MITSUBISHI ELECTRIC
Changes for the Better

FATEC

Mitsubishi Programmable Controllers Training Manual Real-time Data Analyzer Basic Course

SAFETY PRECAUTIONS

(Always read these instructions before using the products.)

When designing the system, always read the relevant manuals and give sufficient consideration to safety.

During the exercise, pay full attention to the following points and handle the product correctly.

[EXERCISE PRECAUTIONS]

⚠WARNING

- Do not touch the terminals while the power is on to prevent electric shock.
- Before opening the safety cover, turn off the power or ensure the safety.

⚠CAUTION

- Follow the instructor's direction during the exercise.
- Do not remove the module of the demonstration machine or change wirings without permission.
  Doing so may cause failures, malfunctions, personal injuries and/or a fire.
- Turn off the power before mounting or removing the module.
  Failure to do so may result in malfunctions of the module or electric shock.
- When the demonstration machine (such as X/Y table) emits abnormal odor/sound, press the "Power switch" or "Emergency switch" to turn off.
- When a problem occurs, notify the instructor as soon as possible.

REVISIONS

*The manual number is given on the bottom left of the back cover.

Revision date	*Manual number	Description
April 2020	SH(NA)-082343ENG-A	First edition

TRADEMARKS

Microsoft and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

The company names, system names and product names mentioned in this manual are either registered trademarks or trademarks of their respective companies.

In some cases, trademark symbols such as '™' or '®' are not specified in this manual.

CONTENTS

INTRODUCTION

This text describes the functions, specifications, and setting methods of the hardware and software used to build a system for the purpose of learning the necessary procedure for diagnosis using Real-time Data Analyzer.
The description is provided for Edgecross Basic Software version 1.10.

RELEVANT MANUALS

Manual name [manual number]	Description	Available form
Real-time Data Analyzer User's Manual [SH-081873ENG]	Specifications, procedures before operation, functions, and troubleshooting of Real-time Data Analyzer	e-Manual PDF
SLMP Data Collector User's Manual [SH-081919ENG]	Specifications, procedures before operation, and troubleshooting of SLMP Data Collector	e-Manual PDF

The description related to Edgecross in this text is quoted from the following manual.
The PDF of the following manual can be downloaded from the Edgecross marketplace.

Manual name [manual number]	Description	Available form
Edgecross Basic Software for Windows User's Manual [ECD-MA1-0001]	Specifications, procedures before operation, functions, and troubleshooting of Edgecross Basic Software	PDF

Point

e-Manual refers to the Mitsubishi Electric FA electronic book manuals that can be browsed using a dedicated tool.
e-Manual has the following features:

- Required information can be cross-searched in multiple manuals.
- Other manuals can be accessed from the links in the manual.
- The hardware specifications of each part can be found from the product figures.
- Pages that users often browse can be bookmarked.
- Sample programs can be copied to an engineering tool.

TERMS

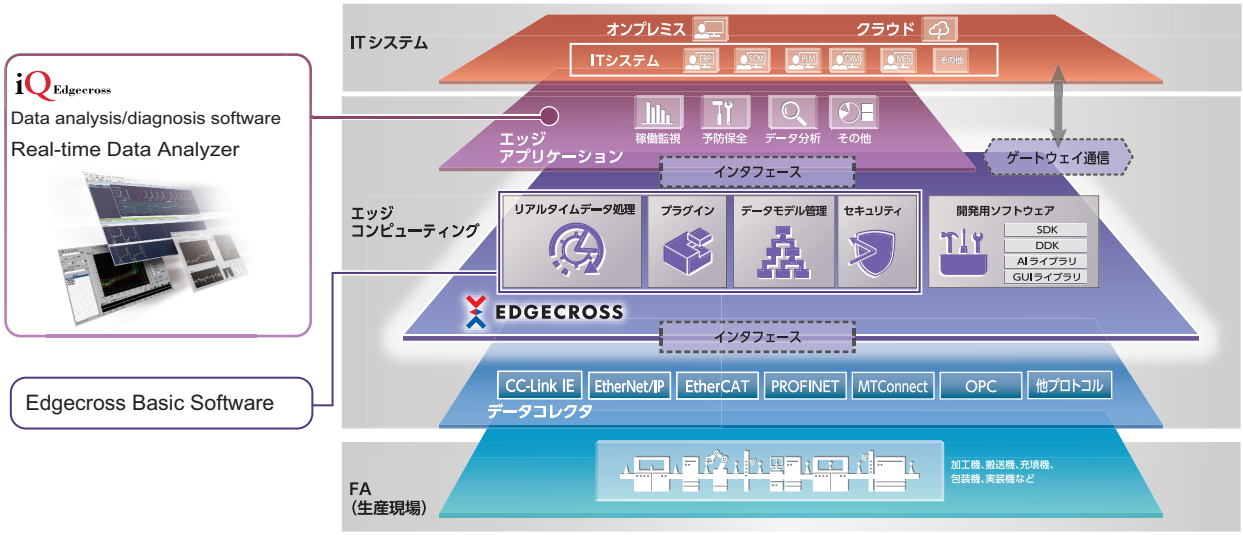
Unless otherwise specified, this manual uses the following terms.

Term	Description
Correlation matrix	A matrix created based on the reference CSV file. It is used for advanced analysis.
Data collection	Processing to collect data for data diagnosis and data analysis.
Data collector	A software component that collects data in production sites through each network. It is provided by vendors for each network and connection target devices.
Data diagnosis	Processing to diagnose if collected data matches preset conditions.
Data modification	Processing to modify collected data into a form suitable for analysis and diagnosis. Further modifications can also be made to the data modified once.
Dataset	A group of data in a read CSV file. It is used for a logic.
Detection	It is to indicate that waveforms are different, as a diagnosis result.
Detection sensitivity	The difficulty of determination that a waveform is similar or dissimilar, as a result of similarity diagnosis. It is difficult to make the determination as the detection sensitivity is higher. (The proportion of waveforms determined to be different increases.)
Diagnosis result	Diagnosis result data. (0: similar, 1: different)
Diagnosis result data	A general term for information on a diagnostic result passed to Real-time Flow Manger after the similarity diagnosis.
Different state	A diagnosis result that indicates 'similarity score < similarity score threshold'.
Edge application	Software that performs various processing for data utilization in production sites using the functions provided by Edgecross in the edge computing area.
Edge computing	An information processing method and area, for not only collecting and analyzing data in production sites in real-time, and feed backing the data, but summarizing the production site data and sharing information with IT systems efficiently with the hardware and software in production sites.
Edgecross	A software platform that implements specifications and concepts for realizing manufacturing solutions by the FA-IT collaboration centering on the edge computing.
Edgecross Basic Software	The name of the software product that implements the Edgecross function.
Feedback	Processing to report a detection result when diagnosed data matches a condition.
GX LogViewer	A software product that has a function to display an inspection waveform and the similarity scores on a graph in real time and a function to display the graph of a diagnosis result file.
Industrial personal computer	A personal computer specialized for industrial use with features such as high reliability, environmental resistance, and long-term supply.
Inspection waveform	Waveform data to be diagnosed.
Internal database	Data group that software included in Real-time Statistic Diagnosis Tool uses to share data.
Management Shell	The name of the Windows version product that implements the model management function.
Management Shell Explorer	Software that sets and refers to data models managed by Management Shell.
MQTT	An abbreviation for MQ Telemetry Transport. MQ Telemetry Transport is a lightweight message communication protocol using TCP/IP, and the standard is published as an open protocol.
MQTT broker	An application that acts as an intermediary between applications that distribute messages and ones that receive the messages by using MQTT.
Process	A generic term for the processing of data collection, data modification, data diagnosis, and feedback that compose a process flow.
Process flow	An execution unit of sequential processing performed by Real-time Flow Manager, consisting of data collection, data modification, data diagnosis, and feedback.
Publishing data definition file	A file that stores the information to set the publishing data to an Edge application in advance.
Real-time Flow Designer	The name of the software component that performs operation setting of Real-time Flow Manager.
Real-time Flow Manager	The name of the Windows version software component that implements the real-time data processing.
Reference waveform	A group of one or more reference waveform files in which waveforms to be referenced for diagnosis are recorded. The main purpose of a waveform similarity diagnosis is determining whether a waveform is similar to a reference waveform.
Reference waveform file	A CSV file in which waveforms to be referenced for diagnosis are recorded.
Reference waveform learning data	Data that stores the learning result of a reference waveform. The property of the reference waveform is recorded. By using this data for the similarity diagnosis instead of a reference waveform, the similarity equivalent to a comparison using the reference waveform can be determined at high speed.
Reference waveform learning data file	A file which stores reference waveform learning data.
Response data definition file	A file that stores the information for passing the response definitions to Real-time Flow Designer.

Term	Description
Response data file	A CSV file which is output when an edge application completed a data analysis and detected an error.
Section	The unit of data used in Real-time Statistic Diagnosis Tool. In Real-time Statistic Diagnosis Tool, an analysis or diagnosis is performed for each section.
Similar waveform recognition	Refers to the following functions: • Learning a reference waveform and creating a reference waveform learning data • Interface to input an inspection waveform or output diagnosis result data • Diagnosing the similarity between a reference waveform and an inspection waveform at high speed by using reference waveform learning data • Outputting a diagnosis result in a CSV file
Similarity diagnosis	Processing to obtain the similarity between a reference waveform and an inspection waveform at high speed by using information of the reference waveform recorded in reference waveform learning data.
Unit	A unit of a setting in Real-time Statistic Diagnosis Tool. It can be defined and used for each CSV file format to be read.
Waveform learning	Processing to learn the property of a reference waveform and create reference waveform learning data in which the learning information is recorded.

1 OVERVIEW

Real-time Data Analyzer is an edge application that analyzes the data of a production site offline and diagnose the data in real time by linking with Edgecross Basic Software. Preventive maintenance and quality improvement can be realized at production sites by using AI technology and various statistical methods.
Real-time Data Analyzer is an Edgecross-compatible edge computing software (iQ Edgecross) of Mitsubishi Electric.
It is compatible with an open software platform "Edgecross" in the edge computing area.



Source: Edgecross Consortium

1.1 Edgecross Basic Software

Edgecross Basic Software is the software that implements the Edgecross function.
Edgecross Basic Software consists of the following software.

Software	Description
Real-time Flow Manager	Software that implements the real-time data processing. It realizes real-time diagnosis and feedback of production site data. Data collectors can be used to collect, modify, and analyze data from connected devices, equipment, and lines.
Real-time Flow Designer	Software that implements the functions to create, save, and display various settings required for the operation of Real-time Flow Manager, start/stop Real-time Flow Manager operation, and perform diagnosis.
Management Shell	Software that implements the data model management function. Data related to devices, equipment, or lines at a production site are modeled and managed in a hierarchical structure. Data collectors can be used to read/write data from/to connected devices, equipment, and lines.

Edge application

Edge application is the software that uses Edgecross in the edge computing area to perform various processing using the data from a production site.

Data collector

A data collector is a software component that collects data of a production site through each network. Data collectors for various protocols can collect data from various devices.

1.2 Real-time Data Analyzer

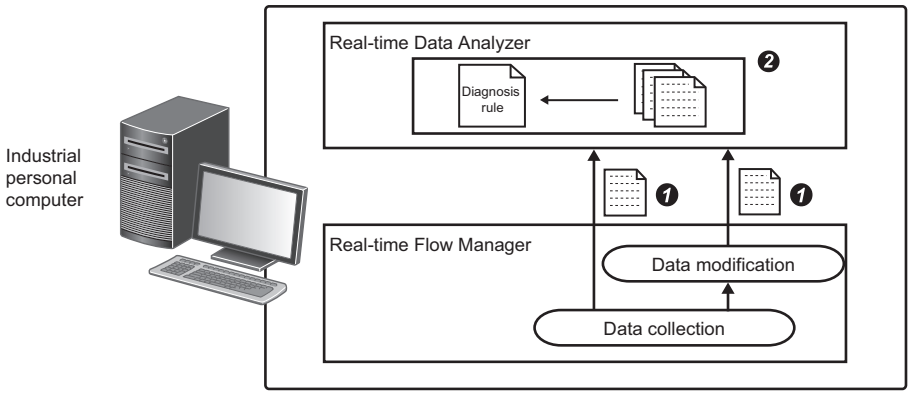
Real-time Data Analyzer is an edge application that analyzes the data of a production site offline and diagnose the data in real time. Preventive maintenance and quality improvement can be realized at production sites by using AI technology and various statistical methods. Real-time Data Analyzer consists of the following tools.

Tool	Description
Similar Waveform Recognition Tool	AI-equipped software that calculates the similarity between the waveform to be referenced and an inspection waveform at high-speed and detects the differences of the inspection waveform by using the data created by learning the reference waveform.
Real-time Statistic Diagnosis Tool	Software that diagnoses the waveform data according to the rules which is derived in a statistic method or multivariate analysis and determines whether the data is OK or NG.

By installing this product in an industrial personal computer and using with Real-time Flow Manager, the data collected by Real-time Flow Manager is analyzed offline and diagnosed in real time.

Offline analysis

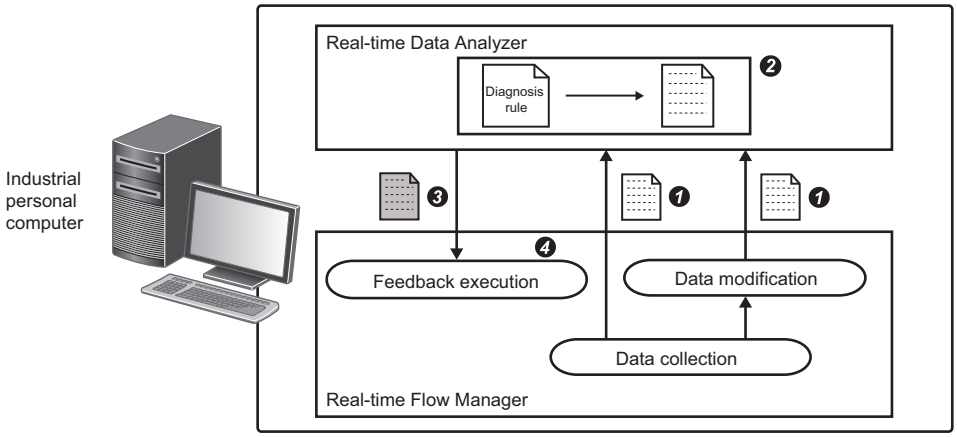
This creates rules to enable users to analyze and diagnose data collected from a production site.
The following figure describes the flow of offline analysis.



❶ Real-time Flow Manager outputs the data collected in the data collection process as a file. (Data will be modified in the data modification process as necessary.)
❷ A user creates diagnosis rules in Real-time Data Analyzer based on the file of the output collection data.

Real-time diagnosis

This diagnoses data collected from a production site in real time according to the diagnosis rules created in offline analysis. The following figure describes the flow of real-time diagnosis.



❶ Real-time Flow Manager outputs the data collected in the data collection process. (Data will be modified in the data modification process as necessary.)
❷ Real-time Data Analyzer diagnoses collected data which was output by Real-time Flow Manager according to the diagnosis rules created in offline analysis.
❸ Real-time Data Analyzer outputs the diagnosis result data.
❹ Real-time Flow Manager sends a feedback based on the diagnosis result data.

2 FUNCTION LIST

2.1 Function List of Real-time Data Analyzer

This section shows the function list of Real-time Data Analyzer.

Similar Waveform Recognition Tool

The following table lists the functions of Similar Waveform Recognition Tool.
Offline analysis is included in the waveform learning function and real-time diagnosis is included in the data diagnostic function.

Function	Description
Waveform learning function	To create the reference waveform learning data used for similar waveform recognition. It extracts unit waveforms from a reference waveform for diagnosing the similarity.
Data diagnostic function	To monitor an inspection waveform that was input from Real-time Flow Manager and notify Real-time Flow Manager of a waveform determined to be different, that is the similarity score is lower than a threshold value, if found.
GX LogViewer interaction function	To display the diagnostic status of similar waveform recognition in GX LogViewer.

Real-time Statistic Diagnosis Tool

The following table lists the functions of Real-time Statistic Diagnosis Tool.

Offline analysis and real-time diagnosis are included in the data analysis/diagnostic function.

Function			Description
CSV file reading function			To read a CSV file output to a specified folder.
Data analysis/ diagnostic function	Display function	—	To display data of a read CSV file.
		Read data display	To display data of a CSV file as a waveform. Analysis by overlapping or connecting data can be performed.
		Read data statistics display	To calculate and display the statistics of CSV file data. The changes of statistics and correlation of data can be analyzed.
		Read data frequency display	To perform STFT conversion and display the spectrogram, or perform Wavelet conversion and display the scalogram on data in a CSV file. Facility failure can be analyzed by visualizing the frequencies.
	Simple analysis/ diagnosis function	—	To analyze and diagnose data by operating GUI.
		SPC	To calculate the statistics for each unit of collected data and diagnose it according to the SPC rule. A sign of failure can be detected based on the changes of statistics.
		Multivariate analysis	To detect an event to be a trigger based on the model of the multivariate analysis result.
		Guard band diagnosis	To diagnose data by using a guard band created based on the normal waveform data. The upper and lower limit values can be specified without using the reference waveform.
	Advanced analysis function	—	To perform multivariate analysis by the correlation analysis, multiple regression analysis, or Mahalanobis-Taguchi method.
		Correlation matrix creating	To create a correlation matrix for correlation analysis.
		Multiple regression analysis (LMR)	To perform multiple regression calculation by selecting one objective variable and multiple explanatory variables to obtain the correlation between multiple variables.
		Mahalanobis - Taguchi method (MT)	To collect the sample of multiple variables to be referenced and calculate the Mahalanobis distance for the standard section and the changes in variation based on the correlation of multiple variables.
	Analysis/ diagnosis logic operation function	—	Functions to create arbitrary analysis logic/data diagnosis logics
		Logic editing	To edit the analysis and data diagnosis logics.
		Logic variable setting	To edit variables used in the analysis and data diagnosis logics.
	Data display function after execution		To display multiple waveforms in a single area. Analysis with the display method by connecting multiple sections of single data or overlapping different data in the same section can be performed.
	Diagnosis result display function	—	To display the simple diagnosis result or diagnosis logic execution result.
		Simple diagnosis result display	To display the result of simple diagnosis (SPC, multivariate analysis, or guard band diagnosis).
		Diagnostic logic result display	To display the result of diagnosis logic (expansion trace GB, SPC diagnostic, or log writing and error notification).
	Management function		To manage data used in Real-time Statistic Diagnosis Tool. Data to be displayed can be selected or narrowed down.
Data analysis/ diagnostic function	Option setting function	—	To set the setting on Real-time Statistic Diagnosis Tool.
		Data management setting	To set the setting on data management.
		Waveform display setting	To set the setting on the waveform display.
		Logic setting	To set the setting on logics.
Diagnostic result notification function			To issue an alarm when an error is detected in a diagnostic result.

2.2 Function List of Edgecross Basic Software

This section shows the function list of Edgecross Basic Software.

Real-time Flow Manager

The following table lists the functions of Real-time Flow Manager.

Function		Description
Data collection function		To collect data of connected devices, equipment, and lines via a data collector.
Data modification function	Data extraction function	To extract data according to specified conditions.
	Data modification plug-in execution function	To execute the data modification plug-in.
Data diagnostic function	Edge application interaction function	To publish data (collection data and modification data) from Real-time Flow Manager to an edge application and receive response data from the edge application.
	Data diagnosis plug-in execution function	To execute the data diagnosis plug-in.
Feedback execution function	Device command feedback function	To update data of connected device via a data collector.
	Program execution feedback function	To execute the executable program from the command line.
Data storing function	File save function	To save the collected/modified data or diagnosis result data of Real-time Flow Manager to a file in a format specified in Real-time Flow Designer.
	DB save function	To save (INSERT) the collected/modified data or diagnosis result data of Real-time Flow Manager to a database specified in Real-time Flow Designer.
Data publishing function	MQTT publishing function	To send the output of data collection, data modification, and data diagnosis process to the edge application using MQTT.

Real-time Flow Designer

The following table lists the functions of Real-time Flow Designer.

Function		Description
Target device setting		To select the data collector to be used and set the target device.
Data logging flow setting		To set the setting of data logging flow.
Data diagnosis flow setting		To set the setting of data diagnosis flow.
Moving process flow		To change the type of process flow.
Data collection setting		To set the setting to collect data of the target device.
Data storing setting	Data storing setting (file save)	To set the setting to output the process result in a file format.
	Data storing setting (DB save)	To set the setting to output the process result to the database.
Data publishing setting		To set the setting to send the process result to the edge application with MQTT.
Data extraction setting		To set the setting of data extraction.
Data modification plug-in setting		To set the setting of data modification plug-in.
Edge application diagnosis setting	Edge application diagnosis (MQTT) setting	To set the setting to send the process result to the edge application with MQTT and the setting to receive the diagnosis result from the edge application with MQTT.
	Edge application diagnosis (file) setting	To set the setting to send the process result to the edge application in a file format and the setting to obtain response data from the edge application in a file format.
Data diagnosis plug-in setting		To set the setting of data diagnosis plug-in.
Feedback setting after data diagnosis		To set the setting of the feedback to be performed based on the result of the data diagnosis.
Real-time Flow Manager diagnosis		To switch and diagnose the operating status of Real-time Flow Manager.

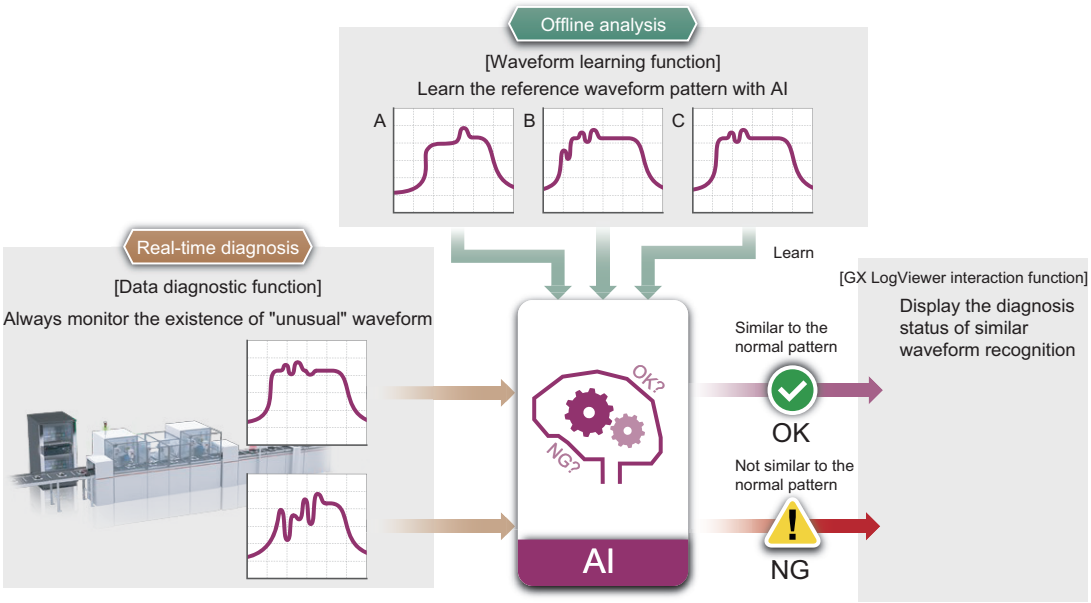
3 START-UP OF DEMONSTRATION MACHINE

3.1 Exercise Content

Use Real-time Data Analyzer to perform exercises for preventive maintenance of tool damage by collecting and monitoring the spindle motor current of aluminum case processing machine in real time.
Collect the current value from the ladder program of a CPU module by generating pseudo data.
The purpose of this training is to learn the diagnosis and analysis methods using Real-time Data Analyzer. Perform diagnosis in two ways: "similar waveform recognition" using Similar Waveform Recognition Tool and "SPC" using Real-time Statistic Diagnosis Tool.

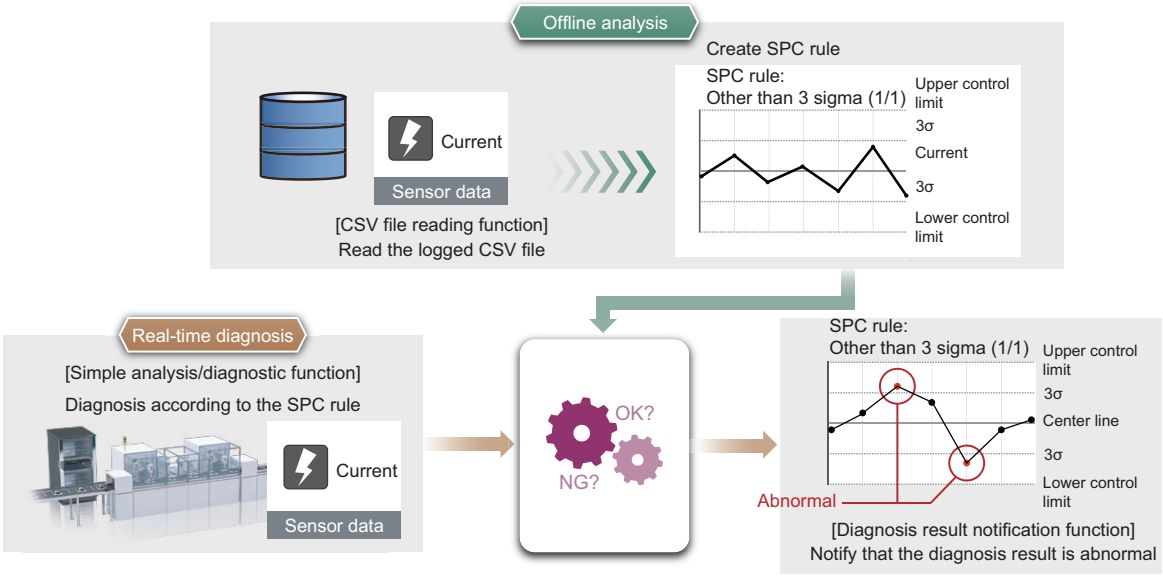
Similar waveform recognition

The reference waveform used as a reference for diagnosis is created from the logged current value. The current value input in real time is compared with the reference waveform to diagnose whether it is similar to the normal pattern.



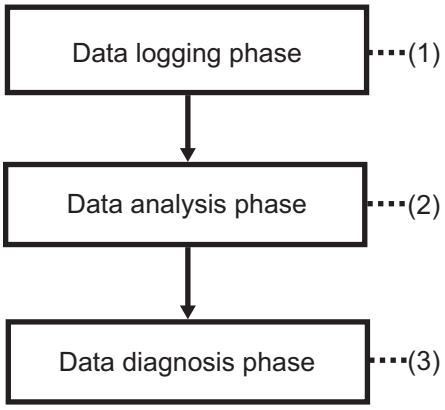
SPC

The SPC rule used as a diagnosis rule is created from the logged current value. The current value is input in real time is diagnosed according to the SPC rule.



Operation overview

Diagnoses using similar waveform recognition and SPC are performed in the following three phases.



Item	Purpose	Description
(1)	Collection and accumulation of data used in the data analysis phase	Collects the data to be used for analysis. ■ Similar waveform recognition ☞ Page 31 Data Logging ■ SPC ☞ Page 74 Data Logging
(2)	Creation of basic diagnosis rules of data diagnosis	■ Similar waveform recognition Creates a diagnosis reference (reference waveform learning data) for data diagnosis using the data collected in the data logging phase. ☞ Page 42 Data Analysis ■ SPC Creates the SPC rule for data diagnosis using the data collected in the data logging phase. ☞ Page 83 Data Analysis
(3)	Feedback to the production site	■ Similar waveform recognition Monitors the inspection waveform input from Real-time Flow Manager and sends the feedback set in Real-time Flow Designer if any waveform is different from the reference waveform (similarity score is lower than the threshold value). ☞ Page 47 Data Diagnosis ■ SPC Performs real time diagnosis based on the created diagnosis rules using the CSV file input from Real-time Flow Manager, and outputs the diagnosis result when an error is detected. Real-time Flow Manager detects the output of diagnosis result and executes the feedback. ☞ Page 93 Data Diagnosis

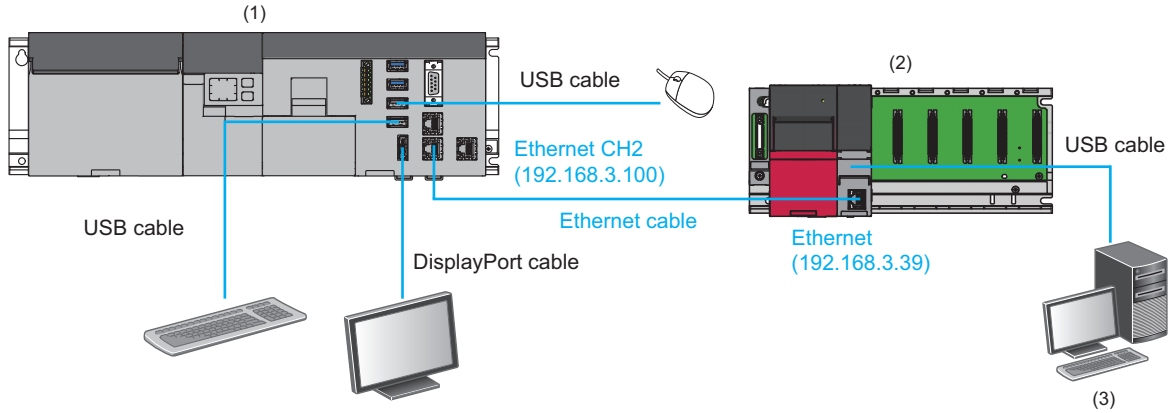
Sequence program

There are two types of programs for generating data to be logged and monitored: similar waveform recognition and SPC.
This course does not include programming. When writing a program to the CPU module, write the programmed project "school_SimilarWave.gx3" or "school_SPC.gx3".
"school_SimilarWave.gx3 is the project data for similar waveform recognition, and "school_SPC.gx3" is for SPC.

3.2 Demonstration Machine

System configuration of demonstration machine

The following figure shows the system configuration of the demonstration machine.



Device/software			Model name/description
(1)	Industrial personal computer	MELIPC*1	MI5122-VW
	Edgecross compatible software	iQ Edgecross Real-time Data Analyzer	SW1DND-RDA-M
(2)	Programmable controller system	Main base unit	R35B
		Power supply module	R61P
		CPU module*2	R16ENCPU
(3)	Personal computer		Windows operating personal computer
	OS		Microsoft Windows 10 Professional Operating System (64-bit)
	Engineering tool	GX Works3	SWnDND-GXW3 (n indicates the version.)
		GX LogViewer	SW1DNN-VIEWER-M

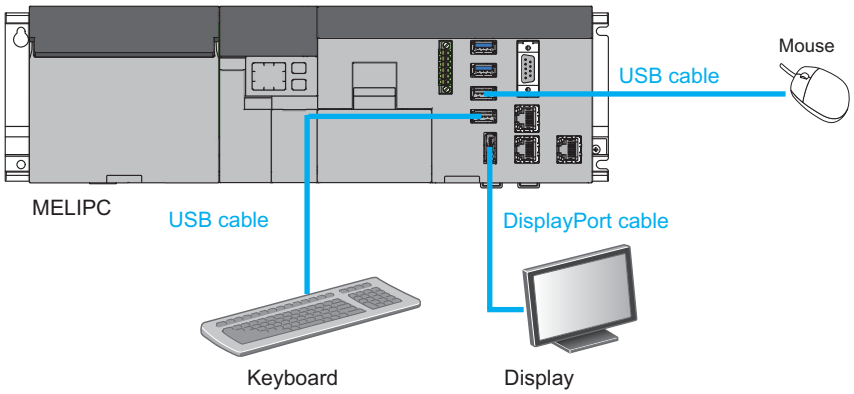
*1 The IP address of MELIPC is 192.168.3.100.

*2 The IP address of CPU module is 192.168.3.39.

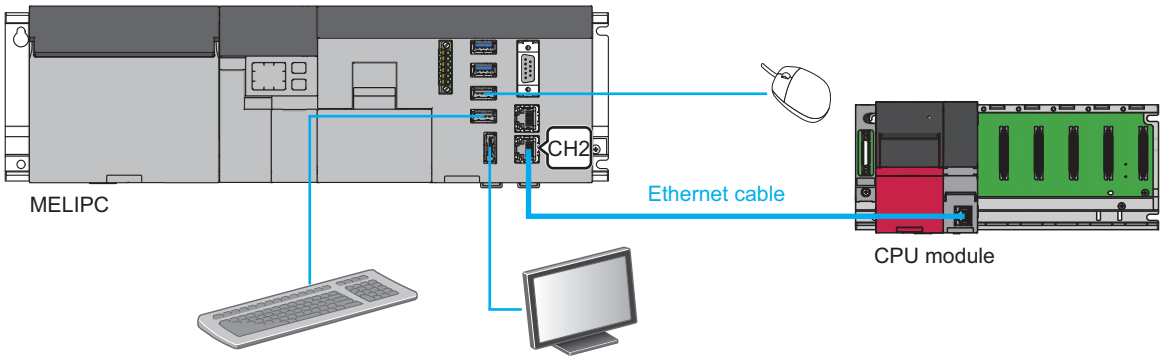
Wiring of demonstration machine

The following describes the wiring procedure of the demonstration machine.

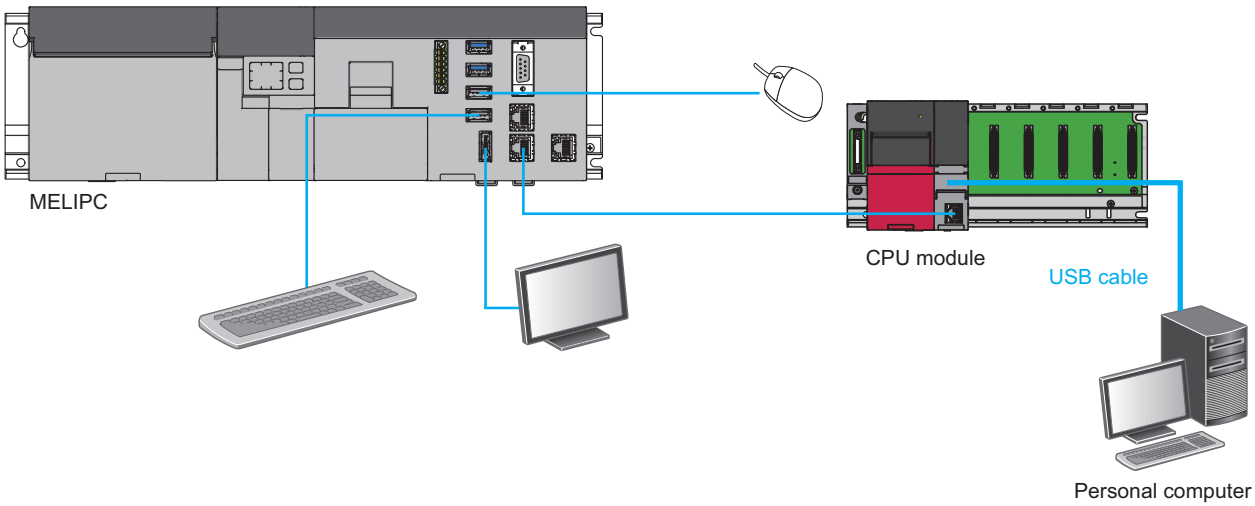
1. Connect peripherals (a keyboard, a display, and a mouse) to MELIPC.



2. Connect MELIPC (CH2) and a CPU module with an Ethernet cable.



3. Connect the CPU module and personal computer with a USB cable.



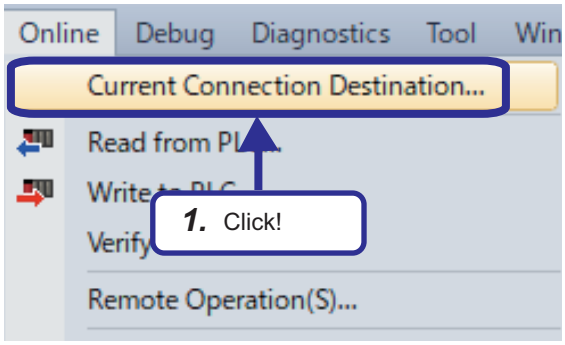
4 SETTINGS BEFORE EXERCISE

4.1 GX Works3

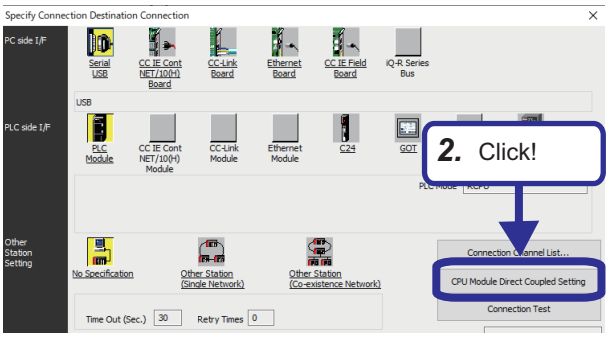
Specifying the connection destination

Specify the connection destination.

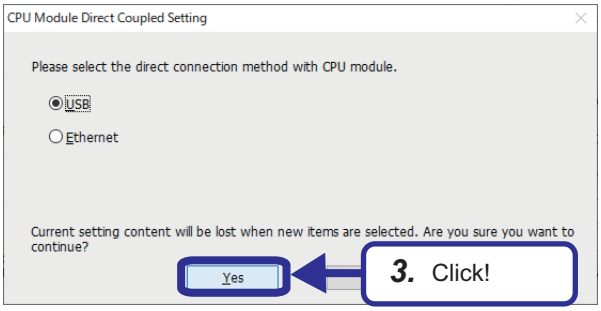
Operating procedure



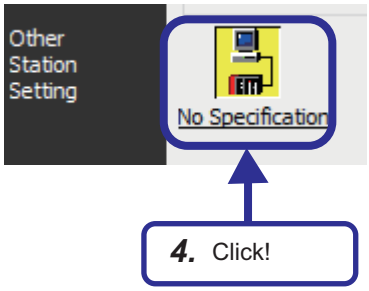
1. Open the project "school_SimilarWave.gx3" and click [Online] ⇨ [Current Connection Destination...] from the menu of the engineering tool.



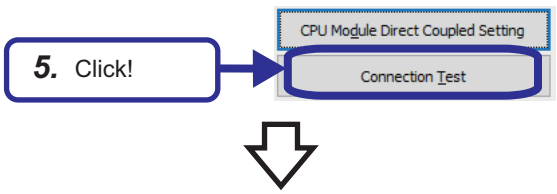
2. Click the [CPU Module Direct Coupled Setting] button on the "Specify Connection Destination Connection" window.
The CPU module direct coupled setting dialog is displayed.



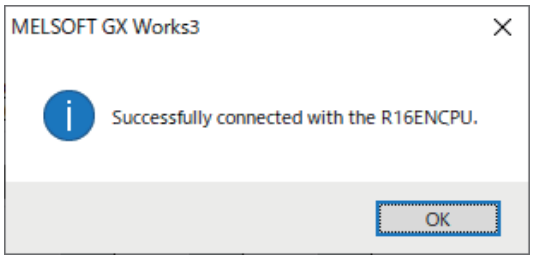
3. Select a method of connection with the CPU module and click the [Yes] button.



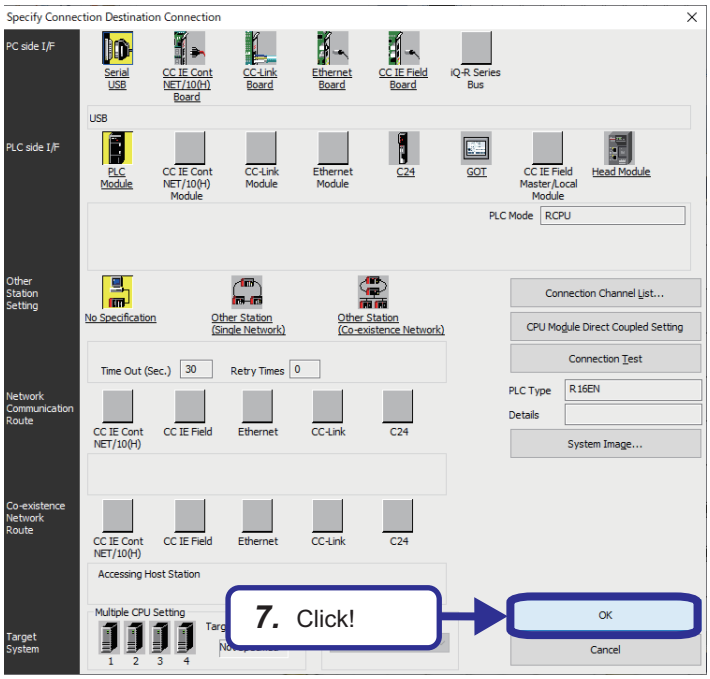
4. Click "No Specification" in the other station setting.



5. Click the [Connection Test] button.



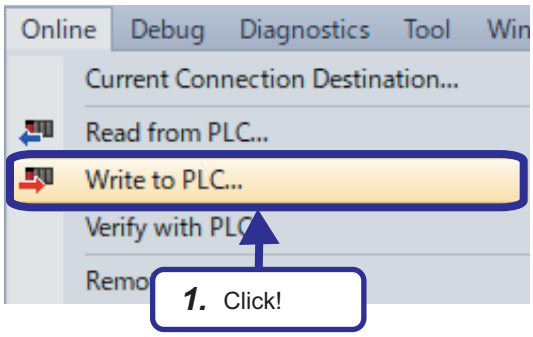
6. Check that the connection with the CPU module is succeeded.



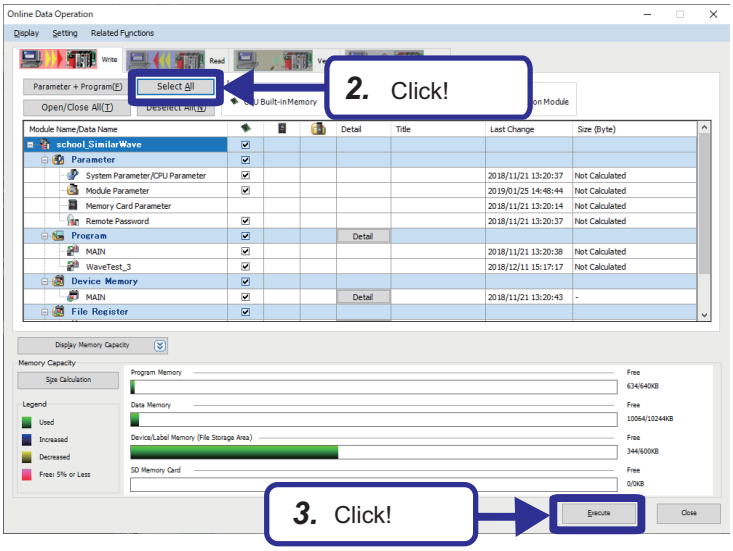
7. Click the [OK] button.

Writing program to the CPU module

Write the ladder program to the CPU module.

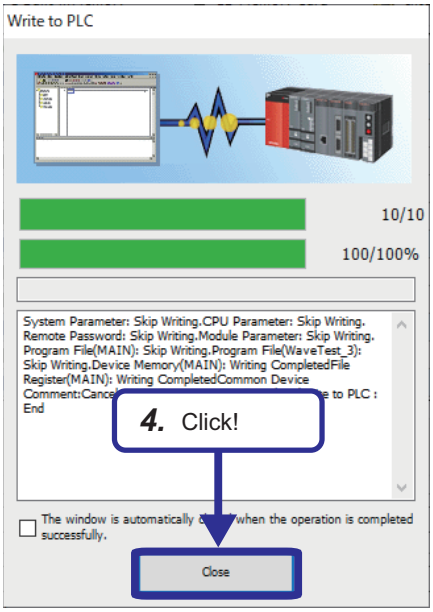


1. Open the project "school_SimilarWave.gx3" and select [Online] ⇨ [Write to PLC...] from the menu of the engineering tool.



2. When the online data operation dialog is displayed, click the [Select All] button.

3. Click the [Execute] button.

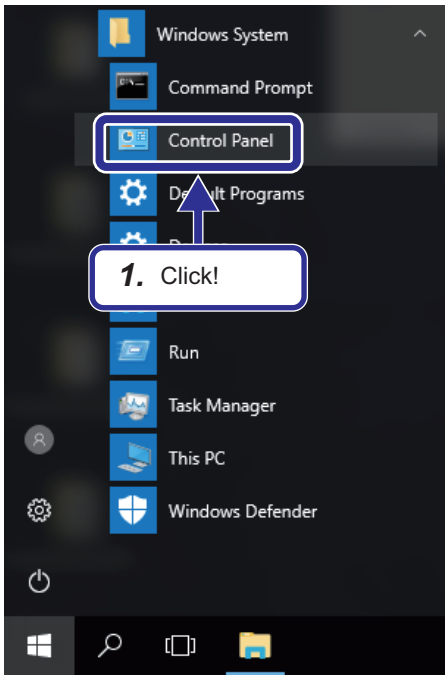


4. The write to PLC dialog box is displayed. When the writing is completed, the message "Completed." is displayed. Then, click the [Close] button.

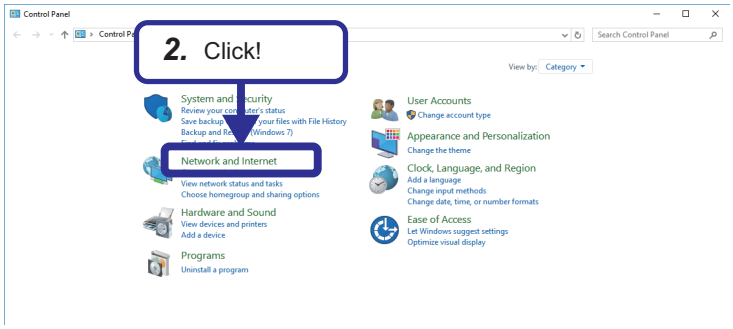
4.2 TCP/IP Setting of MELIPC

Configure the TCP/IP setting of MELIPC.

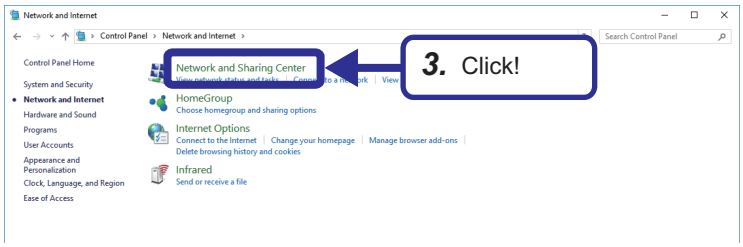
Operating procedure



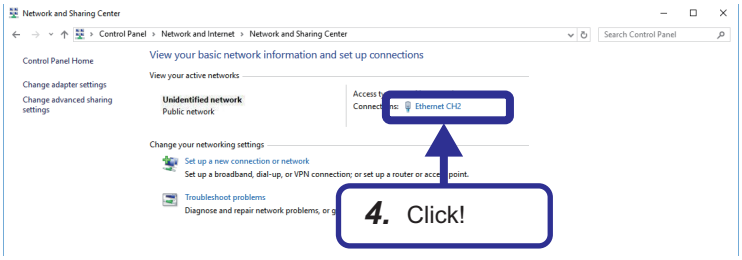
1. From Windows® start, click [Windows System] ⇨ [Control Panel].



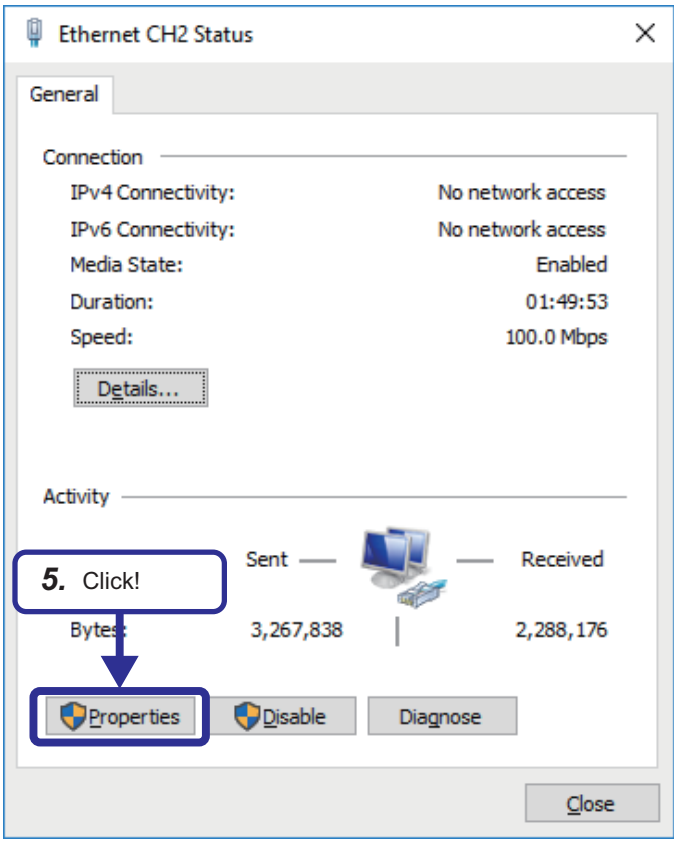
2. When the control panel dialog box is displayed, click "Network and Internet".



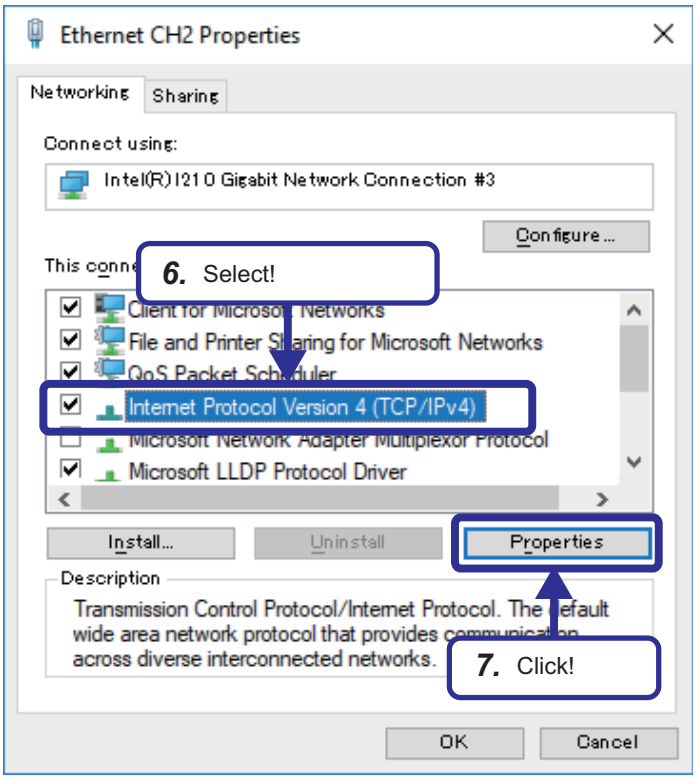
3. Click "Network and Sharing Center".



4. Click "Ethernet CH2".

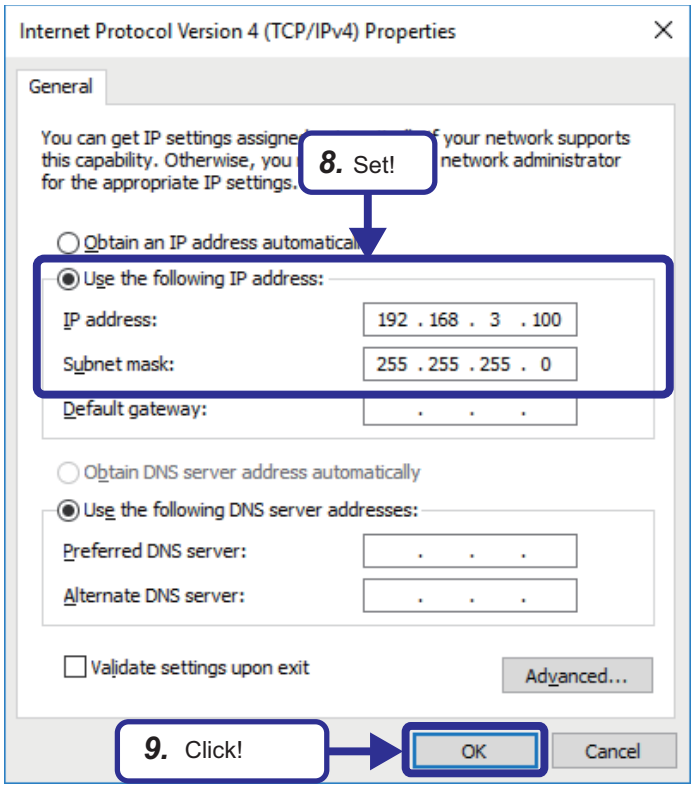


5. Click the [Properties] button.



6. Select "Internet Protocol Version 4 (TCP/IPv4)".

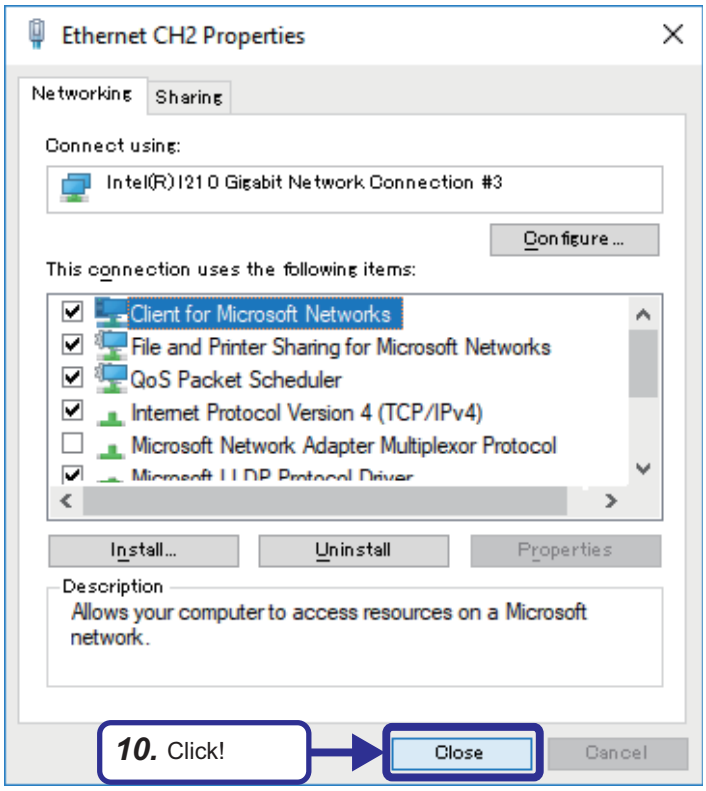
7. Click the [Properties] button.



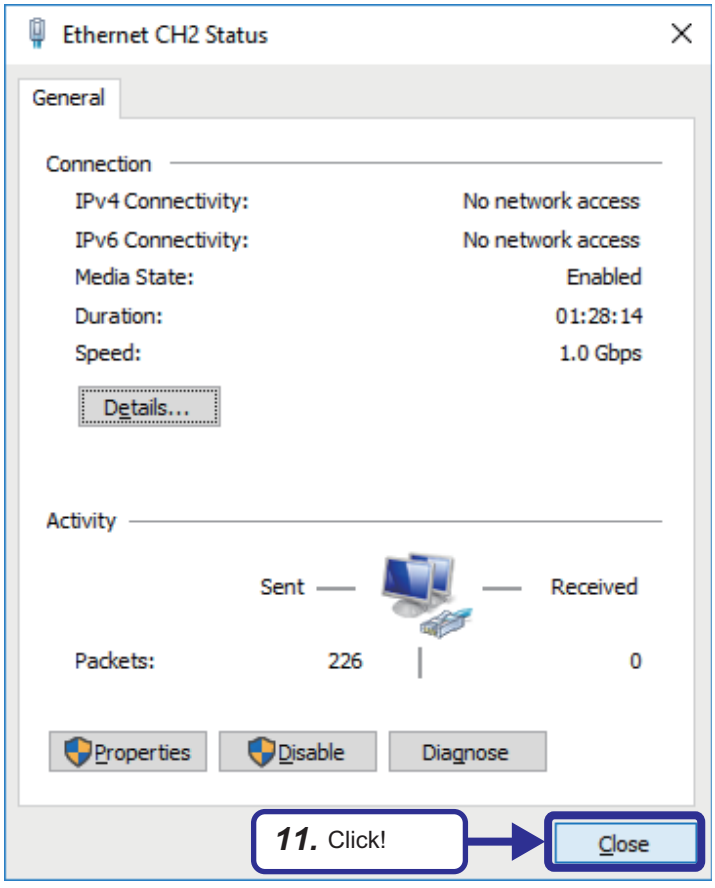
8. Select "Use the following IP address" and set the following details.
[Setting details]
IP address: 192.168.3.100
Subnet mask: 255.255.255.0

9. Click the [OK] button.

10. Click the [Close] button.

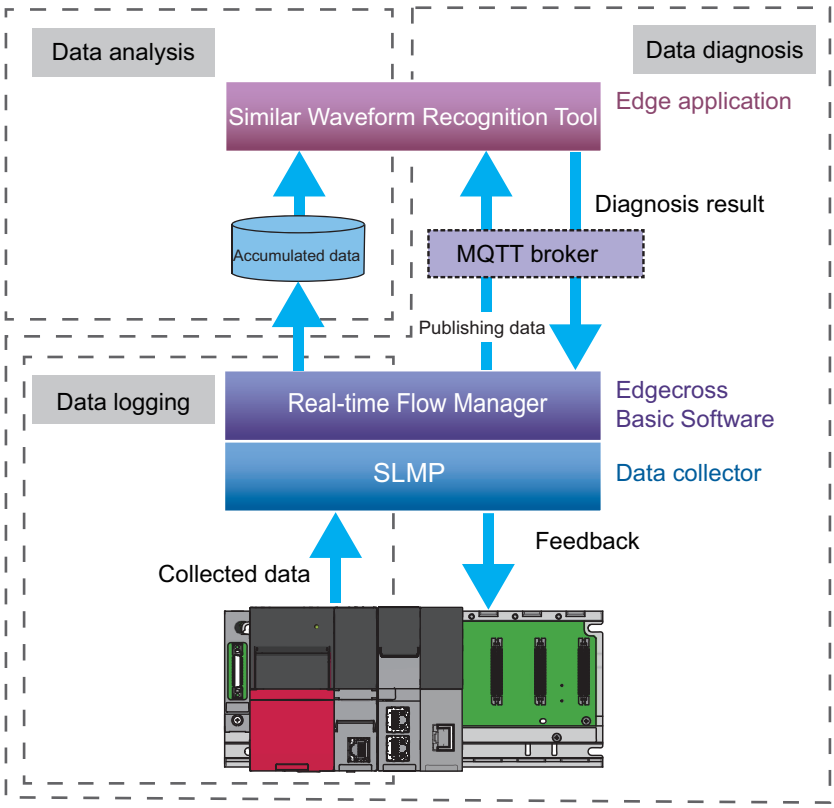


11. Click the [Close] button.



5 EXERCISE 1 ANALYSIS AND DIAGNOSIS WITH SIMILAR WAVEFORM RECOGNITION

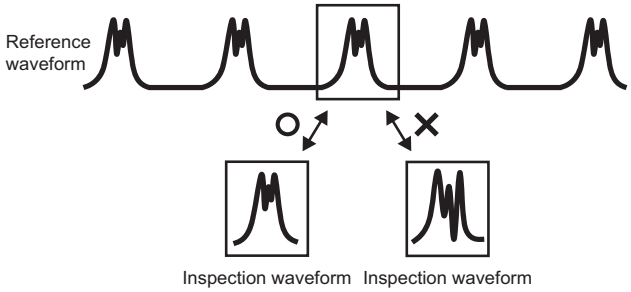
In the similar waveform recognition, data logging is performed from the CPU module using the SLMP data collector and a reference waveform is generated as a reference for diagnosis. With Similar Waveform Recognition Tool, the data input in real time is compared with the reference waveform to diagnose whether it is similar to the normal pattern. If any waveform is different from the reference waveform (similarity score is lower than the threshold), a feedback is sent to the CPU module. "Page 17 Operation overview" describes that the operation is divided into three phases of data logging, data analysis, and data diagnosis. Each phase is data communication between devices and applications as shown below.



5.1 Overview of Similar Waveform Recognition Tool

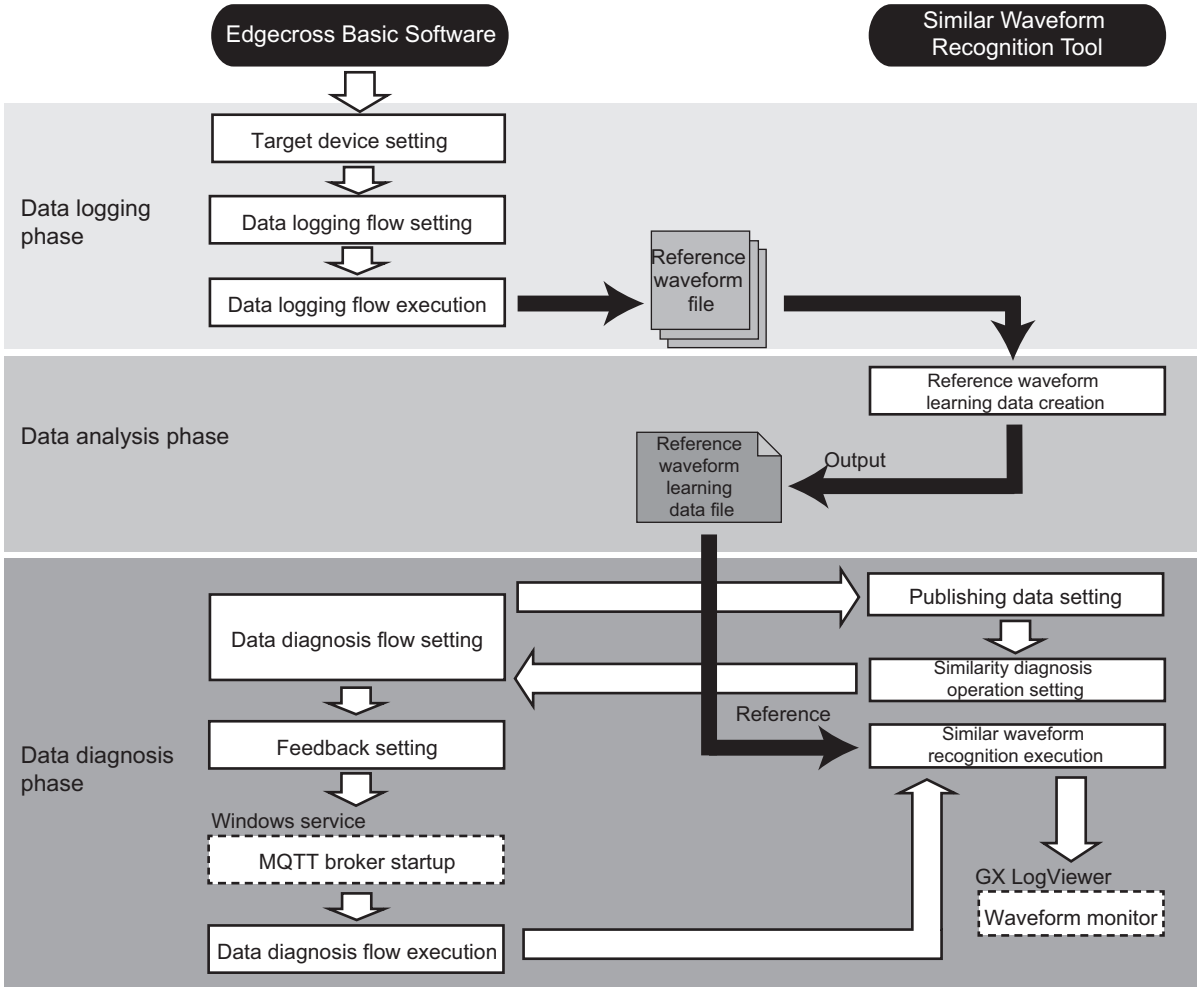
Similar Waveform Recognition Tool is an edge application that consists of the following functions.

- A function for automatically learning a given reference cyclic waveform (reference waveform). This function learns even a waveform of which the cycle is not constant or in which multiple patterns are switched as the characteristic of the normal cyclic waveform.
- A function for diagnosing the similarity between a waveform (inspection waveform) input as a diagnosis target and a learned waveform at high-speed and calculating an index for representing similarity (similarity score).
- A function for notifying both Real-time Flow Manager and users of the diagnosis result calculated based on the similarity score.



Similar waveform recognition setting procedure

Similar waveform recognition can be configured in the following procedure.



Item	Description	Setting method
Target device setting	Add an SLMP data collector and configure the settings for connecting the programmable controller.	☞ Page 31 Target device setting
Data logging flow setting	Set the device, collection data type, collection cycle, and data save setting of the data collected from the programmable controller.*1	☞ Page 34 Data logging flow setting
Data logging flow execution	Collect data from the programmable controller and create the reference waveform data.	☞ Page 40 Data logging execution
Reference waveform learning data creation	Configure the settings to create the reference waveform learning data file from the reference waveform file.	☞ Page 83 Importing files
Data diagnosis flow setting	Send the waveform data received from the programmable controller to Similar Waveform Recognition Tool and configure the setting for receiving the similar waveform diagnosis result.*1	☞ Page 47 Data diagnosis flow setting (creating a publishing data definition file) ☞ Page 56 Data diagnosis flow setting (reading a response data definition file)
Publishing data setting	Configure the settings related to the target publishing data of similar waveform recognition.	☞ Page 51 Publishing data setting
Similarity diagnosis operation setting	Specify the reference waveform learning data file for similar waveform diagnosis and configure the settings such as the detection sensitivity.	☞ Page 53 Operation setting
Feedback setting	Configure the settings to feedback the similarity waveform diagnosis result to the programmable controller.	☞ Page 57 Feedback setting
MQTT broker startup	Start the MQTT communication on Windows service.	☞ Page 117 MQTT Broker Setup
Data diagnosis flow execution	Start the data diagnosis flow of Real-time Flow Manager and feedback the result of similarity diagnostic function to the programmable controller.	☞ Page 61 Executing data diagnosis
Similar waveform recognition execution	Execute the similar waveform recognition with Similar Waveform Recognition Tool and monitor the execution condition.	☞ Page 62 Similar waveform recognition execution

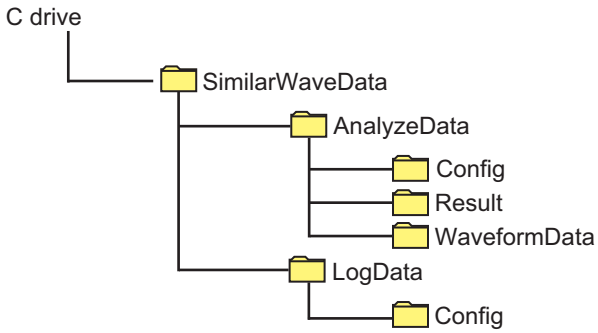
Item	Description	Setting method
Waveform monitor	Start GX LogViewer and execute the waveform monitor.	☞ Page 64 Diagnosis with waveform monitor

*1 The following shows the number of processes that can be used in each process.

Flow type	Data collection	Data modification	Data diagnosis	Feedback execution
Data logging flow	1 (Required)	3	—	—
Data diagnosis flow	1 (Required)	3	1 (Required)	1 (Required)

5.2 Data Logging

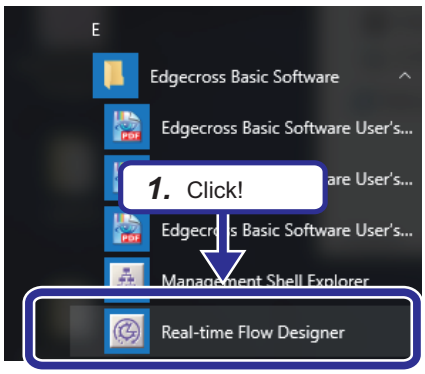
Data logging is performed from the CPU module using the SLMP data collector and a reference waveform is generated as a reference for diagnosis.
Create new folders in advance with the following folder structure.



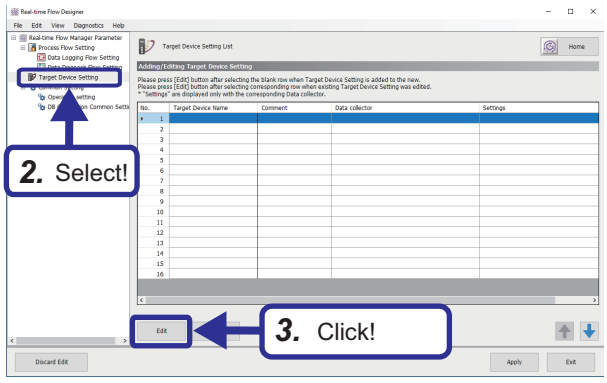
Target device setting

Select the data collector to be used and set the target device.

Operating procedure

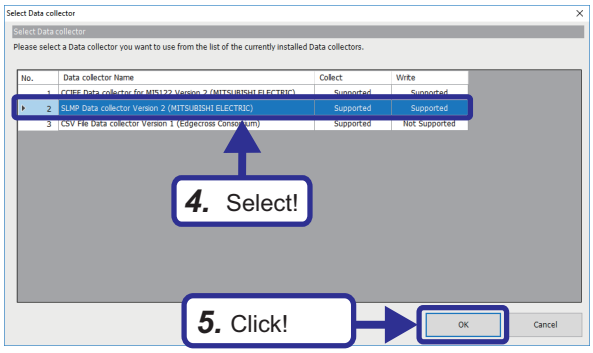


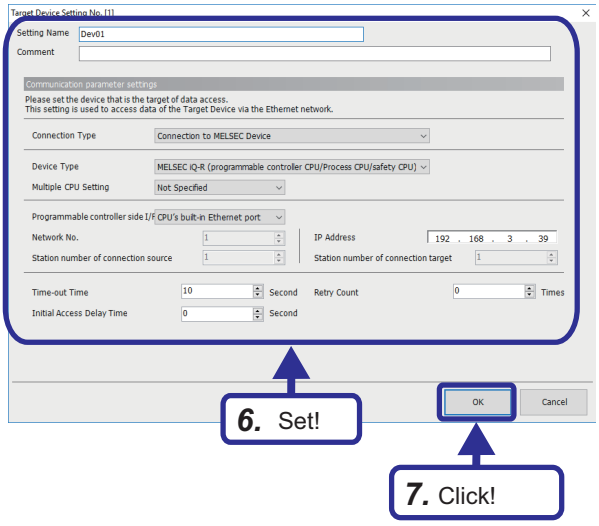
1. Click Windows® start ⇨ [Edgecross Basic Software] ⇨ [Real-time Flow Designer].

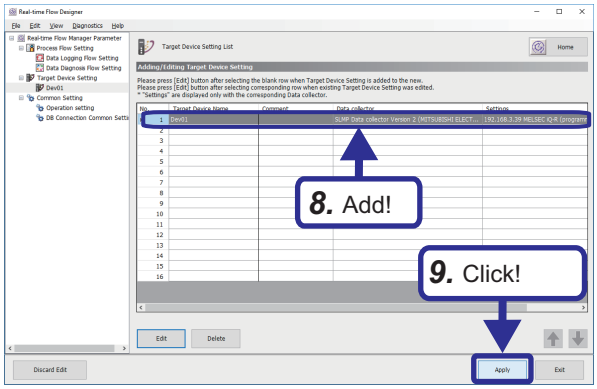


2. Select "Target Device Setting" in the edit item tree.

3. Select a blank row in the target device setting list and click the [Edit] button.
The settings can be added from the detail setting window of data collection.







4. In the "Select Data collector" window, select "SLMP Data collector Version.X[*1](MITSUBISHI ELECTRIC)".

*1 X indicates the version.

5. Click the [OK] button.

6. When the target device setting window is displayed, set as follows.

[Setting details]

Setting Name: Dev01

Connection Type: Connection to MELSEC Device

Device Type: MELSEC iQ-R (programmable controller CPU/Process CPU/safety CPU)

Multiple CPU Setting: Not Specified

Programmable controller side I/F: CPU's built-in Ethernet port

Network No.: 1

Station number of connection source: 1

IP Address: 192.168.3.39

Time-out Time: 10 Second

Retry Count: 0 Times

Initial Access Delay Time: 0 Second

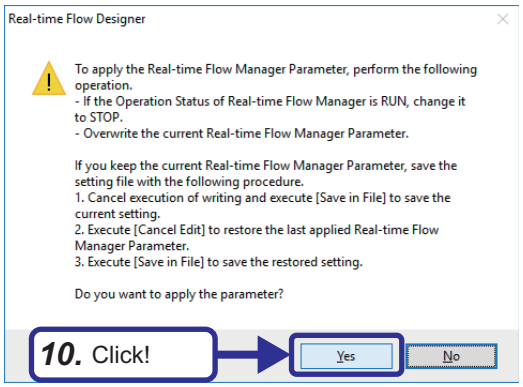
Point

Set the same IP address as that of the CPU module.

7. Click the [OK] button.

8. The setting is added to the target device setting list.

9. Click the [Apply] button.

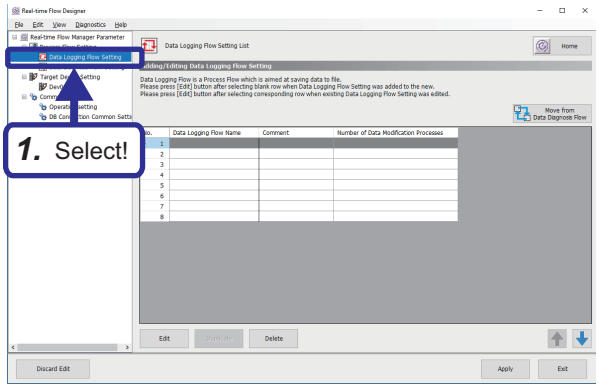


10. Click the [Yes] button and save the setting.

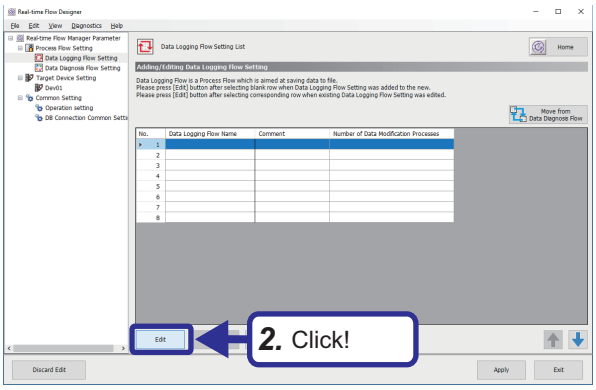
Data logging flow setting

Collect data from the target device and save it as a CSV file.

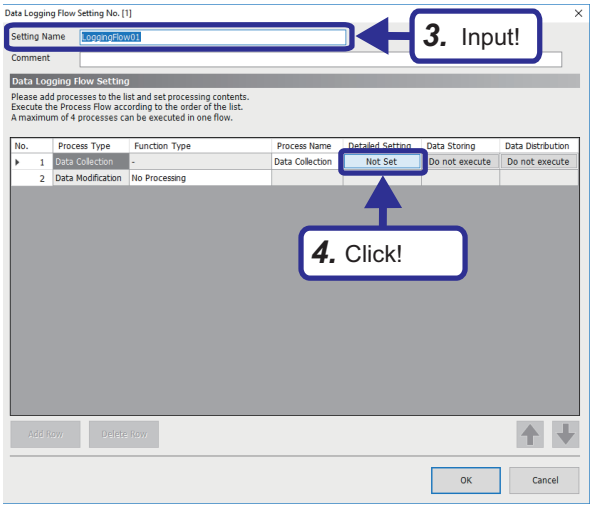
Operating procedure



1. Select "Data Logging Flow Setting" in the edit item tree of Real-time Flow Designer.

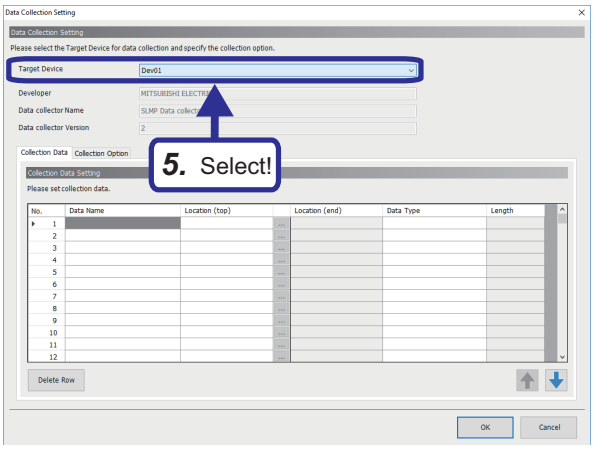


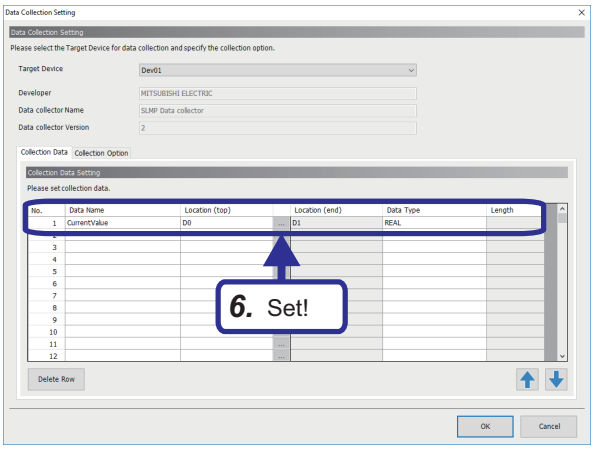
2. Select a blank row in the data logging flow setting list and click the [Edit] button.

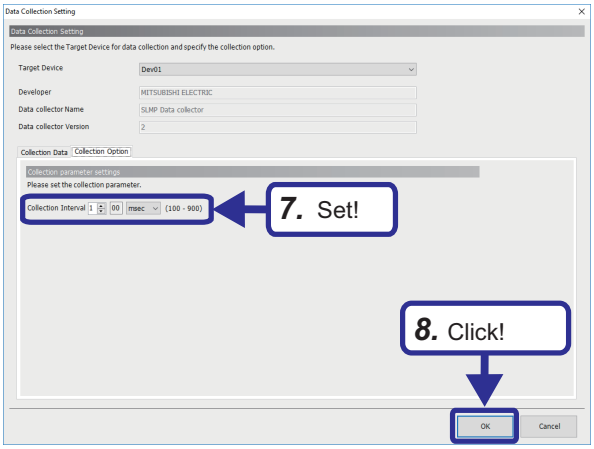


3. When the data logging flow setting window is displayed, enter the following.
[Setting details]
Setting Name: LoggingFlow01

4. Click "Not Set" in the detailed setting.





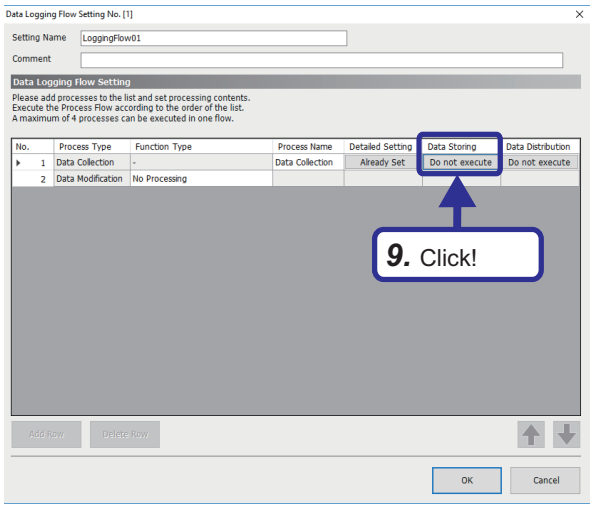


5. Select the target device of the SLMP data collector.
[Setting details]
Target Device: Dev01

6. Select the "Collection Data" tab and set the data name, device address, and data type of the data to be collected as follows.
[Setting details]
Data Name: CurrentValue
Location (top): D0
Data Type: REAL

7. Select the "Collection Option" tab and set the collection interval as follows.
[Setting details]
Collection Interval: 100 msec

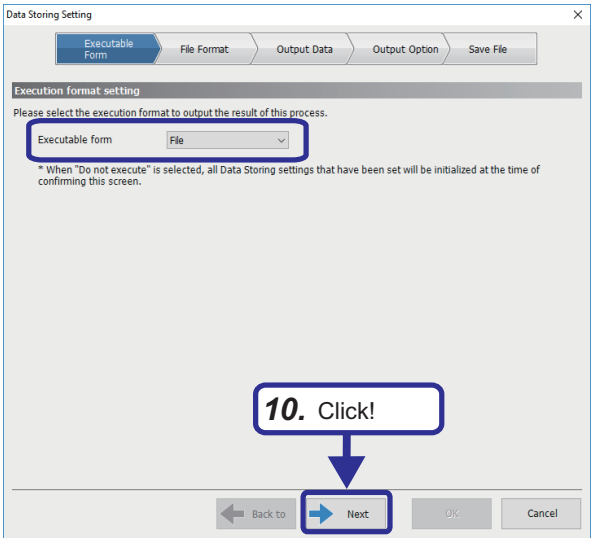
8. Click the [OK] button.



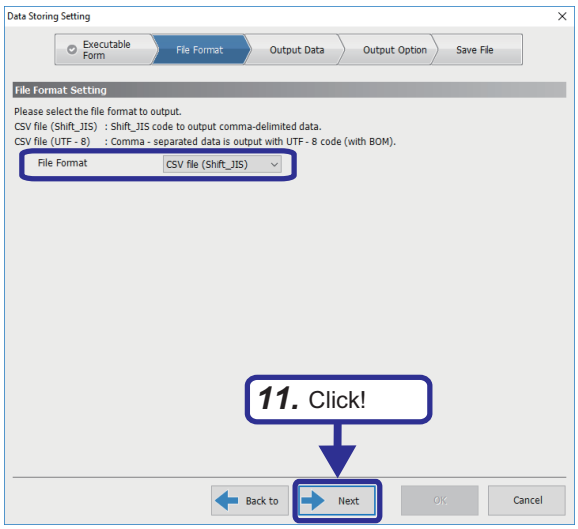
9. Click "Do not execute" in data storing.

Point

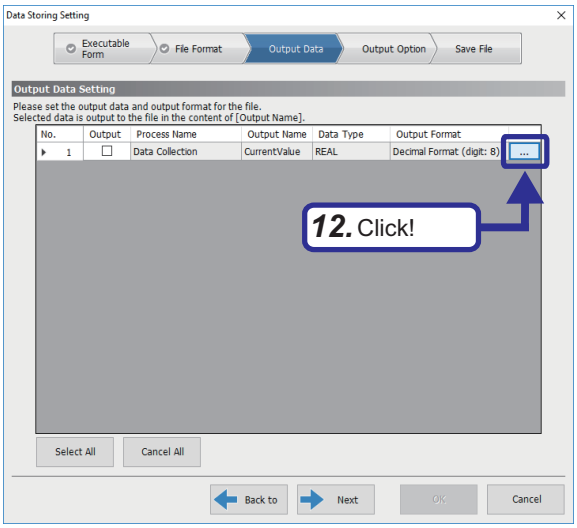
Data storing and data distribution can be executed up to twice in each flow to maintain data that flows between processes.



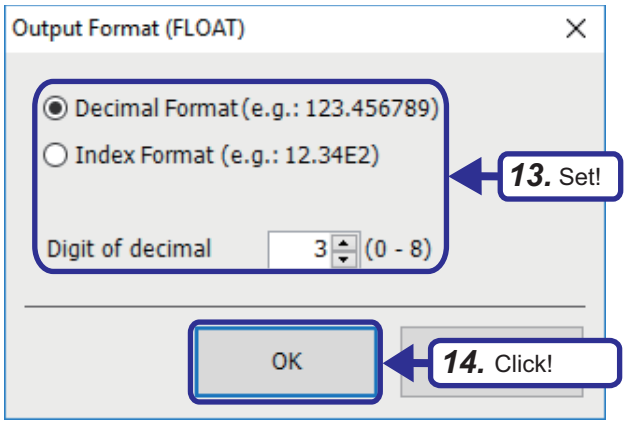
10. Select "File" for the executable form and click the [Next] button.



11. Select "CSV file (Shift_JIS)" for the file format and click the [Next] button.

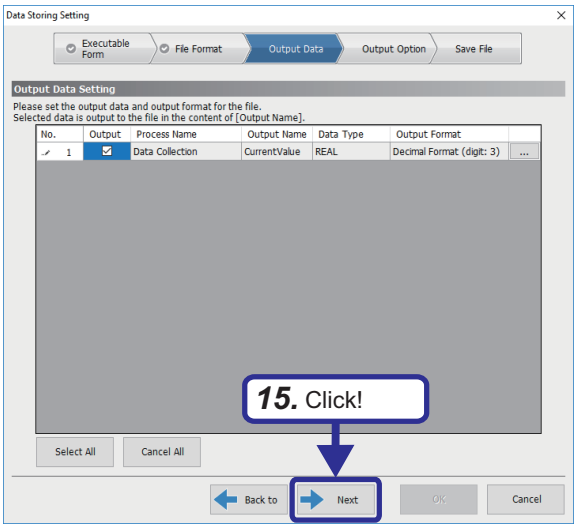


12. Click the [...] button to display the output format (float) window.

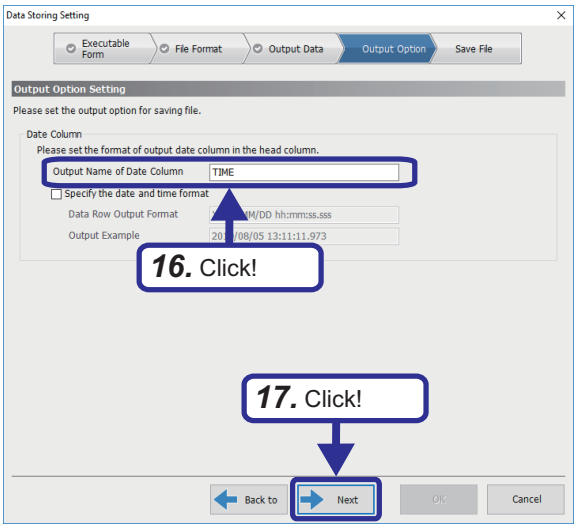


13. Set "Output Format" as follows.
[Setting details]
Decimal Format: Checked
Digit of decimal: 3

14. Click the [OK] button.



15. Select the data to be output and click the [Next] button.



16. Set "Output Option" as follows.

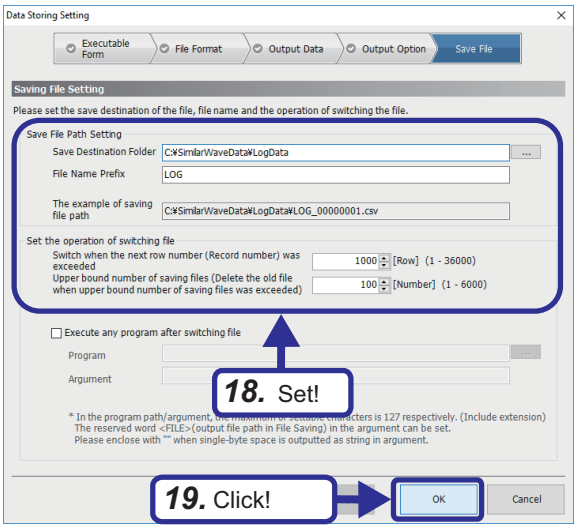
[Setting details]

Output Name of Date Column: TIME

17. Click the [Next] button.

Point

When "Specify the date and time format" is selected, the data format of date column can be changed.



18. Set "Save File" as follows.

[Setting details]

Save Destination Folder:

C:\SimilarWaveData\LogData

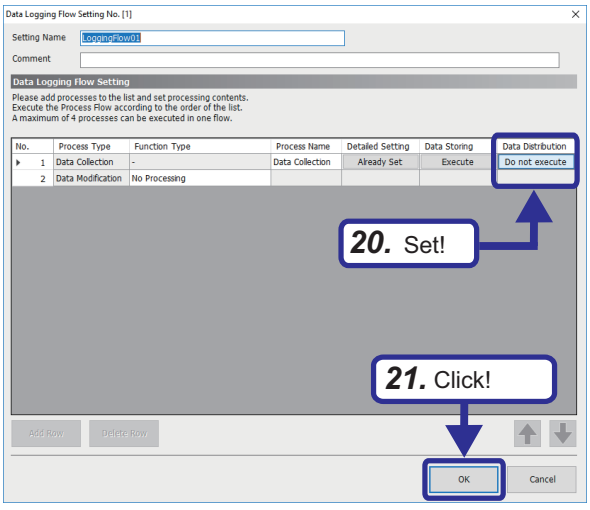
File Name Prefix: LOG

Switch when the next row number (Record number) was exceeded

: 1000

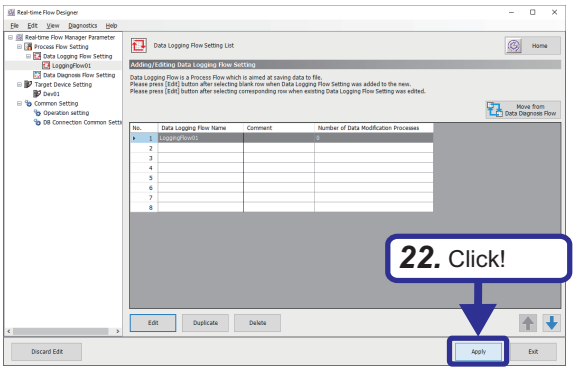
Upper bound number if saving files: 100

19. Click the [OK] button.

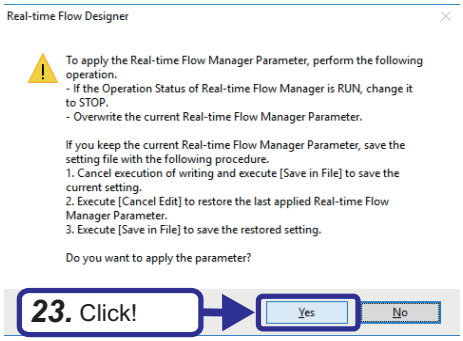


20. Set "Data Distribution" to "Do not execute".

21. Click the [OK] button.



22. Click the [Apply] button.

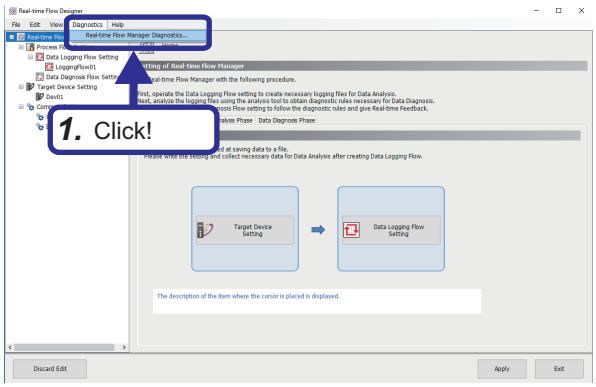


23. Click the [Yes] button.

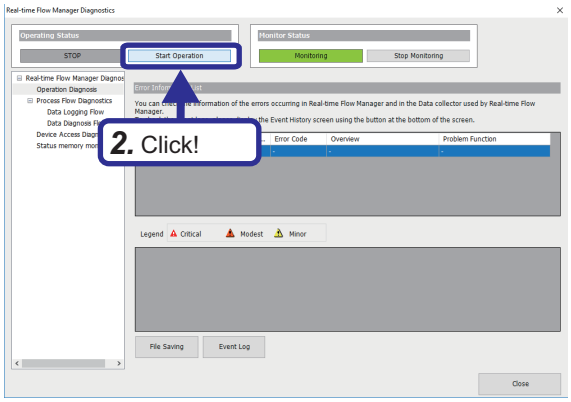
Data logging execution

Execute logging with the settings configured in Real-time Flow Designer.

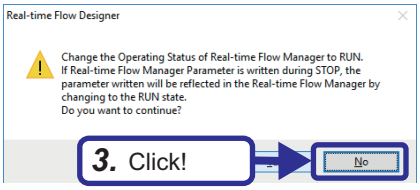
Operating procedure



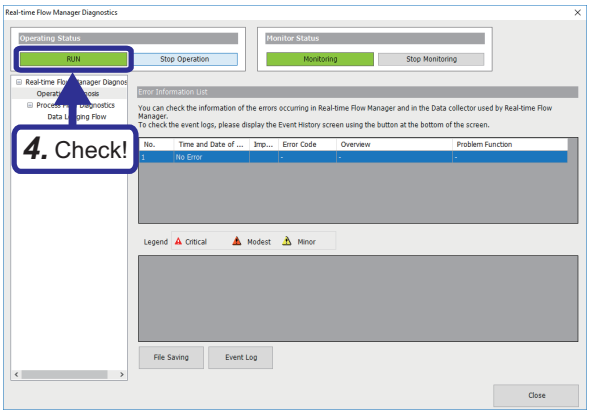
1. Click [Diagnostics] ⇨ [Real-time Flow Manager Diagnostics...] from the menu of Real-time Flow Designer.



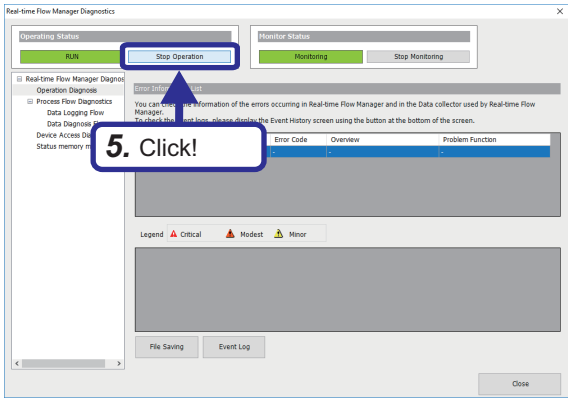
2. Click the [Start Operation] button.



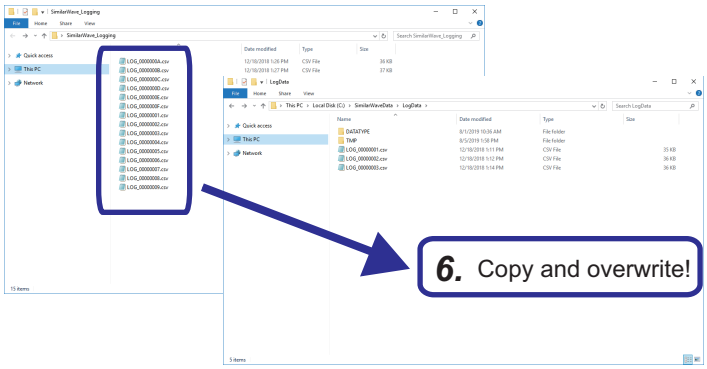
3. Click the [Yes] button.



4. Check that "Operating Status" is set to RUN and that the file is created in the save destination folder set in the data logging flow.



5. When the required number of files has been created, click the [Stop Operation] button in "Operating Status" to stop creating files.



6. In this training, perform analysis and diagnosis using the logging data prepared in advance. Copy the reference waveform file in the SimilarWave_Logging folder to the save destination folder (C:\SimilarWaveData\LogData) and overwrite it.

Point

In the actual operation, determine the number of required files before logging.
The minimum number of records is as follows:

- To satisfy the restrictions of the waveform learning function: Records should be more than four times of the unit waveform width and temporally consecutive in one or more sections.
- To enable the minimum diagnosis operation: Records in which the basic cycle of a reference waveform is four cycles or more and temporally consecutive in one or more sections.
- To enable the practical operation: Records in which the basic cycle of a reference waveform is 16 cycles or more and temporally consecutive in one or more sections.

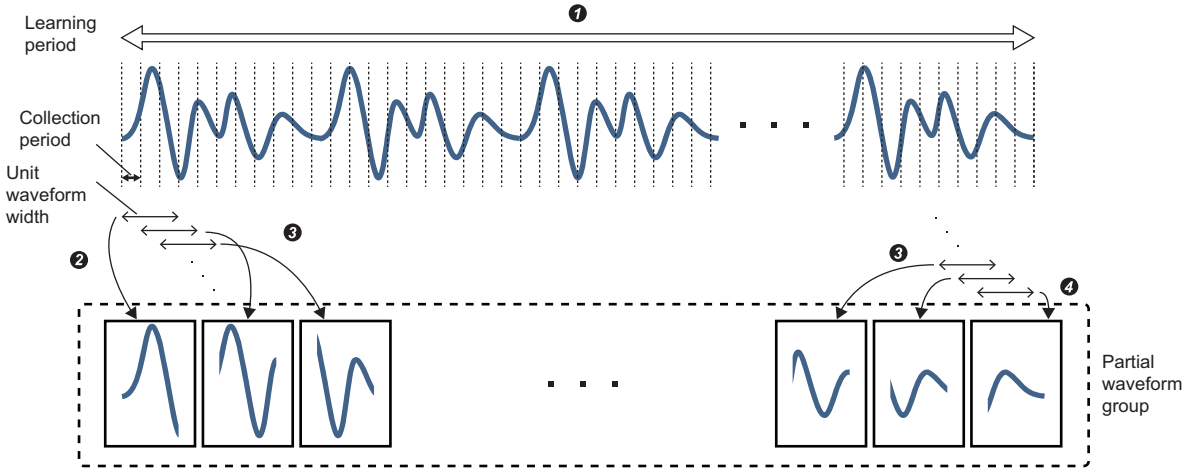
5.3 Data Analysis

This section describes the procedure for creating a diagnosis criterion (reference waveform learning data) for an inspection waveform used for data diagnosis based on the data collected in the data logging flow.

Creating reference waveform learning data

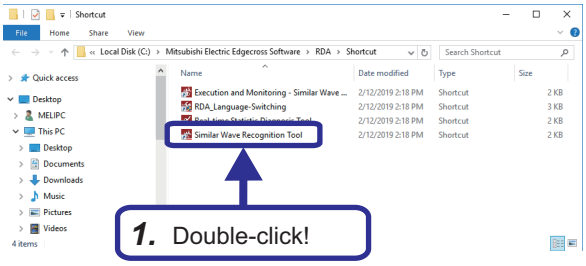
Operation overview in waveform learning

The following describes the operation overview in waveform learning.
The waveform (partial waveform) corresponding to the number of records in the unit waveform width is extracted from the reference waveform included in the learning period, shifting one record at a time, to generate a partial waveform group.
The partial waveform group is used as an index to see how similar a waveform is to the inspection waveform during the data diagnosis flow.
Detailed operation in waveform learning is as follows:
❶ Import a waveform for the period specified as the learning period.
❷ Analyze and learn the shape of the waveform (partial waveform) for the number of records specified in the unit waveform width.
❸ Repeat ❷ for each record (collection cycle).
❹ The analysis ends when all partial waveforms included in a learning period have been learned and all partial waveforms have been saved in a reference waveform learning data file.

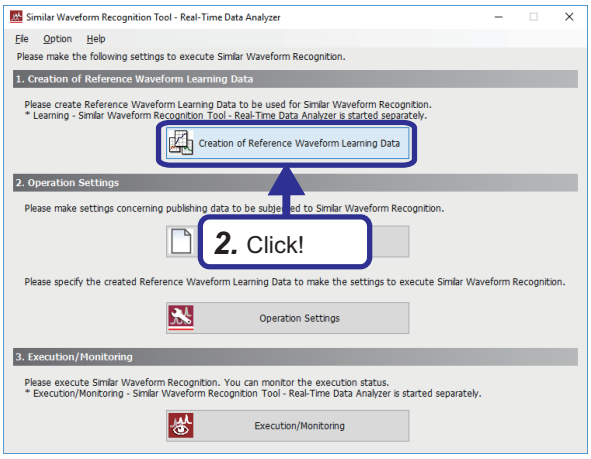


Creation setting of reference waveform learning data

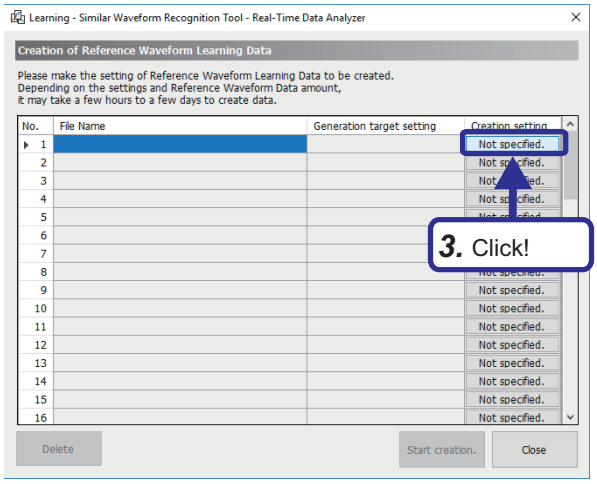
Operating procedure



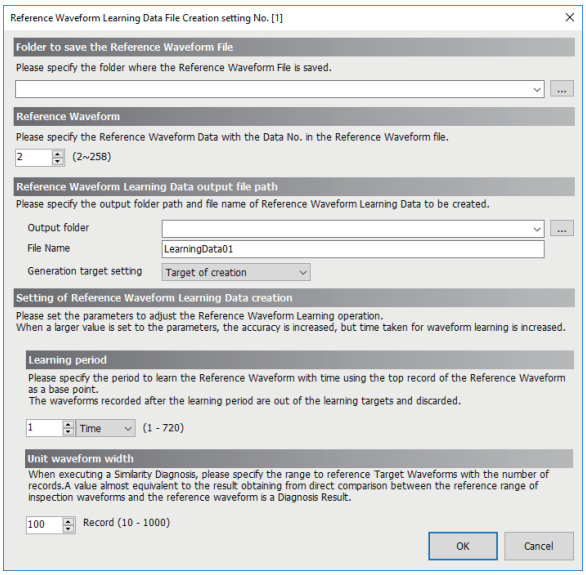
1. From Windows® start ⇨ [Mitsubishi Electric Edgecross Software] ⇨ [Real-time Data Analyzer], double-click [Similar Wave Recognition Tool].



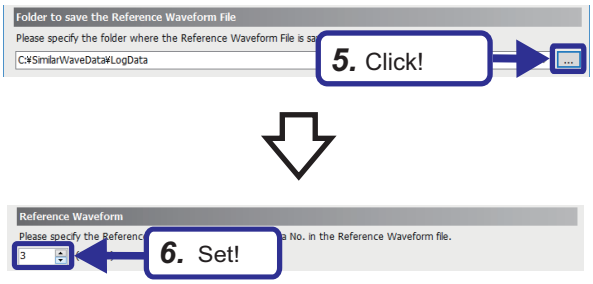
2. When Similar Waveform Recognition Tool is started, click the [Creation of Reference Waveform Learning Data] button.



3. Select a blank row in "Creation of Reference Waveform Learning Data" and click "Not specified.".



4. The "Reference Waveform Learning Data File Creation setting" window is displayed.

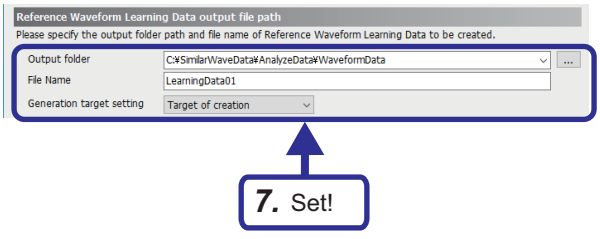


5. Click the [...] button in "Folder to save the Reference Waveform File" and select "C:\SimilarWaveData\LogData".

6. In "Reference Waveform", set the waveform data column of the logged CSV file as follows.
[Setting details]
Data No.: 3

Point

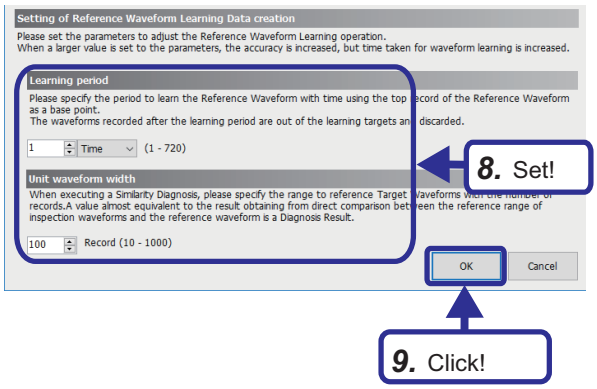
For the data No., check the logged CSV file and specify the column that contains the current value to be diagnosed.



7. Set "Reference Waveform Learning Data output file path" as follows.
[Setting details]
Output folder:
C:\SimilarWaveData\AnalyzeData\WaveformData
File Name: LearningData01
Generation target setting: Target of creation

Point

To set only the reference waveform learning data, select "Out of target of creation".



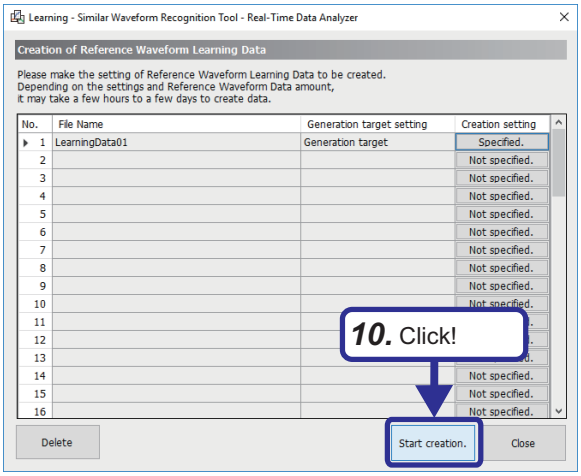
8. Set "Learning period" and "Unit waveform width" as follows.

[Setting details]

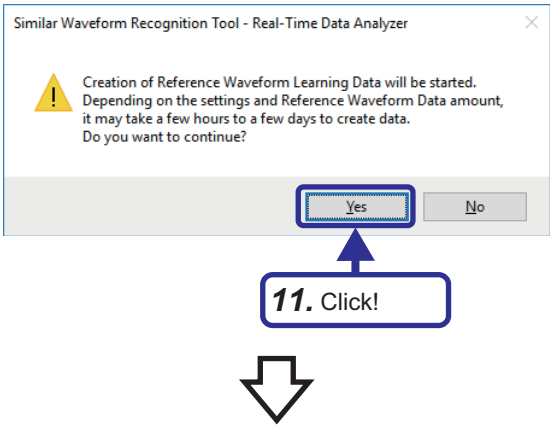
Learning period: 1 Time

Unit waveform width: 100

9. Click the [OK] button.

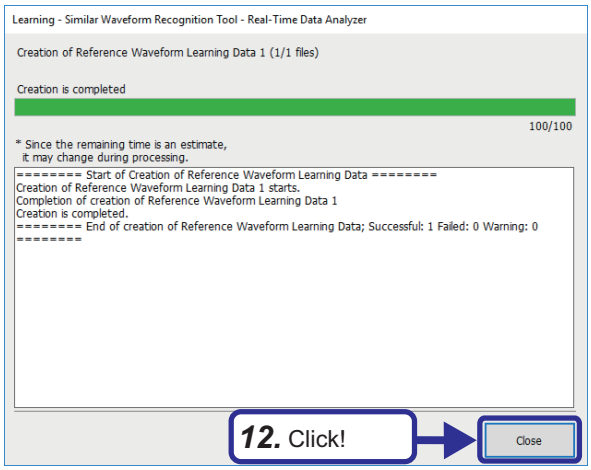


10. Click the [Start creation.] button.

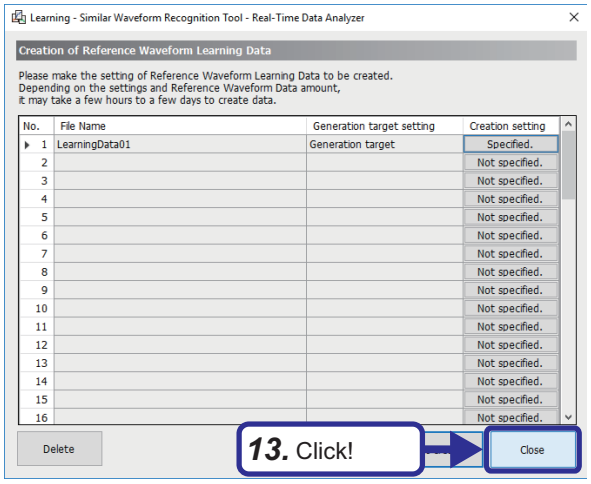


11. Click the [Yes] button.

The reference waveform learning data "LearningData01.dspr" is created in the output destination folder (C:\SimilarWaveData\AnalyzeData\WaveformData).



12. When the reference waveform learning data is created, click the [Close] button.



13. Click the [Close] button.

5.4 Data Diagnosis

The data diagnosis function monitors the inspection waveform input from Real-time Flow Manager and notifies Real-time Flow Manager of the number of waveforms that differ from the reference waveform (the similarity score is lower than the threshold) and the difference from the similarity score threshold.
The inspection waveform can be displayed in real time by connecting GX LogViewer.
In addition, the diagnosed inspection waveform and diagnosis result data can be saved in a file (the diagnosis result file can be output) and the diagnosis status can be checked after the diagnosis

Point

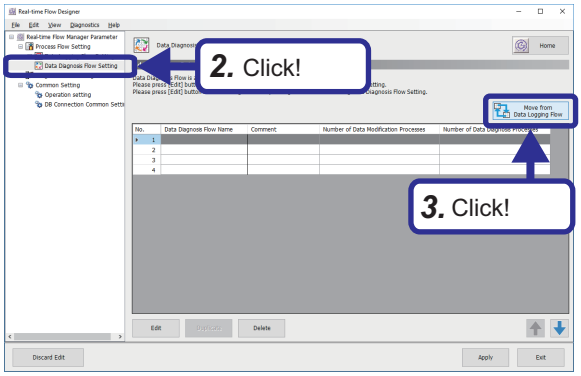
- GX LogViewer is installed at the same time when installing Real-time Data Analyzer.
- When the load on an industrial personal computer is high, the limit of the processing performance may be exceeded and the similarity diagnosis may stop. Before starting an actual operation, monitor the load of the industrial personal computer and check that a similarity diagnosis does not stop by referring to the following.

Real-time Data Analyzer User's Manual

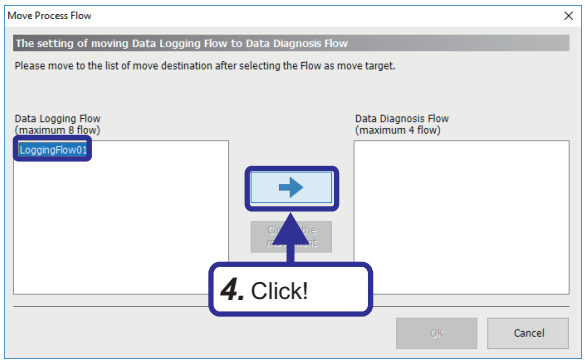
Data diagnosis flow setting (creating a publishing data definition file)

Create a publishing data definition file with Real-time Flow Designer.

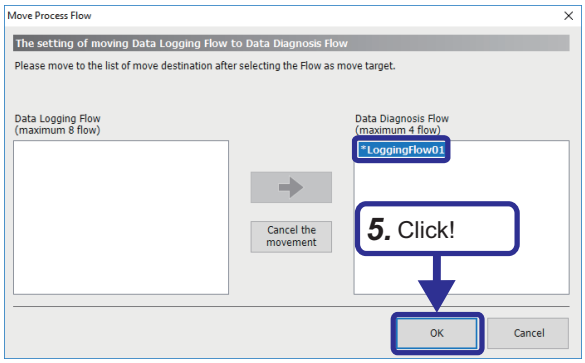
Operating procedure



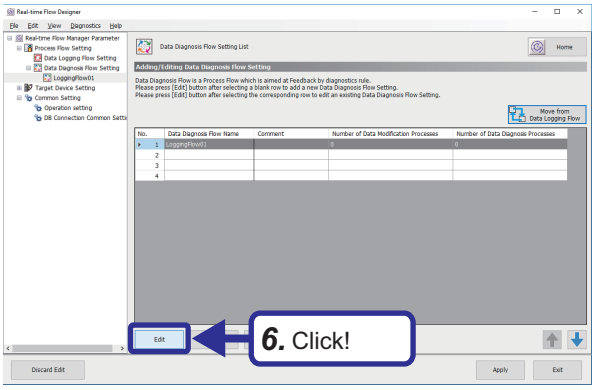
1. Start Real-time Flow Designer.
2. Click "Data Diagnosis Flow Setting" in the edit item tree.
3. Click the [Move from Data Logging Flow] button.



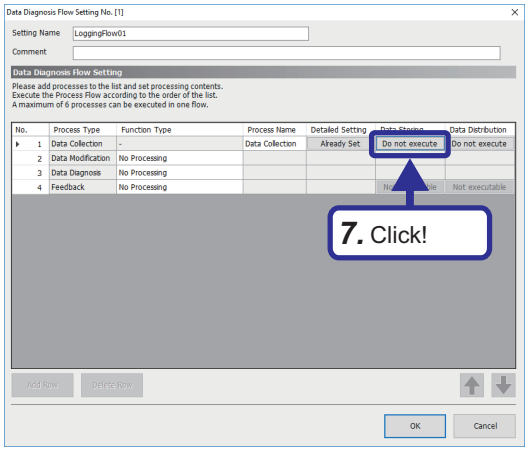
4. Select "LoggingFlow01" and click the [⇨] button.



5. Click the [OK] button.
The flow set in the data logging flow is moved to the data diagnosis flow.



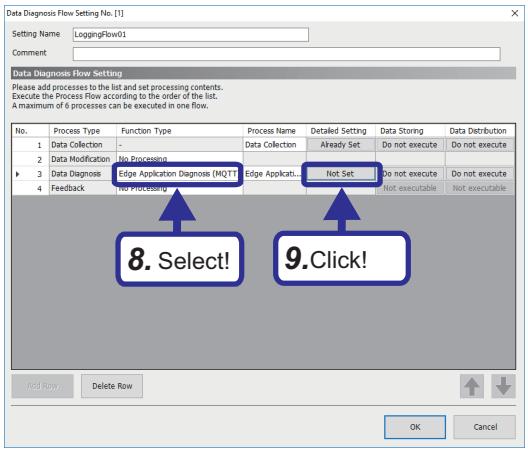
6. Click the [Edit] button.
The "Data Diagnosis Flow Setting" window is displayed.

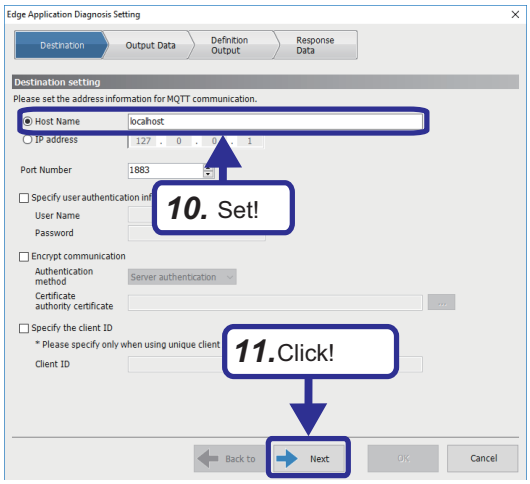


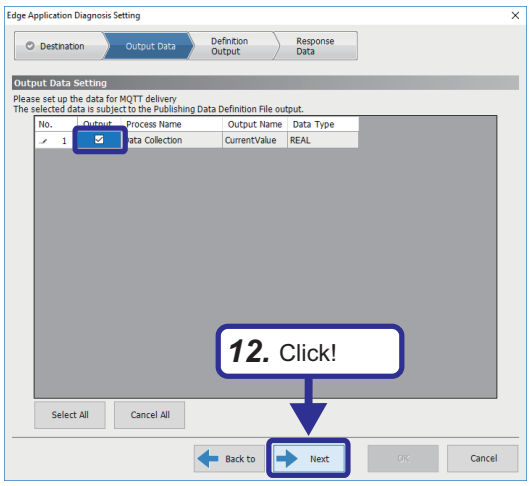
7. Select "Do not execute" for "Data Storing" of data collection.

Point

Data storing and data distribution can be executed up to twice in each flow to maintain data that flows between processes.







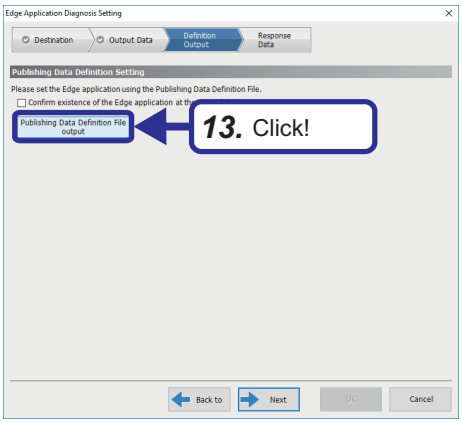
8. Select "Edge Application Diagnosis (MQTT)" for "Function Type" of data diagnosis.

9. Click "Not Set" in "Detailed Setting".

10. When the "Edge Application Diagnosis Setting" window is displayed, set as follows.
[Setting details]
Host Name: localhost

11. Click the [Next] button.

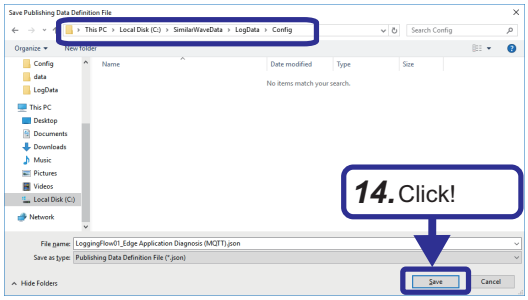
12. Select the checkbox in the "Output" column and click the [Next] button.



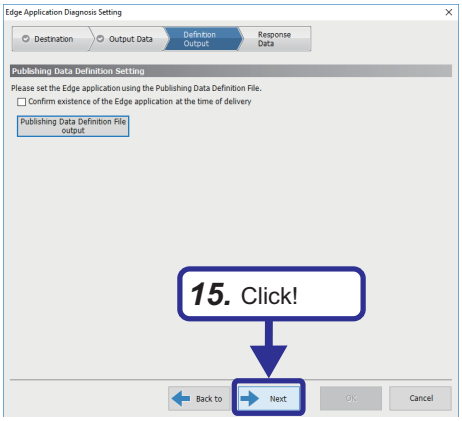
13. Click the [Publishing Data Definition File output] button.

Point

To detect a stop of similarity diagnosis with Real-time Flow Manager, select "Confirm existence of the edge application at the time of delivery".



14. When the "Save Publishing Data Definition File" window is displayed, select the following folder and output "LoggingFlow01_Edge Application Diagnosis (MQTT).json".
[Output destination folder]
C:\SimilarWaveData\LogData\Config

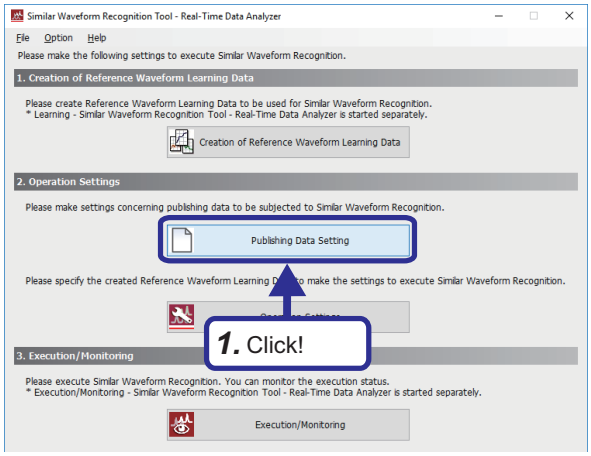


15. When the window is returned to the "Edge Application Diagnosis Setting" window, click the [Next] button.
When the window with the "Response Data" tab is displayed, the setting is temporarily completed. Leave this window open and proceed to the publishing data setting.

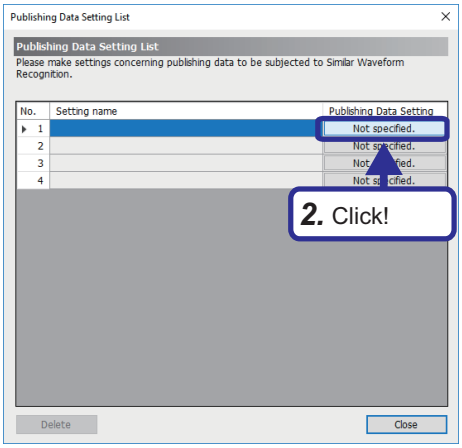
Publishing data setting

Set the diagnosis target data to be published to Similar Waveform Recognition Tool.

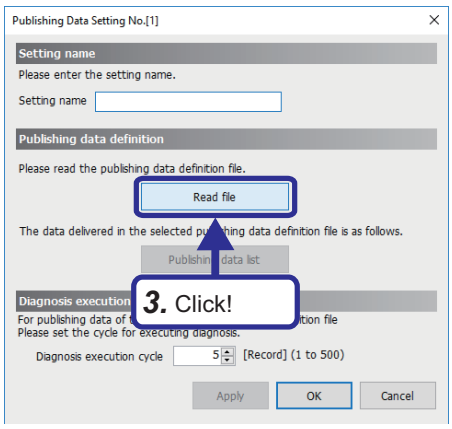
Operating procedure



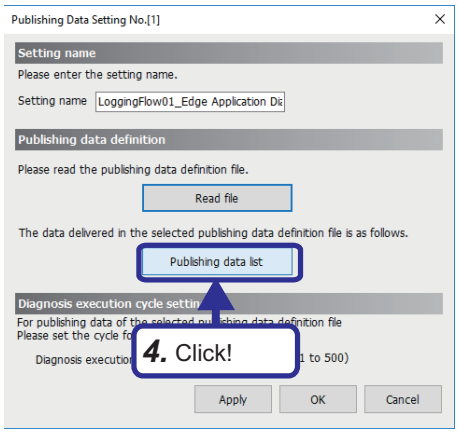
1. Click the [Publishing Data Setting] button of Similar Waveform Recognition Tool.



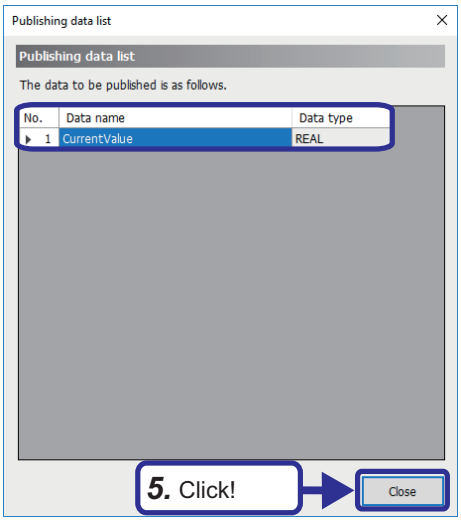
2. Select a blank row in "Publishing Data Setting List" and click "Not specified.".



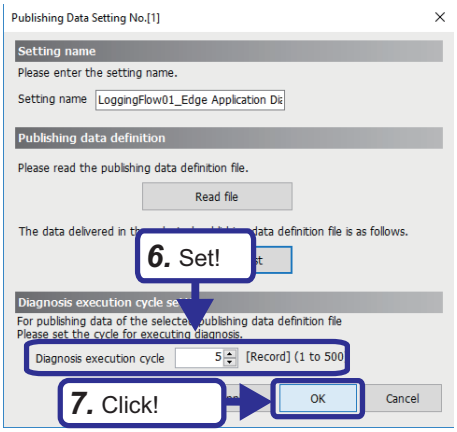
3. Click the [Read file] button and select "C:\SimilarWaveData\LogData\Config\LoggingFlow01_Edge Application Diagnosis (MQTT).json" in the displayed file selection dialog.



4. Click the [Publishing data list] button.

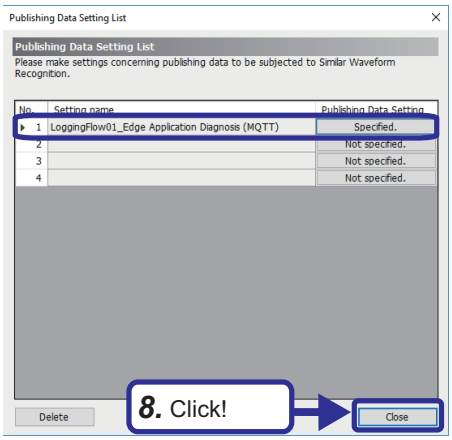


5. Check that the data set in Real-time Flow Designer is displayed and click the [Close] button.



6. Set "Diagnosis execution cycle" as follows.
[Setting details]
Diagnosis execution cycle: 5

7. Click the [OK] button.

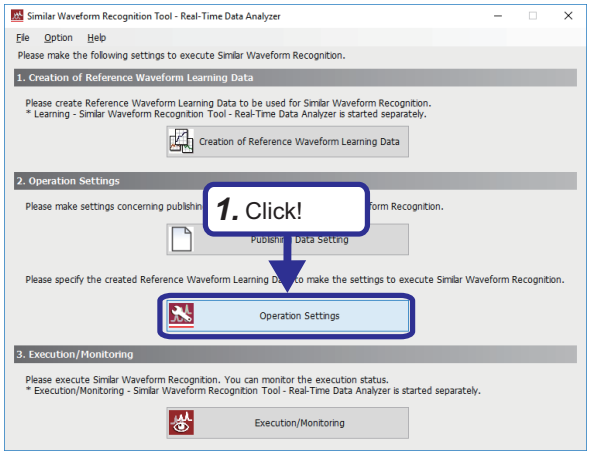


8. Check that "Publishing Data Setting" is set to "Specified." and click the [Close] button.

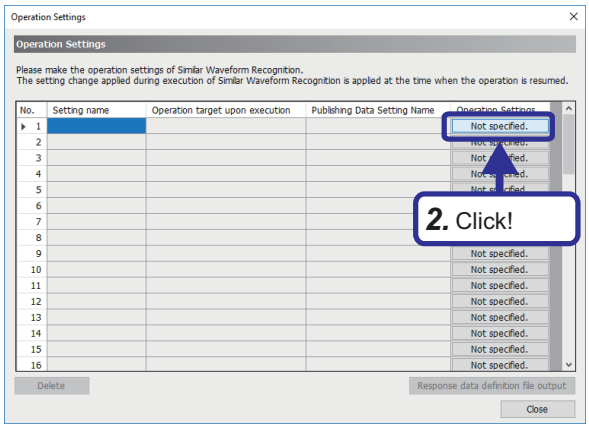
Operation setting

Configure the operation setting for similarity diagnosis with Similar Waveform Recognition Tool.

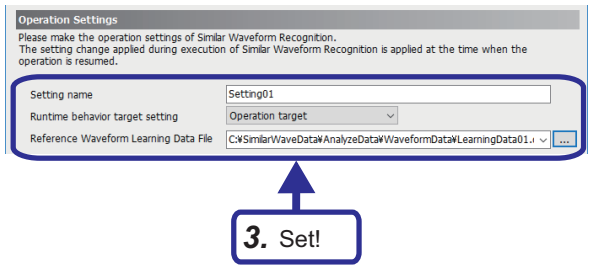
Operating procedure



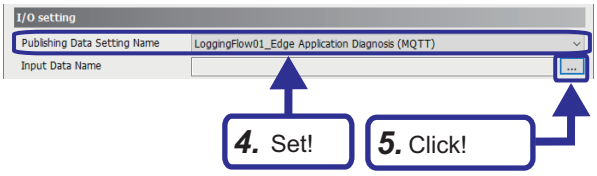
1. Click the [Operation Settings] button of Similar Waveform Recognition Tool.



2. Click "Not specified." in the operation settings.

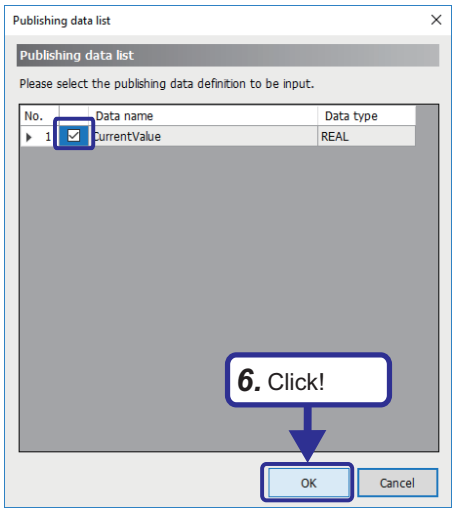


3. Set "Operation Settings" as follows.
[Setting details]
Setting name: Setting01
Runtime behavior target setting: Operation target
Reference Waveform Learning Data File:
C:\SimilarWaveData\AnalyzeData\WaveformData\LearningData01.dspr

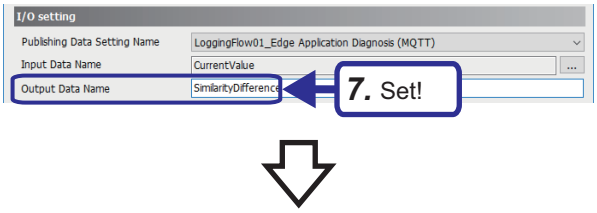


4. Set "I/O setting" as follows.
[Setting details]
Publishing Data Setting Name: LoggingFlow01_Edge Application Diagnosis (MQTT)

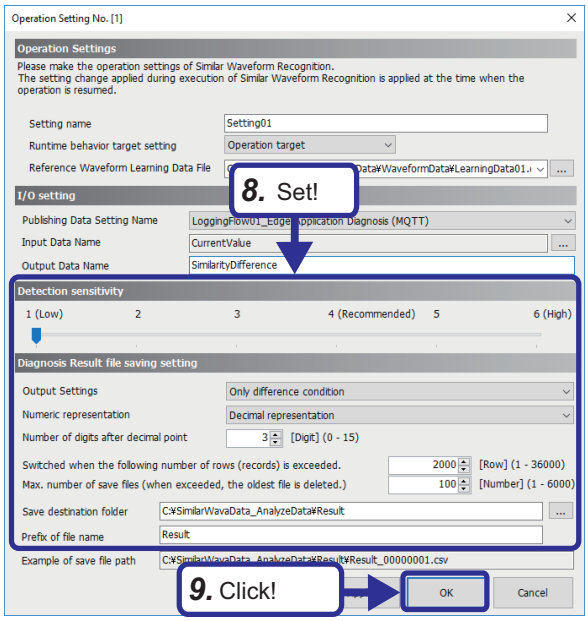
5. Click the [...] button of "Input Data Name".



6. Select the name of data to be diagnosed and click the [OK] button.

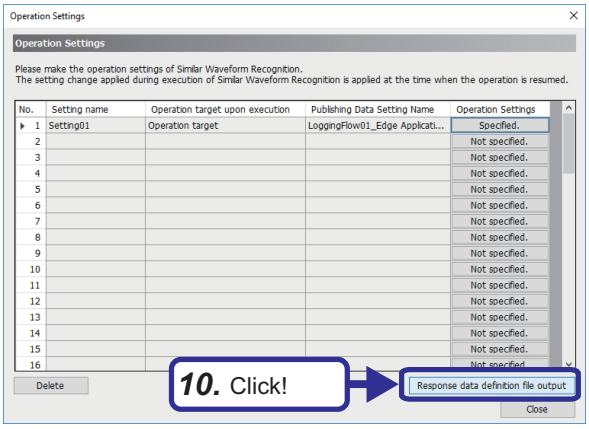


7. Set the following.
[Setting details]
Output Data Name: SimilarityDifference

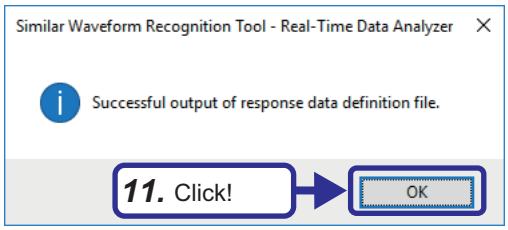


8. Set "Detection sensitivity" and "Diagnosis Result file saving setting" as follows.
[Setting details]
Detection sensitivity: 1
Output Settings: Only difference condition
Numeric representation: Decimal representation
Number of digits after decimal point: 3
Switched when the following number of rows (records) is exceeded.: 2000
Max. number of save files: 100
Save destination folder:
C:\SimilarWaveData\AnalyzeData\Result
Prefix of file name: Result

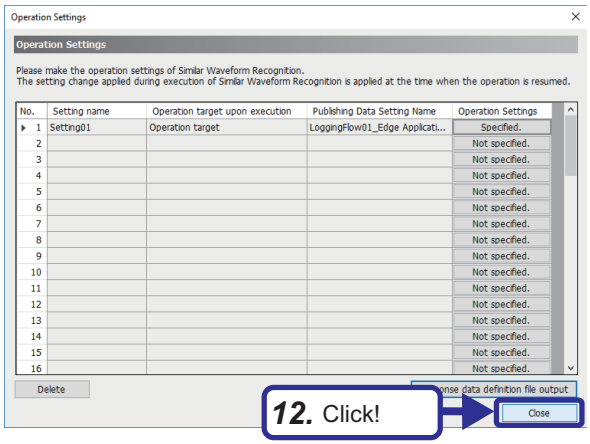
9. Click the [OK] button.



10. Click the [Response data definition file output] button.
In the displayed file selection dialog, select C:\SimilarWaveData\AnalyzeData\Config as the output destination folder and click the [OK] button.



11. Click the [OK] button.
The response data definition file "LoggingFlow01_Edge Application Diagnosis (MQTT)_Outputdata.json" is created.

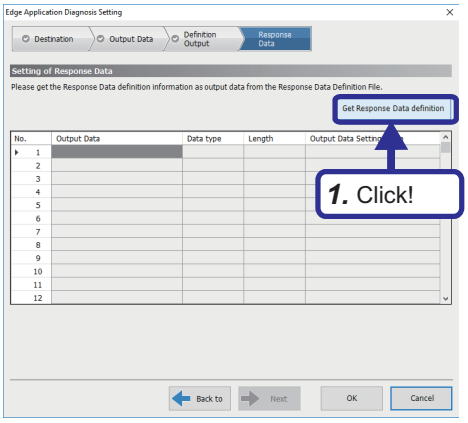


12. Click the [Close] button.

Data diagnosis flow setting (reading a response data definition file)

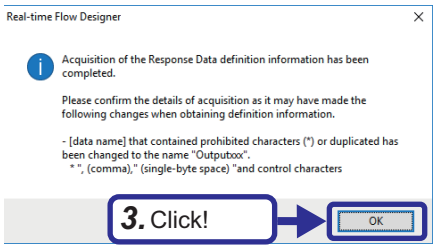
Read a response data definition file with Real-time Flow Designer.

Operating procedure

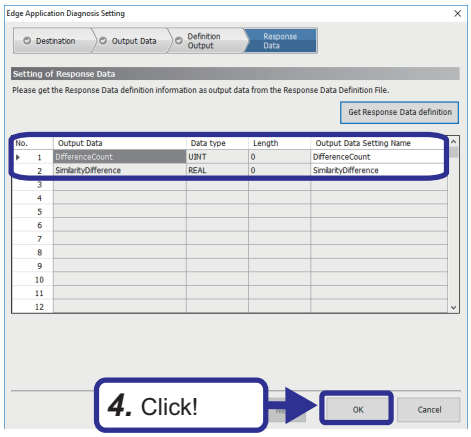


1. Click the [Get Response Data definition] button of [Response Data] tab in the edge application diagnosis setting.

2. Select the response data definition file (LoggingFlow01_Edge Application Diagnosis (MQTT)_Outputdata.json) stored in the folder C:\SimilarWaveData\AnalyzeData\Config.



3. Click the [OK] button.

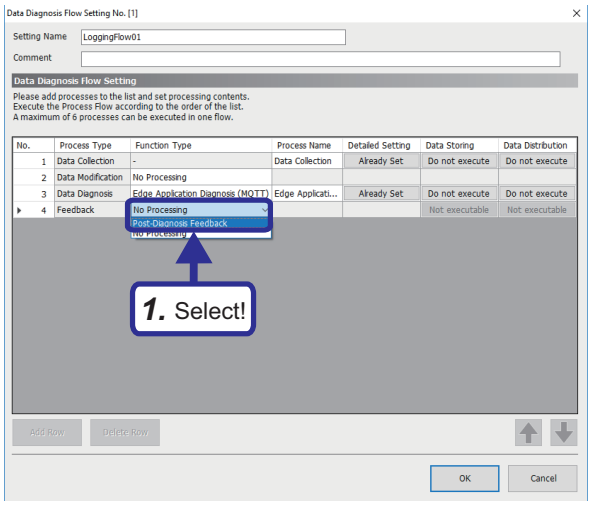


4. When the response data definition file has been read successfully, the output data will be displayed. Click the [OK] button.

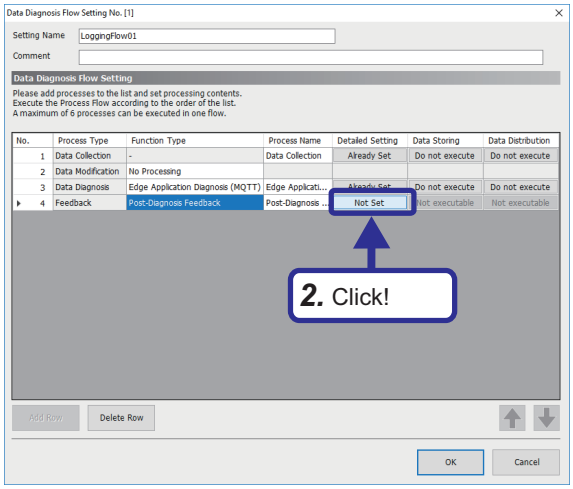
Feedback setting

The feedback from Similar Waveform Recognition Tool is published to Real-time Flow Manager via the MQTT broker. Configure the setting of the feedback to be performed based on the result of the data diagnosis process with Real-time Flow Designer.

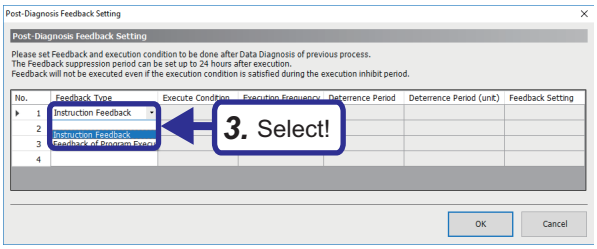
Operating procedure



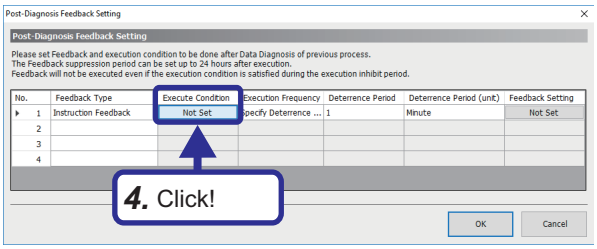
1. In the "Data Diagnosis Flow Setting" window of Real-time Flow Designer, select "Post-Diagnosis Feedback" for "Function Type" of feedback.



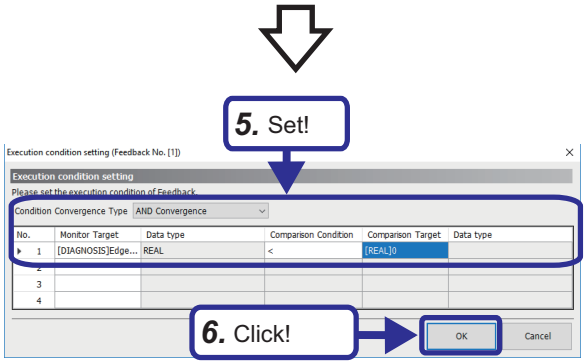
2. Click "Not Set" in "Detailed Setting".



3. In the post-diagnosis feedback setting window, select "Instruction Feedback" for "Feedback Type".



4. Click "Not Set" in "Execute Condition".

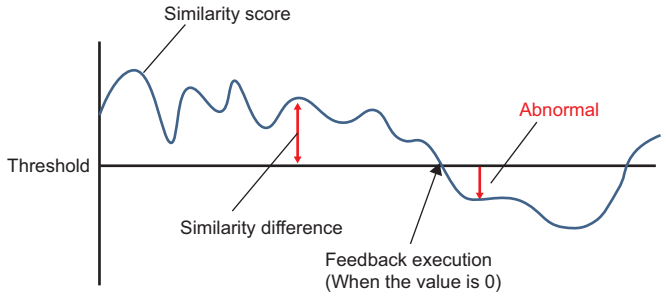


5. Set "Execution condition setting" as follows.
[Setting details]
Condition Convergence Type: AND Convergence
Monitor Target: Data diagnosis result ⇨ Edge application diagnosis (MQTT) ⇨ Similarity difference
Comparison Condition: <
Comparison Target: Constant ⇨ [REAL]
Enter 0 as a real number value.

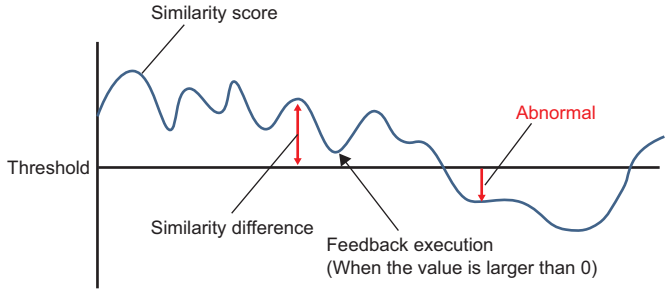
6. Click the [OK] button.

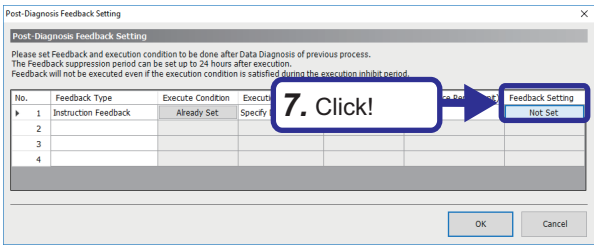
Point

In this setting, the execution condition is met when the similarity score is lower than the similarity score threshold (diagnosis result is different).

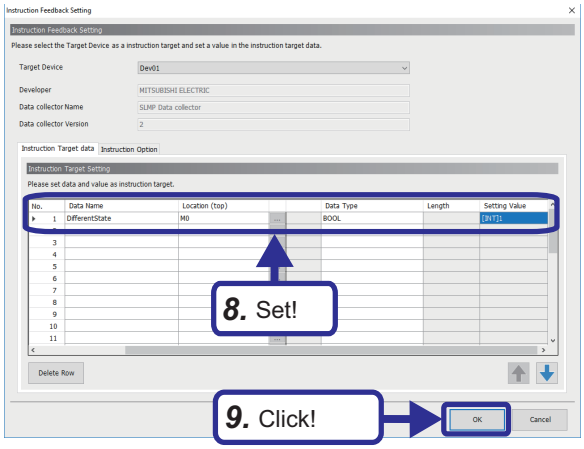


When a value larger than 0 is entered as the real number value to be compared, feedback is executed before the similarity score reaches the similarity score threshold.



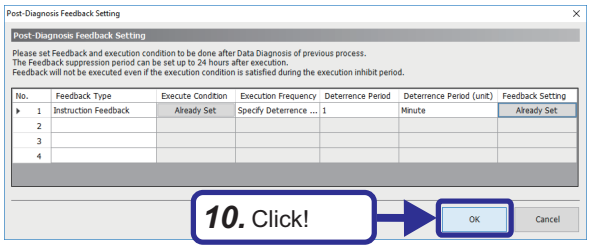


7. Click "Not Set" in "Feedback Setting".

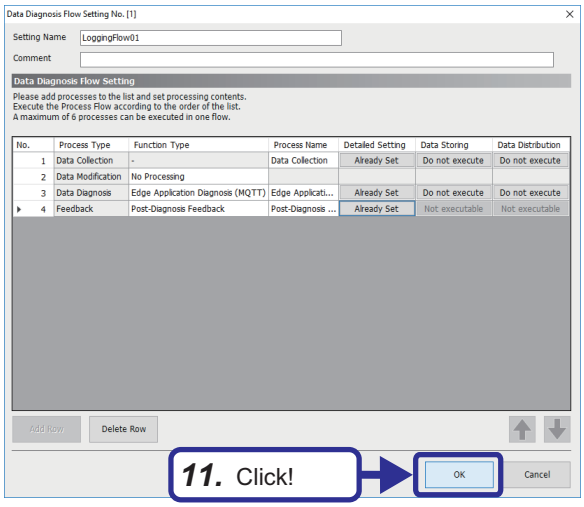


8. When the "Instruction Feedback Setting" window is displayed, configure the instruction target as follows.
[Setting details]
Data Name: DifferentState
Location (top): M0
Data Type: BOOL
Setting Value: Constant ⇨ [INT]
Enter 1 as an integer value.

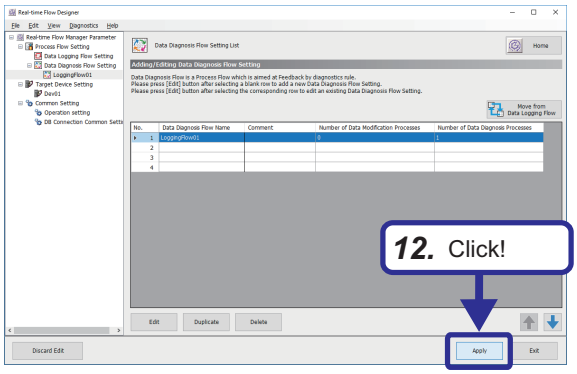
9. Click the [OK] button.



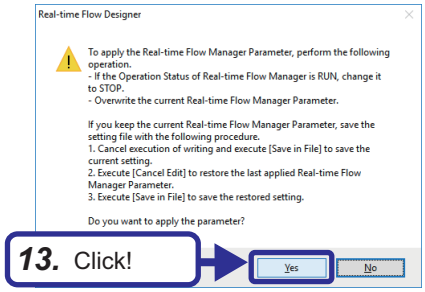
10. Click the [OK] button.



11. Click the [OK] button.



12. Click the [Apply] button.

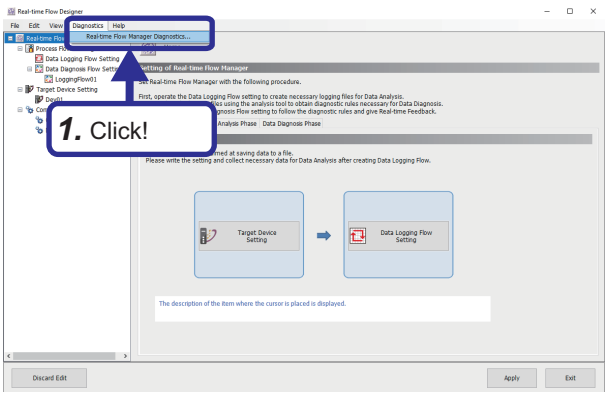


13. When the caution dialog shown on the left is displayed, click the [Yes] button.

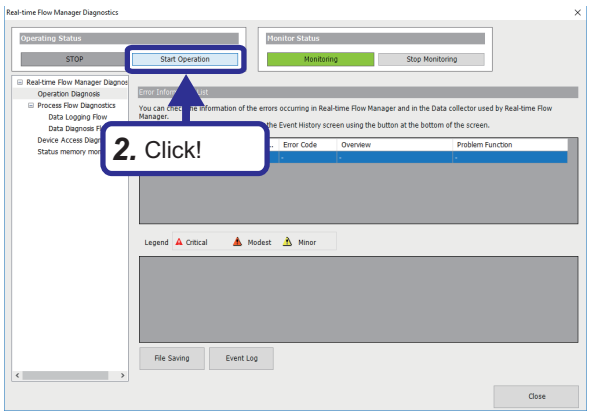
Executing data diagnosis

Execute the data diagnosis flow with the settings configured in Real-time Flow Designer.

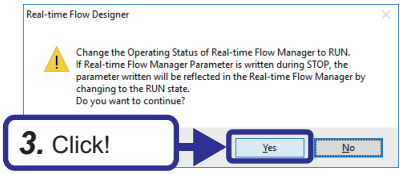
Operating procedure



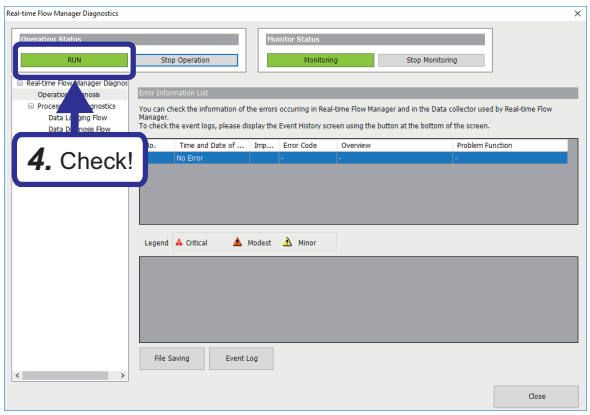
1. Click [Diagnostics] ⇨ [Real-time Flow Manager Diagnostics...] from the menu of Real-time Flow Designer.



2. Click the [Start Operation] button.



3. Click the [Yes] button.

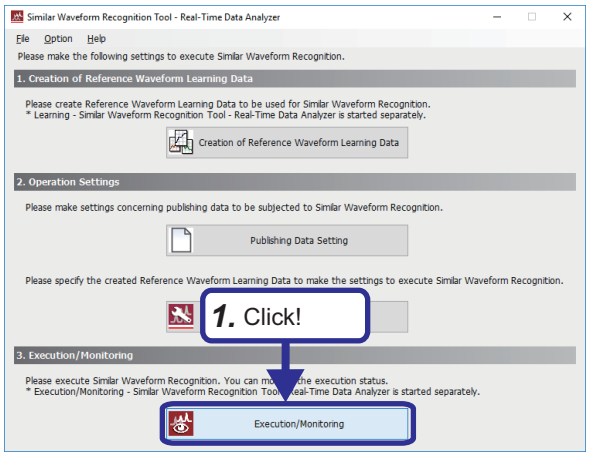


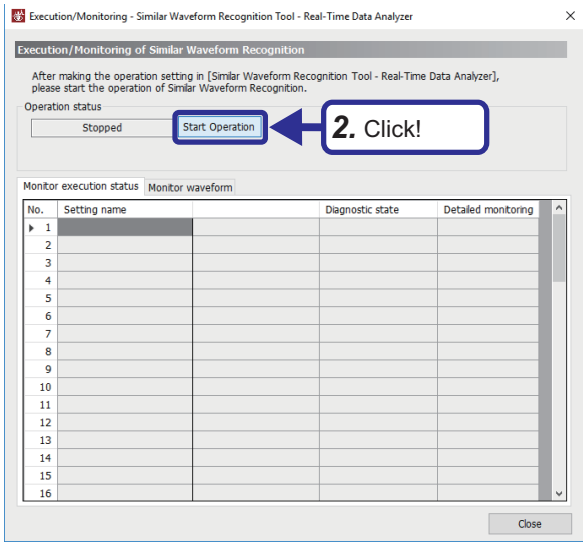
4. Check that "Operating Status" is set to RUN.

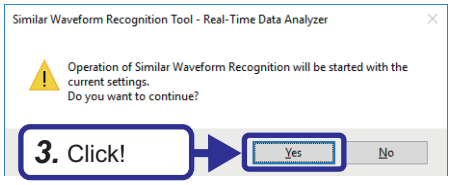
Similar waveform recognition execution

Execute Edgecross and Similar Waveform Recognition Tool and perform monitoring.
Similar waveform recognition receives data published from Edgecross through an MQTT broker and performs similarity diagnosis.

Operating procedure



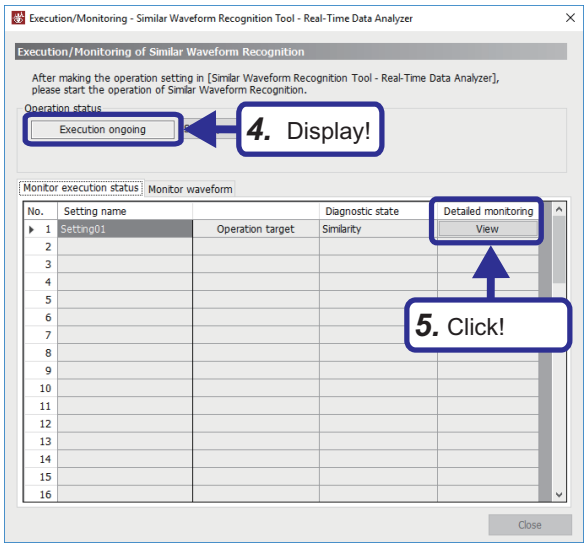


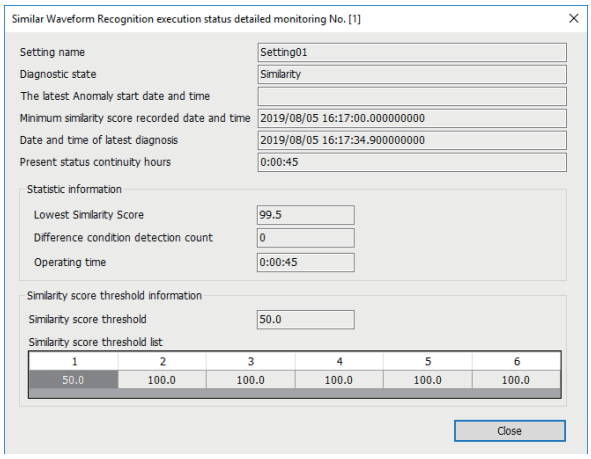


1. Click the [Execution/Monitoring] button of Similar Waveform Recognition Tool.

2. Click the [Start Operation] button.

3. Click the [Yes] button.





4. The operation status in the "Execution/Monitoring" window is displayed as "Execution ongoing".

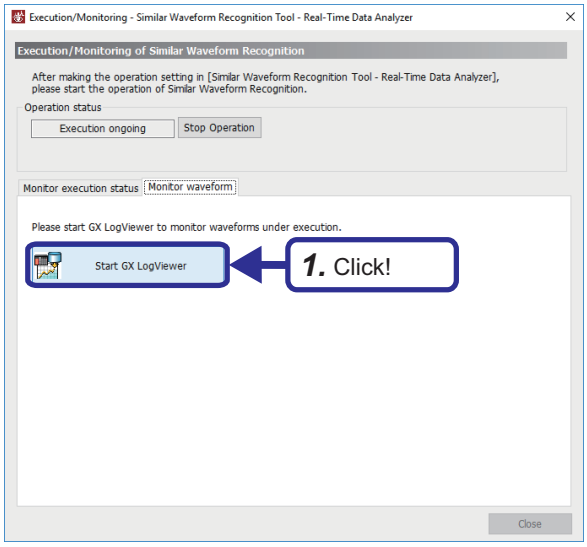
5. Click "View" in "Detailed monitoring".

6. The "Similar Waveform Recognition execution status detailed monitoring" window is displayed.
The execution status of the similarity diagnosis in progress can be checked.

Diagnosis with waveform monitor

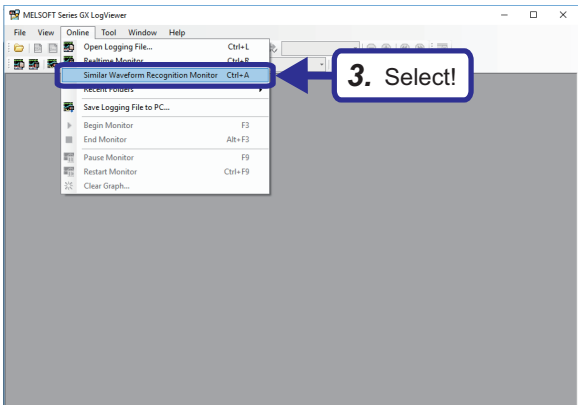
Display the waveform monitor with GX LogViewer.

Operating procedure

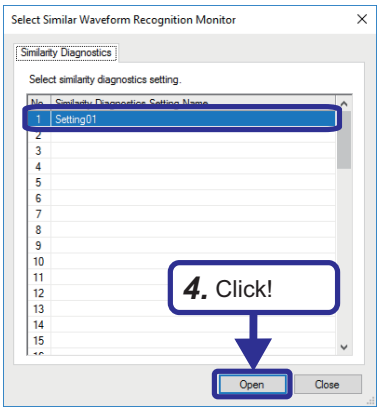


1. Click the [Start GX LogViewer] button in the "Monitor waveform" tab of the "Execution/Monitoring" window.

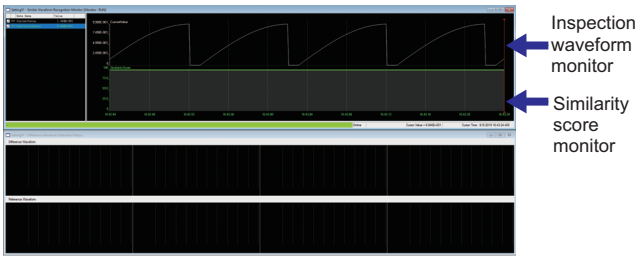
2. When GX LogViewer is started and the assistant window is displayed, click the [Close] button.



3. Select [Online] ⇨ [Similar Waveform Recognition Monitor] from the menu of GX LogViewer.

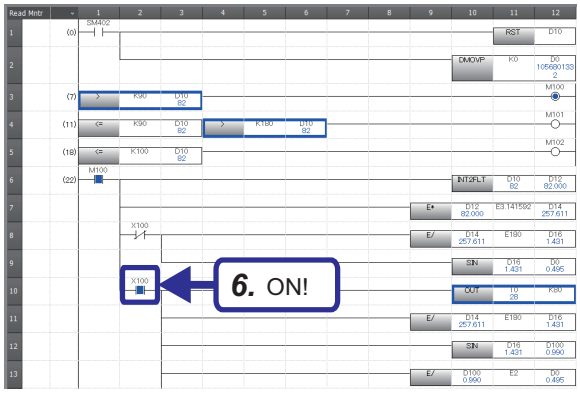


4. In the "Select Similar Waveform Recognition Monitor" window, select the name of the diagnosis to be monitored and click the [Open] button.

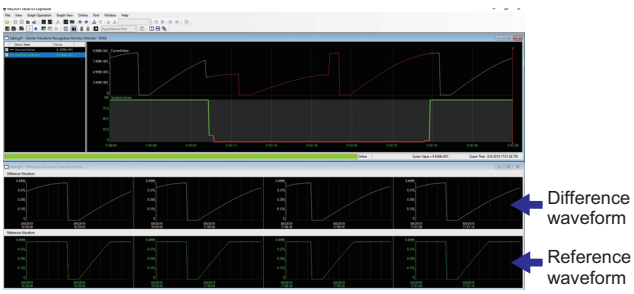


5. The "Similar Waveform Recognition Monitor" window is displayed.
The waveform shown on the left is obtained by adjusting the upper and lower limits of the inspection waveform and the similarity score.
☞ Page 66 Adjusting the upper/lower limits

Item	Description
Inspection waveform monitor	The input inspection waveform is displayed in real time.
Similarity score monitor	The diagnosis result similarity score is displayed in real time.



6. Turn on "X100" in the ladder program and generate an abnormal current value.



7. Check that the abnormal waveform is displayed in the "Similar Waveform Recognition Monitor" window.

Point

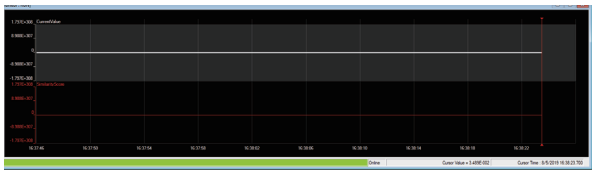
When "X100" is turned on, an abnormal current value is generated for approximately five seconds, and then a normal current value is automatically generated. To generate an abnormal current value again, turn on "X100" again.

Item	Description
Difference waveform	The waveform diagnosed as being different from the reference waveform is displayed in unit waveform width. Up to four difference waveforms are displayed. After that, the oldest one is deleted.
Reference waveform	A snapshot (unit waveform width) of the reference waveform which is the most similar to the displayed difference waveform is displayed.

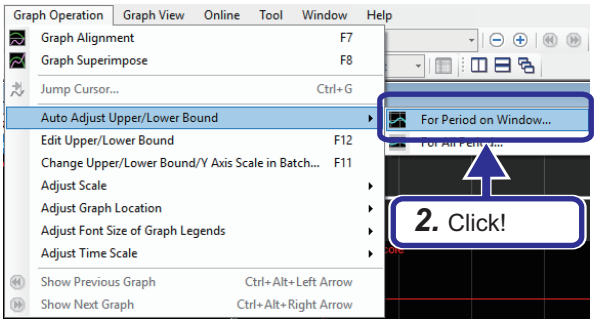
Adjusting the upper/lower limits

When the "Similar Waveform Recognition Monitor" window is displayed, it may be difficult to check the changes of the waveform with the default upper and lower limits of the graph.
In that case, adjust the upper and lower limits of the graph with the following procedure.

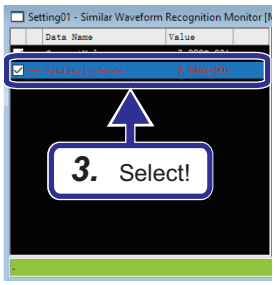
Operating procedure



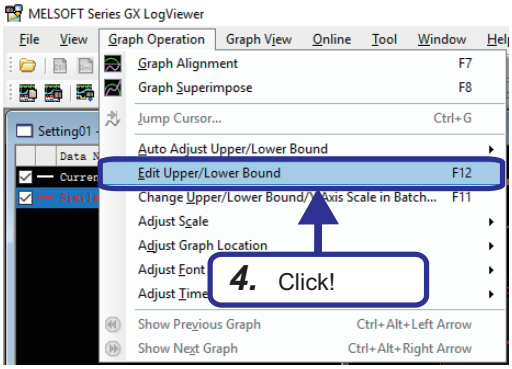
1. The window with the default upper/lower limit of the graph.



2. Click [Graph Operation] ⇨ [Auto Adjust Upper/Lower Bound] ⇨ [For Period on Window] from the menu.

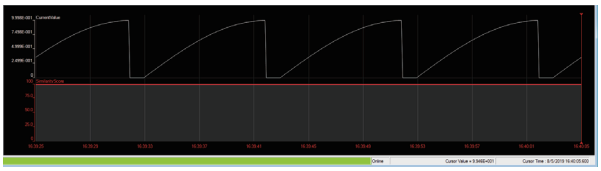


3. Select "SimilarityScore".



4. Click [Graph Operation] ⇨ [Edit Upper/Lower Bound] from the menu.

5. Set the upper and lower limits as follows.
[Setting details]
Upper limit: 100
Lower limit: 0

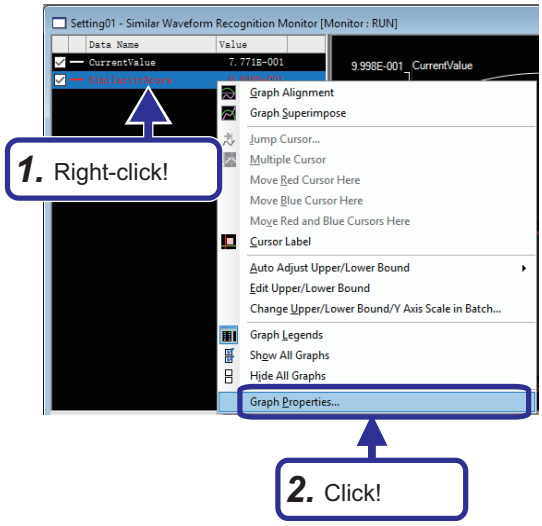


6. The window shown on the left is obtained after adjustment.
The values are automatically adjusted according to the set upper limit and lower limit.

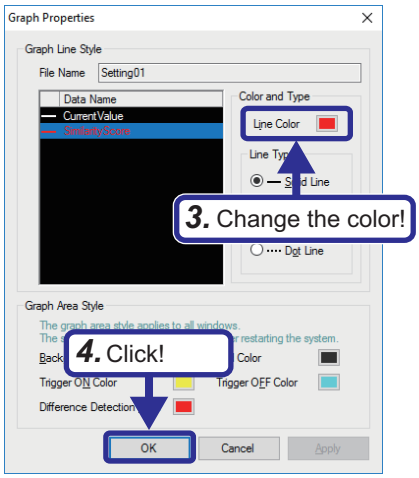
Changing the line color

When the "Similar Waveform Recognition Monitor" window is displayed, it may be difficult to distinguish the abnormal waveform with the default line color of the similarity score monitor.
In that case, change the line color with the following procedure.

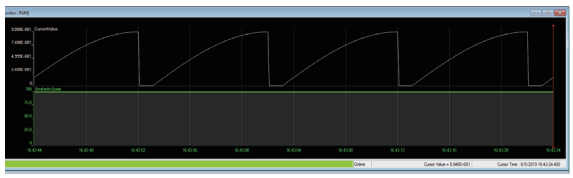
Operating procedure



1. Right-click "SimilarityScore" in the similar waveform recognition monitor.
2. Click [Graph Properties...].



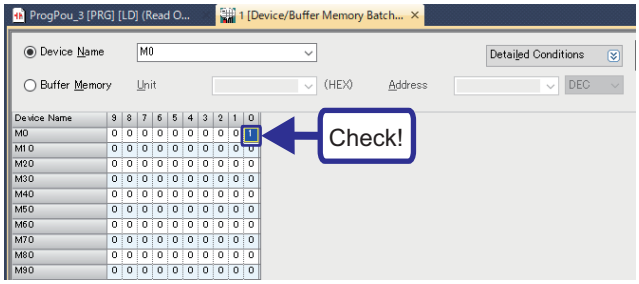
3. Change the line color.
4. Click the [OK] button.



5. Click [Graph Operation] ⇨ [Auto Adjust Upper/Lower Bound] ⇨ [For Period on Window] from the menu.

Checking the feedback result

Detect an abnormality with the similar waveform recognition and check that the feedback set in Real-time Flow Designer is executed correctly.



Check that M0 is turned on with the device/buffer memory batch monitor of GX Works3.

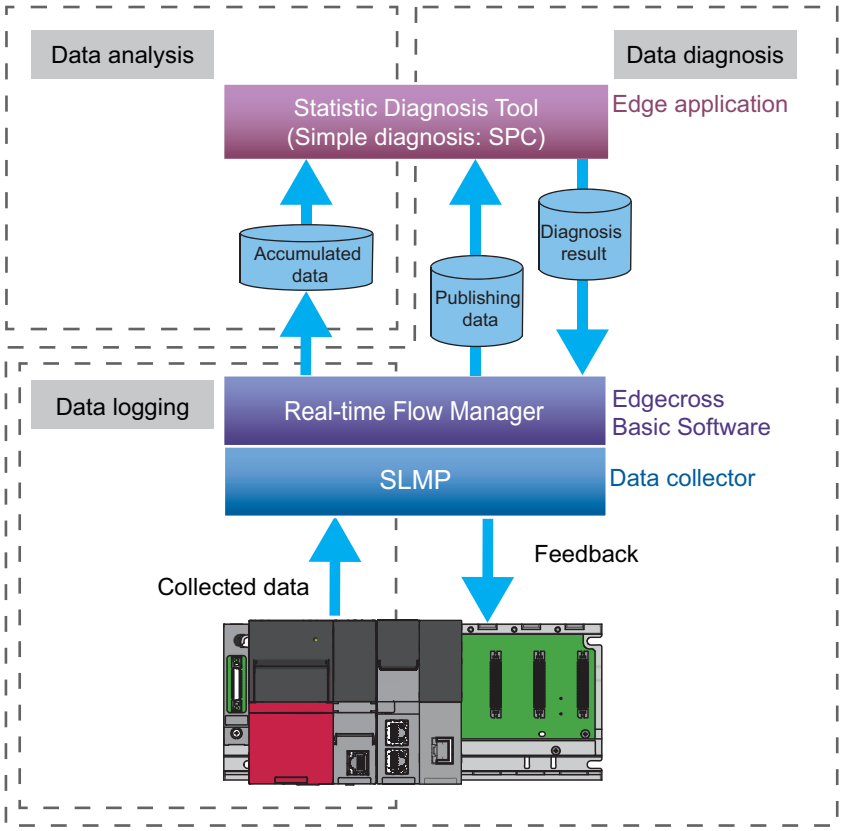
Point

- Once the device has been turned on, it will not turn off automatically even if the detection status returns to normal. Therefore, turn it off manually if necessary.
- At the production site, the device can be assigned to an alarm or lamp to notify of an error and be used for preventive maintenance.

5

6 EXERCISE 2 ANALYSIS AND DIAGNOSIS WITH SPC

SPC perform data logging using the SLMP data collector from the CPU module and creates SPC rules diagnosis rules. Data input in real time is diagnosed according to SPC rules, and feedback is executed when an abnormality is detected.
"Page 17 Operation overview" describes that the operation is divided into three phases of data logging, data analysis, and data diagnosis. Each phase is data communication between devices and applications as shown below.



6.1 Overview of Real-time Statistic Diagnosis Tool

Real-time Statistic Diagnosis Tool is an edge application that analyzes and diagnoses CSV file data output by Real-time Flow Manager using statistical methods and multivariate analysis.

Real-time Statistic Diagnosis Tool can mainly perform the following operations.

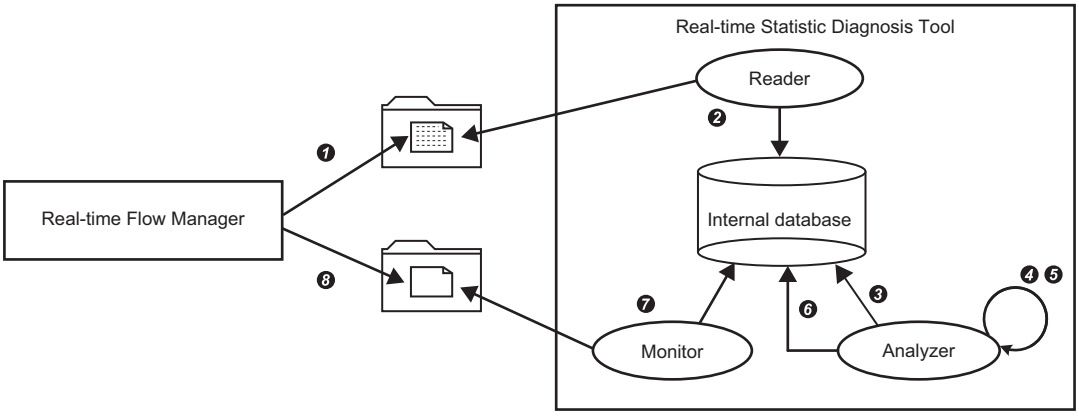
- Read a CSV file, analyze the data in the CSV file, and create diagnosis rules.
- Perform diagnosis based on the set rule, and when an abnormality is detected, notify the abnormality by outputting the response data file or displaying a pop-up on the screen.

Software components

Real-time Statistic Diagnosis Tool consists of the following software.

Software	Description
Reader	Reads a CSV file output to a specified folder and registers it to the internal database.
Analyzer	Analyzes and diagnoses the data in the internal database registered by Reader.
Monitor	Diagnoses whether Analyzer has detected an abnormality. After a diagnosis, the detection result is displayed on the screen and a response data file is output.

The operation flow of each software when working with Real-time Flow Manager is as follows.



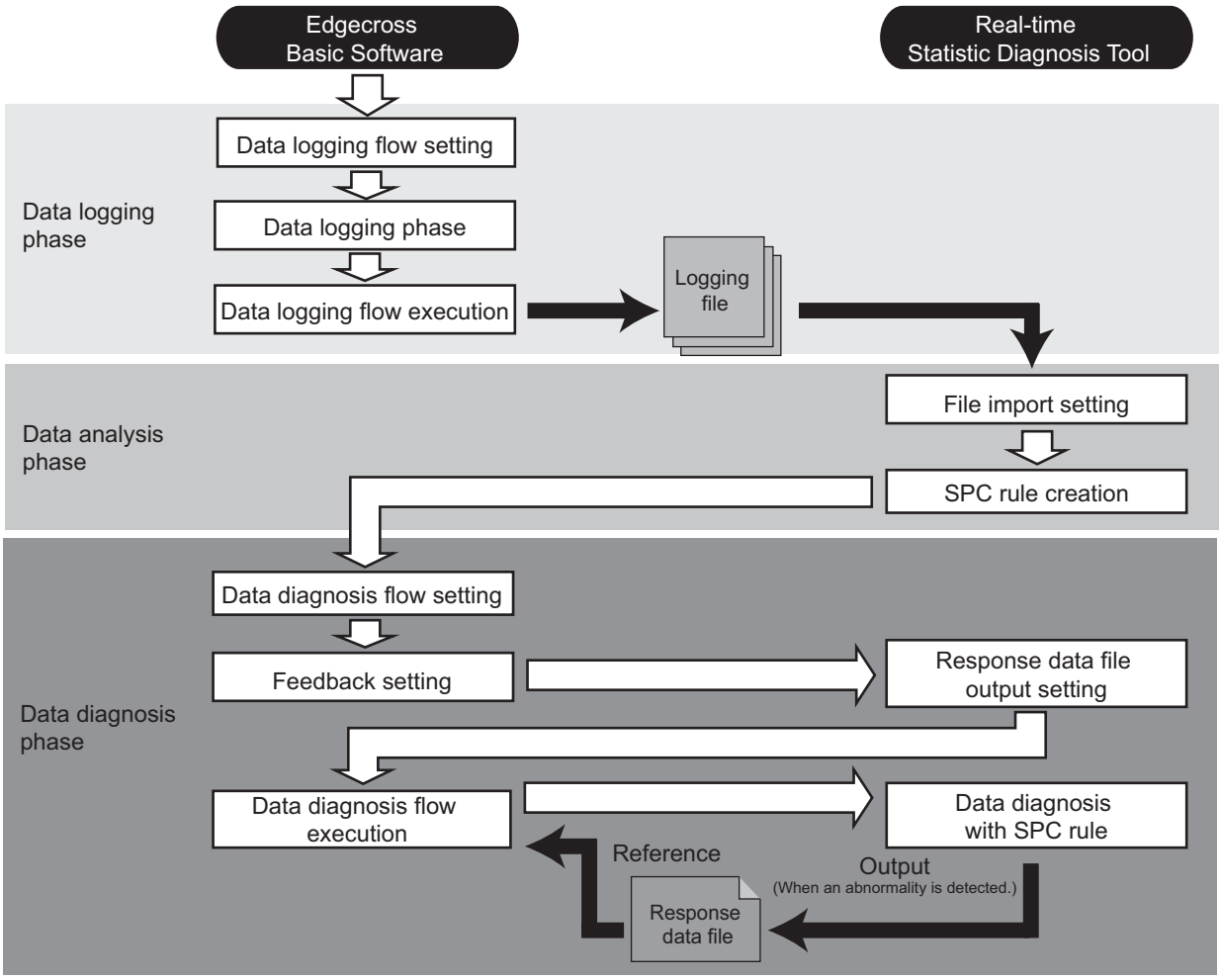
❶ Real-time Flow Manager outputs the data collected in a production site to a specified folder as a CSV file.
❷ Reader reads the CSV file and registers it to the internal database of Real-time Statistic Diagnosis Tool.
❸ Analyzer references the data registered in the internal database.
❹ A user analyzes the data offline and set collection data to be diagnosed and diagnosis rules by using Analyzer.
❺ Analyzer starts a diagnosis according to the set diagnosis rule.
❻ When an abnormality is detected, Analyzer registers the abnormality to the internal database.
❼ Monitor monitors whether Analyzer has registered an abnormality to the internal database, then outputs a response data file to a specified folder when the registration of an abnormality is detected.
❽ Real-time Flow Manager checks the output of a response data file and executes feedback when the output is detected.

6.2 SPC

The data in the CSV file read by Reader is evaluated with SPC rules and diagnosed by calculating the statistic for each variable in each section.
The SPC (Statistical Process Control) is a method to visually diagnose the changes in the statistics of production data using the abnormality judgment rule (SPC rule) defined by JIS. SPC can be used to detect signs of abnormalities in the manufacturing process before they occur.

Setting procedure of real-time statistic diagnosis (SPC)

SPC can be configured in the following procedure.



Item	Description	Setting method
Target device setting	Add an SLMP data collector and configure the settings for connecting the programmable controller.	☞ Page 74 Target device setting
Data logging flow setting	Set the device, collection data type, collection cycle, and data save setting of the data collected from the programmable controller.*1	☞ Page 74 Data logging flow setting
Data logging flow execution	Collect the data from CSV files and create the logging file for SPC diagnosis.	☞ Page 81 Data logging execution
File import setting	Import the logging data for SPC diagnosis with the Reader function of real-time statistic diagnosis for use by Analyzer.	☞ Page 83 Importing files
SPC rule creation	Create the rules for SPC diagnosis with Analyzer.	☞ Page 88 SPC rule creation
Data diagnosis flow setting	Send the waveform data received from the programmable controller to Real-time Statistic Diagnosis Tool and configure the setting for receiving the real-time statistic diagnosis result.*1	☞ Page 93 Data diagnosis flow setting
Feedback setting	Configure the setting to feedback the SPC diagnosis result to the programmable controller.	☞ Page 98 Feedback setting

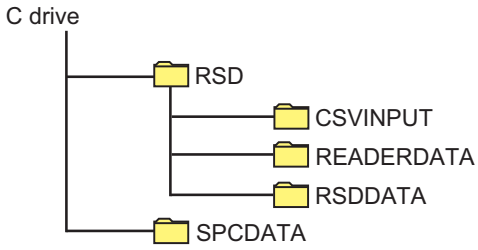
Item	Description	Setting method
Response data file output setting	Configure the setting to output the response data file with the Monitor function of real-time statistic diagnosis.	☞ Page 101 Response data file output setting
Data diagnosis flow execution	Detect the output of the response data file and check that the feedback set in Real-time Flow Designer is executed correctly.	☞ Page 103 Executing data diagnosis
Executing data diagnosis with SPC rule	Execute data diagnosis according to the SPC rule.	☞ Page 104 Data diagnosis with SPC rule

*1 The following shows the number of processes that can be used in each process.

Flow type	Data collection	Data modification	Data diagnosis	Feedback execution
Data logging flow	1 (Required)	3	—	—
Data diagnosis flow	1 (Required)	3	1 (Required)	1 (Required)

6.3 Data Logging

Data logging is performed from the CPU module using the SLMP data collector and the SPC rules are created as diagnosis rules.
Create new folders in advance with the following folder structure.



Target device setting

Select the data collector to be used and set the target device.
For the operating procedure, refer to the following.
☞ Page 31 Target device setting

Point

Since the setting is the same as the "Target Device Setting" that is set in the similar waveform recognition, it is not required to be added or changed if the setting is not deleted.

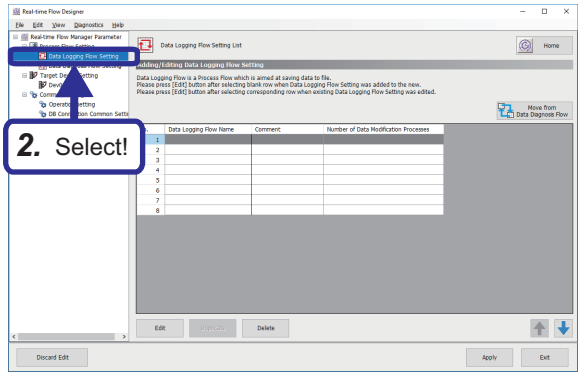
Data logging flow setting

Collect data from the target device and save it as a CSV file.

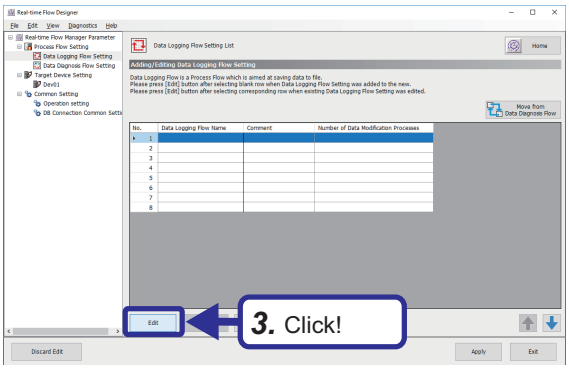
Point

Before configuring the setting, save the diagnosis flow created in Exercise 1 and delete it from Real-time Flow Designer.
For how to save and delete a setting file, refer to the following.
☞ Page 107 Saving/Deleting/Reading a Setting File

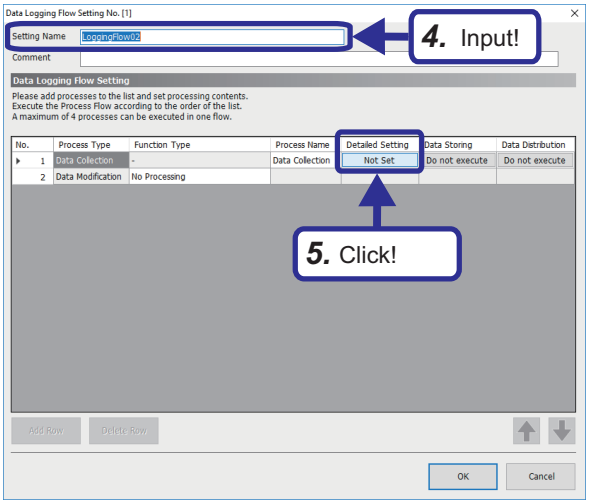
Operating procedure



1. Open the SPC project "school_SPC.gx3" and write it to the programmable controller.
   For the operating procedure, refer to the following.
   ☞ Page 22 Writing program to the CPU module
2. Select "Data Logging Flow Setting" in the edit item tree.

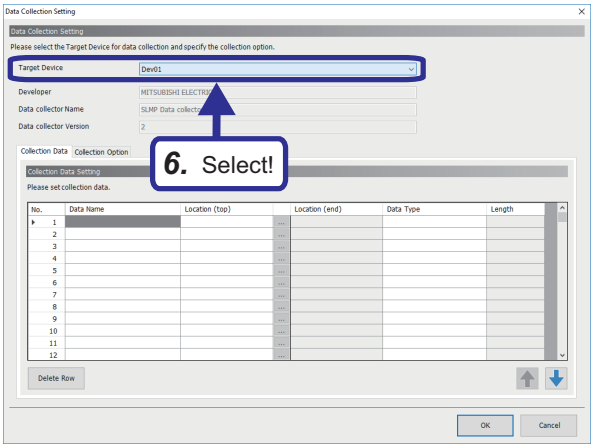


3. Select a blank row in the data logging flow setting list and click the [Edit] button.

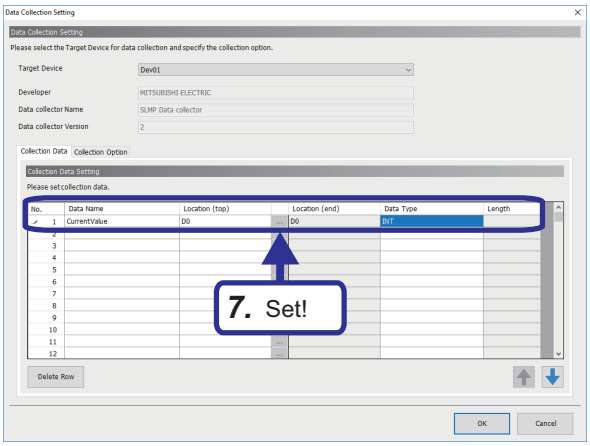


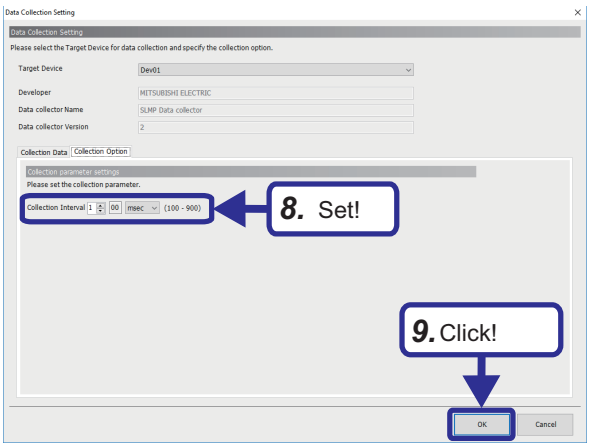
4. When the data logging flow window is displayed, enter the following.
[Setting details]
Setting Name: LoggingFlow02

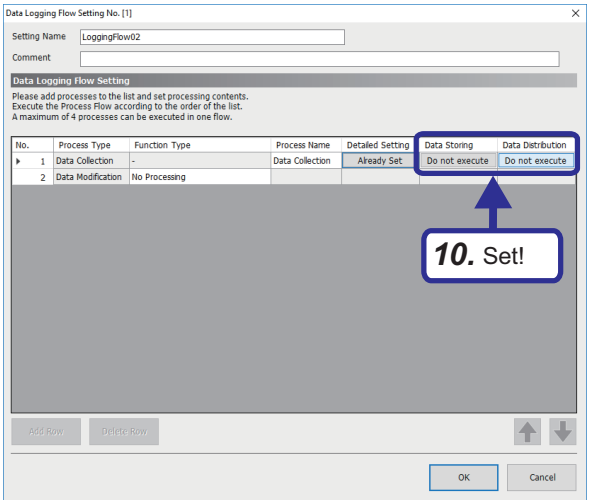
5. Click "Not Set" in the detailed setting.



6. Select the target device of the SLMP data collector.
[Setting details]
Target Device: Dev01







7. Select the "Collection Data" tab and set the data name, device address, and data type of the data to be collected as follows.
[Setting details]
Data Name: CurrentValue
Location (top): D0
Data Type: INT

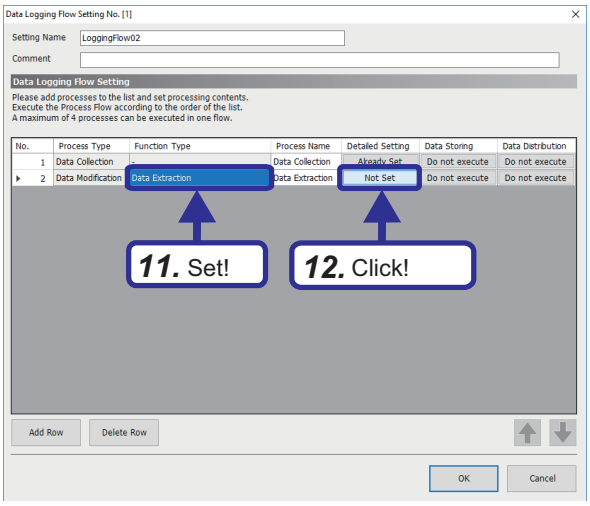
8. Select the "Collection Option" tab and set the collection interval as follows.
[Setting details]
Collection Interval: 100 msec

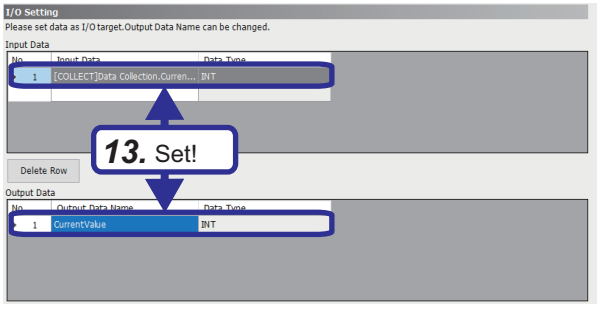
9. Click the [OK] button.

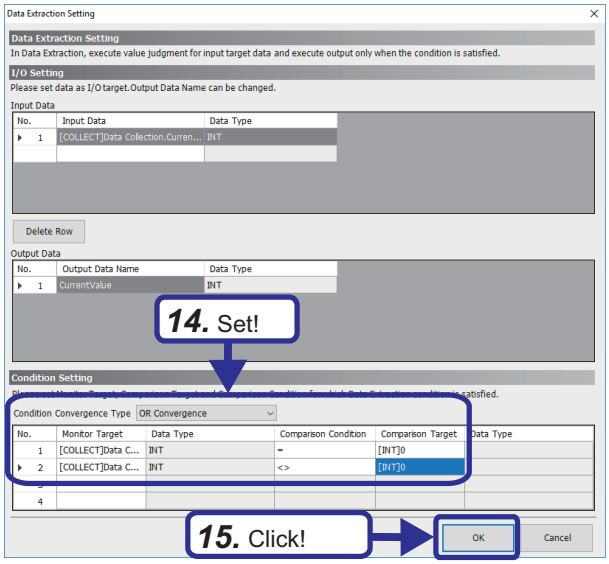
10. Set data storing and data distribution to "Do not execute".

Point

Data storing and data distribution can be executed up to twice in each flow to maintain data that flows between processes.







11. Select "Data Extraction" for "Function Type" of data modification.

12. Click "Not Set" in the detailed setting.

13. Set the I/O setting as follows.

[Setting details]

Input Data: Data collection result ⇨ Data collection ⇨Current value

Output Data: CurrentValue

14. Configure the condition setting as follows.

[Setting details]

Condition Convergence Type: OR Convergence

No.1

Monitor Target: Data collection result ⇨ Data collection ⇨ Current value

Comparison Condition: =

Comparison target: Constant ⇨ [INT]

Enter 0 as an integer value.

No.2

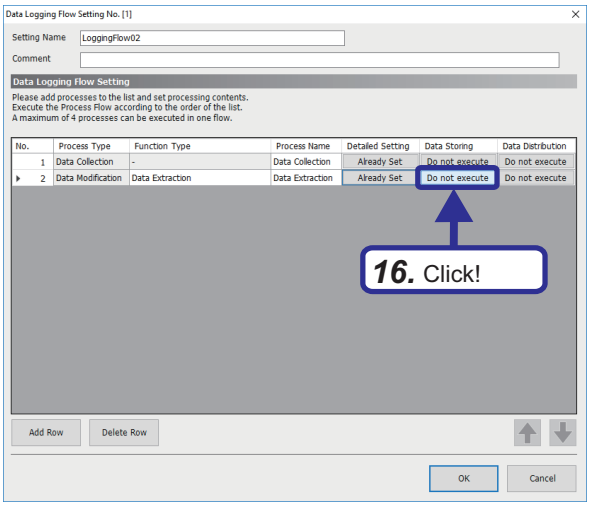
Monitor Target: Data collection result ⇨ Data collection ⇨ Current value

Comparison Condition: ≠

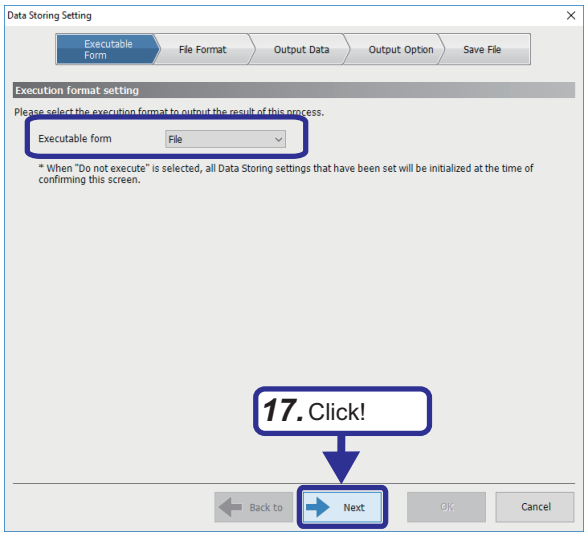
Comparison target: Constant ⇨ [INT]

Enter 0 as an integer value.

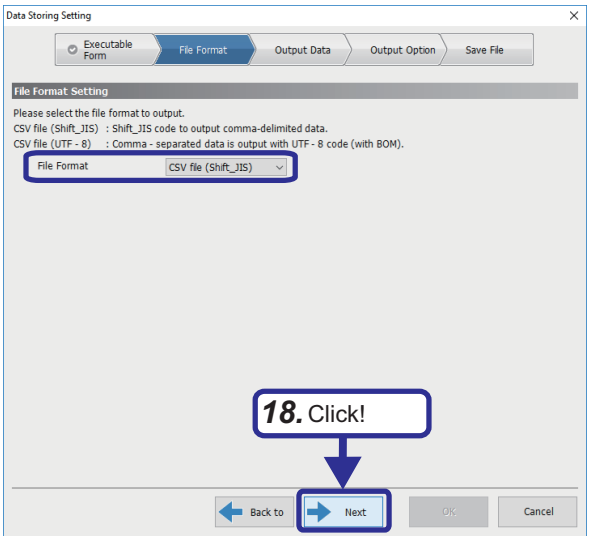
15. Click the [OK] button.



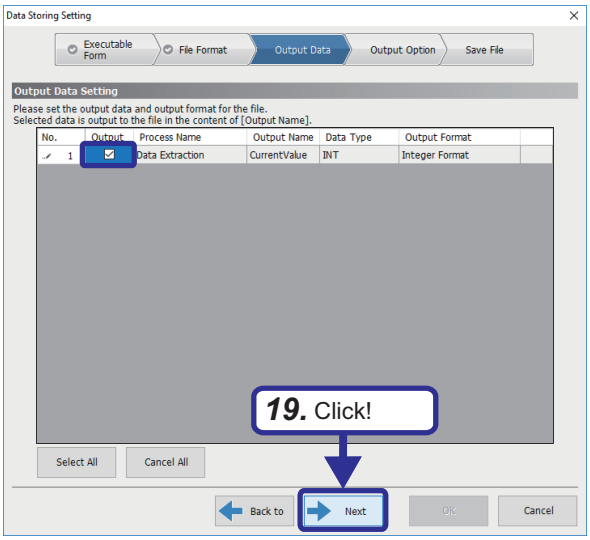
16. Click "Do not execute" in data storing.



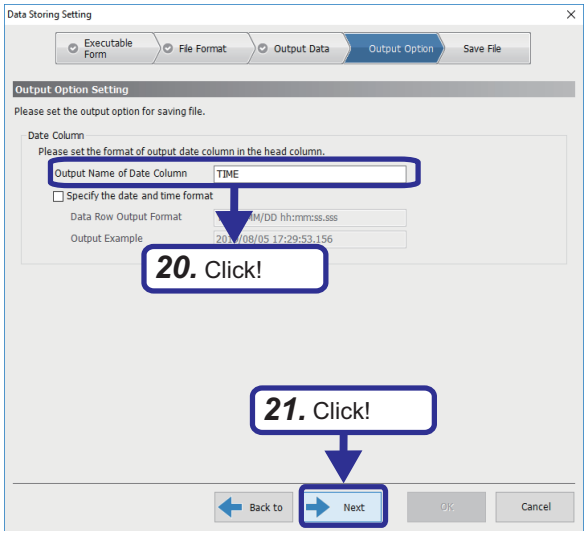
17. Select "File" for the executable form and click the [Next] button.



18. Select "CSV file (Shift_JIS)" for the file format and click the [Next] button.



19. Select the data to be output and click the [Next] button.

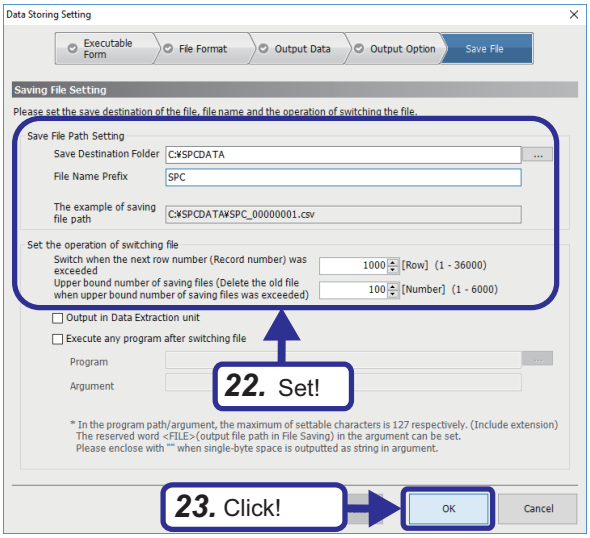


20. Set "Output Option" as follows.
[Setting details]
Output Name of Date Column: TIME

21. Click the [Next] button.

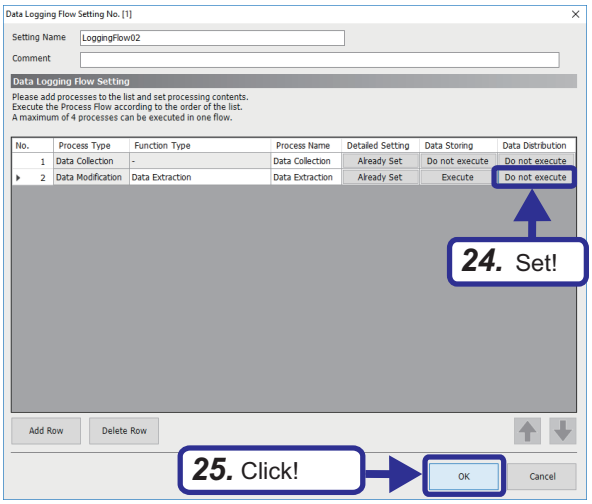
Point

When "Specify the date and time format" is selected, the data format of date column can be changed.



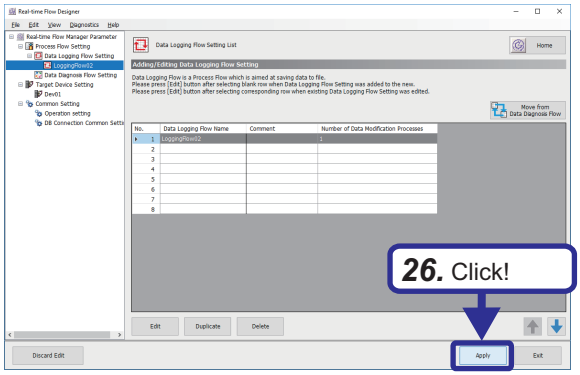
22. Set "Save File" as follows.
[Setting details]
Save Destination Folder: C:\SPCDATA
File Name Prefix: SPC
Switch when the next row number (Record number) was exceeded: 1000
Upper bound number of saving files: 100

23. Click the [OK] button.

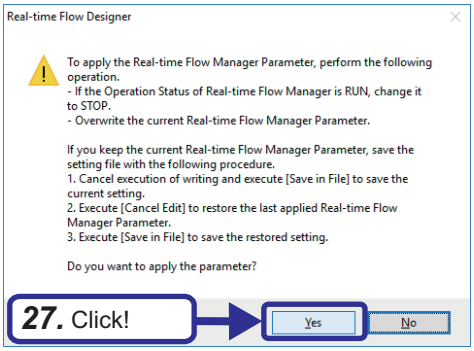


24. Set "Data Distribution" to "Do not execute".

25. Click the [OK] button.



26. Click the [Apply] button.

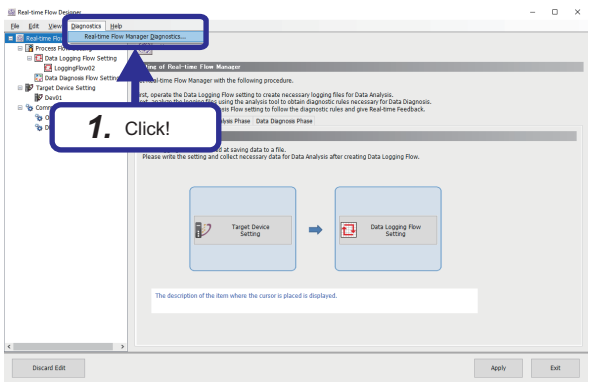


27. Click the [Yes] button.

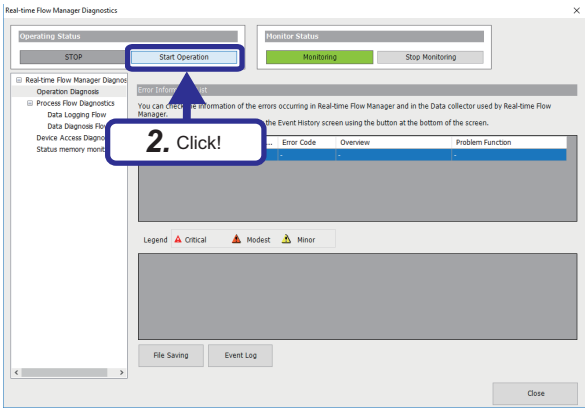
Data logging execution

Execute logging with the settings configured in Real-time Flow Designer.

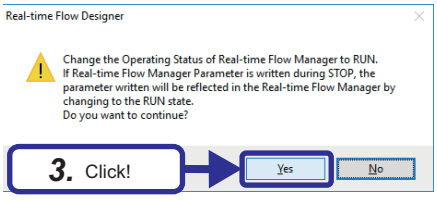
Operating procedure



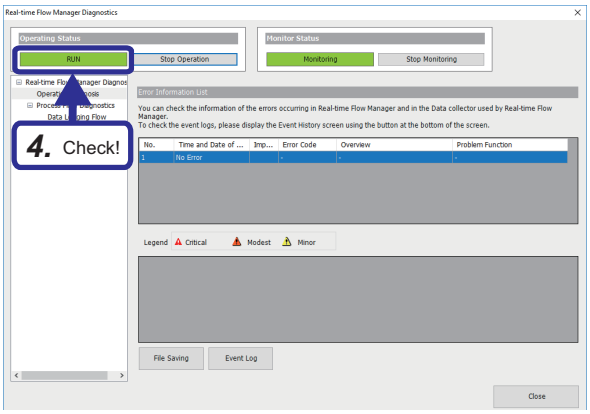
1. Click [Diagnostics] ⇨ [Real-time Flow Manager Diagnostics...] from the menu of Real-time Flow Designer.



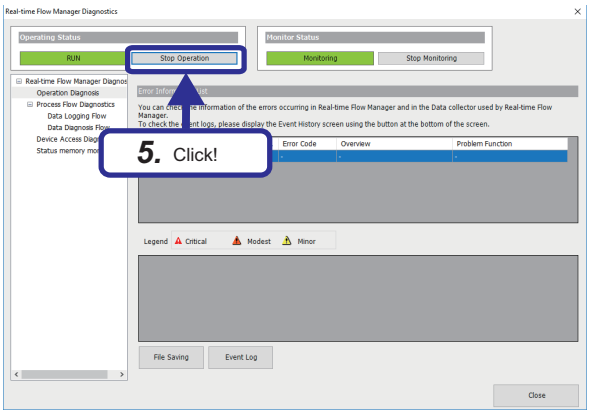
2. Click the [Start Operation] button.



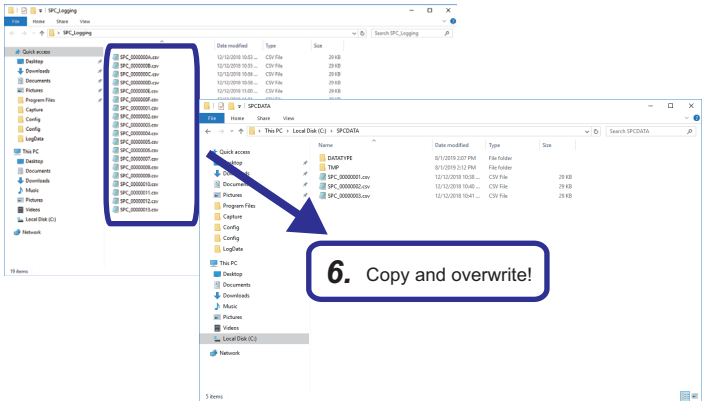
3. Click the [Yes] button.



4. Check that "Operating Status" is set to RUN and that the file is created in the save destination folder set in the data logging flow.



5. When the required number of files has been created, click the [Stop Operation] button in "Operating Status" to stop creating files.



6. In this training, perform analysis and diagnosis using the logging data prepared in advance. Copy the logging file in the SPC_Logging folder to the save destination folder (C:\SPCDATA), and overwrite it.

Point

In the actual operation, determine the number of required files before logging.

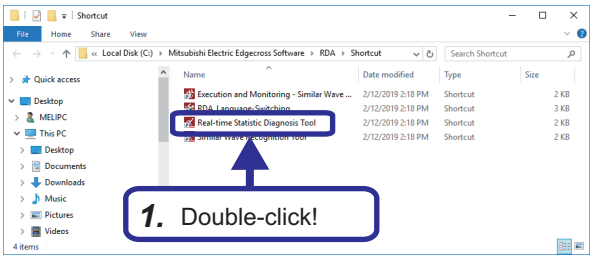
6.4 Data Analysis

With Real-time Statistic Diagnosis Tool, create the diagnosis rule with the CSV file output in the data logging flow of Real-time Flow Manager.

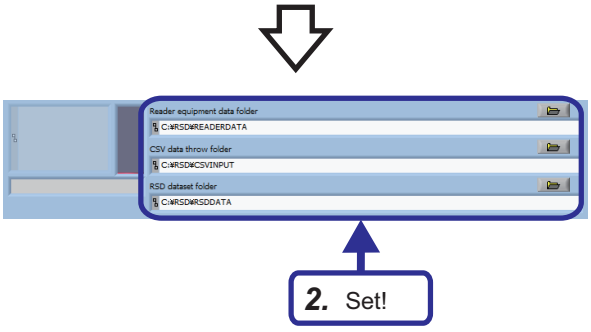
Importing files

Specify the sample CSV file, define the CSV file to be read by Reader (definition of the module), and output the response data definition file.

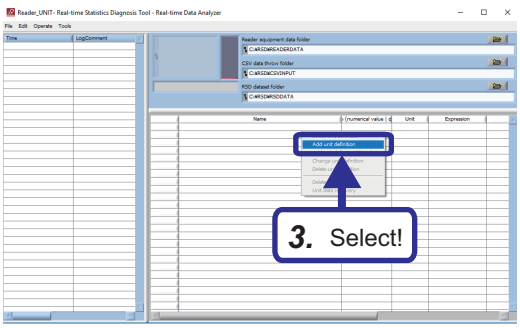
Operating procedure



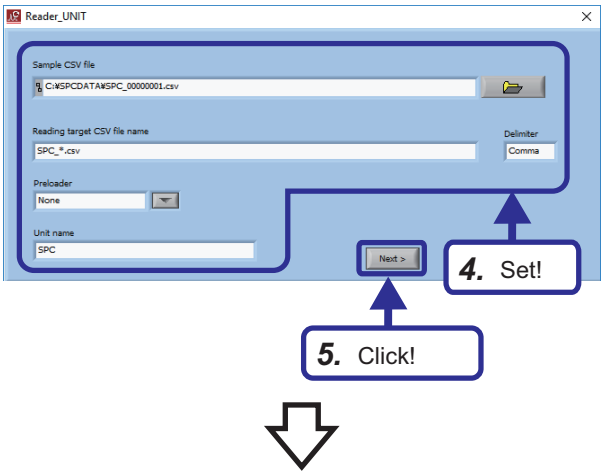
1. From Windows® start ⇨ [Mitsubishi Electric Edgecross Software] ⇨ [Real-time Data Analyzer], double-click [Real-time Statistic Diagnosis Tool].



2. Set each folder of Reader as follows.
[Setting details]
Reader equipment data folder: C:\RSD\READERDATA
CSV data throw folder: C:\RSD\CSVINPUT
RSD dataset folder: C:\RSD\RSDDATA

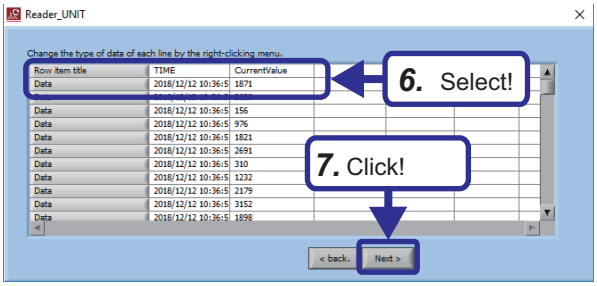


3. In the Reader window, right-click a blank row ⇨ select [Add unit definition].



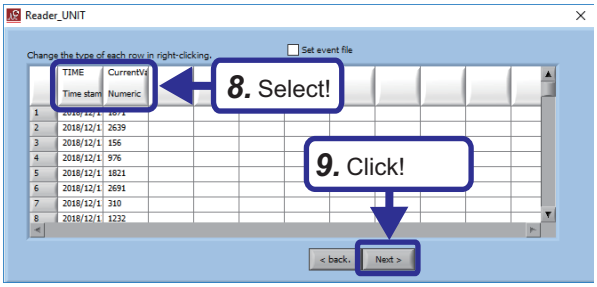
4. Set the unit definition as follows.
[Setting details]
Sample CSV file: C:\SPCDATA\SPC_00000001.csv
Reading target CSV file name: SPC_*.csv
Delimiter: Comma
Preloader: None
Unit name: SPC

5. Click the [Next>] button.



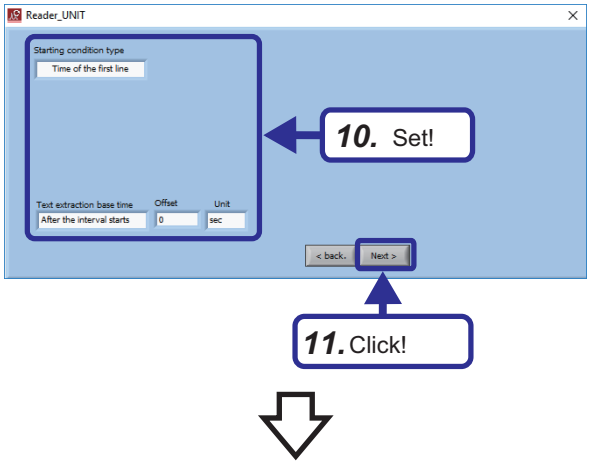
6. Right-click each row and set "Data type" as follows.
[Setting details]
First row: Row item title
Second row: Data

7. Click the [Next>] button.



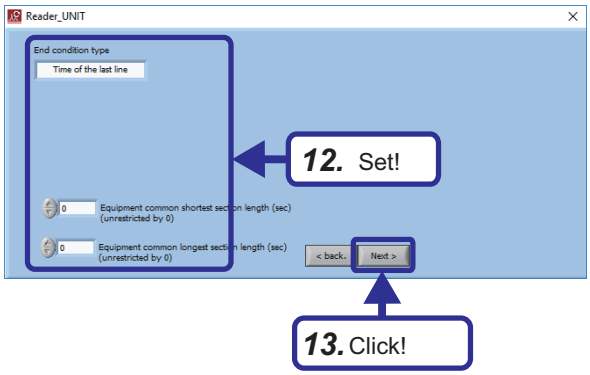
8. Right-click each column item and set "Data type" as follows.
[Setting details]
TIME: Time stamp
CurrentValue: Numeric

9. Click the [Next>] button.



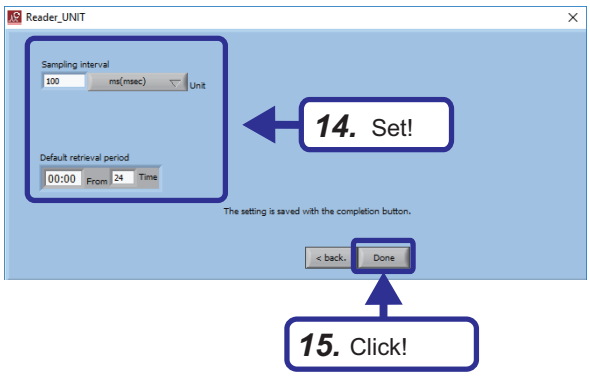
10. Set the start condition of data as follows.
[Setting details]
Starting condition type: Time of the first line
Text extraction base time: After the interval starts
Offset: 0
Unit: sec

11. Click the [Next>] button.



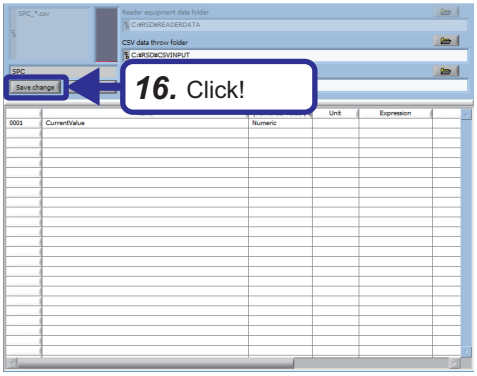
12. Set the end condition as follows.
[Setting details]
End condition type: Time of the last line
Equipment common shortest section length (sec): 0
Equipment common longest section length (sec): 0

13. Click the [Next>] button.

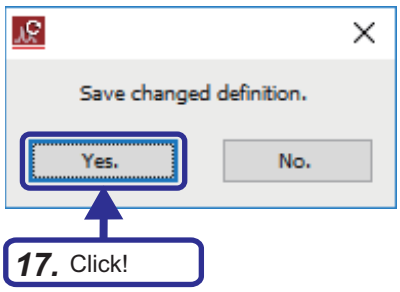


14. Set the sampling interval as follows.
[Setting details]
Sampling interval: 100ms
Default retrieval period: 00:00 From 24 Time

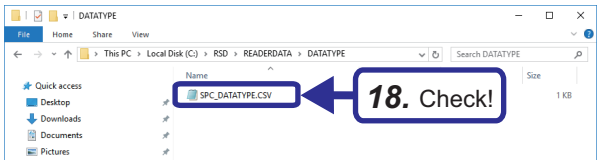
15. Click the [Done] button.



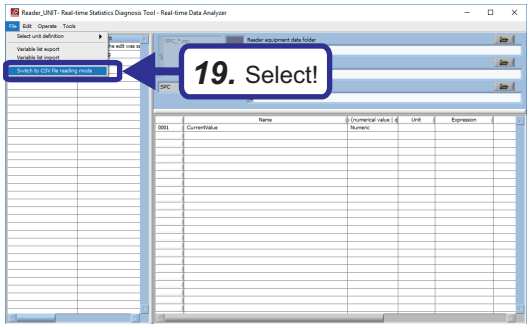
16. Check the setting details and always click the [Save change] button to save the setting details.



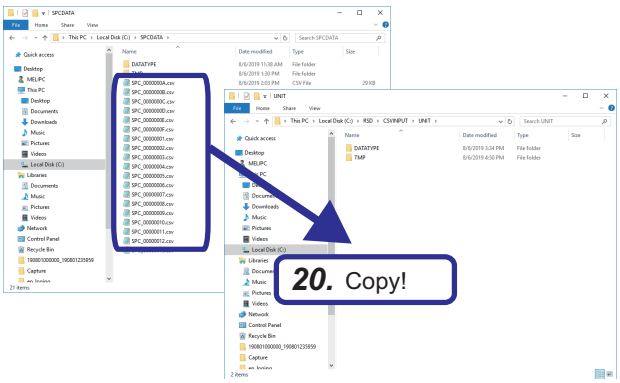
17. Click the [Yes] button.



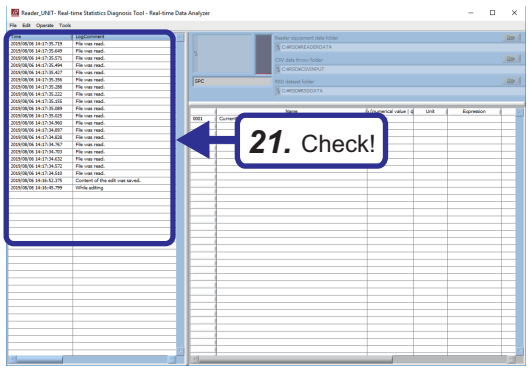
18. The response data definition file "SPC_DATATYPE.CSV" is created in the following folder.
C:\RSD\READERDATA\DATATYPE



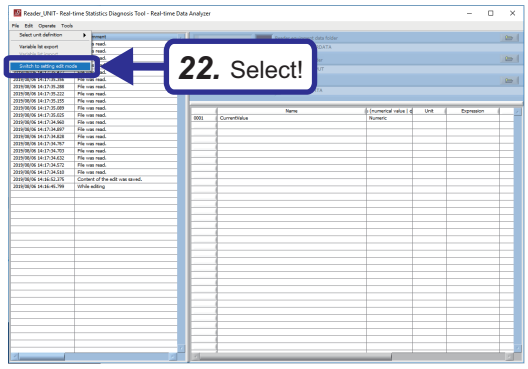
19. Select [File] ⇨ [Switch to CSV file reading mode] from the menu of Reader.
Reader is restarted.



20. Manually copy the data collected by data logging to the following folder.
Copy source: C:\SPCDATA*.csv
Copy destination: C:\RSD\CSVINPUT\UNIT



21. Files are automatically read and log information will be displayed.
Check the LogComment and confirm that the files are read successfully.



22. Select [File] ⇨ [Switch to setting edit mode] from the menu of Reader.
Reader is restarted.

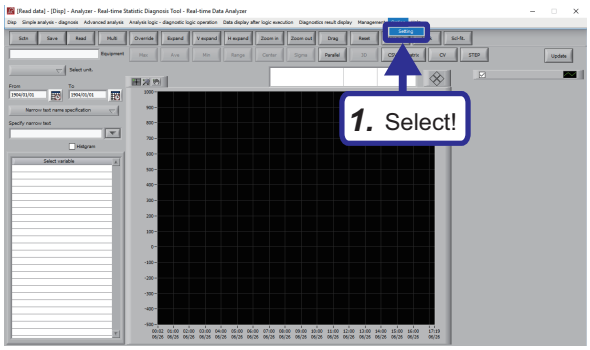
Point

When the file read is not completed successfully, perform the same procedure again for [Delete unit definition] ⇨ [Add unit definition] after "Switch to setting edit mode".

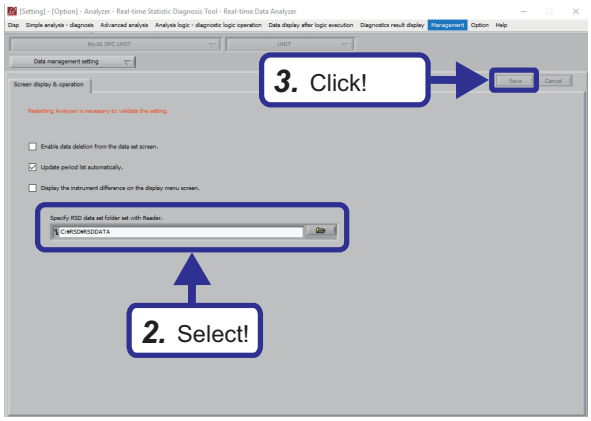
SPC rule creation

Create the SPC rule for SPC diagnosis with Analyzer.

Operating procedure

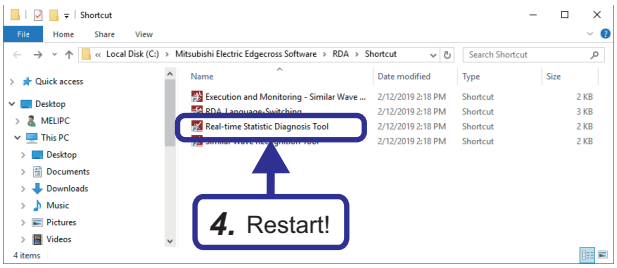


1. Select [Option] ⇨ [Setting] from the menu of Analyzer and display the setting window.

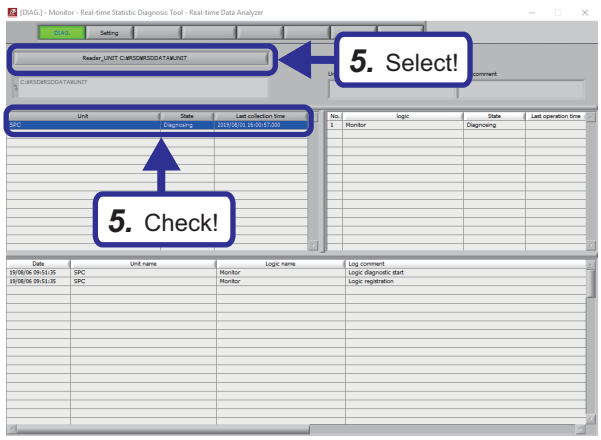


2. Select C:\RSD\RSDDATA for the RSD data set folder set with Reader.

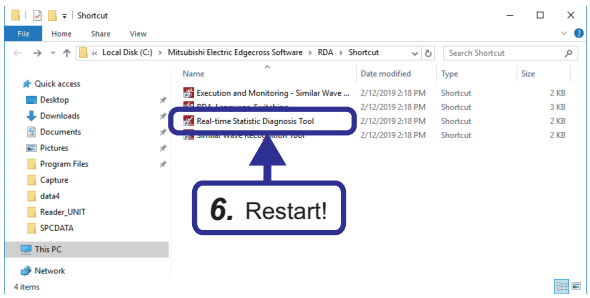
3. Click the [Save] button.



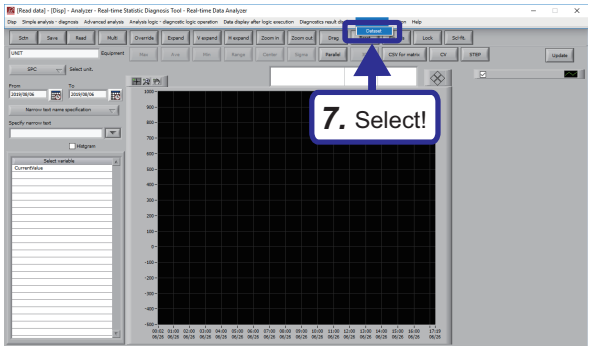
4. End the program with the [×] button at the upper right of Monitor, and then restart it.



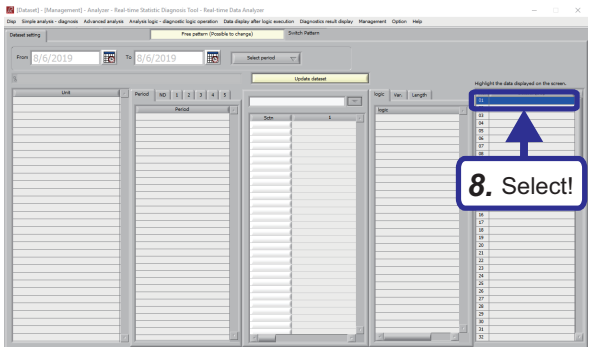
5. Click "Select equipment" in Monitor and select the unit (Reader_UNIT C:\RSD\RSDDATA\UNIT) specified in Reader.
Check that the SPC is displayed as the unit name.



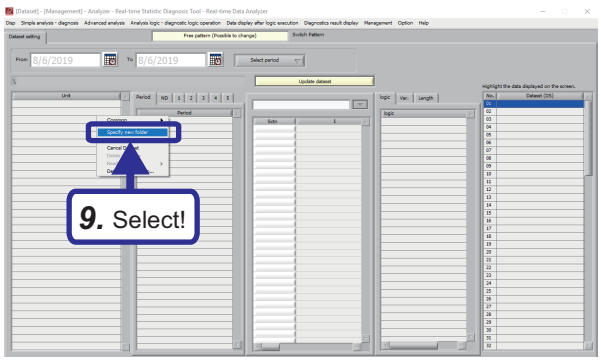
6. End the program with the [×] button at the upper right of Analyzer and Monitor, and then restart it.



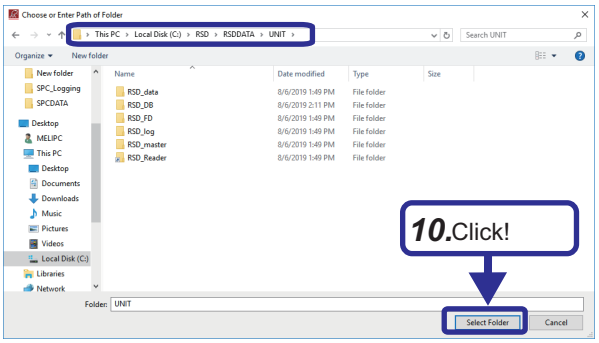
7. Select [Management] ⇨ [Dataset] from the menu of Analyzer and display the setting window.



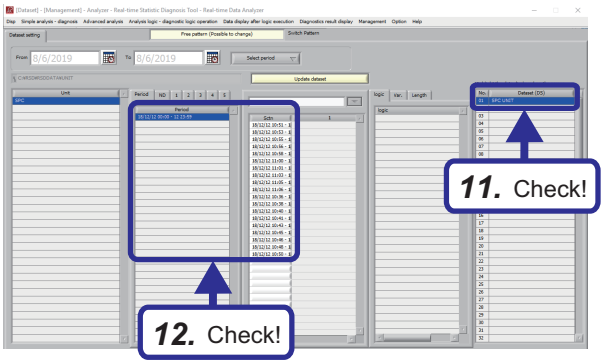
8. Select a blank row of "Dataset (DS)".



9. Right-click any place on "Unit" ⇨ select [Specify new folder].



10. In the folder selection dialog, select "C:\RSD\RSDDATA\UNIT" and click the [Select Folder] button.

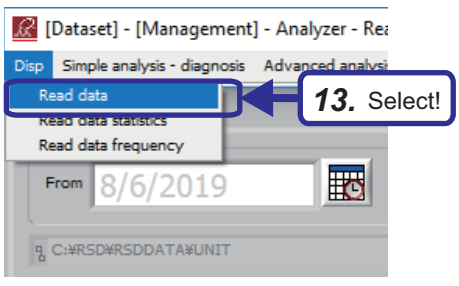


11. Check that "SPC UNIT" is set in "Dataset (DS)" and "SPC" is set in "Unit".

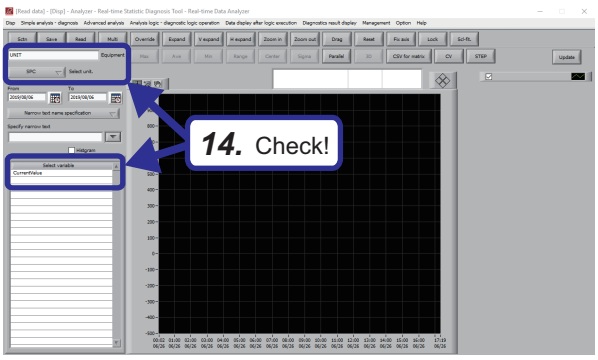
12. Check that the period and section of the data are displayed.

Point

The section is not displayed unless the period is selected.



13. Select [Disp] ⇨ [Read data] from the menu of Analyzer.



14. Check that the settings are as follows.

[Setting details]

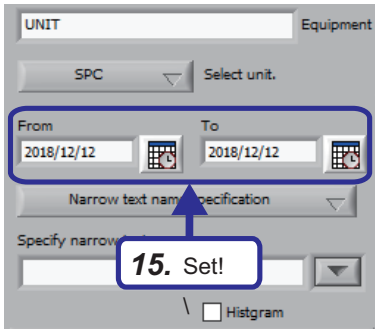
Equipment: UNIT

Select unit.: SPC

Select variable: CurrentValue

Point

If the settings are not displayed, click the [Update] button.



15. Set the period of the data to be diagnosed.

Since the prepared logging data is used, set the following according to the period of the logging data.

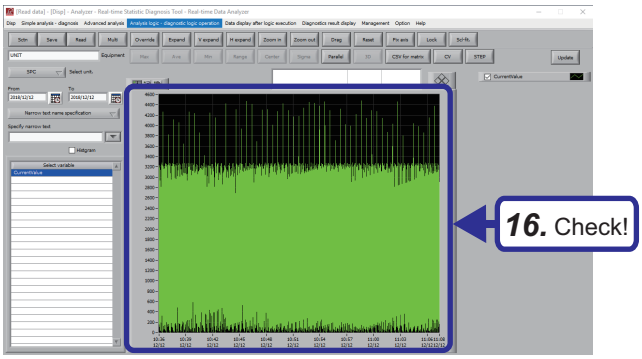
[Setting details]

From: 2018/12/12

To: 2018/12/12

Point

If the settings are not displayed, restart Analyzer, Monitor, and Reader, and click the [Update] button.

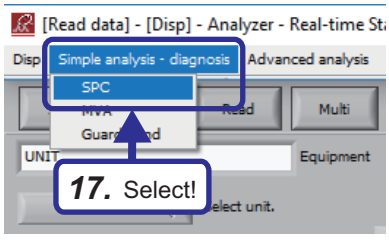


16. Select "CurrentValue" for "Select variable" and check that the data is displayed.

Point

For details on the display, refer to the following.

☞ Page 112 Read data



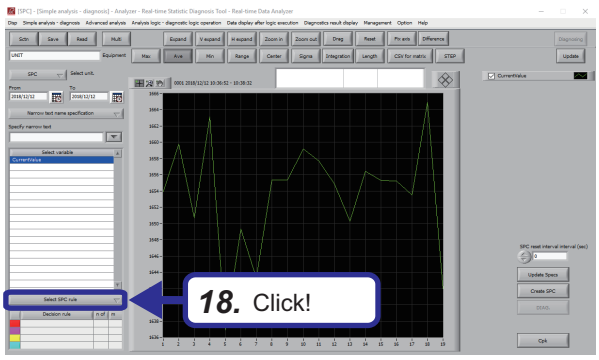
17. Select [Simple analysis - diagnosis] ⇨ [SPC] from the menu of Analyzer.

Point

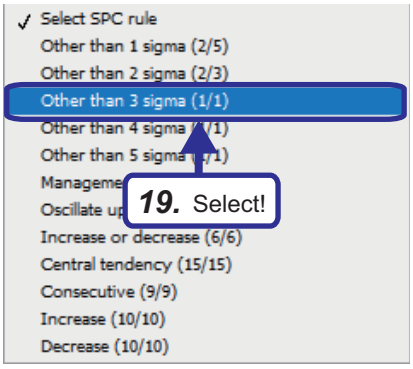
In the window displayed after [SPC] is selected, the statistics of the variable selected in "Select variable" will be displayed.

For details on the display of statistics, refer to the following.

☞ Page 113 Read data statistics



18. Click the [Select SPC rule] button.

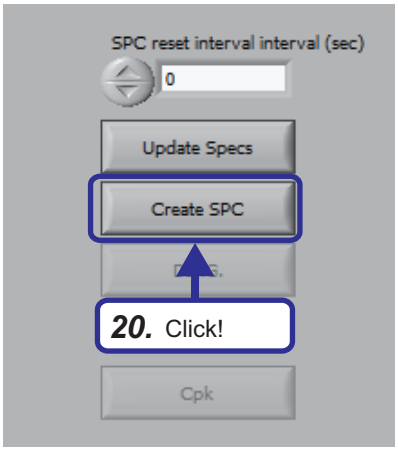


19. Select "Other than 3 sigma (1/1)".

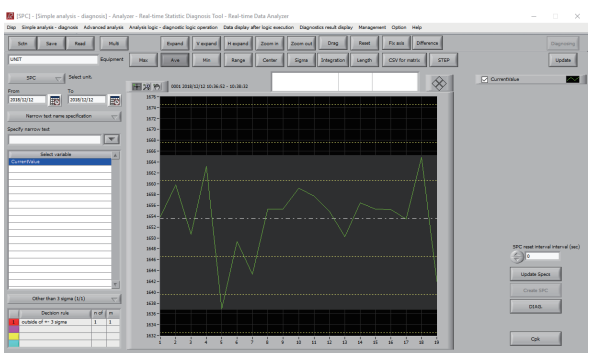
Point

For the SPC rule, refer to the following.

☞ Page 114 Default SPC Rule



20. Click the [Create SPC] button.



21. Check that the SPC specification value is displayed.

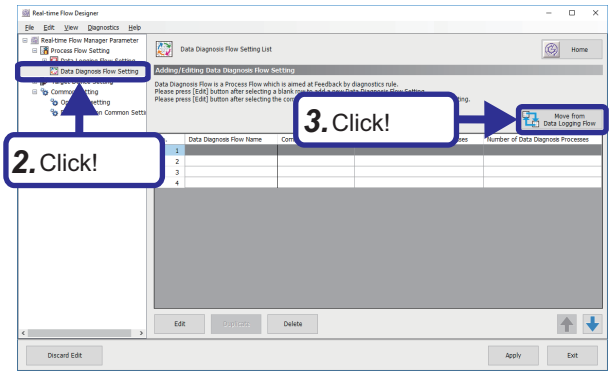
6.5 Data Diagnosis

Use the diagnosis target CSV file output in the data diagnosis flow of Real-time Flow Manager to perform diagnosis according to the diagnosis rule.
Real-time Statistic Diagnosis Tool outputs the response data file when an abnormality is detected in the diagnosis.
Real-time Flow Manager detects the output of the response data file and executes the feedback set in Real-time Flow Designer.

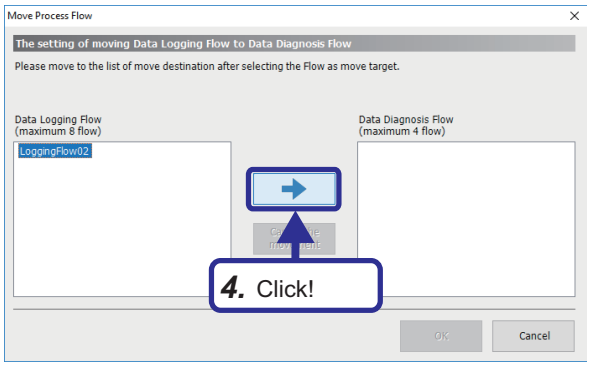
Data diagnosis flow setting

Create the data diagnosis flow setting with Real-time Flow Designer.

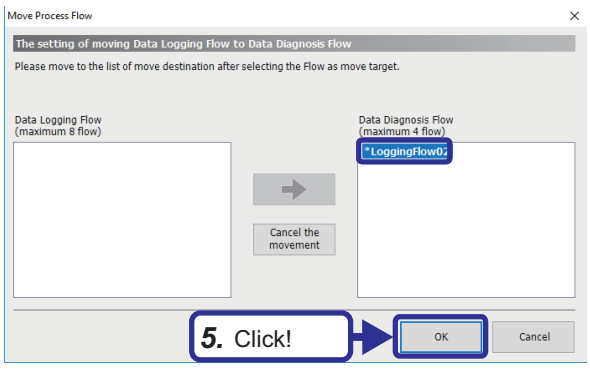
Operating procedure



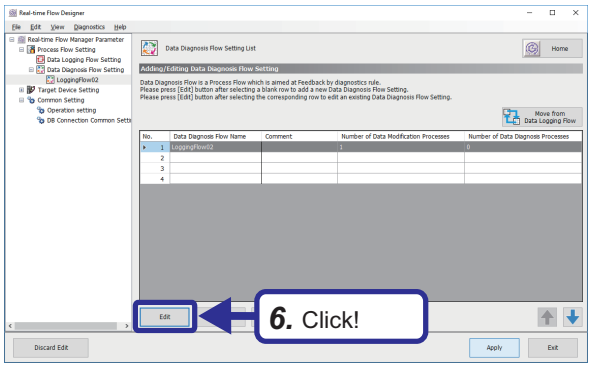
1. Start Real-time Flow Designer.
2. Click "Data Diagnosis Flow Setting" in the edit item tree.
3. Click the [Move from Data Logging Flow] button.



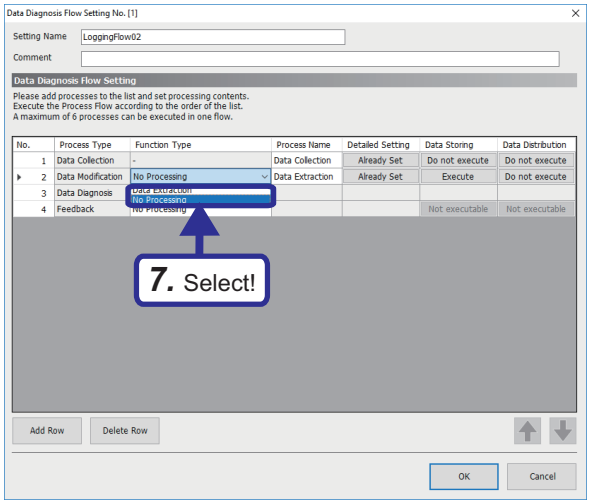
4. Select "LoggingFlow02" and click the [⇨] button.



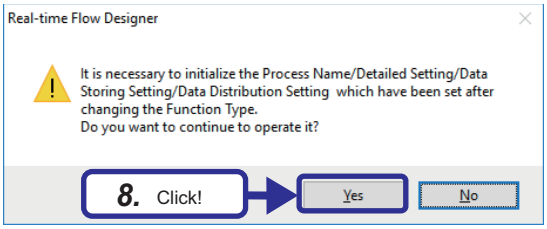
5. Click the [OK] button.
   The flow set in the data logging flow is moved to the data diagnosis flow.



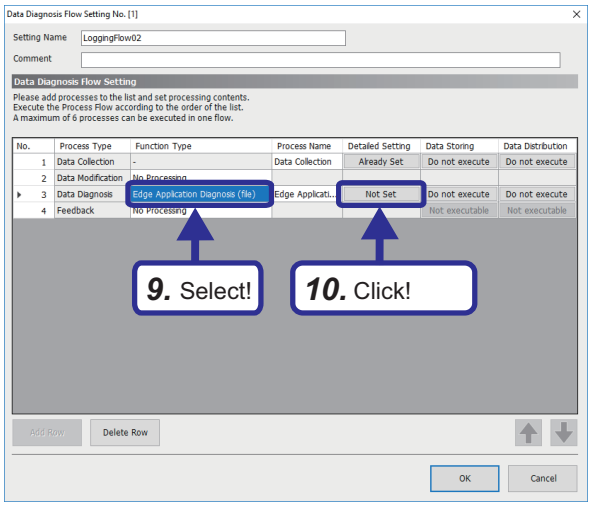
6. Select "LoggingFlow02" and click the [Edit] button.
The "Data Diagnosis Flow Setting" window is displayed.



7. Select "No Processing" for "Function Type" of data modification.

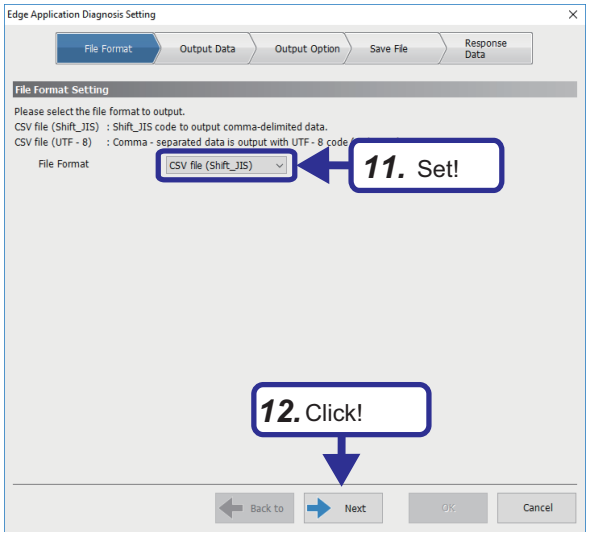


8. Click the [Yes] button.



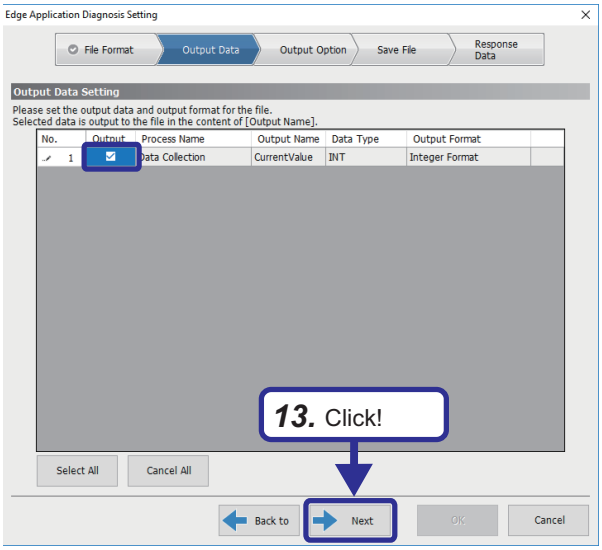
9. Select "Edge Application Diagnosis (file)" for "Function Type" of data diagnosis.

10. Click "Not Set" in "Detailed Setting".

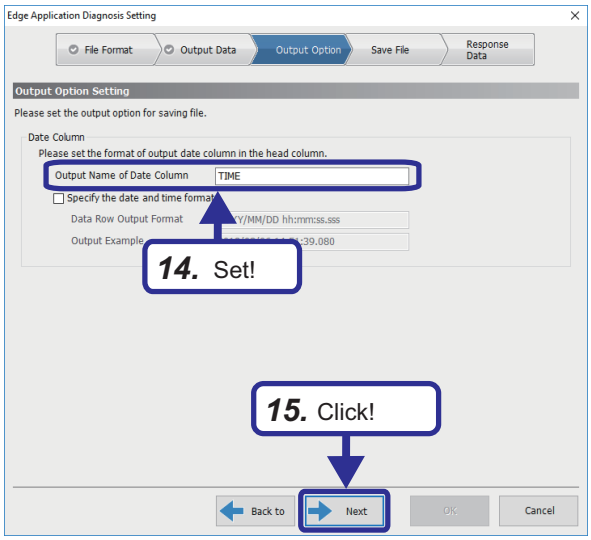


11. When the "Edge Application Diagnosis Setting" window is displayed, set as follows.
[Setting details]
File Format: CSV file (Shift_JIS)

12. Click the [Next] button.



13. Select the data to be output and click the [Next] button.

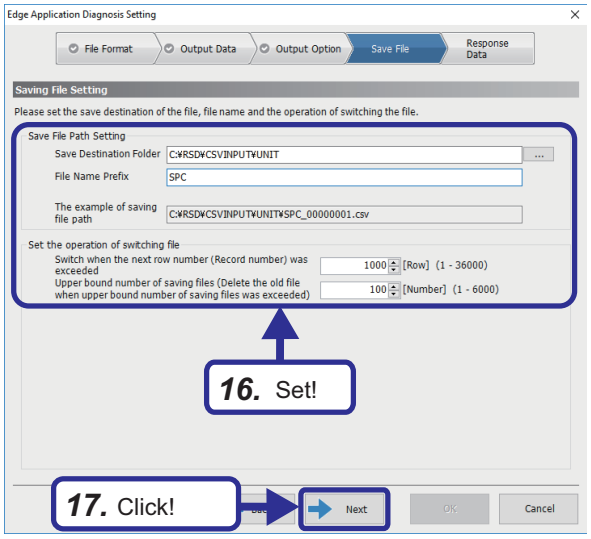


14. Set "Output Option" as follows.

[Setting details]

Output Name of Date Column: TIME

15. Click the [Next] button.



16. Set "Save File" as follows.

[Setting details]

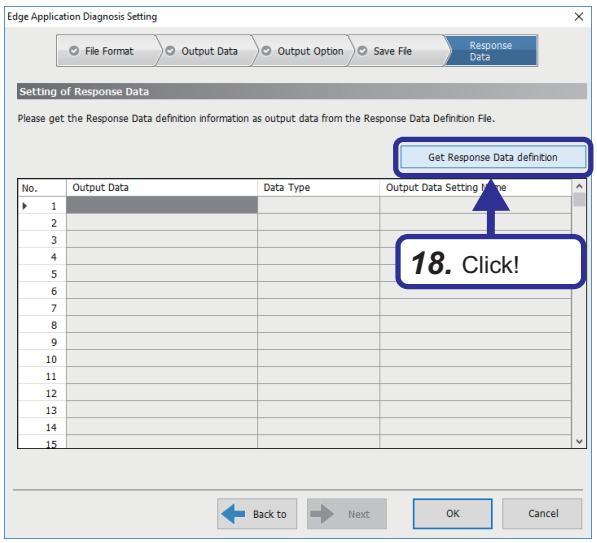
Save Destination Folder: C:\RSD\CSVINPUT\UNIT

File Name Prefix: SPC

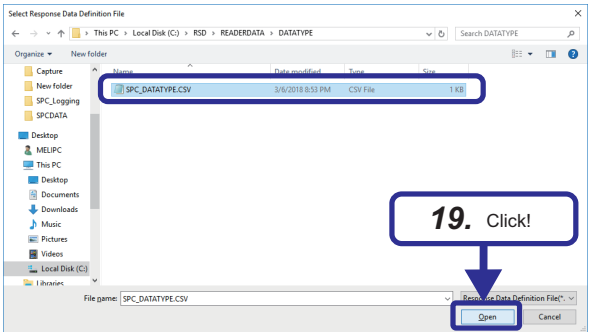
Switch when the next row number (Record number) was exceeded: 1000

Upper bound number of saving files: 100

17. Click the [Next] button.



18. Click the [Get Response Data definition] button.

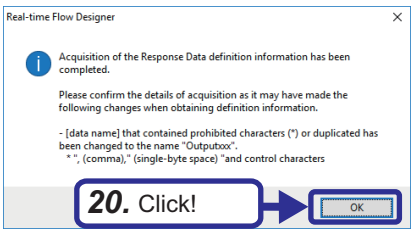


19. Select the response data definition file "C:\RSD\READERDATA\DATATYPE\SPC_DATATYPE.CSV" which is output for the unit definition of Reader.

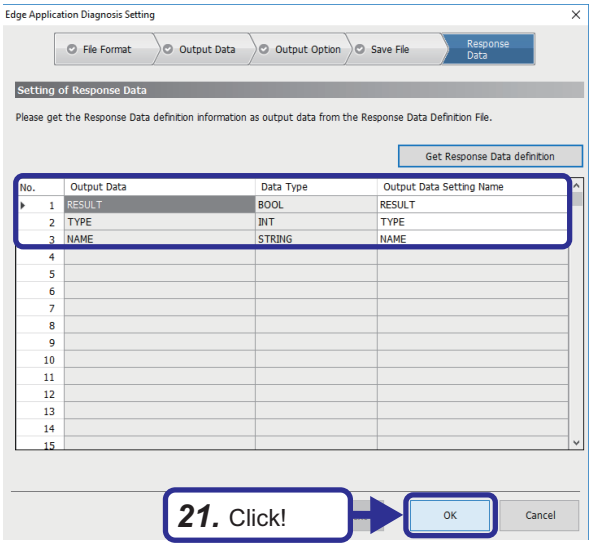
Point

The response data definition file is the data created in the following section.

☞ Page 83 Importing files



20. Click the [OK] button.

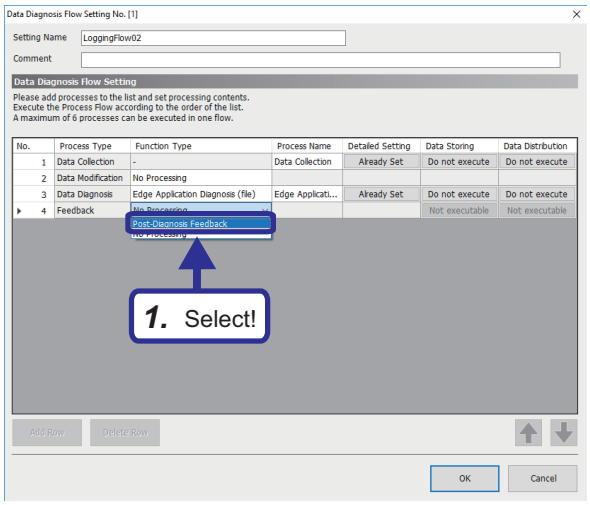


21. When the response data definition file has been read successfully, the output data will be displayed. Click the [OK] button.

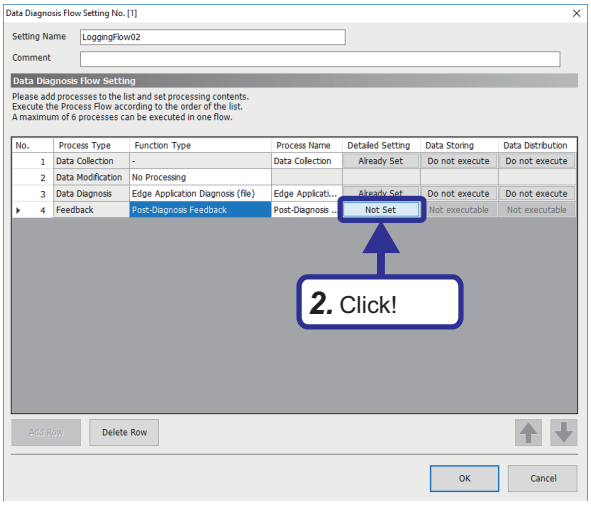
Feedback setting

Distribute the feedback from Real-time Statistic Diagnosis Tool to Edgecross in a file format.
Configure the setting of the feedback to be performed based on the result of the data diagnosis process with Real-time Flow Designer.

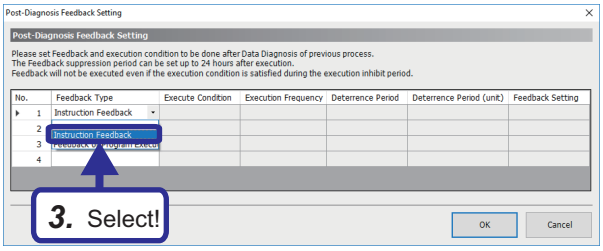
Operating procedure



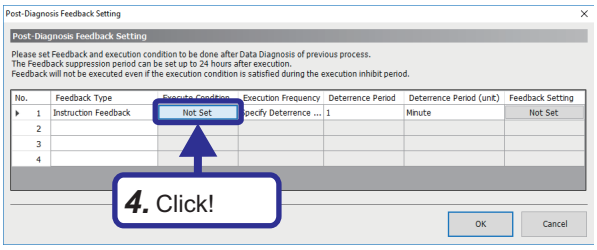
1. In the "Data Diagnosis Flow Setting" window of Real-time Flow Designer, select "Post-Diagnosis Feedback" for "Function Type" of feedback.

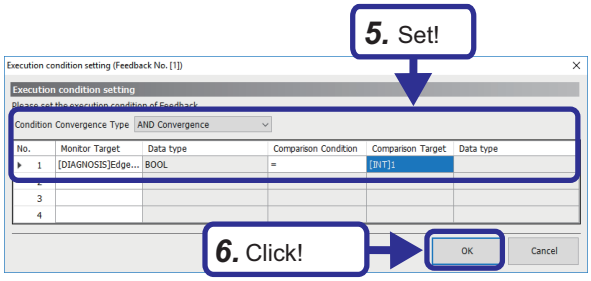


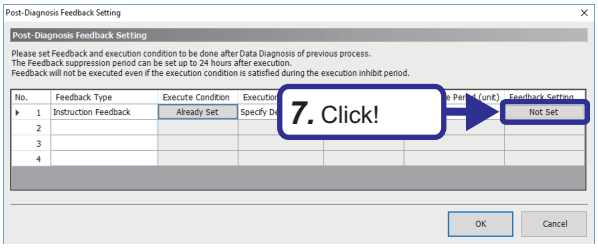
2. Click "Not Set" in "Detailed Setting".

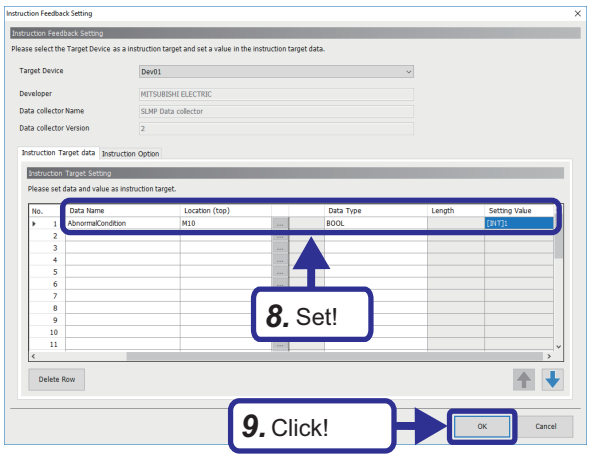


3. In the post-diagnosis feedback setting window, select "Instruction Feedback" for "Feedback Type".









4. Click "Not Set" in "Execute Condition".

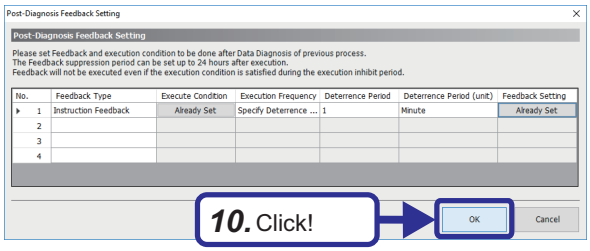
5. Set "Execution condition setting" as follows.
[Setting details]
Condition Convergence Type: AND Convergence
Monitor Target: Data diagnosis result ⇨ Edge application diagnosis (file) ⇨ RESULT
Comparison Condition: =
Comparison Target: Constant ⇨ [INT]
Enter 1 as an integer value.

6. Click the [OK] button.

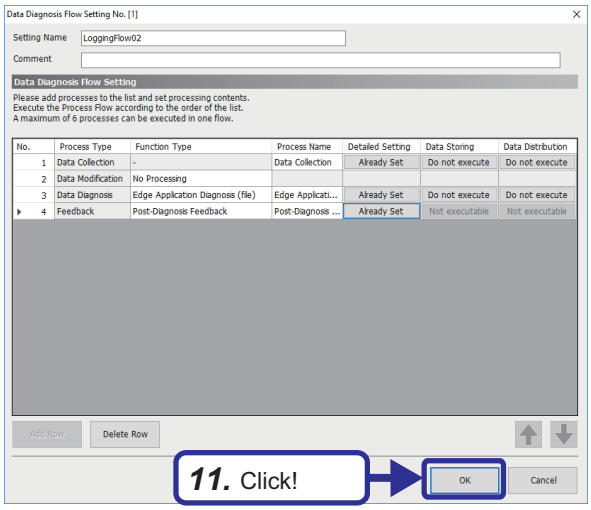
7. Click "Not Set" in "Feedback Setting".

8. When the "Instruction Feedback Setting" window is displayed, configure the instruction target as follows.
[Setting details]
Data Name: AbnormalCondition
Location (top): M10
Data Type: BOOL
Setting Value: Constant ⇨ [INT]
Enter 1 as an integer value.

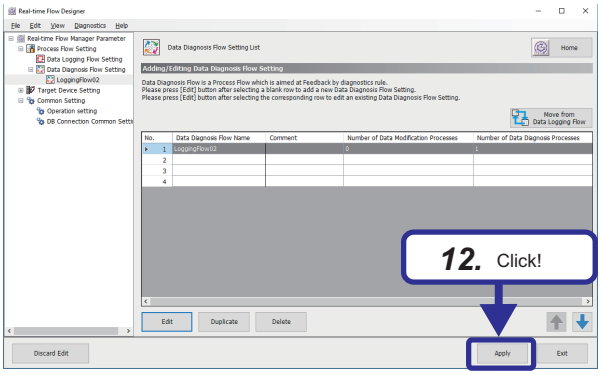
9. Click the [OK] button.



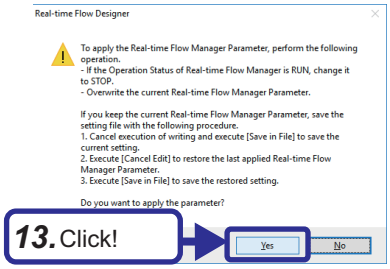
10. Click the [OK] button.



11. Click the [OK] button.



12. Click the [Apply] button.

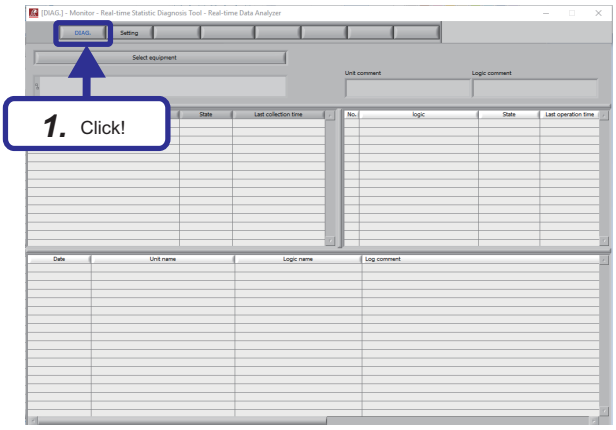


13. When the caution dialog shown on the left is displayed, click the [Yes] button.

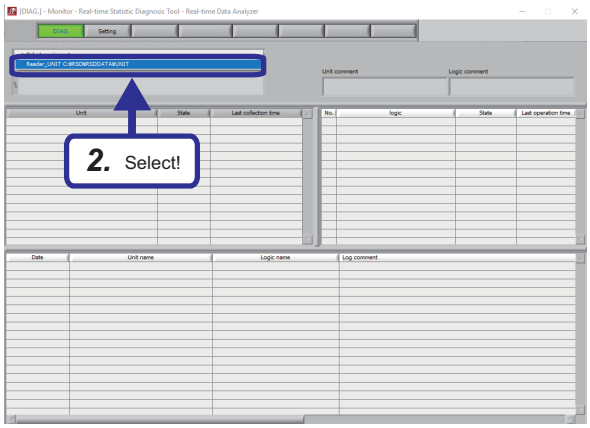
Response data file output setting

Using Monitor, configure the settings to output the response data file when an abnormality is detected in the diagnosis.

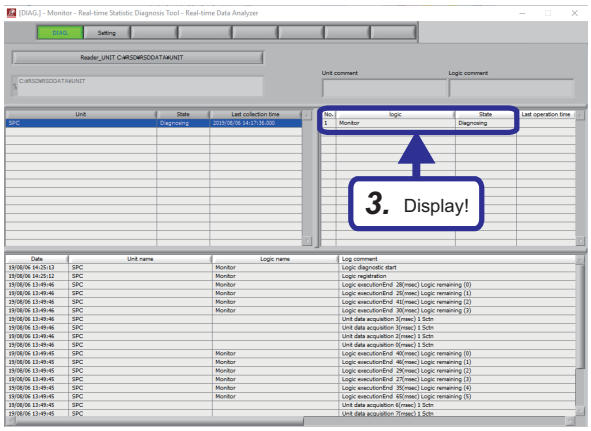
Operating procedure



1. Click the [DIAG.] button.



2. Click the [Select equipment] button and select the unit (Reader_UNIT C:\RSD\RSDDATA\UNIT) specified in Reader.



3. The logic is displayed in the logic information list.
When the state is "Diagnosing", Real-time Data Analyzer can be connected with Edgecross Basic software.
The simple diagnosis (SPC) of Analyzer applies to the logic that displays "Monitor" in the logic.

Point

To select equipment, all of the following conditions must be satisfied.

❶ The folder definitions are performed in Reader.

☞ Page 83 Importing files

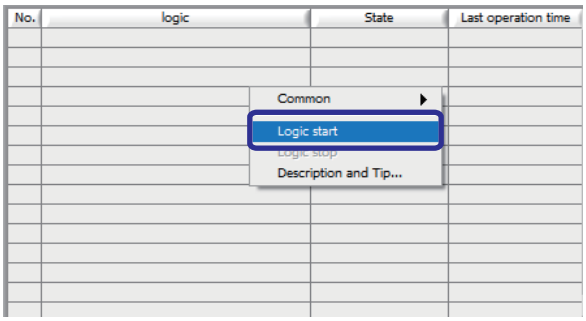
❷ [Monitor] is selected in the setting of [Tool] ⇨ [Monitor] from the menu bar of Reader.

❸ "Switch to CSV file reading mode" of Reader has been performed after the completion of ❶ and ❷.

❹ After ❸ is performed, Monitor is restarted.

- When the appropriate logic is not displayed, right-click in the logic information list and select the logic from [Logic start].

  When Reader reads a CSV file, the logic displayed in the logic information list is subject to the diagnosis.



Precautions

- During a diagnosis, keep this window with Monitor started.
- A logic with the auto-start logic setting is restarted and diagnosed even after the logic is stopped.

  To completely stop the logic, perform either of the following:

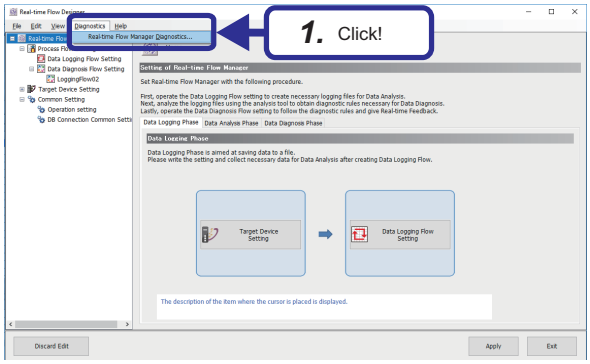
  Stop the logic after deleting the logic name from the automatic start logic setting. (☞ Page 101 Response data file output setting)

  Delete the logic in Analyzer. (📖 Real-time Data Analyzer User's Manual)

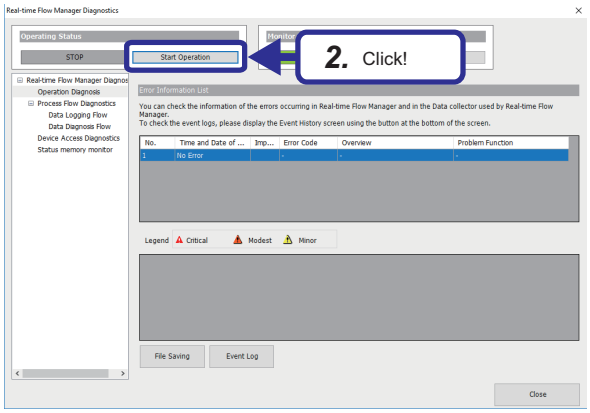
Executing data diagnosis

The following describes the execution procedure of data diagnosis with the SPC rule.

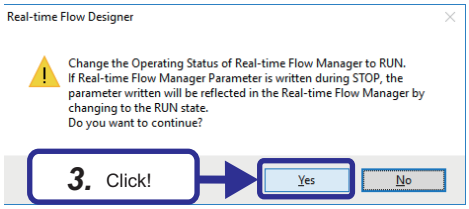
Operating procedure



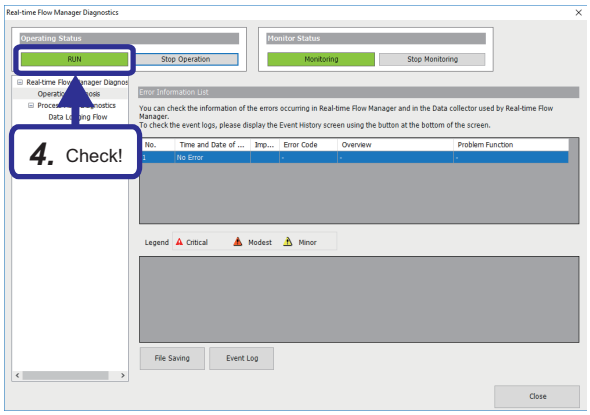
1. Click [Diagnostics] ⇨ [Real-time Flow Manager Diagnostics] from the menu of Real-time Flow Designer.



2. Click the [Start Operation] button.



3. Click the [Yes] button.



4. Check that "Operating Status" is set to "RUN".

Precautions

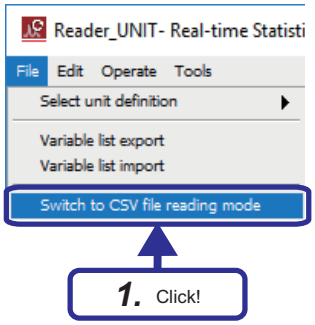
The edge application must start running within the timeout time (300 seconds) after Real-time Flow Manager Diagnostics is switched to RUN. If it is not running, an error occurs.

Data diagnosis with SPC rule

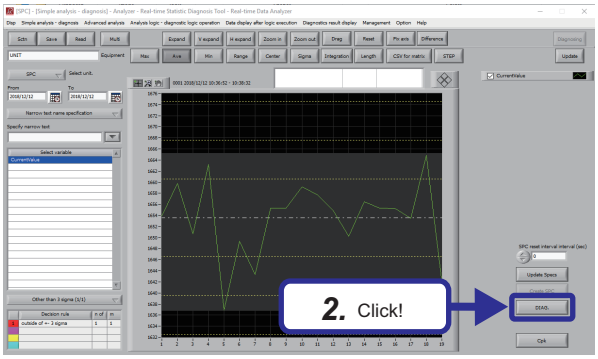
Select the SPC rule to be diagnosed according to the trend of the collected data. Various SPC rules are provided by default. For details on the SPC rule, refer to the following.

☞ Page 114 Default SPC Rule

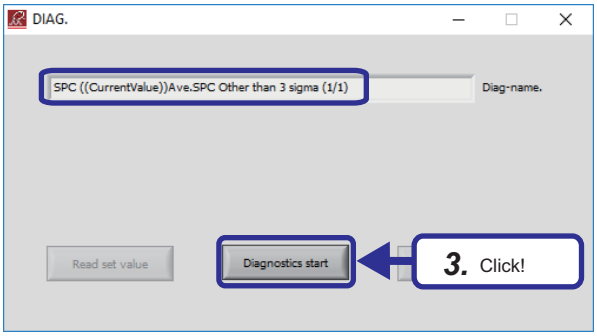
Operating procedure



1. Select [File] ⇨ [Switch to CSV file reading mode] from the menu of Reader.

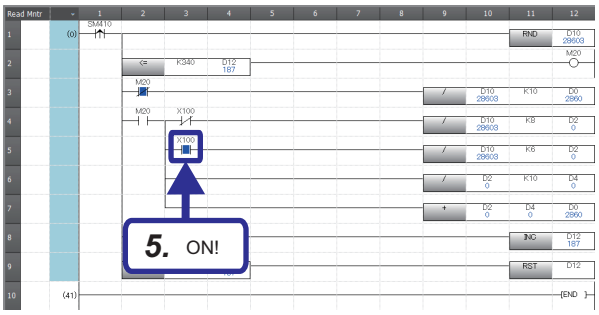


2. Click the [DIAG.] button of Analyzer.

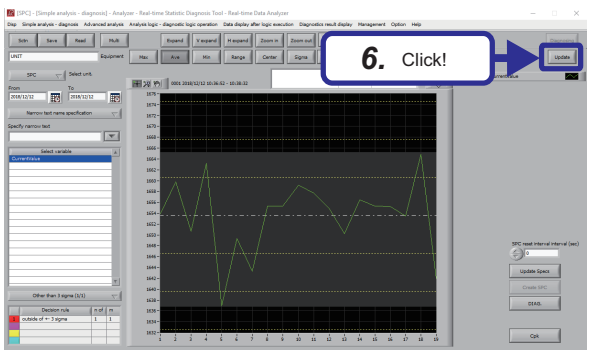


3. Check that the diagnosis name is set to "SPC ((CurrentValue))Ave.SPC Other than 3 sigma (1/1)" and click the [Diagnostics start] button.

4. When the confirmation dialog is displayed, click the [OK] button.



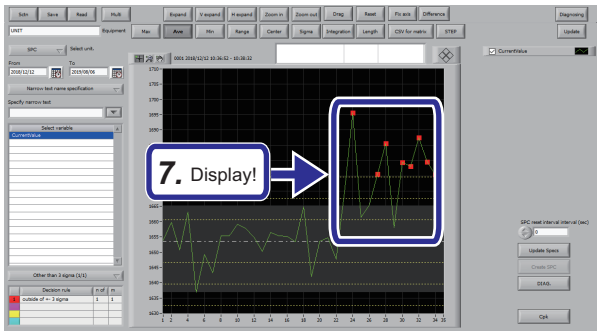
5. Turn on "X100" of the ladder program and generate an abnormal current value.



6. Click the [Update] button.

Point

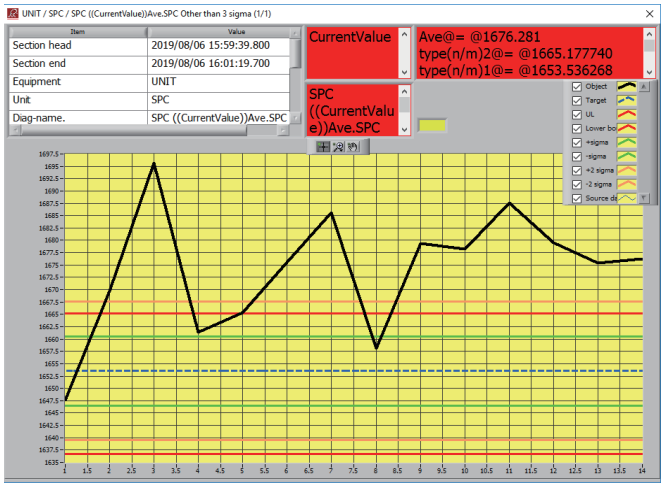
Clicking the [Update] button displays the latest time data.
Set the display period as follows. (Each time the [Update] button is clicked, the setting is required.)
[Setting details]
From: 2018/12/12
To: Today's date



7. A red mark is displayed at the position outside the SPC rule (Other than 3 sigma (1/1)).

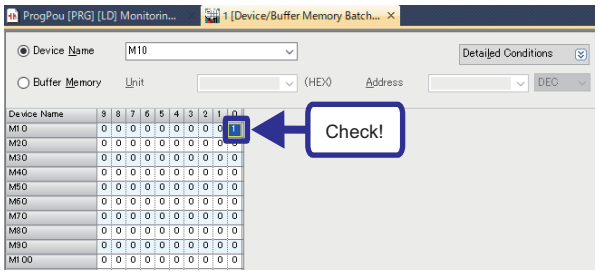
Point

When an abnormality is detected in the diagnosis, a pop-up window is displayed.
The feedback is executed when the pop-up window is displayed.



Checking the feedback result

Detect the output of the response data file and check that the feedback set in Real-time Flow Designer is executed correctly.



Check that M10 is turned on with the device/buffer memory batch monitor of GX Works3.

Point

- Once the device has been turned on, it will not turn off automatically even if the detection status returns to normal. Therefore, turn it off manually if necessary.
- At the production site, the device can be assigned to an alarm or lamp to notify of an error and be used for preventive maintenance.

APPENDICES

Appendix 1 Saving/Deleting/Reading a Setting File

This section describes how to save, delete, and read a setting file in Real-time Flow Designer and Similar Waveform Recognition Tool. Perform the following procedure as necessary.

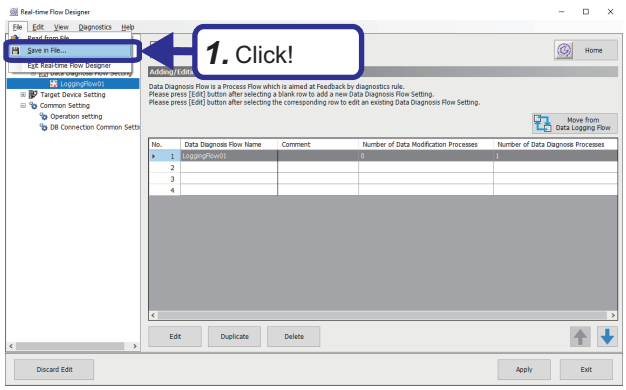
Managing the diagnosis flow setting of Real-time Flow Designer

If more than one diagnosis flow is set at the start of the diagnosis, all the configured diagnosis flows are executed. Delete unnecessary diagnosis flows in advance. By saving the current setting status as a setting file, the setting information saved as a setting file can be read even if the settings are deleted.

■Save

Save the current setting status as a setting file.

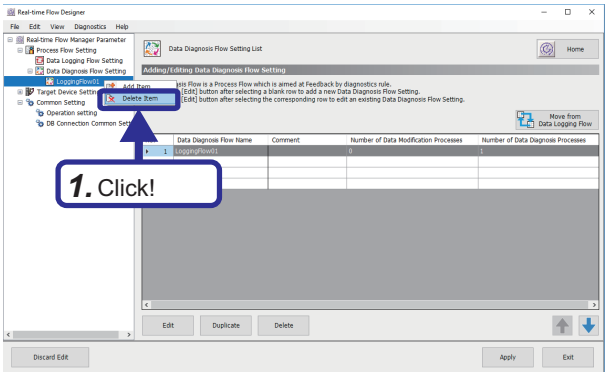
Some setting information may not be saved depending on the data collector used. For details, refer to the manual of the data collector used.



1. Click [File] ⇨ [Save in File...] from the menu.
Create a save destination folder and save the file with the desired name.

■Delete

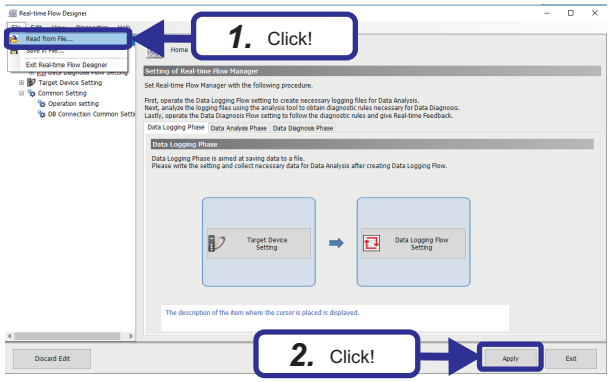
Delete the selected item.



1. Right-click the flow to be deleted from the data diagnosis flow setting of the edit item tree and click [Delete Item].

■Read

Read the setting information saved as a setting file.



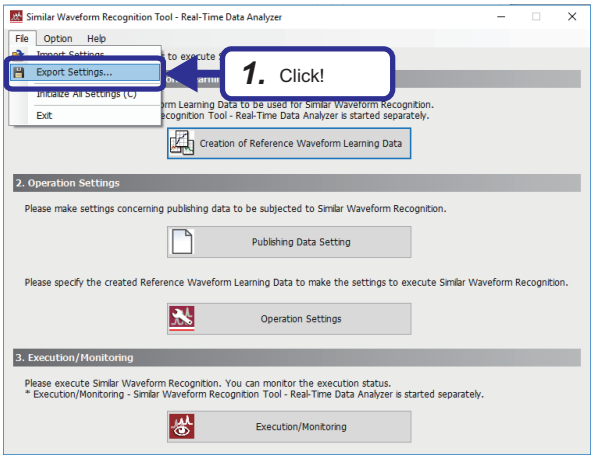
1. Click [File] ⇨ [Read from File...] from the menu of Real-time Flow Designer and read the data diagnosis flow setting file.
2. Click the [Apply] button.

Saving/reading the setting file of Similar Waveform Recognition Tool

By saving the current setting status before deleting or overwriting the setting file, the information saved as a setting file can be read again when needed.

■Save

Save the current setting status of Similar Waveform Recognition Tool as a setting file.



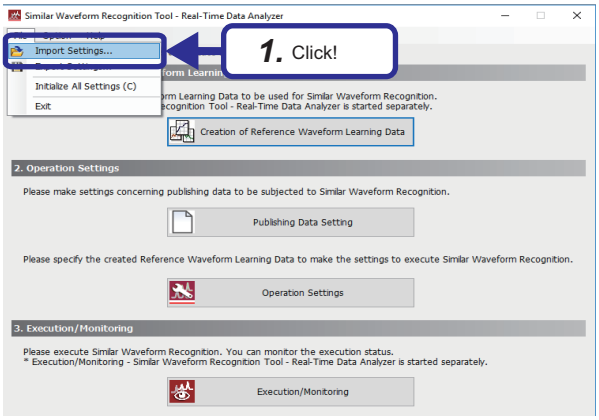
1. Click [File] ⇨ [Export Settings...] from the menu of Similar Waveform Recognition Tool and save the Similar Waveform Recognition Tool setting file.

Point

The reference waveform learning data file is saved in the folder set below. Perform a backup as necessary.
☞ Page 43 Creation setting of reference waveform learning data

■Read

Read the exported setting file to Similar Waveform Recognition Tool.



1. Click [File] ⇨ [Import Settings...] from the menu of Similar Waveform Recognition Tool and read the Similar Waveform Recognition Tool setting file.

Appendix 2 Additional Similar Waveform Recognition Exercise 1

Using Similar Waveform Recognition Tool, change the detection sensitivity of the abnormal waveform detection from 1 to 6 to see how the result of the similarity diagnosis changes.

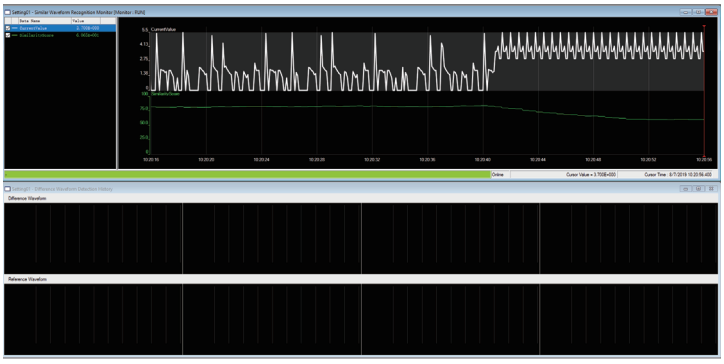
Point

Before configuring the setting, save the diagnosis flow created in Exercise 2 and delete it from Real-time Flow Designer.
For how to save and delete a setting file, refer to the following.
☞ Page 107 Saving/Deleting/Reading a Setting File

Operating procedure

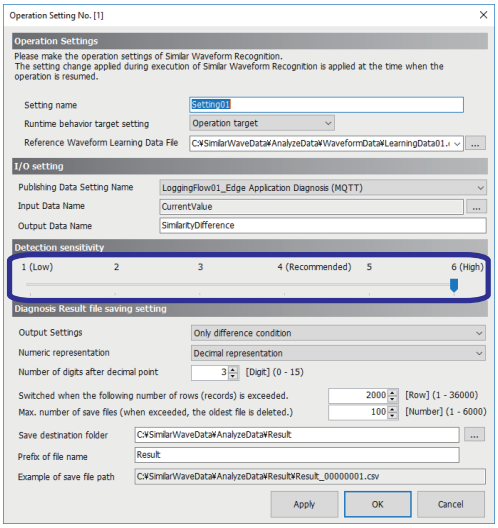
1. Open the project for additional exercise of Similar Waveform Recognition "school_SimilarWave-2.gx3", and click the [Select All] button to write the ladder program to the CPU module.
2. Read the data diagnosis flow setting file (SimilarWave_SettingFile.rfmcfg) to Real-time Flow Designer. (☞ Page 107 Managing the diagnosis flow setting of Real-time Flow Designer)
3. Copy the reference waveform learning data file (LearningData01.dspr) into the project folder C:\SimilarWaveData\AnalyzeData\WaveformData.
4. Import the setting file of Similar Waveform Recognition Tool (SmilarWave_Tool_SettingFile_1.swrcfg). (☞ Page 108 Saving/reading the setting file of Similar Waveform Recognition Tool)
5. Execute the data diagnosis flow. (☞ Page 61 Executing data diagnosis)
6. Execute the similar waveform recognition. (☞ Page 62 Similar waveform recognition execution)
7. Start GX LogViewer, turn "X100" of the ladder program to "ON", and check the waveform. (☞ Page 64 Diagnosis with waveform monitor)
8. Stop the diagnosis and set the detection sensitivity to 6 from "Operation Settings" of Similar Waveform Recognition Tool. (☞ Page 53 Operation setting)
9. *5.* to *7.* apply the procedure for checking the waveform.

Operation check

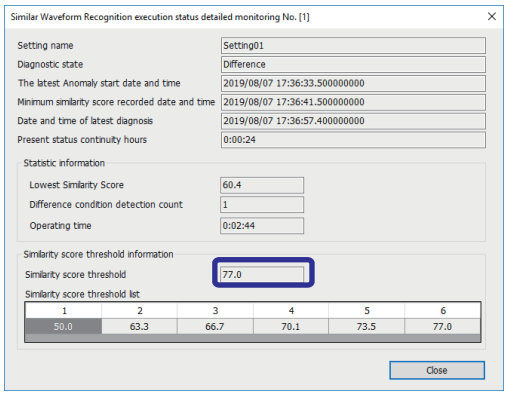


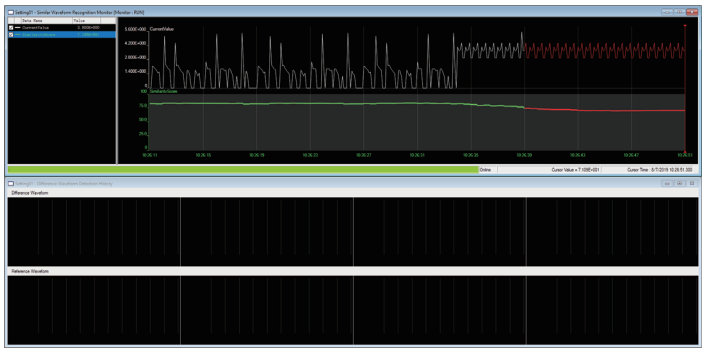
1. When the detection sensitivity is "1", the abnormal waveform is not detected because the similarity score does not fall below the threshold of the similarity score "50.0" even if an abnormality is generated.

Operation setting window



Similar Waveform Recognition execution status monitoring window





2. Change the detection sensitivity from "1" to "6" in "Operation Settings" of Similar Waveform Recognition Tool.
When the detection sensitivity is changed to "6", the similarity score threshold is automatically changed.
The similarity score threshold can be checked in the "Similar Waveform Recognition execution status detailed monitoring" window.

3. When the similarity score falls below the similarity score threshold "77.0" by changing the setting of detection sensitivity, an abnormality is detected.

Appendix 3 Additional Exercise of SPC

Change the SPC rule from the setting in Exercise 2 to see how the diagnosis result changes.

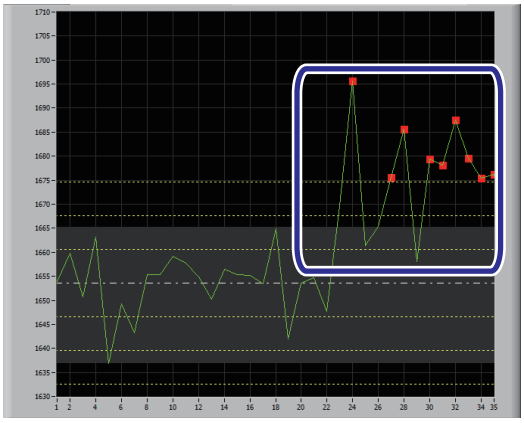
Operating procedure

1. Start Real-time Statistic Diagnosis Tool and check that the data set in Exercise 2 is displayed.
2. Click the [Select equipment] button in Monitor and select the unit (Reader_UNIT C:\RSD\RSDDATA\UNIT) specified in Reader. (☞ Page 88 SPC rule creation)
3. Select "CurrentValue" in "Select variable" of Analyzer and check that the data of Exercise 2 is displayed. (☞ Page 88 SPC rule creation)
4. Select [Simple analysis - diagnosis] ⇨ [SPC] from the menu of Analyzer. (☞ Page 88 SPC rule creation)
5. Change the SPC rule to "Other than 4 sigma (1/1)" in Analyzer. (☞ Page 88 SPC rule creation)
6. Check the diagnosis result. (☞ Page 111 Operation check)

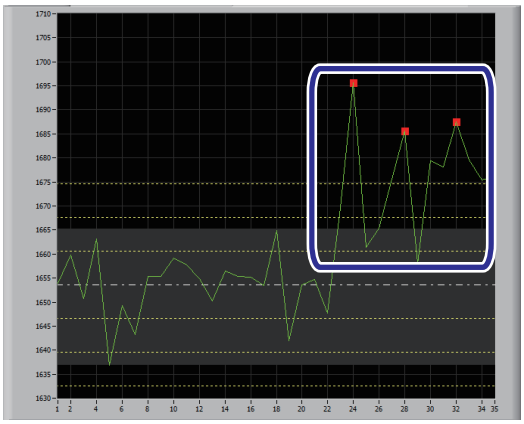
Operation check

Check how the diagnosis result is changed by changing the SPC rule to "SPC((CurrentValue))Ave.SPC Other than 4 sigma (1/1)".

Diagnosis result before the rule change (Other than 3 sigma)



Diagnosis result after the rule change (Other than 4 sigma)



1. Changing the SPC rule to "SPC((CurrentValue))Ave.SPC Other than 4 sigma (1/1)" will increase the range diagnosed as normal.
   Therefore, the number of abnormalities will decrease.

Point

For the SPC rule, refer to the following.
☞ Page 114 Default SPC Rule

A

Appendix 4 Read Data and Statistics of SPC

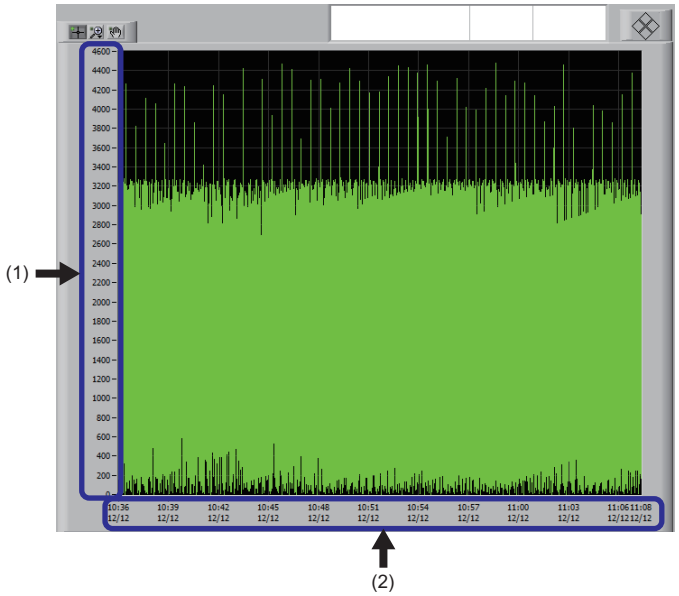
This section describes the read data and statistics displayed in Analyzer during analysis and diagnosis with SPC.

Read data

The CSV file data read by Reader is displayed as a waveform.

Waveforms of data from multiple sections can be overlapped or arranged horizontally to be displayed and analyzed.

When arranged horizontally, each section is shown as a single waveform and sections are not consecutive.

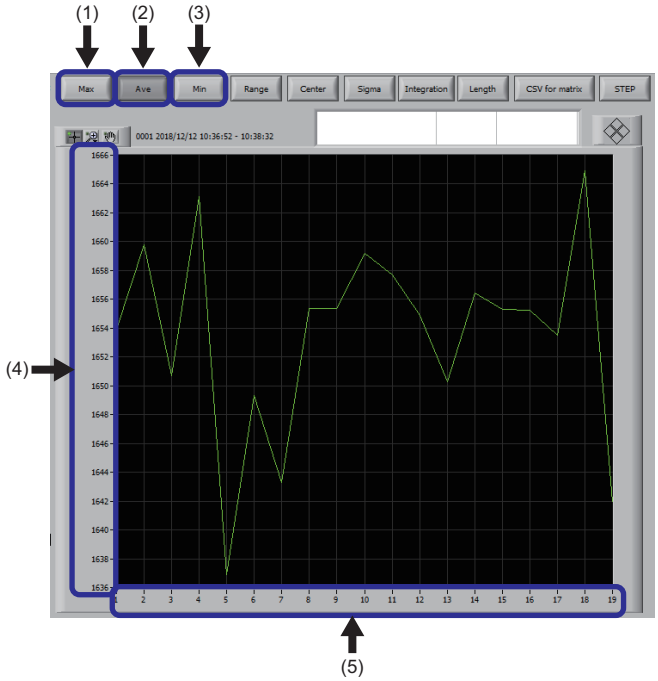


Item		Description
(1)	Vertical axis	Automatically scaled according to the maximum and minimum values of the displayed waveform (section data).
(2)	Horizontal axis	Displays the date and time of the selected section. When the [Overlay] button is selected, the elapsed time (second) from the start time of a single section is displayed.

Read data statistics

From the CSV file data read by Reader, statistics for each variable are calculated in each section and displayed for the period specified by "From" and "To".

The display value can be switched by clicking the [Max] button, [Ave] button, and [Min] button.



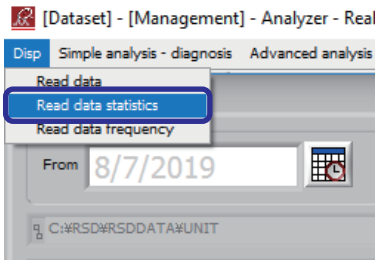
Item		Description
(1)	[Max] button	Displays the maximum value of the waveform for each section.
(2)	[Ave] button	Displays the mean value of the waveform for each section.
(3)	[Min] button	Displays the minimum value of the waveform for each section.
(4)	Vertical axis	Automatically scaled according to the maximum and minimum values of the displayed waveform.
(5)	Horizontal axis	Displays the number of sections in the period specified by "From" and "To" (equal to the number of files read by Reader).

Point

In this training, for the purpose of learning the procedure of analysis and diagnosis using SPC, the procedure is described in Exercise 2 on the assumption that SPC is performed. In actual use, display the read data statistics after displaying the read data to consider the optimum diagnosis method based on the analysis result.

The read data statistics can be displayed with the following procedure.

[Disp] ⇨ [Read data statistics] from the menu in Analyzer



A

Appendix 5 Default SPC Rule

The default SPC rules are shown below.

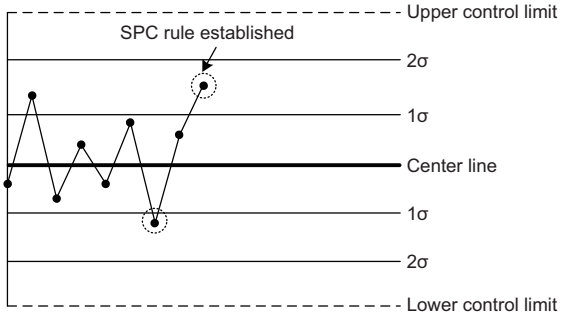
When the condition is satisfied, data is judged as abnormal.

Point

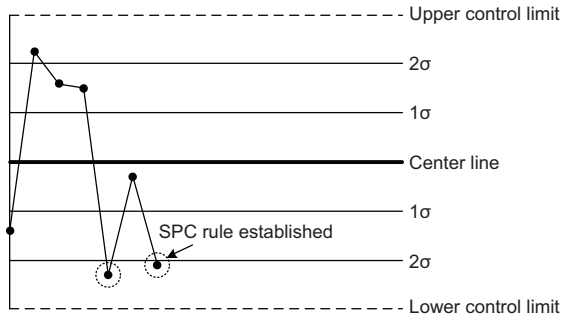
Calculate the following using statistics for the period specified by "From" and "To" of the selected variable.

- Center line: Mean value of all sections
- σ: Standard deviation
- Upper control limit: Maximum value
- Lower control limit: Minimum value

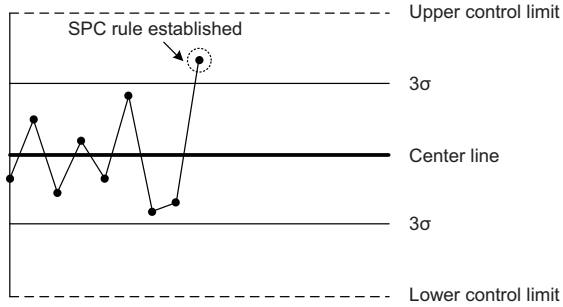
- Other than 1 sigma (2/5): outside of +- 1 sigma (2/5)
  2 out of 5 consecutive points are outside 1 sigma.



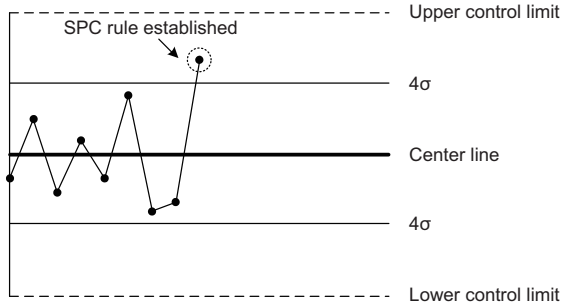
- Other than 2 sigma (2/3): outside of +- 2 sigma (2/3)
  2 out of 3 consecutive points are outside 1 sigma.



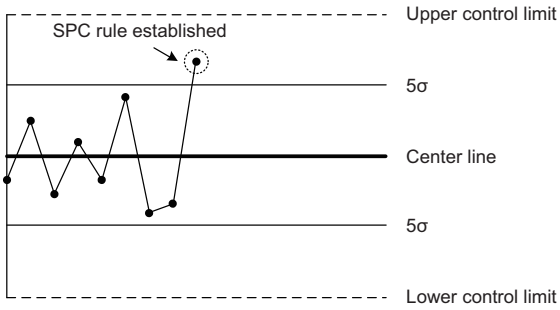
- Other than 3 sigma (1/1): outside of +- 3 sigma (1/1)
  1 point is outside 3 sigma.



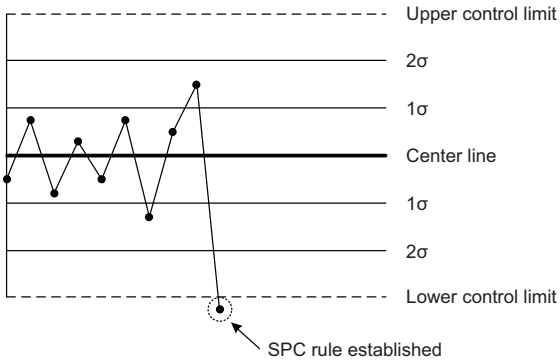
- Other than 4 sigma (1/1): outside of +- 4 sigma (1/1)
  1 point is outside 4 sigma.



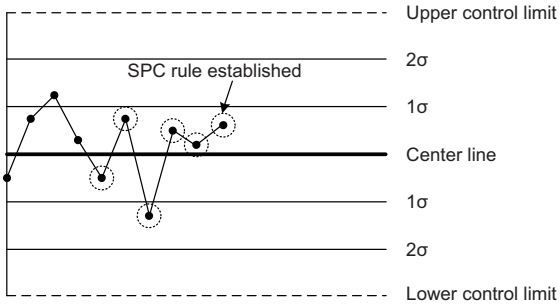
• Other than 5 sigma (1/1): outside of +- 5 sigma (1/1)
1 point is outside 5 sigma.



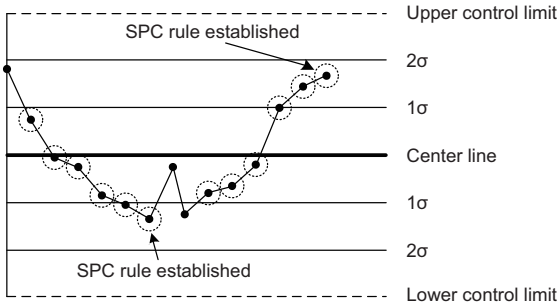
• Control limit level (1/1): outside of control limits Lv.1 (1/1)
1 point is outside the upper or lower control limit.



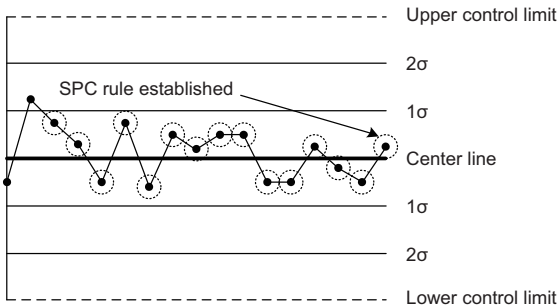
• Alternate increase and decrease (6/6): alternating direction (6/6)
6 points alternately increase and decrease.



• Increase and decrease (6/6): increasing or decreasing (6/6)
Consecutive 6 points increase or decrease.

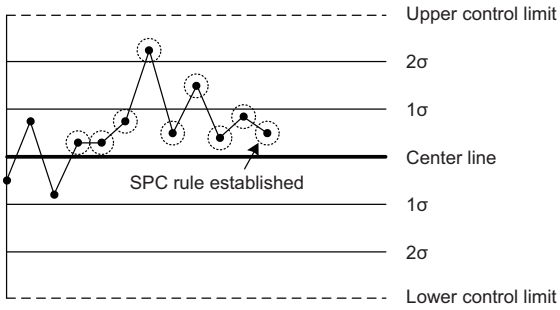


• Toward center (15/15): within one sigma (15/15)
15 consecutive points are within 1 sigma.

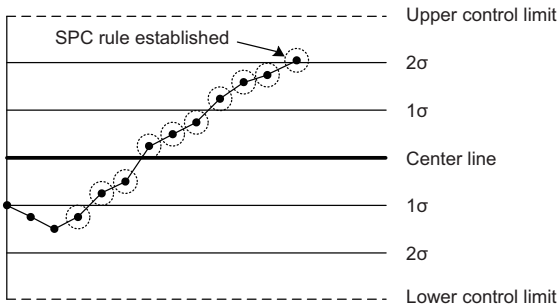


A

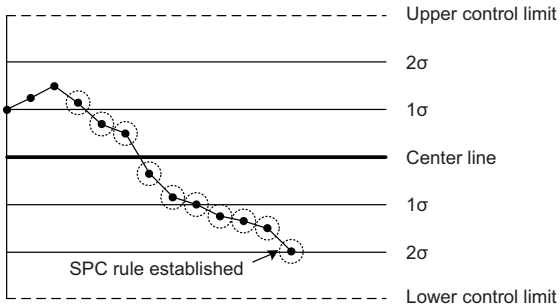
• Continuous (9/9): plot on the same side (9/9)
9 consecutive points are on one side of the center line.



• Increase (10/10): increasing (10/10)
Increase (10 consecutive points increase.)



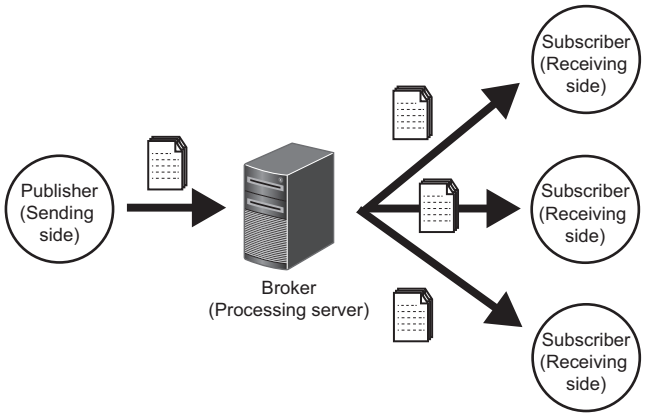
• Decrease (10/10): decreasing (10/10)
Decrease (10 consecutive points decrease.)



Appendix 6 MQTT Broker Setup

MQTT

MQTT is a Publish/Subscribe messaging predefined protocol.
MQTT classifies the sending side of the message into Publisher and receiving side of the message into Subscriber, and the Broker relays the message.
The Publisher can send messages to the server without considering Subscribers, while the server is responsible for receiving, managing, and properly publishing those messages to Subscribers.
Therefore, MQTT is suitable for data communication in a low-band network environment and a communication environment with long waiting time.
The MQTT Broker whose operation has been confirmed by Edgecross Consortium is Eclipse Mosquitto.

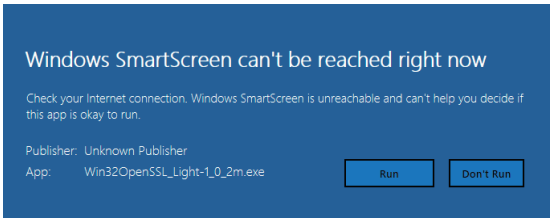


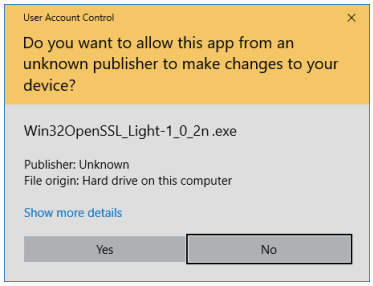
Eclipse Mosquitto setup

The following describes the setup procedure of Eclipse Mosquitto.

Precautions

If the following window is displayed during installation, check that the file was downloaded from the appropriate website and click the [Run] button and the [Yes] button.





Operating procedure

1. Install Visual Studio® 2013 or Visual C++® 2015 redistributable package.
2. Create the Eclipse Mosquitto installation folder and obtain the installer.
3. Install OpenSSL.
4. Install Pthread.
5. Install Eclipse Mosquitto.

Installation of Visual C++ 2013 redistributable package

The following describes the installation procedure of Visual C++ 2013 redistributable package.

Operating procedure

1. Access the following and download "vcredist_x86.exe".
   - www.microsoft.com/ja-jp/download/details.aspx?id=40784
2. Execute "vcredist_x86.exe".
3. If you agree to the license terms, select "I agree to the license terms and conditions" and click the [Install] button.

Installation of Visual C++ 2015 redistributable package

The following describes the installation procedure of Visual C++ 2015 redistributable package.

Operating procedure

1. Access the following and download "vcredist_x86.exe".
   - www.microsoft.com/ja-jp/download/details.aspx?id=48145
2. Execute "vcredist_x86.exe".
3. If you agree to the license terms, select "I agree to the license terms and conditions" and click the [Install] button.

Creating the Eclipse Mosquitto installation folder and obtaining the installer

The following describes the procedure for creating the Eclipse Mosquitto installation folder and obtaining the installer.

Operating procedure

1. Create an installation folder (folder name: mosquitto) in the desired location.
2. Access the following and download the installer of Eclipse Mosquitto.
   - www.edgecross.org/en

Installing OpenSSL

The following describes the installation procedure of OpenSSL.

Operating procedure

1. Access the following and download the installer of OpenSSL.
   - www.edgecross.org/en
2. Execute the installer.
3. Click the [Next>] button.
4. Check the license agreement and select "I accept the agreement", and click the [Next>] button.
5. Select the installation destination folder, and click the [Next>] button.
6. Select the folder name to be added to the start menu, and click the [Next>] button.
7. Select "The OpenSSL binaries (/bin) directory", and click the [Next>] button.
8. Click the [Install] button.
9. Select/clear[*1] the amount to donate, and click the [Finish] button.

   *1 When the [Finish] button is clicked while the checkbox is selected, the donation website will open. If it is accidentally selected, donation can be canceled by closing the window of the donation website.
10. Copy "libeay32.dll" and "ssleay32.dll" in the installation folder selected in step 5 to the Eclipse Mosquitto installation folder.

Installing Pthread

The following describes the installation procedure of Pthread.

Operating procedure

1. Access the following and download Pthread.

• www.edgecross.org/en

2. Copy "pthreadVC2.dll" to the Eclipse Mosquitto installation folder.

Installing Eclipse Mosquitto

The following describes the installation procedure of Eclipse Mosquitto.

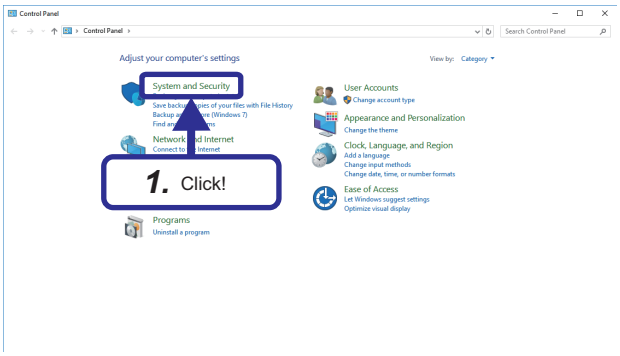
Operating procedure

1. Execute the installer of Eclipse Mosquitto.
2. Click the [Next>] button.
3. Click the [Next>] button.
4. Check that "Service" is selected, and click the [Next>] button.
5. Select the folder created in the procedure for creating the Eclipse Mosquitto installation folder and obtaining the installer as the installation destination folder, and click the [Install] button.
6. Click the [Finish] button.

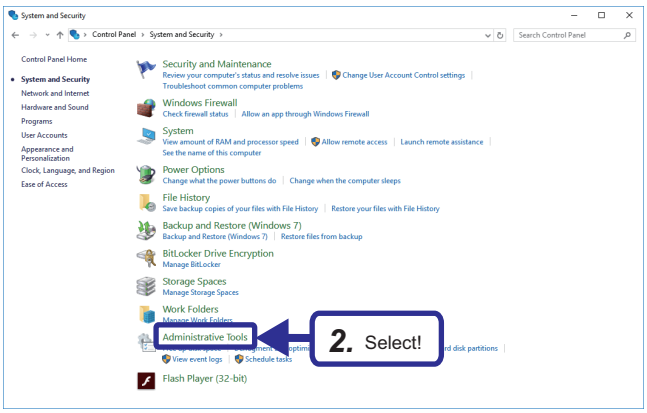
Starting Eclipse Mosquitto

The following describes the procedure for starting Eclipse Mosquitto.

Operating procedure

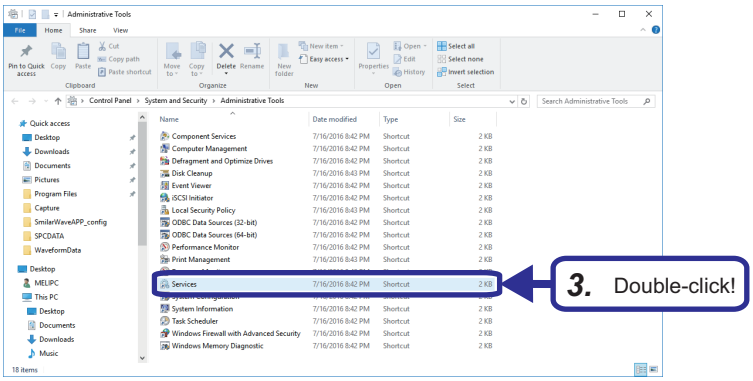


1. Click the control panel of Windows® ⇨ [System and Security].

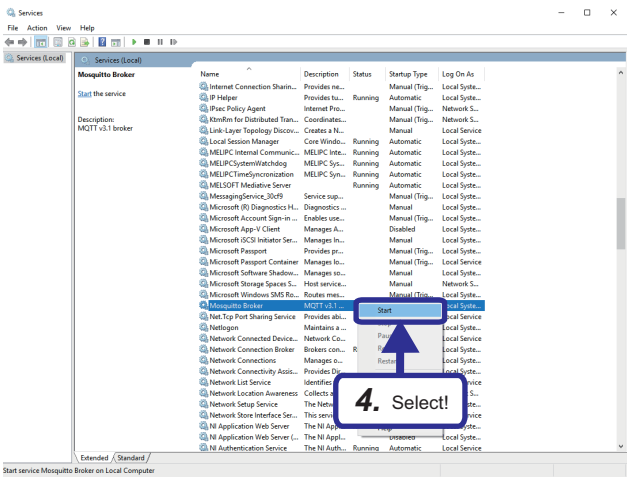


2. Select "Administrative Tools".

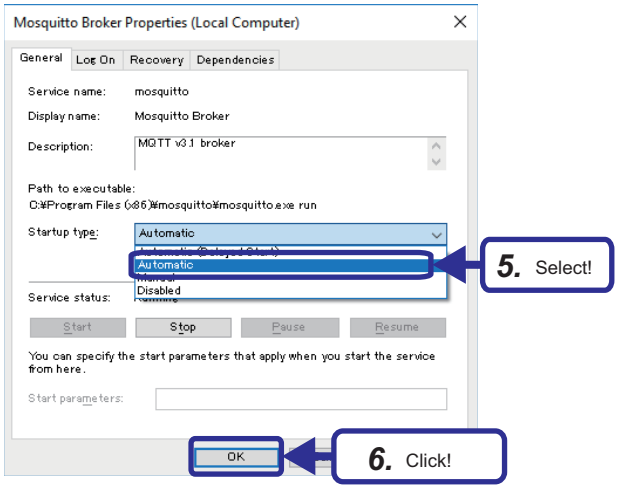
A



3. Double-click "Services".



4. If the status of Mosquitto Broker is not "Running", select "Start" in the right-click menu.



5. If the startup type is not "Automatic", select "Automatic".
The service starts automatically the next time it starts.

6. Click the [OK] button.

Appendix 7 Contact Information

For Real-time Data Analyzer, please consult your local Mitsubishi representative.

MEMO

Mitsubishi Programmable Controllers Training Manual
Real-time Data Analyzer Basic Course

MODEL	SCHOOL-R ANALYZER-E
MODEL CODE	-
SH(NA)-082343ENG-A(2004)MEE	

MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE: TOKYO BLDG., 2-7-3, MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN
NAGOYA WORKS: 1-14, YADA-MINAMI 5-CHOME, HIGASHI-KU, NAGOYA 461-8670, JAPAN