FH	Loop2 Filter coefficient	0	R/W	○
4416	1140H	Loop2 Upper limit output limiter setting	10000	R/W	○
4417	1141H	Loop2 Lower limit output limiter setting	0	R/W	○
4418	1142H	Loop2 Output variation limiter setting	0	R/W	○
4419	1143H	Loop2 MAN output setting	0	R/W	—
4420	1144H	Loop2 Output shifting amount to conversion value	0	R/W	—
4421	1145H	Loop2 PID continuation flag on HOLD	0	R/W	○
4422 to 4439	1146H to 1157H	System area	—	—	—
4440	1158H	Loop2 Auto-tuning execution command	0	R/W	—
4441	1159H	Loop2 Auto-tuning timeout time	100	R/W	○
4442	115AH	Loop2 Auto-tuning hysteresis	100	R/W	○
4443	115BH	Loop2 Auto-tuning output upper limit value	10000	R/W	○
4444	115CH	Loop2 Auto-tuning output lower limit value	0	R/W	○
4445	115DH	Loop2 Auto-tuning control type setting	0	R/W	○
4446 to 4459	115EH to 116BH	System area	—	—	—
4460	116CH	PID operation expression selection monitor	0	R	—
4461 to 4699	116DH to 125BH	System area	—	—	—
4700	125CH	CH1 A/D conversion status	0	R	—
4701	125DH	CH2 A/D conversion status	0	R	—
4702 to 4709	125EH to 1265H	System area	—	—	—
4710	1266H	CH1 Analog input monitor	0	R	—
4711	1267H	CH1 Analog input monitor unit	0	R	—
4712	1268H	CH2 Analog input monitor	0	R	—
4713	1269H	CH2 Analog input monitor unit	0	R	—
4714 to 4749	126AH to 128DH	System area	—	—	—
4750	128EH	CH3 D/A conversion status	0	R	—
4751	128FH	CH4 D/A conversion status	0	R	—

Address (decimal)	Address (hexadecimal)	Name	Default*1	Read/Write *2	Item enabled by turning on and off Operating condition setting request (Y9)
4752 to 4759	1290H to 1297H	System area	—	—	—
4760	1298H	CH3 Analog output command value	0	R	—
4761	1299H	CH3 Analog output command value unit	0	R	—
4762	129AH	CH4 Analog output command value	0	R	—
4763	129BH	CH4 Analog output command value unit	0	R	—
4764 to 4799	129CH to 12BFH	System area	—	—	—

*1 The default value is a value to be set after power-on or after resetting the CPU module.

*2 This shows whether reading the data from or writing the data to the area with programs is possible.
R: Readable
W: Writable

(2) Error history (Un\G4800 to Un\G4999)

Address (decimal)	Address (hexadecimal)	Name				Default*1	Read/Write *2	Item enabled by turning on and off Operating condition setting request (Y9)
4800	12C0H	Latest address of error history				0	R	—
4801 to 4809	12C1H to 12C9H	System area				—	—	—
4810	12CAH	No.1	Error code			0	R	—
4811	12CBH		Error time	First two digits of the year	Last two digits of the year	0	R	
4812	12CCH			Month	Day	0	R	
4813	12CDH			Hour	Minute	0	R	
4814	12CEH			Second	Day of the week	0	R	
4815 to 4819	12CFH to 12D3H		System area			—	—	
4820 to 4829	12D4H to 12DDH	No.2	Same as No. 1					—
4830 to 4839	12DEH to 12E7H	No.3	Same as No. 1					—
4840 to 4849	12E8H to 12F1H	No.4	Same as No. 1					—
4850 to 4859	12F2H to 12FBH	No.5	Same as No. 1					—
4860 to 4869	12FCH to 1305H	No.6	Same as No. 1					—
4870 to 4879	1306H to 130FH	No.7	Same as No. 1					—
4880 to 4889	1310H to 1319H	No.8	Same as No. 1					—
4890 to 4899	131AH to 1323H	No.9	Same as No. 1					—
4900 to 4909	1324H to 132DH	No.10	Same as No. 1					—
4910 to 4919	132EH to 1337H	No.11	Same as No. 1					—
4920 to 4929	1338H to 1341H	No.12	Same as No. 1					—
4930 to 4939	1342H to 134BH	No.13	Same as No. 1					—
4940 to 4949	134CH to 1355H	No.14	Same as No. 1					—
4950 to 4959	1356H to 135FH	No.15	Same as No. 1					—
4960 to 4969	1360H to 1369H	No.16	Same as No. 1					—
4970 to 4999	136AH to 1387H	System area				—	—	—

*1 The default value is a value to be set after power-on or after resetting the CPU module.

*2 This shows whether reading the data from or writing the data to the area with programs is possible.
R: Readable
W: Writable

(3) Un\G5000 to Un\G54999

The following each table shows the assignment of the buffer memory addresses Un\G5000 to Un\G54999 separately for the use of the logging function, wave output function, variable arithmetic function, or variable conversion characteristics function. Because these functions cannot be used together, arrange read and write operations according to the function in use. Note that when the variable conversion characteristics function + variable arithmetic function is used, the combination of the following (c) and (d) is used.

(a) When the logging function is used

Address (decimal)	Address (hexadecimal)	Name	Default*1	Read/Write *2	Item enabled by turning on and off Operating condition setting request (Y9)
5000 to 14999	1388H to 3A97H	CH1 Logging data	0	R	—
15000 to 24999	3A98H to 61A7H	CH2 Logging data	0	R	—
25000 to 54999	61A8H to D6D7H	System area	—	—	—

*1 The default value is a value to be set after power-on or after resetting the CPU module.
*2 This shows whether reading the data from or writing the data to the area with programs is possible.
R: Readable
W: Writable

(b) When the wave output function is used

Address (decimal)	Address (hexadecimal)	Name	Default*1	Read/Write *2	Item enabled by turning on and off Operating condition setting request (Y9)
5000 to 54999	1388H to D6D7H	Wave data registry area	0	R/W	—

*1 The default value is a value to be set after power-on or after resetting the CPU module.
*2 This shows whether reading the data from or writing the data to the area with programs is possible.
R: Readable
W: Writable

(c) When the variable arithmetic function is used

Address (decimal)	Address (hexadecimal)	Name	Default*1	Read/Write*2	Item enabled by turning on and off Operating condition setting request (Y9)
5000 to 54999	1388H to D6D7H	System area	—	—	—

*1 The default value is a value to be set after power-on or after resetting the CPU module.
*2 This shows whether reading the data from or writing the data to the area with programs is possible.
R: Readable
W: Writable

(d) When the variable conversion characteristics function is used

Address (decimal)	Address (hexadecimal)	Name	Default*1	Read/Write*2	Item enabled by turning on and off Operating condition setting request (Y9)
5000 to 37000	1388H to 9088H	Conversion characteristics table	0	R/W	—
37001 to 54999	9089H to D6D7H	System area	—	—	—

*1 The default value is a value to be set after power-on or after resetting the CPU module.
*2 This shows whether reading the data from or writing the data to the area with programs is possible.
R: Readable
W: Writable

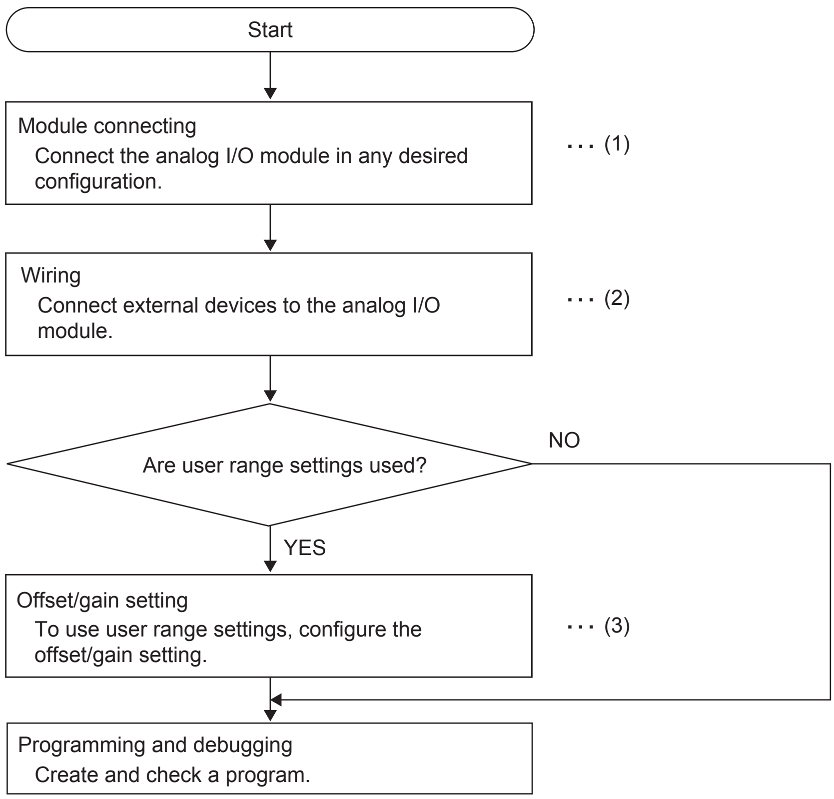
(4) Un\G55000 to Un\G61439

Address (decimal)	Address (hexadecimal)	Name	Default*1	Read/Write*2	Item enabled by turning on and off Operating condition setting request (Y9)
55000 to 61439	D6D8H to EFFFH	System area		—	—

*1 The default value is a value to be set after power-on or after resetting the CPU module.
*2 This shows whether reading the data from or writing the data to the area with programs is possible.
R: Readable
W: Writable

CHAPTER 4 PROCEDURES BEFORE OPERATION

This chapter describes the procedures before operation.



(1) ☞ Page 46, Section 5.1
(2) ☞ Page 52, Section 6.4
(3) ☞ Page 61, Section 7.5

Memo

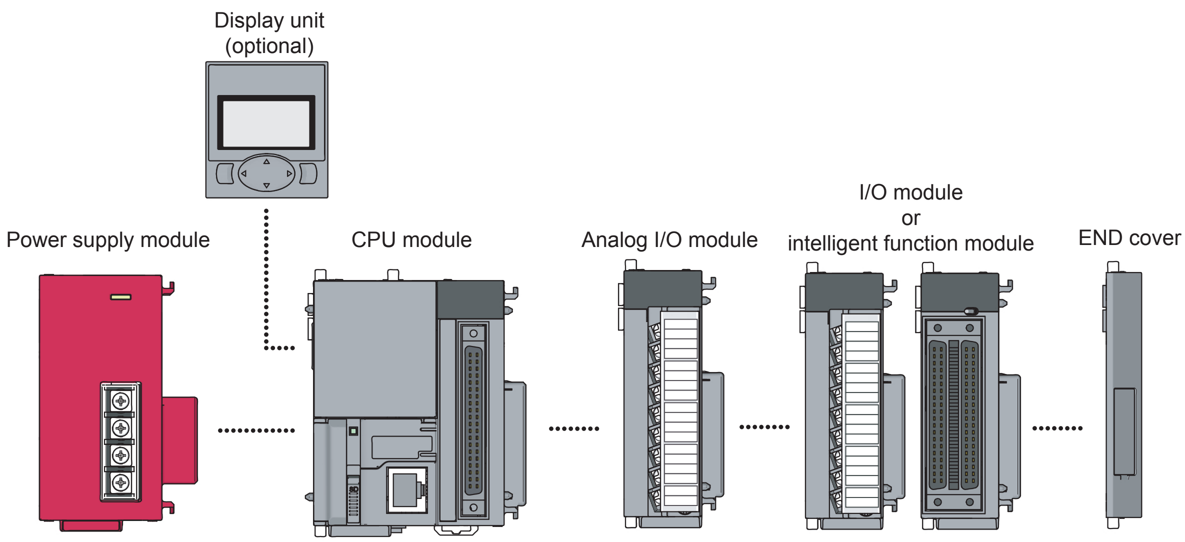
CHAPTER 5 SYSTEM CONFIGURATION

This chapter describes the overall configuration, number of connectable modules, and compatible software version of the analog I/O module.

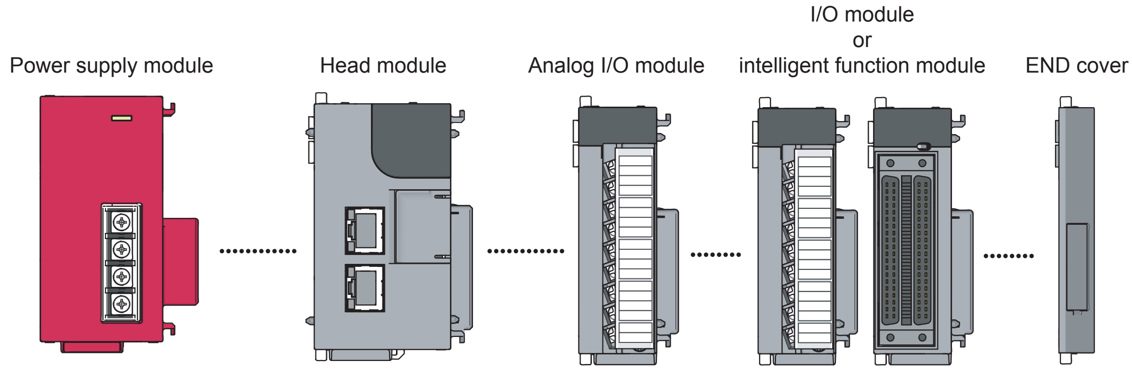
5.1 Overall System Configuration

The following figure shows system configuration examples for using the analog I/O module.

(1) When connected to a CPU module



(2) When connected to a head module



5.2 Applicable System

(1) Number of connectable modules

For the number of connectable modules, refer to the following.

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

MELSEC-L CC-Link IE Field Network Head Module User's Manual

(2) Compatible software version

For the compatible software versions, refer to the following.

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

MELSEC-L CC-Link IE Field Network Head Module User's Manual

5.3 Restrictions When the Analog I/O Module Is Connected to a Head Module

The following describes the restrictions when the analog I/O module is connected to a head module.

- Dedicated instructions cannot be used.
- Some restrictions are provided to use the wave output function. For the restrictions of the wave output function, refer to Page 146, Section 8.18 (3) (d).
- Some restrictions are provided to use the variable arithmetic function. For the restrictions of the variable arithmetic function, refer to Page 195, Section 8.19 (2) (f).
- Some restrictions are provided to use the variable conversion characteristics function. For the restrictions of the variable conversion characteristics function, refer to Page 214, Section 8.20 (2) (d).

CHAPTER 6 INSTALLATION AND WIRING

This chapter describes the installation and wiring of the analog I/O module.

6.1 Installation Environment and Installation Position

For precautions for the installation environment and installation position, refer to the following.

📖 MELSEC-L CPU Module User's Manual (Hardware Design, Maintenance and Inspection)
📖 MELSEC-L CC-Link IE Field Network Head Module User's Manual

6.2 Terminal Block

(1) Precautions

Tighten the terminal block screws within the following specified torque range.

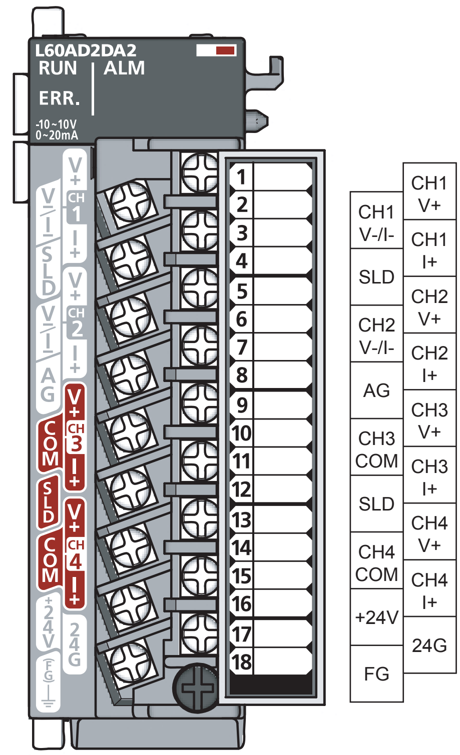
Screw type	Tightening torque range
Terminal screw (M3 screw)	0.42 to 0.58N·m
Terminal block mounting screw (M3.5 screw)	0.66 to 0.89N·m

The following table lists applicable solderless terminals connected to the terminal block. When wiring, use applicable wires and an appropriate tightening torque. Use UL-approved solderless terminals and, for processing, use a tool recommended by their manufacturer. Sleeved solderless terminals cannot be used.

Solderless terminal		Wire			
Model	Tightening torque	Diameter	Type	Material	Temperature rating
R1.25-3	0.42 to 0.58N·m	22 to 18 AWG	Stranded	Copper	75℃ or greater

(2) Signal names of the terminal block

The following table shows signal names of the terminal block.



Terminal Block	Pin number	Signal name		Remarks
	1	CH1	V+	Analog input
	2	CH1	V-/I-	Analog input
	3	CH1	I+	Analog input
	4	SLD		Analog input
	5	CH2	V+	Analog input
	6	CH2	V-/I-	Analog input
	7	CH2	I+	Analog input
	8	AG		Analog input
	9	CH3	V+	Analog output
	10	CH3	COM	Analog output
	11	CH3	I+	Analog output
	12	SLD		Analog output
	13	CH4	V+	Analog output
	14	CH4	COM	Analog output
	15	CH4	I+	Analog output
	16	+24V		—
	17	24G		—
	18	FG		—

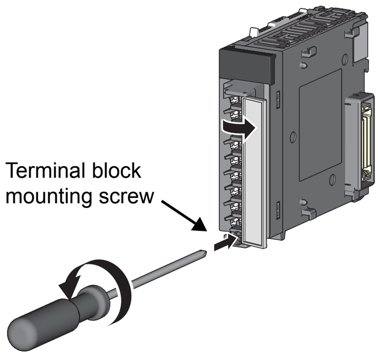
6

6.2 Terminal Block

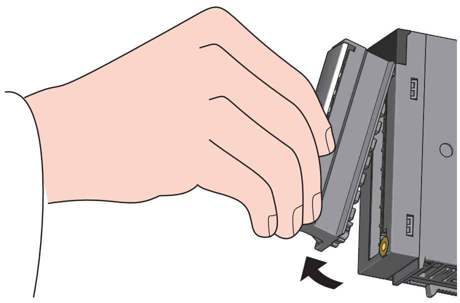
(3) Removal and installation of the terminal block

The following procedures show how to remove and install the terminal block.

(a) Removal procedure

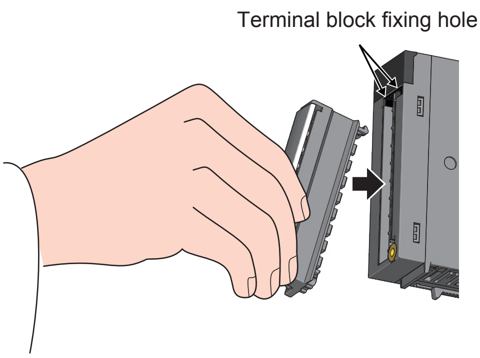


1. **Open the terminal cover and loosen the terminal block mounting screw.**

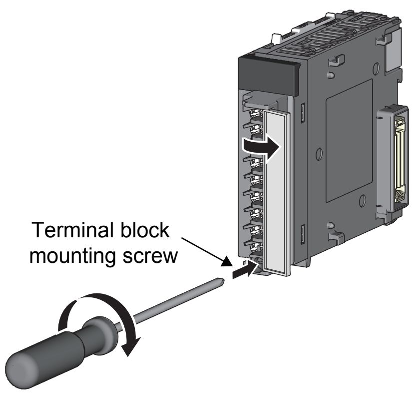


2. **Use the terminal block fixing holes as a fulcrum and remove the terminal block.**

(b) Installation procedure



1. **Fully insert the projections on the top of the terminal block into the terminal block fixing holes and press the terminal block until it snaps into place.**

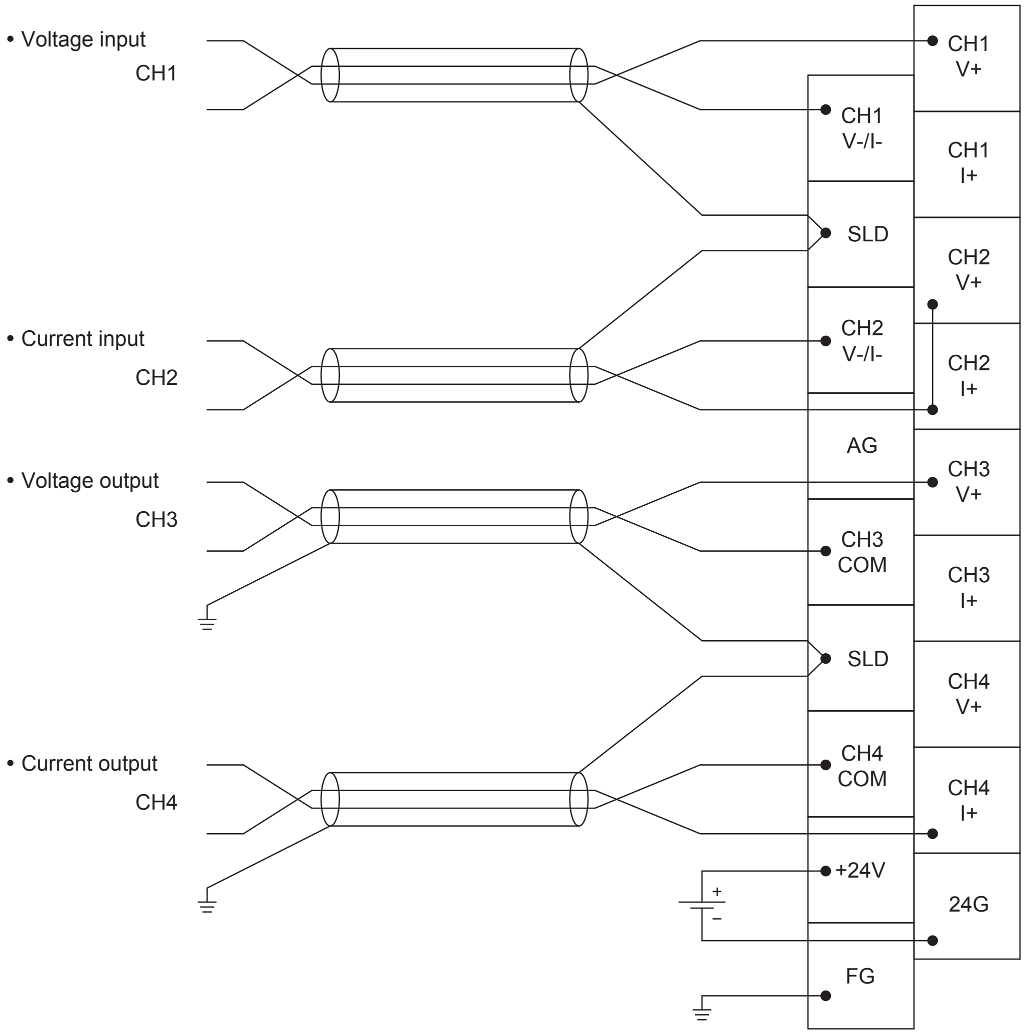


2. **Open the terminal cover and tighten the terminal block mounting screw.**

6.3 Wiring

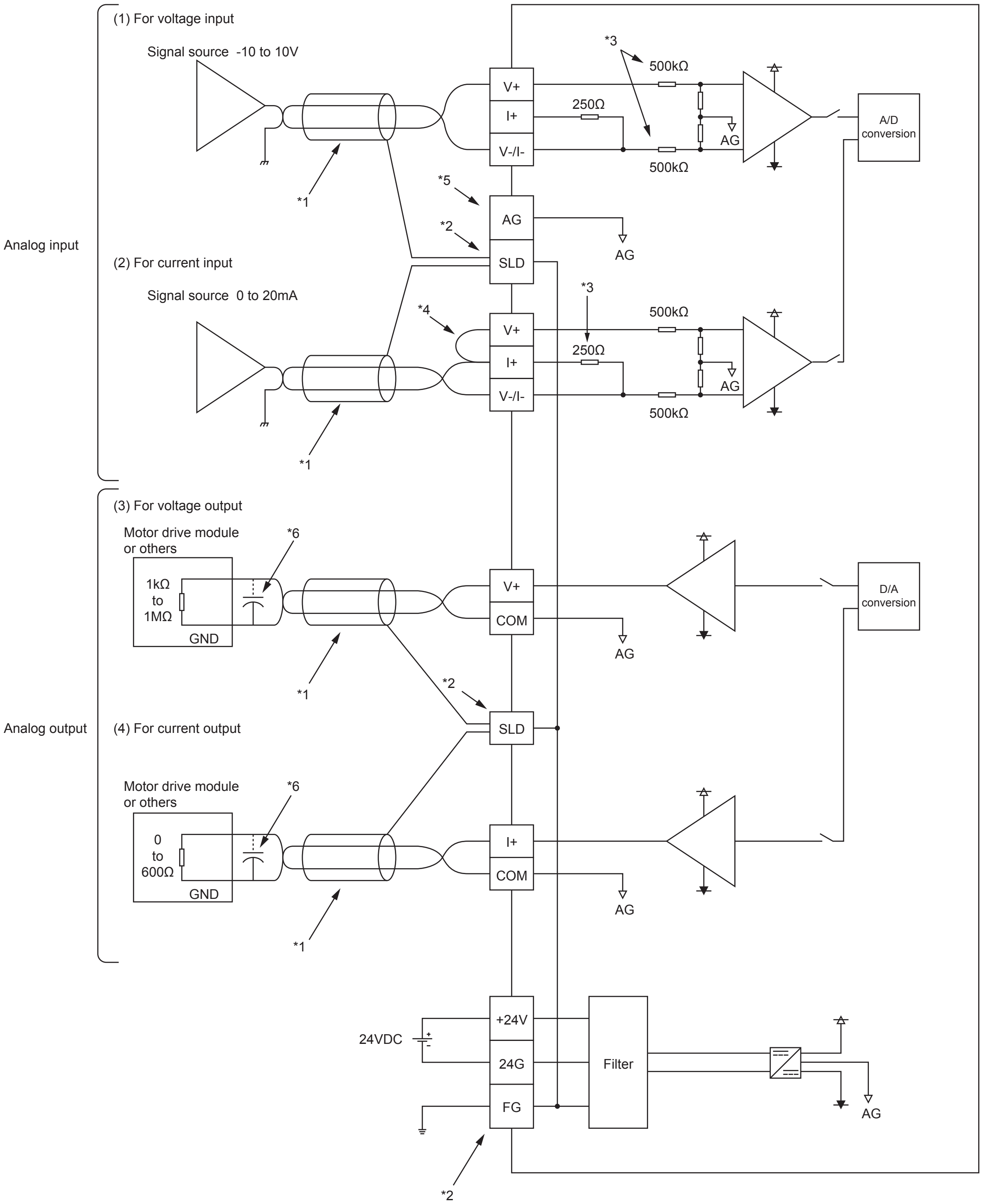
(1) Wiring to a terminal block

The following figures show wirings to a terminal block.



6.4 External Wiring

The following figures show the external wiring.



*1 For the wire, use the shielded twisted pair cable.

*2 Always connect the shielded cable for each channel to the shield terminal and ground the FG terminal.
In addition, ground the FG terminal of the power supply module.
One shield terminal is used for each analog input and analog output.
Connect the shielded cable of the analog input (CH1, CH2) to the SLD terminal with the pin number 4 and the shielded cable of the analog output (CH3, CH4) to the SLD terminal with the pin number 12.

*3 This indicates the input resistance of the analog I/O module.

*4 For the current input, always connect the terminals (V+) and (I+).

*5 In either of the following cases, connect the AG terminal and the GND of the external device.

- When the potential difference is found between the AG terminal and the GND of the external device
- When the GNDs of the external device which are connected to each channel are common

For details, refer to ☞ Page 332, Section 11.6.2 (1) (d).
If the AG terminal is connected to the GND of the external device, some errors may be observed on the I/O conversion characteristic.
When some errors are observed on the I/O conversion characteristic, adjust the I/O conversion characteristic with the offset/gain setting.

*6 If noise or ripple occurs for analog signals, connect a capacitor with the value of 0.1 to 0.47μF (withstand voltage 25V or higher) to the input terminal of an external device.

Point

- The analog I/O module cannot perform the A/D conversion or D/A conversion unless the external power supply 24VDC is input. Always wire the external power supply 24VDC.
- If the circuit between the terminals of unused channels is kept open and the A/D conversion is enabled, an undefined digital value may be output. To prevent this phenomenon, perform any of the following measures.
  - Set the value in A/D conversion enable/disable setting (Un\G0) in the unused channel to A/D conversion disable (1). Note that changing the value in A/D conversion enable/disable setting (Un\G0) from A/D conversion enable (0) to A/D conversion disable (1) reduces the A/D conversion cycle.
  - Short-circuit the input terminals (V+) and (V-) of the unused channel.

CHAPTER 7 VARIOUS SETTINGS

This chapter describes the setting procedures of the analog I/O module.

Point

- After writing the contents of the new module, parameter settings, and auto refresh settings into the CPU module, reset the CPU module and switch its status as STOP → RUN → STOP → RUN, or turn off and on the power supply to activate the settings.
- After writing the contents of the switch settings to the CPU module, reset the CPU module or turn off and on the power supply to activate the settings.

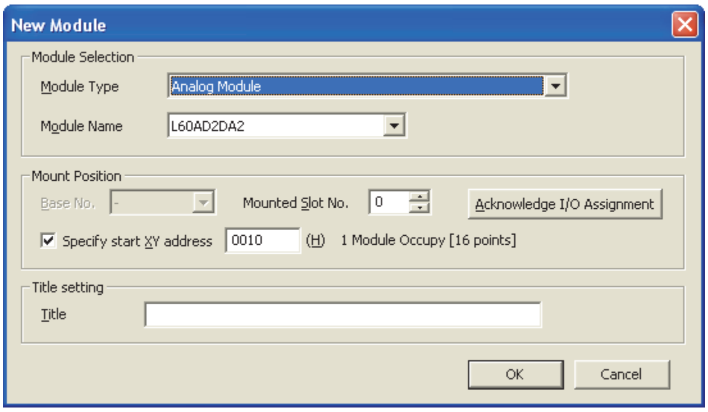
7.1 Addition of Modules

Add the module name of an analog I/O module to use on the project.

(1) Addition procedure

Open the "New Module" window.

Project window ⇨ [Intelligent Function Module] ⇨ right-click
⇨ [New Module]



Item		Description
Module Selection	Module Type	Set "Analog Module".
	Module Name	Select the name of the module to be connected.
Mount Position	Mounted Slot No.	Set the slot No. where the module is connected.
	Specify start XY address	The start I/O number (hexadecimal) of the module is set according to the mounted slot No. Setting any start I/O number is also possible.
Title setting	Title	Set any title.

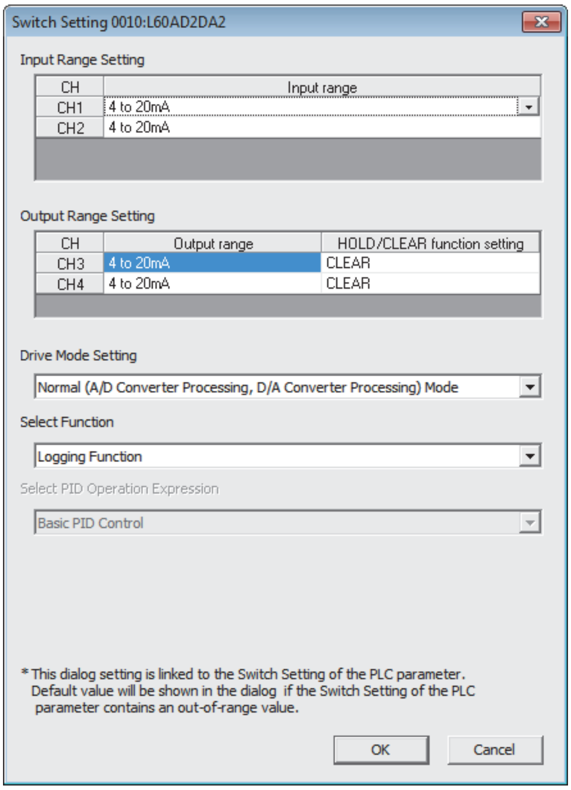
7.2 Switch Setting

Set the I/O ranges, HOLD/CLEAR function setting, select function, select PID operation expression, and drive mode setting used in each channel.

(1) Setting procedure

Open the "Switch Setting" window.

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Switch Setting]



Item		Description	Setting value
Range setting	Input Range Setting (CH1, CH2)	Set the input range used in each channel.	• 4 to 20mA (default value) • 0 to 20mA • 1 to 5V • 0 to 5V • -10 to 10V • 0 to 10V • 4 to 20mA (Extended Mode) • 1 to 5V (Extended Mode) • User Range Setting (Current) • User Range Setting (Voltage)
	Output Range Setting (CH3, CH4)	Set the output range used in each channel.	• 4 to 20mA (default value) • 0 to 20mA • 1 to 5V • 0 to 5V • -10 to 10V • User Range Setting (Current) • User Range Setting (Voltage)
	HOLD/CLEAR function setting*1 (only for CH3 and CH4)	Set whether to hold the output analog value or clear it (0mA/0V output) in each channel when the CPU module enters to the STOP status or when an error occurs.	• CLEAR (default value) • HOLD
Drive Mode Setting		Set the drive mode. Set "Offset/Gain Setting Mode" to configure the offset/gain setting with the user range setting being selected.	• Normal (A/D Converter Processing, D/A Converter Processing) Mode (default value) • Offset/Gain Setting Mode
Select Function		Set the function to be used.	• Logging Function (default value) • Wave Output Function • Free Operation Function • Free Conversion Characteristics Function • Free Conversion Characteristics Function + Free Operation Function • PID Control Function
Select PID Operation Expression		Select an operation expression when the PID control function is used.	• Basic PID Control (default value) • 2 Freedom PID Control • Basic PID Control (Variable Speed Integration) • 2 Freedom PID Control (Variable Speed Integration)

*1 The analog output status varies depending on the setting of "Select Function". For details, refer to the following.
- Analog Output HOLD/CLEAR Function (☞ Page 127, Section 8.14)

(a) Intelligent function module switch setting (Switch 1 to 5)

The items described above also can be set in Switch 1 to 5 of the intelligent function module switch setting of "PLC parameter". The following are the switches to set each item.

- Switch 1: Input range setting, output range setting
- Switch 3: HOLD/CLEAR function setting
- Switch 4: Drive mode setting, function selection, PID operation expression selection

For the setting procedure, refer to the following.

- Intelligent function module switch setting (☞ Page 450, Appendix 9.1 (2))

Though the example of procedure is for GX Developer, same settings and values can be used for GX Works2 as well.

7.3 Parameter Setting

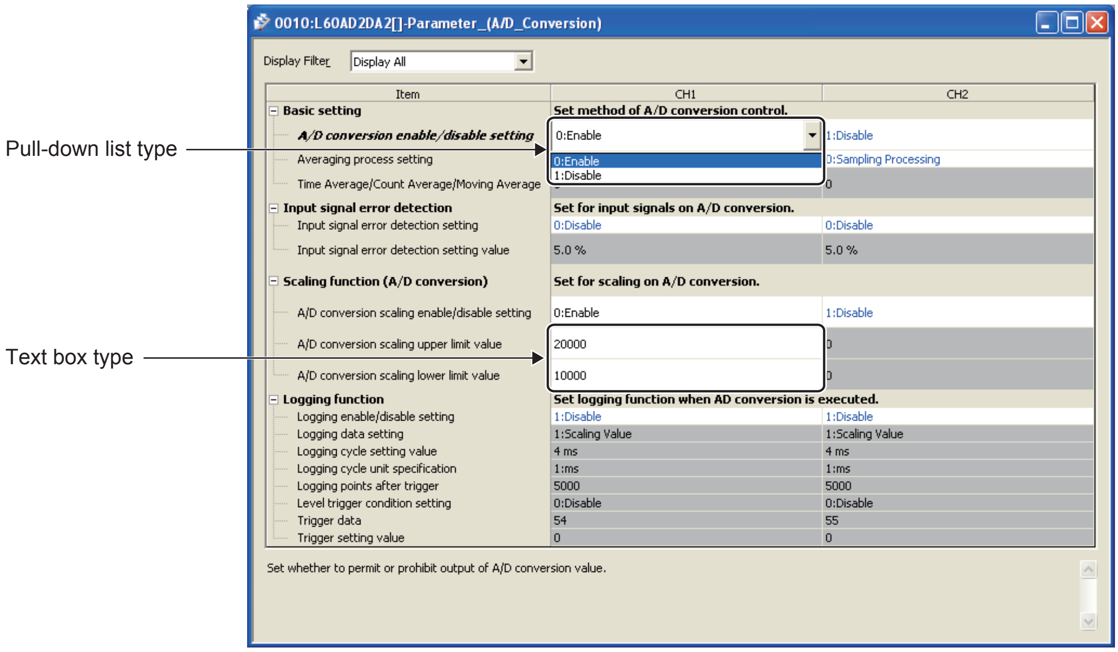
Set the parameters of each channel.
By setting the parameters, the setting by programming becomes unnecessary.

(1) Setting procedure

Open the "Parameter (A/D Conversion)" window or the "Parameter (D/A Conversion)" window.

1. Start "Parameter (A/D Conversion)".

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(A/D_Conversion)]



2. Double-click the item to change the setting, and input the setting value.

- Items to be selected from a pull-down list: Double-click the item to be set and from the pull-down list that appears, select the item.
- Items to be entered via text box: Double-click the item to be set, and enter a numerical value.

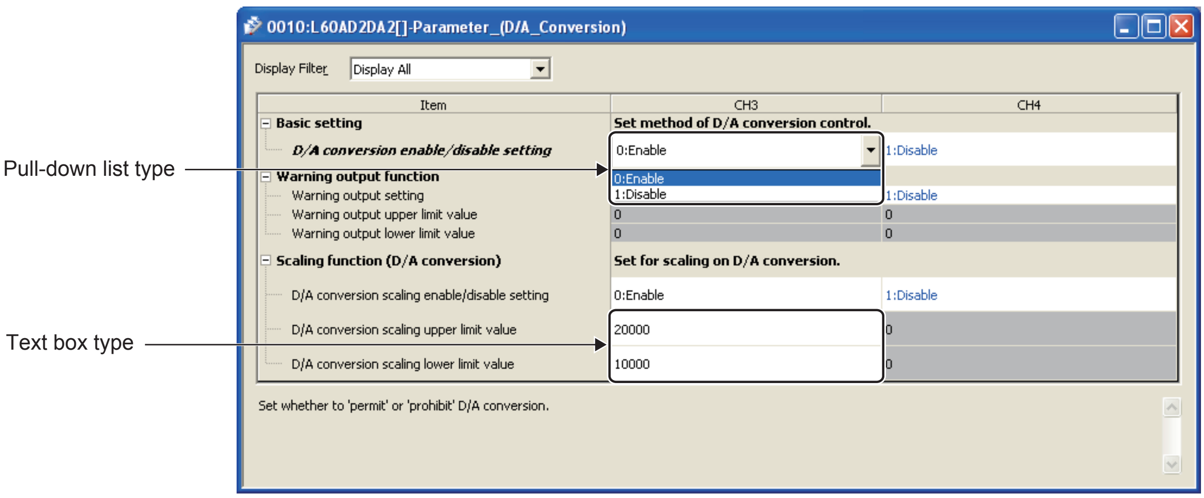
3. For setting CH2, follow the operation of step 2.

<table>
<tr><th colspan="2">Item</th><th colspan="2">Setting value</th><th>Reference</th></tr>
<tr><td rowspan="5">Basic setting</td><td>A/D conversion enable/disable setting</td><td colspan="2">Enable
Disable (default value)</td><td>Page 85, Section 8.4</td></tr>
<tr><td>Averaging process setting</td><td colspan="2">Sampling Processing (default value)
Time Average
Count Average
Moving Average</td><td rowspan="4">Page 86, Section 8.5</td></tr>
<tr><td rowspan="3">Time Average/Count Average/Moving Average</td><td>Time Average</td><td>2 to 5000ms (default value: 0)</td></tr>
<tr><td>Count Average</td><td>4 to 62500 Times (default value: 0)</td></tr>
<tr><td>Moving Average</td><td>2 to 1000 Times (default value: 0)</td></tr>
</table>

Item		Setting value	Reference
Input signal error detection	Input signal error detection setting	Disable (default value) Upper and Lower Detection 2: Lower Detection Upper Detection Disconnection Detection	Page 93, Section 8.8
	Input signal error detection setting value	0 to 25.0% (default value: 5.0%)	
Scaling function (A/D conversion)	A/D conversion scaling enable/disable setting	Enable Disable (default value)	Page 100, Section 8.9
	A/D conversion scaling upper limit value	-32000 to 32000 (default value: 0)	
	A/D conversion scaling lower limit value	-32000 to 32000 (default value: 0)	
Logging function	Logging enable/disable setting	Enable Disable (default value)	Page 106, Section 8.10
	Logging data setting	Digital Output Value Scaling Value (default value)	
	Logging cycle setting value	μs: 80 to 32767 (default value: 4) ms: 1 to 32767 (default value: 4) s: 1 to 3600 (default value: 4)	
	Logging cycle unit specification	0: μs 1: ms (default value) 2: s	
	Logging points after trigger	1 to 10000 (default value: 5000)	
	Level trigger condition setting	Disable (default value) Above Below Pass Through	
	Trigger data	0 to 4999 (CH1 default value: 54, CH2 default value: 55)	
	Trigger setting value	-32768 to 32767 (default value: 0)	

4. **Start "Parameter (D/A Conversion)".**

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(D/A_Conversion)]



5. **Double-click the item to change the setting, and input the setting value.**

- Items to be selected from a pull-down list: Double-click the item to be set and from the pull-down list that appears, select the item.
- Items to be entered via text box: Double-click the item to be set, and enter a numerical value.

6. **For setting CH4, follow the operation of step 2.**

Item		Setting value	Reference
Basic setting	D/A conversion enable/disable setting	Enable Disable (default value)	Page 125, Section 8.12
Warning output function	Warning output setting	Enable Disable (default value)	Page 141, Section 8.17
	Warning output upper limit value	-32768 to 32767 (default value: 0)	
	Warning output lower limit value	-32768 to 32767 (default value: 0)	
Scaling function (D/A conversion)	D/A conversion scaling enable/disable setting	Enable Disable (default value)	Page 134, Section 8.16
	D/A conversion scaling upper limit value	-32000 to 32000 (default value: 0)	
	D/A conversion scaling lower limit value	-32000 to 32000 (default value: 0)	

7.4 Auto Refresh

Set the buffer memory of the analog I/O module to be refreshed automatically.
By the auto refresh setting, reading/writing data by programming becomes unnecessary.

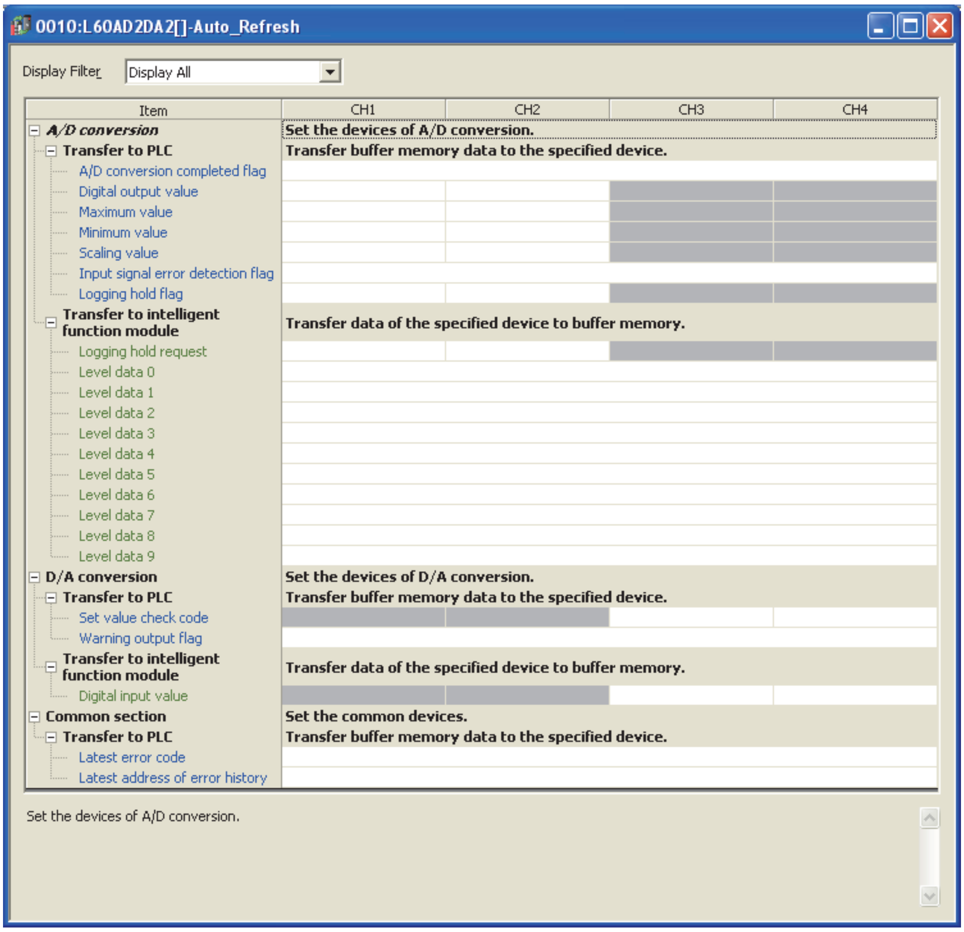
(1) Setting procedure

Open the "Auto_Refresh" window.

1. Start "Auto_Refresh".

Project window ⇨ [Intelligent Function Module] ⇨ module name
⇨ [Auto_Refresh]

2. Click the item to be set, and input the auto refresh target device.



Point

Available devices are X, Y, M, L, B, T, C, ST, D, W, R, and ZR.
When a bit device X, Y, M, L, or B is used, set the number that is divisible by 16 points (example: X10, Y120, M16). Data in the buffer memory are stored in 16 points of devices from the set device No. (Example: When X10 is set, the data are stored in X10 to X1F.)

7.5 Offset/gain Setting

When using the user range setting (voltage) or user range setting (current), configure the offset/gain setting with the following operations.
When the factory default setting is used, the offset/gain setting is not required.
The offset/gain setting can be configured by the following two types of operations.

- Setting from "Offset/Gain Setting" of GX Works2 (☞ Page 61, Section 7.5.1)
- Setting from a program (☞ Page 68, Section 7.5.2)

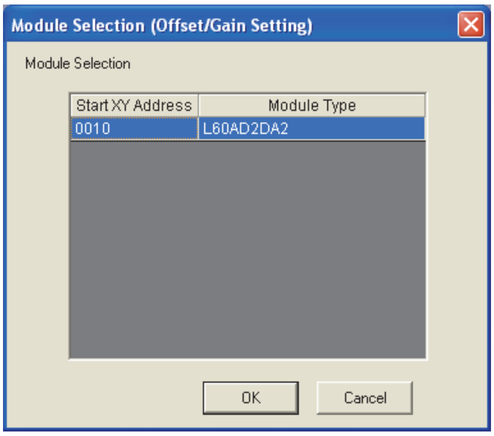
Configure the offset/gain setting in accordance with the actual use situation.

7.5.1 Setting from "Offset/Gain Setting" of GX Works2

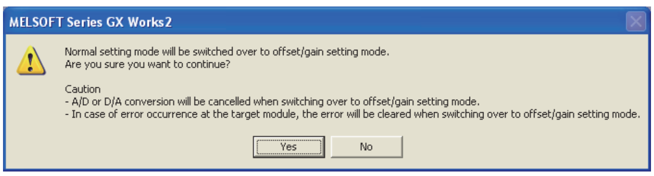
(1) Setting procedure

Open the "Offset/Gain Setting" window. Note that "Offset/Gain Setting" cannot be used if the function other than "Logging Function" is set to "Select Function" in "Switch Setting". Set "Logging Function" to "Select Function" or set "Offset/Gain Setting Mode" to "Drive Mode Setting" before using "Offset/Gain Setting".
In addition, do not turn off the external power supply during the offset/gain setting. If the external power supply is turned off, the offset/gain setting is not configured properly.

[Tool] ⇨ [Intelligent Function Module Tool] ⇨ [Analog Module]
⇨ [Offset/Gain Setting]



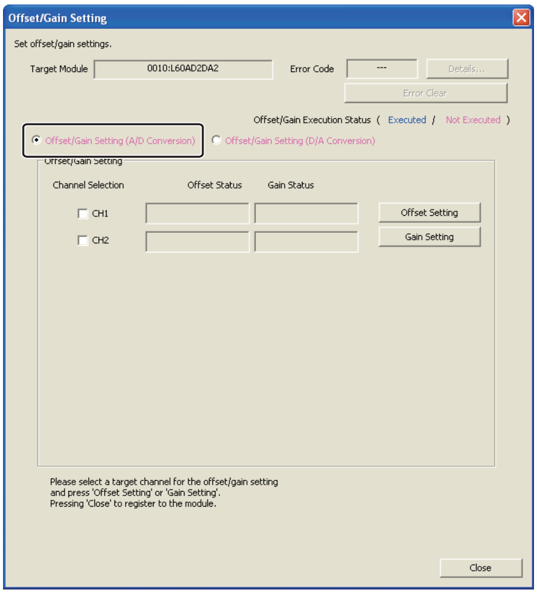
1. **Select the module to configure the offset/gain setting, and click the OK button.**



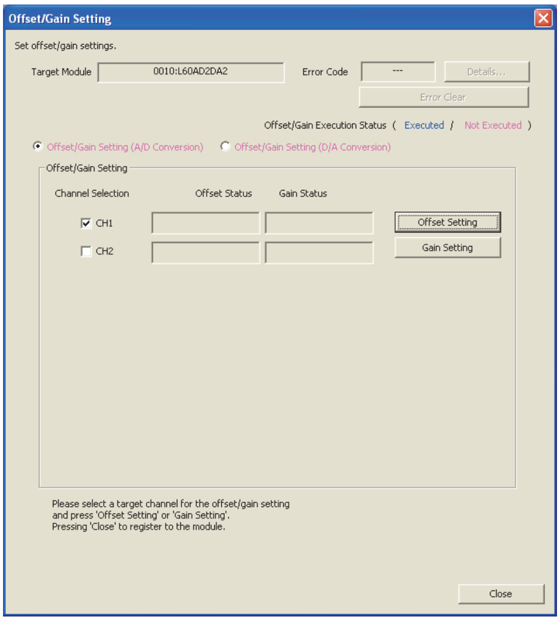
2. **Click the Yes button.**

3. **To configure the offset/gain setting for the A/D conversion channel (CH1, CH2), follow the procedure of ☞ Page 62, Section 7.5.1 (1) (a).**
To configure the offset/gain setting for the D/A conversion channel (CH3, CH4), follow the procedure of ☞ Page 64, Section 7.5.1 (1) (b).

(a) Offset/gain setting for A/D conversion



↓



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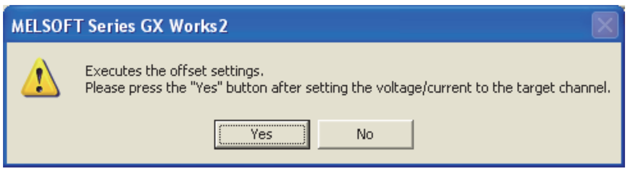
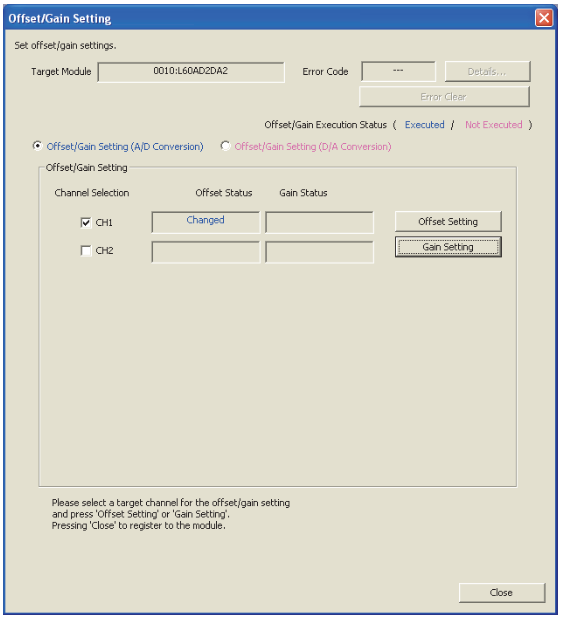


↓

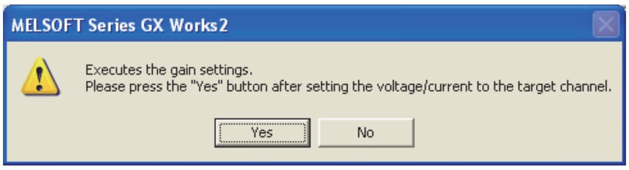
1. Select "Offset/Gain Setting (A/D Conversion)".

2. Select the channel to use the offset/gain setting, and click the Offset Setting button.

3. Input the offset value voltage or current in the target channel terminal, and click the Yes button.



↓



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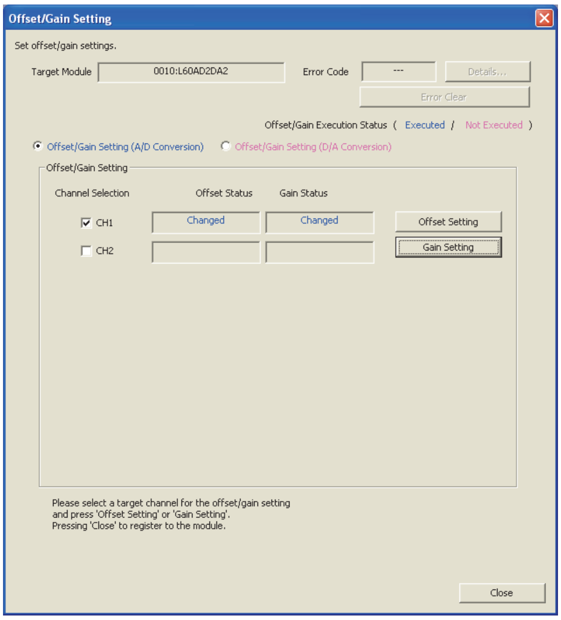


4. Check that "Offset Status" has changed to "Changed".

"Offset/Gain Setting (A/D Conversion)" becomes blue at this point.

5. Click the [Gain Setting] button.

6. Input the gain value voltage or current in the target channel terminal, and click the [Yes] button.

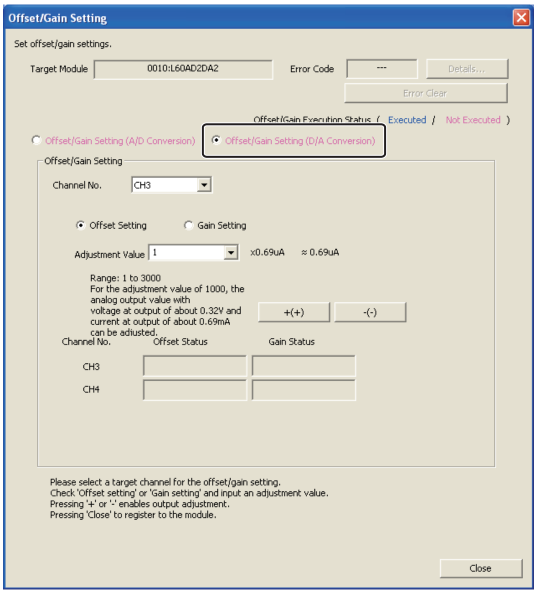
7. Check that "Gain Status" has changed to "Changed".

The offset/gain setting for A/D conversion is completed here.

8. To register the set contents and complete the offset/gain setting, follow the procedure of ☞ Page 67, Section 7.5.1 (1) (c).

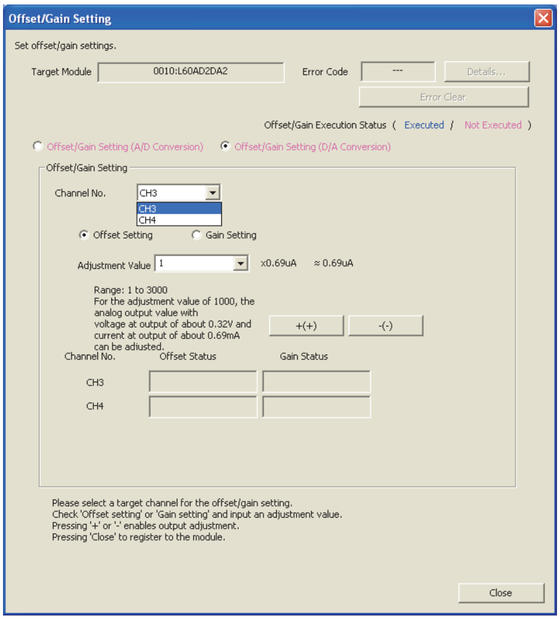
To configure the offset/gain setting for the D/A conversion channel, follow the procedure of ☞ Page 64, Section 7.5.1 (1) (b).

(b) Offset/gain setting for D/A conversion



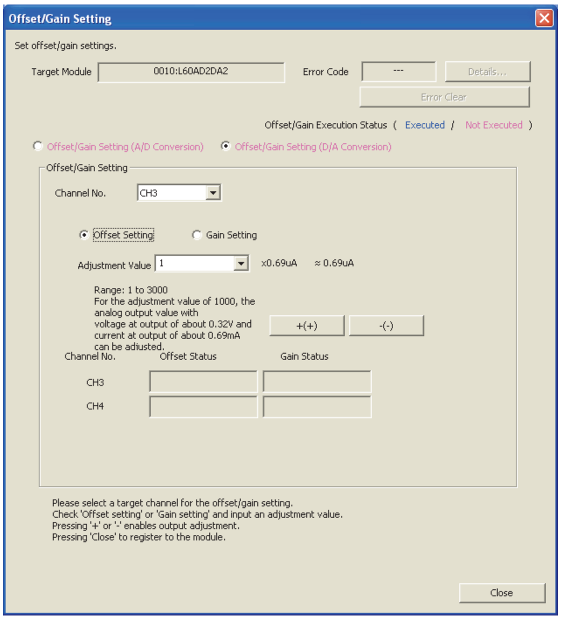
1. Select "Offset/Gain Setting (D/A Conversion)".

↓



2. Select the channel to use the offset/gain setting.

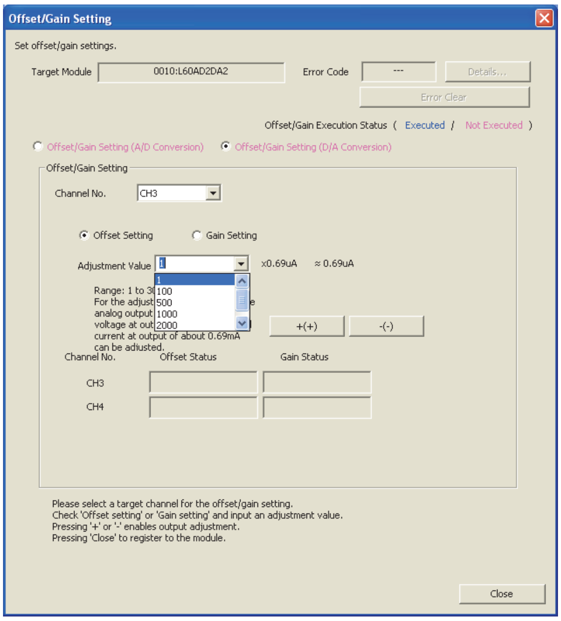
↓



↓

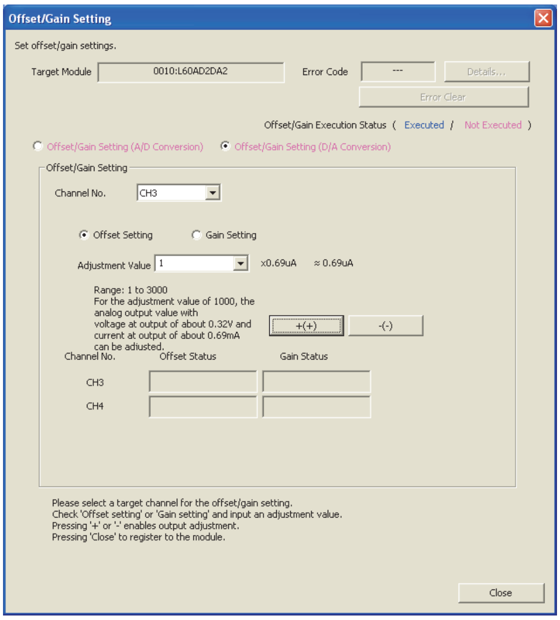
3. **Use the radio button to specify whether to perform the offset setting or gain setting.**

(Step 4 and later describe the case when the offset setting is specified.)



↓

4. **The adjustment amount of the offset value or gain value can be selected from "1", "100", "500", "1000", "2000", and "3000" or it can be set by inputting any value (1 to 3000).**



5. Clicking the +(+) or -(-) button fine-tunes the analog output voltage or analog output current value corresponding the set adjustment value.

6. Check that the offset status in the selected channel has changed to "Changed".

"Offset/Gain Setting (D/A Conversion)" becomes blue at this point.

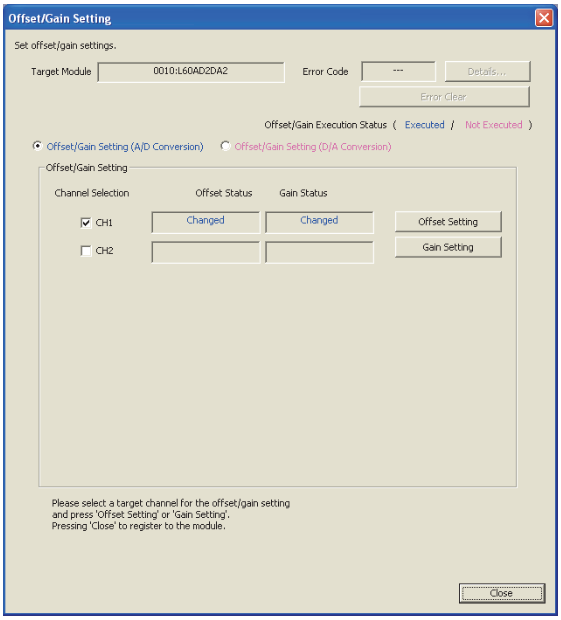
7. To perform the gain setting, repeat the procedure from step 3.

The offset/gain setting for D/A conversion is completed here.

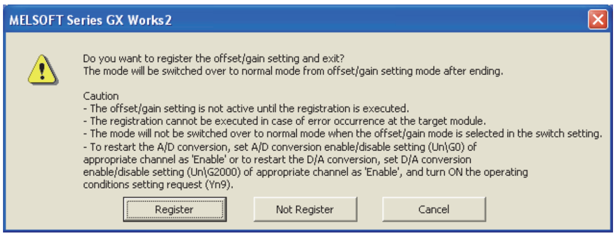
8. To register the set contents and complete the offset/gain setting, follow the procedure of ☞ Page 67, Section 7.5.1 (1) (c).

To configure the offset/gain setting for the A/D conversion channel, follow the procedure of ☞ Page 62, Section 7.5.1 (1) (a).

(c) Completion of the offset/gain setting



↓



↓

End

1. **Click the Close button.**

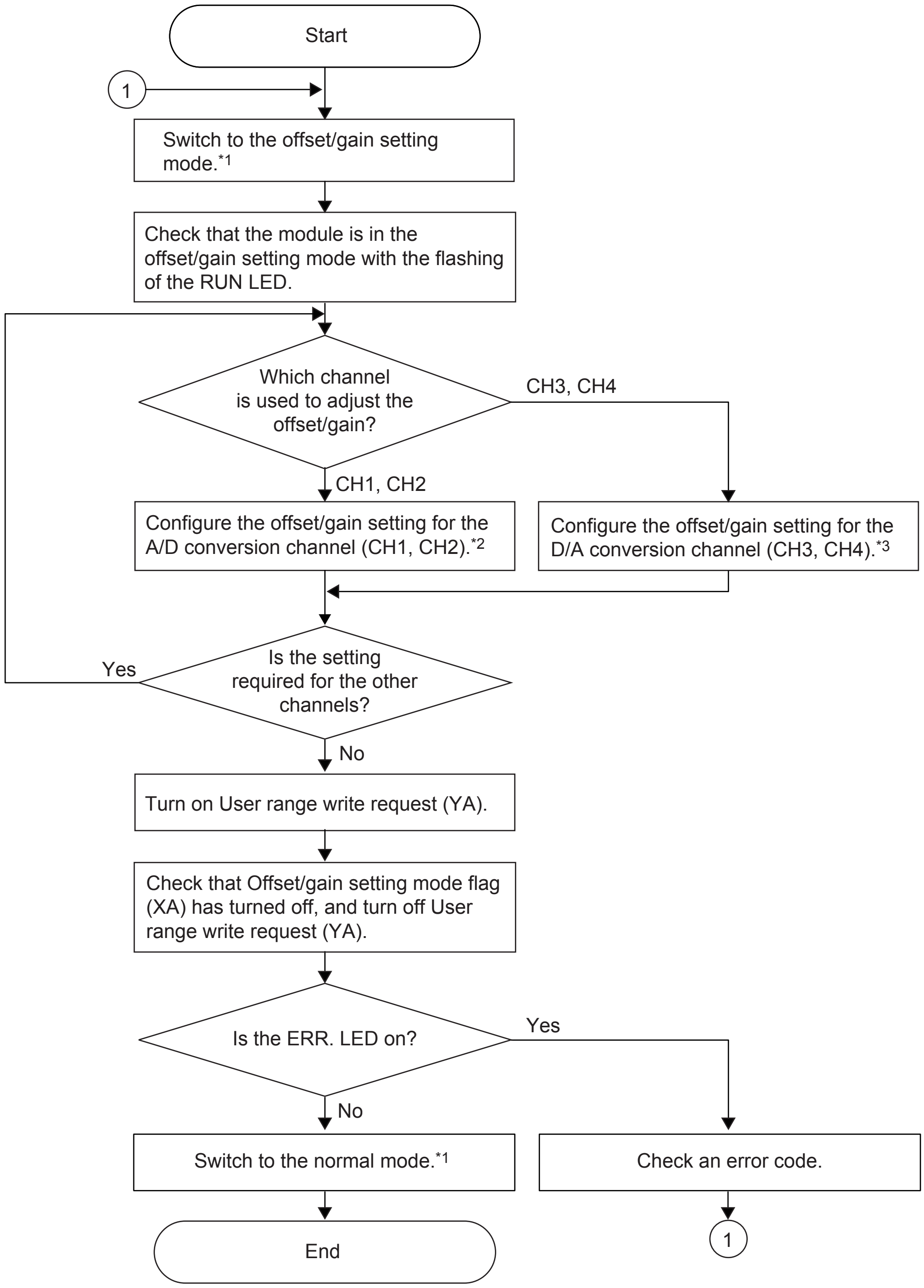
2. **If "Offset Status" or "Gain Status" has changed to "Changed" for any of the channels, the window on the left is displayed.**

Click the Register button.

7.5.2 Setting from a program

(1) Setting procedure

The following describes the procedures to configure the offset/gain setting from a program.



*1 The following shows the procedure for switching the mode (normal mode → offset/gain setting mode or offset/gain setting mode → normal mode).

- Dedicated instruction (G(P).OFFGAN) (☞ Page 433, Appendix 5.2)
- Setting for Mode switching setting (Un\G158, Un\G159) and turning on and off Operating condition setting request (Y9) (☞ Page 365, Appendix 2 (17))
- Switch setting (☞ Page 55, Section 7.2 (1))

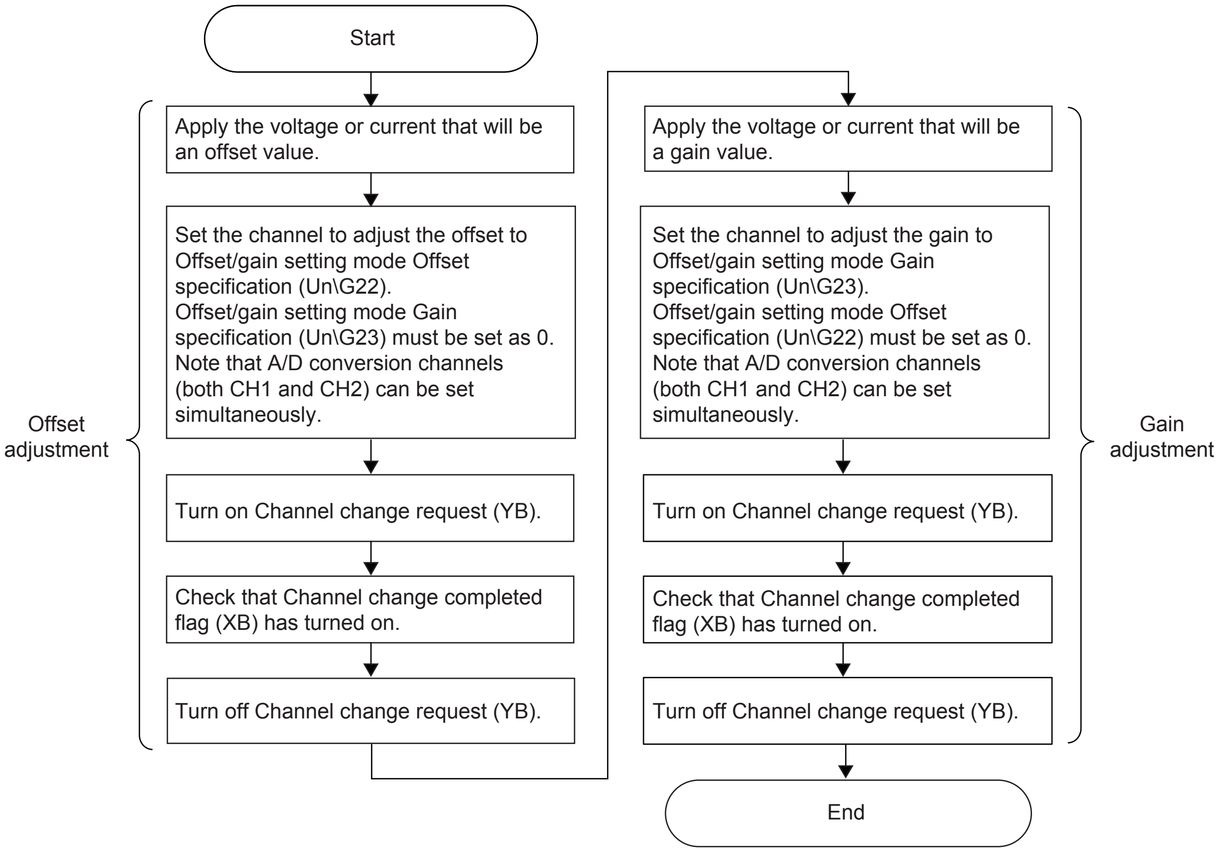
*2 ☞ Page 70, Section 7.5.2 (1) (a)

*3 ☞ Page 71, Section 7.5.2 (1) (b)

Point

- Offset and gain values are recorded in the flash memory in the analog I/O module by turning on and off User range write request (YA) and are not deleted even after the power is turned off.
  When the values are written 26 times in succession, an error occurs to prevent an improper write to the flash memory. The error code (162) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR. LED turns on.
- If the power is turned off or the CPU module is reset while offset and gain values are being written to the flash memory (while Offset/gain setting mode flag (XA) is off), a write to the flash memory may fail and the offset and gain values may be deleted.
  Therefore, do not turn off the power or do not reset the CPU module while data is being written in the flash memory.
- When an error occurs even in one channel, offset/gain values are not written to the module. Check the value in Latest error code (Un\G19) and perform the following procedures to reconfigure the offset/gain setting.
  Error Code List (☞ Page 315, Section 11.4)
- If the mode is switched (normal mode → offset/gain setting mode or offset/gain setting mode → normal mode), A/D conversion or D/A conversion is stopped. (When the mode is switched from the offset/gain setting mode to the normal mode, A/D conversion disable (1) is stored in A/D conversion enable/disable setting (Un\G0). D/A conversion disable (1) is stored in D/A conversion enable/disable setting (Un\G2000) as well.)
  To resume the A/D conversion or D/A conversion, set A/D conversion enable (0) or D/A conversion enable (0) for the corresponding channels and turn on and off Operating condition setting request (Y9).

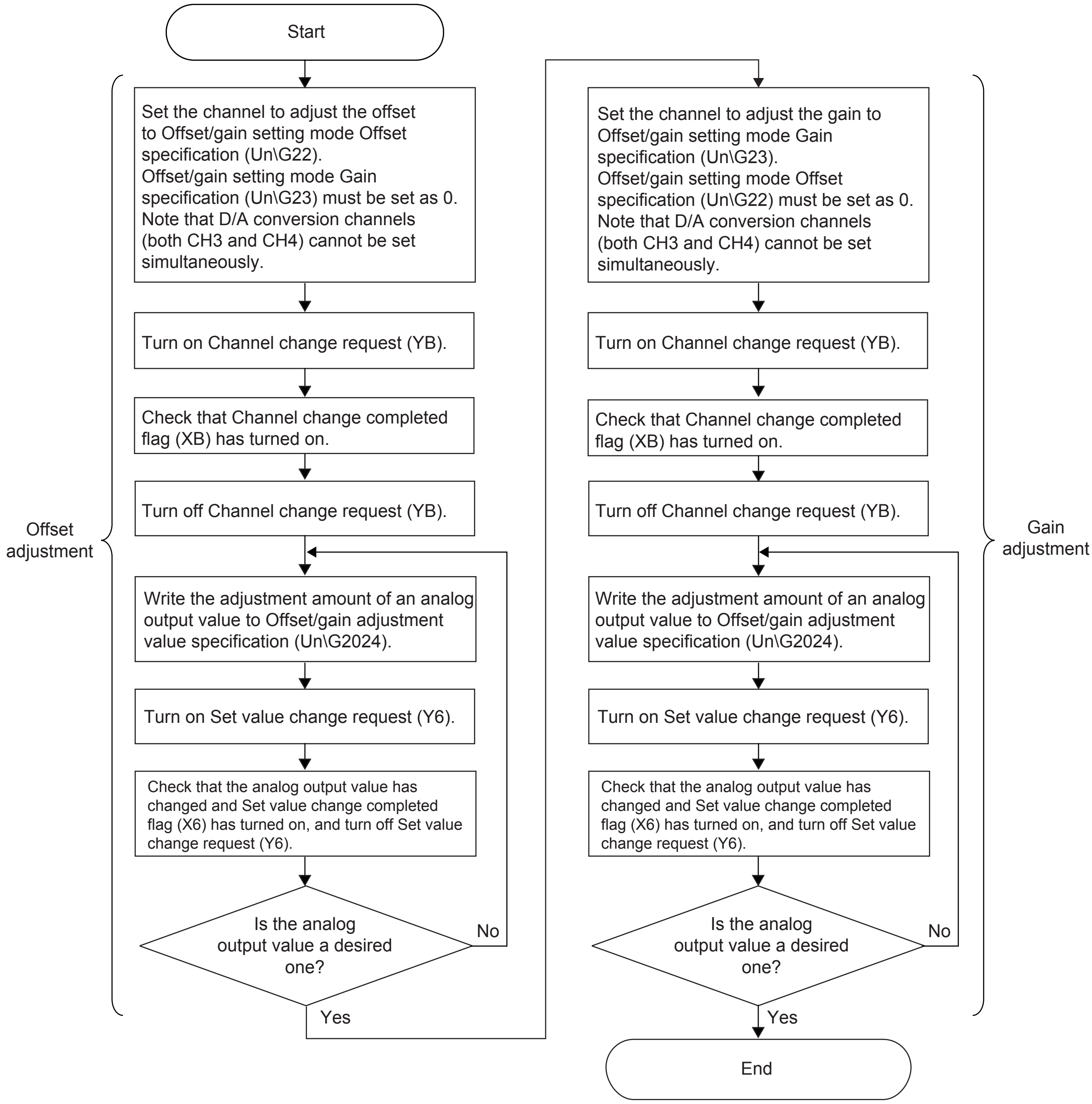
(a) Offset/gain setting for A/D conversion (CH1, CH2)



Point

- Configure the offset/gain setting for A/D conversion in the range satisfying the following condition. When the setting value out of the range is configured, the resolution and accuracy of the module may not fall within the range shown in the following performance specifications.
  - I/O conversion characteristic of A/D conversion (☞ Page 425, Appendix 3.1)
- Configure the settings for offset and gain channels separately. When settings are configured for offset and gain channels at the same time, an error occurs. The error code (500) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.
- The offset/gain settings can be simultaneously configured for both CH1 and CH2 (A/D conversion channels).
- The module operates as follows when the external power supply is off.
  - Channel change completed flag (XB) does not turn on even though Channel change request (YB) is turned on. Turn on the external power supply, and turn on and off Channel change request (YB) again.

(b) Offset/gain setting for D/A conversion (CH3, CH4)



Point

- Configure the offset/gain setting for D/A conversion in the range satisfying the following condition.
  When the setting value out of the range is configured, the resolution and accuracy of the module may not fall within the range shown in the following performance specifications.
    - I/O conversion characteristic of D/A conversion (☞ Page 428, Appendix 3.2)
- Configure the settings for offset and gain channels separately. When settings are configured for offset and gain channels at the same time, an error occurs. The error code (500) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.
- To configure the offset/gain setting for D/A conversion (CH3, CH4), set each channel separately. When settings are configured for multiple channels at the same time, an error occurs. The error code (501) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.
- The module operates as follows when the external power supply is off.
    - Channel change completed flag (XB) does not turn on even though Channel change request (YB) is turned on. Turn on the external power supply, and turn on and off Channel change request (YB) again.
    - Set value change completed flag (X6) does not turn on even though Set value change request (Y6) is turned on. Turn on the external power supply, and turn on and off Set value change request (Y6) again.

(2) Program example

(a) Device

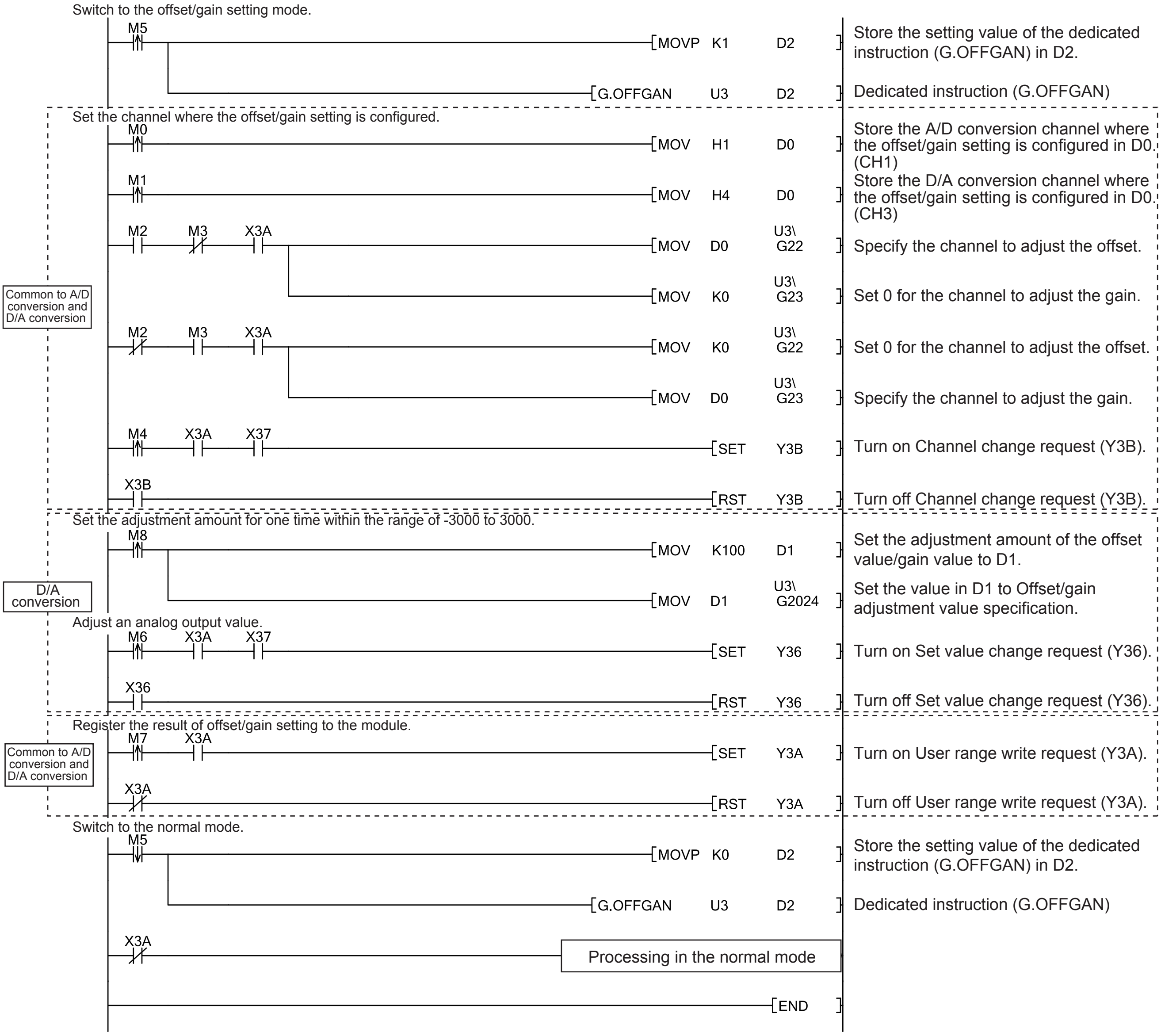
Ex. I/O number of the analog I/O module is X/Y30 to X/Y3F
The following table lists the devices used in the program example.

Device	Functions
M0	Channel selection (CH1)
M1	Channel selection (CH3)
M2	Offset setting
M3	Gain setting
M4	Offset/gain setting channel change command
M5	Mode switching
M6	Analog output value adjustment command
M7	Write command to module of offset/gain setting value
M8	Adjustment amount setting
M50	Check signal for offset/gain setting mode
M51	Check signal for normal mode
M100	Module READY checking flag
D0	Storage device for the specified channel
D1	Storage device for the setting value of the adjustment amount
D2	Storage device for the setting value of the dedicated instruction (G(P).OFFGAN)

(b) Switching the mode by the dedicated instruction (G(P).OFFGAN)

The program is to perform the following operations.

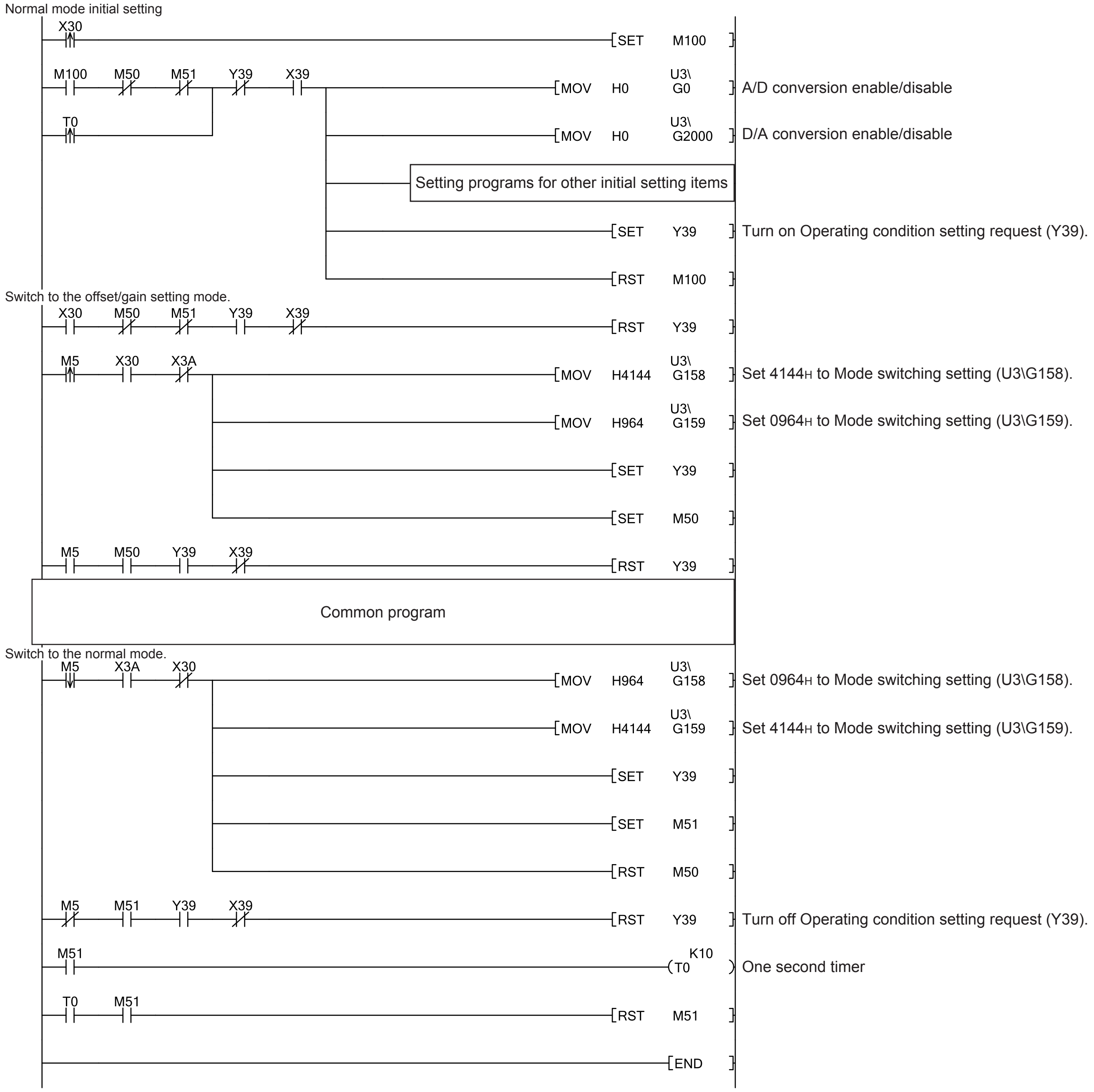
- Switch the mode from normal mode to offset/gain setting mode by using the dedicated instruction (G(P).OFFGAN).
- Switch the channel where the offset/gain setting is configured.
- Write the offset/gain value to the analog I/O module.
- Switch the mode from offset/gain setting mode to normal mode by using the dedicated instruction (G(P).OFFGAN).



Point

- The part enclosed by the dotted line is common to the following three programs.
  - Switching the mode by the dedicated instruction (G(P).OFFGAN) (☞ Page 74, Section 7.5.2 (2) (b))
  - Switching the mode by setting Mode switching setting (Un\G158, Un\G159) and by Operating condition setting request (Y9) (☞ Page 75, Section 7.5.2 (2) (c))
  - Switching the mode by using the switch setting (☞ Page 75, Section 7.5.2 (2) (d))
- When the mode has been switched from the offset/gain setting mode to the normal mode by the dedicated instruction (G(P).OFFGAN), Module READY (X0) turns on.
  Note the initial setting process is performed at the switching of the mode if a program executes the initial setting when Module READY (X0) turns on.

(c) Switching the mode by setting Mode switching setting (Un\G158, Un\G159) and by Operating condition setting request (Y9)



Point

When the mode has been switched from the offset/gain setting mode to the normal mode by setting Mode switching setting (Un\G158, Un\G159), Module READY (X0) turns on.
Note the initial setting process is performed at the switching of the mode if a program executes the initial setting when Module READY (X0) turns on.

(d) Switching the mode by using the switch setting

Only the common program is required.

Configure the switch setting, and reset the CPU module or turn off and on the power to switch the mode.

CHAPTER 8 FUNCTIONS

This chapter describes the functions of the analog I/O module and the setting procedures for those functions.
For details of the I/O signals and the buffer memory, refer to the following.

- Details of I/O Signals (☞ Page 344, Appendix 1)
- Details of Buffer Memory Addresses (☞ Page 354, Appendix 2)

8.1 Modes

Common

The analog I/O module has the following operation modes. Change the mode according to the function used.

(1) Operation mode

Operation mode	Description
Normal mode	Performs normal A/D conversion and D/A conversion.
Offset/gain setting mode	Makes the offset/gain setting. For details of the offset/gain setting, refer to the following. Offset/gain Setting (☞ Page 61, Section 7.5)

(a) Selecting a function of the normal mode

In the normal mode, the functions can be selected for "Select Function" of "Switch Setting". (The following functions cannot be used simultaneously.)

Setting value of "Select Function"	A/D conversion	D/A conversion
Logging Function	Performs normal A/D conversion on CH1 and CH2. The analog input value of each channel is converted into a digital value and the digital value is stored in CH□ Digital output value (Un\G11, Un\G12).	[Normal output] Performs normal D/A conversion on CH3 and CH4. The value set in CH□ Digital input value (Un\G2003, Un\G2004) is converted into an analog value and the analog value is output.
Wave Output Function		[Wave output] Performs the wave output function on CH3 and CH4. The value set in Wave data registry area (Un\G5000 to Un\G54999) is output in analog after D/A conversion.
Free Operation Function	[Variable arithmetic] Performs normal A/D conversion on CH1 and CH2. The analog input value of each channel is converted into a digital value and the digital value is stored in CH□ Digital output value (Un\G11, Un\G12). CH□ Digital output value (Un\G11, Un\G12) can be used in polynomial expressions.	[Variable arithmetic] Converts the digital value operated with a polynomial expression into an analog value and outputs the analog value.
Free Conversion Characteristics Function	[Variable conversion characteristics] Converts an analog value into a digital value according to the factory default setting. The A/D conversion value is used as an address of the conversion characteristics table. The data corresponding to the address is stored in CH□ Digital output value (Un\G11, Un\G12). When Analog output (1) is set to Variable conversion characteristics table selection (Un\G4100), normal A/D conversion is performed.	[Variable conversion characteristics] The digital value is used as an address of the conversion characteristics table. The data stored in the address is converted into an analog value and the analog value is output. When Analog input (0) is set to Variable conversion characteristics table selection (Un\G4100), normal output is performed.
Free Conversion Characteristics Function + Free Operation Function	[Variable conversion characteristics] Converts an analog input value into a digital value according to the conversion characteristics table and stores the digital value in CH□ Digital output value (Un\G11, Un\G12). [Variable arithmetic] CH□ Digital output value (Un\G11, Un\G12) or Variable conversion characteristics digital value monitor (Un\4111, Un\G4121) can be used in polynomial expressions.	[Variable conversion characteristics] The data of CH□ Digital input value (Un\G2003, Un\G2004) is used as an address of the conversion characteristics table. The data corresponding to the address is stored in Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121). [Variable arithmetic] Converts the digital value operated with a polynomial expression into an analog value and outputs the analog value.

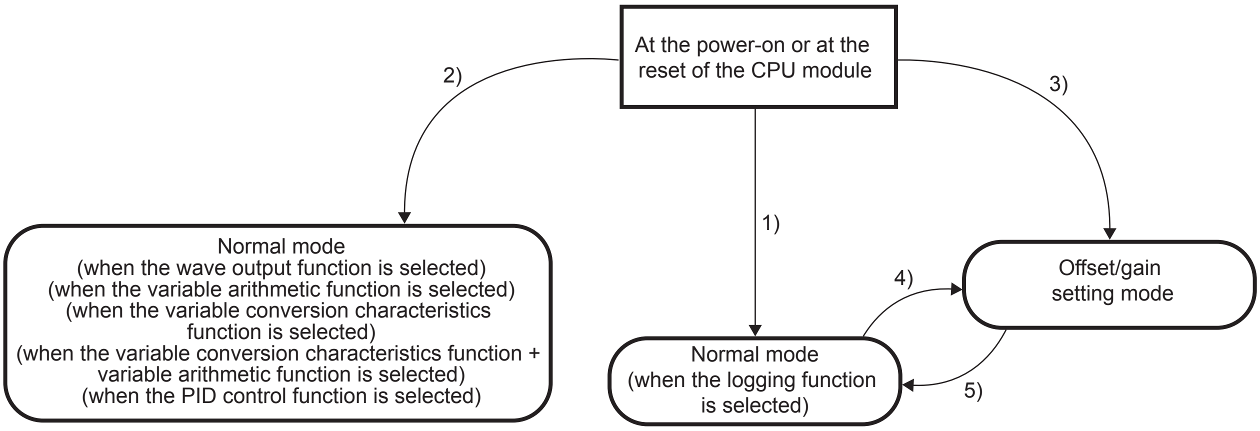
Setting value of "Select Function"	A/D conversion	D/A conversion
PID Control Function	[PID control] Performs normal A/D conversion on CH1 and CH2. The analog input value of each channel is converted into a digital value and the digital filter is applied to the digital value. This digital value is stored in CH☐ Digital output value (Un\G11, Un\G12) as the process value (PV).	[PID control] The operation changes according to the setting of Control mode switching (Un\G4320, Un\G4400) on CH3 and CH4. • When Automatic mode (0) is set, the manipulated value (MV) calculated using CH☐ Digital output value (Un\G11, Un\G12) in PID operation is output in analog. • When Manual mode (1) is set, the manipulated value (MV) set in MAN output setting (Un\G4339, Un\G4419) is output in analog.

For details of each function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)
- Wave Output Function (☞ Page 144, Section 8.18)
- Variable Arithmetic Function (☞ Page 192, Section 8.19)
- Variable Conversion Characteristics Function (☞ Page 212, Section 8.20)
- Variable Conversion Characteristics Function + Variable Arithmetic Function (☞ Page 239, Section 8.21)
- PID Control Function (☞ Page 246, Section 8.22)

(2) Mode transitions

The following figure and table describe the transition condition for each mode.



No.	Transition condition	
1)	Set "Drive Mode Setting" to "Normal (A/D Converter Processing, D/A Converter Processing) Mode" and "Select Function" to "Logging Function" in "Switch Setting" of GX Works2.	
2)	Set "Drive Mode Setting" to "Normal (A/D Converter Processing, D/A Converter Processing) Mode" and "Select Function" to any of the following in "Switch Setting" of GX Works2. • "Wave Output Function" • "Free Operation Function" • "Free Conversion Characteristics Function" • "Free Conversion Characteristics Function + Free Operation Function" • "PID Control Function"	
3)	Set "Drive Mode Setting" to "Offset/Gain Setting Mode" in "Switch Setting" of GX Works2.	
4)	Perform the mode transition by either of the following methods.	
	Method 1	Execute G(P).OFFGAN (ArgumentⓈ: 1: Transition to the offset/gain setting mode).*1
	Method 2	Set the following values for Mode switching setting (Un\G158, Un\G159) and turn on and off Operating condition setting request (Y9).*1 Un\G158: 4144H Un\G159: 0964H
5)	Perform the mode transition by either of the following methods.	
	Method 1	Execute G(P).OFFGAN (ArgumentⓈ: 0: Transition to the normal mode).
	Method 2	Set the following values for Mode switching setting (Un\G158, Un\G159) and turn on and off Operating condition setting request (Y9).*1 Un\G158: 0964H Un\G159: 4144H

*1 A/D conversion and D/A conversion stop at the time of the mode transition.

(3) Checking method

The current mode can be checked with the following items.

Mode		RUN LED status	Stored value of Function selection monitor (Un\G21)	Offset/gain setting mode flag/Arithmetic expression data write status flag (XA)
Normal mode	Logging function	ON	0	OFF*1
	Wave output function	ON	1	OFF
	Variable arithmetic function	ON	2	OFF*1
	Variable conversion characteristics function	ON	3	OFF
	Variable conversion characteristics function + variable arithmetic function	ON	4	OFF*1
	PID control function	ON	5	OFF
Offset/gain setting mode		Flashing	0	ON*1

*1 When User range write request/Arithmetic expression data write request (YA) is off

8.2 Enable/Disable Setting and Conversion Speed of A/D and D/A Conversion

Common

(1) Enable/disable setting of A/D and D/A conversion

For the A/D conversion channels (CH1, CH2) and the D/A conversion channels (CH3, CH4), whether to enable or disable conversion can be set by channel. For details of the setting procedure, refer to the following.

- A/D Conversion Enable/Disable Function (☞ Page 85, Section 8.4)
- D/A Conversion Enable/Disable Function (☞ Page 125, Section 8.12)

(2) Conversion speed

The conversion speed varies depending on the setting of "Select Function" of "Switch Setting".

Setting value of "Select Function"	Conversion speed	
	A/D conversion	D/A conversion
Logging Function	80μs /channel	
Wave Output Function		
Free Conversion Characteristics Function	100μs/channel	
Free Operation Function	160μs/channel	320μs/2 channels
Free Conversion Characteristics Function + Free Operation Function		
PID Control Function	200μs/channel	

(a) When the logging function or wave output function is selected

For the A/D conversion channels and D/A conversion channels where conversion is enabled, conversion is performed every 80μs by channel in turn. The following shows the conversion speed of each channel.

Conversion speed of A/D conversion channel (CH1, CH2)	Conversion speed of D/A conversion channel (CH3, CH4)
80μs × Number of channels where A/D conversion is enabled	80μs × Number of channels where D/A conversion is enabled

(b) When the variable conversion characteristics function is selected

For the A/D conversion channels and D/A conversion channels where conversion is enabled, conversion is performed every 100μs by channel in turn. The following shows the conversion speed of each channel.

Conversion speed of A/D conversion channel (CH1, CH2)	Conversion speed of D/A conversion channel (CH3, CH4)
100μs × Number of channels where A/D conversion is enabled	100μs × Number of channels where D/A conversion is enabled

(c) When the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function is selected

For the A/D conversion channels where conversion is enabled, conversion is performed every 160μs by channel in turn.

The operation speed of polynomial expressions is 320μs. Since each operation result of two polynomial expressions is output on each D/A conversion channel, D/A conversion is executed at intervals of 320μs regardless of the number of D/A conversion enabled channels. The following shows the conversion speed of each channel.

Conversion speed of A/D conversion channel (CH1, CH2)	Conversion speed of D/A conversion channel (CH3, CH4)
160μs × Number of channels where A/D conversion is enabled	320μs/2 channels

(d) When the PID control function is selected

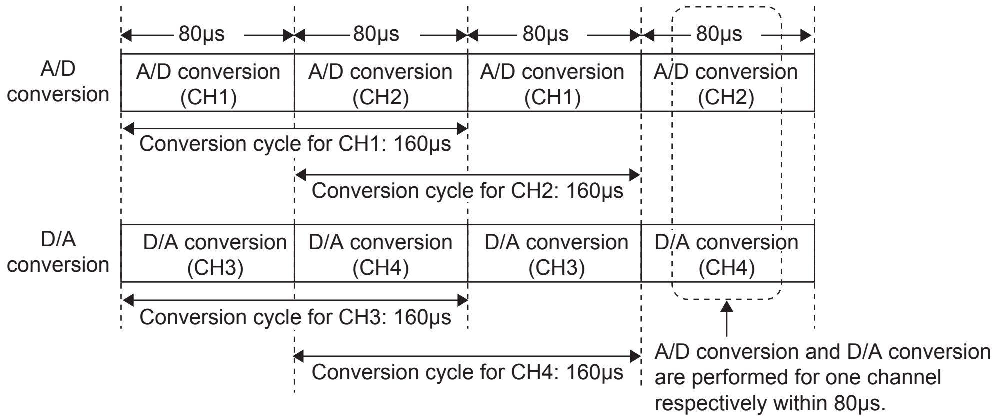
For the A/D conversion channels and D/A conversion channels where conversion is enabled, conversion is performed every 200μs by channel in turn. The following shows the conversion speed of each channel.

Conversion speed of A/D conversion channel (CH1, CH2)	Conversion speed of D/A conversion channel (CH3, CH4)
200μs × Number of channels where A/D conversion is enabled	200μs × Number of channels where D/A conversion is enabled

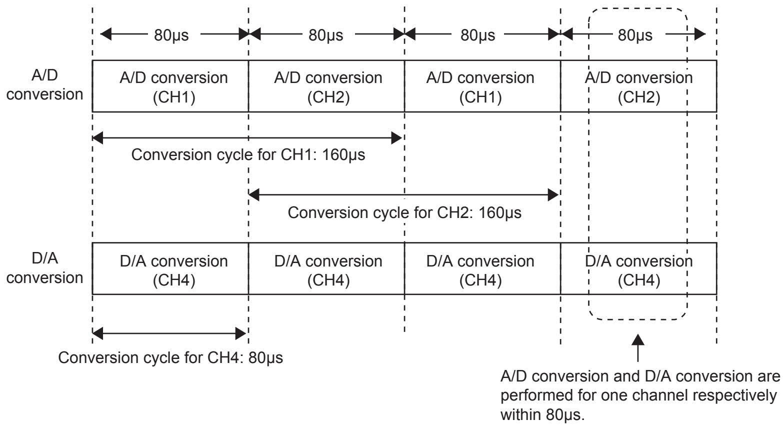
(3) Conversion order of A/D conversion and D/A conversion by number of channels where conversion is enabled

The following examples use the conversion speed of when the logging function or wave output function is selected (80μs).

(a) When all channels are allowed to perform conversion



(b) When CH1, CH2, and CH4 are allowed to perform conversion

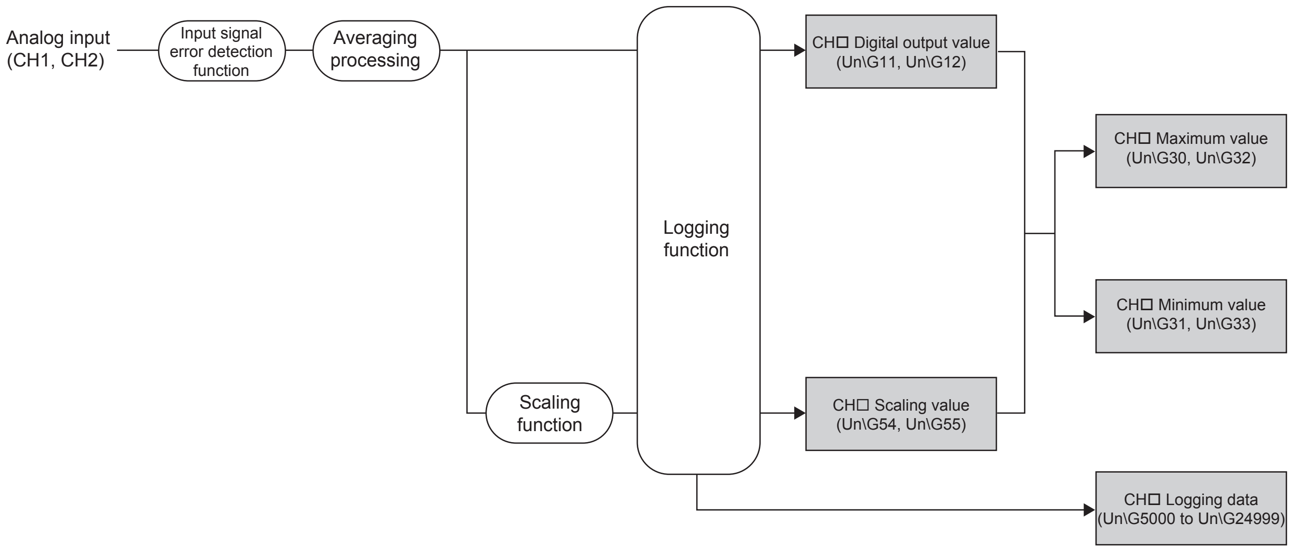


8.3 Processing Order of Each A/D Conversion Function

A/D conversion

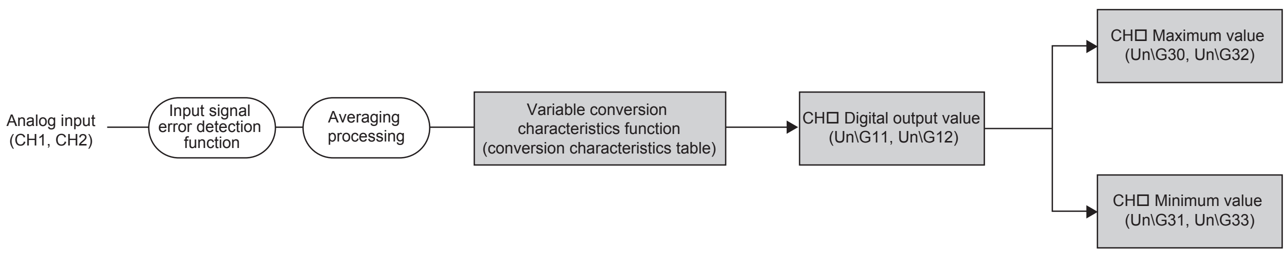
(1) Normal A/D conversion processing

When any of the logging function, wave output function, or variable arithmetic function is selected in "Select Function", analog input values and the digital values of (4) to (7) are processed in the order shown below. If multiple functions are enabled, the output of the first processed function is used as the input of the next function.



(2) A/D conversion processing of the variable conversion characteristics function

This processing order is for when the variable conversion characteristics function or the variable conversion characteristics function + variable arithmetic function is selected. Analog input values and the digital values of (4) to (6) are processed in the order shown below. If multiple functions are enabled, the output of the first processed function is used as the input of the next function.
The analog value is converted into a digital value and the digital value is used as an address of the conversion characteristics table. The data corresponding to the address is stored in CH☐ Digital output value (Un\G11, Un\G12).
(When Analog output (1) is set to Variable conversion characteristics table selection (Un\G4100), the values are converted in the order shown in ☞ Page 83, Section 8.3 (1).)



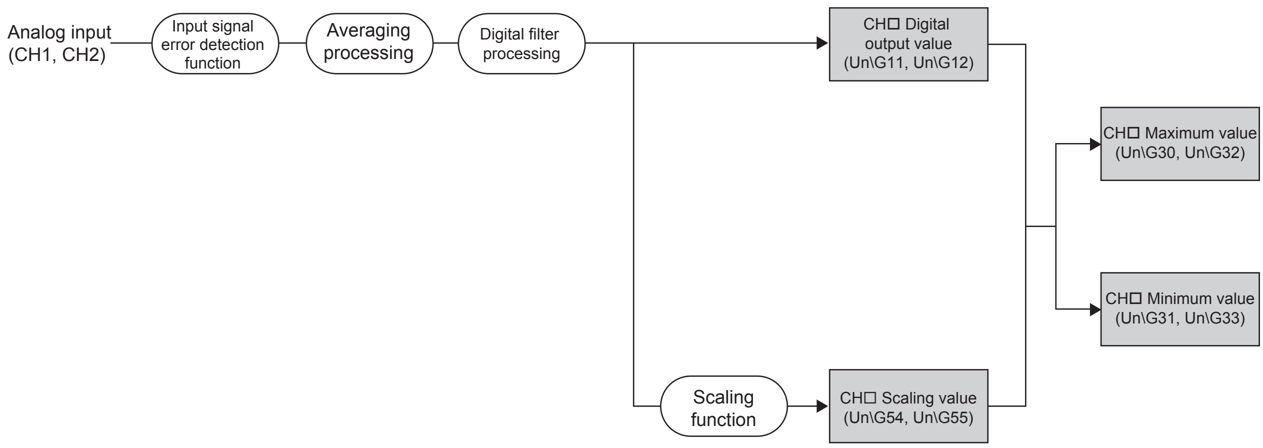
The conversion characteristics table is a data table for referring to a conversion value corresponding to the digital value for resolution when the variable conversion characteristics function is used. Set the conversion characteristics table using the "Create Conversion Characteristics Table" tool of GX Works2.
For details, refer to the following.

- Variable Conversion Characteristics Function (☞ Page 212, Section 8.20)

(3) A/D conversion processing of the PID control function

This processing order is for when the PID control function is selected. Analog input values and the digital values of (4) to (6) are processed in the order shown below.

The analog input value is converted into a digital value and the digital filter is applied to the digital value. This digital value is stored in CH□ Digital output value (Un\G11, Un\G12) as the process value (PV).



(4) Digital output values

The digital values obtained in sampling processing or averaging processing are stored.

(5) Scaling values

The values obtained in scale conversion of digital output values by the scaling function (A/D conversion) are stored. When the scaling function (A/D conversion) is not used, the values same as the digital output values are stored.

(6) Maximum and minimum values

The maximum digital output value and minimum digital output value are stored. When the scaling function (A/D conversion) is used, the maximum scaling value and minimum scaling value are stored.

(7) Logging data

When the logging function is used, the digital output values or scaling values are collected.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Point

- When averaging processing (time average/count average) is performed on digital output values, scaling values, and maximum and minimum values, the values are stored at every averaging process cycle.
- In the use of the input signal error detection function, A/D conversion is stopped if an input signal error occurs.
  In this case, the digital output values, scaling values, and maximum and minimum values are not updated. The values obtained before the input signal error is detected are held.
  When the analog input signal returns to a normal value, A/D conversion resumes.
  For details of the input signal error detection function, refer to the following.
  - Input Signal Error Detection Function (☞ Page 93, Section 8.8)

8.4 A/D Conversion Enable/Disable Function

A/D conversion

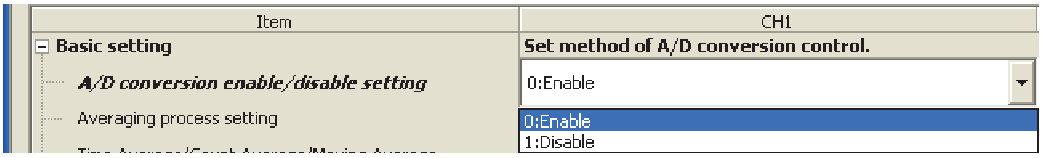
This function sets whether to enable or disable the A/D conversion for each channel.
Disabling the A/D conversion for unused channels reduces the A/D conversion cycle.
The conversion speed of this module varies depending on the setting of "Select Function".

Setting value of "Select Function"	Conversion speed
Logging Function	80µs/channel
Wave Output Function	
Free Conversion Characteristics Function	100µs/channel
Free Operation Function	160µs/channel
Free Conversion Characteristics Function + Free Operation Function	
PID Control Function	200µs/channel

(1) Setting procedure

Set "A/D conversion enable/disable setting" to "0: Enable".

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(A/D_Conversion)]



8.5 A/D Conversion Method

A/D conversion

Set sampling processing or averaging processing for each channel.
The conversion speed varies depending on the setting value of "Select Function".

Setting value of "Select Function"	Conversion speed
Logging Function	80μs/channel
Wave Output Function	
Free Conversion Characteristics Function	100μs/channel
Free Operation Function	160μs/channel
Free Conversion Characteristics Function + Free Operation Function	
PID Control Function	200μs/channel

(1) Sampling processing

Analog input values are converted into digital at every sampling cycle and stored in the buffer memory as digital output values.

Point

The conversion cycle is "Conversion speed × Number of channels where A/D conversion is enabled".
Whether to enable or disable can be set for each channel. Disabling A/D conversion for unused channels reduces the A/D conversion cycles.

Example: Conversion cycle that applies when the logging function is selected and the two channels (CH1, CH2) get A/D conversion enabled

80 × 2 = 160 (μs)
The conversion cycle is 160μs.

(2) Averaging processing

Averaging processing is performed on digital output values for each channel. The values obtained in averaging processing are stored in the buffer memory. The following three types of averaging processing are provided.

- Time average
- Count average
- Moving average

(a) Time average

A/D conversion is performed for a set period of time and averaging processing is performed on the total value excluding the maximum and the minimum values. The values obtained in averaging processing are stored in the buffer memory.
The number of processing times within a set period of time changes depending on the number of channels where A/D conversion is enabled.

$$\text{Number of processing times (times)} = \frac{\text{Set time}}{\text{Conversion speed} \times \text{Number of channels where A/D conversion is enabled}}$$

Ex. The processing times with the following settings is calculated below.

Item	Setting
Select function	Logging Function
Number of channels where A/D conversion is enabled	2 channels (CH1, CH2)
Set period of time	15ms

$$\frac{15}{0.08 \times 2} = 93.75 \text{ (times)}$$ ··· The value after the decimal point shall be rounded down.

→ The processing is performed 93 times and the average value is output.

(b) Count average

A/D conversions are performed a set number of times and averaging processing is performed on the total value excluding the maximum and the minimum values. The values obtained in averaging processing are stored in the buffer memory.
The time taken for the mean value calculated through average processing to be stored in the buffer memory changes depending on the number of channels where A/D conversion is enabled.

Processing time (ms) = Set number of times × (Conversion speed × Number of channels where A/D conversion is enabled)

Ex. The processing times with the following settings is calculated below.

Item	Setting
Select function	Logging Function
Number of channels where A/D conversion is enabled	2 channels (CH1, CH2)
Set number of times	20 times

$20 \times (0.08 \times 2) = 3.2$ (ms) → A mean value is output every 3.2ms.

Point

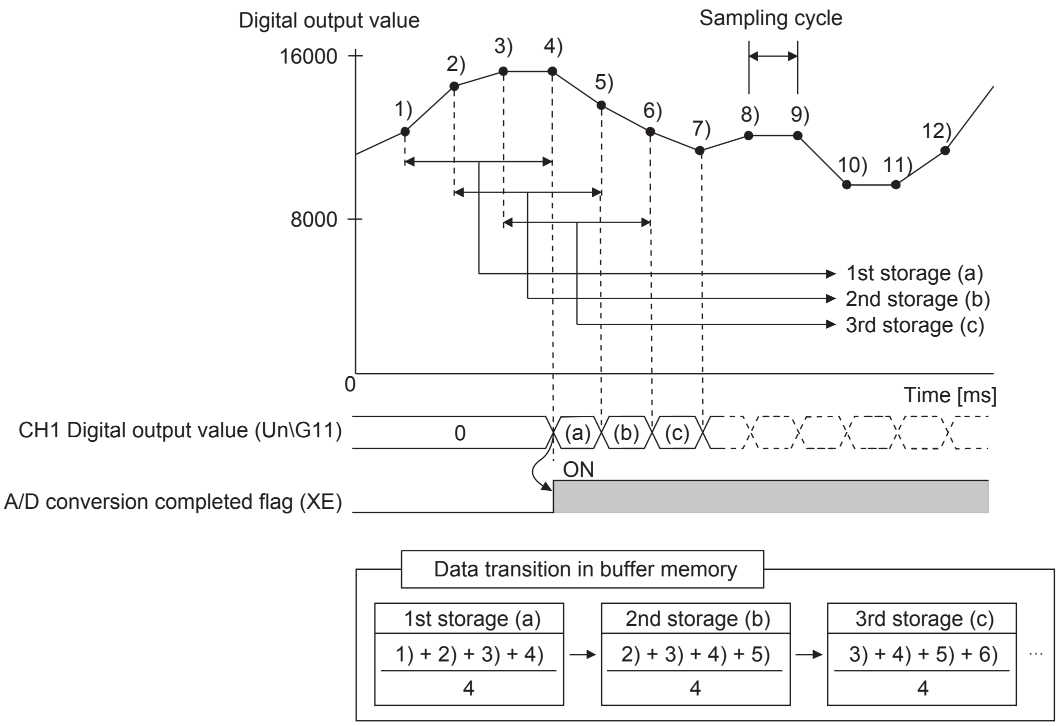
Because the count average requires a sum of at least two counts excluding the maximum and minimum values, set four or larger number of counts.

(c) Moving average

The average of a specified number of digital output values is calculated at every sampling cycle and is stored in the buffer memory.

Because the target set of values for averaging processing shifts to another to involve a subsequent value at every sampling processing, the latest digital output values can be always obtained.

The following figure shows the moving average processing of when the set number of times is four.

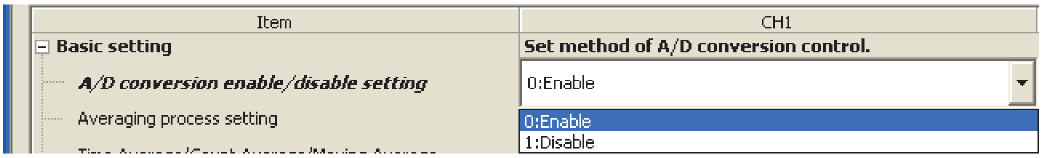


(3) Setting procedure

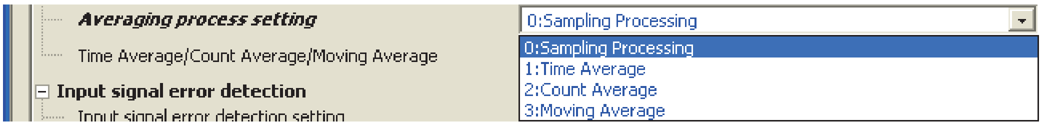
(a) Sampling processing

1. **Set "A/D conversion enable/disable setting" to "0: Enable".**

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(A/D_Conversion)]



2. **Set "Averaging process setting" to "0: Sampling Processing".**

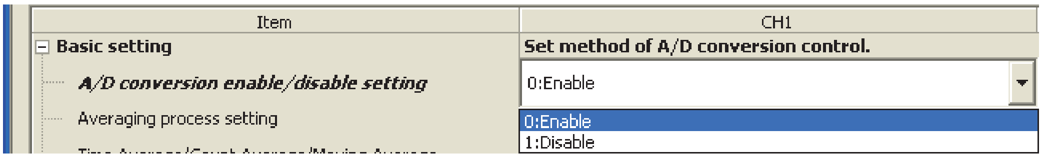


(b) Averaging processing

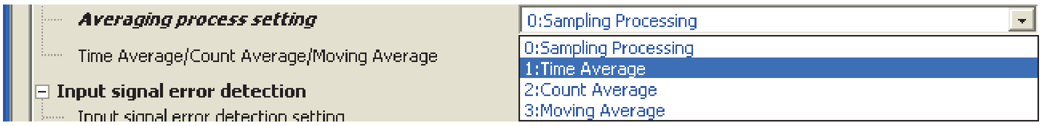
Ex. When "Averaging process setting" is set to "1: Time Average"

1. **Set "A/D conversion enable/disable setting" to "0: Enable".**

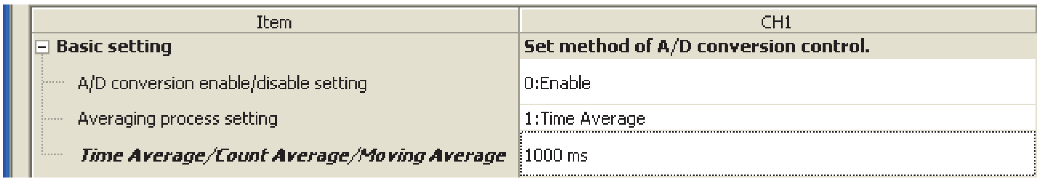
Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(A/D_Conversion)]



2. **Set "Averaging process setting" to "1: Time Average".**



3. **Set "Time Average/Count Average/Moving Average" to an averaging processing value.**



Setting item	Setting range
Time Average	2 to 5000ms
Count Average	4 to 62500 times
Moving Average	2 to 1000 times

Point

The time average and count average processing cannot be used when the PID control function is used. When the PID control function is used and "1: Time Average" or "2: Count Average" is set for "Averaging process setting", the setting value of "Time Average/Count Average/Moving Average" is ignored and the module performs the sampling processing.

8.6 Input Range Extension Function

A/D conversion

This function extends the input range of 4 to 20mA and that of 1 to 5V.

Input range setting	Input range	Digital output value
4 to 20mA	4 to 20mA	0 to 12000
1 to 5V	1 to 5V	

↔

Input range setting	Input range	Digital output value
4 to 20mA (Extended mode)	0.0 to 22.0mA	-3000 to 13500
1 to 5V (Extended mode)	0.0 to 5.5V	

(1) Overview

- Within the input range of 4 to 20mA and 1 to 5V, an analog input value can be monitored even when an error in the signal from a sensor is so great that the value falls short of 4mA or 1V.
- Although the slope of the I/O characteristic of the extended mode is the same as that of the normal range, the upper limit value and the lower limit value of the input range and the digital output value are extended. For details, refer to the following. I/O conversion characteristic of A/D conversion (☞ Page 425, Appendix 3.1)
- The resolution is the same as that the input range of 4 to 20mA and 1 to 5V has (1333nA and 333μV). Therefore, the A/D conversion with higher resolution than that of the input range of 0 to 20mA and 0 to 5V (resolution of 1666nA and 416μV) is achieved.

(2) Setting procedure

Set the extended mode for "Input Range Setting" of "Switch Setting".

Point

When the input range extension function is used with the scaling function (A/D conversion), the scaling values may exceed the range of -32768 to 32767.
In that case, the upper limit value (32767) or the lower limit value (-32768) is stored as a scaling value.

Example: When 32000 is set for the A/D conversion scaling upper limit value and -32000 is set for the A/D conversion scaling lower limit value, the following operations are performed.
- When the digital output value is 12144 or greater, 32767 is stored as a scaling value.
- When the digital output value is -144 or smaller, -32768 is stored as a scaling value.

8.7 Maximum Value/Minimum Value Hold Function

A/D conversion

This function stores the maximum digital value and minimum digital output value in the buffer memory for each channel.

Values are updated at every averaging process cycle if averaging processing is selected, otherwise updated at every sampling cycle.

For the buffer memory address where the values are stored, refer to the following.

- List of Buffer Memory Addresses (☞ Page 32, Section 3.5)

(1) Resetting the maximum value and the minimum value

When one of the following operations is performed, the maximum value and the minimum value are replaced with the current digital output value.

- Turning on and off Maximum value/minimum value reset request (YD)
- Turning on and off Operating condition setting request (Y9)

Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

(2) Target value for the maximum value/minimum value hold function

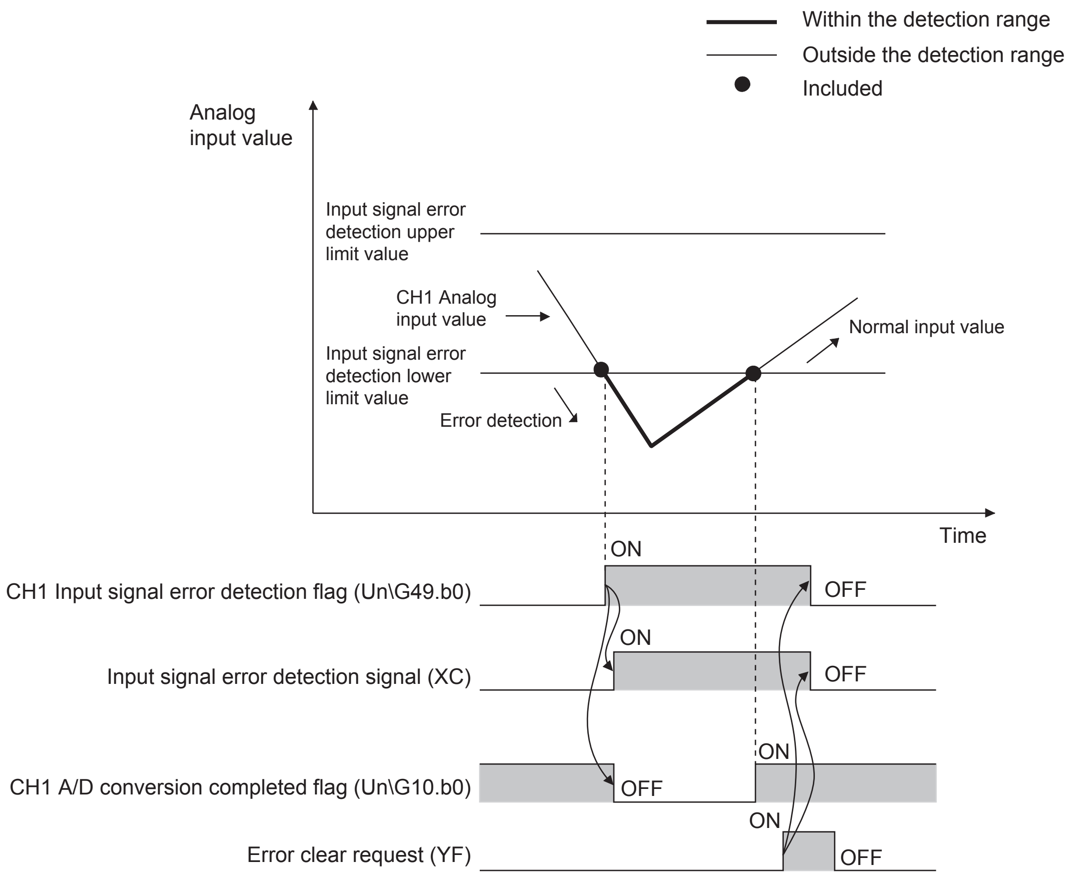
The maximum digital output value and minimum digital output value are stored.

If the scaling function is enabled, the maximum scaling value and minimum scaling value are stored.

8.8 Input Signal Error Detection Function

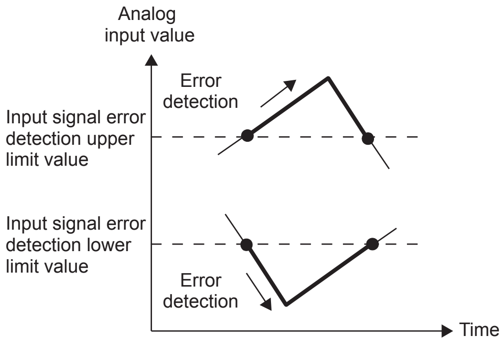
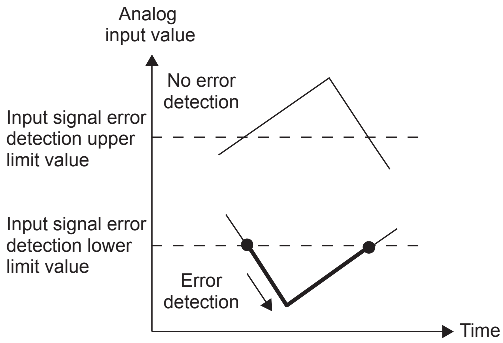
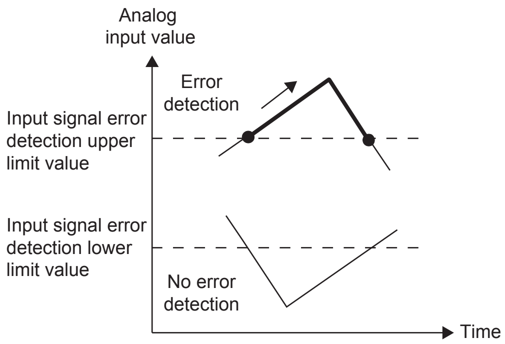
A/D conversion

This function outputs an alarm when the analog input value exceeds a preset range.



(1) Detection method

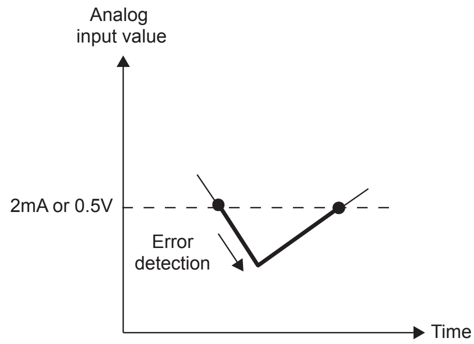
One of the following detection methods can be selected.

Detection method	Detection condition	
Upper and lower detection	When the analog input value becomes equal to or greater than the input signal error detection upper limit value, or becomes equal to or smaller than the input signal error detection lower limit value, an error is detected.	
Lower detection	When the analog input value becomes equal to or smaller than the input signal error detection lower limit value, an error is detected. When the analog input value becomes equal to or greater than the input signal error detection upper limit value, an error is not detected.	
Upper detection	When the analog input value becomes equal to or greater than the input signal error detection upper limit value, an error is detected. When the analog input value becomes equal to or smaller than the input signal error detection lower limit value, an error is not detected.	
Disconnection detection	Disconnection detection is performed. For details, refer to the following. • Disconnection detection (☞ Page 95, Section 8.8 (1) (a))	

(a) Disconnection detection

By combining this function with the input range extension function, simple disconnection detection is enabled. When either of the following conditions is satisfied, Input signal error (1) is stored in the bit of Input signal error detection flag (Un\G49) corresponding to the channel number.

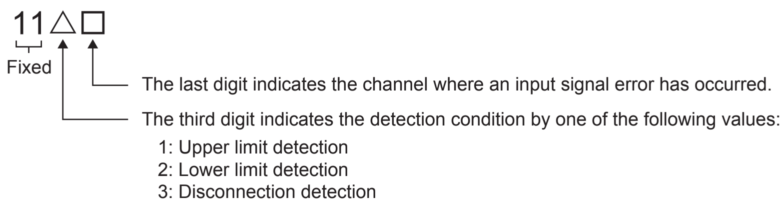
Input range	Disconnection detection condition
4 to 20mA (Extended mode)	Analog input value ≤ 2mA
1 to 5V (Extended mode)	Analog input value ≤ 0.5V



The setting for CH☐ Input signal error detection setting value (Un\G142, Un\G143) is ignored.

(2) Notifying input signal errors

When an input signal error or a disconnection is detected, the error is notified by Input signal error detection flag (Un\G49), Input signal error detection signal (XC), and flashing ALM LED (0.5s intervals). In addition, the alarm code (11△☐) is stored in Latest error code (Un\G19). The value of the alarm code to be stored depends on the condition (upper limit, lower limit, or disconnection detection) under which an input signal error is detected.
The following figure shows the alarm codes stored.



For details of the alarm codes, refer to the following.

- Alarm Code List (☞ Page 324, Section 11.5)

(3) Operations performed when an input signal error is detected

On the channel where an error is detected, the digital output value obtained immediately before the error is detected is held. In addition, "During A/D conversion or unused (0)" is stored in the bit of A/D conversion completed flag (Un\G10) corresponding to the channel and A/D conversion completed flag (XE) turns off.
When the analog input value falls back within the set range, A/D conversion resumes even if Input signal error detection flag (Un\G49) and Input signal error detection signal (XC) are reset. After the update of the first digital output value, A/D conversion completed (1) is stored in the bit of A/D conversion completed flag (Un\G10) corresponding to the channel (The ALM LED keeps flashing.).

Point

- When an input signal error occurs, the values of CH□ Digital output value (Un\G11, Un\G12) and CH□ Scaling value (Un\G54, Un\G55) are not updated.
- In the concurrent use of the logging function and input signal error detection function, the logging performed on the corresponding channel is stopped if an input signal error is detected. For details of the logging function, refer to the following.
  - Logging Function (☞ Page 106, Section 8.10)
- If an input signal error occurs when the PID control function is used, the PID operation stops and Manipulated value (MV) (Un\G4301, Un\G4381) and Output conversion value (Un\G4302, Un\G4382) are cleared to 0. For details on the PID control function, refer to the following.
  - PID Control Function (☞ Page 246, Section 8.22)

(4) Detection cycle

This function works at every sampling cycle.

(5) Clearing input signal errors

After the analog input value returns within the set range, turn on and off Error clear request (YF). If disconnection detection has been enabled, turn on and off Error clear request (YF) after the analog input value exceeds 2.0mA or 0.5V.
When an input signal error is cleared, the analog I/O module performs as follows.

- Clears Input signal error detection flag (Un\G49).
- Turns off Input signal error detection signal (XC).
- Turns off the ALM LED.
- Clears the alarm code (11△□) stored in Latest error code (Un\G19).

(6) How to set the input signal error detection setting value

Set the input signal error detection upper limit value and input signal error detection lower limit value by 1 (0.1%) based on the input signal error detection setting value.
Both the input signal error detection upper limit value and the input signal error detection lower limit value reflect the input signal error detection setting value.

(a) Input signal error detection upper limit value

This value is calculated by adding "Input range width (gain value - offset value) × Input signal error detection setting value" to the gain value. Only the value equal to or greater than the gain value can be set.
To calculate the input signal error detection setting value based on the input signal error detection upper limit value, use the following equation.

$$\text{Input signal error detection setting value} = \frac{\text{Input signal error detection upper limit value - Gain value of each range}}{\text{Gain value of each range - Offset value of each range}} \times 1000$$

(b) Input signal error detection lower limit value

This value is calculated by subtracting "Input range width (gain value - offset value) × Input signal error detection setting value" from the lower limit value of each range. Only the value below the lower limit value of the range can be set.
To calculate the input signal error detection setting value based on the input signal error detection lower limit value, use the following equation.

$$\text{Input signal error detection setting value} = \frac{\text{Lower limit value of each range - Input signal error detection lower limit value}}{\text{Gain value of each range - Offset value of each range}} \times 1000$$

Remark

The following table lists the lower limit value, offset value, and gain value for each range.

Input range		Lower limit value	Offset value	Gain value
Current	4 to 20mA	4mA		20mA
	0 to 20mA	0mA		20mA
	4 to 20mA (Extended mode)	4mA		20mA
	User range setting (Current)	Analog input equivalent to the digital output value of -12000	Analog input value set as an offset value by users	Analog input value set as a gain value by users
Voltage	1 to 5V	1V		5V
	0 to 5V	0V		5V
	-10 to 10V	-10V	0V	10V
	0 to 10V	0V		10V
	1 to 5V (Extended mode)	1V		5V
	User range setting (Voltage)	Analog input value equivalent to the digital output value of -12000	Analog input value set as an offset value by users	Analog input value set as a gain value by users

(c) When setting -10 to 10V, 0 to 10V, or the user range setting (voltage) for the input range

When setting -10 to 10V, 0 to 10V, or the user range setting (voltage) for the input range, set the input signal error detection upper limit value and the input signal error detection lower limit value in the following ranges. When the values are out of the ranges, input signal errors may not be detected as intended.

- 10V ≤ Input signal error detection upper limit value ≤ 10.24V
- -10.24V ≤ Input signal error detection lower limit value ≤ -10V (Only for -10 to 10V and the user range setting (voltage))

Ex. Input signal error detection setting value calculated when Input signal error detection upper limit value = 10.24V and the input range is 0 to 10V

$$\text{Input signal error detection setting value} = \frac{10.24\text{V} - 10\text{V}}{10\text{V} - 0\text{V}} \times 1000 = 24\ (2.4\%)$$

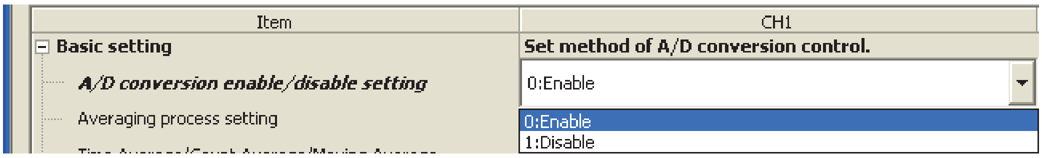
8

8.8 Input Signal Error Detection Function

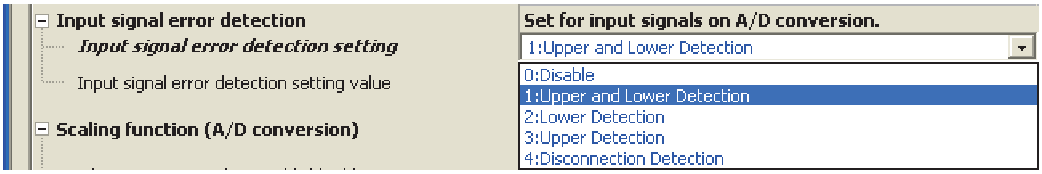
(7) Setting procedure

1. **Set "A/D conversion enable/disable setting" to "0: Enable".**

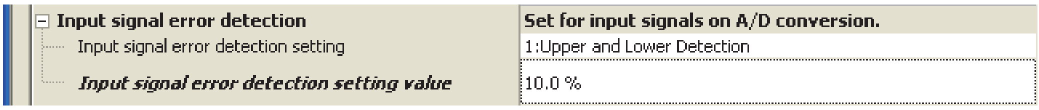
Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(A/D_Conversion)]



2. **Select a detection method from "Input signal error detection setting".**



3. **Set a value for "Input signal error detection setting value".**



Item	Setting range
Input signal error detection setting value	0 to 25.0%

Point

- When "4: Disconnection Detection" is set for "Input signal error detection setting", the setting for "Input signal error detection setting value" becomes invalid.
- When "4: Disconnection Detection" is set for "Input signal error detection setting" on the channel where the input range is set to a range other than 4 to 20mA (Extended mode) and 1 to 5V (Extended mode), an error occurs. The error code (82□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on.
- When the specifications of disconnection detection, 2mA (4 to 20mA (extended mode) or 0.5V (input range: 1 to 5V (extended mode)), do not fill the needs of the system, set "Input signal error detection setting" to "2: Lower Detection" and set "Input signal error detection setting value" to a judging value to detect a disconnection.

(8) Setting example of input signal error detection

To detect an error on a channel where the input range of 4 to 20mA is set when the analog input value is 2.4mA or lower, make the following substitutions in the equation based on the input signal error detection lower limit value.

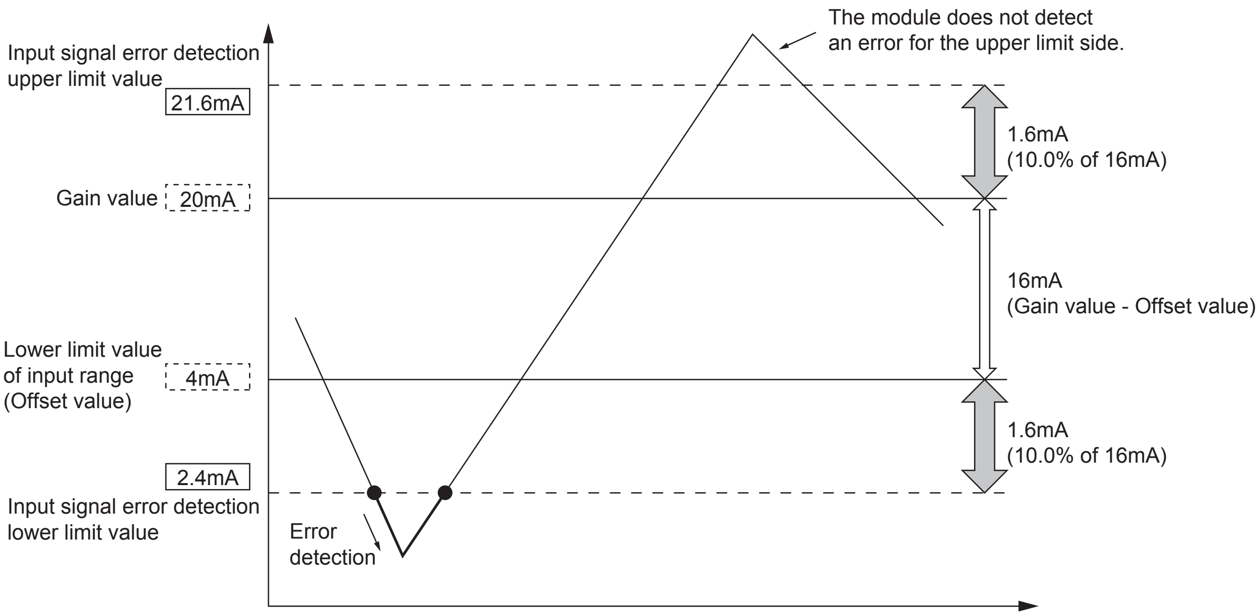
- Input signal error detection lower limit value: 2.4mA
- The lower limit value of the input range (offset value): 4.0mA
- Gain value: 20.0mA

$$\text{Input signal error detection setting value} = \frac{4.0 - 2.4}{20.0 - 4.0} \times 1000$$

$$= 100(10.0\%)$$

Thus, set the input signal error detection setting value to "100(10.0%)".

Ex. When "2: Lower Detection" is set for "Input signal error detection setting", the input signal error detection value works as shown below.



8.9 Scaling Function (A/D Conversion)

A/D conversion

This function performs scale conversion on the digital output values. The values are converted within the range between a specified A/D conversion scaling upper limit value and A/D conversion scaling lower limit value. The converted values are stored in CH☐ Scaling value (Un\G54, Un\G55).

(1) Concept of scaling setting

Ex. When the input range is set to -10 to 10V:
For the A/D conversion scaling lower limit value, set a value corresponding to the lower limit of the input range (-16000).
For the A/D conversion scaling upper limit value, set a value corresponding to the upper limit of the input range (16000).

(2) Calculating the scaling value

The scaling value is calculated based on the following equations.
(All digits to the right of the decimal point are discarded during scale conversion.)

Current: 4 to 20mA, 0 to 20mA, 4 to 20mA (Extended mode)*1, user range setting (Current)

Voltage: 1 to 5V, 0 to 5V, 0 to 10V, 1 to 5V (Extended mode)*1, user range setting (Voltage)

$$\text{Scaling value} = \frac{D_X \times (S_H - S_L)}{D_{Max}} + S_L$$

Voltage: -10 to 10V

$$\text{Scaling value} = \frac{D_X \times (S_H - S_L)}{D_{Max} - D_{Min}} + \frac{(S_H + S_L)}{2}$$

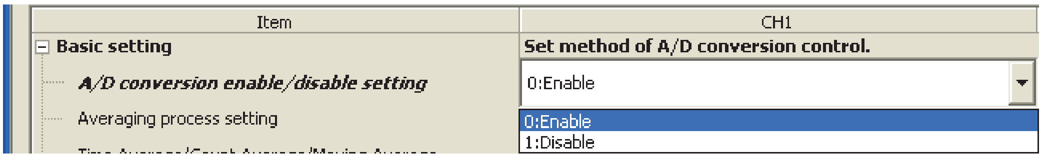
Item	Description
Dx	Digital output values
D_{Max}	Maximum digital output value of the input range in use
D_{Min}	Minimum digital output value of the input range in use
S_H	A/D conversion scaling upper limit value
S_L	A/D conversion scaling lower limit value

*1 Although the range of the digital output value in the extended mode is -3000 to 13500, this function scales digital output values within the range of 0 to 12000. For an example of scaling setting using the extended mode, refer to the following.
Setting example of scaling function (A/D conversion) (☞ Page 102, Section 8.9 (4))

(3) Setting procedure

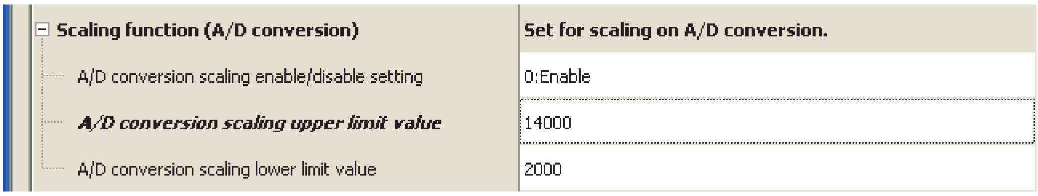
1. Set "A/D conversion enable/disable setting" to "0: Enable".

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(A/D_Conversion)]



2. Set "A/D conversion scaling enable/disable setting" to "0: Enable".

3. Set values for "A/D conversion scaling upper limit value" and "A/D conversion scaling lower limit value".



Item	Setting range
A/D conversion scaling upper limit value	- 32000 to 32000
A/D conversion scaling lower limit value	

Point

- Whatever the settings for the A/D conversion scaling upper limit value and the A/D conversion scaling lower limit value, the resolution does not become higher.
- If the relation between the values is A/D conversion scaling lower limit value > A/D conversion scaling upper limit value, the scale conversion can be performed according to a negative slope.
- Set different values for the A/D conversion scaling upper limit value and A/D conversion scaling lower limit value. If the same value is set, an error occurs. The error code (91□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on.
- When the variable conversion characteristics function is used, the scaling function (A/D conversion) cannot be used. When any of the following has been set and the scaling function (A/D conversion) is enabled, an error occurs. The error code (500□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on.

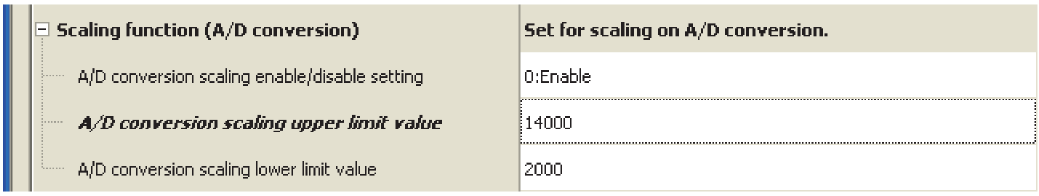
Select function	Variable conversion characteristics table selection (Un\G4100)
Free Conversion Characteristics Function	Analog input (0)
Free Conversion Characteristics Function	Analog I/O (2)
Free Conversion Characteristics Function + Free Operation Function	Analog input (0)
Free Conversion Characteristics Function + Free Operation Function	Analog I/O (2)

- When the PID control function is used, the scaling function (A/D conversion) can be used. The process value (PV) used in the PID operation is CH□ Digital output value (Un\G11, Un\G12) before scale conversion.

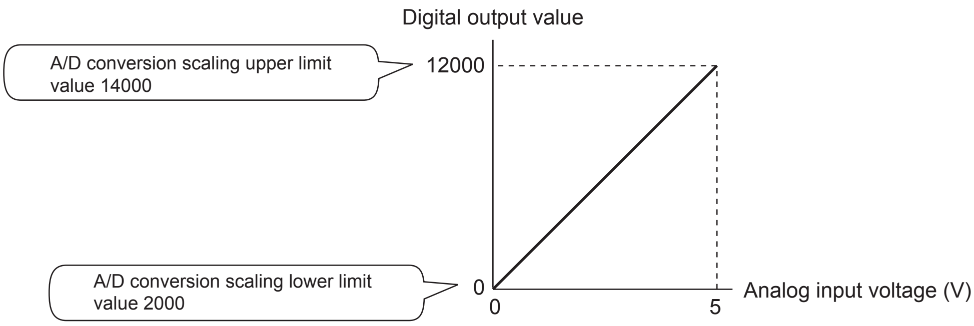
(4) Setting example of scaling function (A/D conversion)

Ex. When the following values are set for a channel with an input range of 0 to 5V:

- "A/D conversion scaling enable/disable setting": Enable"
- "A/D conversion scaling upper limit value":
- "A/D conversion scaling lower limit value":



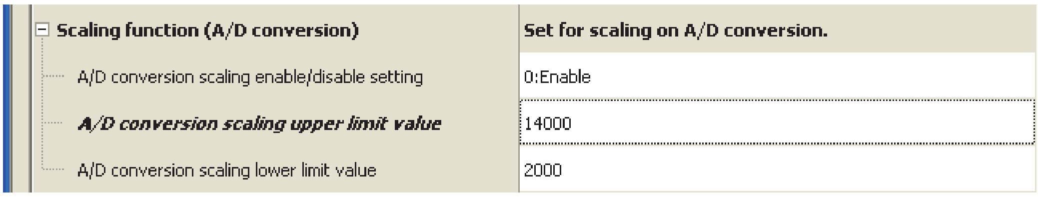
The following figure and table show the digital output values and the corresponding scaling values.



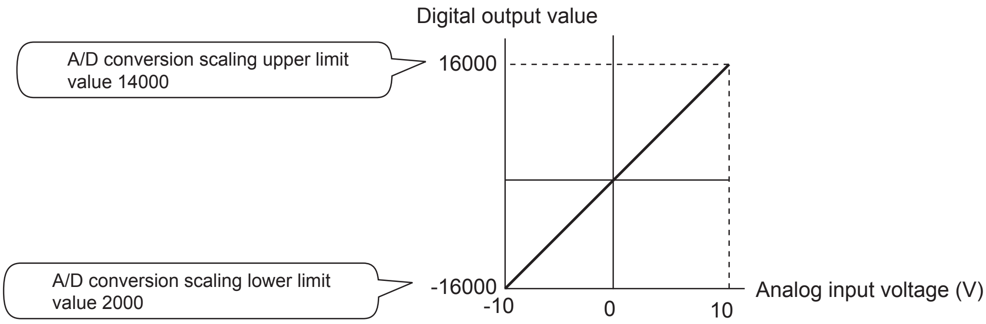
Analog input voltage (V)	Digital output value	Scaling value
0	0	2000
1	2400	4400
2	4800	6800
3	7200	9200
4	9600	11600
5	12000	14000

Ex. When the following values are set for a channel with an input range of -10 to 10V:

- "A/D conversion scaling enable/disable setting": Enable"
- "A/D conversion scaling upper limit value":
- "A/D conversion scaling lower limit value":



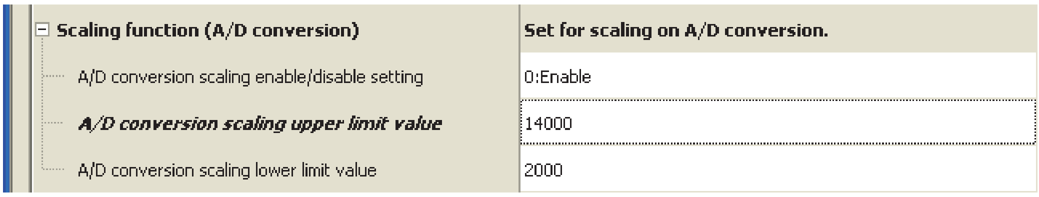
The following figure and table show the digital output values and the corresponding scaling values.



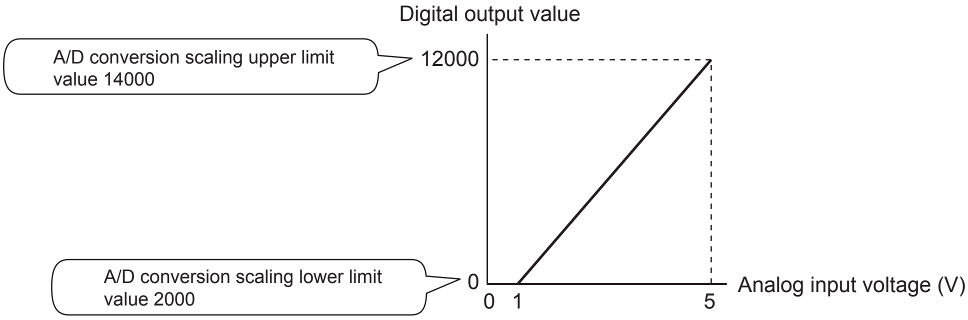
Analog input voltage (V)	Digital output value	Scaling value
-10	-16000	2000
-5	-8000	5000
0	0	8000
5	8000	11000
10	16000	14000

Ex. When the following values are set for a channel with an input range of 1 to 5V (Extended mode):

- "A/D conversion scaling enable/disable setting": Enable"
- "A/D conversion scaling upper limit value":
- "A/D conversion scaling lower limit value":



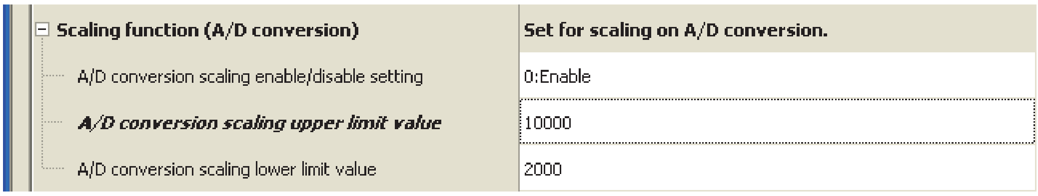
The following figure and table show the digital output values and the corresponding scaling values.



Analog input voltage (V)	Digital output values	Scaling value
0	-3000	-1000
1	0	2000
2	3000	5000
3	6000	8000
4	9000	11000
5	12000	14000
5.5	13500	15500

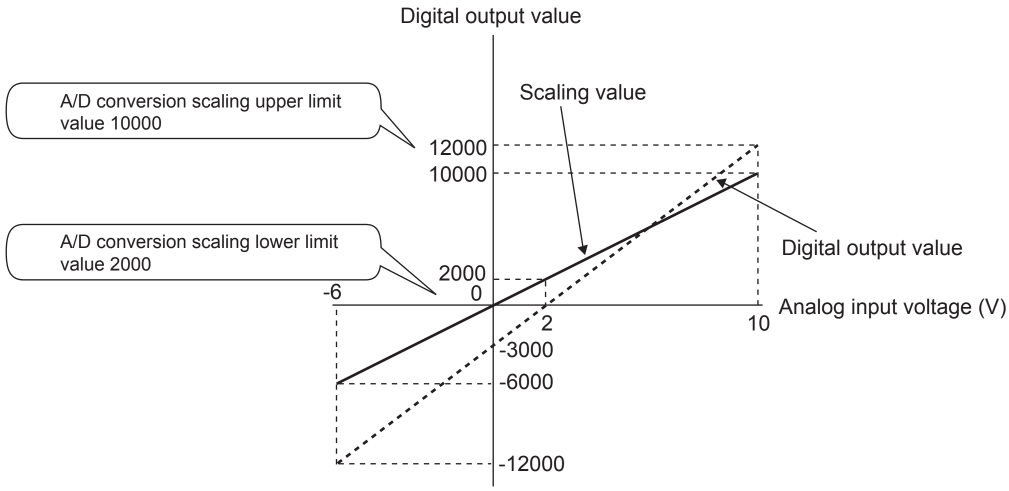
Ex. When the following values are set for a channel with a user range of 2 to 10V:

- "A/D conversion scaling enable/disable setting": Enable"
- "A/D conversion scaling upper limit value":
- "A/D conversion scaling lower limit value":



Scaling function (A/D conversion)	Set for scaling on A/D conversion.
A/D conversion scaling enable/disable setting	0:Enable
A/D conversion scaling upper limit value	10000
A/D conversion scaling lower limit value	2000

The following figure and table show the digital output values and the corresponding scaling values.



Analog input voltage (V)	Digital output values	Scaling value
-6	-12000	-6000
-4	-9000	-4000
-2	-6000	-2000
0	-3000	0
2	0	2000
4	3000	4000
6	6000	6000
8	9000	8000
10	12000	10000

8.10 Logging Function

A/D conversion

This function stores 10000 points of the digital output values or scaling values in the buffer memory for each channel. In addition, the data collection can be stopped by using the status change of the data as a trigger. The data retention around the trouble allows easy symptom analysis.

Point

To perform the logging function, select "Logging Function" in "Select Function" of "Switch Setting".
(☞ Page 55, Section 7.2)
If a function other than "Logging Function" is set for "Select Function" of "Switch Setting" and Enable (0) is set for CH□ Logging enable/disable setting (Un\G1000, Un\G1001), an error occurs. The error code (208□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.

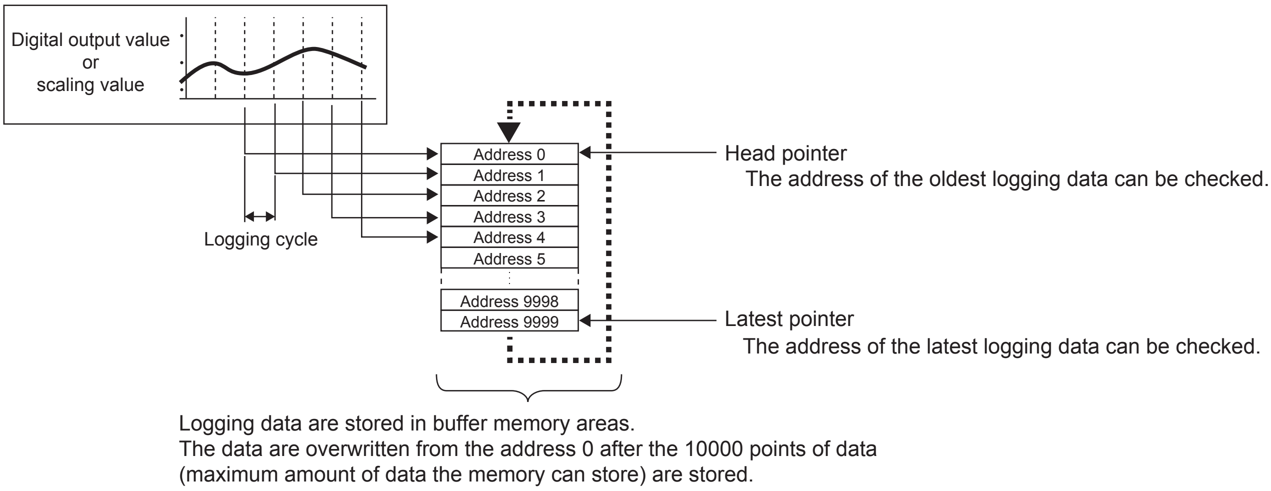
(1) Logging function

(a) Collecting logging data

Logging data is collected as follows.

- 10000 points of the latest digital output values or scaling values can be always collected for each channel.
- The data can be collected at intervals of 80μs at a minimum and of 3600s at a maximum.

An address where the latest/oldest data is stored can be checked with the latest/head pointer.

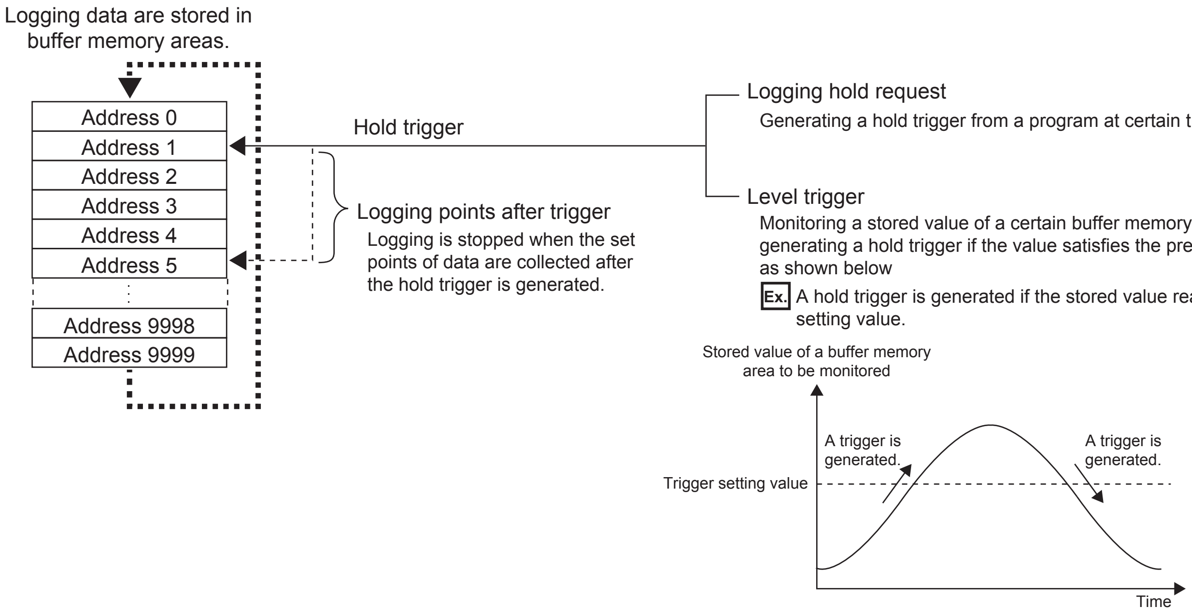


(b) Stopping the logging operation

The logging data is refreshed at high speed during logging. Stop logging when the logging data needs to be referred without paying attention to the refresh cycle.

Logging can be stopped by the hold trigger. (☞ Page 113, Section 8.10.1)

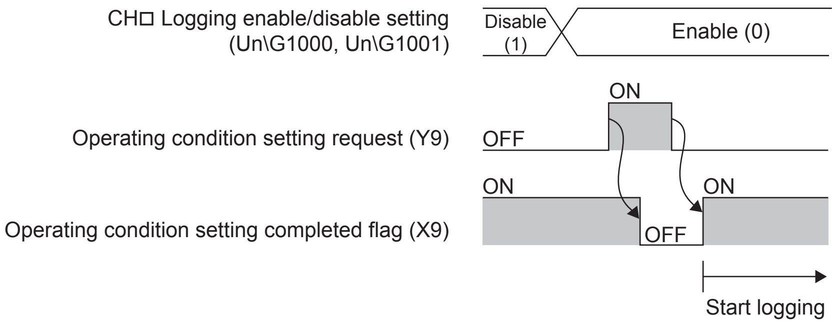
- A hold trigger allows two options: "Logging hold request" or "Level trigger".
- The number of data points to be collected after a hold trigger occurs can be set.



(2) Operation of logging

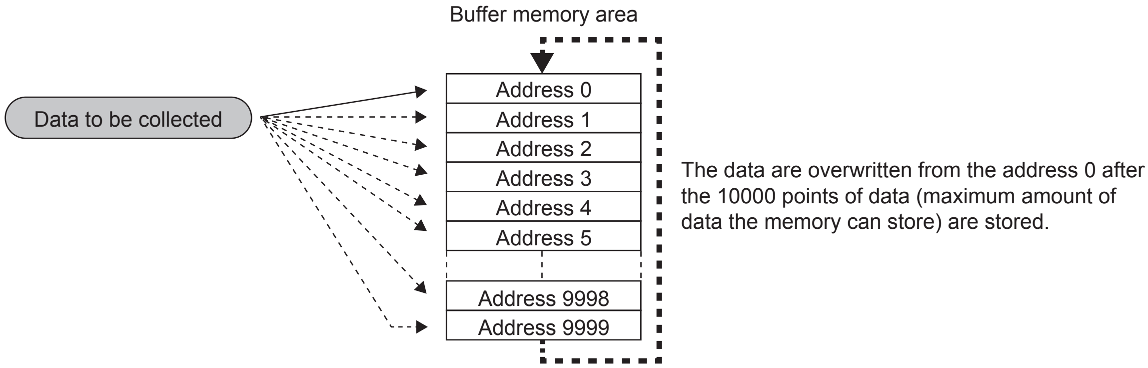
(a) Start of logging data collection

Logging data collection starts when Enable (0) is set to CH☐ Logging enable/disable setting (Un\G1000, Un\G1001) and Operating condition setting request (Y9) is turned on and off. Data are collected on the preset logging cycle.



(b) Logging data

Logging data are stored in the following buffer memory areas.



Channel	Storage area for logging data
CH1	CH1 Logging data (Un\G5000 to Un\G14999)
CH2	CH2 Logging data (Un\G15000 to Un\G24999)

If logging has been performed even once, all the data in CH☐ Logging data (Un\G5000 to Un\G24999) are cleared to 0 when Operating condition setting request (Y9) is turned on.

(3) Logging data setting

Select data type from the following with CH☐ Logging data setting (Un\G1024, Un\G1025).

- Digital output value (0)
- Scaling value (1)

(4) Logging cycle

(a) Logging cycle setting

Set the logging cycle with CH□ Logging cycle setting value (Un\G1032, Un\G1033) and CH□ Logging cycle unit setting (Un\G1040, Un\G1041).
Set the interval at which data are collected for CH□ Logging cycle setting value (Un\G1032, Un\G1033).
Set the unit of the interval at which data are collected for CH□ Logging cycle unit setting (Un\G1040, Un\G1041).

Setting value of CH□ Logging cycle unit setting (Un\G1040, Un\G1041)	Setting range of CH□ Logging cycle setting value (Un\G1032, Un\G1033)
μs(0)	80 to 32767
ms (1)	1 to 32767
s (2)	1 to 3600

The logging cycle must be an integral multiple of the conversion cycle. If the set logging cycle is not an integral multiple of the conversion cycle, the actual logging cycle becomes the integral multiple of the conversion cycle which is smaller than the set logging cycle.
The following table lists the conversion cycles of each A/D conversion method.

Conversion method	Conversion cycle
Sampling processing	0.08ms × Number of channels where A/D conversion is enabled
Time average	$\left(\frac{\text{Time set in "Time Average/Count Average/Moving Average"}}{\text{Conversion speed} \times \text{Number of used channels}}\right)^{*1} \times \text{Conversion speed} \times \text{Number of used channels}$
Count average	Number set in "Time Average/Count Average/Moving Average" × 0.08ms × Number of channels where A/D conversion is enabled
Moving average	0.08ms × Number of channels where A/D conversion is enabled

*1 Values after the decimal point are rounded down.

Ex. With the following settings, the conversion cycle is 160μs and the actual logging is performed every 6880μs (the integral multiple of 160μs). The values are stored in CH1 Logging cycle monitor value (Un\G1122 to Un\G1124) as shown in the table below.

- A/D conversion-enabled channels: CH1, CH2
- CH1 Averaging process setting: Sampling processing
- CH1 Logging cycle setting value: 7000
- CH1 Logging cycle unit setting: μs

Buffer memory address	Item		Stored value
1122	CH1 Logging cycle monitor value	s	0
1123		ms	6
1124		μs	880

(b) When the logging function becomes disabled

The logging is not performed when even one of the following errors occurs after the logging function is enabled and Operating condition setting request (Y9) is turned on and off.

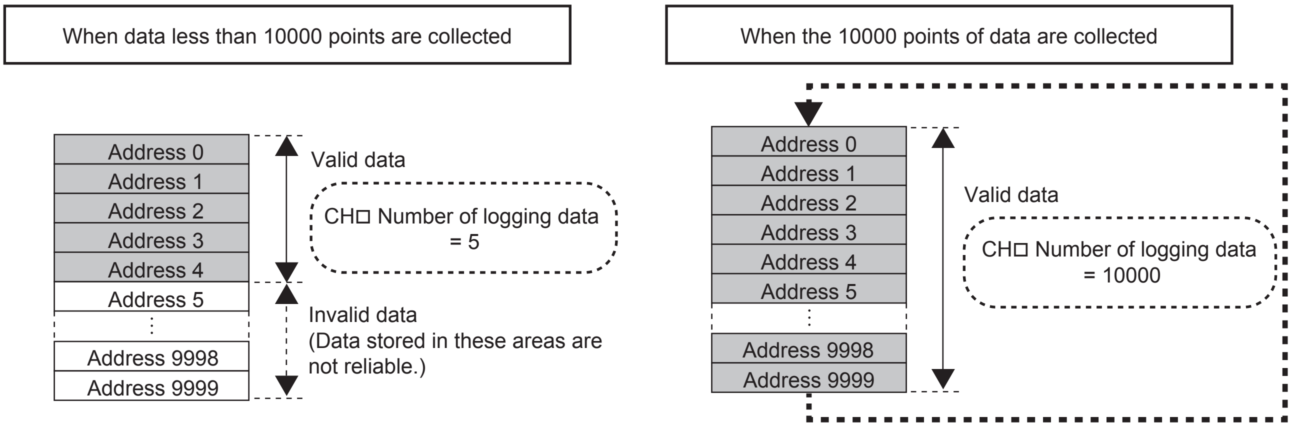
- Error code (20□): Setting error of CH□ Time Average/Count Average/Moving Average (Un\G1, Un\G2)
- Error code (30□): Setting error of CH□ Time Average/Count Average/Moving Average (Un\G1, Un\G2)
- Error code (31□): Setting error of CH□ Time Average/Count Average/Moving Average (Un\G1, Un\G2)
- Error code (200□ to 206□, 208□): Setting error of the parameter settings of the logging function

Point

When Operating condition setting request (Y9) is turned on and off on the condition that the logging cycle determined by CH□ Logging cycle setting value (Un\G1032, Un\G1033) and CH□ Logging cycle unit setting (Un\G1040, Un\G1041) is shorter than the conversion cycle, an error occurs and logging does not start. The error code (202□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.

(5) Number of logging data

The number of valid data in CH☐ Logging data (Un\G5000 to Un\G24999) can be checked with CH☐ Number of logging data (Un\G1106, Un\G1107).

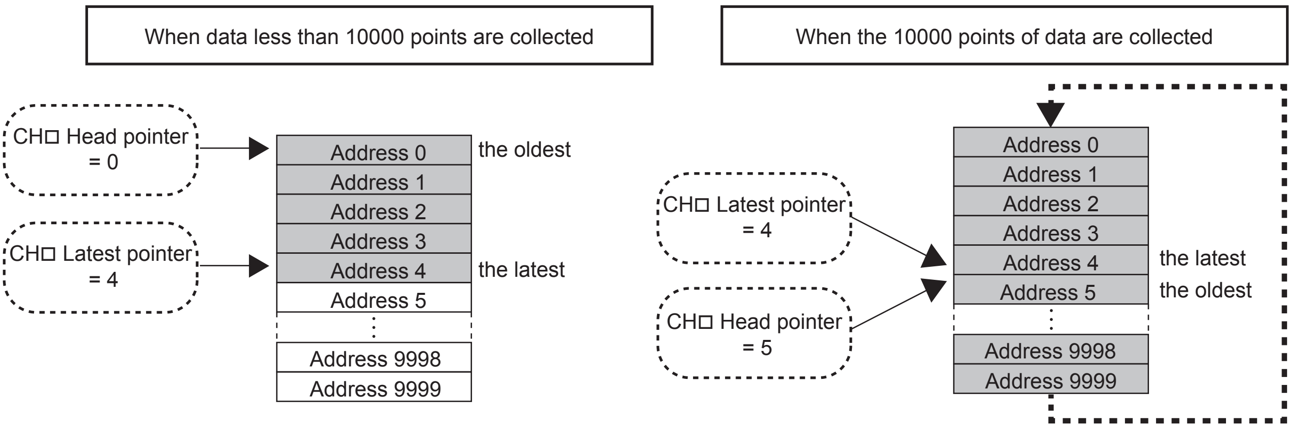


The number of logging data increases by one each time new data is stored.
When CH☐ Logging data (Un\G5000 to Un\G24999) becomes full (Number of logging data = 10000), the next data is stored in the first address of CH☐ Logging data (Un\G5000 to Un\G24999), and the logging operation continues overwriting the existing data. The number of logging data is fixed to 10000.

(6) Head pointer and latest pointer

The storage location of the oldest data and the latest data in CH☐ Logging data (Un\G5000 to Un\G24999) can be checked with the following buffer memory areas.

Buffer memory	Description
CH☐ Head pointer (Un\G1090, Un\G1091)	The buffer memory address of the oldest data in CH☐ Logging data (Un\G5000 to Un\G24999) can be checked with this buffer memory area. The offset value (0 to 9999) counted from the start address (Un\G5000, Un\G15000) of CH☐ Logging data (Un\G5000 to Un\G24999) is stored.
CH☐ Latest pointer (Un\G1098, Un\G1099)	The buffer memory address of the latest data in CH☐ Logging data (Un\G5000 to Un\G24999) can be checked with this buffer memory area. The offset value (0 to 9999) counted from the start address (Un\G5000, Un\G15000) of CH☐ Logging data (Un\G5000 to Un\G24999) is stored.



The head pointer does not change until CH☐ Logging data (Un\G5000 to Un\G24999) becomes full after the logging start (The value is fixed to 0). The head pointer moves by one point when CH☐ Logging data (Un\G5000 to Un\G24999) becomes full and the overwriting of data starts from the first address.

8

8.10 Logging Function

(7) Logging status monitor value

Logging status can be checked with CH□ Logging status monitor value (Un\G1146, Un\G1147).

Stored value of CH□ Logging status monitor value (Un\G1146, Un\G1147)	Logging status
FH	Logging is not performed.
0H	Waiting for a logging hold request (during logging)
1H	Waiting for a level trigger (during logging)
2H	A hold trigger has occurred. (during logging)
3H	A logging hold processing is completed and logging stops.

(8) Checking logging data without stopping the logging operation

Logging data can be checked during logging operation with CH□ Head pointer (Un\G1090, Un\G1091), CH□ Latest pointer (Un\G1098, Un\G1099), and CH□ Number of logging data (Un\G1106, Un\G1107).
To check logging data during logging operation, follow the precautions below because logging data may be refreshed while data is being read out.

- Set the cycle to CH□ Logging cycle setting value (Un\G1032, Un\G1033) so that data checking and reading surely complete before logging data is refreshed. If the logging cycle is short, logging data may be refreshed during data checking and reading.
- After obtaining the logging data which need to be checked, monitor the variation of the head pointer and the number of logging data, and obtain logging data just after the stored value has changed.
- If the data refresh and the data being checked do not synchronize due to the relationship between the logging cycle and the scan time of the CPU module, adjust the logging cycle.

To check the logging data without paying attention to logging cycle, stop the logging operation. (☞ Page 113, Section 8.10.1)

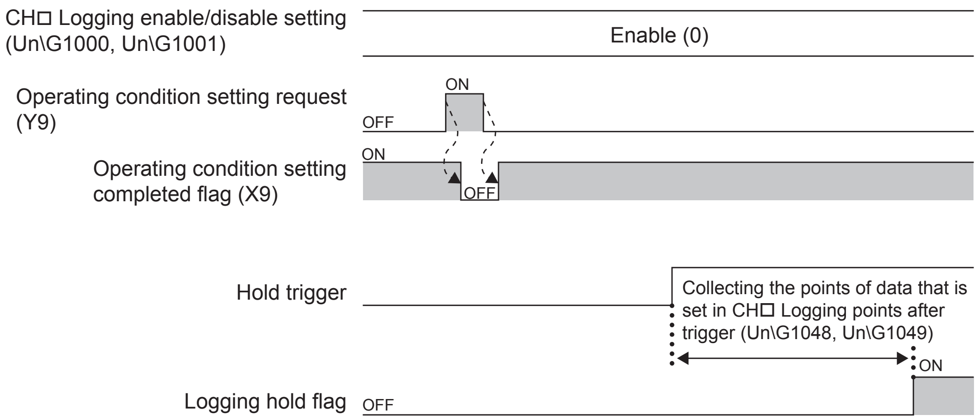
8.10.1 Stopping the logging operation

Logging operation stops (hold) when the preset trigger condition is satisfied and the set points of the data are collected.

A trigger that is generated when the condition is satisfied is called a hold trigger.
To generate a hold trigger, the following two methods are available.

- Logging hold request (☞ Page 117, Section 8.10.2)
- Level trigger (☞ Page 118, Section 8.10.3)

When a hold trigger is detected during data collection, the logging operation stops after the points of the data set in CH☐ Logging points after trigger (Un\G1048, Un\G1049) are collected.



(1) Logging points after trigger

Set the number of data collected in the period from the detection of a hold trigger to logging operation stop to CH☐ Logging points after trigger (Un\G1048, Un\G1049).

(2) Checking on logging stop

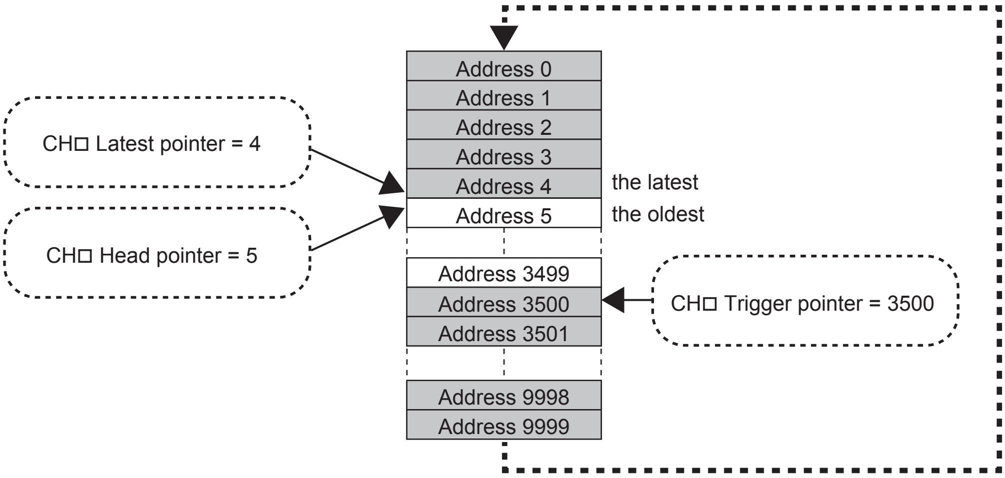
Check that CH☐ Logging hold flag (Un\G1016, Un\G1017) is on.

(3) Checking data when a hold trigger has occurred

The storage location of the data when a hold trigger has occurred can be checked with CH□ Trigger pointer (Un\G1114, Un\G1115). The offset value (0 to 9999) counted from the start address (Un\G5000, Un\G15000) of CH□ Logging data (Un\G5000 to Un\G24999) is stored in CH□ Trigger pointer (Un\G1114, Un\G1115).

Ex. The stored value of the trigger pointer when the logging operation stops under the following conditions

- CH1 Logging points after trigger (Un\G1048): 6505 points
- The data where a hold trigger has occurred: 3500th data



(a) Checking trigger detection time

The trigger detection time can be checked with CH□ Trigger detection time (Un\G1154 to Un\G1161). Even when the logging cycle is set to a period less than 1s, the minimum time unit recorded in the trigger detection time is second. Use the trigger detection time as an indication to refer to the logging data.

Ex. When CH1 Trigger detection time (Un\G1154 to Un\G1157) is monitored

	b15 to b8	b7 to b0
Un\G1154	First two digits of the year	Last two digits of the year
Un\G1155	Month	Day
Un\G1156	Hour	Minute
Un\G1157	Second	Day of the week

- First two digits of the year, last two digits of the year, month, day, hour, minute, and second are all stored in the BCD code.
- In the day of the week segment, one of the following values in the BCD code indicating the corresponding day is stored.

Sunday: 00H, Monday: 01H, Tuesday: 02H, Wednesday: 03H, Thursday: 04H, Friday: 05H, Saturday: 06H

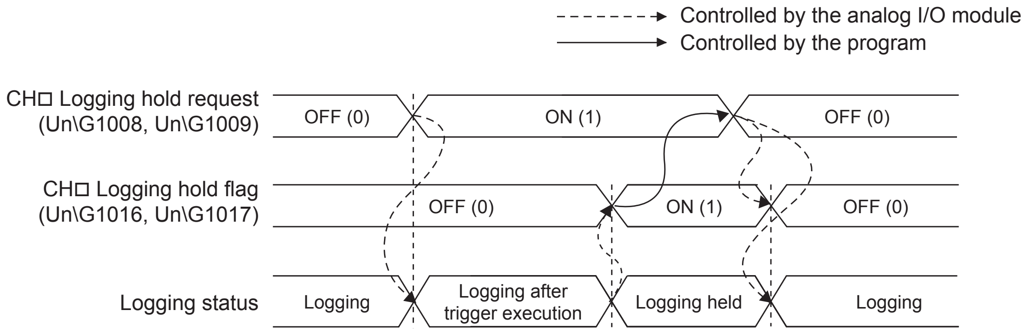
Point

The trigger detection time is obtained from the clock data of the CPU module. Therefore, when a hold trigger is generated right after the programmable controller system is powered on, the analog I/O module may not obtain the clock data from the CPU module. If the module could not obtain the time, the trigger detection time is recorded as "0:0:0 on January 1st, 2000".

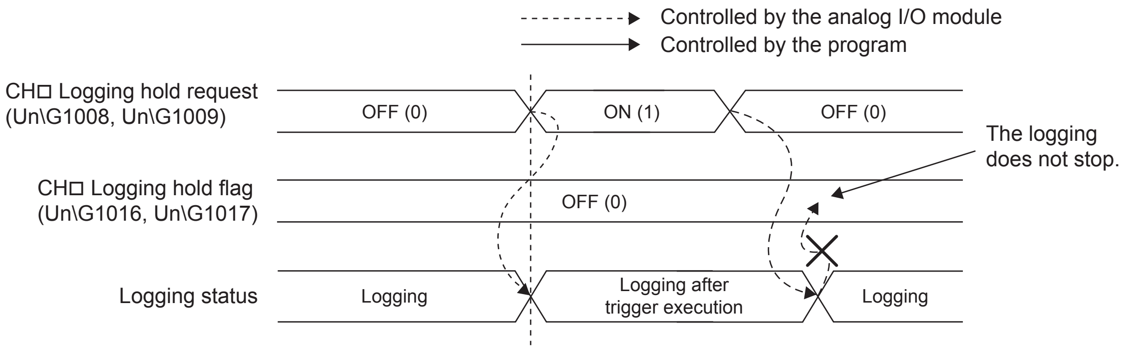
(4) Resuming logging

To resume logging, turn off CH□ Logging hold request (Un\G1008, Un\G1009). After logging resumes, the value is stored from the start buffer memory area of CH□ Logging data (Un\G5000 to Un\G24999).
In addition, OFF (0) is stored in CH□ Logging hold flag (Un\G1016, Un\G1017).

It may take time until ON (1) is stored in CH□ Logging hold flag (Un\G1016, Un\G1017) after CH□ Logging hold request (Un\G1008, Un\G1009) is turned on. To resume logging, check that ON (1) is stored in CH□ Logging hold flag (Un\G1016, Un\G1017) and turn off CH□ Logging hold request (Un\G1008, Un\G1009).



- Logging does not stop when CH□ Logging hold request (Un\G1008, Un\G1009) is turned off before ON (1) is stored in CH□ Logging hold flag (Un\G1016, Un\G1017).



(a) Buffer memory status when logging resumes

The following table shows the buffer memory status when logging resumes.

Buffer memory	Value status
CH☐ Head pointer (Un\G1090, Un\G1091)	Values are initialized (default value:
CH☐ Latest pointer (Un\G1098, Un\G1099)	
CH☐ Number of logging data (Un\G1106, Un\G1107)	
CH☐ Trigger pointer (Un\G1114, Un\G1115)	
CH☐ Logging status monitor value (Un\G1146, Un\G1147)	
CH☐ Trigger detection time (Un\G1154 to Un\G1161)	
CH☐ Logging data (Un\G5000 to Un\G24999)	• The values before logging resumes are not initialized. • After logging resumes, the value is stored from the start address (Un\G5000, Un\G15000) of CH☐ Logging data (Un\G5000 to Un\G24999). To refer to the logging data, check which area has valid data with CH☐ Number of logging data (Un\G1106, Un\G1107).

(5) Operation when the external power supply is off or an input signal error is detected

If the external power supply is off or an input signal error is detected during logging operation, logging stops after the points of the data set in the logging points after trigger are collected.
The following are the channels where logging stops.

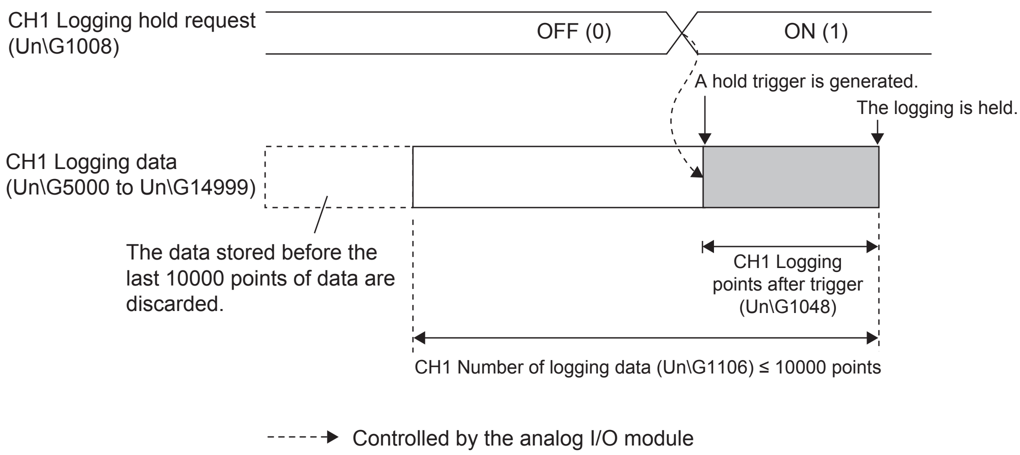
Cause of logging stop	Channel where logging stops
External power supply OFF	Logging stops for all channels where the logging functions are enabled.
Input signal error detection (when the input signal error detection function is enabled)	Logging stops only for the channels where input signal errors are detected.

ON (1) is not set to CH☐ Logging hold flag (Un\G1016, Un\G1017) in these cases.
In addition, logging does not resume even though the external power supply is turned on or an analog input value becomes normal. To resume logging, check the following items and turn on and off Operating condition setting request (Y9).

- The external power supply is on.
- An input signal error is not detected.
- The analog I/O module and external devices are normal.

8.10.2 Logging hold request

A hold trigger is generated from a program at any timing.
When CH☐ Logging hold request (Un\G1008, Un\G1009) is turned on, a preset number of the data is collected and the logging stops.



Point

- The following delay time occurs until the analog I/O module receives a hold trigger after CH☐ Logging hold request (Un\G1008, Un\G1009) is turned on.
  Trigger delay = Logging cycle (Actual logging cycle) + Scan time of the CPU module
- Check that CH☐ Logging hold flag (Un\G1016, Un\G1017) is turned on and turn off CH☐ Logging hold request (Un\G1008, Un\G1009). If CH☐ Logging hold request (Un\G1008, Un\G1009) is turned off before the logging stops, the logging does not stop.
- If a value other than OFF (0) and ON (1) is set to CH☐ Logging hold request (Un\G1008, Un\G1009), an error occurs. The error code (207☐) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.

(1) Checking on logging stop

Check that CH☐ Logging hold flag (Un\G1016, Un\G1017) is on.

8.10.3 Level trigger

When a value in the monitored buffer memory area of the analog I/O module satisfies a preset condition, a hold trigger is generated.
The target data of a level trigger is monitored on the refresh cycle of the digital output value or the scaling value.

(1) Initial setting of a level trigger

(a) Setting of a target to be monitored

As a condition to generate a hold trigger, set the buffer memory address to be monitored to CH☐ Trigger data (Un\G1064, Un\G1065).

Item	Setting range
CH☐ Trigger data (Un\G1064, Un\G1065)	0 to 4999

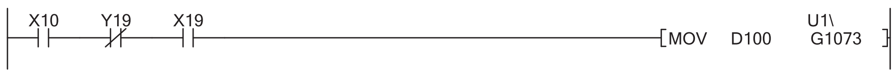
To monitor a device value of a module other than the analog I/O module such as a device of the CPU module, configure the setting as shown below.

- Set a value between 1072 and 1081 (Level data ☐ (Un\G1072 to Un\G1081)) to CH☐ Trigger data (Un\G1064, Un\G1065).
- Write a value of the monitored device to Level data ☐ (Un\G1072 to Un\G1081) by using the MOV instruction.

Item	Setting range
Level data☐ (Un\G1072 to Un\G1081)	-32768 to 32767

Ex. Usage example of Level data☐ (Un\G1072 to Un\G1081): To monitor the data register D100 in the CPU module and operate the level trigger in CH1, create a program as follows.

1. **Set 1073 (Level data 1) to CH1 Trigger data (Un\G1064). (When Level data 1 is used)**
2. **Store the storage data of D100 in Level data 1 (Un\G1073) by the program continuously. (The start I/O number is set to 10H in the following program example.)**

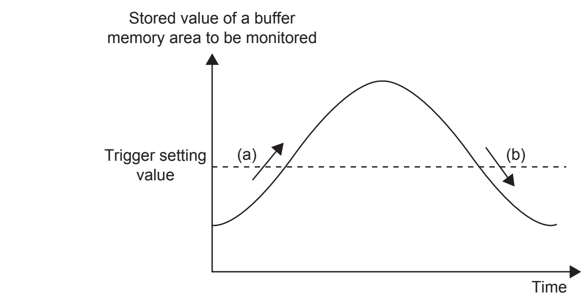


Point

Specify appropriate data such as CH☐ Digital output value (Un\G11, Un\G12), CH☐ Scaling value (Un\G54, Un\G55), and Level data ☐ (Un\G1072 to Un\G1081) to CH☐ Trigger data (Un\G1064, Un\G1065). When a setting area or a system area is specified, normal operation is not guaranteed.

(b) Setting of the condition

- Set a condition to generate a hold trigger to CH☐ Level trigger condition setting (Un\G1056, Un\G1057).

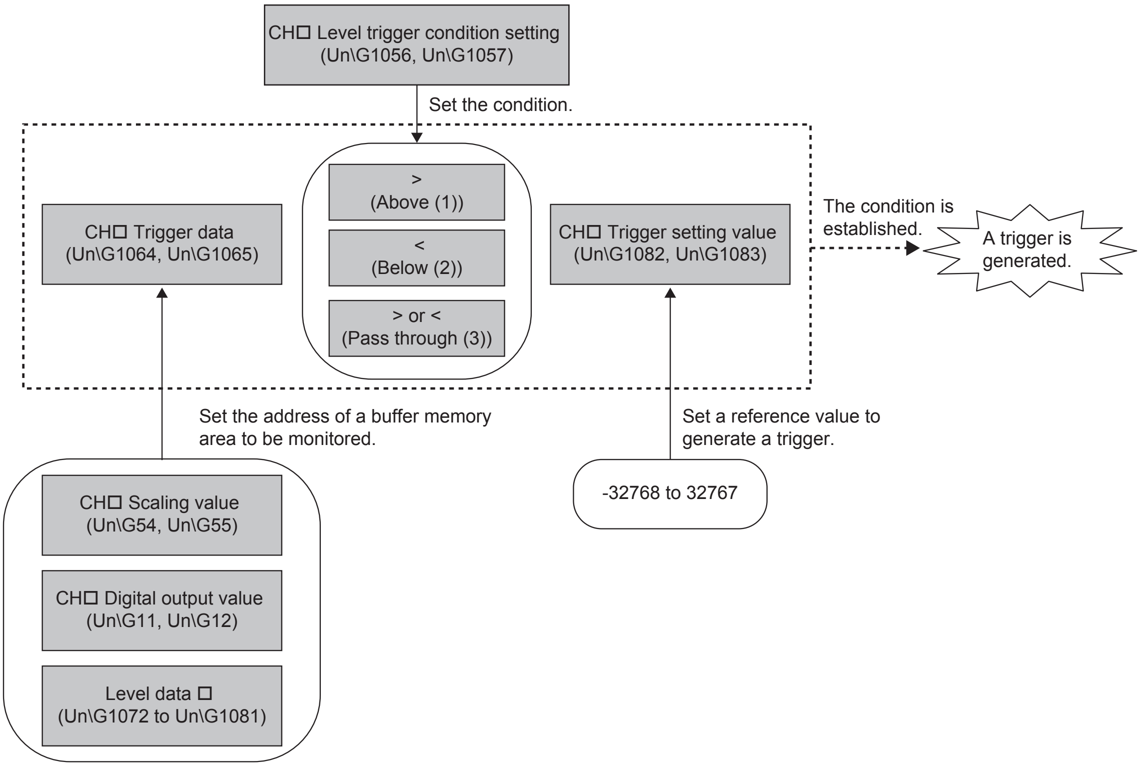
Setting value	Description	
Above (1)		A hold trigger is generated under the condition (a).
Below (2)		A hold trigger is generated under the condition (b).
Pass through (3)	A hold trigger is generated when the relation between the values changes from "Stored value of a buffer memory area to be monitored ≤ Trigger setting value" to "Stored value of a buffer memory area to be monitored > Trigger setting value".	A hold trigger is generated under the condition (a) or (b).

- Set a value where a hold trigger is generated to CH☐ Trigger setting value (Un\G1082, Un\G1083).

Item	Setting range
CH☐ Trigger setting value (Un\G1082, Un\G1083)	-32768 to 32767

Point

The following figure shows the relation between setting items to be configured for the initial setting of a level trigger.



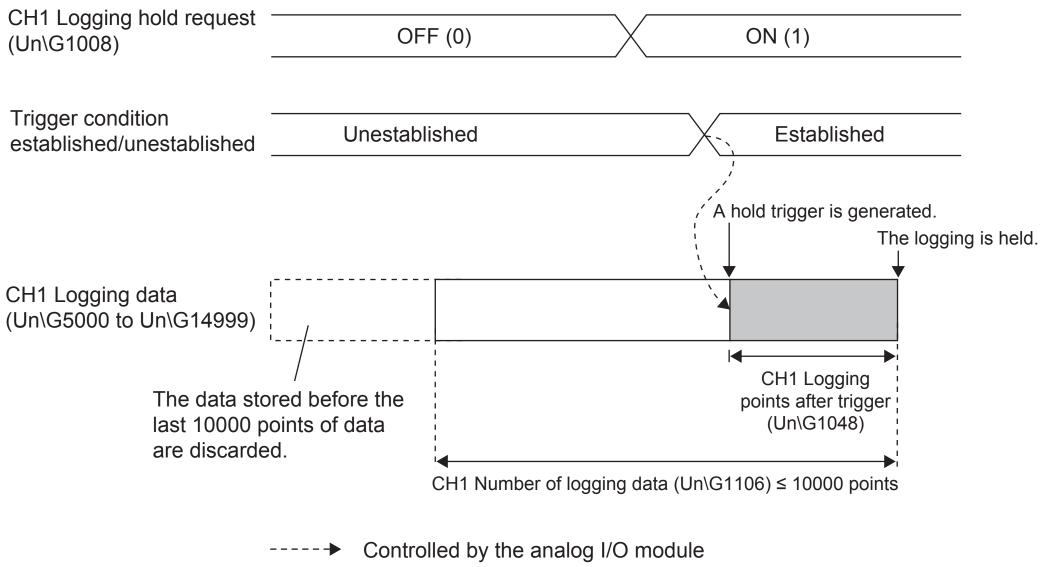
To generate a hold trigger when the value in CH1 Digital output value becomes greater than 10000, configure settings as follows.

- CH1 Level trigger condition setting (Un\G1056): Above (1)
- CH1 Trigger data (Un\G1064): 11
- CH1 Trigger setting value (Un\G1082): 10000

(2) Operation of a level trigger

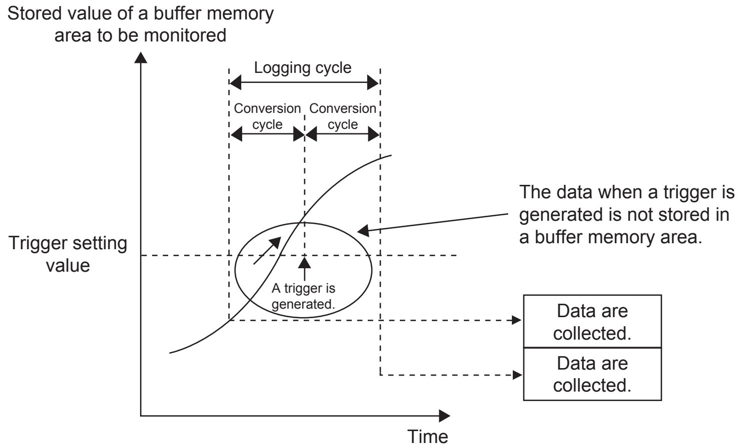
To use a level trigger, turn on CH□ Logging hold request (Un\G1008, Un\G1009) in advance. At the point where CH□ Logging hold request (Un\G1008, Un\G1009) is turned on, the module becomes the trigger condition wait status.

Data collection starts when the trigger condition has been satisfied, and stops when the set points of the data have been collected.



Point

The target data of a level trigger is detected on the refresh cycle of the digital output value or the scaling value. Therefore, the data when a hold trigger is generated may not be stored in CH□ Logging data (Un\G5000 to Un\G24999) depending on the setting of the logging cycle. To store the data when a hold trigger is generated in CH□ Logging data (Un\G5000 to Un\G24999), arrange related settings so that the conversion cycle of the target value (trigger data) and the logging cycle (actual logging cycle) have the same time period.



(a) Checking on logging stop

Check that CH□ Logging hold flag (Un\G1016, Un\G1017) is on.

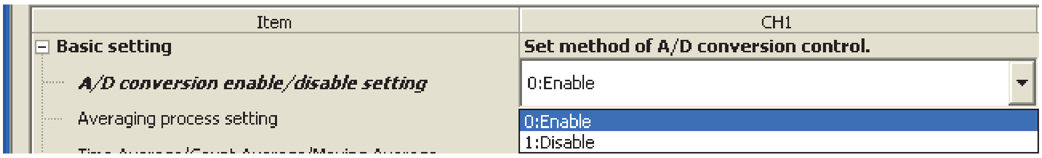
8.10.4 Initial setting for the logging function

The following are the initial setting procedure to use the logging function.

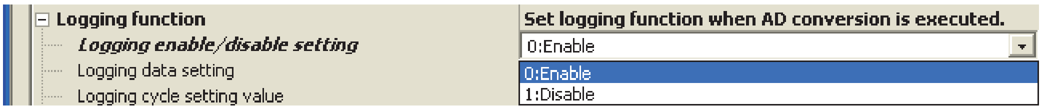
(1) Setting procedure

1. Set "A/D conversion enable/disable setting" to "0: Enable".

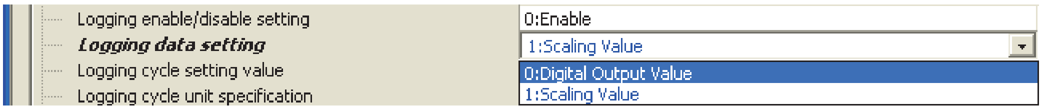
Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(A/D_Conversion)]



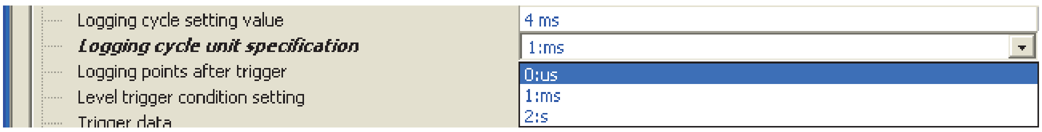
2. Set "Logging enable/disable setting" to "0: Enable".



3. Set the target data in "Logging data setting".

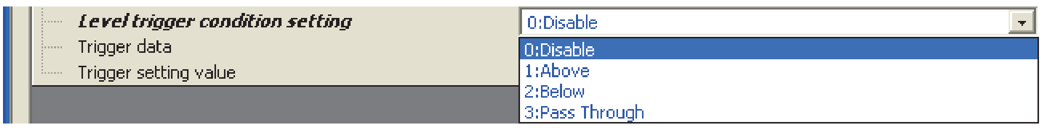


4. Select a unit of "Logging cycle setting value" in "Logging cycle unit specification", and set the cycle of storing logging data to "Logging cycle setting value".



5. Set "Logging points after trigger" to the number of the data points collected for the time period from a hold trigger occurrence to logging stop.

6. Set a condition to generate a hold trigger in "Level trigger condition setting". When "Level trigger condition setting" is set to "0: Disable", skip the procedure 7 and 8.



7. Set the buffer memory address to be monitored using a level trigger to "Trigger data".

8. Set "Trigger setting value" to a level where a level trigger operates.

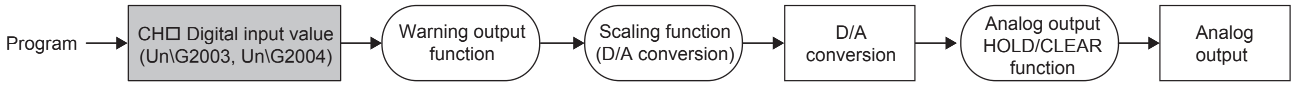
8.11 Processing Order of Each D/A Conversion Function

D/A conversion

The following six types of D/A conversion are provided. Those types use different functions selected for "Select Function" of "Switch Setting".

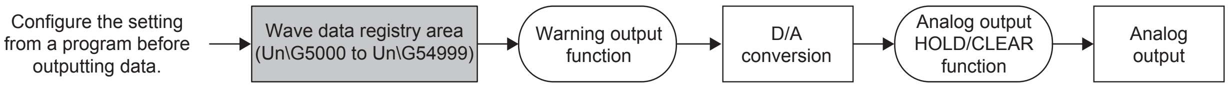
(1) Normal output

Normal output is an analog output method used when the logging function is selected.
The value written in CH☐ Digital input value (Un\G2003, Un\G2004) is converted into an analog value and the analog value is output.



(2) Wave output

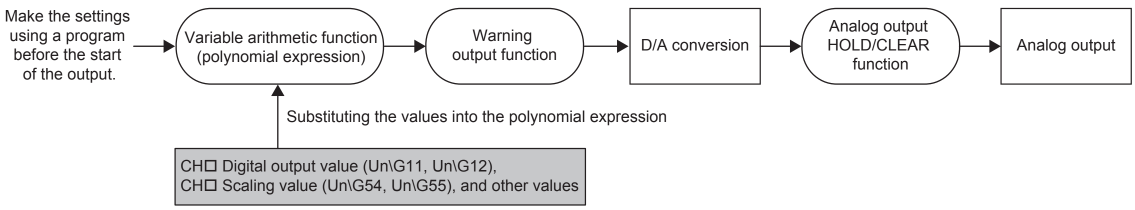
Wave output is an analog output method used when the wave output function is selected.
The values registered in Wave data registry area (Un\G5000 to Un\G54999) are successively converted from digital to analog and output.



For details of the wave output function, refer to the following.
Wave Output Function (☞ Page 144, Section 8.18)

(3) Analog output of the variable arithmetic function

Analog output of the variable arithmetic function is an analog output method used when the variable arithmetic function is selected.
The operation result calculated by the arithmetic expression registered in the analog I/O module is converted into an analog value and the analog value is output.



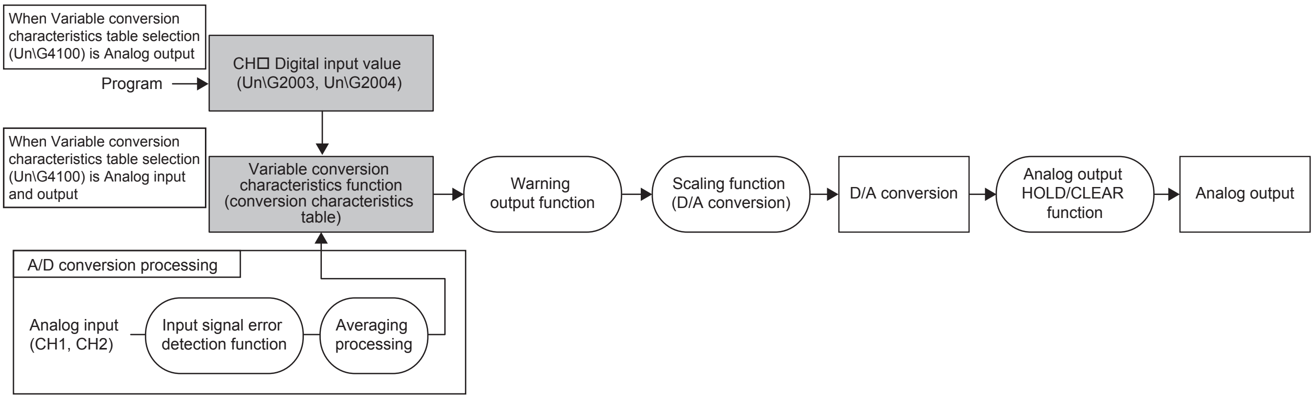
For details on the variable arithmetic function, refer to the following.
Variable Arithmetic Function (☞ Page 192, Section 8.19)

(4) Analog output of the variable conversion characteristics function

Analog output of the variable conversion characteristics function is an analog output method used when the variable conversion characteristics function is selected.

The operation of analog output varies depending on the setting value of Variable conversion characteristics table selection (Un\G4100).

Variable conversion characteristics table selection (Un\G4100)	Analog output
Analog Input	Analog output is performed in the operation of "normal output". (☞ Page 122, Section 8.11 (1))
Analog output	CH□ Digital input value (Un\G2003, Un\G2004) is used as an address of the conversion characteristics table and the data corresponding to the address is converted into an analog value and the analog value is output.
Analog I/O	The A/D conversion values of CH1 and CH2 are used as the address of conversion characteristics table and the data corresponding to the address is converted into an analog value and the analog value is output.



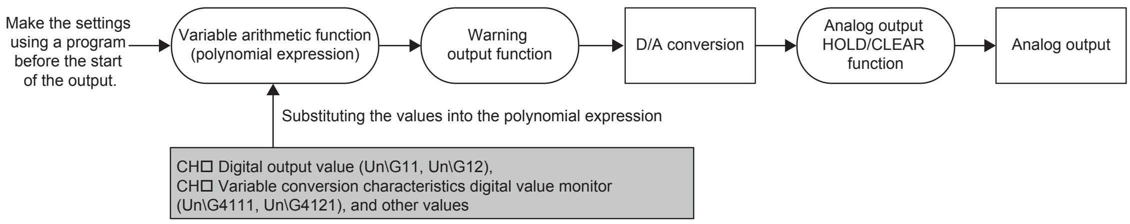
For details on the variable conversion characteristics function, refer to the following.

Variable Conversion Characteristics Function (☞ Page 212, Section 8.20)

(5) Analog output of the variable conversion characteristics function + variable arithmetic function

Analog output of the variable conversion characteristics function + variable arithmetic function is an analog output method used when the variable conversion characteristics function + variable arithmetic function is selected.

The operation result calculated by the arithmetic expression registered in the analog I/O module is converted into an analog value and the analog value is output. The digital value converted according to the conversion characteristics table can be used for polynomial expressions.



For details on the variable conversion characteristics function + variable arithmetic function, refer to the following.

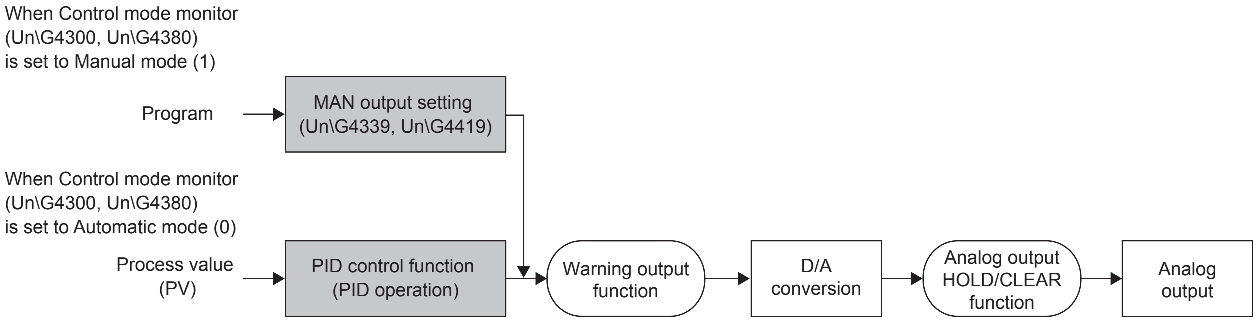
Variable Conversion Characteristics Function + Variable Arithmetic Function (☞ Page 239, Section 8.21)

(6) Analog output of the PID control function

Analog output of the PID control function is an analog output method used when the PID control function is selected.

Control mode monitor (Un\G4300, Un\G4380)*1	Analog output
Automatic mode (0)	The PID operation is performed using the value set in CH☐ Digital output value (Un\G11, Un\G12) as the process value (PV). The obtained output conversion value is converted into an analog value and the analog value is output.
Manual mode (1)	The value written in MAN output setting (Un\G4339, Un\G4419) is converted into an analog value and the analog value is output.

*1 Set the control mode with Control mode switching (Un\G4320, Un\G4400).



For details on the PID control function, refer to the following.

PID Control Function (☞ Page 246, Section 8.22)

8.12 D/A Conversion Enable/Disable Function

D/A conversion

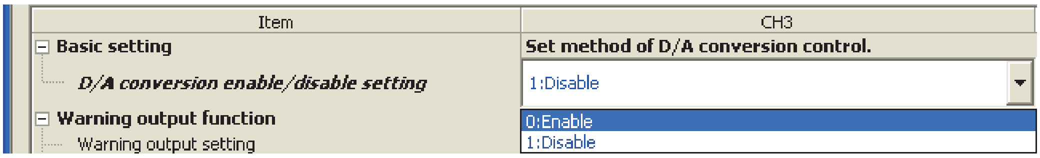
This function sets whether to enable or disable D/A conversion for each channel.
The conversion speed of this module varies depending on the setting of "Select Function".

Setting value of "Select Function"	Conversion speed
Logging Function	80µs/channel
Wave Output Function	
Free Conversion Characteristics Function	100µs/channel
Free Operation Function	320µs/2 channels
Free Conversion Characteristics Function + Free Operation Function	
PID Control Function	200µs/channel

(1) Setting procedure

1. Set "D/A conversion enable/disable setting" to "0: Enable".

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(D/A_Conversion)]



8.13 D/A Output Enable/Disable Function

D/A conversion

This function sets whether to output the D/A converted value or the offset value, for each channel.
The conversion speed is a constant, regardless of the output enable/disable status.

(1) Setting procedure

Set the type of output value with CH□ Output enable/disable flag (Y3, Y4).

CH□ Output enable/disable flag (Y3, Y4)	Analog output
Enable (ON)	The D/A conversion value is output.
Disable (OFF)	The offset value is output.

8.14 Analog Output HOLD/CLEAR Function

D/A conversion

This function sets whether to hold the output analog value (HOLD) or clear the output analog value (CLEAR) when the CPU module operating status is RUN, STOP, or stop error.

(1) Analog output status and combinations of settings

The analog output status varies depending on the setting of "Select Function". The following shows the analog output status and the combinations of settings.

(a) Normal output

With the following setting, the analog output status changes as shown in the following table, depending on the combination of the settings for D/A conversion enable/disable setting (Un\G2000) and CH□ Output enable/disable flag (Y3, Y4).

- "Select Function" is set to "Logging Function".
- "Select Function" is set to "Free Operation Function".
- "Select Function" is set to "Free Conversion Characteristics Function" and Variable conversion characteristics table selection (Un\G4100) is set to Analog input (0).
- "Select Function" is set to "Free Conversion Characteristics Function + Free Operation Function".

Execution status	D/A conversion enable/disable setting (Un\G2000)	Enable			Disable
	CH□ Output enable/disable flag (Y3, Y4)	Enable		Disable	Enable or disable
	Analog output HOLD/CLEAR function setting	HOLD	CLEAR	HOLD or CLEAR	HOLD or CLEAR
Analog output produced when the CPU module is in the RUN status		An analog value converted from the corresponding digital input value through D/A conversion is output.*3		Offset value	0V/0mA
Analog output produced when the CPU module is in the STOP state		Hold	Offset value	Offset value*2	0V/0mA
Analog output produced when the CPU module is in the stop error state		Hold	Offset value	Offset value	0V/0mA
Analog output produced when a watchdog timer error*1 occurs		0V/0mA	0V/0mA	0V/0mA	0V/0mA

*1 The error occurs due to a hardware failure of the analog I/O module or other causes. Module READY (X0) and the RUN LED of the analog I/O module turn off.

*2 The following operation is performed when the CPU module is in the STOP state, D/A conversion enable/disable setting (Un\G2000) is set to D/A conversion enable (0) for the channel where HOLD is set, and Operating condition setting request (Y9) is turned on and off.

- When Output enable/disable flag is off: Outputs 0V/0mA.
- When Output enable/disable flag is turned on: Outputs the offset value.

*3 When the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function is set, an analog value converted from the corresponding digital value in Variable arithmetic value for analog output (Un\G4003, Un\G4007) through D/A conversion is output.

(b) Wave output

With the following setting, the analog output status changes as shown in the following table, depending on the combination of the settings for D/A conversion enable/disable setting (Un\G2000) and CH□ Output enable/disable flag (Y3, Y4).

- "Select Function" is set to "Wave Output Function".

Execution status	D/A conversion enable/disable setting (Un\G2000)	Enable							Disable
	CH□ Output enable/disable flag (Y3, Y4)	Enable						Disable	Enable or disable
	Analog output HOLD/CLEAR function setting	HOLD			CLEAR			HOLD or CLEAR	HOLD or CLEAR
	Wave output status	Output	Stop	Pause	Output	Stop	Pause	Stop	Stop
Analog output produced when the CPU module is in the RUN status		Wave data	*2	Hold	Wave data	*2	Offset value	Offset value	0V/0mA
Analog output produced when the CPU module is in the STOP status		Hold			Offset value			Offset value	0V/0mA
Analog output produced when the CPU module is in the stop error status		Hold			Offset value			Offset value	0V/0mA
Analog output produced when a watchdog timer error*1 occurs		0V/0mA			0V/0mA			0V/0mA	0V/0mA

*1 The error occurs due to a hardware failure of the analog I/O module or other causes. Module READY (X0) and the RUN LED of the analog I/O module turn off.

*2 Analog output is produced according to the setting in CH□ Output setting during wave output stop (Un\G3010, Un\G3011).

(c) Output with variable conversion characteristics

With the following setting, the analog output status changes as shown in the following table, depending on the combination of the settings for D/A conversion enable/disable setting (Un\G2000) and CH□ Output enable/disable flag (Y3, Y4).

- "Select Function" is set to "Free Conversion Characteristics Function" and Variable conversion characteristics table selection (Un\G4100) is set to Analog output (1) to Analog I/O (2).

Execution status	D/A conversion enable/disable setting (Un\G2000)	Enable			Disable
	CH□ Output enable/disable flag (Y3, Y4)	Enable		Disable	Enable or disable
	Analog output HOLD/CLEAR function setting	HOLD	CLEAR	HOLD or CLEAR	HOLD or CLEAR
Analog output produced when the CPU module is in the RUN state		An analog value converted from the corresponding digital value through D/A conversion with the analog output conversion characteristics table or analog I/O conversion characteristics table is output.		Offset value*2	0V/0mA
Analog output produced when the CPU module is in the STOP state		Hold	Offset value*2	Offset value*2	0V/0mA
Analog output produced when the CPU module is in the stop error state		Hold	Offset value*2	Offset value*2	0V/0mA
Analog output produced when a watchdog timer error*1 occurs		0V/0mA	0V/0mA	0V/0mA	0V/0mA

*1 The error occurs due to a hardware failure of the analog I/O module or other causes. Module READY (X0) and the RUN LED of the analog I/O module turn off.

*2 This value is the factory default setting offset value.

(d) PID control

With the following setting, the analog output status changes as shown in the following table, depending on the combination of the settings for D/A conversion enable/disable setting (Un\G2000), CH☐ Output enable/disable flag (Y3, Y4), and PID continuation flag on HOLD (Un\G4341, Un\G4421), and the stored value of Control mode monitor (Un\G4300, Un\G4380).

- "Select Function" is set to "PID Control Function".

<table>
<tr><th rowspan="6">Execution status</th><th>A/D conversion enable/disable setting (Un\G0)</th><th colspan="8">Enable</th><th colspan="2">Disable</th></tr>
<tr><th>D/A conversion enable/disable setting (Un\G2000)</th><th colspan="7">Enable</th><th>Disable</th><th>Enable</th><th>Disable</th></tr>
<tr><th>CH☐ Output enable/disable flag (Y3, Y4)</th><th colspan="6">Enable</th><th>Disable</th><th colspan="3">Enable or disable</th></tr>
<tr><th>Analog output HOLD/CLEAR function setting</th><th colspan="4">HOLD</th><th colspan="2">CLEAR</th><th colspan="4">HOLD or CLEAR</th></tr>
<tr><th>Control mode monitor (Un\G4300, Un\G4380)*1</th><th colspan="2">Automatic mode</th><th colspan="2">Manual mode</th><th>Automatic mode</th><th>Manual mode</th><th colspan="4">Automatic mode or manual mode</th></tr>
<tr><th>PID continuation flag on HOLD (Un\G4341, Un\G4421)</th><th>Continue PID operation</th><th>Hold output</th><th>Continue PID operation</th><th>Hold output</th><th colspan="6">Continue PID operation or hold output</th></tr>
<tr><td colspan="2">Analog output produced when the CPU module is in the RUN state</td><td colspan="2">*3</td><td colspan="2">*4</td><td>*3</td><td>*4</td><td>Offset value</td><td>0V/0mA</td><td>Offset value</td><td>0V/0mA</td></tr>
<tr><td colspan="2">Analog output produced when the CPU module is in the STOP state</td><td>*3</td><td>Hold*5</td><td>*4</td><td>Hold</td><td>Offset value*5</td><td>Offset value</td><td>Offset value</td><td>0V/0mA</td><td>Offset value</td><td>0V/0mA</td></tr>
<tr><td colspan="2">Analog output produced when the CPU module is in the stop error state</td><td>*3</td><td>Hold</td><td>*4</td><td>Hold</td><td>Offset value</td><td>Offset value</td><td>Offset value</td><td>0V/0mA</td><td>Offset value</td><td>0V/0mA</td></tr>
<tr><td colspan="2">Analog output produced when a watchdog timer error*2 occurs</td><td colspan="10">0V/0mA</td></tr>
</table>

*1 Set the control mode with Control mode switching (Un\G4320, Un\G4400).

*2 The error occurs due to a hardware failure of the analog I/O module or other causes. Module READY (X0) and the RUN LED of the analog I/O module turn off.

*3 The result of the PID operation is stored in Output conversion value (Un\G4302, Un\G4382) and an analog value converted from the corresponding digital value is output.

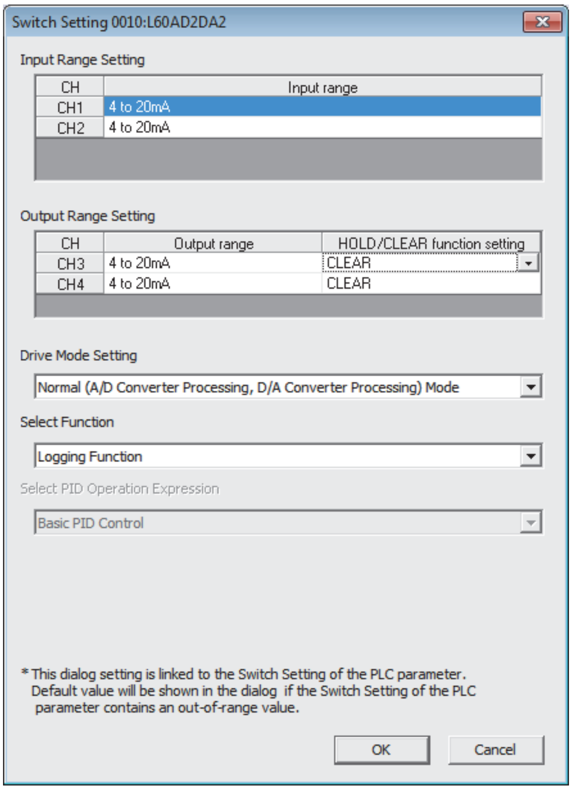
*4 The value set in MAN output setting (Un\G4339, Un\G4419) is used as the manipulated value (MV) and output as an analog value.

*5 When the CPU module is in the STOP state, the PID operation stops. When the CPU module state is changed to RUN from STOP, the PID operation starts from the beginning.

(2) Setting procedure

Set "HOLD/CLEAR function setting".

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Switch Setting]



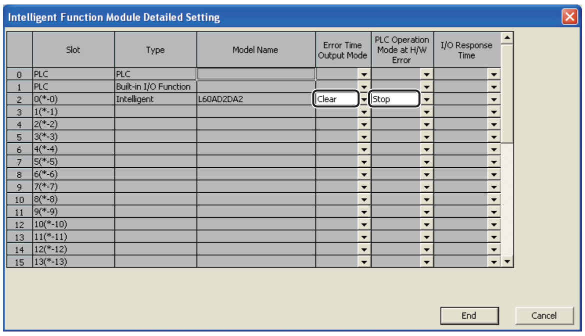
(3) When using the analog output HOLD/CLEAR function with the module connected to the head module

The following describes the conditions for using the analog output HOLD/CLEAR function when the analog I/O module is connected to the head module.

- Enable the block data assurance per station of the cyclic data on the send side.
- To hold the D/A conversion output when a link error occurs, set "Hold" for "Error Time Output Mode"*1 of the I/O assignment setting. The analog output HOLD/CLEAR function setting of the switch setting is disabled.

This setting is enabled module by module. Setting by each channel is not available. To match the output status given when CPU module is in the stop error or STOP status with that given when a link error occurs, choose the same setting for the analog output HOLD/CLEAR function setting for all the channels.

Project window ⇨ [Parameter] ⇨ [PLC Parameter] ⇨ [I/O Assignment]
⇨ Detailed Setting



Operating status	Error Time Output Mode*1	Analog output HOLD/CLEAR function setting (Make the same setting for all the channels.)
Holds the analog output	Hold	HOLD
Clears the analog output (Outputs the offset value)	Clear	CLEAR

For the block data assurance per station of cyclic data, refer to the following manual.
MELSEC-Q CC-Link IE Field Network Master/Local Module User's Manual
MELSEC-L CC-Link IE Field Network Master/Local Module User's Manual

*1 Situation in which Error Time Output Mode takes effect
- When a data link stops due to a network error
- When a data link stops for the CC-Link IE Field diagnostic of GX Works2

8.15 Analog Output Test When CPU Module Is in STOP Status

D/A conversion

Analog output tests can be carried out when the CPU module is in the STOP status.
The following functions are enabled during the analog output test.

- Scaling Function (D/A Conversion) (except when the variable arithmetic function, the variable conversion characteristics function, or the PID control function is used) (☞ Page 134, Section 8.16)
- Warning Output Function (☞ Page 141, Section 8.17)

When a digital input value out of the range is written to each channel, an error (error code: 60□) occurs and the corresponding check code is stored in CH□ Set value check code (Un\G2013, Un\G2014).
For the analog output test of wave output, refer to the following.

- Wave output step action function (☞ Page 183, Section 8.18.4)

(1) Setting procedure

To carry out an analog output test, make settings in the device test of GX Works2 following the procedure shown below.

1. **Set D/A conversion enable/disable setting (Un\G2000) to D/A conversion enable (0) for the channel where the analog output test is necessary.**
2. **Turn on Operating condition setting request (Y9).**
3. **Check that Operating condition setting completed flag (X9) turns off, and turn off Operating condition setting request (Y9).**
4. **Set the digital input value equivalent to the analog value to be output for CH□ Digital input value (Un\G2003, Un\G2004) in the buffer memory.**
5. **Turn on CH□ Output enable/disable flag (Y3, Y4) for the channel where the analog output test is necessary.**

Setting combination	D/A conversion enable/disable setting (Un\G2000)	Enable		Disable	
	CH□ Output enable/disable flag (Y3, Y4)	Enable	Disable	Enable	Disable
Analog output test		Allowed	Not allowed	Not allowed*1	

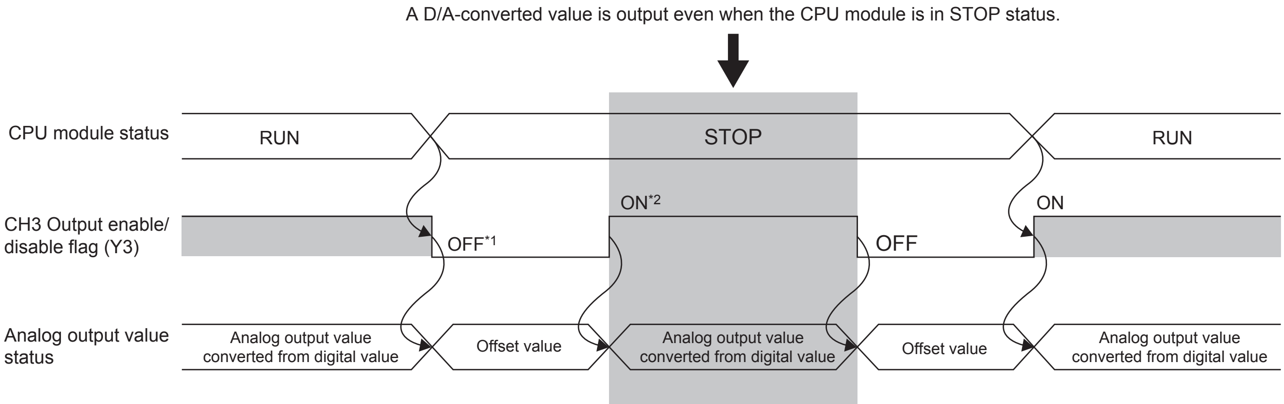
*1 When carrying out the analog output test, set D/A conversion enable/disable setting (Un\G2000) to D/A conversion enable (0) beforehand.

Point

- When "Select Function" is set to "Free Conversion Characteristics Function" and Variable conversion characteristics table selection (Un\G4100) is set to Analog I/O (2), change the setting of Variable conversion characteristics table selection (Un\G4100) to Analog output (1) and perform the analog output test.
- When "Select Function" is set to "PID Control Function", change the setting of Control mode switching (Un\G4320, Un\G4400) to Manual mode (1). Instead of step 4 above, set the manipulated value (MV) equivalent to the analog value to be output in MAN output setting (Un\G4339, Un\G4419). Perform the analog output test.

(2) Operation timing

By forcibly turning on CH□ Output enable/disable flag (Y3, Y4) when the CPU module is in the STOP state, the analog output value is changed from the offset value to the D/A-converted analog value.
The following diagram shows how the analog output value changes according to the status of CH3 Output enable/disable flag (Y3) when the CPU module is in the STOP status.



*1 CH3 Output enable/disable flag (Y3) turns off when the status is changed into CPU STOP.
*2 By forcibly turning on CH3 Output enable/disable flag (Y3), the analog output value is changed from the offset value to the D/A-converted analog value.

Point

When the module is connected to the head module, analog output tests can be carried out even when the CPU module of the master station causes a stop error.

8.16 Scaling Function (D/A Conversion)

D/A conversion

This function performs scale conversion on the digital output values. The values are converted within the range between a specified D/A conversion scaling upper limit value and D/A conversion scaling lower limit value. The program for scale conversion can be omitted.
However, the scaling function (D/A conversion) is enabled only for normal output.

(1) Concept of scaling setting

The necessary settings for the D/A conversion scaling lower limit value and D/A conversion scaling upper limit value depend on whether the factory default setting or the user range setting is used for the analog output range.

(a) When the factory default setting is used for the analog output range

- For the D/A conversion scaling upper limit value, set a value corresponding to the upper limit value of the set analog output value.
- Set a value corresponding to the lower limit value of the set analog output value for the D/A conversion scaling lower limit value.

(b) When the user range setting is used for the analog output range

- Set a value corresponding to the gain value for the D/A conversion scaling upper limit value.
- Set a value corresponding to the offset value for the D/A conversion scaling lower limit value.

(2) Calculating the scaling value

For D/A conversion, the scaling value is calculated based on the following equations.
(All digits to the right of the decimal point are discarded during scale conversion.)

(a) When the factory default setting is used for the output range

Current: 4 to 20mA, 0 to 20mA
Voltage: 1 to 5V, 0 to 5V

$$\text{Digital input value used for D/A conversion} = \frac{12000}{S_H - S_L} \times (D_X - S_L)$$

When the voltage is -10 to 10V

$$\text{Digital input value used for D/A conversion} = \frac{32000}{S_H - S_L} \times (D_X - S_L) - 16000$$

(b) When the user range setting is used for the output range

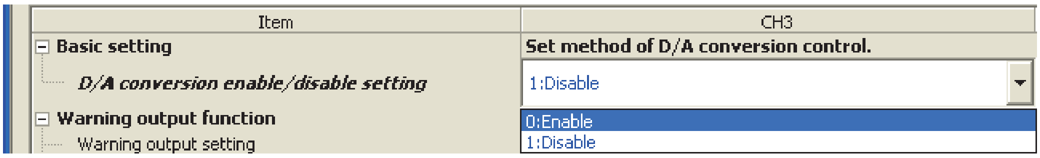
$$\text{Digital input value used for D/A conversion} = \frac{12000}{S_H - S_L} \times (D_X - S_L)$$

Item	Description
D_X	Digital input value
S_H	D/A conversion scaling upper limit value
S_L	D/A conversion scaling lower limit value

(3) Setting procedure

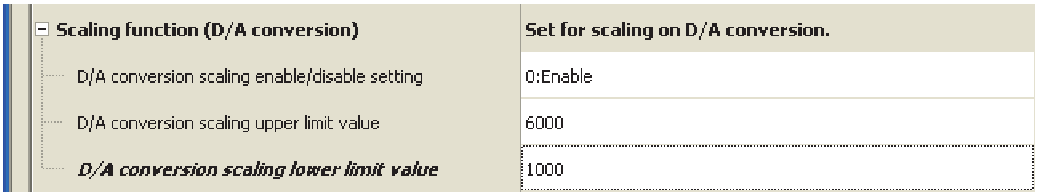
1. **Set "D/A conversion enable/disable setting" to "0: Enable".**

Project window ⇨ [Intelligent Function Module] ⇨ module name
⇨ [Parameter_(D/A_Conversion)]



2. **Set "D/A conversion scaling enable/disable setting" to "0: Enable".**

3. **Set values for "D/A conversion scaling upper limit value" and "D/A conversion scaling lower limit value".**



Item	Setting range
D/A conversion scaling upper limit value	- 32000 to 32000
D/A conversion scaling lower limit value	

Point

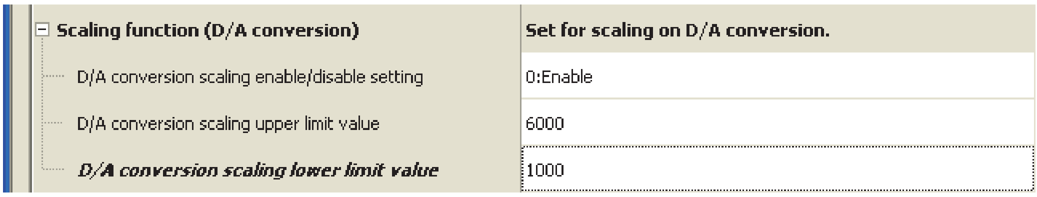
- If the relation between the values is D/A conversion scaling lower limit value > D/A conversion scaling upper limit value, the scale conversion can be performed according to a negative slope.
- Set different values for the D/A conversion scaling upper limit value and D/A conversion scaling lower limit value.
If the same value is set, an error occurs. The error code (91□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on.
- The scaling function (D/A conversion) is enabled only for normal output. When any of the following conditions is set, an error occurs in the channel where "D/A conversion scaling enable/disable setting" is set to "0: Enable". The error code is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.

Setting condition which triggers an error	Error code
"Select Function" is set to "Wave Output Function".	301□
"Select Function" is set to "Free Operation Function".	401□
When "Select Function" is set to "Free Conversion Characteristics Function" and Variable conversion characteristics table selection (Un\G4100) is set to Analog output (1) or Analog I/O (2).	500□
"Select Function" is set to "Free Conversion Characteristics Function + Free Operation Function".	401□
"Select Function" is set to "PID Control Function".	601□

- Even if the input range of the digital input value is extended, the resolution does not become higher than that provided when the scaling function is not used.

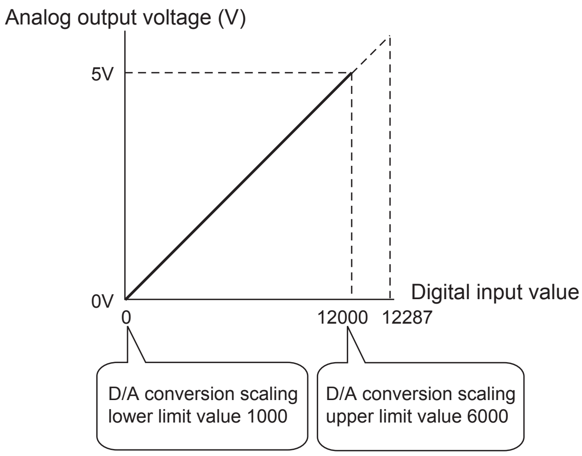
(4) Example of scaling setting

Ex. When the following values are set for a channel with an output range of 0 to 5V:
"D/A conversion scaling upper limit value": 6000
"D/A conversion scaling lower limit value": 1000



Scaling function (D/A conversion)	Set for scaling on D/A conversion.
D/A conversion scaling enable/disable setting	0:Enable
D/A conversion scaling upper limit value	6000
D/A conversion scaling lower limit value	1000

The following figure and table show the digital input values and the corresponding digital values obtained after scaling.

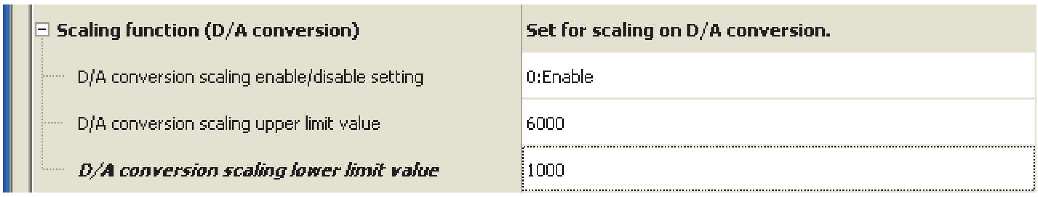


Digital input value	Digital value after scaling	Analog output voltage (V)
999 or smaller*1	0	0
1000	0	0
3500	6000	2.5
6000	12000	5
6119	12285	5.12
6120 or greater*1	12287	5.12

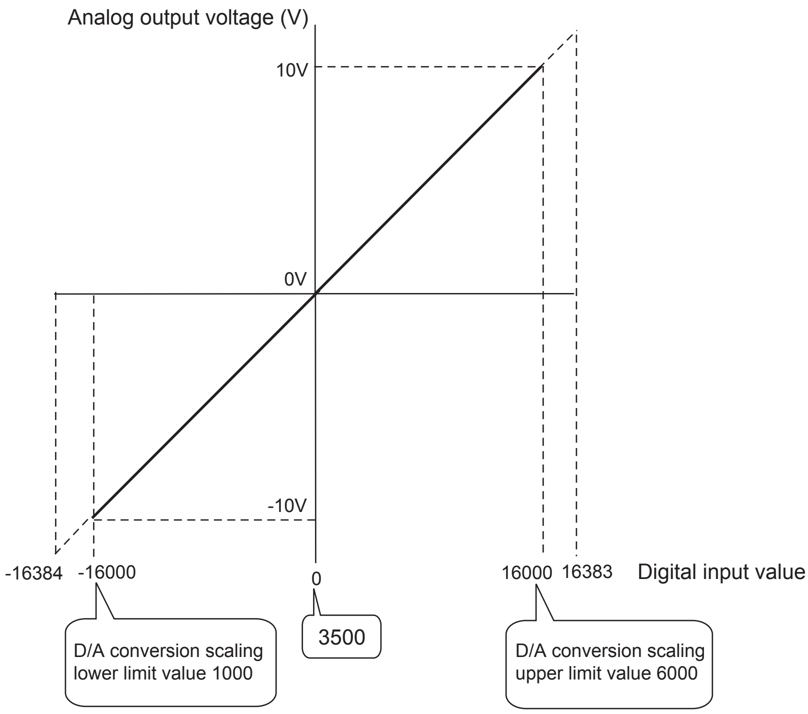
*1 When the digital input value is 999 or smaller, or 6120 or greater, the out-of-range digital value setting error occurs. The error code (60□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.

Ex. When the following values are set for a channel with an output range of -10 to 10V:

- "D/A conversion scaling upper limit value": 6000
- "D/A conversion scaling lower limit value": 1000



The following figure and table show the digital input values and the corresponding digital values obtained after scaling.



Digital input value	Digital value after scaling	Analog output voltage (V)
939 or smaller[*1]	-16384	-10.24
940	-16384	-10.24
1000	-16000	-10
2250	-8000	-5
3500	0	0
4750	8000	5
6000	16000	10
6059	16377	10.24
6060 or greater[*1]	16383	10.24

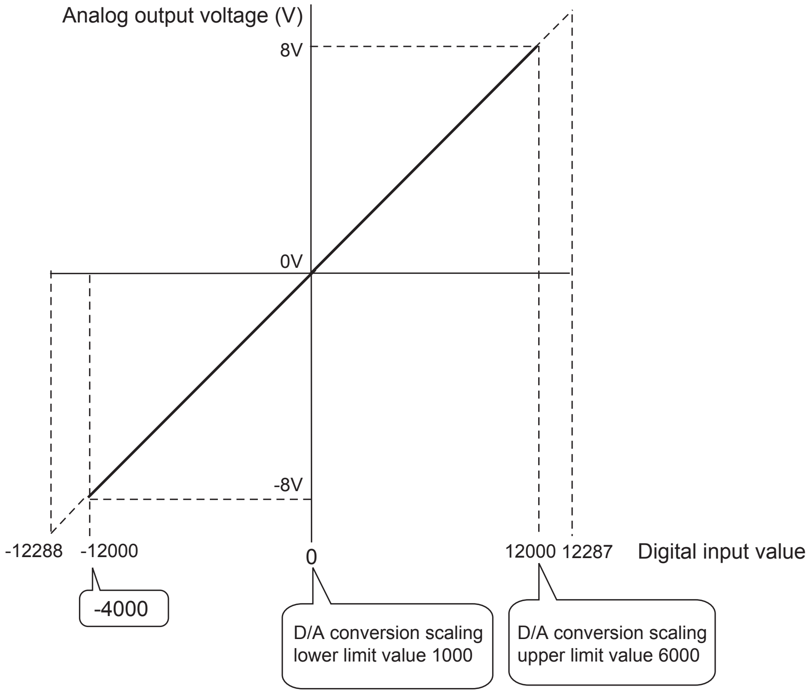
*1 When the digital input value is 939 or smaller, or 6060 or greater, the out-of-range digital value setting error occurs. The error code (60□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.

Ex. When the following values are set for a channel with a user range setting (voltage) of -8 to 8V:

- "D/A conversion scaling upper limit value": 6000
- "D/A conversion scaling lower limit value": 1000

Scaling function (D/A conversion)	Set for scaling on D/A conversion.
D/A conversion scaling enable/disable setting	0:Enable
D/A conversion scaling upper limit value	6000
D/A conversion scaling lower limit value	1000

The following figure and table show the digital input values and the corresponding digital values obtained after scaling.



Digital input value	Digital value after scaling	Analog output voltage (V)
-4121 or smaller*1	-12288	-8.19
-4120	-12288	-8.19
-4000	-12000	-8
-1500	-6000	-4
1000	0	0
3500	6000	4
6000	12000	8
6119	12285	8.19
6120 or greater*1	12287	8.19

*1 When the digital input value is -4121 or smaller, or 6120 or greater, the out-of-range digital value setting error occurs. The error code (60□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.

Point

- When the scaling function (D/A conversion) is used, the digital input value can be set to a value out of the range between the D/A conversion scaling upper and lower limit values (in the dotted lines in the I/O characteristics graph) before being scaled. However, use the scaling function (D/A conversion) within the range of the analog output practical range (in the solid line in the I/O characteristics graph). If the value exceeds the analog output practical range, the resolution and accuracy may not fall within the range of performance specifications.
- The default digital input value "0" may not be appropriate, depending on the scaling function (D/A conversion) setting.
  In particular in the examples of when the output range is 0 to 5V and -10 to 10V, the out-of-range digital value error (error code: 60□) occurs if CH□ Output enable/disable flag (Y3, Y4) is turned on with the digital input value "0". The error code (60□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.
  Therefore, set an appropriate digital input value within the scaling range before turning on CH□ Output enable/disable flag (Y3, Y4).
  The following shows the error codes that occur.

  60□

  Fixed — The last digit indicates the channel where an error has occurred.

- When using the user range, note that the D/A conversion scaling lower limit value is equal to the offset value.

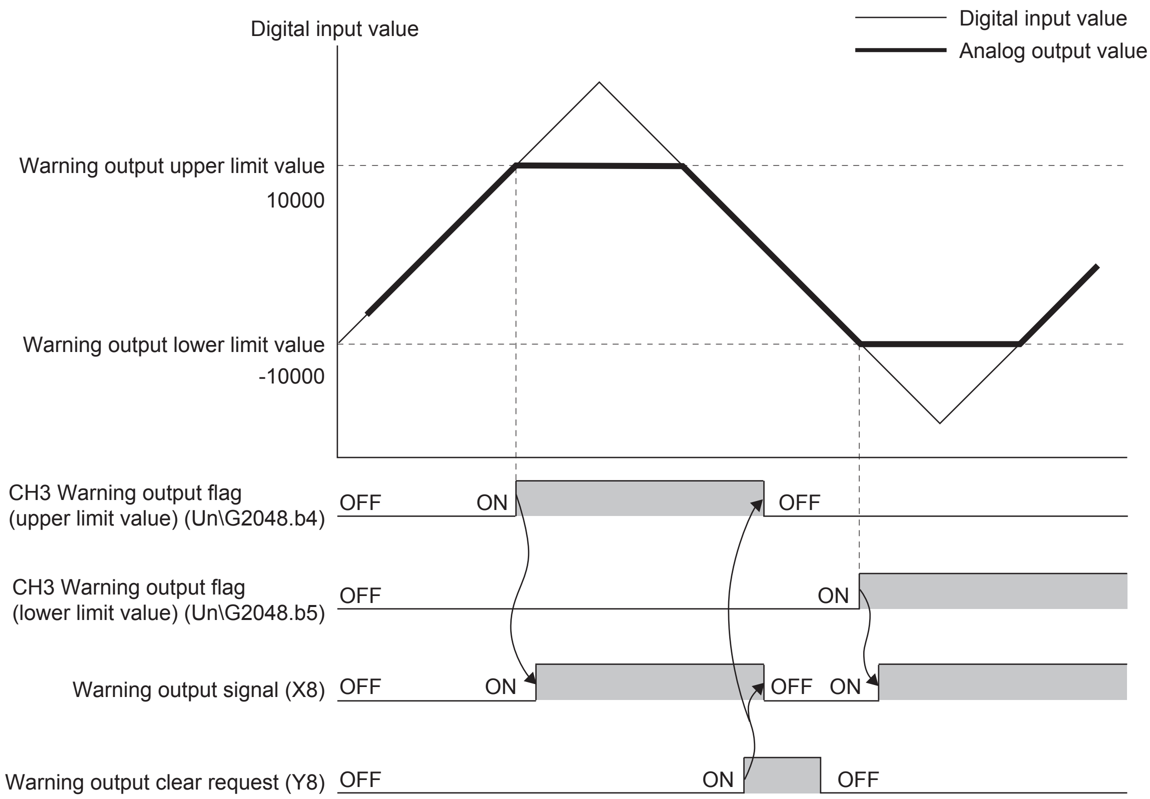
8.17 Warning Output Function

D/A conversion

This function outputs a warning when the digital input value exceeds the warning output upper limit value or becomes less than the warning output lower limit value.

The warning target depends on the setting for Select Function, as shown below.

- Logging Function: CH□ Digital input value (Un\G2003, Un\G2004)
- Wave Output Function: Wave data registry area (Un\G5000 to Un\G54999)
- Free Operation Function: Variable arithmetic value for analog output (Un\G4003, Un\G4007)
- Free Conversion Characteristics Function: Conversion characteristics table (Un\G5000 to Un\G37000)
- Free Conversion Characteristics Function + Free Operation Function: Variable arithmetic value for analog output (Un\G4003, Un\G4007)
- PID Control Function: Output conversion value (Un\G4302, Un\G4382)

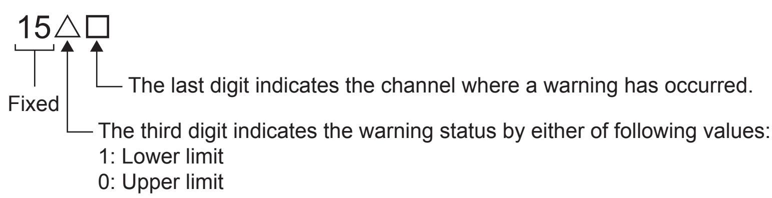


(1) Warning output notification

When the digital input value exceeds the warning output upper limit value or becomes less than the warning output lower limit value, a warning is output by Warning output flag (Un\G2048), Warning output signal (X8) and the ALM LED flashing (1s intervals).

In addition, the alarm code (15△□) is stored in Latest error code (Un\G19).

The following figure shows the alarm codes stored.



(2) Operation performed when a warning is output

When the digital input value exceeds the warning output upper limit value or becomes less than the warning output lower limit value, a warning is output. The corresponding analog output value is either of the following.

- When the digital input value exceeds the warning output upper limit value: An analog value converted from the digital input value corresponding to the warning output upper limit value
- When the digital input value becomes less than the warning output lower limit value: An analog value converted from the digital input value corresponding to the warning output lower limit value

After a warning is output, the analog output value returns to normal by changing the digital input value to a value within the setting range. However, Warning output flag (Un\G2048) and Warning output signal (X8) are not cleared. (The ALM LED keeps flashing (1s intervals).)

(3) Clearing a warning

A warning can be cleared in the following two methods:

- Turning on and off Warning output clear request (Y8)
- Turning on and off Operating condition setting request (Y9)

Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

When a warning is cleared, the analog I/O module performs as follows.

- Clears Warning output flag (Un\G2048).
- Turns off Warning output signal (X8).
- Turns off the ALM LED.
- Clears the alarm code (15△□) stored in Latest error code (Un\G19).

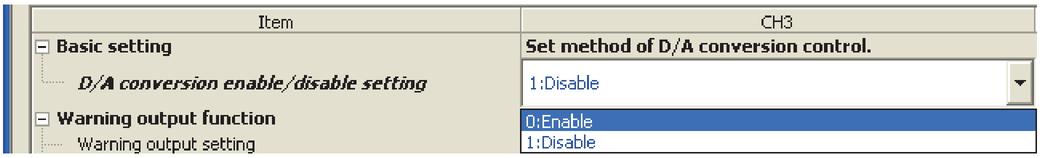
(4) If the scaling function is enabled

If D/A conversion scaling enable/disable setting (Un\G2053) is set to Enable (0), the digital input value converted within the scaling range becomes the target for warning detection.
For CH3 Warning output upper limit value (Un\G2090) to CH4 Warning output lower limit value (Un\G2093), set values in consideration of the scaling range.

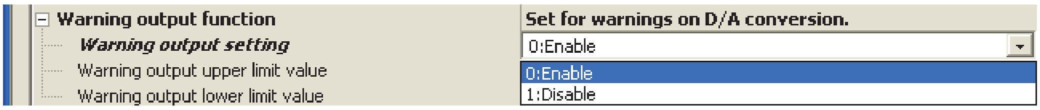
(5) Setting procedure

1. Set "D/A conversion enable/disable setting" to "0: Enable".

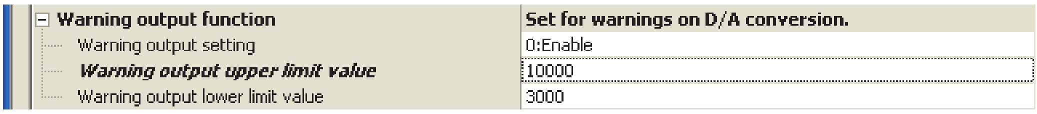
Project window ⇨ [Intelligent Function Module] ⇨ module name
⇨ [Parameter_(D/A_Conversion)]



2. Set "Warning output setting" to "0: Enable".



3. Set values for "Warning output upper limit value" and "Warning output lower limit value".



Item	Setting range
Warning output upper limit value	-32768 to 32767
Warning output lower limit value	

Point

Set the values so that they satisfy the condition of "Warning output upper limit value" > "Warning output lower limit value". When a value that does not satisfy the condition is set, an error occurs in the corresponding channel. The error code (62□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on.

8.18 Wave Output Function

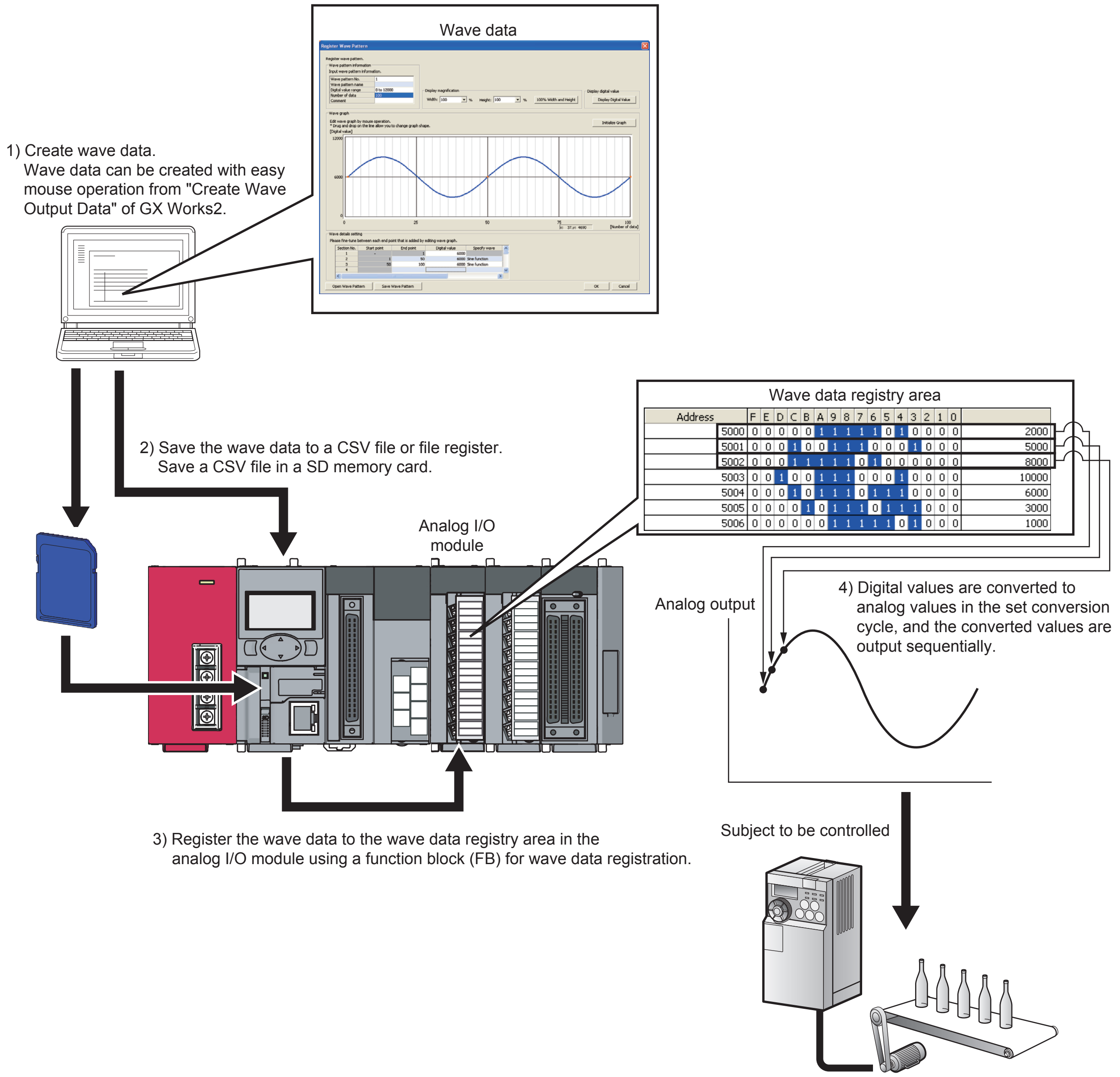
D/A conversion

This function registers the prepared wave data (digital input value) on the analog I/O module and continuously outputs the data (analog value) in the set conversion cycle. A faster and smoother control than a program is achieved by the automatic output of the control wave data registered in the analog I/O module for the analog (torque) control such as pressing machines and injection molding units. The control can be executed only by registering the wave data to the analog I/O module. Therefore, the program-less control is available for the repeat control such as the line control, and man-hours for programming can be reduced.

The wave output function is only available when "Wave Output Function" is set to "Select Function" in the switch setting.

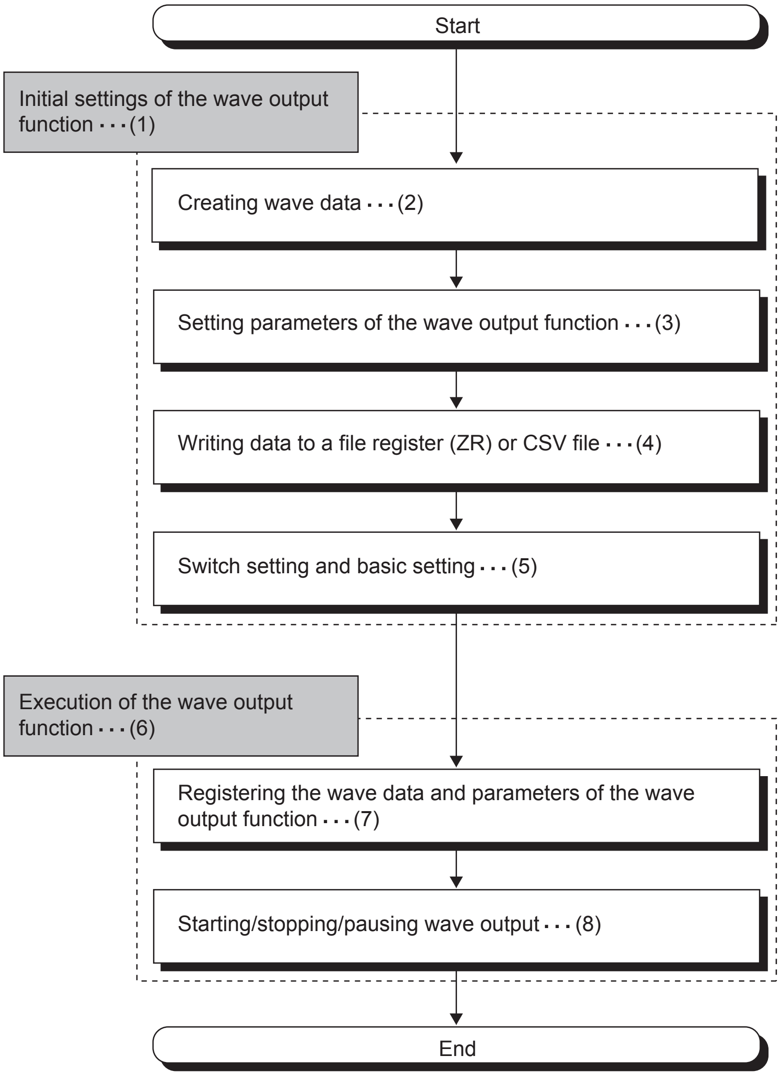
For the setting procedure of "Select Function", refer to the following.

- Switch setting (☞ Page 165, Section 8.18.1 (4) (a))



(1) Wave output function procedure

The following shows how to use the wave output function.



(1) ☞ Page 152, Section 8.18.1
(2) ☞ Page 152, Section 8.18.1 (1)
(3) ☞ Page 159, Section 8.18.1 (2)
(4) ☞ Page 162, Section 8.18.1 (3)
(5) ☞ Page 165, Section 8.18.1 (4)
(6) ☞ Page 168, Section 8.18.2
(7) ☞ Page 168, Section 8.18.2 (1)
(8) ☞ Page 169, Section 8.18.2 (2)

The wave data creation and parameter setting of the wave output function can be executed easily with "Create Wave Output Data" of GX Works2. These setting contents are saved in the file register (ZR) of the CPU module or in a CSV file and registered to the buffer memory of the analog I/O module with the function block (FB) for the wave data registration.

(2) Parameter settings for the wave output function

Set the parameters of the wave output function to the following buffer memory areas to use the wave output function. For details on each buffer memory area, refer to the following.

- Details of Buffer Memory Addresses (☞ Page 354, Appendix 2)

Setting item	Buffer memory address	Reference
Output setting during wave output stop	Un\G3010, Un\G3011	Page 384, Appendix 2 (48)
Output value during wave output stop	Un\G3018, Un\G3019	Page 385, Appendix 2 (49)
Wave pattern start address setting	Un\G3028 to Un\G3031	Page 386, Appendix 2 (50)
Wave pattern data points setting	Un\G3044 to Un\G3047	Page 387, Appendix 2 (51)
Wave pattern output repetition setting	Un\G3058, Un\G3059	Page 388, Appendix 2 (52)
Constant for wave output conversion cycle	Un\G3066, Un\G3067	Page 388, Appendix 2 (53)
Wave data registry area	Un\G5000 to Un\G54999	Page 423, Appendix 2 (111)

For details on the parameter setting, refer to the following.

- Setting parameters of the wave output function (☞ Page 159, Section 8.18.1 (2))

(3) Restrictions and precautions on the wave output function

The wave output function has the following restrictions and precautions.

(a) Output range setting

The user range cannot be used. When executing the wave output function, use the range other than the user range. For the setting procedure of the output range, refer to the following.
Switch setting (☞ Page 165, Section 8.18.1 (4) (a))

(b) Scaling function

The scaling function cannot be used when the wave output function is selected. When executing the wave output function, disable the scaling function.

(c) Logging Function

The logging function and the wave output function cannot be set at the same time. When executing the wave output function, set "Wave Output Function" to "Select Function" in the switch setting.

(d) Head module

When the analog I/O module is used with the head module, function block (FB) cannot be used. To execute the wave output function, refer to the following.
How to register data when a head module is used (☞ Page 173, Section 8.18.2 (4))

(e) Analog output HOLD/CLEAR function

The operation of the analog output HOLD/CLEAR function for the normal output differs from the operation for the wave output.
For details, refer to the following.
Analog output HOLD/CLEAR function (☞ Page 128, Section 8.14 (1) (b))

(4) Wave data

The wave data indicate the time-series arrangement of the digital input values to be output in analog. Up to 50000 points can be used. The wave data are registered in Wave data registry area (Un\G5000 to Un\G54999).

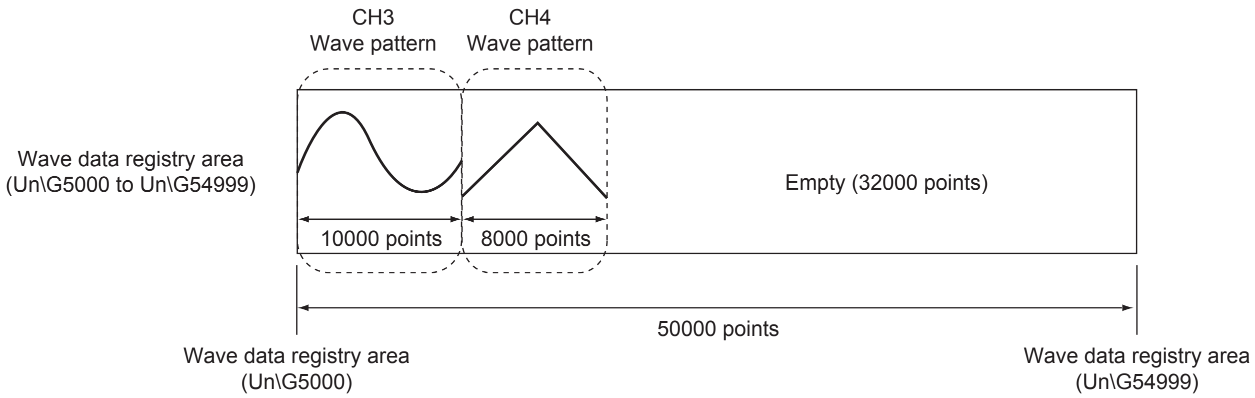
(5) Wave pattern

To use the wave output function, select any points from the registered wave data for each channel and set the wave pattern. The following table lists the setting contents for the wave pattern.

Setting item	Buffer memory address	Description
Wave pattern start address setting	Un\G3028 to Un\G3031	Set the start address of the wave pattern to be output for each channel. The D/A conversion starts from the digital input value of the buffer memory address set in this area and the converted values are output sequentially.
Wave pattern data points setting	Un\G3044 to Un\G3047	This area is for setting the points of the wave pattern to be output for each channel. From the start address of the wave pattern, the D/A conversion starts for the points of wave data set in this area and the converted values are output.

If the address value (total of the set values for Wave pattern start address setting and Wave pattern data points setting - 1) exceeds the last address (Un\G54999) of the wave data registry area, an error occurs. The error code (311□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on.

Ex. Setting example to output separate waves from CH3 and CH4

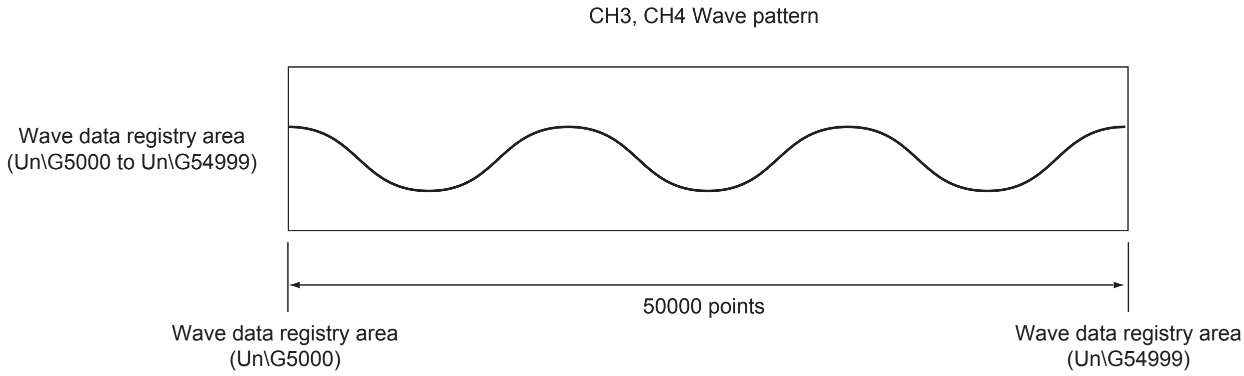


Setting item	Buffer memory address	Setting value
CH3 Wave pattern start address setting	Un\G3028, Un\G3029	5000
CH3 Wave pattern data points setting	Un\G3044, Un\G3045	10000
CH4 Wave pattern start address setting	Un\G3030, Un\G3031	15000
CH4 Wave pattern data points setting	Un\G3046, Un\G3047	8000

8

8.18 Wave Output Function

Ex. Setting example to output same waves from CH3 and CH4

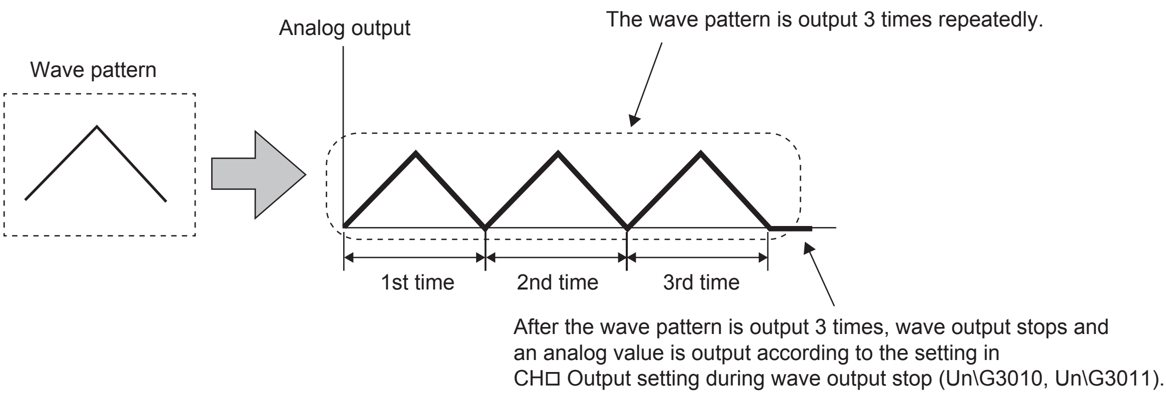


Setting item	Buffer memory address	Setting value
CH3 Wave pattern start address setting	Un\G3028, Un\G3029	5000
CH3 Wave pattern data points setting	Un\G3044, Un\G3045	50000
CH4 Wave pattern start address setting	Un\G3030, Un\G3031	5000
CH4 Wave pattern data points setting	Un\G3046, Un\G3047	50000

(6) Wave pattern output count

The wave pattern can be output repeatedly according to the setting of CH□ Wave pattern output repetition setting (Un\G3058, Un\G3059). Set the output count within 1 to 32767. The wave pattern also can be output in analog repeatedly and unlimitedly.

Ex. When the wave pattern output count is set to three

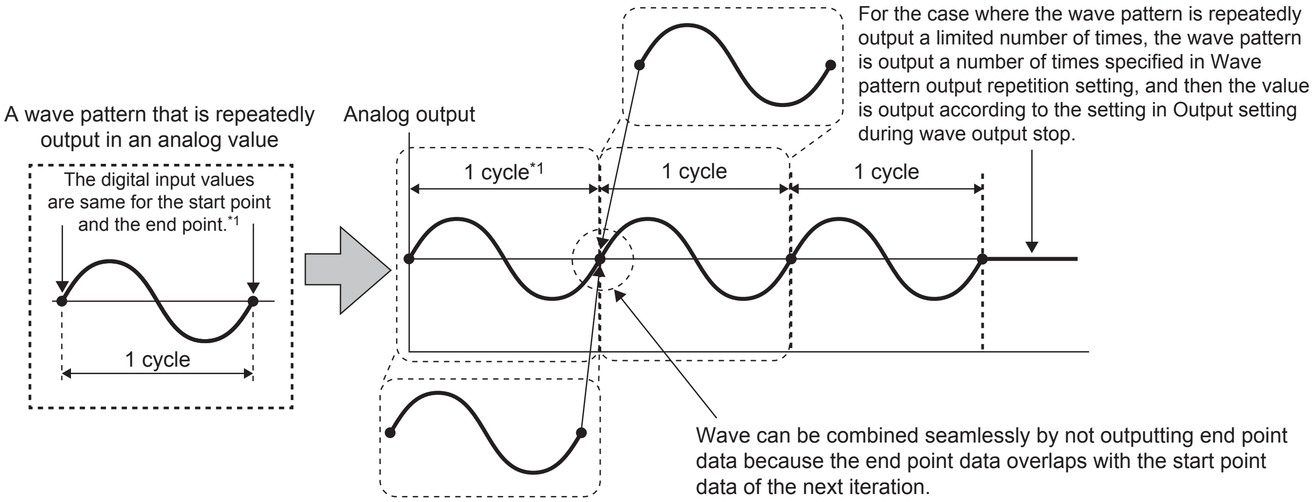


The following section describes "repeat control" in which the same wave pattern is output repeatedly from the analog I/O module.

(a) When the digital input values are same for the start point and the end point

An end point of a wave pattern overlaps with the start point of the wave pattern of the next iteration in the analog I/O module's processing; therefore, the end point is not output in analog. The analog output of the wave pattern end point varies as follows depending on the setting of CH☐ Wave pattern output repetition setting (Un\G3058, Un\G3059).

- Limited repetition: When a value of 2 to 32767 is set to CH☐ Wave pattern output repetition setting (Un\G3058, Un\G3059), the digital input value of the end point is not output in analog till the wave pattern of the final iteration output. After the digital input value of the end point is output in analog at the wave pattern of the final iteration output, the value is output in analog according to the setting in CH☐ Output setting during wave output stop (Un\G3010, Un\G3011).
- Unlimited repetition: The digital input value of the wave pattern end point is not output in analog.



*1 The output cycle of a wave pattern is calculated by the following calculation formula.
Output cycle of a wave pattern = (Wave output conversion cycle) × (Wave pattern data points - 1)

For details on the wave output conversion cycle, refer to the following.
- Wave output conversion cycle (☞ Page 151, Section 8.18 (7))

Ex. Calculating the output cycle of a wave pattern

Setting item	Buffer memory address	Setting value
D/A conversion enable/disable setting	Un\G2000	D/A conversion enable for CH3 only (8H)
CH3 Wave pattern data points setting	Un\G3044, Un\G3045	101
CH3 Wave pattern output repetition setting	Un\G3058	3
CH3 Constant for wave output conversion cycle	Un\G3066	1

With the above setting, the output cycle of a wave pattern becomes as follows.

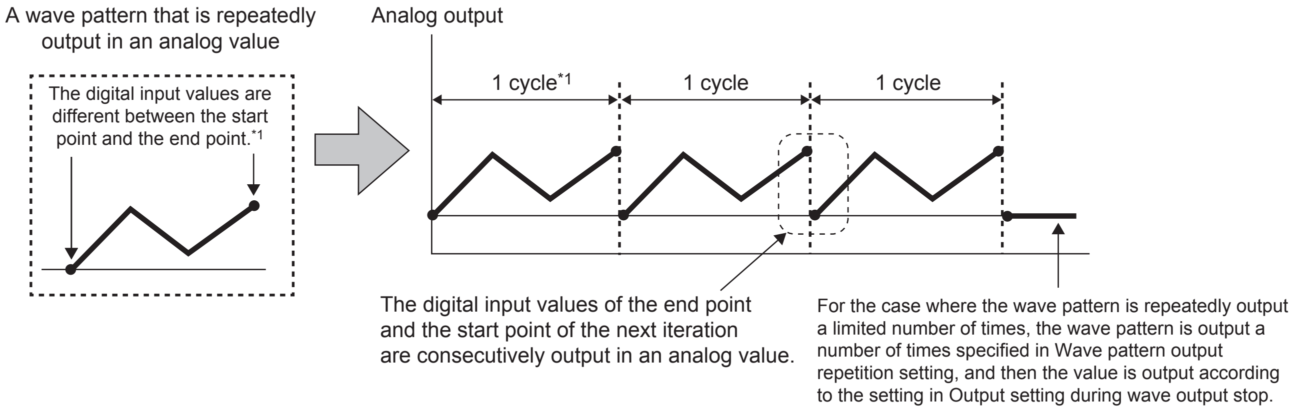
$$\text{Output cycle of a wave pattern } (\mu s) = \text{Conversion speed} \times \text{Number of channels where D/A conversion is enabled} \times \text{Constant for wave output conversion cycle} \times (\text{Wave pattern data points} - 1)$$

$$= 80 \times 1 \times 1 \times 100$$

$$= \underline{8000}$$

(b) When the digital input values are different between the start point and the end point

The wave pattern end point is output in analog as it is. The set wave patterns are continuously output in analog regardless of the setting in CH☐ Wave pattern output repetition setting (Un\G3058, Un\G3059).



*1 The output cycle of a wave pattern is calculated by the following calculation formula.
Output cycle of a wave pattern = (Wave output conversion cycle) × (Wave pattern data points)

For details on the wave output conversion cycle, refer to the following.

- Wave output conversion cycle (☞ Page 151, Section 8.18 (7))

Ex. Calculating the output cycle of a wave pattern

Setting item	Buffer memory address	Setting value
D/A conversion enable/disable setting	Un\G2000	D/A conversion enable for CH3 only (8H)
CH3 Wave pattern data points setting	Un\G3044, Un\G3045	101
CH3 Wave pattern output repetition setting	Un\G3058	3
CH3 Constant for wave output conversion cycle	Un\G3066	1

With the above setting, the output cycle of a wave pattern becomes as follows.

$$\text{Output cycle of a wave pattern } (\mu s) = \text{Conversion speed} \times \text{Number of channels where D/A conversion is enabled} \times \text{Constant for wave output conversion cycle} \times \text{Wave pattern data points}$$

$$= 80 \times 1 \times 1 \times 101$$

$$= \underline{8080}$$

(7) Wave output conversion cycle

The wave output conversion cycle is calculated by the following formula.

$$\underset{(\mu s)}{\text{Conversion cycle}} = \underset{(80\mu s)}{\text{Conversion speed}} \times \text{Number of channels where D/A conversion is enabled} \times \boxed{\text{Constant for wave output conversion cycle}}$$

In the wave output function, the conversion cycle can be set for each channel by setting CH☐ Constant for wave output conversion cycle (Un\G3066, Un\G3067). The conversion cycle of the current output wave can be checked in CH3 Wave output conversion cycle monitor (L) (Un\G3112) to CH4 Wave output conversion cycle monitor (H) (Un\G3115).

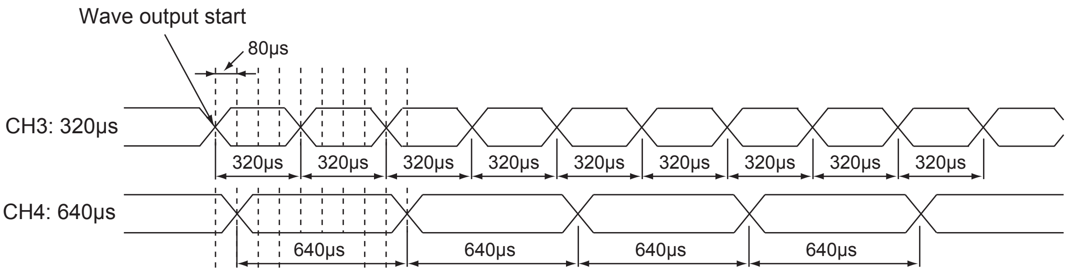
Ex. The conversion cycle and operation timing

Setting item		Setting value
D/A conversion enable/disable setting (Un\G2000)		All the channels are set to D/A conversion enable (0).
CH☐ Constant for wave output conversion cycle (Un\G3066, Un\G3067)	CH3	2
	CH4	4

The following figure shows the conversion cycle of each channel with the above settings.

- CH3: 80 × 2 × 2 = 320µs
- CH4: 80 × 2 × 4 = 640µs

D/A conversion is performed with this conversion cycle, and an analog value is output.



8.18.1 Initial settings of the wave output function

For the wave output function, set the following items as the initial setting. Before using the wave output function, complete the procedures described in this section.

- Creating wave data (☞ Page 152, Section 8.18.1 (1))
- Setting parameters of the wave output function (☞ Page 159, Section 8.18.1 (2))
- Writing data to a file register (ZR) or CSV file (☞ Page 162, Section 8.18.1 (3))
- Switch setting and basic setting (☞ Page 165, Section 8.18.1 (4))

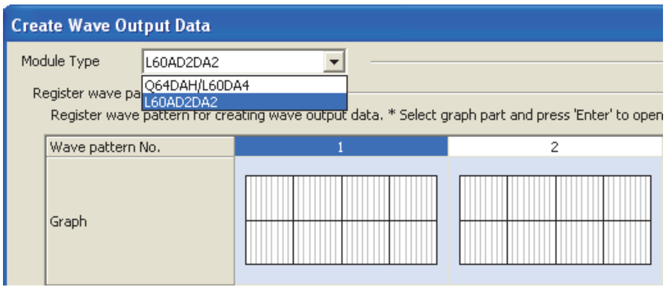
(1) Creating wave data

Create the wave data in "Create Wave Output Data" of GX Works2.

1. Start "Create Wave Output Data".

[Tool] ⇨ [Intelligent Function Module Tool] ⇨ [Analog Module]
⇨ [Create Wave Output Data]

2. Select "L60AD2DA2" in "Module Type".

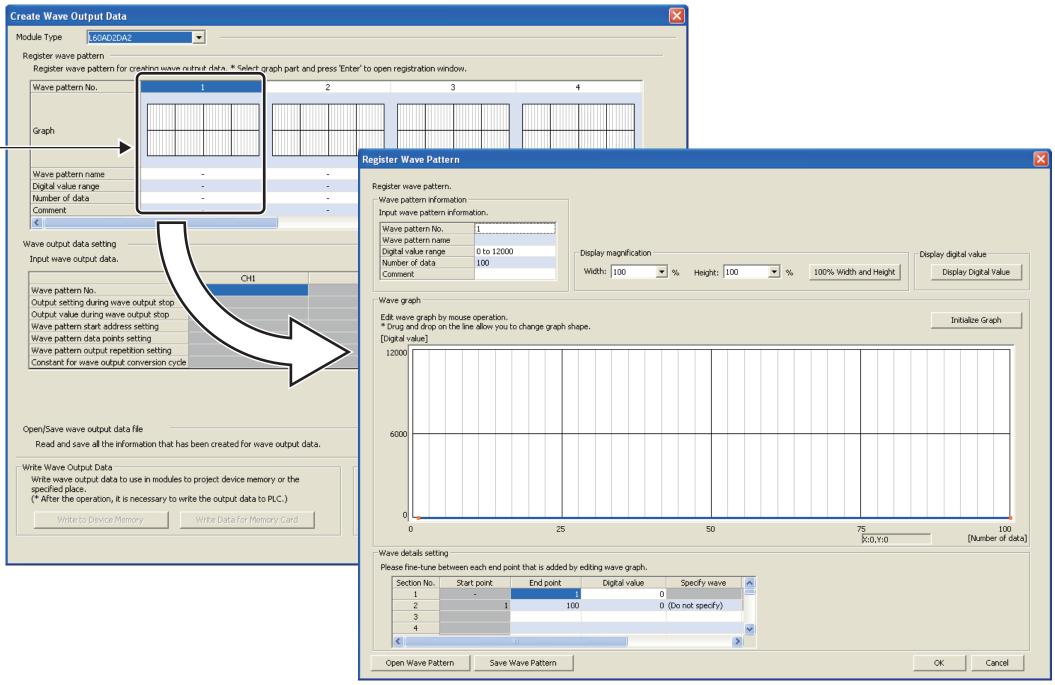


Point

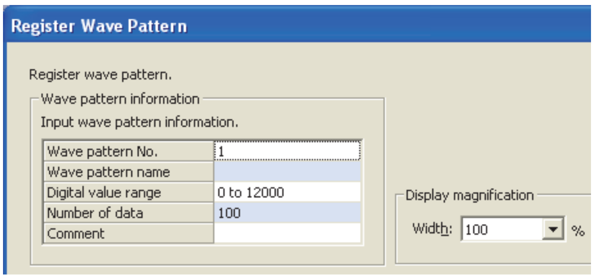
If the type other than "L60AD2DA2" is selected, proper wave data cannot be created because a corresponding channel or a range of digital values differs.
In addition, the wave pattern and wave output data are completely deleted by changing "Module Type".
Therefore, set the correct value in "Module Type" and follow the procedure 3 or later.

3. **Select the graph displayed in "Register wave pattern" and press the [Enter] key on the keyboard. The "Register Wave Pattern" window is displayed.**

Press the [Enter] key.

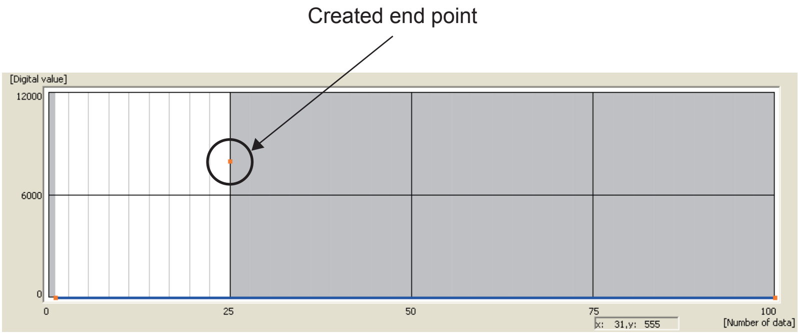


4. **Set "Wave pattern information".**

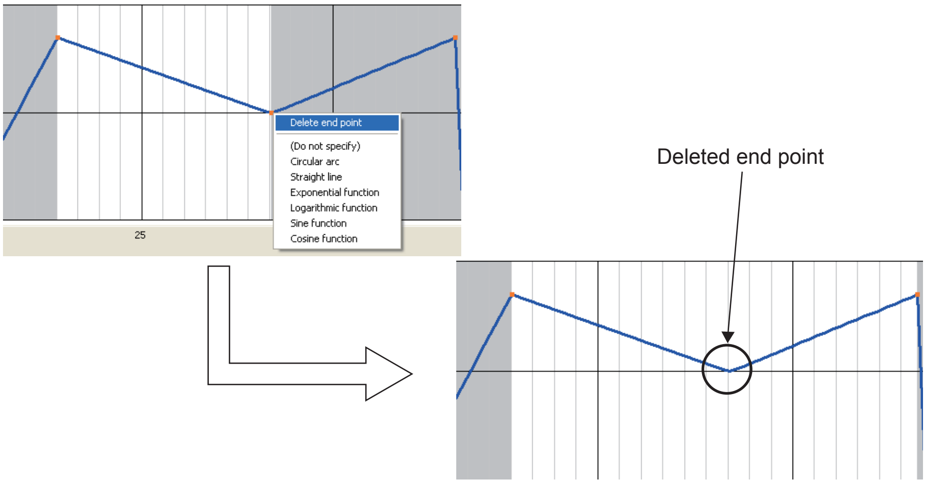


Item	Description	Setting range
Wave pattern No.	The wave pattern number selected in the "Create Wave Output Data" window is displayed. Up to 10 wave patterns can be created.	—
Wave pattern name	Set the name of the wave pattern.	16 characters
Digital value range	Select the setting range of the digital value according to the output range to be used.	• 0 to 12000 (default value) • -16000 to 16000
Number of data	Set the number of the digital values of the wave pattern.	1 to 50000 (default value: 100)
Comment	Set the comment of the wave pattern.	64 characters

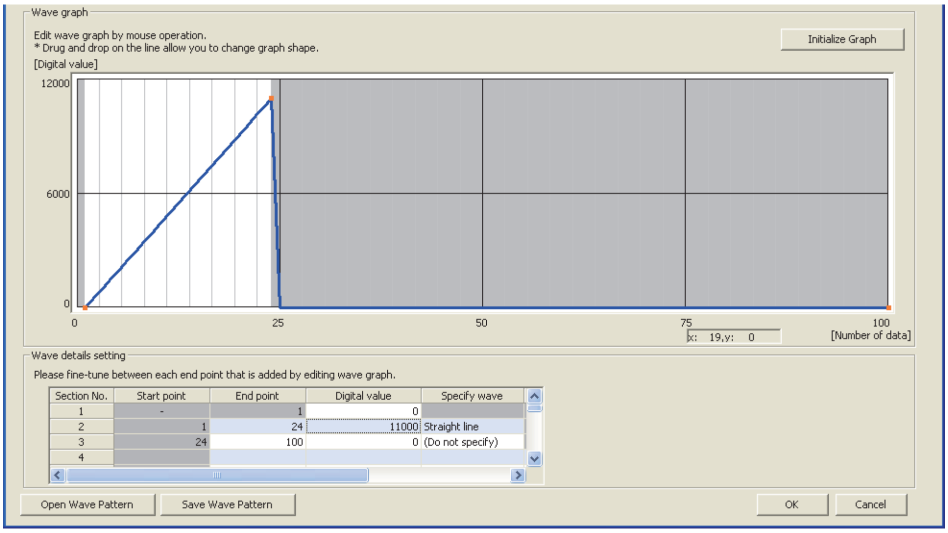
5. **Click any position on the wave graph to create an end point. The created end point is displayed with ■ .**

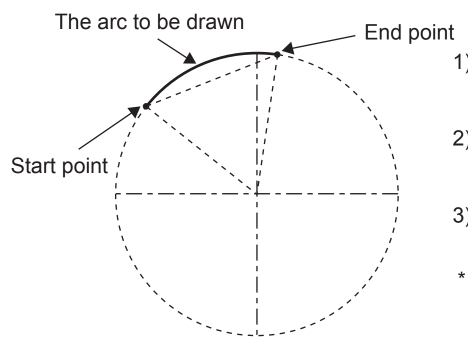
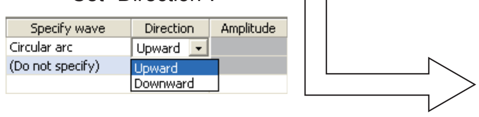
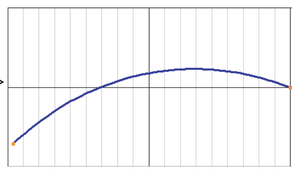
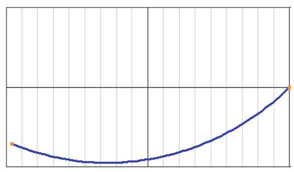
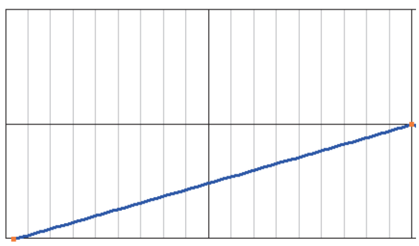


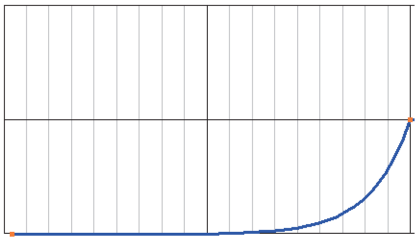
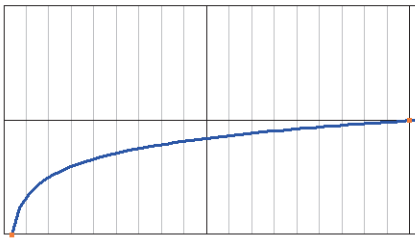
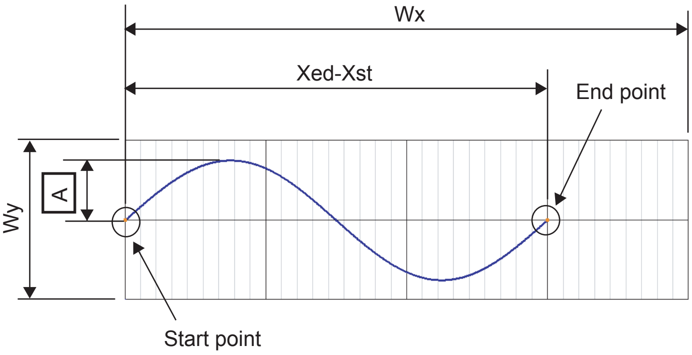
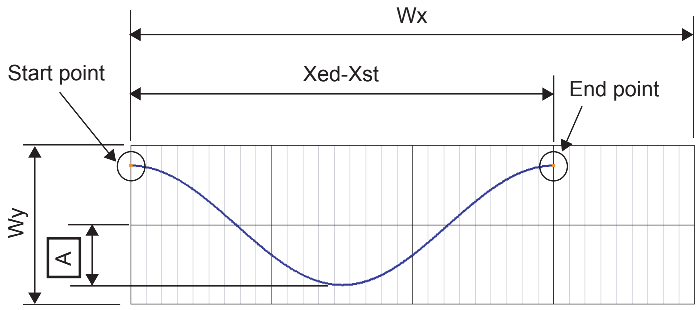
To delete the end point, move the mouse pointer to the point. Then select "Delete end point" from the right-click menu. When the mouse pointer is on the end point, the display of the mouse pointer is changed to ┼ .



6. **Set the wave between end points from the right-click menu or in "Specify wave" of "Wave details setting".**

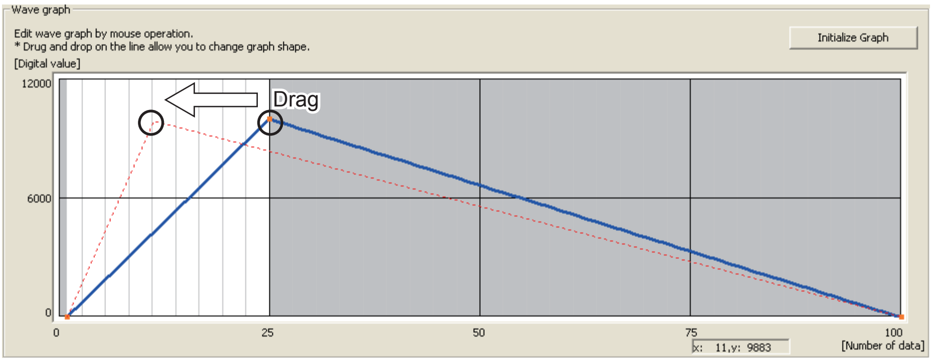


Item	Setting result
Circular arc	The interval of the start point and end point is drawn in an arc. When the circular arc is selected, the arc direction can be set in "Direction"; it can be inverted. The arc is drawn in the procedure below.  1) Construct an equilateral triangle having the start and end points as its vertices. 2) Construct a circle having the other vertex of the triangle as its center and a side of the triangle as its radius. 3) Draw the minor arc connecting the start and end points on the wave graph. * The steps 1) and 2) are processed inside GX Works2, and not displayed on the wave graph. Set "Direction".  In an upward direction  In a downward direction 
Straight line	The interval of the start point and end point is drawn in a straight line. 

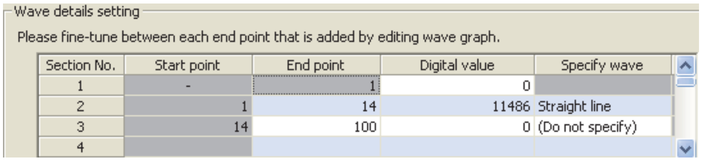
<table>
<tr><th>Item</th><th>Setting result</th></tr>
<tr><td>Exponential function</td><td>The graph is drawn with an adjustment so that the start point and end point are on the edge points of the exponential function of $y = e^x$ (x = 0 to 10).
</td></tr>
<tr><td>Logarithmic function</td><td>The graph is drawn with an adjustment so that the start point and end point are on the edge points of the logarithmic function of $y = \log_e X$ (x = 1 to 101).
</td></tr>
<tr><td>Sine function*1</td><td>The interval between the start point and end point is drawn in a sine function wave. The amplitude A of the sine function to be drawn is the value set in "Amplitude". The start position can be changed by 180° by setting "Phase".
Number of data in a wave pattern: Wx
Digital value range: Wy
Data position of the start point: Xst
Data position of the end point: Xed

</td></tr>
<tr><td>Cosine function*1</td><td>The interval between the start point and end point is drawn in a cosine function wave. The amplitude A of the cosine function to be drawn is the value set in "Amplitude".
The start position can be changed by 180° by setting "Phase".
Number of data in a wave pattern: Wx
Digital value range: Wy
Data position of the start point: Xst
Data position of the end point: Xed

</td></tr>
</table>

*1 When setting the sine function and cosine function, set the same digital value for the start point and end point.

7. **Drag the created end point to adjust the position.**



The end point position also can be adjusted by changing the value of "End point" and "Digital value" in "Wave details setting".



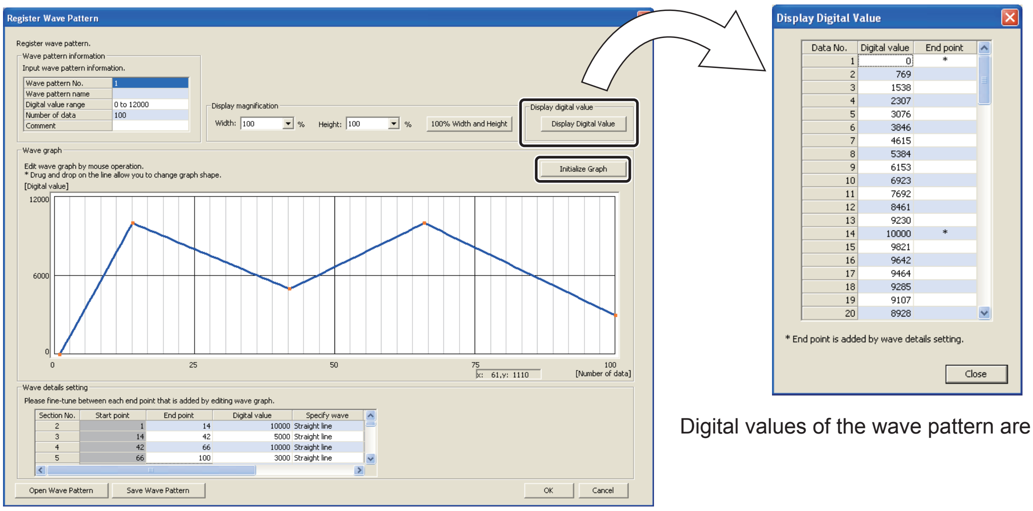
Section No.	Start point	End point	Digital value	Specify wave
1	-	1	0	
2	1	14	11486	Straight line
3	14	100	0	(Do not specify)
4				

Item	Description
Start point	The end point of the previous interval is displayed. To change the start point, change the end point of the previous interval.
End point	Set the number of data (position) for the destination end point. Note that the section No.1 cannot be changed because it is the first point of the wave pattern.
Digital value	Set the digital value for the destination end point.

8. **Repeat procedures 5 to 7 to create the wave to be output.**

Each digital value of the created wave pattern can be checked by clicking the Display Digital Value button.

Click the Initialize Graph button to clear the created wave pattern contents. The graph and the contents of "Wave details setting" are cleared.

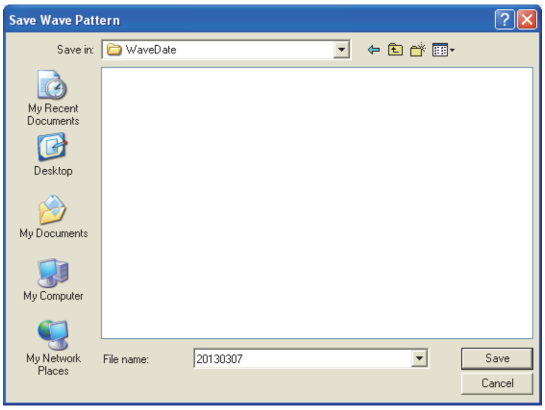


Digital values of the wave pattern are displayed.

8

8.18 Wave Output Function
8.18.1 Initial settings of the wave output function

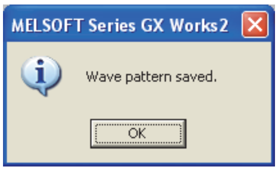
9. **Click the** Save Wave Pattern **button.**



The saved wave pattern can be opened by clicking the Open Wave Pattern button.

10. **Set the save destination and the file name, then click the** Save **button.**

11. **Click the** OK **button.**



12. **Click the** OK **button in the "Register Wave Pattern" window to register the created wave pattern.**

13. **Repeat procedures 3 to 12 to create other wave patterns.**

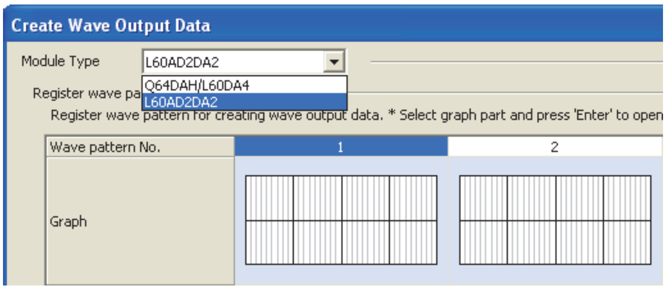
(2) Setting parameters of the wave output function

Set the parameters of the wave output function in "Create Wave Output Data" of GX Works2. Before the parameter setting, create the wave data.

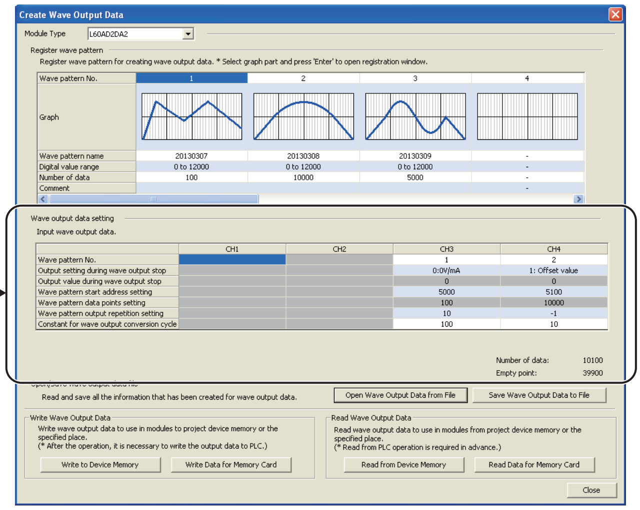
1. Start "Create Wave Output Data".

[Tool] ⇨ [Intelligent Function Module Tool] ⇨ [Analog Module] ⇨ [Create Wave Output Data]

2. Select "L60AD2DA2" in "Module Type".



3. Set the parameters of the wave output function in "Wave output data setting".



Set parameters of the wave output function.

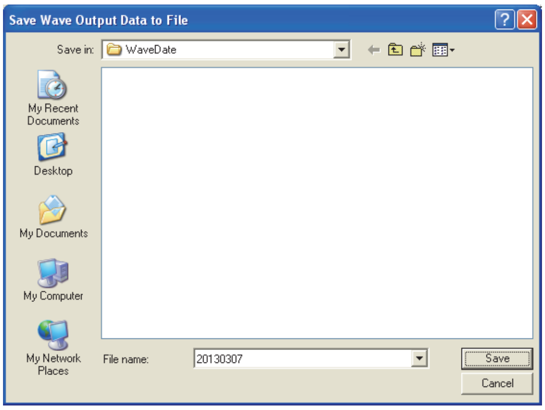
Item	Description	Setting range
Wave pattern No.	Up to three patterns can be specified at a time from registered wave patterns. When specifying multiple wave patterns, set the pattern No. as follows. • When No. 1 and No. 2 are used: • When No. 1, No. 5, and No. 10 are used: • When No. 1 to No. 3 are used:	1 to 10
Output setting during wave output stop	Set the analog output during the wave output stop.	• 0V/mA (default value) • Offset value • Setting value during stop
Output value during wave output stop	Set the value to be output while the wave output is stopped. This setting is enabled only when "Output setting during wave output stop" is set to "2: Setting value during stop". Set the value within the output range to be used.	• 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V: 0 to 12287 (practical range: 0 to 12000) • -10 to 10V: -16384 to 16383 (practical range: -16000 to 16000)
Wave pattern start address setting	Set the start address of the wave pattern to be output in analog.	5000 to 54999 (default value:
Wave pattern data points setting	This setting is not required because the data points of the wave pattern to be used are stored automatically.	—
Wave pattern output repetition setting	This area is for setting the repeat count to output the wave pattern repeatedly.	• -1 (Unlimitedly repeat output) • 1 to 32767 (default value:
Constant for wave output conversion cycle	The conversion cycle of the wave output is determined from the combination of the conversion speed, number of channels where D/A conversion is enabled, and this setting. For the calculation method of the wave output conversion cycle, refer to the following. • Wave output conversion cycle (☞ Page 151, Section 8.18 (7))	1 to 5000 (default value:

Remark

"Wave output data setting" can be set only for CH3 and CH4 in an analog I/O module.

4. Click the [Save Wave Output Data to File] button.

The created wave pattern and the parameter setting of the wave output function are saved.



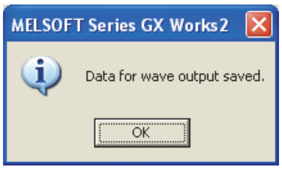
The saved wave pattern and parameter setting of the wave output function can be opened by clicking the [Open Wave Output Data from File] button.

Point

Note that if the data created for the module type other than "L60AD2DA2" is opened, the module type cannot be changed by setting "L60AD2DA2" to "Module Type".

5. Set the save destination and the file name, then click the [Save] button.

6. Click the [OK] button.



(3) Writing data to a file register (ZR) or CSV file

Write the wave data and the parameter setting of the wave output function to the file register (ZR) or the CSV file.

Point

Data unnecessary for control such as "Wave pattern name", "Comment", and "Wave details setting" is not written to the file register (ZR) or the CSV file.

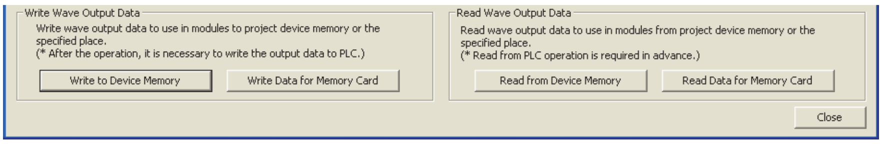
Saving the wave data and the parameter setting of the wave output function using the [Save Wave Output Data to File] button before writing them is recommended.

(a) Writing data to a file register (ZR)

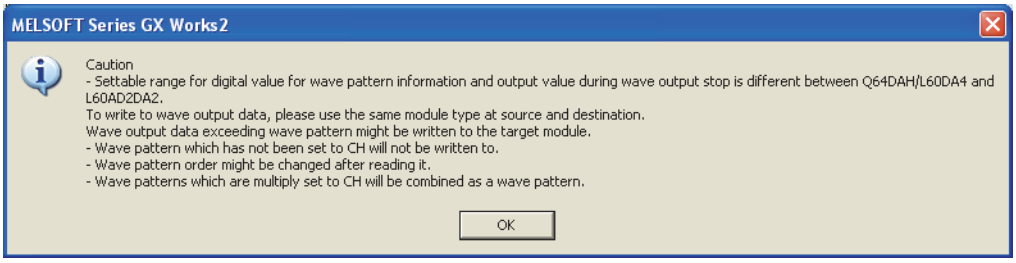
When writing the data to the file register (ZR), set the capacity of the file register (ZR) for the number of required data points. For the setting procedure, refer to the following.

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

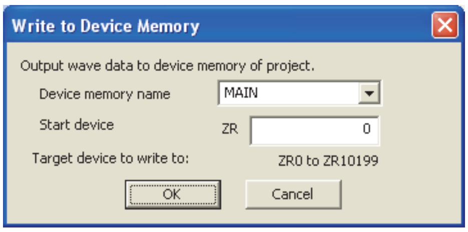
1. Click the [Write to Device Memory] button of the "Create Wave Output Data" window.



2. Click the [OK] button.

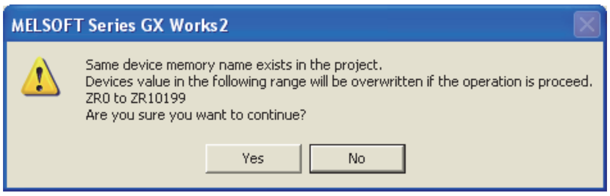


3. Set "Device memory name" and "Start device". Then click the [OK] button.

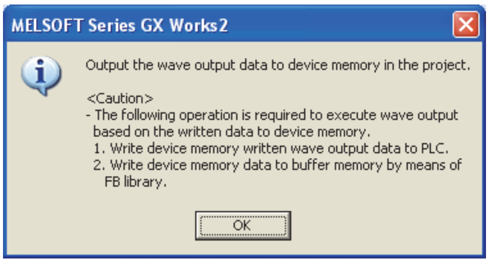


Item	Description
Device memory name	Set the device memory to be written to the file register (ZR). Select the device memory to be written from the pull-down menu or enter the device memory name to be created.
Start device	Set the start address for the output of the device memory.
Target device to write to	The file register (ZR) range to write to is displayed.

4. **Click the Yes button.**



5. **Click the OK button.**



6. **Click the Close button in the "Create Wave Output Data" window to close the window.**

7. **Write the device memory to the CPU module from "Write to PLC".**

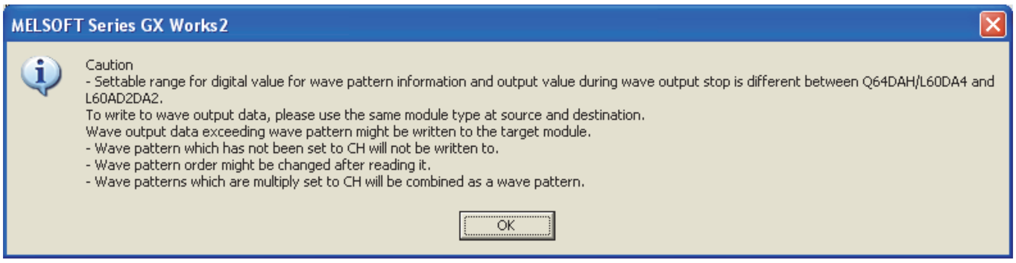
[Online] ⇨ [Write to PLC]

(b) Writing data to a CSV file

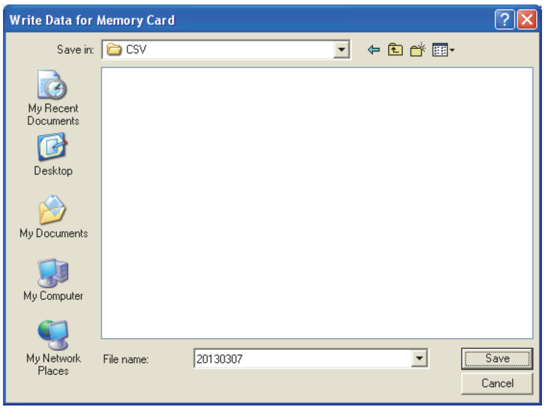
When writing data to a CSV file, store the CSV file to an SD memory card.

1. Click the [Write to Device Memory] **button in the "Create Wave Output Data" window.**

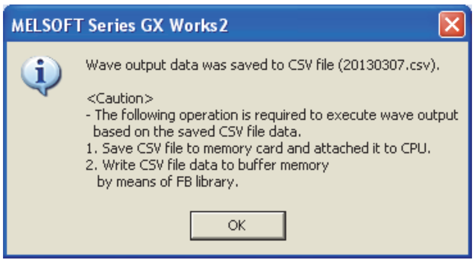
2. Click the [OK] **button.**



3. Set the save destination and the file name, then click the [Save] **button.**



4. Click the [OK] **button.**



5. Click the [Close] **button in the "Create Wave Output Data" window to close the window.**

6. Store the CSV file to an SD memory card. Then install the SD memory card to the CPU module.

Point

Some oscilloscopes or pulse generators can output the input wave or output wave to the CSV file. To output the wave with the wave output function by using the CSV file data, convert the data format into the one described in the following manual. In addition, convert the fractional value into the integer because the fractional value is unavailable in the wave output function.

(4) Switch setting and basic setting

To use the wave output function, the switch setting and basic setting are required in addition to the parameter setting of the wave output function.

Item		Reference
Switch Setting	Output range	Page 165, Section 8.18.1 (4) (a)
	Select Function	
Basic setting	D/A conversion enable/disable setting	Page 167, Section 8.18.1 (4) (b)

For the parameter settings for the wave output function, refer to the following.

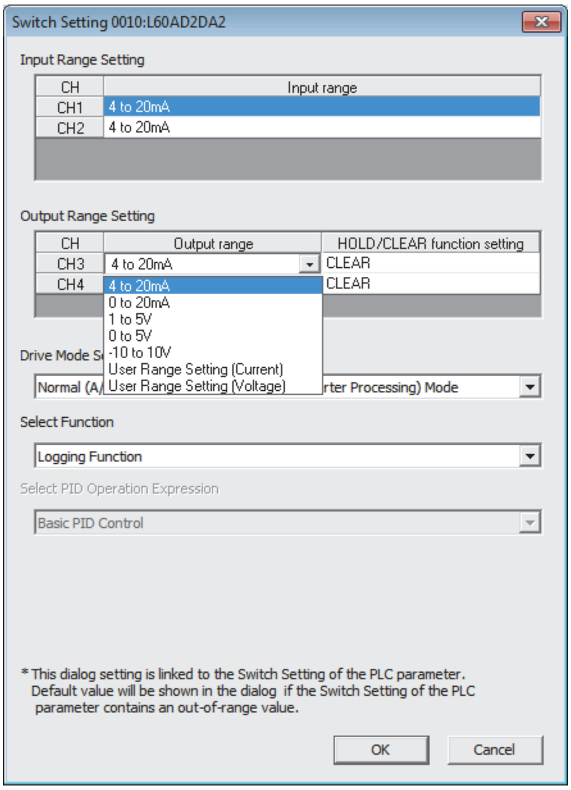
- Setting parameters of the wave output function (☞ Page 159, Section 8.18.1 (2))

(a) Switch setting

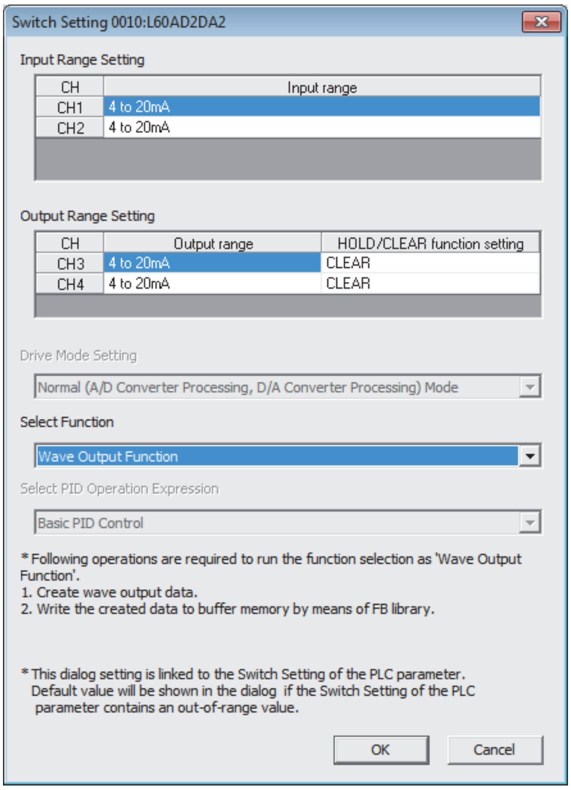
1. Open the "Switch Setting" window.

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Switch Setting]

2. Set "Output range" of CH3 and CH4 to the value other than "User Range Setting".



3. **Set "Select Function" to "Wave Output Function".**



(b) Basic setting

Change D/A conversion enable/disable setting (Un\G2000) using a program or function block (FB). Register the wave data and parameters for the wave output function first, then change D/A conversion enable/disable setting (Un\G2000).

For registration of the wave data and parameters for the wave output function, refer to the following.

- Registering the wave data and parameters of the wave output function (Page 168, Section 8.18.2 (1))

Enable D/A conversion only for the channel to be used because the conversion cycle of the wave output varies depending on the number of channels where D/A conversion are enabled.

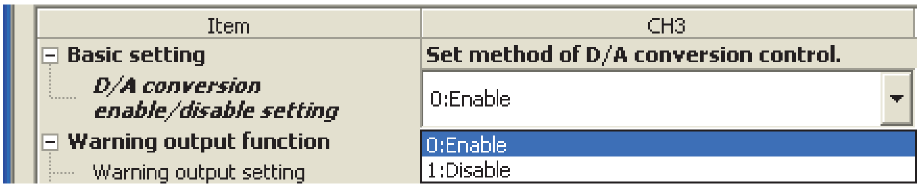
[Precaution]

The setting also can be configured through "D/A conversion enable/disable setting" in "Parameter (D/A Conversion)" of GX Works2.

1. **Start "Parameter (D/A Conversion)".**

Project window ⇨ [Intelligent Function Module] ⇨ module name
⇨ [Parameter_(D/A_Conversion)]

2. **Set "D/A conversion enable/disable setting" to "0: Enable".**



When the setting is configured by the above procedure, an error occurs if the setting is activated by resetting the CPU module or by turning off and on the power. The error code (307□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on. This error occurs because the wave pattern data points setting is set to 0 (default value) for the channel where D/A conversion enable is set. To clear this error, register wave data and parameters for the wave output function. Then turn on and off Operating condition setting request (Y9) by the procedure described in Page 168, Section 8.18.2 (1).

8.18.2 Execution of the wave output function

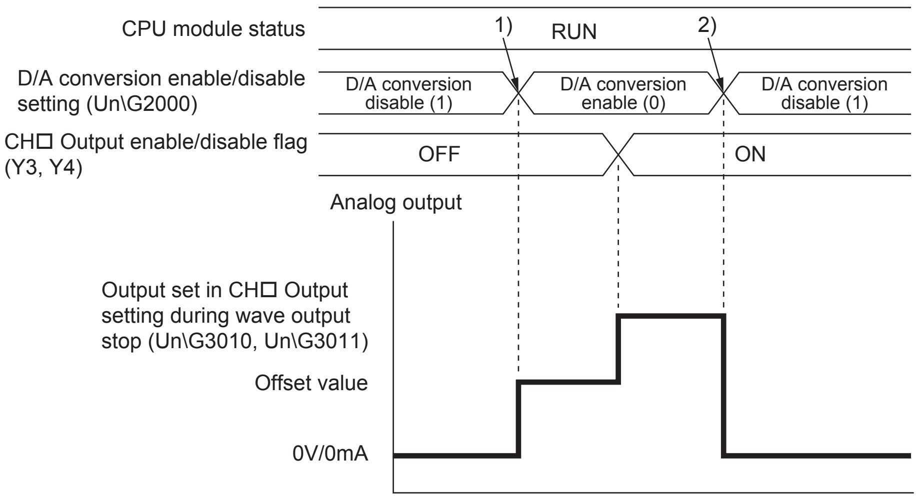
This section describes the execution procedures for the wave output function. Execute the contents in this section after the initial setting of the wave output function.

(1) Registering the wave data and parameters of the wave output function

Register the wave data and parameter settings for the wave output function, which is created from "Create Wave Output Data" of GX Works2, to the analog I/O module. Use the function block (FB) for the wave data registration. For how to use the function block (FB) for the wave data registration, refer to the following.

The contents registered by the function block (FB) for the wave data registration need to be enabled by turning on and off Operating condition setting request (Y9). When the setting is enabled, the analog output value of the channel where the D/A conversion is enabled varies depending on the CH☐ Output enable/disable flag (Y3, Y4) status as shown below.

- CH☐ Output enable/disable flag (Y3, Y4) is off: The offset value is output.
- CH☐ Output enable/disable flag (Y3, Y4) is on: A value is output according to the setting of CH☐ Output setting during wave output stop (Un\G3010, Un\G3011).



1): Set D/A conversion enable (0) to D/A conversion enable/disable setting (Un\G2000), and turn on and off Operating condition setting request (Y9).

2): Set D/A conversion disable (1) to D/A conversion enable/disable setting (Un\G2000), and turn on and off Operating condition setting request (Y9).

Point

With the wave output function being used, only when the wave output is stopped in all the channels (Wave output stop (0) is set to CH☐ Wave output status monitor (Un\G3102, Un\G3103) in all the channels), the parameter setting can be enabled by turning on and off Operating condition setting request (Y9).
When Operating condition setting request (Y9) is turned on and off with a channel being set to a value other than Wave output stop, a warning occurs. The alarm code (160☐) is stored in Latest error code (Un\G19), Warning output signal (X8) turns on, and the ALM LED flashes at intervals of 1s. The parameter setting cannot be enabled in this case.

(a) When a head module is used

Function block (FB) cannot be used for an analog I/O module connected to a head module.
For how to transfer the wave data and parameter settings for the wave output function, which is created from "Create Wave Output Data" of GX Works2, to the analog I/O module, refer to the following.
How to register data when a head module is used (☞ Page 173, Section 8.18.2 (4))

(2) Starting/stopping/pausing wave output

(a) Starting the wave output

The wave output can be started by the following procedures after the wave data registration.

1. Turn on CH□ Output enable/disable flag (Y3, Y4).

The value is output in analog according to the setting in "Output setting during wave output stop".

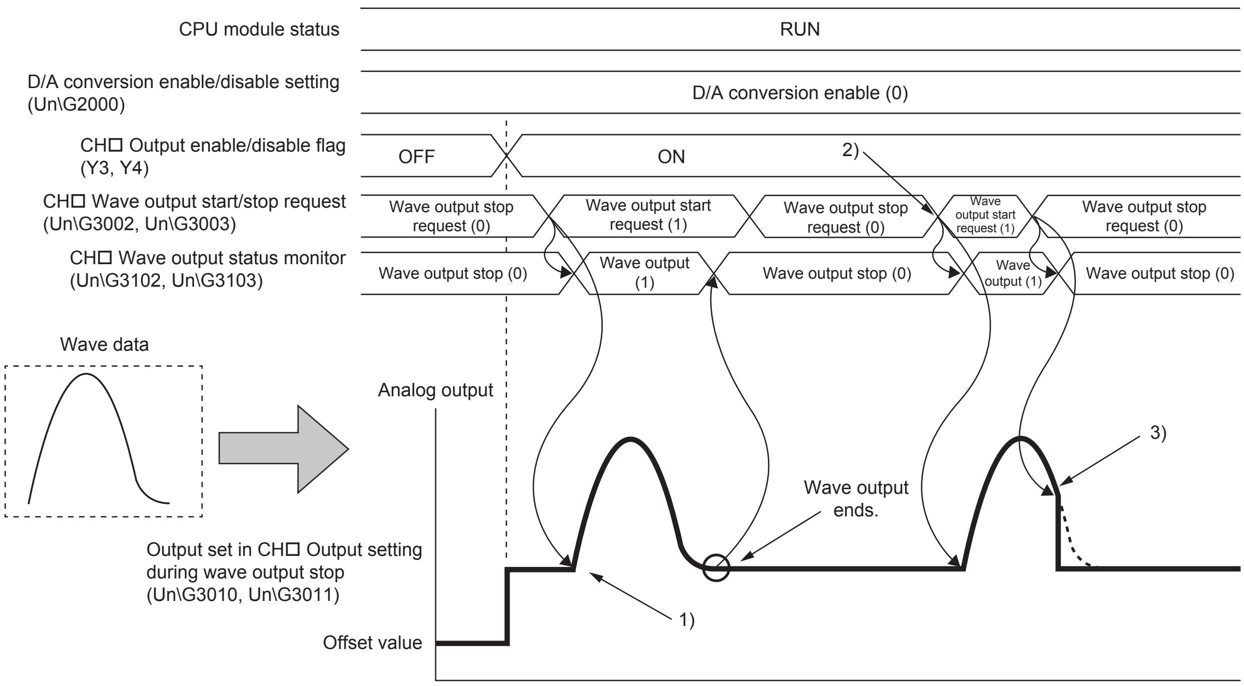
2. Set Wave output start request (1) to CH□ Wave output start/stop request (Un\G3002, Un\G3003).

When Wave output stop request (0) or Wave output pause request (2) is changed to Wave output start request (1), the wave output is started.

When a value other than "Wave Output Function" is set to "Select Function" in "Switch Setting", if the value in CH□ Wave output start/stop request (Un\G3002, Un\G3003) is changed to Wave output start request (1), a warning occurs. The alarm code (161□) is stored in Latest error code (Un\G19), Warning output signal (X8) turns on, and the ALM LED flashes at intervals of 1s.

(b) Stopping the wave output

To stop the wave output at a desired timing during the wave output, set CH□ Wave output start/stop request (Un\G3002, Un\G3003) to Wave output stop request (0). When Wave output start request (1) or Wave output pause request (2) is changed to Wave output stop request (0), the wave output is completely stopped. When the wave output is stopped, Wave output stop (0) is stored in CH□ Wave output status monitor (Un\G3102, Un\G3103). The wave output cannot be resumed at the stop point.
When the wave pattern outputs for the count set in CH□ Wave pattern output repetition setting (Un\G3058, Un\G3059) are finished, the wave output is also stopped.



1): Wave output starts when Wave output start request (1) is set to CH□ Wave output start/stop request (Un\G3002, Un\G3003).

2): To execute wave output again, set Wave output stop request (0) to CH□ Wave output start/stop request (Un\G3002, Un\G3003), then change the value to Wave output start request (1).

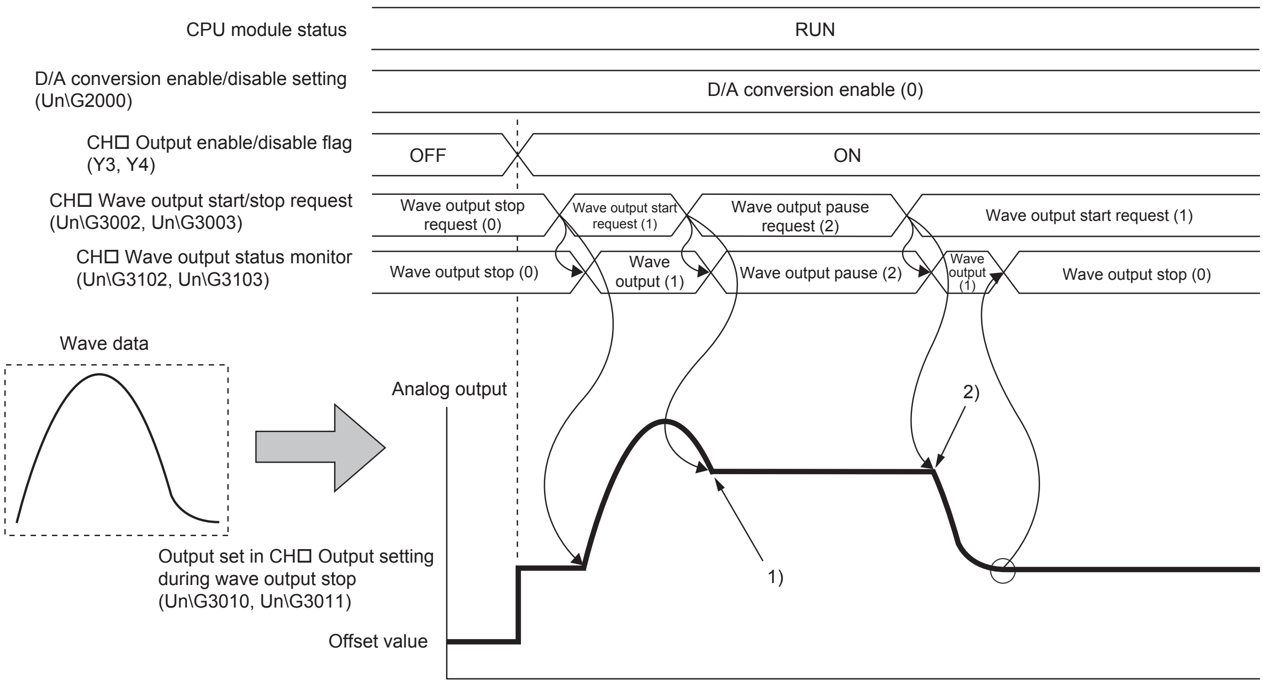
3): Wave output stops when Wave output stop request (0) is set to CH□ Wave output start/stop request (Un\G3002, Un\G3003) during the wave output.

8

8.18 Wave Output Function
8.18.2 Execution of the wave output function

(c) Pausing the wave output

- To stop the wave output temporarily, set Wave output pause request (2) to CH☐ Wave output start/stop request (Un\G3002, Un\G3003). When Wave output start request (1) is changed to Wave output pause request (2), the wave output is paused. Wave output pause (2) is stored in CH☐ Wave output status monitor (Un\G3102, Un\G3103).
- To resume the wave output, change the value in CH☐ Wave output start/stop request (Un\G3002, Un\G3003) from Wave output pause request (2) to Wave output start request (1). The wave output is resumed from the paused point.
- When Wave output pause request (2) is set to CH☐ Wave output start/stop request (Un\G3002, Un\G3003) during the wave output stop, the digital input value of the wave pattern start address is converted into an analog value and the analog value is output.



1): Wave output pauses when Wave output pause request (2) is set to CH☐ Wave output start/stop request (Un\G3002, Un\G3003) during the wave output.

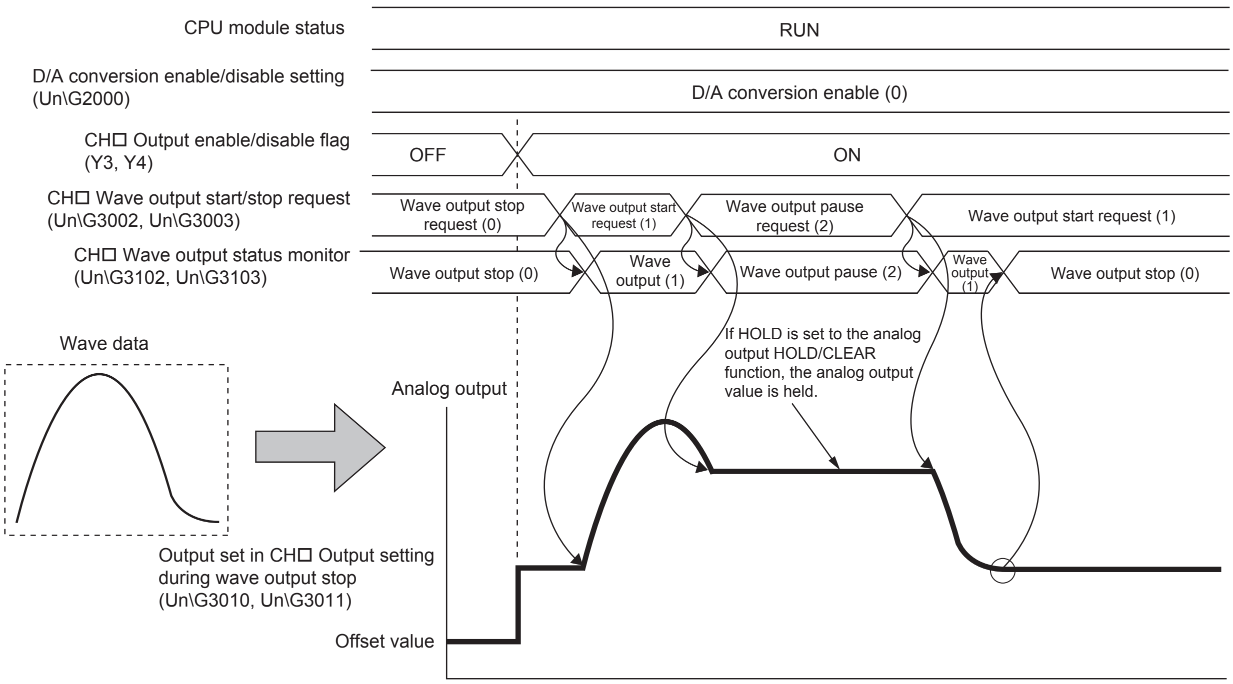
2): Wave output resumes when Wave output start request (1) is set to CH☐ Wave output start/stop request (Un\G3002, Un\G3003) during the wave output pause.

The analog output value while the wave output is paused differs depending on the setting of the analog output HOLD/CLEAR function. For details, refer to the following.

- Analog output HOLD/CLEAR function (☞ Page 128, Section 8.14 (1) (b))

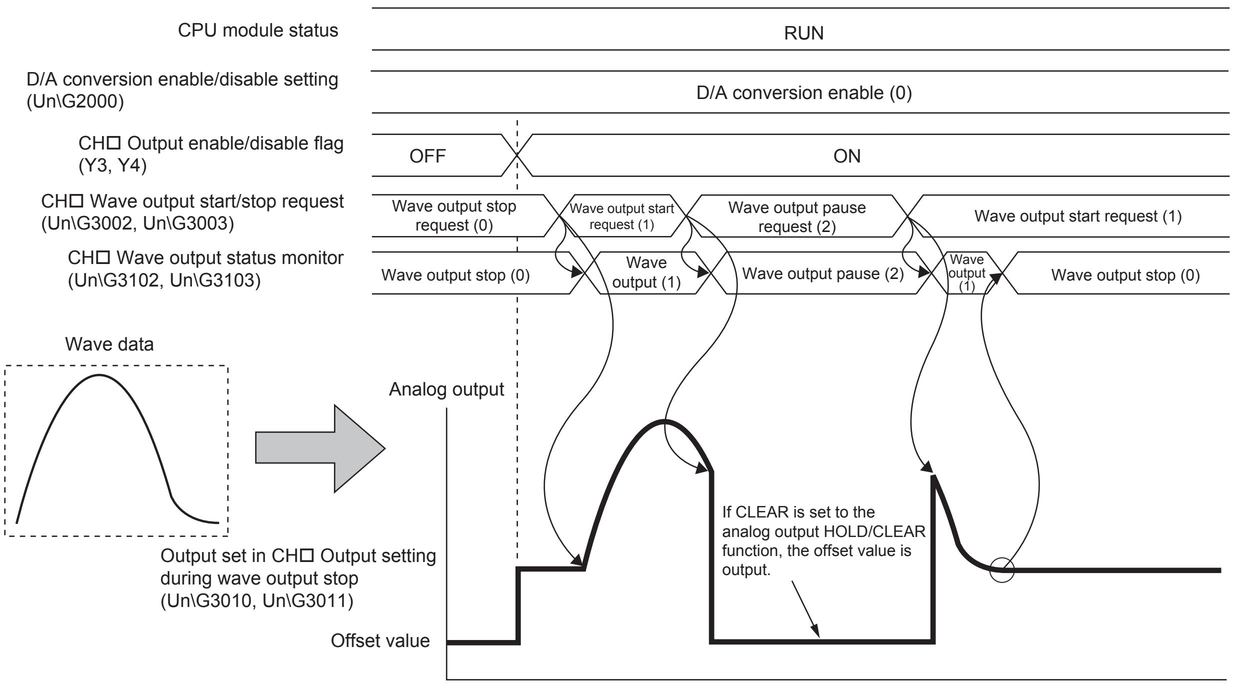
- For HOLD setting

While the wave output is paused, analog output value during the pause is held.



- For CLEAR setting

While the wave output is paused, the offset value is output.



Point

- Wave output start request is accepted only when the CPU module is in the RUN status. When a value in CH□ Wave output start/stop request (Un\G3002, Un\G3003) is changed to Wave output start request (1) with a CPU module state other than the RUN state, the wave output is not started.
- Wave output stop request is accepted when the CPU module is in the RUN or STOP status.
- Wave output pause request is accepted only when the CPU module is in the RUN status.
- When a value other than 0 to 2 is set to CH□ Wave output start/stop request (Un\G3002, Un\G3003), an error occurs. The error code (303□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on. However, the process will continue.

(3) Checking the setting for the wave output function

The setting for the wave output function can be checked in the following buffer memory areas.

Item	Buffer memory address	Description	Reference
Wave output status monitor	Un\G3102, Un\G3103	The wave output status is stored in this area.	Page 391, Appendix 2 (56)
Wave output conversion cycle monitor	Un\G3112 to Un\G3115	The conversion cycle of the wave output is stored in 32-bit signed binary in this area. The unit of the stored value is μs.	Page 391, Appendix 2 (57)
Wave pattern output count monitor	Un\G3126, Un\G3127	The output count of the wave pattern is stored in this area.	Page 391, Appendix 2 (58)
Wave output current address monitor	Un\G3136 to Un\G3139	The buffer memory address of the currently output wave data is stored in 32-bit signed binary in this area.	Page 392, Appendix 2 (59)
Wave output current digital value monitor	Un\G3150, Un\G3151	The digital input value which is being currently output is stored in this area.	Page 393, Appendix 2 (60)
Wave output digital value outside the range address monitor	Un\G3160 to Un\G3163	When the wave data with the digital input value out of the setting range is output, the buffer memory address to register the wave data is stored in 32-bit signed binary in this area. When the multiple wave data with the digital input value out of the setting range are detected, only the buffer memory address of the wave data detected first is stored.	Page 394, Appendix 2 (61)
Wave output warning Address monitor	Un\G3176 to Un\G3179	The buffer memory address of the wave data where a warning has occurred is stored in 32-bit signed binary in this area. When a warning has occurred in the multiple wave data, only the buffer memory address of the wave data where the warning occurred first is stored.	Page 395, Appendix 2 (62)

(4) How to register data when a head module is used

The following is the way to transfer the wave data and parameter settings for the wave output function, which is created from "Create Wave Output Data" of GX Works2, to the analog I/O module.

- Setting procedure

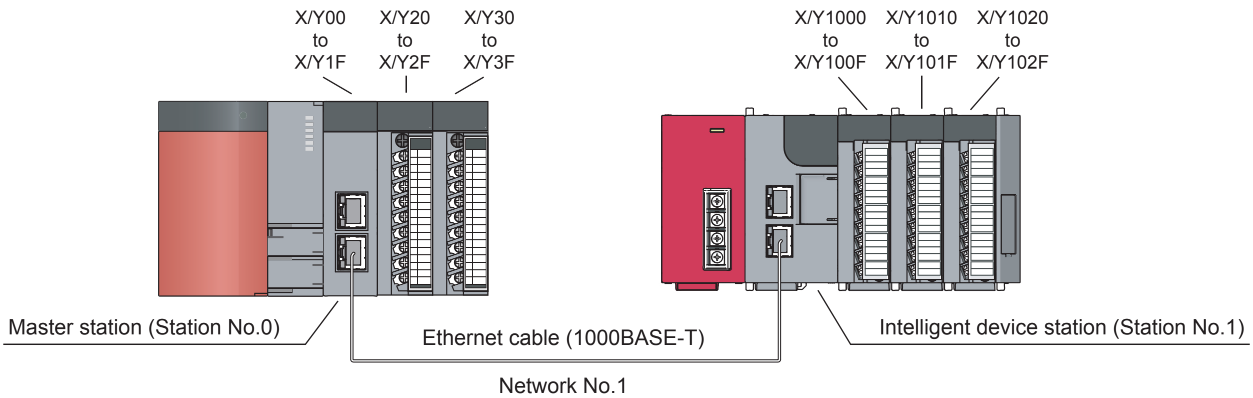
1. **Write wave data and parameters for the wave output function to the file register (ZR) of the CPU module on the master station side using "Create Wave Output Data" of GX Works2.**

2. **Transfer the data and parameters from the file register (ZR) to the analog I/O module connected to the head module using the ZP.REMTO instruction.**
Register the wave data and parameters for the wave output function first, then change D/A conversion enable/disable setting (Un\G2000).

3. **Request a wave output start/stop through a program.**

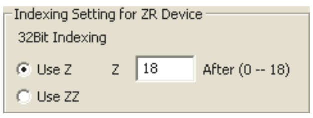
Power supply module (Q62P)
CPU module (Q10UDHCPU)
Master/local module (QJ71GF11-T2)
Input module (QX10)
Output module (QY40P)

Power supply module (L61P)
Head module (LJ72GF15-T2)
Analog I/O module (L60AD2DA2)
Input module (LX40C6)
Output module (LY10R2)
END cover (L6EC)



- Index setting for the ZR device

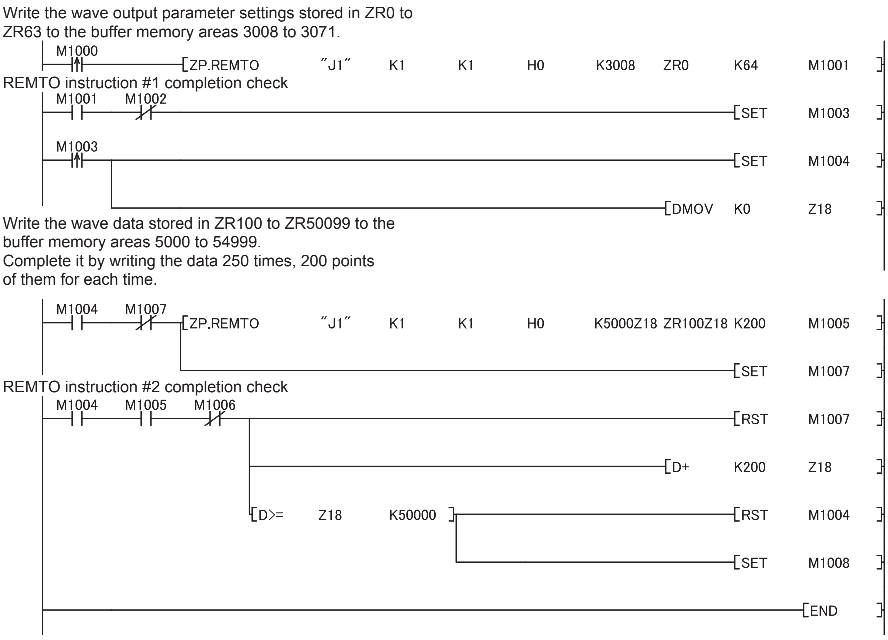
Project window ⇨ [Parameter] ⇨ [PLC Parameter] ⇨ "Device"



The following table lists the devices used in the program.

Device	Description
M1000	Wave output function parameter setting write command
M1001	Check device for wave output function parameter setting write completion
M1002	
M1003	Normal completion of wave output function parameter setting write
M1004	Wave data write command
M1005	Check device for wave data write completion
M1006	
M1007	Device for wave data write command repetitive control
M1008	Wave data write final completion
ZR0 to ZR99	File register that stores parameter setting for the wave output function
ZR100 to ZR50099	File register that stores wave data

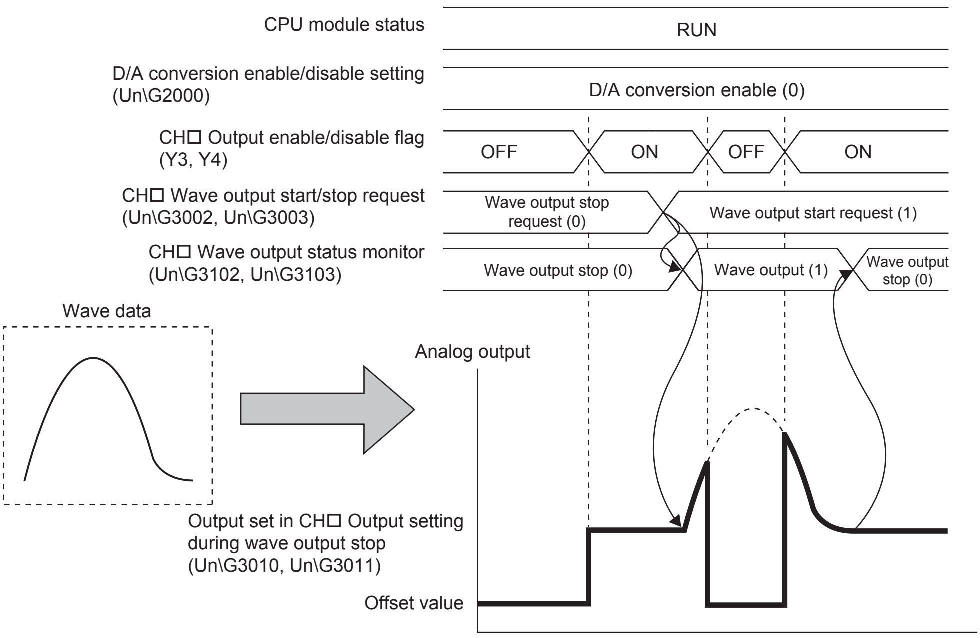
- Program



8.18.3 Points to use the wave output function

(1) When CH☐ Output enable/disable flag (Y3, Y4) is changed during the wave output

When CH☐ Output enable/disable flag (Y3, Y4) is turned off during the wave output, the analog output value becomes the offset value though the wave output is continued. The wave output continues to be updated while CH☐ Output enable/disable flag (Y3, Y4) is off. When CH☐ Output enable/disable flag (Y3, Y4) is turned on, the analog output is resumed.

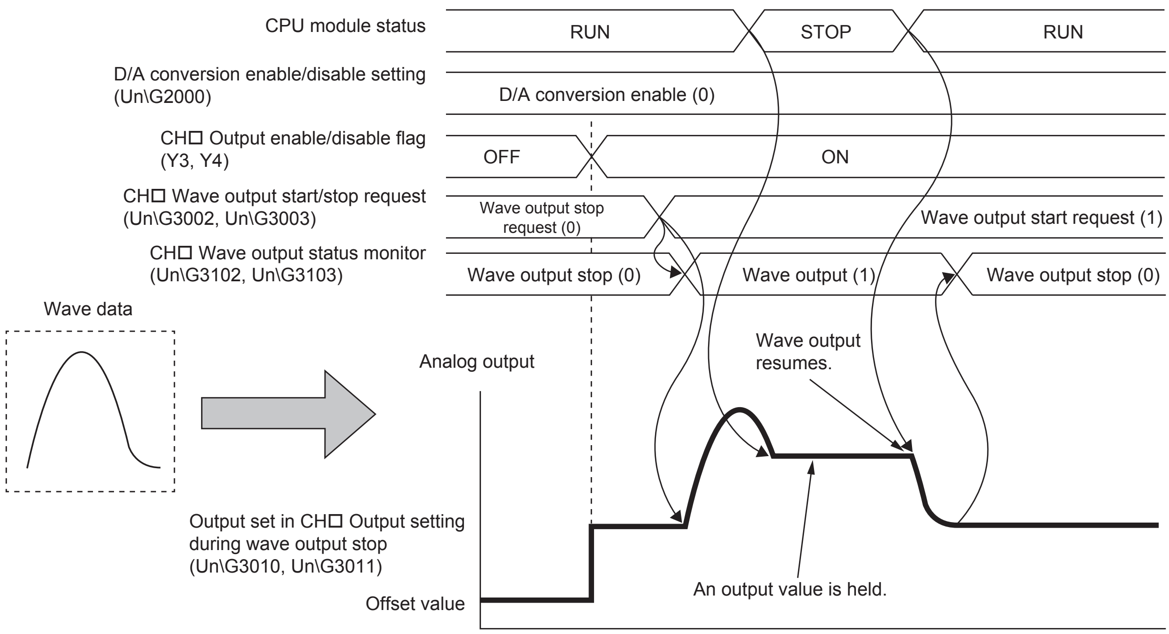


(2) When changing the CPU module status during the wave output

When the CPU module status is changed during the wave output, the operation of the module varies depending on the setting of the analog output HOLD/CLEAR function as shown below.

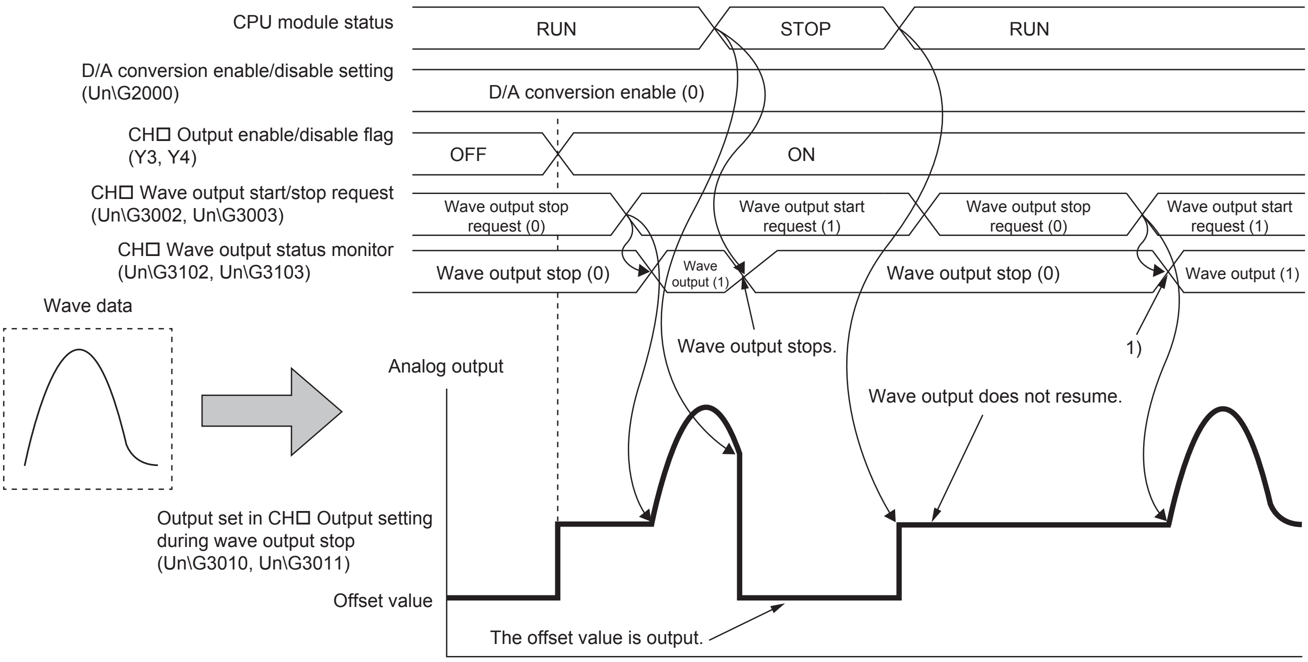
(a) For HOLD setting

When the CPU module state is changed to STOP from RUN, the analog output value at the change is held and the wave output pauses. When the CPU module state is changed to RUN from STOP, the wave output resumes. To prevent the wave output from resuming, set Wave output stop request (0) to CH☐ Wave output start/stop request (Un\G3002, Un\G3003) after changing the CPU module state to STOP from RUN.



(b) For CLEAR setting

When the CPU module state is changed to STOP from RUN, the wave output is finished and the offset value is output. When the CPU module state is changed to RUN from STOP, the value is output according to the setting in CH☐ Output setting during wave output stop (Un\G3010, Un\G3011). The wave output does not resume.
To execute the wave output again, set CH☐ Wave output start/stop request (Un\G3002, Un\G3003) to Wave output stop request (0) after changing the CPU module state to RUN from STOP. Then, change the value in CH☐ Wave output start/stop request (Un\G3002, Un\G3003) from Wave output stop request (0) to Wave output start request (1).



1): Wave output starts when the value set in CH☐ Wave output start/stop request (Un\G3002, Un\G3003) is changed from Wave output stop request (0) to Wave output start request (1).

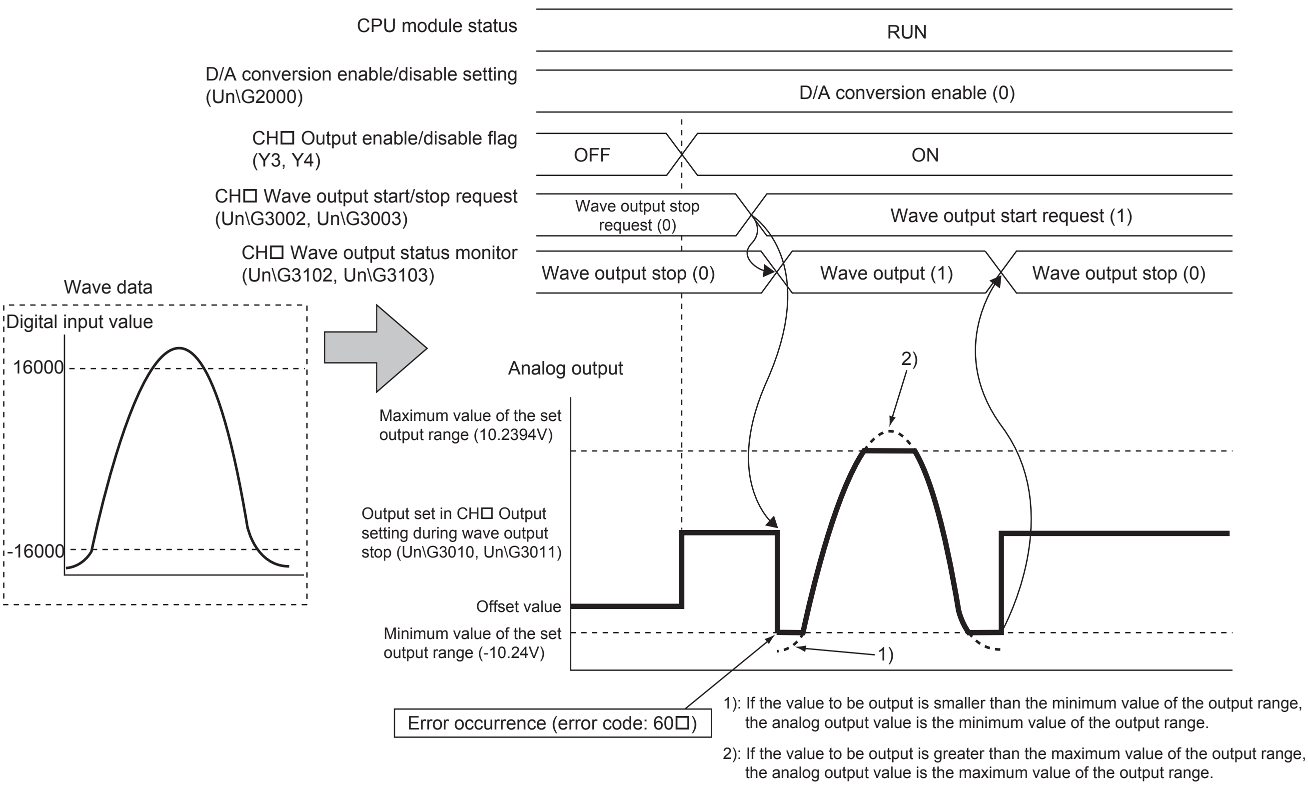
(3) When the error (error code: 60□) has occurred

When the value to be output is out of the output range, an error occurs. The error code (60□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the ERR.LED turns on. When the error (error code: 60□) occurs during the wave output, the analog output value becomes as follows.

- If the value to be output is greater than the maximum value of the output range, the maximum value of the output range is output in analog.
- If the value to be output is smaller than the minimum value of the output range, the minimum value of the output range is output in analog.

When the error (error code: 60□) has occurred, correct the digital input value of the wave data so that the value is within the output range. Then, turn on and off Error clear request (YF).

When -10 to 10V is set to the output range



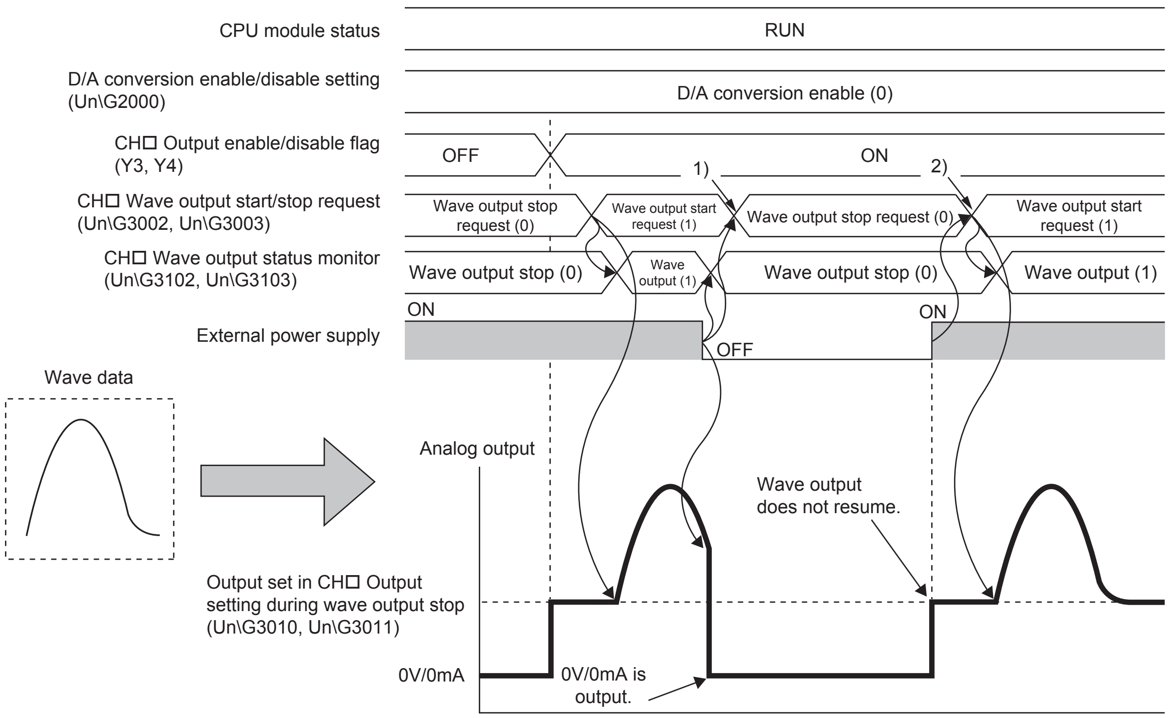
In addition, when the digital input value out of the range has been set and the error (error code: 60□) has occurred, correct the value to the one within the range and turn on and off Error clear request (YF).
To check the buffer memory address where the wave data with the value out of the range is to be registered, use Wave output digital value outside the range Address monitor (Un\G3160 to Un\G3163).

(4) When the external power supply is turned off during the wave output

When the external power supply is turned off during the wave output, the wave output status of all the channels becomes the wave output stop (the wave output stops). The wave output does not resume even when the external power supply is turned on.

To resume the wave output, check the analog I/O module and external devices after turning on the external power supply, and set CH☐ Wave output start/stop request (Un\G3002 to Un\G3003) to Wave output start request (1).

Wave output start/stop request cannot be accepted when the external power supply is off.



1): Because the external power supply was turned off and wave output stopped, change the value set in CH☐ Wave output start/stop request (Un\G3002, Un\G3003) to Wave output stop request (0).

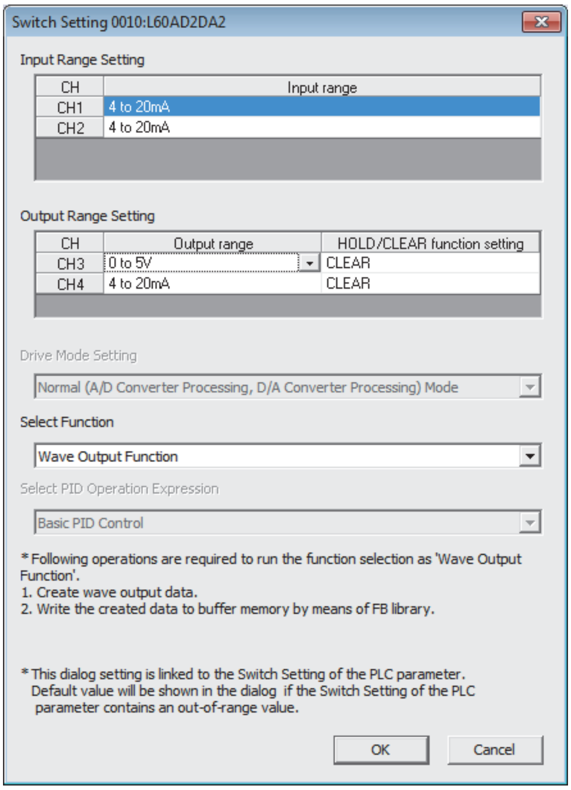
2): To resume wave output, change the value set in CH☐ Wave output start/stop request (Un\G3002, Un\G3003) from Wave output stop request (0) to Wave output start request (1).

(5) When using the wave output function as PWM

The wave output function can also be used as PWM with the minimum pulse width of 80μs.
Also the man-hours for programming can be reduced because necessary numbers of pulses can be output in analog by creating a wave pattern only for one pulse.

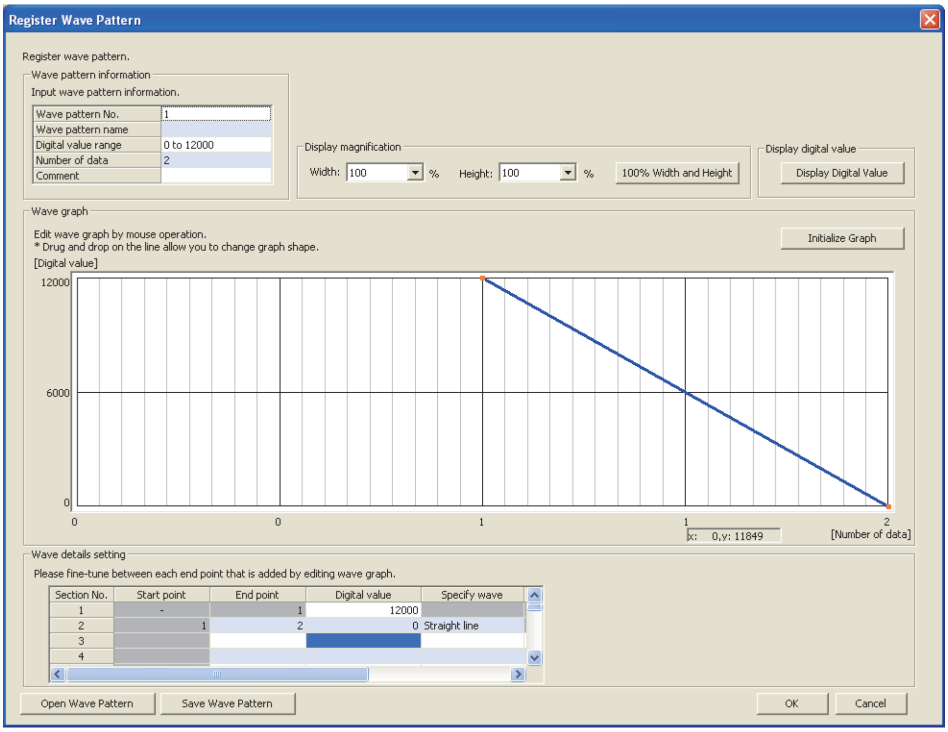
Ex. When a wave pattern with a pulse width of 80μs, amplitude of 5V, and duty ratio of 50% is created

1. Configure "Switch Setting" as shown below.



Setting item	Setting details
Output range for CH3	0 to 5V

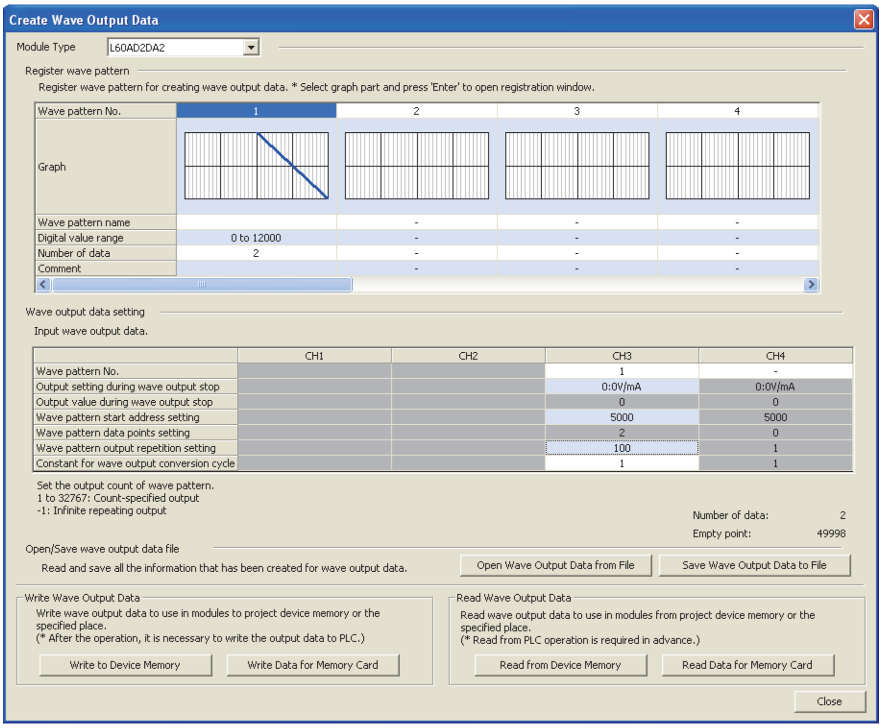
2. **Create a wave pattern for one pulse*1 in "Create Wave Output Data".**



Setting item		Setting details
Wave pattern information	Digital value range	0 to 12000
	Number of data	2
Wave details setting	Digital value for Section No.1	12000
	Digital value for Section No.2	0
	Specify wave for Section No.2	Straight line

*1 The wave pattern to be output in analog differs from the one to be monitored on GX Works2.

3. **Configure "Wave output data setting" as shown below.**



Setting item	Setting details
Wave pattern No. for CH3	Wave pattern created in step 2
Wave pattern start address setting for CH3	5000 (default value)
Wave pattern output repetition setting for CH3	Set the number of repetitions.
Constant for wave output conversion cycle for CH3	1 (default value)

4. **Register the wave data and parameters of the wave output function to the analog I/O module. For how to register the wave data and parameters, refer to the following.**

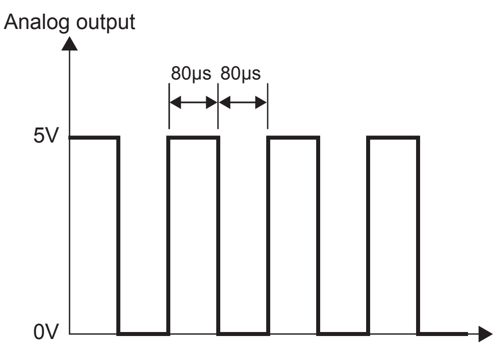
- Registering the wave data and parameters of the wave output function (☞ Page 168, Section 8.18.2 (1))

5. **Set D/A conversion enable (8H) to D/A conversion enable/disable setting (Un\G2000) for CH3 only.**

6. **Turn on and off Operating condition setting request (Y9).**

7. **Turn on CH3 Output enable/disable flag (Y3).**

8. **Start wave output by setting Wave output start request (1) to CH3 Wave output start/stop request (Un\G3002). Then the values are output in analog as shown below.**

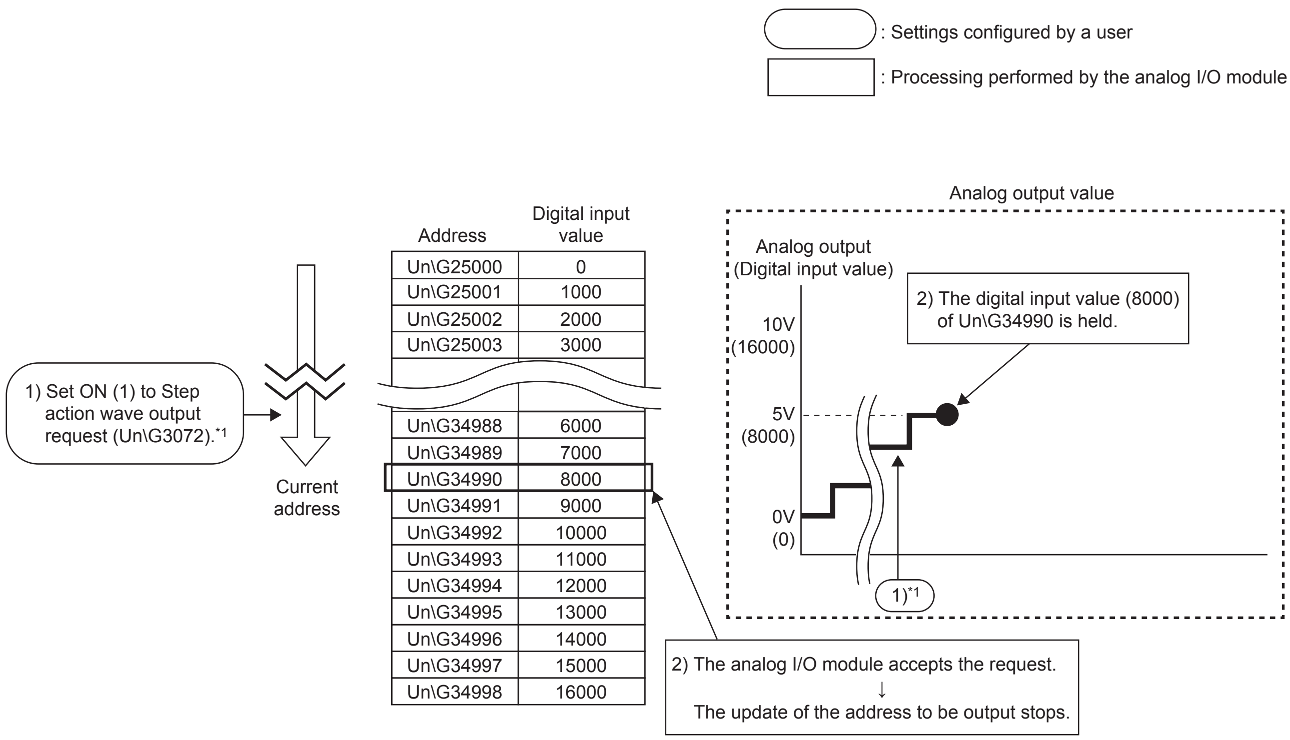


8.18.4 Wave output step action function

This function changes addresses and data values to be output to change the analog output flexibly at any timing when the wave output function is used.
This function is useful for the analog output test during the wave output function execution and for debugging the wave output function.

Ex. : Wave output step action on the following conditions
- The output range is set to "-10 to 10V".
- The wave output status is the wave output.
- The address of when the step action wave output request is accepted is 34990.

1 Set ON (1) to Step action wave output request (Un\G3072) during the wave output.

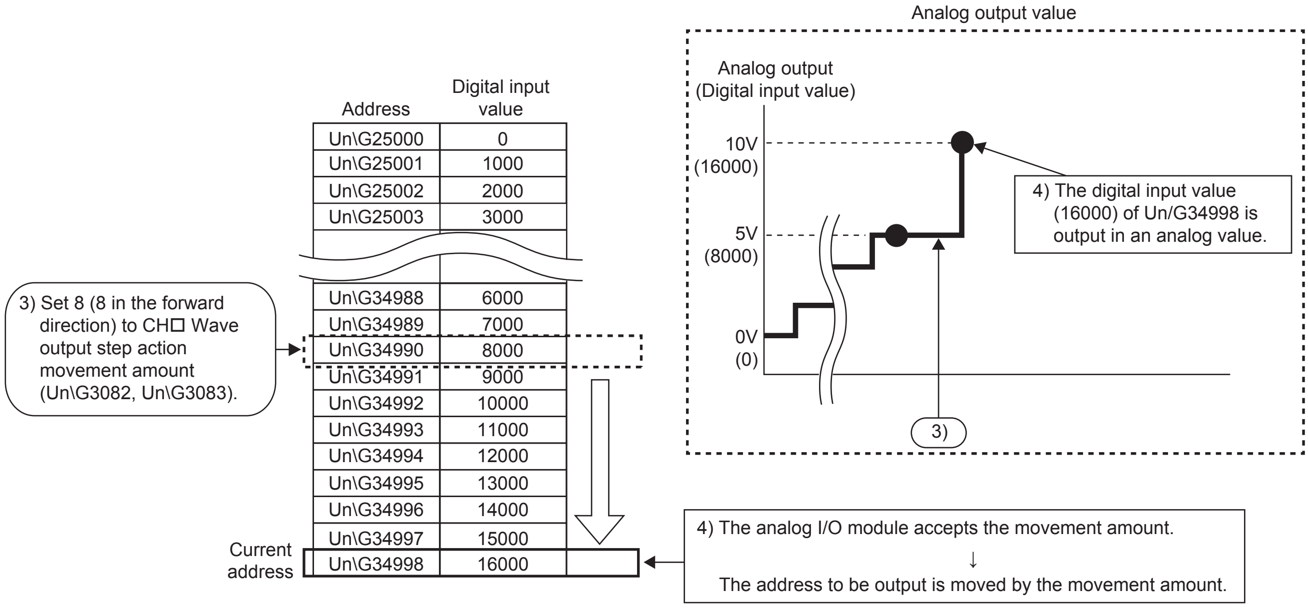


*1 The contents described here is the case when the wave output status is the wave output at the timing of 1). If the wave output status is the status other than the wave output, following operations are performed at the timing of 2).
- When the wave output status is the wave output stop
  The digital input value of the address set as the wave pattern start address is output in an analog value and held.
- When the wave output status is the wave output pause
  The data of the address during the wave output pause (wave output current address) is held.

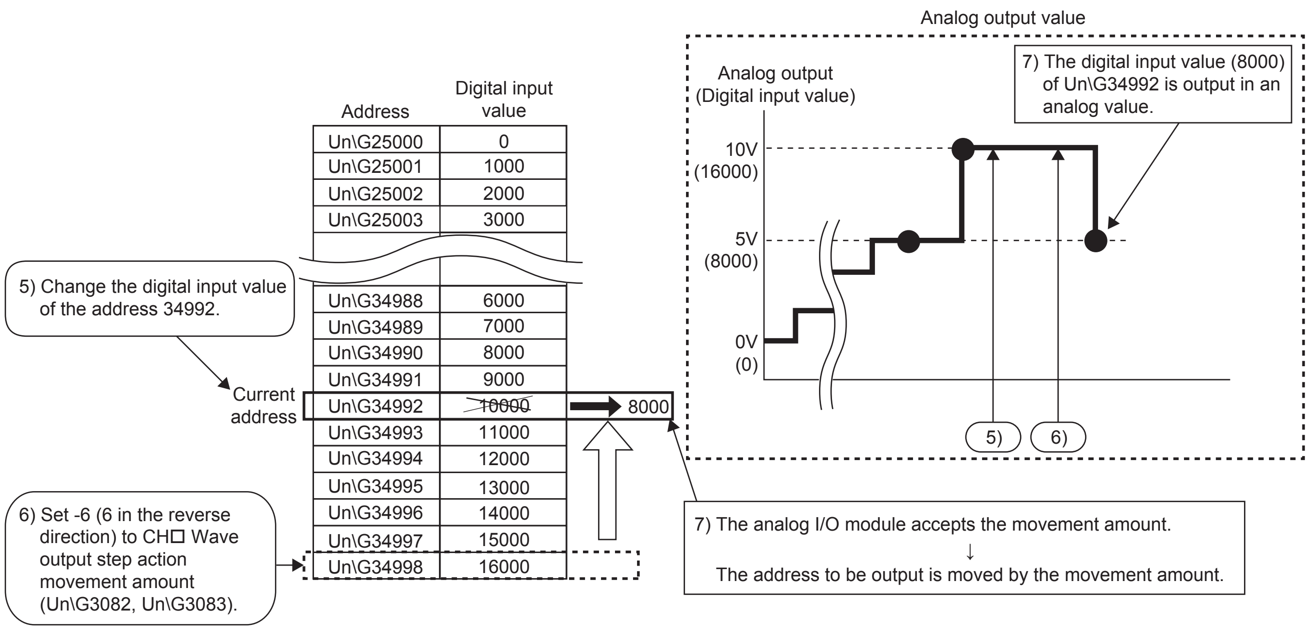
8

8.18 Wave Output Function
8.18.4 Wave output step action function

2 Set 8 (8 in the forward direction) to CH☐ Wave output step action movement amount (Un\G3082, Un\G3083).



3 Change the digital input value (in the address 34992) to 8000, and set -6 (6 in the reverse direction) to CH☐ Wave output step action movement amount (Un\G3082, Un\G3083).



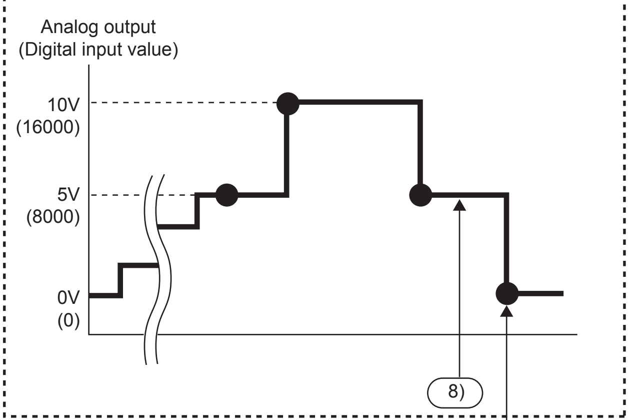
4 Set OFF (0) to Step action wave output request (Un\G3072).

8) Set OFF (0) to Step action wave output request (Un\G3072).

Current address

Address	Digital input value
Un\G25000	0
Un\G25001	1000
Un\G25002	2000
Un\G25003	3000
Un\G34988	6000
Un\G34989	7000
Un\G34990	8000
Un\G34991	9000
Un\G34992	10000
Un\G34993	11000
Un\G34994	12000
Un\G34995	13000
Un\G34996	14000
Un\G34997	15000
Un\G34998	16000

Analog output value



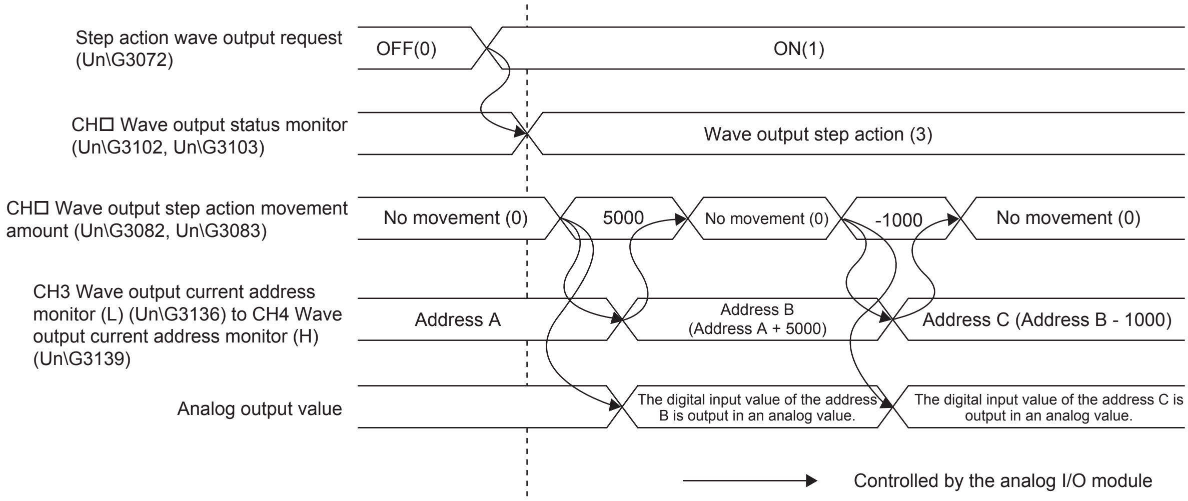
9) The analog I/O module accepts the request.
↓
The wave output status is changed to the wave output stop.

9) The value is output according to the setting in CH□ Output setting during wave output stop (Un\G3010, Un\G3011).*2

*2 This graph shows the value when 0V/0mA (0) is set to CH□ Output setting during wave output stop (Un\G3010, Un\G3011).

(1) Operation of the wave output step action function

The wave output step action function is executed as follows.



Turn on Step action wave output request (Un\G3072) to set the wave output status to the wave output step action. By setting a value in CH ☐ Wave output step action movement amount (Un\G3082, Un\G3083) during the wave output step action, the address moves to the address of the target wave data for the output test. Set the amount for movement from the current wave data address in CH☐ Wave output step action movement amount (Un\G3082, Un\G3083).

After the movement, the value in CH☐ Wave output step action movement amount (Un\G3082, Un\G3083) is changed to No movement (0) and the wave data of the target address is output in analog.
The available range for movement by using CH☐ Wave output step action movement amount (Un\G3082, Un\G3083) depends on the setting values of the wave pattern start address and wave pattern data points. The following shows the available range for movement.

(Wave pattern start address) to (Wave pattern start address + Wave pattern data points - 1)

Ex. Set 5000 to CH3 Wave pattern start address setting (Un\G3028, Un\G3029).
Set 10000 to CH3 Wave pattern data points setting (Un\G3044, Un\G3045).
→ The available range for movement is Un\G5000 to Un\G14999.

If a value of the wave pattern data points or greater is set for CH☐ Wave output step action movement amount (Un\G3082, Un\G3083), the operation is proceeding using the value of wave pattern data points.

(2) Execution of the wave output step action function

To use the wave output step action function, the initial setting for the wave output function must be set in advance. For details on the initial setting for the wave output function, refer to the following.

- Initial settings of the wave output function (☞ Page 152, Section 8.18.1)
- Registering the wave data and parameters of the wave output function (☞ Page 168, Section 8.18.2 (1))

(a) Switch to the wave output step action status

Switch the wave output status to the wave output step action in the following procedure.

1. **Change the value in Step action wave output request (Un\G3072) to ON (1).**

2. **Check that Wave output step action (3) has been set for CH□ Wave output status monitor (Un\G3102, Un\G3103) in all the channels where the D/A conversion is enabled.**

When a value other than "Wave Output Function" is set to "Select Function" in the switch setting, if a value other than OFF (0) is set to Step action wave output request (Un\G3072), a warning occurs. The alarm code (1610) is stored in Latest error code (Un\G19), Warning output signal (X8) turns on, and the ALM LED flashes at intervals of 1s.

(b) Execution of the wave output step action

After switching the status to the wave output step action status, execute the wave output step action in the following procedure. Repeating this procedure tests analog output during the wave output function execution and debugs the wave output function.

1. **Change the value of the target wave data for the wave output step action to any value.**

2. **Set a value for CH□ Wave output step action movement amount (Un\G3082, Un\G3083).**
Set the following value according to the direction to move.

Movement direction	Description	Setting value
No movement	The buffer memory address of the wave data to be output is not moved.	0
Forward movement	The buffer memory address of the wave data to be output is moved in the address increasing direction from the buffer memory address of the currently output wave data. Ex.) When 10000 is set in CH□ Wave output step action movement amount (Un\G3082, Un\G3083) with the buffer memory address of the currently output wave data Un\G20000 → The buffer memory address of the wave data to be output is changed to Un\G30000.	1 to 30000
Reverse movement	The buffer memory address of the wave data to be output is moved in the address decreasing direction from the buffer memory address of the currently output wave data. Ex.) When -10000 is set in CH□ Wave output step action movement amount (Un\G3082, Un\G3083) with the buffer memory address of the currently output wave data Un\G40000 → The buffer memory address of the wave data to be output is changed to Un\G30000.	-1 to -30000

3. **Check that the value in CH□ Wave output step action movement amount (Un\G3082, Un\G3083) has become No movement (0).**

4. **Check that CH3 Wave output current address monitor (L) (Un\G3136) to CH4 Wave output current address monitor (H) (Un\G3139) became the buffer memory addresses of the wave data to be output. At this time, the value of the target wave data is output in analog.**

5. **Check that proper analog values are output.**

(c) End of the wave output step action

End the wave output step action in the following procedure.

1. **Change the value in Step action wave output request (Un\G3072) to OFF (0).**
2. **Check that Wave output stop (0) has been set for CH☐ Wave output status monitor (Un\G3102, Un\G3103) in all the channels. If a value other than Wave output stop request (0) has been set for CH☐ Wave output start/stop request (Un\G3002, Un\G3003), the value is changed to Wave output stop request (0) forcibly at this timing. Also check the value of this buffer memory area.**

To execute the wave output after the wave output step action, set Wave output start request (1) for CH☐ Wave output start/stop request (Un\G3002, Un\G3003).

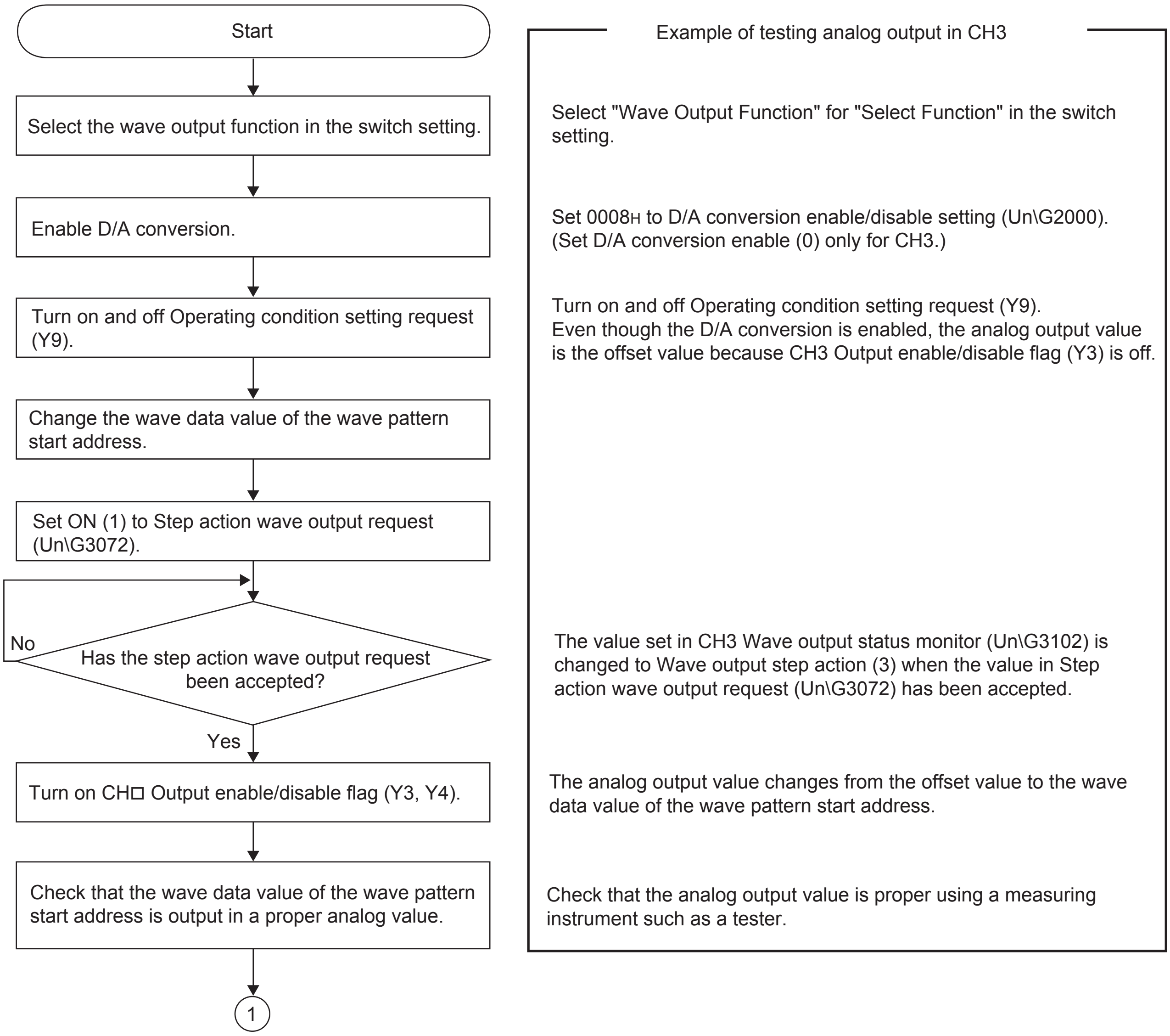
Point

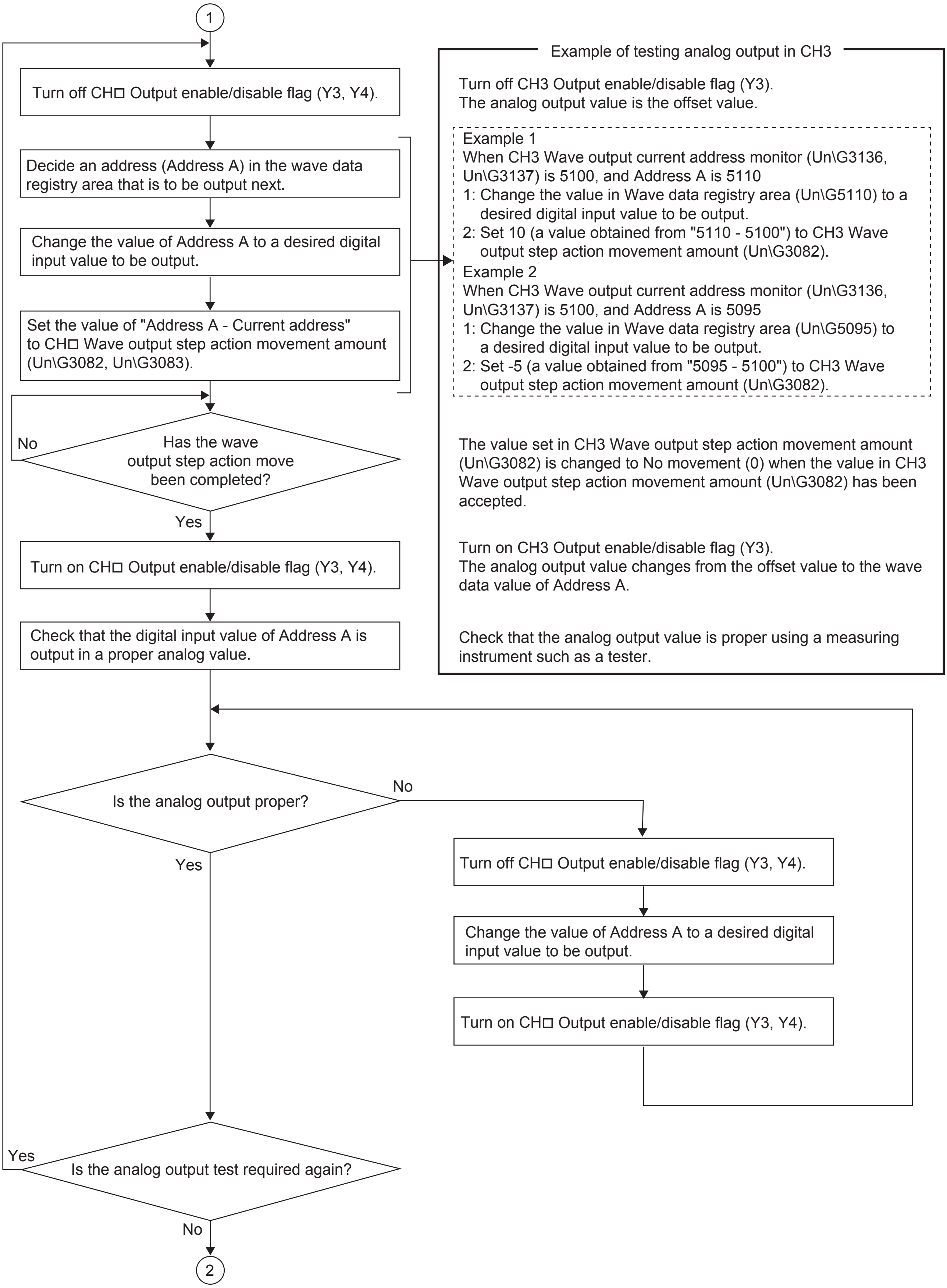
- Analog output may be changed suddenly when a value is set to CH☐ Wave output step action movement amount (Un\G3082, Un\G3083). To prevent a sudden change, use of CH☐ Wave output step action movement amount (Un\G3082, Un\G3083) in combination with CH☐ Output enable/disable flag (Y3, Y4) is recommended. For the combination, refer to the following.
    - Analog output HOLD/CLEAR function (☞ Page 127, Section 8.14 (1) (a))

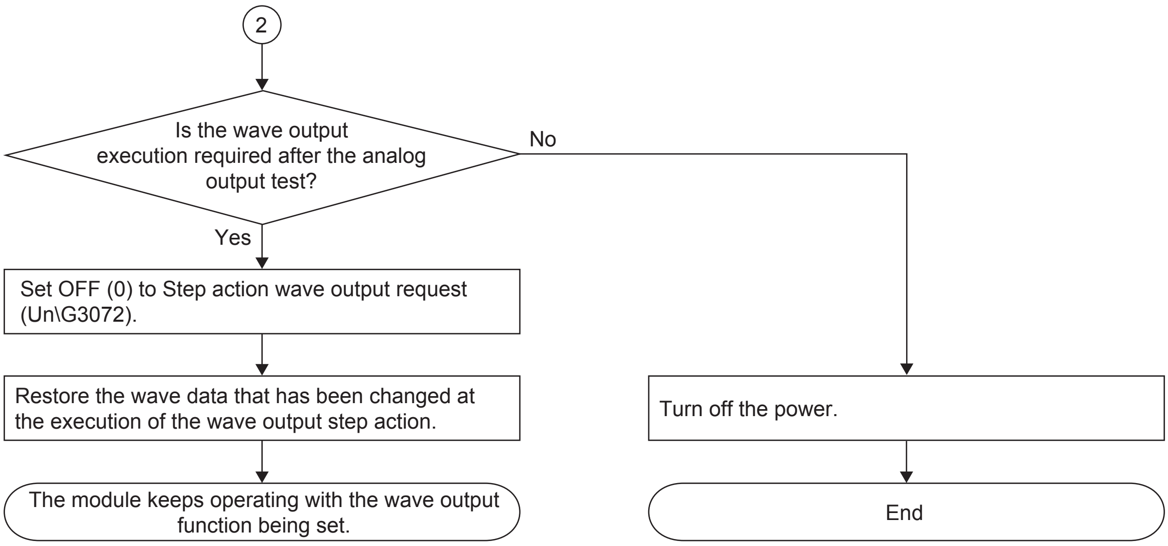
  Analog output can be changed at any timing as well by using CH☐ Wave output step action movement amount (Un\G3082, Un\G3083) in combination with CH☐ Output enable/disable flag (Y3, Y4) during the wave output step action. For details, refer to the following.
    - Analog output test when the wave output function is used (☞ Page 189, Section 8.18.4 (3))
- During the wave output step action, the wave output status is not changed even when a value is set to CH☐ Wave output start/stop request (Un\G3002, Un\G3003). To change the wave output status, set OFF (0) to Step action wave output request (Un\G3072) (set the status to the wave output stop).

(3) Analog output test when the wave output function is used

The following shows the procedure of the analog output test using the wave output step action function.
The example of testing analog output in CH3 is described as well.




1
Turn off CH□ Output enable/disable flag (Y3, Y4).
Decide an address (Address A) in the wave data registry area that is to be output next.
Change the value of Address A to a desired digital input value to be output.
Set the value of "Address A - Current address" to CH□ Wave output step action movement amount (Un\G3082, Un\G3083).
Has the wave output step action move been completed?
No
Yes
Turn on CH□ Output enable/disable flag (Y3, Y4).
Check that the digital input value of Address A is output in a proper analog value.
Example of testing analog output in CH3
Turn off CH3 Output enable/disable flag (Y3).
The analog output value is the offset value.
Example 1
When CH3 Wave output current address monitor (Un\G3136, Un\G3137) is 5100, and Address A is 5110
1: Change the value in Wave data registry area (Un\G5110) to a desired digital input value to be output.
2: Set 10 (a value obtained from "5110 - 5100") to CH3 Wave output step action movement amount (Un\G3082).
Example 2
When CH3 Wave output current address monitor (Un\G3136, Un\G3137) is 5100, and Address A is 5095
1: Change the value in Wave data registry area (Un\G5095) to a desired digital input value to be output.
2: Set -5 (a value obtained from "5095 - 5100") to CH3 Wave output step action movement amount (Un\G3082).
The value set in CH3 Wave output step action movement amount (Un\G3082) is changed to No movement (0) when the value in CH3 Wave output step action movement amount (Un\G3082) has been accepted.
Turn on CH3 Output enable/disable flag (Y3).
The analog output value changes from the offset value to the wave data value of Address A.
Check that the analog output value is proper using a measuring instrument such as a tester.
Is the analog output proper?
No
Yes
Turn off CH□ Output enable/disable flag (Y3, Y4).
Change the value of Address A to a desired digital input value to be output.
Turn on CH□ Output enable/disable flag (Y3, Y4).
Is the analog output test required again?
Yes
No
2


2
Is the wave output execution required after the analog output test?
No
Yes
Set OFF (0) to Step action wave output request (Un\G3072).
Restore the wave data that has been changed at the execution of the wave output step action.
The module keeps operating with the wave output function being set.
Turn off the power.
End

8.19 Variable Arithmetic Function

Variable arithmetic

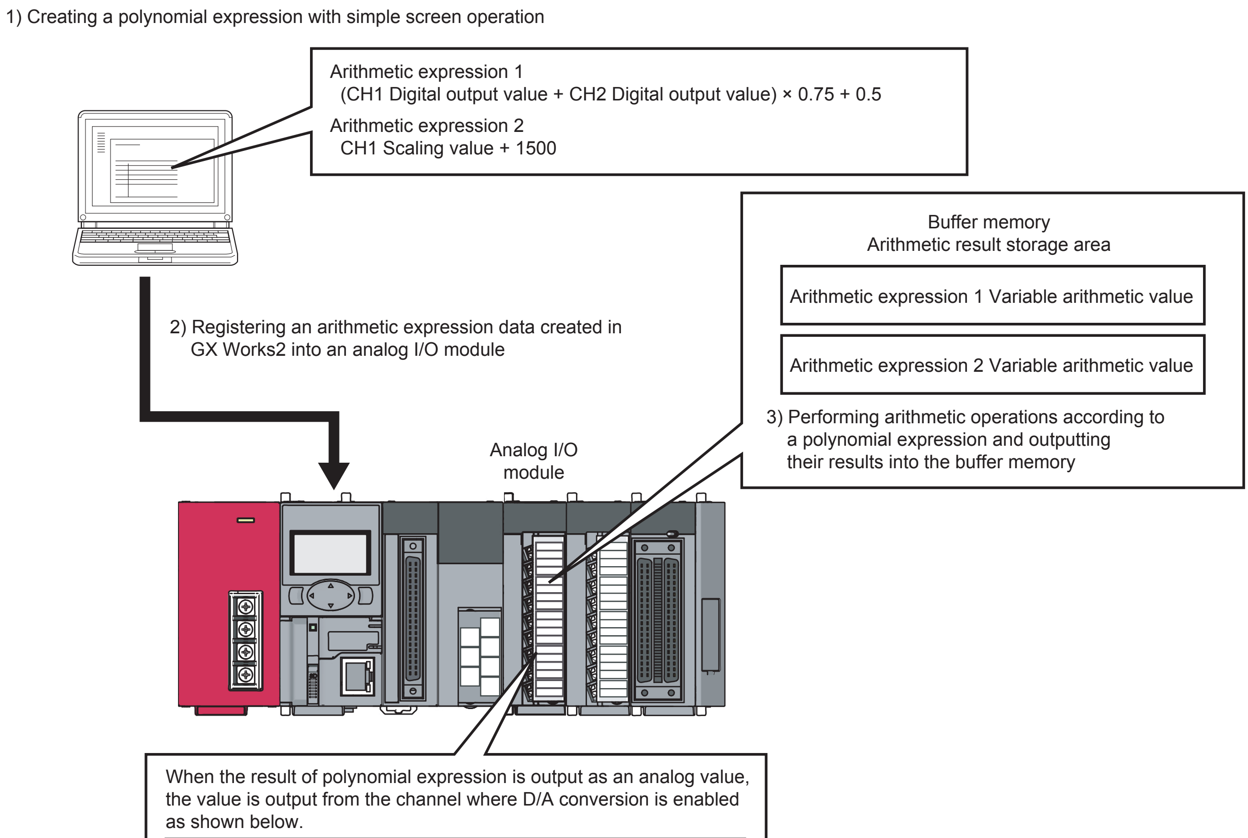
This function executes polynomial operations in the analog I/O module. For the polynomial expressions, any combination of parentheses, operators, constants set by users, and data stored in the buffer memory can be used. Up to two polynomial expressions can be registered. When conversion is enabled for a D/A conversion channel, operation results are output in analog.

Only by registering arithmetic expression data in the analog I/O module, polynomial operations can be executed. Thus, no programs for the operation are required on the CPU module and the man-hour for creating programs can be reduced. In addition, advanced operations independent of the scan time of the CPU module can be executed.

The variable arithmetic function is available only when "Free Operation Function" is set for "Select Function" in the switch setting.

For the setting procedure of "Select Function", refer to the following.

- Switch setting (☞ Page 203, Section 8.19.1 (4))



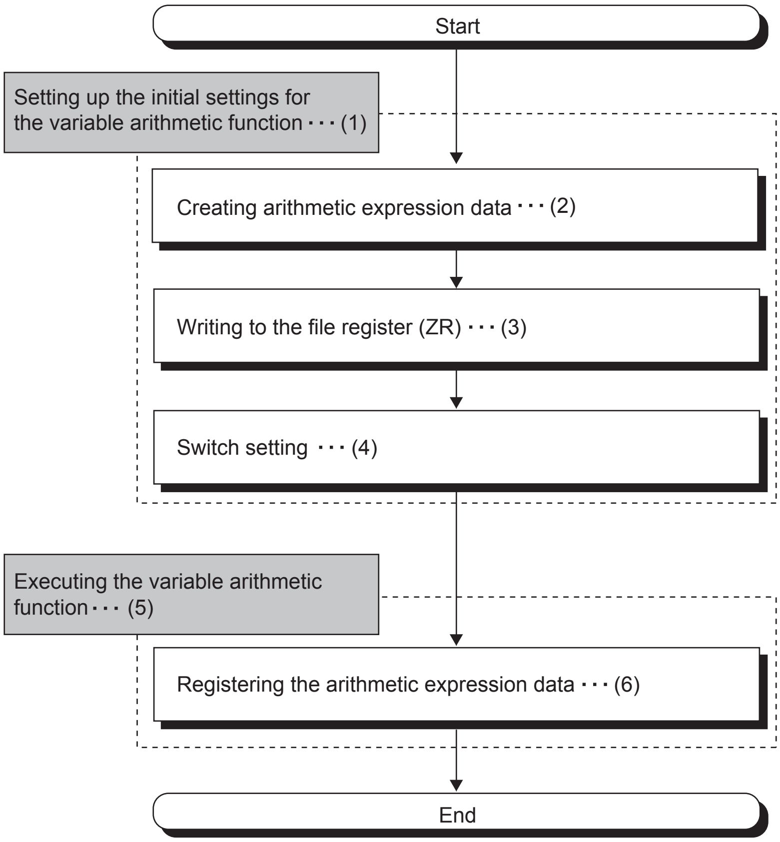
Arithmetic expression	Channel where D/A conversion is enabled
Arithmetic expression 1	CH3
Arithmetic expression 2	CH4

Point

- Although operation results are output as 32-bit signed data and stored in Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005), the analog I/O module can perform D/A conversion only for 16-bit signed data. Thus, when the operation results are output in analog, the value of Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) is rounded off to the nearest integer and converted into 16-bit signed data. This 16-bit signed data is called Variable arithmetic value for analog output (Un\G4003, Un\G4007). Since analog output is controlled to stay within the output range, set polynomial expressions including input data and constants so that analog output stays within this range.
- When the external power supply is off, the variable arithmetic function cannot be used.
- Arithmetic expressions (both Operation Expression 1 and 2) are not registered in the factory default setting. Thus, register an arithmetic expression when using the variable arithmetic function.
  When both or either of them is not registered, the value of Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) of the corresponding arithmetic expression is fixed to 0. In addition, Variable arithmetic value for analog output (Un\G4003, Un\G4007) is fixed to 0. Thus, the offset values are output from the D/A conversion channels as follows.
  - When Operation Expression 1 is not registered: The offset value is output from CH3.
  - When Operation Expression 2 is not registered: The offset value is output from CH4.

(1) Procedure for using the variable arithmetic function

The following shows how to use the variable arithmetic function.



(1) ☞ Page 197, Section 8.19.1
(2) ☞ Page 198, Section 8.19.1 (2)
(3) ☞ Page 202, Section 8.19.1 (3)
(4) ☞ Page 203, Section 8.19.1 (4)
(5) ☞ Page 205, Section 8.19.2
(6) ☞ Page 205, Section 8.19.2 (1)

- Arithmetic expression data can be created easily by using the "Free Operation Function Setting" of GX Works2. This data can be saved in the file register (ZR) of the CPU module.
- Arithmetic expression data registered in the analog I/O module can be saved in the flash memory. When the data has been saved in the flash memory, the analog I/O module operates with the saved setting at the next startup. Therefore, registering the data is unnecessary when the setting is not changed.

(a) Feature of the file register (ZR) concerning arithmetic expression data storage

The arithmetic expression data and parameter setting contents remain in the CPU module even after power off or reset of the CPU module.

(2) Restrictions and precautions on the variable arithmetic function

The variable arithmetic function has the following restrictions and precautions.

(a) D/A conversion

In the variable arithmetic function, the same D/A conversion as that in the normal mode cannot be used because analog output is produced according to created arithmetic expressions. However, the equivalent operation can be performed by using arithmetic expressions. For details, refer to the following.
To perform normal analog output when an arithmetic expression is not used (☞ Page 211, Section 8.19.3 (4))

(b) Input range setting

The user range cannot be used. When executing the variable arithmetic function, use a range other than the user range. For the setting procedure of the input range, refer to the following.
Switch setting (☞ Page 203, Section 8.19.1 (4))

(c) Output range setting

The user range cannot be used. When executing the variable arithmetic function, use a range other than the user range. For the setting procedure of the output range, refer to the following.
Switch setting (☞ Page 203, Section 8.19.1 (4))

(d) Drive mode setting

When using the variable arithmetic function, set "Normal (A/D Converter Processing, D/A Converter Processing) Mode" for "Drive Mode Setting" in the switch setting.

(e) Select function

When using the variable arithmetic function, set "Free Operation Function" for "Select Function" in the switch setting.

(f) Head module

When the analog I/O module is used with the head module, the function block (FB) cannot be used. When executing the variable arithmetic function, refer to the following.
How to register data when a head module is used (☞ Page 209, Section 8.19.2 (5))

(g) Analog output HOLD/CLEAR function

The output status of the analog output HOLD/CLEAR function is the same as that of normal output. For details, refer to the following.
Analog output HOLD/CLEAR function (☞ Page 128, Section 8.14 (1) (c))

(h) A/D conversion enable/disable setting

To use CH□ Digital output value (Un\G11, Un\G12) for an arithmetic expression, enable conversion in the A/D conversion channel used. If the channel where conversion is disabled is used for an arithmetic expression, the digital output value is calculated as 0.
When saving the arithmetic expression data in the flash memory, disable conversion in all the channels during the saving.

(i) Averaging process setting

Set the averaging processing method for the channels where A/D conversion is performed in the same way as for normal output.
When averaging processing is set in A/D conversion, an operation is executed with the averaged value.

(j) Input signal error detection function

Set the input signal error detection setting for the channels where A/D conversion is performed in the same way as for normal output.

(k) Scaling function (A/D conversion)

Set the scaling enable/disable setting for the channels where A/D conversion is performed to Enable in the same way as for normal output.
To use the scaling value for an operation, specify CH□ Scaling value (Un\G54, Un\G55) for "Operation Value" in "Create Operation Expression".

(l) Logging function

The logging function and variable arithmetic function cannot be selected at the same time. When executing the variable arithmetic function, set "Free Operation Function" for "Select Function" in the switch setting.

(m) D/A conversion enable/disable setting

To output operation results, enable conversion in the D/A conversion channel.
When saving the arithmetic expression data in the flash memory, disable conversion in all the channels during the saving.

(n) Warning output function

The warning detection target when the variable arithmetic function is used is Variable arithmetic value for analog output (Un\G4003, Un\G4007).

(o) Scaling function (D/A conversion)

The scaling function (D/A conversion) cannot be used when the variable arithmetic function is selected. To execute the variable arithmetic function, disable the scaling function (D/A conversion).

8.19.1 Initial setting of the variable arithmetic function

The variable arithmetic function executes the following as the initial setting. Before executing the variable arithmetic function, execute the procedures described in this section.

- Creating arithmetic expression data (☞ Page 198, Section 8.19.1 (2))
- Writing to a file register (ZR) (☞ Page 202, Section 8.19.1 (3))
- Switch setting (☞ Page 203, Section 8.19.1 (4))

(1) Arithmetic expression data

Arithmetic expression data is numeric value data converted from arithmetic expressions operated by the analog I/O module.
For an arithmetic expression, up to five constants or buffer memory areas can be used.

- Since 0 to 4 can be set as the decimal point, a value between -32768 $\times$ 10^{-N} and 32767 $\times$ 10^{-N} (N indicates the decimal point (0 to 4)) can be used as a constant.
- When buffer memory areas are used, the data with address 0 to 4999 can be used. The decimal point (0 to 4) can be set for the specified address data of a buffer memory area.

Point

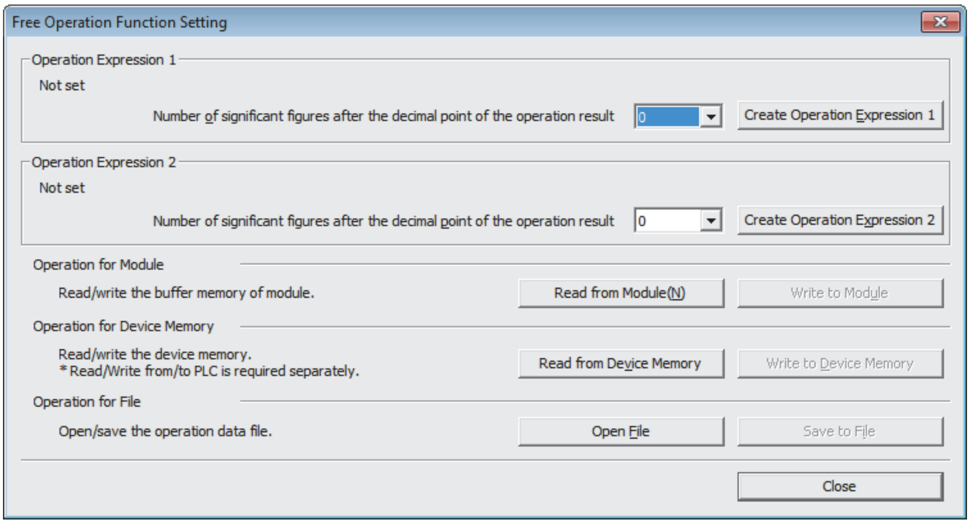
When the variable arithmetic function is used, the result of normal A/D conversion is stored in CH□ Digital output value (Un\G11, Un\G12).
When using buffer memory addresses including CH□ Digital output value (Un\G11, Un\G12) for each arithmetic expression, specify a buffer memory address listed with "R/W" and "W" in the buffer memory list such as CH□ Digital output value (Un\G11, Un\G12) and CH□ Scaling value (Un\G54, Un\G55).
Do not specify a system area because normal operation is not guaranteed.
For details on the buffer memory addresses, refer to the following.
☞ List of Buffer Memory Addresses (Page 32, Section 3.5)

(2) Creating arithmetic expression data

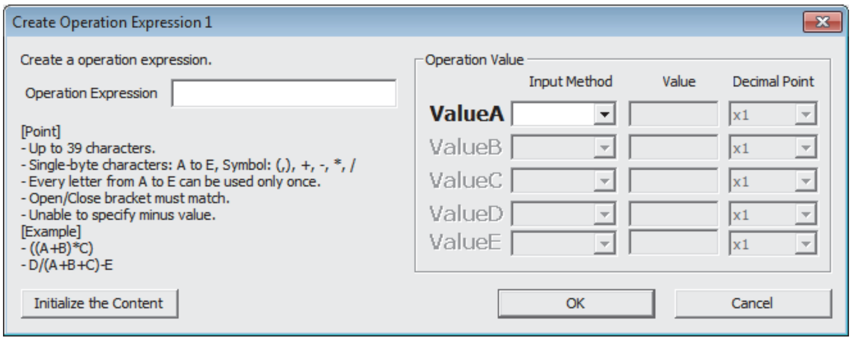
Create arithmetic expression data in "Free Operation Function Setting" of GX Works2.

1. Open the "Free Operation Function Setting" window.

[Tool] ⇨ [Intelligent Function Module Tool] ⇨ [Analog Module]
⇨ [Free Operation Function Setting]



2. Click "Create Operation Expression 1" or "Create Operation Expression 2". The "Create Operation Expression" window appears.



3. **Create an arithmetic expression.**

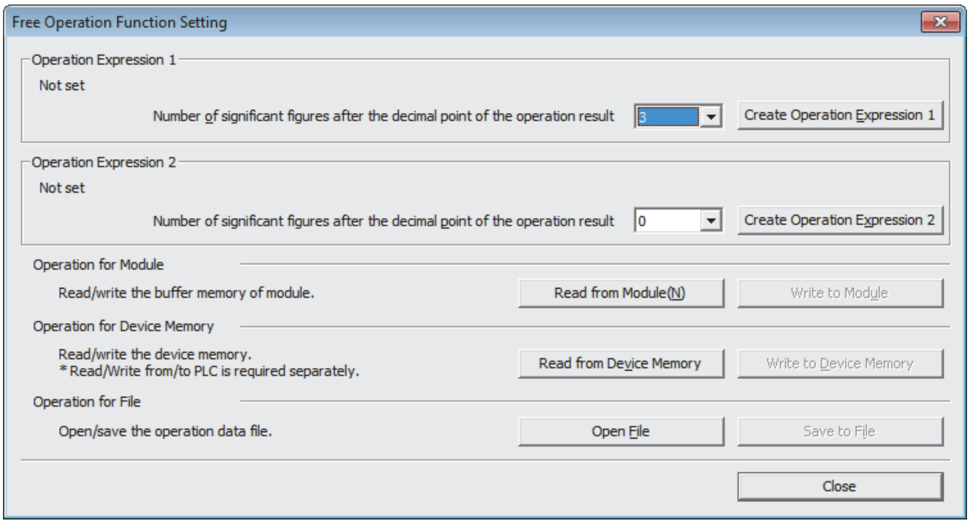
Item		Description	Setting range
Operation Expression		Enter an arithmetic expression.	—
Operation Value	Input Method	Specify whether the operation value is a constant or a buffer memory address of the analog I/O module.	• Constant • Address
	Value	Enter a constant or a buffer memory address used for the operation.	• Constant: -32768 to 32767 • Address: 0 to 4999
	Decimal Point	Specify the decimal point of the operation value.	• ×1 • ×0.1 • ×0.01 • ×0.001 • ×0.0001

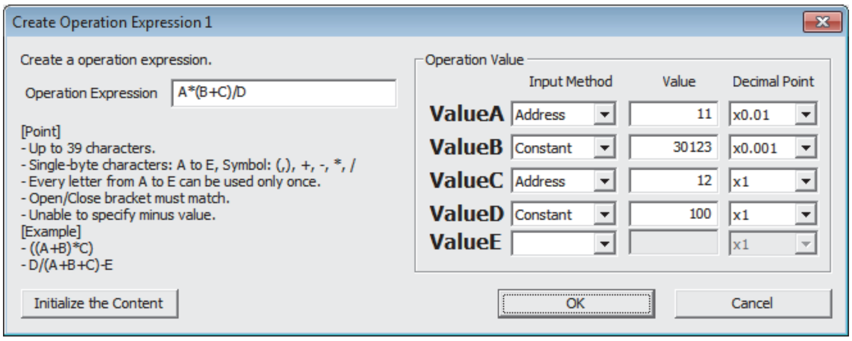
Point

When using a buffer memory address for the operation value, specify the buffer memory address listed with "R/W" or "W" in the buffer memory list. Do not specify a system area because normal operation is not guaranteed.
For details on the buffer memory addresses, refer to the following.
☞ List of Buffer Memory Addresses (Page 32, Section 3.5)

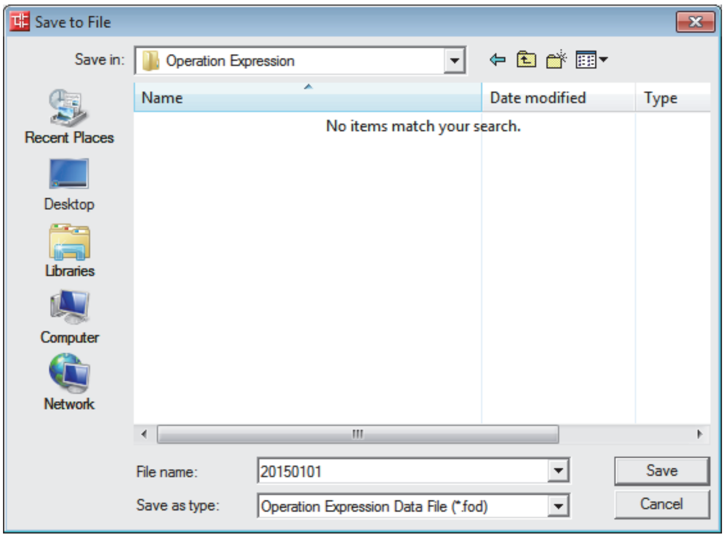
Ex. The following shows the windows of when the A/D conversion values of CH1 and CH2 are operated and output. The setting condition is shown in the table below.

Item	Description
Arithmetic expression	Operation Expression 1
Arithmetic expression	CH1 Digital output value (Un\G11) × ((30.123 + CH2 Digital output value (Un\G12)) ÷ 100)
Decimal point of CH1 Digital output value	×0.01
Decimal point of CH2 Digital output value	×1
Calculation result	The three digits after the decimal point are displayed.





4. **Click the Save to File button.**



The saved arithmetic expression data can be opened by clicking the Open File button.

5. **Set the save destination and the file name, and click the Save button.**

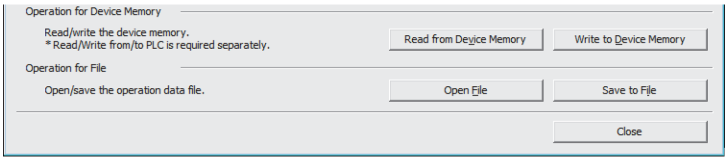
(3) Writing to a file register (ZR)

Write the arithmetic expression data to a file register (ZR).

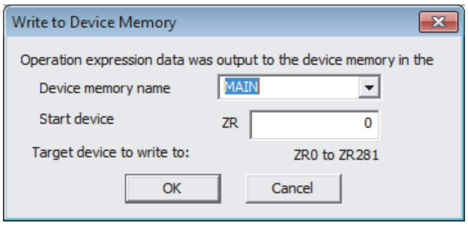
When writing the data to the file register (ZR), set the capacity of the file register (ZR) for the number of required data points. For the setting procedure, refer to the following.

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

1. **Click the** [Write to Device Memory] **button in the "Free Operation Function Setting" window.**

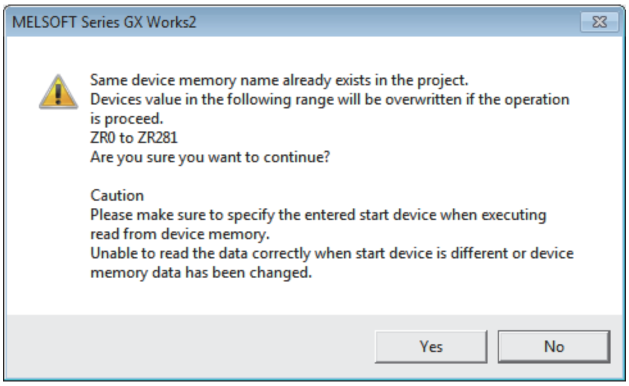


2. **Set "Device memory name" and "Start device". Then click the** [OK] **button.**

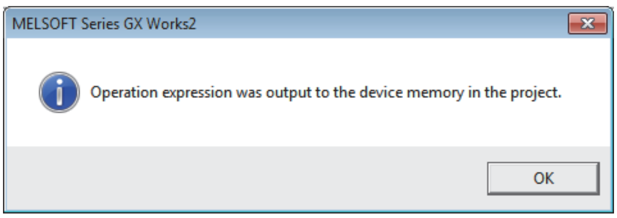


Item	Description
Device memory name	Set the device memory to be written to the file register (ZR). Select the device memory to be written from the pull-down menu or enter the device memory name to be created.
Start device	Set the start address for the output of the device memory.
Target device to write to	The file register (ZR) range to write to is displayed.

3. **Click the** [Yes] **button.**



4. **Click the** [OK] **button.**



5. **Click the** [Close] **button in the "Free Operation Function Setting" window to close the window.**

6. **Write the device memory to the CPU module from "Write to PLC".**

[Online] ⇨ [Write to PLC]

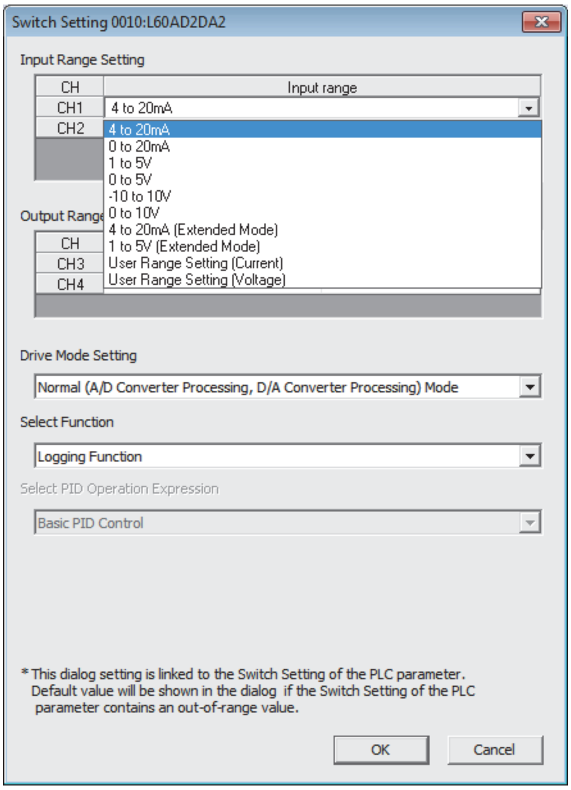
(4) Switch setting

To use the variable arithmetic function, the switch setting is required.

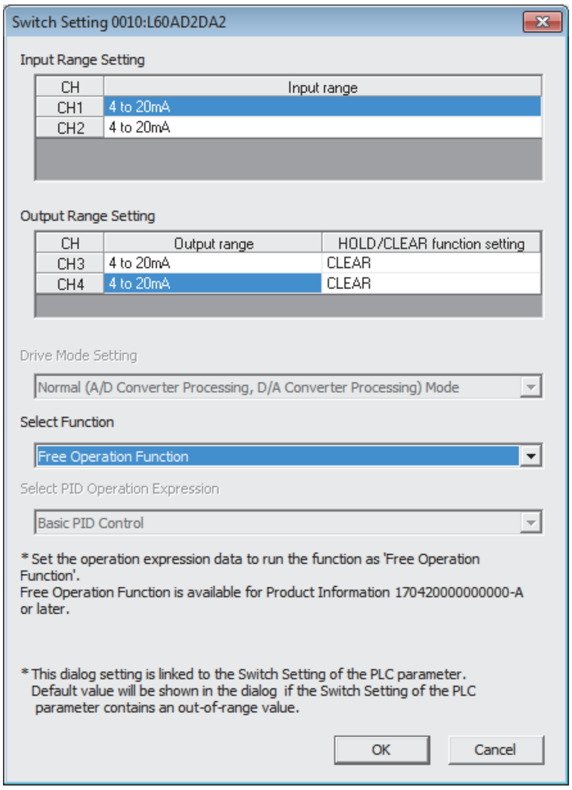
1. Open the "Switch Setting" window.

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Switch Setting]

2. Set "Input range" and "Output range" to a range other than "User Range Setting".



3. **Set "Select Function" to "Free Operation Function".**



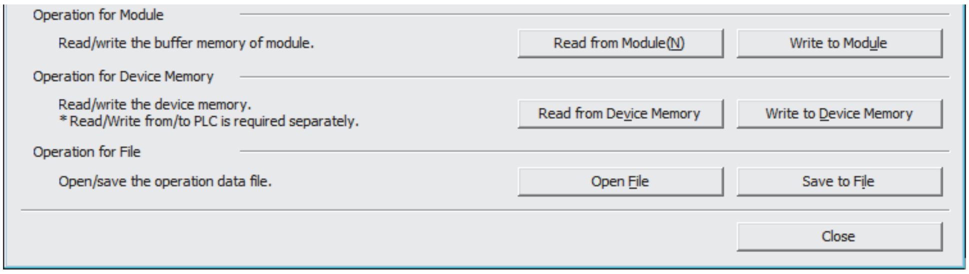
8.19.2 Execution of the variable arithmetic function

This section describes the execution procedures for the variable arithmetic function. Execute the contents in this section after the initial setting of the variable arithmetic function.

(1) Registering arithmetic expression data

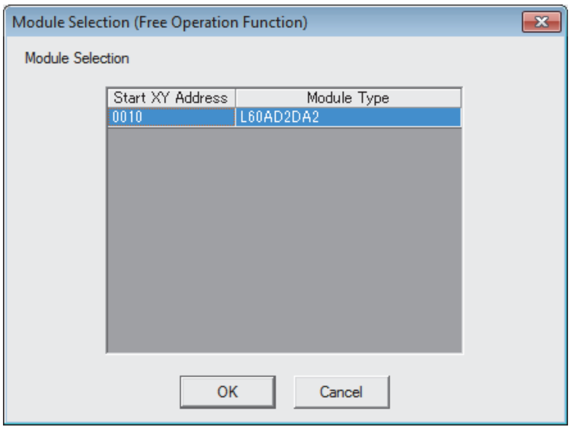
Register the arithmetic expression data which is created in "Free Operation Function Setting" of GX Works2 in the analog I/O module.

1. Click the [Write to Module] button in the "Free Operation Function Setting" window.

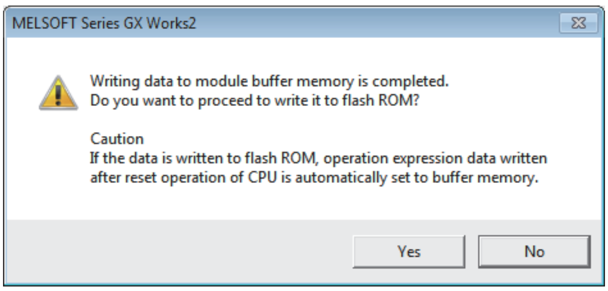


The saved arithmetic expression data can be read by clicking the [Read from Module(N)] button.

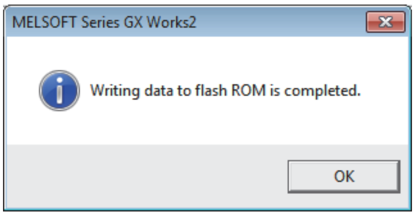
2. Click the [OK] button.



3. To register the arithmetic expression data in the flash memory of the analog I/O module, click the [Yes] button. Not to register the data, click the [No] button.



4. **Click the OK button.**



5. **Turn on and off Operating condition setting request (Y9) to enable the setting.**

When "Parameter Setting" of GX Works2 is used, turning on and off Operating condition setting request (Y9) is not required.

Point

The arithmetic expression data registered in the analog I/O module is saved in Un\G50000 to Un\G50281 of the buffer memory. Since Un\G50000 to Un\G50281 is used for the variable arithmetic function, do not configure a setting for these areas. If the setting is configured, the operation cannot be guaranteed.

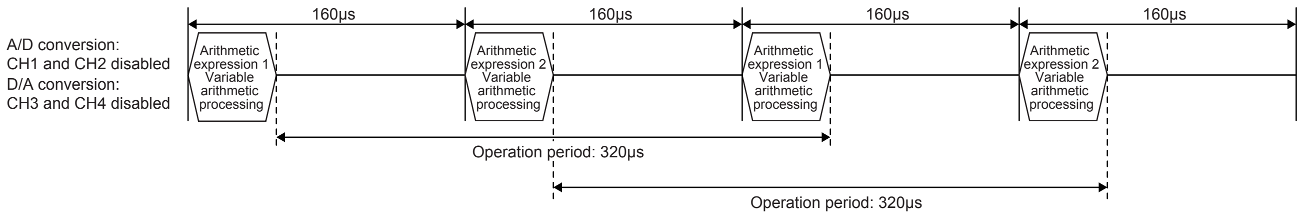
(2) Order of variable arithmetic processing

When arithmetic expression data is enabled, variable arithmetic processing for Operation Expression 1 and 2 is executed every conversion cycle.

The following shows how A/D conversion, D/A conversion, and variable arithmetic processing relate each other.

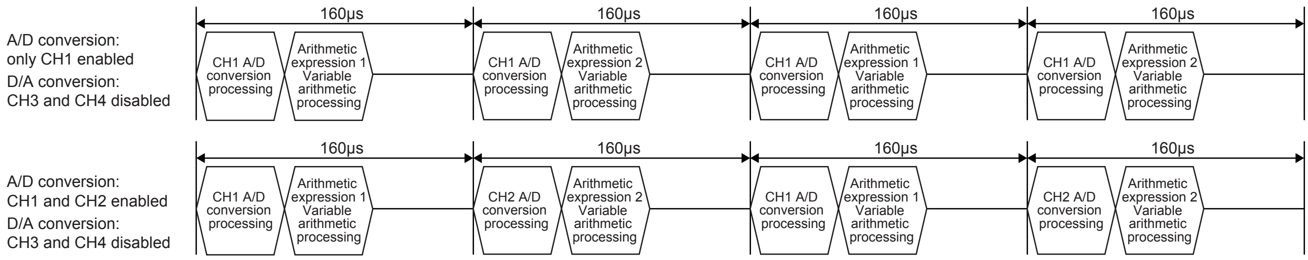
(a) When conversion is disabled in the A/D conversion channel and D/A conversion channel

Because A/D conversion processing and D/A conversion processing are not executed, the processing of Operation Expression 1 and 2 is executed by turns.



(b) When conversion is enabled only in the A/D conversion channel

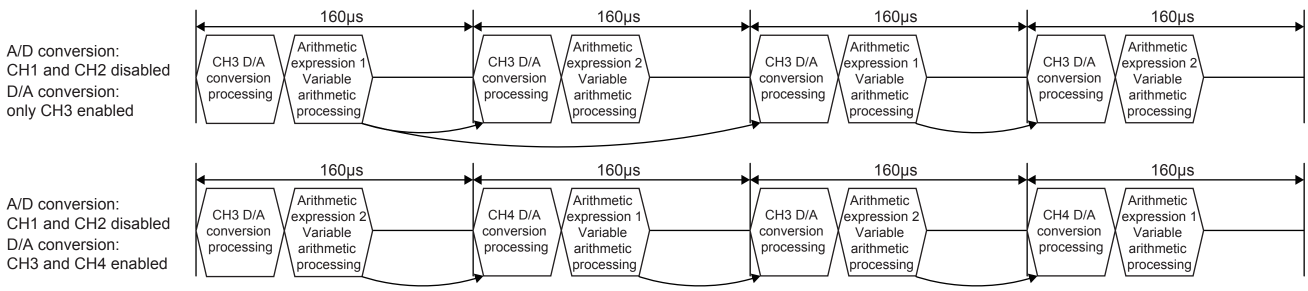
A/D conversion processing is executed only in the channel where conversion is enabled and the variable arithmetic processing of Operation Expression 1 and 2 is executed by turns.



(c) When conversion is enabled only in the D/A conversion channel

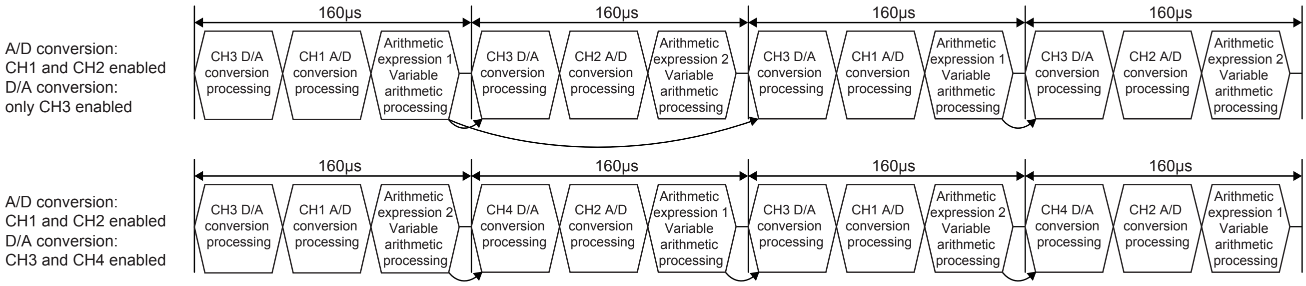
D/A conversion processing is executed only in the channel where conversion is enabled and the variable arithmetic processing of Operation Expression 1 and 2 is executed by turns.

- When conversion is enabled only in CH3, the processing is executed from Operation Expression 1. When conversion is enabled only in CH4, the processing is executed from Operation Expression 2.
- When conversion is enabled in CH3 and CH4, processing is executed from Operation Expression 2.
- Analog output changes according to the variable arithmetic value for analog output of the arithmetic expression corresponding to the D/A-conversion enabled channel.



(d) When conversion is enabled in the A/D conversion channel and D/A conversion channel

A/D conversion processing and D/A conversion processing are executed only in the channel where conversion is enabled and the variable arithmetic processing of Operation Expression 1 and 2 is executed by turns.



Point

If conversion is enabled in CH1 and 2, and the A/D-converted value (digital output value or scaling value) of CH2 is used for an arithmetic expression, the first operation is executed with the value before conversion.
For example, in the above-mentioned "When conversion is enabled in the A/D conversion channel and D/A conversion channel", the variable arithmetic processing for Operation Expression 2 is executed in CH2 with the value before the A/D conversion processing.
For this reason, when an A/D-converted value (digital output value or scaling value) is used for an arithmetic expression, read the operation result (such as variable arithmetic value) after A/D conversion completed flag (XE) turns on.

(3) Analog output enable/disable

Turn on CH□ Output enable/disable flag (Y3, Y4) of the channel where an analog value is output. When CH□ Output enable/disable flag (Y3, Y4) is turned on, the variable arithmetic value for analog output is output in analog.
When CH□ Output enable/disable flag (Y3, Y4) is turned off during an operation, an analog output value becomes an offset value though the operation is continued. When CH□ Output enable/disable flag (Y3, Y4) is turned on again, the analog output is resumed.
The D/A conversion is executed in a conversion cycle of 160μs. However, analog output changes every 320μs because the conversion cycle of the arithmetic expression is 320μs.

(4) Checking the status of the variable arithmetic function

The status of the variable arithmetic function can be checked with the following buffer memory areas.

Item	Buffer memory address	Description	Reference
Variable arithmetic value	Operation Expression 1: Un\G4000, Un\G4001 Operation Expression 2: Un\G4004, Un\G4005	These areas store the digital value of the current operation result as a 32-bit signed binary value when the variable arithmetic function is used.	Page 396, Appendix 2 (63)
Variable arithmetic decimal point monitor	Operation Expression 1: Un\G4002 Operation Expression 2: Un\G4006	These areas store the decimal point of Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005).	Page 397, Appendix 2 (64)
Variable arithmetic value for analog output	Operation Expression 1: Un\G4003 Operation Expression 2: Un\G4007	These areas store the value of Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) which is rounded off to the nearest integer as a 16-bit signed binary value.	Page 398, Appendix 2 (65)

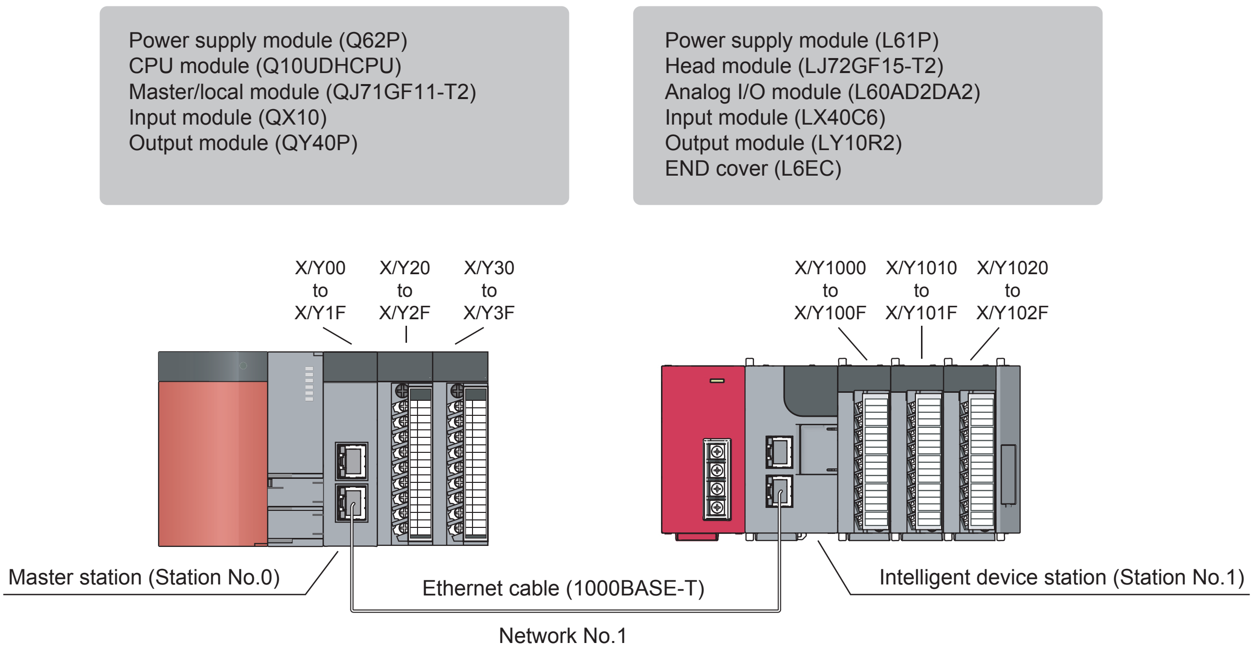
(5) How to register data when a head module is used

The following shows how to transfer the arithmetic expression data which is created in "Free Operation Function Setting" of GX Works2 in the analog I/O module.

- Setting procedure

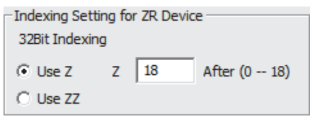
1. **Write the arithmetic expression data to the file register (ZR) of the CPU module on the master station side using "Free Operation Function Setting" of GX Works2.**

2. **Transfer the data from the file register (ZR) to the analog I/O module connected to the head module using the ZP.REMTO instruction.**
At this time, register the arithmetic expression data first. Then change the setting of A/D conversion enable/disable setting (Un\G0) and D/A conversion enable/disable setting (Un\G2000).



- Index setting for the ZR device

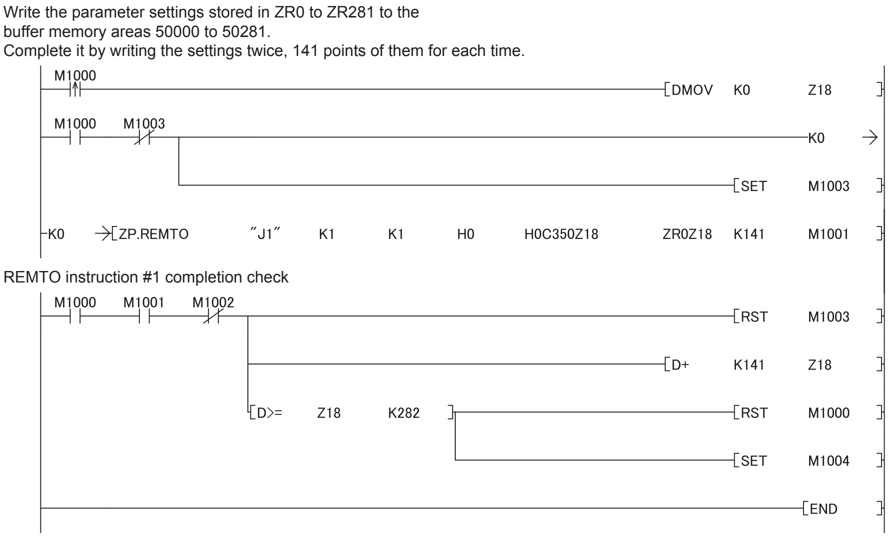
Project window ⇨ [Parameter] ⇨ [PLC Parameter] ⇨ "Device"



The following table lists the devices used in the program.

Device	Description
M1000	Command to write arithmetic expression data
M1001	Device to check write completion of arithmetic expression data
M1002	
M1003	Device for repetitive control of the command to write arithmetic expression data
M1004	Final completion of arithmetic expression data write
ZR0 to ZR281	Arithmetic expression data

- Program



8.19.3 Points to use the variable arithmetic function

(1) When division by 0 has occurred during an operation

When division by 0 has occurred during an operation, the alarm (alarm code: 172□) occurs. This division is processed as division by 1 and the operation continues.

Point

If the alarm (alarm code: 172□) occurs during operation, check the whole arithmetic expression including input data and constants.

(2) When the CPU module status is changed during operation execution

When the CPU module status is changed during operation execution, the operation is continued. However, the status of analog output is the same as that of normal output.
For details on the analog output status depending on the CPU module status, refer to the following.

- Normal output (☞ Page 127, Section 8.14 (1) (a))

(3) When the external power supply is off during operation execution

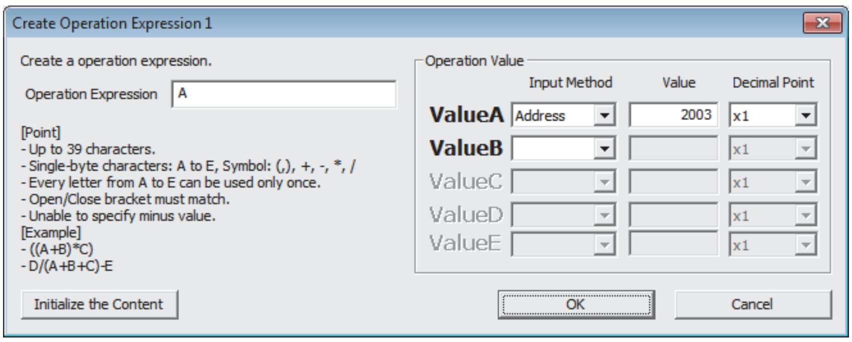
When the external power supply is turned off during operation execution, the operation stops.
When the external power supply is turned on, the operation resumes.

(4) To perform normal analog output when an arithmetic expression is not used

When either Operation Expression 1 or 2 is not used, normal analog output can be performed by the following setting.

Ex. To perform normal analog output in CH3 when Operation Expression 1 is not used

1. **Configure the setting in "Create Operation Expression 1" as follows.**



2. **Register arithmetic expression data in the analog I/O module. For how to register the data, refer to the following.**

- Registering arithmetic expression data (☞ Page 205, Section 8.19.2 (1))

3. **Turn on and off Operating condition setting request (Y9).**

4. **Write a digital value in CH3 Digital input value (Un\G2003).**

5. **Turn on CH3 Output enable/disable flag (Y3). Normal analog output is performed according to the value of CH3 Digital input value (Un\G2003).**

8.20 Variable Conversion Characteristics Function

Variable conversion

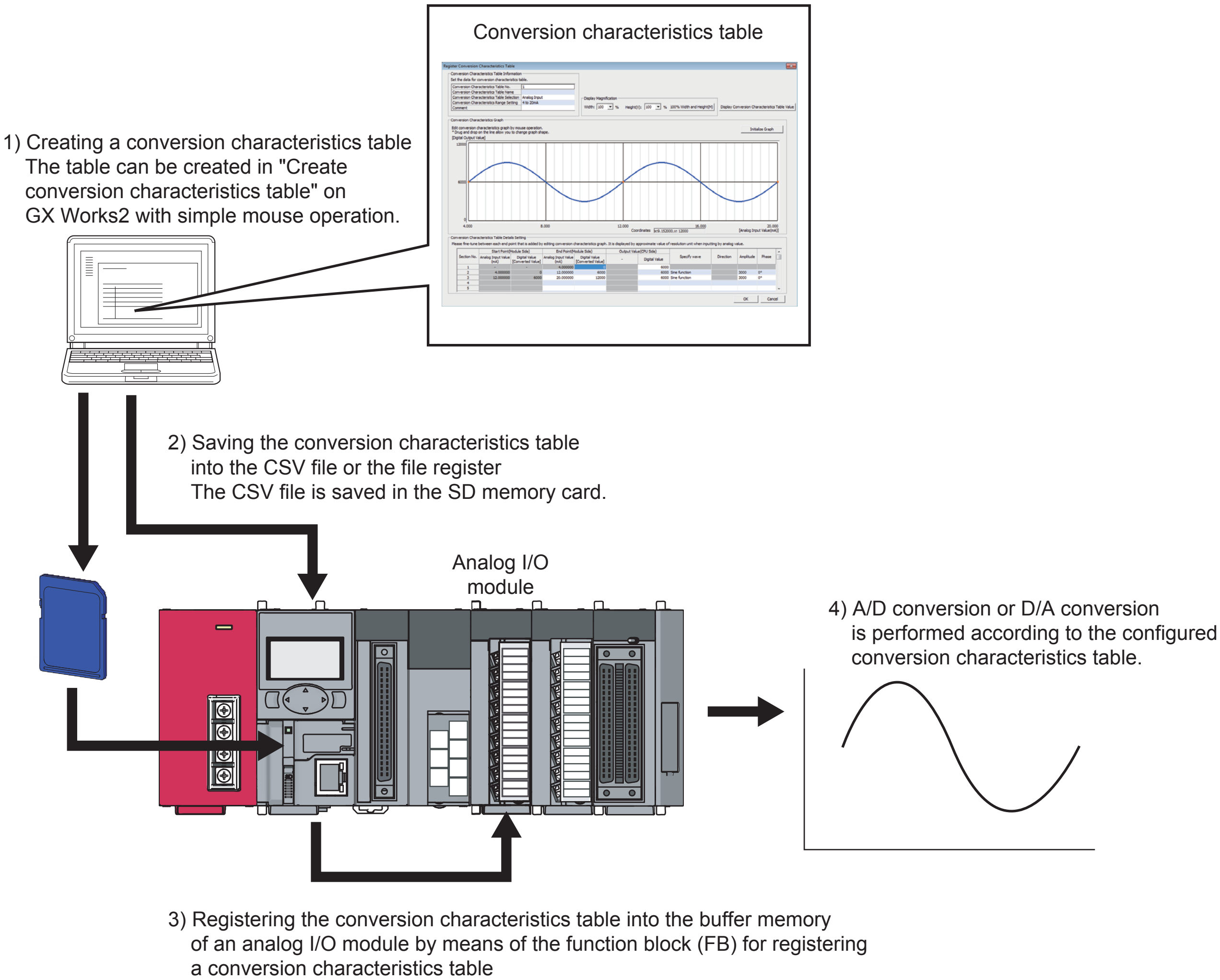
Conventionally, the I/O conversion characteristic of the analog I/O module (A/D conversion and D/A conversion) is indicated with a straight line connecting the offset value and the gain value. However, with this function, the conversion characteristic can be set by users.

Only by registering a conversion characteristics table in this module, values are converted according to the conversion characteristics. Thus, no programs for the operation are required on the CPU module and the man-hour for creating programs can be reduced. With high-speed performance that the analog I/O module has, analog input, analog output, and analog input/output can be performed with the variable conversion characteristic created by users.

The variable conversion characteristics function is available only when "Free Conversion Characteristics Function" is set for "Select Function" in the switch setting.

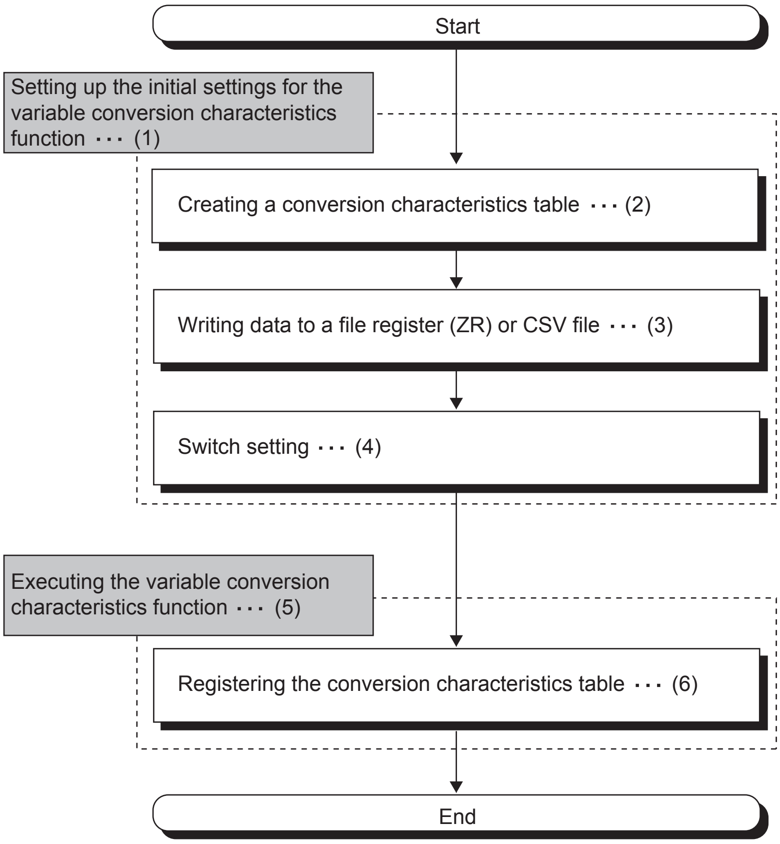
For the setting procedure of "Select Function", refer to the following.

- Switch setting (☞ Page 228, Section 8.20.1 (4))



(1) Procedure for using the variable conversion characteristics function

The following shows how to use the variable conversion characteristics function.



(1) ☞ Page 218, Section 8.20.1
(2) ☞ Page 224, Section 8.20.1 (2)
(3) ☞ Page 225, Section 8.20.1 (3)
(4) ☞ Page 228, Section 8.20.1 (4)
(5) ☞ Page 229, Section 8.20.2
(6) ☞ Page 229, Section 8.20.2 (1)

With "Create Conversion Characteristics Table" of GX Works2, a conversion characteristics table can be created easily and the parameter setting of the variable conversion characteristics function can be configured easily. These setting contents are saved in the file register (ZR) of the CPU module or in a CSV file and registered on the buffer memory of the analog I/O module with the function block (FB) for the conversion characteristics table registration.

(a) Feature of the file register (ZR) and the CSV file concerning conversion characteristics table storage

- File register (ZR): The conversion characteristics table setting contents remain in the CPU module even after power off or reset of the CPU module.
- CSV file: The conversion characteristics table setting can be used for the analog I/O module of other programmable controller systems only by copying a CSV file.

(2) Restrictions and precautions on the variable conversion characteristics function

The variable conversion characteristics function has the following restrictions and precautions.

(a) Input range setting, output range setting

Since the range of the channel for which the variable conversion characteristics function is used is set in Variable conversion characteristics range setting (Un\G4101), the range setting of the switch setting is ignored. Values are output in channels for which the variable conversion characteristics function is not used with the input range setting or output range setting of the switch setting.

(b) Drive mode setting

When using the variable conversion characteristics function, set "Normal (A/D Converter Processing, D/A Converter Processing) Mode" for "Drive Mode Setting" in the switch setting.

(c) Function selection

When using the variable conversion characteristics function, set "Free Conversion Characteristics Function" for "Select Function" in the switch setting.

(d) Head module

When the analog I/O module is used with the head module, the function block (FB) cannot be used. When executing the variable conversion characteristics function, refer to the following.

How to register data when a head module is used (☞ Page 237, Section 8.20.2 (4))

(e) Analog output HOLD/CLEAR function

For the combination for the analog output status when the variable conversion characteristics function is used, refer to the following.

Output with variable conversion characteristics (☞ Page 128, Section 8.14 (1) (c))

(f) A/D conversion enable/disable setting

Enable conversion in the A/D conversion channel to be used.

For "Analog I/O", set Enable (0) in both of the corresponding A/D conversion channel and D/A conversion channel. When Enable (0) is set only in one channel, the error (error code: 504□) occurs. When the error occurs, conversion does not start.

(g) Averaging process setting

Set the averaging processing method for the channels where A/D conversion is performed in the same way as for normal input.

When averaging processing is set for the channel for which the variable conversion characteristics function is used, the digital value after the averaging processing is used as an address of the conversion characteristics table. Then, the data stored in the address is stored in CH□ Digital output value (Un\G11, Un\G12).

When "Analog I/O" is selected in Variable conversion characteristics table selection and averaging processing is set, the value stored in CH□ Digital output value (Un\G11, Un\G12) of the corresponding D/A conversion channel is converted into an analog value and the analog value is output every conversion cycle. However, the output is updated every cycle set with averaging processing.

(h) Input signal error detection function

Set the input signal error detection setting for the channels where A/D conversion is performed in the same way as for normal input.

When an input signal error occurs with the variable conversion characteristics function used, the value indicated by the address just before the error detection is held.

(i) Scaling function (A/D conversion)

Since the scaling function (A/D conversion) cannot be used for a channel for which the variable conversion characteristics function is used, disable the function.

(j) Logging function

The logging function and variable conversion characteristics function cannot be selected at the same time. When executing the variable conversion characteristics function, set "Free Conversion Characteristics Function" for "Select Function" in the switch setting.

(k) D/A conversion enable/disable setting

Enable conversion in the D/A conversion channel to be used.
When Variable conversion characteristics table selection is set to "Analog I/O", set Enable (0) in both of the corresponding A/D conversion channel and D/A conversion channel. When Enable (0) is set only in one channel, the error (error code: 504□) occurs. When the error occurs, conversion does not start.

(l) Warning output function

The warning detection target when the variable conversion characteristics function is used is the conversion characteristics table.

(m) Scaling function (D/A conversion)

Since the scaling function (D/A conversion) cannot be used for a channel for which the variable conversion characteristics function is used, disable the function.

(3) Conversion characteristics table

To use the variable conversion characteristics function, create a conversion characteristics table.

The conversion characteristics table is classified into the following three tables.

- Analog input conversion characteristics table
- Analog output conversion characteristics table
- Analog I/O conversion characteristics table

Only one conversion characteristics table can be used. The conversion characteristics table for use can be selected with Variable conversion characteristics table selection. Depending on the selected conversion characteristics table, the function varies.

Conversion characteristics table	Description
Analog input	The conversion characteristics of the A/D conversion channels (CH1 and CH2) can be freely set with the analog input conversion characteristics table. Because only one conversion characteristics table can be used, both CH1 and CH2 refer to the same conversion characteristics table. To the D/A conversion channels (CH3 and CH4), for which the analog input conversion characteristics table is not used, the normal conversion characteristics (slope of a straight line connecting the offset value and the gain value) are applied.
Analog output	The conversion characteristics of the D/A conversion channels (CH3 and CH4) can be freely set with the analog output conversion characteristics table. Because only one conversion characteristics table can be used, both CH3 and CH4 refer to the same conversion characteristics table. To the A/D conversion channels (CH1 and CH2), for which the analog output conversion characteristics table is not used, the normal conversion characteristics (slope of a straight line connecting the offset value and the gain value) are applied.
Analog I/O	The conversion characteristics of analog output corresponding to analog input can be freely set with the analog I/O conversion characteristics table. The following show the correspondence between the analog input channels and analog output channels: • Route 1: The analog input of CH1 and the analog output of CH3 correspond. • Route 2: The analog input of CH2 and the analog output of CH4 correspond. Because only one conversion characteristics table can be used, route 1 and route 2 refer to the same conversion characteristics table.

(a) Correspondence of routes and channels

Route 1 corresponds to CH1 and CH3, and route 2 corresponds to CH2 and CH4. For the I/O signals and the buffer memory, routes correspond to each channel in the same way.

Therefore, when the conversion characteristics table is analog input or analog output and Variable conversion characteristics conversion value monitor or other buffer memory areas is monitored, check the areas of the route number corresponding to the channel.

(b) Storage location of the conversion characteristics table

The conversion characteristics table is registered in Conversion characteristics table (Un\G5000 to Un\G37000) of the analog I/O module.

The addresses of the conversion characteristics table are assigned from the start (Un\G5000) of the conversion characteristics table registration area. Depending on the range, the data points vary.

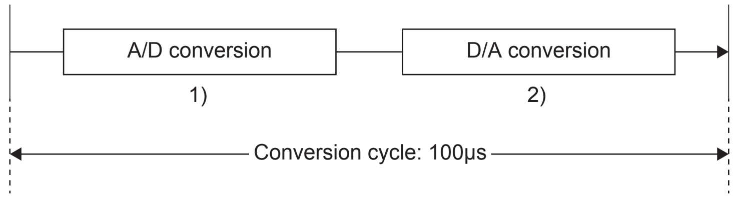
Range	Buffer memory address		Conversion characteristics table		Data point
	Start	Last	Start	Last	
4 to 20mA 0 to 20mA 1 to 5V 0 to 5V	5000	17000	0	12000	12001
4 to 20mA (Extended mode) 1 to 5V (Extended mode)		21500	-3000	13500	16501
0 to10V		21000	0	16000	16001
-10 to 10V		37000	-16000	16000	32001

(4) Conversion speed of the variable conversion characteristics function

When the variable conversion characteristics function is set, the conversion speed of A/D conversion channels and D/A conversion channels is set to 100µs/CH.

Point

When the analog I/O conversion characteristics table is selected, D/A conversion processing is performed after A/D conversion processing in a conversion cycle (100µs). The following figure shows the operation.



No.	Operation
1)	An analog input value is converted into a digital value.
2)	The digital value converted in 1) is used as an address of the conversion characteristics table. The address data is converted into an analog value and the analog value is output.

8.20.1 Initial setting of the variable conversion characteristics function

The variable conversion characteristics function executes the following items as the initial setting. Before executing the variable conversion characteristics function, execute the procedures described in this section.

- Creating a conversion characteristics table (☞ Page 218, Section 8.20.1 (1))
- Saving a conversion characteristics table (☞ Page 224, Section 8.20.1 (2))
- Writing data to a file register (ZR) or CSV file (☞ Page 225, Section 8.20.1 (3))
- Switch setting (☞ Page 228, Section 8.20.1 (4))

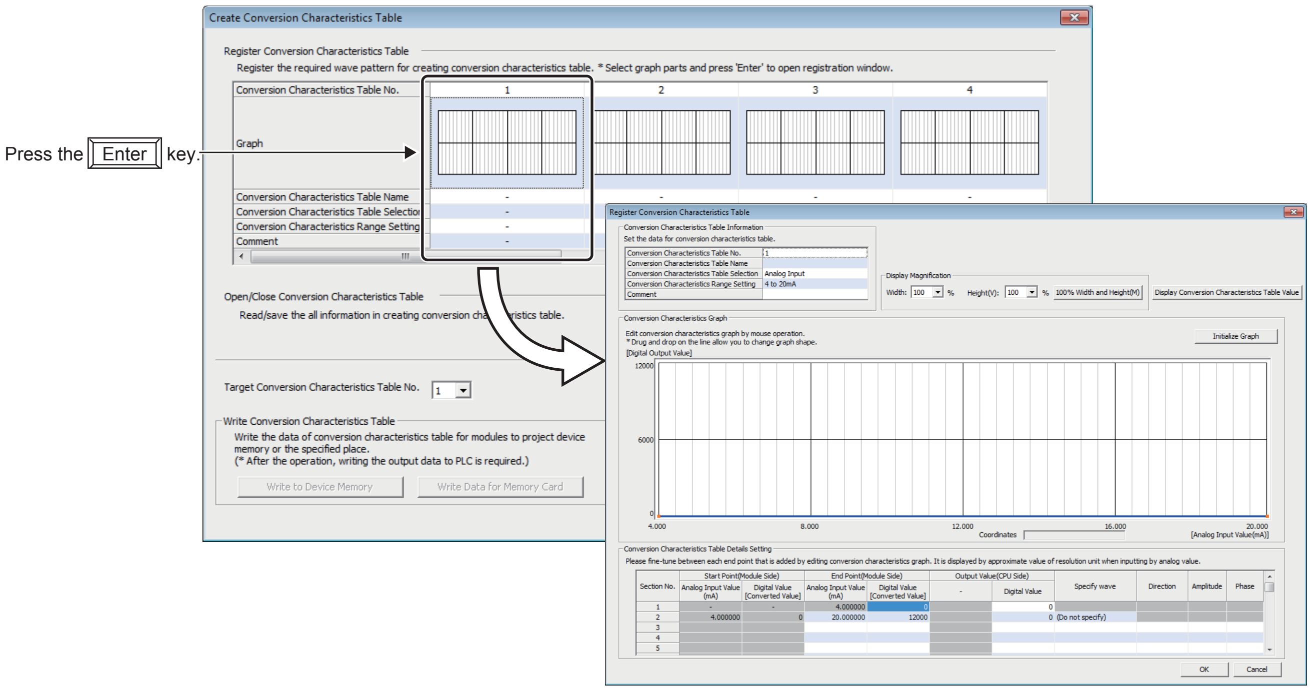
(1) Creating a conversion characteristics table

Create a conversion characteristics table in "Create Conversion Characteristics Table" of GX Works2.

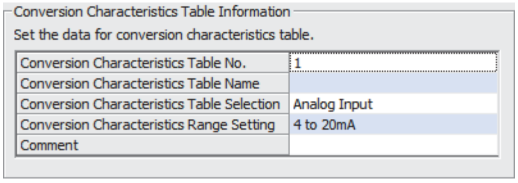
1. Open the "Create Conversion Characteristics Table" window.

[Tool] ⇨ [Intelligent Function Module Tool] ⇨ [Analog Module]
⇨ [Create Conversion Characteristics Table]

2. Select the graph displayed in "Register Conversion Characteristics Table" and press the Enter key on the keyboard. The "Register Conversion Characteristics Table" window appears.

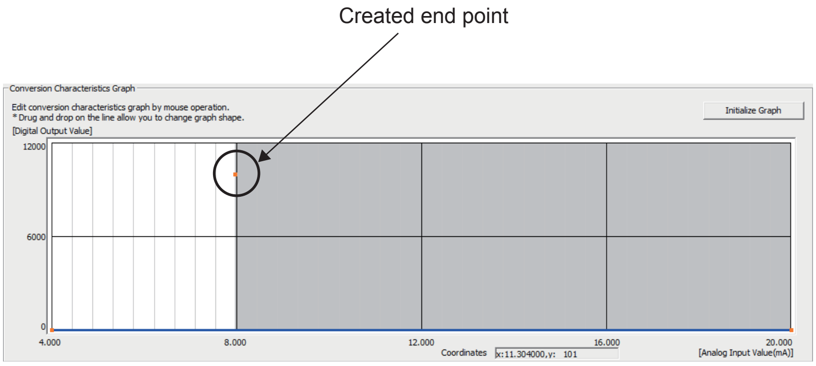


3. **Set "Conversion Characteristics Table Information".**

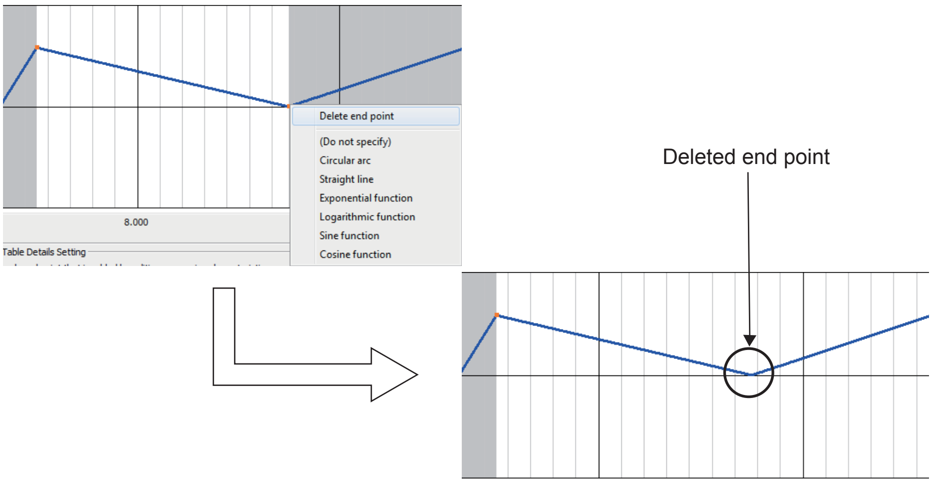


Item	Description	Setting range
Conversion Characteristics Table No.	The conversion characteristics table number selected in the "Create Conversion Characteristics Table" window is displayed. Up to 10 conversion characteristics tables can be created.	—
Conversion Characteristics Table Name	Set the name of the conversion characteristics table.	16 characters
Conversion Characteristics Table Selection	Select a conversion characteristics table for use.	• Analog Input • Analog Output • Analog I/O
Conversion Characteristics Range Setting	Select a range for the variable conversion characteristics.	• 4 to 20mA • 0 to 20mA • 1 to 5V • 0 to 5V • -10 to 10V • 0 to 10V • 4 to 20mA (Extended Mode) • 1 to 5V (Extended Mode)
Comment	Set a comment of the conversion characteristics table.	64 characters

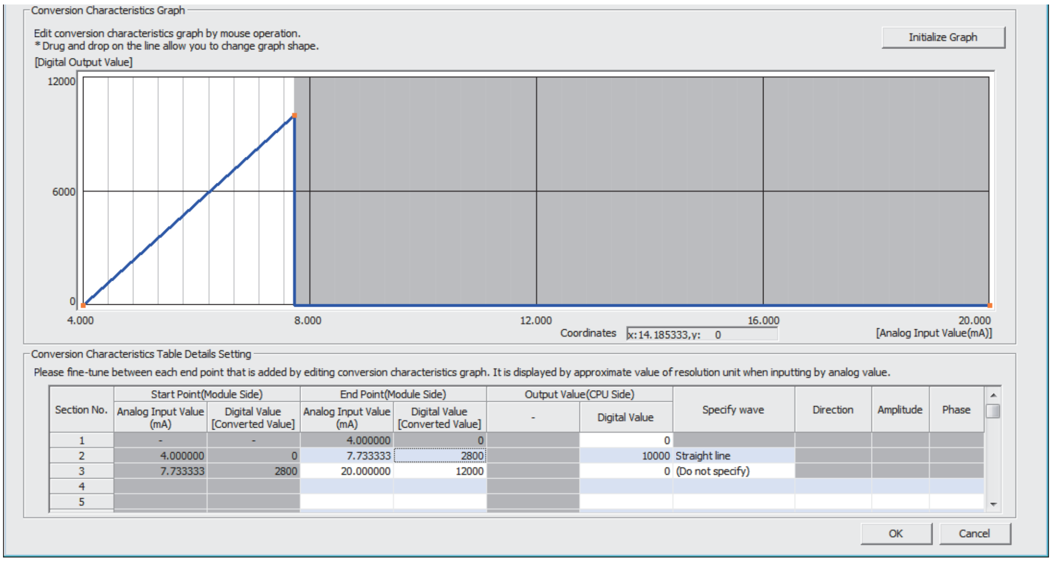
4. **Click any position on the conversion characteristics graph to create an end point. The created end point is displayed as ■ .**



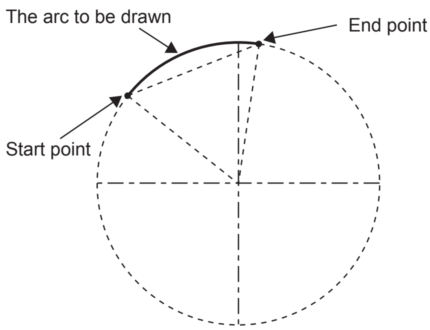
To delete the end point, move the mouse pointer to the point. Then select "Delete end point" from the right-click menu. When the mouse pointer is on the end point, the display of the mouse pointer is changed to ┼.



5. **Set the wave between the end points from the right-click menu or in "Specify wave" of "Conversion Characteristics Table Details Setting".**



<table>
<tr><th>Item</th><th>Setting result</th></tr>
<tr><td>Circular arc</td><td>The interval of the start point and end point is drawn in an arc. When the circular arc is selected, the arc direction can be set in "Direction"; it can be inverted. The arc is drawn in the procedure below.

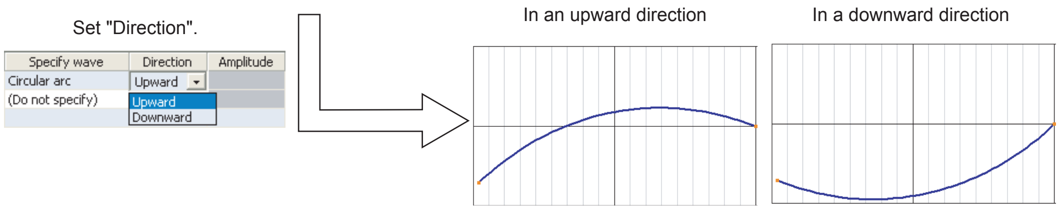


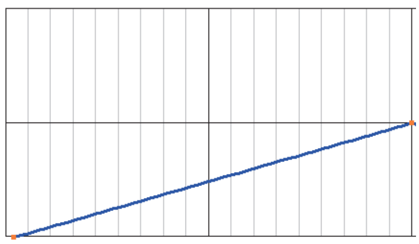
1) Construct an equilateral triangle having the start and end points as its vertices.

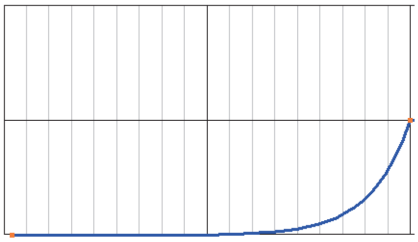
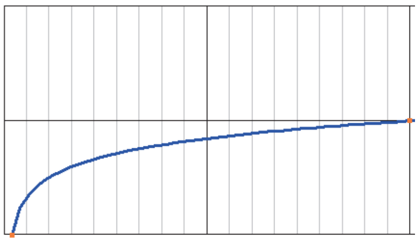
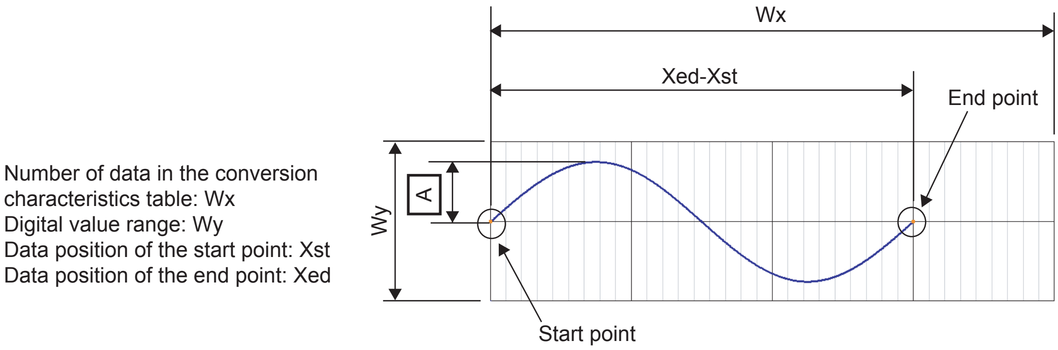
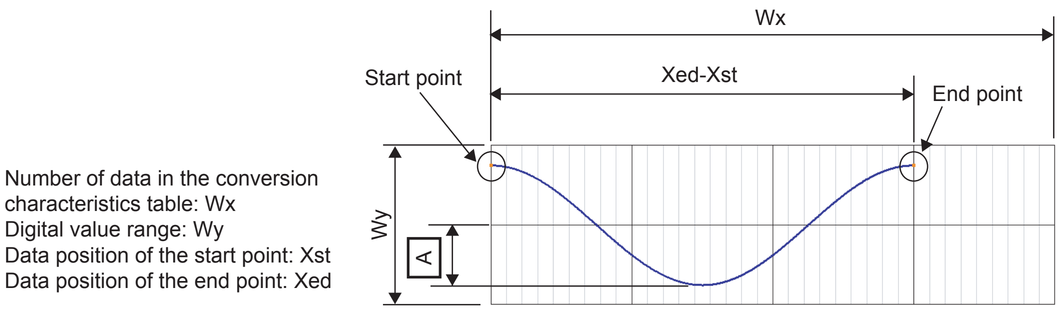
2) Construct a circle having the other vertex of the triangle as its center and a side of the triangle as its radius.

3) Draw the minor arc connecting the start and end points on the wave graph.

* The steps 1) and 2) are processed inside GX Works2, and not displayed on the conversion characteristics graph.

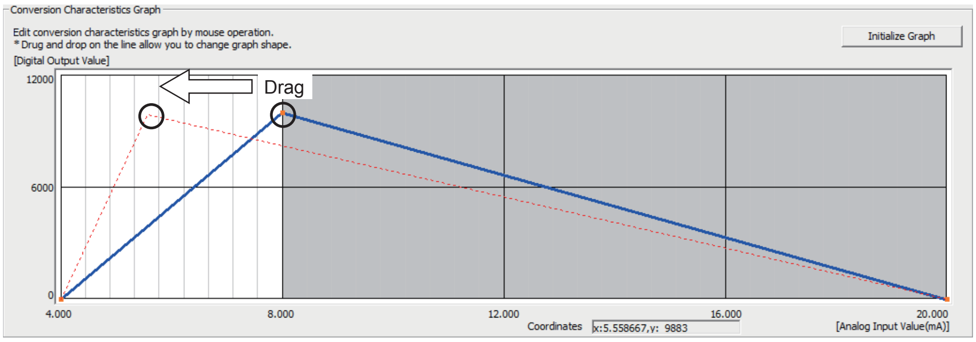

</td></tr>
<tr><td>Straight line</td><td>The interval of the start point and end point is drawn in a straight line.

</td></tr>
</table>

Item	Setting result
Exponential function	The graph is drawn with an adjustment so that the start point and end point are on the edge points of the exponential function of y = e^x (x = 0 to 10). 
Logarithmic function	The graph is drawn with an adjustment so that the start point and end point are on the edge points of the logarithmic function of y = $\log_e$ X (x = 1 to 101). 
Sine function[*1]	The interval between the start point and end point is drawn in a sine function wave. The amplitude A of the sine function to be drawn is the value set in "Amplitude". The start position can be changed by 180° by setting "Phase". 
Cosine function[*1]	The interval between the start point and end point is drawn in a cosine function wave. The amplitude A of the cosine function to be drawn is the value set in "Amplitude". The start position can be changed by 180° by setting "Phase". 

*1 When setting the sine function and cosine function, set the same digital value for the start point and end point.

6. Drag the created end point to adjust the position.



The end point position also can be adjusted by changing the value of "End Point" and "Output Value" in "Conversion Characteristics Table Details Setting".

Conversion Characteristics Table Details Setting

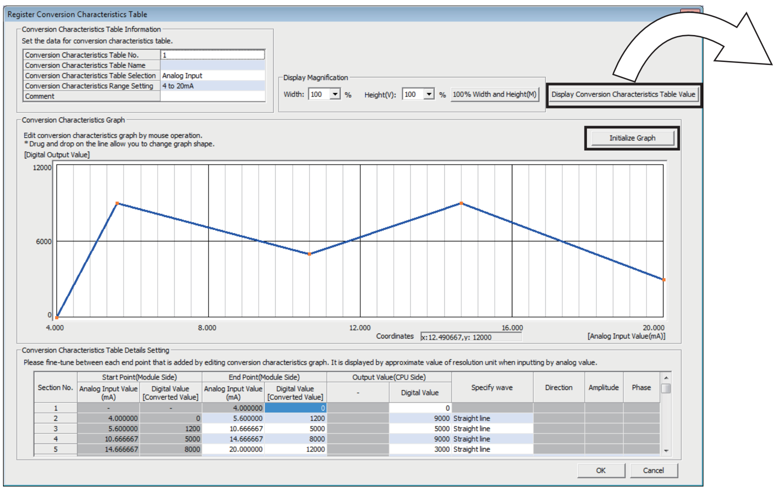
Please fine-tune between each end point that is added by editing conversion characteristics graph. It is displayed by approximate value of resolution unit when inputting by analog value.

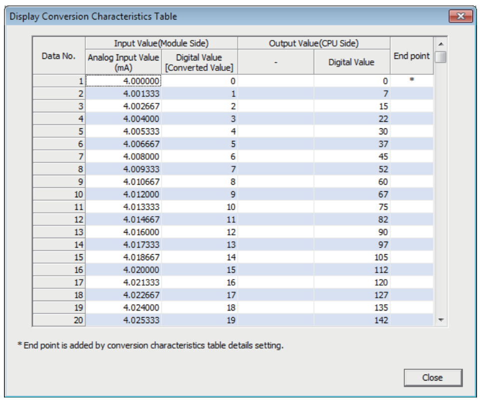
Section No.	Start Point(Module Side)		End Point(Module Side)		Output Value(CPU Side)		Specify wave	Direction	Amplitude	Phase
	Analog Input Value (mA)	Digital Value [Converted Value]	Analog Input Value (mA)	Digital Value [Converted Value]	-	Digital Value				
1	-	-	0.000000	0		0				
2	0.000000	0	4.000000	2400		9883	Straight line			
3	4.000000	2400	20.000000	12000		0	Straight line			
4										
5										

Item	Description
Start Point	The end point of the previous interval is displayed. To change the start point, change the end point of the previous interval.
End Point	Set the number of data (position) for the destination end point. Note that the section No. 1 cannot be changed because it is the first point of the conversion characteristics table.
Output Value	Set the digital value (or analog value) for the destination end point.

7. Repeat steps 4 to 6 and create the conversion characteristics table to be output.

Each digital value of the created conversion characteristics table can be checked by clicking the [Display Conversion Characteristics Table Value] button. Click the [Initialize Graph] button to clear the created conversion characteristics table contents. The graph and the contents of "Conversion Characteristics Table Details Setting" are cleared.





Digital values in the conversion characteristics table are displayed.

8. Click the [OK] button in the "Register Conversion Characteristics Table" window to register the created conversion characteristics table.

9. Repeat steps 2 to 8 to create another conversion characteristics table.

(2) Saving a conversion characteristics table

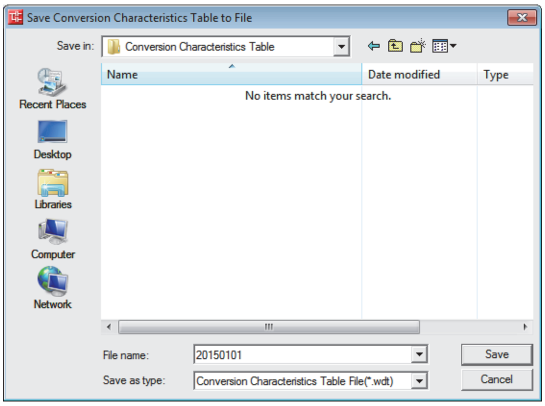
Save a conversion characteristics table in "Create Conversion Characteristics Table" of GX Works2. Before performing the save operation, create a conversion characteristics table.

1. Open the "Create Conversion Characteristics Table" window.

[Tool] ⇨ [Intelligent Function Module Tool] ⇨ [Analog Module]
⇨ [Create Conversion Characteristics Table]

2. Click the Save Conversion Characteristics Table to File button.

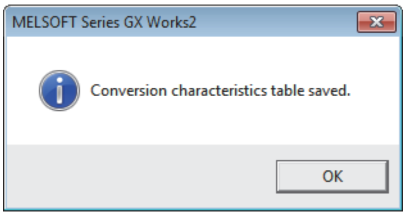
The created conversion characteristics table and the parameter setting of the variable conversion characteristics function are saved.



The saved conversion characteristics table can be opened by clicking the Open Conversion Characteristics Table from File(W) button.

3. Set the save destination and the file name, and click the Save button.

4. Click the OK button.



(3) Writing data to a file register (ZR) or CSV file

Write a conversion characteristics table to a file register (ZR) or CSV file.

Point

Data unnecessary for conversion such as "Conversion Characteristics Table Name", "Comment", and "Conversion Characteristics Table Details Setting" is not written to the file register (ZR) or the CSV file.

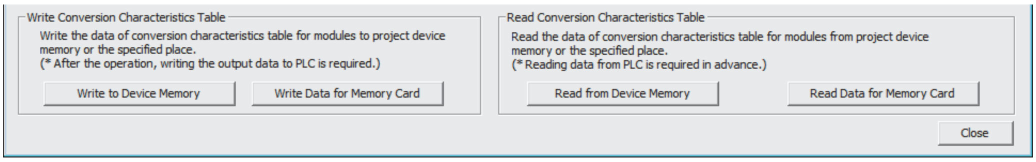
Thus, saving the conversion characteristics table using the [Save Conversion Characteristics Table to File] button before writing it is recommended.

(a) Writing data to a file register (ZR)

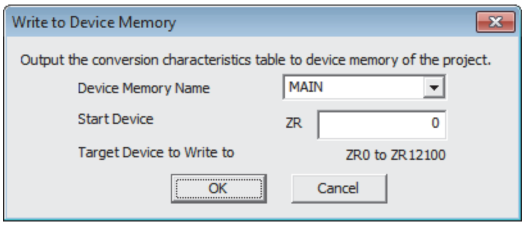
When writing the data to the file register (ZR), set the capacity of the file register (ZR) for the number of required data points. For the setting procedure, refer to the following.

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

1. **Click the [Write to Device Memory] button in the "Create Conversion Characteristics Table" window.**

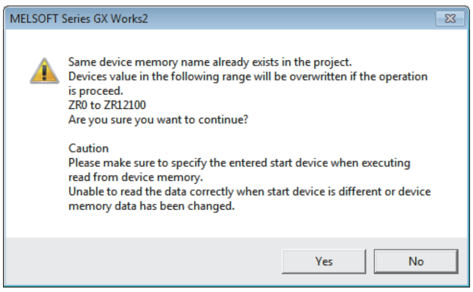


2. **Set "Device Memory Name" and "Start Device". Then click the [OK] button.**

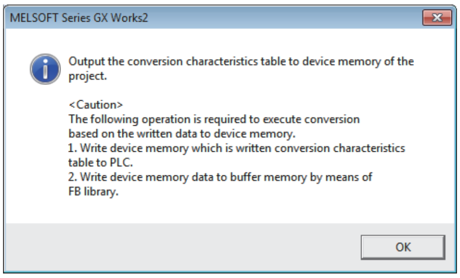


Item	Description
Device Memory Name	Set the device memory to be written to the file register (ZR). Select the device memory to be written from the pull-down menu or enter the device memory name to be created.
Start Device	Set the start address for the output of the device memory.
Target Device to Write to	The file register (ZR) range to write to is displayed.

3. **Click the [Yes] button.**



4. **Click the OK button.**



5. **Click the Close button in the "Create Conversion Characteristics Table" window to close the window.**

6. **Write the device memory to the CPU module from "Write to PLC".**

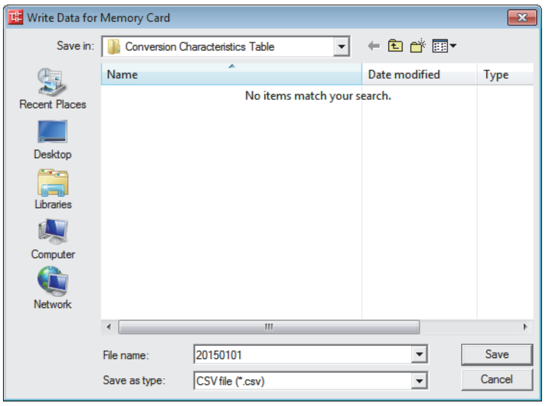
[Online] ⇨ [Write to PLC]

(b) Writing data to a CSV file

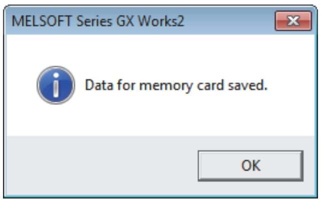
When writing data to a CSV file, store the CSV file to an SD memory card.

1. **Click the [Write Data for Memory Card] button in the "Create Conversion Characteristics Table" window.**

2. **Set the save destination and the file name and click the [Save] button.**



3. **Click the [OK] button.**



4. **Click the [Close] button in the "Create Conversion Characteristics Table" window to close the window.**

5. **Store the CSV file to an SD memory card. Then install the SD memory card to the CPU module.**

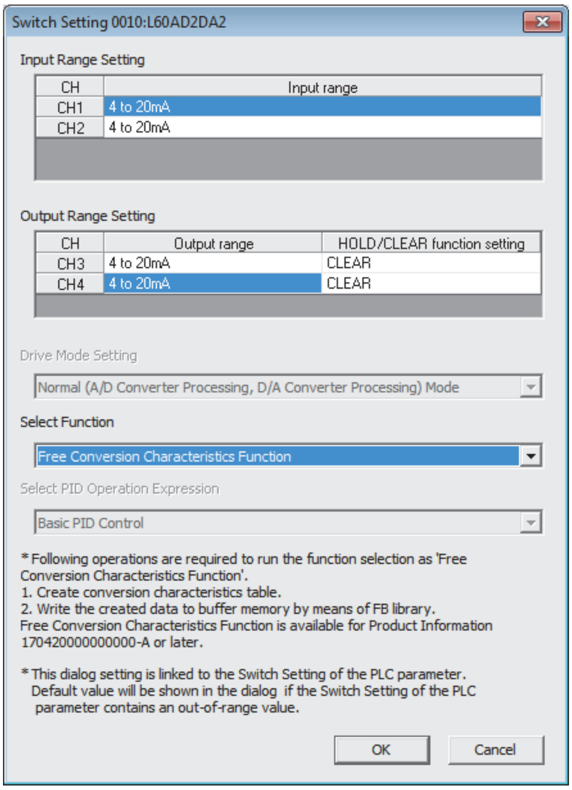
(4) Switch setting

To use the variable conversion characteristics function, the switch setting is required.

1. Open the "Switch Setting" window.

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Switch Setting]

2. Set "Select Function" to "Free Conversion Characteristics Function".



In the channel where the variable conversion characteristics function is used, operation is performed according to the range set in "Conversion Characteristics Range Setting". Because the setting values of "Input range" and "Output range" in "Switch Setting" are ignored, do not change these values from the default value (4 to 20mA).
However, in the channel where the variable conversion characteristics function is not used, operation is performed according to the range set in "Switch Setting".

Ex. When "Analog Input" is set for "Conversion Characteristics Table Selection", the operation in the A/D conversion channel is performed according to the range set in "Conversion Characteristics Range Setting". The operation in the D/A conversion channel is performed according to the range set in "Switch Setting".

8.20.2 Execution of the variable conversion characteristics function

(1) Registering the conversion characteristics table

Register the conversion characteristics table, which is created in "Create Conversion Characteristics Table" of GX Works2, and parameter settings for the variable conversion characteristics function to the analog I/O module. Use the function block (FB) for the conversion characteristics table registration.

The contents registered by the function block (FB) for the conversion characteristics table registration need to be enabled by turning on and off Operating condition setting request (Y9).

Point

If the conversion characteristics table is changed as follows after the conversion characteristics table is registered in the analog I/O module, 0V/0mA is output on the analog output channel used for the variable conversion characteristics function.

- When the setting of Variable conversion characteristics table selection is changed from analog input to analog I/O.
- When the setting of Variable conversion characteristics table selection is changed from analog output to analog I/O.
- When the variable conversion characteristics range setting is changed while analog I/O is used in Variable conversion characteristics table selection.

To enable the new conversion characteristics table, turn on and off Operating condition setting request (Y9).

(a) Analog output enable/disable

Turn on CH□ Output enable/disable flag (Y3, Y4) for the channel where the analog output is performed. When Variable conversion characteristics table selection (Un\G4100) is set to Analog output (1) or Analog I/O (2), the digital value is converted into an analog value according to the selected conversion characteristics table and the analog value is output by turning on CH□ Output enable/disable flag (Y3, Y4).
When CH□ Output enable/disable flag (Y3, Y4) is turned off during D/A conversion, an analog output value becomes an offset value though the conversion is continued. When CH□ Output enable/disable flag (Y3, Y4) is turned on again, the analog output is resumed.

(b) When a head module is used

The function block (FB) cannot be used for an analog I/O module connected to a head module.
For how to transfer the conversion characteristics table, which is created in "Create Conversion Characteristics Table" of GX Works2, and the parameter settings for the variable conversion characteristics function to the analog I/O module, refer to the following.
How to register data when a head module is used (☞ Page 237, Section 8.20.2 (4))

(2) Operation of variable conversion characteristics

The following shows the operation of variable conversion characteristics according to the setting of Variable conversion characteristics table selection.

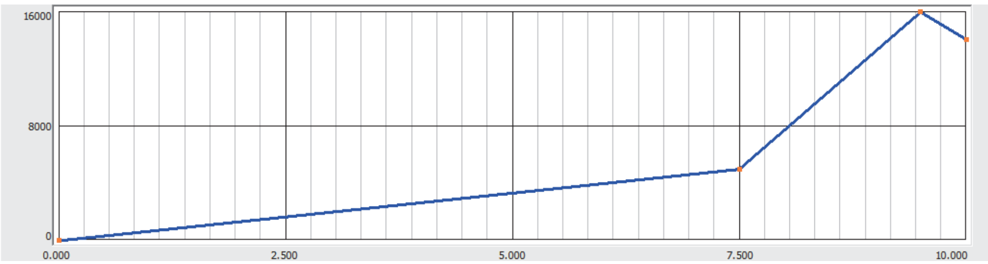
Point

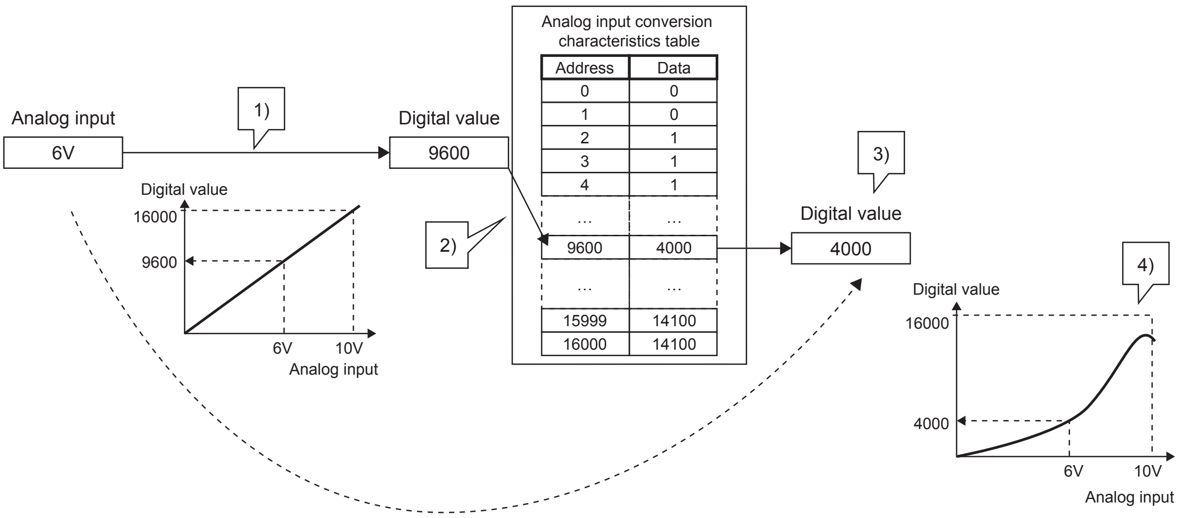
If the data stored in the conversion characteristics table is overwritten while the variable conversion characteristics function is used, the analog I/O module operates according to the new conversion characteristics table.

(a) Analog input

The analog input values which are input in A/D conversion channels (CH1 and CH2) are converted into digital values based on the factory shipment value. The A/D conversion value is used as an address of the analog input conversion characteristics table and the data stored in the address is stored in CH☐ Digital output value (Un\G11, Un\G12).

Ex. When the following conversion characteristics table is created





No.	Description
1)	The analog input value is converted into a digital value based on the factory shipment value.
2)	The address corresponding to the digital value is referred to.
3)	The digital value is replaced with the data stored in the conversion characteristics table.
4)	Variable conversion characteristics are available.

When an A/D conversion value is out of the range of the address of the analog input conversion characteristics table, the digital value corresponding to the maximum or minimum value of the address is output. At that time, an alarm (alarm code: 180□) occurs.
If the set data of the analog input conversion characteristics table is out of the range, the value of the conversion characteristics table (-32768 to 32767) is output as a digital value. No error occurs.

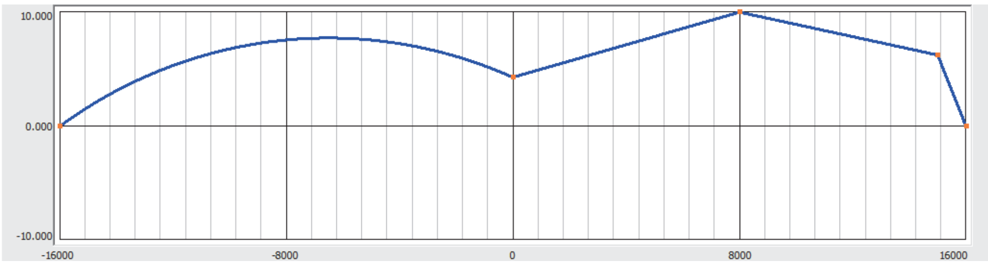
Analog input range setting	Address/data of the analog input conversion characteristics table	
	Minimum	Maximum
4 to 20mA	0	12000
0 to 20mA		
1 to 5V		
0 to 5V		
-10 to 10V	-16000	16000
0 to 10V	0	
4 to 20mA (Extended mode)	-3000	13500
1 to 5V (Extended mode)		

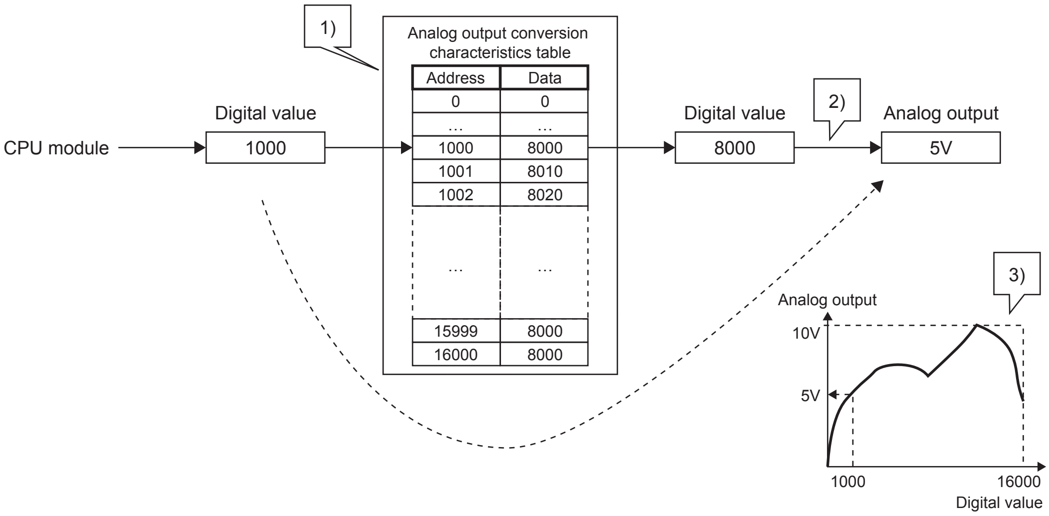
When conversion is enabled in a D/A conversion channel, the normal conversion characteristics (slope of a straight line connecting the offset value and the gain value) are applied. To the conversion speed, the conversion speed of the variable conversion characteristics function (100μs) is applied.

(b) Analog output

CH□ Digital input value (Un\G2003, Un\G2004) is used as an address of the analog output conversion characteristics table. The data stored in the address is converted into an analog value and the analog value is output from the D/A conversion channel (CH3 and CH4).

Ex. When the following conversion characteristics table is created





No.	Description
1)	The address corresponding to the digital value received from the CPU module is referred to.
2)	The data stored in the conversion characteristics table is converted into an analog value.
3)	Variable conversion characteristics are available.

When a set digital input value is out of the address range of the analog output conversion characteristics table, the analog value corresponding to the maximum or minimum value of the address is output. At that time, an error (error code: 503□) occurs.
When set data is out of the range of the analog output conversion characteristics table, the analog value corresponding to the maximum or minimum value of the data is output. At that time, a check code is stored in CH□ Set value check code (Un\G2013, Un\G2014) and an error (error code: 60□) occurs.
The address storing data outside the range can be checked with Variable conversion characteristics digital value outside the range address monitor (Un\G4112 to Un\G4113, Un\G4122 to Un\G4123).

Analog output range setting	Address/data of the analog output conversion characteristics table	
	Minimum	Maximum
4 to 20mA	0	12000
0 to 20mA		
1 to 5V		
0 to 5V		
-10 to 10V	-16000	16000

When conversion is enabled in an A/D conversion channel, the normal conversion characteristics (slope of a straight line connecting the offset value and the gain value) are applied. To the conversion speed, the conversion speed of the variable conversion characteristics function (100μs) is applied.

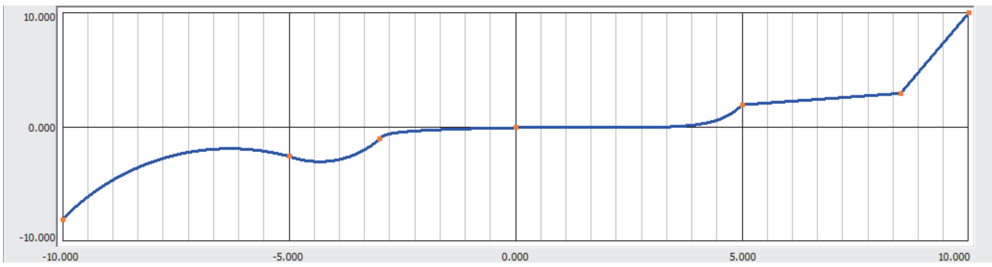
(c) Analog I/O

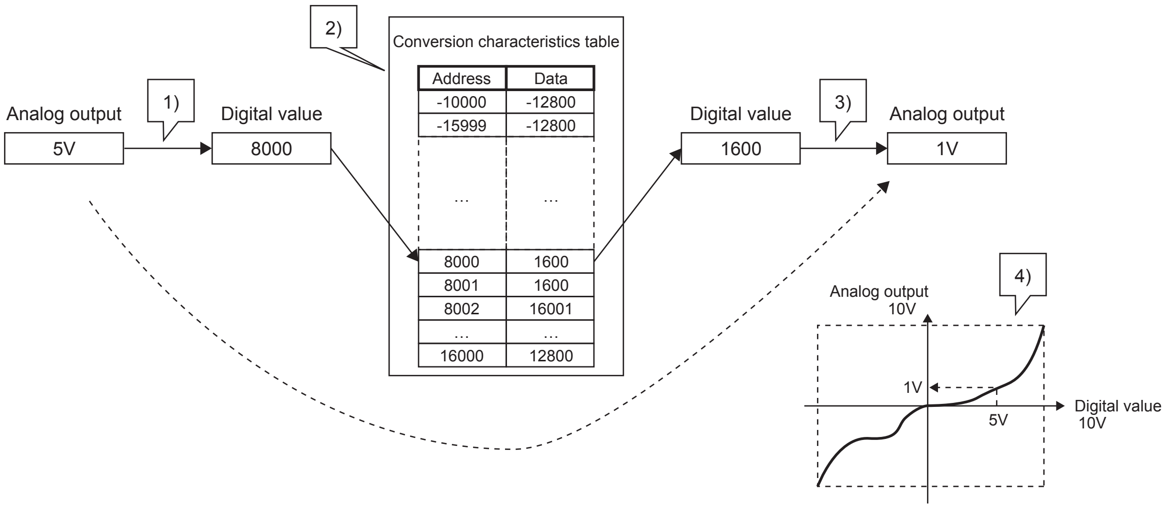
The analog values which are input in A/D conversion channels (CH1 and CH2) are converted into digital values based on the factory shipment value. The A/D conversion value is used as an address of the analog I/O conversion characteristics table. The data stored in the address is converted into an analog value and the analog value is output from the D/A conversion channel (CH3 and CH4).

The following shows the correspondence of A/D conversion channels and D/A conversion channels.

- Route 1: The analog input of CH1 and the analog output of CH3 correspond.
- Route 2: The analog input of CH2 and the analog output of CH4 correspond.

Ex. When the following conversion characteristics table is created





No.	Description
1)	The analog input value is converted into a digital value based on the factory shipment value.
2)	The address corresponding to the digital value is referred to.
3)	The data stored in the conversion characteristics table is converted into an analog value.
4)	Variable conversion characteristics are available.

When an A/D conversion value is out of the address of the analog I/O conversion characteristics table, the digital value corresponding to the maximum or minimum value of the address is used. At that time, an alarm (alarm code: 180□) occurs.
When set data is out of the range of the analog I/O conversion characteristics table, the analog value corresponding to the maximum or minimum value of the data is output. At that time, a check code is stored in CH□ Set value check code (Un\G2013, Un\G2014) and an error (error code: 60□) occurs.
The address storing data outside the range can be checked with Variable conversion characteristics digital value outside the range address monitor (Un\G4112 to Un\G4113, Un\G4122 to Un\G4123).

Analog input range setting/analog output range setting	Address/data of the analog I/O conversion characteristics table	
	Minimum	Maximum
4 to 20mA	0	12000
0 to 20mA		
1 to 5V		
0 to 5V		
-10 to 10V	-16000	16000

(3) Checking the status of the variable conversion characteristics function

The status of the variable conversion characteristics function can be checked with the following buffer memory areas.

Item	Buffer memory address	Description	Reference
Variable conversion characteristics conversion value monitor	Route 1: 4110 Route 2: 4120	The digital value converted from an analog value based on the factory shipment value is stored in this area.	Page 401, Appendix 2 (69)
Variable conversion characteristics digital value monitor	Route 1: 4111 Route 2: 4121	The digital value of the conversion characteristics table currently being converted is stored in this area.	Page 401, Appendix 2 (70)
Variable conversion characteristics digital value outside the range address monitor	Route 1: 4112 to 4113 Route 2: 4122 to 4123	The buffer memory address of the conversion characteristics table where the digital value out of the setting range is set is stored in this area in 32-bit signed binary. If multiple digital values out of the setting range are detected, only the buffer memory address of the conversion characteristics table where the out-of-range value is firstly detected is stored.	Page 402, Appendix 2 (71)
Variable conversion characteristics warning address monitor	Route 1: 4114 to 4115 Route 2: 4124 to 4125	The buffer memory address of the conversion characteristics table where a warning has occurred is stored in this area in 32-bit signed binary. If a warning has occurred in multiple digital values, only the buffer memory address of the conversion characteristics table where the first warning occurred is stored.	Page 403, Appendix 2 (72)

(4) How to register data when a head module is used

For how to transfer the conversion characteristics table, which is created in "Create Conversion Characteristics Table" of GX Works2, to the analog I/O module, refer to the following.

- Setting procedure

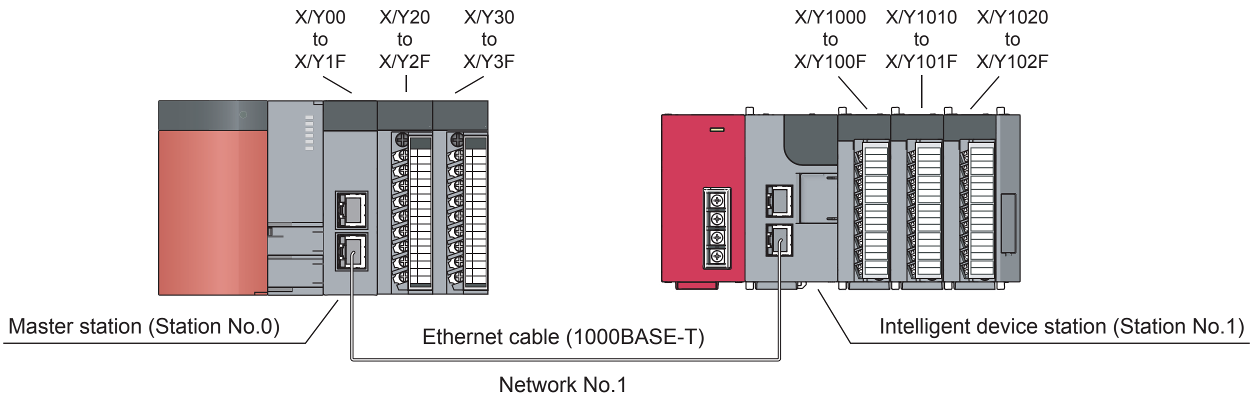
1. Write the conversion characteristics table and the parameter setting for the variable conversion characteristics function to the file register (ZR) of the CPU module on the master station side using "Create Conversion Characteristics Table" of GX Works2.

2. Transfer the data from the file register (ZR) to the analog I/O module connected to the head module using the ZP.REMTO instruction.

At this time, register the conversion characteristics table first. Then change the setting of A/D conversion enable/disable setting (Un\G0), D/A conversion enable/disable setting (Un\G2000), Variable conversion characteristics table selection (Un\G4100), and Variable conversion characteristics range setting (Un\G4101).

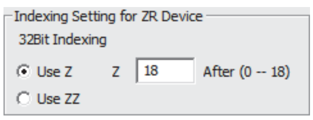
Power supply module (Q62P)
CPU module (Q10UDHCPU)
Master/local module (QJ71GF11-T2)
Input module (QX10)
Output module (QY40P)

Power supply module (L61P)
Head module (LJ72GF15-T2)
Analog I/O module (L60AD2DA2)
Input module (LX40C6)
Output module (LY10R2)
END cover (L6EC)



- Index setting for the ZR device

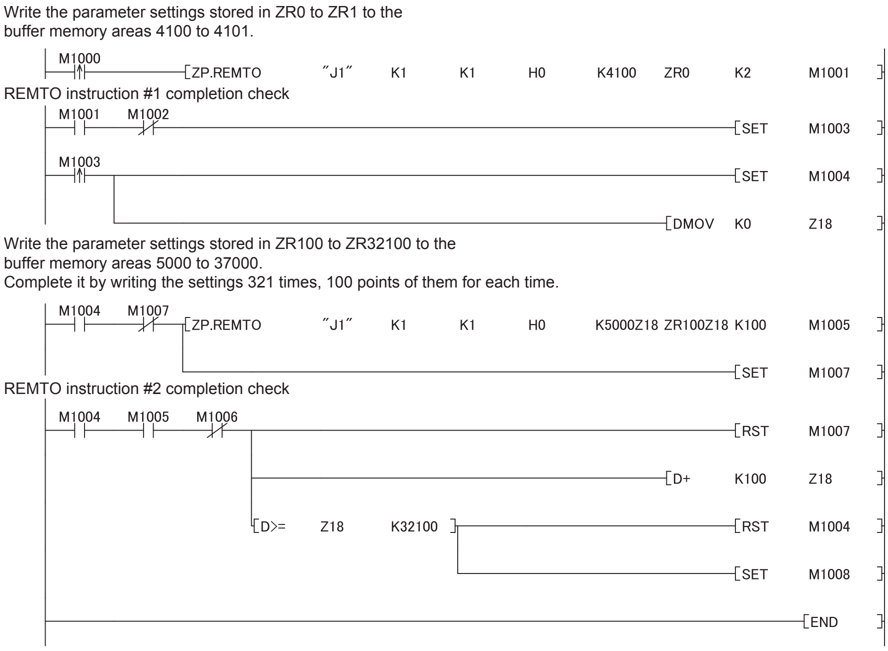
Project window ⇨ [Parameter] ⇨ [PLC Parameter] ⇨ "Device"



The following table lists the devices used in the program.

Device	Description
M1000	Command to write the parameter setting for the variable conversion characteristics function
M1001	Device to check write completion of the parameter setting for the variable conversion characteristics function
M1002	
M1003	Normal write completion of the parameter setting for the variable conversion characteristics function
M1004	Command to write the conversion characteristics table
M1005	Device to check write completion of the conversion characteristics table
M1006	
M1007	Device for repetitive control of the command to write the conversion characteristics table
M1008	Final completion of conversion characteristics table write
ZR0 to ZR1	File register storing the parameter setting for the variable conversion characteristics function
ZR100 to ZR32100	File register storing the conversion characteristics table

- Program



8.21 Variable Conversion Characteristics Function + Variable Arithmetic Function

Variable arithmetic Variable conversion

The variable conversion characteristics function and the variable arithmetic function can be used together. This function executes the operation for digital values converted according to variable conversion characteristics with polynomial expressions registered by users.

The variable conversion characteristics function + variable arithmetic function is available only when "Free Conversion Characteristics Function + Free Operation Function" is set for "Select Function" in the switch setting.

For the setting procedure of "Select Function", refer to the following.

- Switch setting (☞ Page 241, Section 8.21.1 (3))

When the variable conversion characteristics function + variable arithmetic function is used, the conversion speed of A/D conversion channels is 160μs/channel and that of D/A conversion channels is 320μs/2 channels.

(1) Operation difference depending on the conversion characteristics table for use

Depending on the conversion characteristics table set in Variable conversion characteristics table selection (Un\G4100), the operation of the variable conversion characteristics function + variable arithmetic function varies.

(a) When the analog input conversion characteristics table is selected

In A/D conversion channels, the converted value according to the analog input conversion characteristics table is stored in CH☐ Digital output value (Un\G11, Un\G12). By setting CH☐ Digital output value (Un\G11, Un\G12) for a polynomial expression as a term, the operation can be executed for values converted according to the conversion characteristics table.

When conversion is enabled for a D/A conversion channel, operation results can be converted to analog output values.

(b) When the analog output conversion characteristics table is selected

In D/A conversion channels, the data referred to from the analog output conversion characteristics table is stored in Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121). By setting Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121) for a polynomial expression as a term, the operation can be executed for the data referred to from the conversion characteristics table, the operation results are converted into analog values, and the analog values are output.

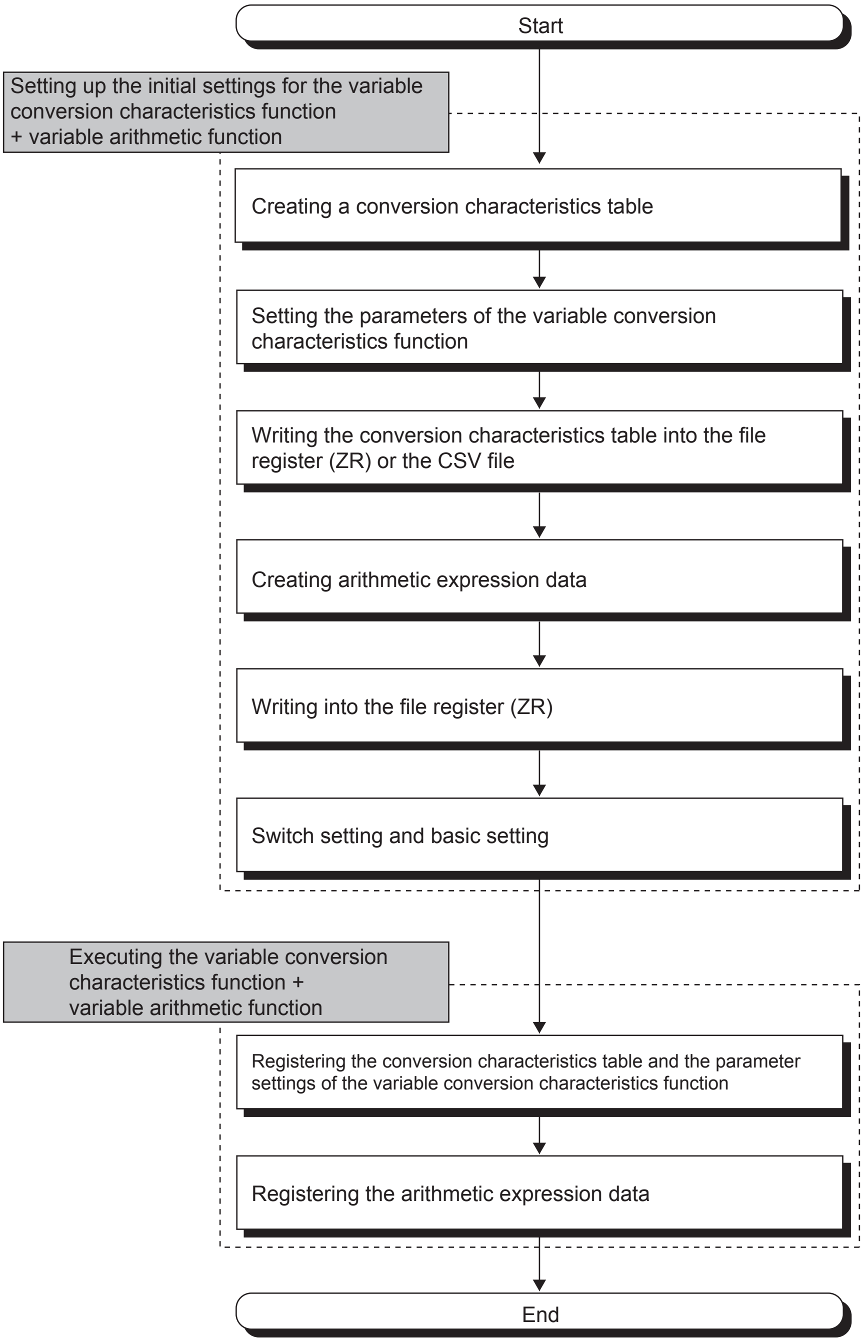
(c) When the analog I/O conversion characteristics table is selected

In A/D conversion channels, the converted value according to the analog I/O conversion characteristics table is stored in CH☐ Digital output value (Un\G11, Un\G12). By setting CH☐ Digital output value (Un\G11, Un\G12) for a polynomial expression as a term, the operation can be executed for values converted according to the conversion characteristics table.

In D/A conversion channels, operation results are converted into analog values and the analog values are output.

(2) Procedure for using the variable conversion characteristics function + variable arithmetic function

The following shows how to use the variable conversion characteristics function + variable arithmetic function.



(3) Restrictions and precautions on the variable conversion characteristics function + variable arithmetic function

Refer to the following.

- Restrictions and precautions on the variable arithmetic function (☞ Page 195, Section 8.18.4 (2))
- Restrictions and precautions on the variable conversion characteristics function (☞ Page 214, Section 8.19.3 (2))

8.21.1 Initial setting of the variable conversion characteristics function + variable arithmetic function

The variable conversion characteristics function + variable arithmetic function execute the following items as the initial setting. Before executing the variable conversion characteristics function + variable arithmetic function, execute the procedures described in this section.

(1) Creating and registering a conversion characteristics table

Create a conversion characteristics table in "Create Conversion Characteristics Table" and register the table using the function block (FB) in the analog I/O module. For details, refer to the following.

- Initial setting of the variable conversion characteristics function (☞ Page 218, Section 8.20.1)

(2) Creating and registering arithmetic expression data

Create arithmetic expression data in "Create Operation Expression" and register the data using the function block (FB) in the analog I/O module. For details, refer to the following.

- Initial setting of the variable arithmetic function (☞ Page 197, Section 8.19.1)

When arithmetic expression data has been saved in the flash memory, operation is started with the saved setting.

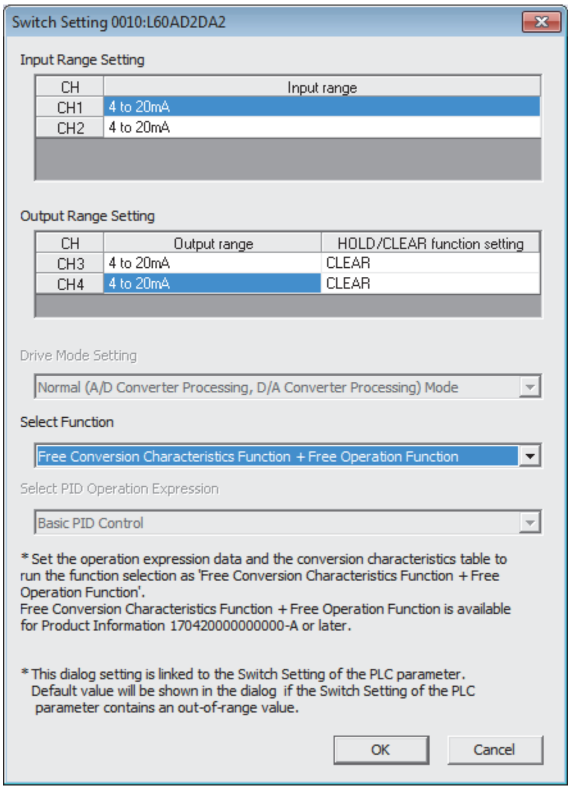
(3) Switch setting

To use the variable conversion characteristics function + variable arithmetic function, the switch setting is required.

1. Open the "Switch Setting" window.

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Switch Setting]

2. Set "Select Function" to "Free Conversion Characteristics Function + Free Operation Function".



(4) Operating condition setting request

When the parameter setting is written to the buffer memory of this module with a program, turn on and off Operating condition setting request (Y9) to enable the setting. (When the parameter setting of GX Works2 is configured and intelligent function module parameters are written to the CPU module, turning on and off Operating condition setting request (Y9) is not required.)

(5) Analog output enable/disable

Turn on CH☐ Output enable/disable flag (Y3, Y4) for the channel where the analog output is performed.
When CH☐ Output enable/disable flag (Y3, Y4) is turned on, Variable arithmetic value for analog output (Un\G4003, Un\G4007) is output in analog.
When CH☐ Output enable/disable flag (Y3, Y4) is turned off during an operation, an analog output value becomes an offset value though the operation is continued. When CH☐ Output enable/disable flag (Y3, Y4) is turned on again, the analog output is resumed.

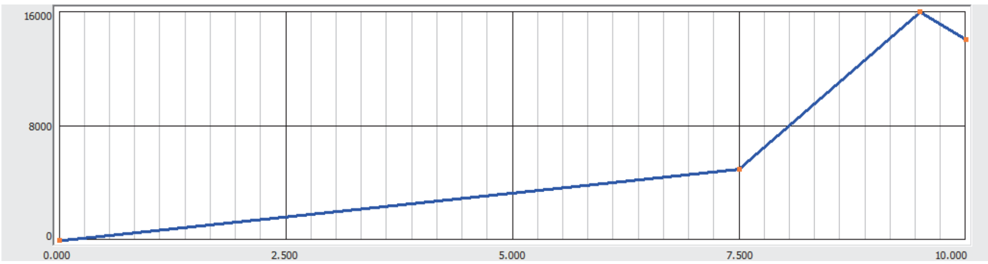
8.21.2 Operation of the variable conversion characteristics function + variable arithmetic function

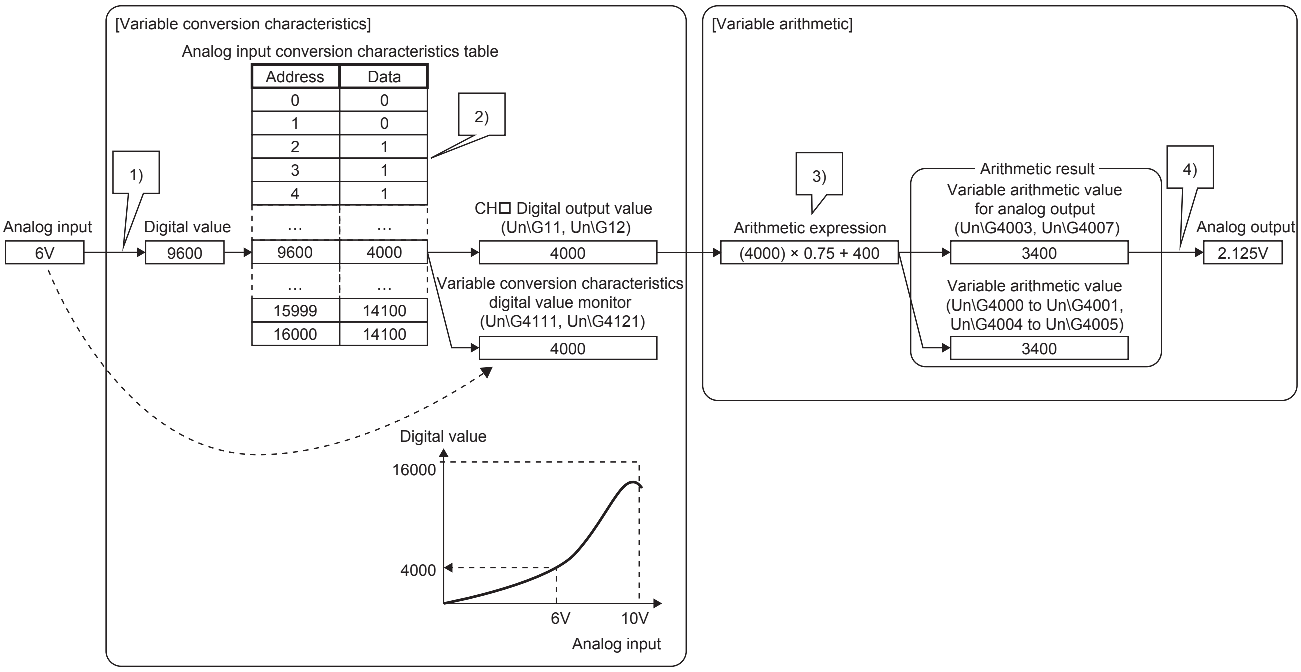
Depending on the setting of Variable conversion characteristics table selection (Un\G4100), the operation varies.

(1) Analog input

Ex. When the following arithmetic expression and conversion characteristics table are created

Arithmetic expression: CH1 Digital output value × 0.75 + 400

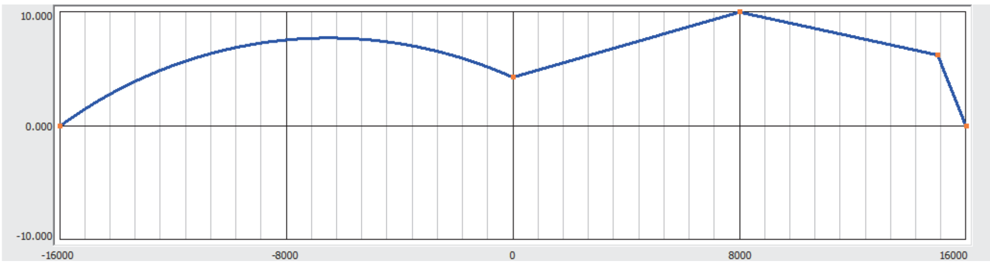


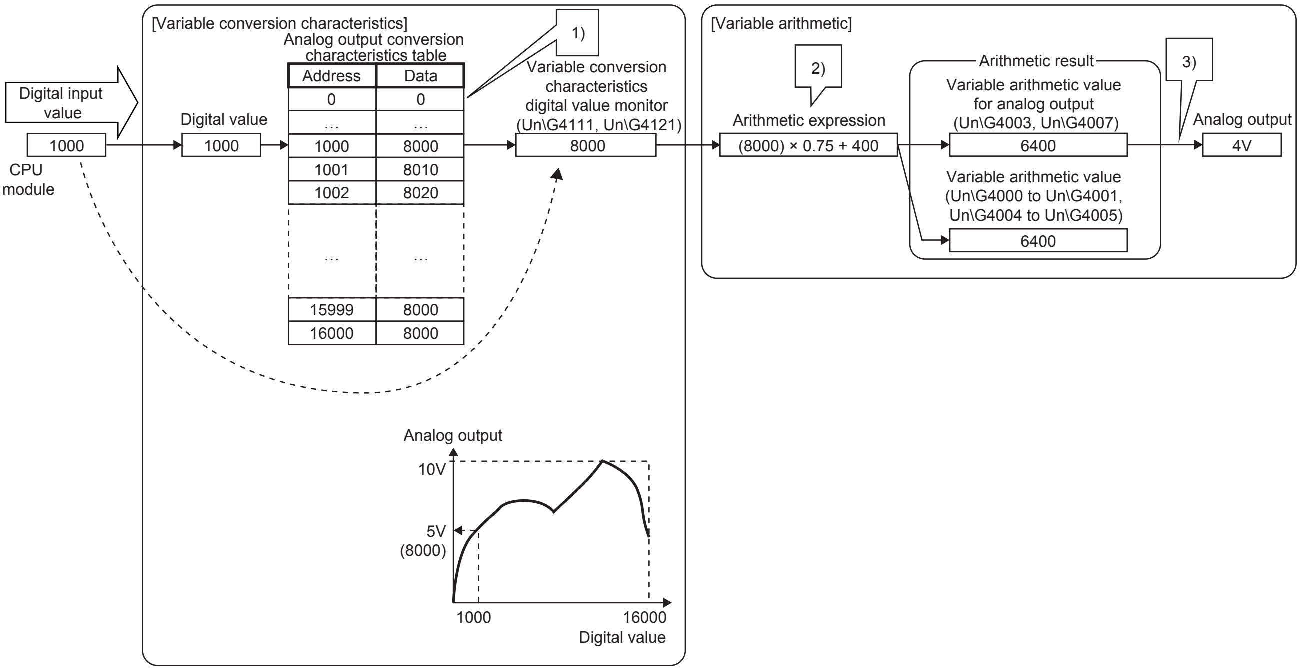


No.	Operation
(1)	The analog values which are input in A/D conversion channels (CH1 and CH2) are converted into digital values based on the factory shipment value.
(2)	The A/D conversion value is used as an address of the analog input conversion characteristics table and the data stored in the address is stored in CH☐ Digital output value (Un\G11, Un\G12). The same value as that of CH☐ Digital output value (Un\G11, Un\G12) is also stored in Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121).
(3)	By setting CH☐ Digital output value (Un\G11, Un\G12) or Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121) for a polynomial expression as a term, the operation is executed for values converted according to the conversion characteristics table. The operation result is stored in Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) and Variable arithmetic value for analog output (Un\G4003, Un\G4007).
(4)	When conversion is enabled in D/A conversion channels (CH3 and CH4), the operation result is converted into an analog value and the analog value is output.

(2) Analog output

Ex. When the following arithmetic expression and conversion characteristics table are created
Arithmetic expression: Variable conversion characteristics digital value monitor × 0.75 + 400





No.	Operation
(1)	The data of CH☐ Digital input value (Un\G2003, Un\G2004) is used as an address of the analog output conversion characteristics table and the data stored in the address is stored in Variable conversion characteristics digital value monitor (Un\4111, Un\G4121).
(2)	By setting Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121) for a polynomial expression as a term, the operation can be executed for the data referred to from the conversion characteristics table. The operation result is stored in Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) and Variable arithmetic value for analog output (Un\G4003, Un\G4007).
(3)	The operation result is converted into an analog value and the analog value is output from D/A conversion channels (CH3 and CH4).

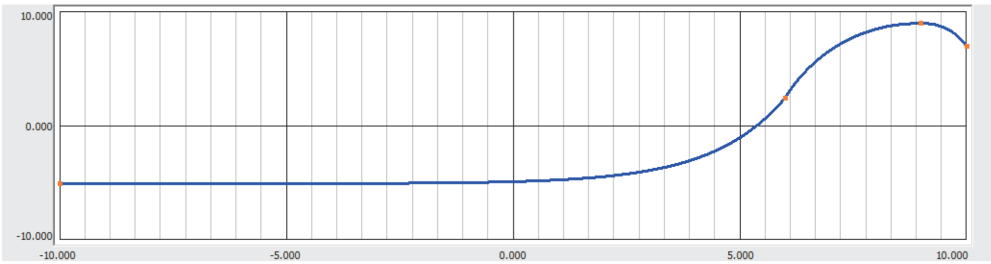
Point

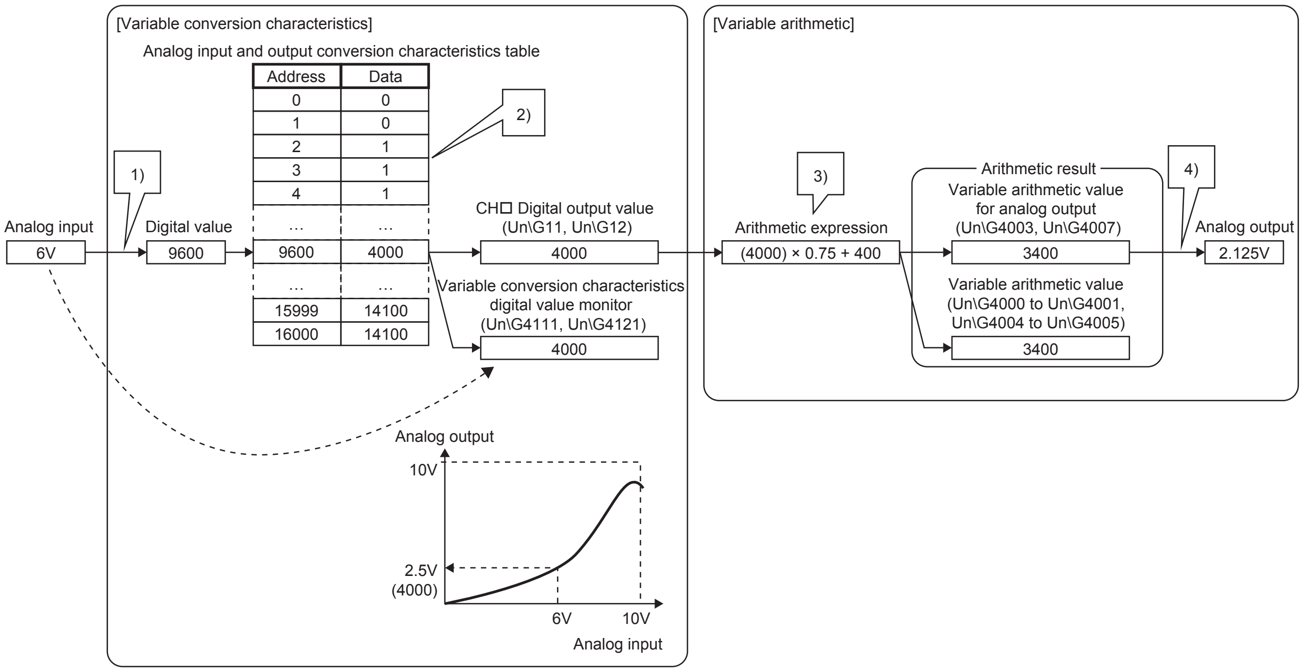
In the variable conversion characteristics function + variable arithmetic function, Variable arithmetic value for analog output (Un\G4003, Un\G4007) is a target of check code detection because the operation result of a polynomial expression is converted from a digital value into an analog value. Thus, Variable conversion characteristics digital value outside the range address monitor (Un\G4112 to Un\G4113, Un\G4122 to Un\G4123) is disabled.

(3) Analog I/O

Ex. When the following arithmetic expression and conversion characteristics table are created

Arithmetic expression: CH1 Digital output value × 0.75 + 400





No.	Operation
(1)	The analog input values which are input in A/D conversion channels (CH1 and CH2) are converted into digital values based on the factory shipment value.
(2)	The A/D conversion value is used as an address of the analog I/O conversion characteristics table and the data stored in the address is stored in CH□ Digital output value (Un\G11, Un\G12). The same value as that of CH□ Digital output value (Un\G11, Un\G12) is also stored in Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121).
(3)	By setting CH□ Digital output value (Un\G11, Un\G12) or Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121) for a polynomial expression as a term, the operation is executed for values converted according to the conversion characteristics table. The operation result is stored in Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) and Variable arithmetic value for analog output (Un\G4003, Un\G4007).
(4)	The operation result is converted from a digital value to an analog value and the analog value is output.

Point

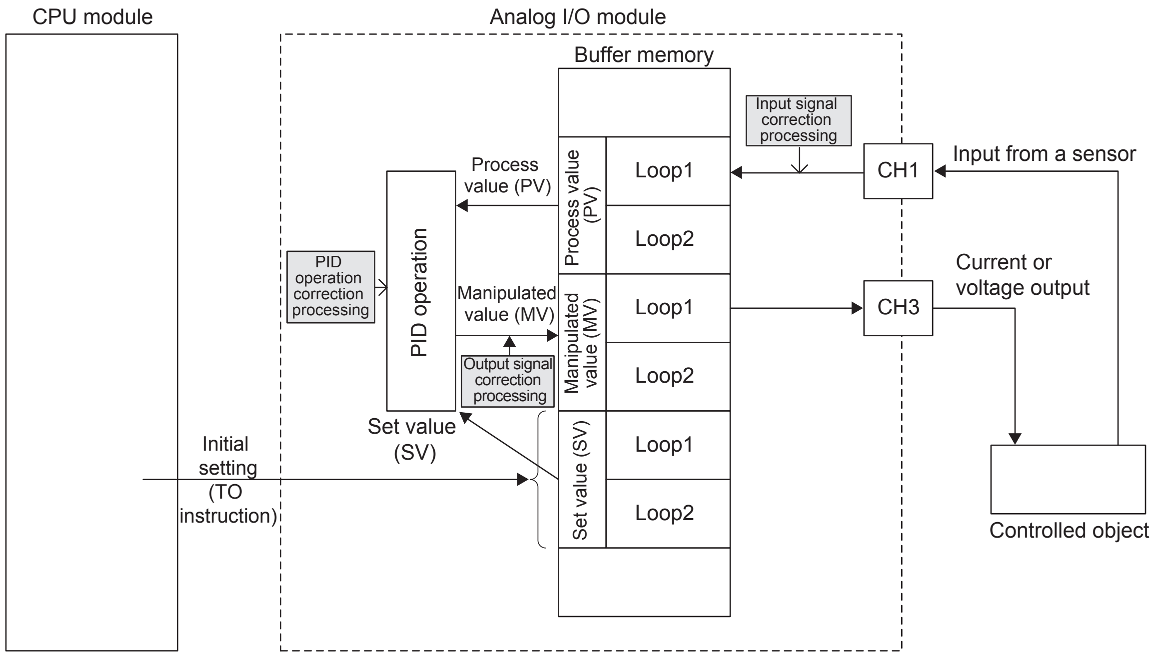
In the variable conversion characteristics function + variable arithmetic function, Variable arithmetic value for analog output (Un\G4003, Un\G4007) is a target of check code detection because the operation result of a polynomial expression is converted from a digital value into an analog value. Thus, Variable conversion characteristics digital value outside the range address monitor (Un\G4112 to Un\G4113, Un\G4122 to Un\G4123) is disabled.

8.22 PID Control Function

PID control

Using this function, an analog input signal from a sensor (such as pressure and flow rate) is input to the module as the process value (PV) (16-bit signed binary) and the PID operation is performed in the module so that the input value reaches the set value (SV). The manipulated value (MV) calculated in the PID operation is output to an external operation device as an analog value of current or voltage.
Because the PID control is performed with the operation cycle of 200μs/CH, the control can be applied to a field which requires high-speed control such as the forming field.
The PID control function is available only when "PID Control Function" is set for "Select Function" in the switch setting.
For the setting procedure of "Select Function", refer to the following.

- Switch setting (☞ Page 258, Section 8.22.1 (1) (a))



Two loops can be used for the PID control. A loop consists of an analog input channel and an analog output channel. The following channels are used for each loop.

Loop	Analog input channel	Analog output channel
Loop 1	CH1	CH3
Loop 2	CH2	CH4

(1) Restrictions and precautions on the PID control function

The PID control function has the following restrictions and precautions.

(a) Input range setting

The user range cannot be used. When executing the PID control function, use a range other than the user range. For the setting procedure of the input range, refer to the following.
Switch setting (☞ Page 258, Section 8.22.1 (1) (a))

(b) Output range setting

The user range cannot be used. When executing the PID control function, use a range other than the user range. For the setting procedure of the output range, refer to the following.
Switch setting (☞ Page 258, Section 8.22.1 (1) (a))

(c) Drive mode setting

When using the PID control function, set "Normal (A/D Converter Processing, D/A Converter Processing) Mode" for "Drive Mode Setting" in the switch setting.

(d) Select function

When using the PID control function, set "PID Control Function" for "Select Function" in the switch setting.

(e) Select PID operation expression

Set the arithmetic expression of the PID control to be used for "Select PID Operation Expression" in the switch setting.

- To use the basic PID control, select "Basic PID Control".
- To use the two-degree-of-freedom PID control, select "2 Freedom PID Control" or "2 Freedom PID Control (Variable Speed Integration)".
- To use the variable speed integral function, select "Basic PID Control (Variable Speed Integration)" or "2 Freedom PID Control (Variable Speed Integration)".

(f) Analog output HOLD/CLEAR function

For the combination of the analog output status when the PID control function is used, refer to the following.
PID control (☞ Page 129, Section 8.14 (1) (d))

(g) A/D conversion enable/disable setting

Enable conversion in the A/D conversion channel on the target loop. When conversion is disabled, the PID control is not performed.

(h) Averaging process setting

When the PID control function is used, the moving average can be set as the averaging processing method. (When another method is set, the module performs the sampling processing.)
When the averaging processing is set, the averaged value is used as the process value (PV) to perform the PID control.

(i) Input signal error detection function

Set the input signal error detection setting for the channels where A/D conversion is performed in the same way as for normal output.

(j) Scaling function (A/D conversion)

Set the scaling enable/disable setting to be enabled for the channels where A/D conversion is performed in the same way as for normal output.
The process value (PV) used in the PID operation is CH□ Digital output value (Un\G11, Un\G12) before scale conversion.

(k) Logging function

The logging function and PID control function cannot be selected at the same time. When executing the PID control function, set "PID Control Function" for "Select Function" in the switch setting.

(l) D/A conversion enable/disable setting

Enable conversion in the D/A conversion channel on the target loop. When conversion is disabled, the PID control is not performed.

(m) Warning output function

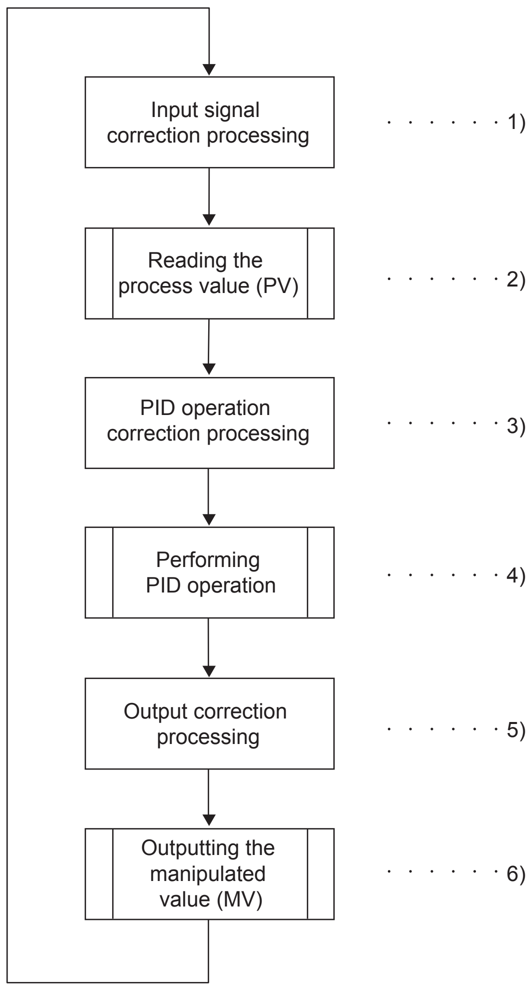
The warning detection target when the PID control function is used is Output conversion value (Un\G4302, Un\G4382).

(n) Scaling function (D/A conversion)

The scaling function (D/A conversion) cannot be used when the PID control function is selected. To execute the PID control function, disable the scaling function (D/A conversion).

(2) PID control

The PID control is performed as follows.



No.	Description
1)	The correction processing is performed for the result of the A/D conversion of the analog signal input from various sensors.
2)	The result of the input signal correction processing is read as the process value (PV) and the value is stored in CH□ Digital output value (Un\G11, Un\G12).
3)	The correction processing is performed for the PID operation.
4)	The PID operation is performed according to the set value (SV) and process value (PV).
5)	The correction processing is performed for the result calculated by the PID operation and the value is converted into a manipulated value (MV).
6)	The manipulated value (MV) after the output correction processing is converted into an analog value and the analog value is output.

(3) PID control method

In the PID control function, two types of control, basic PID control and two-degree-of-freedom PID control, can be used.

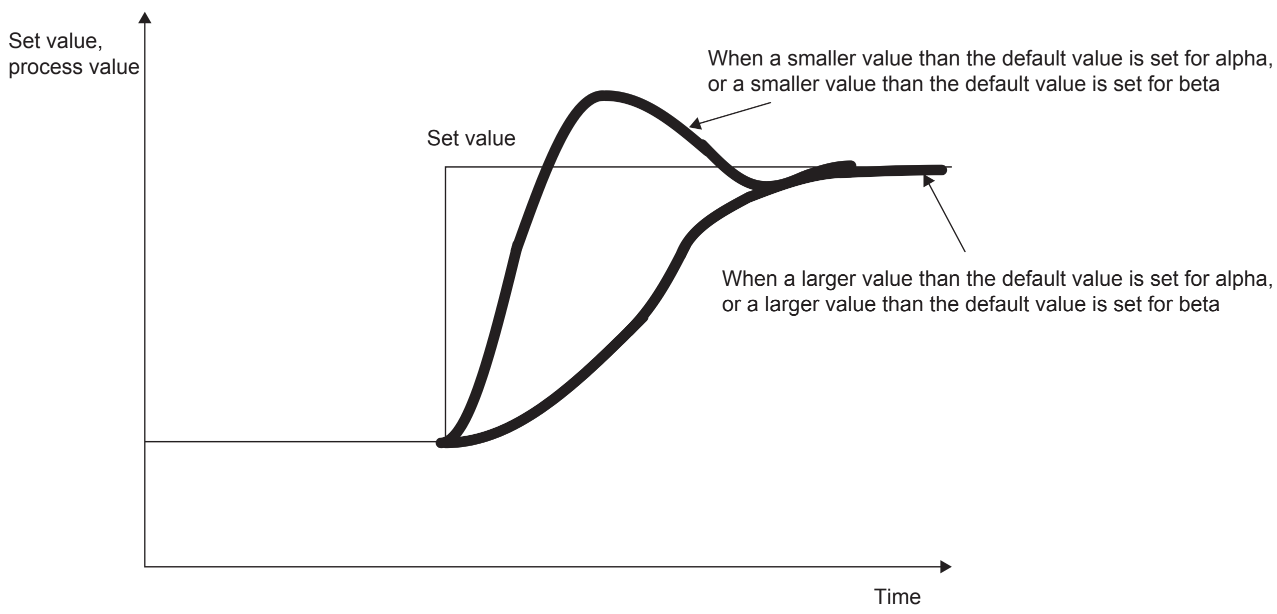
(a) Basic PID control

In this method, control is performed with the combination of the proportional action (P action), integral action (I action), and derivative action (D action).

(b) Two-degree-of-freedom PID control

In this method, the feedforward compensation element is added to the basic PID control.
In the basic PID control, when the PID constants are set to improve the "response to changes of the set value (SV)", the "response to disturbances" deteriorates. On the other hand, when the PID constants are set to improve the "response to disturbances", the "response to changes of the set value (SV)" deteriorates. In the two-degree-of-freedom PID control, both the disturbance suppression and the characteristics to follow the set value (SV) can be optimized by adjusting two-degree-of-freedom parameters.
In the two-degree-of-freedom PID control, the characteristics can be changed by adjusting alpha (feedforward proportion) and beta (feedforward derivation) of the two-degree-of-freedom parameters after setting the PID constants.
When alpha and beta of the two-degree-of-freedom parameters are changed from the default value (alpha = 0, beta = 1), the control is performed as follows.

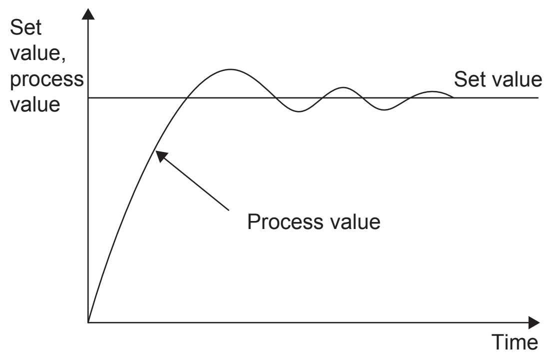
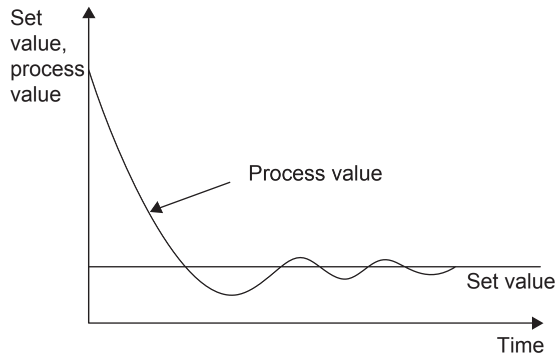
Adjustment	Operation
When a larger value is set for alpha	The performance to follow the set value (SV) decreases. The manipulated value (MV) does not change suddenly when the set value (SV) is changed. Therefore, this adjustment is effective for a control where an overshoot is not allowed or a response is sent slowly to prevent shock to the final control element or controllers.
When a smaller value is set for beta	The effect of the derivative action to the deviation (difference between the set value (SV) and process value (PV)) becomes large and the performance to follow the set value (SV) increases.



When alpha and beta of the two-degree-of-freedom parameters are set to the default value (alpha = 0, beta = 1), the same PID operation as the basic PID control is performed.

(4) Forward action and reverse action

The forward action increases the manipulated value (MV) when the process value (PV) becomes greater than the set value (SV).
The reverse action increases the manipulated value (MV) when the process value (PV) becomes smaller than the set value (SV).
For both the forward action and reverse action, as the difference between the set value (SV) and process value (PV) is larger, the manipulated value (MV) increases.

Reverse action	Forward action
	

(5) Correction processing

This processing corrects the following items when the required control cannot be achieved only with the basic PID control or two-degree-of-freedom PID control.

Correction processing	Description
Input signal	The analog input value converted into a digital value is corrected. The analog I/O module has the following function. • Digital filter function (☞ Page 252, Section 8.22 (5) (a))
PID operation	The analog I/O module automatically corrects the arithmetic expression according to the set value (SV) and process value (PV). When the basic PID control or two-degree-of-freedom PID control cannot improve the response to disturbances or the response to changes of the set value (SV), this processing enables more detailed adjustment. The analog I/O module has the following functions. • PID control function with a gap (☞ Page 252, Section 8.22 (5) (b)) • Variable speed integral function (☞ Page 253, Section 8.22 (5) (c)) • Anti-reset windup function (☞ Page 255, Section 8.22 (5) (d))
Output signal	The numerical value correction processing is performed for the manipulated value (MV) obtained through the PID operation. The corrected manipulated value (MV) is converted into a digital value within the analog output range and the digital value is stored in Output conversion value (Un\G4302, Un\G4382). Output conversion value (Un\G4302, Un\G4382) is converted into an analog value and the analog value is output from the D/A conversion channel. The analog I/O module has the following function. • Output shifting amount to conversion value (☞ Page 256, Section 8.22 (5) (e))

(a) Digital filter function

The digital filter (exponent filter) processing is performed after an analog input value is converted into a digital value. The digital filter can be used as a filter to remove noise of the process value (PV).

The digital filter processing is performed with the following expression. The value for which the digital filter processing was performed is treated as the process value (PV) used for the PID operation.

- $PV_{fn} = PV + \alpha \times (PV_{fn-1} - PV)$

Symbol	Description
α	Filter coefficient
PV	Current digital output value
PV_{fn}	Current filter value
PV_{fn-1}	Filter value in the previous cycle

(b) PID control function with a gap

This function changes the output gain (K) to the gap gain (GG) when the deviation is within the range of the gap width (GW). Thus, this function can be used for suppressing vibration of the manipulated value (MV) when the deviation becomes small.

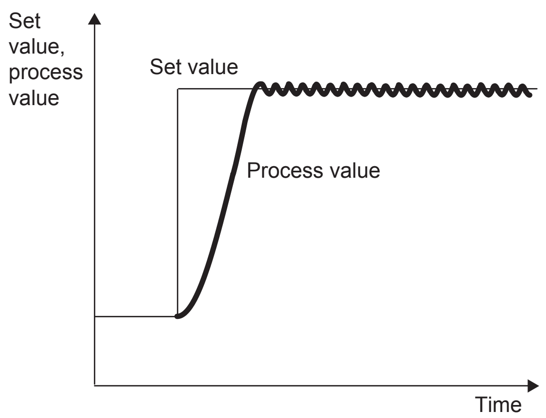
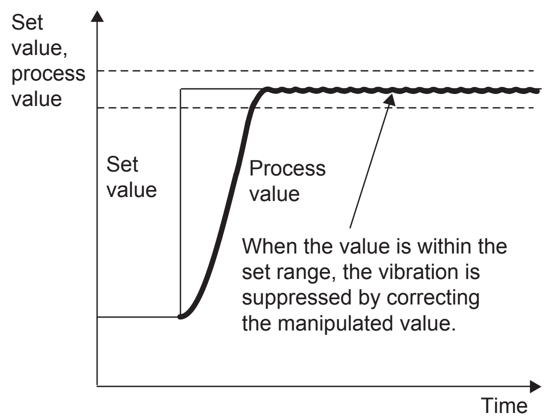
The gain (K_P) to be used in the operation is calculated with the output gain (K) and Proportional gain (P) setting (Un\G4323, Un\G4403) by the following calculation formula.

- $K_P = K \times P$

The output gain (K) is calculated by the calculation formula listed in the table below. In that formula, EV indicates the deviation (%), GW indicates the gap width (%) (ratio of the gap width to the deviation), and GG indicates the gap gain.

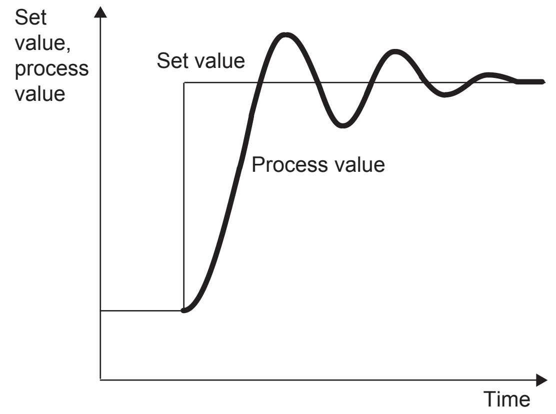
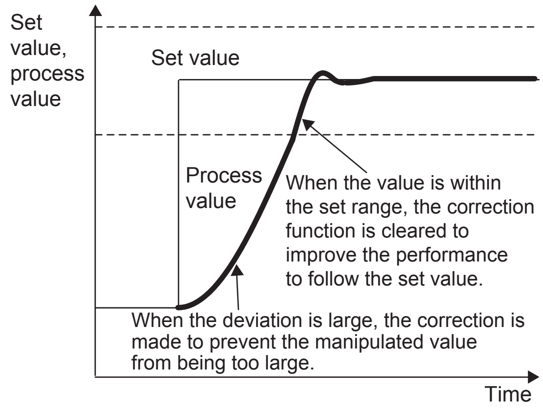
Condition		Output gain (K)
GW = 0 (default)		1
GW > 0	$\lvert EV \rvert \leq GW$	GG
	$\lvert EV \rvert > GW$	$K = 1 - \frac{(1 - GG) \times GW}{\lvert EV \rvert}$

The following shows the operation when the PID control function with a gap is used.

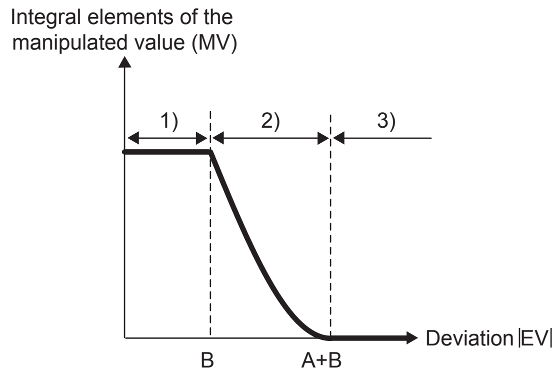
Standard PID control	When the PID control function with a gap is used
	

(c) Variable speed integral function

In the standard PID control, setting a small value as the integral constant to improve the performance of the process value (PV) to follow the set value (SV) causes an overshoot or vibration of the system. To prevent this problem, this function automatically corrects the integral elements of the manipulated value (MV) according to the deviation value.

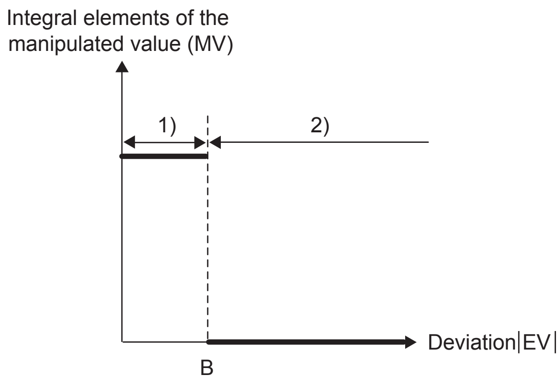
Standard PID control	When the variable speed integral function is used
	

When the deviation is large, the integral constants of the manipulated value (MV) are corrected to reduce the effect. Thus, the overshoot and vibration of the system are reduced. When the deviation is small, the effect is increased to improve the performance of the process value (PV) to follow the set value (SV).



No.	Operation
1)	When the deviation is equal to or less than the judgment value B, the operation of the integral elements resumes to improve the performance of the process value (PV) to follow the set value (SV).
2)	When the deviation is equal to or more than the judgment value B and is equal to or less than the judgment value (A + B), the integral elements are automatically corrected according to the deviation value.
3)	When the deviation is equal to or more than the judgment value (A + B), the operation of the integral elements stops to reduce the overshoot and the vibration of the system.

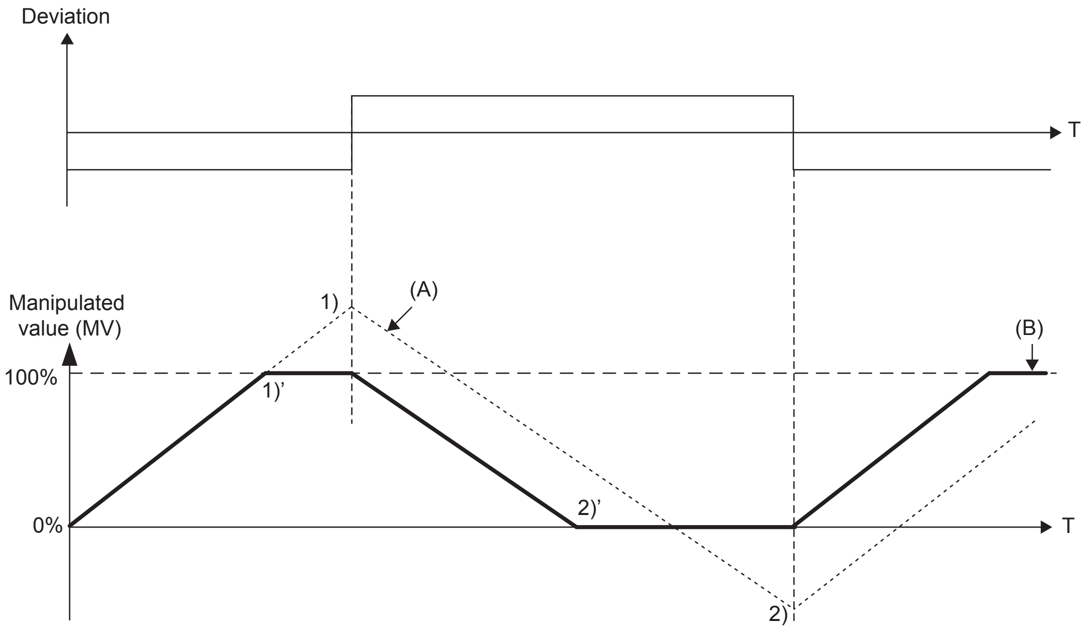
When the variable speed integral judgment value A is set to 0, whether to execute the operation of the integral elements of the manipulated value (MV) or not is determined by the deviation value.



No.	Operation
1)	When the deviation is equal to or less than the judgment value B, the operation of the integral elements resumes to improve the performance of the process value (PV) to follow the set value (SV).
2)	When the deviation is equal to or less than the judgment value (A + B), the operation of the integral elements stops to reduce the overshoot and the vibration of the system.

(d) Anti-reset windup function

When the deviation is too large for a long time, the integral elements of the manipulated value (MV) are accumulated and the operation result of the manipulated value (MV) exceeds the upper limit or lower limit value of output. When the set value (SV) is changed and the direction of the deviation is changed in this state, the operation to restore the manipulated value (MV) for the excess of the upper limit value or lower limit value is performed. The time until the direction change of the manipulated value (MV) extends for the time of this operation. This phenomenon is called the reset windup.
The anti-reset windup function suppresses the reset windup. When the manipulated value (MV) exceeds the output upper limit value or output lower limit value, it is adjusted to the output upper limit value or output lower limit value. In addition, to enable immediate response to an inversion of the deviation, the operation of the integral elements of the manipulated value (MV) in the direction of the excess stops automatically when the output limit is exceeded.
Since the anti-reset windup function is performed automatically, the setting is not required.



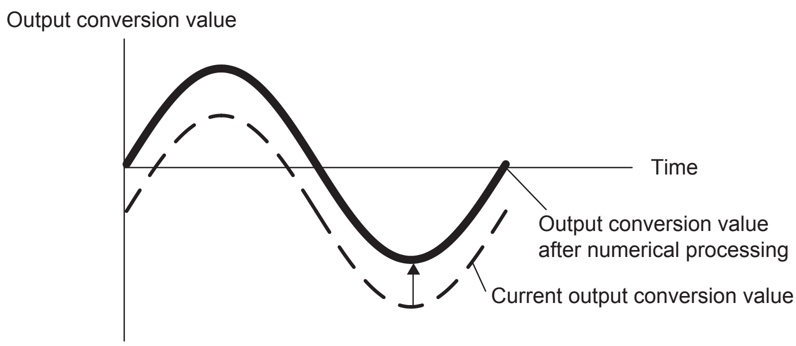
Symbol	Description
(A)	Indicates the operation without the measure against the reset windup. When the direction of the deviation changes from the increasing direction to the decreasing direction (part 1)) or from the decreasing direction to the increasing direction (part 2)), the response of the manipulated value (MV) delays.
(B)	Indicates the operation with the measure against the reset windup. When the manipulated value (MV) exceeds the upper or lower limit value, it is adjusted to the upper or lower limit value (part 1)' and 2)') to prevent the reset windup. When the manipulated value (MV) falls within the output range, the operation of the integral elements resumes.

(e) Output shifting amount to conversion value

This function adds (shifts) a set output shifting amount to conversion value to Output conversion value (Un\G4302, Un\G4382).

This function is used to correct the gap between the input characteristics of a control target and the analog output value of the analog I/O module.

Ex. The following shows an example where Output conversion value (Un\G4302, Un\G4382) is shifted in the increasing direction. As shown in this example, Output shifting amount to conversion value (Un\G4340, Un\G4420) is added and the output conversion value is shifted in the increasing direction.



(6) Setting the manual mode as the control mode

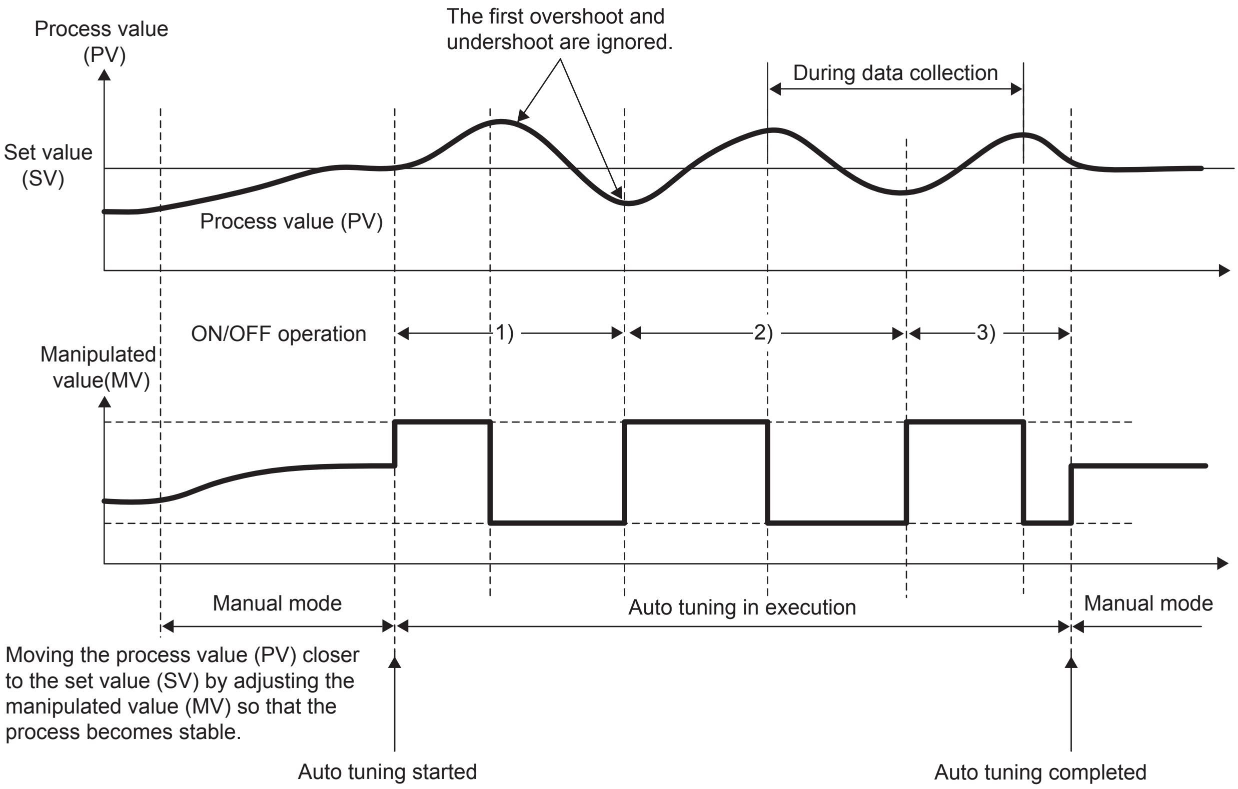
In the manual control, the manipulated value (MV) is not automatically calculated by the PID operation. Instead, the value is set by users manually.

The control is performed normally in the automatic mode where the analog I/O module automatically performs the PID control. However, any manipulated value (MV) can be output by changing the setting of Control mode switching (Un\G4320, Un\G4400) to Manual mode (1) and setting MAN output setting (Un\G4339, Un\G4419).

(7) Adjusting the PID constants using the auto tuning

With this function, the analog I/O module sets an optimal PID constants automatically.

In the auto tuning, the ON/OFF operation of the control output is performed. The PID constants are calculated according to the hunting cycle and amplitude generated when overshoots and undershoots of the process value (PV) to the set value (SV) are repeated.



In the auto tuning, the proportional gain (P), integral time (I), and derivative time (D) used in the PID operation are calculated. After the auto tuning is completed, the PID constants are stored in the following addresses.

PID constants	Address	
	Loop 1	Loop 2
Proportional gain (P)	Un\G4323	Un\G4403
Integral time (I)	Un\G4324, Un\G4325	Un\G4404, Un\G4405
Derivative time (D)	Un\G4326	Un\G4406

8.22.1 Initial setting of the PID control function

To perform the PID control function, configure the initial setting by performing the following operations.

- Switch setting and basic setting (☞ Page 258, Section 8.22.1 (1))
- Parameters of the PID control function (☞ Page 260, Section 8.22.1 (2))
- CH□ Output enable/disable flag (Y3, Y4) (☞ Page 262, Section 8.22.1 (3))

(1) Switch setting and basic setting

To use the PID control function, the switch setting and basic setting are required.

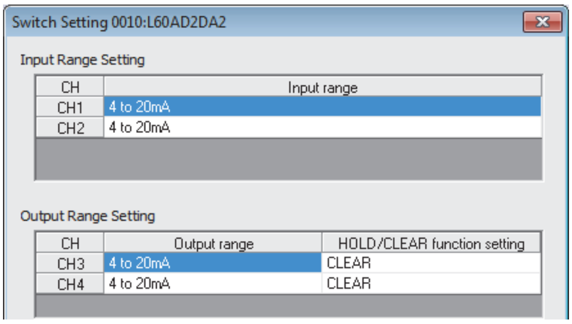
Item		Reference
Switch Setting	Input Range Setting	Page 258, Section 8.22.1 (1) (a)
	Output Range Setting	
	Select Function	
	Select PID Operation Expression	
Basic setting	A/D conversion enable/disable setting	Page 259, Section 8.22.1 (1) (b)
	D/A conversion enable/disable setting	

(a) Switch setting

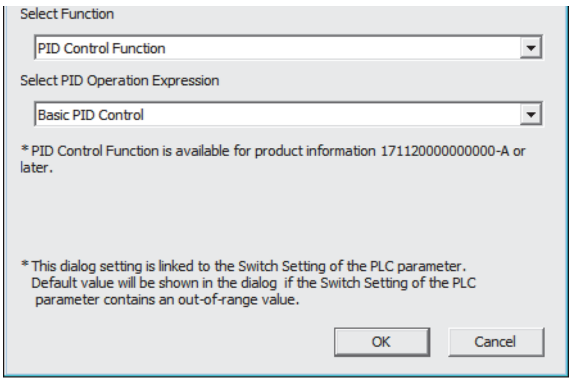
1. Open the "Switch Setting" window.

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Switch Setting]

2. Set "Input Range Setting" of CH1 and CH2 to a value other than "User Range Setting". Set "Output Range Setting" of CH3 and CH4 to a value other than "User Range Setting".



3. Set "Select Function" to "PID Control Function". Set the arithmetic expression of the PID control to be used for "Select PID Operation Expression".



(b) Basic setting

1. In the parameter setting of GX Works2, set "A/D conversion enable/disable setting" and "D/A conversion enable/disable setting" of the corresponding loop to "0: Enable".

Project window ⇨ [Intelligent Function Module] ⇨ module name
⇨ [Parameter_(A/D_Conversion)] and [Parameter_(D/A_Conversion)]

2. Set the following items as needed.

Item			Application
Parameter_(A/D_Conversion)	Basic setting	Averaging process setting	Set this item to reduce the effects of rapid change in the analog input value on the PID control.
		Time Average/Count Average/Moving Average	
	Input signal error detection	Input signal error detection setting	Set this item to detect an error of the analog input value.
		Input signal error detection setting value	
	Scaling function (A/D conversion)	A/D conversion scaling enable/disable setting	Set this item to monitor the result of the scale conversion of the process value (PV).
		A/D conversion scaling upper limit value	
		A/D conversion scaling lower limit value	
Parameter_(D/A_Conversion)	Warning output function	Warning output setting	Set this item to detect an error of the manipulated value (MV).
		Warning output upper limit value	
		Warning output lower limit value	

(2) Parameters of the PID control function

1. **Set the cycle for the PID control in Control cycle setting (Un\G4321, Un\G4401).**

Item	Setting range
Control cycle setting (Un\G4321, Un\G4401)	2 to 60000 (0.2 to 6000.0ms)

2. **Set the proportional gain (P) for the PID control in Proportional gain (P) setting (Un\G4323, Un\G4403).**

Item	Setting range
Proportional gain (P) setting (Un\G4323, Un\G4403)	1 to 10000 (0.01 to 100.00)

3. **Set the integral time (I) for the PID control in Integral time (I) setting (Un\G4324 to Un\G4325, Un\G4404 to Un\G4405).**

Item	Setting range
Integral time (I) setting (Un\G4324 to Un\G4325, Un\G4404 to Un\G4405)	0 to 300000 (0.00 to 3000.00s)

Set 0 to perform the P control or PD control.

4. **Set the derivative time (D) for the PID control in Derivative time (D) setting (Un\G4326, Un\G4406).**

Item	Setting range
Derivative time (D) setting (Un\G4326, Un\G4406)	0 to 30000 (0.00 to 300.00s)

Set 0 to perform the P control or PI control.

5. **A time period (delay in operation) can be given to the derivative action with Derivative gain setting (Un\G4331, Un\G4411).**

Item	Setting range
Derivative gain setting (Un\G4331, Un\G4411)	1 to 30000 (0.01 to 300.00)

6. **Set the feedforward proportion value for the two-degree-of-freedom PID control in Two-degree-of-freedom parameter alpha setting (Un\G4329, Un\G4409).**
When a larger value is set as the setting value (α), the effect of the proportion to the set value change reduces.

Item	Setting range
Two-degree-of-freedom parameter alpha setting (Un\G4329, Un\G4409)	0 to 100 (0.00 to 1.00)

7. **Set the feedforward derivative value for the two-degree-of-freedom PID control with Two-degree-of-freedom parameter beta setting (Un\G4330, Un\G4410).**
When a smaller value is set as the setting value (β), the effect of the derivation to the set value change increases.

Item	Setting range
Two-degree-of-freedom parameter beta setting (Un\G4330, Un\G4410)	0 to 100 (0.00 to 1.00)

8. **Set whether to use the PID control in forward action or reverse action in Forward/reverse action setting (Un\G4334, Un\G4414).**

Item	Setting value
Forward/reverse action setting (Un\G4334, Un\G4414)	• Reverse action (0) • Forward action (1)

9. **Set the set value for the PID control in Set value (SV) setting (Un\G4322, Un\G4402).**

The setting range varies depending on the input range setting.

Item	Input range setting	Setting range
Set value (SV) setting (Un\G4322, Un\G4402)	0 to 5V	0 to 12000
	1 to 5V	
	0 to 20mA	
	4 to 20mA	
	0 to 10V	0 to 16000
	-10 to 10V	-16000 to 16000
	1 to 5V (Extended mode)	-3000 to 13500
	4 to 20mA (Extended mode)	

10. **Set the filter coefficient of the digital filter (exponent filter) processing for the digital output value in Filter coefficient (Un\G4335, Un\G4415).**

Item	Setting range
Filter coefficient (Un\G4335, Un\G4415)	0 to 99 (0.00 to 0.99)

11. **To adjust the PID constants automatically, perform the auto tuning.**

Refer to the following for the procedure.

Executing the auto tuning (☞ Page 263, Section 8.22.2)

12. **Set the gap width for the PID control with a gap (a control where a gap width is used to make the deviation used for the PID operation smaller than the actual deviation) in Gap width setting (Un\G4327, Un\G4407). Set it within the range of the deviation in which the PID control with a gap is performed (0 to 100%).**

Item	Setting range
Gap width setting (Un\G4327, Un\G4407)	0 to 10000 (0.00 to 100.00%)

When "|Deviation| ≤ Gap width" is satisfied, the PID control with a gap is performed.

13. **Set the gap gain for the PID control with a gap (a control where a gap width is used to make the deviation used for the PID operation smaller than the actual deviation) in Gap gain setting (Un\G4328, Un\G4408). Set it as the gain for the actual deviation at which the PID control with a gap is performed (0 to 100%).**

Item	Setting range
Gap gain setting (Un\G4328, Un\G4408)	0 to 100 (0.00 to 1.00)

The deviation used for the PID operation is calculated with "Actual deviation × Gap gain".

14. **When using the variable speed integral function, set the deviation range in which the integral elements of the manipulated value (MV) are corrected in Variable speed integral judgment value A setting (Un\G4332, Un\G4412) and Variable speed integral judgment value B setting (Un\G4333, Un\G4413).**

Item	Setting range
Variable speed integral judgment value A setting (Un\G4332, Un\G4412)	0 to 10500 (0.00 to 105.00%)
Variable speed integral judgment value B setting (Un\G4333, Un\G4413)	

The following operations are performed by setting the range.

Range	Operation
Deviation < Judgment value B	The operation of the integral elements is performed.
Judgment value B ≤ Deviation < (Judgment value A + Judgment value B)	The integral elements are corrected according to the deviation value.
(Judgment value A + Judgment value B) ≤ Deviation	The integral action is stopped.

15. **Set the digital value that is used to correct the output conversion value in Output shifting amount to conversion value (Un\G4340, Un\G4420).**

Item	Setting range
Output shifting amount to conversion value (Un\G4340, Un\G4420)	-32768 to 32767

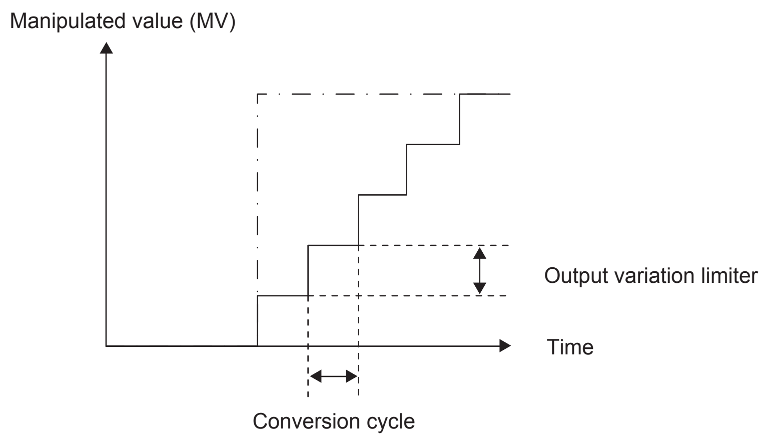
16. **Set the upper limit value and lower limit value that limit the manipulated value (MV) calculated by the PID operation in Upper limit output limiter setting (Un\G4336, Un\G4416) and Lower limit output limiter setting (Un\G4337, Un\G4417).**

Item	Setting range
Upper limit output limiter setting (Un\G4336, Un\G4416)	-500 to 10500 (-5.0 to 105.00%)
Lower limit output limiter setting (Un\G4337, Un\G4417)	

The condition "Lower limit output limiter setting < Upper limit output limiter setting" must be satisfied.

17. **Set the allowable change width of the manipulated value (MV) for each control cycle in Output variation limiter setting (Un\G4338, Un\G4418). Even if a change width exceeds the allowable change width, the manipulated value changes only by the change width set as the output variation limiter. (When 0 is set, the output variation limiter does not operate.)**

Item	Setting range
Output variation limiter setting (Un\G4338, Un\G4418)	0 to 10000 (0.00 to 100.00%)



18. **Set whether to continue the PID control or stop the control and keep the output when the CPU module operating status is RUN, STOP, or stop error during the PID control in PID continuation flag on HOLD (Un\G4341, Un\G4421).**

Item	Setting value
PID continuation flag on HOLD (Un\G4341, Un\G4421)	• Hold output (0) • Continue PID operation (1)

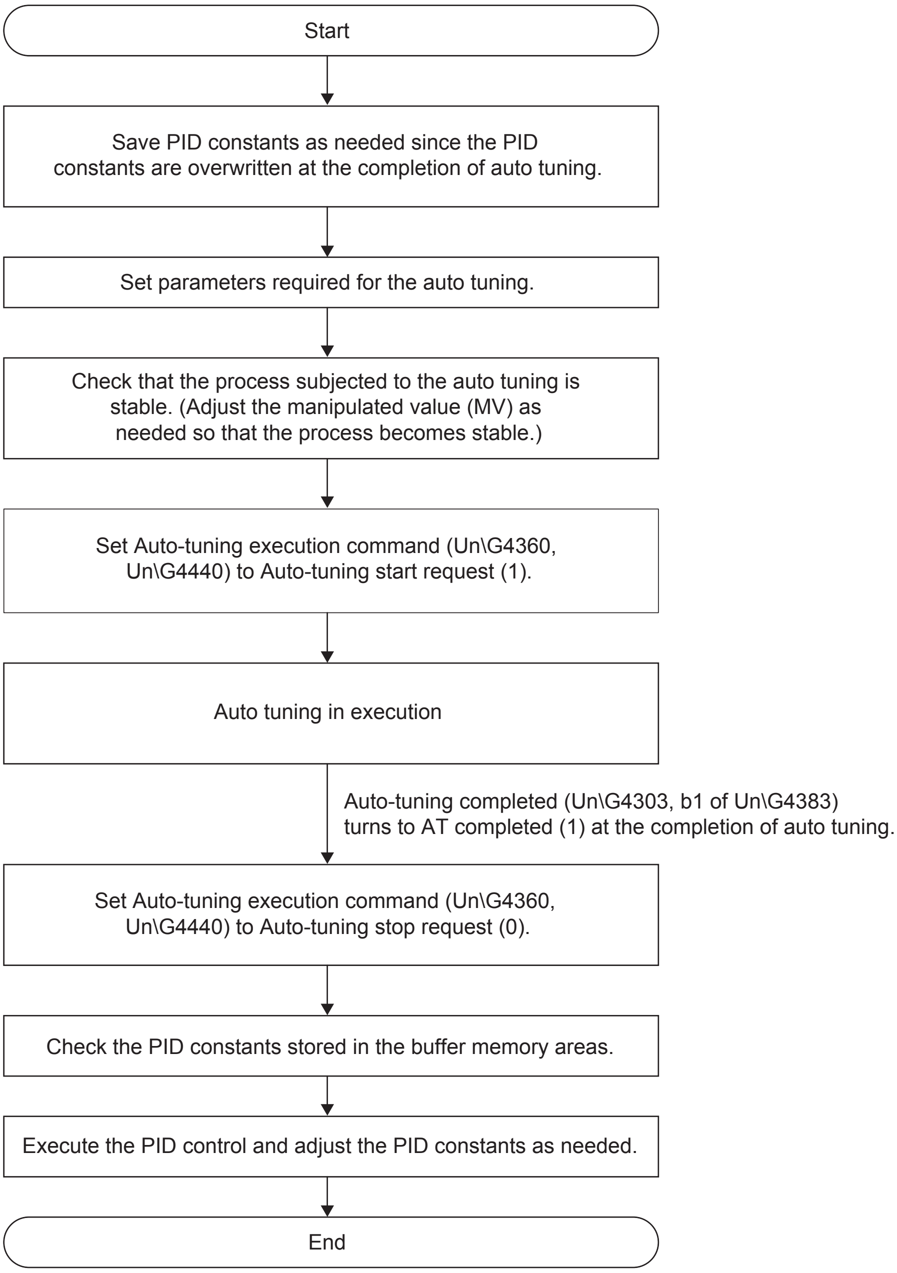
19. **Turn on and off Operating condition setting request (Y9).**

(3) CH☐ Output enable/disable flag (Y3, Y4)

Turn on CH☐ Output enable/disable flag (Y3, Y4) of the loop where the PID control is performed.
When Automatic mode (0) has been stored in Control mode monitor (Un\G4300, Un\G4380) and CH☐ Output enable/disable flag (Y3, Y4) is turned off, an analog output value becomes an offset value and the PID control stops.
When CH☐ Output enable/disable flag (Y3, Y4) is turned on again, the PID operation starts from the beginning.

8.22.2 Executing the auto tuning

The following shows the procedure of the auto tuning.



Point

When one of the following conditions is met, the auto tuning is not executed.

- When conversion is disabled in the A/D conversion channel or D/A conversion channel of the corresponding loop
- When CH□ Output enable/disable flag (Y3, Y4) of the corresponding loop is off
- When a hardware error has occurred

(1) Setting of the auto tuning

The following shows the items that are set to execute the auto tuning.

1. **Set the time for the auto-tuning processing from the start to the automatic stop in Auto-tuning timeout time (Un\G4361, Un\G4441).**

Item	Setting range
Auto-tuning timeout time (Un\G4361, Un\G4441)	0 to 7200 (0 to 7200s)

The default value is 100 (100s). When the auto tuning processing takes time, change the setting value.

2. **Set the hysteresis to prevent chattering of the process value (PV) during the auto tuning in Auto-tuning hysteresis (Un\G4362, Un\G4442).**

Item	Setting range
Auto-tuning hysteresis (Un\G4362, Un\G4442)	0 to 1000 (0.00 to 10.00%)

The default value is 100 (1.00s). Usually, the value does not need to be changed. When an abnormal process value (PV) is detected during the auto tuning, change the setting value.

3. **Set the range of the manipulated value (MV) in the ON/OFF control during the auto tuning in Auto-tuning output upper limit value (Un\G4363, Un\G4443) and Auto-tuning output lower limit value (Un\G4364, Un\G4444).**

Item	Setting range
Auto-tuning output upper limit value (Un\G4363, Un\G4443)	-500 to 10500 (-5.00 to 105.00%)
Auto-tuning output lower limit value (Un\G4364, Un\G4444)	

Set the values as follows: "Auto-tuning output upper limit value ≤ Upper limit output limiter setting", "Auto-tuning output lower limit value ≥ Lower limit output limiter setting", and "Auto-tuning output upper limit value > Auto-tuning output lower limit value".

4. **Set the calculation method of the PID control parameters for the auto tuning in Auto-tuning control type setting (Un\G4365, Un\G4445).**

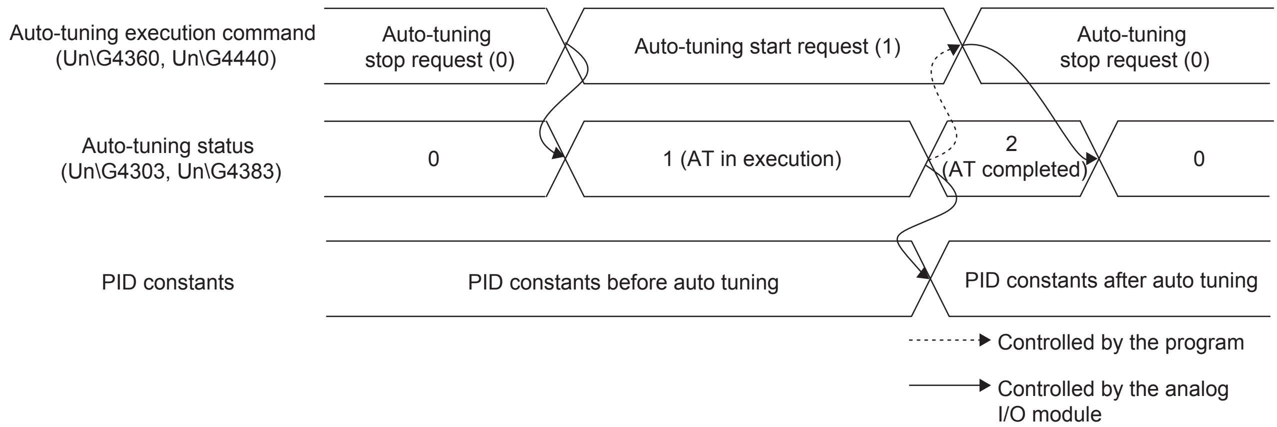
Item	Setting value	Remarks
Auto-tuning control type setting (Un\G4365, Un\G4445)	• Constant-value PI control (0) • Constant-value PID control (1)	The constant-value control improves the responsiveness to disturbances.
	• Variable-value PI control (2) • Variable-value PID control (3)	The variable-value control suppresses an overshoot at a change of the set value (SV).

5. **Turn on and off Operating condition setting request (Y9).**

(2) Timing chart of the auto tuning

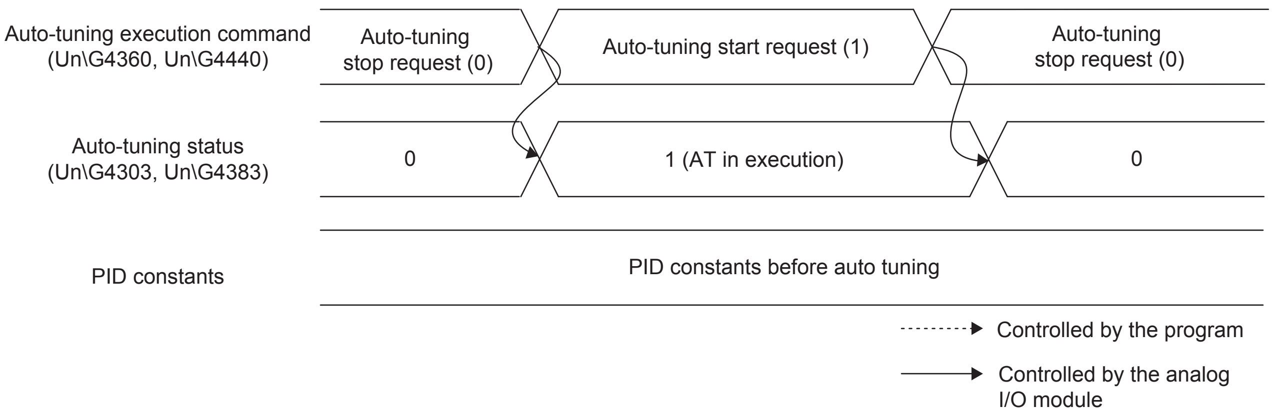
(a) When completed successfully

The following shows the timing chart from the start to the normal completion of the auto tuning.



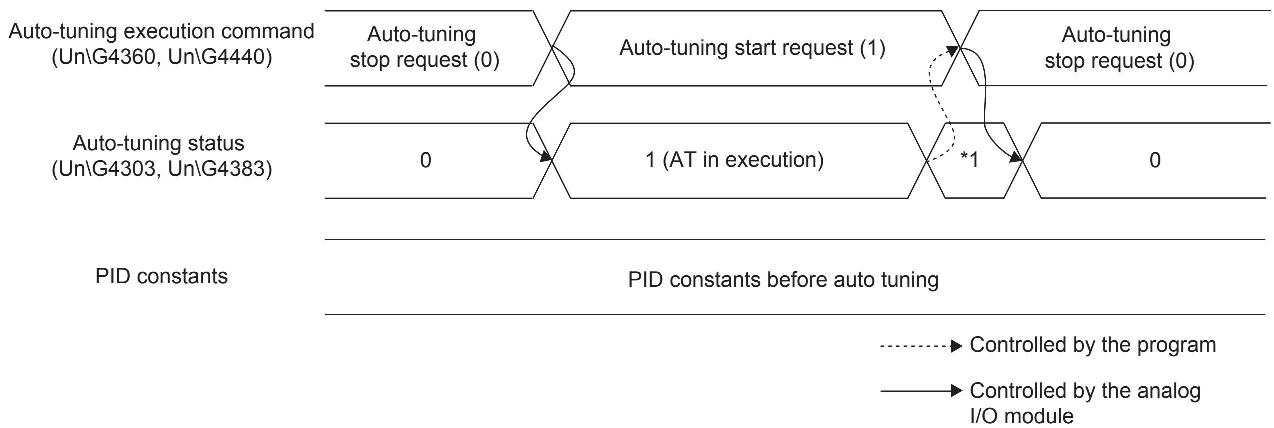
(b) When stopped

The following shows the timing chart when the auto tuning is stopped.



(c) When completed abnormally

The following shows the timing chart when the auto tuning is completed abnormally.



*1 The bit 1 and one of bit 4 to 12 are on (auto-tuning error)

(3) Precautions on executing the auto tuning

- Do not change the value of Control mode switching (Un\G4320, Un\G4400) during the auto tuning. When it is changed, the auto tuning stops and Control mode error occurred (1) is stored in Control mode error (Un\G4303, b10 of Un\G4383). Before changing the control mode, check that AT not executed (0) is stored in Auto-tuning in execution (Un\G4303, b0 of Un\G4383).
- When an input signal error is detected during the auto tuning, the auto tuning stops. At this time, 1 is stored in Input upper limit error (Un\G4303, b4 of Un\G4383) or Input lower limit error (Un\G4303, b5 of Un\G4383). To execute the auto tuning again, eliminate the detection cause.
- When a warning is output during the auto tuning, the auto tuning stops. At this time, 1 is stored in Output upper limit warning occurrence (Un\G4303, b7 of Un\G4383) or Output lower limit warning occurrence (Un\G4303, b8 of Un\G4383). To execute the auto tuning again, eliminate the detection cause, turn on and off Warning output clear request (Y8), and clear Warning output flag (Un\G2048) and Warning output signal (X8).

8.22.3 Monitoring the PID control

The PID control can be monitored with the following buffer memory areas.

Item	Description	Reference
CH□ Digital output value (Un\G11, Un\G12)	The process value (PV) for which the digital filter processing has been performed is stored.	Page 356, Appendix 2 (4)
Output conversion value (Un\G4302, Un\G4382)	The manipulated value (MV) converted into a digital input value corresponding to the output range is stored.	Page 404, Appendix 2 (75)
Auto-tuning status (Un\G4303, Un\G4383)	The auto-tuning status can be checked.	Page 405, Appendix 2 (76)
PID operation expression selection monitor (Un\G4460)	The PID operation in use can be checked.	Page 417, Appendix 2 (101)

8.22.4 Points to use the PID control function

(1) When Operating condition setting request (Y9) is turned on and off during the PID control

When Operating condition setting request (Y9) is turned on and off during the PID control, the PID control stops and Manipulated value (MV) (Un\G4301, Un\G4381) and Output conversion value (Un\G4302, Un\G4382) are cleared to 0. When Operating condition setting completed flag (X9) turns on, the PID operation starts from the beginning.
At this time, the analog output value varies depending on the status of Control mode monitor (Un\G4300, Un\G4380) as follows.

Control mode monitor (Un\G4300, Un\G4380)	Analog output value
Automatic mode (0)	When Operating condition setting request (Y9) is turned on, the analog output value becomes an offset value. After that, when Operating condition setting request (Y9) is turned off and the first PID operation is completed, Output conversion value (Un\G4302, Un\G4382) is output in analog.
Manual mode (1)	Even though Operating condition setting request (Y9) is turned on, the analog output value is held.

(2) When the output range is set to -10 to 10V and the PID control is performed

When an operating condition is set (when Operating condition setting request (Y9) is turned on and off), the PID control starts from the beginning according to the new operation condition. Thus, Manipulated value (MV) (Un\G4301, Un\G4381) is cleared to 0. For the analog output range of -10 to 10V, -10V is output if the manipulated value (MV) is 0. Therefore, the analog output may change rapidly after the operating condition is set. To avoid this situation, set Control mode switching (Un\G4320, Un\G4400) to Manual mode (1) and then turn on and off Operating condition setting request (Y9).
After that, check that Operating condition setting completed flag (X9) and A/D conversion completed flag (XE) are on, and then shift the control mode to the automatic mode.

(3) When the PID control and the input signal error detection function are used together

If an input signal error is detected during the PID control, the PID control of the corresponding loop stops and Manipulated value (MV) (Un\G4301, Un\G4381) and Output conversion value (Un\G4302, Un\G4382) are cleared to 0.

When the analog input value falls within the setting range, the PID control starts from the beginning without resetting Input signal error detection flag (Un\G49) and Input signal error detection signal (XC). (The ALM LED keeps flashing.) At this time, the analog output value varies depending on the status of Control mode monitor (Un\G4300, Un\G4380) as follows.

Control mode monitor (Un\G4300, Un\G4380)	Operation
Automatic mode (0)	When an input signal error is detected, the analog output value becomes an offset value. After that, when the analog input value falls within the setting range and the first PID operation is completed, Output conversion value (Un\G4302, Un\G4382) is output in analog.
Manual mode (1)	Even though an input signal error is detected, the analog output value is held.

(4) When the CPU module status is changed during the PID control

When the CPU module status is changed during the PID control, the operation varies depending on the setting of "HOLD/CLEAR function setting" in "Switch Setting".

"HOLD/CLEAR function setting"	Operation
CLEAR	The output status is the same as that of normal output.
HOLD	Whether to hold the output or continue the PID processing can be selected by setting PID continuation flag on HOLD (Un\G4341, Un\G4421). For details, refer to the following. • PID control (☞ Page 129, Section 8.14 (1) (d))

(5) Operation of when the external power supply is turned off during the PID control

When the external power supply is turned off during the PID control, the PID control stops on all the loops. After the external power supply is turned on, the PID operation is executed from the beginning when External power supply READY flag (X7) turns on.

To execute the PID control again, turn off CH□ Output enable/disable flag (Y3, Y4) after the external power supply is turned off for safety. After that, check the status of the module and the external devices. And then, turn on CH□ Output enable/disable flag (Y3, Y4) after the external power supply is turned on. When CH□ Output enable/disable flag (Y3, Y4) is turned on, the PID control is executed from the beginning.

8.23 Error Log Function

Common

This function stores a history of errors and alarms that occurred in the analog I/O module to the buffer memory (Un\G4810 to Un\G4969).
A total of 16 errors and alarms can be stored.

(1) Process of the error log function

The error code and the error time are stored in the buffer memory area, starting from Error history No.1 (start address: Un\G4810) and sequentially thereafter. Error time is stored as follows:

Ex. For error history No. 1

	b15 to b8	b7 to b0
Un\G4810	Error code	
Un\G4811	First two digits of the year	Last two digits of the year
Un\G4812	Month	Day
Un\G4813	Hour	Minute
Un\G4814	Second	Day of the week
Un\G4815 to Un\G4819	System area	

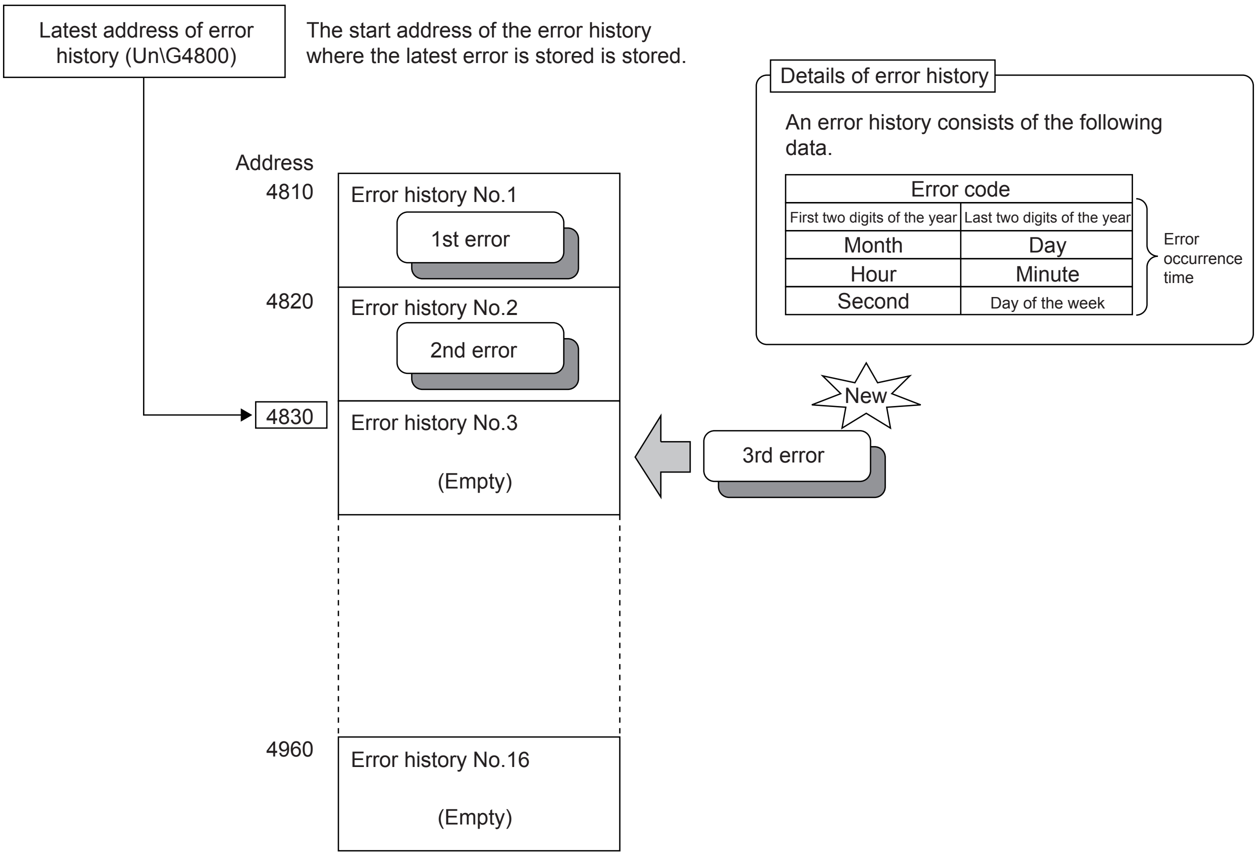
Item	Stored value and code	Example[*1]
First two digits of the year/Last two digits of the year	Stored in BCD code.	2013H
Month/Day		0501H
Hour/Minute		1234H
Second		56H
Day of the week	The value that corresponds to the day of the week is stored in BCD code. • Sunday: 00H • Monday: 01H • Tuesday: 02H • Wednesday: 03H • Thursday: 04H • Friday: 05H • Saturday: 06H	03H

*1 Values stored when an error occurs on Wednesday May 1, 2013 at 12:34:56.

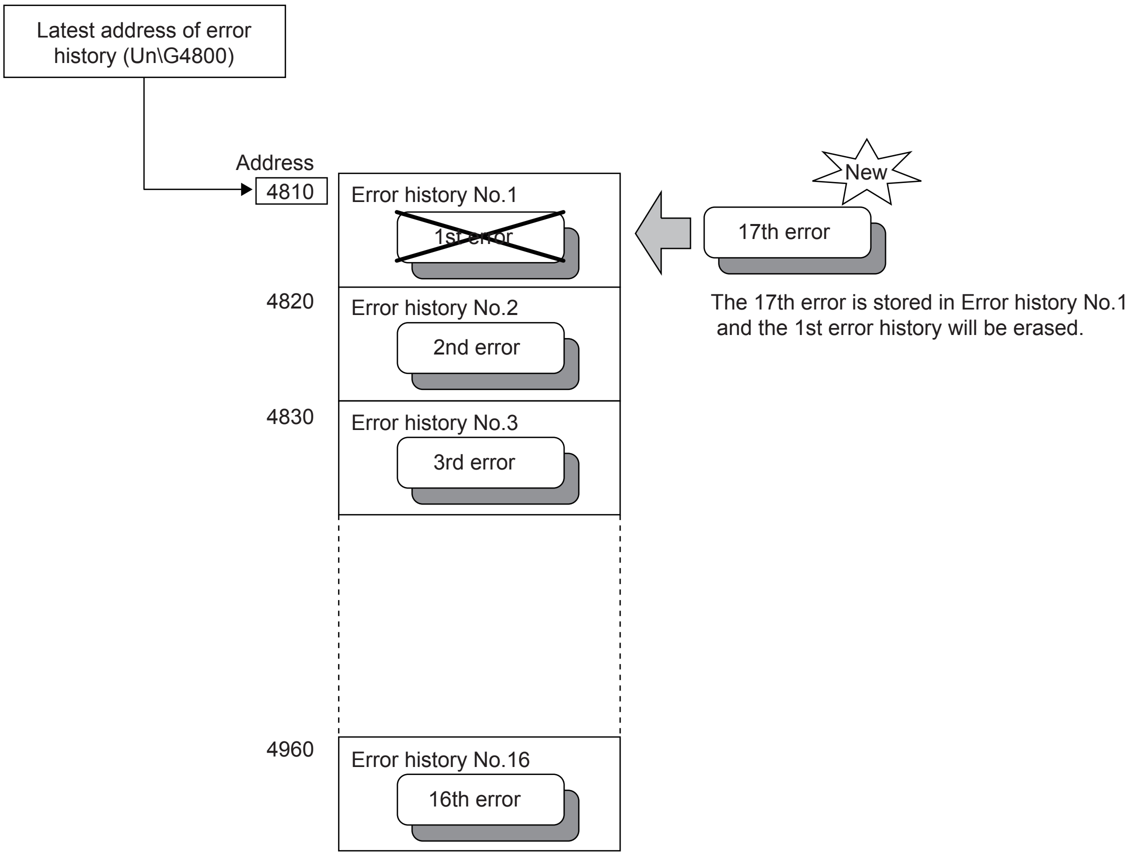
(2) Checking error history

The start address of the latest stored error can be checked in Latest address of error history (Un\G4800).

Ex. An occurrence of the third error results in the third error being stored in Error history No.3, and 4830 (start address of Error history No.3) being stored in Latest address of error history (Un\G4800).



Ex. An occurrence of the 17th error results in the 17th error being stored in Error history No.1, and Latest address of error history (Un\G4800) being overwritten with 4810 (start address of Error history No.1).



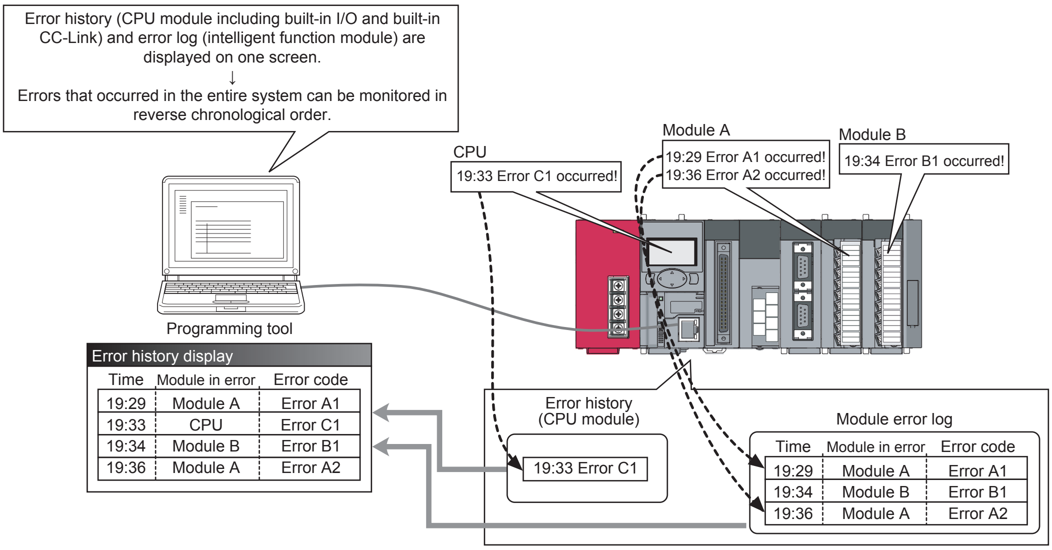
Point

- The same process for errors is used when an alarm occurs.
- Once the error history storage area becomes full, subsequent error information will overwrite the existing data, starting from Error history No.1 (Un\G4810 to Un\G4819), and continues sequentially thereafter. (The overwritten history is deleted.)
- The stored error history is cleared when the analog I/O module is powered off, or when the CPU module is reset.

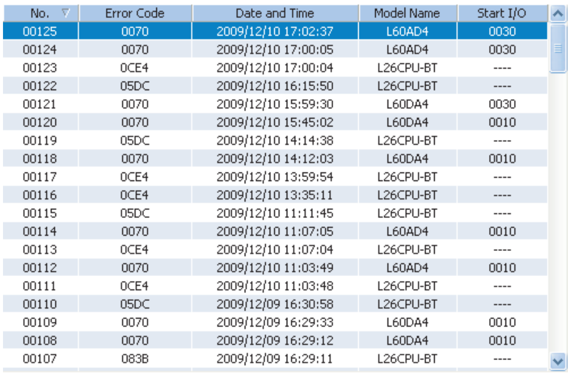
8.24 Module Error Collection Function

Common

This function collects errors and alarms that occurred in the analog I/O module and stores them to the CPU module. By holding the module errors in a CPU module memory that can hold data in the event of power failure, the details on errors can be held even after the module is powered off or reset.



[Example of screen display]



No.	Error Code	Date and Time	Model Name	Start I/O
00125	0070	2009/12/10 17:02:37	L60AD4	0030
00124	0070	2009/12/10 17:00:05	L60AD4	0030
00123	0CE4	2009/12/10 17:00:04	L26CPU-BT	----
00122	05DC	2009/12/10 16:15:50	L26CPU-BT	----
00121	0070	2009/12/10 15:59:30	L60DA4	0030
00120	0070	2009/12/10 15:45:02	L60DA4	0010
00119	05DC	2009/12/10 14:14:38	L26CPU-BT	----
00118	0070	2009/12/10 14:12:03	L60DA4	0010
00117	0CE4	2009/12/10 13:59:54	L26CPU-BT	----
00116	0CE4	2009/12/10 13:35:11	L26CPU-BT	----
00115	05DC	2009/12/10 11:11:45	L26CPU-BT	----
00114	0070	2009/12/10 11:07:05	L60AD4	0010
00113	0CE4	2009/12/10 11:07:04	L26CPU-BT	----
00112	0070	2009/12/10 11:03:49	L60AD4	0010
00111	0CE4	2009/12/10 11:03:48	L26CPU-BT	----
00110	05DC	2009/12/09 16:30:58	L26CPU-BT	----
00109	0070	2009/12/09 16:29:33	L60DA4	0010
00108	0070	2009/12/09 16:29:12	L60DA4	0010
00107	083B	2009/12/09 16:29:11	L26CPU-BT	----

Point

For details on the module error collection function, refer to the following.
MELSEC-L CPU Module User's Manual (Function Explanation, Program Fundamentals)

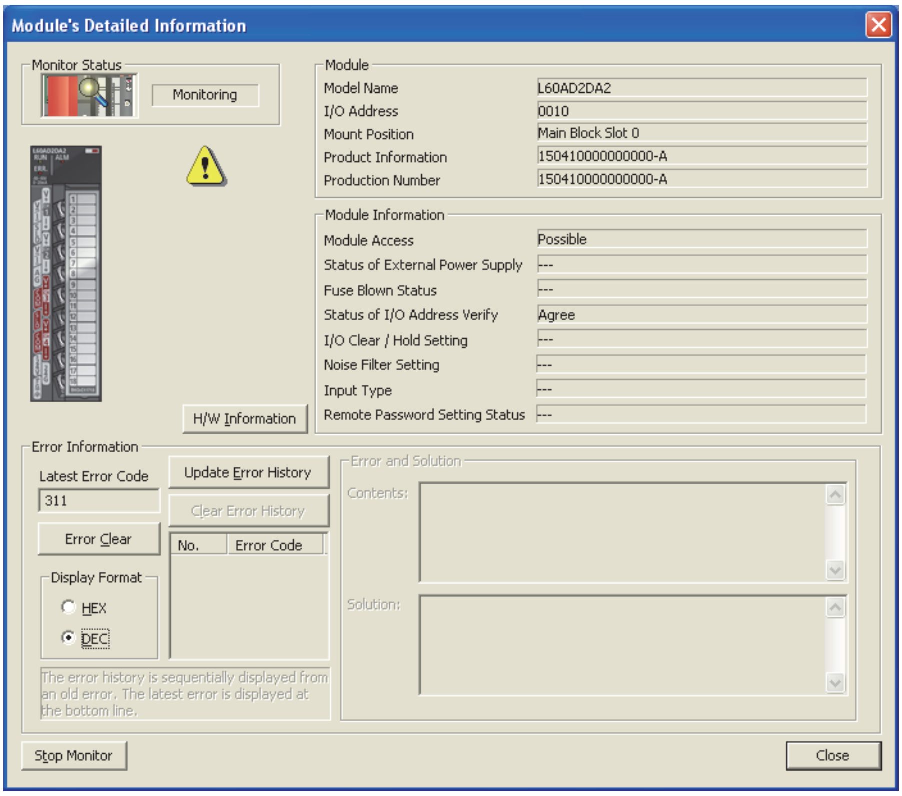
8.25 Error Clear Function

Common

This function clears errors that occur using the system monitor.

By clicking the Error Clear button in "System Monitor", the latest error code stored in Latest error code (Un\G19) is cleared and the ERR.LED turns off. The operation is the same as that for Error clear request (YF) and clearing the error from the display unit.
However, the error history cannot be cleared with the button.
For instructions on Error clear request (YF) and clearing the error from the display unit, refer to the following.

- Error clear request (YF) (☞ Page 353, Appendix 1.2 (8))
- Checking and Clearing Errors (☞ Page 288, Section 9.4)



8.26 Save/Restoration of Offset/Gain Value

Common

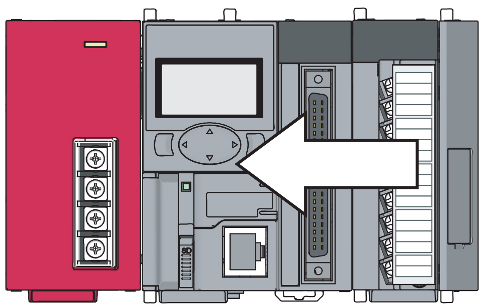
The offset/gain value of the user range setting can be saved and restored in the analog I/O module.

- Save: Saves the offset/gain information, registered in this module in the offset/gain setting, in the CPU module.
- Restoration: Writes the information saved in the CPU module to this module.

In the event that the analog I/O module fails and needs to be replaced, the offset/gain values of the failed analog I/O module can be restored onto the replaced analog I/O module.
In addition, if multiple analog I/O modules are connected on a system, the offset/gain values set for one of the modules can be applied to the other modules.
However, if the offset/gain values are saved and restored, the accuracy after the restoration decreases by approximately three times compared to that before the restoration.
Reconfigure the offset/gain setting when required.

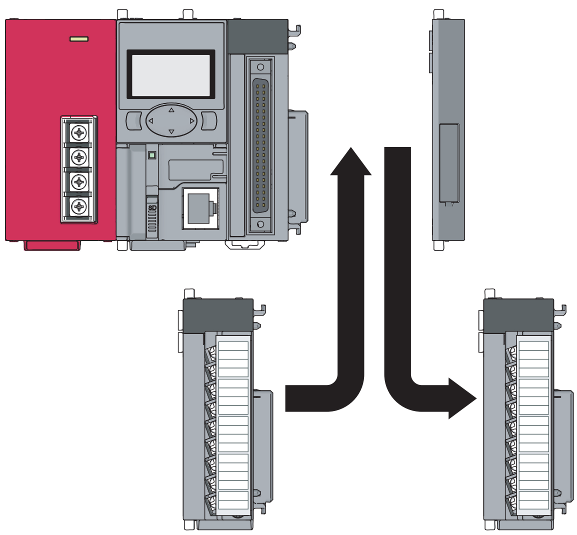
(1) Procedure for saving and restoring offset/gain values

(a) To restore offset/gain values onto a new replaced module:



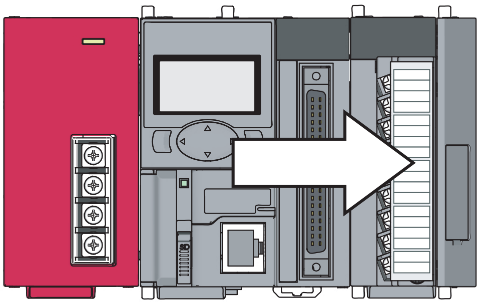
1. **Save the offset/gain values.**

↓



2. **Replace the analog I/O module.**

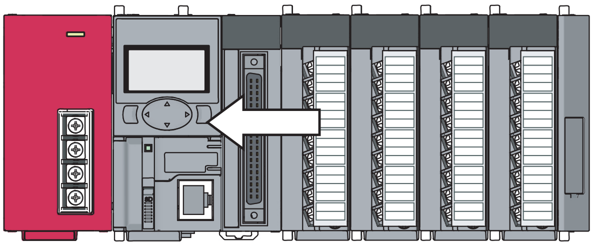
↓



3. **Restore the offset/gain values.**

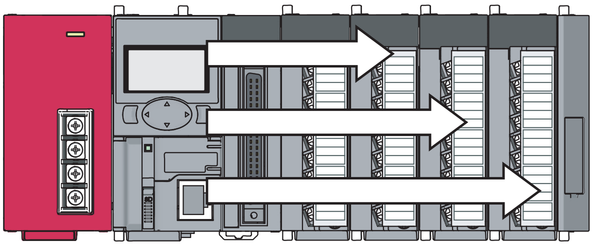
(b) To apply the offset/gain values set in one module to the other modules in the same system:

Ex. When the offset/gain values in module No.1 are applied to modules No.2 to No.4



1. **Save the offset/gain values of module No.1.**

↓



2. **Apply the offset/gain values to modules No.2 to No.4.**

(2) Methods for saving and restoring offset/gain values

There are two methods for saving and restoring offset/gain values.

- Saving and restoring by dedicated instructions
- Saving and restoring by reading from and writing to the buffer memory

(a) Saving and restoring by dedicated instructions

Use the dedicated instruction G(P).OGLOAD to temporarily save the offset/gain values of the source analog I/O module to the internal device of the CPU module, then use G(P).OGSTOR to write the values to the destination analog I/O module.

Prevent the saved offset/gain value data from being deleted, by one of the following methods before replacing the modules:

- Use latch settings for the internal device of the destination module.
- Save the data onto an SD memory card.

To write data: use the SP.FWRITE instruction.

To read data: use the SP.FREAD instruction.

- Store the saved data.

For use of dedicated instructions, refer to the following.

- Dedicated Instruction (☞ Page 432, Appendix 5)

Point

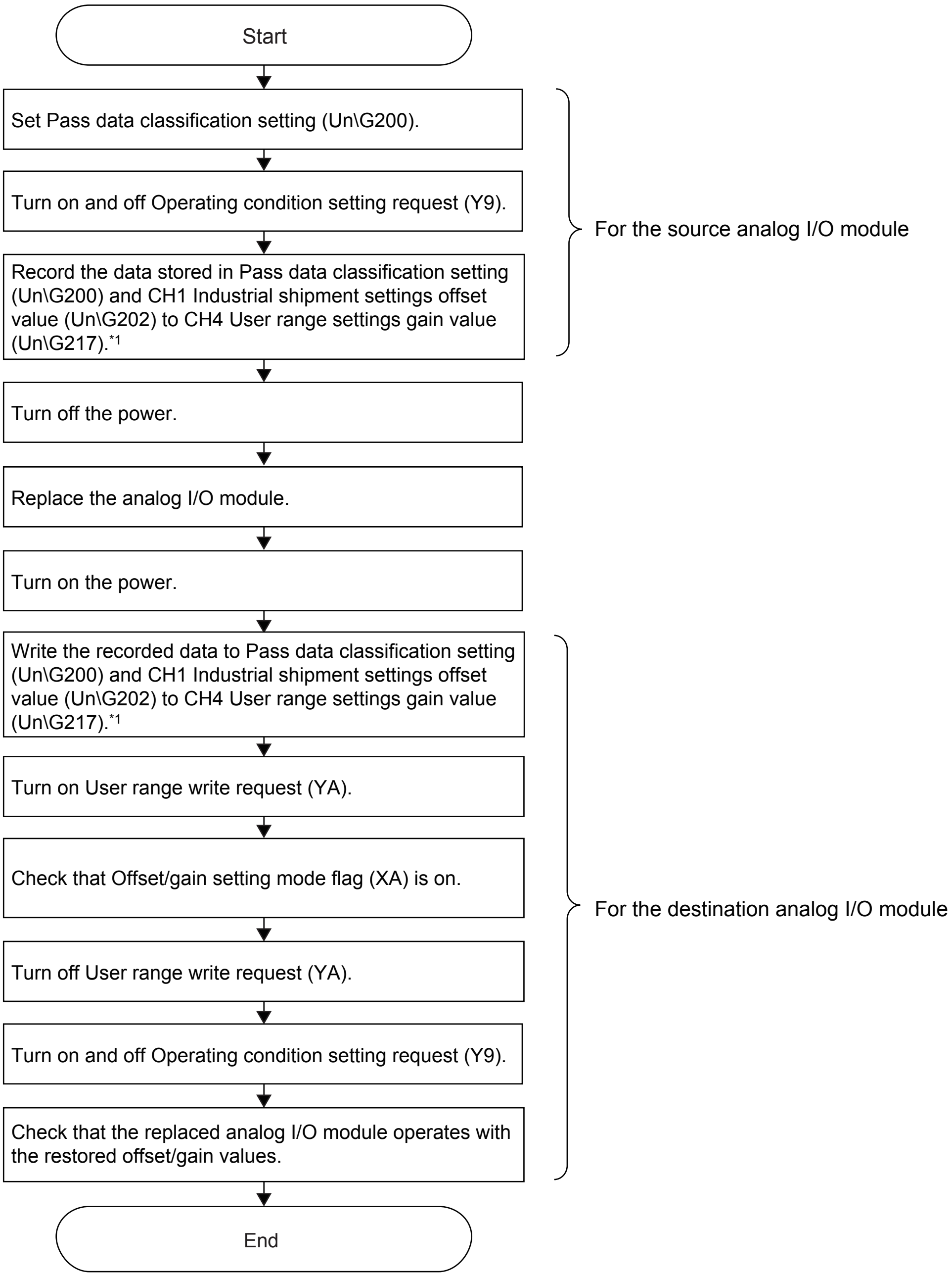
When the dedicated instruction G(P).OGSTOR is executed, the A/D conversion and D/A conversion stop.
Turning on and off Operating condition setting request (Y9) resumes the A/D conversion and D/A conversion.

(b) Saving and restoring by reading from and writing to the buffer memory

Use Pass data classification setting (Un\G200), CH1 Industrial shipment settings offset value (Un\G202) to CH4 User range settings gain value (Un\G217), and User range write request (YA). Read the offset/gain values from the source analog I/O module, then use the buffer memory again to write the values to the destination analog I/O module.

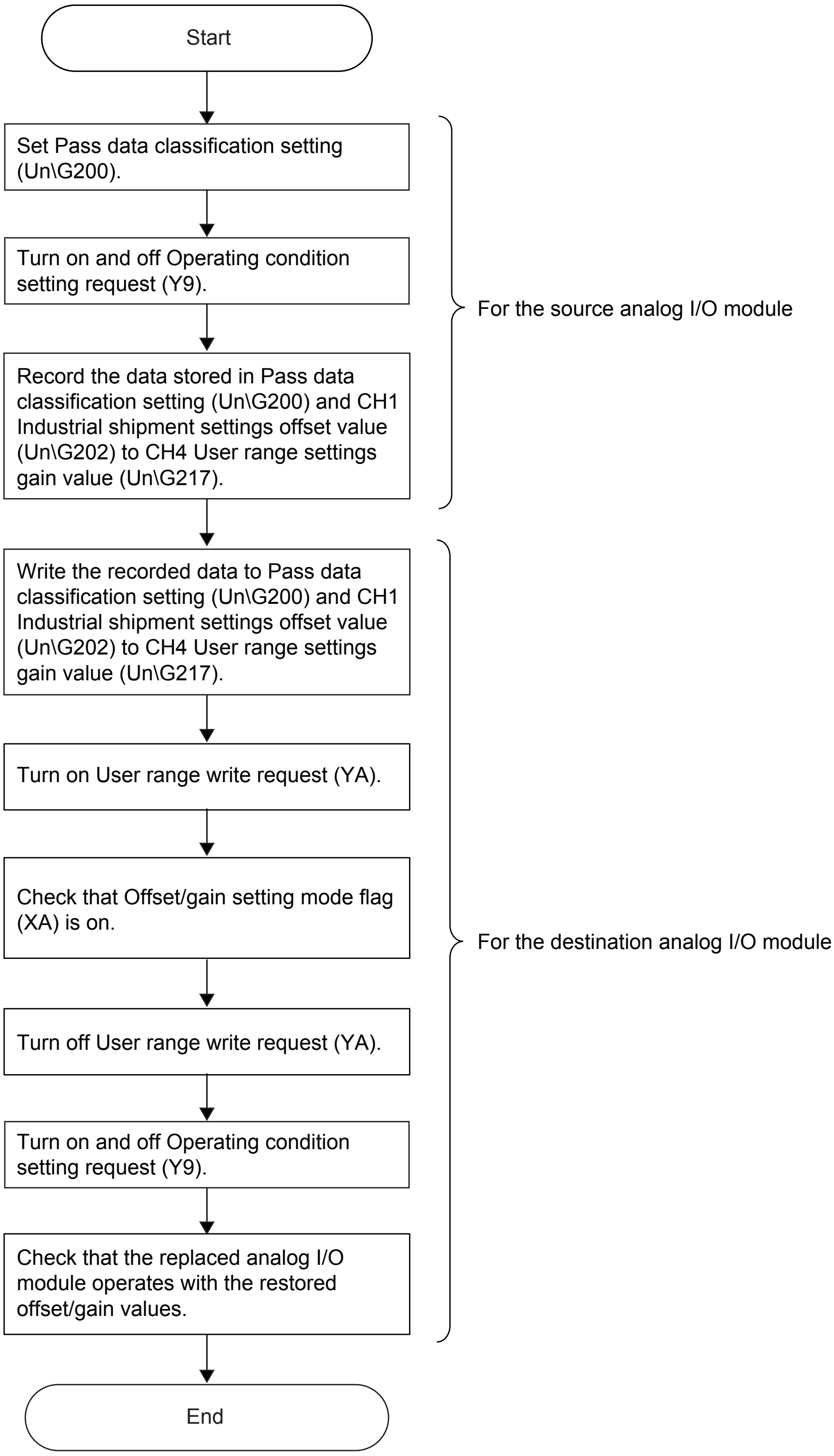
The following describes the procedure for using the buffer memory.

- To restore offset/gain values onto a new replaced module:



*1 When replacing the module, perform one of the following operations before turning off the power to prevent the loss of saved offset/gain value data.
- Use latch settings for the internal device of the destination module.
- Store the saved data on an SD memory card.
  To write data: Use the SP.FWRITE instruction.
  To read data: Use the SP.FREAD instruction.
- Record the saved data.

- To apply the offset/gain values set in one module to the other modules



Point

When the data is written to the following buffer memory addresses of the destination analog I/O module and User range write request (YA) is turned on, the A/D conversion and D/A conversion stop.

- Pass data classification setting (Un\G200)
- CH1 Industrial shipment settings offset value (Un\G202) to CH4 User range settings gain value (Un\G217)

Turning on and off Operating condition setting request (Y9) resumes the A/D conversion and D/A conversion.

(3) Range reference table

The following describes the range reference table to be used for saving and restoring offset/gain values.

(a) Reference table for CH1 Industrial shipment settings offset value (Un\G202) to CH4 Industrial shipment settings gain value (Un\G209)

The reference values differ depending on the setting of Pass data classification setting (Un\G200) (voltage or current).

Description		Pass data classification setting	Reference value (hexadecimal)
A/D conversion (CH1, CH2)	Industrial shipment settings offset value	Voltage	Approx. 7FFFH
		Current	Approx. 7FFFH
	Industrial shipment settings gain value	Voltage	Approx. FA17H
		Current	Approx. BD0BH
D/A conversion (CH3, CH4)	Industrial shipment settings offset value	Voltage	Approx. 7FBEH
		Current	Approx. 7FBEH
	Industrial shipment settings gain value	Voltage	Approx. FA56H
		Current	Approx. F063H

(b) Reference table for CH1 User range settings offset value (Un\G210) to CH4 User range settings gain value (Un\G217)

- A/D conversion (CH1, CH2)

Offset/gain value		Reference value (hexadecimal)
Voltage	0V	Approx. 7FFFH
	1V	Approx. 8C35H
	5V	Approx. BD0BH
	10V	Approx. FA17H
Current	0mA	Approx. 7FFFH
	4mA*1	Approx. 8C35H
	20mA*2	Approx. BD0BH

*1 This is the value that is stored in User range settings offset value by default.
*2 This is the value that is stored in User range settings gain value by default.

- D/A conversion (CH3, CH4)

Offset/gain value		Reference value (hexadecimal)
Voltage	0V	Approx. 7FBEH
	1V	Approx. 8C00H
	5V	Approx. BD0AH
	10V	Approx. FA56H
Current	0mA	Approx. 7FBEH
	4mA*1	Approx. 9645H
	20mA*2	Approx. F063H

*1 This is the value that is stored in User range settings offset value by default.
*2 This is the value that is stored in User range settings gain value by default.

CHAPTER 9 DISPLAY UNIT

This chapter describes the functions of the display unit that can be used with the analog I/O module.
For instruction on operating the display unit, or for details on the functions and menu configuration, refer to the following.
📖 MELSEC-L CPU Module User's Manual (Function Explanation, Program Fundamentals)

9.1 Display Unit

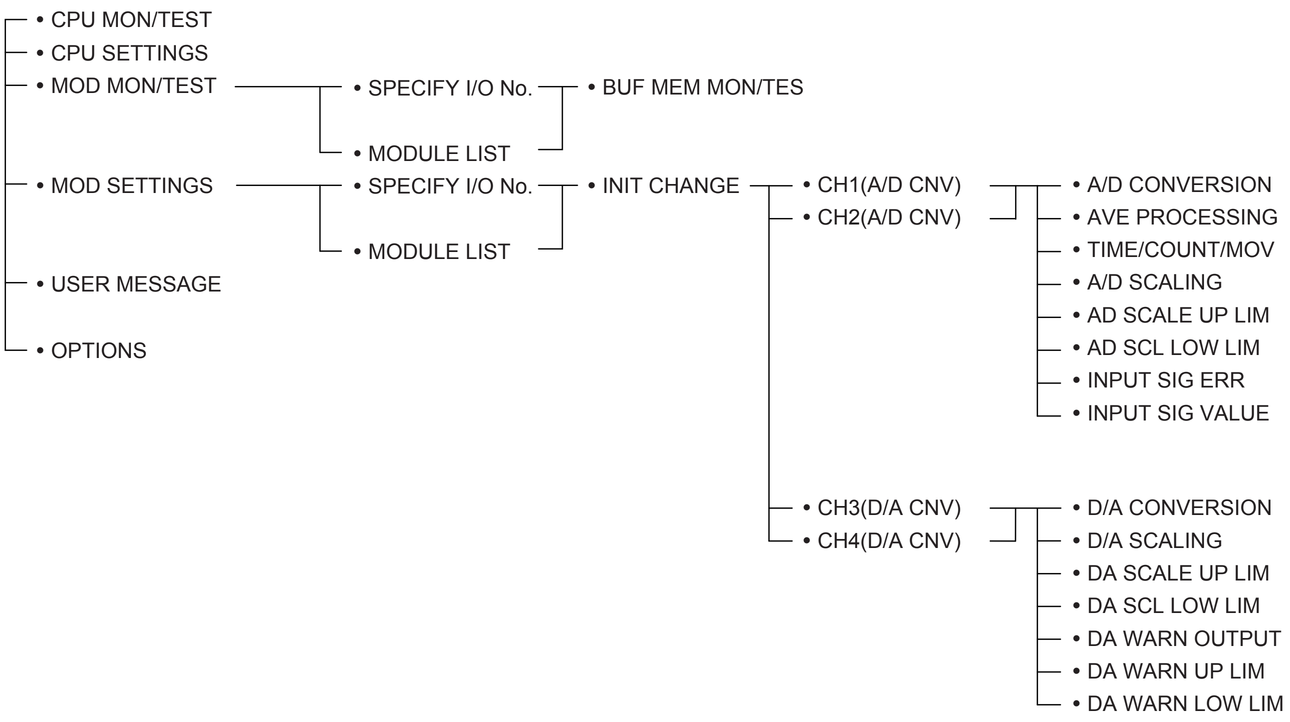
The display unit is an LCD attachable to the CPU module. By attaching it to the CPU module, the status of the system can be checked and the system settings can be changed without the software package.
In addition, if a problem occurs, the cause of the problem can be identified by displaying the error information.
For details on how to check and clear an error from the display unit, refer to the following.

- Checking and Clearing Errors (☞ Page 288, Section 9.4)

9.2 Menu Transition

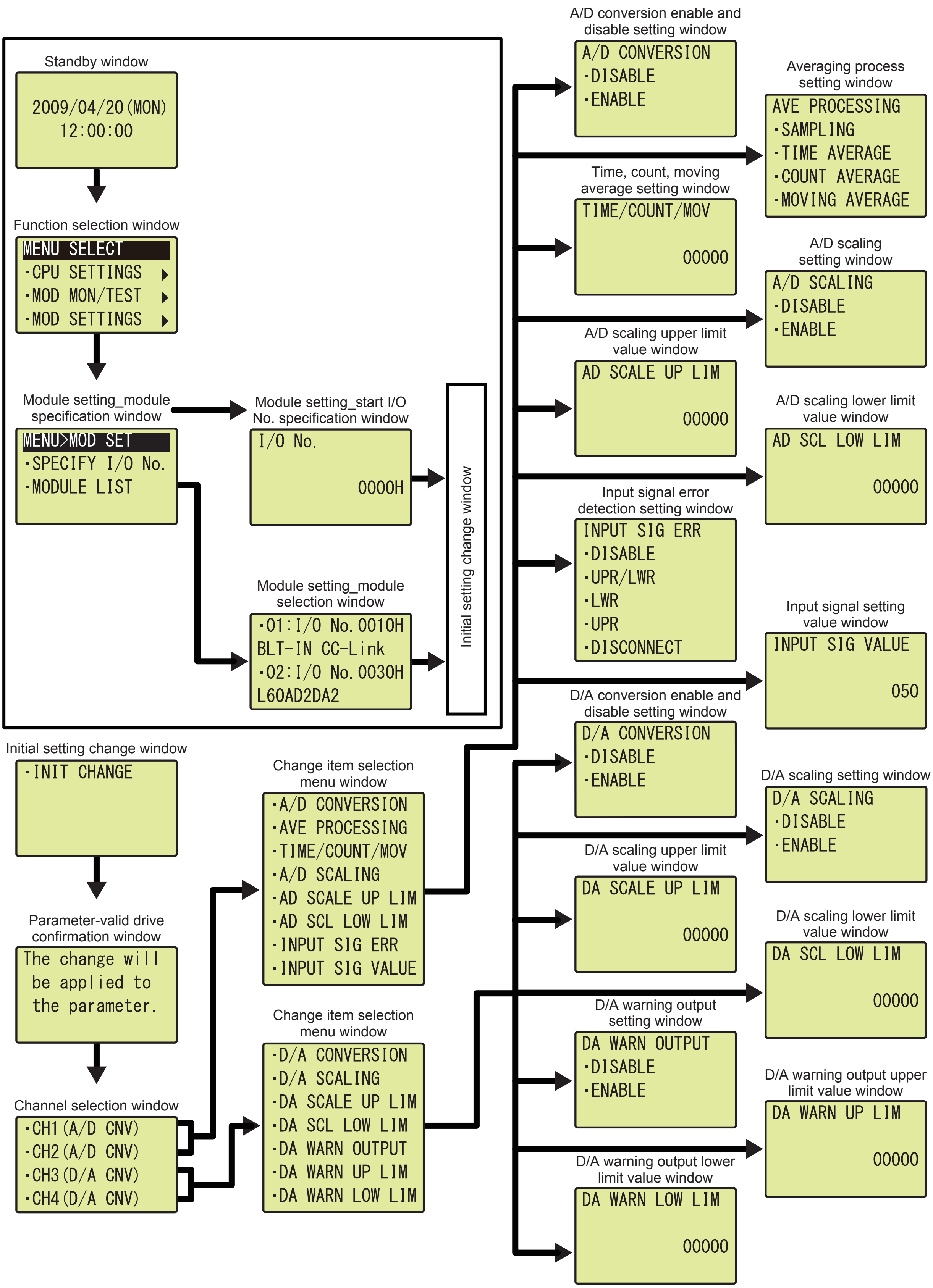
(1) Organization

The following diagram shows how the "MOD MON/TEST" and "MOD SETTINGS" menus are organized.



(2) Window transitions up to the initial setting change window

The following diagram shows how the windows transition to the initial setting change window.



9.3 List of Setting Value Change Windows

The following table lists the setting value change windows.

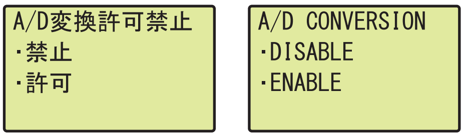
(1) Displayed in English:

Name		Window format	Input limits	
Setting item	Window display		Upper limit	Lower limit
A/D conversion enable/disable setting	A/D CONVERSION	Selection	—	—
Averaging process setting	AVE PROCESSING	Selection	—	—
Time Average/ Count Average/ Moving Average	TIME/COUNT/MOV	Numeric	62500	0
A/D conversion scaling enable/disable setting	A/D SCALING	Selection	—	—
A/D conversion scaling upper limit value	AD SCALE UP LIM	Numeric	32000	-32000
A/D conversion scaling lower limit value	AD SCL LOW LIM	Numeric	32000	-32000
Input signal error detection setting	INPUT SIG ERR	Selection	—	—
Input signal error detection setting value	INPUT SIG VALUE	Numeric	250	0
D/A conversion enable/disable setting	D/A CONVERSION	Selection	—	—
D/A conversion scaling enable/disable setting	D/A SCALING	Selection	—	—
D/A conversion scaling upper limit value	DA SCALE UP LIM	Numeric	32000	-32000
D/A conversion scaling lower limit value	DA SCL LOW LIM	Numeric	32000	-32000
Warning output setting	DA WARN OUTPUT	Selection	—	—
Warning output upper limit value	DA WARN UP LIM	Numeric	32767	-32768
Warning output lower limit value	DA WARN LOW LIM	Numeric	32767	-32768

(2) A/D conversion enable/disable setting

Select "DISABLE" or "ENABLE" in the "A/D CONVERSION" window.

"A/D CONVERSION" window



1. **Use the ▲ and ▼ buttons to select "DISABLE" or "ENABLE", and confirm with the OK button.**

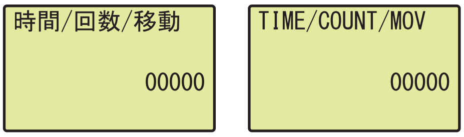
(3) Averaging process setting

In the "AVE PROCESSING" window, select whether to perform sampling processing or averaging processing (time average, count average, moving average).

"AVE PROCESSING" window

↓

"TIME/COUNT/MOV" window



1. **Use the ▲ and ▼ buttons to select "SAMPLING", "TIME AVERAGE", "COUNT AVERAGE", or "MOVING AVERAGE", and confirm with the OK button. (When a value other than "SAMPLING" is selected, follow the procedure 2.)**

2. **Move the cursor using the ◀ and ▶ buttons. Then increment or decrement the value at the cursor using the ▲ or ▼ buttons. Confirm with the OK button.**

Table of input items

Input item	Input range	
	Input upper limit	Input lower limit
TIME	5000	2
COUNT	62500	4
MOV	1000	2

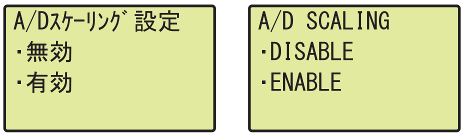
Point

A value between 0 and 62500 can be input for any type of averaging processing on the display unit. However, if the value is outside the setting range of the selected averaging processing, an error occurs on the analog I/O module.

(4) A/D scaling setting

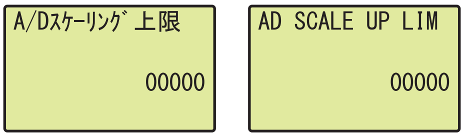
Select "DISABLE" or "ENABLE" in the "A/D SCALING" window.

"A/D SCALING" window



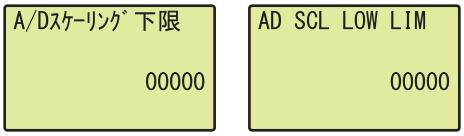
↓

"AD SCALE UP LIM" window



↓

"AD SCL LOW LIM" window



1. **Use the ▲ and ▼ buttons to select "DISABLE" or "ENABLE", and confirm with the OK button. (When "ENABLE" is selected, follow the rest of the procedure.)**

2. **Move the cursor using the ◀ and ▶ buttons. Then increment or decrement the value at the cursor using the ▲ or ▼ buttons. Confirm with the OK button.**

3. **Move the cursor using the ◀ and ▶ buttons. Then increment or decrement the value at the cursor using the ▲ or ▼ buttons. Confirm with the OK button.**

Table of input items

Input item	Input range	
	Input upper limit	Input lower limit
AD SCALE UP LIM	32000	-32000
AD SCL LOW LIM		

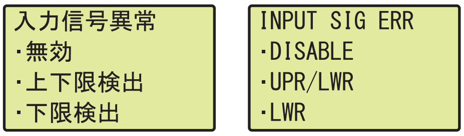
Point

Set the different values for "AD SCALE UP LIM" and "AD SCL LOW LIM".
Even though the same value can be input for "AD SCALE UP LIM" and "AD SCL LOW LIM" on the display unit, an error occurs on the analog I/O module.

(5) Input signal error detection setting

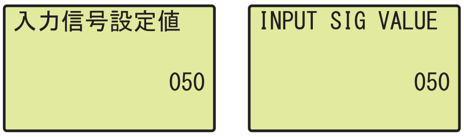
Select a detection method in the "INPUT SIG ERR" window.

"INPUT SIG ERR" window



↓

"INPUT SIG VALUE" window



1. **Use the ▲ and ▼ buttons to select the detection method from the following, and confirm with the OK button.**

- DISABLE
- UPR/LWR
- LWR
- UPR
- DISCONNECT

(When "UPR/LWR", "LWR", or "UPR" is selected, follow the procedure 2.)

2. **Move the cursor using the ◀ and ▶ buttons. Then increment or decrement the value at the cursor using the ▲ or ▼ buttons. Confirm with the OK button.**

Table of input items

Input item	Input range	
	Input upper limit	Input lower limit
INPUT SIG VALUE	250	0

(6) D/A conversion enable/disable setting

Select "DISABLE" or "ENABLE" in the "D/A CONVERSION" window.

"D/A CONVERSION" window

```
D/A変換許可禁止
・禁止
・許可
```

```
D/A CONVERSION
・DISABLE
・ENABLE
```

1. **Use the ▲ and ▼ buttons to select "DISABLE" or "ENABLE", and confirm with the OK button.**

(7) D/A scaling setting

Select "DISABLE" or "ENABLE" in the "D/A SCALING" window.

"D/A SCALING" window

```
D/Aｽｹｰﾘﾝｸﾞ設定
・無効
・有効
```

```
D/A SCALING
・DISABLE
・ENABLE
```

↓

"DA SCALE UP LIM" window

```
D/Aｽｹｰﾘﾝｸﾞ上限
          00000
```

```
DA SCALE UP LIM
          00000
```

↓

"DA SCL LOW LIM" window

```
D/Aｽｹｰﾘﾝｸﾞ下限
          00000
```

```
DA SCL LOW LIM
          00000
```

1. **Use the ▲ and ▼ buttons to select "DISABLE" or "ENABLE", and confirm with the OK button. (When "ENABLE" is selected, follow the rest of the procedure.)**

2. **Move the cursor using the ◀ and ▶ buttons. Then increment or decrement the value at the cursor using the ▲ or ▼ buttons. Confirm with the OK button.**

3. **Move the cursor using the ◀ and ▶ buttons. Then increment or decrement the value at the cursor using the ▲ or ▼ buttons. Confirm with the OK button.**

Table of input items

Input item	Input range	
	Input upper limit	Input lower limit
DA SCALE UP LIM	32000	-32000
DA SCL LOW LIM		

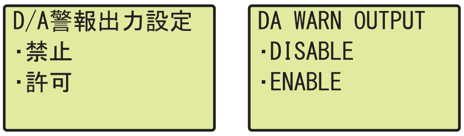
Point

Set the different values for "DA SCALE UP LIM" and "DA SCL LOW LIM".
Even though the same value can be input for "DA SCALE UP LIM" and "DA SCL LOW LIM" on the display unit, an error occurs on the analog I/O module.

(8) Warning output setting

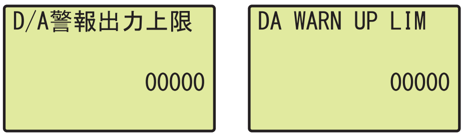
Select "DISABLE" or "ENABLE" in the "DA WARN OUTPUT" window.

"DA WARN OUTPUT" window



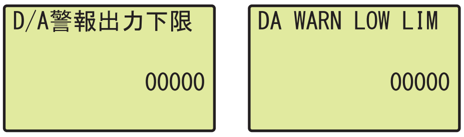
↓

"DA WARN UP LIM" window



↓

"DA WARN LOW LIM" window



1. **Use the ▲ and ▼ buttons to select "DISABLE" or "ENABLE", and confirm with the OK button. (When "ENABLE" is selected, follow the rest of the procedure.)**

2. **Move the cursor using the ◀ and ▶ buttons. Then increment or decrement the value at the cursor using the ▲ or ▼ buttons. Confirm with the OK button.**

3. **Move the cursor using the ◀ and ▶ buttons. Then increment or decrement the value at the cursor using the ▲ or ▼ buttons. Confirm with the OK button.**

Table of input items

Input item	Input range	
	Input upper limit	Input lower limit
DA WARN UP LIM	32767	-32768
DA WARN LOW LIM		

Point

Set the values so that DA WARN UP LIM is greater than DA WARN LOW LIM.
Even though the value satisfying the condition where "DA WARN UP LIM" is equal to or smaller than "DA WARN LOW LIM" can be input on the display unit, an error occurs on the analog I/O module.

9.4 Checking and Clearing Errors

The errors that occurred in the analog I/O module can be checked from the display unit. In addition, the existing error can be cleared.

(1) Checking errors

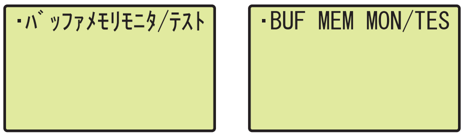
The error that occurred in the analog I/O module can be checked by specifying Latest error code (Un\G19) from "BUF MEM MON/TES".

For details on the error codes or alarm codes, refer to the following.

- Error Code List (☞ Page 315, Section 11.4)
- Alarm Code List (☞ Page 324, Section 11.5)

Ex. When an error has occurred in the analog I/O module with start I/O number 10

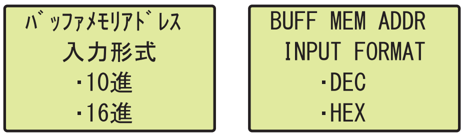
"BUF MEM MON/TES" window



1. **Press the OK button.**

↓

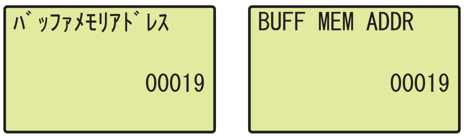
"BUFF MEM ADDR INPUT FORMAT" window



2. **Use the ▲ and ▼ buttons to select "DEC" for the input format of the buffer memory address, and confirm with the OK button.**

↓

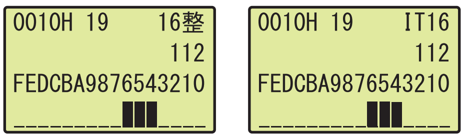
"BUFF MEM ADDR" window



3. **Move the cursor using the ◀ and ▶ buttons. Then increment or decrement the value at the cursor using the ▲ and ▼ buttons, and set the value to 19. Confirm with the OK button.**

↓

"Buffer memory monitor" window



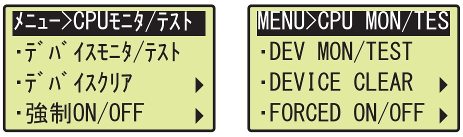
4. **The error that occurred can be checked in the "Buffer memory monitor" window.**

(2) Clearing errors

An error can be cleared by eliminating the cause of the error, and turning on and off Error clear request (YF) from "DEV MON/TEST".

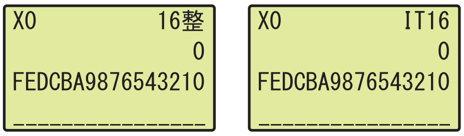
Ex. When an error has occurred in the analog I/O module with start I/O number 10

"CPU MON/TES" window



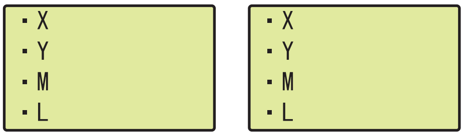
1. **Use the ▲ and ▼ buttons to select "DEV MON/TEST", and confirm with the OK button.**

Device monitor window



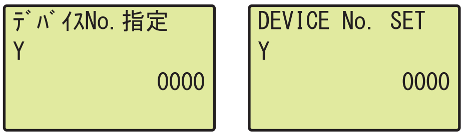
2. **Press the ◀ button.**

Device selection window



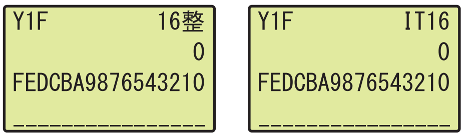
3. **Use the ▲ and ▼ buttons to set the device to Y, and confirm with the OK button.**

"DEVICE No. SET" window



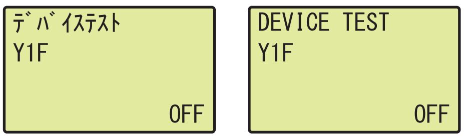
4. **Set the device to Error clear request (Y1F) and press the OK button.**

Device monitor window

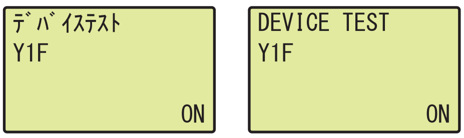


5. **Press the OK button.**

"DEVICE TEST" window



6. **Press the OK button.**



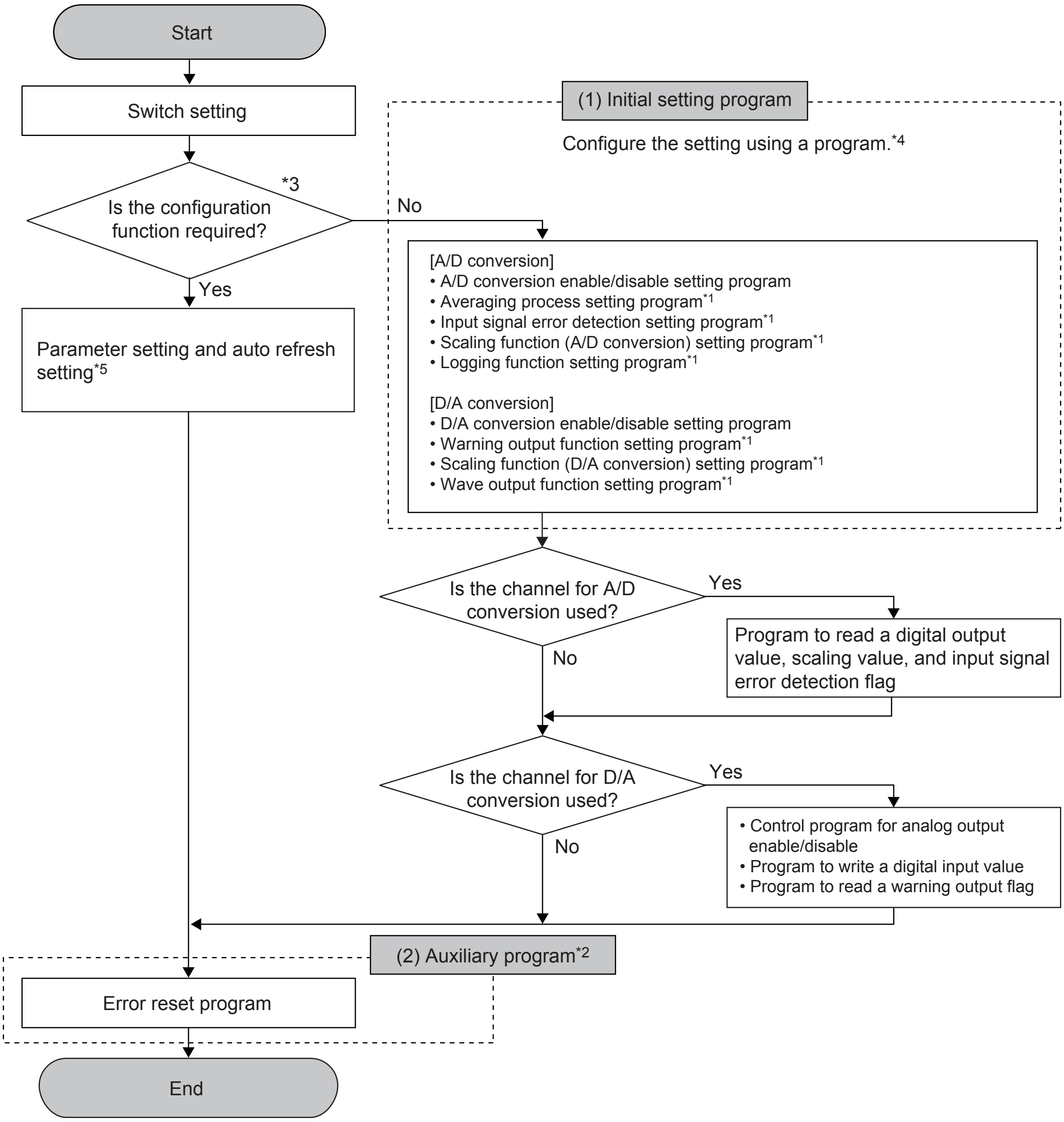
7. **Use the ▲ and ▼ buttons to switch on, and confirm with the OK button.**

CHAPTER 10 PROGRAMMING

This chapter describes the procedure for programming and the basic program of analog I/O module.

10.1 Procedure for Programming

Create a program to execute the analog I/O module according to the following procedure.



*1 A program which is created according to the used function.

*2 A program which is added according to the control target. Create it as needed.

*3 When the wave output function is used, setting "D/A conversion enable/disable setting" to "0: Enable" in the parameter setting of the configuration function causes an error at the start-up of the analog I/O module. Then, the error code (307□) is stored to Latest error code (Un\G19). This error occurs because the wave pattern data points setting is set to 0 (default value) for the channel where D/A conversion enable is set.
To prevent the error, set D/A conversion enable by the procedure described in the following section.
- Basic setting (☞ Page 167, Section 8.18.1 (4) (b))

*4 ☞ Page 292, Section 10.2

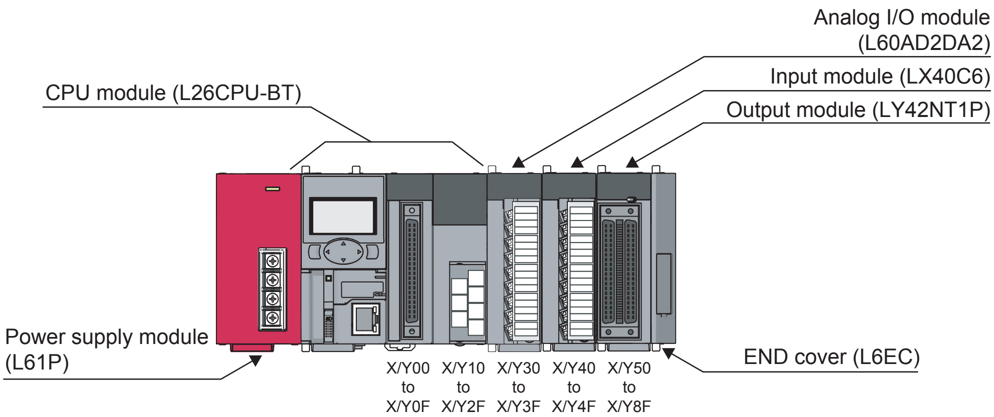
*5 ☞ Page 292, Section 10.2

10.2 When Using the Module in a Standard System Configuration

This section shows a program example where the following system configuration and conditions apply.

(1) System configuration

The following shows a system configuration example.



(2) Programming condition

[A/D conversion]

- This program sets A/D conversion enable for CH1 and CH2 and reads digital output values.
- This program performs the sampling processing to CH1 and the averaging processing every 50 times to CH2 for the A/D conversion.
- This program performs the input/output signal error detection for CH1.

[D/A conversion]

- This program sets D/A conversion enable for CH3 and CH4 and writes digital input values.
- This program configures the scaling setting for CH3 and the warning output setting for CH4.

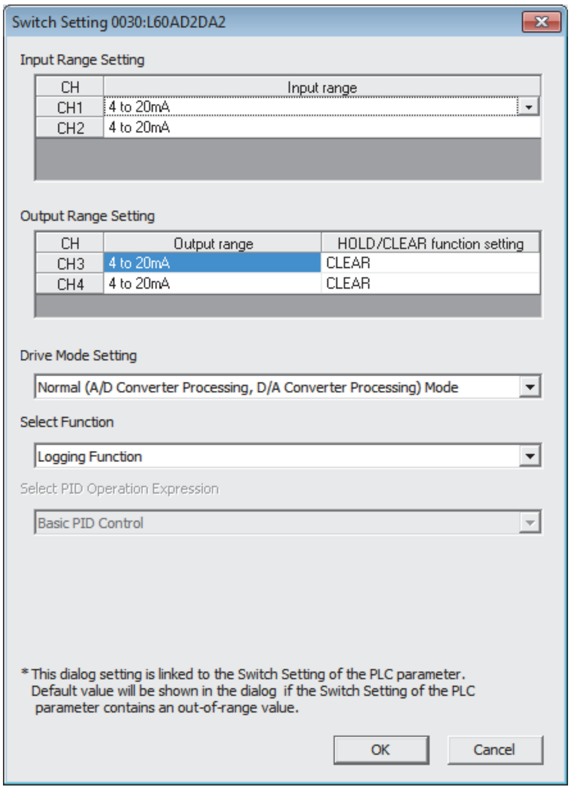
[Common]

- If an error occurs in the analog I/O module, an error code is indicated in BCD (external output from the LY42NT1P).

(3) Switch setting

Set the input range, output range, HOLD/CLEAR function, Drive Mode, and Select Function.

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Switch Setting]



(4) Initial setting

(a) Channel setting (A/D conversion part)

Setting item	CH1	CH2
Basic setting		
A/D conversion enable/disable setting	0: Enable	0: Enable
Averaging process setting	0: Sampling Processing	2: Count Average
Time Average/Count Average/Moving Average	0	50 Times
Input signal error detection		
Input signal error detection setting	1: Upper and Lower Detection	0: Disable
Input signal error detection setting value	10.0%	5.0%
Scaling function (A/D conversion)		
A/D conversion scaling enable/disable setting	1: Disable	1: Disable
A/D conversion scaling upper limit value	0	0
A/D conversion scaling lower limit value	0	0
Logging function		
Logging enable/disable setting	1: Disable	1: Disable
Logging data setting	1: Scaling Value	1: Scaling Value
Logging cycle setting value	4ms	4ms
Logging cycle unit setting	1: ms	1: ms
Logging points after trigger	5000	5000
Level trigger condition setting	0: Disable	0: Disable
Trigger data	54	55
Trigger setting value	0	0

(b) Channel setting (D/A conversion part)

Setting item	CH3	CH4
Basic setting		
D/A conversion enable/disable setting	0: Enable	0: Enable
Warning output function		
Warning output setting	1: Disable	0: Enable
Warning output upper limit value	0	10000
Warning output lower limit value	0	3000
Scaling function (D/A conversion)		
D/A conversion scaling enable/disable setting	0: Enable	1: Disable
D/A conversion scaling upper limit value	32000	0
D/A conversion scaling lower limit value	0	0

(c) Device for user

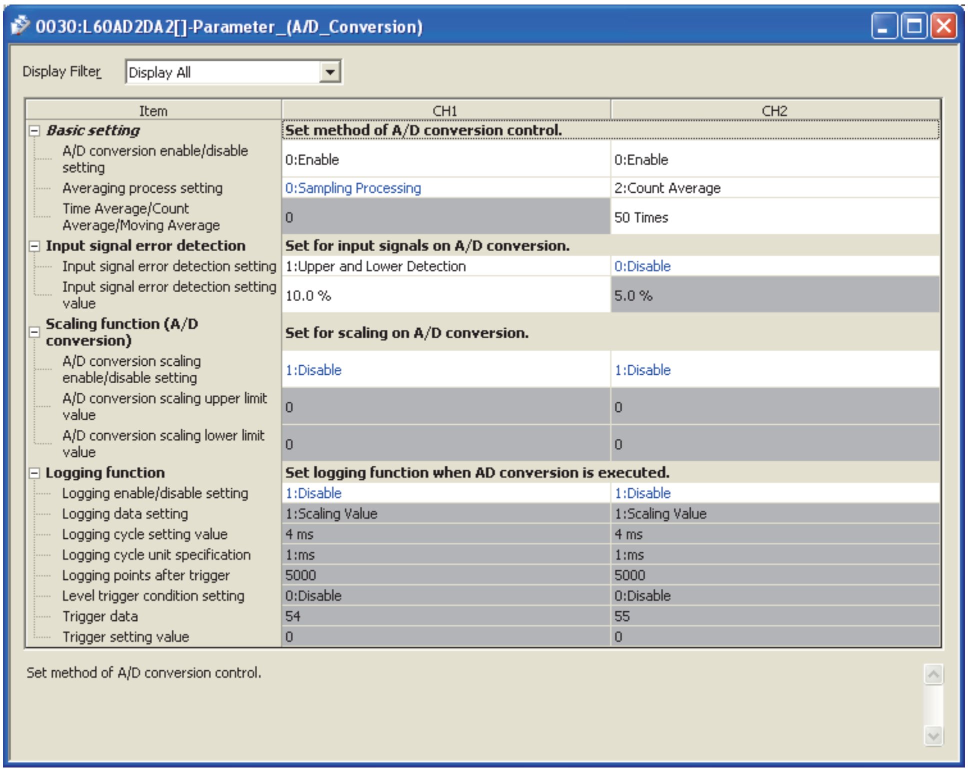
Device	Description	
D1(D11)	CH1 Digital output value	
D2(D12)	CH2 Digital output value	
D3	CH3 Digital input value	
D4	CH4 Digital input value	
D7	Warning output flag	
D8	Input signal error detection flag	
D10	Error code	
M0	CH1 A/D conversion completed flag	
M1	CH2 A/D conversion completed flag	
M20 to M27	Warning output flag	
M50 to M53	Input signal error detection flag	
M100	Module READY checking flag	
X40	Digital output value read command input signal	LX40C6 (X40 to X4F)
X41	Batch output enable signal	
X42	Digital input value write command input signal	
X43	Input signal error detection reset signal	
X44	Warning output reset signal	
X45	Error reset signal	
Y50 to Y5F	Error code notation (BCD 4 digits)	LY42NT1P (Y50 to Y5F)

(5) Program example for using the parameter of the intelligent function module

(a) Parameter setting (A/D conversion part)

Configure the initial settings in the parameter.

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(A/D_Conversion)]


0030:L60AD2DA2[]-Parameter_(A/D_Conversion)

Display Filter: Display All

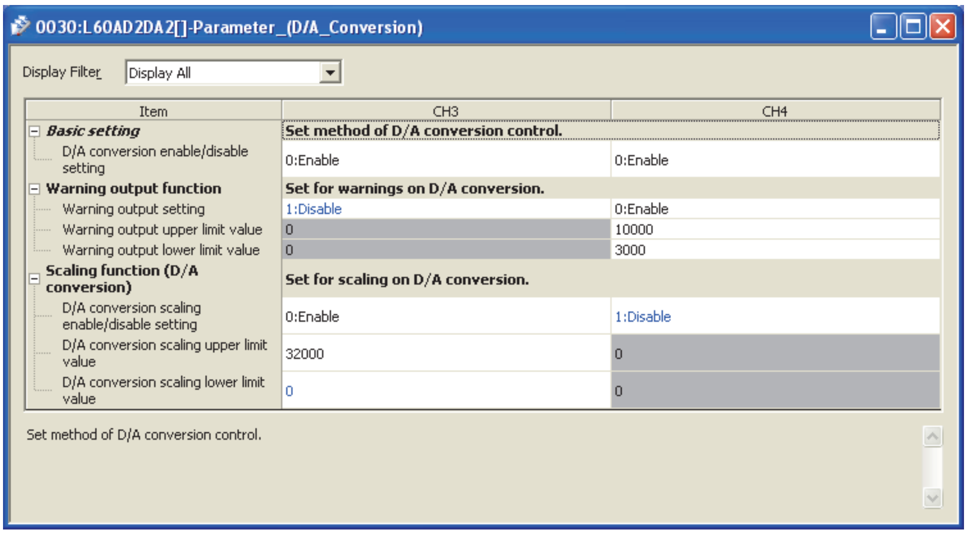
Item	CH1	CH2
Basic setting	**Set method of A/D conversion control.**	
A/D conversion enable/disable setting	0:Enable	0:Enable
Averaging process setting	0:Sampling Processing	2:Count Average
Time Average/Count Average/Moving Average	0	50 Times
Input signal error detection	**Set for input signals on A/D conversion.**	
Input signal error detection setting	1:Upper and Lower Detection	0:Disable
Input signal error detection setting value	10.0 %	5.0 %
Scaling function (A/D conversion)	**Set for scaling on A/D conversion.**	
A/D conversion scaling enable/disable setting	1:Disable	1:Disable
A/D conversion scaling upper limit value	0	0
A/D conversion scaling lower limit value	0	0
Logging function	**Set logging function when AD conversion is executed.**	
Logging enable/disable setting	1:Disable	1:Disable
Logging data setting	1:Scaling Value	1:Scaling Value
Logging cycle setting value	4 ms	4 ms
Logging cycle unit specification	1:ms	1:ms
Logging points after trigger	5000	5000
Level trigger condition setting	0:Disable	0:Disable
Trigger data	54	55
Trigger setting value	0	0

Set method of A/D conversion control.

(b) Parameter setting (D/A conversion part)

Configure the initial settings in the parameter.

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(D/A_Conversion)]


0030:L60AD2DA2[]-Parameter_(D/A_Conversion)

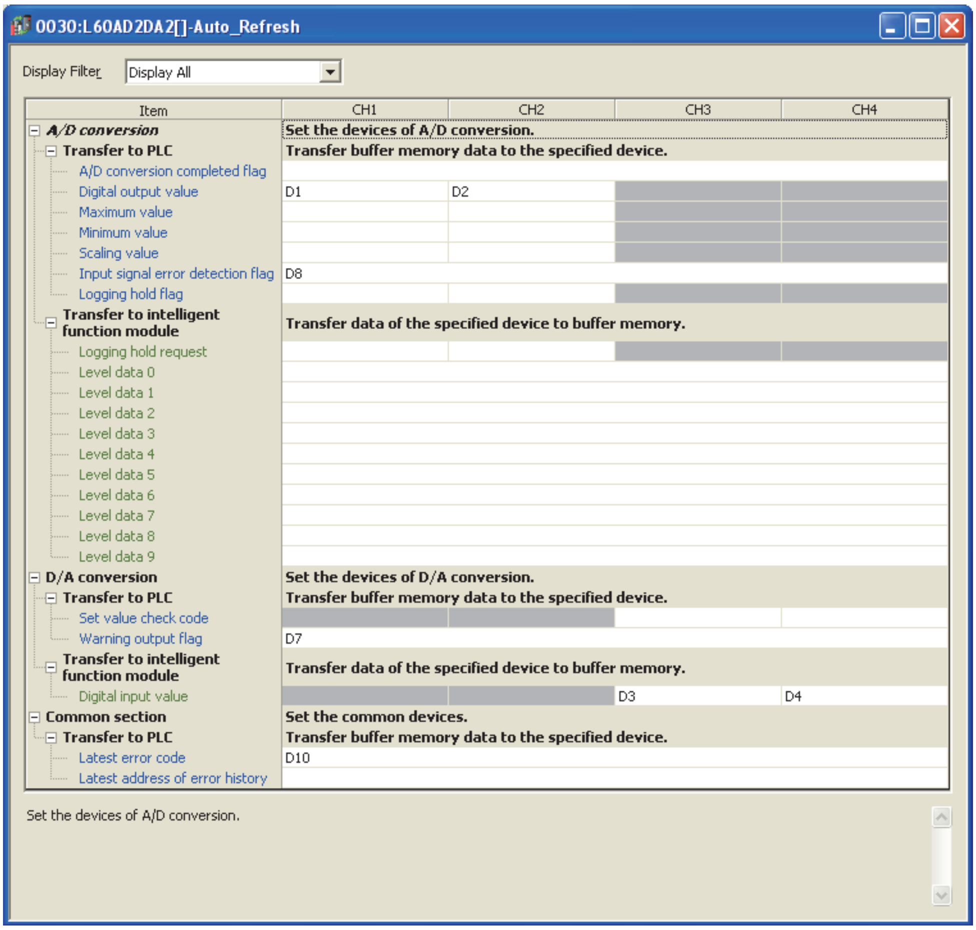
Display Filter: Display All

Item	CH3	CH4
Basic setting	**Set method of D/A conversion control.**	
D/A conversion enable/disable setting	0:Enable	0:Enable
Warning output function	**Set for warnings on D/A conversion.**	
Warning output setting	1:Disable	0:Enable
Warning output upper limit value	0	10000
Warning output lower limit value	0	3000
Scaling function (D/A conversion)	**Set for scaling on D/A conversion.**	
D/A conversion scaling enable/disable setting	0:Enable	1:Disable
D/A conversion scaling upper limit value	32000	0
D/A conversion scaling lower limit value	0	0

Set method of D/A conversion control.

(c) Auto Refresh setting

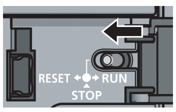
Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Auto_Refresh]



(d) Writing the parameter of the intelligent function module

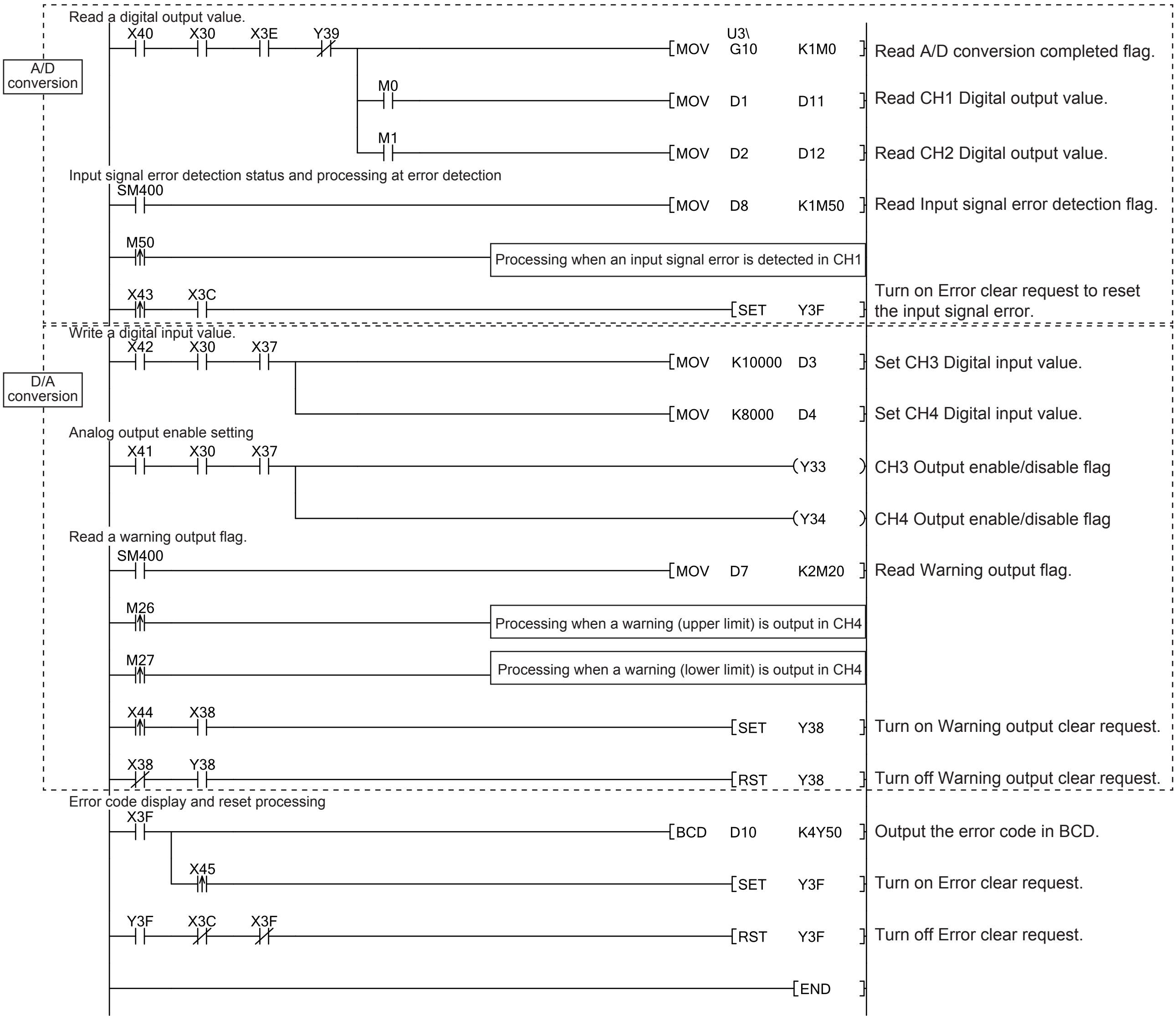
Write the set parameter to the CPU module and reset the CPU module, or power off and on the programmable controllers.

[Online] ⇨ [Write to PLC]

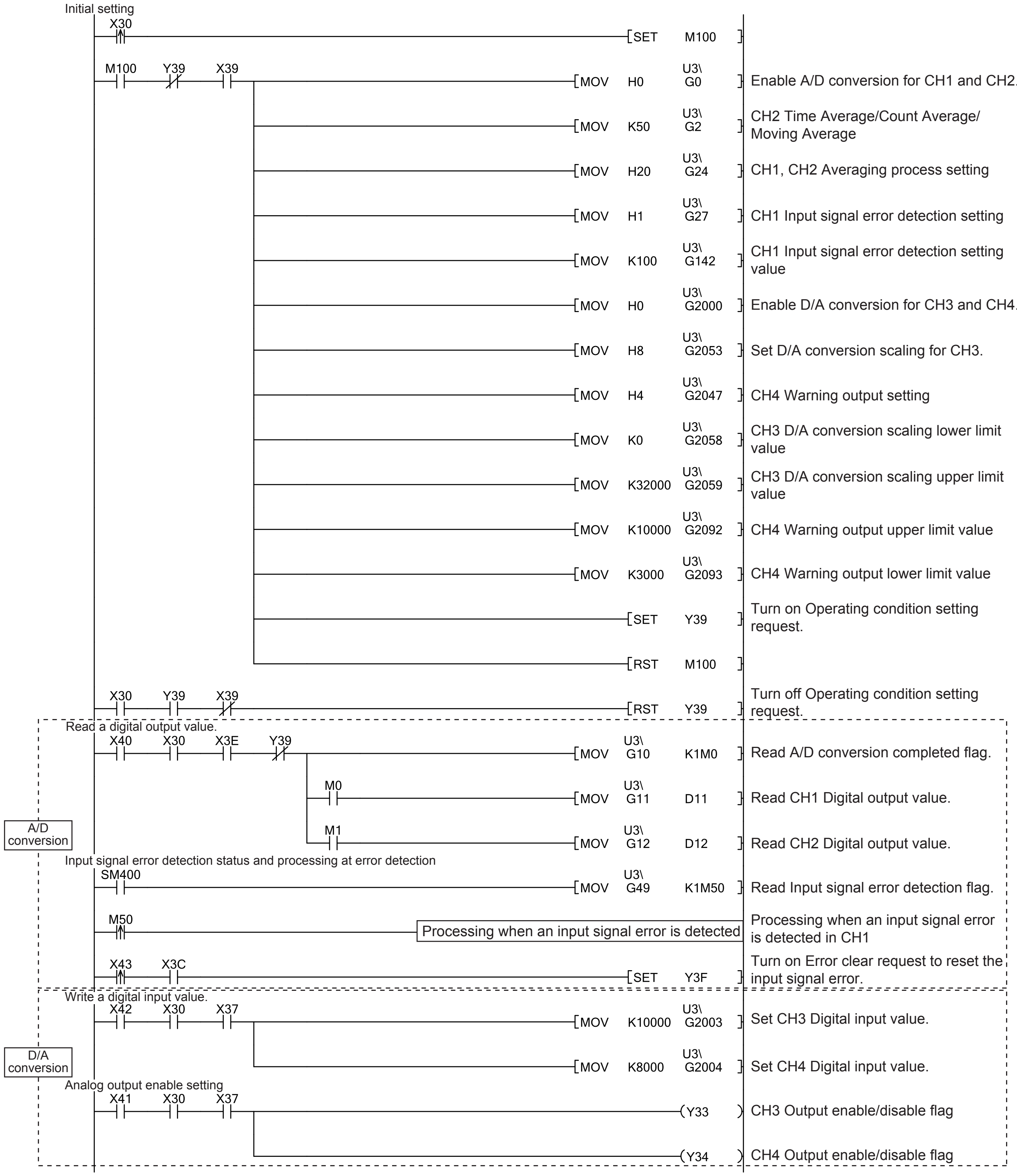


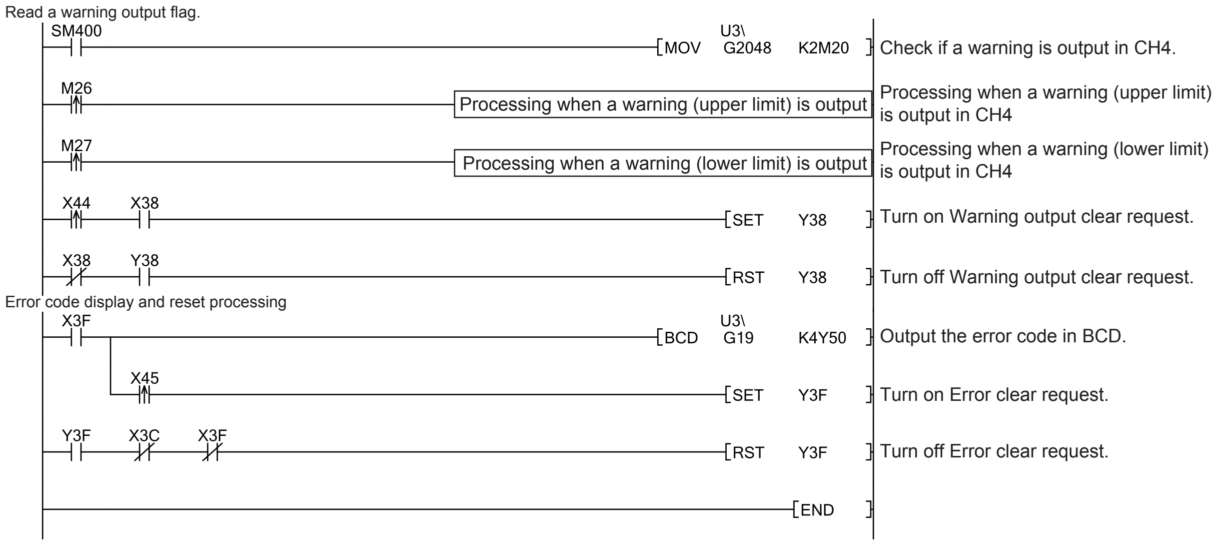
or Power OFF → ON

(e) Program example



(6) Program example for not using the parameter of the intelligent function module

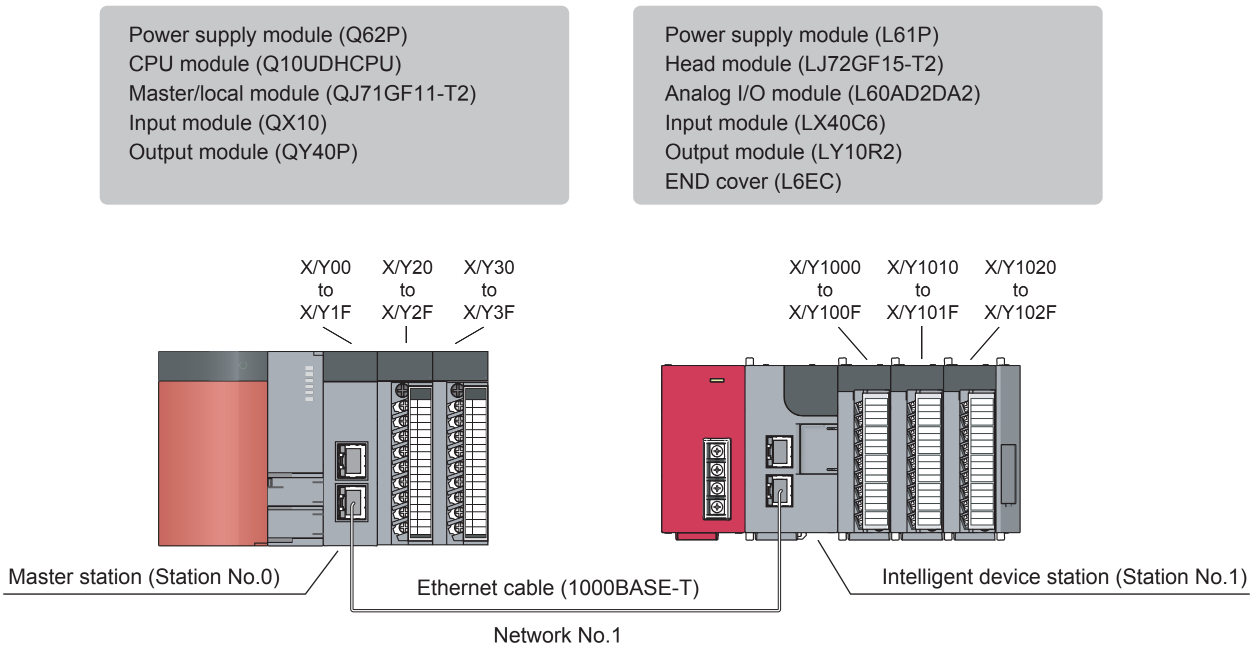



Read a warning output flag.
SM400
MOV U3\ G2048 K2M20
Check if a warning is output in CH4.
M26
Processing when a warning (upper limit) is output
Processing when a warning (upper limit) is output in CH4
M27
Processing when a warning (lower limit) is output
Processing when a warning (lower limit) is output in CH4
X44 X38
SET Y38
Turn on Warning output clear request.
X38 Y38
RST Y38
Turn off Warning output clear request.
Error code display and reset processing
X3F
BCD U3\ G19 K4Y50
Output the error code in BCD.
X45
SET Y3F
Turn on Error clear request.
Y3F X3C X3F
RST Y3F
Turn off Error clear request.
END

10.3 When an Analog I/O Module Is Connected to a Head Module

This section shows the system configuration of the analog I/O module and a program example under the operation condition.

(1) System configuration



(2) Programming condition

[A/D conversion]

- This program sets A/D conversion enable for CH1 and CH2 and reads digital output values.
- This program performs the sampling processing to CH1 and the averaging processing every 50 times to CH2 for the A/D conversion.
- This program performs the input/output signal error detection for CH1.

[D/A conversion]

- This program sets D/A conversion enable for CH3 and CH4 and writes digital input values.
- This program configures the scaling setting for CH3 and the warning output setting for CH4.

[Common]

- If an error occurs in the analog I/O module, an error code is indicated in BCD (external output from the QY40P).

(3) Initial setting

(a) Channel setting (A/D conversion part)

Setting item	CH1	CH2
Basic setting		
A/D conversion enable/disable setting	0: Enable	0: Enable
Averaging process setting	0: Sampling Processing	2: Count Average
Time Average/Count Average/Moving Average	0	50 Times
Input signal error detection		
Input signal error detection setting	1: Upper and Lower Detection	0: Disable
Input signal error detection setting value	10.0%	5.0%
Scaling function (A/D conversion)		
A/D conversion scaling enable/disable setting	1: Disable	1: Disable
A/D conversion scaling upper limit value	0	0
A/D conversion scaling lower limit value	0	0
Logging function		
Logging enable/disable setting	1: Disable	1: Disable
Logging data setting	1: Scaling Value	1: Scaling Value
Logging cycle setting value	4ms	4ms
Logging cycle unit setting	1: ms	1: ms
Logging points after trigger	5000	5000
Level trigger condition setting	0: Disable	0: Disable
Trigger data	54	55
Trigger setting value	0	0

(b) Channel setting (D/A conversion part)

Setting item	CH3	CH4
Basic setting		
D/A conversion enable/disable setting	0: Enable	0: Enable
Warning output function		
Warning output setting	1: Disable	0: Enable
Warning output upper limit value	0	10000
Warning output lower limit value	0	3000
Scaling function (D/A conversion)		
D/A conversion scaling enable/disable setting	0: Enable	1: Disable
D/A conversion scaling upper limit value	32000	0
D/A conversion scaling lower limit value	0	0

(4) Device for user

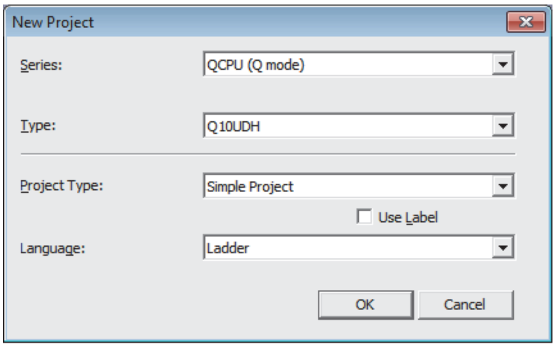
Device	Description	
W3	CH3 Digital input value	
W4	CH4 Digital input value	
W1000	A/D conversion completed flag	
W1001 (D11)	CH1 Digital output value	
W1002 (D12)	CH2 Digital output value	
W1007	Warning output flag	
W1008	Input signal error detection flag	
W1010	Error code	
M0	CH1 A/D conversion completed flag	
M1	CH2 A/D conversion completed flag	
M20 to M27	Warning output flag	
M50 to M53	Input signal error detection flag	
M100	Module READY checking flag	
X20	Digital output value read command input signal	QX10 (X20 to X2F)
X21	Batch output enable signal	
X22	Digital input value write command input signal	
X23	Input signal error detection reset signal	
X24	Warning output reset signal	
X25	Error reset signal	
X26	Initial setting signal	
Y30 to Y3F	Error code notation (BCD 4 digits)	QY40P (Y30 to Y3F)
SB49	Data link status (own station)	
SWB0.0	Data link status (each station) (station No.1)	
N0	Nesting (station No.1)	
M100	Flag for meeting the communication condition (station No.1)	

(5) Setting on the master station

1. Create a project on GX Works2.

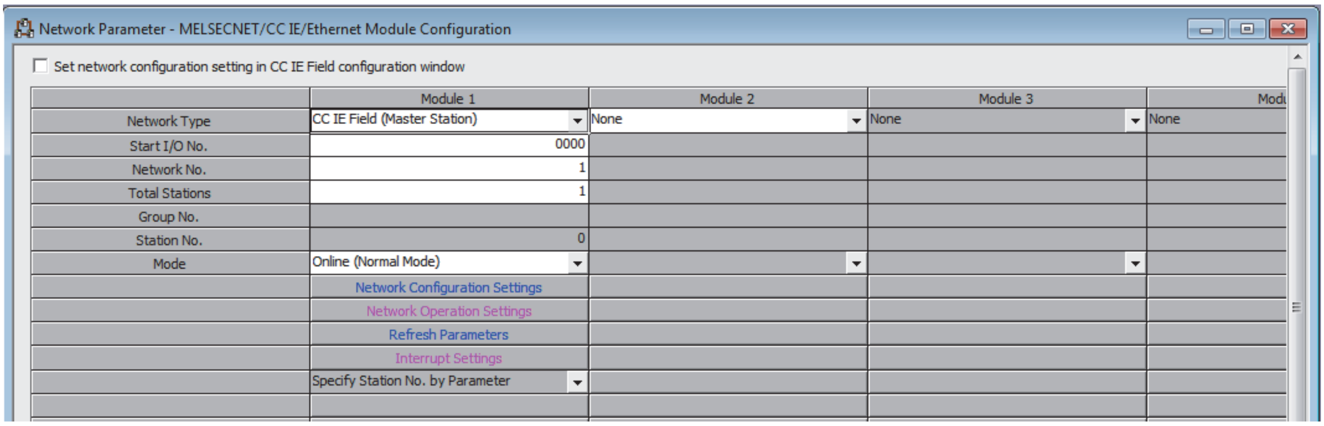
Select "QCPU (Q mode)" for "Series" and select "Q10UDH" for "Type".

[Project] ⇨ [New]



2. Display the Network Parameter window and configure the setting as follows.

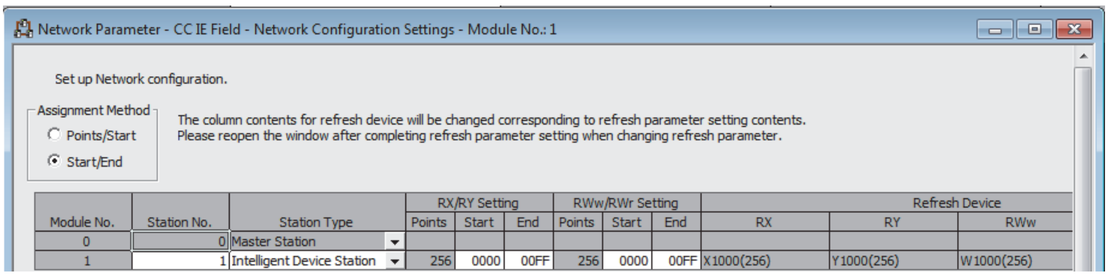
Project window ⇨ [Parameter] ⇨ [Network Parameter]
⇨[Ethernet/CC IE/MELSECNET]



3. Display the Network Configuration Settings window and configure the setting as follows.

Project window ⇨ [Parameter] ⇨ [Network Parameter]

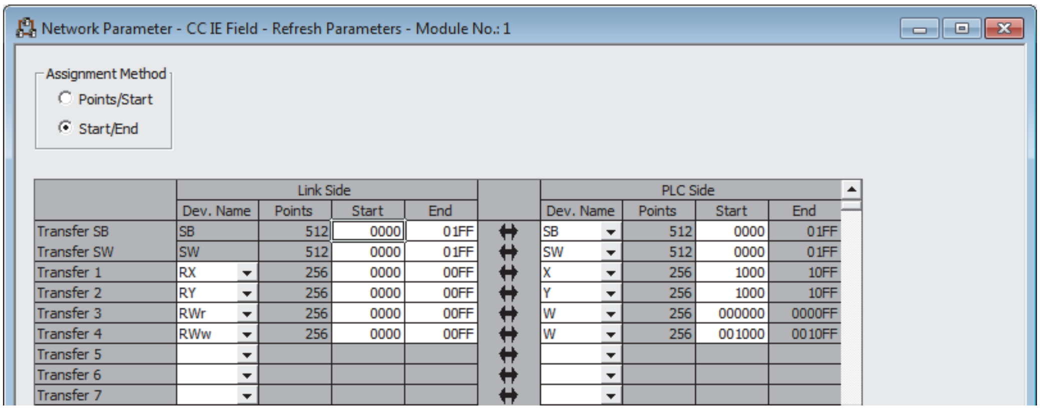
⇨ [Ethernet/CC IE/MELSECNET] ⇨ Network Configuration Settings button



4. Display the Refresh Parameters window and configure the setting as follows.

Project window ⇨ [Parameter] ⇨ [Network Parameter]

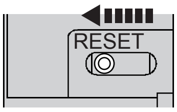
⇨ [Ethernet/CC IE/MELSECNET] ⇨ Refresh Parameters button



	Link Side					PLC Side			
	Dev. Name	Points	Start	End		Dev. Name	Points	Start	End
Transfer SB	SB	512	0000	01FF	↔	SB	512	0000	01FF
Transfer SW	SW	512	0000	01FF	↔	SW	512	0000	01FF
Transfer 1	RX	256	0000	00FF	↔	X	256	1000	10FF
Transfer 2	RY	256	0000	00FF	↔	Y	256	1000	10FF
Transfer 3	RWr	256	0000	00FF	↔	W	256	000000	0000FF
Transfer 4	RWw	256	0000	00FF	↔	W	256	001000	0010FF
Transfer 5					↔				
Transfer 6					↔				
Transfer 7					↔				

5. Write the set parameter to the CPU module of the master station and reset the CPU module, or power off and on the programmable controllers.

[Online] ⇨ [Write to PLC]



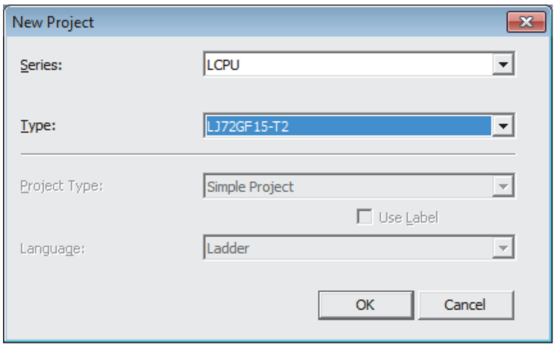
or Power OFF → ON

(6) Setting on the intelligent device station

1. **Create a project on GX Works2.**

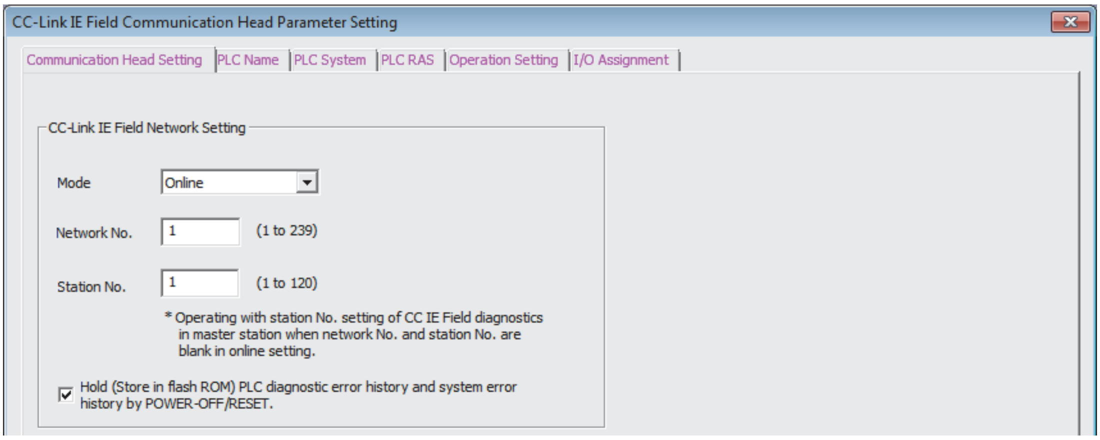
Select "LCPU" for "Series" and select "LJ72GF15-T2" for "Type".

[Project] ⇨ [New]



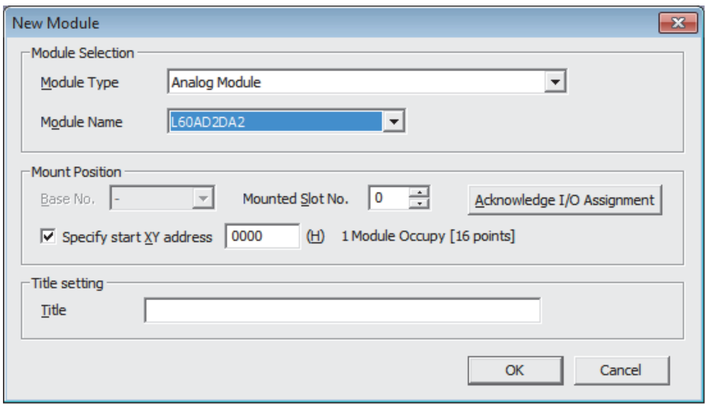
2. **Display the PLC Parameter window and configure the setting as follows.**

Project window ⇨ [Parameter] ⇨ [PLC Parameter] ⇨ "Communication Head Setting"



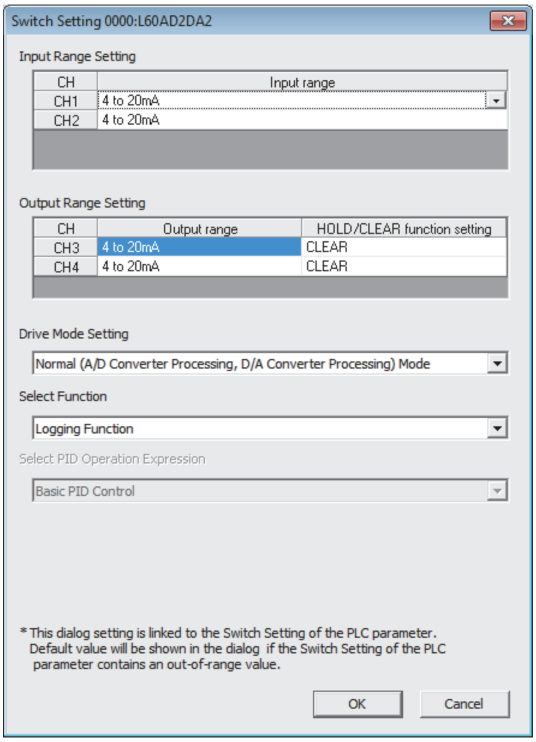
3. **Add the analog I/O module (L60AD2DA2) to the project of GX Works2.**

Project window ⇨ [Intelligent Function Module]⇨ right-click
⇨ [New Module]



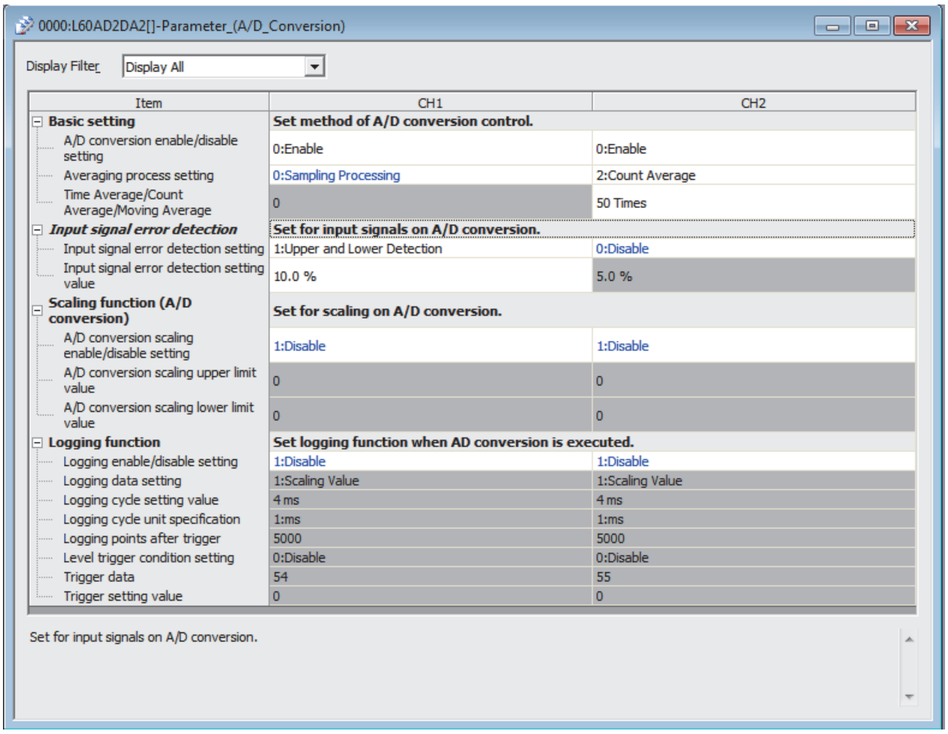
4. **Display the Switch Setting window for the analog I/O module (L60AD2DA2) and configure the setting as follows.**

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Switch Setting]



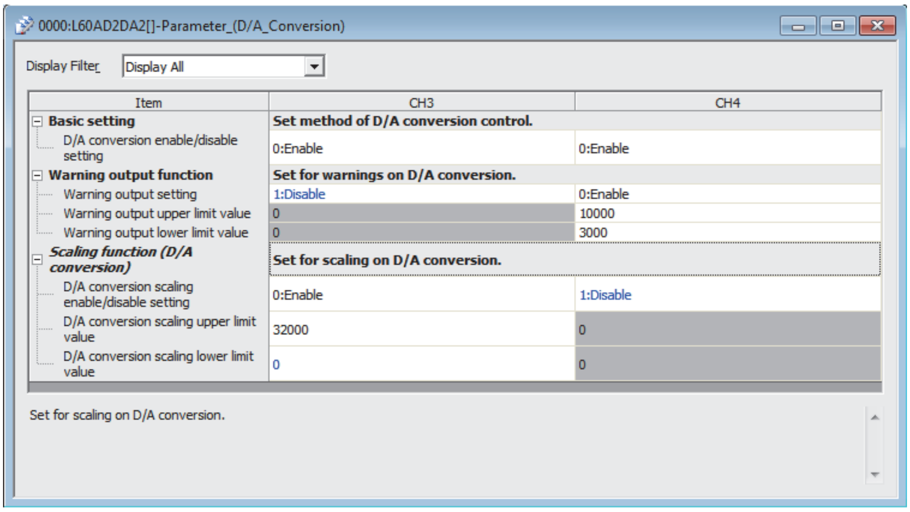
5. **Display the initial setting window for the analog I/O module (L60AD2DA2) and configure the setting as follows.**

Project window ⇨ [Intelligent Function Module] ⇨ module name ⇨ [Parameter_(A/D_Conversion)]



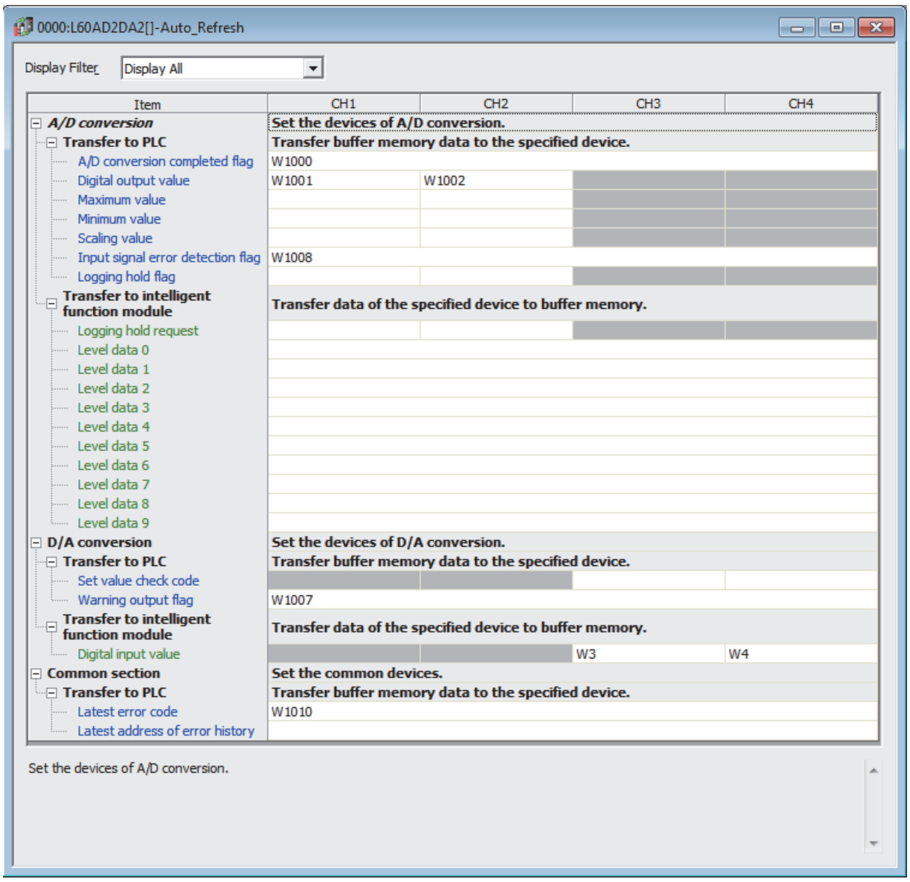
6. Display the initial setting window for the analog I/O module (L60AD2DA2) and configure the setting as follows.

Project window ⇨ [Intelligent Function Module] ⇨ module name
⇨ [Parameter_(D/A_Conversion)]



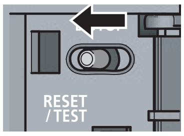
7. Display the Auto Refresh setting window for the analog I/O module (L60AD2DA2) and configure the setting as follows.

Project window ⇨ [Intelligent Function Module] ⇨ module name
⇨ [Auto_Refresh]



8. **Write the set parameter to the head module and reset the head module, or power off and on the programmable controllers.**

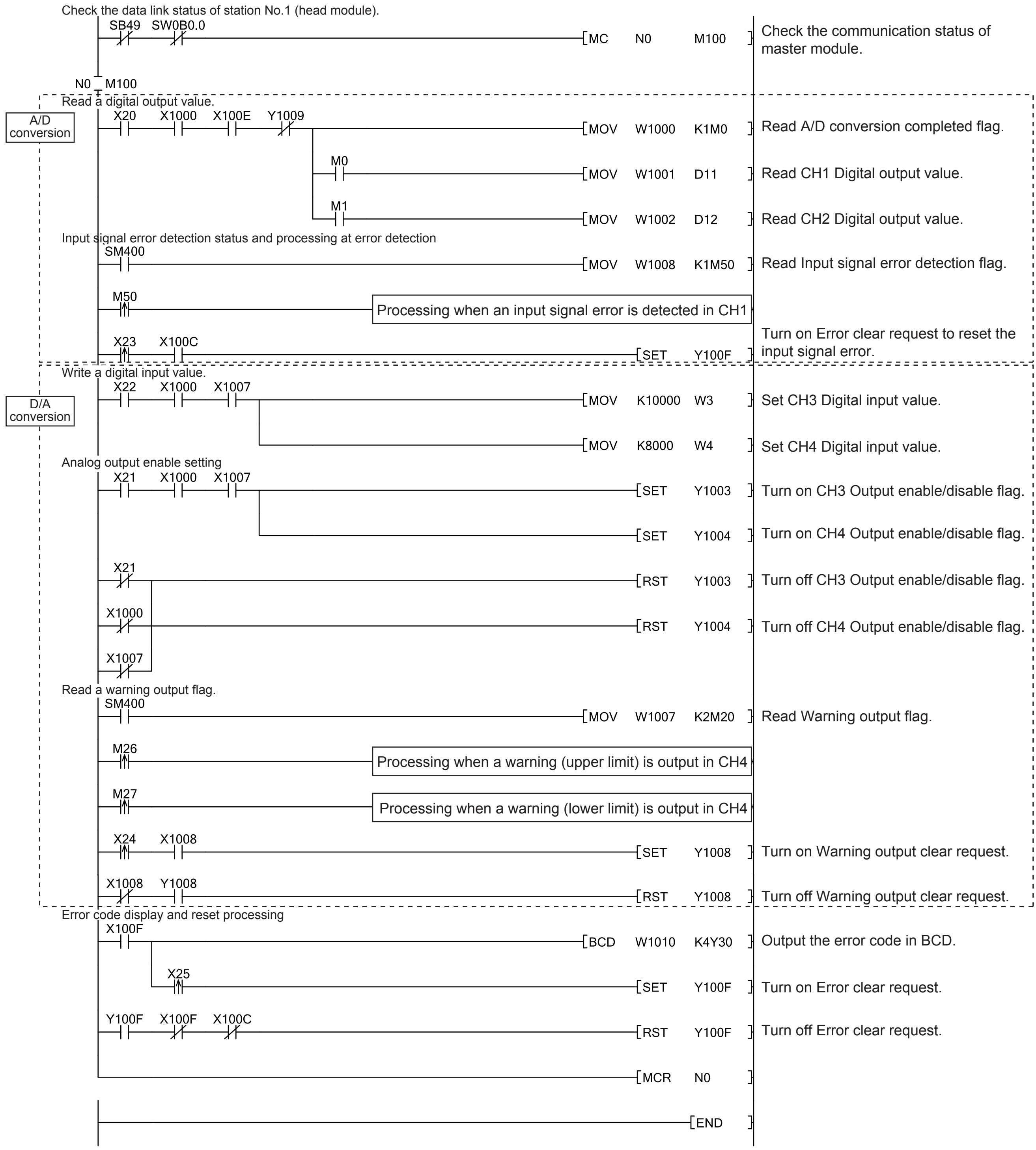
[Online] ⇨ [Write to PLC]



or Power OFF → ON

(7) Program example

The following shows a program example. A program can be written to the CPU module of the master station.



CHAPTER 11 TROUBLESHOOTING

This chapter describes errors that may occur while using the analog I/O module, and those troubleshooting.

(1) Checking for the error codes and the alarm codes

The errors and alarms that occurred in the analog I/O module can be checked with the following methods.
Choose a method depending on the purpose and application.

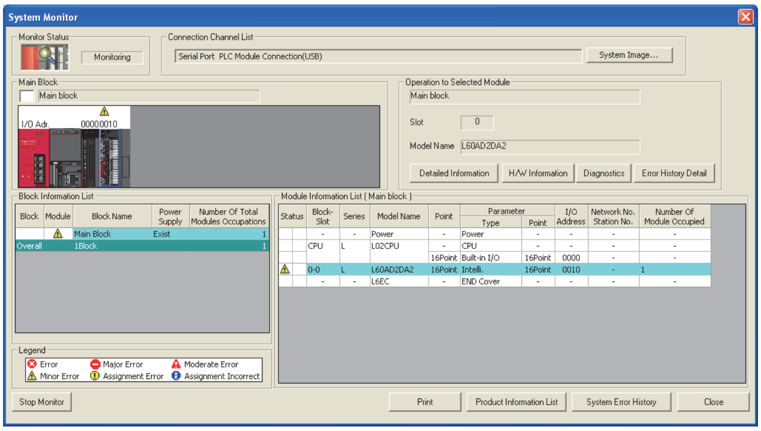
- Checking on the "Module's Detailed Information" Window (☞ Page 312, Section 11.1)
- Checking in Latest error code (Un\G19) (☞ Page 313, Section 11.2)
- Checking Through the Module Error Collection Function (☞ Page 314, Section 11.3)
- Checking on the display unit (☞ Page 288, Section 9.4)

11.1 Checking on the "Module's Detailed Information" Window

The following section describes how to check the errors on the module detailed information.

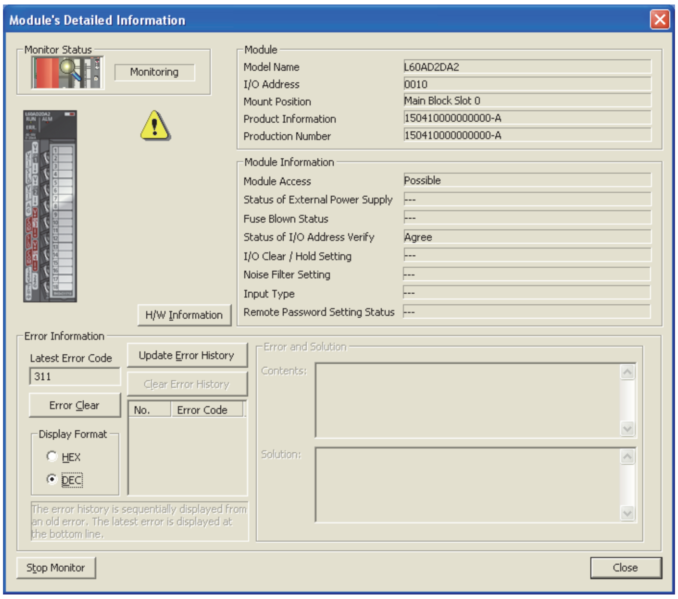
[Diagnostics] ⇨ [System Monitor]

1. **Select the analog I/O module in "Main Base" and click the** Detailed Information **button.**



↓

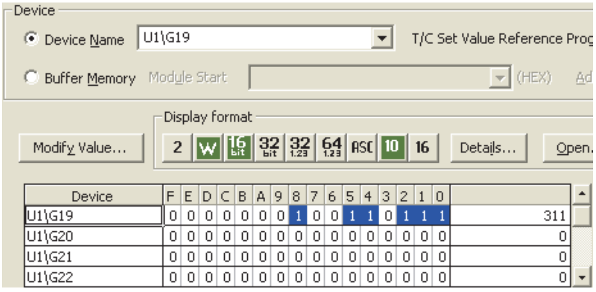
2. **"Module's Detailed Information" of the analog I/O module is displayed.**



11.2 Checking in Latest error code (Un\G19)

The following section describes how to check the errors in Latest error code (Un\G19).

[Online] ⇨ [Monitor] ⇨ [Device/Buffer Memory Batch]



Point

When multiple errors or warnings occur, the latest error code or alarm code is stored in Latest error code (Un\G19).

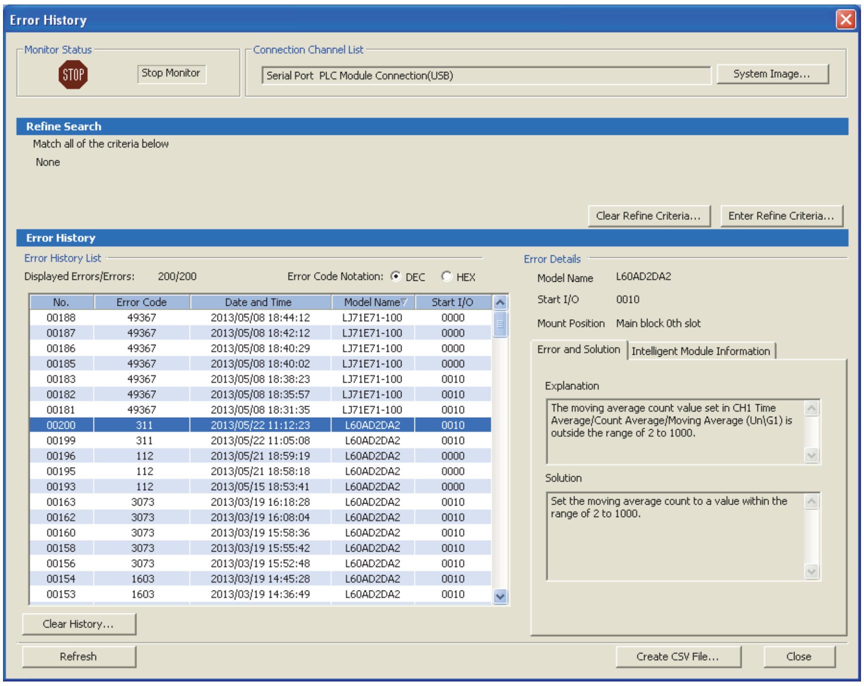
11.3 Checking Through the Module Error Collection Function

The errors occurred in the analog I/O module are saved in the CPU module through the module error collection function. The error information can be held even after the CPU module is powered off and on or is reset.

(1) How to check the errors through the module error collection function

To check the errors of the analog I/O module collected by the CPU module, open the "Error History" window.

[Diagnostics] ⇨ [System Monitor] ⇨ Click the Error History Detail button.



(2) Errors to be collected

The analog I/O module reports the following information to the CPU module:

- Error Code List (☞ Page 315, Section 11.4)
- Alarm Code List (☞ Page 324, Section 11.5)

11.4 Error Code List

The following table lists error codes.
When an error occurs, the error code is stored in Latest error code (Un\G19).
At the same time, the analog I/O module reports the error to the CPU module.

Error code (decimal)	Channel	Description and cause of error	Action
10□	CH1 to CH4	The input range or output range is set with a value outside the setting range for Switch 1 of the intelligent function module switch setting of "PLC parameter". The channel where the error has occurred fits in □.	Set a valid value to the input range and output range for Switch 1 of the intelligent function module switch setting.
111	—	A hardware failure has occurred in the module.	Power off and on the module. If the error occurs again, a failure might have occurred on the module. Please consult your local Mitsubishi representative.
112	—	A value other than 0 is set to Switch 5 of the intelligent function module switch setting of "PLC parameter".	Set 0 to Switch 5 of the intelligent function module switch setting.
113*1	—	The flash memory data is an error.	Check the digital output value and analog output value. If the values are abnormal, please consult your local Mitsubishi representative.
114	—	The function selection is set with a value other than 0 to 5 for Switch 4 of the intelligent function module switch setting of "PLC parameter".	Set a value within the range of 0 to 4 to the function selection for Switch 5 of the intelligent function module switch setting.
120*1*2	—	An invalid value is set to the offset/gain setting. The number of an error channel cannot be identified.	Perform offset/gain setting again for all channels where the user range setting has been configured. If the error occurs again, a failure might have occurred on the module. Please consult your local Mitsubishi representative.
12□*1*3	CH1 to CH4	An invalid value is set to the offset/gain setting. The channel where the error has occurred fits in □.	Start over the offset/gain setting of the channel where the error has occurred. If the error occurs again, a failure might have occurred on the module. Please consult your local Mitsubishi representative.
161*4	—	The G(P).OGSTOR instruction was executed when Switch 4 of the intelligent function module switch setting of "PLC parameter" is the following conditions. • The offset/gain setting mode is set. • A function other than the logging function is set to the function selection for Switch 4.	Do not execute the G(P).OGSTOR instruction when Switch 4 of the intelligent function module switch setting is the following conditions. • The offset/gain setting mode is set. • A function other than the logging function is set to the function selection for Switch 4.
162*1	—	• The G(P).OGSTOR instruction has been consecutively executed. • For the offset/gain setting, a setting value has been consecutively written to the flash memory more than 25 times.	• Execute the G(P).OGSTOR instruction once per module. • Write the setting value into the flash memory only once for each offset/gain setting.
163*1	—	• The G(P).OGSTOR instruction has been executed on a module different from the one on which the G(P).OGLOAD instruction was executed. • The G(P).OGSTOR instruction has been executed ahead of the G(P).OGLOAD instruction.	• Execute the G(P).OGLOAD and G(P).OGSTOR instructions to the same module. • After executing the G(P).OGLOAD instruction on the module from which data is saved, execute the G(P).OGSTOR instruction on the module to which the data is restored.
170*1	—	The maximum number of offset/gain settings and the arithmetic expression data writes has been exceeded.	No more offset/gain setting or arithmetic expression data write is reflected on the operation successfully.
20□*1	CH1 CH2	The averaging time value set in CH□ Time Average/Count Average/Moving Average (Un\G1, Un\G2) is outside the range of 2 to 5000ms. The channel where the error has occurred fits in □.	Set the averaging time to a value within the range of 2 to 5000ms.
30□*1	CH1 CH2	The averaging count value set in CH□ Time Average/Count Average/Moving Average (Un\G1, Un\G2) is outside the range of 4 to 62500. The channel where the error has occurred fits in □.	Set the averaging count to a value within the range of 4 to 62500.
31□*1	CH1 CH2	The moving average count value set in CH□ Time Average/Count Average/Moving Average (Un\G1, Un\G2) is outside the range of 2 to 1000. The channel where the error has occurred fits in □.	Set the moving average count to a value within the range of 2 to 1000.

Error code (decimal)	Channel	Description and cause of error		Action
40□[*1]	CH1 to CH4	When the user range setting is performed or restored, the offset value is greater than or equal to the gain value. The channel where the error has occurred fits in □.		Correct the value so that the offset value becomes smaller than the gain value.
500[*1]	—	In offset/gain setting, channel numbers or "0" is set for both Offset/gain setting mode Offset specification (Un\G22) and Offset/gain setting mode Gain specification (Un\G23).		Correct the Offset/gain setting mode Offset specification (Un\G22) value and/or the Offset/gain setting mode Gain specification (Un\G23) value.
501[*1]	CH3 CH4	In offset/gain setting, analog output channels of both CH3 and CH4 are set for Offset/gain setting mode Offset specification (Un\G22) or Offset/gain setting mode Gain specification (Un\G23).		Correct Offset/gain setting mode Offset specification (Un\G22) or Offset/gain setting mode Gain specification (Un\G23).
60□[*1]	CH3 CH4	Normal output	A value outside the setting range is set to CH□ Digital input value (Un\G2003, Un\G2004). The channel where the error has occurred fits in □.	Set a value within the setting range to CH□ Digital input value (Un\G2003, Un\G2004). The setting range varies depending on the set output range as shown below. 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V : 0 to 12000 -10 to 10V : -16000 to 16000 User range setting (current/voltage) : -12000 to 12000 However, when Enable (0) is set to D/A conversion scaling enable/disable setting (Un\G2053), the setting range is CH□ D/A conversion scaling lower limit value (Un\G2058, Un\G2060) to CH□ D/A conversion scaling upper limit value (Un\G2059, Un\G2061).
		Wave output	A value outside the setting range is set to part of Wave data registry area (Un\G5000 to Un\G54999), which is used for a wave outputting channel. The channel where the error has occurred fits in □.	Set a value within the setting range to the corresponding area of Wave data registry area (Un\G5000 to Un\G54999), which is used for the error channel. The setting range varies depending on the set output range as shown below. 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V : 0 to 12000 -10 to 10V : -16000 to 16000 (The error data can be checked in CH3 Wave output digital value outside the range Address monitor (L) (Un\G3160) to CH4 Wave output digital value outside the range Address monitor (H) (Un\G3163).)
	1, 2 (arithmetic expression number)	Variable arithmetic	The value of Variable arithmetic value for analog output (Un\G4003, Un\G4007) is outside the setting range of the output range. The arithmetic expression number where the error has occurred fits in □.	In the arithmetic expression where the error has occurred, check the whole arithmetic expression including input data and constants and set a value so that Variable arithmetic value for analog output (Un\G4003, Un\G4007) is within the range. The setting range varies depending on the set output range as shown below. 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V : 0 to 12000 -10 to 10V : -16000 to 16000
	CH3 CH4	Variable conversion characteristics	Values outside the setting range are set to a part of data of Conversion characteristics table (Un\G5000 to Un\G37000). The channel where the error has occurred fits in □.	Set a value within the setting range to the data of Conversion characteristics table (Un\G5000 to Un\G37000) which is used for the channel where the error has occurred. The setting range varies depending on the set output range as shown below. 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V : 0 to 12000 -10 to 10V : -16000 to 16000 (Error data can be checked with Variable conversion characteristics digital value outside the range address monitor (Un\G4112 to Un\G4113, Un\G4122 to Un\G4123)).

Error code (decimal)	Channel	Description and cause of error	Action
60□[*1]	CH3 CH4	PID operation The value of Output conversion value (Un\G4302, Un\G4382) is outside the setting range of the output range. The channel where the error has occurred fits in □.	Perform any of the following operations to the loop where the error has occurred. • Check the values of Upper limit output limiter setting (Un\G4336, Un\G4416) and Lower limit output limiter setting (Un\G4337, Un\G4417), and correct the settings so that the value of Output conversion value (Un\G4302, Un\G4382) is within the range. • Correct the PID control parameters so that the value of Output conversion value (Un\G4302, Un\G4382) is within the range. The setting range varies depending on the set output range as shown below. 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V : 0 to 12000 -10 to 10V : -16000 to 16000
62□[*1]	CH3 CH4	Among CH3 Warning output upper limit value (Un\G2090) to CH4 Warning output lower limit value (Un\G2093), any of the lower limit value is greater than or equal to the corresponding upper limit value. The channel where the error has occurred fits in □.	Correct the value so that the upper limit value is greater than the lower limit value.
700[*1]	CH3 CH4	In the offset/gain setting mode, a value outside the range of -3000 to 3000 is set to Offset/gain adjustment value specification (Un\G2024).	Set a value within the range of -3000 to 3000 to Offset/gain adjustment value specification (Un\G2024).
80□[*1]	CH1 CH2	A value outside the range of 0 to 250 is set to CH□ Input signal error detection setting value (Un\G142, Un\G143). The channel where the error has occurred fits in □.	Set a value within the range of 0 to 250 to CH□ Input signal error detection setting value (Un\G142, Un\G143).
81□[*1]	CH1 CH2	A value outside the range of 0 to 4 is set to Input signal error detection setting (Un\G27). The channel where the error has occurred fits in □.	Set one of the following values to Input signal error detection setting (Un\G27) for a channel where the error has occurred. • Disable (0) • Upper and Lower Detection (1) • Lower Detection (2) • Upper Detection (3) • Disconnection Detection (4)
82□[*1]	CH1 CH2	Disconnection Detection (4) is set to Input signal error detection setting (Un\G27), and a value other than the following is set to the input range. • 4 to 20mA (Extended mode) • 1 to 5V (Extended mode) The channel where the error has occurred fits in □.	• To perform disconnection detection using the input signal error detection function, set 4 to 20mA (Extended mode) or 1 to 5V (Extended mode) to the input range of the corresponding channel. • Not to perform disconnection detection, set a value other than Disconnection Detection (4) to Input signal error detection setting (Un\G27) of the corresponding channel.
90□[*1]	CH1 to CH4	A value outside the range of -32000 to 32000 is set to any of the following: • CH1 A/D conversion scaling lower limit value (Un\G62) to CH2 A/D conversion scaling upper limit value (Un\G65) • CH3 D/A conversion scaling lower limit value (Un\G2058) to CH4 D/A conversion scaling upper limit value (Un\G2061) The channel where the error has occurred fits in □.	Set a value within the range of -32000 to 32000 to CH1 A/D conversion scaling lower limit value (Un\G62) to CH2 A/D conversion scaling upper limit value (Un\G65), and to CH3 D/A conversion scaling lower limit value (Un\G2058) to CH4 D/A conversion scaling upper limit value (Un\G2061).
91□[*1]	CH1 to CH4	• The same value is set to both CH□ A/D conversion scaling lower limit value (Un\G62, Un\G64) and CH□ A/D conversion scaling upper limit value (Un\G63, Un\G65). • The same value is set to both CH□ D/A conversion scaling lower limit value (Un\G2058, Un\G2060) and CH□ D/A conversion scaling upper limit value (Un\G2059, Un\G2061). The channel where the error has occurred fits in □.	• Set different values to CH□ A/D conversion scaling lower limit value (Un\G62, Un\G64) and CH□ A/D conversion scaling upper limit value (Un\G63, Un\G65). • Set different values to CH□ D/A conversion scaling lower limit value (Un\G2058, Un\G2060) and CH□ D/A conversion scaling upper limit value (Un\G2059, Un\G2061).
200□[*1]	CH1 CH2	A value other than 0 and 1 is set to CH□ Logging enable/disable setting (Un\G1000, Un\G1001). The channel where the error has occurred fits in □.	Set Enable (0) or Disable (1) to CH□ Logging enable/disable setting (Un\G1000, Un\G1001).
201□[*1]	CH1 CH2	A value outside the setting range is set to one or both of CH□ Logging cycle setting value (Un\G1032, Un\G1033) and CH□ Logging cycle unit setting (Un\G1040, Un\G1041). The channel where the error has occurred fits in □.	Set a value within the setting range to one or both of CH□ Logging cycle setting value (Un\G1032, Un\G1033) and CH□ Logging cycle unit setting (Un\G1040, Un\G1041). For the setting procedure of the logging cycle, refer to the following. • Logging Function (☞ Page 106, Section 8.10)

Error code (decimal)	Channel	Description and cause of error	Action
202□[*1]	CH1 CH2	The set logging cycle is shorter than the refresh cycle of the logged value (digital output value or scaling value). The channel where the error has occurred fits in □.	Set CH□ Logging cycle setting value (Un\G1032, Un\G1033) and CH□ Logging cycle unit setting (Un\G1040, Un\G1041) so that the logging cycle is equal to or longer than the refresh cycle of the logged value. For the setting procedure of the logging cycle, refer to the following. • Logging Function (☞ Page 106, Section 8.10)
203□[*1]	CH1 CH2	A value other than 0 and 1 is set to CH□ Logging data setting (Un\G1024, Un\G1025). The channel where the error has occurred fits in □.	Set Digital output value (0) or Scaling value (1) to CH□ Logging data setting (Un\G1024, Un\G1025).
204□[*1]	CH1 CH2	A value outside the range of 1 to 10000 is set to CH□ Logging points after trigger (Un\G1048, Un\G1049). The channel where the error has occurred fits in □.	Set a value within the range of 1 to 10000 to CH□ Logging points after trigger (Un\G1048, Un\G1049).
205□[*1]	CH1 CH2	A value outside the range of 0 to 3 is set to CH□ Level trigger condition setting (Un\G1056, Un\G1057). The channel where the error has occurred fits in □.	Set one of the following values to CH□ Level trigger condition setting (Un\G1056, Un\G1057). • Disable (0) • Above (1) • Below (2) • Pass through (3)
206□[*1]	CH1 CH2	A value outside the range of 0 to 4999 is set to CH□ Trigger data (Un\G1064, Un\G1065). The channel where the error has occurred fits in □.	Set a value within the range of 0 to 4999 to CH□ Trigger data (Un\G1064, Un\G1065).
207□[*1]	CH1 CH2	A value other than 0 and 1 is set to CH□ Logging hold request (Un\G1008, Un\G1009). The channel where the error has occurred fits in □.	Set OFF (0) or ON (1) to CH□ Logging hold request (Un\G1008, Un\G1009).
208□[*1]	CH1 CH2	Enable (0) is set to CH□ Logging enable/disable setting (Un\G1000, Un\G1001) with a function other than the logging function set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". The channel where the error has occurred fits in □.	When executing the logging function, set the logging function to the function selection for Switch 4 of the intelligent function module switch setting. After that, set Enable (0) to CH□ Logging enable/disable setting (Un\G1000, Un\G1001).
301□[*1]	CH3 CH4	The scaling function (D/A conversion) is enabled with the wave output function being set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". The channel where the error has occurred fits in □.	When executing the wave output function, set Disable (1) to D/A conversion scaling enable/disable setting (Un\G2053).
302□[*1]	CH3 CH4	Both of the following contents are set for the intelligent function module switch setting of "PLC parameter". • The user range setting (current/voltage) is set to the output range for CH3 or CH4. • The wave output function is set to the function selection for Switch 4. The channel where the error has occurred fits in □.	• When executing the wave output function, set a value other than the user range setting (current/voltage) to the output range for Switch 1 of the intelligent function module switch setting. • When using the user range setting, set a function other than the wave output function to the function selection for Switch 4 of the intelligent function module switch setting.
303□[*1]	CH3 CH4	A value outside the range of 0 to 2 is set to CH□ Wave output start/stop request (Un\G3002, Un\G3003). The channel where the error has occurred fits in □.	Set one of the following values to CH□ Wave output start/stop request (Un\G3002, Un\G3003). • Wave output stop request (0) • Wave output start request (1) • Wave output pause request (2)
304□[*1]	CH3 CH4	A value outside the range of 0 to 2 is set to CH□ Output setting during wave output stop (Un\G3010, Un\G3011). The channel where the error has occurred fits in □.	Set one of the following values to CH□ Output setting during wave output stop (Un\G3010, Un\G3011). • 0V/0mA (0) • Offset value (1) • Setting value during stop (2)
305□[*1]	CH3 CH4	A value outside the setting range is set to CH□ Output value during wave output stop (Un\G3018, Un\G3019). The channel where the error has occurred fits in □.	Set a value within the setting range to CH□ Output value during wave output stop (Un\G3018, Un\G3019). The setting range varies depending on the set output range as shown below. 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V : 0 to 12000 -10 to 10V : -16000 to 16000

Error code (decimal)	Channel	Description and cause of error	Action
306□[*1]	CH3 CH4	A value outside the range of 5000 to 54999 is set to CH3 Wave pattern start address setting (L) (Un\G3028) to CH4 Wave pattern start address setting (H) (Un\G3031). The channel where the error has occurred fits in □.	Set a value within the range of 5000 to 54999 to CH3 Wave pattern start address setting (L) (Un\G3028) to CH4 Wave pattern start address setting (H) (Un\G3031).
307□[*1]	CH3 CH4	A value outside the range of 1 to 50000 is set to CH3 Wave pattern data points setting (L) (Un\G3044) to CH4 Wave pattern data points setting (H) (Un\G3047). The channel where the error has occurred fits in □.	Set a value within the range of 1 to 50000 to CH3 Wave pattern data points setting (L) (Un\G3044) to CH4 Wave pattern data points setting (H) (Un\G3047).
308□[*1]	CH3 CH4	A value outside the setting range is set to CH□ Wave pattern output repetition setting (Un\G3058, Un\G3059). The channel where the error has occurred fits in □.	Set one of the following values to CH□ Wave pattern output repetition setting (Un\G3058, Un\G3059). • Unlimitedly repeat output (-1) • Specified number of times (1 to 32767)
309□[*1]	CH3 CH4	A value outside the range of 1 to 5000 is set to CH□ Constant for wave output conversion cycle (Un\G3066, Un\G3067). The channel where the error has occurred fits in □.	Set a value within the range of 1 to 5000 to CH□ Constant for wave output conversion cycle (Un\G3066, Un\G3067).
3100[*1]	—	A value other than 0 and 1 is set to Step action wave output request (Un\G3072).	Set OFF (0) or ON (1) to Step action wave output request (Un\G3072).
311□[*1]	CH3 CH4	The value obtained from the following formula is greater than 54999 (last buffer memory address in Wave data registry area). CH3 Wave pattern start address setting (L) (Un\G3028) to CH4 Wave pattern start address setting (H) (Un\G3031) + CH3 Wave pattern data points setting (L) (Un\G3044) to CH4 Wave pattern data points setting (H) (Un\G3047) - 1 The channel where the error has occurred fits in □.	Set the values to CH3 Wave pattern start address setting (L) (Un\G3028) to CH4 Wave pattern start address setting (H) (Un\G3031) and CH3 Wave pattern data points setting (L) (Un\G3044) to CH4 Wave pattern data points setting (H) (Un\G3047) so that they meet the following condition: • ["Wave pattern start address setting" + "Wave pattern data points setting" - 1] is equal to or smaller than 54999.
400□[*1]	CH1 to CH4	For Switch 1 of the intelligent function module switch setting of "PLC parameter", the user range setting for the input range or output range is set. At the same time, either of the following is set to the function selection for Switch 4. • Variable arithmetic function • Variable conversion characteristics function + variable arithmetic function The channel where the error has occurred fits in □.	• When using the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function, set a range other than the user range setting for Switch 1 of the intelligent function module switch setting. • When using the user range setting, set the logging function to the function selection for Switch 4 of the intelligent function module switch setting.
401□[*1]	CH3 CH4	Enable (0) is set to D/A conversion scaling enable/disable setting (Un\G2053) with one of the following functions set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". • Variable arithmetic function • Variable conversion characteristics function + variable arithmetic function The channel where the error has occurred fits in □.	When using the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function, set Disable (1) to D/A conversion scaling enable/disable setting (Un\G2053).
4020[*1]	1, 2 (arithmetic expression number)	An invalid value is set to the arithmetic expression data stored in the flash memory. The number of an error arithmetic expression cannot be identified.	Save the arithmetic expression data in the flash memory again. If the error occurs again, a failure might have occurred on the module. Please consult your local Mitsubishi representative.
402□[*1]	1, 2 (arithmetic expression number)	An invalid value is set to the arithmetic expression data stored in the flash memory. The arithmetic expression number where the error has occurred fits in □.	Save the arithmetic expression data in the flash memory again. If the error occurs again, a failure might have occurred on the module. Please consult your local Mitsubishi representative.
403□	CH1 to CH4	The arithmetic expression data cannot be saved because conversion is enabled for some channel in A/D conversion enable/disable setting (Un\G0) or D/A conversion enable/disable setting (Un\G2000). The channel where the error has occurred fits in □.	For all the channels, set Disable to A/D conversion enable/disable setting (Un\G0) and D/A conversion enable/disable setting (Un\G2000).

Error code (decimal)	Channel	Description and cause of error	Action
500□[*1]	CH1 to CH4	Enable (0) is set to A/D conversion scaling enable/disable setting (Un\G53) or D/A conversion scaling enable/disable setting (Un\G2053) with the following function set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". • Variable conversion characteristics function The channel where the error has occurred fits in □.	When using the variable conversion characteristics function, set Disable (1) to A/D conversion scaling enable/disable setting (Un\G53) or D/A conversion scaling enable/disable setting (Un\G2053).
	CH1 CH2	Enable (0) is set to A/D conversion scaling enable/disable setting (Un\G53) with the following function set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". • Variable conversion characteristics function + variable arithmetic function The channel where the error has occurred fits in □.	When using the variable conversion characteristics function + variable arithmetic function, set Disable (1) to A/D conversion scaling enable/disable setting (Un\G53).
5010[*1]	CH1 to CH4	A value outside the range of 0 to 2 is set to Variable conversion characteristics table selection (Un\G4100). The channel where the error has occurred fits in □.	Set a value within the range of 0 to 2 to Variable conversion characteristics table selection (Un\G4100).
5020[*1]	CH1 to CH4	• When Analog input (0) is set to Variable conversion characteristics table selection (Un\G4100), a value other than 0H to 5H, AH, and BH is set to Variable conversion characteristics range setting (Un\G4101). • When Analog output (1) or Analog I/O (2) is set to Variable conversion characteristics table selection (Un\G4100), a value outside the range of 0H to 4H is set to Variable conversion characteristics range setting (Un\G4101). The channel where the error has occurred fits in □.	• When Analog input (0) is set to Variable conversion characteristics table selection (Un\G4100), set a value of 0H to 5H, AH, or BH to Variable conversion characteristics range setting (Un\G4101). • When Analog output (1) or Analog I/O (2) is set to Variable conversion characteristics table selection (Un\G4100), set a value within the range of 0H to 4H to Variable conversion characteristics range setting (Un\G4101).
503□[*1]	CH3 CH4	With one of the following functions set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter" and Analog output (1) set to Variable conversion characteristics table selection (Un\G4100), a value outside the range of the address of the conversion characteristics table is set to CH□ Digital input value (Un\G2003, Un\G2004). • Variable conversion characteristics function • Variable conversion characteristics function + variable arithmetic function The channel where the error has occurred fits in □.	Set a value within the range of the address of the conversion characteristics table to CH□ Digital input value (Un\G2003, Un\G2004). The setting range varies depending on the set output range as shown below. 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V : 0 to 12000 -10 to 10V : -16000 to 16000
504□[*1]	1, 2 (route number)	When Analog I/O (2) is set to Variable conversion characteristics table selection (Un\G4100), the setting of A/D conversion enable/disable setting (Un\G0) of a channel differs from the setting of D/A conversion enable/disable setting (Un\G2000) of the corresponding channel. The route number where the error has occurred fits in □.	Correct the setting for A/D conversion enable/disable setting (Un\G0) and D/A conversion enable/disable setting (Un\G2000) so that the conversion enable/disable settings of the corresponding channels are the same.
600□[*1]	CH1 to CH4	For Switch 1 of the intelligent function module switch setting of "PLC parameter", the user range setting for the input range or output range is set. At the same time, the PID control function is set to the function selection for Switch 4. The channel where the error has occurred fits in □.	• When using the PID control function, set a value other than the user range setting for Switch 1 of the intelligent function module switch setting. • When using the user range setting, set the logging function to the function selection for Switch 4 of the intelligent function module switch setting.
601□[*1]	CH3 CH4	Enable (0) is set to D/A conversion scaling enable/disable setting (Un\G2053) with the PID control function set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". The channel where the error has occurred fits in □.	When using the PID control function, set Disable (1) in D/A conversion scaling enable/disable setting (Un\G2053).
602□[*1]	1, 2 (loop No.)	A value other than 0 and 1 is set in Control mode switching (Un\G4320, Un\G4400). The loop number where the error has occurred fits in □.	Set Automatic mode (0) or Manual mode (1) in Control mode switching (Un\G4320, Un\G4400).
603□[*1]	1, 2 (loop No.)	• A value outside the range of 2 to 60000 is set in Control cycle setting (Un\G4321, Un\G4401). • The setting of Control cycle setting (Un\G4321, Un\G4401) does not meet the condition "Control cycle setting ≥ 200μs × Number of A/D conversion channels in use". The loop number where the error has occurred fits in □.	• Set a value within the range of 2 to 60000ms in Control cycle setting (Un\G4321, Un\G4401). • Set a value that meets the condition shown on the left.

Error code (decimal)	Channel	Description and cause of error	Action
604□*1	1, 2 (loop No.)	A value outside the setting range is set in Set value (SV) setting (Un\G4322, Un\G4402). The loop number where the error has occurred fits in □.	Set a value within the setting range in Set value (SV) setting (Un\G4322, Un\G4402). The setting range varies depending on the set input range as shown below. 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V : 0 to 12000 -10 to 10V : -16000 to 16000 0 to 10V : 0 to 16000 4 to 20mA (Extended mode) 1 to 5V (Extended mode) : -3000 to 13500
605□*1	1, 2 (loop No.)	A value outside the range of 1 to 10000 is set in Proportional gain (P) setting (Un\G4323, Un\G4403). The loop number where the error has occurred fits in □.	Set a value within the range of 1 to 10000 in Proportional gain (P) setting (Un\G4323, Un\G4403).
606□*1	1, 2 (loop No.)	A value outside the range of 0 to 300000 is set in Integral time (I) setting (Un\G4324 to Un\G4325, Un\G4404 to Un\G4405). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 300000 in Integral time (I) setting (Un\G4324 to Un\G4325, Un\G4404 to Un\G4405).
607□*1	1, 2 (loop No.)	A value outside the range of 0 to 30000 is set in Derivative time (D) setting (Un\G4326, Un\G4406). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 30000 in Derivative time (D) setting (Un\G4326, Un\G4406).
608□*1	1, 2 (loop No.)	A value outside the range of 0 to 10000 is set in Gap width setting (Un\G4327, Un\G4407). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 10000 in Gap width setting (Un\G4327, Un\G4407).
609□*1	1, 2 (loop No.)	A value outside the range of 0 to 100 is set in Gap gain setting (Un\G4328, Un\G4408). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 100 in Gap gain setting (Un\G4328, Un\G4408).
610□*1	1, 2 (loop No.)	A value outside the range of 0 to 100 is set in Two-degree-of-freedom parameter alpha setting (Un\G4329, Un\G4409). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 100 in Two-degree-of-freedom parameter alpha setting (Un\G4329, Un\G4409).
611□*1	1, 2 (loop No.)	A value outside the range of 0 to 100 is set in Two-degree-of-freedom parameter beta setting (Un\G4330, Un\G4410). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 100 in Two-degree-of-freedom parameter beta setting (Un\G4330, Un\G4410).
612□*1	1, 2 (loop No.)	A value outside the range of 1 to 30000 is set in Derivative gain setting (Un\G4331, Un\G4411). The loop number where the error has occurred fits in □.	Set a value within the range of 1 to 30000 in Derivative gain setting (Un\G4331, Un\G4411).
613□*1	1, 2 (loop No.)	A value outside the range of 0 to 10500 is set in Variable speed integral judgment value A setting (Un\G4332, Un\G4412). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 10500 in Variable speed integral judgment value A setting (Un\G4332, Un\G4412).
614□*1	1, 2 (loop No.)	A value outside the range of 0 to 10500 is set in Variable speed integral judgment value B setting (Un\G4333, Un\G4413). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 10500 in Variable speed integral judgment value B setting (Un\G4333, Un\G4413).
615□*1	1, 2 (loop No.)	A value other than 0 and 1 is set in Forward/reverse action setting (Un\G4334, Un\G4414). The loop number where the error has occurred fits in □.	Set Reverse action (0) or Forward action (1) in Forward/reverse action setting (Un\G4334, Un\G4414).
616□*1	1, 2 (loop No.)	A value outside the range of 0 to 99 is set in Filter coefficient (Un\G4335, Un\G4415). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 99 in Filter coefficient (Un\G4335, Un\G4415).
617□*1	1, 2 (loop No.)	The value of Lower limit output limiter setting (Un\G4337, Un\G4417) is equal to or larger than the value of Upper limit output limiter setting (Un\G4336, Un\G4416). The loop number where the error has occurred fits in □.	Set values so that the value of Lower limit output limiter setting (Un\G4337, Un\G4417) is smaller than the value of Upper limit output limiter setting (Un\G4336, Un\G4416).
618□*1	1, 2 (loop No.)	• A value larger than 10500 is set in Upper limit output limiter setting (Un\G4336, Un\G4416). • A value smaller than -500 is set in Lower limit output limiter setting (Un\G4337, Un\G4417). The loop number where the error has occurred fits in □.	Set values within the range of -500 to 10500 in Upper limit output limiter setting (Un\G4336, Un\G4416) and Lower limit output limiter setting (Un\G4337, Un\G4417).
619□*1	1, 2 (loop No.)	A value outside the range of 0 to 10000 is set in Output variation limiter setting (Un\G4338, Un\G4418). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 10000 in Output variation limiter setting (Un\G4338, Un\G4418).

Error code (decimal)	Channel	Description and cause of error	Action
620□[*1]	1, 2 (loop No.)	A value outside the range of -500 to 10500 is set in MAN output setting (Un\G4339, Un\G4419). The loop number where the error has occurred fits in □.	Set a value within the range of -500 to 10500 in MAN output setting (Un\G4339, Un\G4419).
621□[*1]	1, 2 (loop No.)	A value other than 0 and 1 is set in PID continuation flag on HOLD (Un\G4341, Un\G4421). The loop number where the error has occurred fits in □.	Set Hold output (0) or Continue PID operation (1) in PID continuation flag on HOLD (Un\G4341, Un\G4421).
622□[*1]	1, 2 (loop No.)	A value outside the range of 0 to 7200 is set in Auto-tuning timeout time (Un\G4361, Un\G4441). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 7200 in Auto-tuning timeout time (Un\G4361, Un\G4441).
623□[*1]	1, 2 (loop No.)	A value outside the range of 0 to 1000 is set in Auto-tuning hysteresis (Un\G4362, Un\G4442). The loop number where the error has occurred fits in □.	Set a value within the range of 0 to 1000 in Auto-tuning hysteresis (Un\G4362, Un\G4442).
624□[*1]	1, 2 (loop No.)	The value of Auto-tuning output lower limit value (Un\G4364, Un\G4444) is equal to or larger than the value of Auto-tuning output upper limit value (Un\G4363, Un\G4443). The loop number where the error has occurred fits in □.	Set values so that the value of Auto-tuning output lower limit value (Un\G4364, Un\G4444) is smaller than the value of Auto-tuning output upper limit value (Un\G4363, Un\G4443).
625□[*1]	1, 2 (loop No.)	The value of Auto-tuning output upper limit value (Un\G4363, Un\G4443) is larger than the value of Upper limit output limiter setting (Un\G4336, Un\G4416). The loop number where the error has occurred fits in □.	Set a value that is equal to or smaller than the value of Upper limit output limiter setting (Un\G4336, Un\G4416) in Auto-tuning output upper limit value (Un\G4363, Un\G4443).
626□[*1]	1, 2 (loop No.)	The value of Auto-tuning output lower limit value (Un\G4364, Un\G4444) is smaller than the value of Lower limit output limiter setting (Un\G4337, Un\G4417). The loop number where the error has occurred fits in □.	Set a value that is equal to or larger than the value of Lower limit output limiter setting (Un\G4337, Un\G4417) in Auto-tuning output lower limit value (Un\G4364, Un\G4444).
627□[*1]	1, 2 (loop No.)	A value outside the range of 0 to 3 is set in Auto-tuning control type setting (Un\G4365, Un\G4445). The loop number where the error has occurred fits in □.	Set any of the following values in Auto-tuning control type setting (Un\G4365, Un\G4445). • Constant-value PI control (0) • Constant-value PID control (1) • Variable-value PI control (2) • Variable-value PID control (3)
628□[*1]	1, 2 (loop No.)	Since the A/D conversion stopped during auto tuning, the auto tuning has abnormally ended. The loop number where the error has occurred fits in □.	Check that Operating condition setting request (Y9) has not been turned on and off during auto tuning.
629□[*1]	1, 2 (loop No.)	Since the D/A output stopped during auto tuning, the auto tuning has abnormally ended. The loop number where the error has occurred fits in □.	Check that none of the following operations has been performed during auto tuning. • Turning off of CH□ Output enable/disable flag (Y3, Y4) • Turning on and off of Operating condition setting request (Y9) with D/A conversion enable/disable setting (Un\G2000) set to Disable (1)
630□[*1]	1, 2 (loop No.)	Since the control mode was changed during auto tuning, the auto tuning has abnormally ended. The loop number where the error has occurred fits in □.	Do not change the value of Control mode switching (Un\G4320, Un\G4400) during auto tuning.
631□[*1]	1, 2 (loop No.)	The auto tuning has timed out and abnormally ended. The loop number where the error has occurred fits in □.	• When the value of CH□ Digital output value (Un\G11, Un\G12) does not reach the value of Set value (SV) setting (Un\G4322, Un\G4402) during auto tuning, check wiring of the input channel and output channel. • When the value of CH□ Digital output value (Un\G11, Un\G12) has reached the value of Set value (SV) setting (Un\G4322, Un\G4402) during auto tuning, set a large value in Auto-tuning timeout time (Un\G4361, Un\G4441).
632□[*1]	1, 2 (loop No.)	Though the auto tuning has been performed, PID constants cannot be calculated. The loop number where the error has occurred fits in □.	Check the following settings, and then perform auto tuning again. If an error still occurs, set PID constants with a program. • CH□ Time Average/Count Average/Moving Average (Un\G1, Un\G2) (when Moving Average (3) is set in Averaging process setting (Un\G24)) • Filter coefficient (Un\G4335, Un\G4415) • Auto-tuning hysteresis (Un\G4362, Un\G4442) • Auto-tuning output upper limit value (Un\G4363, Un\G4443), Auto-tuning output lower limit value (Un\G4364, Un\G4444) • Auto-tuning control type setting (Un\G4365, Un\G4445)

*1 This error code can be cleared by setting a value within the setting range and performing either of the following operations.
- Turning on and off Error clear request (YF)
- Turning on and off Operating condition setting request (Y9)

Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

*2 If an error occurs, A/D conversion and D/A conversion that are being performed in all channels will stop.
Perform the offset/gain setting again and reconfigure initial settings.

*3 If an error occurs, only the A/D conversion or D/A conversion that is being performed in the error channel will stop.
Perform the offset/gain setting again and reconfigure initial settings.

*4 An error code is not stored in Latest error code (Un\G19).
The code is stored in completion status area Ⓢ+1 of the G(P).OGSTOR instruction.

Point

For Switch 1 to 5, refer to the following.
- Intelligent function module switch setting (☞ Page 450, Appendix 9.1 (2))

11.5 Alarm Code List

The following table lists alarm codes.

When an alarm occurs, the alarm code is stored in Latest error code (Un\G19).

At the same time, the analog I/O module reports the alarm to the CPU module.

Alarm code (decimal)	Channel	Description and cause of alarm	Action
11△□*1	CH1 CH2	An input signal error is occurring. The channel where the input signal error has occurred fits in □. A value that fits in △ indicates that the detection status is as follows: Upper limit detection 2: Lower limit detection Disconnection detection This alarm code is stored when an input signal error is detected according to the setting of the input signal error detection function.	The corresponding bit of Input signal error detection flag (Un\G49) and Input signal error detection signal (XC) turn off by turning on and off Error clear request (YF) after the analog input value returns to the one within the setting range.

Alarm code (decimal)	Channel	Description and cause of alarm	Action	
15△□[*2]	CH3 CH4	A value greater than the warning output upper limit value or a value smaller than the warning output lower limit value is set to the following buffer memories. • For normal output: CH□ Digital input value (Un\G2003, Un\G2004) • For wave output: Wave data registry area (Un\G5000 to Un\G54999) • For variable arithmetic: Variable arithmetic value for analog output (Un\G4003, Un\G4007) • For variable conversion characteristics: Conversion characteristics table (Un\G5000 to Un\G37000) • For PID control: Output conversion value (Un\G4302, Un\G4382) The channel where the warning has occurred fits in □. A value that fits in △ indicates that the warning status is as follows: • A value greater than the warning output upper limit value is set • A value smaller than the warning output lower limit value is set	Normal output	Set a value within the setting range to CH□ Digital input value (Un\G2003, Un\G2004) and turn on and off Warning output clear request (Y8). The setting range is shown below. • Warning output upper limit value ≥ Setting value ≥ Warning output lower limit value
			Wave output	Set a value within the setting range to the corresponding area of Wave data registry area (Un\G5000 to Un\G54999), which is used for the channel where the warning has occurred. After that, turn on and off Warning output clear request (Y8). The setting range is shown below. • Warning output upper limit value ≥ Setting value ≥ Warning output lower limit value (The error data can be checked in CH3 Wave output warning Address monitor (L) (Un\G3176) to CH4 Wave output warning Address monitor (H) (Un\G3179).)
			Variable arithmetic	For the arithmetic expression where the warning has occurred, check the whole expression including input data and constants to correct the setting of Variable arithmetic value for analog output (Un\G4003, Un\G4007) within the range and turn on and off Warning output clear request (Y8). The setting range is shown below. • Warning output upper limit value ≥ Setting value ≥ Warning output lower limit value
			Variable conversion characteristics	After setting a value within the setting range to the corresponding data of Conversion characteristics table (Un\G5000 to Un\G37000) which is used for the channel where the warning has occurred, turn on and off Warning output clear request (Y8). The setting range is shown below. • Warning output upper limit value ≥ Setting value ≥ Warning output lower limit value (Error data can be checked with Variable conversion characteristics warning address monitor (Un\G4114 to Un\G4115, Un\G4124 to Un\G4125).)
			PID control	Perform any of the following operations to the loop where a warning has occurred. • Check the values of Upper limit output limiter setting (Un\G4336, Un\G4416) and Lower limit output limiter setting (Un\G4337, Un\G4417), and correct the settings so that the value of Output conversion value (Un\G4302, Un\G4382) is within the range. Then, turn on and off Operating condition setting request (Y9). • Correct the PID control parameters so that the value of Output conversion value (Un\G4302, Un\G4382) is within the range. Then, turn on and off Warning output clear request (Y8).
160□[*2]	CH3 CH4	Operating condition setting request (Y9) was turned on and off in a state other than "wave output stop". The channel where the warning has occurred fits in □.	Turn on and off Operating condition setting request (Y9) after wave output stops in all channels.	
1610[*2]	—	A value other than OFF (0) is set to Step action wave output request (Un\G3072) when a function other than the wave output function is set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter".	Set the wave output function to the function selection for Switch 4 of the intelligent function module switch setting, then set ON (1) to Step action wave output request (Un\G3072).	

Alarm code (decimal)	Channel	Description and cause of alarm	Action
161□[*2]	CH3 CH4	A value other than Wave output stop request (0) is set to CH□ Wave output start/stop request (Un\G3002, Un\G3003) when a function other than the wave output function is set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". The channel where the warning has occurred fits in □.	Set the wave output function to the function selection for Switch 4 of the intelligent function module switch setting, then set Wave output start request (1) to CH□ Wave output start/stop request (Un\G3002, Un\G3003).
170□[*2]	1, 2 (arithmetic expression number)	The value set in Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) has exceeded the range of -2147483648 to 2147483647 with one of the following functions set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". • Variable arithmetic function • Variable conversion characteristics function + variable arithmetic function The arithmetic expression number where the warning has occurred fits in □.	Check the whole arithmetic expression including input data and constants.
171□[*2]	1, 2 (arithmetic expression number)	The value set in Variable arithmetic value for analog output (Un\G4003, Un\G4007) has exceeded the range of -32768 to 32767 with one of the following functions set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". • Variable arithmetic function • Variable conversion characteristics function + variable arithmetic function The arithmetic expression number where the warning has occurred fits in □.	Check the whole arithmetic expression including input data and constants.
172□[*2]	1, 2 (arithmetic expression number)	Division by 0 has occurred during an operation with one of the following functions set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter". • Variable arithmetic function • Variable conversion characteristics function + variable arithmetic function The arithmetic expression number where the warning has occurred fits in □.	Check the whole arithmetic expression including input data and constants.
180□[*2]	CH1 CH2	With one of the following functions set to the function selection for Switch 4 of the intelligent function module switch setting of "PLC parameter" and Analog input (0) or Analog I/O (2) set to Variable conversion characteristics table selection (Un\G4100), an A/D-converted value is outside the range of the address of the conversion characteristics table. • Variable conversion characteristics function • Variable conversion characteristics function + variable arithmetic function The channel where the warning has occurred fits in □.	Correct the analog input value so that the A/D-converted value is within the range of the address of the conversion characteristics table. The setting range varies depending on the set input range as shown below. 4 to 20mA, 0 to 20mA, 1 to 5V, 0 to 5V : 0 to 12000 -10 to 10V : -16000 to 16000 0 to 10V : 0 to 16000 4 to 20mA (Extended mode) 1 to 5V (Extended mode) : -3000 to 13500

*1 This alarm code can be cleared by eliminating the alarm cause and performing either of the following operations.
- Turning on and off Error clear request (YF)
- Turning on and off Operating condition setting request (Y9)

Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

*2 This alarm code can be cleared by eliminating the alarm cause and performing either of the following operations.
- Turning on and off Warning output clear request (Y8)
- Turning on and off Operating condition setting request (Y9)

Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

Point

For Switch 1 to 5, refer to the following.

- Intelligent function module switch setting (☞ Page 450, Appendix 9.1 (2))

11.6 Troubleshooting

11.6.1 Troubleshooting using LEDs

(1) When the RUN LED flashes or turns off

(a) When flashing

Check item	Cause	Action
Is the module in offset/gain setting mode?	Offset/gain setting mode is set to the drive mode setting in the switch setting.	Set normal mode to the drive mode setting in the switch setting. After that, power off and on the module or reset the CPU module.
	The G(P).OFFGAN instruction has been executed and the mode has been switched to offset/gain setting mode.	When using the analog I/O module in normal mode, check if the program for the G(P).OFFGAN instruction has been mistakenly executed.
	The value in Mode switching setting (Un\G158, Un\G159) has been changed and the mode has been switched to offset/gain setting mode.	When using the analog I/O module in normal mode, check if the program to change the value in Mode switching setting (Un\G158, Un\G159) has been mistakenly executed.

(b) When turning off

Check item	Action
Is the power supplied?	Check that the supply voltage of power supply module is within the rated range.
Is the capacity of power supply module enough?	Check that the power capacity is enough by calculating the current consumption of connected modules, such as the CPU module, I/O modules, and intelligent function modules.
Is the module connected properly?	Check the module connection.
The case other than the above	A watchdog timer error may have occurred. Reset the CPU module, and check that the RUN LED turns on. If the RUN LED remains off, the module may be failed. Please consult your local Mitsubishi representative.

(2) When the ERR.LED turns on or flashes

(a) When turning on

Check item	Action
Has any error occurred?	Check Latest error code (Un\G19), and take actions described in the error code list. • Error Code List (☞ Page 315, Section 11.4)

(b) When flashing

Check item	Action
Is the value other than 0 set for Switch 5 of the intelligent function module switch setting?	With the parameter setting, set 0 for Switch 5 in the intelligent function module switch setting.

(3) When the ALM LED turns on or flashes

(a) When turning on

Check item	Action
Have an input signal error and other alarms simultaneously occurred?	Check Input signal error detection flag (Un\G49), Warning output flag (Un\G2048), and Latest error code (Un\G19). For the action, refer to the following. • Error Code List (☞ Page 315, Section 11.4) • Alarm Code List (☞ Page 324, Section 11.5)

(b) When flashing (at intervals of 1s)

Check item	Action
Has any alarm occurred?	Check Latest error code (Un\G19), and take actions described in the alarm code list. • Alarm Code List (☞ Page 324, Section 11.5)

(c) When flashing faster (at intervals of 0.5s)

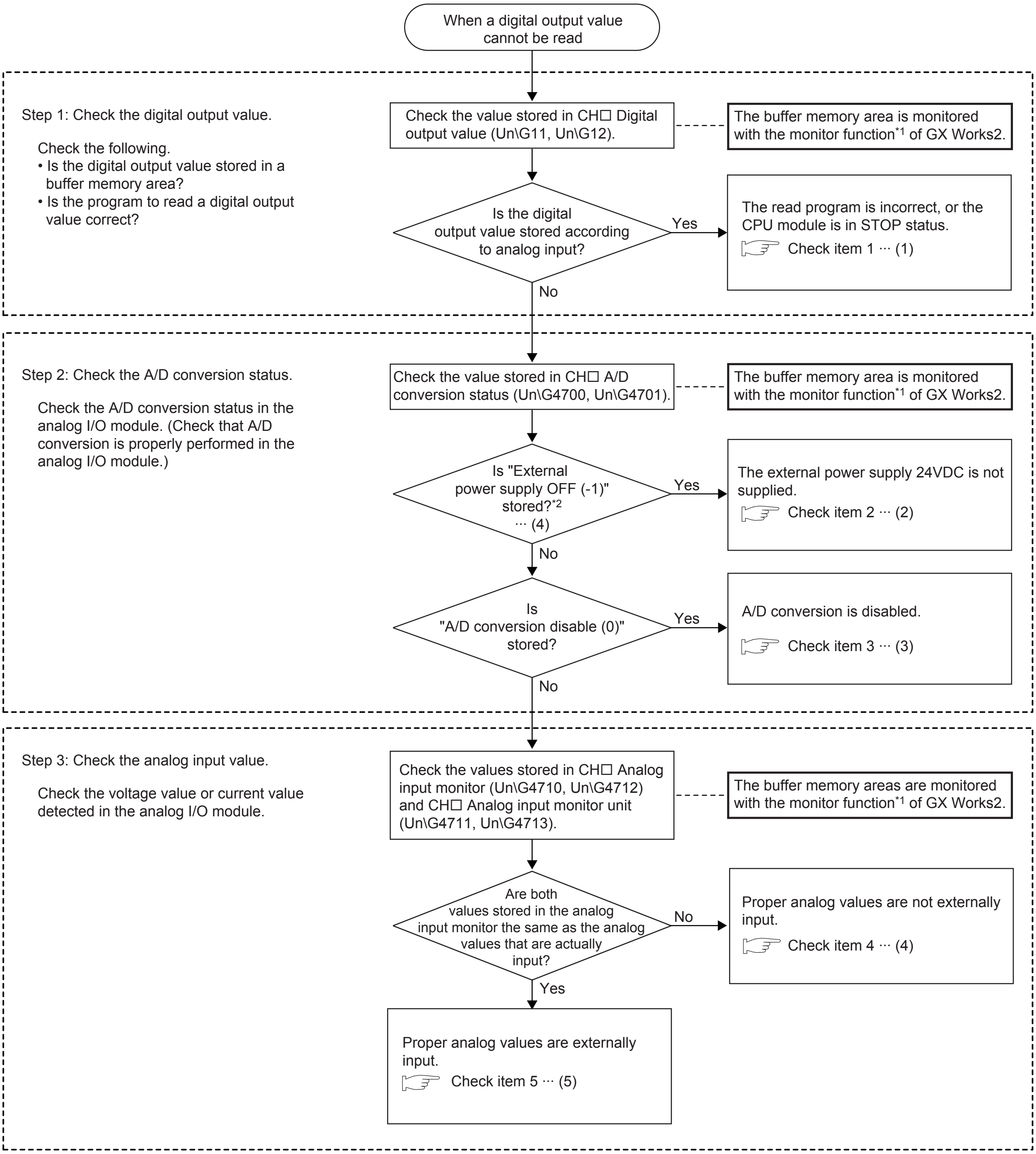
Check item	Action
Has any input signal error occurred?	Check Input signal error detection flag (Un\G49). Input signal error detection flag (Un\G49) turns on when an analog input value becomes the input signal error detection upper limit value or greater, or input signal error detection lower limit value or smaller. When Input signal error detection flag (Un\G49) is on, check the external wiring, voltage value or current value of analog input signal.

11.6.2 Troubleshooting for the A/D conversion

A/D conversion

(1) When a digital output value cannot be read

Check the cause with the flowchart below.



(1) ☞ Page 331, Section 11.6.2 (1) (a)
(2) ☞ Page 332, Section 11.6.2 (1) (b)
(3) ☞ Page 332, Section 11.6.2 (1) (c)
(4) ☞ Page 332, Section 11.6.2 (1) (d)
(5) ☞ Page 333, Section 11.6.2 (1) (e)

*1 Use "Device/Buffer Memory Batch" or "Intelligent Function Module Monitor" to monitor the buffer memory areas.
*2 The status of external power supply 24VDC can be checked with External power supply READY flag (X7) as well. For details, refer to the following.
External power supply READY flag (X7) (☞ Page 345, Appendix 1.1 (3))

Point

If the digital output value cannot be read even after the above actions are taken, the analog I/O module may be failed. Please consult your local Mitsubishi representative.

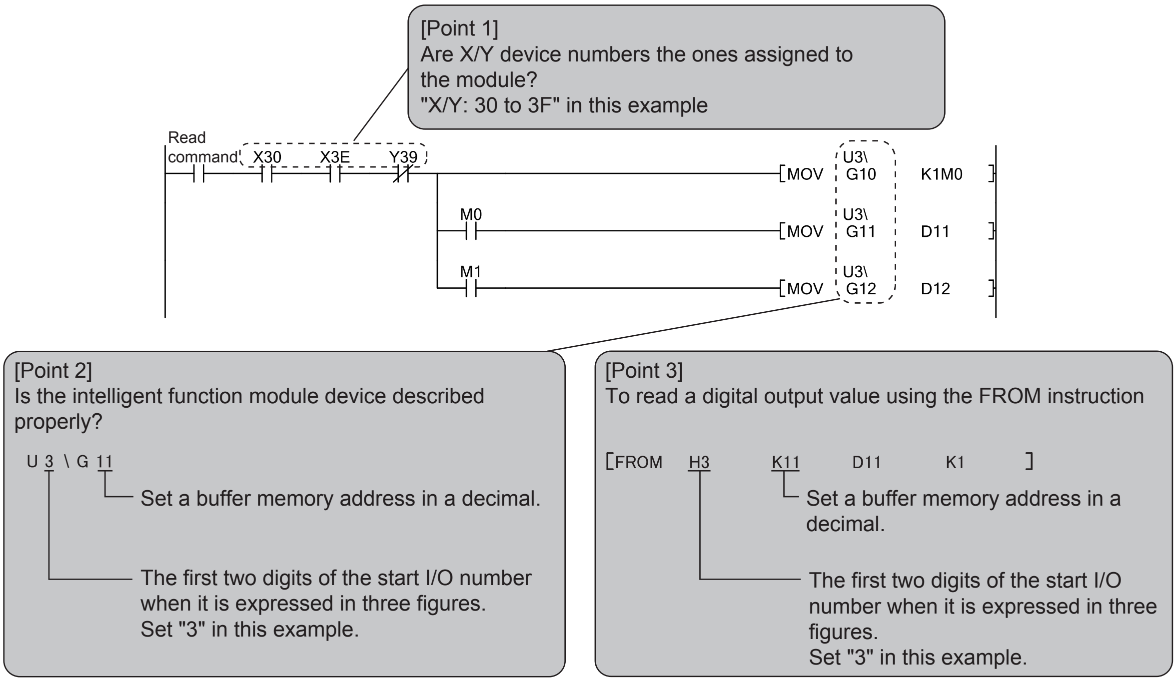
(a) Check item 1

The read program is incorrect, or the CPU module is in STOP status. Check the following items.

Check item	Action
Is the program to read a digital output value correct?	Check CH□ Digital output value (Un\G11, Un\G12). If the digital output value is stored according to the analog input, correct the read program.
Is the auto refresh setting correct?	If the value in CH□ Digital output value (Un\G11, Un\G12) is transferred to the device of the CPU module using auto refresh, check that the auto refresh setting is correct.
Is the CPU module in the STOP status?	Change the status of the CPU module to RUN.

Point

The following are the points to check the read program.
- Program example for the analog I/O module where the start I/O number is set to X/Y30



(b) Check item 2

The external power supply 24VDC is not supplied. Check the following item.

Check item	Action
Is the external power supply 24VDC supplied?	Supply 24VDC to the external power supply terminal (pin number 16, 17).

(c) Check item 3

A/D conversion is disabled. Check the following items.

Check item	Action
Is A/D conversion disable (1) set to A/D conversion enable/disable setting (Un\G0) of the channel to input a value?	Check A/D conversion enable/disable setting (Un\G0) and set A/D conversion enable (0) using a program or parameter setting.
Has Operating condition setting request (Y9) been executed?	Turn on and off Operating condition setting request (Y9)*1 and check that a digital output value is stored in CH□ Digital output value (Un\G11, Un\G12). If a correct value is stored, check the program whether the descriptions of Operating condition setting request (Y9) is correct.

*1 If Operating condition setting request (Y9) is on, A/D conversion does not start. Therefore, check that Operating condition setting completed flag (X9) is off after turning on Operating condition setting request (Y9), and turn off Operating condition setting request (Y9).

(d) Check item 4

An analog value is not properly input from outside. Check the following items.

Check item	Action
Is there any problem with wiring, such as off or disconnection of analog signal lines?	Check the faulty area by checking the signal line visually or conductively.
Are the terminals (V+) and (I+) connected at the current input?	For the current input, connect the terminals (V+) and (I+) by referring to the external wiring example. • External Wiring (☞ Page 52, Section 6.4)
Is there any potential difference between the AG terminal and the external device GND?	If the wiring is long, a potential difference may occur between the AG terminal and the external device GND, and A/D conversion may not be performed properly. Connect the AG terminal and the external device GND to eliminate the potential difference.
Is the same external device GND used for all channels?	If the same external device GND is used for all channels, noise occurs between channels and some errors may occur in A/D converted values. Connect the AG terminal and the external device GND to eliminate the errors.

(e) Check item 5

An analog value is properly input from outside. Check the following items in order.

No.	Check item	Action
1	Is the input range setting correct?	Check Setting range (Un\G20). If the input range setting is incorrect, correct the switch setting.
2	Has any input signal error occurred?	A digital output value is not updated if an input signal error is detected. Check if Input signal error detected (3) is set to CH☐ A/D conversion status (Un\G4700, Un\G4701). If Input signal error detected (3) is set, check the values in Input signal error detection setting (Un\G27) and CH☐ Input signal error detection setting value (Un\G142, Un\G143) to check that the input signal error detection upper limit value and the input signal error detection lower limit value are appropriate. For details on the input signal error detection function, refer to the following. • Input Signal Error Detection Function (☞ Page 93, Section 8.8) If the values are appropriate, change the analog input value so that an input signal error does not occur.
3	Is the offset/gain setting correct?	After turning on and off Operating condition setting request (Y9), compare the values of CH1 User range settings offset value (Un\G210) to CH2 User range settings gain value (Un\G213) with the values in the range reference tables. If the stored values are not desired offset/gain value, perform the offset/gain setting again. For the range reference table, refer to the following. • Range reference table (☞ Page 279, Section 8.26 (3))

Point

An input signal error may be detected in the following cases even though the analog input signal has a correct value.

- When the value for input range setting, Input signal error detection setting (Un\G27), or CH☐ Input signal error detection setting value (Un\G142, Un\G143) is incorrect
- When the offset/gain setting is not properly configured with the user range setting being used

A digital output value is not updated if an input signal error is detected.
When checking whether a digital output value can be properly read or not at the system start-up, check the operation with the input signal error detection function being disabled to prevent the misunderstanding of the cause of a problem. Enable the input signal error detection function after checking that a digital output value was properly read.

(2) When A/D conversion completed flag does not turn on in normal mode

Check item	Action
Has any input signal error occurred?	Check Input signal error detection flag (Un\G49).

(3) When a digital output value does not fall within the range of accuracy

Check item	Action
Is any measure against noise taken?	Take measures against noise, such as using a shielded cable for connection.

(4) When a digital output value cannot be read while the variable conversion characteristics function is used

Check the following items in order.

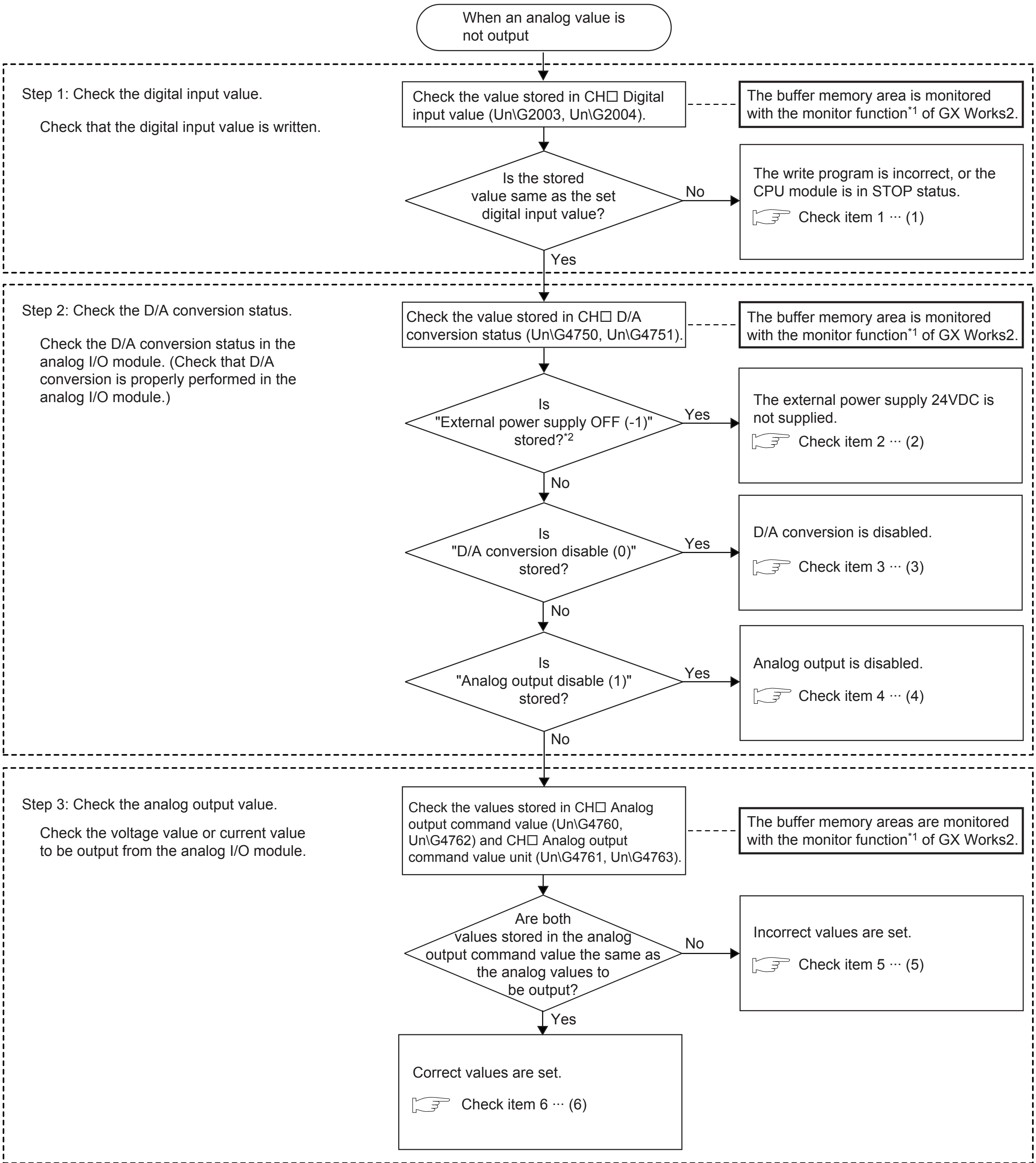
No.	Check item		Action
1	Check the switch setting.	Is the drive mode setting correct?	Check that Offset/gain setting mode flag (XA) is off. Then, check the normal mode is set to the drive mode setting. If the normal (A/D conversion processing, D/A conversion processing) mode is not set, set the normal mode to the drive mode setting.
		Is "Select Function" correctly set?	Check that Function selection monitor (Un\G21) is set to the variable conversion characteristics function. If the variable conversion characteristics function is not set, set "Free Conversion Characteristics Function" or "Free Conversion Characteristics Function + Free Operation Function" to "Select Function" in "Switch Setting".
2	Check the program.	Is Analog output (1) set to Variable conversion characteristics table selection (Un\G4100)?	Check Variable conversion characteristics table selection (Un\G4100) and set Analog input (0) or Analog I/O (2).
		Is A/D conversion disable (1) set to A/D conversion enable/disable setting (Un\G0) of the channel for which the variable conversion characteristics function is used?	Check A/D conversion enable/disable setting (Un\G0) and set A/D conversion enable (0).
		Is D/A conversion disable (1) set to D/A conversion enable/disable setting (Un\G2000) of the corresponding output channel when Analog I/O (2) is set to Variable conversion characteristics table selection (Un\G4100)?	Check D/A conversion enable/disable setting (Un\G2000) and set D/A conversion enable (0).
		Is a value written in Conversion characteristics table (Un\G5000 to Un\G37000)?	Check the value in Conversion characteristics table (Un\G5000 to Un\G37000).
		Has Operating condition setting request (Y9) been executed?	Turn on and off Operating condition setting request (Y9) to enable the parameter setting of the variable conversion characteristics function.
3	Check the connection method.	Is the external power supply 24VDC supplied?	Check External power supply READY flag (X7), and if the flag is off, supply a 24VDC to the external power supply terminal (terminal number 16, 17).

11.6.3 Troubleshooting for the D/A conversion

D/A conversion

(1) When an analog value is not output

Check the cause with the flowchart below.



(1) ☞ Page 336, Section 11.6.3 (1) (a)
(2) ☞ Page 337, Section 11.6.3 (1) (b)
(3) ☞ Page 337, Section 11.6.3 (1) (c)
(4) ☞ Page 337, Section 11.6.3 (1) (d)
(5) ☞ Page 337, Section 11.6.3 (1) (e)
(6) ☞ Page 337, Section 11.6.3 (1) (f)

*1 Use "Device/Buffer Memory Batch Monitor" or "Intelligent Function Module Monitor".
*2 The status of external power supply 24VDC can be checked with External power supply READY flag (X7) as well. For details, refer to the following.
External power supply READY flag (X7) (☞ Page 345, Appendix 1.1 (3))

Point

If the analog output value does not come out even after the above actions are taken, the module may be failed. Please consult your local Mitsubishi representative.

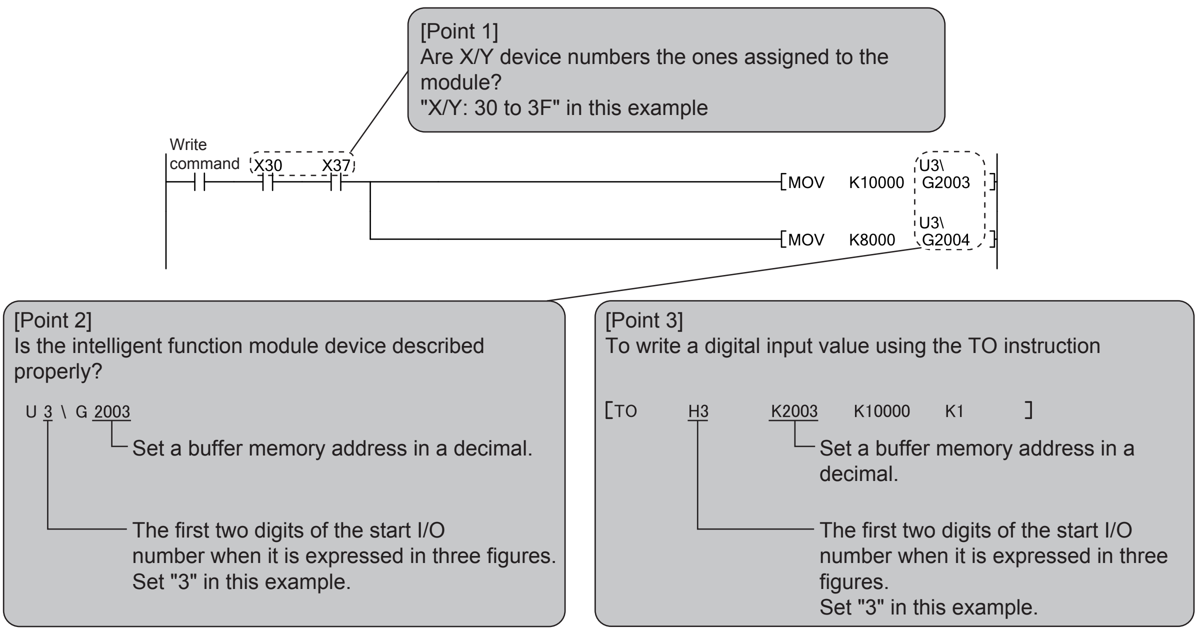
(a) Check item 1

The write program is incorrect, or the CPU module is in STOP status. Check the following items.

Check item	Action
Is the program to write a digital input value correct?	Check CH□ Digital input value (Un\G2003, Un\G2004). If the value set to CH□ Digital input value (Un\G2003, Un\G2004) is not stored, correct the write program.
Is the auto refresh setting correct?	If the stored value in the device of the CPU module is transferred to CH□ Digital input value (Un\G2003, Un\G2004) using auto refresh, check that the auto refresh setting is correct.
Is the CPU module in the STOP status?	Change the status of the CPU module to RUN.

Point

The following are the points to check the write program.
- Program example for the analog I/O module where the start I/O number is set to X/Y30



(b) Check item 2

The external power supply 24VDC is not supplied. Check the following item.

Check item	Action
Is the external power supply 24VDC supplied?	Supply 24VDC to the external power supply terminal (pin number 16, 17).

(c) Check item 3

D/A conversion is disabled. Check the following items.

Check item	Action
Is D/A conversion disable (1) set to D/A conversion enable/disable setting (Un\G2000) of the channel to output a value?	Check D/A conversion enable/disable setting (Un\G2000), and set D/A conversion enable (0) using a program or parameter setting.
Has Operating condition setting request (Y9) been executed?	Turn on and off Operating condition setting request (Y9) and check that the analog output is performed properly. If the analog output is performed properly, check the program whether the descriptions of Operating condition setting request (Y9) is correct.

(d) Check item 4

Analog output is disabled. Check the following item.

Check item	Action
Is CH☐ Output enable/disable flag (Y3, Y4) of the channel to output a value off?	Check the status of CH☐ Output enable/disable flag (Y3, Y4). If CH☐ Output enable/disable flag (Y3, Y4) is off, correct the program. In addition, check that the CPU module is not in the STOP status.

(e) Check item 5

A setting value is incorrect. Check the following items.

Check item	Action
Is the output range setting correct?	Check Setting range (Un\G20). If the output range setting is incorrect, correct the switch setting.
Is the offset/gain setting correct?	After turning on and off Operating condition setting request (Y9), compare the values of CH3 User range settings offset value (Un\G214) to CH4 User range settings gain value (Un\G217) with the values in the range reference tables. If the stored values are not desired offset/gain value, perform the offset/gain setting again. For the range reference table, refer to the following. • Range reference table (☞ Page 279, Section 8.26 (3))

(f) Check item 6

A correct value is set to each setting. Check the following item.

Check item	Action
Is there any problem with wiring, such as off or disconnection of analog signal lines?	Check the faulty area by checking the signal line visually or conductively.

(2) When an analog value is not output with the wave output function being selected

Check the following items in order.

No.	Check item		Action
1	Check the switch setting.	Is the drive mode setting correct?	Check that Offset/gain setting mode flag (XA) is off. Then, check the normal mode is set to the drive mode setting. If the normal (A/D conversion processing, D/A conversion processing) mode is not set, set the normal mode to the drive mode setting.
		Is the select function correctly set?	Check Function selection monitor (Un\G21) and confirm that the wave output function is set. If the wave output function is not set, set "Wave Output Function" to "Select Function" in "Switch Setting".
		Is the user range setting selected?	If "Wave Output Function" is set to "Select Function" in "Switch Setting", the user range setting cannot be selected for the output range. If the user range setting is set to the output range, set the value other than the user range setting.
2	Check the program.	Is D/A conversion disable (1) set to D/A conversion enable/disable setting (Un\G2000) of the channel to output a wave signal?	Check D/A conversion enable/disable setting (Un\G2000) and set D/A conversion enable (0).
		Has Operating condition setting request (Y9) been executed?	Turn on and off Operating condition setting request (Y9) to enable the parameter setting of the wave output function.
		Is any value written to Wave data registry area (Un\G5000 to Un\G54999) which is used for the channel to output a wave signal?	Check the value in Wave data registry area (Un\G5000 to Un\G54999) which is used for the channel to output a wave signal. During a pause of the wave output, the monitors of the wave output function can be checked. After setting HOLD to the analog output HOLD/CLEAR function, set Wave output pause request (2) to CH☐ Wave output start/stop request (Un\G3002, Un\G3003) to pause the wave output. Then, check the monitors.
		Is Wave output stop request (0) set to CH☐ Wave output start/stop request (Un\G3002, Un\G3003) of the channel to output a wave signal?	Check CH☐ Wave output status monitor (Un\G3102, Un\G3103) of the channel to output a wave signal. If Wave output stop (0) is set to CH☐ Wave output status monitor (Un\G3102, Un\G3103), set Wave output start request (1) to CH☐ Wave output start/stop request (Un\G3002, Un\G3003).
		Is CH☐ Output enable/disable flag (Y3, Y4) of the channel to output a wave signal off?	Check the status of CH☐ Output enable/disable flag (Y3, Y4). If CH☐ Output enable/disable flag (Y3, Y4) is off, correct the program.
3	Check the connection method.	Is the external power supply 24VDC supplied?	Check External power supply READY flag (X7), and if the flag is off, supply a 24VDC to the external power supply terminal (terminal number 16, 17).

Point

For details on the wave output function, refer to the following.
- Wave Output Function (☞ Page 144, Section 8.18)

(3) When HOLD of analog output value is not available

Check item	Action
Is the analog output HOLD/CLEAR function setting correct?	Check HOLD/CLEAR function setting (Un\G2026). If the HOLD/CLEAR function setting is incorrect, correct the switch setting.
Is the analog I/O module used with the head module?	Refer to the points in the following section and check that the setting is configured for using the analog output HOLD/CLEAR function with the head module. • Analog Output HOLD/CLEAR Function (☞ Page 127, Section 8.14)

(4) When an analog value is not output with the variable arithmetic function being selected

Check the following items in order.

No.	Check item		Action
1	Check the switch setting.	Is the drive mode setting correct?	Check that Offset/gain setting mode flag (XA) is off. Then, check the normal mode is set to the drive mode setting. If the normal (A/D conversion processing, D/A conversion processing) mode is not set, set the normal mode to the drive mode setting.
		Is "Select Function" correctly set?	Check that Function selection monitor (Un\G21) is set to the variable arithmetic function. If the variable arithmetic function is not set, set "Free Operation Function" or "Free Conversion Characteristics Function + Free Operation Function" to "Select Function" in "Switch Setting".
		Is the user range setting selected?	When "Free Operation Function" or "Free Conversion Characteristics Function + Free Operation Function" is set to "Select Function" in "Switch Setting", the user range setting cannot be set to the output range. If the user range setting is set to the output range, set a range other than the user range setting.
2	Check the program.	Is A/D conversion disable (1) set to the specified channel of A/D conversion enable/disable setting (Un\G0) when CH☐ Digital output value (Un\G11, Un\G12) is specified for a polynomial expression?	Check A/D conversion enable/disable setting (Un\G0) and set A/D conversion enable (0).
		Is D/A conversion disable (1) set to D/A conversion enable/disable setting (Un\G2000) of the channel for which the variable arithmetic function is used?	Check D/A conversion enable/disable setting (Un\G2000) and set D/A conversion enable (0).
		Has arithmetic expression data been registered?	Register the arithmetic expression data using the arithmetic expression creation tool.
		Has Operating condition setting request (Y9) been executed?	Turn on and off Operating condition setting request (Y9) to enable the parameter setting of the variable conversion characteristics function.
		Is CH☐ Output enable/disable flag (Y3, Y4) of the channel to output the result of the arithmetic expression off?	Check the status of CH☐ Output enable/disable flag (Y3, Y4). If CH☐ Output enable/disable flag (Y3, Y4) is off, correct the program.
3	Check the connection method.	Is the external power supply 24VDC supplied?	Check External power supply READY flag (X7), and if the flag is off, supply a 24VDC to the external power supply terminal (terminal number 16, 17).

(5) When an analog value is not output with the variable conversion characteristics function being selected

Check the following items in order.

No.	Check item		Action
1	Check the switch setting.	Is the drive mode setting correct?	Check that Offset/gain setting mode flag (XA) is off. Then, check the normal mode is set to the drive mode setting. If the normal (A/D conversion processing, D/A conversion processing) mode is not set, set the normal mode to the drive mode setting.
		Is "Select Function" correctly set?	Check that Function selection monitor (Un\G21) is set to the variable arithmetic function. If the variable conversion characteristics function or the variable conversion characteristics function + variable arithmetic function is not set, set "Free Conversion Characteristics Function" or "Free Conversion Characteristics Function + Free Operation Function" to "Select Function" in "Switch Setting".
2	Check the program.	Is Analog input (0) set to Variable conversion characteristics table selection (Un\G4100)?	Check Variable conversion characteristics table selection (Un\G4100) and set Analog output (1) or Analog I/O (2).
		Is D/A conversion disable (1) set to D/A conversion enable/disable setting (Un\G2000) of the channel for which the variable conversion characteristics function is used?	Check D/A conversion enable/disable setting (Un\G2000) and set D/A conversion enable (0).
		Is A/D conversion disable (1) set to A/D conversion enable/disable setting (Un\G0) of the corresponding output channel when Analog I/O (2) is set to Variable conversion characteristics table selection (Un\G4100)?	Check A/D conversion enable/disable setting (Un\G0) and set A/D conversion enable (0).
		Is a value written in Conversion characteristics table (Un\G5000 to Un\G37000)?	Check the value in Conversion characteristics table (Un\G5000 to Un\G37000).
		Has Operating condition setting request (Y9) been executed?	Turn on and off Operating condition setting request (Y9) to enable the parameter setting of the variable conversion characteristics function.
		Is CH□ Output enable/disable flag (Y3, Y4) of the channel for which the variable conversion characteristics function is used off?	Check the status of CH□ Output enable/disable flag (Y3, Y4). If CH□ Output enable/disable flag (Y3, Y4) is off, correct the program.
3	Check the connection method.	Is the external power supply 24VDC supplied?	Check External power supply READY flag (X7), and if the flag is off, supply a 24VDC to the external power supply terminal (terminal number 16, 17).

(6) When an analog value is not output with the PID control function being selected

Check the following items in order.

No.	Check item		Action
1	Check the switch setting.	Is the drive mode setting correct?	Check that Offset/gain setting mode flag (XA) is off. Then, check the normal mode is set to the drive mode setting. If the normal (A/D conversion processing, D/A conversion processing) mode is not set, set the normal mode to the drive mode setting.
		Is "Select Function" correctly set?	Check that Function selection monitor (Un\G21) is set to the PID control function. If the PID control function is not set, set "PID Control Function" to "Select Function" in "Switch Setting".
		Is the user range setting selected?	If "PID Control Function" is set to "Select Function" in "Switch Setting", the user range setting cannot be selected for the input range or output range. If the user range setting is set to the input range and output range, set a range other than the user range setting.
2	Check the program.	Is D/A conversion disable (1) set to D/A conversion enable/disable setting (Un\G2000) of the channel for which the PID control function is used?	Check D/A conversion enable/disable setting (Un\G2000) and set D/A conversion enable (0).
		Is A/D conversion disable (1) set to A/D conversion enable/disable setting (Un\G0) of the channel for which the PID control function is used?	Check A/D conversion enable/disable setting (Un\G0) and set A/D conversion enable (0).
		Is CH□ Output enable/disable flag (Y3, Y4) of the channel for which the PID control function is used off?	Check the status of CH□ Output enable/disable flag (Y3, Y4). If CH□ Output enable/disable flag (Y3, Y4) is off, correct the program.
		Has Operating condition setting request (Y9) been executed?	Turn on and off Operating condition setting request (Y9) to enable the parameter setting of the PID control function.
		Is a value outside the setting range set in Control cycle setting (Un\G4321, Un\G4401)?	Check the value of Control cycle setting (Un\G4321, Un\G4401) and set a value within the setting range.
		Is Manual mode (1) set in Control mode monitor (Un\G4300, Un\G4380)?	When a result of the PID operation is output in analog, set Automatic mode (0) in Control mode switching (Un\G4320, Un\G4400). Check that Automatic mode (0) is set in Control mode monitor (Un\G4300, Un\G4380).
		Is Auto-tuning status (Un\G4303, Un\G4383) in execution (b0: On)?	Check Auto-tuning status (Un\G4303, Un\G4383) is not in execution (b0: Off), and perform PID control.
3	Check the manipulated value (MV).	Has any input signal error occurred?	Check Input signal error detection flag (Un\G49).
4	Check the connection method.	Is the external power supply 24VDC supplied?	Check External power supply READY flag (X7), and if the flag is off, supply a 24VDC to the external power supply terminal (terminal number 16, 17).

11.7 Checking the Status of Analog I/O Module by the System Monitor

To check the LED status or the setting status of the intelligent function module switch setting, select "H/W information" of the analog I/O module on the system monitor of GX Works2.

(1) Hardware LED information

LED status is displayed.

<table>
<tr><th>No.</th><th>LED name</th><th>Status</th></tr>
<tr><td>1)</td><td>RUN LED</td><td rowspan="3">0000H: Indicates that the LED is off.
0001H: Indicates that the LED is on.
Alternating indication between 0000H and 0001H: Indicates that the LED is flashing.
(GX Works2 displays the communication status with the analog I/O module. The values 0000H and 0001H are not always displayed evenly.)</td></tr>
<tr><td>2)</td><td>ERR. LED</td></tr>
<tr><td>3)</td><td>ALM LED</td></tr>
</table>

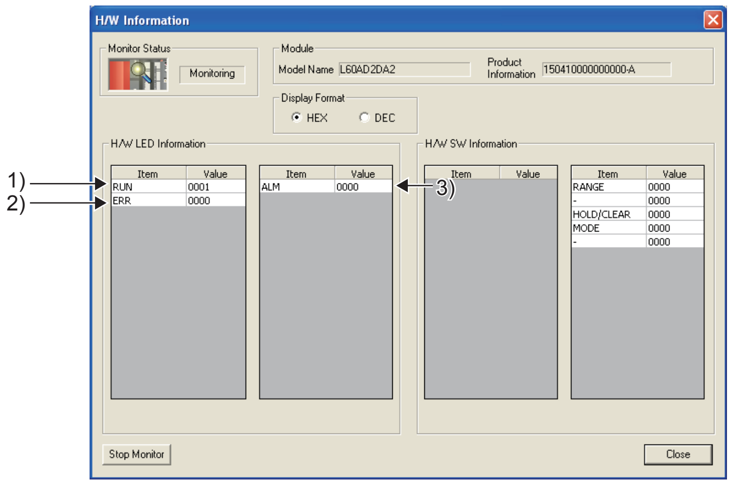
(2) Hardware switch information

The setting status of the intelligent function module switch setting is displayed.

For details on the setting status, refer to the following.

- Intelligent function module switch setting (☞ Page 450, Appendix 9.1 (2))

Item	Intelligent function module switch
RANGE	Switch 1
—	Switch 2
HOLD/CLEAR	Switch 3
MODE	Switch 4
—	Switch 5



Memo

APPENDICES

Appendix 1 Details of I/O Signals

The following describes the details of the I/O signals for the analog I/O module which are assigned to the CPU module. The I/O numbers (X/Y) described in Appendix 1 are for the case when the start I/O number of the analog I/O module is set to 0.

Appendix 1.1 Input signal

(1) Module READY (X0) Common

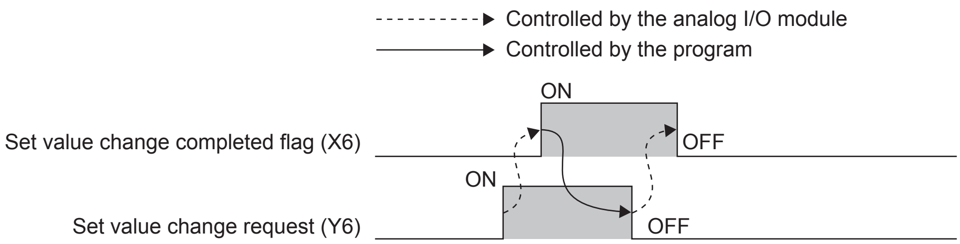
Module READY (X0) turns on to indicate that the preparation for the A/D and D/A conversions is completed after the power-on or after the reset operation of the CPU module.
In the following cases, Module READY (X0) turns off.

- In the offset/gain setting mode (In this case, the A/D and D/A conversions are performed.)
- When a watchdog timer error occurs in the analog I/O module (A/D conversion processing and D/A conversion processing are not performed.)

(2) Set value change completed flag (X6) D/A conversion

This signal is used as an interlock condition to turn on and off Set value change request (Y6) when the offset/gain setting is adjusted on the D/A conversion channels (CH3 and CH4).
For details on the offset/gain setting, refer to the following.

- Offset/gain Setting (☞ Page 61, Section 7.5)



(a) When the external power supply is off

Set value change completed flag (X6) does not turn on. Turn on the external power supply, and turn on and off Set value change request (Y6) again.

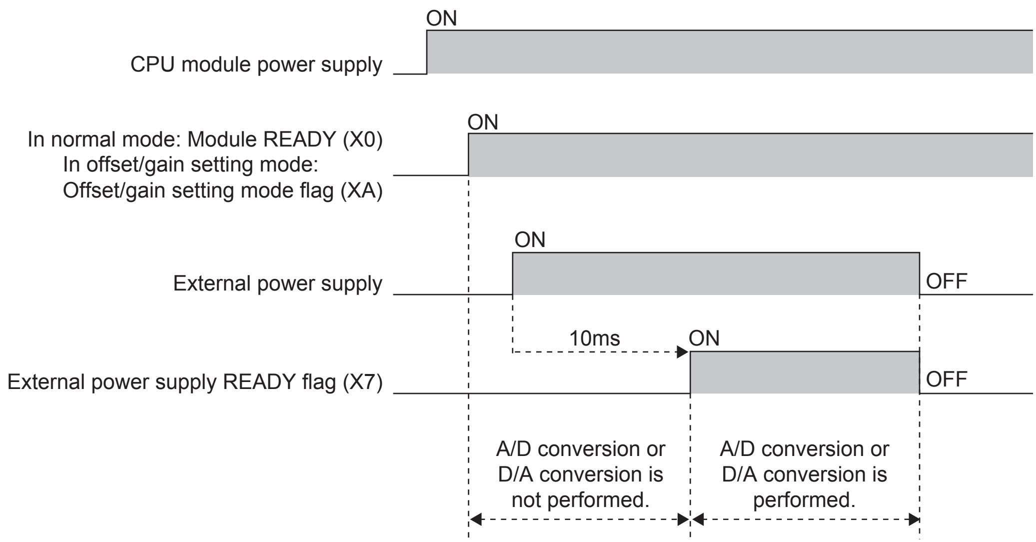
(3) External power supply READY flag (X7) Common

(a) When the external power supply is off or before a lapse of 10ms after the power-on of the supply

External power supply READY flag (X7) remains off and A/D conversion processing and D/A conversion processing are not performed.
In this situation, A/D conversion completed flag (XE) turns off.
Additionally, the analog output values of the D/A conversion channels (CH3, CH4) become 0mA/0V.

(b) When the external power supply turns on

After 10ms, External power supply READY flag (X7) turns on. The A/D conversion processing and D/A conversion processing are started on the channels where the conversion is enabled.



(c) When the external power supply turns off

External power supply READY flag (X7) turns off and the A/D conversion processing and D/A conversion processing stop.
In this situation, A/D conversion completed flag (XE) turns off.
In addition, the analog output values of the D/A conversion channels (CH3, CH4) become 0mA/0V.

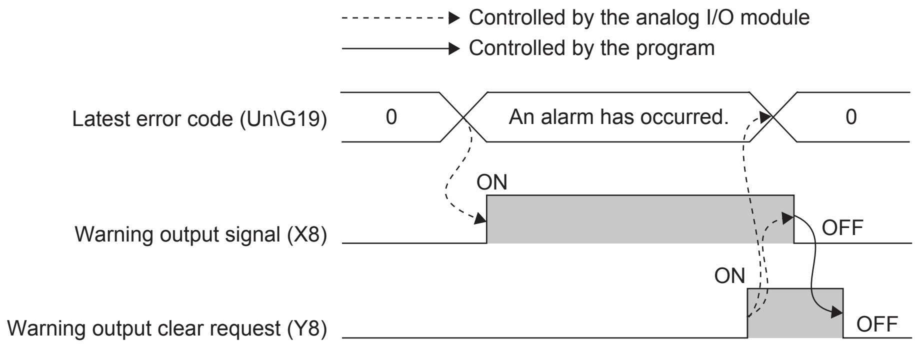
Under the above condition, if the external power supply is turned on again, External power supply READY flag (X7) operates as shown in above (b) and the A/D conversion processing or D/A conversion processing resume.

Point

Use the external power supply which satisfies the specifications described in the performance specifications (☞ Page 25, Section 3.2 (3))
If the external power supply in use does not satisfy the specifications, External power supply READY flag (X7) may not turn on.

(4) Warning output signal (X8) D/A conversion

Warning output signal (X8) turns on when an alarm (excluding an input signal error) occurs on either of the channels.



(a) Turning off Warning output signal (X8)

Warning output signal (X8) turns off by performing either of the following two operations.

- Turning on and off Warning output clear request (Y8)
- Turning on and off Operating condition setting request (Y9)

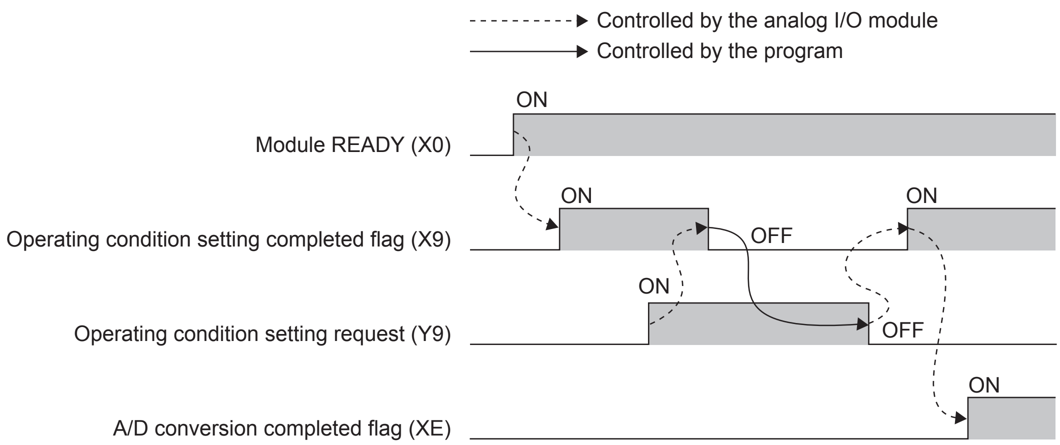
If an alarm code has been stored in Latest error code (Un\G19), the alarm code is cleared to 0.
Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

(5) Operating condition setting completed flag (X9) Common

This signal is used as an interlock condition to turn on and off Operating condition setting request (Y9) when the value of a buffer memory area is changed. For the buffer memory items for which turning on and off Operating condition setting request (Y9) is required to enable a new value when the setting value is changed, refer to the following.

- List of Buffer Memory Addresses (☞ Page 32, Section 3.5)

When Operating condition setting completed flag (X9) is off, the A/D conversion is not performed.
When Operating condition setting request (Y9) is on, Operating condition setting completed flag (X9) turns off.



A

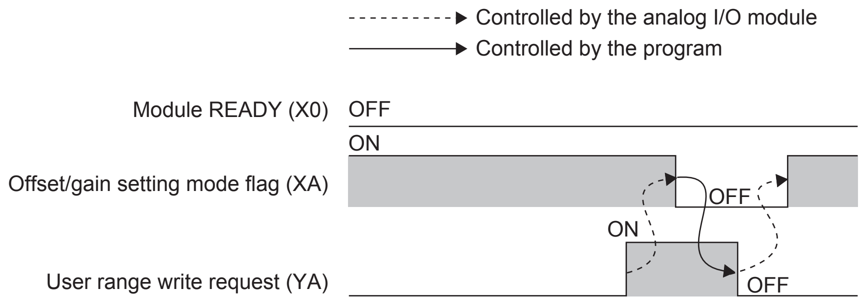
(6) Offset/gain setting mode flag/Arithmetic expression data write status flag (XA) Common

(a) Offset/gain setting mode

This signal is used as an interlock condition to turn on and off User range write request (YA) when an offset value or the gain value which is adjusted with the offset/gain setting is registered.

For details on the offset/gain setting, refer to the following.

- Offset/gain Setting (☞ Page 61, Section 7.5)

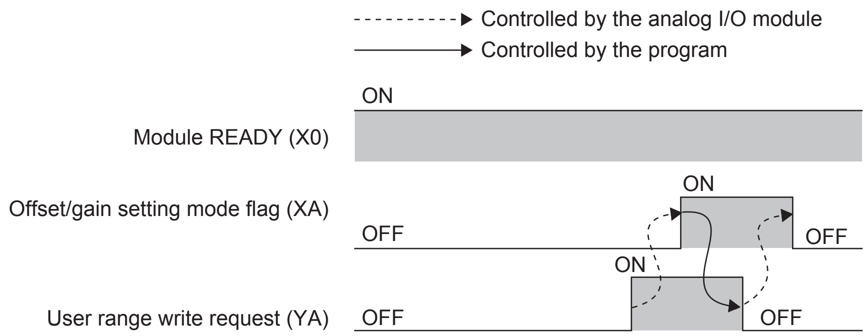


(b) Normal mode (logging function)

This signal is used as an interlock condition to turn on and off User range write request (YA) when the user range setting is restored.

For details on restoration of the user range setting, refer to the following.

- Save/Restoration of Offset/Gain Value (☞ Page 274, Section 8.26)

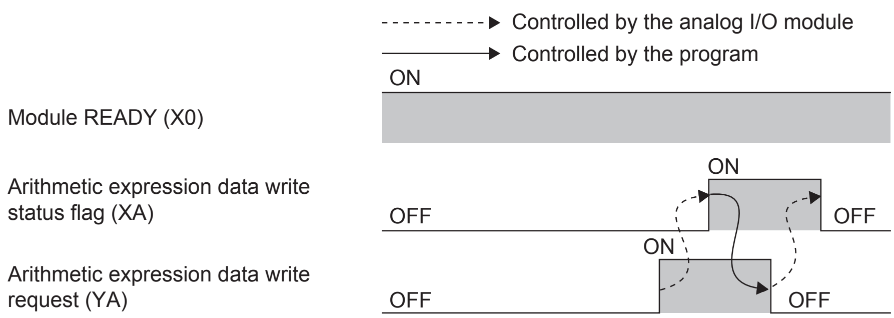


(c) Normal mode (variable arithmetic function, variable conversion characteristics function + variable arithmetic function)

This signal is used as an interlock condition to turn on and off Arithmetic expression data write request (YA) when arithmetic expression data is written.

For details on writing of arithmetic expression data, refer to the following.

- Variable Arithmetic Function (☞ Page 192, Section 8.19)

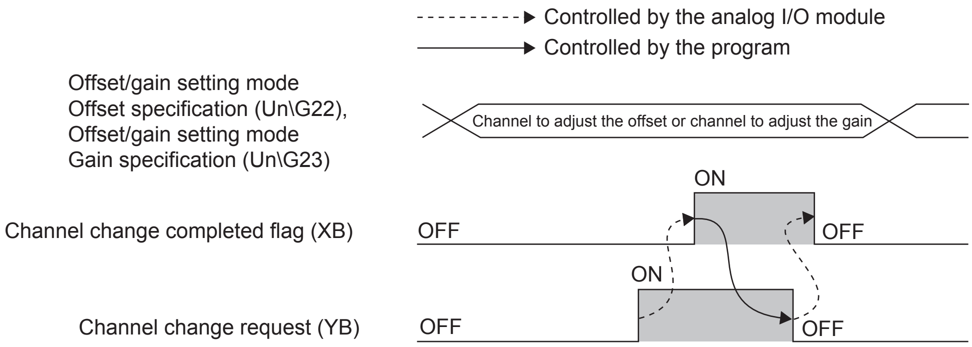


(7) Channel change completed flag (XB) Common

This signal is used as an interlock condition to turn on and off Channel change request (YB) when the channel for which the offset/gain setting is configured is changed.

For details on the offset/gain setting, refer to the following.

- Offset/gain Setting (☞ Page 61, Section 7.5)



(a) When the external power supply is off

Channel change completed flag (XB) does not turn on. Turn on the external power supply, and turn on and off Channel change request (YB) again.

(8) Input signal error detection signal (XC) A/D conversion

(a) Turning on Input signal error detection signal (XC)

This signal turns on when a detection condition is set to Input signal error detection setting (Un\G27) and the analog input value exceeds the range set in CH☐ Input signal error detection setting value (Un\G142, Un\G143) in any of the channels where A/D conversion is enabled. When the disconnection detection is set, the setting for CH☐ Input signal error detection setting value (Un\G142, Un\G143) is ignored, and this signal turns on at disconnection detection.

When Input signal error detection signal (XC) turns on, the following subsequent events occur.

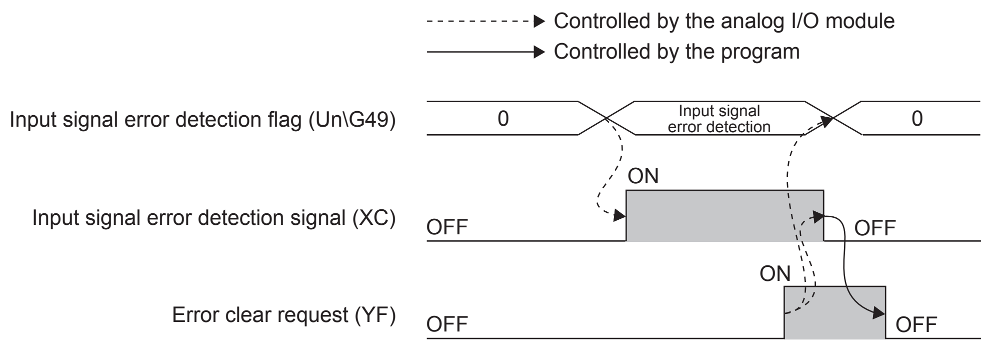
- A/D conversion completed flag (Un\G10) of the channel where the error was detected turns off (0).
- The channel where the error was detected holds the preceding digital output value and scaling value just before the error detection in the buffer memory.
- The ALM LED flashes.

(b) Turning off Input signal error detection signal (XC)

Input signal error detection signal (XC) turns off by turning on and off Error clear request (YF) after the analog input value falls within the setting range.

When Input signal error detection signal (XC) turns off, the following subsequent events occur.

- Turns off the ALM LED.
- Latest error code (Un\G19) is cleared.

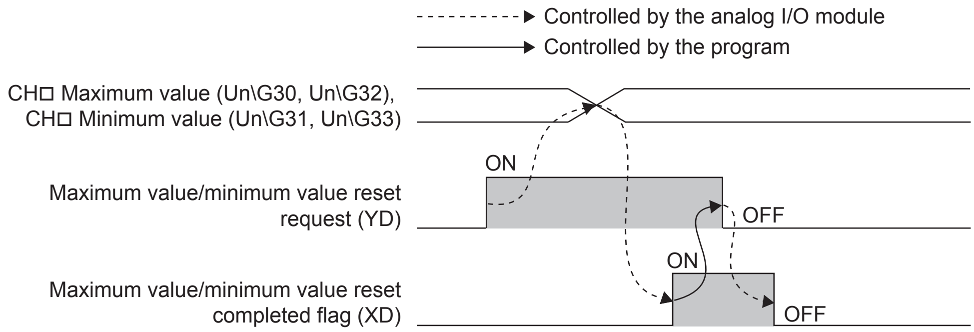


Point

- After the analog input value falls within the setting range, A/D conversion is resumed without turning on and off Error clear request (YF). However, the ON state of Input signal error detection signal (XC) and the flashing state of the ALM LED are not changed.
- When the first A/D conversion after the resumption is completed, A/D conversion completed flag (Un\G10) turns to A/D conversion completed (1).
- Averaging processing starts over after the A/D conversion resumes.

(9) Maximum value/minimum value reset completed flag (XD) A/D conversion

This signal turns on when the maximum value stored in CH☐ Maximum value (Un\G30, Un\G32) or the minimum value stored in CH☐ Minimum value (Un\G31, Un\G33) is reset by turning on Maximum value/minimum value reset request (YD).
When Maximum value/minimum value reset request (YD) is turned off after Maximum value/minimum value reset completed flag (XD) turns on, Maximum value/minimum value reset completed flag (XD) turns off.

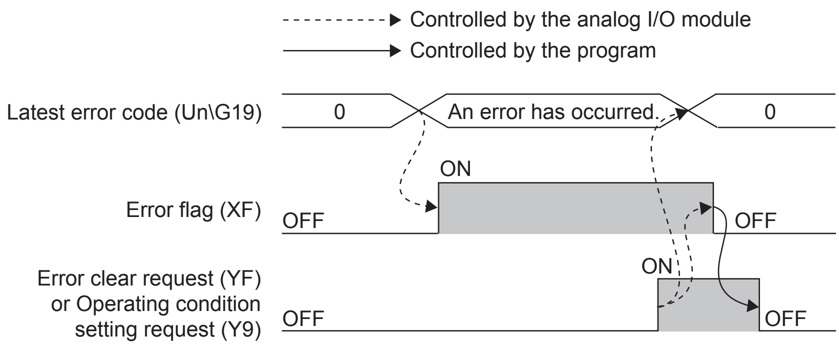


(10) A/D conversion completed flag (XE) A/D conversion

A/D conversion completed flag (XE) turns on at the time when the first A/D conversion is complete on all the channels where A/D conversion is enabled.
When the external power supply turns off, A/D conversion completed flag (XE) turns off and A/D conversion stops. The digital output value and scaling value stored before the external power supply turns off are held.
When the external power supply turns on, A/D conversion is resumed and A/D conversion completed flag (XE) turns on at the time when the first A/D conversion is complete on all the channels where A/D conversion is enabled. Averaging processing starts over after the A/D conversion resumes.

(11) Error flag (XF) Common

This flag turns on when an error occurs.



(a) Turning off Error flag (XF)

Error flag (XF) turns off by eliminating the error cause and performing either of the following two operations.

- Turning on and off Error clear request (YF)
- Turning on and off Operating condition setting request (Y9)

When Error clear request (YF) or Operating condition setting request (Y9) is turned on, Error flag (XF) and Latest error code (Un\G19) are cleared.
Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

Appendix 1.2 Output signal

(1) CH□ Output enable/disable flag (Y3, Y4) D/A conversion

This signal is used to set whether to output the D/A conversion value or the offset value, for each channel.
ON: D/A conversion value
OFF: Offset value

(a) D/A conversion speed

The conversion speed varies depending on the number of D/A conversion enabled channels regardless of the on/off state of CH□ Output enable/disable flag (Y3, Y4).
For details on the D/A conversion speed, refer to the following.

- Enable/Disable Setting and Conversion Speed of A/D and D/A Conversion (☞ Page 81, Section 8.2)

(2) Set value change request (Y6) D/A conversion

Turn on and off this signal to increase or decrease the analog output value at adjustment for the offset/gain setting on D/A conversion channels (CH3 and CH4).
The analog output value is changed according to the value set in Offset/gain adjustment value specification (Un\G2024).
For details on the timing of turning on and off, refer to the following.

- Set value change completed flag (X6) (☞ Page 344, Appendix 1.1 (2))

For details on the offset/gain setting, refer to the following.

- Offset/gain Setting (☞ Page 61, Section 7.5)

(3) Warning output clear request (Y8) D/A conversion

Turn on and off this signal to clear an alarm (except for input signal errors).
For details on the timing of turning on and off, refer to the following.

- Warning output signal (X8) (☞ Page 346, Appendix 1.1 (4))

(4) Operating condition setting request (Y9) Common

Turn on and off this signal to enable the initial setting of the analog I/O module.
For details on the timing of turning on and off, refer to the following.

- Operating condition setting completed flag (X9) (☞ Page 346, Appendix 1.1 (5))

For the setting items of the buffer memory that are enabled, refer to the following.

- List of Buffer Memory Addresses (☞ Page 32, Section 3.5)

When an error or warning output has occurred, eliminating the error cause and turning on and off this signal clears the error or warning output.
When the wave output function is used, check that CH□ Wave output status monitor (Un\G3102, Un\G3103) for CH3 and CH4 is set to Wave output stop (0) before turning on and off this signal.

(5) User range write request/Arithmetic expression data write request (YA) Common

(a) Offset/gain setting mode

Turn on and off this signal to register the adjustment value of the offset/gain setting in the analog I/O module. When this signal is turned on, the data is written in the flash memory.

For details on the timing of turning on and off, refer to the following.

- Offset/gain setting mode flag (XA) (☞ Page 347, Appendix 1.1 (6))

For details on the offset/gain setting, refer to the following.

- Offset/gain Setting (☞ Page 61, Section 7.5)

(b) Normal mode (logging function)

Turn on and off this signal to restore the user range setting.

For details on the timing of turning on and off, refer to the following.

- Offset/gain setting mode flag (XA) (☞ Page 347, Appendix 1.1 (6))

For details on restoration of the user range setting, refer to the following.

- Save/Restoration of Offset/Gain Value (☞ Page 274, Section 8.26)

(c) Normal mode (variable arithmetic function, variable conversion characteristics function + variable arithmetic function)

Turn on and off this signal to register arithmetic expression data in the analog I/O module. When turning on and off this signal, set 434CH to Un\G4098 and 5354H to Un\G4099 of Arithmetic expression data write setting (Un\G4098, Un\G4099).

Only when A/D conversion enable/disable setting (Un\G0) and D/A conversion enable/disable setting (Un\G2000) are set to 1 (conversion is disabled) for all the channels, this request is accepted and the arithmetic expression data is written in the flash memory. If A/D conversion enable/disable setting (Un\G0) or D/A conversion enable/disable setting (Un\G2000) is set to 0 (conversion is enabled) for any channel, an error (error code: 403□) occurs and the arithmetic expression data is not written in the flash memory.

For details on the timing of turning on and off, refer to the following.

- Offset/gain setting mode flag/Arithmetic expression data write status flag (XA) (☞ Page 347, Appendix 1.1 (6))

(6) Channel change request (YB) Common

Turn on and off this signal to change the channel for which the offset/gain setting is configured.

For details on the timing of turning on and off, refer to the following.

- Channel change completed flag (XB) (☞ Page 348, Appendix 1.1 (7))

For details on the offset/gain setting, refer to the following.

- Offset/gain Setting (☞ Page 61, Section 7.5)

(7) Maximum value/minimum value reset request (YD) A/D conversion

Turn on and off this signal to reset CH□ Maximum value (Un\G30, Un\G32) and CH□ Minimum value (Un\G31, Un\G33).

For details on the timing of turning on and off, refer to the following.

- Maximum value/minimum value reset completed flag (XD) (☞ Page 350, Appendix 1.1 (9))

(8) Error clear request (YF) Common

Turn on and off this signal to clear Error flag (XF), Input signal error detection signal (XC), and Latest error code (Un\G19).

For details on the timing of turning on and off, refer to the following.

- Input signal error detection signal (XC) (☞ Page 349, Appendix 1.1 (8))
- Error flag (XF) (☞ Page 350, Appendix 1.1 (11))

Appendix 2 Details of Buffer Memory Addresses

The following describes the details of the buffer memory addresses of the analog I/O module.

(1) A/D conversion enable/disable setting (Un\G0) A/D conversion

Set whether to enable or disable A/D conversion for each channel.

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	CH2	CH1

Data for b2 to b15 are fixed to "0".

0: A/D conversion enable
1: A/D conversion disable

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to A/D conversion disable (1).

Point

When the mode is switched from the offset/gain setting mode to the normal mode, all channels are set to A/D conversion disable (1).

(2) CH□ Time Average/Count Average/Moving Average (Un\G1, Un\G2) A/D conversion

Set average time, an average count, and moving average by channel where the averaging process setting is enabled.

- The following table lists the setting range.

Processing method	Setting range
Time average	2 to 5000 (ms)
Count average	4 to 62500 (times)*1
Moving average	2 to 1000 (times)

*1 When a program is used to set 32768 to 62500 (times), set the value in hexadecimal. For example, to set 62500 (times), set F424H.

- When a value outside the above range is written, an error occurs on the corresponding channel. The corresponding error code is stored in Latest error code (Un\G19), Error flag (XF) turns on, and A/D conversions are performed using the previous setting.
- On a channel where Averaging process setting (Un\G24) has been set to Sampling processing (0), any setting for this area is ignored.
- The time average and count average processing cannot be used when the PID control function is used. When the PID control function is used and Time average (1H) or Count average (2H) is set for Averaging process setting (Un\G24), the setting value in CH□ Time Average/Count Average/Moving Average (Un\G1, Un\G2) is ignored.

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to 0.

Point

The default value is 0. Change the value according to the processing method.

(3) A/D conversion completed flag (Un\G10) A/D conversion

A/D conversion status can be checked with this flag.

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	CH2	CH1

Data for b2 to b15 are fixed to "0".

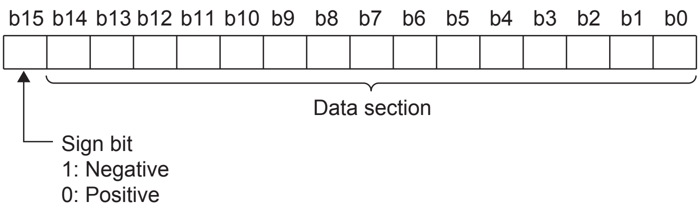
1: A/D conversion completed
0: During A/D conversion or unused

(a) A/D conversion completion

When the first A/D conversion is completed in the channel where the A/D conversion is enabled, the flag turns to A/D conversion completed (1). A/D conversion completed flag (XE) turns on when the conversion of all the channels where the A/D conversion is enabled is completed.
Turning on and off Operating condition setting request (Y9) turns the flag back to its default "During A/D conversion or unused (0)", and when the first A/D conversion is complete, the flag turns to A/D conversion completed (1).

(4) CH□ Digital output value (Un\G11, Un\G12) A/D conversion

The A/D-converted digital output value is stored in 16-bit signed binary.
When the PID control function is used, the process value (PV) for which the digital filter processing has been performed is stored.



(a) Updating cycle

If averaging processing is used, values are updated every set averaging process cycle. Otherwise values are updated every sampling cycle.

(b) Resetting the stored value

If any of the following operations is performed when the variable conversion characteristics function or the variable conversion characteristics function + variable arithmetic function is used, CH□ Digital output value (Un\G11, Un\G12) is reset.

- Changing the setting value of Variable conversion characteristics table selection (Un\G4100) and turning on and off Operating condition setting request (Y9)
- Changing the setting value of Variable conversion characteristics range setting (Un\G4101) and turning on and off Operating condition setting request (Y9) when Analog input (0) or Analog I/O (2) is set in Variable conversion characteristics table selection (Un\G4100)

(5) Latest error code (Un\G19) Common

The latest error code or alarm code, which the analog I/O module detects, is stored.
For details on error codes and alarm codes, refer to the following.

- Error Code List (☞ Page 315, Section 11.4)
- Alarm Code List (☞ Page 324, Section 11.5)

(a) Clearing an error

Turn on and off Error clear request (YF) or Operating condition setting request (Y9).
Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

(6) Setting range (Un\G20) Common

The input range and output range that have been set using the Switch Setting can be checked with this area.

b15 to b12	b11 to b8	b7 to b4	b3 to b0
CH4	CH3	CH2	CH1
Output range		Input range	

Input range and output range	Stored value
4 to 20mA	0H
0 to 20mA	1H
1 to 5V	2H
0 to 5V	3H
-10 to 10V	4H
0 to 10V	5H
4 to 20mA (Extended mode)	AH
1 to 5V (Extended mode)	BH
User range setting (Current)	EH
User range setting (Voltage)	FH

Point

The input range and output range cannot be changed using Setting range (Un\G20).
To change the input range and output range, change the Switch Setting.
For the Switch Setting, refer to the following.

- Switch Setting (☞ Page 55, Section 7.2)

(7) Function selection monitor (Un\G21) Common

The function that has been selected using the Switch Setting for Intelligent Function Module can be checked with this area.

Function	Stored value
Logging function	0H
Wave output function	1H
Variable arithmetic function	2H
Variable conversion characteristics function	3H
Variable conversion characteristics function + variable arithmetic function	4H
PID control function	5H

Point

The function cannot be changed using Function selection monitor (Un\G21).
To change the function, change the Switch Setting.
For the Switch Setting, refer to the following.

- Switch Setting (Page 55, Section 7.2)

(8) Offset/gain setting mode Offset specification (Un\G22), Offset/gain setting mode Gain specification (Un\G23) Common

Specify the channel to perform the offset/gain setting adjustment.

- Offset/gain setting mode Offset specification (Un\G22): channel to adjust the offset
- Offset/gain setting mode Gain specification (Un\G23): channel to adjust the gain

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Offset/gain setting mode Offset specification (Un\G22)	0	0	0	0	0	0	0	0	0	0	0	0	CH4	CH3	CH2	CH1
Offset/gain setting mode Gain specification (Un\G23)	0	0	0	0	0	0	0	0	0	0	0	0	CH4	CH3	CH2	CH1

Data for b4 to b15 are fixed to "0".

1: Setting-target channel
0: Disable

(a) Enabling the setting

In the offset/gain setting mode, turn on and off Channel change request (YB) to enable the setting.

(b) Default value

All channels are set to Disable (0).

Point

- The offset/gain setting can be configured for the A/D conversion channels (CH1, CH2) simultaneously, but not for the D/A conversion channels (CH3, CH4). If CH3 and CH4 are set simultaneously, the error (error code: 501) occurs.
- Set either Offset/gain setting mode Offset specification (Un\G22) or Offset/gain setting mode Gain specification (Un\G23) to Disable (0).
  When both settings are configured simultaneously, the error (error code: 500) occurs.
- For details of the offset/gain setting, refer to the following.
  - Offset/gain Setting (Page 61, Section 7.5)

(9) Averaging process setting (Un\G24) A/D conversion

Select sampling processing or averaging processing for each channel.
When averaging processing is selected, time average, count average, or moving average can be selected.

b15 to b8	b7 to b4	b3 to b0
Fixed to 0	CH2	CH1

Processing method	Setting value
Sampling processing	0H
Time average	1H
Count average	2H
Moving average	3H

- A channel where a value out of the above setting range is written operates with the sampling processing.
- The time average and count average processing cannot be used when the PID control function is used. When the PID control function is used and Time average (1H) or Count average (2H) is set, the setting value is ignored and the corresponding channel operates with the sampling processing.

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to Sampling processing (0).

(10)Input signal error detection setting (Un\G27) A/D conversion

To use the input signal error detection function, set the method of detecting input signal errors for each channel.
For details of the input signal error detection function, refer to the following.

- Input Signal Error Detection Function (☞ Page 93, Section 8.8)

b15 to b8	b7 to b4	b3 to b0
Fixed to 0	CH2	CH1

Detection method	Setting value
Disable	0H
Upper and Lower Detection	1H
Lower Detection	2H
Upper Detection	3H
Disconnection Detection	4H

- When a value outside the above range is set, an error occurs on the corresponding channel. The error code (81□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to Disable (0).

Point

Disconnection Detection (4) is valid only when the input range is set as 4 to 20mA (extended mode) or 1 to 5V (extended mode). When the channel with another range is set to Disconnection Detection (4), an error occurs. The error code (82□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(11)CH□ Maximum value (Un\G30, Un\G32), CH□ Minimum value (Un\G31, Un\G33)

A/D conversion

The maximum digital output value and minimum digital output value are stored in 16-bit signed binary.
When the following operations are performed, CH□ Maximum value (Un\G30, Un\G32) and CH□ Minimum value (Un\G31, Un\G33) are updated.

- When Maximum value/minimum value reset request (YD) is turned on and off
- When turning on and off Operating condition setting request (Y9) changes the setting

Point

- For the channel to which the averaging processing is specified, the maximum and minimum values are stored at averaging processing time intervals.
- If the scaling function is enabled, the maximum scaling value and minimum scaling value are stored.

(12)Input signal error detection flag (Un\G49) A/D conversion

Input signal status can be checked with this flag.

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	CH2	CH1

Data for b2 to b15 are fixed to "0".

0: Normal
1: Input signal error

(a) Input signal error detection flag (Un\G49) status

- When an analog input value exceeding the setting range for CH□ Input signal error detection setting value (Un\G142, Un\G143) is detected, Input signal error detection flag (Un\G49) corresponding to each channel is turned to Input signal error (1).
- Even when an error is detected on just one of channels where A/D conversion and input signal error detection are enabled, Input signal error detection signal (XC) turns on.

(b) Clearing Input signal error detection flag (Un\G49)

To clear Input signal error detection flag (Un\G49), adjust the analog input value so that it falls within the setting range and turn on and off Error clear request (YF).
Turning on and off Operating condition setting request (Y9) also clears Input signal error detection flag (Un\G49), but A/D conversion and D/A conversion are reset and are resumed from the beginning.

(13)A/D conversion scaling enable/disable setting (Un\G53) A/D conversion

Set whether to enable or disable scaling for each channel.
For details of the scaling function (A/D conversion), refer to the following.

- Scaling Function (A/D Conversion) (☞ Page 100, Section 8.9)

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	CH2	CH1

Data for b2 to b15 are fixed to "0".

0: Enable
1: Disable

When the variable conversion characteristics function is used, the scaling function (A/D conversion) cannot be used. If any of the following settings is set in "Select Function" of "Switch Setting" and Variable conversion characteristics table selection (Un\G4100), an error occurs in the channel where A/D conversion scaling enable/disable setting (Un\G53) is set to Enable (0). The error code (500□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

Combination No.	Select function	Variable conversion characteristics table selection (Un\G4100)
1	Free Conversion Characteristics Function	Analog input (0)
2	Free Conversion Characteristics Function	Analog I/O (2)
3	Free Conversion Characteristics Function + Free Operation Function	Analog input (0)
4	Free Conversion Characteristics Function + Free Operation Function	Analog I/O (2)

(a) Enabling the setting

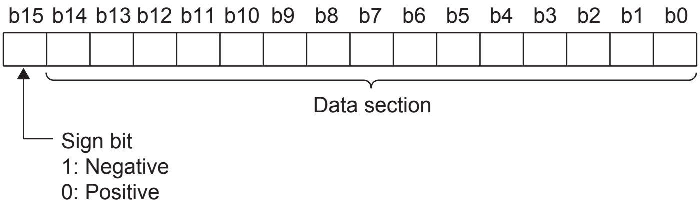
Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to Disable (1).

(14)CH□ Scaling value (Un\G54, Un\G55) A/D conversion

The scaling value calculated by using the scaling function (A/D conversion) is stored in 16-bit signed binary.



(a) Updating cycle

If averaging processing is used, values are updated every set averaging process cycle. Otherwise values are updated every sampling cycle.

Point

- When the scaling function (A/D conversion) is not used, the values same as CH□ Digital output value (Un\G11, Un\G12) are stored.
- When the PID control function is used and A/D conversion scaling enable/disable setting (Un\G53) is set to Enable, the process value (PV) obtained in scale conversion is stored in this area.

(15)CH☐ A/D conversion scaling lower limit value (Un\G62, Un\G64), CH☐ A/D conversion scaling upper limit value (Un\G63, Un\G65) A/D conversion

Set the range of scale conversion for each channel.
For details on the scaling function, refer to the following.

- Scaling Function (A/D Conversion) (☞ Page 100, Section 8.9)

(a) Setting range

- The setting range is between -32000 and 32000. If the relation between the values is A/D conversion scaling lower limit value > A/D conversion scaling upper limit value, the scale conversion can be performed according to a negative slope.
- Set different values for the A/D conversion scaling upper limit value and A/D conversion scaling lower limit value. If the same value is set, an error occurs. The error code (91☐) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- If a value outside the setting range is set, an error occurs on the corresponding channel. The error code (90☐) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- When A/D conversion scaling enable/disable setting (Un\G53) is set to Disable (1), the settings for CH☐ A/D conversion scaling lower limit value (Un\G62, Un\G64) and CH☐ A/D conversion scaling upper limit value (Un\G63, Un\G65) are ignored.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 0.

Point

The default value is 0. To use the scaling function (A/D conversion), change the value.

(16)CH□ Input signal error detection setting value (Un\G142, Un\G143) A/D conversion

Set the setting value to detect an error for an input analog value for each channel.

For details of the input signal error detection function, refer to the following.

- Input Signal Error Detection Function (☞ Page 93, Section 8.8)

(a) Setting range

- The setting range is between 0 and 250 (0 to 25.0%). Set it in a unit of 1 (0.1%).
- When a value outside the above range is set, an error occurs on the corresponding channel. The error code (80□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- The input signal error detection upper and lower limit values are calculated as follows based on the input signal error detection setting value. The calculated input signal error detection upper and lower limit values vary depending on the input range used.

[Input signal error detection upper limit value]

$$= \text{Gain value of each range} + \left(\text{Gain value of each range} - \text{Offset value of each range}\right) \times \frac{\text{Input signal error detection setting value}}{1000}$$

[Input signal error detection lower limit value]

$$= \text{Lower limit value of each range} + \left(\text{Gain value of each range} - \text{Offset value of each range}\right) \times \frac{\text{Input signal error detection setting value}}{1000}$$

Ex. When the input signal error detection setting value is set to 100 (10%)

Range used: 4 to 20mA

The upper and lower limit values of input signal error detection are as follows:

$$\text{Input signal error detection upper limit value} = 20 + (20 - 4) \times \frac{100}{1000} = 21.6\text{mA}$$

$$\text{Input signal error detection lower limit value} = 4 - (20 - 4) \times \frac{100}{1000} = 2.4\text{mA}$$

- Conditions vary as follows depending on the setting in Input signal error detection setting (Un\G27).

Input signal error detection setting (Un\G27)	Detection condition
Upper and Lower Detection (1)	Input signal error detection upper limit value or input signal error detection lower limit value
Lower Detection (2)	Input signal error detection lower limit value
Upper Detection (3)	Input signal error detection upper limit value
Disconnection Detection (4)	• 2mA or lower, or 0.5V or lower • The setting for CH□ Input signal error detection setting value (Un\G142, Un\G143) is ignored. • Input ranges other than 4 to 20mA (extended mode) or 1 to 5V (extended mode) cannot be used.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 5% (50).

(17)Mode switching setting (Un\G158, Un\G159) Common

Set the setting value for the mode to be switched to.

Mode to be switched to	Setting value	
	Un\G158	Un\G159
Normal mode	0964H	4144H
Offset/gain setting mode	4144H	0964H

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) After the mode is switched

When the mode is switched, this area is cleared to 0 and Operating condition setting completed flag (X9) turns off.
After checking that Operating condition setting completed flag (X9) is off, turn off Operating condition setting request (Y9).

Point

- When "Select Function" of "Switch Setting" is set to a value other than "Logging Function", any setting value set for this area is ignored. Only the operating condition is changed. (The mode switching between the normal mode and offset/gain setting mode cannot be performed.)
  When selecting "Wave Output Function", "Free Operation Function", "Free Conversion Characteristics Function", "Free Conversion Characteristics Function + Free Operation Function", or "PID Control Function", switch the mode with "Drive Mode Setting" of "Switch Setting".
  For the Switch Setting, refer to the following.
  - Switch Setting (☞ Page 55, Section 7.2)
- When the following operations are performed, mode switching is not performed. Only the operating condition is changed.
  - A value other than the above is written and Operating condition setting request (Y9) is turned on and off.
  - A value that corresponds to the current operation mode is written and Operating condition setting request (Y9) is turned on and off.

(18)Pass data classification setting (Un\G200) Common

This area saves and restores the offset/gain setting value in user range setting.
Specify the offset/gain setting value to be saved and restored as either voltage or current.

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0	0	0	0	0	0	0	0	0	0	0	0	CH4	CH3	CH2	CH1

Data for b4 to b15 are fixed to "0".
(Even though the value is set, it is ignored.)

0: Voltage
1: Current

(19)CH1 Industrial shipment settings offset value (Un\G202) to CH4 User range settings gain value (Un\G217) Common

This area restores the offset/gain setting value in user range setting.
When the following operations are performed, the data to be used are stored (saved).

- Writing the initial setting by programming tool
- Turning on User range write request (YA) (in the offset/gain setting mode)
- Turning on Operating condition setting request (Y9)*1

*1 The data is not saved when a setting value is written to Mode switching setting (Un\G158, Un\G159).

To restore the offset/gain setting value in user range setting, set the data saved in this area in the same way for the same area in the destination analog I/O module for restoring.
For the procedure for setting offset/gain values or saving and restoring offset/gain values, refer to the following.

- Offset/gain Setting (☞ Page 61, Section 7.5)
- Save/Restoration of Offset/Gain Value (☞ Page 274, Section 8.26)

(20)CH□ Logging enable/disable setting (Un\G1000, Un\G1001) A/D conversion

Set whether to enable or disable the logging function for each channel.
For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Logging enable/disable setting	Setting value
Enable	0
Disable	1

- When a value other than the above setting values is set, an error occurs. The error code (200□) is stored in Latest error code (Un\G19). The logging function is not performed.
- When "Select Function" of "Switch Setting" is set to a value other than "Logging Function" and CH□ Logging enable/disable setting (Un\G1000, Un\G1001) is set to Enable (0), an error occurs. The error code (208□) is stored in Latest error code (Un\G19). The logging function is not performed.

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.
Enabling the setting starts the logging.

(b) Default value

All channels are set to Disable (1).

(21)CH☐ Logging hold request (Un\G1008, Un\G1009) A/D conversion

Use CH☐ Logging hold request (Un\G1008, Un\G1009) as a trigger to hold (stop) logging at any time during the logging.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Logging hold request	Setting value
OFF	0
ON	1

- When a value other than the above setting values is set, an error occurs on the corresponding channel. The error code (207☐) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. However, the logging is continued.
- When CH☐ Logging enable/disable setting (Un\G1000, Un\G1001) is set to Disable (1), the setting for CH☐ Logging hold request (Un\G1008, Un\G1009) is ignored.

(a) Operation of the logging hold processing

- When CH☐ Level trigger condition setting (Un\G1056, Un\G1057) is set to Disable (0), the logging hold processing is started by turning on CH☐ Logging hold request (Un\G1008, Un\G1009).
- When CH☐ Level trigger condition setting (Un\G1056, Un\G1057) is set to a value other than Disable (0), the logging hold processing starts when the preset level trigger condition is satisfied after CH☐ Logging hold request (Un\G1008, Un\G1009) is turned on. When enabling the level trigger, use CH☐ Logging hold request (Un\G1008, Un\G1009) as an interlock to operate the level trigger.
- If CH☐ Logging hold request (Un\G1008, Un\G1009) is turned off during the logging hold processing, the hold status is cleared and the logging restarts.

(b) Default value

All channels are set to OFF (0).

Point

The stop status of logging can be checked with CH☐ Logging hold flag (Un\G1016, Un\G1017).

(22)CH☐ Logging hold flag (Un\G1016, Un\G1017) A/D conversion

Hold (stop) status of logging can be checked with this flag.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Logging hold flag	Stored value
OFF	0
ON	1

- CH☐ Logging hold flag (Un\G1016, Un\G1017) turns on at the completion of transition from the status in which data is collected in CH☐ Logging data (Un\G5000 to Un\G24999) to the stop status.
- When the logging restarts by turning off CH☐ Logging hold request (Un\G1008, Un\G1009), CH☐ Logging hold flag (Un\G1016, Un\G1017) is turned off.

(23)CH☐ Logging data setting (Un\G1024, Un\G1025) A/D conversion

When using the logging function, set the digital output value or the scaling value as the target value for collecting.
For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Target for collecting	Setting value
Digital output value	0
Scaling value	1

- When a value other than the above setting values is set, an error occurs on the corresponding channel. The error code (203☐) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. Logging is not performed.
- When CH☐ Logging enable/disable setting (Un\G1000, Un\G1001) is set to Disable (1), the setting for CH☐ Logging data setting (Un\G1024, Un\G1025) is ignored.

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to Scaling value (1).

(24)CH☐ Logging cycle setting value (Un\G1032, Un\G1033), CH☐ Logging cycle unit setting (Un\G1040, Un\G1041) A/D conversion

Set the cycle of storing the logging data.
Set the interval at which data are collected for CH☐ Logging cycle setting value (Un\G1032, Un\G1033).
Set the unit of the interval at which data are collected for CH☐ Logging cycle unit setting (Un\G1040, Un\G1041).
For details on the logging function, refer to the following.

- Logging Function (☞ Page 109, Section 8.10 (4))

(a) Setting range

- The setting range of CH☐ Logging cycle setting value (Un\G1032, Un\G1033) depends on the setting of CH☐ Logging cycle unit setting (Un\G1040, Un\G1041).

Logging cycle unit	Setting value of CH☐ Logging cycle unit setting (Un\G1040, Un\G1041)	Setting range of CH☐ Logging cycle setting value (Un\G1032, Un\G1033)
μs	0	80 to 32767
ms	1	1 to 32767
s	2	1 to 3600

- When a value outside the above range is set in CH☐ Logging cycle setting value (Un\G1032, Un\G1033) or CH☐ Logging cycle unit setting (Un\G1040, Un\G1041), an error occurs. The error code (201☐) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. Logging is not performed.
- When the set logging cycle is shorter than the refreshing cycle of the logging target data, an error occurs. The error code (202☐) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. Logging is not performed.
- When CH☐ Logging enable/disable setting (Un\G1000, Un\G1001) is set to Disable (1), the settings for CH☐ Logging cycle setting value (Un\G1032, Un\G1033) and CH☐ Logging cycle unit setting (Un\G1040, Un\G1041) are ignored.

(b) Actual logging cycle

The actual logging cycle is an integral multiple of the conversion cycle of the digital output value or scaling value.

Ex. When the A/D conversion is performed for CH1 and CH2 with the sampling processing
→ The actual logging cycle is the integral multiple of 160μs (80μs × 2) with the value set in CH☐ Logging cycle setting value (Un\G1032, Un\G1033) and CH☐ Logging cycle unit setting (Un\G1040, Un\G1041) as the upper limit value.

(c) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(d) Default value

- For CH☐ Logging cycle setting value (Un\G1032, Un\G1033), all channels are set to 4.
- For CH☐ Logging cycle unit setting (Un\G1040, Un\G1041), all channels are set to ms (1).

(25)CH☐ Logging points after trigger (Un\G1048, Un\G1049) A/D conversion

When using the logging function, set the number of values collected over the period of time from the instant when a hold trigger event occurs to the instant when the logging stops.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

(a) Setting range

- The setting range is between 1 and 10000.
- When a value outside the above setting range is set, an error occurs on the corresponding channel. The error code (204☐) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. Logging is not performed.
- When CH☐ Logging enable/disable setting (Un\G1000, Un\G1001) is set to Disable (1), the setting for CH☐ Logging points after trigger (Un\G1048, Un\G1049) is ignored.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 5000.

(26)CH☐ Level trigger condition setting (Un\G1056, Un\G1057) A/D conversion

When using a level trigger, set the condition that causes the hold trigger.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Setting content	Setting value
Disable	0
Above	1
Below	2
Pass through	3

- When a value other than the above setting values is set, an error occurs on the corresponding channel. The error code (205☐) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. Logging is not performed.
- When CH☐ Logging enable/disable setting (Un\G1000, Un\G1001) is set to Disable (1), the setting for CH☐ Level trigger condition setting (Un\G1056, Un\G1057) is ignored.

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to Disable (0).

A

(27)CH☐ Trigger data (Un\G1064, Un\G1065) A/D conversion

When using the logging function, set the target buffer memory address for monitoring as the level trigger condition.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

(a) Setting range

- The setting range is between 0 and 4999.
- When a value outside the above setting range is set, an error occurs on the corresponding channel. The error code (206☐) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. Logging is not performed.
- When CH☐ Logging enable/disable setting (Un\G1000, Un\G1001) is set to Disable (1), the setting for CH☐ Trigger data (Un\G1064, Un\G1065) is ignored.

Point

Set the following buffer memory addresses for CH☐ Trigger data (Un\G1064, Un\G1065). For details on the buffer memory addresses, refer to the list of buffer memory addresses (☞ Page 32, Section 3.5).

- CH☐ Digital output value (Un\G11, Un\G12): 11, 12
- CH☐ Scaling value (Un\G54, Un\G55): 54, 55
- Level data ☐ (Un\G1072 to Un\G1081): 1072 to 1081
- Buffer memory addresses shown with "R" in the list of buffer memory addresses

Do not set the buffer memory addresses shown with "R/W" and "W" in the list (except for Level data ☐ (Un\G1072 to Un\G1081)) and system areas.

If the above areas are set, normal operations of the analog I/O module are not guaranteed.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

The default value is set as shown below.

Channel	Default value	Buffer memory to be monitored
CH1	54	CH1 Scaling value (Un\G54)
CH2	55	CH2 Scaling value (Un\G55)

(28)Level data ☐ (Un\G1072 to Un\G1081) A/D conversion

This area stores the data to be monitored when the level trigger of the logging function is used.

Ten types of data are available: Level data 0 (Un\G1072) to Level data 9 (Un\G1081).

Use Level data ☐ (Un\G1072 to Un\G1081) to monitor and use device values in modules other than the analog I/O module as triggers.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

(a) Setting range

The setting range is between -32768 and 32767.

(b) Default value

The default value is 0 for all the areas.

(29)CH□ Trigger setting value (Un\G1082, Un\G1083) A/D conversion

When using the logging function, set a level to cause a level trigger.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

(a) Setting range

The setting range is between -32768 and 32767.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 0.

(30)CH□ Head pointer (Un\G1090, Un\G1091) A/D conversion

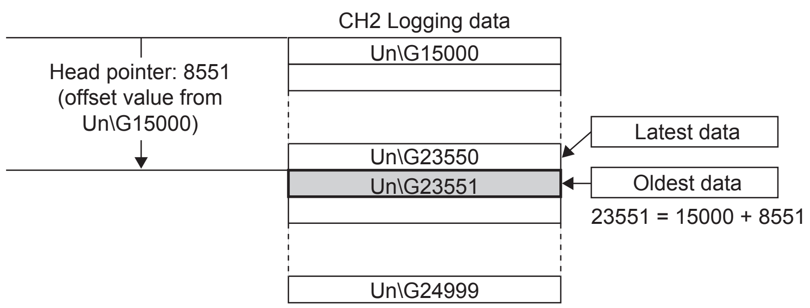
The buffer memory address of the oldest data in CH□ Logging data (Un\G5000 to Un\G24999) can be checked with this buffer memory area.

The offset value (0 to 9999) counted from the start address (CH1: Un\G5000, CH2: Un\G15000) of CH□ Logging data (Un\G5000 to Un\G24999) is stored.

For details on the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Ex. When the value of CH2 Head pointer (Un\G1091) is 8551



Point

- Until the first 10000 points have been logged from the beginning of the logging, the value in CH□ Head pointer (Un\G1090, Un\G1091) is fixed to 0 because the oldest data is stored in the start address of CH□ Logging data (Un\G5000 to Un\G24999).
  After the number of collected data points has reached 10000, a value in CH□ Head pointer (Un\G1090, Un\G1091) increases one by one each time a new data is stored.
- When CH□ Logging hold request (Un\G1008, Un\G1009) is turned off, CH□ Head pointer (Un\G1090, Un\G1091) is cleared to 0.

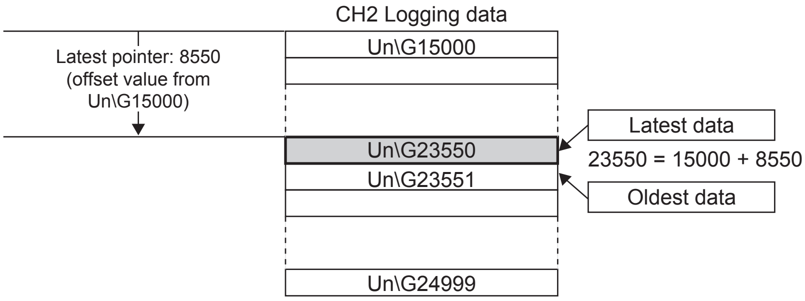
A

(31)CH□ Latest pointer (Un\G1098, Un\G1099) A/D conversion

The buffer memory address of the latest data in CH□ Logging data (Un\G5000 to Un\G24999) can be checked with this buffer memory area.
The offset value (0 to 9999) counted from the start address (CH1: Un\G5000, CH2: Un\G15000) of CH□ Logging data (Un\G5000 to Un\G24999) is stored.
For details on the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Ex. When the value of CH2 Latest pointer (Un\G1099) is 8550



Point

- After the logging starts, a value in CH□ Latest pointer (Un\G1098, Un\G1099) increases one by one each time a new value is stored.
- When CH□ Logging hold request (Un\G1008, Un\G1009) is turned off, CH□ Latest pointer (Un\G1098, Un\G1099) is cleared to 0.

(32)CH□ Number of logging data (Un\G1106, Un\G1107) A/D conversion

The number of data points stored in CH□ Logging data (Un\G5000 to Un\G24999) can be checked with this buffer memory area while logging is being performed.
For details on the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Point

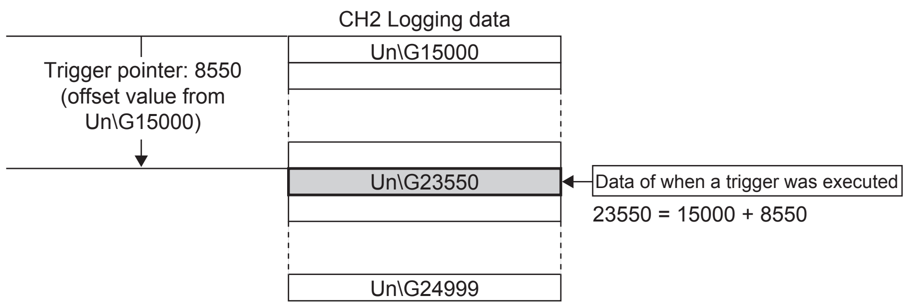
- The number of logging data in this area increases one by one each time a new value is stored from the beginning of the logging.
- After the number of logging data points reaches 10000, the stored data are overwritten from the oldest. Thus, CH□ Number of logging data (Un\G1106, Un\G1107) is fixed to 10000.
- When CH□ Logging hold request (Un\G1008, Un\G1009) is turned off, CH□ Number of logging data (Un\G1106, Un\G1107) is cleared to 0.

(33)CH☐ Trigger pointer (Un\G1114, Un\G1115) A/D conversion

The buffer memory address of CH☐ Logging data (Un\G5000 to Un\G24999) storing the data of when logging is held with hold trigger can be checked with this buffer memory area.
The offset value (0 to 9999) counted from the start address (CH1: Un\G5000, CH2: Un\G15000) of CH☐ Logging data (Un\G5000 to Un\G24999) is stored.
For details on the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Ex. When the value of CH2 Trigger pointer (Un\G1115) is 8550



Point

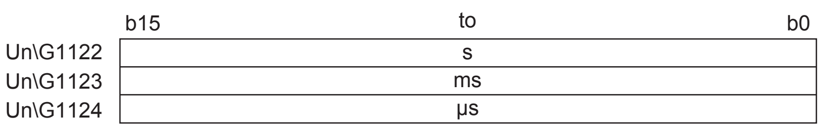
When CH☐ Logging hold request (Un\G1008, Un\G1009) is turned off, CH☐ Trigger pointer (Un\G1114, Un\G1115) is cleared to 0.

(34)CH☐ Logging cycle monitor value (Un\G1122 to Un\G1127) A/D conversion

This area stores the actual logging cycle which is calculated from the refresh cycle of data to be logged.
When Operating condition setting request (Y9) is turned on and off, the actual logging cycle is stored in CH☐ Logging cycle monitor value (Un\G1122 to Un\G1127) of the corresponding channel where the logging function is enabled.
For details on the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

The following figure shows how values are stored in CH1 Logging cycle monitor value (Un\G1122 to Un\G1124).



Ex. When the calculated logging cycle of CH1 is 6960μs

Buffer memory address	Stored value
Un\G1122	0(s)
Un\G1123	6(ms)
Un\G1124	960(μs)

(35)CH☐ Logging status monitor value (Un\G1146, Un\G1147) A/D conversion

This area stores the execution status of logging.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Logging status	Stored value
Stop (disabled)	FH
Wait for logging hold request (during logging)	0H
Wait for level trigger (during logging)	1H
Trigger detected (during logging)	2H
Logging hold complete (stop)	3H

(36)CH☐ Trigger detection time (Un\G1154 to Un\G1161) A/D conversion

The time of the occurrence of a hold trigger event is recorded.

For details of the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

The following figure shows how values are stored in CH1 Trigger detection time (Un\G1154 to Un\G1157).

	b15 to b8	b7 to b0
Un\G1154	First two digits of the year	Last two digits of the year
Un\G1155	Month	Day
Un\G1156	Hour	Minute
Un\G1157	Second	Day of the week

Item	Stored value and code	Storage example[*1]
First two digits of the year/Last two digits of the year	Stored in BCD code.	2013H
Month/Day		0501H
Hour/Minute		1234H
Second		56H
Day of the week	The value that corresponds to the day of the week is stored in BCD code. • Sunday: 00H • Monday: 01H • Tuesday: 02H • Wednesday: 03H • Thursday: 04H • Friday: 05H • Saturday: 06H	03H

*1 Values stored when a hold trigger event occurs on Wednesday May 1, 2013 at 12:34:56.

Point

- Time units shorter than one second are not recorded.
- When CH☐ Logging hold request (Un\G1008, Un\G1009) is turned off, CH☐ Trigger detection time (Un\G1154 to Un\G1161) is cleared to 0.

(37)D/A conversion enable/disable setting (Un\G2000)

D/A conversion

Set whether to enable or disable D/A conversion for each channel.

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0	0	0	0	0	0	0	0	0	0	0	0	CH4	CH3	0	0

Data for b4 to b15 are fixed to "0".

Data for b0 and b1 are fixed to "0".

0: D/A conversion enable
1: D/A conversion disable

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to D/A conversion disable (1).

Point

When the mode is switched from the offset/gain setting mode to the normal mode, all channels are set to D/A conversion disable (1).

A

(38)CH☐ Digital input value (Un\G2003, Un\G2004) D/A conversion

This area is for writing a digital input value for D/A conversion in 16-bit signed binary from the CPU module.

- The setting range is as follows:

Output range setting	When the scaling function (D/A conversion) is disabled		When the scaling function (D/A conversion) is enabled[*1]
	Setting range (practical range)	A written digital input value out of the setting range is treated as	Setting range
0: 4 to 20mA	0 to 12287 (practical range: 0 to 12000)	12288 or greater: 12287 -1 or smaller: 0	-32000 to 32000
1: 0 to 20mA			
2: 1 to 5V			
3: 0 to 5V			
4: -10 to 10V	-16384 to 16383 (practical range: -16000 to 16000)	16384 or greater: 16383 -16385 or smaller: -16384	
E: User range setting (Current)	-12288 to 12287 (practical range: -12000 to 12000)	12288 or greater: 12287 -12289 or smaller: -12288	
F: User range setting (Voltage)			

*1 The setting range valid when the scaling function (D/A conversion) is enabled and the practical range depend on the settings for the D/A conversion scaling upper limit value (Un\G2059, Un\G2061) and D/A conversion scaling lower limit value (Un\G2058, Un\G2060).

- When the value out of the setting range is written, the D/A conversion is performed with the upper and lower limit value of the setting range. In addition, a check code is stored in CH☐ Set value check code (Un\G2013, Un\G2014) and the error code (60☐) is stored in Latest error code (Un\G19).

(a) Default value

All channels are set to 0.

Point

- When the wave output function is selected, this area is disabled because registered wave data are output.
- The setting of this area is invalid for when the variable arithmetic function or variable conversion characteristics function + variable arithmetic function is selected, because outputs for Variable arithmetic value for analog output (Un\G4003, Un\G4007) are performed.
- The setting of this area is invalid for when the variable conversion characteristics function is selected and Analog I/O (2) is set in Variable conversion characteristics table selection (Un\G4100), because outputs for CH☐ Digital output value (Un\G11, Un\G12) are performed.
- The setting range of this area is different when the variable conversion characteristics function or variable conversion characteristics function + variable arithmetic function is selected and Analog output (1) is set in Variable conversion characteristics table selection (Un\G4100), because CH☐ Digital input value (Un\G2003, Un\G2004) is used as the address of the conversion characteristics table. For details, refer to the following.
  ☞ Analog output (Page 232, Section 8.20.2 (2) (b))
- When the PID control function is selected, the setting of this area is invalid because outputs using Output conversion value (Un\G4302, Un\G4382) are performed.

(39)CH□ Set value check code (Un\G2013, Un\G2014) D/A conversion

When a set digital input value is out of the setting range, a check code is stored.

(a) Check target

The check target depends on the settings of "Select Function" and Variable conversion characteristics table selection (Un\G4100).

Select function	Variable conversion characteristics table selection (Un\G4100)	Check target
Logging Function	—	CH□ Digital input value (Un\G2003, Un\G2004)
Wave Output Function	—	A digital input value currently being output in Wave data registry area (Un\G5000 to Un\G54999)*1
Free Operation Function	—	Variable arithmetic value for analog output (Un\\G4003, Un\\G4007)
Free Conversion Characteristics Function	Analog input (0)	CH□ Digital input value (Un\G2003, Un\G2004)
	Analog output (1)	A digital input value currently being output in Conversion characteristics table (Un\G5000 to Un\G37000)*2
	Analog I/O (2)	A digital input value currently being output in Conversion characteristics table (Un\G5000 to Un\G37000)*2
Free Conversion Characteristics Function + Free Operation Function	—	Variable arithmetic value for analog output (Un\\G4003, Un\\G4007)
PID Control Function	—	Output conversion value (Un\G4302, Un\G4382)

*1 The buffer memory addresses in which digital input values outside the setting range have been registered can be checked in the following:
CH3 Wave output digital value outside the range Address monitor (L) (Un\G3160) to CH4 Wave output digital value outside the range Address monitor (H) (Un\G3163) (☞ Page 394, Appendix 2 (61))

*2 The buffer memory address of the conversion characteristics table in which digital input values outside the setting range have been registered can be checked in the following:
Variable conversion characteristics digital value outside the range address monitor (Un\G4112 to Un\G4113, Un\G4122 to Un\G4123) (☞ Page 402, Appendix 2 (71))

(b) Stored check codes

Check code	Description
000FH	A digital input value exceeding the setting range has been written.
00F0H	A digital input value falling short of the setting range has been written.
00FFH	A digital input value falling short of the setting range and a digital input value exceeding the setting range have been written. The check code of 00FFH is stored, for example, when a digital input value exceeding the setting range is written, and subsequently, without the check code being reset, a digital input value falling short of the setting range is written.

Once the check code is stored, the code is not reset even when the digital input value falls within the setting range.
When the scaling function (D/A conversion) is used, the value of CH□ Digital input value (Un\G2003, Un\G2004) is scale-converted and checked.
Note that some errors may be observed in the digital input value for which a check code is stored due to the calculation error of scale conversion when a scale-converted value falls within the setting range.

(c) Resetting the check codes

Set a digital input value within the setting range and turn on and off Error clear request (YF).

(40)Offset/gain adjustment value specification (Un\G2024) D/A conversion

This area is for setting the adjustment value of analog output value in the offset/gain setting mode.

Ex. The setting value of 1000 corresponds to:
the analog adjustment value of approx. 0.32V (in voltage output) or approx. 0.69mA (in current output).

(a) Setting range

- The setting range is between -3000 and 3000.
- When a value out of the above setting range is set, an error occurs. The error code (700) is stored in Latest error code (Un\G19) and Error flag (XF) turns on.

(b) Enabling the setting

Turn on and off Set value change request (Y6) to enable the setting.

(41)HOLD/CLEAR function setting (Un\G2026) D/A conversion

The settings which have been configured for the HOLD/CLEAR function of the analog I/O module can be checked.
For details of the HOLD/CLEAR function, refer to the following.

- Analog Output HOLD/CLEAR Function (☞ Page 127, Section 8.14)

b15 to b12	b11 to b8	b7 to b0
CH4	CH3	Fixed to 0

HOLD/CLEAR function setting	Stored value
CLEAR	0H
HOLD	1 to FH (values other than 0)

Point

The setting cannot be changed using HOLD/CLEAR function setting (Un\G2026).
For changing the setting, refer to the following.

- Switch Setting (☞ Page 55, Section 7.2)

(42)Warning output setting (Un\G2047) D/A conversion

Set whether to enable or disable the warning output for each channel.
For details of the warning output function, refer to the following.

- Warning Output Function (☞ Page 141, Section 8.17)

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0	0	0	0	0	0	0	0	0	0	0	0	CH4	CH3	0	0

Data for b4 to b15 are fixed to "0".
Data for b0 and b1 are fixed to "0".
0: Enable
1: Disable

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to Disable (1).

(43)Warning output flag (Un\G2048) D/A conversion

Whether the warning is upper limit warning or lower limit warning can be checked for each channel.
For details of the warning output function, refer to the following.

- Warning Output Function (☞ Page 141, Section 8.17)

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0	0	0	0	0	0	0	0	CH4 Lower limit value	CH4 Upper limit value	CH3 Lower limit value	CH3 Upper limit value	0	0	0	0

Data for b8 to b15 are fixed to "0".

0: Normal
1: Warning output

Data for b0 to b3 are fixed to "0".

(a) Warning output flag (Un\G2048) status

When the following detection target exceeds the setting range of CH3 Warning output upper limit value (Un\G2090) to CH4 Warning output lower limit value (Un\G2093) and a warning is detected, Warning output (1) is stored in Warning output flag corresponding to the channel. The warning detection target depends on the settings of "Select Function" and Variable conversion characteristics table selection (Un\G4100).

Select function	Variable conversion characteristics table selection (Un\G4100)	Warning detection target
Logging Function	—	CH☐ Digital input value (Un\G2003, Un\G2004)
Wave Output Function	—	A value of Wave data registry area (Un\G5000 to Un\G54999) to be output
Free Operation Function	—	Variable arithmetic value for analog output (Un\\G4003, Un\\G4007)
Free Conversion Characteristics Function	Analog input (0)	CH☐ Digital input value (Un\G2003, Un\G2004)
	Analog output (1)	A value of Conversion characteristics table (Un\G5000 to Un\G37000) to be output
	Analog I/O (2)	A value of Conversion characteristics table (Un\G5000 to Un\G37000) to be output
Free Conversion Characteristics Function + Free Operation Function	—	Variable arithmetic value for analog output (Un\\G4003, Un\\G4007)
PID Control Function	—	Output conversion value (Un\G4302, Un\G4382)

Even when a warning is detected on just one of the two channels where D/A conversion and warning output are enabled, Warning output signal (X8) also turns on.

(b) Clearing Warning output flag (Un\G2048)

To clear Warning output flag (Un\G2048), set a digital input value within the setting range and turn on and off Warning output clear request (Y8).
Turning on and off Operating condition setting request (Y9) also clears Warning output flag (Un\G2048), but A/D conversion and D/A conversion are reset and are resumed from the beginning.

(44)D/A conversion scaling enable/disable setting (Un\G2053) D/A conversion

Set whether to enable or disable scaling for each channel.

For details of the scaling function (D/A conversion), refer to the following.

• Scaling Function (D/A Conversion) (☞ Page 134, Section 8.16)

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
0	0	0	0	0	0	0	0	0	0	0	0	CH4	CH3	0	0

Data for b4 to b15 are fixed to "0".

0: Enable
1: Disable

Data for b0 and b1 are fixed to "0".

When any of the following settings is set, an error occurs in the channel where D/A conversion scaling enable/disable setting (Un\G2053) is set to Enable (0). An error code is stored in Latest error code (Un\G19) and Error flag (XF) turns on.

Combination No.	Select function	Variable conversion characteristics table selection (Un\G4100)	Error code
1	Wave Output Function	—	301□
2	Free Operation Function	—	401□
3	Free Conversion Characteristics Function + Free Operation Function	—	401□
4	Free Conversion Characteristics Function	Analog output (1)	500□
5		Analog I/O (2)	500□
6	PID Control Function	—	601□

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to Disable (1).

(45)CH□ D/A conversion scaling lower limit value (Un\G2058, Un\G2060), CH□ D/A conversion scaling upper limit value (Un\G2059, Un\G2061) D/A conversion

Set the range of scale conversion for each channel.

For details of the scaling function (D/A conversion), refer to the following.

- Scaling Function (D/A Conversion) (☞ Page 134, Section 8.16)

(a) Setting range

- The setting range is between -32000 and 32000. If the relation between the values is D/A conversion scaling lower limit value > D/A conversion scaling upper limit value, the scale conversion can be performed according to a negative slope.
- Set different values for the D/A conversion scaling upper limit value and D/A conversion scaling lower limit value. If the same value is set, an error occurs. The error code (91□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- If a value outside the setting range is set, an error occurs on the corresponding channel. The error code (90□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- When D/A conversion scaling enable/disable setting (Un\G2053) is set to Disable (1), the settings for CH□ D/A conversion scaling lower limit value (Un\G2058, Un\G2060) and CH□ D/A conversion scaling upper limit value (Un\G2059, Un\G2061) are ignored.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 0.

Point

The default value is 0. To use the scaling function (D/A conversion), change the value.

(46)CH□ Warning output upper limit value (Un\G2090, Un\G2092), CH□ Warning output lower limit value (Un\G2091, Un\G2093) D/A conversion

Set the upper and lower limit values of the warning output range.
For details of the warning output function, refer to the following.

- Warning Output Function (☞ Page 141, Section 8.17)

(a) Setting range

- Setting range: -32768 to 32767
- Set the values so that they satisfy the condition of Warning output upper limit value > Warning output lower limit value.
- When using the scaling function (D/A conversion), set values in consideration of the scaling range.
- When a value that does not satisfy the conditions above is set, an error occurs in the corresponding channel. The error code (62□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on.
- When Warning output setting (Un\G2047) is set to Disable (1), the settings for CH□ Warning output upper limit value (Un\G2090, Un\G2092) and CH□ Warning output lower limit value (Un\G2091, Un\G2093) are ignored.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 0.

Point

The default value is 0. To use the warning output function, change the value.

(47)CH□ Wave output start/stop request (Un\G3002, Un\G3003) D/A conversion

This area is for requesting the start, stop, and pause of the wave output for each channel. The setting for this area is valid only when the wave output function is selected.
For details of the wave output function, refer to the following.

- Wave Output Function (☞ Page 144, Section 8.18)

Wave output start/stop request	Setting value
Wave output stop request	0
Wave output start request	1
Wave output pause request	2

- While Step action wave output request (Un\G3072) is ON (1), changes of the setting value are ignored.
- When Step action wave output request (Un\G3072) is turned off, the wave output status changes to Wave output stop and Wave output stop request (0) is set for all channels.
- When a value outside the above setting range is set, an error occurs on the corresponding channel. The error code (303□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The operation of the wave output before the change continues.
- If a function other than "Wave Output Function" is set in "Select Function" of "Switch Setting" and a value other than Wave output stop request (0) is set in CH□ Wave output start/stop request (Un\G3002, Un\G3003), an alarm (alarm code: 161□) occurs and Warning output signal (X8) turns on.

(a) Default value

All channels are set to Wave output stop request (0).

(48)CH☐ Output setting during wave output stop (Un\G3010, Un\G3011)

D/A conversion

This area is for setting the analog output during the wave output stop for each channel. The setting for this area is valid only when the wave output function is selected. When the wave output function is not selected, changes of the value are ignored.

For details of the wave output function, refer to the following.

- Wave Output Function (☞ Page 144, Section 8.18)

Analog output value	Description	Setting value
0V/0mA	0V or 0mA is output.	0
Offset value	The offset value of the set output range is output.	1
Output value during wave output stop	The value set in CH☐ Output value during wave output stop (Un\G3018, Un\G3019) is output.	2

- When a value outside the above setting range is set, an error occurs on the corresponding channel. The error code (304☐) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The operation of the wave output before the change is continued.

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All channels are set to Offset value (1).

(49)CH□ Output value during wave output stop (Un\G3018, Un\G3019) D/A conversion

This area is for setting the value to be output during the wave output stop for each channel. When Output value during wave output stop (2) is set in CH□ Output setting during wave output stop (Un\G3010, Un\G3011), a value set in this area is converted into an analog value and output.
The setting in this area is valid only when the wave output function is selected. When the wave output function is not selected, changes of the value are ignored.
For details on the wave output function, refer to the following.

- Wave Output Function (☞ Page 144, Section 8.18)

(a) Setting range

The setting range varies depending on the output range setting. Follow the setting range below.

Output range setting	Setting range (practical range)
0: 4 to 20mA	0 to 12287 (practical range: 0 to 12000)
1: 0 to 20mA	
2: 1 to 5V	
3: 0 to 5V	
4: -10 to 10V	-16384 to 16383 (practical range: -16000 to 16000)

- When a value outside the above setting range is set, an error occurs on the corresponding channel. The error code (305□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The wave output does not start. However, when CH□ Output setting during wave output stop (Un\G3010, Un\G3011) is set to a value other than Output value during wave output stop (2), the above error does not occur and thus the error code (305□) is not stored.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

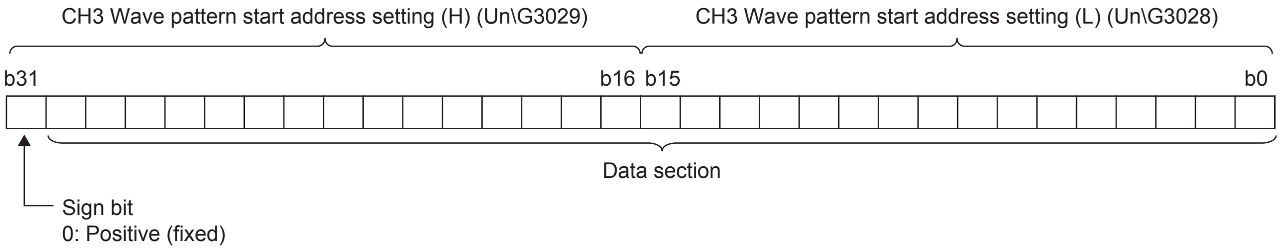
All channels are set to 0.

Point

As the default value, 0 is set. Thus change the setting value for CH□ Output setting during wave output stop (Un\G3010, Un\G3011) if Output value during wave output stop (2) has already been set.

(50)CH3 Wave pattern start address setting (L) (Un\G3028) to CH4 Wave pattern start address setting (H) (Un\G3031) D/A conversion

This area is for setting the start address of the wave pattern to be output for each channel. The digital input value in the buffer memory address set in this area is the first target for D/A conversion. Subsequently, the successive values are converted to analog and output in turn.
The setting for this area is valid only when the wave output function is selected. When the wave output function is not selected, changes of the value are ignored.
For this area, set a value in 32-bit signed binary.



For details on the wave output function, refer to the following.

- Wave Output Function (☞ Page 144, Section 8.18)

(a) Setting range

- The setting range is between 5000 and 54999. Set an address within the range of the buffer memory addresses of Wave data registry area (Un\G5000 to Un\G54999).
- When a value outside the above setting range is set, an error occurs on the corresponding channel. The error code (306□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The wave output does not start.
- In the channel where the setting values of this area and CH3 Wave pattern data points setting (L) (Un\G3044) to CH4 Wave pattern data points setting (H) (Un\G3047) satisfy the following condition, an error occurs. The error code (311□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The wave output does not start.

$$\left(\text{Wave pattern start address + Wave pattern data points - 1}\right) > 54999$$

(b) Enabling the setting

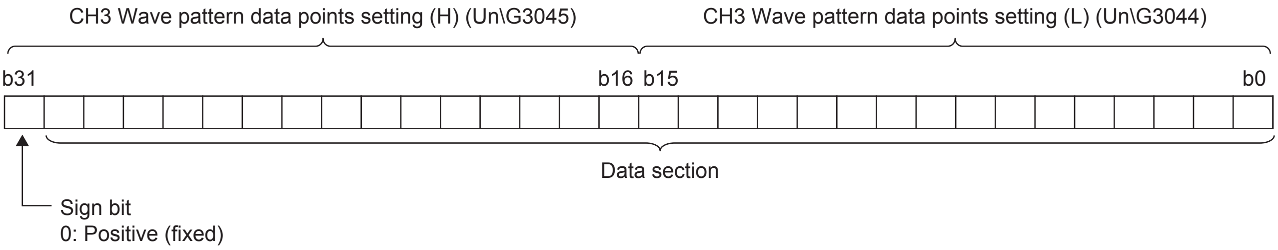
Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 5000.

(51)CH3 Wave pattern data points setting (L) (Un\G3044) to CH4 Wave pattern data points setting (H) (Un\G3047) D/A conversion

This area is for setting the points of the wave pattern to be output for each channel. From the start address of the wave pattern, the D/A conversion starts for the points of wave data set in this area and the converted values are output.
The setting for this area is valid only when the wave output function is selected. When the wave output function is not selected, changes of the value are ignored.
For this area, set a value in 32-bit signed binary.



For details on the wave output function, refer to the following.

- Wave Output Function (☞ Page 144, Section 8.18)

(a) Setting range

- The setting range is between 1 and 50000. A number of data points corresponding to that of Wave data registry area (Un\G5000 to Un\G54999) can be set.
- When a value outside the above setting range is set, an error occurs on the corresponding channel. The error code (307□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The wave output does not start. However, when the value of CH3 Wave pattern start address setting (L) (Un\G3028) to CH4 Wave pattern start address setting (H) (Un\G3031) is outside the setting range, the above error does not occur and thus the error code (307□) is not stored.
- In the channel where the setting values of this area and CH3 Wave pattern start address setting (L) (Un\G3028) to CH4 Wave pattern start address setting (H) (Un\G3031) satisfy the following condition, an error occurs. The error code (311□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The wave output does not start.

$$\left(\text{Wave pattern start address} + \text{Wave pattern data points} - 1\right) > 54999$$

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 0.

Point

The default value is 0. When selecting the wave output function, change the value.

(52)CH□ Wave pattern output repetition setting (Un\G3058, Un\G3059) D/A conversion

This area is for setting the repeat count to output the wave pattern repeatedly. The setting for this area is valid only when the wave output function is selected. When the wave output function is not selected, changes of the value are ignored.

For details of the wave output function, refer to the following.

- Wave Output Function (☞ Page 144, Section 8.18)

(a) Setting range

Follow the setting range below.

Setting value	Description
-1	The wave pattern is output in analog unlimitedly.
1 to 32767	The wave pattern is output in analog for the counts of the setting value.

- When a value outside the above setting range is set, an error occurs on the corresponding channel. The error code (308□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The wave output does not start.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 1.

(53)CH□ Constant for wave output conversion cycle (Un\G3066, Un\G3067)

D/A conversion

This area is for setting the value by which the conversion speed (80μs) for the wave output function is multiplied. The conversion cycle is determined as shown below.

Conversion cycle (μs) = Conversion speed (80μs) × Number of channels where D/A conversion is enabled × Constant for wave output conversion cycle

The setting in this area is valid only when the wave output function is selected. When the wave output function is not selected, changes of the value are ignored.

For details on the wave output function, refer to the following.

- Wave Output Function (☞ Page 144, Section 8.18)

(a) Setting range

- Setting range: 1 to 5000
- When a value outside the above setting range is set, an error occurs on the corresponding channel. The error code (309□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The wave output does not start.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All channels are set to 1.

(54)Step action wave output request (Un\G3072) D/A conversion

This area is for setting whether to start or end the wave output step action function for all channels in a batch. The setting for this area is valid only when the wave output function is selected.
For details of the wave output step action function, refer to the following.

- Wave output step action function (☞ Page 183, Section 8.18.4)

Step action wave output request	Setting value
OFF	0
ON	1

- Turning on Step action wave output request (Un\G3072) changes the wave output status of all the channels where the D/A conversion is enabled to the wave output step action, and the wave output step action function is enabled. Wave output step action (3) is stored in CH□ Wave output status monitor (Un\G3102, Un\G3103).
- Turning off Step action wave output request (Un\G3072) changes the wave output status of all the channels to the wave output stop status, and the wave output step action function ends.
- When a value outside the above range is written, an error occurs on the corresponding channel. The error code (3100) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The current wave output status is retained.
- When "Select Function" of the Switch Setting is set to a value other than "Wave Output Function" and Step action wave output request (Un\G3072) is set to ON (1), the alarm (alarm code: 1610) occurs and Warning output signal (X8) turns on.

(a) Default value

All channels are set to OFF (0).

(55)CH□ Wave output step action movement amount (Un\G3082, Un\G3083)

D/A conversion

This area is for specifying the target digital input value for D/A conversion in wave output, and for checking if the target has been obtained, for each channel. The value set in this area is subtracted from or added to the buffer memory address that has been storing the value being output in analog and so the buffer memory address of Wave data registry area (Un\G5000 to Un\G54999) that has been storing the target digital value is specified. When a value is set in this area, the target address starts to be specified and when specifying the address is complete, No movement (0) is stored.

This area can be set only when the following conditions are satisfied.

- Wave output function
- Wave output step action (3) is stored in CH□ Wave output status monitor (Un\G3102, Un\G3103).

For details of the wave output step action function, refer to the following.

- Wave output step action function (☞ Page 183, Section 8.18.4)

(a) Setting range

- Setting range: -30000 to 30000
- Set the following value according to the direction to move.

Movement direction	Description	Setting value
No movement	The buffer memory address of the wave data to be output is not moved.	0
Forward movement	The buffer memory address of the wave data to be output is moved in the address increasing direction from the buffer memory address of the currently output wave data. Ex.) When 10000 is set in CH□ Wave output step action movement amount (Un\G3082, Un\G3083) with the buffer memory address of the currently output wave data Un\G30000 → The buffer memory address of the wave data to be output is changed to Un\G40000.	1 to 30000
Reverse movement	The buffer memory address of the wave data to be output is moved in the address decreasing direction from the buffer memory address of the currently output wave data. Ex.) When -10000 is set in CH□ Wave output step action movement amount (Un\G3082, Un\G3083) with the buffer memory address of the currently output wave data Un\G30000 → The buffer memory address of the wave data to be output is changed to Un\G20000.	-1 to -30000

- The following shows the available range for movement with CH□ Wave output step action movement amount (Un\G3082, Un\G3083):

(Wave pattern start address) to (Wave pattern start address + Wave pattern data points - 1)

- Even if a value set is outside the above range, no error occurs. When a value smaller than -30000 is set, the value is processed as -30000. When a value greater than 30000 is set, the value is processed as 30000.

(b) Default value

All channels are set to No movement (0).

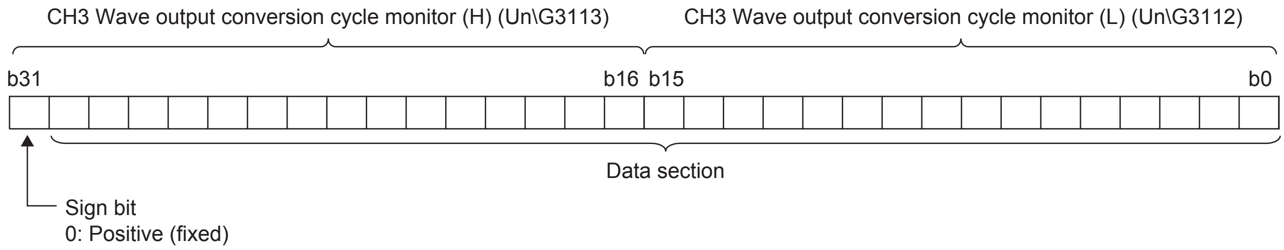
(56)CH□ Wave output status monitor (Un\G3102, Un\G3103) D/A conversion

This area stores the wave output status for each channel.
A value is stored only when the wave output function is selected. When the wave output function is not selected, 0 is stored.

Wave output status	Stored value
Wave output stop	0
Wave output	1
Wave output pause	2
Wave output step action	3

(57)CH3 Wave output conversion cycle monitor (L) (Un\G3112) to CH4 Wave output conversion cycle monitor (H) (Un\G3115) D/A conversion

This area stores the wave output conversion cycle in 32-bit signed binary for each channel.
The unit of the stored value is μs.
A value is stored only when the wave output function is selected. When the wave output function is not selected, 0 is stored.



(a) Update of the stored value

When Operating condition setting request (Y9) is turned on and off, the stored value is updated.

(58)CH□ Wave pattern output count monitor (Un\G3126, Un\G3127) D/A conversion

This area stores the output count of the wave pattern for each channel.
A value is stored only when the wave output function is selected. When the wave output function is not selected, 0 is stored.

(a) Count of the wave pattern output

The stored value increases by one every time one cycle of a wave pattern is output.

(b) Count range of the wave pattern output

- Count range: 0 to 32767

When CH□ Wave pattern output repetition setting (Un\G3058, Un\G3059) is set to -1 (endless output), the count returns to 0 and starts again from 1 after the 32767th count.

(c) Reset of the stored value

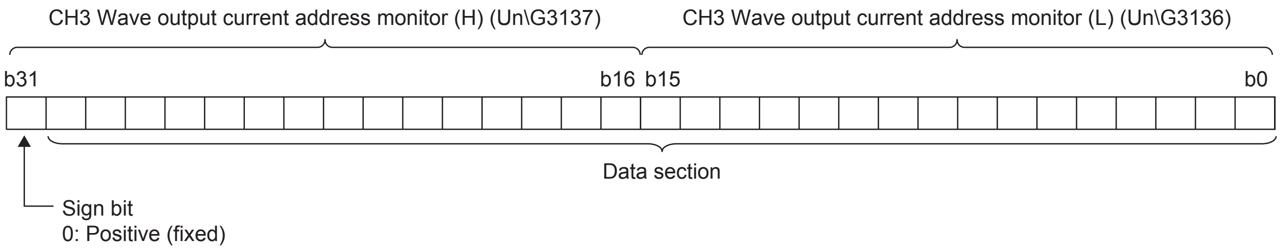
In the following cases, the stored value of CH□ Wave pattern output count monitor (Un\G3126, Un\G3127) is reset.

- When Operating condition setting request (Y9) is turned on and off
- When the wave output status transitions from its stop status to another

(59)CH3 Wave output current address monitor (L) (Un\G3136) to CH4 Wave output current address monitor (H) (Un\G3139) D/A conversion

This area stores the buffer memory address of the currently output wave data in 32-bit signed binary for each channel.

A value is stored only when the wave output function is selected. When the wave output function is not selected, 0 is stored.



(a) Update of the stored value

The stored value is updated when CH□ Wave output status monitor (Un\G3102, Un\G3103) is Wave output (1) or Wave output step action (3).

(b) Reset of the stored value

When Operating condition setting request (Y9) is turned on and off, the stored value is reset.

(60)CH☐ Wave output current digital value monitor (Un\G3150, Un\G3151)

D/A conversion

This area stores the currently output digital input value for each channel.

A value is stored only when the wave output function is selected. When the wave output function is not selected, 0 is stored.

The stored value depends on the wave output status.

<table>
<tr><th>Wave output status</th><th colspan="2">Stored value*1</th></tr>
<tr><td rowspan="5">Wave output stop</td><td colspan="2">The digital input value of the output set in CH☐ Output setting during wave output stop (Un\G3010, Un\G3011) is stored.</td></tr>
<tr><td>The setting value of CH☐ Output setting during wave output stop (Un\G3010, Un\G3011)</td><td>The stored value of CH☐ Wave output current digital value monitor (Un\G3150, Un\G3151)</td></tr>
<tr><td>0V/0mA (0)</td><td rowspan="2">0</td></tr>
<tr><td>Offset value (1)</td></tr>
<tr><td>Setting value during stop (2)</td><td>The setting value of CH☐ Output value during wave output stop (Un\G3018, Un\G3019)</td></tr>
<tr><td>Wave output</td><td colspan="2">The digital input value stored in the buffer memory address indicated by CH3 Wave output current address monitor (L) (Un\G3136) to CH4 Wave output current address monitor (H) (Un\G3139) is stored.</td></tr>
<tr><td rowspan="4">Wave output pause</td><td colspan="2">The stored value depends on the setting of the analog output HOLD/CLEAR function.</td></tr>
<tr><td>Analog output HOLD/CLEAR function</td><td>The stored value of CH☐ Wave output current digital value monitor (Un\G3150, Un\G3151)</td></tr>
<tr><td>HOLD setting</td><td>The digital input value stored in the buffer memory addresses indicated by CH3 Wave output current address monitor (L) (Un\G3136) to CH4 Wave output current address monitor (H) (Un\G3139)</td></tr>
<tr><td>CLEAR setting</td><td>0</td></tr>
<tr><td>Wave output step action</td><td colspan="2">The digital input value stored in the buffer memory address indicated by CH3 Wave output current address monitor (L) (Un\G3136) to CH4 Wave output current address monitor (H) (Un\G3139) is stored.</td></tr>
</table>

*1 The stored values shown are for when D/A conversion enable/disable setting (Un\G2000) is enabled and CH☐ Output enable/disable flag (Y3, Y4) is on. For the analog output in other statuses, refer to the following.

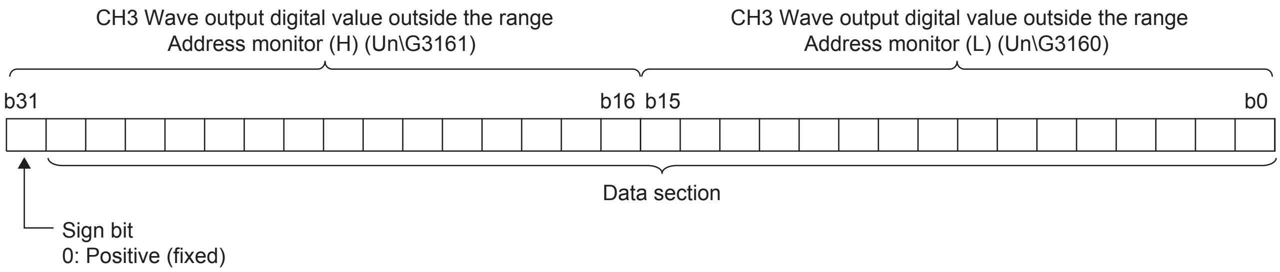
- Analog Output HOLD/CLEAR Function (☞ Page 127, Section 8.14)

(a) Resetting the stored value

When Operating condition setting request (Y9) is turned on and off, the stored value is reset.

(61)CH3 Wave output digital value outside the range Address monitor (L) (Un\G3160) to CH4 Wave output digital value outside the range Address monitor (H) (Un\G3163) D/A conversion

When a digital input value, registered as wave data, is outside the setting range, this area stores the corresponding buffer memory address in 32-bit signed binary for each channel at the time of the value being output.
When the multiple wave data with the digital input value out of the setting range are detected, only the buffer memory address of the wave data detected first is stored.
A value is stored only when the wave output function is selected. When the wave output function is not selected, 0 is stored.



(a) Update of the stored value

When the first detection of the digital input value out of the range occurs in a wave output status other than "Wave output stop", the stored value is updated.

(b) Reset of the stored value

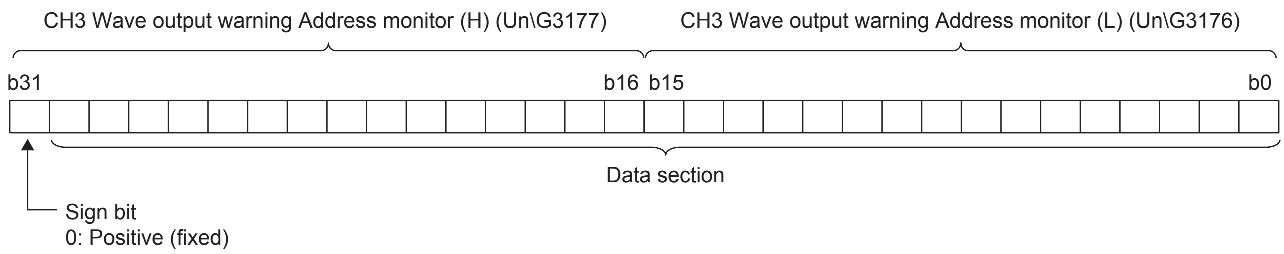
To reset the value being stored, first change values of wave data that have been outside the setting range so that they fall within the setting range then perform either of the following operations.

- Turning on and off Error clear request (YF)
- Turning on and off Operating condition setting request (Y9)

Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

(62)CH3 Wave output warning Address monitor (L) (Un\G3176) to CH4 Wave output warning Address monitor (H) (Un\G3179) D/A conversion

When a digital input value of wave data causes a warning, this area stores the corresponding buffer memory address in 32-bit signed binary for each channel.
When a warning has occurred in the multiple wave data, only the buffer memory address of the wave data where the warning occurred first is stored.
A value is stored only when the wave output function is selected. When the wave output function is not selected, 0 is stored.



(a) Update of the stored value

When the first warning occurs in a wave output status other than "Wave output stop", the stored value is updated.

(b) Reset of the stored value

To reset the value being stored, first change values of wave data that have been outside the setting range so that they fall within the setting range then perform either of the following operations.

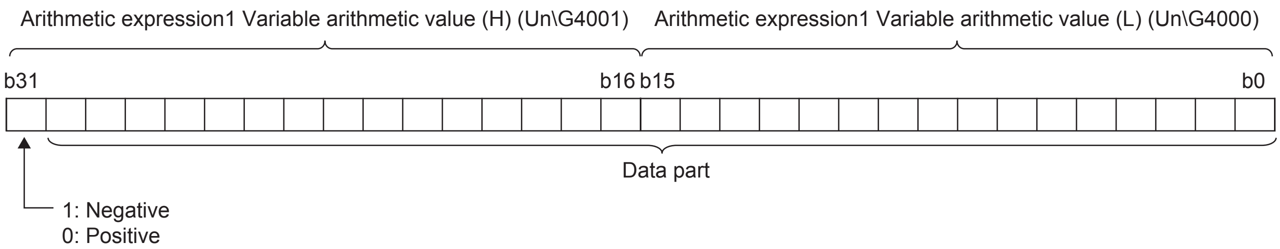
- Turning on and off Warning output clear request (Y8)
- Turning on and off Operating condition setting request (Y9)

Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

(63)Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005)

Variable arithmetic

When the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function is used, the digital value of the current operation result is stored in 32-bit signed binary in this area.
In this area, only when the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function is used and the normal mode is set, a value is stored. In the other cases, 0 is stored.



(a) Storage range of the variable arithmetic value

The range is between -2147483648 and 2147483647.
Check the decimal point of the variable arithmetic value with Variable arithmetic decimal point monitor (Un\G4002, Un\G4006). For details, refer to the following.

- Variable arithmetic decimal point monitor (Un\G4002, Un\G4006) (☞ Page 397, Appendix 2 (64))

Point

- When the digital value of Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) is smaller than -2147483648, -2147483648 is stored, and when the digital value is greater than 2147483647, 2147483647 is stored. In addition, an alarm (alarm code: 170□) occurs.
- This area is for read-only. A value cannot be written for analog output.

(b) Precautions

- If the alarm code 170□ occurs during operation, check the whole arithmetic expression including input data and constants.
- When two values whose absolute values are almost the same are subtracted each other, an error may be caused due to underflow.

Ex. With the following arithmetic expression, the operation result may be a value other than 0 due to the operation error.
Un\G55 (decimal point: 0) + Un\G11 (decimal point: 4) - Un\G55 (decimal point: 0) - Un\G11 (decimal point: 4)

(c) Reset of the variable arithmetic value

When Operating condition setting request (Y9) is turned on and off, the stored value is reset.

(64)Variable arithmetic decimal point monitor (Un\G4002, Un\G4006) Variable arithmetic

When the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function is used, the decimal point of Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) is stored in this area.
Only when the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function is used and the normal mode is set, a value is stored. In the other cases, 0 is stored.

(a) Storage range

The storage range is between 0 and 4.

Point

This area stores the decimal point position of Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005).
Variable arithmetic value for analog output (Un\G4003, Un\G4007) is not the storage target.

(b) Storage example

- When the operation result is 1000 and 2 is stored in Variable arithmetic decimal point monitor (Un\G4002, Un\G4006), the operation result is $1000 \times 10^2 = 100000$. In Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005), 100000 is stored.
- When the operation result is 1.2345 and 3 is stored in Variable arithmetic decimal point monitor (Un\G4002, Un\G4006), the operation result is $1.2345 \times 10^3 = 1234.5$. After the value has been rounded off to an integer value, 1235 is stored in Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005).

(65)Variable arithmetic value for analog output (Un\G4003, Un\G4007) Variable arithmetic

When the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function is used, a value calculated by rounding off the value of Variable arithmetic value (Un\G4000 to Un\G4001, Un\G4004 to Un\G4005) to an integer value is stored in 16-bit signed binary in this area. The operation result of this area can be used for analog output.
Only when the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function is used and the normal mode is set, a value is stored. In the other cases, 0 is stored.

(a) Storage range

The storage range is between -32768 and 32767.
By setting D/A conversion enable/disable setting (Un\G2000) to D/A conversion enable (0), the digital value stored in this area is converted into an analog value and output from the channel where D/A conversion is enabled.

Point

- When the digital value of Variable arithmetic value for analog output (Un\G4003, Un\G4007) is smaller than -32768, -32768 is stored, and when the digital value is greater than 32767, 32767 is stored. In addition, an alarm (alarm code: 171□) occurs.
- This area is for read-only. A value cannot be written for analog output.

(b) Operation of when the stored value is outside the output range

A value outside the output range cannot be output in analog. If Variable arithmetic value for analog output (Un\G4003, Un\G4007) is outside the output range, the following operation is performed.

Variable arithmetic value for analog output	Analog output value
Maximum value of output range ≤ Variable arithmetic value for analog output	Maximum value of output range
Variable arithmetic value for analog output ≤ Minimum value of output range	Minimum value of output range

If the value is outside the output range, an error (error code: 60□) occurs and the check code is stored in CH□ Set value check code (Un\G2013, Un\G2014).
Check the whole arithmetic expression including input data and constants. After adjust settings so that Variable arithmetic value for analog output (Un\G4003, Un\G4007) becomes within the range, turn on and off Error clear request (YF).

(c) Resetting the stored value

When Operating condition setting request (Y9) is turned on and off, the stored value is reset.

(66)Arithmetic expression data write setting (Un\G4098, Un\G4099) Variable arithmetic

Set values in these buffer memory areas to write arithmetic expression data to a flash memory.

Setting value	
Un\G4098	Un\G4099
$434C_H$	5354_H

(a) Enabling the setting

Setting the above values enables the arithmetic expression data for the variable arithmetic function or the variable conversion characteristics function + variable arithmetic function to be written.
Turn on and off Arithmetic expression data write request (YA) to write the arithmetic expression data.

(b) After writing the arithmetic expression data

After writing has been completed, this area is cleared to 0 and Arithmetic expression data write status flag (XA) turns on.
After checking that Arithmetic expression data write status flag (XA) is on, turn off Arithmetic expression data write request (YA).

(67)Variable conversion characteristics table selection (Un\G4100) Variable conversion

Select the conversion characteristics table for use.
The setting in this area is valid only when the variable conversion characteristics function or the variable conversion characteristics function + variable arithmetic function is used and the operation mode is the normal mode. In the other cases, changing the value is ignored.

(a) Setting range

Setting value	Description
Analog input (0)	The conversion characteristics of the A/D conversion channels (CH1 and CH2) can be freely set with the analog input conversion characteristics table. Because only one conversion characteristics table can be used, both CH1 and CH2 refer to the same conversion characteristics table. To the D/A conversion channels (CH3 and CH4), for which the analog input conversion characteristics table is not used, the normal conversion characteristics (slope of a straight line connecting the offset value and the gain value) are applied.
Analog output (1)	The conversion characteristics of the D/A conversion channels (CH3 and CH4) can be freely set with the analog output conversion characteristics table. Because only one conversion characteristics table can be used, both CH3 and CH4 refer to the same conversion characteristics table. To the A/D conversion channels (CH1 and CH2), for which the analog output conversion characteristics table is not used, the normal conversion characteristics (slope of a straight line connecting the offset value and the gain value) are applied.
Analog I/O (2)	The conversion characteristics of analog output corresponding to analog input can be freely set with the analog I/O conversion characteristics table. The following show the correspondence between the analog input channels and analog output channels: • Route 1: The analog input of CH1 and the analog output of CH3 correspond. • Route 2: The analog input of CH2 and the analog output of CH4 correspond. Because only one conversion characteristics table can be used, route 1 and route 2 refer to the same conversion characteristics table.

- When a value other than the above setting values is set, an error occurs. The error code (5010) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. A/D conversion or D/A conversion does not start.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

Analog input (0) is set.

(68)Variable conversion characteristics range setting (Un\G4101) Variable conversion

The range selected with this area is applied to the channel where the variable conversion characteristics function is used.

The setting in this area is valid only when the variable conversion characteristics function or the variable conversion characteristics function + variable arithmetic function is used and the operation mode is the normal mode. In the other cases, changing the value is ignored.

(a) Setting range

I/O method	Setting value
4 to 20mA	0H
0 to 20mA	1H
1 to 5V	2H
0 to 5V	3H
-10 to 10V	4H
0 to 10V	5H*1
4 to 20mA (Extended mode)	AH*1
1 to 5V (Extended mode)	BH*1

*1 These setting values can be set only when Analog input (0) is set in Variable conversion characteristics table selection (Un\G4100). If Analog output (1) or Analog I/O (2) is set, the settings are outside the range.

- In the channel where the variable conversion characteristics function is used, the settings of input range and output range with the switch setting are ignored. The range set with this area is applied.
- All channels where the variable conversion characteristics function is used use the same range.
- When a value other than the above setting values is set, an error occurs. The error code (5020) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. A/D conversion or D/A conversion does not start.

(b) Default value

The default value is 4 to 20mA (0H).

(69)Variable conversion characteristics conversion value monitor (Un\G4110, Un\G4120) Variable conversion

The digital value converted from an analog value based on the factory shipment value is stored in this area. The stored value is used as a reference address of the conversion characteristics table.
Only when the variable conversion characteristics function or the variable conversion characteristics function + variable arithmetic function is used and the normal mode is set, the value is stored. In the other cases, 0 is stored.

(a) Storage range

The storage range is between -16000 and 16000.

Point

- When Variable conversion characteristics table selection (Un\G4100) is set to Analog output (1), the value of CH□ Digital input value (Un\G2003, Un\G2004) is stored.
- If a digital value converted from an analog value or CH□ Digital input value (Un\G2003, Un\G2004) becomes outside the address range of the conversion characteristics table, the maximum value or the minimum value of the address range is stored.

(b) Resetting the stored value

If any of the following settings is set, Variable conversion characteristics conversion value monitor (Un\G4110, Un\G4120) is reset.

- Changing the setting value of Variable conversion characteristics table selection (Un\G4100) and turning on and off Operating condition setting request (Y9)
- Changing the setting value of Variable conversion characteristics range setting (Un\G4101) and turning on and off Operating condition setting request (Y9) when Analog input (0) or Analog I/O (2) is set in Variable conversion characteristics table selection (Un\G4100)

(70)Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121) Variable conversion

The digital value of the conversion characteristics table currently being converted is stored in this area.
Only when the variable conversion characteristics function or the variable conversion characteristics function + variable arithmetic function is used and the normal mode is set, the value is stored. In the other cases, 0 is stored.

(a) Storage range

The storage range is between -32768 and 32767.

Point

- When Variable conversion characteristics table selection (Un\G4100) is set to Analog input (0), the value of CH□ Digital output value (Un\G11, Un\G12) is stored.
- This area is for read-only. A value cannot be written for output.

(b) Resetting the stored value

If any of the following settings is set, Variable conversion characteristics digital value monitor (Un\G4111, Un\G4121) is reset.

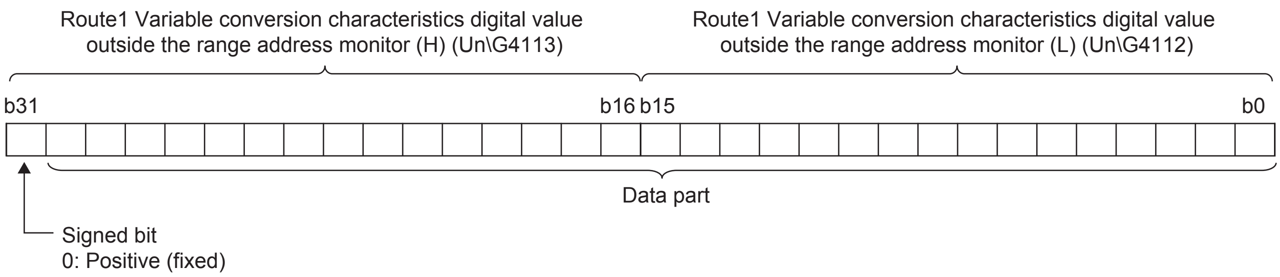
- Changing the setting value of Variable conversion characteristics table selection (Un\G4100) and turning on and off Operating condition setting request (Y9)
- Changing the setting value of Variable conversion characteristics range setting (Un\G4101) and turning on and off Operating condition setting request (Y9) when Analog input (0) or Analog I/O (2) is set in Variable conversion characteristics table selection (Un\G4100)

(71)Variable conversion characteristics digital value outside the range address monitor (Un\G4112 to Un\G4113, Un\G4122 to Un\G4123) Variable conversion

The buffer memory address of the conversion characteristics table where the digital value out of the setting range is set is stored in this area in 32-bit signed binary.

If multiple digital values out of the setting range are detected, only the buffer memory address of the conversion characteristics table where the out-of-range value is firstly detected is stored.

Only when the variable conversion characteristics function is used and the normal mode is set, a value is stored. In the other cases, 0 is stored.



- This area is valid only when Variable conversion characteristics table selection (Un\G4100) is set to Analog output (1) or Analog I/O (2).
- When "Free Conversion Characteristics Function + Free Operation Function" is selected in "Select Function", this area is invalid.

(a) Resetting the stored value

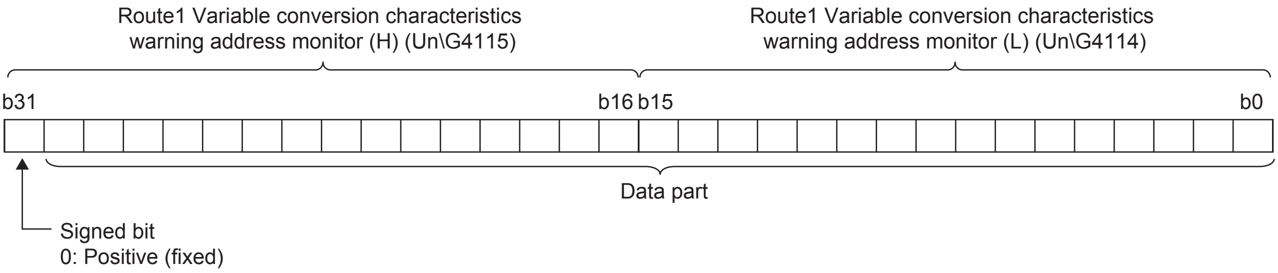
To reset the stored value, set a value of the conversion characteristics table within the setting range and perform any of the following operations.

- Turning on and off Error clear request (YF)
- Turning on and off Operating condition setting request (Y9)

Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

(72)Variable conversion characteristics warning address monitor (Un\G4114 to Un\G4115, Un\G4124 to Un\G4125) Variable conversion

The buffer memory address of the conversion characteristics table where a warning has occurred is stored in this area in 32-bit signed binary.
If a warning has occurred in multiple digital values, only the buffer memory address of the conversion characteristics table where the first warning occurred is stored.
Only when the variable conversion characteristics function is used and the normal mode is set, a value is stored. In the other cases, 0 is stored.



- This area is valid only when Variable conversion characteristics table selection (Un\G4100) is set to Analog output (1) or Analog I/O (2).
- When "Free Conversion Characteristics Function + Free Operation Function" is selected in "Select Function", this area is invalid.

(a) Resetting the stored value

To reset the stored value, set a value of the conversion characteristics table within the setting range and perform any of the following operations.

- Turning on and off Warning output clear request (Y8)
- Turning on and off Operating condition setting request (Y9)

Note that the A/D conversion or the D/A conversion is reset and the operation starts over again if Operating condition setting request (Y9) is turned on and off.

(73)Control mode monitor (Un\G4300, Un\G4380) PID control

The control mode status of PID control is stored.

Only when the PID control function is used and the normal mode is set, a value is stored in this area. In the other cases, 0 is stored.

Control mode	Stored value
Automatic mode	0
Manual mode	1

- When the control mode is changed with Control mode switching (Un\G4320, Un\G4400) and switching the control mode is completed, a value is stored in this area.

(74)Manipulated value (MV) (Un\G4301, Un\G4381) PID control

The result of the PID operation based on the process value (PV) in the PID control is stored.

Only when the PID control function is used and the normal mode is set, a value is stored in this area. In the other cases, 0 is stored.

(a) Storage range

The storage range is between -500 and 10500 (-5.00 and 105.00%).

The rate (%) to the full scale of an output range is stored. For example, when the output range is 4 to 20mA, 4mA is output at 0%, 12mA is output at 50%, and 20mA is output at 100%.

(75)Output conversion value (Un\G4302, Un\G4382) PID control

The manipulated value (MV) converted into a digital input value corresponding to the output range is stored.

Only when the PID control function is used and the normal mode is set, a value is stored in this area. In the other cases, 0 is stored.

(a) Storage range

When the output range is -10 to 10V (digital input range: -16000 to 16000), the following values are stored in this area.

Value of Manipulated value (MV) (Un\G4301, Un\G4381)	Stored value of Output conversion value (Un\G4302, Un\G4382)
0 (0%)	-16000
5000 (50%)	0
10000 (100%)	16000

(b) Analog output

The value stored in this area is converted into an analog value and the analog value is output from the D/A conversion channel.

(76)Auto-tuning status (Un\G4303, Un\G4383) PID control

The auto-tuning status can be checked.

Only when the PID control function is used and the normal mode is set, a value is stored in this area. In the other cases, 0 is stored.

Bit	Status	Stored value	Description
b0	Auto-tuning in execution	0: AT not executed 1: AT in execution	The auto tuning is being executed.
b1	Auto-tuning completed	0: AT not completed 1: AT completed	The auto tuning is completed.
b4	Input upper limit error	0: Input upper limit error not occurred 1: Input upper limit error occurred	An input signal upper limit error has occurred and the auto tuning has abnormally ended.
b5	Input lower limit error	0: Input lower limit error not occurred 1: Input lower limit error occurred	An input signal lower limit error has occurred and the auto tuning has abnormally ended.
b6	A/D conversion stop	0: A/D conversion stop not occurred 1: A/D conversion stop occurred	Since the A/D conversion stopped, the auto tuning has abnormally ended.
b7	Output upper limit warning occurrence	0: Output upper limit warning not occurred 1: Output upper limit warning occurred	Since the warning output flag (upper limit) is on, the auto tuning has abnormally ended.
b8	Output lower limit warning occurrence	0: Output lower limit warning not occurred 1: Output lower limit warning occurred	Since the warning output flag (lower limit) is on, the auto tuning has abnormally ended.
b9	D/A output stop	0: D/A output stop not occurred 1: D/A output stop occurred	Since the D/A output stopped, the auto tuning has abnormally ended.
b10	Control mode error	0: Control mode error not occurred 1: Control mode error occurred	Since the control mode was changed, the auto tuning has abnormally ended.
b11	Auto-tuning timeout	0: AT timeout not occurred 1: AT timeout occurred	The auto tuning has timed out and abnormally ended.
b12	Identification error	0: Identification error not occurred 1: Identification error occurred	Though the auto tuning has been performed, PID constants cannot be calculated.

- Bits other than the above are fixed to 0.
- Auto-tuning completed (b1) turns on when the auto tuning ends regardless of whether it ends normally or abnormally.
- Input upper limit error (b4) to Identification error (b12) turn on when an error is detected during the auto tuning.
- When the value of Auto-tuning execution command (Un\G4360, Un\G4440) is changed from Auto-tuning start request (1) to Auto-tuning stop request (0), Auto-tuning status (Un\G4303, Un\G4383) is cleared.

(77)Control mode switching (Un\G4320, Un\G4400) PID control

This area is for switching the PID control mode between the automatic mode and manual mode.

Setting content	Setting value
Automatic mode	0
Manual mode	1

- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (602□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- When the control mode is changed in the auto tuning, an error occurs on the corresponding loop. The error code (630□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the auto tuning abnormally ends.

(a) Operation in each control mode

- In the automatic mode, the manipulated value (MV) calculated in the PID operation is output in analog.
- In the manual mode, the manipulated value written in MAN output setting (Un\G4339, Un\G4419) is output in analog.

(b) Enabling the setting

When a value is set, the set control mode is enabled without turning on and off Operating condition setting request (Y9).

(c) Default value

All loops are set to Automatic mode (0).

(78)Control cycle setting (Un\G4321, Un\G4401) PID control

This area is for setting the PID control cycle.

(a) Setting range

- The setting range is between 2 and 60000 (0.2 to 6000.0ms). Set it in increments of 0.1ms.
- When a value outside the above setting range is set, an error occurs on the corresponding loop. The error code (603□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The PID control is not performed.
- When a program is used to set 32768 to 60000 (3276.8 to 6000.0ms), set the value in hexadecimal. For example, to set 60000 (6000.0ms), set EA60H.

(b) Actual control cycle

The actual control cycle is an integral multiple of the conversion cycle (200μs/CH).

Ex. When one loop is used and 0.9ms is set for this area, the actual control cycle is 0.8ms (200μs × 4) because the actual control cycle is an integral multiple of 200μs which is equal to or smaller than the value set in this area.

(c) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(d) Default value

All loops are set to 10 (1.0ms).

(79)Set value (SV) setting (Un\G4322, Un\G4402) PID control

This area is for setting the set value (SV) in the PID control.

(a) Setting range

The setting range varies depending on the input range setting. Follow the setting range below.

Input range setting	Setting range
0 to 5V	0 to 12000
1 to 5V	
0 to 20mA	
4 to 20mA	
0 to 10V	0 to 16000
-10 to 10V	-16000 to 16000
1 to 5V (Extended mode)	-3000 to 13500
4 to 20mA (Extended mode)	

When a value outside the above setting range is set, an error occurs on the corresponding loop. The error code (604□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the upper limit or lower limit value of the input range.

(b) Enabling the setting

When a value is set, the set value (SV) that has been set is enabled without turning on and off Operating condition setting request (Y9).

(c) Default value

All loops are set to 0.

(80)Proportional gain (P) setting (Un\G4323, Un\G4403) PID control

This area is for setting the proportional gain (P) for the PID control.

(a) Setting range

- The setting range is between 1 and 10000 (0.01 to 100.00). Set it in increments of 0.01.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (605□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(b) Enabling the setting

When a value is set, the set proportional gain (P) is enabled without turning on and off Operating condition setting request (Y9).

(c) Default value

All loops are set to 100 (1.00).

(81)Integral time (I) setting (Un\G4324 to Un\G4325, Un\G4404 to Un\G4405) PID control

This area is for setting the integral time (I) for the PID control.

(a) Setting range

- The setting range is between 0 and 300000 (0.00 to 3000.00s). Set it in increments of 0.01s.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (606□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- To perform the P control or PD control, set 0 for this area.

(b) Enabling the setting

When a value is set, the set integral time (I) is enabled without turning on and off Operating condition setting request (Y9).

(c) Default value

All loops are set to 1000 (10.00s).

(82)Derivative time (D) setting (Un\G4326, Un\G4406) PID control

This area is for setting the derivative time (D) for the PID control.

(a) Setting range

- The setting range is between 0 and 30000 (0.00 to 300.00s). Set it in increments of 0.01s.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (607□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- To perform the P control or PI control, set 0 for this area.

(b) Enabling the setting

When a value is set, the set derivative time (D) is enabled without turning on and off Operating condition setting request (Y9).

(c) Default value

All loops are set to 0 (0.00s).

(83)Gap width setting (Un\G4327, Un\G4407) PID control

This area is for setting the gap width for the PID control with a gap (a control where a gap width is used to make the deviation used for the PID operation smaller than the actual deviation). The gap width is set within the range of the deviation in which the PID control with a gap is performed (0 to 100%). When "|Deviation| ≤ Gap width" is satisfied, the PID control with a gap is performed.

(a) Setting range

- The setting range is between 0 and 10000 (0.00 to 100.00%). Set it in increments of 0.01%.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (608□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All loops are set to 0 (0.00%).

(84)Gap gain setting (Un\G4328, Un\G4408) PID control

This area is for setting the gap gain for the PID control with a gap (a control where a gap width is used to make the deviation used for the PID operation smaller than the actual deviation). The gap gain is set as the gain to the actual deviation at which the PID control with a gap is performed (0 to 100%). The deviation used for the PID operation is calculated with "Actual deviation × Gap gain".

(a) Setting range

- The setting range is between 0 and 100 (0.00 to 1.00). Set it in increments of 0.01.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (609□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All loops are set to 100 (1.00).

(85)Two-degree-of-freedom parameter alpha setting (Un\G4329, Un\G4409) PID control

This area is for setting the feedforward proportional value for the two-degree-of-freedom PID control. When a larger value is set as the setting value of this area (α), the effect of the proportion to the set value change reduces.

(a) Setting range

- The setting range is between 0 and 100 (0.00 to 1.00). Set it in increments of 0.01.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (610□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- To use the two-degree-of-freedom PID control, select "2 Freedom PID Control" or "2 Freedom PID Control (Variable Speed Integration)" in "Select PID Operation Expression" of "Switch Setting". When another PID operation expression is selected, the setting value in this area is ignored.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All loops are set to 0 (0.00).

(86)Two-degree-of-freedom parameter beta setting (Un\G4330, Un\G4410) PID control

This area is for setting the feedforward derivative value for the two-degree-of-freedom PID control. When a smaller value is set as the setting value of this area (β), the effect of the derivation to the set value change increases.

(a) Setting range

- The setting range is between 0 and 100 (0.00 to 1.00). Set it in increments of 0.01.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (611□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- To use the two-degree-of-freedom PID control, select "2 Freedom PID Control" or "2 Freedom PID Control (Variable Speed Integration)" in "Select PID Operation Expression" of "Switch Setting". When another PID operation expression is selected, the setting value in this area is ignored.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All loops are set to 100 (1.00).

(87)Derivative gain setting (Un\G4331, Un\G4411) PID control

A time period (delay in operation) can be given to the derivative action.

- As the setting value in this area is larger, the time period becomes shorter and the operation becomes closer to the exact differential. However, the control system becomes unstable because this setting increases high-frequency noise components.
- As the setting value in this area is smaller, the effect level of noise components decreases. However, the time period of the manipulated value increases.

(a) Setting range

- The setting range is between 1 and 30000 (0.01 to 300.00). Set it in increments of 0.01.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (612□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All loops are set to 800 (8.00).

(88)Variable speed integral judgment value A setting (Un\G4332, Un\G4412), Variable speed integral judgment value B setting (Un\G4333, Un\G4413) PID control

This area is for setting the deviation range in which integral elements of the manipulated value (MV) are corrected with the variable speed integral function. The following operations are performed by setting the range.

Range	Operation
Deviation < Judgment value B	The operation of the integral elements is performed.
Judgment value B ≤ Deviation < (Judgment value A + Judgment value B)	The integral elements are corrected according to the deviation value.
(Judgment value A + Judgment value B) ≤ Deviation	The integral action is stopped.

(a) Setting range

- The setting range is between 0 and 10500 (0.00 to 105.00%). Set it in increments of 0.01%.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (613□ or 614□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- To use this area, select "Basic PID Control (Variable Speed Integration)" or "2 Freedom PID Control (Variable Speed Integration)" in "Select PID Operation Expression" of "Switch Setting". When another PID operation expression is selected, the setting value in this area is ignored.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

The following values are set.

- Variable speed integral judgment value A setting (Un\G4332, Un\G4412): 0 (0.00%)
- Variable speed integral judgment value B setting (Un\G4333, Un\G4413): 10500 (105.00%)

(89)Forward/reverse action setting (Un\G4334, Un\G4414) PID control

This area is for setting whether the PID control is used in forward action or reverse action.

Setting content	Setting value	Remarks
Reverse action	0	The reverse action increases the manipulated value (MV) when the process value (PV) becomes smaller than the set value (SV).
Forward action	1	The forward action increases the manipulated value (MV) when the process value (PV) becomes greater than the set value (SV).

When a value outside the above range is set, an error occurs on the corresponding loop. The error code (615□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All loops are set to Reverse action (0).

(90)Filter coefficient (Un\G4335, Un\G4415) PID control

This area is for setting the filter coefficient of the digital filter (exponent filter) processing for the digital output value.

(a) Digital filter operation

The digital filter is calculated by the following calculation formula. It is the sum of "the current digital output value" and "the product of the weight (filter coefficient) and the difference between the previous filter value and the current digital output value".

$PV_{fn} = PV + \alpha \times (PV_{fn-1} - PV)$

Symbol	Description
α	Filter coefficient
PV	Current digital output value
PV_{fn}	Current filter value
PV_{fn-1}	Previous filter value

(b) Setting range

- The setting range is between 0 and 99 (0.00 to 0.99). Set it in increments of 0.01.
- When a value outside the above range is set, an error occurs on the corresponding loop. The error code (616□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(c) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(d) Default value

All loops are set to 0 (0.00).

(91)Upper limit output limiter setting (Un\G4336, Un\G4416), Lower limit output limiter setting (Un\G4337, Un\G4417) PID control

This area is for setting the upper limit value and lower limit value that limit the manipulated value (MV) calculated by the PID operation.

(a) Setting range

- The setting range is between -500 and 10500 (-5.0 to 105.00%). Set it in increments of 0.01%.
- The condition "Lower limit output limiter setting < Upper limit output limiter setting" must be satisfied. When the condition is not satisfied in a loop, an error occurs on the corresponding loop. The error code (617□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- If a value outside the setting range is set, an error occurs on the corresponding loop. The error code (618□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the upper or lower limit value of the setting range.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

The following values are set.

- Upper limit output limiter setting (Un\G4336, Un\G4416): 10000 (100.00%)
- Lower limit output limiter setting (Un\G4337, Un\G4417): 0 (0.00%)

(92)Output variation limiter setting (Un\G4338, Un\G4418) PID control

This area is for setting the allowable change width of the manipulated value (MV) for each control cycle. Even if a change width exceeds the allowable change width, the manipulated value changes only by the change width set as the output variation limiter.

(a) Setting range

- The setting range is between 0 and 10000 (0.00 to 100.00%). Set it in increments of 0.01%.
- When 0 is set, the output variation limiter does not operate.
- If a value outside the setting range is set, an error occurs on the corresponding loop. The error code (619□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All loops are set to 0.

(93)MAN output setting (Un\G4339, Un\G4419) PID control

This area is for setting the manipulated value (MV) in the manual mode.

(a) Setting range

- The setting range is between -500 and 10500 (-5.00 to 105.00%). Set it in increments of 0.01%.
- If a value outside the setting range is set, an error occurs on the corresponding loop. The error code (620□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the upper or lower limit value of the setting range.

(b) Enabling the setting

When a value is set, the set MAN output setting is enabled without turning on and off Operating condition setting request (Y9).
Write a value to MAN output setting (Un\G4339, Un\G4419) after checking that Manual mode (1) is stored in Control mode monitor (Un\G4300, Un\G4380). Even if a value was written with Automatic mode (0) stored, it is overwritten with the manipulated value (MV) calculated by the analog I/O module with the PID operation.

(c) Default value

All loops are set to 0 (0.00%).

(94)Output shifting amount to conversion value (Un\G4340, Un\G4420) PID control

This area is for setting the digital value that is used to correct the output conversion value.

(a) Setting range

The setting range is between -32768 and 32767.

(b) Enabling the setting

When a value is set, the set output shifting amount to conversion value is enabled without turning on and off Operating condition setting request (Y9).

(c) Default value

All loops are set to 0.

(95)PID continuation flag on HOLD (Un\G4341, Un\G4421) PID control

This area is for setting whether to continue the PID control or stop the control and hold the output when the CPU module operating status is RUN, STOP, or stop error during the PID control.

Setting content	Setting value
Hold output	0
Continue PID operation	1

- If a value outside the above setting range is set, an error occurs on the corresponding loop. The error code (621□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.
- This area is valid only for the loop where "HOLD" is set for "HOLD/CLEAR function setting" of "Switch Setting". The setting for this area is ignored on the loop where "CLEAR" is set.
- For details on the analog output status, refer to the Analog Output HOLD/CLEAR Function (☞ Page 127, Section 8.14).

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All loops are set to Hold output (0).

A

(96)Auto-tuning execution command (Un\G4360, Un\G4440) PID control

This area is for setting the auto tuning start or stop.

Auto-tuning execution command	Setting value
Auto-tuning stop request	0
Auto-tuning start request	1

(a) Enabling the setting

When a value is set, the set request is enabled without turning on and off Operating condition setting request (Y9).

(b) Default value

All loops are set to Auto-tuning stop request (0).

(97)Auto-tuning timeout time (Un\G4361, Un\G4441) PID control

This area is for setting the time for the auto-tuning processing from the start to the automatic stop when the processing takes some time.

(a) Setting range

- The setting range is between 0 and 7200 (0 to 7200s).
- If a value outside the setting range is set, an error occurs on the corresponding loop. The error code (622□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All loops are set to 100 (100s).

(98)Auto-tuning hysteresis (Un\G4362, Un\G4442) PID control

This area is for setting the hysteresis to prevent chattering for the process value (PV) during the auto tuning. Usually, the setting value of this area does not need to be changed.

(a) Setting range

- The setting range is between 0 and 1000 (0.00 to 10.00%).
- If a value outside the setting range is set, an error occurs on the corresponding loop. The error code (623□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the upper or lower limit value of the setting range.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

All loops are set to 100 (1.00%).

(99)Auto-tuning output upper limit value (Un\G4363, Un\G4443), Auto-tuning output lower limit value (Un\G4364, Un\G4444) PID control

This area is for setting the range of manipulated value (MV) in the ON control/OFF control during the auto tuning.

(a) Setting range

- The setting range is between -500 and 10500 (-5.00 to 105.00%). Set it in increments of 0.01%.
- Set the values as follows: "Auto-tuning output upper limit value ≤ Upper limit output limiter setting", "Auto-tuning output lower limit value ≥ Lower limit output limiter setting", and "Auto-tuning output upper limit value > Auto-tuning output lower limit value".
- If a value outside the setting range is set, an error occurs on the corresponding loop. The error code (625□ or 626□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the auto-tuning output operates with the upper limit output limiter setting or lower limit output limiter setting.
- When values which do not satisfy "Auto-tuning output upper limit value > Auto-tuning output lower limit value" are set, an error occurs on the corresponding loop. The error code (624□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(b) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(c) Default value

The following values are set.

- Auto-tuning output upper limit value (Un\G4363, Un\G4443): 10000 (100.00%)
- Auto-tuning output lower limit value (Un\G4364, Un\G4444): 0 (0.00%)

(100)Auto-tuning control type setting (Un\G4365, Un\G4445) PID control

This area is for setting the calculation method of PID control parameters for the auto tuning.

Setting content	Setting value	Remarks
Constant-value PI control	0	Responsiveness to disturbances is improved.
Constant-value PID control	1	
Variable-value PI control	2	An overshoot at a change of the set value (SV) is suppressed.
Variable-value PID control	3	

If a value outside the above setting range is set, an error occurs on the corresponding loop. The error code (627□) is stored in Latest error code (Un\G19), Error flag (XF) turns on, and the module operates with the previous setting.

(a) Enabling the setting

Turn on and off Operating condition setting request (Y9) to enable the setting.

(b) Default value

All loops are set to Constant-value PI control (0).

(101)PID operation expression selection monitor (Un\G4460) PID control

The PID operation expression that has been selected using Switch Setting for Intelligent Function Module can be checked with this area.

Only when the PID control function is used and the normal mode is set, a value is stored in this area. In the other cases, 0 is stored.

PID operation expression	Stored value
Basic PID control	0H
Two-degree-of-freedom PID control	1H
Basic PID control (variable speed integral)	2H
Two-degree-of-freedom PID control (variable speed integral)	3H

Point

The PID operation expression cannot be changed with PID operation expression selection monitor (Un\G4460).
To change the PID operation expression, change the Switch Setting.
For the Switch Setting, refer to the following.

- Switch setting (☞ Page 55, Section 7.2)

(102)CH☐ A/D conversion status (Un\G4700, Un\G4701) A/D conversion

The status of A/D conversion is stored.

Use this area for troubleshooting. For details, refer to the following.

- Troubleshooting for the A/D conversion (☞ Page 330, Section 11.6.2)

A/D conversion status	Stored value	Description
External power supply OFF	-1	The external power supply 24VDC is not supplied.
A/D conversion disable	0	A/D conversion has been disabled. A/D conversion has not been performed on the corresponding channel.
A/D conversion start	1	A/D conversion has been enabled and the first A/D conversion has yet to be complete.
A/D conversion completion	2	The first A/D conversion has been complete. A/D conversion is in execution.
Input signal error detected	3	In the use of the input signal error detection function, an input signal error has been detected. (When the input signal error detection function is not used, this value is not stored.)
A/D conversion start (variable conversion characteristics)	4	In the channel where the variable conversion characteristics function is used, A/D conversion has been enabled and the first A/D conversion has yet to be complete.
A/D conversion completion (variable conversion characteristics)	5	In the channel where the variable conversion characteristics function is used, the first A/D conversion has been complete. The A/D conversion is being executed.

(103)CH□ Analog input monitor (Un\G4710, Un\G4712) A/D conversion

The amount of analog input, a current or a voltage, is stored for each channel.

This value is updated at periods of about 1ms.

Use this area for troubleshooting. For details, refer to the following.

- Troubleshooting for the A/D conversion (☞ Page 330, Section 11.6.2)

CH□ Analog input monitor (Un\G4710, Un\G4712) depends on the value stored in CH□ A/D conversion status (Un\G4700, Un\G4701), as described below.

(a) For "A/D conversion start (1)" to "A/D conversion completion (variable conversion characteristics) (5)"

The following value is stored.

- Current input range: A value of current input value [mA] × 100 is stored. When 20mA is input, 2000 is stored.
- Voltage input range: A value of voltage input value [V] × 100 is stored. When 10V is input, 1000 is stored.

(b) "External power supply OFF (-1)", "A/D conversion disable (0)"

0 is stored.

Point

This buffer memory area does not have the resolution or accuracy described in the performance specifications (☞ Page 23, Section 3.2). Do not practically use this area for actual control.
Use the value as a guide to the status of analog input at a system startup or other events.

(104)CH□ Analog input monitor unit (Un\G4711, Un\G4713) A/D conversion

The unit of CH□ Analog input monitor (Un\G4710, Un\G4712) is stored.

Use this area for troubleshooting. For details, refer to the following.

- Troubleshooting for the A/D conversion (☞ Page 330, Section 11.6.2)

Unit	Stored value
$\times 10^{-2}$mA	0
$\times 10^{-2}$V	1

(105)CH□ D/A conversion status (Un\G4750, Un\G4751) D/A conversion

The status of D/A conversion is stored.

Use this area for troubleshooting. For details, refer to the following.

- Troubleshooting for the D/A conversion (☞ Page 335, Section 11.6.3)

D/A conversion status	Stored value	Description
External power supply OFF	-1	The external power supply 24VDC is not supplied.
D/A conversion disable	0	D/A conversion has been disabled. D/A conversion has not been performed on the corresponding channel.
Analog output disable	1	Analog output has been disabled. (D/A conversion has been enabled.)*1*3
Analog output enable	2	Analog output has been enabled. According to digital input values, the analog equivalents are output.*2*3*4
Analog output disable (variable conversion characteristics)	3	In the channel where the variable conversion characteristics function is used, analog output has been disabled. (D/A conversion has been enabled.)*1
Analog I/O conversion wait (variable conversion characteristics)	4	In the channel where the variable conversion characteristics function is used, analog output has been enabled and the first A/D conversion has yet to be completed. (This status is stored only when the variable conversion characteristics function is used together with the analog I/O conversion characteristics table.)*1
Analog output enable (variable conversion characteristics)	5	In the channel where the variable conversion characteristics function is used, the converted value according to the conversion characteristics table is output in analog.*1

*1 Depending on the status of the CPU module and the setting for the analog output HOLD/CLEAR function ("HOLD/CLEAR function setting" of "Switch Setting"), the status of analog output varies.
For details, refer to the following.
- Analog output status and combinations of settings (☞ Page 127, Section 8.14 (1))

*2 When the wave output function is selected, the wave data is output according to CH□ Wave output status monitor (Un\G3102, Un\G3103).
For details, refer to the following.
- Wave output status monitor (☞ Page 391, Appendix 2 (56))

*3 When "Free Operation Function" or "Free Conversion Characteristics Function + Free Operation Function" is set to "Select Function" of "Switch Setting", the value in Variable arithmetic value for analog output (Un\G4003, Un\G4007) is output in analog.

*4 When "PID Control Function" is set to "Select Function" of "Switch Setting", the value in Output conversion value (Un\G4302, Un\G4382) is output in analog.

A

(106)CH□ Analog output command value (Un\G4760, Un\G4762) D/A conversion

The analog value that the analog I/O module commands the analog output circuit to output is stored.
This value is updated at periods of about 1ms.
Use this area for troubleshooting. For details, refer to the following.

- Troubleshooting for the D/A conversion (☞ Page 335, Section 11.6.3)

CH□ Analog output command value (Un\G4760, Un\G4762) depends on the value stored in CH□ D/A conversion status (Un\G4750, Un\G4751), as described below.

(a) For "Analog output disable (1)" to "Analog output enable (variable conversion characteristics) (5)"

The following value is stored.

- Current output: A value of current output value [mA] × 100 is stored. When 20mA is output, 2000 is stored.
- Voltage output: A value of voltage output value [V] × 100 is stored. When 10V is output, 1000 is stored.

(b) "External power supply OFF (-1)", "D/A conversion disable (0)"

0 is stored.

Point

Do not use the value in this area for actual controls.
Use the value as a guide to the status of analog output at a system startup or other events.

(107)CH□ Analog output command value unit (Un\G4761, Un\G4763) D/A conversion

The unit of CH□ Analog output command value (Un\G4760, Un\G4762) is stored.
Use this area for troubleshooting. For details, refer to the following.

- Troubleshooting for the D/A conversion (☞ Page 335, Section 11.6.3)

Unit	Stored value
$\times 10^{-2}$mA	0
$\times 10^{-2}$V	1

(108)Latest address of error history (Un\G4800) Common

The buffer memory address of Error history No.□ (Un\G4810 to Un\G4969) that stores the latest error code is stored.

(109)Error history No.☐ (Un\G4810 to Un\G4969) Common

Up to 16 errors that occur in the module are recorded.

For details of the error log function, refer to the following.

- Error Log Function (☞ Page 269, Section 8.23)

	b15 to b8	b7 to b0
Un\G4810	Error code	
Un\G4811	First two digits of the year	Last two digits of the year
Un\G4812	Month	Day
Un\G4813	Hour	Minute
Un\G4814	Second	Day of the week
Un\G4815 to Un\G4819	System area	

Item	Stored value and code	Storage example[*1]
First two digits of the year/Last two digits of the year	Stored in BCD code.	2013H
Month/Day		0501H
Hour/Minute		1234H
Second		56H
Day of the week	The value that corresponds to the day of the week is stored in BCD code. • Sunday: 00H • Monday: 01H • Tuesday: 02H • Wednesday: 03H • Thursday: 04H • Friday: 05H • Saturday: 06H	03H

*1 Values stored when an error occurs on Wednesday May 1, 2013 at 12:34:56.

(110)CH□ Logging data (Un\G5000 to Un\G24999) A/D conversion

When "Select Function" is set to "Logging Function", the collected data is stored in this area.
This area is valid only when the logging function is used.
Up to 10000 values can be stored per channel. After the number of data points stored in CH□ Logging data (Un\G5000 to Un\G24999) of each channel has reached 10000 points, the data collection continues, writing new data over the stored data from the start address.
For details on the logging function, refer to the following.

- Logging Function (☞ Page 106, Section 8.10)

Point

- When Operating condition setting request (Y9) is turned on and off, the logging data of all the channels are cleared to 0.
- Even if the logging restarts by turning off CH□ Logging hold request (Un\G1008, Un\G1009), the logging data are not cleared to 0.

(111)Wave data registry area (Un\G5000 to Un\G54999) D/A conversion

When "Select Function" is set to "Wave Output Function", this area is used to register wave data for analog output.
When the function other than "Wave Output Function" is set in "Select Function", do not register wave data in this area. Otherwise, the selected function may not operate normally.

- Wave Output Function (☞ Page 144, Section 8.18)

(a) Setting range

- The setting range varies depending on the output range setting. Follow the setting range below.

Output range setting	Setting range (practical range)
0: 4 to 20mA	0 to 12287 (practical range: 0 to 12000)
1: 0 to 20mA	
2: 1 to 5V	
3: 0 to 5V	
4: -10 to 10V	-16384 to 16383 (practical range: -16000 to 16000)

- When the wave data with a value outside the above setting range is output, an error occurs on the corresponding channel. The error code (60□) is stored in Latest error code (Un\G19) and Error flag (XF) turns on. The wave output operations continue to be performed. However, the analog output value corresponding to a digital input value outside the setting range is fixed to the maximum or minimum value of the output range.

(112)Conversion characteristics table (Un\G5000 to Un\G37000) Variable conversion

When the variable conversion characteristics function or the variable conversion characteristics function + variable arithmetic function is used, the conversion characteristics table is registered in this area.
When the function other than "Free Conversion Characteristics Function" or "Free Conversion Characteristics Function + Free Operation Function" is set in "Select Function", do not register the conversion characteristics table in this area. Otherwise, the selected function may not operate normally.

(a) Setting range

The setting range varies depending on the input range setting or output range setting. Observe the following setting range.

Variable conversion characteristics table selection (Un\G4100)	Range setting	Setting range	
		Minimum	Maximum
Analog input (0)	4 to 20mA	0	12000
	0 to 20mA		
	1 to 5V		
	0 to 5V		
	-10 to 10V	-16000	16000
	0 to 10V	0	
	4 to 20mA (Extended mode)	-3000	13500
	1 to 5V (Extended mode)		
Analog output (1)	4 to 20mA	0	12000
	0 to 20mA		
	1 to 5V		
	0 to 5V		
	-10 to 10V	-16000	16000
Analog I/O (2)	4 to 20mA	0	12000
	0 to 20mA		
	1 to 5V		
	0 to 5V		
	-10 to 10V	-16000	16000

- If a value outside the above setting range is set in A/D conversion, the setting value (-32768 to 32767) is output as a digital value.
- If a value outside the above setting range is set in D/A conversion, the maximum value or minimum value of the setting range is applied to the operation. In addition, a check code is stored in CH☐ Set value check code (Un\G2013, Un\G2014), an error (error code: 60) occurs, and Error flag (XF) turns on.

Appendix 3 I/O Conversion Characteristic

This chapter describes the I/O conversion characteristic of the analog I/O module.

Appendix 3.1 I/O conversion characteristic of A/D conversion

The I/O conversion characteristic of A/D conversion is the slope of the line that joins the offset value and gain value, both of which are used when an analog signal (voltage or current) from outside the programmable controller is converted to the corresponding digital value.
The variable conversion characteristics function enables the conversion characteristics to be freely set based on the voltage/current input conversion characteristics. For details on the variable conversion characteristics function, refer to the following.

- Variable Conversion Characteristics Function (☞ Page 212, Section 8.20)

(1) Offset value

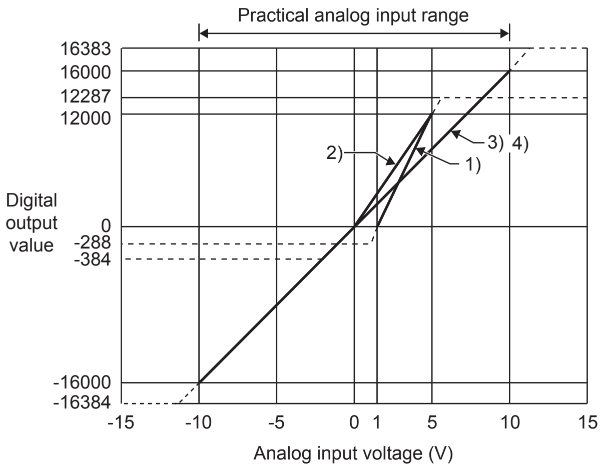
The analog input value (voltage or current) corresponding to the digital output value 0

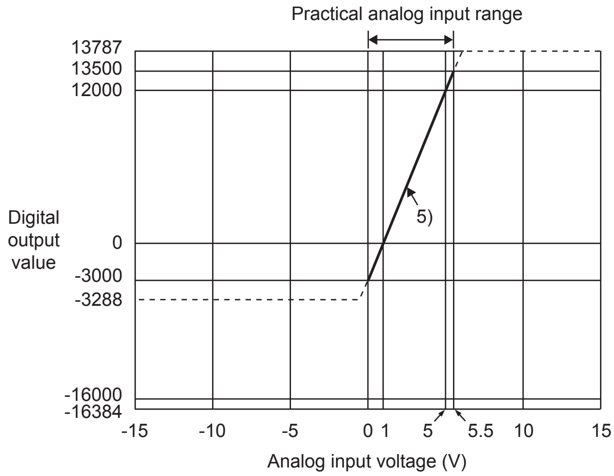
(2) Gain value

The analog input value (voltage or current) corresponding to the digital output value 16000 (12000)

(3) Voltage input characteristic

The following graph shows the voltage input characteristic.





No.	Analog input range setting	Offset value	Gain value	Digital output value*2	Resolution
1)	1 to 5V	1V	5V	0 to 12000	333μV
2)	0 to 5V	0V	5V		416μV
3)	-10 to 10V	0V	10V	-16000 to 16000	625μV
4)	0 to 10V	0V	10V	0 to 16000	
5)	1 to 5V (Extended mode)	1V	5V	-3000 to 13500	333μV
—	User range setting (voltage)	*1	*1	-12000 to 12000	321μV*3

*1 For the user range setting (voltage), set the offset value and gain value within the range satisfying the following conditions. If the following conditions are not satisfied, A/D conversion may not be properly performed.

- Setting range of the offset value and gain value: -10 to 10V
- Gain value - Offset value ≥ 4.0V

*2 When an analog input exceeds the range of digital output values, the corresponding digital output value is fixed to the maximum or minimum.

Analog input range setting	Digital output value	
	Minimum	Maximum
1 to 5V	-288	12287
0 to 5V		
-10 to 10V	-16384	16383
0 to 10V	-384	
1 to 5V (Extended mode)	-3288	13787
User range setting (Voltage)	-12288	12287

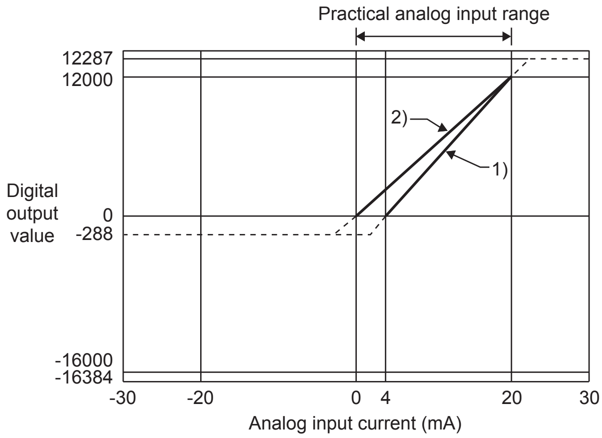
*3 Maximum resolution for the user range setting (voltage).

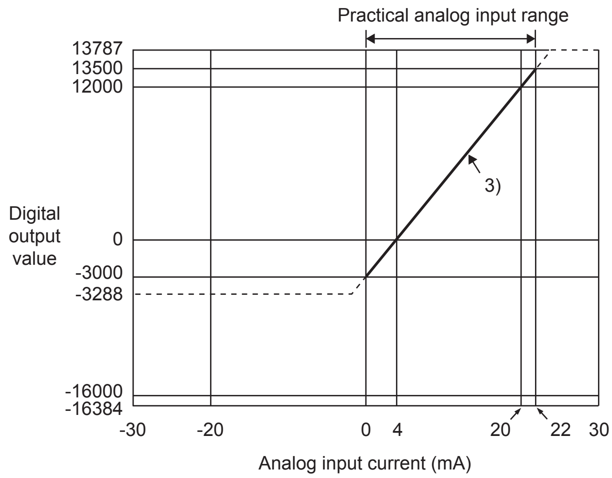
Point

- Use the analog I/O module with values within the practical analog input range and practical digital output range of each input range. If a value is out of the range, the resolution and accuracy may not fall within the range of performance specifications.
(Do not use the values in the dotted lines in the above voltage input characteristic graph.)
- Do not input a voltage of ±15V or higher/lower. This may damage the elements.

(4) Current input characteristic

The following graph shows the current input characteristic.





No.	Analog input range setting	Offset value	Gain value	Digital output value*2	Resolution
1)	4 to 20mA	4mA	20mA	0 to 12000	1333nA
2)	0 to 20mA	0mA	20mA		1666nA
3)	4 to 20mA (Extended mode)	4mA	20mA	-3000 to 13500	1333nA
—	User range setting (Current)	*1	*1	-12000 to 12000	1287nA*3

*1 For the user range setting (current), set the offset value and gain value within the range satisfying the following conditions.
If the following conditions are not satisfied, A/D conversion may not be properly performed.
- Gain value ≤ 20mA, Offset value ≥ 0mA
- Gain value - Offset value ≥ 16.0mA

*2 When an analog input exceeds the range of digital output values, the corresponding digital output value is fixed to the maximum or minimum.

Analog input range setting	Digital output value	
	Minimum	Maximum
4 to 20mA	-288	12287
0 to 20mA		
4 to 20mA (Extended mode)	-3288	13787
User range setting (Current)	-12288	12287

*3 Maximum resolution for the user range setting (current).

Point

- Use the analog I/O module with values within the practical analog input range and practical digital output range of each input range. If a value is out of the range, the resolution and accuracy may not fall within the range of performance specifications.
(Do not use the values in the dotted lines in the above current input characteristic graph.)
- Do not input a current of ±30mA or higher/lower. This may damage the elements.

Appendix 3.2 I/O conversion characteristic of D/A conversion

The I/O conversion characteristic of D/A conversion is the slope of the line that joins the offset value and gain value, both of which are used when a digital input value written from the CPU module is converted to the corresponding analog output value (voltage or current output).
The variable conversion characteristics function enables the conversion characteristics to be freely set based on the voltage/current output conversion characteristics. For details on the variable conversion characteristics function, refer to the following.

- Variable Conversion Characteristics Function (☞ Page 212, Section 8.20)

(1) Offset value

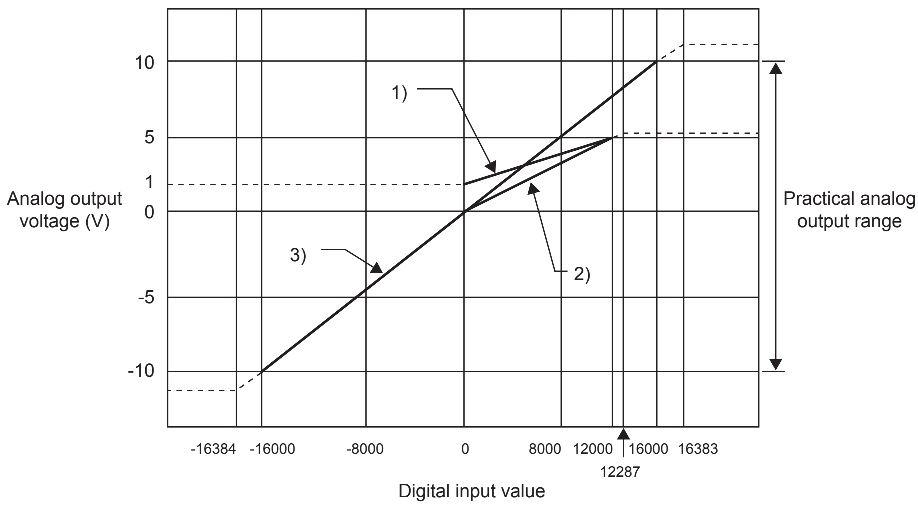
The analog output value (voltage or current) corresponding to the digital input value 0 that is set through the CPU module

(2) Gain value

The analog output value (voltage or current) corresponding to the digital input value 16000 (12000) that is set through the CPU module

(3) Voltage output characteristic

The following graph shows the voltage output characteristic.



No.	Analog output range setting	Offset value	Gain value	Digital input value	Resolution
1)	1 to 5V	1V	5V	0 to 12000	333μV
2)	0 to 5V	0V	5V		416μV
3)	-10 to 10V	0V	10V	-16000 to 16000	625μV
—	User range setting (voltage)	*1	*1	-12000 to 12000	319μV*2

*1 For the user range setting (voltage), set the offset value and gain value within the range satisfying the following two conditions.

- Setting range: -10 to 10V
- Gain value - Offset value ≥ 4V

*2 Maximum resolution for the user range setting (voltage).

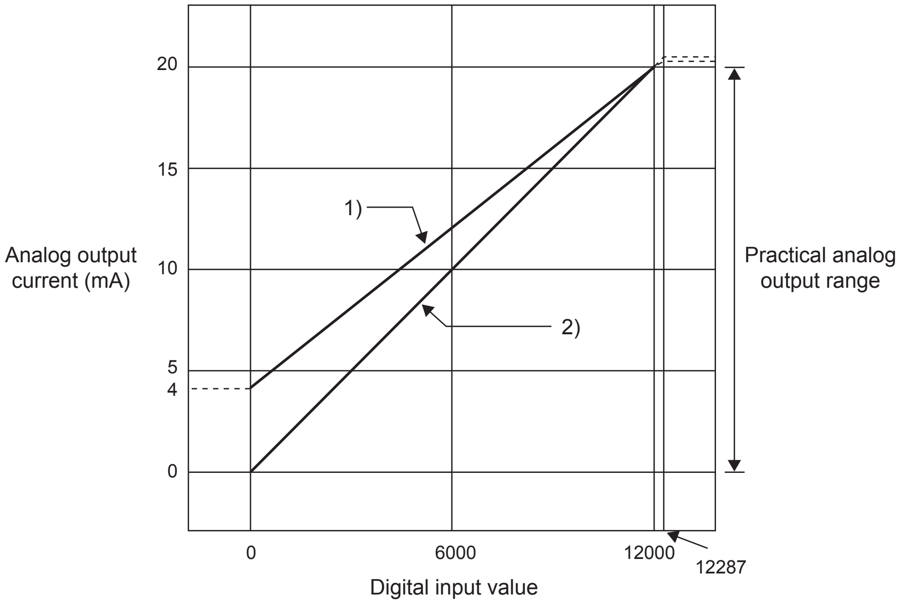
A

Point

Use the analog I/O module with values within the practical digital input range and practical analog output range of each output range. If a value is out of the range, the resolution and accuracy may not fall within the range of performance specifications.
(Do not use the values in the dotted lines in the above voltage output characteristic graph.)

(4) Current output characteristic

The following graph shows the current output characteristic.



No.	Analog output range setting	Offset value	Gain value	Digital input value	Resolution
1)	4 to 20mA	4mA	20mA	0 to 12000	1333nA
2)	0 to 20mA	0mA	20mA		1666nA
—	User range setting (Current)	*1	*1	-12000 to 12000	696nA*2

*1 For the user range setting (current), set the offset value and gain value within the range satisfying the following two conditions.
- Setting range: 0 to 20mA
- Gain value - Offset value ≥ 10mA

*2 Maximum resolution for the user range setting (current).

Point

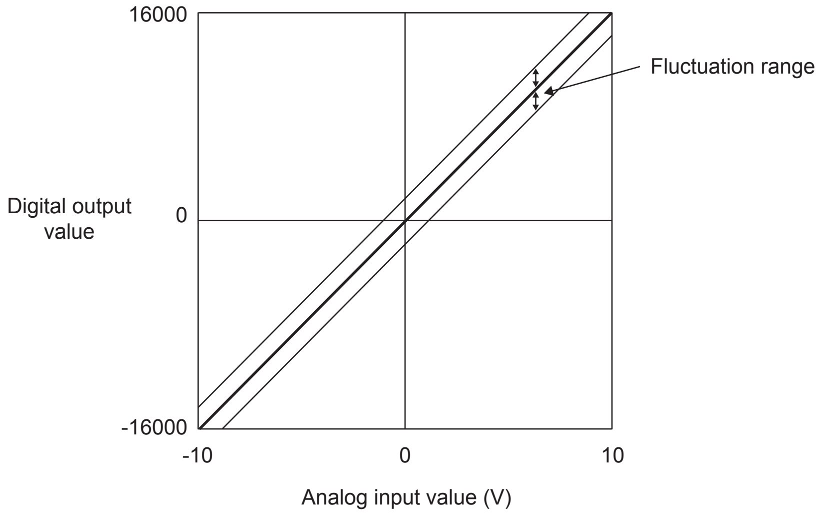
Use the analog I/O module with values within the practical digital input range and practical analog output range of each output range. If a value is out of the range, the resolution and accuracy may not fall within the range of performance specifications.
(Do not use the values in the dotted lines in the above current output characteristic graph.)

Appendix 4 Accuracy

This chapter describes the accuracy of the analog I/O module.

Appendix 4.1 A/D conversion accuracy

The A/D conversion accuracy is the accuracy for the maximum value of digital output values.
Even if the offset/gain setting and input range are changed and thus the input characteristic is changed, the accuracy does not change and is kept within the range of the described performance specifications.
The following graph shows the fluctuation range of accuracy when the range of -10 to 10V is selected.

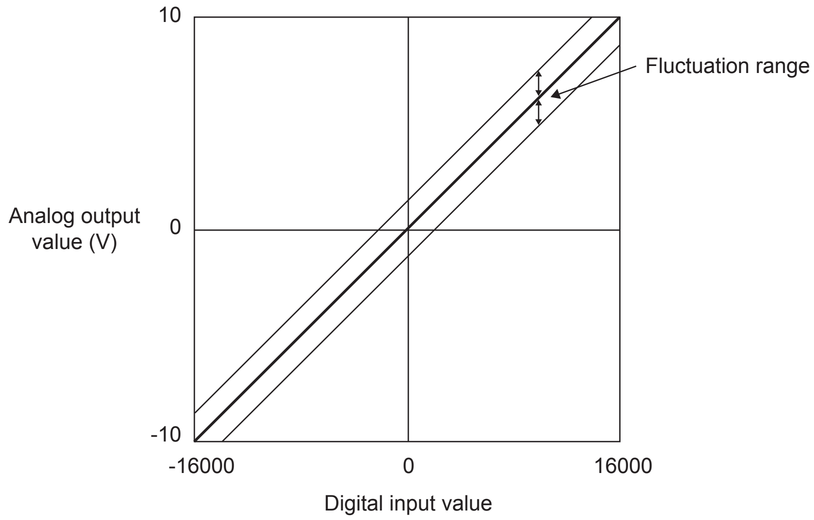


The fluctuation range differs depending on the ambient temperature and the input range as described in the following table.
Noise influences are not considered in the following.

Analog input range		Fluctuation range	
		Ambient temperature: 25 ±5℃	**Ambient temperature: 0 to 55℃**
Voltage	0 to 10V	Within ±0.2% (±32 digits)	Within ±0.3% (±48 digits)
	-10 to 10V		
	0 to 5V	Within ±0.2% (±24 digits)	Within ±0.3% (±36 digits)
	1 to 5V		
	1 to 5V (Extended mode)		
Current	0 to 20mA		
	4 to 20mA		
	4 to 20mA (Extended mode)		

Appendix 4.2 D/A conversion accuracy

The D/A conversion accuracy is the accuracy for the maximum value of analog output values.
Even if the offset/gain setting and output range are changed and thus the output characteristic is changed, the accuracy does not change and is kept within the range of the described performance specifications.
The following graph shows the fluctuation range of accuracy when the range of -10 to 10V is selected.



The fluctuation range differs depending on the ambient temperature and the output range as described in the following table.
Noise influences are not considered in the following.

Analog output range		Fluctuation range	
		Ambient temperature: 25 ±5℃	Ambient temperature: 0 to 55℃
Voltage	0 to 5V	Within ±0.2% (±10mV)	Within ±0.4% (±20mV)
	1 to 5V		
	-10 to 10V	Within ±0.2% (±20mV)	Within ±0.4% (±40mV)
Current	0 to 20mA	Within ±0.2% (±40μA)	Within ±0.4% (±80μA)
	4 to 20mA		

Appendix 5 Dedicated Instruction

This chapter describes the dedicated instructions that can be used in the analog I/O module.

Appendix 5.1 Instruction list

The following table lists the dedicated instructions that can be used in the analog I/O module.

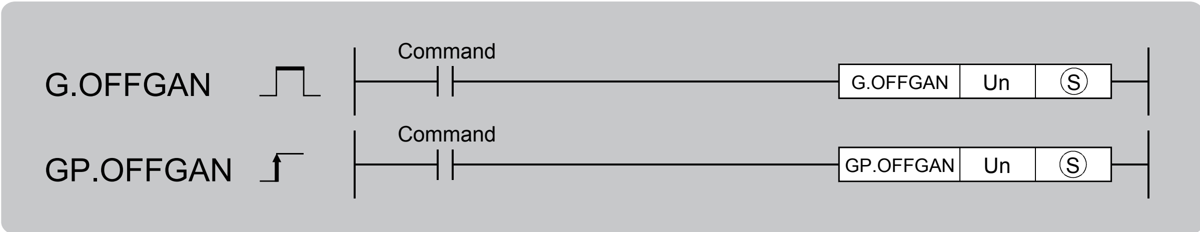
Instruction	Description
G(P).OFFGAN	• The operation mode is changed from the normal mode to the offset/gain setting mode. • The operation mode is changed from the offset/gain setting mode to the normal mode.
G(P).OGLOAD	The offset/gain setting value in the user range setting is read out to the CPU module.
G(P).OGSTOR	The offset/gain setting value in the user range setting stored in the CPU module is restored to the analog I/O module.

Point

When any function other than the logging function is selected in Select Function, note the following.

- The G(P).OFFGAN and G(P).OGLOAD instructions are invalid.
- When the G(P).OGSTOR instruction is performed, an error (error code: 161) occurs.

Appendix 5.2 G(P).OFFGAN



Setting data	Internal device		R, ZR	J□\□		U□\G□	Zn	Constant K, H, $	Others
	Bit	Word		Bit	Word				
Ⓢ	—	○		—					

(1) Setting data

Device	Description	Setting range	Data type
Un	Start I/O number of the module	0 to FEH	BIN 16 bits
Ⓢ	Mode change Changed to the normal mode Changed to the offset/gain setting mode When a value other than the above is set, the mode is changed to the offset/gain setting mode.	0, 1	BIN 16 bits

(2) Functions

This instruction switches the operation mode of the analog I/O module.

- Normal mode → Offset/gain setting mode (Offset/gain setting mode flag (XA) is on and the RUN LED flashes.)
- Offset/gain setting mode → Normal mode (Offset/gain setting mode flag (XA) is off and the RUN LED is on.)

Point

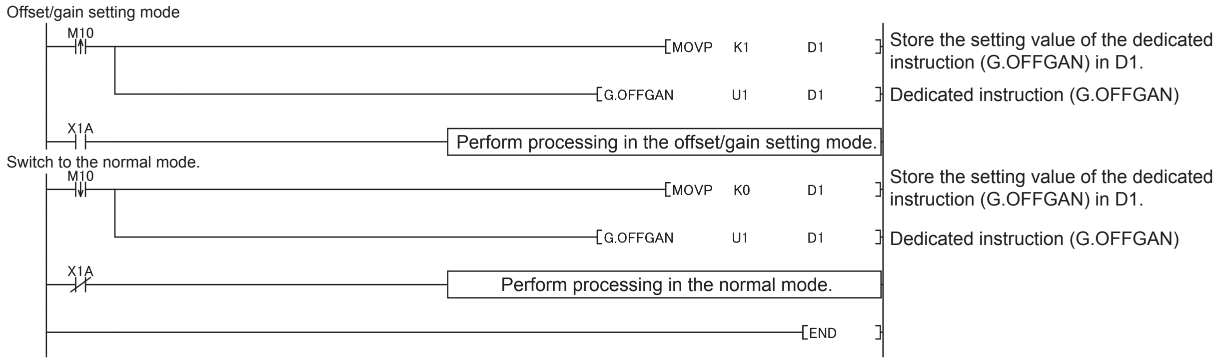
- When the mode is switched from the offset/gain setting mode to the normal mode, Module READY (X0) turns on. Note the initial setting process is performed at the switching of the mode if a program executes the initial setting when Module READY (X0) turns on.
- When the mode is switched, the A/D conversion and D/A conversion stop. When the mode is switched from the offset/gain setting mode to the normal mode, A/D conversion disable (1) is stored to A/D conversion enable/disable setting (Un\G0) and D/A conversion disable (1) is stored to D/A conversion enable/disable setting (Un\G2000). To resume the A/D conversion or D/A conversion, set A/D conversion enable (0) or D/A conversion enable (0) for the corresponding channels and turn on and off Operating condition setting request (Y9).
- If the mode to be switched to is the same as the current mode (if this instruction is performed when the operation mode is the normal mode and "0: Changed to the normal mode" is set, or when the operation mode is the offset/gain setting mode and "1: Changed to the offset/gain setting mode" is set), the operation is invalid.

(3) Errors

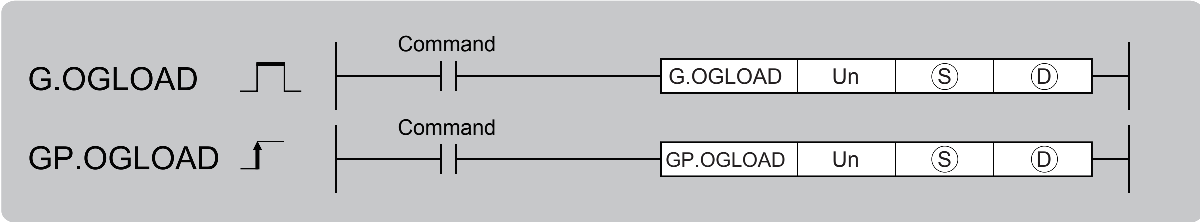
The instruction has no errors.

(4) Program example

The following shows the program of the analog I/O module, which is installed in I/O number X/Y10 to X/Y1F, with the following conditions: Turning on M10 switches the operation mode to the offset/gain setting mode. Turning off M10 restores the operation mode to the normal mode.



Appendix 5.3 G(P).OGLOAD



Setting data	Internal device		R, ZR	J□\□		U□\G□	Zn	Constant K, H, $	Others
	Bit	Word		Bit	Word				
Ⓢ	—	○		—					
Ⓓ	○			—					

(1) Setting data

Device	Description	Setting range	Data type
Un	Start I/O number of the module	0 to FEH	BIN 16 bits
Ⓢ	Start number of the device where control data is stored	Within the range of the specified device	Device name
Ⓓ	Device which turns on for one scan at the processing completion of the dedicated instruction In error completion, Ⓓ+1 also turns on.	Within the range of the specified device	Bit

(2) Control data*1

Device	Item	Setting data	Setting range	Set by
Ⓢ	System area	—	—	—
Ⓢ+1	Completion status	The status on instruction completion is stored. 0: Normal completion Other than 0: Error completion (error code)	—	System
Ⓢ+2	Pass data classification setting	Specify the type of offset/gain setting values to read out. Voltage Current b15 to b8 b7 b6 b5 b4 b3 b2 b1 b0 0 0 0 0 0 0 0 CH4 CH3 CH2 CH1	0000H to 000FH	User
Ⓢ+3	System area	—	—	—
Ⓢ+4	CH1 Industrial shipment settings offset value	—	—	System
Ⓢ+5	CH1 Industrial shipment settings gain value	—	—	System
Ⓢ+6	CH2 Industrial shipment settings offset value	—	—	System
Ⓢ+7	CH2 Industrial shipment settings gain value	—	—	System
Ⓢ+8	CH3 Industrial shipment settings offset value	—	—	System
Ⓢ+9	CH3 Industrial shipment settings gain value	—	—	System
Ⓢ+10	CH4 Industrial shipment settings offset value	—	—	System
Ⓢ+11	CH4 Industrial shipment settings gain value	—	—	System
Ⓢ+12	CH1 User range settings offset value	—	—	System
Ⓢ+13	CH1 User range settings gain value	—	—	System
Ⓢ+14	CH2 User range settings offset value	—	—	System
Ⓢ+15	CH2 User range settings gain value	—	—	System
Ⓢ+16	CH3 User range settings offset value	—	—	System
Ⓢ+17	CH3 User range settings gain value	—	—	System
Ⓢ+18	CH4 User range settings offset value	—	—	System
Ⓢ+19	CH4 User range settings gain value	—	—	System

*1 Configure the setting of Pass data classification setting Ⓢ+2 only.
When the data is written to the area to be set by system, offset/gain setting values are not correctly read out.

(3) Functions

- This instruction reads out the offset/gain setting value in the user range setting of the analog I/O module to the CPU module.
- The interlock signal of the G(P).OGLOAD instruction includes a completion device Ⓓ and a completion status indication device Ⓓ+1.

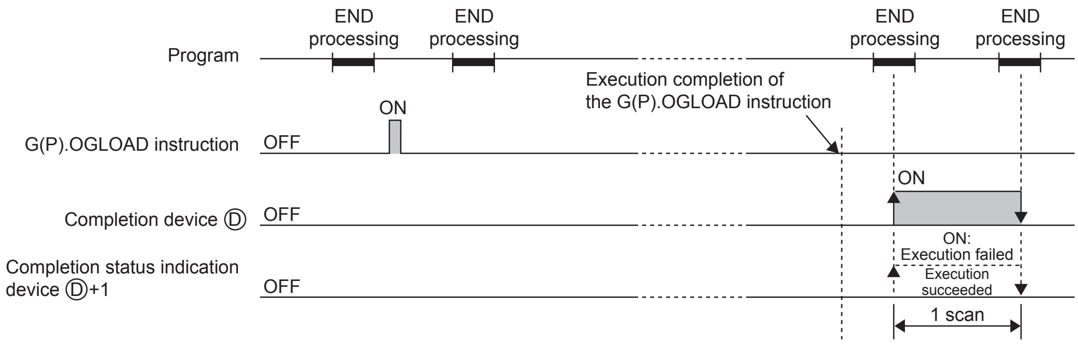
(a) Completion device

The device turns on at the END processing for the scan where the G(P).OGLOAD instruction is completed, and turns off at the next END processing.

(b) Completion status indication device

This device turns on and off depending on the status of the G(P).OGLOAD instruction completion.

- Normal completion: The device is kept to be off.
- Error completion: The device turns on at the END processing for the scan where the G(P).OGLOAD instruction is completed, and turns off at the next END processing.

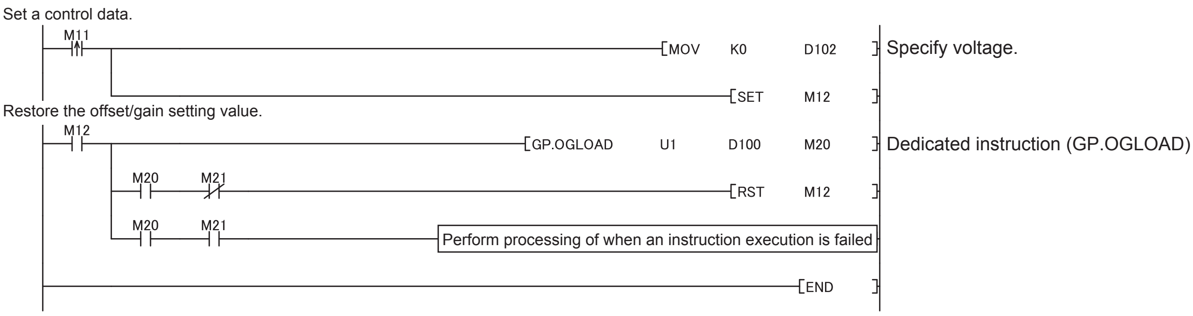


(4) Errors

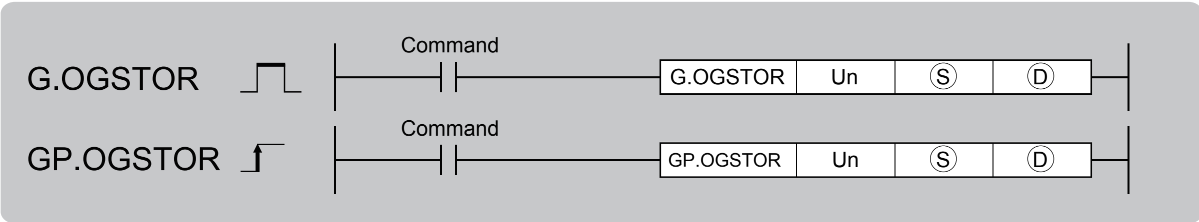
The instruction has no errors.

(5) Program example

The following shows the program to read out the offset/gain setting value of the analog I/O module, which is installed in I/O number X/Y10 to X/Y1F, by turning on M11.



Appendix 5.4 G(P).OGSTOR



Setting data	Internal device		R, ZR	J□\□		U□\G□	Zn	Constant K, H, $	Others
	Bit	Word		Bit	Word				
Ⓢ	—	○		—					
Ⓓ	○			—					

(1) Setting data

Device	Description	Setting range	Data type
Un	Start I/O number of the module	0 to FEH	BIN 16 bits
Ⓢ*1	Start number of the device where control data is stored	Within the range of the specified device	Device name
Ⓓ	Device which turns on for one scan at the processing completion of the dedicated instruction In error completion, Ⓓ+1 also turns on.	Within the range of the specified device	Bit

*1 Specify the device specified Ⓢ to on execution of the G(P).OGLOAD instruction.
Do not change the data which is read out by the G(P).OGLOAD instruction. If the data is changed, the normal operation may not be ensured.

(2) Control data

Device	Item	Setting data	Setting range	Set by
Ⓢ	System area	—	—	—
Ⓢ+1	Completion status	The status on instruction completion is stored. 0: Normal completion Other than 0: Error completion (error code)	—	System
Ⓢ+2	Pass data classification setting	The value which is set for Pass data classification setting Ⓢ+2 by the G(P).OGLOAD instruction is stored. Voltage Current b15 to b8 b7 b6 b5 b4 b3 b2 b1 b0 0 0 0 0 0 0 0 CH4 CH3 CH2 CH1	0000H to 000FH	System
Ⓢ+3	System area	—	—	—
Ⓢ+4	CH1 Industrial shipment settings offset value	—	—	System
Ⓢ+5	CH1 Industrial shipment settings gain value	—	—	System
Ⓢ+6	CH2 Industrial shipment settings offset value	—	—	System
Ⓢ+7	CH2 Industrial shipment settings gain value	—	—	System
Ⓢ+8	CH3 Industrial shipment settings offset value	—	—	System
Ⓢ+9	CH3 Industrial shipment settings gain value	—	—	System
Ⓢ+10	CH4 Industrial shipment settings offset value	—	—	System
Ⓢ+11	CH4 Industrial shipment settings gain value	—	—	System
Ⓢ+12	CH1 User range settings offset value	—	—	System
Ⓢ+13	CH1 User range settings gain value	—	—	System
Ⓢ+14	CH2 User range settings offset value	—	—	System
Ⓢ+15	CH2 User range settings gain value	—	—	System
Ⓢ+16	CH3 User range settings offset value	—	—	System
Ⓢ+17	CH3 User range settings gain value	—	—	System
Ⓢ+18	CH4 User range settings offset value	—	—	System
Ⓢ+19	CH4 User range settings gain value	—	—	System

(3) Functions

- The offset/gain setting value in the user range setting stored in the CPU module is restored to the analog I/O module.
- The interlock signal of the G(P).OGSTOR instruction includes a completion device Ⓓ and a completion status indication device Ⓓ+1.

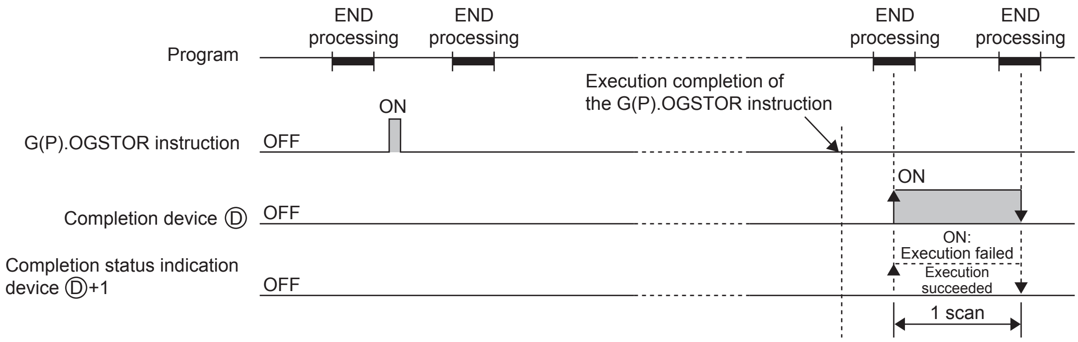
(a) Completion device

The device turns on at the END processing for the scan where the G(P).OGSTOR instruction is completed, and turns off at the next END processing.

(b) Completion status indication device

This device turns on then off depending on the status of the G(P).OGSTOR instruction completion.

- Normal completion: The device is kept to be off.
- Error completion: The device turns on at the END processing for the scan where the G(P).OGSTOR instruction is completed, and turns off at the next END processing.



(c) Accuracy

The accuracy after the restoration of the offset/gain setting value is lower than the one before the restoration. The difference is about three times.

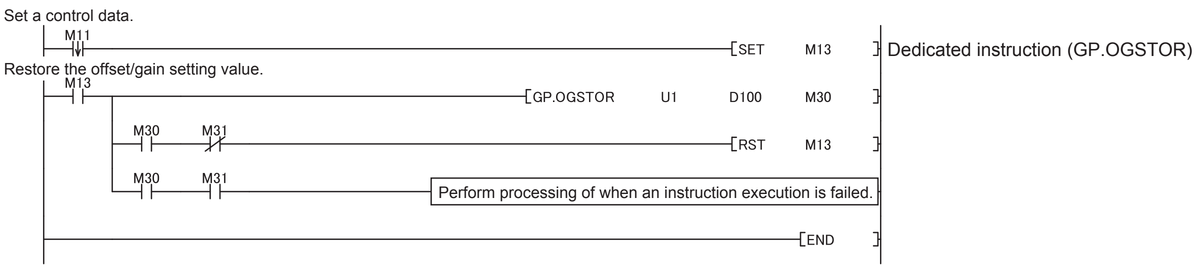
(4) Errors

In the following cases, an error occurs and an error code is stored in a completion status area +1.

Error code	Description of operation error
161	• The G(P).OGSTOR instruction is executed in the offset/gain setting mode. • The G(P).OGSTOR instruction is executed when any function other than the logging function is selected in Select Function.
162	The G(P).OGSTOR instruction is continuously executed.
163	• The G(P).OGSTOR instruction is executed to the model different from the one to which the G(P).OGLOAD instruction is executed. • The G(P).OGSTOR instruction has been executed before the execution of the G(P).OGLOAD instruction.

(5) Program example

The following shows the programs to write the offset/gain setting value to the analog I/O module, which is installed in I/O number X/Y10 to X/Y1F, by turning off M11.



A

Appendix 6 PID

Appendix 6.1 PID operation

This section describes proportional action (P action), integral action (I action), and derivative action (D action) in PID control.

(1) Proportional action (P action)

A proportional action obtains a manipulated value (MV) proportional to the deviation (difference between the set value (SV) and process value (PV)).

(a) Proportional gain

The following formula shows the relationship between the deviation (E) and manipulated value (MV) in the proportional action.

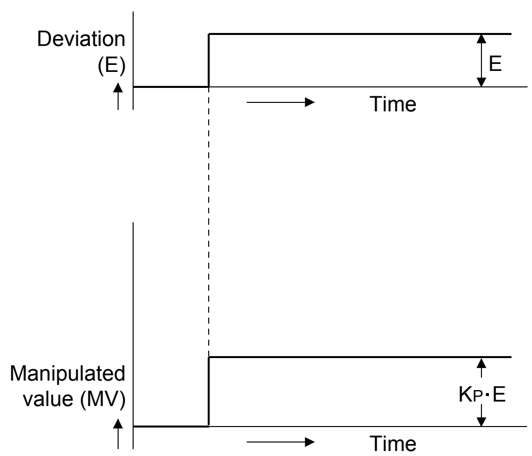
- $MV = K_P \cdot E$

K_P is a proportional constant and is called a "proportional gain". The manipulated value (MV) varies within the range of -5.0 to 105.0%.

The following table describes operation differences depending on the proportional gain value K_P.

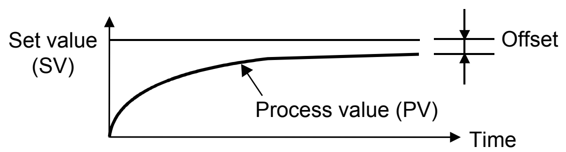
Condition	Proportional action
When the proportional gain K_P is small	The control operation speed becomes slow.
When the proportional gain K_P is large	Although the control operation speed becomes fast, hunting is likely to occur.

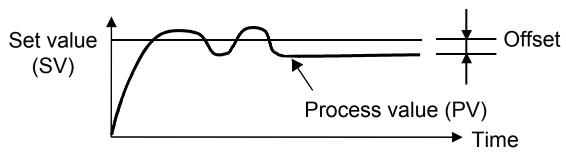
The following figure shows the proportional action in step response with a constant deviation (E).



(b) Offset

A certain error between the process value (PV) and set value (SV) is called an offset (residual deviation).
A proportional action generates an offset.





(2) Integral action (I action)

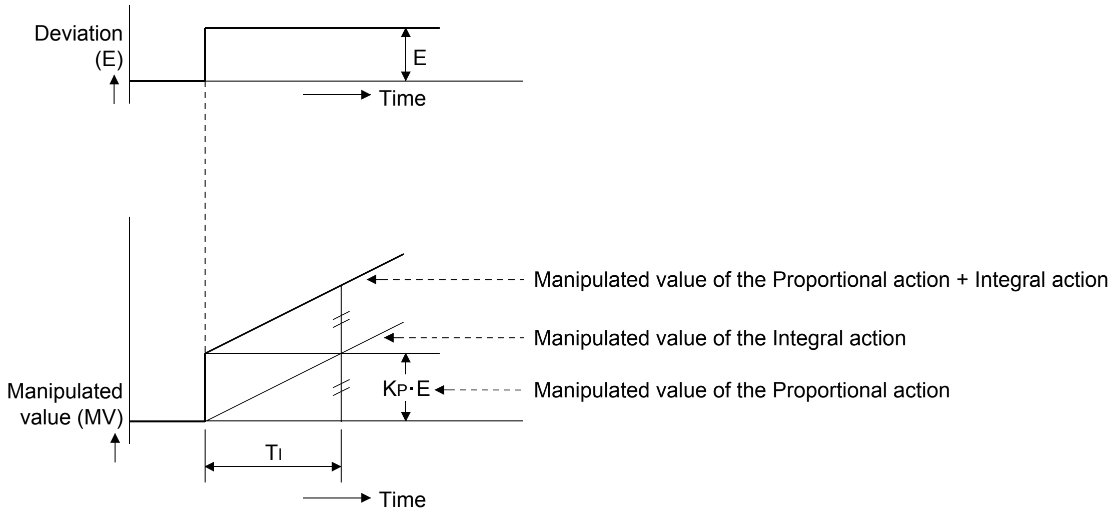
An integral action continuously changes a manipulated value (MV) to eliminate a deviation (E) when it is generated. An integral action eliminates the offset that is generated in the proportional action.

In integral action, the time to be taken for the manipulated value (MV) of the integral action after the generation of a deviation (E) to reach the manipulated value (MV) of a proportional action is called integral time and is expressed as T_I.

The following table describes operation differences depending on the integral time value T_I.

Condition	Integral action
When the integral time T_I is short	Integral effects increase and the time taken to eliminate an offset becomes short. However, hunting is likely to occur.
When the integral time T_I is long	Integral effects decrease and the time taken to eliminate an offset becomes long.

The following figure shows the integral action in step response with a constant deviation (E).



The integral action is always used together with the proportional action (PI action) or with the proportional and derivative actions (PID action). The integral action cannot be used solely.

A

(3) Derivative action (D action)

A derivative action adds a manipulated value (MV) proportional to the change rate of a deviation (E) to eliminate the deviation.

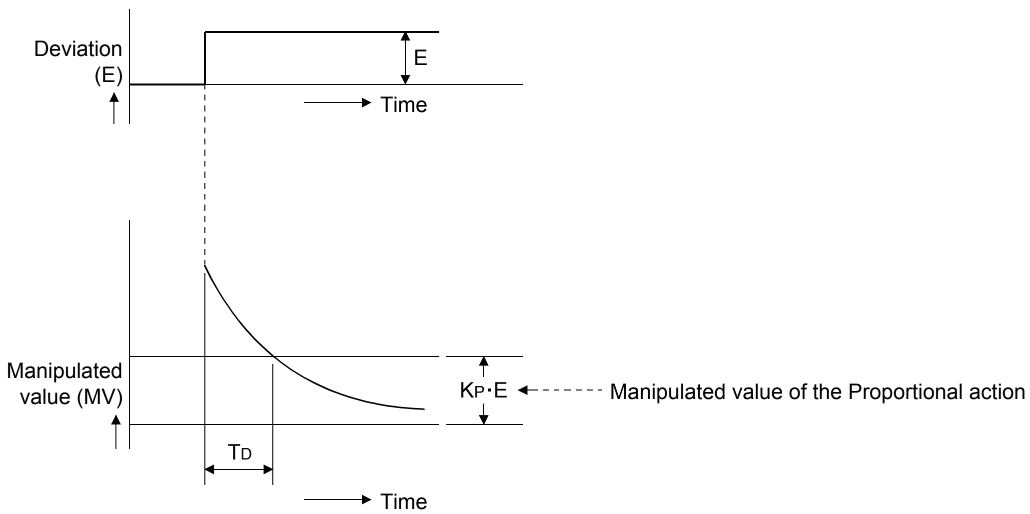
The derivative action prevents significant fluctuations of the control target due to disturbances.

In derivative action, the time to be taken for the manipulated value (MV) of the derivative action after the generation of a deviation (E) to reach the manipulated value (MV) of a proportional action is called derivative time and is expressed as T_D.

The following table describes operation differences depending on the derivative time value T_D.

Condition	Derivative action
When the derivative time T_D is short	Derivative effects decrease.
When the derivative time T_D is long	Derivative effects increase. However, short-cycle hunting is likely to occur.

The following figure shows the derivative action in step response with a constant deviation (E).



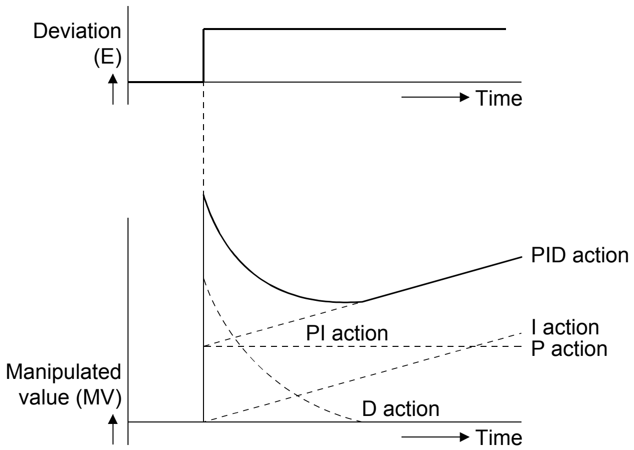
The derivative action is always used together with the proportional action (PD action) or with the proportional and integral actions (PID action).

The derivative action cannot be used solely.

(4) PID action

A PID action carries out controls using a manipulated value (MV) calculated as a result of the proportional action, integral action, and derivative action.

The following figure shows PID action in step response with a constant deviation (E).

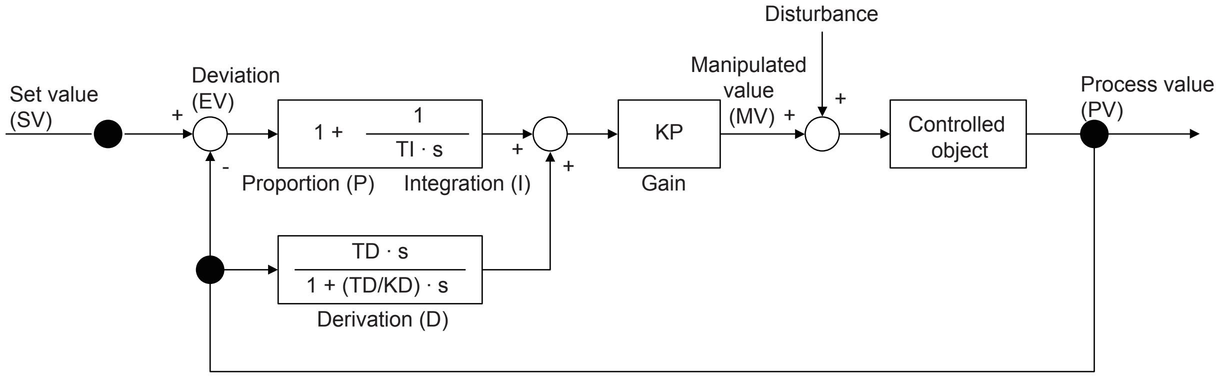


Appendix 6.2 Operation method

The following describes operation methods for the PID control function of the analog I/O module.

(1) Basic PID control

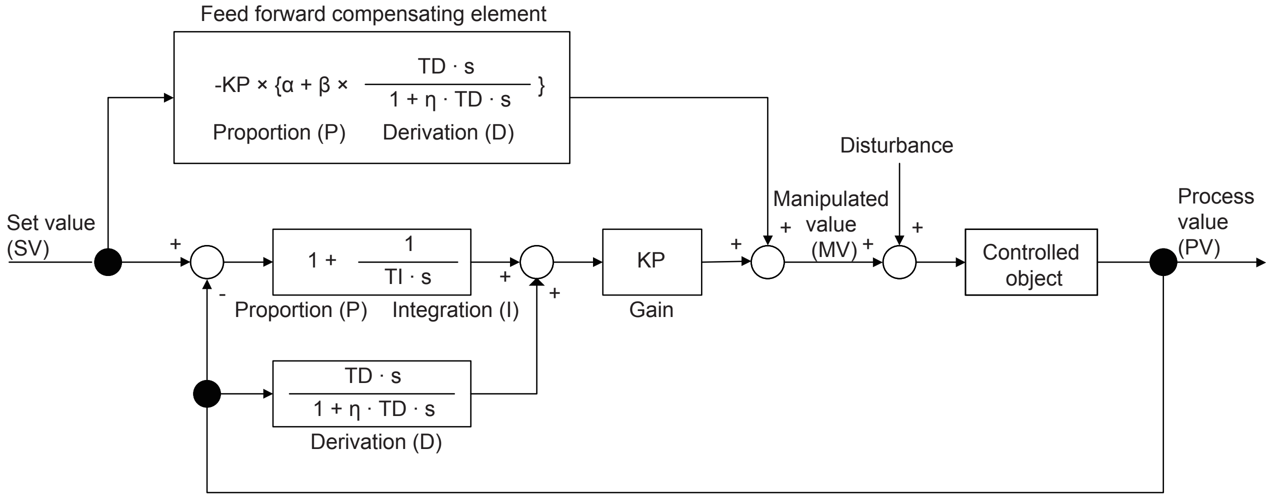
The basic PID control of the analog I/O module is the velocity inexact differential type.



KP	: Proportional gain	KD	: Derivative gain
T1	: Integral constant	η	: Derivative
TD	: Derivative constant	s	: Laplace transform conversion

(2) Two-degree-of-freedom PID control

In this method, the feedforward compensation element is added to the basic PID control.



KP	: Proportional gain	η	: Derivative
T1	: Integral constant	s	: Laplace transform conversion
TD	: Derivative constant	α	: Two-degree-of-freedom parameter (feedforward proportional)
KD	: Derivative gain	β	: Two-degree-of-freedom parameter (feedforward differential)

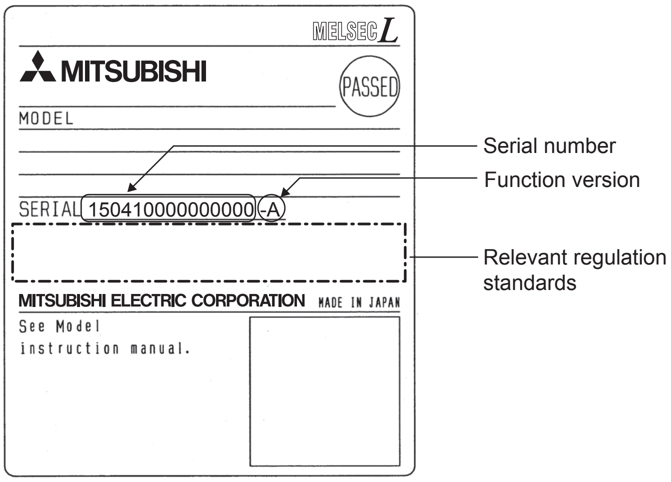
Appendix 7 How to Check the Function Version and Serial Number

The serial number and the function version of the analog I/O module can be checked with the following methods.

- Checking on the rating plate
- Checking on the front part of the module
- Checking on the system monitor of a programming tool

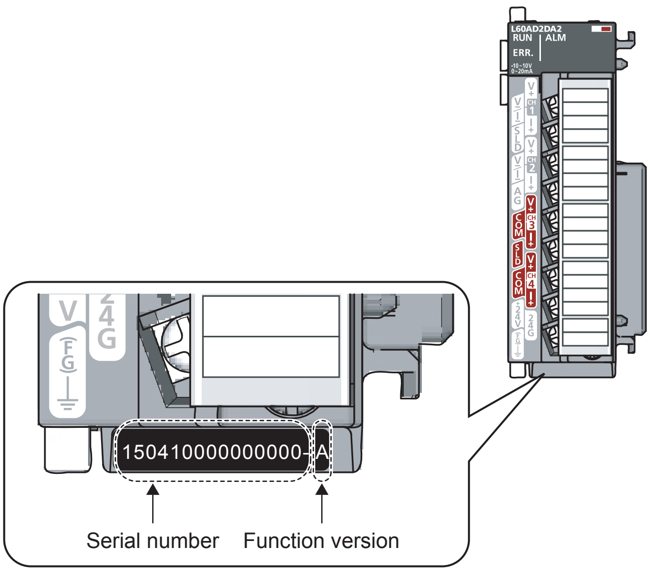
(1) Checking on the rating plate

The rating plate is on the side of the analog I/O module.



(2) Checking on the front part of the module

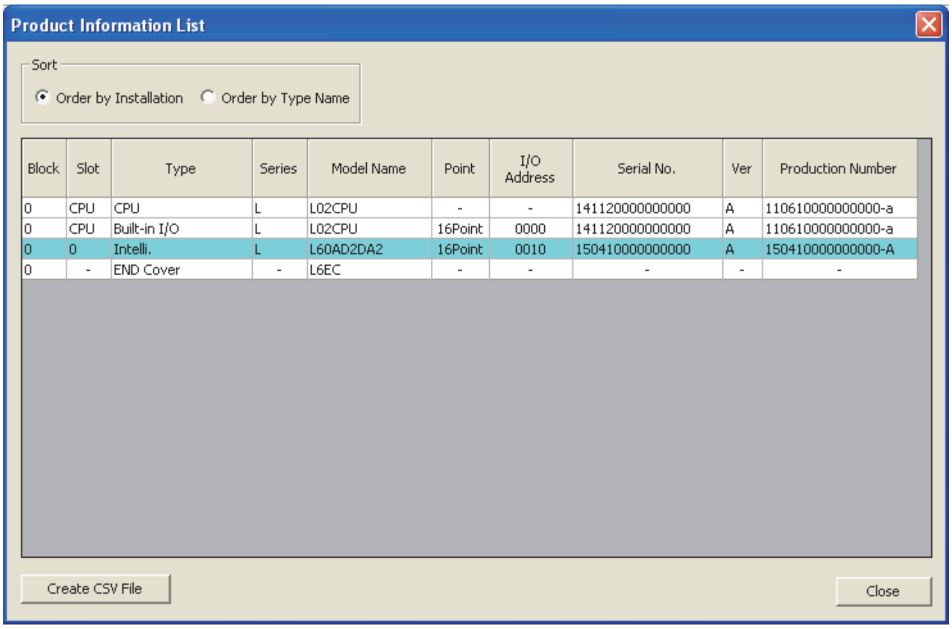
The function version and serial number on the rating plate are also shown on the front part (bottom part) of the module.



(3) Checking on the system monitor

The function version and serial number can be checked on the "Product Information List" window.

[Diagnostics] ⇨ [System Monitor...] ⇨ Product Information List button



(a) Displaying production number

The serial number (production number) on the rating plate is displayed in "Production Number".
Thus, the serial number (production number) can be checked without checking the module.

Point

The serial number displayed on the product information list of a programming tool may differ from that on the rating plate and on the front part of the module.

- The serial number on the rating plate and front part of the module indicates the management information of the product.
- The serial number displayed on the product information list of a programming tool indicates the function information of the product. The function information of the product is updated when a new function is added.

Appendix 8 Added and Changed Functions

Appendix 8.1 Added functions

This section shows the functions added to the analog I/O module and GX Works2, applicable product information of the analog I/O module, and the compatible software version of GX Works2.

Added function	First five digits of the product information of the analog I/O module	GX Works2 version	Reference
Variable arithmetic function	17042 or later	1.535H or later	Page 192, Section 8.19
Variable conversion characteristics function			Page 212, Section 8.20
Variable conversion characteristics function + variable arithmetic function			Page 239, Section 8.21
PID control function	17112 or later	1.540N or later	Page 246, Section 8.22

Appendix 9 When Using GX Developer

This chapter describes the operating procedure when GX Developer is used.

(1) Compatible software version

For the compatible software versions, refer to the following.

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

Appendix 9.1 Operation of GX Developer

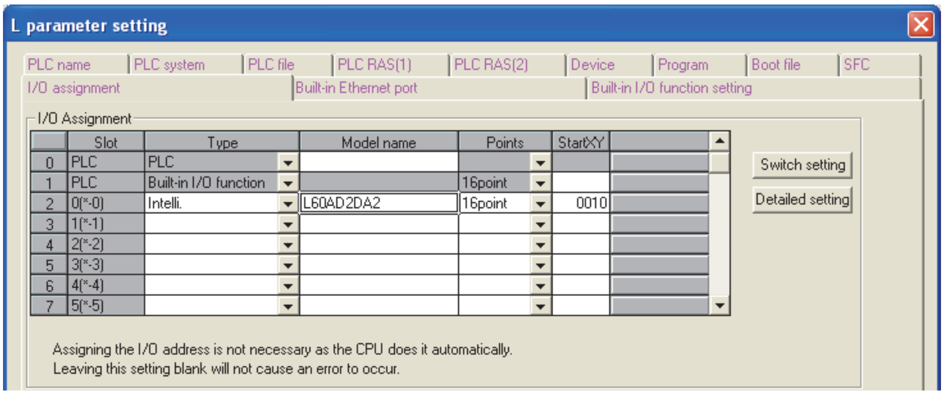
Configure the setting on the following window when using GX Developer.

Window name	Application	Reference
I/O assignment	Set the type of module installed and the range of I/O signals.	Page 449, Appendix 9.1 (1)
Switch setting	Configure the switch setting of an intelligent function module.	Page 450, Appendix 9.1 (2)
Offset/gain setting	Configure the setting when using the user range setting for the I/O range.	Page 68, Section 7.5.2 (1)

(1) I/O assignment

Configure the setting from "I/O Assignment" in "PLC parameter".

Parameter ⇨ [PLC Parameter] ⇨ [I/O Assignment]

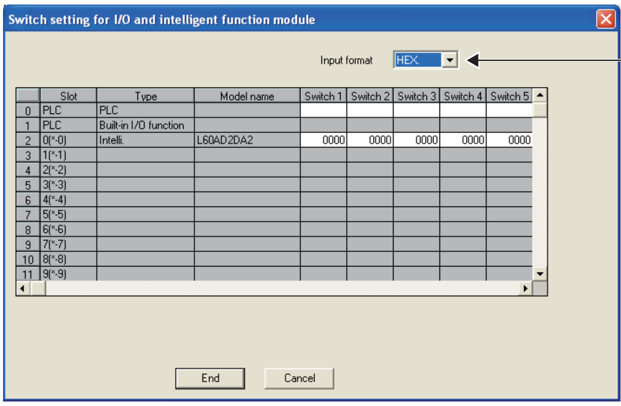


Item	Description
Type	Select "Intelli."
Model name	Enter the model name of the analog I/O module.
Points	Select "16point".
StartXY	Enter a desired start I/O number of the analog I/O module.

(2) Intelligent function module switch setting

Configure the setting from "Switch Setting" in "PLC parameter".

Parameter ⇨ [PLC Parameter] ⇨ [I/O Assignment] ⇨ Click the Switch setting button.



Select "HEX.".

Item	Setting item		
Switch 1	Range setting (CH1 to CH4) □□□□H CH4 CH3 CH2 CH1	Input range setting (CH1, CH2)	
		Analog input range	Input range setting value
		4 to 20mA	0H
		0 to 20mA	1H
		1 to 5V	2H
		0 to 5V	3H
		-10 to 10V	4H
		0 to 10V	5H
		4 to 20mA (Extended mode)	AH
		1 to 5V (Extended mode)	BH
		User range setting (current)	EH
		User range setting (voltage)	FH
		Output range setting (CH3, CH4)	
		Analog output range	Output range setting value
		4 to 20mA	0H
		0 to 20mA	1H
		1 to 5V	2H
		0 to 5V	3H
		-10 to 10V	4H
		User range setting (current)	EH
		User range setting (voltage)	FH
Switch 2	Fixed		
Switch 3	HOLD/CLEAR function setting (CH3, CH4) □□□□H CH4 CH3 Fixed to 0H	Setting value	HOLD/CLEAR
		0	CLEAR
		1H to FH*1	HOLD

Item	Setting item
Switch 4[*3]	Function selection, PID operation expression selection, drive mode setting □□□□ H Function selection 0H : Logging function 1H : Wave output function 2H : Variable arithmetic function 3H : Variable conversion characteristics function 4H : Variable arithmetic function + Variable conversion characteristics function 5H : PID control function 6H to FH : Invalid[*2] PID operation expression selection[*4] 0H : Basic PID control 1H : Two-degree-of-freedom PID control 2H : Basic PID control (variable speed integral) 3H : Two-degree-of-freedom PID control (variable speed integral) 0H: Fixed Drive mode setting 0H : Normal (A/D conversion processing, D/A conversion processing) mode 1H to FH[*1] : Offset/gain setting mode
Switch 5	Fixed[*5]

*1 The operation is the same when any value within the setting range is set.

*2 If a value other than 0H to 5H is set, an error (error code: 114) occurs.

*3 The operation differs depending on the setting value of the function selection. For details, refer to the following.
☞ Page 452, Appendix 9.1 (2) (a)

*4 PID operation expression selection is available only when PID control function (5H) is set to the function selection. When a value other than PID control function (5H) is set to the function selection, the set value is ignored. When a value other than 0H to 3H is set, the module operates with Basic PID control (0H).

*5 If a value other than 0 is set, an error (error code: 112) occurs.

(a) Difference in operation depending on the function selection

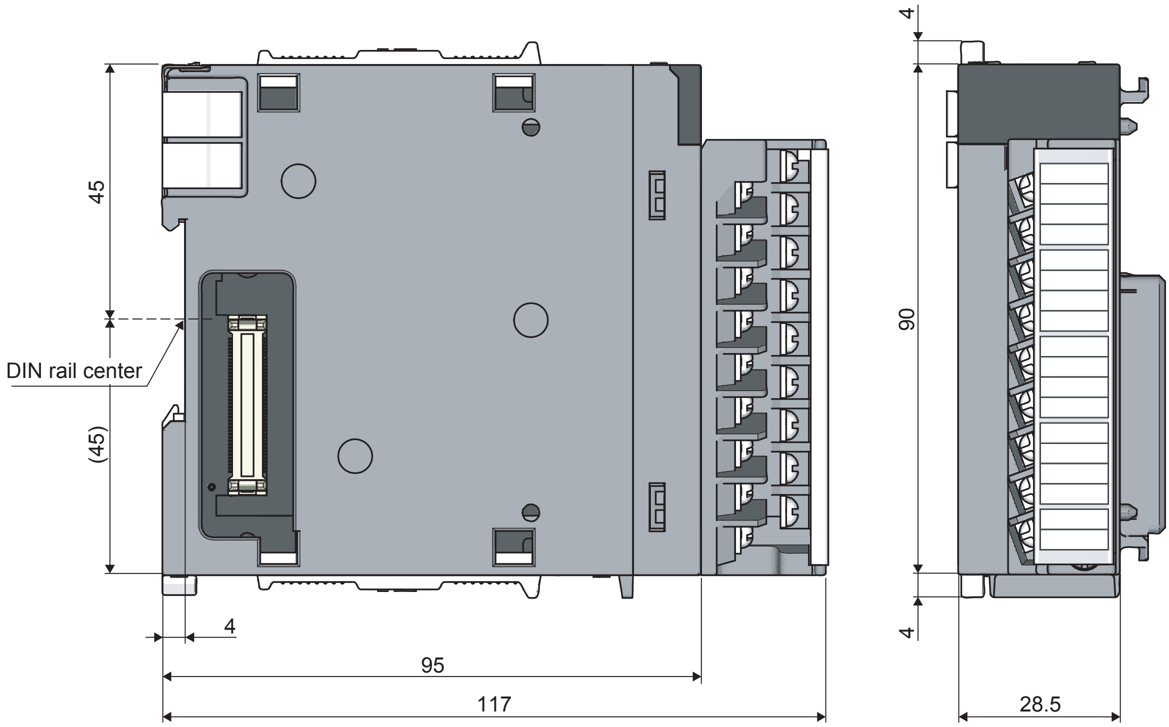
Function selection	Operation
Logging function (0H)	The logging function can be used.
Wave output function (1H)	• The wave output function can be used. To use the wave output function, set the wave data and parameters of the wave output function in the program. • The user range setting (EH or FH) cannot be used in Switch 1. If the output range setting is set to "EH or FH" with the wave output function selected, an error (error code: 302□) occurs.
Variable arithmetic function (2H)*1	• The variable arithmetic function can be used. To use the variable arithmetic function, set the arithmetic expression data and parameters of the variable arithmetic function with a program. • The user range setting (EH or FH) cannot be used in Switch 1. If the range setting is set to "EH or FH" with the variable arithmetic function selected, an error (error code: 400□) occurs.
Variable conversion characteristics function (3H)*1	• The variable conversion characteristics function can be used. To use the variable conversion characteristics function, set the conversion characteristics table and parameters of the variable conversion characteristics function with a program. • For the channel where the variable conversion characteristics function is used, the setting of Switch 1 is ignored. Set the range with Variable conversion characteristics range setting (Un\G4101) for the channel where the variable conversion characteristics function is used.
Variable conversion characteristics function + variable arithmetic function (4H)*1	• The variable conversion characteristics function + variable arithmetic function can be used. • The user range setting (EH or FH) cannot be used in Switch 1. If the range setting is set to "EH or FH" with the variable conversion characteristics function + variable arithmetic function selected, an error (error code: 400□) occurs. • For the channel where the variable conversion characteristics function is used, the setting of Switch 1 is ignored. Set the range with Variable conversion characteristics range setting (Un\G4101) for the channel where the variable conversion characteristics function is used.
PID control function (5H)	• The PID control function can be used. To use the PID control function, set the PID control parameters with a program. • The user range setting (EH or FH) cannot be used in Switch 1. If the range setting is set to "EH or FH" with the PID control function selected, an error (error code: 600□) occurs.

*1 To use the variable arithmetic function or variable conversion characteristics function, use GX Works2. The Intelligent Function Module Tool of GX Works2 is required to create arithmetic expression data or a conversion characteristics table.

Appendix 10 External Dimensions

The following figure shows the external dimensions of the analog I/O module.

(1) L60AD2DA2



(Unit: mm)

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REVISIONS

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

Print date	*Manual number	Revision
July 2013	SH(NA)-081167ENG-A	First edition
December 2014	SH(NA)-081167ENG-B	Error correction
July 2015	SH(NA)-081167ENG-C	Addition of the variable arithmetic function, variable conversion characteristics function, and variable conversion characteristics function + variable arithmetic function
February 2016	SH(NA)-081167ENG-D	Addition of the PID control function
February 2018	SH(NA)-081167ENG-E	Partial correction SAFETY PRECAUTIONS, INTRODUCTION, COMPLIANCE WITH EMC AND LOW VOLTAGE DIRECTIVES, Section 3.2, 8.18.4, 11.4, Appendix 2

Japanese manual version SH-081166-E

WARRANTY

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

1. Gratis Warranty Term and Gratis Warranty Range

If any faults or defects (hereinafter "Failure") found to be the responsibility of Mitsubishi occurs during use of the product within the gratis warranty term, the product shall be repaired at no cost via the sales representative or Mitsubishi Service Company.

However, if repairs are required onsite at domestic or overseas location, expenses to send an engineer will be solely at the customer's discretion. Mitsubishi shall not be held responsible for any re-commissioning, maintenance, or testing on-site that involves replacement of the failed module.

[Gratis Warranty Term]

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

[Gratis Warranty Range]

(1) The range shall be limited to normal use within the usage state, usage methods and usage environment, etc., which follow the conditions and precautions, etc., given in the instruction manual, user's manual and caution labels on the product.

(2) Even within the gratis warranty term, repairs shall be charged for in the following cases.

1. Failure occurring from inappropriate storage or handling, carelessness or negligence by the user. Failure caused by the user's hardware or software design.
2. Failure caused by unapproved modifications, etc., to the product by the user.
3. When the Mitsubishi product is assembled into a user's device, Failure that could have been avoided if functions or structures, judged as necessary in the legal safety measures the user's device is subject to or as necessary by industry standards, had been provided.
4. Failure that could have been avoided if consumable parts (battery, backlight, fuse, etc.) designated in the instruction manual had been correctly serviced or replaced.
5. Failure caused by external irresistible forces such as fires or abnormal voltages, and Failure caused by force majeure such as earthquakes, lightning, wind and water damage.
6. Failure caused by reasons unpredictable by scientific technology standards at time of shipment from Mitsubishi.
7. Any other failure found not to be the responsibility of Mitsubishi or that admitted not to be so by the user.

2. Onerous repair term after discontinuation of production

(1) Mitsubishi shall accept onerous product repairs for seven (7) years after production of the product is discontinued. Discontinuation of production shall be notified with Mitsubishi Technical Bulletins, etc.

(2) Product supply (including repair parts) is not available after production is discontinued.

3. Overseas service

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

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

Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation to:

(1) Damages caused by any cause found not to be the responsibility of Mitsubishi.

(2) Loss in opportunity, lost profits incurred to the user by Failures of Mitsubishi products.

(3) Special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than Mitsubishi products.

(4) Replacement by the user, maintenance of on-site equipment, start-up test run and other tasks.

5. Changes in product specifications

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

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SH(NA)-081167ENG-E(1802)MEE
MODEL: L60AD2DA2-U-E
MODEL CODE: 13JZ87

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