HITACHI PROGRAMMABLE AUTOMATION CONTROLLER

HX Series

APPLICATION MANUAL (Hybrid)
(SERVICE MANUAL)

NJI-653(X)

○ Warranty period and coverage

The warranty period is the shorter period either 18 months from the date of manufacture or 12 months from the date of installation.

However even within the warranty period, the warranty will be void if the fault is due to;

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

(2) Malfunction or failure caused by external device.

(3) Attempted repair by unauthorized personnel.

(4) Other force majeure, such as natural disasters, which beyond the responsibility of manufacturer.

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

In case of repair, replacement parts ordering, or any other inquiries, 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 to install PAC
・PAC system engineer
・Person handling PAC
・Person who maintain the installed PAC

Warning

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(2) The content of this document may be changed without notice.
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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 below:

🚫 : 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 programmable automation controller (hereinafter referred to as 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 series or HX series for supplying electric power.

⚠ CAUTION

- Do not connect DC power supply module EH-PSD / HX-PSD to a master power circuit. Supply a power to EH-PSD through an appropriate isolation transformer less than up to 150 VA 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	2018.05	NJI-653(X)

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Chapter 1 Introduction

Thank you very much for choosing Hitachi Programmable Automation Controller (hereinafter referred to as PAC) HX series hybrid model.

This manual describes how to use the HX series hybrid model. Please read this manual thoroughly before using it for creating programs.

For details on installation, maintenance, inspection, and PLC software and commands, see the separate manuals shown in Table 1.1.

Table 1.1 List of documents

Items	Related document name	Manual Number
HX Series	HX Series APPLICATION MANUAL (Hardware)	NJI-637*1(X)
	HX Series APPLICATION MANUAL (Software)	NJI-638*1(X)
	HX Series APPLICATION MANUAL (Command Reference)	NJI-639*1(X)
	HX Series APPLICATION MANUAL (Hybrid Model) (This manual)	NJI-653*1(X)

*1 The last alphabet of manual No. stands for the version starting from blank, A, B, C…

1.1 Doing after Unpacking

(1) Preparation of programming environment

To use this product, integrated development environment HX-CODESYS Ver.3.5 SP8 Patch 4 or later and application integrated development environment HX-Studio are required. Use HX-CODESYS for PLC setting, programming, and maintenance, and HX-Studio for C-language programming and maintenance.

Please do not use EHV-CODESYS, programming software for Hitachi programmable controller EHV+ series, for HX series CPU module (hereinafter referred to as HX-CPU) as it is not supported.

(2) Initializing of the user program

Since a memory in the HX-CPU is not set at first, error code to mean memory error may be displayed on the 7-segment LED. Please initialize the memory in the HX-CPU first by using HX-CODESYS.

(3) Error code displayed when the battery is not installed

HX-CPU is shipped without a lithium battery. The battery is sold separately from CPU.

Therefore when Battery error detection*2 (OK LED blinking in the battery error) of HX-CODESYS is set Enable, HX-CPU detects a battery error, and "71" is displayed in 7-segment LED. When you want to invalidate battery error detection, please set this parameter in Disable (invalidity).

*2 The tab of Configuration in Device of the project tree has the setting of Battery error detection.

Battery error detection is set in Enable in initial setup.

1.2 About Manuals

Various modules for EH-150 / EHV series shown in Table 1.2 are able to be used with HX-CPU. There is some module that HX-CPU does not support yet. Un-supported modules are going to be supported.

Please refer to manuals shown in Table 1.2 for the detail specification of various modules. Please refer to Chapter 5 and subsequent chapters in HX Series APPLICATION MANUAL (Hardware).

Table 1.2 Related manuals to HX-CPU (1/2)

Product name	Model	Specification	Application manual No.	
			Japanese	English
Power supply module	EH-PSA	Input 100 to 240 V AC	-	-
	HX-PSA	Input 100 to 240 V AC	-	-
	EH-PSD	Input 21.6 to 26.4 V DC	-	-
	HX-PSD	Input 21.6 to 26.4 V DC	-	-
	EH-PSR	Input 100 to 240 V AC for redundancy (ambient temperature of up to 45°C)	-	-
I/O controller	EH-IOCH2	I/O controller for expansion unit	-	-
Digital input module	EH-XD8	8 points, 24 V DC input	-	-
	EH-XD16	16 points, 24 V DC input	-	-
	EH-XDL16	16 points, 24 V DC input, Intensified filter	-	-
	EH-XDS16	16 points, 24 V DC Fast input	-	-
	EH-XD32	32 points, 24 V DC input	-	-
	EH-XDL32	32 points, 24 V DC input, Intensified filter	-	-
	EH-XDS32	32 points, 24 V DC Fast input	-	-
	EH-XD32E	32 points, 24 V DC input, Spring type terminal block	-	-
	EH-XDL32E	32 points, 24 V DC input, Spring type terminal block, Intensified filter	-	-
	EH-XD32H	32 points, 24 V DC input, Compatible connecter with EM and H-200	-	-
	EH-XD64	64 points, 24 V DC input	-	-
	EH-XA16	16 points, 100 to 120 V AC input	-	-
	EH-XAH16	16 points, 200 to 240 V AC input	-	-
Digital output module	EH-YR8B	8 points, relay output (isolated contact point), 100 / 240VAC, 24V DC	-	-
	EH-YR12	12 points, relay output, 100 / 240 V AC, 24 V DC	-	-
	EH-YR16	16 points, relay output, 100 / 240 V AC, 24 V DC, 16 points / 1 common	-	-
	EH-YR16D	16 points, relay output, 100 / 240 V AC, 24 V DC, 8 points / 1 common	-	-
	EH-YT8	8 points, transistor output, 12 / 24 V DC (sink type)	-	-
	EH-YTP8	8 points, transistor output, 12 / 24 V DC (source type)	-	-
	EH-YT16	16 points, transistor output, 12 / 24 V DC (sink type)	-	-
	EH-YTP16	16 points, transistor output, 12 / 24 V DC (source type)	-	-
	EH-YTP16S	16 points, transistor output, 12 / 24 V DC (source type), short-circuit protection	-	-
	EH-YT32	32 points, transistor output, 12 / 24 V DC (sink type)	-	-
	EH-YTP32	32 points, transistor output, 12 / 24 V DC (source type)	-	-
	EH-YT32E	32 points, transistor output, 12 / 24 V DC (sink type) Spring terminal block	-	-
	EH-YTP32E	32 points, transistor output, 12 / 24 V DC (source type) Spring terminal block	-	-
	EH-YT32H	32 points, transistor output, 5 / 12 / 24 V DC (sink type) Compatible connecter with EM and H-200	–	–
	EH-YT64	64 points, transistor output, 12 / 24 V DC (sink type)	-	-
	EH-YTP64	64 points, transistor output, 12 / 24 V DC (source type)	-	-
	EH-YS16	16 points, triac output, 100 / 240 V AC	-	-

Table 1.3 Related manuals to HX-CPU (2/2)

Product name	Model	Specification	Application manual No. Japanese	English
Analog input module	EH-AX44	12 bits analog input (4 to 20 mA, 0 to 10 V) each 4 ch.	-	-
	EH-AX8V	12 bits analog input 8 ch., Voltage (0 to +10 V)	-	-
	EH-AX8H	12 bits analog input 8 ch., Voltage (-10 to +10 V)	-	-
	EH-AX8I	12 bits analog input 8 ch., Current (4 to 20 mA)	-	-
	EH-AX8IO	12 bits analog input 8 ch., Current (0 to 22 mA)	-	-
	EH-AXH8M	14 bits analog input 8 ch. (0 to 22 mA, 4 to 22 mA, -10 to +10 V, 0 to 10 V)	-	-
	EH-AXG5M	Isolation between channels, 16 bits analog input 5ch. (0 to 22 mA, 4 to 22 mA, -10 to +10 V, 0 to 10 V)	-	-
Analog output module	EH-AY22	12 bits analog output (4 to 20 mA, 0 to 10 V) each 2 ch.	-	-
	EH-AY2H	12 bits analog output 2 ch., Voltage (-10 to +10 V)	-	-
	EH-AY4V	12 bits analog output 4 ch., Voltage (0 to +10 V)	-	-
	EH-AY4H	12 bits analog output 4 ch., Voltage (-10 to +10 V)	-	-
	EH-AY4I	12 bits analog output 4 ch., Current (4 to 20 mA)	-	-
	EH-AYH8M	14 bits analog output 8 ch., (0 to 22 mA, 4 to 22 mA, 0 to 10 V)	-	-
	EH-AYG4M	Isolation between channels, 16 bits analog output 4 ch. (0 to 22 mA, 4 to 22 mA, -10 to +10 V, 0 to 10 V)	-	-
RTD input module	EH-PT4	4 channels resistance temperature detector, Signed 15 bits Platinum (Pt 100 Ω / Pt 1000 Ω)	NJI-323*	NJI-324*(X)
	EH-RTD8	6/8 channels resistance temperature detector, Signed 15 bits Platinum (Pt 100 Ω / Pt 1000 Ω)	-	-
Thermocouple input module	EH-TC8	Signed 15 bits, Thermocouple input (K, E, J, T, B, R, S, N) 8 channels	-	-
Positioning and counter module	EH-CU	2 channels high-speed counter input, Maximum frequency of 100 kHz, 1/2-phases switchover, 4-point opened collector output	NJI-321*	NJI-321*(X)
	EH-CUE	1 channel high-speed counter input, Maximum frequency of 100 kHz, 1/2-phases switchover, 2-point opened collector output	-	-
	EH-POS	1-axis pulse positioning module	NJI-314*	NJI-315*(X)
Communication module	EH-RMP2	PROFIBUS-DP master module, 512 / 512 words I/O, 8 units per CPU can be installed	NJI-621*	NJI-621*(X)
	EH-IOCP2	PROFIBUS-DP slave controller, 122 / 122 words I/O	NJI-612*	NJI-612*(X)
	EH-IOCA	EtherCAT slave controller, 176 words I/O	NJI-599*	NJI-599*(X)
	EH-FLN3	FL-net interface module	NJI-410*	-
	EH-LNK	CPU link module (coaxial), 8 units per CPU can be mounted	NJI-381*	NJI-381*(X)
	EH-OLNK	CPU link module (optical fiber), 8 units per CPU can be mounted	NJI-395*	NJI-395*(X)
	EH-OLNKG	CPU link module (support optical fiber GI50 / 125 μm cable), 8 units per CPU can be mounted	NJI-395*	NJI-395*(X)
	EH-OLNKE	CPU link module (support optical fiber GI62.5 / 125 μm cable), 8 units per CPU can be mounted	NJI-395*	NJI-395*(X)

* The last alphabet of manual No. stands for version starting from blank, A, B, C...

1.3 Guidelines for Safe Use

Be sure to check the following product characteristics for safe operation of this product before creating a program or

building a system:

When using the shared memory, if you changed the DataSharing registration information, be sure to update the header file on the C-language program project.

When you log-in to a virtual controller from HX-Studio, the C-language program running on the target virtual controller is stopped (a function such as online change in PLC is not supported).

To use a library function dedicated to operating the shared memory in the C-language program, be sure to obtain the return value to check the process result.

C-language program creation must be in accordance with the GCC compiler specifications.

To synchronize between the PLC program and C-language program, it is recommended that the shared memory should be used as a synchronization flag.

There is no timeout between the web browser and server in the web server function. When communication is disconnected due to a cable break, the on-going process may remain displayed.

The C-language program is executed when the PLC program is in idle state. For this reason, the C-language program operation speed may change depending on the PLC program load status.

In the Ethernet communication setting on HX-CODESYS, virtual NICs used in the virtual controller are displayed in the list. Be sure to select a physical NIC (ETH1, ETH2, ETH3).

You can connect to the web server function from multiple web browsers, but a process timeout may occur due to increasing CPU load if requests are issued from multiple browsers at the same time.

Chapter 2 Features of Hybrid Model

Edge computing to support IoT application of industrial systems

In addition to the PLC program, information processing programs (C / C++ language program) can be embedded to the hybrid model. Using an information processing program to share data with the PLC program makes it easier to process field data, allowing on-premises* visualization, deployment to analytics platforms, and edge computing at production sites.

HX series CPU module
hybrid model

C-language programing application IDE
HX-Studio (including HX-CODESYS)

✓ Cloud-based or on-premises visualization & deployment to analytics platform

✓ Edge computing at sites, such as facilities
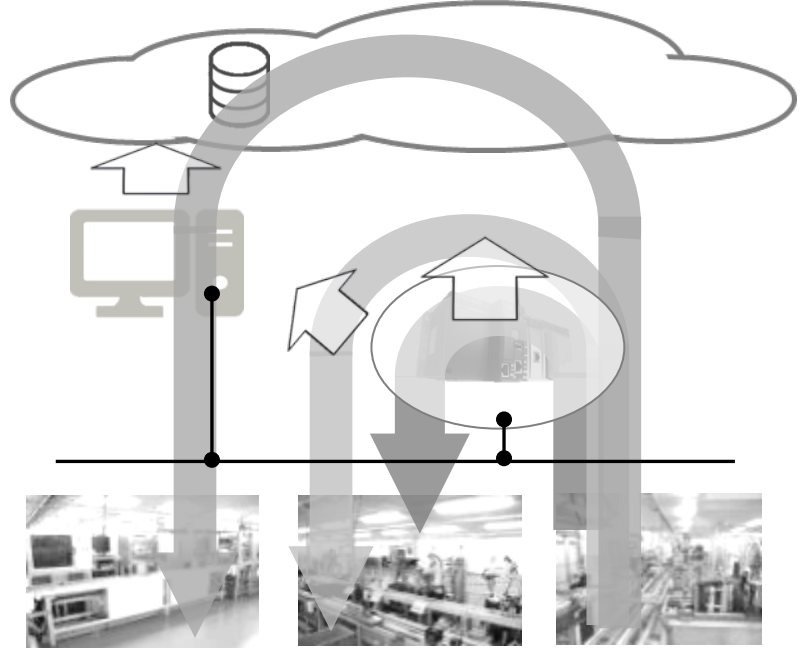
* On-premises: The company owns information system equipment and operates the system on its premises.

Implementing and operating a C-language program without affecting control

In this product, the PLC program and embedded C-language program run in parallel, with the C-language program not affecting the PLC program, for stable controller operation in the control system. The shared memory allows real-time handling of control data in the C-language program. The C-language program can be embedded and swapped while the PLC program is running.
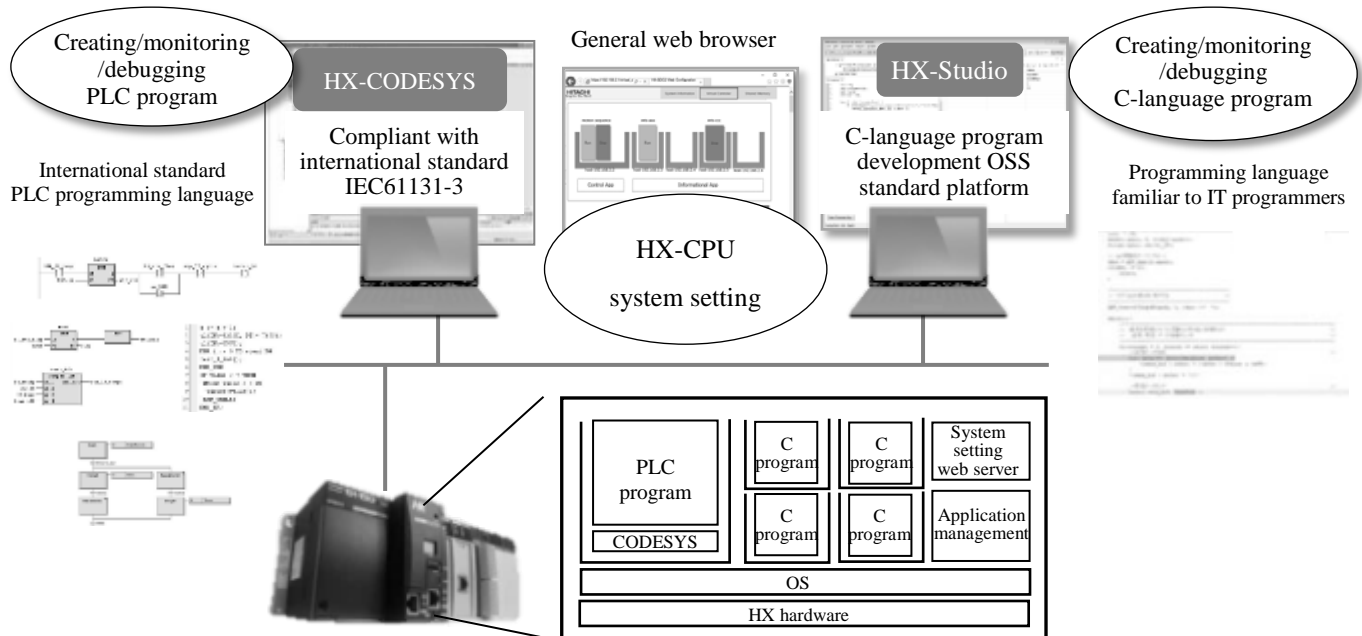
Sharing data between the PLC program and C-language program

Data can be shared using the same variable names between the PLC program and C-language program. To protect important control data, specify variables to be shared with the C-language program in the PLC program.

Variables set to be shared are also downloaded as the header file of the shared variable list when the PLC program is downloaded to the CPU. In HX-Studio, this header file can be obtained online for creating C-language programs. In the C-language program, control data used in the PLC program can be shared by using the dedicated functions to access the shared memory.
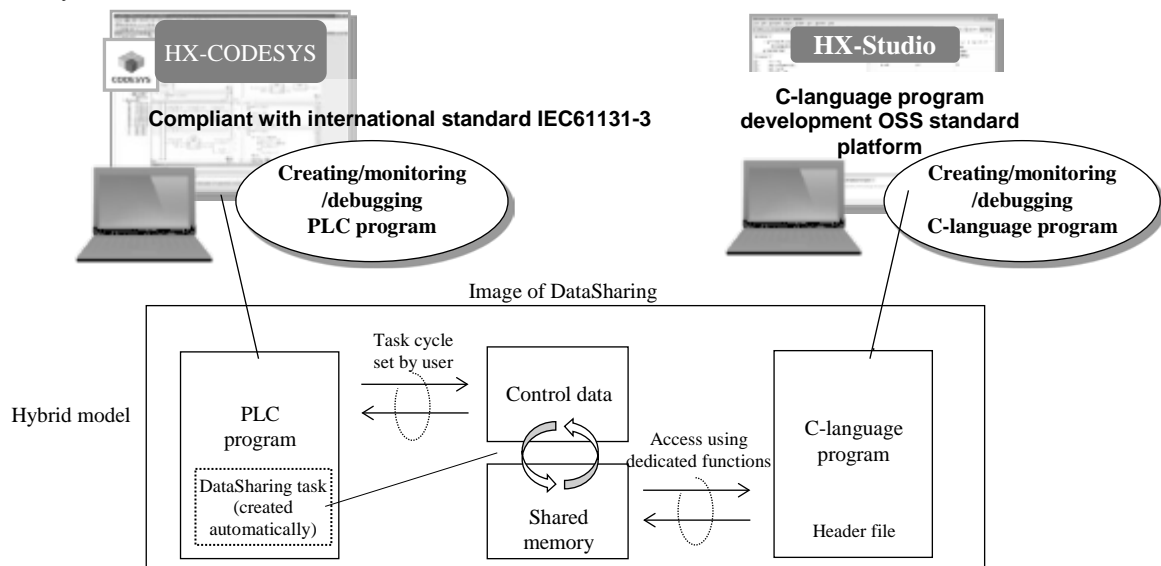
Integrated development environment HX-Studio

HX-Studio is an integrated development environment for C / C++ language programs, which is based on popular open source software Eclipse CDT. With OSS usability remaining, this software contains functions specific to the HX-CPU hybrid model added by default as plug-ins. This allows C / C++ language programming, which is familiar to IT engineers.

HX-Studio

Creating/monitoring /debugging C-language program

Editor view

Outline view

Task list view

Build Targets view

Project explorer view

Tasks view

Console view

Properties view

Example of HX-Studio dedicated plug-in

Add operation icon

LOGIN ▾ LOGOUT

Hybrid model CPU online connection wizard
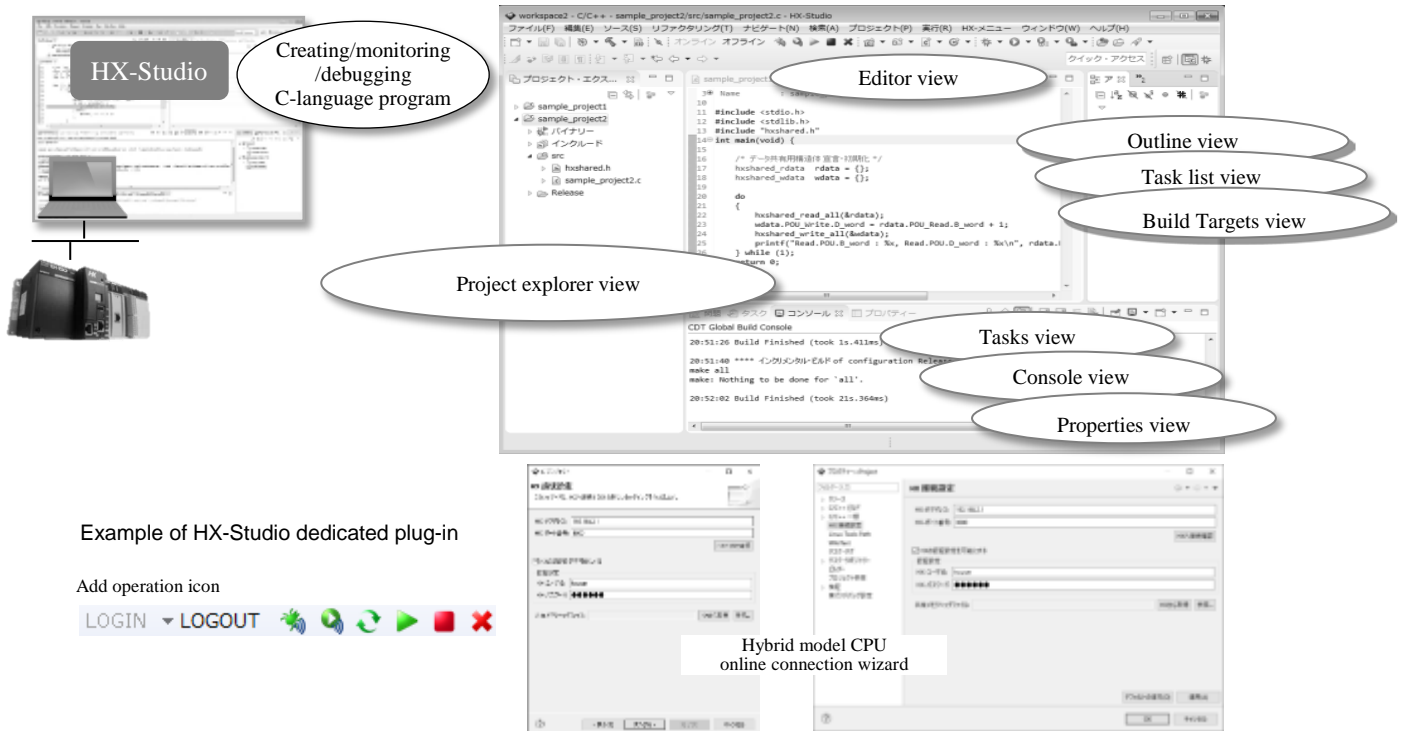
Web server function for C-language program management

You can manage C-language programs by accessing the web server of this product from a general web browser on the PC. No dedicated software needs to be installed to the PC.

Web server

(1) System monitor

(2) Virtual controller information

(3) Shared memory information

Virtual controller setting
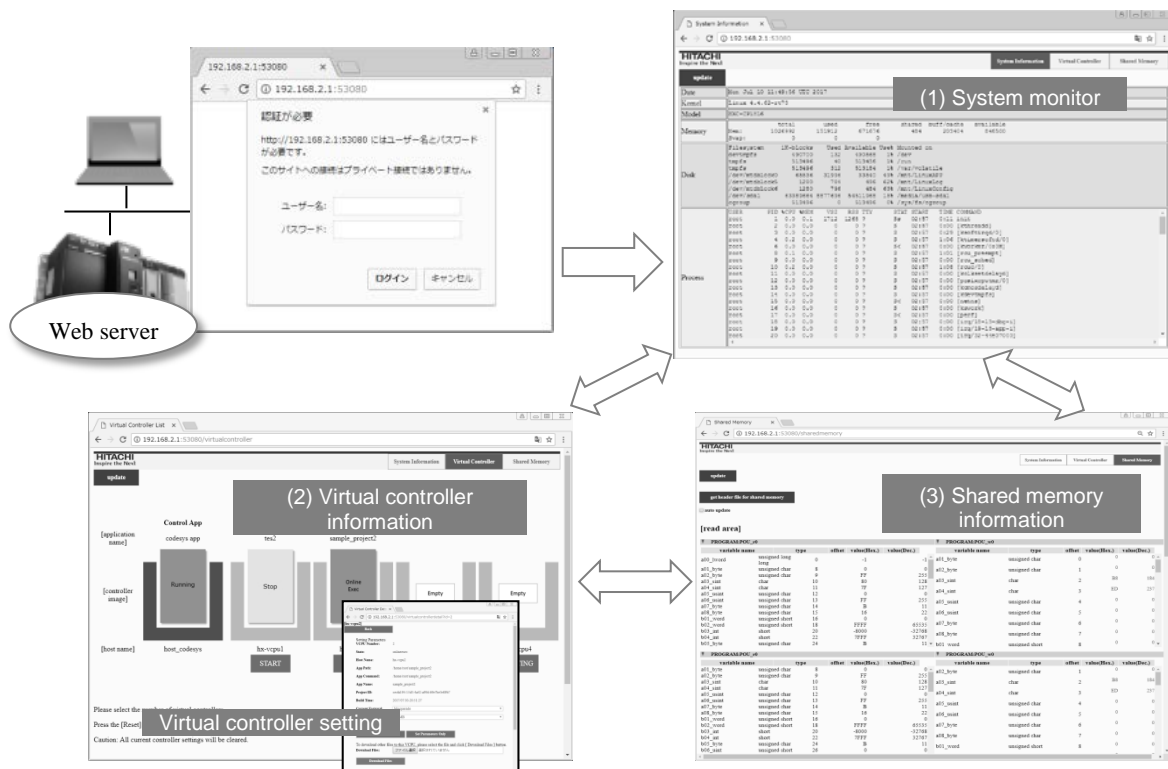
Specifying shared variables from HX-CODESYS

Use the data sharing object (DataSharing) to specify control data variables used in the PLC program.
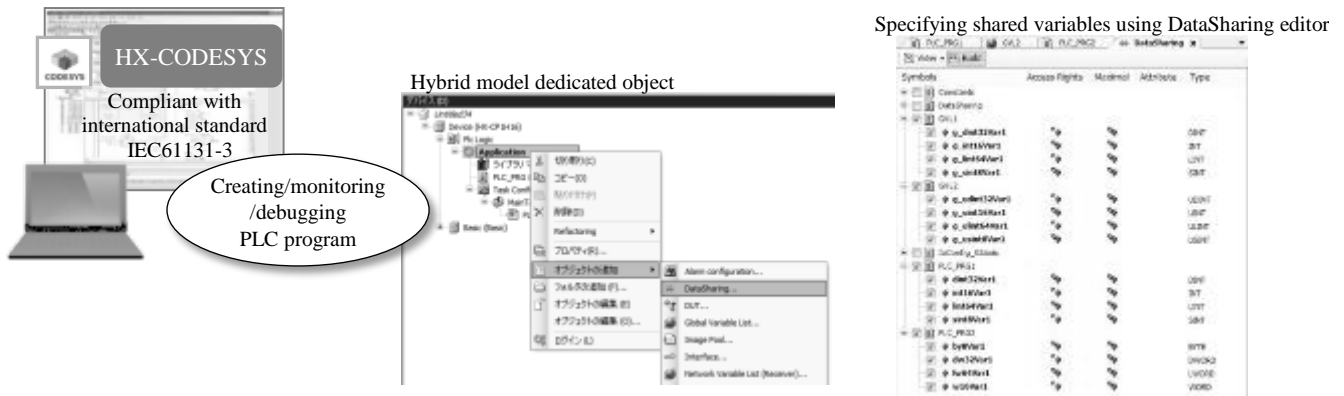
Accessing control data from the C-language program

Specifying shared variables allows programming using the same variable names between the PLC program and C-language program. Therefore, user does not need to be conscious of the actual addresses of shared data.

C-language program development

Creating/monitoring /debugging C-language program

[Procedure] (a) Include the header file.
(b) Assign the self-program and declare the structure.
(c) Program using the same variable names.

[Example]
```
#include "hxshared.h"
hxshared_rdata myReadData;
hxshared_wdata myWriteData;

hxshared_read_all(&myReadData);

myWriteData.PLC_PLG_Write.int16var2= myReadData.PLC_PLG_Read.int16var1
hxshared_write(&myWriteData.PLC_PLG_Write.int16var3,&myWriteData);
```

OnlineDebug / OnlineChange the C-language program

You can debug / change the C-language program online individually while the PLC program is running.

Security protection support function*

The HX-CPU series uses the security plan method to conduct a security analysis procedure so that OS protocol stack level measures are taken against threats beyond the network. Ethernet communication in C-language programs can be authenticated / encrypted (IPsec) to prevent wiretapping and spoofing.

* The security protection support function of each system component is just one way to ensure a security level required for the system and does not mean that it completely protects the system from increasing security risks. To responsibly implement and maintain a necessary security level, continued improvement is required. You need to clarify the system security protection target and take necessary measures before building and operating the system.

Chapter 3 Product Specifications

3.1 Performance Specifications

Table 3.1 Performance specifications (1/2)

Item		Specifications				
		HX-CP1S08	HX-CP1S08M	HX-CP1H16	HX-CP1H16M	HXC-CP1H16
Model		Standard	Motion	Full Function	CNC Motion	Hybrid
User program memory [*1]		8 MB		16 MB		
Source file memory [*1]		8 MB		16 MB [*2]		
Data memory (non-retain) [*1]		8 MB		16 MB		
Data memory (retain) [*1]		250 KB				1024 KB
Data memory (persistent) [*1]		250 KB				1024 KB
Field bus / Marker memory		48 KB				
Number of expansion base units		5 units				
Expansion cables		Between stations: 0.5 m, 1 m, 2 m Total length: 8 m or less				
Number of I/O points (using 64 points module)		4,224 points				
I/O modules		Same as EH-150 / EHV series				

PLC programming language		IEC61131-3 compliant 5 languages + CFC
		  LD : Ladder Diagram
		  FBD : Function Block Diagram
		  SFC : Sequential Function Chart
		  IL : Instruction List
		  ST : Structured Text
		  CFC : Continuous Function Chart				

C program	Adaptation of C / C++ program	-				✓
	Data sharing	-				✓
	Web server for application management	-				✓
I/O update cycle		Refresh processing				
Execution speed	Boolean instruction	min. 1.0 ns				
	Double-precision floating point	min. 6.6 ns				
Library	PLC standard library	✓	✓	✓	✓	✓
	SM3_Basic (for motion)	-	✓	-	✓	-
	SM3_Robotics (for motion)	-	-	-	✓	-
	SM3_CNC (for motion)	-	-	-	✓	-
Available communication	OPC UA Server	✓	✓	✓	✓	✓
	Web Visualization	-	-	✓	✓	✓
	NTP (network time protocol)	✓	✓	✓	✓	✓
	FTP Server	✓	✓	✓	✓	✓
	EtherCAT Master [*3]	✓	✓	✓	✓	✓
	Modbus-TCP Client	✓	✓	✓	✓	✓
	Modbus-TCP Server [*4]	✓	✓	✓	✓	✓
	Modbus-RTU Master	-	-	✓	✓	✓
	Modbus-RTU Slave	-	-	✓	✓	✓
Communication interface	Ethernet	2 ports (10/100BASE-T/TX)		3 ports (10/100BASE-T/TX)		
	Hardening [*8]	✓	✓	✓	✓	✓
	Certification / Cryptograph [*8]	-	-	-	-	✓ (ETH3)
	Serial	-		1 port (RS-485)		
	USB device	1 port (Mini-B type connector, USB 2.0 High speed)				
USB host		1 port (A type connector, USB 2.0 High speed) for USB memory [*5]				
SD memory card slot		-		1 slot (SD / SDHC)		

(The notes are provided on the next page.)

Table 3.2 Performance specifications (2/2)

Item		Specifications				
		HX-CP1S08	HX-CP1S08M	HX-CP1H16	HX-CP1H16M	HXC-CP1H16
Model		Standard	Motion	Full Function	CNC Motion	Hybrid
Display and switch	Display	RUN LED, ERR LED, 7-segment LED (2 digits)				
	RUN / STOP switch	STOP / RUN (Remote control of RUN / STOP over communication from HX-CODESYS is enable when switch position is in RUN.)				
	Error clear switch	Clear of error code				
	2-bit switch (SW1)	Reset the factory default settings				
	4-bit switch (SW3)	-		Reserved for future		
Real-time clock		Built-in RTC (deviation ±60 s/month at 25 °C)				
Battery (Option for RTC)		HX-BAT (for RTC) [6]				
Startup time		About 20 to 30 s [7]				About 70s or more [7]
Maintenance function		Self-diagnosis (microcomputer error, watchdog timer error, memory error, battery under-voltage detection, and others)				
Supported standards		UL/cUL, CE, RCM				UL/cUL, CE
Available version of HX-CODESYS		3.5 SP8 Patch 4 or newer				

*1 Since additional information needs to be saved, available memory size is slightly smaller than nominal value.
*2 Data for Web visualization is stored in the source file memory.
*3 EtherCAT master function must be configured as stand alone. Do not configure other function with EtherCAT master function.
*4 The maximum number of Modbus-TCP client: 16
*5 For data storage.
*6 The battery is option for realtime clock.
*7 It depends on the size of the user program.
*8 The security protection support function of each system component is just one way to ensure a security level required for the system and does not mean that it completely protects the system from increasing security risks. To responsibly implement and maintain a necessary security level, continued improvement is required. You need to clarify the system security protection target and take necessary measures before building and operating the system.

3.2 Hybrid Model Specific Specifications

Table 3.3 List of HX-CPU hybrid model specific specifications

Item		Specification
Virtual controller for application execution	Programming software	IDE for Hybrid model application HX-Studio (DVD includes HX-CODESYS.)
	Adaptation means [*1]	Download from built-in Web server IF or from HX-Studio
	Programming language	C / C++
	Number of Virtual controllers	Max. 4 (selectable from 1, 2, 4)
	ROM size for application [*2]	Max. 32 MB (Referred files like Library files can be stored in SD card or USB memory)
	Work RAM	Max. 512 MB (e.g.: 512x1, 256x2, 128x4)
	Access port	Ethernet (ETH3), SD card, Serial port (RS-485), USB host port
	IP address of application	Masquerade, IP forward, Port forward
	Data sharing with PLC program	Read: Max. 5,000 variables, Max. size: 64 KB Write: Max. 5,000 variables, Max. size: 64 KB Variables to be shared are selected at HX-CODESYS. Those can be set as RETAIN / PERSISTENT. Supported data type: BOOL, BYTE, USINT, SINT, WORD, UINT, INT, DWORD, UDINT, DINT, LWORD, ULINT, LINT, REAL, LREAL
	Security protection	Certification / Cryptograph (IPsec)
Web server for application management	Supported browser	HTML5 supporting browser (IE11 or newer, Edge38 or newer, Chrome53 or newer, Firefox49 or newer)
	System information display	Window to display system information
	Virtual controller information display	1. Status display of virtual controller 2. Configuration of virtual controller 3. Operation (Start / Stop) of application
	Shared memory information display	Data display and force of shared memory
	User management display	Registration and delete of user information to access Web server IF

*1 ETH3 port must be used to connect to built-in Web server IF or HX-Studio.

*2 Since system information needs to be saved, available memory size is slightly smaller than nominal value.

3.3 Application Integrated Development Environment Specifications

Table 3.4 List of application integrated development environment HX-Studio (HX-STD) specifications

Item		Specification
Operating environment	CPU	Intel Core 2 Duo 2 GB or more recommended
	Required memory	1 GB or more (2 GB or more recommended)
	Available hard disk space	Installation 4 GB or more (Execution size: Virtual memory 512 MB or more)
	Display	Resolution 1024 x 768 dots or more recommended
	Installation disk	DVD drive
	Required interface	Ethernet 10BASE-T/100BASE-TX
	Supported OS	Microsoft Windows ® 7, 8, 8.1, 10 32/64-bit (Japanese / English)
Platform		Eclipse 4.6 Neon CDT 9.1.0 base (Japanese / English supported)
Supported language		C language (C / C++)
HX-CPU connection		Ethernet (connection to ETH3 port of this product)
Compiler		Cross GCC (gcc-linaro-5.3-2016.02)
Debug		Debug execution / Restart / Forcible stop, Break point, Step execution, Variable / Structure value view / edit
Dedicated function		New project creation wizard dedicated to HX-CPU
		HX-CPU connection communication setting
		Acquisition of the shared memory header file from HX-CPU
		Login
		New download, Overwrite update (including swap)
		Logout
		Remote debug, Remote execution
		Application execution, Application stop, Application deletion

3.4 Part Names and Functions

Module features		Type	HXC-CP1H16
		Weight	Approx. 0.24 kg (0.53 lb.)
		Current consumption	1,200 mA
		Dimensions (mm(in.))	

Front cover

45 (1.77)   115 (4.53)   100 (3.94)

READY LED (green)
ACCESS LED (yellow)
SD card switch (SW2)
Battery /
Battery holder

Lock button
Battery connector
Error clear switch
RUN LED (green)
ERR LED (red)

Serial port

4-bit switch (SW3)

RUN/STOP switch
2-bit switch (SW1)
7-segment LED
USB host port (Type: A)

SD card slot

USB device port
(Type: mini-B)
Ethernet port
(ETH1)

Ethernet port
(ETH2)

Ethernet port
(ETH3)

Front view

FE terminal

Bottom view

ETH3 L/A LED (green)

ETH1 L/A LED (green)
ETH1 SPEED LED (yellow)

ETH3 SPEED LED
(yellow)

ETH2 SPEED LED (yellow)

ETH2 L/A LED (green)

Detail of Ethernet port

Ethernet port
(ETH2)

Table 3.5 List of hybrid model part function details (1/2)
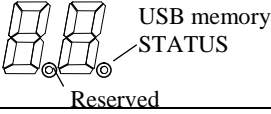
Item	Description	Access from application
RUN LED	Indicates operation status. (Green lighting: RUN / off: STOP)	-
ERR LED	Indicates error status. (Red blinking: battery error, I/O module mismatch or initialization of RTC (real time clock) etc. / red lighting: other errors / off: no error)	-
7-segment LED	Indicates error code. And indicates the status of the USB memory with dot LED ".". on the right. (Lighting: mounting, off: unmount) USB memory STATUS Reserved	-
USB host port (Type: A)	USB host function (Data logging) is supported. User program is needed to use data logging (File read / write / compare). Support device is USB memory only.	✓
USB device port (Type: mini-B)	USB port supports gateway function (with HX-CODESYS) only. USB cable is not included with CPU package nor supplied by Hitachi-IES. Use type Mini-B USB cable.	-
Serial port	Serial communication port has a RS-485 interface with terminal. [Usage on applications] It is needed to enable RS-485 communication setting on the corresponding virtual controller setting display on Web server. Default setting is disabled. [Usage on PLC program] It is supporting Modbus-RTU (master / slave) and general purpose. User program is needed to use general purpose.	✓
Ethernet port (ETH 1, 2)	Ethernet port 1, 2 have both gateway function (with HX-CODESYS / HMI / OPC) and IEC programming function supporting global network variable, EtherCAT master, Modbus-TCP client / server and OPC UA server. Do not use other function if EtherCAT master can be used.	-
Ethernet port (ETH 3)	ETH3 is used to connect to HX-Studio or built-in Web server interface for application management. Although this port can be used at PLC program same as ETH1, 2, it is highly recommended to use only for the connection to HX-Studio or built-in Web server interface and the usage on applications. [Usage on applications] Set forwarding configuration, if needed. Default setting is Masquerade. [Usage on PLC program] Ethernet port 3 has both gateway function (with HX-CODESYS / HMI / OPC) and IEC programming function supporting global network variable, Modbus-TCP client / server and OPC UA server. EtherCAT master function is not supported.	✓
SD card slot	SD / SDHC card are supported. Data logging function is supported. User program is needed to use data logging (File read / write / compare).	✓
RUN / STOP switch	When this switch position is in RUN (left), CPU start executing program. At the same time, remote controlling is enabled, in which case, CPU is started or stopped by HX-CODESYS over communication. When this switch position is in STOP (right), CPU stop executing program. In this status, remote controlling is disabled.	-
Error clear switch (E.CLR)	If any error occurs, error code is displayed in 7-segment LED and remains after the error cause is deactivated. When pressing this button, error code is cleared. If the error cause is still remaining, error code will be displayed again.	-
SD card switch (SW2)	When pressing this switch, SD card is unmounted. Please check lights-out of READY LED before pull out SD card.	✓
ACCESS LED	Not supported.	-
READY LED	Indicates the status of SD card. Do not pull out SD card during lighting. (Green lighting: mounting, off: unmount)	✓
SPEED LED	Indicates communication speed of each Ethernet port. (Yellow lighting: 100Mbps, off: 10Mbps or link-down)	-
L/A LED	Indicates the status of each Ethernet communication. (Green lighting: Ethernet link-up, blinking: Data is sent or received, off: link-down)	-

Table 3.6 List of hybrid model part function details (2/2)

Item	Description	Access from application
2-bit switch (SW1)	Resetting the factory default settings.	-
4-bit switch (SW3)	Not supported. Please keep off.	-
Lock button	Press this button to dismount from the base units. Module can be fixed firmly by a screw of M4×10mm (0.39 in.).	-
Front cover	Open this cover when operating the switch, button or replacing the battery. Keep the cover closed while CPU execute program.	-
Battery holder Battery connector	RTC (real time clock) data is retained by battery. Data specified as RETAIN and PERSISTENT and user program are retained without battery. -The battery has polarity. When plugging in, check the polarity carefully. -The battery is not included with CPU package. -Replace the battery every five years even when doesn't reach the end of the battery.	-
FE terminal	Connect to Class D grounding.	-

3.5 List of System Equipment

(1) Modules

Table 3.7 List of system equipment (1/2)

Product name	Model	Specification	Standard compliant	Remarks
Power module	EH-PSA	Input 100 to 240 V AC, Output 5 V DC 3.8 A, 24 V DC 0.4 A	CE, UL, RCM	*1
	HX-PSA	Input 100 to 240 V AC, Output 5 V DC 3.8 A, 24 V DC 0.4 A	CE, UL	*1
	EH-PSD	Input 24 V AC, Output 5 V DC 3.8 A	CE, UL, RCM	*1
	HX-PSD	Input 24 V AC, Output 5 V DC 3.8 A	CE, UL	*1
	EH-PSR	Input 100 to 240 V AC, output 5 V DC 5.6 A *5	CE	*1
I/O controller	EH-IOCH2	I/O control module (1 unit / expansion base unit)	CE, UL, RCM	*1
Base unit	EH-BS3A	3 I/O modules installed	CE, UL, RCM	Commonly used for basic or expansion base
	EH-BS5A	5 I/O modules installed	CE, UL, RCM	
	EH-BS6A	6 I/O modules installed	CE, UL, RCM	
	EH-BS8A	8 I/O modules installed	CE, UL, RCM	
	EH-BS11A	11 I/O modules installed	CE, UL, RCM	
	EH-BS8R	Redundant power supply, 8 I/O modules installed	-	
Digital input module	EH-XD8	8 pts., 24 V DC input (response time 5 ms)	CE, UL, RCM	*3
	EH-XD16	16 pts., 24 V DC input (response time 5 ms)	CE, UL, RCM	*3
	EH-XDL16	16 pts., 24 V DC input (response time 16 ms)	CE, RCM	*3
	EH-XDS16	16 pts., 24 V DC input (response time 1 ms)	CE, RCM	*3
	EH-XDA16	16 pts., 48 V DC input (response time 5 ms)	-	*3
	EH-XD32	32 pts., 24 V DC input (response time 5 ms)	CE, UL, RCM	-
	EH-XDL32	32 pts., 24 V DC input (response time 16 ms)	-	-
	EH-XDS32	32 pts., 24 V DC input (response time 1 ms)	CE, RCM	-
	EH-XD32E	32 pts., 24 V DC input (response time 1 ms), Spring type terminal	CE, UL, RCM	-
	EH-XDL32E	32 pts., 24 V DC input (response time 16 ms), Spring type terminal	CE, UL, RCM	-
	EH-XD32H	32 pts., 24 V DC input (response time 4 ms), compatible connector with PIM / H-DM (EM / H-200)	CE, RCM	-
	EH-XD64	64 pts., 24 V DC input (response time 1 ms)	CE, UL, RCM	-
	EH-XA16	16 pts., 100 to 120 V AC input (response time 15 ms)	CE, UL, RCM	*3
	EH-XAH16	16 pts., 200 to 240 V AC input (response time 15 ms)	CE, UL, RCM	*3
Digital output module	EH-YR8B	8 pts., Independent relay output, 100 / 240 V AC, 24 V DC	CE, RCM	*3, *4
	EH-YR12	12 pts., Relay, 100 / 240 V AC, 24 V DC	CE, UL, RCM	*3, *4
	EH-YR16	16 pts., Relay, 100 / 240 V AC, 24 V DC	CE, UL, RCM	*3, *4
	EH-YR16D	16 pts., Relay, 100 / 240 V AC, 24 V DC, 2-common	CE, RCM	*3
	EH-YT8	8 pts., Transistor, 12 / 24 V DC (sink type)	CE, UL, RCM	*3, *4
	EH-YTP8	8 pts., Transistor, 12 / 24 V DC (source type)	CE, UL, RCM	*3, *4
	EH-YT16	16 pts., Transistor, 12 / 24 V DC (sink type)	CE, UL, RCM	*3, *4
	EH-YTP16	16 pts., Transistor, 12 / 24 V DC (source type)	CE, UL, RCM	*3, *4
	EH-YTA16	16 pts., Transistor, 24 / 48 V DC (sink type)	-	*3
	EH-YTPA16	16 pts., Transistor, 24 / 48 V DC (source type)	-	*3
	EH-YTP16S	16 pts., Transistor, 12 / 24 V DC (source type) *3	CE, UL, RCM	Electric short circuit protection
	EH-YT32	32 pts., Transistor, 12 / 24 V DC (sink type) *2	CE, UL, RCM	
	EH-YTP32	32 pts., Transistor, 12 / 24 V DC (source type) *2	CE, UL, RCM	
	EH-YT32E	32 pts., Transistor, 12 / 24 V DC (sink type), Spring type terminal	CE, UL, RCM	
	EH-YTP32E	32 pts., Transistor, 12 / 24 V DC (source type), Spring type terminal	CE, UL, RCM	
	EH-YT32H	32 pts., Transistor, 5 / 12 / 24 V DC (sink type) compatible connector with POM / H-DM (EM / H-200)	CE, RCM	-
	EH-YT64	64 pts., Transistor, 12 / 24 V DC (sink type)	CE, UL, RCM	Electric short circuit protection
	EH-YTP64	64 pts., Transistor, 12 / 24 V DC (source type)	CE, UL, RCM	
	EH-YS16	16 pts., Triac, 100 / 240 V AC	CE, RCM	*3, *4
Analog input module	EH-AX44	12 bits, 8 ch. (4 ch. of 4 to 20 mA, 4 ch. of 0 to 10 V)	CE, UL, RCM	*3
	EH-AX8V	12 bits, 8 ch., Voltage (0 to 10 V)	CE, UL, RCM	*3
	EH-AX8H	12 bits, 8 ch., Voltage (−10 to +10 V)	CE, UL, RCM	*3
	EH-AX8I	12 bits, 8 ch., Current (4 to 20 mA)	CE, UL, RCM	*3
	EH-AX8IO	12 bits, 8 ch., Current (0 to 22 mA)	CE, UL, RCM	*3
	EH-AXH8M	14 bits, 8 ch. (0 to 22 mA, 4 to 22 mA, −10 to +10 V, 0 to 10 V)	CE, UL, RCM	*3
	EH-AXG5M	12 / 16 bits, 5 ch. (0 to 22 mA, 4 to 22 mA, −10 to +10 V, 0 to 10 V), Galvanic isolation between channels	CE, RCM	*3
	EH-PT4	Signed 15 bits, 4 ch. Resistance Temperature Detector input, PT100 / PT1000	CE, UL, RCM	*3
	EH-RTD8	Signed 15 bits, 6 ch. (3-wire) / 8 ch. (2-wire) Resistance Temperature Detector input, PT100 / PT1000	CE, RCM	*3
	EH-TC8	Signed 15 bits, 8 ch. Thermocouple input (K,E,J,T,B,R,S,N)	CE, UL, RCM	*3

(The notes are provided on the next page.)

Table 3.8 List of system equipment (2/2)

Product name	Model	Specification	Standard compliant	Remarks
Analog output module	EH-AY22	12 bits, 4 ch. (2 ch. of 4 to 20 mA, 2 ch. of 0 to 10 V)	CE, UL, RCM	*3
	EH-AY2H	12 bits, 2 ch., Voltage (−10 to +10 V)	CE, UL, RCM	*3
	EH-AY4V	12 bits, 4 ch., Voltage (0 to 10 V)	CE, UL, RCM	*3
	EH-AY4H	12 bits, 4 ch., Voltage (−10 to +10 V)	CE, UL, RCM	*3
	EH-AY4I	12 bits, 4 ch., Current (4 to 20 mA)	CE, UL, RCM	*3
	EH-AYH8M	14 bits, 8 ch. (0 to 22 mA, 4 to 22 mA, 0 to 10 V)	CE, UL, RCM	*3
	EH-AYG4M	12 / 16 bits, 4 ch. (0 to 22 mA, 4 to 22 mA, 0 to 10 V, −10 to +10 V), Galvanic isolation between channels	CE, RCM	*3
Counter and Positioning module	EH-CU	2 channels high-speed counter input, Maximum frequency of 100 kHz, 1/2-phases switchover, 4-point opened collector output	CE, UL, RCM	-
	EH-CUE	1 channel high-speed counter input, Maximum frequency of 100 kHz, 1/2-phases switchover, 2-point opened collector output	CE, UL, RCM	-
	EH-POS	1-axis pulse positioning module	UL, RCM	-
Communication module	EH-RMP2	PROFIBUS-DP master module, 512 / 512 words I/O	CE, RCM	8 units per CPU
	EH-IOCP2	PROFIBUS-DP slave controller, 1,408 points (176 words) I/O	CE, RCM	*1
	EH-IOCA	EtherCAT slave controller, 1408 points (176 words) I/O	CE, RCM	*1
	EH-FLN3	FL-net interface module, FL-net version 3.01	CE, RCM	2 units per CPU
	EH-LNK	CPU link module (coaxial)	UL, RCM	8 units per CPU
	EH-OLNK	CPU link module (optical fiber)	UL, RCM	8 units per CPU
	EH-OLNKG	CPU link module (support optical fiber GI50 / 125 μm cable)	UL, RCM	8 units per CPU
	EH-OLNKE	CPU link module (support optical fiber GI62.5 / 125 μm cable)	UL, RCM	8 units per CPU
Dummy module	EH-DUM	Module for an opened slot	CE, UL, RCM	-

*1 CPUs, power modules and I/O controllers (EH-IOCH2, EH-IOCP2, EH-IOCA) are mounted on reserved positions only.
*2 Short circuit protection version is from May 2001 production. (MFG. No. 01Exx)
*3 The suggested torque for the terminal connections is 9 in-lbs as below.
*4 Supporting module version is from April 2005 production. (MFG. No. 05Dxx)
*5 Please use the maximum output current of EH-PSR on the following conditions.
    Less than 45 degree of ambient temperature: 5.6 A
    From 45 to 55 degree of ambient temperature: 5.0 A

Cable for wiring			Torque to tighten the terminal
Wire Size	Material	Type	
22 - 14 AWG	Cu	Sol / Str.	9in.-lbs (1.02 Nm)

[Installing restriction]

- EH-(O)LNK / RMP2 can be mounted up to 8 units per CPU. Available position is from slot 0 to 7 of basic base only.
- EH-FLN3 can be mounted up to 2 units per CPU. Available position is from 0 to 7 of basic base only.

⚠ Caution

The system of HX-CPU supports a maximum of 11 modules per base units. However, the number of modules which can be provided depends on the maximum output current of the power module. Make sure to use HX-CPU in a permissible level of the maximum output current of the power module.

(2) Peripheral devices

Table 3.9 peripheral device of HX series

Product name	Model	Specification
HX-Studio	HX-STD	Eclipse 4.6 Neon CDT 9.1.0 base IDE for Hybrid model application Programming language: C / C++, Connection means to HX-CPU: Ethernet (ETH3) Supported operating system: Windows ® 7, 8, 8.1, 10 (32 / 64 bit) (IEC 61131-3 compliant HX-CODESYS (HX-CDS) is included in DVD)
HX-CODESYS	HX-CDS	IEC 61131-3 full compliant programming software with ST (Structured Text), SFC (Sequential Function Chart), FBD (Function Block Diagram), LD (Ladder Logic Diagram) and IL (Instruction List). Supported operating system *1: Windows ® XP SP3, Vista, 7, 8, 8.1, 10 (32 / 64 bit) Multilingual support (Japanese, English, German, Spanish, French, Italy, Russian, Chinese)

*1 In order to use the function of data sharing with PLC program, Windows ® 7 or higher is required.
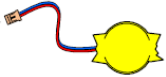
(3) Connection cables

Table 3.10 connection cables of HX series

Product name	Model	Specification
Cable for connecting basic base I/O controller *1	EH-CB05A	0.5 m (1.64 ft.) length (basic to expansion and expansion to expansion)
	EH-CB10A	1 m (3.28 ft.) length (basic to expansion and expansion to expansion)
	EH-CB20A	2 m (6.56 ft.) length (basic to expansion and expansion to expansion)
Cable for 32 / 64-points I/O module (Both edges connector type)	EH-CBM01W	1 m (3.28 ft.) length (32 / 64-points I/O module to terminal block adaptor)
	EH-CBM03W	3 m (9.84 ft.) length (32 / 64-points I/O module to terminal block adaptor)
	EH-CBM05W	5 m (16.4 ft.) length (32 / 64-points I/O module to terminal block adaptor)
	EH-CBM10W	10 m (32.8 ft.) length (32 / 64-points I/O module to terminal block adaptor)
Cable for 32 / 64-points I/O module (One edges connector type)	EH-CBM01	1 m (3.28 ft.) length (32 / 64-points I/O module to external equipments)
	EH-CBM03	3 m (9.84 ft.) length (32 / 64-points I/O module to external equipments)
	EH-CBM05	5 m (16.4 ft.) length (32 / 64-points I/O module to external equipments)
	EH-CBM10	10 m (32.8 ft.) length (32 / 64-points I/O module to external equipments)
Cable for counter input module	EH-CUC01	1 m (3.28 ft.) length (Counter input module to external equipments)
	EH-CUC02	2 m (6.56 ft.) length (Counter input module to external equipments)
	EH-CUC03	3 m (9.84 ft.) length (Counter input module to external equipments)
	EH-CUC04	4 m (13.1 ft.) length (Counter input module to external equipments)
	EH-CUC05	5 m (16.4 ft.) length (Counter input module to external equipments)

*1 Use in a maximum of 2 m (6.56ft.) between stations, 8 m (26.24ft.) in total.

(4) Optional product

Table 3.11 Optional product of HX series

Model	Use	Remarks
HX-BAT	The battery is to work real-time clock only.	

During the 8 days or more of a power cut, if the retention of realtime clock data is required, please use the Lithium battery. But even in the case of using real time clock, Battery is unnecessary when HX-CPU are always synchronized with NTP server. HX-CPU stores user program and data (retain and persistent) to a nonvolatile memory, so the battery is unnecessary for them. The durable life of the battery is 5 years. Even if the battery is not a life, replace it every 5 years.

Table 3.12 The life of battery

The life of battery (Total power failure) [Hr]	
Guaranteed value (MIN) @55 °C	Actual service value (MAX) @25 °C
25,000	67,000

Chapter 4 Web Server Function

4.1. Overview of Web Server Function

The web server function allows system management, such as virtual controller settings and state check for this product.

The web server consists of the following three screens:

(1) System information screen

(2) Virtual controller information screen

(3) Shared memory information screen

4.2 User Authentication Function

This product allows you to register and delete users for the web management function. Users can be registered and managed based on the following three types:

Table 4.1 List of user types

Type name	Authority type	Operation rights
Administrator	Administrator rights	- Register and delete users for the web server function - Set the virtual controllers (if this user type is used, administrative attention is required because some of the parameter settings may affect the system stability) - Start / stop the application - View and write data in the shared memory
MaintenanceStaff	User rights	For future expansion
Developer	User rights	- Set the virtual controllers (only parameters that do not affect the system stability) - Start / stop the application - View and write data in the shared memory

4.3 How to Access Web Server

A general web browser is used to access the web server of this product. Use an HTML5-supported web browser. The following web browsers are recommended:

- Chrome 53 or higher, Firefox 49 or higher

- IE 11 or higher, Edge 38 or higher

1. Connect between this product and the PC with the LAN cable using the ETH3 port of this product.
2. Launch the web browser and enter "<IP address of the ETH3 port of this product>:53080" in the address field. The default ETH3 IP address is "192.168.2.1", so enter "192.168.2.1:53080".
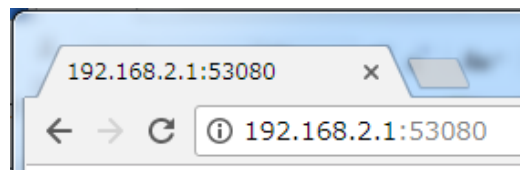
Fig 4.1 Entering the address on the web browser

3. When the login screen appears, enter the following information:

    [For login with user rights]

    User name: hxuser

    Password: hxuser

    [For login with administrator rights]

    User name: admin

    Password: manager
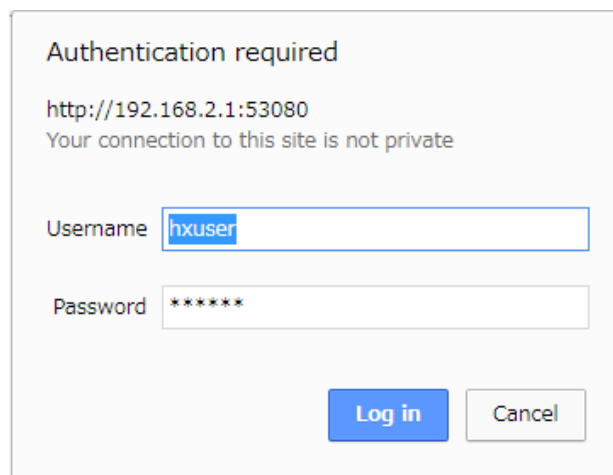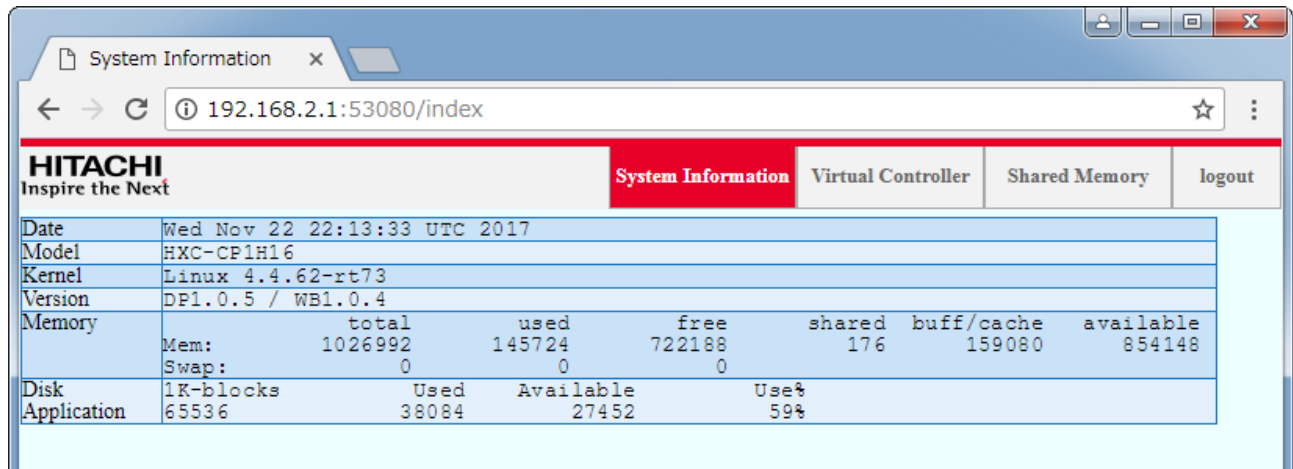
Fig. 4.2 Login screen

> **Note**
>
> Since the default password of the initial registered user name is common to the HX series hybrid model, please change it before use and periodically update it. If you forget your user name or password, you need to initialize the user information. Please keep your user name and password safe. For user registration / deletion, please refer to section 4.7.

4.4 System Information Screen

This section describes the layout of the system information screen and the part names and functions.

Fig. 4.3 System information screen (for user rights)

Fig. 4.4 System information screen (for administrator rights)

Table 4.2 System information items

No.	Display	Name	Description
1	System Information Virtual Controller Shared Memory logout	Menu button	Select the screen to display. The button for the currently displayed screen is highlighted.
2	Date	Current time	Displays the current date and time set in HX-CPU in the following format: www MMM DD hh:mm:ss Time Zone (three letters) YYYY
3	Model	Model name display	Displays the HX-CPU model name (HXC-CP1H16).
4	Kernel	Kernel version	Displays the HX-CPU kernel version.
5	Version	Software version	Displays the version of the HX-CPU hybrid model specific software.
6	Memory	Memory usage status	Displays the memory usage status. total: Entire memory space in HX-CPU (fixed to 1026992) used: Used memory space free: Available memory space shared: Memory allocated to the shared memory buff/cache: Used cache size available: Sum of the available memory space and releasable cache size * total = used + free + buff/cache
7	Disk Application	Disk (FLASH) usage status	Displays the FLASH usage status. 1K-blocks: Entire disk space in HX-CPU (fixed to 65536) Used: Used disk space (including the system area) Available: Available disk space for application storage Use%: Percentage of the used disk space
8	Process (Administrator rights only)	Process	Displays the list of processes running on this product.

4.5 Virtual Controller Information Screen

The virtual controller information screen consists of the virtual controller state screen and virtual controller setting screen.

4.5.1 Virtual controller state screen

The following shows the layout of the virtual controller state screen and the part names and functions:
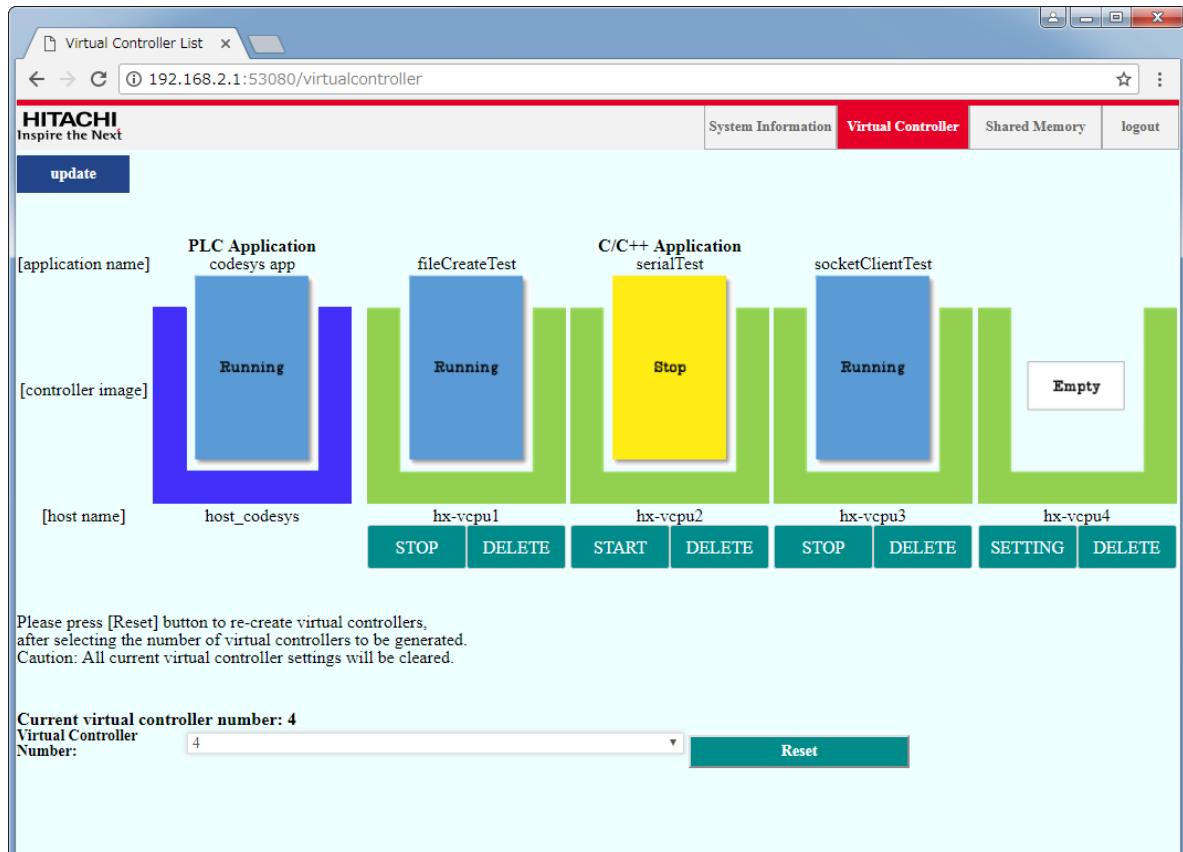
Fig. 4.5 Virtual controller state screen

Table 4.3 Virtual controller state display items (1/2)

No.	Display	Name	Description
1		Menu button	Select the screen to display. The button for the currently displayed screen is highlighted.
2	[application name]	Application name	Displays the name of the application currently registered in the virtual controller. The PLC program name is always "codesys app".

Table 4.4 Virtual controller state display items (2/2)

No.	Display	Name	Description
3	[controller image]	Virtual controller image	Displays the state of the virtual controller for application and the operation status of the currently registered application. "Error": The virtual controller is in fault state. "Empty" The application has not been registered. "Stop": The application has been downloaded and is stopped. "Running": The application is running.[*1] "Online Exec": The application is being executed remotely from HX-Studio. "Online Debug": The application is being debugged remotely from HX-Studio. The state of "codesys app" is displayed as "Stop" or "Running" depending on the operation status.
4	[host name]	Virtual controller name	Displays the virtual controller name (The name is fixed).
5	START DELETE	Virtual controller state change buttons	Used to change the state of the virtual controller for application. For Error: The button is hidden. Reset the virtual controller to recover. For Empty: [SETTING] [DELETE][*2] For Stop: [START] [DELETE] For Running: [STOP] [DELETE] For Online Exec: [STOP] [DELETE] For Online Debug: [STOP] [DELETE]
6	Current virtual controller number	Current number of virtual controllers	Displays the current number of virtual controllers for application.
7	Virtual Controller Number	Virtual controller number select box	Select the number of virtual controllers in reset. The options are 1, 2, and 4.
8	Reset	Virtual controller reset button	Re-creates as many virtual controllers as the number specified in No. 7 above.
9	update	Update button	Updates to the latest information.

*1: If you execute a C-language program that is not a loop program, the state remains "Running" even after the program is finished.

*2: If you execute [DELETE], the virtual controller is initialized with the IP Route and Memory Limit settings remaining.

4.5.2 Virtual controller setting screen

The following shows the layout of the virtual controller setting screen and the part names and functions:

Fig. 4.6 Virtual controller setting screen (for user rights)

Fig. 4.7 Virtual controller setting screen (for administrator rights)

Table 4.5 Virtual controller setting items (1/2)

No.	Display	Name	Description
1	Back	[Back] button	Used to return to the virtual controller state screen.
2	Setting Parameters VCPU Number	Virtual controller identification number	Displays the virtual controller identification number.
3	State	Application state	Displays the application state. empty: Not registered stop: Registered, stopped run: Running online exec: Being executed remotely from HX-Studio online debug: Being debugged remotely from HX-Studio
4	Host Name	Virtual controller name	Displays the virtual controller name.
5	App Path	Application path	Displays the full path including the execution file name of the application.
6	App Command	Command path	Displays the full path (including the command file name) of the application execution command.
7	App Name	Application name	Displays the execution file name.
8	Project ID	Project ID	Displays the project ID automatically created when a project is created in HX-Studio.
9	Build Time	Build time	Displays the build / download time in HX-Studio.
10	IP Route	IP routing	Set the IP addresses.
10-1	Alias IP Addresses	Alias IP address	[When Masquerade / Port forward is selected] Displays the IP address of the ETH3 port. [When Ip forward is selected] Specify the IP address (alias IP address) to be added to the ETH3 port and use it for the virtual controller only.
10-2	Internal IP Addresses	Internal IP address	Set the internal IP address of virtual controller.[*1]
10-3	Pair IP Addresses	Pair IP address	Set the IP address pair to the internal IP address.[*2]
11	Current Forward	Forwarding method select box	Select the forwarding method. - Port forward - Ip forward - Masquerade (default)
12	Port Forward (Displayed only when Port Forward is selected in Current Forward)	Port forward setting	- Select the protocol (tcp or udp) - Set the host port (the port number of ETH3)[*3] - Set the forwarding destination port (port number used in the application) - Add the setting values with the [Add] button - Delete the setting values with the [Delete] button
13	Memory Limit	Memory limit	Select the maximum memory size used in the virtual controller.[*4] The options are 4MB, 8MB, 16MB, 32MB, 64MB, 128MB, 256MB, and 512MB.
14	Show Advanced Settings (Administrator rights only)	Advanced setting item show / hide button	Used to show the advanced setting items.
15	Real-time Priority (Administrator rights only)	Real-time priority	Specify the real-time priority of application.[*5] Non-Real-time Real-time:Low Real-time:Middle Real-time:High Real-time:Very High
16	Device	Device use / non-use checkbox	Set whether or not to use RS-485 (/dev/ttyO1).

Table 4.6 Virtual controller setting items (2/2)

No.	Display	Name	Description
17	Restore value	Clear input value button	Used to reset the input values.
18	Set Parameters	Set parameters button	Used to apply the input values to this product.
19	Choose Files (The button display varies depending on the browser.)	Download file browse button	Select a file to be forwarded to the virtual controller, such as execution file of application, shell file, ini file, and VM environment.
20	Confirm	Confirm button	Used to forward the file selected with the download file browse button to this product.
21	Run AppCmd	Application execution command	Displays the command to execute the application set as the execution file.*[6]
22	No Run App File Name Delete / 1 ○ fileCreateTest □	Download file list	Displays the list of files forwarded to this product in No. 20. Run App: Select an application to launch. File Name: Displays the name of the file forwarded to this product. Delete: Select a file to delete from this product.
23	Apply Files	Apply button	Creates a virtual controller with the setting in No. 22.
24	Delete Files	Delete files button	Deletes the file selected in No. 22 "Delete".

*1: The network address (upper three octets) must be the same as the pair IP address and not duplicate other virtual controller values.

*2: The network address (upper three octets) must be the same as the internal IP address and not duplicate other virtual controller values.

*3: When Port forward is selected in the Current Forward setting, specify a port number other than the reserved port numbers of HX-CPU as the host port setting.

Table 4.7 Reserved port numbers

Port number	Purpose
1740 to 1743	CODESYS connection (UDP/IP)
11740	CODESYS connection (TCP/IP)
1217	Gateway communication (TCP/IP)
1202	Network variable (UDP/IP)
8080	CODESYS web server (WebVisu)
4840	CODESYS OPC-UA server
502	Modbus-TCP server
20	FTP server (data transfer)
21	FTP server (control)
123	NTP server (UDP/IP)
4000 to 4007	CAA.NetBaseService receive (both UDP/IP and TCP/IP)

*4: If the memory space secured in the program exceeds the Memory Limit value specified in the virtual controller settings, the process of executing the target program will end due to insufficient resources. Pay extra attention in memory usage management by referring to the memory usage status on the system information screen.

*5: If you set the real-time priority to other than Non-Real-Time and create a C-language program that does not end due to the infinite loop of the main function, **be sure** to call the usleep function at the end of the loop to set the wait time. The C-language program continues to be executed on the real-time priority, preventing other tasks, such as PLC process and communication, from running.

*6: A file with a name starting with "." cannot be specified as a boot file in Run App Cmd.

4.6 Shared Memory Information Screen

This section describes the layout of the shared memory information screen and the part names and functions.

Fig. 4.8 Shared memory information screen

Fig. 4.9 Shared memory information screen (shared variable list)

Table 4.8 Shared memory information screen

No.	Display	Name	Description
1		Menu button	Select the screen to display. The button for the currently displayed screen is highlighted.
2	Auto Update Read Area Write Area	Automatic update setting	If the checkbox is selected, the shared memory values are updated at the interval set in No. 3 "Update Interval". If unselected, the automatic update is disabled.
3	Update Interval (sec.)	Update interval setting	Specify the interval at which the displayed shared variable values are automatically updated. [1]
4	[Read Area] [Write Area] PROGRAM	Object name	Displays the object names that declared the variables displayed in No. 5 shared variable list. Clicking this name shows / hides the variable name list.
5		Shared variable list	Displays the variable name, data type, offset address, and value (hexadecimal / decimal) for the shared variables. Variables shown in [Write Area] can be written a value.

*1: When the CPU is high load, the actual update interval may be longer than the setting value.

4.7 User Registration Screen

This section describes the layout of the user registration screen and the part names and functions. This screen can be displayed only when you log-in to the system with administrator rights.

Fig. 4.10 User registration screen

Table 4.9 User registration items

No.	Display	Name	Description
1		Menu button	Select the screen to display. The button for the currently displayed screen is highlighted.
2	User Name	User name input field	Enter a user name to add or modify. (Max. 16 characters. 0 to 9, a to z, A to Z, underscore(_), and hyphen(-) only)
3	Password	Password input field	Set the password with one to eight characters.
4	Confirm Password	Password confirmation input field	Enter the password used in No. 3 again.
5	Access Authority	Access rights	Specify the user access rights. - Administrator: Administrator rights - MaintenanceStaff: User rights (for future expansion) - Developer: User rights
6	Reset	Reset button	Clears all the input fields.
7	Register	Register button	Register the user after confirming that the above input fields are correct.
8	User List	User list	Displays the registered users. (Up to 30 users) User Name: User name Access Authority: Access rights Delete: Select to delete the user.
9	Delete	Delete button	Deletes the user selected in No. 8 "Delete". (The initially registered user names "admin", "mainte", and "hxuser" cannot be deleted.)

4.8 Virtual Controller Network Settings

To use the Ethernet communication function in virtual controllers, you need to select one of the following three address conversion methods. For packet receive in the UDP communication or passive connection open in the TCP communication, set Ip forward or Port forward.

Table 4.10 List of address conversion methods for virtual controllers

Method	UDP communication		TCP communication		Forwarding setting
	Send	Receive	Active open	Passive open	
Masquerade	✓	-	✓	-	Not required (the IP address of the ETH3 port is shared).
Ip forward	✓	✓	✓	✓	Specify the forwarding destination IP address.
Port forward	✓	✓	✓	✓	Specify the receiving port number and forwarding destination port number.

4.8.1 When Masquerade is selected

This is an address conversion method to share the ETH3 IP address with the target virtual controller. In this method, the forwarding setting is not required, but peripheral equipment cannot access the virtual controller.

Fig. 4.11 IP Route setting screen (when Masquerade is selected)

Table 4.11 IP Route setting description (when Masquerade is selected)

Item	Setting description
Alias IP Addresses	Displays the IP address set on the ETH3 port in the HX-CODESYS project.
Internal IP Addresses	Use the default value for this setting. However, if the IP address set in Alias IP Addresses duplicates the network address (upper three octets), specify a different network IP address. Example: If Alias IP Addresses is 192.168.121.25, use an IP address other than 192.168.121.xxx, such as 192.168.200.xxx.
Pair IP Addresses	Use the default value for this setting. However, if Internal IP Addresses was changed, specify the same network address as Internal IP Addresses. Example: If Internal IP Address is set to 192.168.200.10, use an IP address such as 192.168.200.11.

4.8.2 When Ip forward is selected

This is an address conversion method to forward IP packets to the target virtual controller via the ETH3 port by specifying the IP address for the target virtual controller.

Fig. 4.12 IP Route setting screen (when Ip forward is selected)

Table 4.12 IP Route setting description (when Ip forward is selected)

Item	Setting description
Alias IP Addresses	Specify the IP address used in the C-language program. The network (upper three octets) is fixed to the one set on the ETH3 port in the HX-CODESYS project. Specify a different node address (fourth octet) from that of the ETH3 port. Example: If the IP address of the ETH3 port is 192.168.2.1, use an IP address other than 192.168.2.1, such as 192.168.2.100.
Internal IP Addresses	Use the default value for this setting. However, if the IP address set in Alias IP Addresses duplicates the network address (upper three octets), specify a different network IP address. Example: If Alias IP Addresses is 192.168.121.25, use an IP address other than 192.168.121.xxx, such as 192.168.200.xxx.
Pair IP Addresses	Use the default value for this setting. However, if Internal IP Addresses was changed, specify the same network address as Internal IP Addresses. Example: If Internal IP Address is set to 192.168.200.10, use an IP address such as 192.168.200.11.

4.8.3 When Port forward is selected

This is an address conversion method to forward packets that are sent to a specific ETH3 port number to the preset port number of the target virtual controller.

Fig. 4.13 IP Route setting screen (when Port forward is selected)

Table 4.13 IP Route setting description (when Port forward is selected)

Item	Setting description
Alias IP Addresses	Displays the IP address set on the ETH3 port in the HX-CODESYS project.
Internal IP Addresses	Use the default value for this setting. However, if the IP address set in Alias IP Addresses duplicates the network address (upper three octets), specify a different network IP address. Example: If Alias IP Addresses is 192.168.121.25, use an IP address other than 192.168.121.xxx, such as 192.168.200.xxx.
Pair IP Addresses	Use the default value for this setting. However, if Internal IP Addresses was changed, specify the same network address as Internal IP Address. Example: If Internal IP Address is set to 192.168.200.10, use an IP address such as 192.168.200.11.
Port Forward	Specify TCP or UDP for the protocol. host Port: Specify the destination port number for data transmission from peripheral equipment. forward Port: Specify the local port number used in the C-language program.

MEMO

Chapter 5 Application Integrated Development Environment HX-Studio

5.1 About HX-Studio

HX-Studio is an integrated development environment to develop C-language programs that are to be embedded into this product. HX-Studio is based on the open source integrated development environment "Eclipse" and C/C++ language development plug-in "CDT". HX-Studio uses the Eclipse CDT standard high-functional editor and debug tool to provide a wide range of support from designing to debugging of C-language programs.

5.1.1 System configuration

The ETH3 port of HX-CPU is used to connect HX-CPU to a PC where HX-Studio is installed. The system configuration is as shown below:
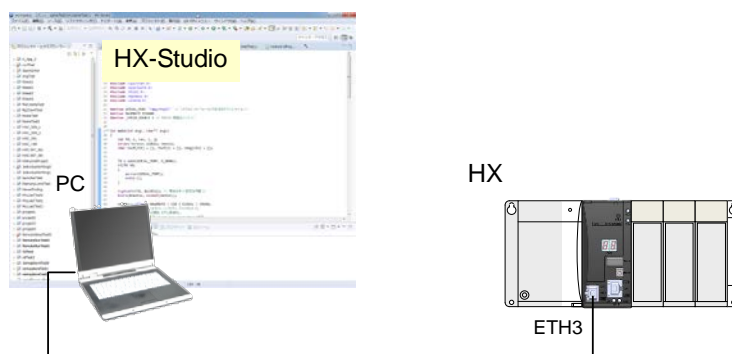
Fig 5.1 System configuration

5.1.2 Operating environment

The operating environment of HX-Studio is as follows:

Table 5.1 Operating environment of HX-Studio

CPU	Intel Core 2 Duo 2 GB or more recommended
Required memory	1 GB or more (2 GB or more recommended)
Available HDD space	4 GB or more (Execution size: Virtual memory 512 MB or more)
Display	Resolution 1024 x 768 dots or more recommended
Disk drive	DVD drive
Interface	Ethernet 10BASE-T/100BASE-TX
OS	Microsoft Windows® 7, 8, 8.1, 10 32/64-bit (Japanese / English)

5.2 Installation

This section describes how to install HX-Studio.

5.2.1 Installing HX-Studio

Close all other running Windows applications before installing HX-Studio. Otherwise, HX-Studio may not be correctly installed.

1. Double-click the setup file (setup_HXStudioV****.exe) in the installation CD.

2. Install HX-Studio using the following installation wizard:
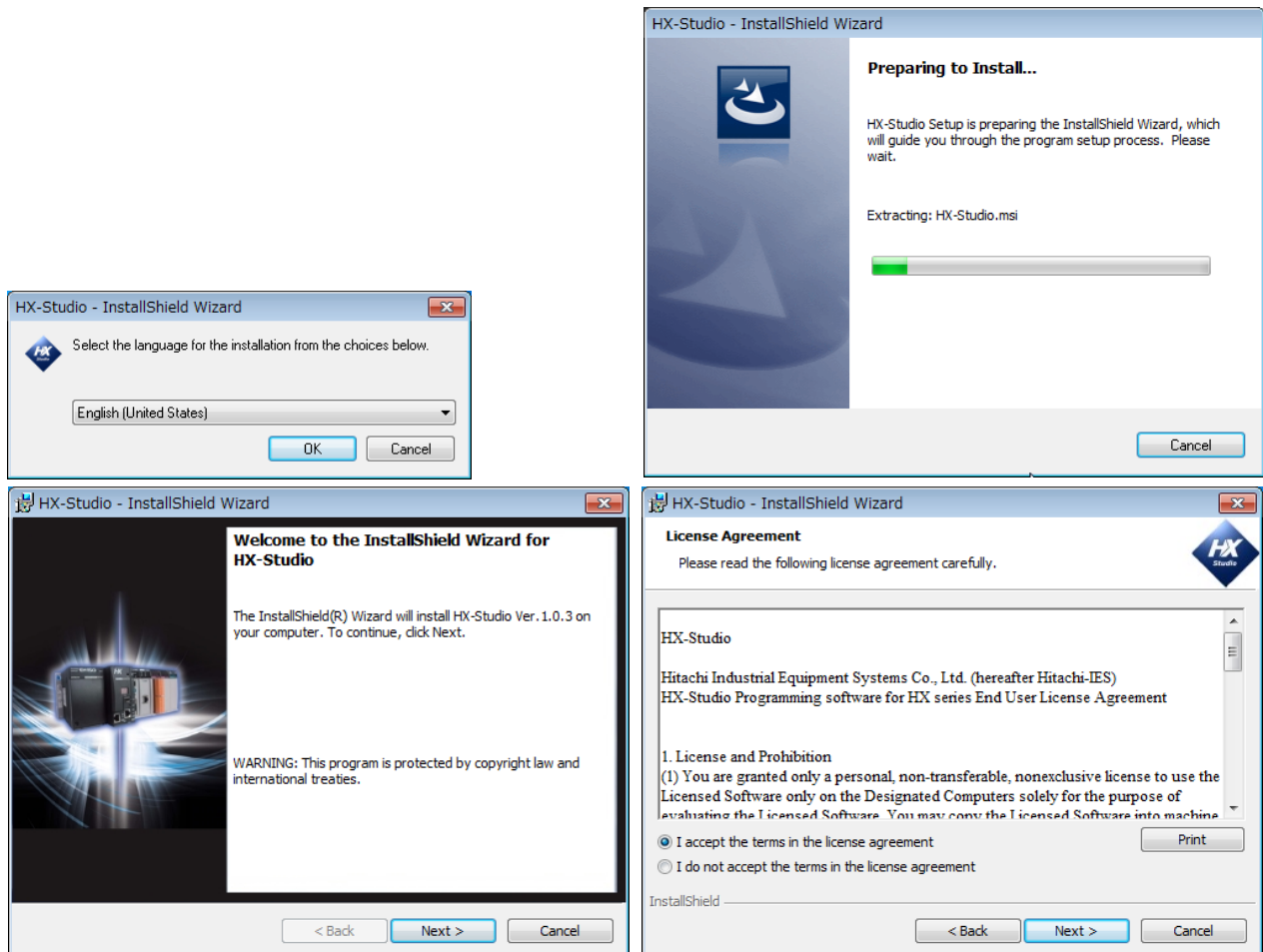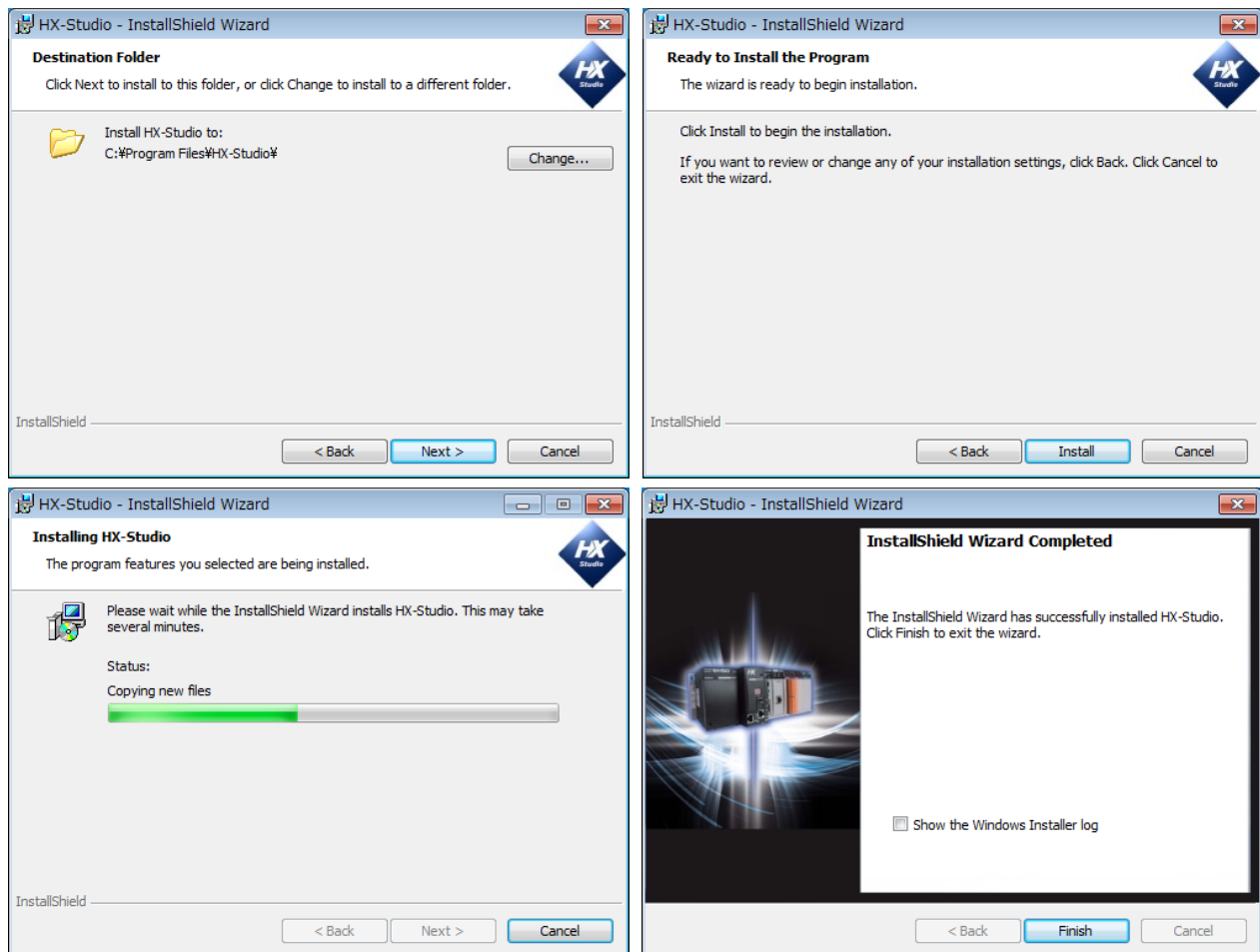
The file configuration of the installation folder is as follows:

```
HX-Studio
├configuration
├jre
├MSYS-20111123
├p2
├toolchain_5.3-2016.02.32
├artifacts.xml
├HX-Studio.exe
└HX-Studio.ini
```

5.2.2 Launching HX-Studio

1. Double-click the HX-Studio.exe shortcut created on the desktop.

2. Select a directory to be used as workspace and click [OK].
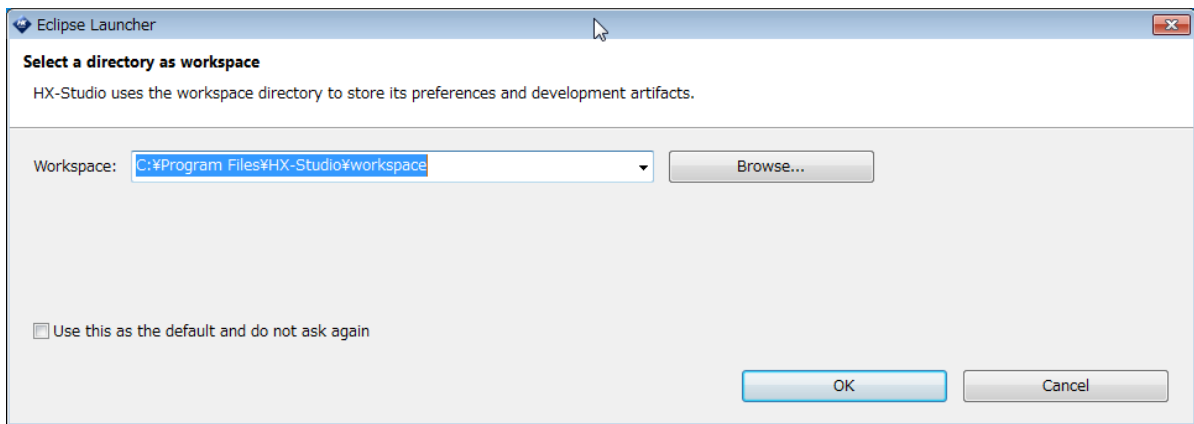
Fig 5.2 Workspace launcher screen

3. The launcher logo screen is displayed, preparing for startup.

4. When the startup is finished, the HX-Studio main screen appears.
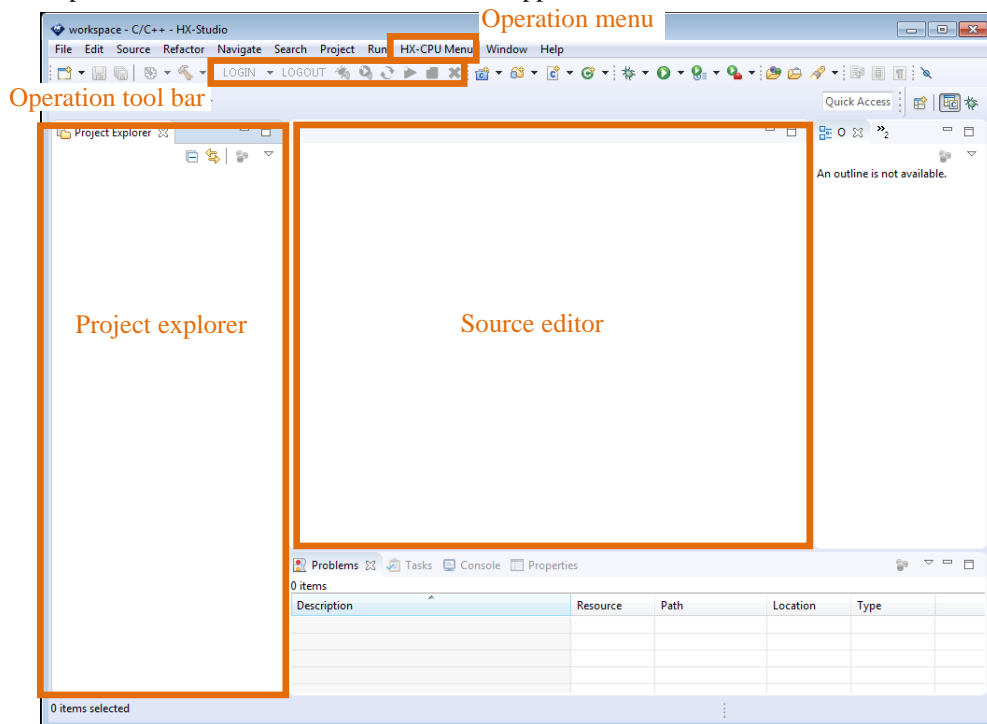
Fig 5.3 HX-Studio main screen

Caution

When you are using Windows with an account having a general user rights, if a directory under C:¥Program files is selected for the workspace path, a virtual folder is automatically created in C:¥Users¥<user name>¥AppData¥Local¥VirtualStore¥Program Files¥ due to the Windows function. Set an appropriate workspace path as necessary.

5.3 Project Creation

This section describes how to create a C / C++ application project.

5.3.1 Creating a new project

1. Click [File] - [New] - [C project for HX-CPU] or [C++ project for HX-CPU] from the menu to display the new project wizard selection screen.
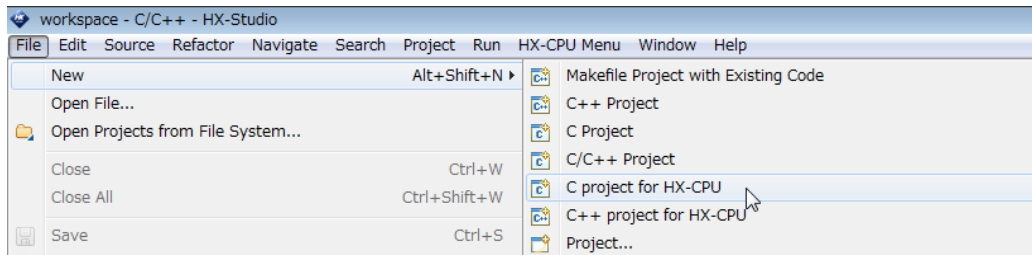
Fig 5.4 Project creation menu

2. Enter a project name and set the project type and tool chain.

    Select the following project type:

    For C projects

    [HX ANSI C Project for DataSharing] or [HX ANSI C Project]

    For C++ projects

    [HX C++ Project for DataSharing] or [HX C++ Project]

    Select [Cross GCC] for the tool chain.

    After the setting, click [Next >].
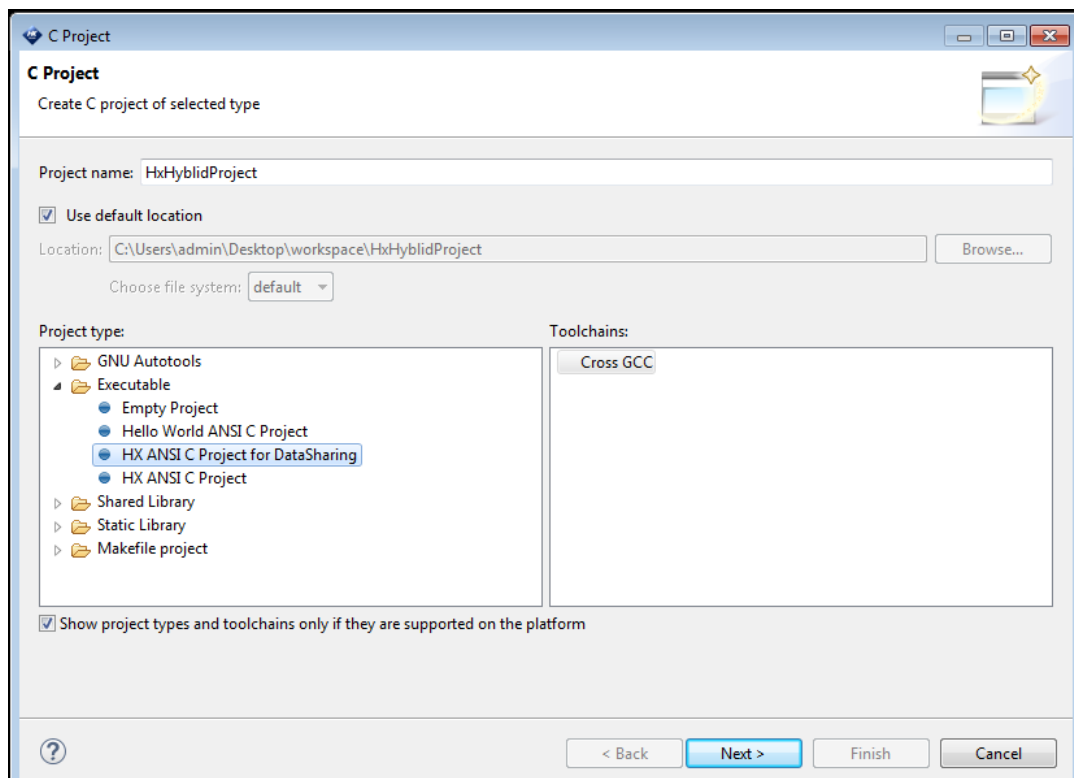
Fig. 5.5 Creating a new project

3. The basic settings screen appears. Enter information to be written to the template source file and click [Next >].
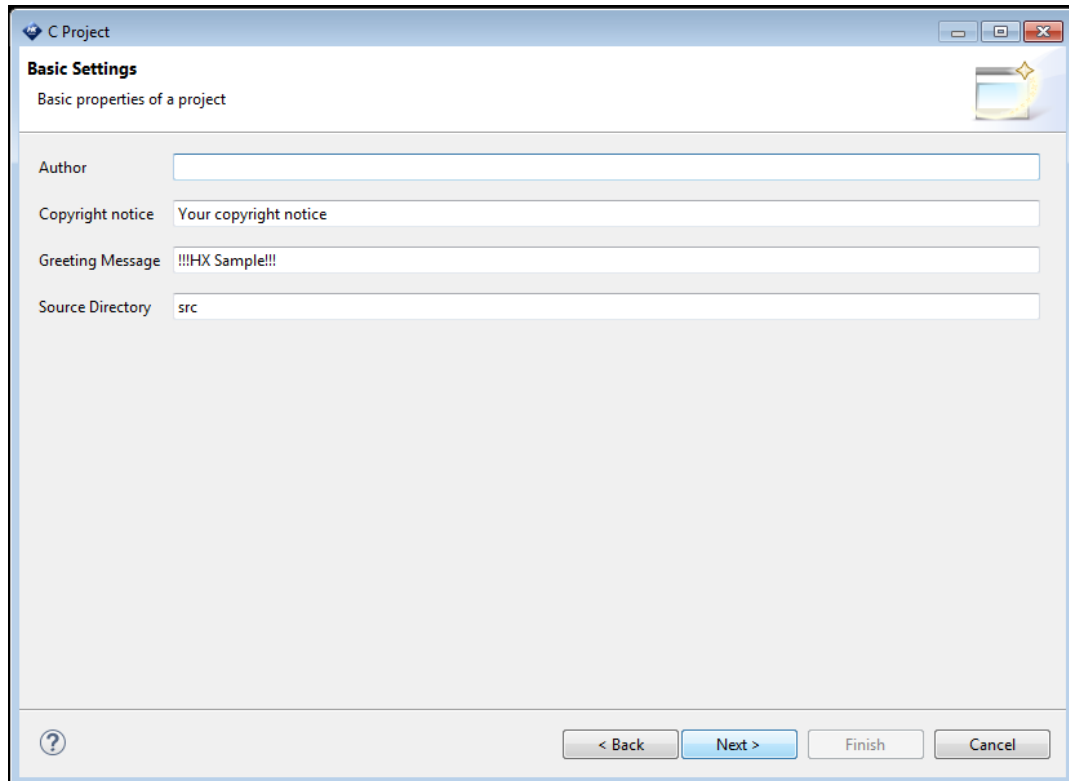
Fig. 5.6 Basic settings screen

4. The select configurations screen appears. Click [Next >].
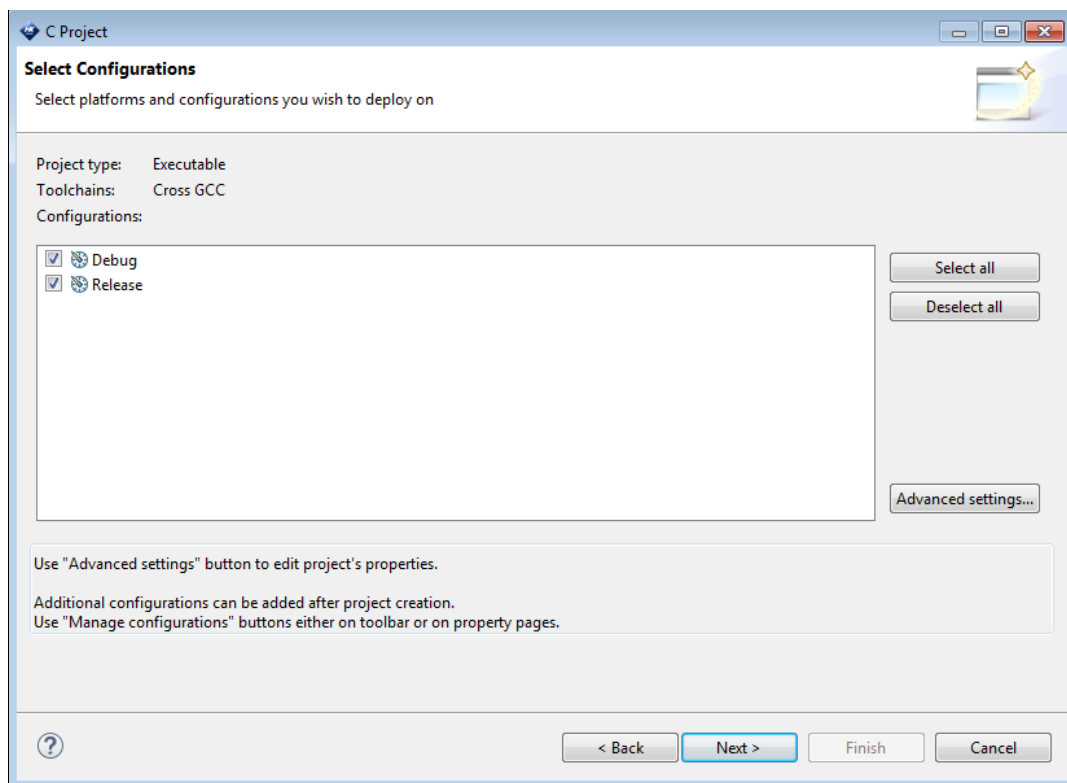
Fig. 5.7 Select configurations screen

5. Set the cross compiler prefix and cross compiler path and click [Next >].
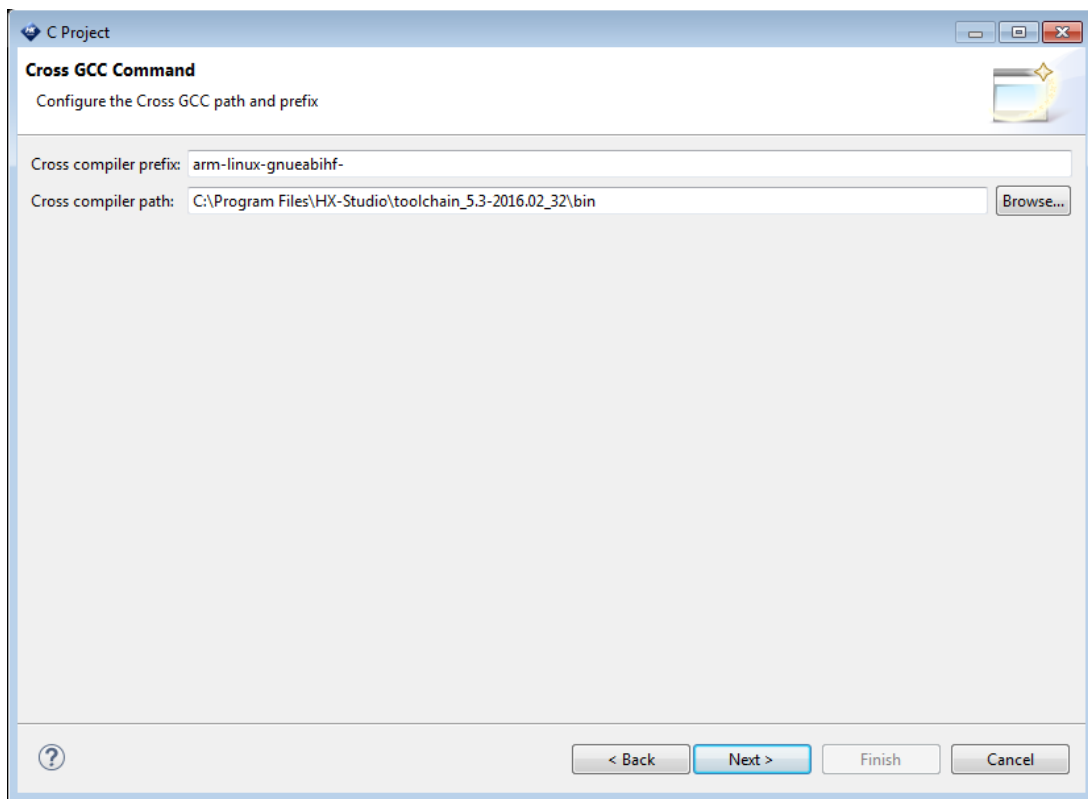
Fig. 5.8 Cross GCC setting screen

6. The HX-CPU connection setting screen appears. Set the IP address to connect to the HX-CPU web server, connection timeout time, and login user name / password and click [Finish].

The default settings are as follows:

HX-CPU IP address: 192.168.2.1

HX-CPU timeout: 30000 ms (30 seconds)

HX-CPU user name / password: hxuser
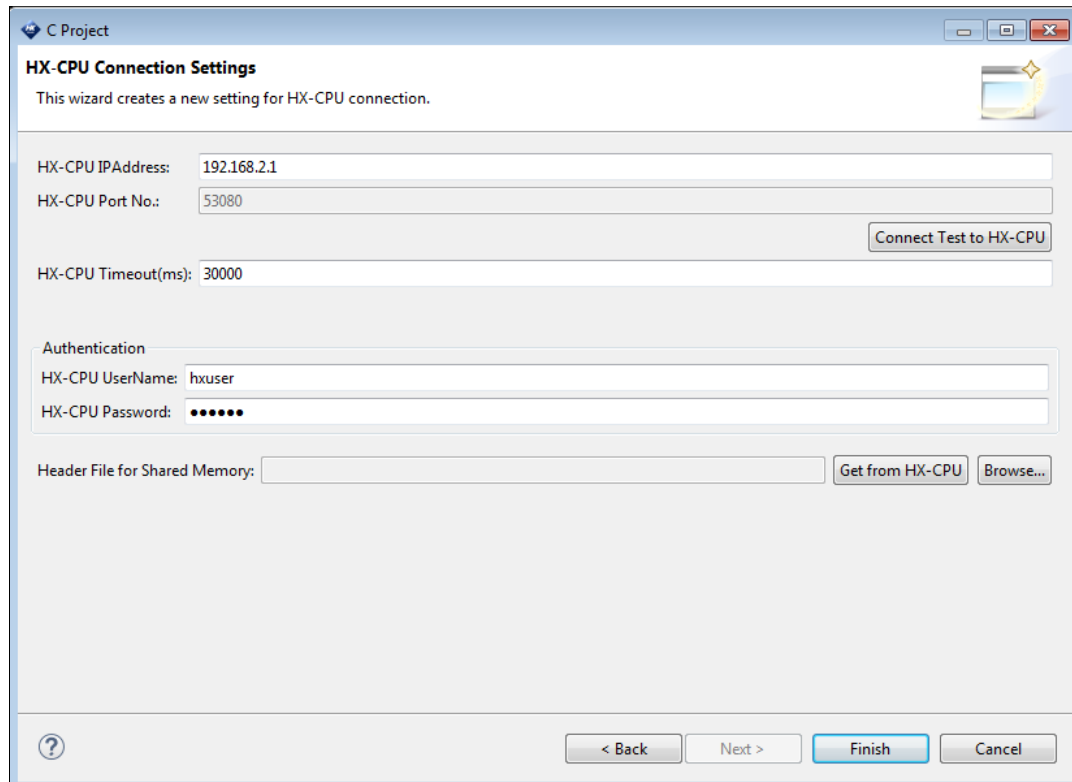
Fig. 5.9 HX-CPU connection setting screen

When you click [Connect Test to HX-CPU], you can check if the PC can connect to HX-CPU.

Fig. 5.10 Confirmation message (normal)

If the settings are incorrect or a LAN cable is not connected to the ETH3 port of HX-CPU, an error message appears after the timeout time passes.
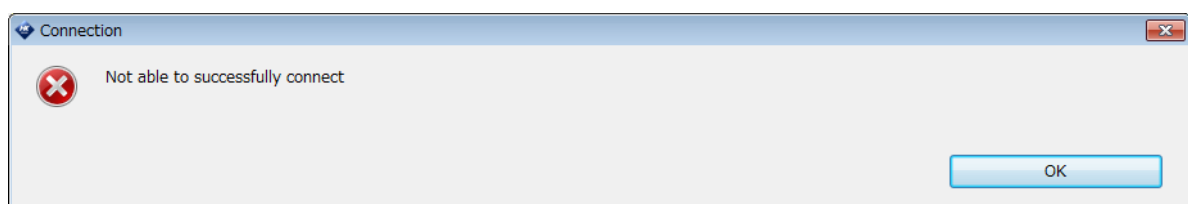
Fig. 5.11 Confirmation message (error)

When you click [Get from HX-CPU], the shared memory header file[*1] is obtained from HX-CPU.
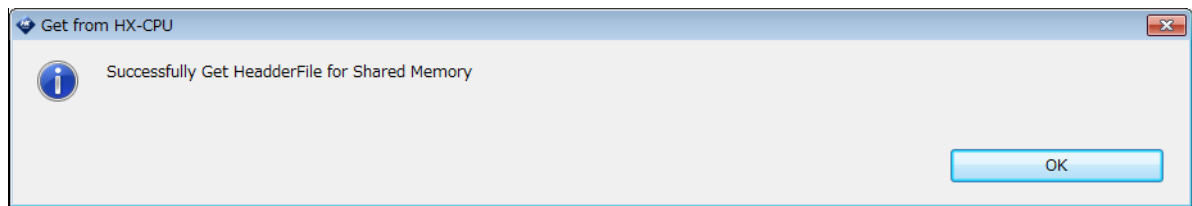
Fig. 5.12 Confirmation message (normal)

If no shared variables are set in the connected HX-CPU, an error message appears.
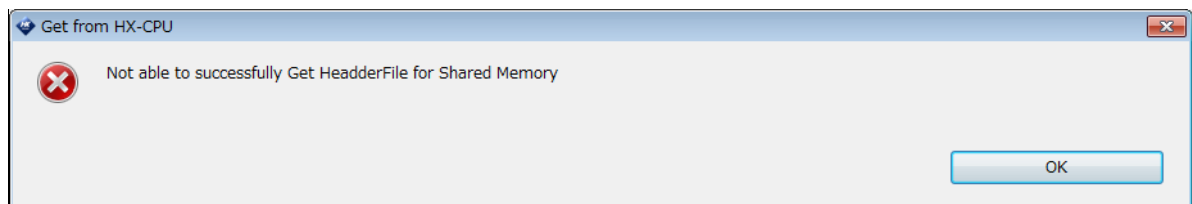
Fig. 5.13 Confirmation message (error)

If the shared memory header file is already saved in the PC, you can click [Browse…] to select the target shared memory header file.
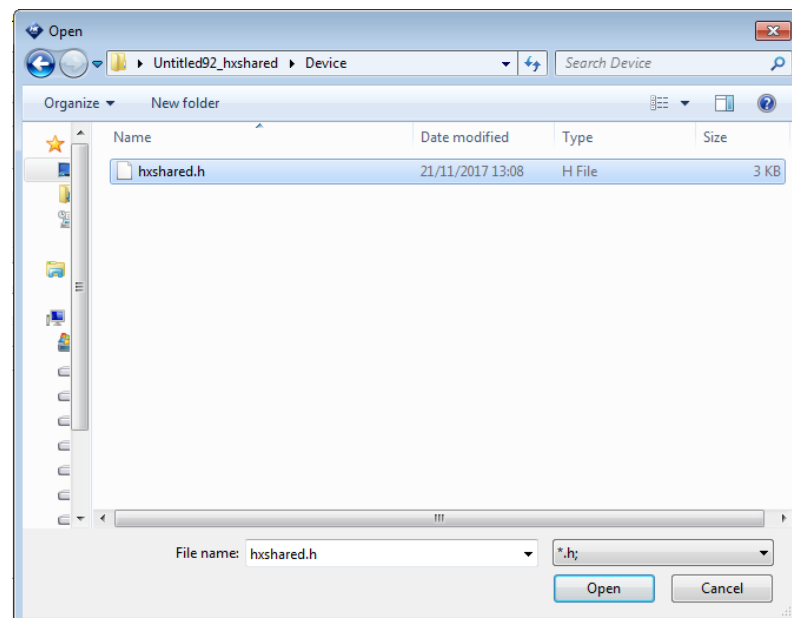
Fig 5.14 Browse dialog

*1 This is a header file used to write a code to access the shared memory. It declares a list of variables that can be read / written from the C-language program and the function definitions used to synchronize with the shared memory.

5.3.2 How to change the HX-CPU connection settings in a project

You can change the HX-CPU connection settings even after creating a project. The following shows the modification procedure:

1. Right-click a created project in the "project explorer". When the pop-up menu opens, click [Properties].
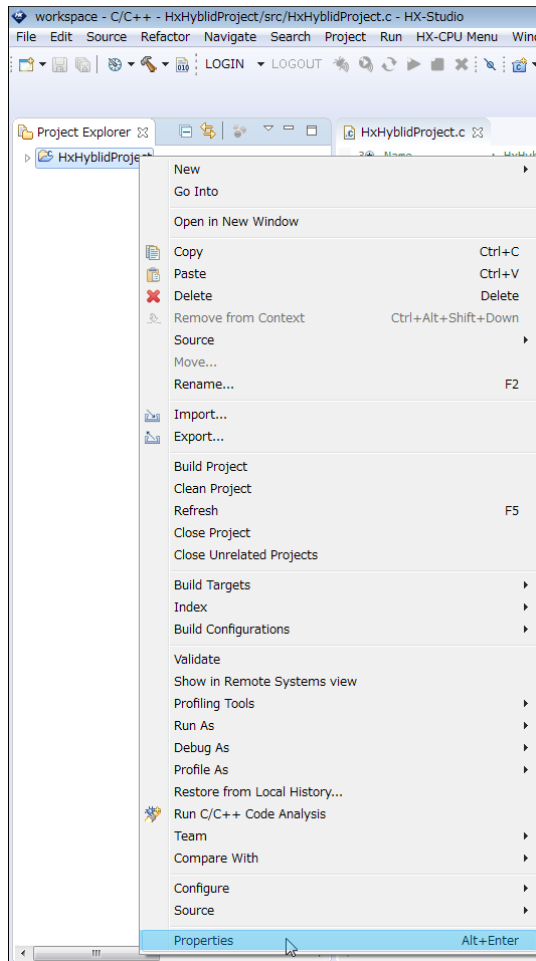
2. Click [HX-CPU Settings] on the property screen.
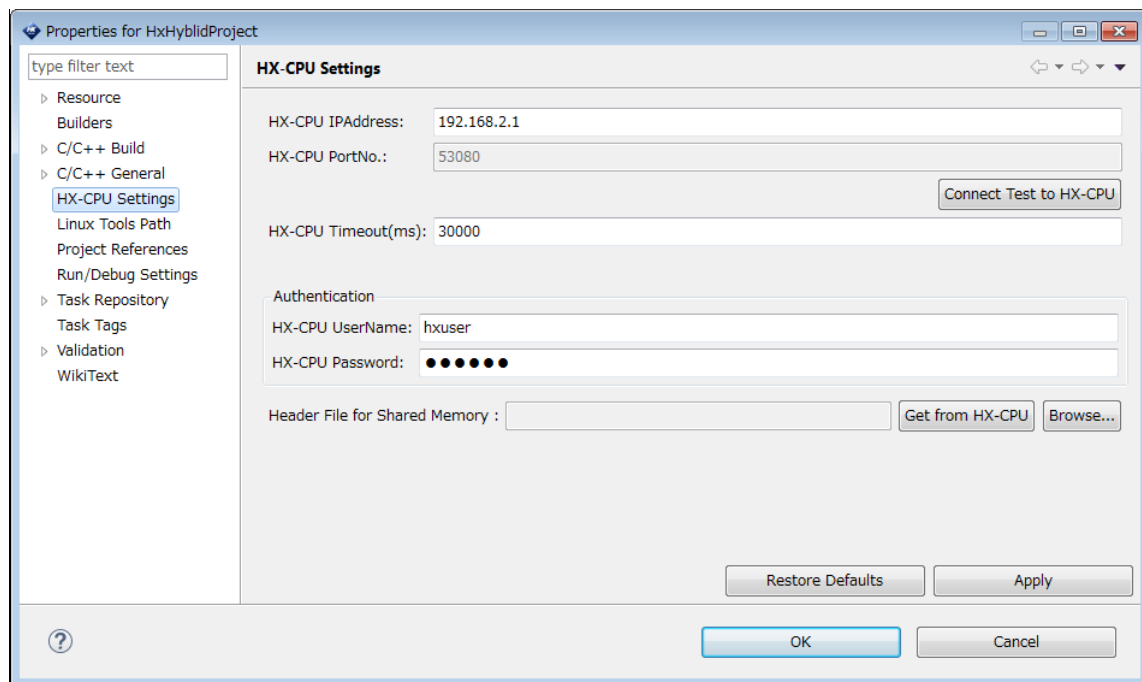
Fig. 5.15 HX-CPU connection setting screen

3. Enter "HX-CPU IPAddress", "HX-CPU Timeout", "HX-CPU UserName", and "HX-CPU Password" and click [Apply] to apply the settings. If you do not perform "Get the header file for shared memory" below, click [OK] to apply the setting and close the screen.

4. Get the header file for shared memory.
   Click [Get from HX-CPU] to obtain the shared memory header file from HX-CPU.
   If the header file is located in the local folder on the PC, click [Browse…] and select the desired shared memory header file in the file selection dialog.
   Click [Apply] or [OK] to add/update the header file to the project.

Caution

If you change a shared variable in HX-CPU from HX-CODESYS, be sure to perform the step "Get the header file for shared memory" to update the header file referenced in the HX-Studio project.

5.4 HX-CPU Connection and C-language Program Execution / Debugging

By clicking the toolbar icons on the main screen, you can execute and debug the application.

Fig. 5.16 Toolbar icons (when logged in)

Fig. 5.17 Toolbar icons (when logged out)

Table 5.2 List of tool bar icons

Function	Icon	Description
Login	LOGIN ▼	Automatically identifies an unused virtual controller or one where an application with the same name was registered, logs in to the controller, and downloads the application to HX-CPU.
Specified login	LOGIN ▼ LOGOUT Download :hx-vcpu1 Download :hx-vcpu2 Download :hx-vcpu3 Download :hx-vcpu4	You can specify a virtual controller to which the application is downloaded.
Logout	LOGOUT	Logs out of the logged-in virtual controller.
Application execution	▶	Executes the application.
Application stop	■	Stops the application.
Application update	↻	Updates the application.
Application deletion	✖	Deletes the application.
Remote debug	🐞	Debugs the application under development remotely in HX-CPU.
Remote execution	🌐	Executes the application under development remotely in HX-CPU.

Caution

You cannot update the application when it is running (a function such as online change in PLC is not supported).

When you update the application, it is stopped.

5.4.1 Login

Click to select a project you want to connect to in the project explorer (tree view on the left side of HX-Studio) and click **LOGIN ▼** on the tool bar. The project build is executed, and a different download confirmation dialog appears according to the registration state of the C-language program. The description of the confirmation dialog and the button press actions are as shown in the table below. The connection state of the selected project goes online, allowing you to execute or debug the application.

Table 5.3 Download confirmation dialog

Application registration state	Confirmation dialog message	Action
No application with the same name exists, and registration is available.	Do you want to download this application as a new application?	[Yes] writes the application to HX-CPU. [No] does not write the application and makes you remain logged off.
An application with the same name already exists.	Do you want to update current application?	[Yes] updates the application to HX-CPU. The existing application is stopped when update is executed. [No] does not update the application and makes you log in.
The number of registered applications has reached the limit.	There is no available space in the HX-CPU.	The application is not downloaded.
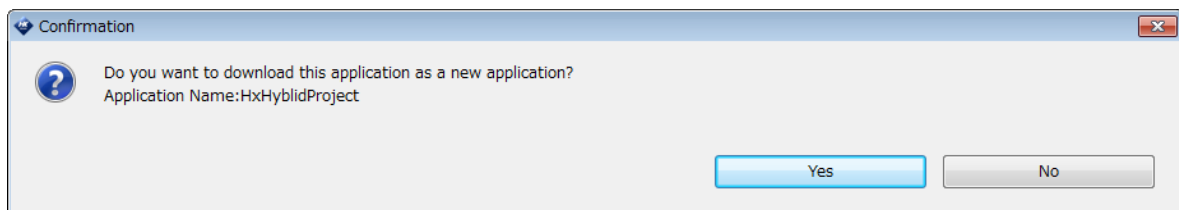
Fig. 5.18 Download confirmation dialog (new download)
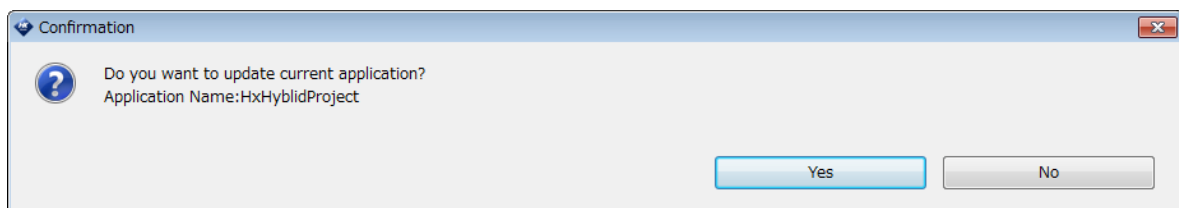
Fig. 5.19 Download confirmation dialog (update download)

Fig. 5.20 Download confirmation dialog (download not allowed)

5.4.2 Specified login

Click to select a project you want to connect to in the project explorer (tree view on the left side of HX-Studio) and click ▼ of **LOGIN ▼** on the toolbar. The names of virtual controllers that can be specified in HX-CPU are listed.
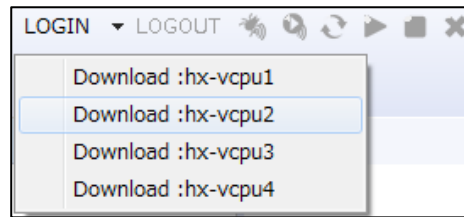
Fig. 5.21 List of virtual controllers

When you select a virtual controller name, you will be logged in to the specified virtual controller. The description of the confirmation dialog and the button press actions are as shown in the table below.

Table 5.4 Download confirmation dialog

Application registration state	Confirmation dialog message	Action
The specified virtual controller is not used.	Do you want to download this application as a new application?	[Yes] writes the application to HX-CPU. [No] does not write the application and makes you remain logged off.
An application with the same name already exists in the specified virtual controller.	Do you want to update current application?	[Yes] updates the application to HX-CPU. The existing application is stopped when update is executed. [No] does not update the application and makes you log in.
An application with another name exists in the specified virtual controller.	Do you want to replace exiting application with this application?	[Yes] overwrites the application to HX-CPU. [No] does not overwrite the application and makes you log in.
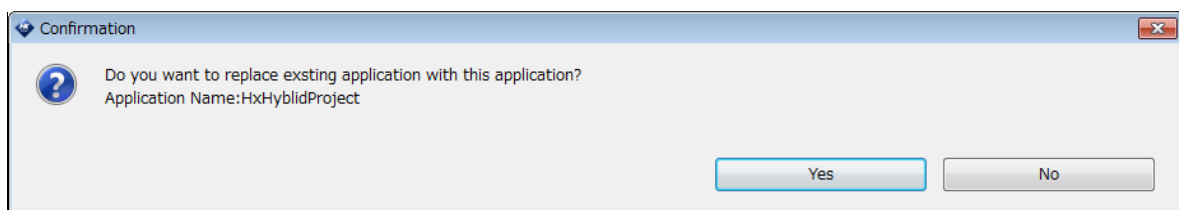
Fig. 5.22 Download confirmation dialog (overwrite download)

5.4.3 Logout

Click to select a project you want to disconnect from and click ⎡ **LOGOUT** ⎤ on the toolbar. When the offline confirmation dialog appears, click [OK].

The connection state of the selected project goes offline, prohibiting you from executing or debugging the application.
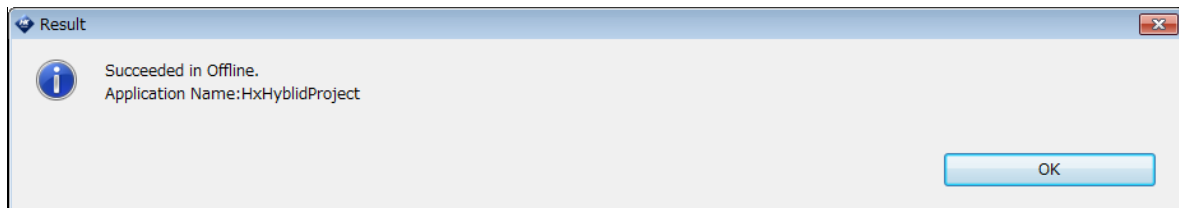
Fig. 5.23 Offline result dialog

5.4.4 Remote debug

Click to select a project you want to debug remotely and click 🛠 on the tool bar.
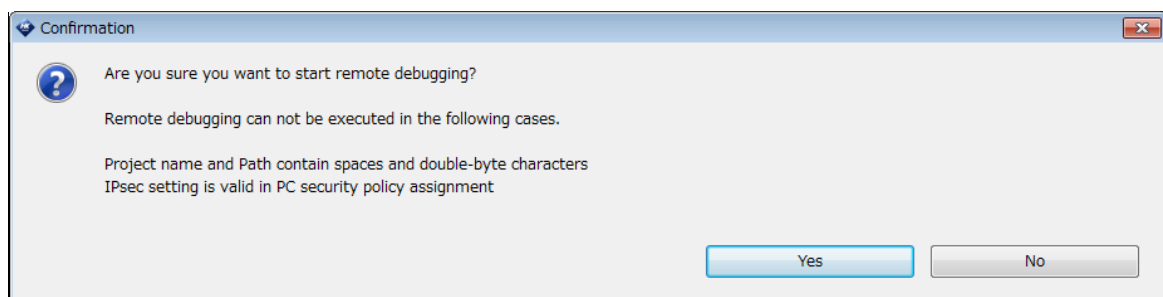
Fig. 5.24 Remote debug confirmation dialog

When you select [Yes] on the above confirmation dialog, the authentication screen appears. Select [Yes], and the authentication is performed automatically.

Fig. 5.25 Remote debug authentication dialog

Caution

If the workspace path or project name contains a space or double-byte character or the IPsec setting is enabled in the security policy assignment of your PC, the remote debug function cannot be used.

When the authentication is completed, the dialog appears. Click [OK].
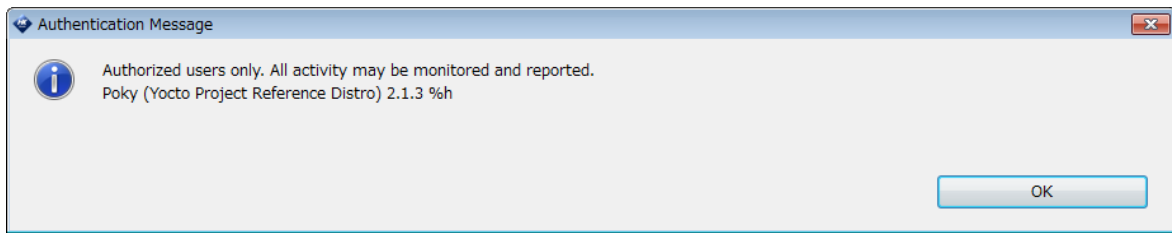
Fig. 5.26 Remote debug authentication completion dialog

When a confirmation dialog appears, select [Yes] to switch the screen layout to the debug screen.
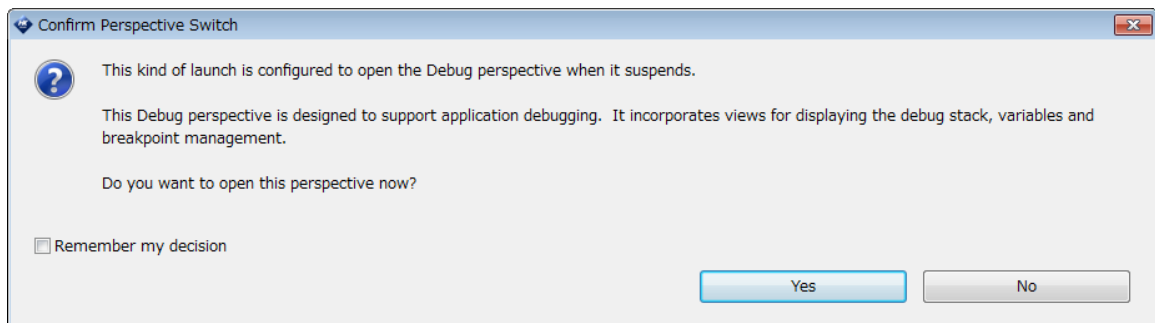
Fig. 5.27 Perspective (screen layout) switch confirmation dialog

■ Setting a break point

To set a break point, double-click the selected source code file and open the file in the editor. Move the cursor over the marker bar (left edge of the editor area) on a line that contains the code you want to stop. Then, double-click it to set a break point.
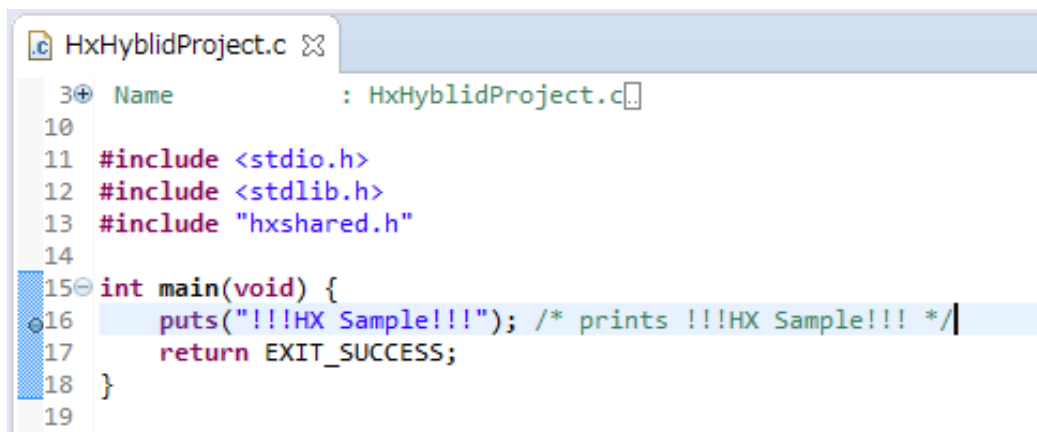
Fig. 5.28 Setting a break point

When remote debugging starts, you will move to the debug screen.
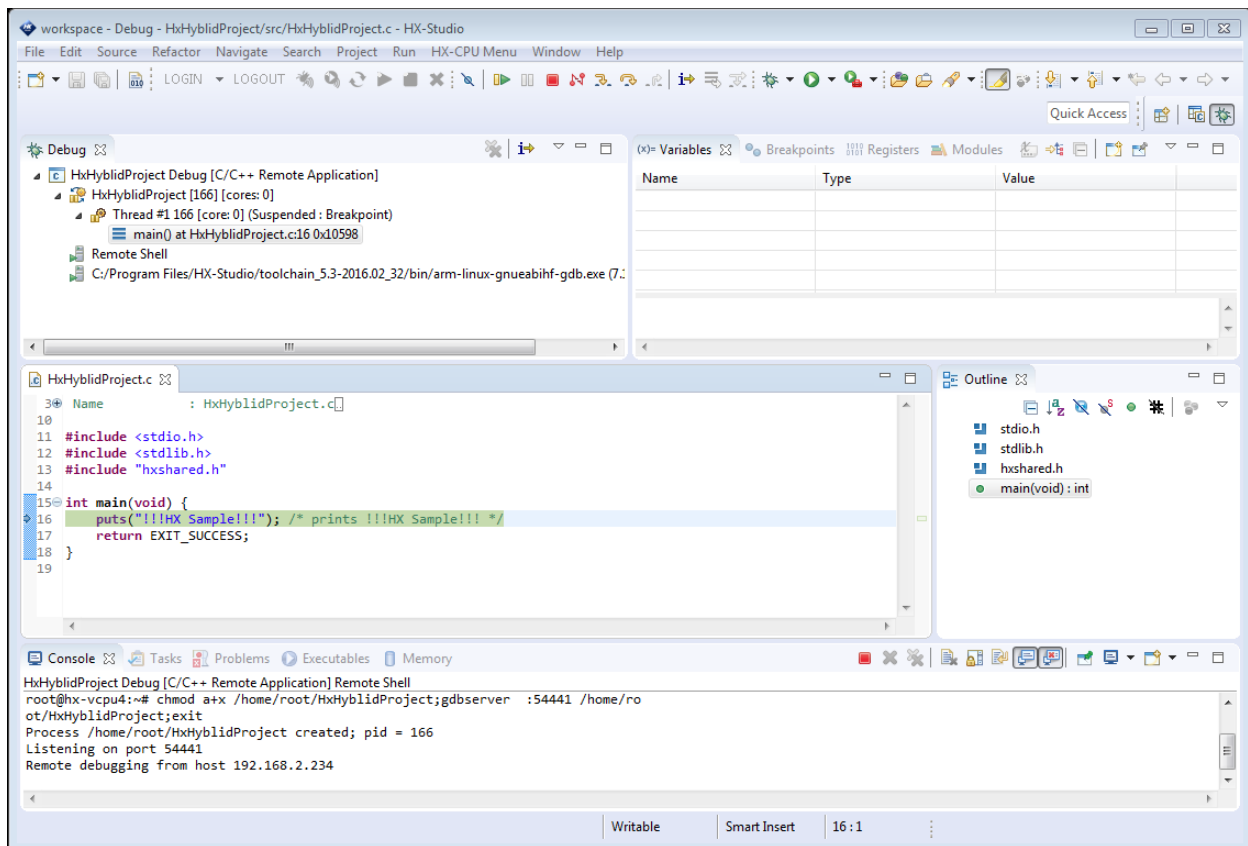
Fig. 5.29 Debug screen

5.4.5 Remote execution

Click to select a project you want to execute online and click 　 on the tool bar.

Fig. 5.30 Remote execution confirmation dialog

When you select [Yes] on the above confirmation dialog, the authentication screen appears. Select [Yes], and the authentication is performed automatically.
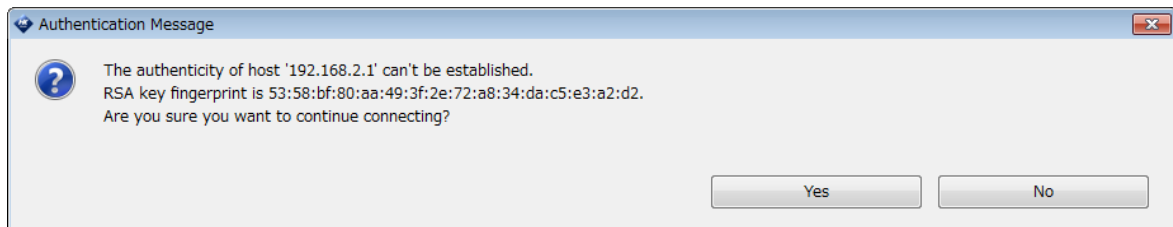
Fig. 5.31 Remote execution authentication dialog

When the authentication is completed, the dialog appears. Click [OK].
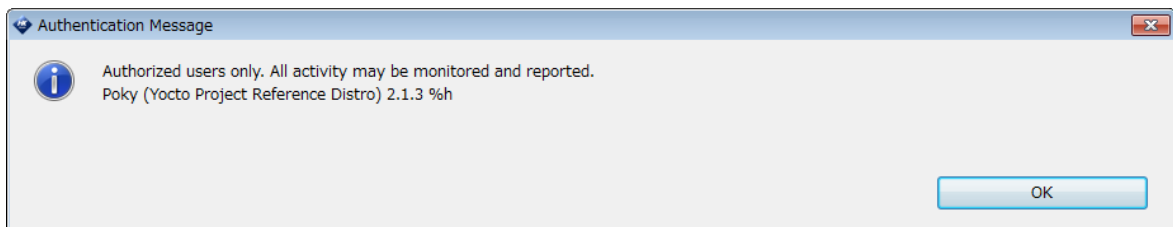
Fig. 5.32 Remote execution authentication completion dialog

When remote execution starts, the HX-Studio console view can be used as the program standard I/O.
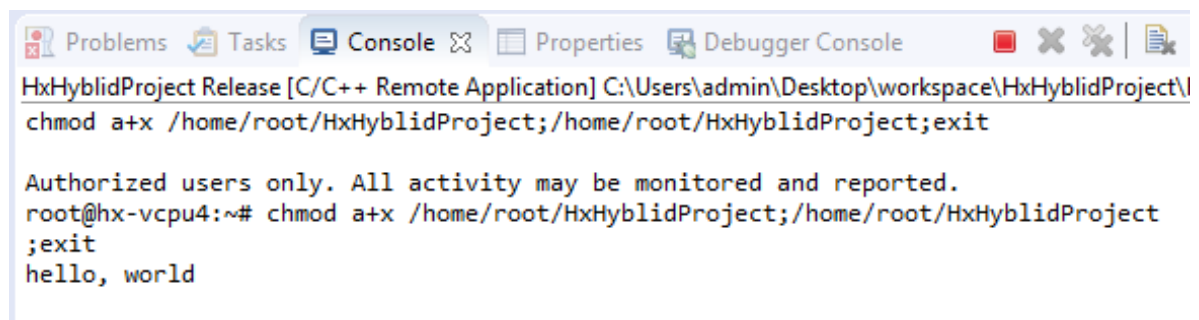
Fig. 5.33 Console view

5.4.6 Application execution

Click to select a project for which you want to execute the application and click ▶ on the tool bar. The application downloaded to the virtual controller in HX-CPU is executed.
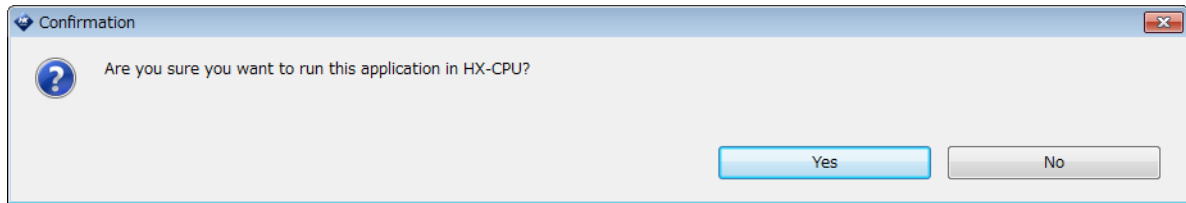
Fig. 5.34 Application execution confirmation dialog

If the target application is already running, the application is stopped first and then it is executed again.
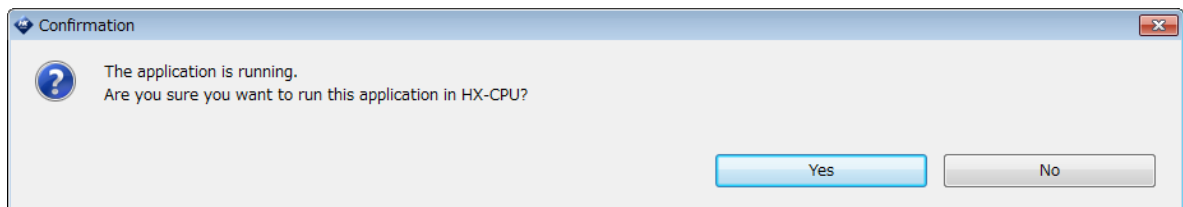
Fig. 5.35 Application execution confirmation dialog (during execution)

5.4.7 Application update

Click to select a project for which you want to update the application and click 🔄 on the tool bar. The application registered in the target virtual controller is updated.
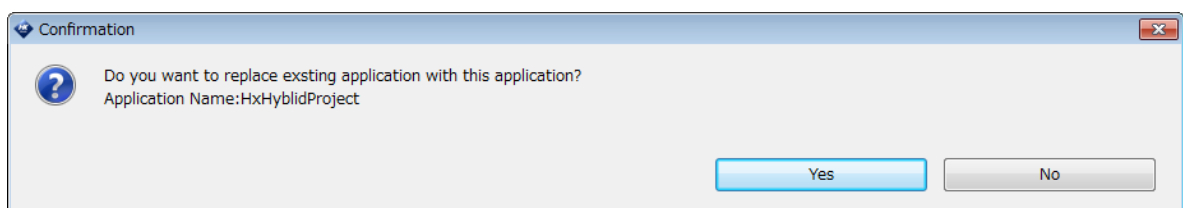
Fig. 5.36 Application update confirmation dialog

5.4.8 Application stop

Click to select a project for which you want to stop the application and click ■ on the tool bar. The running application in HX-CPU is stopped.
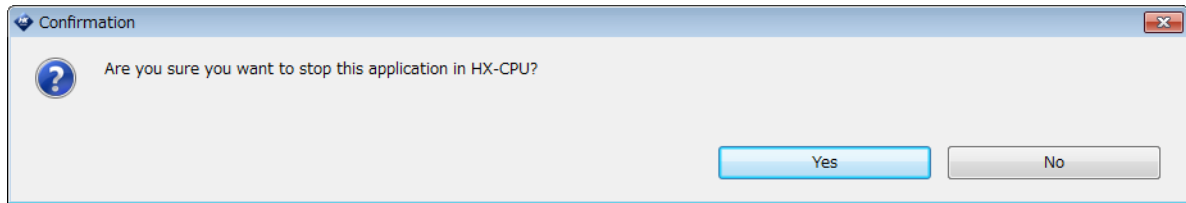
Fig. 5.37 Application stop confirmation dialog

5.4.9 Application deletion

Click to select a project for which you want to delete the application and click ✖ on the tool bar. The application downloaded to the virtual controller in HX-CPU is deleted.
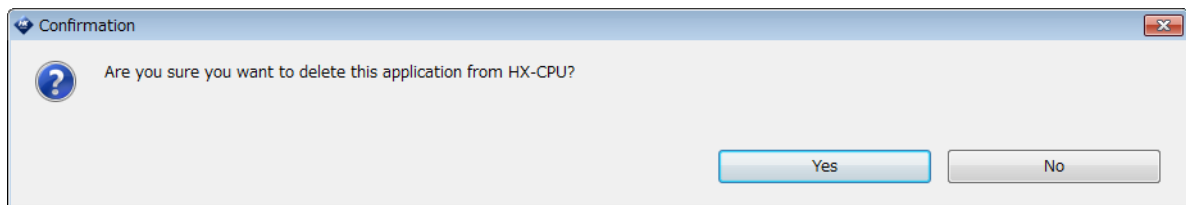
Fig. 5.38 Application deletion confirmation dialog

5.5 Programming in HX-Studio

This section describes notes on creating programs in HX-Studio.

5.5.1 Importing a project

Files related to a project used in HX-Studio must be saved in the currently open workspace. To open a project saved in a location other than the workspace directory, be sure to import it before open.

Select [Import…] on the right-click menu in the project explorer.
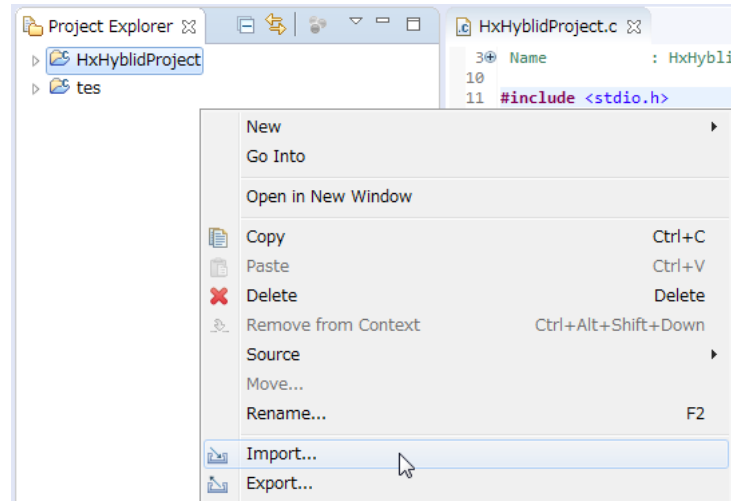
Fig. 5.39 Import menu

Select [General] - [Existing Projects into Workspace].
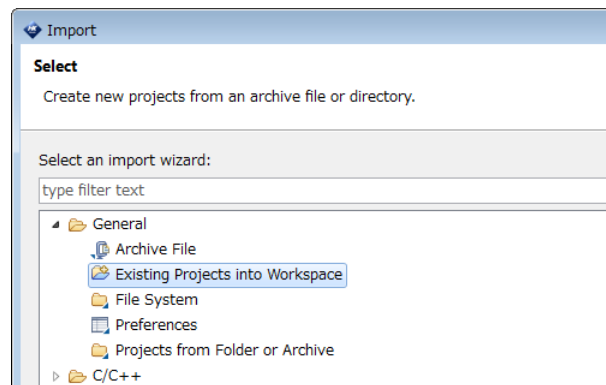
Fig. 5.40 Import dialog

When you select a project to import, be sure to select the [Copy projects into workspace] checkbox to import the project.
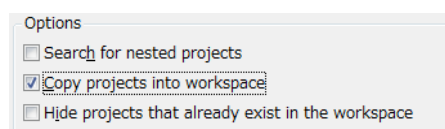
Fig. 5.41 Import option

When the imported project is performed [Build], the following error may be detected. This error indicates the Path to the Makefile that is automatically generated at performing [HX-CPU Menu]-[LOGIN] is not set though the build of project is completed. Perform [HX-CPU Menu]-[LOGIN] to set the Path to the project.

```
**** Build of configuration Debug for project <Project Name> ****
make all
Cannot run program "make": Launching failed

Error: Program "make" not found in PATH
PATH=[<Path>]

Build Finished (took XXXms)
```

5.5.2 Updating the header file

If you changed DataSharing (shared variable setting) in HX-CODESYS, perform the step "Get the header file for shared memory" in section 5.3.2 to update the header file referenced in the HX-Studio project.

The header file defines the DataSharing functions to read / write shared variables. Each function has a return value that shows the process result. When you execute a DataSharing function, it is recommended that you should store the return value in a variable, obtain the process result, and create a necessary error handling.

Unrecommended example: The return value is not stored in a variable.

```
hxshared_write(&wDat.PLC_PRG_Write.dwVarApp2, &wDat);

/* Subsequent processes */
```

Recommended example: The return value is stored in a variable.

```
ret = hxshared_write(&wDat.PLC_PRG_Write.dwVarApp2, &wDat);

if(ret == HXSHARED_WARNING_CODESYS_STOPPED)

{    // When the PLC is stopped

        /* Process when the PLC is stopped */

}

/* Subsequent processes */
```

5.5.3 Library packages available for C-language programs

The packages shown in the table below are pre-installed to this product. To use a library that is not contained in the listed packages in a C-language program, use the web server function to download the library file to the target virtual controller.

Table 5.5 List of pre-installed packages (1/2)

No.	Package name	Version	RPM
1	base-files	3.0.14	base-files-3.0.14-r89.ehv_core.rpm
2	base-passwd	3.5.29	base-passwd-3.5.29-r0.cortexa9hf_vfp_neon.rpm
3	bash	4.3.30	bash-4.3.30-r0.cortexa9hf_vfp_neon.rpm
4	busybox	1.24.1	busybox-1.24.1-r0.cortexa9hf_neon.rpm
5	busybox-hwclock	1.24.1	busybox-hwclock-1.24.1-r0.cortexa9hf_neon.rpm
6	busybox-syslog	1.24.1	busybox-syslog-1.24.1-r0.cortexa9hf_neon.rpm
7	busybox-udhcpc	1.24.1	busybox-udhcpc-1.24.1-r0.cortexa9hf_neon.rpm
8	coreutils	8.25	coreutils-8.25-r0.cortexa9hf_neon.rpm
9	cracklib	2.9.5	cracklib-2.9.5-r0.cortexa9hf_vfp_neon.rpm
10	dropbear	2016.72	dropbear-2016.72-r0.armv7ahf_neon.rpm
11	eudev	3.1.5	eudev-3.1.5-r0.cortexa9hf_neon.rpm
12	init-ifupdown	1.0	init-ifupdown-1.0-r7.cortexa9hf_vfp_neon.rpm
13	initscripts	1.0	initscripts-1.0-r155.cortexa9hf_vfp_neon.rpm
14	initscripts-functions	1.0	initscripts-functions-1.0-r155.cortexa9hf_vfp_neon.rpm
15	iproute2	4.4.0	iproute2-4.4.0-r0.armv7ahf_neon.rpm
16	iptables	1.6.0	iptables-1.6.0-r0.cortexa9hf_neon.rpm
17	lftp	4.6.3a	lftp-4.6.3a-r0.cortexa9hf_vfp_neon.rpm
18	libattr1	2.4.47	libattr1-2.4.47-r0.cortexa9hf_vfp_neon.rpm
19	libblkid1	2.27.1	libblkid1-2.27.1-r0.cortexa9hf_vfp_neon.rpm
20	libc6	2.23	libc6-2.23-r0.cortexa9hf_neon.rpm
21	libcap2	2.24	libcap2-2.24-r0.cortexa9hf_vfp_neon.rpm
22	libcrypto1.0.0	1.0.2h	libcrypto1.0.0-1.0.2h-r0.cortexa9hf_neon.rpm
23	libexpat1	2.1.0	libexpat1-2.1.0-r0.cortexa9hf_vfp_neon.rpm
24	libgcc1	5.3.0	libgcc1-5.3.0-r0.cortexa9hf_neon.rpm
25	libgmp10	6.1.0	libgmp10-6.1.0-r0.cortexa9hf_neon.rpm
26	libidn11	1.32	libidn11-1.32-r0.cortexa9hf_neon.rpm
27	libkmod2	22+git0+42f32b8ae4	libkmod2-22+git0+42f32b8ae4-r0.cortexa9hf_neon.rpm
28	libpam	1.2.1	libpam-1.2.1-r5.cortexa9hf_vfp_neon.rpm
29	libpam-runtime	1.2.1	libpam-runtime-1.2.1-r5.cortexa9hf_vfp_neon.rpm
30	libperl5	5.22.1	libperl5-5.22.1-r0.cortexa9hf_neon.rpm
31	libreadline6	6.3	libreadline6-6.3-r0.cortexa9hf_vfp_neon.rpm
32	libssl1.0.0	1.0.2h	libssl1.0.0-1.0.2h-r0.cortexa9hf_neon.rpm
33	libstdc++6	5.3.0	libstdc++6-5.3.0-r0.cortexa9hf_neon.rpm
34	libtinfo5	6.0+20160213	libtinfo5-6.0+20160213-r0.cortexa9hf_neon.rpm
35	libuuid1	2.27.1	libuuid1-2.27.1-r0.cortexa9hf_neon.rpm
36	libz1	1.2.8	libz1-1.2.8-r0.cortexa9hf_vfp_neon.rpm
37	modutils-initscripts	1.0	modutils-initscripts-1.0-r7.cortexa9hf_vfp_neon.rpm
38	ncurses-terminfo-base	6.0+20160213	ncurses-terminfo-base-6.0+20160213-r0.cortexa9hf_neon.rpm
39	netbase	5.3	netbase-5.3-r0.cortexa9hf_vfp_neon.rpm
40	openssl-conf	1.0.2h	openssl-1.0.2h-r0.armv7ahf_neon.rpm
41	packagegroup-core-boot	1.0	packagegroup-core-boot-1.0-r17.ehv_core.rpm
42	pam-plugin-cracklib	1.2.1	pam-plugin-cracklib-1.2.1-r5.cortexa9hf_vfp_neon.rpm
43	pam-plugin-deny	1.2.1	pam-plugin-deny-1.2.1-r5.cortexa9hf_vfp_neon.rpm
44	pam-plugin-env	1.2.1	pam-plugin-env-1.2.1-r5.cortexa9hf_vfp_neon.rpm
45	pam-plugin-faildelay	1.2.1	pam-plugin-faildelay-1.2.1-r5.cortexa9hf_vfp_neon.rpm

Table 5.6 List of pre-installed packages (2/2)

No.	Package name	Version	RPM
46	pam-plugin-group	1.2.1	pam-plugin-group-1.2.1-r5.cortexa9hf_vfp_neon.rpm
47	pam-plugin-lastlog	1.2.1	pam-plugin-lastlog-1.2.1-r5.cortexa9hf_vfp_neon.rpm
48	pam-plugin-limits	1.2.1	pam-plugin-limits-1.2.1-r5.cortexa9hf_vfp_neon.rpm
49	pam-plugin-mail	1.2.1	pam-plugin-mail-1.2.1-r5.cortexa9hf_vfp_neon.rpm
50	pam-plugin-motd	1.2.1	pam-plugin-motd-1.2.1-r5.cortexa9hf_vfp_neon.rpm
51	pam-plugin-nologin	1.2.1	pam-plugin-nologin-1.2.1-r5.cortexa9hf_vfp_neon.rpm
52	pam-plugin-permit	1.2.1	pam-plugin-permit-1.2.1-r5.cortexa9hf_vfp_neon.rpm
53	pam-plugin-rootok	1.2.1	pam-plugin-rootok-1.2.1-r5.cortexa9hf_vfp_neon.rpm
54	pam-plugin-securetty	1.2.1	pam-plugin-securetty-1.2.1-r5.cortexa9hf_vfp_neon.rpm
55	pam-plugin-shells	1.2.1	pam-plugin-shells-1.2.1-r5.cortexa9hf_vfp_neon.rpm
56	pam-plugin-unix	1.2.1	pam-plugin-unix-1.2.1-r5.cortexa9hf_vfp_neon.rpm
57	pam-plugin-warn	1.2.1	pam-plugin-warn-1.2.1-r5.cortexa9hf_vfp_neon.rpm
58	perl	5.22.1	perl-5.22.1-r0.cortexa9hf_neon.rpm
59	run-postinsts	1.0	run-postinsts-1.0-r9.all.rpm
60	shadow	4.2.1	shadow-4.2.1-r0.cortexa9hf_vfp_neon.rpm
61	shadow-base	4.2.1	shadow-base-4.2.1-r0.cortexa9hf_vfp_neon.rpm
62	shadow-securetty	4.2.1	shadow-securetty-4.2.1-r3.ehv_core.rpm
63	sysvinit	2.88dsf	sysvinit-2.88dsf-r14.cortexa9hf_vfp_neon.rpm
64	sysvinit-inittab	2.88dsf	sysvinit-inittab-2.88dsf-r10.ehv_core.rpm
65	sysvinit-pidof	2.88dsf	sysvinit-pidof-2.88dsf-r14.cortexa9hf_vfp_neon.rpm
66	udev-cache	3.1.5	udev-cache-3.1.5-r0.cortexa9hf_neon.rpm
67	update-alternatives-opkg	0.1.8+git0+53274f0875	update-alternatives-opkg-0.1.8+git0+53274f0875-r0.cortexa9hf_vfp_neon.rpm
68	update-rc.d	0.7	update-rc.d-0.7-r5.all.rpm
69	util-linux-sulogin	2.27.1	util-linux-sulogin-2.27.1-r0.cortexa9hf_neon.rpm

5.5.4 Executing / debugging a C-language program on the PC

HX-Studio is designed to connect to HX-CPU for execution and debugging. If you want to execute or debug a program on the PC, you need to install a Windows GNU tool chain (Cygwin GCC, MinGW GCC, etc.) to HX-Studio. Since the Windows execution environment is different from the HX-CPU execution environment, it is also recommended that projects to be executed or debugged on the PC should be managed differently from ones to be executed in HX-CPU.

Selecting a Windows GNU tool chain at the time of creating a project allows you to execute / debug the C-language program on the PC. To execute / debug the program, use the [Run] menu instead of [HX-CPU Menu].
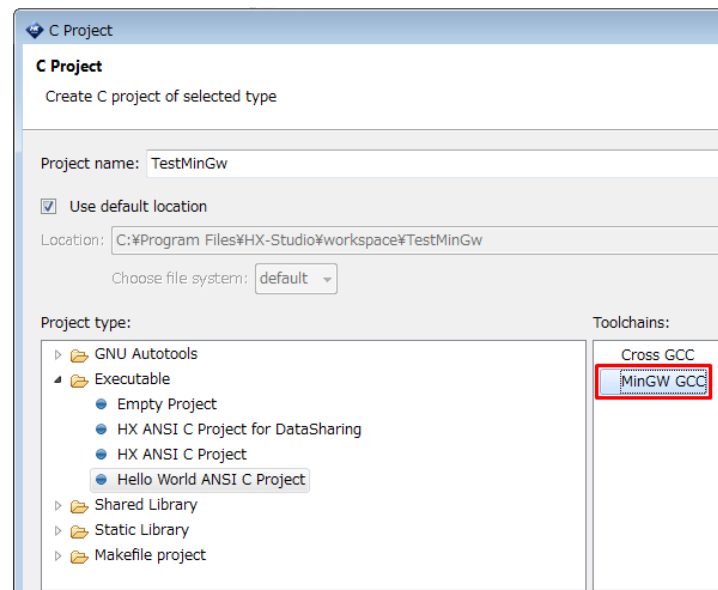
Fig. 5.42 Specifying the tool chain (MinGW GCC)
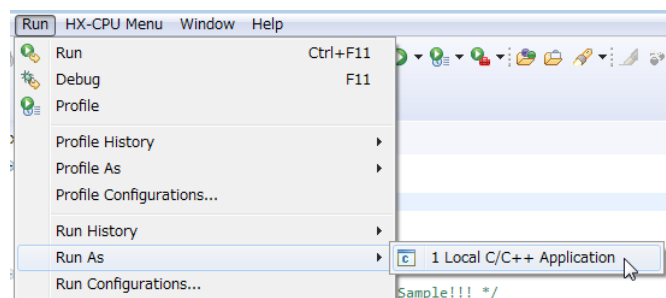
Fig. 5.43 [Run] menu on the PC

5.6 Version Information Check

Click [Help] - [About HX-Studio] from the menu.

The HX-Studio version is displayed.
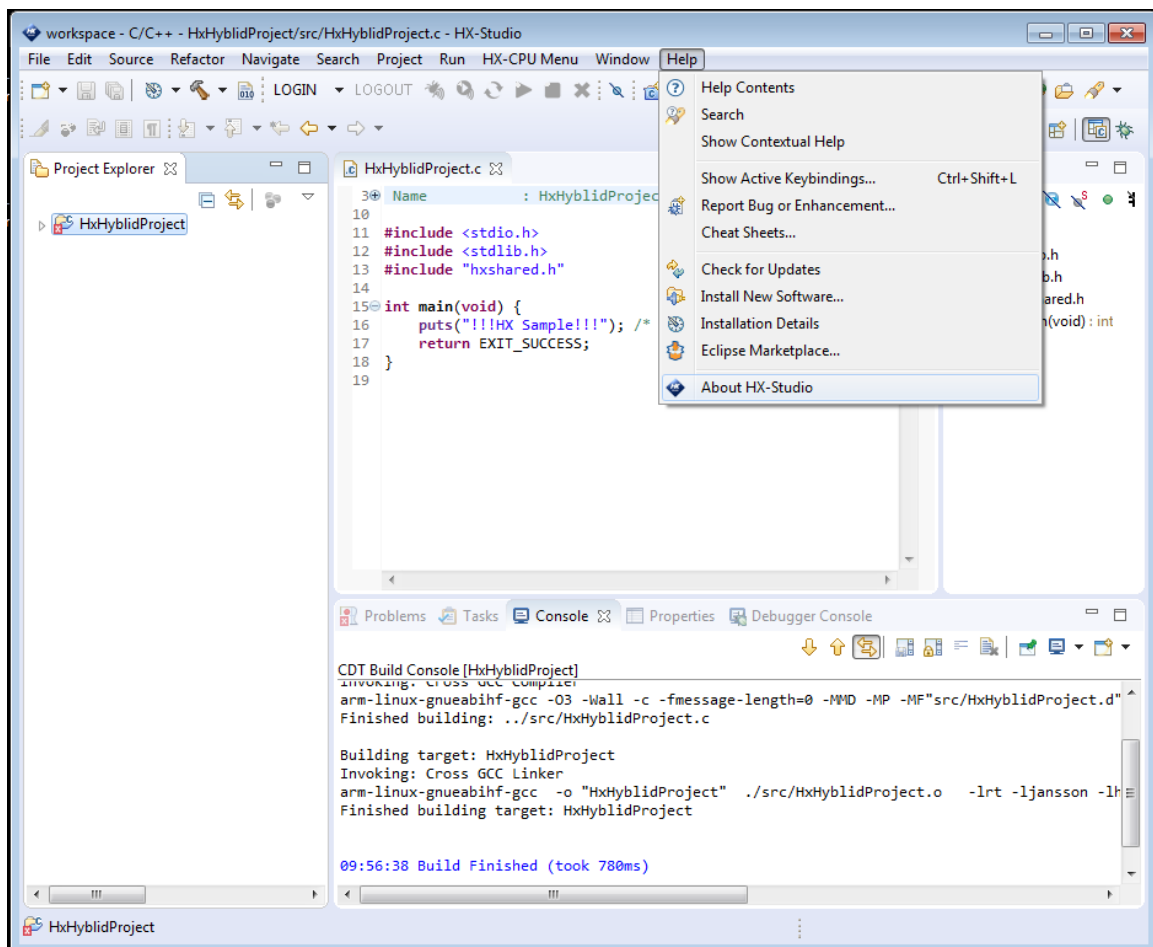
Fig. 5.44 Main screen ([Help] menu)
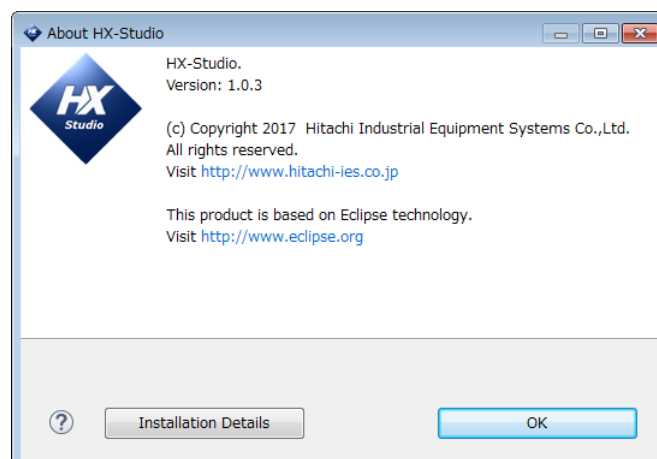
Fig 5.45 Version screen

Chapter 6 DataSharing Setting

6.1 Overview of DataSharing

The DataSharing is a function to share variable values through the common memory area (shared memory) between the PLC program and C-language program that are running in the CPU module. (Fig. 6.1)

Reading / writing data (refreshment) from the PLC program to the shard memory is conducted in the data sharing POU (Program Organization Unit) in the PLC program. Meanwhile, reading / writing data from the C-language program to the shard memory is conducted using the dedicated functions of the DataSharing library for C / C++. (For details on the DataSharing library, see "Chapter 7 DataSharing Library for C/C++".)
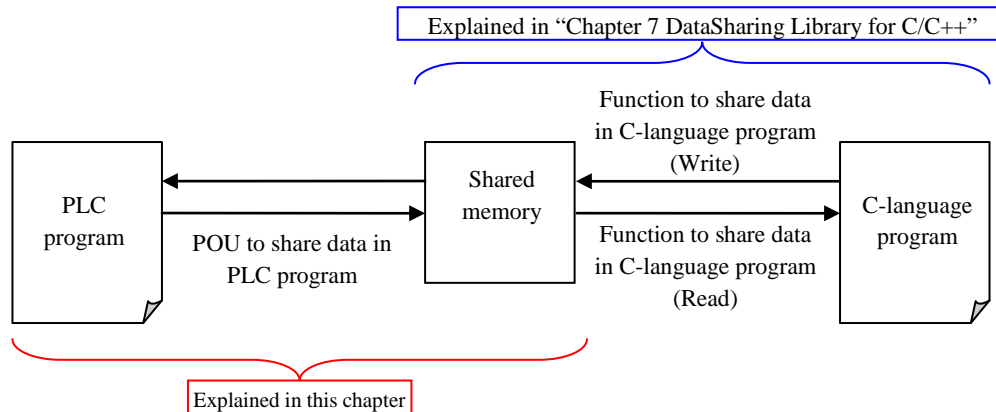
Fig. 6.1 Overview of the DataSharing

Shared data (variable) is set on the DataSharing setting screen ([DataSharing] object) in HX-CODESYS. When you configure the settings, the DataSharing POU (POU with the name "DataSharing") is automatically created in the specified task. In this DataSharing POU, Reading / writing data (refreshment) from the PLC program to the shared memory is conducted.
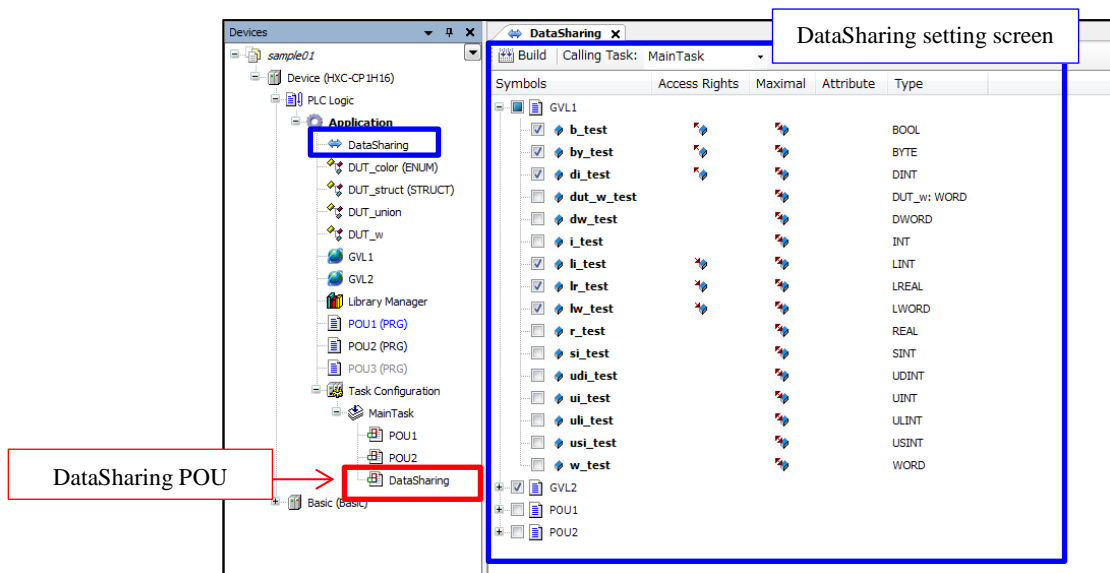
Fig. 6.2 HX-CODESYS DataSharing setting screen

Caution

- The DataSharing setting function was added in HX-CODESYS V3.5 SP8 Patch 4 rev.3.5.8.422 or later.
- The DataSharing function is supported in Windows ® 7 or higher. (Not supported in Windows ® XP SP3)

6.2 How to Set DataSharing

6.2.1 Adding the DataSharing setting ([DataSharing] object)

Right-click [Application] and select [Add Object] - [DataSharing…]. After selecting, the [Add DataSharing] screen appears.
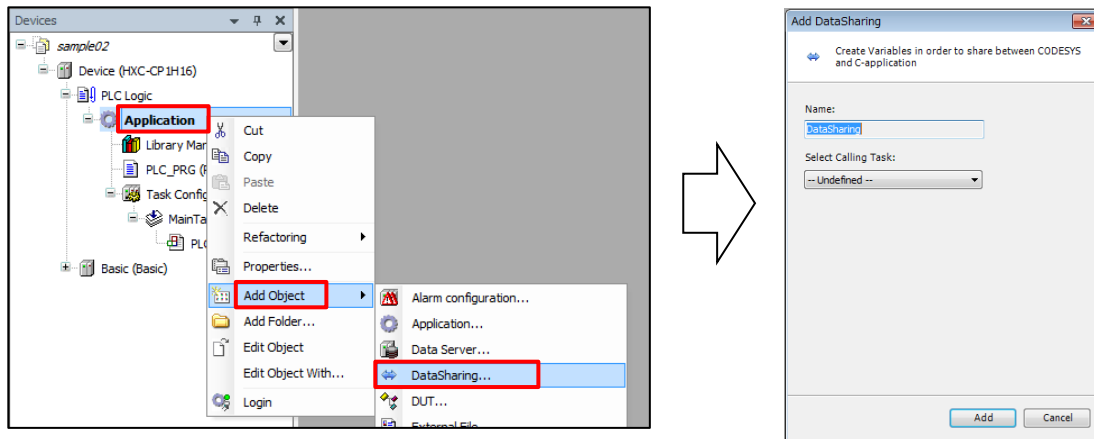
Fig. 6.3 Adding the DataSharing setting ([DataSharing] object)

Only one [DataSharing] object can be registered. If the [DataSharing] object has already been resistered, the object is not displayed on the [Add Object] menu.

In the [Select Calling Task] field on the [Add DataSharing] screen, select a task to add the DataSharing POU from the tasks registered in [Task Configuration]. This setting can be changed later in the [Calling Task] field on the DataSharing setting screen.
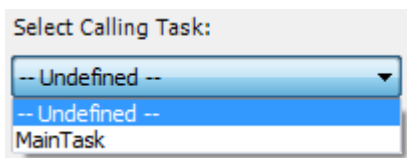
- When adding in the Undefined setting
- When adding by specifying the task

(An example of MainTask is shown below)
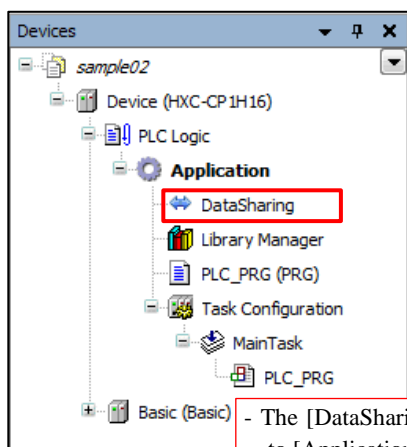
- The [DataSharing] object is added to [Application].
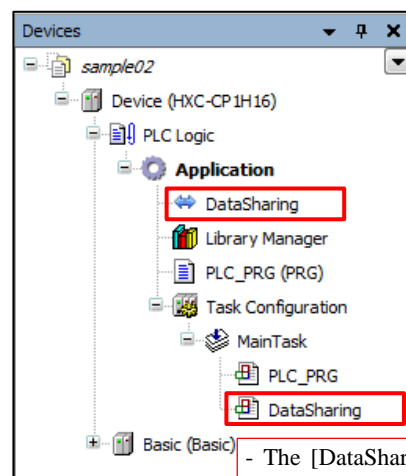
- The [DataSharing] object is added to [Application].
- The DataSharing POU is added to the specified task.

Fig. 6.4 [Select Calling Task] setting

6 - 2

6.2.2 Editing the DataSharing setting

When you click the [Build] button in the DataSharing setting screen, the variable list of POU and GVL (global variable) registered in the task is displayed. Then, edit the [Access Rights] field for the variables to be shared. When you finish editing, click the [Build] button again to apply the changes.

Specify the access rights.
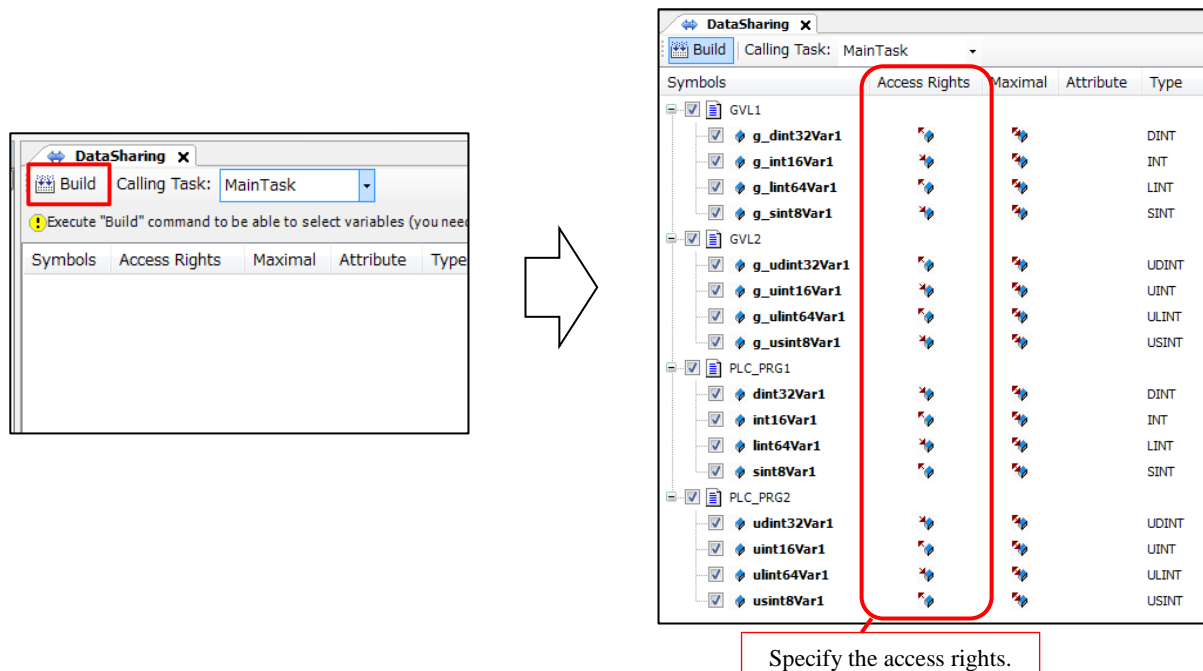
Fig. 6.5 Editing the DataSharing setting

Table 6.1 Display items on the DataSharing setting screen

No.	Item name	Description
1	Symbols	Displays the list of variables for each POU and GVL in a tree.
2	Access Rights	Displays the access rights viewed from the C-language program. Specify read (⚬) or write (⚬) for variables to be shared.
3	Maximal	Displays the maximum access rights. ⚬ indicates that both read and write can be set.
4	Type	Displays the data type of variables.

Caution

● The variables declared in POU / GVL that is not registered in the task are not displayed.

● The variables declared in other than POU / GVL (such as variables defined in the external I/O module screen) cannot be used.

● POU / GVL / variables with a name containing Japanese or double-byte alphanumeric characters (multi-byte characters) cannot be used.

● Variables with a non-supported data type cannot be used.
   (Supported data types: BOOL, BYTE, WORD, DWORD, LWORD, SINT, INT, DINT, LINT, USINT, UINT, UDINT, ULINT, REAL, LREAL)

● Note that if too many variables, such as more than 1,000 variables, are set to be shared, the [Build] process takes longer.

● If the following warning appears during [Build], try clicking the [Build] button again.
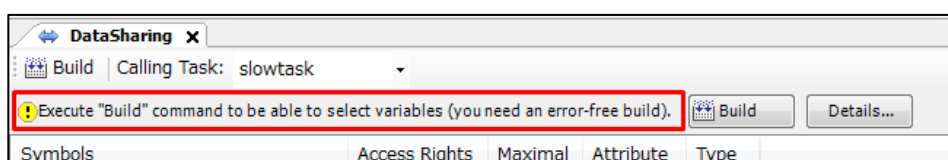
6.2.3 Generating the DataSharing header file (hxshared.h)

If you click the [Build] button in the DataSharing setting screen or download a program, files including the "DataSharing header file (hxshared.h)" are created in the same directory as the HX-CODESYS project on the PC. When a program is downloaded, the above files are also forwarded to the HX-CPU module.
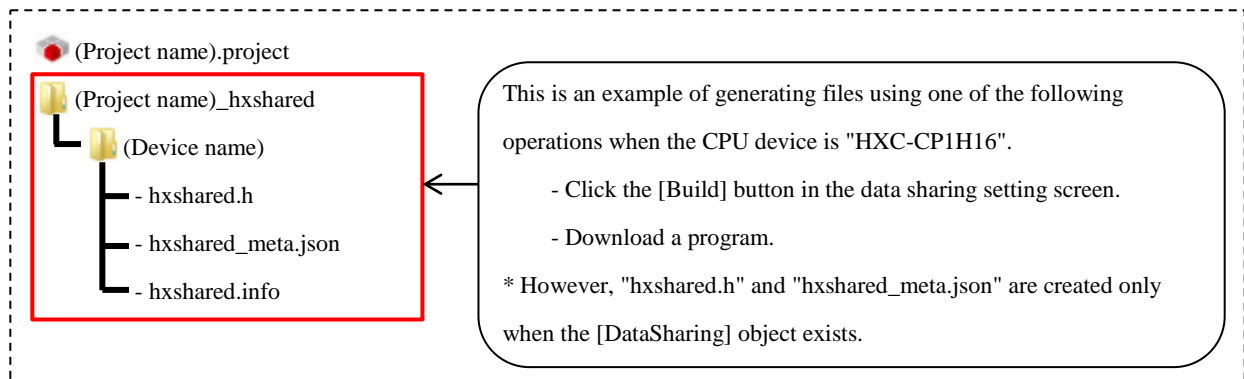
Fig. 6.6 Files created on the PC

To use functions dedicated to reading / writing data in the shared memory from the C-language program, you need to obtain the latest DataSharing header file from HX-Studio. (For details on how to obtain the header file on HX-Studio, refer to section 5.3.)

Caution

If you perform [Build] on the HX-CODESYS menu bar instead of using the [Build] button in the DataSharing setting screen, the header file may not be created / updated.

To create / update the header file, use the following build procedure:

    - Click the [Build] button in the DataSharing setting screen.

    - Perform [Build] on the menu bar while the DataSharing setting screen is open (the DataSharing tab is displayed on the main screen).

6.3 DataSharing POU Operations

You can configure how the DataSharing POU is executed in the settings for a task where the DataSharing POU was registered. Configure the execution priority, program execution cycle, and others in the task settings.

Caution

- If there are too many data to be shared, the data sharing POU process takes longer, so it is recommended that the POU should be registered in a task with such a lower priority that it does not affect the PLC program operations.

  (For details on the task settings, refer to "HX Series APPLICATION MANUAL (Software)".)

- Reset operations do not change the values in the shared memory. After the RUN operation, all the values in the shared memory become "0" when the data sharing POU is executed for the first time.

  (Reset operations: Reset warm / Reset cold / Reset origin / Reset origin device)

- The shared memory is deleted when the HX-CPU module is turned off.

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Chapter 7 DataSharing Library for C / C++

7.1 Overview of DataSharing Library for C / C++

This library defines functions to read / write data in the shared memory from the C-language program.
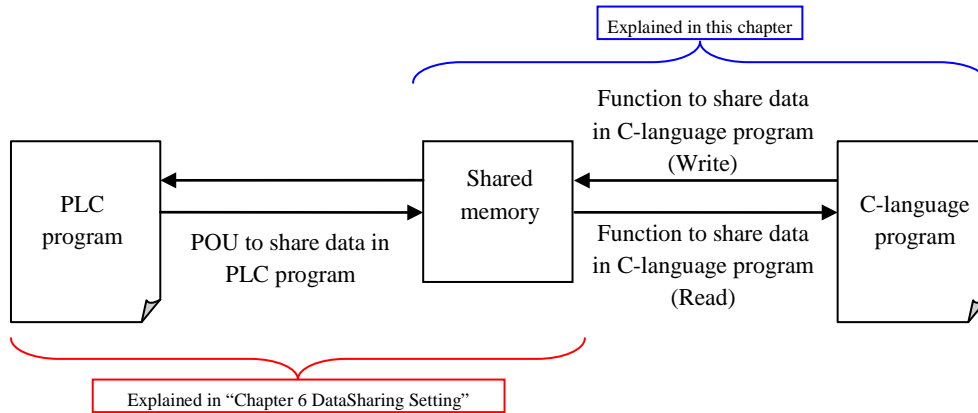
Fig. 7.1 Overview of the DataSharing

7.2 Programming Flow

The following three main items (a) to (c) are additionally described when programming the DataSharing process in the C-language program:

    (a) Include the DataSharing header file (hxshared.h).

    (b) Declare the DataSharing structure (hxshared_rdata type, hxshared_wdata type).

    (c) Describe the DataSharing functions (The same variable names as ones on the PLC program can be used for the arguments).

Refer to section 7.3 for details on (a) and (b) and refer to section 7.4 for details on (c).

C-language program sample:

```
/*
  ==============================================================================
  This program reads two variables (A_int, B_int) from the shared memory and writes the sum into the shared
memory (C_int).
    However, this example assumes that the POU name that declares the above three variables is "POU1".
  ==============================================================================
*/


#include <stdio.h>
#include "hxshared.h"          (a)


int main(void) {
    /* Declare and initialize the structure for DataSharing. */
    hxshared_rdata  rdata = {};          (b)
    hxshared_wdata  wdata = {};


    /* Read_all */
    hxshared_read_all(&rdata);          (c)


    /* Calculation (addition) */
    wdata.POU_Write.C_int = rdata.POU_Read.A_int + rdata.POU_Read.B_int;


    /* Write */
    hxshared_write(&wdata.POU_Write.C_int, &wdata);          (c)


    printf("A_int : %x, B_int : %x, C_int : %x¥n",
        rdata.POU_Read.A_int, rdata.POU_Read.B_int, wdata.POU_Write.C_int);


    return 0;
}
```

7.3 Specifications of DataSharing Header File (hxshared.h)

The DataSharing header file (hxshared.h) is created in the same directory as the HX-CODESYS project on the PC when you click the [Build] button on the DataSharing setting screen or download the PLC program in HX-CODESYS. And the header file is forwarded to the HX-CPU module at the same time when the PLC program is downloaded.

To use the DataSharing library, you need to obtain the latest DataSharing header file from HX-Studio. (For details on how to obtain the header file on HX-Studio, refer to section 5.3.)

The header file mainly consists of the error code definition area, structure definition area, and function definition area. The structure definition area varies depending on the DataSharing setting in HX-CODESYS.

7.3.1 Error code definition area

This area defines the error codes for the DataSharing functions (return values when the DataSharing function processes fail). For details on the error codes, refer to section 7.4.3.

```
Error code definition area in hxshared.h:

#define HXSHARED_ERR_CHECK_CODESYS_STATE           -1001
#define HXSHARED_ERR_INIT_LOCK                     -1002
#define HXSHARED_ERR_LOCK_WRITING                  -1003
#define HXSHARED_ERR_UNLOCK_WRITING                -1004
#define HXSHARED_ERR_INPUT_IS_NULL                 -3001
#define HXSHARED_ERR_OPEN_SHARED_MEMORY            -3002
#define HXSHARED_ERR_GET_STRUCT_SIZE               -3003
#define HXSHARED_ERR_GET_SIZE                      -3004
#define HXSHARED_ERR_OUT_OF_RANGE                  -3005
#define HXSHARED_ERR_COPY_DATA                     -3006
#define HXSHARED_ERR_CONF_CHANGED                  -3007
#define HXSHARED_ERR_CHECK_DATASHARING_STATE       -3008
#define HXSHARED_WARNING_CODESYS_STOPPED           -5001
#define HXSHARED_WARNING_DATASHARING_NOT_EXIST     -5002
```

7.3.2 Structure definition area

This area defines the dedicated structure used by the DataSharing functions. There are two structure types to be defined: Read structure (hxshared_rdata type) and write structure (hxshared_wdata). The read structure is used to store variables read from the shared memory while the write structure is used to store variables written to the shared memory.

Each structure consists of the GVL structure and POU structure, both of which contain variable names and data types to be shared. When there is no variable to be shared, the structure will be empty.

```
Example of the structure definition area in hxshared.h:


// Read structure
typedef struct _hxshared_rdata {
    // Variables in the POU "POU1" are defined as the structure.
    struct _POU1_Read {
        char sint8Var1 __attribute__((aligned (8)));
        short int16Var1 __attribute__((aligned (8)));
    }POU1_Read;
    // Variables in the GVL "GVL1" are defined as the structure.
    struct _GVL1_Read {
        char g_sint8Var1 __attribute__((aligned (8)));
        short g_int16Var1 __attribute__((aligned (8)));
    }GVL1_Read;
} hxshared_rdata;


// Write structure
typedef struct _hxshared_wdata {
    // Variables in the POU "POU1" are defined as the structure.
    struct _POU1_Write {
        long dint32Var1 __attribute__((aligned (8)));
        long long lint64Var1 __attribute__((aligned (8)));
    }POU1_Write;
    // Variables in the GVL "GVL1" are defined as the structure.
    struct _GVL1_Write {
        long g_dint32Var1 __attribute__((aligned (8)));
        long long g_lint64Var1 __attribute__((aligned (8)));
    }GVL1_Write;
} hxshared_wdata;
```

The data type relationships between HX-CODESYS and C language are shown in the table below:

Table 7.1 Data type relationships between HX-CODESYS and C-language

Data type	HX-CODESYS data type	C language data type
1-bit integer	BOOL	Unsigned char [1]
1-byte integer (unsigned)	BYTE / USINT	Unsigned char
2-byte integer (unsigned)	WORD / UINT	Unsigned short
4-byte integer (unsigned)	DWORD / UDINT	Unsigned long
8-byte integer (unsigned)	LWORD / ULINT	Unsigned long long
1-byte integer (signed)	SINT	Char
2-byte integer (signed)	INT	Short
4-byte integer (signed)	DINT	Long
8-byte integer (signed)	LINT	Long long
4-byte real number (floating point)	REAL	Float
8-byte real number (floating point)	LREAL	Double

*1 Note that if a value of 2 or more which is stored in the Unsigned char type on the C-language program is written on the BOOL type variable in the PLC program, the value is not correctly recognized.

7.3.3 Function definition area

This area defines the DataSharing functions available for the C-language program. For details on the specifications of the DataSharing functions, refer to section 7.4.

```
DataSharing functions definition area in hxshared.h:


#define hxshared_read_all(pReadStruct)        hxshared_read_all_cs( pReadStruct, HXSHARED_HEADER_CHECK_SUM)
#define hxshared_read( pValue, pReadStruct)   hxshared_read_cs( pValue, pReadStruct, HXSHARED_HEADER_CHECK_SUM)
#define hxshared_write_all(pWriteStruct)      hxshared_write_all_cs( pWriteStruct, HXSHARED_HEADER_CHECK_SUM)
#define hxshared_write( pValue, pWriteStruct)  hxshared_write_cs( pValue, pWriteStruct, HXSHARED_HEADER_CHECK_SUM)
#define hxshared_wread_all(pWReadStruct)      hxshared_wread_all_cs( pWReadStruct, HXSHARED_HEADER_CHECK_SUM)
#define hxshared_wread( pValue, pWReadStruct)  hxshared_wread_cs( pValue, pWReadStruct, HXSHARED_HEADER_CHECK_SUM)


(Structure definition area)


extern int hxshared_read_all_cs(hxshared_rdata *, const char *);
extern int hxshared_read_cs(void *, hxshared_rdata *, const char *);


extern int hxshared_write_all_cs(hxshared_wdata *, const char *);
extern int hxshared_write_cs(void *, hxshared_wdata *, const char *);


extern int hxshared_wread_all_cs(hxshared_wdata *, const char *);
extern int hxshared_wread_cs(void *, hxshared_wdata *, const char *);
```

7.4 Specifications of DataSharing Functions

7.4.1 List of functions

The DataSharing functions are grouped into functions used to read / write all variables to be shared (hxshared_***_all) and functions used to read / write one specified variable (hxshared_***).

(The "***" part should be "read", "write", or "wread".)

Table 7.2 List of DataSharing functions

Function name	Description
hxshared_read_all	Copies the values of all variables with "" set on the [DataSharing] object screen in HX-CODESYS from the shared memory to the C-language program memory.
hxshared_write_all	Copies the values of all variables with "" set on the [DataSharing] object screen in HX-CODESYS from the C-language program memory to the shared memory.
hxshared_wread_all	Copies the values of all variables with "" set on the [DataSharing] object screen in HX-CODESYS from the shared memory to the C-language program memory.
hxshared_read	Copies the value of only the variable, which is specified in the first argument pValue of all variables with "" set on the [DataSharing] object screen in HX-CODESYS, from the shared memory to the C-language program memory.
hxshared_write	Copies the value of only the variable, which is specified in the first argument pValue of all variables with "" set on the [DataSharing] object screen in HX-CODESYS, from the C-language program memory to the shared memory.
hxshared_wread	Copies the value of only the variable, which is specified in the first argument pValue of all variables with "" set on the [DataSharing] object screen in HX-CODESYS, from the shared memory to the C-language program memory.

7.4.2 Details of function specifications

Name	hxshared_read_all	

Syntax	`#include <hxshared.h>`
	
	`int hxshared_read_all(hxshared_rdata *pReadStruct);`	

Description	Copies the values of all variables with "" set on the [DataSharing] object screen in HX-CODESYS from the shared memory to the C-language program memory.	
Parameters	`hxshared_rdata *pReadStruct`	Structure head pointer of the read destination (A memory area of the hxshared_rdata structure size must be secured in the call source.) * The hxshared_rdata structure is defined in hxshared.h.
Return value	0: Success Negative value: Failure (For details, refer to section 7.4.3.)	

Overview of data copy flow

Name	hxshared_write_all

Syntax	`#include <hxshared.h>`
	
	`int hxshared_write_all(hxshared_wdata *pWriteStruct);`

Description	Copies the values of all variables with "🔷" set on the [DataSharing] object screen in HX-CODESYS from the C-language program memory to the shared memory. The process is halted while the shared memory is accessed by other write function.
Parameters	`hxshared_wdata *pWriteStruct`	Structure head pointer of the write source (A memory area of the hxshared_wdata structure size must be secured in the call source.) * The hxshared_wdata structure is defined in hxshared.h.
Return value	0: Success Negative value: Failure (For details, refer to section 7.4.3.)

Overview of data copy flow

Name	hxshared_wread_all
Syntax	`#include <hxshared.h>` `int hxshared_wread_all(hxshared_wdata *pWReadStruct);`
Description	Copies the values of all variables with "🔷" set on the [DataSharing] object screen in HX-CODESYS from the shared memory to the C-language program memory.
Parameters	`hxshared_wdata *pWReadStruct`	Structure head pointer of the read destination (A memory area of the hxshared_wdata structure size must be secured in the call source.) * The hxshared_wdata structure is defined in hxshared.h.
Return value	0: Success Negative value: Failure (For details, refer to section 7.4.3.)

Overview of data copy flow

Caution

Note that it is not guaranteed that data read using this function has been reflected to the value of the variable on the PLC program.

Name	hxshared_read	

Syntax	`#include <hxshared.h>`
	
	`int hxshared_read(void* pValue, hxshared_rdata* pReadStruct);`	

Description	Copies the value of only the variable, which is specified in the first argument pValue out of all variables with " " set on the [DataSharing] object screen in HX-CODESYS, from the shared memory to the C-language program memory.	
Parameters	`void* pValue`	A pointer of read target variable in the second argument "pReadStruct" structure
	`hxshared_rdata* pReadStruct`	Structure head pointer of the read destination (A memory area of the hxshared_rdata structure size must be secured in the call source.) * The hxshared_rdata structure is defined in hxshared.h.
Return value	0: Success Negative value: Failure (For details, refer to section 7.4.3.)	

Overview of data copy flow

Name	hxshared_write

Syntax	`#include <hxshared.h>`
	
	`int hxshared_write(void* pValue, hxshared_wdata* pWriteStruct);`

Description	Copies the value of only the variable, which specified in the first argument pValue out of all variables with "🔧" set on the [DataSharing] object screen in HX-CODESYS, from the C-language program memory to the shared memory. The process is halted while the shared memory is accessed by other write function.
Parameters	`void* pValue` A pointer of write target variable in the second argument "pWriteStruct" structure
	`hxshared_wdata* pWriteStruct` Structure head pointer of the write source (A memory area of the hxshared_wdata structure size must be secured in the call source.) * The hxshared_wdata structure is defined in hxshared.h.
Return value	0: Success Negative value: Failure (For details, refer to section 7.4.3.)

Overview of data copy flow

Name	hxshared_wread	

Syntax	`#include <hxshared.h>`
	
	`int hxshared_wread(void* pValue, hxshared_wdata* pWReadStruct);`	

Description	Copies the value of only the variable, which is specified in the first argument pValue out of all variables with " " set on the [DataSharing] object screen in HX-CODESYS, from the shared memory to the C-language program memory.	
Parameters	`void* pValue`	A pointer of read target variable in the second argument "pWReadStruct" structure
	`hxshared_wdata* pWReadStruct`	Structure head pointer of the read destination (A memory area of the hxshared_wdata structure size must be secured in the call source.) * The hxshared_wdata structure is defined in hxshared.h.
Return value	0: Success Negative value: Failure (For details, refer to section 7.4.3.)	

Overview of data copy flow

Caution

Note that it is not guaranteed that data read using this function has been reflected to the value of the variable on the PLC program.

7.4.3 Error codes

This section describes the error codes (return values when the DataSharing function processes fail). An error code is a negative integer and is defined as a string in hxshared.h (For details, refer to section 7.3.1). The error codes are categorized into the following three large groups:

- -1000 to -2999: Serious error

- -3000 to -4999: Minor error

- -5000 or above: Warning (* Data is still copied.)

Table 7.3 Relationships between DataSharing functions and errors that can occur

Error code (return value)	Error name	Category	hxshared_read	hxshared_write_all	hxshared_wread_all	hxshared_read	hxshared_write	hxshared_wread
HXSHARED_ERR_ CHECK_CODESYS_STATE (-1001)	CODESYS_run check (error)	Serious error	✓	✓	✓	✓	✓	✓
HXSHARED_ERR_ INIT_LOCK (-1002)	Exclusive pre-lock error	Serious error		✓			✓	
HXSHARED_ERR_ LOCK_WRITING (-1003)	Exclusive (lock) error	Serious error		✓			✓	
HXSHARED_ERR_ UNLOCK_WRITING (-1004)	Exclusive (unlock) error	Serious error		✓			✓	
HXSHARED_ERR_ INPUT_IS_NULL (-3001)	NULL check error	Minor error	✓	✓	✓	✓	✓	✓
HXSHARED_ERR_ OPEN_SHARED_MEMORY (-3002)	Shared memory open error	Minor error	✓	✓	✓	✓	✓	✓
HXSHARED_ERR_ GET_STRUCT_SIZE (-3003)	Structure size acquisition error	Minor error	✓	✓	✓			
HXSHARED_ERR_ GET_SIZE (-3004)	Variable size acquisition error	Minor error				✓	✓	✓
HXSHARED_ERR_ COPY_DATA (-3006)	Data copy error	Minor error	✓	✓	✓	✓	✓	✓
HXSHARED_ERR_ CONF_CHANGED (-3007)	Header sum value verification error	Minor error	✓	✓	✓	✓	✓	✓
HXSHARED_ERR_ CHECK_DATASHARING_STATE (-3008)	DataSharing setting presence check (Error)	Minor error	✓	✓	✓	✓	✓	✓
HXSHARED_WARNING_ CODESYS_STOPPED (-5001)	CODESYS_run check (STOP)	Warning	✓	✓	✓	✓	✓	✓
HXSHARED_WARNING_ DATASHARING_NOT_EXIST (-5002)	DataSharing setting presence check (No sharing setting)	Warning	✓	✓	✓	✓	✓	✓

Table 7.4 Error causes and solutions for the error codes

Error code (return value)	Error cause	Solution
HXSHARED_ERR_ CHECK_CODESYS_STATE (-1001)	- Failed to access the system file correctly.	The data may be corrupted. Turn on the power again.
HXSHARED_ERR_ INIT_LOCK (-1002)	- Failed to access the system file correctly.	The data may be corrupted. Turn on the power again.
HXSHARED_ERR_ LOCK_WRITING (-1003)	- Failed to access the system file correctly.	The data may be corrupted. Turn on the power again.
HXSHARED_ERR_ UNLOCK_WRITING (-1004)	- Failed to access the system file correctly.	The data may be corrupted. Turn on the power again.
HXSHARED_ERR_ INPUT_IS_NULL (-3001)	- The argument value is NULL.	Check if the argument value in the DataSharing function is NULL.
HXSHARED_ERR_ OPEN_SHARED_MEMORY (-3002)	- The DataSharing function was executed before the shared memory was created by the DataSharing POU (when the DataSharing POU was executed for the first time after RUN).	If the DataSharing setting has not been configured on the PLC program, configure the setting and log-in to the PLC. Then, start running the PLC program. If the problem is not solved, the data may be corrupted. After turning on the power again, initialize the PLC in HX-CODESYS and log-in to the PLC again.
HXSHARED_ERR_ GET_STRUCT_SIZE (-3003)	- Failed to access the DataSharing setting information file correctly.	The data may be corrupted. Initialize the PLC in HX-CODESYS and log-in to the PLC again.
HXSHARED_ERR_ GET_SIZE (-3004)	- The argument value is incorrect. - Failed to access the DataSharing setting information file correctly.	Check if the argument value in the DataSharing function is correct. If the problem is not solved, the data may be corrupted. Initialize the PLC in HX-CODESYS and log-in to the PLC again.
HXSHARED_ERR_ COPY_DATA (-3006)	- The argument value is incorrect.	Check if the argument value in the DataSharing function is correct.
HXSHARED_ERR_ CONF_CHANGED (-3007)	- The DataSharing setting was changed on the PLC program, and the DataSharing function was executed without the C-language program re-compiled using the latest hxshared.h.	If the DataSharing setting was changed on the PLC program, obtain the latest hxshared.h from HX-Studio and re-compile the C-language program. If the problem is not solved, the data may be corrupted. Initialize the PLC in HX-CODESYS and log-in to the PLC again. Then, obtain the latest hxshared.h from HX-Studio and re-compile the C-language program.
HXSHARED_ERR_ CHECK_DATASHARING_STATE (-3008)	- The DataSharing function was executed before logging in to the PLC program for the first time.	If you have not logged in to the PLC program, log-in to the PLC. If the problem is not solved, the data may be corrupted. Initialize the PLC in HX-CODESYS and log-in to the PLC again.
HXSHARED_WARNING_ CODESYS_STOPPED (-5001)	- The DataSharing function was executed when the PLC program was stopped. (* Data is still copied.)	Start running the PLC program.
HXSHARED_WARNING_ DATASHARING_NOT_EXIST (-5002)	- The DataSharing function was executed when the DataSharing setting was not configured on the PLC program. (* Data is still copied.)	Configure the DataSharing setting on the PLC program and download the PLC program to HX-CPU.

Chapter 8 Troubleshooting

This chapter describes troubleshooting specific to the HX-CPU hybrid model. For details on troubleshooting common to the HX series CPU, such as PLC error codes, refer to "HX Series APPLICATION MANUAL (Hardware)".

8.1 Appropriate Settings for Your Purposes

Starting a C-language program automatically after power-on
Executing the application and turning off the power without stopping the application

C-language programs inherit the execution state before power shut-down. To start a C-language program automatically at the next power-on, turn off the power while the target C-language program is running. To start the program manually, turn off the power while the program is stopped.

However, if the power is shut down while the C-language program is being executed or debugged remotely from HX-Studio, the system starts up with the program stopped at the next power-on.

The RUN switch on the CPU module is only used to control the PLC program.

Synchronizing the PLC program and C-language program
Using the shared variables

This product is designed to start with processing the PLC program on the higher priority after power-on. When the PLC program and C-language program are set to run automatically after power-on, the PLC program starts up first and then the C-language program. During this C-language program startup, it may take a long time, only for temporarily, to initialize the Modbus-TCP communication in the PLC program. Adjust the process timing according to the system requirements.

8.2 Problems

8.2.1 General operation problems
Data are not shared correctly between the PLC and C-language programs.

Cause 1: The header file included in the C-language program is incorrect.

Check the return value of the library function. When the PLC program is downloaded from HX-CODESYS to the CPU, the hxshared.h header file is also forwarded. If the DataSharing configuration is changed in the HX-CODESYS project, be sure to obtain the latest header file from the CPU to the HX-Studio project.

Cause 2: The argument of the library function is NULL or another inappropriate value.

Check the return value of the library function and specify a correct argument for the library function to be used. For the detailed specifications of each function, refer to chapter 7.

Cause 3: DataSharing information is not registered in this product.

Check the return value of the library function, configure the DataSharing setting ([DataSharing] editor) in HX-CODESYS, and download it to the CPU.

Cause 4: The CPU is stopped.

Check the return value of the library function. The data shared memory is configured when the PLC starts running. Execute the library function after the PLC starts running.

The CPU detects E24 during C-language program download.

Cause 1: The CPU load increases due to a communication interrupt.

If a file transferred from the web server to the CPU is large, the CPU load temporarily increases due to a file transfer communication interrupt.

If you create a C-language program that does not end due to the infinite loop of the main function, be sure to call the usleep function at the end of the loop to set the wait time. Also, adjust the watch dog time for the user program.

The CPU detects E25 during C-language program download.

Cause 1: The CPU load increases due to a communication interrupt.

If a file transferred from the web server to the CPU is large, the CPU load temporarily increases due to a file transfer communication interrupt.

If you create a C-language program that does not end due to the infinite loop of the main function, be sure to call the usleep function at the end of the loop to set the wait time. Modify the program to reduce the user program load, such as increasing the interval of the task executed in the PLC program.

Caution

The header file may not be created / updated by performing [Build] - [Build] operation on the menu bar in HX-CODESYS. To create / update the header file, use one of the following build procedures:

- Press [Build] in the [DataSharing] editor.
- Select [Build] - [Build] operation on the menu bar while the [DataSharing] editor is open (the DataSharing tab is displayed on the main screen).

8.2.2 HX-Studio (C-language programming) related problems

The Ethernet communication is not established.

Cause 1: The Auto-Negotiation setting is not completed.

If the Ethernet communication is not established with the Ethernet port L/A LED flashing, the Auto-Negotiation communication speed setting may not be completed. Fix the communication speed setting of the connection device to 10 MB full-duplex or 10 MB half-duplex.

Remote debugging is not executed.

Cause 1: The workspace path or project name contains a double-byte character or space.

If you use the remote debug function, specify a path that does not contain a space or double-byte character when creating a project.

Cause 2: IPSec is enabled on the PC.

IPSec is disabled by default on Windows. If it is enabled, the remote debug function cannot be used. To use the remote debug function, select [Control Panel] - [System and Security] - [Administrative Tools] and open [Local Security Policy]. Then, select [IP Security Policies on Local Computer] and unassign the target security policy.

The data value is unexpected.

Cause 1: The data is partially lost due to casting.

When a large type is converted to a small type by type conversion (casting), the data may be partially truncated, resulting in an unexpected value. Create a program with extra caution.

An unintended virtual controller runs.

Cause 1: The same application has been downloaded to multiple virtual controllers.

When the target application has already been downloaded to a virtual controller, if you only log-in to a different virtual controller (canceling to download program at login) using [Designated login] from HX-Studio, [APPEXEC] starts the application on the virtual controller where it has been downloaded, instead of the logged-in virtual controller, because the application does not exist in the target virtual controller. Download the application to the target virtual controller and execute the application. If the application has not been registered in any virtual controller, the error message "The application is not downloaded." appears.

8.2.3 Web server function related problems

You forgot your login ID / password.

Initializing the user information initializes the login ID / password registered in this product. For details on how to initialize the information, refer to section 8.3.2. Note that once the user information is initialized, the hybrid model specific information, such as virtual controller settings, is initialized.

Values on the shared memory information screen are not updated.

Cause1: The automatic update setting is not reflected to the CPU.

The automatic update setting is transferred to the CPU when the checkbox is selected on the screen. If the CPU power is turned off and on after the automatic update checkbox is selected, the automatic update is not enabled even if the automatic update checkbox is selected on the screen. Set the automatic update again.

Cause 2: The CPU processing load is high.

The display may not be updated at the update interval set in the automatic update depending on the CPU processing load. Set the update interval longer or review the CPU processing to reduce the load.

Values on the shared memory information screen are incorrect.

Cause 1: The CPU is stopped.

The shared memory in the CPU is configured when the PLC starts running. If the CPU is stopped after the shared memory configuration is changed, the data before change may be displayed in the shared memory information screen on the web server because the shared memory configuration before change remains on the screen. Run the PLC to update the shared memory configuration. Alternatively, click [Reset origin] or select [Reset origin device [<device name>]] on HX-CODESYS to delete the shared memory configuration.

8.3 Product Initialization

8.3.1 Resetting to the factory default setting

If the problem persists even after restart or the system cannot connect to HX-CODESYS online, you can reset HX-CPU to the factory default setting.

<Procedure to reset to the factory default setting>

(1) Remove power from the HX-CPU.
(2) Toggle the RUN / STOP switch to STOP position (to the right).
(3) Turn on all 2 bits switches (SW1).
(4) Supply power to the HX-CPU with E.CLR switch pressed until "SP" is displayed in the 7-segment LED.

(5) Toggle the RUN / STOP switch to RUN position (to the left).
(6) It takes about four minutes to finish the process. Then "Fn" is displayed in the 7-segment LED.
    Note that the 7-segment LED remains "SP" until the process is finished.

(7) Turn off all 2 bits switches (SW1).
    When turning on the power next time, it starts with the factory default settings.
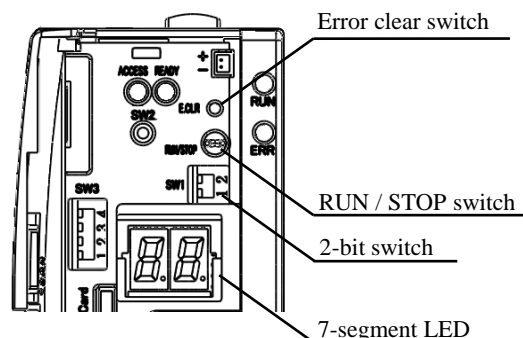
8.3.2 Initializing the user information

When you forgot the login ID / password for the web server function of this product or want to initialize the hybrid

model specific information, such as virtual controller settings, you can initialize the user information.

<Procedure to initialize the user information>

(1) Remove power from the HX-CPU.
(2) Toggle the RUN / STOP switch to STOP position (to the right).
(3) Set the No. 1 bit of the 2-bit switch (SW1) to OFF and No. 2 bit to ON.
(4) Supply power to the HX-CPU with E.CLR switch pressed until "UP" is displayed in the 7-segment LED.

```
UP
```

(5) Toggle the RUN / STOP switch to RUN position (to the left).
(6) It takes about two minutes to finish the process. Then "Fn" is displayed in the 7-segment LED.
    Note that the 7-segment LED remains "UP" until the process is finished.

```
Fn
```

(7) Turn off all 2 bits switches (SW1).
    When turning on the power next time, it starts with the user information initialized.

Appendix 1 Open Source Software (OSS) List

This product is using open source software (hereinafter OSS).

Information about OSS used for this product is as follows. After checking the contents, please use product.

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    whichever is longer.

[GPLv1 application software package list]

      perl-5.22.1

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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

      ca-certificates-20160104

      ethtool-4.2

      eudev-3.1.5

      glibc-2.23

      init-ifupdown-1.0

      initscripts-1.0

      iproute2-4.4.0

      iptables-1.6.0

      kernel-4.4.62

      kmod-22+git0+42f32b8ae4

      netbase-5.3

      nettle-3.2

      opkg-utils-0.1.8+git0+53274f0875

      procos-3.3.11

      strongswan-5.3.2

      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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>
> findutils-4.6.0
>
> gcc-runtime-5.3.0
>
> gnutls-3.4.9
>
> lftp-4.6.3a
>
> libdn-1.32
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      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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