

# **SYSMAC CS/CJ Series**

**Loop Control Boards**  
**CS1W-LCB01/LCB05**

**Process-control CPU Units**  
**CS1D-CPU□□P**

(CPU Unit: CS1D-CPU□□H, Loop Controller: LCB05D)

**Loop-control CPU Units**  
**CJ1G-CPU42P**

(CPU Unit: CJ1G-CPU42H, Loop Controller: LCB01)

**CJ1G-CPU43P/44P/45P**

(CPU Unit: CJ1G-CPU43H/44H/45H, Loop Controller: LCB03)

# **OPERATION MANUAL**

**OMRON**



# **SYSMAC CS/CJ Series**

## **Loop Control Boards**

**CS1W-LCB01/LCB05**

## **Process-control CPU Units**

**CS1D-CPU□□P**

(CPU Unit: CS1D-CPU□□H, Loop Controller: LCB05D)

## **Loop-control CPU Units**

**CJ1G-CPU42P**

(CPU Unit: CJ1G-CPU42H, Loop Controller: LCB01)

**CJ1G-CPU43P/44P/45P**

(CPU Unit: CJ1G-CPU43H/44H/45H, Loop Controller: LCB03)

## **Operation Manual**




*Revised January 2013*



## Notice:

OMRON products are manufactured for use according to proper procedures by a qualified operator and only for the purposes described in this manual.

The following conventions are used to indicate and classify precautions in this manual. Always heed the information provided with them. Failure to heed precautions can result in injury to people or damage to property.

-  **DANGER** Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Additionally, there may be severe property damage.
-  **WARNING** Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.
-  **Caution** Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

## OMRON Product References

All OMRON products are capitalized in this manual. The word “Unit” is also capitalized when it refers to an OMRON product, regardless of whether or not it appears in the proper name of the product.

The abbreviation “Ch,” which appears in some displays and on some OMRON products, often means “word” and is abbreviated “Wd” in documentation in this sense.

The abbreviation “PLC” means Programmable Controller. “PC” is used, however, in some Programming Device displays to mean Programmable Controller.

## Visual Aids

The following headings appear in the left column of the manual to help you locate different types of information.

**Note** Indicates information of particular interest for efficient and convenient operation of the product.

**1,2,3...** 1. Indicates lists of one sort or another, such as procedures, checklists, etc.

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# About Loop Controllers

## Loop Control Types, Functional Elements, and Versions

### Loop Controller Types

There are two types of CS/CJ-series Loop Controller: Separate Loop Controllers and Loop Controllers Pre-installed in CPU Units

Loop Controller type	Type name	Product name	Model	PLC series and Unit type
Separate	Separate Loop Controller	Loop Control Unit	CS1W-LC001	CS-series CPU Bus Unit Loop Controller
		Loop Control Board	CS1W-LCB01/05	CS-series Inner Board Loop Controller
Pre-installed in CPU Unit	CPU Unit with Pre-installed Loop Controller	Process-control CPU Unit	CS1D-CPU□□P	A one-Unit Loop Controller consisting of an Inner Board pre-installed in a CS-series CS1D-H CPU Unit
		Loop-control CPU Unit	CJ1G-CPU□□P	A one-Unit Loop Controller consisting of an Inner Board pre-installed in a CJ-series CJ1-H CPU Unit

### Loop Controller Functional Elements

- Separate Loop Controllers consist of only the Loop Controller functional element (i.e., the Loop Controller element).
- CPU Units with Pre-installed Loop Controller consists of a CPU Unit functional element (i.e., the CPU Unit element) and the Loop Controller functional element (i.e., the Loop Controller element).

### Versions

The functional elements (i.e., the CPU Unit element and Loop Controller element) have versions.

## Model Numbers and Functional Elements

The following table lists the Loop Controller product model numbers, the functional element names for the CPU Unit elements and Loop Controller elements, and the versions of the functional elements.

Product name	Product model number	Unit version of the product model (See note.)	Configuration			
			CPU unit element		Loop Controller element	
			CPU Unit model with same functionality	Functional element unit version	Functional element name	Functional element
Loop Control Unit	CS1W-LC001	Pre-Ver. 2.0	---		LC001	Ver. 2.5
Loop Control Board	CS1W-LCB01	Ver. 2.0 to Ver. 3.6	---		LCB01	Ver. 2.0 to Ver. 3.6
	CS1W-LCB05				LCB05	
Process-control CPU Unit	CS1D-CPU65P	---	CS1D-CPU65H	Ver. 1.0 or higher	LCB05D	Ver. 1.0
	CS1D-CPU67P		CS1D-CPU67H	Ver. 1.0 or higher	LCB05D	
Loop-control CPU Unit	CJ1G-CPU42P	---	CJ1G-CPU42H	Ver. 3.0 or higher	LCB01	Ver. 2.0 to Ver. 3.6
	CJ1G-CPU43P		CJ1G-CPU43H	Ver. 3.0 or higher	LCB03	
	CJ1G-CPU44P		CJ1G-CPU44H	Ver. 3.0 or higher	LCB03	
	CJ1G-CPU45P		CJ1G-CPU45H	Ver. 3.0 or higher	LCB03	

**Note** Only Separate Loop Controllers have a unit version for the product model. CPU Units with Pre-installed Loop Controllers do not have a unit version for the product model.

## ***Notation in this Manual***

This manual uses the following notation.

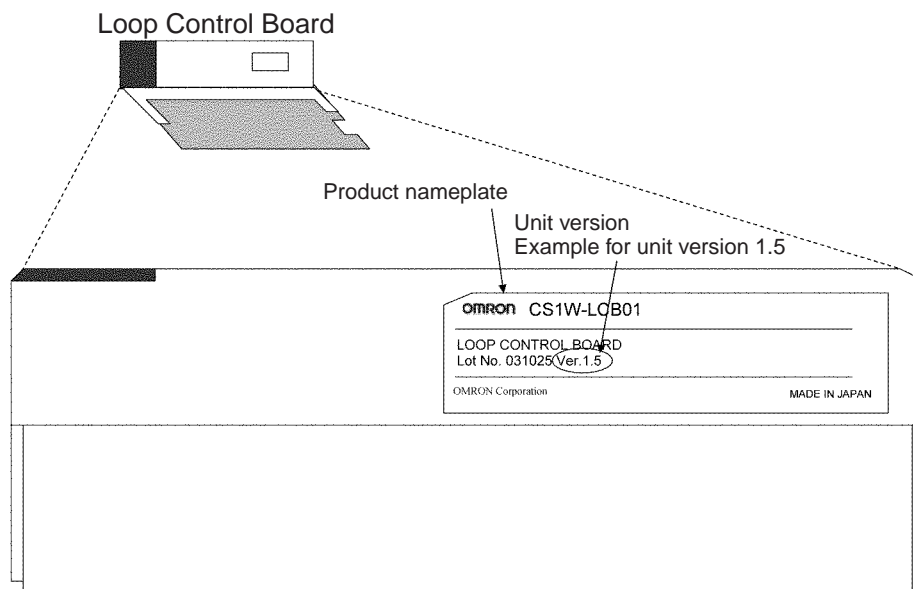
- “Loop Controller” is used as a generic term to refer to the Loop Controllers in general.
- “LCB□□” is used to refer to specific Loop Controller functional elements. For example, the Loop Controller function element in a CS1W-LCB05 Loop Control Board is the LCB05, so “LCB05” is used to refer to the Loop Controller functional element. The Loop Controller function element in a CJ1G-CPU44P Loop-control CPU Unit is the LCB03, so “LCB03” is used to refer to the Loop Controller functional element.
- Model numbers are used to refer to specific Loop Controller models.

In the *CX-Process Tool Operation Manual* for version 3.2 or lower, functional element names (LCB□□) are given as “Loop Control Board.” In the *CX-Process Tool Operation Manual* for version 4.0 or higher, simply “LCB□□” is used.

# Unit Version Notation on Products

## Loop Control Boards

A “unit version” has been introduced to manage CPU Units, Special I/O Units, and Inner Boards in the CS/CJ Series according to differences in functionality accompanying upgrades. This system applies to Units manufactured since October 1, 2003. The unit version code is provided on the nameplate of the product for which unit versions are being managed, as shown below for the Loop Control Board.



The CX-Process Tool can be used to confirm the unit versions of Loop Control Boards in the Monitor Run Status Window. After connecting the CX-Process Tool online, select **Operation – Monitor Run Status** from the Execute Menu. Confirm the unit version in ITEM099 (MPU/FROM version display) under from the System Common Block (Block Model 000) in the Monitor Run Status Window.

ITEM	Data name	Data
099	MPU/FROM version indication	V1.50

Version V1.50 and onwards must be indicated.

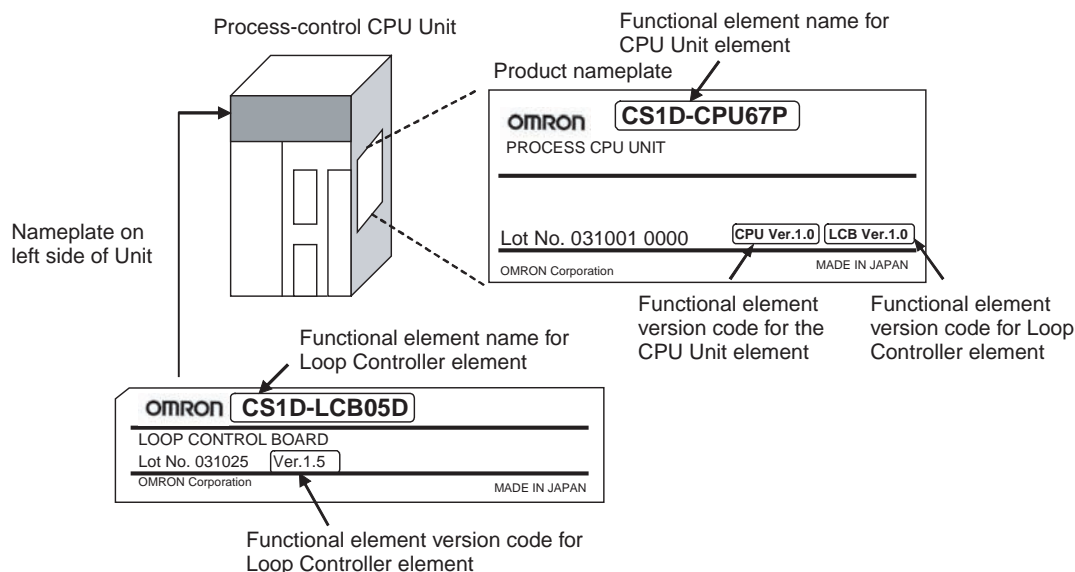


## Functional Element Name and Version Code for Process-control CPU Units and Loop-control CPU Units

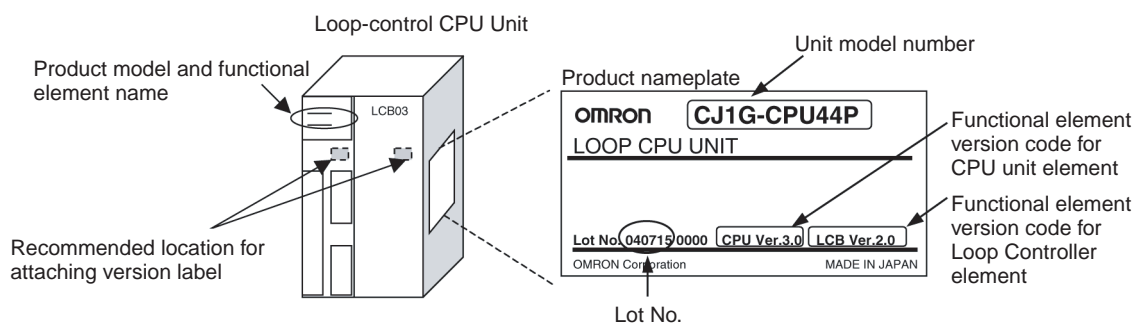
The functional element name and functional element version code for Process-control CPU Units and Loop-control CPU Units are provided on the nameplate as shown in the following diagrams.

### Process-control CPU Units

**Note** CPU Unit elements for which no version code is provided are pre-Ver. 2.0 CPU Units.



### Loop-control CPU Units



## Confirming CPU Unit Element Versions with Support Software

CX-Programmer version 4.0 can be used to confirm the unit version using either of the following two methods.

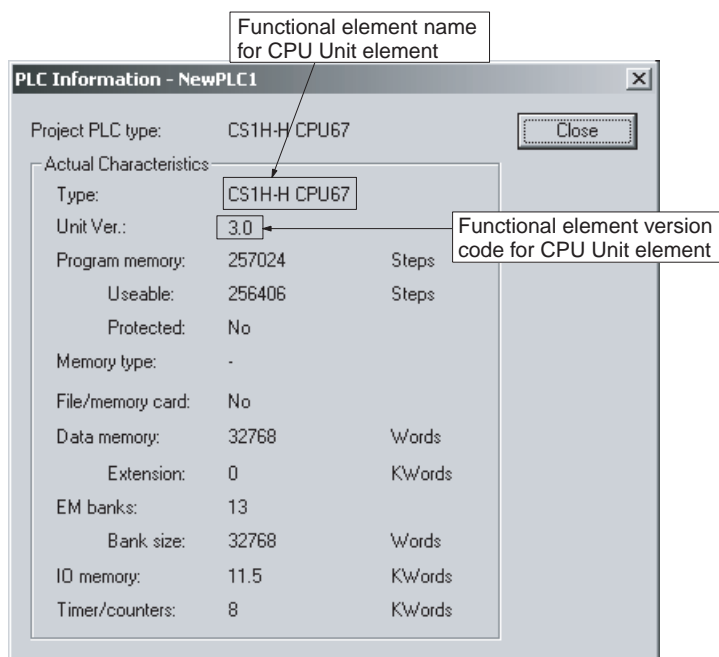
- Using the *PLC Information*
- Using the *Unit Manufacturing Information* (This method can also be used for Special I/O Units and CPU Bus Units.)

**Note** CX-Programmer version 3.3 or lower cannot be used to confirm unit versions.

## PLC Information

1,2,3...

1. If you know the device type and CPU type, select them in the **Change PLC** dialog box, go online, and select **PLC – Edit – Information** from the menus. If you do not know the device type and CPU type, but are connected directly to the CPU Unit on a serial line, select **PLC – Auto Online** to go online, and then select **PLC – Edit – Information** from the menus.
2. In either case, the following PLC Information Dialog Box will be displayed.

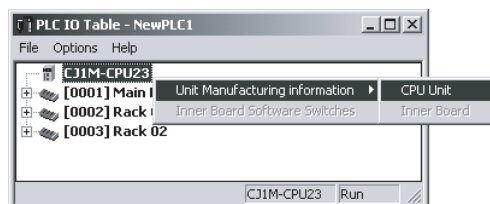


Use the above display to confirm the unit version of the CPU Unit that is connected online.

## Unit Manufacturing Information

1,2,3...

1. In the I/O Table Window, right-click and select **Unit Manufacturing Information – CPU Unit**.



2. The following Unit Manufacturing Information Dialog Box will be displayed.

Use the above display to confirm the unit version of the CPU Unit connected online.

## **Functional Element Versions and Programming Devices**

The Programming Device that supports the functional element version code must be used to enable all the functions in the corresponding functional element.

**Note** Upgrading versions is not necessary if only the basic functions of the CPU Unit element are required.

### **CPU Unit Element**

Loop Controller		Programming Device	
Functional element name	Functional element version	CX-Process Tool	CX-Programmer (See note.)
CS1G/H-CPU□□H	Pre-Ver. 2.0	---	---
	Ver. 2.0		Ver. 4.0 or higher
	Ver. 3.0		Ver. 5.0 or higher
	Ver. 4.0		Ver. 7.0 or higher
CS1D-CPU□□H	Ver. 1.1		Ver. 4.0 or higher
CJ1G-CPU□□H	Ver. 3.0		Ver. 5.0 or higher
	Ver. 4.0		Ver. 7.0 or higher

### Loop Controller Element

Loop Controller		Programming Device	
Functional element name	Functional element version	CX-Process Tool	CX-Programmer (See note.)
LCB01	Ver. 1.0	Not specific	---
	Ver. 1.5	Ver. 3.2 or higher	
	Ver. 2.0	Ver. 4.0 or higher	
	Ver. 3.0	Ver. 5.0 or higher	
	Ver. 3.5	Ver. 5.2 or higher	
	Ver. 3.6	Ver. 5.2 or higher (See note.)	
LCB05	Ver. 1.0	Not specific	
	Ver. 1.5	Ver. 3.2 or higher	
	Ver. 2.0	Ver. 4.0 or higher	
	Ver. 3.0	Ver. 5.0 or higher	
	Ver. 3.5	Ver. 5.2 or higher	
	Ver. 3.6	Ver. 5.2 or higher (See note.)	
LCB05D	Ver. 1.0	Ver. 3.2 or higher	
LCB03	Ver. 2.0	Ver. 4.0 or higher	
	Ver. 3.0	Ver. 5.0 or higher	
	Ver. 3.5	Ver. 5.2 or higher	
	Ver. 3.6	Ver. 5.2 or higher (See note.)	

**Note** When using function component version 3.6 for LCB01, LCB03, or LCB05, use the CX-One Auto Update function to update the CX-Process Tool Software to version 5.23 or higher.

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## About this Manual:

This manual describes the installation and operation of the CS-series CS1W-LCB01 and CS1W-LCB05 Loop Control Boards, CS1D-CPU□□P Process-control CPU Units, and CJ1G-CPU□□P Loop-control CPU Units, and includes the sections described below.

The CS-series CS1W-LCB01 and CS1W-LCB05 Loop Control Boards, CS1D-CPU□□P Process-control CPU Units, and CJ1G-CPU□□P Loop-control CPU Units help you build an instrumentation system comprising multiple loops. A Loop Control Board is installed as an Inner Board in the CPU Unit of a CS-series PLC (Programmable Controller).

The CS1W-LCB01 and CS1W-LCB05 Loop Control Boards must be installed in CS1-H CPU Units. They cannot be used in CS1 CPU Units.

Please read this manual and the other manuals related to the CS1W-LCB01 and CS1W-LCB05 Loop Control Boards, CS1D-CPU□□P Process-control CPU Units, and CJ1G-CPU□□P Loop-control CPU Units carefully and be sure you understand the information provided before attempting to install and operate the products. The manuals used with the CS1W-LCB01 and CS1W-LCB05 Loop Control Boards, CS1D-CPU□□P Process-control CPU Units, and CJ1G-CPU□□P Loop-control CPU Units are listed in the following table. The suffixes have been omitted from the catalog numbers. Be sure you are using the most recent version for your area.

Name	Contents	Cat. No. (suffixes omitted)
SYSMAC CS/CJ Series CS1W-LCB01, CS1W-LCB05, CS1D-CPU□□P, and CJ1G-CPU□□P Operation Manuals	Describes the basic running of the Loop Control Boards (excluding detailed descriptions of the function blocks).	W406
SYSMAC CS/CJ Series CS1W-LCB01, CS1W-LCB05, CS1D-CPU□□P, and CJ1G-CPU□□P Function Block Reference Manual	Provides detailed information on the function blocks.	W407
SYSMAC CX-One FA Integrated Tool Package CXONE-AL□□C-V4/AL□□D-V4 CXONE-LT□□C-V4 Setup Manual	Provides an overview of the CX-One FA Integrated Tool and installation procedures.	W463
SYSMAC CS/CJ Series CX-Process Tool Operation Manual	Describes operation of the CX-Process Tool.	W372
Faceplate Auto-Builder for NS Operation Manual	Describes operation of the software that generates NS-series PT projects from a SCADA CSV file output by the CX-Process Tool.	W418

When using CS1D Process-control CPU Units, refer to the following manuals for information on the CS1D CPU Unit elements.

Name	Contents	Cat. No. (suffixes omitted)
SYSMAC CS Series CS1D-CPU□□H, CS1D-DPL01 CS1D-PA/PD□□□ CS1D Duplex System Operation Manual	Describes the setup and operation of CS1D Duplex systems.	W405

## About this Manual, Continued

When using CJ Series Loop-control CPU Units, refer to the following manuals for information on the CJ1-H CPU Unit elements.

Name	Contents	Cat. No. (suffixes omitted)
SYSMAC CJ Series Programmable Controllers Operation Manual CJ1G/H-CPU□□H, CJ1G-CPU□□P, CJ1MCPU□□, CJ1G-CPU□□	Provides an outlines of and describes the design, installation, maintenance, and other basic operations for the CJ-series PLCs.	W393
SYSMAC CS/CJ Series Programmable Controllers Programming Manual CS1G/H-CPU□□-EV1, CS1G/H-CPU□□H, CS1DCPU□□H, CS1D-CPU□□S, CJ1G/H-CPU□□H, CJ1G-CPU□□P, CJ1M-CPU□□, CJ1G-CPU□□	This manual describes programming and other methods to use the functions of the CS/CJ-series PLCs.	W394
SYSMAC CS/CJ/NSJ Series CJ2H-CPU6□-EIP, CJ2H-CPU6□, CJ2M-CPU□□, CS1G/H-CPU□□H, CS1G/H-CPU□□-EV1, CS1D-CPU□□H, CS1D-CPU□□S, CJ1H-CPU□□H-R, CJ1G/H-CPU□□H, CJ1G-CPU□□P, CJ1M-CPU□□, CJ1G-CPU□□, NSJ□-□□□□(B)-G5D, NSJ□-□□□□(B)-M3D Programmable Controllers Instructions Refer- ence Manual	Provides detailed descriptions of the instruc- tions. When programming, use this manual together with the manuals for your CPU Unit.	W474

**Section 1** outlines the features and application of the Loop Controllers and provides Loop Controller specifications.

**Section 2** describes the names and functions of parts, and provides other information required to install and operate Loop Controllers.

**Section 3** provides information on the control mechanism, basic operation, exchanging data with other Units and software, and fail-safe countermeasures for Loop Controllers.

**Section 4** describes a simple example of how to use Loop Controllers.

**Section 5** describes basic examples of combining function blocks.

**Section 6** provides information on how to use FINS commands.

**Section 7** provides information on errors that may occur while running of Loop Controllers and guidelines for troubleshooting these errors.

**Appendix A** describes how to use the Step Ladder Program block on the LCB□□s and **Appendix B** describes how to use the Sequence Table block on the LCB□□s.



**WARNING**

Failure to read and understand the information provided in this manual may result in personal injury or death, damage to the product, or product failure. Please read each section in its entirety and be sure you understand the information provided in the section and related sections before attempting any of the procedures or operations given.



## ***Read and Understand this Manual***

Please read and understand this manual before using the product. Please consult your OMRON representative if you have any questions or comments.

## ***Warranty and Limitations of Liability***

### ***WARRANTY***

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

### ***LIMITATIONS OF LIABILITY***

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall the responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

## ***Application Considerations***

### ***SUITABILITY FOR USE***

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the products.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this manual.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

**NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCTS ARE PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.**

### ***PROGRAMMABLE PRODUCTS***

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

## ***Disclaimers***

### ***CHANGE IN SPECIFICATIONS***

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the products may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased products.

### ***DIMENSIONS AND WEIGHTS***

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

### ***PERFORMANCE DATA***

Performance data given in this manual is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

### ***ERRORS AND OMISSIONS***

The information in this manual has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.



# PRECAUTIONS

This section provides general precautions for using the Programmable Controller (PLC) and related devices.

**The information contained in this section is important for the safe and reliable application of the Programmable Controller. You must read this section and understand the information contained before attempting to set up or operate a PLC system.**

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## 1 Intended Audience

This manual is intended for the following personnel, who must also have knowledge of electrical systems (an electrical engineer or the equivalent) and knowledge about instrumentation systems.

- Personnel in charge of installing FA systems
- Personnel in charge of designing FA systems
- Personnel in charge of managing FA systems and facilities


## 2 General Precautions

The user must operate the product according to the performance specifications described in the operation manuals.

Before using the product under conditions which are not described in this manual or applying the product to nuclear control systems, railroad systems, aviation systems, vehicles, combustion systems, medical equipment, amusement machines, safety equipment, petrochemical plants, and other systems, machines, and equipment that may have a serious influence on lives and property if used improperly, consult your OMRON representative.


Make sure that the ratings and performance characteristics of the product are sufficient for the systems, machines, and equipment, and be sure to provide the system, machines and equipment with double safety mechanism.


This manual provides information for running CS1W-LCB01 and CS1W-LCB05 Loop Control Boards, CS1D-CPU□□P Process-control CPU Unit, and CJ1G-CPU□□P Loop-control CPU Unit. Be sure to read this manual before attempting to use these products and related software (CX-Process Tool) and keep this manual close at hand for reference during running.


 **WARNING** It is extremely important that a PLC and all PLC Units be used for the specified purpose and under the specified conditions, especially in applications that directly or indirectly affect human life. You must consult with your OMRON representative before applying a PLC System to the above-mentioned applications.



### 3 Safety Precautions

 **WARNING** Do not attempt to take any Unit or Board apart while power is being supplied. Doing so may result in electric shock.


 **WARNING** Do not touch live terminals. Electric shock will result.

 **WARNING** Provide safety measures in external circuits (i.e., not in the Programmable Controller), including the following items, to ensure safety in the system if an abnormality occurs due to malfunction of the PLC or another external factor affecting the PLC operation. Not doing so may result in serious accidents.


- Emergency stop circuits, interlock circuits, limit circuits, and similar safety measures must be provided in external control circuits.
- When using a CS1D-CPU□□P Process-control CPU Unit, the CS1D Duplex System will stop operating and all outputs will be turned OFF in the following cases:
  - The self-diagnostic function detected errors at the same time in both the active side (CPU Unit or Loop Controller) and the standby side (CPU Unit or Loop Controller).
  - A SEVERE FAILURE ALARM (FALS) instruction is executed and generated fatal errors at the same time in both the active CPU Unit and the standby CPU Unit.
  - The self-diagnostic function detected an error while operating in simplex mode or performing duplex initialization in duplex mode.
  - A SEVERE FAILURE ALARM (FALS) instruction was executed and generated a fatal error while operating in simplex mode or performing duplex initialization in duplex mode.


Unexpected operation, however, may still occur for errors in the I/O control section, errors in I/O memory, and other errors that cannot be detected by the self-diagnosis function. As a countermeasure for all such errors, external safety measures must be provided to ensure safety in the system.

- When a CS1W-LCB01 or CS1W-LCB05 Loop Control Board is mounted in a CS1-H CPU Unit, the CPU Unit will stop operating and all outputs will be turned OFF if the self-diagnostic function detected an error or a SEVERE FAILURE ALARM (FALS) instruction was executed. As a countermeasure for such errors, external safety measures must be provided to ensure safety in the system.
- The PLC outputs may remain ON or OFF due to deposition or burning of the output relays or destruction of the output transistors. As a countermeasure for such problems, external safety measures must be provided to ensure safety in the system.
- When the 24-V DC output (service power supply to the PLC) is overloaded or short-circuited, the voltage may drop and result in the outputs being turned OFF. As a countermeasure for such problems, external safety measures must be provided to ensure safety in the system.

 **WARNING** Check the following items before starting to run the Loop Controller:

- Do not allow the bank of the EM Area with the number specified for allocation to the HMI (human-machine interface) data to overlap with any other area used by the CPU Unit or other Units. The block allocated for the HMI is specified in ITEM 050 (EM Area Bank Allocated for HMI Memory = 0 to 12) of the System Common block (Block Model 000). If areas overlap, the system may operate in an unexpected manner, which may result in injury.
- Do not allow the area to which user link table data is written to overlap with any other area used by the CPU Unit or other Units. If areas overlap, the system may operate in an unexpected manner, which may result in injury.
- When using a user link table to write bit data to I/O memory in the CPU Unit. Never allow ladder programming or communications processes in the CPU Unit to write to any bits in the words in which bits are written from a user link table. Depending on the timing, any attempts to write to these words from ladder programming or communications processes may be ignored. Example: If tag A in a user link table writes to bit 00 of W000 and an OUT instruction in the ladder program in the CPU Unit write to bit 01 of W000, the write from the ladder program may be ignored.
- Analog Input/Output Units used in combination with the Loop Controller must be mounted correctly, and the unit number set on the front panel of the Analog Input/Output Unit must match the unit number set on the Field Terminal block. If the unit numbers do not match, input/output (read/write) is performed on the data of another Special I/O Unit (whose unit number is set on the Field Terminal block).
- The defaults of the System Common block on the Loop Controller must be set correctly.
- Always stop the operation of the Loop Controller before converting any of the EM Area to file memory. If any part of the EM Area that is being used by the Loop Controller for the s is converted to file memory during Board operation, the system may operate in an unexpected manner, which may result in injury.

 **WARNING** Do not use battery-free operation for the CS1-H CPU Unit or the CPU Unit element of a Process-control CPU Unit or Loop-control CPU Unit. If battery-free operation is used for the CPU Unit or CPU Unit element, the contents of the EM Area will not be stable when the power supply is turned ON, possibly causing illegal values in the HMI data in the Loop Controller.

 **WARNING** Do not perform processing in such a way that the Loop Controller and CPU Unit perform writing on identical I/O memory addresses allocated to an contact output or analog output to an external Unit. If writing is performed on identical addresses, the externally connected load may act unexpectedly and cause injury.

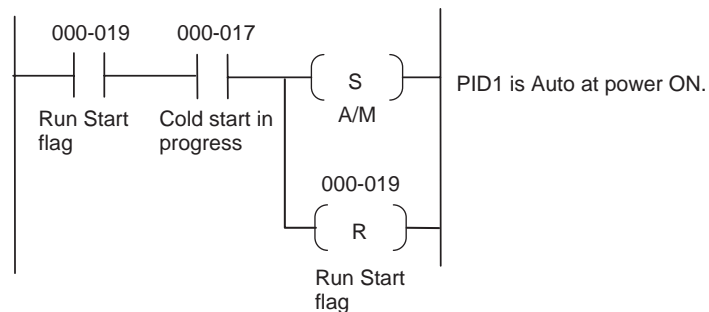
**⚠ WARNING** The Loop Controller will automatically start using a cold start even if the start-up mode is set to a hot start if the power is turned ON after being OFF for 24 hours or longer. If this happens, the auto/manual setting for the Control Block will be set to manual mode (MV=0%) and the remote/local setting will be set to local. To automatically switch to auto mode at the same time as starting operation after the power is turned ON after being OFF for 24 hours or longer, the ladder diagrams in the Sequence Table or Step Ladder Program blocks must be programmed as follows (same as the procedure for switching to remote operation):

Processing: ITEM 086 (Auto/Manual switch) of the Basic PID block or Advanced PID block is set to 1 using ITEM019 (Run Start Flag) and ITEM017 (cold start in progress) of the System Common block as the input conditions.

### Sequence Table

Signal	00
STEP	
000.019 Run Start flag	Y
000.017 Cold start in progress	Y
:	
:	
001.086 A/M	Y
000.019 Run Start flag	N
:	
:	
NEXT STEP	THEN
	ELSE




### Step Ladder Program



For details on hot and cold start operations, refer to 3-2-3 *Details of Hot Start, Cold Start and Stop State*.

**⚠ WARNING** When using the CS1D-CPU□□P Process-control CPU Unit, both the CPU Unit's cycle time and the Loop Controller's operation cycle will be temporarily longer than normal during duplex initialization (in duplex mode). The extended cycle time and operation cycle may temporarily worsen the control characteristics, so verify the system's operation in test runs before actually running the system.

**⚠ Caution** When downloading a sequence table for the Loop Control Board (version 1.5 or higher) that has been edited online with the CX-Process Tool version 3.2 or higher, confirm that the system will operate normally with the edited sequence. If the sequence is not suitable for operation, unexpected operation may result.

-  **Caution** Confirm in advance the conditions at any node for which the sequence table is being edited over a Controller Link or Ethernet network. Not doing so may result in unexpected operation.
-  **Caution** Do not use the HMI function to write a value that is outside of the data range shown in the ITEM list in the *Function Block Reference Manual* (Cat. No. W407) to the receive area (CPU Unit to Loop Controller) in the EM Area. Writing an out-of-range value can result in unexpected operation by the controlled machine or equipment.
-  **Caution** When executing calibration functions, the MV (manipulated variable) will be changed when the PV (process value) is changed in the control block. Therefore, before executing this function, make sure that the equipment will be safe even if the MV changes by setting pseudo-inputs. Otherwise, unexpected equipment operation may result, causing a serious accident.

## 4 Operating Environment Precautions

### 4-1 CS1D-CPU□□P Process-control CPU Unit Precautions

- Normal operation will be possible only if the CS1D-CPU□□P Process-control CPU Unit is used in the combination in which it was shipped. Normal operation may not be possible if the CS1D-CPU□□P Process-control CPU Unit is used in any other combination. Therefore, do not remove the Loop Controller component from the CPU Unit. Always replace the entire CS1D Process-control CPU Unit as one Unit even if only the Loop Controller or CPU Unit has failed.
- The CS1D CPU Unit's cycle time and the Loop Controller component's LCB load rate are different in duplex mode and simplex mode. Verify the system's operation in both modes in trial operation before actually running the system.
- When replacing a CS1D Process-control CPU Unit while power is supplied to the PLC, always switch the DPL Unit's CPU USE/NO USE switch to "NO USE." Removing the CS1D Process-control CPU Unit with the switch set to "USE" (power supplied) may damage the CPU Duplex Backplane, CS1D CPU Unit, DPL Unit, and Loop Controller component of the Process-control CPU Unit.

### 4-2 CS1W-LCB01/CS1W-LCB05 Loop Control Board Precautions


Do not use a CS1W-LCB01 or CS1W-LCB05 Loop Control Board in any CPU Unit other than the CS1-H.

- If a CS1W-LCB01 or CS1W-LCB05 Loop Control Board is used in a CS1 CPU Unit, a non-fatal INNER Board error will occur and the Loop Control Board will not operate. (The CPU Unit itself will be able to operate.)
- If a CS1W-LCB01 or CS1W-LCB05 Loop Control Board is used in a CS1D CPU Unit, a fatal INNER Board error will occur. (In this case, neither the Loop Control Board nor the CPU Unit will operate.)
- Loop Control Boards before version 1.5 cannot be used with CS1D-CPU□□S CS1D CPU Units for Single-CPU Systems.
- Do not connect pin 6 (+5 V power supply line) of the RS-232C port on the CPU Unit to any external device except the CJ1W-CIF11 RS-422A Adapter or NT-AL001 RS-232C/RS-422A Adapter. Doing so may damage the external device or Loop Control Board.


### 4-3 Precautions for All Loop Control Boards, Process-control CPU Units, and Loop-control CPU Units

 **Caution** Do not operate the control system in the following places:

- Locations subject to direct sunlight
- Locations subject to temperature or humidity outside the range specified in the specifications
- Locations subject to condensation as the result of severe changes in temperature
- Locations subject to corrosive or flammable gases
- Locations subject to dust (especially iron dust) or salts
- Locations subject to exposure to water, oil, or chemicals
- Locations subject to shock or vibration


 **Caution** Take appropriate and sufficient countermeasures when installing systems in the following locations:

- Locations subject to static electricity or other forms of noise
- Locations subject to strong electromagnetic fields
- Locations subject possible exposure to radioactivity
- Locations close to power supplies


 **Caution** The operating environment of the PLC System can have a large effect on the longevity and reliability of the system. Improper operating environments can lead to malfunction, failure, and other unforeseeable problems with the PLC System. Be sure that the operating environment is within the specified conditions at installation and remains within the specified conditions during the life of the system.

## 5 Application Precautions

Observe the following precautions when using the PLC.

 **WARNING** Always heed these precautions. Failure to abide by the following precautions could lead to serious or possibly fatal injury.

- Always turn OFF the power to the PLC before attempting any of the following. Not turning OFF the power may result in malfunction or electric shock.
  - Mounting or dismounting I/O Units, including Inner Boards
  - Assembling the Racks
  - Setting DIP switches or unit number setting switches
  - Connecting or wiring the cables
  - Connecting or disconnecting the connectors

 **Caution** Failure to abide by the following precautions could lead to faulty operation of the PLC or the system, or could damage the PLC or PLC Units. Always heed these precautions.

- If the power supply is turned OFF while function block data is being backed up from RAM to flash memory, the backup will not be completed normally. If the power supply is turned back ON within 24 hours, however, the super capacitor will have held the RAM data. The backup operation will restart when power is turned ON and operation will start when the backup has been completed. If the power supply is turned OFF for more than 24 hours, however, RAM data will be lost and operation will be started with the data that was previously saved to flash memory. If this happens, the Cold Start Auto-execution Flag (A35807) will turn ON to show that the previous data has been used. Use this bit in programming to take whatever steps are necessary, such as downloading the most recent function block data.
- To hold analog outputs or contact outputs at specific values (for example, maximum value or minimum value) when the Loop Controller has stopped running, create a Step Ladder Program on the CPU Unit so that each of the allocated bits on the Analog Output Unit or Contact Output Unit are set to a specific value taking the N.C. condition of the Loop Controller Running flag (A35801) as the input condition.
- When a fatal error occurs on the CPU Unit (including execution of the FALS instruction), the Loop Controller also stops running. To hold the analog output to the previous value before the stop occurred, and to set the analog output to either the minimum value or maximum value, use the output hold function of the Analog Output Unit or Analog Input/Output Unit.
- Before turning ON the power to the PLC, make sure that the facilities are safe.
- The analog output values and contact outputs from the Loop Controller are updated at the same time that the power to the PLC is turned ON regardless of the operation mode of the CPU Unit (including the PROGRAM mode). (Internally, the analog output values and contact outputs are sent via the CPU Unit to the Basic I/O Unit and Analog Output Unit.)
- The Loop Controller itself does not have a human-machine interface. So, an external interface such as SCADA software must be provided.
- Fail-safe measures must be taken by the customer to ensure safety in the event of incorrect, missing, or abnormal signals caused by broken signal lines, momentary power interruptions or other causes.
- Before touching the PLC, be sure to first touch a grounded metallic object in order to discharge any static build-up. Otherwise, it might result in a malfunction or damage.
- Take appropriate measures to ensure that the specified power with the rated voltage and frequency is supplied. Be particularly careful in places where the power supply is unstable. An incorrect power supply may result in malfunction.
- Do not attempt to disassemble, repair, or modify any Units or Boards.
- Leave the dust-protection label attached to the top Unit when wiring. Removing the label may result in malfunction.
- Remove the label after the completion of wiring to ensure proper heat dissipation. Leaving the label attached may result in malfunction.
- Check the user program for proper execution before actually running it on the Unit or Board. Not checking the program may result in an unexpected operation.

- Double-check all the wiring before turning ON the power supply. Incorrect wiring may result in burning.
- Tighten the PLC Backplane mounting screws, terminal block screws, and cable (connector) screws to the torque specified in user manuals.
- Confirm that no adverse effect will occur in the system before attempting any of the following:
  - Changing the operating mode of the PLC
  - Force-setting/force-resetting of any contact in memory
  - Changing the present value or any set value in memory

## 6 EC Directives

CS-series products confirm to EC Directives. For the system to conform to EC Directives, however, the following precautions must be adhered to.

- CS-series Units must be installed within control panel.
- Use reinforced insulation of double insulation for the DC power supplies used for the I/O power supplies.
- CS-series products that meet EC Directives also meet the Common Emission Standard (EN61000-6-4). The measure necessary to ensure that standards, such as the radiated emission standard (10 m), are met, however, will vary depending on the overall configuration of the control panel, the other devices to the control panel, and wiring. You must therefore confirm that EC Directives are met for the overall machine or device.

## 7 Other Applicable Directives

### Applicable Directives

- EMC Directive
- Low Voltage Directive

### EMC and Low Voltage Directives

#### EMC Directive

In order that OMRON products can be used with any machinery and in combination with other manufacturer's equipment, the products themselves are designed to comply with EMC standards (see Note), so that the assembled machinery or device can then also easily comply with EMC standards.

Even if machinery and equipment complies with EMC standards before assembly, this compliance may change depending on the device, the configuration of the control panel, and wiring, so OMRON cannot guarantee that a particular system complies with the directive. You must therefore confirm that EMC Directives are met for the overall machine or device.

**Note** EMC: One directive relating to Electro-Magnetic Compatibility  
 EMS: Electro-Magnetic Susceptibility standard EN6100-6-2  
 EMI: Electro-Magnetic Interference standard EN61000-6-4

Common Emission Standard EN61000-6-4, radiated emission standard (10 m)

**Low Voltage Directive**

The Low Voltage Directive provides that necessary safety standards are guaranteed for devices operating at voltages of 50 to 1,000 V AC or 75 to 1,500 V DC to comply with EN61131-2.



# SECTION 1

## Introduction

This section outlines the features and application of the Loop Controllers and provides Loop Controller specifications.

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## 1-1 Outline

### 1-1-1 Outline

Various process operations, including PID control, can be performed for up to 500 blocks with the LCB05 and LCB05D, up to 300 blocks with the LCB03, or up to 50 blocks with the LCB01. (See note.) Process operations include basic logic sequence control and step-progression control. The Loop Controller can also be used to implement an alarm/monitor terminal on a computer without using PID control functions.

**Note** The maximum number of control loops is determined by the operation cycle. In most cases, such as when each loop consists of an Ai4 Terminal, a Segment Linearizer, a Basic PID, and an Ao4 Terminal block the maximum number of control loops would be as shown in the following tables.

#### Loop Control Boards CS1W-LCB01 and CS1W-LCB05 (LBC01/05)

Operation cycle	Maximum number of loops
0.01 s	20 loops
0.02 s	35 loops
0.05 s	70 loops
0.1 s	100 loops
0.2 s	180 loops
0.5 s	250 loops
1 s	250 loops
2 s	250 loops

#### Process-control CPU Units CS1D-CPU□□P (LCB05D)

Operation cycle	Maximum number of loops
0.1 s	80 loops
0.2 s	140 loops
0.5 s	250 loops
1 s	250 loops
2 s	250 loops

#### Loop-control CPU Units CJ1G-CPU43P/44P/45P (LCB03)

Operation cycle	Maximum number of loops
0.01 s	20 loops
0.02 s	35 loops
0.05 s	70 loops
0.1 s	100 loops
0.2 s	150 loops
0.5 s	150 loops
1 s	150 loops
2 s	150 loops

**CJ1G-CPU42P (LCB01)**

Operation cycle	Maximum number of loops
0.01 s	20 loops
0.02 s	25 loops
0.05 s	25 loops
0.1 s	25 loops
0.2 s	25 loops
0.5 s	25 loops
1 s	25 loops
2 s	25 loops

The Loop Control Boards, Process-control CPU Units, and Loop-control CPU Units have no external I/O functions. So, they must be used in a pair with a Unit having an external interface, such as an Analog I/O Unit or Basic I/O Unit. The Loop Controller exchanges data with the Unit having the external interface via the CPU Unit I/O memory.

You can achieve all functions (operation functions/designation of field input/output) simply by combining Control blocks, Operation blocks, and other function blocks. This allows you to easily build a professional instrumentation system on your PLC (Programmable Controller).

The following functions can be achieved by function blocks:

**Internal Operations**

- Control and operation blocks (500 function blocks max. for LCB05 and LCB05D (See note.), 300 function blocks max. for LCB03, or 50 function blocks max. for LCB01): 2-position ON/OFF, Basic PID, Advanced PID, Ratio Setting, Alarm/Signal Restrictions/Hold, Arithmetic (addition, subtraction, multiplication and division), Functions (Square Root, Absolute Value, Segment Linearizer, etc.), Time Functions (Lead/Delay, Dead Time, Ramp Program, etc.), Pulse Train Operation (Accumulator), Signal Selection/Switching (Rank Selector, Constant Selector, etc.), Sequential Control (Timers, Counter, etc.)

**Note** Only 100 function blocks can be used on the LCB05 and LCB05D if Fuzzy Logic, Arithmetic Operation, or Time Sequence Data Statistics blocks are used.

- External controllers (32 function blocks max.):  
ES100X Controller Terminal (Cannot be used on the CS1D-CPU□□P and CJ1G-CPU□□P.)
- Logic sequence/step progression control (200 function blocks max. for LCB03, LCB05, and LCB05D, 20 blocks max. for LCB01. 2,000 commands in total.):  
Step Ladder Program and sequence table (LCB05 and LCB05D only)

**External I/O**

- Each of the points on the Analog I/O Unit and Basic I/O Unit is read and written by the Field Terminal block (max. 80 function blocks).
- Specified contacts or analog data in the CPU Unit I/O memory is read and written by user link tables.
- Data for Control, Operation, and External Controller blocks can be read and written for SCADA software using the HMI function.

**Note** The CMND instruction can be executed in the ladder program in the CPU Unit to send FINS commands to the Loop Controller to read and write function block data.

**Loop Control Boards**

Loop Control Boards (CS1W-LCB01 and CS1W-LCB05) are classified as CS-series Inner Boards. The CS1W-LCB01 and CS1W-LCB05 Loop Control Boards must be mounted in a CS1-H CPU Unit. (They will not operate and cannot be used in a CS1 CPU Unit.)

Loop Control Boards before version 1.5 cannot be used with CS1D-CPU□□S CS1D CPU Units for Single-CPU Systems.

The following table shows available Loop Control Board models.

Model	Mountable PLCs	Duplex Mode	Number of control and operation blocks	Sequence tables (See note.)	Step Ladder Programs (See note.)
CS1W-LCB01	CS1-H CPU Units	Not supported	50 blocks max.	Not supported	20 blocks max.
CS1W-LCB05			500 blocks max.	Supported	200 blocks max.

**Note** Sequence tables and Step Ladder Programs cannot be used simultaneously.

**Process-control CPU Units**

The Process-control CPU Unit (CS1D-CPU□□P) is a CS1D CPU Unit for CS1D Duplex Systems. It consists at a Duplex Loop Control Board mounted in a CS1D CPU Unit. The Duplex Loop Control Board cannot be purchased as separate products. The Board is sold only when mounted in a CS1D CPU Unit as a set called the CS1D-CPU□□P Process-control CPU Unit.

The Duplex Loop Control Boards (Inner Boards) included with Process-control CPU Units cannot be removed and mounted in other CS1D CPU Units.

**Note** For duplex operation, always use two CS1D Process-control CPU Units of the same model mounted to a CPU Duplex Backplane.

The following table shows available Process-control CPU Units models.

Model	Duplex Mode	Number of control and operation blocks	Sequence tables (See note.)	Step Ladder Programs (See note.)	Remarks
CS1D-CPU65P	Supported	500 blocks max.	Supported	200 blocks max.	Select the CS1D-CPU65H as the PLC type from the Programming Device. CPU Unit program capacity: 60 Kwords
CS1D-CPU67P					Select the CS1D-CPU67H as the PLC type from the Programming Device. CPU Unit program capacity: 250 Kwords

**Note** Sequence tables and Step Ladder Programs cannot be used simultaneously.

Unlike Loop Control Boards (CS1W-LCB01 or CS1W-LCB05), the Process-control CPU Units have the following restrictions.

- External Controller Terminal Blocks (Block Model 045) are not supported.
- The operation cycle for function blocks and the refresh cycle for user link tables cannot be set to 0.01, 0.02, or 0.05 seconds.
- The minimum operation cycle for function blocks is 5 times the cycle time of the mounted CS1D CPU Unit and must be set to 0.1, 0.2, 0.5, 1, or 2 seconds.

## Loop-control CPU Units

Loop Control Boards are built into the CJ1 CPU. The following table shows available Loop-control CPU Unit models.

Model	Block name		Number of control and operation blocks	Step Ladder Programs	Remarks
	CPU Unit	Loop Controller component			
CJ1G-CPU42P	CJ1G-CPU42H	LCB01	50 blocks max.	20 blocks max.	Select the CJ1G-CPU42H as the PLC type from the Programming Device. CPU Unit program capacity: 60 Kwords
CJ1G-CPU43/44/45P	CJ1G-CPU43/44/45H	LCB03	300 blocks max.	200 blocks max.	Select the CJ1G-CPU□□H as the PLC type from the Programming Device. CPU Unit program capacity: 250 Kwords

Unlike Loop Control Boards (CS1W-LCB01/05), Loop-control CPU Units have the following restrictions.

- External Controllers (ES100X Controller Terminal (Block Model 045)) are not supported.
- Sequence tables are not supported.

## 1-1-2 Features

### Common Features of Loop Controllers

#### **High-speed Execution of Function Blocks for Multi-loop Control with an Operation Cycle of 10 ms**

Function blocks are executed at high speed approximately ten times faster than for the Loop Control Units. For example, with a standard loop containing an Ai4 Terminal, a Segment Linearizer, a Basic PID, and an Ao4 Terminal block, 20 loops can be executed in 10 ms (except for the CS1D-CPU□□P).

#### **All Functions Achieved by Using Only Function Blocks (Operation Functions/Designation of Field Input/Output)**

Wiring function blocks in the software allows you to achieve not only combinations of operation blocks but also all functions including specification of field I/O.

#### **Almost All Control Types Freely Achieved by Combining Function Blocks**

In addition to regular PID control, cascade control, feedforward control, dead time compensation control, override control and other special control types can be achieved as desired by combining function blocks for up to 250 loops for the LCB03, LCB05, and LCB05D or 50 loops for the LCB01. Control can also be easily configured for processes with prolonged dead time, non-linear processes, and processes involving fluctuating loads. Changes in control type after start of operation can also be flexibly accommodated.

#### **Function Blocks with High-speed Execution**

Operation cycles for control, operation, and other function blocks can be set to 10 ms, 20 ms, or 50 ms as well as to longer periods. The shortest operation cycle that could be set for Loop Control Units was 100 ms. With faster execution, for example, four loops of PID control can all be executed in a 10-ms operation cycle.

- Note** Operation cycles of 10 ms, 20 ms, and 50 ms cannot be set for the CS1D-CPU□□P.

#### **High-speed I/O Refreshing with the CPU Unit Using User Link Tables**

User link tables can be set to refresh cycles of 10 ms, 20 ms, or 50 ms, and the Loop Controller with refresh data with the CPU Unit at the specified cycle. With this speed, the Loop Controller can quickly (within one cycle time) refresh contact and analog values.

- Note** With the Loop Control Unit, there was a delay of up to 2 cycle times for field terminal blocks (e.g., Di, Do, Ai, and Ao).

#### **Designate I/O Memory in the CPU Unit Using Registered Tags**

User-specified tags and CPU Unit data exchange conditions (such as I/O memory addresses) can be registered in user link tables on the CX-Process Tool. The tags registered in a user link table is used to perform data exchange with the CPU Unit on the specified refresh cycle. In sequence tables and other function blocks, tags can then be used to specify CPU Unit I/O memory (or bit or analog I/O values).

User link tables can also be pasted into block diagrams as virtual blocks, or tags can be automatically registered in the user link table when a field terminal block is pasted.

- Note** User link tables provide the same type of functionality as expanded CPU terminals do in Loop Control Units. With the previous method, however, it was necessary to use expanded CPU terminals or CPU terminals to achieve data exchange with the CPU Unit, making it necessary to keep track of I/O memory addresses in the CPU Unit and function block ITEM numbers in expanded CPU terminals or CPU terminals.

#### **Execute Sequence or Step-progression Control Using Sequence Tables (CS1W-LCB05 Only)**

In process control, the commonly used sequence control operations are often written in sequence tables. With a LCB□□, you can select either step ladder programming, the same method used by Loop Control Units, or use sequence tables, whichever you prefer.

Process progression for step transition (even to other tables), timer/counter functions, wiring to function block ITEM variables, or comparison operations using relational expressions are also supported for sequence tables.

#### **Simulated Software Connections between Function Blocks**

CX-Process Tool allows you to simulate wiring between function blocks in the software by joining lines on your computer's screen.

#### **Specify the Order of Operations in Function Block Diagrams**

ITEMs can be set in function blocks in block diagrams to specify the order of processing control and operation blocks. (Blocks are processed left to right and then top to bottom by default.) With Loop Control Units, operation blocks were processed first followed by control blocks in the order of block addresses.

#### **Easily Create a SCADA Interface with the HMI Function**

Space for HMI data for control, operation, and external controller blocks is automatically allocated in the specified bank of the EM area. The bank number is specified in the System Common block.

With SCADA software, the HMI data in the control, operation, and external controller blocks can be read and written by specifying the CSV tags.

**Note** The HMI functions corresponds to the Receive All (Block Model 461) and Send All (Block Model 462) blocks in the Loop Control Units.

It is also possible to add tags from the user link table as CSV tags following the HMI tags. Doing so enables using User Link Table tags from the SCADA software to read and write CPU Unit I/O memory.

#### **Connect ES100X Controllers Externally (CS1W-LCB01/05 Only)**

ES100X Controllers can be connected to the RS-232C port on the Loop Controller and ES100X External Controller Terminal function blocks can be used to monitor ES100X parameters, such as the SP, PV, and MV, and to set ES100X parameters, such as the SP and PID constants. Converting from RS-232C to RS-422A/485 enables connecting up to 32 ES100X Controllers.

#### **Message Communications by FINS Commands**

Data on each of the function blocks can also be read and written as desired by issuing FINS commands by the CMND (DELIVER COMMAND) command in the Step Ladder Program on the CPU Unit or by issuing FINS commands from the host computer. Function block data can also be read and written from PLCs (CPU Units) on other networked nodes.

### **Process-control CPU Unit Features (CS1D-CPU□□P Only)**

#### **Duplex Systems**

In a duplex system with two CS1D Process-control CPU Units, the Process-control CPU Unit (CS1D-CPU□□P) will continue to operate even if a fatal Inner Board error occurs in the Loop Controller of one Process-control CPU Unit. The system will switch to the Loop Controller of the other Process-control CPU Unit and Loop Controller operation (loop control) will continue. Furthermore, when the cause of the error is removed, the Loop Controllers will automatically reset to the original duplex operation status, just like duplex CPU Units. This makes the Loop Controllers of Process-control CPU Units suitable for 24-hour continuous operation systems.

**Note** When using a Process-control CPU Unit (CS1D-CPU□□P), the function block operation cycle must be a minimum of 5 times the CS1D CPU Unit cycle time and also must be set to either 100 ms, 200 ms, 500 ms, 1 s, or 2 s.

## **1-1-3 LCB01/05 Version 1.5 Upgrade Information**

The following functions have been added to the LCB01/05 with the upgrade to version 1.5.

### **Change Sequences during Sequence Execution (Supported by CX-Process Tool Version 3.2 or Higher)**

When validating sequence tables, sequence tables can be edited online while the Loop Controller and sequence tables are operating. Sequence table operation continues even after the sequence tables have been edited online and downloaded.

To perform this function, select **Edit - Start** from the Sequence Table Action Validation Screen, and after editing the table, select **Edit - Download**.

**Note** Previously, sequence tables could be downloaded one at a time while the Loop Controller was operating. After downloading, however, the tables would be executed from step 1. As a result, operation did not continue during the time the tables were downloading.

### **Display PVs and Change SPs for Timers and Counters in Sequence Tables (Supported by CX-Process Tool Version 3.2 or Higher)**

When validating sequence tables, the present values of elements (timers and counters) are displayed. The set values for the elements (timers, counters) can also be changed during operation of the Loop Controller and sequence tables.

**PID Constant Bank Selector Block (Block Model 168)**

The PID constant bank selection function supported by OMRON Thermac R-series Temperature Controllers can now be used simply with PLCs. The Bank Selector block (Block Model 168) is used together with the Basic PID block (Block Model 011), Advanced PID block (Block Model 012), or Blended PID block (Block Model 013).

Up to 8 sets (bank numbers 1 to 8) can be recorded for each of the P, I, D, MH, ML, and local SP values. The bank numbers can be switched and the recorded bank data can be written all at once to the P, I, D, MH, ML, and local SP values in the Basic PID or Advanced PID block at the connection destination, according to the analog input range or the ON status of input bits 1 to 8.

The autotuning results of Basic PID and Advanced PID blocks can also be reflected in the PID setting for the current bank.

**Split Converter Block (Block Model 169)**

The Split Converter block (Block Model 169) is used in combination with the Basic PID block (Block Model 011) or Advanced PID block (Block Model 012). The MV output value is converted into two analog outputs for V characteristics or parallel characteristics (e.g., MV for heating and MV for cooling) and output. Both a heating side PID SP and cooling side PID SP are provided, and the PID block SP at the MV connection source can be changed according to whether the output is for heating or cooling. Conversely, autotuning results for the PID blocks can also be reflected in either the PID constant for heating or cooling.

This block simplifies continuous proportional control for heating/cooling, which previously needed to be combined with segment approximation.

**Disturbance Overshooting Suppression**

A disturbance overshooting suppression function has been added for the Basic PID block (Block Model 011) and Advanced PID block (Block Model 012). Therefore, the influence of disturbance can be suppressed in applications that require high-speed response control, in particular (such as ceramic heater control, flowrate control, and pressure control).

When disturbance overshooting suppression is enabled, the influence of disturbance can be suppressed by setting the characteristics for disturbance (disturbance gain and time constant of disturbance) that enters the control system. Once the error has entered the disturbance stabilization zone (error considered to be stabilized), the disturbance overshooting control function is automatically started if the disturbance width is exceeded.

**Note**

This function is disabled during autotuning, while changing the target value (changing width exceeding the disturbance stabilization band), and during PD control.

**MV Limit Alarm Stop Switch**

In Control blocks, such as Basic PID, even if the MV reaches the MV upper or lower limit when the MV Limit Alarm Stop Switch turns ON, the MV Upper Limit Flag or MV Lower Limit Flag is disabled and will not be set to ON. (The MV limit will operate, however.).

**MV Error Control Stop Switch**

In Control blocks, such as Basic PID, the MV Error Control Stop Switch turns ON when an MV error occurs at the MV output value before MV traceback, and the MV is maintained.

**Calculate High Speeds with Ramped Switch (Block Model 167)**

The calculation cycle for the Ramped Switch (Block Model 167) can be specified as 0.01 s, 0.02 s, or 0.05 s.



## 1-1-4 LCB01/05 Version 2.0 Upgrade Information

### Simple Memory Card Backup for Function Block Data

LCB01/05 Version 2.0 is supported by the easy backup function for data for specified Units and Boards of the CS1-H CPU Unit. The function block data in Loop Control Board RAM can be easily backed up in the same ways as data from Motion Control Units, Position Control Units, and DeviceNet Units.

The simple backup function can back up, recover, and verify all PLC data, including data for Loop Control Boards. This simplifies the task of replacing damaged Boards or making copies of entire PLC-based process control systems.

### Tag Settings, Comments, and User Link Table Connection Data Back Up

The tag settings, comments, and user link table connection data created using the CX-Process Tool can be backed up on PLC Memory Card. This means that tag data and other settings do not have to be reset when it is uploaded from PLC Memory Card using the CX-Process Tool.

### Enhanced Segment Program 2 (Block Model 157)

#### First or Second Reference Input Match for Program Start

With the previous version of the reference input function, Y1 was output starting from the first set value that matched reference input X1. The enhanced version offers a choice so you can specify whether to start from the first or second set value that matches the reference input.

#### **Note**

An error occurred with the original function if there was no match. With the enhanced function, the program can be started from B0 (default setting) when there is no match.

#### Synchronized Segment Programs

A Segment Program (Block Model 156) was used originally to synchronize time axes when there was more than one Segment Program and, for example, it was necessary to use the same PV start time. The data for time axis output Y2 for one Segment Program had to be written to the time axis output for the other Segment Programs using ITEM write blocks. This took up valuable Segment Program space because each program has only 15 program steps.

The enhanced version of Segment Program 2 (Block Model 157) has a function for synchronizing Segment Programs. With more than one Segment Program 2, you can designate one to be the master to provide a reference time axis and the others to be slaves who follow the master's time axis. Segment Program 2 slaves do not calculate their own time axis and can be synchronized to the time axis of the Segment Program 2 master. This enables other program settings to be easily synchronized and started at the PV start point for one measurement when using programmed temperature settings for multiple zones or programmed temperature and pressure settings.

### Hot Start Enabled Time Setting

As long as the super capacitor did not discharge, hot starts were performed in the past when the power was turned ON if the power was turned OFF less than 24 hours and hot start was selected as the START mode.

The newly added START mode performs a hot start when the power is turned ON only if it has been OFF for a specified amount of time (specified time for hot start). With this mode selected, a hot start is always performed as long as the power is OFF for less than the specified amount of time (within one hour). This function enables selecting either a hot start or a cold start depending on how long the power supply has been OFF (as long as it has been OFF for less than an hour). If the power is OFF for longer than the specified amount of time, then a cold start is performed when the power is turned ON.

### **Secondary Loop Anti-Reset Wind-up with Cascade Control**

The PID block on the primary loop side can be prevented from operating when the high or low MV limit turns ON in the PID block on the secondary loop side during cascade control. This prevents reset wind-up and can be used to prevent the integral action from building up in the PID block on the primary side at the high/low MV limits on the PID block on the secondary side.

### **Split Converter Block (Block Model 169) Input Range**

The only input signal range available for the Split Converter block (Block Model 169) had been –100.00% to 100.00%. This meant that the MV limit for the PID block had to be changed to  $\pm 100.00\%$  for heating and cooling control. The Split Converter block (Block Model 169) now has another input signal range that can be set from 0.00% to 100.00%.

### **Field Terminal Blocks**

I/O field terminal blocks have been added for the following Units.

Unit	Type	Block model	Block name
CS-series Isolated-type Thermocouple Input Unit	CS1W-PTS51	566	Ai 4-point Terminal (PTS51)
	CS1W-PTS55	568	Ai 8-point Terminal (PTS55)
CS-series Isolated-type Resistance Thermometer Input Unit	CS1W-PTS52	567	Ai 4-point Terminal (PTS52)
	CS1W-PTS56	569	Ai 8-point Terminal (PTS56)
CS-series Isolated-type Direct Current Input Unit	CS1W-PDC55	570	Ai 8-point Terminal (PDC55)
CJ-series Analog Output Unit	CJ1W-DA021	591	Ao 2-point Terminal (DA021)
CJ-series Analog Input Unit	CJ1W-MAD42	592	Ai 4-point/Ao 2-point Terminal (MAD42)

## **1-1-5 LCB01/03/05 Version 3.0 Upgrade Information**

### **Wireless Debugging (PV Pseudo-inputs) (Calibration Mode)**

During Loop Controller operation, pseudo-inputs (fixed values) can be assigned to the PV in Control Blocks (e.g., Basic PID, Advanced PID) from the CX-Process Tool or SCADA Software/Programmable Terminal. This enables easy confirmation of how the Function Blocks operate according to the Control Block PV, even when there is no actual Sensor or other external device connected. If a Sensor error occurs, the Sensor can be easily replaced during operation by assigning pseudo-inputs.

### **MV Tight Shut**

This function enables tight shut outputs of the values output to the I/O memory of the CPU Unit in the field terminals (analog output terminals) or user link tables. When the output value drops to 0% or lower, the value set as the lower limit (–20.00% min.) is output, and when the output value rises to 100% or higher, the value set as the upper limit (115.00% max.) will be output. This function enables 0% or 100% output of the MV from the Control Block to close a valve completely.

### **MV Analog Output Inversion**

This function enables inverting values output to the I/O memory of the CPU Unit from the field terminals (analog output terminals) or user link tables. Outputs are inverted so that an output value of 100.00% is output as 0.00% and an output value of 0.00% is output as 100.00%. Inversion of analog outputs is a simple means of dealing with purchased valves that are found to have a reversed opening/closing direction.

### **PID Function Block RUN/STOP**

Contact input (RUN/STOP switch) can be used in Basic PID (Block Model 011) or Advanced PID (Block Model 012) to start or stop PID calculation for

each function block. The MV at stop setting can also be used to specify the MV when PID calculations are stopped.

Previously, alarm processing and PV input processing was stopped when calculation stopped for each function block. With this function, however, PID calculation only is stopped and the quantity specified for the MV is maintained while the calculation can be restarted.

### **Sequence Table Referencing**

Evaluation results of the condition rules for a sequence table can be referenced from another sequence table. This enables common processing (as with subroutines) to be compiled in a table for referencing.

### **Step Ladder Timer Command**

A timer can be used in the Step Ladder block (Block Model 301).

### **User Link Table Pulse Output**

In user link tables, when a specified ITEM in a function block starts, a pulse (one-shot pulse) that turns ON only for one refresh cycle can be written to the specified bit address in the CPU Unit's I/O memory. This enables trigger signal output processing and other tasks for the CPU Unit to be performed simply from the Loop Controller.

### **Expanded User Link Table EM Specification**

In user link tables, EM bank numbers 1 to C can be specified as the memory type to enable user link tables to be used even when EM bank number 0 is being used in ladder programs or file memory functions with functions other than the Loop Controller.

### **Field Terminal Blocks Increased**

I/O field terminal blocks have been added for the following Units.

Unit name	Model	Block Model	Block Name
CS-series Analog Input Unit	CS1W-AD161	582	AI 16-point Terminal (AD161) CS1W-AD161
CJ-series Isolated-type Thermocouple Input Unit	CS1W-PTS15	571	AI 2-point Terminal (PRS15/16, PDC15)
CJ-series Isolated-type Resistance Thermometer Input Unit	CJ1W-PTS16		
CJ-series Isolated-type Direct Current Input Unit	CJ1W-PDC15		

### **Switch Meter Block Added**

The Switch Meter block (Block Model 225) has been added. This block enables starting/stopping multiple devices such as motors and pumps, and simple manipulation and monitoring of the status of ON/OFF valves.

### **Constant ITEM Setting (Block Model 171)**

The number of constants that can be set for the Constant ITEM Setting (Block Model 171) has been increased from 8 maximum to 16 maximum.

### **Saving Tag Settings, Comments, and Block Diagrams Created with CX-Process Tool to the Internal Flash Memory (CX-Process Tool Ver. 5.0 or Higher)**

CX-Process Tool Ver. 5.0 or higher enables tag settings, comments, and block diagram information created using the CX-Process Tool to be backed up in the Loop Controller's internal flash memory.

**User-specified  
Location of Block  
Diagrams (CX-  
Process Tool Ver. 5.0  
or Higher)**

CX-Process Tool Ver. 5.0 or higher enables user-specified location of block diagrams.

**Easy Backup  
Function Improved**

**Tag, Comment, and Other Data Also Backed Up**

Block diagram information, tags, comments, and annotation data is now backed up. Previously this data was not included in the data backed up by the easy backup function.

**Flash Memory Data Backed Up Instead of RAM Data**

For LCB01/03/05 Ver. 3.0 or later, the easy backup function backs up the data in flash memory rather than the data in RAM. This means that a verification error will not occur for the backup function even if the data in RAM has been changed by program execution in the Loop Controller. (Previously an error would occur.)

## 1-1-6 Upgraded Functions for LCB01/05 and LCB03 Version 3.5

### **Segment Program 3 Block (Block Model 158) Added**

**Up to 100 Steps Can Be Used**

The maximum number of steps that can be used per program has been increased to 100, making it easier to create more complex temperature control programs.

**Built-in Bank (e.g., PID) Switching Function**

A built-in bank (e.g., PID) switching function makes it possible to change to the optimum PID parameters when moving between steps.

**Auto-tuning Commands for PID Blocks**

Auto-tuning can be started from the Segment Program 3 block for a Basic PID block (Block Model 011) or an Advanced PID block (Block Model 012), making it easy to execute auto-tuning for each step.

**Batch Reading and Writing of Program Pattern Data from and to the CPU Unit**

Program data and other data can be read from the LCB to the DM Area of the CPU Unit, or written from the DM Area to the LCB, making it easy to quickly replace program data.

**Time Data Added**

The following data is output as time information during temperature control program execution: elapsed time since the run/stop command turned ON, program total time, step time output, step remaining time, program time output, and program remaining time.

### **Data Backup during Loop Controller Operation Added**

By using an external backup specification in the System Common block (Block Model 000), function block data can be backed up to Flash memory during Loop Controller operation without using the CX-Process Tool.

### **Function Block Data Replacement (Direct Recovery) Added**

The simple backup function supported by the LCB01, LCB03, and LCB05 has been further improved. Previously, a Memory Card was required both for backup (LCB to Memory Card) and restoration (Memory Card to LCB). The improved function allows data to be restored using a communications command (FINS command) with no need for a Memory Card. Function blocks in the LCB can thus be overwritten by using communications from a host personal computer.

## **Improved Segment Program 2 Block (Block Model 157) Functionality**

When the program is restarted using the X1 reference input function and there is more than one matching point for the X1 reference input, it is possible to specify the matching point from which the program is to be restarted.

## **Terminal Blocks Added**

I/O field terminal blocks have been added for the Units listed in the following table.

Unit name	Model	Block model	Block name
CJ-series Isolated-type High-resolution Analog Input Unit with	CJ1W-PH41U	572	AI 4-point Terminal (PH41U)
CJ-series Isolated-type General-purpose Analog Input Unit with Fully Universal Inputs	CJ1W-AD04U	573	AI 4-point Terminal (AD04U)
CJ-series High-speed Analog Input Unit	CJ1W-ADG41	581	AI 4-point Terminal (ADG41)

## **1-1-7 Upgraded Functions for LCB01/05 and LCB03 Version 3.6**

### **PV Lag Offset Correction for PID Function Blocks Added**

PV lag offset correction can be used for program control when a Segment Program 2 block (Block Model 157) or Segment Program 3 block (Block Model 158) is used as the remote SP for a Basic PID block (Block Model 011) or Advanced PID block (Block Model 012). This improves tracking of SP ramp section set values during program control.

## **1-1-8 Basic System Configuration**

**1,2,3...**

### **1. Unit Having External Interface Functions**

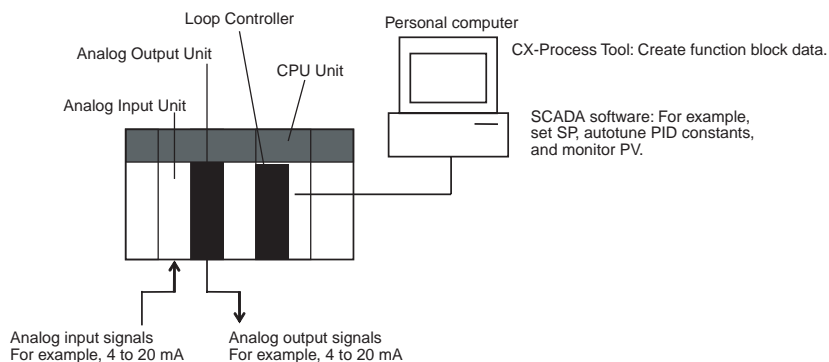
The Loop Controller itself does not have external analog I/O and external contact I/O functions. So, it must be used in combination with a Unit having external interface functions such as an Analog I/O Unit as shown in the example figures in the following pages.

### **2. CX-Process Tool**

The Loop Controller itself does not have a HMI for preparing function block data. So, function block data must be prepared on CX-Process Tool, and then downloaded to the Loop Controller for use as shown in the example figures in the following pages.

### **3. SCADA Software**

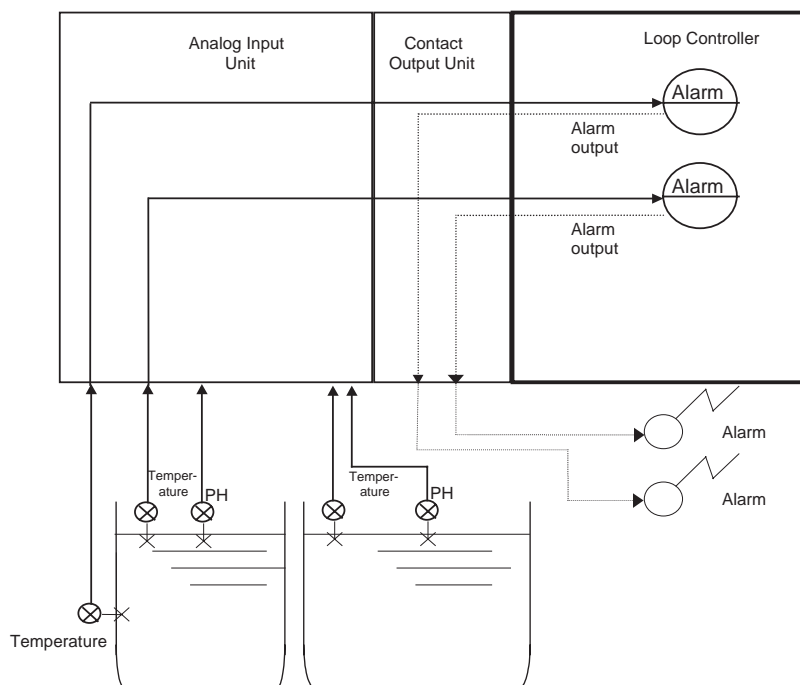
The Loop Controller itself does not have a HMI for setting the Set Point and PID constant values, and displaying the PV. So, the Set Point and PID constant values must be set, and PV monitored using SCADA software or a PT (Programmable Terminal).

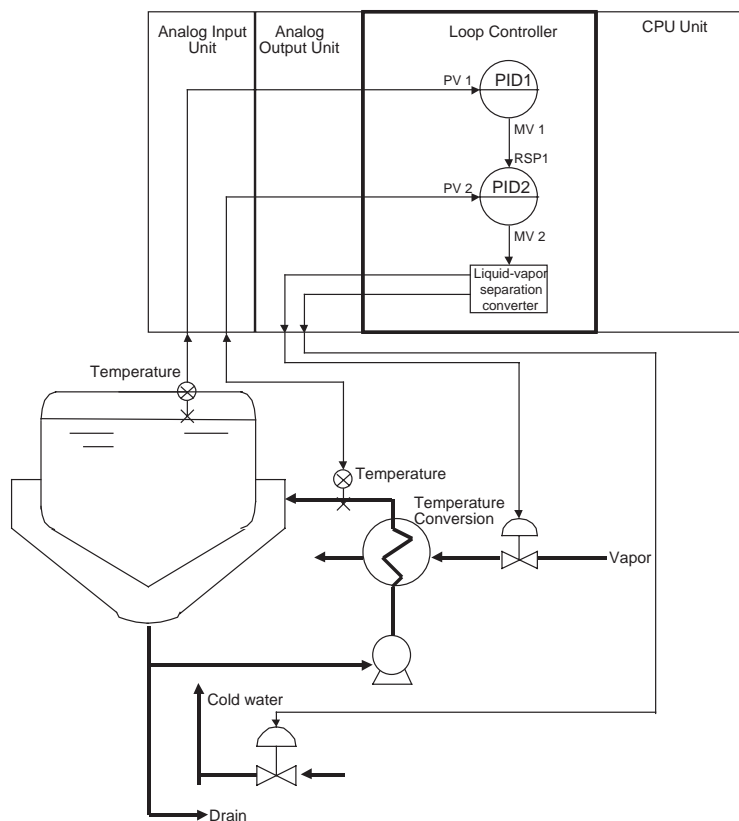
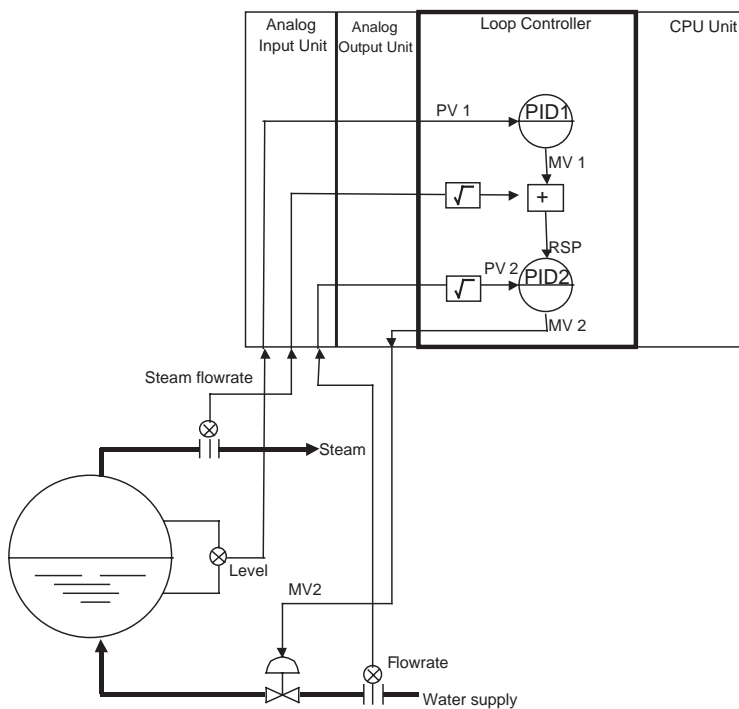


## 1-1-9 Application Examples

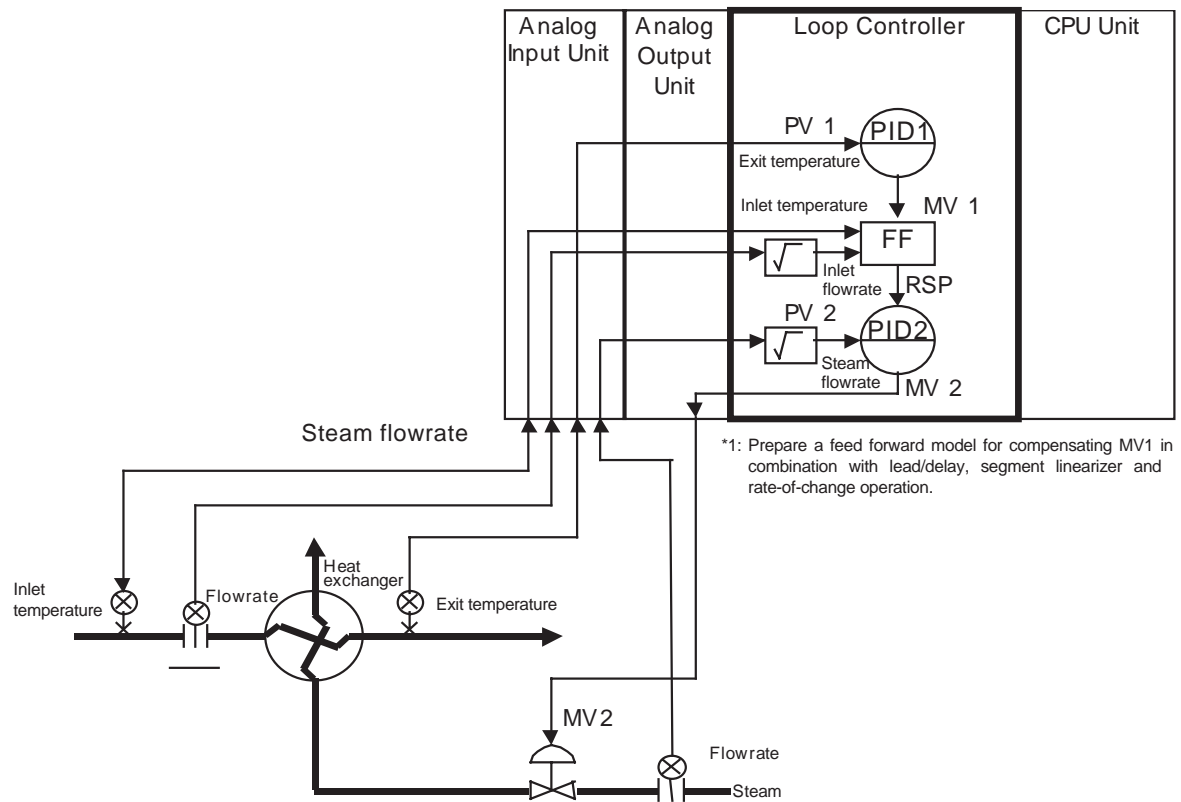
The Loop Controller can be used, for example, to build control systems capable of high-density monitoring of analog data through to advanced control of instrumentation such as in the following four examples.

### High-density Monitoring of Waterworks and Sewage Systems



**Temperature Control of Kettle Reboiler (Cascade Control)****Boiler Drum Level Control (with Cascade Feedforward Control Function)**

### Heat Exchanger Exit Temperature Control (with Cascade Feedforward Control)

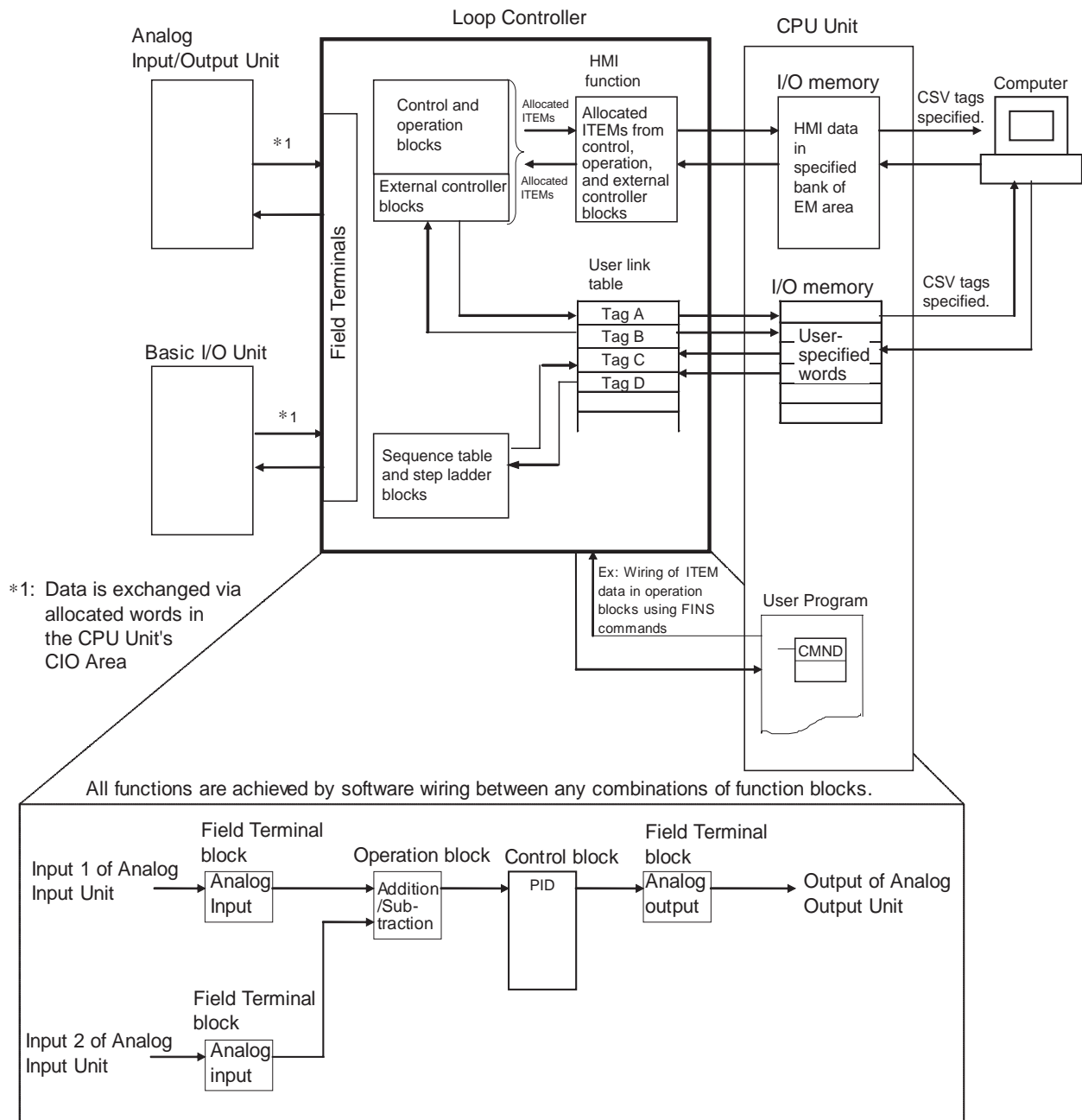




## 1-1-10 Loop Controller Mechanism

### Overall Mechanism

The following illustration shows a block diagram of the overall mechanism.



The following describes each of the functions of the Loop Controller.

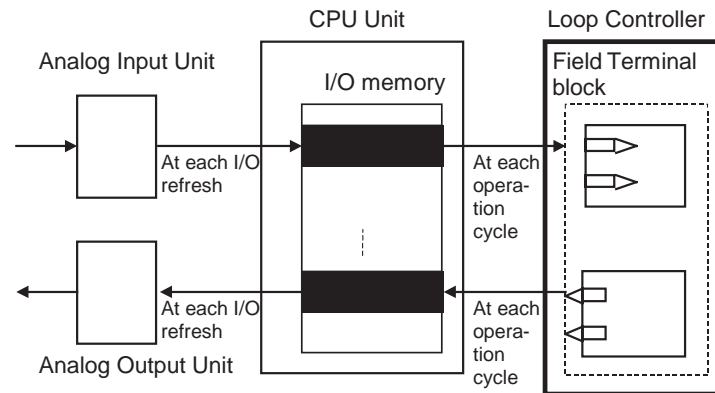
### 1) External I/O

**⚠ WARNING** Do not perform writing operations on the same I/O memory address allocated to contact outputs or analog outputs between the Loop Controller component and the CPU Unit. If writing is performed on the same address, the externally connected load may function unexpectedly, causing an injury.

**Analog I/O or Contact I/O**

Analog signals or contact signals are input and output constantly (at each operation cycle) between the Analog I/O Unit or Basic Unit on the same PLC and the CPU Unit I/O memory. At this time, the user is not required to be aware of I/O memory addresses as the Field Terminal block is used.

With analog I/O, only the unit number of the Analog I/O Unit is set. With contact I/O, however, the leading allocated address in I/O memory must be set.



**Note** The Loop Controller uses the Field Terminal block (regardless of the user program on the CPU Unit) to read and write areas allocated for contact or analog signals. So, do not perform write operations on the same allocated areas between the Loop Controller and the CPU Unit.

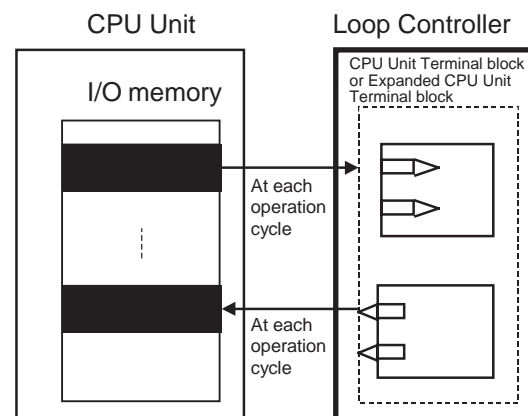
**Data Exchange with Specified CPU Unit I/O Memory**

I/O operations can be performed internally on the Loop Controller constantly (at each operation cycle) with any specified CPU Unit I/O memory. In this case, the CPU Unit Terminal block or the Expanded CPU Unit Terminal block is used, and the I/O memory address must be specified.

Data exchange is possible with the following I/O memories:

- CIO (channel I/O) Area
- Work Area (W)
- Holding Area (H)
- Data Memory (D)
- Extended Data Memory (E) bank No. 0

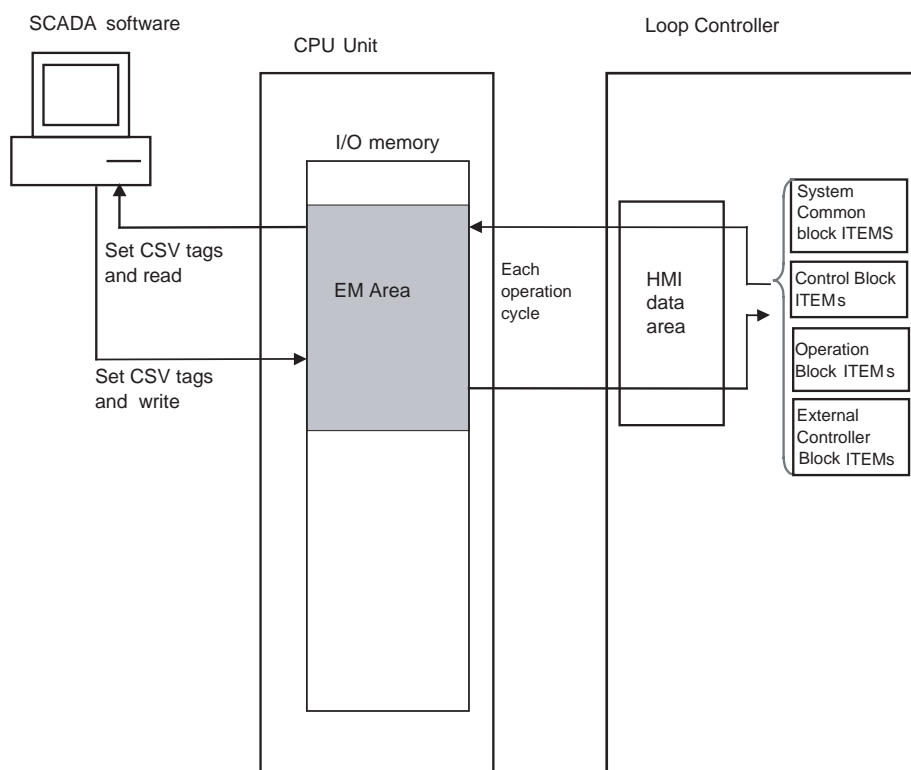
**Note** 1. This function can also be used to designate Units (DeviceNet, CompoBus/S and other Communications Units) on which field terminals are not supported, and CPU Unit I/O memory (remote I/O allocated area, etc.) for enabling I/O.



2. The Loop Controller uses user link tables (regardless of the user program on the CPU Unit) to read and write to specified CPU Unit I/O memory. So, do not perform write operations on the same I/O memory addresses between the Loop Controller and the CPU Unit.

### Data Exchange with SCADA Software

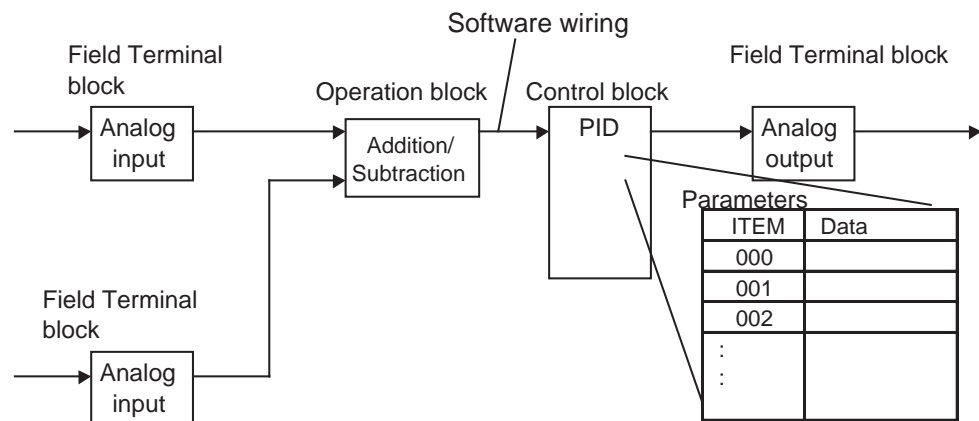
Commercially available SCADA software can also be used to read and write function block data for the Loop Controller. CSV tags can be specified from the SCADA software to read and write ITEM data allocated for the HMI in the CPU Unit's EM area from control, operation, external controller, and the System Common block. (See note 1.) The CSV tags are created with the CX-Process Tool.



- Note**
1. The EM area bank to be allocated for the HMI is specified in the System Block (Block Model 000), ITEM 050 (EM area bank to allocated for HMI memory, 1 to 12).
  2. User Link Table tags can be treated as CSV tags just like the HMI data described above. By specifying these tags, the I/O memory in the CPU Unit can be read and written from the SCADA software.

## 2) Internal Processing

- Prepare a data sheet for the function blocks shown below on CX-Process Tool, and store the data sheet on the Loop Controller. The function block data sheet describes: (a) software wiring of each function block and (b) parameters in each function block.



- The Loop Controller handles analog I/O signals not in engineering units but in percentage units.

**Example 1**

At analog input, the converted values 0000 to 0FA0 (FF38 to 1068) Hex from the Analog Input Unit for input 4 to 20 mA (3.2 to 20.8 mA) are converted to 0.00 to 100.00% (–5.00 to 105.00%) before they are processed by the Loop Controller.

**Example 2**

At analog input, the converted values F830 to 07D0 (F768 to 0898) Hex from the Analog Input Unit for input –10 to +10 mV (–11 to +11 V) are converted to 0.00 to 100.00% (–5.00 to 105.00%) before they are processed by the Loop Controller.

**Example 3**

At analog output, the values 0.00 to 100.00% (–5.00 to 105.00%) are converted to setting values 0000 to 0FA0 (FF38 to 1068) Hex before 4 to 20 mA (3.2 to 20.8 mA) is output from the Analog Output Unit.

**Note** Converted values (in the case of analog input) for 0 to 100% on the Loop Controller and setting values (in the case of analog output) for 0 to 100% on the Loop Controller are fixed to the same values as the user ranges. However, in the case of Isolated-type Analog Input Units (CS1W-PTS01/02/03, PTW01, PDC01, PPS01, PTR01), the Analog Input Unit itself has a range setting function. So, any values can be specified as the converted values (on condition that the same setting as the range setting is made).

- Likewise, data exchange with the CPU Unit is handled not in engineering units but in percentage units. Values in I/O memory words are converted to percentage units based upon the specified range before they are input to the Loop Controller. Alternatively, percentage values are converted to Hex values based upon the specified range before they are output to CPU Unit I/O memory.

**Example 1**

At input from the CPU Unit, the values of 0000 to 0FA0 Hex in the I/O memory words are converted to 0.00 to 100.00% before they are input to the Loop Controller when the range 0 to 4000 (0000 to 0FA0 Hex) is specified.

**Example 2**

At output to the CPU Unit, the values of 0.00 to 100.00% are converted to 0000 to 0FA0 Hex before they are output to the Control Unit when the range 0 to 4000 (0000 to 0FA0 Hex) is specified.

- Note**
1. In data exchange with the CPU Unit, data can be actually exchanged within the range –320.00 to +320.00% and not within the range 0.00 to 100.00%. So, in the above example, the conversion range for 0 to 4000 (0000 to 0FA0 Hex) is 0.00 to +100.00. However, in actual operation, 8300 to FFFF

Hex and 0000 to 7D00 Hex are converted to  $-320.00$  to  $-0.01$  and  $0.00$  to  $+320.00\%$ , respectively, before they are processed.

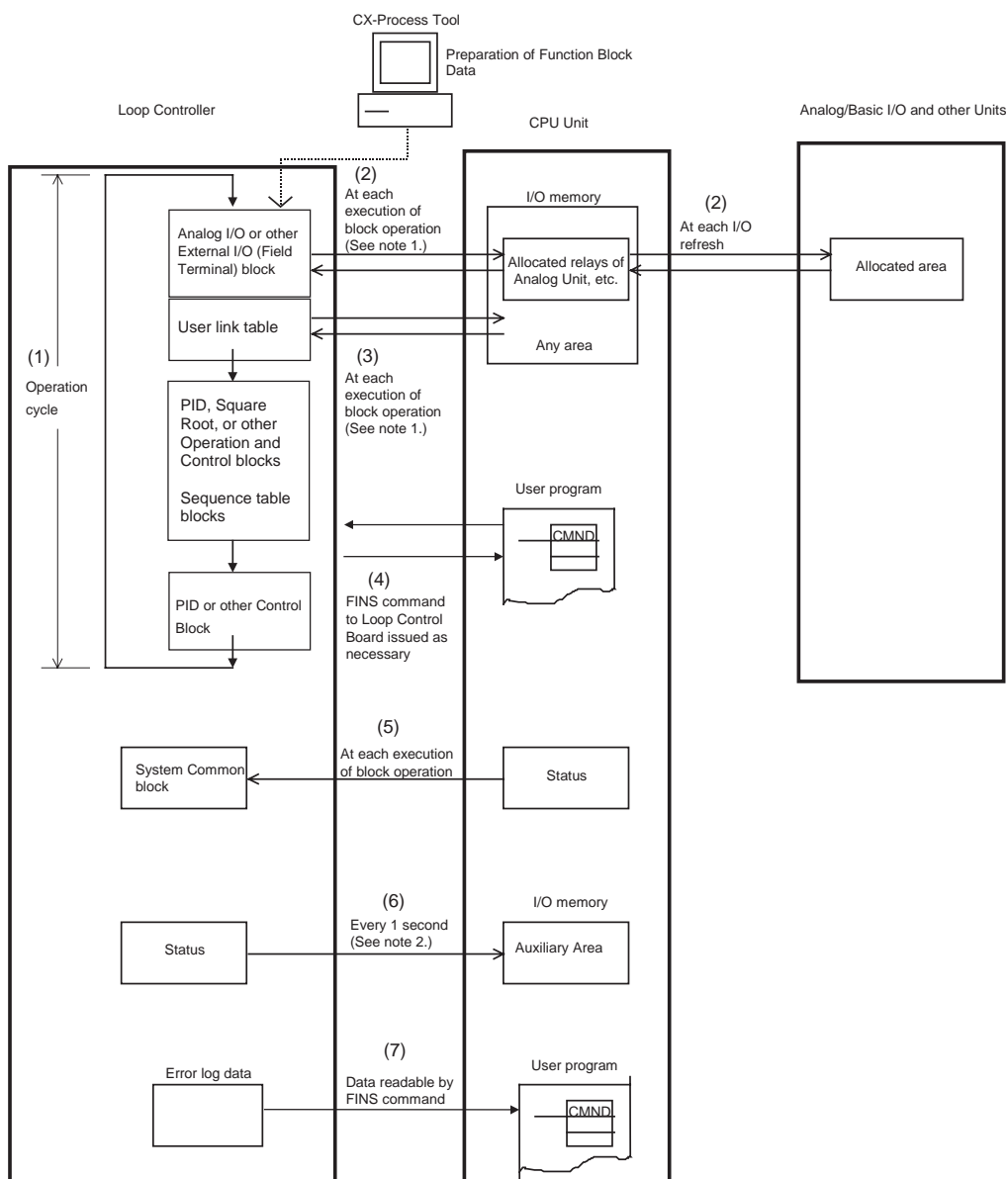
- Any data range in CPU Unit I/O memory corresponding to 0 to 100% on the Loop Controller can be specified. (The data range is dependent on the specified input range and output range in the user link table.)

CX-Process Tool scales these percentage values to engineering units values, and SCADA software or a PT monitors and sets the values in engineering units. (For details, see 3-1 Configuration of Function Blocks.)

- The Loop Controller does not process analog data in engineering units (scaled values). (All analog data is processed in percentage values.) To monitor/and set analog data in engineering units, the analog data must be scaled on CX-Process Tool and then monitored and set on SCADA software or a PT.

## 1-1-11 Overall Mechanism of Data Exchange

The following block diagram shows the overall mechanism of data exchange.



- Note**
1. For the CS1D-CPU□□P, data is refreshed over several CPU Unit cycles in the operation cycle.
  2. Data is refreshed each CPU Unit cycle for the CS1D-CPU□□P.

### **1. Function Block Operations (independent of and asynchronous with CPU Unit)**

The function blocks on the Loop Controller are cyclically executed according to fixed operation cycles. Operations are executed asynchronously with the user program on the CPU Unit.

The operation cycle is one of 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1 or 2 seconds (\*1), and can be specified to each function block. (The default operation cycle is one second for each function block.) or the LCB05D, cycles of 0.01, 0.02, and 0.05 seconds cannot be set, and for LCB01, LCB03, and LCB05, cycles of 0.01, 0.02, and 0.05 seconds cannot be set for some blocks, i.e., they cannot be set for the System Common block (Block Model 000).

Operation is started when the PLC is turned ON regardless of the CPU Unit operation mode.

**\*1** The execution cycle for commands in the Step Ladder Program block (Block Model 301) on the Loop Controller is one of 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1 or 2 seconds for each operation cycle in the Step Ladder Program block. This applies to Sequence Table blocks (Block Model 302) as well.

### **2. External I/O (via the CPU Unit I/O memory)**

The Loop Controller actually updates external I/O data from each Unit via CPU Unit I/O memory at each operation cycle of the Field Terminal block.

### **3. Constant Data Exchange with CPU Unit (by Function block)**

The Loop Controller refreshes data I/O with specified CPU Unit I/O memory areas at each operation cycle of the CPU Unit Terminal block or the Expanded CPU Unit Terminal block.

### **4. On-demand Data Exchange with CPU Unit (by FINS command issued to Unit)**

The CPU Unit can read and write Loop Controller data by issuing the FINS command to the Loop Controller by the CMND (DELIVER COMMAND) command in the Step Ladder Program whenever necessary.

### **5. CPU Unit Status Notification (by reflecting in System Common block)**

The status of the CPU Unit (operation mode, fatal error, etc.) is reflected in the System Common block on the Loop Controller. If necessary, the Loop Controller extracts data from this System Common block.

### **6. Loop Controller Status Notification (by Auxiliary Area)**

The status of the Loop Controller is reflected on the Auxiliary Area in the CPU Unit. Note, however, that this status is reflected every second for LCB01 and LCB05, and not at the I/O refresh cycle. For the LCB05D, this status is reflected each CPU Unit cycle (split refresh).

### **7. Reading of Error Log Data on Loop Controller**

Error log data is stored on the Loop Controller. (The error code, detailed information, date (year/month) and time (hour/minute/second) of occurrence are recorded as one error log data record, and the latest 256 data records are stored.) The time information, including year, month, hour, minutes, and seconds, are read from the CPU Unit. Adjust the time in the CPU Unit when necessary. Error log data can be read using the read error log FINS command (command code 2102 Hex).

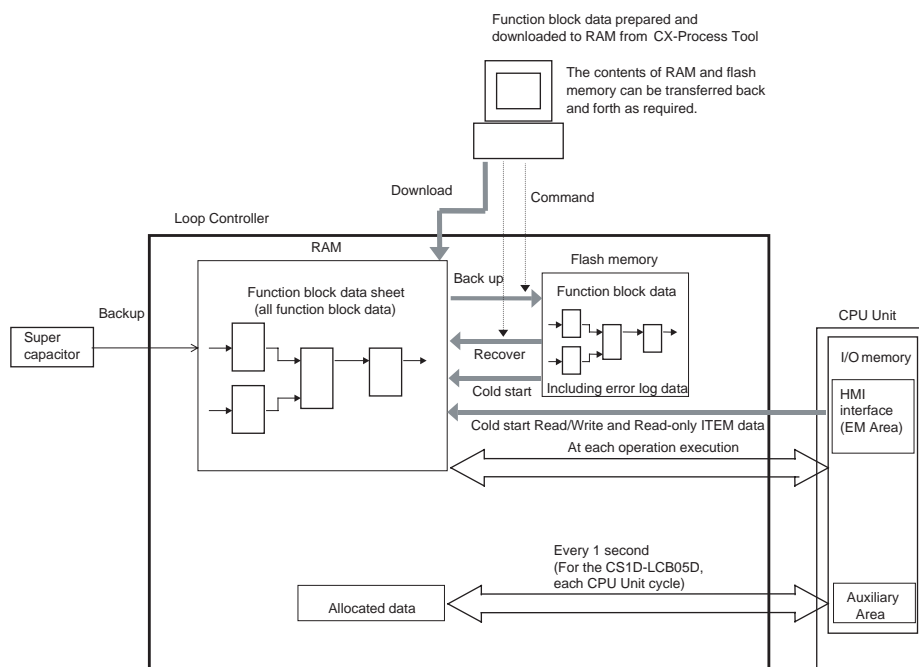
**Note** Relationship between CPU Unit I/O Memory and Loop Controller  
The Loop Controller can read from and write to CPU Unit I/O memory by the methods indicated in the following table.

Data direction	Purpose of data on Loop Controller		
	Loop Controller ↔ CPU Unit	Loop Controller ↔ CPU Unit	Loop Controller → CPU Unit
I/O memory area type on CPU Unit	Reading or writing at CPU Unit Terminals, Expanded CPU Unit Terminals, or Send/Receive All Blocks ○ : Possible, ---: Impossible	Reading or writing at field terminals	Writing using the Auxiliary Area
CIO	○	Reading/writing of CIO area on corresponding Unit at field terminals	Notifying of Loop Controller status
Work Area (W)	○	---	---
Holding Area (H)	○	---	---
Auxiliary Area	---	---	---
TR Area	---	---	---
Timer	---	---	---
Counter	---	---	---
Data Memory Area (D)	○	---	---
Extended Data Memory Area (E)	○ (bank No.0 only)	---	---

## 1-1-12 Internal Mechanism of Loop Controllers

The following describes the internal mechanism of the Loop Controller.

- Function block data and error log data are backed up by a super capacitor in RAM. During actual operation, the Loop Controller uses the data in RAM.
- Function block data is prepared and downloaded to RAM and flash memory in the Loop Controller from CX-Process Tool running on the computer. From the CX-Process Tool, you can transfer data between RAM and flash memory whenever necessary.
- Error log data is stored in flash memory can be read using the READ ERROR LOG FINS command (command code 2102 Hex).
- In the default state, function block data is not stored on the Loop Controller. Function block data must be downloaded from a computer to RAM and flash memory in the Loop Controller before the Loop Controller can be run.



- Note**
- Function block data in RAM can be backed up to flash memory using either of the following methods.
    - When downloading LCB01, LCB05, or LCB05D function block data (i.e., by LCBs), specify LCB backup for the download (i.e., by placing a check mark by "LCB back up indication after download").
    - Specify backup from the CX-Process Tool software using the **Execute - Backup** menu command.
  - Recovering data from flash memory to RAM is also possible using either of the following methods.
    - Set the power ON startup mode to Cold Start and turn ON the power supply to the CPU Unit.
    - Specify recovery from the CX-Process Tool software using the **Execute - Recovery** menu command.
  - Specify backup using ITEM 125 (Backup start command while running) of the System Common Block (Block Model 000).  
During operation of the Loop Controller, the backup will start when ITEM 125 (Backup start command while running) of the System Common Block (Block Model 000) is turned ON.
  - If duplex operation is used with the CS1D-CPU□□P and data in LCB Units is downloaded during operation, operation data will be backed up in the flash memory of only the active Board. The Loop Controller will stop operating at this time. If the power supply is turned OFF before starting operation with either a hot or cold start, the data will exist only in the flash memory of the active Board, so a duplex verification error will occur. If this occurs, check the RDY indicator on the standby Loop Controller in the CPU Unit to make sure that it is ready to operate and then press the initialization switch on the Duplex Unit to initialize duplex operation.



## 1-1-13 List of Function Blocks

- Note**
- (1) The Function Blocks dealing with high-speed operation (operation cycle: 0.01, 0.02, and 0.05 seconds is possible) However, Not supported by the LCB05D.
  - (2) LCB01/05 Ver.1.5 or later only.
  - (3) LCB05/05D only.
  - (4) LCB01/05 Ver.2.0 or later and LCB03 only.
  - (5) CS-series only.
  - (6) CJ-series only.
  - (7) LCB01/03/05 Ver. 3.5 or later only.

Category	Type	Block Model	Block Name	Function	Allocatable Block Address
System Common Block		000	System Common	Makes settings common to all function blocks and outputs signals for the system.	000
Control Block	Controller	001 (See note 1.)	2-position ON/OFF	2-position type ON/OFF controller	LCB05/05D: 001 to 500 LCB03: 001 to 300 LCB01: 001 to 050
		002 (See note 1.)	3-position ON/OFF	3-position type ON/OFF controller for heating/cooling ON/OFF control	
		011 (See note 1.)	Basic PID	Performs basic PID control.	
		012 (See note 1.)	Advanced PID	Performs PID with two degrees of freedom control for enabling deviation/MV compensation, MV tracking, etc.	
		013	Blended PID	Performs PID control on the cumulative value (cumulative deviation) between the accumulated value PV and accumulated value Remote Set Point.	
		014	Batch Flowrate Capture	Functions to open the valve at a fixed opening until a fixed batch accumulated value is reached.	
		016	Fuzzy Logic	Outputs up to two analog outputs based on fuzzy logic performed on up to 8 analog inputs.	LCB05/05D: 001 to 100 LCB03: 001 to 100 LCB01: 001 to 050
		031 (See note 1.)	Indication and Setting	Manual setter with PV indication and SP setting functions	
		032 (See note 1.)	Indication and Operation	Manual setter with PV indication and MV setting functions	
		033 (See note 1.)	Ratio Setting	Ratio and bias setter with PV indication and ratio setting function	
External Controller Block	External Controller Block	045	ES100X Controller Terminal	Performs monitoring and setting for an ES100X Controller connected directly to the RS-232C port on the Loop Control Unit.	LCB01/05: 601 to 632 LCB05D, LCB03: Not supported.

Category	Type	Block Model	Block Name	Function	Allocatable Block Address
Operation Block	Alarm/Signal restrictions/Hold	111 (See note 1.)	High/Low Alarm	Provides the alarm contact outputs for the high and low limits of single analog signals.	LCB05/05D: 001 to 500 LCB03: 001 to 300 LCB01: 001 to 050
		112 (See note 1.)	Deviation Alarm	Provides the alarm contact outputs for the deviation of two analog signals.	
		113 (See note 1.)	Rate-of-change Operation and Alarm	Provides the alarm contact outputs for the high and low limits of rate-of-change operation when the analog signal rate-of-change is output.	
		115 (See note 1.)	High/Low Limit	Limits the high and low limits of single analog signals.	
		116 (See note 1.)	Deviation Limit	Calculates the deviation between two analog signals, and limits the deviation within that range.	
		118 (See note 1.)	Analog Signal Hold	Holds the maximum, minimum or instantaneous value of single analog signals.	
	Arithmetic	121 (See note 1.)	Addition or Subtraction	Performs addition/subtraction with gain and bias on up to 4 analog signals.	LCB05/05D: 001 to 100 LCB03: 001 to 300 LCB01: 001 to 050
		122 (See note 1.)	Multiplication	Performs multiplication with gain and bias on up to 2 analog signals.	
		123 (See note 1.)	Division	Performs division with gain and bias on up to 2 analog signals.	
		126 (See note 1.)	Arithmetic Operation	Performs various math operation (trigonometric, logarithmic, etc.) on floating-point decimal values converted (to industrial units) from up to 8 analog inputs.	
		127 (See note 1.)	Range Conversion	Easily converts up to 8 analog signals simply by inputting the 0% and 100% input values and 0% and 100% output values.	
	Functions	131 (See note 1.)	Square Root	Performs square root extraction (with low-end cutout) on single analog signals.	LCB05/05D: 001 to 500 LCB03: 001 to 300 LCB01: 001 to 050
		132 (See note 1.)	Absolute Value	Performs non-linear (3 gain values) operation on single analog signals. Analog signals can also set as a dead band (with different gap).	
		133 (See note 1.)	Non-linear Gain (Dead Band)	Outputs the absolute value of single analog signals	
		134 (See note 1.)	Low-end Cutout	Sets output to zero close to the zero point of single analog signals.	
		135 (See note 1.)	Segment Linearizer	Converts single analog signals to 15 segments before the signals is output.	
		136 (See note 1.)	Temperature And Pressure Correction	Performs temperature and pressure correction.	

Category	Type	Block Model	Block Name	Function	Allocatable Block Address
Operation Block (continued)	Time Function	141 (See note 1.)	First-order Lag	Performs first-order lag operation on single analog signals.	LCB05/05D: 001 to 500 LCB03: 001 to 300 LCB01: 001 to 050
		143 (See note 1.)	Rate-of-change Limit	Performs rate-of-change restriction on single analog signals.	
		145 (See note 1.)	Moving Average	Performs moving average operation on single analog signals.	
		147 (See note 1.)	Lead/Delay	Performs lead/delay operation on single analog signals.	
		148 (See note 1.)	Dead Time	Performs dead time and first-order lag operations on single analog signals.	
		149 (See note 1.)	Dead Time Compensation	Used for Smith's dead time compensation PID control	
		150	Accumulator for instantaneous value input	Accumulates analog signals, and outputs 8-digit accumulated value signals.	
		151	Run Time Accumulator	Accumulates the operating time, and outputs the pulse signal per specified time.	
		153 (See note 1.)	Time Sequence Data Statistics	Records time sequence data from analog signals and calculates statistics, such as averages and standard deviations.	LCB05/05D: 001 to 100 LCB03: 001 to 100 LCB01: 001 to 050
		155	Ramp Program	Ramp program setter for combining ramps for time and hold values.	LCB05/05D: 001 to 500 LCB03: 001 to 300 LCB01: 001 to 050
		156	Segment Program	Segment program setter setting the output values with respect to time.	
		157	Segment Program 2	Segment program setting with wait function for setting the output values with respect to time	
		158 (See note 7.)	Segment Program 3	Segment program setting with wait function and bank (e.g., PID) switching function for setting output values with respect to time.	
		601	Step Data	Expansion settings for Segment Program 3 block (Block Model 158). Sets step data, such as the time width and output value.	
		602	Bank Data	Expansion settings for Segment Program 3 block (Block Model 158). Sets bank data, such as the PID constants.	

Category	Type	Block Model	Block Name	Function	Allocatable Block Address
Operation Block (continued)	Signal Selection/Switching	161 (See note 1.)	Rank Selector	Selects the rank of up to 8 analog signals.	LCB05/05D: 001 to 500 LCB03: 001 to 300 LCB01: 001 to 050
		162 (See note 1.)	Input Selector	Selects the specified analog signals specified by the contact signal from up to 8 analog signals.	
		163 (See note 1.)	3-input Selector	Selects and outputs one of three analog input signals.	
		164 (See note 1.)	3-output Selector	Outputs one analog input signal in three switched direction.	
		165 (See note 1.)	Constant Selector	Selects 8 preset constants by the contact signal.	
		166 (See note 1.)	Constant Generator	Outputs 8 independent constants.	
		167	Ramped Switch	Switches two analog inputs (or constants) with a ramp.	
		168 (See note 2.)	Bank Selector	Records the PID parameters (SP, P, I, D, MH, ML) in up to 8 sets in advance, and switches the PID parameter for Basic/Advanced/Blended PID Blocks according to the analog input range (zone) or input bits.	
		169 (See note 2.)	Split Converter	Inputs the MV from the Basic PID block or Advanced PID block, converts the MV into two analog outputs for V characteristics or parallel characteristics (e.g., MV for heating or cooling) and outputs them.	
	ITEM Settings	171 (See note 1.)	Constant ITEM Setting	Writes the constant to the specified ITEM at the rising edge of the send command contact.	LCB05/05D: 001 to 500 LCB03: 001 to 300 LCB01: 001 to 050
		172 (See note 1.)	Variable ITEM Setting	Writes the analog signal to the specified ITEM at the rising edge of the send command contact.	
		174 (See note 1.)	Batch Data Collector	Stores each of max. 8 analog inputs to buffer by a certain timing within sequential processing.	
	Pulse Train Operation	182	Accumulated Value Input Adder	Adds up to four accumulated value signals.	
		183	Accumulated Value Analog Multiplier	Multiplies analog signals by the accumulated value signals.	
		184	Accumulator for accumulated value input	Converts 4-digit accumulated value signals to 8 digits.	
		185	Contact input/Accumulated value output	Counts low-speed contact pulses, and outputs 8-digit accumulated signals.	
		186	Accumulated Value Input/Contact Output	Converts 4-digit accumulated value signals to low-speed contact pulses before they are output.	

Category	Type	Block Model	Block Name	Function	Allocatable Block Address
Operation Block (continued)	Others	192 (See note 1.)	Analog/Pulse Width Converter	Changes the ON/OFF duration ratio in a constant cycle duration so that it is proportional to the analog signal.	LCB05/05D: 001 to 500 LCB03: 001 to 300 LCB01: 001 to 050
	Sequence Operation	201 (See note 1.)	Contact Distributor	Connect contact signals between function blocks in a 1: 1 connection.	
		202 (See note 1.)	Constant Comparator	Compares up to eight sets of analog signals and constants, and outputs the comparison results as contacts.	
		203 (See note 1.)	Variable Comparator	Compares up to eight pairs of analog signals, and outputs the comparison results as contacts.	
		205 (See note 1.)	Timer	2-stage output type addition timer for forecast values and reached values. Can also output the present value.	
		206 (See note 1.)	ON/OFF Timer	Timer for performing ON-OFF operation at preset ON and OFF times.	
		207 (See note 1.)	Clock Pulse	Manipulates and monitors ON/OFF valves with open/close limit switches.	
		208 (See note 1.)	Counter	2-stage output type addition timer for forecast values and arrival values. Can also output the current value.	
		209 (See note 1.)	Internal Switch	Temporary storage contact for accepting relays in the Step Ladder Program block. (Note: One internal switch is already allocated as "temporary storage" in CX-Process Tool.)	
		210 (See note 1.)	Level Check	Checks an analog input for 8 levels and outputs a contact corresponding to the level. The level number is also output as an analog value.	
	Contact Type Control Target	221	ON/OFF Valve Manipulator	Manipulates and monitors ON/OFF valves with open/close limit switches.	LCB05/05D: 001 to 500 LCB03: 001 to 300 LCB01: 001 to 050
		222	Motor Manipulator	Manipulates and monitors motor operation.	
		223	Reversible Motor Manipulator	Manipulates and monitors reversible motor operation.	
		224	Motor Opening Manipulator	Inputs a target opening, and manipulates an electric positional-proportional motor.	
		225	Switch Meter	Manipulates and monitors multiple devices (up to 8) such as ON/OFF valves, motors, and pumps.	
Sequential Control		301 (See note 1.)	Step Ladder Program	Performs logic sequence and step progression control.	LCB01: 701 to 720 LCB03/05/05D: 701 to 900
		302 (See note 3.)	Sequence table	Conditions and actions are listed in table format to perform logic sequence or step progression control. <b>Note:</b> CS1W-LCB05/05D only; not supported by the CS1W-LCB01.	

Category	Type	Block Model	Block Name	Function	Allocatable Block Address
Field Terminal	Contact I/O	501 (See note 1.)	DI 8-point Terminal	Inputs 8 contacts from 8-point Input Unit.	901 to 980
		502 (See note 1.)	DI 16-point Terminal	Inputs 16 contacts from 16-point Input Unit.	
		503 (See note 1.)	DI 32-point Terminal	Inputs 32 contacts from 32-point Input Unit.	
		504 (See note 1.)	DI 64-point Terminal	Inputs 64 contacts from 64-point Input Unit.	
		511 (See note 1.)	DO 5-point Terminal	Outputs 5 contacts from 5-point Output Unit.	
		512 (See note 1.)	DO 8-point Terminal	Outputs 8 contacts from 8-point Output Unit.	
		513 (See note 1.)	DO12-point Terminal	Outputs 12 contacts from 12-point Output Unit.	
		514 (See note 1.)	DO16-point Terminal	Outputs 16 contacts from 16-point Output Unit.	
		515 (See note 1.)	DO32-point Terminal	Outputs 32 contacts from 32-point Output Unit.	
		516 (See note 1.)	DO64-point Terminal	Outputs 64 contacts from 64-point Output Unit.	
		518 (See note 1.)	DI 16-point/DO16-point Terminal	Inputs and outputs 16 contacts each from 16-point Input/16-point Output Units.	
		525 (See note 1.)	DI 96-point Terminal	Inputs 96 contacts from 96-contact Input Units.	
		537 (See note 1.)	DO 96-point Terminal	Outputs 96 contacts from 96-contact Output Units.	
		544 (See note 1.)	DI 48-point/DO 48-point Terminal	Inputs and outputs 48 contacts each from 48-point Input/48-point Output Units.	
	Analog I/O	551 (See note 1.)	AI 8-point Terminal (AD003)	Inputs 8 analog signals from the C200H-AD003.	901 to 980
		552 (See note 1.)	AO 8-point Terminal (DA003/4)	Inputs 8 analog signals from the C200H-DA003/DA003.	
		553 (See note 1.)	AI 2-point/AO 2-point Terminal (MAD01)	Inputs and outputs 2 analog signals each from the C200H-MAD01.	
		561 (See notes 1 and 5.)	AI 4-point Terminal (PTS01/02/03, PDC01, PTW01)	Inputs 4 analog signals from one of CS1W-PTS01 (Isolated-type Thermocouple Input Unit), CS1W-PTS02/03 (Isolated-type Temperature-resistance Thermometer Input Unit), CS1W-PDC01 (Isolated-type Analog Input Unit) or CS1W-PTW01 (2-lead Transmitter Input Unit).	
		562 (See notes 1 and 5.)	PI 4-point Terminal (PPS01)	Inputs 4 instantaneous values and accumulated values each from CS1W-PPS01 (Isolated-type Pulse Input Unit).	
		563 (See notes 1 and 5.)	AO 4-point Terminal (PMV01)	Outputs 4 analog signals from CS1W-PMV01 (Isolated-type Control Output Unit).	

Category	Type	Block Model	Block Name	Function	Allocatable Block Address
Field Terminal	Analog I/O	564 (See notes 1 and 5.)	AI 8-point Terminal (PTR01/02)	Inputs 8 analog signals from CS1W-PTR01 (Power Transducer Input Unit) or CS1W-PTR02 (Analog Input Unit (100 mV)).	901 to 980
		565 (See notes 1 and 5.)	AO 4-point Terminal (PMV02)	Outputs 4 analog signals from CS1W-PMV02 (Isolated-type Control Output Unit).	
		566 (See note 4.)	AI 4-point Terminal (PTS51)	Inputs 4 analog signals from CS1W-PTS51 or CJ1W-PTS51 (Isolated-type Thermocouple Input Unit).	
		567 (See note 4.)	AI 4-point Terminal (PTS52)	Inputs 4 analog signals from CS1W-PTS52 or CJ1W-PTS52 (Isolated-type Thermocouple Input Unit).	
		568 (See notes 4 and 5.)	AI 8-point Terminal (PTS55)	Inputs 8 analog signals from CS1W-PTS55 (Isolated-type Thermocouple Input Unit).	
		569 (See notes 4 and 5.)	AI 8-point Terminal (PTS56)	Inputs 8 analog signals from CS1W-PTS56 (Isolated-type Thermocouple Input Unit).	
		570 (See notes 4 and 5.)	AI 8-point Terminal (PDC55)	Inputs 8 analog signals from CS1W-PDC55 (Direct current Input Unit).	
		571 (See note 7.)	AI 2-point Terminal (PTS15/16, PDC15)	Inputs 2 analog outputs from CS1W-PTS15, CS1W-PTS16, or CS1W-PDC15.	
		572 (See notes 6 and 7.)	AI 4-point Terminal (PH41U)	Inputs 4 analog signals from CJ1W-PH41U (Isolated-type High-resolution Analog Input Unit with Fully Universal Inputs)	
		573 (See notes 6 and 7.)	AI 4-point Terminal (AD04U)	Inputs 4 analog signals from CJ1W-AD04U Isolated-type General-purpose Input Unit with Fully Universal Inputs)	
		581 (See notes 6 and 7.)	AI 4-point Terminal (ADG41)	Inputs 4 analog signals from CJ1W-ADG41 (High-speed Analog Input Unit)	
		582 (See note 7.)	AI 16-point Terminal (AD161)	Inputs 16 analog outputs from CS1W-AD161.	
		583 (See notes 1 and 5.)	AI 4-point/AO 4-point Terminal (MAD44)	Inputs and outputs 4 analog signals each from the CS1W-MAD44.	
		584 (See note 1.)	AI 8-point Terminal (AD081)	Inputs 8 analog signals from the CS1W-AD081(-V) or CJ1W-AD081(-V).	
		585 (See note 1.)	AO 8-point Terminal (DA08V/C)	Outputs 8 analog signals from the CS1W-DA08V/DA08C or CJ1W-DA08V/DA08C.	
		586 (See note 1.)	AI 4-point Terminal (AD041)	Inputs 4 analog signals from the CS1W-AD041(-V1) or CJ1W-AD041(-V1)	
		587 (See note 1.)	AO 4-point Terminal (DA041)	Outputs 4 analog signals from the CS1W-DA041 or CJ1W-DA041.	
		588 (See note 1.)	AI 4-point Terminal (DRT1-AD04)	Inputs four analog signals from a DRT1-AD04 DeviceNet Slave Analog Input Unit.	
		589 (See note 1.)	AO 2-point Terminal (DRT1-DA02)	Outputs two analog signals from a DRT1-DA02 DeviceNet Slave Analog Output Unit.	
		591 (See notes 4 and 5.)	AO 2-point Terminal (DA021)	Outputs 4 analog signals from the CJ1W-DA021.	
		592 (See notes 4 and 5.)	AI 4-point/AO 2-point Terminal (MAD42)	Inputs 4 analog signals and outputs 2 analog signals each from the CJ1W-MAD42.	

## 1-1-14 Differences between Loop Control Units and Boards

Area	Item	Loop Control Unit	Loop Control Board	Process-control CPU Unit	Loop-control CPU Unit
Model number		CS1W-LCU01	CS1W-LCB01/05	CS1D-LCB05D	CJ1G-CPU□□P
Functional components	CPU Unit component	---	---	CS1D-CPU□□H	CJ1G-CPU□□H
	Loop Controller component	LC001	LCB01/05	LCB05D	LCB01: CJ1W-CPU42P LCB03: CJ1W-CPU43/44/45P
Hardware	Unit classification	CPU Bus Unit	Inner Board LCB01 Control and Operation Blocks: 50 max. LCB05 Control and Operation Blocks: 500 max.	Process-control CPU Unit (a CS1D-CPU□□H and Loop Control Board set) 500 Control and Operation Blocks max.	CJ1 CPU Unit with built-in Loop Control Board
	Compatible CPU Units	CS1, CS1-H, or CS1D CPU Units	CS1-H CPU Units	---	---
	Number of mountable Units/Boards per CPU Backplane	3 Units	1 Board	Two CS1D Process-control CPU Units of the same model (each Unit includes 1 Board)	---
	Duplex mode	Not supported	Not supported	Supported	Not supported
	Unit number settings	0 to F	None		
	RAM backup method	Super capacitor and battery	Super capacitor		Super capacitor (Super capacitor is backed up by Battery in CPU Unit.)
	LED Indicators	RUN, ERC, ERH, SD, and RD	RDY, EXEC, and COMM		



Area	Item	Loop Control Unit	Loop Control Board	Process-control CPU Unit	Loop-control CPU Unit
Main functions	Operation cycle	100, 200, 500, 1,000, or 2,000 ms	10, 20, 50, 100, 200, 500, 1,000, or 2,000 ms	100, 200, 500, 1,000, or 2,000 ms <b>Note 1:</b> 10, 20, and 50 ms are not supported. <b>Note 2:</b> The operation cycle must be set to a minimum of 5 times the CPU Unit cycle time.	10, 20, 50, 100, 200, 500, 1,000, or 2,000 ms
	Execution speed	1	About 10 times faster than the Loop Control Unit	About 8 times faster than the Loop Control Unit	About 10 times faster than the Loop Control Unit
	CPU Unit cycle time restrictions	None	None	Must be 1/5 the shortest operation cycle or less.	None
	Speed of data exchange with CPU Unit	1 cycle time + operation cycle	Operation cycle	Refreshing split over multiple CPU Unit cycles during Board operation cycle	Operation cycle
	Max. delay before hot start	Up to one year after power is turned OFF.	Up to 24 hours after power is turned OFF (at an ambient temperature of 25°C).		Up to 5 minutes after power is turned OFF (at an ambient temperature of 25°C).
	Cold start	The internal memory used for operations is cleared to 0.	The Board reads the function block data that was backed up to flash memory and also reads the HMI data stored in the CPU Unit's EM area. The internal memory used for operations is cleared to 0.		
	Automatic transfer from flash memory to RAM at Power ON	Executed when DIP switch pin 2 is ON.	Executed in a cold start.		
	Load rate	Displayed each operation cycle.	Changes from the LCB load rate and displays the overall load rate.		
	Operation cycle shift down	The Unit automatically shifts to a longer operation cycle when the load rate exceeds 70%.	The Board does not shift to a longer operation cycle. If the load rate exceeds 80% for six seconds consecutively, a non-fatal Inner Board error will occur (operation will continue) and the High Load Alarm Flag (A42408) will turn ON. If the operations cannot be executed in the operation cycle, the operation cycle will be extended and the operations will be executed.		
	User Link Table function	None (Expanded CPU Unit Terminals are used.)	Supported		
	Memory areas allocated to the CPU Unit for SCADA software	Send and receive areas of all Blocks	HMI function (specified EM bank)		
	Contents of CSV tag files	Allocated Control Block and Operation Block ITEMS set in the CSV tags.	1) Allocated Control Block, Operation Block, and System Common Block ITEMS set in the CSV tags. 2) User Link Table tags		
	Sequence control/Step progression control	Performed with the Step Ladder Program.	Performed with either the sequence table or Step Ladder Program. <b>(Note:</b> The CS1W-LCB01 supports step ladder programming only.)		

Area	Item	Loop Control Unit	Loop Control Board	Process-control CPU Unit	Loop-control CPU Unit
Function blocks	Max. number of registered Blocks	Control Blocks: 32 Operation Blocks: 249	The total number of Control Blocks and Operation Blocks is limited as follows: LCB01: 50 Blocks max. LCB05: 500 Blocks max. The total number of Fuzzy Logic Blocks (Block Model 016), Arithmetic Operation Blocks (Block Model 126), and Time Sequence Data Statistics Blocks (Block Model 153) is limited to 100 Blocks max.	The total number of Control Blocks and Operation Blocks is limited to 500 Blocks max. External Controller Terminal Blocks (Block Model 045) are not supported. The total number of Fuzzy Logic Blocks (Block Model 016), Arithmetic Operation Blocks (Block Model 126), and Time Sequence Data Statistics Blocks (Block Model 153) is limited to 100 Blocks max.	The total number of Control Blocks and Operation Blocks is limited as follows: LCB01: 50 Blocks max. LCB03: 300 Blocks max. External Controller Terminal Blocks (ES100X Controller Terminal (Block Model 045)) are not supported. The total number of Fuzzy Logic Blocks (Block Model 016), Arithmetic Operation Blocks (Block Model 126), and Time Sequence Data Statistics Blocks (Block Model 153) is limited to 100 Blocks max.
	Types of Function Blocks	Step Ladder Program	Step Ladder Program or sequence table (cannot be used together) ( <b>Note:</b> LCB01 and LCB03 support step ladder programming only.)		
		ES100X Controller Terminal	ES100X Controller Terminal	Not supported	
		DI Terminal from CPU Unit	User link table		
		DO Terminal to CPU Unit			
		AI Terminal from CPU Unit			
		AO Terminal from CPU Unit			
		Expanded DI Terminal from CPU Unit			
		Expanded DO Terminal from CPU Unit			
		Expanded AI Terminal from CPU Unit			
		Expanded AO Terminal from CPU Unit			
		Receive All Blocks	HMI function (HMI-related ITEM settings for System Common Block)		
		Send All Blocks			
		4-Point Warning Indicator	None (Combined with the Indicator Block (Block Model 034.))		

Area	Item	Loop Control Unit	Loop Control Board	Process-control CPU Unit	Loop-control CPU Unit
Function Blocks (continued)	Types of Function Blocks (continued)	DO to Computer	Function block for CX-Process Monitor software		
		AO to Computer	The CX-Process Monitor software cannot be used for the Loop Control Boards, Process-control CPU Units, or Loop-control CPU Units.		
		1-Block Send Terminal to Computer			
		4-Block Send Terminal to Computer	The CX-Process Monitor Plus can be used for the Loop Control Board.		
		DO Terminal to All Nodes	User link table		
		AO Terminal to All Nodes			
		DO Terminal Settings from Computer			
		AO Terminal Settings from Computer			
		DI Terminal From All Nodes			
		AI Terminal From All Nodes			
		DI 8-point Terminal			
		DI 16-point Terminal			
		DI 32-point Terminal			
		DI 64-point Terminal			
		DO 5-point Terminal			
		DO 8-point Terminal			
		DO 12-point Terminal			
		DO 16-point Terminal			
		DO 32-point Terminal			
		DO 64-point Terminal			
		DI 16-point/DO 16-point Terminal			
		DI 96-point Terminal			
		DO 96-point Terminal			
		DI 48-point/DO 48-point Terminal			

Area	Item	Loop Control Unit	Loop Control Board	Process-control CPU Unit	Loop-control CPU Unit
Status	Operating status of Unit or Board	1) ITEMS in System Common Block 2) Flags in the allocated CPU Bus Unit area (word n)	1) ITEMS in System Common Block 2) Flags in Auxiliary Area word A355		
	OR output of all Function Block alarms	None	Flags in Auxiliary Area word A356		
	Other	None	Inner Board Flags in Auxiliary Area words A401, A402, and A424		
Command Bits	START Mode at Power ON	None	Auxiliary Area word A609	Not supported.	

## 1-1-15 Version Upgrade Information

The following functions have been added to the CS1W-LCB01 and CS1W-LCB05 Loop Control Boards with the upgrade from Ver. 3.5 to Ver. 3.6.

- Select the appropriate unit version when registering an LCB/LC001 in CX Process Tool (select **Insert - Insert Node** from the Settings Menu). If the setting is incorrectly set to V1.0, V1.5, or V2.0, select **Convert LCB Model** from the Execute Menu, and increase the unit version of the LCU/LCB to the later version.

Item	Ver. 1.0	Ver. 1.5	Ver. 2.0	Ver. 3.0	Ver. 3.5	Ver. 3.6
Compatible CX-Process Tool version	Ver. 3.2 or lower	Ver. 3.2 or higher	Ver. 4.0 or higher	Ver. 5.0 or higher	Ver. 5.2 or higher	Ver. 5.2 or higher (See note.)
PV Lag Offset Correction PV lag offset correction improves tracking set values during program control, using Basic PID blocks (Block Model 011) or Advanced PID blocks (Block Model 012).	Not supported	Not supported	Not supported	Not supported	Not supported	Supported
Segment Program 3 block (Block Model 158) added.	Not supported	Not supported	Not supported	Not supported	Supported	Supported
Data backup during Loop Controller operation added.	Not supported	Not supported	Not supported	Not supported	Supported	Supported
Simple backup file recovery using FINS command added.	Not supported	Not supported	Not supported	Not supported	Supported	Supported
Improved Segment Program 2 block (Block Model 157) functionality	Not supported	Not supported	Not supported	Not supported	Supported	Supported
Online editing of sequence tables	Not supported	Supported	Supported	Supported	Supported	Supported
Displaying PVs and changing SPs for timers and counters in sequence tables	Not supported	Supported	Supported	Supported	Supported	Supported
Bank Selector block (Block Model 168) for PID constants	Not supported	Supported	Supported	Supported	Supported	Supported
Split Converter block (Block Model 169)	Not supported	Supported	Supported	Supported	Supported	Supported
Disturbance overshooting suppression for Basic PID (Block Model 011) and Advanced PID (Block Model 012)	Not supported	Supported	Supported	Supported	Supported	Supported

Item	Ver. 1.0	Ver. 1.5	Ver. 2.0	Ver. 3.0	Ver. 3.5	Ver. 3.6
MV Limit Alarm Stop switch and MV Alarm Control Stop switch for general Control blocks	Not supported	Supported	Supported	Supported	Supported	Supported
Easy backup of function block data from Loop Controller to Memory Card	Not supported	Not supported	Supported	Supported	Supported	Supported
Memory Card backup for tag settings, comments, and user link table connection information prepared using CX-Process Tool	Not supported	Not supported	Supported	Supported	Supported	Supported
First or second reference input match selection for Segment Program 2 (Block Model 157) start	Not supported	Not supported	Supported	Supported	Supported	Supported
Synchronization of Segment Program 2 (Block Model 157)	Not supported	Not supported	Supported	Supported	Supported	Supported
Hot start enabled time setting	Not supported	Not supported	Supported	Supported	Supported	Supported
Secondary loop anti-reset wind-up with cascade control	Not supported	Not supported	Supported	Supported	Supported	Supported
Added Split Converter block (Block Model 169) input range setting from 0.00 to 100.00%	Not supported	Not supported	Supported	Supported	Supported	Supported
Added field terminal blocks	---	---	AI 4-point Terminal (PTS51/52) AI 8-point Terminal (PTS55/56) AI 4-point Terminal (PDC55) AO 2-point Terminal (DA021) AI 4-point/AO 2-point Terminal (MAD42)	AI 2-point Terminal (PTS15/16, PDC15) AI 16-point Terminal (AD161)	In addition to the ones shown to the left, the following field terminal blocks were added: AI 4-point Terminal (PH41U)AI 4-point Terminal (AD04U)AI 4-point Terminal (ADG41)	---
Other added function blocks	Not supported	Not supported	Not supported	Switch Instrument block (Block Model 225)	---	---
Wireless debugging function (Allows the user to enter pseudo-inputs to a function block's PVs from the CX-Process Tool or HMI I/F.)	Not supported	Not supported	Not supported	Supported	Supported	Supported
MV tight shut function (An analog output terminal can be a tight shut output to the CPU Unit's I/O memory from a user link table.)	Not supported	Not supported	Not supported	Supported	Supported	Supported
MV analog output reversing function (A field terminal (analog output terminal) can be inverted to the CPU Unit's I/O memory from a user link table.)	Not supported	Not supported	Not supported	Supported	Supported	Supported
RUN/STOP function (Can execute a RUN or STOP command for only one PID function, either the Basic PID (Block Model 011) or Advanced PID (Block Model 012)).	Not supported	Not supported	Not supported	Supported	Supported	Supported

Item	Ver. 1.0	Ver. 1.5	Ver. 2.0	Ver. 3.0	Ver. 3.5	Ver. 3.6
Switch control action direction function (Can switch the control action direction when operating the Basic PID block (Block Model 011) or Advanced PID (Block Model 012) in Auto mode.)	Not supported	Not supported	Not supported	Supported	Supported	Supported
Reference sequence table function (Can reference another table's condition judgment in the Sequence Table block (Block Model 302).)	Not supported	Not supported	Not supported	Supported	Supported	Supported
Added timer function (Can specify a TIM (timer) command in the Step Ladder block (Block Model 301).)	Not supported	Not supported	Not supported	Supported	Supported	Supported
Pulse output function (Can generate a pulse output (ON for 1 refresh cycle) in the user link table.)	Not supported	Not supported	Not supported	Supported	Supported	Supported
Expanded user link table EM specification (EM banks other than EM bank 0 (EM0) can be specified as data areas in the user link table.)	Not supported	Not supported	Not supported	Supported banks EM1 to EMC can be specified.	Supported banks EM1 to EMC can be specified.	Supported banks EM1 to EMC can be specified.
Number of constants that can be set for the Constant ITEM Setting (Block Model 171) increased from 8 maximum to 16 maximum.	Not supported	Not supported	Not supported	Supported	Supported	Supported
Including block diagram information, tags, comments, and annotation data in easy backup data along with function block data	Not supported	Not supported	Not supported	Supported	Supported	Supported
Changing the data that is backed up for easy backup function from RAM data to flash memory data	Not supported	Not supported	Not supported	Supported	Supported	Supported

**Note** When using function component version 3.6 for LCB01, LCB03, or LCB05, use the CX-One Auto Update function to update the CX-Process Tool Software to version 5.23 or higher.

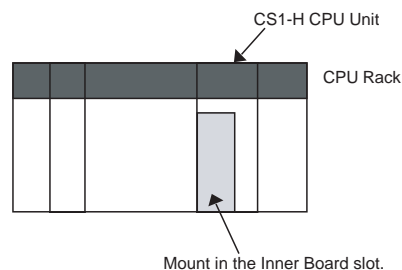
## 1-2 Configuration of Instrumentation System

### 1-2-1 Mounting Location

#### Loop Control Boards

##### CS1W-LCB01 Loop Control Board

The CS1W-LCB01 Loop Control Board is a non-duplex Inner Board for the CS-series PLCs. It can be mounted in a CS1-H CPU Unit. It is not supported by and cannot be mounted in a CS1 CPU Unit.



**Mountable CPU Unit Models**

Loop Control Board	Inner Board type	PLC Series	CPU Unit model
CS1W-LCB01	Non-duplex standard	CS	CS1H-CPU □□H CS1G-CPU□□H

**CS1W-LCB05 Loop Control Board**

The CS1W-LCB05 Loop Control Board is a non-duplex Inner Board for the CS-series PLCs. It can be mounted in a CS1-H CPU Unit. It is not supported by and cannot be mounted in a CS1 CPU Unit.

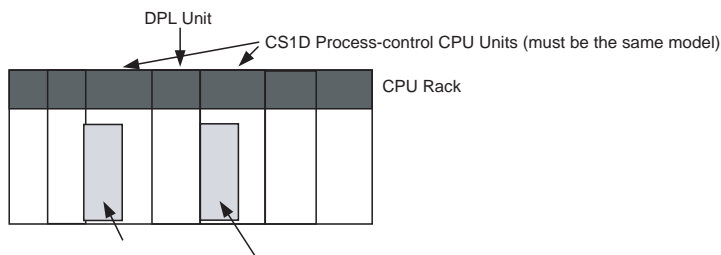
**Mountable CPU Unit Models**

Loop Control Board	Inner Board type	PLC Series	CPU Unit model
CS1W-LCB05	Non-duplex special	CS	CS1H-CPU □□H CS1G-CPU□□H

**Process-control CPU Units**

The functions of Duplex Loop Control Board are built into the Inner Board of the Process-control CPU Unit (CS1D-CPU□□P), so there is no need to mount a separate Loop Control Board.

An Inner Board that is removed from one Unit cannot be mounted in any other CS1D CPU Unit. Normal operation may not be possible if the Board is installed in another CPU Unit.



Duplex Loop Control Boards are mounted in the Inner Board slots of the CS1D Process-control CPU Units. Do not remove these Boards.

The Loop Control Board mounted in the active CPU Unit is active, and the Loop Control Board mounted in the standby CPU Unit is the standby.

**CPU Units**

For duplex operation, always use two CS1D Process-control CPU Units of the same model mounted to a CPU Duplex Backplane.

CS1D Process-control CPU Units	Description
CS1D-CPU65P	Set consisting of the CS1D-CPU65H and the CS1D-LCB05D. Write ladder programs for the CS1D-CPU65H.
CS1D-CPU67P	Set consisting of the CS1D-CPU67H and the CS1D-LCB05D. Write ladder programs for the CS1D-CPU67P.

**Loop-control CPU Units**

A Loop Control Board is built into the Loop-control CPU Unit (CJ1G-CPU□□P), so there is no need to mount a Board.

**CPU Units**

Loop-control CPU Units	Description
CJ1G-CPU42P	CPU Unit with built-in Loop Control Board. Write ladder programs for the CJ1G-CPU42H.
CJ1G-CPU43/44/45P	CPU Unit with built-in Loop Control Board. Write ladder programs for the CJ1G-CPU43H/44H/45H.

**1-2-2 Determining the System Configuration**

Check the following points when determining the system configuration:

1,2,3...

**1. Number of Analog I/O Points Used on Loop Controller**

Which analog signals are input/output on the AI/AO terminals of the Field Terminal block, and which analog signals are input/output on the CPU Unit Terminal block or the Expanded CPU Unit Terminal block?

The total number of usable AI/AO terminals on the Field Terminal block combined with the DO/DI terminals is 80. (For details of the Unit types that can be used, see *1-2-3 Description of Basic System Configuration*.)

The maximum number of usable CPU Unit Terminal blocks is 16. (For details of I/O memory area that can be specified, see *3-3-3 Exchanging Data*.)

**2. Number of Contact I/O Points Used on Loop Controller**

Which contact signals are input/output on the DI/DO terminals of the Field Terminal block, and which contact signals are input/output on the CPU Unit Terminal block or the Expanded CPU Unit Terminal block?

The total number of DI/DO terminals on the Field Terminal block combined with the AO/AI terminals is 80 for the LCB01/05, 30 for the CJ1G-CPU42/43P, and 40 for the CJ1G-CPU44/45P. (For details of the Unit types that can be used, see *1-2-3 Description of Basic System Configuration*.)

The maximum number of usable CPU Unit Terminal blocks is 2,400. (For details of I/O memory area that can be specified, see *3-3-3 Exchanging Data*.)

**3. Current Consumption**

Is the current consumption of the Units mounted on the rack less than the current consumption of the Power Supply Unit?

Refer to *CS1-series Operation Manual* (Cat. No. W339), *2-6 Unit Current Consumption*.

**4. Evaluation of Load Rate**

The Loop Controller cyclically processes operation of its own function blocks asynchronously with I/O refreshing of the CPU Unit. The cycle by which operations are processed, or the "operation cycle," is dependent on the type and number of function blocks used.

For this reason, when many function blocks whose operation takes a long time to process are used, the actual operation cycle of the entire Loop Controller or an individual function block increases. As a result, the desired preset operation cycle sometimes cannot be satisfied.

The ratio between the actual execution time required for processing operation and the preset operation cycle is called the "load rate." The maximum values and current value of each operation cycle group can be confirmed on CX-Process Tool.

A load rate of 80% or less is required in all operation cycle groups on this Loop Controller.



**Note** The High Load Alarm Flag (A42408) turns ON if the load rate exceeds 80% for 6 seconds. If this happens, select the function blocks that can have longer operation cycles and increase their operation cycles. If the load rate is still too high, add on a CPU Unit or a CPU Unit and a Loop Control Unit and distribute function block processing between the mounted Units.

#### 5. CPU Unit Cycle Time and Minimum Operation Cycle (Process-control CPU Unit Only)

When the Process-control CPU Unit (CS1D-CPU□□P) is used, the CPU Unit cycle time must be considered in relation to the minimum operation cycle in relation to the load rates outlined above.

##### a. Effect on CPU Unit Cycle Time

Effect on Normal CPU Unit Cycle Time

The following table shows the extra time added to the normal CPU Unit cycle time when a Loop Controller is mounted.

Functional component	Extra time added to normal cycle time
Loop Control Board (CS1W-LCB01/05)	0.8 ms (depending on the function block data contents)
Loop Controller component in the Process-control CPU Unit (LCB05D)	25 ms max. (depending on the function block data contents)

#### Example of the Influence of the Process-control CPU Unit's Loop Controller on Normal Cycle Time

Function block and user link table operation cycle (See note (a).)	100 ms		
Number of function blocks	100	150	200
Number of user link tables	100	150	200
Load rate	39	55	71
Influence (ms) by 2-ms cycle time of ladder program (See note (b).)	+7.8	+10.5	+13.6
Influence (ms) by 19-ms cycle time of ladder program (See note (b).)	+10.3	+14.4	+20.8

**Note** (a) The influence of the function block and user link table operation cycle on the CPU Unit's cycle time is greatest when the function block and user link table operation cycle is 100 ms.

(b) The influence of the CS1D-LCB05D on the CPU Unit's cycle time is greatest when the cycle time of the CPU Unit is 19 ms.

(c) When sequence tables are used, the extra time in the above table is further extended. The additional extra time required depends on how the sequence tables are used, as follows:

- Not expanding sequence tables: +3 ms
- Expanding sequence tables vertically or horizontally: +6 ms
- Expanding sequence tables both vertically and horizontally: +12 ms

The extended cycle time will not be lengthened if the number of expanded sequence tables increases, but the number of times that the cycle time is extended will increase.

**b. Restrictions on Minimum Operation Cycle for Loop Controller Internal Function Blocks**

**The operation cycle must be a minimum of 5 times the CPU Unit cycle time.**

When the Process-control CPU Unit (CS1D-CPU□□P) is used, it is desirable to set the longest possible operation cycle to prevent errors in the operation cycle. However, the operation cycle for the internal function blocks of the Loop Controller component in the Process-control CPU Unit must be set to a minimum of 5 times the CPU Unit's normal cycle time. The normal cycle time is the cycle time other than during duplex initialization.

**Example:** If the CPU Unit cycle time is 40 ms, the minimum operation cycle for the function blocks in the Loop Controller component must be at least 200 ms (i.e., 200 ms, 500 ms, 1 s, or 2 s.)

If the CPU Unit's normal cycle time is longer than 1/5 the minimum operation cycle for the internal function blocks of the Loop Controller component in the Process-control CPU Unit, the error in the operation cycle will increase. The error can be an increase of up to one CPU Unit cycle time.

**Note** If the CPU Unit's normal cycle time is longer than 30% of the minimum operation cycle for the Loop Controller's internal function blocks for 3 consecutive cycles, Auxiliary Area bit A42409 (Operation Cycle Error) will turn ON. Monitor this flag from the CX-Process Tool system operation verification screen and if it turns ON, then set the Loop Controller's operation cycle to a minimum of 5 times the CPU Unit's normal cycle time.


**c. Effect on the Cycle Time of the CPU Unit and the Operation Cycle of the Process-control CPU Unit's Loop Controller during Duplex Initialization**

With the Process-control CPU Unit, a maximum of 152 seconds is required for duplex initialization. The CS1D CPU Units and the active Loop Control Board will operate during duplex initialization. The CPU Unit's cycle time and the Loop Controller's operation cycle, however, will be temporarily longer than normal. This increase in the cycle time and operation cycle will be the largest during the last cycle time during which duplex initialization is being performed. The increase will be the same for both the cycle time and the operation cycle.

Design the overall system so that no system errors will occur during an extended cycle time and operation cycle. Refer to *3-5 Duplex Operation of Loop Controllers* for details on duplex initialization.

**d. Details of Extended CPU Unit Cycle Time and Extended Operation Cycle**

- Duplex Initialization (Only in Duplex Mode)

 **Caution** When using the Process-control CPU Unit (CS1D-CPU□□P), both the CPU Unit cycle time and the Loop Controller component operation cycle will be temporarily longer than normal during Duplex Initialization (in Duplex Mode). There will be a temporary extension to the cycle time and operation cycle of a maximum of 2.1 s at a maximum of approximately 150 s after the start of duplex initialization. The extended cycle time and operation cycle may temporarily worsen the control characteristics, so verify the system's operation in trial operation before actually running the system.

- For Cycles Other Than the Last CPU Unit Cycle (150 s max. during Duplex Initialization)

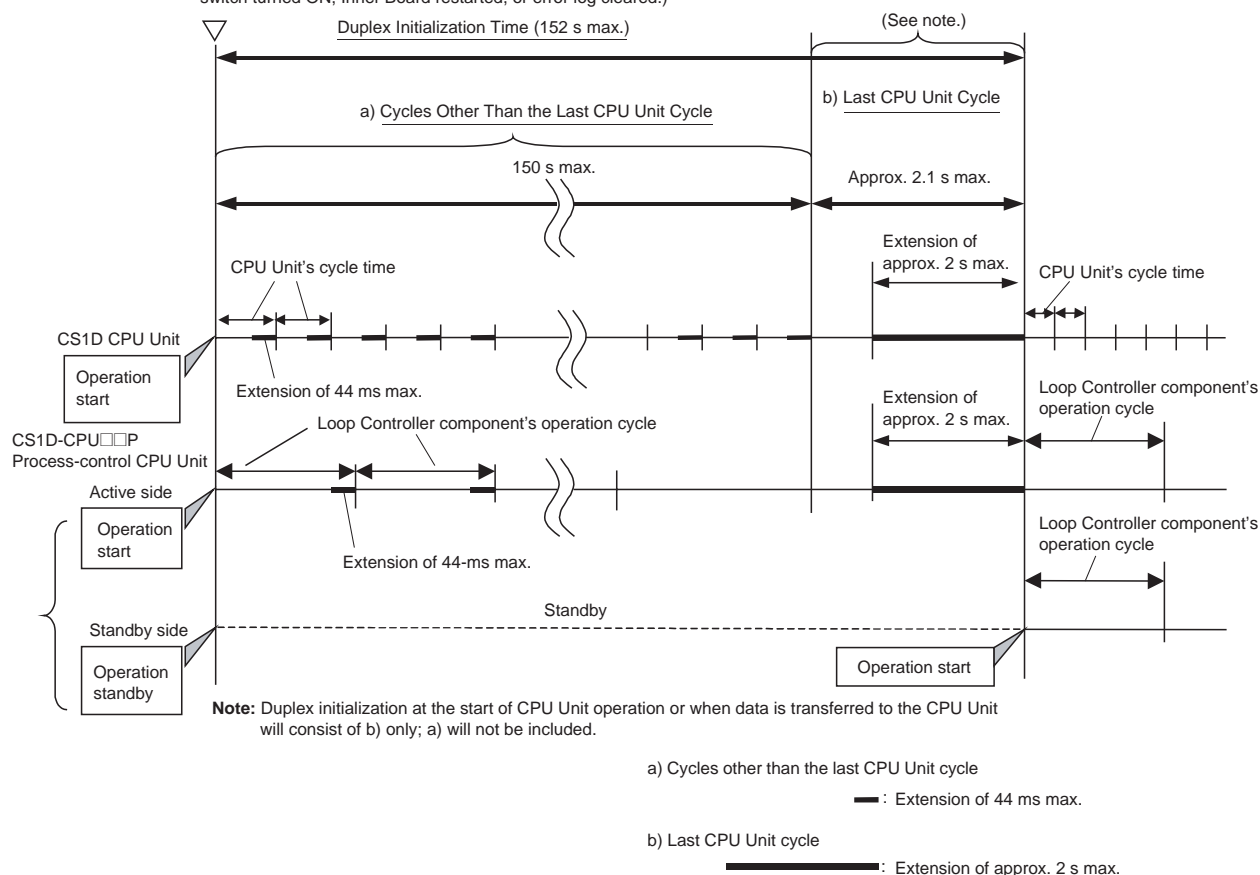
Situation		Extra CPU Unit Cycle Time and Duplex CS1D-LCB05D Operation Cycle Time
Operation on CPU Unit component	<ul style="list-style-type: none"> <li>• Power ON to PLC.</li> <li>• When the Duplex Unit's initialize switch is turned ON.</li> </ul>	44 ms max. (For both CS1D-CPU65H and CS1D-CPU67H)
Operation on Loop Controller component	Cold start command to Loop Controller component	
	Inner Board restart when A60800 turns ON.	
	When Loop Controller component's internal error history is cleared.	

- For the Last CPU Unit Cycle during Duplex Initialization

Situation		Extra CPU Unit Cycle Time and Duplex CS1D-LCB05D Operation Cycle Time
Operation on CPU Unit	<ul style="list-style-type: none"> <li>• Power ON to PLC.</li> <li>• When the Duplex Unit's initialize switch is turned ON.</li> <li>• When CPU Unit operation started.</li> <li>• When data transferred to CPU Unit (user programs, PLC Setup, I/O tables, CPU Bus Unit system settings area transfers, online editing, and timer/counter setting changes)</li> </ul>	CS1D-CPU65H: 1.83 s max. CS1D-CPU67H: 2.13 s max. The extra time depends on the contents of the LCB05D function block data, as shown in the following examples. Example 1: For 40 function blocks, 5 sequence tables, and 30 user link tables: CS1D-CPU65H: 0.40 s max. CS1D-CPU67H: 0.73 s max. Example 2: For 200 function blocks, 50 sequence tables, and 600 user link tables:
Operation on Loop Controller component	Cold start command to Loop Controller component	CS1D-CPU65H: 1.26 s max. CS1D-CPU67H: 1.59 s max.
	Inner Board restart when A60800 turns ON.	Example 3: For 500 function blocks, 200 sequence tables, and 2,400 user link tables: CS1D-CPU65H: 1.83 s max.
	When Loop Controller component's internal error history is cleared.	CS1D-CPU67H: 2.13 s max.

## Duplex Initialization Start

(Power to PLC turned ON, cold or hot start command executed, initialize switch turned ON, Inner Board restarted, or error log cleared.)



**Note** The time required for duplex initialization depends on the type of operation being performed, as shown in the following table.

Operation		Duplex initialization time
Operations for CPU Unit	Turning ON power to PLC	a) 150 s max. + b) 2.1 s max.
	Pressing initialization switch on Duplex Unit	
	Starting CPU Unit operation	Only b) 2.1 s max.
	Transferring data to CPU Unit	
Operations for Loop Controller component	Sending a cold or hot start command to the Loop Controller	a) 150 s max. + b) 2.1 s max.
	Restarting the Loop Controller component as an Inner Board	
	Clearing the error log in the Loop Controller	

## 6. Evaluation of External I/O Response Cycle (Dependent on CPU Unit's Cycle Time)

The operating speed (operation cycle) itself of each function block on the Loop Controller is not related to the CPU Unit's cycle time. However, as the CPU Unit's I/O memory is accessed during data exchange, for example, between Analog I/O Units and the Basic I/O Unit, the timing of data exchange is greatly influenced by the CPU Unit's cycle time.

The external analog I/O response cycle (equivalent to the I/O response cycle on a general controller) when the Loop Controller is configured as part

of an instrumentation system is not the same as the operation cycle of the function blocks; but is a cycle heavily dependent on the CPU Unit's cycle time.

In most cases, the maximum external analog I/O response cycle is as follows depending on the operation timing:

“approximately 2 times the CPU Unit's cycle time” + “approximately twice the operation cycles of the Loop Controller's function blocks”

So, when determining the system configuration, calculate how long the external analog I/O response cycle will be within the instrumentation system based upon factors such as the CPU Unit's cycle time and the operation cycles of the Loop Controller's function blocks. Also, assess whether or not there will be any problems when running applications at the analog I/O response cycle that you have calculated.

(For details on the relationship between the Loop Controller's operation cycles and the CPU Unit's cycle time, see 3-2 *Description of Operations*. For details on how to calculate the CPU Unit's cycle time, refer to the CS1-series *Operation Manual* (Cat. No. W339), 15-4 *Computing the Cycle Time*.)

## 7. Evaluation of Using Battery-free Operation for CPU Unit or CPU Unit Element

Battery-free operation cannot be used for the CS1-H CPU Unit or the CPU Unit element of a Process-control CPU Unit or Loop-control CPU Unit.

**⚠ WARNING** Do not use battery-free operation for the CS1-H CPU Unit or the CPU Unit element of a Process-control CPU Unit or Loop-control CPU Unit. If battery-free operation is used for the CPU Unit or CPU Unit element, the contents of the EM Area will not be stable when the power supply is turned ON, possibly causing illegal values in the HMI data in the Loop Controller.

## 1-2-3 Description of Basic System Configuration

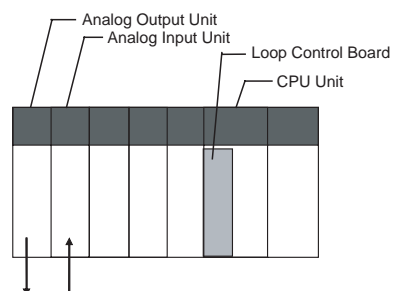
### Mounting of Units for External Analog I/O and Contact I/O

The Loop Controller does not have direct external analog I/O and contact I/O functions. External I/O is achieved via Analog I/O Units and Basic I/O Units mounted on a basic PLC System (see note). (It is also possible to handle I/O with external devices through DeviceNet Analog Slaves.)

**Note** CS Series: CPU Rack, Expansion Rack, Expansion I/O Rack for the C200H, or SYSMAC BUS Remote I/O Slave Rack  
CJ Series: CPU Rack or Expansion Rack

So, in the basic system configuration, Analog I/O Units (Analog Input Unit, Analog Output Unit, and Analog I/O Unit) must be mounted for the same PLC. (It is also possible to input and output data for Analog I/O Units on other nodes in a Controller Link or other network.)

A Basic I/O Unit must also be mounted for the same PLC as necessary.



**Input and Output of  
Analog Data**

The table below shows the Units with which the Loop Controller can exchange data without using user link tables. In data exchange with these Units, use the AI Terminal or AO Terminal blocks on the Field Terminal block that corresponds to the required Unit model as the Loop Controller's function blocks.

On the AI Terminal and AO Terminal blocks, set the unit number of the Analog I/O Unit to enable input/output of analog signals.

## CS Series

Unit information	Name	Specification	Model	Function block
CS-series Special I/O Unit	Analog Input/Output Unit	4 inputs (1 to 5 V, 4 to 20 mA, etc.) 4 outputs (1 to 5 V, 0 to 10 V, etc.)	CS1W-MAD44	AI 4-point/AO 4-point Terminal (Block Model 583)
	Analog Input Unit	4 inputs (1 to 5 V, 4 to 20 mA, etc.)	CS1S-AD041	AI 4-point Terminal (Block Model 586)
		8 inputs (1 to 5 V, 4 to 20 mA, etc.)	CS1S-AD081	AI 8-point Terminal (Block Model 584)
		16 inputs (1 to 5 V, 4 to 20 mA, etc.)	CS1W-AD161	AI 16-point Terminal (Block Model 582)
	Analog Output Unit	4 outputs (1 to 5 V/4 to 20 mA, etc.)	CS1W-DA041	AO 4-point Terminal (Block Model 587)
		8 outputs (1 to 5 V, etc.)	CS1W-DA08V	AO 8-point Terminal (Block Model 585)
		8 outputs (4 to 20 mA)	CS1W-DA08C	AO 8-point Terminal (Block Model 585)
	Isolated-type Thermocouple Input Unit	4 inputs (B, E, J, K, N, R, S, T, DC±80 mV)	CS1W-PTS01-V1	AI 4-point Terminal (Block Model 561)
		4 inputs (B, E, J, K, L, N, R, S, T, U, WRe5-26, PLII, mV)	CS1W-PTS11	Not supported
		4 inputs (K, J, L, R, S, T, B)	CS1W-PTS51	Ai 4-point Terminal (Block Model 566)
		8 inputs (K, J, L, R, S, T, B)	CS1W-PTS55	Ai 8-point Terminal (Block Model 568)
	Isolated-type Temperature-resistance Thermometer Input Unit	4 inputs (Pt100, JPt)	CS1W-PTS02	AI 4-point Terminal (Block Model 561)
		4 inputs (Ni508.4Ω)	CS1W-PTS03	AI 4-point Terminal (Block Model 561)
		4 inputs (Pt100, JPt100, Pt50, Ni508.4Ω)	CS1W-PTS12	Not supported
		4 inputs (Pt100, JPt100)	CS1W-PTS52	Ai 4-point Terminal (Block Model 567)
		8 inputs (Pt100, JPt100)	CS1W-PTS56	AI 8-point Terminal (Block Model 569)
	Isolated-type 2-lead Transmitter Input Unit	4 inputs (1 to 5 V, 4 to 20 mA), built-in power supply for 2-lead Transmitter	CS1W-PTW01	AI 4-point Terminal (Block Model 561)
	Isolated-type Analog Input Unit	4 inputs (1 to 5 V, 4 to 20 mA, etc.)	CS1W-PDC01	AI 4-point Terminal (Block Model 561)
		4 inputs (1 to 5 V, 4 to 20 mA, etc.)	CS1W-PDC11	Not supported
		8 inputs (1 to 5 V, 4 to 20 mA, etc.)	CS1W-PDC55	AI 8-point Terminal (Block Model 570)
	Isolated-type Analog Output Unit (Analog Output Unit)	4 outputs (1 to 5 V, 4 to 20 mA)	CS1W-PMV01	AO 4-point Terminal (Block Model 563)
		4 outputs (−10 to 10 V, 0 to 10 V, −5 to 5 V, 1 to 5 V, −1 to 1 V, 0 to 1 V)	CS1W-PMV02	AO 4-point Terminal (Block Model 565)
	Power Transducer Input Unit	8 inputs (−1 to 1 mA, 0 to 1 mA)	CS1W-PTR01	AI 8-point Terminal (Block Model 564)
	Analog Input Unit (100 mV)	8 inputs (−100 to 100 mA, 0 to 100 mA)	CS1W-PTR02	AI 8-point Terminal (Block Model 564)
	Isolated-type Pulse Input Unit	4 pulse inputs (0 to 20 Kpulses/s, 0 to 20 pulses/s)	CS1W-PPS01	PI 4-point Terminal (Block Model 562)

Unit information	Name	Specification	Model	Function block
C200H Special I/O Unit	Analog Input Unit	8 inputs (select from 1 to 5 V, 4 to 20 mA, 0 to 10 V, or -10 to 10 V), Resolution: 1/4000	C200H-AD003	AI 8-point Terminal (Block Model 551)
	Analog Output Unit	8 outputs (select from 1 to 5 V, 0 to 10 V, or -10 to 10 V), Resolution: 1/4000	C200H-DA003	AO 8-point Terminal (Block Model 552)
		8 outputs (4 to 20 mA), Resolution: 1/4000	C200H-DA004	AO 8-point Terminal (Block Model 552)
	Analog Input/Output Unit	2 inputs (1 to 5 V, 4 to 20 mA, etc.) 2 outputs (1 to 5 V, 4 to 20 mA, etc.)	C200H-MAD01	AI 2-point/AO 2-point Terminal (Block Model 553)

**Note** In the case of an analog output Field Terminal block, select the function block according to the Unit model.

### CJ Series

Name	Specification	Model	Function block
Analog Input/Output Unit	4 inputs (1 to 5 V, 4 to 20 mA, etc.) 2 outputs (1 to 5 V, 0 to 10 mA, etc.)	CJ1W-MAD42	AI 4-point/AO 2-point Terminal (Block Model 583)
Analog Input Unit	4 inputs (1 to 5 V, 4 to 20 mA, etc.)	CJ1W-AD041-V1	AI 4-point Terminal (Block Model 586)
	4 inputs (1 to 5 V, 4 to 20 mA, etc.)	CJ1W-AD081-V1	AI 8-point Terminal (Block Model 584)
	4 inputs (high-speed model) (1 to 5 V, 4 to 20 mA, etc.)	CJ1W-ADG41	AI 4-point Terminal (Block Model 581)
Analog Output Unit	4 outputs (1 to 5 V/4 to 20 mA, etc.)	CJ1W-DA041	AO 4-point Terminal (Block Model 587)
	8 outputs (1 to 5 V, etc.)	CJ1W-DA08V	AO 8-point Terminal (Block Model 585)
	8 outputs (4 to 20 mA)	CJ1W-DA08C	AO 8-point Terminal (Block Model 585)
	2 outputs (1 to 5 V/4 to 20 mA, etc.)	CJ1W-DA021	AO 2-point Terminal (Block Model 591)
Isolated-type Thermocouple Input Unit	4 inputs (B, E, J, K, L, N, R, S, T, U, WRe5-26, PLII, mV)	CJ1W-PTS51	AI 4-point Terminal (Block Model 566)
	2 inputs (B, E, J, K, L, N, R, S, T, U, WRe5-26, PLII)	CJ1W-PTS15	AI 2-point Terminal (Block Model 571)
Isolated-type Temperature-resistance Thermometer Input Unit	4 inputs (Pt100, JPt)	CJ1W-PTS52	AI 4-point Terminal (Block Model 567)
	2 inputs (Pt100, JPt100, Pt50, Ni508.4)	CJ1W-PTS16	AI 2-point Terminal (Block Model 571)
	2 inputs (1 to 5 V, 4 to 20 mA)	CJ1W-PDC15	AI 2-point Terminal (Block Model 571)
Isolated-type High-resolution Input Unit with Fully Universal Inputs	4 inputs (K, J, T, E, L, U, N, R, S, B, WRe5-26, PLII, Pt100 (JIS, IEC 3-wire), JPt100 (3-wire), Pt1000 (3-wire), Pt100 (3-wire), Pt100 (JIS, IEC 4-wire), 4 to 20 mA, 0 to 20 mA, 1 to 5 V, 0 to 1.25 V, 0 to 5 V, 0 to 10 V, $\pm 100$ mV, -1.25 to 1.25 V, -5 to 5 V, -10 to 10 V)	CJ1W-PH41U	AI 4-point Terminal (Block Model 572)
Isolated-type General-purpose Input Unit with Fully Universal Inputs	4 inputs (K, J, T, L, R, S, B, Pt100, Pt1000, JPt100, 4 to 20 mA, 0 to 20 mA, 1 to 5 V, 0 to 5 V, 0 to 10 V)	CJ1W-AD04U	AI 4-point Terminal (Block Model 573)

**Note** In data exchange above, the Loop Controller handles analog I/O signals not in engineering units but in percentage units. For example, the data 0000 to 0F0A (FF38 to 1068) Hex from the Analog Input Unit for input 4 to 20 mA (3.2 to



20.8 mA) are converted to 0.00 to 100.00 (-5.00 to 105.00)% before they are processed by the Loop Controller.

These percentage unit values are scaled to engineering units values using SCADA software.

**⚠ WARNING** When the Field Terminal block is used for analog I/O, the unit number set on the Field Terminal block must match the unit number set on the Analog I/O Unit front panel. Otherwise, input/output (read/write) operations will be performed by mistake on the data of another Special I/O Unit (having the unit number set on the field terminals).

- Note**
1. With a User Link Table Read (Rd) tag, the word data is interpreted as decimal data and the user can freely specify the range that determines which value is equivalent to 0% and which value is equivalent to 100%. For example, if a range of 0 to 4,000 (0000 to 0FA0 Hex) is specified for inputs from the CPU Unit, I/O memory word contents between 0000 and 0FA0 will be converted to the range 0.00 to 100.00% and then input.
  2. Conversely, with a User Link Table Write (Wr) tag, the user can specify the value to which 0% will be converted and the value to which 100% will be converted. For example, if a range of 0 to 4,000 (0000 to 0FA0 Hex) is specified for outputs to the CPU Unit, outputs in the range 0.00 to 100.00% will be converted to values between 0000 and 0FA0 and then output to I/O memory words in the CPU. In the SCADA software, these percentage units scale the output to the desired industrial units.

### Input and Output of Contacts

The Loop Controller can exchange contacts (bit data) with the Basic I/O Unit or the Contact I/O Unit of the Special I/O Unit. In data exchange with these Units, use the DI Terminal and DO Terminal blocks on the Field Terminal block having the corresponding number of contact I/O points.

On the DI Terminal and DO Terminal blocks, set the leading allocated address of the Contact I/O Unit for performing contact I/O operations.

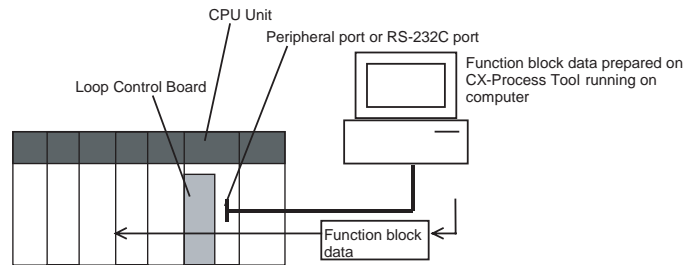
Unit	I/O	Number of points	Function block
Contact Input Unit	I	8	DI 8-point Terminal (Block Model 501)
		16	DI 16-point Terminal (Block Model 502)
		32	DI 32-point Terminal (Block Model 503)
		64	DI 64-point Terminal (Block Model 504)
Contact Output Unit	O	5	DO 5-point Terminal (Block Model 511)
		8	DO 8-point Terminal (Block Model 512)
		12	DO 12-point Terminal (Block Model 513)
		16	DO 16-point Terminal (Block Model 514)
		32	DO 32-point Terminal (Block Model 515)
		64	DO 64-point Terminal (Block Model 516)
Contact I/O Unit	I/O	16/16	DI 16-point/DO 16-point Terminal (Block Model 518)

**Note** In the case of a contact I/O Field Terminal block, select the function block not according to Unit model but according to the number of contact I/O points.

- Note**
1. When user link tables are used to exchange data with the Contact I/O Unit allocated CIO Area, data exchange functionally is the same as when the Field Terminal blocks are used to perform data exchange.

2. Do not write to the same I/O memory addresses when exchanging data between the Loop Controller and the CPU Unit.

### **Connecting to CX-Process Tool**



The Loop Controller achieves all functions by combining function blocks. Function block data must be prepared on CX-Process Tool and then downloaded to the Loop Controller for use.

The tag settings for SCADA software must also be prepared on CX-Process Tool.

CX-Process Tool runs on a computer that is connected to the peripheral port or RS-232C port of the CPU Unit. (The Host Link can be used in the serial communications mode but not on the Peripheral bus.)

CX-Process Tool is installed on a computer on which the Controller Link Support Board is mounted, and function block data can be downloaded from CX-Process Tool to the Loop Controller via the Controller Link.

### **Transferring Data to and from SCADA Software**

#### **Read and Writing Control, Operation, and External Controller Block ITEMS (HMI Data)**

The following methods can be used to read and write Loop Controller data with commercially available SCADA software.

#### **Reading Data**

The HMI function is used to transfer specific ITEMS (HMI data) in Control Blocks, Operation Blocks, and External Controller Blocks to the specified words in I/O memory in the CPU Unit. SCADA software is then used to read the data from the I/O memory of the CPU Unit.

#### **Writing Data**

SCADA software is used to write data to words in the I/O memory of the CPU Unit. The HMI function is then used to transfer specific ITEMS (HMI data) in Control Blocks, Operation Blocks, and External Controller Blocks from the specified words in I/O memory to the Loop Controller.

#### **Read and Writing Other Data**

#### **Reading Data**

User link tables are used to transfer the specified ITEMS in to specified words in I/O memory in the CPU Unit. SCADA software is then used to read the data from the I/O memory of the CPU Unit.

#### **Writing Data**

SCADA software is used to write data to words in the I/O memory of the CPU Unit. User link tables are then used to transfer the specified ITEMS from the specified words in I/O memory to the Loop Controller.

## 1-3 Specifications

### 1-3-1 General Specifications

These specifications conform to the general specifications of the SYSMAC CS-series.

### 1-3-2 Specifications

Item		Specification
Product name		Loop Control Board, Process-control CPU Unit, Loop-control CPU Unit
Model numbers	Non-duplex Inner Boards	Loop Control Board: CS1W-LCB01 and CS1W-LCB05 Loop-control CPU Unit: CJ1G-CPU□□P
	Duplex Inner Boards	Process-control CPU Unit: CS1D-CPU□□P
Applicable CPU Units	CS1W-LCB01	CS1G/H-CPU□□H
	CS1W-LCB05	CS1D-CPU□□S (supported for Loop Control Board version 1.5 or later only)
	Process-control CPU Unit	CS1D-CPU Unit with built-in Duplex Loop Controller
Unit classification		CS-series Inner Board
Data exchange method with CPU Unit	Words in Auxiliary Area in CPU Unit	Loop Controller → CPU Unit: Operation status, PV error input ON, MV error input ON, occurrence of execution error, function block database error, cold start ready for hot start command, flash memory backup in progress, function blocks changed, etc. CPU Unit → Loop Controller: Hot/cold start command at power ON (Not supported for CS1D-CPU□□P.)
	Allocated Words to Inner Board in CIO Area of CPU Unit	Not used
	Allocated Words to Inner Board in DM Area of CPU Unit	Not used
	User allocations in I/O memory	User memory tables used to allocate function block ITEM data for user-specified memory in the CPU Unit (CIO, Work, HR, DM, or EM Area (bank 0, but also banks 1 to 12 for Ver. 3.0 or later)).
	EM Area (bank number) allocations (for SCADA software)	HMI function used allocate function block ITEM data for Control, Operation, External Controller, and System Common blocks in the specified bank of the EM Area in the CPU Unit. The real PV in calibration mode can be allocated (Ver. 3.0 or later).
Setting		None
Indicators		Loop-control CPU Units: 2 LEDs (RUN and ready) Other Controllers: 3 LEDs: RUN, ready, and communications port send/receive
Front panel interface		RS-232C port x 1 (Used for connection to ES100X Controller.) (Not supported by Loop-control CPU Units and Process-control CPU Units.)
Super capacitor backup data		All function block data (including Step Ladder Program commands), stored error log data
Super capacitor backup time		CS Series (CS1W-LCB01/05 or CS1D-CPU□□P): 24 hours at 25°C (life shortened by use at higher temperatures) CJ Series (CJ1G-CPU□□P): 5 min at 25°C (Backed up by the Battery in the CPU Unit.)
Data stored in flash memory		Function block data
Backup from RAM to flash memory		Executed from CX-Process Tool (as required).

Item	Specification
Recovery from flash memory to RAM	Automatic at power ON if startup mode is set for a cold start, or executed from CX-Process Tool (as required).
Influence on CPU Unit cycle time	Loop Control Boards (CS1W-LCB01/05): 0.8 ms max. (Depends on function block contents.) Process-control CPU Units (CS1D-LCB05D): 25 ms max. (Depends on function block contents.) For details, refer to <i>Example of the Influence of the Process-control CPU Unit's Loop Controller on Normal Cycle Time</i> on page 41. Loop-control CPU Unit (CJ1G-CPU□□P): 0.8 ms max. (Depends on function block contents.)
Current consumption (supplied from Power Supply Unit)	Loop Control Board: 0.22 A at 5 V DC Process-control CPU Unit (CPU Unit element): 0.82 A at 5 V DC Loop Control element: 0.22 A at 5 V DC Loop-control CPU Unit: 1.06 A at 5 VDC Note: Increased by 150 mA when NT-AL001 Link Adapter is used.
Standard accessories	None

### 1-3-3 Function Specifications

Item	Description			
Operation method	Function block method			
Number of function blocks	Total CS1W-LCB01: 103 blocks max., CS1W-LCB05: 733 blocks max., CS1D-CPU□□P: 701 blocks max., CJ1G-CPU42P: 71 blocks max., CJ1G-CPU43/44/45P: 501 blocks max.			
	Analog operation	Control Blocks	PID and other control functions	LCB01: 50 blocks max., LCB03: 300 blocks max., LCB05/05D: 500 blocks max.
		Operation Blocks	Alarm, square root operation, time operations, pulse train operation, and other operation functions for various processes	
		External Controller Block	Monitoring and setting functions for external controllers	32 blocks max. (Cannot be used for CS1D-CPU□□P, CJ1G-CPU□□P.)
	Sequential Control	Sequence tables	Logic sequence and step sequence functions (CS1W-LCB05 and CS1D-CPU□□P only)	Totals 32 x 200 rules max., 1 block/32 rules max., 32 conditions and 32 actions per rule max.
		Step Ladder Program block	Logic sequence and step sequence functions	4,000 commands max. 100 commands/1 block max. Can be divided into 100 steps max. 100 commands/1 step max.
	I/O block	Field Terminal block	Analog I/O function with Analog I/O Unit, contact I/O function with Basic I/O Unit	80 blocks max.
		User link tables	Analog data I/O and contact data I/O function for CPU Unit Can be added to CSV tags.	2,400 data max.
		HMI function	I/O function for function block ITEM data for Control, Operation, External Controller, and System Common blocks for CPU Unit	Control/Operation Blocks LCB01: 50 blocks max. + 20 send/receive words LCB03: 300 blocks max. + 20 send/receive words LCB05/05D: 500 blocks max. + 20 send/receive words External Controller Blocks CS1W-LCB01/05: 32 blocks max. + 20 send/receive words (Cannot be used for the CS1D-CPU□□P, CJ1G-CPU□□P.) System Common Block 20 send/receive words Real PV Input Monitor Area LCB01: 50 words max. LCB03: 300 words max. LCB05: 500 words max.
	System Common block		System common operation cycle setting, run/stop command, load rate monitor, etc.	Single block
Function block data preparation/download	Function block data prepared by CX-Process Tool (sold separately) and downloaded to Loop Controller			

Item			Description
Execution of function blocks	Function block execution conditions	Common to all function blocks	<ul style="list-style-type: none"><li>- Operation of all function blocks by turning power ON to the PLC (Hot or cold start can be specified.) For cold starts, function block data is transferred from flash memory to RAM.</li><li>- Function block operation can be stopped by CX-Process Tool or FINS command.</li><li>- Hot start (state active before Board was stopped is continued before operation is started) or cold start (all state signals and function block internally held values are cleared before operation is started) is possible by CX-Process Tool or FINS command.</li></ul>
		For individual function block	<ul style="list-style-type: none"><li>- Function block operation can be stopped and hot start (state active before Unit was stopped is continued before operation is started) is possible CX-Process Tool or FINS command.</li></ul>
	Function block operation cycle		<p>Standard: Operation of all function blocks is executed at the same operation cycle preset to ITEM 004 in the System Common block.</p> <p>Settable operation cycles: 0.1 s, 0.2 s, 0.5 s, 1 s, 2 s (default: 1 s)</p> <p><b>Note:</b> Cannot be set to the same operation cycle for some function blocks.</p> <p>Option: Operation of individual function blocks is executed at the same operation cycle preset to ITEM 004 in the System Common block.</p> <p>Settable operation cycles: 0.01 seconds<sup>*1</sup>, 0.02 seconds<sup>*1</sup>, 0.05 seconds<sup>*1</sup>, 0.1 seconds, 0.2 seconds, 0.5 seconds, 1 second, and 2 seconds (default: 1 second)</p> <p><sup>*1</sup>: When LCB05D is used, 0.01 seconds, 0.02 seconds, and 0.05 seconds cannot be set. The function block operation cycle must be set to a minimum of 5 times the mounted CS1D CPU Unit's cycle time when the CS1D-CPU□□P is used.</p> <p><b>Note:</b> The external I/O response cycle on a single control loop does not necessarily match the operation cycle. The response cycle is heavily dependent on the CPU Unit's cycle time. (See the external I/O response cycle item below.)</p>
	Function blocks supporting high-speed operation (Not supported for the CS1D-LCB05D.)		<p>The following operation cycles can be set for the blocks listed below: 0.01, 0.02, and 0.05 s.</p> <p>Control/Operation blocks: Block Models 016, 150, 151, 155 to 157, 167, 182 to 184, 186, and 221 to 224</p> <p>Sequence control and Field Terminal blocks</p> <p>Refer to note after table in <i>1-1-13 List of Function Blocks</i>.</p>
	LCB load rate		<p>The “LCB load rate” refers to the ratio between the actually applied execution time and preset operation cycle.</p> <p>The maximum value and current value are displayed for each operation cycle group on the CX-Process Tool.</p> <p>A LCB load rate of 80% or less is required in all operation cycle groups.</p> <p>When the load rate exceeds 80% for 6 seconds, the LCB load rate automatically changes to the next longer operation cycle. (This is called the “automatic operation cycle switching function.”)</p> <p><b>Note:</b> The High Load Alarm Flag (A42408) turns ON if the load rate exceeds 80% for six seconds consecutively (non-fatal Inner Board error). (If execution is not possible within the operation cycle, the operation cycle will be extended.) If this happens, select the function blocks that can have longer operation cycles and increase their operation cycles. If the load rate is still too high, processing of the function blocks must be separated for processing by additional Loop Control Units.</p>
External I/O response cycle			The time from external input of analog signals up to external output of analog signals on a single control loop depends on the function block's operation cycle and the CPU Unit's cycle time.

Item			Description		
Internal Operation	Number of control loops		The maximum number of loops that can be used if the LCB load rate is 80% for a standard applications (e.g., with each loop consisting of one Ai4 Terminal, Segment Linearizer, Basic PID, and A04 terminal) is shown in the following table.		
			CS1W-LCB01/05 (LCCB01/05)		
			Operation cycle: Maximum number of loops		
			0.01 s: 20 loops	0.02 s: 35 loops	0.05 s: 70 loops
			0.1 s: 100 loops	0.2 s: 180 loops	0.5 s: 250 loops
			1 s: 250 loops	2 s: 250 loops	
			CS1D-CPU□□P (LCB05D)		
			Operation cycle: Maximum number of loops		
			0.1 s: 80 loops	0.2 s: 140 loops	0.5 s: 250 loops
			1 s: 250 loops	2 s: 250 loops	
CJ1W-CPU43P/44P/45P (LCB03)					
Operation cycle: Maximum number of loops					
0.01 s: 20 loops	0.02 s: 35 loops	0.05 s: 70 loops			
0.1 s: 100 loops	0.2 s: 150 loops	0.5 s: 150 loops			
1 s: 150 loops	2 s: 150 loops				
CJ1W-CPU42P (LCB01)					
Operation cycle: Maximum number of loops					
0.01 s: 20 loops	0.02 s: 25 loops	0.05 s: 25 loops			
0.1 s: 25 loops	0.2 s: 25 loops	0.5 s: 25 loops			
1 s: 25 loops	2 s: 25 loops				
	Number of operations for process (excluding control)	LCB01: Max. 50 blocks LCB03: Max. 30 blocks LCB05: Max. 500 blocks			
	Sequential control (Use only one or the other)	Step ladders	LCB01: 20 blocks per Board and total max. 2,000 commands per Board LCB03/05/05D: 200 blocks per Board and total max. 4,000 commands per Board Loop Controllers common: Divisible to 100 commands max. per block and 100 steps max. per block (100 commands max. per step)		
		Sequence tables	Sequence tables: 200 max. (LCB05 and 05D only)		
Control method	PID control	PID with two degrees of freedom			
	Possible control type combinations	Basic PID control, cascade control, feedforward control, sample PI control, dead time compensation, PID control with differential gap, override control, program control, time-proportional control and other control types can be achieved by combining function blocks.			
Alarm	Integrated into PID block	4 PV alarms (high/high limit, high limit, low limit, low/low limit) per PID block, 1 deviation alarm			
	Alarm block	High/Low Alarm block, Deviation Alarm block			
Internal analog signal			Min. -320.00% to max. +320.00% Scaling of the engineering units depends on the CX-Process Tool (sold separately).		
Operating status monitor method			Executed by commercially available SCADA software. In the SCADA software, tags set on the CX-Process Tool are specified.		

Item		Description	
External I/O	External I/O signals	By data exchange with Analog I/O Unit via the Field Terminal block	Total number of I/O points: (max. 8 points on Analog Input Unit or Analog Output Unit, or max. 96 points on Basic I/O Unit) x 80 blocks
	External contact I/O signals	By data exchange with Basic I/O Unit via the Field Terminal block	
	CPU Unit analog data I/O	By data exchange with CPU Unit I/O memory via user link tables	Total number of I/O points: 2,400
	CPU Unit contact data I/O	By data exchange with CPU Unit I/O memory via user link tables	
	Analog/contact I/O with SCADA software	Data transfer between Loop Controller and I/O memory in CPU Unit for Control, Operation, and External Controller blocks using HMI function	CS1W-LCB05: 19,660 CS1W-LCB01: 2,560 CJ1G-CPU42P: 2,040 CJ1G-CPU43/44/45P: 12,040
	FINS command to Loop Controller	Read/write of ITEMS in Loop Controller function blocks and execution of run/stop commands are possible from the CPU Unit (including other networked nodes) or host computer by issuing the following FINS commands to the Loop Controller. - READ MULTIPLE ITEMS IN FUNCTION BLOCK (0240 HEX) - WRITE MULTIPLE ITEMS IN FUNCTION BLOCK (0241 HEX) - READ ITEM IN MULTIPLE FUNCTION BLOCKS (0242 HEX) - WRITE ITEM IN MULTIPLE FUNCTION BLOCKS (0243 HEX) - READ UNIT INFORMATION (0501 HEX) - ECHOBACK TEST (0801 HEX) - READ ERROR LOG (2102 HEX) - CLEAR ERROR LOG (2103 HEX)	
System common status signals	Status output signal for sequence control	Constantly ON flags, constantly OFF flags, clock pulse (ON/OFF every 0.5 and 1 seconds)	
	Clock timing output signal	Differential output at 00:00 every day, noon every day, every 10 minutes, every minute and every 10 seconds <b>Note:</b> The CPU Unit's clock data are read as these clock data.	
	Calendar/clock output signal	Year, year/month, month/hour, day/time, hour/minute and minute/second <b>Note:</b> The CPU Unit's clock data is read as these clock data.	
Error display		By front panel indicators: hardware test error, function block database error, battery error Storage of function block execution-related error codes to ITEM 003 of each function block: source/destination designation error, illegal function block combination, illegal parameter, etc.	



### 1-3-4 Outline of PID Block Specifications

This item mainly describes an outline of the PID block specifications.

In the Basic PID block (Block Model 011) and Advanced PID block (Block Model 012), the functions are set to ON and OFF. For actual details on each ITEM setting, see the descriptions for each block.

○: supported, ×: not supported

Item		Description	Basic PID	Advanced PID
Operation cycle		Depends on operation cycle set for each block (0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, or 2 s) (0.01, 0.02, and 0.05 s are not supported for the CS1D-LCB05D.)	○	○
PV (Process Variable) Input	Number of points	1	○	○
	Input Range	–15.00 to +115.00%		
	Operation function	None (Calculation of square root, first-order lag, bias, etc. is required by external blocks.)		
	Sampling cycle	According to the specified operation cycle of this block (one of 0.1, 0.2, 0.5, 1, 2 seconds or 1 to 128 seconds)		
	PV error input	When the PV error contact turns ON, the Loop Controller is forced to enter the Manual mode, and the MV value active at that moment is held. At the same time, the PV error is transferred to the SCADA software or other device.		
SP (Set Point)	Number of points	1	○	○
	Setting range	–15.00 to +115.00%		
	Remote/Local switching	Possible		
	SP rate-of-change limiter	Possible (0 to 115.00%/s)	×	○
	PV tracking	Match the SP (Set Point) to the PV (Process Variable) if the Loop Controller is in the Local and Manual modes when PV tracking is set to ON.	○	○
	Bumpless processing between primary/secondary loops	When the local node is performing cascade control as the secondary controller, processing is performed on the MV of the primary controller to be input.		
Deviation	PV compensation	Arithmetic operation (addition, subtraction, substitution) is performed on the PV signals to be input to the PID control section when the PV compensation input switch is ON.	×	○

Item		Description	Basic PID	Advanced PID
PID Control	Control method	Advanced PID (Various PID methods (proportional priority type, PV differential priority type, deviation differential type, etc.) can be selected according to the settings of parameters a and b.)	○	○
	RUN/STOP	A contact input (RUN/STOP switch) can be used to start/stop PID calculations for each function block (LCB01/03/05 Ver. 3.0 or later).		
	Control action	Direct/reverse switchable Note: The control action can be changed during operation (LCB01/03/05 Ver. 3.0 or later).		
	PID constants	1 set		
		Automatic setting (AT: auto-tuning) by the limit cycle mode is possible.		
		Proportional band: 0.1 to 999.9% (0.1% increments)		
		Integral time: 0 to 9999 s. (1 second increments) 0: No accumulator Integral stop can be indicated from external contacts. Differential time: 0 to 9999 s. 0: No differentiation		
		High-speed control supported: If the operation cycle is set to 0.01, 0.02, or 0.05 s, the integral and derivative times are set in units of 0.01 s. Integral time: 0.00 to 99.99 s (unit: 0.01 s) Derivative time: 0.00 to 99.99 s (unit: 0.01 s)		
	Manual reset	–320.00 to 320.00 (0.01% increments)	○	○

Item		Description	Basic PID	Advanced PID
MV (Manipulated Variable)	Number of points	1 set	x	○
	Output range	–320.00 to +320.00%		
	Output refresh cycle	According to the specified operation cycle of this block (one of 0.1, 0.2, 0.5, 1, 2 seconds)		
	Auto/manual switching	Possible (according to CX-Process Tool or contact signal from Sequence Table block/Step Ladder Program block/Contact Distributor block)		
	High/low MV limit	High limit: –320.00 to +320.00%, low limit: –320.00 to +320.00%		
	MV high rate-of-change limit	0 to 115.00%/s		
	Preset MV switching	When the preset MV switch is set to ON, the MV switches to the preset MV (fixed value) and control is continued at this value.		
	MV hold	The MV (Manipulated Variable) is held at the current value when the MV hold switch is ON.		
	MV tracking	The MV is switched (tracks) to the input value from other blocks.		
	MV compensation	Arithmetic operation (addition, subtraction, substitution) is performed on the MV signals from the PID control section when the MV compensation input switch is ON.		
	Out-of-range processing at MV output destination block	PID accumulator is stopped when the range is exceeded on the function block to which MV is connected.	○	○
	MV error input	MV error is transferred to SCADA software or other external device when the MV error contact turns ON.		
Alarm	PV alarm	4 (high/high limit, high limit, low limit, low/low limit), setting range: each –15.00 to +115.00% Hysteresis: 0 to +115.00%		
	Deviation alarm	1 (ON outside deviation)		
State Output		1 current Set Point output (–15.00 to +115.00%), 1 deviation output (–115.00 to +115.00%)		

## 1-3-5 Software Specifications

The following software (sold separately) is required to use the Loop Controller:

- CX-Process Tool: Tool for preparing function block data (essential)

### CX-Process Tool Specifications

Item		Specification
Product name		CX-Process Tool (included with CX-One) CS1D-CPU□□P: CX-Process Tool (version 3.1 or higher) CJ1G-CPU□□P: CX-Process Tool (version 4.0 or higher) CX-Process Tool Version 5.2 or higher is required to use all functions of LCB01/03/05 Version 3.5.
Model		WS02-LCTC1EV3 (Ver. 5.0)
Applicable PLC-series		CS/CJ-series
Applicable Unit		Loop Control Unit, Loop Control Board, Process-control CPU Unit, or Loop-control CPU Unit
Applicable computer	Computer	IBM PC/AT or compatible
	Operating system (OS) (See note.) Japanese or English	Windows XP (Service Pack 3 or higher), Windows Vista, or Windows 7
	Processor	A processor that is recommended by Microsoft Corporation
	Memory	The memory that is recommended by Microsoft Corporation
	Hard disk	A minimum of approx. 2.8 GB is required to install all of the CX-One software.
	Monitor	XGA (1,024×768) and 16-bit high color or better
	Disk device	CD-ROM driver or DVD-ROM drive
Connecting method	Connection with CPU Unit (or Serial Communications Board/Unit)	Using the FinsGateway Serial Unit Driver Communications protocol with PLC: Host Link (not supported on Peripheral bus) The computer is connected to the CPU Unit peripheral port or built-in RS-232C port, or RS-232C port of the Serial Communications Unit/Board. - Connector cable: When connecting to the CPU Unit peripheral ports: Model CS1W-CN□□□ (2 m, 6 m) When connecting to the CPU Unit's RS-232C port: Model XW2Z-□□□-□ (2 m, 5 m) (For details on model numbers, see 2-3 <i>Connecting to CX-Process Tool</i> .)
		Using the CX-Server Communications protocol with PLC: Host Link or peripheral bus
	Connection via Controller Link	Using the FinsGateway CLK (PCI) Driver The Driver is installed on the computer on which the PCI Controller Link Support Board is mounted to enable communications with the PLC on which the Controller Link Unit is mounted.
		Using the FinsGateway Controller Link Driver or the CX-Server The Driver is installed on the computer on which the ISA Controller Link Support Board is mounted to enable communications with the PLC on which the Controller Link Unit is mounted.
	Connection via Ethernet	Using the FinsGateway ETH_UNIT Driver or the CX-Server The Driver is installed on the computer on which the Ethernet Board is mounted to enable communications with the PLC on which the Ethernet Unit is mounted.

Item	Specification
Offline operation functions	<ul style="list-style-type: none"><li>- Setting of function block ITEM data (including System Common block settings)</li><li>- Software wiring of analog signals</li><li>- Pasting, displaying, and printing text-string comments (memos) in block or ladder diagrams.</li><li>- Inputting Step Ladder Program block commands</li><li>- Inputting sequence tables</li><li>- Initializing Loop Controller memory (RAM)</li></ul>
Online operation functions	<ul style="list-style-type: none"><li>- Downloading of function block data (download/upload to and from Loop Controller)</li><li>- Run/stop command for Loop Controller (all function blocks)</li><li>- System monitor run status: Monitoring/manipulation of System Common block (Block Model 000) (including monitoring of LCB load rate)</li><li>- Loop Controller monitor run status: Confirmation of function block wiring operation (including operation stop/stop cancel on each function block), confirmation of Step Ladder Program operation, and validation of sequence tables</li><li>- Autotuning PID constants and other parameters.</li></ul>

**Note** Precautions on Operating Systems That Are Compatible with CX-One

- (1) The required system and required hard disk space depend on the system environment.
- (2) Operation is not possible on the 64-bit edition of Windows XP.

## 1-4 How to Use Function Blocks for Specific Operations

To perform this specific operation		Perform the following	See page:
Data Exchange	Direct exchange of large amounts of data between the CPU Unit and function blocks for data exchange with a PT (Programmable Terminal) for example	Use the Expanded CPU Unit Terminal Blocks (Block Models 455 to 458).	<i>Function Block Reference Manual</i>
	Continuous data exchange with the CPU Unit	Use the CPU Unit Terminal blocks (Block Models 451 to 454).	3-3 <i>Exchanging Data with the CPU Unit</i>
	Read/write of specified data (ITEMs) from a CPU Unit (including a CPU Unit on a networked PLC) whenever necessary	Execute the CMND (DELIVER COMMAND) instruction in the Step Ladder Program, and issue the FINS command (ITEM read/write command).	
	Reading/writing specific ITEMs for Control, Operation, and External Controller Blocks with SCADA software	Use HMI function to transfer Loop Controller data using tags created with CX-Process Tool.	3-4 <i>Exchanging Data Using SCADA and Other Software</i>
	Reading/writing I/O memory in CPU Unit using SCADA software	Use user link tables. Use the CSV tags generated when adding user link tables with CS-Process Tool to specify I/O memory addresses in CPU Unit.	3-4 <i>Exchanging Data Using SCADA and Other Software</i>
Run/Stop	Instruction of run start/stop of the Loop Controller (all function blocks) from the CPU Unit whenever necessary	Execute the CMND (DELIVER COMMAND) instruction in the Step Ladder Program, and issue the FINS command (ITEM read/write command) to change ITEM 014 (run/stop command) of the System Common block. Or, use the ITEM setting commands (Block Models 171 and 172) to stop ITEM 014 (run/stop command) of the System Common block. (In this case, operation cannot be started.) <b>Note:</b> Operation can also be stopped or started on CX-Process Tool and SCADA software.	3-2 <i>Description of Operation</i> 3-2-9 <i>Stop Each Function Block Operation and Cancel Operation-Stop</i>
	Instruction of operation stop/stop cancellation on individual function blocks from the CPU Unit whenever necessary	Execute the CMND (DELIVER COMMAND) instruction in the Step Ladder Program, and issue the FINS command (ITEM read/write command) to change ITEM 000 (stop block operation command) of the relevant block. <b>Note:</b> Arithmetic operation stop/stop cancel on a relevant block can also be indicated by monitoring the run status on CX-Process Tool.	
	Execution of required processing on the CPU Unit according to run status (e.g. in RUN mode, execution error, function block data error) of the Loop Controller	Execute the required processing on the CPU Unit taking bits 00 to 05 of the nth leading words of the CPU Bus Unit as the input conditions.	3-3 <i>Exchanging Data with the CPU Unit</i>
	Execution of required processing on the Loop Controller according to run status (e.g., operation mode, fatal error, Output OFF) of the CPU Unit	Execute the required processing on the Loop Controller using the Sequence Table or Step Ladder Program block based upon the CPU Unit run status of ITEMs 007 to 011 and 013 in the System Common block.	
	To operate Loop Controllers in duplex mode (to enable continued operation on the other Loop Controller if one Loop Controller has a fatal Inner Board error)	Use two Process-control CPU Units (CS1D-CPU□□P) in a CS1D Duplex System.	Refer to the <i>CS1D Duplex System Installation Guide</i> (Cat. No. W350).
High-speed processing	High-speed processing of specific function blocks	Set the operation cycle of the relevant function block to a shorter value.	3-2 <i>Description of Operation</i> 3-2-14 <i>Specifying the Operation Cycle</i>
High-density monitor	High-density monitoring of analog signals	Monitor analog signals by the Field Terminal blocks (Block Models 501 to 587) and Send to Computer blocks (Block Models 401 to 404)	3-4 <i>Exchanging Data Using SCADA and Other Software</i> <i>Appendix B How to Use the Sequence Table Block</i>
Monitoring/ Setting External Controllers	Monitoring and setting a stand-alone external controller.	Connect an ES100X Controller to the RS-232C port on the Loop Controller and use the ES100X Controller Terminal (Block Model 045). (Not supported for the CS1D-CPU□□P, CJ1G-CPU□□P.)	<i>Function Block Reference Manual</i>
Batch Data Collection	Data collection by a certain timing within sequence processing in a batch processing plant	Use the Batch Data Collector block (Block Model 174).	<i>Function Block Reference Manual</i>

To perform this specific operation		Perform the following	See page:
Analog control	ON/OFF control	Use the 2-position ON/OFF block (Block Model 001).	Function Block Reference Manual
	Heating/cooling ON/OFF control	Use the 3-position ON/OFF block (Block Model 002).	
	Time-proportional control	Use the Analog/Pulse Width Converter block (Block Model 192).	5-1 Basic Examples of PID Control, 5-1-6 Time-proportional Control, and Function Block Reference Manual
	Continuous proportional control for heating/cooling	Use with the Basic/Advanced PID block and Split Converter block (Block Model 169). (Supported only by Loop Control Board version 1.5)	Function Block Reference Manual
	Application of input filter on PV	Use the First-order Lag block (Block Model 141).	
	Application of bias on PV	Use the Ratio Setting block (Block Model 033) or the Addition/Subtraction block (mode 121).	
	Application of ratio on Set Point and PV		
	Inputting the difference between two PVs	Use the Addition or Subtraction block (Block Model 121)	
	Entry of differential pressure transmitter to calculate flowrate	Use the Square Root block (Block Model 131) (with low-end cutout function).	
	Entry of pulse output flowmeter for accumulation of flowrate	Use the Pulse Input Unit, and enter to the Accumulator for accumulated value input block (Block Model 184) for continuous accumulation.	5-1 Basic Examples of PID Control, 5-1-7 Monitoring and Accumulating Flowrate and Function Block Reference Manual
	Temperature and pressure correction	Use the Temperature and Pressure Correction block (Block Model 136).	Function Block Reference Manual
	Setting of the PID constant values for multiple words	Use the Constant Item Setting block (Block Model 171).	5-1 Basic Examples of PID Control, 5-1-2 Multi-channel PID Control and Function Block Reference Manual
	Switching of multiple Set Point values	Use the Constant Selector block (Block Model 165) or the Constant Item Setting block (Block Model 171).	5-1 Basic Examples of PID Control, 5-1-3 PID Control for Switching Multiple Set Points and Function Block Reference Manual
	Switching of multiple PID sets	Use the Constant Item Setting block (Block Model 171).	5-1 Basic Examples of PID Control 5-1-4 PID Control for Switching PID Constants by Three Set Point Zones and Function Block Reference Manual
	Setting multiple SPs and PID constants, and switching the SPs and PID constants under certain conditions. Examples: • Switching set values (SPs, PID constants) according to product type. • Switching set values (SPs, PID constants) according to time.	Use the Bank Selector block (Block Model 168), and Basic PID block (Block Model 011), or Advanced PID block (Block Model 012). (Supported by LCB01/05 with version 1.5 or later and LCB03 only.)	
	Ramp control of Set Point values (program control)	Use the Ramp Program block (Block Model 155), the Segment Program block (Block Model 156), the Segment Program 2 block (Block Model 157), or the Segment Program 3 block (Block Model 158).	• Ramp Program Block (Block Model 155) • Segment Program Block (Block Model 156) • Segment Program 2 Block (Block Model 157) • Segment Program 3 Block (Block Model 158) • 5-1 Basic Examples of PID Control
	Cascade control	Use a serial connection for the Basic PID block (Block Model 011) or Advanced PID block (Block Model 012).	5-2 Examples of Applied Control Types, 5-2-1 Cascade Control and Function Block Reference Manual
Dead time compensation control	Use the Dead Time Compensation block (Block Model 149) or the Advanced PID block (Block Model 012).	5-2 Examples of Applied Control Types, 5-2-4 Dead Time Compensation and Function Block Reference Manual	
Feedforward control	Use the Advanced PID block (Block Model 012) or the Lead/Delay block (Block Model 147).	5-2 Examples of Applied Control Types, 5-2-2 Feedforward Control and Function Block Reference Manual	
Non-interfering control			
Sample PI control	Use the ON/OFF Timer block (Block Model 206).	5-2 Examples of Applied Control Types, 5-2-3 Sample PI Control and Function Block Reference Manual	

To perform this specific operation		Perform the following	See page:
Analog control, continued	PID control with differential gap	Use the Constant Item Setting block (Block Model 171).	<i>Function Block Reference Manual</i>
	Selective control	Use the Rank Selector block (Block Model 161).	
	Using fuzzy control based on knowledge from ambiguous expressions	Use the Fuzzy Logic block (Block Model 016).	
	Suppresses influence of disturbances in applications requiring high-speed responses.	Enable disturbance overshooting control for the Basic PID block (Block Model 011) or Advanced PID block (Block Model 012).	
Special math operations	Performing calculation in engineering units rather than percentages	Use the Arithmetic Operation block (Block Model 126).	<i>Function Block Reference Manual</i>
	Performing special calculations, such as trigonometric or logarithmic operation		
	Calculating statistics (e.g., average, standard deviation, etc.) for time sequence data	Use the Time Sequence Data Statistics block (Block Model 153).	
Accumulation processing	Accumulation (accumulator) of instantaneous analog signals such as flowrate signals on the Loop Controller	Use the Accumulator for instantaneous value input block (Block Model 150).	<i>5-1 Basic Examples of PID Control, 5-1-7 Monitoring and Accumulating Flowrate and Function Block Reference Manual</i>
	Continuous accumulation of 4-digit accumulated value signals (repeat signals 0000 to 9999) and conversion to 8-digit signals	Use the Accumulator for accumulated value input block (Block Model 184).	<i>Function Block Reference Manual</i>
	Input and accumulation of low-speed pulse signals such as the power signal	Use the Contact input/Accumulated value output block (Block Model 185).	
	Notification of accumulated values on a field mechanical counter for contact inputs	Use the Accumulated Value Input/Contact Output block (Block Model 186).	
	Batch flowrate capture	Use the Batch Flowrate Capture block (Block Model 014).	
	Ratio control of accumulated values	Use the Batch Flowrate Capture block (Block Model 014) and the Blended PID block (Block Model 013).	
	Addition of accumulated values	Use the Accumulated Value Input Adder block (Block Model 182).	
	Multiplication of analog signals with accumulated values	Use the Accumulated Value Analog Multiplier block (Block Model 183).	



To perform this specific operation		Perform the following	See page:
Sequence control	AND, OR and other logical operations on the Loop Controller	Use the Sequence Table block (Block Model 302) or Step Ladder Program block (Block Model 301). Use the Internal Switch block (Block Model 209).	Appendix A How to Use the Step Ladder Program Block, Appendix B Step Tables, and Function Block Reference Manual
	One-shot contact output of the ON input state when the contact state changes from OFF to ON and vice versa only in 1-operation cycles (system common operation cycle)		
	Constantly ON contacts and other system contacts		
	Step progression control and other control on the Loop Controller		
	Acceptance of bits in the Step Ladder Program		
	Execution of special processing at each fixed cycle longer than operation cycle in Step Ladder Program	Generate a fixed cycle timing signal by the Clock Pulse block (Block Model 207).	Function Block Reference Manual
	Execution of timers/counters on the Loop Controller	Use the Timer block (Block Model 205) and the Counter block (Block Model 208).	
Constant setting/selection	Constant transmission of constants as analog signals	Use the Constant Generator block (Block Model 166).	3-1 Configuration of Function Blocks and Function Block Reference Manual  Function Block Reference Manual
	Setting of constants to specified ITEMS under certain conditions	Use the Constant Item Setting block (Block Model 171).	
	Selection of one of multiple constants and transmission of that constant as an analog signal	Use the Constant Selector block (Block Model 165).	
	Changing PID constants and other parameters in stages according to a process value (e.g., temperature).	Use the Level Check block (Block Model 210) and the Constant ITEM Setting block (Block Model 171) together to change parameters for other blocks according to the level.	

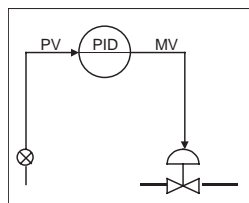
To perform this specific operation	Perform the following	See page:
Analog signal setting/selection	Setting of analog signals to specified ITEMS under certain conditions	3-1 Configuration of Function Blocks and Function Block Reference Manual
	Selection of one of multiple analog signals and transmission of that analog signal as an analog signal	Function Block Reference Manual
	Selection of the maximum value from multiple analog signals and transmission of that maximum value as an analog signal	
	Selection of the minimum value from multiple analog signals and transmission of that minimum value as an analog signal	
	Selection of the nth largest value from multiple analog signals and transmission of the signal as an analog signal	
	Switching of sensors on a different measuring system or measurement target	
	Switching of operation nodes on a different measuring system or measurement target	
	Changing two settings with a ramp (e.g., opening and closing valves)	
	Converting ranges of analog signals merely by setting values for 0% and 100% inputs and 0% and 100% outputs	
	Comparison of constant and analog signals	
	Comparison of two analog signals	
Manipulation/monitor/control of special external control target	Manipulation and monitoring of ON/OFF valve with open/close limit switches	Use the ON/OFF Valve Manipulator block (Block Model 221) and Switch Meter block (Block Model 225).
	Manipulation and monitoring of motors	Use the Motor Manipulator block (Block Model 222) and Switch Meter block (Block Model 225).
	Manipulation and monitoring of reversible motors	Use the Reversible Motor Manipulator block (Block Model 223).
	Manipulation of a electric positional-proportional motor as the control target	Use the Basic PID (Block Model 011)/ Advanced PID block (Block Model 012) and Motor Opening Manipulator block (Block Model 224) and Switch Meter block (Block Model 225).

## 1-5 Basic Procedure for Using the Loop Controller

This section describes the basic procedure for using the Loop Controller.  
For examples of actual procedures, see *Section 4 Simple Examples of Use*.

### 1. Design

- 1,2,3...** 1. Prepare an instrumentation drawing.

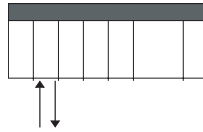


See this Section (for understanding which functions can be used on the Loop Controller).

See *Section 5 Examples of Function Block Combinations*.

2. Decide on the PLC system configuration.

This mainly involves selection of the Analog Input and Output Units.



See 1-2 Configuration of Instrumentation System.

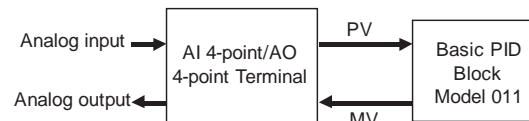
See Section 3 Mechanism of the Loop Controller.

3. Select the required function blocks.

See 1-4 How to Use Function Blocks for Specific Operations.

See Section 3 Mechanism of the Loop Controller.

4. Decide on the function block system configuration.



5. Assess the LCB load rate and the external I/O response cycle.

See 1-2 Configuration of Instrumentation System.

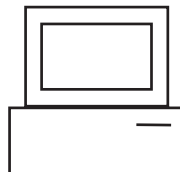
See 3-2 Description of Operation.

6. Assess fail-safe countermeasures.

See 3-5 Fail-safe Countermeasure Guidelines.

## 2. Preparing Function Block Data (by CX-Process Tool)

- 1,2,3... 1. Set up and start CX-Process Tool.



Prepare the function block data on CX-Process Tool running on the computer.

Refer to *CX-Process Tool Operation Manual*.

2. Set the System Common block data.

(For example, set the operation cycle and leading Data Memory address for the Node Terminals.)

Refer to the *Function Block Reference Manual*.

3. In CX-Process Tool, wire the analog signals between the Selector blocks (analog signals and accumulated value signals only).

Refer to the *CX-Process Tool Operation Manual*.

4. Set the ITEMS in each function block.

(If necessary, program step ladder commands in the Step Ladder Program block including contact signals.)

Refer to *CX-Process Tool Operation Manual*.

Refer to the *Function Block Reference Manual*.

**Note** Set function block initial setting parameters (refer to the item “(S): Initial setting data” describing how to read/write in the *Function Block Reference Manual*) on CX-Process Tool.

5. Using SCADA Software  
Set the CSV tags and create the CSV tag files.  
Refer to the *CX-Process Tool Operation Manual*.

### **3. Setting up the Loop Controller and Other I/O Units**

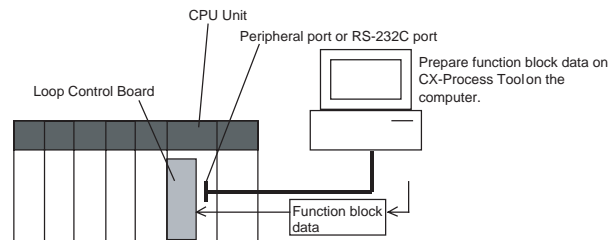
- 1,2,3...**
1. Mount the Loop Controller and wire the Analog Input and Output Units.  
The Loop Controller itself need not be wired.  
See 2-2 *Installation* and refer to the manual for other *Analog Input and Output Units*.
  2. Set the unit number setting switch on the front panel of the Units.
  3. Connect the Programming Devices.  
Refer to *Programming Devices (CX-Programmer or Programming Console) Operation Manual*.

**Note** For CS1D CPU Units when the CS1D-LCB05D is being used, connect to the active CPU Unit.

4. Turn power ON to the PLC.
5. Create I/O tables using the Programming Devices.  
Refer to the *Programming Devices (CX-Programmer or Programming Console) Operation Manual*.
6. If necessary, set the communications conditions of the serial communications port in the PLC Setup using the Programming Devices.  
Refer to the *Programming Devices (CX-Programmer or Programming Console) Operation Manual*.
7. Set the allocated Data Memory (D) on the Analog Input and Output Units using the Programming Devices.  
Refer to the *Analog Input and Output Unit manuals*.

### **4. Downloading the function block data to the Loop Controller**

- 1,2,3...**
1. Turn power OFF to the PLC.
  2. Set the unit number setting switch on the front panel of the CPU Unit.  
Refer to the *CS1 PLC Operation Manual*.
  3. Connect the CPU Unit to the computer on which CX-Process Tool is running.
  4. Turn the PLC ON.
  5. Set the network address (000) and node address (01).  
Refer to the *CX-Process Tool Operation Manual*.
  6. Perform the Host Link connection operation on CX-Process Tool (**File - Initialize Serial Port**).  
Refer to the *CX-Process Tool Operation Manual*.
  7. Download the function block data to the Loop Controller specified in the Function Block Data Sheet of CX-Process Tool (**Execute - Download**).  
Refer to the *CX-Process Tool Operation Manual*.



**Note** Check the following points before you start Loop Controller operation.

- a. The correct combination of Analog I/O Units must be mounted.
  - b. Analog Input/Output Units used in combination with the Loop Control Board must be mounted correctly, and the unit number set on the front panel of the Analog Input/Output Unit must match the unit number set on the Field Terminal block. If the unit numbers do not match, input/output (read/write) is performed on the data of another Special I/O Unit (whose unit number is set on the Field Terminal block).
  - c. The correct defaults of the System Common block on the Loop Controller must be set.
8. Execute the run/stop command on CX-Process Tool (**Execute - Operation - Monitor run status**) or turn the PLC power OFF then back ON again.  
Refer to *CX-Process Tool Operation Manual*.

**Note** When the CS1D-LCB05D is being used, the standby Loop Controller can take up to 150 seconds (for duplex initialization) before starting operation after the PLC power is turned ON. (The EXEC LED on the front and the DPL STATUS LED will flash for 150 seconds and then will be lit.)

9. Check the LEDs on the front panel of the Loop Controller (RDY LED lit, EXEC LED lit).

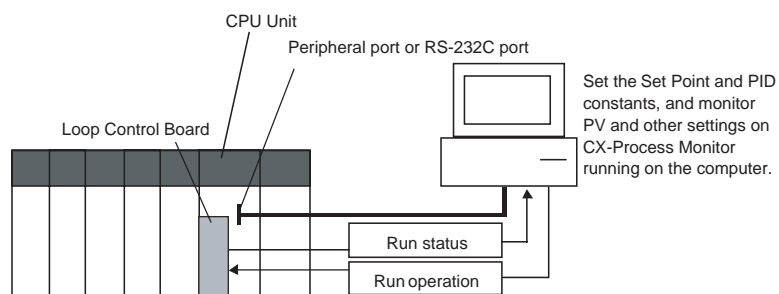
See 7-1 *Errors and Alarm Troubleshooting*.

## 5. Trial Operation

- 1,2,3...**
1. Execute the run/stop command on CX-Process Tool (**Execute - Operation - Monitor run status**) or turn the PLC power OFF then back ON again.  
See 3-2 *Description of Operations*.  
Refer to *CX-Process Tool Operation Manual*.
  2. Monitor the run status on CX-Process Tool (**Execute - Operation - Monitor run status**).  
Execute the load rate check and other diagnostic checks.  
Refer to the *CX-Process Tool Operation Manual*.

**Note** To disable inadvertent generation of analog signals when running of the Loop Controller is started merely for checking the load rate, disconnect the analog output connections.

3. Check the connections on CX-Process Tool (**Validate action - Start**).  
Refer to the *CX-Process Tool Operation Manual*.
4. Set up and start CX-Process Tool.  
Refer to *CX-Process Tool Operation Manual*.
5. Set the Set Point and other settings from CX-Process Tool or from SCADA software.  
Refer to the *CX-Process Tool Operation Manual*.



## 6. Actual Operation

- 1,2,3...**
1. Tune the Loop Controller using the CX-Process Tool or SCADA software.  
(For example, change the settings and PID constants.)  
Refer to the *CX-Process Tool Operation Manual*.
  2. Monitor PV and alarms on CX-Process Tool or SCADA software.  
Refer to the *CX-Process Tool Operation Manual*.

## SECTION 2

# Components, Installation, and Wiring

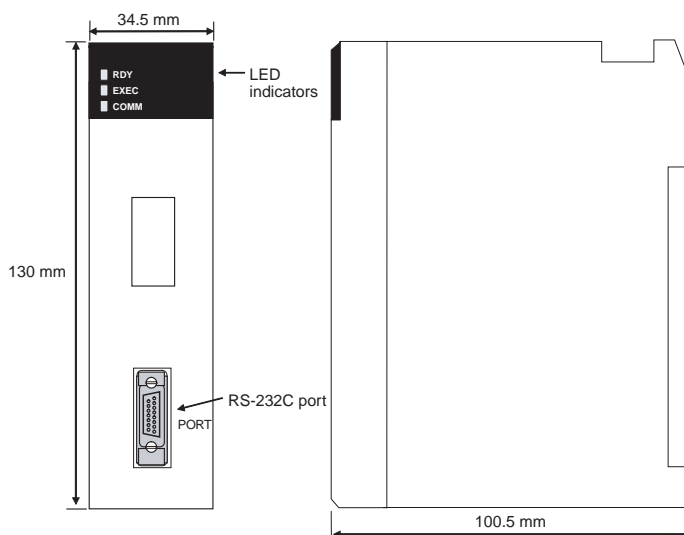
This section describes the components of the Loop Controller and installation and wiring methods

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2-1-1	Names and Functions of Parts . . . . .	72
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## 2-1 Names and Functions of Parts

### 2-1-1 Names and Functions of Parts

#### Loop Control Boards and Process-control CPU Units

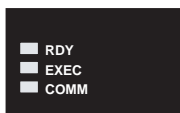


#### RS-232C port:

Used to connect to an ES100X Controller. (Cannot be used for the Process-control CPU Unit (CS1D-CPU□□P).) Using the port is enabled by creating an ES100X Controller Terminal block (Block Model 045).

**Caution** Do not connect pin 6 (+5 V power supply line) of the RS-232C port on the CPU Unit to any external device except the CJ1W-CIF11 RS-422A Adapter or NT-AL001 RS-232C/RS-422A Adapter. Doing so may damage the external device or CPU Unit.

#### LED Indicators

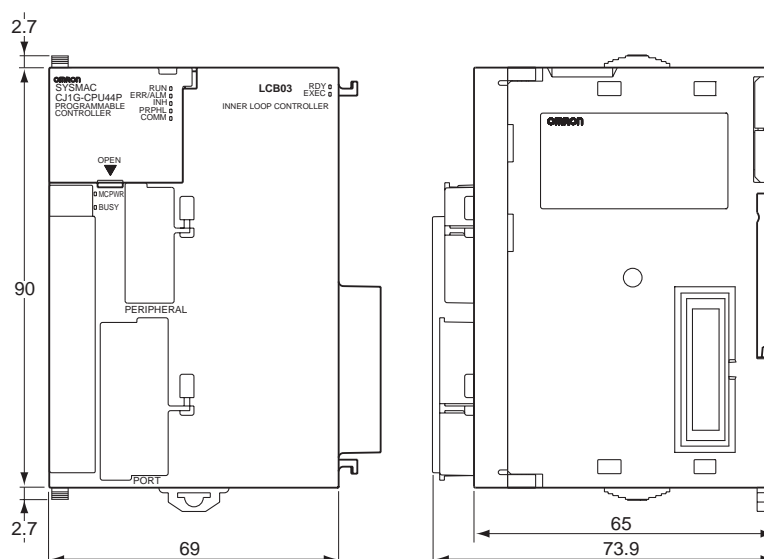


Indicator	Name	Color	Status	Description
RDY	Ready	Green	Not lit	The Loop Control Board is not operating for one of the following reasons: <ul style="list-style-type: none"> <li>• A Fatal Inner Board Error occurred (A40112 ON.)</li> <li>• Initialization is not completed yet.</li> <li>• A fatal error occurred.</li> <li>• The flash memory backup data is invalid.</li> <li>• The Loop Control Board is initializing.</li> <li>• A hardware failure occurred in the Loop Control Board.</li> <li>• Power is not being supplied from the Power Supply Unit.</li> <li>• A Loop Control Board WDT error occurred.</li> </ul>
			Flashing	• A WDT error occurred in the CPU Unit.
			Lit	The Loop Control Board is ready for operation.



Indicator	Name	Color	Status	Description
EXEC	Running	Green	Not lit	The system is stopped for one of the following reasons: <ul style="list-style-type: none"> <li>• The Loop Control Board is initializing.</li> <li>• A hardware failure occurred in the Loop Control Board.</li> <li>• Power is not being supplied from the Power Supply Unit.</li> <li>• A Loop Control Board WDT error occurred.</li> <li>• The Loop Control Board is not running.</li> <li>• Data is being written to flash memory.</li> </ul>
			Flashing (at 0.5-s intervals)	Erasing flash memory for the CS1D-CPU□□P.
			Flashing (0.2-s intervals)	Backup operation to function block flash memory in progress
			Lit	The Loop Control Board is not running.
COMM	Communicating	Yellow	Not lit	Waiting for data transfer.
			Flashing	Transferring data.

### Loop-control CPU Units



### Indicators



Indicator	Name	Color	Status	Description
RDY	Ready	Green	Not lit	The Loop Controller is not operating for one of the following reasons: <ul style="list-style-type: none"> <li>• A Fatal Inner Board Error occurred (A40112 ON.)</li> <li>• Initialization is not completed yet.</li> <li>• A fatal error occurred.</li> <li>• The flash memory backup data is invalid.</li> <li>• The Loop Controller is initializing.</li> <li>• A hardware failure occurred in the Loop Control Board.</li> <li>• Power is not being supplied from the Power Supply Unit.</li> <li>• A Loop Controller WDT error occurred.</li> </ul>
			Flashing	• A WDT error occurred in the CPU Unit.
			Lit	The Loop Controller is ready for operation.

Indicator	Name	Color	Status	Description
EXEC	Running	Green	Not lit	The system is stopped for one of the following reasons: <ul style="list-style-type: none"> <li>• The Loop Controller is initializing.</li> <li>• A hardware failure occurred in the Loop Control Board.</li> <li>• Power is not being supplied from the Power Supply Unit.</li> <li>• A Loop Controller WDT error occurred.</li> <li>• The Loop Controller is not running.</li> <li>• Data is being written to flash memory.</li> </ul>
			Flashing (at 0.5-s intervals)	Erasing flash memory.
			Flashing (0.2-s intervals)	Backup operation to function block flash memory in progress
			Lit	The Loop Controller is not running.

## 2-2 Installation

### 2-2-1 Mountable Units

#### Loop Control Boards (CS1W-LCB01 and CS1W-LCB05)


The CS1W-LCB01 and CS1W-LCB05 Loop Control Boards are mounted in the Inner Board slot of a CS1-H CPU Unit. Only one Board can be mounted in each CPU Unit.

- Note**
1. Loop Control Boards before version 1.5 cannot be used with CS1D-CPU□□S CS1D CPU Units for Single-CPU System.
  2. Always turn OFF the power supply before mounting or removing the Board. If the Board is mounted or removed with power supplied, the CPU Unit may malfunction or internal elements may be destroyed.
  3. Before handling the Board, touch a grounded metal object to discharge static electricity from your body.

#### Process-control CPU Units (CS1D-CPU□□P)

Duplex Loop Control Boards are already mounted in the Process-control CPU Unit (CS1D-CPU□□P).

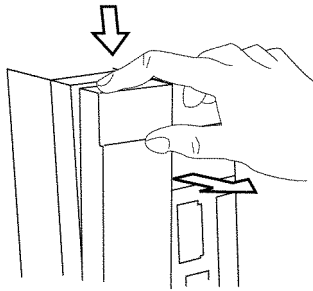
Normal operation will be possible only if the CS1D CPU Unit is used in the combination in which it was shipped.

 **WARNING** Do not remove the Duplex Loop Control Board (Inner Board) from the CS1D-CPU□□P CS1D Process-control CPU Unit. Normal operation may not be possible if the Board is removed.

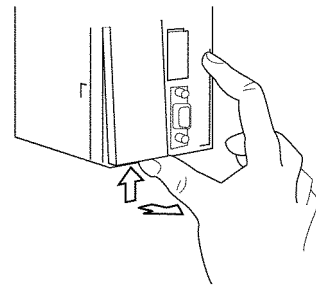
### 2-2-2 Mounting Procedure (CS1W-LCB01/LCB05 Loop Control Boards Only)

Follow the procedure below to mount the CS1W-LCB01 or CS1W-LCB05 Loop Control Board in the CPU Unit.

- 1,2,3...**
1. Lock the top of the CS1W-LCB01 or CS1W-LCB05 Loop Control Board onto the Backplane by the hook and rotate the Loop Control Board downwards as shown in the figure.

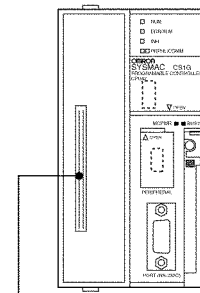
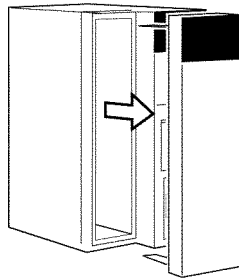


Press the top catch.



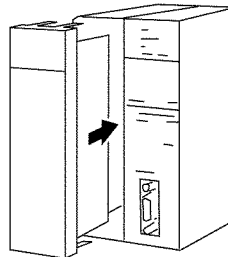
Press the bottom catch.

2. Remove the Inner Board compartment cover.



Inner Board Connector

3. Insert the Serial Communications Board.



**Note** Be sure to tighten the mounting screw on the bottom side securely to the tightening torque of 0.4 N·m.

#### Precaution When Handling the Loop Control Board

- Always turn OFF the power to the PLC before removing the CS1W-LCB01 or CS1W-LCB05 Loop Control Board.
- If the RS-232C port is not being used, leave the dust cover attached to the port during operation.

### 2-2-3 Handling Analog Input/Output Units

**Note** The Loop Controller is used in combination with an Analog Input/Output Unit. Note the following points when handling the Analog Input/Output Unit:

- Before starting running of the Loop Controller, make sure that the Analog Input/Output Unit is correctly mounted on the same PLC Unit. Even if running of the Loop Controller is started without the Analog Input/Output Unit mounted on the same PLC Unit, warning messages to this effect are not displayed on the screens of CX-Process Tool.
- The unit number set on the front panel of the Analog Input/Output Unit must be set to the same as the unit number specified in the Field Terminal block. If unit numbers should differ, reading and writing will be performed

erroneously on another Special I/O Unit having the unit number specified in the Field Terminal block.

## 2-3 Connecting to CX-Process Tool

Either one of the following communications drivers can be selected to support the connection with a PLC (Programmable Controller):

- FinsGateway
- CX-Server

When the CX-Process Tool starts up, a dialog box is displayed to select whether FinsGateway or CX-Server will be used as the communications driver.

### 2-3-1 Using FinsGateway

The following three methods can be used to connect to the PLC. Regardless of the connection method, use FinsGateway Version 2 or higher (embedded) as the communications driver.

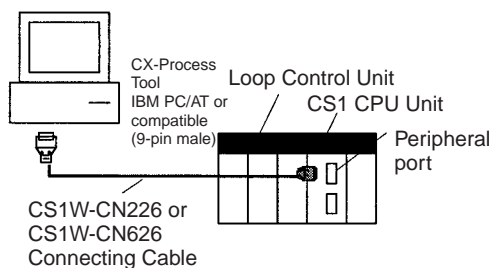
Communications network		FinsGateway communications driver	Contents
Serial Communications	Host Link	Serial Unit Driver	Connecting to the PLC's peripheral or RS-232C port via Host Link.
	Peripheral bus (Toolbus)		
Controller Link Network		CLK (PCI slot) Driver (Not supported by FinsGateway Version 2)	Connecting through the Controller Link Support Board to a PLC with a Controller Link Unit mounted.
		Controller Link Driver	
Ethernet Network		ETN_UNIT Driver	Connecting through the Ethernet Board to a PLC with an Ethernet Unit mounted.

- Note**
- (1) Host Link communications use FINS commands enclosed in a header and terminator data (i.e., SYSWAY-CV for FinsGateway). Host Link communications (SYSMAC WAY) is set for the PLC.
  - (2) FinsGateway version 2003 or later only.

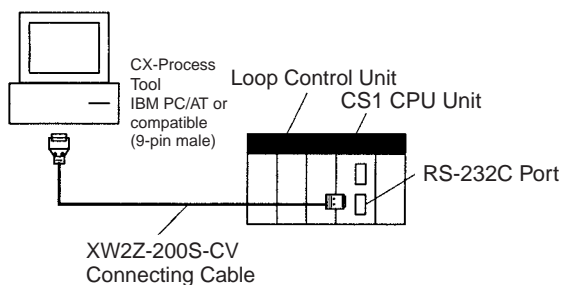
### Connecting via Host Link

The personal computer uses the FinsGateway (Version 2 or 3) Serial Unit Driver to connect to the PLC's peripheral or RS-232C port via Host Link communications.

**Connections to the Peripheral Port of the CPU Unit**



**Connections to the RS-232C port of the CPU Unit or Serial Communications Board or Unit**

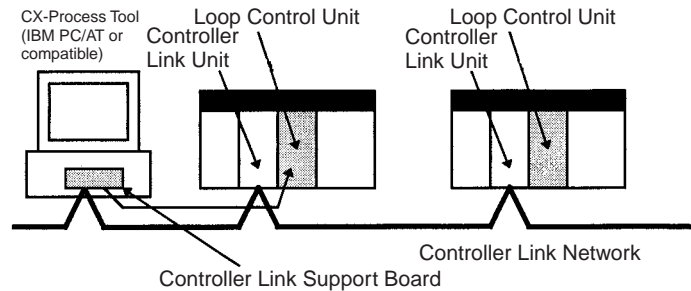


- Note**
1. The Serial Communications Mode must be set to Host Link. Host Link communications use FINS commands wrapped in header and terminator data (i.e., SYSWAY-CV for FinsGateway). The peripheral bus cannot be used.

2. The FinsGateway Version 3 Serial Unit Driver must be installed to enable connecting the PLC via Host Link communications.
3. The following Connecting Cables are used to connect the CX-Process Tool (personal computer) to the PLC (CPU Unit or Serial Communications Board/Unit).

### **Connecting through a Controller Link Support Board**

The personal computer can be connected to the PLC through a Controller Link Network using the FinsGateway Version 3 CLK (PCI slot) Driver or the FinsGateway Version 2 or 3 Controller Link Driver.



**Note** The Controller Link Driver (FinsGateway Version 3 CLK (PCI slot) Driver or the FinsGateway Version 2 or higher Controller Link Driver) must be installed in order to connect to the PLC via a Controller Link Network.

#### **Controller Link Unit Models**

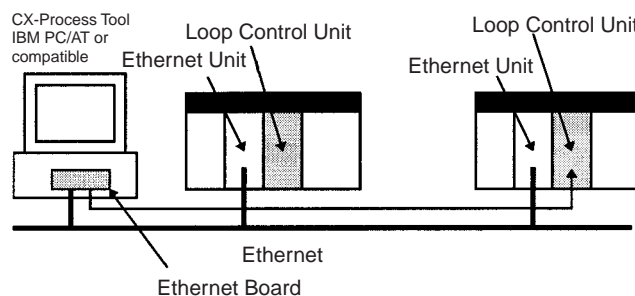
Controller Link Unit	PLC	Unit	Type	Transmission path
CS1W-CLK21	CS Series	CPU Bus Unit	Wired	Twisted-pair cable
CS1W-CLK12			Optical	H-PCF Optical fiber cable
CS1W-CLK52			Optical	GI Optical fiber cable

#### **Controller Link Support Boards**

Controller Link Support Board	Transmission medium	Computer	FinsGateway Driver
3G8F7-CLK12	Optical fiber cable (ring configuration)	IBM PC/AT or compatible (PCI slot)	CLK (PCI slot) Driver (FinsGateway Version 2 cannot be used.)
3G8F7-CLK52			
3G8F7-CLK21	Wire	IBM PC/AT or compatible (ISA slot)	Controller Link Driver
3G8F5-CLK11	Optical fiber cable		
3G8F5-CLK21	Wire		

### **Connections via Ethernet**

The personal computer can be connected to the PLC through an Ethernet Network using the FinsGateway Version 2 or higher ETN\_UNIT Driver.



**Note** The FinsGateway Version 2 or higher ETN\_UNIT Driver must be installed in order to connect to the PLC via an Ethernet Network.

## Ethernet Unit Model

Model	PLC	Unit	Ethernet
CS1W-ETN01	CS Series	CPU Bus Unit	10Base-5
CS1W-ETN11			10Base-T
CS1W-ETN21			100Base-TX

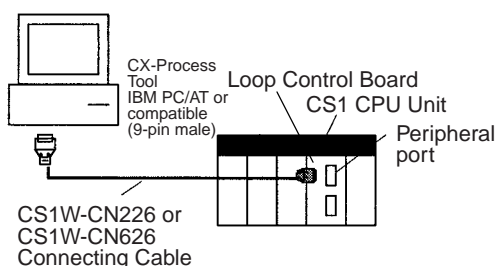
## 2-3-2 Using CX-Server

The following two methods can be used to connect to the PLC.

Communications network	Network type specified in dialog box	Usage	Cable connection
Peripheral Bus (Toolbus)	Select <b>Toolbus</b> .	Special high-speed communications protocol for Programming Devices	Connect to the PLC's peripheral or RS-232C port.
Host Link (SYS-MAC WAY)	Select <b>SYSMAC WAY</b> .	Standard protocol for general-purpose host computers	

The connections shown in the following diagram can be used with either Peripheral Bus or Host Link connections. (For Process-control CPU Units (CS1D-CPU□□P), the connections are made to the active CPU Unit.)

Connections to the Peripheral Port of the CPU Unit



Connections to the RS-232C port of the CPU Unit or Serial Communications Board or Unit

Recommended cable:  
OMRON XW2Z-200S-CV

**Note** The Peripheral Bus connection cannot be used with a Serial Communications Board or Unit.

## 2-3-3 Connecting Cables

The following table lists the Connecting Cables that can be used for Peripheral Bus and Host Link connections. All of the cables connect to a male 9-pin D-Sub serial port on an IBM PC/AT or compatible computer.

Unit	Port location	Serial Communications Mode	Model	Length	Remarks
CPU Unit	Built-in peripheral port	Host Link (SYSMAC WAY) or Peripheral Bus (Toolbus)	CS1W-CN226	2.0 m	---
			CS1W-CN626	6.0 m	
	Built-in RS-232C port Female 9-pin D-SUB		XW2Z-200S-CV	2 m	Anti-static connector
			XW2Z-500S-CV	5 m	
Serial Communications Board or Unit	RS-232C port Male 9-pin D-SUB	Host Link (SYSMAC WAY)	XW2Z-200S-CV	2 m	Anti-static connector
			XW2Z-500S-CV	5 m	

**Note** Touch a grounded metal to discharge all static electricity from your body before connecting any of the above cable connectors to the RS-232C port of the PLC.

The XW2Z-□□□S-CV Cable uses the anti-static XM2S-0911-E Connector Hood. For safety sake, however, discharge all static electricity from your body before touching the connector.

The following components are used to connect RS-232C cable to the peripheral port. Connect to a male 9-pin D-Sub serial port on an IBM PC/AT or compatible computer.

Unit	Port location	Serial Communications Mode	Model	Length	Remarks
CPU Unit	Built-in peripheral port	Host Link (SYSMAC WAY)	CS1W-CN118 + XW2Z-200S-CV	0.1 m + (2 or 5 m)	The XW2Z-□□□S-CV is an anti-static connector.
		or Peripheral Bus (Toolbus)	CS1W-CN118 + XW2Z-200S-V		---

The following components are available for connecting the CQM1CIF01 or CQM1-CIF02 Cable to the peripheral port. Connect to a male 9-pin D-Sub serial port on an IBM PC/AT or compatible computer.

Unit	Port on Unit	Serial Communications Mode	Model	Length	Remarks
CPU Unit	Built-in peripheral port	Host Link (SYSMAC WAY)	CS1W-CN114 + CQM1-CIF02	0.5 m + 3.3 m	---

The following components are available for connecting the IBM PC/AT or compatible over RS-232C. Connect to a male 9-pin D-Sub serial port.

Unit	Port on Unit	Serial Communications Mode	Model	Length	Remarks
CPU Unit	Built-in RS-232C port Female 9-pin D-SUB	Host Link (SYSMAC WAY)	XW2Z-200S-V	2 m	---
			XW2Z-500S-V	5 m	
Serial Communica- tions Board or Unit	RS-232C Port Female 9-pin D-SUB		XW2Z-200S-V	2 m	
			XW2Z-500S-V	5 m	





## SECTION 3

# Mechanism of the Loop Controller

This section describes the operation of the Loop Controller.

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## 3-1 Configuration of Function Blocks

All Loop Controller functions can be achieved by connecting the function blocks in the software.

### 3-1-1 Configuration of Function Blocks

Function blocks comprise data items called ITEMS each starting from 000.

Function block	ITEM	Data
	000	
	001	
	002	
	003	
	004	
	⋮	

ITEMs 000 to 004 are common to all function blocks.

ITEM006 and onwards differ according to the Block Model.

### 3-1-2 Preparing Function Block Data Sheets

CX-Process Tool is used to set data to each item in each function block, and prepare function block data sheets. Function blocks are registered to function block data sheets by being allocated to a block address (address for execution). These function block data sheets need only be transferred (downloaded) to the Loop Controller to enable use of the Loop Controller. Function block data sheets are prepared as function block files appended with the .lst extension.

**Note** When the Loop Controller is shipped from the factory, function block data sheets are not stored on the Unit. Be sure to prepare function block data sheets using CX-Process Tool and transfer (download) the sheets to the Loop Controller.

Follow the procedure below to prepare and download function block data sheets.

**1,2,3...**

1. Allocate the function blocks to block addresses.

Select the function blocks to be used, and allocate them to block addresses in the function block data sheets. Function blocks become executable data once they have been allocated to block addresses. Allocatable block addresses are determined as follows according to the type of function block. Block addresses other than these cannot be allocated.

Function block type		Allocatable block address
Control blocks and operation blocks	Basic PID (Block Model 011) and other Control blocks	LCB05/05D: 001 to 500 LCB03: 001 to 003 LCB01: 001 to 050
	Square Root (Block Model 131) and other Operation blocks	
External Controller blocks	External Controller block	601 to 632
Sequence Control blocks	Step Ladder Program block (Block Model 301)	LCB01: 701 to 720 LCB03/05/05D: 701 to 900
	Sequence Table block (Block Model 302)	
Field Terminal blocks		901 to 980

**Note** (a) Which function block data is written to or which function block data is read from is determined by the block address for each ITEM.

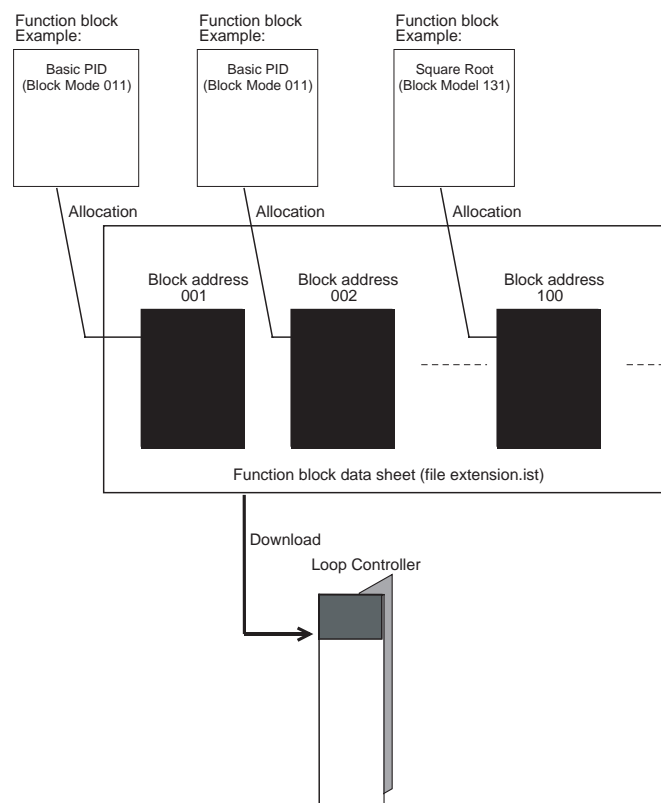
(b) Block Model and Block Address

The “Block Model” is a number for specifying the type of block and is not set by the user in CX-Process Tool. Be careful not to confuse the Block Model with the “block address” that is used as the address for execution that is set by the user.

2. Wire analog signals (or accumulated value signals) between function blocks. (See 3-1-5 *Connecting Function Blocks* described later.)
3. Set ITEM data other than the analog signals.

(c) Wiring of analog signals (or accumulated value signals) between function blocks is also possible by setting the data of each ITEM.

4. Download the function block data sheets to the Loop Controller.



## 3-1-3 ITEMS Common to All Function Blocks

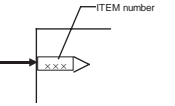
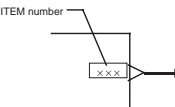
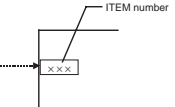
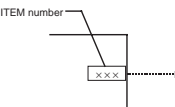
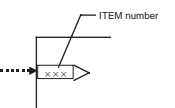
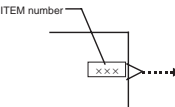
ITEM type	ITEM No.	Name	Description	R/W mode R: Read, W: Write, R/W: R/W-enabled, —: R/W-disabled <b>Note:</b> r and r/w: Read and write for confirmation of CX-Process Tool oper- ation		
				According to CX- Process Tool	According to ITEM Setting block	According to Step Ladder Program
Contact input	000	Stop block operation command	To stop operation of this function block using a FINS command, set this ITEM to 1. When this ITEM is returned to 0, a hot start (state active before the Board was stopped is continued before operation is started) is performed. <b>Note</b> System Common block (Block Model 000) ITEM000 cannot be used. (Must be set to 0.)	---	---	R/W
Parameter	001	Comment	A comment up to 23 characters long can be described in this ITEM. <b>Note</b> The default in CX-Process Tool is the name of the function block (eight letters).	R/W	---	---
	002	Block Model	Set the Block Model of the function block to be registered (allocated) to blocks having this number. The settings of ITEM006 onwards is determined according to the Block Model set here.	R/W	---	---
Special	003	Execution error display	An error code is stored here if the data that is set to each ITEM in this function block is inappropriate, an error has occurred in execution of the function block, or the function block data is in error. <b>Note</b> For details of error codes, see <i>7-1 Errors and Alarm Troubleshooting</i> .	r R/W (See note 2.)	--- (W) (See note 2.)	
Parameter	004	Operation cycle	Specify the operation cycle group of this function block. Specify whether to execute the function block at the operation cycle (standard setting) specified in the System Common block (Block Model 000), or to execute the block at a different specific operation cycle group (1 to 5). <b>Note</b> To change the operation cycle, first set System Common block (Block Model 000) ITEM014 to 0 (stop). The operation cycle cannot be changed while the Loop Controller is running.	R/W	---	---

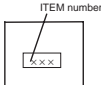
- Note**
- (1) ITEM types and settable modes are the same as for individual ITEMS shown in *3-1-4 ITEMS Unique to Individual Function Blocks*. For details of each ITEM type, see the explanation for the individual function block.
  - (2) This function is enabled only for Basic PID (Block Model 011), Advanced PID (Block Model 012), and Segment Program 3 (Block Model 158) with LCB01/03/05 Version 3.5 or higher. When an execution error occurs, the error can be cleared by setting ITEM 003 to 0.

### 3-1-4 ITEMS Unique to Individual Function Blocks

#### Internal Operations Blocks

ITEM types are divided according to connection and setup mode.

ITEM type	Block diagram symbol	Description	Example	Setting method
Analog input connection information		This is indication data for receiving analog data (unit: %) from an analog output ITEM in another function block.	PV source designation (ITEM006) of the Basic PID block	Specify the block address of the source designation and the ITEM number (analog output ITEM). <b>Note</b> This data can also be set as data for each ITEM or wired in the software.
Analog input	No symbol in block diagram	This is analog data (unit: %) that is received from the source designation specified by the analog input connection information ITEM.	PV input (ITEM007) of the Basic PID block	---
Analog output		Analog data (unit: %) is sent to the analog input ITEM of another function block.	MV output (ITEM087) of the Basic PID block	This is not specified. (The connection is made by specifying output at the send destination block.)
Contact input		Contact signals are input from the Sequence Table block (Block Model 302) or Step Ladder Program block (Block Model 301) or the Contact Distributor block (Block Model 201). *1 Contact signals can also be output to the Step Ladder Program block (Block Model 301) or the Contact Distributor block (Block Model 201). Exception: Note that with some ITEMS the source designation is sometimes specified in the same way as analog input for inputting contact signals.	Remote/Local switch (ITEM026) of the Basic PID block	Contact signals are output to the contact input ITEM of the specified block according to the output instruction in the Sequence Table block (Block Model 302) or Step Ladder Program block (Block Model 301) or according to the destination of the Contact Distributor block (Block Model 201). <b>Note</b> Contact signals are input once via the Sequence Table block (Block Model 302), Step Ladder Program block or the Contact Distributor block also from the System Common block (Block Model: 000, state output for sequence control).
Contact output		Contact signals are output to Sequence Table block (Block Model 302) or Step Ladder Program block (Block Model 301) or the Contact Distributor block (Block Model 201).	High alarm output (ITEM014) of the Basic PID block	Contact signals are input to the contact output ITEM of the specified block according to the input instruction in the Sequence Table block (Block Model 302) or Step Ladder Program block (Block Model 301) or according to the source designation of the Contact Distributor block (Block Model 201).
Accumulated value input connection information		This is the indication data for receiving the accumulation data (00000000 to 99999999) from the accumulated value output ITEM of another function block.	Source designation (ITEM007) of the Accumulated Value Input/Contact Output block (Block Model 186)	Specify the ITEM number (accumulated value output ITEM) of the block Block Model of the source designation. <b>Note</b> This data can also be set as data for each ITEM or wired in the software.
Accumulated value input	No symbol in block diagram	This is the accumulated value data that is received from the source designation specified by the accumulated value input connection information.	Accumulated value input (ITEM008) of the Accumulated Value Input/Contact Output block (Block Model 186)	---
Accumulated value output		Accumulation data (00000000 to 99999999) is sent to the accumulated value input ITEM of another function block.	Accumulated value (ITEM011, 012) of the Contact Input/Accumulated Value Input block (Block Model 185)	This is not specified. (The connection is made by specifying output at the send destination block.)

ITEM type	Block diagram symbol	Description	Example	Setting method
Parameter	<p>Basically, no symbol in block diagram (expressed as follows in some cases as an explanation)</p> 	<p>This is internal data upon which neither the above-described analog input/output nor contact input/output operations are performed.</p> <p>There are two types of parameters: parameters whose value can be changed by one or a combination of the methods 1) to 4) below, and parameters whose value cannot be changed by any of the following methods (only indicated) in 5) below.</p>		
		1) Parameter value can be changed by CX-Process Tool	High alarm setting (ITEM009) of the Basic PID block	Set in CX-Process Tool.
		2) Parameter value can be changed using SCADA software.	Local Set Point setting (ITEM023) of the Basic PID block	Set in SCADA software.
		3) Parameter value can be changed by the Constant ITEM Setting block (Block Model 171) or the Variable ITEM Setting block (Block Model 172).	Proportional band setting (ITEM054) of the Basic PID block	Constants or variables (analog signals) are written according to the write destination of the Constant ITEM Setting block (block number 171) or the Variable ITEM Setting block (block number 172).
		4) Parameter value can be changed by the Sequence Table block (Block Model 302) or Step Ladder Program block (Block Model 301) or the Contact Distributor block (Block Model 201).	Auto/Manual switch (ITEM086) of the Basic PID block	This data is set according to the Sequence Table block (Block Model 302) or Step Ladder Program block (block number 301) or the Contact Distributor block (block number 201). <b>Note:</b> Only "parameters" that are also "contact inputs" (ITEMs whose ITEM type is specified as "contact input/parameters" in the Function Block Reference Manual)
		5) Indication only (by Step Ladder Program)	PV execution error indication (ITEM019) of the Basic PID block	Cannot be set

### Field Input/Output blocks

Function	ITEM type	Description	Setting method
External analog input	Specification of external analog input	Analog signals are received from the Analog Input Unit having the specified unit number.	Specify the unit number of the Analog Input Unit.
	Analog output	Same as regular analog output ITEM	
External analog output	Analog input connection information	Same as regular analog input ITEM	
	Analog input		
	Specification of external analog output	Analog signals are sent to the Analog Output Unit having the specified unit number.	Specify the unit number of the Analog Output Unit.
External contact input	Specification of external contact input	Contact signals are received from the Contact Input Unit allocated to the leading specified CIO (channel I/O) Area.	Specify the leading CIO (channel I/O) Area allocated to the Contact Input Unit.
	Contact output	Same as regular contact output ITEM	
External contact output	Contact input	Same as regular contact input ITEM	
	Specification of external contact output	Specify the leading CIO (channel I/O) Area allocated to the Contact Output Unit.	Contact signals are sent to the Basic I/O Unit allocated to the leading specified CIO (channel I/O) Area.

#### Note Conventions Used in Describing ITEMs

Refer to the *Function Block Reference Manual*.

The Function Block Reference Manual defines reading and writing methods according to the following four methods as one of R: Read, W: Write, or R/W: R/W-enabled.

**1,2,3...****1. According to CX-Process Tool**

- Upload/download of function block files (appended with the .ist extension)
- This indicates reading/writing on validate action or monitor run status windows.

By uploading/downloading by function block files (appended with the .ist extension), ITEMS are divided into two types: ITEMS to be set as defaults (called "default data") and ITEMS (called "operation data") that can be set in either CX-Process Tool or SCADA software.

R: Upload by file, W: Download by file

(S): Initial setting data, (O): Operation data

r: Read in the validate action window of CX-Process Tool

w: Write in the validate action window of CX-Process Tool

**2. According to ITEM Setting block**

This indicates reading/writing by the Constant ITEM Setting block (Block Model 171) or the Variable ITEM Setting block (Block Model 172).

**3. According to Sequence Tables or Step Ladder Program**

This indicates reading/writing by the Sequence Table (Block Model 302), Step Ladder Program (Block Model 301) or the Contact Distributor block (Block Model 201).

**4. According to HMI**

This indicates sending/receiving data for the CPU Unit using the HMI.

ITEM type: Indicates the type of ITEM according to the following categories:  
(For details of categories, see 3-1-1 "Configuration of Function Blocks" in this manual.)  
Contact input, contact output, analog input, analog output, analog input connection information, accumulated value input, accumulated value output, accumulated value input connection information and parameter

ITEM: Indicates the ITEM number in ascending order.

Symbol: Indicates the symbol that is indicated in CX-Process Tool.  
Analog input: X, Analog output: Y, Contact input: S, Contact output: U, etc.

Data description: Indicates the name of the ITEM and its content.

Data range: Indicates the range of data that can be stored.

Default: Indicates the default on CX-Process Tool.

Cold start initialization: Indicates whether the content of the ITEM is initialized when a cold start is performed.

R/W mode: Indicates which of the following modes each ITEM can be read or written by. (R: Read, W: Write, R/W: R/W-enabled)  
CX-Process Tool,  
ITEM Setting blocks (block models 171/172), Sequence Control  
Program (block model 301/302), HMI function.

**Note:** On CX-Process Tool, the R/W mode is indicated by W: Download in file units, R: Upload in file units, r: Read in the validate action window or monitor run status window, r/w: Read/write in the validate action window or monitor run status window, (S): Initial setting data (O): Operation data

Data length: Indicates the data length (bytes) when each ITEM is read or written by a FINS command. This item has no meaning for other commands.

ITEM type	ITEM	Symbol	Data description	Data range	Default	Cold start initialization	R/W mode R: Read, W: Write, R/W: R/W-enabled, ---: R/W-disabled <b>Note:</b> r and r/w: Read and readwrite for validate action or monitor run status by CX-Process Tool. S: Initial setting data, (O): Operation				Data length (bytes)
							According to CX-Process Tool	According to ITEM Setting block	According to Sequential Control Block	According to HMI	
Contact input	000		Stop block operation command (0: Cancel stop, 1: Stop)	0, 1	0	Yes	---	---	---	S, R	1
Parameter	001		Comment	23 characters	Block name	---	R/W (S)	---	---	---	24
	002		Model: Basic PID	011	011	---	R/W (S)	---	---	---	2
Special	003		Execution error indication 0: Normal, Other: Error (See Appendix "Execution Error Code List.")		0000	Yes	R	---	---	S	2

Each of the ITEMS in function blocks can be read and written by FINS commands (command codes 0240, 0241, 0242 or 0243 Hex).

All ITEMS excluding the following items can be read and written by FINS commands:

- Sequence commands (ITEM 011 onwards) of Step Ladder Program block (Block Model 301) and Sequence Table (Block Model 302) rules

**Note** All analog signals on the Loop Controller are processed (input or output) in % units. (They are not processed in engineering units.) Though the data range varies according to each ITEM, the maximum range is  $-320.00$  to  $+320.00\%$ . For example, the data range for PV or Set Point in Control blocks such as the PID block is  $-15.00$  to  $+115.00\%$ , and the data range for MV is  $-320.00$  to  $+320.00\%$ . When analog signals are connected, data is handled with “%” as the common unit regardless of differences in the data ranges between ITEMS. (Note, however, that minus values are regarded as  $0.00\%$  when entered to ITEMS whose data range starts from  $0.00\%$ .) When the function block’s initial setting data (S) is downloaded, the internal memory used for calculating the blocks, and the MV, A/M switch, and R/L switch are initialized. The MV is calculated from 0.

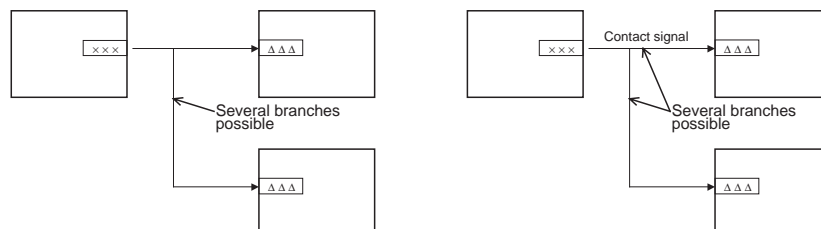
### 3-1-5 Connecting Function Blocks

- For analog signals (variables) and accumulated value signals, specify the block address and ITEM number of the source designation in the ITEMS of the send destination block.
- Specify contacts not in that function block but in the Step Ladder Program block (Block Model 301) or the Contact Distributor block (Block Model 201).
- Also, specify parameters\*1 not in that function block but in the Constant ITEM Setting block (Block Model 171) or the Variable ITEM Setting block (Block Model 172).

\*1: Some parameters cannot be set by ITEM Setting blocks. (For details, refer to the read/write details of each ITEM in the *Function Block Reference Manual*.)

**Note** Contacts can be connected only via the Step Ladder Program block (Block Model 301) or the Contact Distributor block (Block Model 201). In other words, contacts cannot be connected directly.

- When connecting accumulated values, analog signals and contact signals between function blocks, only one signal can be connected to a single input ITEM. However, an infinite number of branches can be made from a single output ITEM.



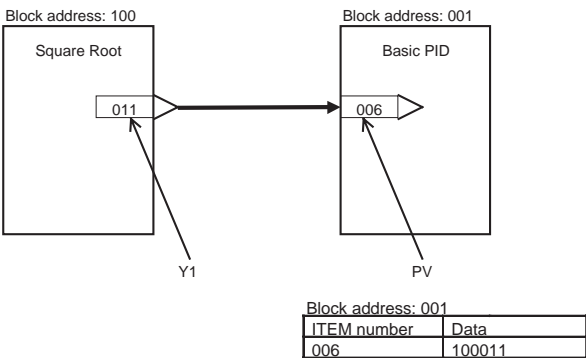


**Connecting analog signals (variables) and accumulated value signals**

**Example**

Specify in the analog input ITEMS which analog output ITEM and its block address are to be used to introduce analog signal function blocks on the input side.

To introduce ITEM006 (PV) of the Basic PID block of block address 001 from ITEM011 (Y1) of the Square Root block of block address 100.



**Note** Connection of analog signals or accumulated value signals can be executed on CX-Process Tool separately from setting of ITEM data as wiring of function blocks. (Connection of analog signals or accumulated value signals can also be set as ITEM data.)

**Connecting contact signals**

Contact signals are connected via the Sequence Table block (Block Model 302), Step Ladder Program block (Block Model 301), or the Contact Distributor Block (Block Model 201). \*1

Specify both contact inputs (Sequence Table block, Step Ladder Program block, or Contact Distributor block to specified function block) and contact outputs (specified function block to Sequence Table block, Step Ladder Program block, or Contact Distributor block) in the Step Ladder Program block (Block Model 301) or the Contact Distributor Block (Block Model 201). Do not specify these contact signals to ITEMS in the specified function block.

**Note** On CX-Process Tool, connection of contact signals is executed at setting of ITEM data.

\*1: As an exception, with some of the ITEMS (PV error input of ITEM018 and MV error input of ITEM090 of the Basic PID block or the Advanced PID block) contacts are input specified as the source designation.

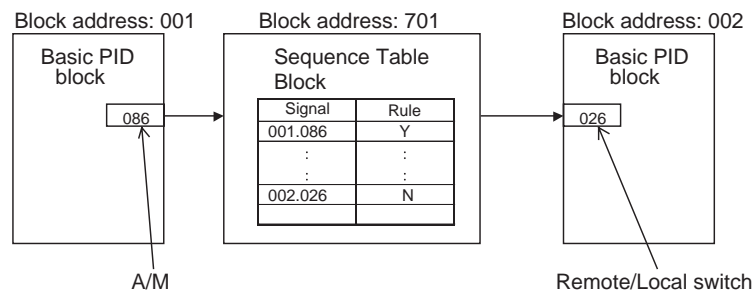
### Connecting via a Sequence Table block or Step Ladder Program block

#### Example

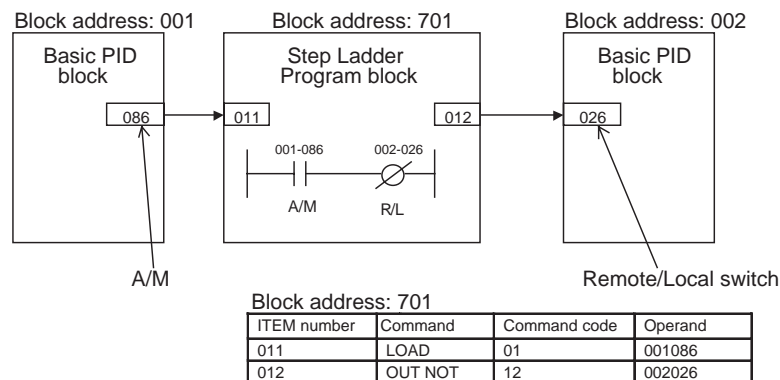
When logical operation is required, use a Sequence Table block (Block Model 302) or Step Ladder Program block (Block Model 301).

Input ITEM086 (Auto/Manual switch) of the Basic PID block of block address 001, and output ITEM026 (Remote/Local switch) of the Basic PID block of block address 002.

#### ■ Using A Sequence Table



#### ■ Using A Step Ladder Program

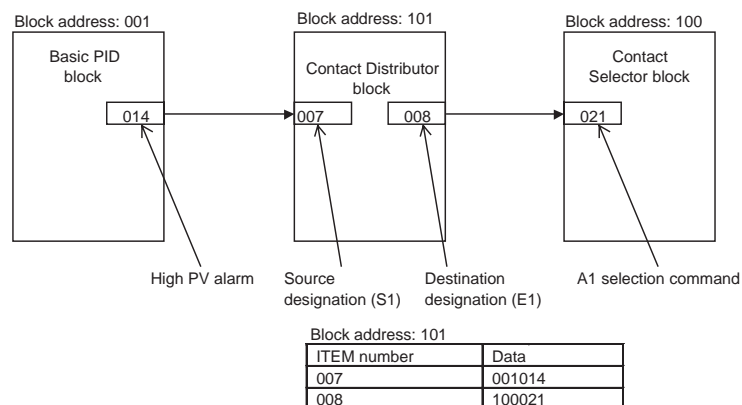


### Connecting via the Contact Distributor block

#### Example

When logical operation is not required, use the Contact Distributor block (Block Model 201).

Input ITEM014 (High PV alarm) of the Basic PID block of block address 001, and write ITEM014 to ITEM021 (A1 selection command) of the Constant Selector block (Block Model 165) of block address 100.



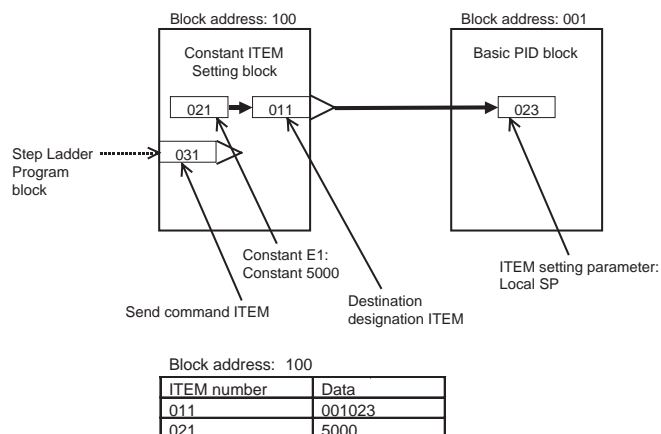
## Connecting ITEM settable parameters

Constants (fixed values) or variables (analog signals) are set by the Constant ITEM Setting block (Block Model 171) or Variable ITEM Setting (Block Model 172).

### To write constants (fixed values)

#### Example

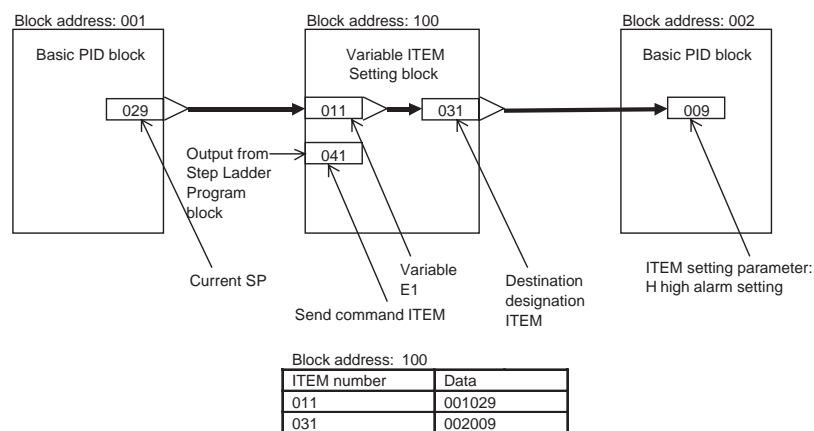
Set constant 5000 (50.00) to ITEM023 (local Set Point) of the Basic PID block of block address 001.



### To write variables (analog signals)

#### Example

Set the value of ITEM029 (current Set Point) of the Basic PID block of block address 001 to ITEM009 (H high alarm setting) of the Basic PID block of block address 002.



**Note** When connections between function blocks are set by ITEM data, do not mistake the ITEM type (for example, specify a connect ITEM as the source designation for an analog signal).

## 3-2 Description of Operation

### 3-2-1 When Turning the Power ON to the PLC

#### Default status

Function block data is not stored to the Loop Controller when it is shipped from the factory. CX-Process Tool must be used to prepare function blocks and download them to RAM and flash memory in the Loop Controller.

## Status after function block data is downloaded

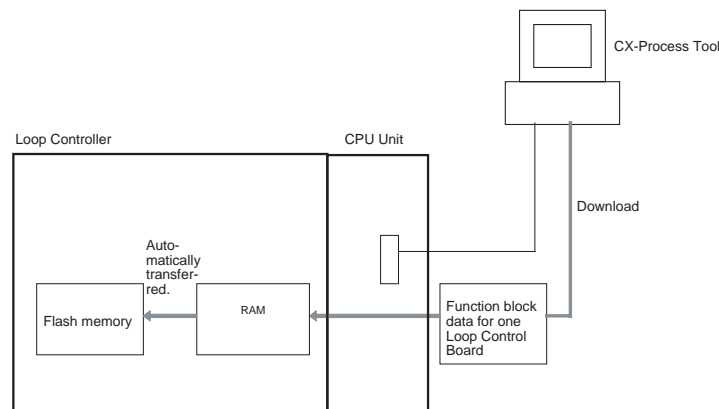
### ■ Operating status

After the function block data is downloaded to RAM and flash memory in the Loop Controller, the Loop Controller will be stopped.

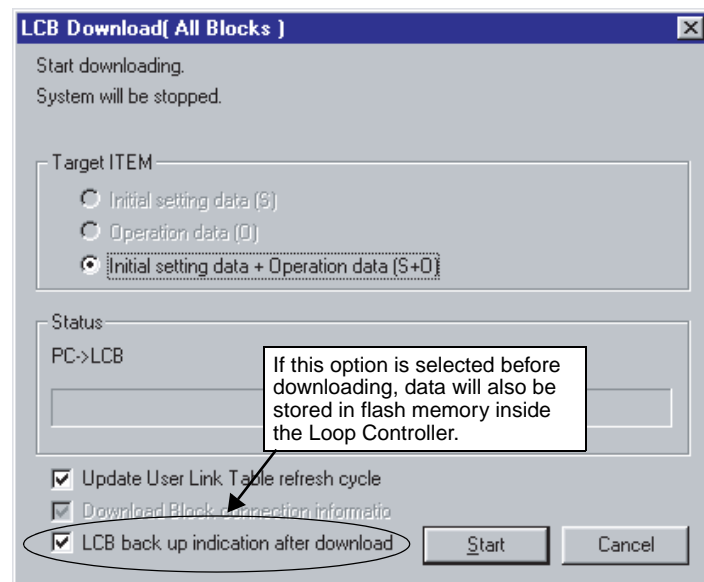
**Note** The Loop Controller will also be stopped after the CX-Process Tool is used to recover flash memory data to the RAM.

### ■ Status of stored data

Function block data will be transferred to RAM in the Loop Controller when the **Execute - Download** command is selected from the CX-Process Tool to transfer data.



**Note** If the LCB back up indication after download selection is checkmarked (check-marked by default), the function block data will automatically be transferred to flash memory for backup.



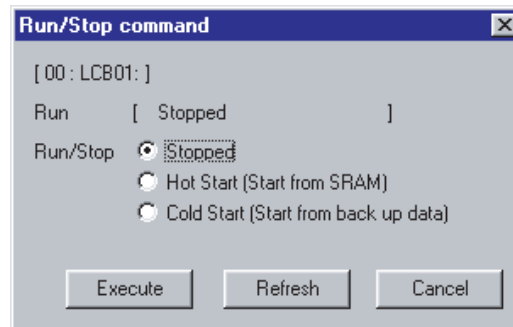
If duplex operation is used with a Process-control CPU Unit (CS1D-CPU□□P) and data in LCB units is downloaded during duplex operation, operation data will be backed up in the flash memory of only the active Board. If the power supply is turned OFF before starting operation with either a hot or cold start, the data will exist only in the flash memory of the active Board, so a duplex verification error will occur. If this occurs, check the RDY indicator on the standby Process-control CPU Unit Loop Controller to make sure that it is

ready to operate and then press the initialization switch on the Duplex Unit to initialize duplex operation.

### Starting operation after transferring function block data

Use one of the following methods to start Loop Controller operation from the CX-Process Tool.

- 1) Use CX-Process Tool to indicate either a hot start or a cold state. (**Execution - Run - Run/stop command**) or 2) Click the **RUN** Button on the toolbar.







**Note** By a hot start, operation is started continued at the state that was active before the stop occurred. By a cold start, operation is started after all internal operation memory is initialized. (PID is reset to the Manual mode with MV = 0% and a local SP.)

For details on hot start and cold start, see 3-2-3 *Details of Hot Start, Cold Start and Stop State*.

- 3) Turn the power to the PLC OFF then back ON again.

**! WARNING** Check the following items before starting to run the Loop Controller:

- 1,2,3...**
1. Do not allow the bank of the EM Area with the number specified for allocation to the HMI (human-machine interface) data to overlap with any other area used by the CPU Unit or other Units. The block allocated for the HMI is specified in ITEM 050 (EM Area Bank Allocated for HMI Memory = 0 to 12) of the System Common block. If areas overlap, the system may operate in an unexpected manner, which may result in injury.
  2. Do not allow the area to which user link table data is written to overlap with any other area used by the CPU Unit or other Units. If areas overlap, the system may operate in an unexpected manner, which may result in injury.
  3. Analog Input/Output Units used in combination with the Loop Controller must be mounted correctly, and the unit number set on the front panel of the Analog Input/Output Unit must match the unit number set on the Field Terminal block. If the unit numbers do not match, input/output (read/write) is performed on the data of another Special I/O Unit (whose unit number is set on the Field Terminal block).
  4. The defaults of the System Common block on the Loop Controller must be set correctly.

-  **WARNING** Always stop the operation of the Loop Controller before converting any of the EM Area to file memory. If any part of the EM Area that is being used by the Loop Controller for the HMI is converted to file memory during Board operation, the system may operate in an unexpected manner, which may result in injury. Analog Input/Output Units used in combination with the Loop Controller must be mounted correctly, and the unit number set on the front panel of the Analog Input/Output Unit must match the unit number set on the Field Terminal block. If the unit numbers do not match, input/output (read/write) is performed on the data of another Special I/O Unit (whose unit number is set on the Field Terminal block).
-  **WARNING** Be sure to check the status of the connected devices before transferring the settings for the MV tight shut function and MV analog output inversion function to the Loop Controller. If the transfer destination is incorrect, unexpected operation of the machinery and equipment may result.
-  **WARNING** When program pattern data is transferred from the Loop Controller to the CPU Unit, be sure to confirm that the transfer destination words are not also used by another Unit. If the transfer destination words are used by another Unit, the system may operate unexpectedly or hazardously.
-  **WARNING** When program pattern data is transferred from the CPU Unit to the Loop Controller, be sure to confirm that the program pattern data is set correctly. If incorrect program parameters are transferred to the Loop Controller, the Loop Controller may operate unexpectedly or hazardously.

### Selecting the START mode at power ON

Whether to use a cold start or a hot start when the PLC's power supply is turned ON or the Loop Controller is restarted (i.e., when A60800, the Inner Board Restart Bit, is turned from OFF to ON) can be set by using the CX-Process Tool to set ITEM018 (START mode at power ON) in the System Common block (Block Model 000).

There are four START modes that can be set.

ITEM018	Content	Default	
		CS Series	CJ Series
0	Hot start within specified time (supported for LCB01/05 version 2.0 or later and LCB03).	---	Default
1	Hot start	Default	---
2	Cold start	---	---
3 (See note.)	Specification from CPU Unit (Not supported for CS1D-LCB05D.) (A60901 turns ON to indicate a hot start, A60902 to indicate a cold start.)	---	---

**Note** Access from the CX-Process Tool software and data exchange between the Loop Controller and the CPU Unit or other external devices will not be possible at startup until either A609.01 or A609.02 turns ON.

#### Default mode

The default mode when the PLC's power supply is turned ON or the Loop Controller is restarted is a hot start for CS-series PLCs and a hot start within specified time for CJ-series PLCs. Refer to 3-2-3 *Details of Hot Start, Cold Start and Stop State* for details on the start modes.

**Hot start mode (ITEM018 = 1)**

When operation is started in hot start mode (ITEM018 = 1), operation will start with all ITEMS and function block values held at the values that existed before the power was turned OFF or the Loop Controller was restarted. The EXEC Indicator on the front panel will light at the same time.

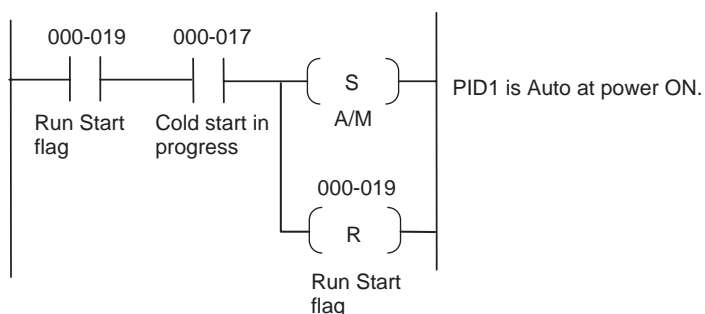
A hot start cannot be performed more than 24 hours after power is turned OFF for CS-series and CJ-series PLCs. If more than 24 hours has passed, a cold start will be used.

**Caution** If the power is turned ON after being OFF for 24 hours or longer, the Loop Controller will automatically start using a cold start even if the startup mode is set to a hot start. If this happens, the auto/manual setting for the Control Block will be set to manual mode (MV=0%) and the remote/local setting will be set to local. To automatically switch to auto mode at the same time as starting operation after the power is turned ON after being OFF for 24 hours or longer, the ladder diagrams in the Sequence Table or Step Ladder Program block must be programmed as follows (same as the procedure for switching to remote operation):

Processing: ITEM086 (Auto/Manual switch) of the Basic PID block or Advanced PID block is set to 1 using ITEM 019 (Run Start flag) and ITEM 017 (cold start in progress) of the System Common block as the input conditions.

**Sequence Table**

Signal	00
STEP	
000.019 Run Start flag	Y
000.017 Cold start in progress	Y
:	
:	
001.086 A/M	Y
000.019 Run Start flag	N
:	
:	
NEXT STEP	THEN
	ELSE

**Step Ladder Program**

For details on hot and cold start operations, refer to 3-2-3 *Details of Hot Start, Cold Start and Stop State*.

**Cold start mode (ITEM018 = 2)**

When operation is started in hot start mode (ITEM018 = 2), the memory area used for operations, as well as the MV output, Auto/Manual switch, and Remote/Local switch settings, are initialized as soon as the PLC's power supply is turned ON or the Loop Controller is restarted and before operation is started. The parameters for control and operation blocks and the SPs for control blocks are read from flash memory and written to RAM, and the HMI

send/receive data is then read from the CPU Unit's HMI data area (in the EM area) and written to RAM.

**Hot start within specified time (ITEM018 = 0)**

When operation is started in hot start mode (ITEM018 = 0), a hot start is performed after recovering from a power interruption if the time that power is interrupted is within the time specified in ITEM037 (Hot start enabled time: 0 to 3,600 s (1 hour)). Cold starts are performed if power is interrupted for longer than this time.

If a hot start within specified time is specified, but a cold start is used because the specified time has been exceeded, the cold start will differ from normal cold starts in that the parameters for control and operation blocks and the SPs for control blocks will not be read from flash memory and the HMI interface data area, i.e., the data that is already in RAM will be used. For CS-series PLCs, however, a normal cold start will be used if the power has been interrupted for more than 24 hours.



## Operations for hot starts, cold starts, and hot starts within specified time

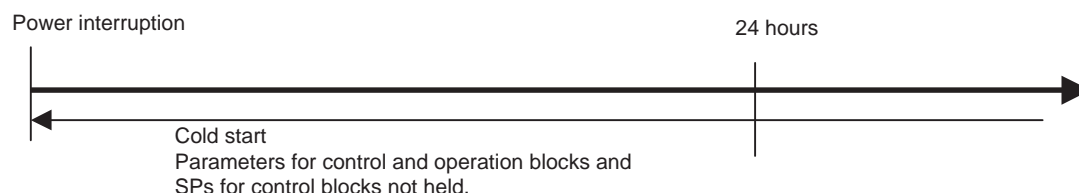
### Hot start mode (System Common block ITEM018 = 1)

#### CS and CJ Series



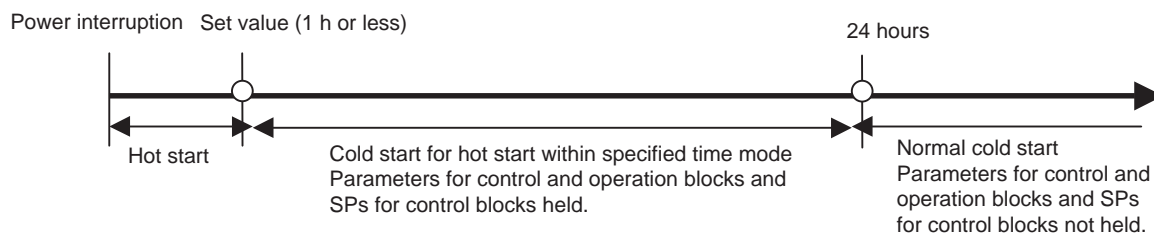
### Cold start mode (System Common block ITEM018 = 2)

#### CS and CJ Series

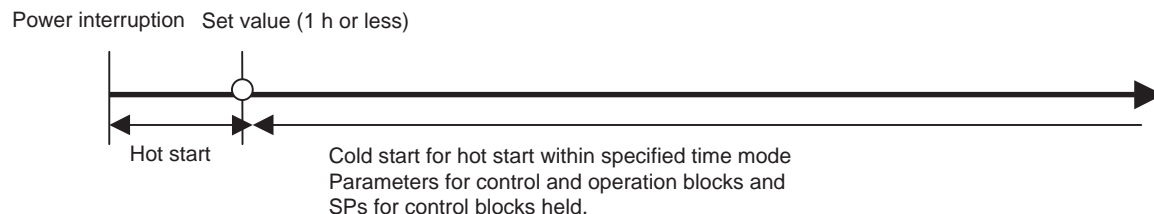


### Hot start within specified time mode (System Common block ITEM018 = 0)

#### CS Series



#### CJ Series



### Relationship with the operation mode of the CPU Unit

The Loop Controller continues running regardless of the operation mode of the CPU Unit.

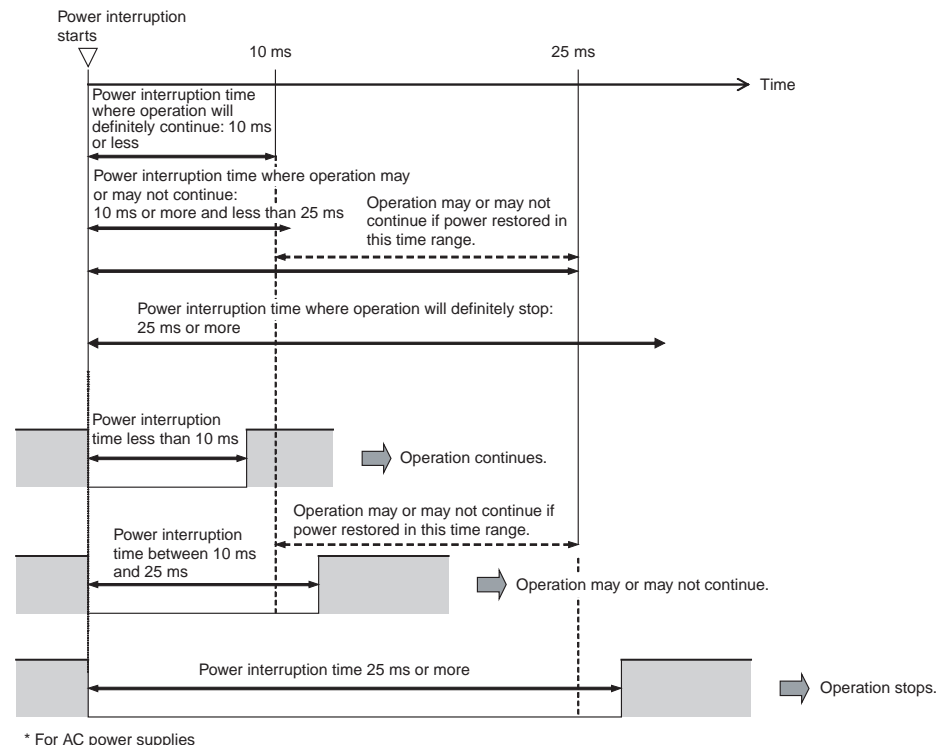
CPU Unit operation mode	Running of Loop Controller
PROGRAM mode	Running is continued.
RUN mode	
MONITOR mode	

### **Continued and stopped Loop Controller operation during momentary power interruptions**

The following information outlines whether or not Loop Controllers will continue or stop operation when a momentary power interruption has occurred in the PLC (Power Supply Unit) power supply. The conditions are the same as for CS-series CPU Units.

Operation conditions will change as indicated below when the momentary power interruption to the PLC power supply voltage (85% or less of the rated voltage) is of the following duration:

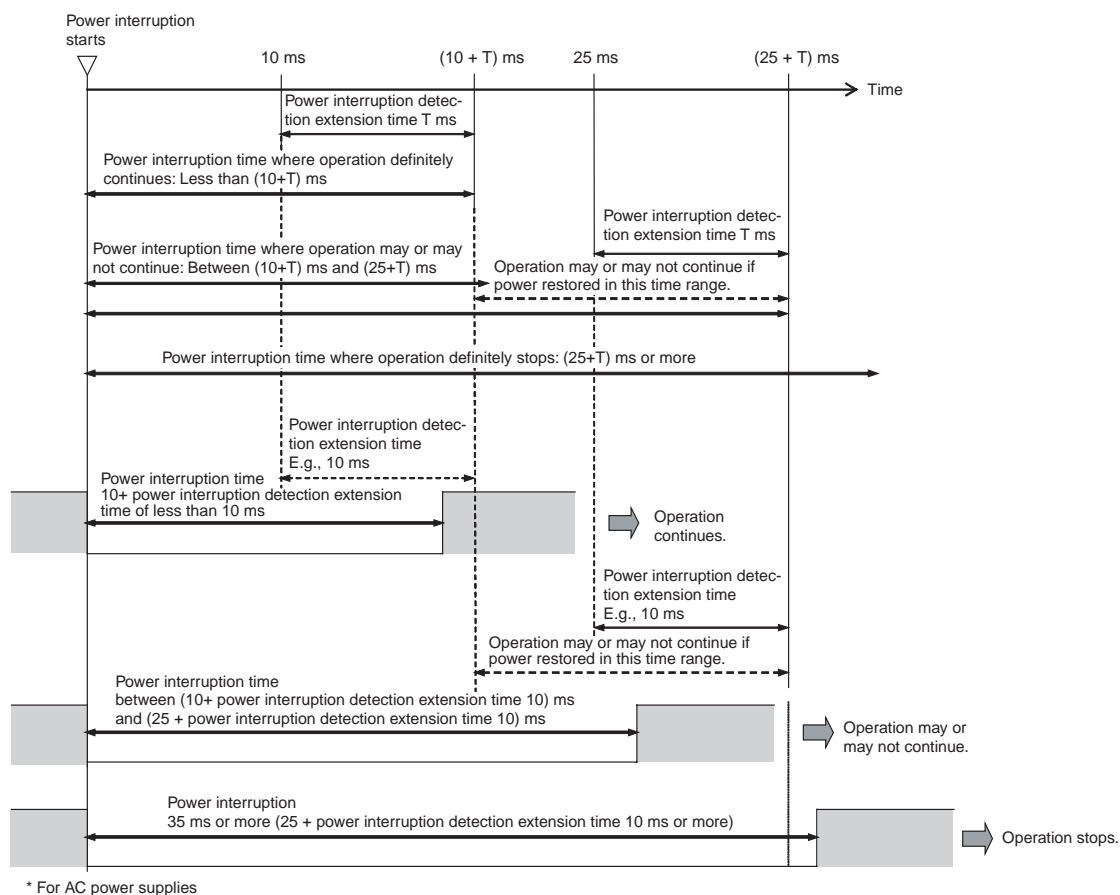
- Less than 0 to 10 ms for AC power supply or less than 0 to 2 ms for DC power supply: Operation continues.
- Between 10 and 25 ms for AC power supply or between 2 and 5 ms for DC power supply: Operation sometimes continues and sometimes stops.
- 25 ms or more for AC power supply or 5 ms or more for DC power supply: Operation stops.



If the power interruption detection extension time (T) is set in the PLC Setup, the time that operation will definitely continue after a power interruption can be set to between 0 and (10+T). T can be set between 0 and 10 ms.

Operation conditions will change as indicated below when the momentary power interruption to the PLC power supply voltage (85% or less of the rated voltage) is of the following duration:

- Less than 0 to (10 + T) ms for AC power supply or less than 0 to (2 + T) ms for DC power supply: Operation continues.
- Between (10 + T) and (25 + T) ms for AC power supply or between (2 + T) and (5 + T) ms for DC power supply: Operation sometimes continues and sometimes stops.
- (25 + T) ms or more for AC power supply or (5 + T) ms or more for DC power supply: Operation stops.



### 3-2-2 Reference: Operations at Power ON

Conditions		A42410 (RAM Error Flag)	A42411 (Inner Board Fatal Error Flag)	System Common Block ITEM018 (START mode at Power ON)	Start method	Transfer processing	A35807 (Automatic Cold Start Execution Flag)
Normal	Normal	OFF	OFF	1 (Hot start setting)	Hot start	None	OFF
				2 (Cold start setting)	Cold start	Transfers (recovers) flash memory data to RAM and transfers the reception data and send/receive data for the HMI to RAM.	OFF
Error (Including data loss due to discharged backup capacitor)	Normal	ON	OFF	1 or 2 (Setting is irrelevant.)	Automatic Cold start	Transfers (recovers) flash memory data to RAM and transfers the reception data and send/receive data for the HMI to RAM.	ON

Conditions		A42410 (RAM Error Flag)	A42411 (Inner Board Fatal Error Flag)	System Common Block ITEM018 (START mode at Power ON)	Start method	Transfer processing	A35807 (Automatic Cold Start Execution Flag)
RAM	Flash memory						
Normal	Error	OFF	OFF	1 or 2 (Setting is irrelevant.)	System Common Block ITEM101 (Backup start specification) set to 1: Performs a cold start automatically after retrying the backup automatically.	After transferring (backing up) RAM data to flash memory, transfers (recovers) flash memory data to RAM and transfers the reception data and send/receive data for the HMI to RAM.	ON (OFF when operation stops)
					System Common Block ITEM101 (Backup start specification) set to 0: Operation stops.	---	---
Error (Including data loss)	Error	ON	ON	1 or 2 (Setting is irrelevant.)	Operation stops.	None <b>Note:</b> The following steps are required to restore operation: Download data to the Loop Controller (LCB level). Specify a cold start.	ON

### 3-2-3 Details of Hot Start, Cold Start and Stop State

There are two ways that the Loop Controller can start operation: either a hot start or a cold start. With the default settings, the Loop Controller will perform a hot start when the power is turned ON or the Loop Controller is restarted.

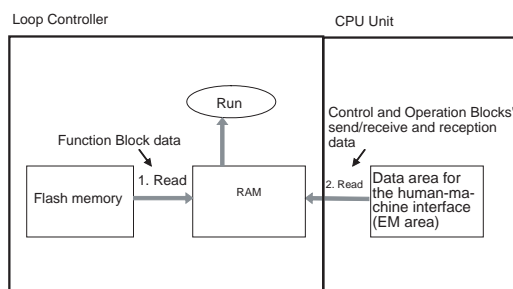
If there is an error in the RAM data due to a discharged backup capacitor or other cause, the Loop Controller will recover the backup data from flash memory and perform a cold start.

#### ■ Cold start

Use the cold start method when it isn't necessary to continue operation with the same values that existed before the power was turned OFF and it is acceptable for the Board to start operation with the following settings: Local Set Point, MV = 0, and Manual mode.

#### 1,2,3...

1. The Board reads the Function block data from flash memory and writes the data to RAM.
2. The Board reads the reception data (SP, PID, etc.) and the Control/Operation Blocks' HMI send/receive data from the CPU Unit's HMI data area (in the EM area) and writes the data to RAM.
3. The Board starts to run after initializing the memory area used for operations as well as the MV output, Auto/Manual switch, and Remote/Local switch settings.

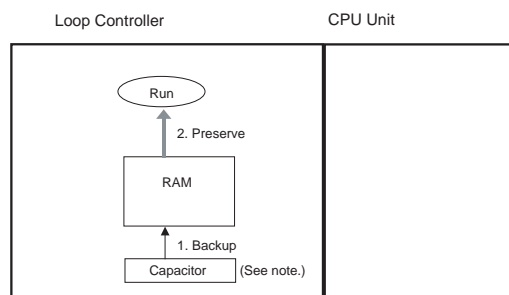


### ■ Hot start

Use the hot start method when it is preferable to continue operations after a short power interruption or it is necessary to use the same Remote/Local setting, MV output value, and Auto/Manual setting that existed before the power went OFF. A hot start cannot be performed if the backup capacitor has discharged. (The backup capacitor can preserve the contents of RAM for about 24 hours for CS-series PLCs and 5 minutes for CJ-series PLCs.)

1,2,3...

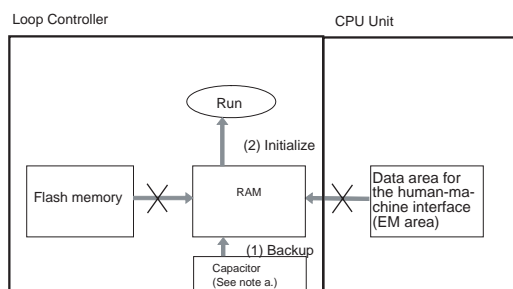
1. If the Function block data has been preserved by the backup capacitor, the Board does not initialize the memory area used for operations or the MV output, Auto/Manual switch, and Remote/Local switch settings.
2. The Board restarts operation with the settings that were preserved from before the power interruption.



**Note** The capacitor is backed up by the battery in the CPU Unit element for CJ-series CPU Units.

### Cold starts when a “hot started within specified time” is specified

A cold start will be used when a “hot started within specified time” is specified but the power supply is interrupted longer than the specified time. The cold start in this case, however, will differ from normal cold starts in that function block data will not be read from the flash memory to RAM and HMI interface send/receive data and receive data (SPs, PID parameters, etc.) for control and operation blocks will not be read from the HMI interface data area (in the EM Area in the CPU Unit). The function block data in RAM (backed up by a capacitor (1)) will be used to initialize the MV, A/M switch, and R/L switch in internal memory for processing (2) and then operation will be started.



**Note** (a) The capacitor is backed up by the battery in the CPU Unit element for CJ-series CPU Units.

(b) Operation is different between CS-series CPU Units and CJ-series CPU Units for power interruptions of more than 24 hours when the hot start within specified time mode is used. Refer to *Operations for hot starts, cold starts, and hot starts within specified time* on page 97 for details.

The following table describes each of the Loop Controller states at a hot start, cold start or in a stop state.

Description		Start of running		Run stop
		Cold start	Hot start	
Basic operation		Operation is started after contact/analog I/O values and internally held values are cleared to zero.	State active before the Board was stopped is continued before running is started.	Running is stopped with the state active before the stop held.
Control blocks	Set Points	If a “hot started within specified time” is specified, but a cold start is used: The status before the power interruption will be maintained.  Other cases: Data read from EM Area bank for HMI function in CPU Unit *1	State active before stop is held. *3	State active before stop is held. *3
	MV	0%		
	Auto/Manual switching	Manual state		
Control blocks, Operation blocks	Parameters	If a “hot started within specified time” is specified, but a cold start is used: The status before the power interruption will be maintained.  Other cases: Data read from EM Area bank for HMI function in CPU Unit *1		
	Contact/analog I/O value	Initialization *2		
	Internal hold value for operation	Initialization *2		
	Step Ladder Program			
Sequence Table		STEP00 and STEP01		
Data exchange with CPU Unit	Status of the Loop Controller (allocated CIO area)	Execution at each 1s regardless of running state		
	Data exchange with function blocks	Refresh is executed at each running cycle.		Data exchange stopped

\*1: The following data is read from the HMI function bank of the EM Area in the CPU Unit for a cold start: Operation and control block HMI send/receive data and receive data (SPs, PID parameters, etc.). (Refer to the column for HMI in the ITEM tables in the *Function Block Reference*

*Manual* for details. ITEMS that are sent or received are indicated in this column.)

Values will not be read from the EM Area when operation is started using a hot or cold start after downloading LCUs/LCBs for the System Common Block or using the CX-Process Tool software.

- \*2: Data to be initialized (cleared) at a cold start are the following values held internally for operations:

Result of previous operation on time function blocks such as the First-order Lag block or Accumulator blocks

Current measurement values of the Step Ladder Program block such as the Timer block or Counter block

- \*3: Parameters that are held in memory are all ITEMS and values held internally for operations

- Note**
1. When the START mode at power ON is set to hot start, correct operation results cannot be obtained if the power is turned ON after it has been OFF for more than 24 hours. For this reason, use CX-Process Tool to stop running of the Loop Controller and start the Board in the cold start mode to clear old data held internally in function blocks that was active before the power was turned OFF.
  2. All function blocks are executed at all times by turning the PLC power ON or restarting the Loop Controller.  
However, execution of some function blocks is triggered by changes in the state of specific ITEMS for some functions, for example, in the Constant ITEM Setting block (Block Model 171) and the Variable ITEM Setting block (Block Model 172).

### 3-2-4 Backup/Recovery Operations and Automatic Transfer of ITEM Data

#### RAM to flash memory backup operation

The Loop Controller will transfer (back up) the function block data in RAM to flash memory in the following cases:

- **Execution - Backup** is executed from the CX-Process Tool.
- The Backup LCB Data to FROM box is checkmarked with the CX-Process Tool before the LCB data is downloaded.
- Backup has been specified using ITEM 125 (Backup start command while running) of the System Common Block (Block Model 000).

- Note**
1. A35813 (Backup Flag) will turn ON during backup and will automatically turn OFF once the backup has been completed normally.
  2. This operation is required after downloading specific function blocks or ITEMS or downloading only the user link table or a sequence table online (all of these are possible while the Loop Controller is operating) if the easy backup function is being used to backup RAM function block data in a Memory Card in the CPU Unit. If this operation is not performed under these conditions, the contents of the Memory Card will differ from the contents of flash memory.
  3. If RAM to flash memory backup is executed (i.e., the Execute/Backup command is selected) during Loop Controller operation, the Loop Controller will continue operating while the data is being backed up.

Data can be backed up during Loop Controller operation with the following combinations.

- CX-Process Tool software version 3.1 or higher and CS1W-LCB01/05 version 1.2 or later or a Process-control CPU Unit (CS1D-CPU□□P)
- CX-Process Tool software version 4.0 or higher and a Loop-control CPU Unit (CS1G-CPU□□P)
- Data can be backed up during operation using ITEM 125 (Backup start command while running) of the System Common Block (Block Model 000) with a Loop-control CPU Unit (CJ1G-CPU□□P) of version 3.5 or later and Loop Control Board (CS1W-LCB□□) or version 3.5 or later.

Backup during operation may, however, take up to 10 minutes to be completed. (Backup while operation is stopped takes up to approximately 10 seconds.)

4. If there is a power interruption while backing up during operation, the system will automatically retry backup after power is restored. In such cases, backup will be re-executed with Loop Controller operation stopped (and the CPU Unit also stopped for Process-control CPU Units (CS1D-CPU□□P). With Process-control CPU Units, however, backup will be automatically performed only for the active Loop Controller and when backup has been completed, a DPL verification error will occur. Check that the RDY LED for the standby Loop Controller is lit (i.e., that the standby Loop Controller is ready) and press the Duplex Unit's initialization switch to execute duplex initialization.
5. If duplex operation is used with Process-control CPU Units (CS1D-CPU□□P) and data in LCB element units is downloaded during operation, operation data will be backed up in the flash memory of only the active Loop Controller. The operation of the Loop Controllers will stop at this time. If the power supply is turned OFF before starting operation with either a hot or cold start, the data will exist only in the flash memory of the active Board, so a duplex verification error will occur. If this occurs, check the RDY indicator on the standby Loop Controller on the Process-control CPU Unit to make sure that it is ready to operate and then press the initialization switch on the Duplex Unit to initialize duplex operation.
6. Only function block (not including blocks common to the system) ITEMS can be changed when data is backed up during operation. The following operations cannot be performed by other Loop Controllers.  
 Batch setting the operating order  
 Batch setting the operation cycle -> download  
 Editing ladder diagrams  
 Downloading user link tables  
 Writing passwords  
 Downloading function block  
 Deleting stored blocks  
 Downloading block wiring diagrams  
 All clear  
 Batch downloading  
 Recovery

### **Flash memory to RAM recovery operation**

The Loop Controller will transfer (recover) the function block data from flash memory to RAM in the following cases:

- **Execution - Recovery** is executed from the CX-Process Tool.
- The Loop Controller performs a cold start.
- A cold start will be performed automatically because the contents of RAM were invalid (including lost data) when the power was turned ON.



- The data will be backed up (from RAM to flash memory) and a cold start will be performed automatically if the power is turned ON and the System Common Block ITEM101 (Backup start specification) is set to 1, the contents of RAM are valid, and the contents of flash memory are invalid.

### Automatic transfer of ITEM data from the HMI area

When a cold start is performed, the function block data is transferred from flash memory to RAM and then the reception and send/receive data for the control and function blocks' HMI is read from the CPU Unit's EM area (the HMI data area.)

**⚠ Caution** When a cold start is performed, RAM data (other than the reception and send/receive data for the control and function blocks' HMIs) will be overwritten with the flash memory data. If it is necessary to preserve the data even when the backup capacitor is discharged, you must use the CX-Process Tool to change the data in function block or ITEM units and then transfer the function block data to flash memory.

## 3-2-5 Simple Backup of Function Block Data to a Memory Card (LCB01/03/05 Ver. 2.0)

### Outline

With LCB01/03/05 Ver. 2.0, the following data (in addition to all data in the CPU Unit) can be simultaneously and automatically backed up, restored, or compared using the Memory Card for the Loop Controller RAM using the simple backup operation.

- Function block data (See note 1.)

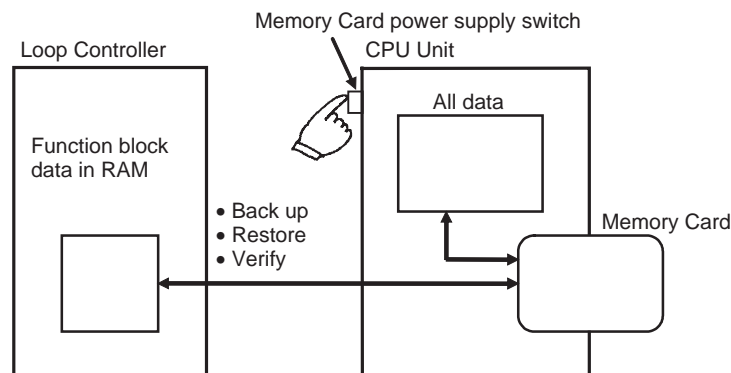
**Note:** (1) Function block ITEM data is the data that is not initialized for a cold start. (i.e., ITEM data with an n-dash (–) in the *COLD start initialization* column for the function block reference ITEM). This is the data that is backed up, restored, or compared using a Memory Card.

The Loop Controller RAM data described above is backed up on Memory Card as a Unit/Board backup file with the following file name whenever the easy backup is used to write data to the Memory Card.

File name: BACKUPE1.PRM

(2) E1 is the Loop Controller's unit number = E1 hex.

Data in this file can be restored and compared from Memory Card. The Loop Controller backup file is called a function block data file in the following description.



### Applications

This backup function is used when backing up data a PLC, including the CPU Unit, Motion Control Units, DeviceNet Units, and Serial Communications Units/Boards, or when all Units are replaced.

## Procedure

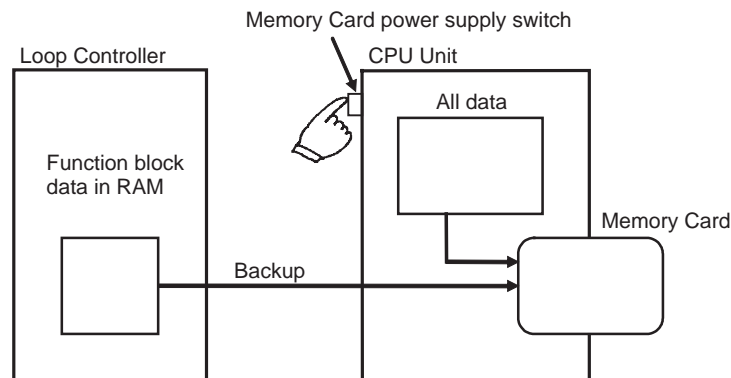
### Backing up function block data files to a Memory Card

**Note** If this operation is performed after downloading specific function blocks or ITEMS or downloading only the user link table or a sequence table online (all of these are possible while the Loop Controller is operating) when the easy backup function is being used to backup RAM function block data in a Memory Card in the CPU Unit, always perform the following operation before performing the easy backup operation to backup the data in RAM to flash memory. If the following operation is not performed, the contents of the Memory Card will differ from the contents of flash memory.

- Select **Execute - Backup** from the CX-Process Tool menus to backup RAM data to the flash memory.
- Alternately, select the *LCB backup indication after download* Option from the CX-Process Tool and download the entire Loop Controller (LCU/LCB).

Set the DIP switch on the front of the CPU as shown in the following table, then press and hold the Memory Card power supply switch for 3 s.

DIP switch on front of CPU unit	
Pin 7	Pin 8
ON	OFF



This creates a function block data file and writes that file along with other backup files to the Memory Card. When the Memory Card power supply switch is pressed, the MCPWR indicator on the front of the CPU Unit flashes once and remains lit while data is being written. The indicator goes out after data has been written normally to the Memory Card.

**Note**

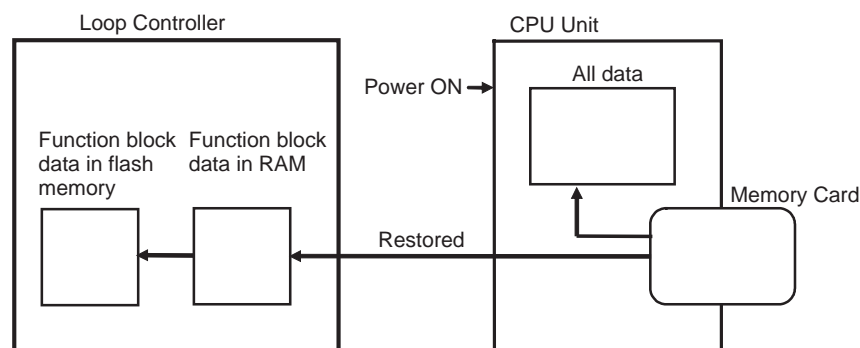
- (1) When password protection is set for the Loop Controller using the CX-Process Tool, the RDY indicator on the front of the Loop Controller will flash if the Memory Card power supply switch is pressed to perform simple backup. Perform simple backup after clearing the password set for the Loop Controller using the CX-Process Tool. If the easy backup operation is performed to backup data in a Memory Card for function block data in a Loop Controller for which a password is set, an empty backup file will be created on the Memory Card.
- (2) Online operations may not be possible from the CX-Process Tool during simple backup. If they are attempted, a communications timeout error or an error response code of 3001 may occur.
- (3) Recovery will start if a Memory Card is inserted and the power supply is turned ON with pin 7 on the DIP switch turned ON. Be sure to turn OFF pin 7 after the operation has been completed.

- (4) Do not perform a download operation, all clear operation, or flash memory recovery operation during execution of an easy backup operation on a Loop Control Board of Version 2.0. Doing so will prevent the data from being backed up correctly. If this data is later restored from the Memory Card, a database error will occur and bit 10 in A424 will turn ON.

### Restoring function block data files from a Memory Card to the Unit

Set the DIP switch on the front of the CPU as shown in the following table, then turn ON the PLC.

DIP switch on front of CPU Unit	
Pin 7	Pin 8
ON	OFF



This reads the function block data file on the Memory Card and restores it to the Loop Controller. The CPU Unit will change to PROGRAM mode.

**Note** When data is restored, the data read from Memory Card to Loop Controller RAM is checked. If the result of the check is normal, the data is automatically written to flash memory.

When the power is turned ON, the MCPWR indicator on the front of the CPU Unit lights, flashes once, and remains lit while data is being read. The indicator goes out after the data is read normally. When this operation has been completed, turn OFF the power supply, turn OFF pin 7, and then turn ON the power supply again.

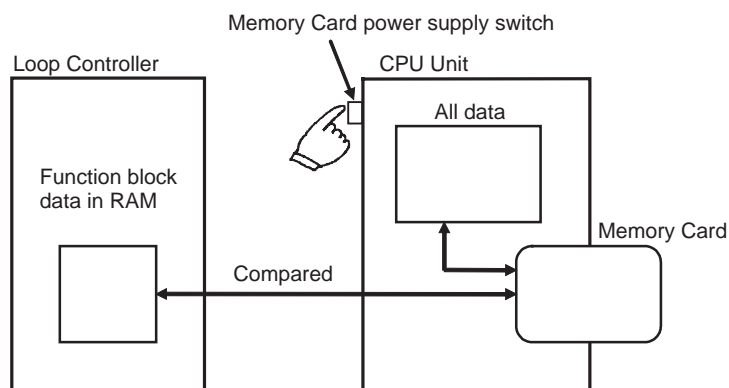
**Note** If the power supply to the PLC is turned ON with pin 7 on the DIP switch turned ON under the following conditions, the RDY indicator on the front of the Loop Controller will flash, a function block database (RAM) error will occur, and A42410 will turn ON in the CPU Unit.

- There is no Memory Card in the CPU Unit.
- The model of the Loop Controller is different from the one in the project saved on the Memory Card.
- The function block data backed up on the Memory Card is corrupted.
- There is an empty backup file on the Memory Card created for a simple backup operation performed for a Loop Controller for which a password has been set.

### Comparing function block data files on Memory Card

Set the DIP switch on the front of the CPU as shown in the following table, then press and hold the Memory Card power supply switch for the Memory Card for 3 s.


DIP switch on front of CPU Unit	
Pin 7	Pin 8
OFF	OFF



This compares data in the function block data file on the Memory Card with the data in RAM in the Loop Controller. When the power ON button is pressed, the MCPWR indicator on the front of the CPU Unit flashes once and remains lit while the data is being compared. If the data matches, the indicator will go out when the comparison is completed. If the data does not match, the MCPWR indicator on the front of the CPU Unit will flash.

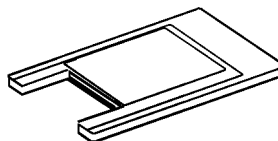
**Note**

- (1) With CX-Process Tool version 4.0 or higher, this easy backup function cannot be used to back up comment data files (comment data, annotation data, tag data, and function block connection information) stored on the Memory Card in the CPU Unit.
- (2) Use an OMRON Memory Card. Operations may be unstable if a non-OMRON Memory Card (compact flash memory) is used.

File memory	Memory type	Memory capacity	Model
	Flash memory	30 Mbytes	HMC-EF372
		64 Mbytes	HMC-EF672
		128 Mbytes	HMC-EF183

**Note** (a) A Memory Card can be written up to approximately 100,000 times. (Each write operation to the Memory Card must be counted regardless of the size of the write.) Be particularly careful not to exceed the life of the Memory Card when writing to it from the ladder program.

(b) The HMC-AP001 Memory Card Adapter is shown below.



For details on the Memory Card, refer to the *SYSMAC CS-series Programmable Controllers Operation Manual* (Cat. No. W339).

**Note** Online operations from the CX-Process Tool software are restricted as shown in the following table during backup operations to a Memory Card for Loop Controller Ver. 2.0.

Online operation from CX-Process Tool			During simple backup operation	Results on CX-Process Tool when operation is not possible	Backup continued/ interrupted	Data in Memory Card resulting from simple backup operation
Download	Downloading individual function block ITEMS (operation data)		Possible	---	Possible	Simple backup operation ends normally, but the data may not be backed up in the Memory Card.
	Downloading block connection information		Possible, but backup may not be normal	---		The data may not be backed up in the Memory Card.  The data backed up in the Memory Card may not be correct. If the data is not correct, a function block database error (RAM) will occur and A42410 will turn ON when recovery is attempted.
	Downloading LCU/LCB		Not possible	Communications timeout error		Simple backup operation ends normally, but the data will not be backed up in the Memory Card.
	Download- ing individual function blocks	System common block	Not possible	Communications timeout error		Simple backup operation ends normally, but the data will not be backed up in the Memory Card.
		Operation blocks				
		Control blocks				
		Sequence control blocks				
		Field terminals				
	Download- ing user link tables	Selected entries	Not possible	FINS response code of 3001 (cannot access Memory Card) returned.		Simple backup operation ends normally, but the data will not be backed up in the Memory Card.
All entries		FINS response code of 3001 (cannot access Memory Card) returned.		Simple backup operation ends normally, but the data will not be backed up in the Memory Card.		
Upload	Upload new		Not possible	Communications timeout error	Possible	Simple backup operation ends normally.
	Update previous		Possible	---		Simple backup operation ends normally.
Verification			Possible	---	Possible	Simple backup operation ends normally.
Deleting registered blocks			Possible	---	Possible	Simple backup operation ends normally, but the data may not be deleted in the Memory Card.
Setting operation cycle globally			Possible	---	Possible	Simple backup operation ends normally, but the data may not be backed up in the Memory Card.

Online operation from CX-Process Tool			During simple backup operation	Results on CX-Process Tool when operation is not possible	Backup continued/ interrupted	Data in Memory Card resulting from simple backup operation
Operation commands	Cold start		Possible, but backup may not be normal	---	Possible	The data backed up in the Memory Card may not be correct. If the data is not correct, a function block database error (RAM) will occur and A42410 will turn ON when recovery is attempted.
	Hot start		Possible	---		Simple backup operation ends normally.
	Stop		Possible	---		Simple backup operation ends normally.
System operation validation			Possible	---	Possible	Simple backup operation ends normally.
Action validation			Possible	---	Possible	Simple backup operation ends normally.
All clear			Possible, but backup may not be normal	---	Possible	The data backed up in the Memory Card may not be correct. If the data is not correct, a function block database error (RAM) will occur and A42410 will turn ON when recovery is attempted.
Tuning			Possible	---	Possible	Simple backup operation ends normally.
Password protection			Possible	---	Possible	The simple backup operation will be cancelled if password protection is set.
Version check			Possible	---	Possible	Simple backup operation ends normally.
Backup/ recovery	Backup (transfer to flash memory in Loop Controller)	While transferring	Possible	---	Possible	Simple backup operation ends normally.
		While stopped	Not possible	MCPWR indicator flashes on CPU Unit and simple backup operation ends in an error.	Not possible	Simple backup operation will not be possible.
	Recovery (transfer from flash memory to RAM in Loop Controller)		Possible, but backup may not be normal	---	Possible	The data backed up in the Memory Card may not be correct. If the data is not correct, a function block database error (RAM) will occur and A42410 will turn ON when recovery is attempted.

### 3-2-6 Simple Backup of Function Block Data to a Memory Card (LCB01/03/05 Ver. 3.0 or Later)

#### Outline

With LCB01/03/05 Ver. 3.0 or later, the following data (in addition to all data in the CPU Unit) can be simultaneously and automatically backed up, restored, or compared using the Memory Card for the Loop Controller RAM using the simple backup operation.

- Function block data (See note 1.)
- Tag and comment data (block diagram information, tags, comments, and annotations)

**Note:** (1) Function block ITEM data is the data that is not initialized for a cold start. (i.e., ITEM data with an n-dash (-) in the *COLD start initialization* column for the function block reference ITEM). This is the data that is backed up, restored, or compared using a Memory Card.

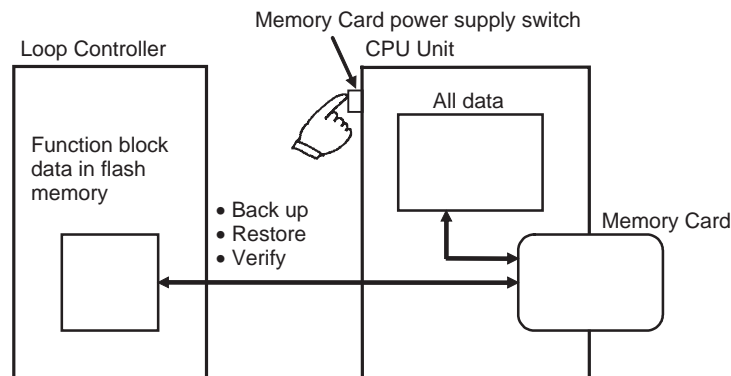
With LCB01/03/05 Ver. 3.0 or later, block diagram information, tags, comments, and annotations are backed up for the easy backup function. This data was not backed up for earlier versions. Also, the data that is backed up has changed from the data in RAM to the data in flash memory. This prevents verification errors from occurring during the easy backup operation when function block parameter ITEMS have been changed in RAM data for Loop Controller program operations. (A verification error will occur with earlier versions.)

The Loop Controller RAM data described above is backed up on Memory Card as a Unit/Board backup file with the following file name whenever the easy backup is used to write data to the Memory Card.

File name: BACKUPE1.PRM

(2) E1 is the Loop Controller's unit number = E1 hex.

Data in this file can be restored and compared from Memory Card. The Loop Controller backup file is called a function block data file in the following description, though it also contains tag and comment data.



**Note** Do not perform an easy backup operation from the CX-Process Tool while backing up function block data from RAM to flash memory or while transferring tag and comment data (function block diagrams, tags, comments, and annotations) to flash memory. The data in flash memory is backed up for LCB01/03/05 Ver. 3.0 or later, and the easy backup operation will not be performed correctly if these operations are performed.

## Applications

This backup function is used when backing up data a PLC, including the CPU Unit, Motion Control Units, DeviceNet Units, and Serial Communications Units/Boards, or when all Units are replaced.

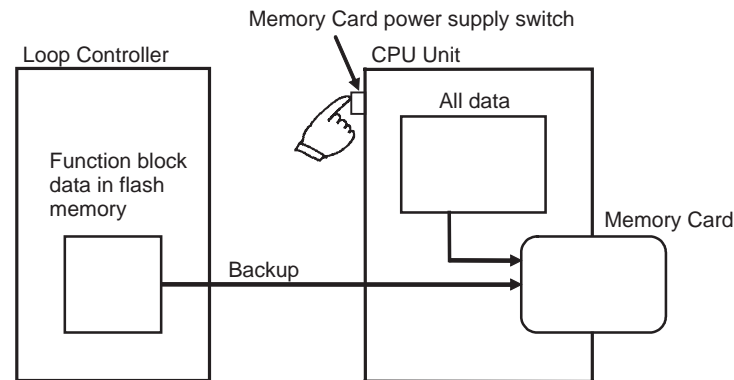
## Procedure

### Backing up function block data files to a Memory Card

**Note** Select **Execute - Backup** from the CX-Process Tool menus to backup RAM data to the flash memory before performing the easy backup operation after downloading specific function blocks or ITEMS or downloading only the user link table or a sequence table online (all of these are possible while the Loop Controller is operating) if the downloaded data is also to be backed up to the Memory Card

Set the DIP switch on the front of the CPU as shown in the following table, then press and hold the Memory Card power supply switch for 3 s.

DIP switch on front of CPU unit	
Pin 7	Pin 8
ON	OFF



This creates a function block data file and writes that file along with other backup files to the Memory Card. When the Memory Card power supply switch is pressed, the MCPWR indicator on the front of the CPU Unit flashes once and remains lit while data is being written. The indicator goes out after data has been written normally to the Memory Card.

#### Note

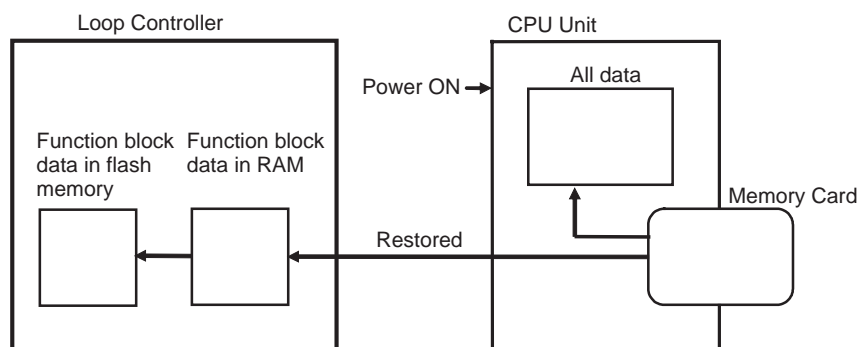
- (1) When password protection is set for the Loop Controller using the CX-Process Tool, the RDY indicator on the front of the Loop Controller will flash if the Memory Card power supply switch is pressed to perform simple backup. Perform simple backup after clearing the password set for the Loop Controller using the CX-Process Tool. If the easy backup operation is performed to backup data in a Memory Card for function block data in a Loop Controller for which a password is set, an empty backup file will be created on the Memory Card.
- (2) Online operations may not be possible from the CX-Process Tool during simple backup. If they are attempted, a communications timeout error or an error response code of 3001 may occur.
- (3) Recovery will start if a Memory Card is inserted and the power supply is turned ON with pin 7 on the DIP switch turned ON. Be sure to turn OFF pin 7 after the operation has been completed.
- (4) Do not perform a save operation to flash memory during execution of an easy backup operation on a Loop Control Board of Version 3.0 or later. Doing so will prevent the data from being backed up correctly. If this data is later restored from the Memory Card, a database error will occur and bit 10 in A424 will turn ON.

#### Restoring function block data files from a Memory Card to the Unit

Set the DIP switch on the front of the CPU as shown in the following table, then turn ON the PLC.

DIP switch on front of CPU Unit	
Pin 7	Pin 8
ON	OFF





This reads the function block data file on the Memory Card and restores it to the Loop Controller. The CPU Unit will change to PROGRAM mode.

**Note** When data is restored, the data read from Memory Card to Loop Controller RAM is checked. If the result of the check is normal, the data is automatically written to flash memory.

When the power is turned ON, the MCPWR indicator on the front of the CPU Unit lights, flashes once, and remains lit while data is being read. The indicator goes out after the data is read normally. When this operation has been completed, turn OFF the power supply, turn OFF pin 7, and then turn ON the power supply again.

**Note** If the power supply to the PLC is turned ON with pin 7 on the DIP switch turned ON under the following conditions, the RDY indicator on the front of the Loop Controller will flash, a function block database (RAM) error will occur, and A42410 will turn ON in the CPU Unit.

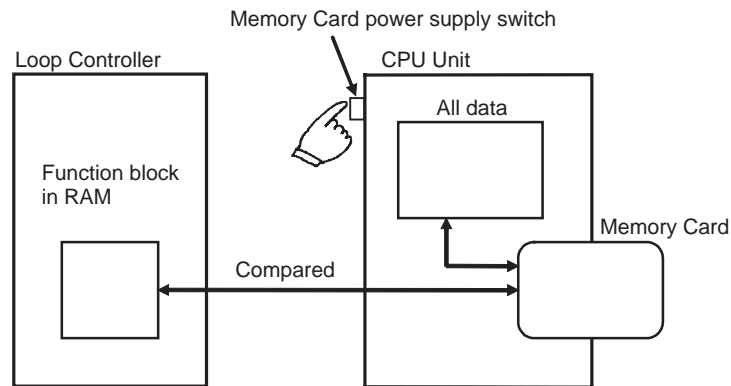
- There is no Memory Card in the CPU Unit.
- The model of the Loop Controller is different from the one in the project saved on the Memory Card.
- The function block data backed up on the Memory Card is corrupted.
- There is an empty backup file on the Memory Card created for a simple backup operation performed for a Loop Controller for which a password has been set.

**Note** Data can be restored and verified when the version of the Loop Controller to which data is being restored is newer than the easy backup data in the Memory Card. Data cannot be restored and verified when the version of the Loop Controller to which data is being restored is older than the easy backup data in the Memory Card because new functions are not supported.

### Comparing function block data files on Memory Card

Set the DIP switch on the front of the CPU as shown in the following table, then press and hold the Memory Card power supply switch for the Memory Card for 3 s.


DIP switch on front of CPU Unit	
Pin 7	Pin 8
OFF	OFF



This compares data in the function block data file on the Memory Card with the data in RAM in the Loop Controller. When the power ON button is pressed, the MCPWR indicator on the front of the CPU Unit flashes once and remains lit while the data is being compared. If the data matches, the indicator will go out when the comparison is completed. If the data does not match, the MCPWR indicator on the front of the CPU Unit will flash.

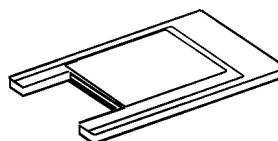
**Note**

- (1) The data that is backed up has changed from the data in RAM to the data in flash memory for LCB01/03/05 Ver. 3.0 or later. This prevents verification errors from occurring during the easy backup operation when function block parameter ITEMS have been changed in RAM data for Loop Controller program operations. (A verification error will occur with earlier versions.)
- (2) Use an OMRON Memory Card. Operations may be unstable if a non-OMRON Memory Card (compact flash memory) is used.

File memory	Memory type	Memory capacity	Model
Memory Card 	Flash memory	30 Mbytes	HMC-EF372
		64 Mbytes	HMC-EF672
		128 Mbytes	HMC-EF183

**Note** (a) A Memory Card can be written up to approximately 100,000 times. (Each write operation to the Memory Card must be counted regardless of the size of the write.) Be particularly careful not to exceed the life of the Memory Card when writing to it from the ladder program.

(b) The HMC-AP001 Memory Card Adapter is shown below.



For details on the Memory Card, refer to the *SYSMAC CS-series Programmable Controllers Operation Manual* (Cat. No. W339).

**Note**

Online operations from the CX-Process Tool software are restricted as shown in the following table during backup operations to a Memory Card for Loop Controller Ver. 3.0.

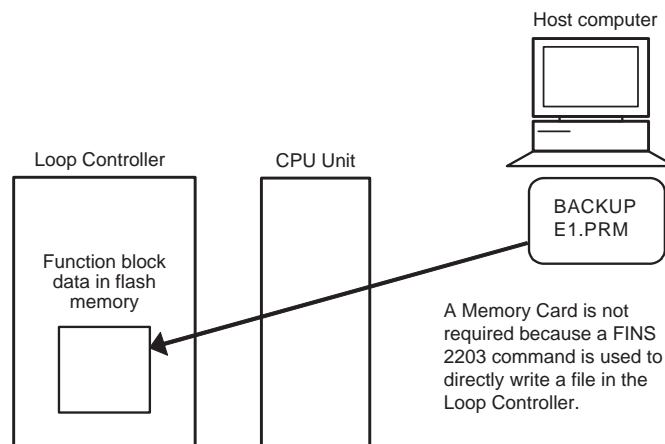
Online operation from CX-Process Tool			During simple backup operation	Results on CX-Process Tool when operation is not possible	Backup continued/ interrupted	Data in Memory Card resulting from simple backup operation	
Download	Downloading individual function block ITEMS (operation data)		Possible	---	Possible	Simple backup operation ends normally, but the data may not be backed up in the Memory Card.	
	Data transfer to flash memory		Possible, but backup may not be normal	---		Simple backup operation ends normally, but the data will not be backed up in the Memory Card.	
	Downloading LCU/LCB		Possible, but backup may not be normal	---		Simple backup operation ends normally, but the data will not be backed up in the Memory Card.	
	Download- ing individual function blocks	System common block	Possible	---			Simple backup operation ends normally, but the data will not be backed up in the Memory Card.
		Operation blocks					
		Control blocks					
		Sequence control blocks					
		Field terminals					
	Download- ing user link tables	Selected entries	Possible	---			Simple backup operation ends normally, but the data will not be backed up in the Memory Card.
All entries		---		Simple backup operation ends normally, but the data will not be backed up in the Memory Card.			
Upload	Upload new		Possible	---	Possible	Simple backup operation ends normally.	
	Update previous		Possible	---		Simple backup operation ends normally.	
Verification			Possible	---	Possible	Simple backup operation ends normally.	
Deleting registered blocks			Possible	---	Possible	Simple backup operation ends normally, but the data may not be deleted in the Memory Card.	
Setting operation cycle globally			Possible	---	Possible	Simple backup operation ends normally, but the data may not be backed up in the Memory Card.	
Operation commands	Cold start		Possible	---	Possible	Simple backup operation ends normally.	
	Hot start		Possible	---		Simple backup operation ends normally.	
	Stop		Possible	---		Simple backup operation ends normally.	
System operation validation			Possible	---	Possible	Simple backup operation ends normally.	
Action validation			Possible	---	Possible	Simple backup operation ends normally.	
All clear			Possible	---	Possible	Simple backup operation ends normally.	
Tuning			Possible	---	Possible	Simple backup operation ends normally.	

Online operation from CX-Process Tool			During simple backup operation	Results on CX-Process Tool when operation is not possible	Backup continued/interrupted	Data in Memory Card resulting from simple backup operation
Password protection			Possible	---	Possible	An empty backup file will be created if a password is set. The RDY indicator will flash.
Version check			Possible	---	Possible	Simple backup operation ends normally.
Backup/recovery	Backup (transfer to flash memory in Loop Controller)	While transferring	Possible, but backup may not be normal	---	Possible	The data backed up in the Memory Card may not be correct. If the data is not correct, a function block database error (RAM) will occur and A42410 will turn ON when recovery is attempted.
		While stopped	Possible, but backup may not be normal	MCPWR indicator flashes on CPU Unit and simple backup operation ends in an error.	Not possible	The data backed up in the Memory Card may not be correct. If the data is not correct, a function block database error (RAM) will occur and A42410 will turn ON when recovery is attempted.
	Recovery (transfer from flash memory to RAM in Loop Controller)		Possible	---	Possible	Simple backup operation ends normally.

### 3-2-7 Replacing Function Block Data in the Loop Controller (LCB01/03/05 Ver. 3.5)

#### Outline

The simple backup function enables directly updating the output BACKUPE1.PRM backup file (i.e., function block data file) in the Loop Controller by using a FINS 2203 command (SINGLE FILE WRITE). This enables replacing the Loop Controller function block data from the host computer. For information on using FINS commands, refer to 6-3 *Description of FINS Commands*.



#### Applications

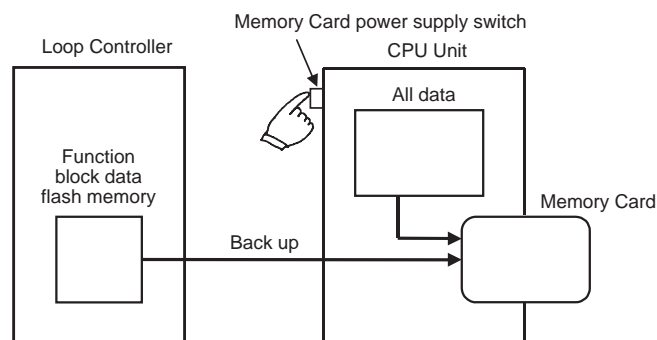
The function block data in the Loop Controller can all be replaced in a batch operation by using a host computer to write to the Loop Controller the BACKUPE1. PRM file, which has been prepared in advance. Using special Support Software (CX-Process Tool) is not required.

## Procedure

### Creating a Function Block Data File (Output to Memory Card)

Set the DIP switch on the front of the CPU Unit as shown in the following table, and then press the Memory Card Power Supply Switch for 3 s.

DIP switch on front of CPU Unit	
Pin 7	Pin 8
ON	OFF

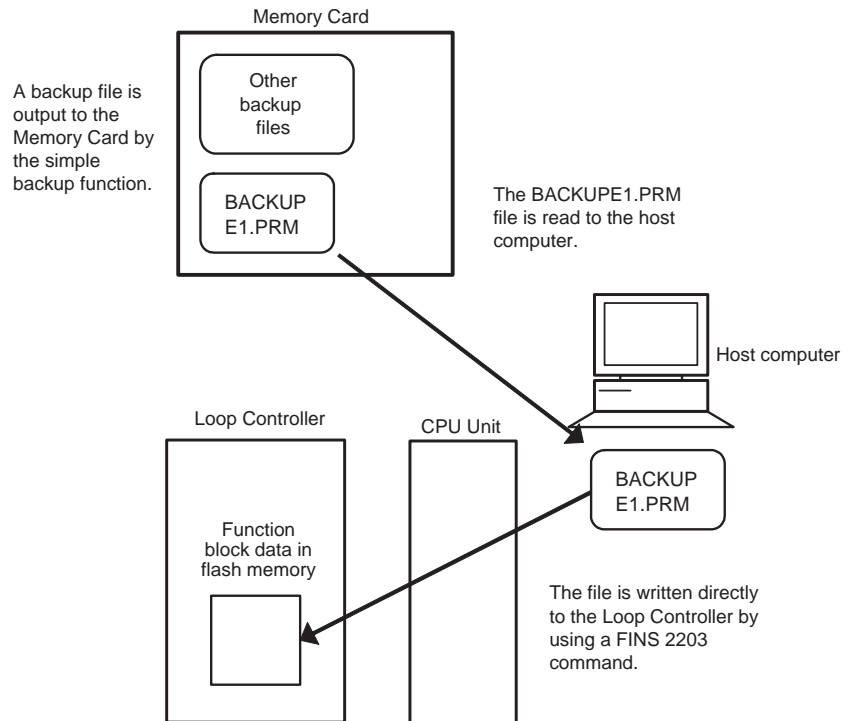


The function block file will be created and written to the Memory Card along with the other backup files. For details, refer to 3-2-6 *Simple Backup of Function Block Data to a Memory Card (LCB01/03/05 Ver. 3.0 or Later)*.

**Note** Use an OMRON Memory Card for the Memory Card. Operation may not be dependable if a non-OMRON Memory Card (i.e., flash memory) is used.

### Writing Function Block Data Files Using FINS Commands

- The BACKIPE1.PRM file made in advance can be written to the Loop Controller by using a FINS command (2203).
- It is not necessary to use the DIP switch or Memory Card Power Supply Switch on the front panel of the CPU Unit.
- If a FINS command (2203) is sent while the Loop Controller is operating, Loop Controller operation will stop.
  - CPU Unit operation will continue.
  - LCB operation will stop.



- The function block data file will be written using the FINS command, and then Loop Controller operation will stop. Use the following procedure to start operation after downloading.

#### ■ LCB Restart

The LCB will restart and then operation will start when A60800 (Inner Board Restart Bit) is turned ON in the Auxiliary Area in the CPU Unit.

#### ■ Cycling the PLC Power Supply

A hot start or cold start can be specified using ITEM 018 (START mode at power ON) of the System Common Block.

### 3-2-8 Indicating Loop Controller Run/Stop (All Function Blocks)

Running of the Loop Controller is started according to the START mode at power ON by turning ON the power to the PLC or by restarting the Loop Controller.

There are three ways of indicating run/stop of the Loop Controller (common to all function blocks) when the PLC power is turned ON.

- 1,2,3...**
1. By operating CX-Process Tool (Both run start and stop can be specified.)
  2. By issuing the FINS WRITE ITEM commands (command codes 0241 and 0243 Hex) to change ITEM014 (run/stop command) of the System Common block (Block Model 000)(Both run start and stop can be specified.)
  3. By changing ITEM014 (run/stop command) of the System Common block (Block Model 000) by the ITEM Setting blocks (Block Models 171 and 172). (Only run stop can be specified.)

- Note**
1. ITEM014 of the System Common block cannot be set to 1 (hot start) or 2 (cold start) by ITEM Setting blocks. Only 0 can be set.
  2. Setting to a hot start or cold start is not accepted if these modes are instructed while the Loop Controller is already running.

- ITEM014 (run/stop command) of the System Common block (Block Model 000) cannot be changed directly by the Step Ladder Program block (Block Model 301). It is changed via the ITEM Setting blocks.

### 3-2-9 Stop Each Function Block Operation and Cancel Operation-Stop

Operation of each function block can also be stopped and stop canceled.

Note, however, that the START mode when an operation stop of each function block is canceled is the hot start mode. The cold start mode cannot be set.

There are three ways of performing the above operations.

- By CX-Process Tool (Both operation can be stopped and operation stop canceled in the Monitor run status screen.)
- By issuing the FINS WRITE ITEM commands (command codes 0241 and 0243 Hex) to change ITEM000 (stop block operation command) of the System Common block (Block Model 000)
- HMI function

- Note**
- Be sure to set 0 to ITEM000 of the System Common block (Block Model 000). If this ITEM is set to 1, the Loop Controller stops running, and data exchange with the CPU Unit is stopped.
  - The following shows the relationship between the run/stop command (ITEM014) of the System Common block and the stop block operation command (ITEM000) of each function block.

When the hot start mode or cold start mode has been set by run/stop command (ITEM014) of the System Common block, ITEM000 of all function blocks automatically becomes 0 (cancel stop), and operation is started by a hot start or cold start.

		ITEM014 of System Common block		
		Set to 0 (stop)	Set to 1 (hot start)	Set to 2 (cold start)
ITEM000 of each function block (stop/cancel stop)	If 1 (stop)	The function block remains stopped (1).	0 Becomes 0 (cancel stop) and hot start is performed.	Becomes 0 (cancel stop) and cold start is performed.
	If 0 (cancel stop)	Stop (priority given to System Common blocks)		

### Indicating Loop Controller start/stop from the CPU Unit

#### Start/stop of running of all function blocks

To instruct Loop Controller start/stop under certain conditions by the CPU Unit, execute the CMND command in the Step Ladder Program on the Loop Controller, and issue the FINS WRITE ITEM command (command codes 0241 or 0243 Hex) to change ITEM014 (run/stop command) of the System Common block.



### 3-2-10 Starting (RUN/STOP) PID Calculation Only for Each Function Block (LCB01/03/05 Ver. 3.0 or Later)

A contact input (RUN/STOP switch) can be used in Basic PID (Block Model 011) or Advanced PID (Block Model 012) to start or stop PID calculations for each function block. The MV at stop setting can also be used to specify the MV when PID calculations are stopped (LCB01/03/05 Ver. 3.0 or later only).

When STOP is switched to RUN, bumpless processing of the MV output value does not function (as a result, the startup time required for high-speed temperature-rise control can be shortened).

**Note** When the calculations are stopped for each function block, alarm processing and PV input processing also stop. When the RUN/STOP switch is used for starting and stopping, PID calculations only can be stopped (specified MV is output) or started.

### 3-2-11 Monitoring the Run Status of Function Blocks

The run status of function blocks can be monitored as follows:

#### When monitoring the run status common to all function blocks

The run status common to all function blocks on the Loop Controller can be monitored by one of the following methods.

Check method		Running	Stopped
1.	RUN LED on front panel of Loop Controller	Lit	Out
2.	Monitor the run status ( <b>Execute - Run - Monitor run status</b> ) on CX-Process Tool	1 (ON): Hot start in progress or cold start in progress	1 (ON): Stopped
3.	ITEM015 of System Common block	0 (OFF)	1 (ON)
	ITEM016 of System Common block	Hot start: 1 (ON)	0 (OFF)
	ITEM017 of System Common block	Cold start: 1 (ON)	0 (OFF)

#### When monitoring the run status of individual function blocks

The run status of individual function blocks can be monitored by either of the following methods when the run status common to all function blocks on the Loop Controller is “running.”

	Method	Running	Stopped
1.	Monitor the run status ( <b>Monitor run status - Start</b> ) on CX-Process Tool	No indication	“Stopped” indicated
2.	ITEM000 of each function block	0 (OFF)	1 (ON)

### 3-2-12 Wireless Debugging (LCB01/03/05 Ver. 3.0 or Later)

Wireless debugging refers to the function that performs online debugging of created function blocks. Wireless debugging uses the following mode.

#### Calibration Mode

This mode enables pseudo-inputs (fixed values) to be forcibly set in the PV (process value) for the following function blocks.

#### Function Blocks and ITEMS

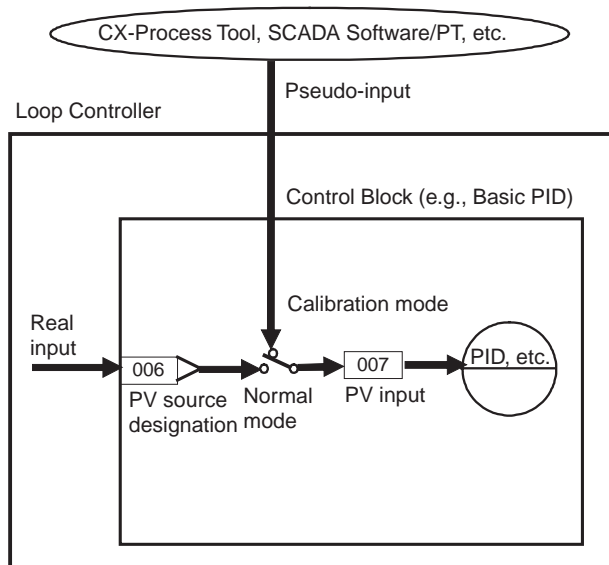
Function block and Block Model	ITEM number	Settable ITEM	Maximum setting	Minimum setting
2-position ON/OFF (Block Model 001)	007	PV [PV input value]	115.00 (%)	-15.00 (%)
3-position ON/OFF (Block Model 002)	007	PV [PV input value]	115.00 (%)	-15.00 (%)
Basic PID (Block Model 011)	007	PV [PV input value]	115.00 (%)	-15.00 (%)
Advanced PID (Block Model 012)	007	PV [PV input value]	115.00 (%)	-15.00 (%)
Blended PID (Block Model 013)	007	P1 [P1 input value]	9,999	0
Batch Flowrate Capture (Block Model 014)	007	P1 [P1 input value]	9,999	0
Indication and Setting (Block Model 031)	007	PV [PV input value]	115.00 (%)	-15.00 (%)



Function block and Block Model	ITEM number	Settable ITEM	Maximum setting	Minimum setting
Indication and Operation (Block Model 032)	007	PV [PV input value]	115.00 (%)	-15.00 (%)
Ratio Setting (Block Model 033)	007	PV [Basic input value]	115.00 (%)	-15.00 (%)
Indicator (Block Model 034)	007	PV [PV input value]	115.00 (%)	-15.00 (%)

### Operation Overview

During Loop Controller operation, pseudo-inputs (fixed values) can be assigned to the PV for the Control Block (e.g., Basic PID) from the CX-Process Tool or SCADA Software/PT during Loop Controller operation.



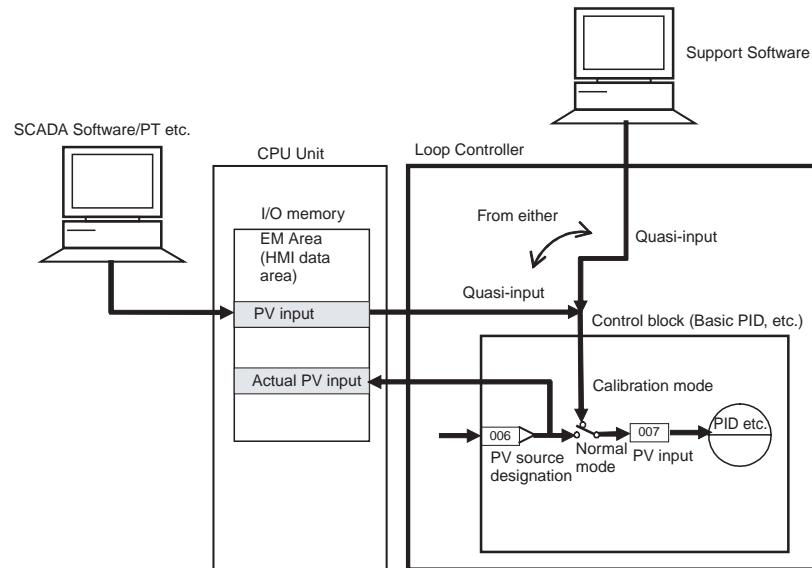
Even if there is no actual sensor externally connected, the operation (e.g., alarm operation) for the entire function block in response to the PV value in the Control Block can be easily confirmed. If a Sensor error occurs, pseudo-inputs can be assigned to enable easy sensor replacement during operation.

### Note

This function eliminates the previous need for function block programming that assigns pseudo-inputs using ITEM write blocks for variables.

### Operations in Calibration Mode

- Use either of the following methods to switch to calibration mode.
  - a. Using CX-Process Tool: Use the wireless debugging setting operation from the operation confirmation window in the block diagram.
  - b. Using SCADA Software/PT, etc. (HMI interface): Turn ON the Calibration Mode Selection Bit in the HMI data area.
- After switching to calibration mode, the actual input specified in ITEM 006 (PV source designation) will be tracked in ITEM 007 (PV input or P1 input). (In other words, the PV will not be changed merely by switching to calibration mode and will be changed only after the PV input value in ITEM 007 is changed.)
- During calibration mode, ITEM 007 (PV input or P1 input) can be changed from the CX-Process Tool, or SCADA Software/PT, etc. (HMI interface).
- The actual PV input in the ITEM 006 (PV source designation) will be reflected in the actual PV input monitoring area (500 words from EM□\_29020) in the HMI data area (in all modes including calibration mode).



### Switching to Calibration Mode and Setting Pseudo-inputs

**Caution** When executing calibration functions, the MV (manipulated variable) will be changed when the PV (process value) is changed in the control block. Therefore, before executing this function, make sure that the equipment will be safe even if the MV changes by setting pseudo-inputs. Otherwise, unexpected equipment operation may result, causing a serious accident.

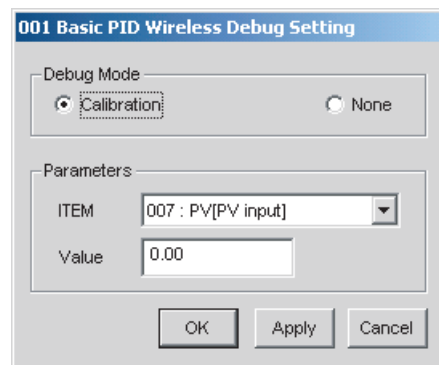
#### Operations from CX-Process Tool

Use the following procedure.

#### Switching to Calibration Mode and Assigning Pseudo-inputs to the PV

1,2,3...

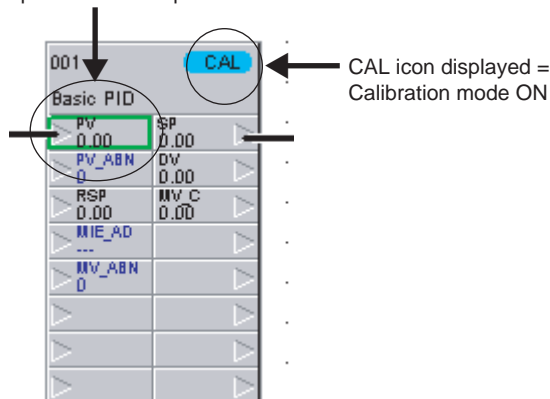
1. Check the block diagram operation.
2. Right-click the function block to which pseudo-inputs are to be assigned, and select **Wireless Debug** from the pop-up menu. The following dialog box will be displayed.



3. Select **Fixed input** under **Debug Mode**, and then enter the value.
4. Click the **OK** or **Apply** Button.
  - When the OK Button is clicked, the setting is applied and the dialog box closes.

- When the Apply Button is clicked, the setting is applied but the dialog box does not close.
5. The display in the function block in the block diagram is as follows:
- The CAL icon is displayed in the top right corner.
  - The PV set as the pseudo-input is framed in green.

Example: Pseudo – input = 100.00



### Exiting Calibration Mode

1,2,3...

1. Right-click the function block for which calibration mode is to be turned OFF, and select **Wireless Debug** from the pop-up menu.
2. Select **No** under *Debug Mode* and then click the **OK** or **Apply** Button.

Operation from the SCADA Software/PT (HMI Interface)

Use the following procedure.

### Switching to Calibration Mode and Assigning Pseudo-inputs to the PV

1,2,3...

1. Set the calibration mode setting ( $EM[ ]15000 + 20 \times \text{Block address} + \text{word } 19$ .  $[ ]$  indicates the bank number) in the HMI data area for the function block to which pseudo-inputs are to be assigned to 1. This procedure will switch operation to calibration mode.
2. Change the PV input or P1 input in the HMI data area ( $EM[ ]15000 + 20 \times \text{Block address} + \text{word } 0$ .  $[ ]$  indicates the bank number).

### Exiting Calibration Mode

Calibration mode can be exited by turning OFF (setting to 0) the Calibration Mode Bit ( $EM[ ]15000 + 20 \times \text{block address} + \text{word } 19$  words, bit 15) in the HMI data area for the function block for which calibration mode is to be exited.

List of related tag ITEMS in SCADA Software.

Offset	ITEM	SCADA Software CSV tag	Data name	Send/Receive
		Tag ITEM (Fixed)		
+ 0 words (first word)	007	PV/P1	PV input/P1 input	Send and receive
+ 18 words (bit 15)	000	MT_ST	Calculation stop command	Send and receive
+ 19 words (bit 15)	000	SYM	Calibration mode	Send and receive

### Note

- (1) Even if the PV input (ITEM 007) is forcibly set in calibration mode, the value will be overwritten when the user link table is executed if the PV input (ITEM 007) is output using the user link table destination designation.
- (2) Operation cannot be switched to calibration mode when calculation is stopped using the HMI interface.

- (3) Calibration mode will be exited and calculation will stop if calculation is stopped from calibration mode. Thereafter, even if the calculation stop status is cleared, operation will start in normal mode and will not return to calibration mode. To return to calibration mode, switch the operation mode again.
- (4) During calibration mode, performing a hot start or cold start, turning ON the power, or restarting the Inner Board will cancel calibration mode.

### **Monitoring Actual PV Input**

When using LCB Ver. 3.0, the real PV input of the function block for calibration mode is always (whether in calibration mode or normal mode) output to the real PV input monitor area. (See note.)

**Note**

- (1) The actual PV input monitor area is allocated in EM□\_29020+N-1 (□ indicates the EM Bank No. and N indicates the block address (1 to 500)).
- (2) When calibration mode is not enabled for the function block, 0 will be output to the actual PV input monitor area.

## **3-2-13 Relationship between CPU Unit States and Loop Controller States**

### **Conditions for stopping and continuing running**

Running of the Loop Controller is stopped or continued under the following conditions.

Running stop conditions	Running continuation conditions
<ul style="list-style-type: none"> <li>• When the following malfunctions occur:               <ul style="list-style-type: none"> <li>• Initial recognition error</li> <li>• Unit error</li> <li>• Function block database error (when all function blocks are in error)</li> <li>• CPU Unit error (WDT error, cyclic monitor error, bus error)</li> <li>• CPU of CPU Unit in standby mode</li> <li>• CPU Unit fatal error (including execution of FALS command)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• When the following malfunctions occur:               <ul style="list-style-type: none"> <li>• Function block database error (when only a specific function block is in error)</li> <li>• CPU Unit non-fatal error (including execution of the FAL command)</li> </ul> </li> <li>• When CPU is in one of PROGRAM, RUN or MONITOR modes</li> <li>• When output of the CPU Unit is OFF (Output OFF flag is ON)</li> </ul>

**Note**

The High Load Alarm Flag (A42408) turns ON if the LCB load rate exceeds 80% three times consecutively. The Loop Controller will continue operation. (For details, 3-2-17 *About the LCB Load Rate.*)

### **Operation of the Loop Controller at a CPU Unit fatal error**

When running of the CPU Unit has stopped due to a fatal error (including execution of the FALS command), running of the Loop Controller is also stopped.

**Note**

Analog Output Units CS1W-PMV01/PMV02, Analog Output Units C200H-DA003/004, CS1W-DA08V/C and CS1W-DA041 and Analog Input/Output Units C200H-MAD01 and CS1W-MAD44 have a function (output hold function) for holding the analog output value to one of the previous value, minimum value or maximum value when either of the following has occurred:

- Fatal error (including execution of the FALS command)
- Output OFF

For this reason, use this output hold function of the Analog Output Unit to hold the analog output values to a specific value when running of both the CPU Unit and Loop Controller has stopped.

### **Operation of the Loop Controller when the CPU Unit is in the PROGRAM mode**

The Loop Controller continues to run even if the CPU Unit is in the PROGRAM mode.

### **Operation of the Loop Controller when the CPU Unit is in the Output OFF condition**

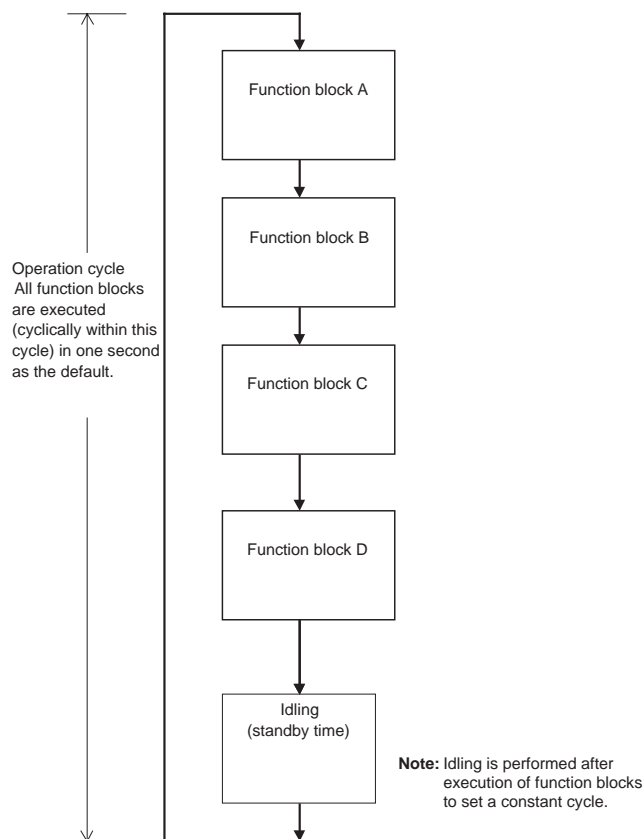
The Loop Controller continues to run even if the Output OFF flag causes output refreshing of the CPU Unit to stop. Note, however, that in this case contacts are not output and turn OFF, and the output hold function of the Analog Output Unit holds analog output to a specific value. For this reason, the Loop Controller only performs internal operations, and does not perform control on the outside.

### **3-2-14 Specifying the Operation Cycle**

All of the function blocks (for example, all Field Terminals and the Step Ladder Program block) on the Loop Controller are executed cyclically.

Basically\*1, all function blocks (including the Step Ladder Program block) are executed at a default common operation cycle of one second that is set in the System Common block (Block Model 000). In other words, at the default setting, the operation cycle of all function blocks is one second, and all function blocks are executed at every second.

For example, when all function blocks A, B, C and D in the figure below are executed and the total execution time is less than one second, function block execution idles until the preset 1-second operation cycle is reached, and execution is resumed from function block A as the next operation cycle.



### **When executing all function blocks at a common operation cycle**

Basically\*1, the default operation cycle (ITEM004) of all function blocks is the system common operation cycle. (In other words, the operation cycle of each function block is interlocked with the value set at ITEM004 of the System Common block.) The default system common operation cycle (ITEM004) of the System Common block (Block Model 000) is one second.

To change the system common operation cycle to a value other than one second, set one of the following values to the system common operation cycle (ITEM004) of the System Common block (Block Model 000).

1: 0.1 sec, 2: 0.2 sec, 3: 0.5 sec, 4: 1 sec, 5: 2 sec (default is 4: 1 sec)

\*1: As an exception, 0 (system common operation cycle) and 5 (2 sec) cannot be set only in ITEM004 (operation cycle) of the following function blocks:

Rate-of-change Operation and Alarm (Block Model 113)

Analog Signal Hold (Block Model 118)

Moving Average (Block Model 145)

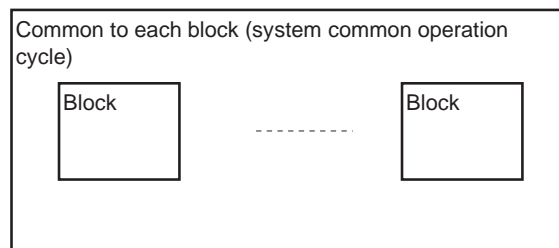
Ramp Program (Block Model 155)

Segment Program (Block Model 156)

Segment Program 2 (Block Model 157)

Time Sequence Data Statistics (Block Model 153)

**Note** Before changing ITEM004 (system common operation cycle) of the System Common block (Block Model 000), be sure to stop running of the Loop Controller, and then resume running of the Unit in the cold start mode. Otherwise, the Unit does not function normally.

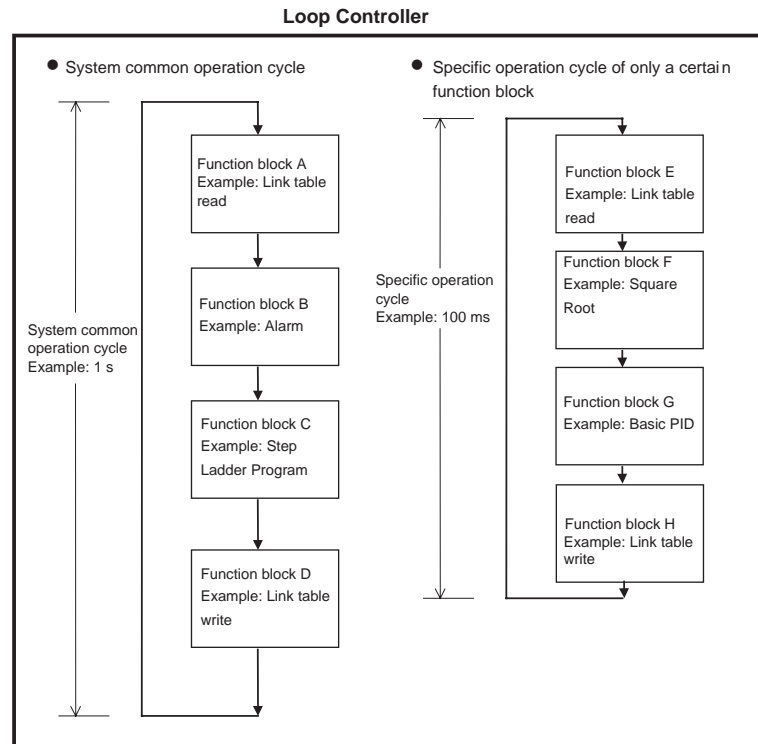


### **When executing a specific function block at a specified operation cycle**

When changing the operation cycle of a specific function block, change ITEM004 (operation cycle) of the respective function block to one of 1: 0.1 sec, 2: 0.2 sec, 3: 0.5 sec, 4: 1 sec, 5: 2 sec, 6: 0.01 sec, 7: 0.02 sec, or 8: 0.05 sec from the default "0: common to each block."

In this way, you can set the operation cycle of each function block to any one of five groups (0.1 sec, 0.2 sec, 0.5 sec, 1 sec, 2 sec, 0.01 sec, 0.02 sec, or 0.05 sec) (nine groups if the system common operation cycle is included). Operation cycle settings of specific function blocks can co-exist with the system common operation cycle. This means that certain function blocks can execute at the system common operation cycle, while other groups can execute at another operation cycle, for example, 0.1 seconds.

**Note** The following settings cannot be set for the LCB05D: 0.01 s (10 ms), 0.02 s (20 ms), and 0.05 s (50 ms).



The operation cycle of specific function blocks can be specified to be shorter than the default 1-second operation cycle in the following instances:

- To increase the response time of analog input/output and the PID operation execution cycle in a pressure or flowrate control loop

In this case, set the operation cycle of all function blocks that are used in a single loop (for example, analog input, square root and other operations, PID control and analog output) to the same shorter value.

- To increase the execution timing, for example, in Remote/Local switching
- To reduce the minimum resolution (time accuracy) of Timer and Counter blocks on the Loop Controller
- The minimum resolution (time accuracy) of Timer and Counter blocks on the Loop Controller is the same as the operation cycle. So, in this case, set the operation timer of the Timer block (Block Model 205) and Counter block (Block Model 208) to shorter values.

### 3-2-15 Conditions for Determining the Operation Cycle

The following conditions must be satisfied on the Loop Controller when determining the operation cycle:

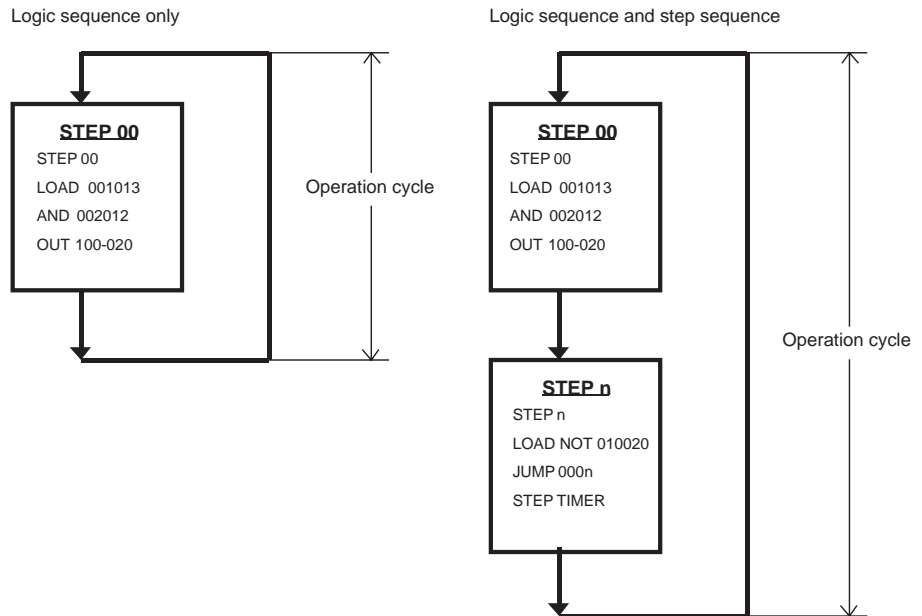
**1,2,3...**

1. The LCB load rate (ratio between actual operation execution time and set operation execution time) must be 80% or less. (For details, see 3-2-17 *About the LCB Load Rate* on page 130.)
2. The external I/O response time of the entire system must be appropriate for the application.

The external I/O response time of the entire system relies on the CPU Unit's cycle time and function block operation cycle. (Refer to 3-2-19 *External I/O Response Cycle on the Overall System* on page 132 for details.)

3. For Process-control CPU unit (CS1D-CPU□□P) only, the operation cycle must be a minimum of 5 times the CPU Unit cycle time.

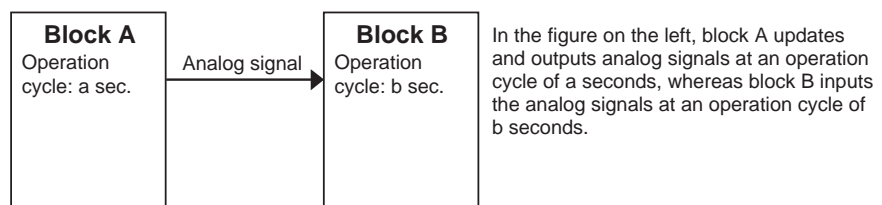
**Note** The execution cycle of sequence commands in the Step Ladder Program block depends on the operation cycle of the Step Ladder Program block (Block Model 301) itself. So, the operation cycle is slower than the execution cycle (cycle time) of commands on the CPU Unit. For this reason, the Step Ladder Program block is used in combination with other function blocks. When high-speed processing is required, use commands on the CPU Unit.



**Note** The minimum resolution (accuracy) of the step timer of the Timer block (Block Model 205), ON/OFF Timer block (Block Model 206), and the Step Ladder Program block (Block Model 301) is the same as the operation cycle set to ITEM004.

### Relationship between inter-function block connections and operation cycle

Even if data connections are made between function blocks having different operation cycles, the inputs and outputs of each function block are refreshed according to the operation cycle of the local node.



**Note** For example, if the output of function blocks having an operation cycle of 0.1 seconds is connected to function blocks having an operation cycle of one second, the 1-second function blocks accept data after 10 operations of the 0.1 second function blocks.

Even if the operation cycles are synchronized, the order of operation of the function blocks does not necessarily match the connection order in the software wiring. (In the above example, function block B does not necessarily follow function block A.) For details, see 3-2-16 *Order of Operations* below.

User link tables are downloaded from the CX-Process with the shortest operation cycle of any of the connected blocks.



### 3-2-16 Order of Operations

The order of execution for all of the functions block that are to be executed in the same cycle is, first of all, determined by execution groups set by the system. Within these groups, the order of execution is determined either by the block addresses or, for control and operation blocks, by user settings or the arrangement of the blocks in the block diagram.

The groups set by the system are as follows (in order from 1 to 4):

- 1,2,3...**
1. Input user link table blocks (including the Di and Ai field input terminals created as virtual blocks on the CX-Process Tool)
  2. System Common block
  3. Control, Operation, External Controller, Sequence Table, and Step Ladder blocks

The order of execution for control, operation, external controller, sequence table, and step ladder blocks is (1) and then (2):

(1) Function blocks in which ITEM 004 is set to 0 (operation cycle specified in the System Common block) are executed first.

(2) Function blocks in which ITEM 004 is not set to 0 are executed next.

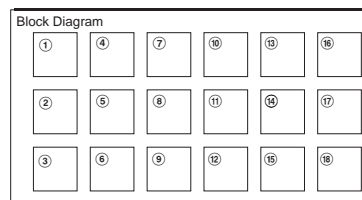
Within groups (1) and (2), blocks are executed in the order: control/operation blocks, external controller blocks, and then sequence tables/step ladder blocks. The order within each of this is as follows:

- The default order of execution for control and operation blocks is in order of block address. The user, however, can set the system to execute control and operation blocks either according to user ITEM settings or according to their position in the block diagram.
  - a. When using user ITEM settings
 

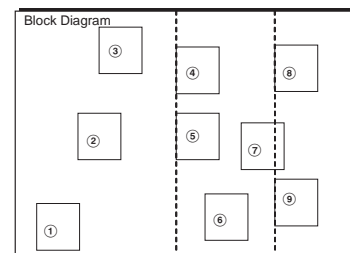
Set ITEM 005 (Execution order) in each block from the CX-Process Tool. ITEM 005 can be set to between 1 and 2,000.
  - b. To execute according to block diagram position
 

Select Settings/Setting Block Operating Order from the menus. The function block diagrams will be executed in order from 1 on, and blocks within each function block diagram will be executed (for the following example) 1, 2, 3, etc., through 18.

Fixed Location Mode



Free Location Mode



**Note** If the same function block is in more than one block diagram, it will be executed in the block diagram with the smallest number.

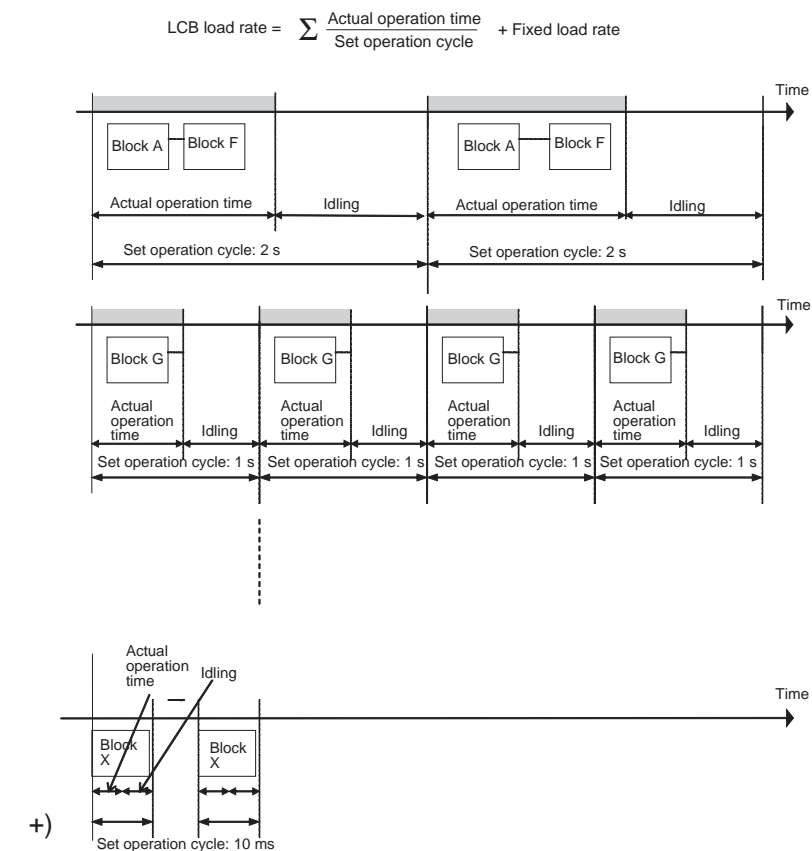
- External Controller blocks are executed in order of block address. Only one External Controller block is executed each cycle.
  - Sequence Table and Step Ladder blocks are all executed each cycle in order of block address.
4. Output User Link Tables (including the Do and Ao field output terminals created as virtual blocks on the CX-Process Tool)

**Note** Set by User Link Tables for the Process-control CPU Unit (CS1D-CPU□□P). The replacement processing is refreshed over multiple cycle times within the operation cycle.

### 3-2-17 About the LCB Load Rate

The minimum operation cycle of each of the function blocks on the Loop Controller can be set to 0.1 seconds. However, when many function blocks are used, the processing capability of the Loop Controller prevents processing at the specified operation cycle. For this reason, the Loop Controller is provided with the LCB load rate concept as an indicator of its processing capability. This load rate is one condition for determining the operation cycle of the function blocks. (See 3-2-15 *Conditions for Determining the Operation Cycle*.)

The LCB load rate is a fixed load rate plus the summation of all actual execution times (the time required for execution before idling) divided by the corresponding set operation times.



LCB load rate is the time actually required for actual operation for all operation cycles divided by the summation of the set operation cycles plus a fixed load rate.

The actual operation execution cycle is a total of the following two times:

- 1,2,3... 1. Overhead time (FINS command communications and internal processing)
2. Total operation execution time of each function block in the same operation cycle group

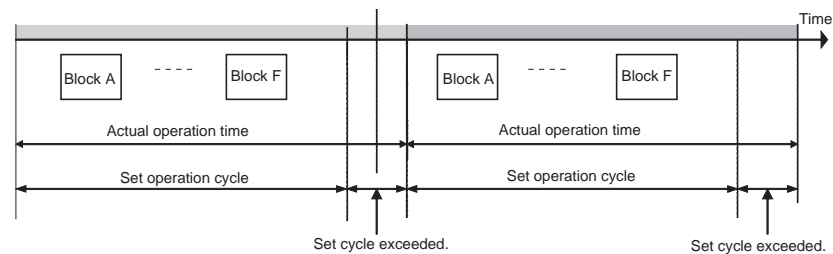
### 3-2-18 Evaluating the LCB Load Rate at the System Design Stage

The guideline LCB load rate for function blocks on the Loop Controller is 80%. At the system design stage study whether or not the LCB load rate of each function block is 80% or less.

Though errors caused by PID and other operations do not occur when the LCB load rate exceeds 80%, use the Loop Controller at a LCB load rate of 80% or lower as there is possibility that the LCB load rate will temporarily increase due to fluctuations in the overhead time of FINS command communications and internal processing.

Monitor the maximum LCB load rate from the CX-Process Tool system operation verification function. (Select **Operation - Validation** from the Execute Menu and check the value of ITEM 048 (maximum LCB load rate). The value that is given will be the largest LCB load rate since operation was begun.

If the LCB load rate exceeds 1005, operation will continue and the operation cycles will be exceeded as shown below. There will be errors, however, in PID calculations.



Take the following steps if the LCB load rate exceeds 80%.

1,2,3...

1. If there are any blocks for which a longer operation cycle can be set without affecting the applications, increase their operation cycles.
2. If the LCB load rate still exceeds 80% and the operation cycles cannot be increased any further, add on a CPU Unit.
3. If a CPU Unit cannot be added, add on a Loop Control Unit (up to three Loop Control Units can be mounted on a single PLC) and distribute processing between the mounted Units.

### **Monitoring the LCB load rate at the trial operation stage**

At the trial operation stage, monitor which value the LCB load rate actually reaches at the preset operation cycle(s) on CX-Process Tool.

Follow the procedure below to monitor the LCB load rate.

1,2,3...

1. Download the function block data to the Loop Controller.
2. Start running of the Loop Controller using CX-Process Tool or by turning the PLC power OFF then back ON again.
3. Establish the connection to CX-Process Tool, and select **Operation - Run monitor status** from the Execute menu.

The following LCB load rates (current LCB load rate and maximum LCB load rate) are displayed in the Run monitor status screen:

Each of the current LCB load rates and maximum LCB load rates for the system common operation cycle and each of the 0.1 s/0.2 s/0.5 s/1 s/2 s operation cycle groups

If the maximum LCB load rate of a certain operation cycle group exceeds 80%, change the operation cycle of function blocks among function blocks within that group, for which an increased operation cycle will not affect the application, to a longer operation cycle (group).

If it is estimated that an operation cycle longer than this cannot be set when the LCB load rate exceeds 80%, add on a CPU Unit or a Loop Control Unit (up to three Loop Control Units can be mounted on a single PLC) and distribute processing between the mounted Units.

**Note** The LCB□□s do not support the automatic operation cycle switching function of the Loop Control Units. The High Load Alarm Flag (A42408), however, will turn ON if the LCB load rate exceeds 80% for 6 seconds. If this bit turns ON, use longer operation cycles or add Loop Control Units to distribute processing.

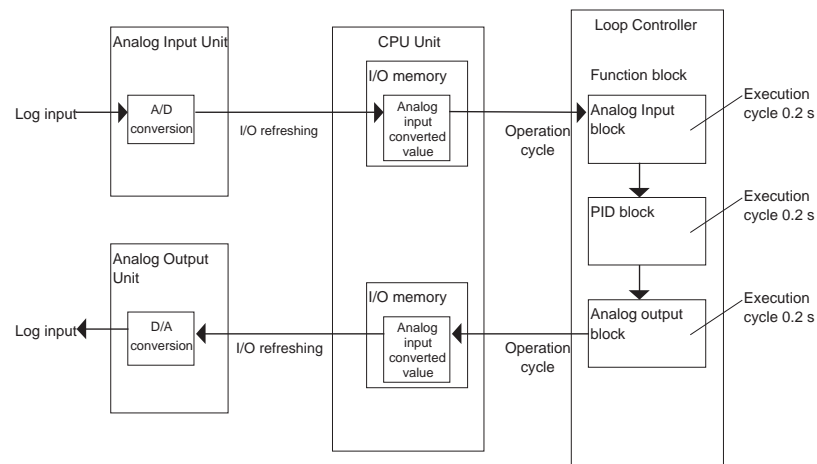
### 3-2-19 External I/O Response Cycle on the Overall System

The Loop Controller exchanges field I/O values (analog input values, analog output values, contact inputs and contact outputs) with external Units by the following method.

- 1,2,3... 1. The Analog Input/Output Unit or the Basic I/O Unit refresh the I/O memory on the CPU Unit.
2. The Loop Controller exchanges data allocated to I/O memory on the CPU Unit according to the operation cycle of each function block.

#### Example

Data exchange of analog input, PID operation and analog output



The external I/O response time in the overall system (simply called “the external I/O response time” from here on) refers to the time from when the analog input data is converted and the Analog Input Unit reads the analog input value to when the PID operation is performed and the Analog Output Unit outputs analog output value. This response time indicates the response of the overall system.

**Note** The external I/O response time is equivalent to twice the input sampling cycle (or operation cycle) on a general controller. For this reason, when designing the system, calculate the external I/O response time according to the formulae shown below, and study whether or not there will be any problem with control with the target application. In particular, study whether or not there will be any problem in controllability of PID control in the case of fast-response control targets, such as pressure or flowrate. Calculate the external I/O response time using the methods described in the following sections.

#### Maximum External I/O Response Time

CS1W-LCB01 and CS1W-LCB05 Loop Control Boards and Loop-control CPU Units (CJ1G-CPU□□P)

The maximum external I/O response time is calculated as follows:

$$2 \times \text{A/D conversion time} + (2 \times \text{CY}) + (2 \times \text{T}) + 2 \times \text{D/A conversion time}$$

where,

CY: Cycle time of the CPU Unit

T: Operation cycle

**Example** Cycle time of 20 ms, operation cycle of 0.1 seconds (100 ms), A/D conversion time = 8 ms, D/A conversion time = 8 ms  
 In this example, the maximum I/O response time would be as follows:  
 $2 \times 8 \text{ ms} + (2 \times 20 \text{ ms}) + (2 \times 100 \text{ ms}) + 2 \times 8 \text{ ms} = 272 \text{ ms}$

**Process-control CPU Unit (CS1D-CPU□□P)** The maximum external I/O response time is calculated as follows:  
 $2 \times \text{A/D conversion time} + (2 \times \text{CY}) + (3 \times \text{T}) + 2 \times \text{D/A conversion time}$   
 where,  
 CY: Cycle time of the CPU Unit (\*1)  
 T: Max. operation cycle time (\*2)  
 \*1: If the actual cycle time is less than 20 ms, use 20 ms for CY (cycle time).  
 \*2: Longest operation cycle in the function block group comprising the loop

**Example** Cycle time of 20 ms, max. operation cycle of 0.1 seconds (100 ms), A/D conversion time = 8 ms, D/A conversion time = 8 ms  
 In this example, the maximum I/O response time would be as follows:  
 $2 \times 8 \text{ ms} + (2 \times 20 \text{ ms}) + (3 \times 100 \text{ ms}) + 2 \times 8 \text{ ms} = 372 \text{ ms}$

### Minimum External I/O Response Time

**CS1W-LCB01 and CS1W-LCB05 Loop Control Boards and Loop-control CPU Units (CJ1G-CPU□□P)** The minimum external I/O response time is calculated as follows:  
 $\text{A/D conversion time} + (1.0 \times \text{T}) + \text{D/A conversion time}$   
 where,  
 T: Operation cycle

**Example** Operation cycle of 0.01 seconds (10 ms), A/D conversion time = 1 ms, D/A conversion time = 1 ms  
 In this example, the maximum I/O response time would be as follows:  
 $1 \text{ ms} + (1.0 \times 10 \text{ ms}) + 1 \text{ ms} = 12 \text{ ms}$

**Process-control CPU Unit (CS1D-CPU□□P)** The minimum external I/O response time is calculated as follows:  
 $\text{A/D conversion time} + (1.0 \times \text{T}) + \text{D/A conversion time}$   
 where,  
 T: Operation cycle

**Example** Operation cycle of 0.1 seconds (100 ms), A/D conversion time = 1 ms, D/A conversion time = 1 ms  
 In this example, the maximum I/O response time would be as follows:  
 $1 \text{ ms} + (1.0 \times 100 \text{ ms}) + 1 \text{ ms} = 102 \text{ ms}$

**Note** Precautions when Using the Analog Input/Output Unit

The unit number set on the front panel of the Unit must always match the unit number setting of the Field Terminals.

When running of the Loop Controller is started using the Field Terminals, the Loop Controller executes the following writing on the allocated CIO area of the unit number specified by the Field Terminals.

- 1,2,3...**
1. Analog values are written on the allocated CIO area of the analog output data on the Analog Output Unit and Analog Input/Output Unit.
  2. Writing is performed internally on the leading words (n) of the allocated CIO area on the Analog Output Unit and Analog Input/Output Unit.

For this reason, if the wrong unit number on the Field Terminals is set, the wrong data will be written to the allocated CIO area of the Special I/O Unit having that unit number, and may cause the overall PLC system to malfunction.

Before starting running of the Loop Controller, first make sure that the unit number on the Field Terminals matches that set on the front panel of the Analog Input/Output Unit.

Field Terminals that undergo writing by the Loop Controller

Model	Function block name	Target Analog Input/Output Unit	Internal writing by Loop Controller	Writing of analog values
552	AO 8-point Terminal (DA003/4)	C200H-DA003/004	00FF Hex is stored to leading allocated word (n).	Analog value is stored to allocated area n+1 to n+8.
553	AI 2-point/AO 2-point Terminal (MAD01)	C200H-MAD01	0003 Hex is stored to leading allocated word (n).	Analog value is stored to allocated area n+1 to n+2.
583	AI 4-point/AO 4-point Terminal (MAD44)	CS1W-MAD44	000F Hex is stored to leading allocated word (n).	Analog value is stored to allocated area n+1 to n+4.
563	AO 4-point Terminal (PMV01)	CS1W-PMV01 (isolated-type control output)	None	Analog value is stored to allocated area n+1 to n+4.
585	AO 8-point Terminal (DA08V/C)	CS1W-DA08V/C	00FF Hex is stored to leading allocated word (n).	Analog value is stored to allocated area n+1 to n+8.
587	AO 4-point Terminal (DA041)	CS1W-DA041	000F Hex is stored to leading allocated word (n).	Analog value is stored to allocated area n+1 to n+4.
565	AO 4-point Terminal (PMV02)	CS1W-PMV02 (isolated-type control output)	None	Analog value is stored to allocated area n+1 to n+4.
591	AO 2-point Terminal (DA021)	CJ1W-DA021	0003 Hex is stored to leading allocated word (n).	Analog value is stored to allocated area n+1 to n+2.
592	AI 4-point/AO 2-point Terminal (MAD42)	CJ1W-MAD42	0003 Hex is stored to leading allocated word (n).	Analog value is stored to allocated area n+1 to n+2.

**Note** Field Terminals that do not undergo writing by the Loop Controller

Model	Function block name	Target Analog Input/Output Unit	Internal writing by Loop Controller	Writing of analog values
551	AI 8-point Terminal (AD003)	C200H-AD003	None	None
561	AI 4-point Terminal (PTS01/02/03/11/12, PDC01/11, PTW01)	CS1W-PTS01/PTS11 (isolated-type thermocouple input), CS1W-PTS02/03/12 (isolated-type temperature-resistance thermometer), CS1W-PDC01/11 (isolated-type analog input), CS1W-PTW01 (2-wire transmitter input)		
562	AI 4-point Terminal (PPS01)	CS1W-PPS01 (isolated-type pulse input)		
564	AI 8-point Terminal (PTR01/02)	CS1W-PTR01 (Power Transducer Input Unit), CS1W-PTR02 (analog input 100 mV)		
566	AI 4-point Terminal (PTS51)	CS1W-PTS51/CJ1W-PTS51 (isolated-type thermocouple input)		
567	AI 4-point Terminal (PTS52)	CS1W-PTS52/CJ1W-PTS52 (isolated-type temperature resistance thermometer input)		
568	AI 8-point Terminal (PTS55)	CS1W-PTS55 (isolated-type thermocouple input)		
569	AI 8-point Terminal (PTS56)	CS1W-PTS56 (isolated-type temperature resistance thermometer input)		
570	AI 8-point Terminal (PDC55)	CS1W-PTS56 (isolated-type analog input)		
571	AI 2-point Terminal (PRS15/16, PDC15)	CJ1W-PTS15 (isolated-type thermocouple input), CJ1W-PTS16 (isolated-type temperature resistance thermometer input), CJ1W-PDC15 (isolated-type analog input)		
572	AI 4-point Terminal (PH41U)	CJ1N-PH41U Isolated-type High-resolution Analog Input Unit with Fully Universal Inputs		
573	AI 4-point Terminal (AD04U)	CJ1W-AD04U Isolated-type General-purpose Analog Input Unit with Fully Universal Inputs		
581	AI 4-point Terminal (ADG41)	CJ1W-ADG41 High-speed Analog Input Unit		
582	AI 16-point Terminal (AD161)	CS1W-AD161		
584	AI 8-point Terminal (AD081)	CS1W-AD081		
586	AI 4-point Terminal (AD041)	CS1W-AD041		

**When Analog Output Units C200H-DA003/004, CS1W-DA08V/C or CS1W-DA041 and Analog Input/Output Unit C200H-MAD01 or CS1W-MAD44 are used**

When the operation mode of the CPU Unit changes from RUN or MONITOR to PROGRAM, the Conversion Enable flag of the Analog Output Unit and the Analog Input/Output Unit is turned OFF from the CPU Unit, and the output hold function holds analog output values at the previous value, minimum value or maximum value.

The Loop Controller forcibly turns this Conversion Enable flag ON when the Unit is in use.

However, when the CPU Unit changes to the PROGRAM mode, the Conversion Enable flag momentarily (operation cycle of Loop Controller) turns OFF, and as a result the analog output value is momentarily switched to the momentary output hold value.

To prevent the analog output value from being switched to the momentary output hold value when the CPU Unit changes to the PROGRAM mode, set the I/O Memory Hold flag (A50012) of the CPU Unit to ON, and set "Hold ON/OFF of I/O Memory Hold flag at power ON" to ON in the PLC Setup.

**When isolated-type Control Output Unit CS1W-PMV01/02 is used**

Isolated-type Control Output Units do not have a Conversion Enable flag. Disabling of conversion is indicated by the setting of the allocated Data Memory area. As the default setting, conversion is executed, and analog output values are refreshed and output. Conversion is executed at all times as long as it is not disabled by this allocated Data Memory area (except by a CPU Unit fatal error).

However, when the CPU Unit changes to the PROGRAM mode, the analog output value momentarily (operation cycle of Loop Controller) turns OFF, and as a result, the analog output value is momentarily switched to the lower limit (minimum) value.

To prevent the analog output value from being switched to the lower limit (minimum) value when the CPU Unit changes to the PROGRAM mode, set the I/O Memory Hold flag (A50012) of the CPU Unit to ON, and set "Hold ON/OFF of I/O Memory Hold flag at power ON" to ON in the PLC Setup.

## 3-3 Exchanging Data with the CPU Unit

The Loop Controller exchanges the following two types of data with the CPU Unit:

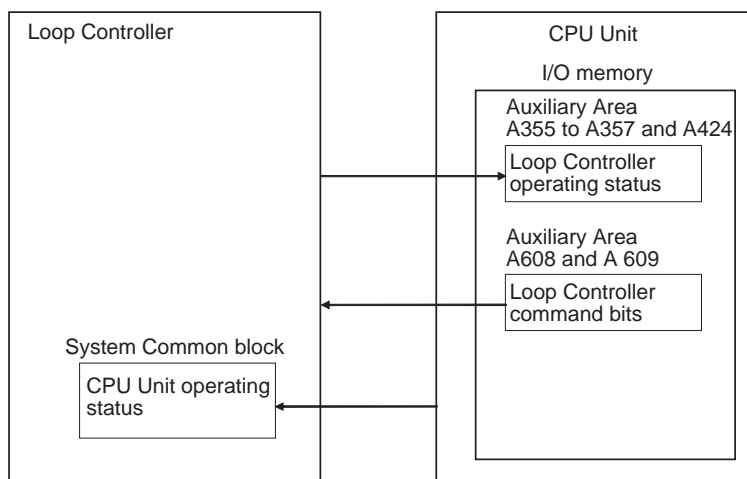
1. Mutual exchange of run status
2. Commands from CPU Unit to Loop Controller
3. Exchange of any data

### 3-3-1 Mutual Exchange of Run Status

The run status of the Loop Controller and the CPU Unit can be monitored mutually by the following two areas:

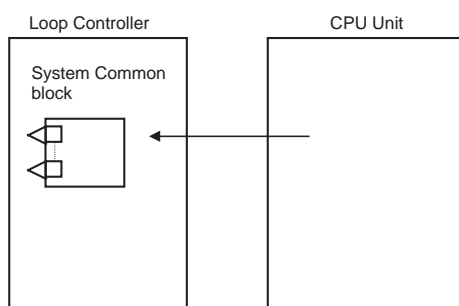
- Allocated CIO area for CPU Bus Unit: Run status of Loop Controller is sent to the CPU Unit.
- System Common blocks (Block Model 000): Run status of the CPU Unit is sent to the Loop Controller.





### Run status of CPU Unit

The run status of the CPU Unit is reflected in ITEM007 to ITEM011 and ITEM013 of the System Common block at all times. For this reason, the required processing can be executed on the Loop Controller by the Step Ladder Program block (Block Model 301) or other blocks based on the contact output of the System Common block.



CPU Unit run status in System Common block

ITEM	1 (ON)	0 (OFF)
007	Fatal error (fatal error detected by system self-diagnostics or execution of FALS instruction)	Not fatal error
008	CPU Unit running (RUN mode or MONITOR mode)	Stopped (PROGRAM mode or fatal error)
009	Output OFF (Auxiliary Area A50015 turns ON.)	Not output OFF
010	RUN mode	Not RUN mode
011	MONITOR mode	Not MONITOR mode
013	PROGRAM mode	Not PROGRAM mode

### To perform processing on the Loop Controller according to the run status of the CPU Unit

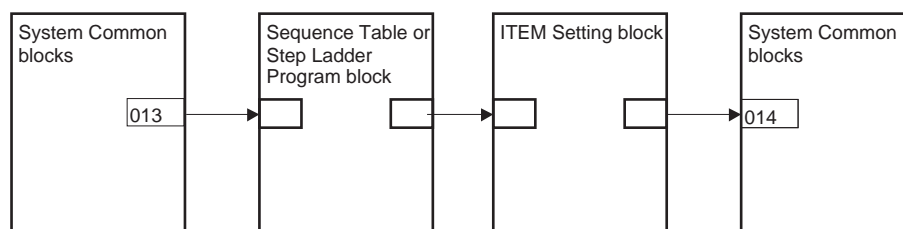
To perform specific processing on the Loop Controller according to the run status of the CPU Unit, use a Sequence Table or Step Ladder Program block to perform the required processing taking the following run status (ITEM007 to ITEM011, ITEM013) of the System Common block as the input conditions.

#### Example

To indicate stop when the CPU Unit is in the PROGRAM mode

To forcibly stop running of the Loop Controller when the CPU Unit is in the PROGRAM mode, input ITEM013 (PROGRAM mode) of the System Common block (Block Model 000) as the run status of the CPU Unit, and set ITEM014 (run/stop command) of the System Common block to 0 (stop) by the

Sequence Table block (Block Model 302), the Step Ladder Program block (Block Model 301) and the ITEM Setting blocks (Block Models 171 and 172).

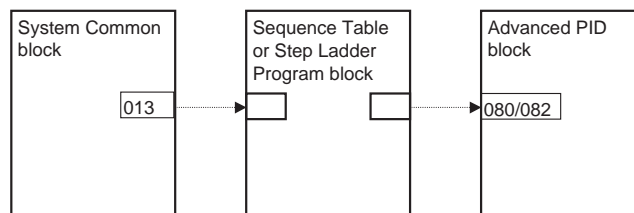


**Note** When ITEM014 (run/stop command) of the System Common block is set to 0, the Loop Controller will not start to run as it is even if the CPU Unit operation mode is set to RUN or MONITOR. To resume running of the Loop Controller, ITEM014 (run/stop command) of the System Common block must be set to either 1 (hot start) or 2 (cold start).

### Example

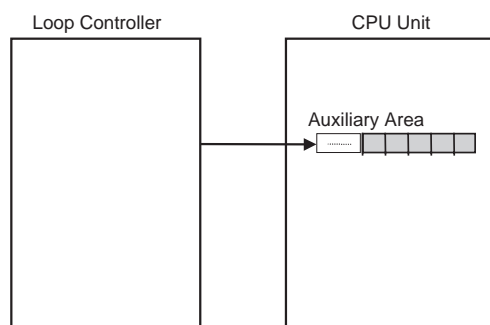
To indicate switching to the preset MV value of PID control or MV hold in the System Common block

Likewise, to forcibly set the MV (manipulated variable) to a specific value from the Advanced PID block when the CPU Unit is in the PROGRAM mode, input ITEM013 (PROGRAM mode) of the System Common block as the run status of the CPU Unit, and set the preset MV switch (ITEM080) or the MV hold switch (ITEM082) of the Advanced PID block to ON.



### Run status of Loop Controller

The run status of the Loop Controller is reflected at all times in A35800 to A35815 in the CPU Unit. For this reason, the required processing can be executed by the Step Ladder Program of the CPU Unit taking this run status as the input conditions.



**Note** On the Loop Controller, the refresh timing of the words allocated in the Auxiliary Area of the CPU Unit is not the I/O refresh timing of the CPU Unit, but the refresh timing of the 1 sec operation cycle (fixed) for LCB01 and LCB05. (The refresh timing is the CPU Unit cycle time (each duplex refresh) for LCB05D.)

### To perform processing from the CPU Unit according to the run status of the Loop Controller

So that the CPU Unit can perform specific processing (for example, changing the analog output value to a specific value) according to the run status of the Loop Controller, create a Step Ladder Program taking bits A35800 to A35815.

**Example 1:**

To perform processing when the Loop Controller has stopped running

Execution of a specific process is enabled as follows when the Loop Controller has stopped running or a data exchange error has occurred with the CPU Unit functioning as an Inner Board:

**Example 2:**

To notify that function blocks have changed while the Loop Controller was running.

If a function block is changed from the CX-Process Tool during Loop Controller operation, notification is made by creating a warning or other indication of the change.

**Auxiliary Area Flags Relevant to the Loop Controller****Flags (Loop Controller to CPU Unit)**

Word	Bit	Name	Explanation	Settings
A324	06	Right-side Inner Board Nonfatal Error Flag (Process-control CPU Unit (CS1D-CPU□□P) only)	This flag is set to 1 (ON) when the right-side Inner Board has a nonfatal error when the CS1D CPU Unit is in duplex mode.	1: Nonfatal error 0: No nonfatal error
	07	Left-side Inner Board Nonfatal Error Flag (Process-control CPU Unit (CS1D-CPU□□P) only)	This flag is set to 1 (ON) when the left-side Inner Board has a nonfatal error when the CS1D CPU Unit is in duplex mode.	1: Nonfatal error 0: No nonfatal error

Word	Bit	Name	Explanation	Settings
A358	01	PV Error Input Flag	This flag notifies the CPU Unit whether ITEM018 (PV error input) of the Basic PID block (block model 011) or Advanced PID block (block model 012) is ON or OFF. <b>Note:</b> Normally specify the Analog Input Block's "output from disconnected line detection contact ITEM" as the source of ITEM018 (PV error contact source designation.)	1: PV error input is ON. 0: PV error input is OFF.
	02	MV Error Input Flag	This flag notifies the CPU Unit whether ITEM090 (MV error input) of the Basic PID block (block model 011) or Advanced PID block (block model 012) is ON or OFF. <b>Note:</b> Normally specify the Analog Output Unit's "output from disconnected line detection contact ITEM" as the source of ITEM090 (MV error contact source designation.)	1: MV error input is ON. 0: MV error input is OFF.
	03	Execution Error Flag	This flag notifies the CPU Unit that a function block execution error has occurred when ITEM003 (the execution error code) of one or more blocks is non-zero. <b>Note:</b> When an execution error has occurred (there is an error code other than 0), refer to <i>7-1 Errors and Alarm Troubleshooting</i> for details on troubleshooting the error.	1: Execution error(s) occurred 0: No execution errors
	04	Function Block Database (RAM) Error Flag	This flag notifies the CPU Unit that the function block data in the Loop Controller's RAM has been corrupted. If the function block data in RAM is invalid, a cold start will be performed even if a hot start is specified. <b>Note:</b> When an error has occurred, use the CX-Process Tool to execute the <b>Clear All</b> , <b>Download</b> , or <b>Recovery</b> operation or transfer the affected function block's settings again.	1: Function block database error occurred 0: No function block database error
	07	Automatic Cold Start Execution Flag	This flag notifies the CPU Unit that a cold start was executed automatically because the RAM data was invalid due to a discharged backup capacitor or other cause while power was not being supplied (i.e., that the Board is running with the data that was last backed up to flash memory). This flag will be 0 (OFF) when the Board is not running. When necessary, check whether this flag is 1 (ON) and download the most up-to-date function block data.	1: A cold start was executed automatically after writing backup data from the flash memory to RAM. 0: Automatic cold start not executed.
	11	Run Status Flag	This flag notifies the CPU Unit that the Loop Controller is running. The flag is 1 (ON) when the Board is running.	1: Loop Controller running 0: Stopped
	13	Backup during Operation Flag	Notifies the CPU Unit whether or not the Loop Controller is backing up data during operation.	1: Backup during operation 0: No backup during operation.
	15	Function Block Changed Flag	This flag notifies the CPU Unit that the function block data download (change) operation was executed from the CX-Process Tool while the Loop Controller was running. Monitor the status of this flag in the CPU Unit's ladder program and perform any required processes, such as a notification of function block data change, if the function block data has been changed during operation (i.e., if online editing of the Loop Controller has been executed). <b>Note:</b> When the function block data has been downloaded (changed) by an operation from the CX-Process Tool, the function block data is not stored in flash memory. Always execute the <b>Backup</b> operation from the CX-Process Tool to backup data to flash memory after downloading function block data.	1: Function block data (file) was downloaded. 0: Function block data (file) was not downloaded, a hot start was performed, or a cold start was performed.

Word	Bit	Name	Explanation	Settings
A356	00 to 06	ORed Function Block Alarm Outputs	These flags notify the CPU Unit when one of the following alarms occurred in any function block (logical OR of all function block outputs.)	---
	00		MV Low Limit Alarm Flag (MLA: ITEM079)	1: At or below the low limit 0: Above the low limit
	01		MV High Limit Alarm Flag (MHA: ITEM078)	1: At or above the high limit 0: Below the high limit
	02		Deviation Alarm Flag (DVA: ITEM 042)	1: At or above the set value 0: Below the set value
	03		Low/Low Limit Alarm Flag (LL: ITEM 016)	1: At or below the set value 0: Above the set value
	04		Low Limit Alarm Flag (L: ITEM 015)	1: At or below the set value 0: Above the set value
	05		High Limit Alarm Flag (H: ITEM 014)	1: At or above the set value 0: Below the set value
	06		High/High Limit Alarm Flag (HH: FITEM013)	1: At or above the set value 0: Below the set value
A357	00	Duplex Operation Flag (for Process-control CPU Unit (CS1D-CPU□□P) only)	This flag is set to 1 (ON) while the Inner Board is performing duplex operation when CS1D CPU Unit is in duplex mode.	1: Performing duplex operation 0: Not performing duplex operation
	02	Duplex Initialization Flag (for Process-control CPU Unit (CS1D-CPU□□P) only)	This flag is set to 1 (ON) while duplex initialization being performed on Inner Board (while data being transferred/verified from active Inner Board to standby Inner Board) when CS1D CPU Unit in duplex mode.	1: Performing duplex initialization 0: Not performing duplex initialization
A401	12	Inner Board Stopped Error Flag (Fatal error)	<p>This flag is set to 1 (ON) when an error occurs in the Loop Controller such as a WDT error or Inner Board bus error. The CPU Unit will stop running and the ERR/ALM Indicator on the front of the CPU Unit will light.</p> <p>If an error occurs in the Loop Controller for the active Process-control CPU Unit (CS1D-CPU□□P), operation will be switched to the Loop Controller in the standby Process-control CPU Unit.</p> <p><b>Note 1:</b> This flag can be reset to 0 (OFF) by clearing the error, but it will go ON again unless the cause of the error is eliminated.</p> <p><b>Note 2:</b> The cause of the error is indicated in bits A42400 to A42403.</p>	1: Error occurred 0: Normal
A402	08	Inner Board Error Flag (Non-fatal error)	<p>This flag is set to 1 (ON) when an error occurs in the data exchange between the Loop Controller and CPU Unit (including errors originating in the Loop Controller itself). The CPU Unit will continue running and the ERR/ALM Indicator on the front of the CPU Unit will flash. The Loop Controller will stop operating.</p> <p><b>Note 1:</b> The cause of the error is indicated in bits A42404 to A42415.</p> <p><b>Note 2:</b> This flag will be reset to 0 (OFF) when the error is cleared.</p>	1: Error occurred 0: No error

Word	Bit	Name	Explanation	Settings
A424	00 to 12	Inner Board Error Information	The following flags provide details on Inner Board errors (errors common to all Inner Boards as well as errors specific to Loop Controllers.)	---
	00	Inner Board WDT Error Flag (fatal error)	This flag is set to 1 (ON) if the Loop Controller is faulty.	1: Inner Board WDT Error 0: Normal
	01	Inner Board Bus Error Flag (fatal error)	This flag is set to 1 (ON) if an Inner Board Bus Error has occurred.	1: Inner Board Bus Error 0: Normal
	02	Cyclic Monitor Error Flag (fatal error)	This flag is set to 1 (ON) when a Cyclic Monitor Error is detected, i.e., the cyclic area's access right token was not returned to the Loop Controller within the cyclic monitor time.	1: Cyclic Monitor Error 0: Normal
	03	Flash Memory Data Error or All Function Block Database (RAM) Error during Duplex Operation Flag (fatal error)	This flag is set to 1 (ON) in the situations outlined below. Use the CX-Process Tool software to download all function blocks (LCB/LCU unit). Alternatively, backup to flash memory. When there is a flash memory data error during the data check at a cold start. A database (RAM) error occurred for all function blocks during operation in duplex mode when mounted to a CS1D CPU Unit.	1: Flash Memory Data Error or All Function Block Database (RAM) Error 0: Flash memory normal and all function block database (RAM) normal during duplex operation
	04	Incompatible CPU Unit Error Flag (non-fatal error)	This flag is set to 1 (ON) when the Loop Control Board is mounted in a CPU Unit other than a CS1-H CPU Unit. <b>Note:</b> The CS1 CPU Units without the "-H" suffix do not support the Loop Control Board.	1: The Loop Control Board is mounted in a CPU Unit that does not support the Board. The EM file memory has been created or the EM does not exist. 0: Normal
	05	Not used.	---	---
	06	CPU Bus Unit Settings Area Error Flag	(Loop Control Units only.)	---
	07	Routing Table Error Flag	(Loop Control Units only.)	---
	08	Loop Controller High Load Flag (non-fatal error)	This flag is set to 1 (ON) when the LCB load rate exceeds 80% for three consecutive cycles. If this error occurs, extend the operation cycles of function blocks that can be extended. If the error recurs after extending the operation cycles, add a Loop Control Unit and divert some of the load to that Unit.	1: Loop Controller running at a high load rate 0: Normal
	09	Operation Cycle Error Flag (non-fatal error) (for Process-control CPU Unit (CS1D-CPU□□P) only)	This flag is set to 1 (ON) when the Loop Controller's operation cycle is inaccurate because the cycle time is too long (when the CPU Unit's cycle time is more than 30% of the minimum operation cycle of the Loop Controller for three consecutive cycles) during duplex mode operation when mounted in a CS1D CPU Unit.	1: Operation cycle error 0: Normal

Word	Bit	Name	Explanation	Settings
A424	10	Partial Function Block Database (RAM) Error During Simplex Operation (non-fatal error)	Changes to 1 (turns ON) when a database (RAM) error occurs for some function blocks or when an error occurs while restoring data from the Memory Card using the simple backup function when mounted to CS1D CPU Units and operating in simplex mode or when mounted to CS1-H CPU Units.	1: Function block database error during simplex operation or error while restoring data. 0: Normal
	11	Backup Data (Flash Memory) Error Flag	This flag is set to 1 (ON) when the parameter data stored in flash memory has been corrupted.	1: Flash memory data error 0: Normal
	12	Specified EM Bank Unusable Error Flag	This flag is set to 1 (ON) when specified EM bank is not a usable bank.	1: Cannot be used. 0: Can be used.
	13 to 14	Not used.	---	---
	15	Automatic Recovery from Cycle Offset Flag (nonfatal error)	If something unforeseen causes the cycle to the right or left to be offset, duplex initialization is automatically executed to restore synchronous operation. The flag is set to 1 (ON) when recovery is achieved.	1: Duplex initialization executed for synchronous displacement recovery. 0: Normal

### 3-3-2 Commands from the CPU Unit to the Loop Controller

The Loop Controller's start mode at power ON can be specified from the CPU Unit.

#### Auxiliary Area Control Bits Relevant to the Loop Controller

##### Control Bits (CPU Unit to Loop Controller)

Word	Bit	Name	Explanation	Settings	Status when Run Mode Changes	Status when power goes ON	Timing of setting
A608	00	Inner Board Restart Bit	Turn this bit from OFF to ON to restart the Loop Controller. (The Loop Controller will start initialization.) <b>Note:</b> The bit will be reset to 0 (OFF) automatically when initialization is completed.	0 → 1: Restarts the Inner Board	Pre-served	Cleared	User's choice
A609	01	Start Mode at Power ON: Hot Start (Cannot be used for Process-control CPU Unit (CS1D-CPU□□P).)	When this bit is set to 1 (ON), the Loop Controller's "start mode at power ON" will be hot start mode (as a command from the CPU Unit to the Loop Controller.) This bit is effective only when ITEM018 of the System Control block (block model 000) is set to 3 (command from CPU Unit.) <b>Note:</b> If bits A60901 and A60902 are both ON at the same time, this bit takes precedence and a hot start will be performed.	1: Perform a hot start when power is turned ON. 0: If A60902 is also set to 0, the Board stops running. If A60902 is set to 1, a cold start will be performed when power is turned ON.	Pre-served	Pre-served	User's choice
	02	Start Mode at Power ON: Cold Start (Cannot be used for Process-control CPU Unit (CS1D-CPU□□P).)	When this bit is set to 1 (ON), the Loop Controller's "start mode at power ON" will be cold start mode (as a command from the CPU Unit to the Loop Controller.) This bit is effective only when ITEM018 of the System Control block (block model 000) is set to 3 (command from CPU Unit.) <b>Note:</b> If bits A60901 and A60902 are both ON at the same time, A60901 takes precedence and a hot start will be performed.	1: Perform a cold start when power is turned ON. 0: If A60901 is also set to 0, the Board stops running. If A60902 is set to 1, a hot start will be performed when power is turned ON.	Pre-served	Pre-served	User's choice

**Note** When ITEM018 (Start Mode at Power ON) of the System Control block (block model 000) has been set to "3: Command from CPU Unit," the Loop Controller will not operate (including exchanging data with the CPU Unit) until the RDY LED indicator goes ON and either A60901 or A60902 is set to 1 (ON).



### 3-3-3 Exchanging Data

The Loop Controller can exchange any kind of data with the CPU Unit by either of the following two methods.

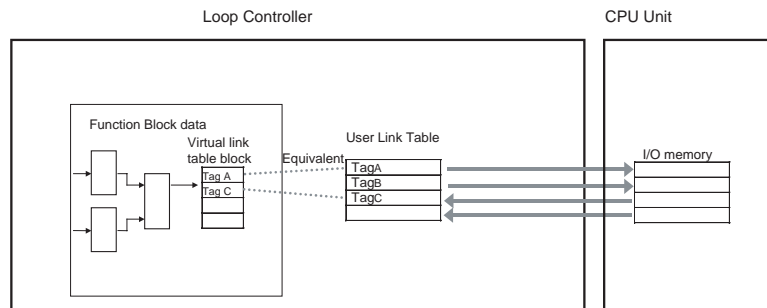
- Exchanging data regularly or for a specified condition (when a function block ITEM goes ON):  
Use the User Link Table (i.e., register a tag in the User Link Table and use that tag in the function block).
- Exchanging data with the CPU Unit only when required:  
Use a CMND(490) instruction in the user program to send a FINS command to the Loop Controller.

**Note** Data for the HMI (Control, Function, External Control, or System Common Block) can be read and written by reading and writing data in the EM area from the CPU Unit's ladder program specifying the EM area words allocated as the HMI data area.

#### Using the user link table to exchange data with the CPU Unit

##### Explanation of the user link table

The User Link Table is a table in the Loop Controller that is used to exchange data with the CPU Unit.



Set the necessary data in each line, including the user-defined tag name and other parameters such as the CPU Unit's I/O memory address, 0%/100% scaling values, refresh period, and function block ITEMS to be read/written.

Each tag can read or write data in the specified CPU Unit I/O memory for the specified conditions. It is also possible to exchange data regularly or refresh a particular function block's ITEM data when there is a change in the CPU Unit's I/O memory. Up to 2,400 tags can be created.

Use the CX-Process Tool to register tags in the User Link Table.

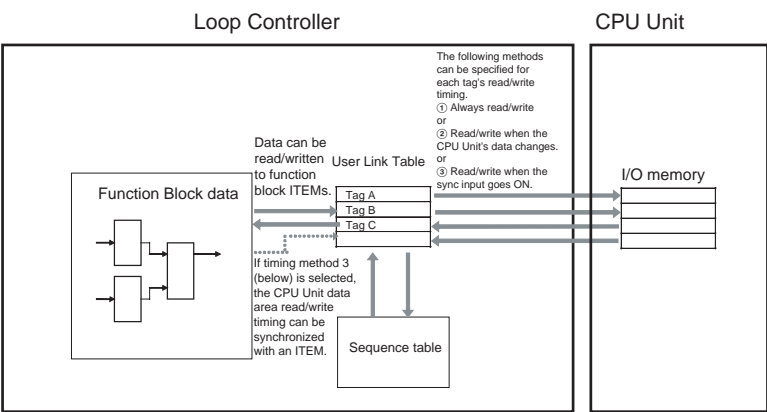
Once the tags have been registered in the User Link Table, the tag names can be used in Loop Controller programming such as connections or sequence tables, so it isn't necessary to know the specific CPU Unit I/O memory addresses associated with each tag when programming.

The User Link Table can also be pasted in a block diagram as a virtual function block.

**Note**

It is also possible to store the User Link Table's tags in CSV format.

If the tags are stored in CSV format, the CPU Unit's I/O memory can be read and written from SCADA software just by specifying the User Link Table tags. The User Link Table tags will be stored just after the CSV tags for the HMI if the "Add User Link Table Information" selection is checkmarked in the Compile CSV Tags dialog box with the CX-Process Tool.



Operation

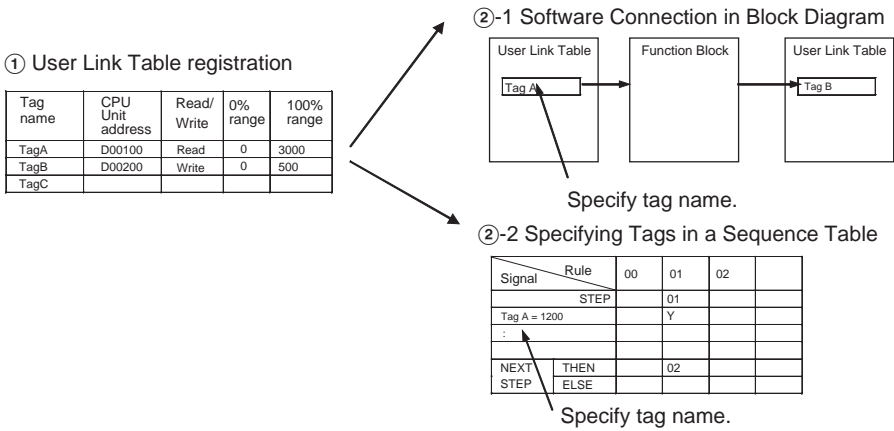
Use the following procedure:

- 1,2,3...
1.

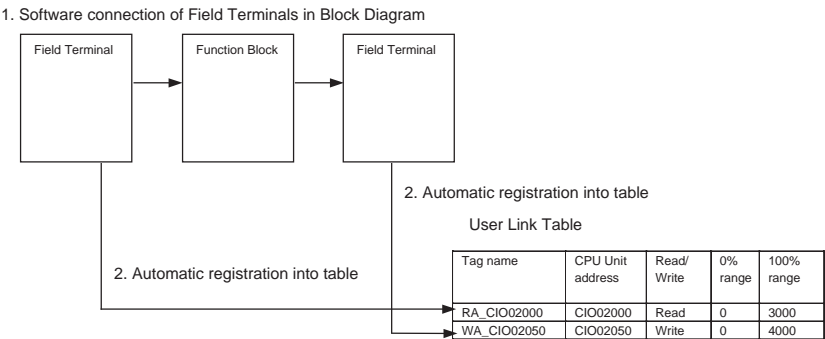
Register the CPU Unit I/O memory address that will be read/written from the Loop Controller in the User Link Table.
- 2-1.

Paste the User Link Table function block, make a software connection for the analog value just by specifying the tag name. Data can be exchanged with the CPU Unit's I/O memory area just by making a software connection to the analog value.
- 2-2.

Use a contact or an analog value in the sequence table.  
Data in the CPU Unit's I/O memory area can be used in a condition expression or action expression just by specifying the tag name in the sequence table.



When creating block diagrams with the CX-Process Tool, the User Link Table data can be created and specified automatically within the Loop Controller if a connection is made by virtually pasting a Field Terminal Block such as DI, DO, AI, or AO. This method also allows the data exchanged with the CPU Unit to be managed by tag names.



**WARNING** Always verify the following points when setting CPU Unit I/O memory addresses in the User Link Table:

- Words specified as “write” words in the User Link Table must not be allocated to another function in the CPU Unit or other Units. If the specified words are allocated to another function or Units, the PLC system may operate in an unexpected manner and cause personal injury.
- When using a user link table to write bit data to I/O memory in the CPU Unit. Never allow ladder programming or communications processes in the CPU Unit to write to any bits in the words in which bits are written from a user link table. Depending on the timing, any attempts to write to these words from ladder programming or communications processes may be ignored. Example: If tag A in a user link table writes to bit 00 of W000 and an OUT instruction in the ladder program in the CPU Unit write to bit 01 of W000, the write from the ladder program may be ignored.

**Note** Even if you delete a field terminal block from the block diagram, it will not be deleted from the registered user link table. Also, if you delete the connection line to the field terminal, the number of links that is given in the user link table will change to 0, but even then the specified I/O memory in the CPU Unit will be read and written for the specified conditions. To prevent reading and writing the specified I/O memory in the CPU Unit, delete the link from the user link table.

Creating the user link table with the CX-Process Tool

Use one of the following methods to create a user link table.

- Method 1: Registration on the User Link Table Edit Screen
- Method 2: Registration from the Block Diagram

- 1,2,3...
1. Method 1: Registration on the User Link Table Edit Screen
    - a. Select **Edit User Link Table** from the Settings Menu.
    - b. Right-click on the User Link Table Edit Screen and select **Add** from the pop-up menu.
  2. Method 2: Registration from the Block Diagram
    - a. Right-click on the block diagram and select **Register/Link Input (Read from CPU Memory)** or **Register/Link Output (Write to CPU Memory)** from the pop-up menu. A user link table block will be created.
    - b. Select the block that was created, right-click, and select **Register Block Cell** from the pop-up menu.

The following dialog box will be displayed for either method 1 or 2.

### User Link Table Settings

Item		Setting
Number		Entry number
Refresh period		<p>The refresh cycle for CPU Unit data. The cycle can be set to the system common operating cycle, 0.01 s, 0.02 s, 0.05 s, 0.10 s, 0.20 s, 0.50 s, 1.00 s, or 2.00 s</p> <p>(If the user link table is pasted in a block diagram to make software connections and the function block data is downloaded to the Loop Control Board with the <b>Update User Link Table Refresh Cycle</b> selection selected in the CX-Process Tool, the setting made here will be ignored and data refreshing with the CPU Unit will be performed on the operating cycle of the function blocks that are the destination of the software connections.)</p>
Tag Name		16 characters max., any text string
Comment		23 characters max., any text string
Specify Link memory	Link Mode	Constant, On change, External sync
	Memory Type	Area in I/O memory of CPU Unit: CIO, W, H, DM, or EM0 (See note 2.)
	Memory Address	The address of the word in I/O memory to be allocated
	A/D	Analog or contact
	Bit Position	00 to 15
	R/W	RD (To Loop Controller) Wr (From Loop Controller)
Range Conversion		ON/OFF 0% value and 100% value
Contact Synchronization	Synchronous Signal	ITEM specified (function block address and ITEM number)
Read from ITEM/Write to ITEM		ON/OFF Specify a read ITEM and/or WRITE item (function block address and ITEM number)
Pulse Output (See note 1.)		<p>Select to specify a one-shot pulse output when the signal changes from OFF to ON. (Turns ON the output only once during the refresh cycle for user link tables and writes to the I/O memory of the CPU Unit.)</p> <p>Enabled only when A/D is a contact and R/W is Wr (from the Loop Control Board).</p>

Item	Setting
Output as CSV Tag Information	Select this option to add user link table tags to the SCADA tag file or RS View tag file.  <b>Note</b> If this option is not selected when registering the user link table, the user link table tags will not be output even if adding user link table information is selected during the output process.
Monitor Plus Tag setting	Creates Monitor Plus tags. Select this option when monitoring or setting the user link table from the CX-Process Monitor Plus.
Alarm Set	Creates alarm tags. If alarm tags are set, they can be displayed in the CX-Process Monitor Plus Alarm Log Screens.

- Note**
- (1) EM1 to EM12 can be used in LCB□□ Ver. 3.0 or later projects.
  - (2) Pulse outputs can be used in LCB□□ Ver. 3.0 or later projects.

### Tag

A character string can be input with up to 16 characters.

### Comment

A character string can be input with up to 23 characters.

### Refresh Period

This setting specifies the refresh period with the CPU Unit when the Link mode (read/write timing method) is set to **Constant** or **External Sync**. The refresh period can be set to one of the following values and a different period can be set for each tag.

System common operation cycle, 0.01 s, 0.02 s, 0.05 s, 0.10 s, 0.20 s, 0.50 s, 1.00 s, or 2.00 s (For LCB05D, 0.01 s, 0.02 s, and 0.05 s cannot be specified.)

- Note**
- 1. When the User Link Table was pasted in the block diagram, the software connection was made, and then the function block data was downloaded with the **Update User Link Table Refresh Cycle** selection checkmarked, the refresh period setting will be ignored and data will be refreshed with the CPU Unit using the connected function block's operation cycle.
  - 2. For CS1D-CPU□□P Process-control CPU Units, refresh is split over several CPU Unit cycle times within the refresh cycle specified here.

### Range Conversion

These values can be set freely to define which values in CPU Unit's I/O memory correspond to 0% and 100% in the Loop Controller.

Input signed decimal for the 0% value even if it is a signed binary value (negatives expressed as 2's complement) in the CPU Unit's I/O memory.

Likewise, input signed decimal for the 100% value even if it is a signed binary value (negatives expressed as 2's complement) in the CPU Unit's I/O memory.

### Link Mode (Read/Write Timing Method)

Specify the read/write timing for data transfers with the CPU Unit's I/O memory. Each tag's link mode is set independently.

- a. Constant: Data is read/written every refresh period.  
**or**
- b. At Change: Data is read/written only when the CPU Unit's I/O memory contents have changed.  
**or**
- c. External Sync: After a user link table is started, the specified I/O memory area in the CPU Unit is read/written once when the specified external contact input (any ITEM in any function block) turns ON. The

external contact input will be turned OFF by the user link table when the read/write operation has been completed.

### CPU Unit Memory Type (Area) and Memory Address

Specify the I/O memory address in the CPU Unit that contains the data to be read/written. Each tag's address is set independently. A bit address can be specified by setting the A/D (Allocation Size) parameter to **Contact**.

#### A/D (Allocation Size)

Specify whether the data being read/written is bit or word data. If the data unit is a bit, select **Contact**. If the data unit is a word, select **Analog**. Each tag's A/D size is set independently.

#### R/W (Read or Write)

Specify whether data is being read from the CPU Unit's I/O memory to the Loop Controller or written from the Loop Controller to the CPU Unit's I/O memory.

When data is being read, select **Rd (→LCB)**. When data is being written, select **Wr (LCB→)**.

#### Contact Synchronization

When the Link mode (read/write timing method) has been set to **External Sync**, specify the function block ITEM that will be used as the Sync signal. Data will be refreshed (read/written) with the CPU Unit each refresh period while the specified ITEM is ON.

After execution, by turning OFF the ITEM execution will be performed again.

#### Reading from an ITEM and Writing to an ITEM

When the R/W setting is **Rd (→LCB)**, reading from the ITEM is enabled, the ITEM designation is set, and the data in I/O memory of the CPU Unit is read to the specified ITEM in the LCB (Loop Controller).

When the R/W setting is **Wr (LCB→)**, writing from the ITEM is enabled, the ITEM designation is set, and the designated ITEM in the LCB (Loop Controller) is written to the data in I/O memory of the CPU Unit.

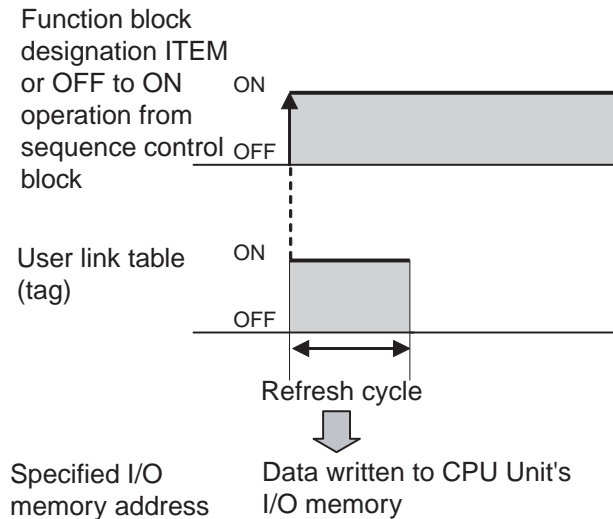
#### Writing ITEM

When a field terminal block is pasted in a block diagram, the link memory tag for the I/O memory address allocated to that field terminal will be registered in the User Link Table automatically. At that point, a tag name will be created automatically if the CX-Process Tool is set to Field Terminal/Auto-Registration Mode (see note).

**Note** To set Field Terminal/Auto-Registration Mode, click the right mouse button in the User Link Table edit window, and select **Field Terminal/Auto-Registration Mode** so that a check mark appears next to the menu selection.

#### Pulse Output (LCB01/05 Ver. 3.0 or Later, LCB03 Ver. 3.0 or Later)

When the specified ITEM changes from OFF to ON or when the OFF to ON operation is performed from a sequence control block (step ladder or sequence table), the pulse output is turned ON only once, it is turned OFF in the user link table refresh cycle, and then written to the CPU Unit's I/O memory.



This function can be set when the following settings are selected.

A/D (allocation size): Contact

R/W: Wr (LCB →) (data written from the Loop Controller to the CPU Unit)

### User Link Table Errors

A user link table error will occur if the user link table is executed with the following settings.

**1,2,3...**

1. The function block address and ITEM number set for writing to the ITEM do not exist.
2. An EM bank number that does not exist in the CPU Unit has been set as the memory type. The user link table in which the user link table error occurred will not execute. The entry number for the user link table in which the error occurred is displayed in ITEM 095 of the System Common Block.

If multiple user link table errors occur, the errors will be displayed according to the following priority.

**1,2,3...**

1. If an Rd (→LCB) and Wr (LCB→) error occur, the entry number of the Rd (→LCB).
2. If multiple Rd (→LCB) errors occur, the entry number for the user link table that was downloaded first will be displayed.
3. If multiple Wr (LCB→) errors occur, the entry number for the user link table that was downloaded last will be displayed.

### Note

- (1) The Loop Controller can read and write data in the CPU Unit's I/O memory using the User Link Table (independent of the CPU Unit's user program.) To avoid conflicts, do not write to the same I/O memory address from both the Loop Controller and CPU Unit.
- (2) If the user link table cannot be executed for the following reasons, the user link table entry number will be displayed in ITEM 095 (user link table error) of the System Common Block.
  - The ITEM does not exist at the connection destination.
  - The ITEM is unsuitable.
  - The CPU Unit I/O memory area does not exist.

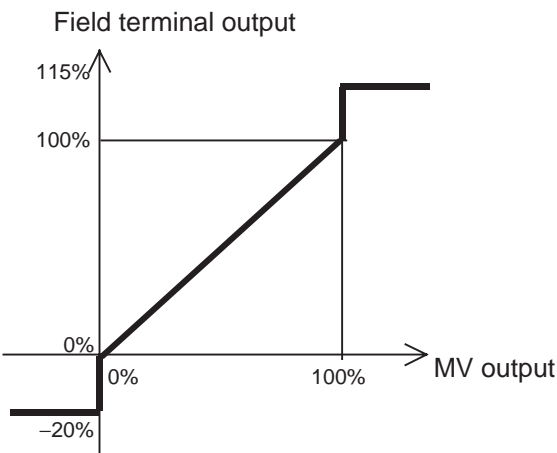
### MV Tight Shut Function (LCB01/03/05 Ver. 3.0 or Later)

Tight shut outputs can be made to the CPU Unit I/O memory area from field terminals (analog output terminals) or user link tables. If the output value is 0% or lower, the value set as the lower limit will be output. If the output value is 100% or higher, the value set as the upper limit will be output. With this

function, the valve can be fully closed simply by outputting 0% or 100% output as the MV from the Control Block.

Example: PMV01

Set value  
Upper limit: 11500  
Lower limit: -2000



Application Example:  
Valve Tight-shut Operation

Setting Tight Shut  
Function from the CX-  
Process Tool

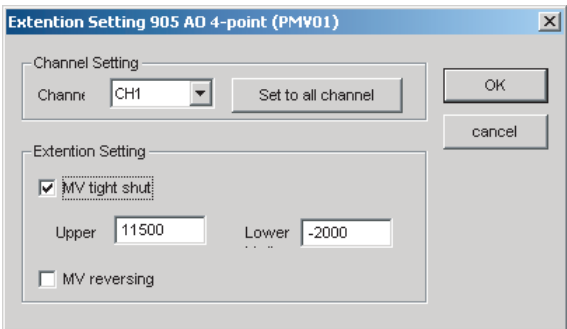
Method 1: Setting from the ITEM Setting Window in the Field Terminal  
(Analog Output Terminal). (See note.)

Right-click in the ITEM Setting Window of the Field Terminal (Analog Output Terminal), and select **Extension**.

**Note** The following table shows the applicable Field Terminals (Analog Output Terminals).

Field Terminal name	Upper limit (default)	Lower limit (default)
AO 4-point Terminal (PMV01) (Block Model 563)	11500	-2000
AO 4-point Terminal (PMV02) (Block Model 565)	11500	-1500

The following dialog box will be displayed.



The details are as follows:

Setting			Details	
			PMV01	PMV02
Channel setting	Channel		Channels 1 to 4	
Expansion setting	MV tight shut function	Upper limit	-2000 to 15000	-1500 to 15000
		Lower limit	-2000 to 15000	-1500 to 15000



**Channel**

Select the channel number of the relevant output.

**Reflecting Setting in All Connected Channels**

The same setting is reflected in all connected channels.

**Upper Limit**

When the output is 100.00%, the value is latched at the upper limit.

**Lower Limit**

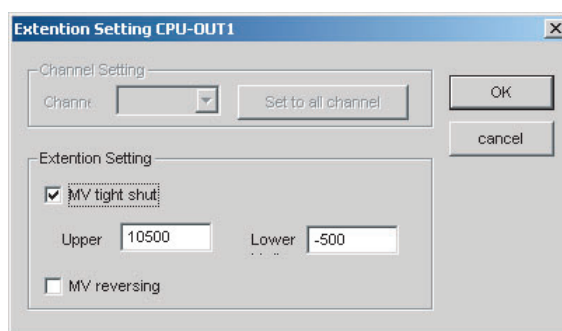
When the output is 0.00%, the value is latched at the lower limit.

**MV reversing**

Output is inverted so that when the output value is 100.00%, 0.00% is output, and when the output value is 0.00%, 100.00% is output.

**Method 2: Setting from the User Link Table**

Right-click in the user link table and select **Edit - Extension**.



The following dialog box will be displayed.

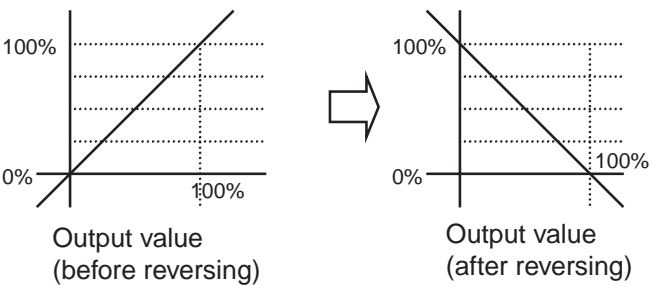
Setting item			Details
Expansion setting	MV tight shut	Upper limit	Sets the value at which to cut off when the output value reaches 100.00%
		Lower limit	Sets the value at which to cut off when the output value reaches 0.00%

**Caution** Be sure to check the status of the connected devices before transferring settings for the MV tight shut function and MV analog output inversion function. Transferring settings to an incorrect transfer destination may result in unexpected operation of the device and machinery.

**Reversing the MV Analog Output (LCB01/03/05 Ver. 3.0 or Later)**

The value output to the CPU Unit I/O memory area can be reversed in the Field Terminal (Analog Output Terminal) or User Link Table. As a result, if the purchased valve is found onsite to have a reversed switching direction, it can still be used simply by inverting the analog output.

**Note** Inversion is not possible during Loop Controller operation.



Setting Analog Output  
Reversing from the CX-  
Process Tool

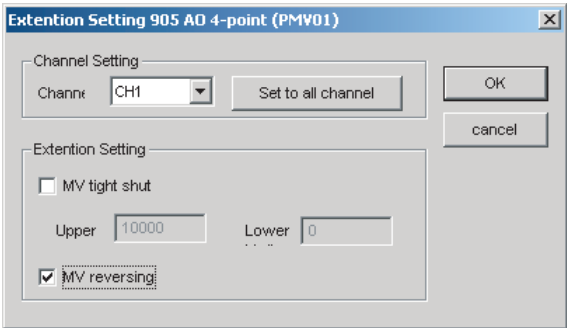
Method 1: Setting from the ITEM Setting Window for the Field Terminal  
(Analog Output Terminal) (See note.)

Right-click in the ITEM Setting Window for the Field Terminal (Analog Output Terminal) and select **Expansion Settings**.

**Note** The following table shows the applicable Field Terminals (Analog Output Terminals).

Field Terminal name
AO 4-point Terminal (PMV01) (Block Model 563)
AO 4-point Terminal (PMV02) (Block Model 565)

The following dialog box will be displayed.



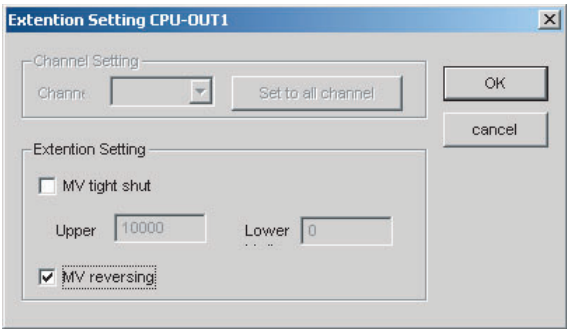
**MV Reversing**

Output can be reversed so that when the output value is 100.00%, 0.00% is output, and when the output value is 0.00%, 100.00% is output.

Method 2: Setting from the User Link Table

Right-click in the User Link Table and select **Edit - Expansion**.

The following dialog box will be displayed.



Setting item		Details
Expansion setting	MV reversing	When the output value is 100.00%, 0.00% is output, and when the output value is 0.00%, 100.00% is output.

**MV Reversing**

Output can be reversed so that when the output value is 100.00%, 0.00% is output, and when the output value is 0.00%, 100.00% is output.

**Timing for exchanging data with the CPU Unit**

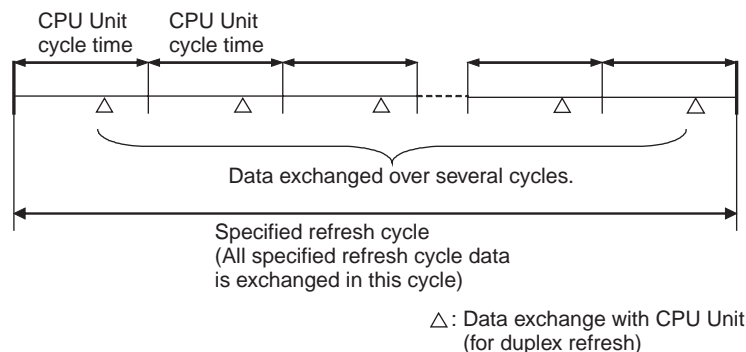
The timing for exchanging data with the CPU Unit depends on the Loop Controller model, as shown on the following table.

Data Type	Timing for Exchanging Data with the CPU Unit's I/O Memory	
	Loop Control Boards (CS1W-LCB01/05) and Loop-control CPU Units (CJ1G-CPU□□P)	Process-control CPU Unit (CS1D-CPU□□P)
User Link Table refresh	Executed for each refresh cycle (Asynchronous with the CPU Unit's cycle time.)	Refreshes data over multiple CPU Unit cycle times (At the duplex refresh timing.) (See note.)
HMI data area (EM Area) refresh (HMI function)		
Refresh with I/O memory allocated to Field Terminal blocks		
Refresh A355 and other Auxiliary Area data related to Loop Controllers	Executed every second. (Not synchronous with the CPU Unit's cycle time.)	

**Note** With the first three types of data listed above, all data is not refreshed in one cycle (duplex refresh cycle) when Process-control CPU Units (CS1D-CPU□□P) are used. The data is refreshed over several cycles, under the specified cycle conditions outlined below.

- 1,2,3...**
1. User Link Tables: Specified refresh cycle for each tag.
  2. HMI data area (EM Area): Refresh cycle specified by ITEM051 (HMI function's operation cycle) of the System Common Block.
  3. I/O memory allocated to Field Terminal blocks: Operation cycle specified by ITEM004 of the Field Terminal block.

Refresh Timing for User Link Tables, HMI Data, and I/O Memory Allocated to Field Terminal Blocks



**Note** For CS1W-LCB01 and CS1W-LCB05 Loop Control Boards, User Link Table and HMI data area refresh are executed independently of the CPU Units cycle (i.e., asynchronously). In contrast, the Process-control CPU Unit (CS1D-CPU□□P) refreshes data set to a certain refresh cycle within that refresh cycle (synchronous with the CPU Unit) and always over several CPU Unit

cycles, as shown above.

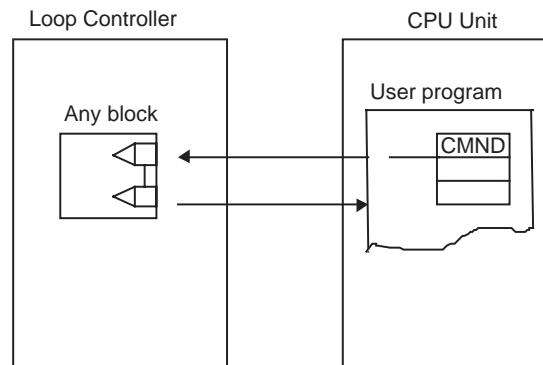
This means that the data read and written to the CPU Unit may not be concurrent for Process-control CPU Unit (CS1D-CPU□□P) in the following cases.

- When writing from the CPU Unit to Loop Controllers:  
The data in one CPU Unit cycle may not be concurrent in the Loop Control Board.  
Example: When CPU Unit cycle 1 data is SP1 = 100 and SP2 = 200 and cycle 2 is SP1 = 120 and SP2 = 300, the data may be SP = 100 and SP = 300 in the Loop Controller.
- When reading to the CPU Unit from Loop Controllers:  
The Loop Controller data in the same refresh cycle may not be concurrent until the last CPU Unit cycle in that refresh cycle.  
Example: When the Loop Controller data is PV1 = 100 and PV2 = 300, the CPU Unit may read PV1 = 100 (leaving PV2 unchanged) in cycle 1 and read PV2 = 300 in cycle 2 (in the final cycle), at which point the data is refreshed to PV1 = 100 and PV2 = 300.

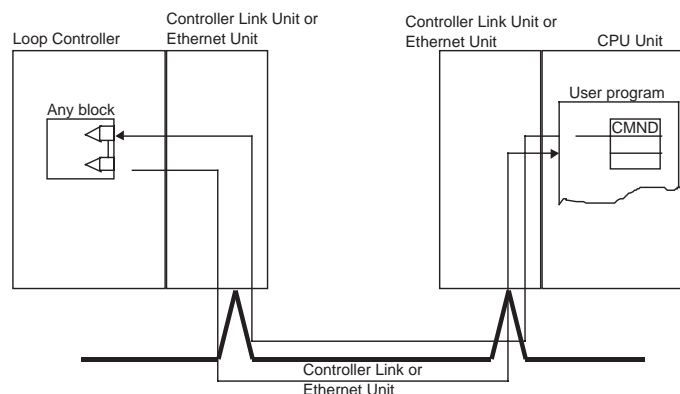
**To exchange data with the CPU Unit whenever necessary (by the CMND command)**

The CPU issues FINS command to the Loop Controller from CMND command within the user program to read and write Loop Controller data when it requires the data.

For details on FINS commands that can be issued, see *Section 6 How to Use FINS Commands*.



**Note** FINS commands can also be issued from the CPU Unit at other networked nodes.



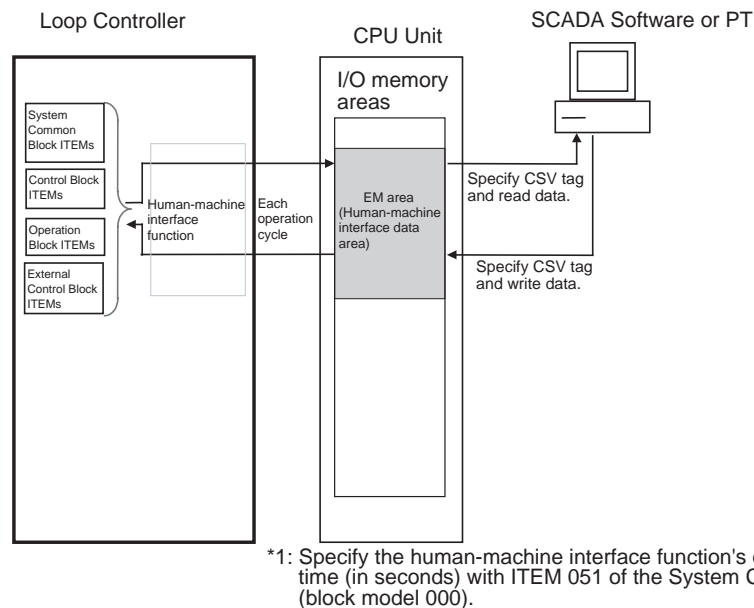
**Note** Words in the CPU Unit's EM area can be allocated for HMI data (Control/Operation, External Control, or System Common Block) for access from SCADA Software. (Refer to 3-4 *Exchanging Data Using SCADA and Other Software*.)

It is possible to read and write the HMI data from the ladder program by specifying the corresponding words allocated in the EM area (the HMI area.)

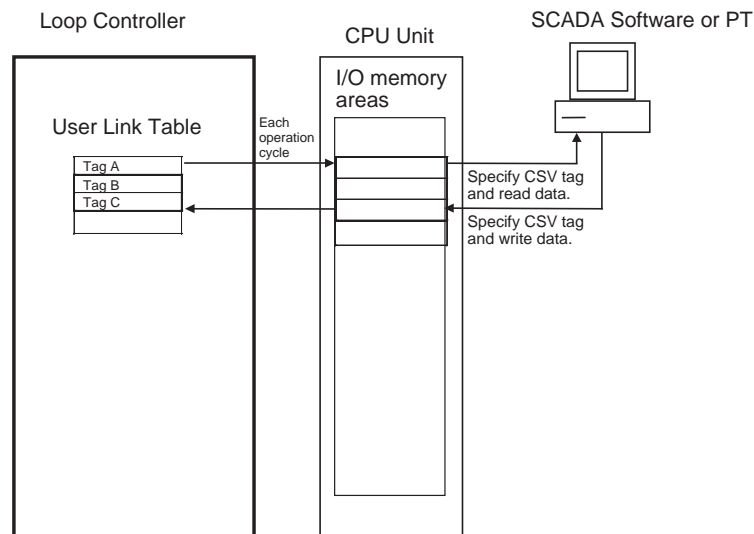
## 3-4 Exchanging Data Using SCADA and Other Software

### 3-4-1 Exchanging Data Using SCADA, PTs, and Other Software

The Loop Controller can use CSV tags (tags can be created in CSV format with the CX-Process Tool) to read/write the HMI data for the Control/Operation Block, External Control Block, and System Common Block from SCADA software or from a PT (Programmable Terminal) through the HMI data area (in the CPU Unit's specified EM area bank).



**Note** The User Link Table's tags can be handled as CSV tags just like the tags for the HMI data. If the User Link Table's tags are in CSV format, it will be possible to read/write data in the CPU Unit's I/O memory areas from SCADA software or a PT by specifying User Link Table tag names.



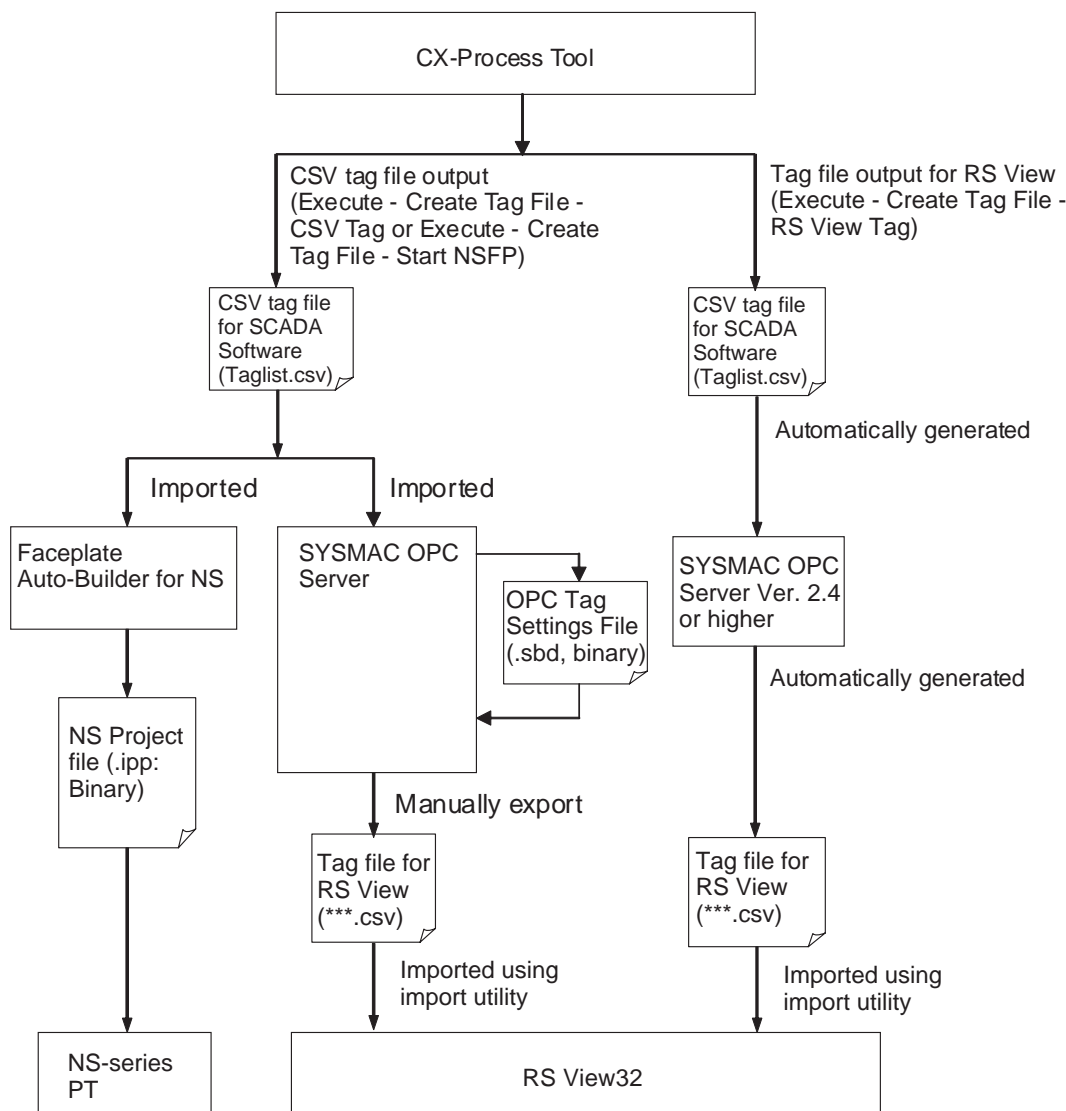
**Process for  
Exchanging Data with  
SCADA Software or  
Programmable  
Terminals**

All analog signals in Loop Controllers are processed in percentage units, and not in engineering units. Also, Loop Controller ITEM data input/output with external devices is performed via the CPU Unit HMI data area (the specified bank of the EM Area).

This means that the following processing must be performed using SCADA software or a PT (Programmable Terminal) to read or write Loop Controller ITEM data.

- Based on a correspondence table called the CSV Tag File, such as ***Tag name/Tag ITEM - Engineering Units/Scaling - CPU Unit EM Area address***,
- Use SCADA software or a PT to specify the tag name/tag ITEM. Specify the EM area address in the CPU Unit.
- When reading data: Read the percentage unit value and convert to engineering units (scaled value).  
When writing data: Perform the reverse action, i.e., convert the engineering units to percentage units, and write this scaled value.

- Note**
1. CSV tag files are created using the CX-Process Tool software.
  2. For OMRON NS-series PTS, use the WS02-NSFC1-E NS Face Plate Auto-Builder to automatically generate a project file for NS-series PTS, based on CSV tag files (configured with special process face places for Loop Controllers.) This allows Loop Controller monitoring and tuning (data read/write in engineering units) to be performed easily from a PT, without having to create screens and make CPU Unit EM Area settings.

**Procedure****Using Faceplate Auto-Builder for NS****1,2,3...**

1. Start the Faceplate Auto-Builder for NS.
2. Set the CSV tag file from which the project will be built (CSV tag file for SCADA Software), the project name, and output folder.
3. Set the NS-Series PT settings in the *PT Model*, *Comm. Type*, and *Screen No. Offset* and other fields under the *Build Condition* heading.
4. Click the **Build** Button.
5. The NS-Designer project file for the specified file name will be automatically built in the specified output folder.
6. Use NS-Designer to read the automatically built project files.
7. Use NS-Designer to edit the project files as required.
8. Set the initial settings for communications between the NS-series PT and PLC in the NS-Designer System Settings.
9. Transfer the settings from NS-Designer to the NS-series PT (or save the settings to a Memory Card, and then install the Memory Card in the NS-series PT).

**Example using the SCADA Software's RS View32**

10. Start the system, and perform monitoring/tuning of the Loop Controller from the NS-series PT.

The following procedure shows how to specify an ITEM in the Loop Controller from RS View32.

1,2,3...

1. Set the CSV tags (tag name, scaling factor, units, etc.) with the CX-Process Tool.
  - a. When CX-Process Tool Ver. 3.1 or later is used, the CSV tags are automatically registered and then edited in Excel.
  - b. Once the Control/Operation Block, External Control Block, or System Common Block has been registered, select the Block and then select **Settings - Set CSV Tags** from the menu.)
2. Create the RS View tag files (see note below) with the CX-Process Tool. (Select **Execute - Create Tag File - RS View Tag** from the menu.)

**Note** The RS View tag file is a CSV formatted tag file for the SCADA Software's RS View32. The file is composed of the following two parts.

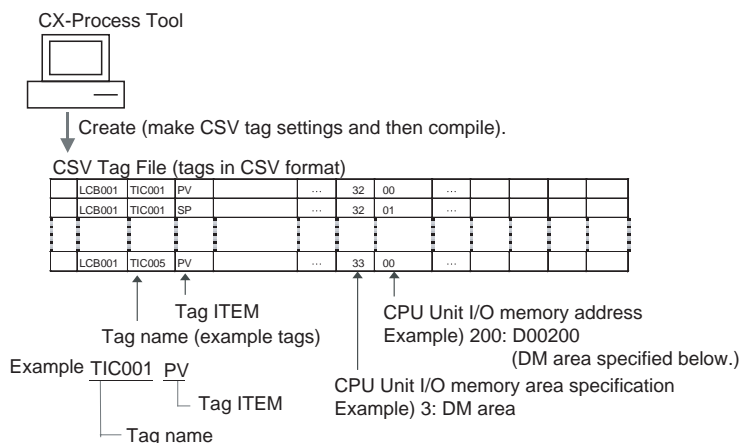
a) HMI Tags

Includes the tag names set in each function block as well as the tag ITEMS associated with each ITEM (fixed for each function block), and other values such as the I/O memory area address allocated to the ITEM.

b) User Link Table Tags

Includes the tag names set in the User Link Table as well as other values associated with each tag name, such as the I/O memory area address allocated to the tag.

(To attach the User Link Table tags after the regular HMI tags described above, place a checkmark next to **Add User Link Table Information** in the Compile CSV Tags dialog box that appears when you select **Compile CSV Tags** from the Execute menu.)



3. Import the CSV tag files using RS View32.
4. Specify the required parameters (tag name and tag ITEM for the HMI tags, just the tag name for User Link Table tags) from the SCADA Software, such as RS View32, and read/write data in the Loop Controller or CPU Unit I/O memory area through the SYSMAC OPC Server.  
(When RS View32 is used, the SYSMAC OPC Server's Item ID (device name, group name, tag name) is registered in the data source's address.)

**Note** When SCADA Software other than RS View32 is used, use the communications driver for OMRON PLCs that is provided with that SCADA Software.



The contents of a CSV tag file is shown below.

Contents	Setting range for ITEMS		
	HMI tags	User link table tags	OPC Server direct access tags
Record number	1 to 65535		
Function block file name	Max. 6 characters		FDAC + node number
LCU/LCB element name	LCB05, LCB01, LCB03, LCB05D, LC0011, LC0012, LC0013	LCB05, LCB01, LCB03, LCB05D	LCB05, LCB01, LCB05D, LC0011, LC0012, LC0013
Tag name (representative tag)	16 characters max. (Unusable characters: None)	Always LNK	16 characters max. (Unusable characters: None)
Tag ITEM	Fixed for each function block item	Tag name from user link table	Fixed for each function block item
Tag comment	16 characters max. (Unusable characters: None)	Tag comment from user link table, 23 characters max. (Unusable characters: None)	16 characters max. (Unusable characters: None)
Tag type	0: Analog, 1: Contact		
Data attribute (See note 1.)	1: Integer, U: Unit, 0: Contact		0: Contact, B: 1-byte data, U: UINT, I: INT
Contact alarm tag	0: Normal, 1: Alarm	0	0
Scaling upper limit	-5000 to 99999 (Example for DP position of 1: -500.0 to 9999.9)		-5000 to 99999 (Example for DP position of 1: -500.0 to 9999.9)
Scaling lower limit	-5000 to 99999 (Example for DP position of 1: -500.0 to 9999.9)		-5000 to 99999 (Example for DP position of 1: -500.0 to 9999.9)
Decimal point position (for scaling)	0 to 9		
Unit	Max. 8 characters (Unusable characters: None)		
Data range upper limit	-340680 to 330779 (When scaling $\pm 320\%$ data with an upper limit of 99999 and a lower limit of -5000)	65535 (Fixed)	-340680 to 330779 (When scaling $\pm 320\%$ data with an upper limit of 99999 and a lower limit of -5000)
Data range lower limit	-340680 to 330779 (When scaling $\pm 320\%$ data with an upper limit of 99999 and a lower limit of -5000)	-32768 (Fixed)	-340680 to 330779 (When scaling $\pm 320\%$ data with an upper limit of 99999 and a lower limit of -5000)
Network address	0 to 127		
Node address	1 to 32		
Unit address	16 to 31, 225	225	16 to 31, 225
I/O memory area	0: CIO, 1: W, 2: H, 3: D, 4: E0, 5: E1, 6: E2 ..., 15: EB, 16: EC		Always 99
I/O memory address	0 to 65535		0
Bit position	0 to 15		0
Function block model	0 to 999	-1	0 to 999
Block address	0 to 999	-1	0 to 999
ITEM number	0 to 999	-1	0 to 999

Contents	Setting range for ITEMS		
	HMI tags	User link table tags	OPC Server direct access tags
Offset (write data)	±32767 0: Same address for read and write, Not 0: Read address + offset	0	
Read/write	R: Read, RW: Read/write, W: Write	R: Read, W: Write Read and write are from the viewpoint of the SCADA software. If the tag is set for reading from the CPU Unit (to the Loop Controller), it will be write data from the SCADA software. If the tag is set for writing to the CPU Unit (from the Loop Controller), it will be read data from the SCADA software.	R: Read, RW: Read/write, W: Write
Upper limit for range conversion	0	–32000 to 32000	0
Lower limit for range conversion	0	–32000 to 32000	0
Expanded scaling setting (See note 3.)	0: Disabled 1: Enabled	Same as HMI interface tags.	

- Note**
1. Data attributes and contact alarm tags are used mainly by the OPC Server.
  2. The offset is stored when there are both write and read ITEM numbers in the Loop Controller. If the CPU Unit's I/O memory address in the same for both reading and writing, the offset will be 0. If they are different, the value of the write address minus the read address will be stored.
  3. Expanded scaling data can be exported only when using CX-Process Tool version 4.0 or higher.

### HMI Function

The HMI function constantly allocates ITEM data (20 words/Block) for the Control/Operation Block, External Control Block, and System Common Block. The ITEM data is allocated in the specified EM bank in the CPU Unit in the same order as the function block addresses.

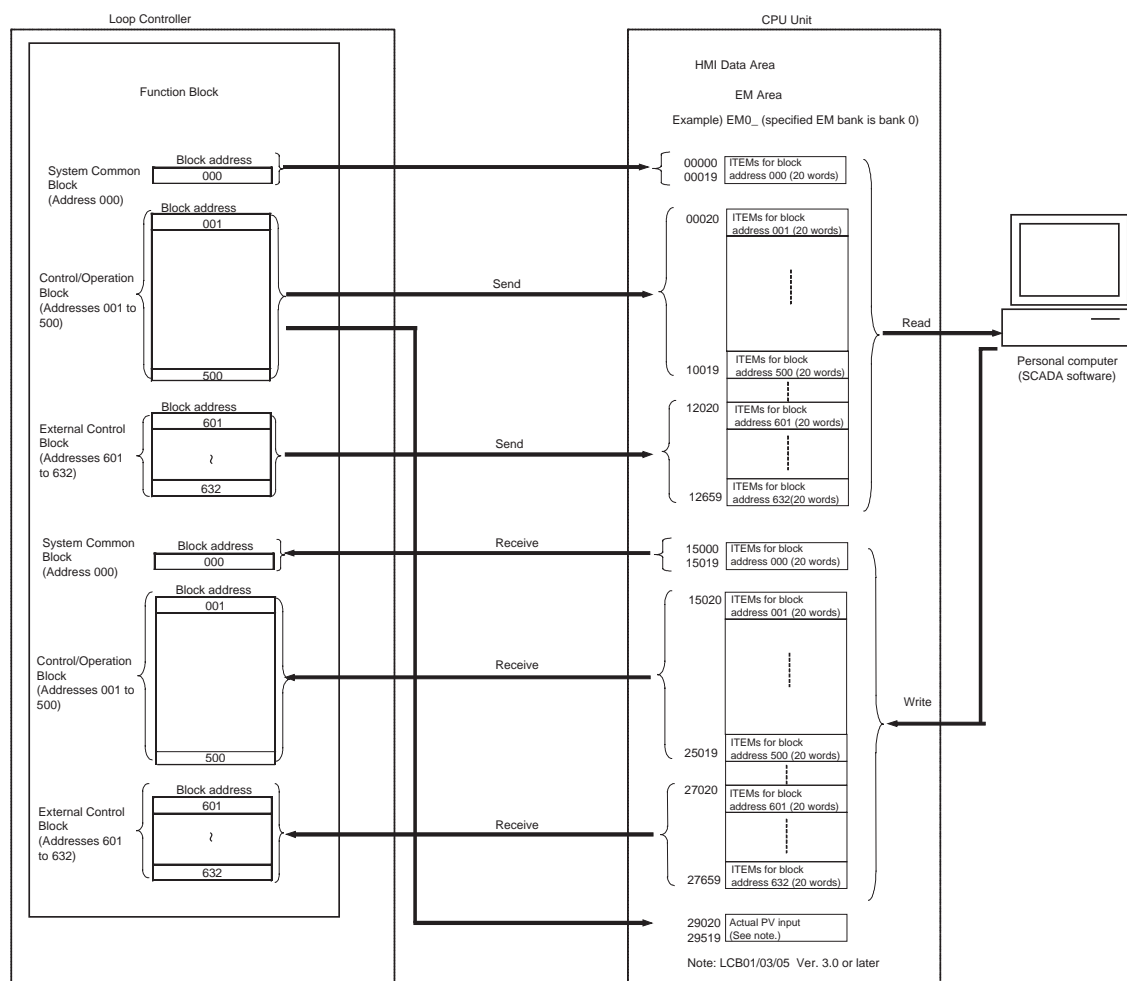
The EM bank number where the ITEM data is allocated (known as the HMI data area) is specified by ITEM050 of the System Common Block (block model 000.) The setting range for the HMI EM bank number is 0 to 12.

The refresh period for the HMI data is specified by ITEM051 of the System Common Block (block model 000.) ITEM051 is known as the "HMI function's operation cycle" and is set in seconds.

- Note**
- Reception from the CPU Unit's EM area can be stopped with ITEM056 of the System Common Block (block model 000). This ITEM is called the "reception stop switch."  
Transmission to the CPU Unit's EM area can be stopped with ITEM057 of the System Common Block (block model 000). This ITEM is called the "transmission stop switch."
  - ITEM059 of the System Common Block (block model 000) is the "HMI function disable switch." Set this ITEM to 1 (Not used) in advance when the HMI function is not being used.

## Relevant ITEMS in the System Common Block (block model 000)

ITEM type	ITEM	Data contents	Data range	Default
Parameter	050	HMI EM bank number	0 to C (Hexadecimal)	0
	051	HMI function's operation cycle (s) 1 (0.1 s), 2 (0.2 s), 3 (0.5 s), 4 (1 s), or 5 (2 s) <b>Note:</b> Always stop operation before changing this ITEM.	1 to 5	4 (1 s)
Input	056	Reception stop switch 0: Normal; 1: Stop reception	0 or 1	0
	057	Transmission stop switch 0: Normal; 1: Stop transmission	0 or 1	0
Parameter	059	HMI function disable switch 0: Used; 1: Not used	0 or 1	0



The function blocks ITEM data (20 words/Block) is allocated from address 00000 in the specified EM bank in order (starting with the Control/Operation Block and ending with the External Control Block.)

Data is exchanged with the CPU Unit continuously while the Loop Controller is operating. The refresh period is set with ITEM051 of the System Common Block (block model 000.) ITEM051 is called the "HMI function's operation cycle" and can be set between 0.1 and 2 s.

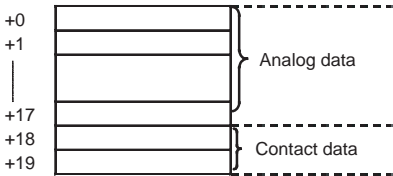
**Note** For the CS1D-CPU□□P, the refresh is split over multiple CPU Unit cycle times within the refresh cycle set here.

The bank number (0 to 12) of the EM bank allocated to the HMI data area is set with ITEM050 of the System Common Block (block model 000.)

- System Common Block  
EM area words 00000 to 00019 are allocated to send data.  
EM area words 15000 to 15019 are allocated to receive data.
- Control/Operation Block: block addresses 001 to 500  
EM area words 00020 to 10019 are allocated to send data.  
EM area words 15020 to 25019 are allocated to receive data.
- External Control Block: block addresses 601 to 632  
EM area words 12020 to 12659 are allocated to send data.  
EM area words 27020 to 27659 are allocated to receive data.

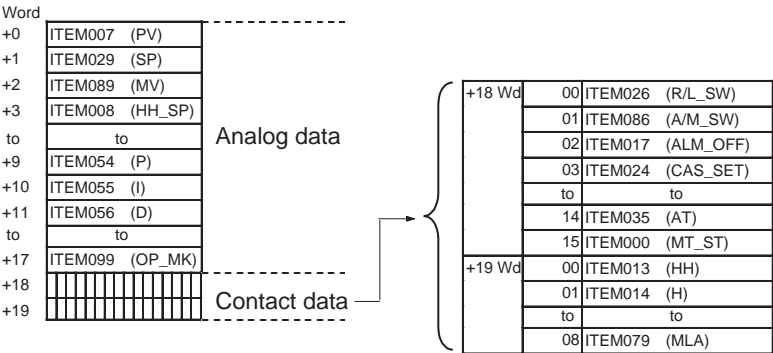
**Note** (a) Even if there are unused block addresses, the blocks and addresses are not shifted. The block addresses always retain the same structure.

(b) A total of 20 words is allocated to each function block as shown below. The first 18 words (through the +17 words) are allocated to analog data. The words +18 and +19 from the beginning words are allocated as bit data.





The ITEMS received for each function block model are predetermined as Receive Block ITEMS.


Example: Basic PID (Block Model 011) ITEMS



**Caution** Do not allow the bank of the EM Area with the number specified for allocation to the HMI data to overlap with any other area used by the CPU Unit or other Units. The block allocated for the HMI is specified in ITEM 050 (EM Area Bank Allocated for HMI Memory = 0 to 12) of the System Common block (Block Model 000). If areas overlap, the system may operate in an unexpected manner, which may result in injury.

 **Caution** Always stop the operation of the Loop Controller before converting any of the EM Area to file memory. If any part of the EM Area that is being used by the Loop Controller for the HMI is converted to file memory during Loop Controller operation, the system may operate in an unexpected manner, which may result in injury. If a batch download or System Common Block download is performed in this state (i.e., with EM Area converted to file memory), a 0x0A0D error (FINS response 0x110C) will occur, and the download will stop before completion. When the power supply is turned ON again, A424.04 (Incompatible CPU Unit Error Flag) will turn ON to indicated a non-fatal Inner Board error. Clear the EM Area file memory.

 **Caution** Do not use battery-free operation for the CS1-H CPU Unit or the CPU Unit element of a Process-control CPU Unit or Loop-control CPU Unit when using the HMI interface. If batteryfree operation is used for the CPU Unit or CPU Unit element, the contents of the EM Area will not be stable when the power supply is turned ON, possibly causing illegal values in the HMI data in the Loop Controller.

 **Caution** Do not use the HMI function to write a value that is outside of the data range shown in the ITEM list in the *Function Block Reference Manual* (Cat. No. W407) to the receive area (CPU Unit to Loop Controller) in the EM Area. Writing an out-of-range value can result in unexpected operation by the controlled machine or equipment.

**Note** 1. Data values that are 8 digits long (such as accumulated values) are divided into two 4-digit ITEMS. Consequently, 8-digit values are divided into two words when they are stored in the EM area. (For example, the accumulated value of the batch flowrate capture is stored in words n+10 and n+11, with the rightmost 4 digits in n+10 and the leftmost 4 digits in n+11.) When reading and writing 8-digit values, observe the following precautions and perform any required processing in the SCADA Software to verify that the 8-digit data is correct.

a. Writing Data from SCADA Software to the EM Area's Reception Area (CPU Unit → Loop Controller)

When ITEM data has been changed by internal Loop Controller processing or changed directly by the CX-Process Tool or FINS command (not through the EM area), the Loop Controller will write the new data in the EM area's reception area.

If the same ITEM is overwritten from the SCADA Software, the write processes may conflict. It is possible that the two adjacent 4-digit ITEMS making up an 8-digit value (such as an accumulated value) will not be consistent. (For example, it is possible that the ITEM containing the leftmost 4 digits will contain data written from SCADA software and the ITEM containing the rightmost 4 digits will contain data written from the Loop Controller.)

To prevent 8-digit values, such as accumulated values, from being corrupted when writing from the SCADA Software, read the ITEM data from the 2 ITEMS immediately after they have been written and verify that they contain the correct data. In the unlikely event that the 2 ITEMS do not contain the correct data, write the data again.

b. Reading the EM Area's Send Area Data from SCADA Software (Loop Controller → CPU Unit)

When an 8-digit value (such as an accumulated value) is being read from the SCADA Software and being overwritten simultaneously from the Loop Controller, it is possible that only one of the two ITEMS will

contain the new value. In this case, the data cannot be read properly. To be sure that both ITEMS contain the correct data, read the 8-digit value (such as an accumulated value) two times, compare the two 8-digit values, and proceed only when the two values are equal.

2. Perform the same processing described above to verify the accuracy of 8-digit values in the HMI area when reading or writing the values from the CPU Unit instead of the SCADA Software.

## EM Area Allocation

Specified CS1W-LCB05 EM Bank CS1D-CPU□□P	Specified CS1G-CPU43/44/45P EM Bank	Specified CS1W-LCB01 EM Bank CJ1G-CPU42P
00000 System Common 20 words Send	00000 System Common 20 words Send	00000 System Common 20 words Send
00020 Control/Operation Block 10,000 words (Addresses 001 to 500)	00020 Control/Operation Block 6000 words (Addresses 001 to 300)	00020 Control/Operation Block 1000 words (Addresses 001 to 050)
10020 Reserved 2000 words (Addresses 501 to 600)	06020 Reserved 6640 words	01020 Reserved 11,000 words (Addresses 051 to 600)
12020 External Control Block 640 words except for CS1D-CPU□□P (Addresses 601 to 632)	12660 Reserved 1360 words	12020 External Control Block 640 words (Not supported by CJ1G-CPU□□P) (Addresses 601 to 632)
12660 Reserved 1,360 words (Addresses 633 to 700)	14020 System Use 700 words 700 addresses	12660 Reserved 1360 words (Addresses 633 to 700)
14020 System Use 700 words 700 addresses	14720 Reserved 280 words	14020 System Use 700 words 700 addresses
14720 Reserved 280 words	15000 System Common 20 words Receive	14720 Reserved 280 words ---
15000 System Common 20 words Receive	15020 Control/Operation Block 10,000 words (Addresses 001 to 300)	15000 System Common 20 words Receive
15020 Control/Operation Block 10,000 words (Addresses 001 to 500)	21020 Reserved 6640 words	15020 Control/Operation Block 1000 words (Addresses 001 to 050)
25020 Reserved 2000 words (Addresses 501 to 600)	27660 Reserved 1,360 words	16020 Reserved 11,000 words (Addresses 051 to 600)
27020 External Control Block 640 words except for CS1D-CPU□□P (Addresses 601 to 632)	29020 Real PV input value monitor area Send	27020 External Control Block 640 words (Not supported by CJ1G-CPU□□P) (Addresses 601 to 632)
27660 Reserved 1,360 words (Addresses 633 to 700)	29320 Reserved ---	27660 Reserved 6856 words ---
29020 Real PV input value monitor area Send	32767	29020 Real PV input value monitor area Send
29520 Reserved ---		29070 Reserved ---
32767		32767

**Note CSV Output Functions for HMI Data Allocation Parameters (CX-Process Tool Ver. 3.2 or Higher)**

When CX-Process Tool Ver. 3.2 or higher is used, the HMI data allocation parameters (indicating which tag or tag ITEM is to be allocated in which address of the EM Area) can be output in CSV format.

Select **Execute - Create Tag Files - Create HMI I/F memory map**, execute CSV tag compilation, specify the file name (default: HMI\_IFMap.csv), and save the CSV file.

The format of the data is as follows:

- Analog data  
`<Tag_name>_<ITEM_tag_name>,INT(or UNIT),<allocated_EM_Bank No.>,<Address>,<Comment>`
- Digital data (standard)  
`<Tag_name>_<ITEM_tag_name>,<Bit_position>,BOOL,<EM_Bank_No.>,<Address>,<Comment>`

## 3-5 Duplex Operation of Loop Controllers

If Process-control CPU-Units (CS1D-CPU□□P) are used, Loop Controller errors will not cause the whole system to go down and loop control will continue. This enables PLCs to be used to construct restorable and highly reliable process control systems.

The duplex function and restrictions that apply when Process-control CPU-Units (CS1D-CPU□□P) are used in duplex mode are described below.

Refer to the *CS1D Duplex System Installation Guide* (Cat. No. W350) for details of the entire CS1D Duplex System.

### 3-5-1 Loop Controller Duplex Function

#### Operation in Duplex Mode

Mount two Process-control CPU-Units (CS1D-CPU□□P) of the same model to the CPU Duplex Backplane, and set the Duplex Unit DPL/SPL mode setting switch to DPL.

Both Process-control CPU Unit Loop Controllers always perform operations for the same function block data. Both Loop Controllers exchange data with the CPU Units.

The Loop Controller mounted to the active CPU Unit (i.e., the active Loop Controller) exchanges data with external devices via the CPU Unit. The active Loop Controller is monitored and settings are made using CX-Process Tool software, SCADA software, or PTs (Programmable Terminals).

#### Conditions for Switching Operation

Operation switches when a fatal Inner Board error occurs on the active Loop Controller. (The Fatal Inner Board Error Flag A40112 will turn ON to indicate this error). The standby CPU becomes the active CPU and operation switches to the Loop Controller mounted to the standby CPU (i.e., the standby Loop Controller). The CS1D system changes from duplex mode to simplex mode. The following fatal errors cause the operation to switch:

- WDT error: A42400 turns ON
- Inner bus error: A42401 turns ON
- Cyclic monitor error: A42402 turns ON
- Flash memory data error or function block database error (when all function blocks are in error) in duplex mode: A42403 turns ON.

The system will stop running if the same error occurs in the Loop Controller that was on standby or if an operation switching error or fatal error occurs in the CPU Unit.

### Automatic Reset to Duplex Mode Function Using Self-diagnostics

The CS1D system will be automatically restored from simplex mode to duplex mode if self-diagnostics detects that a fatal Inner Board error has been cleared after the error caused the CS1D system to change from duplex mode to simplex mode and if the *Return Automatically* option is enabled in the PLC Setup. The Loop Controller diagnosed as normal by self-diagnostics will be on standby.

### Conditions for Executing Duplex Initialization

Duplex initialization is executed in the following conditions when Process-control CPU Units (CS1D-CPU□□P) are used in duplex mode.

1,2,3...

1. Operations on CPU Units
  - When power is supplied to PLC
  - When Duplex Unit's initialize switch is turned ON
  - When the CPU Unit starts operating
  - When data is transferred to the CPU Unit (user programs, PLC Setup, I/O tables, CPU Bus Unit system setting area transfers, timer/counter setting changes, or online editing)
2. Operations on Loop Controllers
  - When a cold start command is sent to Loop Controller
  - When the Inner Board is restarted when A60800 turns ON
  - When Loop Controller internal error log is cleared

**Note**

1. The following operations cannot be performed using the CX-Process Tool software while duplex initialization is being executed.
  - All clear, batch download, recovery, and backup.

**Note** Any operation stop command that is sent for an LCB during duplex initialization will be ignored and operation will be started automatically when duplex initialization has been completed.

2. Duplex initialization will restart when any of the following is performed during duplex initialization.
  - Function block data is downloaded from the CX-Process Tool software, whether the data is sent to the whole LCB, to one function block, or as individual ITEMS.
  - An ITEM is written in a Loop Control Board using the FINS command.
  - An operation command is sent to the Loop Control Board.
3. The function block data in the left and right Loop Control Boards may not be the same after a power interruption occurs during duplex initialization. A database error may thus occur after recovery from a power interruption. If this happens, download the function block data again from the CX-Process Tool.
4. User link tables and the HMI interface can be used to read and write I/O memory in the CPU Unit even during duplex initialization.

## 3-5-2 Outline of Procedure for Using Duplex Mode

1,2,3...

1. Connect the CX-Process Tool software to the active CPU Unit and download the function block data. Function block data cannot be downloaded if the CX-Process Tool software is connected to the standby CPU Unit.
2. Send the run command from the CX-Process Tool to start operation.



3. Duplex initialization is executed in a cold start. The CS1D system will enter duplex mode after the duplex initialization has been completed (150 seconds max.)
4. The active Loop Controller's operation cycle will be temporarily lengthened by 3 seconds max.

### 3-5-3 Restrictions on Duplex Loop Controllers

#### Effect on CPU Unit Cycle Times

##### Effect on CPU Unit Normal Cycle Times

The following table shows the time added to the CPU Unit's normal cycle time by the Loop Controllers in the Process-control CPU Unit.

Loop Controller model	Time added to normal cycle time
CS1D-CPU□□P	25 ms max.

#### Example of Process-control CPU Unit's Influence on Normal Cycle Time

Function block and user link table operation cycle (See note (a).)	100 ms		
Number of function blocks	100	150	200
Number of user link tables	100	150	200
Load rate	39	55	71
Influence (ms) by 2-ms cycle time of ladder program (See note (b).)	+7.8	+10.5	+13.6
Influence (ms) by 19-ms cycle time of ladder program (See note (b).)	+10.3	+14.4	+20.8

**Note** (a) The influence of the function block and user link table operation cycle on the CPU Unit's cycle time is greatest when the function block and user link table operation cycle is 100 ms.

(b) The influence of the Process-control CPU Unit Loop Controllers on the CPU Unit's cycle time is greatest when the cycle time of the CPU Unit is 19 ms.

(c) When sequence tables are used, the extra time in the above table is further extended. The additional extra time required depends on how the sequence tables are used, as follows:

- Not expanding sequence tables: +3 ms
- Expanding sequence tables vertically or horizontally: +6 ms
- Expanding sequence tables both vertically and horizontally: +12 ms

The extended cycle time will not be lengthened if the number of expanded sequence tables increases, but the number of times that the cycle time is extended will increase.

##### Effect on CPU Unit Cycle Time and Loop Controller Operation Cycle during Duplex Initialization

Refer to page 41.

##### Restrictions on Minimum Operation Cycle for Loop Controller Function Blocks

When using Process-control CPU Unit (CS1D-CPU□□P), it is recommended that the longest possible operation cycle is set to prevent operation cycle errors. The operation cycle time for Loop Controller function blocks must be a minimum of 5 times the CPU normal cycle time (i.e., the cycle time other than when duplex initialization is being executed).

**Example**

If the CPU Unit cycle time is 40 ms, the minimum cycle time for all the Loop Controller function blocks must be at least 200 ms (200 ms, 500 ms, 1 s, or 2 s.)

If the CPU Unit's normal cycle time is longer than 1/5 of the minimum operation cycle for the Loop Controller function blocks, the error in the length of the function block operation cycle will increase. The error will be up to one CPU Unit cycle time longer.

**Note** If the CPU Unit's normal cycle time is longer than 30% of the minimum operation cycle for the Loop Controller's internal function blocks for 3 consecutive cycles, Auxiliary Area bit A42409 (Operation Cycle Error) will be set to 1 (ON). Monitor this flag from the CX-Process Tool system operation verification screen and if it is reset to 1 (ON), then set the Loop Controller's operation cycle to a minimum of 5 times the CPU Unit's normal cycle time.

**Note** If the cycle time is less than 20 ms, the cycle will be considered to last through the next cycle time.  
For example, if the cycle time is 11 ms, it will be treated as 22 ms.

**Time until the Process-control Unit (CS1D-CPU□□P) Starts Operation****Time to Operation Start for Active Loop Controllers**

When the Process-control CPU Unit (CS1D-CPU□□P) is used in DPL mode, the active Loop Controller will start operation without waiting for duplex initialization in the following circumstances (see note):

At power ON, when initialization switch is turned ON, at the start of operation, or when data is being transferred

However, the operation cycle will be temporarily extended by up to 2.1 seconds during a period of up to 150 seconds<sup>\*1</sup> after operation has started.

<sup>\*1</sup> Up to 120 seconds when the *Run under Duplex initial* option is set to *Do not automatically return to duplex operation* in the PLC Setup in the CPU Unit, and up to 150 seconds when the *Run under Duplex initial* option is set to *Automatically return to duplex operation*.

**Note** Even when the *Run under Duplex initial* option in the PLC Setup in the CPU Unit is set to the default (*Automatically return to duplex operation*, i.e., start operation after duplex initialization), the active Loop Controller will start operation without waiting for duplex initialization.

**Time to Operation Start for Standby Loop Controllers**

When the Process-control CPU Unit (CS1D-CPU□□P) is used in DPL mode, the standby Loop Controller will take up to 92 seconds before operation starts (i.e., the time taken for duplex initialization). The DPL STATUS indicator on the Duplex Unit will flash green for 150 seconds<sup>\*1</sup> and then will switch to being lit (green) at up to 2.1 seconds after that.

At power ON, when the initialization switch is turned ON, at the start of operation, or when data is being transferred

<sup>\*1</sup> Up to 120 seconds when *Run under Duplex initial* option is set to *Automatically Return to duplex operation* in the PLC Setup in the CPU Unit, and up to 150 seconds when *Run under Duplex initial* option is set to *Do not automatically return to duplex operation*.

**Changes to LCB Load Rate in Duplex and Simplex Modes**

The CS1D CPU Unit's cycle time and the Loop Controller's LCB load rate are different in duplex mode and simplex mode. Verify the system's operation in both modes in trial operation before actually running the system.

**Restrictions in Data Continuity when Switching Operation**

The Process-control CPU Unit (CS1D-CPU□□P) cannot synchronize data between the active and standby Loop Controllers for the following ITEMS and HMI.

If any of the following data is used in calculations in the Loop Controllers or read using the ladder program in the CPU Unit, calculation results using this data will not necessarily be the same in the active and standby Boards, or the data read from the active Board will not necessarily be the same as the data read from the standby Board.

If operation is switched to the standby Board when the following data is used in calculations or to control operation, continuity of the results may be lost. Do not use the following data in calculations or read it using the ladder program in a way that will affect operation, e.g. to stop operation at a specific time or to output an alarm at a specific load rate.

**ITEM Data That Is Not Synchronized**

The following ITEMS in the System Common block (Block Model 000) are not synchronized.

- ITEMS 031 to 036: Date and time data (year, year/month, month/day, hours/minutes, minutes/seconds)
- ITEMS 047 and 048: LCB load factor and LCB maximum load factor
- ITEMS 099 to 110: Memory processing (Backup start command, Recovery start command, Backup error display, Flash memory write count display, etc.)

**HMI Data That Is Not Synchronized**

The following HMI data is not synchronized.

- EM□\_00001: LCB load rate
- EM□\_00003: LCB maximum load rate

**Restrictions on Startup Mode**

The Process-control CPU Unit (CS1D-CPU□□P) cannot specify the startup mode when power is turned ON. In other words, ITEM018 (START mode at power ON) in the System Common block cannot be set to 3 (Specification from CPU Unit).

**Restrictions on Duplex Unit Initial (INIT) Switch Operation**

With a Process-control CPU Unit (CS1D-CPU□□P), the Duplex Unit's Initial (INIT) switch cannot be pressed while the active Loop Controller's RDY indicator is not lit (\*1). Wait until the RDY indicator is lit for both Loop Controllers before pressing the initial (INIT) switch

\*1 When replacing standby CPU Units and Loop Controllers, the RDY indicator will not be lit until approximately 10 seconds after the Duplex Unit's CPU USE/NO USE switch is set to "USE."

## 3-6 Fail-safe Countermeasure Guidelines

Implement fail-safe countermeasures on the Loop Controller according to the following guidelines.

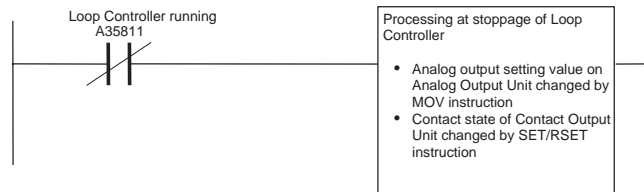
### 3-6-1 Measures When the Loop Controller Has Stopped Running

When the Loop Controller stops running, the state before the stop occurred is held and all operations that were being executed on the Loop Controller are stopped. Refreshing between the CPU Unit and the function blocks on the Loop Controller is also stopped. For this reason, the values of the allocated areas on the Analog Output Unit and the Contact Output Unit whose refreshing cycle was changed are held at the state before the stop occurred by the AO and DO terminals of the Field Terminal block.

**Fail-safe countermeasures for adapting to stoppage of the Loop Controller when the CPU Unit is in the RUN or MONITOR mode (CS1W-LCB01/05 or CS1D-CPU□□P in simplex mode)**

Implement the following fail-safe measures to hold analog outputs or contact outputs at specific values (for example, maximum value or minimum value) when the Loop Controller has stopped running.

To hold analog outputs or contact outputs at specific values when the Loop Controller (CS1W-LCB01/05) or Process-control CPU Unit (CS1D-CPU□□P) in simplex mode has stopped running, create a Step Ladder Program on the CPU Unit so that each of the bits on the Analog Output Unit or Contact Output Unit are set to a specific value taking the N.C. condition of the Loop Controller CPU Unit Running flag (A35801) as the input condition.



**Fail-safe countermeasures for adapting to stoppage of the Loop Controller when the CPU Unit is in the PROGRAM mode**

**Analog output operation**

When an Analog Output Unit (for example, CS1W-MAD44) is used in regular operation (that is, operation without a Loop Controller), the Analog Output Conversion Enable flag turns OFF and analog output values are output according to the setting of the output hold function when the CPU Unit changes from the RUN or MONITOR mode to the PROGRAM mode.

However, when analog values are output via the Analog Output Unit by the Loop Controller, the Analog Output Conversion Enable flag is forcibly turned ON by the Loop Controller even if the CPU Unit is in the PROGRAM mode, and the output hold function does not work.

The analog output setting values are refreshed and then output.

**Contact output operation**

Normally, the Contact Output Unit also turns OFF when the CPU Unit changes from the RUN or MONITOR mode to the PROGRAM mode. (The I/O Memory Hold flag is used to hold output values.)

However, when contact values are output via the Contact Output Unit by the Loop Controller, contact outputs are refreshed and then output if the CPU Unit is in the PROGRAM mode.

Implement the following fail-safe measures to hold analog outputs or contact outputs at specific values (for example, maximum value or minimum value) when the Loop Controller has stopped running even if the CPU Unit is in the PROGRAM mode.

**1,2,3...**

1. When the user uses SCADA software or CX-Process Tool to stop running of the Loop Controller when the CPU Unit is in the PROGRAM mode:  
Before the Loop Controller is made to stop running, switch Control blocks such as PID blocks to Manual, and use or CX-Process Tool to execute setting so that the MV becomes the required value.
2. To set ITEM014 (run/stop command) of the System Common block to 0 (stop) by the ITEM Setting blocks on the Loop Controller:  
Before writing to the ITEM Setting blocks, switch Control blocks such as PID blocks to Manual, and create a sequence so that the MV becomes the required value beforehand using the Step Ladder Program block.

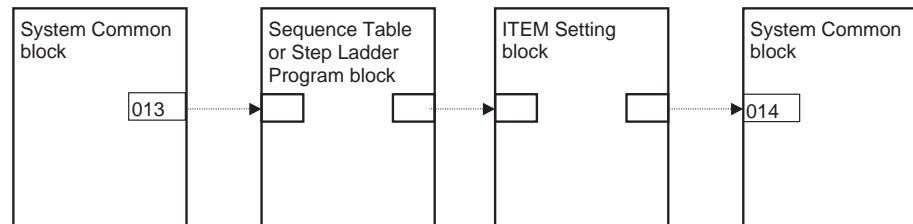
**Note**

1. When the Loop Controller stops running due to a malfunction of the Loop Controller itself when the CPU Unit is in the PROGRAM mode, analog output or contact output cannot be held at specific values (for example, max-

imum value or minimum value). This must be taken into consideration when designing the system.

2. Processing that causes the Loop Controller to stop running can also be executed when the CPU Unit is in the PROGRAM mode.

In this case, enter ITEM013 (PROGRAM mode) of the System Common block (Block Model 000) as the CPU Unit run status, and set ITEM014 (run/stop command) of the System Common block to 0 (stop) by the Step Ladder Program block (Block Model 301) and the ITEM Setting blocks (Block Models 171 and 172).



### 3-6-2 Measures for a CPU Unit fatal error

When a fatal error occurs on the CPU Unit (including during execution of the FALS command), the Loop Controller also stops running. To hold the analog output to the previous value before the stop occurred, and to set the analog output to either the minimum value or maximum value, use the output hold function of the Analog Output Unit or Analog Input/Output Unit.

**Note** The Loop Controller continues to run even if the Output OFF flag causes output refreshing of the CPU Unit to stop. Note, however, that in this case contacts are not output and turn OFF, and the output hold function of the Analog Output Unit holds analog output to a specific value. For this reason, the Loop Controller only performs internal operations, and does not perform control on the outside.

### 3-6-3 Required Conditions for the Man-Machine Interface

The Loop Controller Interface itself does not have a man-machine interface. So, an external interface such as SCADA software that satisfies the following conditions must be provided:

- Loop Controller run/stop command function and run status display function (operation of ITEM014 to ITEM017 of the System Common block)
- Loop Controller error status display function (operation of ITEM091 to ITEM095 of System Common block)
- Basic display function for Set Point, PV, MV and other values
- Basic setting function for Set Point and other settings
- Function for changing P, I, D and other parameters
- Auto/Manual switching and manual operation functions



## SECTION 4

### Simple Example of Use

This section provides examples of using the Loop Controller for a simple application

4-1	Simple Example of Use. ....	176
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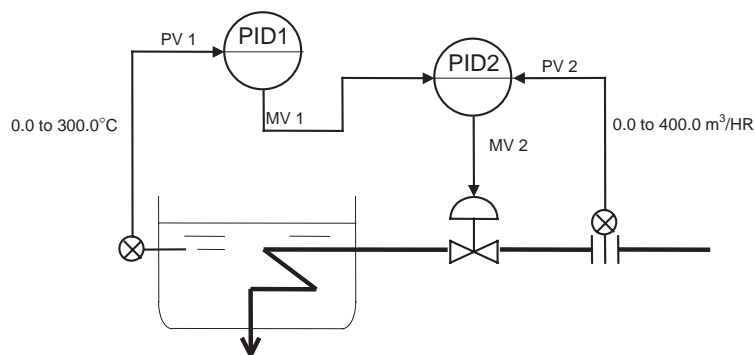
## 4-1 Simple Example of Use

This section describes the basic procedure for using the Loop Controller for cascade control.

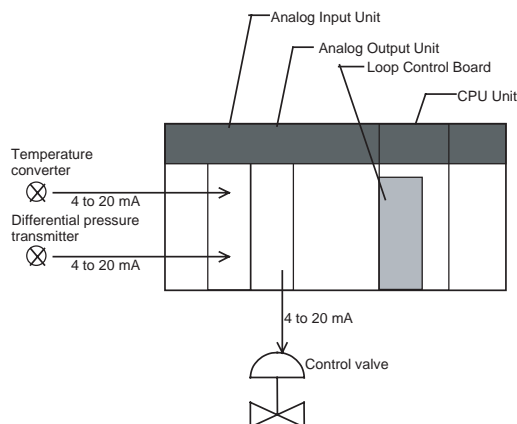
### Step 1

### Design

- 1,2,3... 1. Prepare an instrumentation drawing.



2. Decide on the PLC system configuration.

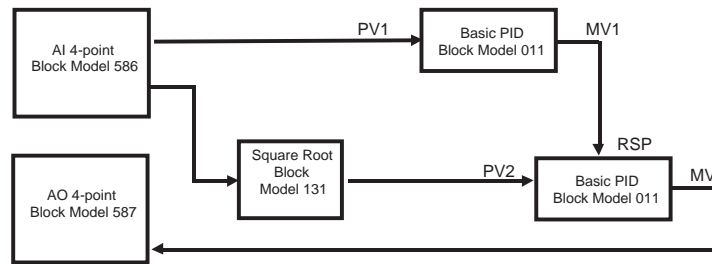


Product name	Model	Description
CPU Unit	CS1H/G-CPU□□	
Loop Control Board	CS1W-LCB01	
Analog Input Unit	CS1W-AD041	<ul style="list-style-type: none"> <li>Analog input 1: 4 to 20 mA (temperature conversion input)</li> <li>Analog input 2: 4 to 20 mA (differential pressure transmitter input)</li> </ul>
Analog Output Unit	CS1W-DA041	<ul style="list-style-type: none"> <li>Analog output 1: 4 to 20 mA (output to control valve)</li> </ul>

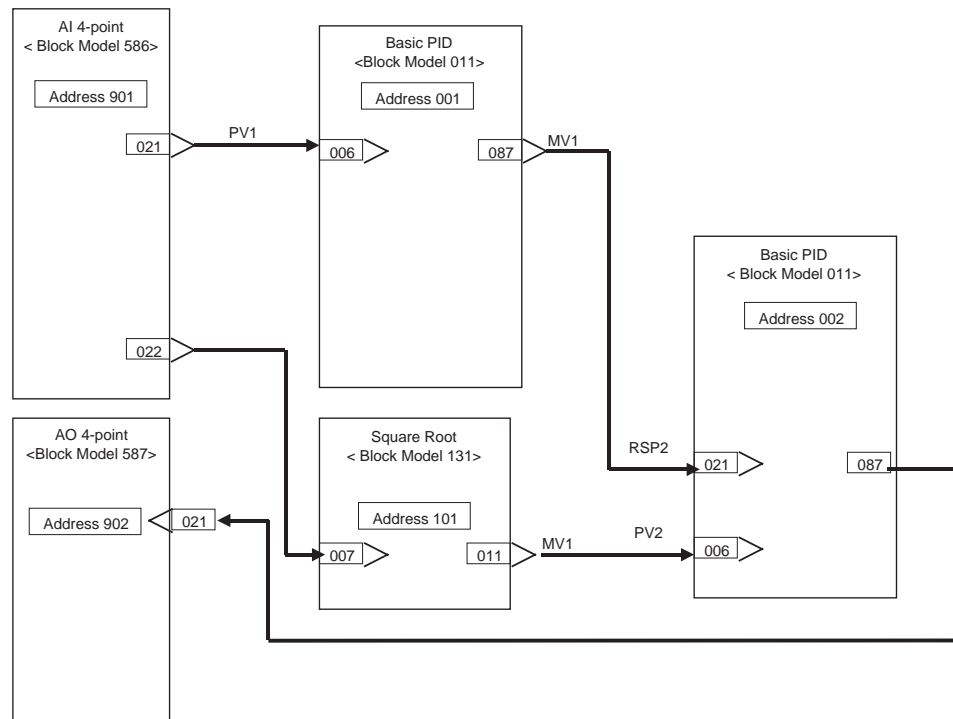
3. Select the required function blocks.

Software type	Function block name
Field terminal	AI 4-point (Block Model 586)
	AO 4-point Terminal (Block Model 587)
Wiring diagram	Square Root (Block Model 131)
	Basic PID (Block Model 011)
	Basic PID (Block Model 011)





4. Decide on the function block system configuration.



5. Decide on the data to be monitored and manipulated by SCADA software, a PT, etc.

The following table shows the function blocks to be monitored.

Block address	Function block name	Tag No.	Tag comment	High limit (RH)	Low limit (RL)	Unit (UNIT)	Decimal point (DP)
001	Basic PID	PID1		0	300	°C	1
002	Basic PID	PID2		0	400	m <sup>3</sup> /HR	1

## Step 2

### Preparing Function Block Data on CX-Process Tool

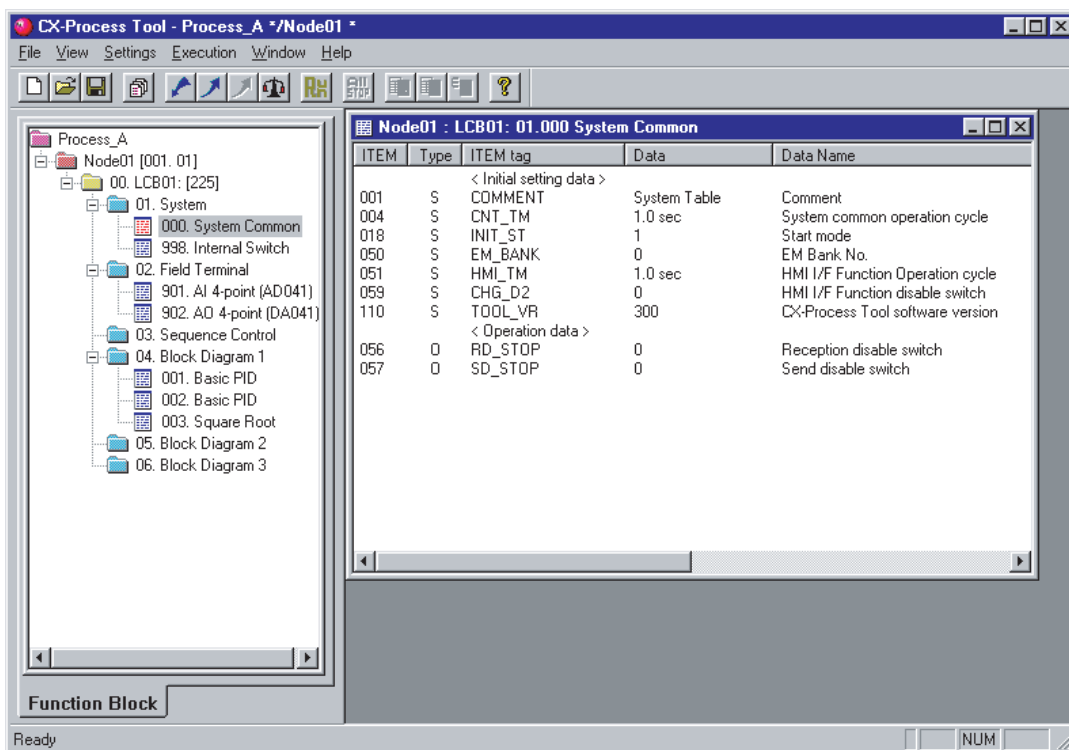
- 1,2,3... 1. Set up and start CX-Process Tool.  
2. Set the System Common block data.

Set the specifications common to each function block in the System Common block (Block Model 000). The ITEMS in this block must be set as the initial settings when the Loop Control Board is to be used.

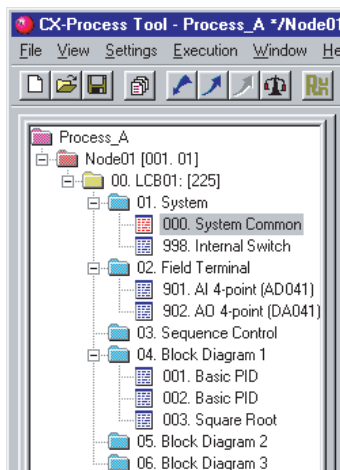
In this example, set as follows:

- Set the operation cycle in the System Common block to 0.5 s
- Set the START mode at power ON to Hot start (1).

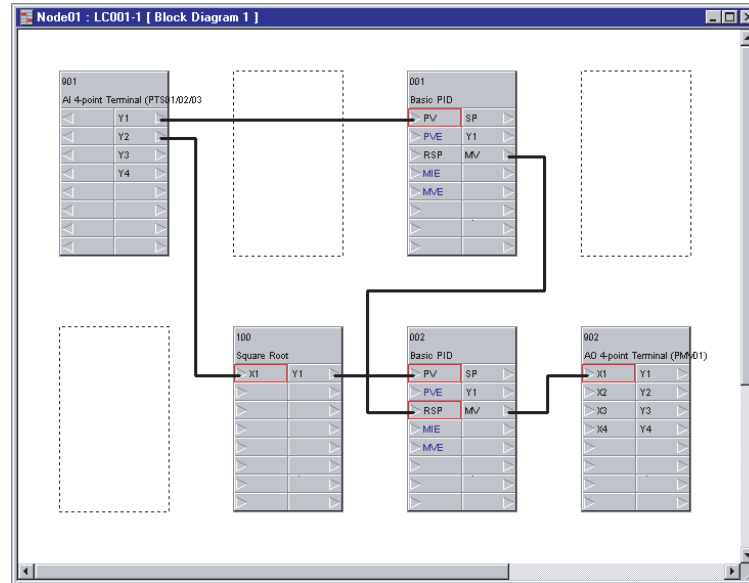
ITEM	Data description	Data range	Setting example
004	Operation cycle (s) 1: 0.1, 2: 0.2, 3: 0.5, 4: 1, 5: 2	1 to 5	3
018	Start mode at power ON 1: Hot start, 2: Cold start	1 or 2	1



3. In CX-Process Tool, select the function blocks to be used (including allocations to block addresses).



4. Wire in the software the analog signals between blocks.



5. Set the ITEMS in each function block.

ITEM	Type	ITEM tag	Data	Data Name
< Initial setting data >				
001	S	COMMENT	Basic PID	Comment
002	S	MODEL	011	Model:Basic PID
004	S	CNT_TME	System common operation ...	Operation cycle(0:common)
005	S	SCAN_NO	2000	Operation order
006	S	PV_AD	000.000	PV source designation
012	S	HS_SP	1.00	Hysteresis setting
018	S	PVE_AD	000.000	PV error source designation
020	S	ALM_LIM	0	Alarm limit
021	S	RSP_AD	000.000	RSP source
024	S	CAS_SET	0	Set Point setting mode (default)
025	S	S2	0	PV tracking at local (MAN)
032	S	S8	0	Bumpless processing
043	S	DV_SQ	1	Deviation alarm standby sequence
051	S	PID_RATE	0	Processing cycle of PID control
052	S	DIR_REV	0	Control action
061	S	MIE_AD	000.000	Out-of-range processing
062	S	MV_RTM	0	Output retrace time for PV error
088	S	MV_REV	0	Inversion of host indicated MV
090	S	MVE_AD	000.000	MV error source designation
< Operation data >				
008	O	HH_SP	115.00	High/high alarm setting
009	O	H_SP	100.00	High alarm setting
010	O	L_SP	0.00	Low alarm setting
011	O	LL_SP	-15.00	Low/low alarm setting
017	O	AOF	0	Alarm stop switch
023	O	SP_W	0.00	Local Set Point setting
026	O	R/L_SW	0	Remote/Local switch
035	O	AT	0	AT command/AT Executing

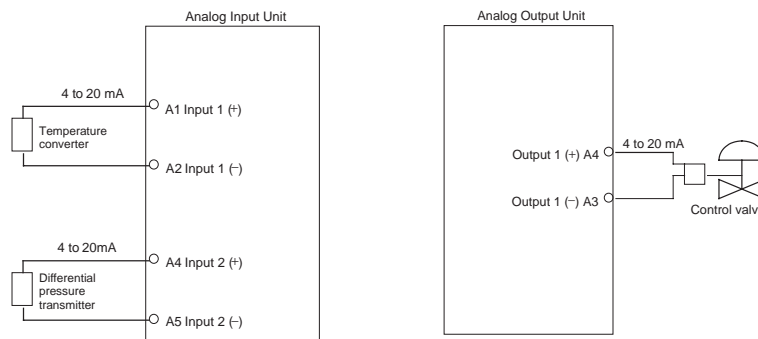
Set function block initial setting parameters (refer to the item “(S): Initial setting data” describing how to read/write in the *Function Block Reference Manual*) such as direct/reverse action and Set Point setting mode (Remote/Local) on CX-Process Tool.

Operation-related parameters (refer to the item “(O): Operation Data” describing how to read/write in the *Function Block Reference Manual*) such as PID constants may be set either on CX-Process Tool or using SCADA software.

6. Set the CSV tags.
7. Create (compile) the CSV tag file

**Step 3****Setting up the Loop Control Board**

1. Mount the Loop Control Board, and wire the Analog Input Unit and Analog Output Unit.



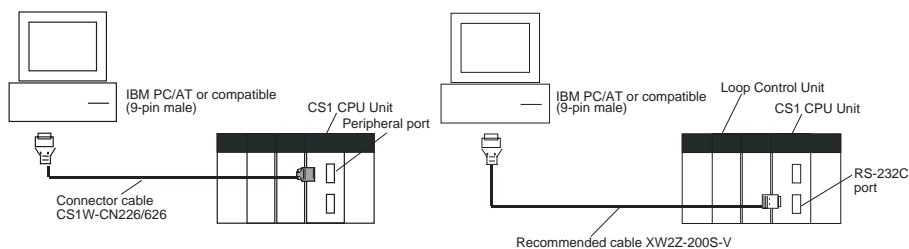
The Loop Control Board itself need not be wired.

2. Connect the Programming Devices.
3. Turn power ON to the PLC.
4. Prepare I/O tables using the Programming Devices.
5. Set the communications conditions of the serial communications port in the PLC Setup using the Programming Devices if necessary.
6. Set the allocated Data Memory area of the Analog Input Unit or Analog Output Unit using the Programming Devices.

**Step 4****Downloading the Function Block Data to the Loop Controller**

1,2,3...

1. Turn power OFF to the PLC.
  2. Set the DIP switches on the front panel of the CPU Unit (SW4: ON when using the peripheral port, OFF when using the RS-232C port).
  3. Connect the CPU Unit to the Computer on which CX-Process Tool is running. (Connect to the active CPU Unit for CS1D-CPU□□P Process-control CPU Units.)
- Connection to peripheral port • Connection to RS-232C port (only Host Link connection is supported)



4. Turn power ON to the PLC.
5. Set the network address (000) and node address (01) on CX-Process Tool. (**Settings - Network Settings**)
6. Establish the Host Link connection on CX-Process Tool. (**File - Initialize Serial Port/F**)

7. Download the function block data prepared on CX-Process Tool to the Loop Control Board. (**Execution - Download**)
8. Execute the run/stop command on CX-Process Tool (**Execute - Run - Run/Stop Command**) or turn the PLC OFF then back ON again.

**Note** Check the following points before you start Loop Controller operation.

- a. Be sure the bank of the EM Area with the number specified for allocation to the HMI (human-machine interface) data does not overlap with any other area used by the CPU Unit or other Units. The block allocated for the HMI is specified in ITEM 050 (EM Area Bank Allocated for HMI Memory = 0 to 12) of the System Common block (Block Model 000). If areas overlap, the system may operate in an unexpected manner, which may result in injury.
  - b. Be sure the area to which user link table data is written does not overlap with any other area used by the CPU Unit or other Units. If areas overlap, the system may operate in an unexpected manner, which may result in injury.
  - c. The correct combination of Analog Input/Output Units must be mounted. The unit address set on the front panel of Analog Input/Output Units must match the unit number set on the Field Terminals. Otherwise, data input/output (read/write) operations will be performed by mistake on the data of another Special I/O Unit (having the unit number set on the Field Terminals).
  - d. The correct defaults of the System Common block on the Loop Controller must be set.
9. Check the LEDs on the front panel of the Loop Controller (EXEC LED lit).

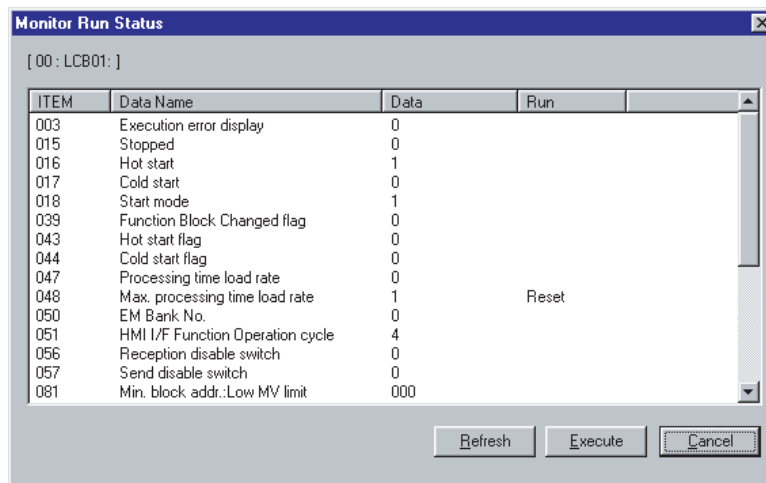
**Note** When the CS1D-LCCB05D is being used, the standby Loop Controller can take up to 150 seconds (for duplex initialization) before starting operation after the PLC power is turned ON. (The EXEC LED on the front and the Duplex Unit's DPL STATUS LED will flash for 150 seconds and then will be lit.)

## **Step 5**

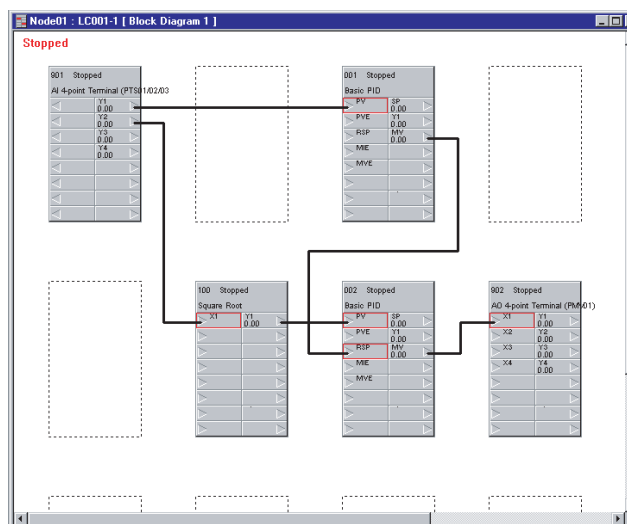
### **Trial Operation**

- 1,2,3... 1. Execute the run/stop command on CX-Process Tool (**Execute - Run - Run/Stop Command**) or turn the PLC OFF then back ON again.
2. Check system operation on CX-Process Tool. (**Execute - Run - Monitor run status**)

Execute the load rate check and other diagnostic checks.



3. Check the wiring on CX-Process Tool. (**Validate Action - Start**)



4. Set up and start the CX-Process Tool or SCADA software.
5. Set the Set Point and other settings on CX-Process Tool or SCADA software.

## Step 6

### Actual Operation

1. Tune the Loop Control Board using SCADA software. (For example, change the settings and PID constants.)
2. Monitor PV and alarms using SCADA software.

# SECTION 5

## Examples of Function Block Combinations

This section shows some typical examples of how to combine function blocks.

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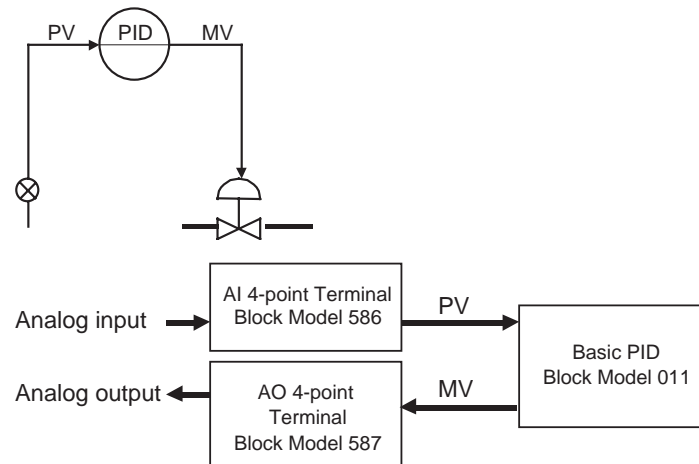
## 5-1 Basic Examples of PID Control

This section shows basic examples of how to connect the function blocks when performing PID control.

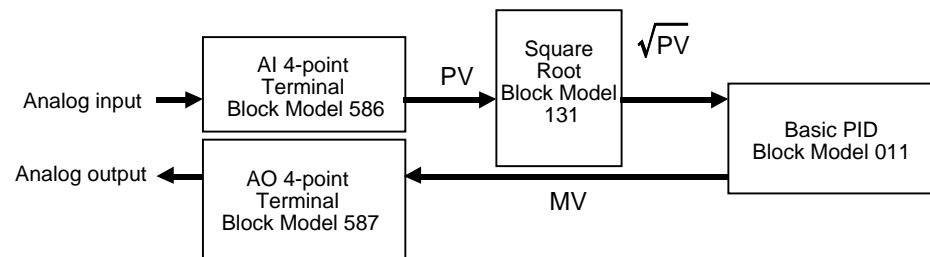
### 5-1-1 Simple PID Control

Function block used: Basic PID (Block Model 011)

Use the Field I/O Terminal blocks (AI 4-point/AO 4-point Terminal blocks, etc.) as the analog input/outputs.



**Note** When the square root function is used in flowrate control, insert the Square Root block (Block Model 131) in analog input.

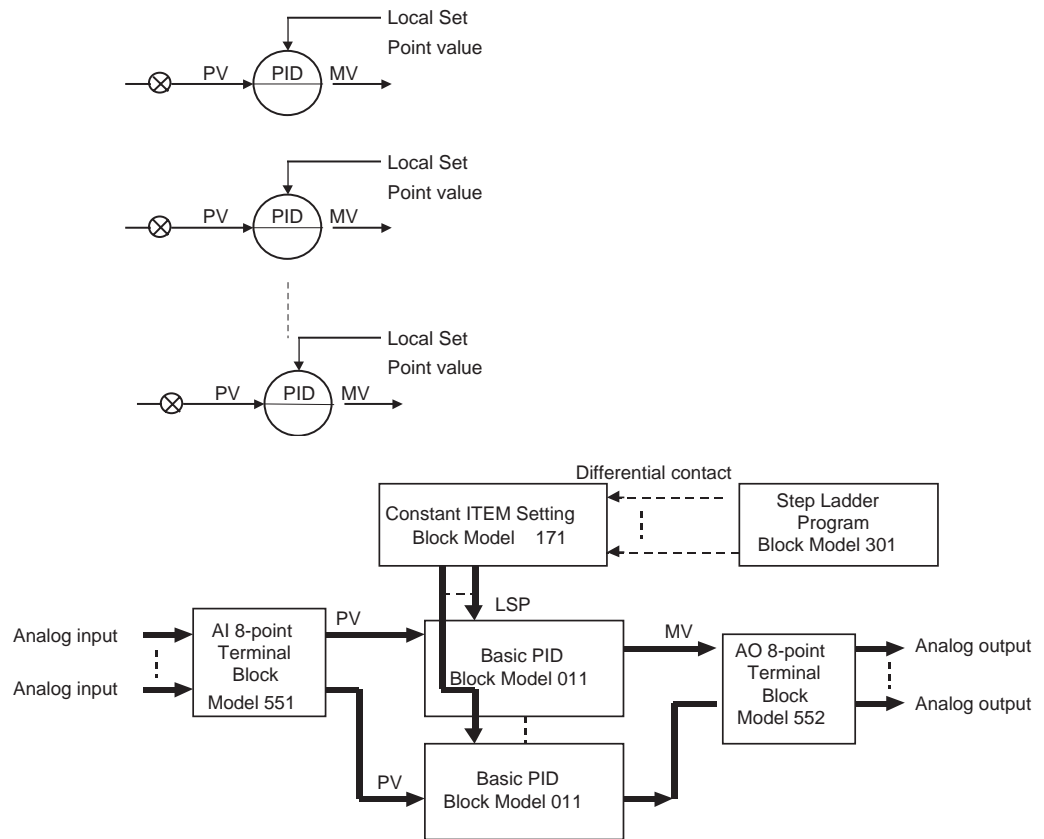


### 5-1-2 Multi-channel PID Control

Function blocks used: Basic PID (Block Model 011)  
 Constant ITEM Setting (Block Model 171)  
 Step Ladder Program (Block Model 301)



Use the Field I/O Terminal blocks (AI 8-point/AO 8-point Terminal blocks, etc.) as the analog input/outputs.

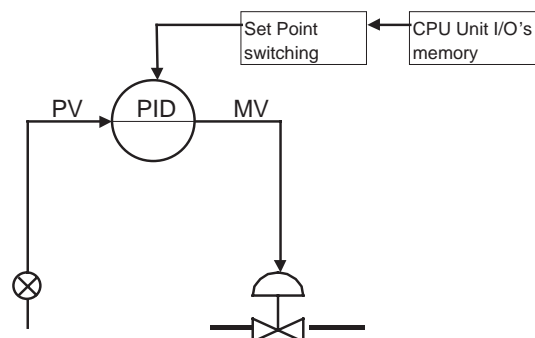


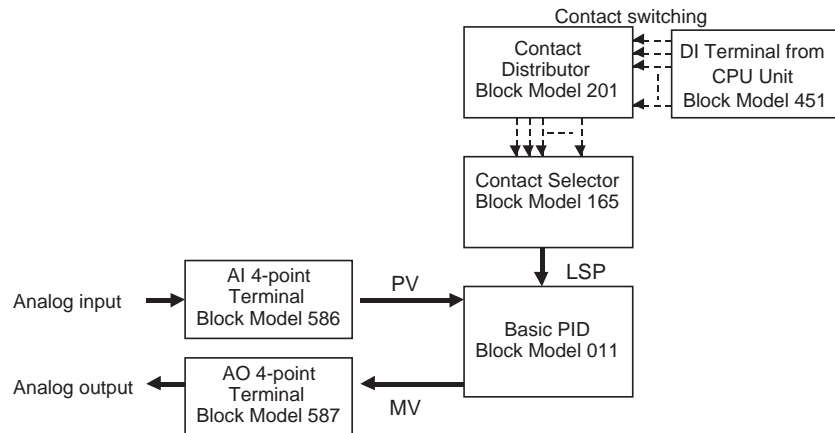
### 5-1-3 PID Control for Switching Multiple Set Points

Function blocks used: Basic PID (Block Model 011)  
 Contact Selector (Block Model 165)  
 DI Terminal from CPU Unit (Block Model 451)

Register multiple Set Points for switching in advance to the Constant Selector block. Connect the DI Terminal from CPU Unit block to the Constant Selector block, and switch the Local Set Points of the Basic PID block according to the I/O memory (contacts) of the CPU Unit.

Use the Field I/O Terminal blocks (AI 4-point/AO 4-point Terminal blocks, etc.) as the analog input/outputs.

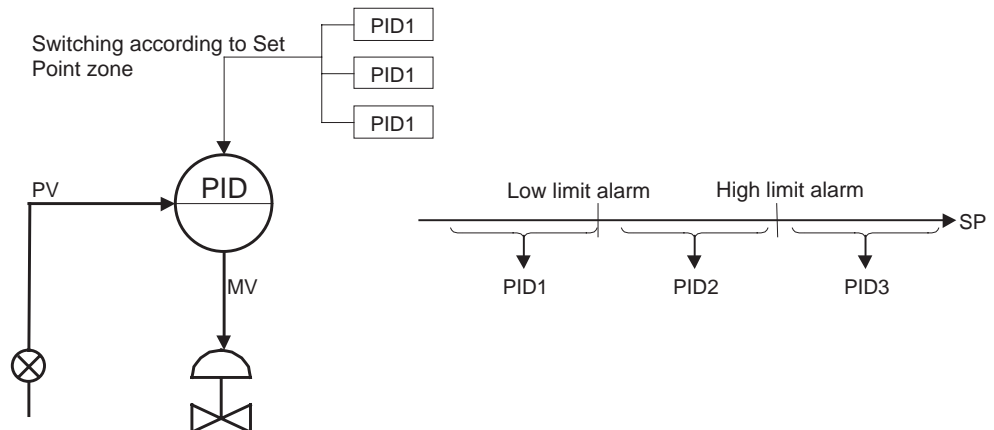


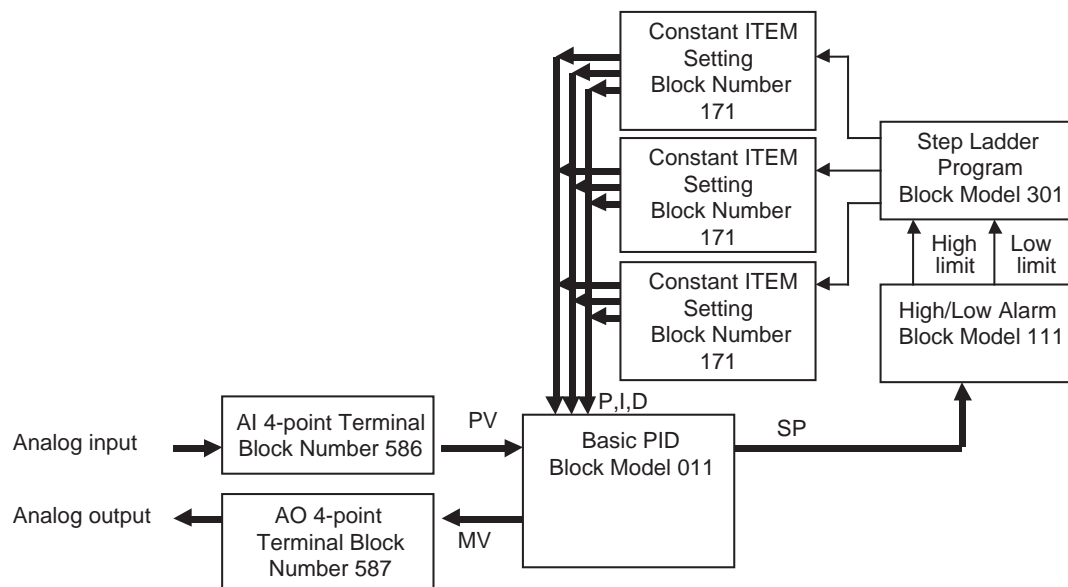


### 5-1-4 PID Control for Switching PID Constants by Three Set Point Zones

Function blocks used: Basic PID (Block Model 011)  
 ITEM Setting (Block Model 171)  
 High/Low Alarm (Block Model 111)  
 Step Ladder Program (Block Model 301)

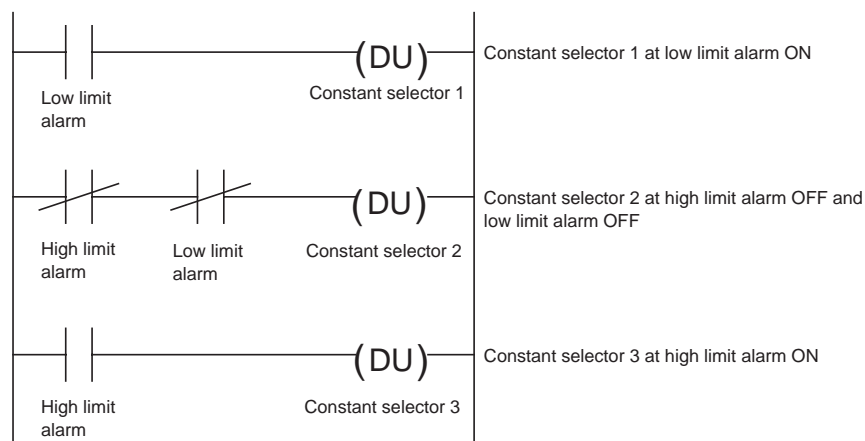
Register three sets of PID constants for switching in advance to the three Constant ITEM Setting blocks. Input the current Set Point value of the Basic PID block to the High/Low Alarm block. Three Set Point zones can be prepared in the Step Ladder Program block by combining the high alarms and low alarms of the High/Low Alarm block. Select the Constant ITEM Setting block according to the Set Point zone.





Block address	ITEM No.	Data	Explanation
901	002	586	AI 4-point Terminal block
	021		Y1 (analog input 1)
902	002	587	AO 4-point terminal block
	021	001087	X1 (analog output 1) source designation
	031		X1 (analog output 1)
001	002	011	Basic PID Block
	006	901021	PV source designation
	029		Current SP
	054		P (proportional band)
	055		I (integral time)
	056		D (derivative time)
	087		MV
100	002	111	High/low limit alarm block
	007	001029	X1 input value source designation
	012		U1 high limit alarm
	013		U2 low limit alarm
400	002	301	Step Ladder Program block
		2100	STEP00 declaration
		01100013	When ITEM013 low alarm of LOAD address 100
		11101039	Set constant ITEM of OUT address 101. (batch send command)
		02100012	When not ITEM012 (high alarm) of LOAD NOT address 100
		04100013	When not ITEM013 (low alarm) of AND NOT address 100
		11102039	Set constant ITEM of OUT address 102. (batch send command)
		01100012	When ITEM012 high alarm of LOAD address 100
		11103039	Set constant ITEM of OUT address 103. (batch send command)

Block address	ITEM No.	Data	Explanation
101	002	171	Constant ITEM Setting block
	021		Setting of P (proportional band) 1 value
	022		Setting of I (integral time) 1 value
	023		Setting of D (derivative time) 1 value
	011	001054	Destination designation of ITEM021
	012	001055	Destination designation of ITEM022
	013	001056	Destination designation of ITEM023
	039		Batch send switch
102	002	171	Constant ITEM Setting block
	021		Setting of P (proportional band) 2 value
	022		Setting of I (integral time) 2 value
	023		Setting of D (derivative time) 2 value
	011	001054	Destination designation of ITEM021
	012	001055	Destination designation of ITEM022
	013	001056	Destination designation of ITEM023
	039		Batch send switch
103	002	171	Constant ITEM setting block
	021		Setting of P (proportional band) 3 value
	022		Setting of I (integral time) 3 value
	023		Setting of D (derivative time) 3 value
	011	001054	Destination designation of ITEM021
	012	001055	Destination designation of ITEM022
	013	001056	Destination designation of ITEM023
	039		Batch send switch



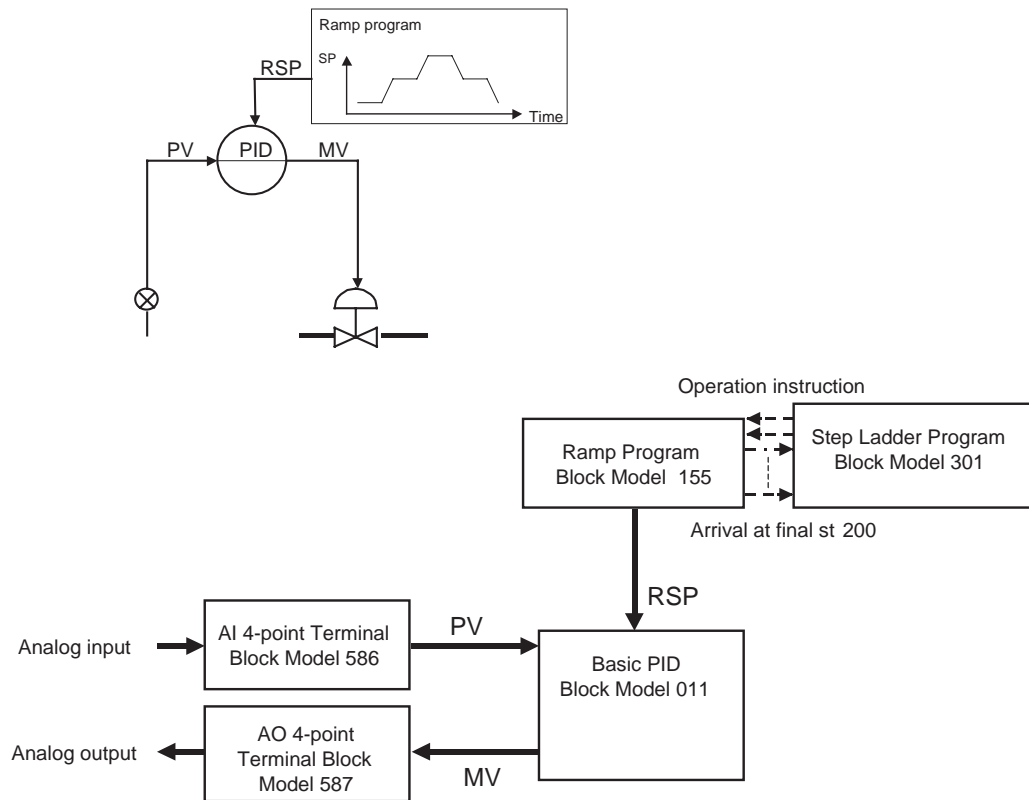
### 5-1-5 Ramp Program Control

Follow the procedure below to perform program control for changing the Set Point value in a ramp manner proportionately to the elapsed time.

Function blocks used: Basic PID (Block Model 011)  
 Ramp Program (Block Model 155)  
 Step Ladder Program (Block Model 301)

Register the ramp program (max. seven steps, each step comprising a ramp rate and soak value) in advance to the Step Ladder Program block. The Step Ladder Program is used in combination with the run/stop command from the

Step Ladder Program block and the arrival at final signal to the Step Ladder Program block.

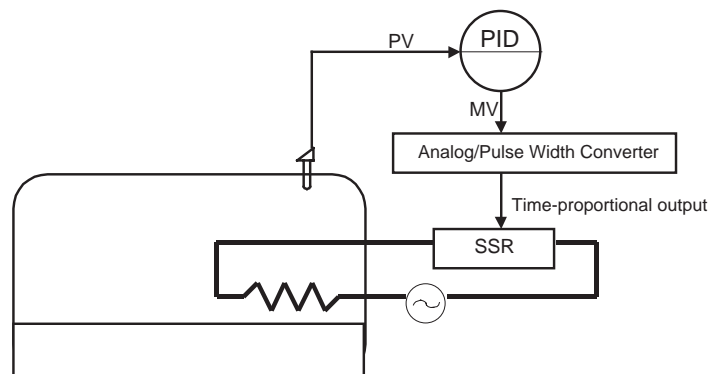


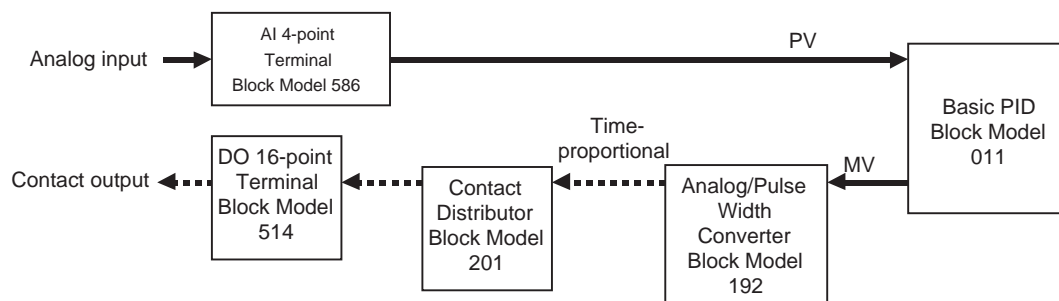
### 5-1-6 Time-proportional Control

Follow the procedure below to perform time-proportional control where contact output (ON/OFF) changes proportionally to the ON/OFF time ratio.

Function blocks used: Basic PID (Block Model 011)  
Analog/Pulse Width Converter (Block Model 192)

Assign the MV of the PID function block to the Analog/Pulse Width Converter block. The Analog/Pulse Width Converter block outputs the ON/OFF pulse signal obtained by changing the ON and OFF times proportionally to MV.





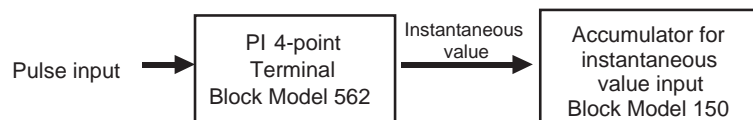
### 5-1-7 Monitoring and Accumulating Flowrate

Function blocks used: PI 4-point Terminal (Block Model 562)  
Accumulator for instantaneous value input (Block Model 150)

Connect the instantaneous value output value of the PI 4-point Terminal block to the Accumulator for instantaneous value input block when accumulating 8-digit accumulated values based on the instantaneous values from the Pulse Input Unit CS1W-PPS01.

#### Example

Let's apply scaling of 0 to 6000 to zero (0%) through to span (100%) of the pulse input instantaneous value, and set accumulation to maximum 1200.00 per hour. (The accumulated value is taken to be 1200.00 when 6000 has continued for 100% for one hour.) The accumulation result is stored to ITEM012 and ITEM013 of the Accumulator for instantaneous value input block.



Block address	ITEM No.	Data	Explanation
901	002	562	PI 4-point terminal block
	010	3	Instantaneous value output range 3: 0 to 6000
	021	0 to 115.00%	Y1 (instantaneous value output value 1) (See Note.)
100	002	150	Accumulator for instantaneous value input
	007	901021	X1 source designation
	008		Input
	009	1200.00	QR accumulation rate (accumulation value when input 100% is continuous for one hour)
	010	2	TU time unit (2: time)
	012	0000 to 9999	Accumulated value (lower 4 digits)
	013	0000 to 9999	Accumulated value (upper 4 digits)

**Note** This instantaneous value differs from the instantaneous value, that is reflected in words n+1 to n+4 allocated to the Pulse Input Unit CS1W-PPS01 in the CIO area, in that the instantaneous value is for each operation cycle of the PI 4-point Terminal block.

## 5-2 Examples of Applied Control Types

This section shows examples of applied control types when controlling special control targets.

As the function blocks of the Loop Controller can be combined as desired (excluding restrictions on the number of function blocks according to function block address), use this feature to build a control system suited to your particular control requirements.

The following table shows the relationship between example control types corresponding to special control targets and the purpose of the control.

Control purpose	Control type example	Section
Suppression of disturbance (on secondary loop)	Cascade control	5-2-1 Cascade Control
Adaptation to dead time from secondary through to primary loop		
Suppression of disturbance (on primary loop) Suppression of disturbance (on primary and secondary loops)	Feedforward control	5-2-2 Feedforward Control
Suppression of disturbance (on primary and secondary loops)	Cascade + feedforward control	5-2-1 Cascade Control/5-2-2 Feedforward Control
Adaptation to mutual interaction between processes	Non-interacting control (a type of feedforward control)	5-2-2 Feedforward Control
Adaptation to dead time	Sample PI control	5-2-3 Sample PI Control
	Dead time compensation	5-2-4 Dead Time Compensation
Adaptation to changes in dead time	Variable sample cycle control	5-2-4 Dead Time Compensation

**Note** “Special control targets” here refer to the following.

- Processes having a prolonged dead time
- Processes whose dynamic or static characteristics change
- Processes whose dynamic characteristics are not the “regular dead time + first-order lag”
- Processes whose non-linearity of dynamic or static characteristics are large
- Processing involving a large number of variables and strong mutual interaction

However, design your system taking into consideration the possibility that the control target cannot be completely controlled by this Loop Controller (take into consideration that functions for observing the characteristics of the control target are required).

### 5-2-1 Cascade Control

In the following instances, input the MV of PID1 on the primary loop and the Remote Set Point of PID2 on the secondary loop, and connect the PLC in series. This configuration is referred to as “cascade control.”

- When there are two controllable processes, and the process to be controlled is one of the processes (PV of primary loop)
- When the other (primary loop) can be controlled by controlling the other of the two (secondary loop)
- When there is disturbance on the other process (secondary loop), or when there is dead time until the effect of change on the other (secondary loop) operated terminal appears in the PV of the other (primary loop)

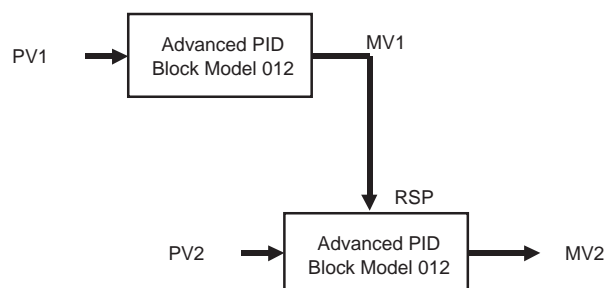
PID1 of the primary loop indirectly controls the finite control element of the secondary loop by controlling the setting value of PID2.

By this control, PID2 of the secondary loop absorbs the disturbance on the secondary loop, and suppresses the influence of the disturbance on the secondary loop on the primary loop. (The effect on the disturbance on the secondary loop increases as the response of the secondary loop process becomes faster than primary loop processes.)

**Note** This kind of cascade control has no effect on disturbance entering the primary loop. Cascade control must be combined with feedforward control in this case.

Function blocks used: Two Advanced PID blocks (Block Model 012)

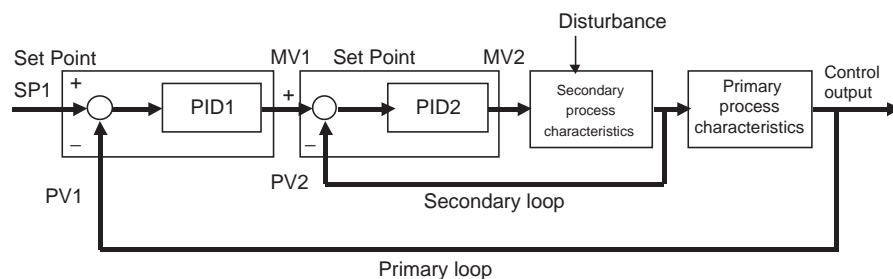
### Example



MV output of one Advanced PID block is input to the Remote Set Point of the other Advanced PID block.

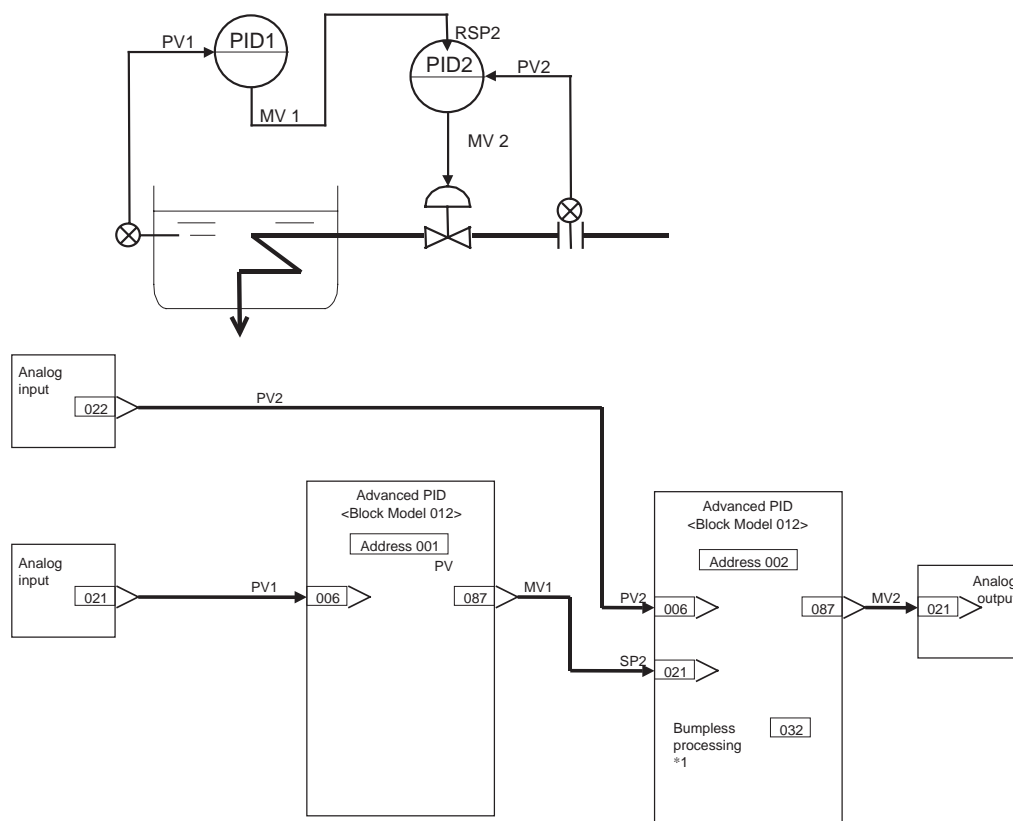
**Note** In cascade control, when the secondary loop PID2 is set to Local, MV1 of the primary loop PID1 must be tracked to changes on the Local Set Point setting (LSP2) (matched to LSP2).

The Loop Controller is provided with a bumpless MV tracking function on the primary and secondary sides during cascade processing in ITEM032 (bumpless processing between primary/secondary loops) in the Basic PID block (Block Model 011) and Advanced PID block (Block Model 012). The primary side MV1 is overwritten with the Local Set Point of the local node when the secondary side is local merely by setting 1 (bumpless processing ON) to ITEM032 of the Basic PID or Advanced PID block on the secondary side.





## Example



\*1: The self node overwrites the actual Local Set Point 2 value with primary side MV1 when the self node is the local node by setting bumpless output to 1 (ON).

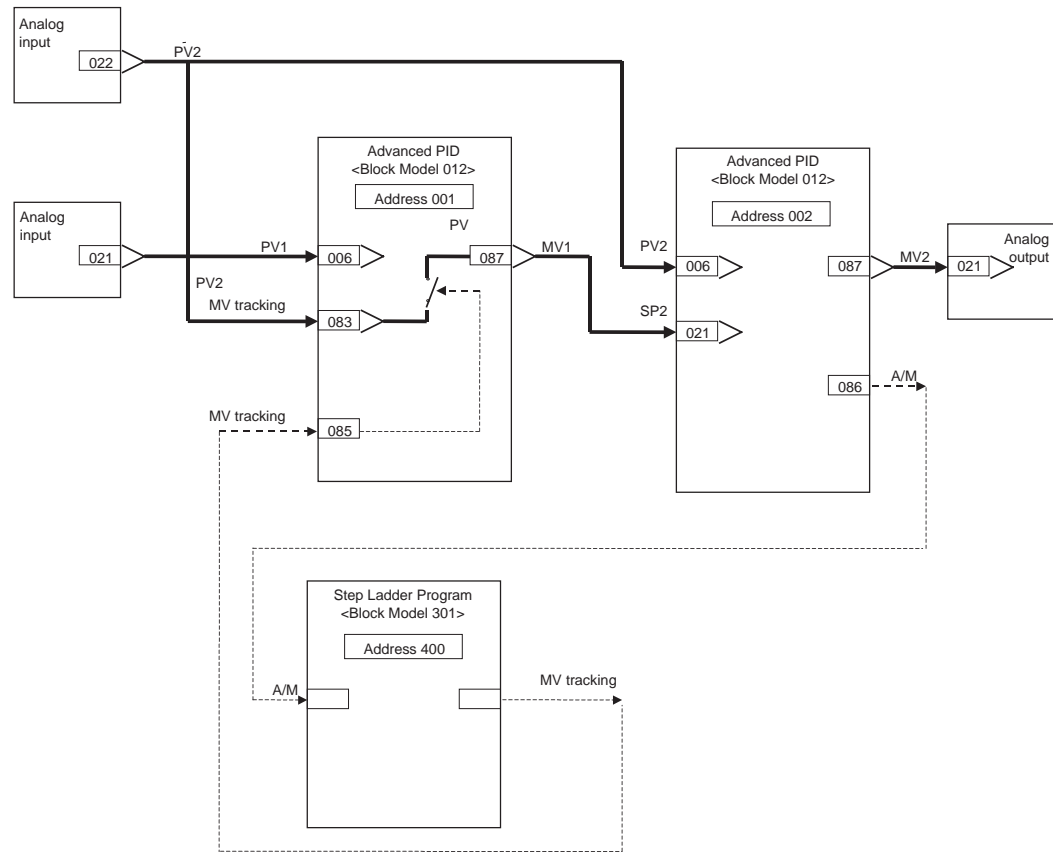
Block address	ITEM No.	Data	Explanation
901	002	586	AI 4-point Terminal block
	021		Y1 (analog input 1)
	022		Y2 (Analog input 2)
902	002	587	AO 4-point terminal block
	021	002087	X1 (analog output 1) source designation
	031		X1 (analog output 1)
001	002	012	Advanced PID block
	006	901021	PV source designation
	087		MV
002	002	012	Advanced PID block
	006	901022	PV source designation
	021	001087	RSP source designation
	032	1	Bumpless processing between primary/secondary loops *1
	087		MV

\*1: By this function, the value of the secondary loop LSP2 is forcibly written over the primary loop MV1 when the secondary loop is set to Local.

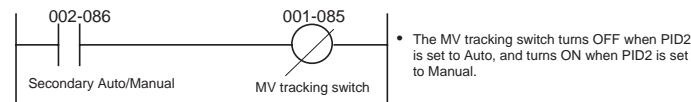
**Note** As shown above, the function of ITEM032 (bumpless processing between primary/secondary loops) of the Basic PID block (Block Model 011) or Advanced PID block (Block Model 012) can be used to enable switching of primary loop MV1 to the secondary loop LSP2 when the secondary loop is set to Local.

However, control is as follows when the primary loop MV1 must be switched to the secondary loop PV2 when the secondary loop is set to Manual.

When the secondary loop is set to Manual, turn the primary loop MV tracking switch ON and use the secondary loop PV2 to switch the primary loop MV1 to this PV2. The following shows an example of this.



Ladder in Step Ladder Program block

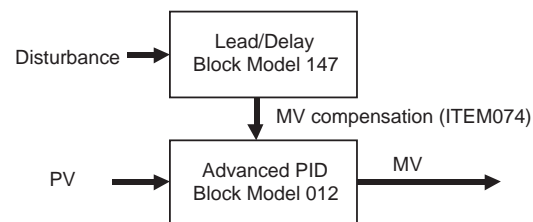


## 5-2-2 Feedforward Control

Before the influence of disturbances such as load fluctuation appears in the process result, disturbance is detected beforehand to correct MV so that its influence is canceled. Feedforward control is used in combination with feedback control.

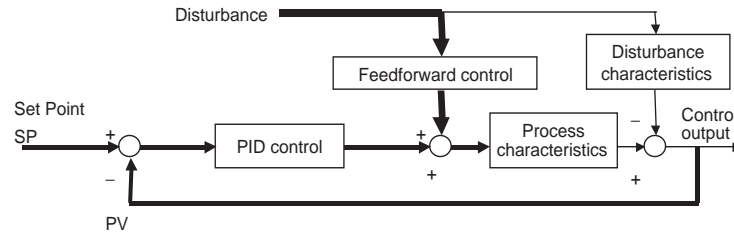
### Example

Function block used: Lead/Delay (Block Model 147)



The output of the Lead/Delay block is added to the MV output of the Advanced PID block.

- Note** 1. Though cascade control can suppress the influence of disturbance on the secondary loop, it cannot suppress the influence of disturbance on the primary loop. Whereas, feedforward control can suppress the influence of disturbance on the primary loop in cascade control.



2. A general feedforward control model is obtained by dividing the disturbance characteristics by the process characteristics. The transfer function of feedforward control is as follows when the disturbance characteristic is  $K_2/(T+T_2 \cdot s)$  as its transfer function is approximated by the first-order lag, and the process characteristic is  $K_1/(1+T_1 \cdot s)$  as its transfer function is approximated by the first-order lag:

$$K_2/K_1 \times (1+T_1 \cdot s) / (1+T_2 \cdot s)$$

where,

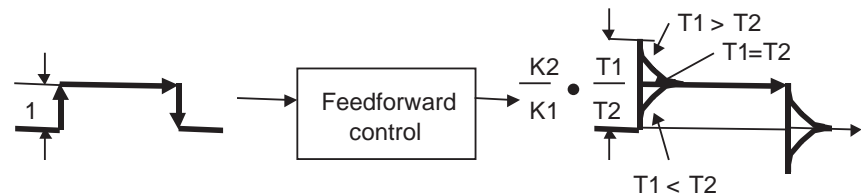
T1: Time constant of process

T2: Time constant of disturbance

K1: Process gain

K2: Disturbance gain

The step response in this model is as follows:

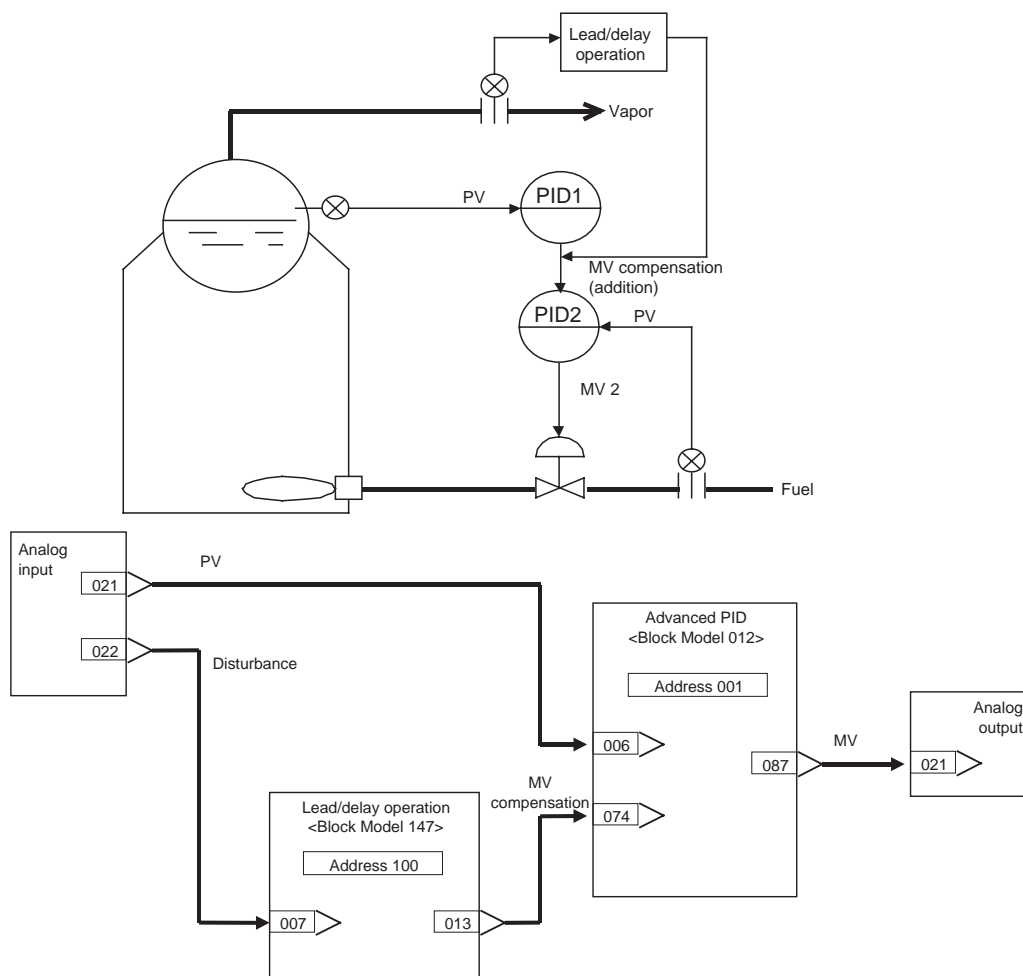


As shown above, when T1 (time constant of process) is longer than T2 (time constant of disturbance) ( $T_1 > T_2$ ), a lead is applied to the feedforward control signals (lead compensation). Alternatively, when  $T_1 < T_2$ , a delay is applied to the feedforward control signals (delay compensation).

To minimize the influence of disturbance in feedforward control, the values of T1 (time constant of process) and T2 (time constant of disturbance) must be set to the appropriate values.

Set T1 (time constant of process = time constant of lead), T2 (time constant of disturbance = time constant of delay) and K (disturbance gain and process gain) in the Lead/Delay block (Block Model 147).

## Example



Block address	ITEM No.	Data	Explanation
901	002	586	AI 4-point Terminal block
	021		Y1 (analog input 1)
	022		Y2 (Analog input 2)
902	002	587	AO 4-point terminal block
	021	001087	X1 (analog output 1) source designation
	031		X1 (analog output 1)
001	002	012	Advanced PID block
	006	901021	PV source designation
	074	100013	MV compensation (addition)
	087		MV
002	002	147	Lead/delay operation blocks
	007	901022	X1 source designation
	009		K (gain) 0 to 10.000
	010		T1 (lead time constant) 0 to 999.9 s
	011		T2 (delay time constant) 0 to 999.9 s
	013		Y1 output value

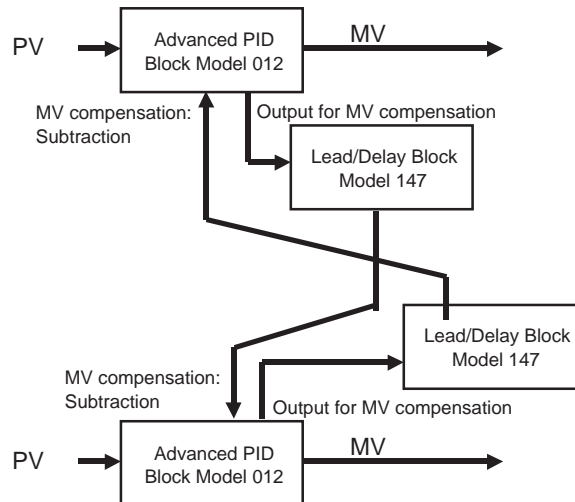
**Note Noninteracting Control**

Noninteracting control suppresses mutual action between processes, and is the same as feedforward control. Influence caused by mutual action is regarded as disturbance, and is controlled by noninteracting control together with feedforward control.

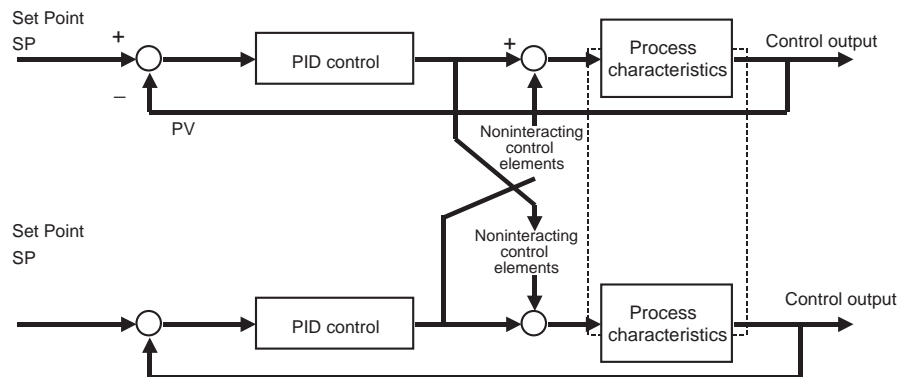
Function blocks used: Advanced PID (Block Model 012)

Lead/Delay (Block Model 147)

Processing by which the value after lead/delay operation is subtracted from other MVs is enabled by the MV compensation function of advanced PID.

**Example**

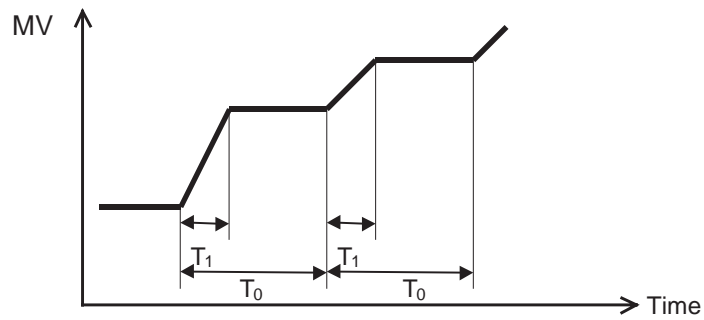
3. Noninteracting control elements generally are one cause of lag.

**5-2-3 Sample PI Control**

When processes with prolonged dead time or an ON/OFF measurement analyzer are taken as the control finite element, the next manipulated variable is determined after the effect of having changed the manipulated variable has sufficiently manifested itself.

PI control for time  $T_1$  is performed at every time  $T_0$ , and resulting output is held at a fixed value.

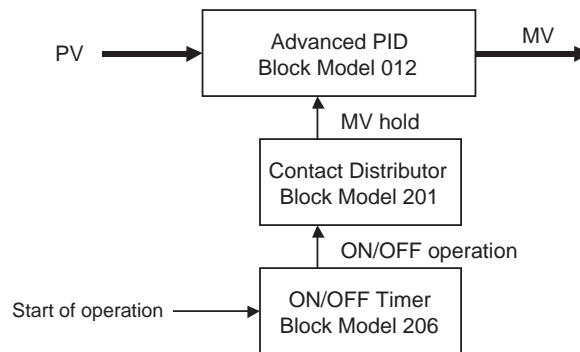
This is also called the “wait and see” method.



Function blocks used: ON/OFF Timer (Block Model 206)

Contact Distributor (Block Model 201)

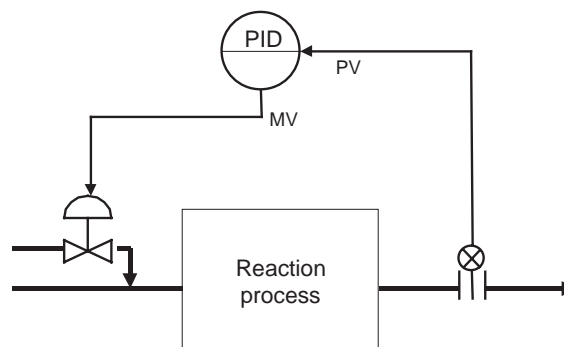
(Step Ladder Program [Block Model 301] as necessary)

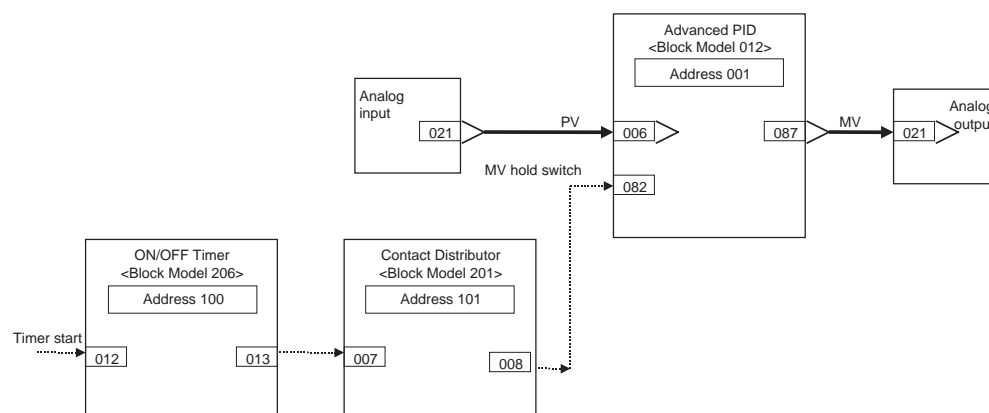


The contact signals from the ON/OFF Timer block are connected to the MV hold input of the Advanced PID block.

**Note** In processes where the dead time changes according to certain conditions, make the hold time variable according to those conditions. (PI control of variable sample cycle). In this case, set the ON time ( $T_1$ ) of the ON/OFF timer by other function blocks.

### Example





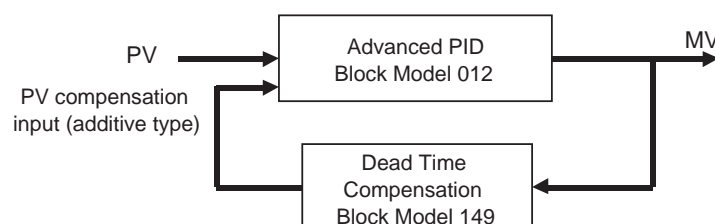
Block address	ITEM No.	Data	Explanation
901	002	586	AI 4-point Terminal block
	021		Y1 (analog input 1)
902	002	587	AO 4-point terminal block
	021	001087	X1 (analog output 1) source designation
	031		X1 (analog output 1)
001	002	012	Advanced PID block
	006	901021	PV source designation
	082		MV hold switch
	087		MV
100	002	206	ON/OFF Timer block
	013		Contact output
101	002	201	Contact Distributor block
	007	100013	Source designation (ITEM013 of ON/OFF timer is entered.)
	008	001082	Destination designation (output to ITEM082 of Advanced PID)

### 5-2-4 Dead Time Compensation

In processes having a large dead time that does not change much, the control target is regarded and controlled as a process not having a dead time by canceling the dead time element equivalent to the process on the PLC. Dead time compensation cannot adapt to disturbances such as load fluctuations.

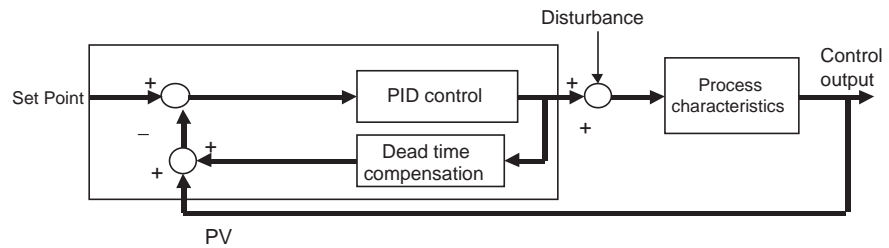
Function block used: Dead Time Compensation (Block Model 149)

#### Example

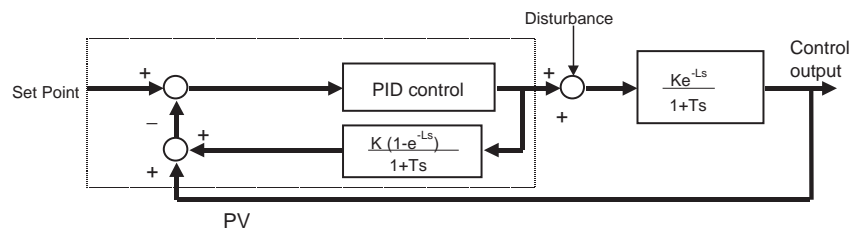


Dead time compensation is performed on the MV output from the Advanced PID block, and the result is connected to the PV compensation input of the Advanced PID block. The PV compensation mode is set to "add".

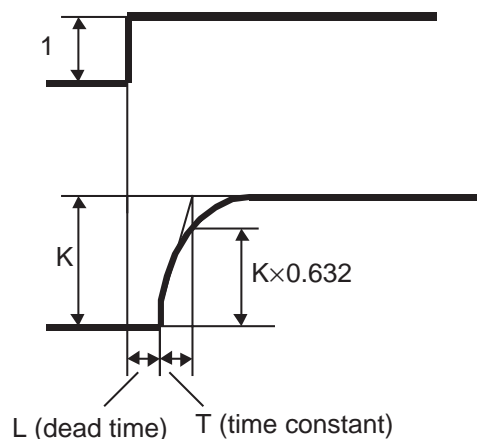
- Note**
1. Before dead time compensation is performed, the dead time, time constant and gain of the target process must be investigated.
  2. By dead time compensation control, dead time compensation is performed on MV as shown below and the result is added to the PV of PID control.



As dead time  $L$  worsens controllability, control is performed on process  $K/(1+Ts)$  not having dead time element ( $e^{-Ls}$ ) by compensating the dead time element within the PLC.

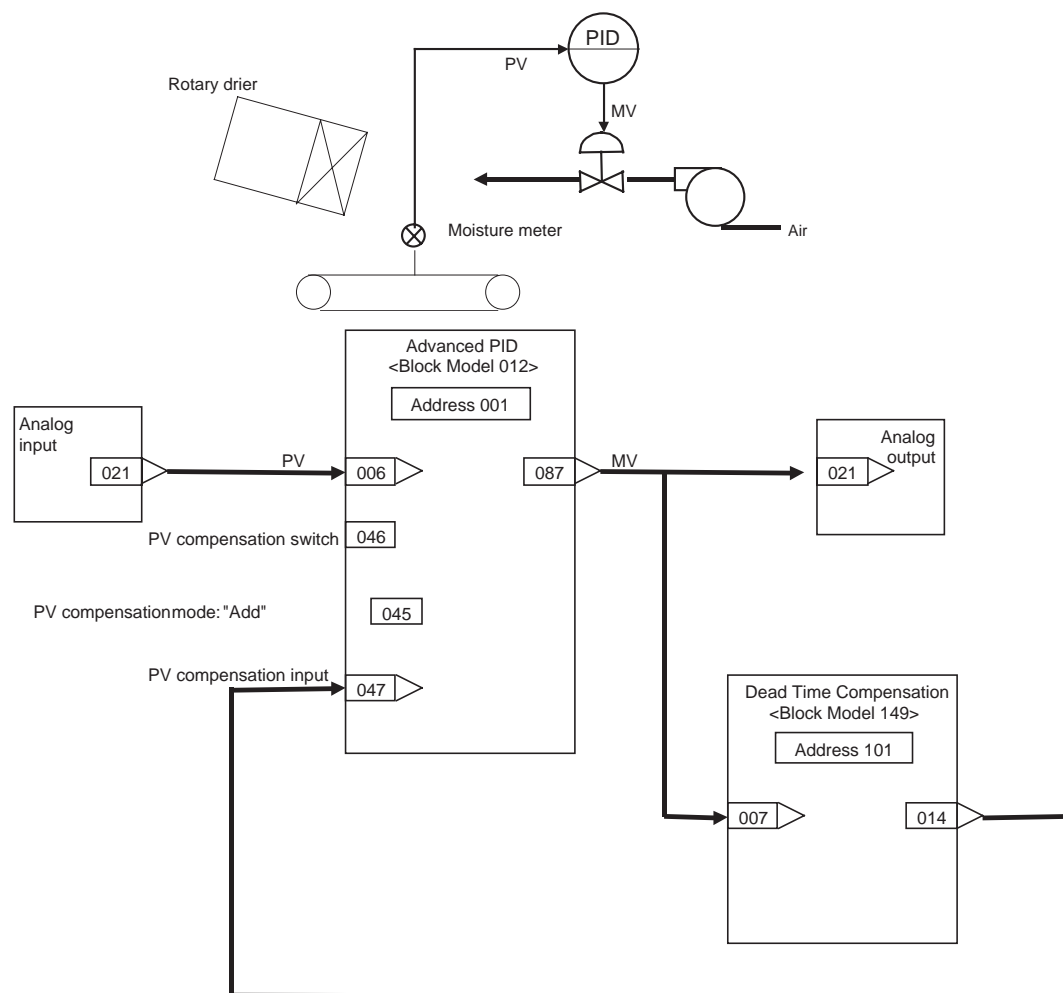


The Dead Time Compensation block (Block Model 149) inputs MV for  $K(1-e^{-Ls})/(1+Ts)$ , and outputs the result to ITEM047 (PV compensation) of Advanced PID block (Block Model 012). The PV compensation mode is set to "add". The Dead Time Compensation block (Block Model 149) sets  $K$  (process gain),  $T$  (time constant of process) and  $L$  (dead time) to equal  $H$  (sampling cycle) multiplied by  $N$  (number of samples). Set MV to manual, apply step changes to the process, and calculate these constants from the changes in PV.





## Example



Block address	ITEM No.	Data	Explanation
901	002	586	AI 4-point Terminal block
	021		Y1 (analog input 1)
902	002	587	AO 4-point terminal block
	021	001087	X1 (analog output 1) source designation
	031		X1 (analog output 1)
001	002	012	Advanced PID block
	006	901021	PV source designation
	045	1	PV compensation system (add)
	046		PV compensation switch
	047	100014	PV compensation input source designation
	087		MV

Block address	ITEM No.	Data	Explanation
100	002	149	Dead Time Compensation block
	007	001087	X1 source designation
	009		K (gain) 0 to 10.000
	010		T (lead time constant) 0 to 999.9 s
	011		H (sampling cycle) 0 to 9999 s
	012		N (number of samples) 0 to 20
	014		Y1 output value

# SECTION 6

## How to Use FINS Commands

This section describes how to use FINS commands to access and control Loop Controllers.

6-1	How to Use FINS Commands. . . . .	204
6-2	FINS Commands for Loop Controllers. . . . .	206
6-3	Description of FINS Commands. . . . .	206

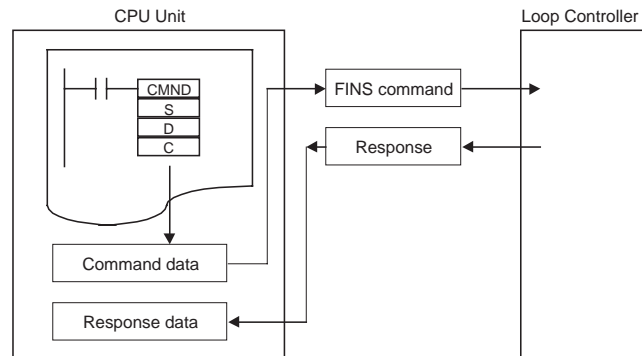
## 6-1 How to Use FINS Commands

FINS commands can be issued to the Loop Controller by one of the following two methods:

1. By the CMND (DELIVER COMMAND) instruction from the CPU Unit
2. By the Host Link or the networked host computer

### 1) By the CMND (DELIVER COMMAND) instruction from the CPU Unit

FINS commands can be issued to the Loop Controller by executing the CMND (DELIVER COMMAND) instruction in the program on the CPU Unit or networked PLC (CPU Unit) on which the Loop Controller is mounted.



When this method is used, the user need not consider the frame format of the FINS command. Basically, the user executes the following.

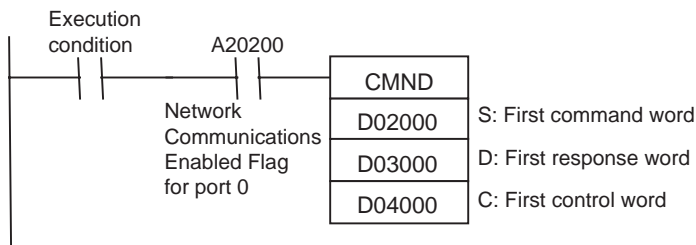
- 1,2,3...**
1. Store the data in the command format of the FINS command to an I/O memory area such as Data Memory. (S onwards: command data.)
  2. Store the number of send data bytes or the addresses of the send destination to the I/O memory area such as Data Memory. (C to C+5: control data)

**Note** When the FINS command is issued to the Loop Controller mounted on the local node, set the send destination network address to 00 Hex (local network) and the send destination node address to 00 Hex (local node).

3. Specify S (first command word number), D (first response word number) and C (first control data word) as the operands of the CMND (DELIVER COMMAND) instruction, and execute the CMND instruction.
4. When the FINS response frame is returned from the Loop Controller, data conforming to the response format is stored to the response address. The response is then read when the Network Communications Enabled Flag corresponding to the communications port number to be used turns ON.
5. For details, refer to items describing the CMND (DELIVER COMMAND) instruction in the *Communications Commands Reference Manual* (Cat. No. W342) or the *CS/CJ Series PLC Instructions Reference Manual* (Cat. No. W474).

**Example**

To read ITEM007 (PV) at block address 001 (e.g. in the case of Basic PID) on the Loop Controller currently mounted on the local node

**Command data**

S	D02000	0240	Command code: 0240 (READ MULTIPLE ITEMS FROM FUNCTION BLOCK)
S+1	D02001	0001	Block address: 0001
S+2	D02002	0001	Number of ITEMS: 1
S+3	D02003	0007	Read start address (example: PV of basic PID)

**Response data**

D	D03000	0240	Command code: 0240 (READ MULTIPLE ITEMS FROM FUNCTION BLOCK)
D+1	D03001	Store	End code
D+2	D03002	0001	Number of normal read ITEMS: 1
D+3	D03003	0007	Read start address: 007
D+4	D03004	02 □ □	Data length: 2 bytes
D+5	D03005	□ □	Read data: □ □

**Control data**

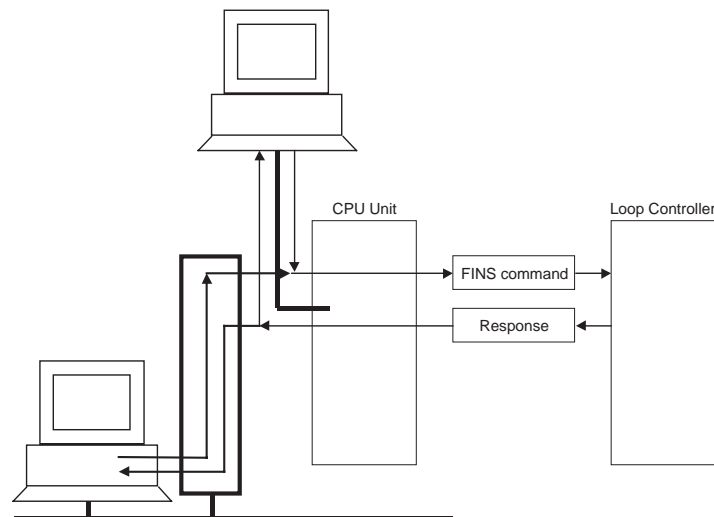
C	D04000	0008	Number of command data bytes: Above eight bytes (0008 Hex)
C+1	D04001	000B	Number of response data bytes: 11 bytes (000B Hex)
C+2	D04002	0000	Fixed to 00 Hex. Send destination network address
C+3	D04003	00E1	Send destination node address (00 Hex*1), Send destination unit address (E1 Hex*2)
C+4	D04004	0000	Response required/not required (0 Hex: required), Communications port number (0 Hex), fixed to 0 Hex, re-send count (0 Hex)
C+5	D04005	0000	Response monitor time (0000: 2s default)

\* 1: Set to 00 Hex as destination is self node.

\* 2: Unit number of Loop Control Board is set to E1 Hex.

**2) By the Host Link or the networked host computer**

The FINS command frame is sent to the Loop Controller delimited by the Host Link header or terminator from the host computer.



When this method is used, the user needs to consider the frame format of the FINS command.

For details, refer to the *Communications Command Reference Manual* (Cat. No. W342).

## 6-2 FINS Commands for Loop Controllers

Command (Hex)	Name	Description	
0240	READ MULTIPLE ITEMS FROM FUNCTION BLOCK	Reads specified continuous (multiple) ITEMS from a single function block.	<b>Note</b> Specifiable ITEMS are all ITEMS in all blocks excluding the sequence commands (ITEM011 onwards) of the Step Ladder Program block (Block Model 301).
0241	WRITE MULTIPLE ITEMS TO FUNCTION BLOCK	Writes specified continuous (multiple) ITEMS to a single function block.	
0242	READ ITEM FROM MULTIPLE FUNCTION BLOCKS	Reads specified ITEM from multiple function blocks.	
0243	WRITE ITEM TO MULTIPLE FUNCTION BLOCKS	Writes specified ITEM to multiple function blocks.	
0501	READ LOOP CONTROLLER INFORMATION	Reads the format and version information of the Loop Controller.	
0801	ECHOBACK TEST	Performs the echoback test between Loop Controller.	
2102	READ ERROR LOG	Reads the error log in the Loop Controller.	
2103	CLEAR ERROR LOG	Clears the error log in the Loop Controller.	
2203	SINGLE FILE WRITE	Replaces the function block data in the Loop Controller.	

**Note** All of the following data are expressed in Hex in FINS commands issued to the Loop Controller:

Function block address, ITEM number (address), number of ITEMS, number of bytes, write data, etc.

## 6-3 Description of FINS Commands

This section describes the command and response formats for FINS commands issued to the Loop Controller.

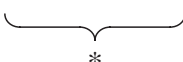
<b>READ MULTIPLE ITEMS FROM FUNCTION BLOCK</b>	<b>Command code</b>
	<b>02 40</b>

### Function

Reads multiple ITEMS from a single function block.

### Command format

Data format

Command code		Parameter type (block address)	Number of ITEMS	Read start address	* repeated
02 Hex	40 Hex				
1	1	2	2	2	---
					

Data length (bytes)

### 1) Parameter type

Specify function block addresses 0 to 999 within the range 0 to 03E7 Hex.

### 2) Number of ITEMS

Specify the number of ITEMS to be read from the specified function block.

**3) Read start address**

Specify ITEM numbers 0 to 999 in the function block specified by parameter type within the range 0 to 03E7 Hex.

Specifiable ITEMS are all ITEMS in all function blocks excluding the sequence commands (ITEM011 onwards) in the Step Ladder Program block (Block Model 301).

- Note** 1. Specify the read start address for the number of ITEMS.

**Response format**

Data format	Command code		Response code		Number of normal read ITEMS	Read start address	Data length (byte)	Read data	* repeated
	02 Hex	40 Hex	MRES	SRES					
Data length (bytes)	1	1	1	1	2	2	1	---	---
						}			*

2. When one or more ITEMS has been read correctly, this shall be regarded as a normal completion. By a normal completion, the number of ITEMS that were read correctly and the data of the number of ITEMS that were read correctly (1 to number of ITEMS) are returned as the FINS response.

The length of the read data is expressed in bytes.

3. For details of the data length of each ITEM, refer to the rightmost column "Data length (bytes)" in the ITEM Lists in *Section 2 Description of Function Blocks in the Function Block Reference Manual*.

**Response code**

Response code	Meaning
0000 Hex	Normal completion
1001 Hex	Command length over <ul style="list-style-type: none"> <li>The command length exceeds 2002 bytes.</li> </ul>
1002 Hex	Insufficient command length <ul style="list-style-type: none"> <li>The command length is less than six bytes.</li> </ul>
1003 Hex	Number of elements/number of data mismatch <ul style="list-style-type: none"> <li>The number of read start addresses does not match the number of ITEMS.</li> </ul>
1101 Hex	No type <ul style="list-style-type: none"> <li>An unusable block address was specified in the parameter type.</li> <li>The block address specified in the parameter type is an unregistered function block.</li> <li>Function blocks other than System Common blocks cannot be accessed as the RAM has not yet been initialized (cleared) after a battery failure causes content of RAM to be lost.</li> </ul>
1103 Hex	Specified address out-of-range error <ul style="list-style-type: none"> <li>There is not even one ITEM specified by the start address.</li> </ul>
110B Hex	Response exceeds maximum response length <ul style="list-style-type: none"> <li>The length of the read data section exceeds 968 bytes.</li> </ul>
110C Hex	Other item parameter error <ul style="list-style-type: none"> <li>Number of ITEMS is 0.</li> </ul>

WRITE MULTIPLE ITEMS FROM FUNCTION BLOCK	Command code
	02 41

**Function**

Writes multiple ITEMS in a single function block.

**Command format**

Data format	Command code		Parameter type (block address)	Number of ITEMs	Write start address	Data length (byte)	Write data	* repeated
	02 Hex	41 Hex						
Data length (bytes)	1	1	2	2	2	1	---	---
					* -----			

**1) Parameter type**

Specify function block addresses 0 to 999 within the range 0 to 03E7 Hex.

**2) Number of ITEMS**

Specify the number of ITEMS to write in the specified function block.

**3) Write start address**

Specify ITEM numbers 0 to 999 in the function block specified by parameter type within the range 0 to 03E7 Hex.

Specifiable ITEMS are all ITEMS in all function blocks excluding the sequence commands (ITEM011 onwards) in the Step Ladder Program block (Block Model 301).

**4) Data length**

Specify the number of bytes to write.

Set the data length according to the ITEM to be written to.

**Note** For details of the data length of each ITEM, refer to the rightmost column "Data length (bytes)" in the ITEM Lists in *Section 2 Description of Function Blocks in the Function Block Reference Manual*.

**5) Write data**

Data to be written to ITEMS in the specified function block

**Note** Specify the write start address, data length and write data for the number of ITEMS.

**Response format**

Data format	Command code		Response code	
	02 Hex	41 Hex	MRES	SRES
Data length (bytes)	1	1	1	1

When all ITEMS to be written can be written, and all ITEMS have been written successfully, this shall be regarded as a normal completion.



**Response code**

<b>Response code</b>	<b>Meaning</b>
0000 Hex	Normal completion
1001 Hex	Command length over <ul style="list-style-type: none"> <li>• The command length exceeds 2002 bytes.</li> </ul>
1002 Hex	Insufficient command length <ul style="list-style-type: none"> <li>• The command length is less than six bytes.</li> </ul>
1003 Hex	Number of elements/number of data mismatch <ul style="list-style-type: none"> <li>• The number of data items does not match the number of ITEMS.</li> </ul>
1101 Hex	No type <ul style="list-style-type: none"> <li>• An unusable block address was specified in the parameter type.</li> <li>• The block address specified in the parameter type is an unregistered function block.</li> <li>• Function blocks other than System Common blocks cannot be accessed as the RAM has not yet been initialized (cleared) after a battery failure causes content of RAM to be lost.</li> </ul>
1103 Hex	Specified address out-of-range error <ul style="list-style-type: none"> <li>• The start address contains a non-existent ITEM.</li> <li>• An attempt was made to write to the format setting of a System Common block.</li> </ul>
110C Hex	Other item parameter error <ul style="list-style-type: none"> <li>• Number of ITEMS is 0.</li> <li>• The specified data length does not match the actual data of each ITEM specified by the write start address.</li> <li>• The combination of block address and block format is forbidden.</li> <li>• Write data is out of the data range for each ITEM.</li> </ul>
2605 Hex	Service in operation The function block data in the Loop Controller was replaced, and then the LCB started operation without restarting the LCB restart or cycling the PLC power supply. (An attempt was made to write 1 or 2 to the System Common Block ITEM 014 (run/stop command).)

READ ITEM FROM MULTIPLE FUNCTION BLOCKS	Command code
	02 42

**Function**

Reads the specified ITEM from multiple function blocks.

**Command format**

Data format	Command code		Number of ITEMs	Parameter type (block address)	Read start address	* repeated
	02 Hex	42 Hex				
Data length (bytes)	1	1	2	2	2	---
				*		

**1) Number of ITEMs**

Specify the number of ITEMs to read.

**2) Parameter type**

Specify function block addresses 0 to 999 within the range 0 to 03E7 Hex

**3) Read start address**

Specify ITEM numbers 0 to 999 in the function block specified by parameter type within the range 0 to 03E7 Hex.

Specifiable ITEMs are all ITEMs in all function blocks excluding the sequence commands (ITEM011 onwards) in the Step Ladder Program block (Block Model 301).

- Note** 1. Specify the parameter type and read start address for the number of ITEMs.

**Response format**

Data format	Command code		Response code		Number of normal read ITEMs	Parame- ter type	Read start address	Data length (byte)	Read data	* repeated
	02 Hex	42 Hex	MRES	SRES						
Data length (bytes)	1	1	1	1	2	2	2	1	---	---
						*				

2. When one or more ITEMs has been read correctly, this shall be regarded as a normal completion. By a normal completion, the number of ITEMs that were read correctly and the data of the number of ITEMs that were read correctly (1 to number of ITEMs) are returned as the FINS response.  
The length of the read data is expressed in bytes.
3. For details of the data length of each ITEM, refer to the rightmost column "Data length (bytes)" in the ITEM Lists in *Section 2 Description of Function Blocks in the Function Block Reference Manual*.

**Response code**


Response code	Meaning
0000 Hex	Normal completion
1001 Hex	Command length over <ul style="list-style-type: none"><li>• The command length exceeds 2002 bytes.</li></ul>
1002 Hex	Insufficient command length <ul style="list-style-type: none"><li>• The command length is less than four bytes.</li></ul>
1003 Hex	Number of elements/number of data mismatch <ul style="list-style-type: none"><li>• The number of read start addresses does not match the number of ITEMS.</li></ul>
1101 Hex	No type <ul style="list-style-type: none"><li>• An unusable block address was specified in the parameter type.</li><li>• The block address specified in the parameter type is an unregistered function block.</li><li>• Function blocks other than System Common blocks cannot be accessed as the RAM has not yet been initialized (cleared) after a battery failure causes content of RAM to be lost.</li></ul>
1103 Hex	Specified address out-of-range error <ul style="list-style-type: none"><li>• There is not even one ITEM specified by the start address.</li></ul>
110B Hex	Response exceeds maximum response length <ul style="list-style-type: none"><li>• The length of the read data section exceeds 968 bytes.</li></ul>
110C Hex	Other item parameter error <ul style="list-style-type: none"><li>• Number of ITEMS is 0.</li></ul>

WRITE ITEM TO MULTIPLE FUNCTION BLOCKS	Command code
	02 43

**Function**

Writes the specified ITEM to multiple function blocks.

**Command format**

Data format	Command code		Number of ITEMS	Parameter type (block address)	Write start address	Data length (byte)	Write data	* repeated
	02 Hex	43 Hex						
Data length (bytes)	1	1	2	2	2	1	---	---
								

**1) Number of ITEMS**

Specify the number of ITEMS to write.

**2) Parameter type**

Specify function block addresses 0 to 999 within the range 0 to 03E7 Hex.

**3) Write start address**

Specify ITEM numbers 0 to 999 in the function block specified by parameter type within the range 0 to 03E7 Hex.

Specifiable ITEMS are all ITEMS in all function blocks excluding the sequence commands (ITEM011 onwards) in the Step Ladder Program block (Block Model 301).

**4) Data length**

Specify the number of bytes to write.

Set the data length according to the ITEM to be written to.

**Note** For details of the data length of each ITEM, refer to the rightmost column "Data length (bytes)" in the ITEM Lists in *Section 2 Description of Function Blocks in the Function Block Reference Manual*.

**5) Write data**

Write data to be written to the ITEM of the specified function block

**Note** Specify the parameter type, write start address, data length and write data for the number of ITEMS.

**Response format**

Data format	Command code		Response code	
	02 Hex	43 Hex	MRES	SRES
Data length (bytes)	1	1	1	1

**When all ITEMS to be written can be written, and all ITEMS have been written successfully, this shall be regarded as a normal completion.**

**Response code**

<b>Response code</b>	<b>Meaning</b>
0000 Hex	Normal completion
1001 Hex	Command length over <ul style="list-style-type: none"> <li>• The command length exceeds 2002 bytes.</li> </ul>
1002 Hex	Insufficient command length <ul style="list-style-type: none"> <li>• The command length is less than four bytes.</li> </ul>
1003 Hex	Number of elements/number of data mismatch <ul style="list-style-type: none"> <li>• The number of data items does not match the number of ITEMS.</li> </ul>
1101 Hex	No type <ul style="list-style-type: none"> <li>• An unusable block address was specified in the parameter type.</li> <li>• The block address specified in the parameter type is an unregistered function block.</li> <li>• Function blocks other than System Common blocks cannot be accessed as the RAM has not yet been initialized (cleared) after a battery failure causes content of RAM to be lost.</li> </ul>
1103 Hex	Specified address out-of-range error <ul style="list-style-type: none"> <li>• The start address contains a non-existent ITEM.</li> <li>• An attempt was made to write to the format setting of a System Common block.</li> </ul>
110C Hex	Other item parameter error <ul style="list-style-type: none"> <li>• Number of ITEMS is 0.</li> <li>• The specified data length does not match the actual data of each ITEM specified by the write start address.</li> <li>• The combination of block address and block format is forbidden.</li> <li>• Write data is out of the data range for each ITEM.</li> </ul>
2605 Hex	Service in operation The function block data in the Loop Controller was replaced, and then the LCB started operation without restarting the LCB restart or cycling the PLC power supply. (An attempt was made to write 1 or 2 to the System Common Block ITEM 014 (run/stop command).)

READ LOOP CONTROLLER INFORMATION	Command code
	05 01

**Function**

Reads the model number and version information of the Loop Controller.

**Command format**

Data format	Command code	
	05 Hex	01 Hex
Data length (bytes)	1	1

**Response format**

Data format	Command code		Response code		Block Model	Version
	05 Hex	01 Hex	MRES	SRES		
Data length (bytes)	1	1	1	1	20	20

**1) Model number**

The format comprising up to 20 ASCII code characters beginning from the left is returned. The model number is filled with spaces (20 Hex) from the right if less than 20 characters.

The model numbers of the Loop Control Board are CS1W-LCB01 and CS1W-LCB05.

**2) Version**

The version of the system program comprising up to 20 ASCII code characters beginning from the left is returned. The model number is filled with spaces (20 Hex) from the right if less than 20 characters.

The version returned looks as if it has two versions "V1.00V1.00". The former version is the version of the system program stored in MPU built-in ROM, and the latter is the version stored in flash ROM.

**Response code**

Response code	Meaning
0000 Hex	Normal completion
1001 Hex	Command length over • The command length exceeds two bytes.

ECHOBACK TEST	Command code
	08 01

**Function**

Performs an echoback test with the Loop Controller. This test is used to check whether or not FINS protocol communications with the Loop Controller is functioning normally.

**Command format**

Data format	Command code		Test data
	08 Hex	01 Hex	
Data length (bytes)	1	1	Bytes 1 to 1998

**1) Test data**

Any test data

**Response format**

Data format	Command code		Response code		Test data
	08 Hex	01 Hex	MRES	SRES	
Data length (bytes)	1	1	1	1	Same as test data of command

**2) Test data**

Same data as the test data assigned by the command

**Response code**

Response code	Meaning
0000 Hex	Normal completion
1001 Hex	Command exceeds maximum command length <ul style="list-style-type: none"> <li>The command length exceeds 2000 bytes.</li> </ul>
1002 Hex	Insufficient command length <ul style="list-style-type: none"> <li>Command length is less than three bytes.</li> </ul>

READ ERROR LOG	Command code
	21 02

**Function**

Reads the error log on the Loop Controller.

The configuration of each error log is as follows, and error logs are stored in RAM (battery-backed up) on the Loop Controller. The configuration of each error log is as follows and is regarded as a single record. For details on error codes, see 7-1 *Errors and Alarm Troubleshooting*.

1 record	Error code
	Detailed information
	Date (year/month) and time (hour/minute/second) of occurrence

**Command format**

Data format	Command code		Read start record number	Number of read records
	21 Hex	02 Hex		
Data length (bytes)	1	1	2	2

**1) Read start record number**

Specify the first record number to read in Hex.

The first record number (oldest record) is 0000 Hex.

**2) Number of read records**

Specify the number of records to read in Hex from 0000 onwards.

**Response format**

Data format	Command code		Response code		Maximum number of stored records	Number of stored records	Number of read records	
	21 Hex	02 Hex	MRES	SRES				
Data length (bytes)	1	1	1	1	2	2	2	

Data format	Error code	Detailed information	Minute	Second	Date	Hour	Year	Month
Data length (bytes)	2	2	1	1	1	1	1	1

**1) Maximum number of stored records**

The maximum number of error logs that can be stored is returned in Hex.

**2) Number of stored records**

The number of error log records currently stored at the time of command execution is returned in Hex.

**3) Number of read records**

The actual number of read records is returned in Hex.

**4) Error code**

Indicates the error details as a code. For details on error codes, see 7-1 *Errors and Alarm Troubleshooting*.



**5) Detailed information**

Indicates the detailed information of the error. For details on error codes, see *7-1 Errors and Alarm Troubleshooting*.

**6) Minutes, seconds, day, hours, year, month**

All values are expressed in BCD (Binary-Coded Decimal). The time data is read from the CPU Unit.

Item	Range
Minute	0 to 59
Second	0 to 59
Day	1 to 31
Hour	0 to 23
Year	0 to 99 (lower 2 digits)
Month	1 to 12

**Response code**

Response code	Meaning
0000 Hex	Normal completion
1001 Hex	Command length over <ul style="list-style-type: none"><li>• The command length exceeds six bytes.</li></ul>
1002 Hex	Insufficient command length <ul style="list-style-type: none"><li>• Command length is less than six bytes.</li></ul>
1103 Hex	Specified address out-of range error <ul style="list-style-type: none"><li>• The read start record No. was specified for the number of currently stored records or more. (excluding 0000 Hex)</li></ul>
110C Hex	Other item parameter error <ul style="list-style-type: none"><li>• Number of read records is 0.</li></ul>

**Note** When there is no error log data for the number of read records, the records currently stored are read, and 0000 Hex (normal completion) is taken as the response code.

SINGLE FILE WRITE	Command code
	22 03

**Function**

A backup file (BACKUPE1.PRM) made with the simple backup function can be written to the Loop Controller.

**Note** BACKUPE1.PRM File

This is the LCB function block data file made using the simple back-up function and output to a Memory Card. The function block parameters in the LCB can be replaced by writing the BACKUPE1.PRM file using the SINGLE FILE WRITE command.

**Command format**

Data format	Command code		Disk number 0x0000 (Cannot be changed.)	Parameter 0x0001 (first frame) Or 0x0002 (second frame and higher)	File name BACKUPE1.PRM (Name cannot be changed and is not case sensitive.)	Write start position	Write data length	File data (write data)	Directory length
	0x22	0x03							
Data length (bytes)	1	1	2	2	12	4	2	---	2

**1) Disk Number**

Disk number	
0x0000	LCB (Cannot be changed.)

**2) Parameter**

Parameter	Meaning	Details
0x0001	Create new file (also overwrite)	<ul style="list-style-type: none"> <li>First frame</li> <li>Creates a new file.</li> <li>If a file with the same name is already in the specified directory, that file will be deleted before the new file is created.</li> </ul>
0x0002	Append to existing file	<ul style="list-style-type: none"> <li>Second frame and higher</li> <li>Appends data to existing file.</li> <li>For files that must be written to multiple frames, this parameter must be specified for the second frame and higher.</li> </ul>

**3) Name of Write File**

The name is always BACKUPE1.PRM and is not case sensitive.

8B	1B	3B
File name: "BACKUPE1.PRM" (4241434B55504531 Hex)	" " (2E Hex)	Extension: PRM (50524D Hex)

**4) Write Start Position**

Write Start Position	
0x0000 0000	Cannot be changed.

**5) Write Data Length**

- The write data length is specified in bytes.
- The file size depends on the type and number of the function blocks used.
- The most significant bit (bit 15) turns ON when the last data item is written.
- Write data length:  
The data lengths that can be specified are different for the first packet and the second or later packets.
  - First packet: 90 bytes (See note 1.) ≤ Write data length ≤ 900 bytes (See note 2.)
  - Second packet: 0 bytes ≤ Write data length ≤ 900 bytes (See note 2.)

- Note**
- (1) Set the first packet to at least 90 bytes including the header data (90 bytes).
  - (2) The maximum write data length depends on the network it will pass through. For Ethernet networks and the peripheral bus, the maximum is 900 bytes, and for SYSWAY, the maximum is 516 bytes.

**6) File Data (Write Data)**

The data on the backup file (BACKUPE1.PRM) created with the simple backup function is divided by write data lengths and written to the Loop Controller.

**7) Directory Length**

- Not used if the command is sent to a Loop Controller. (Set to 0.)

**Response format**

Data format	Command code		Response code	
	22 Hex	03 Hex	MRES	SRES
Data length (bytes)	1	1	1	1

**Response code**

Response code	Meaning
0x0000	Normal completion
0x1001	Write data exceeds 978 bytes.
0x1002	Insufficient command length Required length of 26 bytes not satisfied.
0x1004	Command format error The command format is incorrect, or the write data length and write data size are different.
0x1101	No type The disk number is out of range (i.e., not 0x0000 (LCB)).
0x1103	Specified address out-of-range error For a new file or addition, the write start position is not 0x0000.

Response code	Meaning
0x110C	<p>Other item parameter error</p> <ul style="list-style-type: none"> <li>• The directory length is not 0.</li> <li>• The parameter specification is incorrect.</li> <li>• The Unit model is different in the backup data and the recovery location.</li> <li>• Command ended in one FINS frame (parameter: 0x0001 and bit 15 ON).</li> <li>• Incorrect write data length: A write data length for a FINS command is not in the following range: <ul style="list-style-type: none"> <li>- First packet: 90 bytes (See note 3.) ≤ Write data length ≤ 900 bytes (See note 4.)</li> <li>- Second packet: 0 bytes ≤ Write data length ≤ 900 bytes (See note 4.)</li> </ul> </li> <li>• A FINS command for which the last backup item is specified is received while function blocks are being replaced. (In this case, the function block replacement function will be forced to stop.)</li> <li>• The version is not applicable for the firmware that includes LCBs.</li> </ul>
0x2106	<p>The file does not exist on the specified file device.</p> <ul style="list-style-type: none"> <li>• The second or later packet was received without the FINS for the first packet being completed properly.</li> </ul>
0x250F	<p>A memory error has occurred.</p> <ul style="list-style-type: none"> <li>• Error occurred in checksum.</li> <li>• Failure occurred during backup to FROM.</li> </ul>
0x2606	<p>Error in command</p> <p>The file name is not BACKUPE1.PRM.</p>

- (3) Set the first packet to at least 90 bytes including the header data (90 bytes).
- (4) The maximum write data length depends on the network it will pass through. For Ethernet networks and the peripheral bus, the maximum is 900 bytes, and for SYSWAY, the maximum is 516 bytes.
- (5) The response code for any other FINS commands will be 0x0001 from the first packet until the last packet has been successfully received.
- (6) After the last packet has been successfully received, it will not be possible to execute a hot start or a cold start without restarting the Loop Controller or cycling the power supply. In that case, the FINS response code will be 0x2605.

## SECTION 7

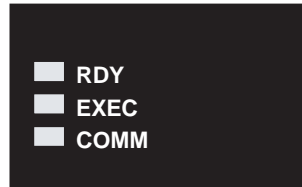
# Errors and Alarm Troubleshooting

This section explains errors that can occur in Loop Controller operation and troubleshooting procedures for alarms that can occur.

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## 7-1 Errors and Alarm Troubleshooting

### 7-1-1 Judging Errors by Indicators



Indicator	Name	Color	Status	Description
RDY	Ready	Green	Not lit	The Loop Controller is not operating for one of the following reasons: <ul style="list-style-type: none"> <li>• A Fatal Inner Board Error occurred (A40112 ON.)</li> <li>• Initialization is not completed yet.</li> <li>• A fatal error occurred.</li> <li>• The flash memory backup data is invalid.</li> <li>• The Loop Controller is initializing.</li> <li>• A hardware failure occurred in the Loop Controller.</li> <li>• Power is not being supplied from the Power Supply Unit.</li> <li>• A Loop Controller WDT error occurred.</li> </ul>
			Flashing	• A WDT error occurred in the CPU Unit.
			Lit	The Loop Controller is ready for operation.
EXEC	Running	Green	Not lit	The system is stopped for one of the following reasons: <ul style="list-style-type: none"> <li>• The Loop Controller is initializing.</li> <li>• A hardware failure occurred in the Loop Controller.</li> <li>• Power is not being supplied from the Power Supply Unit.</li> <li>• A Loop Controller WDT error occurred.</li> <li>• The Loop Controller is not running.</li> <li>• Data is being written to flash memory.</li> </ul>
			Flashing at 0.5-s intervals	Data is being deleted from Process-control CPU Unit (CS1D-CPU□□P) flash memory.
			Flashing at 0.2-s intervals	Function block data is being backed up to flash memory.
			Lit	The Loop Controller is running.
COMM	Communicating	Yellow	Not lit	Waiting for data transfer.
			Flashing	Transferring data.

**Note** (1) No Loop-control CPU Unit (CJ1G-CPU□□P).

- (2) If an error occurs in a Loop Controller, details on the cause of the error will be stored in A424 (Inner Board Error Information).

Word	Bit	Name	Explanation	Settings
A424	00 to 12	Inner Board Error Information	The following flags provide details on Inner Board errors (errors common to all Inner Boards as well as errors specific to Loop Controllers.)	---
	00	Inner Board WDT Error Flag (fatal error)	This flag is set to 1 (ON) if the Loop Controller is faulty.	1: Inner Board WDT Error 0: Normal
	01	Inner Board Bus Error Flag (fatal error)	This flag is set to 1 (ON) if an Inner Board Bus Error has occurred.	1: Inner Board Bus Error 0: Normal
	02	Cyclic Monitor Error Flag (fatal error)	A cyclic monitor error was detected in the Loop Controller of the Process CPU Unit (CS1D-CPU□□P).  This flag is set to 1 (ON) when a Cyclic Monitor Error is detected, i.e., the cyclic area's access right token was not returned to the Loop Controller within the cyclic monitor time.	1: Cyclic Monitor Error 0: Normal
	03	Flash Memory Data Error or All Function Block Database (RAM) Error during Duplex Operation Flag (fatal error)	This flag is set to 1 (ON) in the situations outlined below. Use the CX-Process Tool software to download all function blocks (LCB/LCU unit). Alternatively, backup to flash memory.  When there is a flash memory data error during the data check at a cold start.  A database (RAM) error occurred for all function blocks during operation in duplex mode when mounted to a CS1D CPU Unit.	1: Flash Memory Data Error or All Function Block Database (RAM) Error  0: Flash memory normal and all function block database (RAM) normal during duplex operation
	04	Incompatible CPU Unit Error Flag (non-fatal error)	This flag is set to 1 (ON) when the Loop Control Board is mounted in a CPU Unit other than a CS1-H CPU Unit. <b>Note:</b> The CS1 CPU Units without the "H" suffix do not support the Loop Control Board.	1: The Loop Control Board is mounted in a CPU Unit that does not support the Board. The EM file memory is being created or the EM does not exist. 0: Normal
	05	Cyclic Monitor Error Flag (fatal error)	A cyclic monitor error is detected in the CS-series Loop Control Board (CS1W-LCB01/LCB 05) or Loop-control CPU Unit (CJ1G-CPU□□P).  This flag is set to 1 (ON) when a Cyclic Monitor Error is detected, i.e., the cyclic area's access right token was not returned to the Loop Controller within the cyclic monitor time.	1: Cyclic Monitor Error 0: Normal
	06	CPU Bus Unit Settings Area Error Flag	(Loop Control Units only.)	---
	07	Routing Table Error Flag	(Loop Control Units only.)	---
	08	Loop Controller High Load Flag (non-fatal error)	This flag is set to 1 (ON) when the LCB load rate exceeds 80% for three consecutive cycles. If this error occurs, extend the operation cycles of function blocks that can be extended. If the error recurs after extending the operation cycles, add a Loop Control Unit and divert some of the load to that Unit.	1: Loop Controller running at a high load rate 0: Normal
	09	Operation Cycle Error Flag (non-fatal error) (for Process-control CPU Unit (CS1D-CPU□□P) only)	This flag is set to 1 (ON) when the Loop Controller's operation cycle is inaccurate because the cycle time is too long (when the CPU Unit's cycle time is more than 20% of the minimum operation cycle) during duplex mode operation when mounted in a CS1D CPU Unit.	1: Operation cycle error 0: Normal

Word	Bit	Name	Explanation	Settings
A424	10	Partial Function Block Database (RAM) Error During Simplex Operation (non-fatal error)	Changes to 1 (turns ON) when a database (RAM) error occurs for some function blocks or when an error occurs while restoring data from the Memory Card using the simple backup function when mounted to CS1D CPU Units and operating in simplex mode or when mounted to CS1-H CPU Units.	1: Function block database error during simplex operation or error while restoring data. 0: Normal
	11	Backup Data (Flash Memory) Error Flag	This flag is set to 1 (ON) when the parameter data stored in flash memory has been corrupted.	1: Flash memory data error 0: Normal
	12	Specified EM Bank Unusable Error Flag	This flag is set to 1 (ON) when specified EM bank is not a usable bank.	1: Cannot be used. 0: Can be used.
	13 to 14	Not used.	---	---
	15	Automatic Recovery from Cycle Offset Flag (nonfatal error)	If something unforeseen causes the cycle to the right or left to be offset, duplex initialization is automatically executed to restore synchronous operation. The flag is set to 1 (ON) when recovery is achieved.	1: Duplex initialization executed for synchronous displacement recovery. 0: Normal

## 7-1-2 Errors during Initialization

The following table lists errors that can occur during the initial processing performed after the power is turned ON or the Inner Board is restarted.

LED Indicators on front of Loop Controller		LED Indicator on front of CPU Unit	Problem	Cause	Status	Error code (Stored in error log.)	Corrective action
RDY	EXEC	ERR/ALM (See note.)					
Not lit	Not lit	Undetermined	Power supply problem	The correct internal power supply is not being supplied to the Loop Controller.	Operation is stopped.	None	Check the power supply voltage and verify that the correct voltage is being supplied. Also, check the PLC's total current consumption.
				The Loop Controller is not mounted properly in the CPU Unit.			Mount the Loop Control Board securely. Replace the Loop Control Board if the error recurs after the Board is secured and power is turned ON again.
				The Loop Controller is faulty.			Turn the power OFF and ON again. If the error occurs with a Loop Control Board, replace the Loop Control Board. If the error occurs with the Loop Controller component of a Loop-control CPU Unit, replace the entire Loop-control CPU Unit.
Not lit	Not lit	Lit	Initial recognition error (Inner Board Stopped Error)	The Loop Controller was not recognized properly by the CPU Unit.	Operation is stopped.	None	Mount the Loop Control Board securely. Replace the Loop Control Board if the error recurs after the Board is secured and power is turned ON again. If the error occurs with the Loop Controller component of a Loop-control CPU Unit, replace the entire Loop-control CPU Unit.
Not lit	Not lit	Lit	Inner Board Error	A hardware error was detected (in memory or elsewhere) during the self-diagnostic test.	Operation is stopped.	None	Turn the power OFF and ON again. Replace the Loop Control Board if the error recurs. If the error occurs with the Loop Controller component of a Loop-control CPU Unit, replace the entire Loop-control CPU Unit.



LED Indicators on front of Loop Controller		LED Indicator on front of CPU Unit	Problem	Cause	Status	Error code (Stored in error log.)	Corrective action
RDY	EXEC	ERR/ALM (See note.)					
Not lit	Not lit	Flashing (A42404, the Incompatible CPU Unit Error Flag, is ON.)	Incompatible CPU Unit	<ul style="list-style-type: none"> <li>The CS1W-LCB01/05 Loop Control Board is not mounted under one of the following CPU Units: CS1G-CPU□□H CS1H-CPU□□H</li> <li>The Process-control CPU Unit (CS1D-CPU□□P) Loop Controller is not mounted under a CS1D-CPU□□H CPU Unit.</li> </ul>	Operation is stopped.	None	Replace the CPU Unit with one of the compatible models.
				All the EM banks have been converted into file memory.			Change the setting so that the EM banks are not converted into file memory.
Not lit	Not lit	Lit (A42401, the Inner Board Bus Error Flag, is ON.)	Inner Board Bus Error	An Inner Board Bus Error has occurred.	Operation is stopped.	None	Mount the Loop Control Board securely. Replace the Loop Control Board if the error recurs after the Board is secured and power is turned ON again. If the error occurs with the Loop Controller component of a Loop-control CPU Unit, replace the entire Loop-control CPU Unit.

LED Indicators on front of Loop Controller		LED Indicator on front of CPU Unit	Problem	Cause	Status	Error code (Stored in error log.)	Corrective action
RDY	EXEC	ERR/ALM (See note.)					
Not lit	Not lit	Lit (A42403, the Flash Memory Data Error Flag or the Duplex Function Block Database (RAM) Error Flag, is ON.)	Parameter backup data (flash memory) error	<p>One of the following problems was detected during a cold start.</p> <p>1) The data was corrupted by noise or other factor.</p> <p>2) The power was interrupted during a backup.</p> <p><b>Note:</b> If the function block database (RAM) is valid, the data will be backed up again the next time the power is turned ON.</p>	Operation is stopped.	0331 The details code contains either the relevant block address or FFFF if all data bases are invalid.	Execute the <b>Download</b> or <b>Clear all</b> operation from CX-Process Tool Version 3.0. The Flash Memory Data Error Flag (A42403) will go OFF if the data in RAM becomes valid.
Flashing	Not lit	Flashing (A42410, the RAM Error Flag is ON.)	Parameter	<p>One of the following problems was detected while restoring data using the simple backup function.</p> <ul style="list-style-type: none"> <li>The Memory Card is not mounted.</li> <li>The Loop Controller model is different from that used to create the project saved in the Memory Card.</li> <li>The function block data backed up in the Memory Card is corrupted.</li> <li>There is an empty backup file on the Memory Card created for a simple backup operation performed for a Loop Controller for which a password has been set.</li> <li>The unit version of the LCB backed up in the Memory Card is higher than the unit version of the LCB at the recovery designation.</li> </ul> <p><b>Note:</b> Turn the CPU Unit power from OFF to ON while pin 7 of the DIP switch on the front of the CPU Unit is ON.</p>	Operation is stopped.	None	Reinstall the Memory Card used to back up the function block data (using simple backup), and cycle the CPU Unit power while leaving pin 7 of the DIP switch on the front of the CPU Unit turned ON.

## 7-1-3 Errors during Normal Operation

LED Indicators on front of Loop Controller		LED Indicator on front of CPU Unit	Problem	Cause	Status	Error code (Stored in error log.)	Corrective action
RDY	EXEC	ERR/ALM (See note.)					
Lit	Lit	Not lit	Normal condition	Loop Controller operating normally.	---	None	---
Lit	Not lit	Not lit	Normal condition	The Board is stopped for either of the following reasons.			
				Normal stop of operation	---	None	---
				CPU Unit is waiting.		None	Refer to the CPU Unit's Operation Manual and clear the CPU Unit's waiting status.
Lit	Lit	Flashing (Partial function block database (RAM) error during simplex operation, A42410 turns ON.)	Partial function block database (SRAM) error during simplex operation	A partial function block database (RAM) error was detected in self-diagnosis during operation in either duplex SPL mode or simplex operation.	For only a partial database error, operation stops only for the relevant function blocks (nonfatal error).	0331 The details code contains either the relevant block address or FFF if all data bases have an error.	Execute the <b>Download</b> or <b>Clear all</b> operation from CX-Process Tool Version 3.0 or later. The RAM Error Flag (A42410) will go OFF if the data in RAM becomes valid.
		Flashing (Incompatible Operation Cycle Flag (A42409) turns ON.)	The Loop Controller is operating with a high load rate (error during duplex operation only).	(CS1D-CPU□□P only) The cycle time is too long (i.e., the CPU Unit's cycle time is more than 30% of the minimum operation cycle of the Loop Controller for three consecutive cycles), so there is error in the operation cycle of the Loop Controller.	Operation continues with a large error in the operation cycle (nonfatal error).	None	Set a longer minimum Loop Controller operation cycle (5 times the CPU Unit cycle time or longer).
Lit	Lit	Flashing (A42408, the Loop Controller High Load Flag, is ON.)	The Loop Controller is operating with a high load rate.	The LCB load rate exceeded 80% continuously for 6 seconds.	Operation continues although the operation cycle setting is exceeded (non-fatal error.)	None	Adjust each function block's operation cycle so that the LCB load rate is below 80%. Another solution is to add a Loop Control Unit to the PLC and shift some of the load to that Unit.

LED Indicators on front of Loop Controller		LED Indicator on front of CPU Unit	Problem	Cause	Status	Error code (Stored in error log.)	Corrective action
RDY	EXEC	ERR/ALM (See note.)					
Not lit	Not lit	Lit (A42400, the Inner Board WDT Error Flag, is ON.)	An Inner Board WDT Error occurred.	The Inner Board is malfunctioning.	Operation is stopped (fatal error.)	None	Turn the power OFF and ON again. Replace the Loop Control Board if the error recurs when the power is turned ON.
		Lit (A42401, the Inner Board Bus Error Flag, is ON.)	Inner Board Bus Error	An Inner Board Bus Error occurred.	Operation is stopped (fatal error.)	0014	Mount the Loop Control Board securely. Replace the Loop Control Board if the error recurs after the Board is secured and power is turned ON again.
		Lit (A42403, the Flash Memory Data Error Flag, is ON.)	Parameter backup data (flash memory) error	One of the following problems was detected during a cold start with the CS1W-LCB01/05 or a cold or hot start with the CS1D-CPU□□P. 1) The data was corrupted by noise or other factor. 2) The power was interrupted during a backup. (See note.) 3) The power was interrupted during duplex initialization (CS1D-CPU□□P only) <b>Note:</b> If the function block database (RAM) is valid, the data will be backed up when power is turned ON again.	Operation is stopped (fatal error.)	0331 The details code contains either the relevant block address or FFFF if all data bases are invalid.	Execute the <b>Download</b> or <b>Clear all</b> operation from CX-Process Tool Version 3.0. The Flash Memory Data Error Flag (A42403) will go OFF if the data in RAM becomes valid.
		None of the above	CPU Unit Fatal Error	A fatal error occurred in the CPU Unit.	Operation is stopped (fatal error.)	None	Refer to the CPU Unit's Operation Manual and clear the fatal error.
Flashing	Not lit	Lit	CPU Unit WDT Error	A CPU Unit WDT Error occurred.	Operation is stopped (fatal error.)	0001	Refer to the CPU Unit's Operation Manual.

**Note** The CPU Unit's ALM/ERR Indicator will flash when a non-fatal error has occurred and stay lit when a fatal error has occurred.

## 7-1-4 Error Log Data

The configuration of error log data including error codes is as follows. Error log data is stored in RAM (battery-backed up) on the Loop Controller. The configuration of each error log is as follows and is regarded as a single record.

Error log data is not stored in flash memory.

RAM can hold up to 256 of the latest records:

1 record

Error code
Detailed information
Date (year/month) and time (hour/minute/second) of occurrence

Error log data can be read using the FINS (READ ERROR LOG, [command code 2102 Hex]) command.

A record is not made in the error log if an error for which the error code is already stored in flash memory.

### 7-1-5 Execution Error Code List

- The execution error codes shown in the list below are stored in ITEM003 of each function block.
- When there are function blocks containing an error other than 0 (normal), the smallest block number in these function block numbers is stored to ITEM093 of the System Common block (Block Model 000).
- The following information can be checked in the Monitor Run Status screen on CX-Process Tool (**Execute - Run - Validate Action**):
  - Smallest block address where execution error occurred (ITEM093 of System Common block)
  - Execution error codes that occurred at each function block address (smallest code No. when multiple execution errors occur at a single function block) in the Detailed display screen

Code	Description	Explanation	Operation at error	Remedy
0	Normal			
1	Connection terminal/output terminal connection not defined	Either the function block is not registered to the block address of the source designation or the destination, or the ITEM number does not exist.	Running of the function block in question is stopped, and the functions in question do not operate normally.	Check the block address and ITEM number of the source designation or destination designation.
		In the destination specifications for set values 1 to 5 of a Segment Program 3 block (Block Model 158), a specified block does not exist, an ITEM number does not exist, or ITEM 002 (Model Name) was incorrectly specified	The run/stop command (ITEM 013) turns OFF. The program output (ITEM 008) follows the reset output mode (ITEM 023).	
2	Default error	When the S1 run/stop command turned ON in the ramp program, segment program, segment program 2, or segment program 3, the reference input was outside the up ramp range.	The program does not start and ITEM 015 (X1 input error) turns ON.	Check the connection of the reference input and program settings.
		There are only up ramps or only down ramps when the "reference search input method" is set to "search in specified direction, first/second half" in Segment Program 2 (Block Model 157). (Execution error selection with ITEM 191 set to 0: No matching point)	The program will not start.	Check the settings for Segment Program 2 (Block Model 157).
		The specified search section does not exist when the "reference search input method" is set to "search in specified search section" in the Segment Program 2 block (Block Model 157). (Execution error selection with ITEM 191 set to 0: No matching point)	The program does not start.	Check the Segment Program 2 block (Block Model 157) settings.

Code	Description	Explanation	Operation at error	Remedy
3	Variable value error	A constant between A1 and A8 or an intermediate buffer between B1 and B4 that is used in the conditional statement for Arithmetic Operation (Block Model 126) is not defined.	Execution of the Arithmetic Operation block will be stopped.	Set definitions for all constants A1 to A8 and an intermediate buffers B1 to B4 that are used.
10	Operation process: Division by "0"	An attempt was made to execute division by a "0" denominator in the operation process.	For division, the maximum value is output. For the Segment Linearizer or Temperature and Pressure Correction blocks, the previous data is retained.	For the Segment Linearizer block, check the setting value of the input coordinate side. In the case of temperature and pressure correction, check the gain bias value.
		The operator / was used to divide by zero in an Arithmetic Operation block (Block Model 126).	Execution of the Arithmetic Operation block will be stopped.	Correct the condition or operation so that division by zero is not performed.
11	Operation process: Operation out of restricted value	The output value of the operation result exceeded the data length of two bytes. <b>Note:</b> An error does not occur even if the output range ( $\pm 320.00$ , e.g) is exceeded if the data length of two bytes is not exceeded.	Output becomes the maximum value or minimum value of the output range. (For example, when the output range is $\pm 320.00$ , the output becomes $+320.00$ or $320.00$ .)	If there is a problem, review the settings of related ITEMS.
		The argument or results of operation in an Arithmetic Operation block (Block Model 126) exceeded the allowable range.	Execution of the Arithmetic Operation block will be stopped.	Check the ranges of the argument and results and correct the condition or operation so that the allowable ranges are not exceeded.
12	Argument beyond definition	An argument used in Arithmetic Operation (Block Model 126) is beyond the definition.	Execution of the Arithmetic Operation block will be stopped.	Check the range of the arguments and correct the conditional statement or calculation expressions.
15	AT error	A limit cycle cannot be generated for Basic PID (Block Model 011) or Advanced PID (Block Model 012) or suitable PID constants cannot be calculated.	Execution of the relevant block will be stopped.	Check the contents of the following AT related parameters: Limit cycle MV amplitude (ITEM 036), Limit cycle hysteresis (ITEM 037), AT calculation gain (ITEM 038), Judgment deviation for provisional AT execution (ITEM 039), and the AT type (ITEM 040). Also, set the PID control processing cycle (ITEM 051) to 2 s or less.
		An autotuning error occurred in a PID block connected to a Segment Program 3 (Block Model 158) block.	The PID parameters will not be changed in the bank.	Execute autotuning again or set Execution error display/clear (ITEM 003) in the Segment Program 3 (Block Model 158) block to 0 to clear the error.

Code	Description	Explanation	Operation at error	Remedy
19	Inappropriate operation	Two or more S1 to S3 select switches are set to 1 (ON) at the same time in the 3-output Selector block (Block Model 163) or 3-input Selector block (Block Model 164).	The output value that was active before the error occurred is held.	Re-program the Step Ladder Program block so that S1 to S3 select switches are set to 1 (ON) independent of each other.
		There is a syntax error in Arithmetic Operation (Block Model 126), the THEN or ELSE expression is not defined, or the output reverse scaling limits are not set.	Execution of the Arithmetic Operation block will be stopped.	Check the contents of the conditional statement and calculation expressions and check the settings of the output reverse scaling limits.
		There are syntax errors in the membership functions or rules for the Fuzzy Logic block (Block Model 016) making execution impossible. a) A value does not have one sign character and 5 or fewer numeric characters (e.g., when a + sign is included). b) Values are not separated by colons. c) The values that have been set are insufficient. d) There are more than three critical points in a membership functions. e) Critical points in membership functions do not rise to the right. f) Membership functions are not set for labels specified in rules (NL, NS, ZR, PS, PL).	Operation of the Fuzzy Logic block will stop.	Check the membership functions and rules.  The ITEM number where the problem occurred is given in ITEM 006 (Operation Error Details).
		The "synchronous operation reference parameter designation" set for Segment Program 2 in the slave was changed to 0 (master designation) during synchronous operation using Segment Program 2 (Block Model 157).	The slave's output value is held.	If synchronous operation is not to be used for the Segment Program 2 block specified as the slave, download the setting that was changed during operation (as given in the Explanation column) to the flash memory.  When the Segment Program 2 block is to be used as a slave, specify the correct block address in the "synchronous operation reference parameter designation" for the Segment Program 2 used as the master.
20	Download terminal data exchange error	Data exchange with the CPU Unit is not being executed correctly on Field Terminal blocks.	The data of the function block in question is not updated.	If a malfunction has occurred on the CPU Unit, follow the remedy for that error. If the CPU Unit is normal, turn ON the power supply again.

Code	Description	Explanation	Operation at error	Remedy
21	I/O memory address out-of-range	An address out of the I/O memory address range has been specified on the CPU Unit Terminal, Expanded CPU Unit Terminal, Node Terminals and Field Terminal blocks.	Operation of the function block in question is stopped.	On the CPU Unit Terminal and Expanded CPU Unit Terminal blocks, check the leading address, and on field terminals check the setting of the CIO (channel I/O) Area number setting. In the case of Node Terminals, check the setting of the "leading address of the memory for the node terminals" specified by System Common block ITEM 043.
29	Reception error for external device	A communications frame error was generated by the data received from an ES100X Controller for an ES100X Controller Terminal (Block Model 045). (An FCS check error or frame error occurred 3 times in a row.)	Communications will be stopped with the specified ES100X and tried with another ES100X.	Check the communications path and the communications settings (7 data bits, even parity, and 2 stop bits).
30	Response timeout	A response was not returned after sending data to the Controller for a ES100X Controller Terminal (Block Model 045). (Response was not returned for 5 s 3 times.)	Communications will be stopped with the specified ES100X and tried with another ES100X.	Check the communications path, the communications settings (7 data bits, even parity, and 2 stop bits), and other required settings in the ES100X (parameter setting mode, unit number, etc.).
31	Controller unit number duplicated	The unit number set in ITEM 006 for a ES100X Controller Terminal (Block Model 045) is the same as another ES100X Controller Terminal. (A response timeout will occur if the unit number does not exist.)	Communications will be stopped with the ES100X Controllers.	Change the unit number settings (ITEM 006) so that each is used only once.



Code	Description	Explanation	Operation at error	Remedy
70	Illegal combination of function blocks	The function block on the primary loop side is not basic PID or advanced PID when bumpless processing between primary/secondary loops was specified in basic PID or advanced PID.	Running of the function block in question is stopped.	Check the function block model number on the primary loop side.
		The block address specified as the master is not set to Segment Program 2 (Block Model 157) even though synchronous operation is set for Segment Program 2 (Block Model 157).	The slave's initial output value is not changed and operation does not start.	Specify the block address for Segment Program 2 in the master.
		The Segment Program 2 block specified as the master was deleted during execution of Segment Program 2 (Block Model 157).	The slave's output value is held.	Specify the master correctly.
		The block address of the same Segment Program 2 (Block Model 157) block is set in the "synchronous operation reference parameter designation" (i.e., the Segment Program 2 block is set as its own master).	The initial values are not changed and operation does not start.	Specify the correct block address in the "synchronous operation reference parameter designation."
		A Basic PID block (Block Model 011) or Advanced PID block (Block Model 012) is not set as the "source designation of PID block's MV output" for Split Converter (Block Model 169).	The initial values are not changed and operation does not start.	Specify a Basic PID block (Block Model 011) or Advanced PID block (Block Model 012) for the "source designation of PID block's MV output."
		With the Segment Program 3 block (Block Model 158), the function block with the block address set in the target PID block's address (ITEM 041) is not a Basic PID or Advanced PID block or 000 (not specified).	The program does not start. Program outputs do not operate at the default settings.	Check the settings for the target PID block's address (ITEM 041).
		With a Basic PID block (Block Model 011) or Advanced PID block (Block Model 012), the remote SP source designation is not the Segment Program 2 or Segment Program 3 program output value (ITEM 008) when PV lag offset correction (ITEM 110) is enabled.	PID control is executed with no PV lag offset correction.	Either disable PV lag offset correction (ITEM 110) for the Basic PID block (Block Model 011) or Advanced PID block (Block Model 012), or set the remote SP source designation (ITEM 021) to the Segment Program 2 or Segment Program 3 program output value (ITEM 008).

Code	Description	Explanation	Operation at error	Remedy
71	Inappropriate parameter	a) When restricted conditions are applied across two ITEMS: (example: when the unit pulse output is equal to or greater than the operation cycle when there is unit pulse output in run time accumulation) b) An attempt has been made to write out-of-range data at the ITEM Setting block.	a) The function block in question is not executed. b) Data cannot be written.	Check the settings of the ITEMS.
		The Segment Program 2 block operation cycle set for the Slave does not match the Segment Program 2 block operation cycle set for the Master in Segment Program 2 (Block Model 157).	The slave's initial Segment Program 2 block is not changed and operation does not start.	Change the Segment Program 2 block operation cycle set for the Slave so that it matches the Segment Program 2 block operation cycle set for the Master.
		With the Segment Program 3 block (Block Model 158), the bank number set for a step is greater than the maximum number of banks used.	Program outputs do not operate at the default settings.	Change the bank number so that it is within the maximum number of banks used.
		With the Segment Program 3 block (Block Model 158), an attempt was made to set a value out of range when writing to an ITEM set using a set value 1 to 5.	The run/stop command (ITEM 013) turns OFF. The program output (ITEM 008) is set according to the output mode when S1 is OFF (ITEM 023).	Check the value written to the ITEM set using set value 1 to 5.
		One of the following errors was detected in the Split Converter (Block Model 169): The Heating MV high limit is not greater than the Heating MV low limit. The Cooling MV high limit is not greater than the Cooling MV low limit.	The block in question is not executed.	Correct the limit value settings so that: Heating MV high limit > Heating MV low limit and Cooling MV high limit > Cooling MV low limit.
		One of the following errors was detected in the Split Converter (Block Model 169): The minimum input value for heating was above 100% or the maximum input value for cooling was below -100%.	The block in question is not executed.	Check and correct the settings for the input range type, dead band, and center value offset.

Code	Description	Explanation	Operation at error	Remedy
72	Parameter inconsistency	With the Segment Program 3 block (Block Model 158), the block addresses of the maximum number of steps used (ITEM 038) and the step data block do not match.	Program outputs do not operate at the default values.	Correct the block address settings for the maximum number of steps used (ITEM 038) and the step data block, and then again turn ON the run/stop command.
		With the Segment Program 3 block (Block Model 158), the block addresses of the maximum number of banks used (ITEM 043) and the number of Bank Data blocks do not match.	Program outputs do not operate at the default values.	Correct the block address settings for the maximum number of banks used (ITEM 043) and the Bank Data blocks, and then again turn ON the run/stop command.
		With the Segment Program 3 block (Block Model 158), the "AT result reflection bank number" (ITEM 027) is greater than the maximum number of banks used (ITEM 043). (There is no bank in which to save the AT results.)	The AT command (ITEM 026) turns OFF and the AT command is not output at the connected PID block.	Change the "AT result reflection bank number" (ITEM 027) so that it is no more than the maximum number of banks used (ITEM 043), and then either again turn ON the AT command or clear the error by setting the execution error display/clear (ITEM 003) of the Segment Program 3 block (Block Model 158) to 0.
73	Parameter address error	With the Segment Program 3 block (Block Model 158), when a program pattern data transfer (LCB to CPU Unit) is used, sufficient memory is not available for the maximum number of steps used and the maximum number of banks used from the specified start address (The end address exceeds 32,767.)	Program pattern data is not transferred (LCB to CPU Unit).	Turn OFF the program pattern transfer order (ITEM 030), set the correct start address, and then again turn ON the program pattern transfer order (LCB to CPU Unit).

Code	Description	Explanation	Operation at error	Remedy
74	Transfer source parameter error	With the Segment Program 3 block (Block Model 158), when the program pattern transfer order (CPU Unit to LCB) is executed, the maximum numbers of steps and banks used in the program pattern data in the CPU Unit do not match the Segment Program 3 block (Block Model 158) maximum number of steps used (ITEM 038) and the maximum number of banks used (ITEM 043) settings.	Program pattern data is not transferred (CPU Unit to LCB). In ITEM 024 (error detection address), the parameter offset address where the CPU Unit to LCB transfer failed is indicated (only when an execution error occurs).	Turn OFF the program pattern transfer order (ITEM 031), match the maximum number of steps used and the maximum number of banks used at the CPU Unit with the values in the Segment Program 3, and then again turn ON the program pattern transfer order (CPU Unit to LCB).
		With the Segment Program 3 block (Block Model 158), some program pattern data at the CPU Unit is set out of range.	Program pattern data is not transferred (CPU Unit to LCB). In ITEM 024 (error detection address), the parameter offset address where the CPU Unit to LCB transfer failed is indicated (only when an execution error occurs).	Turn OFF the program pattern transfer order (ITEM 031), make sure all settings are within the specified ranges, and then again turn ON the program pattern transfer order (CPU Unit to LCB).
		With the Segment Program 3 block (Block Model 158), when program pattern data was changed by downloading the ITEM, the time width for the step before the one being executed was changed to 0.0.	The run/stop command (ITEM 013) turns OFF. The program outputs will be the values set for the program outputs at reset.	When the run/stop command is turned ON, operation starts with the step with time width 0.0 as the final step, so reset the step time width before turning ON the run/stop command.
75	Download transfer interrupt detected error	Power was interrupted or LCB operation was stopped during execution of a program pattern transfer order (CPU Unit to LCB) with a Segment Program 3 block (Block Model 158).	The transfer stops. The program pattern transfer order (CPU Unit to LCB) (ITEM 031) stays ON.	Either turn the program pattern transfer order (CPU Unit to LCB) OFF and then back ON, or clear the error by setting the execution error display/clear (ITEM 003) of Segment Program 3 (Block Model 158) to 0.
76	Upload transfer interrupt detected error	Power was interrupted or LCB operation was stopped during execution of a program pattern transfer order (LCB to CPU Unit) with a Segment Program 3 block (Block Model 158).	The transfer stops. The program pattern data transfer command (LCB to CPU Unit) (ITEM 030) stays ON.	Either turn the program pattern data transfer command (LCB to CPU Unit) OFF and then back ON, or clear the error by setting the execution error display/clear (ITEM 003) of Segment Program 3 (Block Model 158) to 0.
77	Inappropriate pattern	The total of the time widths in a Segment Program 3 block (Block Model 158) exceeded the maximum value. Maximum value = 429496729.5 s (approx. 13.61 yr)	The run/stop command will turn OFF if it is ON.	Change the time widths so that the maximum total value is not exceeded.

Code	Description	Explanation	Operation at error	Remedy
80	Step Ladder Program command error	There is an irrelevant command in the Step Ladder Program, or the method of use of commands is wrong, for example, there is an AND command even though there is no input command.	The command in question and onwards are not executed.	Check the program within the Step Ladder Program block.
	Sequence table command error	The condition signal type registered in the conditions is incorrect. The rule setting is not set to Y, N, or blank. The action signal type registered in the action section is incorrect.	The sequence table will not be executed.	Correct the sequence table program.
81	Step Ladder Program source/designation not defined	Either the function block is not registered to the block address currently specified by each command in the Step Ladder Program, or the ITEM number does not exist.	The command in question and onwards are not executed.	Check the block address and ITEM number.
	Sequence Table source/designation not defined	Either the ITEM number of the function block specified as an input source or output destination in the sequence table does not exist. The output destination of the signal registered in the condition signal is incorrect. The timer/counter signal registered in the sequence table is incorrect. The expansion block address registered in the sequence table is incorrect.	The sequence table will not be executed.	Correct the sequence table program.
		The block specified in the TBL command is not set to the reference table.	The sequence table using the TBL command will not be executed.	Check the sequence table at the reference destination and change the reference table setting.
	Sequence Table step/stop command block error	The block address of the current block is specified in the STEP or STOP command in a sequence table.	The sequence table will not be executed.	Specify a different block.
		The block set in the reference table is specified in the STEP command in a sequence table.	The sequence table executed by the STEP command will stop operation.	Correct the block specified in the STEP command to the setting for the host table.
89	Overuse of Step Ladder Program differentiated instruction	The number of differentiated instructions to be simultaneously executed has exceeded 256.	Differentiated instructions exceeding 256 instructions are not executed.	Reduce the number of differentiated instructions to be executed simultaneously.
99	Database error	There was a database error in the Step Data blocks (Block Model 601), Bank Data blocks (Block Model 602), and Segment Program 3 block (Block Model 158) when the Segment Program 3 block was executed.	Execution of the Segment Program 3 block stops.	Executed the Clear all, Download, or Recovery operation from the CX-Process Tool, or reset the Segment Program 3 block.

## 7-2 Maintenance

### 7-2-1 Replacing the Loop Control Board

Follow the procedure below to replace the Loop Control Board.

**When the same function block file (appended by the .ist extender) as the function block data on the Loop Control Board is held in storage**

**To use the parameters (on the Loop Control Board that is to be replaced) that were set using SCADA software, a PT, etc.**

- 1,2,3...**
1. Turn power OFF to the PLC.
  2. Connect the cable to the CPU Unit.
  3. Turn power ON to the PLC.
  4. Read the same function block file (that was set aside and appended with the .ist extension) as the data on the Loop Control Board to be replaced from hard disk or other storage medium using CX-Process Tool.
  5. To check whether or not the file is the same as that on the Loop Control Board, use CX-Process Tool to verify only CX-Process Tool default data between the Loop Control Board and the function block file that has been read.
  6. Upload the function block data from the Loop Control Board. Read the parameters from SCADA software, a PT, etc.
  7. Turn power OFF to the PLC.
  8. Replace the Loop Control Board.
  9. Turn power ON to the PLC.
  10. Use CX-Process Tool to download the function block file whose parameters were read to the Loop Control Board.
  11. Back up the parameters.
  12. Save the function block file whose parameters were read to hard disk or other storage medium.
  13. Check the Loop Control Board again for any malfunction.

**When the parameters (on the Loop Control Board to be replaced) that were set using SCADA software, a PT, etc., are not to be used**

- 1,2,3...**
1. Turn power OFF to the PLC.
  2. Replace the Loop Control Board.
  3. Connect the cable to the CPU Unit.
  4. Turn power ON to the PLC.
  5. Use CX-Process Tool to download the function block file (appended with the .ist extension) that was set aside in the hard disk or other storage medium to the Loop Control Board.
  6. Back up the parameters.
  7. If necessary, use CX-Process Tool to compare all function block files to check whether or not the download has been executed successfully.
  8. Check the Loop Control Board again for any malfunction.
  9. Use SCADA software, a PT, etc., to set the parameters.

**When the same function block file (appended with the .ist extender) as the function block data on the Loop Control Board is not set aside**

**Note** The same function block file (appended with the .ist. extender) as the function block data on the Loop Control Board is needed to read the function block data on the Loop Control Board. If the same function block file (appended with the .ist. extender) has not been set aside, the following restrictions apply to that data when the function block data on the Loop Control Board is simply read. Otherwise, these restrictions do not apply to ITEM data.

- The function blocks that are read will be connected automatically using the shortest connections possible. If the connections between the original function blocks were more indirect, then the connections between the resulting file blocks may be different. (The actual connection information used in execution, however, will be the same.)
- Annotation data is not read.
- Output comments in ladder diagrams are not read.
- Connections between user link tables and function blocks are not restored. These will be automatically connected when a user link table name is set.

Regardless of the above restrictions, follow the procedure below to replace the Loop Control Board when the function block data on the Loop Control Board to be replaced is uploaded and downloaded to the new Loop Control Board.

- 1,2,3...**
1. Turn power OFF to the PLC.
  2. Connect the cable to the CPU Unit.
  3. Turn power ON to the PLC.
  4. Upload the function block data from the Loop Control Board.
  5. Turn power OFF to the PLC.
  6. Replace the Loop Control Board.
  7. Turn power ON to the PLC.
  8. Wire the function blocks in CX-Process Tool as necessary based on the function block file (appended with the .ist extender) that was uploaded from the Loop Control Board.
  9. Download the function block file to the Loop Control Board.
  10. Back up the parameters.
  11. If necessary, use CX-Process Tool to compare all function block files to check whether or not the download has been executed successfully.
  12. Save the function block file whose function blocks have been wired in the software on the hard disk or other storage medium.
  13. Check the Loop Control Board again for any malfunction.

## 7-2-2 Replacing Process-control CPU Units

When replacing a Process-control CPU Unit (CS1D-CPU□□P), switch the Duplex Unit's CPU USE/NO USE switch to "NO USE" to allow the Process-control CPU Unit to be replaced while power is supplied to the PLC.

**Note** When using Process-control CPU Units, always replace the entire Process-control CPU Unit as one Unit, even if only the CPU Unit or Loop Controller component has failed.

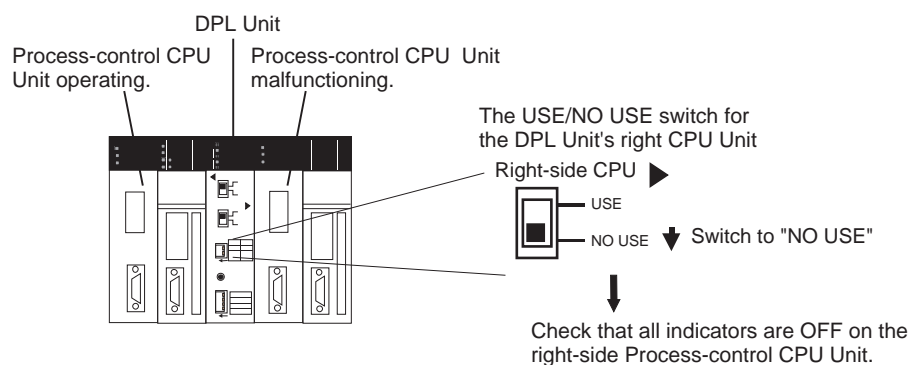
### Step 1

Switch the CPU USE/NO USE switch to "NO USE" on the Duplex Unit for the Process-control CPU Unit that is to be replaced.

While the switch is set to "NO USE," power is turned OFF to the Process-control CPU Unit. Check that no indicators on the CS1D Process-control CPU Unit to be replaced are lit.

**Note** Before replacing the Process-control CPU Unit, always switch the Duplex Unit's CPU USE/NO USE switch to "NO USE." Removing the Process-control CPU Unit with the switch set to "USE" (power supplied) may damage the CPU Duplex Backplane or the Duplex Unit.

**Example:** When the Process-control CPU Unit on the right side is malfunctioning, switch to the left Process-control CPU Unit and operate in simplex mode.



### Step 2

Replace the entire right-side Process-control CPU Unit.

### Step 3

Switch the CPU USE/NO USE switch for the Duplex Unit's right-side CPU Unit to "USE."

**Note** When *Return Automatically* option is set to *Do not Automatically Return to duplex operation* in the PLC Setup (default), the function block data will not be automatically transferred when the CPU USE/NO USE switch is set to "USE." (Operation will remain in simplex mode and operation will not continue if an error occurs in the active Process-control CPU Unit.)

### Step 4

**Perform the following procedure if *Return Automatically* is set to *Do not Automatically Return to duplex operation* in the PLC Setup.**

- 1,2,3...
1. Check that the DPL switch is set to "DPL."
  2. Switch the CPU USE/NO USE switch to "USE" and then press the initialization switch.



**Note** The initialization switch is invalid while the EXEC indicator is flashing after the power is turned ON (clearing flash memory or backing up function block data to flash memory). Press the initialization switch again after the RDY indicator lights. Approximately 10 seconds is required after the power is turned ON to clear flash memory.

3. When the initialization switch is pressed, the Duplex Unit's DPL STATUS and CPU STATUS indicators will flash green and the function block data will be transferred from the Process-control CPU Unit that had been operating to the Process-control CPU Unit that was replaced.

At up to 2.5 minutes later, the Duplex Unit's DPL STATUS and CPU STATUS indicators will change from flashing green to being lit. The function block data transfer has been completed and operation in duplex mode is started again. (The Process-control CPU Unit that was operating will be active and the Process-control CPU Unit that was replaced will be on standby.)

**Perform the following procedure if automatic restoration to duplex operation is set in the PLC Setup.**

Switch the CPU USE/NO USE switch to "USE" to transfer the function block data from the Process-control CPU Unit that was operating to the Process-control CPU Unit that was replaced. Duplex mode will be restored up to 2.5 minutes later. (Process-control CPU Unit that was operating will be active and the Process-control CPU Unit that was replaced will be on standby.)

### 7-2-3 Replacing Loop-control CPU Units

Use the following procedure to replace a Loop-control CPU Unit.

#### STEP 1: Backing Up the Program

##### Connecting the CPU Unit

Connect the cable to the CPU Unit.

##### Backing Up the Program, PLC Setup, and I/O Tables from the CPU Unit

1,2,3...

1. Start the CX-Programmer.
2. Create a new project or open an existing project.
3. Go online to the CPU Unit.
4. Select **PLC - Transfer - From PLC**.
5. Select all of the transfer options.
6. Click the **OK** Button.
7. Save the project.

##### Backing Up the Function Blocks from the Loop Controller

1,2,3...

1. Start the CX-Process Tool.
2. Create a new project or open an existing project.
3. If a new project is created, set the node.
4. Upload the function block data as new data from the Loop Controller.
5. Click the **Option** Button. Select the option to restore tag data from compact flash memory and then click the **OK** Button.
6. Click the **Start** Button.

7. Save the project.

**Note** If the comments, annotations, tags, and connection data for a project is saved in advance to a Memory Card, then this data can be backed up.

### **STEP 2: Replacing the Unit**

- 1,2,3...**
1. Turn OFF the power supply to the PLC.
  2. Replace the Loop-control CPU Unit.
  3. Insert the Memory Card.
  4. Turn ON the power supply to the PLC.

### **STEP 3: Transferring the Program**

**Transferring the Program, PLC Setup, and I/O Tables to the CPU Unit**


- 1,2,3...**
1. Start the CX-Programmer.
  2. Open the new project that was saved in STEP 1.
  3. Go online to the CPU Unit.
  4. Select **PLC - Transfer - To PLC**.
  5. Select all of the transfer options.
  6. Click the **OK** Button.

**Transferring the Function Blocks to the Loop Controller**

- 1,2,3...**
1. Start the CX-Process Tool.
  2. Open the new project that was saved in STEP 1.
  3. Select the LCB and then select **Execution - Download - Selected**.
  4. Click the **Option** Button. Select the option to transfer tag data to compact flash memory and then click the **OK** Button.
  5. Click the **Start** Button.

## **7-2-4 Using the Flash Memory**

Data stored in flash memory is transferred to RAM for use in actual operation when a cold start is made.

 **Caution** Do not turn OFF the power supply to the PLC when data is being transferred from RAM to flash memory. Data will not be transferred correctly if power is interrupted or a communications error occurs before the transfer operation is completed. If a database occurs, download the function block data again from the CX-Process Tool to RAM in the Loop Controller, and then transfer the contents of RAM to flash memory. If, when power is turned back ON, the system detects that a backup operation was in progress and the RAM data is normal, the backup operation will be repeated from the beginning.

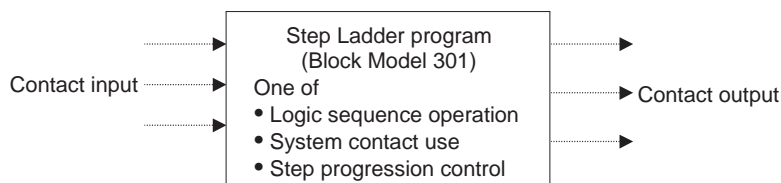
# Appendix A

## How to Use the Step Ladder Program Block

The Step Ladder Program block (Block Model 301) is used in the following cases:

- When logical operations such as AND, OR and NOT are to be performed on the Loop Controller
- When input of changes in the contact state (OFF to ON or ON to OFF) are to be converted to one-shot contact outputs that are ON for only one operation cycle
- When system contacts such as constantly ON contacts are to be used on the Loop Controller
- When step progression control, for example, is to be performed on the Loop Controller

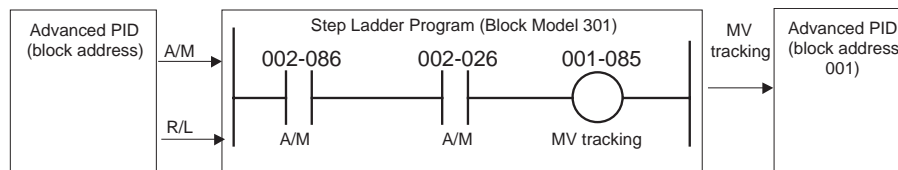
**Note** When contact signals are simply to be connected between function blocks, the Contact Distributor block (Block Model 201) is used.



To be more precise, the Step Ladder Program block is used in the following applications:

- For setting the conditions for indicating Remote/Local switching
- For setting the conditions for indicating Auto/Manual switching
- For setting the tracking switch conditions
- For setting the MV hold conditions
- For setting the PID switching conditions
- For setting command switch conditions (e.g. tracking switch, run/stop command to ITEM Setting blocks)
- For step progression control of devices

### Example



When PID of block address 002 is set to AUTO and the mode is the remote mode, MV tracking of the PID of block address 001 is ON.

- Note**
1. The execution cycle of sequence commands in the Step Ladder Program block is slower than the execution cycle (cycle time) of commands on the CPU Unit. (0.1 to 2 s cycles follow the operation cycle of the Step Ladder Program itself.) For this reason, the Step Ladder Program block is used combined with other function blocks. When high-speed processing is required, use commands on the CPU Unit.
  2. At the Step Ladder Program block, external contacts are not directly input and output. They are input and output via Field Terminal DI or DO terminals.



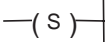

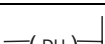
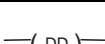

**⚠ WARNING** When the OUT instruction from the Step Ladder Program is to be connected to a DO terminal, do not set the address for the OUT instruction from the Step Ladder Program to the same address as the address for the OUT instruction in the user's program on the CPU Unit. When writing is performed on identical addresses, the externally connected load may act unexpectedly and cause injury.

- A single sequence command (e.g. LOAD or OUT) is described to a single ITEM, and the block address and ITEM number of the specified input/output destination are described at the same time as the operand.
- There are two types of sequence command, basic instructions, and sequence control instructions. Basic instructions can be used only in logical sequences comprising single steps, and sequence control instructions can be used in step sequences comprising multiple steps.
- ITEMS that can be specified by sequence commands are ITEMS whose ITEM category is “contact input” or “contact output.” For details, refer to the reading and writing method indicated in the ITEM list under the function block descriptions in the *Function Block Reference Manual* (Cat. No. W407).

Command type	Settable ITEM type	“According to Step Ladder Program” at “Reading and Writing Method” Item
Input type commands such as LOAD	Contact output	R (read-enabled)
	Contact input	R/W (read/write-enabled)
Output type commands such as OUT	Contact input	


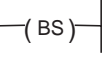
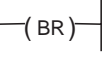
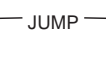


## List of Basic Instructions

	Command	Ladder symbol	Operand	Description	Input conditions	°:Can be used ×:Cannot be used	
						In logic sequence	In step sequence
Input type	LOAD		Read source block address/ITEM number	Indicates a logical start of the logic block, creates an ON/OFF execution condition based on the ON/OFF status of the contact, and connects to the next stage.	Not required	°	°
	LOAD NOT		Read source block address/ITEM number	Indicates a logical start of the logic block, creates an ON/OFF execution condition based on the reverse of the ON/OFF status of the contact, and connects to the next stage.	Not required	°	°
	AND		Read source block address/ITEM number	Takes a logical AND of the status of the contact and the current execution condition.	Required	°	°
	AND NOT		Read source block address/ITEM number	Reverses the status of the contact and takes a logical AND with the current execution condition.	Required	°	°
	OR		Read source block address/ITEM number	Takes a logical OR of the status of the contact and the current execution condition.	Required	°	°
	OR NOT		Read source block address/ITEM number	Reverses the status of the contact and takes a logical OR with the current execution condition.	Required	°	°
	AND LOAD		000000 (fixed)	Takes a logical AND between circuit blocks.	Required (2 or more)	°	°
	OR LOAD		000000 (fixed)	Takes a logical OR between circuit blocks.	Required (2 or more)	°	°

	Command	Ladder symbol	Operand	Description	Input conditions	°: Can be used ×: Cannot be used	
						In logic sequence	In step sequence
Output type	OUT		Write destination block address/ITEM number	Outputs the result (execution condition) of logical processing: 0 (OFF) at condition 0 (OFF), and 1 (ON) at condition 1 (ON).	Required	°	°
	OUT NOT		Write destination block address/ITEM number	Outputs the result (execution condition) of logical processing: 1 (ON) at condition 0 (OFF), and 0 (OFF) at condition 1 (ON).	Required	°	°
	SET		Write destination block address/ITEM number	SET turns the operand bit 1 (ON) when the execution condition is 1 (ON), and does not affect the status of the operand bit when the execution condition is 0 (OFF). Use RESET to turn OFF a bit that has been turned ON with SET.	Required	°	°
	RESET		Write destination block address/ITEM number	RESET turns the operand bit 0 (OFF) when the execution condition is 1 (ON), and does not affect the status of the operand bit when the execution condition is 0 (OFF). Use SET to turn OFF a bit that has been turned ON with RESET.	Required	°	°
	DU		Write destination block address/ITEM number	Outputs 1 (ON) for one operation cycle only when the execution condition goes to 1 (ON) from 0 (OFF).	Required	°	°
	DD		Write destination block address/ITEM number	Outputs 1 (ON) for one operation cycle only when the execution condition goes to 0 (OFF) from 1 (ON).	Required	°	°
	TIM		TIM number 0 to 10	Measures the time when the execution condition is set to 1 (ON).	Required	°	°
---	Draw line			Connects vertical or horizontal lines.	---	°	°
---	Delete line			Deletes vertical or horizontal lines.	---	°	°
---	END	ED		Indicates the end of a program. <b>Note:</b> The END instruction is automatically placed at the end of program when the Step Ladder Program block is prepared using CX-Process Tool. It is placed after STEP00 when the program comprises STEP00 only, and is placed after the nth STEP where the program ends.	Not required	°	°
---	NO OPERATION	NP		This instruction has no function. (No processing is performed for NOP.)	Not required	°	°

- Note**
1. The ON signal for one operation cycle that is generated by the differentiate up (DIFU) or differentiate down (DIFD) command automatically turns OFF at the start of the Step Ladder Program block of the next operation cycle. (This signal does not turn OFF by the DIFU or DIFD command in the Step Ladder Program.)
  2. When the ON signal for one operation cycle that is generated by the DIFU or DIFD command is used by another function block, set the operation cycle to the same or higher than the operation cycle of the Step Ladder Program. The ON signal sometimes cannot be read normally when an operation cycle that is lower than the operation cycle of the Step Ladder Program is set.
  3. A contact ITEM that has been turned ON by the OUT command stays ON even if program execution moves to the next STEP. For this reason, to perform step progression control in a step sequence, use the RESET command at the next STEP to turn OFF the contact ITEM that has been turned ON.

## List of Sequence Control Instructions

Command	Ladder symbol	Operand	Description	Input conditions	°:Can be used -x:Cannot be used	
					In logic sequence	In step sequence
STEP		Step number	STEP declares the step number, and has no input conditions (is a direction connection to the bus). Any numbers in the range 00 to 99 are used as the step number, and are placed in ascending order. 1)Logic sequence: The step number is fixed at 00, and is functional at all times. Declaration of step number 00 can be omitted. 2)Step sequence: When the step number is within the range 01 to 99, only one of the steps is functional. When the program is started, step number 01 is functional.	Not required	°	°
BLOCK SET		Block address/step number	When the input conditions turn ON, operation of the specified step number of the Step Ladder Program block at the specified block address (701 to 900) is started. Run/stop command S1 of the specified block turns automatically 1 (ON). Operation of currently executing steps in already operating Step Ladder Program blocks is interrupted, and execution of the program jumps to the specified step.	Required	---	°
BLOCK RSET		Block address	When the input conditions turn ON, operation of the Step Ladder Program block is stopped at the specified block address (701 to 900). Run/stop command S1 of the specified block automatically turns 0 (OFF).	Required	x-	°
JUMP		Block address/step number	When the input conditions turn ON, execution of the program jumps to the specified step number (01 to 99) of the Step Ladder Program block at the specified block address (701 to 900). • To specify a jump to the current step number, set the block address to 000. • When a jump is made to another Step Ladder Program block, run/stop command S1 of the source block automatically turns 0 (OFF), and run/stop command S1 of the destination block turns 1 (ON).	Required	x-x	°
STEP TIMER		Timer setting value	This is the timer (setting range: 0 to 9999 s) for moving between steps. It has no input conditions. (STEP TIMER is placed in the same line as the STEP command.) Operation is started when program execution moves to the line containing the STEP command. When the time set by STEP TIMER is reached, the program execution moves to the next step. <b>Note:</b> "Input condition commands" are given top priority.	Not required	x-x	°
ALARM TIMER		Timer setting value	This is the timer (setting range: 0 to 9999 s) for monitoring steps. It has no input conditions. (ALARM TIMER is placed in the same line as the STEP command.) Operation is started when program execution moves to the line containing the STEP command. When the time set by ALARM TIMER is reached, the Step Timer Completion flag (step congestion indicator) turns 1 (ON). At this time, the step is held at the current values.	Not required	x-x	°

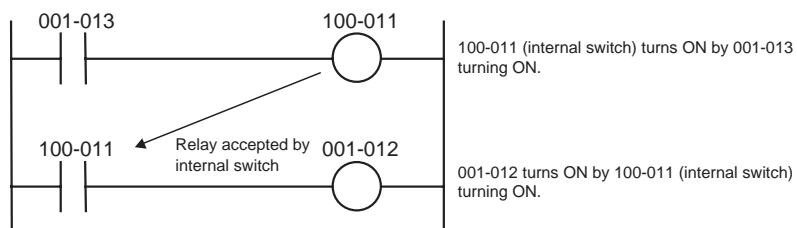
## Internal Switch Block

- To receive data internally by the Step Ladder Program without outputting it to the block address and ITEM number, specify the Internal Switch block (Block Model 209) as the block address.



**Example**

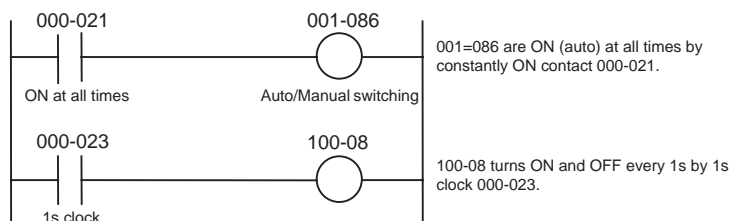
ITEM	Command	Operand
011	LOAD	001013 (block address, ITEM number)
012	OUT	100011 (block address of internal switch, ITEM number)
013	LOAD	100011 (block address of internal switch, ITEM number)
014	OUT	001012 (block address, ITEM number)



- To input constantly ON or constantly OFF contacts or clock pulse contacts, specify state outputs for sequence control (ITEM020 to ITEM028) in the System Common block (Block Model 000) as the block address.

**Example**

Command	Operand
LOAD	000021 (constantly ON)
OUT	001086 (block address, ITEM number)
LOAD	000023 (1sec clock)
OUT	(block address, ITEM number)

**Operating conditions for the Step Ladder Program block**

The operating conditions for the Step Ladder Program block vary according to the startup mode of ITEM006. You can specify one of the following:

- Operation at all times
- When S1 turns ON

**Note** The Step Ladder Program can be started up from other Step Ladder Program blocks by BLOCK SET.

**When a single step is used as a logic sequence**

The default step is STEP000. STEP000 operates at all times when the operating conditions are satisfied. This step operates when run/stop command S1 (ITEM008) of the Step Ladder Program block turns ON.

## Single step (normal)

STEP00	ITEM	Command	Operand
	011	(LOAD)	
	012	(AND)	
	013	(OUT)	
	014	(LOAD NOT)	
	⋮		
	Max. 410		

## When multiple steps are used as a step sequence

Step Ladder Program blocks can be broken up into 99 steps STEP01 to 99. Whereas STEP00 operates at all times when the operating conditions are satisfied, one of steps STEP01 to STEP99 operates when the operating conditions are satisfied

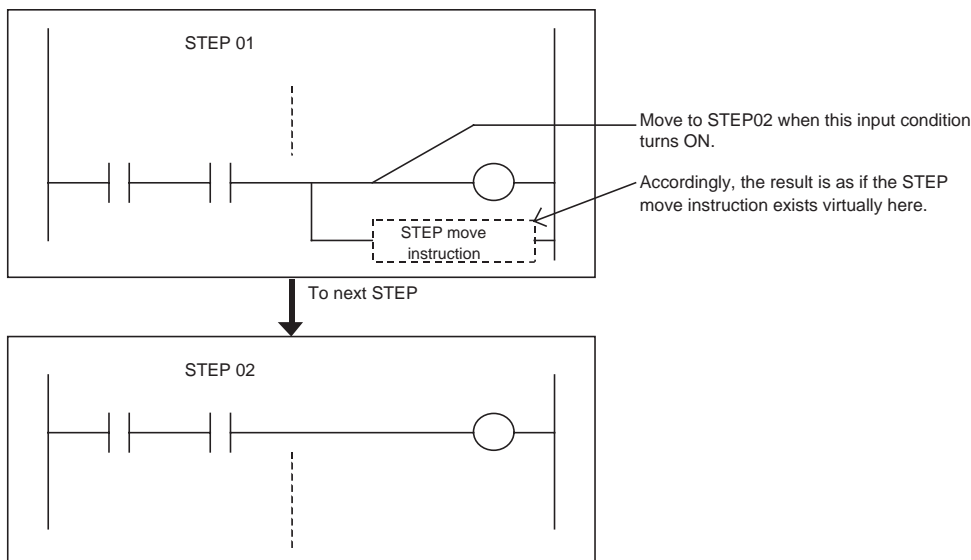
- A Step Ladder Program comprising STEP01 to STEP99 is called a “step sequence.” Sequence control instructions (refer to *List of Sequence Control Instructions* in this Appendix) such as JUMP (jump to a specified step) can be used in step sequences.
- Movement between steps STEP01 to STEP99 is performed according to the following conditions:

1. Move to next STEP when the input conditions of the final sequence command in the STEP are satisfied. \*1
2. Jump to a specified step according to the JUMP command.
3. Move to the next STEP (STEP+1) when the time set by the STEP TIMER command has elapsed.

Movement between steps when input conditions are satisfied in this way allows step progression control to be performed.

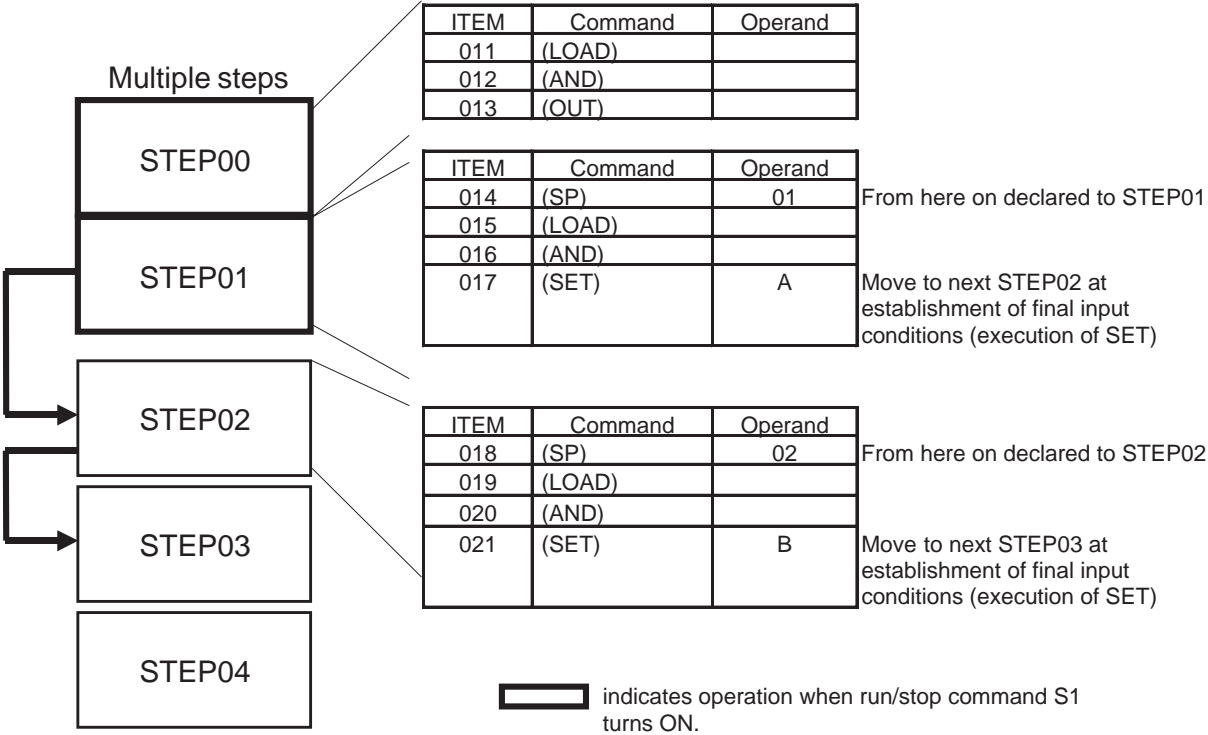
\*1: Basically, movement between STEPs is movement to the next STEP when the input conditions of the last sequence command are ON.

## Example



- To break up a Step Ladder Program, use the STEP command (21). (The default step for the Step Ladder Program block is the constant operation step STEP00.)
- When run/stop command S1 (ITEM008) of the Step Ladder Program block turns ON, STEP00 (constantly available step) and STEP01 (first step of step sequence) operate. Program execution is made to move to other steps (also to specified STEPs in other Step Ladder Program blocks) when the input conditions are satisfied during STEP01. STEP01 onwards only can also be described without describing STEP00 (constantly available step).

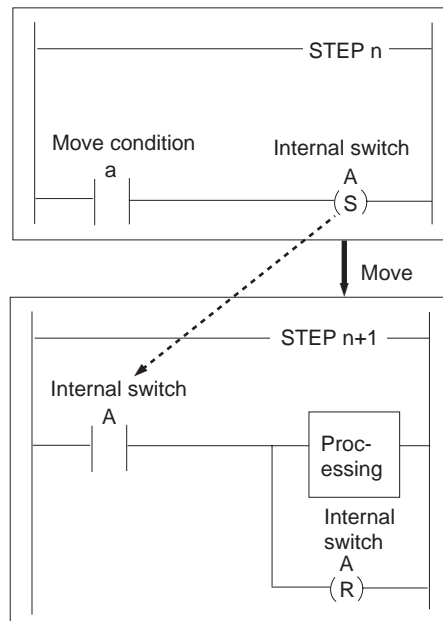
- When contact input to stop move to next step switch S2 (ITEM009) in the entire Step Ladder Program block turns ON, program execution pauses at the currently operating STEP. Output is also held at the current state at this time. When contact input to S2 (ITEM009) returns to OFF, program execution is resumed from the STEP that was paused.



**How to program for step progression control**

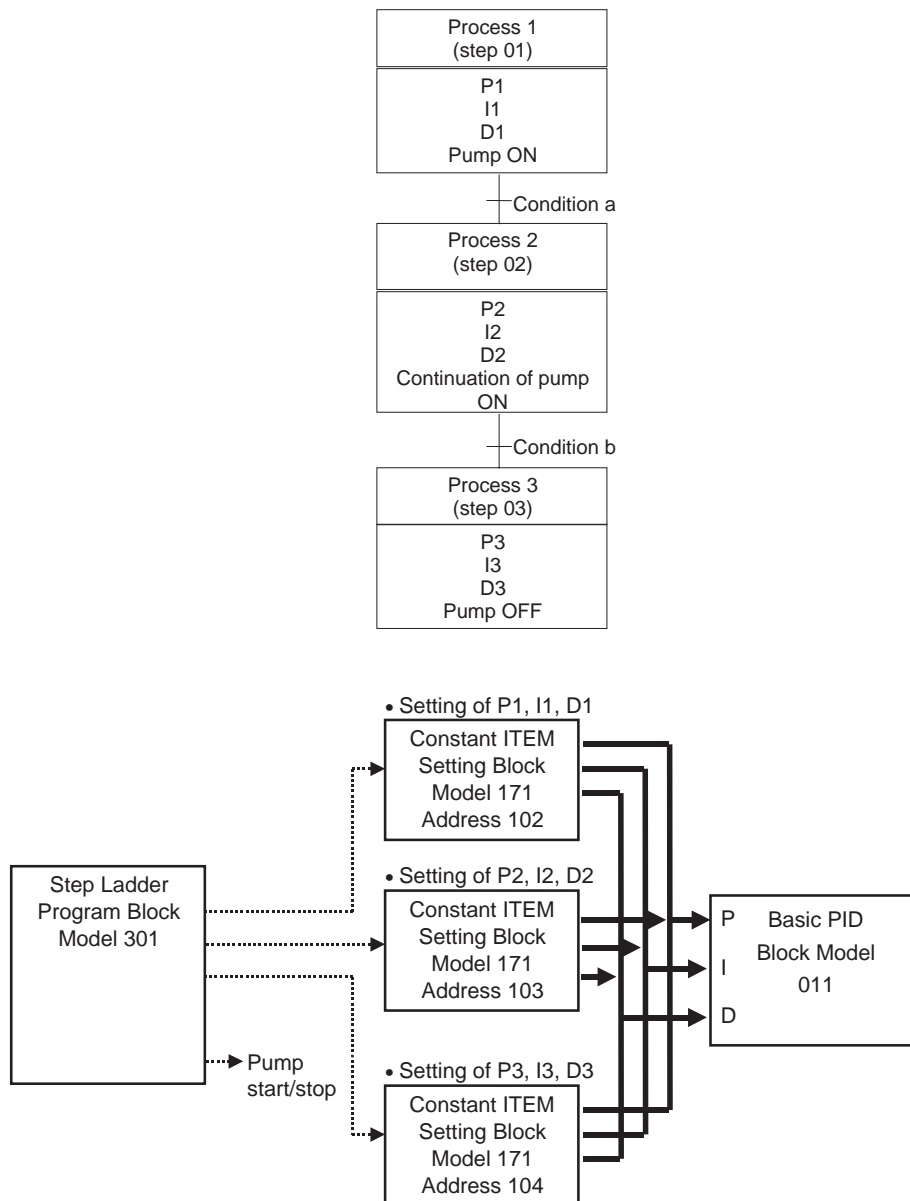
To execute specific processing in each process, program the step sequence as follows:

1. Execute the SET command at the end of STEP n as the input condition for moving to another step, and set the internal switch. Program execution moves to next STEP n+1.
2. Execute the specific process at the start of next STEP n+1 taking the internal switch as the input conditions. Reset the internal switch after completion of the specific process.

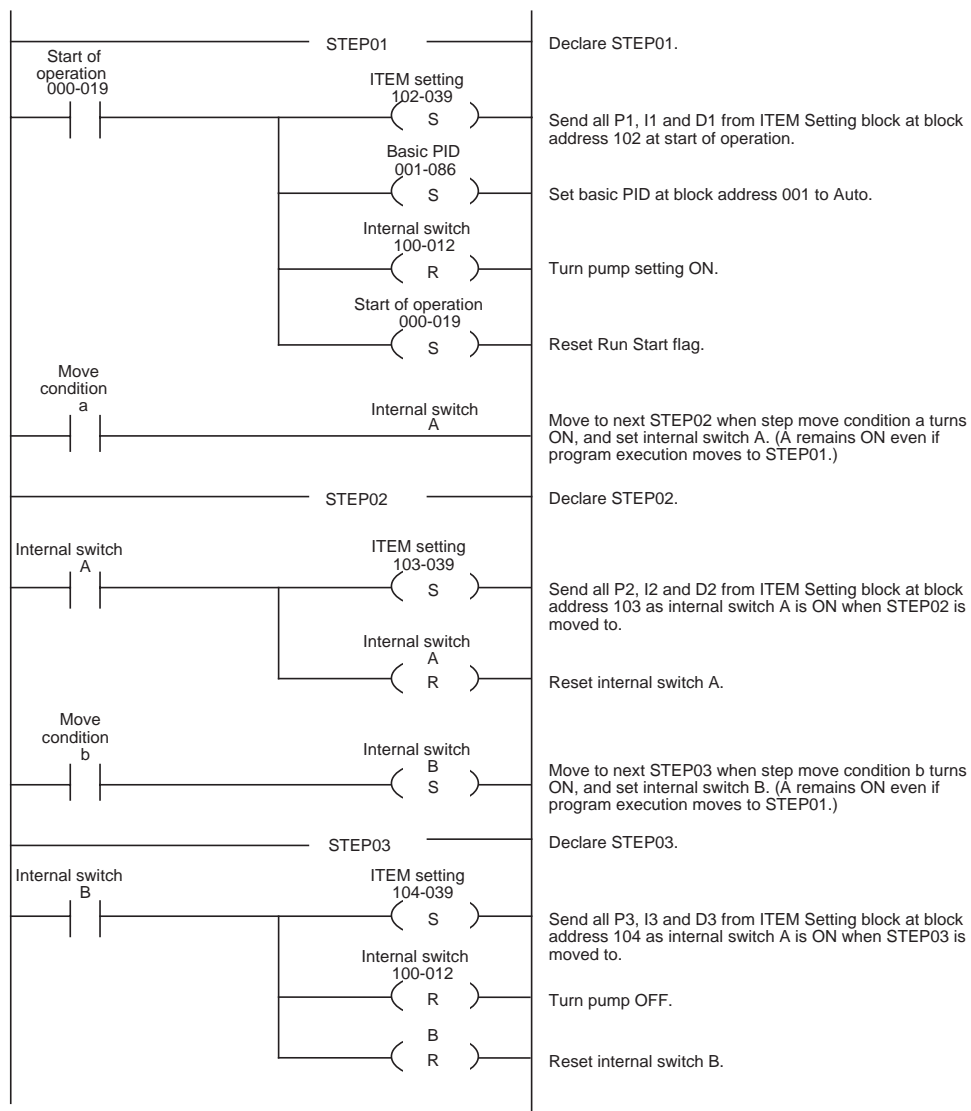


**Example**

The following shows an example where the PID value is switched at each process to simultaneously stop and start pump operation.



## Example of Step Ladder Program



**Note** A contact ITEM that has been turned ON by the OUT command stays ON even if program execution moves to the next STEP. For this reason, care must be taken when using the OUT command when performing step progression control. To turn OFF the contact ITEM, that has been turned ON by the OUT command, by movement between STEPs, use the RESET command to reset the contact ITEM.

# Appendix B

## How to Use the Sequence Table Block

### Introduction

A sequence table is a table containing multiple rules, each of which execute a specified action when the corresponding condition is established. A sequence table is implemented as a function block with block model 302. Up to 200 tables can be used. (Block addresses from 701 to 900 can be allocated.)

- Note**
1. Sequence tables can be used with the LCB05/05D only.
  2. The maximum number of tables that can be used is 100 tables if the number of conditions/actions is expanded from 32 to 64 in all sequence tables, because block addresses are allocated to the expanded portion of the tables in order from block address 701. The maximum number of rules in a table can also be expanded from 32 to 64. The maximum number of tables that can be used is 50 tables if both the number of conditions/actions and the number of rules are expanded from 32 to 64 in all sequence tables.
  3. Up to 200 tables can be registered including main tables and reference tables. (LCB01/03/05 Ver. 3.0 or later).

### Starting a Sequence Table

A sequence table can be executed with any of the following methods.

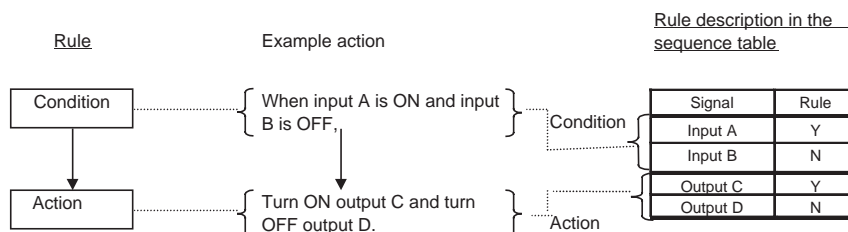
- Execute every cycle (always operating).
- Start with S1. (Starts when control switch S1 is ON and stops when S1 is OFF.)
- Start first cycle only. (Start just one time when the Loop Controller starts operation.)
- Do not start.

To specify one of the start conditions listed above, display the sequence table, select **Sequence Table Execute Form** from the Operation Menu, and specify the desired method.

Sequence table ITEM	Data	Settings
006	Sequence table execute form	0: Every Cycle 1: Start by S1 2: Start Only First Cycle 3: Not Execute

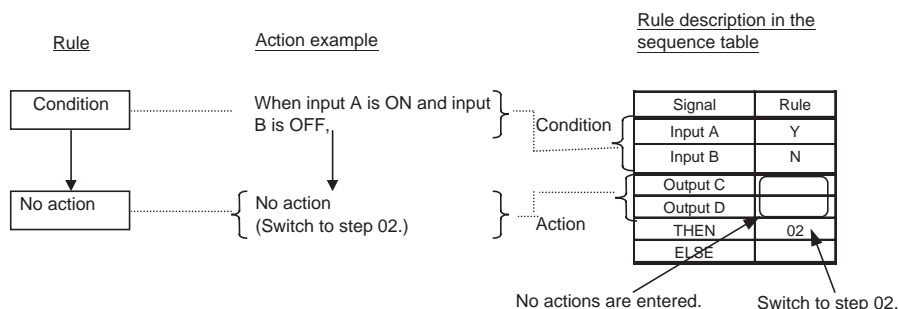
### Rules

- A single rule is composed of a condition generated by logically ANDing the ON/OFF status of two or more input signals and an action that turns output signals ON/OFF when that the condition is met (ON) or goes from not met to met (OFF → ON.)

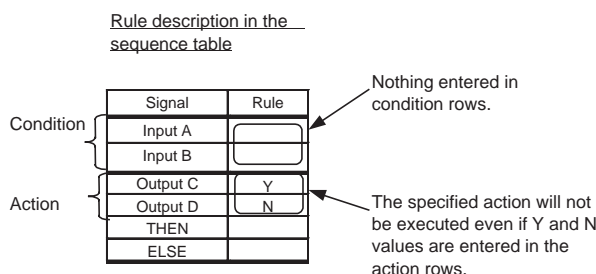


- Note** It is also possible to just switch to a specified step without executing an action when the condition is met or goes from not met to met. (See the following explanation.)

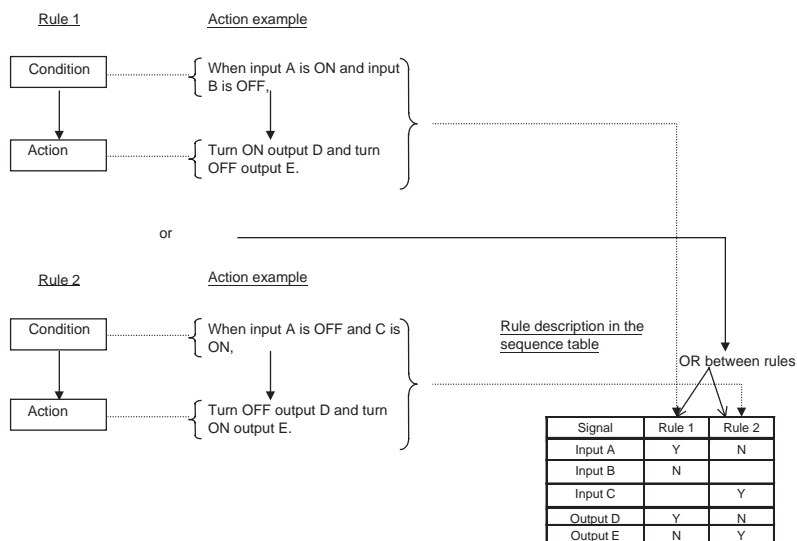
- It is also possible to just switch to another step without executing an action.



- An action cannot be executed without a condition.  
If no Y or N values have been entered in the condition rows, the specified action will not be executed even if Y and N values have been entered in the action rows.



- Execution Method for Each Rule (Same Setting for the Entire Sequence Table.)**  
A rule's action is executed just once when its condition goes from not met to met.
- Number of Rules**  
With the standard (not expanded) settings, up to 32 rules (01 to 32) can be used. With expansion, up to 64 rules (01 to 64) can be used.  
The limitations are the same for condition signals and action signals. Up to 32 condition/action signals (32 each) can be used with the standard settings and up to 64 condition/action signals (64 each) can be used with the expanded settings.  
Specify expanded rule settings and expanded condition/action setting in the Sequence Table Edit Window.
- Order of Rule Execution**  
When two or more rules (condition and action combinations) are described, they are executed simultaneously with OR logic.





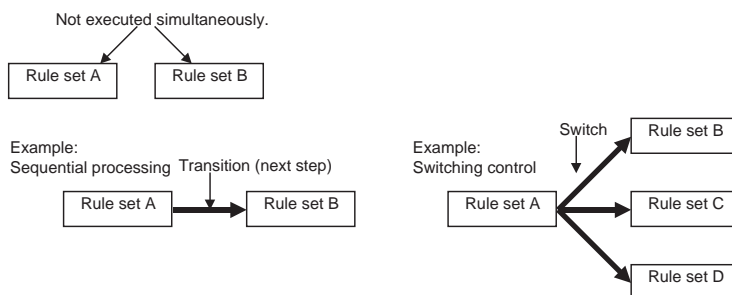
- Note** 1. If the conditions are met for two or more rules within a step, the rules control the same output, and the resulting actions on that output are different (ON and OFF), the result from the highest-numbered rule will have priority.
2. Action signals are processed in the order that they appear in the sequence table (top to bottom). For example, if an output value is to be set manually after switching to manual (M) mode with an A/M switch action, place the ITEM write signal (manual output setting) below the A/M switch action in the sequence table.

## Steps

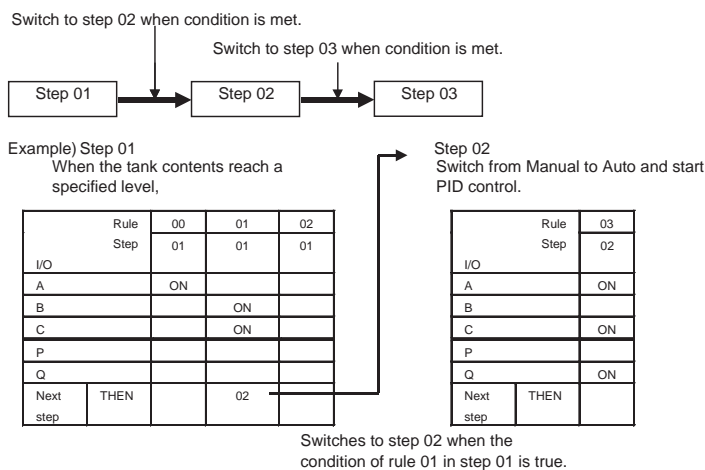
### Summary

The Loop Controller can perform sequential processing by executing a specified set of rules before executing another set of rules. This feature can be used to switch the set of rules being executed for different system conditions (such as different production models.)

A step is thus a group of one or more rules which is executed exclusively as one unit, i.e., two steps not executed simultaneously. Movement between two steps is called a transition.



The transition to the next step can be specified when a rule's condition is met (using THEN) or not met (using ELSE).

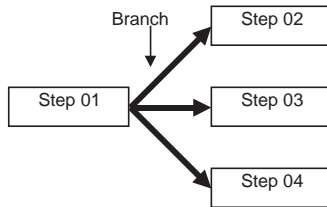


Processing will wait at a step until it is switched to the next step. While processing is waiting at a step, the actions (outputs) in the step will change if the corresponding conditions (inputs) change.

- Note** 1. A THEN step transition will be executed after all of the actions in that rule have been executed.
2. When processing moves to the next step, the conditions for each rule in the next step will be initialized to not met (OFF) status. Consequently, if a condition was already met before the step transition, it will still change from not met to met status when the step is processed.

### Specifying two or more Step Transitions (Branching)

A different destination step can be specified for each rule in a step, so more than one destination step can be specified in a step. This feature allows control parameters, such as SP and PID settings, to be changed for different production models.



Example) Step 01

Changing the destination step for different models

		Rule	
		Step	
I/O		01	02
		01	01
A		Y	
B			Y
C			Y
D			
E			
Next step	THEN	03	02

Model B

Step 02  
SP=50, P=10

		Rule	
		Step	
I/O		03	02
A		Y	
B			
C		Y	
D 10		Y	
E 30		Y	
Next step	THEN		

Model A

Step 03  
SP=100, P=30

		Rule	
		Step	
I/O		04	05
		03	
A		Y	Y
B			
C			N
D 10			Y
E 30			Y
Next step	THEN		

Processing moves to step 03 when the condition of step 01 rule 01 is true.  
Processing moves to step 02 when the condition of step 01 rule 02 is true.

When there are two or more valid step transitions in a single step (the conditions for two or more rules controlling step transitions are met), processing will move to the step indicated by the lowest-numbered rule. The step(s) indicated by higher-numbered rule(s) will not be executed after the step indicated by the lowest-numbered rule.

### Step Numbers

#### Always-executed Step (Step 00)

Step 00 is always executed. When making step settings in the CX-Process Tool, all rules are set to step 00 by default. Always set step 00.

Always executed

Step 00

Example) Step 00

I/O	Rule	01	02
	Step	00	
A		Y	
B			Y
C			Y
P			
Q			

One step executed

Steps 01 to 64

Step 01

I/O	Rule	04	05
	Step	01	
A		Y	Y
B			
C			N
P		N	
Q			Y
Next step	THEN		02

Step 02

I/O	Rule	03
	Step	02
A		Y
B		
C		Y
P		
Q		Y
Next step	THEN	

Up to 64 steps (step numbers 01 to 64) can be used, including step 00. The step numbers do not have to be consecutive (step numbers can be skipped), but they must be used in ascending order.

#### Steps Executed when Sequence Table Starts

At the start of sequential processing, step 00 and the lowest-numbered step (between 01 and 64) will be executed. Just one of the steps between 01 and 64 will be executed. Two of these steps (with step numbers 01 to 64) cannot be executed simultaneously.

#### Actual Timing of Step Execution

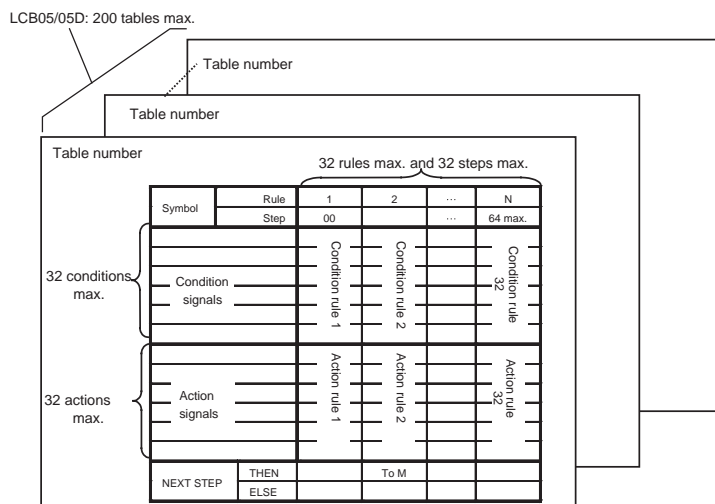
When processing moves to the next step, that step is actually executed in the next operation cycle.

## Basic Structure of the Sequence Tables

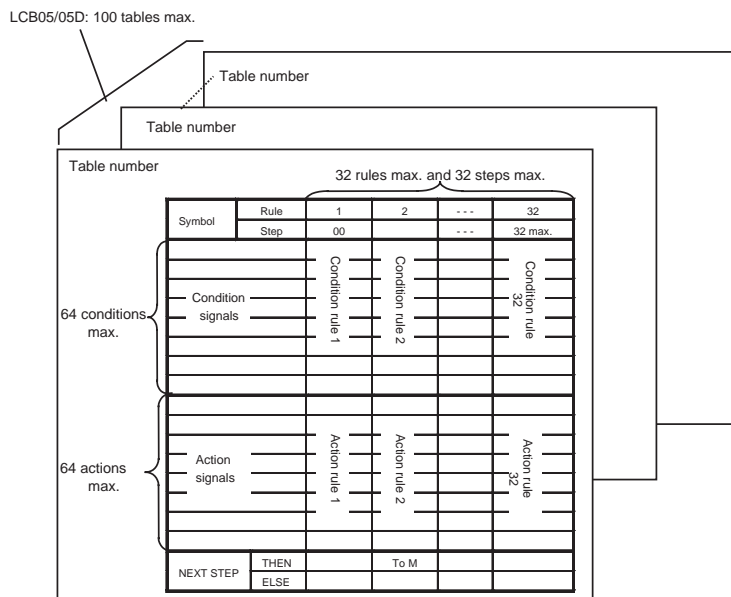
Only the LCB05/05D supports sequence tables. With the standard table settings, up to 200 tables combining main tables and reference tables can be used and each table can have up to 32 rules (with up to 32 conditions and 32 actions).

It is also possible to specify expanded settings for up to 64 rules (and up to 64 conditions/actions) in each table. If expanded settings are used, the maximum number of tables is reduced. If just the rules column or conditions/actions column is expanded, the expanded table occupies two standard tables. If both just the rules column and conditions/actions column are expanded, the expanded table occupies four standard tables.

### Standard



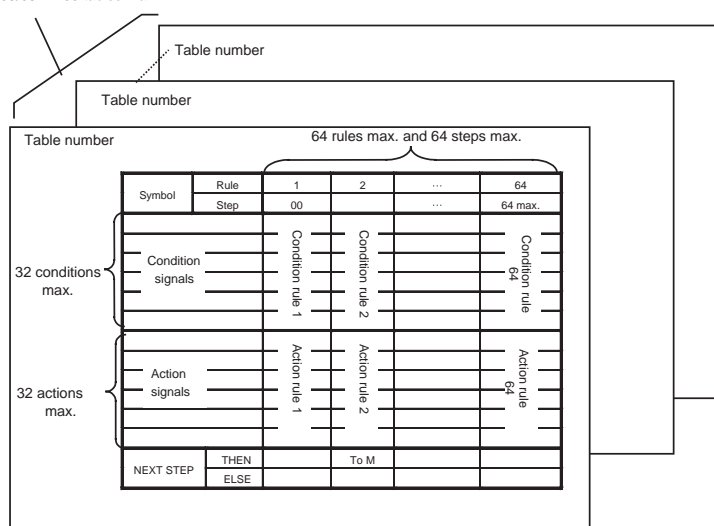
### Only Conditions/Actions Columns Expanded



**Note** To expand the number of conditions and actions in a table, use the CX-Process Tool and select **Expand - Vertical** from the Operation Menu.

### Only Rules Column Expanded

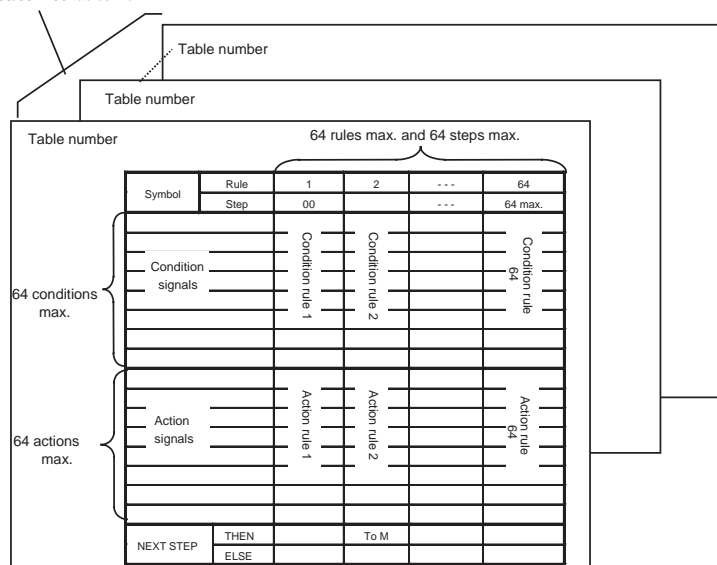
LCB05/05D: 100 tables max.



**Note** To expand the number of rules in a table, use the CX-Process Tool and select **Expand - Horizontal** from the Operation Menu.

### Both Conditions/Actions and Rules Columns Expanded

LCB05/05D: 50 tables max.



**Note** To expand both the number of conditions/actions and the number of rules in a table, use the CX-Process Tool and select **Expand - Vertical** as well as **Expand - Horizontal** from the Operation Menu.

### Table Referencing (LCB01/03/05 Ver. 3.0 or Later)

#### Overview

The table referencing function enables a main sequence table (called the main table) to reference the evaluation results of the condition rules for a reference destination sequence tables (called the reference table).

This function enables common processing to be placed in reference tables. The TBL command (specifies the block address of the reference table) is entered as the input signal condition, and Y (input as is) or N (reverse input) is entered as the rule.

Host Table

Table number		Rule		1	2
Symbol		Step		00	
Condition	TBL (n)			Y	Y
	Condition signals				
	Input as is				Input as is
Action	Action signals				

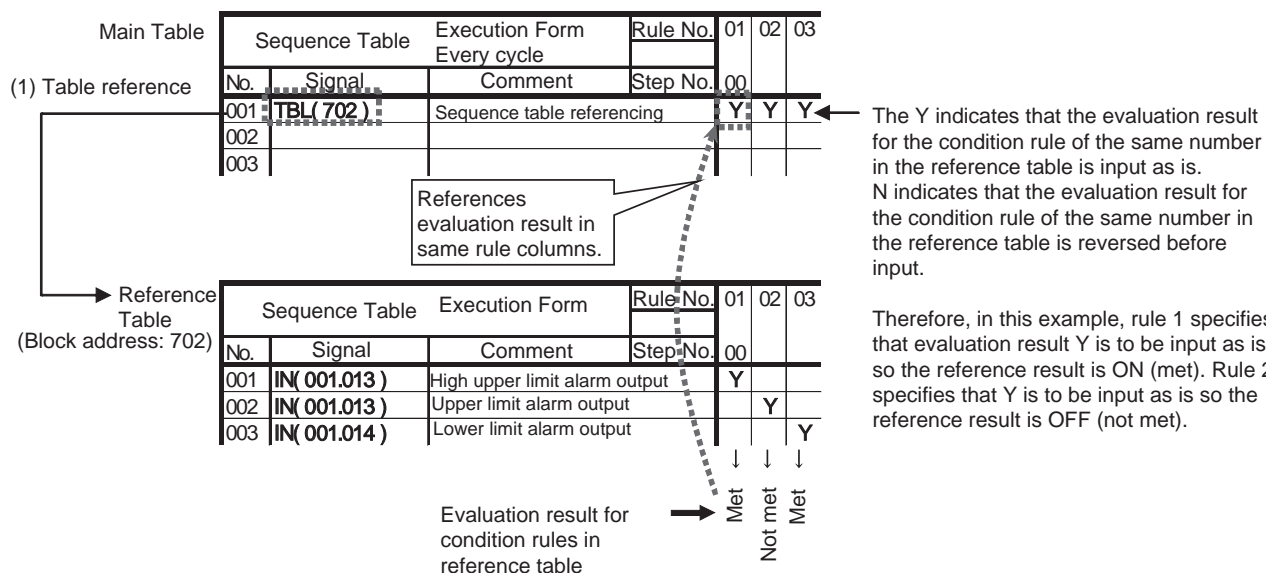
Reference Table

Table number n		Rule		1	2
Symbol		Step		00	
Condition	Condition signals			Evaluation results	Evaluation results
Action	Action signals				

### Explanation

The TBL command in the main table inputs the condition evaluation result for the same rule column in the specified reference table as the condition signal.

When Y is entered as the condition rule for the TBL command, the condition evaluation result is input in the reference destination as is. If N is entered, the input is inverted.



### TBL Command Details

- When the TBL command is used in the main table, the condition contacts (ITEM 025 to ITEM 028) for the TBL command are always 0.
- The reference table condition rules (ITEM 021 to ITEM 024) display the internally held evaluation results.

- The execution steps (ITEM101 to ITEM154) in the reference table are always 0.
- If the reference table condition rules are set to blank in the rule row, the reference table evaluation results will always be “not satisfied.” Therefore, the evaluation results for the TBL command will be as shown in the following table.

Condition rule for TBL command in main table (Y, N, or blank)	TBL command reference result
Y	OFF (not satisfied)
N	ON (satisfied)

- Note**
1. The main table and reference table each operate independently in the calculation cycle. The calculation order and calculation cycle are not checked.
  2. The values referenced by the main table are “not satisfied” from the time Loop Controller operation starts until the reference table is executed.
  3. Execution can be stopped for the reference table only (initial execution, S1 execution, constant execution, etc.). Reference tables retain the condition status when execution is stopped. Main tables operate by referring to that status.
  4. When expanding the number of rules for the main table, the expansion section of the condition rule setting for the TBL command will be treated as blank.
  5. Reference tables will not change steps even if step numbers are set.
  6. ITEM 101 to ITEM 164 in the reference table are always OFF during execution.
  7. The conditional information for reference tables is referenced from the main tables. Therefore, action signals, action rules Y/N, and destination steps (THEN, ELSE) will not be executed.
  8. If the calculation cycle for the main table and reference table is different, correct evaluation will not be possible until the reference table is executed. Therefore, all conditions will not be satisfied when operation is started.

### Limit on Numbers of Main Tables and Reference Tables

Up to 200 sequence tables including main tables and reference tables can be used. The sequence tables set as reference tables can be expanded with up to 64 conditions/actions, and 64 rules. The same applies to main tables. When expanding either the rule or condition/action column, two tables are used, and when expanding both columns, four tables are used.

### Execution Errors

- The TBL command cannot be used in reference tables. Downloading is possible, but an execution error (error code 81) will occur if operation is started.
- An execution error (error code 81) will occur in the main table if a reference table step is specified using the STEP command.
- An execution error (error code 81) will occur in the main table using the TBL command, if downloading is continued after a warning is displayed and operation is started.
- An execution error (error code 81) will occur if the block address in the TBL command is not a reference table or does not exist.
- An execution error (error code 81) will occur in the table used to execute the STEP command if a subtable is specified in the STEP command.

## Actual Sequence Tables

### Summary

- Register the sequence table in function block model 302 and set the desired values in the table.
- The input conditions are described in the upper half of the table and the actions are described in the bottom half of the table.

- Note** Enter “Y” when the output is a non-holding or pulse output. (“N” cannot be entered.)

- 
- The diagram illustrates the structure of a Rule-based Expert System (RBES) using a Sequence Table and a Rules table.
- Sequence Table:** This table lists the conditions and actions for each rule. The columns are labeled "Rule No.", "Signal", "Signal comment", "Execute form", and "Rules". The rows are numbered 0001 to 0020.
- Rules Table:** This table lists the rule numbers and their corresponding actions. The columns are labeled "Rule No." and "Rules". The rows are numbered 0001 to 0020.
- Annotations:**
- Signal:** Points to the "Signal" column in the Sequence Table.
  - Signal comment:** Points to the "Signal comment" column in the Sequence Table.
  - Execute form:** Points to the "Execute form" column in the Sequence Table.
  - Rules:** Points to the "Rules" column in the Sequence Table.
  - Rule numbers:** Points to the "Rule No." column in the Rules table.
  - Step numbers:** Points to the "Rules" column in the Rules table.
  - Conditions:** Points to the "Signal" column in the Sequence Table.
  - Actions:** Points to the "Execute form" column in the Sequence Table.
  - Next step:** Points to the "Rules" column in the Rules table.
- | Rule No. | Signal                | Signal comment             | Execute form | Rules |
|----------|-----------------------|----------------------------|--------------|-------|
| 0001     | IN 000 000 ?          | CPU load high error        |              | Y     |
| 0002     | IN 000 000 ?          | CPU load high error        |              | N     |
| 0003     | ( 000 000 - 000 000 ) | hour                       |              |       |
| 0004     | ing 000 000 ?         | All comments/RT Overriding |              | Y     |
| 0005     |                       |                            |              |       |
| 0006     |                       |                            |              |       |
| 0007     |                       |                            |              |       |
| 0008     |                       |                            |              |       |
| 0009     |                       |                            |              |       |
| 0010     |                       |                            |              |       |
| 0011     |                       |                            |              |       |
| 0012     |                       |                            |              |       |
| 0013     |                       |                            |              |       |
| 0014     |                       |                            |              |       |
| 0015     |                       |                            |              |       |
| 0016     |                       |                            |              |       |
| 0017     |                       |                            |              |       |
| 0018     |                       |                            |              |       |
| 0019     |                       |                            |              |       |
| 0020     |                       |                            |              |       |
| 0021     |                       |                            |              |       |
| 0022     |                       |                            |              |       |
| 0023     |                       |                            |              |       |
| 0024     |                       |                            |              |       |
| 0025     |                       |                            |              |       |
| 0026     |                       |                            |              |       |
| 0027     |                       |                            |              |       |
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| 0036     |                       |                            |              |       |
| 0037     |                       |                            |              |       |
| 0038     |                       |                            |              |       |
| 0039     |                       |                            |              |       |
| 0040     |                       |                            |              |       |
| 0041     |                       |                            |              |       |
| 0042     |                       |                            |              |       |
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| 0060     |                       |                            |              |       |
| 0061     |                       |                            |              |       |
| 0062     |                       |                            |              |       |
| 0063     |                       |                            |              |       |
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| 0068     |                       |                            |              |       |
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| 0080     |                       |                            |              |       |
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| 0082     |                       |                            |              |       |
| 0083     |                       |                            |              |       |
| 0084     |                       |                            |              |       |
| 0085     |                       |                            |              |       |
| 0086     |                       |                            |              |       |
| 0087     |                       |                            |              |       |
| 0088     |                       |                            |              |       |
| 0089     |                       |                            |              |       |
| 0090     |                       |                            |              |       |
| 0091     |                       |                            |              |       |
| 0092     |                       |                            |              |       |
| 0093     |                       |                            |              |       |
| 0094     |                       |                            |              |       |
| 0095     |                       |                            |              |       |



## Conditions

The following contact signals can be used for sequence table conditions.

Signal	Notation on CX-Process Tool screen	Types	Settings on CX-Process Tool screen	Setting method	Example
Input	IN (source specification)	Contact input or contact output ITEMS from function blocks	Input Tab Page source specification: Block and ITEM	Select the block and ITEM and select the ITEM number from the detailed information.	For block address 001 and ITEM 086: 001.086
		CSV tag and tag ITEM (contact input or contact output ITEM for control or operation block)	Input Tab Page source specification: Tag No.	Select the ITEM tag and select the ITEM from the detailed information.	For the A/M switch for the Master01 CSV tag: Master01.A_M
		User link table tag name (I/O memory in CPU Unit)	Input Tab Page source specification: User link table	Select the area type and select the user link table tag name from the detailed information.	For SW01 user link table tag: LNK007:SW01
		Timer/counter completion status or status contact, such as a pre-alarm status contact for a timer/counter	Input Tab Page source specification: Element	Specify the timer/counter number and select the status contact from the detailed information.	---
	TBL (block address)	Reference table	Input Tab Page source specification: Block and ITEM	Select the block address.	
Relational Expression	(parameter 1) < (parameter 2) (parameter) < #(value) “<” can be replaced with other comparison symbols	Result of comparison for relational expression	Relational expression types are set in the command classification on the Relational Expression Tab Page. The same settings are possible for parameters 1 and 2 as for the inputs listed above, i.e. Block and ITEM, Tag No., user link table, or element), or a value (constant) can be set.	Set the relational expression (<, #, #, =, >, or #) parameter 1, and parameter 2. For elements, specify the number and then select the present value of the PV, the remaining time, or the counter value.	For a user link table tag type value equals 200: (LNK005:type = #200)

## Actions

The following contact signals can be used for sequence table outputs.

Signal	Notation on CX-Process Tool screen	Types	Settings on CX-Process Tool screen	Setting method	Example
Output (See note.)	OUT_H (destination): Holding contact output operation	Function block contact output item	Output tab destination specification: Block ITEM	Select the block ITEM and select the ITEM number from the detailed information.	For block address 001 and ITEM 086: 001.086
	OUT_L (destination): Non-holding contact output operation	CSV tag and tag ITEM (Contact output ITEM for control and operation blocks)	Output tab destination specification: Tag No.	Select the ITEM tag and select the tag ITEM from the detailed information.	For the A/M switch for the Master01 CSV tag: Master01.A_M
	OUT_P (destination): Pulse contact output operation	User link table name (I/O memory in CPU Unit)	Output tab destination specification: User link table	Select the block ITEM and select the ITEM number from the detailed information.	For Value1 user link table tag: LNK007:Value01
	OUT_F (destination): Flashing contact output operation	Timer/counter reset start, operation start/stop, and pause commands	Output tab destination specification: Element action (destination)	Select the area type and select the link table tag name from the detailed information.	---
Table Command	STEP(sequence table block address, step number)	Setting of a specific step in another sequence table	Table Command Tab command classification: STEP(block address, step number)	Block address and step number	For block address 702, step 03: 70203
	RUN(sequence table block address)	Starting another sequence table	Table Command Tab command classification: RUN(block address)	Block address	For block address 702: 702
	STOP(sequence table block address)	Stopping another sequence table	Table Command Tab command classification: STOP(block address)	Block address	For block address 702: 702
Write to ITEM	SET(value, destination)	Writing a constant to a function block ITEM write parameter	Write to ITEM tab destination: Block ITEM	Select the block ITEM, select the ITEM number from the detailed information, and input the write data (-32,000 to 32,000).	---
		Writing a constant to a CSV tag and tag ITEM (Contact output ITEM for control and operation blocks)	Write to ITEM tab destination: Tag No.	Select the ITEM tag, select the tag ITEM from the detailed information, and input the write data (-32,000 to 32,000).	---
		User link table (writing a constant to I/O memory in the CPU Unit)	Write to ITEM tab destination: User link table	Select the area type, select the user link table tag from the detailed information, and input the write data (-32,000 to 32,000: Input the scaled value for the user link table).	---

**Note** The following output forms can be selected.

Signal	Output form	Setting screen on CX-Process Tool	Sequence table execute form (ITEM 006)		Y/N specification in rule	Execution condition
			For Every Cycle (0) and Start on S1 (1)	For Start Only First Cycle (2)		
Output	Holding	Output tab command classification: OUT_H ( <i>destination</i> )	Y: ON when the condition is met and remains ON even when the condition is no longer met. Must be turned OFF from another rule. N: OFF when the condition is met and remains OFF even when the condition is no longer met. Must be turned ON from another rule.		Y (ON) or N (OFF)	When condition changes from not met to met
	Non-holding	Output tab command classification: OUT_L ( <i>destination</i> )	Y: Remains ON while condition is met and remain OFF while condition is not met. N: Cannot be specified.	Cannot be used.	Only Y (always ON)	While condition is met
	Pulse	Output tab command classification: OUT_P ( <i>destination</i> )	Y: ON only once when condition is met and turns OFF the next operating cycle. The condition must be not met and then met again before the signal will turn ON again. N: Cannot be specified.	Cannot be used.	Only Y (pulse output)	When condition changes from not met to met
	Flashing	Output tab command classification: OUT_F ( <i>destination</i> )	Y: Changes between ON and OFF when the condition is met and continues flashing even when the condition is no longer met. N: The flashing output is turned ON while the condition is met and remains ON even when the condition is no longer met. <b>Note:</b> To turn OFF and output that is being held ON, Use OUT_H with an N specification. Even when this is done, however, the signal will not turn OFF until the condition for OUT_F is no longer met (for both a Y and N specification).	Cannot be used.	Y (flashing) or N (remains ON when flashing stops)	While condition is met

## Conditions Section

### Inputs

Enter input conditions with either of the following formats.

IN (*designation*)

TBL (*block address*)

**Note** Any of the following parameters can be specified as the designation.

- Function block address.ITEM number
- CSV tag name.Tag ITEM
- User Link Table tag name
- Element numbers that have been set in Element Mode and the following status bits

Timer	HI: Timer completion flag
	LO: Pre-alarm occurring
	NR: Timing
	IO: Stopped
	PS: Paused
Counter	HI: Counter completion flag
	LO: Pre-alarm occurring
	NR: Counting
	IO: Stopped

### The CX-Process Tool's Input Tab Settings

The screenshot shows the 'Signal' dialog box with the 'Input' tab selected. The 'Command type' section has a radio button for 'IN (Specify source)'. Below it is a text box with the instruction 'Read specified source value and execute checking'. The 'Specify source' section contains five radio buttons: 'Block, Item', 'ITEM tag', 'User Link Table', and 'Element'. The 'ITEM tag' option is selected. Below it are dropdown menus for 'Function Block group number' (set to '000: All') and 'Block number' (set to '000: Not set [ System Common ]'). The 'User Link Table' option has a 'Memory type' dropdown. The 'Element' option has a 'Number' dropdown. Below these is a 'Detail information' dropdown set to '007: FAIL [ CPU limit fatal error ]'. At the bottom left is a 'Value' input field set to '0'. The 'parameter2' section on the right has similar options but is currently empty. At the bottom right are 'OK' and 'Cancel' buttons.

## Relational Expressions

A relational expression compares two specified parameters or a parameter and constant.

Enter relational expressions with one of the following formats.

Parameter 1 comparison operator Parameter 2

Parameter 1 comparison operator Constant

Constant comparison operator Parameter 2

The following six comparison operators can be used.

Parameter 1 < Parameter 2

Parameter 1  $\leq$  Parameter 2

Parameter 1 = Parameter 2

Parameter 1  $\neq$  Parameter 2

Parameter 1 > Parameter 2

Parameter 1  $\geq$  Parameter 2

Constants: -32,000 to 32,000

**Note** The following terms can be specified as parameters.

- Function block address.ITEM number
- CSV tag name.Tag ITEM
- User Link Table tag name
- Element numbers that have been set in Element Mode and the following timer/counter PVs (PV range 0 to 32,000)  
 DV for timer: Time remaining (0 to 32,000)  
 DV for counter: Count value remaining (0 to 32,000)

## The CX-Process Tool's Relational Expression Tab Settings

The screenshot shows the 'Signal' dialog box with the 'Relation' tab selected. The 'Command type' section has radio buttons for various comparison operators, with 'parameter1 < parameter2' selected. Below this, a text box says 'Compare the parameter1 and 2 order'. The 'parameter1' and 'parameter2' sections each have radio buttons for 'Block, Item', 'ITEM tag', 'User Link Table', and 'Element'. For 'parameter1', 'Block, Item' is selected, with 'Function Block group number' set to '004: Block Diagram 1' and 'Block number' set to '001: Basic PID'. For 'parameter2', 'Block, Item' is selected, with 'Function Block group number' set to '0005: type:'. Both parameters have 'User Link Table' selected for 'Memory type' and 'ALL' for 'Memory type'. The 'Value' field is set to 0. The 'Detail information' section has a dropdown menu set to '007: PV input' for parameter1 and '0005: type:' for parameter2. The 'OK' and 'Cancel' buttons are at the bottom.

## Actions Section

### Outputs

Contact outputs are set using one of the following notations.

Notation	Output form	Operation	Y/N in rule	Execution condition
OUT_H (destination)	Holding	Y: ON when the condition is met and remains ON even when the condition is no longer met. Must be turned OFF from another rule. N: OFF when the condition is met and remains OFF even when the condition is no longer met. Must be turned ON from another rule.	Y (ON) or N (OFF)	When condition changes from not met to met
OUT_L (destination)	Non-holding	Y: Remains ON while condition is met and remain OFF while condition is not met. N: Cannot be specified.	Only Y (always ON)	While condition is met
OUT_P (destination)	Pulse	Y: ON only once when condition is met and turns OFF the next operating cycle. The condition must be not met and then met again before the signal will turn ON again. N: Cannot be specified.	Only Y (pulse output)	When condition changes from not met to met
OUT_F (destination)	Flashing	Y: Changes between ON and OFF when the condition is met and continues flashing even when the condition is no longer met. N: The flashing output is turned ON while the condition is met and remains ON even when the condition is no longer met. <b>Note:</b> To turn OFF and output that is being held ON, Use OUT_H with an N specification. Even when this is done, however, the signal will not turn OFF until the condition for OUT_F is no longer met (for both a Y and N specification).	Y (flashing) or N (remains ON when flashing stops)	While condition is met

**Note** Any of the following parameters can be set as the destination.

- Function block address.ITEM number
- CSV tag name.tag ITEM
- User link table tag name
- The following can also be specified in Element Display Mode  
Element numbers previous specified in Element Display Mode plus the following:  
In YN column for TIM or CNT: Y = Reset start, N = Timer start  
In YN column for TIM\_PS: Y = Pause timing, N = Resume timing

### The CX-Process Tool's Output Tab Settings

The screenshot shows the 'Signal' dialog box with the 'Output' tab selected. The 'Command type' section has four radio buttons: 'OUT\_H (Specify destination)' (selected), 'OUT\_L (Specify destination)', 'OUT\_P (Specify destination)', and 'OUT\_F (Specify destination)'. Below this is a text field 'Write the value(H,L) to the specified destination by specified method ( Hold type )'. The 'Specify destination' section has two columns of settings. The left column has radio buttons for 'Block, Item' (selected), 'ITEM tag', 'User Link Table', and 'Element'. The right column has radio buttons for 'Block, Item', 'ITEM tag', 'User Link Table', and 'Element'. Both columns have dropdown menus for 'Function Block group number', 'Block number', 'Memory type', and 'Number'. At the bottom, there is a 'Detail information' dropdown menu and a 'Value' input field.

## Table Commands

### Setting the Step of another Sequence Table

Sets the step number of the step to start executing in the specified sequence table (not the local sequence table.)

STEP(*sequence table's  
block address step number*)

Sets the specified step number in the specified block address's sequence table.

**Note:** An execution error (code 81) will occur if the STEP command is executed with the local block address's step address specified.

**Note:** An execution error (code 81) will occur in any block that executes the STEP command for a reference table.

### Stopping and Starting another Sequence Table

Stops or starts operation of the specified sequence table (not the local sequence table.)

**Note** Executing this command is equivalent to writing 0 or 1 to ITEM008 (Switch S1.)

RUN(*sequence table's  
block address*)

Starts operation of the specified block address's sequence table. Unlike the Sequence Table Branch/Execute commands, execution of the local table will continue.

STOP(*sequence table's  
block address*)

Stops operation of the specified block address's sequence table.

**Note:** An execution error (code 81) will occur if the STOP command is executed with the local block address specified.

### The CX-Process Tool's Table Commands Tab Settings

## Write to ITEM

Writes the specified value (with decimal point omitted) to the specified destination.

Use the following notation.

SET(*value*, *destination*)

**Note** 1. Any one of the following parameters can be specified as a destination.

- Function block address.ITEM number
- CSV tag name.Tag ITEM
- User Link Table tag name

2. The constant value can be between -32,000 and 32,000.

Omit the decimal point when inputting the value.

Example) When writing 30.00 to an ITEM with 2 digits after the decimal point, input 3000 and leave out the decimal point.

## The CX-Process Tool's Write to ITEM Tab Settings

Signal

Input Relation Output Table command ITEM Write

Command type

☒ SET(Value, Specify destination)

Write specified value for the destination.

Value

☒ Block, Item

☐ ITEM tag

Function Block group number

Block number

☐ User Link Table

Memory type

☐ Element

Number

Detail information

☒ Value 500

Specify destination

☒ Block, Item

☐ ITEM tag

Function Block group number

Block number

☐ User Link Table

Memory type

☐ Element

Number

Detail information

☒ Value 0

OK Cancel



## Elements

The following operations can be performed after the element (timer/counter) is registered in Element Display Mode.

- Enter as an operation in the actions section (as an output) of the table.
- Read the completion flag in the conditions section (as an input) of the table.
- Read the data such as the PV in the conditions section (in a relational expression) of the table.

## Timers

The timer starts operating when the reset start signal goes ON.

The LO (pre-alarm occurring) signal will be turned ON when the elapsed time reaches the preset alarm value.

The HI (timer completion) signal will be turned ON when the elapsed time reaches the set value.

- Register the timer as an element. (Can be registered in Element Display Mode.)  
Element number: 0 to 999 (Element numbers are shared with counters.)  
Set value: 0 to 32,000  
Pre-alarm value: 0 to 32,000  
Timing unit: 1 to 4 (1: 0.01 s; 2: 0.1 s; 3: 1 s; 4: 1 min)
- Control bits (Can be specified as outputs in the actions section.)  
RS: Reset start (Enter “Y” for timer start or “N” for timer stop.)  
PS: Pause (Enter “Y” to pause timing or “N” to resume timing.)
- Status flags (Can be specified as inputs in the conditions section.)  
HI: Timer completion  
LO: Pre-alarm occurring  
NR: Timing  
IO: Stopped  
PS: Paused
- Status data (Can be specified in relational expressions.)  
PV: Present value (0 to 32,000)  
DV: Remaining time (0 to 32,000)

## Counters

The counter starts operating when the ST (Count start/stop) signal goes ON.

The LO (pre-alarm occurring) signal will be turned ON when the count reaches the preset alarm value. The HI (counter completion) signal will be turned ON when the count reaches the set value.

- Register the counter as an element. (Can be registered in Element Display Mode.)  
Element number: 0 to 999 (Element numbers are shared with timers.)  
Set value: 0 to 32,000  
Pre-alarm value: 0 to 32,000
- Control bits (Can be specified as outputs in the actions section.)  
ST: Counter start/stop (Enter “Y” to start counter or “N” to reset counter.)
- Status flags (Can be specified as inputs in the conditions section.)  
HI: Counter completion flag  
LO: Pre-alarm occurring  
NR: Counting  
IO: Stopped
- Status data (Can be specified in relational expressions.)  
PV: Present value (0 to 32,000)  
DV: Count remaining (0 to 32,000)

**Note** Unlike timers, counters will continue counting even after the set value has been reached and the HI signal is turned ON.

## Element Registration Example (Element Display Mode)

Node01 : LCB05: 03.701 [ Sequence Table ]					
Element( Block )					
No.	Element	Comment	Set Value	Pre-Alarm value	Unit
001	TIM 001		150	100	0.1sec
002	TIM 002		550	500	0.1sec
003	CNT 000		500	400	-
004	CNT 003		300	250	-
005					
006					
007					
008					
009					
010					
011					
012					

Register timers and counters in the following dialog box.

**Element Initial Data Setup**

Element type

☒ Timer

☐ Counter

Set Value:

Pre-Alarm value:

Unit ( 1: 0.01sec., 2: 0.1sec., 3: sec., 4: min.):

Comment:

System element No.:

Registered Block address:

OK Cancel

Sequence Table Design Sheet	Date		Diagram No.	
	Programmer		Project	
	System		Block address	
	Comments			

Sequence Table			Execute method	Rule No.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
No.	Signal	Comment			Step No.																															
Conditions	001																																			
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Sequence Table			Execute method	Rule No.	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Actions	001																																			
	002																																			
	003																																			
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## Revision History

A manual revision code appears as a suffix to the catalog number on the front cover of the manual.

Cat. No. W406-E1-09



Revision code

The following table outlines the changes made to the manual during each revision. Page numbers refer to the previous version.

Revision code	Date	Revised content
1	October 2002	Original production
02	April 2003	Overall additions and revisions to add the CS1D-LCB05D Duplex Loop Control Board.
03	July 2003	Overall additions and revisions to change information on the CS1D-LCB05D Duplex Loop Control Boards that are now mounted as Inner Boards in a CS1D CPU Unit as a set called a CS1D Process-control CPU Unit.
04	December 2003	Overall additions and revisions for the upgrade of the Loop Control Boards to unit Ver. 1.5 as summarized in section <i>1-1-3 Loop Control Board Ver. 1.5 Upgrade Information</i> .
05	August 2004	Overall additions and revisions to add the Loop-control CPU Units (CJ1G-CPU□□P).
06	September 2005	Overall additions and revisions for the upgrade of Loop Control Boards LCB01/03/05 to Ver. 2.0 as summarized in <i>1-1-5 LCB01/03/05 Version 3.0 Upgrade Information</i> .
07	November 2007	Add and modified information for upgrade to LCB01/03/05 version 3.5.
08	February 2009	Add and modified information for upgrade to LCB01/03/05 version 3.6.
09	January 2013	Corrected mistakes. Added descriptions.

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## *Revision History*

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