Cat. No. W406-E1-01

SYSMAC CS Series
CS1W-LCB01 and CS1W-LCB05
Loop Control Boards

OPERATION MANUAL

OMRON

CS1W-LCB01 and CS1W-LCB05 Loop Control Boards

Operation Manual

Produced October 2002

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.

⚠WARNING Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠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.

TABLE OF CONTENTS

TABLE OF CONTENTS

About this Manual:

This manual describes the installation and operation of the CS1W-LCB01 and CS1W-LCB05 Loop Control Boards, and includes the sections described below.

The CS1W-LCB01 and CS1W-LCB05 Loop Control Boards help you build an instrumentation system comprising multiple loops and is installed as an Inner Board in the CPU Unit of a CS-series PLC (Programmable Controller). The 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 carefully and be sure you understand the information provided before attempting to install and operate the Loop Control Boards. There are three manuals used with the CS1W-LCB01 and CS1W-LCB05. These manuals 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 CS1 Series CS1W-LCB01 and CS1W-LCB05 Loop Control Boards Operation Manual	Describes the basic running of the Loop Control Boards (excluding detailed descriptions of the function blocks).	W406
SYSMAC CS1 Series CS1W-LCB01 and CS1W-LCB05 Loop Control Boards Function Block Reference Manual	Provides detailed information on the function blocks.	W407
SYSMAC CS1 Series CX-Process Tool Operation Manual	Describes operation of the CX-Process Tool.	W372

Section 1 describes the features and system configuration of CS1W-LCB01 and CS1W-LCB05 Loop Control Boards.

Section 2 describes the names and functions of parts, and provides other information required to install and operate CS1W-LCB01 and CS1W-LCB05 Loop Control Boards.

Section 3 provides information on the control mechanism, basic operation, exchanging data with other Units and software, and fail-safe countermeasures for CS1W-LCB01 and CS1W-LCB05 Loop Control Boards.

Section 4 describes a simple example of how to use CS1W-LCB01 and CS1W-LCB05 Loop Control Boards.

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 during running of CS1W-LCB01 and CS1W-LCB05 Loop Control Boards and guidelines for troubleshooting these errors.

Appendix 1 describes how to use the Step Ladder Program block on CS1W-LCB01 and CS1W-LCB05 Loop Control Boards and ***Appendix 2*** describes how to use the Sequence Table block on CS1W-LCB01 and CS1W-LCB05 Loop Control Boards

⚠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.

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.

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 system.

- 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 tot he 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 OMRON Loop Control Boards. Be sure to read this manual before attempting to use the Loop Control Boards 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.
- The PLC will turn OFF all outputs when its self-diagnosis function detects any error or when a severe failure alarm (FALS) instruction is 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 Control Board:

- 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.
- 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).
- The defaults of the System Common block on the Loop Control Board must be set correctly.
- Always stop the operation of the Loop Control Board before converting any of the EM Area to file memory. If any part of the EM Area that is being used by the Loop Control Board for the HMI is converted to file memory during Board operation, the system may operate in an unexpected manner, which may result in injury.

⚠WARNING Do not perform processing in such a way that the Loop Control Board 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.

4 Operating Environment Precautions

⚠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 Control Board 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 Control Board Running flag (A35801) as the input condition.
- When a fatal error occurs on the CPU Unit (including execution of the FALS instruction), the Loop Control Board 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 Control Board 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 Control Board 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.
- Turn OFF the power to the PLC before performing the following operations:
  - Mounting or removing the Loop Control Board, CPU Unit, or the Memory Pack
  - Assembling Racks
  - Setting the DIP switch or unit number setting switch
  - Performing wiring or connecting cables
  - When connecting or disconnecting cables
- 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
- 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.

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 (EN50081-2). 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 EN50081-2

Common Emission Standard EN50081-2, 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.

SECTION 1
Introduction

This section outlines the features and application of the Loop Control Board and provides Board specifications.

1-1 Outline

1-1-1 Outline

The Loop Control Board are capable of performing up to 500 blocks for the CS1W-LCB05 or up to 50 blocks for the CS1W-LCB01 of various process operations, including PID control. (See note.) Process operations include basic logic sequence control and step-progression control. The Loop Control Board 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 table.

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

The Loop Control Board is classified as a CS-series Inner Board. It must be mounted in a CS1-H CPU Unit. (It cannot be used in a CS1 CPU Unit.) There are two models of Loop Control Board.

Model	Number of control and operation blocks	Sequence tables (See note.)	Step ladder programs
CS1W-LCB01	50 blocks max.	Not supported	20 blocks max.
CS1W-LCB05	500 blocks max.	200 blocks max.	200 blocks max.

The Loop Control Board itself has no external I/O functions. So, it 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 Control Board 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 CS1W-LCB05 (See note.), 50 function blocks max. for CS1W-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 CS1W-LCB05 if Fuzzy Logic, Arithmetic Operation, or Time Sequence Data Statistics blocks are used.

- External controllers (32 function blocks max.): ES100X Controller Terminal
- Logic sequence/step progression control (200 function blocks max. for CS1W-LCB05, 20 blocks max. for CS1W-LCB01): Step Ladder Program and Sequence Table (CS1W-LCB05 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 on the CPU Unit 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 Control Board to read and write function block data.

1-1-2 Features

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.

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 100 loops for the CS1W-LCB05 or 50 loops for the CS1W-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

The Loop Control Board can be set to operation cycles for control, operation, and other function blocks 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.

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 Control Board with refresh data with the CPU Unit at the specified

cycle. With this speed, the Loop Control Board 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

In process control, the commonly used sequence control operations are often written in sequence tables. With the Loop Control Board, 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

ES100X Controllers can be connected to the RS-232C port on the Loop Control Board 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.

1-1-3 Basic System Configuration

1,2,3...

1. Unit Having External Interface Functions

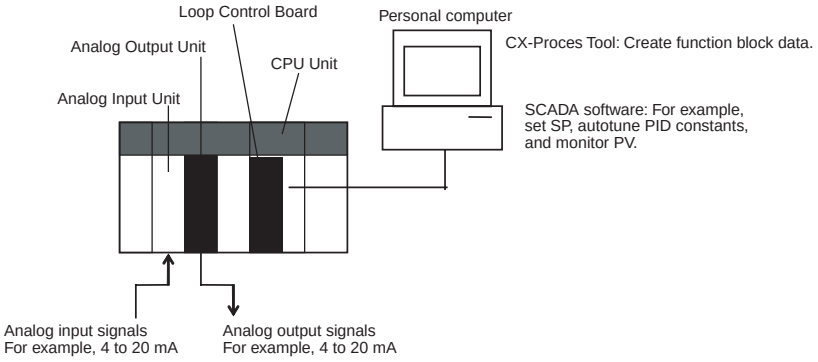
   The Loop Control Board itself does not have external analog I/O and external contact I/O functions. So, it must be used in combination with a Unit having external interface functions such as an Analog I/O Unit as shown in the example figures in the following pages.

2. CX-Process Tool

   The Loop Control Board 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 Control Board for use as shown in the example figures in the following pages.

3. SCADA Software

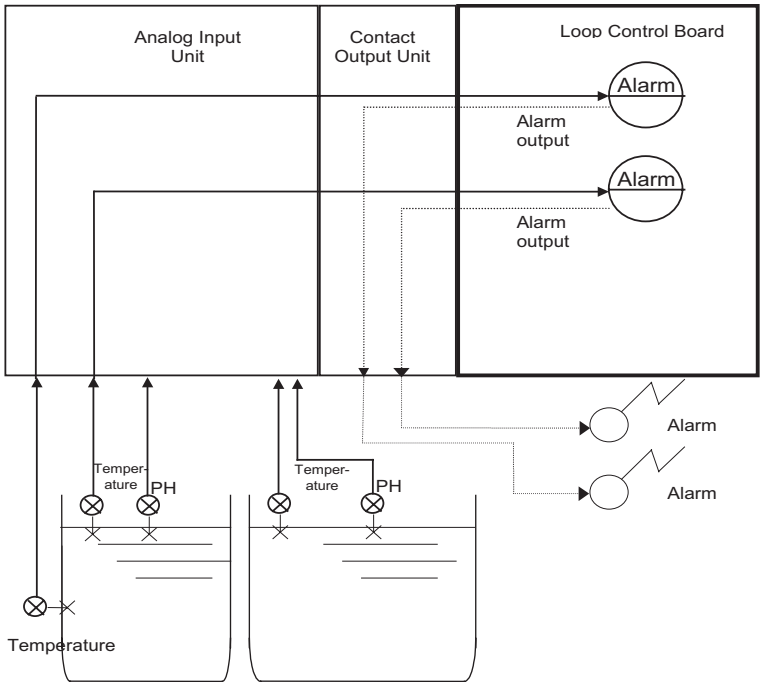
   The Loop Control Board itself does not have a HMI for setting the Set Point and PID constant values, and displaying the PV. So, the Set Point and PID constant values must be set, and PV monitored using SCADA software or a PT (Programmable Terminal).



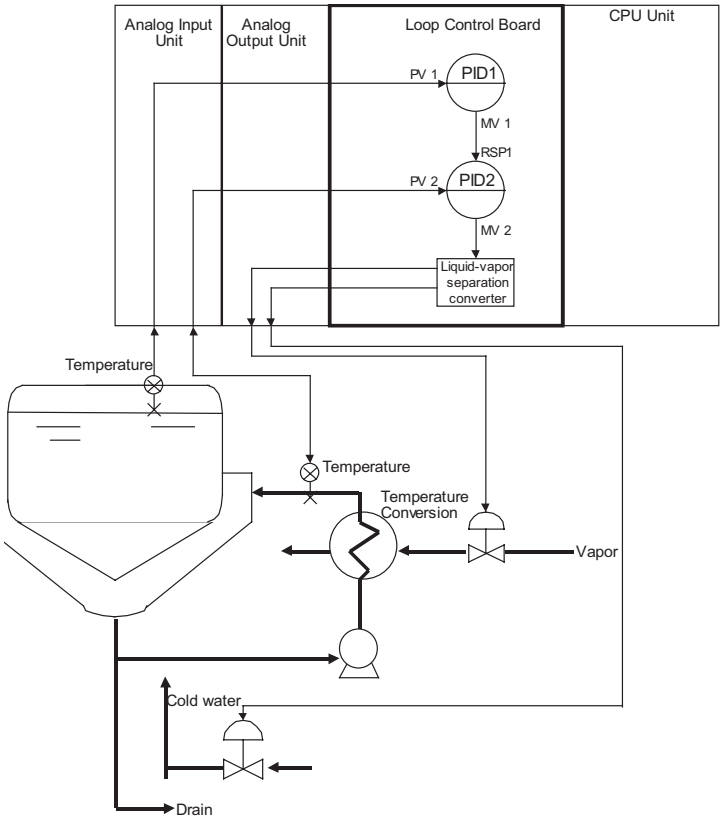
1-1-4 Application Examples

The Loop Control Board 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.

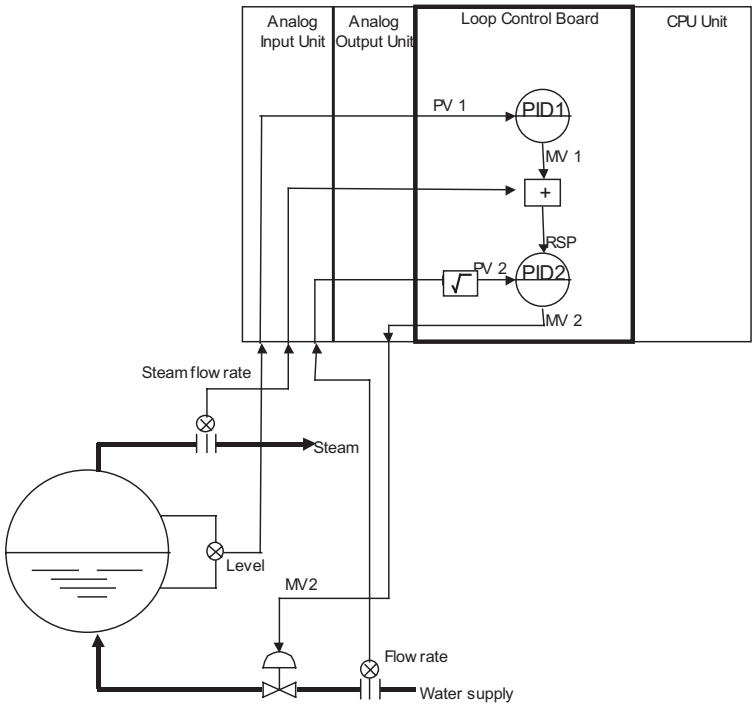
High-density Monitoring of Waterworks and Sewage Systems



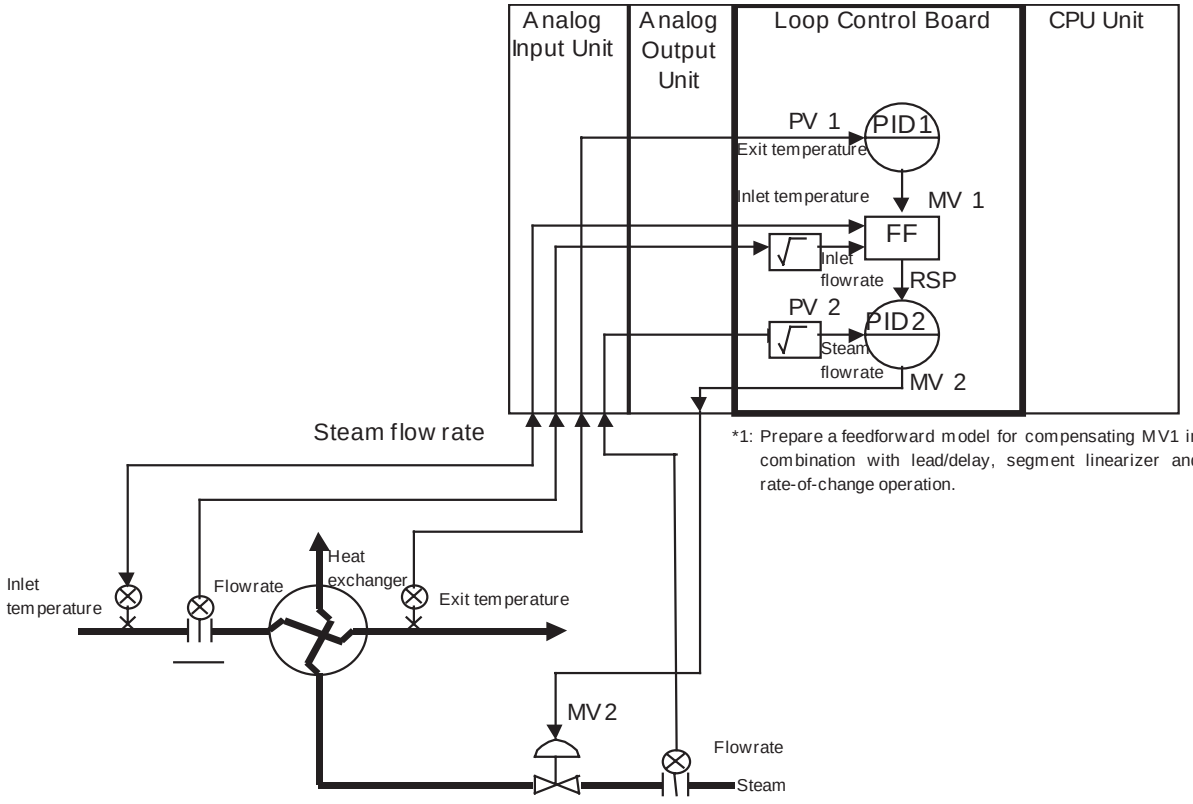
Temperature Control of Kettle Reboiler (Cascade Control)



Boiler Drum Level Control (with Cascade Feedforward Control Function)

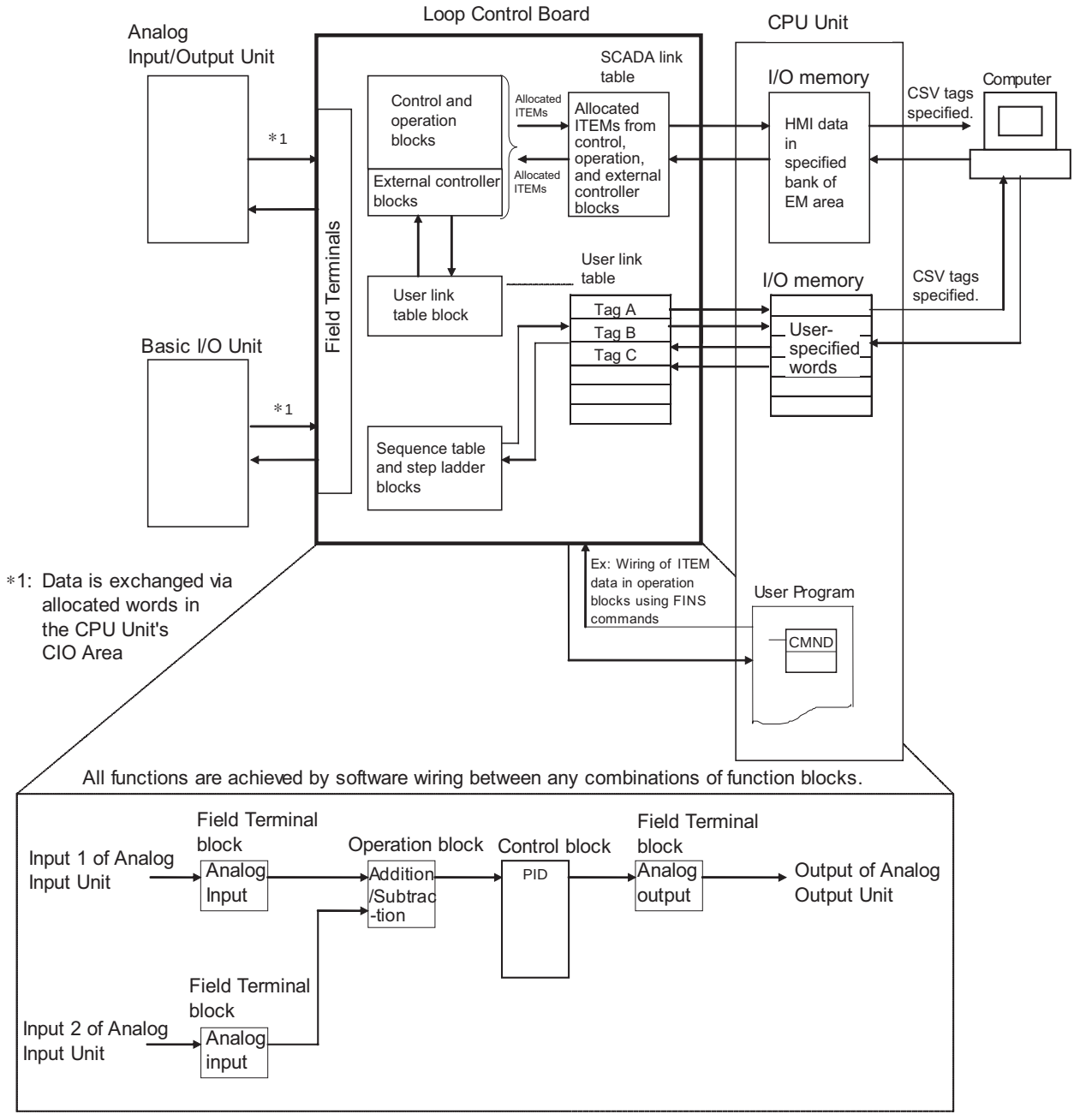


Heat Exchanger Exit Temperature Control (with Cascade Feedforward Control)



1-1-5 Loop Control Board Mechanism

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



The following describes each of the functions of the Loop Control Board.

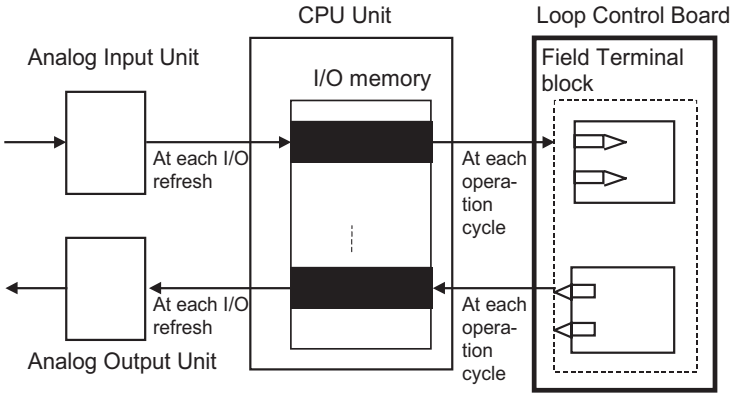
1) External I/O

⚠WARNING Do not perform writing operations on the same I/O memory address allocated to contact outputs or analog outputs between the Loop Control Board 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 Control Board 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 Control Board and the CPU Unit.

Data Exchange with Specified CPU Unit I/O Memory

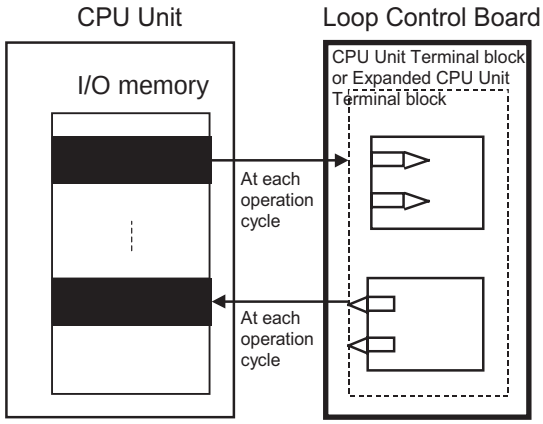
I/O operations can be performed internally on the Loop Control Board constantly (at each operation cycle) with any specified CPU Unit I/O memory. In this case, the CPU Unit Terminal block or the Expanded CPU Unit Terminal block is used, and the I/O memory address must be specified.

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

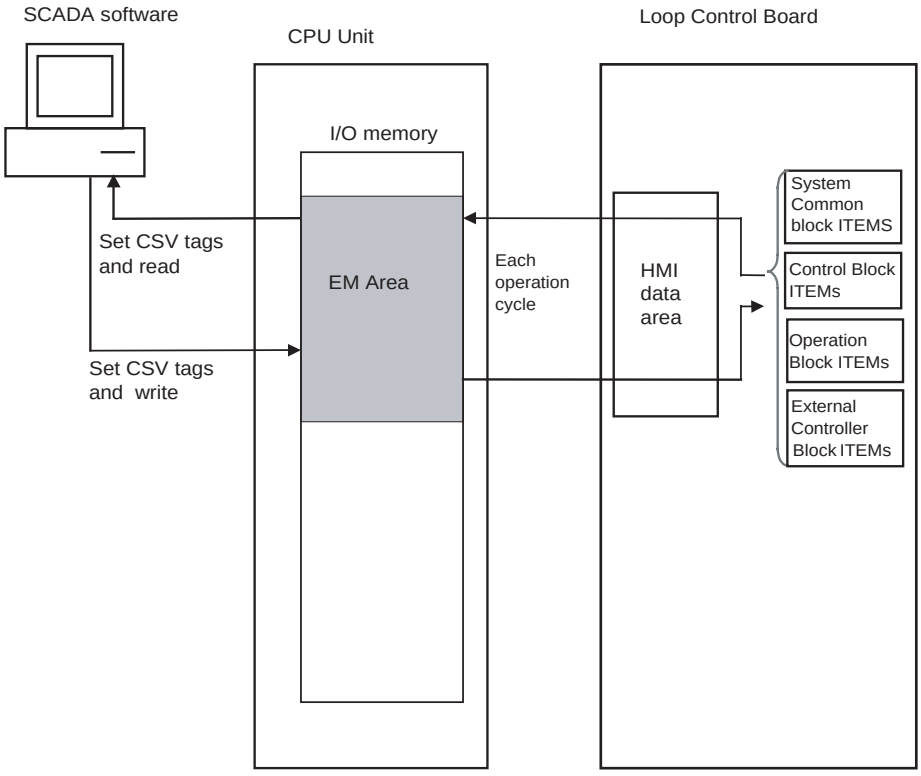
1. This function can also be used to designate Units (DeviceNet, CompoBus/S and other Communications Units) on which field terminals are not supported, and CPU Unit I/O memory (remote I/O allocated area, etc.) for enabling I/O.



2. The Loop Control Board 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 Control Board 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 Control Board. 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.

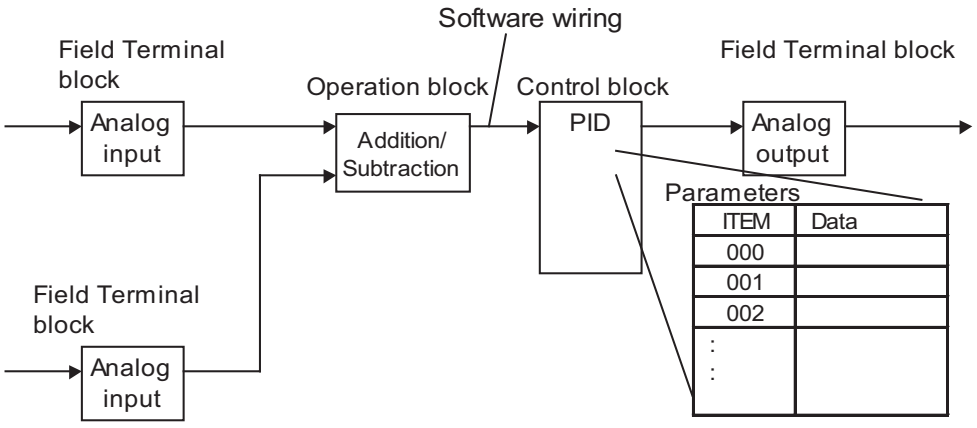


Note 1. The EM area bank to be allocated for the HMI is specified in the System Block (Block Model 000), ITEM 050 (EM area bank to allocated for HMI memory, 1 to 12).

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 Control Board. The function block data sheet describes: (a) software wiring of each function block and (b) parameters in each function block.



- The Loop Control Board 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 Control Board.

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 Control Board.

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 Control Board and setting values (in the case of analog output) for 0 to 100% on the Loop Control Board 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 Control Board. 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 Control Board when the range 0 to 4000 (0000 to 0FA0 Hex) is specified.

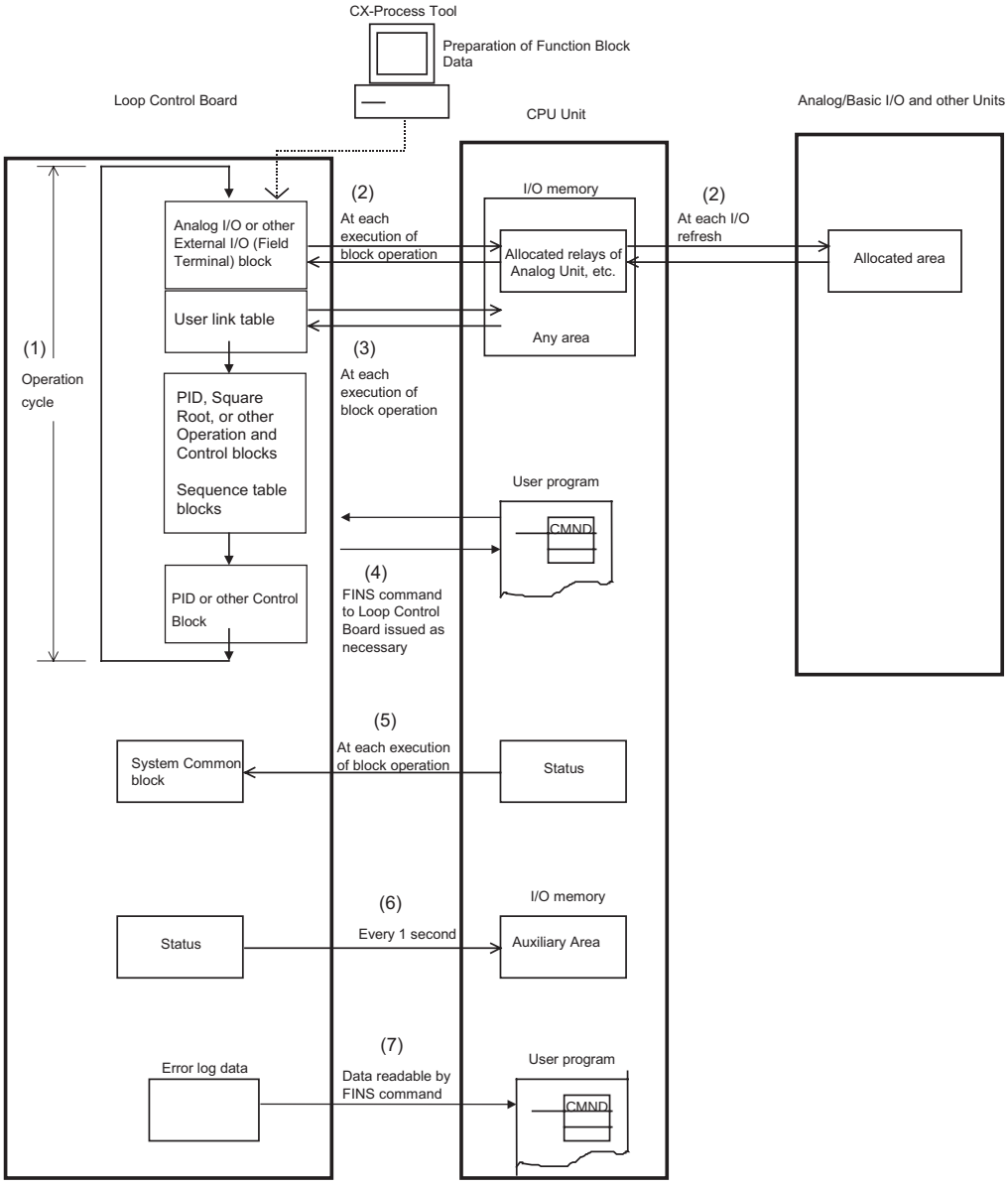
Example 2 At output to the CPU Unit, the values of 0.00 to 100.00% are converted to 0000 to 0FA0 Hex before they are output to the Control Unit when the range 0 to 4000 (0000 to 0FA0 Hex) is specified.

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.
2. Any data range in CPU Unit I/O memory corresponding to 0 to 100% on the Loop Control Board 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.)
3. The Loop Control Board 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.

1-1-6 Overall Mechanism of Data Exchange

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



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

The function blocks on the Loop Control Board 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.) Cycle of 0.01, 0.02, 0.05, and 0.1 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 Control Board 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 Control Board 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 Control Board 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 Control Board data by issuing the FINS command to the Loop Control Board 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 Control Board. If necessary, the Loop Control Board extracts data from this System Common block.

6. Loop Control Board Status Notification (by Auxiliary Area)

The status of the Loop Control Board is reflected on the Auxiliary Area in the CPU Unit. Note, however, that this status is reflected every second and not at the I/O refresh cycle.

7. Reading of Error Log Data on Loop Control Board

Error log data is stored on the Loop Control Board. (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 sections, 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 Control Board
The Loop Control Board can read from and write to CPU Unit I/O memory by the methods indicated in the following table.

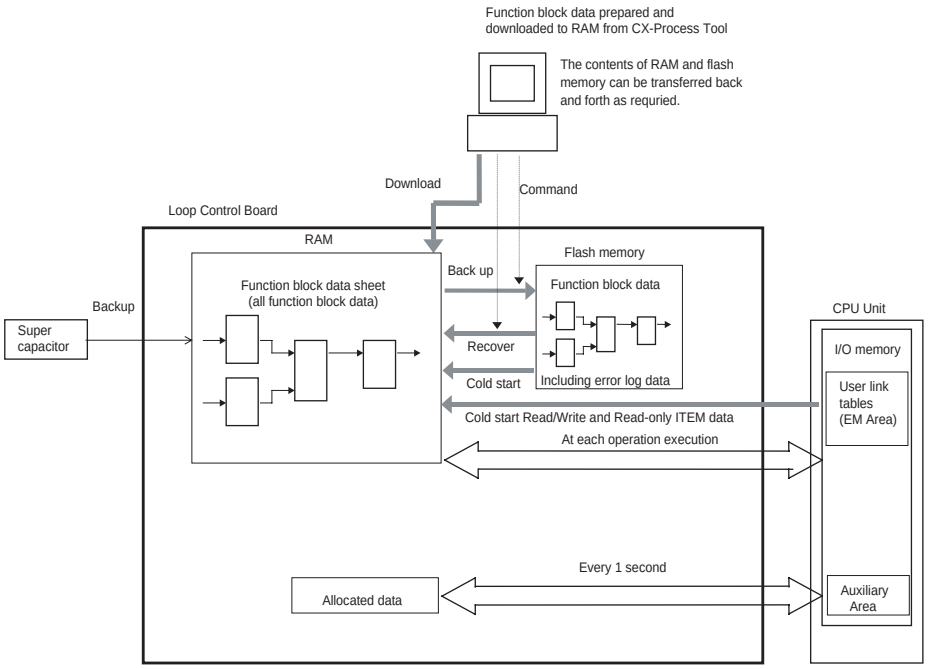
Data direction	Purpose of data on Loop Control Board		
	Loop Control Board ↔ CPU Unit	**Loop Control Board ↔ CPU Unit**	**Loop Control Board → CPU Unit**
I/O memory area type on CPU Unit	Reading or writing at CPU Unit Terminals, Expanded CPU Unit Terminals, or Send/Receive All Blocks ❍: Possible, ---: Impossible	Reading or writing at field terminals	Writing using the Auxiliary Area
CIO	❍	Reading/writing of CIO area on corresponding Unit at field terminals	---
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)	---	---

1-1-7 Internal Mechanism of Loop Control Board

The following describes the internal mechanism of the Loop Control Board.

- Function block data and error log data are backed up by a super capacitor in RAM. During actual operation, the Loop Control Board used the data in RAM.
- Function block data is prepared and downloaded to RAM and flash memory in the Loop Control Board 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 Control Board. Function block data must be downloaded from a computer to RAM and flash memory in the Board before the Loop Control Board can be run.



Note

1. Function block data in RAM can be backed up to flash memory using either of the following methods.
   a) When downloading LCB01 or LCB05 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”).
   b) Specify backup from the CX-Process Tool software using the Execute/Backup menu command.
2. Recovering data from flash memory to RAM is also possible using either of the following methods.
   a) Set the power ON startup mode to Cold Start and turn ON the power supply to the CPU Unit.
   b) Specify recovery from the CX-Process Tool software using the Execute/Recovery menu command.

1-1-8 List of Function Blocks

The following function blocks are combined and used in the Loop Control Board.

Category	Type	Block model	Block name	Function	Allocatable block address
System Common Block	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.)	2-position ON/OFF	2-position type ON/OFF controller	CS1W-LCB05: 001 to 500 CS1W-LCB01: 001 to 050
		002 (See note.)	3-position ON/OFF	3-position type ON/OFF controller for heating/cooling ON/OFF control	
		011 (See note.)	Basic PID	Performs basic PID control.	
		012 (See note.)	Advanced PID	Performs PID with two degrees of freedom control for enabling deviation/MV compensation, MV tracking, etc.	
		013	Blended PID	Performs PIF 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	Inputs up to eight analog inputs and then outputs up to two analog outputs based on fuzzy inferences.	CS1W-LCB05: 001 to 100 CS1W-LCB01: 001 to 050
		031 (See note.)	Indication and Setting	Manual setter with PV indication and SP setting functions	CS1W-LCB05: 001 to 500 CS1W-LCB01: 001 to 050
		032 (See note.)	Indication and Operation	Manual setter with PV indication and MV setting functions	
		033 (See note.)	Ratio Setting	Ratio and bias setter with PV indication and ratio setting function	
		034 (See note.)	Indicator	PV indicator with PV alarm	

Category	Type	Block model	Block name	Function	Allocatable block address
Operation Block	Alarm/ Signal restrictions/ Hold	111 (See note.)	High/Low Alarm	Provides the alarm contact outputs for the high and low limits of single analog signals.	CS1W-LCB05: 001 to 500 CS1W-LCB01: 001 to 050
		112 (See note.)	Deviation Alarm	Provides the alarm contact outputs for the deviation of two analog signals.	
		113 (See note.)	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.)	High/Low Limit	Limits the high and low limits of single analog signals.	
		116 (See note.)	Deviation Limit	Calculates the deviation between two analog signals, and limits the deviation within that range.	
		118 (See note.)	Analog Signal Hold	Holds the maximum, minimum or instantaneous value of single analog signals.	
	Arithmetic	121 (See note.)	Addition or Subtraction	Performs addition/subtraction with gain and bias on up to 4 analog signals.	
		122 (See note.)	Multiplication	Performs multiplication with gain and bias on up to 2 analog signals.	
		123 (See note.)	Division	Performs division with gain and bias on up to 2 analog signals.	
		126 (See note.)	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.)	Range Conversion	Converts analog ranges for up to eight analog signals based only on values input for 0% and 100% inputs and 0% and 100% outputs.	
	Functions	131 (See note.)	Square Root	Performs square root extraction (with low-end cutout) on single analog signals.	
		132 (See note.)	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.)	Non-linear Gain (Dead Band)	Outputs the absolute value of single analog signals.	
		134 (See note.)	Low-end Cutout	Sets output to zero close to the zero point of single analog signals.	
		135 (See note.)	Segment Linearizer	Converts single analog signals to 15 segments before the signals is output.	
		136 (See note.)	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.)	First-order Lag	Performs first-order lag operation on single analog signals.	CS1W-LCB05: 001 to 500 CS1W-LCB01: 001 to 050
		143 (See note.)	Rate-of-change Limit	Performs rate-of-change restriction on single analog signals.	
		146 (See note.)	Moving Average	Performs moving average operation on single analog signals.	
		147 (See note.)	Lead/Delay	Performs lead/delay operation on single analog signals.	
		148 (See note.)	Dead Time	Performs dead time and first-order lag operations on single analog signals.	
		149 (See note.)	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	CPU Unit Running Time Accumulator	Accumulates the operating time, and outputs the pulse signal per specified time.	
		153 (See note.)	Time Sequence Data Statistics	Records time sequence data from analog signals and calculates statistics, such as averages and standard deviations.	CS1W-LCB05: 001 to 100 CS1W-LCB01: 001 to 010
		155	Ramp Program	Ramp program setter for combining ramps for time and hold values.	CS1W-LCB05: 001 to 500 CS1W-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	
	Signal Selection/ Switching	161 (See note.)	Rank Selector	Selects the rank of up to 8 analog signals.	
		162 (See note.)	Input Selector	Selects the specified analog signals specified by the contact signal from up to 8 analog signals.	
		163 (See note.)	3-input Selector	Selects and outputs one of three analog input signals.	
		164 (See note.)	3-output Selector	Outputs one analog input signal in three switched direction.	
		165 (See note.)	Constant Selector	Selects 8 preset constants by the contact signal.	
		166 (See note.)	Constant Generator	Outputs 8 independent constants.	
		167	Ramped Switch	Creates a ramped switch based on two analog inputs or constants.	

Category	Type	Block model	Block name	Function	Allocatable block address
Operation Block (continued)	ITEM Settings	171 (See note.)	Constant ITEM Setting	Writes the constant to the specified ITEM at the rising edge of the send command contact.	CS1W-LCB05: 001 to 500 CS1W-LCB01: 001 to 050
		172 (See note.)	Variable ITEM Setting	Writes the analog signal to the specified ITEM at the rising edge of the send command contact.	
		174 (See note.)	Batch Data Collector	Stores each of max. 8 analog inputs to buffer by a certain timing within sequential processing.	
		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.	
	Pulse Train Operation	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.	
	Others	192 (See note.)	Analog/Pulse Width Converter	Changes the ON/OFF duration ratio in a constant cycle duration so that it is proportional to the analog signal.	
	Sequence Operation	201 (See note.)	Contact Distributor	Connect contact signals between function blocks in a 1:1 connection.	
		202 (See note.)	Constant Comparator	Compares up to eight sets of analog signals and constants, and outputs the comparison results as contacts.	
		203 (See note.)	Variable Comparator	Compares up to eight pairs of analog signals, and outputs the comparison results as contacts.	
		205 (See note.)	Timer	2-stage output-type addition timer for forecast values and reached values. Can also output the present value.	
		206 (See note.)	ON/OFF Timer	Timer for performing ON-OFF operation at preset ON and OFF times.	
		207 (See note.)	Clock Pulse	Outputs clock pulses that turn ON for one operation cycle only at each set time.	
		208 (See note.)	Counter	2-stage output type addition timer for forecast values and arrival values. Can also output the current value.	
		209 (See note.)	Internal Switch	Temporary storage contact for accepting bits in the Step Ladder Program block. (Note: One internal switch is already allocated as “temporary storage” in CX-Process Tool.)	
		210 (See note.)	Level Check	Checks the level of an analog input for eight levels and outputs contacts according to the level. The level number is also output via an analog output.	

Category	Type	Block model	Block name	Function	Allocatable block address
Operation Block (continued)	Contact Type Control Target	221	ON/OFF Valve Manipulator	Manipulates and monitors ON/OFF valves with open/close limit switches.	CS1W-LCB05: 001 to 500 CS1W-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.	
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 Board.	601 to 632
Sequential Control		301 (See note.)	Step Ladder Program	Performs logic sequence and step progression control.	701 to 900
		302 (See note.)	Sequence Table	Performed logic sequences or step progression control based on conditions and actions set in tabular form. Supported by the CS1W-LCB05 only; cannot be used with the CS1W-LCB01.	
Field Terminal	Contact I/O	501	DI 8-point Terminal	Inputs 8 contacts from 8-point Input Unit.	901 to 980
		502	DI 16-point Terminal	Inputs 16 contacts from 16-point Input Unit.	
		503	DI 32-point Terminal	Inputs 32 contacts from 32-point Input Unit.	
		504	DI 64-point Terminal	Inputs 64 contacts from 64-point Input Unit.	
		511	DO 5-point Terminal	Outputs 5 contacts from 5-point Output Unit.	
		512	DO 8-point Terminal	Outputs 8 contacts from 8-point Output Unit.	
		513	DO12-point Terminal	Outputs 12 contacts from 12-point Output Unit.	
		514	DO16-point Terminal	Outputs 16 contacts from 16-point Output Unit.	
		516	DO32-point Terminal	Outputs 32 contacts from 32-point Output Unit.	
		516	DO64-point Terminal	Outputs 64 contacts from 64-point Output Unit.	
		518	DI 16-point/Do16-point Terminal	Inputs and outputs 16 contacts each from 16-point Input/16-point Output Unit.	
		588	Ai4 Terminal (DRT1-AD04)	Inputs 4 analog inputs from a DRT1-AD04 Analog Input Unit (a DeviceNet slave).	
		589	Ao2 Terminal (DRT1-DA02)	Outputs 2 analog outputs from the field outputs on a DRT1-DA04 Analog Output Unit (a DeviceNet slave).	
		525	DI 96-point Terminal	Inputs 96 contacts from 96-contact Input Unit.	
		537	DO 96-point Terminal	Outputs 96 contacts from 96-contact Output Unit.	
		544	DI 48-point/DO 48-point Terminal	Inputs and outputs 48 contacts each from 48-point Input/48-point Output Units.	

Category	Type	Block model	Block name	Function	Allocatable block address
Field Terminal	Analog I/O	551 (See note.)	AI 8-point Terminal (AD003)	Inputs 8 analog signals from the C200H-AD003.	901 to 980
		552 (See note.)	AO 8-point Terminal (DA003/4)	Inputs 8 analog signals from the C200H-DA003/DA003.	
		553 (See note.)	AI 2-point/AO 2-point Terminal (MAD01)	Inputs and outputs 2 analog signals each from the C200H-MAD01.	
	Analog I/O	561 (See note.)	AI 4-point Terminal (PTS01-V1/02/03,PDC01,PTW01)	Inputs 4 analog signals from one of CS1W-PTS01-V1 (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 note.)	PI 4-point Terminal (PPS01)	Inputs 4 instantaneous values and accumulated values each from CS1W-PPS01 (Isolated-type Pulse Input Unit).	
		563 (See note.)	AO 4-point Terminal (PMV01)	Outputs 4 analog signals from CS1W-PMV01 (Isolated-type Control Output Unit).	
		564 (See note.)	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)).	
		565 (See note.)	AO 4-point Terminal (PMV02)	Outputs 4 analog signals from CS1W-PMV02 (Isolated-type Control Output Unit).	
		583 (See note.)	AI 4-point/AO 4-point Terminal (MAD44)	Inputs and outputs 4 analog signals each from the CS1W-MAD44.	
		584 (See note.)	AI 8-point Terminal (AD081)	Inputs 8 analog signals from the CS1W-AD081.	
		585 (See note.)	AO 8-point Terminal (DA08V/C)	Outputs 8 analog signals from the CS1W-DA08V/C.	
		586 (See note.)	AI 4-point Terminal (AD041)	Inputs 4 analog signals from the CS1W-AD041.	
		587 (See note.)	AO 4-point Terminal (DA041)	Outputs 4 analog signals from the CS1W-DA041.	

Note These function blocks support high-speed operation and the operation cycle can be set to 0.01, 0.02, or 0.05 ms when required.

1-1-9 Differences between Loop Control Units and Board

Area	Item	Loop Control Unit	Loop Control Board
Model number		CS1W-LCU01	CS1W-LCB01/05
Hardware	Unit type	CPU Bus Unit	Inner Board CS1W-LCB01: 50 Control and Operation Blocks max. CS1W-LCB05: 500 Control /Operation Blocks max.
	Compatible CPU Units	CS1 and CS1-H CPU Units	CS1-H CPU Units
	Number of mountable Units/Boards per CPU Backplane	3 Units	1 Board
	Unit number settings	0 to F	None
	RAM backup method	Super capacitor and battery	Super capacitor
	LED Indicators	RUN, ERC, ERH, SD, and RD	EXEC, RDY, and COMM
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
	Execution speed	1	About 10 times faster than the Loop Control Unit
	Speed of data exchange with CPU Unit	1 cycle time + 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 25C.)
	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 to the Loop Control Board's load rate and displays the overall load rate.
	Operation cycle shift down	The Unit automatically shifts down to a longer operation cycle when the load rate exceeds 70%.	The Board does not shift down. If the Board's load rate exceeds 80% three times in a row, a non-fatal board error will occur (operation continues) and the Alarm Flag will be turned ON. Even 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 (The 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. (Note: the CS1W-LCB01 supports the step ladder program only.)

Area	Item	Loop Control Unit	Loop Control Board
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: CS1W-LCB01: 50 Blocks max. CS1W-LCB01: 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.
	Types of Function Blocks	Step ladder program	Step ladder program or sequence table (cannot be used together)
		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 functions
		Send All Blocks	
		4-Point Warning Indicator	None (Combined with the Indicator Block (Block Model 034.))
		DO to Computer	The CX-Process Monitor software cannot be used with the Loop Control Board.
		AO to Computer	
		1-Block Send Terminal to Computer	
		4-Block Send Terminal to Computer	
		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	

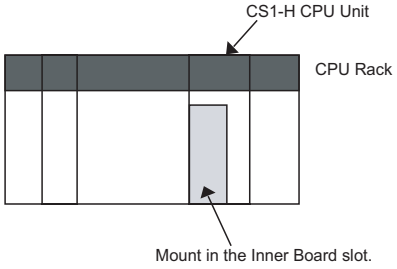
Area	Item	Loop Control Unit	Loop Control Board
Function Blocks (continued)	Types of Function Blocks (continued)	DI 16-point/DO 16-point Terminal	User link table
		DI 96-point Terminal	
		DO 96-point Terminal	
		DI 48-point/DO 48-point Terminal	
Status	Operating status of Unit or Board	1) ITEM in System Common Block 2) Flags in the allocated CPU Bus Unit area (word n)	1) I TEM in System Common Block 2) Flags in Auxiliary area word A358
	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

1-2 Configuration of Instrumentation System

1-2-1 Mounting Location

CS1W-LCB01

The CS1W-LCB01 Loop Control Board in an 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	Standard	CS	CS1H-CPU □□H CS1G-CPU□□H

CS1W-LCB05

The CS1W-LCB05 Loop Control Board in an 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	Special	CS	CS1H-CPU □□H CS1G-CPU□□H

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 Control Board**

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 page 30.)

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 Control Board

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 details of the Unit types that can be used, see *Input and Output of Contacts* on page 30.)

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 Control Board 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 Control Board 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 Control Board.

Note The High Load Alarm Flag (A42408) turns ON if the load rate exceeds 80% three times consecutively. 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 one or more Loop Control Units.

Use the following formula as a general guideline for estimating the load rate of the Loop Control Board at the system design stage.

How to Calculate the Load Rate

Calculate the load rate based upon the following formula.

When all operation cycles are the same operation cycle, the load rate is as shown below. This, however, is to be used only as a guideline.

Formula

Load rate ≅ Sum (ms) of operation execution times of each function block ÷ operation cycle (ms) x 100 + fixed load rate (%)

Note

1. The fixed load rate is 1% regardless of the operation cycle.
2. The “sum (ms) of operation execution times of each function block” is a value obtained by discarding values less than 10 ms from the total time obtained by adding the “operation execution time of the function blocks” to the “execution time of the sequence commands.”
3. For details on the load rate, see 3-2 Description of Operations. For details on the operation execution times for each function block and each of the sequence commands in the Step Ladder Program block, see Appendix-4 List of Operation Execution Times.

5. 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 Control Board 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 Control Board 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 Control Board'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 Control Board'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 Control Board'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 (W339-E1), 15-4 Computing the Cycle Time.)

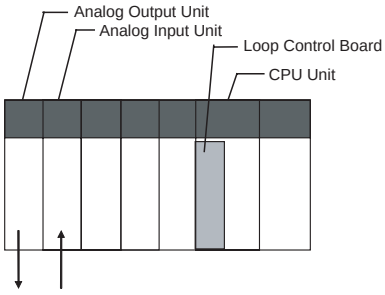
1-2-3 Description of Basic System Configuration

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

The Loop Control Board 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 (CPU Rack, Expansion Rack for the CS1, Expansion I/O Rack for the C200H) or on a SYSMAC BUS Remote I/O Slave Rack. (It is also possible to handle I/O with external devices through DeviceNet Analog Slaves.)

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 Control Board 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 Control Board'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.

Unit information	Name	Model	Specification	Function block
C200H Special I/O Unit	Analog Input Unit	C200H-AD003	8 analog inputs	AI 8-point Terminal (Block Model 551)
	Analog Output Unit	C200H-DA003/004	8 analog outputs	AO 8-point Terminal (Block Model 552)
	Analog Input/Output Unit	C200H-MAD01	2 analog inputs/2 analog outputs	AI 2-point/AO 2-point Terminal (Block Model 553)

Unit information	Name	Model	Specification	Function block
CS1 Special I/O Unit	Analog Input/Output Unit	CS1W-MAD44	4 analog inputs/4 analog outputs	AI 4-point/AO 4-point Terminal (Block Model 583)
	Analog Input Unit	CS1W-AD081	8 analog inputs	AI 8-point Terminal (Block Model 584)
		CS1W-AD041	4 analog inputs	AI 4-point Terminal (Block Model 586)
	Analog Output Unit	CS1W-DA08V/C	8 analog outputs	AO 8-point Terminal (Block Model 585)
		CS1W-DA041	4 analog outputs	AO 4-point Terminal (Block Model 587)
	Isolated-type Thermocouple Input Unit	CS1W-PTS01-V1	4 thermocouple inputs	AI 4-point Terminal (Block Model 561)
	Isolated-type Temperature-resistance Thermometer Input Unit	CS1W-PTS02/03	4 temperature-resistance thermometer inputs	
	2-lead Transmitter Input Unit	CS1W-PTW01	4 2-wire transmitter inputs	
	Isolated-type Analog Input Unit	CS1W-PDC01	4 analog inputs	
	Isolated-type Pulse Input Unit	CS1W-PPS01	4 pulse inputs	PI 4-point Terminal (Block Model 562)
	Isolated-type Analog Output Unit	CS1W-PMV01	4 analog outputs	AO 4-point Terminal (Block Model 563)
	Isolated-type Analog Output Unit	CS1W-PMV02	8 analog outputs	AO 4-point Terminal (Block Model 565)
CS1 Special I/O Unit	Power Transducer Input Unit	CS1W-PTR01	8 power transducer inputs	AI 8-point Terminal (Block Model 564)
	Analog Input Unit (100 mV)	CS1W-PTR002	8 analog inputs	

Note

1. In the case of an analog output Field Terminal block, select the function block according to the Unit model.
2. In data exchange above, the Loop Control Board 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 Control Board.

   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 Control Board 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.

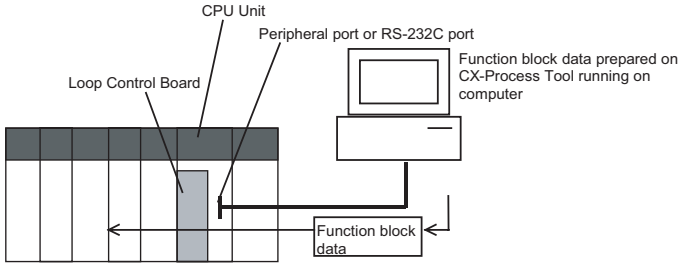
Unit	I/O	Number of points	Function block
Contact Input Unit	I	8	DI 8-point Terminal (Block Model 501)
		16	DI 16-point Terminal (Block Model 502)
		32	DI 32-point Terminal (Block Model 503)
		64	DI 64-point Terminal (Block Model 504)
Contact Output Unit	O	5	DO 5-point Terminal (Block Model 511)
		8	DO 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 Control Board and the CPU Unit.

Connecting to CX-Process Tool



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

Transferring Data to and from SCADA Software

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

Read and Writing Control, Operation, and External Controller Block ITEMs (HMI Data)

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 Control Board.

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 Control Board.

1-3 Specifications

1-3-1 General Specifications

These specifications conform to the general specifications of the SYSMAC CS1 Series.

1-3-2 Specifications

Item		Specification
Product name		Loop Control Board
Model numbers		**CS1W-LCB01 and CS1W-LCB05**
Applicable CPU Units		CS1G/H-CPU□□H
Unit classification		CS-series Inner Board
Mounting location		Inner Board slot in CPU Unit
Number of mountable Units		1 Board max. per CPU Unit
Data exchange method with CPU Unit	Words in Auxiliary Area in CPU Unit	Loop Control Board → 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 Control Board: Hot/cold start command at power ON
	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 CPU Unit (CIO, Work, HR, DM, or EM (bank 0) Area).
	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.
Setting		None
Indicators		3 LEDs: RUN, ready, and communications port send/receive
Front panel interface		RS-232C port x 1 (Used for connection to ES100X Controller.)
Super capacitor backup data		All function block data (including Step Ladder Program commands), stored error log data
Super capacitor life		24 hours at 25°C (life shortened by use at higher temperatures)
Data stored in flash memory		Function block data
Backup from RAM to flash memory		Executed from CX-Process Tool (as required).
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		0.3 to 0.8 ms Depends on number of functions blocks according to the following equation: 0.3 ms + (No. of blocks x 0.3/400 ms + 0.125 ms).
Current consumption (supplied from Power Supply Unit)		220 mA at 5 V DC (Increased by 150 mA when NT-AL001-E Link Adapter is used.)
External dimensions (mm)		34.5 (W) x 130 (H) x 100.5 (D)
Weight		100g max.
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.			
	Analog operation	Control Blocks	PID and other control functions	CS1W-LCB01: 50 blocks max., CS1W-LCB05: 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.
	Sequential Control	Sequence tables	Logic sequence and step sequence functions (CS1W-LCB05 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 CS1W-LCB01: 50 blocks max. + 20 send/receive ITEMs CS1W-LCB05: 500 blocks max. + 20 send/receive ITEMs External Controller Blocks CS1W-LCB01/05: 32 blocks max. + 20 send/receive ITEMs System Common Block CS1W-LCB01/05: 20 send/receive ITEMs
	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 Control Board			

Item			Description
Execution of function blocks	Function block execution conditions	Common to all function blocks	- 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. - Function block operation can be stopped by CX-Process Tool or FINS command. - 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.
		For individual function block	- 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.
	Function block operation cycle		Standard:Operation of all function blocks is executed at the same operation cycle preset to ITEM 004 in the System Common block. Settable operation cycles: 0.1 s, 0.2 s, 0.5 s, 1 s, 2 s (default: 1 s) Option: Operation of individual function blocks is executed at the same operation cycle preset to ITEM 004 in the System Common block. Settable operation cycles: 0.01 s, 0.02 s, 0.05 s, 0.1 s, 0.2 s, 0.5 s, 1 s, 2 s (default: 1 s) Note: Note, however, that the external I/O response cycle on a single control loop does not match this operation cycle. This response cycle is heavily dependent on the CPU Unit's cycle time. (See the external I/O response cycle item below.)
	Function blocks supporting high-speed operation		The following operation cycles can be set for the blocks listed below: 0.01, 0.02, and 0.05 s. Control/Operation blocks: Block Models 016, 150, 151, 155 to 157, 167, 182 to 184, 186, and 221 to 224 Field Terminal blocks: All except for contact I/O blocks (Block Models 501 to 544) Refer to note after table in *1-1-8 List of Function Blocks*.
	LCB load rate		The “LCB load rate” refers to the ratio between the actually applied execution time and preset operation cycle. The maximum value and current value are displayed for each operation cycle group on the CX-Process Tool. A LCB load rate of 80% or less is required in all operation cycle groups. When the load rate continuously exceeds 70% for ten times, the LCB load rate automatically changes to the next longer operation cycle. (This is called the “automatic operation cycle switching function.”) Note: The High Load Alarm Flag (A42408) turns ON if the load rate exceeds 80% three times 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 one or more Loop Control Units.
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. Generally, the external I/O response cycle is obtained by adding the CPU Unit's cycle time to approximately 2 times the operation cycles of the Loop Control Board's function blocks. (For a detailed description of how to calculate the external I/O response cycle, see *3-2 Description of Operation*.)

<table>
<tr><th colspan="3">Item</th><th>Description</th></tr>
<tr><td rowspan="4">Internal Operation</td><td colspan="2">Number of control loops</td><td>CS1W-LCB05: 200 loops max., CS1W-LCB01: 50 loops max.
Simultaneous Control Blocks (ON/OFF control, basic PID, advanced PID, etc.)
CS1W-LCB05: 500 blocks max., CS1W-LCB01: 50 blocks max.
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.
<table>
<tr><th colspan="3">Operation cycle:Maximum number of loops</th></tr>
<tr><td>0.01 s: 20 loops</td><td>0.02 s: 35 loops</td><td>0.05 s: 70 loops</td></tr>
<tr><td>0.1 s: 100 loops</td><td>0.2 s: 180 loops</td><td>0.5 s: 250 loops</td></tr>
<tr><td>1 s: 250 loops</td><td>2 s: 250 loops</td><td></td></tr>
</table></td></tr>
<tr><td colspan="2">Number of operations for process (excluding control)</td><td>Max. 500 blocks</td></tr>
<tr><td rowspan="2">Sequential control (Use only one or the other)</td><td>Step ladders</td><td>CS1W-LCB01: 20 blocks per Board and total max. 2,000 commands per Board
CS1W-LCB05: 200 blocks per Board and total max. 4,000 commands per Board
CS1W-LCB01/05: Divisible to 100 commands max. per block and 100 steps max. per block (100 commands max. per step)</td></tr>
<tr><td>Sequence tables</td><td>Sequence tables: 200 max. (CS1W-LCB05 only; not supported by the CS1W-LCB01)</td></tr>
<tr><td rowspan="2">Control method</td><td colspan="2">PID control</td><td>PID with two degrees of freedom</td></tr>
<tr><td colspan="2">Possible control type combinations</td><td>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.</td></tr>
<tr><td rowspan="2">Alarm</td><td colspan="2">Integrated into PID block</td><td>4 PV alarms (high/high limit, high limit, low limit, low/low limit) per PID block, 1 deviation alarm</td></tr>
<tr><td colspan="2">Alarm block</td><td>High/Low Alarm block, Deviation Alarm block</td></tr>
<tr><td colspan="3">Internal analog signal</td><td>Min. -320.00% to max. +320.00%
Scaling of the engineering units depends on the CX-Process Tool (sold separately).</td></tr>
<tr><td colspan="3">Operating status monitor method</td><td>Executed by commercially available SCADA software. In the SCADA software, tags set on the CX-Process Tool are specified.</td></tr>
</table>

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 Control Board 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
	FINS command to Loop Control Board	Read/write of ITEMs in Loop Control Board 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 Control Board. - 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 Note: 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 Note: 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)	❍	❍
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 Control Board 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 Control Board 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.)	❍	❍
	Control action	Direct/reverse switchable		
	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)	❍	❍
MV (Manipulated Variable)	Number of points	1 set	×	❍
	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 Control Board:

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

CX-Process Tool Specifications

Item		Specification
Product name		CX-Process Tool (version 3.0 or higher)
Model		WS02-LCTC1EV3
Applicable PLC-series		CS1 Series
Applicable Unit		Loop Control Board
Applicable computer	Computer	IBM PC/AT or compatible
	CPU	Min. required: Pentium 133 MHz or faster, Recommended: Celeron 400 MHz or faster
	OS	Microsoft Windows NT4.0 Service Pack 4 or later, Windows 95, 98, Me, 2000, or XP
	Memory	Min. required: 32 Mbytes, Recommended: 64 Mbytes or more
	Hard disk space	Min. required: 20 Mbytes of free space, Recommended: 30 Mbytes or more of free space
	Monitor	Min. required: XGA, Recommended: XGA or better
	CD-ROM drive	At least one
	Mouse	Recommended: Microsoft mouse or compatible pointing device
Connecting method	Connection with CPU Unit (or Serial Communications Board/Unit)	Using the FinsGateway SerialUnit 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 Connecting to CX-Process Tool.)
		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	- Setting of function block ITEM data (including System Common block settings) - Software wiring of analog signals - Pasting, displaying, and printing text-string comments (memos) in block or ladder diagrams. - Inputting Step Ladder Program block commands - Inputting sequence tables - Initializing Loop Control Board memory (RAM)
Online operation functions	- Downloading of function block data (download/upload to and from Loop Control Board) - Run/stop command for Loop Control Board (all function blocks) - System monitor run status: Monitoring/manipulation of System Common block (Block Model 000) (including monitoring of LCB load rate) - Loop Control Board 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 - Autotuning PID constants and other parameters.

Note Windows 95 does not support access via a PCI Control Link Support Board. A Pentium 150-MHz processor or better is recommended for Windows Me.

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).	Function Block Reference Manual
	Continuous data exchange with the CPU Unit	Use the CPU Unit Terminal blocks (Block Models 451 to 454).	3-3 Exchanging Data with the CPU Unit
	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 Control Board data using tags created with CX-Process Tool.	*3-4 Exchanging Data using SCADA Software*
	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 Exchanging Data using SCADA Software*
Run/ Stop	Instruction of run start/stop of the Loop Control Board (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.) Note: Operation can also be stopped or started on CX-Process Tool and SCADA software.	*3-2 Description of Operation* *3-2-6 Stop each function block operation and cancel operation-stop*
	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. Note: 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 Control Board	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 Exchanging Data with the CPU Unit
	Execution of required processing on the Loop Control Board according to run status (e.g. operation mode, fatal error, Output OFF) of the CPU Unit	Execute the required processing on the Loop Control Board 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.	
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 Description of Operation (page 84) *3-2-9 Specifying the Operation Cycle*
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 Exchanging Data SCADA Software Appendix-2 How to Use the Node Terminal Block
Monitoring/ Setting External Controllers	Monitoring and setting a stand-alone external controller.	Connect an ES100X Controller to the RS-232C port on the Loop Control Board and use the ES100X Controller Terminal (Block Model 045).	*Function Block Reference Manual*
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)	*Function Block Reference Manual*

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
	Application of input filter on PV	Use the First-order Lag block (Block Model 141).	Function Block Reference Manual
	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		
	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
	Ramp control of Set Point values (program control)	Use the Ramp Program block (Block Model 155) or the Segment Program block (Block Model 156).	5-1 Basic Examples of PID Control, *5-1-5 Ramp Program Control* and Function Block Reference Manual
	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
	PID control with differential gap	Use the Constant Item Setting block (Block Model 171).	Function Block Reference Manual
	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).	
Special math operations	Performing calculation is engineering units rather than percentages	Use the Arithmetic Operation block (Block Model 126).	
	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).	

To perform this specific operation		Perform the following	See page:
Accumulation processing	Accumulation (accumulator) of instantaneous analog signals such as flowrate signals on the Loop Control Board	Use the Accumulator for instantaneous value input block (Block Model 150).	5-1 Basic Examples of PID Control, *5-1-7 Monitoring and Accumulating Flowrate* and Function Block Reference Manual
	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).	Function Block Reference Manual
	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).	Function Block Reference Manual
	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)	
Sequence control	AND, OR and other logical operations on the Loop Control Board	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 Control Board		
	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).	
	Execution of timers/counters on the Loop Control Board	Use the Timer block (Block Model 205) and the Counter block (Block Model 208).	Function Block Reference Manual
	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.	
Constant setting/selection	Constant transmission of constants as analog signals	Use the Constant Generator block (Block Model 166).	
	Setting of constants to specified ITEMs under certain conditions	Use the Constant Item Setting block (Block Model 171).	3-1 Configuration of Function Blocks and Function Block Reference Manual
	Selection of one of multiple constants and transmission of that constant as an analog signal	Use the Constant Selector block (Block Model 165).	Function Block Reference Manual

To perform this specific operation		Perform the following	See page:
Analog signal setting/ selection	Setting of analog signals to specified ITEMs under certain conditions	Use the Variable ITEM Setting block (Block Model 171).	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	Use the Input Selector block (Block Model 162).	Function Block Reference Manual
	Selection of the maximum value from multiple analog signals and transmission of that maximum value as an analog signal	Use the Rank Selector block (Block Model 161).	Function Block Reference Manual
	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	Use the 3-input Selector block (Block Model 163).	
	Switching of operation nodes on a different measuring system or measurement target	Use the 3-output Selector block (Block Model 164).	
	Changing two settings with a ramp (e.g., opening and closing valves)	Use the Ramped Switch block (Model Block 167).	
	Converting ranges of analog signals merely by setting values for 0% and 100% inputs and 0% and 100% outputs	Use the Range Conversion block (Block Model 127).	
	Comparison of constant and analog signals	Use the Constant Comparator block (Block Model 202)	
	Comparison of two analog signals	Use the Variable Comparator block (Block Model 203)	
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)	
	Manipulation and monitoring of motors	Use the Motor Manipulator block (Block Model 222)	
	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)	

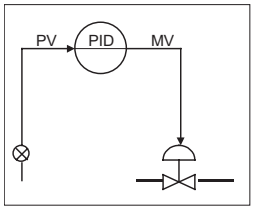
1-5 Basic Procedure for Using the Loop Control Board

This section describes the basic procedure for using the Loop Control Board.

For examples of actual procedures, see *Section 4 Simple Examples of Use*.

1. Design

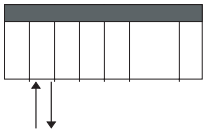
1,2,3... 1. Prepare an instrumentation drawing.



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

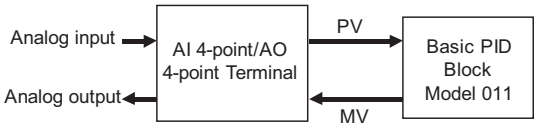
See *Section 5 Examples of Function Block Combinations*.

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 Control Board*.

3. Select the required function blocks.
   See *1-4 How to Use Function Blocks for Specific Operations*.
   See *Section 3 Mechanism of the Loop Control Board*.
4. Decide on the function block system configuration.

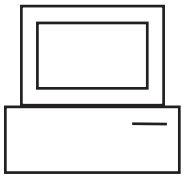


5. Assess the LCB load rate and the external I/O response cycle.
   See *1-2 Configuration of Instrumentation System*.
   See *3-2 Description of Operation*.

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 Control Board

1,2,3...

1. Mount the Loop Control Board and wire the Analog Input and Output Units.
   The Loop Control Board 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 Loop Control Board.
   See *2-1 Names and Functions of Parts*.
   Refer to the *Analog Input and Output Unit Manuals*.
3. Connect the Programming Devices.
   Refer to *Programming Devices (CX-Programmer or Programming Console) Operation Manual*.
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 Control Board

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*.

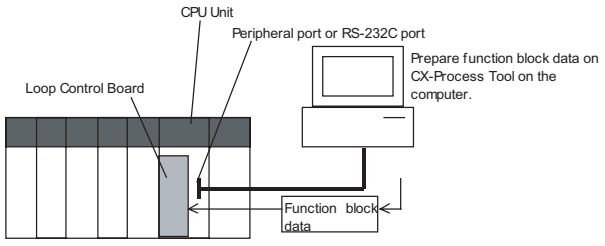
3. Connect the CPU Unit to the computer on which CX-Process Tool is running.

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 Control Board 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 Control Board operation.

a) The correct combination of Analog I/O Units must be mounted.

b) The correct defaults of the System Common block on the Loop Control Board must be set. In particular, make sure that same applications as those for other PLCs are not set for the Data Memory (D) for the Node Terminals on the CPU Unit to be used by the Loop Control Board.

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*.

9. Check the LEDs on the front panel of the Loop Control Board (RUN LED lit, ERC LED out).
   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*.

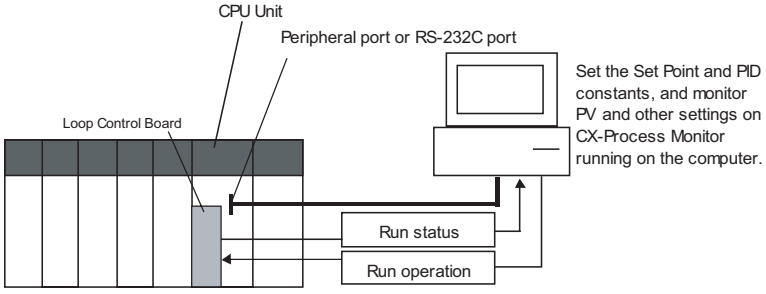
2. Monitor the run status on CX-Process Tool ([Execute]-[Operation]-[Monitor run status]).
Execute the load rate check and other diagnostic checks.
Refer to the *CX-Process Tool Operation Manual*.

Note To disable inadvertent generation of analog signals when running of the Loop Control Board 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 Control Board using the CX-Process Tool or SCADA software. (For example, change the settings and PID constants.)
Refer to the *CX-Process Tool Operation Manual*.

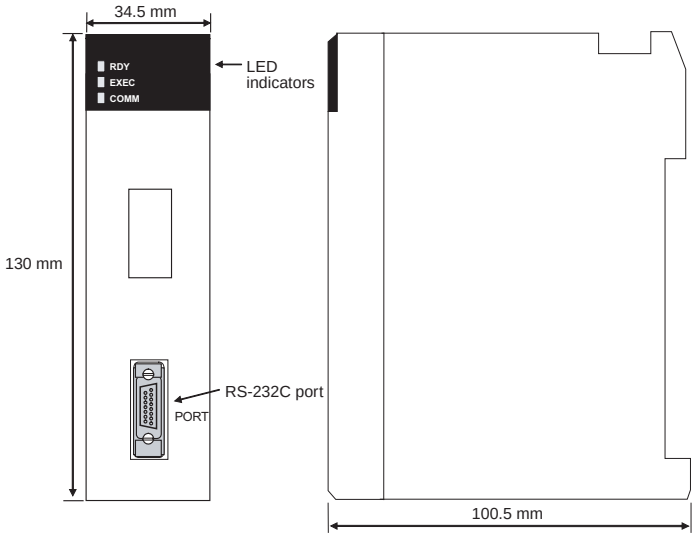
2. Monitor PV and alarms on CX-Process Tool or SCADA software.
Refer to the *CX-Process Tool Operation Manual*.

SECTION 2
Components, Installation, and Wiring

This section describes the components of the Loop Control Board and installation and wiring methods

2-1 Names and Functions of Parts

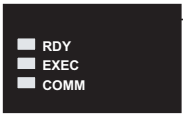
2-1-1 Names and Functions of Parts



RS-232C port: Used to connect to an ES100X Controller. 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: • A Fatal Inner Board Error occurred (A40112 ON.) • Initialization is not completed yet. • A fatal error occurred. • The flash memory backup data is invalid. • The Loop Control Board is initializing. • A hardware failure occurred in the Loop Control Board. • Power is not being supplied from the Power Supply Unit. • A Loop Control Board WDT error occurred.
			Flashing	• Data is being written to flash memory. • 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: • The Loop Control Board is initializing. • A hardware failure occurred in the Loop Control Board. • Power is not being supplied from the Power Supply Unit. • A Loop Control Board WDT error occurred. • The Loop Control Board is not running. • Data is being written to flash memory.
			Flashing	Parameter backup operation in progress
			Lit	The Loop Control Board is not running.
COMM	Communi-cating	Yellow	Not lit	Waiting for data transfer.
			Flashing	Transferring data.

2-2 Installation

2-2-1 Mountable Units

The Loop Control Board is mounted in the Inner Board slot of a CS1-H CPU Unit. Only one Board can be mounted in each CPU Unit.

Note

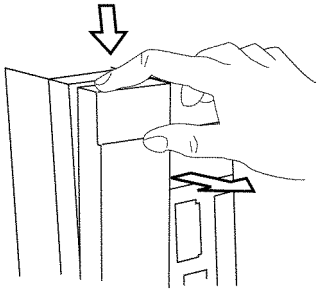
1. Always turn OFF the power supply before mounting or removing the Board. If the Board is mounted or removed with power supplied, the CPU Unit may malfunction or internal elements may be destroyed.
2. Before handling the Board, touch a grounded metal object to discharge static electricity from your body.

2-2-2 Mounting Procedure

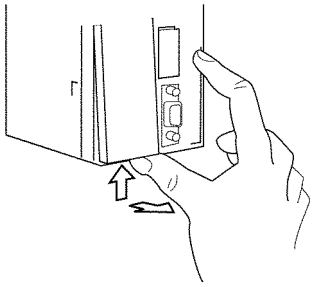
Follow the procedure below to mount the Loop Control Board in the CPU Unit.

1,2,3...

1. Lock the top of the Loop Control Board onto the Backplane by the hook and rotate the Loop Control Board downwards as shown in the figure.

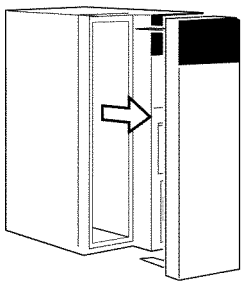


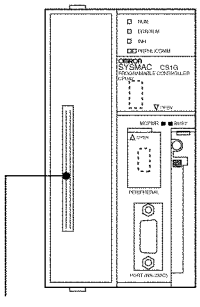
Press the top catch.



Press the bottom catch.

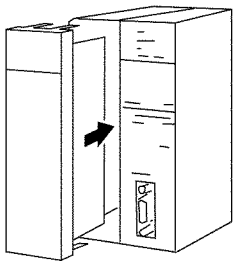
2. Remove the Inner Board compartment cover.





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 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 Control Board 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 Control Board, make sure that the Analog Input/Output Unit is correctly mounted on the same PLC Unit. Even if running of the Loop Control Board 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 3 or Version 2 (embedded) as the communications driver.

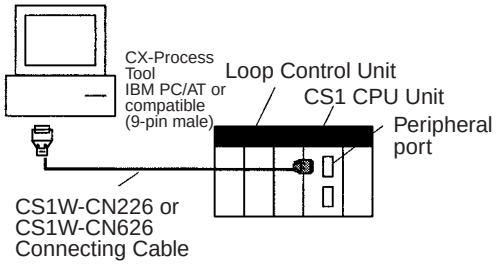
Communications network	FinsGateway communications driver	Contents
Host Link Network (See note.)	Serial Unit Driver	Connecting to the PLC's peripheral or RS-232C port via Host Link.
Controller Link Network	CLK (PCI slot) Driver (Not supported by FinsGateway Version 2)	Connecting through the Controller 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 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.

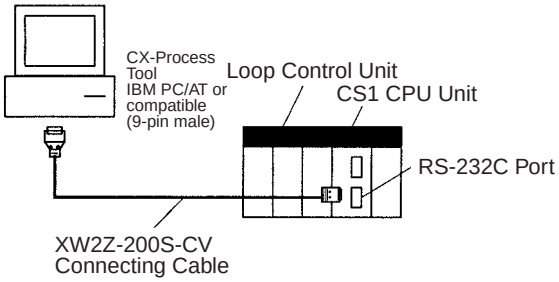
Connecting via Host Link

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

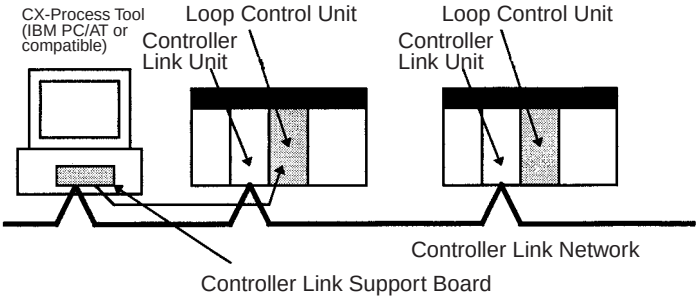


Note

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 3 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		
3G8F5-CLK11	Optical fiber cable	IBM PC/AT or compatible (ISA slot)	Controller Link Driver
3G8F5-CLK21	Wire		

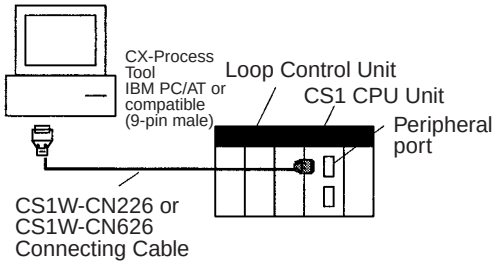
2-3-2 Using CX-Server

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 ***Toolbus***.	Special high-speed communications protocol for Programming Devices	Connect to the PLC's peripheral or RS-232C port.
Host Link (SYSMAC WAY)	Select ***SYSMAC WAY***.	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.

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) or Peripheral Bus (Toolbus)	CS1W-CN118 + XW2Z-200S-CV	0.1 m + (2 or 5 m)	The XW2Z-□□□S-CV is an anti-static connector.
			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 Communications Board or Unit	RS-232C Port Female 9-pin D-SUB		XW2Z-200S-V	2 m	
			XW2Z-500S-V	5 m	

There are two ways of connecting CX-Process Tool to the PLC (Programmable Controller): connecting by Host Link and connecting by the Controller Link Support Board.

Note CX-Process Tool cannot be connected directly to the Loop Control Board.

In either connection, use FinsGateway as the communications driver.

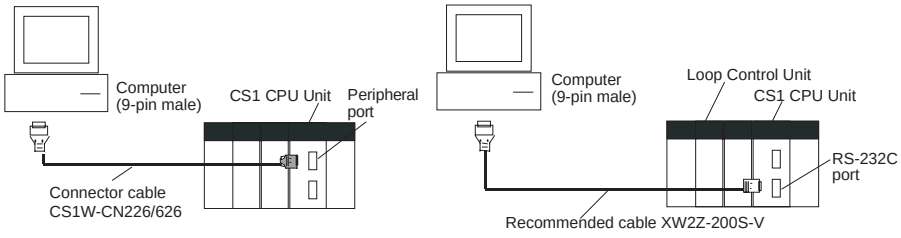
Communications network	Fins Gateway to be used	Description
Host Link	SerialUnit version	Connection to PLC peripheral or RS-232C port (only Host Link connection supported)
Controller Link network	Controller Link version	Connection via Controller Link Support Board to a PLC to which a Controller Link Unit is mounted
Ethernet network	Ethernet version	Connection via an Ethernet port to a PLC to which an Ethernet Unit is mounted

2-3-4 Connecting via Host Link

Use the Fins Gateway Serial Unit version to connect to the peripheral port of the PLC or RS-232C port over the Host Link.

Connect the computer to the RS-232C port of the CPU Unit's peripheral port or to the RS-232C port of the Serial Communications Board/Unit. Note that the computer cannot be connected to the RS-232C port of the Loop Control Board.

- Connecting to the peripheral port of the CPU Unit
- Connecting to the RS-232C port of the CPU Unit or Serial Communications Board/Unit



Note 1. In either of the above connections, the serial communications mode is possible only on the Host Link (SYSMAC WAY), and cannot be connected by the peripheral bus.

If the Fins Gateway Serial Unit version is not installed, connection by the Host Link (SYSMAC WAY) is not supported. (The Fins Gateway Serial Unit version is packed together with CX-Process Tool.)

Even if the CX-Programmer is installed on the computer, connection by the Host Link (SYSMAC WAY) is not supported.

The following table shows the connector cables used for connecting to the computer on which CX-Process Tool is running and to the PLC (CPU Unit or Serial Communications Board/Unit).

Connection port	Serial communications mode	Computer	Length	Model
Connection to CPU Unit peripheral port	Host Link mode	IBM PC/AT or compatible	0.1 m	CS1W-CN118 (Note 2)
			2.0 m	CS1W-CN226
			6.0 m	CS1W-CN626
Connection to CPU Unit or RS-232C port of Serial Communications Board/Unit	Host Link mode	IBM PC/AT or compatible	2.0 m	XW2Z-200S-V
			5.0 m	XW2Z-500S-V

2. The CS1W-CN118 conversion cable is used when the RS-232C cable is connected to the peripheral port of the CPU Unit.
3. Before connecting to the CPU Unit, be sure to set the DIP switch on the front panel of the CPU Unit.

   Connection via peripheral port:Set DIP switch SW4 to ON and set the PLC Setup to Host Link.

   Connection via RS-232C port:Set DIP switch SW5 to OFF.

2-3-5 Connecting by the Controller Link Support Board

Use the FinsGateway Controller Link version to connect to the PLC over the Controller Link network.

Note If the FinsGateway Controller Link version is not installed, connection by the Controller Link is not supported. (The FinsGateway SerialUnit version is packed together with CX-Process Tool.)

Controller Link Units

Model	Mountable PLC	Unit classification	Type	Hardware connection
CS1W-CLK21	CS1	CPU Bus Unit	Wired	Twisted-pair
CS1W-CLK12			Optical ring (H-PCF cable)	H-PCF optical fiber cable
CS1W-CLK52			Optical ring (GI cable)	GI optical fiber cable

Controller Link Support Board

Model	Transmission medium	Applicable computer
3G8F7-CLK12	Optical ring (H-PCF cable)	IBM PC/AT or compatible computer with a PCI bus
3G8F7-CLK52	Optical ring (GI cable)	
3G8F7-CLK21	Wired	
3G8F5-CLK21	Wired	IBM PC/AT or compatible computer with a ISA bus
3G8F5-CLK11	Optical fiber	

SECTION 3
Mechanism of the Loop Control Board

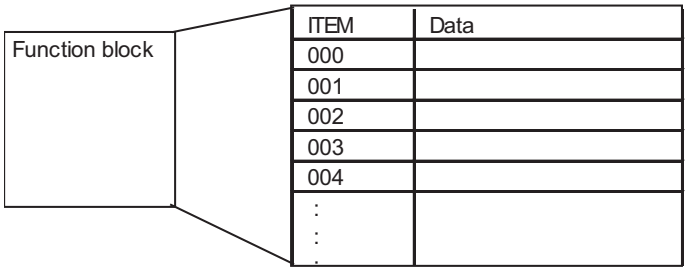
This section describes the operation of the Loop Control Board.

3-1 Configuration of Function Blocks

All Loop Control Board 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.



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 Control Board to enable use of the Loop Control Board. Function block data sheets are prepared as function block files appended with the .ist extension.

Note When the Loop Control Board 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 Control Board.

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	CS1W-LCB05: 001 to 500 CS1W-LCB01: 001 to 050
	Square Root (Block Model 131) and other Operation blocks	
External Controller blocks	External Controller block	601 to 632

Function block type		Allocatable block address
Sequence Control blocks	Step Ladder Program block (Block Model 301)	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.

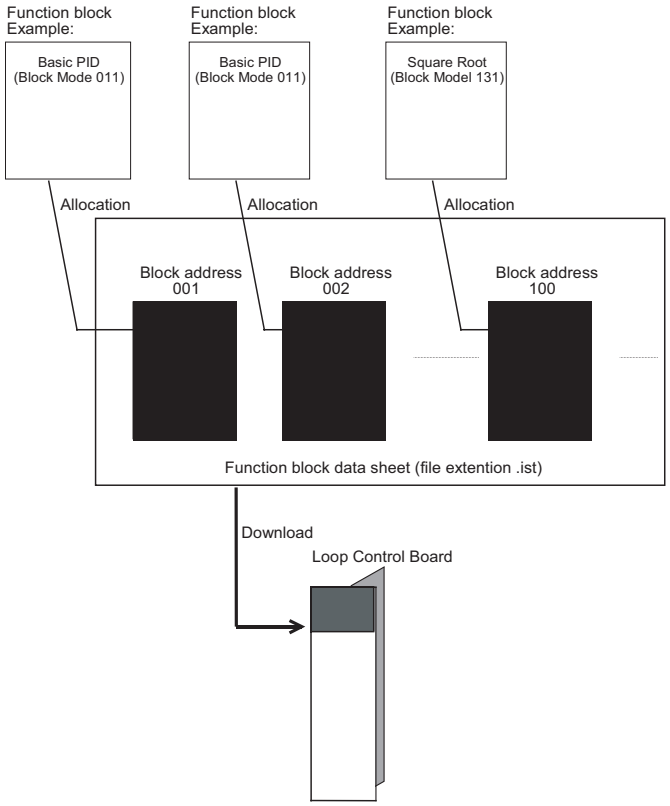
b) Block Model and Block Address

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 Control Board.



3-1-3 ITEMs Common to All Function Blocks

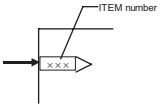
ITEM type	ITEM No.	Name	Description	R/W mode R:Read, W: Write, R/W: R/W-enabled, —:R/W-disabled Note:r and r/w: Read and write for confirmation of CX-Process Tool operation		
				According to CX-Process Tool	**According to ITEM Setting block**	**According to Step Ladder Program**
Contact input	000	Stop 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. **Note** 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. **Note** 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. **Note** For details of error codes, see *7-1 Errors and Alarm Troubleshooting*.	r	---	
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). **Note** 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 Control Board is running.	R/W	---	---

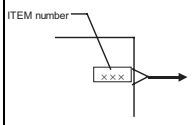
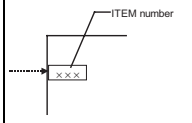
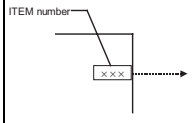
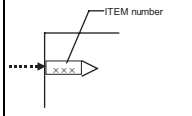
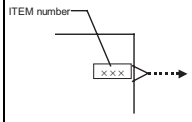
Note ITEM types and settable modes are the same as for individual ITEMs shown in *3-1-4 ITEMs Unique to Individual Function Blocks*. For details of each ITEM type, see the explanation for the individual function block.

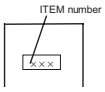
3-1-4 ITEMs Unique to Individual Function Blocks

Internal Operations Blocks

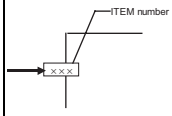
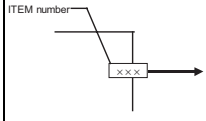
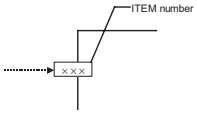
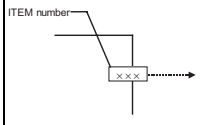
ITEM types are divided according to connection and setup mode.

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). **Note** 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	---

ITEM type	Block diagram symbol	Description	Example	Setting method
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). **Note** 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. **Note** 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	Basically, no symbol in block diagram (expressed as follows in some cases as an explanation) 	This is internal data upon which neither the above-described analog input/output nor contact input/output operations are performed. 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.			
			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). Note: 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	Block diagram symbol	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

a) Upload/download of function block files (appended with the .ist extension)

b) 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

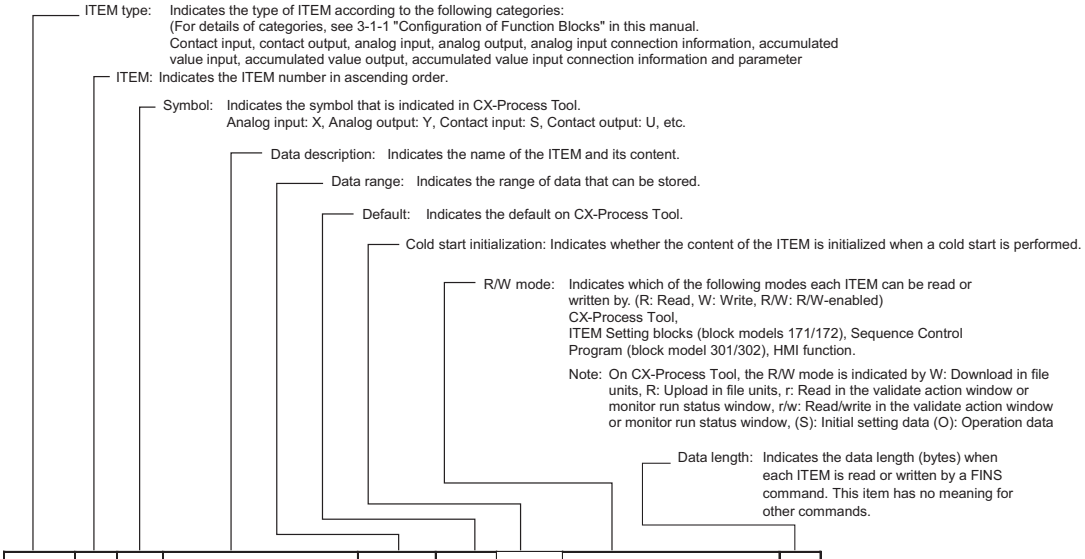
(S): Initial setting data, (O): Operation data

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. Data Link Tables for SCADA Software
   This indicates sending/receiving data for the CPU Unit using data link tables.



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 Note: r and r/w: Read and read/write for validate actionor monitor run status by CX-Process Tool. S: Initial setting data, (O): O peration				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	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).

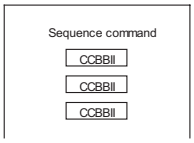
All ITEMs excluding the following items can be read and written by FINS commands:

- Sequence commands (ITEM011 onwards) of Step Ladder Program block (Block Model 301) and Sequence Table (Block Model 302) rules

Note All analog signals on the Loop Control Board 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%.)

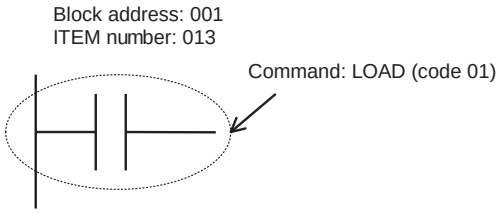
ITEMs in the Step Ladder Program block

The table below shows the content of the 100 ITEMs ITEM011 to ITEM110 in the case of the Step Ladder Program block (Block Model 301).

ITEM type	Block diagram symbol	Description	Setting method
Sequence command	 **Note** CC: Command code, BB: Block address, II: ITEM No.	• ITEM011 to ITEM110 correspond to individual commands. • A single command (e.g. LOAD, OUT) is described to a single ITEM, and the block address and ITEM number of the specified input source and output destination are described as operands. • Commands are described using command codes 01 to 30 (e.g. LOAD is 01 and OUT is 07).	Describe commands to ITEM011 to ITEM110 of the Step Ladder Program block (Block Model 301).

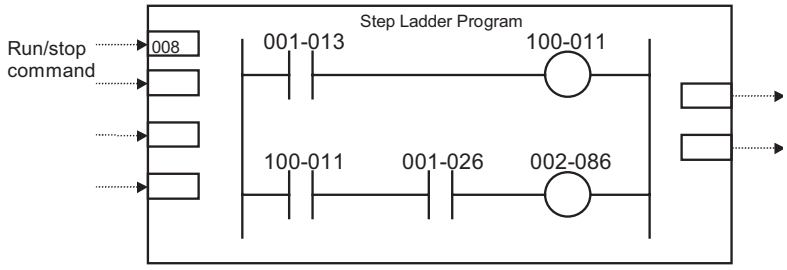
Example of a single command

ITEM	Command code (command)	Operand
011	01 (LOAD)	001 013 (block address, ITEM No.)



Example of multiple commands

ITEM	Command code (command)	Operand
011	01 (LOAD)	001013 (block address, ITEM No.)
012	07 (OUT)	100011 (block address, ITEM No.)
013	01 (LOAD)	100011 (block address, ITEM No.)
014	03 (AND)	001026 (block address, ITEM No.)
015	07 (OUT)	002086 (block address, ITEM No.)
016	000 (END)	(end of block)



• 100-011 turns ON at 001-013 ON.
• 002-086 turns ON at 100-011 ON and 001-026 ON.

3-1-5 Connecting Function Blocks

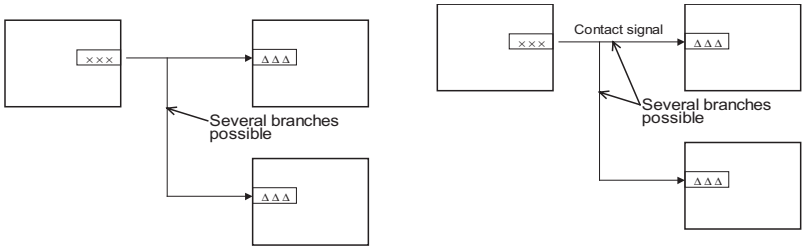
• For analog signals (variables) and accumulated value signals, specify the block address and ITEM number of the source designation in the ITEMs of the send destination block.

- 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.

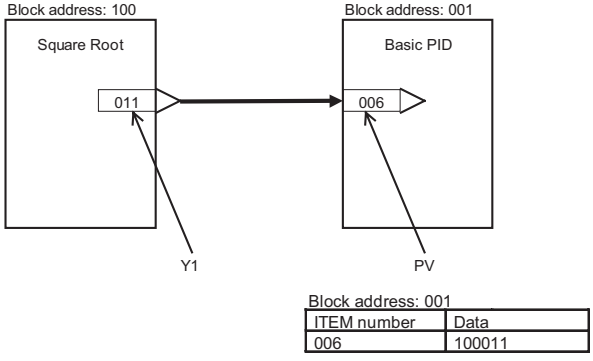


Connecting analog signals (variables) and accumulated value signals

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.

Example

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.



Block address: 001

ITEM number	Data
006	100011

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.

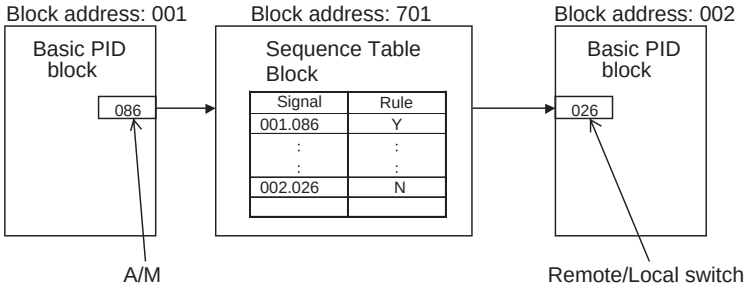
Connecting via a Sequence Table block or Step Ladder Program block

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

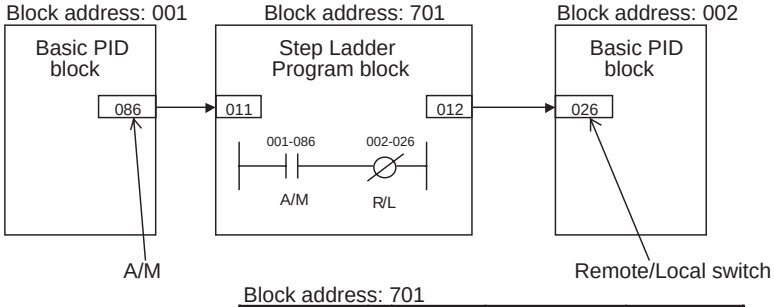
Example

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

■ Using A Sequence Table



■ Using A Step Ladder Program



Block address: 701

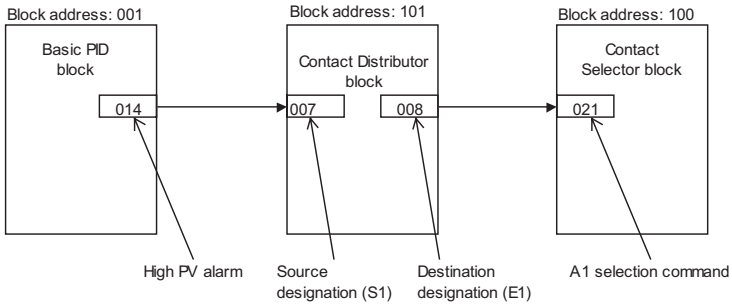
ITEM number	Command	Command code	Operand
011	LOAD	01	001086
012	OUT NOT	12	002026

Connecting via the Contact Distributor block

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

Example

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.



Block address: 101

ITEM number	Data
007	001014
008	100021

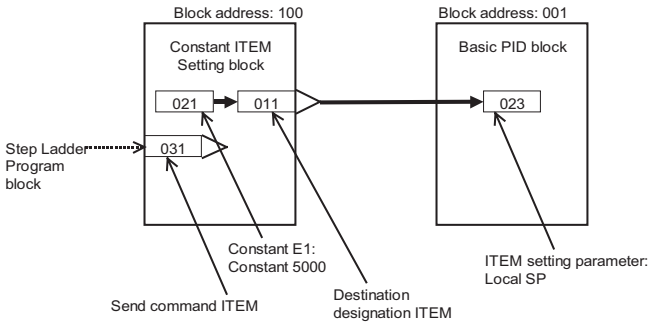
Connecting ITEM settable parameters

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.



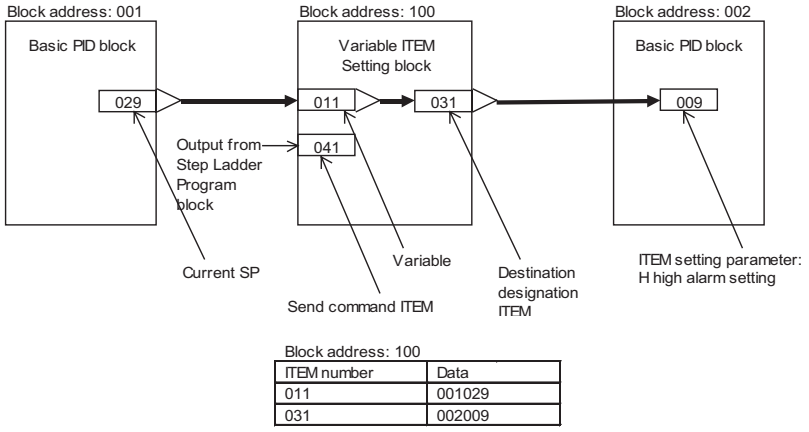
Block address: 100

ITEM number	Data
011	001023
021	5000

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 Control Board 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 Control Board.

Status after function block data is downloaded

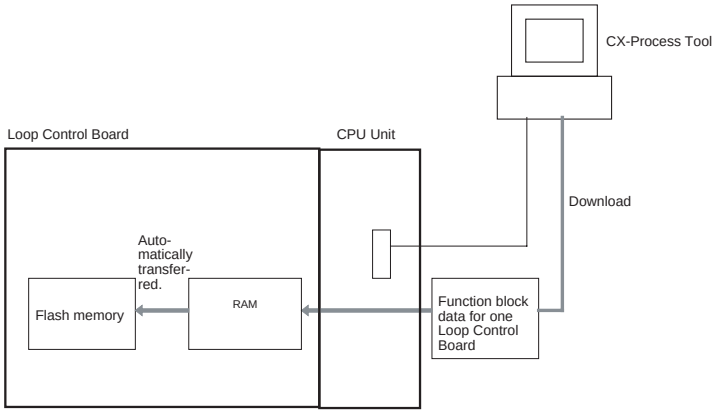
■ **Operating status**

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

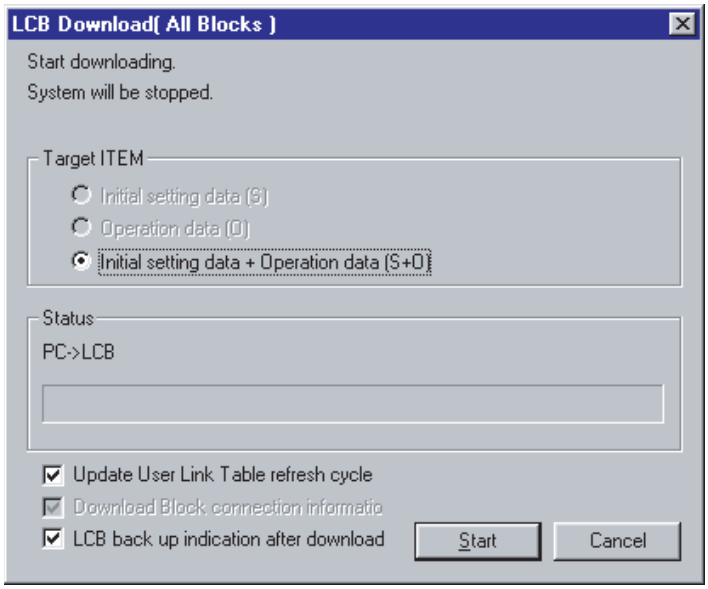
Note The Loop Control Board will also be stopped after the CX-Process Tool is used to recover flash memory data to the RAM.

■ **Status of stored data**

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



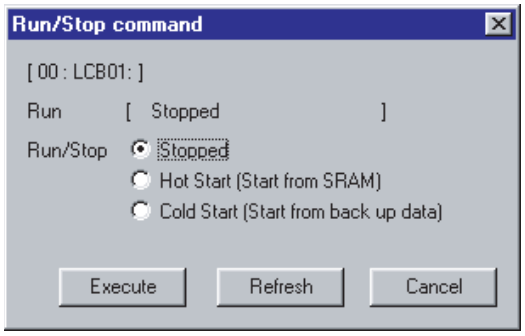
Note If the LCB back up indication after download selection is checkmarked (checkmarked by default), the function block data will automatically be transferred to flash memory for backup.



Starting operation after transferring function block data

Use one of the following methods to start Loop Control Board 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 Control Board:

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 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).
4. The defaults of the System Common block on the Loop Control Board must be set correctly.

⚠WARNING Always stop the operation of the Loop Control Board before converting any of the EM Area to file memory. If any part of the EM Area that is being used by the Loop Control Board 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 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).

Selecting the START mode at power ON

■ Power OFF for less than 24 hours (backup capacitor not discharged)

Use the CX-Process Tool to set ITEM018 (START mode at power ON) in the System Common block (Block Model 000) to either a cold start or hot start. The START mode applies to Loop Control Board startups when the Loop Control Board is turned ON (PC power is turned ON) or the Loop Control Board is restarted (A60800, the Inner Board Restart Bit, is turned from OFF to ON).

ITEM018	Content
1	Hot start (default setting)
2	Cold start
3	Specification from CPU Unit (A60901 indicates hot start and A60902 indicates cold start.)

With the default settings, the Loop Control Board performs a hot start when the power is turned ON or the Board itself is restarted.

When a hot start is performed, operations will start with all ITEMs and function block values held at the values that existed before the power was turned OFF or the Board was restarted. The EXEC LED Indicator on the front panel will light at the same time. The Loop Control Board's RAM is backed up by a capacitor that lasts for 24 hours, so a hot start cannot be performed more than 24 hours after power is turned OFF.

■ Power OFF for more than 24 hours (backup capacitor discharged)

If the Loop Control Board is started (PC power is turned ON or the Board is restarted) after the power has been OFF for more than about 24 hours and the backup capacitor has discharged, the Loop Control Board will automatically perform a cold start regardless of the setting in ITEM018.

Relationship with the operation mode of the CPU Unit

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

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

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)
RAM	Flash memory						
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
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 Note: The following steps are required to restore operation: Download data to the Loop Control Board (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 Control Board can start operation: either a hot start or a cold start. With the default settings, the Loop Control Board will perform a hot start when the power is turned ON or the Board is restarted.

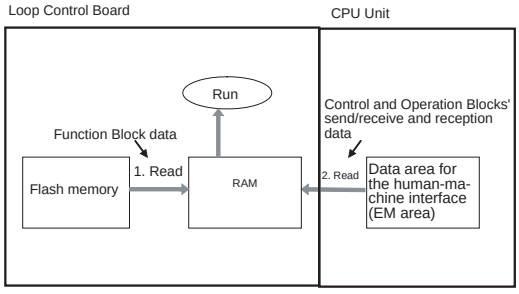
If there is an error in the RAM data due to a discharged backup capacitor or other cause, the Loop Control Board will recover the backup data from flash memory and perform a cold start.

■ 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.

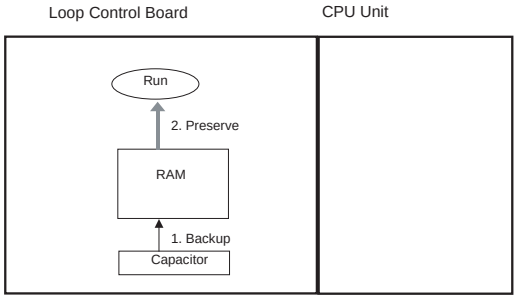


■ Hot Start

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.)

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.



The following table describes each of the Loop Control Board 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	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	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		STEP01		
Sequence Table		STEP00 and STEP01		
Data exchange with CPU Unit	Status of Loop Control Board (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.)

*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

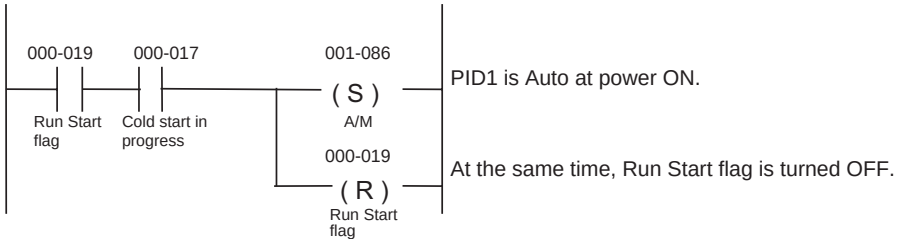
1. When the START mode at power ON is set to hot start, correct operation results cannot be obtained if the power is turned ON after a long power OFF. For this reason, use CX-Process Tool to stop running of the Loop Control Board and start the Board in the cold start mode to clear old data held internally in function blocks that was active before the power was turned OFF.
2. By a cold start, the Basic PID block (Block Model 011) or Advanced PID block (Block Model 012) are set to Manual. Perform either of the following operations after turning the PLC power ON or restarting the Loop Control Board to set the Basic PID block (Block Model 011) or Advanced PID block (Block Model 012) on the Unit to Auto.
   - Switch the Manual mode to the Auto mode using SCADA software.
   - Switch the Manual mode to the Auto mode in the Sequence Table (Block Model 302) or Step Ladder Program block (Block Model 301)

     In this operation, the ladders in the Sequence Table or Step Ladder Program block must be programmed as follows so that ITEM086 (Auto/Manual switch) of the Basic PID block or Advanced PID block is set to 1 taking 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		Y
000.017		Y
:		
:		
001.086		Y
000.019		N
:		
:		
NEXT STEP	THEN	
	ELSE	

Step ladder program



3. All function blocks are executed at all times by turning the PLC power ON or restarting the Loop Control Board.

   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 Control Board 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.

Flash memory to RAM recovery operation

The Loop Control Board 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 Control Board 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 Indicating Board run/stop (all function blocks)

Running of the Loop Control Board is started according to the START mode at power ON by turning ON the power to the PLC or by restarting the Loop Control Board.

There are three ways of indicating run/stop of the Loop Control Board (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 Control Board is already running.
3. 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.

3-2-6 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.

1,2,3...

1. By CX-Process Tool (Both operation can be stopped and operation stop canceled in the Monitor run status screen.)
2. 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)
3. HMI function

Note

1. Be sure to set 0 to ITEM000 of the System Common block (Block Model 000). If this ITEM is set to 1, the Loop Control Board stops running, and data exchange with the CPU Unit is stopped.
2. 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)		

3-2-6-1 Indicating Board start/stop from the CPU Unit

Start/stop of running of all function blocks

To instruct Loop Control Board start/stop under certain conditions by the CPU Unit, execute the CMND command in the Step Ladder Program on the Loop Control Board, and issue the FINS WRITE ITEM command (command codes 0241 or 0243 Hex) to change ITEM014 (run/stop command) of the System Common block.

3-2-7 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 Control Board can be monitored by one of the following methods.

Check method		Running	Stopped
1.	RUN LED on front panel of Loop Control Board	Lit	Out
2.	Monitor the run status ([Execute]-[Run]-[Monitor run status]) 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 Control Board is “running.”

	Method	Running	Stopped
1.	Monitor the run status ([Monitor run status]-[Start]) on CX-Process Tool	No indication	“Stopped” indicated
2.	ITEM000 of each function block	0 (OFF)	1 (ON)

3-2-8 Relationship between CPU Unit states and Loop Control Board States

3-2-8-1 Conditions for stopping and continuing running

Running of the Loop Control Board is stopped or continued under the following conditions.

Running stop conditions	Running continuation conditions

• When the following malfunctions occur:
  • Initial recognition error
  • Unit error
  • Function block database error (when all function blocks are in error)
  • CPU Unit error (WDT error, cyclic monitor error, bus error)
  • CPU of CPU Unit in standby mode
  • CPU Unit fatal error (including execution of FALS command)
	• When the following malfunctions occur:
	  • Function block database error (when only a specific function block is in error)
	  • CPU Unit non-fatal error (including execution of the FAL command)
	• When CPU is in one of PROGRAM, RUN or MONITOR modes
	• When output of the CPU Unit is OFF (Output OFF flag is ON)

Note The High Load Alarm Flag (A42408) turns ON if the LCB load rate exceeds 80% three times consecutively. The Loop Control Board will continue operation. (For details, *3-2-12 About the LCB Load Rate*.)

3-2-8-2 Operation of the Loop Control Board 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 Control Board 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 Control Board has stopped.

3-2-8-3 Operation of the Loop Control Board when the CPU Unit is in the PROGRAM mode

The Loop Control Board continues to run even if the CPU Unit is in the PROGRAM mode.

3-2-8-4 Operation of the Loop Control Board when the CPU Unit is in the Output OFF condition

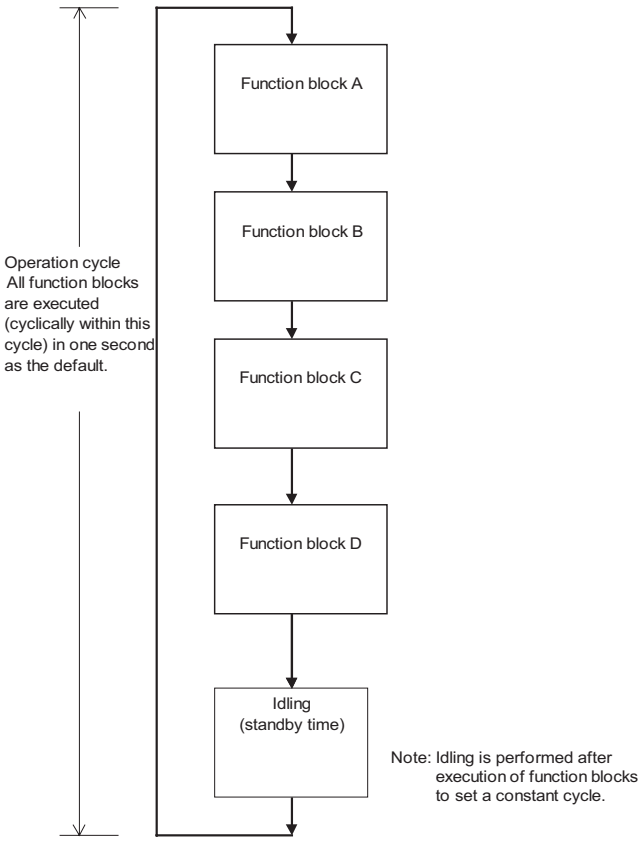
The Loop Control Board continues to run even if the Output OFF flag causes output refreshing of the CPU Unit to stop. Note, however, that in this case contacts are not output and turn OFF, and the output hold function of the Analog Output Unit holds analog output to a specific value. For this reason, the Loop Control Board only performs internal operations, and does not perform control on the outside.

3-2-9 Specifying the Operation Cycle

All of the function blocks (for example, all Field Terminals and the Step Ladder Program block) on the Loop Control Board 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.



3-2-9-1 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)

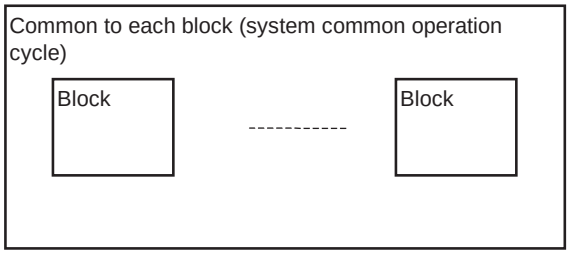
Ramp Program (Block Model 155)

Segment Program (Block Model 156)

Segment Program 2 (Block Model 157)

Time Sequence Data Statistics (Block Model 153)

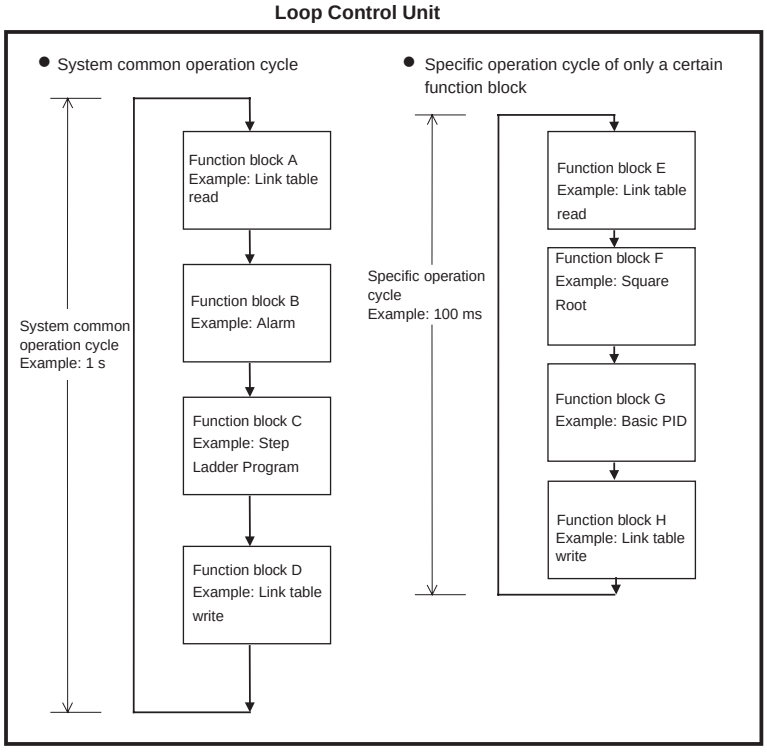
Note Before changing ITEM004 (system common operation cycle) of the System Common block (Block Model 000), be sure to stop running of the Loop Control Board, and then resume running of the Unit in the cold start mode. Otherwise, the Unit does not function normally.



3-2-9-2 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.



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 Control Board
- The minimum resolution (time accuracy) of Timer and Counter blocks on the Loop Control Board 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.

3-2-10 Conditions for Determining the Operation Cycle

The following two conditions must be satisfied on the Loop Control Board when determining the operation cycle:

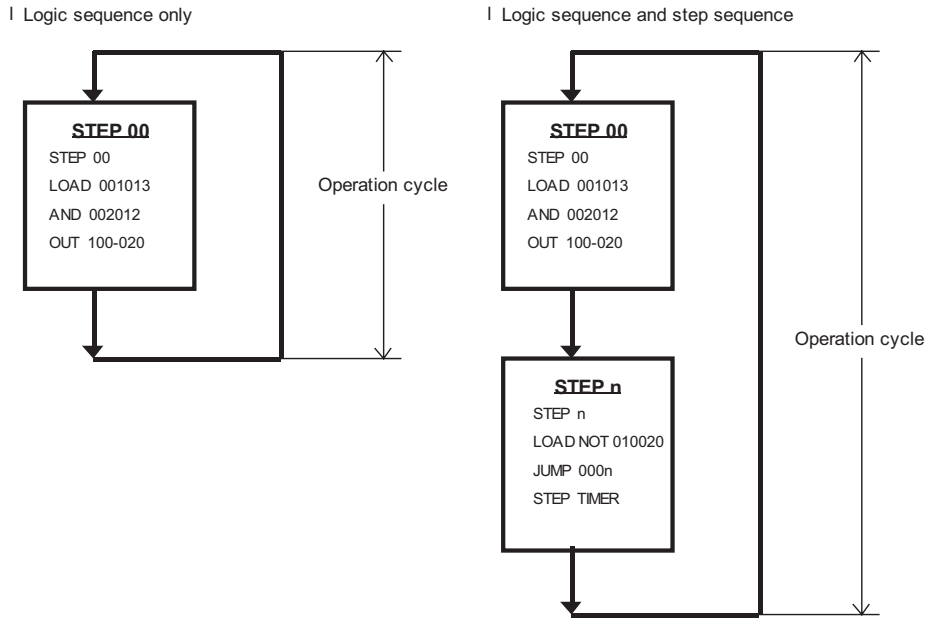
1,2,3...

1. The LCB load rate (ratio between actual operation execution time and set operation time) must be 80% or less. (For details, *3-2-12 About the LCB Load Rate* on page 86.)
2. The external I/O response cycle of the entire system must not be same as the operation cycle of the function blocks. In most cases (i.e., when the operation cycle is 100 ms or more), the maximum external I/O response cycle is as follows depending on the timing of operations:

   Cycle time of the CPU Unit + twice the operation cycle of the function blocks on the Loop Control Board

   Study whether or not any problems will arise in controllability of PID control on the target application. (For details, see *3-2-13 External I/O Response Cycle on the Overall System*.)

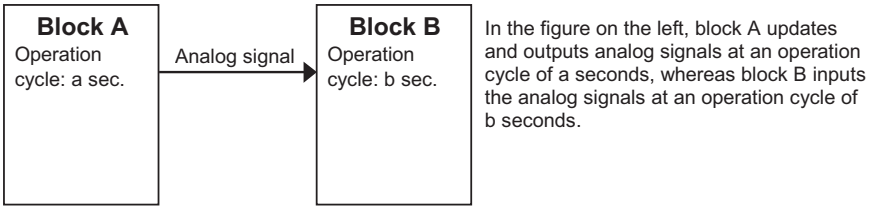
Note The execution cycle of sequence commands in the Step Ladder Program block depends on the operation cycle of the Step Ladder Program block (Block Model 301) itself. So, the operation cycle is slower than the execution cycle (cycle time) of commands on the CPU Unit. For this reason, the Step Ladder Program block is used in combination with other function blocks. When high-speed processing is required, use commands on the CPU Unit.



3. 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.

3-2-10-1 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 *3-2-11 Order of Operations* below.

User link tables are downloaded from the CX-Process with the shortest operation cycle of any of the connected blocks.

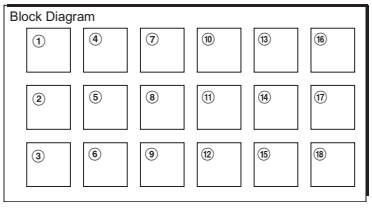
3-2-11 Order of Operations

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:

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
   a) 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.
   - When using 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.
   - 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.



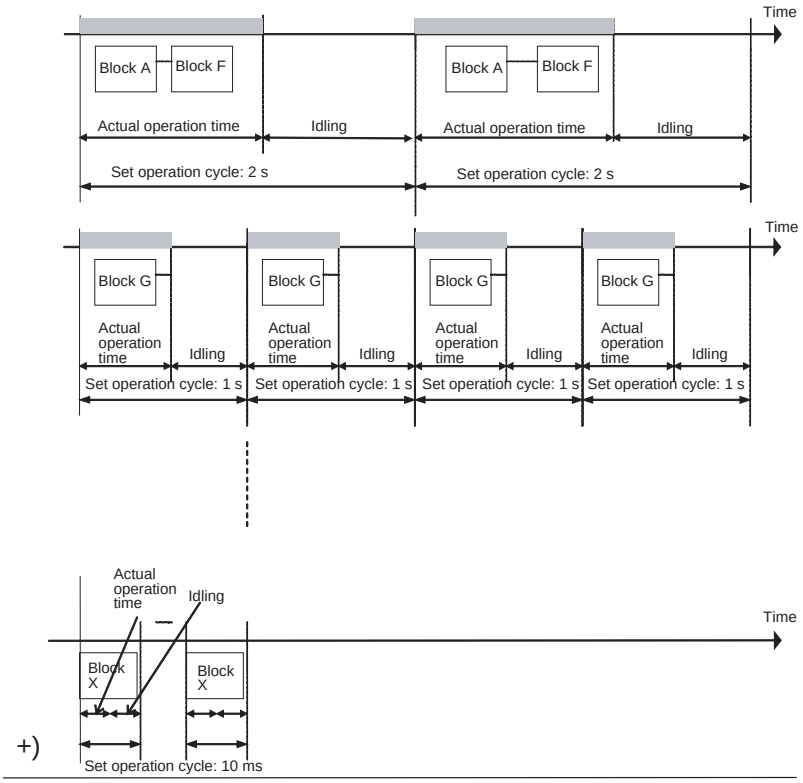
   Note If the same function block is in more than one block diagram, it will be executed in the block diagram with the smallest number.
   b) External Controller blocks are executed in order of block address. Only one External Controller block is executed each cycle.
   c) Sequence Table and Step Ladder 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)

3-2-12 About the LCB Load Rate

The minimum operation cycle of each of the function blocks on the Loop Control Board can be set to 0.1 seconds. However, when many function blocks are used, the processing capability of the Loop Control Board prevents processing at the specified operation cycle. For this reason, the Loop Control Board 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 *3-2-10 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.

$$\text{LCB load rate} = \sum \frac{\text{Actual operation time}}{\text{Set operation cycle}} + \text{Fixed load rate}$$



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

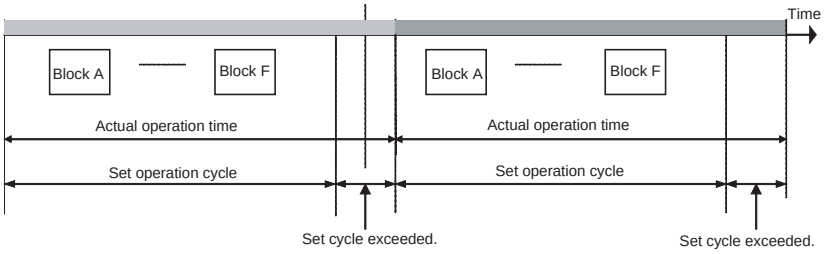
3-2-12-1 Evaluating the LCB load rate at the system design stage

The guideline LCB load rate for function blocks on the Loop Control Board 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 Control Board 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 Execution 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 Loop Control Units and separate process to them (up to three Loop Control Units can be added to one PLC).

3-2-12-2 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 Control Board.

2. Start running of the Loop Control Board 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 sec./0.2 sec./0.5 sec./ 1 sec./2 sec. 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 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 Loop Control Boards 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% three times consecutively. If this bit turns ON, use longer operation cycles or add Loop Control Units to distribute processing.

3-2-13 External I/O Response Cycle on the Overall System

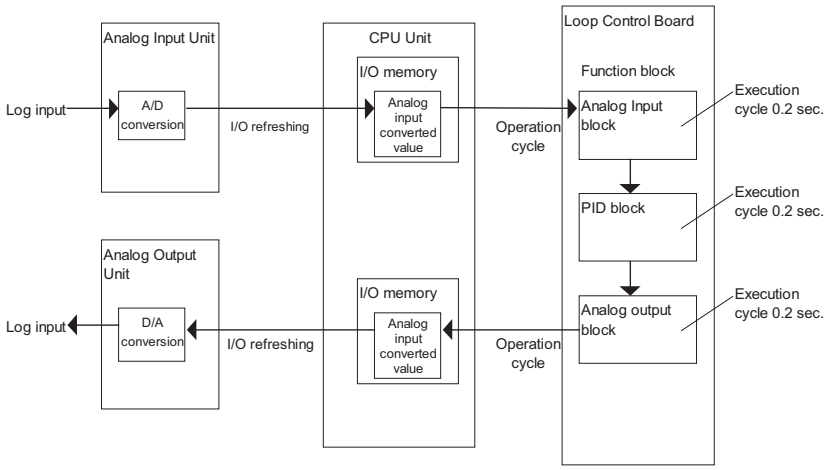
The Loop Control Board exchanges field I/O values (analog input values, analog output values, contact inputs and contact outputs) with external Units by the following method.

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 Control Board 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



Here, the external I/O response time on the overall system (simply called the external I/O response time from here on) refers to the time up to when PID operation is performed and the Analog Input/Output Unit outputs the analog output values after the Analog Input Unit starts to read analog input values. (This fresh cycle indicates the response of the overall system.)

Note The external I/O response time is equivalent to the I/O response time (or operation cycle) on a general controller. For this reason, when designing the system, calculate the external I/O response time according to the formula shown below, and study whether or not there will be any problem in controllability on the target application. In most cases, the maximum external I/O response time is as follows depending on the timing of operations:

Cycle time of the CPU Unit + Twice the operation cycles of the function blocks on the Loop Control Board

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.

3-2-13-1 Maximum external I/O response time (for CS1-H CPU Unit)

The maximum external I/O response time is calculated as follows:

2 x A/D conversion time + (CY) + (2 x T) + 2 x 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 10 ms, use 10 ms for CY 9cycle time).

∗2: Longest operation cycle in the function block group comprising the loop

Example

Cycle time of 15 ms, max. operation cycle of 0.2 seconds (200 ms), A/D conversion time = 8 ms, D/A conversion time = 8 ms, Analog Input Unit and Analog Output Units are separate units

In this example, the maximum I/O response time would be as follows:

2 x 8 ms + (15 ms) + (2 x 200 ms) +15 ms + 2 x 8 ms = 462 ms

3-2-13-2 Minimum external I/O response time

The minimum external I/O response time is calculated as follows:

A/D conversion time + (1.0 x T) + D/A conversion time

where,

T: Max. operation time (∗1)

∗1: Longest operation cycle in the function block group comprising the loop

Example Cycle time of 15 ms, max. operation cycle of 0.01 seconds (10 ms), A/D conversion time = 1 ms, D/A conversion time = 1 ms, Analog Input Unit and Analog Output Units are separate units

In this example, the maximum I/O response time would be as follows:

1 ms + (15 ms) + (1.0 x 10 ms) +1 ms = 18 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 Control Board is started using the Field Terminals, the Loop Control Board 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 Control Board, 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 Control Board

Model	Function block name	Target Analog Input/Output Unit	Internal writing by Loop Control Board	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.

Model	Function block name	Target Analog Input/Output Unit	Internal writing by Loop Control Board	Writing of analog values
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.

Note Field Terminals that do not undergo writing by the Loop Control Board

Model	Function block name	Target Analog Input/Output Unit	Internal writing by Loop Control Board	Writing of analog values
551	AI 8-point Terminal (AD003)	C200H-AD003	None	None
561	AI 4-point Terminal (PTS01/02/03, PDC01, PTW01)	CS1W-PTS01 (isolated-type thermocouple input), CS1W-PTS02/03 (isolated-type temperature-resistance thermometer), CS1W-PDC01 (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)		
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 Control Board 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 Control Board) 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 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 Control Board) 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 Control Board exchanges the following two types of data with the CPU Unit:

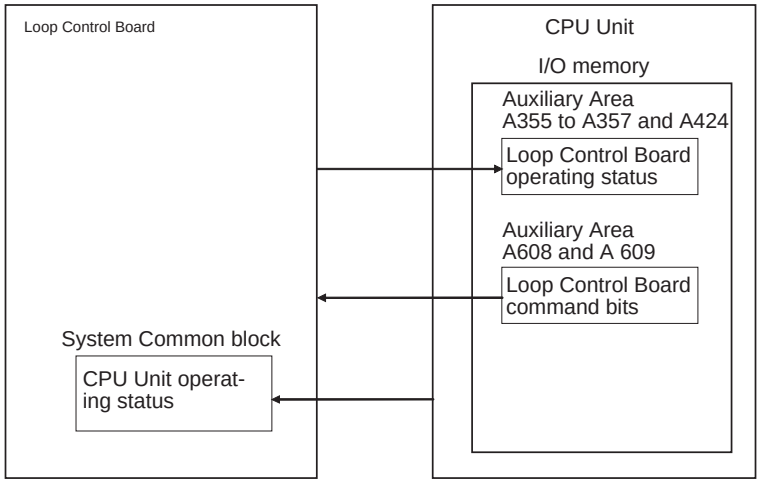
1. Mutual exchange of run status
2. Commands from CPU Unit to Loop Control Board
3. Exchange of any data

3-3-1 Mutual Exchange of Run Status

The run status of the Loop Control Board and the CPU Unit can be monitored mutually by the following two areas:

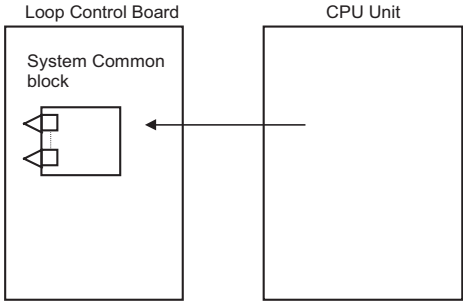
- Allocated CIO area for CPU Bus Unit: Run status of Loop Control Board is sent to the CPU Unit.
- System Common blocks (Block Model 000): Run status of the CPU Unit is sent to the Loop Control Board.

Note The system information and Node Terminal data are also reflected in the Data Memory for the Node Terminals. These data, however, are exclusively for CX-Process Monitor.



3-3-1-1 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 Control Board 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

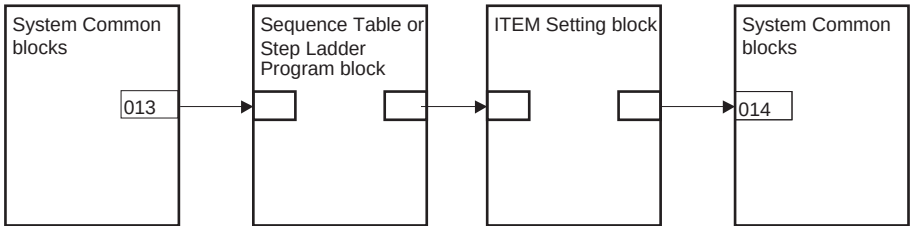
To perform processing on the Loop Control Board according to the run status of the CPU Unit

To perform specific processing on the Loop Control Board 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 Control Board 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).

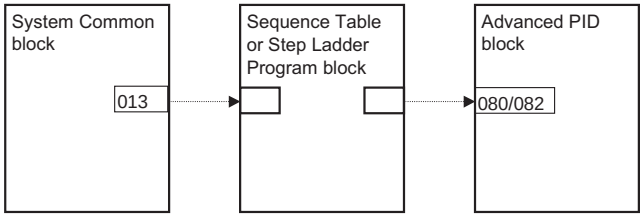


Note When ITEM014 (run/stop command) of the System Common block is set to 0, the Loop Control Board will not start to run as it is even if the CPU Unit operation mode is set to RUN or MONITOR. To resume running of the Loop Control Board, ITEM014 (run/stop command) of the System Common block must be set to either 1 (hot start) or 0 (cold start).

Example

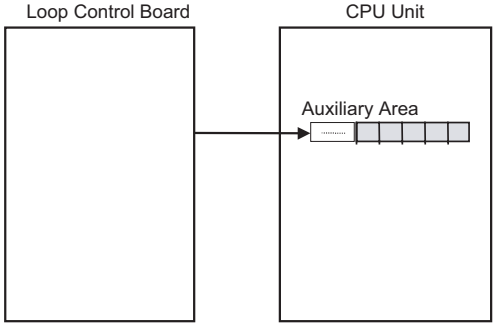
To indicate switching to the preset MV value of PID control or MV hold in the System Common block

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.



3-3-1-2 Run status of Loop Control Board

The run status of the Loop Control Board 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 Control Board, 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).

To perform processing from the CPU Unit according to the run status of the Loop Control Board

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 Control Board, create a Step Ladder Program taking bits A35800 to A35815.

Example 1: To perform processing when the Loop Control Board has stopped running

Execution of a specific process is enabled as follows when the Loop Control Board has stopped running or a data exchange error has occurred with the CPU Unit functioning as a Inner Board:

Example 2: To notify that function blocks have changed while the Loop Control Board was running.

If a function block is changed from the CX-Process Tool during Loop Control Board operation, notification is made by creating a warning or other indication of the change.

3-3-1-3 Auxiliary Area Flags Relevant to the Loop Control Board

Flags (Loop Control Board to CPU Unit)

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. Note: 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. Note: 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. Note: When an execution error has occurred (there is an error code other than 0), refer to *7-1 Errors and Alarm Troubleshooting* 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 Control Board's RAM has been corrupted due to a discharged backup capacitor or other cause. If the function block data in RAM is invalid, a cold start will be performed even if a hot start is specified. Note: When an error has occurred, use the CX-Process Tool to execute the ***Clear All***, ***Download***, or ***Recovery*** 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 even though a hot start was specified because the RAM data was invalid due to a discharged backup capacitor or other cause (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 even though a hot start was specified. 0: Automatic cold start not executed.
	11	Run Status Flag	This flag notifies the CPU Unit that the Loop Control Board is running. The flag is 1 (ON) when the Board is running.	1: Loop Control Board running 0: Stopped
	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 Control Board 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 Control Board has been executed). Note: 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 ***Backup*** 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 A401	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 015)	1: At or below the set value 0: Above the set value
	04		Low Limit Alarm Flag (L: ITEM 016)	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 (HHÅFITEM013Åj	1: At or above the set value 0: Below the set value
	12	Inner Board Stopped Error Flag (Fatal error)	This flag is set to 1 (ON) when an error occurs in the Loop Control Board 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. Note 1: 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. Note 2: The cause of the error is indicated in bits A42400 to A42403.	1: Error occurred 0: Normal
A402	08	Inner Board Error Flag (Non-fatal error)	This flag is set to 1 (ON) when an error occurs in the data exchange between the Loop Control Board and CPU Unit (including errors originating in the Loop Control Board itself). The CPU Unit will continue running and the ERR/ALM Indicator on the front of the CPU Unit will flash. The Loop Control Board will stop operating. Note 1: The cause of the error is indicated in bits A42404 to A42415. Note 2: This flag will be reset to 0 (OFF) when the error is cleared.	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 Control Boards.)	---
	00	Inner Board WDT Error Flag (fatal error)	This flag is set to 1 (ON) if the Loop Control Board 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
	03	Flash Memory Data Error Flag (fatal error)	This flag is set to 1 (ON) when a cold start is performed but the data in flash memory is invalid. Either download the function block data (for the Loop Control Board) again from the CX-Process Tool or backup the data to flash memory.	1: Flash memory data invalid 0: Flash memory data valid
	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. Note: 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. 0: Normal
	05	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 Control Board within the cyclic monitor time.	1: Cyclic Monitor Error 0: Normal
	06	CPU Bus Unit Settings Area Error Flag	(Does not apply to the Loop Control Board.)	---
	07	Routing Table Error Flag	(Does not apply to the Loop Control Board.)	---
	08	Loop Control Board 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 Control Board running at a high load rate 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 15	Not used.	---	---

3-3-2 Commands from the CPU Unit to the Loop Control Board

The Loop Control Board's start mode at power ON can be specified from the CPU Unit.

3-3-2-1 Auxiliary Area Control Bits Relevant to the Loop Control Board

Control Bits (CPU Unit to Loop Control Board)

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 Control Board. (The Loop Control Board will start initialization.) Note: The bit will be reset to 0 (OFF) automatically when initialization is completed.	0 → 1: Restarts the Inner Board	Pre-served	Cleared	
A609	01	Start Mode at Power ON: Hot Start	When this bit is set to 1 (ON), the Loop Control Board's "start mode at power ON" will be hot start mode (as a command from the CPU Unit to the Loop Control Board.) This bit is effective only when ITEM018 of the System Control block (block model 000) is set to 3 (command from CPU Unit.) Note: 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
A609	02	Start Mode at Power ON: Cold Start	When this bit is set to 1 (ON), the Loop Control Board's "start mode at power ON" will be cold start mode (as a command from the CPU Unit to the Loop Control Board.) This bit is effective only when ITEM018 of the System Control block (block model 000) is set to 3 (command from CPU Unit.) Note: 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 Control Board 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 Control Board can exchange any kind of data with the CPU Unit by either of the following two methods.

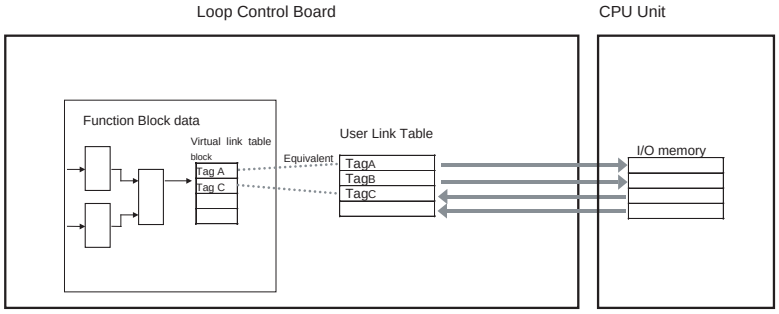
- Exchanging data regularly or for a specified condition (when a function block ITEM goes ON):
  Use the User Link Table (i.e., register a tag in the User Link Table and use that tag in the function block).
- Exchanging data with the CPU Unit only when required:
  Use a CMND(490) instruction in the user program to send a FINS command to the Loop Control Board.

  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 Control Board 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.

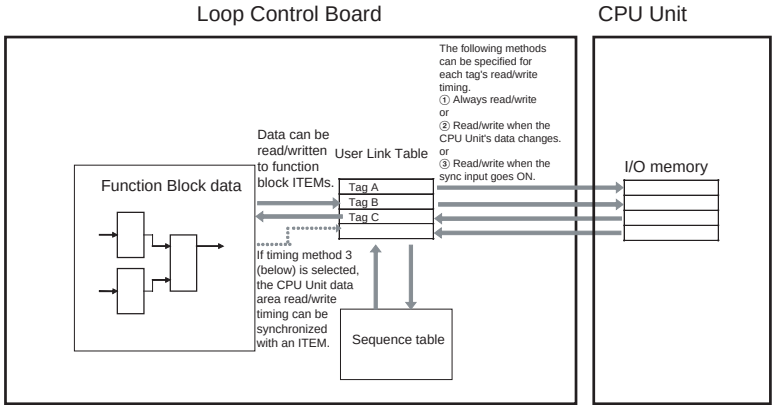
Each tag can read or write data in the specified CPU Unit I/O memory for the specified conditions. It is also possible to exchange data regularly or refresh a particular function block's ITEM data when there is a change in the CPU Unit's I/O memory. Up to 2,400 tags can be created.

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 Control Board 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

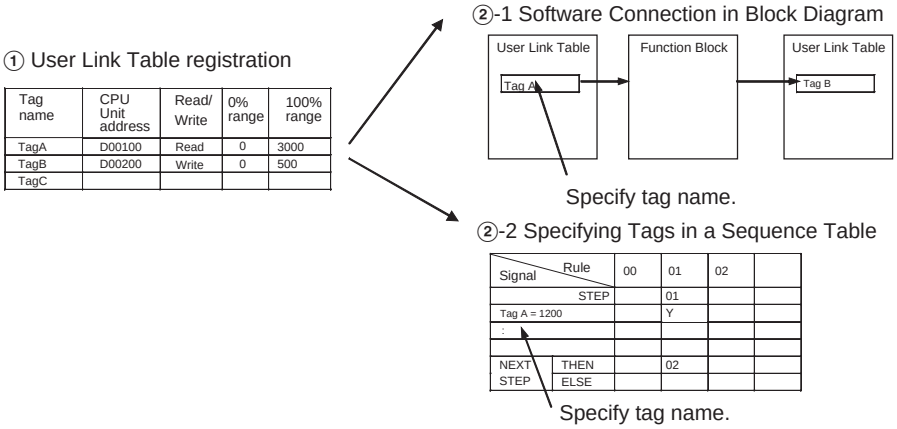
Use the following procedure:

1,2,3...

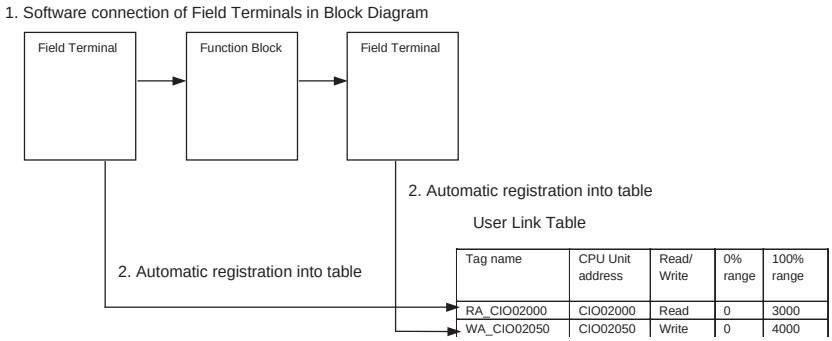
1. Register the CPU Unit I/O memory address that will be read/written from the Loop Control Board in the User Link Table.

2-a. 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-b. 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 Control Board 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.

Creating the User Link Table with the CX-Process Tool

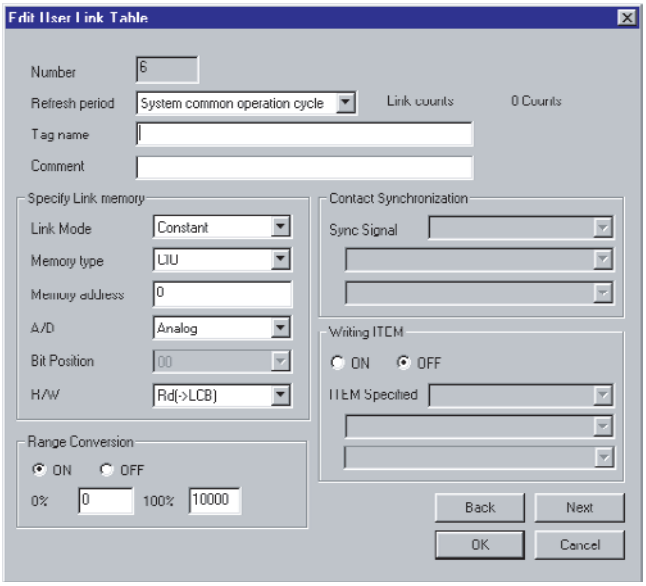
Use one of the following methods to create a user link table.

- Method 1: Registration on the User Link Table Edit Screen
- Method 2: Registration from the Block Diagram
- Method 3: Automatic Registration when Pasting Field Terminal Block and Creating Software Connections

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
Refresh Period		The refresh period for CPU Unit data. The period 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 (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 ***Update User Link Table Refresh Cycle*** selection checkmarked 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.)
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
	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 LCB)
		Wr (From LCB)
Range Conversion		ON/OFF 0% value and 100% value
Contact Synchronization	Sync Signal	ITEM specified (function block address and ITEM number)
Writing ITEM, ITEM Specified		ON/OFF Specify a read ITEM and/or WRITE item (function block address and ITEM number)

3. Method 3: Automatic Registration when Pasting Field Terminal Block and Creating Software Connections
   a) Right-click from the User Link Table Edit Screen and select ***Field Terminal/Auto-Registration Mode.***
   b) Paste the function block on the block diagram.

c) When software connections are made, the ITEMs that are connected to the field terminal block will be automatically registered in the user link table.

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

Note 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.

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 Control Board.

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.

d) Constant: Data is read/written every refresh period.
or

e) At Change: Data is read/written only when the CPU Unit's I/O memory contents have changed.
or

f) External Sync: Data is read/written every refresh period while the specified external sync input is ON.

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 Control Board or written from the Loop Control Board 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.

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).

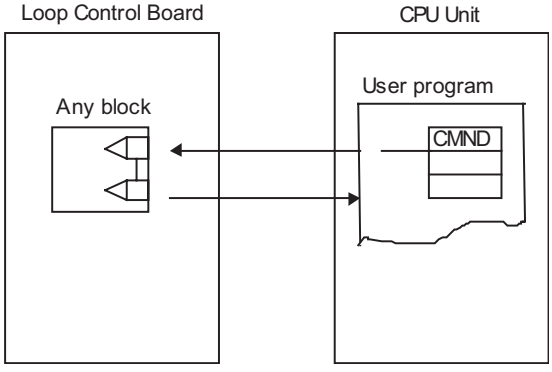
Note To set **Field Terminal/Auto-Registration Mode**, click the right mouse button in the User Link Table edit window, and select **Field Terminal/Auto-Registration Mode** so that a check mark appears next to the menu selection.

Note The Loop Control Board 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 Control Board and CPU Unit.

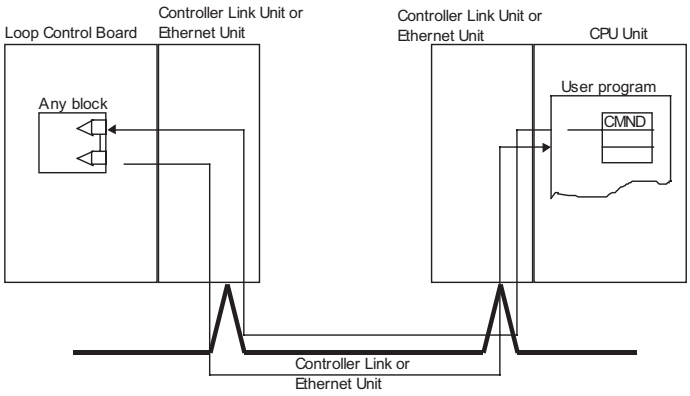
3-3-3-1 To exchange data with the CPU Unit whenever necessary (by the CMND command)

The CPU issues FINS command to the Loop Control Board from CMND command within the user program to read and write Loop Control Board data when it requires the data.

For details on FINS commands that can be issued, see *Section 6 How to Use FINS Commands*.



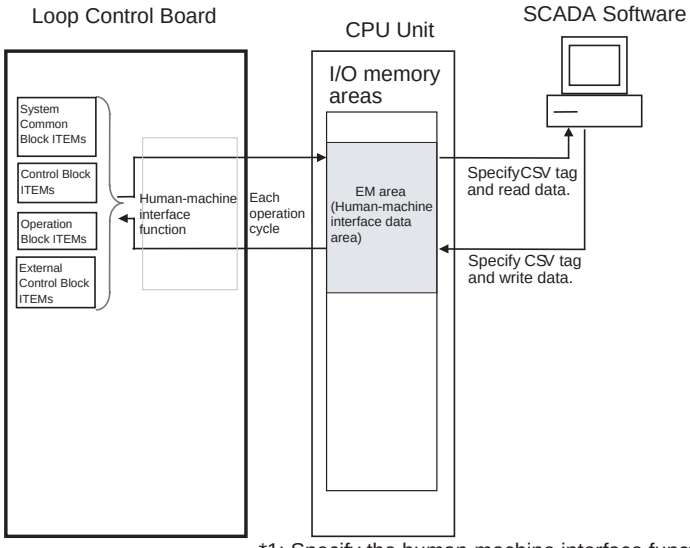
Note FINS commands can also be issued from the CPU Unit at other networked nodes.



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 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.)

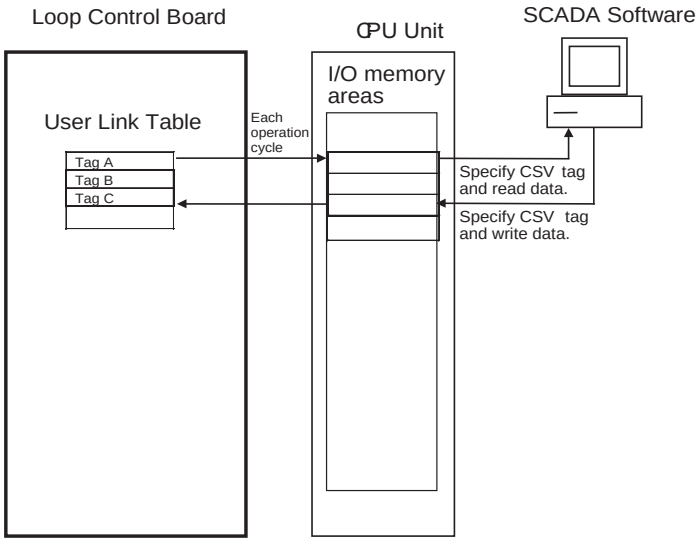
3-4 Exchanging Data using SCADA Software

The Loop Control Board 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 through the HMI data area (in the CPU Unit's specified EM area bank).



*1: Specify the human-machine interface function's operation cycle time (in seconds) with ITEM 051 of the System Common Block (block model 000).

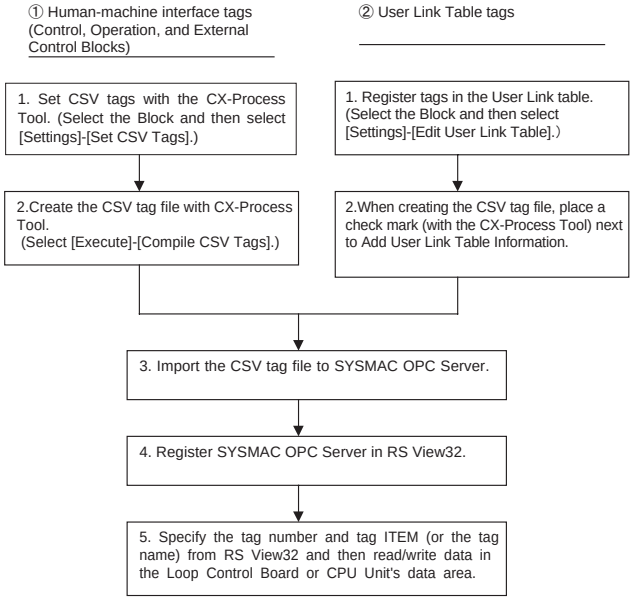
Note The User Link Table's tags can be handled as CSV tags just like the tags for the HMI data. If the User Link Table's tags are in CSV format, it will be possible to read/write data in the CPU Unit's I/O memory areas from SCADA software by specifying User Link Table tag names.



Procedure

- Example using the SCADA Software's RS View32

The following procedure shows how to specify an ITEM in the Loop Control Board from RS View32.

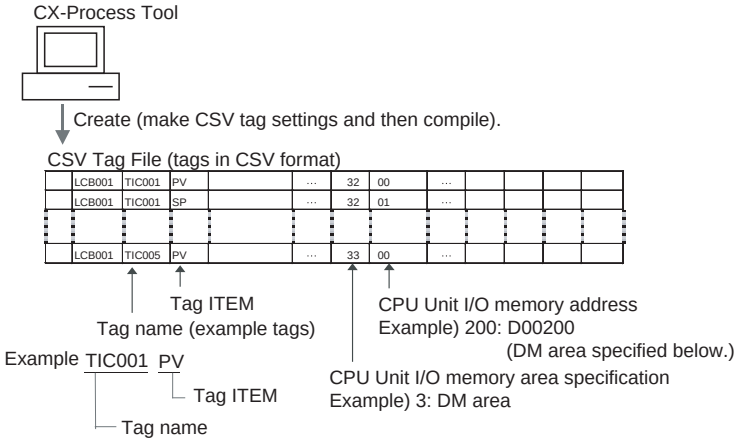


1,2,3...

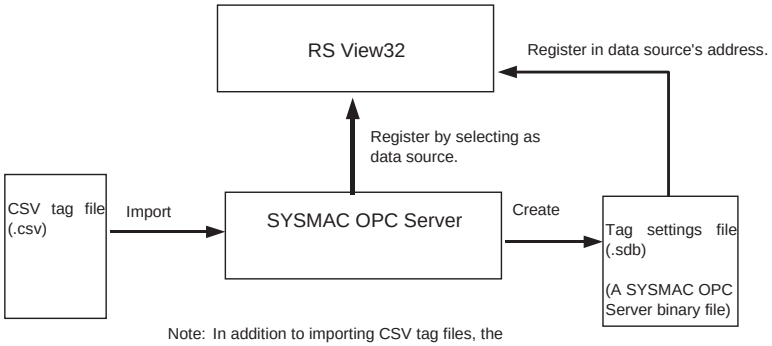
1. Set the CSV tags (tag name, scaling factor, units, etc.) with the CX-Process Tool. (Once the Control/Operation Block, External Control Block, or System Common Block has been registered, select the Block and then select [Settings]-[Set CSV Tags] from the menu.)
2. Create the CSV tag file (see note below) with the CX-Process Tool. (Select [Execution]-[Compile] CSV Tags from the menu.)

   Note The CSV tag file is a CSV formatted tag file for the SCADA Software. 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 check mark next to **Add User Link Table Information** in the Compile CSV Tags dialog box that appears when you select [Compile CSV Tags] from the Settings menu.)



3. Import the CSV tag file in SYSMAC OPC Server. (Select [File]-[Import CX-Process] from the menu.)
4. Register SYSMAC OPC Server in RS View32.



Note: In addition to importing CSV tag files, the SYSMAC OPC Server can be used to create new tags. The SYSMAC OPC Server can also import CSV files that were previously exported and the variable tables in CX-Programmer CXT files.

5. 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 Control Board 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.

Setting	Setting range		Corresponding tag settings for OPC Server	Corresponding LCB property in OPC tag settings
	HMI tags	User link table tags		
Record number	1 to 65535			
Function block file name	Max. 6 characters			
LCU name	Max. 6 characters	LCB05, LCB01, LC0011, LC0012, LC0013		
Tag No. (representative tag)	Max. 16 characters (Unusable characters: None)	LNK (fixed)	Tag name (See note 1.)	
Tag ITEM	Fixed for each function block ITEM	User link table tag name		
Tag comment	Max. 16 characters (Unusable characters: None)	User link table tag comment (max. 23 characters) (Unusable characters: None)	Comment	
Tag type	0: Analog, 1: Contact		data type	
Data attribute (See note 2.)	I: INT, U: UNIT, 0: Contact			
Contact alarm tag (See note 1.)	0: Normal, 1: Alarm	0		Contact alarm tag
Scaling upper limit	–5000 to 99999 (Example for DP position of 1: -550.0 to 9999.9)	0		Scaling upper limit
Scaling lower limit	–5000 to 99999 (Example for DP position of 1: -550.0 to 9999.9)	0		Scaling lower limit
Decimal point position (for scaling)	0 to 9	0		Decimal point position
Unit	Max. 8 characters (Unusable characters: None)	0		Unit
Data range upper limit	–5000 to 99999	0		Data range upper limit
Data range lower limit	–5000 to 99999	0		Data range lower limit
Network address	0 to 127			
Node address	1 to 32			
Unit address	16 to 31	225		
I/O memory area	0: CIO, 1: W, 2: H, 3: D, 4: E0		Area	
I/O memory address	0 to 65535		Word	
Bit position	0 to 15		Bit position	
Function block faceplate (same as block model)	0 to 999	–1		Function block FP number

Setting	Setting range		Corresponding tag settings for OPC Server	Corresponding LCB property in OPC tag settings
	HMI tags	User link table tags		
Block address	0 to 999	–1		Block address
ITEM number	0 to 999	–1		ITEM number
Offset (write data) (See note 3.)	±32767 0: Same address for read and write, Not 0: Read address + offset	0	2-address setting (Write)	
Read/write	R: Read, RW: Read/ write, W: Write	R: Read, W: Write	Area access right	

Note

1. When importing CSV tag files to an OPC Server, the setting to group representative tags will affect processing as follows:
   - If tags are grouped, the OPC Server group will use the CSV tag file tag numbers (representative tags) and the OPC Server tag names will use the CSV tag file ITEM tags.
   - If tags are not grouped, OPC Server tag names will consist of CSV tag file tag numbers (representative tags) separated by ITEM tags with an underscore.
2. The data attribute and contact alarm tag are used mainly by RSView.
3. Offsets are stored for reading and writing for the Loop Control Board ITEM numbers. If the I/O memory addresses for reading and writing in the CPU Unit are the same, the offset will be 0. If the addresses are different, the read address will be used as a bases and the offset, n, will show the offset to the write address, i.e., write address = read address + n.

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.

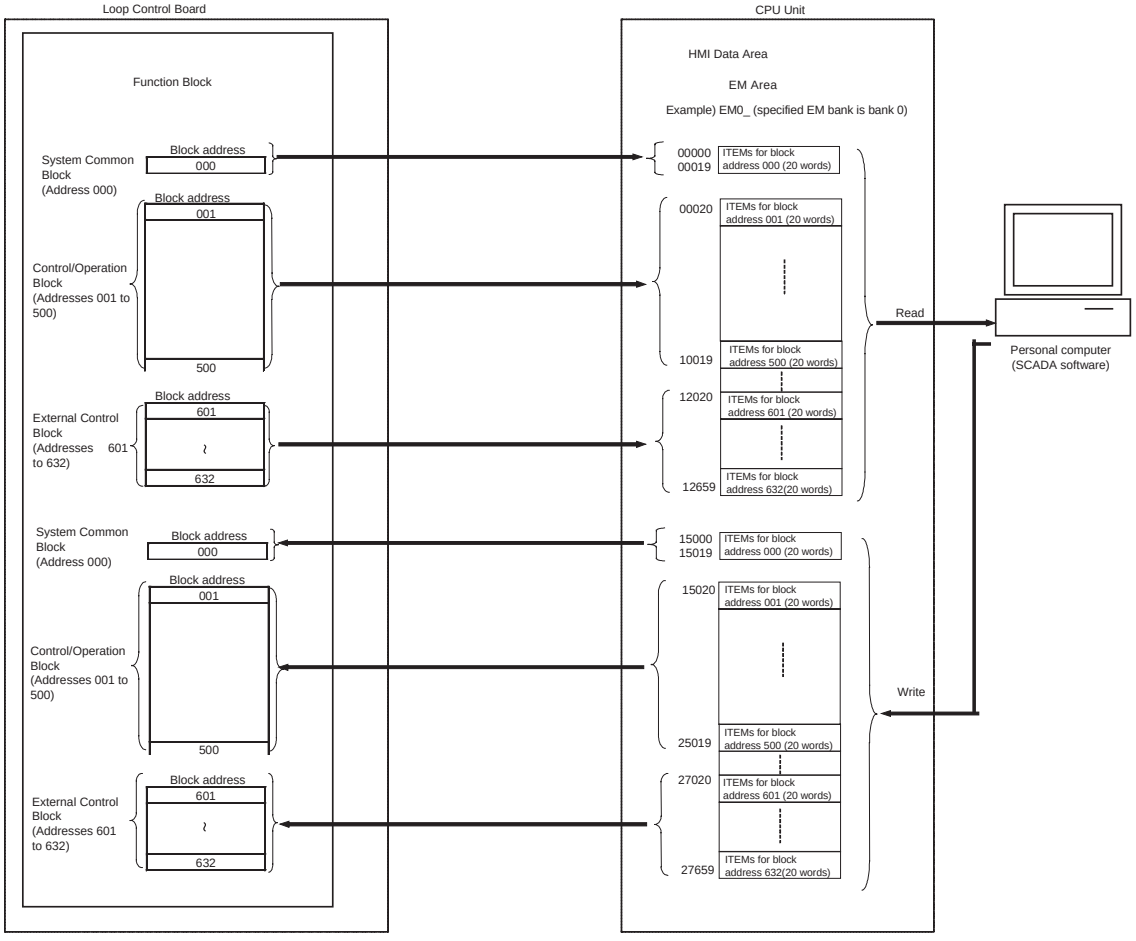
The refresh period for the HMI data is specified by ITEM051 of the System Common Block (block model 000.) ITEM051 is known as the “HMI function's operation cycle” and is set in seconds.

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) Note: 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: Not used; 1: 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.)

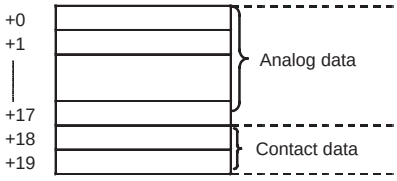
Data is exchanged with the CPU Unit continuously while the Loop Control Board is operating. The refresh period is set with ITEM051 of the System Common Block (block model 000.) ITEM051 is called the “HMI function's operation cycle” and can be set between 0.1 and 2 s.

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 Even if there are unused block addresses, the blocks and addresses are not shifted. The block addresses always retain the same structure.

Note 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

Word		
+0	ITEM007 (PV)	Analog data
+1	ITEM029 (SP)	
+2	ITEM089 (MV)	
+3	ITEM008 (HH_SP)	
to	to	
+9	ITEM054 (P)	
+10	ITEM055 (I)	
+11	ITEM056 (D)	
to	to	
+17	ITEM099 (OP_MK)	
+18		Contact data
+19		

+18 Wd	00	ITEM026 (R/L_SW)
	01	ITEM086 (A/M_SW)
	02	ITEM017 (ALM_OFF)
	03	ITEM024 (CAS_SET)
	to	to
	14	ITEM035 (AT)
	15	ITEM000 (MT_ST)
+19 Wd	00	ITEM013 (HH)
	01	ITEM014 (H)
	to	to
	08	ITEM079 (MLA)

⚠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 Control Board before converting any of the EM Area to file memory. If any part of the EM Area that is being used by the Loop Control Board for the HMI is converted to file memory during Board operation, the system may operate in an unexpected manner, which may result in injury.

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

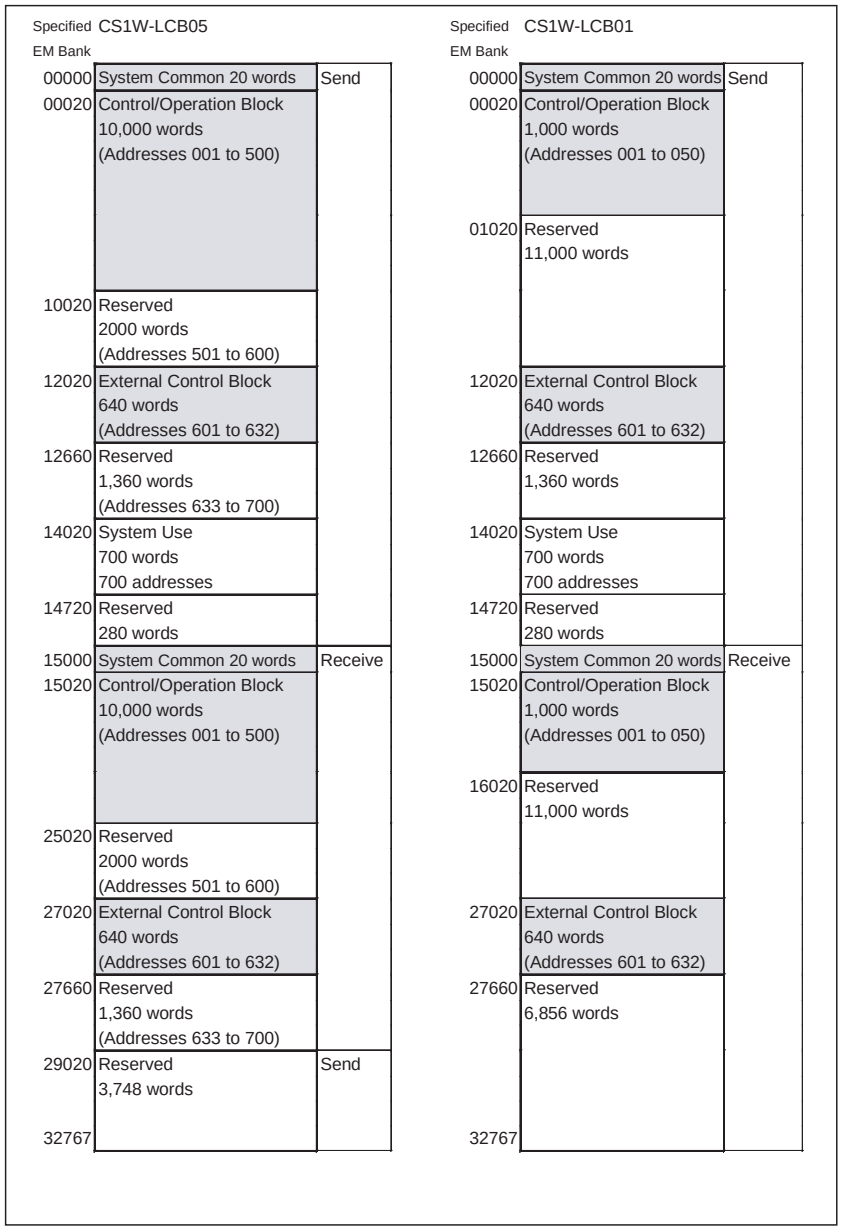
words when they are stored in the EM area. (For example, the accumulated value of the batch flowrate capture is stored in words n+10 and n+11, with the rightmost 4 digits in n+10 and the leftmost 4 digits in n+11.)
When reading and writing 8-digit values, observe the following precautions and perform 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 Control Board)
When ITEM data has been changed by internal Loop Control Board processing or changed directly by the CX-Process Tool or FINS command (not through the EM area), the Loop Control Board 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 Control Board.)
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 Control Board → 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 Control Board, 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. Note: 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



3-5 Fail-safe Countermeasure Guidelines

Implement fail-safe countermeasures on the Loop Control Board according to the following guidelines.

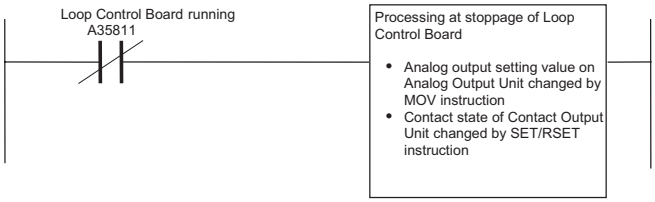
3-5-1 Measures When the Loop Control Board Has Stopped Running

When the Loop Control Board stops running, the state before the stop occurred is held and all operations that were being executed on the Loop Control Board are stopped. Refreshing between the CPU Unit and the function blocks on the Loop Control Board 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.

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 Control Board has stopped running.

3-5-1-1 Fail-safe countermeasures for adapting to stoppage of the Loop Control Board when the CPU Unit is in the RUN or MONITOR mode

To hold analog outputs or contact outputs at specific values when the Loop Control Board 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 Control Board CPU Unit Running flag (A35801) as the input condition.



3-5-1-2 Fail-safe countermeasures for adapting to stoppage of the Loop Control Board 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 Control Board), 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 Control Board, the Analog Output Conversion Enable flag is forcibly turned ON by the Loop Control Board 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 Control Board, 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 Control Board 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 Control Board when the CPU Unit is in the PROGRAM mode:

   Before the Loop Control Board 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.

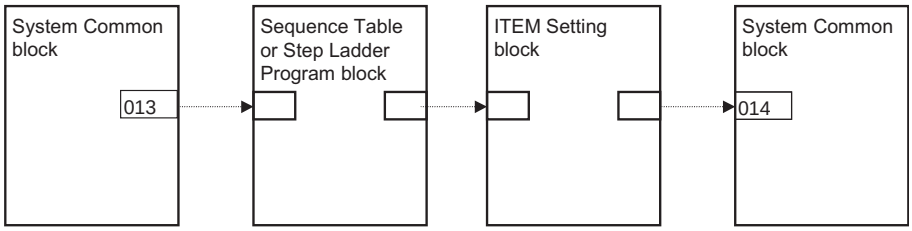
2. To set ITEM014 (run/stop command) of the System Common block to 0 (stop) by the ITEM Setting blocks on the Loop Control Board:

   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 Control Board stops running due to a malfunction of the Loop Control Board itself when the CPU Unit is in the PROGRAM mode, analog output or contact output cannot be held at specific values (for example, maximum value or minimum value). This must be taken into consideration when designing the system.
2. Processing that causes the Loop Control Board 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).



3-5-2 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 Control Board 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 Control Board 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 Control Board only performs internal operations, and does not perform control on the outside.

3-5-3 Required Conditions for the Man-Machine Interface

The Loop Control Board 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 Control Board run/stop command function and run status display function (operation of ITEM014 to ITEM017 of the System Common block)
- Loop Control Board 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

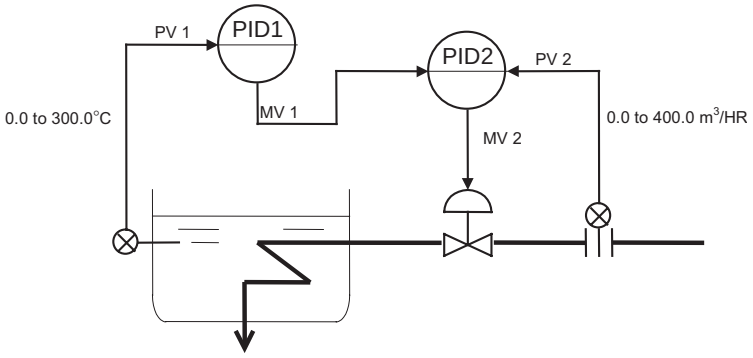
This section provides examples of using the Loop Control Board for a simple application

4-1 Simple Example of Use

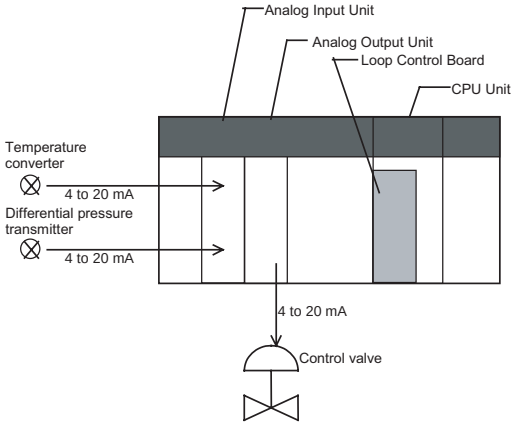
This section describes the basic procedure for using the Loop Control Board for cascade control.

Step 1 Design

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



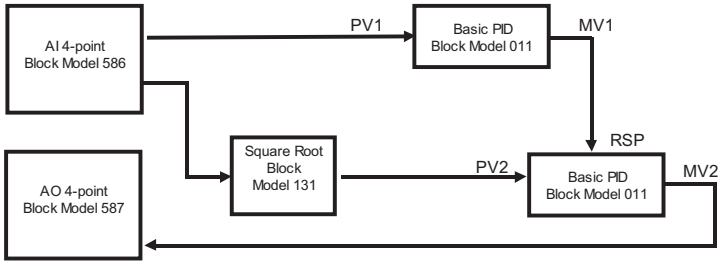
2. Decide on the PLC system configuration.



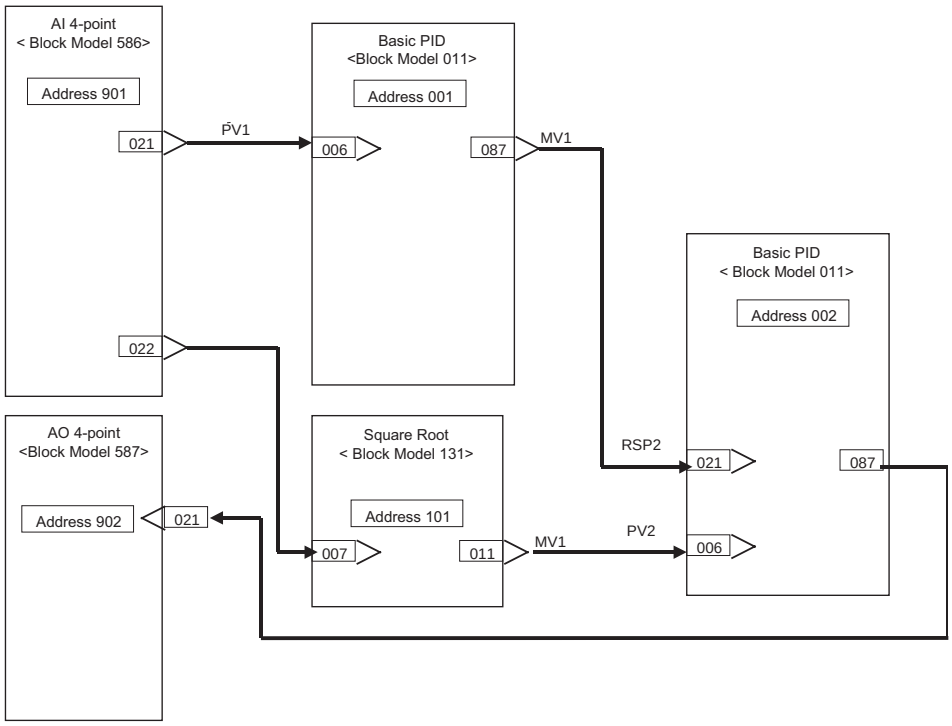
Product name	Model	Description
CPU Unit	CS1H/G-CPU□□	
Loop Control Board	CS1W-LCB01	
Analog Input Unit	CS1W-AD041	• Analog input 1: 4 to 20 mA (temperature conversion input) • Analog input 2: 4 to 20 mA (differential pressure transmitter input)
Analog Output Unit	CS1W-DA041	• Analog output 1: 4 to 20 mA (output to control valve)

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^3/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.

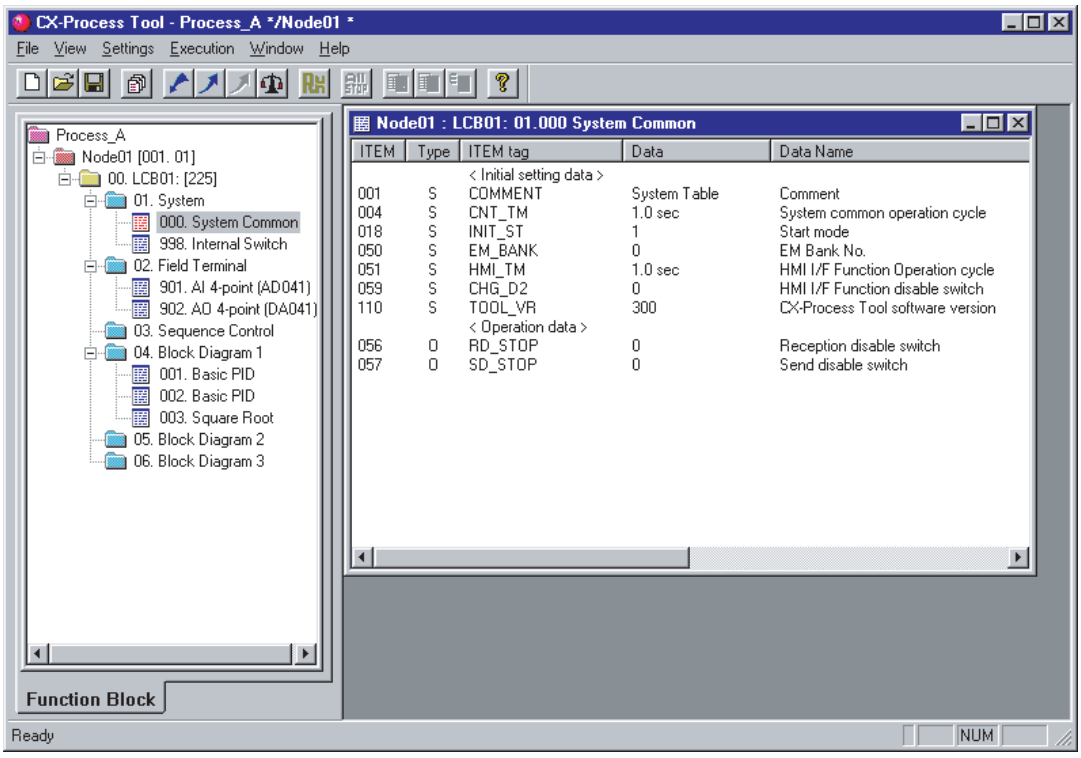
   Set the specifications common to each function block in the System Common block (Block Model 000). The ITEMs in this block must be set as the initial settings when the Loop Control Board is to be used.

   In this example, set as follows:

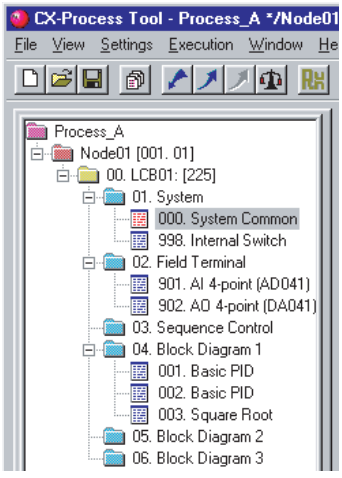
   - Set the operation cycle in the System Common block to 0.5 sec.

• Set the START mode at power ON to Hot start (1).

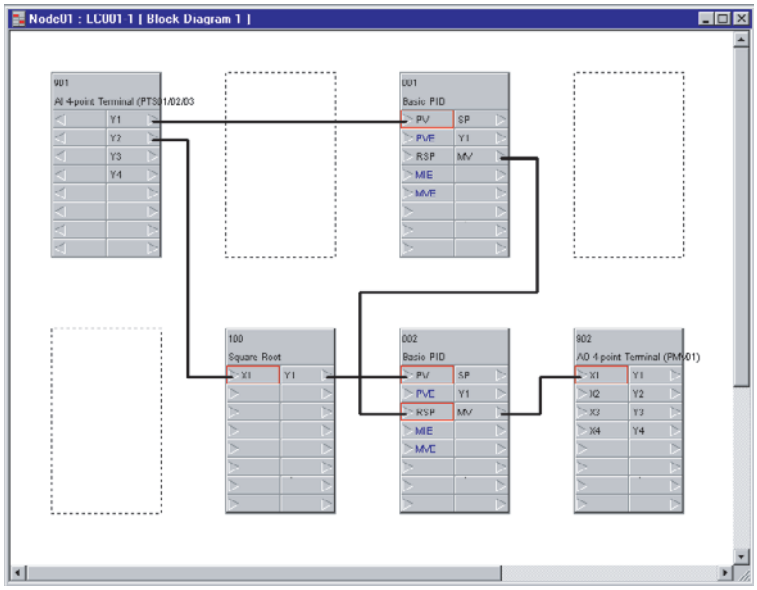
ITEM	Data description	Data range	Setting example
004	Operation cycle (sec.) 1: 0.1, 2: 0.2, 3: 0.5, 4: 1, 5: 2	1 to 5	3
018	Start mode at power ON 1: Hot start, 2: Cold start	1 or 2	1



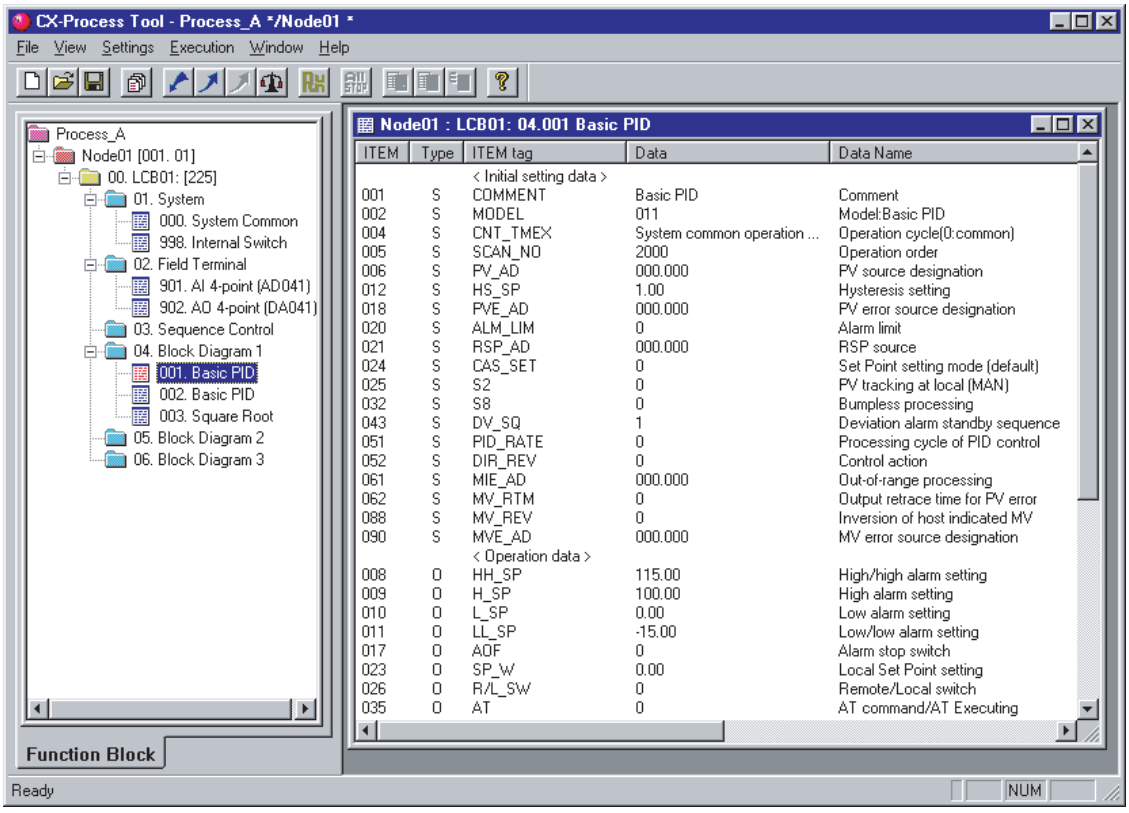
3. In CX-Process Tool, select the function blocks to be used (including allocations to block addresses).



4. Wire in the software the analog signals between blocks.



5. Set the ITEMs in each function block.



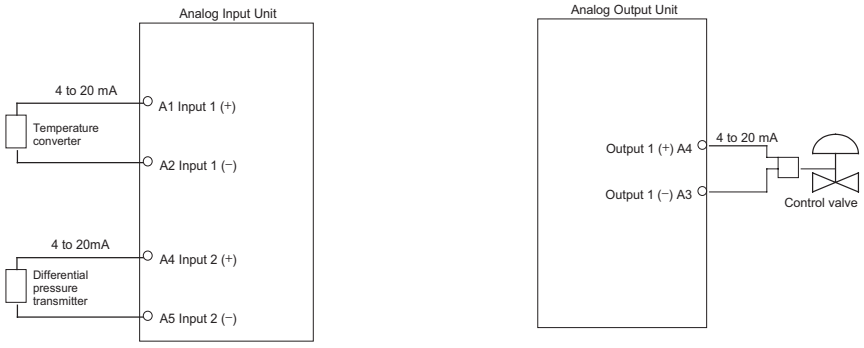
Set function block initial setting parameters (refer to the item “(S): Initial setting data” describing how to read/write in the *Function Block Reference Manual*) such as direct/reverse action and Set Point setting mode (Remote/Local) on CX-Process Tool.

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

1,2,3... 1. Mount the Loop Control Board, and wire the Analog Input Unit and Analog Output Unit.



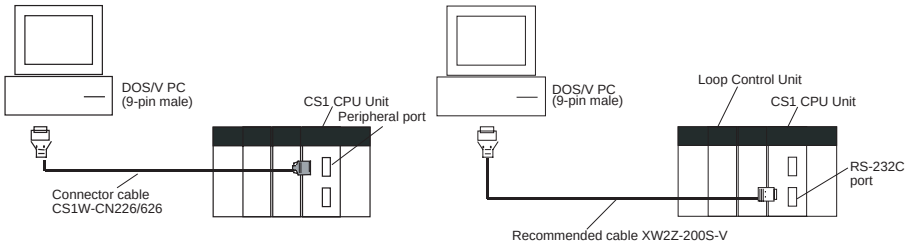
The Loop Control Board itself need not be wired.

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 Control Board

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.

- Connection to peripheral port (only Host Link connection is supported)
- 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 Control Board 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 Control Board must be set.

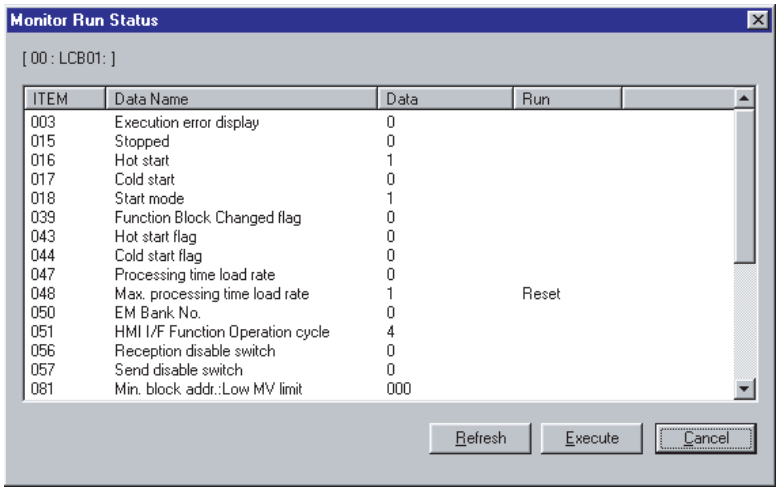
9. Check the LEDs on the front panel of the Loop Control Board (RUN LED lit, ERC LED out).

Step 5 Trial Operation

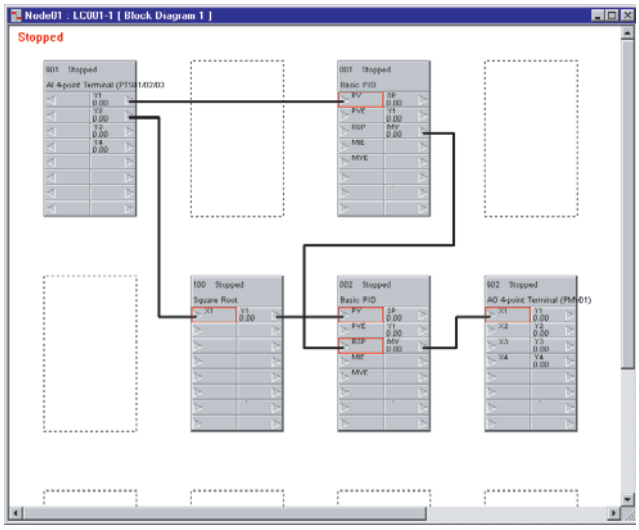
1,2,3...

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.

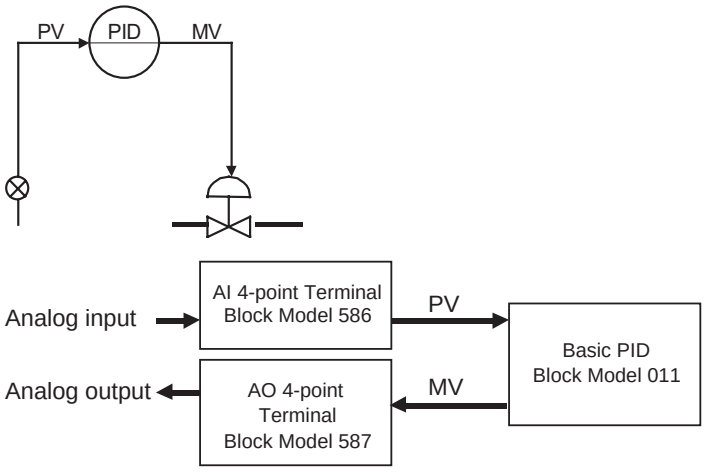
5-1 Basic Examples of PID Control

This section shows basic examples of how to connect the function blocks when performing PID control.

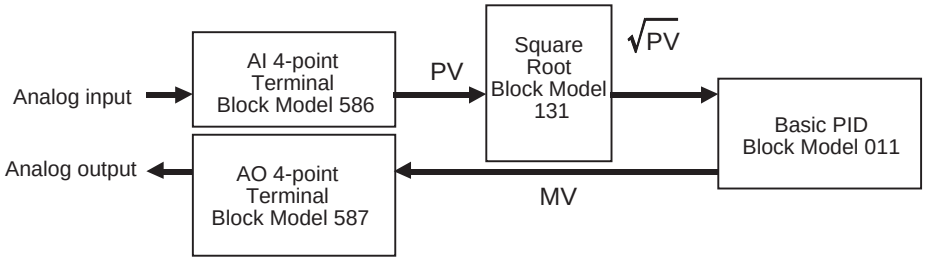
5-1-1 Simple PID Control

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.



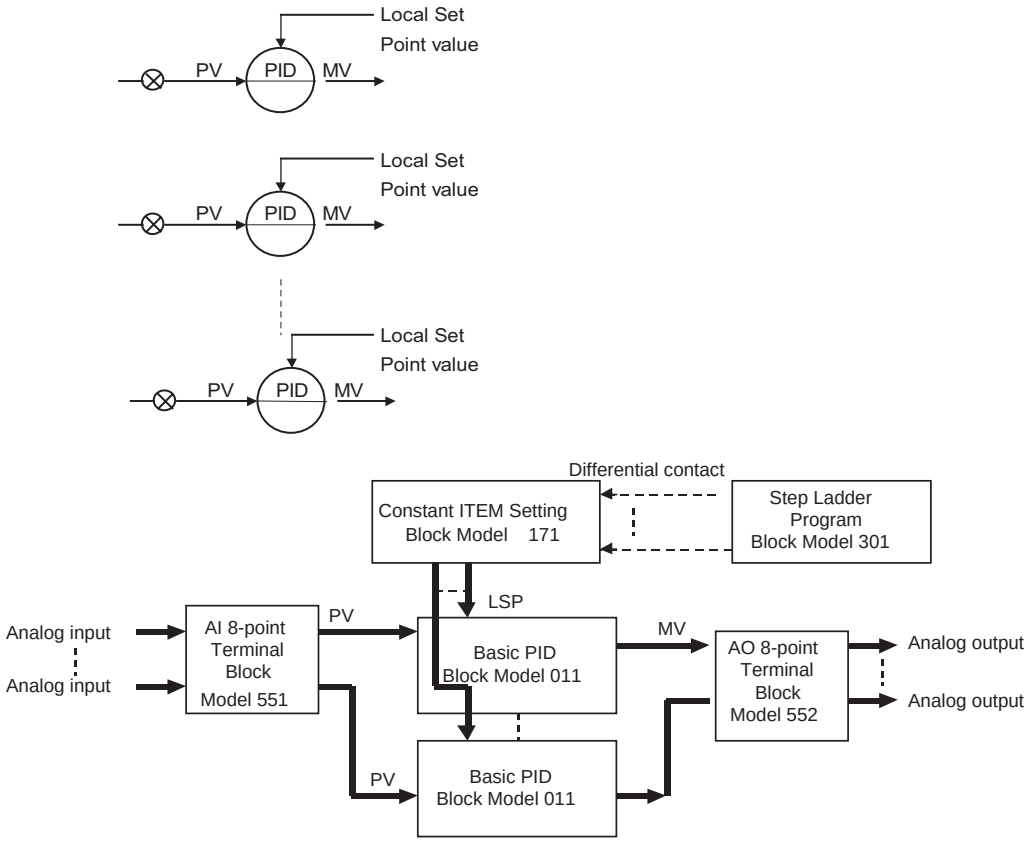
Note When the square root function is used in flowrate control, insert the Square Root block (Block Model 131) in analog input.



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.

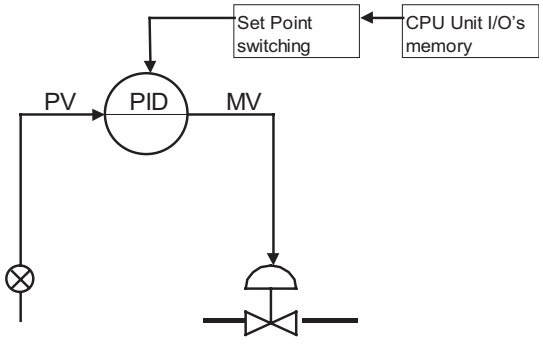


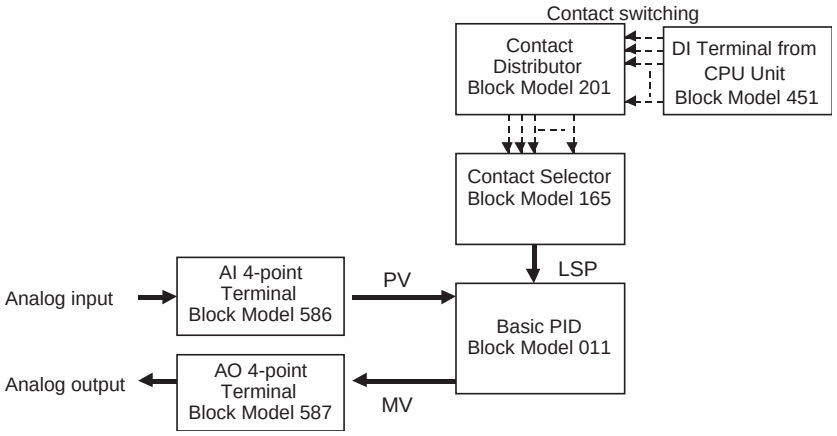
5-1-3 PID Control for Switching Multiple Set Points

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.

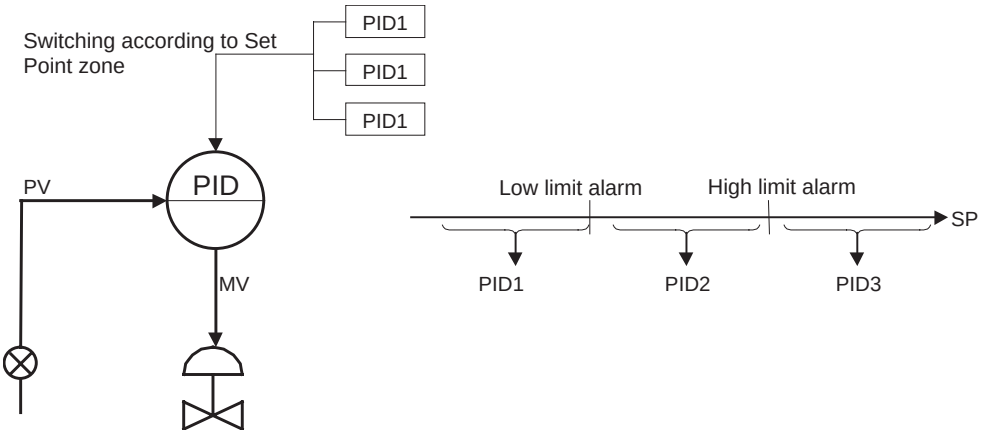


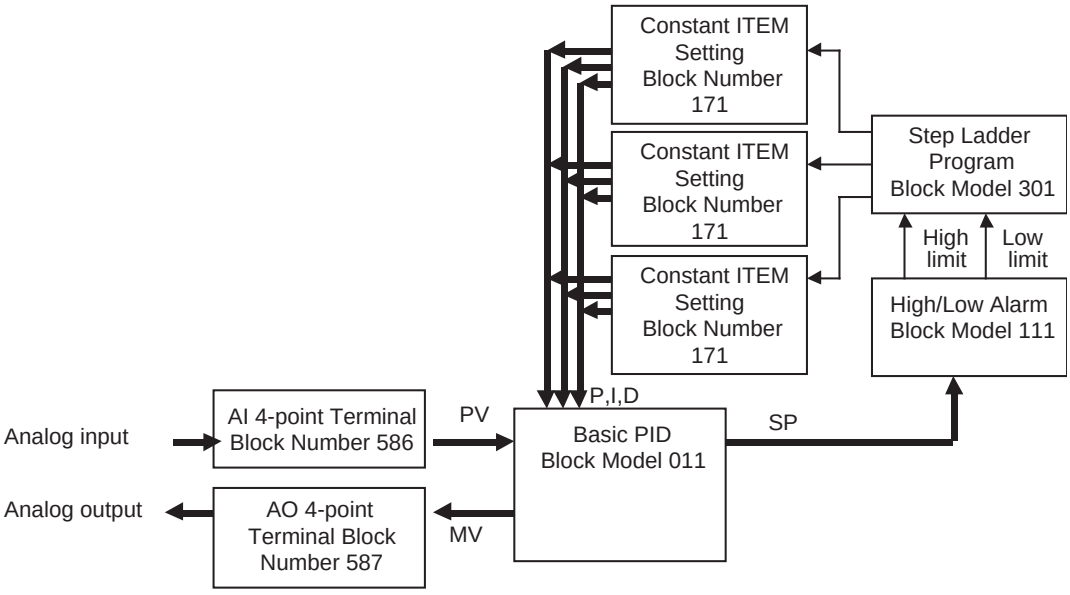


5-1-4 PID Control for Switching PID Constants by Three Set Point Zones

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)

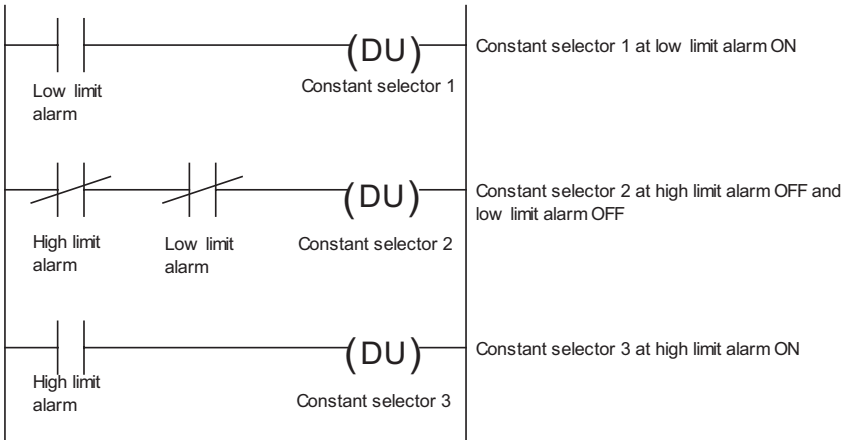
Register three sets of PID constants for switching in advance to the three Constant ITEM Setting blocks. Input the current Set Point value of the Basic PID block to the High/Low Alarm block. Three Set Point zones can be prepared in the Step Ladder Program block by combining the high alarms and low alarms of the High/Low Alarm block. Select the Constant ITEM Setting block according to the Set Point zone.




Constant ITEM Setting Block Number 171
Constant ITEM Setting Block Number 171
Constant ITEM Setting Block Number 171
Step Ladder Program Block Model 301
High limit
Low limit
High/Low Alarm Block Model 111
P,I,D
Analog input
AI 4-point Terminal Block Number 586
PV
Basic PID Block Model 011
SP
Analog output
AO 4-point Terminal Block Number 587
MV

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)
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

Block address	ITEM No.	Data	Explanation
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

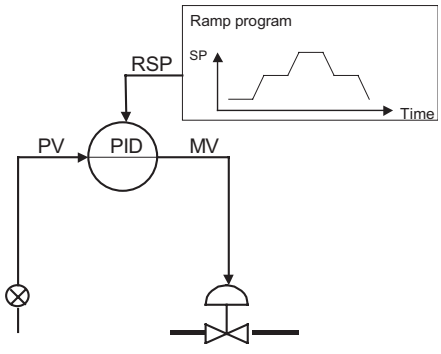


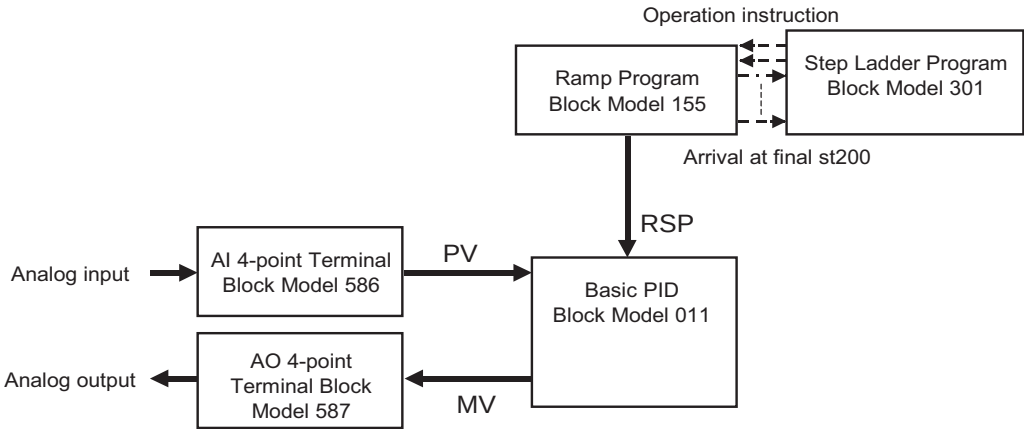
5-1-5 Ramp Program Control

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.



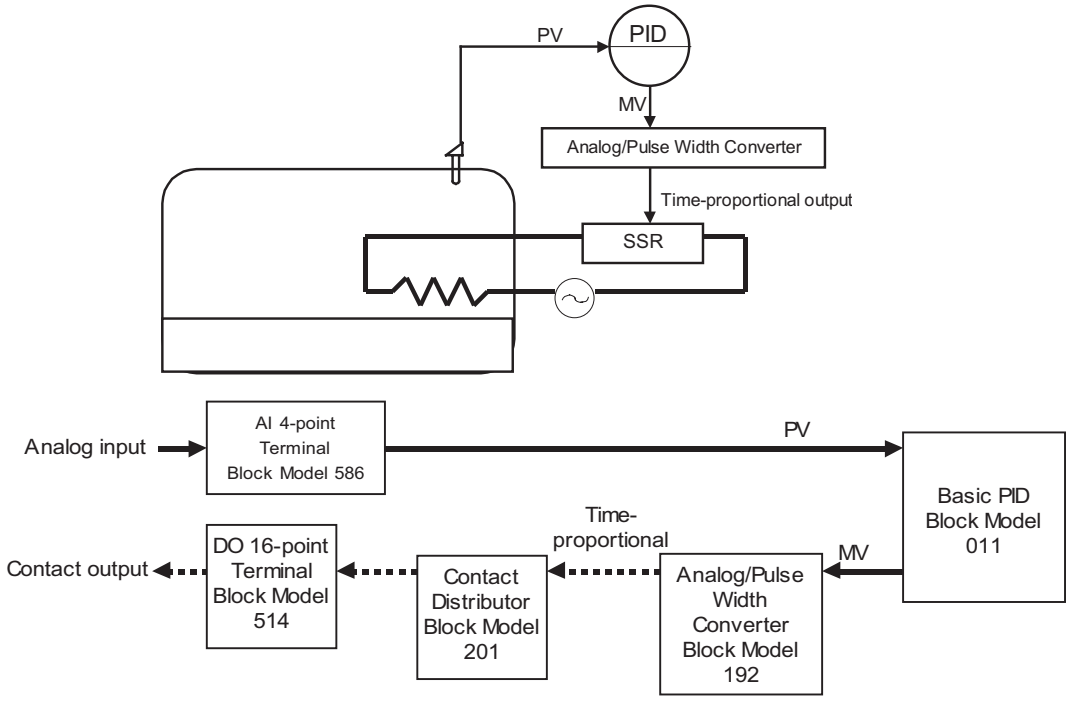


5-1-6 Time-proportional Control

Follow the procedure below to perform time-proportional control where contact output (ON/OFF) changes proportionately 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

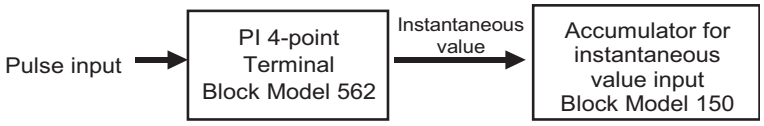
Function blocks used: PI 4-point Terminal (Block Model 562)
Accumulator for instantaneous value input (Block Model 150)

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) Note 1
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 1. 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 Control Board 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*

Control purpose	Control type example	Section
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 who 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 is 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 Control Board (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)

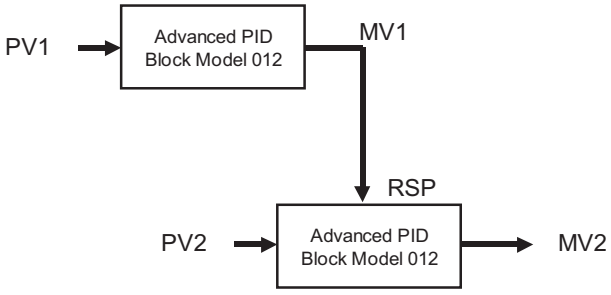
PID1 of the primary loop indirectly controls the finite control element of the secondary loop by controlling the setting value of PID2.

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)

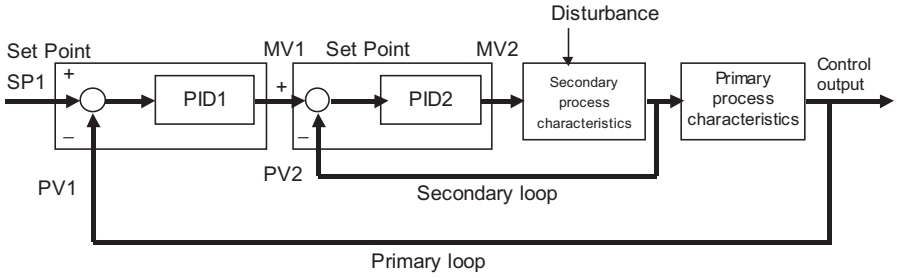
Example



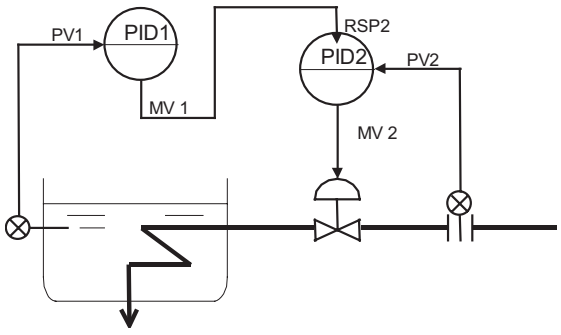
MV output of one Advanced PID block is input to the Remote Set Point of the other Advanced PID block.

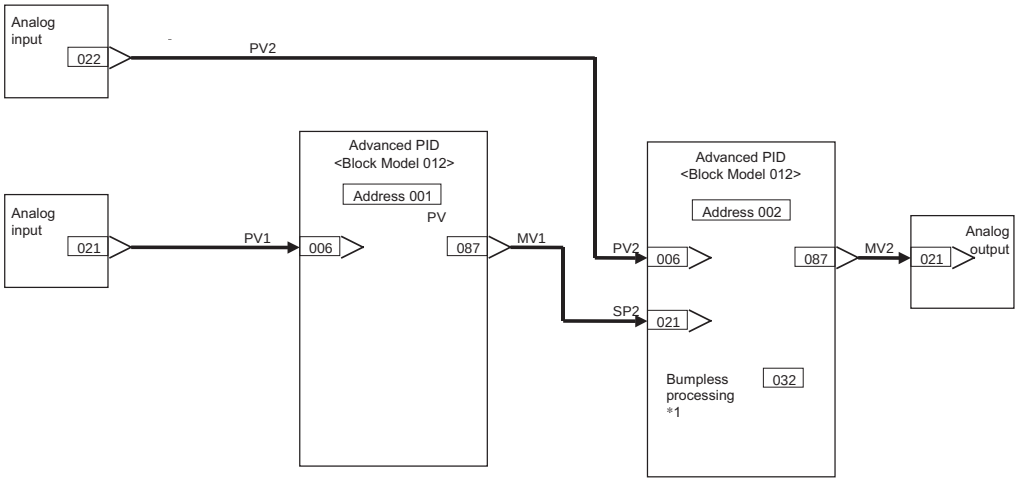
Note In cascade control, when the secondary loop PID2 is set to Local, MV1 of the primary loop PID1 must be tracked to changes on the Local Set Point setting (LSP2) (matched to LSP2).

This Loop Control Board 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).

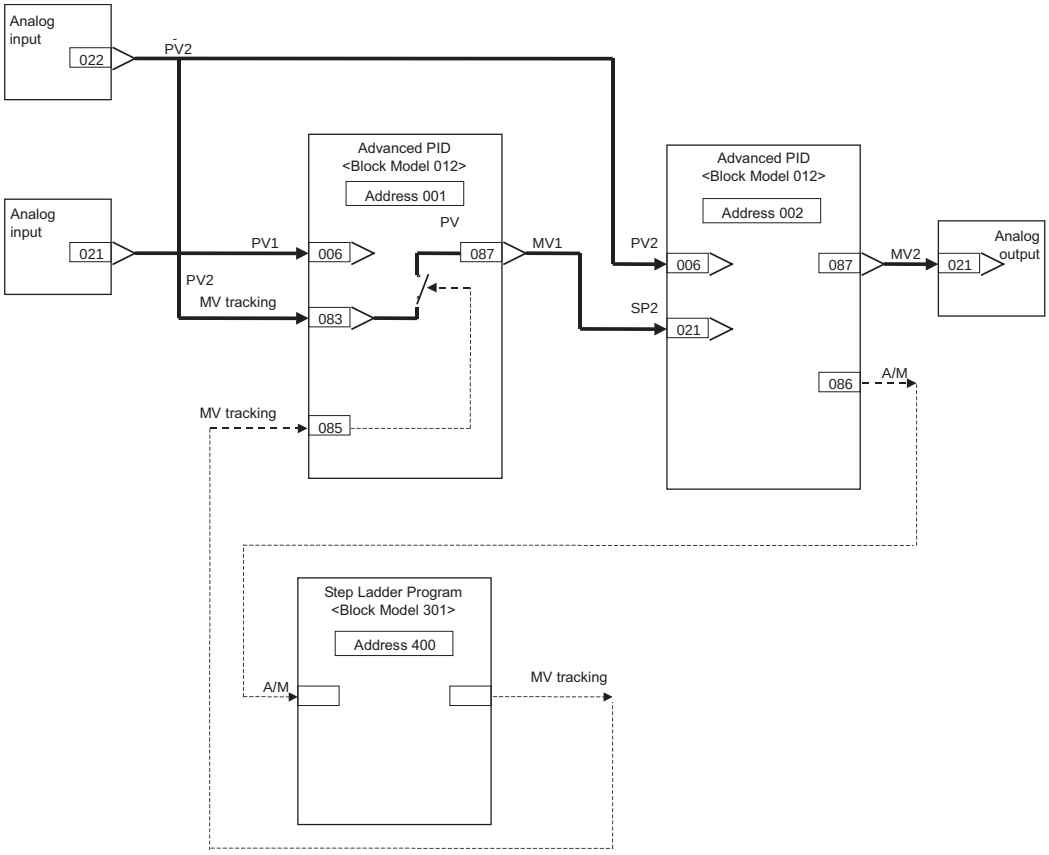
Block address	ITEM No.	Data	Explanation
901	002	586	AI 4-point Terminal block
	021		Y1 (analog input 1)
	022		Y2 (Analog input 2)
902	002	587	AO 4-point terminal block
	021	002087	X1 (analog output 1) source designation
	031		X1 (analog output 1)
001	002	012	Advanced PID block
	006	901021	PV source designation
	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.

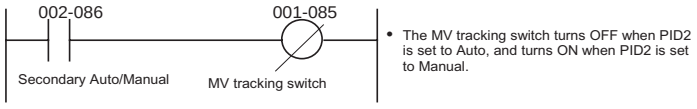
Note As shown above, the function of ITEM032 (bumpless processing between primary/secondary loops) of the Basic PID block (Block Model 011) or Advanced PID block (Block Model 012) can be used to enable switching of primary loop MV1 to the secondary loop LSP2 when the secondary loop is set to Local.

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.



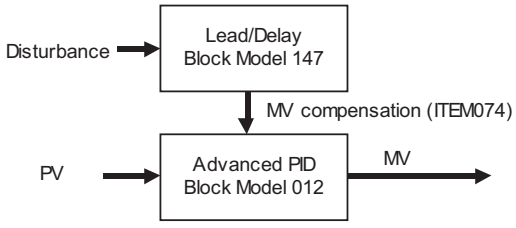
Ladder in Step Ladder Program block



5-2-2 Feedforward Control

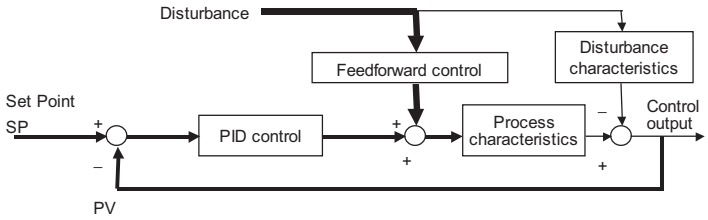
Before the influence of disturbances such as load fluctuation appears in the process result, disturbance is detected beforehand to correct MV so that its influence is canceled. Feedforward control is used in combination with feedback control.

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 K2/(T+T2•s) as its transfer function is approximated by the first-order lag, and the process characteristic is K1/(1+T1•s) as its transfer function is approximated by the first-order lag:

   K2/K1 x (1+T1•s) / (1+T2•s)

   where,

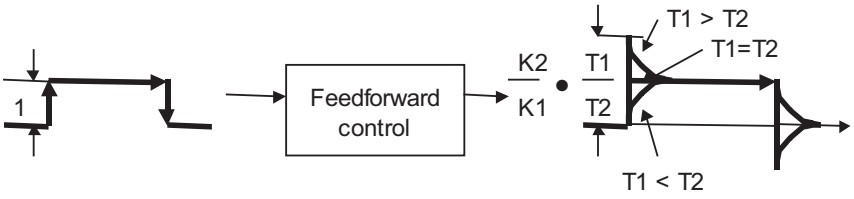
   T1: Time constant of process

   T2: Time constant of disturbance

   K1: Process gain

   K2: Disturbance gain

   The step response in this model is as follows:

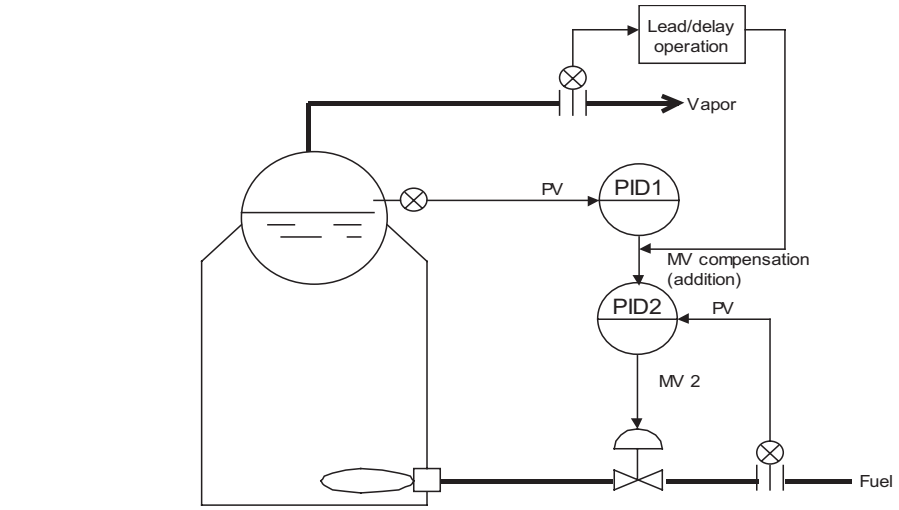


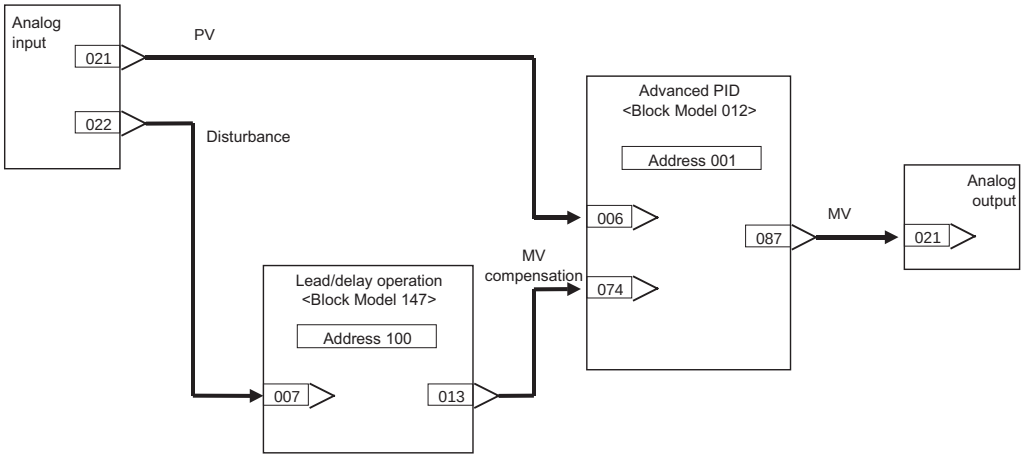
As shown above, when T1 (time constant of process) is longer than T2 (time constant of disturbance) (T1>T2), a lead is applied to the feedforward control signals (lead compensation). Alternatively, when T1<T2, a delay is applied to the feedforward control signals (delay compensation).

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

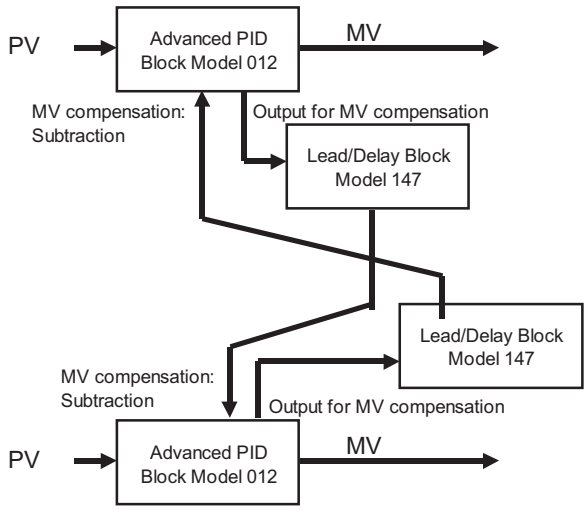
Noninteracting control suppresses mutual action between processes, and is the same as feedforward control. Influence caused by mutual action is regarded as disturbance, and is controlled by noninteracting control together with feedforward control.

Function blocks used: Advanced PID (Block Model 012)

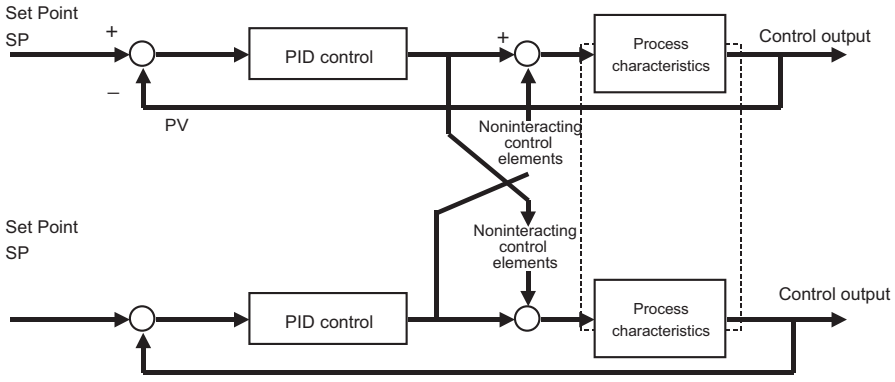
Lead/Delay (Block Model 147)

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.

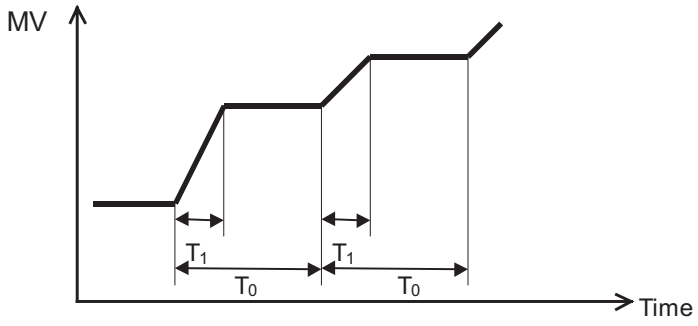


5-2-3 Sample PI Control

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 T1 is performed at every time T0, and resulting output is held at a fixed value.

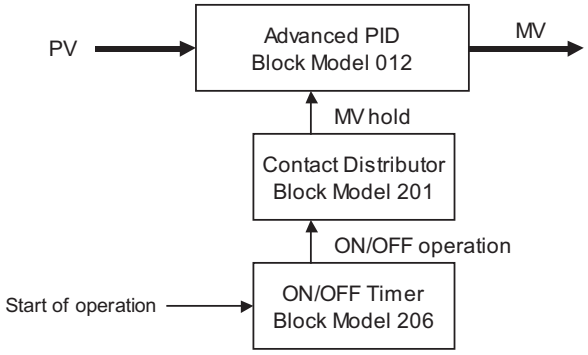
This is also called the “wait and see” method.



Function blocks used: ON/OFF Timer (Block Model 206)

Contact Distributor (Block Model 201)

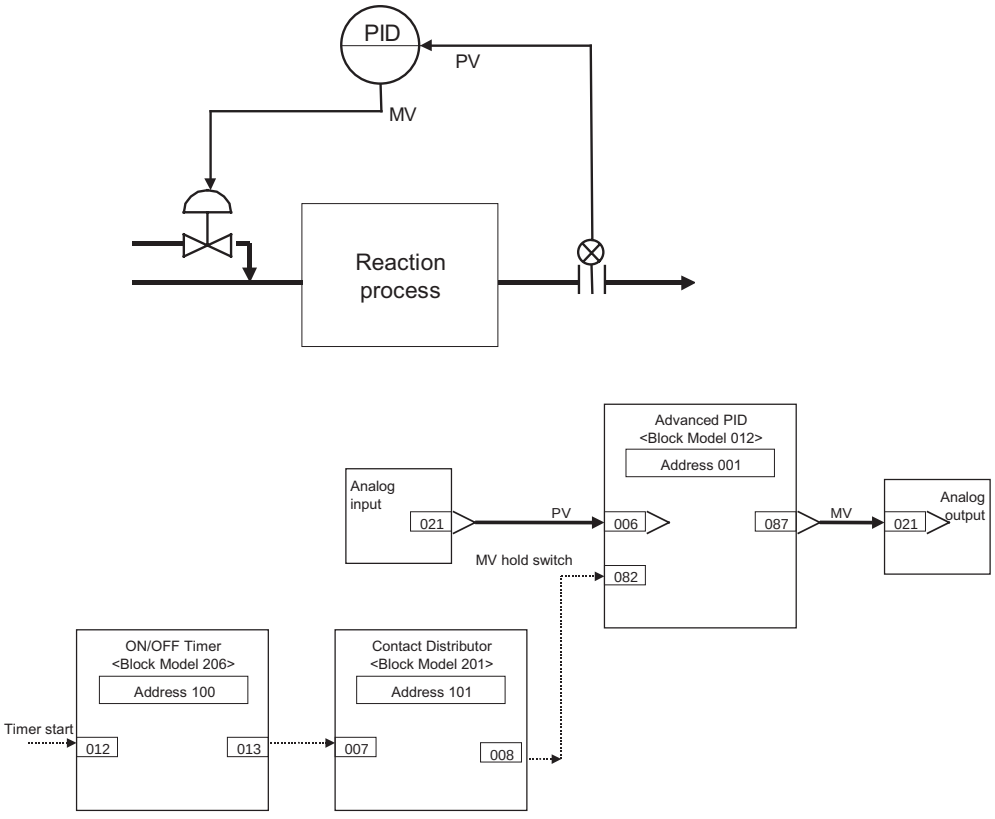
(Step Ladder Program [Block Model 301] as necessary)



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 (T1) of the ON/OFF timer by other function blocks.

Example



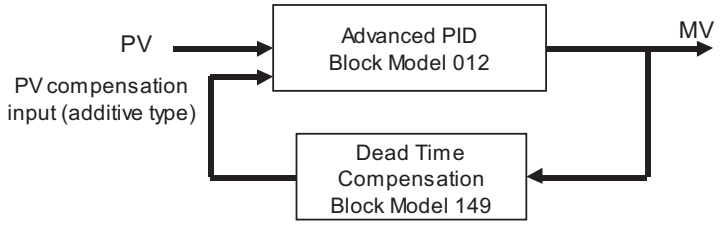
Block address	ITEM No.	Data	Explanation
901	002	586	AI 4-point Terminal block
	021		Y1 (analog input 1)
902	002	587	AO 4-point terminal block
	021	001087	X1 (analog output 1) source designation
	031		X1 (analog output 1)
001	002	012	Advanced PID block
	006	901021	PV source designation
	082		MV hold switch
	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)

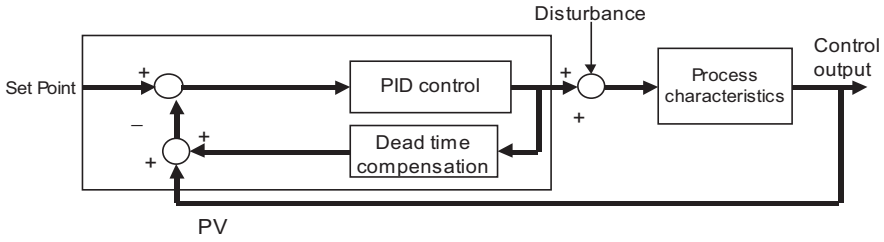
Example



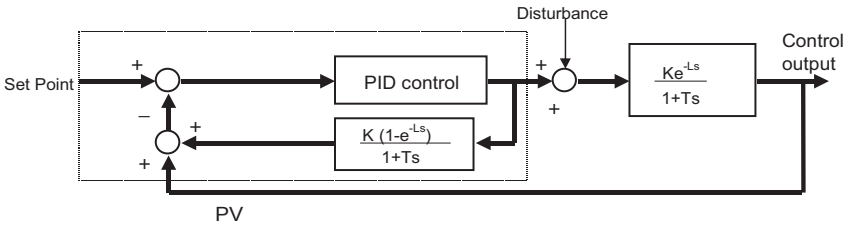
Dead time compensation is performed on the MV output from the Advanced PID block, and the result is connected to the PV compensation input of the Advanced PID block. The PV compensation mode is set to “add”.

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.

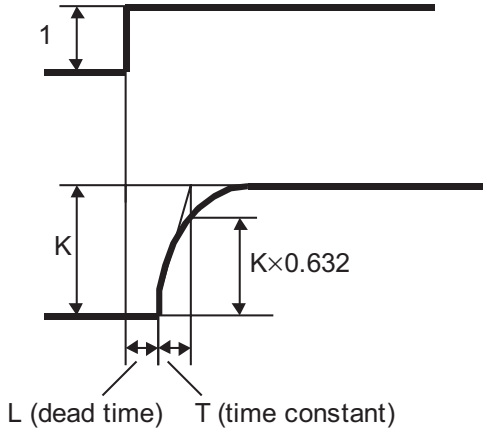


As dead time L worsens controllability, control is performed on process K/(1+Ts) not having dead time element (e^{-Ls}) by compensating the dead time element within the PLC.

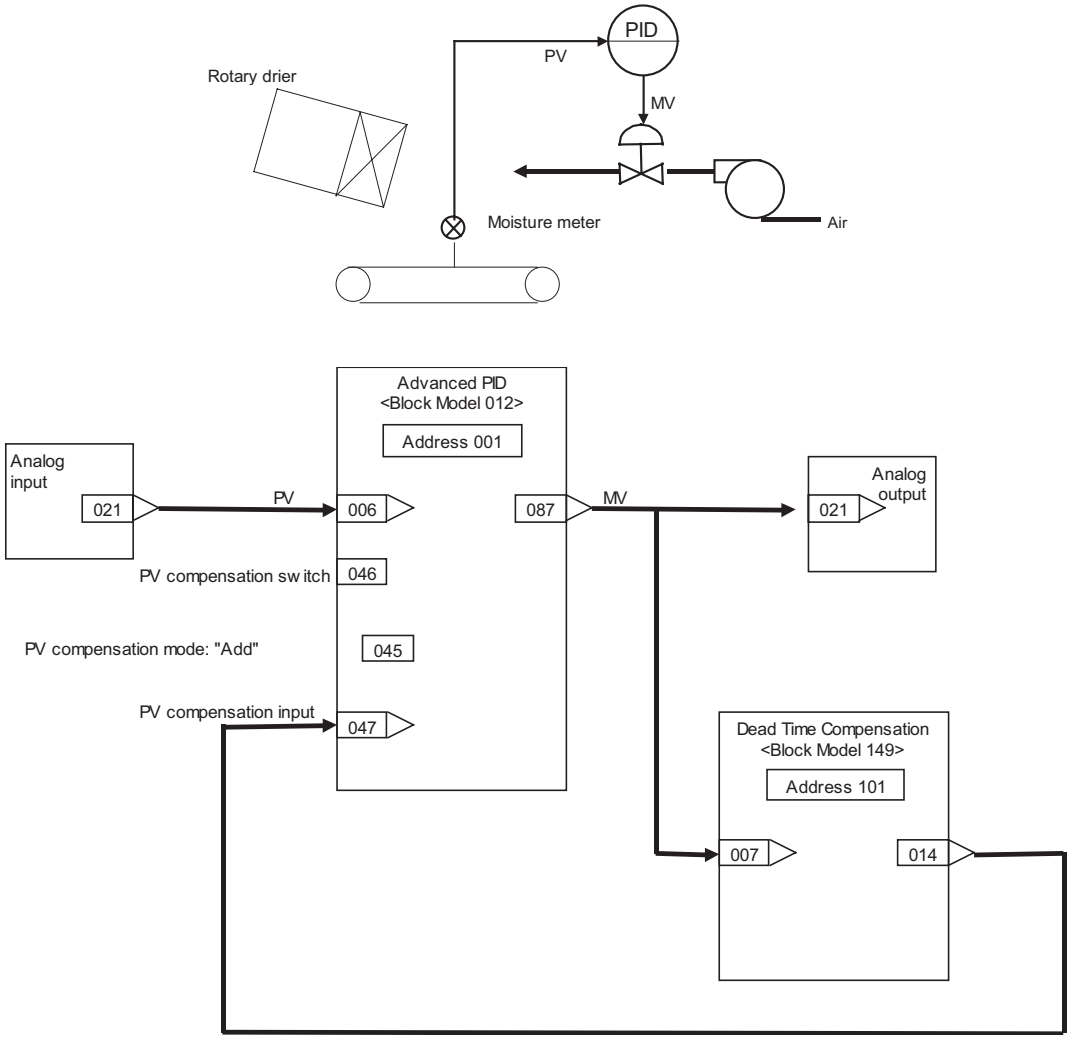


The Dead Time Compensation block (Block Model 149) inputs MV for $K(1-(e^{-Ls}) \div (1+Ts)$, and outputs the result to ITEM047 (PV compensation) of Advanced PID block (Block Model 012). The PV compensation mode is set to “add”. The Dead Time Compensation block (Block Model 149) sets K (process gain), 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
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 Control Boards.

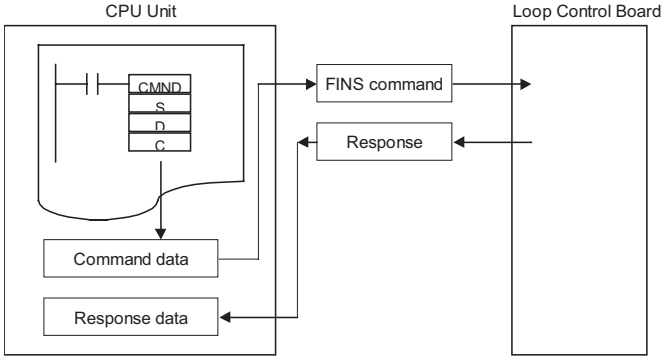
6-1 How to Use FINS Commands

FINS commands can be issued to the Loop Control Board 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 Control Board by executing the CMND (DELIVER COMMAND) instruction in the program on the CPU Unit or networked PLC (CPU Unit) on which the Loop Control Board 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.

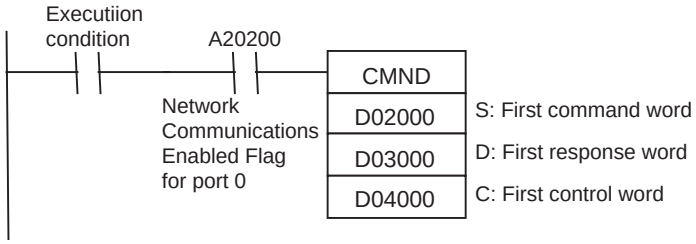
1,2,3...

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 Control Board 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 Control Board, 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 *CS1 Series PLC Instructions Reference Manual* (Cat. No. W340).

Example To read ITEM007 (PV) at block address 001 (e.g. in the case of Basic PID) on the Loop Control Board 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: □□

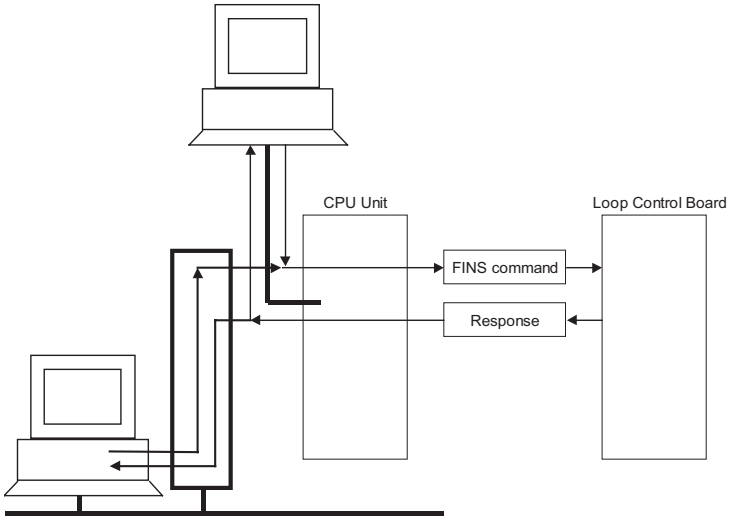
Control data

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	00 E 1	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 Control Board 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 Control Boards

Command (Hex)	Name	Description	
0240	READ MULTIPLE ITEMS FROM FUNCTION BLOCK	Reads specified continuous (multiple) ITEMs from a single function block.	**Note** 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 CONTROL BOARD INFORMATION	Reads the format and version information of the Loop Control Board.	
0801	ECHOBACK TEST	Performs the echoback test between Loop Control Board.	
2102	READ ERROR LOG	Reads the error log in the Loop Control Board.	
2103	CLEAR ERROR LOG	Clears the error log in the Loop Control Board.	

Note All of the following data are expressed in Hex in FINS commands issued to the Loop Control Board:

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 Control Board.

READ MULTIPLE ITEMS FROM FUNCTION BLOCK	Command code
	02 40

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				
Data length (bytes)	1	1	2	2	2	---
					*	

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 • The command length exceeds 2002 bytes.
1002 Hex	Insufficient command length • The command length is less than six bytes.
1003 Hex	Number of elements/number of data mismatch • The number of read start addresses does not match the number of ITEMs.
1101 Hex	No type • An unusable block address was specified in the parameter type. • The block address specified in the parameter type is an unregistered function block. • 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.
1103 Hex	Specified address out-of-range error • There is not even one ITEM specified by the start address.
110B Hex	Response exceeds maximum response length • The length of the read data section exceeds 968 bytes.
110C Hex	Other item parameter error • Number of ITEMs is 0.

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

Response code	Meaning
0000 Hex	Normal completion
1001 Hex	Command length over • The command length exceeds 2002 bytes.
1002 Hex	Insufficient command length • The command length is less than six bytes.
1003 Hex	Number of elements/number of data mismatch • The number of data items does not match the number of ITEMs.
1101 Hex	No type • An unusable block address was specified in the parameter type. • The block address specified in the parameter type is an unregistered function block. • 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.
1103 Hex	Specified address out-of-range error • The start address contains a non-existent ITEM. • An attempt was made to write to the format setting of a System Common block.
110C Hex	Other item parameter error • Number of ITEMs is 0. • The specified data length does not match the actual data of each ITEM specified by the write start address. • The combination of block address and block format is forbidden. • Write data is out of the data range for each ITEM.

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 • The command length exceeds 2002 bytes.
1002 Hex	Insufficient command length • The command length is less than four bytes.
1003 Hex	Number of elements/number of data mismatch • The number of read start addresses does not match the number of ITEMs.
1101 Hex	No type • An unusable block address was specified in the parameter type. • The block address specified in the parameter type is an unregistered function block. • 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.
1103 Hex	Specified address out-of-range error • There is not even one ITEM specified by the start address.
110B Hex	Response exceeds maximum response length • The length of the read data section exceeds 968 bytes.
110C Hex	Other item parameter error • Number of ITEMs is 0.

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

Response code	Meaning
0000 Hex	Normal completion
1001 Hex	Command length over • The command length exceeds 2002 bytes.
1002 Hex	Insufficient command length • The command length is less than four bytes.
1003 Hex	Number of elements/number of data mismatch • The number of data items does not match the number of ITEMs.
1101 Hex	No type • An unusable block address was specified in the parameter type. • The block address specified in the parameter type is an unregistered function block. • 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.
1103 Hex	Specified address out-of-range error • The start address contains a non-existent ITEM. • An attempt was made to write to the format setting of a System Common block.
110C Hex	Other item parameter error • Number of ITEMs is 0. • The specified data length does not match the actual data of each ITEM specified by the write start address. • The combination of block address and block format is forbidden. • Write data is out of the data range for each ITEM.

READ LOOP CONTROL BOARD INFORMATION	Command code
	05 01

Function

Reads the model number and version information of the Loop Control Board.

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 Control Board. This test is used to check whether or not FINS protocol communications with the Loop Control Board 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 • The command length exceeds 2000 bytes.
1002 Hex	Insufficient command length • Command length is less than three bytes.

READ ERROR LOG	Command code
	21 02

Function

Reads the error log on the Loop Control Board.

The configuration of each error log is as follows, and error logs are stored in RAM (battery-backed up) on the Loop Control Board. 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 • The command length exceeds six bytes.
1002 Hex	Insufficient command length • Command length is less than six bytes.
1103 Hex	Specified address out-of range error • The read start record No. was specified for the number of currently stored records or more. (excluding 0000 Hex)
110C Hex	Other item parameter error • Number of read records is 0.

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.

CLEAR ERROR LOG	Command code
	21 03

Function

Clears the error log on the Loop Control Board.

Command format

Data format	Command code	
	21 Hex	03 Hex
Data length (bytes)	1	1

Response format

Data format	Command code		Response code	
	21 Hex	03 Hex	MRES	SRES
Data length (bytes)	1	1	1	1

Response code

Response code	Meaning
0000 Hex	Normal completion
1001 Hex	Command length over • The command length exceeds two bytes.
250F Hex	Memory write error • Error log could not be cleared successfully.

SECTION 7
Errors and Alarm Troubleshooting

This section explains errors that can occur in Loop Control Board operation and troubleshooting procedures for alarms that can occur.

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 Control Board is not operating for one of the following reasons: • A Fatal Inner Board Error occurred (A40112 ON.) • Initialization is not completed yet. • A fatal error occurred. • The flash memory backup data is invalid. • The Loop Control Board is initializing. • A hardware failure occurred in the Loop Control Board. • Power is not being supplied from the Power Supply Unit. • A Loop Control Board WDT error occurred.
			Flashing	• Data is being written to flash memory. • A WDT error occurred in the CPU Unit.
			Lit	The Loop Control Board is ready for operation.
EXEC	Running	Green	Not lit	The system is stopped for one of the following reasons: • The Loop Control Board is initializing. • A hardware failure occurred in the Loop Control Board. • Power is not being supplied from the Power Supply Unit. • A Loop Control Board WDT error occurred. • The Loop Control Board is not running. • Data is being written to flash memory.
			Flashing	Parameter backup operation in progress
			Lit	The Loop Control Board is running.
COMM	Communicating	Yellow	Not lit	Waiting for data transfer.
			Flashing	Transferring data.

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 Control Board		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 Control Board.	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 Control Board 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 Control Board is faulty.			Turn the power OFF and ON again. Replace the Loop Control Board if the error recurs.

LED Indicators on front of Loop Control Board		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	Initial recognition error (Inner Board Stopped Error)	The Board 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.
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.
Not lit	Not lit	Flashing (A42404, the Incompatible CPU Unit Error Flag, is ON.)	Incompatible CPU Unit	The Loop Control Board is not mounted in one of the following CPU Units: CS1G-CPU□□H CS1H-CPU□□H	Operation is stopped.	None	Replace the CPU Unit with one of the compatible models.
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.
Not lit	Not lit	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. 1) The data was corrupted by noise or other factor. 2) The power was interrupted during a backup. Note: If the function block database (RAM) is valid, the data will be backed up when power is turned ON again.	Operation is stopped.	0331 The details code contains either the relevant block address or FFFF if all data bases are invalid.	Execute the [Download] or [Clear all] 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.
Lit	Lit	Not lit (A35804, the Function Block Database (RAM) Error Flag, is ON.)	Function block database (SRAM) error	The Loop Control Board detected corrupt data (caused by noise or other factor) in the function block database (RAM) during a hot start.	When the power is turned ON, the backup data will be read from flash memory automatically and a cold start will be performed. If a hot start is specified, the Automatic Cold Start Execution Flag (A35807) will be turned ON to indicate that a cold start was performed automatically.		Perform a hot start after the automatic cold start is completed. (Performing a hot start will overwrite the corrupted RAM data with valid data.)

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.

7-1-3 Errors during Normal Operation

LED Indicators on front of Loop Control Board		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 Control Board operating normally.	---	None	---
		Not lit (A35804, the Function Block Database (RAM) Error Flag, is ON.)	Function block database (SRAM) error	The Loop Control Board detected corrupt data (caused by noise or other factor) in the function block database (RAM) during a hot start.	When the power is turned ON, the backup data will be read from flash memory automatically and a cold start will be performed. If a hot start is specified, the Automatic Cold Start Execution Flag (A35807) will be turned ON to indicate that a cold start was performed automatically.	0331 The details code contains either the relevant block address or FFFF if all data bases are invalid.	Perform a hot start after the automatic cold start is completed. (Performing a hot start will overwrite the corrupted RAM data with valid data.)
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 (A42408, the Loop Control Board High Load Flag, is ON.)	The Loop Control Board is operating with a high load rate.	The Loop Control Board's 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.
Lit	Not lit	Flashing (A42405, the Cyclic Monitor Error Flag, is ON.)	Cyclic Monitor Error	CPU Unit Monitor Error (The cyclic area's access right token was not returned to the Loop Control Board within the cyclic monitor time.)	Operation is stopped (fatal error.)	0002	Refer to the CPU Unit's Operation Manual. (The Loop Control Board will start operating again when cyclic servicing is restarted.)

LED Indicators on front of Loop Control Board		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. 1) The data was corrupted by noise or other factor. 2) The power was interrupted during a backup. Note: 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 [Download] or [Clear all] 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		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 Control Board. 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.
2	Default error	When run/stop command S1 turned ON in the ramp program or segment program, the reference input was outside the rise ramp range.	The program is not started.	Check the connection of the reference input and program settings.
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.	In the case of Multiplication, DI/AI Terminal from CPU Unit, DI/AI Terminal from Expanded CPU Unit or Field Terminal blocks, the maximum value is output. In the case of the Segment Linearizer or Temperature and Pressure Correction blocks, the previous data is retained.	In the case of DI/AI Terminal from CPU Unit, DI/AI Terminal from Expanded CPU Unit or Field Terminal blocks, check the scaling value, and in the case of 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. Note: An error does not occur even if the output range (±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 ±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.

Code	Description	Explanation	Operation at error	Remedy
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 following AT parameters: ITEM 036 to ITEM 040. Also, set ITEM 051 to 2 s or less.
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 an 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).
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.).

Code	Description	Explanation	Operation at error	Remedy
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.
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.
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.
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.
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 sequence table will not be executed.	Check the block address or ITEM number.
	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.
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.

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 Using the flash memory

Data stored in flash memory is transferred to RAM for use in actual operation when a cold start is made.

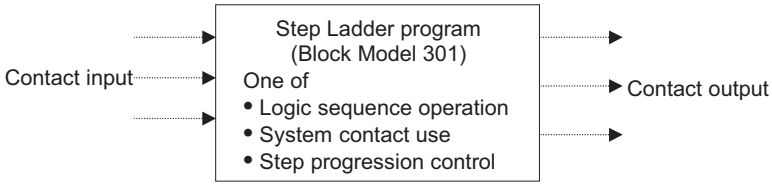
⚠ **Caution** Do not turn OFF the power supply to the PLC when data is being transferred from RAM to flash memory. Data will not be transferred correctly if power is interrupted or a communications error occurs before the transfer operation is completed. If a database occurs, download the function block data gain from the CX-Process Tool to RAM in the Loop Control Board, 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 Control Board
- 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 Control Board
- When step progression control, for example, is to be performed on the Loop Control Board

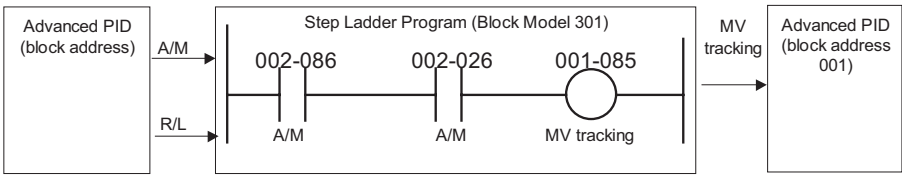
Note When contact signals are simply to be connected between function blocks, the Contact Distributor block (Block Model 201) is used.



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.

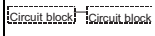
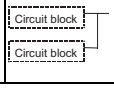
2. At the Step Ladder Program block, external contacts are not directly input and output. They are input and output via Field Terminal DI or DO terminals.

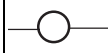
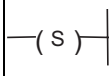
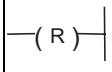
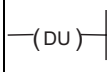
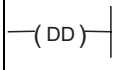
⚠ **WARNING** When the OUT instruction from the Step Ladder Program is to be connected to a DO terminal, do not set the address for the OUT instruction from the Step Ladder Program to the same address as the address for the OUT instruction in the user's program on the CPU Unit. When writing is performed 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.
- Sequence commands are described as a command code within the range 00 to 30. 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, see the Setting Method item in the ITEM lists in the descriptions for each function block.

Command type	Settable ITEM type	“According to Step Ladder Program” at “Settable 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	Command code	Ladder symbol	Operand	Description	Input conditions	°:Can be used ×:Cannot be used	
							In logic sequence	In step sequence
Input type	LOAD	01		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	02		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	03		Read source block address/ ITEM number	Takes a logical AND of the status of the contact and the current execution condition.	Required	°	°
	AND NOT	04		Read source block address/ ITEM number	Reverses the status of the contact and takes a logical AND with the current execution condition.	Required	°	°
	OR	05		Read source block address/ ITEM number	Takes a logical OR of the status of the contact and the current execution condition.	Required	°	°
	OR NOT	06		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	07		000000 (fixed)	Takes a logical AND between circuit blocks.	Required (2 or more)	°	°
	OR LOAD	08		000000 (fixed)	Takes a logical OR between circuit blocks.	Required (2 or more)	°	°

	Command	Command code	Ladder symbol	Operand	Description	Input conditions	°:Can be used ×:Cannot be used	
							In logic sequence	In step sequence
Output type	OUT	11		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	12		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	13		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	14		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	°	°
	DIFU	15		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	°	°
	DIFD	16		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	°	°
---	Draw line				Connects vertical or horizontal lines.	---	°	°

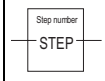
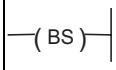
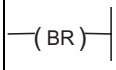
	Command	Command code	Ladder symbol	Operand	Description	Input conditions	°:Can be used ×:Cannot be used	
							In logic sequence	In step sequence
---	Delete line				Deletes vertical or horizontal lines.	---	°	°
---	END	00	ED		Indicates the end of a program. Note: The END instruction is automatically 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	30	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

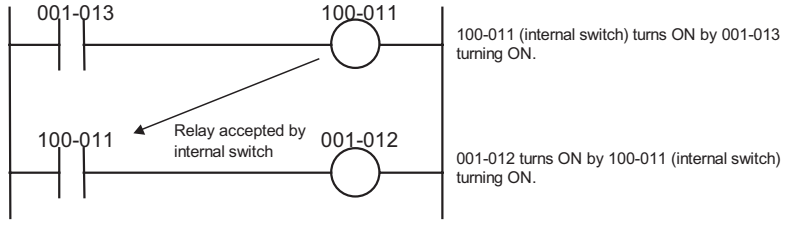
Command	Command code	Ladder symbol	Operand	Description	Input conditions	°:Can be used –×:Cannot be used	
						In logic sequence	In step sequence
STEP	21		Step number	STEP declares the step number, and has no input conditions (is a direction connection to the bus). Any numbers in the range 00 to 99 are 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	22		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 (400 to 499) 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	23		Block address	When the input conditions turn ON, operation of the Step Ladder Program block is stopped at the specified block address (400 to 499). Run/stop command S1 of the specified block automatically turns 0 (OFF).	Required	×–	°
JUMP	25		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 (400 to 499). • 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	×–×	°

Command	Command code	Ladder symbol	Operand	Description	Input conditions	°:Can be used ×:Cannot be used	
						In logic sequence	In step sequence
STEP TIMER	27	— STEP TIMER —	Timer setting value	This is the timer (setting range: 0 to 9999 sec) 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. Note: "Input condition commands" are given top priority.	Not required	×–×	°
ALARM TIMER	28	— ALM TIMER —	Timer setting value	This is the timer (setting range: 0 to 9999 sec) 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	×–×	°

- 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

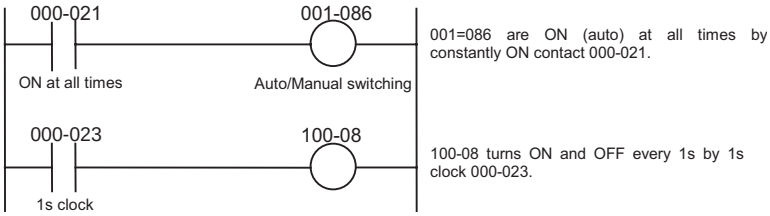
ITEM	Command	Command code	Operand
011	LOAD	01	001013 (block address, ITEM number)
012	OUT	07	100011 (block address of internal switch, ITEM number)
013	LOAD	01	100011 (block address of internal switch, ITEM number)
014	OUT	07	001012 (block address, ITEM number)



- 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	Command code	Operand
LOAD	01	000021 (constantly ON)
OUT	07	001086 (block address, ITEM number)
LOAD	01	000023 (1sec clock)
OUT	07	(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:

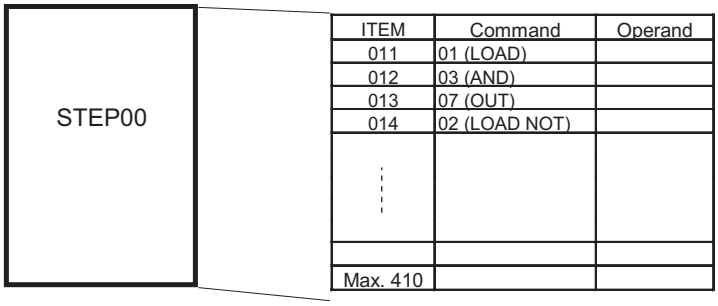
- Operation at all times
- When S1 turns ON

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)



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

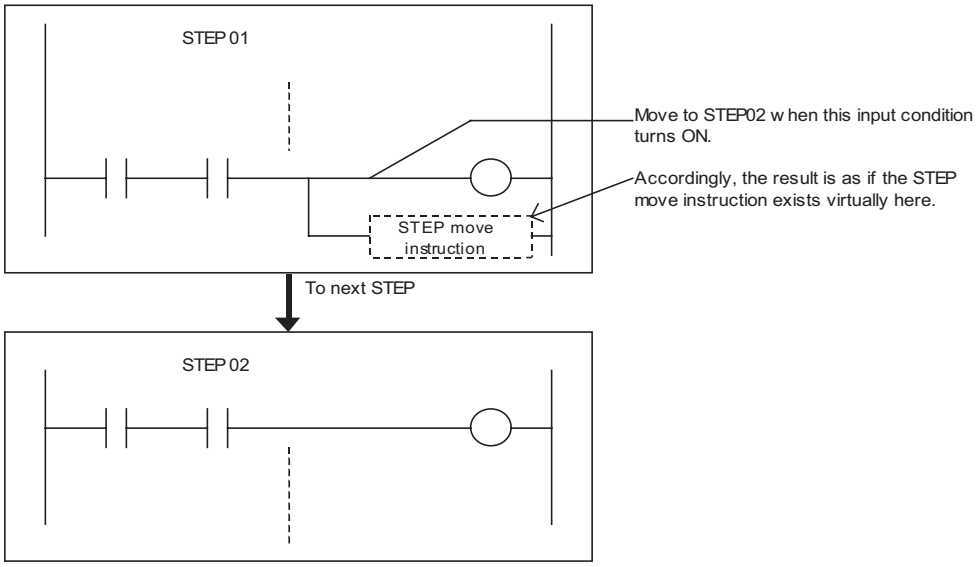
- A Step Ladder Program comprising STEP01 to STEP99 is called a "step sequence." Sequence control instructions (command codes 21 to 28) such as JUMP (jump to a specified step) can be used in step sequences.
- Movement between steps STEP01 to STEP99 is performed according to the following conditions:

1. Move to next STEP when the input conditions of the final sequence command in the previous 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

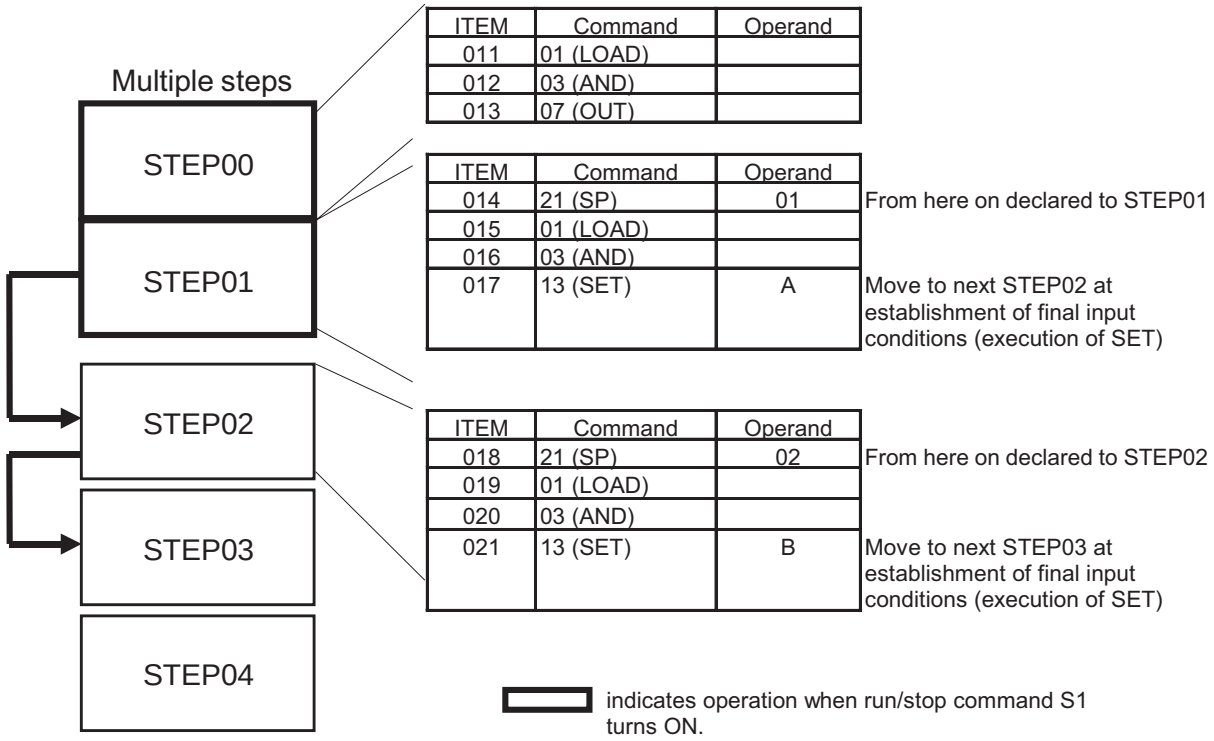
Movement between steps when input conditions are satisfied in this way allows step progression control to be performed.

∗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.



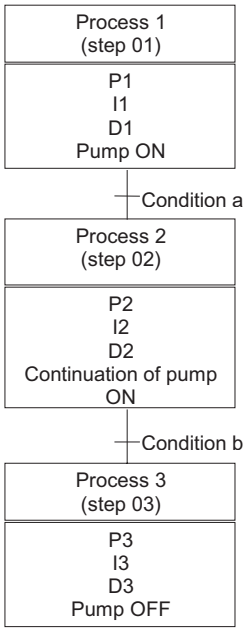
How to program for step progression control

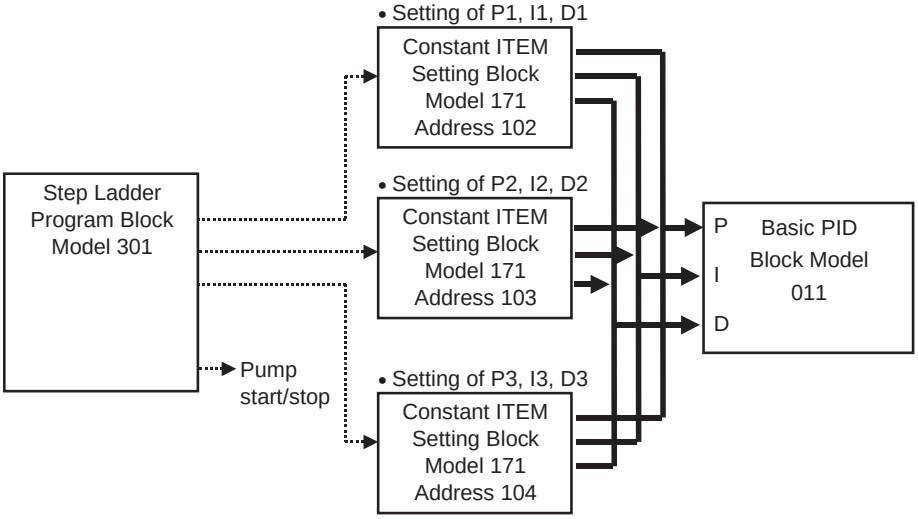
To execute specific processing in each process, program the step sequence as follows:

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.

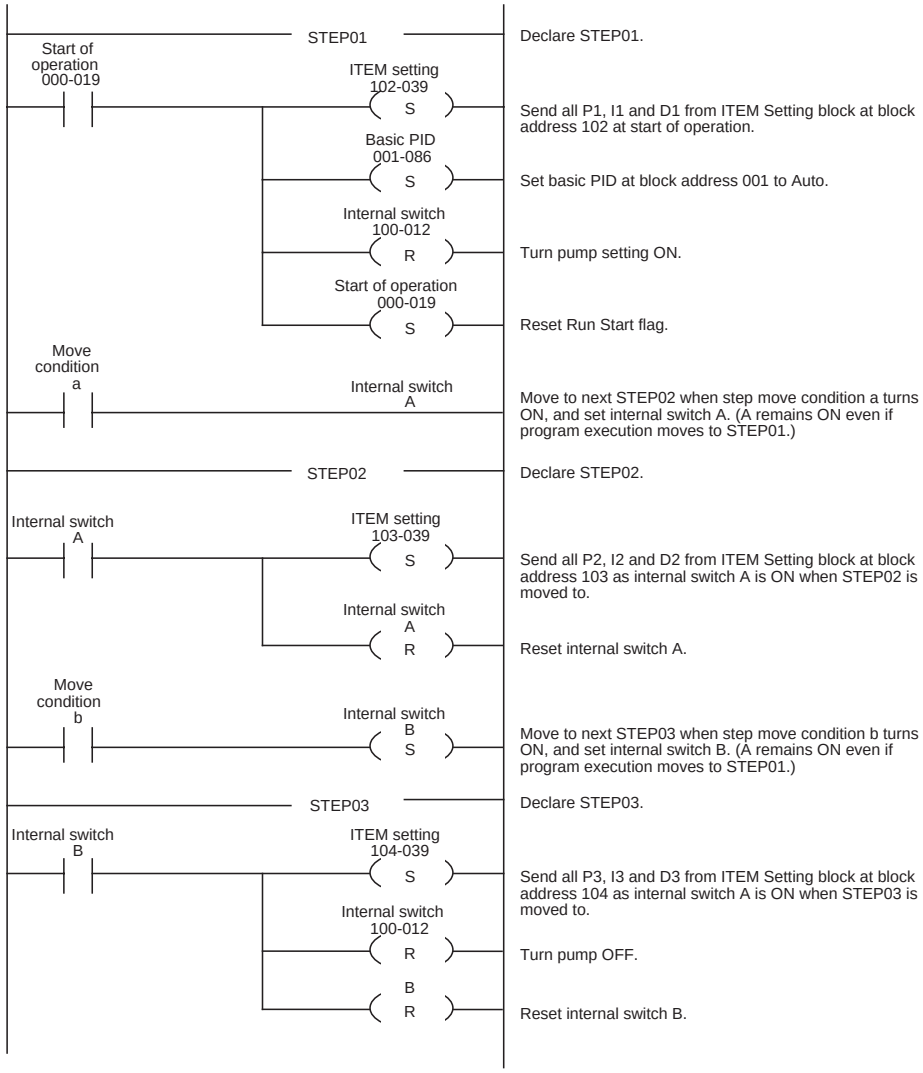
Example

The following shows an example where the PID value is switched at each process to simultaneously stop and start pump operation.


Process 1
(step 01)
P1
I1
D1
Pump ON
Condition a
Process 2
(step 02)
P2
I2
D2
Continuation of pump ON
Condition b
Process 3
(step 03)
P3
I3
D3
Pump OFF


• Setting of P1, I1, D1
Constant ITEM Setting Block Model 171 Address 102
• Setting of P2, I2, D2
Constant ITEM Setting Block Model 171 Address 103
• Setting of P3, I3, D3
Constant ITEM Setting Block Model 171 Address 104
Step Ladder Program Block Model 301
Pump start/stop
P
I
D
Basic PID Block Model 011

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 CS1W-LCB05 Loop Control Board 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.

Starting a Sequence Table

A sequence table can be executed with any of the following methods.

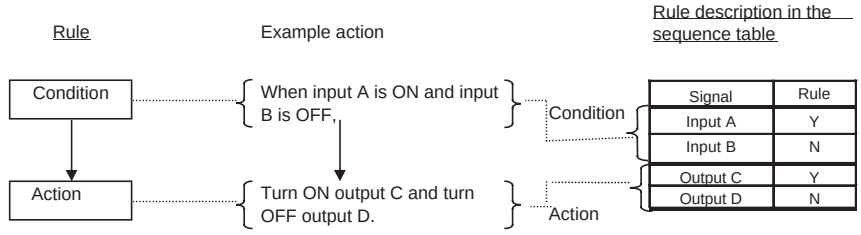
- Execute every cycle (always operating).
- Start with S1. (Starts when control switch S1 is ON and stops when S1 is OFF.)
- Start first cycle only. (Start just one time when the Loop Control Board starts operation.)
- Do not start.

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

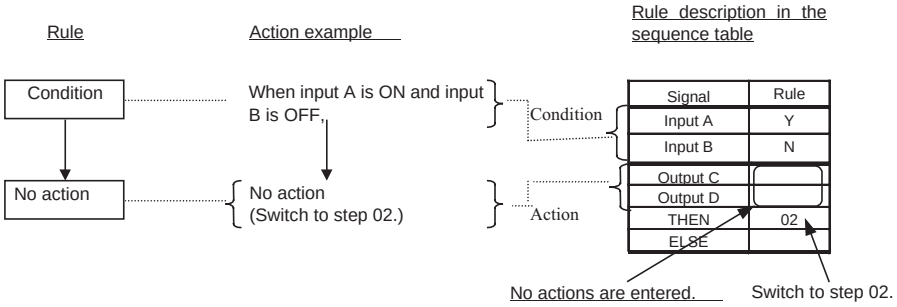
Rules

- 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.)

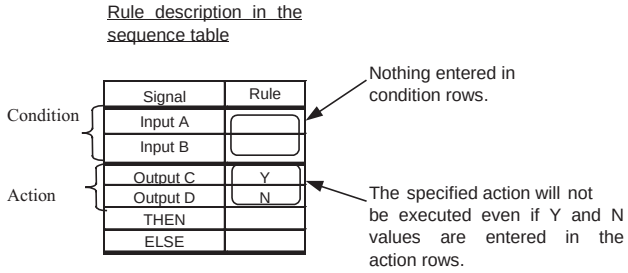


Note It is also possible to just switch to a specified step without executing an action when the condition is met or goes from not met to met. (See the following explanation.)

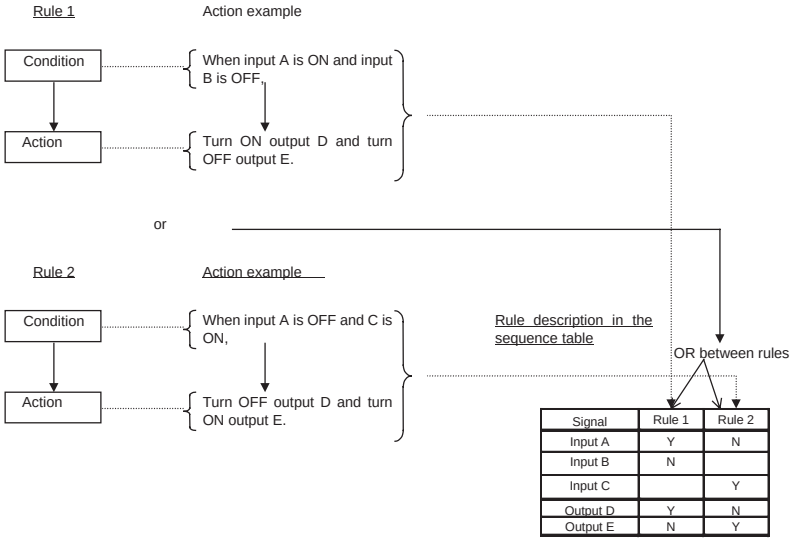
- It is also possible to just switch to another step without executing an action.



- 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.

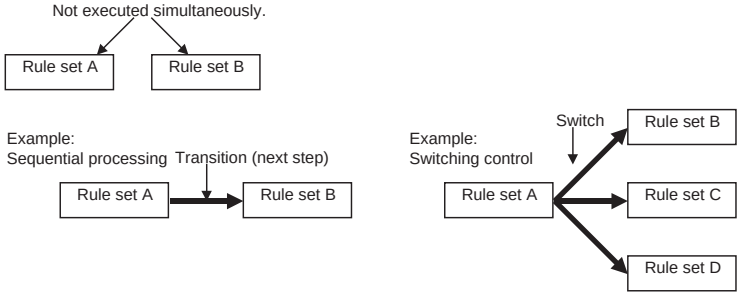
2. Action signals are processed in the order that they appear in the sequence table (top to bottom). For example, if an output value is to be set manually after switching to manual (M) mode with an A/M switch action, place the ITEM write signal (manual output setting) below the A/M switch action in the sequence table.

Steps

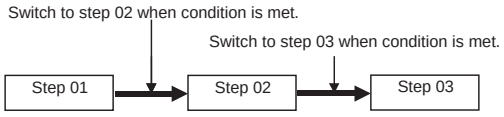
Summary

The Loop Control Board 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).



Example) Step 01
When the tank contents reach a specified level,

	Rule	00	01	02
	Step	01	01	01
I/O				
A		ON		
B			ON	
C			ON	
P				
Q				
Next step	THEN		02	

Step 02
Switch from Manual to Auto and start PID control.

Rule		03
Step		0_2
I/O		
A		ON
B		
C		ON
P		
Q		ON
Next step	THEN	

Switches to step 02 when the condition of rule 01 in step 01 is true.

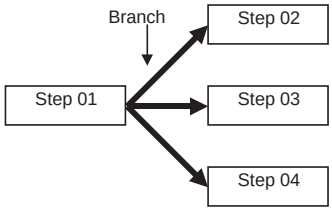
Processing will wait at a step until it is switched to the next step. While processing is waiting at a step, the actions (outputs) in the step will change if the corresponding conditions (inputs) change.

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	01	02
I/O		Step	01	01
A			Y	
B				Y
C				Y
D				
E				
Next step	THEN		03	02

Model B

Step 02
SP=50, P=10

		Rule	03
I/O		Step	02
A			Y
B			
C			Y
D	10		Y
E	30		Y
Next step	THEN		

Model A

Step 03
SP=100, P=30

		Rule	04	05
I/O		Step	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.

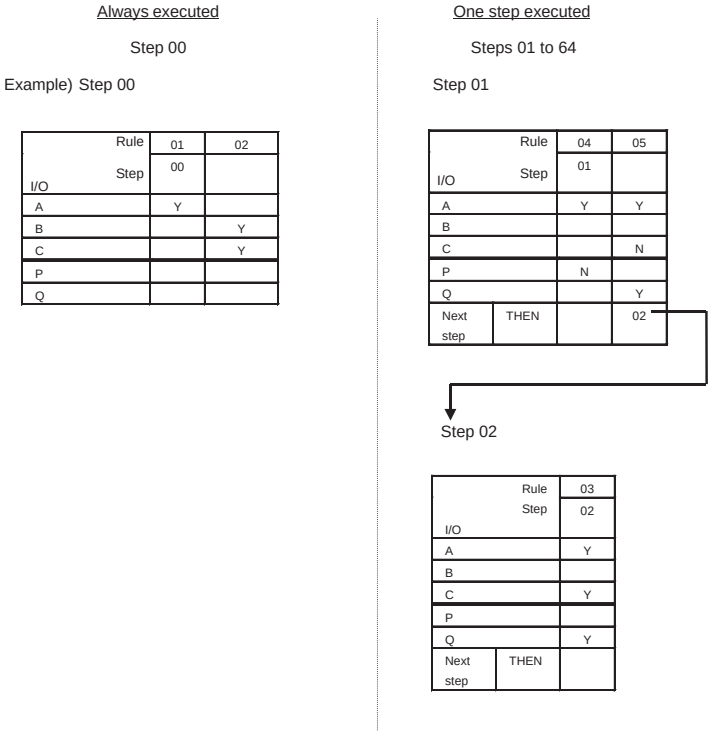
When there are two or more valid step transitions in a single step (the conditions for two or more rules controlling step transitions are met), processing will move to the step indicated by the lowest-numbered rule. The step(s) indicated by higher-numbered rule(s) will not be executed after the step 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.

Note It is not possible to switch from step 00 (always-executed step) to another step or from another step to step 00. When it is necessary to switch to another step, set the step number (01 to 64) in rule number 2 or higher.



In addition to step 00, up to 64 steps (with step numbers 01 to 64) can be used. 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

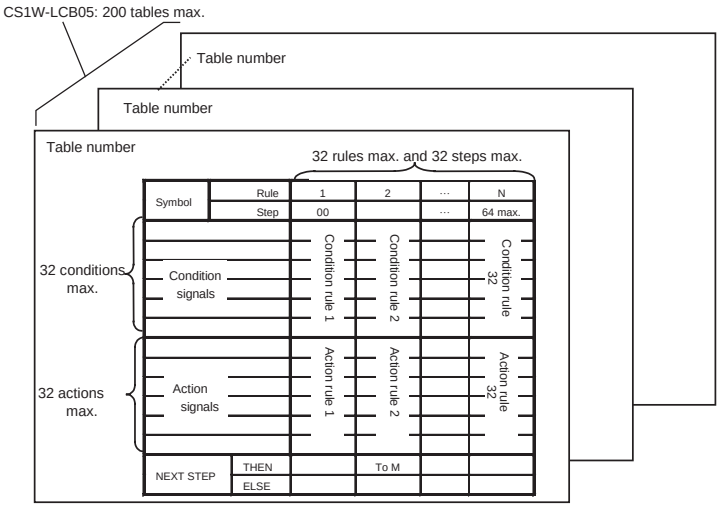
When processing moves to the next step, that step is actually executed in the next operation cycle.

Basic Structure of the Sequence Tables

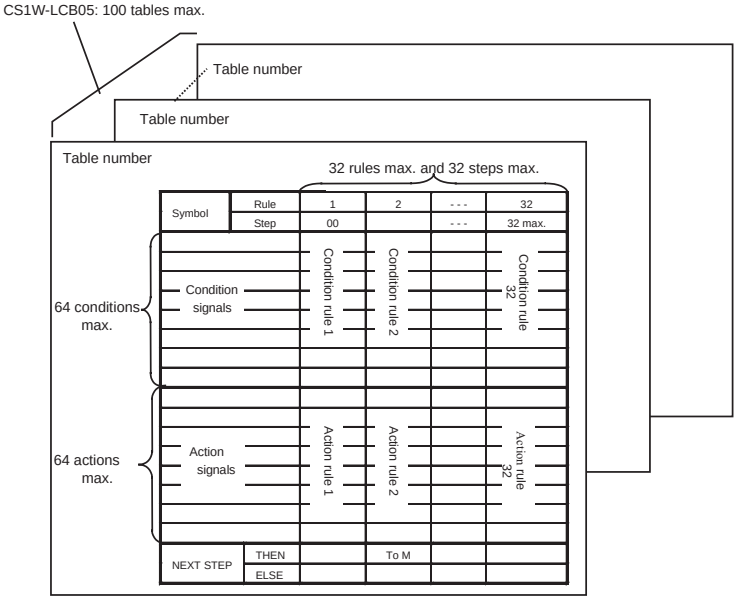
Only the CS1W-LCB05 supports sequence tables. With the standard table settings, up to 200 tables can be used and each table can have up to 32 rules (with up to 32 conditions and 32 actions.)

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

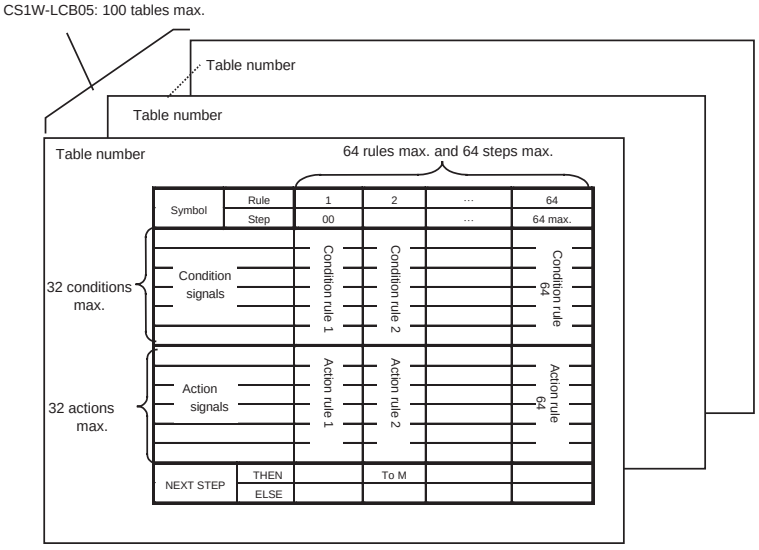


Only Conditions/Actions Columns Expanded



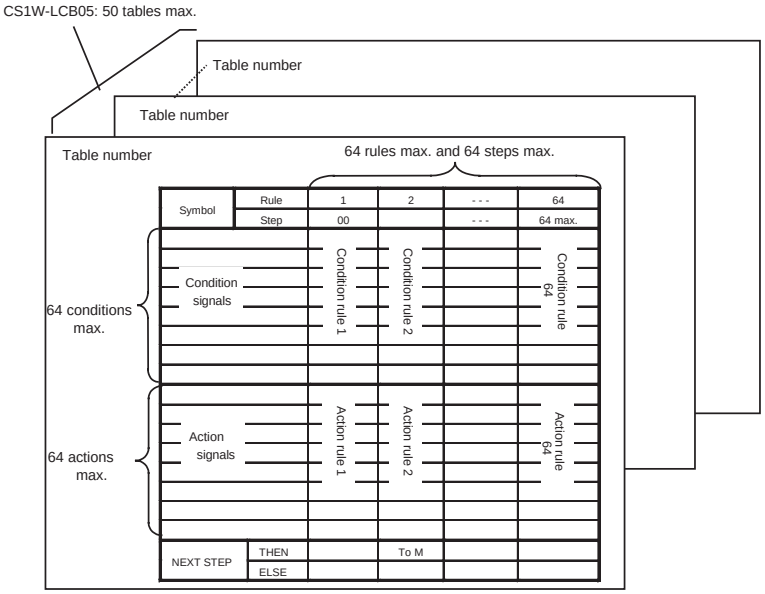
Note To expand the number of conditions and actions in a table, use the CX-Process Tool and select [Expand]-[Vertical] from the Operation Menu.

Only Rules Column Expanded



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



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.

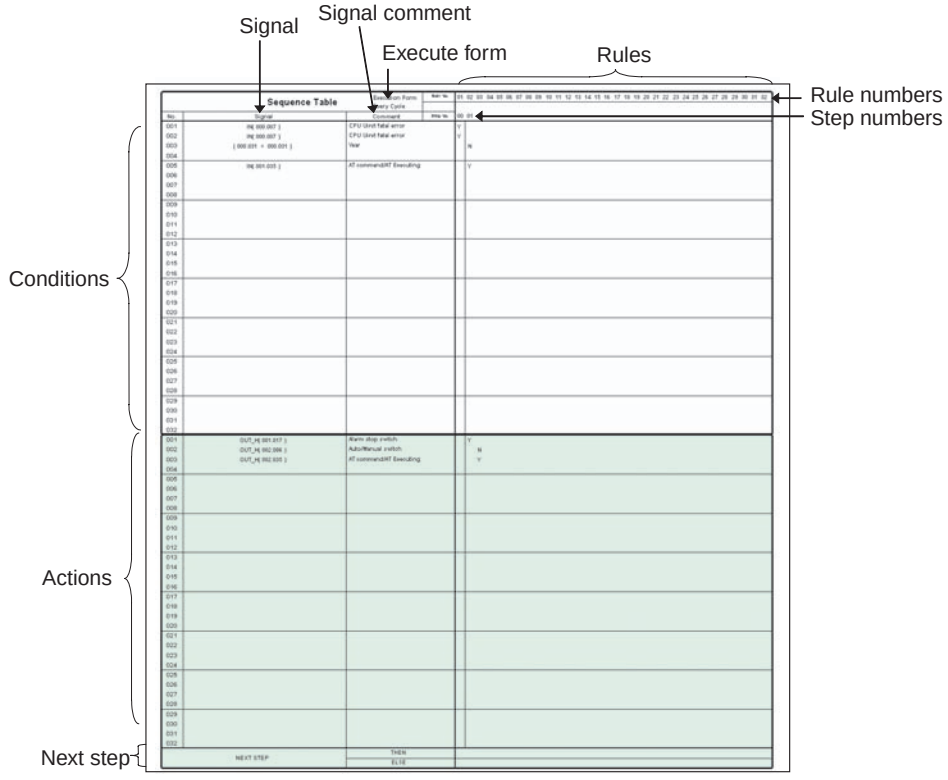
Actual Sequence Tables

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.
- In the conditions half of the table, enter the input signal or relational expression's comparison result to be used. Enter “Y” in the rule's cell to specify an ON condition or “N' to specify an OFF condition. Leave the cell blank if the input signal or relational expression's comparison result is not used in the rule.
- In the actions half of the table, enter the output signal. Enter “Y” in the rule's cell to turn the output ON or “N' to turn the output OFF. Leave the cell blank if the output is not operated by the rule.

Note Enter “Y” when the output is a non-holding or pulse output. (“N” cannot be entered.)

- When an ITEM write command is being used in the actions half of the table, enter the ITEM write command (destination ITEM and write data) in the signal column. Enter “Y” in the rule column if the ITEM will be written by that rule. (“N” cannot be entered.)
- It is also possible to start another sequence table by specifying that sequence table's number (block address) in the actions half of the table. (Execution of the local sequence table will continue and the other table will be started.)
- Always enter step numbers in ascending order. (It is fine to skip step numbers.) When two or more rules are being defined for a single step, enter the step number for the first rule; the step number can be omitted for the remaining rules in the step.
- A destination step number can be entered in the last row of each rule.
  THEN: Processing will switch to the specified step when the rule's condition is met.
  ELSE: Processing will switch to the specified step when the rule's condition is not met.
- It is possible to verify a sequence table's action with the CX-Process Tool. (This function monitors variables such as the step number being executed and whether conditions are met or not met.)



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.	---
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 OUT_L (destination): Non-holding contact output operation OUT_P (destination): Pulse contact output operation OUT_F (destination): Flashing 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
		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
		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
		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 an 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 (*destination*)	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 (*destination*)	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 (*destination*)	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 (*destination*)	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. Note: 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

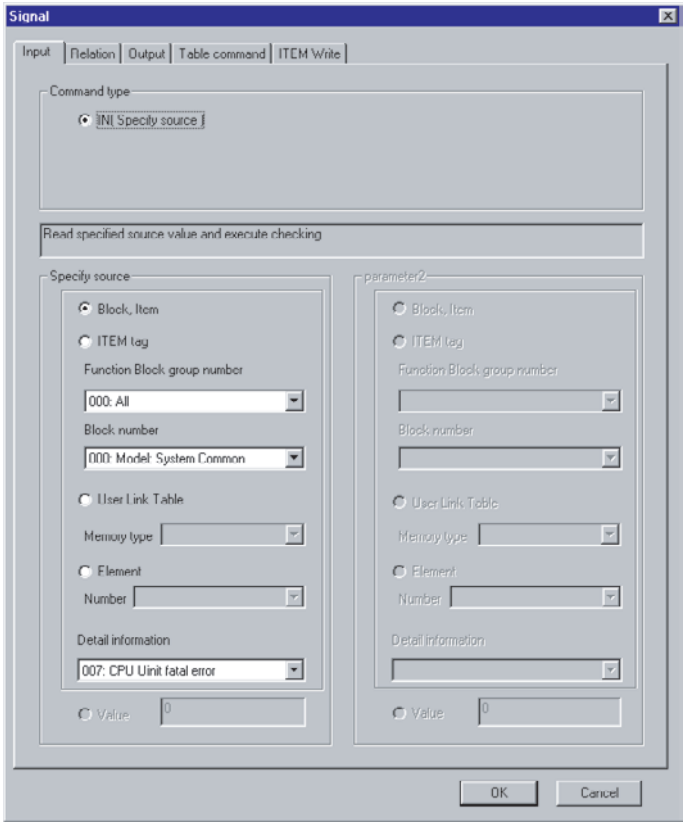
Enter input conditions with the following format.
IN (*designation*)

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



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 ≤ Parameter 2

Parameter 1 = Parameter 2

Parameter 1 ≠ Parameter 2

Parameter 1 > Parameter 2

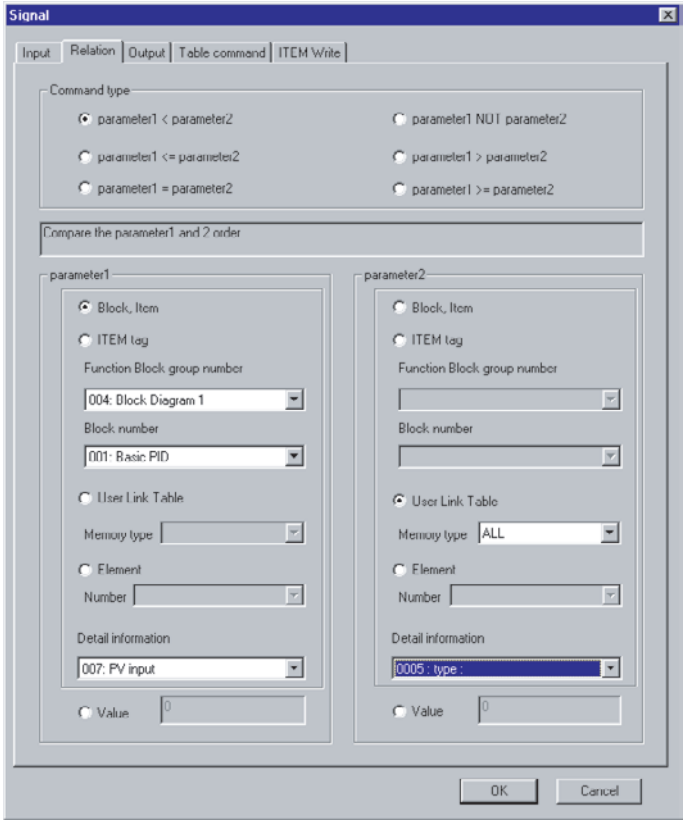
Parameter 1 ≥ Parameter 2

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



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. Note: 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 timeing, N = Resume timing

The CX-Process Tool's Output Tab Settings

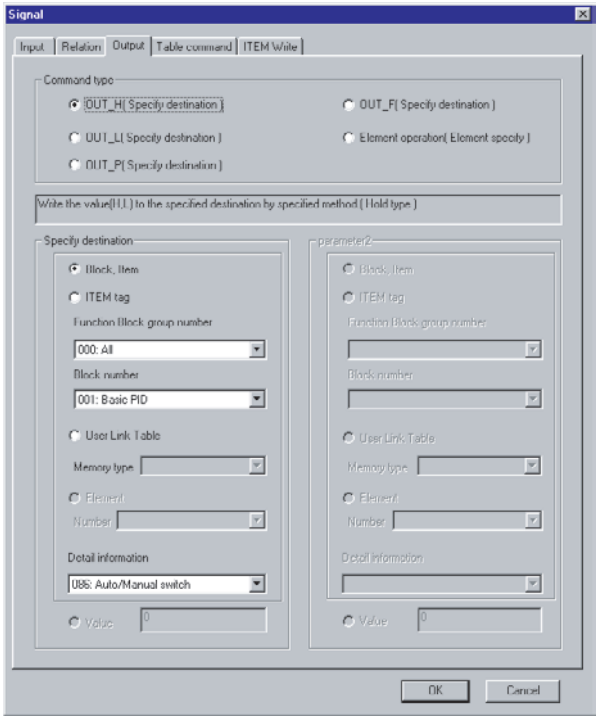


Table Commands

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.

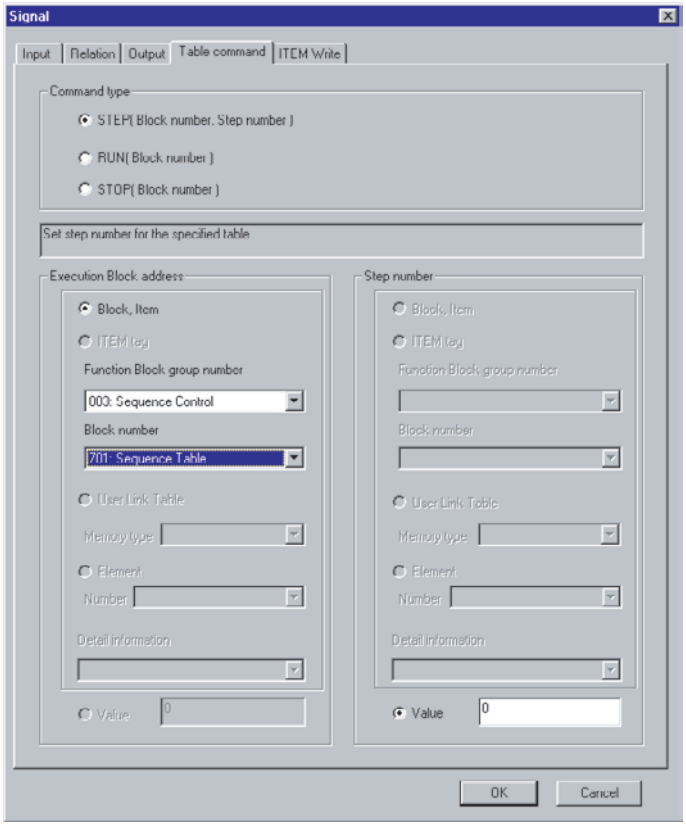
Stopping and Starting another Sequence Table

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.

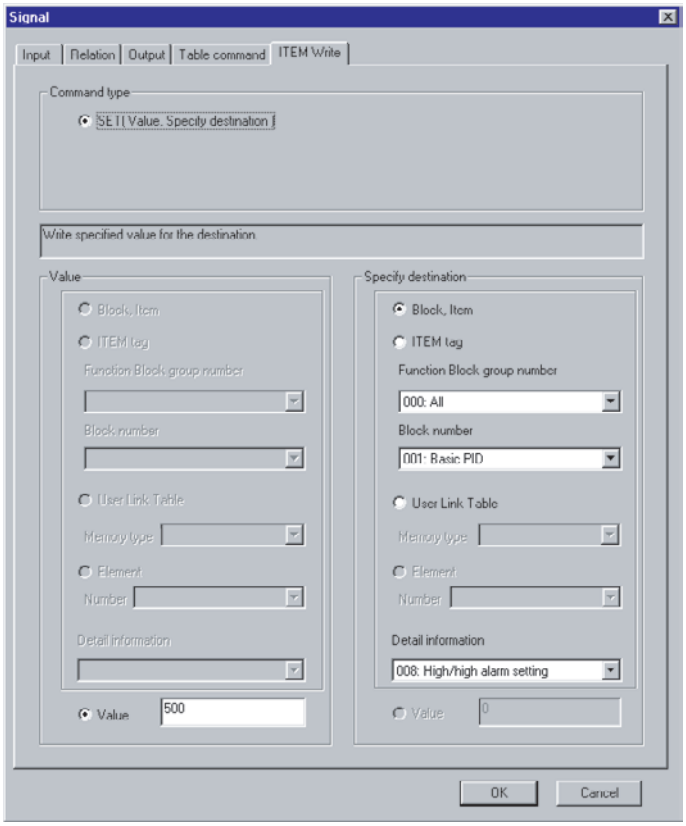
SET(*value*, *destination*)

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



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: 1 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 reset start or “N” for timer reset.)
  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

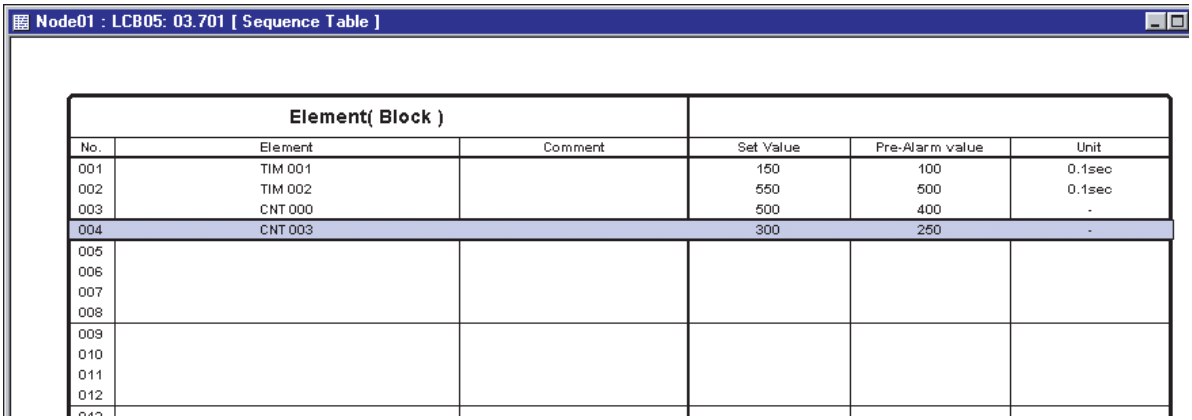
The counter starts operating when the ST (Count start/stop) signal goes ON.

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.

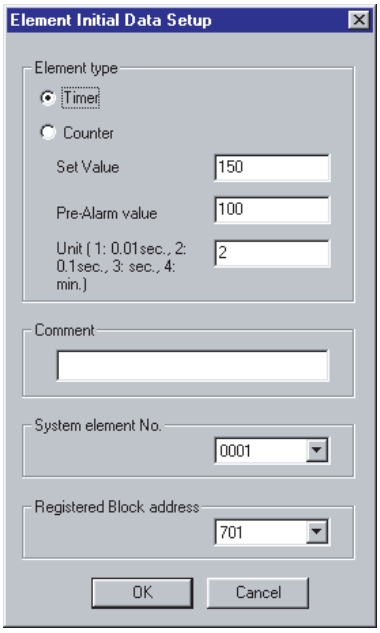
- Register the counter as an element. (Can be registered in Element Display Mode.)
  Element number: 1 to 999 (Element numbers are shared with timers.)
  Set value: 0 to 32,000
  Pre-alarm value: 0 to 32,000
- Control bits (Can be specified as outputs in the actions section.)
  ST: Counter start/stop (Enter “Y” to start counting or “N” to stop counting.)
- 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)



Register timers and counters in the following dialog box.



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																																	
	002																																	
	003																																	
	004																																	
	005																																	
	006																																	
	007																																	
	008																																	
	009																																	
	010																																	
	011																																	
	012																																	
	013																																	
	014																																	
	015																																	
	016																																	
	017																																	
	018																																	
	019																																	
	020																																	
	021																																	
	022																																	
	023																																	
	024																																	
	025																																	
	026																																	
	027																																	
	028																																	
	029																																	
	030																																	
	031																																	
	032																																	

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																																		
	004																																		
	005																																		
	006																																		
	007																																		
	008																																		
	009																																		
	010																																		
	011																																		
	012																																		
	013																																		
	014																																		
	015																																		
	016																																		
	017																																		
	018																																		
	019																																		
	020																																		
	021																																		
	022																																		
	023																																		
	024																																		
	025																																		
	026																																		
	027																																		
	028																																		
	029																																		
	030																																		
	031																																		
	032																																		
NEXT STEP			THEN																																
			ELSE																																

Index

H

I

L

M

N

O

P

R

S

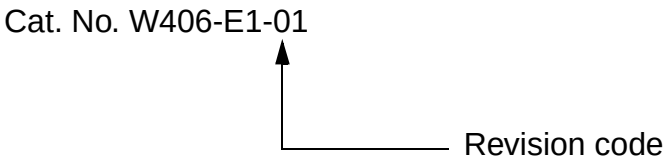
T

U

W

Revision History

A manual revision code appears as a suffix to the catalog number on the front cover of the manual.



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

OMRON CORPORATION
FA Systems Division H.Q.
66 Matsumoto
Mishima-city, Shizuoka 411-8511
Japan
Tel: (81)55-977-9181/Fax: (81)55-977-9045

Regional Headquarters

OMRON EUROPE B.V.
Wegalaan 67-69, NL-2132 JD Hoofddorp
The Netherlands
Tel: (31)2356-81-300/Fax: (31)2356-81-388

OMRON ELECTRONICS LLC
1 East Commerce Drive, Schaumburg, IL 60173
U.S.A.
Tel: (1)847-843-7900/Fax: (1)847-843-8568

OMRON ASIA PACIFIC PTE. LTD.
83 Clemenceau Avenue,
#11-01, UE Square,
Singapore 239920
Tel: (65)6835-3011/Fax: (65)6835-2711

OMRON

Authorized Distributor:

Cat. No. W406-E1-01

Note: Specifications subject to change without notice

Printed in Japan