

# PLC

## PLC MELSEC Process Control System Basics

Welcome to the Basic Course on MELSEC Process Control System.  
This is a tutorial for beginners of the MELSEC process control system.

## Introduction Purpose of the Course



This training course is designed for those who wish to build MELSEC process control systems for the first time. You will learn the features of the MELSEC modules and PX Developer and how to use them.

## Introduction Course Structure

The contents of this course are as follows.  
We recommend that you start from Chapter 1.

### Chapter 1 - What is the MELSEC Process Control System?

You will learn about the features of the modules and software of the MELSEC process control system.

### Chapter 2 - System Configuration

You will learn about the configuration of the process control system on which the course is based.

### Chapter 3 - FBD Programming

You will learn about FBD programming using the PX Developer programming tools, with exercises including FBD programming, parameter setting, and writing to programmable controller CPUs.

### Chapter 4 - Program Monitoring and Tuning

You will learn about program monitoring and tuning using the PX Developer programming and monitoring tools.

### Chapter 5 - Final Test

Passing grade: 60% or higher.

## Introduction How to Use This e-Learning Tool



Go to the next page		Go to the next page.
Back to the previous page		Back to the previous page.
Move to the desired page		"Table of Contents" will be displayed, enabling you to navigate to the desired page.
Exit the learning		Exit the learning. Window such as "Contents" window and the learning will be closed.

## Introduction **Cautions for Use**



### **Safety precautions**

Before using the physical hardware please read the Safety Precautions in the corresponding manuals and follow the relevant safety information contained therein.

## Chapter 1 What is the MELSEC Process Control System?



In this chapter, you will learn the features of key modules and software of a MELSEC process control system.

**1.1****Outline of MELSEC Process Control System**

A MELSEC process control system is designed for process control applications (control of temperature, flow rate, pressure, level, etc.), and consists primarily of the following MELSEC-Q Series modules and software.

- **Process CPU** for high-speed loop and sequence control
- **Analog module with isolated channels** that can be directly connected to sensor, control valve or other input/outputs
- **PX Developer**, an FBD software package for process control system
  - └ **Programming tool**, with which even complex loop control can be programmed easily
  - └ **Monitoring tool**, with which loop control monitoring and tuning can be performed easily
- **Redundant CPUs** to ensure uninterrupted system operation in the event of a sudden failure

# 1.2 Range of Application of MELSEC Process Control Systems

MELSEC process control systems are used in a wide range of fields and applications, from device to plant control, and from continuous to batch to discrete processes.

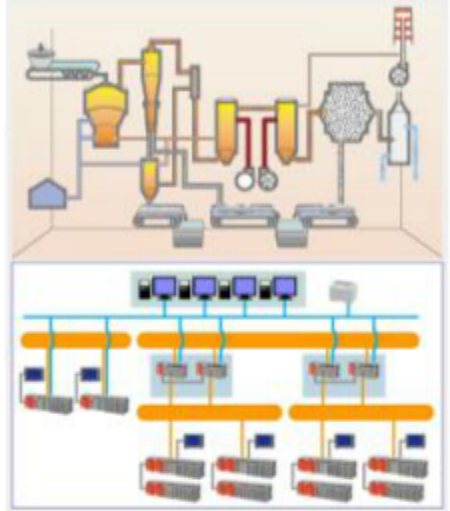
Food processing machine



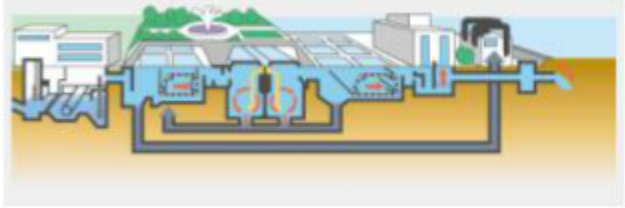
Industrial furnace



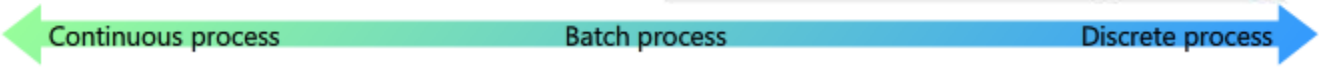
Waste treatment plant



Sewage treatment plant



Fine chemical plant



Applicable fields

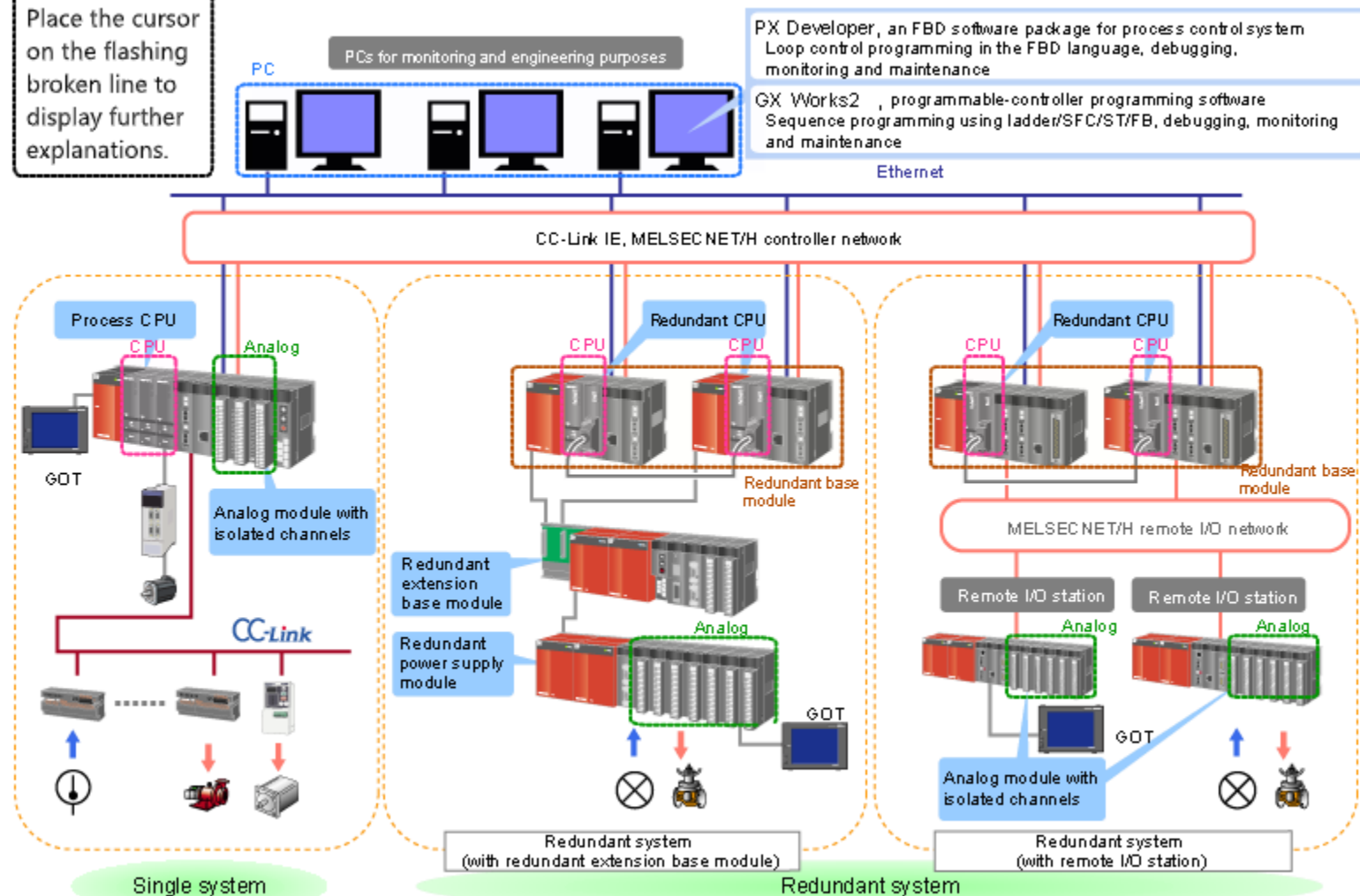
Food, Medicine, Chemical/fine chemical, Steel, Industrial furnaces, Environment, Water supply and sewerage, Paper/pulp, Semiconductors, Building/Air conditioning, Marine vessels



## 1.3 System Components and Features

MELSEC process control systems can be configured to meet various individual needs, as a single system, as a redundant system or as a network of single/dual subsystems. The following figures show typical examples of MELSEC process control systems.






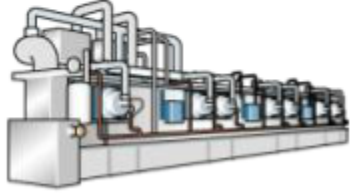
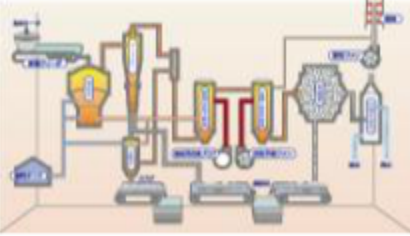
Place the cursor on the flashing broken line to display further explanations.



# 1.4 MELSEC Process Control System Lineup



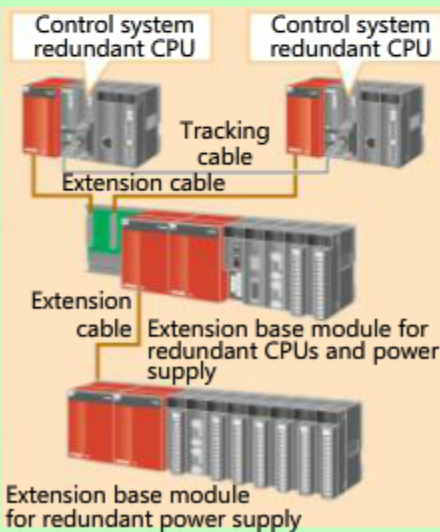
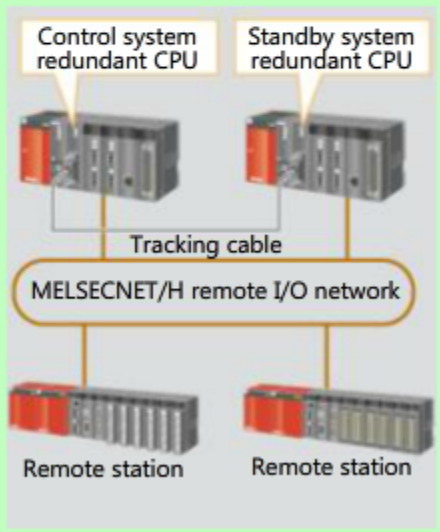
## 1.4.1 Process CPU

A range of process CPUs are available that all offer high-speed loop (400 μs/PID loop) and sequence control. Simply choose the most suitable one for your specific application, devices and plant environment.

Model	Q02PHCPU	Q06PHCPU	Q12PHCPU	Q25PHCPU
Process CPU				
Capacity for programming	28K steps	60K steps	124K steps	252K steps
Applicable fields	<p>Device ← Small <span style="display: inline-block; width: 100px; border-bottom: 1px dashed red;"></span> System size <span style="display: inline-block; width: 100px; border-bottom: 1px dashed red;"></span> Large → Plant</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Food processing machines, industrial furnaces, air conditioning/heat source systems and other applications</p> </div> <div style="text-align: center;">  </div> <div style="text-align: center;">  <p>Plants for water treatment, chemicals, environment, steel and other applications</p> </div> </div>			

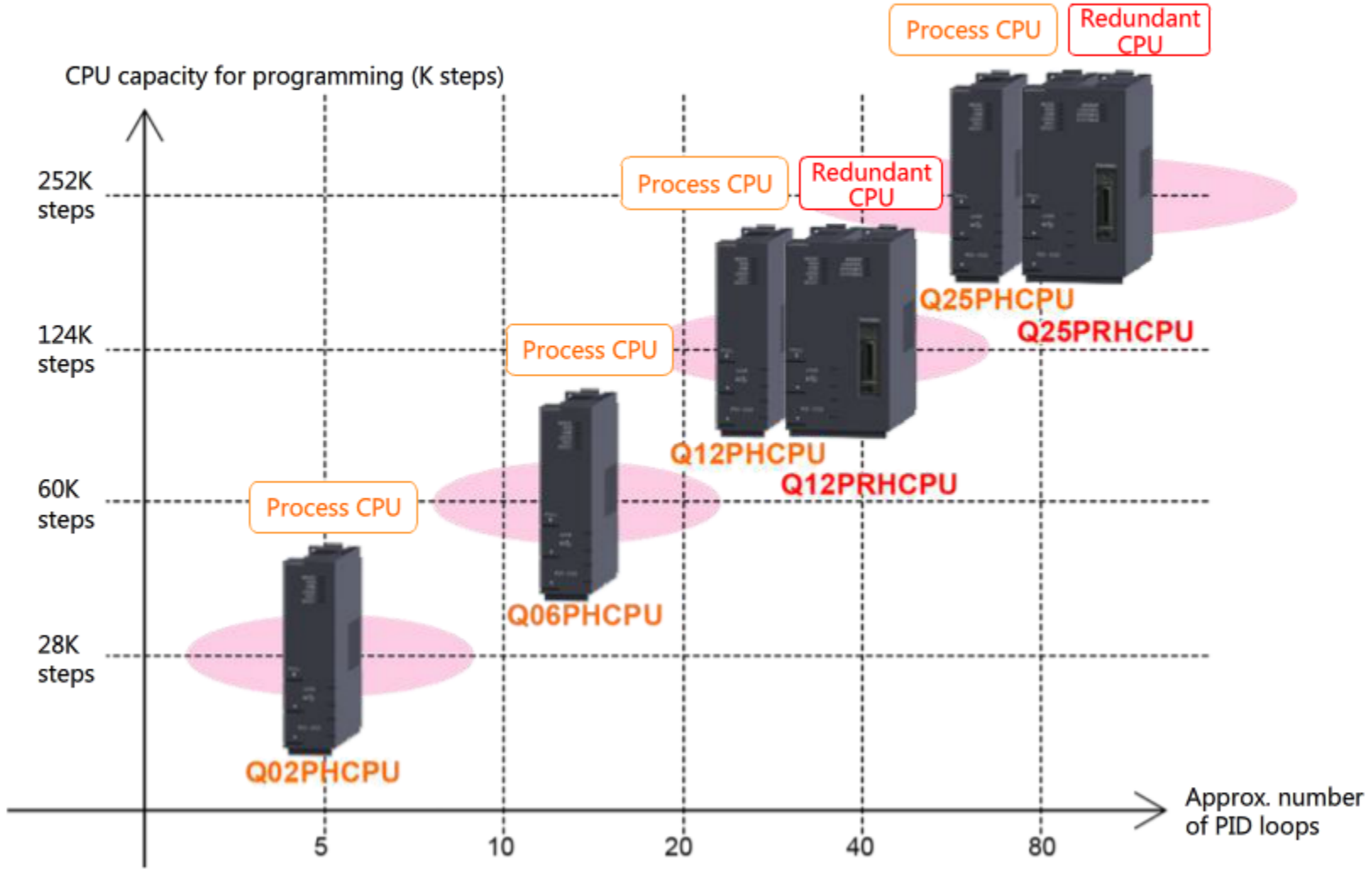
# 1.4.2 Redundant CPU

A redundant system offers highly reliable high-speed loop and sequence control by means of redundant CPUs, networks and power supplies. Choose the extension base module type or the remote I/O station type to suit your specific needs.

Model		Q12PRHCPU	Q25PRHCPU
Redundant CPU			
Capacity for programming		124K steps	252K steps
System structure		Extension base module type	Remote I/O station type
Application	<p>[Extension base module type] Recommended where high-speed response is required.</p> <p>[Remote I/O station type] Recommended where multiple remote stations are installed in the system.</p>	 <p>Control system redundant CPU</p> <p>Control system redundant CPU</p> <p>Tracking cable</p> <p>Extension cable</p> <p>Extension base module for redundant CPUs and power supply</p> <p>Extension base module for redundant power supply</p>	 <p>Control system redundant CPU</p> <p>Standby system redundant CPU</p> <p>Tracking cable</p> <p>MELSECNET/H remote I/O network</p> <p>Remote station</p> <p>Remote station</p>

# 1.4.3 CPU Lineup for Systems of Any Size

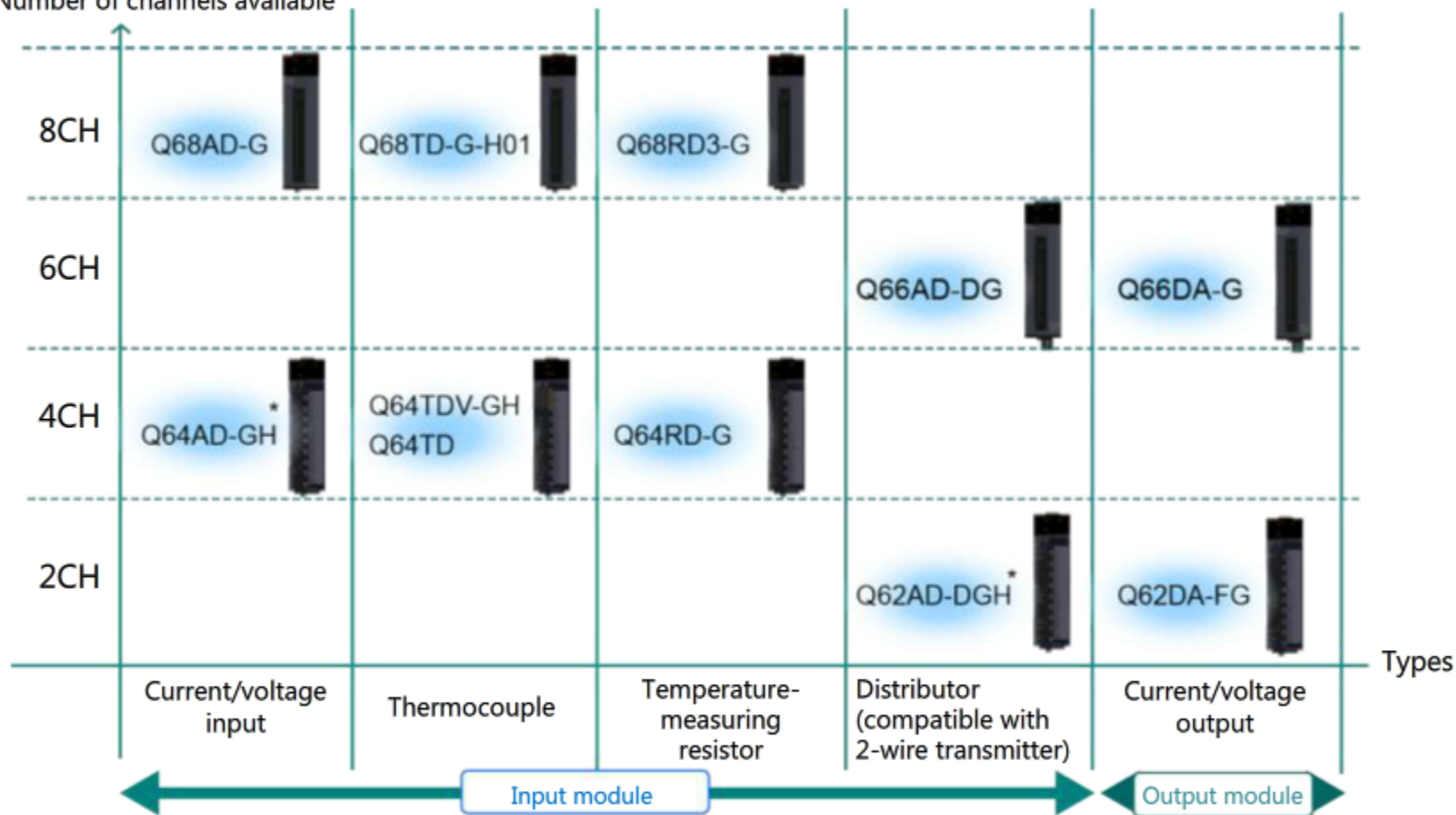
From among the CPU lineup, you can select the right one for the size of your system, whether it is for device process control with several loops or for plant process control with several dozen loops.



## 1.4.4 Analog Module with Isolated Channels

Every analog module is equipped with channels that are isolated from each other. Besides saving space, these modules are available in a variety of specifications including high-precision high-resolution models and multi-channel (6 and 8 channels) versions.

Number of channels available



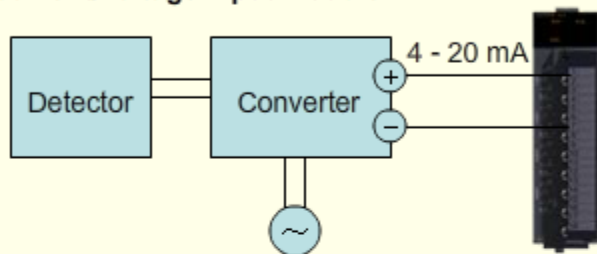
\*: High-precision high-resolution type

## 1.4.4

## Additional Information - Analog Module with Isolated Channels

The following is additional information on analog input modules with isolated channels.

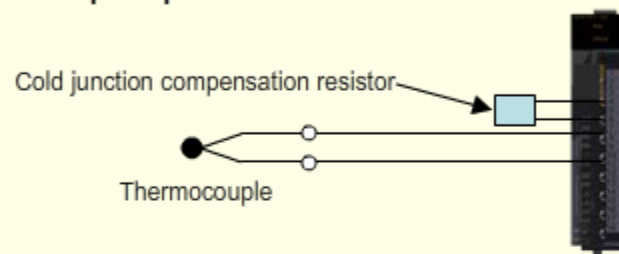
## Current/voltage input module



Example of connection to current/voltage input module

The input module is designed to receive current signals of 4 - 20 mA and voltage signals of 1 - 5 V from a converter.

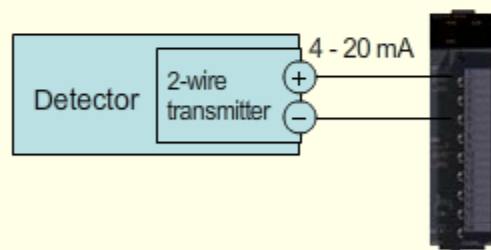
## Thermocouple input module



Example of connection to thermocouple input module

Signal lines from a thermocouple can be directly connected to the input module.

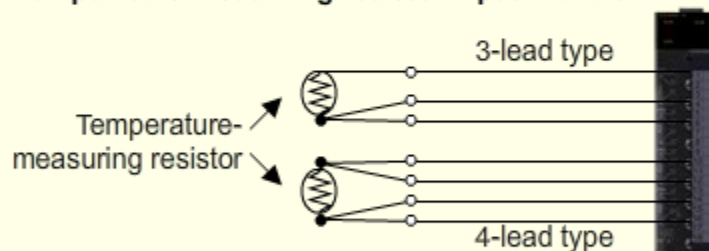
## Distributor



Example of connection to distributor module

The distributor is designed to supply driving voltage via signal lines to a 2-wire transmitter.

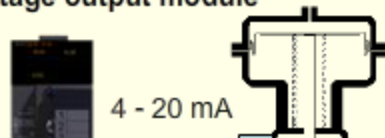
## Temperature-measuring resistor input module

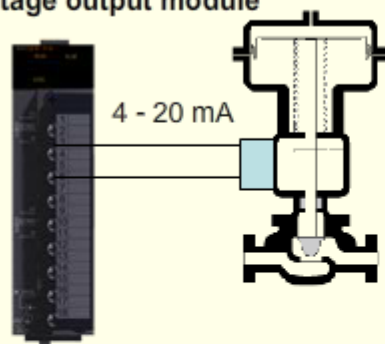


Example of connection to temperature-measuring resistor input module

Signal lines from a platinum/nickel temperature-measuring resistor can be connected directly to the input module.

## Current/voltage output module



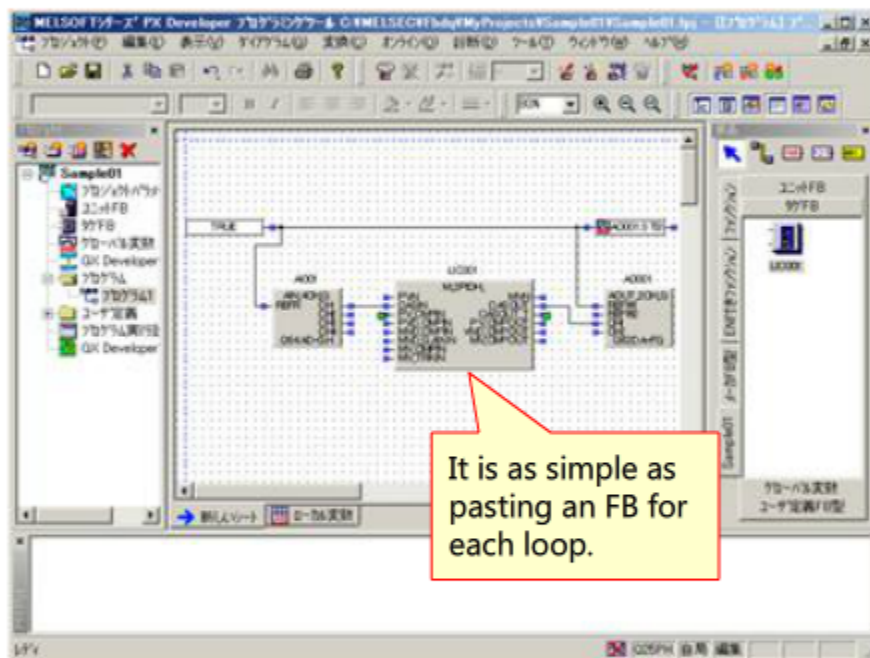
**1.4.4****Additional Information - Analog Module with Isolated Channels****Current/voltage output module**

Example of connection to  
current/voltage output module

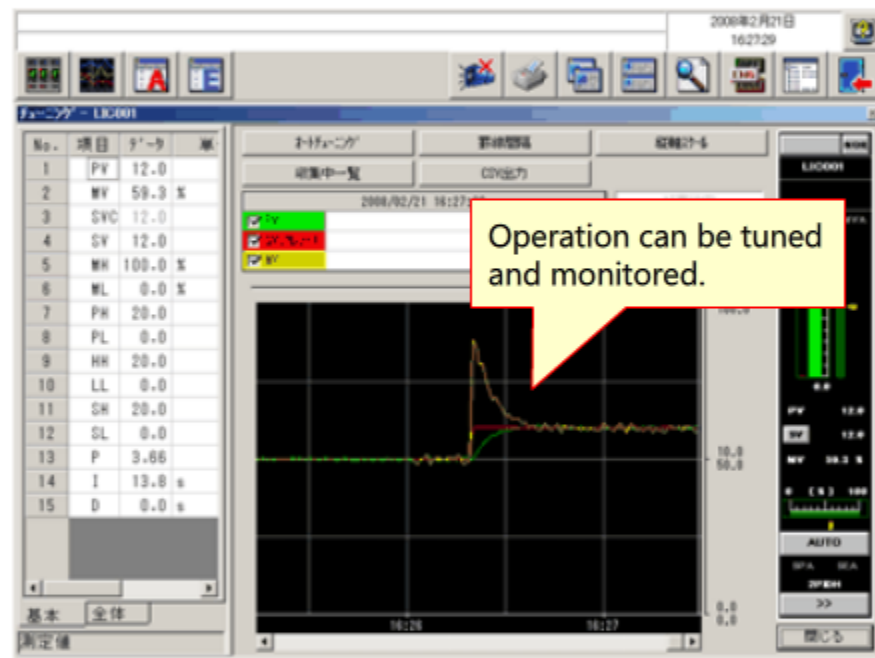
The output module is designed to send current signals of 4 - 20 mA and voltage signals of 1 - 5 V to a valve or other outputs.

## 1.4.5 PX Developer Software Package for Process Control System

- With PX Developer's programming tool, which meets the IEC61131-3 standard, loop control can be programmed easily, simply by pasting FBs and connecting wires. This reduces the time taken to build a process control system.
- The monitoring tool comes as standard with frequently-used features such as tuning, control panel, trend graph and a warning list. Once programming is complete, you can immediately move on to adjustment, startup and operation.



Programming tool

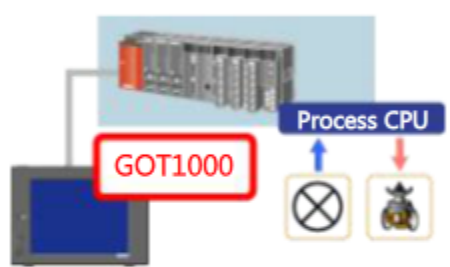
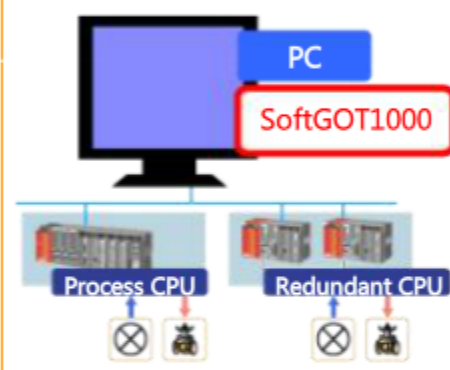
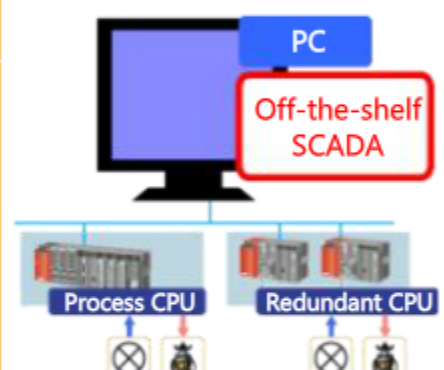


Monitoring tool



# 1.4.6 Process Control System Monitoring

The MELSEC process control system offers a range of monitoring solutions to suit all possible system sizes, whether it is just one device or a whole plant.

Type	Device/site monitoring solution	Facility/plant monitoring solution	Plant monitoring solution
Structure	<p>GOT imaging function Coordinated indicator monitoring</p> 	<p>PC monitoring by coordination between PX Developer monitoring tool and SoftGOT1000</p> 	<p>PC monitoring by coordination between PX Developer monitoring tool and off-the-shelf SCADA</p> 
Function	Graphic screen image	GOT1000 drawing software [GT Designer2]	
	Standard screen image	Automatically generated by GOT imaging function	Generated by PX Developer monitoring tool

\*1 Faceplates, tuning screen and other images of the PX Developer monitoring tool are automatically converted into GT Designer2 image data. This data can then be used for GOT without further processing.

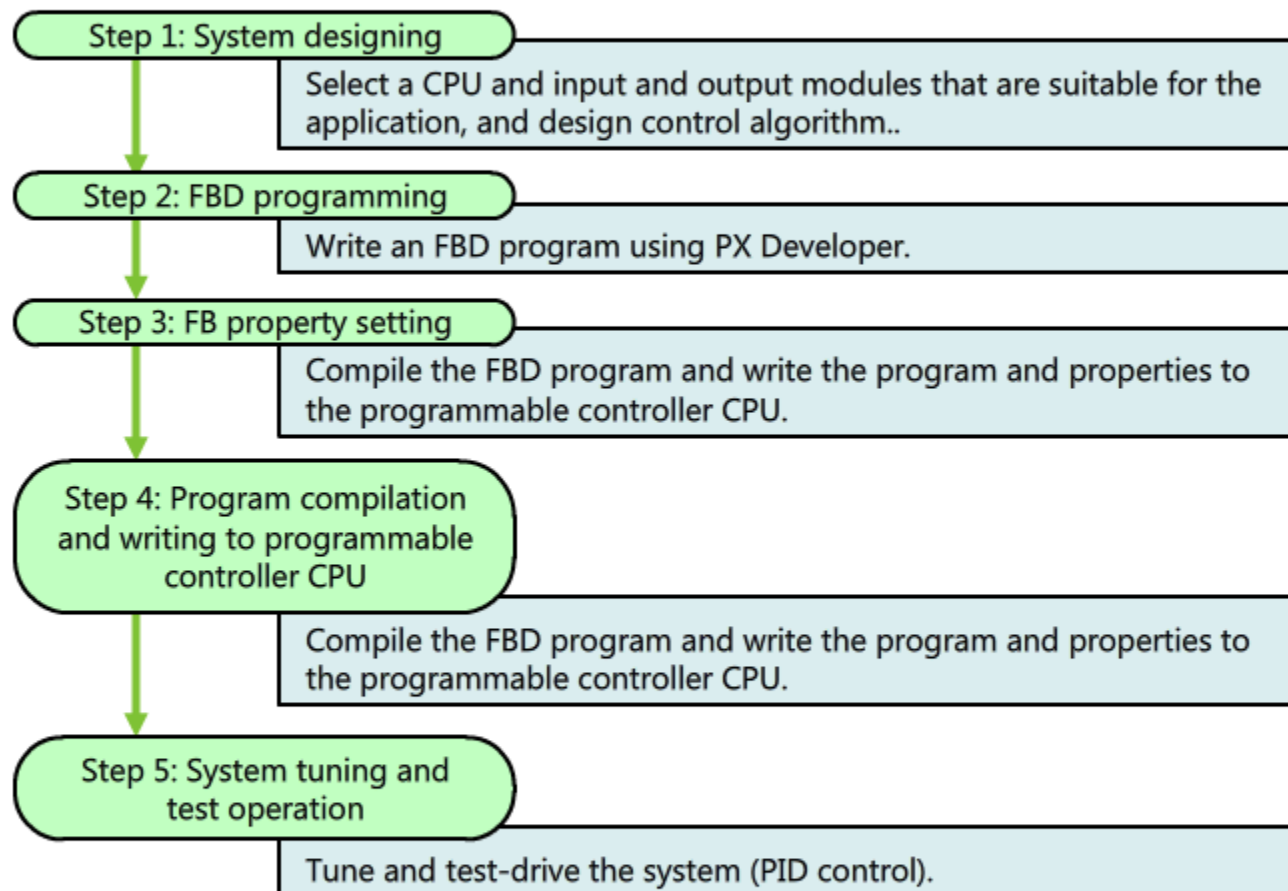
\*2 Images are available by pasting ActiveX faceplate components onto SCADA graphic screen images.

## Chapter 2 System Configuration

In this chapter, you will look at a process control system that controls the water level of a tank, and explore the required configuration and software of the programmable controller.

## 2.1 System Building Procedures

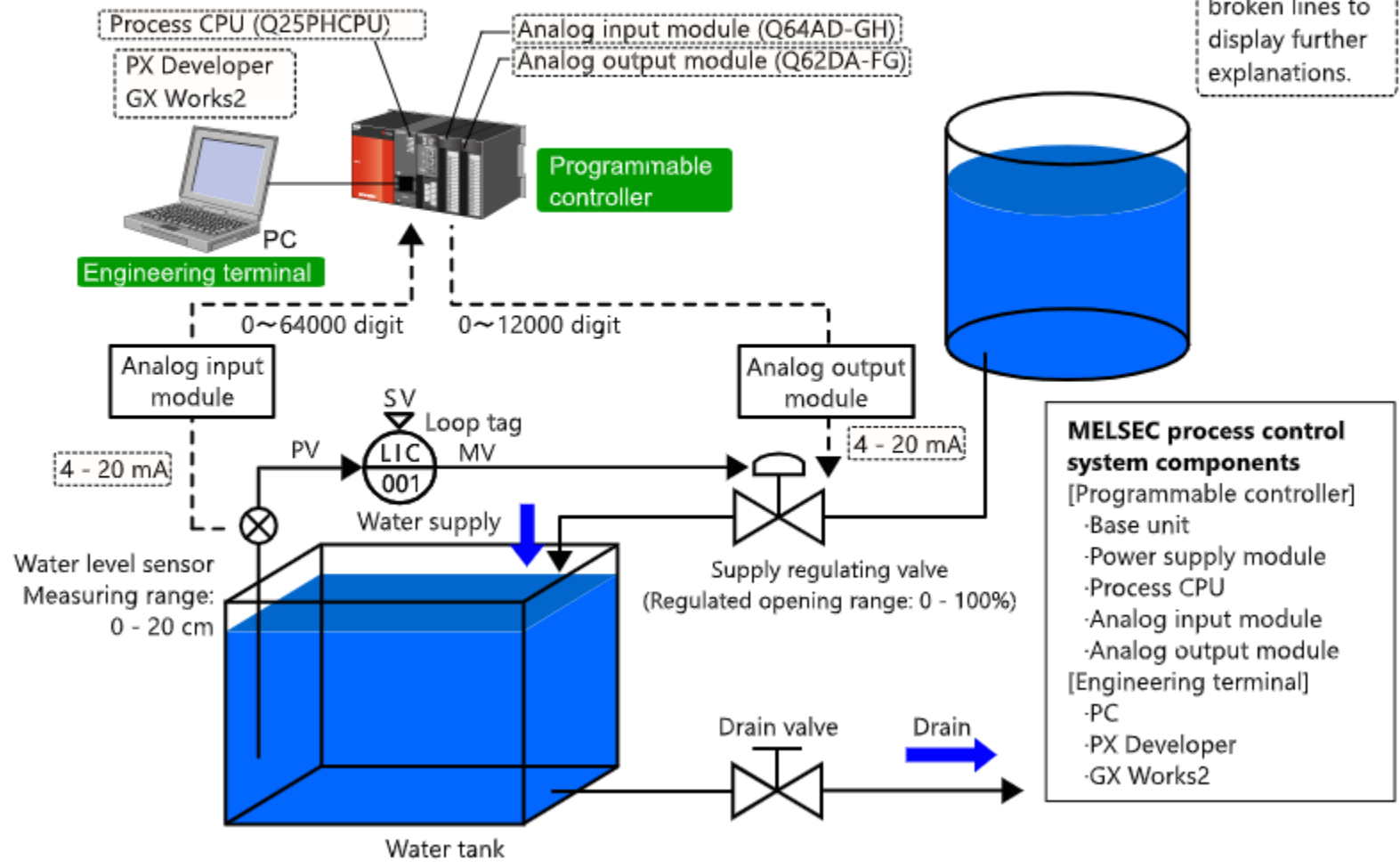
In this example we will build a process control system that maintains the water level in a tank.



# 2.2 System Structure

You will build the MELSEC process control system shown below to keep the water level of a tank at a predetermined level. When the water level in the tank drops due to the drain valve being activated the drop in the water level is detected by a water level sensor. The PID control program responds by activating the supply regulating valve. The structure of this MELSEC process control application is as follows.

Place the cursor on the flashing broken lines to display further explanations.



Engineering terminal

Programmable controller

Process CPU (Q25PHCPU)

PX Developer  
GX Works2

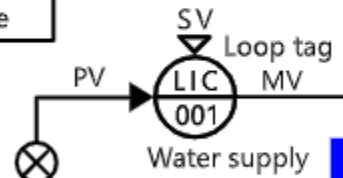
Analog input module (Q64AD-GH)

Analog output module (Q62DA-FG)

PC

Analog input module

Analog output module



Supply regulating valve  
(Regulated opening range: 0 - 100%)

Drain valve

Drain

Water tank

Water level sensor  
Measuring range:  
0 - 20 cm

4 - 20 mA

4 - 20 mA

0~64000 digit

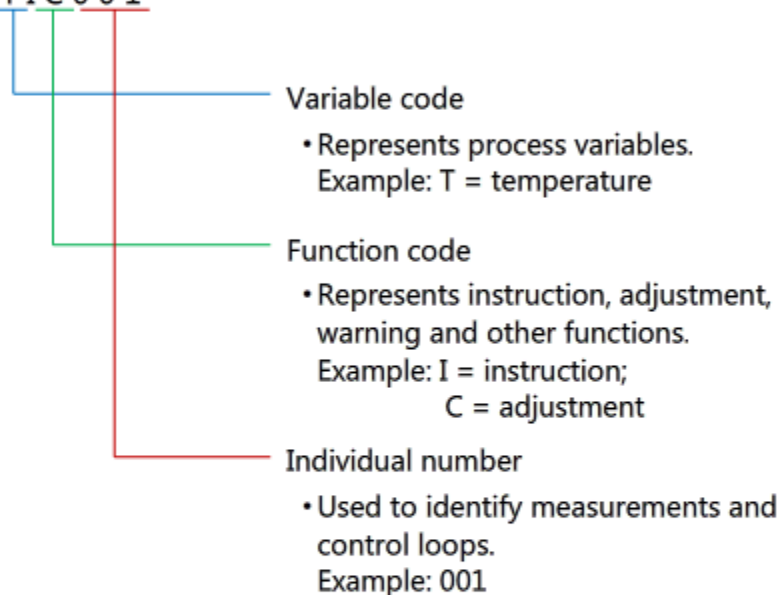
0~12000 digit

## 2.3

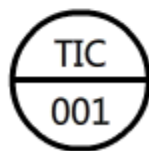
## Additional Information - Loop Control Tag Number

Tags are allocated to the components and functions of the process control system to identify control loop process characteristics. These tags are called loop control tag numbers.

Example: TIC001




"TIC001" indicates loop number 001 for temperature instruction and adjustment.



Symbol for TIC001

	Variable code	Function code
A		Warning
C		Adjustment
D	Density, Specific gravity	
F	Instantaneous flow rate	
G	Position, Length	
H	Manual operation	
I		Instruction
K	Time	
L	Fluid and other levels	
M	Humidity, Moisture content	
P	Pressure, Vacuum	
Q	Quality (composition, concentration)	Integration
R	Radiation	Record
S	Velocity, Speed, Frequency	Switch
T	Temperature	Transmission
V	Viscosity	
W	Mass, Force	
Z		Safety, Emergency

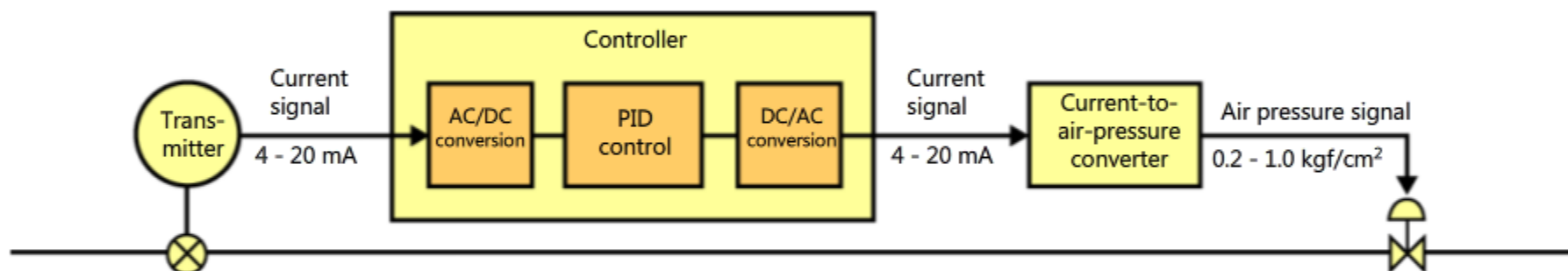
 Frequently used code

## 2.4

## Additional Information - Standardized Signals

Input and output signals for process control systems, such as measurements and actuation commands, are standardized (typically 4 - 20 mA DC). These signals are called **standardized signals**.

Signal type	Signal range
Current	4 - 20 mA DC
Voltage	1 - 5 V DC
Air pressure	0.2 - 1.0 kgf/cm <sup>2</sup>



## 2.5

## Input and Output Modules

The input and output modules for the process control system are shown in the following table. This information is required in Step 2 "FBD programming" and Step 3 "FB property setting."

Module/Device	Slot	Head I/O address	Connection	Range
Analog (current/voltage) input module (Q64AD-GH)	I/O 0	0000	The input signal line from the water level sensor is connected to the channel 1 (CH1) input terminal of the module.	Analog input signal range: 4 - 20 mA Digital output signal range: 0 - 64000
Analog (current/voltage) output module (Q62DA-FG)	I/O 1	0010	The output signal line to the supply regulating valve is connected to the channel 1 (CH1) output terminal of the module.	Digital input signal range: 0 - 12000 Analog output signal range: 4 - 20 mA

Place the cursor on the flashing broken lines to display an arrow.



## Chapter 3 FBD Programming



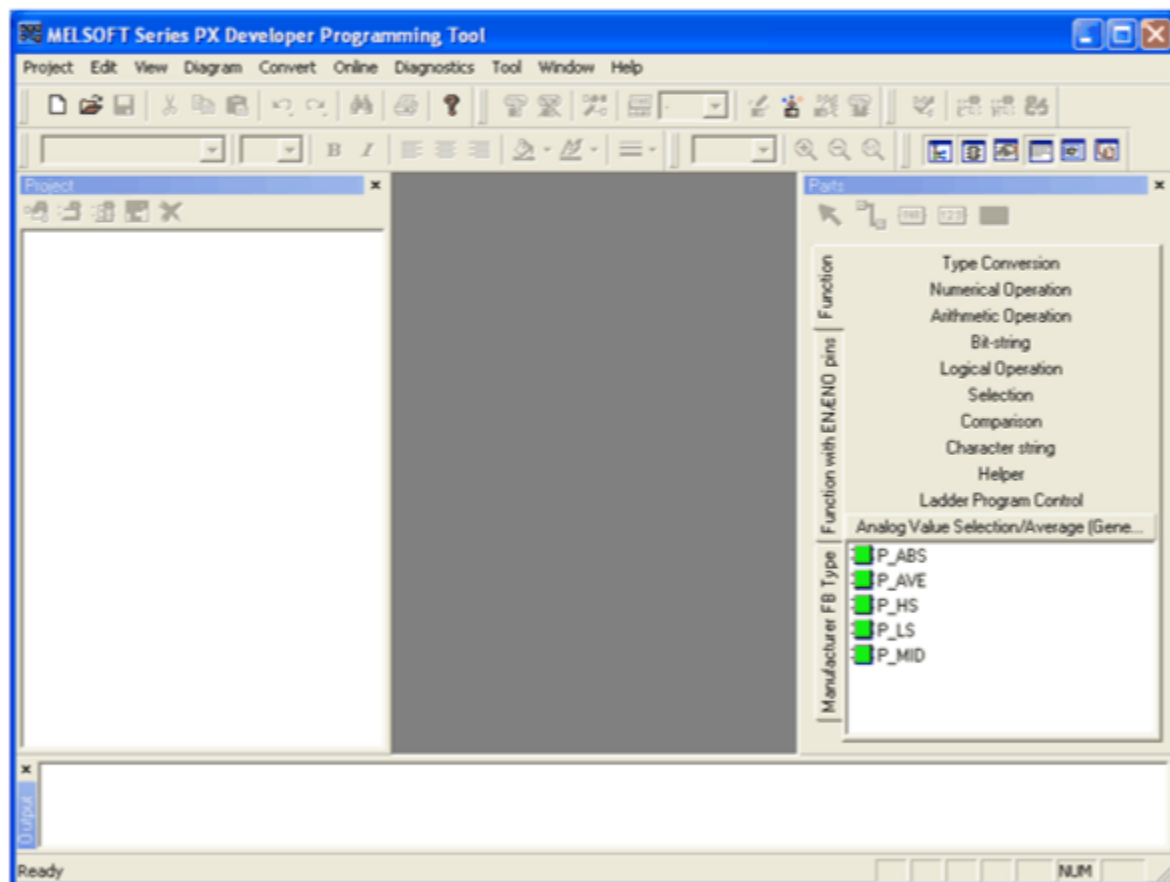
In this chapter, you will write FBD programs using the PX Developer programming tool.



## 3.1 Starting the PX Developer Programming Tool

To perform FBD programming, start the PX Developer programming tool, which is application software.

Click the **Start** menu of Windows, **All Programs** and then **PX Developer Programming Tool** to start the application software.



## 3.2 Creating New Projects

To write programs using the programming tool, you need to create a project. This requires you to set certain items.

### (1) Programmable controller model

Specify a programmable controller CPU. It can be a process CPU or a redundant CPU. In this training course, you will configure the system with a process CPU (Q25PH). Select **Q25PH**.

CPU type	Programmable controller model
Q02PH	Process CPU
Q06PH	
Q12PH	
Q25PH	
Q12PRH	Redundant CPU
Q25PRH	

### (2) Project name

Specify the drive/path to which you want to save the project file and the project name. In this training course, enter the following.

Drive/Path: c:\MELSEC\Flodq\MyProject  
Project name: Sample01

\* When a project name is specified, a folder with the project name is automatically created in the specified drive/path.

# 3.2 Creating New Projects

**MELSOFT Series PX Developer Programming Tool**

Project Edit View Diagram Convert Online Diagnostics Tool Window Help

Project Parts

Function

- Type Conversion
- Numerical Operation
- Arithmetic Operation
- Bit-string
- Logical Operation
- Selection
- Comparison
- Character string
- Helper
- Ladder Program Control

Function with EN/END pins

- Analog Value Selection/Average (Gene...


Manufacturer FB Type

- P\_ABS
- P\_AVE
- P\_HS
- P\_LS
- P\_MID

Output

Ready

A new project has been created.

Click  to proceed.

## 3.3

## Screen Layout of the PX Developer Programming Tool

The screen of the PX Developer programming tool is laid out as shown below.

[Menu Bar]  
To execute functions/operations.

[Tool Bar]  
To execute frequently used functions/operations.

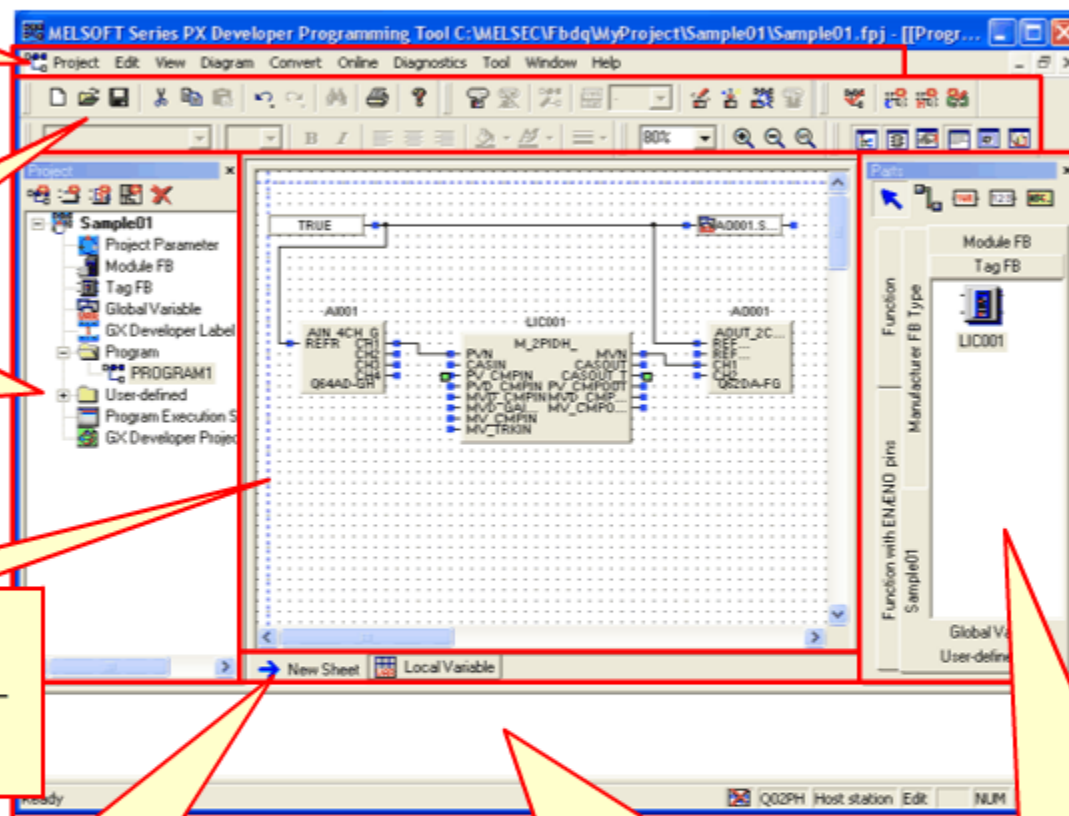
[Project Window]  
To set project parameters, modules, tags, program names, program run frequencies, etc.

[Programming Window]  
To create programs and user-defined FBs. Up to 200 process-description programs can be created.

[Sheet Tab]  
To select sheets. Up to 32 sheets can be created per program.

[Output Window]  
To display information such as the progress of process, errors and warnings during compilation and execution of other commands.

[Parts Window]  
To show a list of FBs/functions that can be pasted to programs and user-defined FBs.



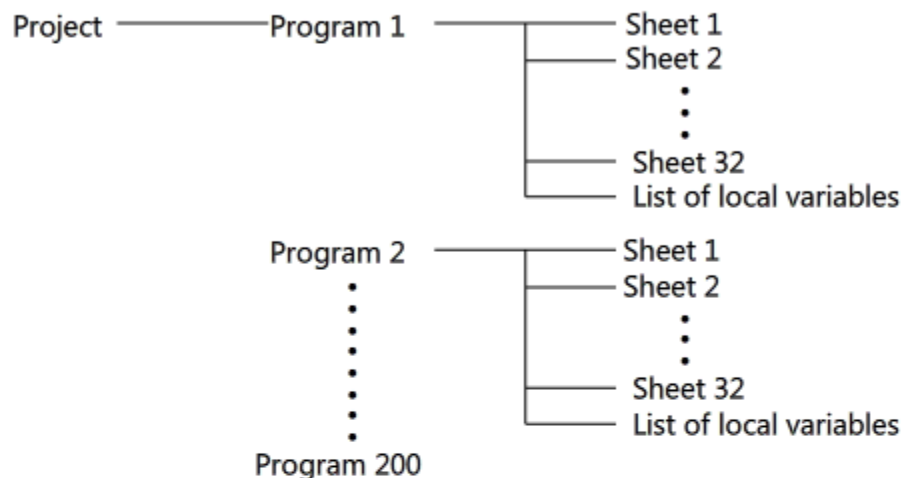
## 3.3.1

## Additional Information - FBD Program Structure and Processing Sequence

The following shows the structure of FBD programs and the processing sequence that are available with PX Developer.

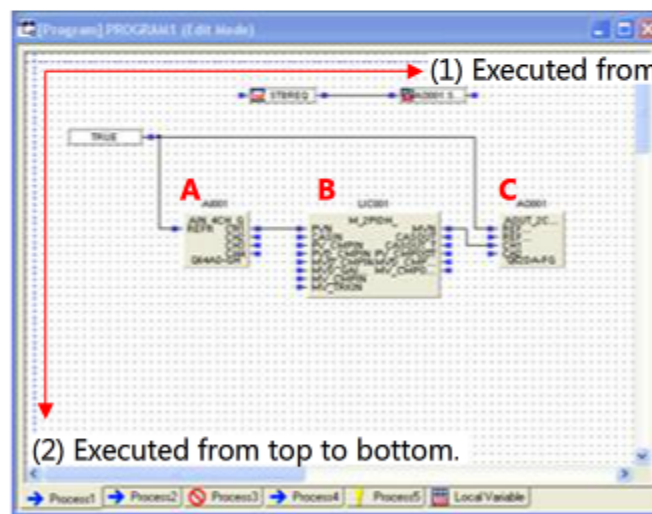
As shown on the right, multiple programs can be created for a project, with each program being able to accommodate a maximum of 32 program sheets.

(For details, please see the user's manual for PX Developer.)



FBD parts that are inserted, arranged and connected on the sheet are executed in the order of (1), (2) and (3) as shown in the illustration on the right.

The FBD parts shown in the illustration are executed in the order of A, B and C.

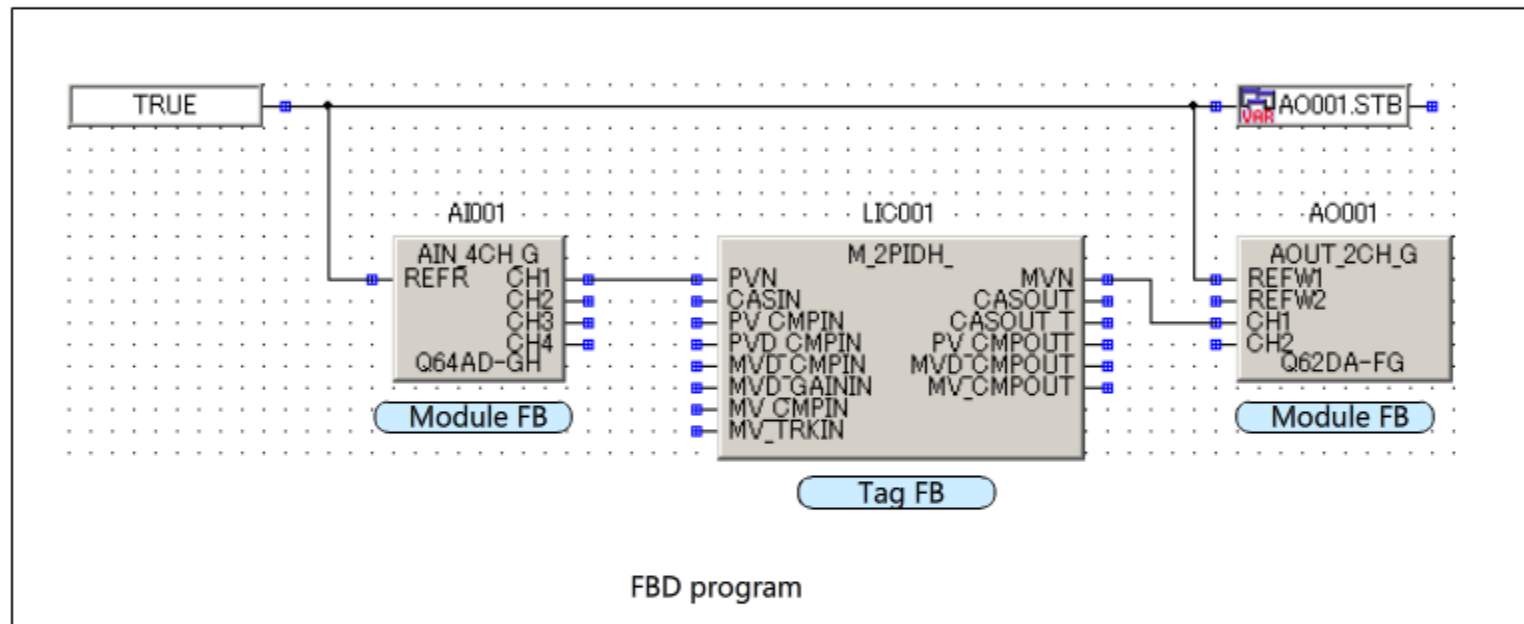


(3) Executed from the leftmost tab sheet to the rightmost tab sheet.

## 3.4 Creating FBD Programs

### 3.4.1 Program to Be Created

In this training course, the following water level control program will be created.



PV (process variable) is sent from a module FB representing the analog input module (Q64AD-GH) to a tag FB, which then performs computation. The results of the computation, or MV (manipulated variable), are sent out to a module FB representing the analog output module (Q62DA-FG).

The program loop tag is a 2-degree-of-freedom high-performance PID control tag FB (M\_2PIDH\_), which can accommodate a wide range of applications with its rich range of functions.

## 3.4.2

# Displaying the Programming Window



To create an FBD program, you need to display the programming window.  
In this training course, you will create an FBD program on the following sheet.

Program name: Program 1  
Sheet name: New sheet


\* Program 1 and a new sheet will be automatically created as you create a new project.

## 3.4.2

## Displaying the Programming Window

The screenshot displays the MELSOFT Series PX Developer Programming Tool interface. The main window is titled "MELSOFT Series PX Developer Programming Tool c:\MELSEC\FBDQ\MyProject\Sample01\Sample01.fpj - [[Progr...". The interface includes a menu bar (Project, Edit, View, Diagram, Convert, Online, Diagnostics, Tool, Window, Help) and a toolbar with various icons for file operations, editing, and execution. The left pane shows the Project tree for "Sample01", including Project Parameter, Module FB, Tag FB, Global Variable, GX Developer Label Assignment, Program (PROGRAM1), User-defined, Program Execution Setting, and GX Developer Project. The central area is a large grid representing the programming window, currently empty. The right pane shows the Parts list, including Function, Manufacturer FB Type, and User-defined FB Type. A status bar at the bottom indicates "Ready" and "Q02PH Host station Edit NUM".

The programming window has been displayed.

Click  to proceed.



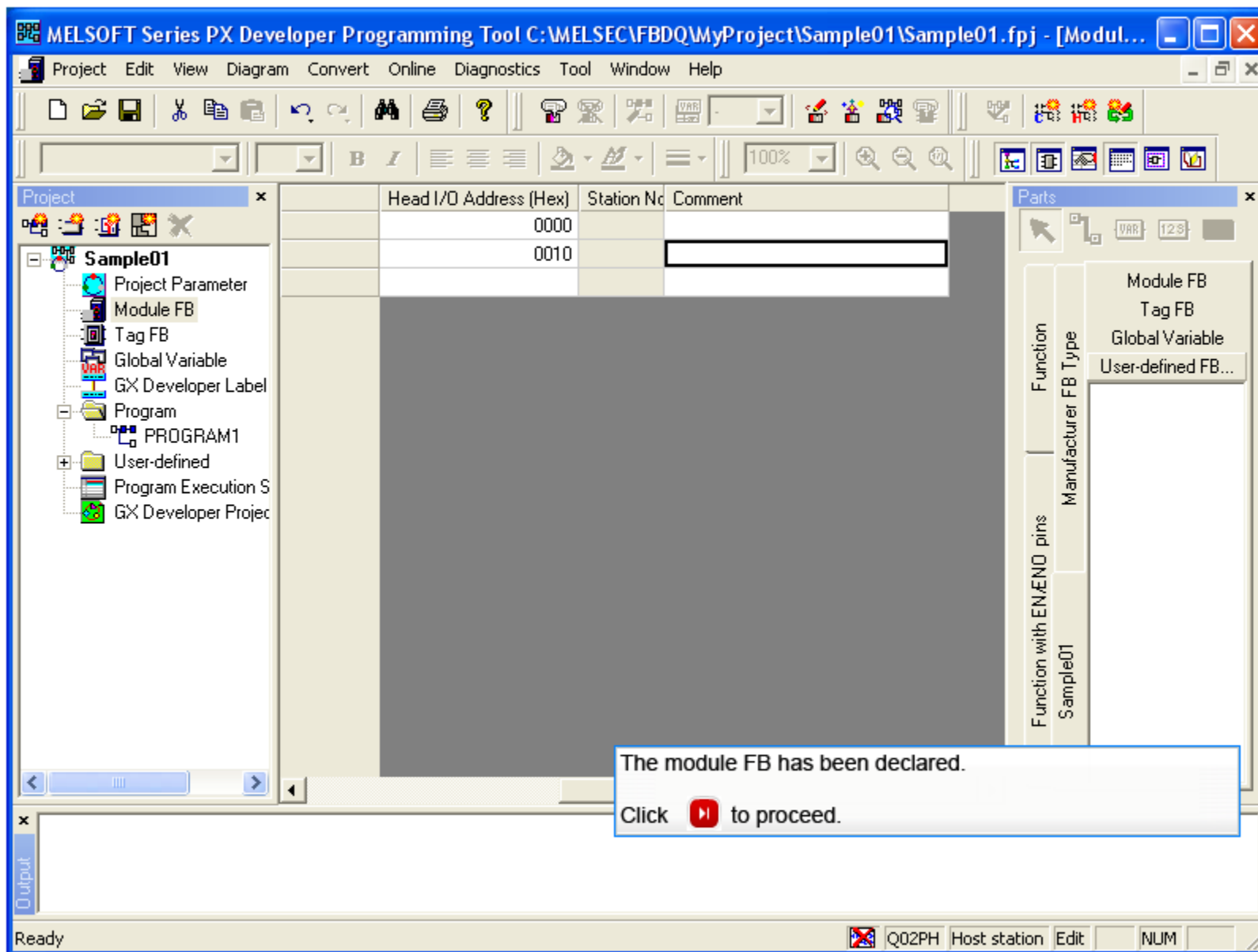
### 3.4.3 Declaring Module FBs

To access the input and output modules (Q64AD-GH and Q62DA-FG) from the program, declare (register) module FBs representing these modules in the module FB declaration window. In the module FB declaration window, set the following items.

Module FB variable name	Module model	Module FB type	Start I/O address
AI001	Q64AD-GH	AIN_4CH	0000
AO001	Q62DA-FG	AOUT_2CH	0010

\* Selecting a module model automatically sets a corresponding module FB type.

# 3.4.3 Declaring Module FBs




The screenshot shows the MELSOFT Series PX Developer Programming Tool interface. The main window displays a table for declaring module function blocks (FBs). The table has columns for 'Head I/O Address (Hex)', 'Station No', and 'Comment'. Two rows are visible: one with address '0000' and another with address '0010'. The '0010' row is currently selected.

Head I/O Address (Hex)	Station No	Comment
0000		
0010		

On the right side of the interface, the 'Parts' panel shows the 'Function' type selected. Under 'Function', 'Module FB' is chosen. Below this, 'Tag FB' and 'Global Variable' are also listed. The 'User-defined FB...' option is visible at the bottom of the list.

A dialog box is displayed in the center of the screen with the following text:

The module FB has been declared.  
 Click  to proceed.

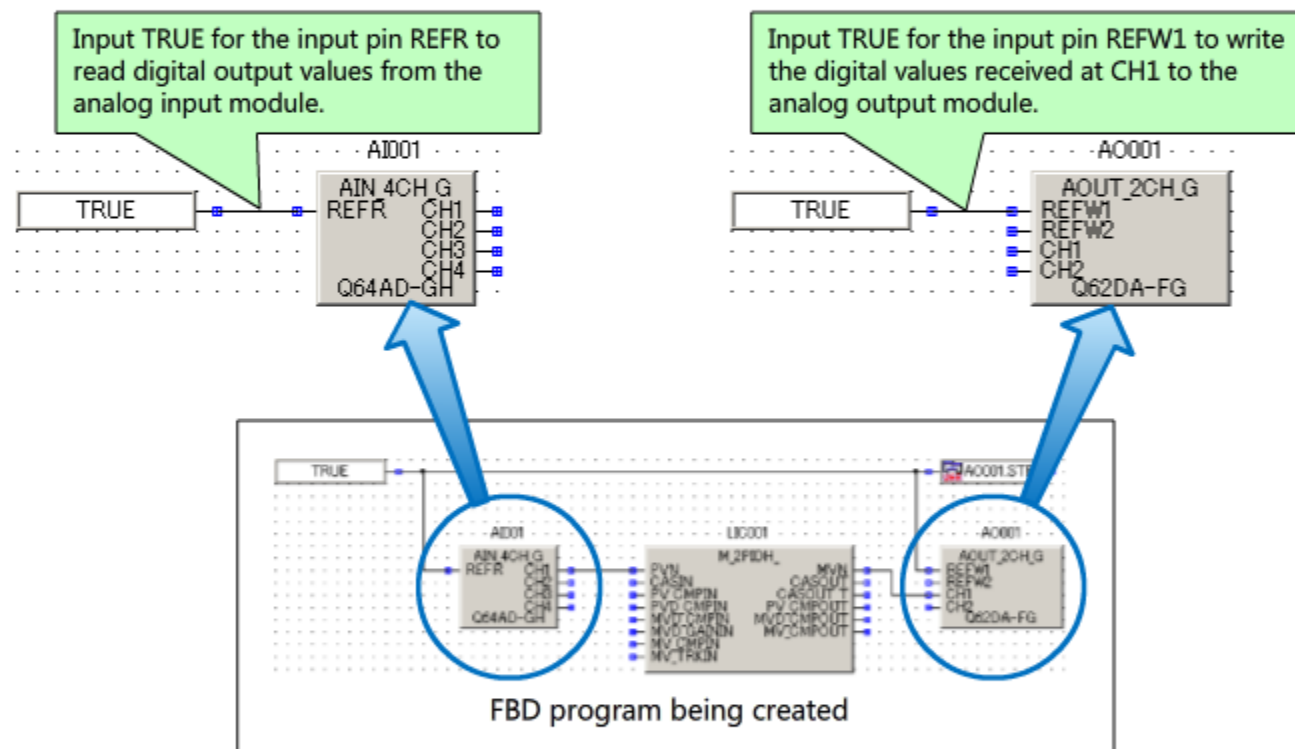
The status bar at the bottom of the window shows 'Ready' on the left and 'Q02PH Host station Edit NUM' on the right.

## 3.4.4 Pasting Module FBs

The module FBs (AI001 and AO001) that have been declared in the module FB declaration window need to be pasted to the programming window. After that, follow the procedure below to enable the module FBs.

- (1) Enabling the AI001 (Q64AD-GH) for output and the AO001 (Q62DA-FG) for input

Input TRUE for REFR and REFW1 to enable the AI001 output pin and the AO001 input pin on the FBD program.



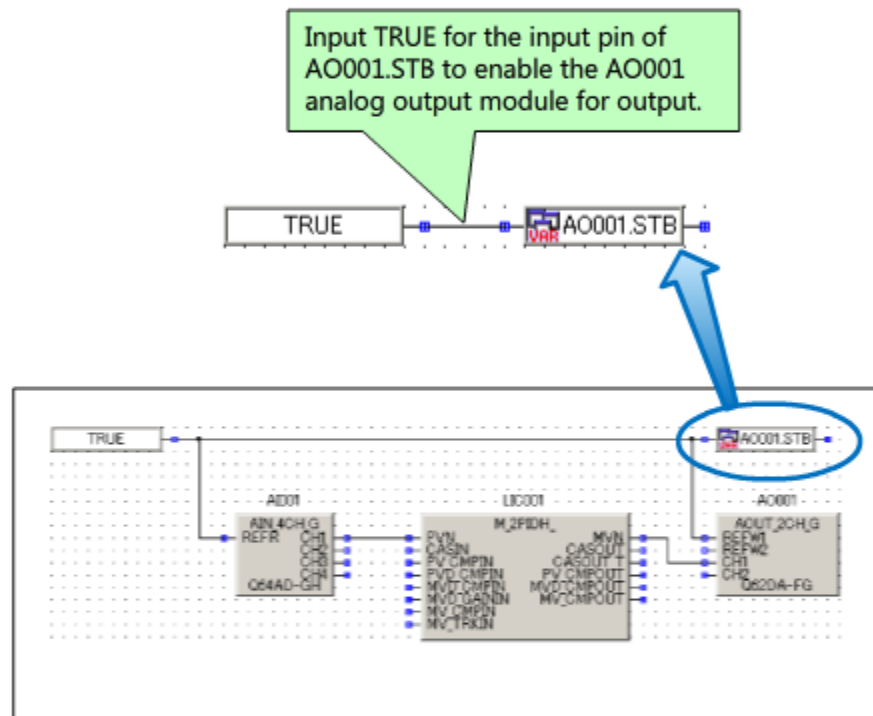
In order to achieve the above, paste TRUE constants to the programming window and connect them to the following two input variables (pins).

Module FB	Variable name	Variable type	Data type	Description
AI001	REFR	Input variable	BOOL	Output condition signal. Executed by TRUE.
AO001	REFW1	Input variable	BOOL	Input condition signal for CH1. Executed by TRUE.

## 3.4.4 Pasting Module FBs

### (2) Enabling the AO001 (Q62DA-FG) for output

Input TRUE to AO001.STB, which is a public variable, to enable the analog output module FB AO001 for analog output.



In order to achieve the above, paste TRUE constants to the programming window and connect them to the following two input variables (pins).

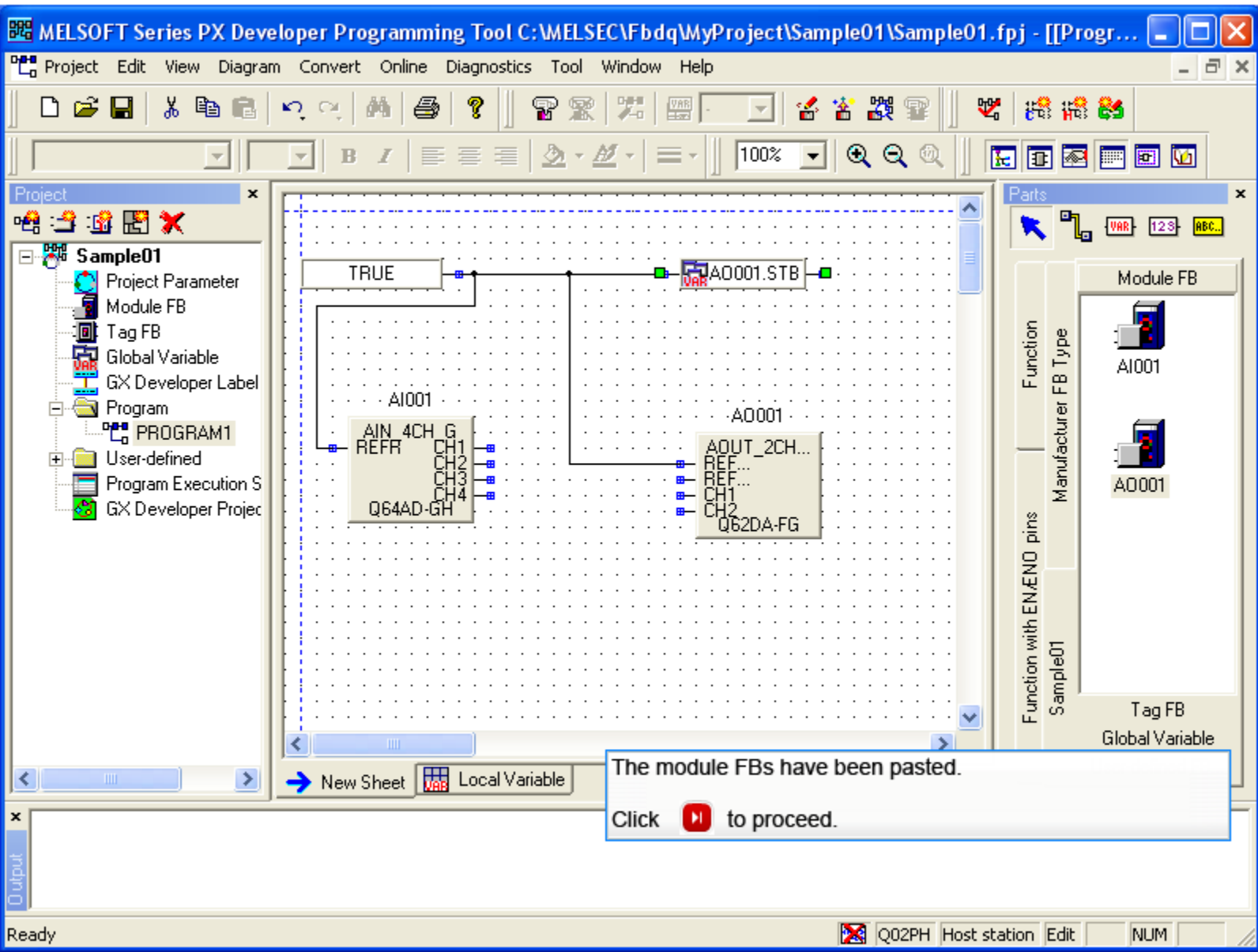
Variable name	Variable type	Data type	Description
AO001.STB	Public variable	BOOL	Operating condition setting request Executes D/A conversion enable/disable setting upon switching from FALSE to TRUE.

\*Because AO001.STB is the public variable of the AO001, there is no need to specify the variable type when creating the variable.

# 3.4.4 Pasting Module FBs

MELSOFT Series PX Developer Programming Tool C:\MELSEC\Fbdq\MyProject\Sample01\Sample01.fpj - [[Progr...

Project Edit View Diagram Convert Online Diagnostics Tool Window Help



The diagram shows a 'TRUE' coil connected to an 'AI001' module (Q64AD-GH) and an 'AOUT\_2CH...' module (Q62DA-FG). The 'Parts' panel on the right lists 'Module FB' components: 'AI001' and 'A0001'. A message box at the bottom states: "The module FBs have been pasted. Click [Next] to proceed."

Project Structure:

- Sample01
  - Project Parameter
  - Module FB
  - Tag FB
  - Global Variable
  - GX Developer Label
  - Program
    - PROGRAM1
  - User-defined
  - Program Execution S
  - GX Developer Projec

Parts Panel:

- Function
  - Manufacturer FB Type
    - AI001
    - A0001
  - Function with EN/END pins
    - Sample01
  - Tag FB
    - Global Variable

Ready

Q02PH Host station Edit NUM

## 3.4.5 Declaring Tag FBs

A 2-degree-of-freedom high-performance PID control tag FB (M\_2PIDH\_) needs to be registered in the tag FB declaration window to enable PID control. In the tag FB declaration window, set the following items. Because the tag FB is used to give instructions and control water level, the tag FB variable is named LIC001.

Tag FB variable name	Tag FB type	Tag type
LIC001	M_2PIDH_	2PIDH

\* The tag type is automatically set.

## 3.4.5

## Declaring Tag FBs

MELSOFT Series PX Developer Programming Tool C:\MELSEC\FbdqMyProject\Sample01\Sample01.fpj - [Tag F...

Project Edit View Diagram Convert Online Diagnostics Tool Window Help

Maximum No. of Tags (0 to 120)

No.	Tag FB Variable Name	Tag FB Type	Tag Type	Assigned Device
1	LIC001	M_2PIDH	2PIDH	ZR3000
2				ZR3130
3				ZR3260
4				ZR3390
5				ZR3520
6				ZR3650
7				ZR3780
8				ZR3910
9				ZR4040
10				ZR4170
11				ZR4300
12				ZR4430
13				ZR4560
14				ZR4690
15				ZR4820
16				ZR4950
17				

Project

- Sample01
  - Project Parameter
  - Module FB
  - Tag FB
  - Global Variable
  - GX Developer Label
  - Program
    - PROGRAM1
  - User-defined
  - Program Execution S
  - GX Developer Project


Parts

Module FB

- AI001
- AO001

Function with EN/END pins  
Sample01

Tag FB  
Global Variable

The tag FB has been declared.  
Click  to proceed.

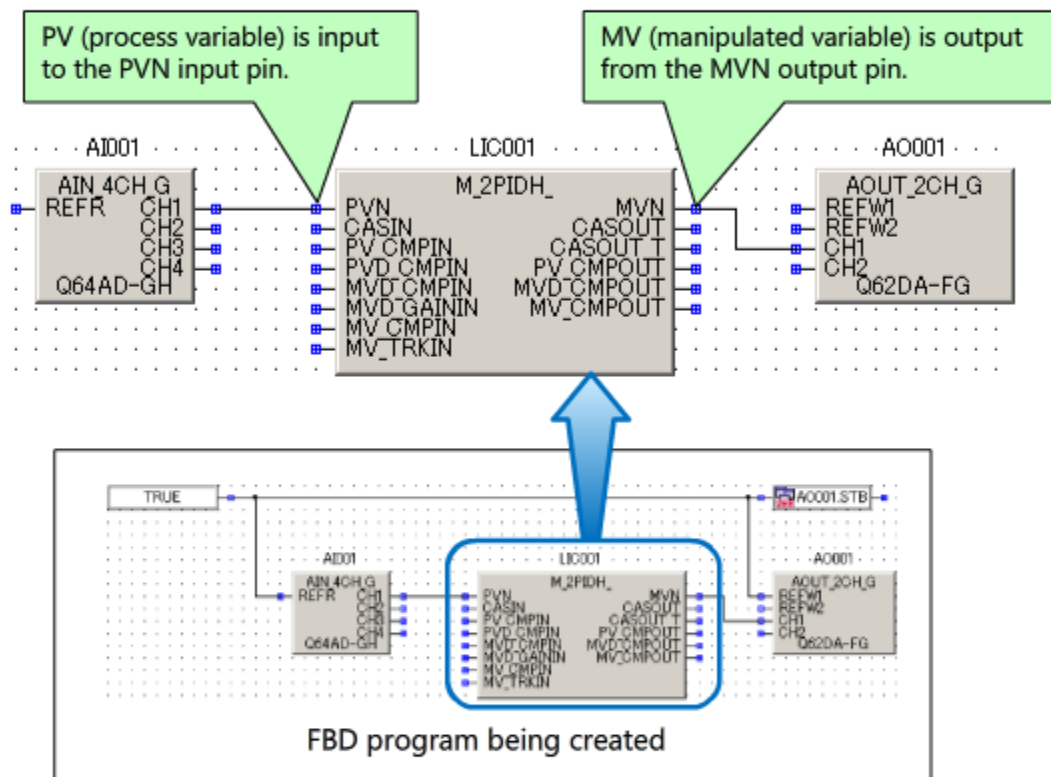
Output

Ready

Q02PH Host station Edit NUM

## 3.4.6 Pasting Tag FBs

Paste the tag FB (LIC001), which has been declared in the tag FB declaration window, to the programming window. Connect the PVN pin for process variable input and the MVN pin for manipulated variable output to the input/output pins of the two module FBs that have been pasted to the window.



As shown below, connect CH1 of the analog input module to PVN and CH1 of the analog input module to MVN.

Output pin			Input pin	
Tag/module variable name	Pin name		Tag/module variable name	Pin name
AI001	CH1	→	LIC001	PVN
LIC001	MVN	→	AO001	CH1



## 3.4.6

## Pasting Tag FBs

MELSOFT Series PX Developer Programming Tool C:\MELSEC\FBDQ\MyProject\Sample01\Sample01.fpj - [[Progr...

Project Edit View Diagram Convert Online Diagnostics Tool Window Help

80%

Project

- Sample01
  - Project Parameter
  - Module FB
  - Tag FB
  - Global Variable
  - GX Developer Label
  - Program
    - PROGRAM1
  - User-defined
  - Program Execution S
  - GX Developer Projec

Parts

Module FB

Tag FB

Function

Manufacturer FB Type

Function with EN/END pins

Sample01

Global Variable

AIN 4CH G REFR A001

PVN M\_2PIDH\_ MVN LIC001

CASIN CASOUT T

PV\_CMPIN PV\_CMP... MVN

PVD\_CM... PV\_CMP... MVN

MVD\_C... MVD\_C... MVN

MVD\_GA... MV\_CMP... MVN

MV\_CMP... MVN

MV\_TRKIN

A0001.S...


A0001

AOUT\_2C... 062DA-FG

TRUE

New Sheet Local Variable

The tag FB has been pasted.

Click  to proceed.

Output

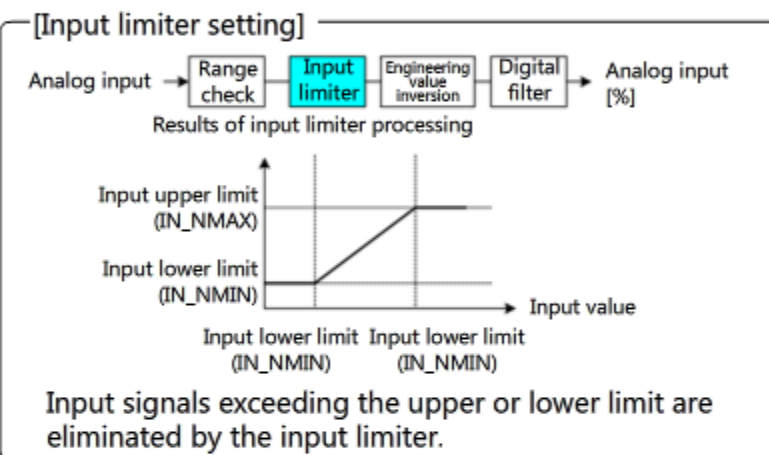
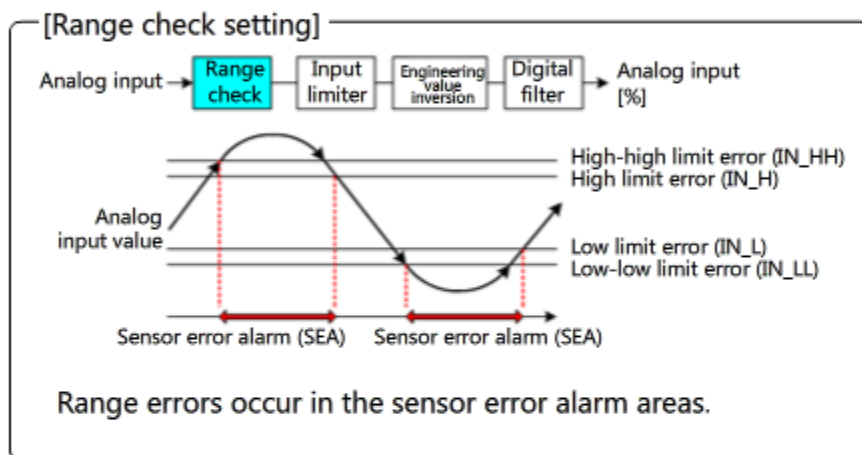
Ready

Q02PH Host station Edit NUM

## 3.4.7 Setting the FB Property Initial Values

Set the initial values such as for input and output ranges of tag FBs according to the input/output characteristics of a controlled device.

First, the setting methods for the range check, which detects errors of analog sensor input from a detector, and input limiter are described.



Because the analog input module used in this course has a digital output range of 0 to 64000, the upper and lower limits of the limiter are set at 64000 and 0 respectively.

Setting item for analog input	Setting value	Description
High-high limit error	65535.0	An error occurs when the analog input value reaches 65535 or above.
High limit error	64000.0	The normal state is restored when the analog input value drops to 64000 or below.
Low limit error	0.0	The normal state is restored when the analog input value rises to 0 or above.
Low-low limit error	-1536.0	An error occurs when the analog input value drops to -1536 or below such as when the sensor circuit opens.
Input upper limit	64000.0	The Q64AD-GH module has a digital output range of 0 to 64000 for conversion of the analog input range of 4 to 20 mA.
Input lower limit	0.0	

\* Out-of-range error thresholds, or setting values, vary depending on the module type.

## 3.4.7

## Setting the FB Property Initial Values

MELSOFT Series FX Developer Programming Tool C:\MELSEC\Fbdq\MyProject\Sample01\Sample01.fpj - [[Progr...

Project Edit View Diagram Convert Online Diagnostics Tool Window Help

Project

Sample01

Project  
Module  
Tag FB  
Global  
GX De  
Program  
PR  
User-de  
Program  
GX De

Module FB  
Tag FB  
LIC001

FB Property Page [LIC001]

Input | PID Operation | Cascade | Output | Other

Analog Input


Input High Limit	64000.0
Input Low Limit	0.0
High Limit Range Error	65535.0
High Limit Range Error Reset	64000.0
Low Limit Range Error Reset	0.0
Low Limit Range Error	-1536.0

PV Engineering Value[Engineering Value]

PV Engineering Value High Limit	100.0
PV Engineering Value Low Limit	0.0
PV High High Limit Alarm Value	100.0
PV High Limit Alarm Value	100.0
PV Low Limit Alarm Value	0.0
PV Low Low Limit Alarm Value	0.0

Input Range: -999999.0 <= Low Limit Range Error <= Low Limit Range Error Reset

Analog input signal range check and input signal limiter setting has been completed.

Click  to proceed.

OK Cancel

Ready Q02PH Host station Edit NUM

## 3.4.7 Setting the FB Property Initial Values

The next setting concerns the range of analog output to the final controlling element.

Because the analog output module used in this course has a digital input range of 0 to 12000, the upper and lower limits of the limiter are set at 12000 and 0 respectively.

Setting item for analog output	Setting value	Description
Output conversion upper limit	12000.0	The Q62DA-FG module has a digital input range of 0 to 12000 for conversion into the analog output range of 4 to 20 mA.
Output conversion lower limit	0.0	

## 3.4.7

## Setting the FB Property Initial Values

MELSOFT Series PX Developer Programming Tool C:\MELSEC\Fbdq\MyProject\Sample01\Sample01.fpj - [[Progr...

Project Edit View Diagram Convert Online Diagnostics Tool Window Help

FB Property Page [LIC001]

Input | PID Operation | Cascade | Output | Other

Analog Output

Output Conversion High Limit	12000.0
Output Conversion Low Limit	0.0


Input Range: -999999.0 <= Output Conversion Low Limit < Output Conversion High Limit

Global Variable

Module FB  
Tag FB  
LIC001

Ready

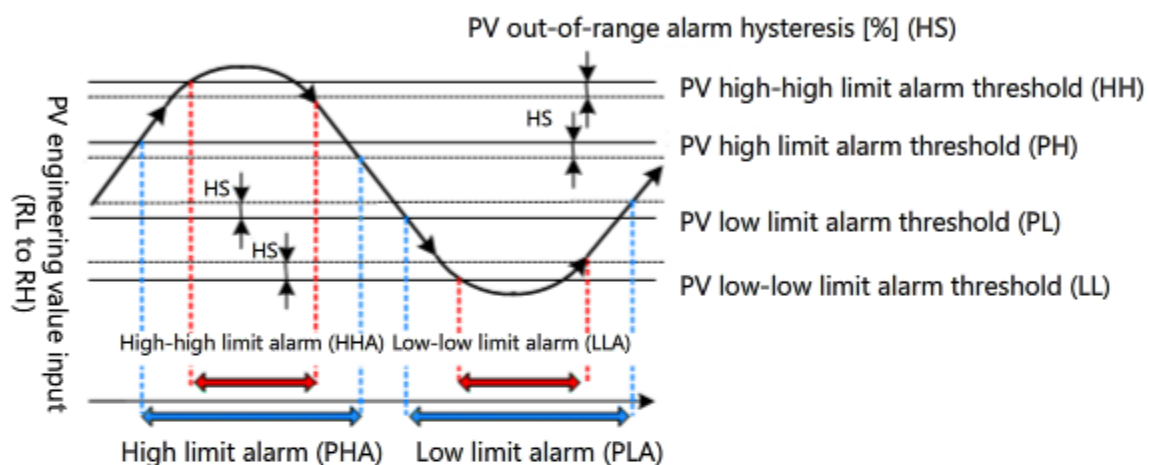
Q02PH Host station Edit NUM

Analogue output signal range setting has been completed.  
Click  to proceed.

OK Cancel

## 3.4.7 Setting the FB Property Initial Values

The next setting concerns the display of water level and related alarms.



Alarms are issued when input exceeds the alarm thresholds.

The following items need to be set in accordance with the tank's upper and lower water-level limits, which are 20 and 0 respectively in this course.

Setting item	Setting value	Description
PV upper limit engineering value	20.0	The upper water-level limit of the tank is 20. Therefore, the high and low limits of the PV (process variable) range are set at 20 and 0 respectively. High and low limit alarm thresholds are also set at 20 and 0 respectively.
PV low limit engineering value	0.0	
PV high-high limit alarm threshold (HH)	20.0	
PV high limit alarm threshold (PH)	20.0	
PV low limit alarm threshold (PL)	0.0	
PV low-low limit alarm threshold (LL)	0.0	

## 3.4.7

## Setting the FB Property Initial Values

MELSOFT Series FX Developer Programming Tool C:\MELSEC\Fbdq\MyProject\Sample01\Sample01.fpj - [[Progr...

Project Edit View Diagram Convert Online Diagnostics Tool Window Help

Project

Sample01

Project  
Module  
Tag FB  
Global  
GX De  
Program  
PR  
User-de  
Program  
GX De

Module FB  
Tag FB  
LIC001

Global Variable

Output

Ready

Q02PH Host station Edit NUM

### FB Property Page [LIC001]

Input | PID Operation | Cascade | Output | Other


Analog Input

Input High Limit	64000.0
Input Low Limit	0.0
High Limit Range Error	65535.0
High Limit Range Error Reset	64000.0
Low Limit Range Error Reset	0.0
Low Limit Range Error	-1536.0

PV Engineering Value[Engineering Value]

PV Engineering Value High Limit	20.0
PV Engineering Value Low Limit	0.0
PV High High Limit Alarm Value	20.0
PV High Limit Alarm Value	20.0
PV Low Limit Alarm Value	0.0
PV Low Low Limit Alarm Value	0.0

PV High Limit Alarm Value is more than PV High High Limit Alarm Value.

Water level display and related alarms have been set.  
Click  to proceed.

OK Cancel

**3.4.7****Setting the FB Property Initial Values**

Finally, set the SV range of the tank water level for PID calculation.

The range here is defined with an upper limit of 20 and a lower limit of 0.

Setting item	Setting value	Description
SV upper limit	20.0	Set the range of tank water level.
SV low limit	0.0	



# 3.4.7 Setting the FB Property Initial Values

MELSOFT Series PX Developer Programming Tool C:\MELSEC\Fbdq\MyProject\Sample01\Sample01.fpj - [[Progr...

Project Edit View Diagram Convert Online Diagnostics Tool Window Help

Project: Sample01
 

- Project Parameter
- Module FB
- Tag FB
- Global Variable
- GX Developer Label
- Program
  - PROGRAM1
- User-defined
- Program Execution S
- GX Developer Projec

Parts:
 

- Module FB
  - Tag FB
    - LIC001

Function with EN/END pins: Sample01

Manufacturer FB Type: LIC001

Global Variable: NUM

Buttons: New Sheet, Local Variable

Output: Ready

Q02PH Host station Edit NUM

The SV range has been set.  
Click to proceed.

**3.5****Compiling Programs**

Compile the created FBD program to write it to the programmable controller.  
The status of the compilation process is shown in the output window. Check the window to confirm that the compilation process has been successfully completed.

# 3.5 Compiling Programs

The screenshot displays the MELSOFT Series PX Developer Programming Tool interface. The main workspace shows a Function Block Diagram (FBD) with a 'TRUE' coil connected to an 'A0001.S...' contact. A modal dialog box titled 'MELSOFT Series GX Developer' is centered on the screen, displaying 'Registering ... Program #FBDQLIB' with a progress bar at 6% and a 'Cancel' button. At the bottom of the tool, a message box reads: 'The FBD program has been compiled. Click [Play] to proceed.' The left-hand 'Project' pane shows a tree view for 'Sample01' containing 'PROGRAM1'. The right-hand 'Parts' pane shows a library with 'Module FB', 'Tag FB', and 'LIC001'. The status bar at the bottom indicates 'Ready' and 'Q02PH Host station Edit NUM'.

**3.6****Writing Programs to the Programmable Controller CPU****3.6.1****Transfer Setup**

Specify a connection channel to write the compiled program to the programmable controller CPU. Here, the PC and programmable controller CPU will be directly connected using a USB cable.

# 3.6.1 Transfer Setup

MELSOFT Series FX Developer Programming Tool C:\MELSEC\Fbdq\MyProject\Sample01\Sample01.fpj - [[Progr...

Project Edit View Diagram Convert Online Diagnostics Tool Window Help

Serial USB CC IE Cont NET/10(H) board NET(II) board CC-Link board Ethernet board PLC board AF board SSC net

USB

PLC module CC IE Cont NET/10(H) module MNET(II) module CC-Link module Ethernet module C24 G4 module Bus

PLC mode QCPU(Qmode)

No specification Other station(Single network) Other station(Co-existence network)

Time out (Sec.) 10 Retry times 0

Target system

C24 CC IE Cont NET/10(H) NET(II) CC-Link Ethernet

Connection channel list...  
 PLC direct coupled setting  
 Connection test

PLC type

The connection channel has been set.  
 Click [Next] to proceed.

1 2 3 4  
 Line connection (Q/A6TEL,C24)...

Target PLC  
 Not specified

OK

Ready

Accessing host station

PLC side I/F

Other station

Network route

Co-existence network route

**3.6.2****Writing to the Programmable Controller**

Write the program to the programmable controller CPU.

# 3.6.2 Writing to the Programmable Controller

The screenshot shows the MELSOFT Series GX Developer software interface. The main window displays a ladder logic diagram with a 'Write to PLC' dialog box overlaid. The dialog box has a blue title bar and contains the text 'Writing...' and 'Parameter' with a progress indicator at '0%'. A 'Cancel' button is visible at the bottom of the dialog. In the background, the software interface includes a menu bar (Project, Edit, View, Diagram, Convert, Online, Diagnostics, Tool, Window, Help), a toolbar with various icons, a Project tree on the left showing 'Sample01' and its sub-items, and a Parts palette on the right. A status bar at the bottom indicates 'Ready' and 'Q02PH Host station Edit NUM'. A message box at the bottom right states: 'Writing to the programmable controller CPU has been completed. Click [Next] to proceed.'

Output  
 x Downloading has started. The start time is 9/17/2008 8:02:47 PM.  
 Preparing for downloading the project data to the PLC...  
 Downloading the parameter data...

Writing to the programmable controller CPU has been completed.  
 Click [Next] to proceed.

## Chapter 4 Program Monitoring and Tuning



This chapter explains how to check that programs work correctly and how to tune PID control using the PX Developer programming and monitoring tools.



## 4.1

# Starting the PX Developer Monitoring Tool

Start the PX Developer monitoring tool to monitor the operation of the FBD program that has been created. Enter the engineer mode, which enables you to set up the monitoring tool.

The monitoring tool has the following modes.

Mode name	Description
Engineer mode (for designing and administration)	In this mode, all of the monitoring tool functions can be used. This mode is used when making initial settings and changing settings.
Operator mode (for monitoring)	In this mode, general monitoring functions can be used while operating conditions and other settings of the functions cannot be changed. The system normally operates in this mode.
Lock mode	This mode blocks an attempt to change the operating conditions and other settings of the functions and to use tags for these purposes.

The engineer mode can be entered by clicking the mode switching button and entering the following user name and password for engineering authorization.

User name: admin

Password: admin

(The user name and password that have been entered can be changed later.)

# 4.1 Starting the PX Developer Monitoring Tool


A 12/9/2008 9:24:10 AM #SYSTEM Communication Open Error : SAMPLE01

Tuesday, December 09, 2008  
9:24:55 AM



- My Documents
- My Computer
- My Network Places
- Internet Explorer
- GX Developer
- Recycle Bin

The PX Developer monitoring tool has been started correctly.

Click  to proceed.



**4.2****Setting a Monitored Project**

Set a project being monitored by the PX Developer monitoring tool.

You will set the Sample01 project that has been created using the PX programming tool as the project for monitoring.

## 4.2

## Setting a Monitored Project

A 2009/09/19 17:44:16 LIC001 SEA



Monitor Tool Setting [Monitor Target Project Setting]

File Edit


User Setting  
**Monitor Target Project Setting**  
 Control Panel Setting  
 Trend Setting  
 Alarm Setting  
 Event Setting  
 User-created Screen Setting  
 Unit Setting  
 Faceplate Display Pattern Setting  
 Faceplate Display Scale Setting  
 Faceplate MV Characters Setting  
 Lockout Tag Setting  
 Option Setting

Apply Cancel Reload

No.	Project Name	Assignment Information Database File	PLC Type	Transfer Setup
1	SAMPLE01	<input checked="" type="radio"/> C:\MELSEC\Fbdq\MyProjects\Sample01\...	Q25PH	USB
2		...		
3		...		
4		...		
5		...		
6		...		
7		...		
8		...		

Duplicated Tag Name

Duplicated Project Name

The project to be monitored has been set.  
 Click  to proceed.

Ready

**4.3****Registering a Faceplate in Control Panel Setup**

The PX Developer monitoring tool offers a control panel setup feature whereby up to eight faceplates, which resemble actual controllers, can be arranged on the same screen.

In this section, you will register a faceplate for the LIC001 tag FB variable that has been created in the program.

## 4.3

## Registering a Faceplate in Control Panel Setup


Monitor Tool Setting [Control Panel Setting]

File Edit

User Setting  
Monitor Target Project Setting  
Control Panel Setting  
Trend Setting  
Alarm Setting  
Event Setting  
User-created Screen Setting  
Unit Setting  
Faceplate Display Pattern Setting  
Faceplate Display Scale Setting  
Faceplate MV Characters Setting  
Lockout Tag Setting  
Option Setting

Apply Cancel

Item	Contents
[-] Group 1	
[-] Group Name	Group1
[-] Faceplate 1	<input checked="" type="radio"/> LIC001
[-] Faceplate 2	
[-] Faceplate 3	
[-] Faceplate 4	
[-] Faceplate 5	
[-] Faceplate 6	
[-] Faceplate 7	
[-] Faceplate 8	
[-] Group 2	
[-] Group Name	
[-] Faceplate 1	
[-] Faceplate 2	
[-] Faceplate 3	
[-] Faceplate 4	
[-] Faceplate 5	
[-] Faceplate 6	
[-] Faceplate 7	
[-] Faceplate 8	
[-] Group 3	
[-] Group Name	
[-] Faceplate 1	
[-] Faceplate 2	

The faceplate has been registered.  
Click  to proceed.

Ready

**4.4****Displaying the Control Panel**

You will now display the control panel to check whether it contains the LIC001 faceplate that has been registered.

# 4.4 Displaying the Control Panel

A 2008/09/19 18:10:18 LIC001 SEA



Control Panel - Group1

NOR

**LIC001**

PVA DVA MVA  
SVA

PV 0.0

SV 0.0

MV 0.0 %

0 (%) 100

MANUAL

SPA SEA OOA

The control panel has been displayed.

Click to proceed.



**4.5****Tuning the PID Control Loop**

Click the **Details** button on the faceplate to open the **Tuning** window, and identify PID constants by auto-tuning.

## 4.5.1

## Additional Information - Auto-tuning

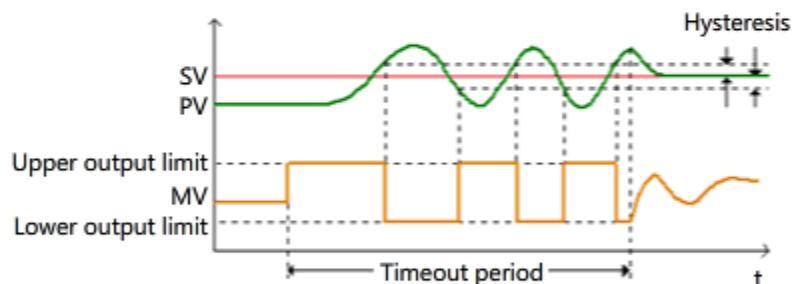
The high-performance PID control tag FB (M\_2PIDH\_) offers a choice of two auto-tuning methods to meet a variety of applications: limit cycle and step response.

### Characteristics of limit cycle and step response methods

The limit cycle method has a minimal noise impact on PV values during the identification of PID constants, offering stable PID constants. The step response method is suitable for control systems that require non-fluctuating MV and PV values.

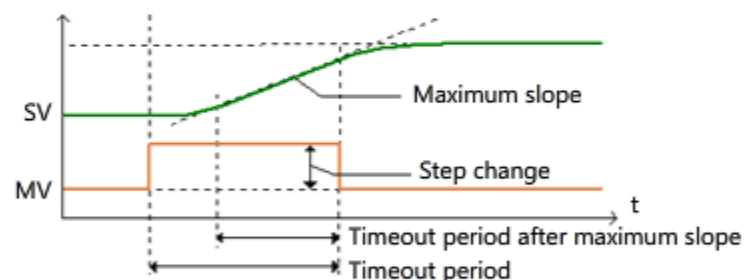
#### Limit cycle method

A two-position (ON/OFF) operation cycle of MV output is repeated three times to temporarily oscillate the controlled system while the amplitude and cycle of PV values are measured to calculate the most appropriate PID constant.



#### Step response method

While generating step changes in MV output, changes in PV values are measured to calculate the most suitable PID constant.



# 4.5.1 Additional Information - Auto-tuning

Tuning - LIC001
[Close]

No.	Item	Data
1	PV	0.0
2	MV	0.0
3	SVC	0.0
4	SV	0.0
5	MH	100.0
6	ML	0.0
7	PH	20.0
8	PL	0.0
9	HH	20.0
10	LL	0.0
11	SH	20.0
12	SL	0.0
13	P	1.00
14	I	10.0
15	D	0.0

Auto Tuning

Collected Tag List

2008/09/19 18:12:25

<input checked="" type="checkbox"/> PV	0.0
<input checked="" type="checkbox"/> SV (Current)	0.0
<input checked="" type="checkbox"/> MV	0.0 %

Gridline Interval

Export to CSV File

Auto Tuning...

Collecting...

Clear Stop Start

Y-axis Scale

NOR

LIC001

PVA DVA MVA

SVA

PV 0.0

SV 0.0

MV 0.0 %

0 (%) 100

>>

Close

Auto-tuning has been completed.

Click to proceed.

Basic All

Process Variable

**4.6****Test Operation of the System**

Test-operate the system for PID loop automatic control using the PID constants identified by auto-tuning, and check whether measured PV values converge onto the target SV value.

# 4.6 Test Operation of the System

Tuning - LIC001
X

No.	Item	Data
1	PV	12.0
2	MV	59.4
3	SVC	12.0
4	SV	12.0
5	MH	100.0
6	ML	0.0
7	PH	20.0
8	PL	0.0
9	HH	20.0
10	LL	0.0
11	SH	20.0
12	SL	0.0
13	P	4.13
14	I	12.0
15	D	0.0

Auto Tuning

Collected Tag List

Gridline Interval

Export to CSV File

Y-axis Scale

2008/09/19 18:46:48

<input checked="" type="checkbox"/> PV	12.1
<input checked="" type="checkbox"/> SV (Current)	12.0
<input checked="" type="checkbox"/> MV	59.4 %

Auto Tuning...

Collecting...

Clear Stop Start

20.0  
100.0

10.0  
50.0

0.0  
0.0

18:45                      18:46

Basic All

Process Variable

NOR

LIC001

PVA DVA MVA  
SVA

PV 12.0

SV 12.0

MV 59.4 %

0 (%) 100

>>

Close

The system test operation has been completed.

Click to proceed.

Now that you have completed all of the lessons of the **PLC MELSEC Process Control System Basics** Course, you are ready to take the final test. If you are unclear on any of the topics covered, please take this opportunity to review those topics.

There are a total of 5 questions (19 items) in this Final Test.

You can take the final test as many times as you like.

### How to score the test

After selecting the answer, make sure to click the **Answer** button. Your answer will be lost if you proceed without clicking the Answer button. (Regarded as unanswered question.)

### Score results

The number of correct answers, the number of questions, the percentage of correct answers, and the pass/fail result will appear on the score page.

Correct Answers : 2

Total Questions : 9

Percentage : 22%

To pass the test, you have to answer **60%** of the questions correct.

Proceed

Review

Retry

- Click the **Proceed** button to exit the test.
- Click the **Review** button to review the test. (Correct answer check)
- Click the **Retry** button to retake the test again.

MELSEC process control system modules/software

For each of the descriptions, choose the corresponding module/software from the list.

Description	Module/Software
An FBD software package for process control system	--Select--
A module designed to receive current/voltage signals of typically 4-20 mA/1-5 V from a converter	--Select--
A CPU module that ensures uninterrupted system operation in the event of a control system malfunction by automatically switching control to the standby system	--Select--
An analog module compatible with two-wire transmitters	--Select--
A module to which signal lines from a platinum/nickel temperature-measuring resistor can be directly connected	--Select--
A module that offers high-speed loop and sequence control and the possibility of developing a multiple-CPU system	--Select--

[Answer](#)[Back](#)

PX Developer programming tool functions

For each of the FB descriptions, choose the corresponding PX Developer programming tool function from the list.

Description	Function
An FB designed to receive and send analog/digital signals like analog modules and I/O modules do	--Select-- ▼
An FB designed to accommodate controllers for PID and other control	--Select-- ▼

[Answer](#)[Back](#)



## PX Developer monitoring tool functions

For each of the screen descriptions, choose the corresponding PX Developer monitoring tool function from the list.

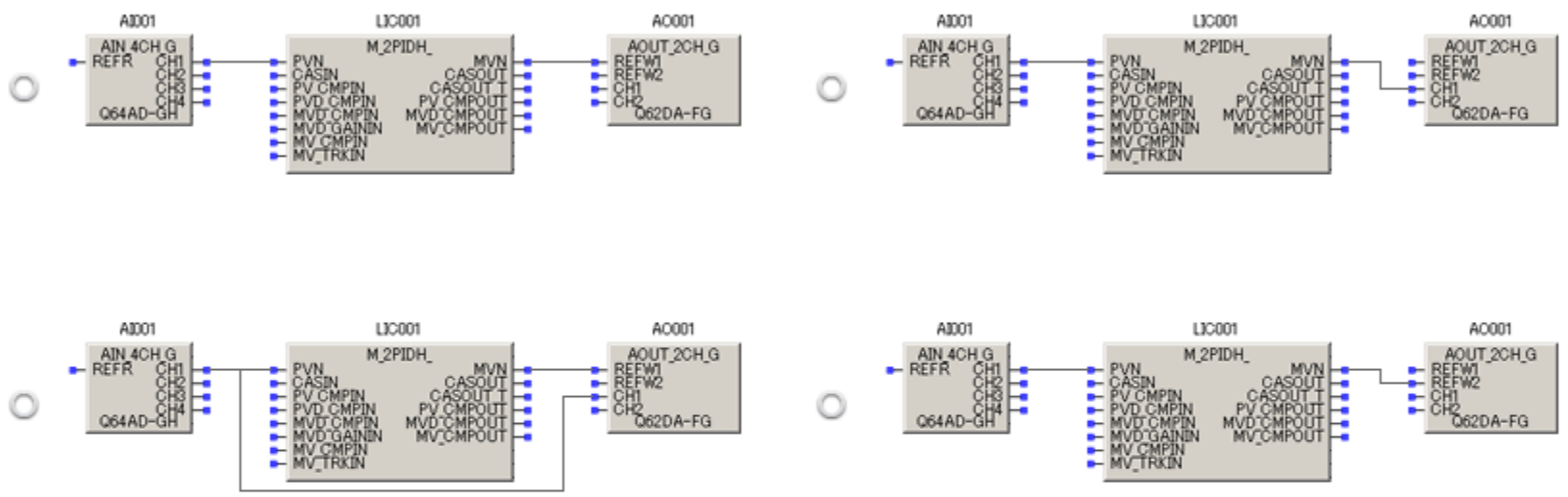
Description	Function
A setting screen for displaying faceplates by the group	--Select-- ▼
A screen to identify PID constants by step response and limit cycle methods	--Select-- ▼

[Answer](#)[Back](#)

# Test Final Test 4

## FBD programming

The following figures show connections between the module FBs representing current/voltage input and output modules and the tag FB for PID control. Choose the one that correctly shows the connection.



Answer

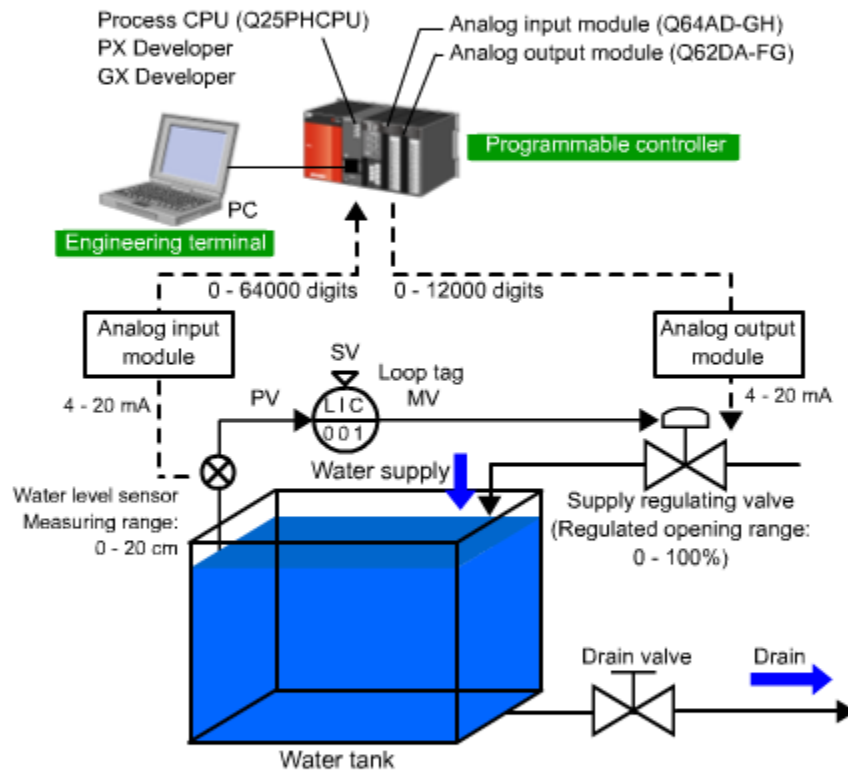
Back

# Test Final Test 5

## FB property

Set properties for a tag FB (M\_2PIDH\_) representing the loop tag LIC001 in the figure below.

Select the correct value for each of the eight setting items.



FB property setting item	Options
Analog input	
Input signal upper limit	<input type="text"/>
Input signal lower limit	<input type="text"/>
Analog output	
Output conversion upper limit	<input type="text"/>
Output conversion lower limit	<input type="text"/>
PV engineering value	
PV engineering value upper limit	<input type="text"/>
PV engineering value lower limit	<input type="text"/>
PID calculation	
SV upper limit	<input type="text"/>
SV lower limit	<input type="text"/>

Answer

Back

You have completed the Final Test. Your results are as follows.  
To end the Final Test, proceed to the next page.

Correct answers : 0

Total questions : 5

Percentage : 0%

Proceed

Review

Retry

**You failed the test.**

You have completed the **PLC MELSEC Process Control System Basics** Course.

Thank you for taking this course.

We hope you enjoyed the lessons and the information you acquired in this course will be useful in the future.

You can review the course as many times as you want.

**Review**

**Close**