HITACHI PROGRAMMABLE AUTOMATION CONTROLLER

HX Series

APPLICATION MANUAL (Software)

(SERVICE MANUAL)

NJI-638(X)

○ Warranty period and coverage

The warranty period is the shorter period either 18 months from the data of manufacture or 12 months from the date of installation.
However within the warranty period, the warranty will be void if the fault is due to;

(1) Incorrect use as directed in this manual and the application manual.

(2) Malfunction or failure of external other devices than this unit.

(3) Attempted repair by unauthorized personnel.

(4) Natural disasters.

The warranty is for the PAC only, any damage caused to third party equipment by malfunction of the PAC is not covered by the warranty.

○ Repair

Any investigation or repair after the warranty period cannot be covered as free of charge. Also any faults caused by above (1) to (4), will be charged for its repair (or for its investigation), even if the product is within the warranty period. In case of any contact, please ask your supplier or local Hitachi distributor. (Depending on failure part, investigation may not be possible to apply)

○ Ordering parts or asking questions

When contacting us for repair, ordering parts or inquiring about other items, please have the following details ready before contacting the place of purchase.

(1) Model

(2) Manufacturing number (MFG.NO.)

(3) Details of the malfunction

○ Reader of this manual

This manual is described for the following person.

・Person considering the introduction of PAC
・PAC system engineer
・Person handling PAC
・Manager after installing PAC

Safety Precautions

Read this manual and related documents thoroughly before installing, operating, performing preventive maintenance or performing inspection, and be sure to use the unit correctly. Use this product after acquiring adequate knowledge of the unit, all safety information, and all cautionary information. Also, make sure this manual enters the possession of the chief person in charge of safety maintenance.
Safety caution items are classifies as “Danger” and “Caution” in this document.

DANGER : Cases where if handled incorrectly a dangerous circumstance may be created, resulting in possible death or severe injury.

CAUTION : Cases where if handled incorrectly a dangerous circumstance may be created, resulting in possible minor to medium injury to the body, or only mechanical damage

However, depending on the circumstances, items marked with CAUTION may result in major accidents.

In any case, they both contain important information, so please follow them closely.

Icons for prohibited items and required items are shown blow:

: Indicates prohibited items (items that may not be performed). For example, when open flames are prohibited, is shown.

: Indicates required items (items that must be performed). For example, when grounding must be performed, is shown.

1. About installation

⚠ CAUTION
• Use this product in an environment as described in the catalog and this document. If this product is used in an environment subject to high temperature, high humidity, excessive dust, corrosive gases, vibration or shock, it may result in electric shock, fire or malfunction. • Perform installation according to this manual. If installation is not performed adequately, it may result in dropping, malfunction or an operational error in the unit. • Do not allow foreign objects such as wire chips to enter the unit. They may become the cause of fire, malfunction or failure.

2. About wiring

REQUIRED

- Always perform grounding (FE terminal).
  If grounding is not performed, there is a risk of electric shocks and malfunctions.

⚠ CAUTION

- Connect power supply that meets rating.
  If a power supply that does not meet rating is connected, fire may be caused.
- The wiring operation should be performed by a qualified personnel.
  If wiring is performed incorrectly, it may result in fire, damage, or electric shock.

3. Precautions when using the unit

⚠ DANGER

- Do not touch the terminals while the power is on.
  There is a risk of electric shock.
- Structure the emergency stop circuit, interlock circuit, etc. outside the PAC.
  Damage to the equipment or accidents may occur due to failure of the PAC.
  However, do not interlock the unit to external load via relay drive power supply of the relay output module.

⚠ CAUTION

- When performing program change, forced output, RUN, STOP, etc., while the unit is running, be sure to verify safety.
  Damage to the equipment or accidents may occur due to operation error.
- Supply power according to the power–up order.
  Damage to the equipment or accidents may occur due to malfunctions.

⚠ CAUTION

- Use power supply unit of EH-PS series for supplying electric power.

⚠ CAUTION

- Do not connect DC power supply module EH-PSD to a master power circuit. Supply a power to EH-PSD through an appropriate isolation transformer less than up to 150VA by all means.

4. About preventive maintenance

DANGER
• Do not connect the +, - of the battery in reverse. Also, do not charge, disassemble, heat, place in fire, or short circuit the battery. There is a risk of explosion or fire.

PROHIBITED
• Do not disassemble or modify the unit. Electric shock, malfunction or failure may result.

CAUTION
• Turn off the power supply before removing or attaching module/unit. Electric shock, malfunction or failure may result.

Revision History

No.	Description of revision	Date of revision	Manual number
1	The first edition	2016.12	NJI-638(X)

Table of contents

Chapter 1 Introduction

1.1 Installation

1.1.1 System Requirements

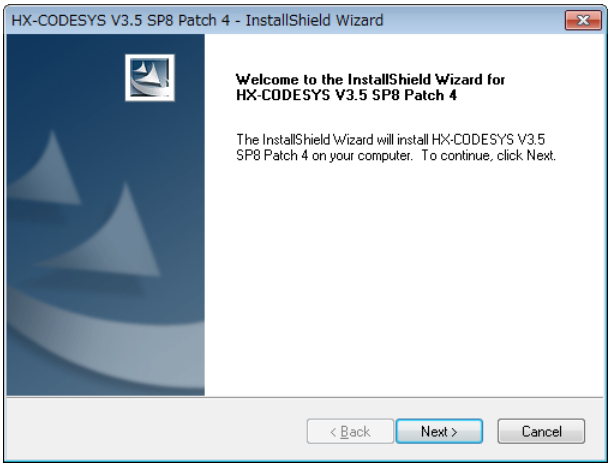
Recommended CPU : Pentium 1 GHz or higher
Memory : 1 GB or more RAM
Free disc space : 3 GB or more
Resolution : 1024 x 768 (XGA) or higher
Operating System : Windows XP SP3 / Vista / 7 (32 / 64 bit) / 8 / 8.1 / 10

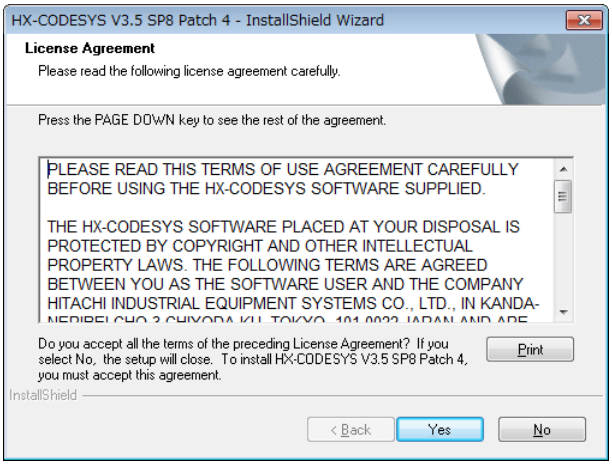
1.1.2 Installation of HX-CODESYS

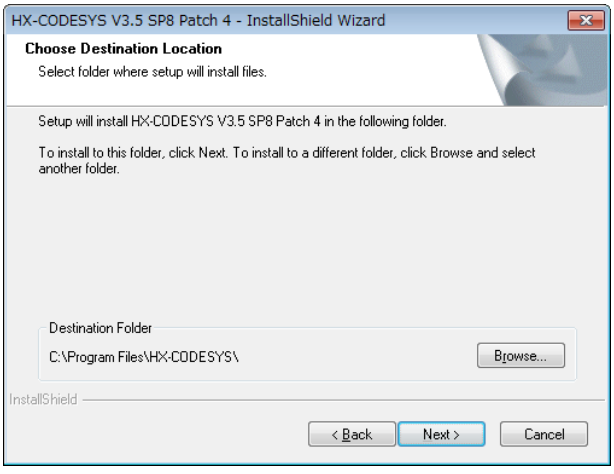
Before installation, shut down all other windows applications. If not, the installation may not be finished correctly.

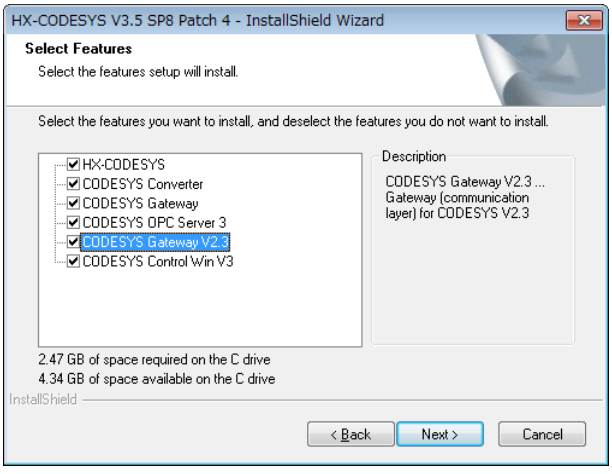
1. The installation wizard starts up automatically by double click [Setup_HXCODESYSV35SP8P4.exe] on HX-CODESYS installation DVD.

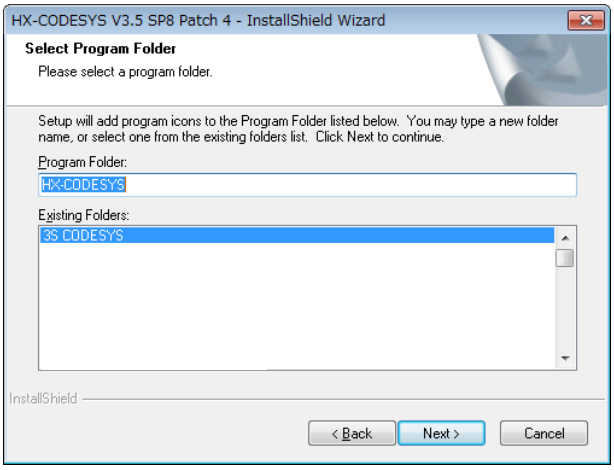
2. Follow the instructions

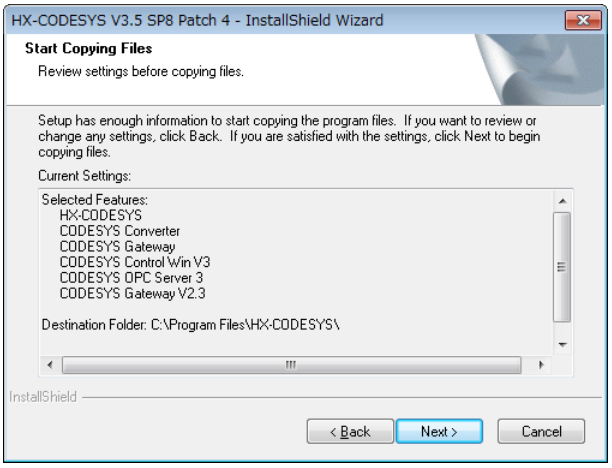


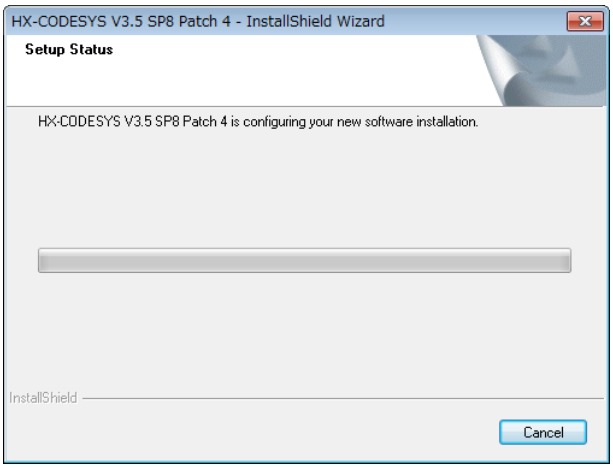


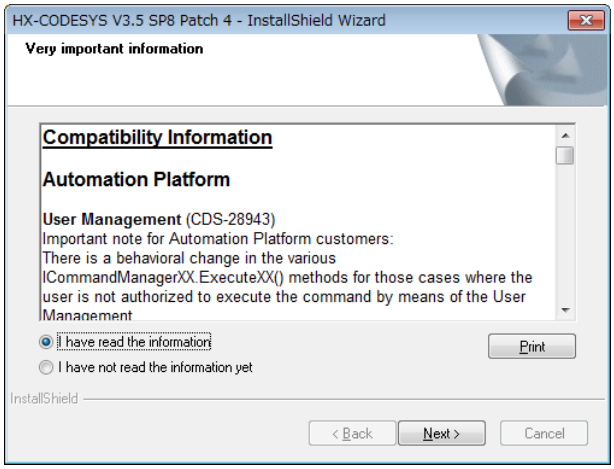


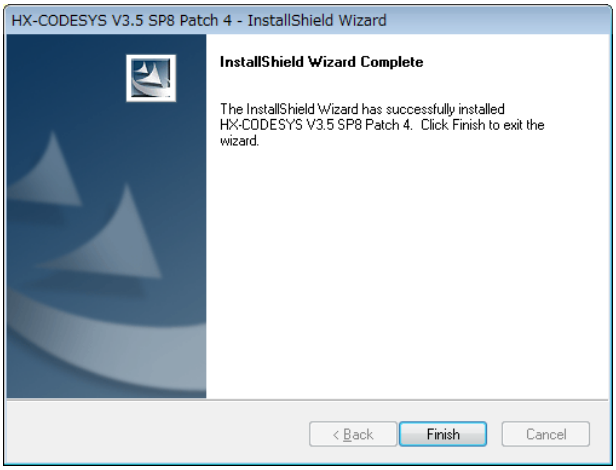








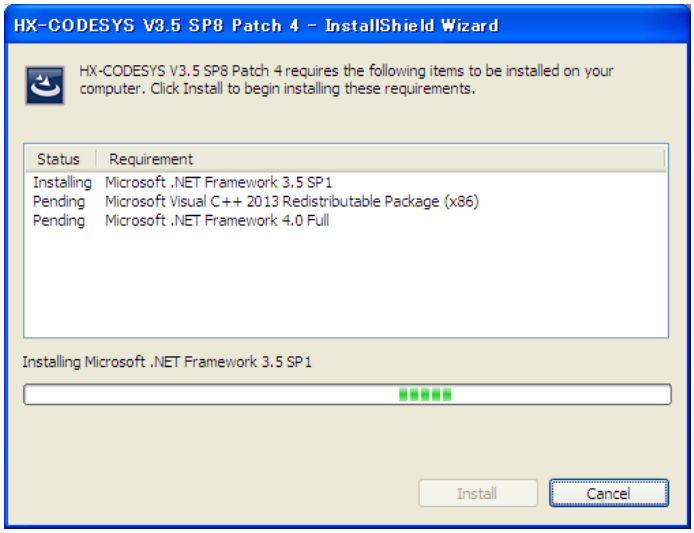




It takes about 30 minutes to 2 hours to finish installation depending on the specifications of PC.

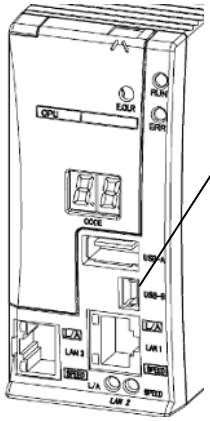
Note

Several Microsoft components are necessary to be installed for HX-CODESYS. If they are not installed in your PC, the installation of HX-CODESYS stops and a dialog appears.
Click [Install] at the dialog to extract from setup file.



1.1.3 Installation of USB Driver

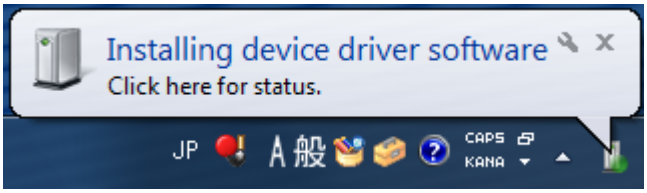
1. Plug USB cable to CPU module.



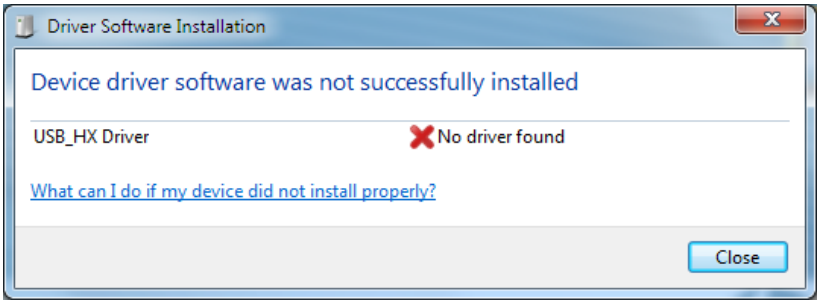
USB device port
(Type:mini B)

USB cable is not included in the product.
To prevent communication error by noise, prepare USB cable with ferrite core (A – mini B).

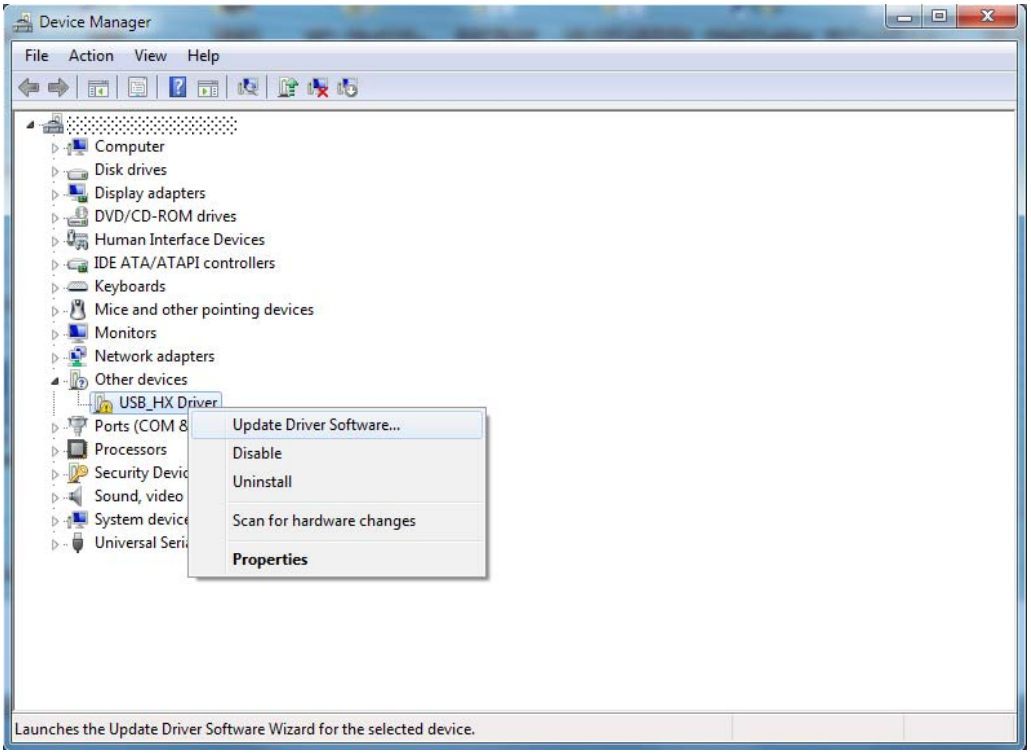
2. Popup window appears at right-bottom of screen. Click the popup window.



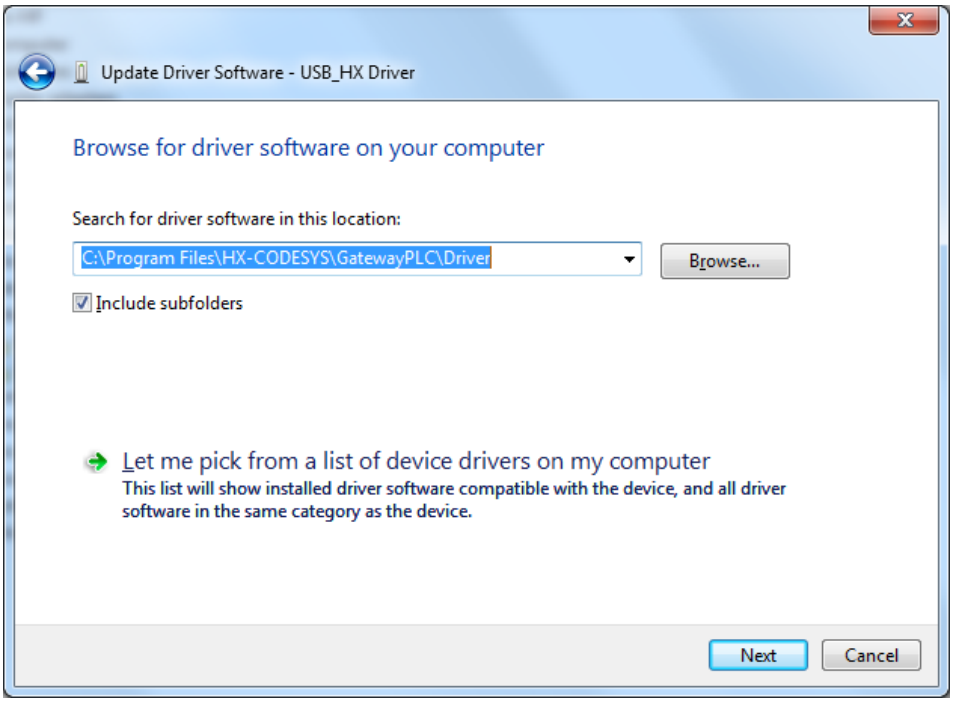
3. Click [Close] in this dialog (skip to search the driver in PC).



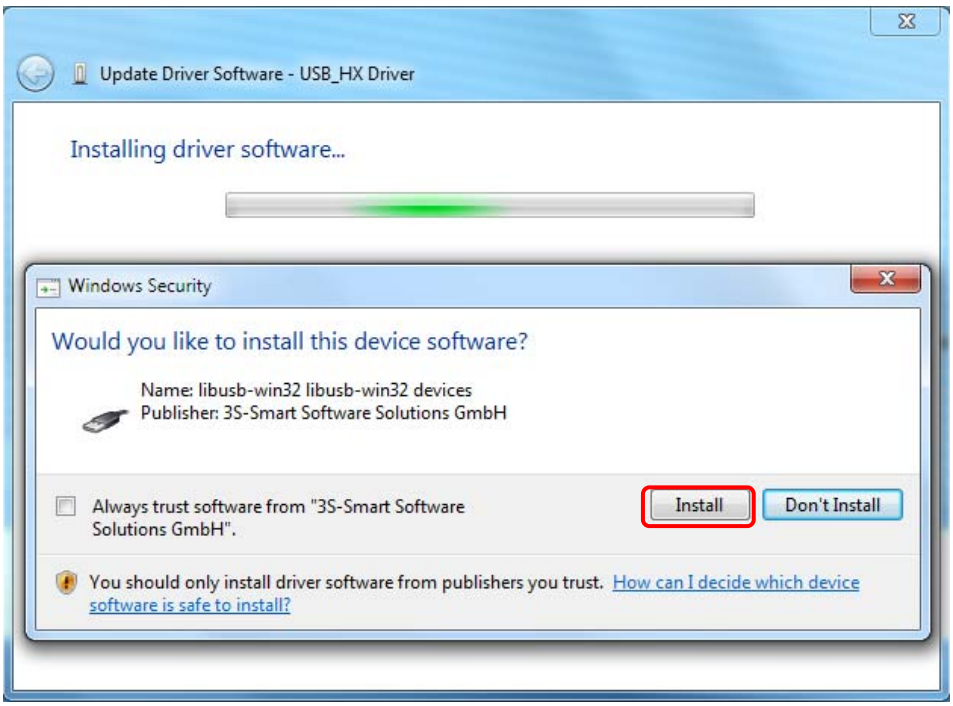
4. Open [Device Manager], right-click on [USB_HX Driver] in [Other devices], and choose [Update Driver Software…].



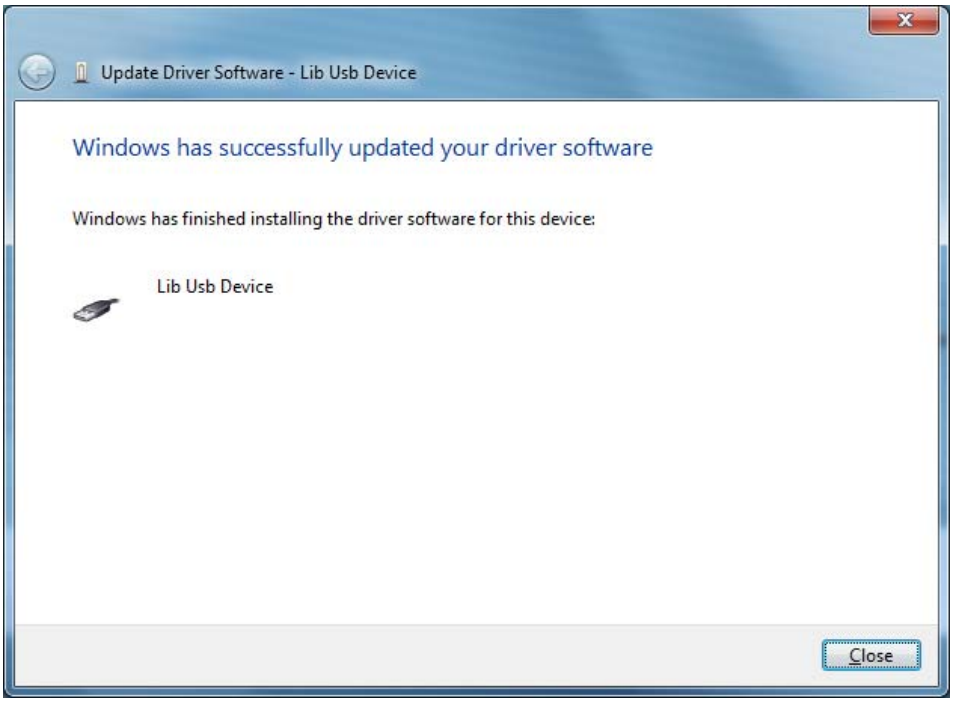
5. Enter the below path and click [Browse] to install the USB driver.

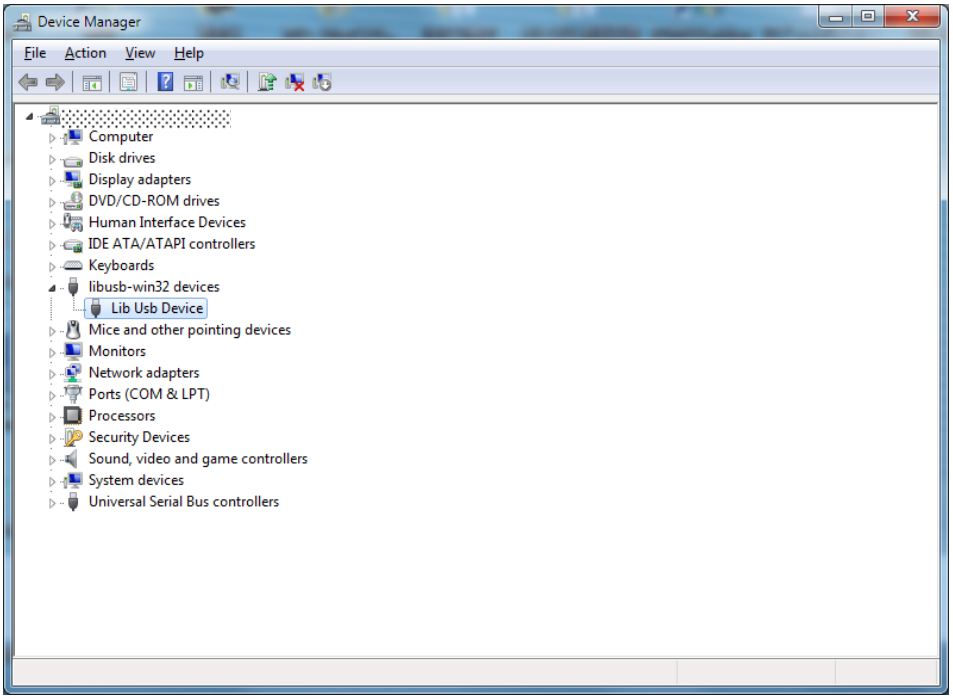


6. Click [Install].



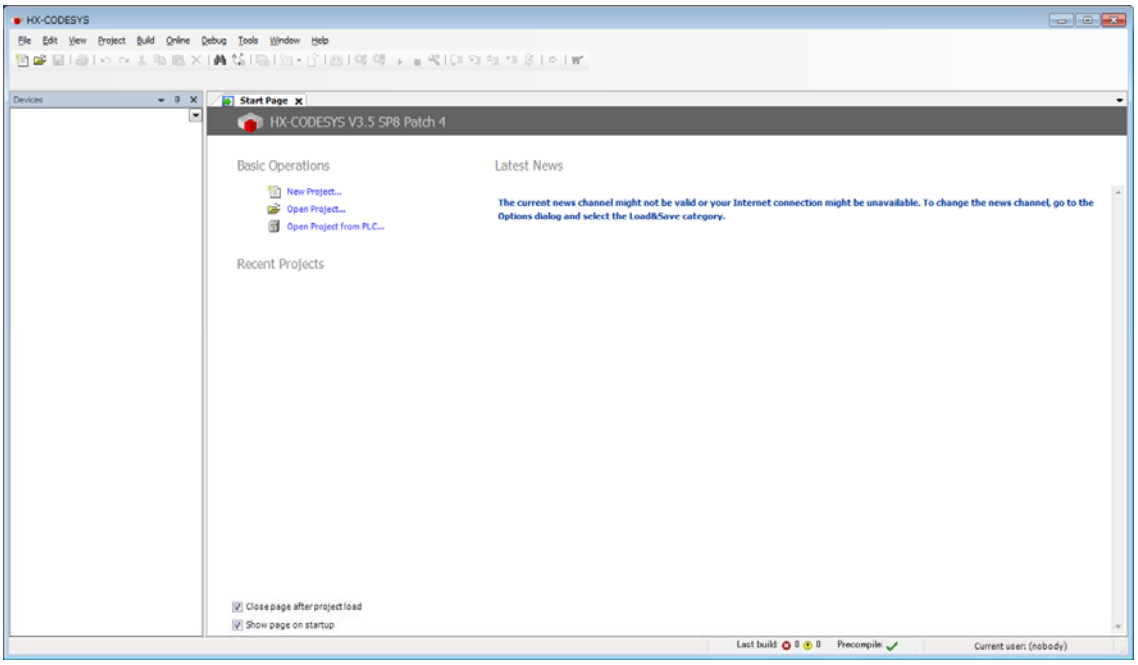
7. If the installation is finished successfully, below dialog appears.



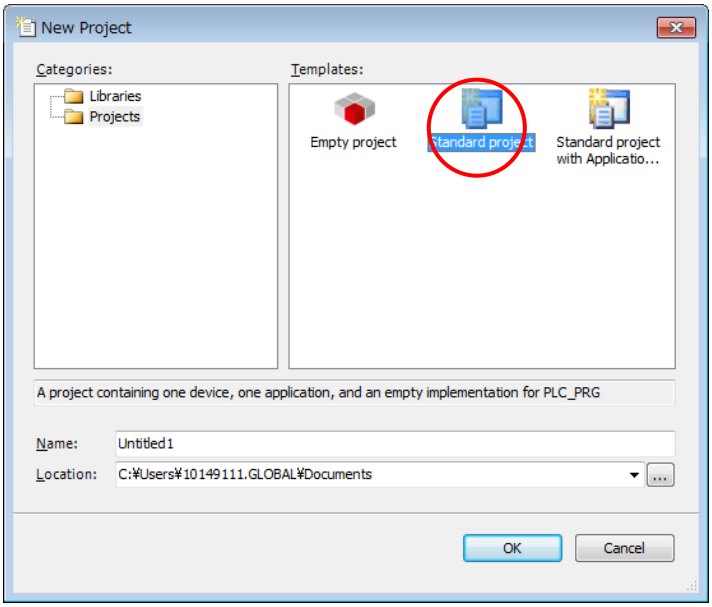


1.2 Startup

Choose [Start menu]-[All programs]-[HX-CODESYS]-[HX-CODESYS V3.5 SP8 Patch 4], then the start page is displayed.

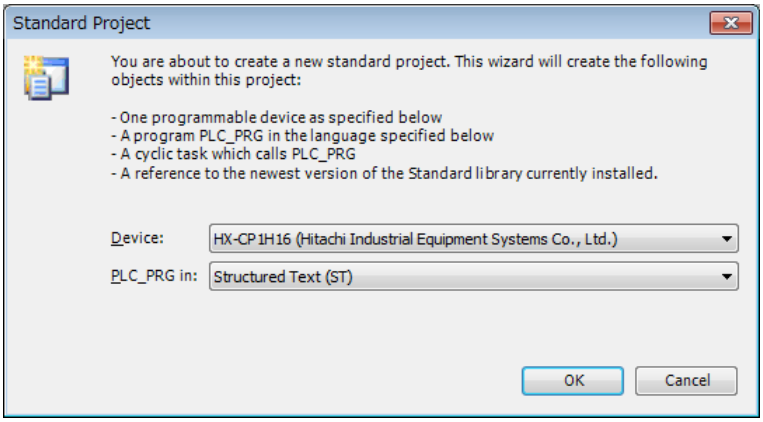


Click  icon or choose [File]-[New Project...] to create a new project file. Then New Project dialog box appears. Choose [Standard project], enter new file name, specify location and click [OK].

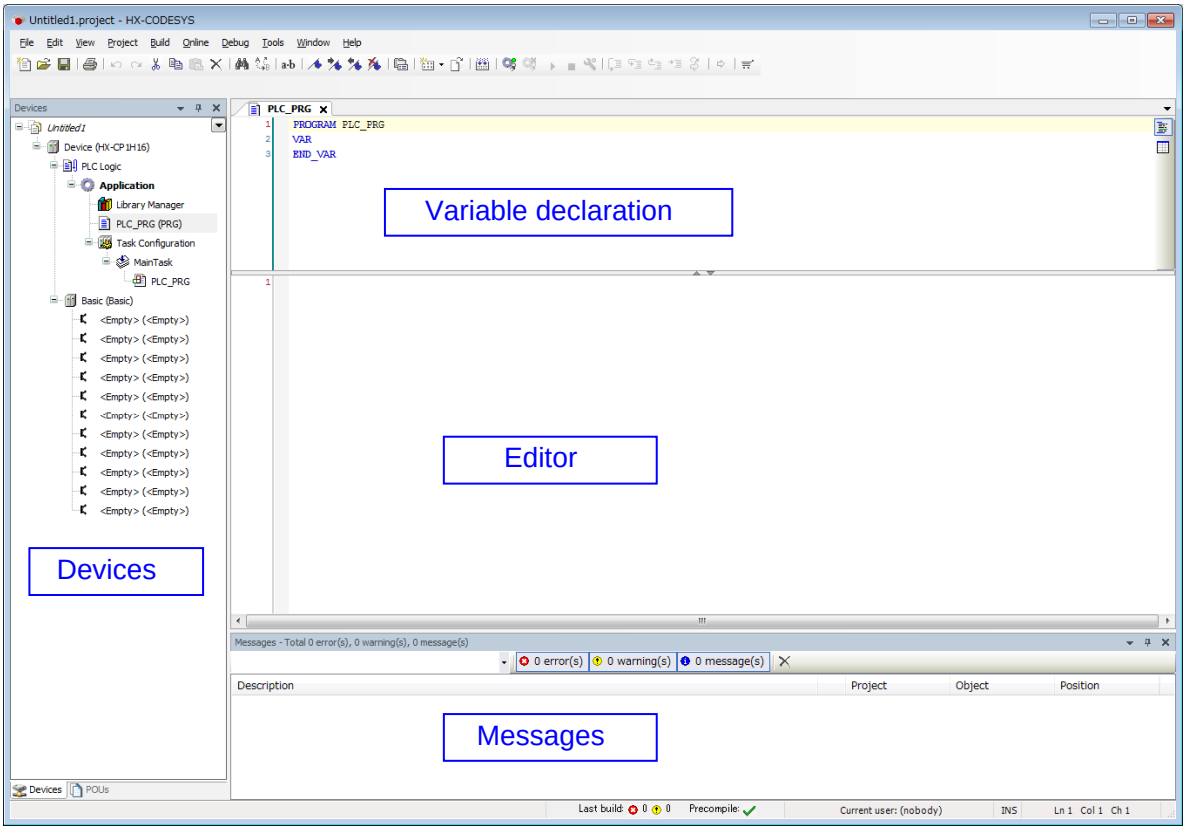


Choose CPU type and programming language and click [OK].
Available languages are as follows.

- Continuous Function Chart (CFC)
- Function Block Diagram (FBD)
- Instruction List (IL)
- Ladder Logic Diagram (LD)
- Sequential Function Chart (SFC)
- Structured Text (ST)



Initial layout of the project is shown like this.



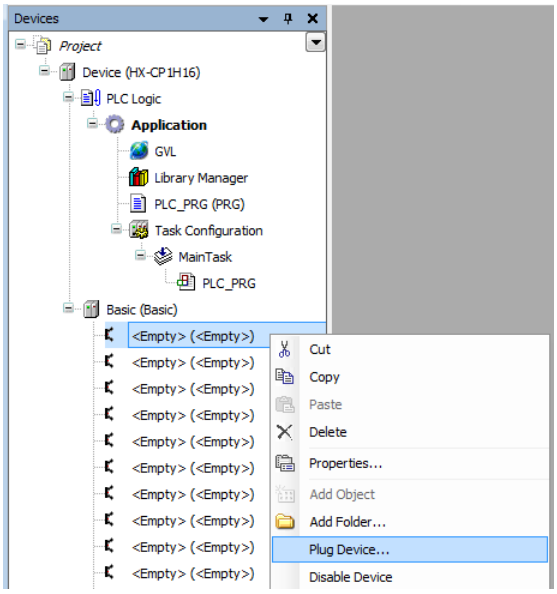
[Devices] and [Massages] window may not be shown at the first startup. They can be viewed with the menu [View]. If [Devices] (device tree) is behind the [POUs] tab, click [Devices] tab to show it. Double-click on POU (PLC_PRG) to open [Editor] and [Variable declaration].

Chapter 2 Programming

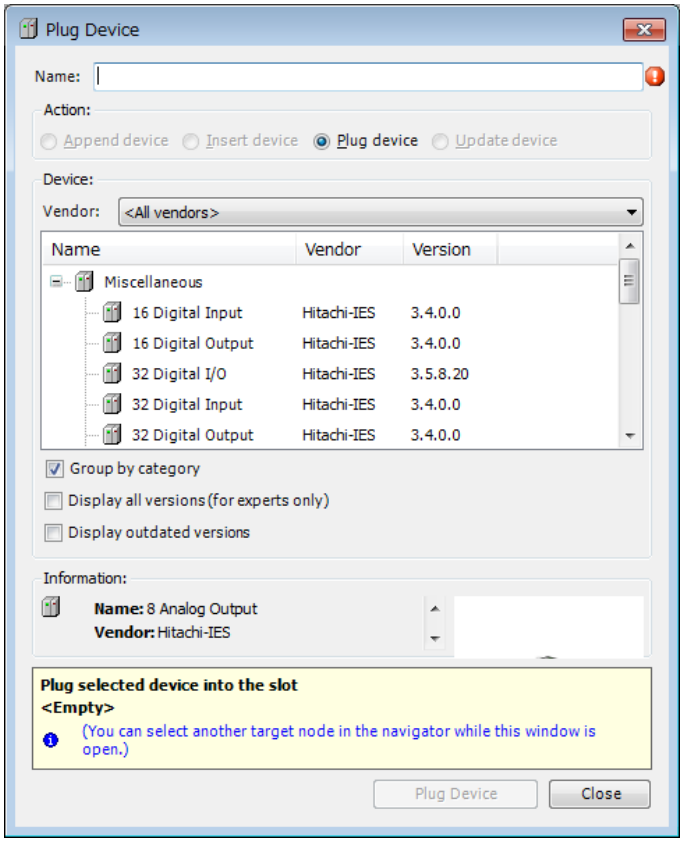
2.1 Plug Device (I/O Configuration)

2.1.1 Plug Device (I/O Configuration)

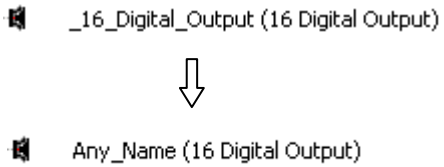
Right click on <Empty> slot and choose [Plug Device...].



Choose I/O module for each slot. The next slot can be configured by clicking next empty slot without closing the Plug Device window every time.



Module name can be renamed at [Properties] in right mouse click menu.



Configure I/O modules according to the list below.

Model names	Device Names	Slot position
EH-XD8, XD16, XDL16	16 Digital input	No restriction
EH-XA16, XAH16		
EH-XD32, XDL32, XD32E, XDL32E, XD32H, XD32S	32 Digital input	
EH-XD64	64 Digital input	
EH-YR8B, YR12, YR16, YR16D	16 Digital output	
EH-YT8, YT16		
EH-YTP8, YTP16, YTP16S		
EH-YS16		
EH-YT32, YT32E, YT32H	32 Digital output	
EH-YTP32, YTP32E		
EH-YT64	64 Digital output	
EH-YTP64		
EH-PT4	4 Analog input	
EH-AX44, AX8V, AX8H, AX8I, AX8IO	8 Analog input	
EH-AXH8M		
EH-AXG5M *1		
EH-TC8		
EH-RTD8		
EH-AY22, AY2H, AY4V, AY4H, AY4I *2	8 Analog output	
EH-AYH8M		
EH-AYG4M *2		
EH-CU, CUE	EH-CU/E	
EH-POS	EH-POS/4	
EH-LNK, OLNK, OLNKE, OLNKG	EH-LNK	Only 0 to 7 slot on basic base *3
EH-RMP2	EH-LNK	
EH-FLN2, FLN3	EH-FLN2/3	

*1 Set [8 Analog input] although this is 5-channel module.

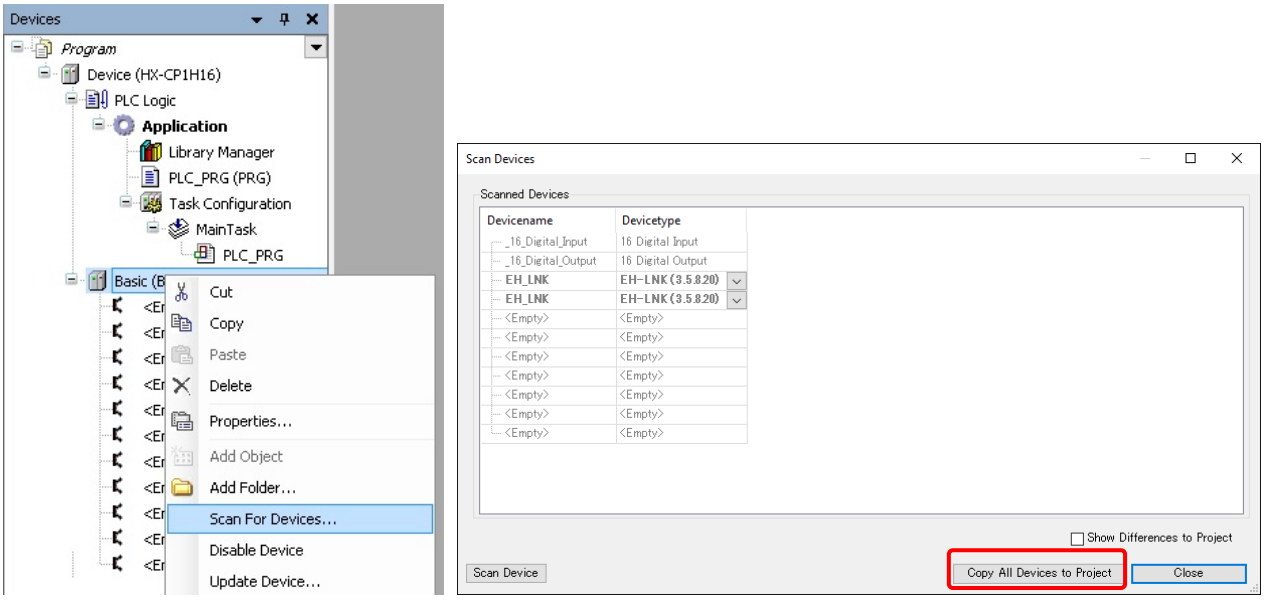
*2 Set [8 Analog output] although this is 2 or 4-channel module.

*3 If the module is mounted on another slot than slot 0 to 7, following error message appears in CPU log.

- EH-LNK is mounted on slot *. Allowed position for EH-LNK is slot 0 to 7.
- EH-FLN2/3 is mounted on slot *. Allowed position for EH-FLN2/3 is slot 0 to 7.

2.1.2 Scan for Devices

Instead of plugging I/O modules one by one, actual I/O module information can be read out from connected CPU.
Right click on basic or expansion base and choose [Scan For Devices...]. Then [Scan Devices] dialog appears. Click [Copy All Devices to Project]. This function works for chosen base only. If you have several expansion bases, repeat [Scan For Device] for each base.

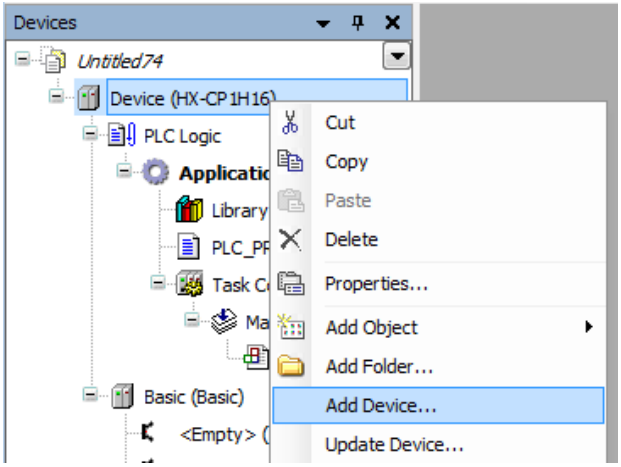


Note

This function is available only when logout (offline). But it is necessary to login once.
If you have never login, this function will not work properly.

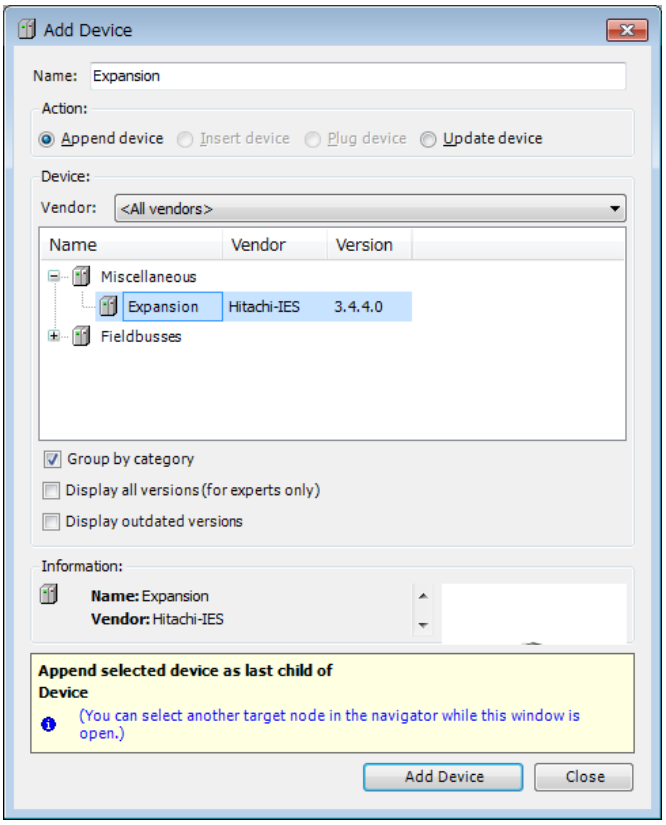
2.1.3 Expansion Unit

Instead of [Plug Device], choose [Add Device] to configure expansion units.



Select [Expansion] under Miscellaneous. HX-CPU allows to expand up to 5 expansion bases.

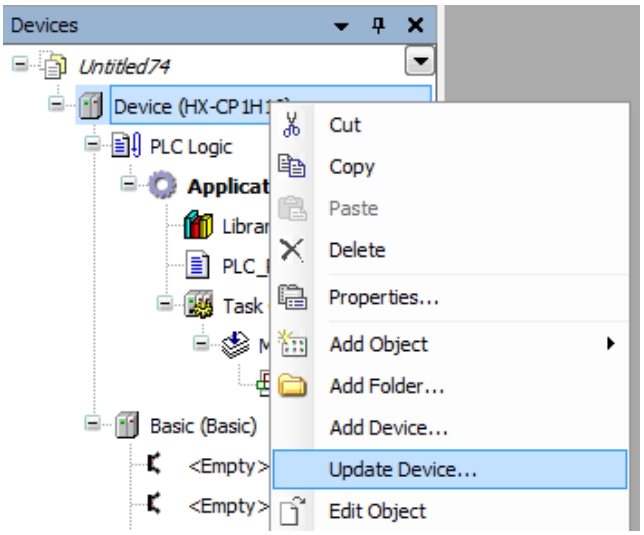
Set station number with ascending order from 1 to the nearest EH-IOCH2 to CPU.



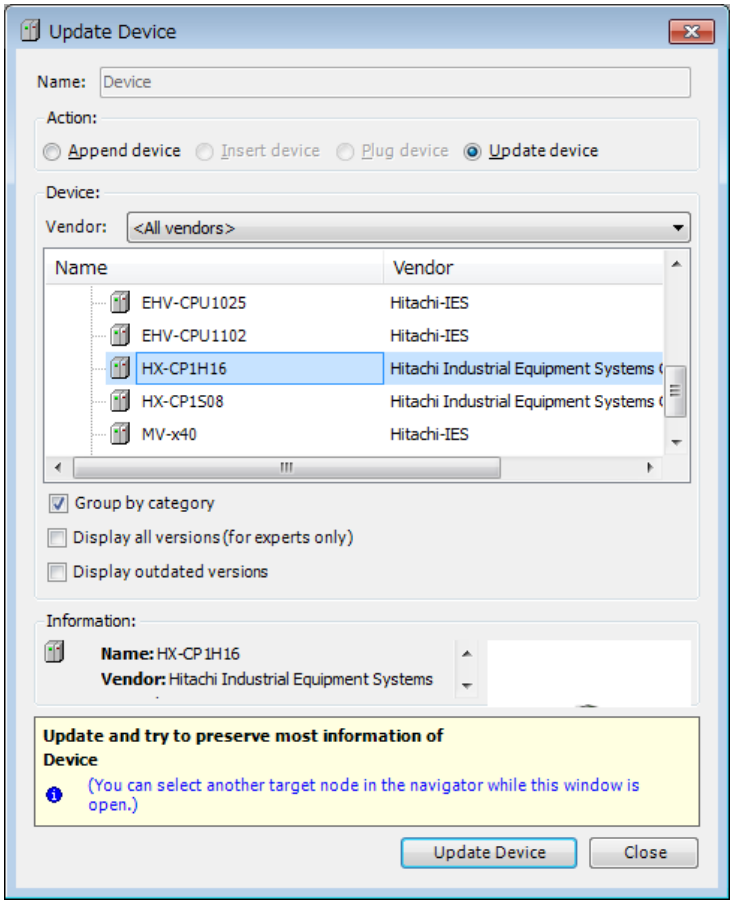
2.1.4 Update Devices

Although device (CPU) type is required to set when creating new project, it can be changed later.

Right mouse click on the device and choose [Update Device]. Then [Update Device] windows appears.



Select CPU type, and click [Update Device].

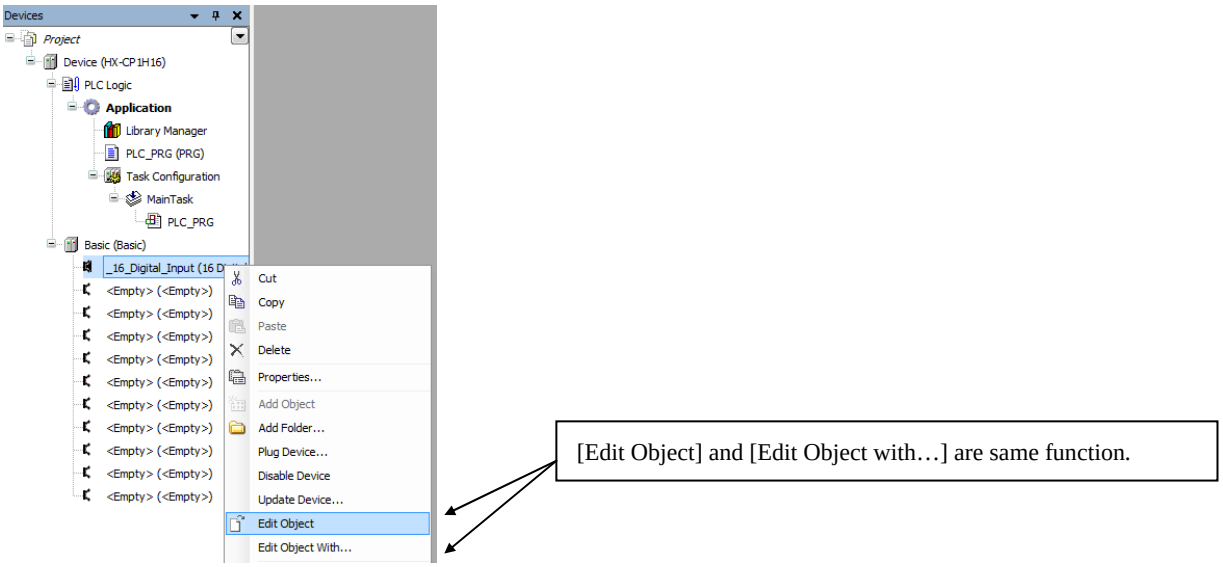


2.1.5 I/O Address

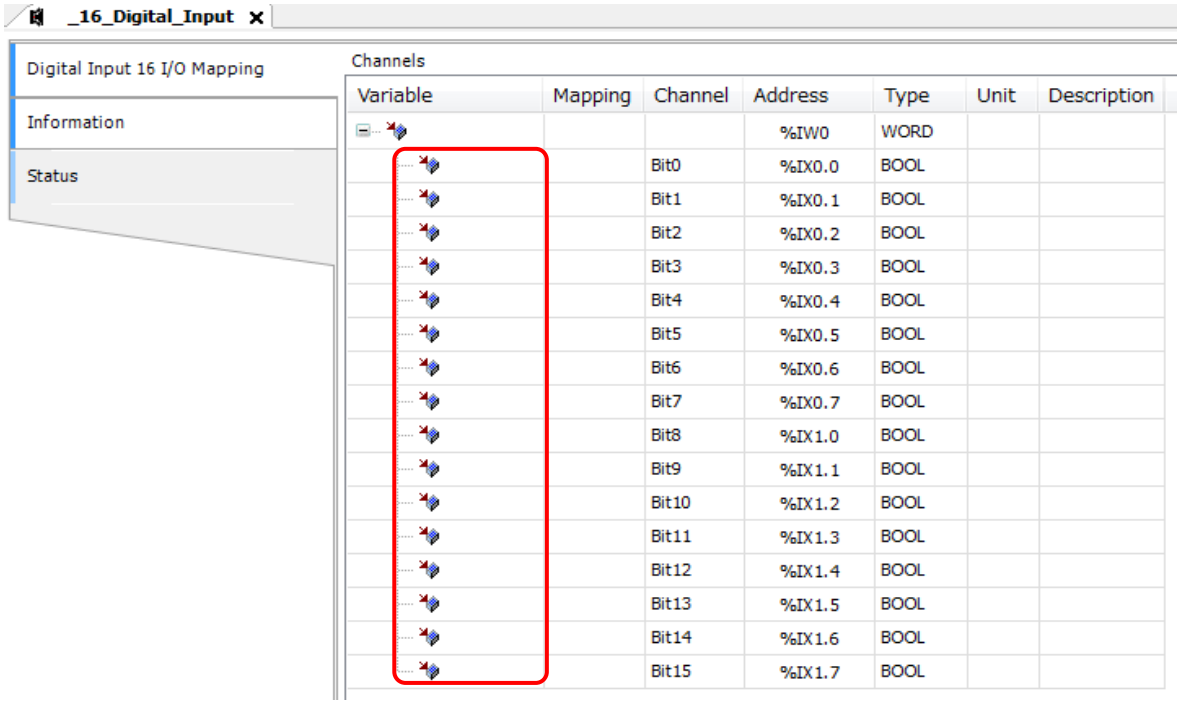
External I/O can be defined as Global variable or Local variable. Be sure to use global variable in normal use.

[Global variable]

Double click on plugged I/O module or right click and choose [Edit Object].



I/O-Bus Mapping window appears as below. Input variable name at the mapping table. These variables are used in the programming.

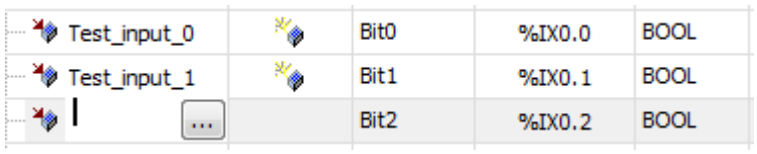


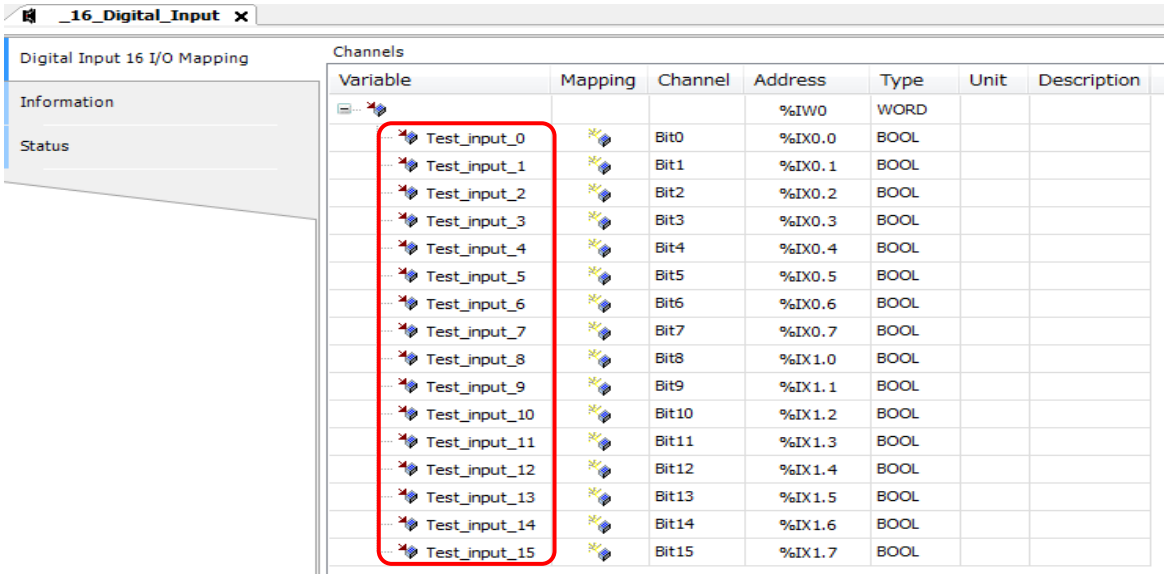
Variable	Mapping	Channel	Address	Type	Unit	Description
			%IW0	WORD		
		Bit0	%IX0.0	BOOL		
		Bit1	%IX0.1	BOOL		
		Bit2	%IX0.2	BOOL		
		Bit3	%IX0.3	BOOL		
		Bit4	%IX0.4	BOOL		
		Bit5	%IX0.5	BOOL		
		Bit6	%IX0.6	BOOL		
		Bit7	%IX0.7	BOOL		
		Bit8	%IX1.0	BOOL		
		Bit9	%IX1.1	BOOL		
		Bit10	%IX1.2	BOOL		
		Bit11	%IX1.3	BOOL		
		Bit12	%IX1.4	BOOL		
		Bit13	%IX1.5	BOOL		
		Bit14	%IX1.6	BOOL		
		Bit15	%IX1.7	BOOL		

Note

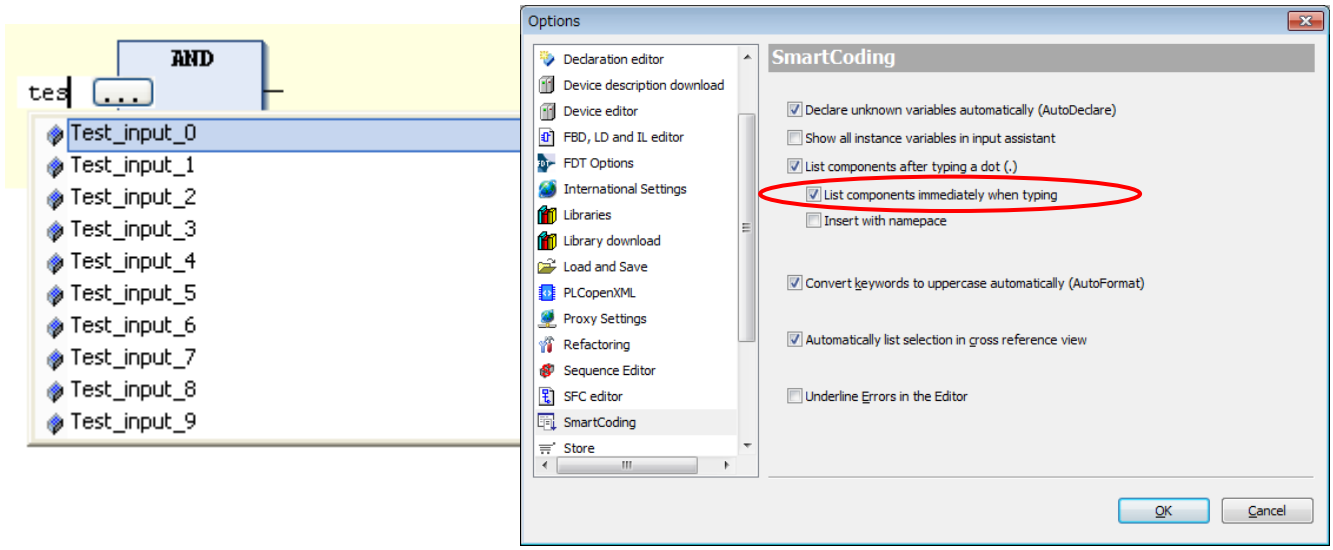
Available characters for variable names are only alphabet a to z, A to Z and number 0 to 9 and _ (underscore). The first character must not be numeric characters. Several words like BOOL, WORD, IF, FOR etc. are reserved.

Input any variable names in the field [Variable] according to your system.

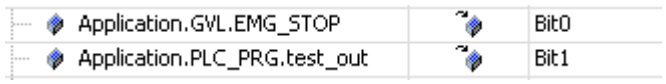




If [List components immediately when typing] in the menu [Tools]-[Options]-[Smart coding] is enabled, defined variable names will be automatically listed up when it is used in all POU with assist of auto-complete.



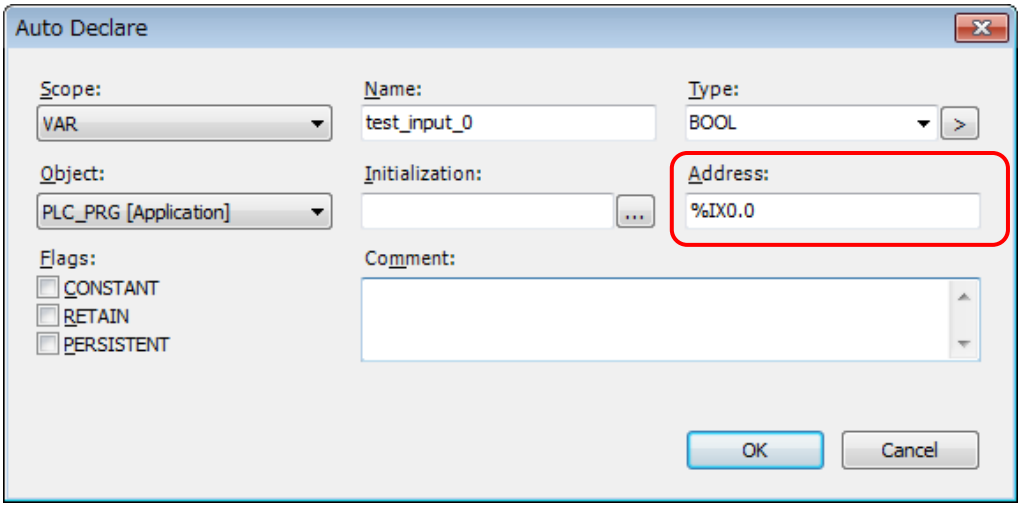
If a variable is already used (declared) in POU or global variable list, it can be taken by clicking ... icon in I/O mapping window. (... icon appears by clicking empty field.)



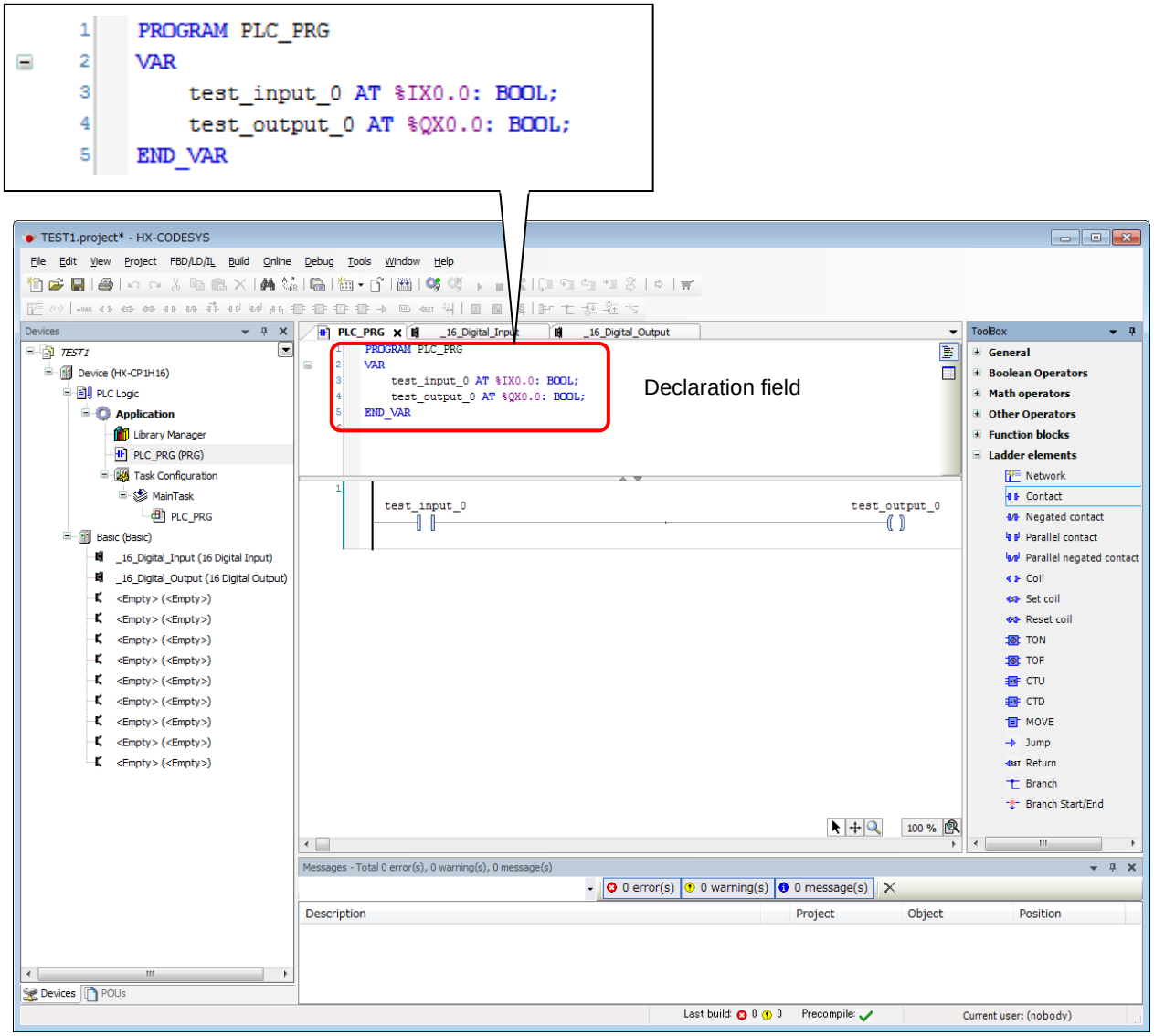
[Local variable]

Local variables are defined in each POU and valid only in the POU.

If new variable name is used in the first time, [Auto Declare] window will appear as below. In this window, there is an input field [Address]. Enter I/O address in this field according to data types. If it is remained as blank, the variable will be mapped in memory area.



After clicking [OK], declared information is added automatically as below.



I/O address example of 64 points output module

Bit number	BOOL	BYTE	WORD	DWORD	LWORD	
Bit 0	%QX0.0	%QB0	%QW0	%QD0	%QL0	LSB
Bit 1	%QX0.1					
Bit 2	%QX0.2					
Bit 3	%QX0.3					
Bit 4	%QX0.4					
Bit 5	%QX0.5					
Bit 6	%QX0.6					
Bit 7	%QX0.7					
Bit 8	%QX1.0	%QB1				
Bit 9	%QX1.1					
Bit 10	%QX1.2					
Bit 11	%QX1.3					
Bit 12	%QX1.4					
Bit 13	%QX1.5					
Bit 14	%QX1.6					
Bit 15	%QX1.7					
Bit 16	%QX2.0	%QB2	%QW1			
Bit 17	%QX2.1					
Bit 18	%QX2.2					
Bit 19	%QX2.3					
Bit 20	%QX2.4					
Bit 21	%QX2.5					
Bit 22	%QX2.6					
Bit 23	%QX2.7					
Bit 24	%QX3.0	%QB3				
Bit 25	%QX3.1					
Bit 26	%QX3.2					
Bit 27	%QX3.3					
Bit 28	%QX3.4					
Bit 29	%QX3.5					
Bit 30	%QX3.6					
Bit 31	%QX3.7					
Bit 32	%QX4.0	%QB4	%QW2	%QD1		
⎮	⎮					
Bit 39	%QX4.7					
Bit 40	%QX5.0	%QB5				
⎮	⎮					
Bit 47	%QX5.7					
Bit 48	%QX6.0	%QB6	%QW3			
⎮	⎮					
Bit 55	%QX6.7					
Bit 56	%QX7.0	%QB7				
⎮	⎮					MSB
Bit 63	%QX7.7					

Following 5 different codes access the same bit.

```
%QX0.0:=1;
%QB0  :=1;
%QW0  :=1;
%QD0  :=1;
%QL0  :=1;
```

Note

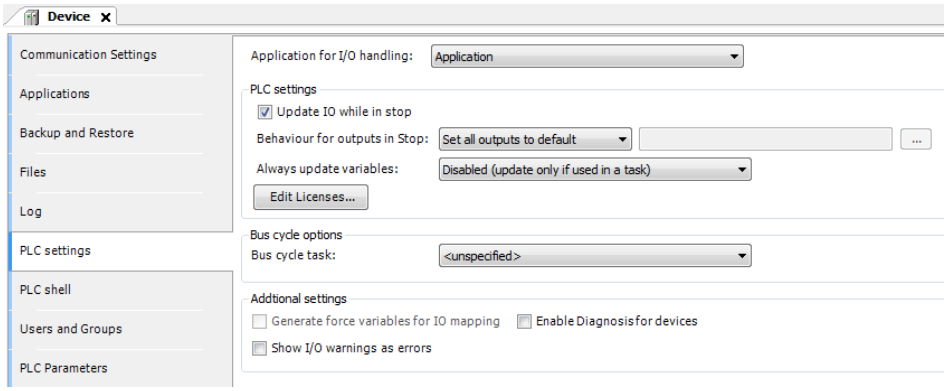
If application program of EHV+ series is reused in HX-series and direct IEC addresses are used, although it is unusual, be noted that I/O addresses are byte-swapped. If variables are defined in I/O mapping tables, then it is no problem.

The deference of I/O address of 64 points output module between EHV+ series and HX series.

	EHV+ series IEC address					HX series IEC address				
Bit	BOOL	BYTE	WORD	DWORD	LWORD	BOOL	BYTE	WORD	DWORD	LWORD
Bit 0	%QX7.0	%QB7	%QW3	%QD1	%QL0	%QX0.0	%QB0	%QW0	%QD0	%QL0
Bit 1	%QX7.1					%QX0.1				
Bit 2	%QX7.2					%QX0.2				
Bit 3	%QX7.3					%QX0.3				
Bit 4	%QX7.4					%QX0.4				
Bit 5	%QX7.5					%QX0.5				
Bit 6	%QX7.6					%QX0.6				
Bit 7	%QX7.7					%QX0.7				
Bit 8	%QX6.0	%QB6				%QX1.0	%QB1			
Bit 9	%QX6.1					%QX1.1				
Bit 10	%QX6.2					%QX1.2				
Bit 11	%QX6.3					%QX1.3				
Bit 12	%QX6.4					%QX1.4				
Bit 13	%QX6.5					%QX1.5				
Bit 14	%QX6.6					%QX1.6				
Bit 15	%QX6.7					%QX1.7				
Bit 16	%QX5.0	%QB5	%QW2			%QX2.0	%QB2	%QW1		
Bit 17	%QX5.1					%QX2.1				
Bit 18	%QX5.2					%QX2.2				
Bit 19	%QX5.3					%QX2.3				
Bit 20	%QX5.4					%QX2.4				
Bit 21	%QX5.5					%QX2.5				
Bit 22	%QX5.6					%QX2.6				
Bit 23	%QX5.7					%QX2.7				
Bit 24	%QX4.0	%QB4				%QX3.0	%QB3			
Bit 25	%QX4.1					%QX3.1				
Bit 26	%QX4.2					%QX3.2				
Bit 27	%QX4.3					%QX3.3				
Bit 28	%QX4.4					%QX3.4				
Bit 29	%QX4.5					%QX3.5				
Bit 30	%QX4.6					%QX3.6				
Bit 31	%QX4.7					%QX3.7				
Bit 32	%QX3.0	%QB3	%QW1	%QD0		%QX4.0	%QB4	%QW2	%QD1	
⋮	⋮					⋮				
Bit 39	%QX3.7					%QX4.7				
Bit 40	%QX2.0	%QB2				%QX5.0	%QB5			
⋮	⋮					⋮				
Bit 47	%QX2.7					%QX5.7				
Bit 48	%QX1.0	%QB1	%QW0			%QX6.0	%QB6	%QW3		
⋮	⋮					⋮				
Bit 55	%QX1.7					%QX6.7				
Bit 56	%QX0.0	%QB0				%QX7.0	%QB7			
⋮	⋮					⋮				
Bit 63	%QX0.7					%QX7.7				

2.2 I/O-Update

Input data is read at the beginning of a task and output data is written at the end of a task. I/O-update settings are configured in [PLC settings] in Device tab. Be noted that only used I/Os in program are updated, unused I/Os are not updated.



Update IO while in STOP

If this option is activated (default), the values of the input and output channels get also updated when the PLC is stopped.

Behaviour for outputs in STOP

Keep current values: The current values will not be modified. If [Update IO while is stop] is deactivated, output data is not updated at CPU stopping.

Set all outputs to default: The default values resulting from the mapping will be assigned. If this setting is used, [Reset all outputs in STOP] of [Device]-[PLC Parameters] parameter must be set as [No], otherwise default value of TRUE is not valid. Refer to the next page for further information.

Execute program: You might determine the outputs behaviour by a program available within the project. Enter the name of this program here and it will be executed when the PLC gets stopped. Via button [...] the Input Assistant can be used for this purpose.

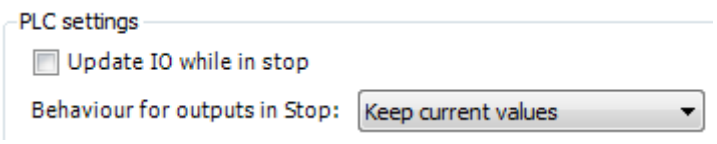
Always update variables:

If this option is activated, then for all devices of the current PLC configuration all I/O variables will get updated in each cycle of the bus cycle task. This corresponds to option [Always update variables], which can be set separately for each device in the [I/O Mapping] dialog.

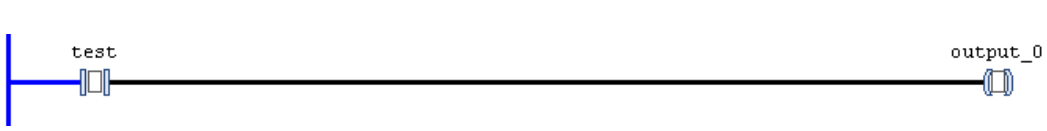
Note

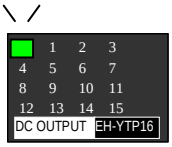
If all the following conditions are fulfilled and reset warm/cold is operated, the last status of output module remains although monitored output status of HX-CODESYS is reset.

- Update IO while in stop in PLC settings: Disabled
- Behavior for outputs in Stop in PLC settings: Keep current values
- Reset all outputs in STOP in Device Configuration: No
- Variable of output module is mapped to existing variable that declared in POU or GVL.



Actual output remains after Reset warm/cold





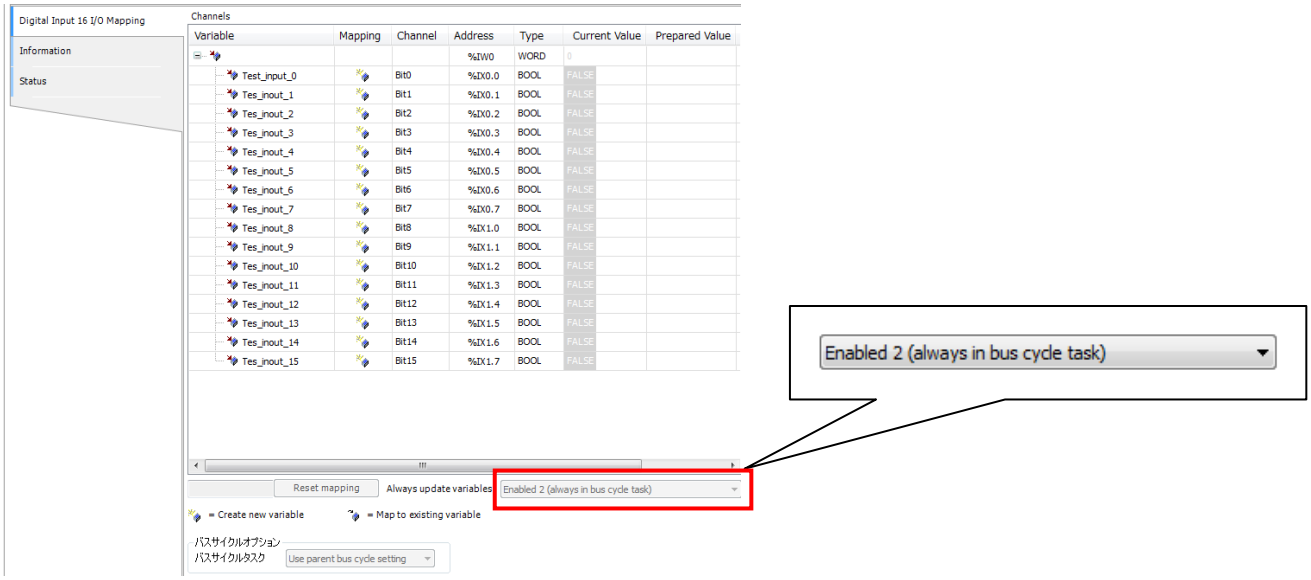
This is expected behavior. If this setting combination is required, keep in mind this mismatching and be careful to use.

Reset all outputs in STOP

This setting is in [Device]-[PLC Parameters]. If [Reset all outputs in STOP] is [Yes] (default), all the PLC outputs including counter outputs and pulse train output of positioning module are reset because it is reset by a certain hardware signal running on the back plane bus. If default value in configured as TRUE in I/O mapping table, it is momentary reset (FALSE) at run or stop timing. If default values should be kept, set [Reset all outputs in STOP] as [No]. In this case, you must be aware following limitation.

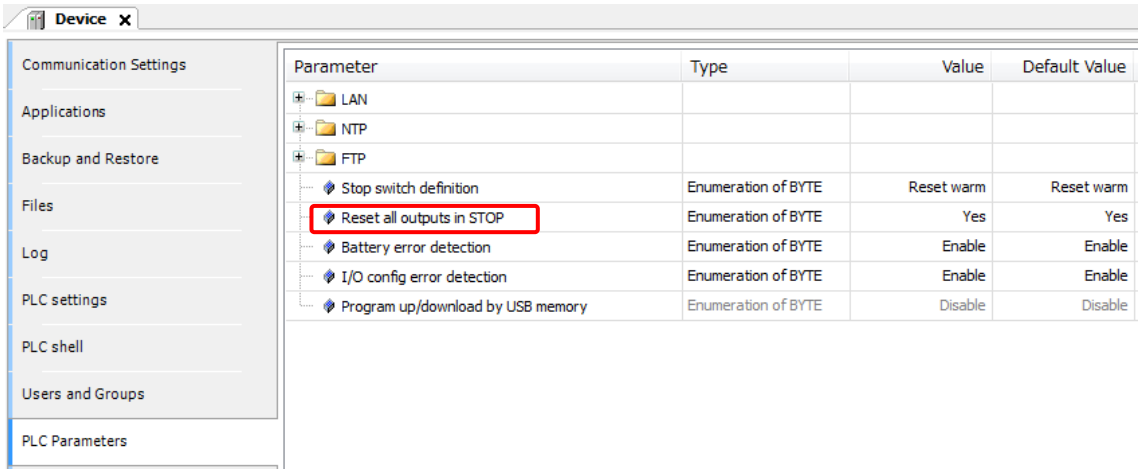
Note

I/O that is not used in program does not refresh. Therefore, you are not seen in TRUE when you monitored a mapping table in online even if the outside input that you don't use set to ON.
When you want to monitor unused I/O, please set [Enabled1] or [Enabled2] to [Always updates variables] of the mapping table of the lower right. I/O is refreshed regardless of use / unused.



Note

If [Reset all outputs in STOP] is [No], PLC outputs without IEC address, such as counter outputs or pulse train outputs, are NOT reset when CPU stops. We recommend you to set [Yes] when using counter or positioning modules.

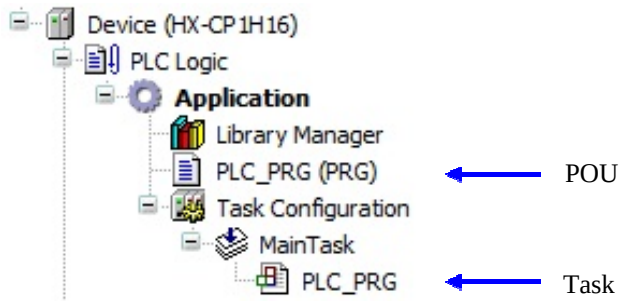


Note

If [Reset all outputs in STOP] is [Yes] (default), default value of [TRUE] in I/O mapping table is momentary reset (FALSE) at run or stop timing.

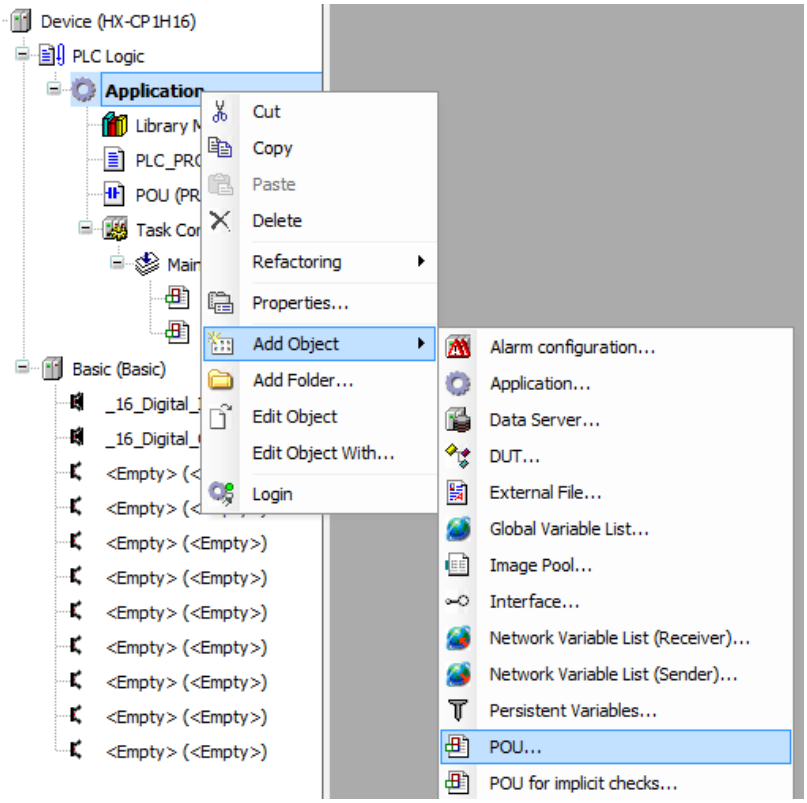
2.3 POU and Task

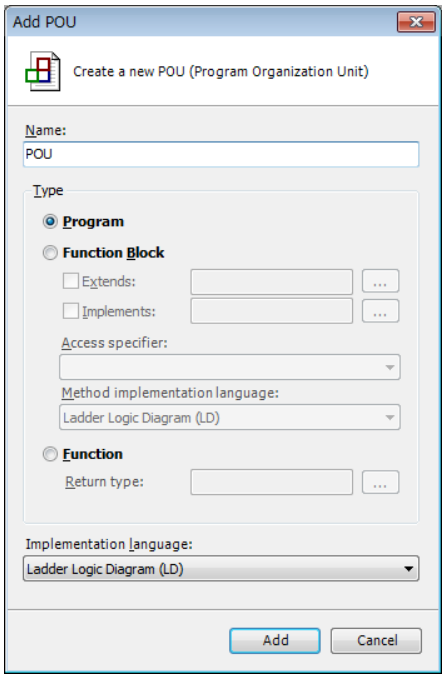
One application has at least one POU and one task as shown below.



POU

POU stands for Program Organization Unit and smallest unit of program. Only one programming language can be used in one POU. If you need another language, add POU by right click on [Application] and choose [Add object]-[POU] and choose language.





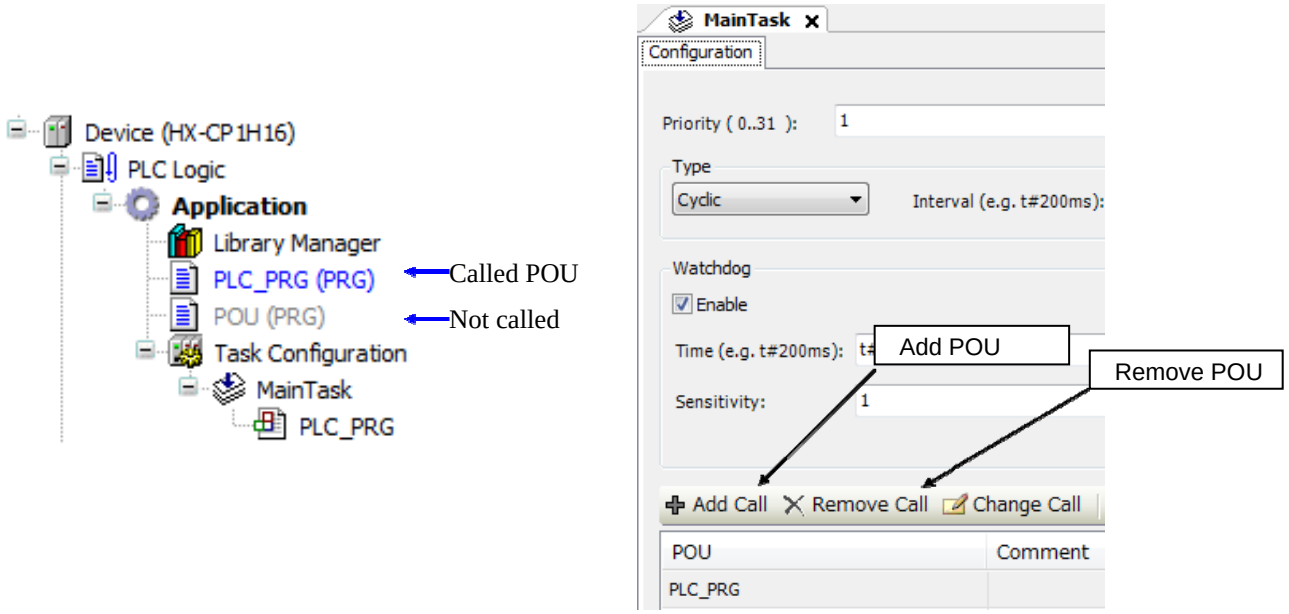
There are three kinds in POU, and each POU are different in how to use.

	Called by task	How to call	I/O limitation	Store data
Program (PRG)	Yes	Direct name	None	Yes
Function Block (FB)	No	Instance (copy)	None	Yes
Function (FUN)	No	Direct name	1 output only	No

Task

POU does not have information how it is executed. This information is handled by task.

Put priority, choose type of task and add or remove POU accordingly. Instead of clicking [Add Call], POU can be dragged into a task. After a project compiled, the color of POU will be changed. If POU is called by a task, it will be blue. If the POU is not called, the color will be gray.



Priority (0..31)

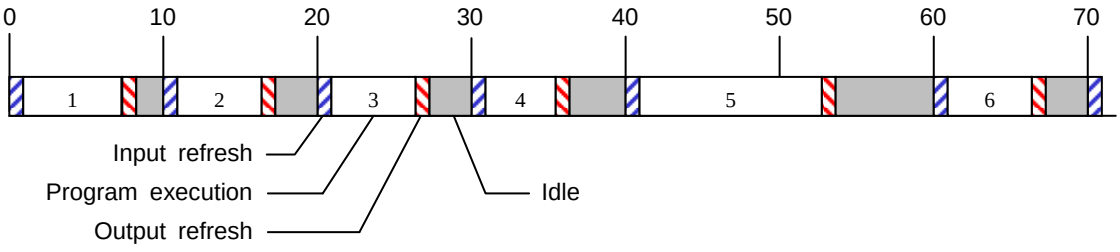
0 is the highest priority, 31 is the lowest.

Type

Choose type of the task. Inputs are read at the beginning of each task, and outputs are written at the end of the program execution.

Cyclic task

The task will be processed cyclic according to the time definition given in the field [Interval]. If actual execution time exceeds the cycle time, the next cycle does not start immediately but wait until the next fixed cycle time. For example, cycle time is set as 10 ms and 5th scan starting from 40 ms takes 12 ms, then 6th cycle starts at 60 ms as below figure.



Event task

The task will be started as soon as the variable defined in the field gets a rising edge.

Freewheeling task

The task will be processed as soon as the program is started and at the end of one run will automatically restarted in a continuous loop. There is no cycle time defined. Be noted that the priority of this task is the lowest and 3 ms of sleeping time is added at the end of each cycle for other tasks to be executed properly.

Status task

The task will be started when selected variable is TRUE.

Watchdog

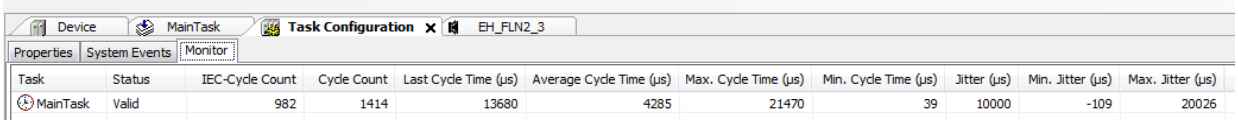
When it is enabled, watchdog function is activated. If program execution time exceeds watchdog time, CPU stops program execution with [24] error code displayed at 7 segment LED.

There are two different conditions to detect watchdog error as follows.

Example: Time: #5 ms, Sensitivity: 3.

- Detect condition 1 : one cycle exceeds 15 ms
- Detect condition 2 : scan cycle exceeds 5 ms in 3 times consecutive

Actual cycle time of each task is monitored in Task configuration as below.



Task	Status	IEC-Cycle Count	Cycle Count	Last Cycle Time (µs)	Average Cycle Time (µs)	Max. Cycle Time (µs)	Min. Cycle Time (µs)	Jitter (µs)	Min. Jitter (µs)	Max. Jitter (µs)
MainTask	Valid	982	1414	13680	4285	21470	39	10000	-109	20026

2.4 Available Characters for Variable Names

Variable name / POU name

Available characters for variable and POU names are alphabets (a to z, A to Z), numbers (0 to 9) and _ (underscore) only. The first character must not be a numeric character. Several words like BOOL, WORD, IF, FOR etc. are reserved.

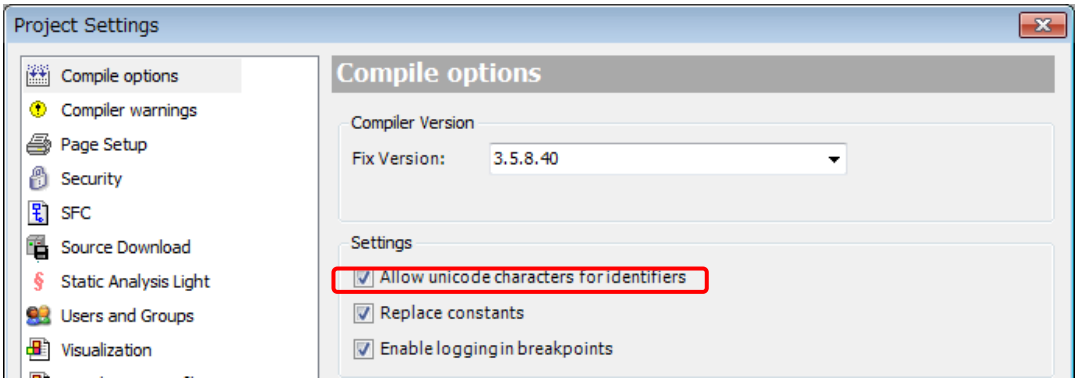
Supported characters

Types	Supported	Remarks
Numerical	0 to 9	Not allowed to begin with numeric characters.
Alphabetical	a to z, A to Z	There is no difference of the small and capital letter.
Symbol	_	Trailing underscores are not allowed.

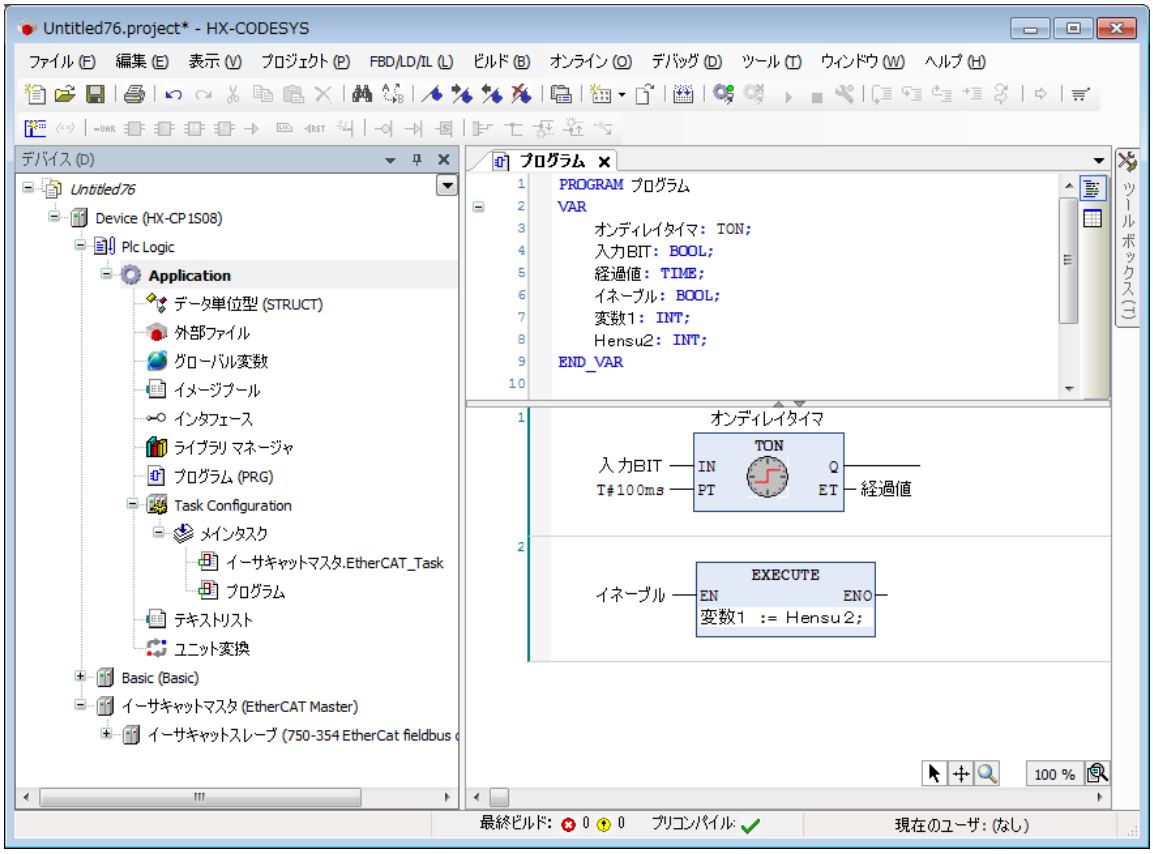
Examples for variable names

Allowed or not	Examples	Descriptions
Allowed	Test_200	-
	TEST	-
	Test55	-
	_Test	-
Not allowed	2test	Starting with numeric character.
	test__200	Trailing underscores are not allowed.
	test-5	Minus sign is not allowed.
	test#3	Other signs than underscore are not allowed.
	test 3	Space is not allowed.
	IF	Reserved word.

If you use unicode characters, click [Project] - [Project setting], and check [Allow unicode characters for identifiers] in [Compile options].

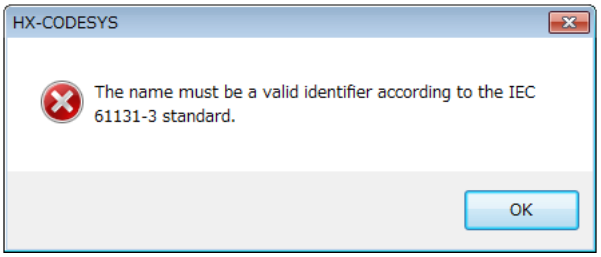


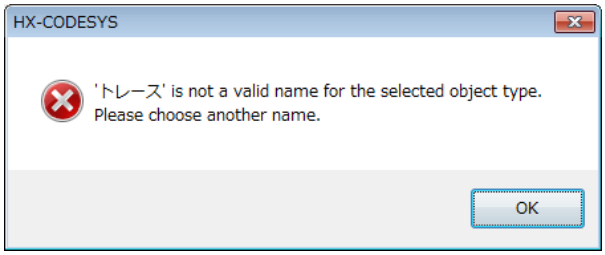
Example: Japanese



Note

If unicode characters are used improperly, warning message is displayed as follows.



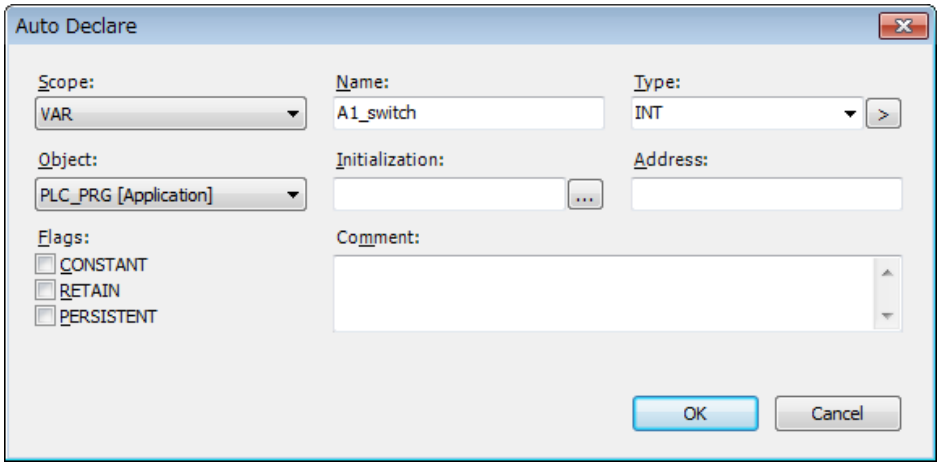


Variables using multibyte characters (Japanese, Chinese, umlaut in German, etc.) cannot be used for HMI or OPC communication.

2.5 Variables

2.5.1 Data Memory

In HX-CODESYS programming, external I/O and data memory (internal registers) are handled as variable names instead of direct I/O addresses, such like [A1_switch]. If new variable name is used, below [Auto Declare] window appears. Enter an each field according to following table.



Item		Descriptions
Scope		Choose [VAR] in normal use. If global variable is used, choose [VAR_GLOBAL]. Refer to section 2.5.8 for further information.
Name		Variable name is defined. (available characters are described in section 2.4.)
Type		Data type is defined. Refer to section 2.5.5.
Object		In case of local variable, POU name is defined.
Initialization		Initial value when program starting can be set here. If it's blank, initialization value is 0.
Address		No need to enter I/O address. EHV-CODESYS will assign to free address automatically.
Comment		Any text comment can be input.
Flags	CONSTANT	Enter a value in the Initialization field.
	RETAIN	The value is retained in nonvolatile RAM. It is not initialized by reset warm. But it is initialized by reset cold or program downloading. (Refer to the section 2.12)
	PERSISTENT	The value is retained in nonvolatile RAM. It is not initialized by reset warm, reset cold, and program downloading. (Refer to the section 2.12)

Bit access

Any bit data in integer type data can be accessed by adding suffix dot and number (decimal 0 to 63).

Example

```
wTest :=5;    ← WORD type（16 bits）

wTest.0;
wTest.1;      ← BOOL type（1 bit）
wTest.2;
wTest.3;
```

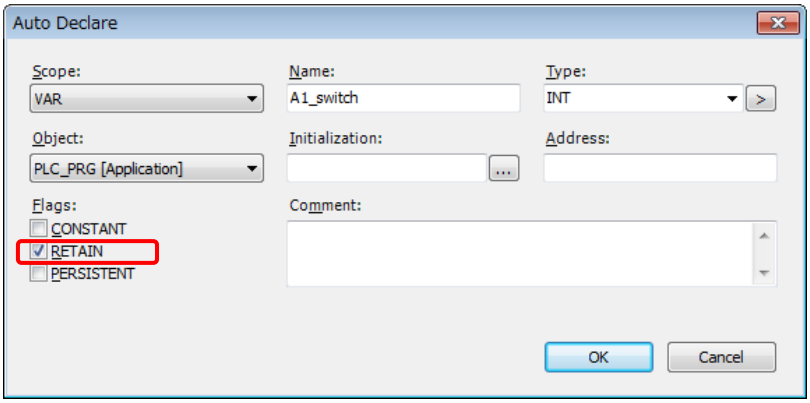
Login display

```
wTest 16#0005 :=5;
wTest 16#0005 .0 TRUE;
wTest 16#0005 .1 FALSE;
wTest 16#0005 .2 TRUE;
wTest 16#0005 .3 FALSE;
```

2.5.2 Retentive Data Memory

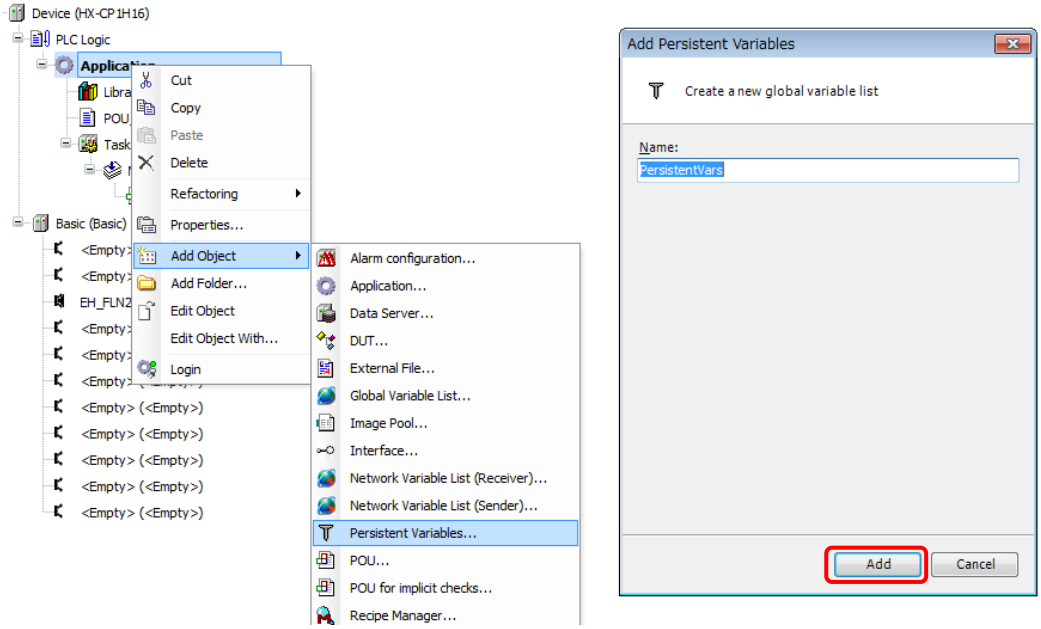
[RETAIN]

Activate [RETAIN] to set retain variable. The value is retained while power failure.

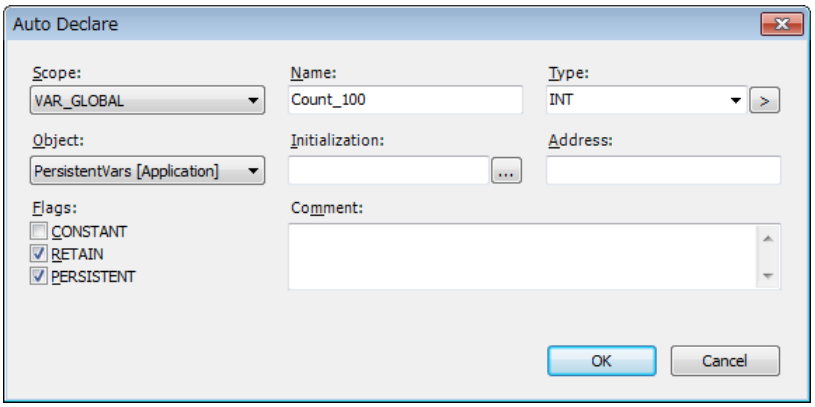


[PERSISTENT]

Add [Persistent Variables] by right mouse click menu on [Application]-[Add Object]-[Persistent Variables].



Activate [RETAIN] and [PERSISTENT] both and choose [VAR_GLOBAL] at [Scope] and [PersistentVars] at [Object] to set persistent variable. The value is retained while power failure. Unlike [RETAIN], it is not initialaized even when reset cold or program downloading.

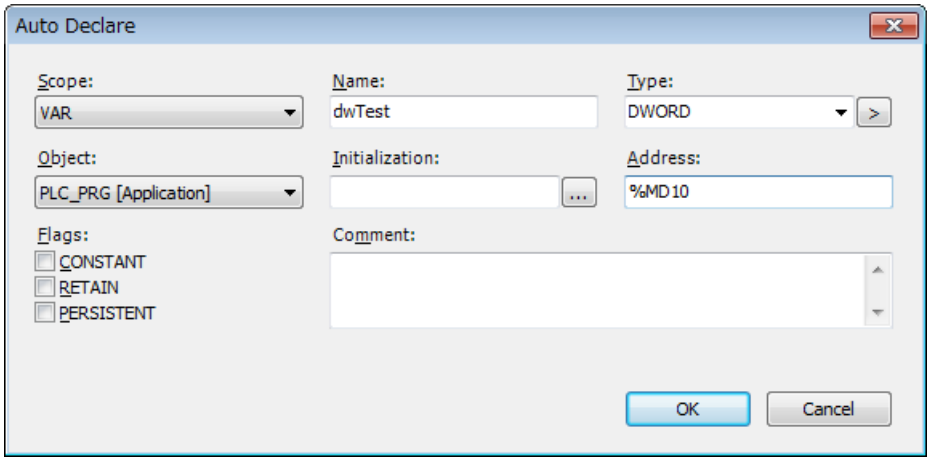


When it is used in POU, add prefix "`PersistentVars.`" to variable names.

```
PersistentVars.Count_100;
```

2.5.3 Marker Memory

Normally users do not have to take care about internal address of data memory.
However if it is necessary to use I/O address consciously, such as accessing only the upper word of DWORD data, use marker memory. The address of marker memory is %M.



For example, DWORD data dwTest, WORD data wTest_H and wTest_L are declared in the address %MD10, %MW20 and %MW21. Then high word and low word can be accessed separately with using %M addresses. The relation between each data types are same as page 2-9. Just replace “Q” with “M”.
The marker memory does not support RETAIN nor PERSISTENT flags.

Variable declaration

```
VAR
    dwTest AT %MD10: DWORD;
    wTest_L AT %MW20:  WORD;
    wTest_H AT %MW21: WORD;

END_VAR
```

Login display

Expression	Type	Value	Prepared value	Address
dwTest	DWORD	16#12345678		%MD10
wTest_L	WORD	16#5678		%MW20
wTest_H	WORD	16#1234		%MW21

The max. size of marker memory is 48KB. Supported address range is shown below.

Data type	Address range
BOOL	%MX0.0 to %MX49151.7
BYTE	%MB0 to %MB49151
WORD	%MW0 to %MW24575
DWORD	%MD0 to %MD12287
LWORD	%ML0 to %ML6143

Note

If CPU Link module or FL-net module are used, the marker memory is used for their shared memory. Be sure use free address if the marker memory is used as general register.

2.5.4 Numeric Literals

The constant inputs in the following formats.

Types	Examples	Remarks
Binary	`FALSE, TRUE, 0, 1, 2#1010_1111`	Underscore is ignored
Decimal	`-12 0 123_456 +986 10#1234`	Underscore is ignored
Hexadecimal	`16#1234, 16#FF00_F000`	Underscore is ignored
Real	`-12.0 0.0 0.4560 3.14159_26`	Underscore is ignored
Time	`T#100ms, T#5.5s`	Timer (TON, etc.)
Date	`DT#2012-12-31-12:34:56`	RTC (Realtime clock)

2.5.5 Elementary Data Types

HX-CODESYS supports below data types.

No.	Data types	Name	Size	Range
1	`BOOL`	Boolean	1	0 or 1
2	`SINT`	Short integer	8	-128 to 127
3	`USINT`	Unsigned short integer	8	0 to 255
4	`BYTE`	Bit string of length 8	8	0 to 255 (16#00 to 16#FF)
5	`INT`	Integer	16	-32,768 to 32,767
6	`UINT`	Unsigned integer	16	0 to 65,535
7	`WORD`	Bit string of length 16	16	0 to 65,535 (16#00 to 16#FFFF)
8	`DINT`	Double integer	32	-2,147,483,648 to 2,147,483,647
9	`UDINT`	Unsigned double integer	32	0 to 4,294,967,295
10	`DWORD`	Bit string of length 32	32	0 to 4,294,967,295 (16#00 to 16#FFFFFFFF)
11	`REAL`	Real numbers	32	±1.175494351 E-38 to 3.402823466E+38
12	`TIME`	Duration	32	0 to 4,294,967,295 ms Unit : [d]: days, [h]: hours, [m]: minutes, [s]: seconds, [ms]: milliseconds Ex. T#100S12ms, t#0.1s
13	`LREAL`	Long reals	64	±1.7976931348623... E+308 to 2.2250738585072... E-308
14	`STRING`	Variable-length single-byte character string	8× n	1 to 255 char.
15	`LINT`	Long integer	64	-2^{63} to $2^{63}-1$
16	`ULINT`	Unsigned long integer	64	0 to $2^{64}-1$
17	`LWORD`	Bit string of length 64	64	0 to $2^{64}-1$
18	`DATE`	Date	32	year-month-day Ex. `DATE#1996-05-06` `d#1972-03-29`
19	`DATE_AND_TIME`	Date and time of Day	32	year-month-day-hour:minute:second Ex. `DATE_AND_TIME#1996-05-06-15:36:30` `dt#1972-03-29-00:00:00`
20	`TIME_OF_DAY`	Time of day	32	hour:minute:second Ex. `TIME_OF_DAY#15:36:30.123` `tod#00:00:00`
21	`LTIME`	Long duration	64	Unit :[us]: microseconds, [ns]: nanoseconds Ex. `LTIME#1000d15h23m12s34ms2us44ns`
22	`WSTRING`	Variable-length double-byte character string	16× n	-

2.5.6 User Defined Data Types

HX-CODESYS supports below data types.

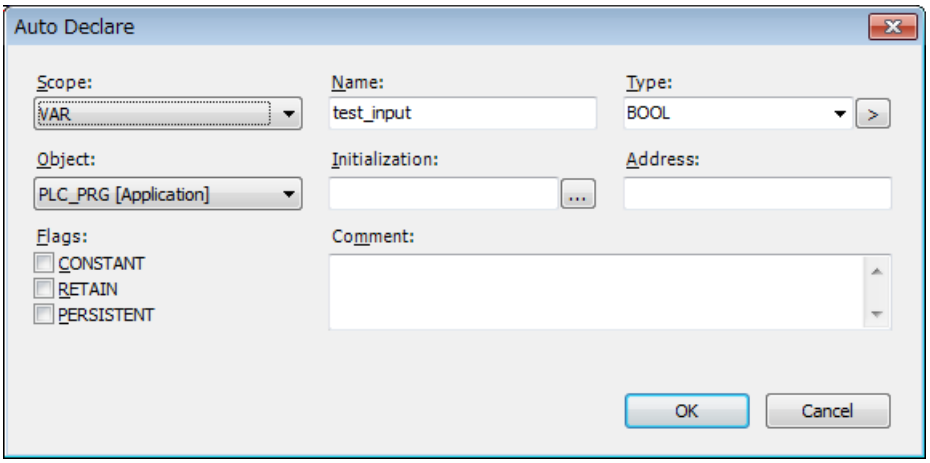
No.	Name	Examples
1	Array	`ARRAY [0..100] OF WORD;` `ARRAY [0..11, 0..22, 0..33] OF REAL;`
2	Subrange	`WORD(0..4095)`

3	Enumeration	`TYPE COLOR:`
		`(Red, Yellow, Green)`
		`:=Green;`
		`END_TYPE`

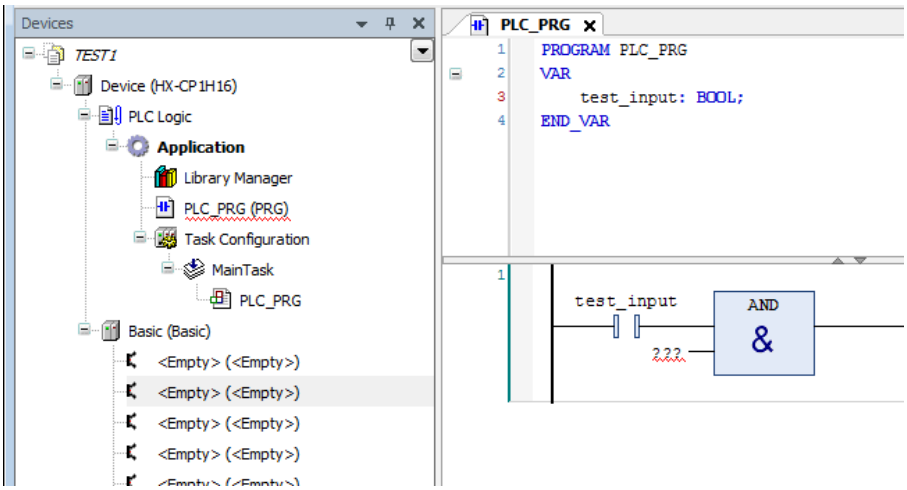
4	Structure	`TYPE STRUCT_sample`
		`STRUCT`
		`ID : WORD;`
		`Flag : BOOL;`
		`Weight : REAL;`
		`END_STRUCT`
		`END_TYPE`

2.5.7 Local Variable

If new variable name is used in POU, [Auto Declare] window appears as below. If the field [Address] is remained as empty, this variable will be assigned in a certain memory area of CPU.



Click [OK], this variable is registered in declaration part of POU as below.

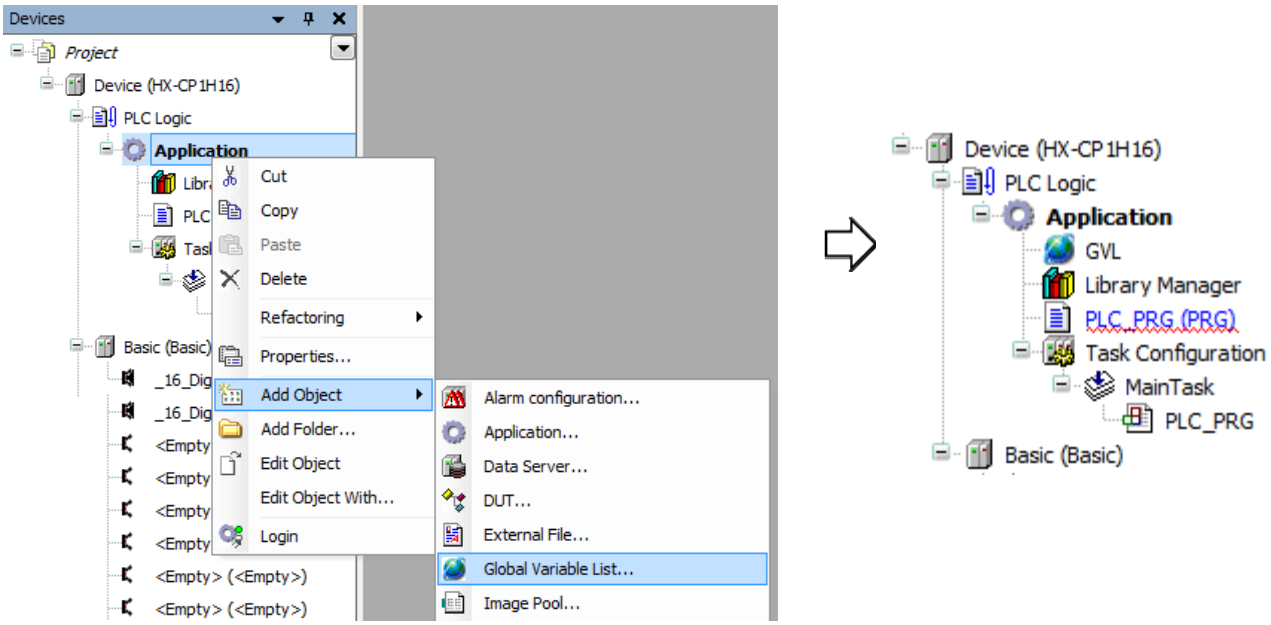


This variable is valid only in the POU. Even if same variable name is used in another POU, [Auto Declare] window will appear and it will be assigned in another memory location and handled as different variable.

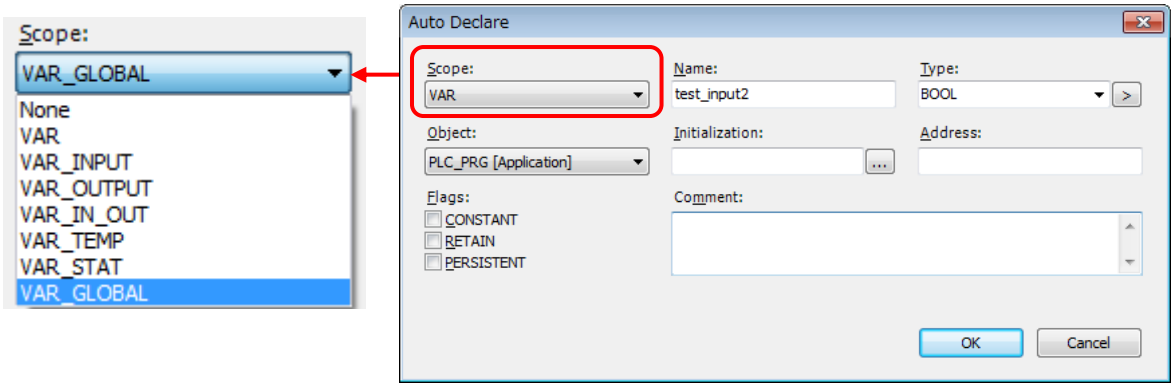
To display the [Auto Declare] window again after defining the variable, place the cursor in the variable and then select [Edit] - [Auto Declare...].

2.5.8 Global Variable

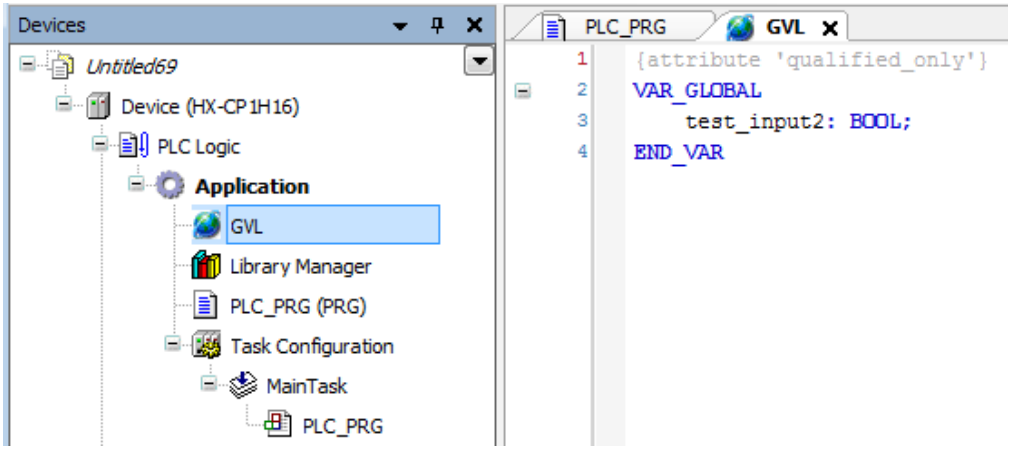
If variables need to be commonly used in all POUs, [Global Variable List] must be created by right click on Application as below.



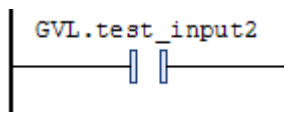
If new variable name is used in POU, [Auto Declare] window appears as shown in local variables. Choose [VAR_GLOBAL] at [Scope] as below.



New variable name [test_input2] is registered in GVL as below instead of POU.



Add a prefix "GVL." to global variable when using in POU.



2.6 Configuration

Open device window and set CPU's parameters in Configuration tab.

Parameter		Description	
LAN/ ETH1, ETH2, ETH3	IP Address	When requesting to change the Ethernet port related parameters, be sure to set [Yes] in [Change IP information], otherwise parameters are not downloaded. Do not forget to set back to [No] after downloading.	
	Subnet Mask		
	Ethernet port Link speed / Duplex mode		
Default Gateway			
Change IP information		Yes	IP information is downloaded together with application.
		No (default)	IP information is not downloaded when application downloading.
NTP	NTP function	Enable / Disable (default)	Setting Use(Enable) calendar clock from NTP server or not(Disable)
	Port number	ETH1 / ETH2 / ETH3	Setting port used calendar clock
	Logical port number	123	The number is fixed.
	Specified by	IP address	How to specify NTP server (fixed)
	IP address or Host name	Setting IP address or host name	
	Access cycle	Setting access cycle to NTP server (Unit: minute default: 60 min.)	
	Timeout	Timeout is 10 s. (fixed)	
	TimeZone	Setting time zone	
FTP	FTP server	Setting parameters regarding FTP server Refer to chapter 4.2	
	Port number		
	Access Media		
	User Name		
	Password		
Stop switch definition		Reset warm (default)	When Run/Stop switch is changed from Run to Stop, [Reset warm] operation is performed.
		Stop	When Run/Stop switch is changed from Run to Stop, [Stop] operation is performed.
Reset all outputs in STOP		Yes (default)	all outputs are reset by hardware signal on the backplane when switching to stop mode. (Refer to chapter 2.2)
		No	all outputs are controlled by IEC program (software)
Battery error detection		Enable (default)	Detect battery error
		Disable	Not detect battery error
I/O config error detection		Enable (default)	Detect I/O configuration error
		Disable	Not I/O configuration error
Program up/download by USB memory		Enable / Disable (default)	Program up/download function is enabled/disabled.

Note

- Do not set network address (host parts 0) nor broadcast address (host parts 255). It is possible to set, but CPU will detect an error and message will be stored in the log.
- Do not set illegal subnet mask such as 255.255.253.0. It is possible to set, but CPU will detect an error and message will be stored in the log.
- When using default gateway, be sure to use correct IP addresses not to duplicate network address of ETH1, 2, 3 with network address of the gateway.

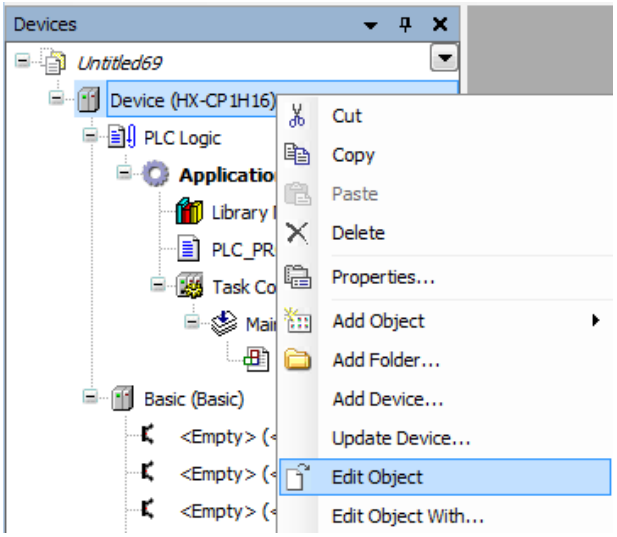
2.7 Communication Settings

How to configure

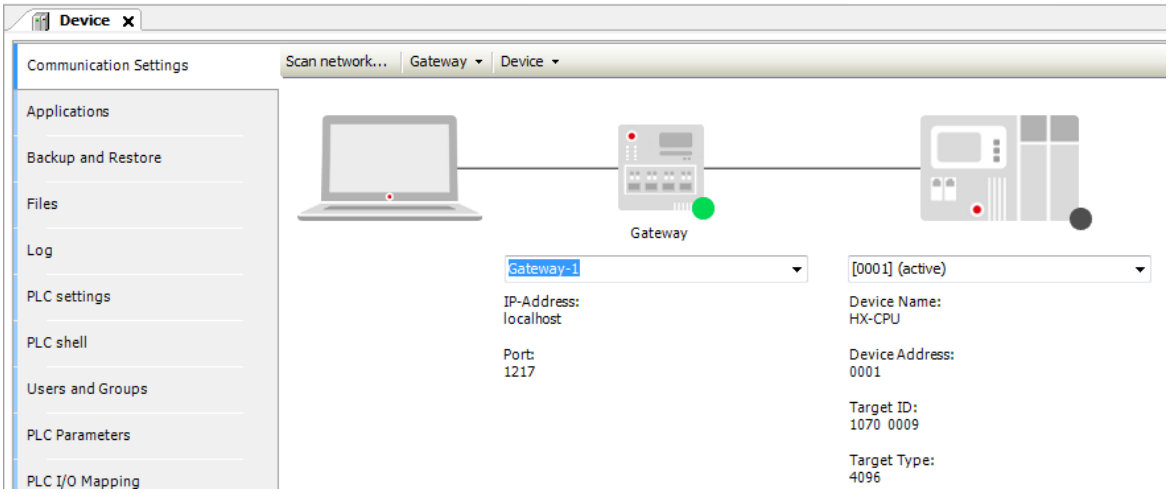
Connect PC to HX-CPU with USB cable (Mini-B) or LAN cable. Either crossover cable or straight cable is available for Ethernet ports of HX-CPU. Be sure to set IP addresses of PC and HX-CPU in the same segment. If not, login with USB and change IP address of HX-CPU accordingly. The default IP addresses of HX-CPU are shown below.

Port	IP address	Subnet mask
ETH1	192.168.0.1	255.255.255.0
ETH2	192.168.1.1	255.255.255.0
ETH3	192.168.2.1	255.255.255.0

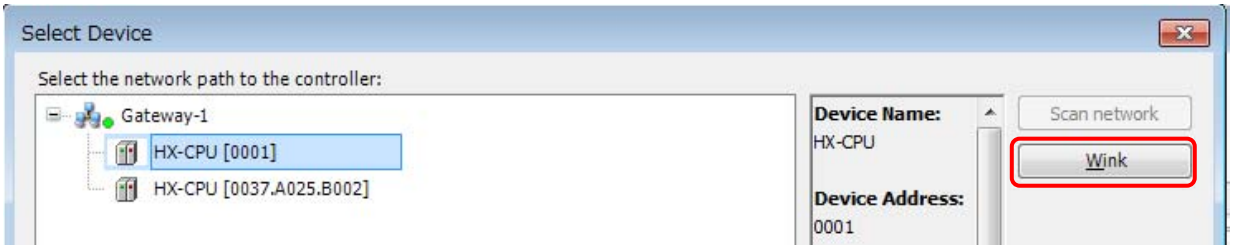
Double click on [Device (HX-CPxxxx)] or right click and choose [Edit Object].



[Device] window will appear as below.



Choose [Communication Settings] tab and click [Scan network]. If multiple CPUs exist in the network, all the CPUs are displayed as below.

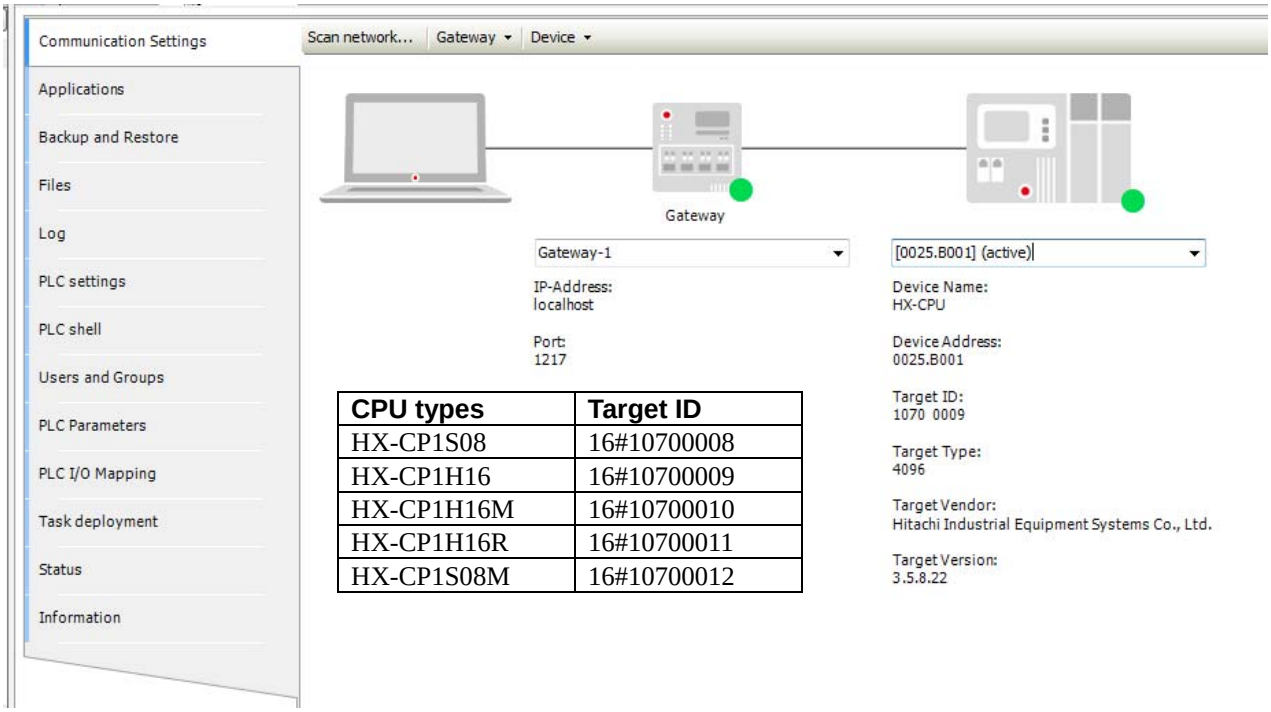


If you choose one of the CPU and click [Wink], RUN LED on the CPU will blink 2 times in case of STOP status or 3 times in case of RUN status.

Note

If you choose [Open Project from PLC…] in the Start Page and click [Wink], CPU does not react.

Click [OK], then the CPU is configured as target device.



CPU types	Target ID
HX-CP1S08	16#10700008
HX-CP1H16	16#10700009
HX-CP1H16M	16#10700010
HX-CP1H16R	16#10700011
HX-CP1S08M	16#10700012

If CPU is not displayed correctly, please check following points.

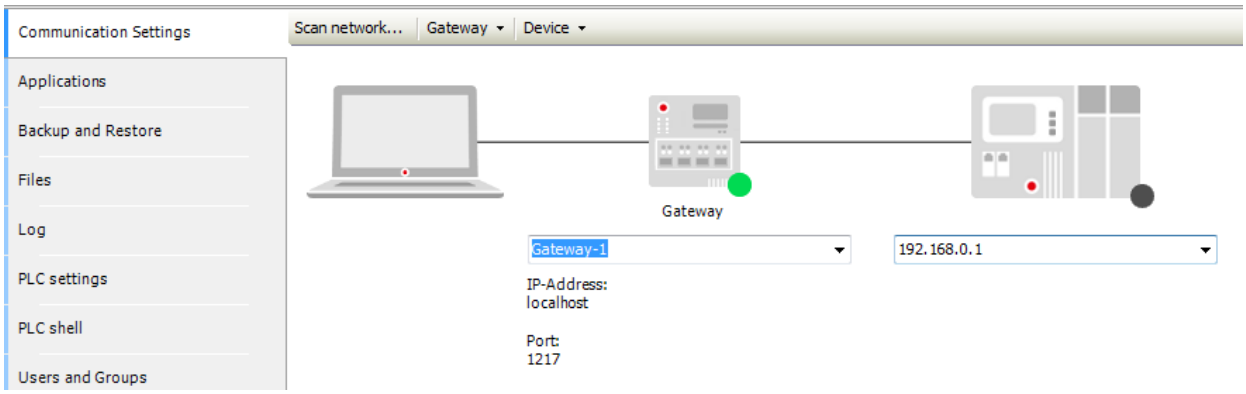
Possible cause	Action
Bad connection of LAN cable	Check the connection of cable and the power of network switches. Check if the LED of L/A at Ethernet connector is lighting in green.
No USB driver installed	Install USB driver (refer to 1.1.3).
Wrong IP address	Check IP address and subnet mask of PC and CPU both. If IP address is unknown, login with USB and set IP address accordingly.
Wrong CPU type	Set right CPU type by right mouse clicking on device and choosing [Update device]. If [Device]-[Filter network scans by target ID] is disabled, other types of CPUs are displayed.

Note

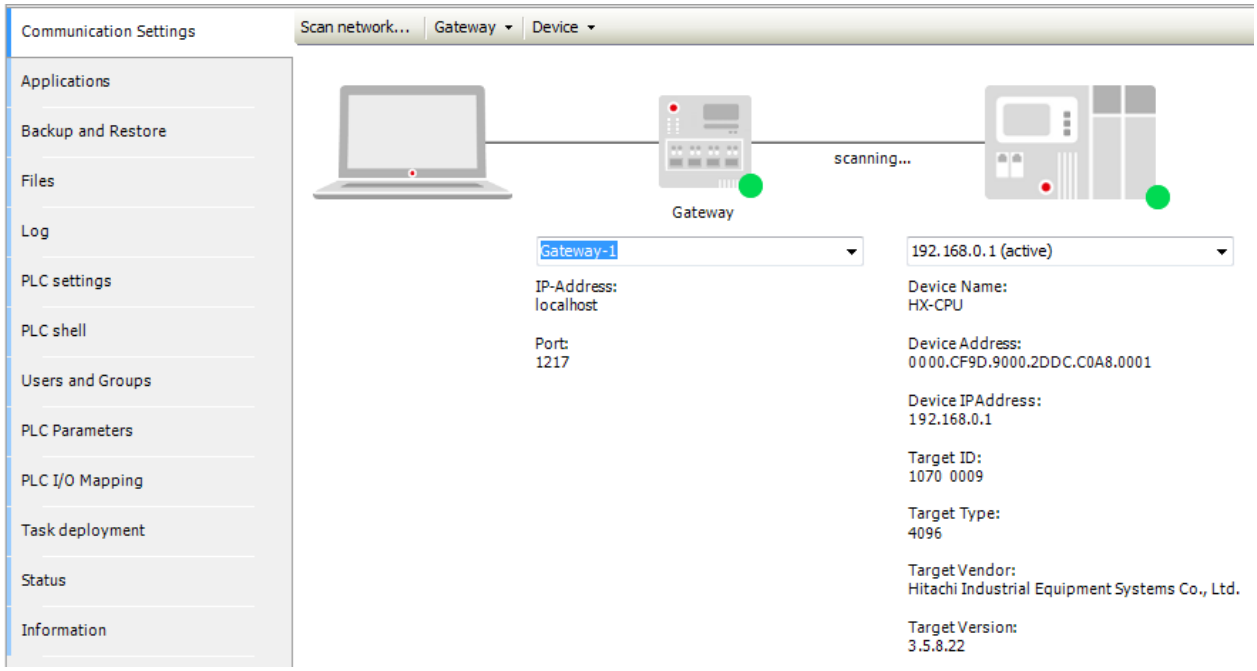
If both USB cable and LAN cable are connected to the same CPU, only one network detected first is displayed.

TCP/IP

The protocol of above mentioned Ethernet communication is UDP/IP. If TCP/IP is required instead of UDP/IP, enter IP address of CPU directly in the address field.

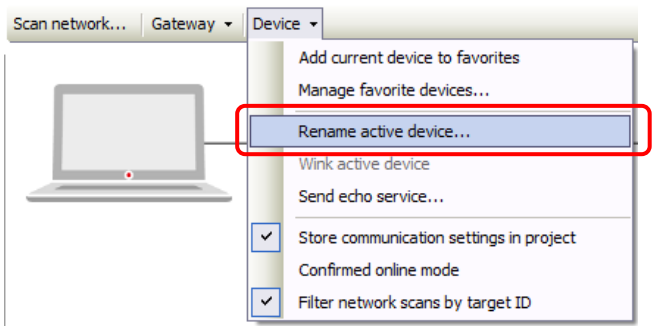


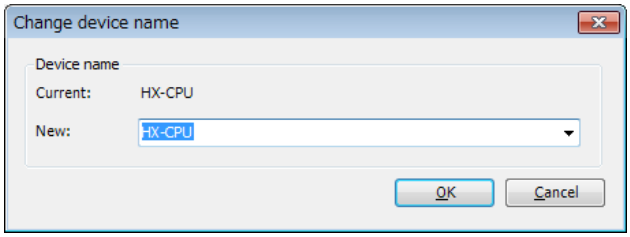
If entered IP is found, information of CPU is displayed.



Rename device

After communication opened, device name of connected CPU can be changed in the menu [Device]-[Rename active device…].



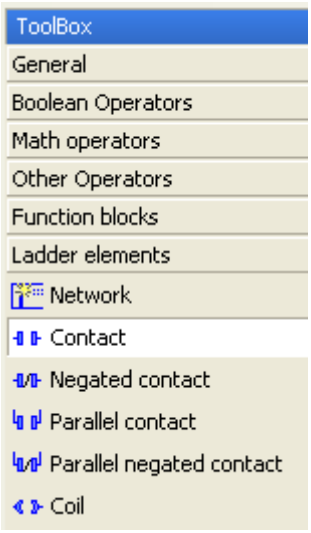


2.8 Programming

Ladder programming

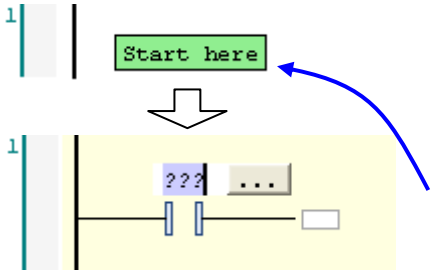
Basic ladder programming is shown below as a first step. Please refer to online-help of HX-CODESYS for further information about programming.

Several ways are available to add contact or coil to POU as below.



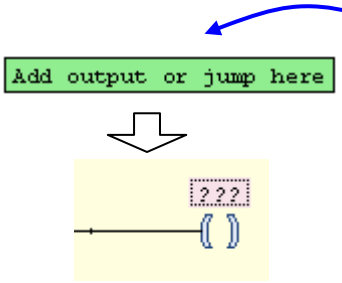
Contact

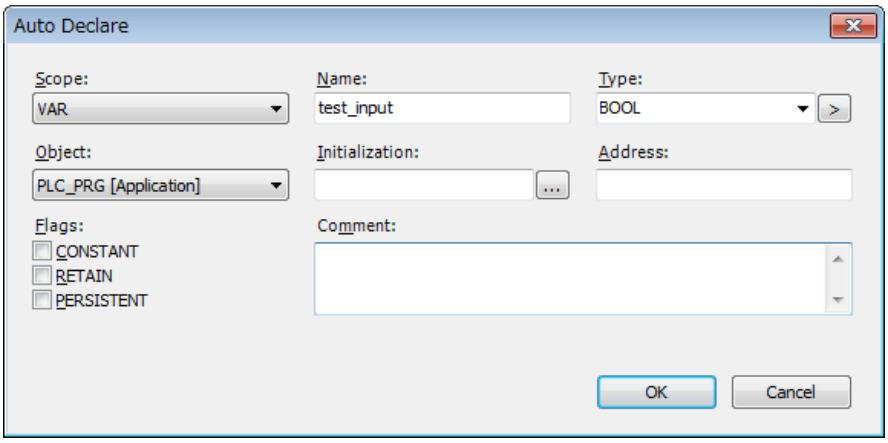
- Drag from ToolBox to [Start here].
- Menu [FBD/LD/IL]-[Insert Contact]
- Right mouse click [Insert Contact]
- Shortcut key [Ctrl + K]



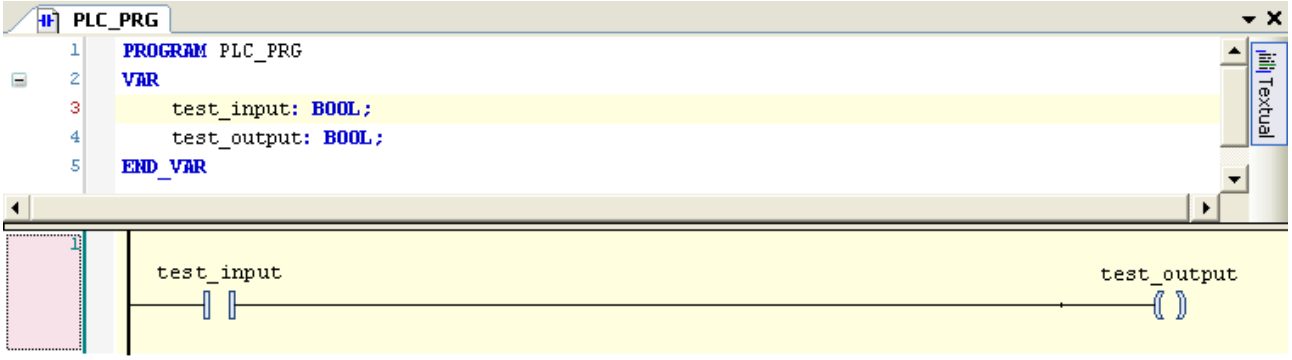
Coil

- Drag from ToolBox to [Add output or jump here].
- Menu [FBD/LD/IL]-[Insert Coil]
- Right mouse click [Insert Coil]
- Shortcut key [Ctrl + A]



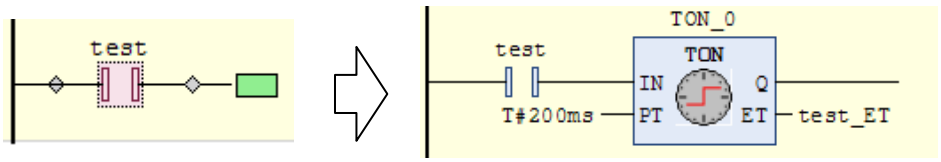


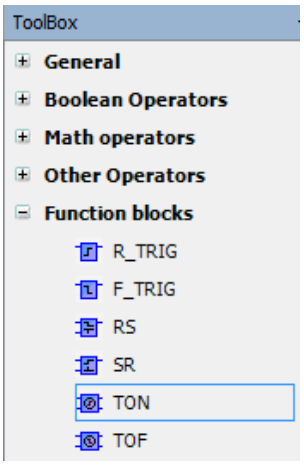
If new variable name is used, [Auto Declare] window appears automatically. Edit each input field and check-boxes if necessary, and Click [OK]. The variable is declared in declaration window as below.



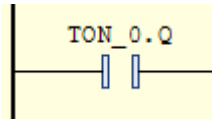
Timer (TON)

Drag TON in Function Blocks to the position to put and drop it.





Specify the name of TON (TON_0 in the figure) and set PT (preset timer value) and the variable for ET (elapsed time). PT is mandatory, but ET is optional. If ET is left as open, delete variable name. New symbol can be added to the output of TON (Q), but this output can be left as open.

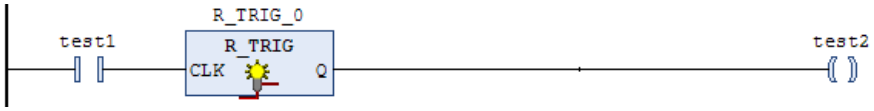


If timer output is used as a contact, put suffix ".Q" to the name of TON. Elapsed time is used as suffix ".ET".

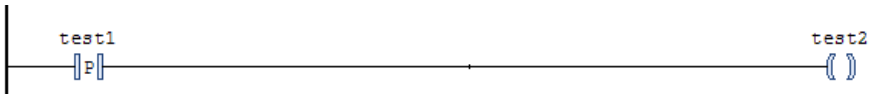
Edge detection

3 different samples with same behavior are shown for rising edge detection.

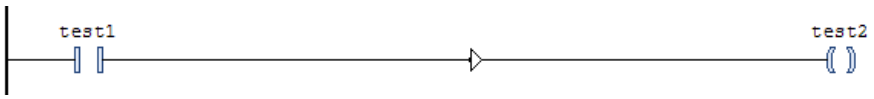
Function block R_TRIG
(F_TRIG for falling edge)



Right mouse click and choose [Edge detection] once.
(—|N|— for falling edge)



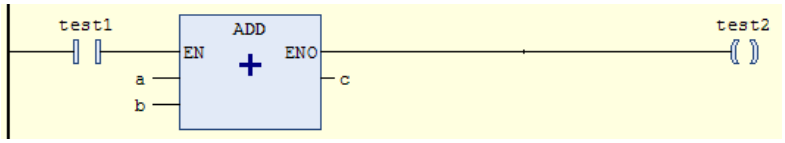
Right mouse click and choose [Edge detection] once.
(—◁— for falling edge)



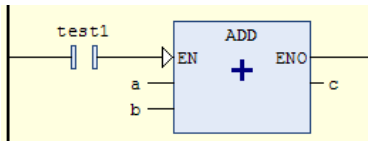
Box with EN/ENO

If EN input is TRUE, the box is executed. By right mouse clicking and choosing [Edge detection] or [Negation], the condition to execute can be changed. The ENO output has the same value as the EN input.

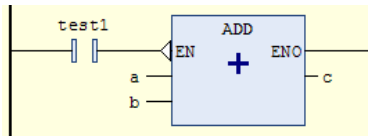
Example 1: The box is executed while [test1] is TRUE.



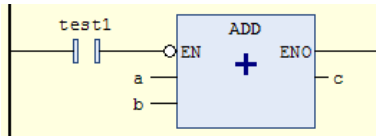
Example 2: Rising edge detection



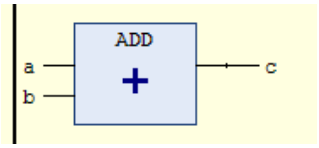
Example 3: Falling edge detection



Example 4: Negation

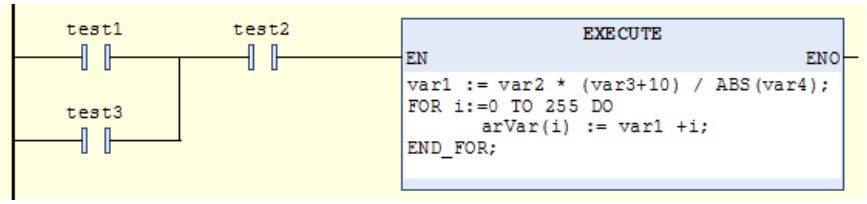


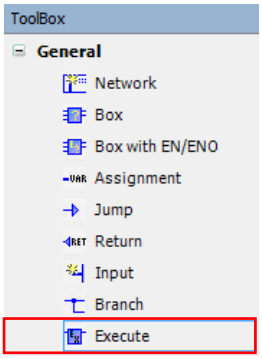
Example 5: Always executed (box without EN/ENO)



Execute Box

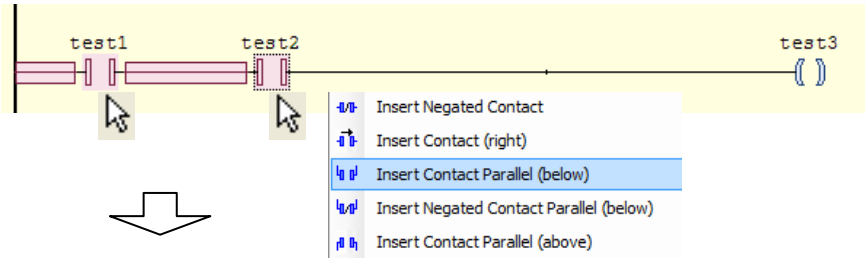
The element is a box that enables you directly enter ST code. LD language is suitable for bitwise operation and ST language is suitable for math calculation. This execute box brings advantages of ST to LD/FBD editor.

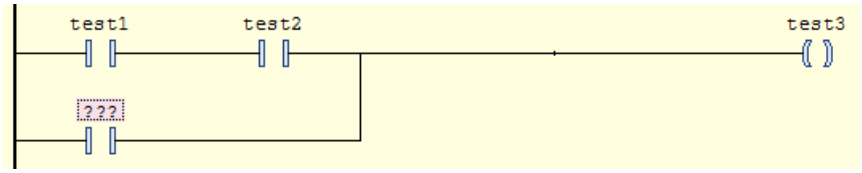




Parallel contact across multiple contacts

If you need to insert a contact in parallel to multiple contacts, choose multiple contacts with pressing [Shift] key, then choose [Insert Contact Parallel (below)] in the right mouse click menu or press [Ctrl+R] key.

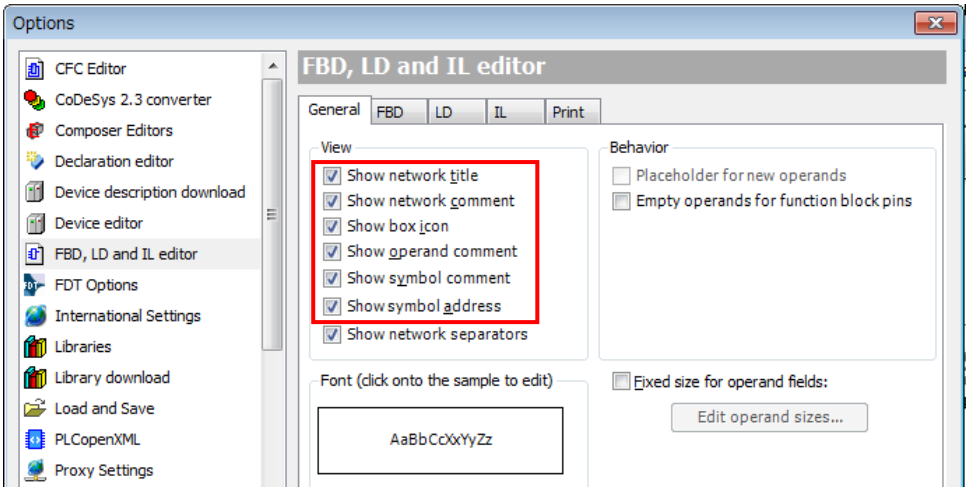


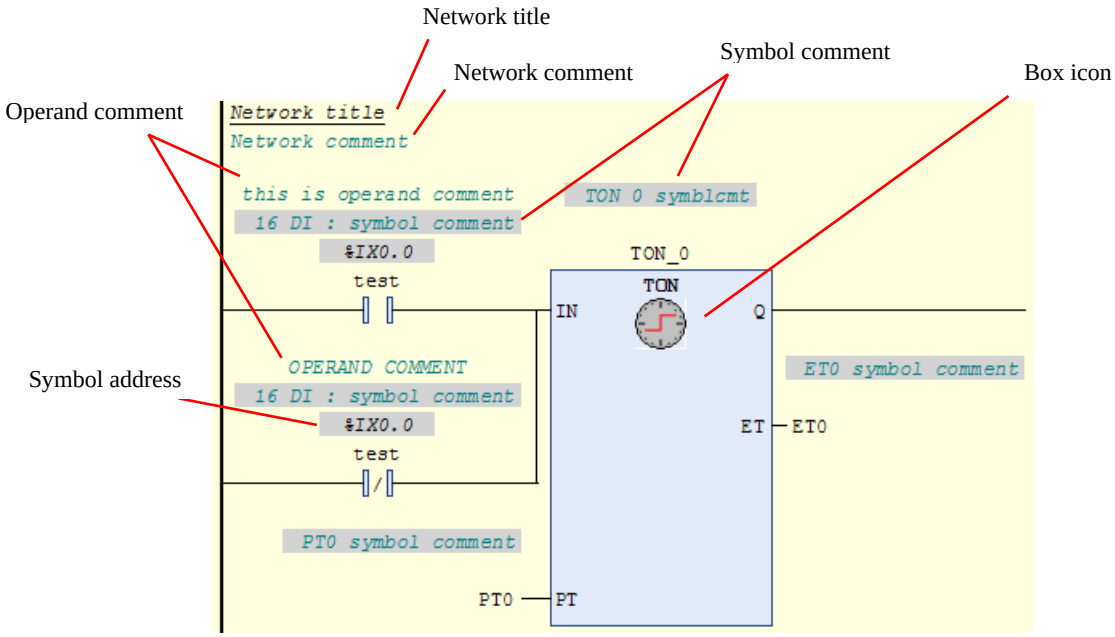


Comment

Several different comments are enabled or disabled in the menu [Tools]-[Options]-[FBD, LD and IL editor].

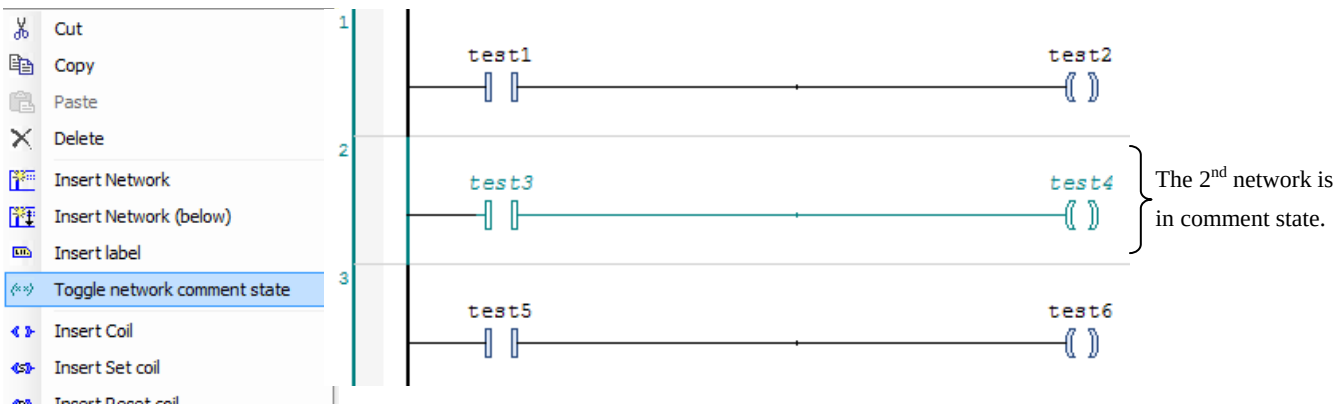
Since symbol comment is linked to variable, if same variables are used in different location, the same symbol comment is used. Operand comment is not linked to variables. If same variables are used, different operand comments can be set.





Toggle network comment state

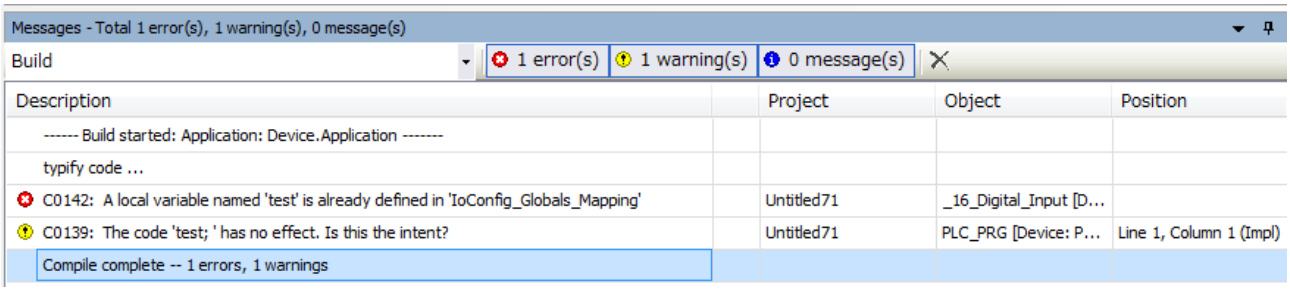
A network can be disabled with visible temporary. Choose [Toggle network comment state] in right mouse click menu. The color of this network will be changed and ignored. Perform the same operation to restore.



2.9 Login / Logout

Login

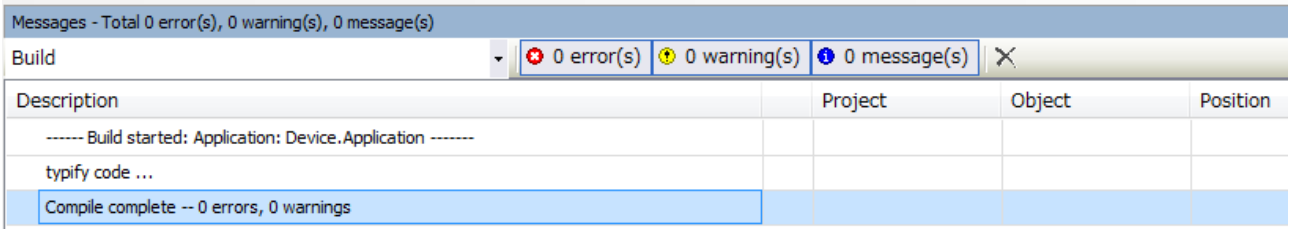
After programming, click  or choose [Build] in Build menu. If compiling fails, error information is shown at [Description] field as follows. Double click the message to jump to the part to be corrected.



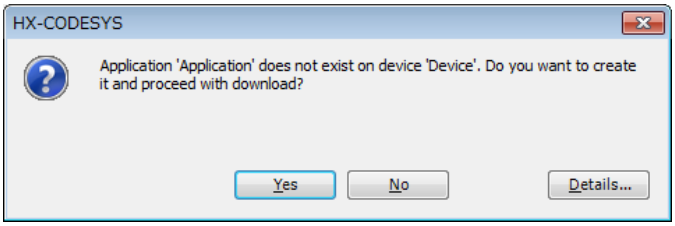
Note

If unknown message appears, it is recommended to [Clean all] in Build menu. All compile information is deleted by this operation.

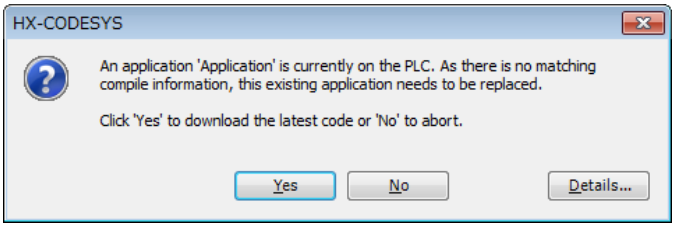
When all errors are removed as below, click  or choose [Login] in Online menu to download the program to CPU.



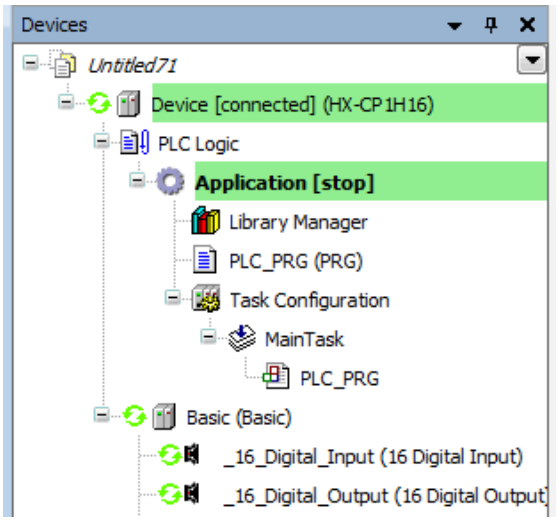
If no application is in the CPU, this message appears. Click [Yes] to download.



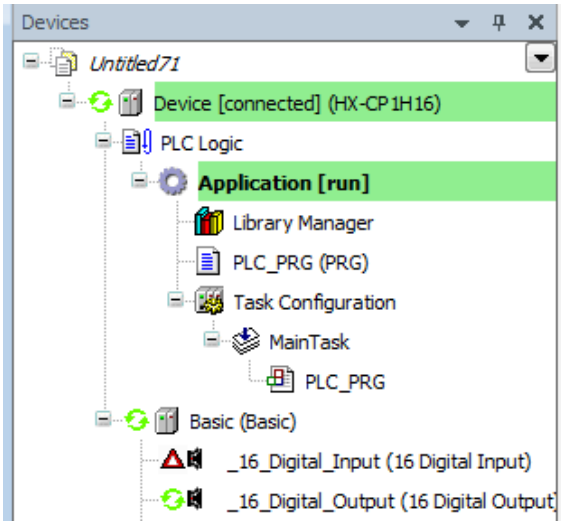
If unknown version of application is in the CPU, this message appears. Click [Yes] to download.



When logging in successfully, green circle icon is displayed at [Device]. If mounted I/O modules are matched with configured ones, green icon is displayed at each I/O module also.



If any mounted I/O module is mismatched, red triangle icon is displayed at mismatched module as below.



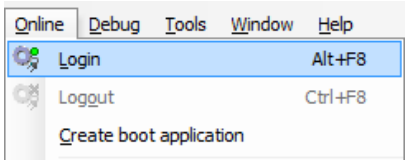
Online change

Online change is a function to change application program while CPU is running without stopping program execution. When online change is performed, only changed program is downloaded to the HX-CPU.

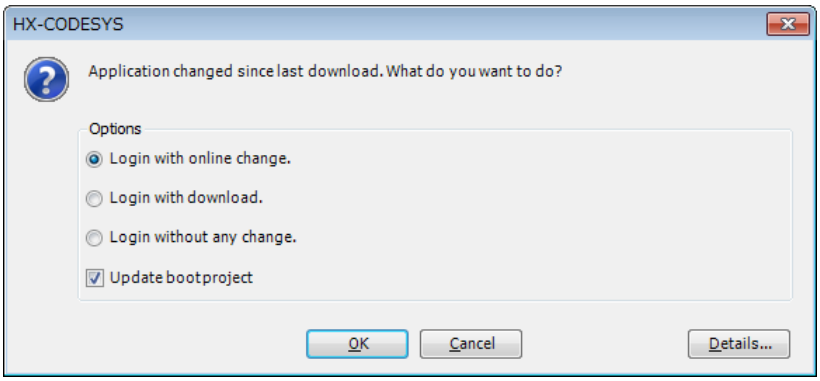
⚠ CAUTION
Since running program is changed by online change operation, the machine might not work as expected, which could cause personal injury or damage. Before performing online change, check new program code carefully.

Operation of online change

To change your program in running CPU (online change), you have to logout at first. After program changing, choose [Login] again. You will have 3 options as below.



Login with online change: Only incremental program is downloaded without CPU stop.
Login with download: Whole the program is downloaded. CPU is forced to stop.
Login without any change: New program is not downloaded.



If [Clean] or [Clean all] or changing of I/O configuration, Task configuration or so on is performed before online change, online change is not possible, and download is required.

Note

Pointer variables retain their values from the last cycle. If a pointer refers to a variable whose value was changed in an online change, then the variable no longer yields the correct value. Make sure that pointer variables are reassigned in each cycle.

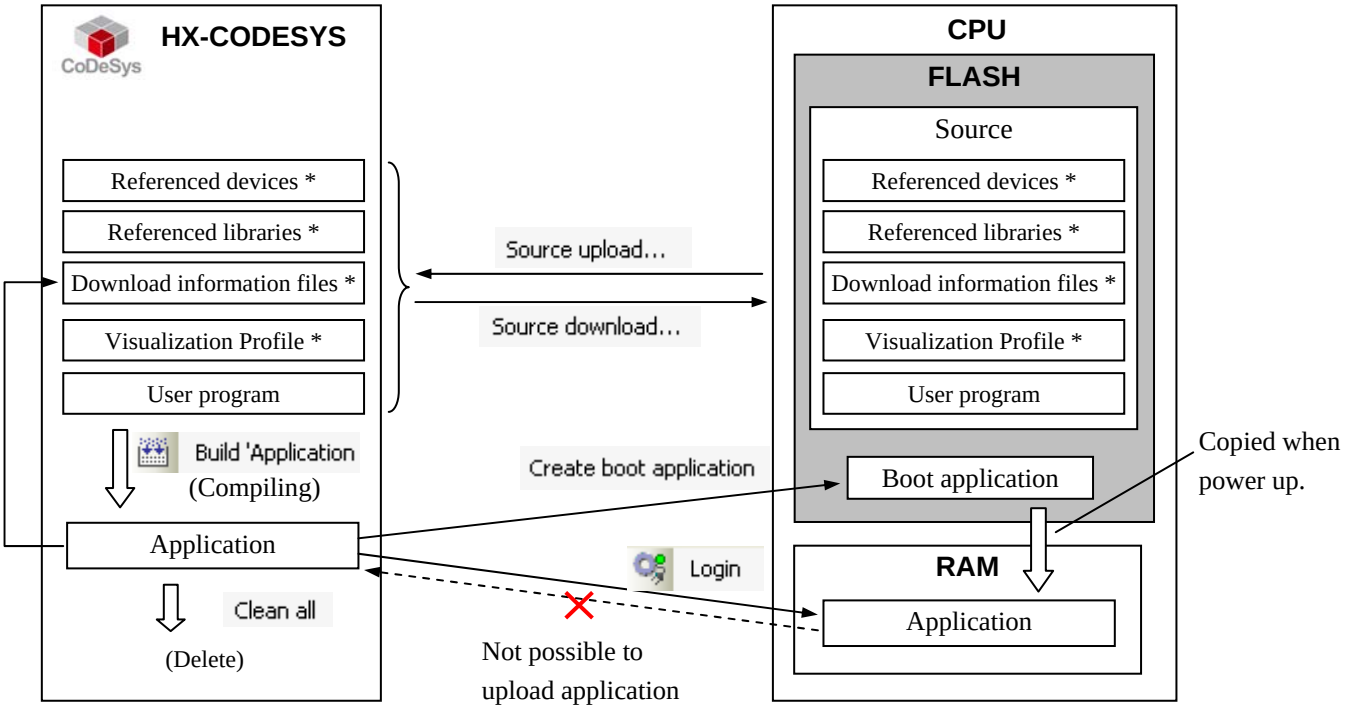
Logout

Choose the menu [Online]-[Logout] or click  icon to logout.

If the total number of variables in opened POU exceeds about 30,000, it takes long time to logout. If 30,000 or more variables are used in a POU, it is recommended to split it 2 or more POUs and not to open all the POUs when login.

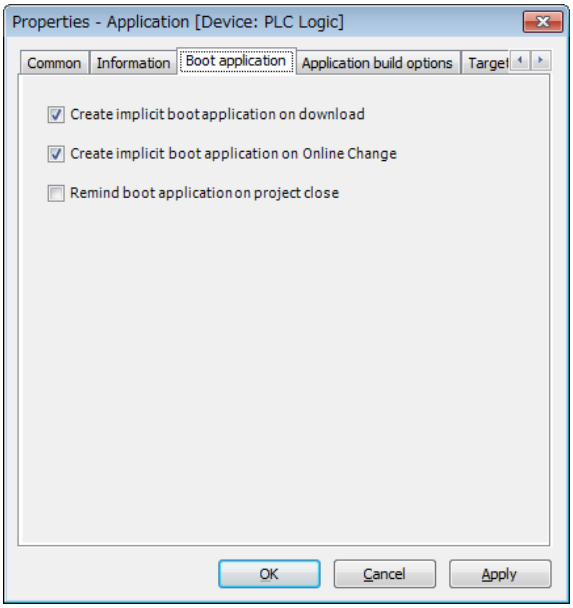
2.10 Boot Application

The basic overview of downloading is shown as below picture. Be noted that an application (compiled user program) is downloaded to volatile RAM memory of the CPU, which means the application is lost when power is removed. If your application needs to be saved in non-volatile FLASH memory, choose [Create boot application] in Online menu while Login. When CPU is power up in the next time, the application is copied from FLASH to RAM and executed automatically if RUN/STOP switch is in RUN position.



*: Optional

Timing to download boot application can be configured in [Properties] of [Application] (Right click on [Application] of the project tree). The default setting is shown below.

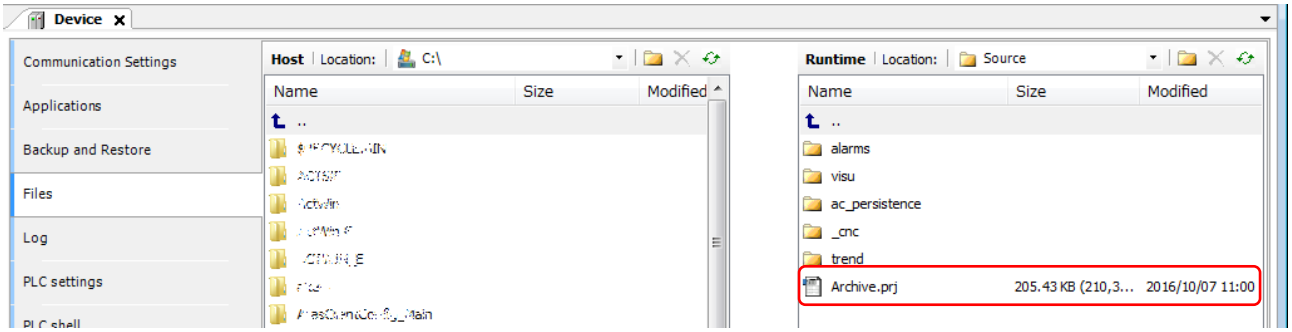


2.11 Source Download / Upload

Path

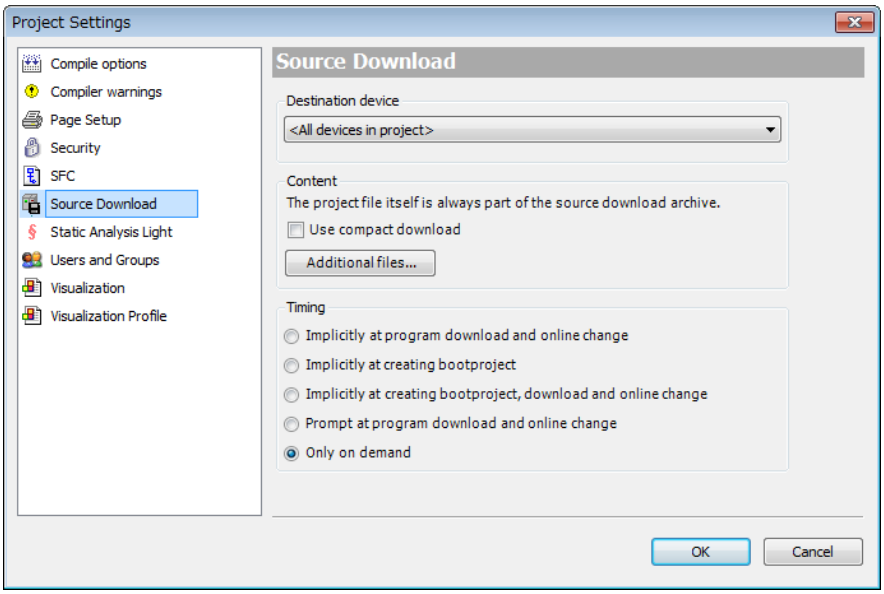
Source file is a file including all the information of project such as programs, variable names, comment, programming language settings and other related information. Source file is downloaded by choosing the menu [Online]-[Source download to connected device] or [File]-[Source download]. Uploading is done by choosing the menu [File]-[Source upload].

If a source file is downloaded to a CPU, it is saved as “Archive.prj” in the folder [Source]. Since executable files such as application file and boot application file are binary format, it is not possible to open as a visible program file or to reverse compile to source file. Be sure to save source files in PC or CPU, otherwise it is not possible to edit or change running program.



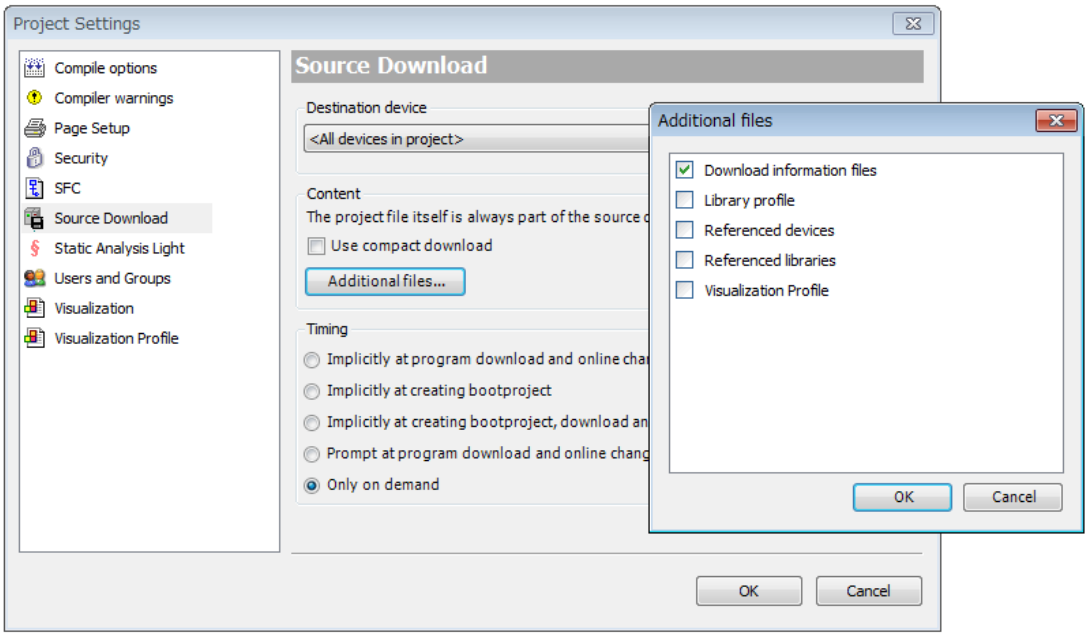
Downloaded timing

Downloaded timing of source file can be set in the menu [Project]-[Project Settings]-[Source Download]. The default setting is [Only on demand]. If source file is to be updated together with application, choose [Implicitly at creating bootproject, download and online change].



Downloaded information files

Besides boot application, source file can be saved in the CPU module, which enables you to upload original program file from PLC even if you don't have it in your PC. Some extra files can be added to source file as below. Choose according to your necessity.



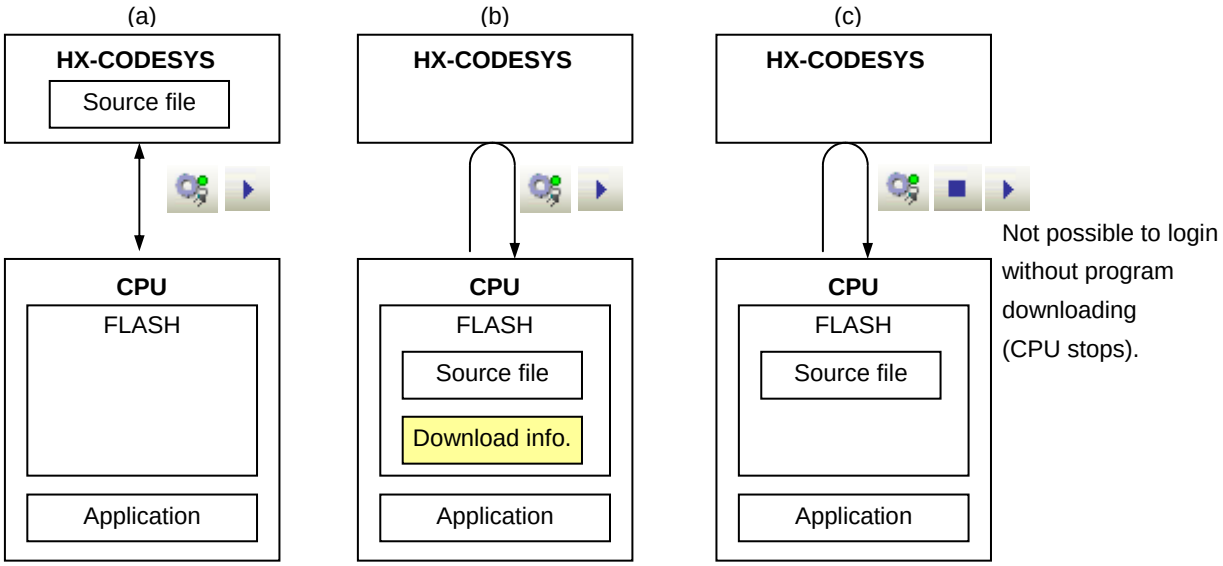
Download information files

[Download information files] in [additional files setting] is not always necessary, but it is needed if you want to login without CPU stop from the PC which does not have original program file shown below as case (b) and (c).

(a) Online change from PC with source file to CPU without source file. ➔ just Login for onlinechange

(b) Online change from PC without source file to CPU with source file and DL info. ➔ Source upload and Login

(c) Online change from PC without source file to CPU with source file. ➔ Source upload and Login, then program download is required because HX-CODESYS is not able to verify if application and source files are identical. It is possible to login after downloading, but CPU must stop at that time.



2.12 Run / Stop / Reset / Initialize

Run/Stop

CPU can be started with HX-CODESYS or Run/Stop switch on the CPU module, but remote controlling with HX-CODESYS is not allowed when the Run/stop switch is in Stop position as shown below.

Switch position / User operations	STOP	RUN
Stop with HX-CODESYS	Stop (ignored)	Stop
Run with HX-CODESYS	Stop (ignored)	Run
Reboot PLC (Cycle power)	Stop	Run *

* CPU starts running independent from the last status before power failure.

HX-CPU resets all the I/O at starting by hardware signal. For this reason, outputs are reset in one task cycle time at the timing from stop to run independent from PLC settings.

Reset

When CPU detects a serious error called “exception”, such as watchdog error, program execution stops. If HX-CODESYS is connected, “Exception” indication blinks until this status is cleared. This exception status is cleared only by [Reset] operation. HX-CODESYS has 2 different types of [Reset] operation: [Reset warm] and [Reset cold]. All of them can initialize exception status, but behaviours of CPU are different as shown below. Be noted that [Reset origin] initializes not only an exception but also your application and boot application in CPU module.

Initialize

Initializing operation is to reset not only exception status and data memory but also non-volatile memory. HX-CODESYS has two different initializing operation, [Reset origin] and [Reset origin device]. Differences are listed in the table below.

Data / Operation	VAR	VAR RETAIN	VAR PERSISTENT	Application (volatile memory)	Boot application (non-volatile)	Source file (non-volatile)	WebVisu Data, Online user info.	IP address, Realtime Clock data
STOP	X	X	X	X	X	X	X	X
Reset warm	-	X	X	X	X	X	X	X
Reset cold	-	-	X	X	X	X	X	X
Download	-	-	X	(updated)	(updated)	(updated)	(updated)	X*1
Online Change	X	X	X	(updated)	(updated)	(updated)	(updated)	X
Reboot PLC	-	X	X	-	X	X	X	X
Reset origin （Initialize PLC）	-	-	-	-	-	X	X	X
Reset origin device [Device]	-	-	-	-	-	-	-	X

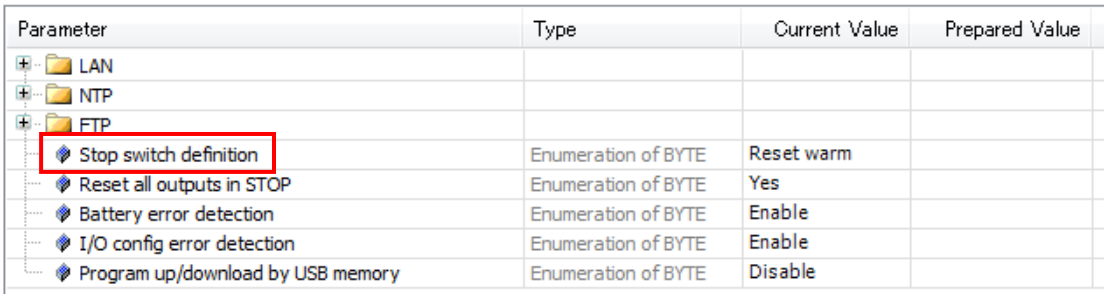
X = maintained, - = initialized, *1: Updated if [Change IP information] is set as YES.

Note

If downloaded application is renamed in [Device]-[File] window of HX-CODESYS, in which the application name in CPU is mismatched with HX-CODESYS, [Reset origin] and [Reset origin device] do not work properly.

Stop switch definition

Definition of stop position of run/stop switch can be configured as [Stop] or [Reset warm] in CPU configuration. Default setting is [Reset warm] since it is almost same behaviour as [Stop] of existing Hitachi PLC.



2.13 Global Network Variables

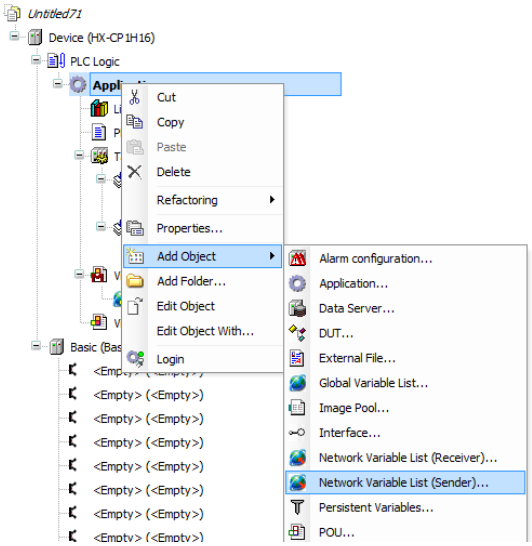
Any variables can be listed in global network variable list, which are sent to all other CPUs (max. 32 CPUs) in the network with broadcast address of UDP/IP. Either port ETH 1/2/3 can be used.

How to configure?

Setting steps for sender CPU and receiver CPU are shown as follows.

[CPU Sender]

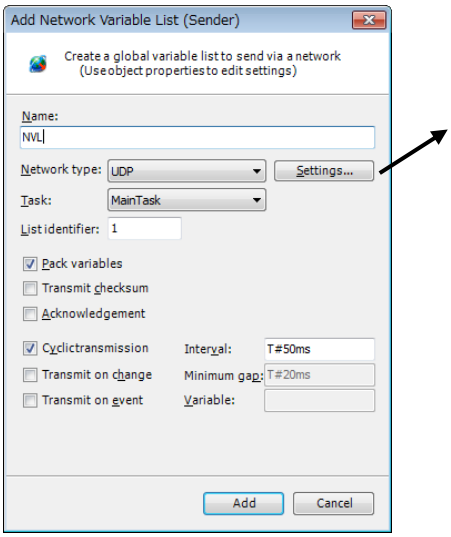
Right click on [Application] of send-CPU and choose [Network Variable List (Sender)].

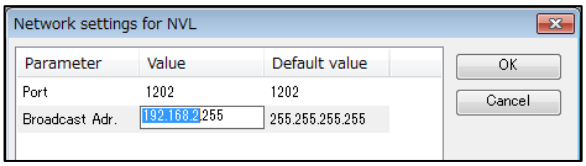


Network type: Choose [UDP].

Settings : Set port number and broadcast address.

Task: Choose any one task. The variables are sent at the end of a task cycle.





Example of Broadcast Adr.
IP address : 192.168.0.1
Subnet mask : 255.255.255.0
Broadcast address in this case is 192.168.0.255

Note

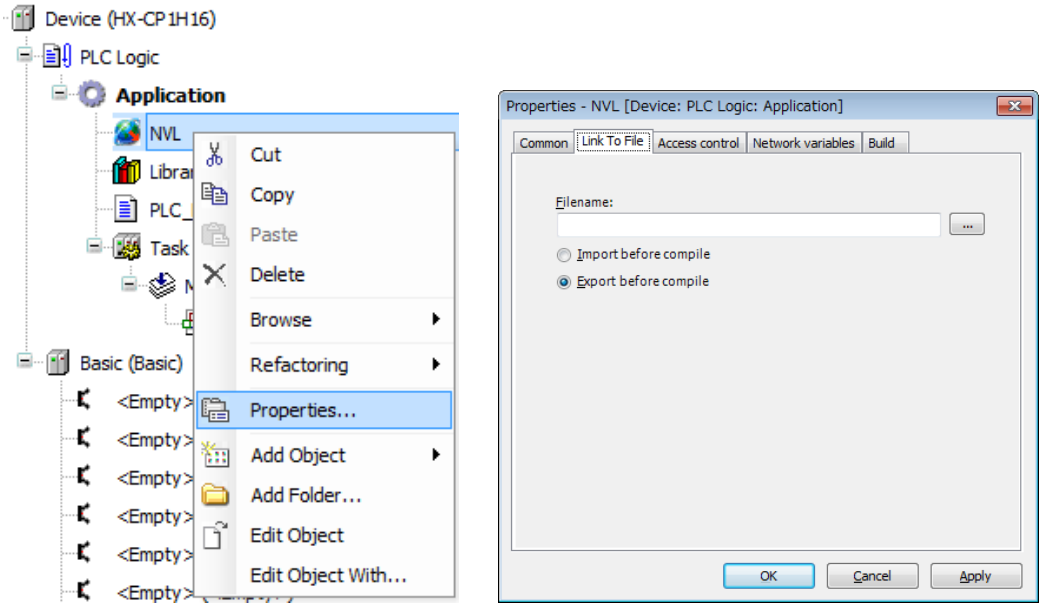
If existing old project is reused for HX and the port number is set as other number than 1202, be sure to set 1202. The port number for network variable is fixed as 1202 in HX-CPU.

List identifier: If more than 2 global variable list is configured, set a number in ascending order.
Cyclic transmission: Since variables are sent every task cycle, set interval time as same or bigger than cycle time of configured task. If smaller time than task cycle is set, actual sending cycle is limited by task cycle.
Transmit on change: Variables are sent only if their values have changed; the Minimum gap can define a minimum time lapse between transfers.
Transmit on event: Variables are sent while specified variable is TRUE. Be noted that it is not edge detection but level detection.
Refer to online help of HX-CODESYS for further information.

After parameter settings of sender CPU are completed, create a file to export to receiver CPU by right mouse clicking and choosing [Properties]-[Link to File]. Be noted that 255 bytes or more of STRING/WSTRING variable are not available in network variables. Parameters of sender CPU can be edited in the tab [Network properties].

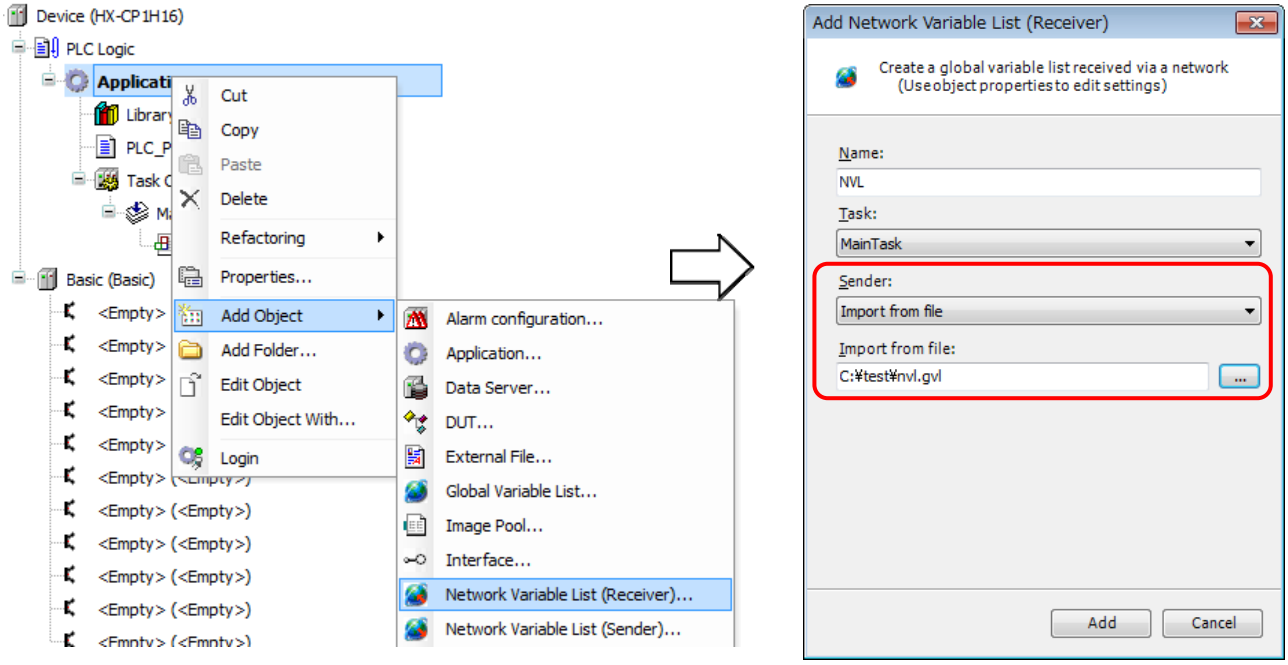
Note

Parameters in properties can be modified in online mode, but new information is not downloaded to CPU when changed. It is recommended to change the parameters in offline mode and then to download.



[CPU Receiver]

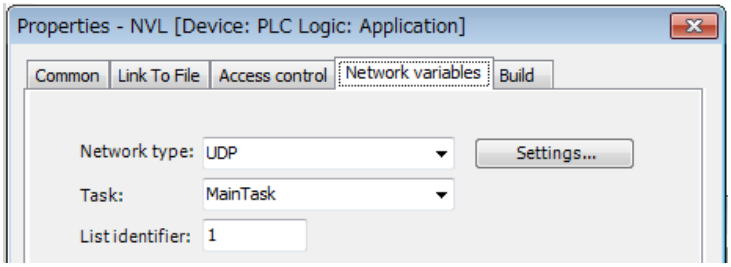
The next step is configuration for receiving CPU. Right click on [Application] of Receive-CPU and choose [Global Network Variable List...]. Be sure to check if Sender is properly set as configured list above.



Configuration is completed for both send and receive-CPU.

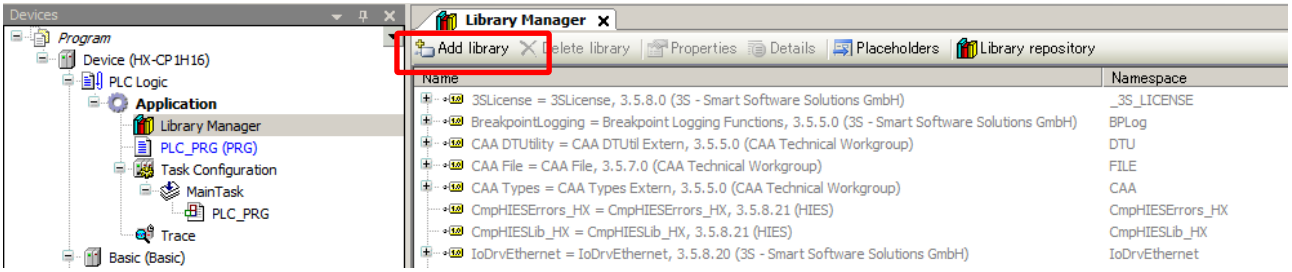
Note

- If any parameters of global variable list is changed, be sure to execute [Clean] or [Clean All] before login.
- If 2 or more network variable lists are configured, be sure to set another [List identifier] in ascending order.



2.14 Library

A library is a package including several function or function blocks. The libraries are stored in the Library repository. If you need to use libraries in your project, you must load it from the library repository by [Add library]. In case of HX-CPU, following libraries are preloaded automatically to new project.



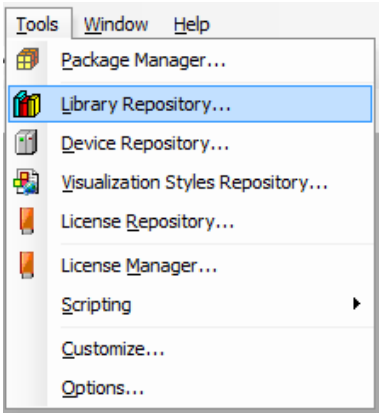
Libraries as shown below are loaded automatically when new project is opened.

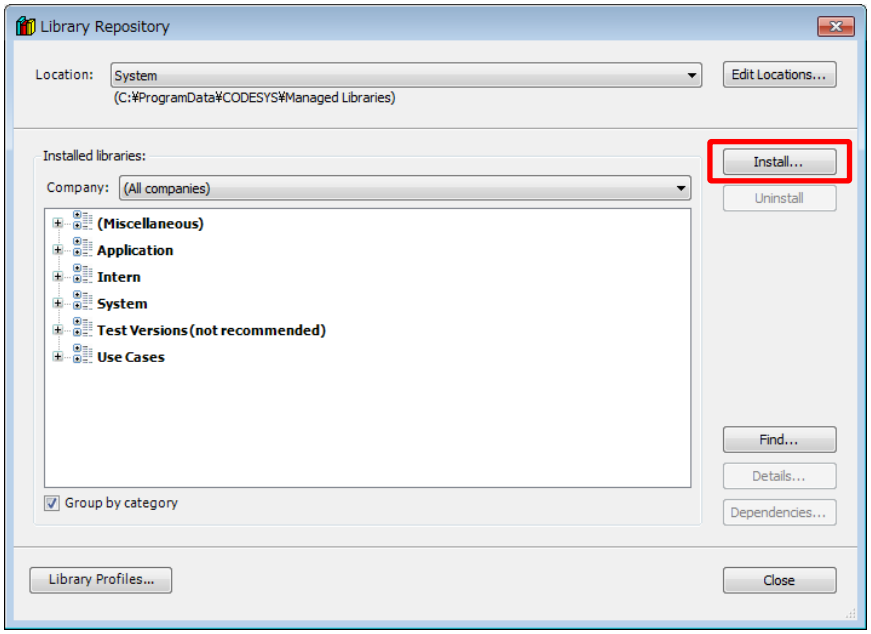
Loaded libraries automatically

Name of Library	Note
IoStandard	System library for I/O control
3SLincense	System library
Standard	IEC61131-3 compliant standard library
Util	PID, BCD and other utility instructions included
CAA DTUtility	RTC (realtime clock) data reading/writing
CAA File	File access library
SysCom	Serial communication library
CAA Types	Sub library for CAA File
CmpHIESLib_HX *1	HX specific instruction library
CmpHIESErrors_HX *1	HX specific error handling library

*1 Use libraries with suffix "_HX". The libraries without "_HX" are for EHV+ series.

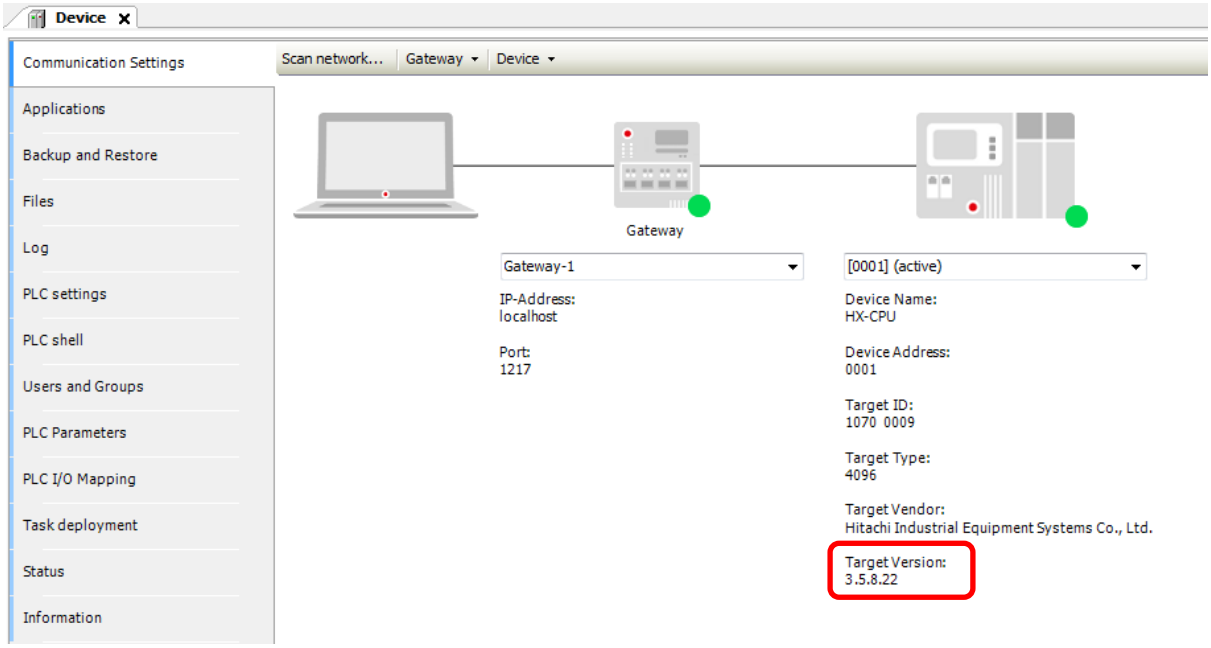
If these libraries are not found in the library manager, install libraries by choosing [Tools]-[Library Repository] and then clicking [Install].





2.15 Version

Firmware version (Target-Version) of your CPU is monitored in communication settings of Device as below.



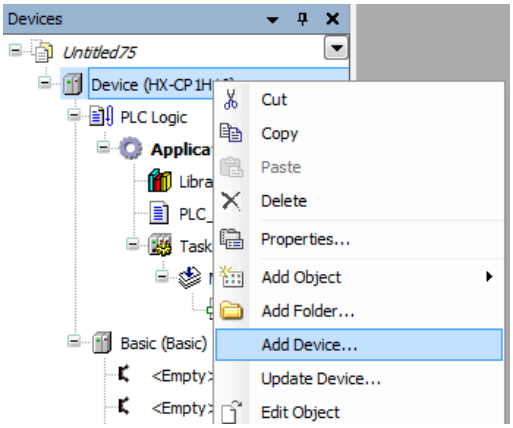
MEMO

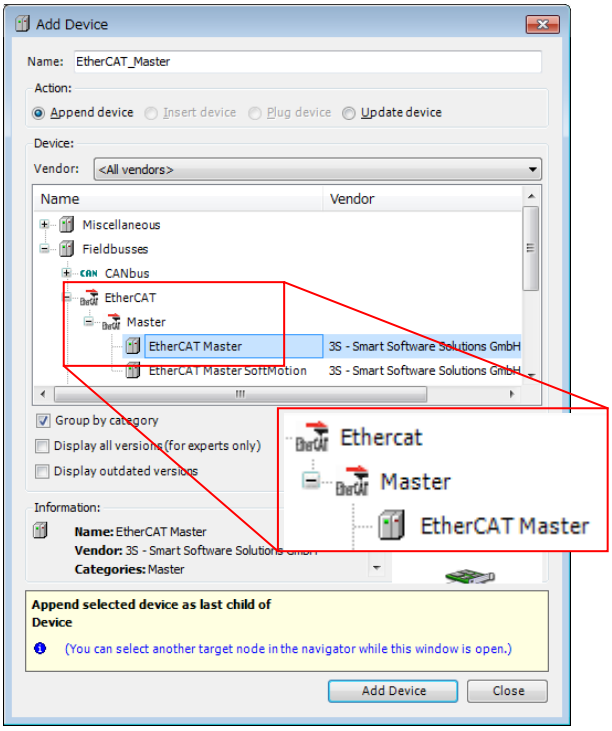
Chapter 3 Communication Function

3.1 EtherCAT Master

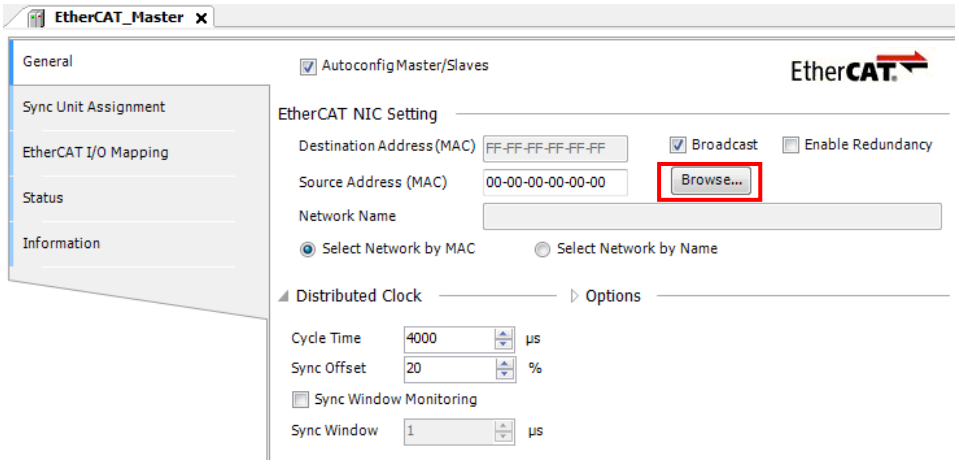
3.1.1 Configuration

Right-click on [Device] and choose [Add Device…].
[Add Device] window appears.
Click [EtherCAT Master] and [Add Device] button.

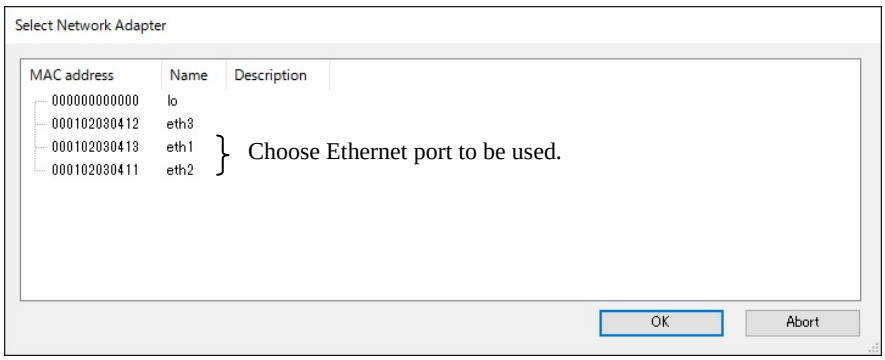




Double click [EtherCAT Master (EtherCAT Master)] to configure Ethernet port. After communication between PC and HX-CPU configured, click [Browse…] button and choose Ethernet port for EtherCAT master.

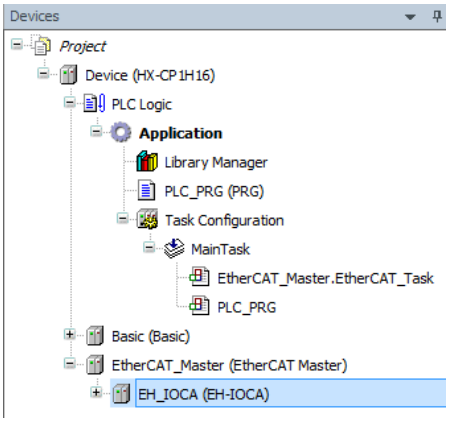


* [Enable Redundancy] is not supported.

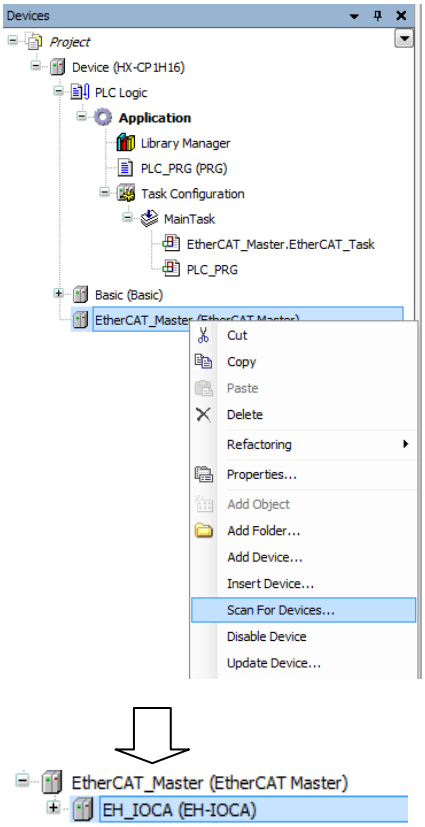


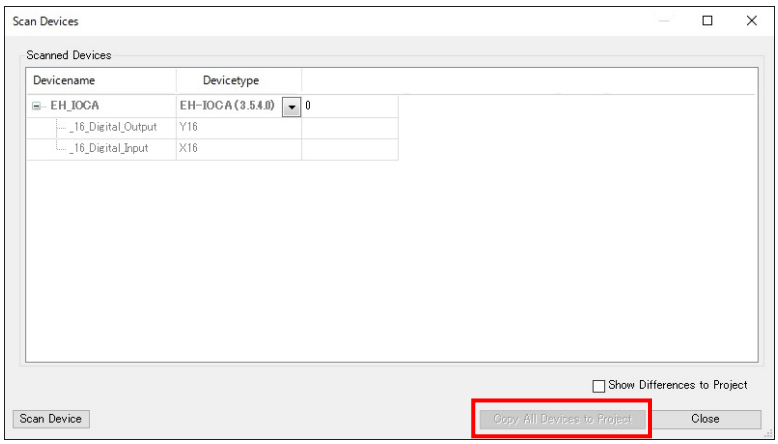
Be sure to use [eth1] or [eth2] for EtherCAT master.

Right mouse click on [EtherCAT master] and choose [Add Device]. The available devices are shown in [Add Device] window. Choose slave units according to your system configuration and click [Add Device] button.



If actual slaves are physically connected, it is possible to search the devices from the network if communication between PC and HX-CPU has been already configured according to chapter 2.7. Right mouse click on [EtherCAT_Master (EtherCAT Master)] and choose [Scan For devices]. Click [Copy All Devices to Project] to complete.

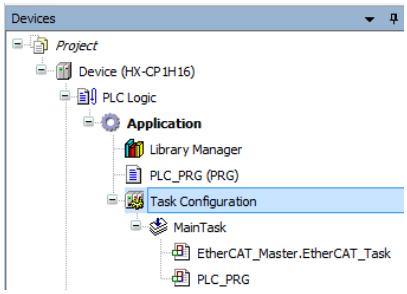




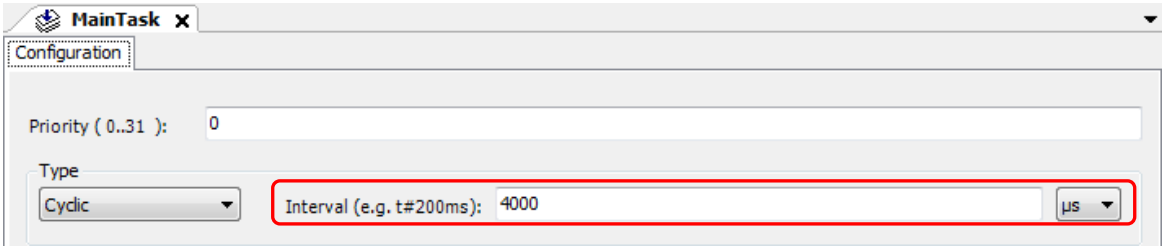
If EtherCAT Slave Information (ESI) file of the slave is not installed, right device name is not shown in the Scan Device dialog. Be sure to obtain the ESI file and install it to HX-CODESYS in advance in the menu [Tools]-[Device Repository].

3.1.2 Cycle of EtherCAT Task

If EtherCAT master is added, EtherCAT Master task is created automatically under MainTask.

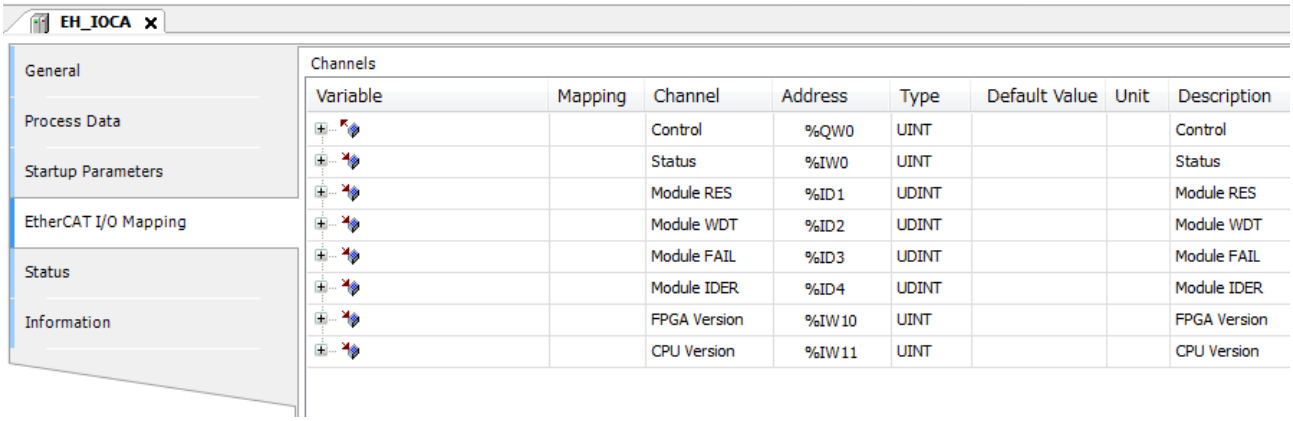


The minimum Cycle time for EtherCAT master is 1 ms because a single microprocessor handles all the tasks in HX-CPU. If cycle time is too small, 25 error (Microprocessor Overload) will be detected. This cycle time depends on user program size and the number of I/O modules however, do not set a value less than 1 ms even if program size and the number of I/O modules are small.



3.1.3 Programming

The mapping of slave's I/O are shown in [EtherCAT I/O mapping] tab as follows. Put variables in this map as same as other I/O modules.



Caution

If PLC is powered up with RUN/STOP switch in RUN position, I/O refresh of EtherCAT slaves may start approximately 1 second later than refresh of standard external I/O due to configuration process of EtherCAT master for slave units. If this delay gives impact your system operation, use xConfigFinished bit. This bit is set when configuration of EtherCAT master is finished. Sample program in ST language is shown as follows.

Sample program

Be sure to use the same instance name as EtherCAT master. Default instance of EtherCAT master is [EtherCAT_Master].

```
IF EtherCAT_Master.xConfigFinished=FALSE THEN
    RETURN;
END_IF;
```

Below program is not executed while EtherCAT_Master.xConfigFinished is FALSE (OFF).

3.1.4 Wiring

(1) Cable

Use category 5 or higher category of STP (Twisted pair with shield) cable.

(2) Hub (switch)

Standard hub (switch) is not allowed to use in EtherCAT network. Special switch for EtherCAT is required if branch topology is required. (Ex. Model CU1128 by Beckhoff)

Caution

Please note that using various Ethernet based communication (EtherCAT master, Modbus-TCP, NVL, Gateway) at the same time will limit the communication performance.

3.2 Modbus-TCP / RTU

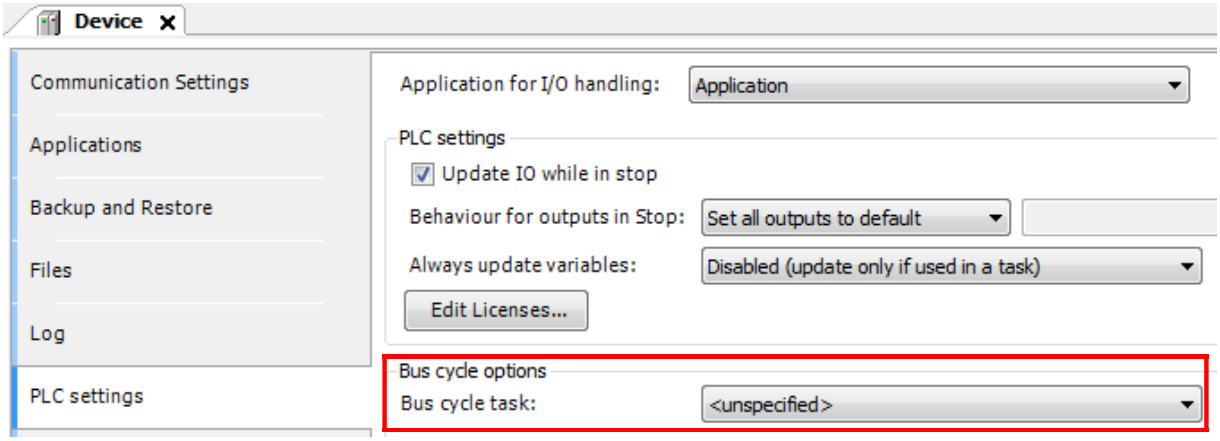
3.2.1 Overview

HX-CPU supports following function codes.

Hexa-decimal	Decimal	Function code	Modbus-TCP		Modbus-RTU	
			Master (Client)	Slave (Server)	Master	Slave
0x01	01	Read Coils	X	X	X	-
0x02	02	Read Discrete Inputs	X	X	X	-
0x03	03	Read Holding Registers	X	X	X	X
0x04	04	Read Input Registers	X	X	X	X
0x05	05	Write Single Coil	X	X	X	-
0x06	06	Write Single Register	X	X	X	X
0x0F	15	Write Multiple Coils	X	X	X	-
0x10	16	Write Multiple Registers	X	X	X	X
0x17	23	Read/Write Multiple Registers	X	X	X	X

X: Supported, -: Not supported

Modbus communication processing is executed by [Bus Cycle Task] specified in [PLC settings] tab of Device. Any task can be assigned for [Bus Cycle Task]. If <unspecified> is chosen, the shortest cycle task is assigned automatically.

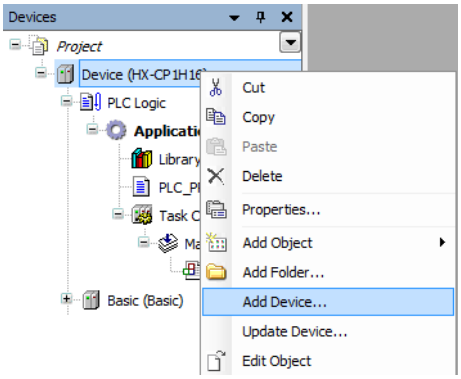


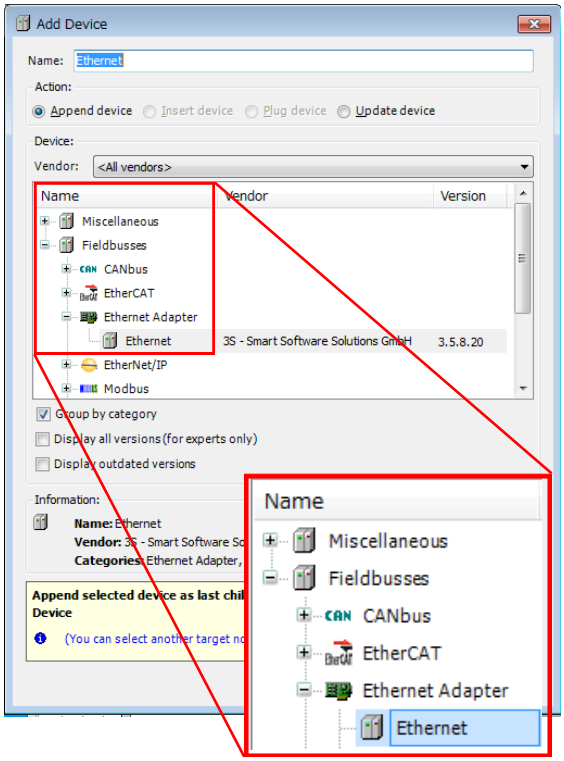
Caution

Modbus-TCP master and Modbus-RTU master do not support broadcast query.

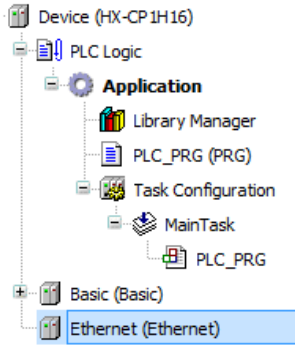
3.2.2 Modbus-TCP Master (Client)

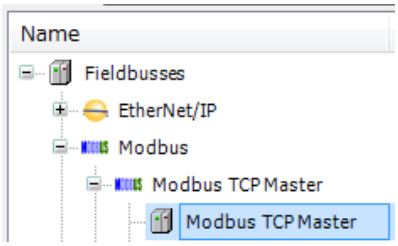
Right-click on [Device] and choose [Add Device…].
[Add Device] window appears.
Click [Ethernet] and [Add Device].



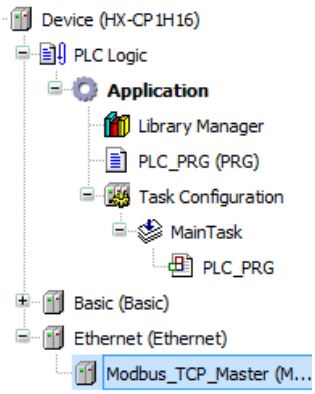


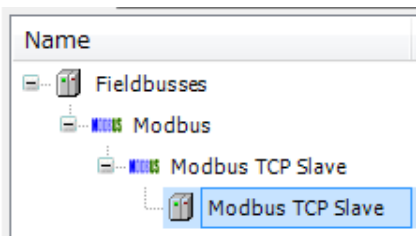
With [Add Device] window opened, click [Ethernet] in the device tree. Then available devices will be shown in the [Add Device] window. Click [Modbus TCP Master] and [Add Device].

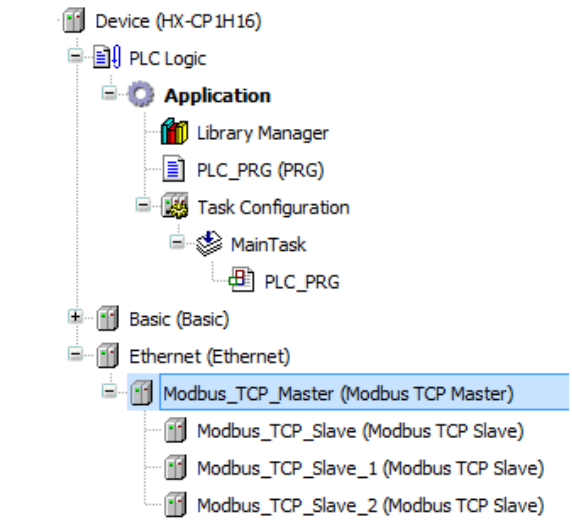




With [Add Device] window opened, click [Modbus_TCP_Master] in the device tree. Then [Modbus TCP Slave] is shown in the [Add Device] window. Click [Modbus TCP Slave] and [Add Device] button according to your Modbus system configuration. If three slave units are used, add three times of slave devices.

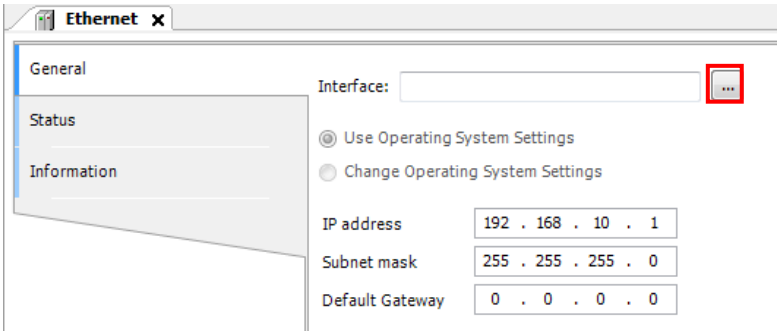


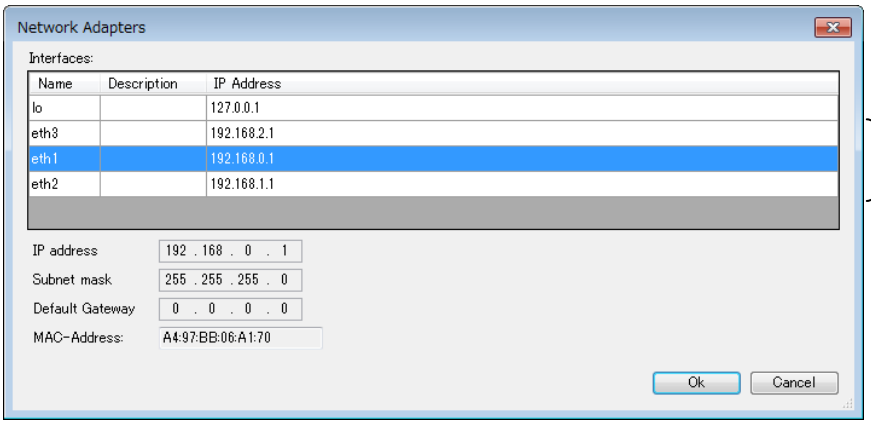




Be sure to configure all slaves to be controlled.

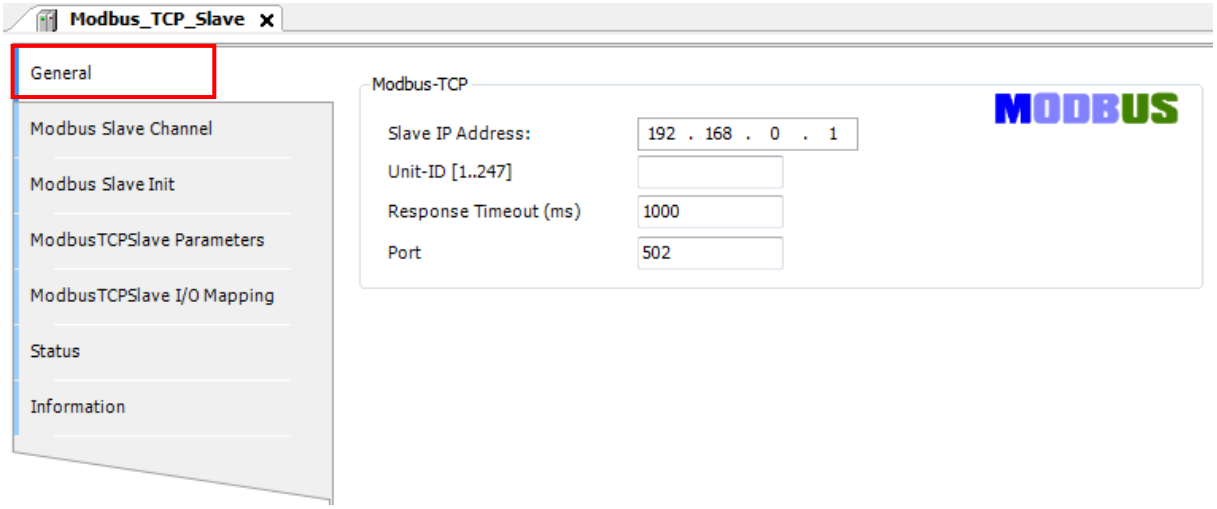
Choose Ethernet port for Modbus-TCP. After communication between PC and HX-CPU configured, click […] button and choose Ethernet port for Modbus-TCP.



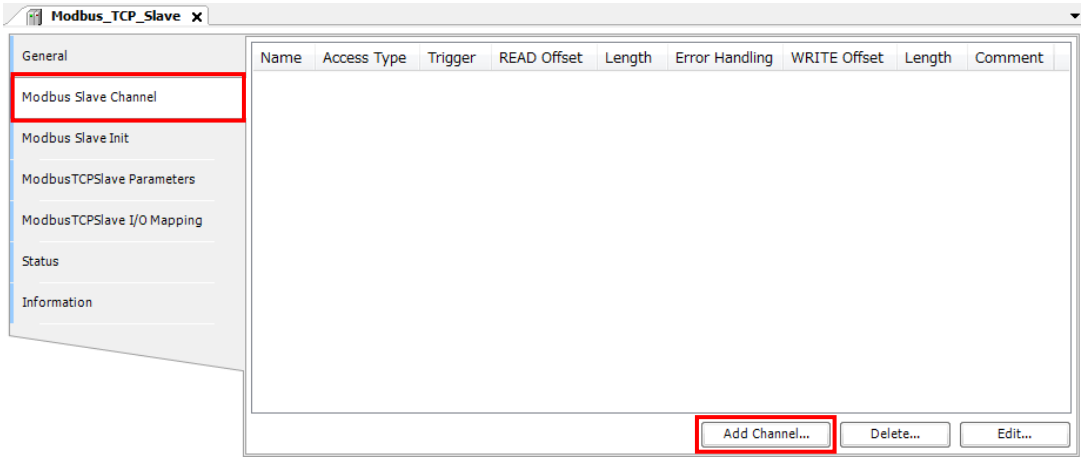


Choose Ethernet port to be used.

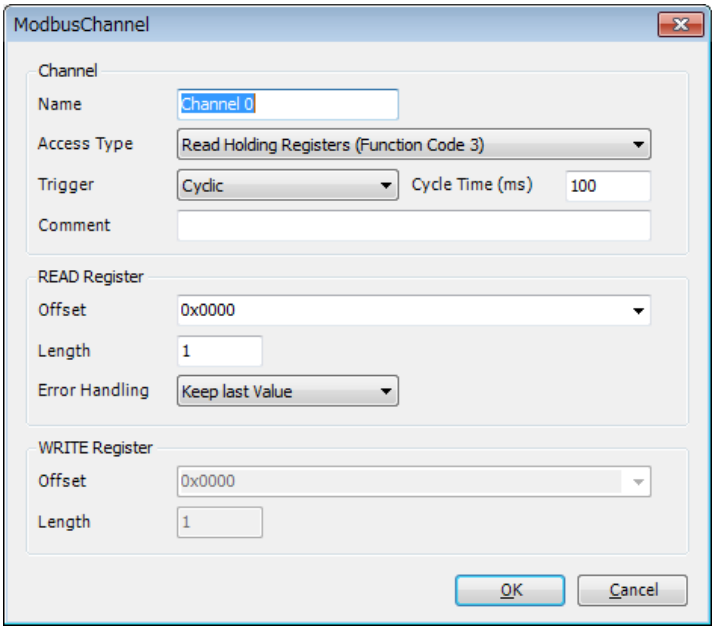
Function codes to be sent must be configured in each slave. Double-click a slave unit to open configuration window. Set IP address, response timeout and port number as follows. Unit-ID is required only when Modbus gateway (Ethernet to serial) device is used.

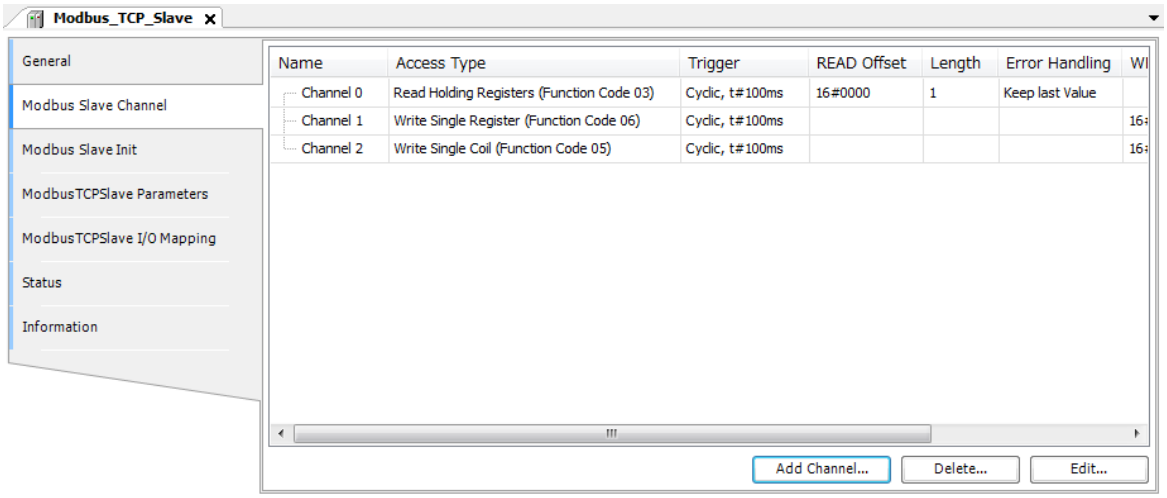


Open [Modbus Slave Channel] tab and click [Add Channel…] to add function codes.

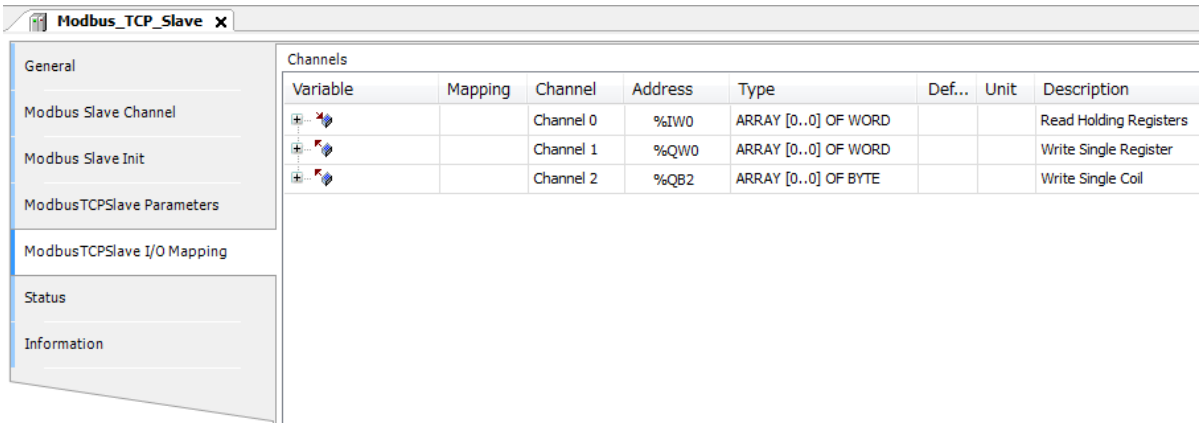


Configure each parameter as below. If the [Trigger] setting is [Rising edge], trigger variable (BOOL) will be automatically assigned in %QX address.





Read and written data from/to slaves is assigned to %IW or %QW as seen in [ModbusTCPSlave I/O Mapping] tab. Read data from slave is assigned to input area (%IW) and data to be written to slave is assigned to output area (%QW).

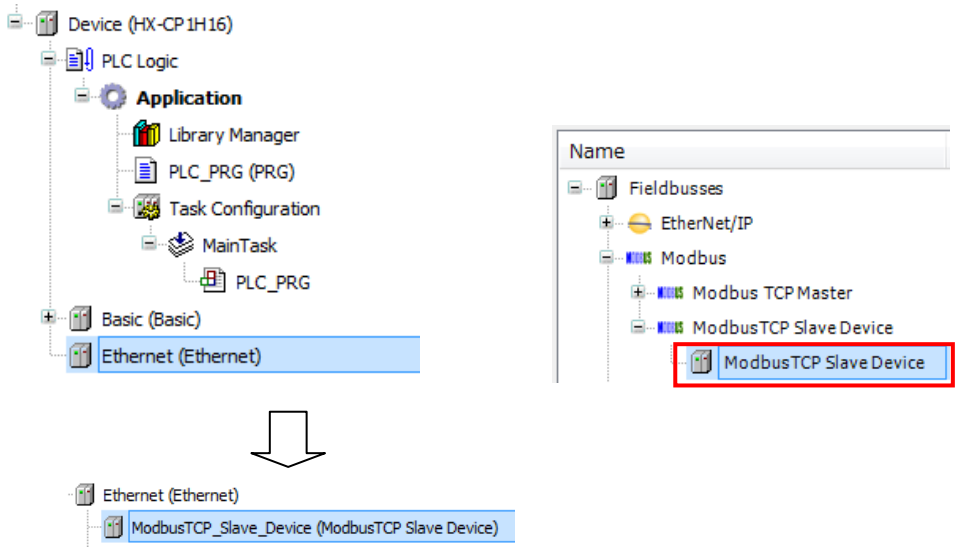


Caution

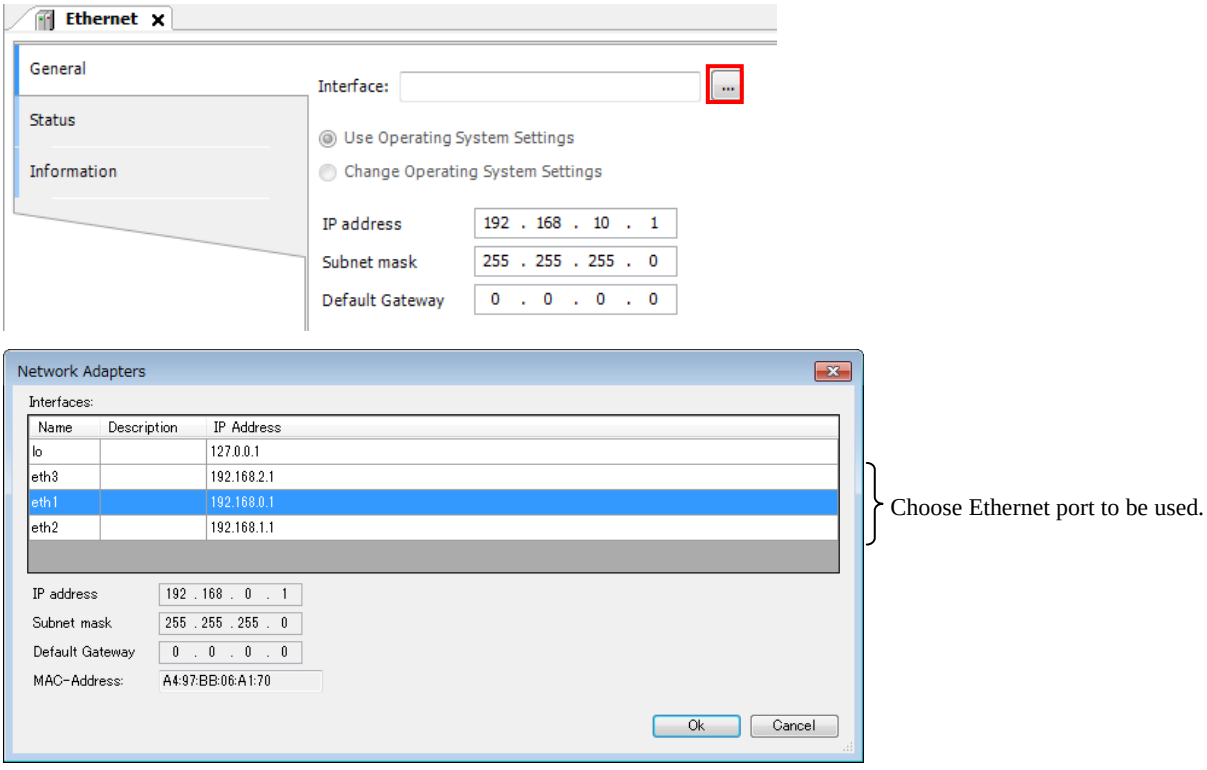
- Modbus master works in the bus cycle task configured in Modbus_TCP_Master. If several channels are configured, single bus cycle can handle only either sending or receiving of one channel.
- If trigger is set as [Rising edge] and this bit is set and reset frequently, command sending and receiving may not work properly. When T1 is defined as time from starting of request command to end of response for channel 1, and T2 is defined as time from starting of request command to end of response for channel 2, do not set or reset trigger variable during T1+T2+...+Tn.

3.2.3 Modbus-TCP Slave (Server)

Right-click on [Ethernet] and choose [Add Device…]. Click [Modbus TCP Slave Device] in the [Add Device] window and [Add Device] button.



Choose Ethernet port for Modbus-TCP. After communication between PC and HX-CPU configured, click […] button and choose Ethernet port for Modbus-TCP.

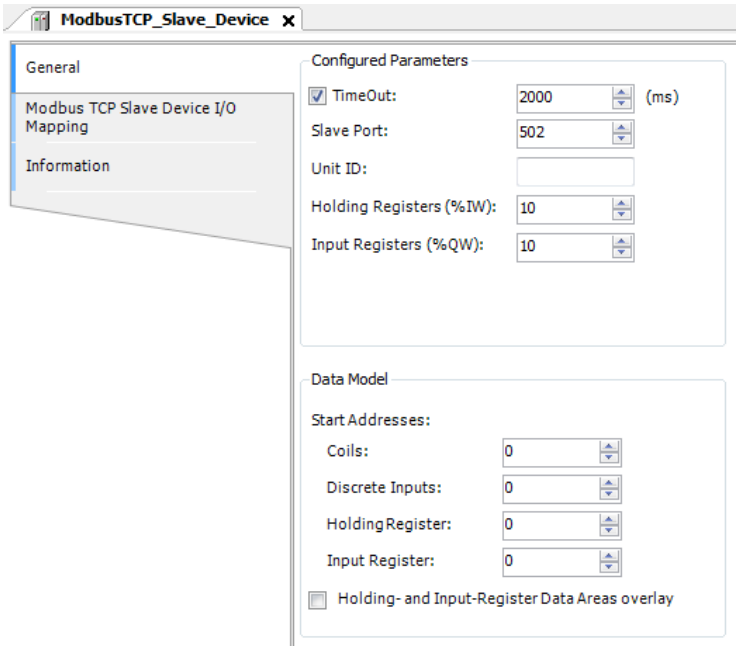


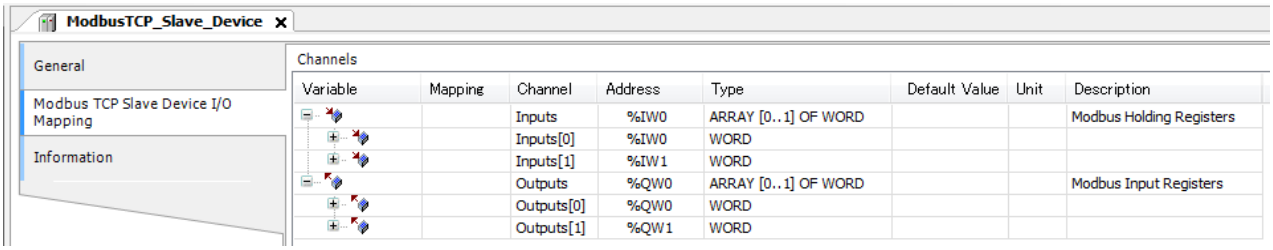
Caution

- Also other Ethernet ports than chosen one work as Modbus-TCP slave however, it is recommended to use configured Ethernet port only.
- Modbus-TCP slave can be added to eth1 to eth3 each, but there is only one Modbus map in the CPU. In this sense, do not configure 2 or more Modbus-TCP slaves. If the same port number is used in several Modbus-TCP slaves, Modbus-TCP slave gets error.
- If warm reset is performed while TCP connection is opened, it takes approximately 1 minute to open the connection again.

Double-click [Modbus TCP Slave Device] and set parameters. Port number for Modbus-TCP is fixed as 502. Do not set other number but 502.

Mapping table will be created in [Modbus TCP Slave Device I/O Mapping] tab according to configured size for Holding Registers (%IW) and Input Registers (%QW).

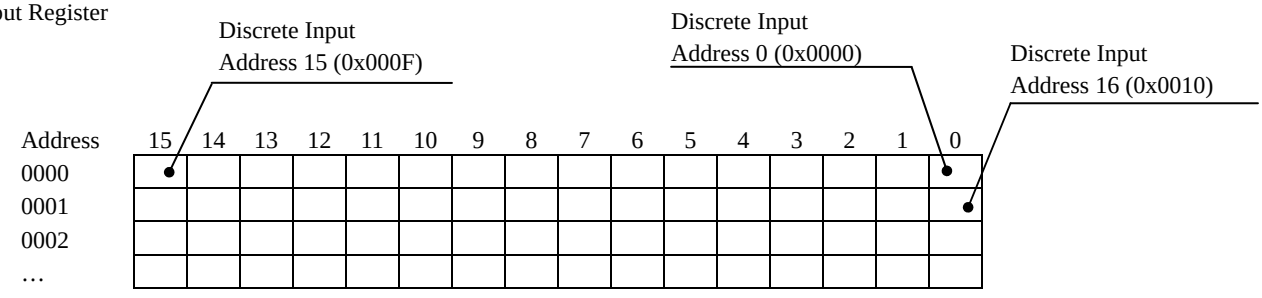




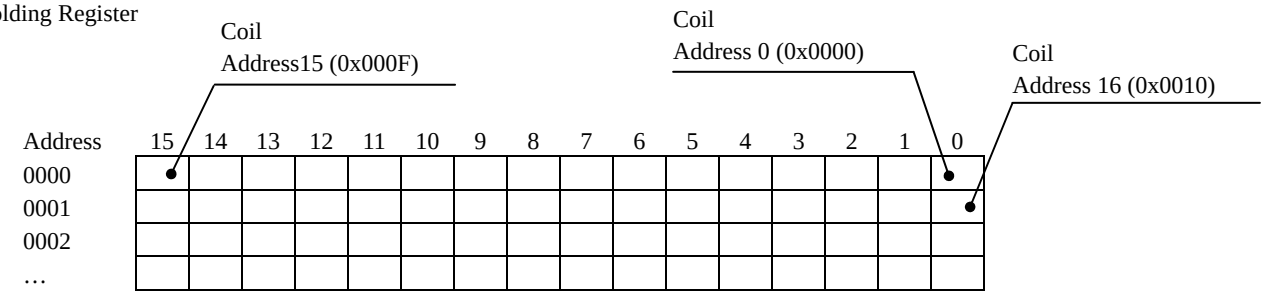
WORD registers and BOOL registers are physically in the same memory as below.

- Input register (WORD) and discrete input (BOOL)
- Holding register (WORD) and Coil (BOOL)

Input Register

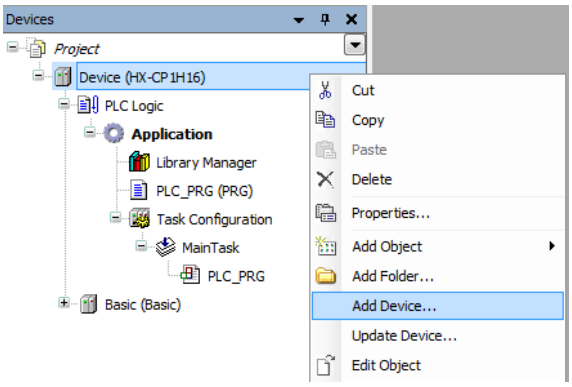


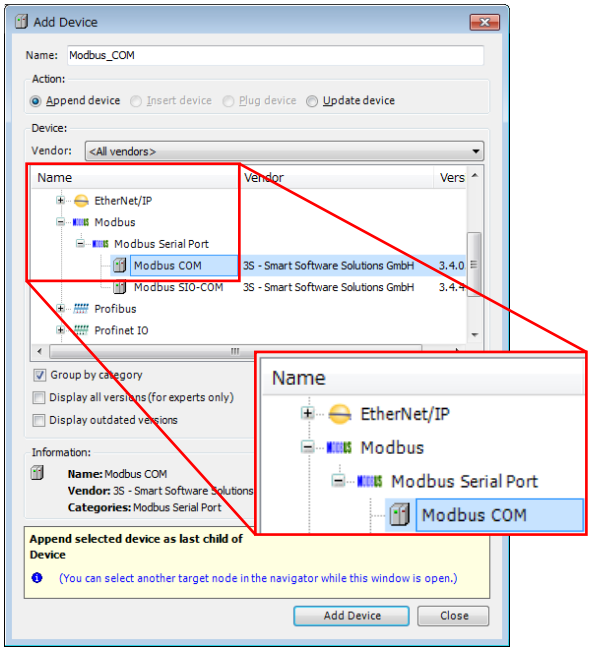
Holding Register



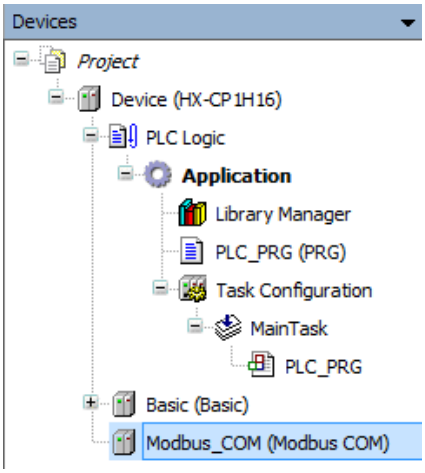
3.2.4 Modbus-RTU Master

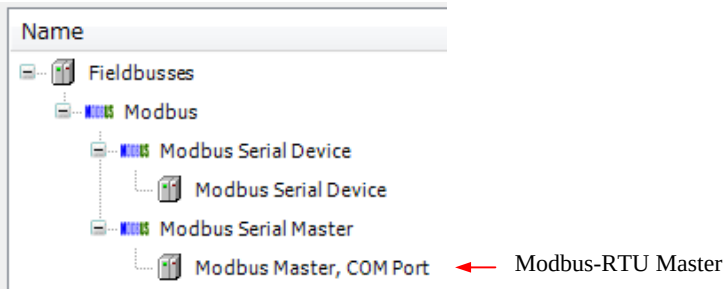
Right-click on [Device] and choose [Add Device…].
[Add Device] window appears.
Click [Modbus COM] and [Add Device] button.



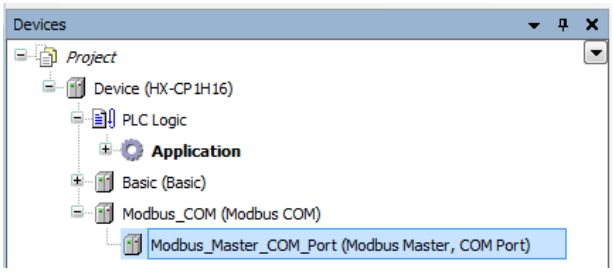


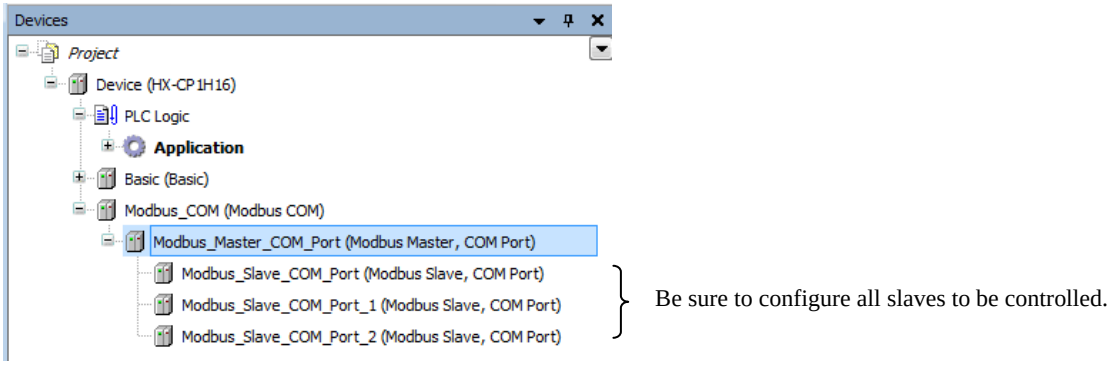
With [Add Device] window opened, click [Modbus_COM] in the device tree. Then available devices will be shown in the [Add Device] window. Click [Modbus Master, COM Port] and [Add Device] button.





With [Add Device] window opened, click [Modbus_Master_COM_Port] in the device tree. Then [Modbus Slave, COM Port] is shown in the [Add Device] window. Click [Modbus Slave, COM Port] and [Add Device] button according to your Modbus system configuration. If three slave units are used, add three times of [Modbus Slave, COM port].

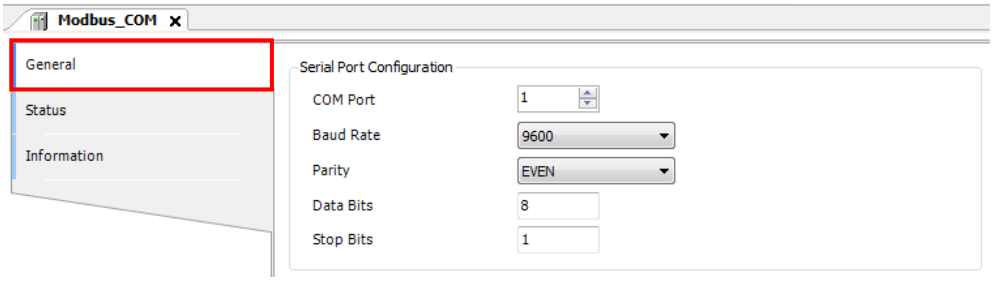




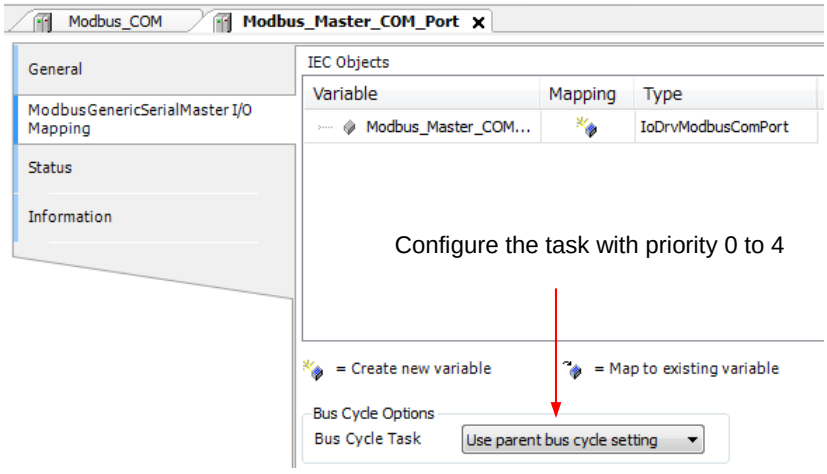
Caution

Be sure to use devices according to Modbus standard. If CPU receives illegal data format, CPU may fail operation.

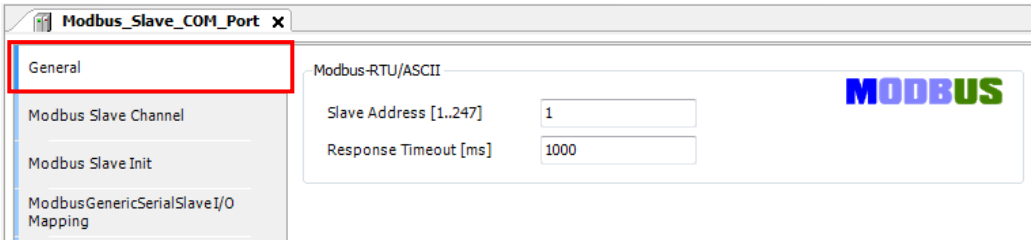
Configure the serial port. Double-click [Modbus_COM (Modbus COM)] to open Modbus_COM window. This configuration must be same as slaves' configuration. COM Port number of HX-CPU is [1]. Available baud rate is from 9600 up to 115200.



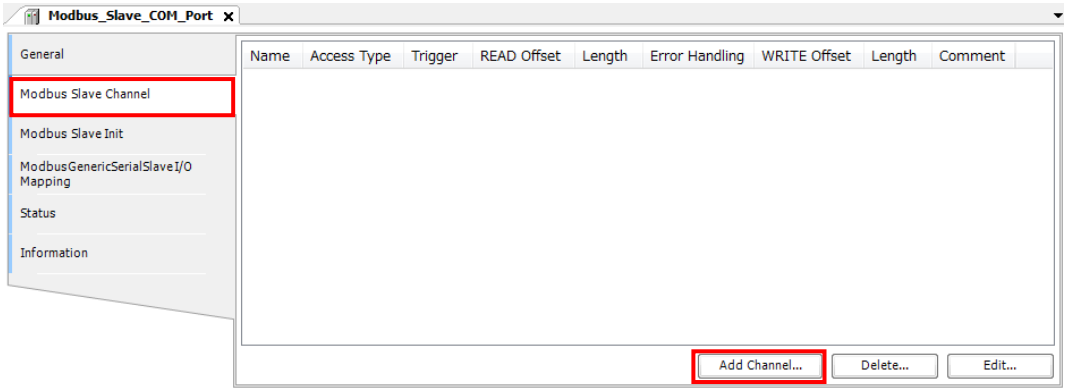
Set the Bus Cycle Task in [Modbus Generic Serial Master I/O Mapping] tab. The priority of assigned task must be from 0 to 4. If 5 or higher priority is set, Modbus may not work properly.



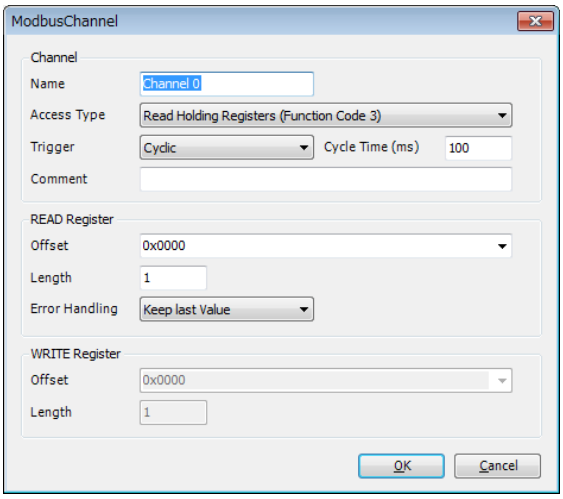
Function codes to be sent must be configured in each slave. Double-click a slave unit to open configuration window. Set slave address and response timeout as follows. Response timeout can be set also in slave individually. If it is set in master and slave both, the value in slave is applied. If response timeout in slave is deleted, then the value in master is applied.

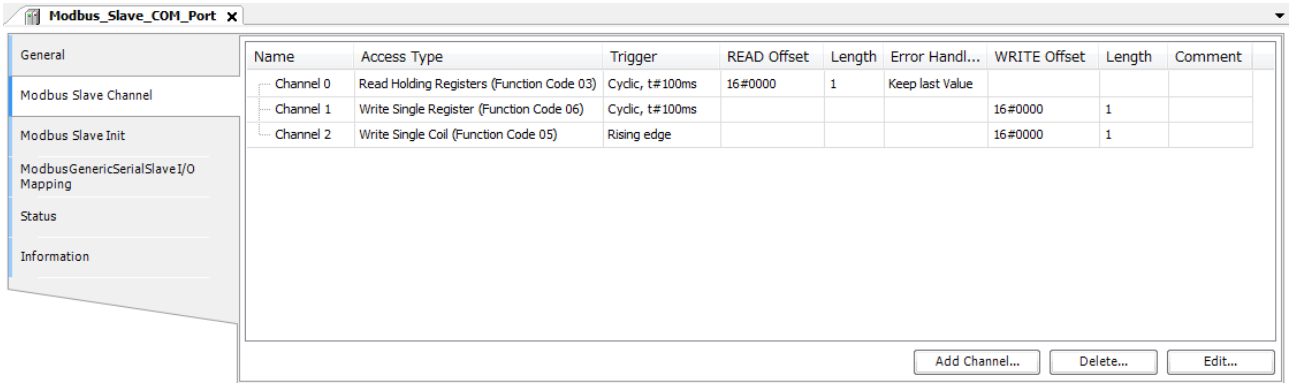


Open [Modbus Slave Channel] tab and click [Add Channel…] to add function codes.

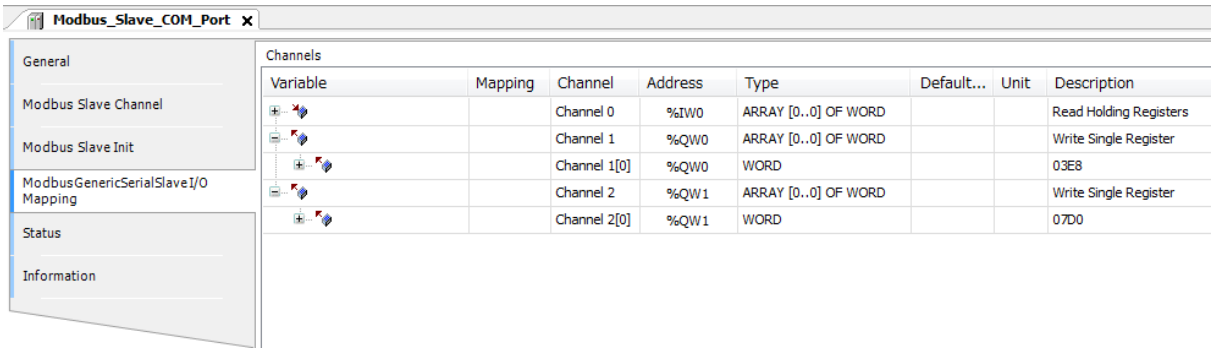


Configure each parameter as below. If the [Trigger] setting is [Rising edge], trigger variable (BOOL) will be automatically assigned in %QX address.





Read and written data from/to slaves is assigned to %IW or %QW as seen in [ModbusTCPSlave I/O Mapping] tab. Read data from slave is assigned to input area (%IW) and data to be written to slave is assigned to output area (%QW). [Default Value] is written once when the status changes from RUN to STOP.

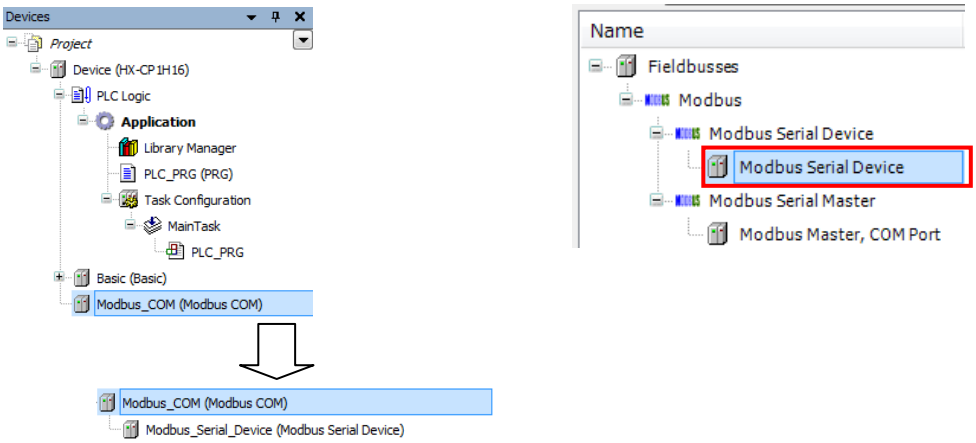


Caution

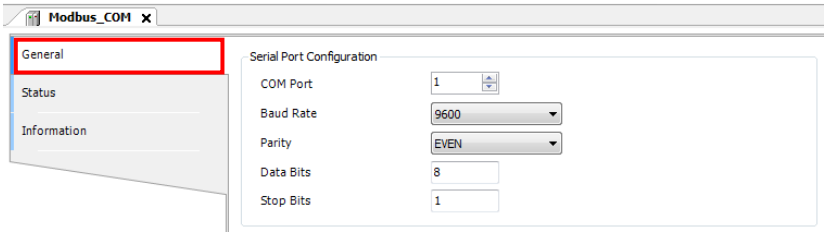
- Modbus master works in the bus cycle task configured in Modbus_Master_COM_Port. If several channels are configured, single bus cycle can handle only either sending or receiving of one channel.
- If trigger is set as [Rising edge] and this bit is set and reset frequently, command sending and receiving may not work properly. When T1 is defined as time from starting of request command to end of response for channel 1, and T2 is defined as time from starting of request command to end of response for channel 2, do not set or reset trigger variable during T1+T2+...+Tn.

3.2.5 Modbus-RTU Slave

Right-click on [Modbus COM] and choose [Add Device…]. Click [Modbus Serial Device] in the [Add Device] window and [Add Device] button.

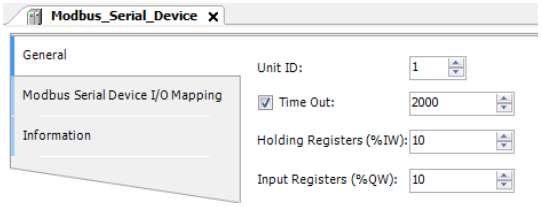


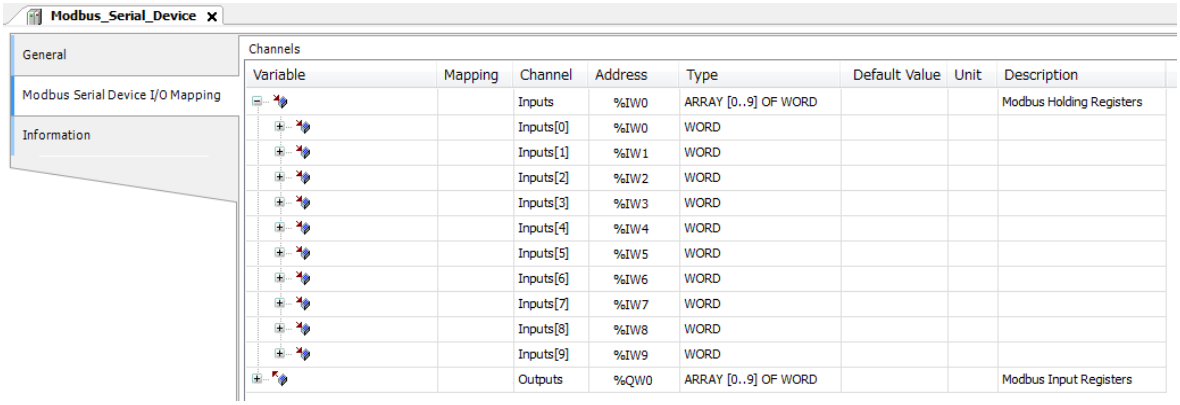
Configure the serial port. Double-click [Modbus_COM (Modbus COM)] to open Modbus_COM window. This configuration must be same as master and other slaves' configuration. COM Port number of HX-CPU is [1].



Double-click on [Modbus Serial Device] and set parameters.

Mapping table will be created in [Modbus Serial Device I/O Mapping] tab according to configured size for Holding Registers (%IW) and Input Registers (%QW).





Caution

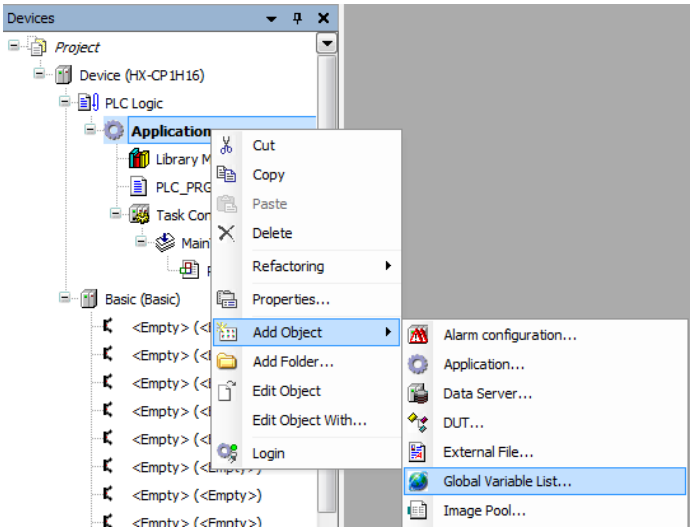
Query from master must be according to Modbus standard. If unsupported function codes, illegal address, data or the number of data are sent, HX-CPU may not send back exception responce properly.

3.3 CPU Link

3.3.1 Overview

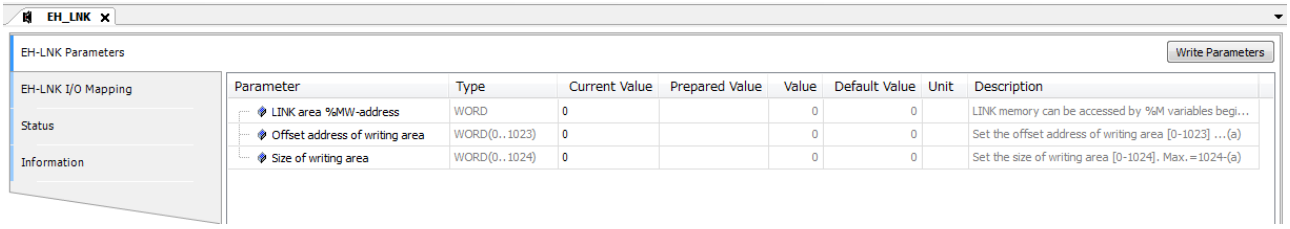
CPU Link System is the network of CPU Link modules connected in loop topology. Common memory called link area is read or written by each CPU in the network. Link area in each CPU is defined as Global Variable List (GVL) with %M address and shared by all the CPUs.

GVL is added by right-clicking on [Application] shown below.



3.3.2 Configuration Link Parameter

Add [EH-LNK] device to the device tree in advance. Double-click [EH-LNK] and set [Offset address of writing area] (Writing area %MW offset address) and [Size of writing area].



Caution

Allowed range of values are shown below. HX-CODESYS does not detect error if the value is out of the range.

- Offset address of writing area : 0 to 1023
- Size of writing area : 0 to 1024

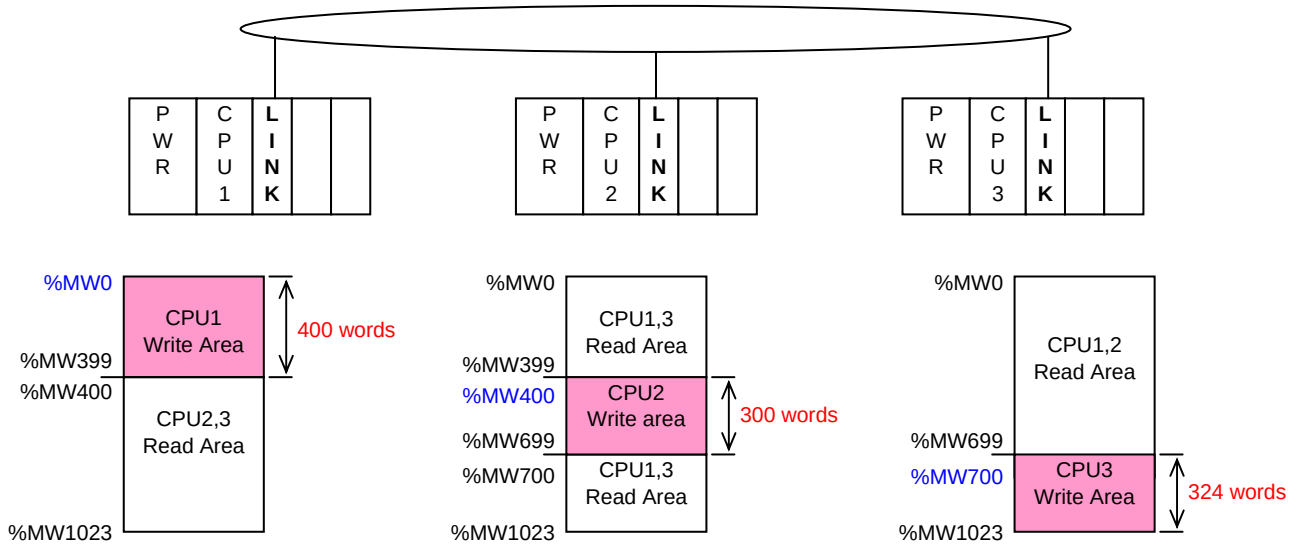
(Since the consistency between above two parameters cannot be checked by HX-CODESYS, invalid values, for example [offset address of writing area] is 1023 and [Size of writing area] is 1024, can be set. In that case, CPU detects an error and outputs error message in the CPU log.)

If PLC settings are set as follows, received link data might not be correct because I/O refresh timing and link refresh timing are not synchronized when CPU is in stop mode.

- Update IO while in stop : Disable
- Behaviour for outputs in Stop : Execute program

Configuration example

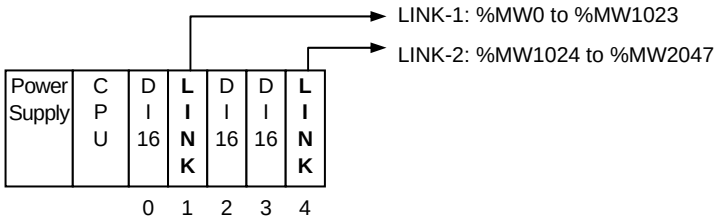
Below figure is an example of 3 CPUs. Each CPU has own writing area in the LINK area, which must not be overlapped. Writing area for a CPU is reading area for the other CPUs.



	CPU1	CPU2	CPU3
Writing area %MW-address (Write area %MW address)	0	400	700
Writing area size (Write area size)	400	300	324

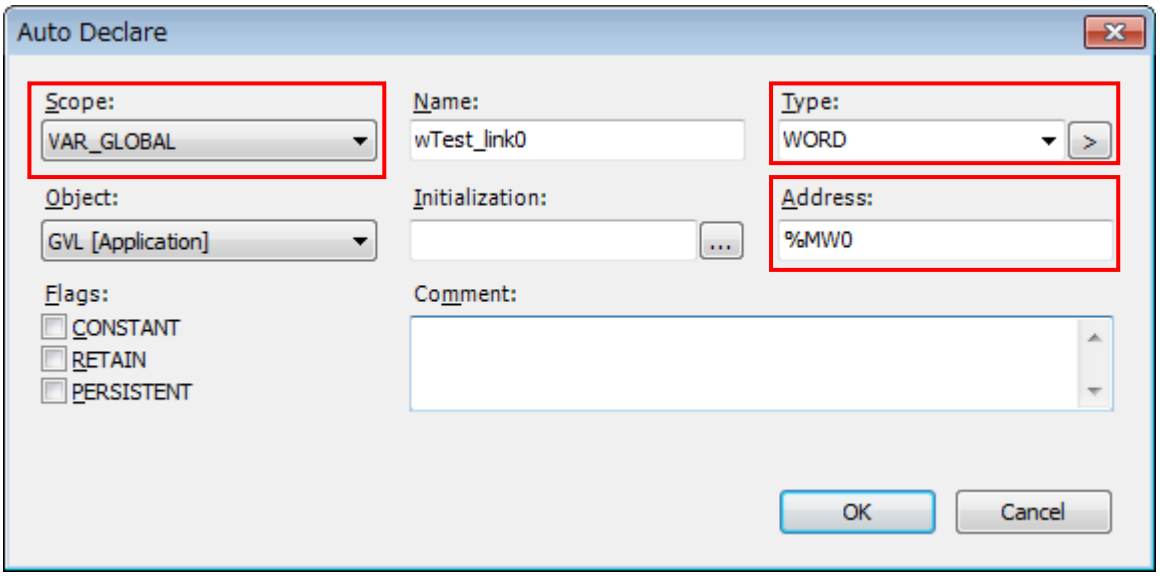
In one CPU Link module is used per CPU, the address of LINK area is from %MW0 to %MW1023. Addresses when several LINK modules used are shown below table. The address is NOT depending on mounted slot number but the number of LINK modules.

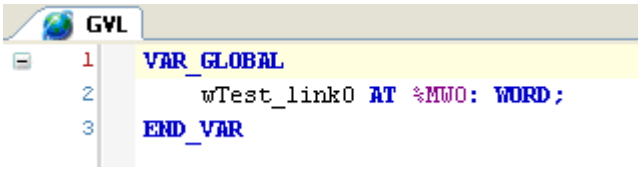
	LINK-1	LINK-2	LINK-3	LINK-4	LINK-5	LINK-6	LINK-7	LINK-8
From	%MW0	%MW1024	%MW2048	%MW3072	%MW4096	%MW5120	%MW6144	%MW7168
To	%MW1023	%MW2047	%MW3071	%MW4095	%MW5119	%MW6143	%MW7167	%MW8191



3.3.3 Declaration of Link Variable

If new variable is declared, [Auto Declare] dialog appears. For variables for LINK, put %MW address at address field and choose [VAR_GLOBAL] in scope field. Then this declaration will be added in GVL.





In POU, prefix "`GVL.`" is necessary for example "`GVL.wTest_link0`".

Note

If CPU Link module is not used, variables with %M addresses can be used as general registers.

Byte order

If EH/EHV-series, EHV+ series and HX series are used in one Link network, byte data is swapped because byte order and addressing rule are different in each series of CPU.

If 4-word data is stored in the link area as below mapping, BYTE, DWORD and LWORD data are seen as follows.

Link area mapping

Word address	Data
0	0x1234
1	0x5678
2	0xAABB
3	0xCCDD
4	…
5	…
…	…
1022	…
1023	…

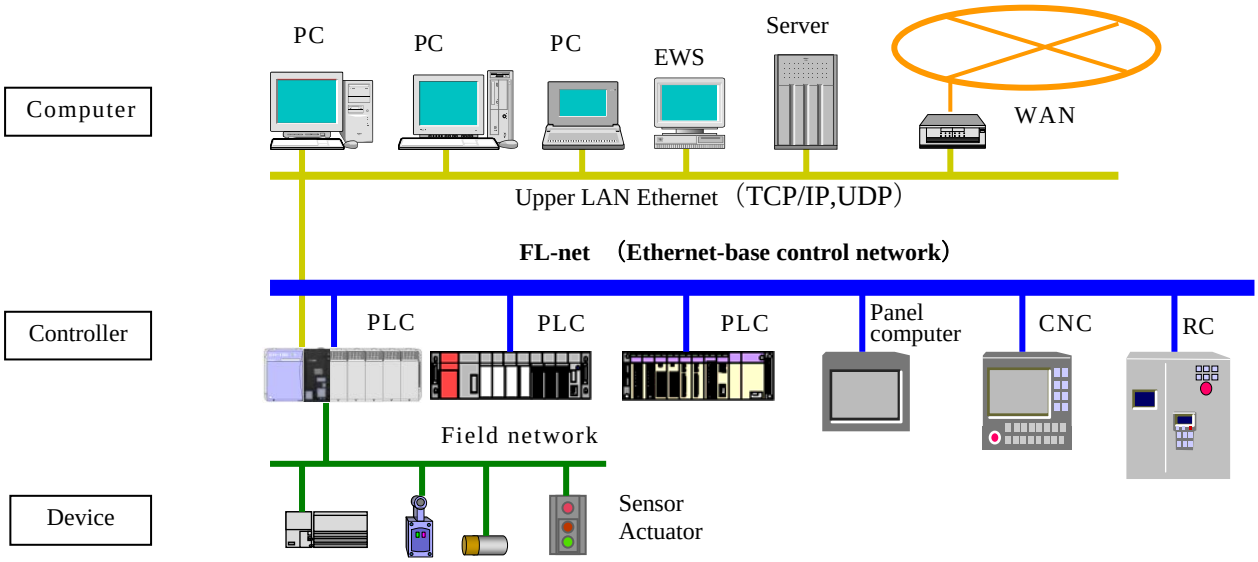
Data format

		EH/EHV			EHV+			HX		
		Address	Data		Address	Data		Address	Data	
			Binary	Dec.		Binary	Dec.		Binary	Dec.
X	bit 0 of word 0	L0	0	4	%MX1.0	0	4	%MX0.0	0	4
	bit 1 of word 0	L1	0		%MX1.1	0		%MX0.1	0	
	bit 2 of word 0	L2	1		%MX1.2	1		%MX0.2	1	
	bit 3 of word 0	L3	0		%MX1.3	0		%MX0.3	0	
	bit 4 of word 0	L4	1	3	%MX1.4	1	3	%MX0.4	1	3
	bit 5 of word 0	L5	1		%MX1.5	1		%MX0.5	1	
	bit 6 of word 0	L6	0		%MX1.6	0		%MX0.6	0	
	bit 7 of word 0	L7	0		%MX1.7	0		%MX0.7	0	
	bit 8 of word 0	L8	0	2	%MX0.0	0	2	%MX1.0	0	2
	bit 9 of word 0	L9	1		%MX0.1	1		%MX1.1	1	
	bit 10 of word 0	LA	0		%MX0.2	0		%MX1.2	0	
	bit 11 of word 0	LB	0		%MX0.3	0		%MX1.3	0	
	bit 12 of word 0	LC	1	1	%MX0.4	1	1	%MX1.4	1	1
	bit 13 of word 0	LD	0		%MX0.5	0		%MX1.5	0	
	bit 14 of word 0	LE	0		%MX0.6	0		%MX1.6	0	
	bit 15 of word 0	LF	0		%MX0.7	0		%MX1.7	0	
B	Low byte of word 0	-	-		%MB1	0x34		%MB0	0x34	
	High byte of word 0	-	-		%MB0	0x12		%MB1	0x12	
	Low byte of word 1	-	-		%MB3	0x78		%MB2	0x78	
	High byte of word 1	-	-		%MB2	0x56		%MB3	0x56	
W	Word 0	WL0	0x1234		%MW0	0x1234		%MW0	0x1234	
	Word 1	WL1	0x5678		%MW1	0x5678		%MW1	0x5678	
	Word 2	WL2	0xAABB		%MW2	0xAABB		%MW2	0xAABB	
	Word 3	WL3	0xCCDD		%MW3	0xCCDD		%MW3	0xCCDD	
D	1st DWORD	DL0	0x56781234		%MD0	0x12345678		%MD0	0x56781234	
	2nd DWORD	DL1	0xCCDDAABB		%MD1	0xAABBCCDD		%MD1	0xCCDDAABB	
L	1st LWORD	—	—		%ML0	0x12345678AABBCCDD		%ML0	0xCCDDAABB56781234	

3.4 FL-net Interface

3.4.1 Overview

FL-net is open FA network based on Ethernet using shared memory accessed by multi-vendors' CPUs. A virtual shared memory called common memory is accessed by each CPU in cyclic.



Common memory 1 and Common memory 2 are defined in FL-net. HX-CPU uses %M address for the common memory same as CPU Link. The address of the Common memory 1 is same as CPU Link module.

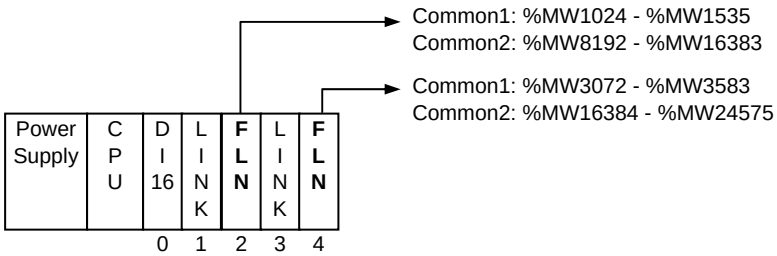
LINK No.	LINK-1	LINK-2	LINK-3	LINK-4	LINK-5	LINK-6	LINK-7	LINK-8
Start of common 1	%MW0	%MW1024	%MW2048	%MW3072	%MW4096	%MW5120	%MW6144	%MW7168
End of common 1	%MW511	%MW1535	%MW2559	%MW3583	%MW4607	%MW5631	%MW6655	%MW7679
Un-used addresses	%MW512 to %MW1023	%MW1536 to %MW2047	%MW2560 to %MW3071	%MW3584 to %MW4095	%MW4608 to %MW5119	%MW5632 to %MW6143	%MW6656 to %MW7167	%MW7680 to %MW8191

Since the size of common memory 1 is 512 words, only the 1st half of Link area is used for FL-net. The 2nd half cannot be used if FL-net module is used.

The address of the Common memory 2 is shown as below.

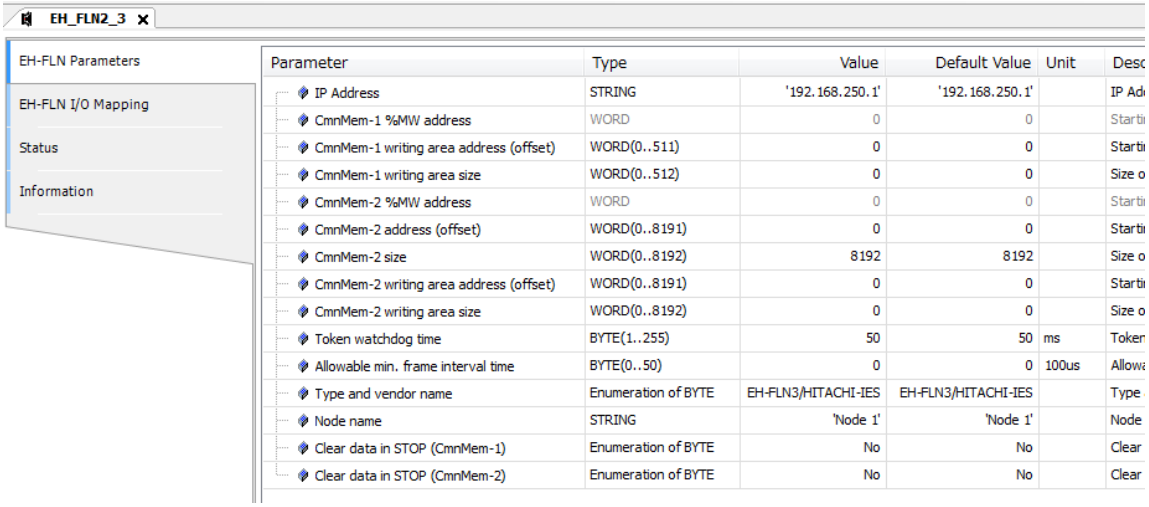
FL-net No.	FL-net 1	FL-net 2
Start of common 2	%MW8192	%MW16384
End of common 2	%MW16383	%MW24575

The size of common memory 2 is 8192 words.



3.4.2 FL-net Parameter Configuration

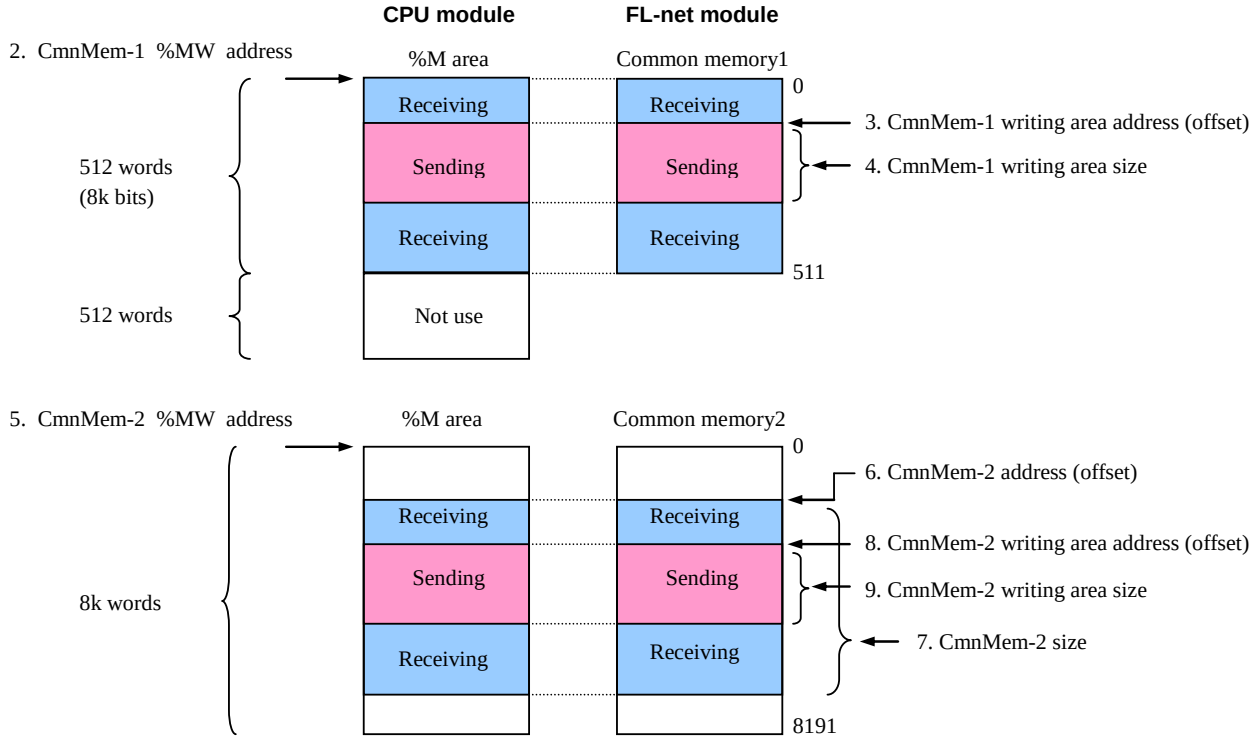
Add FL-net module to device tree in advance. The device name is EH-FLN2/3. Double click [EH-FLN2/3] and set parameters as follows.



No.	Name	Description	Default
1	IP address	IP address of EH-FLN2/3	192.168.250.1
2	CmnMem-1 %MW address	Starting address of common memory 1 is displayed in online mode.	0
3	CmnMem-1 writing area address (offset)	Set starting address (offset) of sending area of common memory 1.	0
4	CmnMem-1 writing area size	Set size of sending area of common memory1.	0
5	CmnMem-2 %MW address	Starting address of common memory 2 is displayed in online mode.	0
6	CmnMem-2 address (offset)	Set starting address (offset) of common memory 2.	0
7	CmnMem-2 size	Set size of common memory 2.	8192
8	CmnMem-2 writing area address (offset)	Set starting address (offset) of sending area of common memory 2.	0
9	CmnMem-2 writing area size	Set size of sending area of common memory 2.	0
10	Token watchdog time	Set monitoring time between token receiving and sending it out the next node.	50
11	Allowable min. frame interval time	Set waiting time between token receiving and sending out data frame to the next node.	0
12	Type and vendor name	Choose vendor name and model name. Functionality is same in both choices.	EH-FLN3/ HITACHIIES
13	Node Name	Set node name within 10 characters.	Node1
14	Clear data in STOP (CmnMem-1)	Set Yes if common memory 1 is to be cleared when CPU stops.	No
15	Clear data in STOP (CmnMem-2)	Set Yes if common memory 2 is to be cleared when CPU stops.	No

Configuration example

Configuration example is shown in below figure.



3.4.3 Cyclic Transfer

If right configuration parameters are downloaded to FL-net module together with application program, FL-net module will automatically take part in the network and start cyclic transmission. Refer to Section 3.4.5 for status of completing initialize.

Caution

If PLC settings in HX-CODESYS are configured as below and receiving area is written by the executed program in stop, the data may be overwritten by FL-net refresh cycle depending on the timing of CPU stop and FL-net refresh cycle.

- Update IO while in stop : Disable
- Behaviour for outputs in Stop : Execute program

3.4.4 Message Transmission

HX-CPU does not support sending of user message transmission for FL-net module.

Responding is limited in a part of commands from another node. If unsupported command is received, timeout is detected by the command sender.

No.	Message	Command	Response
1	Byte block read	NA	NA
2	Byte block write	NA	NA
3	Word block read	NA	NA
4	Word block write	NA	NA
5	Network parameter read	NA	X *1
6	Network parameter write	NA	NA
7	RUN / STOP direction	NA	NA
8	Profile read	NA	NA
9	Communication log data read	NA	X *1
10	Communication log data clear	NA	X *1
11	Return received message	NA	X *1
12	Pass through type message	NA	NA

*1 Response message is handled by FL-net module.

3.4.5 Status Monitor Library

The status information of EH-FLN2/3 can be read by special function block GetFLInfo.

Set FL-net number and xEnable to TRUE, then status is read out in the STRUCT FLInfo when xDone is TRUE.

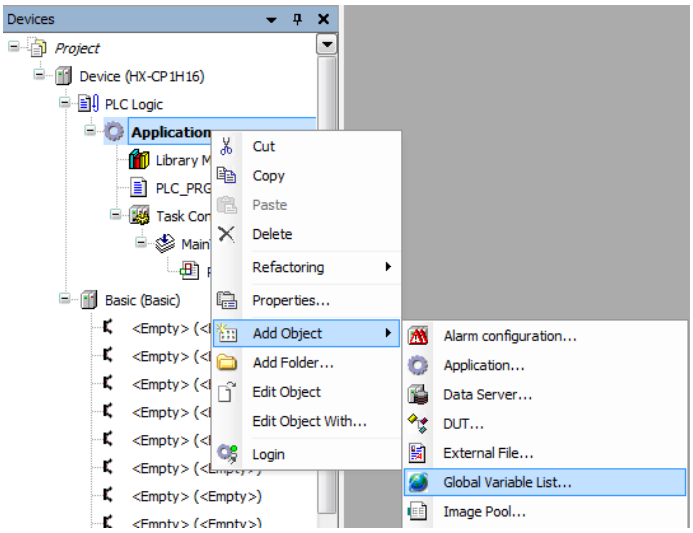
Detail of FLInfo structure

Member name	Description		Type	Remark
xInitDone	Node initialization	0: Not yet 1: Done	BOOL	-
xParamError	Parameter error	0: No error 1: Error	BOOL	-
xAdrDuplicated1	Address duplication area1	0: No error 1: Error	BOOL	-
xAdrDuplicated2	Address duplication area2	0: No error 1: Error	BOOL	-
xWaitforRcv	Wait for receiving status	0: Normal 1: Error (Wait for receiving)	BOOL	-
xTokenWatchdogTime	Timeout of token	0: No error 1: Error	BOOL	-
xNodeDuplicated	Node number duplication	0: No error 1: Error	BOOL	-
xTokenTimeoutOwnNode	Timeout of own node token	0: No error 1: Error	BOOL	-
xTBN_CBN_BSIZE	TBN, CBN or BSIZE error	0: No error 1: Error	BOOL	-
xCableDisconnect	Disconnect Cable	0: No error 1: Error	BOOL	-
xTokenModeUnmatch	Un-match token mode	0: No error 1: Error	BOOL	-
axLinkFlag	Link Node	0: Not join 1: Join	ARRAY[1..254] OF BOOL	-
axRunStatus	Status flag upper layer (Run Status)	0: STOP 1: RUN	ARRAY[1..254] OF BOOL	-
abErrStatus	Status flag upper layer (Error Status)	0: NORMAL 1: WARNING 2: ALARM	ARRAY[1..254] OF BYTE	-
sMACID	MAC address		STRING (12)	Valid FLN3 only
wRefCycleAllowed	Allowed refresh cycle time [ms]		WORD	-
wRefCycleCurrent	Current refresh cycle time (current value) [ms]		WORD	-
wRefCycleMax	Maximum refresh cycle time (maximum value) [ms]		WORD	-
wRefCycleMin	Minimum refresh cycle time (minimum value) [ms]		WORD	-
wMinFrameIntvl	Minimum frame interval [x 100us]		WORD	-
xEthernetStatus	Ethernet status flag	0: No link 1: Link-up	BOOL	Valid FLN3 only
xLinkSpeed	Link speed flag	0: 10Mbps 1: 100Mbps	BOOL	Valid FLN3 only
xDuplexMode	Duplex mode flag	0: Half duplex 1: Full duplex	BOOL	Valid FLN3 only
xSDRAMError	SDRAM error	0: No error 1: Error	BOOL	-
xEEPROMError	EEPROM error	0: No error 1: Error	BOOL	-
xSystemError	System error	0: No error 1: Error	BOOL	-
xFlashError	FLASH error	0: No error 1: Error	BOOL	-
xMPUError	MPU error	0: No error 1: Error	BOOL	-
xSystemRAMError	System RAM error	0: No error 1: Error	BOOL	-
xNodeNumberError	Node number error	0: No error 1: Error	BOOL	-
xLinkAddressError	Link address error	0: No error 1: Error	BOOL	-

3.5 Profibus Master

3.5.1 Overview

Profibus master module EH-RMP/EH-RMP2 is available with HX-CPU. Variables for Profibus master module are declared in Global Variable List (GVL) with %M address. GVL is added by right-clicking on [Application] shown below.



3.5.2 Configuration of Link Parameter

Add [EH-LNK] device to the device tree in advance. Double-click [EH-LNK] and set [Offset address of writing area] (Writing area %MW offset address) and [Size of writing area].

Offset address of writing area

Configure start address of Link area. Set 0 (zero) for EH-RMP/EH-RMP2.

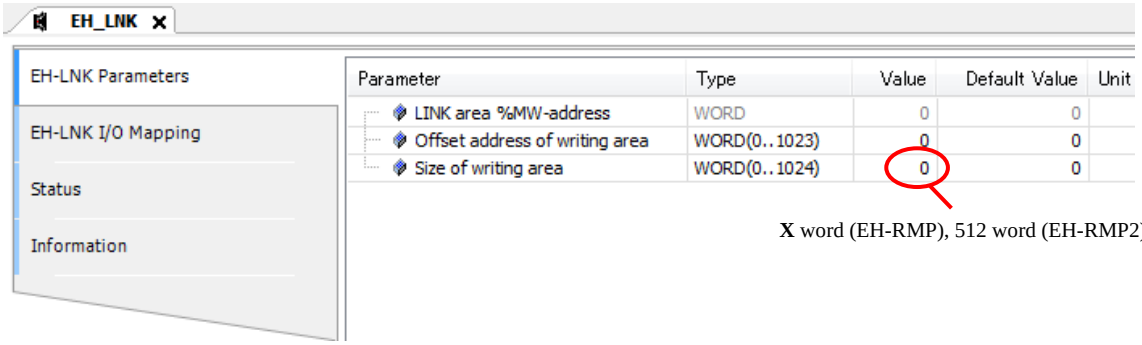
Size of writing area

EH-RMP: Set the actual size configured by Sycon.

EH-RMP2: Set 512 (as fixed value).

Caution

Do not set 0 (zero) for Size of writing area. Even if no output module is used and all slaves are input module only, configure dummy value except 0. If 0 is configured, STATUS LED blinks 4 times in EH-RMP. If other value than 512 is set in EH-RMP2, STATUS LED blinks 4 times.



X word (EH-RMP), 512 word (EH-RMP2)

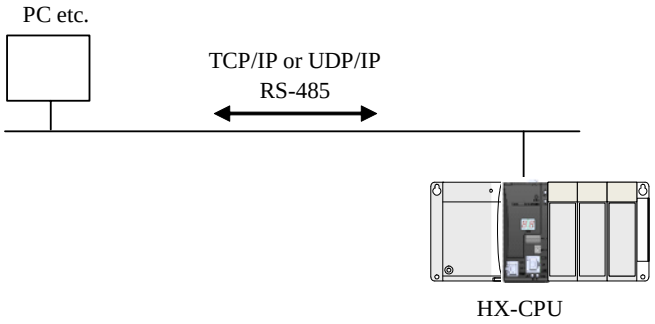
Address of reading area **(**Configuration is not needed.)

Read area is assigned automatically shown in below table.

Word address	Bit address	Hitachi address	Description (EH-RMP)	Description (EH-RMP2)
%MW0	%MX0.0-7,1.0-7	WL0	[**X**] word Write area	Write area （512word）
%MW1	%MX2.0-7,3.0-7	WL1		
%MW2	%MX4.0-7,5.0-7	WL2		
...				
%MW[**X**]		WL[X]		
...			Write area Possible to specify	
%MW255	%MX510.0-7, 511.0-7	WLFF		
%MW256	%MX512.0-7, 513.0-7	WL100	Not supported by EH-RMP (256 word)	
...				
%MW511	%MX1022.0-7, 1023.0-7	WL1FF		
%MW512	%MX1024.0-7, 1025.0-7	WL200	Read area	Read area （512word）
...				
%MW767	%MX1534.0-7, 1535.0-7	WL2FF		
%MW768	%MX1536.0-7, 1537.0-7	WL300	Not supported by EH-RMP (256word)	
...				
%MW1023	%MX2046.0-7, 2047.0-7	WL3FF		

3.6 General Purpose Communication

General purpose communication is available in Ethernet port and serial port of HX-CPU.



3.6.1 General Purpose Communication Over Ethernet

Several function blocks are available in NetBaseService library shown in below table.
Refer CAA_NetBaseService.pdf in NetBaseServices library for further information.

Table of NetBaseServices library

Protocol	Command	Description
TCP/IP	TCP_Server	TCP server set-up
	TCP_Connection	TCP server connection establish
	TCP_Client	TCP client set-up
	TCP_Write	Write sending data
	TCP_WriteBuffer	Write buffered sending data
	TCP_Read	Read receiving data
	TCP_ReadBuffer	Read buffered receiving data
UDP/IP	UDP_Peer	Peer set-up
	UDP_Send	Send UDP data
	UDP_SendBuffer	Send buffered UDP data
	UDP_Receive	Receive UDP data
	UDP_ReceiveBuffer	Receive buffered UDP data

Caution

In general, network byte order is big-endian, which is sending from higher byte, however, it is not always big-endian because it depends on data type such as WORD, DWORD, STRING. If necessary, use the following FUNCTION in SysSocket library to swap data.

- SysSockHtonl (Network byte order conversion from UDINT)
- SysSockHtons (Network byte order conversion from WORD)

Description example in ST language

```
test_out1 16#78563412 :=NBS.SysSocket.SysSockHtonl(test_in1 16#12345678 );
test_out2 16#3412 :=NBS.SysSocket.SysSockHtons(test_in2 16#1234 );
```

3.6.2 General Purpose Communication Over Serial

Function blocks are available in SysCom library shown in below table.
Refer to Application manual (Command reference) for further information.

Table of SysCom library

Commands	Function
SysComOpen	Serial port open
SysComOpen2	Serial port open / configuration
SysComClose	Serial port close
SysComSetSettings	Serial port configuration
SysComPurge	Serial port internal buffer clear
SysComRead	Receiving data (Read)
SysComWrite	Sending data (Write)

Caution

Below functions in SysCom library are not supported by HX-CPU.

- SysComGetSettings
- SysComSetTimeout

Sample program

A sample program for serial port is shown below. It is recommended to use ST language for communication programming. When 1 is set in the variable test, then string data [02 31 32 33 0D] (STX 123 CR) in the variable message is sent out from the serial port.

Variable declaration

```
PROGRAM PLC_PRG
VAR
        COM_sample:COM_Settings;
        COM_sampleEX:COM_SettingsEX;
        message:STRING:='123';
        Result:DWORD;
        Result1:DWORD;
        write_out:UDINT;
        test:INT;
        Status: INT;
        uchwyt: DWORD;
END_VAR
```

Program

```
COM_sample.sPort:=COM_Ports.SYS_COMPORT1;
COM_sample.byParity:=COM_Parity.SYS_NOPARITY;
COM_sample.byStopBits:=COM_Stopbits.SYS_ONESTOPBIT;
COM_sample.ulBaudrate:=COM_Baudrate.SYS_BR_19200;
COM_sample.ulBufferSize:=100;
COM_sample.ulTimeout:=10;
COM_sampleEX.byByteSize:=8;

CASE Status OF
0:
        uchwyt := SysComOpen(SYS_COMPORT1,ADR(Result));
        IF Result = 0 THEN
                Status := Status + 1;
        END_IF
1:
        Result1 := SysComSetSettings(uchwyt,ADR(COM_sample),ADR(COM_sampleEX));
        IF Result1 = 0 THEN
                Status := Status + 1;
        END_IF
2:
        IF test = 1 THEN
                message:=CONCAT('$02',message);
                message:=CONCAT(message,'$0d');
                write_out:=SysComWrite(uchwyt,ADR(message),LEN(message),1000,ADR(Result));
        test:=0;
        END_IF
END_CASE
```

MEMO

Chapter 4 Other Functions

4.1 OPC UA Server

HX-CPU supports OPC UA server function. OPC UA (Unified Architecture) is the newest specification of OPC based on the technology used for Web service and this is data exchanging opened standard between each softwares does not depend on vendors, programming language, operation systems or region. Adaptable scope of OPC UA is expanding not only PLC, SCADA and HMI but also MES or ERP positioned as upper layer.
Client application established by using OPC UA standardized interface, it will be possible to reuse user software system even for different controller vendors of several equipment without a lot of modification.

HX-CPU supports following functionalities as OPC UA server.

Table 4.1 OPC UA Server function

No.	Type	Support
1	supported profile	Micro Embedded Device Server
2	supported information model	PLCOpen Information Model

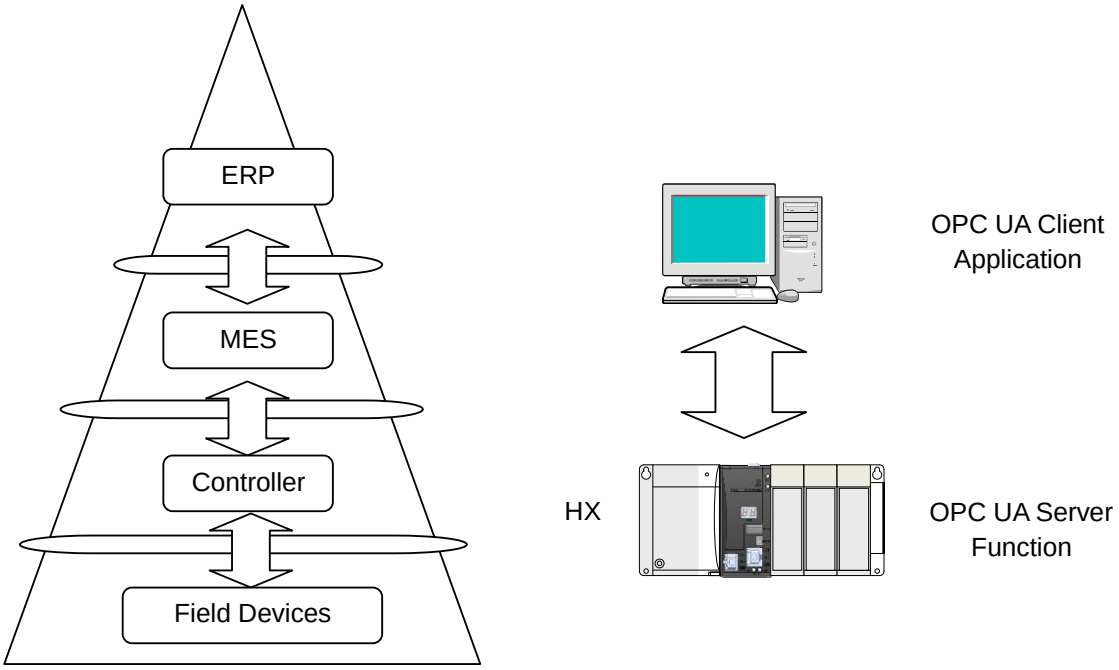


Figure 4.1 Information Models and OPC UA Server Functionality

Several technical documentation are available from OPC Foundation who is Spread promotion group and it can be possible to get them from the following address.
https://opcfoundation.org/.

(1) Configuration of HX-CPU side

Symbol configuration editor

Configure variable accessed by remotely from OPC UA client application using OPC UA server function on [Symbol Configuration] editor.

If [Symbol Configuration] is not on device tree, select [Add Object]-[Symbol Configuration] by clicking [Application].

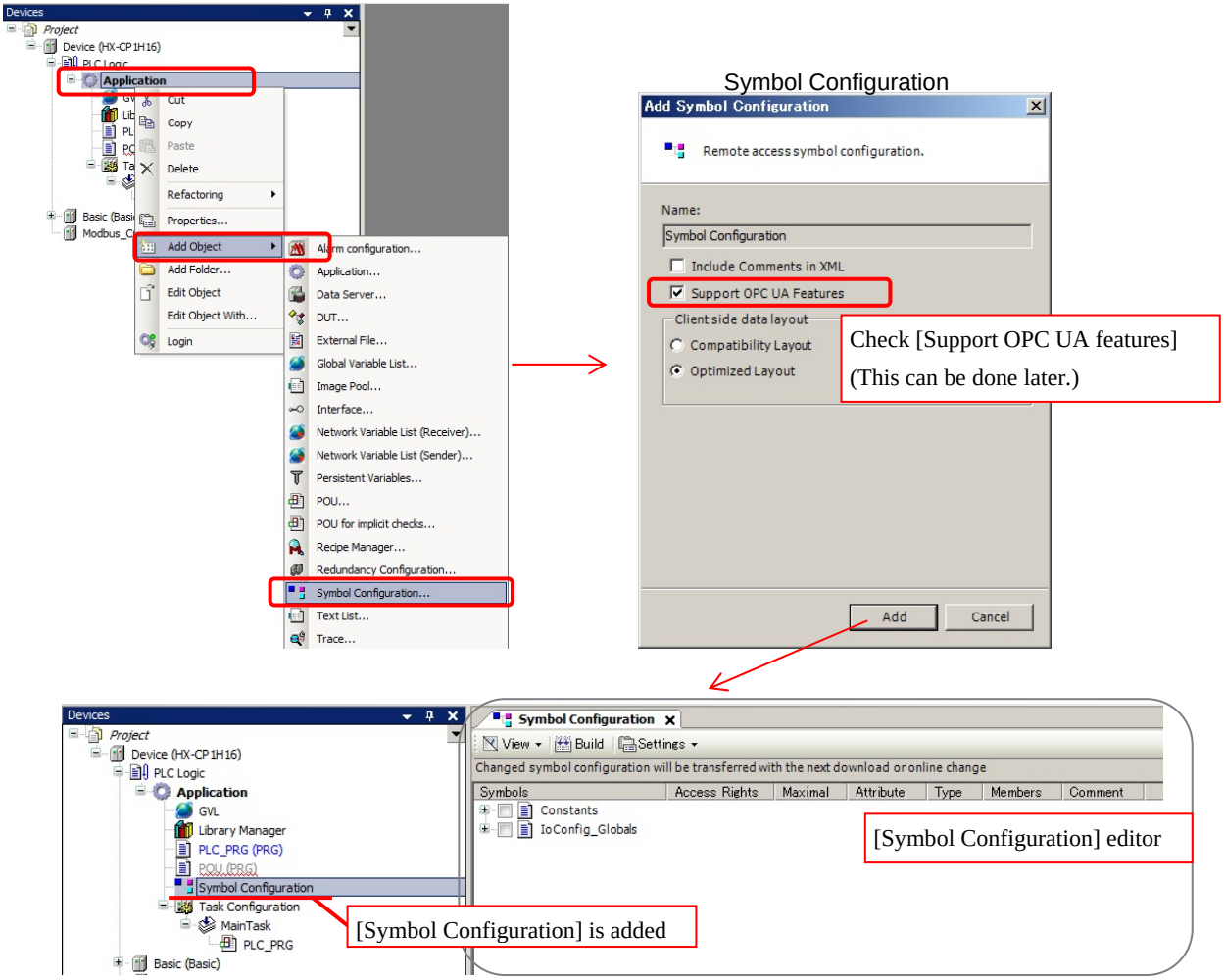


Figure 4.2 [Symbol Configuration] editor

Configuration of Remote accessing variable

List of variable included in Application are shown at [Symbol Configuration]. Specify variable can be accessed remotely.

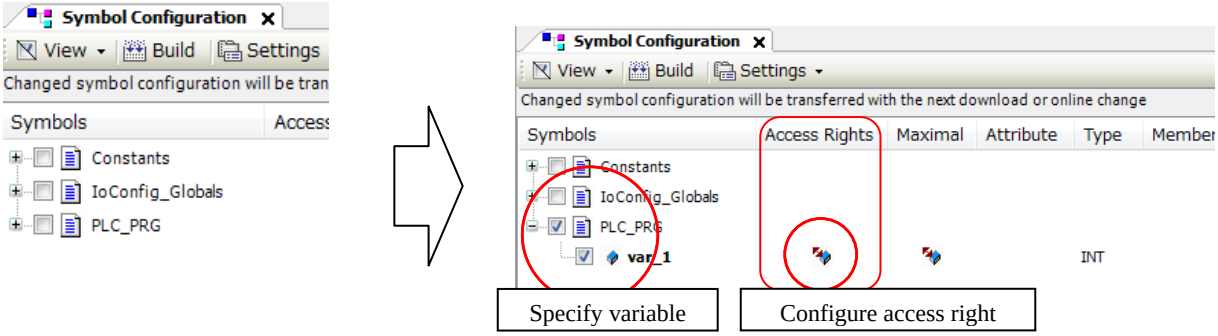


Figure 4.3 Specifying Remote access variable

It is possible to change access right of variable can be accessed remotely. Access right can be changed by each click action. Default setting is read & write.

 Read only  Write only*  Read & write

Figure 4.4 Access right of variable

*Write only is not supported

Enabling OPC UA server function

Check [Support OPC UA Features] by double clicking [Setting] tab of [Symbol Configuration].
(It is check status already when it configured during adding [Symbol Configuration].)

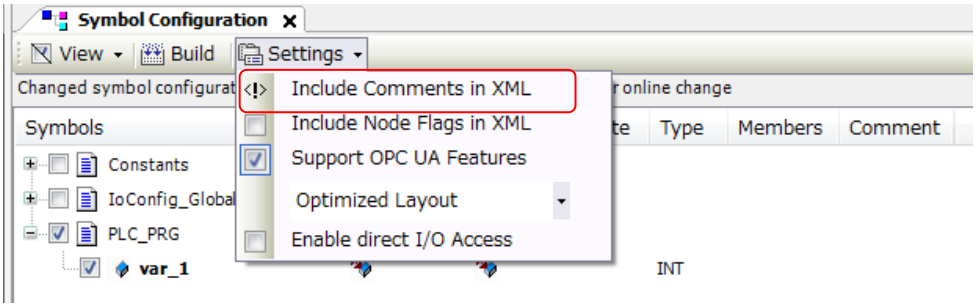


Figure 4.5 Enabling OPC UA server function

It will be possible to access specified variable from OPC UA Client Application by transferring the project to HX-CPU after above configuration and project build operation.

(2) Connecting from OPC UA

Following example shows connecting OPC UA server of HX-CPU from Client Application.
Regarding to the operation, follow client application specification.

Figure 4.6 Connecting OPC UA server

Caution

If HX-CPU is executed reset warm while OPC UA clients monitor data of HX-CPU, OPC UA clients need to re-configuration because monitoring data of HX-CPU is stop.

Make sure what is object of security protecting and take countermeasure for system configuration and operation mentioned security protection as an example by user responsibility.

- Usage of certification function and regular review for program and data should be protected.
- Usage of security function for devices used in network system.
- Connecting protection with unspecified target by usage of specifying function for connecting target.
- Operation management protection by making limitation of key lock of device setting place or user limitation.

4.2 FTP

4.2.1 FTP Server

File read or write access (upload / download) of SD card or USB memory mounted on HX-CPU from PC connected Ethernet, due to built-in FTP server function of HX-CPU. Active mode is necessary for FTP client.

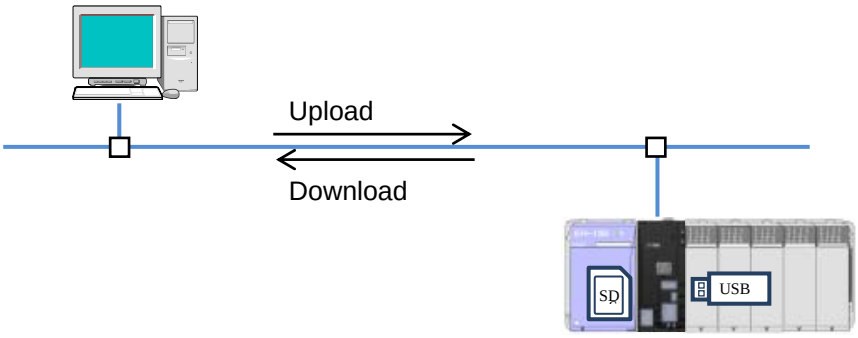


Figure 4.7 FTP server function

4.2.2 FTP Server Configuration

Configure several parameters related FTP server on [PLC Parameters] of [Device] Configuration window.

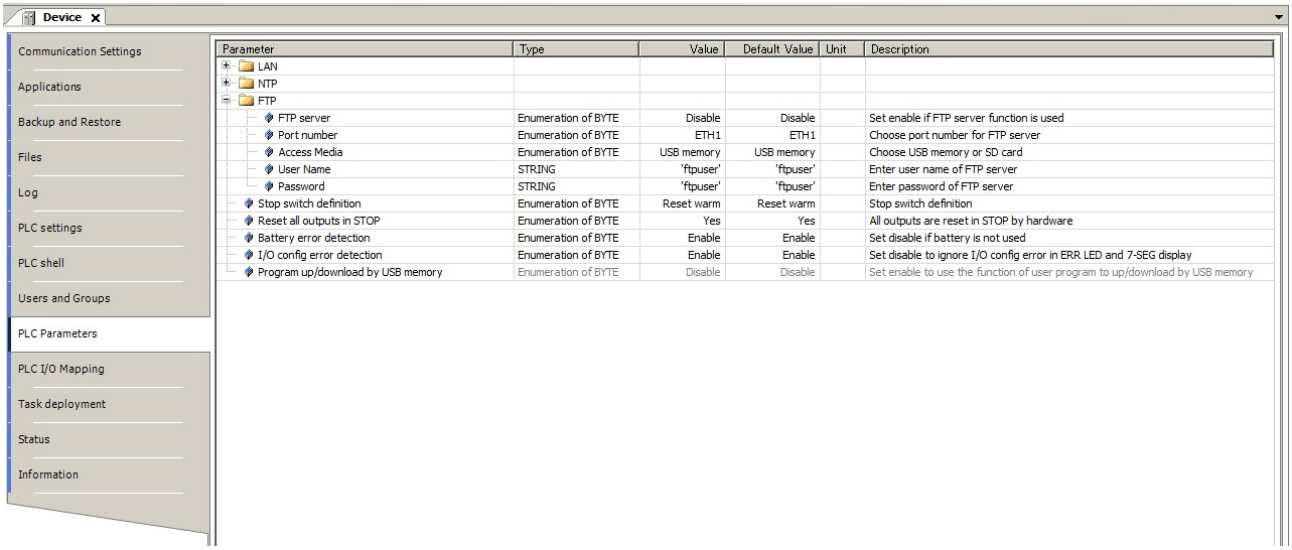


Figure 4.8 FTP server configuration

FTP server：Configure Enable when to use FTP.
Port number：Select communication port using for FTP. (ETH1/ETH2/ETH3)
Access Media：Select access target device. (USB memory/SD card)
If media is not mounted specified access target, login will not be accepted.
User Name：Configure user name for login. (Byte character alphabet or number less than equal 32 characters)
Small alpha character, number and _(under score bar) can be accepted, first character can't be number.
Password：Configure password for login. (Byte alpha character or number 4 to 32 characters)
Usable character is byte character or special character. However, " [¥ $ can't be used.
Number of connections：1 connection.
Timeout： HX-CPU logout from FTP server as timeout when 5 minutes has passed while HX-CPU is in an idle state during login.

4.2.3 List of FTP Commands

Usable command list is shown in below.

Table 4.2 Usable command list

Command	Function
ascii	Set file transfer mode to ASCII.
binary	Set file transfer mode to binary.
bye	Disconnect connection between server and exit client.
cd	Change working directory of server.
close	Disconnect connection between server.
delete	Delete specified file of server.
dir	Show detail list of server files and directories.
get	Transfer file of server into local host. [download]
lcd	Change local working directory.
ls	Show list of server files and directory.
mdelete	Delete multiple files of server.
mdir	Transfer detail of multiple files and directories into local file.
mget	Transfer multiple files of server into local host. [download]
mkdir	Make working directory onto server.
mls	Transfer several files in the several files and directory into local file.
mput	Transfer specified multiple local file into server. [upload]
open	Connect specified server.
prompt	Switch interactive mode. Toggling mode every sending command.
put	Transfer specified local file into server. [upload]
pwd	Display current working directory of server.
quit	(same as bye)
rename	Rename file name of server.
rmdir	Delete working directory of server.
type	Display current file transfer mode.

4.2.4 FTP Command Detail

【ascii】

Format: ftp> ascii
Function: Set file transfer mode to ASCII.

【binary】

Format: ftp> binary
Function: Set file transfer mode to Binary.

【bye】

Format: ftp> bye
Function: Exit ftp.

【cd】

Format: ftp> cd [directory]
Function: Change working directory to specified directory by [directory].
It is not possible upper directory from logged in directory.

【close】

Format: ftp> close
Function: Disconnect connection between FTP server.

【delete】

Format: ftp> delete [file]
Function: Delete specified file.

【dir】

Format: ftp> dir (([directory]) (local file))
Function: Display detail list of server file and directory.
Save this list into file by specified [(local file)].

【get】

Format: ftp> get [file] ([local file])
Function: Transfer file of server to local. [download]
It is possible to specify transferring local file name.

【lcd】

Format: ftp> lcd [local directory]
Function: Change local working directory.

【ls】

Format: ftp> ls
Function: List all file in current directory.

【mdelete】

Format: ftp> mdelete [file 1] ([file 2] …)
Function: Delete multiple files of server.
If interactive mode set off by prompt command, all specified files can be deleted without confirmation.

【mdir】

Format: ftp> mdir [file 1] ([file 2] …) [local file]

Function: Transfer multiple files and directories to local file.

【mget】

Format: ftp> mget [file 1] ([file 2] …)

Function: Transfer multiple files of server to local host.
If interactive mode set off by prompt command, all specified files are transferred without confirmation.

【mkdir】

Format: ftp> mkdir [directory]

Function: Make directory on server.

【mls】

Format: ftp> mls [file 1] ([file 2] …) [local file]

Function: Transfer multiple files and directory list to local file.

【mput】

Format: ftp> mput [file 1] ([file 2] …)

Function: Transfer specified files to server.
If interactive mode set off by prompt command, all specified files are transferred without confirmation.

【open】

Format: ftp> open [host]

Function: Connect server specified IP address or host name.

【prompt】

Format: ftp> prompt

Function: Change interactive mode. Toggling mode every sending command.

【put】

Format: ftp> put [local file] ([server file])

Function: Transfer specified file to server.
If server file is specified, transfer file with specified file name.

【quit】

Format: ftp> quit

Function: Exit ftp.

【rename】

Format: ftp> rename [file] [new file]

Function: Change file name of server.

【rmdir】

Format: ftp> rmdir [directory]

Function: Delete directory of server.

【type】

Format: ftp> type [type]

Function: Display current file transfer mode. It is possible to change file transfer mode by specifying.

4.2.5 Exclusive Control of File Access

Exclusive control by POU is necessary if conflicting file access is occurred between FTP server function and POU. In that case, control the file exclusively with indicating file access status by POU.

Table 4.3 Exclusive file access control for each file

Exclusive file access control for each file		File access by POU	
		Read	Write
FTP command	Read	Not necessary	Necessary
	Write	Necessary	Necessary

Make sure what is object of security protecting and take countermeasure for system configuration and operation mentioned security protection as an example by user responsibility.

- Usage of certification function and regular review for program and data should be protected.
- Usage of security function for devices used in network system.
- Connecting protection with unspecified target by usage of specifying function for connecting target.
- Operation management protection by making limitation of key lock of device setting place or user limitation.

4.3 Visualization

Visualization function supporting program debugging and monitoring by using visual displaying on Integrated Development Environment HX-CODESYS and Web visualization function (available with HX-CP1H16) by using general Web browser are available on HX-CPU.

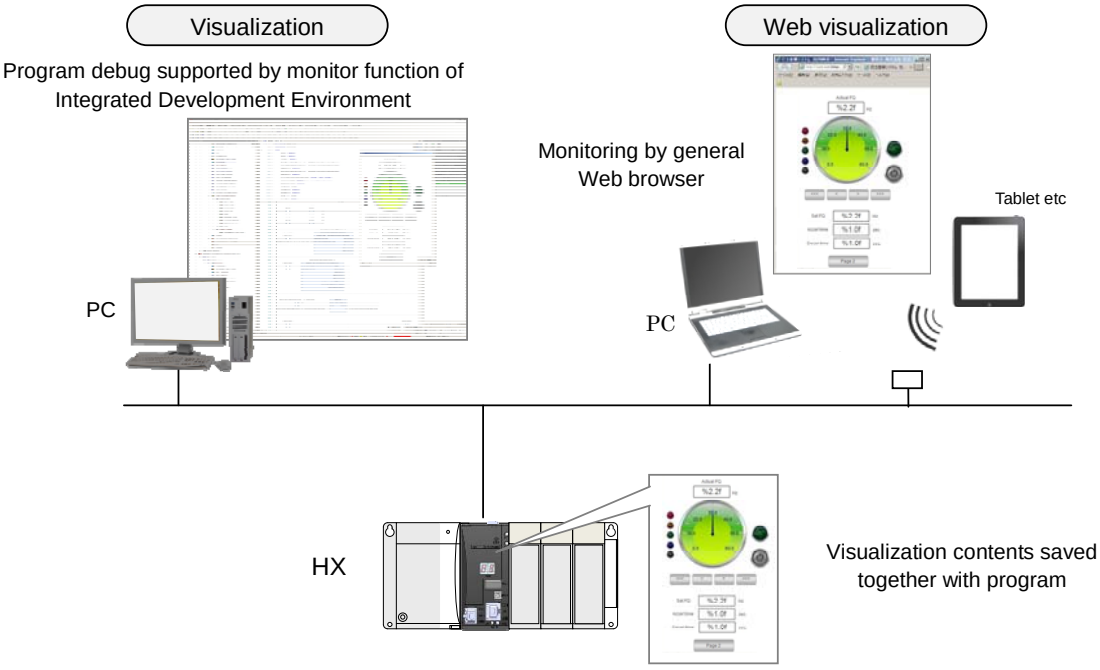


Figure 4.9 Visualization function

Create visualization object

It is needed to add visualization object onto application to enable visualization.

Select [Application]-[Add Object]-[Visualization]. Related visualization object are added device tree.

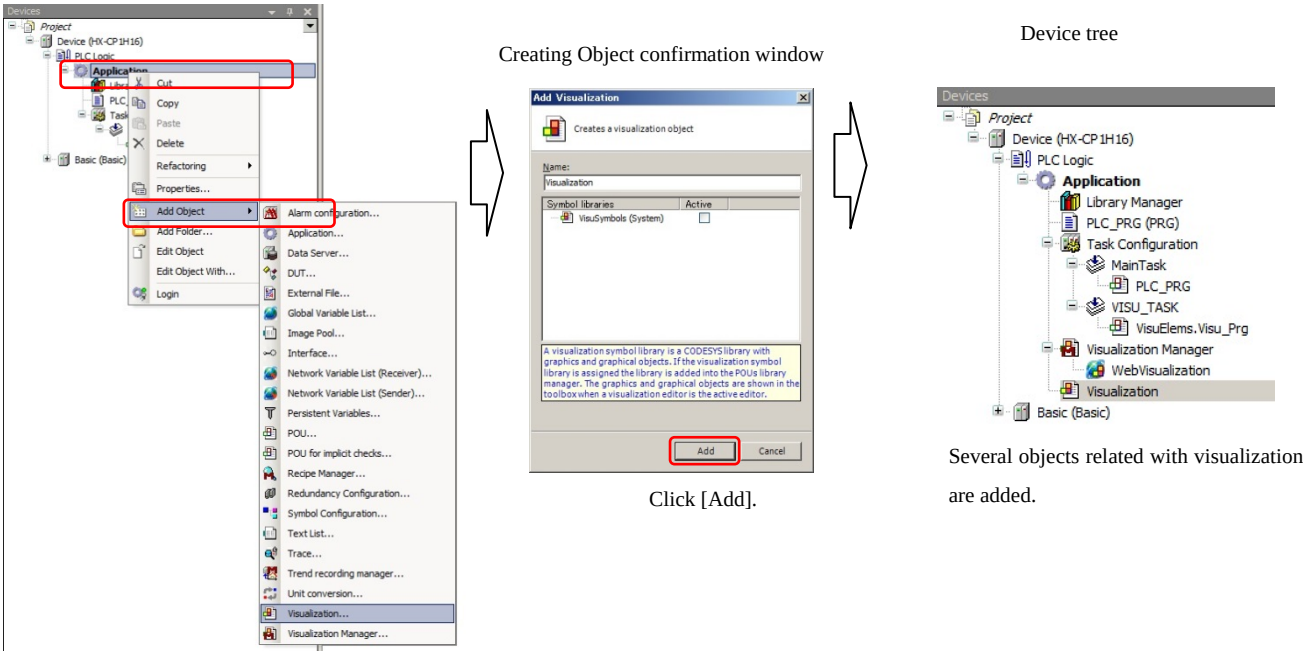


Figure 4.10 Adding Visualization object

Visualization editor

Double click [Visualization] on Device tree. Visualization editor appears.

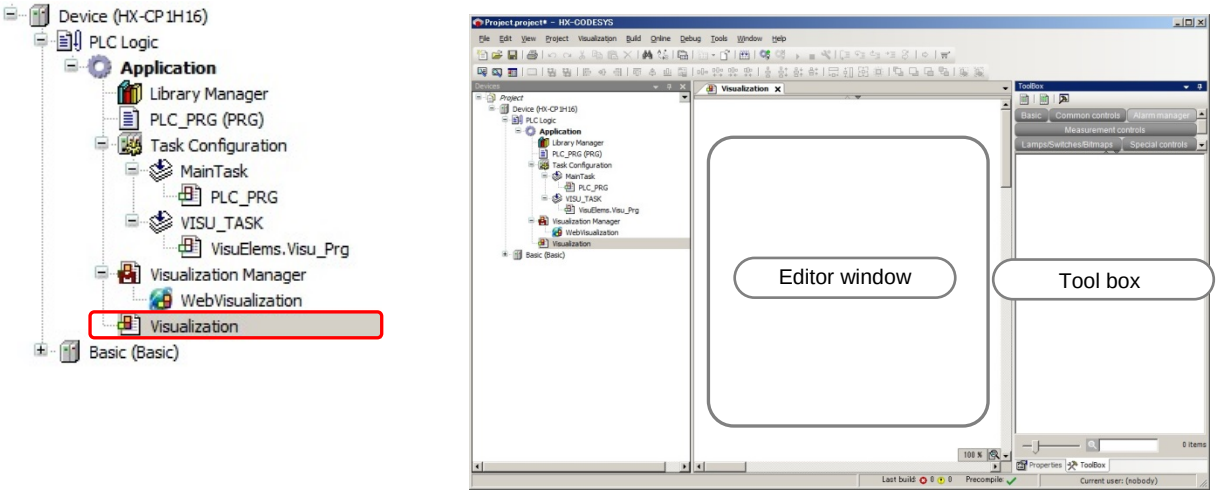


Figure 4.11 Visualization editor

Usage of elements

There are several parts (this after [elements]) available to create graphical display in Tool box. Select element to use from the tool box and drag it into the editor window. The element is placed on the editor window and the property window appears.

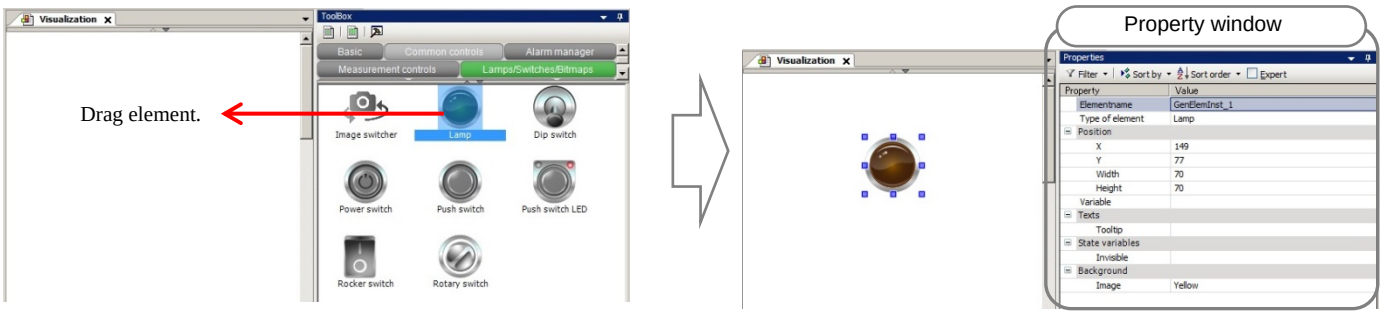


Figure 4.12 Usage of elements

Variable Assignment

Assign variable for element by specifying on “Variable” field of “Property”.

It is also possible to assign variable using in application by Input Assistant.

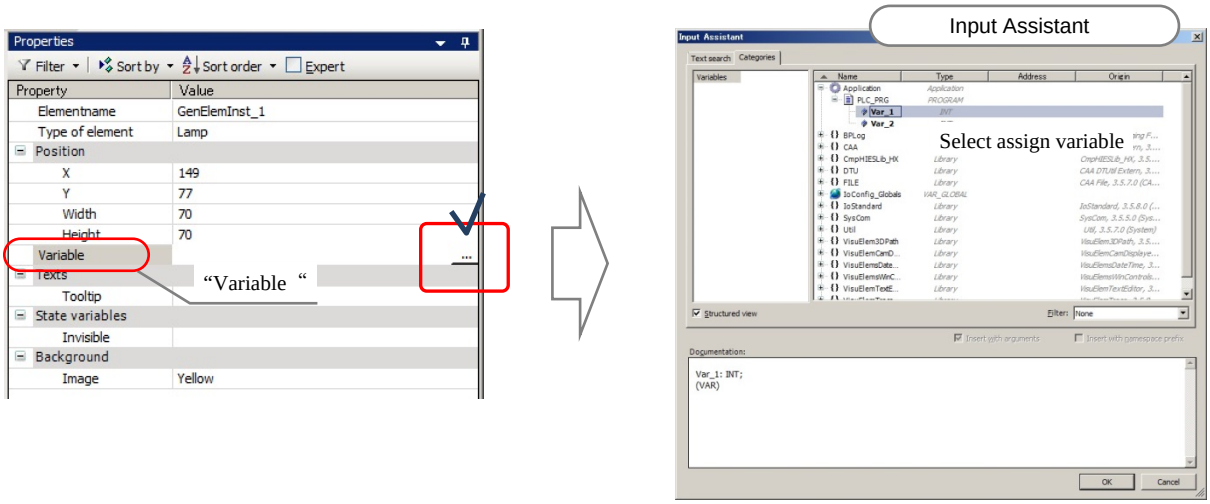


Figure 4.13 Assignment variable for element

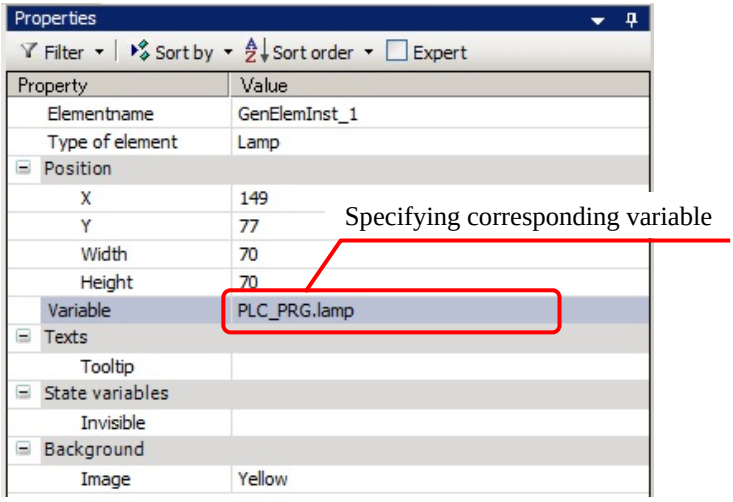
Commonly used elements

Display BOOL type variable (Read)

Display example

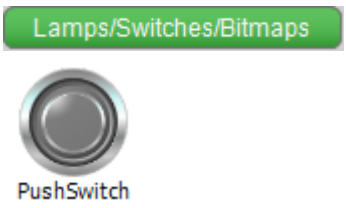
In case of [FALSE]

In case of [TRUE]



- It is possible to specify tooltip when mouse indicates close object by specifying [Texts]-[Tooltip] of Property. (This is same as other elements.)
- It is possible to set Display / Non-display by specifying [State variables]-[Invisible] of Property. (This is same as other elements.)

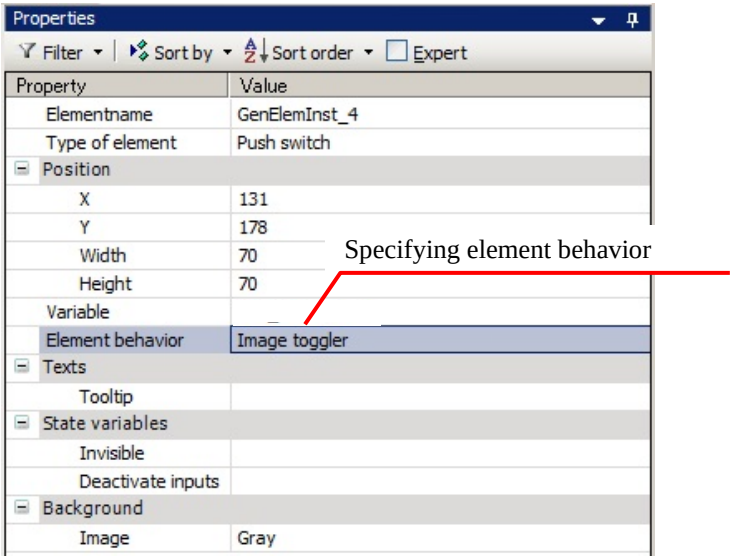
Switching BOOL type variable (Write)



Display example

In case of [FALSE]

In case of [TRUE]



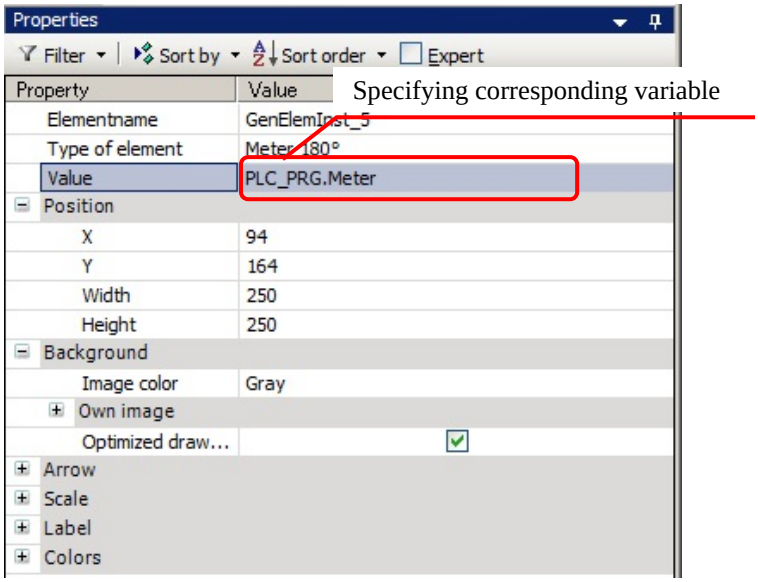
- It is possible to specify element behavior at [Element behavior] of Property.
  Image toggler: Toggle switches behavior. It turns ON by click once and Turns OFF by one more click.
  Image tapper: Push switches behavior. It turns ON during click only.
- It is also possible to be unable to operate by specified variable value by setting [State variables]-[Deactivate inputs] of Property.

Refer online help for further detail of each element specifications.

Graphical display of Variable value

Meter180

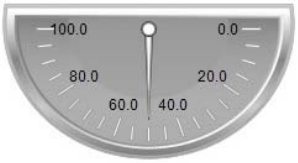
Display example



Specifying corresponding variable

Changing example by Property specifying

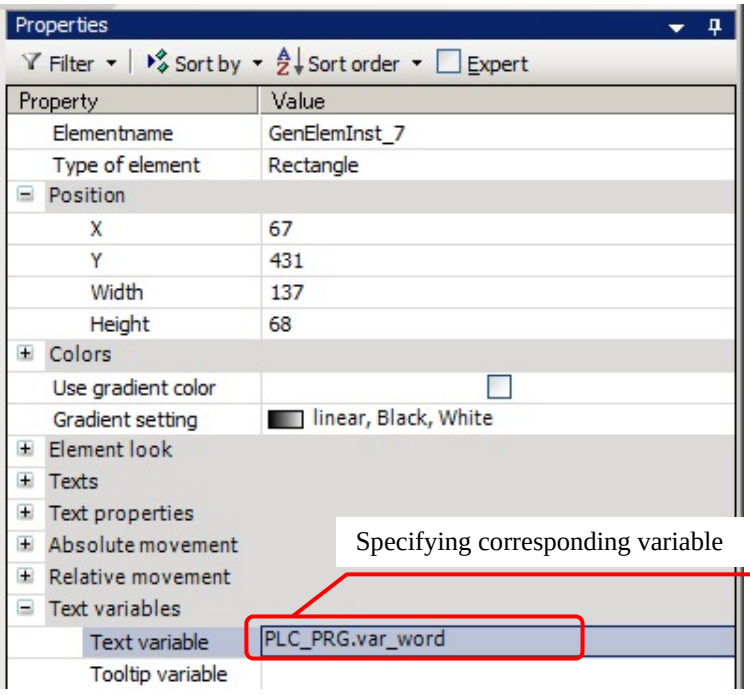
Direction



Color, meter indicator, scale of value, display position etc

Display variable value by text (string)

Rectangle



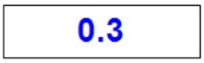
Specifying corresponding variable

%d

Specify type of display	
Signed decimal display	%d
Hexadecimal display	%x
Unsigned decimal display	%u
String display	%s
Floating display	%f

*Changing number of digits is possible

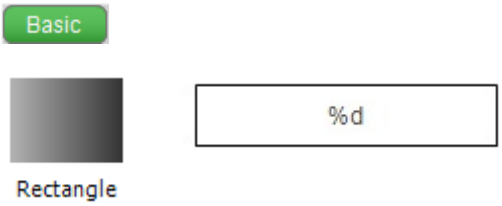
%.1f



%.3f

Refer online help for further detail of each element specifications.

Input variable value by text (string)

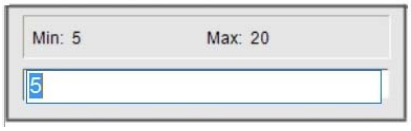


Display example

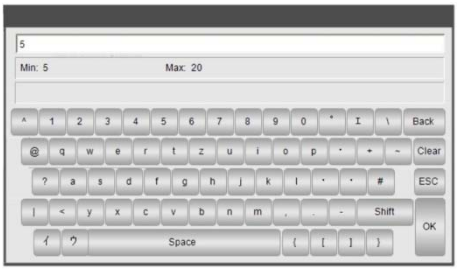
Input types : Text input

In case of PasswordField checked

Input types : Text input with limits

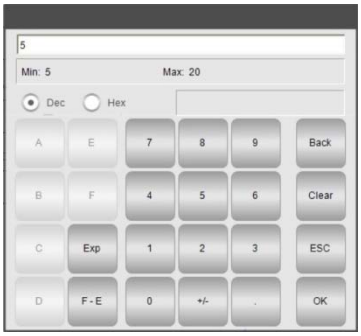


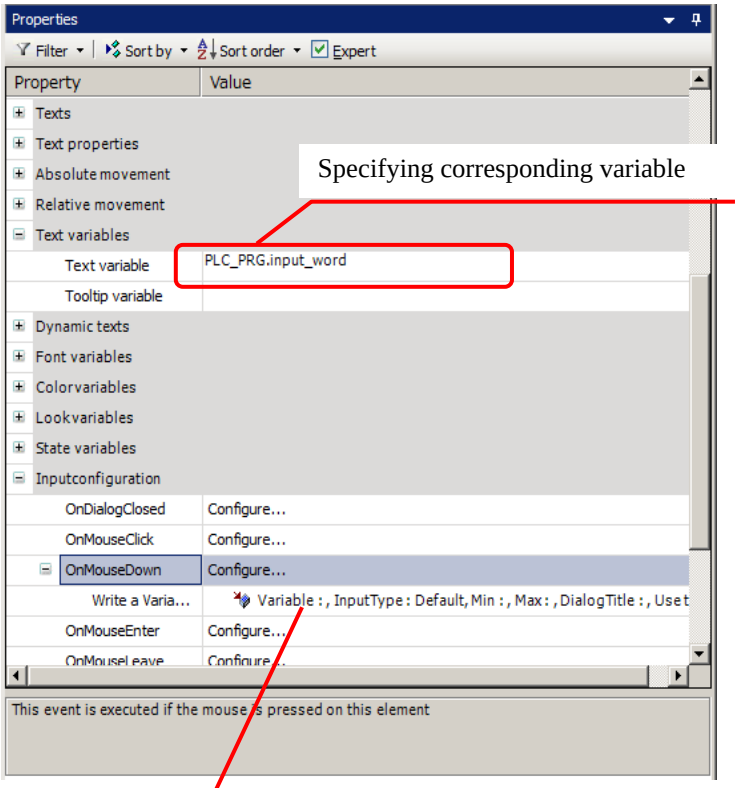
Input types : VisuDialogs Keypad



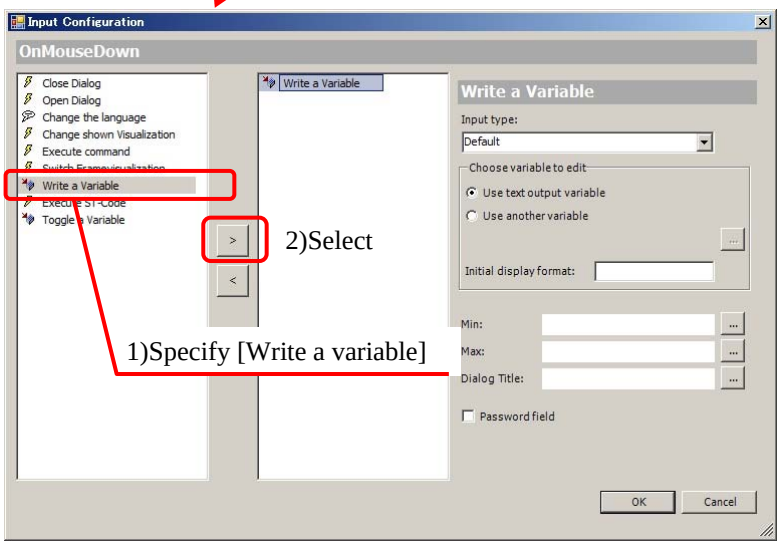
Input types : VisuDialogs Numpad

Input types : VisuDialogs NumpadExtended





Specify input structure by clicking



Input types	Default(Text input) Text input Text input with limits VisuDialogs Keypad VisuDialogs Numpad VisuDialogs NumpadExtended
Choose variable to edit	Use text output variable Pass input value to specified variable at this element. Use another variable Pass input value to other variable. Initial display format Use comment input of Min/Max for VisuDialogs.
Min	Specify minimum value of input.
Max	Specify maximum value of input.
Passwordfield	Display [*(asterisk)] during input.

Refer online help for further detail of each element specifications.

Task configuration of Visualization

"VISU_TASK" is added automatically by adding Visualization object.

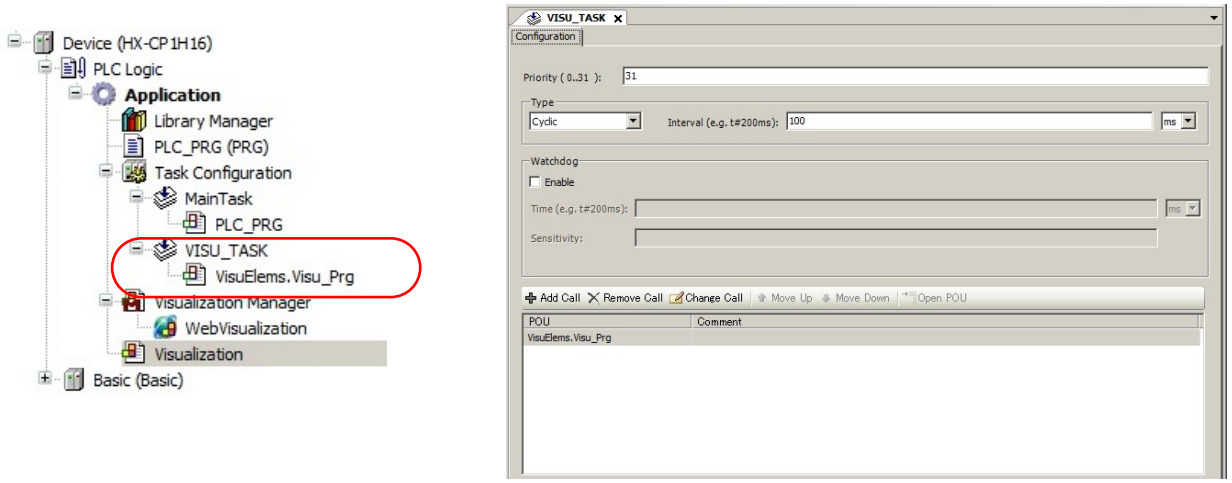


Figure 4.14 Task configuration of Visualization

Priority (0..31)

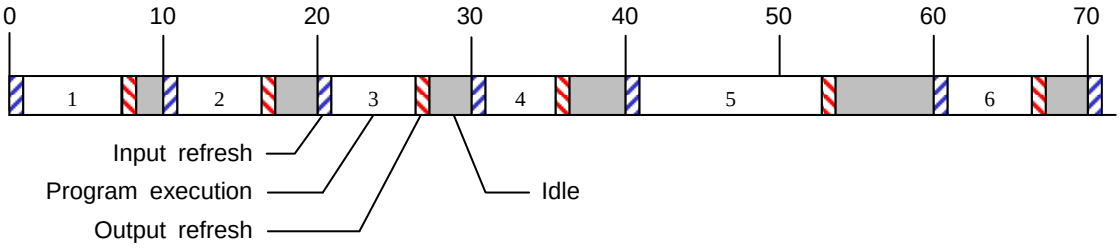
0 is the highest priority, 31 is the lowest.

Type

Choose type of the task. Inputs are read at the beginning of each task, and outputs are written at the end of the program execution.

Cyclic task

The task will be processed cyclic according to the time definition given in the field [Interval]. If actual execution time exceeds the cycle time, the next cycle does not start immediately but wait until the next fixed cycle time. For example, cycle time is set as 10 ms and 5th scan starting from 40 ms takes 12 ms, then 6th cycle starts at 60 ms as below figure.



Event task

The task will be started as soon as the variable defined in the field gets a rising edge.

Freewheeling task

The task will be processed as soon as the program is started and at the end of one run will automatically restarted in a continuous loop. There is no cycle time defined. Be noted that the priority of this task is the lowest and 3 ms of sleeping time is added at the end of each cycle for other tasks to be executed properly.

Status task

The task will be started when selected variable is TRUE.

Watchdog

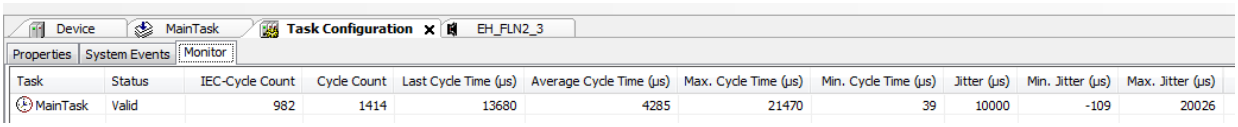
When it is enabled, watchdog function is activated. If program execution time exceeds watchdog time, CPU stops program execution with [24] error code displayed at 7 segment LED.

There are two different conditions to detect watchdog error as follows.

Example: Time: #5 ms, Sensitivity: 3.

- Detect condition 1 : one cycle exceeds 15 ms
- Detect condition 2 : scan cycle exceeds 5 ms in 3 times consecutive

Actual cycle time of each task is monitored in Task configuration as below.



Task	Status	IEC-Cycle Count	Cycle Count	Last Cycle Time (µs)	Average Cycle Time (µs)	Max. Cycle Time (µs)	Min. Cycle Time (µs)	Jitter (µs)	Min. Jitter (µs)	Max. Jitter (µs)
MainTask	Valid	982	1414	13680	4285	21470	39	10000	-109	20026

Visualization manager

This is common configuration items for Visualization and Web Visualization.

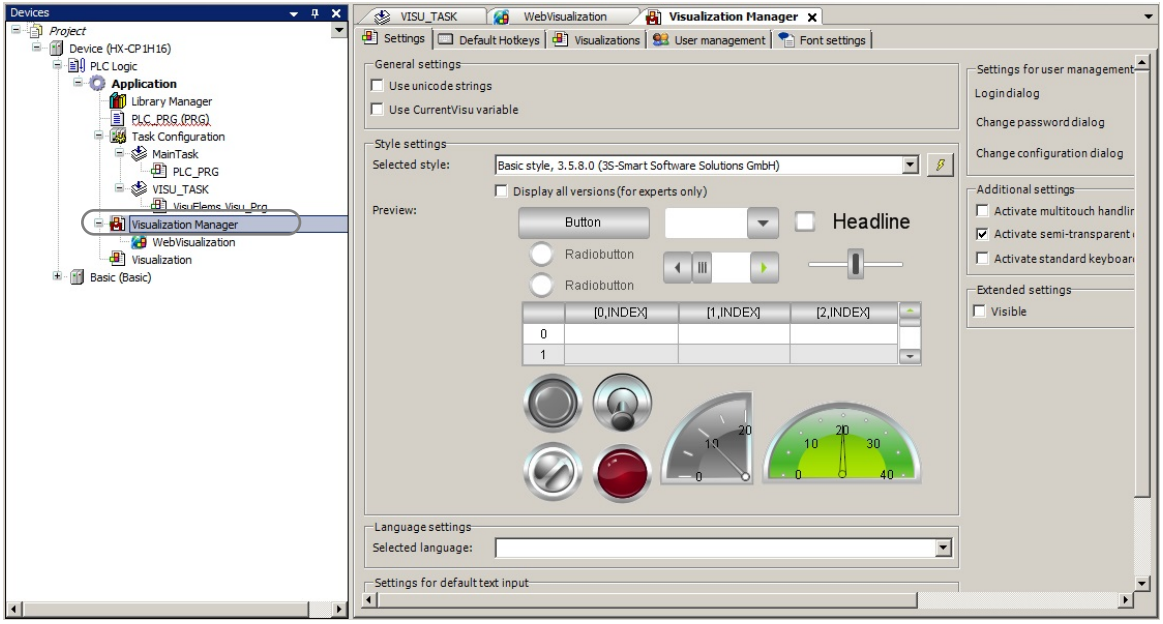
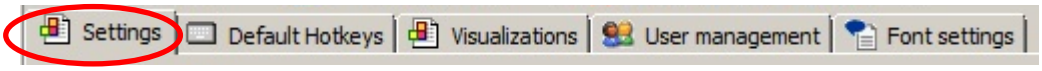
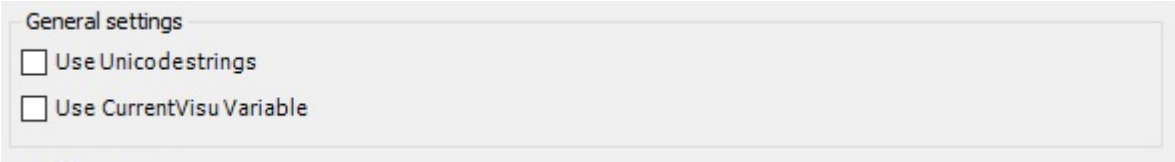


Figure 4.15 Configuration of Visualization manager

Configuration

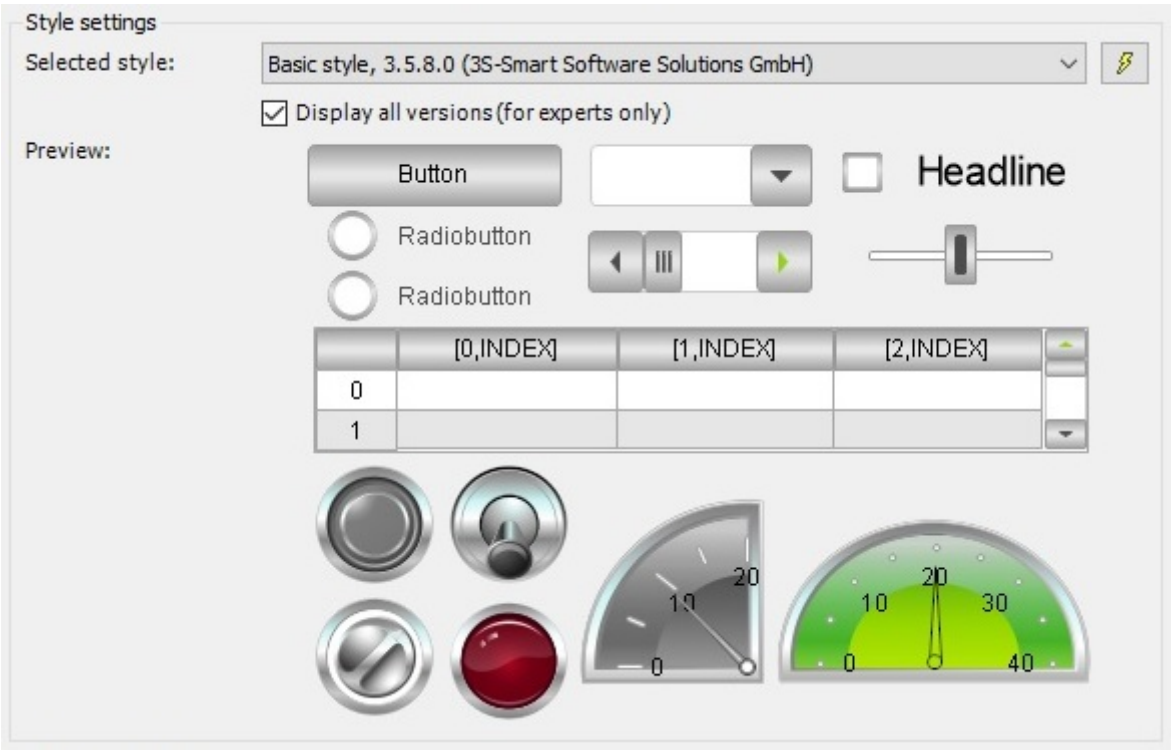


General setting



Use Unicodestrings	All string is executed by Unicode format used in Visualization by this option. If Japanese character is displayed for Web visualization, please check this.
User CurrentVisu Variable	Pass name of current display visualization to Global string variable [CurrentVisu].

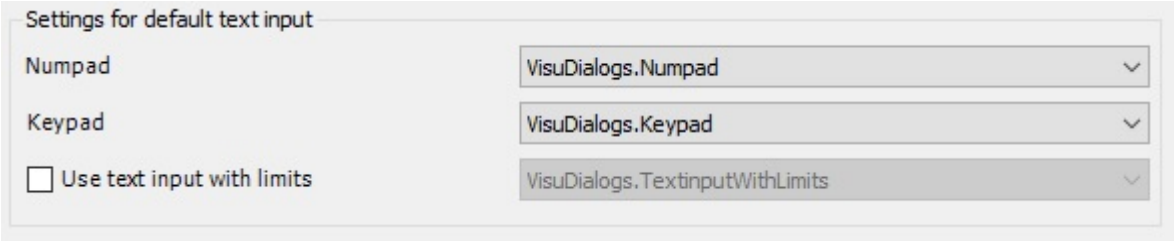
Style settings：(Use this default value without change)



Language settings

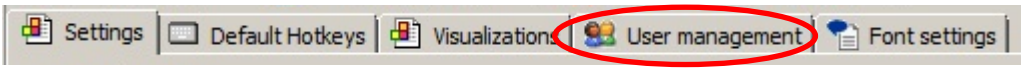
Configured language will be used at the time of start.

Setting for default test input



Use text input with limits	Default of text input is dialog with the minimum and maximum value range.

User Management of Visualization



Configure access limitation for security protection is possible for Visualization.
Refer [4.7 Support function of security protection] for additional information.

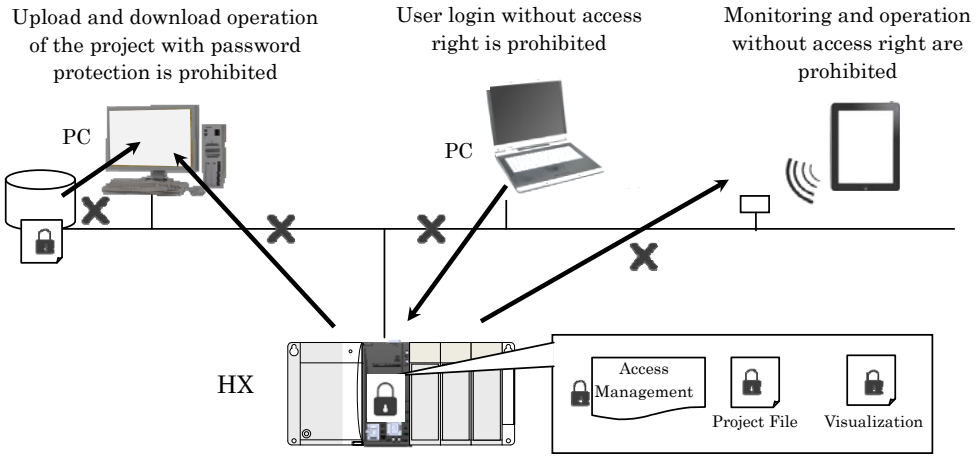
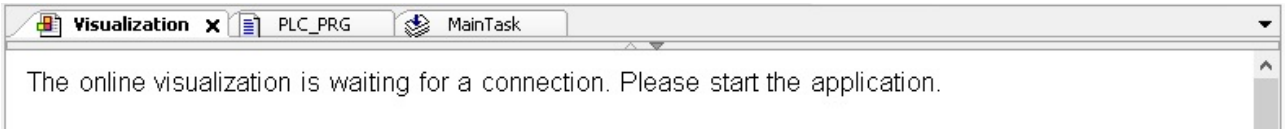


Figure 4.16 Support function of security protection

Start of Visualization

Visualization can start by transferring built project HX-CPU after configuration of visualization is completed.
Following display appears during HX-CPU is stop.



Visualization starts automatically when status of HX-CPU is set to RUN.

Web Visualization (HX-CP1H16 only)

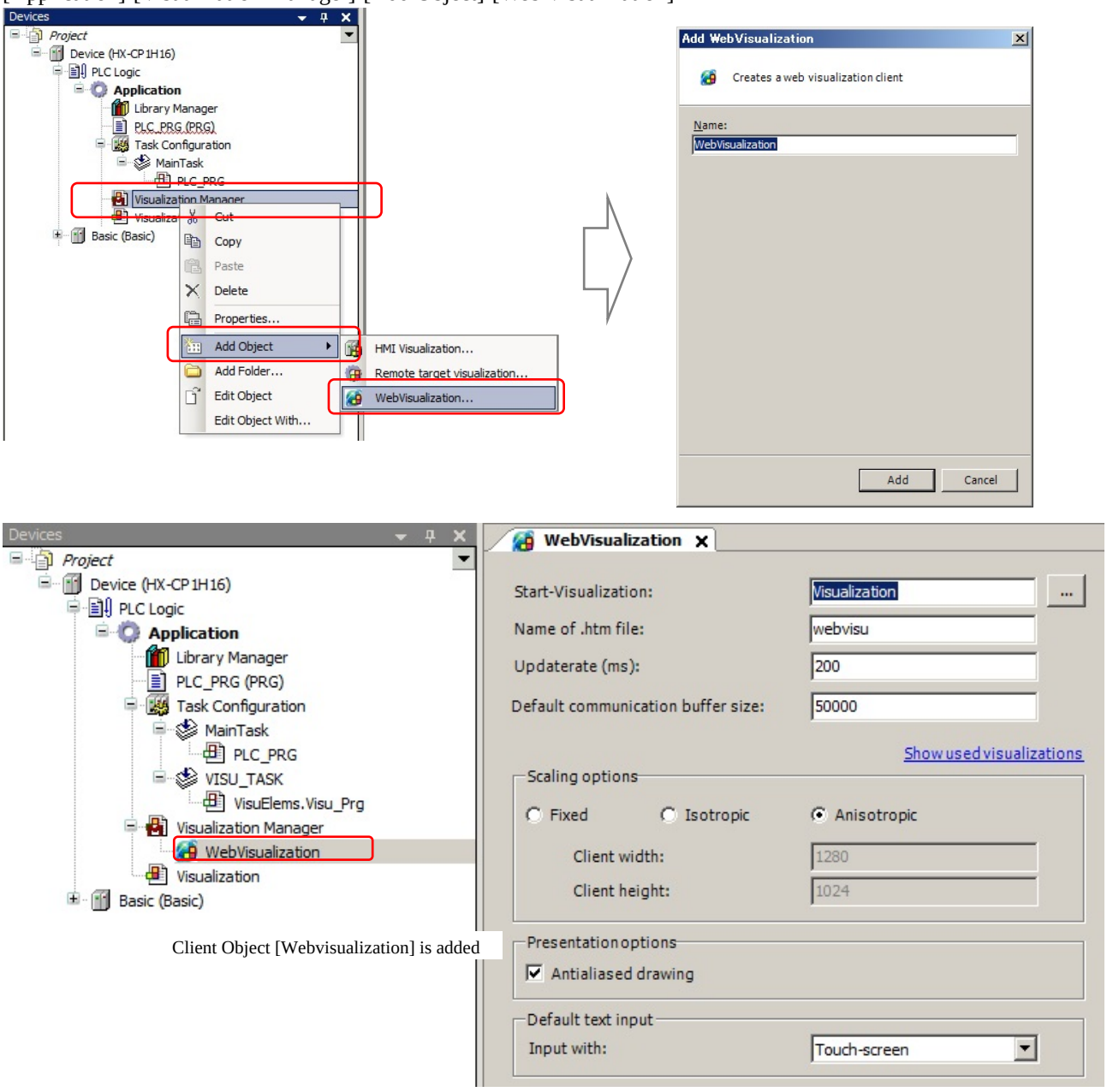
It is possible to access Visualization stored in HX-CPU from general Web browser of PC or tablet. This function is called Web Visualization.
Use Web browser following HTML5 . (Example: Firefox, Safari, Chrome, IE9 or later, etc)
Web Visualization can be used during HX-CPU is in RUN status.

Caution

Web Visualization of HX-CP1S08 operates. However this is only demonstration purpose. Therefore please do not use Web Visualization of HX-CP1S08. Display is limited within 30 minutes.

Add client object of Web Visualization under [Visualization Manager] on Device tree.

[Application]-[Visualization Manager]-[Add Object]-[Web Visualization]



Client Object [Webvisualization] is added

Figure 4.17 Web Visualization Object

If Webvisualization Object configuration display is not displayed on right side, it will appears by double clicking “Webvisualization” object.

Configuration items of Webvisualization object

Start Visualization	Input Visualization name when starts Visualization at the time of start automatically.
Name of .htm file:	Specify HTML file name of Visualization. Usable character for file name is byte alpha or number. File name including Japanese character can't be monitored by browser.
Updaterate (ms)	Specify refresh cycle in ms units for Web browser. (Default is 200 ms)
Default communication buffer size	Specify communication buffer size between browser.

Scaling options

Fixed / Isotropic / Anisotropic	Fixed: Display original size when it is made. Isotropic: Ratio of image is kept and displayed. Anisotropic: Display according to Browser display size after adjusted automatically.
Client width	Specify window width size of browser (Pixel)
Client height	Specify window height size of browser (Pixel)

Presentation options

Antialiased drawing	Check when it needed to display drawing smoothly.

Default text input

Touch-screen	Select when Touch screen is used for Web client.
Keyboard	Select when Keyboard is used for Web client.

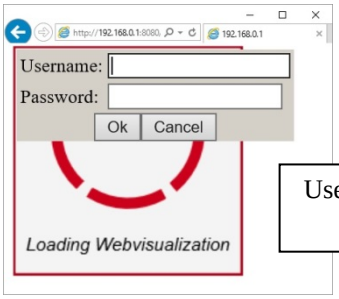
Access method from Web browser

Describe URL following below description to access downloaded Visualization of HX-CPU from Web browser.
http://[IP address]:[8080]/[Web file name]　　Example：http://192.168.0.1:8080/webvisu.htm

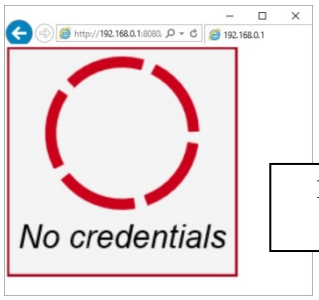
Following display appears after completing access to HX-CPU, and Display of Visualization.

This display appears when HX-CPU is stopping or Visualization is under preparation. Specified Visualization appears after HX-CPU is in running and preparation is completed.

User name and password are required when online user is registered HX-CPU.
Regarding to user name and password, please contact management person of your HX-CPU.



Username and Password are required.

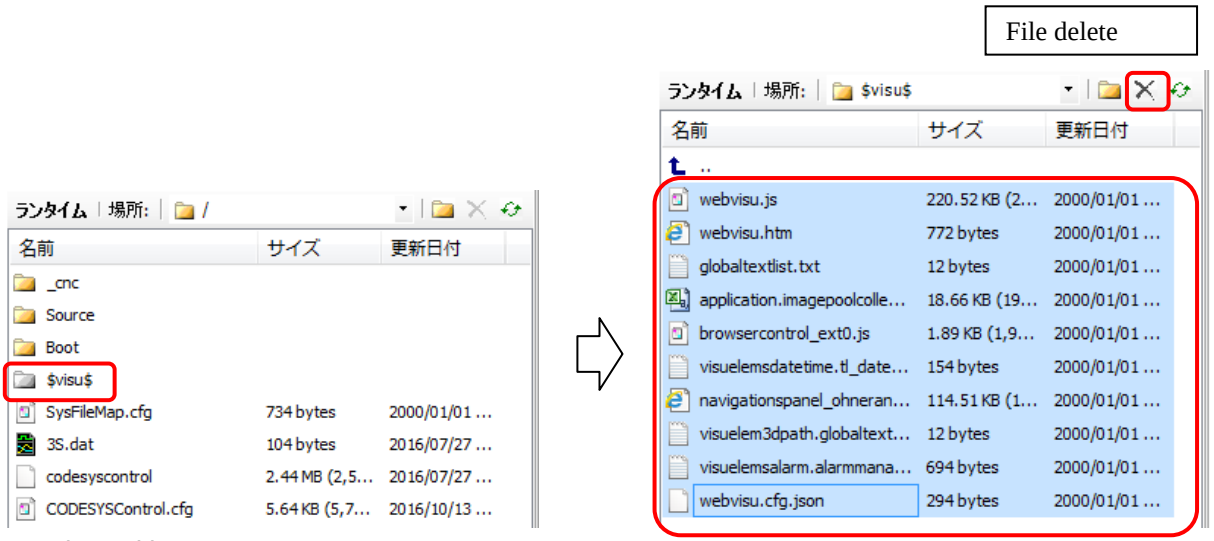


Left display appears by press [Cancel]

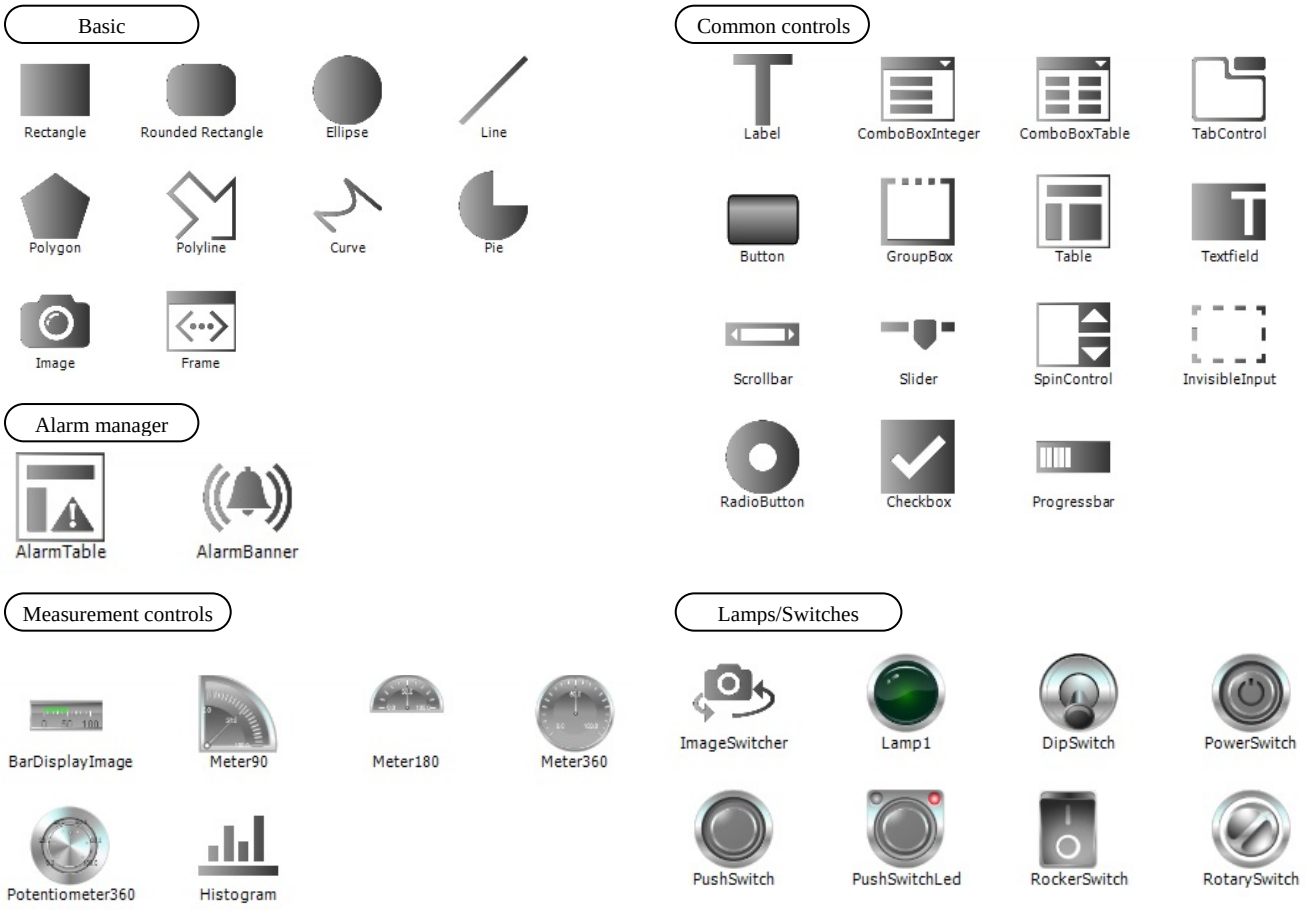
Method of Visualization files deleting

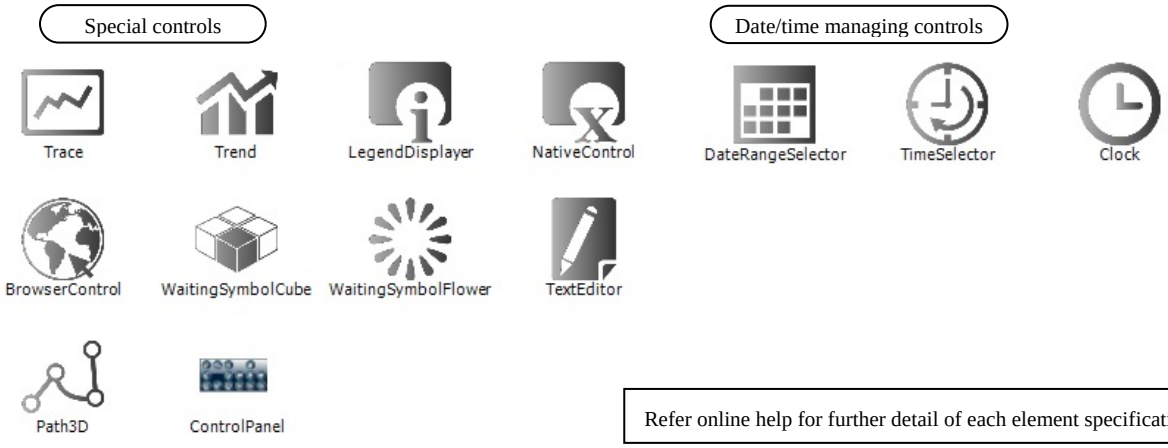
Visualization file registered in HX-CPU, this file is registered dedicated Visu folder inside of HX-CPU.

If Visualization file name is changed, the file having previous name is still remain and remaining free area of folder is shorted , [File Transfer Error] will appear. It is possible to clear inside of [$visu$] folder by file delete in the right click menu of device tree. Do not delete files other than inside of [$visu$] folder.



Element in Tool box





Refer online help for further detail of each element specifications.

Make sure what is object of security protecting and take countermeasure for system configuration and operation mentioned security protection as an example by user responsibility.

- Usage of certification function and regular review for program and data should be protected.
- Usage of security function for devices used in network system.
- Connecting protection with unspecified target by usage of specifying function for connecting target.
- Operation management protection by making limitation of key lock of device setting place or user limitation.

4.4 Calendar Clock Function

HX-CPU includes Calendar clock IC, Clock data can be used in program as system clock. Use this function by setting system clock and time zone information. Configure clock data by dedicated function block (CAA DTUtil library). Refer “System clock command” of HX Application Manual [Command reference edition] for further detail.

Table 4.4 List of CAA DTUtil library

Command	Function
GetDateAndTime	Get system clock
SetDateAndTime	Set system clock
GetTimeZoneInformation	Get time zone information
SetTimeZoneInformation	Set time zone information

Time zone

There are two type of time zone in HX-CPU. Use Clock function by setting same information for both two time zone.

Table 4.5 List of time zone

Time zone	Configure method	Target
Time zone 1	Function block （SetTimeZoneInformation）	GetTimeZoneInformation
Time zone 2	Configuration （PLC Parameters）	GetNTPStatus

Caution

Maximum system clock data of HX-CPU is 2038 January 19th 03:14:17. Configure and manage of clock data not to exceed maximum data due to exceeding maximum value operation may not be correct.
Here is example program to restart from 2000 January 1st 00:00:00 automatically if clock data exceed 2037 December 31st 23:59:59. Use this example program by modifying according to the system specification. Configure NTP Client function invalid, if following example program.

Declaration part of variable.

```
PROGRAM POU
VAR
          BLINK_0: BLINK;
          GetDateAndTime_0: DTU.GetDateAndTime;
          SetDateAndTime_0: DTU.SetDateAndTime;
          GET_TIME_ERROR: BOOL;
          SET_TIME_ERROR: BOOL;
END_VAR
```

Program

```
BLINK_0(ENABLE:=TRUE, TIMELOW:=T#719M, TIMEHIGH:=T#1M);
GetDateAndTime_0(xExecute:=BLINK_0.OUT,
                 xError=>GET_TIME_ERROR);
IF (GetDateAndTime_0.dtDateAndTime >=DT#2037-12-31-23:59:59) THEN
           SetDateAndTime_0(xExecute:=TRUE,
                            xError=>SET_TIME_ERROR,
                            dtDateAndTime:=DT#2000-01-01-0:00:00);
END_IF
```

4.5 NTP Client Function

NTP client function getting clock information from NTP (Network Time Protocol) of network is available with HX-CPU.
It is also possible to set clock information of HX-CPU Calendar Clock IC by getting clock information from NTP server. Get clock information when start RUN, it can be possible to set 1 minute to 1440 minute (24 hours) interval and to get clock information by specified cycle.

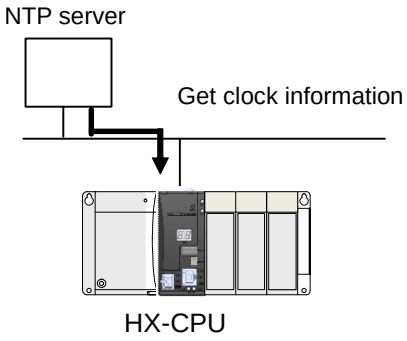


Figure 4.18 NTP Client function

Table 4.6 Specification of NTP client

Items	Specification
Communication protocol	SNTP（Simple Network Time Protocol）
Getting cycle	Start RUN timing, User configuration (00:01-24:00)
Collected clock data	Year / Month and date / Day / Hour / minute / second (data type: DATE_AND_TIME)
Refresh getting interval	Refresh by calendar time clock IC

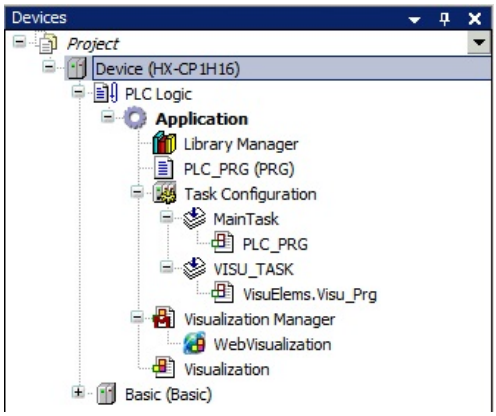
It is possible to get NTP status by using dedicated function block (GetNTPstatus). ExecNormal of GetNTPstatus turn TRUE by getting clock data correctly, therefore if clock data is used in user program, use it after confirming ExecNormal of GetNTPstatus turns TRUE.

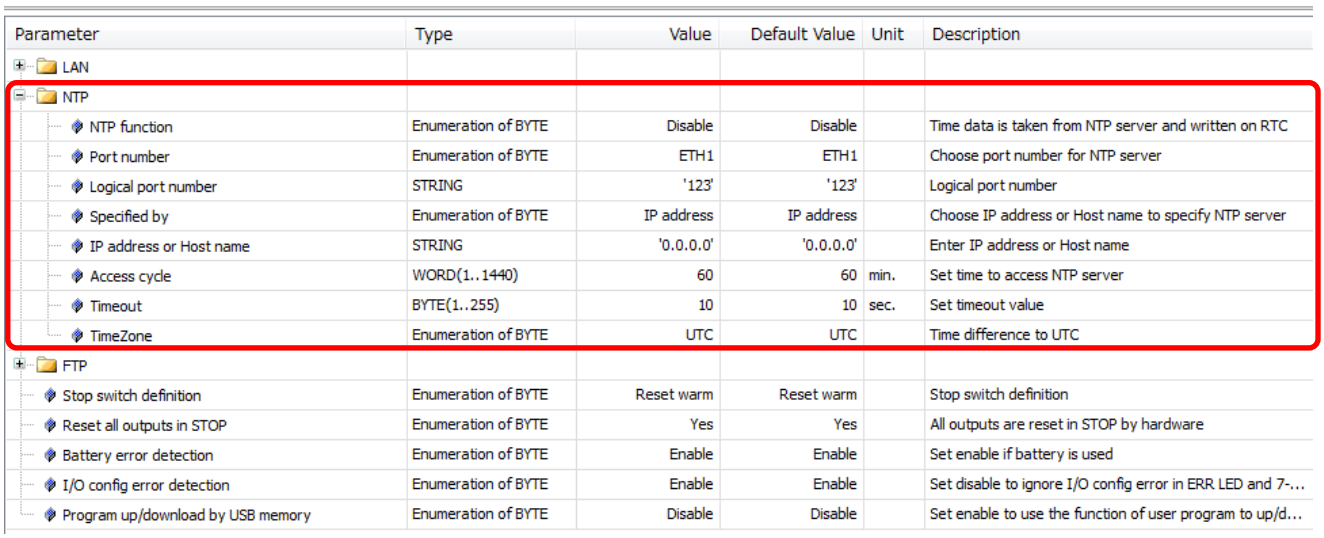
Caution

If NTP client function is used, use it after setting time zone. Configuration is done by dedicated function block (SetTimeZoneInformation). Refer “System clock command” of HX Application Manual [Command reference edition] for further detail information.

Configuration Method

[Device] window appears after selecting [Edit Object] by double clicking or right clicking [Device (HX-CP…)] on Device tree. Select items of [NTP] by double clicking [PLC Parameter] tab.





Parameter	Type	Value	Default Value	Unit	Description
LAN					
NTP					
NTP function	Enumeration of BYTE	Disable	Disable		Time data is taken from NTP server and written on RTC
Port number	Enumeration of BYTE	ETH1	ETH1		Choose port number for NTP server
Logical port number	STRING	'123'	'123'		Logical port number
Specified by	Enumeration of BYTE	IP address	IP address		Choose IP address or Host name to specify NTP server
IP address or Host name	STRING	'0.0.0.0'	'0.0.0.0'		Enter IP address or Host name
Access cycle	WORD(1..1440)	60	60	min.	Set time to access NTP server
Timeout	BYTE(1..255)	10	10	sec.	Set timeout value
TimeZone	Enumeration of BYTE	UTC	UTC		Time difference to UTC
FTP					
Stop switch definition	Enumeration of BYTE	Reset warm	Reset warm		Stop switch definition
Reset all outputs in STOP	Enumeration of BYTE	Yes	Yes		All outputs are reset in STOP by hardware
Battery error detection	Enumeration of BYTE	Enable	Enable		Set enable if battery is used
I/O config error detection	Enumeration of BYTE	Enable	Enable		Set disable to ignore I/O config error in ERR LED and 7-...
Program up/download by USB memory	Enumeration of BYTE	Disable	Disable		Set enable to use the function of user program to up/d...

Table 4.7 Configuration Items of NTP client

Item name	Contents	Setting range
NTP function	Select valid or invalid getting clock information from NTP server.	Disable / Enable
Port number	Select communication port getting clock information.	ETH1 / ETH2 / ETH3
Logical port number	Set port number using for NTP server connection.	123 (Not changeable)
Specified by	Select specifying method of NTP server.	IP address (Fixed IP address)
IP address or Host name	Specify NTP server.	xxx.xxx.xxx.xxx
Access cycle	Set time interval of clock information.	1 to 1,440 (unit: minute)
Timeout	Set detecting time of timeout.	10 (unit: minute (fixed))
TimeZone	Specify time zone.	UTC-12:00 to UTC+12:00

4.6 Removable Media

HX-CPU supports USB memory and SD card (HX-CP1H16) as removable media and file access is possible. Here is sample program description executing data logging on removable media by using CAA File.
This sample program is 3 kinds data (time stamping, dummy data, text) logging making CSV file (File name: LoggingSample.csv) on USB memory. New data is added every 10 seconds automatically. Modify data writing timing according system usage.

	A	B	C
1			
2	DT#2016-05-17-21:25:22	1	This is Test !
3	DT#2016-05-17-21:25:32	2	This is Test !
4	DT#2016-05-17-21:25:42	3	This is Test !
5	DT#2016-05-17-21:25:52	4	This is Test !
6	DT#2016-05-17-21:26:02	5	This is Test !
7	DT#2016-05-17-21:26:13	6	This is Test !

Declaration of variable

```
PROGRAM PLC_PRG
VAR
        USBMountSts     : BOOL;
        SDMountSts              : BOOL;
        sDirSD          : STRING :='/media/sd-mmcblk0p1'; // SD card
        sDirUSB         : STRING :='/media/usb-sda1';    // USB memory
        sFileName               : CAA.FILENAME;
        FileOpen        : File.Open;
        FileClose               : File.Close;
        FileWrite               : File.Write;
        FileFlush               : FILE.Flush;
        sMedia          : STRING;
        iState          : UINT :=1;
        hfile           : CAA.HANDLE;
        sWriteLine              : STRING(128);
        GetRTC          : DTU.GetDateAndTime;
        xRDRTC          : BOOL;
        xReadDone               : BOOL;
        dtTemp          : DATE_AND_TIME;
        sDT             : STRING;
        T1              : TON;
        FileOpenDone    : BOOL;
        FileOpenErr     : BOOL;
        FileWriteDone   : BOOL;
        FileWriteErr    : BOOL;
        FileFlushDone   : BOOL;
        FileFlushErr    : BOOL;
        Err             : BOOL;
        Exclsv          : BOOL;
        iNum            : INT;
        sNum            : STRING;
END_VAR
```

Program

```
USBMountSTS:=UsbMountStatus();
IF USBMountSTS=FALSE THEN
   RETURN;
END_IF

//SDMountSts:=SDMountStatus();
//IF SDMountSTS=FALSE THEN
//       RETURN;
//END_IF

CASE iState OF

         1:
//       sMedia := sDirSD; // SD card
         sMedia := sDirUSB; // USB memory
         sFileName :='/LoggingSample.csv';
         sFileName := CONCAT(sMedia, sFileName);
         iState := 2;

         2: // FileOpen: Mode.MWRITE
                  FileOpen(xExecute:=TRUE, sFileName:=sFileName, xExclusive:=Exclsv, eFileMode:=
File.MODE.MWRITE);
                  IF FileOpen.xDone = TRUE THEN
                           FileOpenDone:=TRUE;
                           hfile:=FileOpen.hFile;
                           FileOpen(xExecute:=FALSE);
                           xRDRTC := TRUE;
                           iState:=10;
                           ELSIF FileOpen.xError=TRUE THEN
                           FileOpenErr:=TRUE;
                           FileOpen(xExecute:=FALSE);
                           iState:=90;
                  END_IF

         3: // FileOpen Mode.MAPPD
                  FileOpen(xExecute:=TRUE, sFileName:=sFileName, xExclusive:=Exclsv, eFileMode:=
File.MODE.MAPPD);
                  IF FileOpen.xDone = TRUE THEN
                           iState:=10;
                           hfile:=FileOpen.hFile;
                           FileOpen(xExecute:=FALSE);
                           xRDRTC := TRUE;
                  ELSIF FileOpen.xError=TRUE THEN
                           FileOpen(xExecute:=FALSE);
                           iState:=90;
                  END_IF

         10: // Get RTC data
                  GetRTC(xExecute:=xRDRTC, xDone=>xReadDone, dtDateAndTime=>dtTemp);
                  IF xReadDone=TRUE THEN
                           sDT:=DT_TO_STRING (dtTemp);
                           GetRTC(xExecute:=FALSE);
                           iState:=11;
                  END_IF

         11: // Create & Combine the data
                  iNum := iNum +1;
                  sNum := INT_TO_STRING(iNum);

                  sWriteLine := CONCAT('$r$n', sDT);
                  sWriteLine := CONCAT(sWriteLine, ',');
                  sWriteLine := CONCAT(sWriteLine, sNum);
                  sWriteLine := CONCAT(sWriteLine, ',');
                  sWriteLine := CONCAT(sWriteLine, 'This is Test ! ');
                  iState:=12;
```

Enable these when logging data on SD card.

```
        12: // FileWrite
                FileWrite(xExecute:=TRUE,hFile:=hfile,pBuffer:=ADR(sWriteLine),
                        szSize:=INT_TO_UDINT(LEN(sWriteLine)));
                IF FileWrite.xDone = TRUE THEN
                   FileWrite(xExecute:= FALSE);
                   FileWriteDone:=TRUE;
                   iState:=20;    // To Flush
                ELSIF FileWrite.xError = TRUE THEN
                        FileWriteErr:=TRUE;
                        FileWrite(xExecute:= FALSE);
                        iState:=90;
                END_IF
                        xRDRTC := FALSE;

        20: // FileFlush
                FileFlush(xExecute:= TRUE, hFile:= hfile);
                IF FileFlush.xDone = TRUE THEN
                   FileFlush(xExecute:= FALSE);
                   FileFlushDone:=TRUE;
                   iState:=30;    // Close that file
                ELSIF FileWrite.xError = TRUE THEN
                   FileFlushErr:=TRUE;
                   FileFlush(xExecute:= FALSE);
                   iState:=90;
                END_IF

        30: // Close that file.
                FileClose(xExecute:= TRUE, hFile:= hfile);
                IF FileClose.xDone = TRUE THEN
                   iState := 40;
                   FileClose(xExecute:= FALSE);
                ELSIF FileClose.xError = TRUE THEN
                   FileClose(xExecute:= FALSE);
                   IState := 90;
                END_IF

        40: // wait 10 seconds
                T1(IN:=TRUE, PT:=T#10S);
                IF t1.Q THEN
                        iState:=3;
                        T1(IN:=FALSE);
                END_IF

        90: // Error
                Err:= TRUE; // Error

END_CASE;
```

Caution

- Access files after confirming USB memory mounting status or SD card mounting status by program when access files of USB memory or SD card. SdMountStatus command and UsbMountStatus command are prepared to get mounting status.
- Don’t remove USB memory or SD card during accessing file or directory. It will be cause can’t access again. If USB memory or SD card needed to be removed during PLC is in RUN status, removing action like SD card switch pressing and execution of UsbUnmount command required after executing Flush/close command. It is convenient to execute by prepared input variable for invoking UsbUnmount command.
- It may take long time for file accessing time depends on USB memory or SD card type. It is recommended to separate file access task and general I/O access task.
- There are some possibilities to access file of USB memory or SD card not only from CAA File but also from FTP client etc at same timing. To avoid this situation, exclusive file access control is required.

4.7 Supporting Function for Security Protection

Supporting function for Security protection protecting illegal access is available on HX-CPU to prepare external security risk via network accessing. Use this supporting function as one of method to keep needed security level for system.

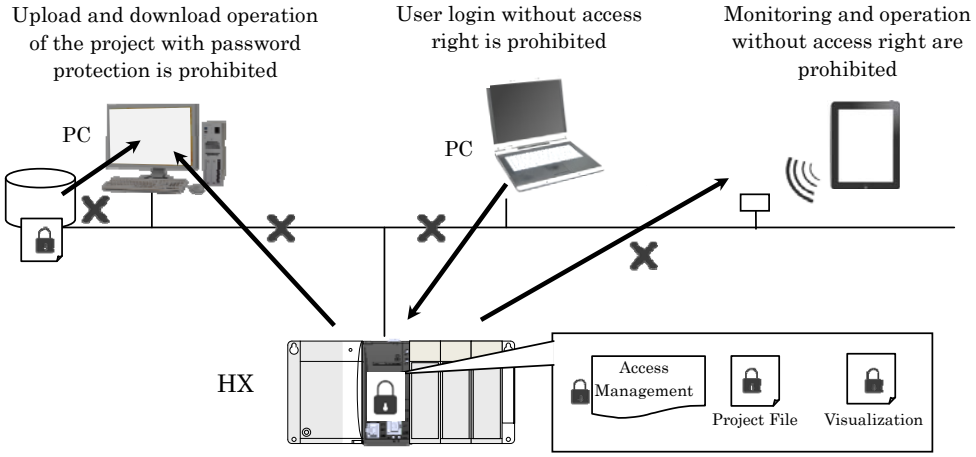
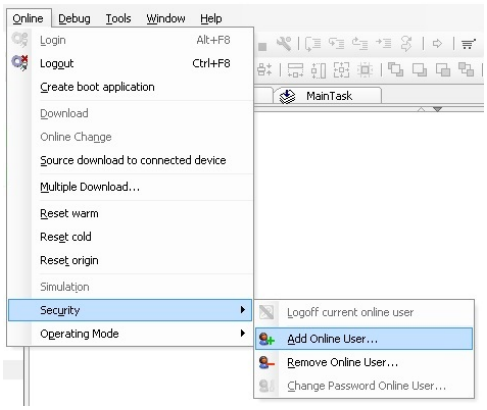


Figure 4.19 Supporting function for security protection via network access

Limitation of online user

It is possible to limit user online connecting HX-CPU. Only the registered user can login HX-CPU by registering name and password. This is same as for Visualization or Web Visualization.

[Online]-[Security]-[Add Online user]



Dialog of Add Online user

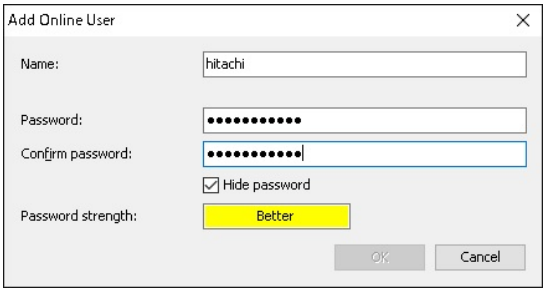
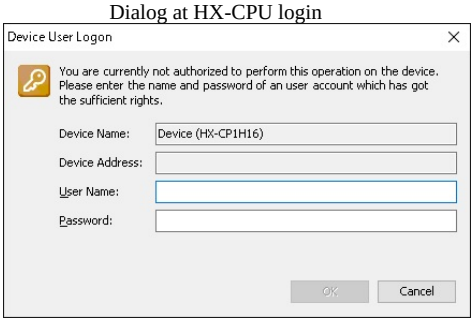


Figure 4.20 Add online user

Following dialog appears at login after registering online user. Input registered name and password.

Dialog at HX-CPU login



At Web visualization access

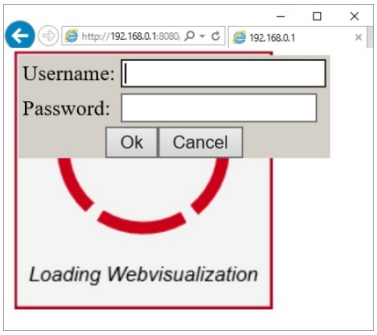


Figure 4.21 Access of HX-CPU registered online user

Dialog at login appears again when user name or password is different from registered. Confirm user name and password with manager registered online user when login can’t be possible.

It is recommended like in below not to image easily.

Length of password more than equal 8 characters (Most suitable is 12 characters or more)
Mixture capital letter and small letter
Mixture number
Mixture special character
Avoid existing name or easily guessed phrase for password (“123”, “abc” or “qwerty” etc)

Caution

Login with empty user name and password can’t be used after adding new user with this procedure.
Please make note registered password without missing.

Registered user can delete online user registration after login. If not to use dialog at login, add new user with name “Everyone” and empty password. It is possible to login without login dialog from next login.

Caution

Be careful, online user is deleted by [Reset origin device] operation.

Password protection of Project

Password protection is possible for project file.

This protection is valid when to open stored file or to open uploaded stored source program in HX-CPU by HX-CODESYS.

Open dialog of [Project]-[Project Settings]-[Security].

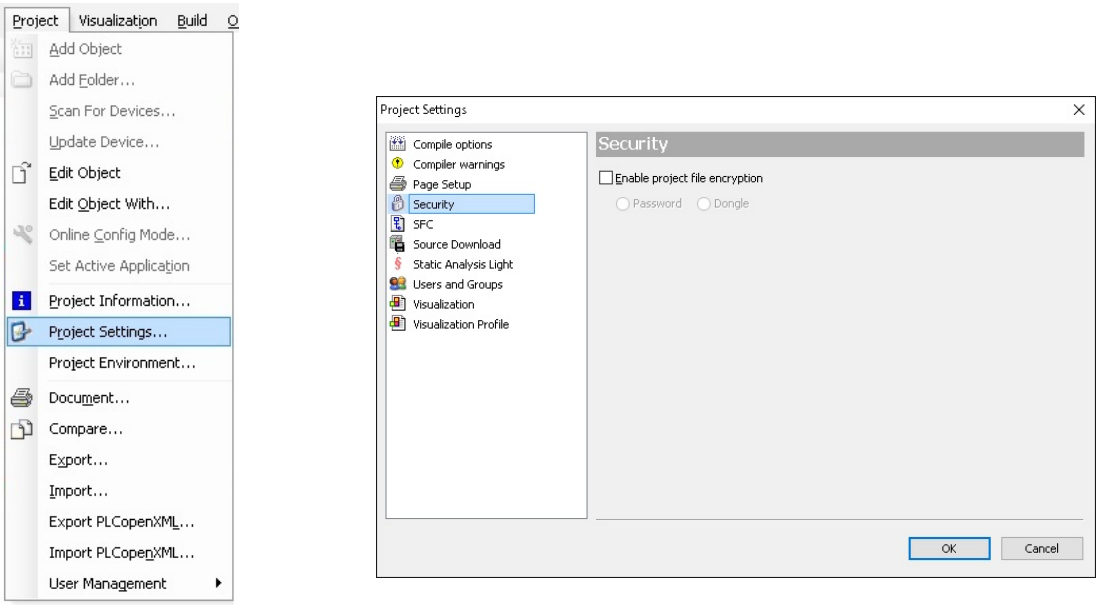


Figure 4.22 Configuration of Project password

Select [Password] by check on [Enable project file encryption].

Input current password, new password and new password confirming.

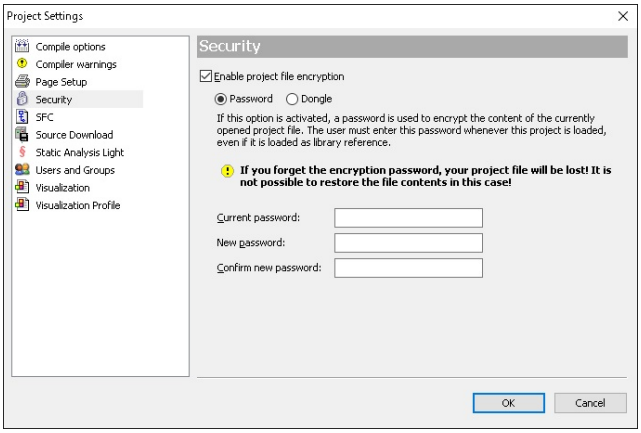
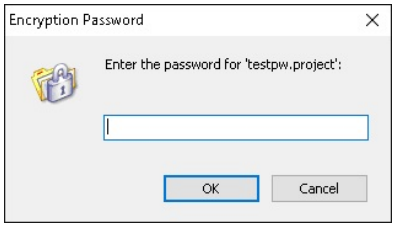


Figure 4.23 Input Project password

Then protection is enabled when to open stored file or to open uploaded source program stored in HX-CPU.

At the time to open project or uploading



In case of password is not correct

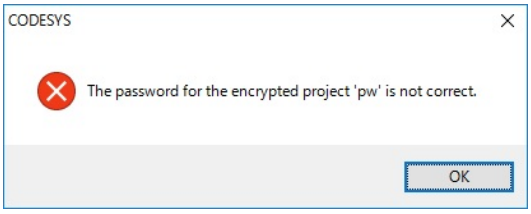


Figure 4.24 Input Project password

Caution

Project can’t be opened if forgetting coding password. Please be careful not to forget password and manage it.

Access limitation of Visualization

It is possible to make access limitation for Visualization page or Display element.
Configure access right for each group by registering user and group belonging its user.

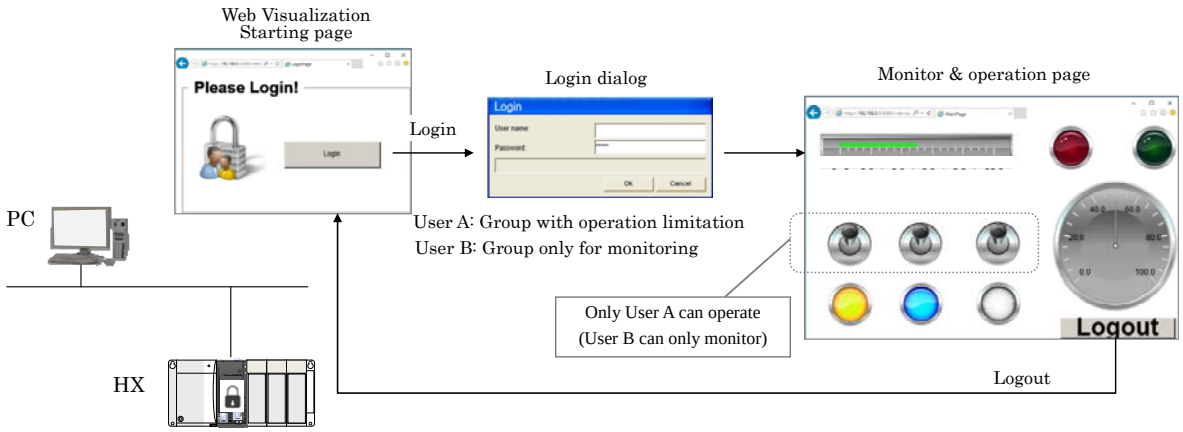


Figure 4.25 Visualization example with access limitation

User management of Visualization

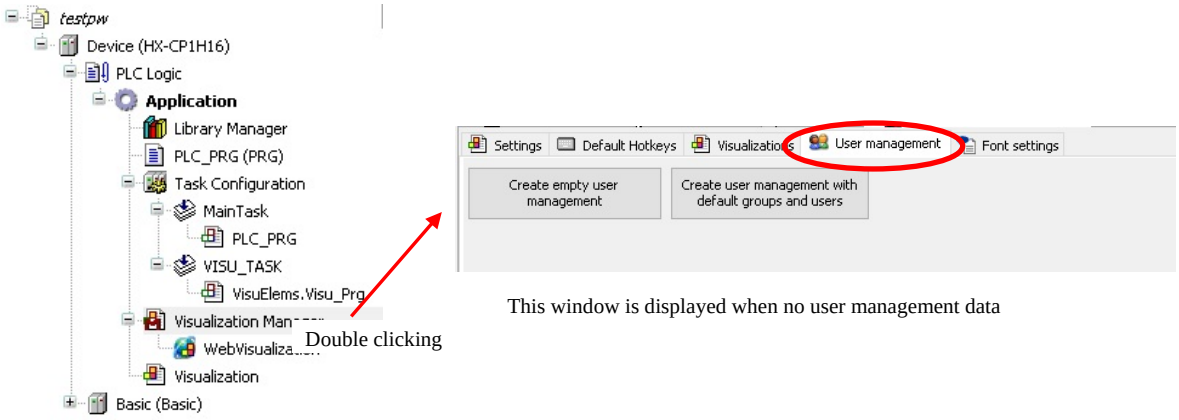
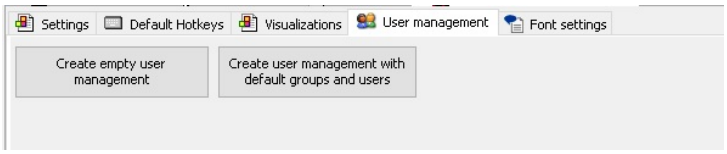
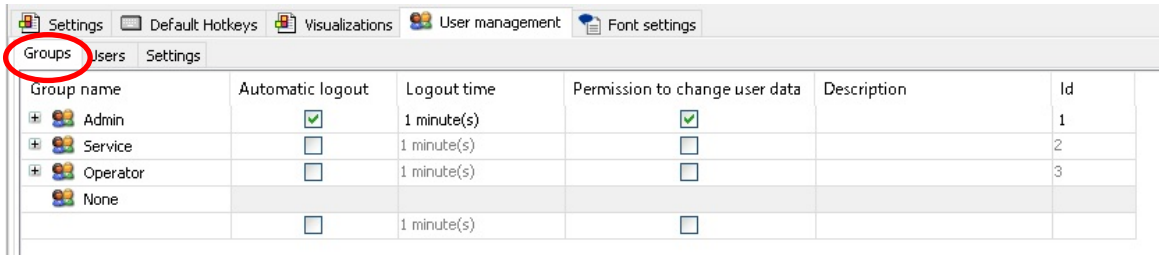


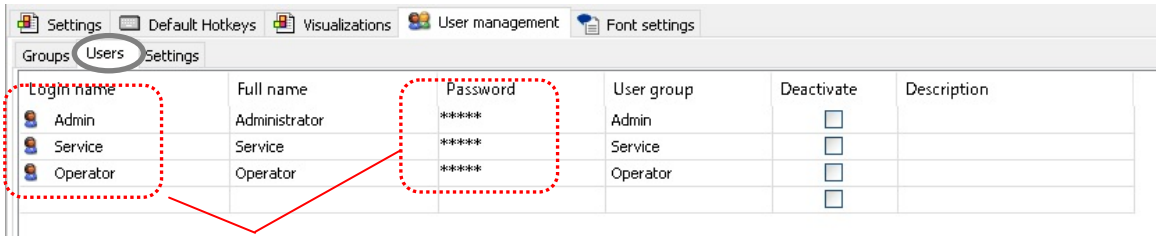
Figure 4.26 Visualization manager

There is no user management data as default setting. Click [Create user management with default groups and users] in order to register user management group and user.



Configuration of Group and User is default setting in below. At this default setting, user belongs to Group [Admin] are configured having right of data changing.



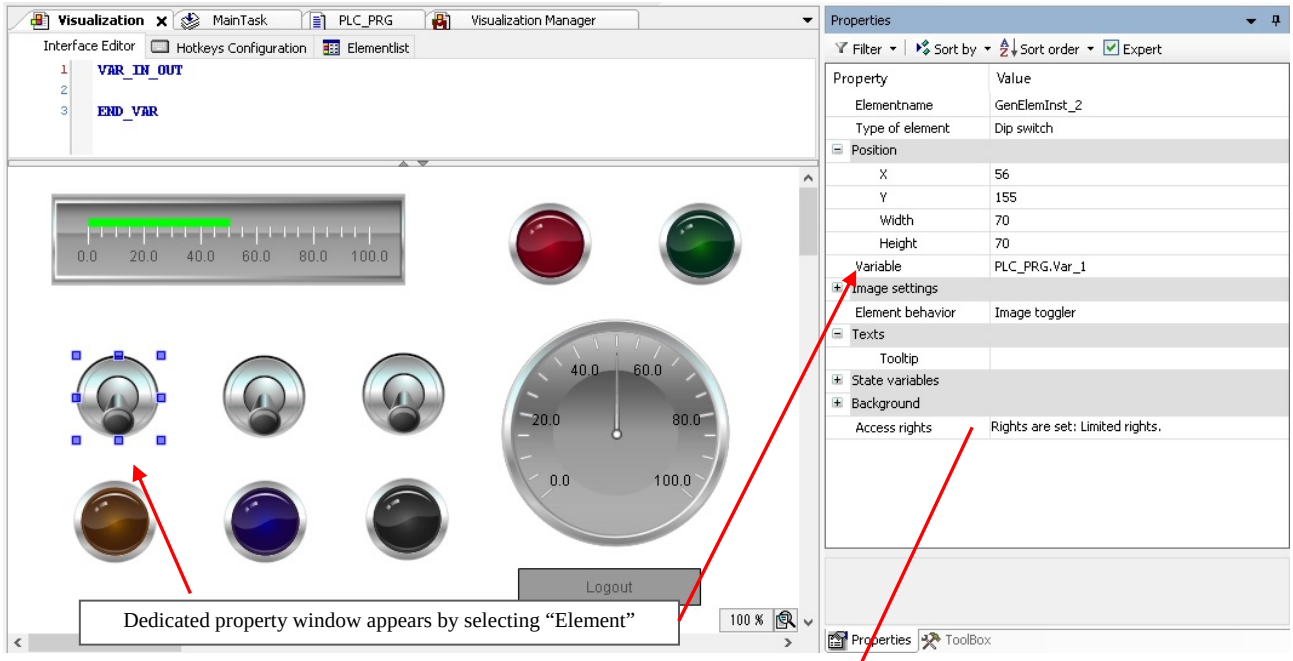


User name to password are same at default setting

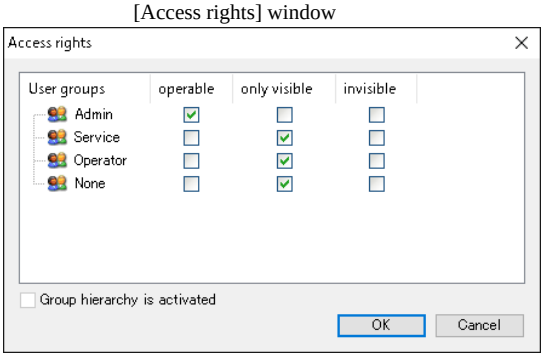
Figure 4.27 User management Visualization manager

Next is explanation of Element configuration of Visualization.

Configure [Access rights] on the property window of element.



[Access rights] window



Double clicking

Configure other than user of Group [Admin] can’t operate.

Figure 4.28 Access right configuration for element of Visualization

⚠ Caution

In the control system, recently, the connection and cooperation with the information communication system progress and information security risks including cyber attacks are growing. In a system applying this product, physical security measures mainly in the installation location and security measures in use via network are needed.

[Security risk example via the network]
- Abnormal operation, performance degradation, information leakage and data tampering by attacks from outside
- Malfunction, harm and damage occurrence due to programs and/or data tampering from outside
- It is used as an attacking step for the-other systems

Hitachi Group is striving security improvement of control systems by establishing prerequisite protecting target defined for each product and equipping security protection functions under the own provision security design procedure.

In order to deal with the security risks from the outside via the network, this product is equipped with a security protection support functions for the purpose of prevention of unauthorized access. However, the security level to be determined by the control system. In addition, the assumed security risk is not fixed, it will be something to change on a daily basis.

Not only in our products, individual security protection support functions of each product configuring the system is one means to ensure the security level required for the system, it does not completely prevent the security risk growing daily.

The construction of the security level required for the control systems are responsible by the system and customer. In addition, for the maintenance of the security level will require continuous improvement measures.

In a system using this product, regardless of the presence or absence of the use of security protection support functions, trouble, accident or damages caused by unauthorized external access, Hitachi Group will not be able to bear any responsibility.

It is required for the customer side to clarify the target of the security protection of the system, following the conduct measures example to a representative, please refer to the construction and operation of the system.

-Utilization and regular review of the authentication function for the program and the data to be protected

-Utilize the security functions of the device configuring the network

-Prevention of the unspecified connection by the use of a particular function to identify connection

-Measures in the operational management, such as to lock the location of devices or limit the operator

MEMO

Chapter 5 Debug Function

Several debugging functions are available in HX-CODESYS. In this chapter, following debug functions are described.

Table 5.1 List of Debug function

No.	Functions	Refer to
1	Monitor	5.2
2	Flow control	5.3
3	Break point	5.4
4	Single cycle and Step over / into / out	5.5
5	Force values and Write values	5.6
6	Trace	5.7

There are two methods, one is online debug done by connecting with HX-CPU, the other is offline debug executing simulation on HX-CODESYS.

5.1 How to Start

Even it is same operation of debug operation between online debug and offline debug, starting operation is different. Each method how to start is described in below.

How to start offline debug

Login and start execution.

How to start simulation

Click [Online]- [Simulation]. Login and start execution.

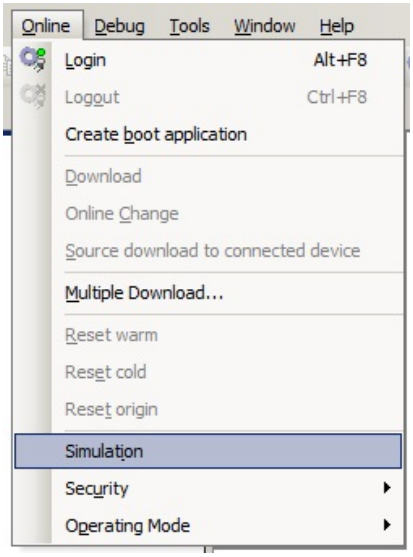


Figure 5.1 Simulation debug

5.2 Monitor

Monitor function is to monitor contact, coil and current value of variable and it is possible to monitor variable declaration part, LD (Ladder logic diagram) display part, FDB (Function Block Diagram) part, ST (Structured Text) display part etc.

Declaration variable part

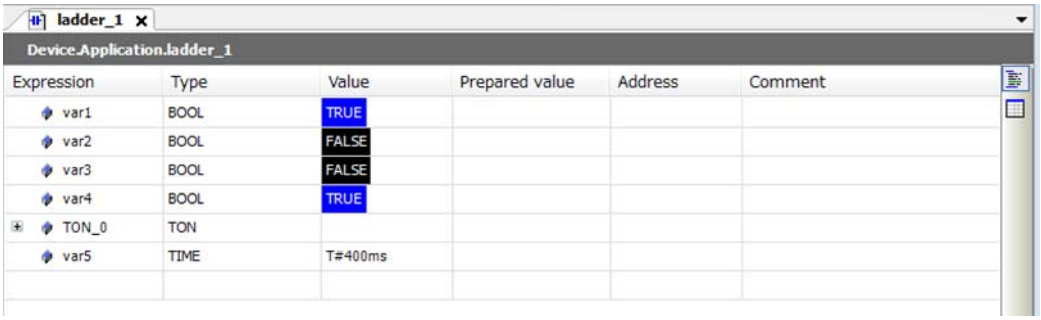


Figure 5.2 Monitor value of variable

Table 5.2 Monitor value of variable

Display	Contents
TRUE	Variable is TRUE.
FALSE	Variable is FALSE.
T#400ms	Value is 400 ms.

Ladder logic diagram

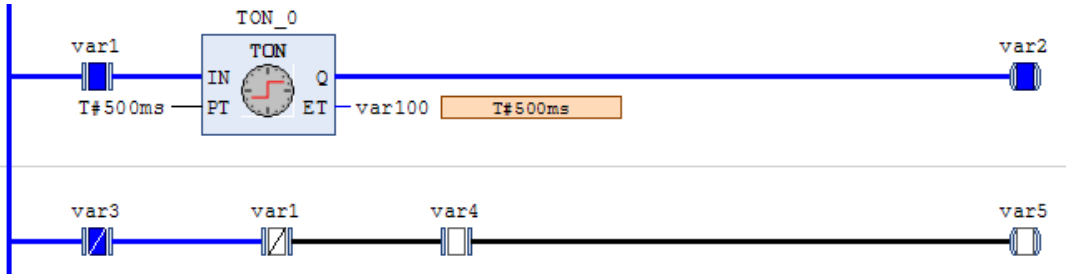


Figure 5.3 Monitor ladder logic diagram

Table 5.3 Monitor ladder logic diagram

Symbol	Description
var1	Contact is TRUE.
var3	Negative contact is TRUE.
var2	Contact is FALSE.
var1	Negative contact is FALSE.
var2	Coil is ON.
var5	Coil is OFF.
T#500ms	Value is 500 ms.

Function Block Diagram

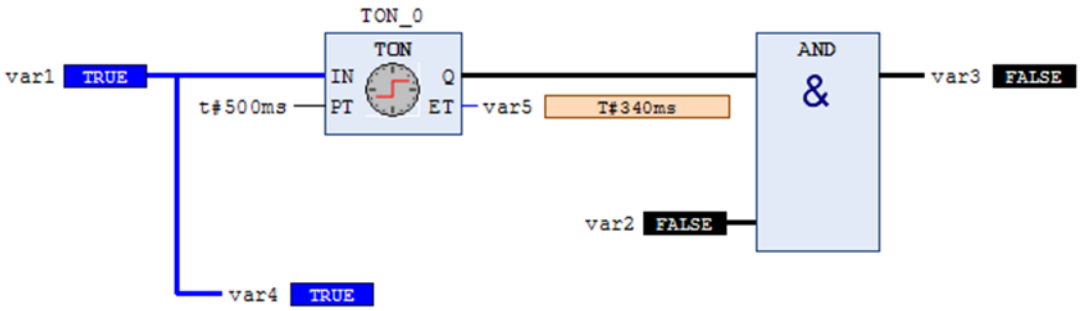


Figure 5.4 Monitor function block diagram

Table 5.4 Monitor function block diagram

Display	Contents
TRUE	Value is ON.
FALSE	Value is OFF.
T#340ms	Value is 340 ms.

Structured text

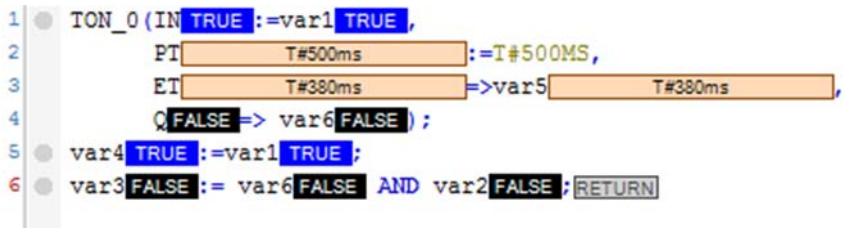


Figure 5.5 Monitor structured text

Table 5.5 Monitor structured text

Display	Contents
TRUE	Value is ON.
FALSE	Value is OFF.
T#500ms	Value is 500 ms.

Change display mode

It is possible to change display for variable monitor with binary, decimal or hexadecimal. Select [Debug]-[Display mode].

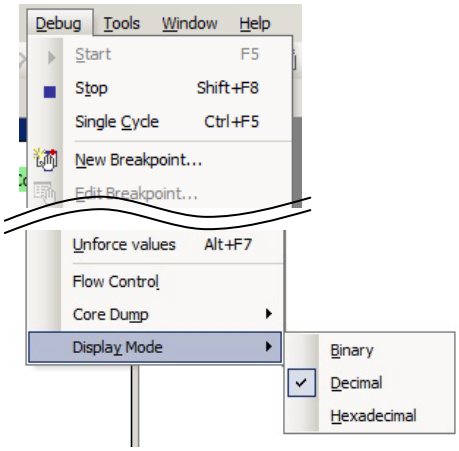


Figure 5.6 Change display mode

Binary display

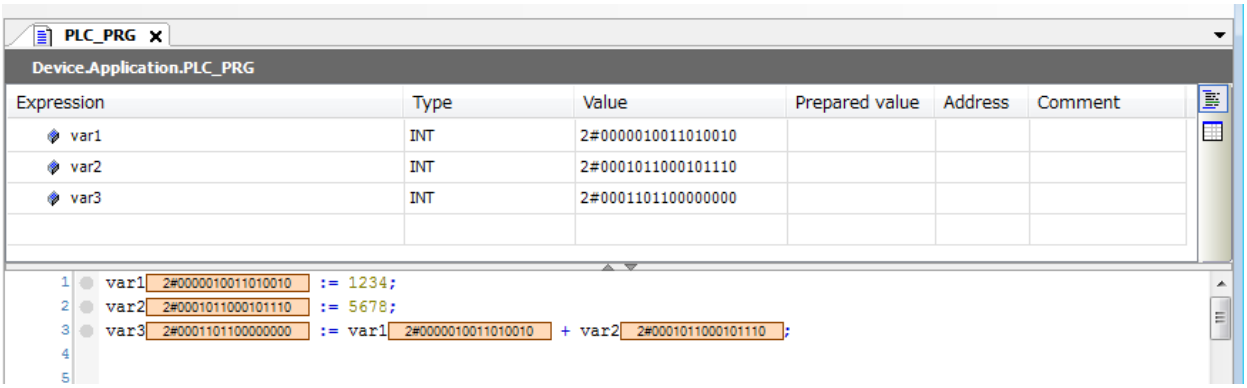


Figure 5.7 Binary display

Decimal display

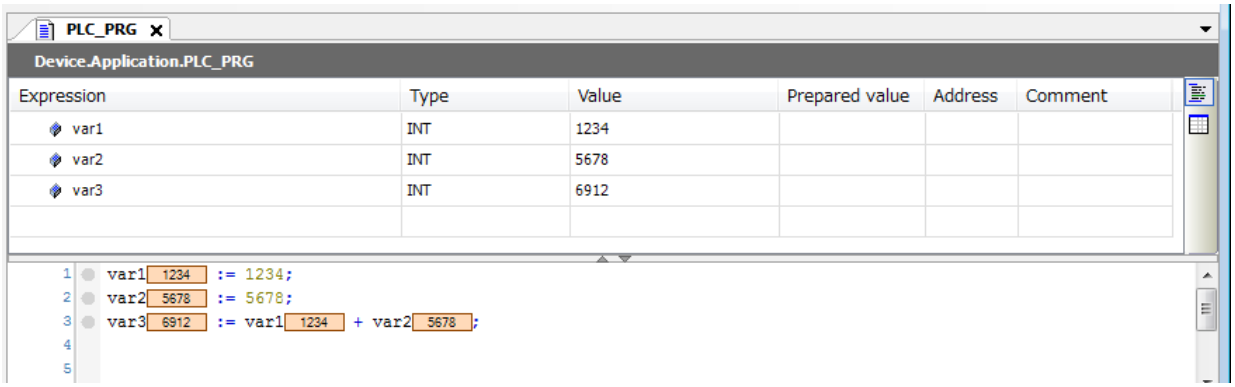


Figure 5.8 Decimal display

Hexadecimal display

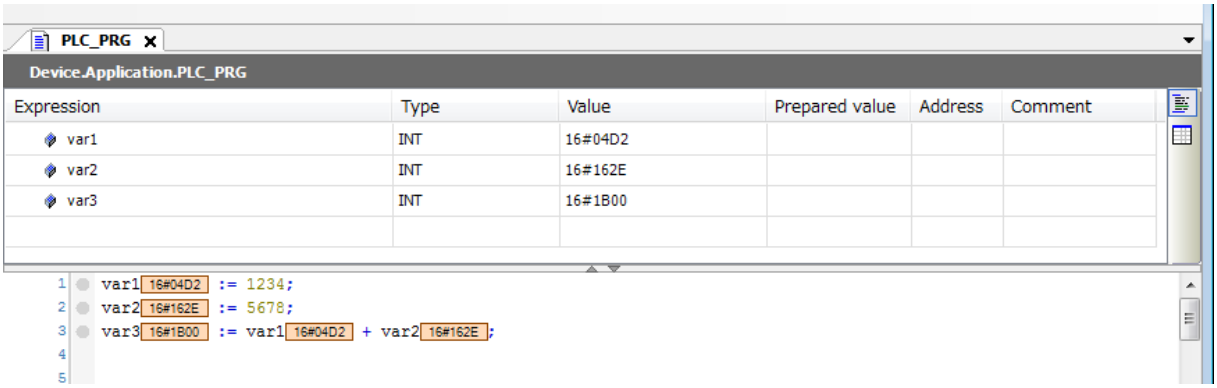


Figure 5.9 Hexadecimal display

Array variable monitor

It can't be display with array variable more than 1,000 if array declaration exceeds 1,000 at the default status.

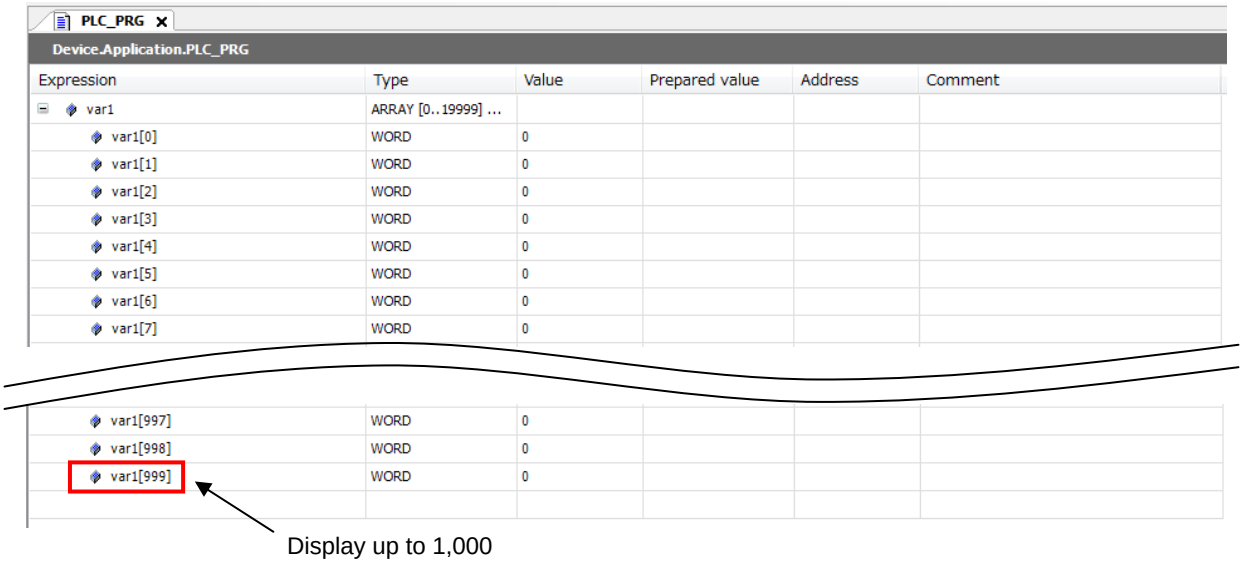


Figure 5.10 Array variable monitor 1

Change range of list display by double clicking [ARRAY[*..***]O..] to monitor array variable more than 1,000. List display is extended up to 20,000.

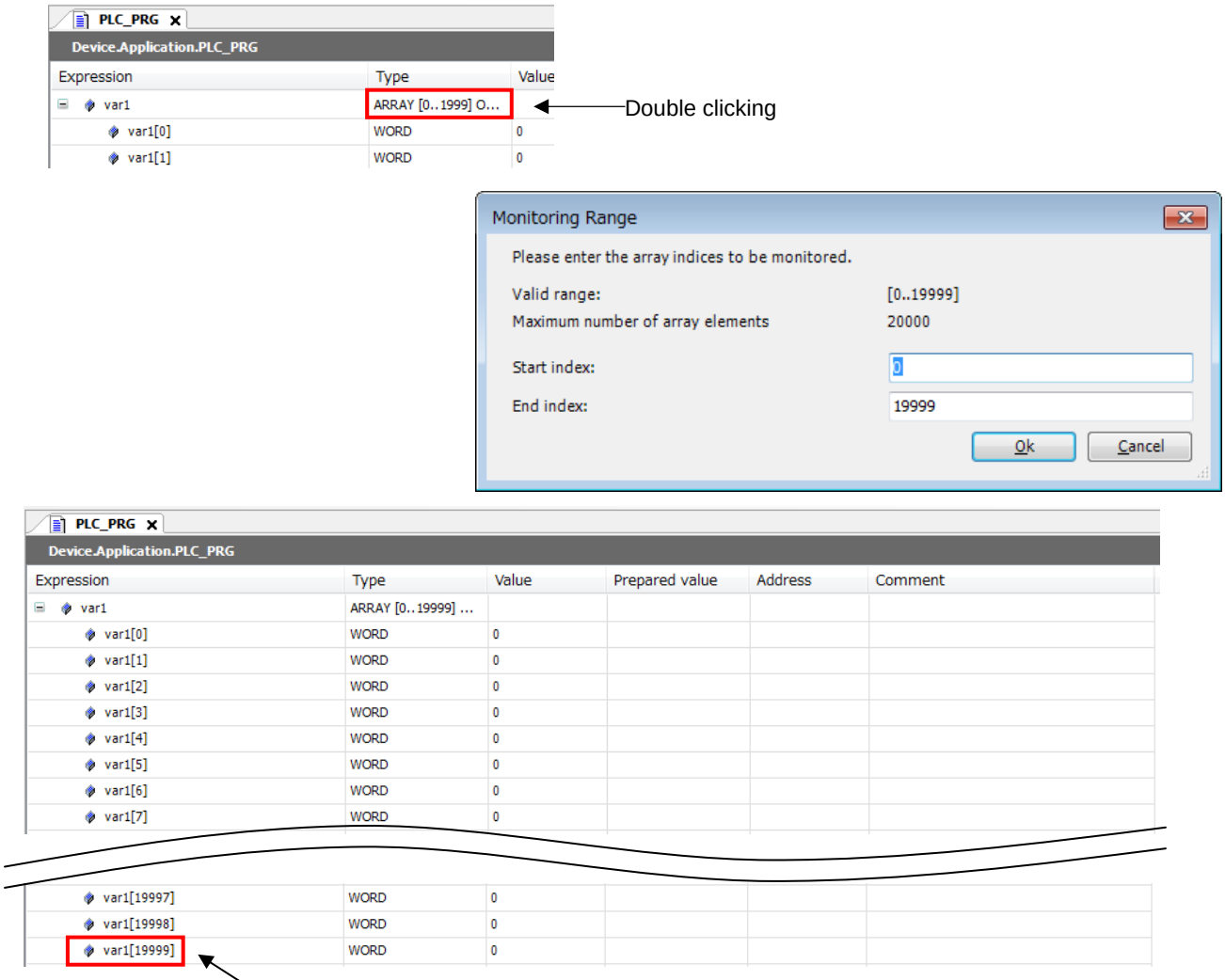


Figure 5.11 Array variable monitor 2

5.3 Flow Control

Flow control function is possible to confirm executing part of program by indicating green color on the part of execution.

Click [Debug]-[Flow Control] after login.

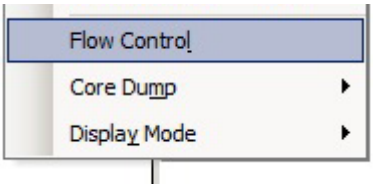


Figure 5.12 Enable flow control

Display only executing part colored green.

```
1  IF x 70 > 100 THEN
2      x 70 :=0;
3  ELSIF x 70 < 50 THEN
4      a 444 := 111; b 555 := 222; c 666 := 333;
5  ELSE
6      a 444 := 444; b 555 := 555; c 666 := 666;
7  END_IF
```

Executing program part.

Figure 5.13 Display flow control

In the above example, there are three condition [x>100], [x<50] and [other] divided by condition of x value. Display executing part with green color in the case of [x=70] shows [other].

5.4 Break Point

Break point function is possible to stop program at the position specified stopping position of application program for debugging.
The possible break point position is the position can be changed value of variable or the position to call program after branch.

Configuration method of Break point

Show example of Break point with structured text.
Grey colored circle appears where break point can be set after login.

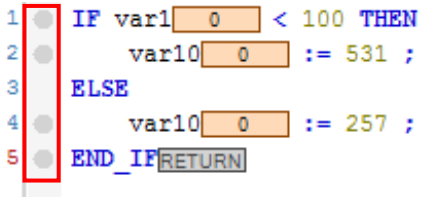


Figure 5.14 Break point position

After click [New Breakpoint] of [Debug] menu, property screen of Break point appears and then click [Location] tab. Specify POU to set Break point at [POU]. Specify the line to set Break point at [Position]. Check [Enable breakpoint immediately] to enable break point immediately after specifying.

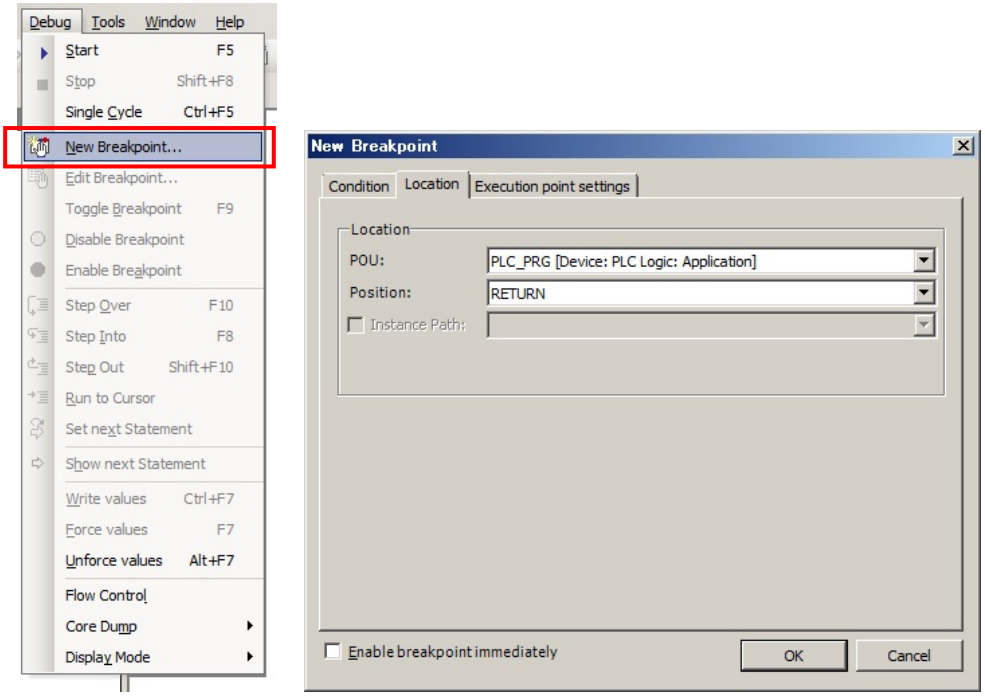
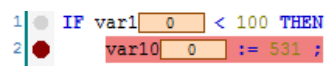
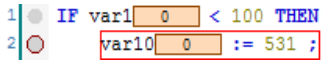


Figure 5.15 Break point settings

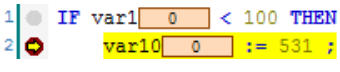
Display red colored circle at valid Break point.



Display grey colored circle at invalid Break point.



Display yellow colored allow at the position program stopped.



5.5 Single Cycle and Step Over / Into / Out

5.5.1 Single Cycle Execution

Single cycle execution function is possible to execute only 1 cycle.

Execute only 1 cycle of program by clicking [Debug]-[Single cycle]. If there are several tasks, all tasks are executed only 1 cycle instead of task cycle.

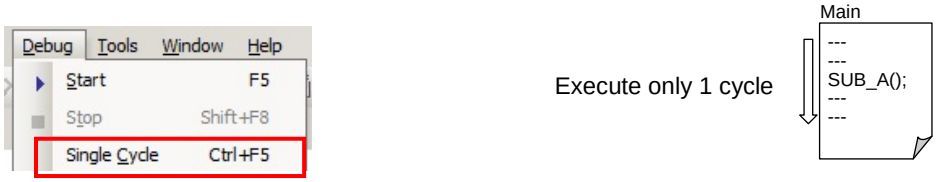


Figure 5.16 Single cycle step function

5.5.2 Step Execution

There are four kinds of step execution function in HX-CODESYS.

Set some Break point is needed due to Step execution function execute program after stopping temporaly.

(1) Step Into function

Step into function execute every one step of function or function block. If this function is to step into at the SUB_A (the line that will be executed next), this function move to the first line of SUB_A, stepping into the call.

Click [Debug]-[Step Into] menu to execute Step in.

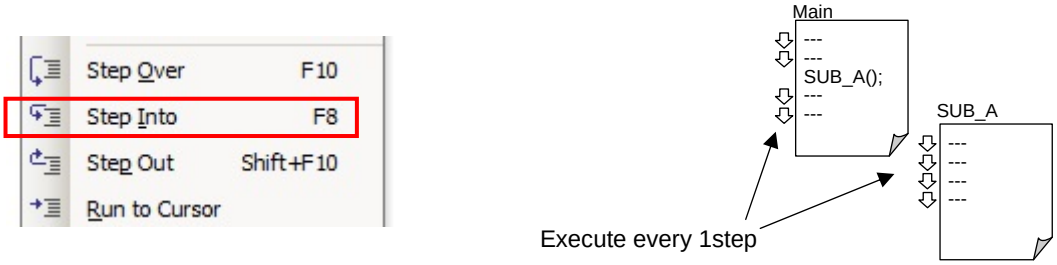


Figure 5.17 Step into function

(2) Step Over function

Step over function execute function or function block at once. If this function is to step into at the SUB_A (the line that will be executed next), this function move to the next SUB_A, stepping over the call.

Click [Debug]-[Step Over] to execute Step over.

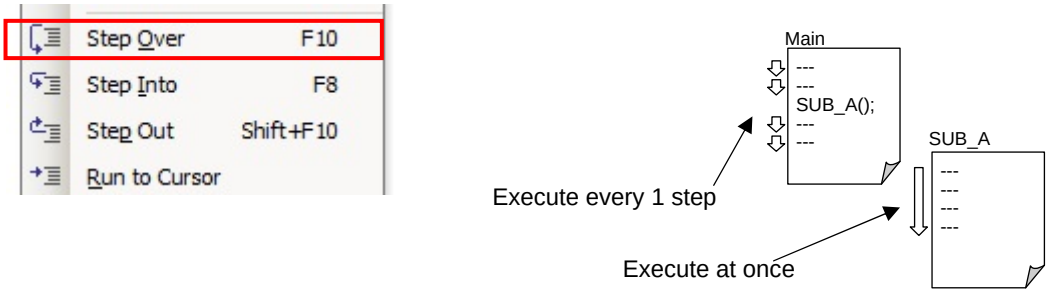


Figure 5.18 Step over function

(3) Step Out function

If Step out function execute during the execution of function or function block by Step into function, execute all program of function or function block and go through original program from function or function block.
Execute Step-in by clicking [Debug]-[Step Out].

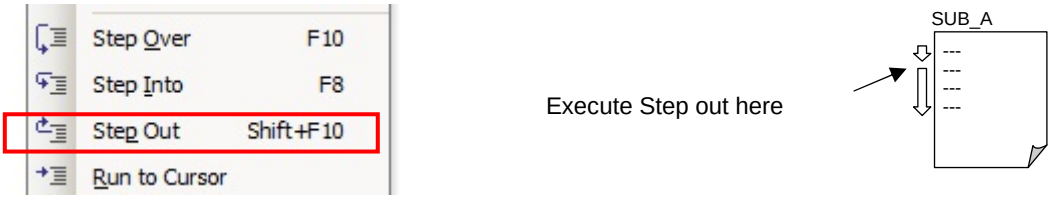


Figure 5.19 Step out function

(4) Run to cursor

Run to Cursor execute program until position of cursor on the line.

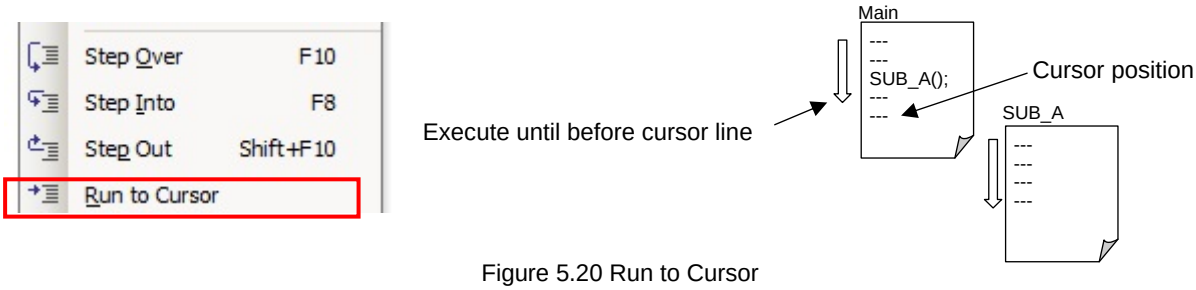


Figure 5.20 Run to Cursor

5.6 Force Values and Write Values

Variable value can be forced to a certain value. In force values, the value is set every cycle. In write values, the value is set once.

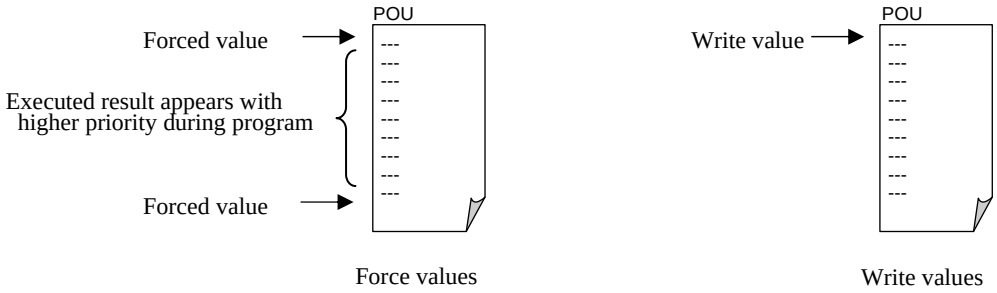
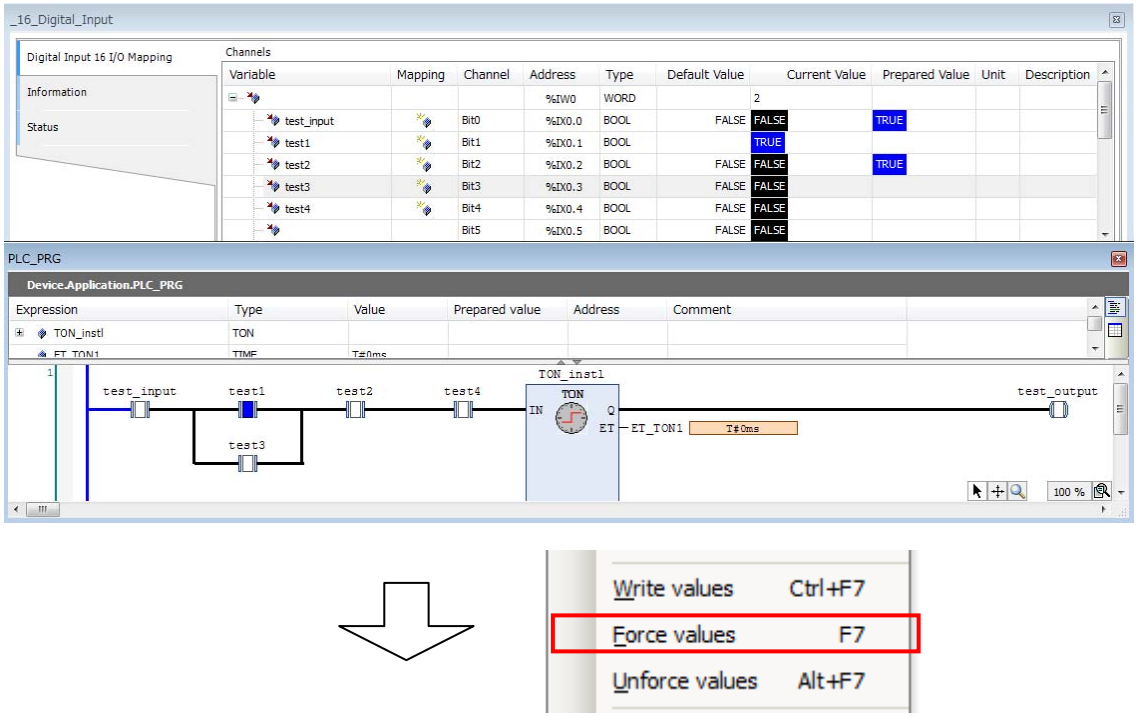


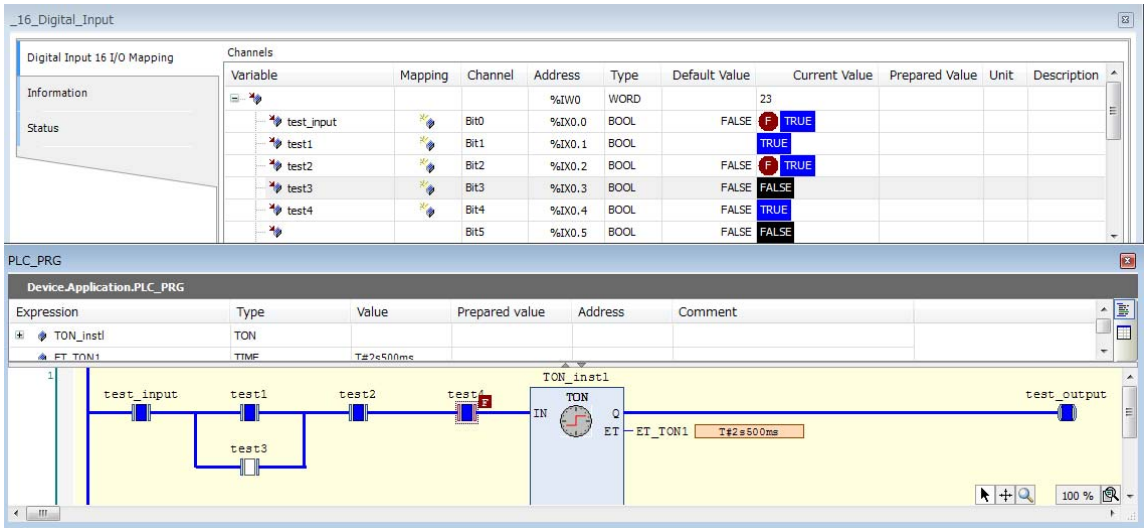
Figure 5.21 Force values and Write values function

⚠ Caution
There is some risk like malfunction of device, danger of human depends on target system caused by use of Value force set and write value function. Please test enough and confirm stable operation of target system with value of variable to use for force values and write values.

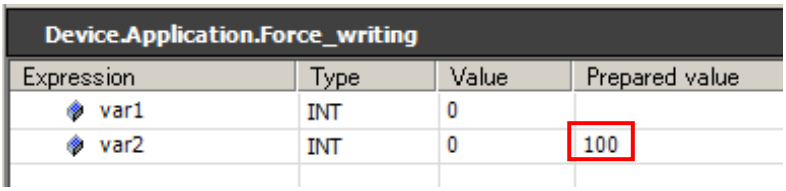
Configuration method of force function

Set write value of variable by double clicking [Prepared value] of variable declaration part.





It is possible to set value for variable similar way.



Display value with “<>” at value monitor part of editor part by setting value.

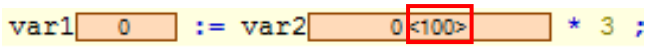


Figure 5.22 method of force function

Configuration method of Write value function

Click [Debug]-[Write value] after setting write value of variable with similar way of Value force set function.

The value is set only once when starting user program execution.

5.7 Trace

Trace function samples variable without dedicated program.

Configuration method

Create trace object

Add trace object by clicking [Add Object]-[Trace] after right clicking [Application].

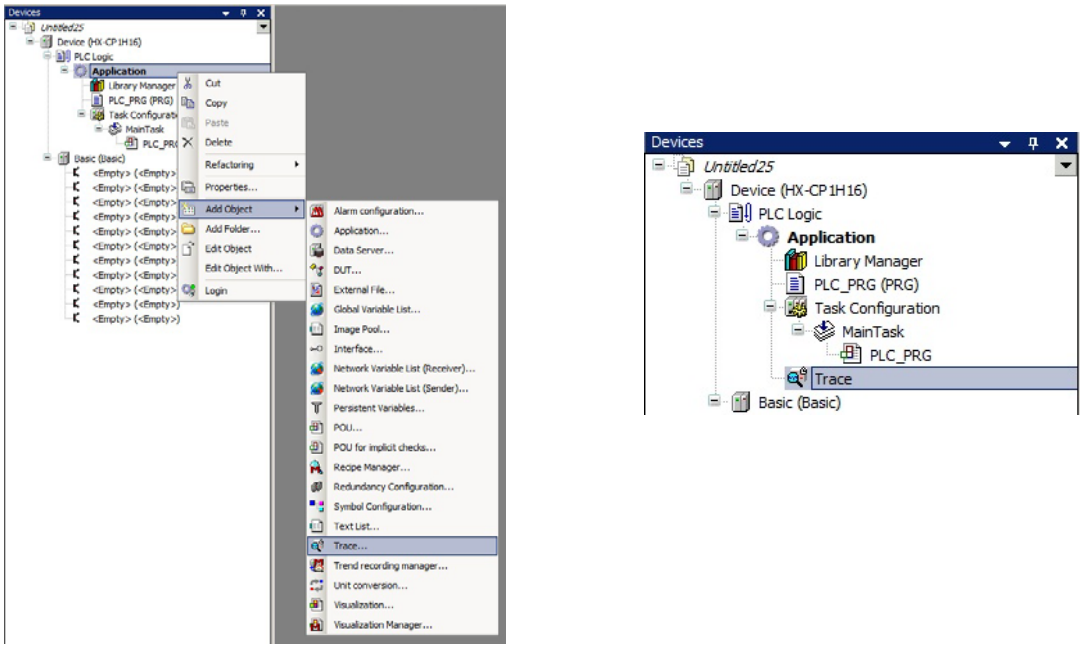


Figure 5.23 Create trace object

Trace editor appears by double clicking [Trace] object.

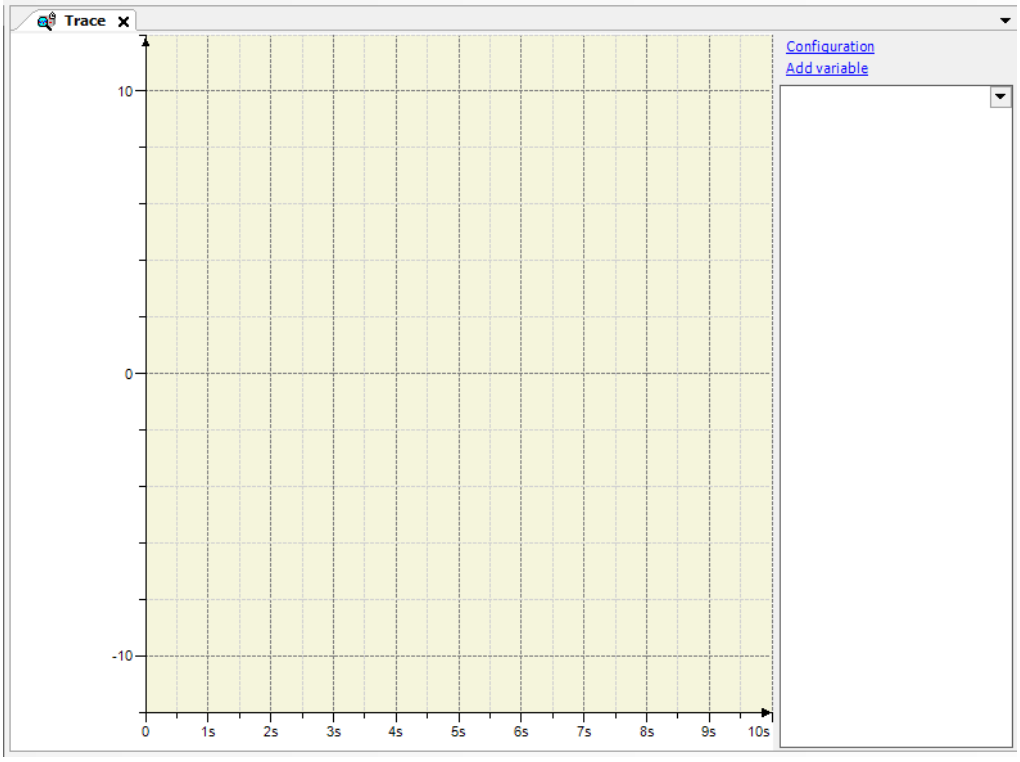


Figure 5.24 Trace editor

Configure [Task] by clicking [Configuration]. Trace sampling cycle is defined by this task configuration. Configure other items if it is needed. It is recommended the trace task priority is configured lower due to avoid impacting the other process of user program when trace task load is heavy.

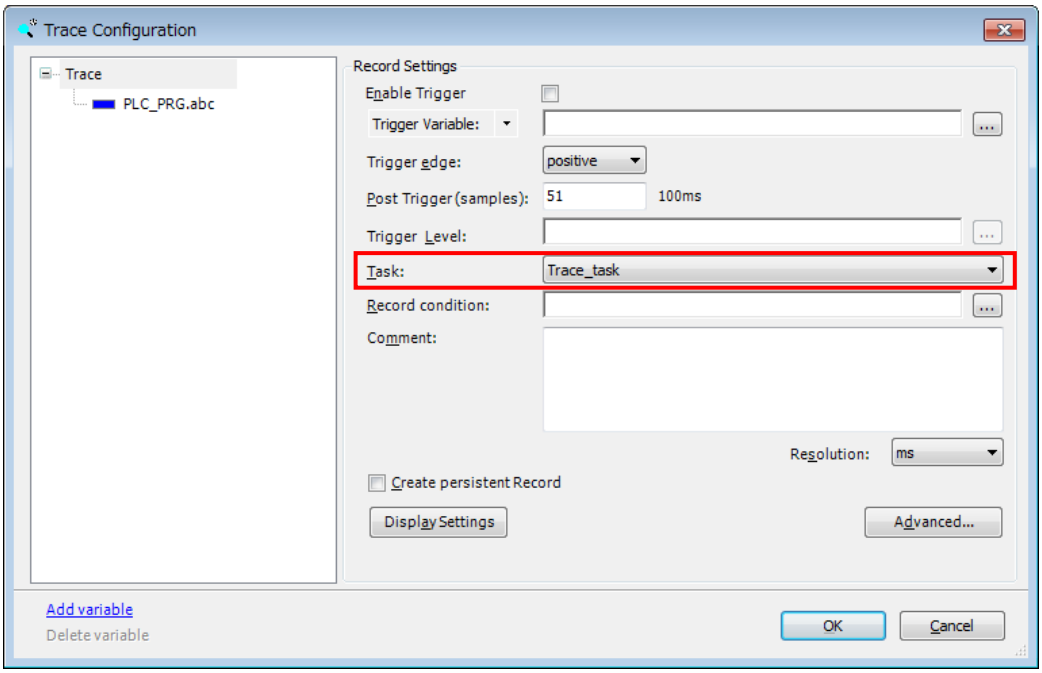


Figure 5.25 Configure trace task

Configure trace variable at [Variable] by clicking [Add variable]. Configure other items if it is needed. In case of adding new variable, configure by clicking [Add variable] with similar way.

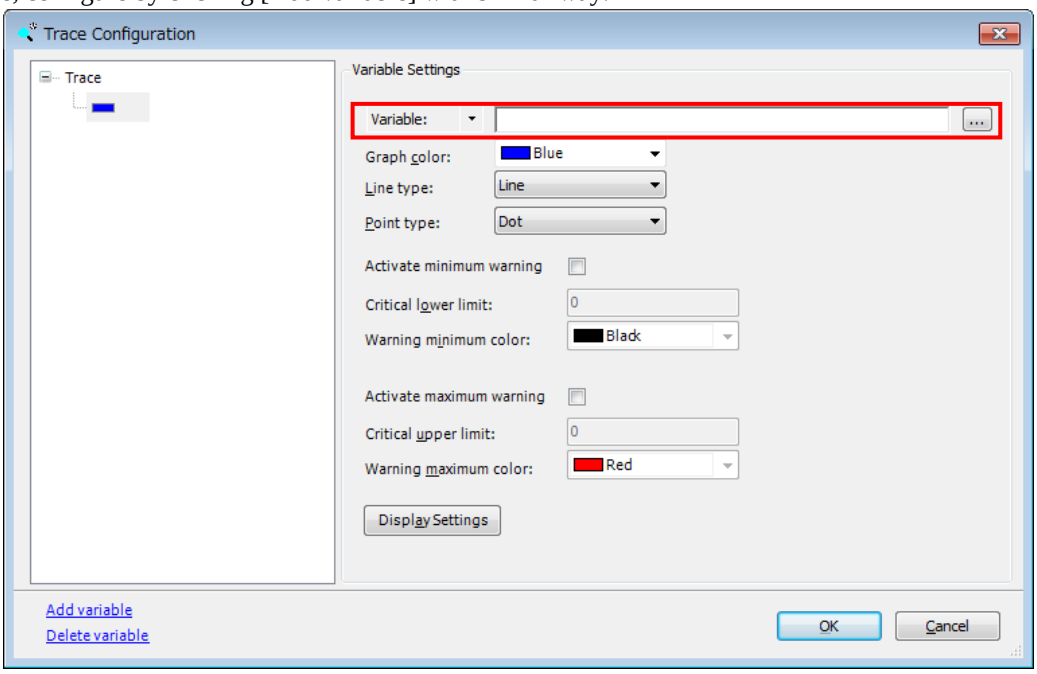


Figure 5.26 Add variable

Download trace data to HX-CPU by clicking [Trace]-[Download Trace] menu after login.

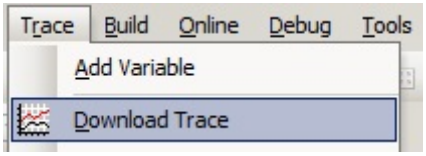


Figure 5.27 Download Trace

Display starts immediately according to the configured contents.

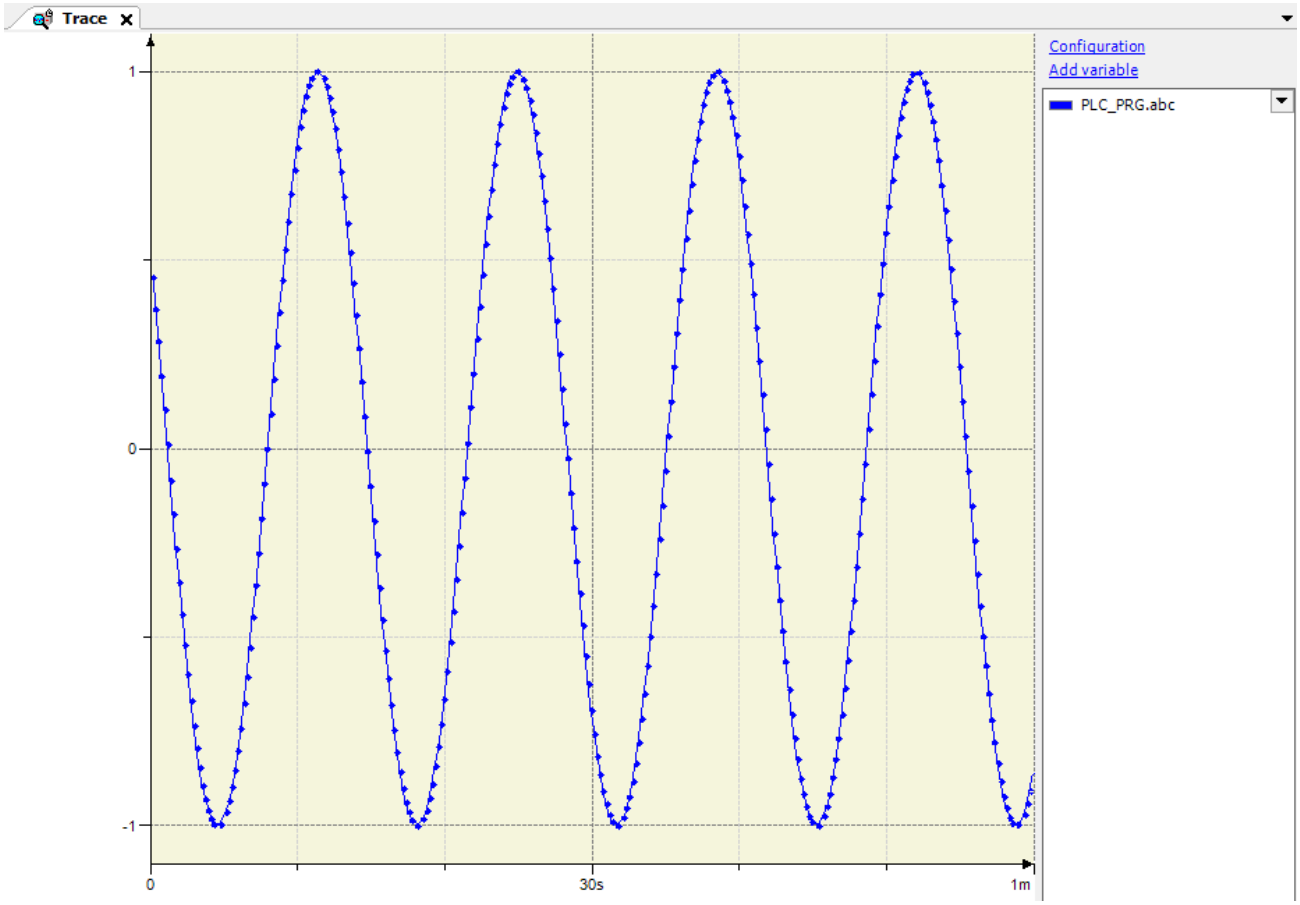


Figure 5.28 Trace data display

Following operation is possible after displaying trace data on [Trace] menu. Please refer online help for further detail information.

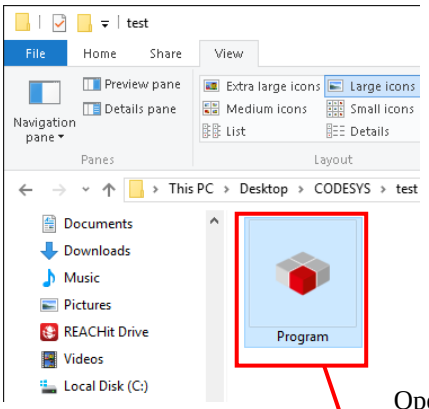
-Start/Stop of Trace data
-Customize display graph
-Access Trace data of HX-CPU
-Save/Read of Trace data

Appendix 1 Known Restrictions

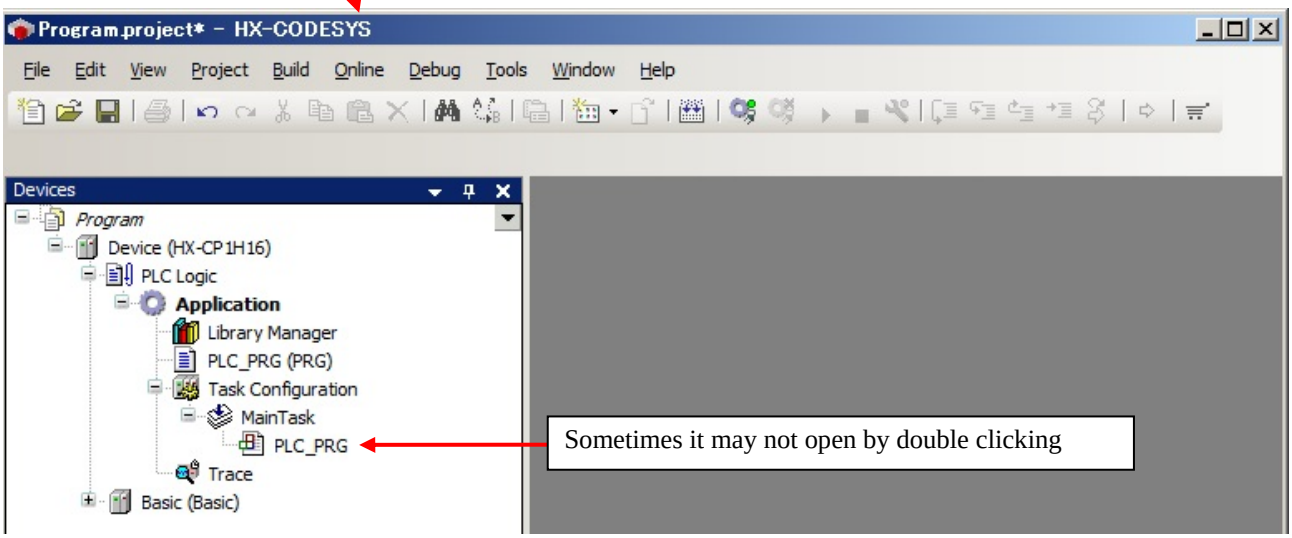
Following restrictions has been recognized with HX-CODESYS V3.5 SP8 Patch4. These are depend on the based software CODESYS V3.5 SP8 Patch4 from 3S-Smart Software Solutions, and will be improved later version.

[Open project]

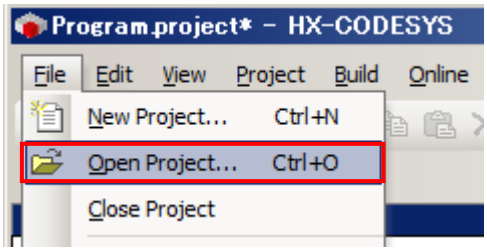
When open project file by specifying file from saved project file, sometimes POU can not be opened.



Open



This can be avoided and Project can be opened by [File]-[Open Project] after invoking HX-CODESYS.



[Leap year]

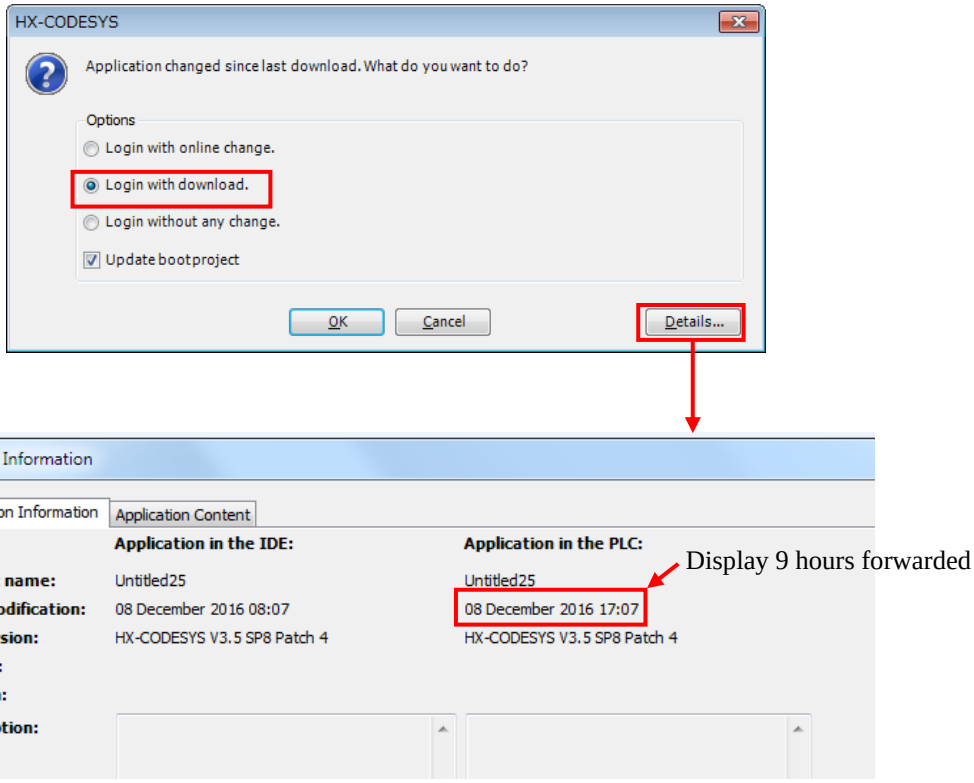
Getting day information command DTU.GetDayOfWeek() can't get correct information on February 29th (leap year) and day information is [7].

```
DOW1  SUNDAY    :=DTU.GetDayOfWeek(dtDate:=D#2016-2-28, peE
DOW2  7         :=DTU.GetDayOfWeek(dtDate:=D#2016-2-29, peE
DOW3  TUESDAY   :=DTU.GetDayOfWeek(dtDate:=D#2016-3-1, peEr
DOW4  WEDNESDAY :=DTU.GetDayOfWeek(dtDate:=D#2016-3-2, peEr
DOW5  THURSDAY  :=DTU.GetDayOfWeek(dtDate:=D#2016-3-3, peEr
DOW6  FRIDAY    :=DTU.GetDayOfWeek(dtDate:=D#2016-3-4, peEr
DOW7  SATURDAY  :=DTU.GetDayOfWeek(dtDate:=D#2016-3-5, peEr
DOW8  SUNDAY    :=DTU.GetDayOfWeek(dtDate:=D#2016-3-6, peEr
DOW9  MONDAY    :=DTU.GetDayOfWeek(dtDate:=D#2016-3-7, peEr
```

[Application information]

It is possible to confirm PLC project and PLC project application information at login, however latest updated day and time of PLC application is forwarded 9 hours if previous download is done by [Login with download]. This is no problem on execution.

*Latest updating day is displayed correctly, when previous download done by [Login with online change].

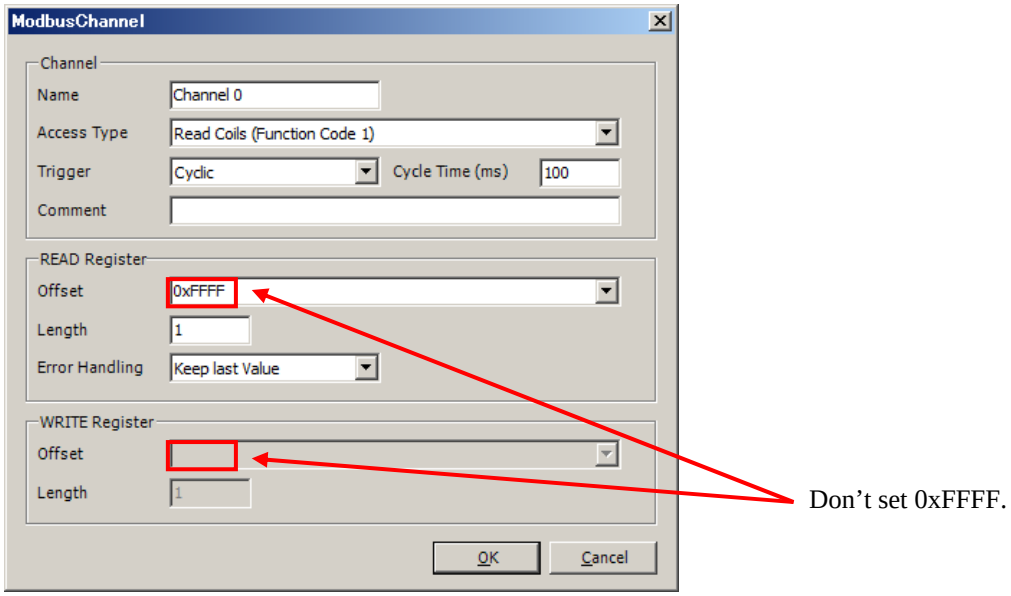


[Modbus-RTU Master]

[Modbus channel offset]

Don’t set “0xFFFF” for ofset value of Slave Modbus channel, when using Modbus-RTU master.

And don't set combination values of offset and lengths exceeding “0xFFFF” for ofset value of Slave Modbus channel.(Example Offset:0xFFFE, Length: 2)



[Modbus-RTU / TCP Slave]

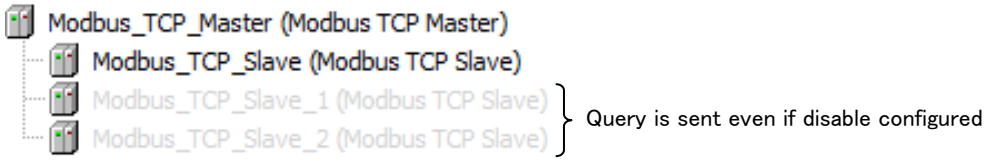
[Disable of Device]

Query will be sent even if Modbus-RTU / TCP slave device is disabled. Therefore, slave function block error(*) is detected due to receive timeout slave is occurred.

* In case of Modbus-RTU: ModbusSlaveComPort_Diag
  In case of Modbus-TCP: ModbusTCPSlave_Diag

In case of Modbus-RTU

In case of Modbus-TCP



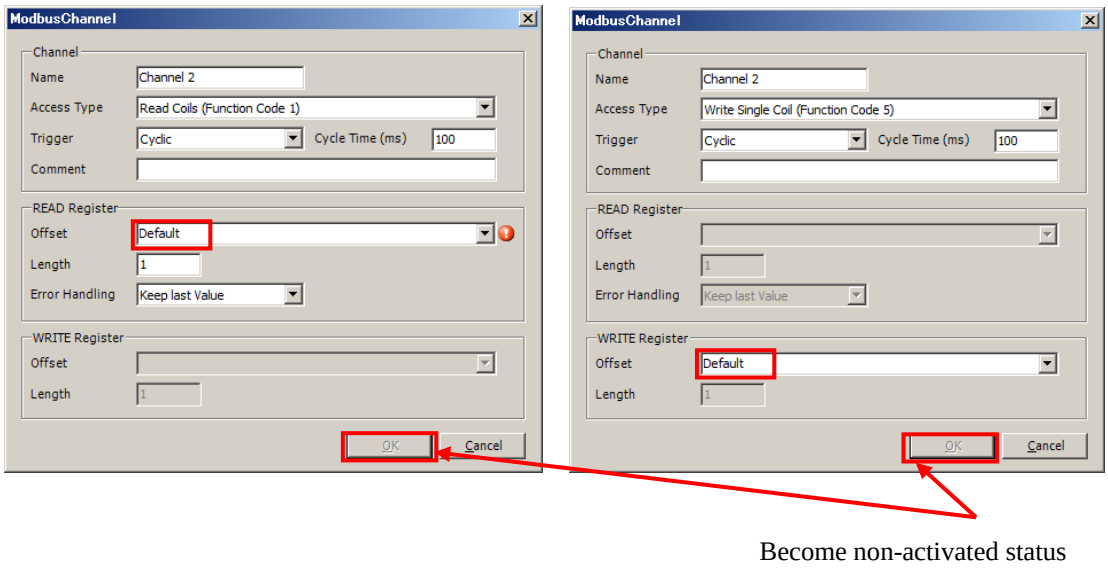
[Modbus-TCP Master]

[Channel configuration]

OK button becomes non-activated if specific offset address is used for slave channel registration at Modbus-TCP master.

Specific offset address: 0x0001 / 0x0005 / 0x03E8

This can be avoided by pressing Enter instead of OK clicking.



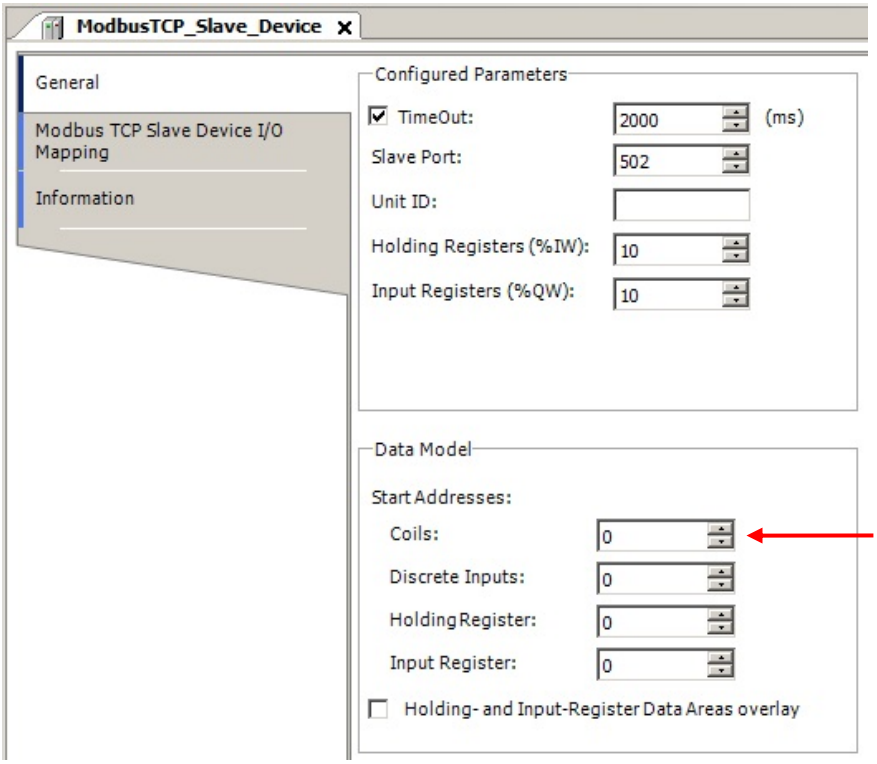
[Modbus-TCP Slave]

[Device function code 15 (Write multiple coils)]

Configure number of coil is 8 integral multiples when write data using Function code 15 (Write multiple coils) from external Modbus-TCP master and HX-CPU is used as Modbus-TCP slave. Operation is not properly if configure is not 8 integral multiples.

[Start address of Coil]

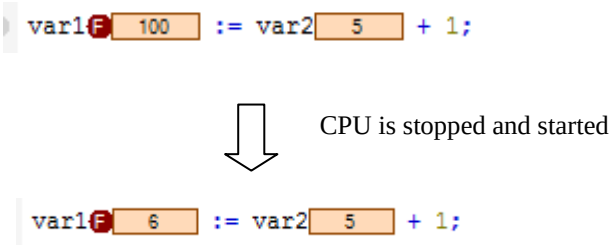
Configure start address of coil is 16 integral multiples when it is not specified 0(zero) and HX-CPU is used as Modbus-TCP slave. Operation of Function code 5 (write single coil) is not properly if other value is set.



Set 16 integral multiples value

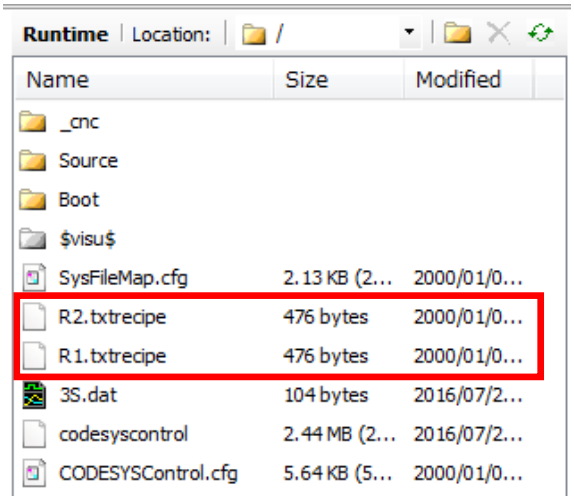
[Force values]

If CPU is stopped by RUN / STOP switch while variables are forced, the variables are automatically unforced because stop position of RUN / STOP switch is [Reset warm]. If HX-CODESYS is connected with online in this case, forced status continues to display. Choose [Debug]-[Unforce values] to release force status.



[Reset origin]

When the project included Recipe Manager is downloaded to HX-CPU, Several files about Recipe Manager are created but these files are not deleted by Reset origin. Please delete each file by [Device]-[Files] tab.



[Visualization]

[Text editor] in visualization function is not supported. Please do not use it. If you use it HX-CPU may operate incorrectly.

[Online change]

Do not make online change with changing FB body and without changing its instance.
If you do that, error dialog appears. Click [Ignore] to continue.

Example: FB is replaced, but instance is not changed as follows.

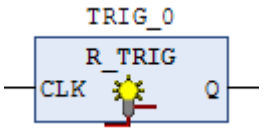
In Structured Text

Before: `TRIG_0 : R_TRIG;`

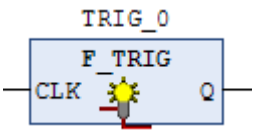
After: `TRIG_0 : F_TRIG;`

In LD/FBD

Before



After

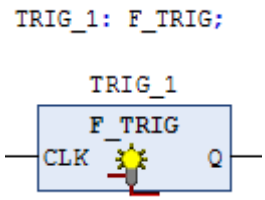


If it is necessary to change like this, choose download (CPU stops) instead of online change. If it's not possible to stop CPU, add new instance as follows.

In Structured Text

After: `TRIG_1 : F_TRIG;`

In LD/FBD



In addition to R_TRIG and F_TRIG, this restriction is applied to TON and TOF also.

Besides FB, it is applied to STRUCT too. Do not make online change with changing STRUCT name and without changing variable name of STRUCT.

Before: `test_STR : STR_A;`

After: `test_STR : STR_B;`

If it is necessary to change like this, choose download (CPU stops) instead of online change. If it's not possible to stop CPU, add new variable as follows.

Before: `test_STR : STR_A;`

After: `test_STR2 : STR_B;`

MEMO

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[GPLv1 application software package list]

perl-5.22.1

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<signature of Ty Coon>, 1 April 1989
Ty Coon, President of Vice

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[GPLv2 application software package list]

attr-2.4.47

base-files-3.0.14

base-passwd-3.5.29

busybox-1.24.1

ethtool-4.2

eudev-3.1.5

glibc-2.23

init-ifupdown-1.0

initscripts-1.0

iptables-1.6.0

kernel-3.14.26

kmod-22+git0+42f32b8ae4

netbase-5.3

opkg-utils-0.1.8+git0+53274f0875

procos-3.3.11

sysvinit-2.88dsf

sysvinit-inittab-2.88dsf

update-rc.d-0.7

util-linux-2.27.1

vsftpd-3.0.3

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[LGPLv2.1 application software package list]

attr-2.4.47

crackklib-2.9.5

glibc-2.23

kmod-22+git0+42f32b8ae4

libdn-1.32

procos-3.3.11

util-linux-2.27.1

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gmp-6.1.0

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```

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GCC RUNTIME LIBRARY EXCEPTION
Version 3.1, 31 March 2009

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