

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]

• 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.

- 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

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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 P

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.

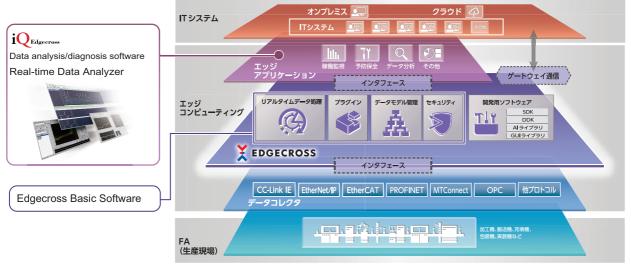
Term	Description
Correlation matrix	A matrix created based on the reference CSV file. It is used for advanced analysis.
Data collection	Processing to collect data for data diagnosis and data analysis.
Data collector	A software component that collects data in production sites through each network. It 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

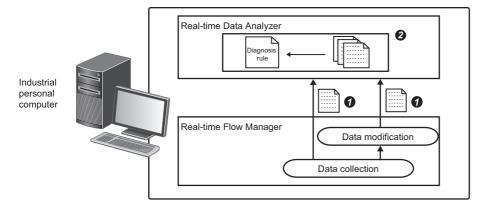
Real-time Data Analyzer is an edge application that analyzes the data of a production site offline and diagnose the data in real time. Preventive maintenance and quality improvement can be realized at production sites by using AI technology and various statistical methods. Real-time Data Analyzer consists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

Tool	Description
Similar Waveform Recognition Tool	Al-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.

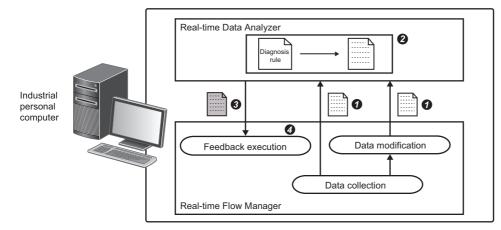


• Real-time Flow Manager outputs the data collected in the data collection process as a file. (Data will be modified in the data modification process as necessary.)

2 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.



• Real-time Flow Manager outputs the data collected in the data collection process. (Data will be modified in the data modification process as necessary.)

2 Real-time Data Analyzer diagnoses collected data which was output by Real-time Flow Manager according to the diagnosis rules created in offline analysis.

3 Real-time Data Analyzer outputs the diagnosis result data.

Ø 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/	Display function	—	To display data of a read CSV file.		
diagnostic function		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/	—	To analyze and diagnose data by operating GUI.		
	diagnosis function	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/	—	Functions to create arbitrary analysis logic/data diagnosis logics		
	diagnosis logic operation function	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	—	To display the simple diagnosis result or diagnosis logic execution result.		
	display function	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 erro 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/	Option setting	—	To set the setting on Real-time Statistic Diagnosis Tool.		
liagnostic unction	function	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) Data storing setting (DB save)		To set the setting to output the process result in a file format.		
		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 set	tting	To set the setting of data modification plug-in.		
Edge application diagnosis 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 settin	g	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

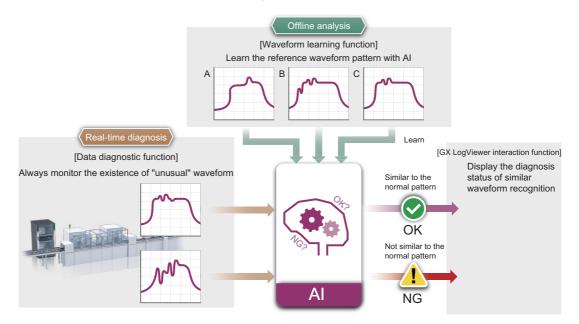
Use Real-time Data Analyzer to perform exercises for preventive maintenance of tool damage by collecting and monitoring the spindle motor current of aluminum case processing machine in real time.

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.

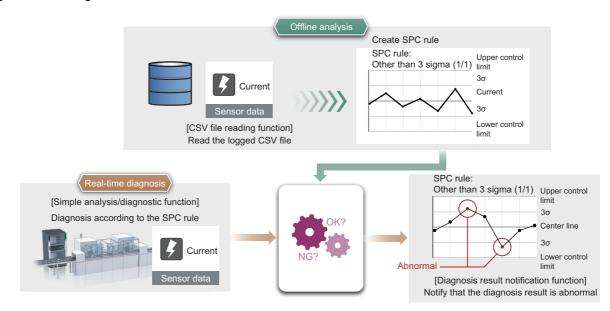
Similar waveform recognition

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.



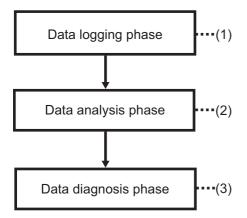
SPC

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 CP Page 31 Data Logging ■ SPC CP 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

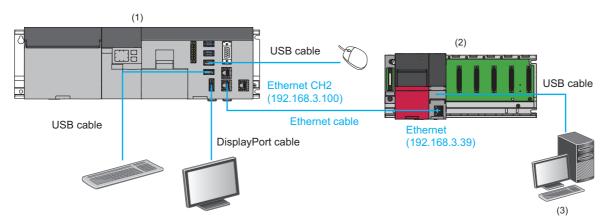
There are two types of programs for generating data to be logged and monitored: similar waveform recognition and SPC. This course does not include programming. When writing a program to the CPU module, write the programmed project "school_SimilarWave.gx3" or "school_SPC.gx3".

"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 co	Programmable controller	Main base unit	R35B	
	system	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	

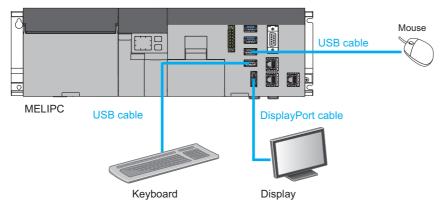
*1 The IP address of MELIPC is 192.168.3.100.

*2 The IP address of CPU module is 192.168.3.39.

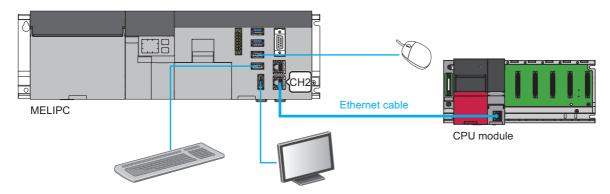
Wiring of demonstration machine

The following describes the wiring procedure of the demonstration machine.

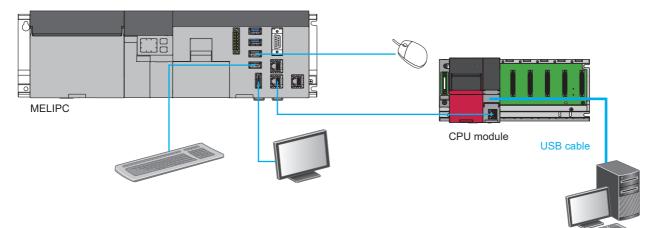
1. Connect peripherals (a keyboard, a display, and a mouse) to MELIPC.



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



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



Personal computer

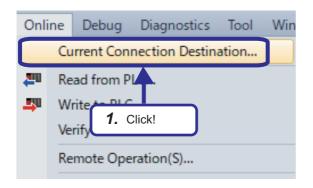
4 SETTINGS BEFORE EXERCISE

4.1 GX Works3

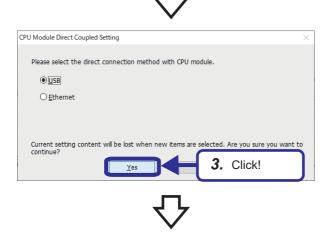
Specifying the connection destination

Specify the connection destination.

Operating procedure

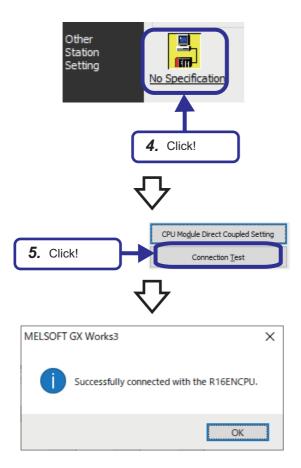


Specify Connection Destination Connection X
PC side I/F
PC side I/



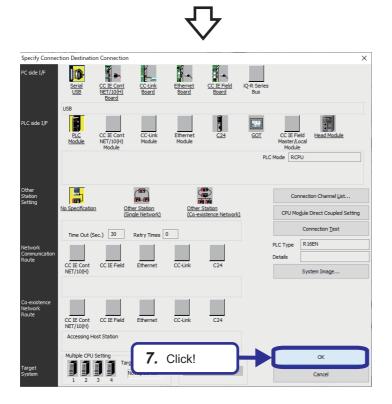
 Click the [CPU Module Direct Coupled Setting] button on the "Specify Connection Destination Connection" window. The CPU module direct coupled setting dialog is displayed.

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



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

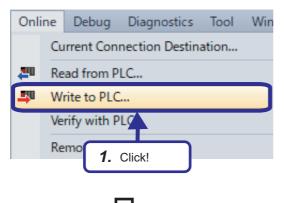
- 5. Click the [Connection Test] button.
- **6.** Check that the connection with the CPU module is succeeded.

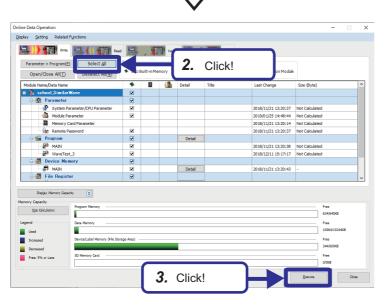


7. Click the [OK] button.

Writing program to the CPU module

Write the ladder program to the CPU module.

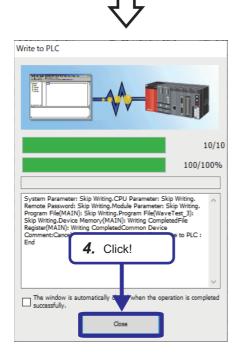




 Open the project "school_SimilarWave.gx3" and select [Online]
 ⇔ [Write to PLC...] from the menu of the engineering tool.

- **2.** When the online data operation dialog is displayed, click the [Select All] button.
- **3.** Click the [Execute] button.

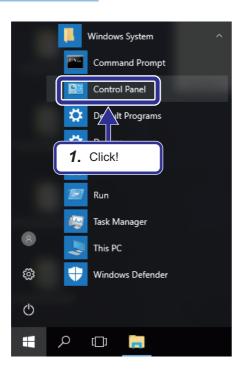
4. The write to PLC dialog box is displayed. When the writing is completed, the message "Completed." is displayed. Then, click the [Close] button.



4.2 TCP/IP Setting of MELIPC

Configure the TCP/IP setting of MELIPC.

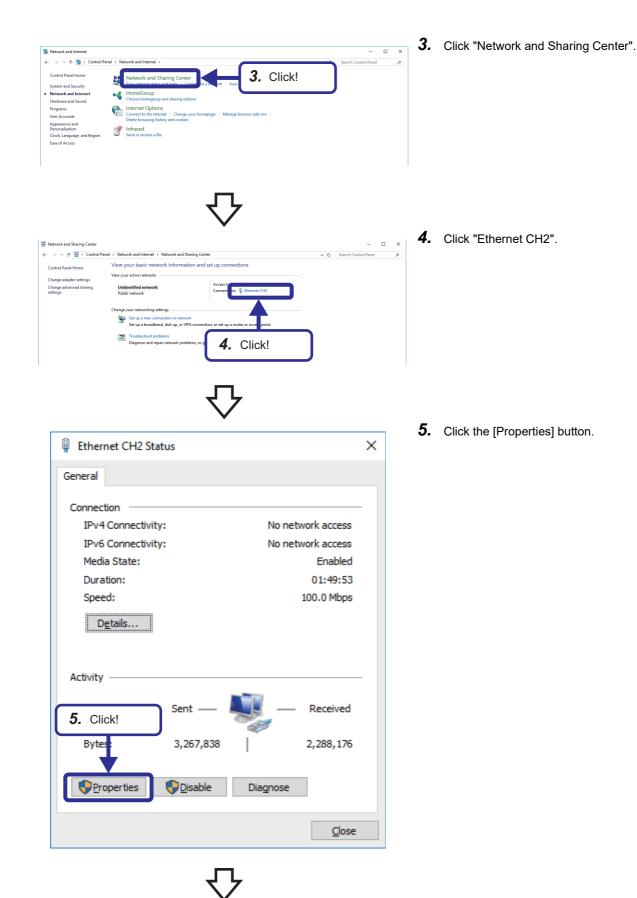
Operating procedure



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



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



🕴 Ethernet CH2 Properties 🛛 🗙
Networkins Sharins
Connect using:
Intel(R) 121 O Gigabit Network Connection #3
This conne 6. Select!
File and Printer Sharing for Microsoft Networks GoS Packet Schuduler
Internet Protocol Version 4 (TCP/IPv4) INICrosoft Ivetwork Adapter Multiplexor Protocol M Microsoft LLDP Protocol Driver
Install Uninstall Properties
Transmission Control Protocol/Internet Protocol. The refault wide area network protocol that provides communication across diverse interconnected networks. 7. Click!
OK Cancel

- 6. Select "Internet Protocol Version 4 (TCP/ IPv4)".
- 7. Click the [Properties] button.

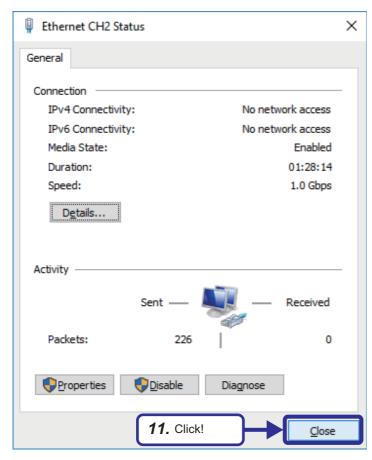


Internet Protocol Version 4 (TCP/IPv4)) Properties X
General	
You can get IP settings assigned this capability. Otherwise, you for the appropriate IP settings.	Set! your network supports
O <u>O</u> btain an IP address automatica	
— O Use the following IP address:	
IP address:	192.168.3.100
S <u>u</u> bnet mask:	255 . 255 . 255 . 0
Default gateway:	
 Obtain DNS server address autor Use the following DNS server add Preferred DNS server: Alternate DNS server: 	
Validate settings upon exit	Ad <u>v</u> anced
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- 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.

Ethernet CH2 Properties	×
Networking Sharing	
Connect using:	
👳 Intel(R) 21 O Gigabit Network Connection #3	
<u>C</u> on figure	
This connection uses the following items:	
 File and Printer Sharing for Microsoft Networks QoS Packet Scheduler Internet Protocol Version 4 (TCP/IPv4) Microsoft Network Adapter Multiplexor Protocol 	^
Install Uninstall Properties	
Description Allows your computer to access resources on a Microsoft network.	2

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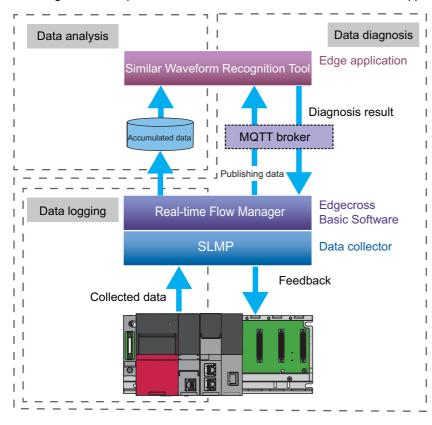


11. Click the [Close] button.

10. Click the [Close] button.

5 EXERCISE 1 ANALYSIS AND DIAGNOSIS WITH SIMILAR WAVEFORM RECOGNITION

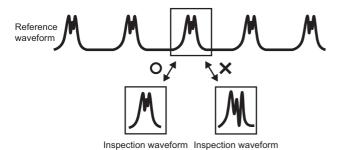
In the similar waveform recognition, data logging is performed from the CPU module using the SLMP data collector and a reference waveform is generated as a reference for diagnosis. With Similar Waveform Recognition Tool, the data input in real time is compared with the reference waveform to diagnose 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

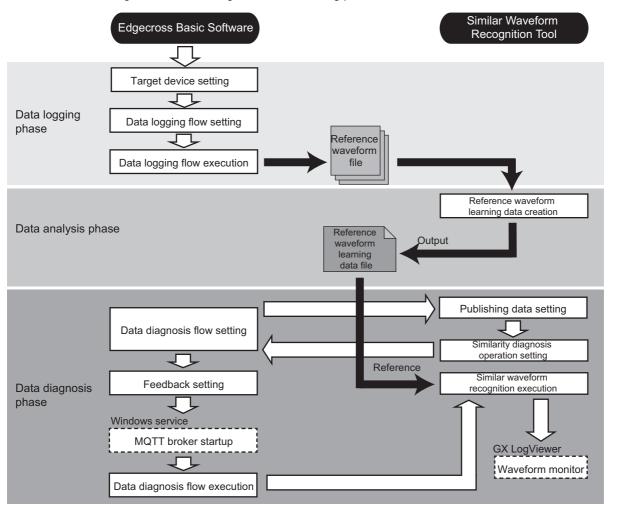
Similar Waveform Recognition Tool is an edge application that consists of the following functions.

- 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.	ST 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.	SP 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}	C Page 47 Data diagnosis flow setting (creating a publishing data definition file) C 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.	ST 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.	েল Page 62 Similar waveform recognition execution

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

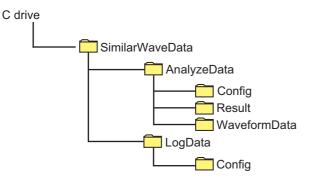
*1 The following shows the number of processes that can be used in each process.

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.

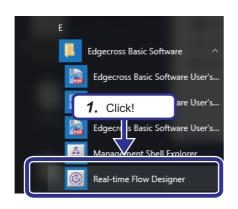
Create new folders in advance with the following folder structure.

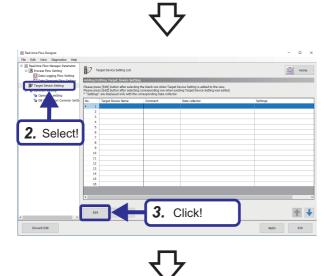


Target device setting

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.
- 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.

	d Data collectors.		
ta collector Name	Collect	Write	
FE Data collector for MIS122 Version 2 (MITSURISHI ELECTRIC)	Supported	Supported	
P Data collector Version 2 (MITSUBISHI ELECTRIC)	Supported	Supported	
File Data collector Version 1 (Edgecross Consortum)	Supported	Not Supported	
	_		_
			5. Click!

tting Name	Dev01								
mment									
	on parameter set								
Please set th This setting i	e device that is th s used to access	ne target of data access data of the Target Dev	ice via the Ethemet	network.					
Connection Type Device Type		Connection to MELSEC Device V							
		MELSEC IQ-R (programmable controller CPU/Process CPU/safety CPU) $ \!$							
Multiple CPU Setting		Not Specified	\sim						
Programma	able controller sid	le I/F CPU's buit-in Ethe	met port 🗸						
Network No. Station number of connection		1		IP Address	192 , 168 ,	3 . 39			
		on source 1	A	Station number of con	nnection target 1	A			
Time-out T	ime	10	Second	Retry Count	0	🕆 Tim			
Initial Acce	ss Delay Time	0	Second						
					ок	Can			
			6 , Se	stl					
			0. 00						
					T				
					7. Click!				

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- Interface and the set of the s

- **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.

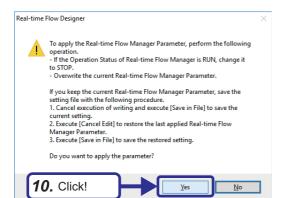
6. When the target device setting window is displayed, set as follows. [Setting details] Setting Name: Dev01 Connection Type: Connection to MELSEC Device Device Type: MELSEC iQ-R (programmable controller CPU/Process CPU/safety CPU) Multiple CPU Setting: Not Specified Programmable controller side I/F: CPU's builtin 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 P

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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.

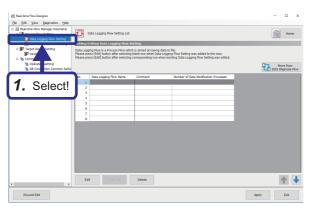


10. Click the [Yes] button and save the setting.

Data logging flow setting

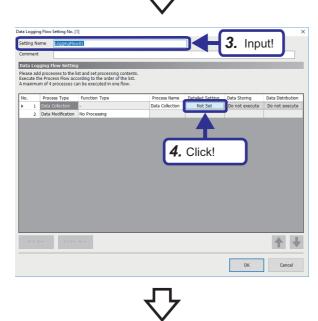
Collect data from the target device and save it as a CSV file.

Operating procedure





💯 Real-time Flow Designer Elle Edit View Diagnostics Help					- = ×		
Real-time Flow Manager Parameter M Process Flow Setting Data Logging Flow Setting	Adding/	Kome Home					
Data Diegnosis Flow Setting							
Target Device Setting	Data Lop Please pr	ging Flow is a Process Flow whic ess (Edit) button after selecting					
🗉 🏠 Common Setting							
😼 Operation setting 🔁 DB Connection Common Setti		Move from Data Diagnosis Flow					
	No.	Data Logging Flow Name	Comment	Number of Data Modification Processes			
	1 2						
	3						
	4						
	5						
	7						
	8						
< >	Ed		2. C	lick!	▲ ◆		
Discard Edit					Apply Exit		



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.

- 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.

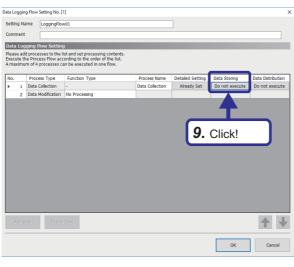
- Data claston Setting view of the collection splot.
- bac Celesion status Celesion status Pare set celesion to acculate tatus age of the celesion age and celesion age Celesion age Celesion age To accumant age of the celesion age of
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Data Collection Setting		
Please select the Target Device	for data collection and specify the collection option.	
Target Device	Dev01	~
Developer	MITSUBISHI ELECTRIC	
Data collector Name	SLMP Data collector	
Data collector Version	2	
Collection Data Collection C	ption	
Collection parameter setti		
Please set the collection p		
	00 mmec v (100-900)	
		8. Click!
		8. Click!
		8. Click!

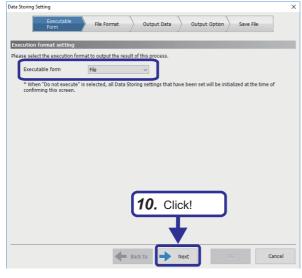
5. Select the target device of the SLMP data collector.[Setting details] Target Device: Dev01

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

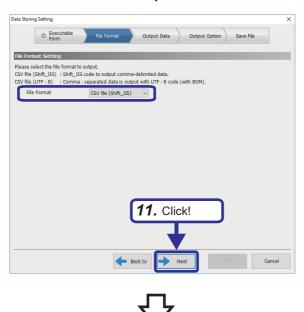
- 7. Select the "Collection Option" tab and set the collection interval as follows.[Setting details]Collection Interval: 100 msec
- 8. Click the [OK] button.











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



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.

- **13.** Set "Output Format" as follows. [Setting details] Decimal Format: Checked Digit of decimal: 3
- **14.** Click the [OK] button.

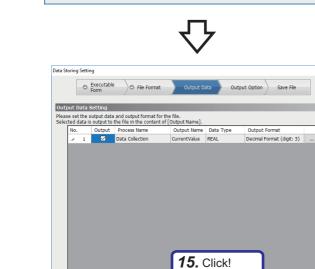
 \times

13. Set!

14. Click!

Cancel

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

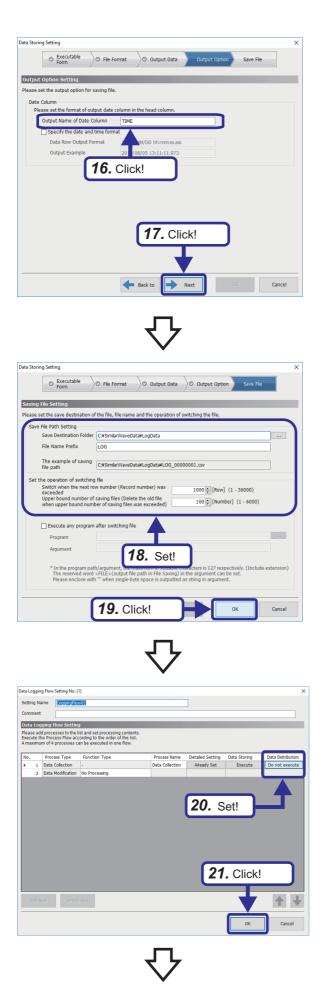


Select All Cancel All

Decimal Format (e.g.: 123.456789) O Index Format (e.g.: 12.34E2) Digit of decimal 3 🚖 (0 - 8) OK

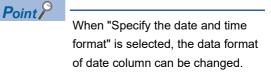
Output Format (FLOAT)

- Data Storing Setting Executable
 Form Sile Format Output Option Save File Output Data Setting ses set the output data and output format for the file. cted data is output to the file in the content of [Output Name]. No. Output Process Name Output Name 1 Data Collection CurrentValue Output Name Data CurrentValue REAL Data Type Output Fo Decimal Format (digit: 1 12. Click! Select All Cancel All Back to Cance



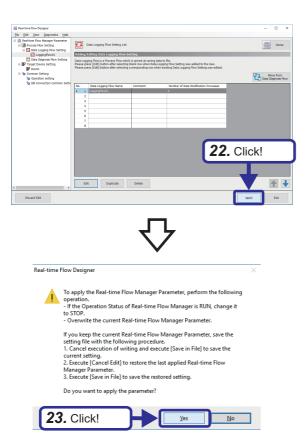
16. Set "Output Option" as follows. [Setting details] Output Name of Date Column: TIME

17. Click the [Next] button.



- **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.



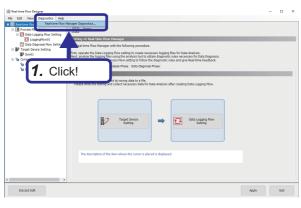
22. Click the [Apply] button.

23. Click the [Yes] button.

Data logging execution

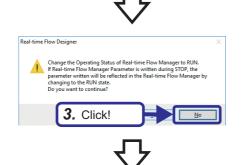
Execute logging with the settings configured in Real-time Flow Designer.

Operating procedure



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 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.

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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.

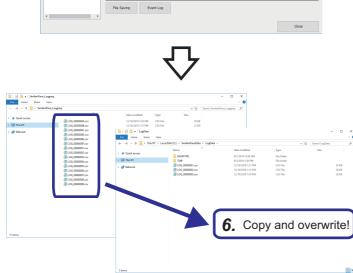
 When the required number of files has been created, click the [Stop Operation] button in "Operating Status" to stop creating files.

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.

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

The minimum number of records is as follows:

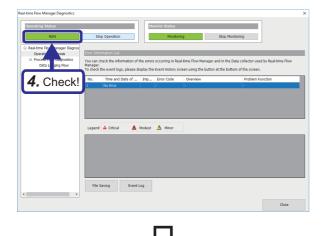
- To satisfy the restrictions of the waveform learning function: Records should be more than four times of the unit waveform width and temporally consecutive in one or more sections.
- To enable the minimum diagnosis operation: Records in which the basic cycle of a reference waveform is four cycles or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



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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.

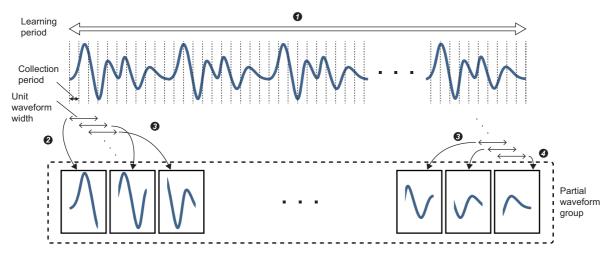
Detailed operation in waveform learning is as follows:

Import a waveform for the period specified as the learning period.

2 Analyze and learn the shape of the waveform (partial waveform) for the number of records specified in the unit waveform width.

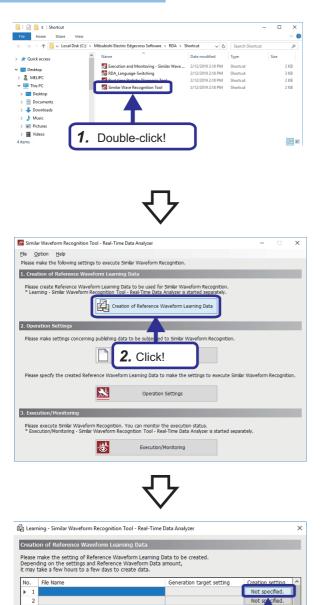
3 Repeat **2** for each record (collection cycle).

• 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



 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.".



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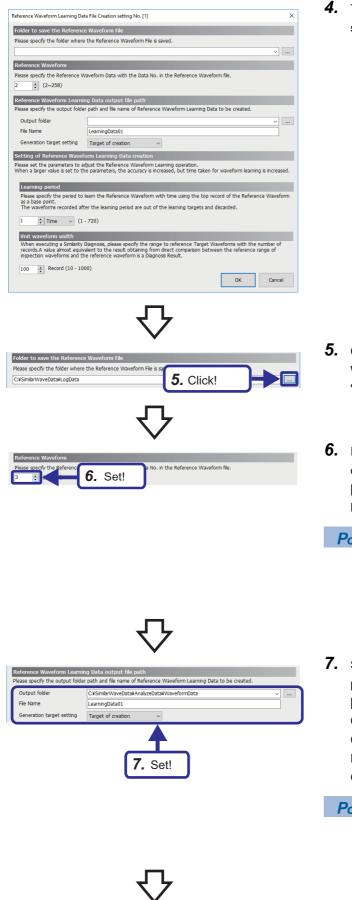
3. Click!

Not specified Not specified

Not specified Not specified Not specified

Not specified

Not specified. Close



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

- 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



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

- 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 P

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

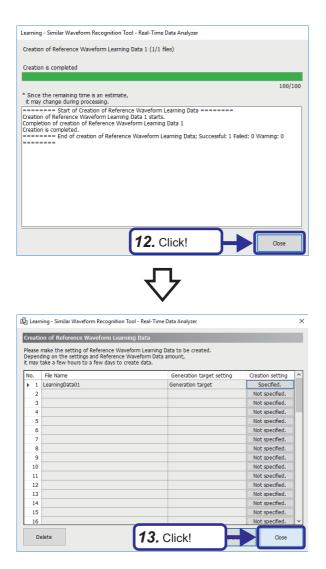
		erence Waveform Learning operation. , the accuracy is increased, but time taken for wave	form learning is increased.
Learn	ing period		_
		erence Waveform with time using the top ecord of	the Reference Waveform
	ase point. aveforms recorded after the learning	g period are out of the learning targets and discarde	he
		g period and out of the learning targets and abcard	
1	➡ Time ∨ (1 - 720)		
llnit v	vaveform width		8. Set!
When	executing a Similarity Diagnosis, plea	ase specify the range to reference Target Vaveform	ns with the number of
record	Is.A value almost equivalent to the reterence v	esult obtaining from direct comparison between the	reference range of
100	Record (10 - 1000)		
			OK Cancel
			T
		9. Cli	ick!
		\checkmark	
	ning - Similar Waveform Recognition	-	3
_	ning - Similar Waveform Recognition on of Reference Waveform Lean	-	;
Creatio Please (Depend	on of Reference Waveform Lear	rning Data aveform Learning Data to be created. 2 Waveform Data amount,	,
Creatio Please Depend t may 1	on of Reference Waveform Lear make the setting of Reference Wa ding on the settings and Reference	rning Data aveform Learning Data to be created. 2 Waveform Data amount,	Creation setting
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Please Depend t may 1 No. 1 2 3 4	on of Reference Waveform Lear make the setting of Reference Wa ding on the settings and Reference take a few hours to a few days to File Name	ming Data weform Learning Data to be created. Waveform Data amount, create data. Generation target setting	Creation setting Specified. Not specified. Not specified.
Creation Please of Depend t may 1 No. 1 2 3 4 5	on of Reference Waveform Lear make the setting of Reference Wa ding on the settings and Reference take a few hours to a few days to File Name	ming Data weform Learning Data to be created. Waveform Data amount, create data. Generation target setting	Creation setting Specfied. Not specfied. Not specfied. Not specfied. Not specfied.
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No. No. 1 2 3 4 5 6 7	on of Reference Waveform Lear make the setting of Reference Wa ding on the settings and Reference take a few hours to a few days to File Name	ming Data weform Learning Data to be created. Waveform Data amount, create data. Generation target setting	Creation setting Specified. Not specified. Not specified. Not specified. Not specified. Not specified. Not specified. Not specified.
Creatic Please Depend t may 1 No. 1 2 3 4 5 6 7 8	on of Reference Waveform Lear make the setting of Reference Wa ding on the settings and Reference take a few hours to a few days to File Name	ming Data weform Learning Data to be created. Waveform Data amount, create data. Generation target setting	Creation setting Specfied. Not specfied. Not specfied. Not specfied. Not specfied. Not specfied. Not specfied.

- 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.

Clo

> **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 P

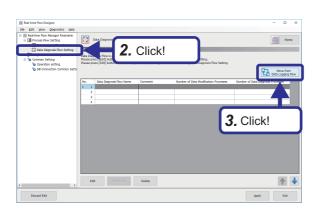
- GX LogViewer is installed at the same time when installing Real-time Data Analyzer.
- When the load on an industrial personal computer is high, the limit of the processing performance may be exceeded and the similarity diagnosis may stop. Before starting an actual operation, monitor the load of the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

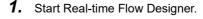
Data diagnosis flow setting (creating a publishing data definition file)

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

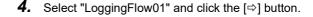
Operating procedure

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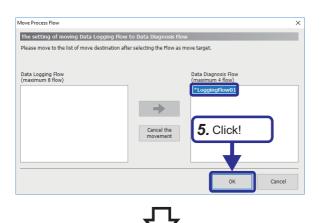


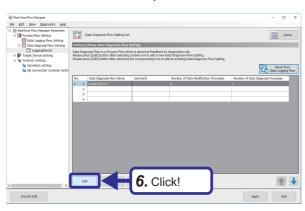


- 2. Click "Data Diagnosis Flow Setting" in the edit item tree.
- **3.** Click the [Move from Data Logging Flow] button.











Data D	liagno	osis Flow	Setting No.	[1]				×
Sett	ing Na	ame	LoggingFlov	/01		1		
Com	ment					_		
Dat	n Din	anasie	Flow Settir					_
				st and set processing conter	ote			
Exec	ute ti	he Proc	ess Flow acc	ording to the order of the lis in be executed in one flow.	st.			
Am	somu	1110101	processes ca	in be executed in one now.				
No.		Proce	iss Type	Function Type	Process Name	Detailed Setting	Data Storing	Data Distribution
+	1	Data 0	Collection		Data Collection	Already Set	Do not execute	Do not execute
	2	Data I	Indification	No Processing				•
	3		Diagnosis	No Processing				
	4	Feedb	ack	No Processing			No ble	Not executable
							<u></u>	
							Click!	
			Delete	Row				
_								
							ОК	Cancel

5. Click the [OK] button.

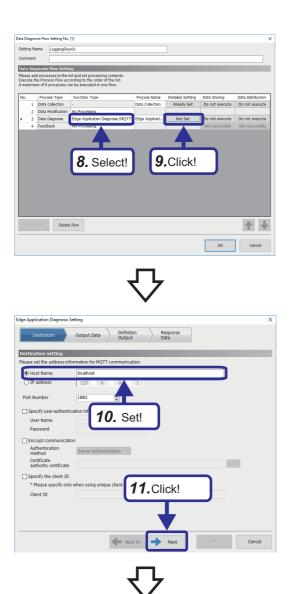
The flow set in the data logging flow is moved to the data diagnosis flow.

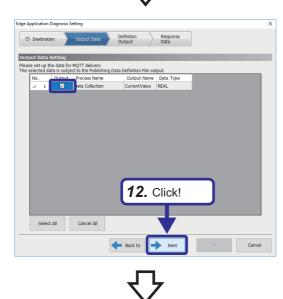
6. Click the [Edit] button. The "Data Diagnosis Flow Setting" window is displayed.

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



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





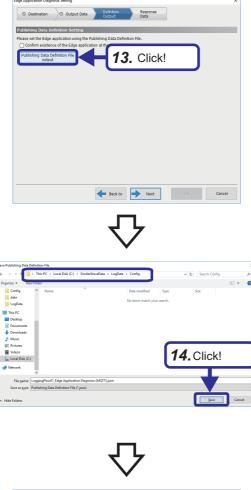
- **8.** Select "Edge Application Diagnosis (MQTT)" for "Function Type" of data diagnosis.
- 9. Click "Not Set" in "Detailed Setting".

- 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.

49

5



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

Point *P*

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

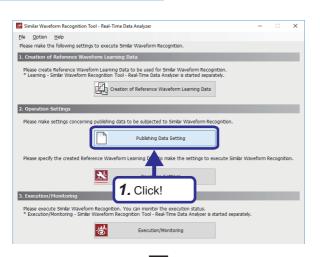
e Application Diagnosis Setting	
Destination Output Data Definition Response Data	
iblishing Data Definition Setting	
ase set the Edge application using the Publishing Data Definition File.	
Publishing Data Definition File	
output	
15. Click	
	: J
10. 0100	

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

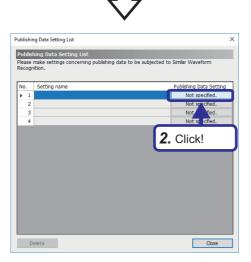
Set the diagnosis target data to be published to Similar Waveform Recognition Tool.

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.".





Publishing Data Setting No.[1]	×
Setting name	
Please enter the setting name.	
Setting name	
Publishing data definition	
Please read the publishing data definition file.	
Read file	
The data delivered in the selected put hing data definition file is as follows.	
Publishin data list	
Diagnosis execution 3. Click!	
For publishing data of the executing diagnosis.	
Diagnosis execution cycle [Record] (1 to 500)	
Apply OK Cancel	

Click the [Read file] button and select
 "C:\SimilarWaveData\LogData\Config\LoggingFlow01_
 Edge Application Diagnosis (MQTT).json" in the
 displayed file selection dialog.

Publishing Data Setting N	lo.[1]	×
Setting name		
Please enter the settin		1
Setting name Logging	JFlow01_Edge Application Dia	
Publishing data defir	hition	
Please read the publish	ing data definition file.	
	Read file	
The data delivered in t	he selected publishing data d	efinition file is as follows.
	Publishing data list	
Dia and a successful a		2
Diagnosis execution For publishing data of t		ofinition file
Please set the cycle fo Diagnosis execution	4. Click!	1 to 500)
Diagnoss execution		J
	Apply	OK Cancel
	4 4	
	•	,
Publishing data list		×
Publishing data list		
The data to be publis	hed is as follows.	
No. Data name		Data type
▶ 1 CurrentValue		REAL
	5. Click!	
	J. CIICK!	Close
	_	
	4 4	
	•	
Publishing Data Setting N	lo.[1]	×
Setting name		
Please enter the settin	g name.	
Setting name Logging		
	Flow01_Edge Application Dia	
Publishing data defir		
Publishing data defir Please read the publish	nition	
	nition ing data definition file.]
Please read the publish	nition ing data definition file. Read file]
	nition ing data definition file. Read file data d	efinition file is as follows.
Please read the publish	nition ing data definition file. Read file]
Please read the publish The data delivered in t Diagnosis execution	iition ing data definition file. Read file 6. Set! t	efinition file is as follows.
Please read the publish The data delivered in t Diagnosis execution	iition ing data definition file. Read file 6. Set! t	efinition file is as follows.
Please read the publish The data delivered in t Diagnosis execution	nition Ing data definition file. Read file 6. Set! t teselecter publishing data d executing diagnoss.	efinition file is as follows.
Please read the publish The data delivered in t Diagnosis execution For publishing data of t Please set the cycle for Diagnosis execution	ition Ing data definition file. Read file 6. Set! t cycle set executina diagnoss. cycle 5t [Record	efinition file is as follows. efinition file 1] (1 to 500
Please read the publish The data delivered in t Diagnosis execution For publishing data of t Please set the cycle for Diagnosis execution	ition Ing data definition file. Read file 6. Set! t cycle set executina diagnoss. cycle 5t [Record	efinition file is as follows.

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.

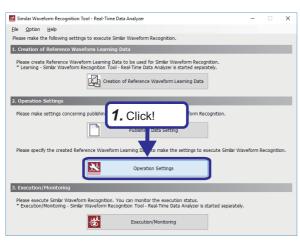
1	Setting name LoggingFlow01_Edge Application Diagnosis (MQTT)	Publishing Data Setting Specified.
2	Logging Iowo1_Loge Appleadon Disgnosis (HQTT)	Not specified.
3		Not specified.
4		Not specified.

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



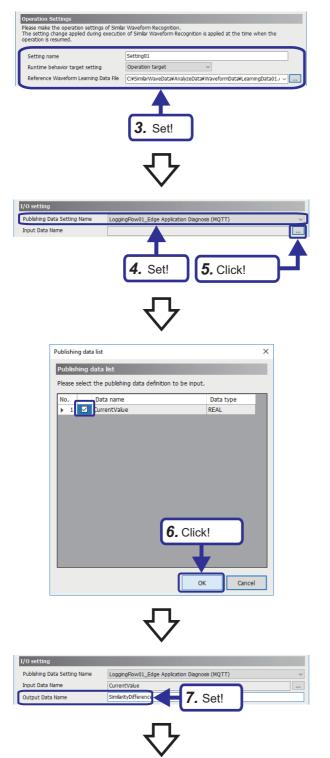
1. Click the [Operation Settings] button of Similar Waveform Recognition Tool.



	tion Settings				
lease The se	make the operation tting change applied	settings of Similar Waveform Recognition during execution of Similar Waveform Re	n. ecognition is applied at the time wi	hen the operation is resum	ed.
No.	Setting name	Operation target upon execution	Publishing Data Setting Name	Operation Settings	1
▶ 1				Not specified.	
2				woe spreened.	
3				Not fied.	
4				Not se cined.	Ľ
5			_ _	Not sr cified	
6			2	Click!	
7			Z	UIICK!	
8			Ľ		
8			2	Not specified.	
8 9 10			2	Not specified.	
8			2	Not specified.	
8 9 10 11			2	Not specified. Not specified. Not specified.	
8 9 10 11 12			2	Not specified. Not specified. Not specified. Not specified.	
8 9 10 11 12 13			2	Not specified. Not specified. Not specified. Not specified. Not specified.	
8 9 10 11 12 13 14				Not specified. Not specified. Not specified. Not specified. Not specified.	

 $\overline{\mathbf{v}}$

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



- 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\Learn
 ingData01.dspr
- 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

Operation Setting No. [1]	×
Operation Settings	
Please make the operation settings The setting change applied during e operation is resumed.	of Similar Waveform Recognition. xecution of Similar Waveform Recognition is applied at the time when the
Setting name	Setting01
Runtime behavior target setting	Operation target \checkmark
Reference Waveform Learning Da	
I/O setting	8. Set!
Publishing Data Setting Name	LoggingFlowU1_Edge upplication Diagnosis (MQTT) ~
Input Data Name	CurrentValue
Output Data Name	SimilarityDifference
Detection sensitivity	
1 (Low) 2	3 4 (Recommended) 5 6 (High)
1	and the second
Diagnosis Result file saving setti	ing
Output Settings	Only difference condition
Numeric representation	Decimal representation \checkmark
Number of digits after decimal poin	t 3 💭 [Digit] (0 - 15)
Switched when the following num	ber of rows (records) is exceeded. 2000 🔷 [Row] (1 - 36000)
Max. number of save files (when ex	xceeded, the oldest file is deleted.) 100 🜩 [Number] (1 - 6000)
Save destination folder C:¥S	imilarWavaData_AnalyzeData¥Result
Prefix of file name Resu	it
Example of save file path C:¥S	imilarWavaData_AnalvzeData¥Result¥Result_00000001.csv
	9. Click!

- 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.

No.	Setting name	Operation target upon execution	Publishing Data Setting Name	Operation Settings
▶ 1	Setting01	Operation target	LoggingFlow01_Edge Applicati	Specified.
2				Not specified.
3				Not specified.
4				Not specified.
5				Not specified.
6				Not specified.
7				Not specified.
8				Not specified.
9				Not specified.
10				Not specified.
11				Not specified.
12				Not specified.
13				Not specified.
14				Not specified.
15				Not specified.
16				Not specified
D	elete	10. Click!	Respons	se data definition file outp

eration Setting

Operation Sett

Similar Waveform Recognition Tool - Real-Time Data Analyzer × Successful output of response data definition file. 11. Click! OK

11. Click the [OK] button.

The response data definition file "LoggingFlow01_Edge Application Diagnosis (MQTT)_Outputdata.json" is created.

No.	Setting name	Operation target upon execution	Publishing Data Setting Name	Operation Settings	
▶ 1	Setting01	Operation target	LoggingFlow01_Edge Applicati	Specified.	
2				Not specified.	
3				Not specified.	
4				Not specified.	
5				Not specified.	
6				Not specified.	
7				Not specified.	
8				Not specified.	
9				Not specified.	
10				Not specified.	
11				Not specified.	
12				Not specified.	
13				Not specified.	
14				Not specified.	
15				Not specified.	
16				Not specified.	

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

O De	itination 🛛 🛇 Output D	ata O Definition Output	Response Data	
	of Response Data		-	
	t the Response Data definition	on information as output (lata from the Res	soonse Data Definition File.
				Get Response Data definition
10.	Output Data	Data type	Length	Output Data Setting
1				
2				
3			_	
4			_	1. Click!
5			-	
7				
8				
9				
10				
11				
12				v
		Back to	Next	OK Cancel
		र्	ን	
Real-tii	ne Flow Designer			×

Acquisition of the Response Data definition info completed.

3, Click!

Please confirm the details of acquisition as it may have made the following changes when obtaining definition information. - (data name) that contained prohibited characters (*) or duplicated has been changed to the name "Outputox". **, (comma), (single-byte space) "and control characters

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

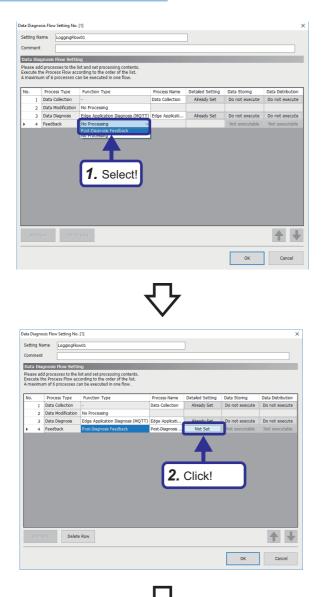
					Get Response Data defi	nition
No.	_	Output Data	Data type	Length	Output Data Setting Name	^
•	1	DifferenceCount	UINT	0	DifferenceCount	15
_	2	SimilarityDifference	REAL	0	SimilarityDifference	
-	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
	11					
	12					~

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

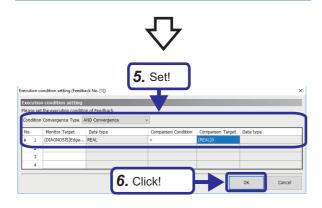


 In the "Data Diagnosis Flow Setting" window of Realtime Flow Designer, select "Post-Diagnosis Feedback" for "Function Type" of feedback.

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

ost-I	Diag	jnosis Feedback Setting			
he Fe	edb	ack suppression period ca	condition to be done after Data Diagnosis of previous process. In be set up to 24 hours after execution.		
	ackı	will not be executed even	f the execution condition is satisfied during the execution inhibit perio Execute Condition Execution Execution Execution		For the shift of the
0.		Instruction Feedback	Execute Condition Execution Frequency Deterrence Period	Deterrence Period (unit)	Feedback Setting
	2	histocoon reedback	3. Select!		
	_	Instruction Feedback Feedback of Program Exe			
	4				
				ок	Cancel

Pos	-Dia	osis Feedback Setting Ignosis Feedback Setting					
Plea	e se	t Feedback and execution o	ondition to be done after	r Data Diagnosis of prev	ious process.		
		back suppression period can will not be executed even if			execution inhibit perio	od.	
			C				
No.		Feedback Type	Execute Condition	Execution Frequency		Deterrence Period (unit)	Feedback Setting
۰.	1	Instruction Feedback	Not Set	specify Deterrence	1	Minute	Not Set
	2						
	3						
	4						
	Í	C	Click!				



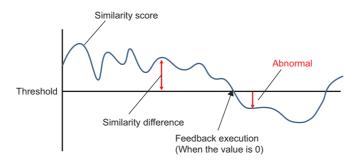
3. In the post-diagnosis feedback setting window, select "Instruction Feedback" for "Feedback Type".

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

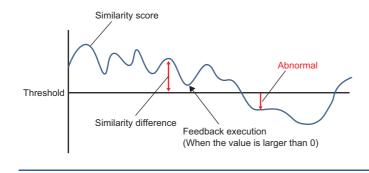
- 5. Set "Execution condition setting" as follows. [Setting details]
 Condition Convergence Type: AND Convergence
 Monitor Target: Data diagnosis result ⇔ Edge
 application diagnosis (MQTT) ⇔ Similarity difference
 Comparison Condition: <
 Comparison Target: Constant ⇔ [REAL]
 Enter 0 as a real number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



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".

- Inductor feeded steing

 Type feeded

 Type feeded

 </t
- 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.

Post-Diagnosis Feedback Setting	×
Post-Brugenous Feedback Setting Fasse at Feedback and searchic condition to be done after Data Diaposts of previous process. The Feedback into previous process. Feedback wing be executed over if the execution condition to a statefed during the execution inhibit period.	
No. Feedback Type Execute Condition Execution Prequency Deterrence Period Deterrence Period (unit) Feedback Set > 1 Instruction Feedback Already Set Specify Deterrence 1 Minute Already Set	
2	
10. Click!	el:
$\overline{\mathbf{V}}$	
Data Disgnosis Flow Setting No. [1]	×
Setting Name LoggingFlow01	
Comment Data Diagnosis flow Setting	J
Please add processes to the list and set processing contents. Execute the Process Flow according to the order of the list. A maximum of 6 processes can be executed in one flow.	
No. Process Type Function Type Process Name Detailed Setting Data Storing Data Data Data Data 1 Data Collection - Data Collection Already Set Do not execute Do not execute	
2 Data Modification No Processing 3 Data Diagnosis Edge Application Diagnosis (MQTT) Edge Application. Already Set Do not execute Do not execute 4 Feedback Post-Diagnosis Feedback Post-Diagnosis multi-securation Already Set Not executable Not executable	
Add Rom Delete Row	ł
\checkmark	
If technis Non-Degree - Dis (Ed. Verice Deprivations Symbol Control Stations) - Dis (Ed. Verice Deprivations Symbol Control Stations) -	×
Control Response Rese Stating	
Comparison C	w
20 Grankster Cennol field 1 1 1 1 1 2 2 3 1	
	Ц
12. Click!	J
↓	
c 3 Edt Dajkon Doke A Con	
$\overline{\mathbf{v}}$	
$\mathbf{\vee}$	
Real-time Flow Designer $ imes$	
To apply the Real-time Flow Manager Parameter, perform the following operation.	
 If the Operation Status of Real-time Flow Manager is RUN, change it 	
to STOP. - Overwrite the current Real-time Flow Manager Parameter.	
Overwrite the current Real-time Flow Manager Parameter. If you keep the current Real-time Flow Manager Parameter, save the setting file with the following procedure. 1. Cancel execution of writing and execute [Save in File] to save the	
Overwrite the current Real-time Flow Manager Parameter. If you keep the current Real-time Flow Manager Parameter, save the setting file with the following procedure. 1. Cancel execution of writing and execute [Save in File] to save the current setting. 2. Execute [Cancel Edit] to restore the last applied Real-time Flow Manager Parameter.	
Overwrite the current Real-time Flow Manager Parameter. If you keep the current Real-time Flow Manager Parameter, save the setting file with the following procedure. 1. Cancel execution of writing and execute [Save in File] to save the current setting. 2. Execute [Cancel Edit] to restore the last applied Real-time Flow	

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



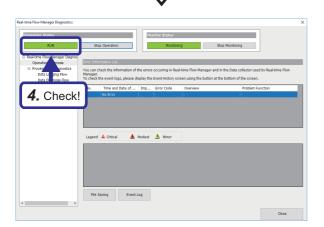
exercises

🔺 Modest 🔺 Min

File Saving Event Log

2. Click the [Start Operation] button.

Real-time Flow Designer × Real-time Flow Designer × Change the Operating Status of Real-time Flow Manager to RUN. Real-time Flow Manager Parameter is written during STOP, the parameter written pulle are reflected in the Real-time Flow Manager by De you want to continue? 3. Click! <u>Yes No</u>



3. Click the [Yes] button.

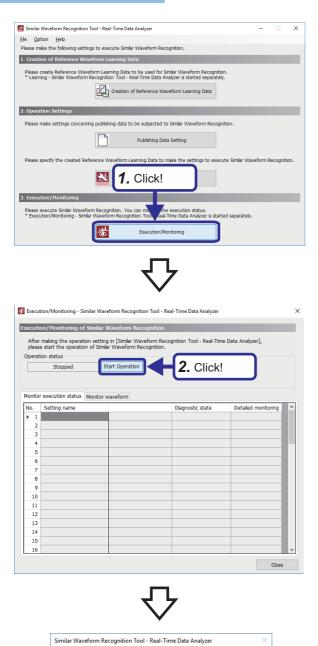
4. Check that "Operating Status" is set to RUN.

5

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



Operation of Similar Waveform Recognition will be started with the

current settings. Do you want to continue

3. Click!

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

2. Click the [Start Operation] button.

3. Click the [Yes] button.

No

pleas	making the operation se e start the operation of s tion status Execution ongoing	tting in [Similar Waveform Rec Similar Waveform Recognition.		e Data Analyzer],
	Execution ongoing	4. Di	splay!	
Ionito	r execution status Moni	tor waveform		
No.	Setting name		Diagnostic state	Detailed monitoring
▶ 1	Setting01	Operation target	Similarity	View
2				
3				
4				
5				
6				5. Click!
7			•	J. CIICK!
8				
9				
10				
11				
12				
13				
14				
15				
16				



Similar Waveform Reco	gnition execution s	status deta	iled mon	itoring No. [1]			×
Setting name			Setting	01			
Diagnostic state			Similarit	y			
The latest Anomaly s	start date and time	е					
Minimum similarity sco	ore recorded date	and time	2019/0	8/05 16:17:00.00	0000000		
Date and time of late	est diagnosis		2019/0	8/05 16:17:34.90	0000000		
Present status conti	nuity hours		0:00:45	5			
Statistic information	1						
Lowest Similarity	Score		99.5				
Difference conditi	on detection cour	it	0				
Operating time			0:00:45	;			
Similarity score thre	shold information						
Similarity score thre	eshold		50.0				
Similarity score three	eshold list						
1	2	3		4	5	6	
50.0	100.0	100	.0	100.0	100.0	100.0	
						Close	

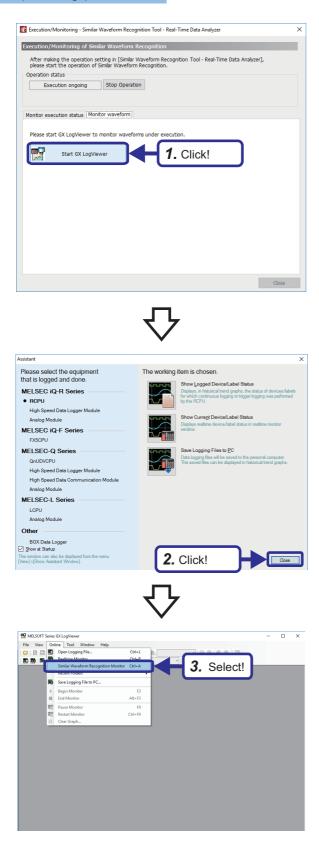
- **4.** The operation status in the "Execution/Monitoring" window is displayed as "Execution ongoing".
- 5. Click "View" in "Detailed monitoring".

 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



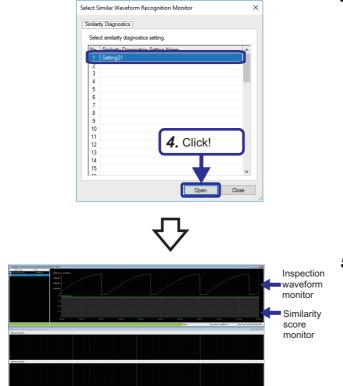
1. Click the [Start GX LogViewer] button in the "Monitor waveform" tab of the "Execution/Monitoring" window.

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.



64



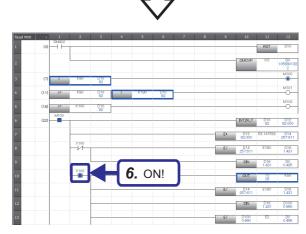
4. In the "Select Similar Waveform Recognition Monitor" window, select the name of the diagnosis to be monitored and click the [Open] button.

5. The "Similar Waveform Recognition Monitor" window is displayed.

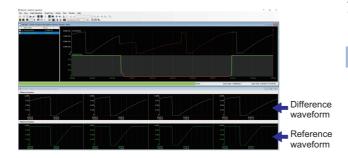
The waveform shown on the left is obtained by adjusting the upper and lower limits of the inspection waveform and the similarity score.

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 P

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.

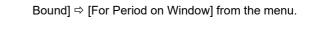
In that case, adjust the upper and lower limits of the graph with the following procedure.

Operating procedure



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





2. Click [Graph Operation] ⇒ [Auto Adjust Upper/Lower



5 EXERCISE 1 ANALYSIS AND DIAGNOSIS WITH SIMILAR WAVEFORM RECOGNITION

5

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.

Setting01 Auto Adjust Upper/Lower Bound Edit Upper/Lower Bound Change Upper/Lower Bo Adjust S<u>c</u>ale Adjust Graph Loca Adjust <u>F</u>ont 4. Click! Adjust <u>T</u>ime Show Previous Graph Ctrl+Alt+Left Arrow Ctrl+Alt+Right Arrow Show Next Graph

MELSOFT Series GX LogViewer

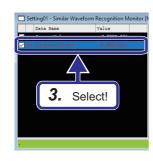
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Jump Cursor..





<u>File View Graph Operation</u> Graph View <u>Online Tool Window H</u>el

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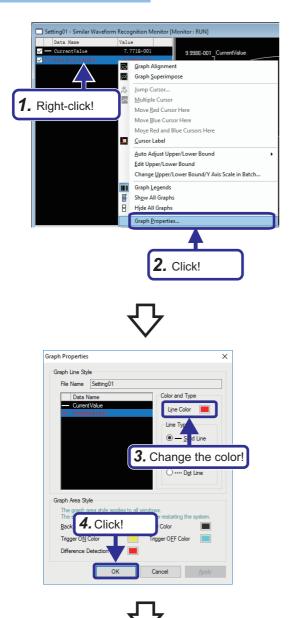
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Ctrl+G

Changing the line color

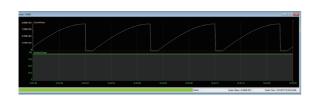
When the "Similar Waveform Recognition Monitor" window is displayed, it may be difficult to distinguish the abnormal waveform with the default line color of the similarity score monitor. In that case, change the line color with the following procedure.

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.

Device <u>N</u> an	ne		M)							✓ Detailed Conditions	۲
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M40	0	0	0	0	0	0	0	0	0	0		
M50	0	0	0	0	0	0	0	0	0	0		
M60	0	0	0	0	0	0	0	0	0	0		
M70	0	0	0	0	0	0	0	0	0	0		
M80	0	0	0	0	0	0	0	0	0	0		
M90	0	0	0	0	0	0	0	0	0	0		

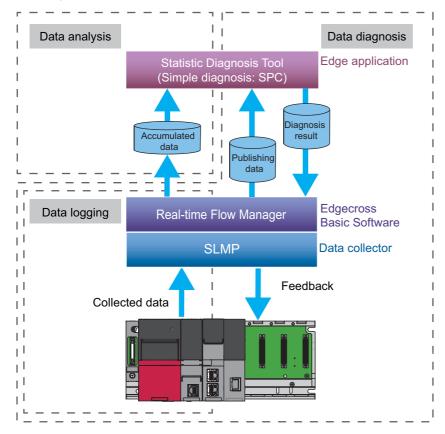
Check that M0 is turned on with the device/buffer memory batch monitor of GX Works3.

Point P

- 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.

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.

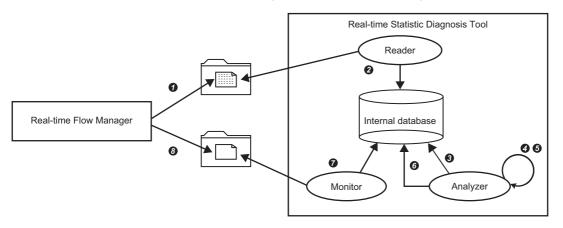
- Read a CSV file, analyze the data in the CSV file, and create diagnosis rules.
- Perform diagnosis based on the set rule, and when an abnormality is detected, notify the abnormality by outputting the response data file or displaying a pop-up on the screen.

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.



- Real-time Flow Manager outputs the data collected in a production site to a specified folder as a CSV file.
- Preader reads the CSV file and registers it to the internal database of Real-time Statistic Diagnosis Tool.
- 3 Analyzer references the data registered in the internal database.
- A user analyzes the data offline and set collection data to be diagnosed and diagnosis rules by using Analyzer.
- **6** Analyzer starts a diagnosis according to the set diagnosis rule.
- **6** When an abnormality is detected, Analyzer registers the abnormality to the internal database.

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.

B Real-time Flow Manager checks the output of a response data file and executes feedback when the output is detected.

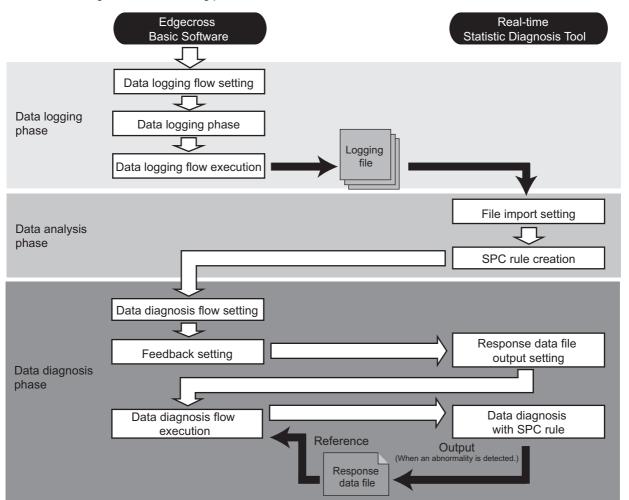
6.2 SPC

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.	েল 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}	SP 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.	SP 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.	ST Page 104 Data diagnosis with SPC rule

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

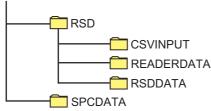
Flow type	Data collection	Data modification	Data diagnosis	Feedback execution
Data logging flow	1 (Required)	3	-	-
Data diagnosis flow	1 (Required)	3	1 (Required)	1 (Required)

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 P

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.

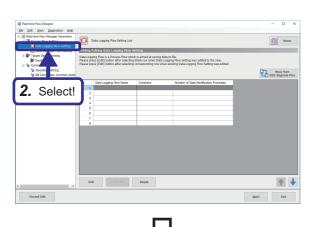
Point P

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

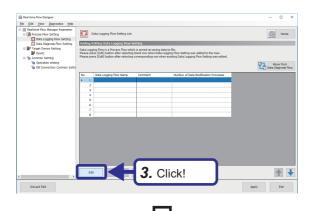
Operating procedure

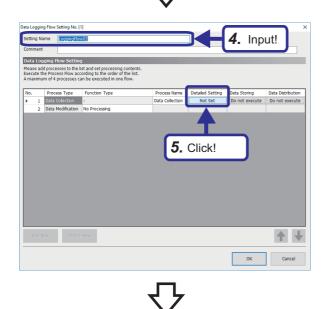


 Open the SPC project "school_SPC.gx3" and write it to the programmable controller. For the operating procedure, refer to the following.

Series Page 22 Writing program to the CPU module

2. Select "Data Logging Flow Setting" in the edit item tree.





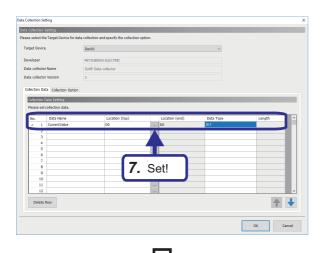
3. Select a blank row in the data logging flow setting list and click the [Edit] button.

- 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

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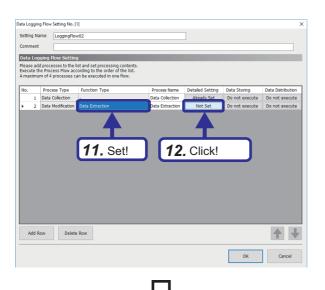
7. Select the "Collection Data" tab and set the data name, device address, and data type of the data to be collected as follows.
[Setting details]
Data Name: CurrentValue
Location (top): D0
Data Type: INT

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

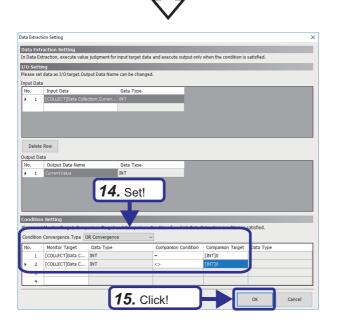
10. Set data storing and data distribution to "Do not execute".

Point P

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

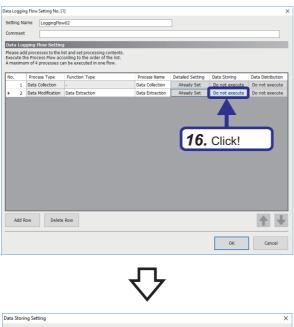


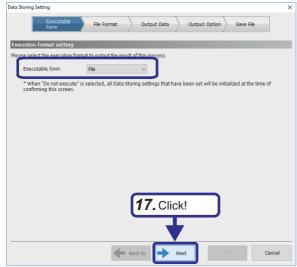
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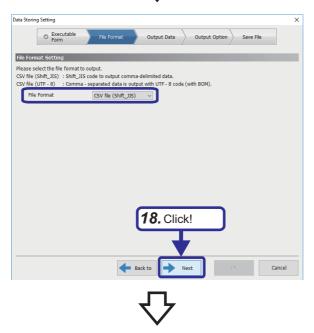
- **11.** Select "Data Extraction" for "Function Type" of data modification.
- **12.** Click "Not Set" in the detailed setting.

- **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.





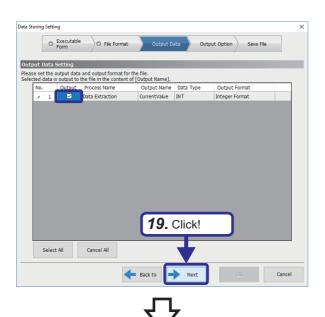




16. Click "Do not execute" in data storing.

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.



Data Storing Settin Executable Form O File Format Output Data Save Fil Output Option Setting Please set the output option for saving file Date Colum ase set the format of output date column in the head colu Output Name of Date Column Specify the date and time fo Data Row Output Fo Output Exam 20. Click! 21. Click! Cancel

Executable Form	File Format Output Data Output Option Save File
Point	
File Setting	
set the save destination of	f the file, file name and the operation of switching the file.
File Path Setting	
Save Destination Folder	C:¥SPCDATA
File Name Prefix	SPC
The example of saving file path	C:#SPCDATA#SPC_00000001.csv
the operation of switching	
the operation of switching	
Switch when the next ro	w number (Record number) was
exceeded	1000 [Kow] (1 - 36000)
exceeded Upper bound number of	w number (Record number) was 1000 (* [Row] (1 - 36000) saving files (Delete the old file ber of saving files was exceeded) 100 (* [Number] (1 - 6000)
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exceeded Upper bound number of when upper bound numl Output in Data Extrac Execute any program Program Argument * In the program pat The reserved word	saving files (Delete the old file ber of saving files was exceeded) 100 [Number] (1 - 6000) 100 [Numbe
exceeded Upper bound number of when upper bound numl Output in Data Extrac Execute any program Program Argument * In the program pat The reserved word	saving files (Delete the old file ber of saving files was exceeded) 100 [Number] (1 - 6000) 100 [Numbe

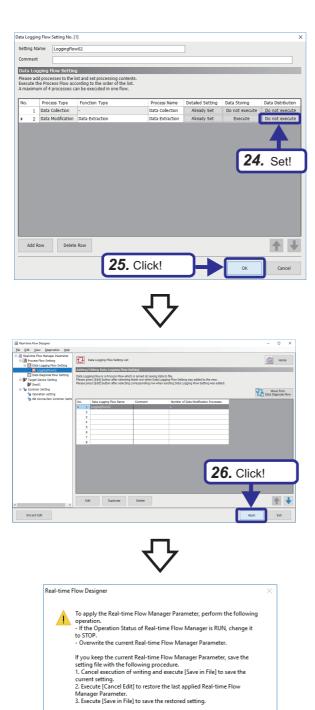
19. Select the data to be output and click the [Next] button.

- **20.** Set "Output Option" as follows. [Setting details] Output Name of Date Column: TIME
- 21. Click the [Next] button.

Point P

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. Oktober 10/4 houter
- 25. Click the [OK] button.

26. Click the [Apply] button.

27. Click the [Yes] button.

Do you want to apply the parameter?

Yes

No

27. Click!

Data logging execution

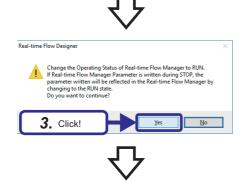
Execute logging with the settings configured in Real-time Flow Designer.

Operating procedure









 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.

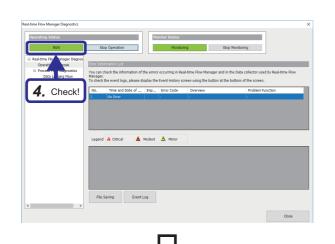
4. Check that "Operating Status" is set to RUN and that the file is created in the save destination folder set in the data logging flow.

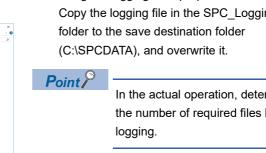
5. When the required number of files has been created, click the [Stop Operation] button in "Operating Status" to stop creating files.

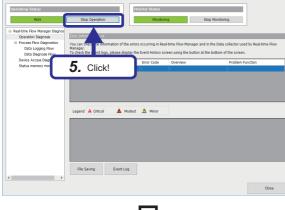
6. In this training, perform analysis and diagnosis using the logging data prepared in advance. Copy the logging file in the SPC_Logging folder to the save destination folder (C:\SPCDATA), and overwrite it.

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

- 5. Click! 🔺 Modest 🔥 Min Legend A Critical File Saving Event Log
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 Location 6. Copy and overwrite!







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

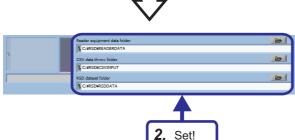
Specify the sample CSV file, define the CSV file to be read by Reader (definition of the module), and output the response data definition file.

Operating procedure

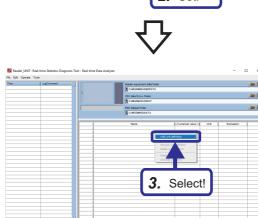


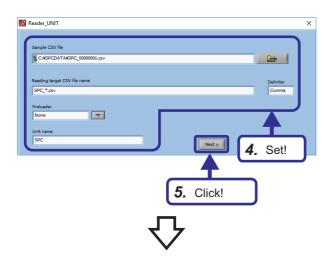
 From Windows[®] start

 [Mitsubishi Electric Edgecross Software]
 [Real-time Data Analyzer], double-click [Real-time Statistic Diagnosis Tool].

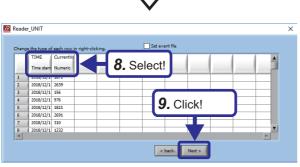


- 2. Set each folder of Reader as follows. [Setting details] Reader equipment data folder: C:\RSD\READERDATA CSV data throw folder: C:\RSD\CSVINPUT RSD dataset folder: C:\RSD\RSDDATA
- **3.** In the Reader window, right-click a blank row ⇒ select [Add unit definition].

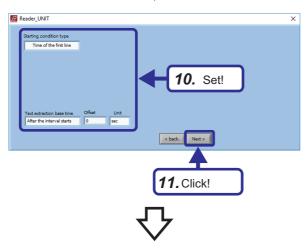




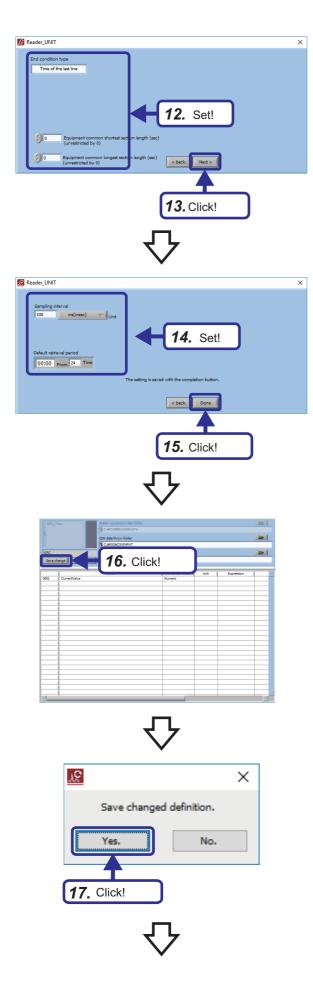
Row item title	TIME	CurrentValue		6	Sele	otl 🔺
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Data	2018/12/12 10:36:5	156				_
Data	2018/12/12 10:36:5	976				
Data	2018/12/12 10:36:5	1821				
Data	2018/12/12 10:36:5	2691	1_			
Data	2018/12/12 10:36:5	310	7. Clie	~k1		
Data	2018/12/12 10:36:5	1232		511:		
Data	2018/12/12 10:36:5	2179		1		
Data	2018/12/12 10:36:5	3152	_			
Data	2018/12/12 10:36:5	1898				T







- **4.** Set the unit definition as follows. [Setting details] Sample CSV file: C:\SPCDATA\SPC_0000001.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.

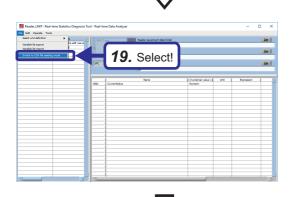


- 12. Set the end condition as follows.
 [Setting details]
 End condition type: Time of the last line
 Equipment common shortest section length (sec): 0
 Equipment common longest section length (sec): 0
- **13.** Click the [Next>] button.

- **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.



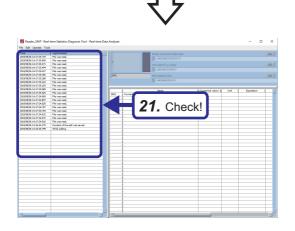
DAT/

20. Copy!

.....

- **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*.csvCopy 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.

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129/06/06 14:17:25.089	File was read.		1		Name	& Inumerical value (Une	Donation		-
19/06/06 14:17:05.025	File was read.		Ormet	at a	NETN	Numerical Value (-	Unit	Distance		
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9/06/06 14:17.34.897	Fie was read.		- 1						-	
9/08/06 14:17-04.828	File was read.		-1						-	
9/08/06 14:17:34.787	Ple was read.		_							
105/05 14:17:34.703	Pie was read.		_							
106/06 14:17:34:632	File was read.		_							
06/06 14:17:34:572	File was read.		_							
000/06 14:17:34.513	File was read.		_						-	
9/06/06 14:16:52.375	Content of the edit was saved.									
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22. Select [File] ⇒ [Switch to setting edit mode] from the menu of Reader.

Reader is restarted.

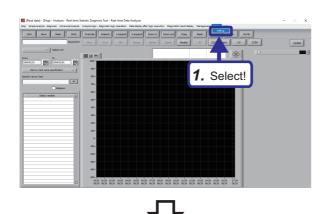


When the file read is not completed successfully, perform the same procedure again for [Delete unit definition] ⇔ [Add unit definition] after "Switch to setting edit mode".

SPC rule creation

Create the SPC rule for SPC diagnosis with Analyzer.

Operating procedure



3. Click!

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.



2. Select!

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

	Reader_UNIT C:MRSDWR	DDATANUNIT			5. Sele	ect!	
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	Unit	Diagnosing	Last collection time 2019/08/01 16:00:57.000	No.	logic Honitor	Diegnosing	Last operation time
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6. Restart!

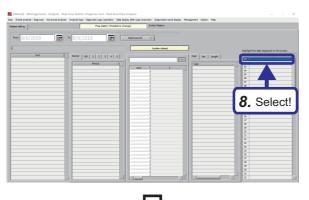
Real

5. Click "Select equipment" in Monitor and select the unit (Reader_UNIT C:\RSD\RSDDATA\UNIT) specified in Reader.

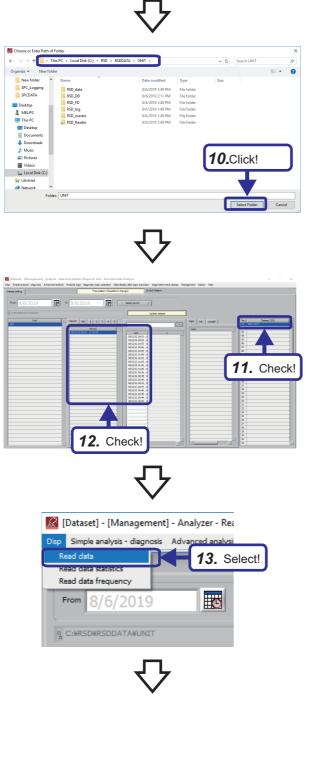
Check that the SPC is displayed as the unit name.

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.
- Image: Second and the second and t



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



0

9. Select!

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.



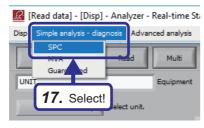
The section is not displayed unless the period is selected.

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

[Setting details] Equipment: UNIT Select unit.: SPC 14. Check! Select variable: CurrentValue Point P If the settings are not displayed, click the [Update] button. **15.** Set the period of the data to be diagnosed. UNIT Equipn Since the prepared logging data is used, set the following according to the period of the logging data. SPC Select unit [Setting details] Fron From: 2018/12/12 2018/12/12 C 2018/12/12 Ø To: 2018/12/12 Narrow text na cification Point P 15. Set! T If the settings are not displayed, restart Analyzer, Monitor, and Reader, and click the Histgra [Update] button. **16.** Select "CurrentValue" for "Select variable" and check Nevel Picers Lock Solifs that the data is displayed. Point P For details on the display, refer to the following.

14. Check that the settings are as follows.



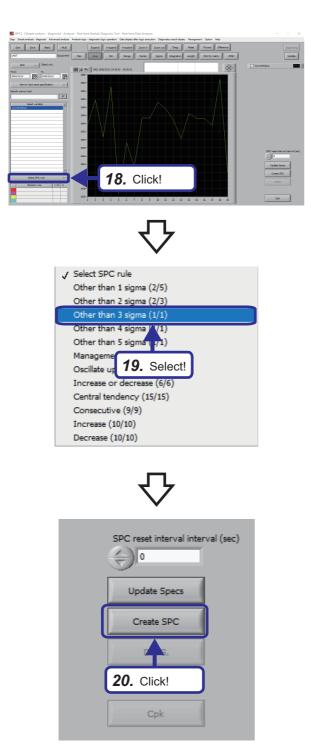


17. Select [Simple analysis - diagnosis] ⇒ [SPC] from the menu of Analyzer.

Page 112 Read data

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)".



For the SPC rule, refer to the following.

20. Click the [Create SPC] button.



 $\label{eq:21.2} \textbf{21.} Check that the SPC specification value is displayed.$

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.

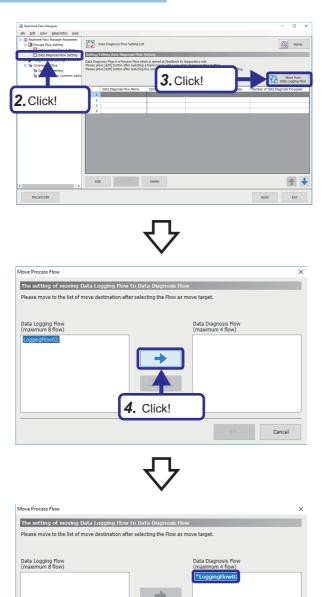
Real-time Statistic Diagnosis Tool outputs the response data file when an abnormality is detected in the diagnosis.

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



Cancel the movement

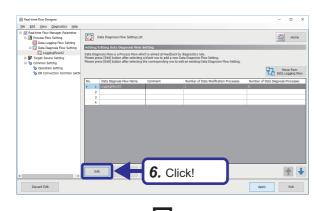
Cance

5. Click!

- **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.

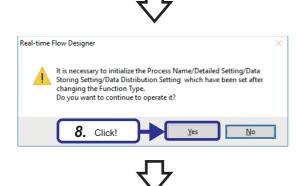
Click the [OK] button.
 The flow set in the data logging flow is moved to the data diagnosis flow.



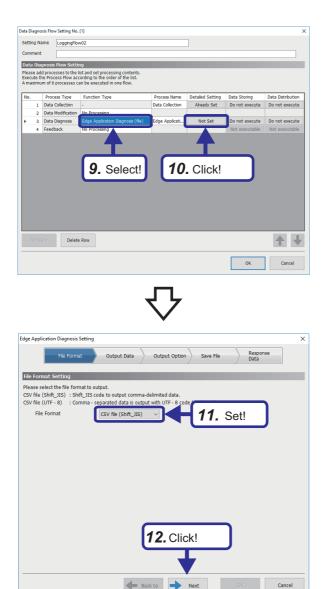
6. Select "LoggingFlow02" and click the [Edit] button. The "Data Diagnosis Flow Setting" window is displayed.

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





8. Click the [Yes] button.

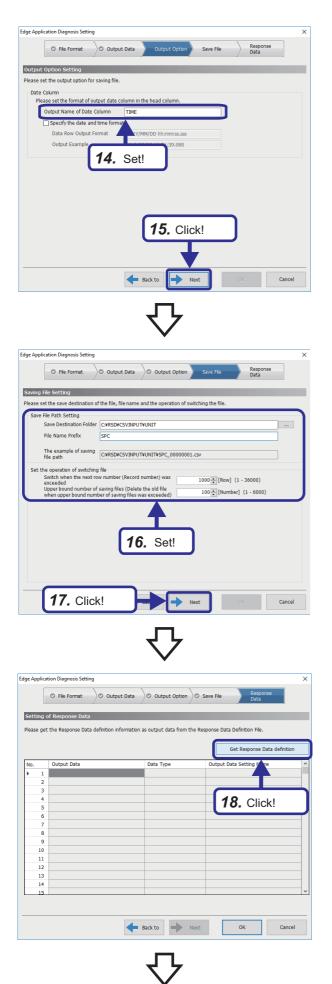


- **9.** Select "Edge Application Diagnosis (file)" for "Function Type" of data diagnosis.
- 10. Click "Not Set" in "Detailed Setting".

- 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.

- Edge Application Diagnosis Setti Respo Data File Format Output Option Save File Output Data Setting ise set the output data and output format for the file. In the data is output to the file in the content of [Output Name]. Output Name Data Type CurrentValue INT Output Format ncess Name ata Collecti Integer Format \sim 13. Click! Select All Cancel All 🔶 Back to Cancel
- **13.** Select the data to be output and click the [Next] button.

6

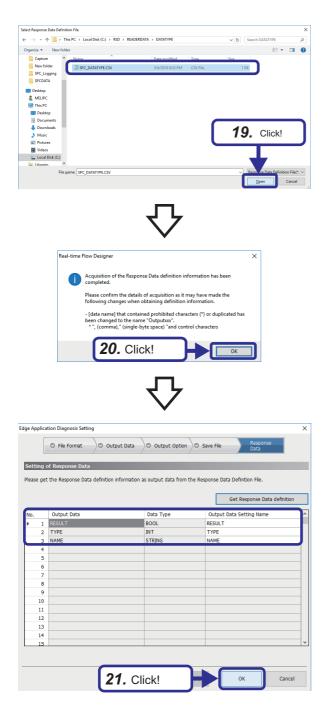


- **14.** Set "Output Option" as follows. [Setting details] Output Name of Date Column: TIME
- 15. Click the [Next] button.

- **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.

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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.

20. Click the [OK] button.

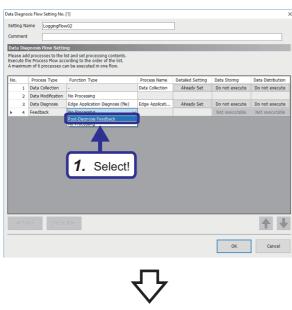
21. When the response data definition file has been read successfully, the output data will be displayed. Click the [OK] button.

Feedback setting

Distribute the feedback from Real-time Statistic Diagnosis Tool to Edgecross in a file format.

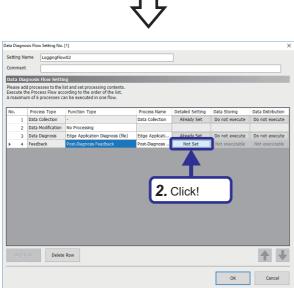
Configure the setting of the feedback to be performed based on the result of the data diagnosis process with Real-time Flow Designer.

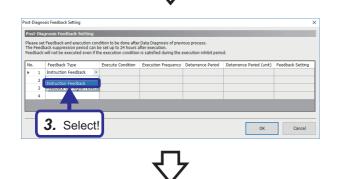
Operating procedure



 In the "Data Diagnosis Flow Setting" window of Realtime 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".



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7. Click!

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".

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- 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.

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Post-Diagnosis										×
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		13 .0	Click!		H	Yes	1	No		
		_								

10. Click the [OK] button.

11. Click the [OK] button.

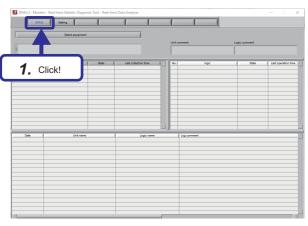
12. Click the [Apply] button.

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



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	2. Sele		Last collection time		logic	State	Last operation
Date (Unit name	1	Logic name)]	og comment		

1. Click the [DIAG.] button.

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

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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.



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

1 The folder definitions are performed in Reader.

- Page 83 Importing files
- ② [Monitor] is selected in the setting of [Tool] ⇒ [Monitor] from the menu bar of Reader.
- **3** "Switch to CSV file reading mode" of Reader has been performed after the completion of **1** and **2**.
- **4** After **3** 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.

No.	logic		State	Last operation time
		Com	non 🕨	J
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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:

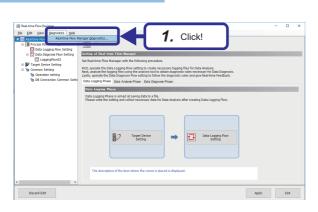
Stop the logic after deleting the logic name from the automatic start logic setting. (EP Page 101 Response data file output setting)

Delete the logic in Analyzer. (III) 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



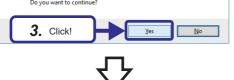
1. Click [Diagnostics] ⇒ [Real-time Flow Manager Diagnostics] from the menu of Real-time Flow Designer.

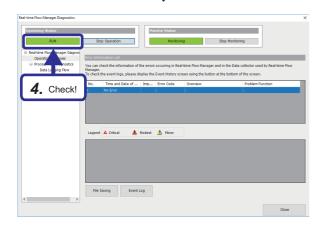
- **2.** Click the [Start Operation] button.
- <complex-block>

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 - time Flow Designer ×
 Change the Operating Status of Real-time Flow Manager to RUN.
 If Real-time Flow Manager Parameter is written during STOP, the
 parameter written will be reflected in the Real-time Flow Manager by
 changing to the RUN state.
 Do you want to continue?





3. Click the [Yes] button.

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

Precautions

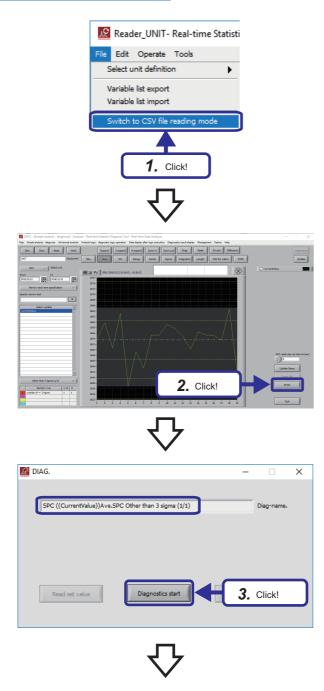
The edge application must start running within the timeout time (300 seconds) after Real-time Flow Manager Diagnostics is switched to RUN. If it is not running, an error occurs.

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

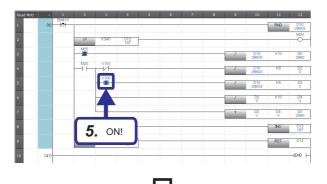
Operating procedure



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.

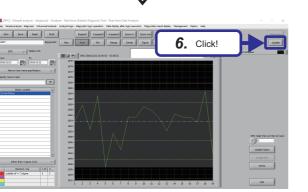


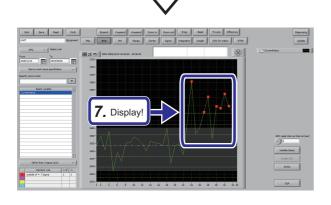
5. Turn on "X100" of the ladder program and generate an abnormal current value.

6. Click the [Update] button.

Point	
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)).

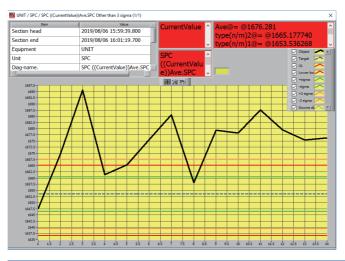






When an abnormality is detected in the diagnosis, a pop-up window is displayed.

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.

🐽 ProgPou [PRG) (LC) [C	٨o	nite	orin			9	1	[D	ice/Buff	er N	lemory E	Batch >					
Device <u>N</u> ame			M10						~	~					Detailed Cond	itions	۲		
O Buffer <u>M</u> emo	ry		<u>U</u> n	it							~		HEX)	<u>A</u> ddre	88		~	DEC	\sim
Device Name	9	8	7	6	5	4	3	2	1	n		-1							
M10	0	0	0	0	0	0	0	0	0	1			Ch	eck!					
M20	0	0	0	0	0	0	0	0	0					COR:					
M30	0	0	0	0	0	0	0	0	0	0									
M40	0	0	0	0	0	0	0	0	0	0									
M50	0	0	0	0	0	0	0	0	0	0									
M60	0	0	0	0	0	0	0	0	0	0									
M70	0	0	0	0	0	0	0	0	0	0									
M80	0	0	0	0	0	0	0	0	0	0									
M90	0	0	0	0	0	0	0	0	0	0									
M1 00	0	0	0	0	0	0	0	0	0	0									

batch monitor of GX Works3.

Point P

 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.

Check that M10 is turned on with the device/buffer memory

• 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.

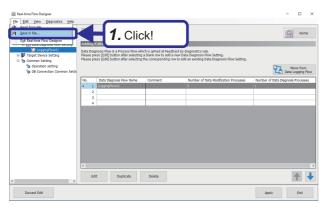
Managing the diagnosis flow setting of Real-time Flow Designer

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.

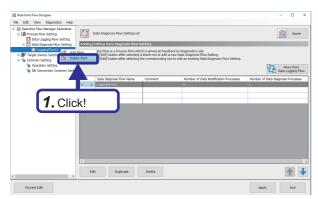


 Click [File]

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

■Delete

Delete the selected item.



 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.

Real-time Flow Designer	
Exit Real-time Flow Designer	Setting of Real-time Flow Manager
III 💕 Target Device Setting	Set Real-time Flow Manager with the following procedure.
So Common Setting So Operation setting So DB Connection Common Setti	Rist, operate the Data Logging Riow setting to create necessary logging files for Data Analysis. Next, analyse the logging files using the analysis toot to obtain diagnostic rules necessary for Data Diagnosis. Lastri, operate the Ubai Diagnosis files estimate fol for the diagnostic rules and give Real-time Readback.
	Data Logging Phase Data Analysis Phase Data Diagnosis Phase
	Data Logging Phase
	Data Logging Phase is aimed at saving data to a file. Please write the setting and collect necessary data for Data Analysis after creating Data Logging Flow.
	Please write the second and conect necessary data for bata energies after creating bata cogging now.
	Target Device Target Device Setting Data Logging Flow Setting
	🗗 Šetting 🥣 🛄 Setting
	The description of the Rem where the cursor is placed is displayed.
>	
Discard Edit	2, Click!

- 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.

Option Help moort Settings	to execute :						
xport Settings							
	o. arm	1. Click!					
nicialize All Settings (C)		. CIICK!					
xit	ecognition Tool - Rea	al-Time Data Analyzer i	started separate	y.			
	Creation of	Reference Waveform	earning Data				
			conning baca				
					_		
eration Settings							
se make settings concerr	ning publishing data to h	he subjected to Similar	Waveform Record	nition.			
		,					
		Publishing Data Settin					
		, consing bata better	y				
se specify the created R	eference Waveform Lea	irning Data to make th	e settings to exec	ute Similar Wavefo	orm Red	cognitic	in
	255	Operation Settings					
ecution/Monitoring							
						_	1
				ted senarately			
(ecution/monitoring - Sim	iai waveroitti Kecogilio	Ion Tool - Kear nine Da	ta Analyzer is star	teu separaceiy.			
		Execution/Monitoring					
	ration Settings e make settings concerr se specify the created Rd cution/Monitoring se execute Smitr Wavel	et cognition Tool - Re creation of the created Reference Waveform Lea cution/Monitoring execute Similar Waveform Recognition. You	et is peoplie in Fool - Real-Time Data Analyzer is food of Reference Waveform I is analyzer is creation of Reference Waveform I is analyzer is analyze	ct icopinton Tool - Real-Time Data Analyzer is started separatel Image: Creation of Reference Waveform Learning Data sation Settings ee make settings concerning publishing data to be subjected to Similar Waveform Recogn Image: Publishing Data Setting ee specify the created Reference Waveform Learning Data to make the settings to exect Image: Operation Settings Operation Settings cuttion//fointtoring ee execute Simbler Waveform Recognition, You can montor the execution status.	Evention Settings reation Setting reation Setting reation Setting reation S	ct icognition Tool - Real-Time Data Analyzer is started separately. Image: Creation of Reference Waveform Learning Data anation Settings ee make settings concerning publishing data to be subjected to Similar Waveform Recognition. Image: Publishing Data Setting ee specify the created Reference Waveform Learning Data to make the settings to execute Similar Waveform Recognition. Image: Operation Settings Operation Settings cutton//fonitoring ue execute Similar Waveform Recognition, You can montor the execution status.	ct icopintion Tool - Real-Time Data Analyzer is started separately. Image: Creation of Reference Waveform Learning Data sation Settings ee make settings concerning publishing data to be subjected to Simiar Waveform Recognition. Image: Publishing Data Setting ee specify the created Reference Waveform Learning Data to make the settings to execute Simiar Waveform Recognition Image: Operation Settings Operation Settings cutton//fonitoring ee execute Simiar Waveform Recognition, You can montor the execution status.

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

		. ()
P	oın	t/

/	
	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.

🔣 Similar Waveform Recognition	Tool - Real-Time Data An	alyzer		-		×
P Import Settings	form Learnin	1. Click!				
Initialize All Settings (C) Exit		e used for Similar Wavefo Fime Data Analyzer is star				
	Creation of Re	ference Waveform Lear	ning Data			
2. Operation Settings						
Please make settings concerning	ng publishing data to be	subjected to Similar Wav	eform Recognition.			
	P	ublishing Data Setting				
Please specify the created Ref	erence Waveform Learni	ng Data to make the set	tings to execute Simila	r Waveform R	tecognitio	n.
	**	Operation Settings				
3. Execution/Monitoring						
Please execute Similar Wavefo * Execution/Monitoring - Simila				ately.		
	*	Execution/Monitoring				

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 P

Before configuring the setting, save the diagnosis flow created in Exercise 2 and delete it from Real-time Flow Designer.

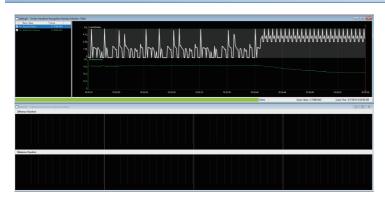
For how to save and delete a setting file, refer to the following.

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. (F Page 62 Similar waveform recognition execution)
- 7. Start GX LogViewer, turn "X100" of the ladder program to "ON", and check the waveform. (SP 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.
 (IP 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						
Operation Setting No. [1]						×
Operation Settings						
Please make the operation setting: The setting change applied during operation is resumed.				applied a	it the tim	e when the
Setting name		Setting01				
Runtime behavior target setting		Operation targe	t s	~		
Reference Waveform Learning D	ata File	C:¥SimilarWaveD	ata¥AnalyzeData¥V	Vaveform	Data¥Lea	mingData01.(V
I/O setting						
Publishing Data Setting Name	Loggi	ngFlow01_Edge A	pplication Diagnosis	s (MQTT)		~
Input Data Name	Curren	ntValue				
Output Data Name	Similar	tyDifference				
Detection sensitivity						
1 (Low) 2		3	4 (Recomme	nded)	5	6 (High)
1						•
Diagnosis Result file saving set	ting					
Output Settings		Only difference	Only difference condition			
Numeric representation		Decimal representation			~	
Number of digits after decimal poi	nt	3 🗘 [D	igit] (0 - 15)			
Switched when the following nur	nber of r	ows (records) is ex	ceeded.		2000 拿	[Row] (1 - 36000)
Max. number of save files (when	exceeded	l, the oldest file is	deleted.)		100 😳	[Number] (1 - 6000)
Save destination folder C:#SimilarWave		weData¥AnalyzeDa	ita¥Result			
Prefix of file name Res						
Example of save file path	SimilarWa	weData¥AnalyzeDa	ita¥Result¥Result_0	0000001	L.CSV	
			Apply		ОК	Cancel

Similar Waveform Recognition execution status monitoring window

imilar Waveform Recognition execution status detailed monitoring No. [1]						3	
Setting name			Setting	Setting01			
Diagnostic state			Differer	nce			
The latest Anomaly start	date and time		2019/0	8/07 17:36:33.50	0000000		
Minimum similarity score r	ecorded date	and time	2019/0	8/07 17:36:41.50	0000000		
Date and time of latest o	liagnosis		2019/0	8/07 17:36:57.40	0000000		
Present status continuity	hours		0:00:24	1			
Statistic information							
Lowest Similarity Scor			60.4				
Difference condition of	letection coun	t	1				
Operating time			0:02:44				
Smlarity score threshold information Smlarity score threshold 77.0							
Similarity score thresho							
1	2	3		4	5	6	
50.0	63.3	66.	/	70.1	73.5	77.0	
					_		
						Close	

 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.

Setting21 - Similar Wavefore Recognition Monitor	Monitar (RUN)	-		_		-				0
Data Yana Talue 2	56000-000_Committee	1				L L.				
	2.005-000 1.4005-000	metilen.		nahm.	NAM	h m	rvvrvvv			
	100 Sambartofoom									
	500, 760,									
	9 1006-11	10.26.15	88.9	10 38 20	10.26.27 10.	83 83			19 26 47	089
							Online	Cursor Value = 7.109E+001	Cusor Time : 8/7/2018 1	
Setting21 - Difference Waveform Detection History Difference Waveform									- 69	8 8
Reference Waseform										

Appendix 3 Additional Exercise of SPC

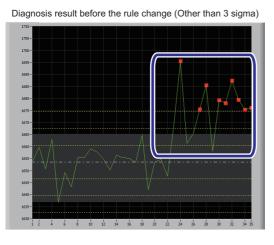
Change the SPC rule from the setting in Exercise 2 to see how the diagnosis result changes.

Operating procedure

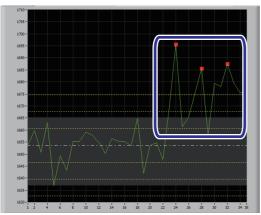
- 1. Start Real-time Statistic Diagnosis Tool and check that the data set in Exercise 2 is displayed.
- 2. Click the [Select equipment] button in Monitor and select the unit (Reader_UNIT C:\RSD\RSDDATA\UNIT) specified in Reader. (
- 3. Select "CurrentValue" in "Select variable" of Analyzer and check that the data of Exercise 2 is displayed. (SP 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 after the rule change (Other than 4 sigma)



 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.



For the SPC rule, refer to the following.

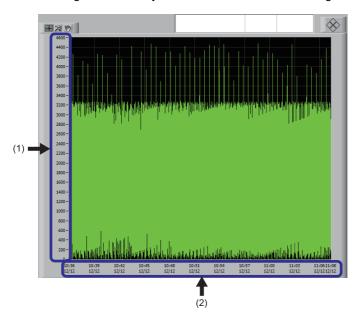
Appendix 4 Read Data and Statistics of SPC

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.

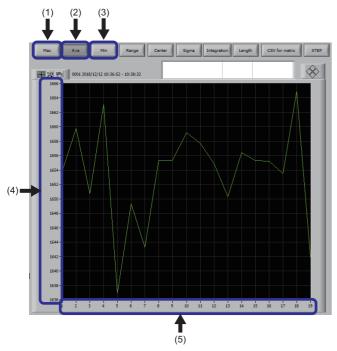


Item		Description
(1)	Vertical axis	Automatically scaled according to the maximum and minimum values of the displayed waveform (section data).
(2)	Horizontal axis	Displays the date and time of the selected section. When the [Overlay] button is selected, the elapsed time (second) from the start time of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



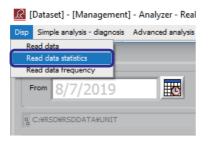
Item		Description
(1)	[Max] button	Displays the maximum value of the waveform for each section.
(2)	[Ave] button	Displays the mean value of the waveform for each section.
(3)	[Min] button	Displays the minimum value of the waveform for each section.
(4)	Vertical axis	Automatically scaled according to 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 P

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



Appendix 5 Default SPC Rule

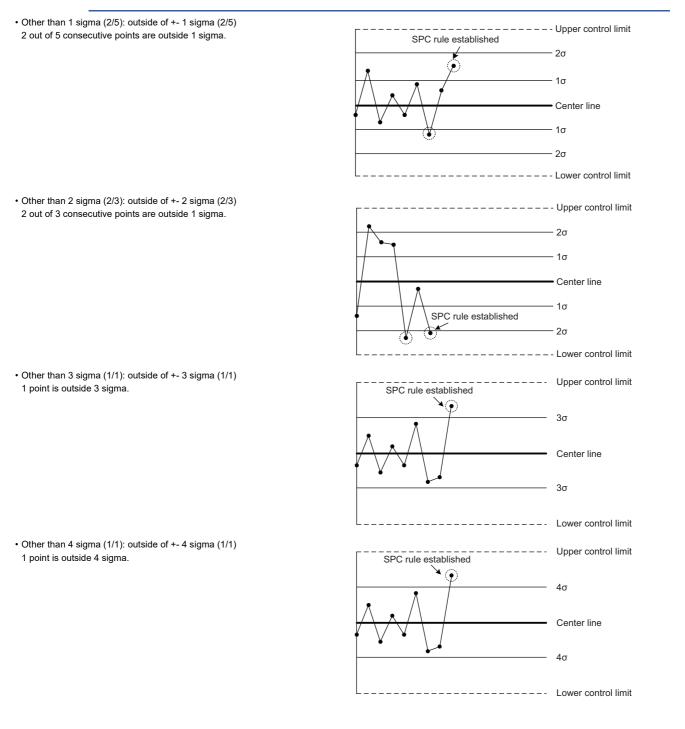
The default SPC rules are shown below.

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



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



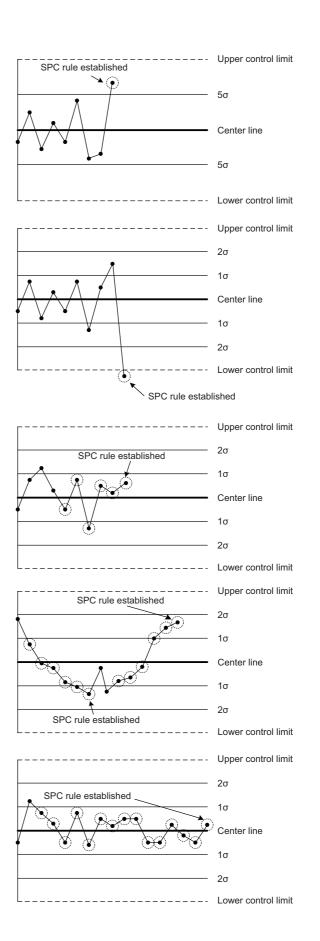
• Other than 5 sigma (1/1): outside of +- 5 sigma (1/1) 1 point is outside 5 sigma.

• 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.

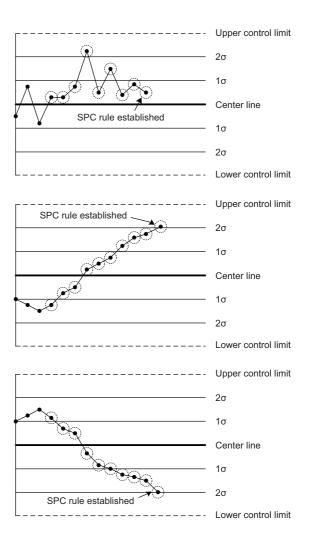
 Increase and decrease (6/6): increasing or decreasing (6/6) Consecutive 6 points increase or decrease.

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



• 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

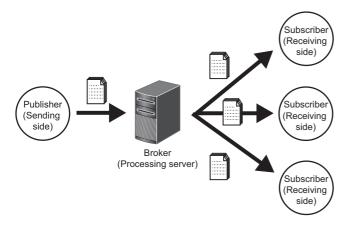
MQTT is a Publish/Subscribe messaging predefined protocol.

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.

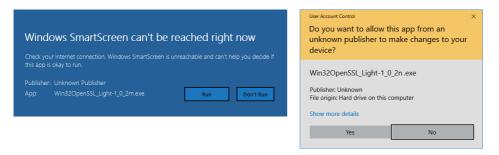


Eclipse Mosquitto setup

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.
- Install Pthread.
- **5.** Install Eclipse Mosquitto.

Α

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

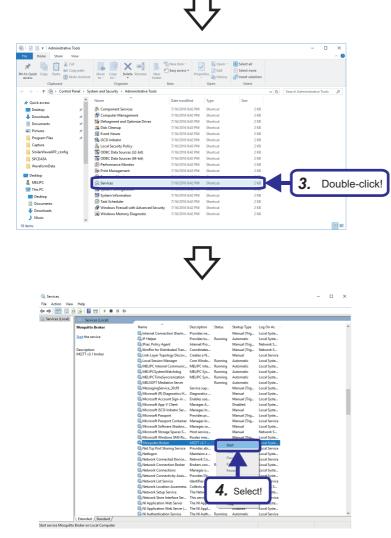
The following describes the procedure for starting Eclipse Mosquitto.

Operating procedure



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

2. Select "Administrative Tools".



 ∇

Mosquitto Broker P	roperties (Local Computer)	×		
General Log On	Recovery Dependencies			
Service name:	mosquitto			
Display name:	Mosquitto Broker			
Description:	MQTT v3.1 broker			
Path to executable C:¥Program Files ()	: &6)¥mosquitto¥mosquitto.exe run			
Startup typ <u>e:</u>	Automatic V			
	Automatic	H	5.	Select!
Service status:	Disabled			
<u>S</u> tart	Stop Pause Resume			
You can specify the from here.	e start parameters that apply when you start the service			
Start para <u>m</u> eters:				
	Click	!		

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.

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

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