OMRON

Machine Automation Controller

NX-series

CPU Unit
Automation Playback

User's Manual

NX502-1□00

SYSMAC
always in control

W639-E1-04

NOTE

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Introduction

Thank you for purchasing an NX-series CPU Unit.
This manual contains information that is necessary to use automation playback with the NX-series CPU Unit. Please read this manual and make sure you understand the functionality and performance of the NX-series CPU Unit before you attempt to use it in a control system.
When you have finished reading this manual, keep it in a safe location where it will be readily available for future use.

Intended Audience

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

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

For programming, this manual is intended for personnel who understand the programming language specifications in international standard IEC 61131-3 or Japanese standard JIS B 3503.

Applicable Products

This manual covers the following product.

- NX-series CPU Unit
  NX502-1□00

Part of the specifications and restrictions for the CPU Unit are given in other manuals. Refer to *Relevant Manuals* on page 2 and *Related Manuals* on page 20.

Relevant Manuals

The following table provides the relevant manuals for the NX-series CPU Units. Read all of the manuals that are relevant to your system configuration and application before you use the NX-series CPU Unit.

Most operations are performed from the Sysmac Studio Automation Software. Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for information on the Sysmac Studio.

Purpose of use	Manual													
	Basic information													
	NX-series NX502 CPU Unit Hardware User's Manual	NJ/NX-series CPU Unit Software User's Manual	NJ/NX-series Instructions Reference Manual	Motion Control User's Manual	NJ/NX-series Motion Control Instructions Reference Manual	Built-in EtherCAT Port User's Manual	Built-in EtherNet/IP Port User's Manual	EtherNet/IP Unit User's Manual	NX-series OPC UA User's Manual	NJ/NX-series FINS Function User's Manual	NX-series CPU Unit User's Manual	NJ/NX-series Database Connection CPU Units User's Manual	Automation Playback User's Manual	NX-series CPU Unit Troubleshooting Manual
Introduction to NX502 CPU Units	●													
Setting devices and hardware														
Using motion control				●										
Using EtherCAT						●								
Using EtherNet/IP							●	●						
Software settings														
Using motion control				●										
Using EtherCAT						●								
Using EtherNet/IP							●	●						
Using OPC UA		●							●					
Using FINS										●				
Using the database connection service												●		
Using automation playback													●	

Purpose of use	Manual													
	Basic information													
	Hardware User's Manual	NX-series NX502 CPU Unit	Software User's Manual	NJ/NX-series CPU Unit	Instructions Reference Manual	NJ/NX-series	Motion Control User's Manual	NJ/NX-series CPU Unit	Motion Control Instructions Reference Manual	NJ/NX-series	Built-in EtherCAT Port User's Manual	NJ/NX-series CPU Unit	Built-in EtherNet/IP Port User's Manual	NJ/NX-series CPU Unit
Writing the user program														
Using motion control							●		●					
Using EtherCAT											●			
Using EtherNet/IP													●	
Using OPC UA			●		●									
Using FINS														
Using the database connection service														
Using automation playback														
Programming error processing														
Testing operation and debugging														
Using motion control							●							
Using EtherCAT											●			
Using EtherNet/IP													●	
Using OPC UA			●											
Using FINS														
Using the database connection service														
Using automation playback														
Learning about error management and corrections*1														
Maintenance		●												
Using motion control							●							
Using EtherCAT											●			
Using EtherNet/IP													●	

Purpose of use	Manual													
	NJ/NX-series CPU Unit	NJ/NX-series Database Connection CPU Units	User's Manual	NX-series CPU Unit	FINS Function User's Manual	NJ/NX-series CPU Unit	OPC UA User's Manual	NX-series	EtherNet/IP Unit User's Manual	NJ/NX-series CPU Unit	Built-in EtherNet/IP Port User's Manual	NJ/NX-series CPU Unit	Built-in EtherCAT Port User's Manual	NJ/NX-series
Writing the user program														
Using motion control													●	●
Using EtherCAT														
Using EtherNet/IP											●			
Using OPC UA							●							
Using FINS					●									
Using the database connection service		●												
Using automation playback														
Programming error processing														
Testing operation and debugging														
Using motion control														●
Using EtherCAT														
Using EtherNet/IP											●			
Using OPC UA							●							
Using FINS					●									
Using the database connection service		●												
Using automation playback														
Learning about error management and corrections*1	△	△	△	△	△									
Maintenance														
Using motion control														●
Using EtherCAT														
Using EtherNet/IP											●			

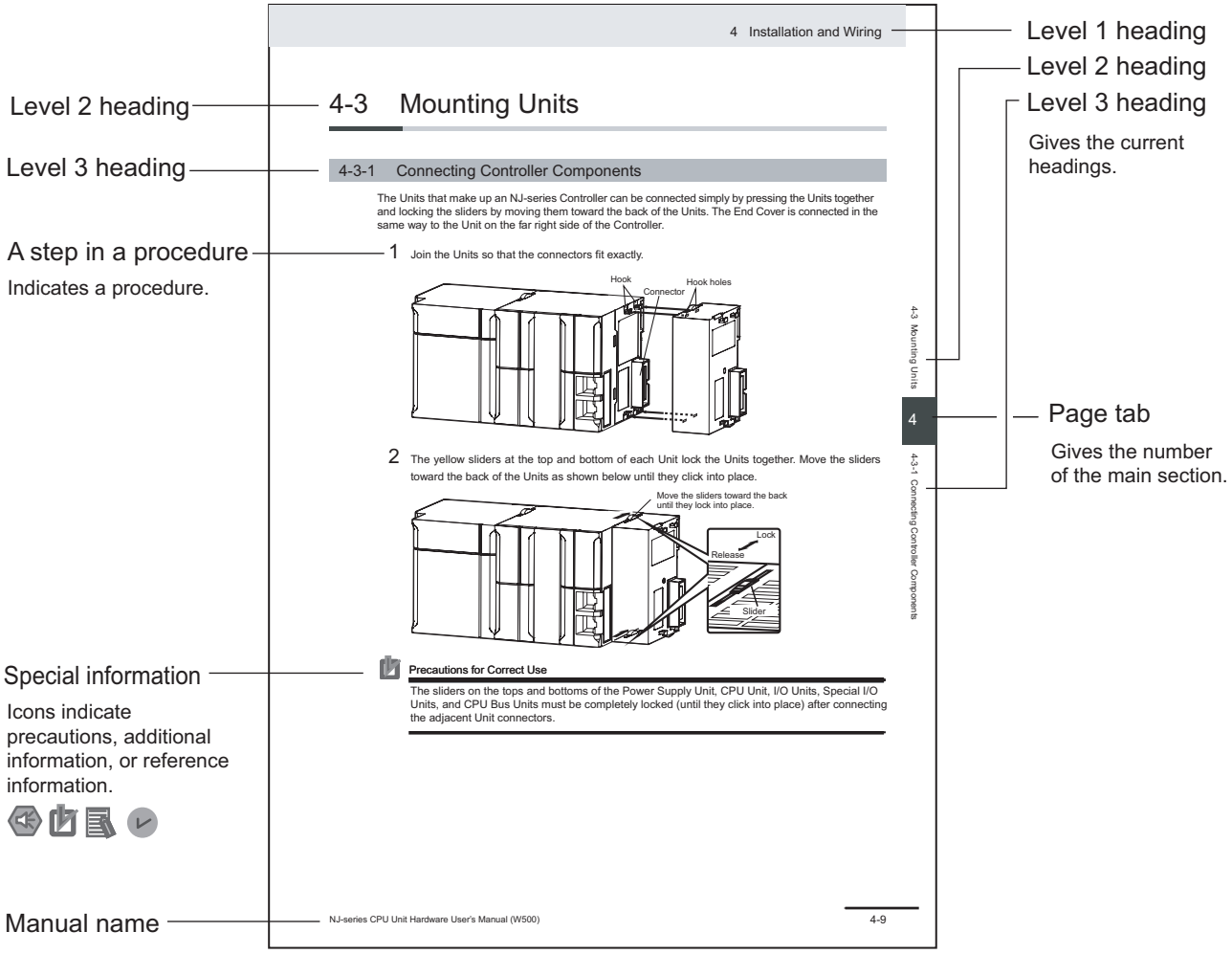
Purpose of use	Manual													
	NJ/NX-series Troubleshooting Manual	NX-series CPU Unit	Automation Playback User's Manual	NJ/NX-series Database Connection CPU Units	User's Manual	NX-series CPU Unit	FINS Function User's Manual	NJ/NX-series CPU Unit	OPC UA User's Manual	NX-series	EtherNet/IP Unit User's Manual	NJ/NX-series CPU Unit	Built-in EtherNet/IP Port User's Manual	NJ/NX-series CPU Unit
Writing the user program														
Using motion control														
Using EtherCAT														
Using EtherNet/IP														
Using OPC UA									●					
Using FINS							●							
Using the database connection service					●									
Using automation playback			●											
Programming error processing	●													
Testing operation and debugging														
Using motion control														
Using EtherCAT														
Using EtherNet/IP											●			
Using OPC UA									●					
Using FINS							●							
Using the database connection service					●									
Using automation playback			●											
Learning about error management and corrections*1	●	△	△	△	△	△	△							
Maintenance														
Using motion control														
Using EtherCAT														
Using EtherNet/IP											●			

*1. Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for the error management concepts and the error items. However, refer to the manuals that are indicated with triangles for details on errors corresponding to the products with the manuals that are indicated with triangles.

Manual Structure

Page Structure

The following page structure is used in this manual.



This illustration is provided only as a sample. It may not literally appear in this manual.

Special Information

Special information in this manual is classified as follows:

 **Precautions for Safe Use**

Precautions on what to do and what not to do to ensure safe usage of the product.

 **Precautions for Correct Use**

Precautions on what to do and what not to do to ensure proper operation and performance.

 **Additional Information**

Additional information to read as required.
This information is provided to increase understanding or make operation easier.

 **Version Information**

Information on differences in specifications and functionality for Controller with different unit versions and for different versions of the Sysmac Studio is given.

Precaution on Terminology

In this manual, "download" refers to transferring data from the Sysmac Studio to the physical Controller and "upload" refers to transferring data from the physical Controller to the Sysmac Studio.
For the Sysmac Studio, "synchronization" is used to both "upload" and "download" data. Here, "synchronize" means to automatically compare the data for the Sysmac Studio on the computer with the data in the physical Controller and transfer the data in the direction that is specified by the user.

Sections in this Manual

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Section 3 Executing Playback

Section 4 Checking Program Behavior Using Playback

Section 5 Checking Time Series Variable Values and Videos Using Playback

Section 6 Troubleshooting

Appendices

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Warranty, Limitations of Liability

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Safety Precautions

Refer to the following manuals for safety precautions.

- *NX-series NX502 CPU Unit Hardware User's Manual (Cat. No. W629)*

Precautions for Safe Use

Refer to the following manuals for precautions for safe use.

- *NX-series NX502 CPU Unit Hardware User's Manual (Cat. No. W629)*

Precautions for Correct Use

Refer to the following manuals for precautions for correct use.

- *NX-series NX502 CPU Unit Hardware User's Manual (Cat. No. W629)*

Regulations and Standards

Refer to the following manuals for regulations and standards.

- *NX-series NX502 CPU Unit Hardware User's Manual (Cat. No. W629)*

Versions

Hardware revisions and unit versions are used to manage the hardware and software in NX-series Units and EtherCAT slaves.
The hardware revision or unit version is updated each time there is a change in hardware or software specifications. Even when two Units or EtherCAT slaves have the same model number, they will have functional or performance differences if they have different hardware revisions or unit versions.

Refer to the following manuals for versions.
- *NX-series NX502 CPU Unit Hardware User's Manual (Cat. No. W629)*

Unit Versions of CPU Units and Sysmac Studio Versions

The functions that are supported depend on the unit version of the NX-series CPU Unit. The version of Sysmac Studio that supports the functions that were added for an upgrade is also required to use those functions.
Refer to *Version Information for NX-series Controllers* in the *NJ/NX-series CPU Unit Software User's Manual (Cat. No. W501)* for the relationship between the unit versions of the CPU Units and the Sysmac Studio versions, and for the functions that are supported by each unit version.

Related Manuals

The following are the manuals related to this manual. Use these manuals for reference.

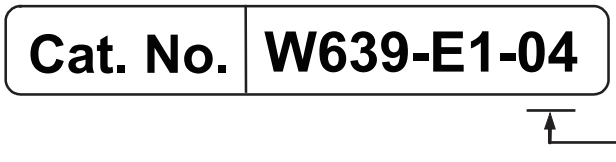
Manual name	Cat. No.	Model numbers	Application	Description
NX-series CPU Unit Automation Playback User's Manual	W639	NX502-□□□□	Using automation playback	Describes automation playback.
NX-series NX502 CPU Unit Hardware User's Manual	W629	NX502-□□□□	Learning the basic specifications of the NX502 CPU Units, including introductory information, designing, installation, and maintenance. Mainly hardware information is provided.	An introduction to the entire NX502 system is provided along with the following information on the CPU Unit. • Features and system configuration • Introduction • Part names and functions • General specifications • Installation and wiring • Maintenance and inspection
NJ/NX-series CPU Unit Software User's Manual	W501	NX701-□□□□ NX502-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Learning how to program and set up an NJ/NX-series CPU Unit. Mainly software information is provided.	The following information is provided on a Controller built with an NJ/NX-series CPU Unit. • CPU Unit operation • CPU Unit features • Initial settings • Programming based on IEC 61131-3 language specifications
NJ/NX-series Instructions Reference Manual	W502	NX701-□□□□ NX502-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Learning detailed specifications on the basic instructions of an NJ/NX-series CPU Unit.	The instructions in the instruction set (IEC 61131-3 specifications) are described.
NJ/NX-series CPU Unit Built-in EtherNet/IP™ Port User's Manual	W506	NX701-□□□□ NX502-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Using the built-in EtherNet/IP port on an NJ/NX-series CPU Unit.	Information on the built-in EtherNet/IP port is provided. Information is provided on the basic setup, tag data links, and other features.
NJ/NX-series Troubleshooting Manual	W503	NX701-□□□□ NX502-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Learning about the errors that may be detected in an NJ/NX-series Controller.	Concepts on managing errors that may be detected in an NJ/NX-series Controller and information on individual errors are described.
Sysmac Studio Version 1 Operation Manual	W504	SYSMAC -SE2□□□	Learning about the operating procedures and functions of the Sysmac Studio.	Describes the operating procedures of the Sysmac Studio.

Terminology

Term	Description
automation playback	A function that captures and records variable data as well as video data while the program in the Controller is running, and reproduces these data on monitor displays in the Sysmac Studio to allow the user to analyze and identify the causes of problems.
sampling	The operation of the CPU Unit to collect variable data.
playback	Reproducing recorded data on monitor displays in the Sysmac Studio.
playback chart	A window that displays the time series variable graph and plays videos during playback.
playback data	Variable data and video data collected and recorded for automation playback. In a broad sense, playback data includes backup data of the project.
backup project	Backing up the project as a file when variable data is collected.
restoration	Reading saved data into the Sysmac Studio so that the Sysmac Studio can handle it as data.
time series variable graph	A graph that displays variable data in a time series.
variable data collection	The act or function of collecting variable data that is used in the program in the Controller according to the collection target and time set by the user.
variable log	Variable data that is collected and recorded in the storage.

Revision History

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



Revision code	Date	Revised content
01	July 2023	Original production
02	January 2024	• Made changes accompanying the upgrade of the CPU Units to unit version 1.65. • Corrected mistakes.
03	January 2024	Corrected mistakes.
04	April 2025	• Made changes accompanying the upgrade of the CPU Units to unit version 1.68. • Corrected mistakes.

1

Overview of Automation Playback

Automation playback is a solution that integrates three activities that you perform in system maintenance.
It provides functionality that integrates three system maintenance activities, which are recording, reproduction, and analysis.

1-1 Features of Automation Playback

Automation playback allows you to reproduce the variables used in the program in the Controller and the captured videos on monitor displays in the Sysmac Studio and identify the causes of problems. Automation playback has the following features:

Collecting and recording of data to use for identifying the causes of problems

- Collect and record variable data used in the Controller's control program in time series.
- You can achieve a system that captures and records videos of on-site manufacturing linked to the operation of the control program in the Controller.
- Back up the project for data collection.

Reproducing the recorded data in the Sysmac Studio

- Reproduce the operation of the control program in the Controller on the Sysmac Studio, based on the recorded data.

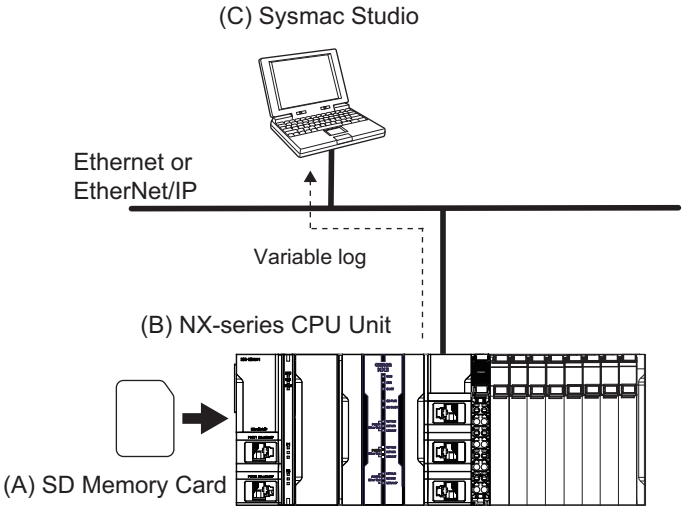
Analyzing the causes of problems in the Sysmac Studio

- Facilitate the identification of the causes of problems through analysis of the control program in the Sysmac Studio.

You can use automation playback with the recorded variable data for the Controller to check how the control program in the Controller operated. You can also use the recorded data to reproduce the operation of the control program in the Controller without the presence of the designer of the control program at the location where the Controller is operating, which enables earlier analysis of problems that occur at a remote location in comparison with when you visit the site.
In addition, you can play videos captured outside the system together with the variable data to check the correspondence between the operation of the control program and the scenes of on-site manufacturing.
Since the project can be backed up at the start of variable data collection, you can import data on a different computer than the one on which you collected the variable data to reproduce the operation.

1-2 System Configuration for Automation Playback

The system configuration consists of a Controller and the Sysmac Studio.



Symbol	Configuration element	Description
A	SD Memory Card	This is mounted on the CPU Unit. • Records variable logs. • Stores a backup of the project at the start of variable data collection if you configure the setting to back up the project in the Automation Playback Settings.
B	NX-series CPU Unit	Collects variable data and records it as a variable log on an SD Memory Card.
C	Sysmac Studio	• Reads the variable logs that were recorded in the NX-series CPU Unit and the video data that was captured outside the system. *1 • Executes playback using the read data to analyze the causes of problems.

*1. You can read the variable logs directly by removing the SD Memory Card from the CPU Unit and then mounting it to the computer on which the Sysmac Studio is running.

Additional Information

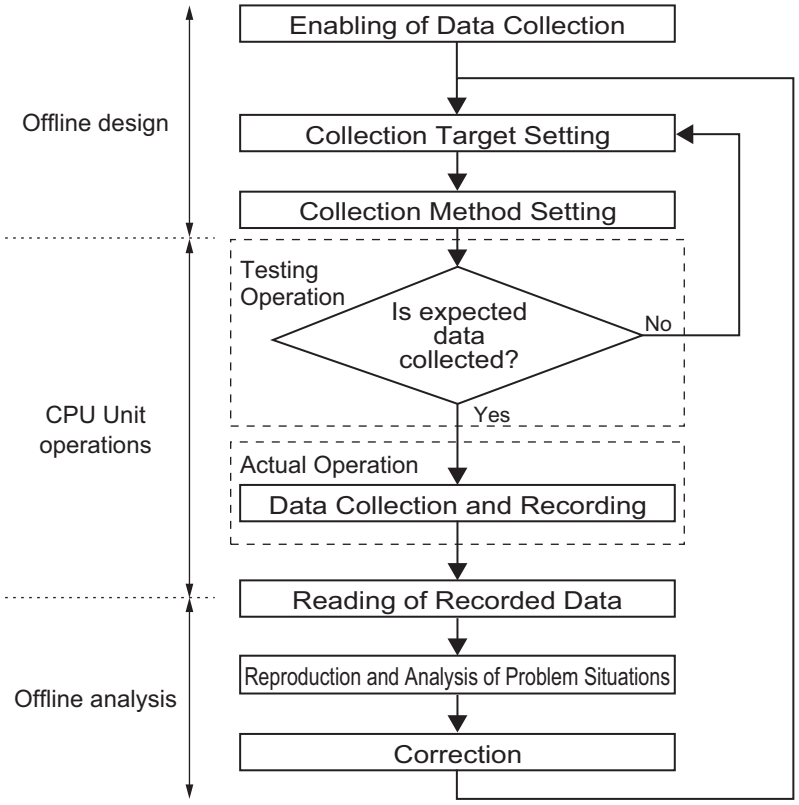
This system assumes that you will take the following measures to prevent data leakage.
- Variable logs recorded on an SD Memory Card and backup for a project
- Video data read from the Sysmac Studio

Additional Information

If you want to use the playback chart and play videos on it, we recommend using Sysmac Studio of 64-bit application.
If you want to show more than 16 variables in the playback chart or play more than 2 video files, Sysmac Studio of 64-bit application is required.

1-3 Flow of Using Automation Playback

The flow of automation playback consists of offline design, CPU Unit operations, and offline analysis.



Process	Overview	Reference
Enabling of Data Collection	Enable automatic playback.	*2-2 Enabling Variable Data Collection* on page 2-11
Collection Target Setting	Set what data should be collected.	*2-3 Setting the Variable Data Sampling Target and Output Method* on page 2-14
Collection Method Setting	Set under what conditions the data should be collected.	
Testing Operation	Check if data that ensures the set sampling time length and data concurrency can be collected and if the collected data meets the expected applications, and adjust the settings.	*2-4 Checking Collected Variable Data* on page 2-31
Actual Operation	Collect data for reproduction and analysis.	---
Reading of Recorded Data	Read the collected data in the Sysmac Studio. Use one of the following methods. • When online with the Controller The Sysmac Studio reads the variable logs from the SD Memory Card mounted on the Controller. • When offline with the Controller Mount the SD Memory Card that contains the variable logs to a computer on which the Sysmac Studio is running, and then directly read the variable logs.	*3-1 Copying Playback Data to a Computer* on page 3-2 *3-2 Starting Playback* on page 3-4

Process	Overview	Reference
Reproduction and Analysis of Problem Situations	Reproduce the operation of the user program in the Sysmac Studio. Then, analyze the causes of the problem.	*Section 4 Checking Program Behavior Using Playback* on page 4-1 *Section 5 Checking Time Series Variable Values and Videos Using Playback* on page 5-1
Correction	Correct the program.	*Section 6 Troubleshooting* on page 6-1

2

Collecting Variable Data

Set up automation playback and enable the function to collect variable data.

2-1 Specifications of Variable Data Collection

This section provides the specifications of variable data collection in automation playback.
The automation playback combines the following operations to collect variable data and output variable logs.

Symbol	Processing	Constraints
(1)	Monitors variables to be collected and samples variable data while ensuring concurrency within the task period.	The size and number of variables to be collected and unused time in task period affect the availability of concurrency.
(2)	Accumulates a certain amount of sampled variable data.	The amount of data that can be accumulated cannot be changed. When accumulated data reaches the upper limit, the oldest data is overwritten and data continues to be accumulated.
(3)	When the condition for the file save trigger is met, stops recording and accumulating variable data and outputs the variable log file.	Variable data for a set sampling time is output to a variable log file from the accumulated data. The time length of the accumulated data may be shorter than the set sampling time.

In this document, (1) is described in terms of sampling and (1) and (2) collectively as the collection processing.

Note that sampling, collection processing, and variable log output processing have performance limitations.
Use this document as a guide and make sure that you can get the variable log as expected before using the automation playback in your system.

2-1-1 Variables to Collect

You can collect data of local and external variables defined in the program POU and function block POU used in the program POU.

Precautions for Correct Use

To collect data of global or system-defined variables, register the global or system-defined variables as external variables of the POU.

The following table shows whether or not it is possible to collect variables with automation playback function.

Variable			Collection
User-defined variables			Possible
Semi-user-defined variables	Device variables	Device variables for EtherCAT slaves	Possible
		Device variables for NX Units	Possible
		Device variables for X Bus Units	Possible
	Cam data variables		Possible

Variable			Collection
System-defined variables	System-defined variables for PLC Function Module		Possible*1
	System-defined variables for motion control	MC Common Variables	Not possible
		Axis Variables*2	Possible only for specific members
		Axes Group Variables	Not possible
	System-defined variables for EtherNet/IP		Possible
	System-defined variables for EtherCAT master		Possible
	System-defined variables for NX bus		Possible
	System-defined variables for X Bus		Possible

*1. P_CY, P_First_RunMode, and P_First_Run cannot be collected.

*2. Axis Variables will be collected when **Include** is selected for **Axis variable sampling** in the sampling setting. Refer to *Items for Variable Data Collection* on page 2-16.
Note also that the axis variables to be collected are limited to the following.
- Position and velocity of axis command values and axis current values (member names: Cmd.Pos, Cmd.Vel, Act.Pos, Act.Vel)
- Members that are used in program POUs

The following table shows whether or not it is possible to collect local variables and external variables from POUs.

Type of variable		POU type		
		Program	FB	FUN
Local variables	Internal variables	Possible	Possible	Not possible
	Input variables	---	Possible	Not possible
	Output variables	---	Possible	Not possible
	In-out variables	---	Not possible	Not possible
External variables		Possible	Possible	Not possible

2-1-2 Upper Limit of Variable Data to Collect

The following table shows the upper limits of variables that can be sampled.
Transferring a sampling setting that exceeds the upper limit value to the Controller changes the automation playback state to Error, causing the automation playback function to stop operating. At this time, the event *Upper Limit of Variable Sampling* (95770000 hex or 95790000 hex) occurs.
To see how automation playback works, use the Automation Playback Operation Monitor in the Sysmac Studio. Refer to *6-3-1 Checking the Operation Status of Automation Playback* on page 6-12 for information on the Automation Playback Operation Monitor.

CPU Unit with Unit Version 1.68 or Later

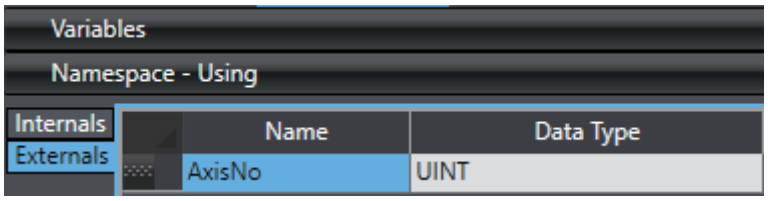
For the total size of variable data, the upper limit is fixed regardless of the task period.

Task to be sampled	Number of variables	Total size of variable data
Primary periodic task	60,000 variables	10,000,000 bytes
Periodic task (priority 16, 17, or 18)*1	60,000 variables	10,000,000 bytes

*1. For periodic tasks, the number of variables and the total size of variable data are the totals of each task.

Additional Information

For Sysmac Studio projects with project unit version 1.68 or later, when an external variable that points to the same global variable in more than one POU is used, the number of variables is counted as one. Similarly, the total size of variable data is the total data size of the global variables, not the total of the external variables in each POU.
For example, when an external variable that points to the global variable *AxisNo* is defined in 10 POUs, the results are as follows.



Project unit version	Number of variables	Total size of variable data
Version 1.68 or later	1 variable	2 bytes
Version earlier than 1.68	10 variables	20 bytes

CPU Unit with Unit Version Earlier Than 1.68

For the total size of variable data, the upper limit is determined by the task period of each task.

Task to be sampled	Number of variables	Task period*1	Total size of variable data	
			CPU Unit with unit version earlier than 1.65	CPU Unit with unit version 1.65 or later but earlier than 1.68
Primary periodic task	60,000 variables	Less than 1 ms	500,000 bytes	
		1 ms or more but less than 8 ms	1,000,000 bytes	
		8 ms	2,000,000 bytes	5,000,000 bytes
Periodic task (priority 16, 17, or 18)*2	60,000 variables	Less than 1 ms	500,000 bytes	
		1 ms or more but less than 8 ms	1,000,000 bytes	
		8 ms or more but less than 16 ms	2,000,000 bytes	5,000,000 bytes
		16 ms or more	3,000,000 bytes	5,000,000 bytes

*1. For the periodic task, this is the period of the highest priority task used among priority-16, priority-17, and priority-18 periodic tasks.
*2. For periodic tasks, the number of variables and the total size of variable data are the totals of each task.

Precautions for Correct Use

Even if the number of sampling target variables is less than the upper limit, the process of collecting variable data may not be completed within the specified processing time. In this case, one of the following occurs.

a. When the processing capacity to collect variable data is exceeded
   The following event occurs. The event that occurs depends on the unit version of the CPU Unit.
   Version 1.65 or earlier: *Upper Limit of Variable Sampling* (95770000 hex)
   Version 1.65 or later: *Upper Limit of Variable Sampling* (95790000 hex)
   Version 1.68 or later: *Upper Limit of Sampling Processing Capacity* (64040000 hex)
b. When data concurrency cannot be ensured in variable logs
   The following event occurs.
   No Variable Log Concurrency (64060000 hex)
   Cycle with No Variable Sampling (64070000 hex)

If these events occur, take corrective action with reference to *6-2 Troubleshooting for Variable Data Collection* on page 6-3. In addition, consider reviewing the design of the POUs and variables to be sampled based on the information in "Additional Information" below.

Additional Information

By considering the following when you design the user program, you can expect more effective variable log collection. Refer to the following when you use the automation playback function.

Designing Program POU

Is it possible to design the program POU that use variables with fixed values such as recipe data separately from the program POU that you want to collect variable logs?

Designing Array Variables

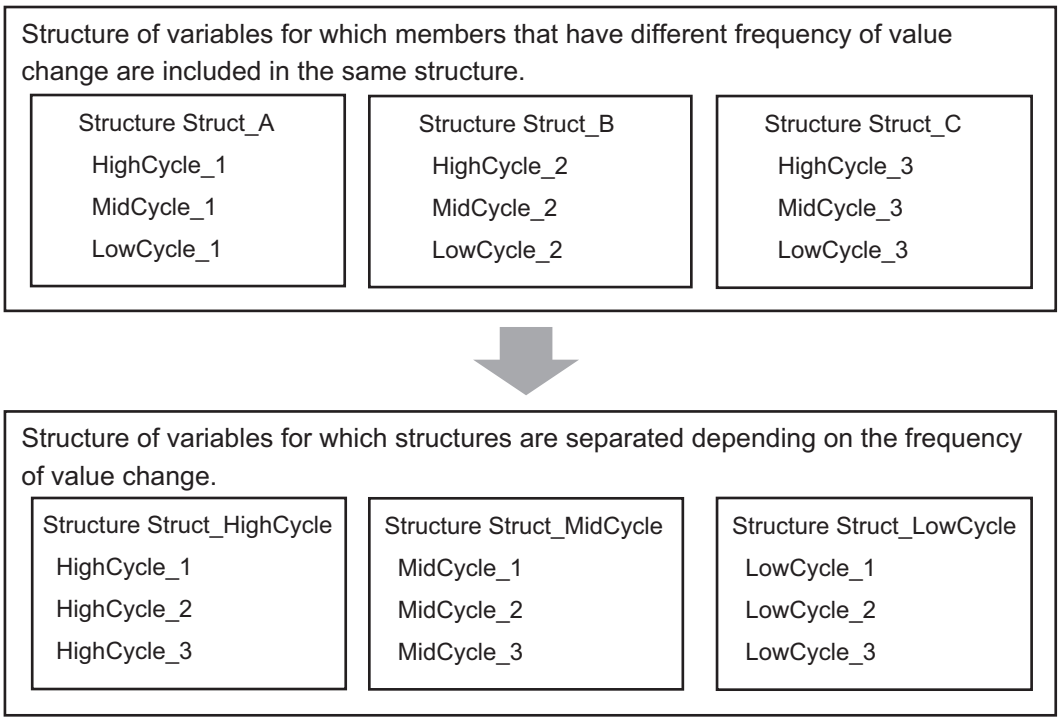
To define the number of array elements, is it possible to decide from the value estimated in the expected range, instead of deciding from the value overestimated in the areas for future expansion?

Designing Structure Variables

Is it possible to classify structures according to how often their values change and add variables in the structure member according to the frequency, instead of including a variable that have high frequency of value change and a variable that have low frequency of value change in the same structure member?

Example:

HighCycle_1, 2, 3: Variables that have high frequency of value change
MidCycle_1, 2, 3: Variables that have middle frequency of value change
LowCycle_1, 2, 3: Variables that have low frequency of value change

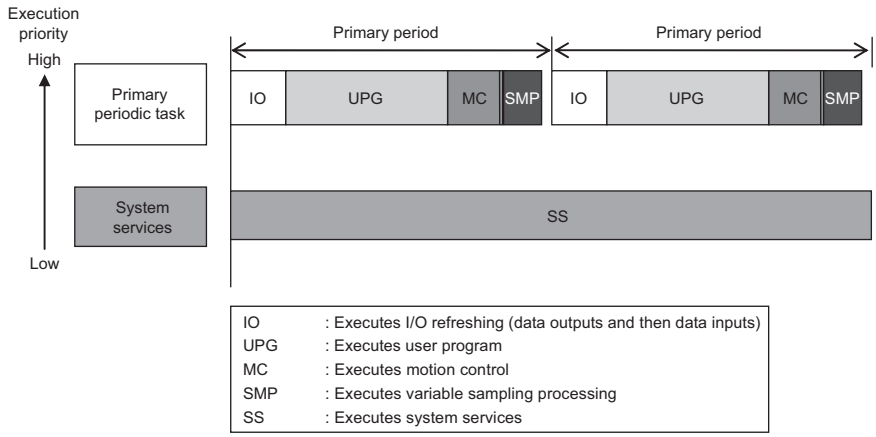


2-1-3 Sampling Operation of Variable Data

Sampling of variable data occurs in unused time of tasks, in processing separate from the tasks.

When Only the Primary Periodic Task Is Executed

The primary periodic task is executed every primary period, and sampling of variable data is performed after execution of motion control.



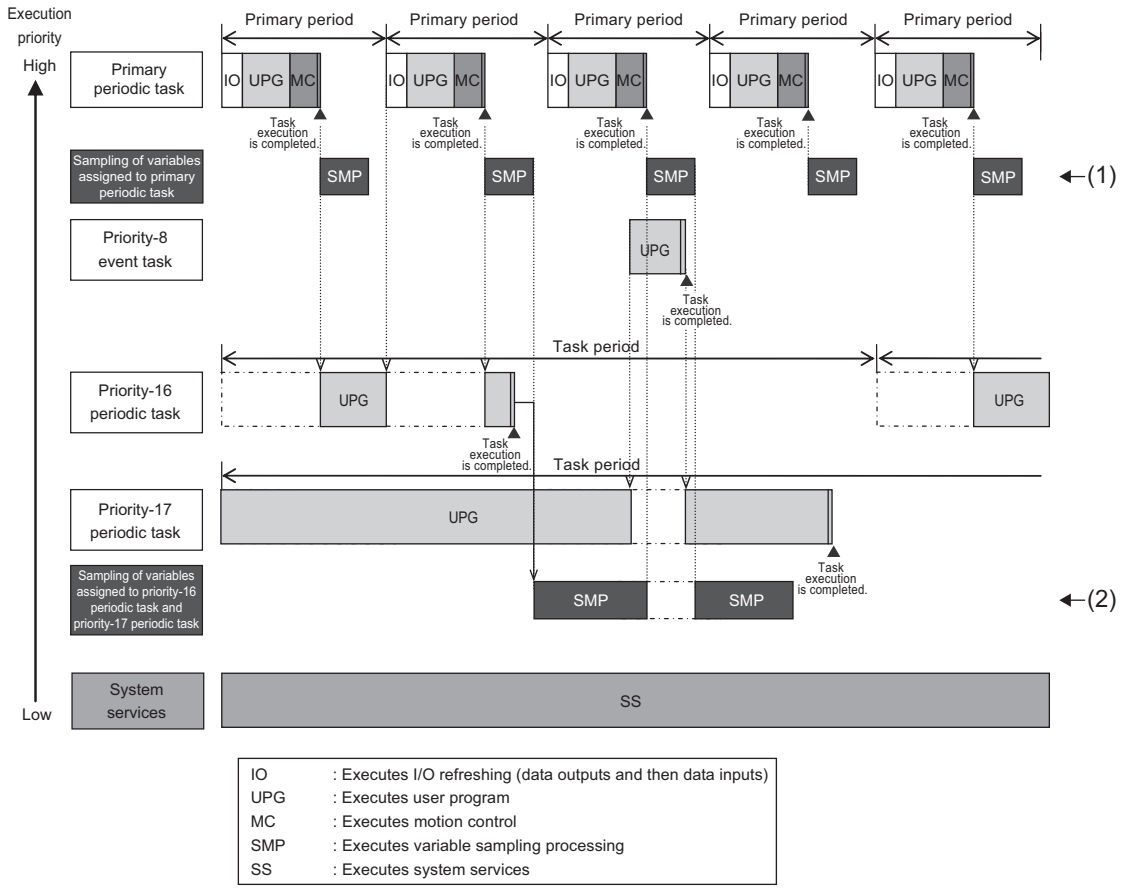
When the Primary Periodic Task, Priority-16 Periodic Task, and Priority-17 Periodic Task Are Executed

Sampling of variable data is performed in two parts: a primary periodic task and periodic tasks. Variables assigned to the primary periodic task are sampled on a priority basis, while variables assigned to the periodic task are sampled when variables assigned to the primary periodic task are not sampled.

1. Sampling of variables to be used in the program POU assigned to the primary periodic task occurs after the primary periodic task is executed every primary period.
2. Sampling of variables to be used in the program POU assigned to the priority-16 periodic task and priority-17 periodic task occurs after the priority-16 periodic task is executed and when (1) is not executed every task period.

Precautions for Correct Use

When several periodic tasks with different execution priorities are used, after execution of the periodic task with the highest execution priority, sampling of variables used in the program POUs assigned to all periodic tasks occurs. For this reason, concurrency is not ensured for variable log data for variables used in the program POUs assigned to other than the periodic task with the highest execution priority.



IO	: Executes I/O refreshing (data outputs and then data inputs)
UPG	: Executes user program
MC	: Executes motion control
SMP	: Executes variable sampling processing
SS	: Executes system services

Precautions for Correct Use

Variable data that is sampled by the automation playback function is based on the values of the variables after execution of the task. This means that the values of variables that you can check when the playback operation is performed with the Sysmac Studio are also the values after execution of the task. Even for internal variables that are used as logical conditions and the values of which are changed in the same program POU, or external variables that are input variables of the program POU, the values after execution of the task are displayed during playback operation, which may not match the values at the start of execution of the program POU. Keep this in mind when you check the values of variables during playback operation.

2-1-4 Outputting Variable Log Files

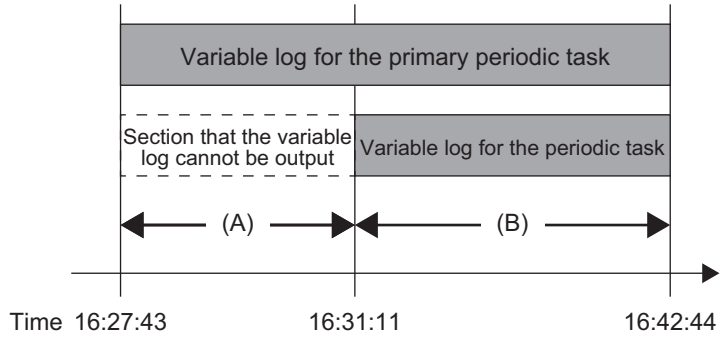
The variable data to be sampled in the primary periodic task and periodic tasks is compiled and output as a variable log file.

The output of the variable log file is executed when the file save trigger changes to TRUE. The time range of the saved variable data varies depending on the output method of the variable log. Refer to *2-3-2 Setting How to Output Variable Logs* on page 2-25 for details.

When the variable log file is output, the variable log information file that records the information of the variable log file is also output. Refer to *Specifications of Variable Log Files* on page 2-9 or *Specifications of Variable Log Information Files* on page 2-10 for information on specifications such as the save destination for the variable log file or variable log information file.

Precautions for Correct Use

The output settings for the variable log are applied to all tasks. There is an upper limit on the total amount of data that can be retained in the memory of the CPU Unit for each task. Therefore, depending on the sampling time specified in the variable log output settings and the timing when the trigger condition is met, all of the data for the specified sampling time cannot be retained in the memory of the CPU Unit, and the sampling time of the data output to the variable log may differ between the primary periodic task and the periodic task.
For example, if the amount of data per hour collected in the periodic task is larger than the data collected in the primary periodic task, there may be a difference in the sampling time of the data output to the variable log between the primary periodic task and the periodic task, as shown below.



In a variable log file with such data, if the variable data of the program POU for a periodic task is displayed in the Program Editor when playback data for the section (A) is played, "!" is displayed for the variable data for the periodic task. In the section (B), the contents of the variable log are displayed.
In addition, when the variable log with such data is read in the Sysmac Studio, the following message is displayed on the **Start Playback** dialog box.

The start time of the periodic task is different. The value of the variable is not displayed until the start time. Periodic task start time: YYYY/MM/DD hh:mm:ss

Specifications of Variable Log Files

The save destination, folder structure, file name, and file format of variable log files are as shown in the table below.

Item	Description	Remarks
Save destination	SD Memory Card mounted on the CPU Unit	
Folder structure	\APB\(hash code)\(output setting name)\	• If the APB folder does not exist in the file output destination, an APB folder and lower folders will be created automatically when sampling of variables starts. • A hash code consists of a 16-byte string. You can get it with the GetPrgHashCode (Get Program Hash Code) instruction.

Item	Description	Remarks
File name	• Project unit version 1.68 or later: VL_YYYYMMDDhhmmss.bin2 • Project unit version earlier than 1.68: VL_YYYYMMDDhhmmss.bin YYYY: Year MM: Month DD: Day hh: Hours (24-hour notation) mm: Minutes ss: Seconds	• The time of the oldest data in the variable log file is used. For example, if the variable log file has data recorded from 13:45:56 on January 2, 2023, the file name is as follows. VL_20230102134556.bin • The time information is based on the Controller's clock. • If you change the file name, the Sysmac Studio cannot read the file. Do not change the file name.
File format	Original format	

Specifications of Variable Log Information Files

The save destination, folder structure, file name, and file format of variable log information files, which are output simultaneously with variable log files, are shown in the table below.
In a variable log information file, a summary of the variable log file is recorded.

Item	Description	Remarks
Save destination	SD Memory Card mounted on the CPU Unit	
Folder structure	\APB\(hash code)\(output setting name)\	• If the APB folder does not exist in the file output destination, an APB folder and lower folders will be created automatically when sampling of variables starts. • A hash code consists of a 32-byte string. You can get it with the GetPrgHashCode (Get Program Hash Code) instruction.
File name	VL_YYYYMMDDhhmmss.ini YYYY: Year MM: Month DD: Day hh: Hours (24-hour notation) mm: Minutes ss: Seconds	• The time of the oldest data in the variable log file is used. For example, if the variable log file has data recorded from 13:45:56 on January 2, 2023, the file name is as follows. VL_20230102134556.ini • The time information is based on the Controller's clock.
File format	Original format	

2-2 Enabling Variable Data Collection

To collect variable data for automation playback, configure the settings to use automation playback.

Precautions for Correct Use

- If you use the automation playback function, design the tasks in the Controller to meet one of the following so that their operations are not affected.
  a) If the task period of the primary periodic task is 250 μs, the task execution time ratio is 60% or less.
  b) The task period of the primary periodic task is 500 μs or more.
- For the CPU Unit (including the factory defaults) set to **Do not use** for **Automation playback**, if the automatic transfer from SD Memory Card is executed with the backup data set to **Use** for **Automation playback**, restart the CPU Unit to use the automation playback function.

Additional Information

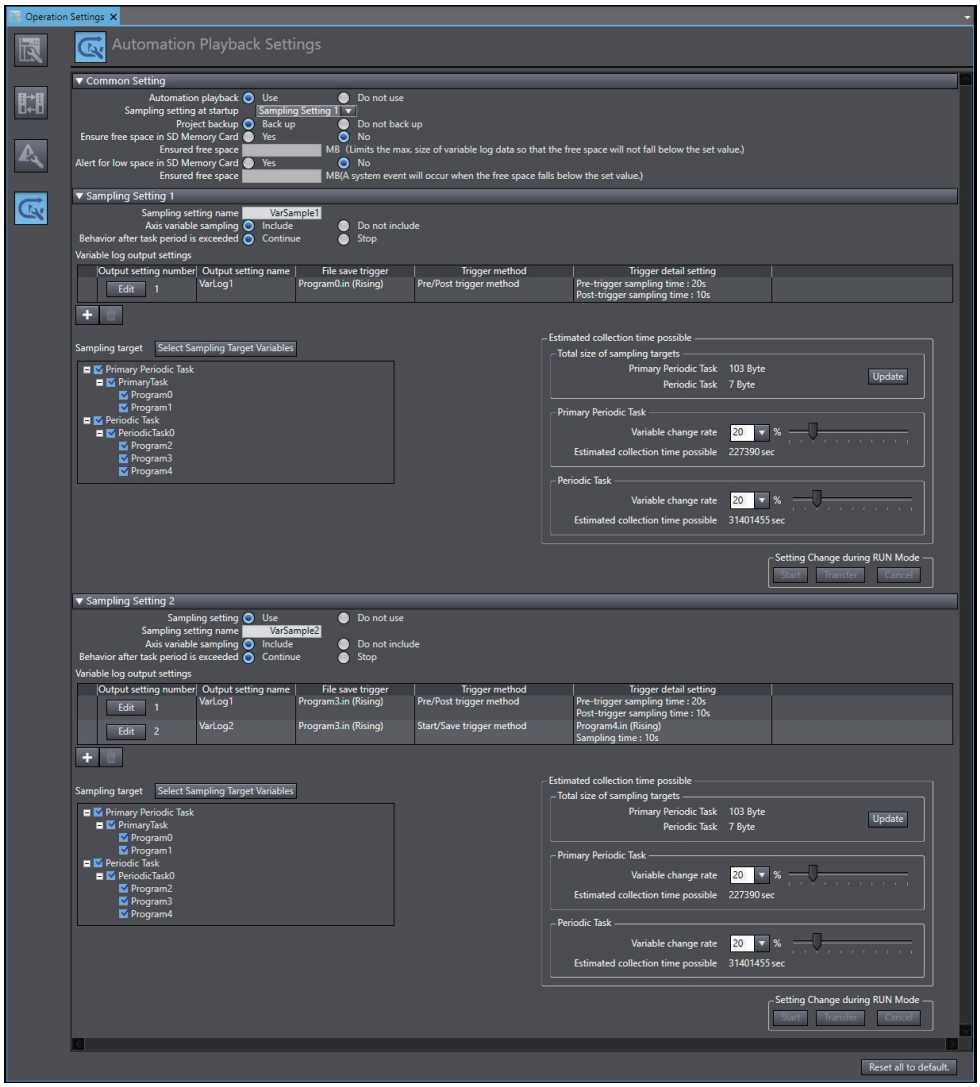
To use automation playback, you must set the trigger to save variable logs and the trigger method.
Before you set them, consider which variable to set as the trigger.
Refer to *2-3-2 Setting How to Output Variable Logs* on page 2-25 for how to set variable logs.

2-2-1 Procedure for Enabling Variable Data Collection

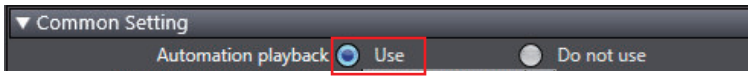
When automation playback is enabled, the CPU Unit starts the variable data collection function when it changes to RUN Mode.
Make sure that the Sysmac Studio and the Controller are offline before you enable variable data collection.

1 Double-click **Operation Settings** under **Configurations and Setup** – **Controller Setup** from the Multiview Explorer of the Sysmac Studio. Or right-click Operation Settings and select **Edit** from the menu.

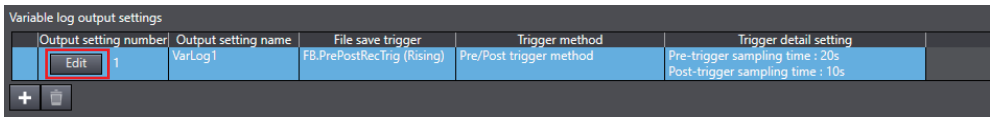
2 In the **Operation Settings** tab page displayed in the Edit pane, click the **Automation Playback Settings** button.
The **Automation Playback Settings** display opens.



3 Select **Use** for **Automation playback** in **Common Setting**.



4 Set the trigger and trigger method to save variable logs in the **Variable log output settings**. Refer to *2-3-2 Setting How to Output Variable Logs* on page 2-25 for details.



5 From the Synchronization window, transfer the Controller Setup to the CPU Unit.

6 Restart the CPU Unit.

Additional Information

To disable automation playback, select **Do not use** for **Automation playback** in **Common Setting**, and transfer the Controller Setup data to the CPU Unit.
Then, restart the CPU Unit.

2-2-2 Items for Enabling Variable Data Collection

There is a setting for whether or not to use automation playback.

Item	Description	Setting range	Default
Automation playback	Set whether or not to use automation playback. When **Use** is selected, the sampling of variable data will be performed according to the sampling setting.	Use or Do not use	Do not use

2-3 Setting the Variable Data Sampling Target and Output Method

Set the variable data to collect and the method to output variable data to a variable log.
You can create up to two variable log output settings per sampling setting.
You can create up to two sampling settings. However, you can enable only one sampling setting.

Additional Information

- To specify the sampling setting to enable at the startup of the Controller, select **Sampling Setting 1** or **Sampling Setting 2** for **Sampling setting at startup** in **Common Setting**.
- You can use the APB_ChangeSamplingSettings instruction in RUN Mode to switch between the sampling settings. However, switching the setting using the APB_ChangeSamplingSettings instruction is not reflected in **Sampling setting at startup** in **Common Setting**. If you perform any of the following operations, the sampling setting returns to the setting selected in **Sampling setting at startup**.
  a) Restarting the Controller
  b) Restoring the Controller
  c) Downloading the project synchronously from the Sysmac Studio
  d) Transferring the settings after editing the settings in **Sampling setting** using **Setting Change during RUN Mode** while the Controller is running

2-3-1 Setting the Variable Data Sampling Target

Set the variable data to collect and the collection behavior.

Procedure for Setting the Variable Data Sampling Target

Set the variable data to collect and the behavior when the execution of sampling exceeds the task period.
To change the setting of the variable data sampling, the Sysmac Studio and the Controller must be offline.

1 Double-click **Operation Settings** under **Configurations and Setup** – **Controller Setup** from the Multiview Explorer of the Sysmac Studio. Or right-click Operation Settings and select **Edit** from the menu.

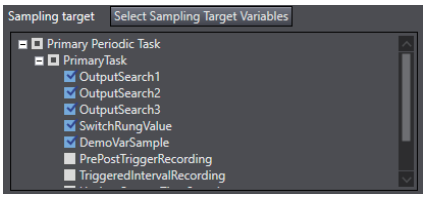
2 In the **Operation Settings** tab page displayed in the Edit pane, click the **Automation Playback Settings** button.
The **Automation Playback Settings** display opens.

3 Click **Sampling Setting 1** or **Sampling Setting 2**.
You can have two sampling settings. **Sampling Setting 1** and **Sampling Setting 2** have the same setting items.
The sampling setting is opened.
To use **Sampling Setting 2**, select **Use** for **Sampling setting** in **Sampling Setting 2**.

Additional Information

To specify the sampling setting to enable at the startup of the Controller, select **Sampling Setting 1** or **Sampling Setting 2** for **Sampling setting at startup** in **Common Setting**.

4 Select the sampling target.



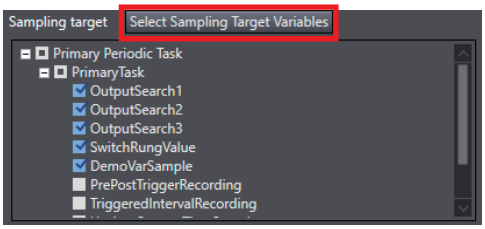
All selectable POUs and their variables are selected by default. Deselect POUs from which you do not need to collect data, such as variables that do not change values during operation.

Selecting a check box in the upper level of the tree also selects all check boxes in the lower levels. Similarly, clearing a check box in the upper level of the tree also clears all items in the lower levels.

Precautions for Correct Use

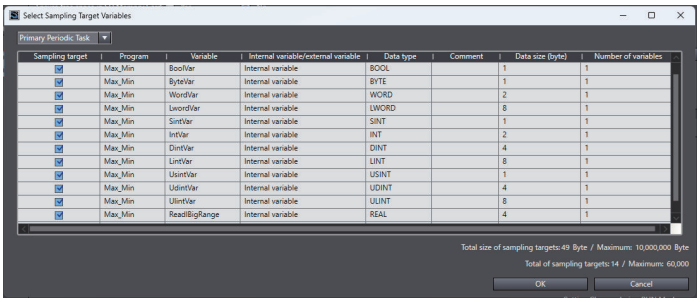
By default, all selectable sampling targets are selected. Refer to *2-1-2 Upper Limit of Variable Data to Collect* on page 2-3 and select sampling targets so that the upper limit is not exceeded.

5 Select the sampling target variables in the POU.
Click the **Select Sampling Target Variables** button.

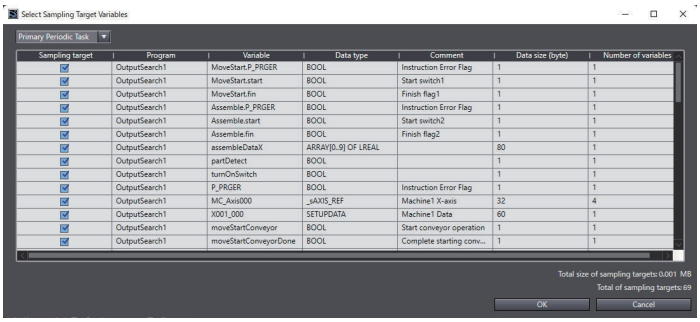


The **Select Sampling Target Variables** dialog box is displayed. Select the variable to include in the sampling target.
By default, all selectable variables are selected. Deselect structure and array variables from which you do not need to collect data, such as variables that do not change values during operation.
In the lower right corner of the **Select Sampling Target Variables** dialog box, you can see the **Total size of sampling targets** and **Total of sampling targets**. Please select sampling targets so that the upper limit in *2-1-2 Upper Limit of Variable Data to Collect* on page 2-3 is not exceeded.

- Project unit version 1.68 or later



- Project unit version earlier than 1.68



For the items on the dialog box for selecting variables of a program POU to include in the sampling target, refer to *Items on the Select Sampling Target Variables Dialog Box* on page 2-18.

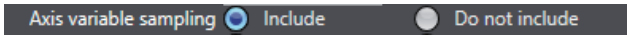
Additional Information

If you deselect a POU, the variables of the POU are no longer displayed in the **Select Sampling Target Variables** dialog box. However, if you select the POU again, the previously selected variables appear again in the **Select Sampling Target Variables** dialog box, unless you click the **OK** button in the dialog box.

Version Information

The function of selecting variables to be include in the sampling target can be used on the CPU Unit with unit version 1.65 or later.

6 Select whether to include axis variables in the sampling target.



7 Select the behavior when the execution of sampling exceeds the task period.

8 From the Synchronization window, transfer the settings to the CPU Unit.

Items for Variable Data Collection

There are settings that specify the sampling setting name, behavior after the task period is exceeded, and sampling target.

Item	Description	Setting range	Default
Sampling setting name	Set the name of the sampling setting.	1-byte to 31-byte string (not including the terminating NULL character). No duplicates are allowed between Sampling Setting 1 and Sampling Setting 2. Refer to *Restrictions on Characters in the Sampling Setting Name* on page 2-17 for usable characters.	
Axis variable sampling	Set whether to include axis variables in the sampling target.	Include or Do not include	Include
Behavior after task period is exceeded	Select the behavior of variable data collection when the execution of sampling exceeds the task period. If you select Continue, it may happen that concurrency cannot be ensured for variable data that will be collected.*1	Continue or Stop	Continue
Sampling target	Select the program POUs from which to collect variable data. For the items on the dialog box for selecting variables of a program POU to include in the sampling target, refer to *Items on the Select Sampling Target Variables Dialog Box* on page 2-18.	All program POUs excluding event tasks	All program POUs excluding event tasks

*1. Refer to *6-2-2 What to Do If Data Concurrency Cannot be Ensured in Variable Logs* on page 6-5 for what to do when concurrency of variable data cannot be ensured.

● Restrictions on Characters in the Sampling Setting Name

There are restrictions on characters that can be used in the sampling setting name.

Item	Description
Usable characters	0 to 9, A to Z, a to z $ % ' - _ @ ! ` ( ) ~ = # & + ^ [ ] { } , . ; Single-byte space (Not allowed at beginning and end of string)
Unusable characters	• Reserved words CON, PRN, AUX, CLOCK$, NUL, COM0, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, LPT0, LPT1, LPT2, LPT3, LPT4, LPT5, LPT6, LPT7, LPT8, LPT9 • Multi-byte characters
Case sensitivity	Not case sensitive
Maximum string size (without NULL)	31 bytes

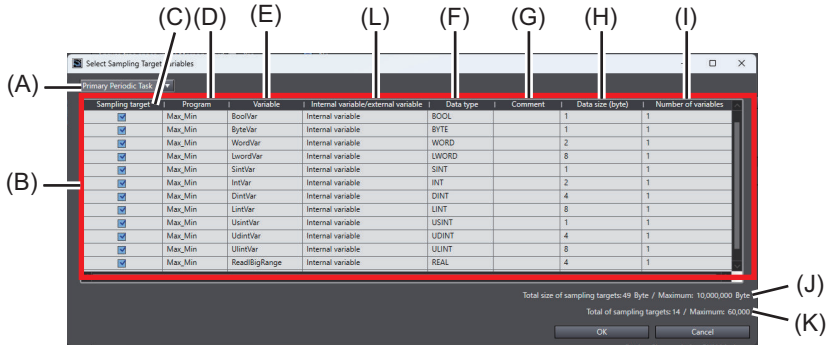
Items on the Select Sampling Target Variables Dialog Box

In the **Select Sampling Target Variables** dialog box, specify variables in a POU to include in the sampling target.

Version Information

The function to select the sampling target for each variable can be used in project unit version 1.65 or later.

The setting items in the **Select Sampling Target Variables** dialog box are as follows.



Symbol	Meaning	Description
A	Task type	You can select the task type from primary periodic task or periodic task to specify the variable to show in the variable list.
B	Variable list	A list of variables included in the program POUs selected as **Sampling target** in the sampling setting is displayed. Refer to the following for operations on the variable list. • *Sorting Variables in the Variable List* on page 2-19 • *Filtering Variables in the Variable List* on page 2-19 • *Showing or Hiding Columns in the Variable List* on page 2-22 • *Selecting All Rows in the Variable List* on page 2-22 • *Copying Data from the Variable List* on page 2-23
C	Sampling target	A checkbox is displayed to select whether or not to include the variable in the sampling target. You can specify multiple items and select or deselect their check boxes all at once. For information on how to select or deselect check boxes at one, refer to *Specifying Multiple Sampling Targets in the Variable List* on page 2-23. By default, they are all selected. When a variable is added to a POU that is included in the sampling target, the check box for that variable is selected (i.e., it is included in the sampling target).
D	Program	The program name that contains the variable is displayed.
E	Variable	The variable name is given. The units of variable to be displayed are as follows. • Basic data type: each variable • Structure/union/enumeration/array: each variable • User-defined function block: Individual internal variable, external variable, input variable and output variable for each instance variable • System-defined function block: each instance variable

Symbol	Meaning	Description
L	Internal variable/ external variable (Project unit version 1.68 or later)	The variable type is shown. • Internal variable: Variables used only within a POU • External variable: Variables that reference global variables outside of a POU. • Other: Other than the above, such as internal variables, input variables, and output variables for FBs
F	Data type	The data type of the variable is shown.
G	Comment	The comment for the variable is displayed.
H	Data size (byte)	The size of the sampled variable is displayed in bytes. For an axis variable, the total size of the sampled members is displayed.
I	Number of variables	The number of sampled variables is displayed. For a system-defined function block instance variable, the total number of sampled input and output variables is displayed. For an axis variable, the total number of sampled members is displayed. For other variables, 1 is displayed.
J	Total size of sampling targets	The total **data size** of variables whose check boxes in the **Sampling target** column are selected is displayed. Change of the check box selection is reflected immediately.
K	Total of sampling targets	The total **number of variables** whose check boxes in the **Sampling target** column are selected is displayed. Change of the check box selection is reflected immediately.

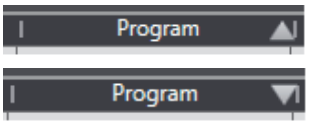
Additional Information

In project unit version 1.68 and later, the number of variables and the total data size may not be reduced even if you deselect the *Sampling target* check boxes for external variables.
To reduce the number of variables and total data size by excluding external variables, deselect the Sampling target check boxes for all of the external variables to exclude.

● Sorting Variables in the Variable List

You can sort the variable in the variable list on the Select Sampling Target Variables dialog box.

1 In the variable list in the **Select Sampling Target Variables** dialog box, click the header of the column to sort.
Variables are listed in ascending order on first click and the ▲ icon is displayed. Variables are listed in descending order on second click and the ▼ icon is displayed. Subsequent clicks toggle between ascending and descending order.



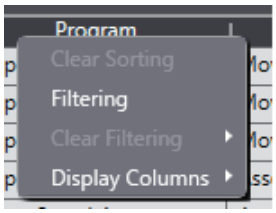
To cancel sorting, right-click on the variable list header and select **Clear Sorting** from the pop-up menu that appears.

● Filtering Variables in the Variable List

You can filter the variable in the variable list on the Select Sampling Target Variables dialog box.

1 In the variable list in the **Select Sampling Target Variables** dialog box, right-click the header of the column to filter.

The pop-up menu is displayed.

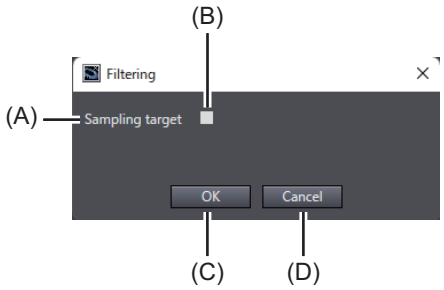


2 Select **Filtering** from the menu.
The Filtering window for the column is displayed.

3 Specify conditions for filtering.
Refer to the description below for the Filtering window and settings for each column.

4 Click the **OK** button.
The Filtering window closes and the variables on the variable list are filtered according to the set conditions.
To cancel filtering, right-click on the variable list header and select **Clear Filtering** from the pop-up menu. You can choose to clear filtering for only selected columns or all columns.

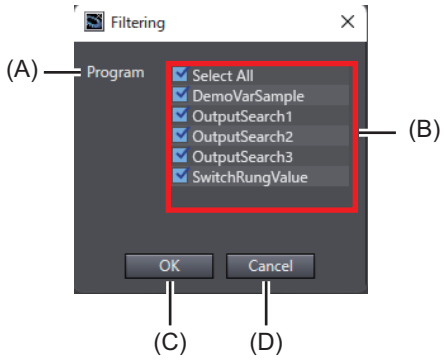
Filtering window for Sampling target column



Symbol	Meaning	Description
A	Setting	The name of the column for which filtering is set.
B	Condition check box	You select this check box to display only the variables specified as sampling targets. By default, this check box is not selected.
C	**OK** button	Clicking this button filters rows that meet the set conditions.
D	**Cancel** button	Clicking this button cancels the changes made and closes the window.

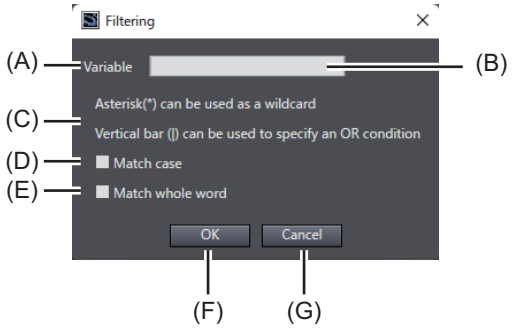
Filtering window for Program column and Data type column

An example of the Filtering window for the **Program** column is shown below. The Filtering window for the **Data type** column has a similar screen configuration.



Symbol	Meaning	Description
A	Setting	The name of the column for which filtering is set.
B	List of conditions	Program names or data types are displayed in ascending order of their string. Identical strings that differ only in upper and lower case are removed and shown. Choose the program names or data types you want to display. It is not possible to change the selection for multiple rows at once. These check boxes are all selected by default.
C	**OK** button	Clicking this button filters rows that meet the set conditions.
D	**Cancel** button	Clicking this button cancels the changes made and closes the window.

Filtering window for Variable, Comment, Data size and Number of variables columns



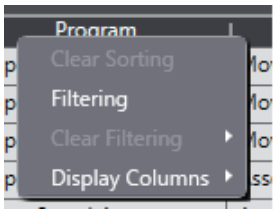
Symbol	Meaning	Description
A	Setting	The name of the column for which filtering is set.
B	Condition input field	You specify the filtering conditions. You can use * (asterisk) as a wildcard. You can also use | (bar) as an OR condition.
C	Description	This is an description of the symbols that can be used in conditions.
D	**Match case** check box	Select this check box to make the entered condition text case sensitive. By default, this check box is not selected.

Symbol	Meaning	Description
E	**Match whole word** check box	Select this check box to filter only those that exactly match the entered text. By default, this check box is not selected.
F	**OK** button	Clicking this button filters rows that meet the set conditions.
G	**Cancel** button	Clicking this button cancels the changes made and closes the window.

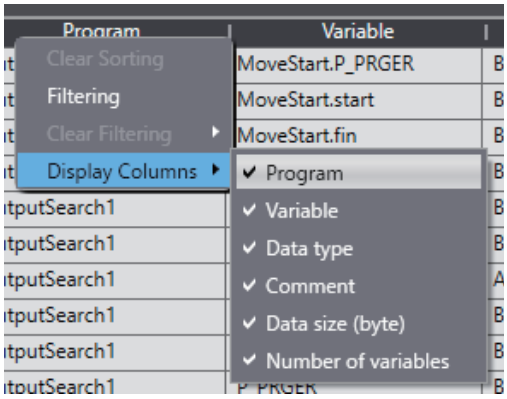
● Showing or Hiding Columns in the Variable List

You can toggle between showing and hiding columns of the variable list in the Select Sampling Target Variables dialog box.
It is convenient for efficiently checking necessary items.

1 Right-click on the column header of the variable list in the **Select Sampling Target Variables** dialog box.
The pop-up menu is displayed.



2 Select **Display Columns**.
The column name is displayed.



A check mark (✓) is displayed for the name of the column being displayed.

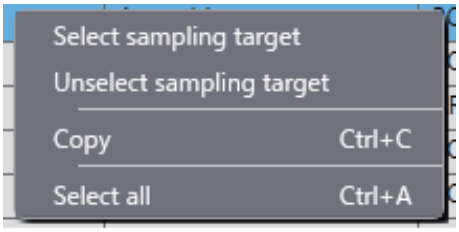
3 Click the name of the column you want to toggle between showing and hiding.
The specified columns are shown or hidden accordingly.

● Selecting All Rows in the Variable List

You can select all rows in the variable list.
This function is useful to select all rows when there are many rows in the variable list.

1 Right-click on the variable list in the **Select Sampling Target Variables** dialog box.

The pop-up menu is displayed.



2 Click the **Select all** menu command.

Additional Information

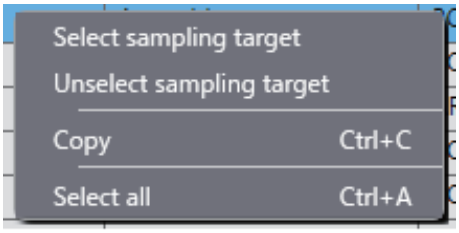
You can also select all rows by pressing Ctrl + A keys on the variable list.

● Copying Data from the Variable List

You can copy the data from the variable list and paste it to an Excel file, etc.

1 On the variable list in the **Select Sampling Target Variables** dialog box, select the row to copy.

2 Right-click on the variable list in the **Select Sampling Target Variables** dialog box.
The pop-up menu is displayed.



3 Select **Copy**.
The data in the selected row is copied to the clipboard.

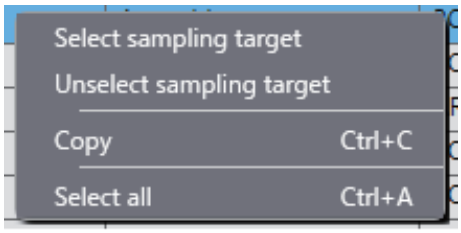
4 Paste it into an Excel file or something.

● Specifying Multiple Sampling Targets in the Variable List

You can specify multiple variables to be included in the sampling target at once on the variable list.

1 From the variable list in the **Select Sampling Target Variables** dialog box, select multiple rows of variables to include in the sampling target or rows that you do not want to include in the sampling target.

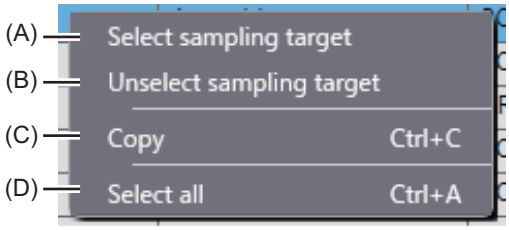
2 Right-click on the variable list in the **Select Sampling Target Variables** dialog box.
The pop-up menu is displayed.



3 If you want to include the variables in the selected rows in the sampling target, click **Select sampling target**. If you want to exclude the variables in the selected rows from the sampling target, select **Unselect sampling target**.
The check boxes for **Sampling target** of these rows are selected or deselected depending on the menu command you selected.

● Pop-up Menu of the Variable List

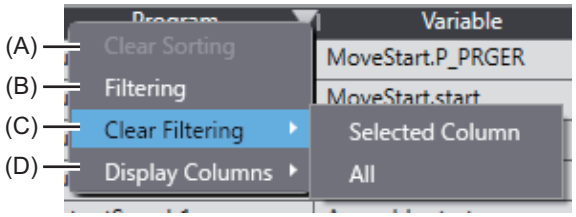
Right-click on the variable list to display the operation menu.



Sym-bol	Meaning	Description
A	Select sampling target	This menu selects the check boxes of the selected rows in the **Sampling target** column.
B	Unselect sampling target	This menu deselects the check boxes of the selected rows in the **Sampling target** column.
C	Copy	This menu copies the data in the selected rows. You can paste the copied data into an Excel file.
D	Select all	This menu selects all rows.

● Pop-up Menu of the Variable List Header

Right-click on the header of the variable list to display the operation menu.



Sym-bol	Meaning	Description
A	Clear Sorting	Select this menu to cancel sorting. This menu is available when data in the column is sorted.

Symbol	Meaning		Description
B	Filtering		Select this menu to filter the data. Refer to *Filtering Variables in the Variable List* on page 2-19 for details on filtering.
C	Clear Filtering		Select this menu to cancel filtering. This menu is available when filtering is applied.
		Selected Column	This menu removes filtering for the selected column.
		All	This menu removes filtering on all columns.
D	Display Columns		Select this menu to display or hide each column. A check mark (✓) is displayed to the left of the column name while the column is displayed. By default, the column is displayed.

2-3-2 Setting How to Output Variable Logs

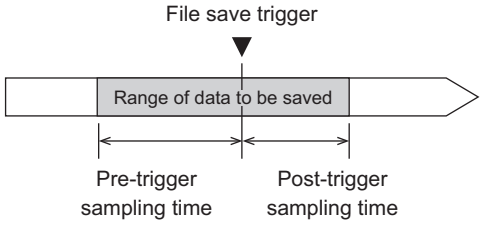
Set the trigger to save a variable log, and the trigger method.
You can create more than one variable log output setting. You can use them for different purposes as follows.

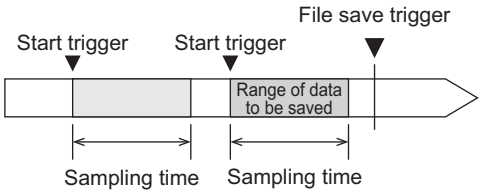
- Save variable logs for a certain period of time using the pre/post trigger method to analyze unexpected problems during system operation.
- Save variable logs only when necessary using the start/save trigger method during system design and debugging.

Once variable log output processing is started by one of the output settings, until the variable log output is completed, variable logs cannot be output by the other output setting. You can check the status of variable log output with the _APB_LogStatus system-defined variable. The status of variable log output is as follows.

- After start of variable log output: Storing
- After completion of variable log output: Sampling

The following trigger methods are available for specifying the range of data to be saved in a variable log.

Trigger method	Description
Pre/Post trigger method	Outputs the data before and after the trigger changes to TRUE to a variable log. This method is used, for example, to save and check data before and after occurrence of a problem in a variable log. 

Trigger method	Description
Start/Save trigger method	Samples the data after the start trigger changes to TRUE. The data sampled by the previous start trigger is output to the variable log when the file save trigger changes to TRUE. This method is used, for example, in debugging to save and check the data when a specific condition is satisfied in the variable log. 

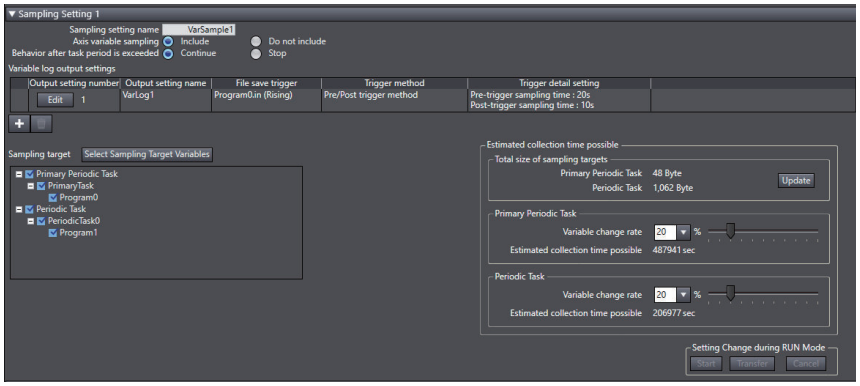
Procedure for Setting How to Output Variable Logs

Configure the detailed settings of the save trigger and trigger method for variable logs.
To change the setting of how to collect variable data, the Sysmac Studio and the Controller must be offline.

1 Double-click **Operation Settings** under **Configurations and Setup** – **Controller Setup** from the Multiview Explorer of the Sysmac Studio. Or right-click Operation Settings and select **Edit** from the menu.

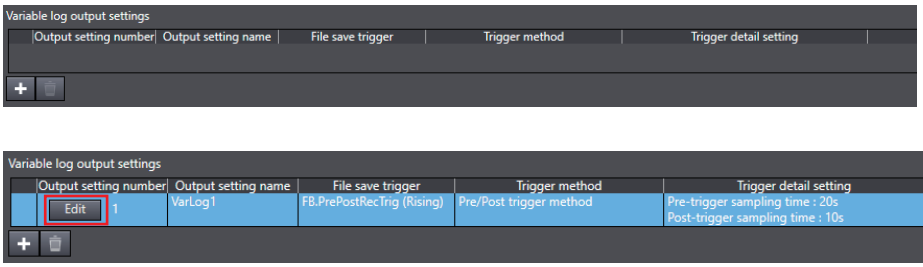
2 In the **Operation Settings** tab page displayed in the Edit pane, click the **Automation Playback Settings** button.
The **Automation Playback Settings** display opens.

3 Click **Sampling Setting 1** or **Sampling Setting 2**.
The sampling setting is opened.



You can have two sampling settings. **Sampling Setting 1** and **Sampling Setting 2** have the same setting items.

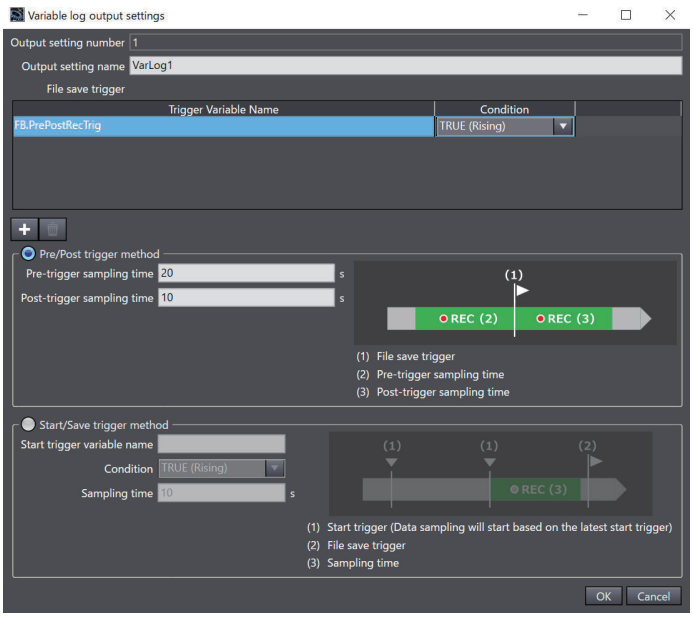
4 In **Variable log output settings**, click the **+** button. If you edit output settings that already exist, click the **Edit** button for the output setting to edit.



Additional Information

If you delete variable log output settings, select the output setting to delete and click the button.

The **Variable log output settings** dialog box is displayed.



5 Set each item.

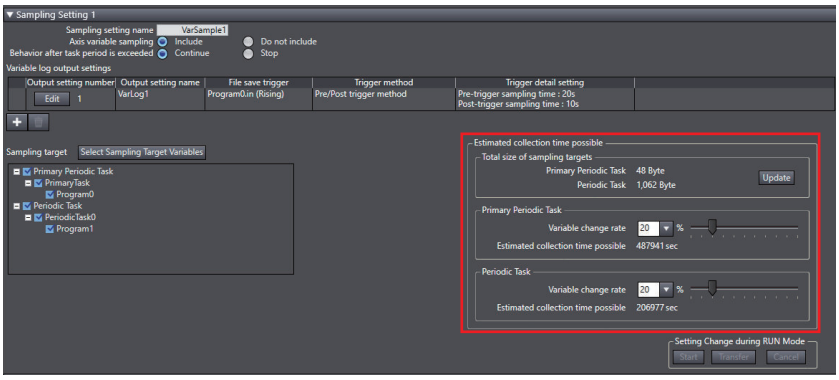
- In **File save trigger**, click the **+** button to add a file save trigger.
- To delete file save triggers, select the file save trigger to delete and click the button.

6 Click the **OK** button.

7 From the Synchronization window, transfer the settings to the CPU Unit.

Additional Information

In project unit version 1.68 or later, you can check the estimated length of time available for sampling using the current settings in the **Estimated collection time possible** in the Automation Playback Settings display. Use the **Estimated collection time possible** as a reference when you set the sampling time in the **Variable log output settings** dialog box.
The length of time available for variable log sampling varies depending on the percentage of variables that change. The larger the percentage of variables that change, the more data needs to be recorded, reducing the length of time available for sampling. By adjusting the **Variable change rate** setting, you can estimate the length of time available for sampling in a variable log with higher accuracy.
Note that the Estimated collection time possible is only a guideline for the maximum length of time that can be recorded in a variable log, and is not guaranteed.



Items for Variable Log Output

There are settings that specify the setting name, file save trigger, and trigger method.

Precautions for Correct Use

If the same variables and the same condition are set as the file save trigger for more than one output setting, the trigger condition for the smallest output setting number is assumed to be met when the file save trigger condition is met.

Item	Description	Setting range	Default
Output setting number	This is automatically set to 1 for the first output setting, and 2 for the second output setting. This number is used in the subscript to specify which output setting is used in the array of the _APB_LogStatus system-defined variable.	1 or 2 The number is automatically set, and you cannot change the number.	---

Item		Description	Setting range	Default
Output setting name		Set the name of the variable log output setting.	1-byte to 31-byte string (not including the terminating NULL character). No duplicates are allowed between Sampling Setting 1 and Sampling Setting 2. Refer to *Restrictions on Characters in the Setting Name of Variable Log Output* on page 2-30 for supported characters.	VarLogN N is the output setting number.
File save trigger	Trigger Variable Name	Set the variables to use as the file save trigger. Up to 4 variables can be specified for each output setting.	BOOL variable	None
	Condition	Set the condition that must be met for the file save trigger to be established	TRUE (Rising) or FALSE (Falling)	None
Trigger method		Select the method to output the sampling results of variable data to the variable log.	Pre/Post trigger method or Start/Save trigger method	Pre/Post trigger method
When **Pre/Post trigger method** is selected in Trigger method	Pre-trigger sampling time [s]	Set how much time data should be output to the variable log before the file save trigger changes to TRUE.	1 to 899 The maximum value is a value in the range where the total value of Pre-trigger sampling time and Post-trigger sampling time is 900 or less.	20
	Post-trigger sampling time [s]	Set how much time data should be output to the variable log after the file save trigger changes to TRUE.	1 to 899 The maximum value is a value in the range where the total value of Pre-trigger sampling time and Post-trigger sampling time is 900 or less.	10

Item		Description	Setting range	Default
When **Start/ Save trigger method** is selected in Trigger method	Start trigger variable name	Set the variable name to use as the start trigger.	BOOL variable	None
	Condition	Set the condition that must be met for the start trigger to be established.	TRUE (Rising) or FALSE (Falling)	None
	Sampling time [s]	Set how much time data should be output to the variable log after the start trigger changes to TRUE.	1 to 900	10

Additional Information

Depending on settings for the following items, the time length of the data output to the variable log is shorter than the set sampling time.
- Variable data set as sampling target
- Unused time in a task

For relationship between the length of the output variable log data and the sampling time, refer to *6-2-3 What to Do If Variable Logs Are Shorter Than the Set Time* on page 6-8.

● Restrictions on Characters in the Setting Name of Variable Log Output

There are restrictions on characters that can be used in the setting name of variable log output.

Item	Description
Usable characters	0 to 9, A to Z, a to z $ % ' - _ @ ! ` ( ) ~ = # & + ^ [ ] { } , . ; Single-byte space (Not allowed at beginning and end of string)
Unusable characters	• Reserved words CON, PRN, AUX, CLOCK$, NUL, COM0, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, LPT0, LPT1, LPT2, LPT3, LPT4, LPT5, LPT6, LPT7, LPT8, LPT9 • Multi-byte characters
Case sensitivity	Not case sensitive
Maximum string size (without NULL)	31 bytes

2-4 Checking Collected Variable Data

Try to run automation playback and check if it works as expected.

1 Check if automation playback works properly.
Open the Automation Playback Operation Monitor in the Sysmac Studio to see if automation playback works correctly. Refer to *6-3-1 Checking the Operation Status of Automation Playback* on page 6-12 for information on the Automation Playback Operation Monitor.
If automation playback does not work correctly, one of the following events occurs.
Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for information on the event.

Event code	Event name	References in this manual
152C0000 hex	Variable Log Save Failed	*6-2-1 What to Do If Automation Playback Does Not Work* on page 6-3
35EF0000 hex	Automation Playback Startup Error	---
95770000 hex (This event occurs for the CPU Unit with unit version earlier than 1.65.)	Upper Limit of Variable Sampling	• When attached information 2 of the event is 0 or 1 *2-1-2 Upper Limit of Variable Data to Collect* on page 2-3 • When attached information 2 of the event is 2 *What to Do When Processing Capacity to Collect Variable Data Is Exceeded* on page 6-3
95790000 hex (This event occurs for the CPU Unit with unit version 1.65 or later.)	Upper Limit of Variable Sampling	
64040000 hex (This event occurs for the CPU Unit with unit version 1.68 or later.)	Upper Limit of Sampling Processing Capacity	*What to Do When Processing Capacity to Collect Variable Data Is Exceeded* on page 6-3

Additional Information

Events whose event level is observation level can be checked in the **Event Log** in the **Troubleshooting** dialog box of the Sysmac Studio.

2 Check if the concurrency in the variable log data is achieved.
Depending on the load of the task and the number and size of the variables to be sampled, all the necessary variable data may not be retrieved within the same task period. In such a case, the concurrency of the variable log data cannot be ensured, and one of the following events occurs.
Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for information on the event.

Event code	Event name	References in this manual
64060000 hex	No Variable Log Concurrency	*6-2-2 What to Do If Data Concurrency Cannot be Ensured in Variable Logs* on page 6-5
64070000 hex	Cycle with No Variable Sampling	

3 Check if the time length of the output variable log meets your usage.
When the output of the variable log is complete, one of the following events occurs. The time length of the output variable log can be checked for the following events.
Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for information on the event.

Event code	Event name	References in this manual
95780000 hex (This event occurs for the CPU Unit with unit version 1.65 or later.)	Variable Log Output Completed	*6-2-3 What to Do If Variable Logs Are Shorter Than the Set Time* on page 6-8
95750000 hex (This event occurs for the CPU Unit with unit version earlier than 1.65.)	Variable Log Output Completed	

Additional Information

The time length of variable logs that can be collected changes depending on the number and size of the sampled variables and how they change in each task period. Therefore, it may not always be possible to obtain variable logs of the set sampling time.

Version Information

Project unit version 1.68 or later allows you to check the estimated available sampling time in the Automation Playback Operation Monitor dialog box without the output of variable logs on the actual equipment in operation.
Note that the estimated available sampling time is only a guideline for the maximum length of time that can be recorded in a variable log.
Refer to *6-3-1 Checking the Operation Status of Automation Playback* on page 6-12 for details.

2-5 Configuring the Setting to Back Up the Project for Playback

To execute playback in the Sysmac Studio without the project on the computer, configure the setting to back up the project when variable data is collected.

2-5-1 Conditions That Must Be Met to Back Up the Project

If the project is set to back up, the Controller will automatically get the backup file when the operation of automation playback function is started.
When all of the following conditions are met, the Controller will get the backup file for a project.

- Project backup is set to back up in the Automation Playback Settings.
  Refer to *2-5-2 Procedure for Configuring the Setting to Back Up the Project* on page 2-33 for information on the setting to back up the project.
- Automation playback function is started. *1
- The project from which to collect variable data is not yet backed up by automation playback.
- **Data backup prohibition to the SD Memory Card**[*2] is set to **Do not use**.

*1. The status of automation playback function changes from Idle to Run. Refer to *A-1-1 State Transitions for Automation Playback Function* on page A-2 for details on the status of automation playback function.
*2. The setting for **Data backup prohibition to the SD Memory Card** is located in **Security Settings** from **Configurations and Setup** – **Controller Setup** – **Operation Settings** – **Basic Settings** in the Multiview Explorer.

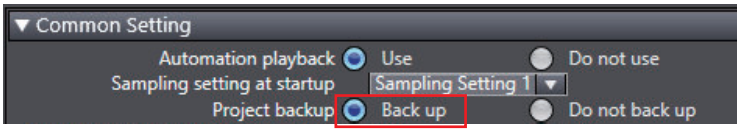
2-5-2 Procedure for Configuring the Setting to Back Up the Project

Enable project backup so that the project will be backed up when variable data is collected.
Make sure that the Sysmac Studio and the Controller are offline before you enable project backup.

1 Double-click **Operation Settings** under **Configurations and Setup** – **Controller Setup** from the Multiview Explorer of the Sysmac Studio. Or right-click Operation Settings and select **Edit** from the menu.

2 In the **Operation Settings** tab page displayed in the Edit pane, click the **Automation Playback Settings** button.
The **Automation Playback Settings** display opens.

3 Select **Back up** for **Project backup** in **Common Setting**.



4 From the Synchronization window, transfer the Controller Setup to the CPU Unit.

2-5-3 Items for Project Backup

There is a setting that specifies whether or not to back up project data.

Item	Description	Setting range	Default
Project backup	Set whether or not to save the backup file to an SD Memory Card at the start of variable data collection. You can use the backup file when the project is reproduced.	Back up or Do not back up	Back up

2-5-4 Specifications of Project Backup Data

The save destination, folder structure, file name, and file format of the project backup file are as shown in the table below.

Item	Description	Remarks
Save destination	SD Memory Card mounted on the CPU Unit	
Folder structure	\APB\(hash code)\PRJ\	• If the APB folder does not exist in the file output destination, an APB folder and lower folders will be created automatically when sampling of variables starts. • A hash code consists of a 32-byte string. You can get it with the GetPrgHashCode (Get Program Hash Code) instruction.
File name	NXBackup.dat, AutoCommand.ini, RestoreCommand.ini	
File format	Original format	

Additional Information

The project backup file is the same as the backup file that you back up on an SD Memory Card.

2-6 Specifying the Operation When Available Data Storage Space Gets Low

Specify whether to issue an event for notification when the available data storage space gets low and how much available space to maintain.

2-6-1 Types of Operation Specification Methods When Available Data Storage Space Gets Low

There are two types of settings, i.e., **Ensure free space in SD Memory Card** that specifies how much available storage space to maintain and **Alert for low space in SD Memory Card** that specifies at what level to issue an event when the available data storage space gets low.

Type	Description
Ensure free space in SD Memory Card	Controls the available storage space for data related to automation playback so that it does not fall below the amount set for this item. If the available storage space for data related to automation playback is expected to fall below the amount set for this item when a new variable log file is output, the Controller automatically deletes files with older timestamps in the destination APB and lower folders to secure available space. If the Controller performs control based on this setting, the Variable Log Overwritten event (95760000 hex) will occur.
Alert for low space in SD Memory Card	This is a function that warns of a situation where the available storage space in the destination storage is getting low by means of an event. Generates the Capacity Warning of Variable Log Save Destination event (64050000 hex) when the available data storage space for data related to automation playback falls below the amount set for this item. You can change the event level to Minor Fault although the default setting is Observation.

2-6-2 Procedure for Specifying the Operation When Available Data Storage Space Gets Low

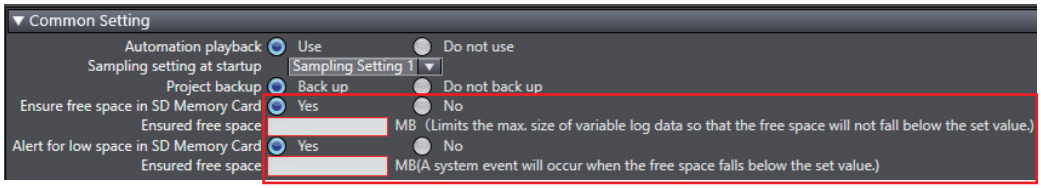
Set the operation to perform when the available data storage space gets low in **Ensure free space in SD Memory Card** and **Alert for low space in SD Memory Card**.
To change the operation settings when the available data storage space gets low, the Sysmac Studio and the Controller must be offline.

1 Double-click **Operation Settings** under **Configurations and Setup** – **Controller Setup** from the Multiview Explorer of the Sysmac Studio. Or right-click Operation Settings and select **Edit** from the menu.

2 In the **Operation Settings** tab page displayed in the Edit pane, click the **Automation Playback Settings** button.
The **Automation Playback Settings** display opens.

3 In **Common Setting**, select **Yes** for **Ensure free space in SD Memory Card** and **Alert for low space in SD Memory Card**.

4 For each item for which you selected **Yes** in step 3, enter the size of available space to specify in **Ensured free space**.



5 From the Synchronization window, transfer the settings to the CPU Unit.

2-6-3 Items for Specifying the Operation When Available Data Storage Space Gets Low

There are two settings, i.e., **Ensure free space in SD Memory Card** and **Alert for low space in SD Memory Card**.

Item		Description	Setting range	Default
Ensure free space in SD Memory Card		Select whether to set available storage space to secure available space on the SD Memory Card.	Yes or No	No
	Ensured free space	Set the available storage space to secure. When this item is not specified, the Controller will delete old files to secure available space if the storage space is expected to get low.	None, or numeric value between 1,024 and 4,096 (MB).	None
Alert for low space in SD Memory Card		Select whether to warn the user when the available space on the SD Memory Card gets low.	Yes or No	No
	Ensured free space	Set the threshold of available storage space at which to issue a warning. When not set, you will not be warned if available storage space gets low.	None, or numeric value between 1,024 and 4,096 (MB).	None

Precautions for Correct Use

- It is not possible to set the value of **Alert for low space in SD Memory Card** to be less than or equal to the value of **Ensure free space in SD Memory Card**.
- If a value that exceeds the total storage capacity is set for both **Ensure free space in SD Memory Card** and **Alert for low space in SD Memory Card**, the Controller will operate as if they were not set.

2-7 Changing Variable Data Sampling Setting While the Controller is in RUN Mode

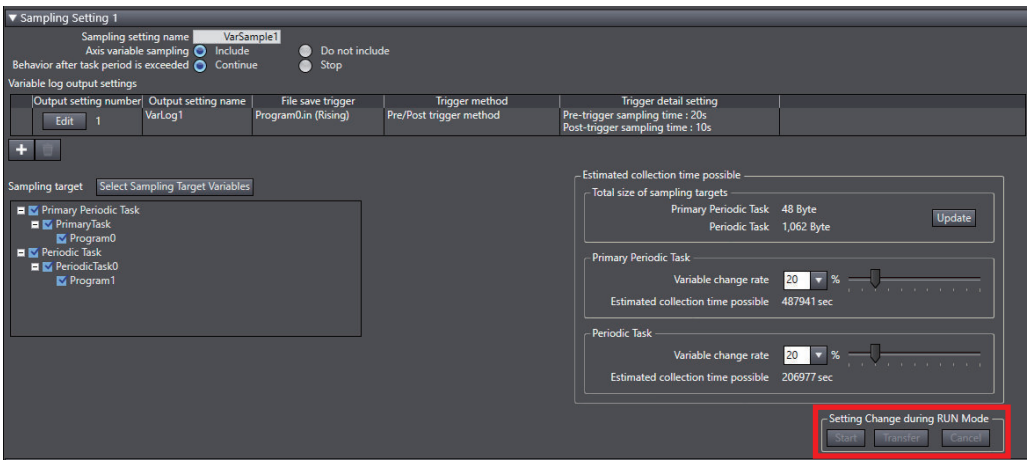
You can change the variable data to be collected without stopping the Controller operation.

Version Information

The function to change the setting of variable data collection while the Controller is running can be used with the CPU Unit with unit version 1.65 or later.

2-7-1 Procedure for Modifying Variable Data Sampling Setting While the Controller is in RUN Mode

You can edit the settings in **Sampling setting** and transfer them while the Controller is running.
After the settings are transferred, the Controller performs sampling with the changed settings.
You can modify the settings for **Sampling Setting 1** and **Sampling Setting 2** individually with the operation buttons in the **Setting Change during RUN Mode** section.



Common Setting cannot be changed.

Precautions for Correct Use

To perform this procedure, **Automation playback** in the **Common Setting** must be set to **Use**.

1. Place the Sysmac Studio online with the Controller.
2. Click the **Start** button for **Setting Change during RUN Mode** in the **Sampling Setting 1** or **Sampling Setting 2** for which you want to change the settings.
   Sampling setting can now be edited.
3. Edit the settings for variable data collection.
   To cancel the changes, click the **Cancel** button. Changes are discarded and setting change during RUN Mode is cancelled.

4 Click the **Transfer** button.

When the transfer of sampling setting is complete, the following message is displayed.

"Setting change during RUN Mode was successfully completed. Sampling starts with the transferred settings. "

Sampling during execution stops, and sampling restarts with the transferred settings. Data of sampling that was stopped during execution is discarded.

Precautions for Correct Use

- If an error message appears when you click the **Start** or **Transfer** buttons, follow the instruction of the message.
- If the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed while the edited sampling settings are being transferred, the Sampling Setting used will not be changed. At this time, an Input Mismatch (54010401 hex) event occurs.

2-8 Additional Information about Automation Playback Settings

Additional information about automation playback settings is as follows.

Security-related Information

- Users with Maintainer or higher authority are allowed to change Automation Playback Settings. Refer to the *NJ/NX-series CPU Unit Software User's Manual (Cat. No. W501)* for information on the operation authority verification.
- To meet the security requirements specified for your operational environment, assign access permissions so that the appropriate users can check the contents of the user program.
- When the settings are changed and synchronized, the Automation Playback Settings Changed event (95720000 hex) is registered.
- Settings related to automation playback are subject to the complete data erasure function. Refer to the *NJ/NX-series CPU Unit Software User's Manual (Cat. No. W501)* for information on the complete data erasure function.

Version-related Information

- If you change from a model or unit version that supports automation playback settings to a model or unit version that does not support Automation Playback Settings, the automation playback setting data will be deleted from the project. If you change to a new model or unit version that supports Automation Playback Settings, the automation playback setting data will be returned to the defaults.

3

Executing Playback

To execute playback, read the data collected by the Controller into the Sysmac Studio and then start playback.

3-1 Copying Playback Data to a Computer

To execute playback, first copy the playback data to a computer.
Playback data refers to the following.

- Variable logs that were collected and recorded by the Controller for playback
- Project backup file that was used to collect variables
- Video data that was captured outside the system

You can also control a camera from the user program to create video data.
For information on a sample program of creating video data using a user program, visit the following URL. Or, contact your OMRON representative.
https://www.ia.omron.com/product/tool/nx5_apb/download.htm

3-1-1 How to Copy Playback Data to a Computer

One method to copy playback data to a computer on which the Sysmac Studio is installed is using the Sysmac Studio function.
Other methods to do so include using the Windows function to copy it to an SD Memory Card mounted on the computer or using the FTP server to copy it to the computer.

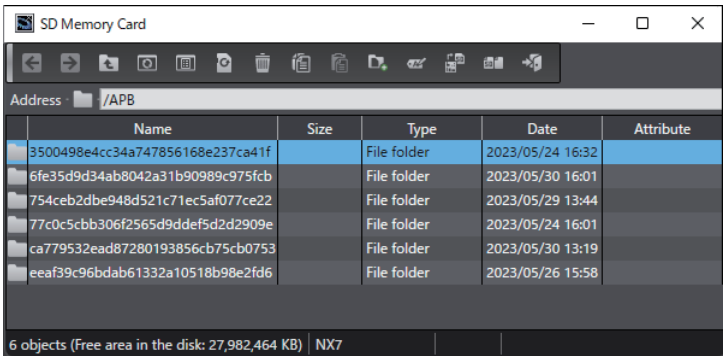
For how to use the FTP server to copy playback data to a computer, refer to the *NJ/NX-series CPU Unit Built-in EtherNet/IP Port User's Manual (Cat. No. W506)*.

For information on how to centrally manage variable logs and video data with scripts that work with the network storage, visit the following URL. Or, contact your OMRON representative.
https://www.ia.omron.com/product/tool/nx5_apb/download.htm

3-1-2 Procedure for Using the Sysmac Studio Function to Copy Variable Logs to a Computer

Copy variable logs from the SD Memory Card on the Controller to a computer on which the Sysmac Studio is installed.
You can copy variable logs when the Sysmac Studio is online with the Controller.

1 Select **Automation Playback** – **Get Variable Log from Controller** from the **Tools** menu of the Sysmac Studio.
The **SD Memory Card** dialog box is displayed.



If the APB folder, which is the automation playback data folder, does not exist on the SD Memory Card, an error message will appear after this dialog box is displayed.

2 In the **SD Memory Card** dialog box, select and copy the target data.
Select the variable log stored in the folder whose name matches the program hash code of the project for which the variable log was obtained. Refer to *2-3-2 Setting How to Output Variable Logs* on page 2-25 for the specifications for saving variable log files.

3 Paste it into any folder in Windows Explorer.
The variable logs are copied to the specified folder.

Additional Information

A program hash code is used to check the link between variable logs and projects. Select a variable log whose program hash code matches. If the program hash code is not matched, data may not be played correctly. The current project's program hash code is displayed in the **Start Playback** dialog box. Refer to *3-2-2 Items in the Start Playback Dialog Box* on page 3-5 for information on the **Start Playback** dialog box.

3-2 Starting Playback

Start playback using the variable logs and video data that you copied to the computer.
When playback starts, the Sysmac Studio enters playback mode. Refer to *4-6 Restrictions during Execution of Playback* on page 4-11 for operations that you cannot perform in playback mode.

3-2-1 Procedure for Starting Playback

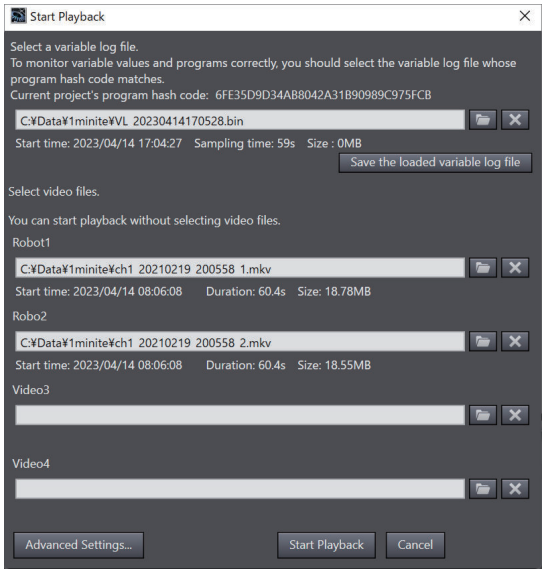
Specify the data to play back and start playback function.
To start playback function, the Sysmac Studio and the Controller must be offline.

1 Open the project to use for playback in the Sysmac Studio.

2 Select **Automation Playback** – **Start Playback** from the **Tools** menu of the Sysmac Studio.

Or, click the **Start Playback** icon ( ) in the toolbar.

The **Start Playback** dialog box is displayed.



3 In the **Start Playback** dialog box, specify the variable log and video data to use for playback.

4 Click the **Start Playback** button.
After a display of the **Starting Playback...** dialog box, the **Playback** dialog box and the **Search Playback Data** tab page are displayed. When video data is specified, the **Video Playback** window is displayed.

The top of the Edit pane is shown in purple.

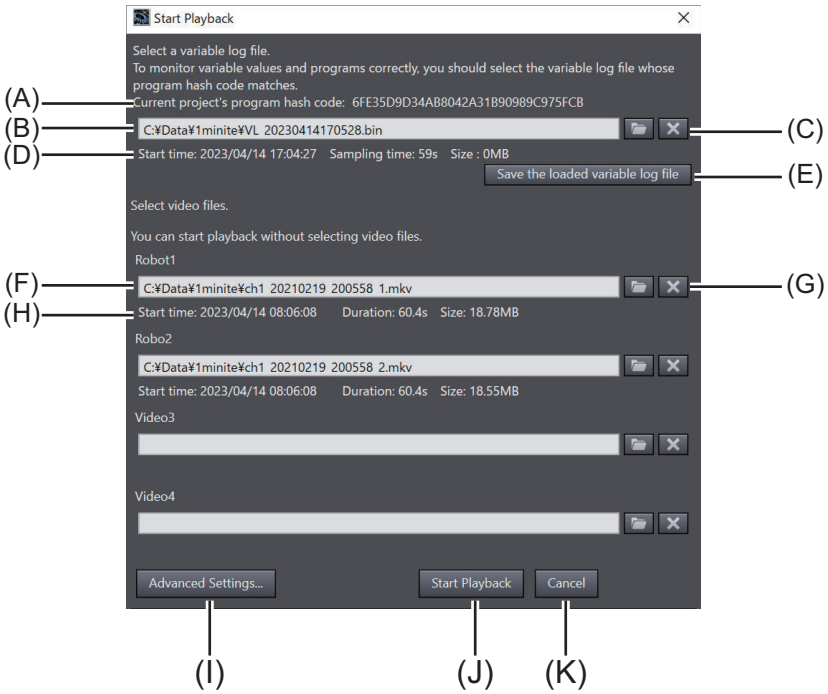
Additional Information

- The **Controller Status** pane is not displayed during execution of playback function.
- The **Search Playback Data** tab page is displayed in a floating state, separate from the Sysmac Studio window. You can cancel the floating state and place it in the window, and bring it back to the floating state again. Refer to the Sysmac Studio Version 1 Operation Manual (Cat. No. W504) for details.

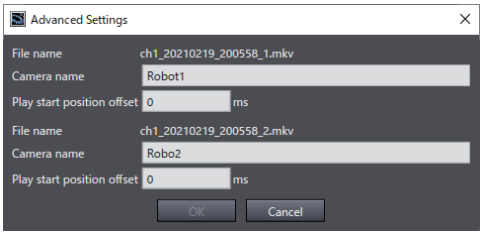
3-2-2 Items in the Start Playback Dialog Box

The Start Playback dialog box allows you to select a variable log and video files.

The items in the **Start Playback** dialog box are as shown in the table below.

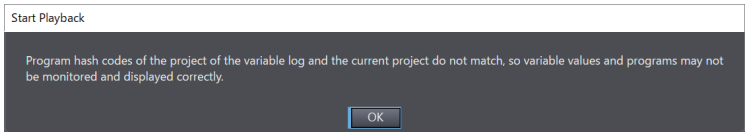


Symbol	Item	Description
A	Current project's program hash code	The program hash code for the current project is displayed. The program hash code is used to check whether a specified variable log was obtained in the project currently open. When you select a variable log, select the variable log whose program hash code matches.
B	File path of variable log	Specify the file path of the variable log to play in the project currently open.*1 Click the button and select the file in the Open dialog box of Windows.
C	Path delete button	Click this button to delete the file path of the variable log.
D	Variable log file information	Information on the variable log file in (B) is displayed. The following items are displayed. • Start time • Sampling time [s] • Size [MB] If there is a significant difference between the start time of data in one task and the start time of data in the other task among the data contained in the variable log, the start time of each is displayed.
E	**Save the loaded variable log file** button	Click this button to save the loaded variable log to the computer. The variable log obtained from the Controller may take a few minutes to load. If you start playback again with the same variable log or specify it as a comparison target, you can shorten the loading time when you save the variable log that has already been loaded. The file size of the loaded variable log may increase, so be careful for the amount of available space on the disk when you save.

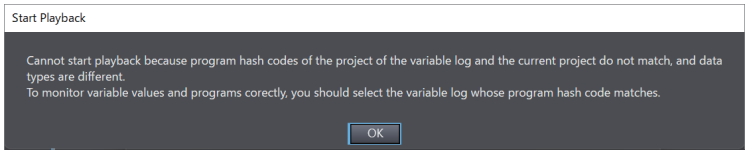
Symbol	Item	Description
F	File path of video	Specify the file path of the video. Click the  button and select the file in the Open dialog box of Windows. Specify **Video 1** through **Video 4** in the same way. For the Sysmac Studio (32 bit), only one video can be specified in the **Start Playback** dialog box.
G	Path delete button	Click this button to delete the file path of the video.
H	Video file information	The following information on the video file is displayed. • Size [MB]
I	**Advanced Settings** button	Click this button to display the **Advanced Settings** dialog box when video files are specified.  In the **Advanced Settings** dialog box, you can configure the settings for a specified video. Refer to *5-5-4 Items in the Video Settings Dialog Box* on page 5-26 for details on each setting item.
J	**Start Playback** button	Click this button to read the variable log and video selected in (B) and (E) and start playback. It is enabled when the file path of the variable log is selected.
K	**Cancel** button	Click this button to cancel the playback without starting it. The selected file paths and the settings configured in the **Advanced Settings** dialog box are not saved.

*1. To correctly display variable values and monitor programs, you need to select the variable log corresponding to the project currently open.

- If the specified variable log does not match the project currently open, the variable values and programs may not be monitored and displayed correctly, although you can start the playback. In this case, when you select the variable log, the following message is displayed.



- If the specified variable log does not match the project currently open and furthermore the data types do not match, you cannot start playback. In this case, the following error message is displayed.



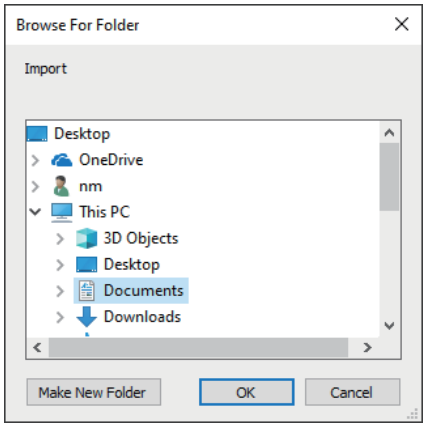
3-3 Restoring the Project When There Is No Project Corresponding to the Variable Log

If there is no project corresponding to the variable log on the computer to execute playback, for example, when you use different computer to copy playback data for playback and play the data, restore the project using the backup file to which you saved the project when collecting the variable log.

3-3-1 Procedure for Restoring the Project File from Playback Data

When you execute playback, you can import the project backup file into the Sysmac Studio and create a project.
As a preparation, save the project backup in advance or when collecting the variable log. To save the project backup file when collecting variable logs, you need to configure the settings in the **Automation Playback Settings** display in advance.

1. Create a project in the Sysmac Studio.
2. Select **Backup** – **Import Backup File** from the **Tools** menu of the Sysmac Studio.
3. Specify the folder where the backup files of the project are stored.



A project for the specified backup file is created.

3-4 Ending the Playback

End the playback.
When the playback function is ended, the Sysmac Studio goes offline from playback mode.

3-4-1 Procedure for Ending the Playback

End the playback from the Sysmac Studio menu.

1 Select **Automation Playback** – **Exit Playback** from the **Tools** menu of the Sysmac Studio. Or, click the **Exit Playback** icon () in the toolbar.

The playback function is ended after the **Playback** dialog box, the **Search Playback Data** tab page, and the **Playback Chart** window are closed.
When the playback function is ended, the Sysmac Studio goes offline from playback mode.

4

Checking Program Behavior Using Playback

Play playback data, display the program and variables, and search for variable change points.

4-1 Playing Playback Data

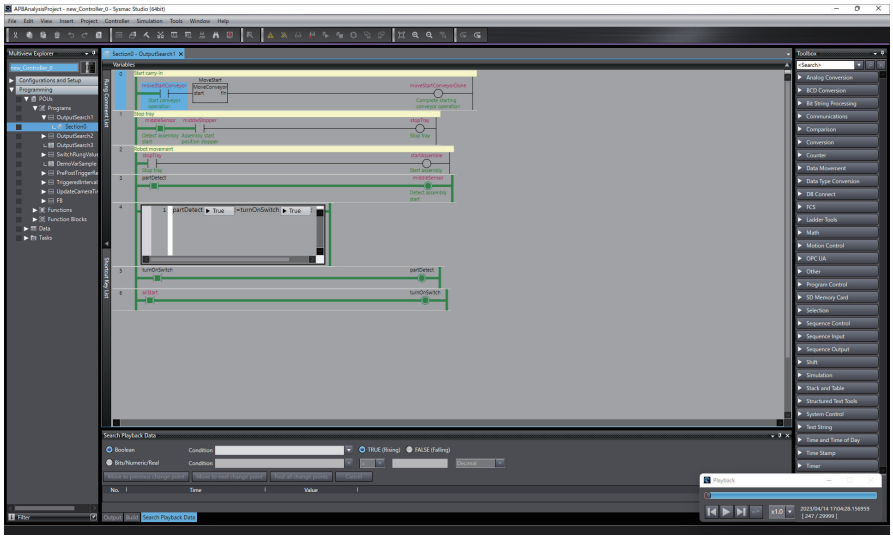
Play, stop, and perform backward/forward playback data.
Playback data is played so that the play operation of the playback data is synchronized with the monitor display of the ladder or ST program and the Watch tab page.

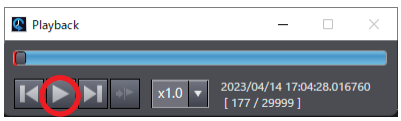
4-1-1 Procedure for Playing Playback Data

In the **Playback** dialog box that appears automatically when playback starts, you can play, stop, and perform backward/forward playback data.
To start playback, the Sysmac Studio and the Controller must be offline.

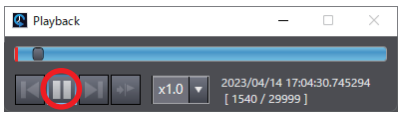
1 Start playback.
The **Playback** dialog box is displayed.

2 In the **Playback** dialog box, click the **Play** button.
The play operation of the playback data causes playback data to be played synchronously with the monitor display of the ladder or ST program and the Watch tab page.





3 To pause playback, click the **Pause** button in the **Playback** dialog box.

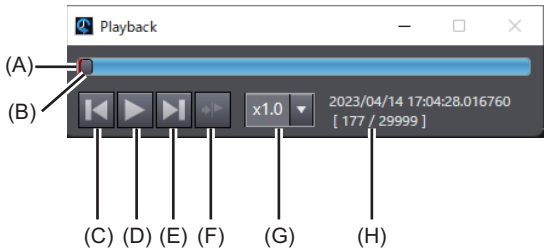


Playback is paused.

When playback is ended, the **Playback** dialog box automatically closes.

4-1-2 Items in the Playback Dialog Box

You can perform various operations while playing playback data.
The items in the **Playback** dialog box are as shown in the table below.



Symbol	Name	Type	Description
A	Trigger position	Button	Click this button to display the time at which the file save trigger changed to TRUE. (The position is displayed on the seek bar. It is inoperable.)
B	Seek bar	Slider	Use this slider to seek the play position. You can drag the slider or click on the bar to move the playback time.
C	Previous frame	Button	Click this button to move the time one sampling period backward. If you press and hold for 0.3 seconds, continuous frames will be sent backward.
D	Play/Pause	Button	Click this button to play or pause the data. During play, the button shows ⏸, so you can click it to pause the playback.
E	Next frame	Button	Click this button to move the time one sampling period forward. If you press and hold for 0.3 seconds, continuous frames will be sent forward.
F	Move to trigger position	Button	Click this button to move to the time at which the file save trigger changed to TRUE.
G	Playback speed multiplier	Drop-down list	You can select the playback speed from among x0.1, x0.5, x1.0, x2.0, x4.0, and x8.0.
H	Time information	Label	The playback time, data number, and total quantity of data are displayed. The total data quantity is displayed to the right of '/'.

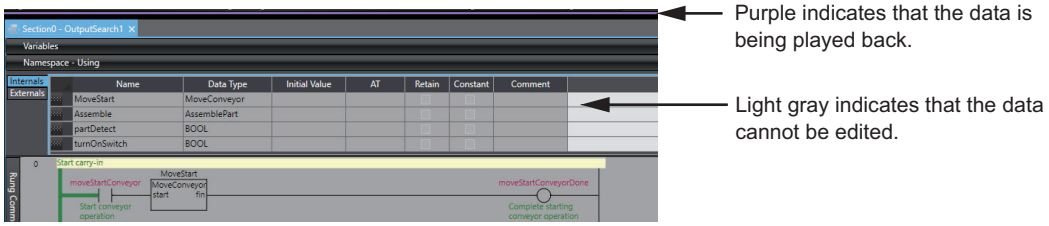
4-2 Displaying the Ladder Program to Check with Playback

If you check the ladder program while playing playback data, select and display the target program or section.
When you start play of playback data, rungs in monitor status in the Ladder Editor will be displayed.

4-2-1 Procedure for Displaying the Ladder Program to Check with Playback

Select and display the ladder program or section to check with playback.

1 Double-click the ladder program or ladder function block under **Programming** in the Multiview Explorer.
The ladder program is displayed in monitor status in the Ladder Editor. The execution status of rungs and the present values of variables are displayed synchronously with the play position specified in the **Playback** dialog box.



When playback is ended, the monitoring of the ladder program ends.
Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for details on monitoring ladder programs.

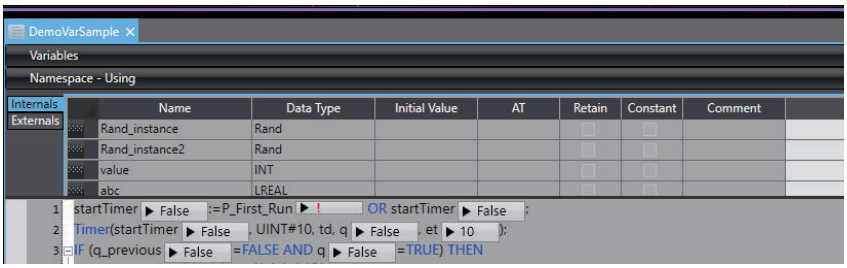
4-3 Displaying the ST Program to Check with Playback

If you check the ST program while playing playback data, select and display the target program.
When you start play of playback data, the program in monitor status in the ST Editor will be displayed.

4-3-1 Procedure for Displaying the ST Program to Check with Playback

Select and display the ST program to check with playback.

1 Double-click the ST program or ST function block under **Programming** in the Multiview Explorer.
The ST Editor is displayed. The present values of variables are displayed synchronously with the play position specified in the **Playback** dialog box.



When playback is ended, the monitoring of the ST program ends.
Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for details on monitoring ST programs.

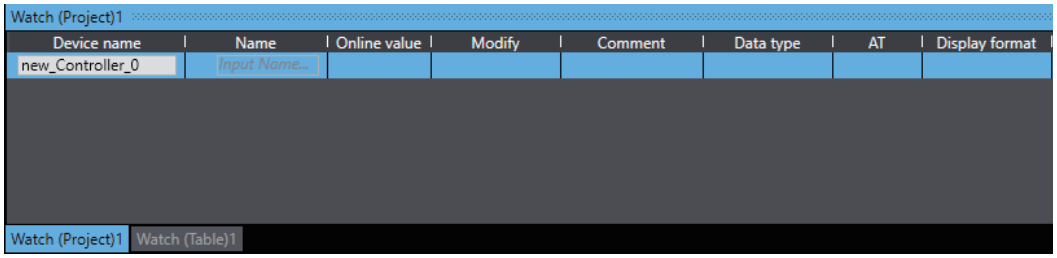
4-4 Displaying the Variable Values to Check with Playback

Display the variable values to check with playback.

4-4-1 Procedure for Displaying the Variable Values to Check with Playback

If you check the values of more than one variable at a time while playing playback data, select and display the Watch tab page.

1 Select **Watch Tab Page** from the **View** menu. If you display the Watch (Table) tab page, select **Watch Tab Page (Table)**.
The Watch (Project) 1 or Watch (Table) 1 tab page is displayed.



When playback is ended, the monitoring in the Watch tab page ends.
Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for details on monitoring in the Watch tab page.

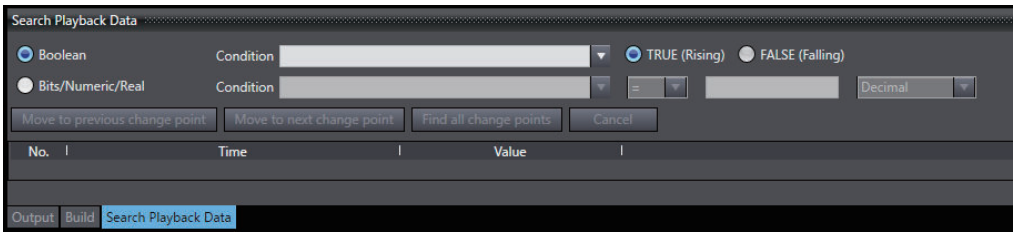
4-5 Searching for Variable Change Points with Playback

Search playback data by specifying variable search conditions, such as the rising edge of a variable. You can jump to the timing when a device variable changes and check the behavior of the device.

4-5-1 Procedure for Searching for Variable Change Points with Playback

Search (previous, next, all) playback data by specifying variable search conditions, such as the rising edge of a variable.

1 When playback starts, the **Search Playback Data** tab page is automatically displayed. Or, select **Automation Playback** – **Search Playback Data Tab Page** from the **Tools** menu of the Sysmac Studio.



2 Select the Boolean or Bits/Numeric/Real option according to the data type of the variable to search.

3 In the variable name input box for **Condition**, enter a variable name in the format of **ProgramName.VariableName**.
When you enter a text string, a drop-down list of candidate variable names is displayed, and then you can select the target variable name.

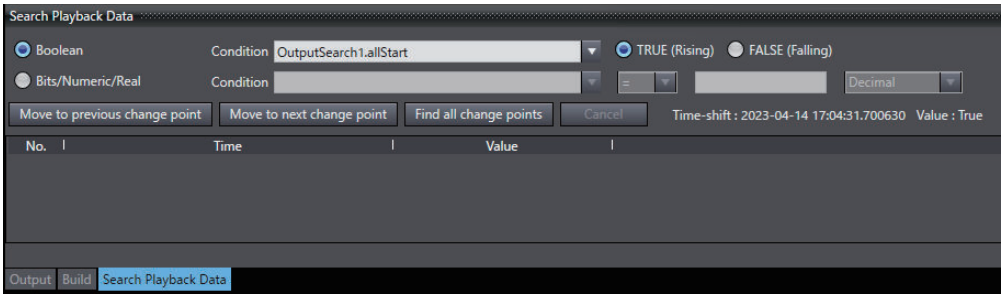
Precautions for Correct Use

When you specify a global or system-defined variable, enter the external variable in which the global or system-defined variable is registered, using the format of **ProgramName.VariableName**.

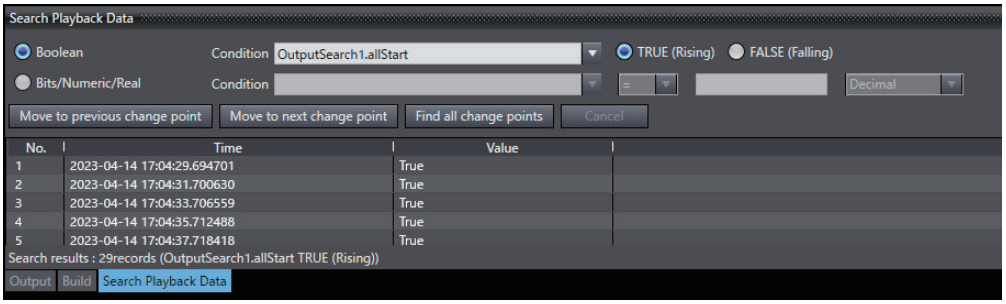
4 If it is a Boolean variable, select the **TRUE (Rising)** or **FALSE (Falling)** option. If it is a Bits/Numeric/Real variable, select the comparison condition and enter the comparison constant in the text box.

5 Depending on the range you want to search, click the **Move to previous change point**, **Move to next change point**, or **Find all change points** button.
The search results are displayed.

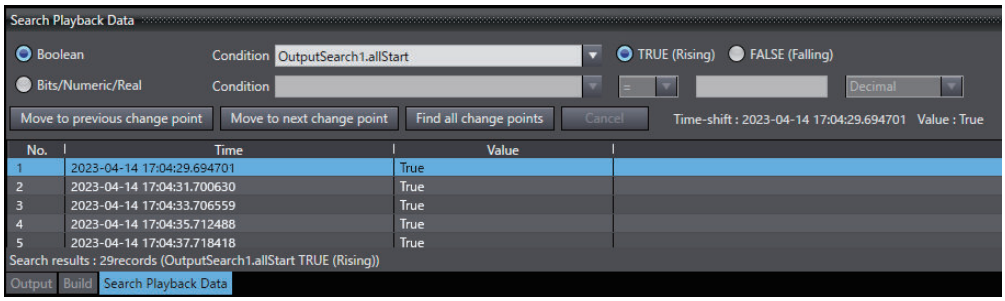
- **Move to previous change point** or **Move to next change point** button:
  Each time you click **Move to previous change point**, you move backward in time to the target time in order.
  Each time you click **Move to next change point**, you move forward in time to the target time in order.



- **Find all change points** button:
  A list of times and variable values for the corresponding playback data is displayed.



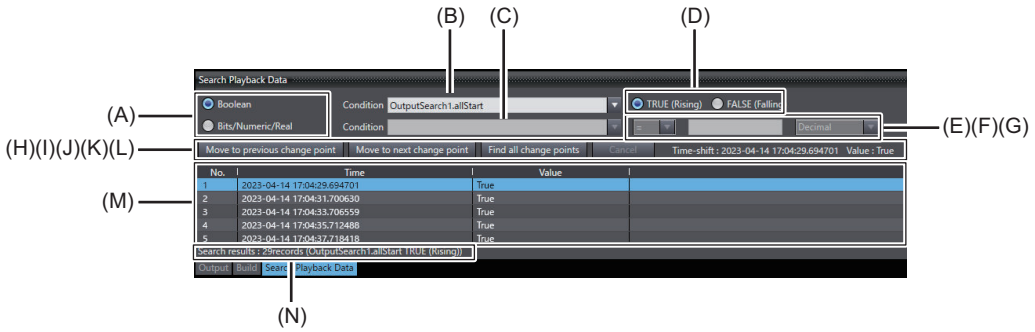
When you search by **Find all change points**, double-click or press the **Enter** key on the item to check in the list of search results, and then you can move to the search results.
When you are monitoring a ladder program or ST program, or when the Watch tab page is displayed, the variable value at the target time is shown.
When the playback chart is displayed, the current time line on the time series variable graph moves to the target time.
The video for the target time is displayed in the Video Playback window. Refer to *Section 5 Checking Time Series Variable Values and Videos Using Playback* on page 5-1 for details on the Video Playback window.



If you move to the search results while playing playback data, the play will pause before moving to the search results.

4-5-2 Items in the Search Playback Data Tab Page

Specify the variable name and search conditions in the **Search Playback Data** tab page.
The **Search Playback Data** tab page has the items shown in the table below.



Symbol	Name	Description
A	Data type options	Set the data type of the variable to search for. Select Boolean or Bit String/Integer/Real.
B	Boolean variable name input box	Set the name of the Boolean variable to search for with one of the following methods. • Enter a search string in the format of **ProgramName.VariableName** (When you enter a text string, a drop-down list of candidate variables is displayed, and then you can select the target variable.) • Select a previously entered string from the drop-down list • Drag and drop a variable from the Program Editor.
C	Bit string, integer, or real variable name input box	Set the comparison constant for the bit string, integer, or real variable to search for. Use one of the following methods. • Enter a search string in the format of **ProgramName.VariableName** (When you enter a text string, a drop-down list of candidate variables is displayed, and then you can select the target variable.) • Select a previously entered string from the drop-down list
D	Boolean variable search condition options	Set the search condition for the Boolean variable to search for. Select **TRUE (Rising)** or **FALSE (Falling)**.

Symbol	Name	Description
E	Bit string, integer, or real variable search condition input box	Set the search condition for the bit string, integer, or real variable to search for. Select from the following conditions. =: When equal to **comparison constant** ≠: When not equal to **comparison constant** >: When greater than **comparison constant** <: When less than **comparison constant** ≥: When greater than or equal to **comparison constant** ≤: When less than or equal to **comparison constant**
F	Comparison constant input box	Set the comparison constant for the bit string, integer, or real variable to search for.
G	Number system list	Select the number system for the comparison constant from Decimal or Hexadecimal.
H	**Move to previous change point** button	Click this button to search for the variable in playback data backward in time.
I	**Move to next change point** button	Click this button to search for the variable in playback data forward in time.
J	**Find all change points** button	Click this button to search all playback data. The search results are listed.
K	**Cancel** button	Click this button to cancel the execution of **Find all change points**.
L	Movement result	When you move to the search results by clicking the **Move to previous change point** or **Move to next change point** button, or jumping from the search results of **Find all change points**, the time at which you move and the value of the variable will be displayed. Also, if an error occurs during the execution of the search or move, the relevant error message will be displayed.
M	Search results	When you execute **Find all change points**, the list of times and values of the search results is displayed. When you double-click the target line in the list, or select the target line and press the **Enter** key, you can jump to the search results. You can right-click on the list and execute **Copy**, **Select All**, or **Clear All**.
N	Number of search hits	When you execute **Find all change points**, the number of search results, the target variables, and search conditions are displayed.

4-6 Restrictions during Execution of Playback

You cannot perform the following operations during execution of playback.

- Editing the Controller configurations and setup
- Editing programs and tasks
- Going online with the Controller
- Axis Status Monitor
- Monitoring in the I/O Map
- Monitoring task execution status and task execution times
- Data tracing
- Changing present values of data
- Online editing
- Simulation

5

Checking Time Series Variable Values and Videos Using Playback

5-1 Playback Chart

You can display changes in variable values during playback in a graph, and play the video. You can also compare their waveforms with those of other playback data.

5-1-1 Applications of the Playback Chart

You can use the playback chart to perform various types of analysis, such as the following.

- Registering variables that are considered to be relevant and checking changes in the variables in time series when an error is detected during video playback or on the program monitoring display.
- Compare data during an error with that of normal operation using the waveform comparison feature.

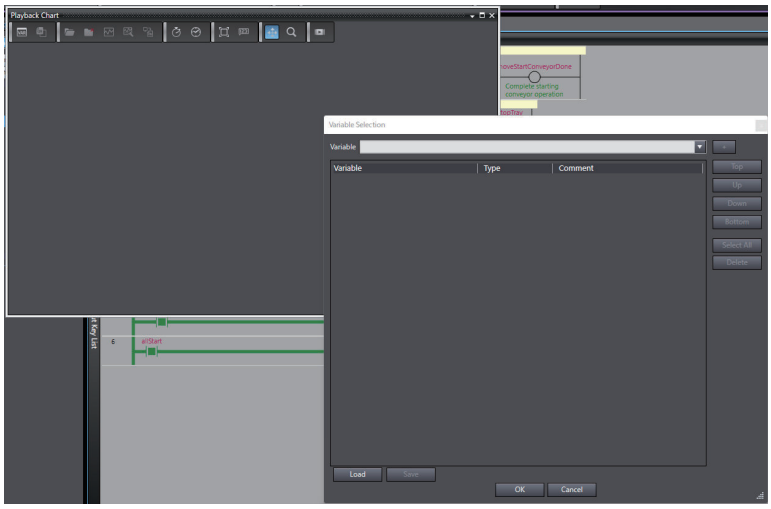
Additional Information

We recommend that you use this function in the Sysmac Studio (64 bit).

5-1-2 Procedure for Starting the Playback Chart

Use the following procedure to start the playback chart. You can perform it in playback mode.

1 Select **Automation Playback** – **Playback Chart** from the **Tools** menu of the Sysmac Studio. The Playback Chart window is displayed.



You can display a time series variable graph when you add variables from the Playback Chart window or the Program Editor.
Refer to *5-2-1 Procedure for Displaying a Time Series Variable Graph* on page 5-7 for how to add variables to the time series variable graph from the Playback Chart window.
Refer to *5-3-6 Procedures for Adding Variables Selected in the Program Editor to the Playback Chart* on page 5-14 for how to add variables to the time series variable graph from the Program Editor.

You can open the Video Playback window from the Playback Chart window.
Refer to *5-5-2 Procedures for Playing Videos* on page 5-24 for how to display the Video Playback window.

The Playback Chart window and the Video Playback window are displayed in a floating state, separate from the Sysmac Studio window. You can cancel the floating state and place it in the window, and bring it back to the floating state again.
Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for details.

5-1-3 Procedure for Exiting the Playback Chart

Use the following procedure to exit the playback chart.

1 Click the × button in the upper right corner of the Playback Chart window.
The playback chart is exited.

Additional Information

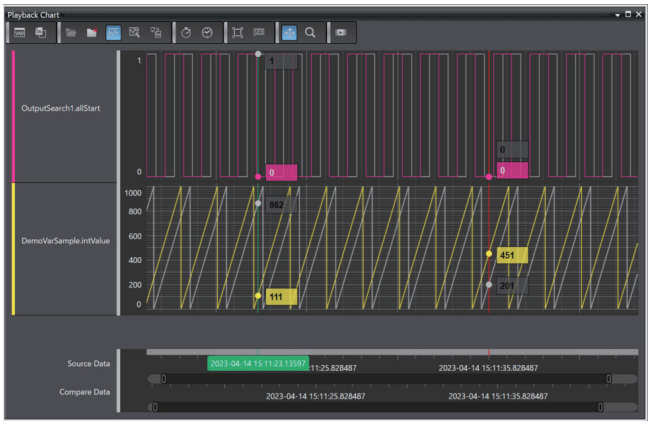
When the playback is ended, automatically exit the playback chart.

5-1-4 Overview of the Playback Chart Window

When you start the playback chart, a time series variable graph is displayed. You can also display the Video Playback window separate from the Playback Chart window.

Time Series Variable Graph

Display the time series variable graph. You can select the variables to display from the variable list or specify the variables used in the rung or program selected in the Ladder Editor or ST Editor at once. You can also specify the variable log to compare and superimpose its waveforms on the displayed waveforms.



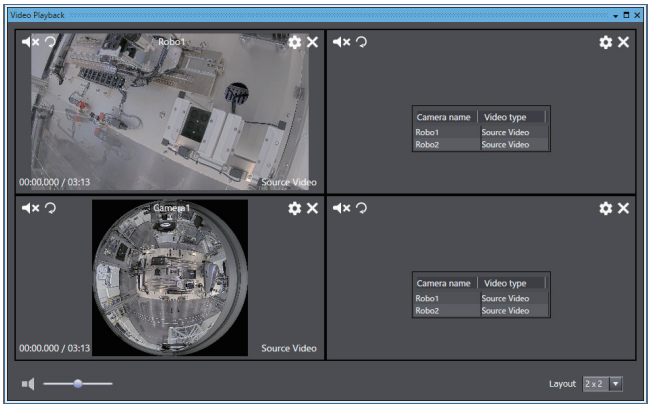
On the time series variable graph, the play position of playback data is indicated by the current time line.

Current Time Line

The playback time specified in the **Playback** dialog box is displayed as a vertical line on the time series variable graph. You cannot move the vertical line.

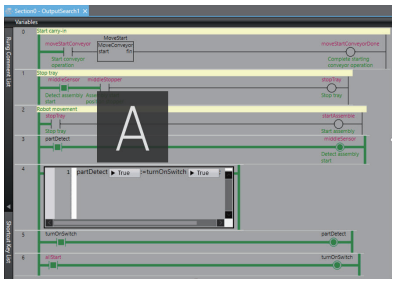
Video Playback Window

In this window, video is played synchronously with play operations that you perform in the **Playback** dialog box.
You can also specify the video data to compare and display its videos side by side. For both comparison source and target data, you can play up to four videos, respectively.

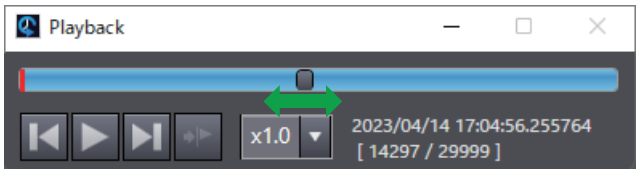


5-1-5 Synchronization between the Playback Chart and the Program Monitoring Display

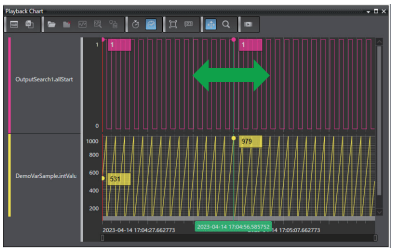
The time series variable graph on the playback chart and the Video Playback window are displayed synchronously with the Program Monitor display.



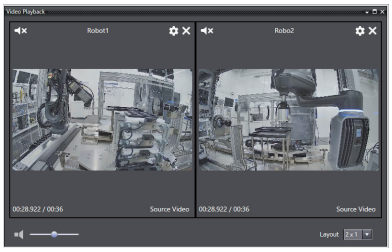
The operation of seek bar is reflected to the Ladder or ST Monitor.



Change a green current time line by the operation of seek bar.



The operation of seek bar is reflected to the video playback.



5-1-6 Playback Chart Toolbar Items and Mouse Operations

You can use the toolbar at the top of the time series variable graph on the playback chart with mouse operations to customize the graph display as you prefer.

The table below shows the toolbar items that you can use for the time series variable graph in the playback chart.

Icon	Name	Description
	Variable Selection	Selects the variables to display in the time series variable graph.
	Export Source Data	Exports the comparison source variable data displayed in the time series variable graph in CSV format.
	Load Compare Data	Opens the **Load Compare Data** dialog box.
	Unload Compare Data	Unloads the comparison target data from the playback chart.
	Show/Hide Compare Data	Shows or hides the comparison target data in the playback chart.

Icon	Name	Description
	Align Data	Displays the area to set the waveform alignment conditions.
	Export Compare Data	Exports the comparisons target variable data displayed in the playback chart in CSV format.
	Relative time mode	Displays the time on the time series variable graph as elapsed time.
	Absolute time mode	Displays the time on the time series variable graph as time.
	Fit To Window	Displays the entire variable data on the time series variable graph.
	Show Cursor Values	Switches between showing and hiding the value cursor on the time series variable graph.
	Panning Mode	Switches to Panning Mode in which you drag (pan) while holding down the left mouse button on the time series variable graph to move in the X direction. You can drag while holding down the right mouse button to zoom in a selected range.
	Zoom Mode	Switches to Zoom Mode in which you drag while holding down the left mouse button on the time series variable graph to zoom in and move a selected range in the X direction. Drag while holding down the right mouse button to move in the X direction.
	Show Video Playback	Opens the Video Playback window.

The table below shows the mouse operations that you can perform on the time series variable graph in the playback chart.

Mouse operation	Description
Mouse wheel	Zooms in or zooms out on the time series variable graph in the X direction.
Shift + mouse wheel	Zooms in or zooms out on the time series variable graph in the Y direction.

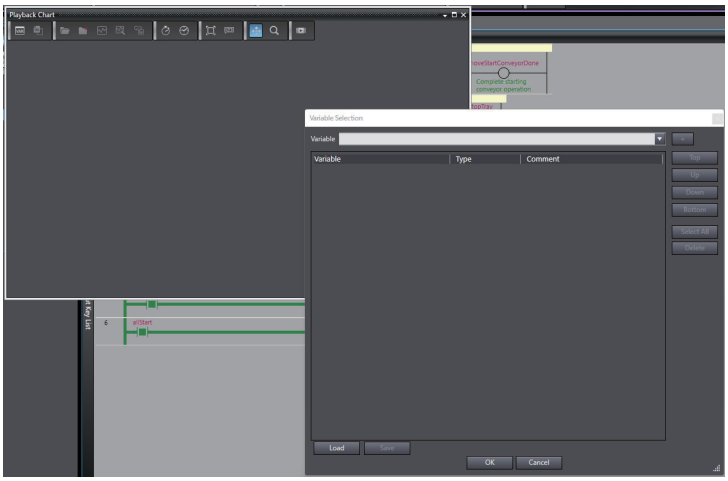
5-2 Checking Variable Values on the Time Series Variable Graph in the Playback Chart

Check variable values on the time series variable graph.

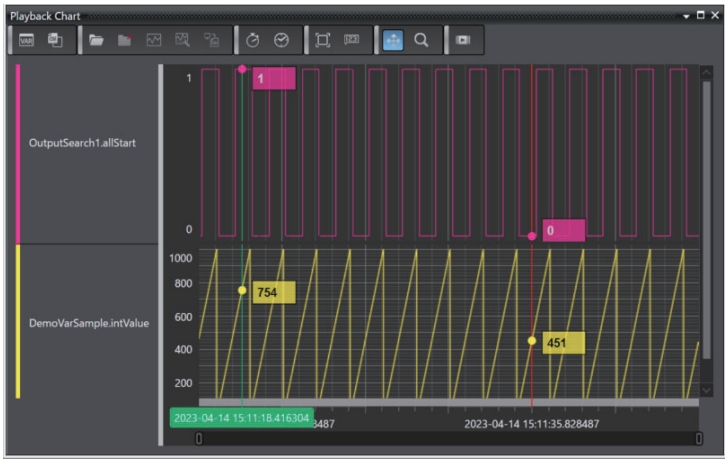
5-2-1 Procedure for Displaying a Time Series Variable Graph

You can display a time series variable graph by adding variables from the Playback Chart window or the Program Editor.
Use the following procedure to display a time series variable graph from the Playback Chart window.

1 Select **Automation Playback** – **Playback Chart** from the **Tools** menu of the Sysmac Studio.
The Playback Chart window is displayed.



2 Click the **Variable Selection** icon in the playback chart toolbar to display the **Variable Selection** dialog box, and add variables.
A time series variable graph is displayed. When you start the playback chart for the first time, the **Variable Selection** dialog box is automatically displayed.



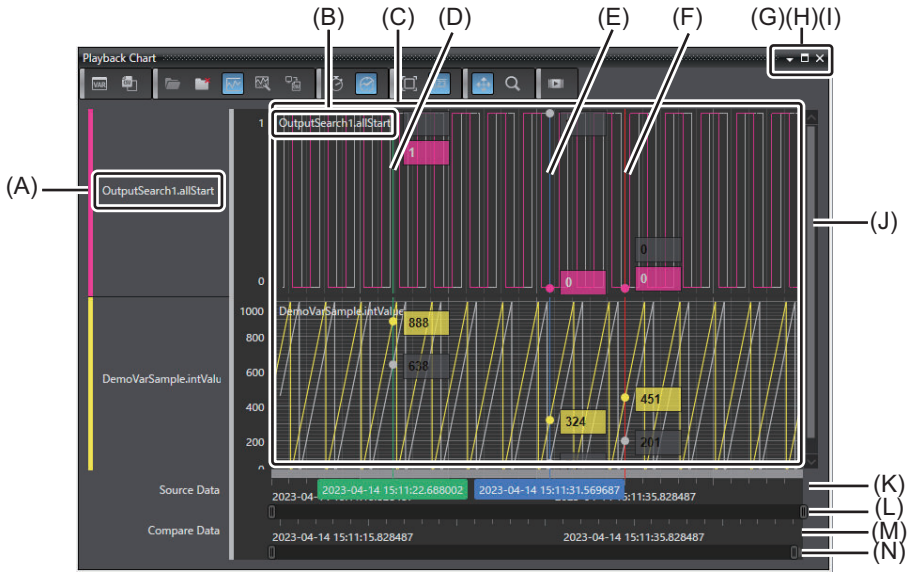
Refer to *5-3-2 Procedure for Selecting the Variables to Display in the Playback Chart* on page 5-11 for how to display the **Variable Selection** dialog box and add a variable.

From the next time on, the Playback Chart window will be displayed with the time series variable graph of the variables selected the last time. Once variables are added, the variables will be retained until the playback is ended.

Refer to *5-3-6 Procedures for Adding Variables Selected in the Program Editor to the Playback Chart* on page 5-14 for the procedure to display a time series variable graph by adding variables from the Program Editor.

5-2-2 Items on the Time Series Variable Graph

The table below shows the detailed menu items that you can use for the time series variable graph in the playback chart.

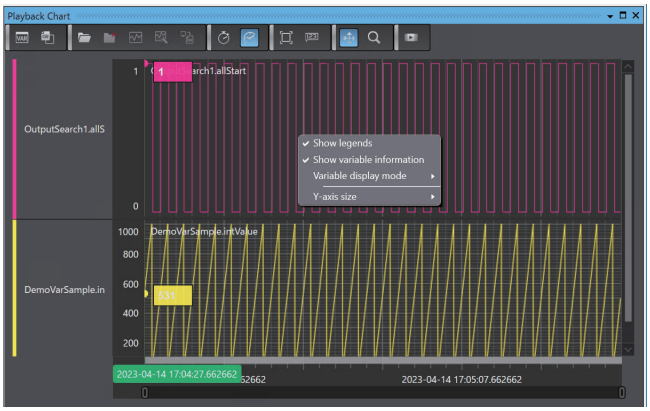


Symbol	Name	Description
A	Variable information display	Displays variable names, comments, and data types according to the item selected in Variable display mode.
B	Show legends	Displays variable names, comments, and data types on the graph according to the item selected in Variable display mode.
C	Trend graph display area	Displays the trend graph of the comparison source data in the foreground in automatically set colors. The trend graph of the comparison target data is displayed in gray on the background. For mouse operations in Panning Mode and Zoom Mode, and mouse operations common to these modes, refer to *5-1-6 Playback Chart Toolbar Items and Mouse Operations* on page 5-5.

Sym-bol	Name	Description
D	Current time line	This is a green vertical line cursor displayed at the target time in the comparison source data that moves synchronously with the play position in the **Playback** dialog box to indicate the current time. The line cannot be manipulated. If the target time data is not displayed, the vertical line will be shown at the target time by reading the data that contains the target time.
E	Variable value cursor	Displays a blue vertical line cursor with the values in the X and Y directions on the graph.
F	Trigger time line	This is a red vertical line cursor displayed at the trigger time corresponding to the trigger position. The line cannot be manipulated.
G	Minimize button	Minimizes the window.
H	Maximize button	Maximizes the window.
I	Close button	Exits the playback chart.
J	Y direction scroll bar	Enables the trend graph display area to be scrolled vertically.
K	X axis of comparison source data	Displays the X axis values of the comparison source data. Displays the time when the **Absolute time mode** toolbar icon is selected, or the elapsed time when the **Relative time mode** toolbar icon is selected. When you drag the scrall bar while holding the left mouse button, you can horizontally scroll through the comparison source and target data.
L	X direction scroll bar for comparison source data	Displays the ratio of the data displayed in the window with a black bar as a percentage of the comparison source data. You can drag the bar while holding the left mouse button to move the displayed time. At this time, the X direction scroll bar for the comparison target data also moves synchronously.
M	X axis of comparison target data	Displays the X axis values of the comparison target data. Displays the time when the **Absolute time mode** toolbar icon is selected, or the elapsed time when the **Relative time mode** toolbar icon is selected.
N	X direction scroll bar for comparison target data	Displays the ratio of the data displayed in the window with a black bar as a percentage of the comparison target data. The bar cannot be manipulated.

5-2-3 Context Menu Items for the Time Series Variable Graph

The table below shows menus that appear when you right-click on the time series variable graph. They are available when either comparison source or target data are read.



Menu	Submenu	Description
Show legends	---	Select whether to show variable information on the graph according to the item selected in Variable display mode.
Show variable information	---	Select whether to show variable information on the left side of the graph according to the item selected in Variable display mode.
Variable information	Name, Comment, or Name and comment	Select the display method for legend and variable information from Name, Comment, or Name and comment.
	Show data types	Select whether to display the data type in the legend and variable information.
Y-axis size	Smallest, Small, Medium, Large, or Largest	Select the display size of the Y axis for each variable on the time series variable graph.

5-3 Selecting the Variables to Display in the Playback Chart

You can select and display any variables in the playback chart.
For both the comparison source and target data, the variables that you select will be displayed.

5-3-1 Variables That You Can Add to the Playback Chart

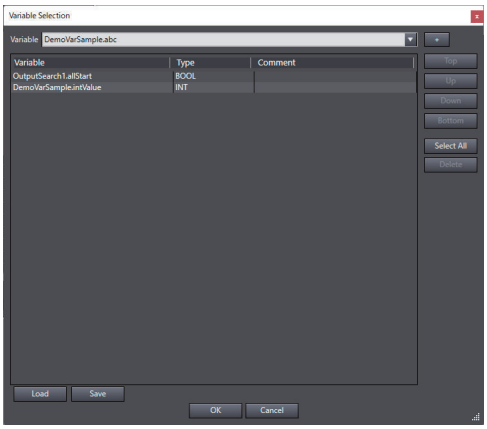
You can add variables that meet all of the following conditions to the playback chart.

- Variables of data types to display on the time series variable graph, which are included in the variable log of the comparison source data
- Variables that are not targets for display on the time series variable graph in the playback chart

5-3-2 Procedure for Selecting the Variables to Display in the Playback Chart

You can select any variables from the comparison source data so that the selected variables will be displayed in the playback chart.
Use the following procedure to select the variables to display in the playback chart.

1 Click the **Variable Selection** icon in the playback chart toolbar.
The **Variable Selection** dialog box is displayed.



2 In the variable name input box for **Variable** in the upper part of the dialog box, enter a variable name in the format of **ProgramName.VariableName**.
When you enter a text string, a drop-down list of candidate variable names is displayed, and then you can select the target variable name.

Precautions for Correct Use

When you specify a global or system-defined variable, specify the external variable in which the global or system-defined variable is registered, using the format of **ProgramName.VariableName**.

3 Click the **+** button.
The selected variable name is added to the variable list.

4 Click the **OK** button.
The **Variable Selection** dialog box closes, and the selected variables are added to the time series variable graph.

5-3-3 Procedure for Saving the Variable List Displayed in the Playback Chart

Use the following procedure to save the variable list displayed in the playback chart.

1 With the selected variables displayed in the display variable list in the **Variable Selection** dialog box, click the **Save** button.
The **Save Variables** dialog box is displayed.

2 Specify the file name and where you want to save the file, and save the list.
A variable selection state file with the .var extension, which summarizes the information in the display variable list, is saved in the specified location.

5-3-4 Procedure for Restoring the Saved Variable List

Use the following procedure to restore the saved variable list.

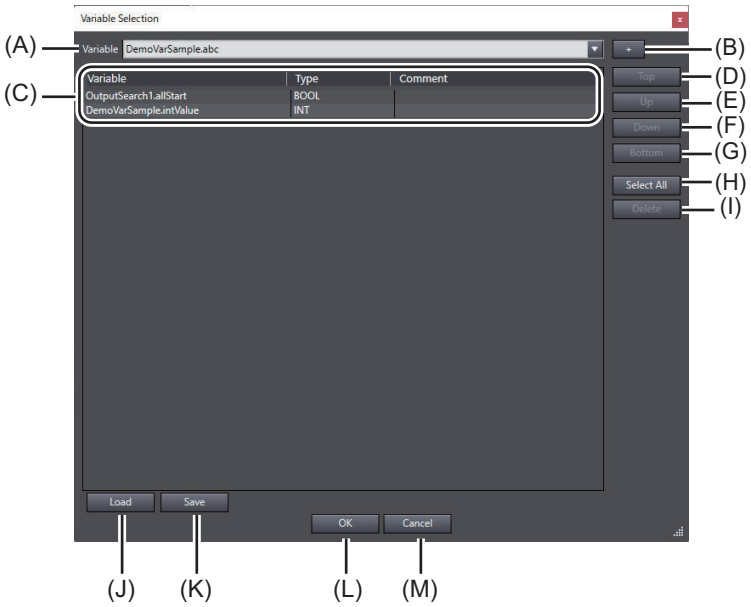
1 In the **Variable Selection** dialog box, click the **Load** button.
The **Load Variables** dialog box is displayed.

2 Select the variable selection state file (extension .var) to restore and click the **OK** button.
The variables saved in the variable selection state file are displayed in the display variable list in the **Variable Selection** dialog box.

3 Click the **OK** button.
The **Variable Selection** dialog box closes. The selected variables are added to the time series variable graph.

5-3-5 Items on the Variable Selection Dialog Box

The items displayed in the **Variable Selection** dialog box are as shown in the table below.



Symbol	Name	Description
A	Variable name input box	Enter a variable name in the format of **ProgramName.VariableName**. When you enter a text string, a drop-down list of candidate variables is displayed, and then you can select the target variable. Variables of the following data types can be filtered. Data type: BOOL/BYTE/WORD/DWORD/LWORD/SINT/INT/DINT/LINT/USNT/UINT/UDINT/ULINT/REAL/LREAL For structures and unions, members of the above data types are targeted. For members of FB instances, variables of the above data types are targeted. For array variables of the above data types, each element is targeted. For enumerations, enumerators are targeted.
B	**+** button	Adds the variable specified in Variable name input box (A) to the end of Display variable list (C).
C	Display variable list	Lists variable names (variable names, their data types and comments) added from Variable name input box (A). An item is selected when you click it, and the item is cleared when you click another item. You can select a range by clicking any two unselected items while holding down the **Shift** key. You can select more than one item by clicking any unselected items while holding down the **Ctrl** key.
D	**Top** button	Moves the variable selected in Display variable list (C) to the top of the list. You can move two or more items at a time.
E	**Up** button	Moves the variable selected in Display variable list (C) one line up in the list. You can move two or more items at a time.
F	**Down** button	Moves the variable selected in Display variable list (C) one line down in the list. You can move two or more items at a time.
G	**Bottom** button	Moves the variable selected in Display variable list (C) to the bottom of the list. You can move two or more items at a time.
H	**Select All** button	Selects all variables.
I	**Delete** button	Deletes the variables selected in Display variable list (C) from the list.

Sym-bol	Name	Description
J	**Load** button	Displays the **Load Variables** dialog box. In the dialog box that appears, you can load the selected variable selection state file and restore the variable selection state in Display variable list (C).
K	**Save** button	Displays the **Save Variables** dialog box. In the dialog box that appears, you can save Display variable list (C) as a file with the extension .var (variable selection state file) in a specified location.
L	**OK** button	Applies the changes. When you click the **OK** button, this window is closed.
M	**Cancel** button	Closes this window. You can also close the window by pressing the **Esc** key.

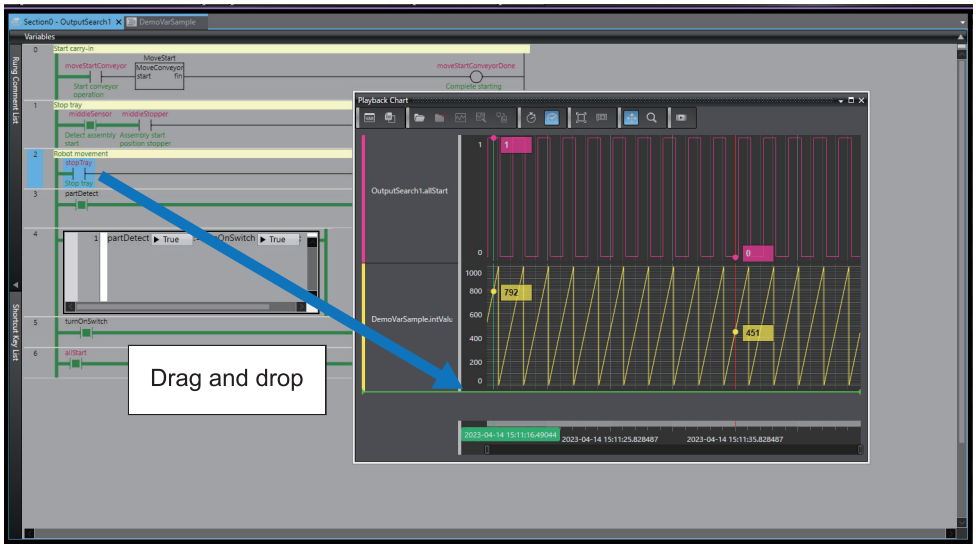
5-3-6 Procedures for Adding Variables Selected in the Program Editor to the Playback Chart

You can add variables used in the rung or program selected in the Ladder Editor or ST Editor.
Use the following procedures to add variables selected in the Program Editor to the playback chart.

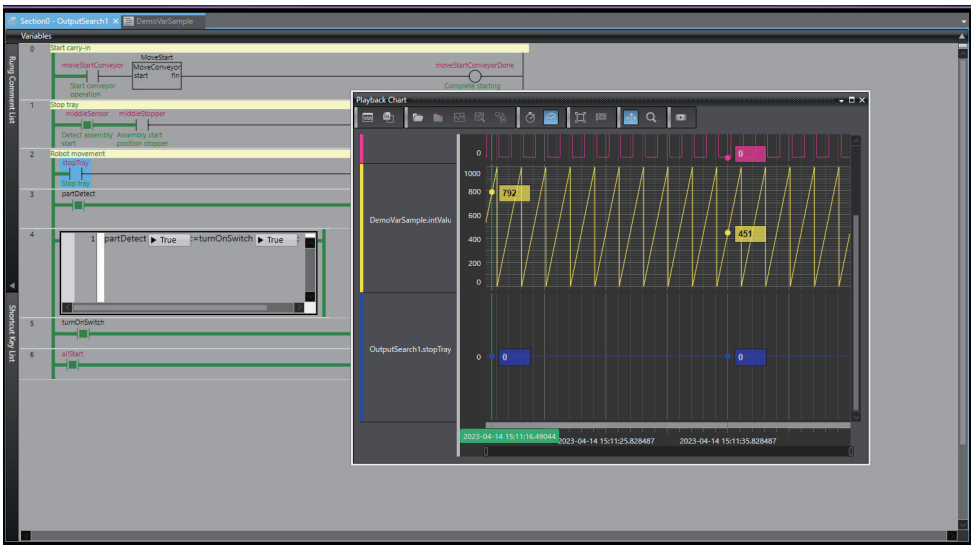
Procedure for Adding Variables Selected in the Ladder Editor to the Playback Chart

● Adding Variables by Drag and Drop

1 In the Ladder Editor, select the rung element to add, and drag and drop it into the Playback Chart window.

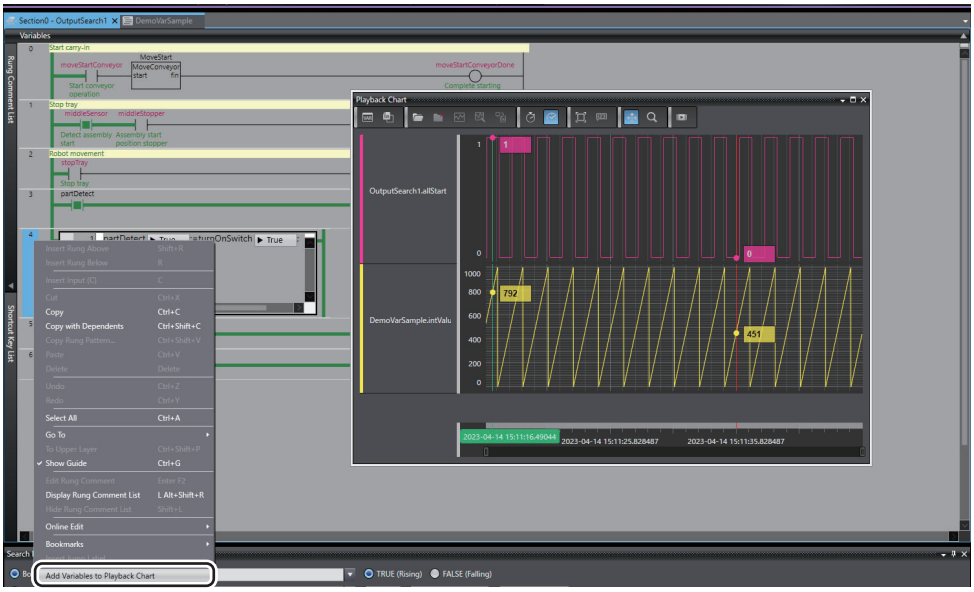


A variable is added to the playback chart.
You can add only one variable per drag and drop.

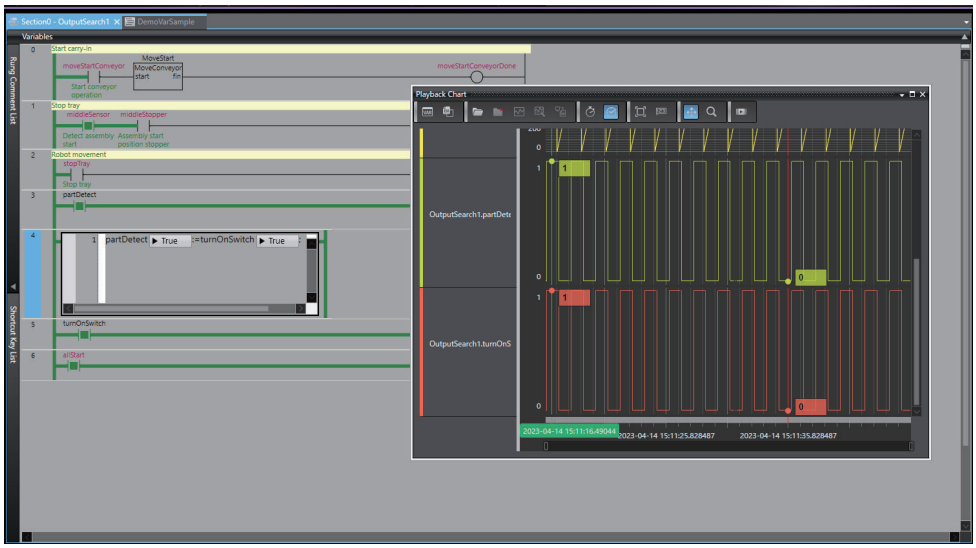


● Adding Variables from the Context Menu

1 Right-click one or more rungs in the Ladder Editor and select **Add Variables to Playback Chart** from the menu.



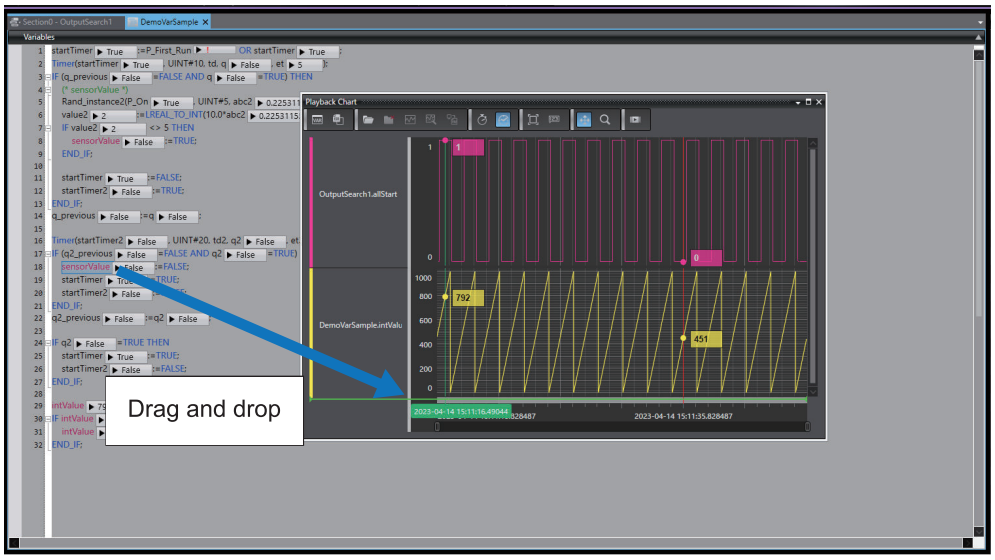
Variables in the selected rungs are added to the playback chart.



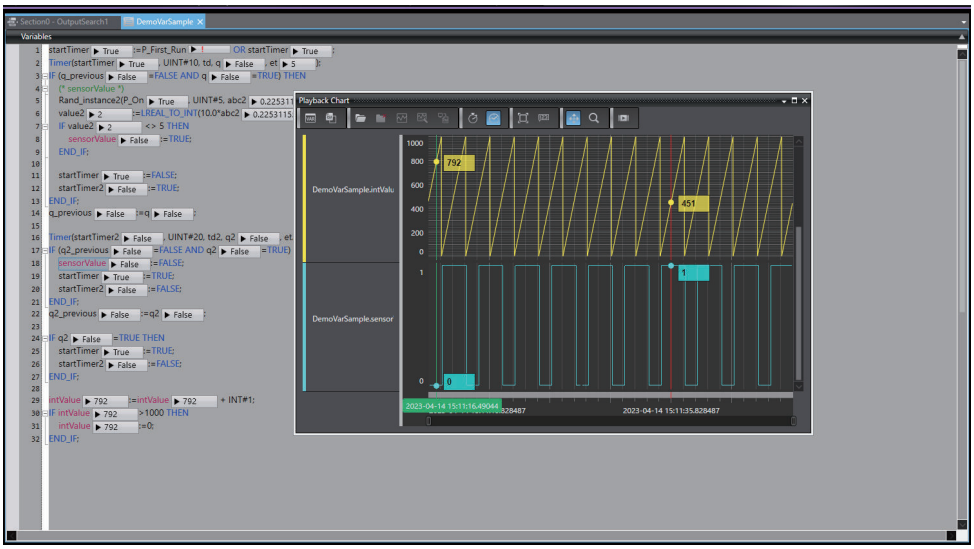
Adding Variables Selected in the ST Editor to the Playback Chart

● Adding Variables by Drag and Drop

1 Select a variable to add in the ST Editor, and drag and drop it into the Playback Chart window.

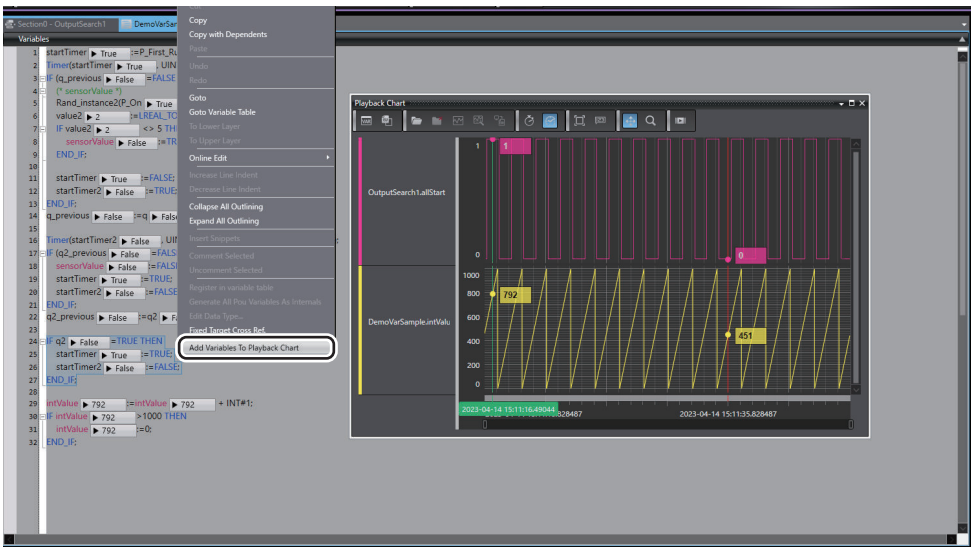


A variable is added to the playback chart.
You can add only one variable per drag and drop.

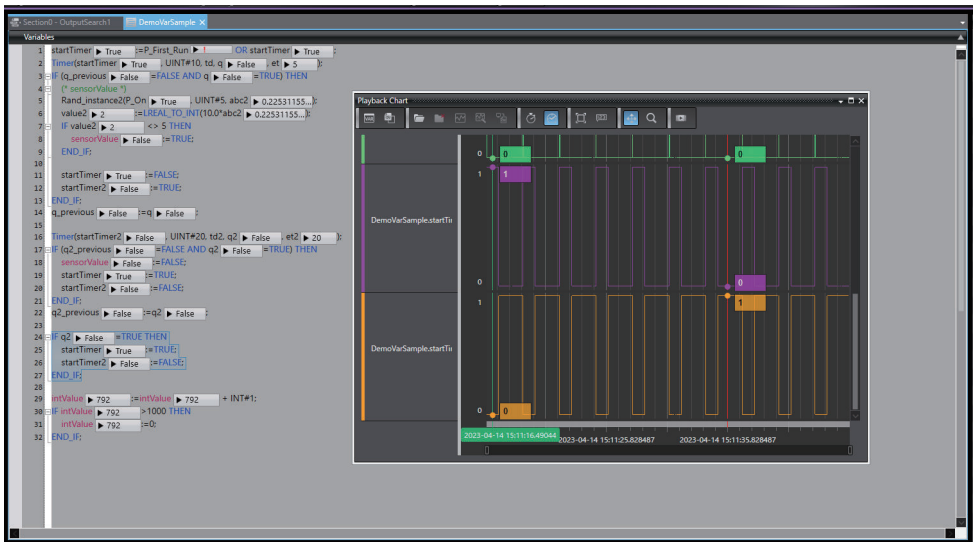


● Adding Variables from the Context Menu

1 Right-click a range in the ST Editor and select **Add Variables to Playback Chart** from the menu.



Variables in the selected range are added to the playback chart.


Playback Chart
DemoVarSample.startTi
DemoVarSample.startTi
2023-04-14 15:11:16.49044
2023-04-14 15:11:25.828487
2023-04-14 15:11:35.828487

5-4 Displaying Waveforms of the Variable Data to Compare in the Playback Chart

The playback chart allows you to compare and analyze waveforms by superimposing waveforms of the time series variable data to compare on the waveforms displayed in the playback chart.
To superimpose waveforms on the displayed waveforms, select the comparison target data file to compare.

5-4-1 Definition of Data to Compare

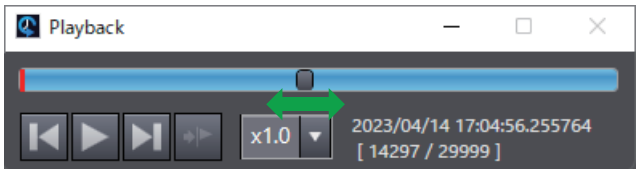
The playback chart allows you to compare variable data on the time series variable graph with video data.
To compare these, “comparison source data” and “comparison target data” are used.
The definitions of “comparison source data” and “comparison target data” are as follows.

Comparison Source Data

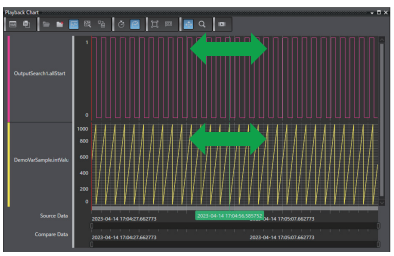
Comparison source data is the variable log and video data specified when you start playback in the Sysmac Studio. Comparison source data is read at startup of the playback chart.

Comparison Target Data

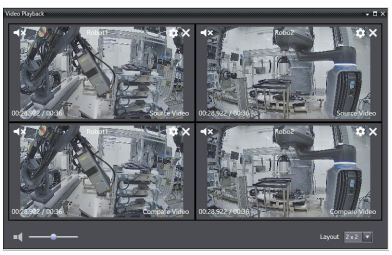
Comparison target data is the variable log and video data to compare in the playback chart. Comparison target data is read when it is specified in the Playback Chart window. Comparison target data is played synchronously with playback operations that you perform on the comparison source data in the **Playback** dialog box.



Change the times for comparison source and target data by the operation of seek bar.



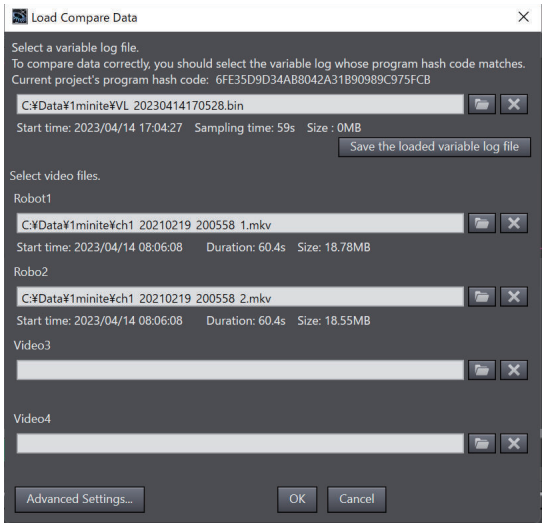
The operation of seek bar is reflected to the video playback for the comparison source and target data.



5-4-2 Procedure for Selecting the Comparison Target Data File to Use for Playback

Select the comparison target data file to use for playback.
Use the following procedure to select the file.

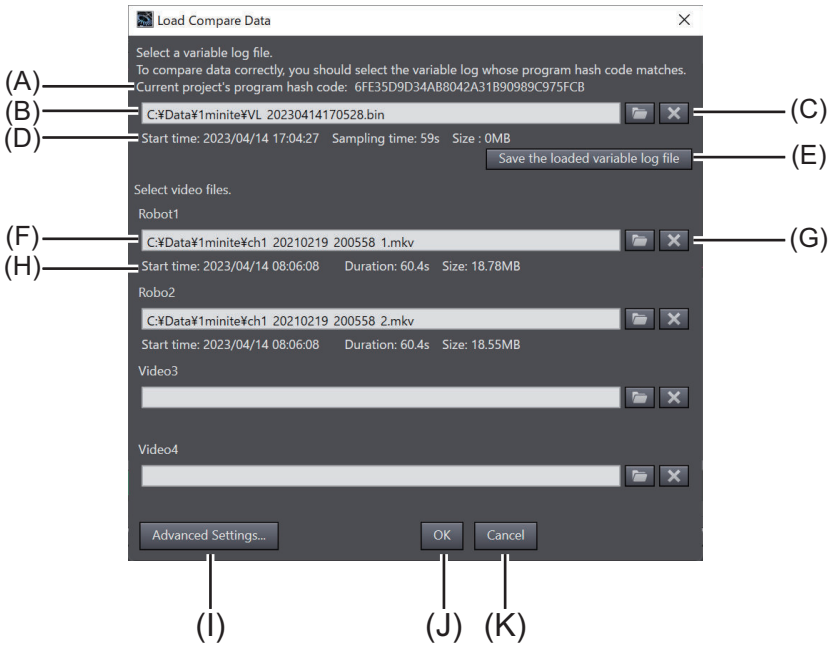
1 Click the **Load Compare Data** icon in the playback chart toolbar.
The **Load Compare Data** dialog box is displayed.



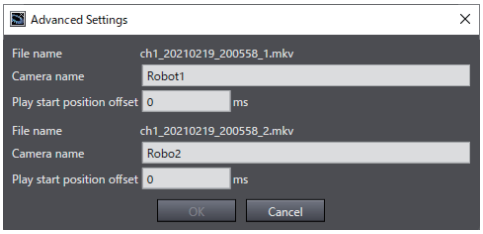
2 Specify the file paths of the variable log file and video data to add as targets for waveform comparison, and click the **OK** button.
Variables with the same variable names and data types as those in the comparison source data displayed on the time series variable graph are displayed. In addition, the specified video files are displayed in the Video Playback window.

5-4-3 Items in the File Selection Dialog Box for Comparison Target Data

In the **Load Compare Data** dialog box, select the comparison target variable log and video files.
The items displayed in the **Load Compare Data** dialog box are as shown in the table below.

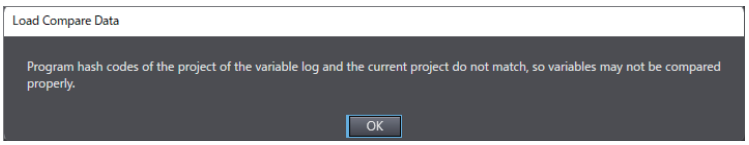


Symbol	Item	Description
A	Current project's program hash code	The program hash code for the current project is displayed. The program hash code is used to check whether a specified variable log was obtained in the project currently open. When you select a variable log, select the variable log whose program hash code matches.
B	File path of variable log	Specify the file path of the variable log to add as waveform comparison targets in the playback chart. *1 Click the  button and select the file in the Open dialog box of Windows.
C	Path delete button	Click this button to delete the file path of the variable log.
D	Variable log file information	Information on the variable log file in (B) is displayed. The following items are displayed. • Start time • Sampling time [s] • Size [MB] If there is a significant difference between the start time of data in one task and the start time of data in the other task among the data contained in the variable log, the start time of each is displayed.
E	**Save the loaded variable log file** button	Click this button to save the loaded variable log to the computer. The variable log obtained from the Controller may take a few minutes to load. If you start playback again with the same variable log or specify it as a comparison target, you can shorten the loading time when you save the variable log that has already been loaded. The file size of the loaded variable log may increase, so be careful for the amount of available space on the disk when you save.

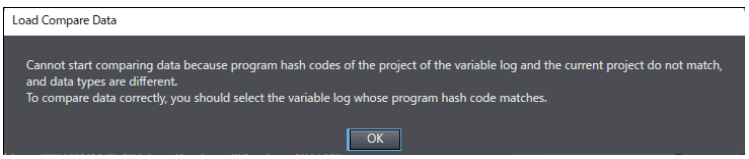
Symbol	Item	Description
F	File path of video	Specify the file path of the video. Click the  button and select the file in the Open dialog box of Windows. Specify **Video 1** through **Video 4** in the same way. For the Sysmac Studio (32 bit), only one video can be specified in the **Load Compare Data** dialog box.
G	Path delete button	Click this button to delete the file path of the video.
H	Video file information	The following information on the video file is displayed. • Size [MB]
I	**Advanced Settings** button	Click this button to display the **Advanced Settings** dialog box when video files are specified.  In the **Advanced Settings** dialog box, you can configure the settings for a specified video. Refer to *5-5-4 Items in the Video Settings Dialog Box* on page 5-26 for details on each setting item.
J	**OK** button	Click this button to add and display only variables with the same names and data types as those in the comparison source data displayed in the time series variable graph. In addition, the specified video files are displayed in the Video Playback window. You cannot add variables that are not included in the comparison source data.
K	**Cancel** button	Click this button to cancel the files specified in (B) and (E) without reading them. The selected file paths and the settings configured in the **Advanced Settings** dialog box are not saved.

*1. To correctly display variable values, you need to select the variable log corresponding to the project currently open.

- If the specified variable log does not match the project currently open, the variable values may not be displayed correctly, although they can be compared. In this case, when you select the variable log, the following message is displayed.



- If the specified variable log does not match the project currently open and furthermore the data types do not match, data cannot be compared. In this case, the following error message is displayed.



5-4-4 Procedure for Aligning Waveforms of the Variable Data to Compare According to the Waveform Alignment Condition

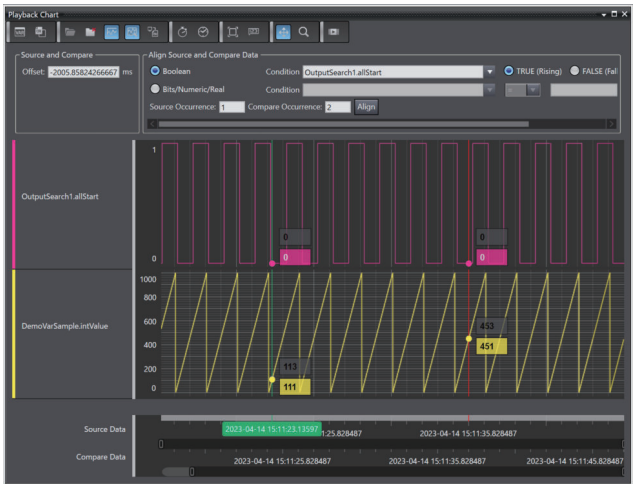
You can superimpose the waveforms of comparison source and target data when you set the waveform aliment condition on the comparison source and target data.

1 Click the **Align Data** icon in the playback chart toolbar.
An area to set the waveform alignment conditions appears in the upper part of the Playback Chart window.

2 Select the Boolean or Bits/Numeric/Real option according to the data type of the variable to set the waveform alignment condition and enter the variable name to search for in the **Condition** drop-down list.

3 If it is a Boolean variable, select the **TRUE (Rising)** or **FALSE (Falling)** option. If it is a Bits/Numeric/Real variable, select the comparison condition and enter the comparison constant in the text box.

4 Enter the number of times that the matching value condition must be met for the comparison source and target data in the **Source Occurrence** and **Compare Occurrence** text boxes and click the **Align** button.
The waveforms of the comparison source and target data are aligned and displayed on the playback chart based on the set conditions.



5-5 Playing Videos

Play video data in the Video Playback window of the playback chart.

Additional Information

We recommend that you use this function in the Sysmac Studio (64 bit).

5-5-1 Video Files That Are Initially Displayed

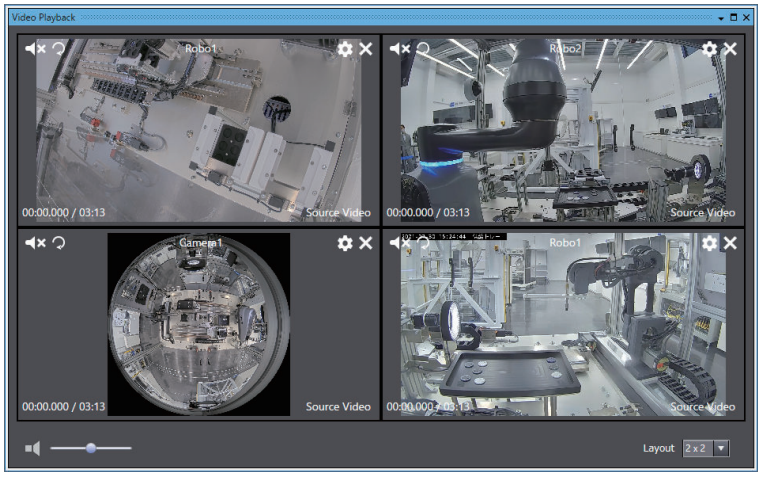
a. When playback is started by selecting the comparison source video data in the **Start Playback** dialog box
All video files selected in the video play frames are displayed.

b. When video data from the comparison target is selected in the **Load Compare Data** dialog box
All video files selected in the video play frames are displayed. If videos are already displayed in a., they will be added to the videos in a. and displayed in the remaining video play frames.

5-5-2 Procedures for Playing Videos

Use the following procedure to play video data. You can perform it in playback mode.

1 Select **Automation Playback** – **Video Playback** from the **Tools** menu of the Sysmac Studio.
Or, click the **Show Video Playback** icon in the toolbar of the Playback Chart window.
The **Video Playback** window is displayed.

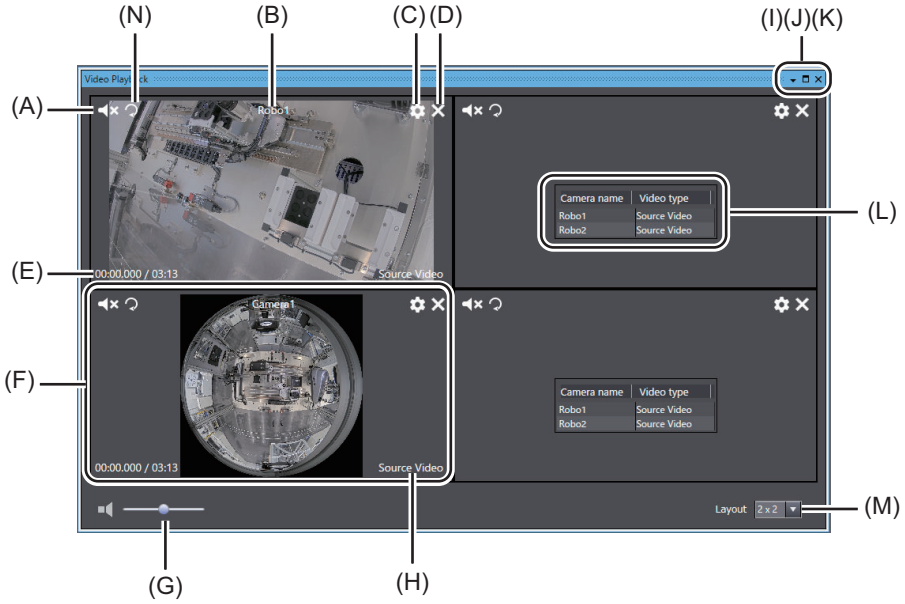


If you select a video file in the **Start Playback** dialog box and start playback, the **Video Playback** window will be automatically displayed.

2 In the **Playback** dialog box, click the **Play/Pause** button.
Video data is played according to the play operations in the **Playback** dialog box.

5-5-3 Items in the Video Playback Window

You can perform various operations in the Video Playback window.
The table below shows the items displayed in the Video Playback window.



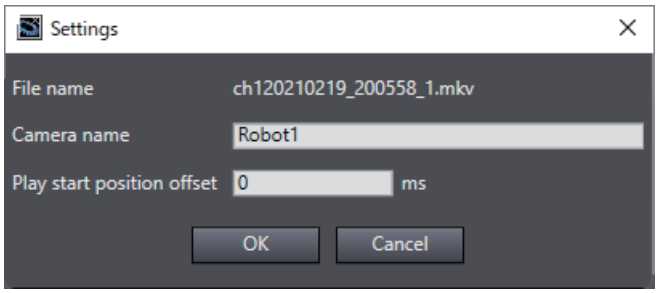
Symbol	Name	Description
A	Mute/Unmute button	Click this button to mute or unmute the audio of the video in each frame.
B	Camera name	The camera name is displayed. If no camera name has been set, **Video N** is displayed (a number from 1 to 4 is entered to N).
C	Settings button	Click this button to open the **Settings** dialog box, and you can set the camera name and start time offset for the video. Refer to *5-5-4 Items in the Video Settings Dialog Box* on page 5-26 for details on each item.
D	Close button	Click this button to close the video file.
E	Time	The elapsed time of the video and the total length of the video are displayed.
F	Video play frames	The video selected from the video selection drop-down list.
G	Volume slider	Use this slider to change the volume for all videos.
H	Video type	The **Source Video** and **Compare Video** are displayed.
I	Minimize button	Click this button to minimize this window.
J	Maximize button	Click this button to maximize this window.
K	Close button	Click this button to close this window.
L	Video selection drop-down list	From the list, select videos for comparison source data and comparison target data that are not displayed in the video play frame. The list shows camera names and video types.
M	**Layout** drop-down list	Select the layout of the video play frames (i.e., number of horizontal frames × number of vertical frames) to display in the Video Playback window. You can select one of the following combinations. 1×1, 1×2, 1×3, 1×4, 2×1, 2×2, 2×3, 2×4, 3×1, 3×2, 4×1, and 4×2
N	Rotate video button*1	Click this button to rotate the video 90 degrees clockwise.

*1. The rotate video button is available in Sysmac Studio version 1.62 or higher.

5-5-4 Items in the Video Settings Dialog Box

You can configure the settings for a specific video in the **Settings** dialog box.
To display the **Settings** dialog box, click the Settings button displayed above each video.

The items displayed in the **Settings** dialog box are shown below.



Name	Description
File name	The video file name is displayed.
Camera name	Enter any camera name.
Play start position offset	Set the offset time in ms for the play start date and time of the video file based on the start date and time of the variable data. The offset is calculated when the recording time of the video overlaps the range of recording time for the variable. If there is no overlap, the offset is 0.
OK button	Click this button to apply the settings.
Cancel button	Click this button to cancel the settings.

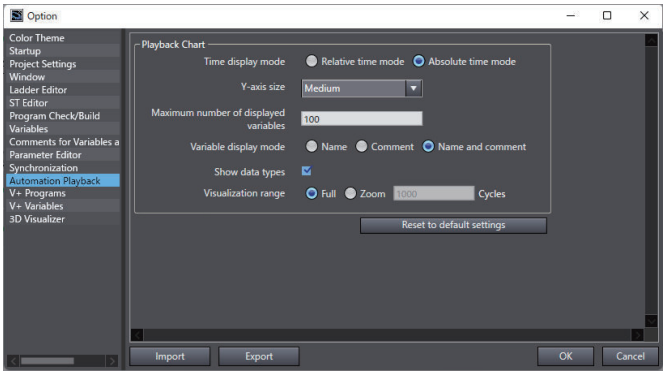
5-6 Configuring the Automation Playback Option Settings

Configure the automation playback option settings.

5-6-1 Procedure for Configuring the Automation Playback Option Settings

Use the following procedure to configure the automation playback option settings.

1 Select **Option** from the **Tools** menu of the Sysmac Studio.
The **Option** dialog box is displayed.



2 Select **Automation Playback** from the menu on the left side of the dialog box.
The Option view for automation playback is displayed.

5-6-2 Items for Automation Playback Option Setting

The table below shows the option setting items that you can configure for automation playback.

Category	Name	Description	Setting range	Default
Automation Playback	Time display mode	Set the display mode for the time displayed on the time series variable graph in the Playback Chart window.	Relative time mode or Absolute time mode	Absolute time mode
	Y-axis size	Set the height of the time series variable graph displayed in the Playback Chart window.	Smallest, Small, Medium, Large, or Largest	Medium
	Maximum number of displayed variables	Set the maximum number of variables that can be displayed as a graph in the Playback Chart window at once.	Sysmac Studio (32 bit): 10 to 16 Sysmac Studio (64 bit): 10 to 256	Sysmac Studio (32 bit): 10 Sysmac Studio (64 bit): 100
	Variable display mode	Select from Name, Comment, and Name and comment to display in the variable information and legend displayed on the graph in the Playback Chart window.	Name, Comment, or Name and comment	Name and comment
	Show data types	Select whether or not to display the data type of the variable in the variable information and legend displayed on the graph in the Playback Chart window.	Selected or Not selected	Selected
	Visualization range	Set the time range of the variables to display in a time series variable graph.	Full or Zoom Cycles (1 to 3,600,000) when Zoom is selected	Full
	Reset to default settings button	Click this button to reset the automation playback option setting items to the default values.	---	---

6

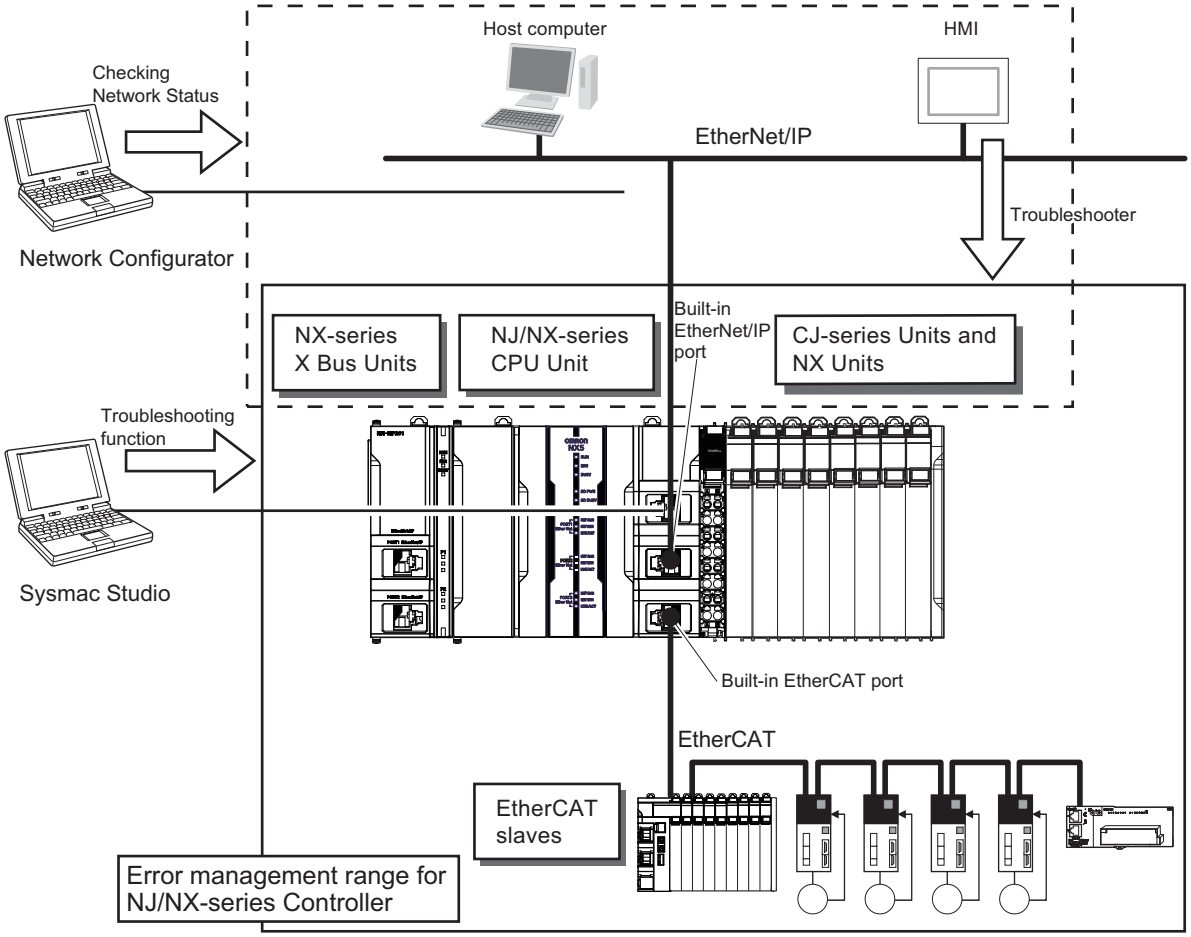
Troubleshooting

Check and correct errors based on the error management method for the NJ/NX-series Controller and troubleshoot problems specific to the automation playback function.

6-1 Overview of Troubleshooting

You manage all of the errors that occur on the NJ/NX-series Controller as events.
This allows you to see what errors have occurred and find corrections for them with the same methods for the entire range of errors that is managed (i.e., CPU Unit, X Bus Units, NX Units, NX-series Slave Terminals, EtherCAT slaves*1, and CJ-series Units).

*1. Only Sysmac devices are supported.



You can use the troubleshooting functions of the Sysmac Studio or the Troubleshooter on an HMI to quickly check for errors that have occurred and find corrections for them.

Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for error types and details, specific corrections when errors occur, and troubleshooting information on the entire NJ/NX-series Controllers.

6-2 Troubleshooting for Variable Data Collection

This section provides information on troubleshooting variable data collection.

6-2-1 What to Do If Automation Playback Does Not Work

To see if automation playback works correctly, use the Automation Playback Operation Monitor in the Sysmac Studio. Refer to *6-3-1 Checking the Operation Status of Automation Playback* on page 6-12 for information on the Automation Playback Operation Monitor.
If the automation playback does not work correctly, check the event log and take action according to the events.

The automation playback does not work in the following cases.

- The number and size of variable data to be collected are large and exceed the collection processing capacity of the Controller.
  The collection processing capacity may be exceeded even if the number and size of the sampled variables is less than the upper limit in *2-1-2 Upper Limit of Variable Data to Collect* on page 2-3.

If the following applies, the variable log is not output even if the automation playback is working.

- When the start/save trigger method is used and time from the establishment of the start trigger condition to the establishment of the file save trigger condition exceeds the time length that the CPU Unit can store data.
- When the storage to output the variable log is unavailable.

What to Do When Processing Capacity to Collect Variable Data Is Exceeded

When the processing capacity to collect variable data is exceeded for a Controller project, automation playback may stop operation. In such cases, variable data cannot be collected.

Problem	Cause	Correction
Automation playback does not work.	Since the number and size of variable data to be collected are large and the collection processing capacity has been exceeded, it is impossible to collect variable data.	Perform one or more of the following corrections. • Exclude POUs and variables that are not required to be collected from the sampling targets. • Exclude large-size variables, such as structure and array variables from the sampling targets. • Increase the task period.

When this problem occurs, the following event occurs.
Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for information on the event.

Event code	Event name
95770000 hex (This event occurs for the CPU Unit with unit version earlier than 1.65.)	Upper Limit of Variable Sampling
95790000 hex (This event occurs for the CPU Unit with unit version 1.65 or later.)	Upper Limit of Variable Sampling
64040000 hex (This event occurs for the CPU Unit with unit version 1.68 or later.)	Upper Limit of Sampling Processing Capacity

When this problem occurs, the following event may have occurred beforehand.

Event code	Event name
64070000 hex	Cycle with No Variable Sampling

What to Do If the Time That the CPU Unit Can Accumulate Data is Exceeded

The start/save trigger method has the following characteristics.

- Sampling of variable data does not stop until the **file save trigger** condition is met.
  Sampling starts when the **start trigger** condition is met and does not stop only after the set sampling time has elapsed, but continues until the **file save trigger** condition is met.
- The sampled data accumulates a certain amount in the memory of the CPU Unit, and if sampling does not stop, the update continues.
  When the **file save trigger** condition is met, data stored in the memory of the CPU Unit is output to the variable log after variable sampling is stopped.

From the above characteristics, depending on the timing when the **file save trigger** condition is met, the time length of the data output to the variable log may be shorter than the set sampling time, or the variable log may not be output.

Problem	Cause	Correction
Variable logs are not output.	Since the interval between establishment of the **start trigger** condition and the **file save trigger** condition is long, the sampled data from the **start trigger** accumulated in the CPU Unit was updated with the subsequent sampled data.	When the start/save trigger method is used and variable log is output, make sure to promptly establish the **file save trigger** condition.
Time length of variable log data is shorter than the set time.	Refer to *6-2-3 What to Do If Variable Logs Are Shorter Than the Set Time* on page 6-8 for details.	

If the variable log cannot be output, the following event occurs.

Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for information on the event.

Event code	Event name
152C000 hex	Variable Log Save Failed

What to Do If the Storage of Output Files Is Unavailable

Variable logs will not be output when the storage at the variable log output destination is unavailable.

Problem	Cause	Correction
Variable logs are not output.	The storage at the variable log output destination is unavailable. • There is no SD Memory Card. • The SD Memory Card has no available space. • The SD Memory Card or the SD Memory Card folder is write-protected. • Power supply to the SD Memory Card has stopped. • The SD Memory Card is unable to write data due to a data error. • The SD Memory Card is damaged. • The SD Memory Card is formatted during output of variable logs.	Check and remove the causes listed on the left.

When this problem occurs, the following event occurs.
Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for information on the event.

Event code	Event name
152C0000 hex	Variable Log Save Failed

6-2-2 What to Do If Data Concurrency Cannot be Ensured in Variable Logs

Depending on the project in the Controller, it may not be possible to ensure data concurrency in variable logs. Data concurrency means that all variable data in a task period is read as data in the same task period. As explained in *2-1-3 Sampling Operation of Variable Data* on page 2-6, automation playback acquires variable data for a task period during the unused time in the task period. The "concurrency of variable data cannot be ensured" if all variable data within a task period is not acquired in the same task period and is obtained over multiple task periods.
When variable logs are used to investigate applications such as high-speed, high-precision motion control where a periodic gap of changes in variable values can cause problems, it is important that data concurrency is ensured in the variable logs. When you use the automation playback, make sure during testing operation with the Automation Playback Operation Monitor that data concurrency of the variable logs is ensured in the actual operating environment. Refer to *6-3-1 Checking the Operation Status of Automation Playback* on page 6-12 for information on the Automation Playback Operation Monitor.

Problem	Cause	Correction
• Data concurrency cannot be ensured in variable logs. • There are periods in which sampling of variables is not performed.	• Number of variables to be sampled If the the number of variables is large, the time required for variable sampling is long. Therefore, if the number of variables is large, sampling of the target variables cannot be completed within the same task period. • Task period If the task period is short, the number of sampling target variables that can be processed in one task period is small. Therefore, if the task period is short, sampling of the target variables cannot be completed within the same task period. • Time required for sampling variables in the primary periodic task If the time required for sampling variables in the primary periodic task is long, the time available for sampling variables in periodic tasks will be short and the sampling in the periodic tasks may not be completed.	Perform one or more of the following corrections. • Reduce the number of sampling target variables. • Reduce the task execution time ratio by setting a longer task period or reducing the number of POUs assigned to the task. • For the primary periodic task, you may exclude axis variables from the sampling target. Refer to *Procedure for What to Do If Data Concurrency Cannot be Ensured in Variable Logs* on page 6-7 for the detailed procedure.

When this problem occurs, the following event occurs.

Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for information on the event.

Event code	Event name
64060000 hex	No Variable Log Concurrency
64070000 hex	Cycle with No Variable Sampling

Precautions for Correct Use

If playback is executed in the Sysmac Studio with a variable log that contains data subject to the Cycle with No Variable Sampling event, the time of the data may not be displayed correctly. For example, if a variable log has 50 non-sampling periods when data was collected for 10,000 periods with the task period set to 1 ms, the sampling time of the data collected at 1,000 ms may be displayed as 1,005 ms. This occurs because the data collected in 9,950 cycles is averaged to 10,000 periods for playback.

Additional Information

- For the procedure to change the variables to be sampled, refer to *Procedure for Setting the Variable Data Sampling Target* on page 2-14.
- Guideline for task execution time ratio is given in the table below. Refer to the *NJ/NX-series CPU Unit Software User's Manual (Cat. No. W501)* for how to design tasks.

Task period of primary periodic task	Guideline for task execution time ratio
250μs	60% or less
500μs or more	80% or less

Procedure for What to Do If Data Concurrency Cannot be Ensured in Variable Logs

The following is the procedure for what to do if data concurrency cannot be ensured in variable logs.

Precautions for Correct Use

The ability to ensure data concurrency in variable logs and sampling variables changes mainly due to the following factors.

- Task period
- Task execution time ratio
- Number of variables included in the sampling target
- Data types of variables included in the sampling target

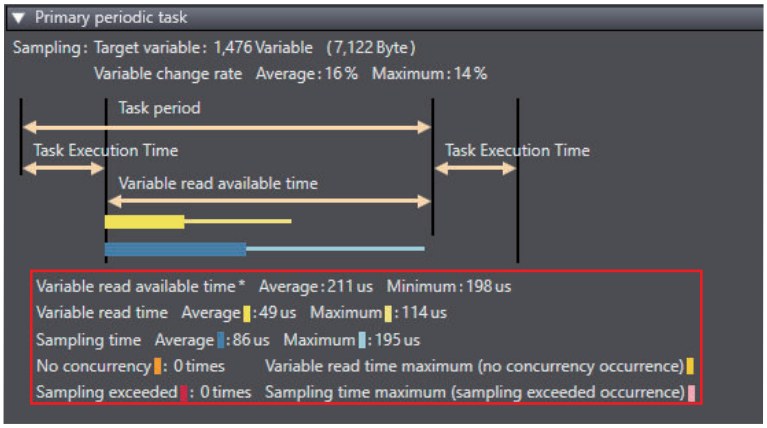
Since these are not uniquely determined by the system environment or program structure that you use, the automation playback function does not place function restrictions on these changing factors. Make the testing operation to confirm whether it can perform as expected in the environment that you use.

1 From the event log, find a task for which data concurrency of variable logs cannot be ensured. The task type for which concurrency of variable log cannot be ensured is shown in Attached information 1 of the No Variable Log Concurrency event (64060000 hex) and Cycle with No Variable Sampling event (64070000 hex).

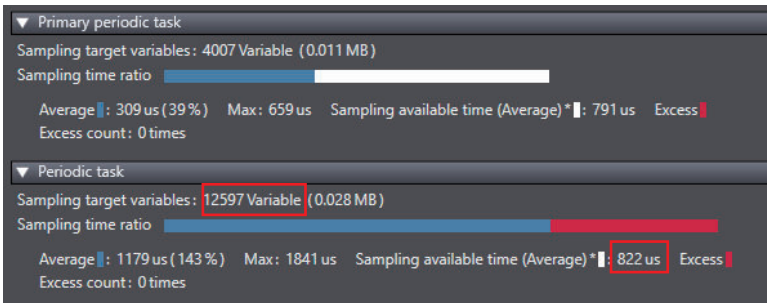
2 Display the **Automation Playback Operation Monitor**.
Refer to *6-3-1 Checking the Operation Status of Automation Playback* on page 6-12 for how to display the **Automation Playback Operation Monitor**.

3 In the **Automation Playback Operation Monitor** dialog box, check the current number of sampling target variables and the sampling operation status in tasks where data concurrency in the variable logs is not ensured.

- Project unit version 1.68 or later
  Check if the *Variable read time* exceeds the *Variable read available time* or if the *No concurrency* count continues increasing.



- Project unit version earlier than 1.68



4 Reduce the number of sampling target variables in Automation Playback Settings.
Refer to *2-3-1 Setting the Variable Data Sampling Target* on page 2-14 for how to reduce the number of sampling target variables.

5 If data concurrency cannot be ensured in variable logs even after sampling targets are reduced, set a longer task period.

6-2-3 What to Do If Variable Logs Are Shorter Than the Set Time

Depending on the project in the Controller, the length of output variable log data may be shorter than the set collection time. You can check the time output to the variable log in the event.
When you use the automation playback, make sure during the testing operation that variable logs for the set time are output in the actual environment.

Problem	Cause	Correction
Variable log data is shorter than the set time	The set sampling data size is larger than the memory size of the CPU Unit available for storing the sampling data. • Number of variables to be sampled The larger the number of variables, the larger the size of the variable sampling data, so the time allowed for output to the variable log is shorter. • Variable data type The automation playback handles structure variables and array variables as single variables. Even if the number of variables is small, the sampling data size is large when it contains a large number of structure variables and array variables. Therefore, when structure variables or array variables are sampled, the time allowed for output to variable logs is shorter than when the same number of basic data types is sampled.	Perform one or more of the following corrections. • Reduce the number of sampling target variables. • For the primary periodic task, you can exclude axis variables from the sampling target. Refer to *2-3-1 Setting the Variable Data Sampling Target* on page 2-14 for how to select program POUs and variables to be included in the sampling target and exclude axis variables from the sampling target.

You can check the time output to the variable log in the attached information of the following event.

Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for information on the event.

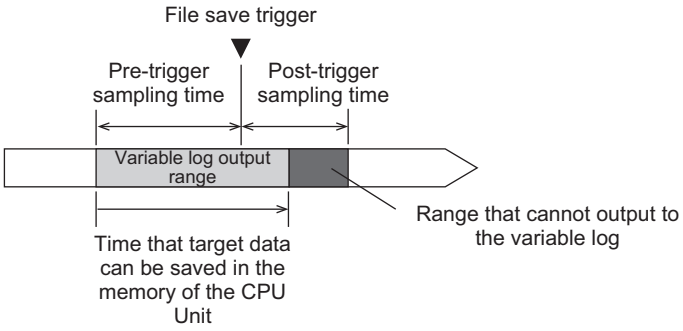
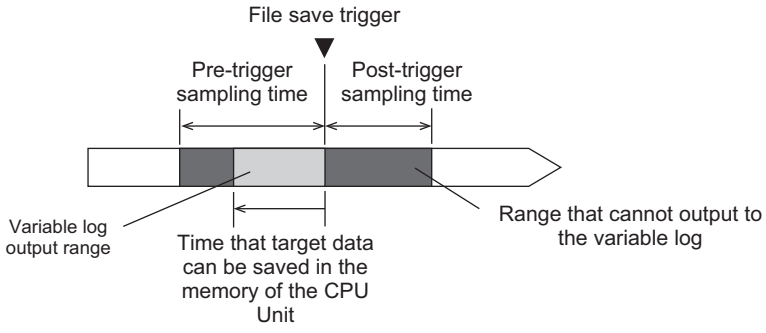
Event code	Event name
95750000 hex	Variable Log Output Completed

Variable Log Output Range If Variable Logs Are Shorter Than the Set Time

If the size of the set sampling data is larger than the memory size of the CPU Unit that can save the sampling data, the time for data output in the variable log will be shorter than the set time.
The range of data output to the variable logs is as follows.

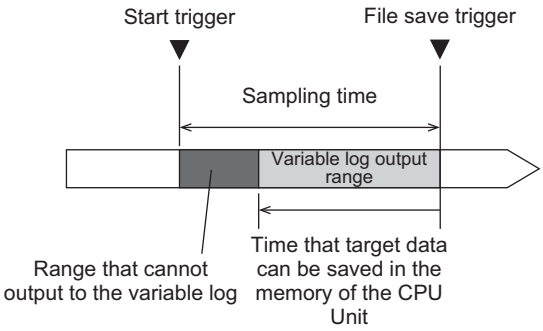
Pre/Post Trigger Method

Data from the pre-trigger sampling time is output to the variable log with priority over data from the post-trigger sampling time. Also, data collected around the time the file save trigger condition is met is prioritized and save to the variable log.

Condition	Variable log output range
The time that target data can be saved in the memory of the CPU Unit is shorter than the sum of the pre-trigger sampling time and post-trigger sampling time, and it is longer than the pre-trigger sampling time.	All data collected in the pre-trigger sampling time and the data in the post-trigger sampling time around the time the file save trigger condition is met are output to the variable log. 
The time that target data can be saved in the memory of the CPU Unit is shorter than the pre-trigger sampling time.	Of the data collected in the pre-trigger sampling time, the data collected around the time the file save trigger condition is met is output to the variable log. 

Start/Save Trigger Method

Data collected around the time the file save trigger condition is met is prioritized and output to the variable log.

Condition	Variable log output range
The time that target data can be saved in the memory of the CPU Unit is shorter than the sampling time.	Of the data collected in the sampling time, the data collected around the time the file save trigger condition is met is output to the variable log. 

Checking the Sampling Data Size

Check the sampling data size. You can know which POU or variable to exclude from the sampling target when you want to reduce the sampling data size.

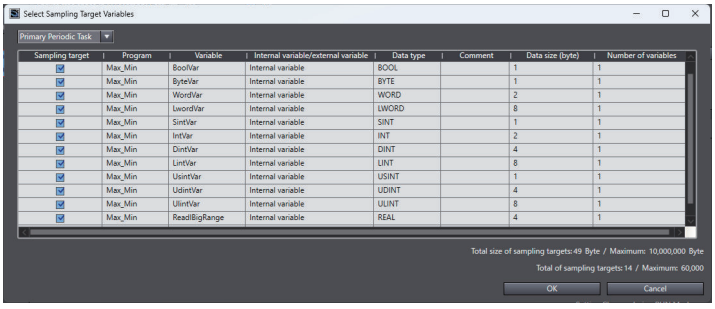
● Checking the Sampling Data Size for Each Variable (Ver. 1.65 or Later)

You can check the sampling data size for each variable in the **Select Sampling Target Variables** dialog box.

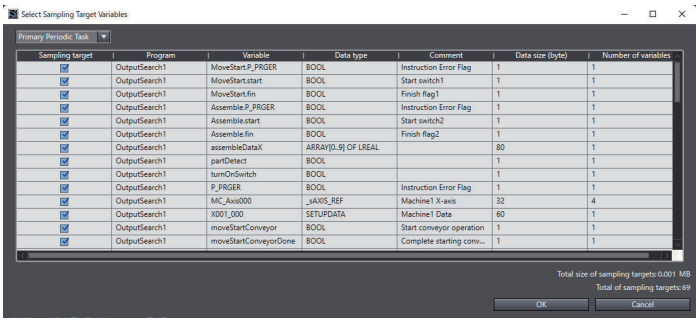
Version Information

This function is available in project unit version 1.65 or later.

- Project unit version 1.68 or later



- Project unit version earlier than 1.68



You can see the size of each variable in **Data size** column in the **Select Sampling Target Variables** dialog box. Sort by variable data size to see which variable has large data size.

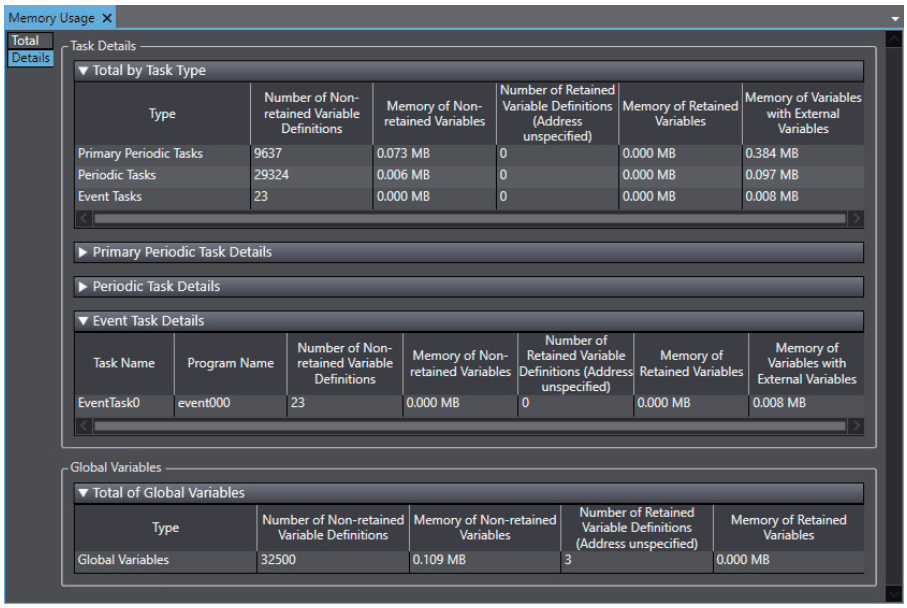
Refer to *Checking the Number of Variables and Memory Usage of Each Variable (Ver. 1.65 or Later)* on page 6-16 for how to display the **Select Sampling Target Variables** dialog box.

How to Check Sampling Data Size Per Program POU

The approximate size of sampling data per program POU is checked on the **Memory Usage** tab page.

When you select the **Details** in the **Memory Usage** tab page, information on variables included in the program POU assigned to each task is displayed. The **Memory of Variables with External Variables** for the program POU in the **Task Details** section is the guideline of the sampling data size per program POU*1.

*1. Some **Memory of Variables with External Variables** may not match completely because they include sizes of variables that are not included in the sampling target.



Refer to *Procedure for Checking the Number of Variables to Use in Program POUs and the Memory Usage* on page 6-17 for information on how to display the **Memory Usage** tab page.

6-3 Checking Information on Sampling for Automation Playback

You can check information on sampling for automation playback.

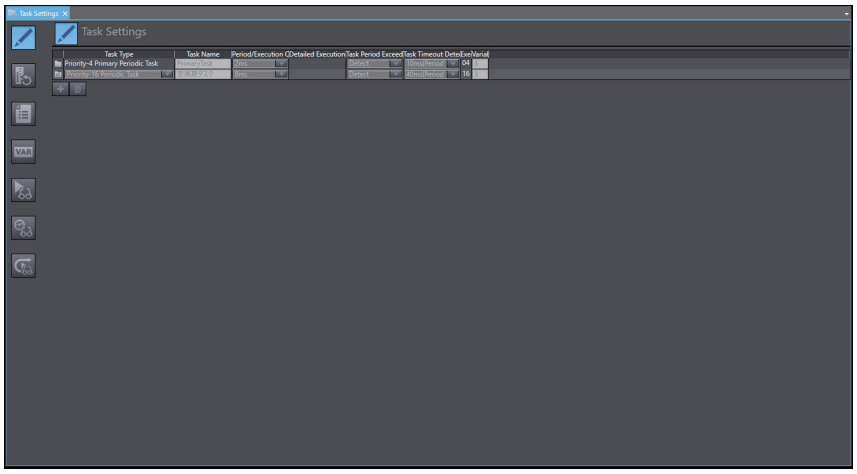
6-3-1 Checking the Operation Status of Automation Playback

Check the operation status using the Automation Playback Operation Monitor.

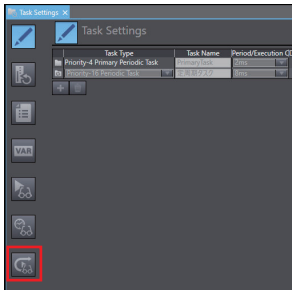
Procedure for Checking the Operation Status of Automation Playback

Use the Automation Playback Operation Monitor in the Sysmac Studio to check the sampling time margin, sampling status, etc.
To use the Automation Playback Operation Monitor, it is required that the CPU Unit is in RUN Mode and that the Sysmac Studio and the Controller are online.

1 Double-click **Task Settings** under **Configurations and Setup** or right-click it and select **Edit** from the menu in the Multiview Explorer of the Sysmac Studio.
The Edit pane is displayed.

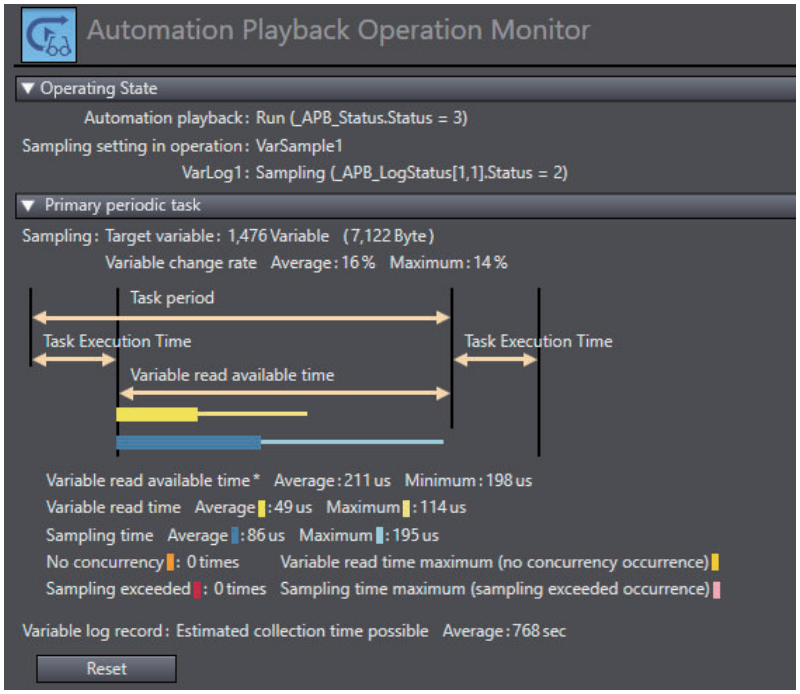


2 In the **Task Settings** display shown in the Edit pane, click the **Automation Playback Operation Monitor** button.

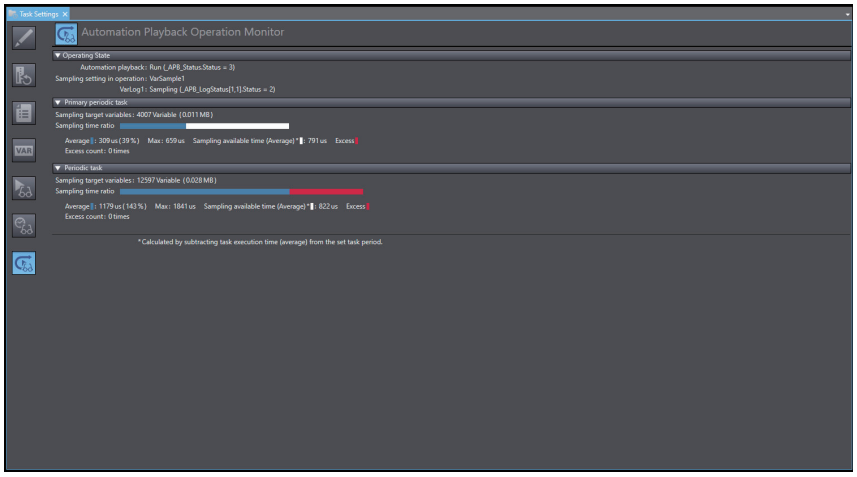


The **Automation Playback Operation Monitor** dialog box is displayed.

- Project unit version 1.68 or later



- Project unit version earlier than 1.68



Additional Information

The **Automation Playback Operation Monitor** dialog box is displayed in a separate window from the **Automation Playback Settings** display, so you can arrange the windows side by side to check playback operation.

3 Check the information.

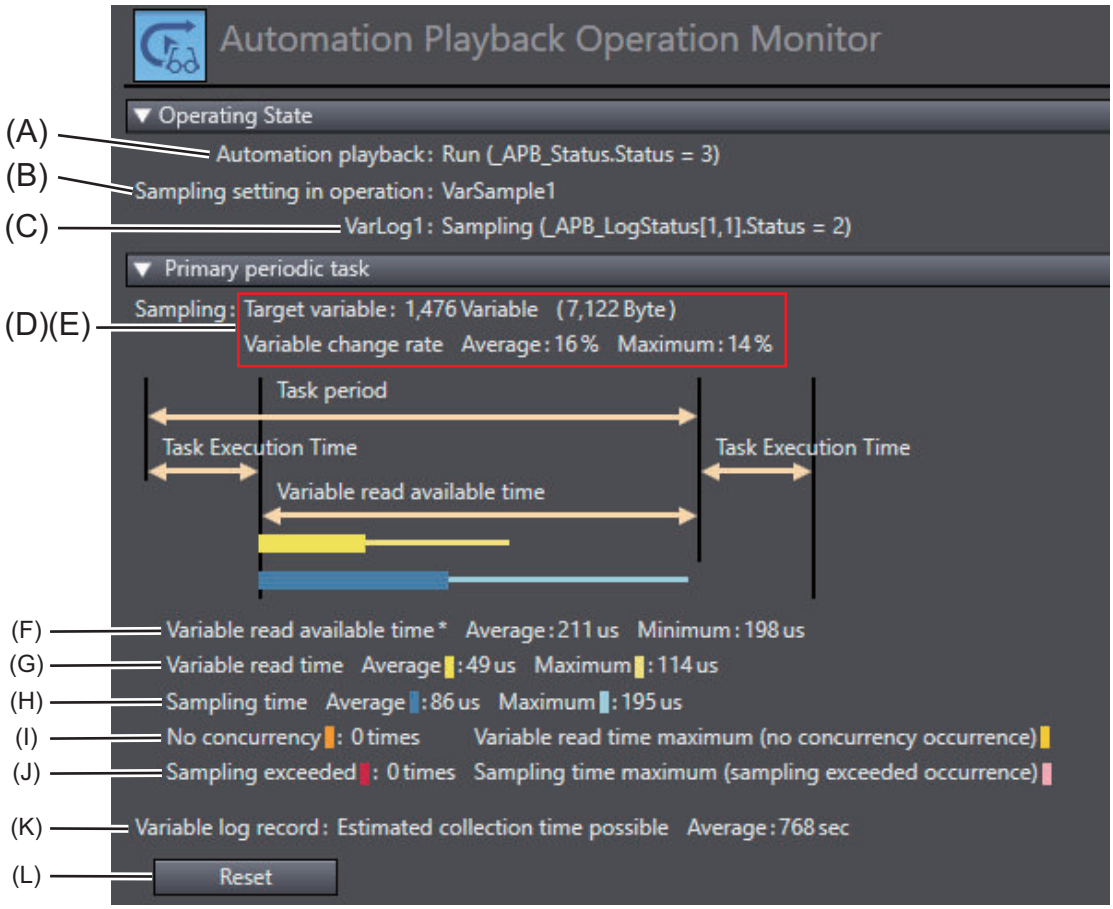
If the sampling time exceeds the task period, data concurrency cannot be ensured. To ensure data concurrency, reduce the number of sampling target variables.

Refer to *6-2-2 What to Do If Data Concurrency Cannot be Ensured in Variable Logs* on page 6-5 for how to ensure data concurrency.

Items That You Can Check in the Automation Playback Operation Monitor

You can check information on sampling for automation playback.

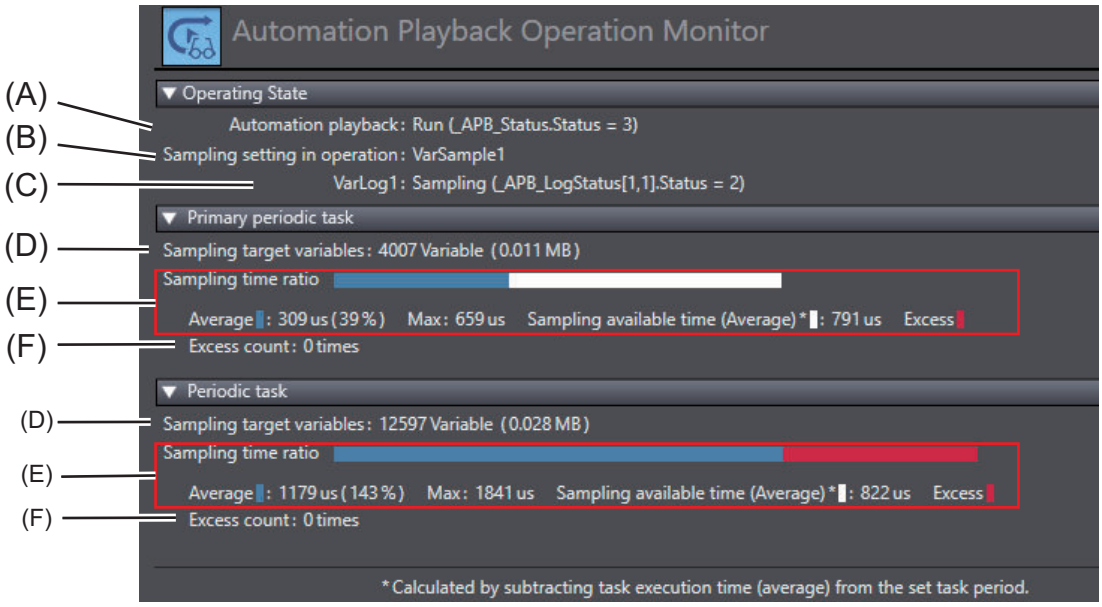
● Automation Playback Operation Monitor (Project unit version 1.68 or later)



Symbol	Item	Description
A	Automation playback	Displays the status of automation playback. When it is disabled, (B) and subsequent monitor values will not be displayed. Refer to *A-1-1 State Transitions for Automation Playback Function* on page A-2 for details on the status of automation playback.
B	Sampling setting in operation	Displays the setting name of the active sampling setting.
C	Variable log output setting during operation	Displays the setting name and sampling state of the variable log output setting during operation.
D	Target variable	Displays the number and the total data size of sampling target variables.
E	Variable change rate	Displays the percentage of the data size of variables whose values changed to the total data size of the sampling target variables.
F	Variable read available time	Displays the time available for reading variables while ensuring data concurrency, which is calculated as (task period - task execution time).

Symbol	Item	Description
G	Variable read time	Displays the time required for reading sampling target variables in sampling processing (from reading to storing the variables in memory).
H	Sampling time	Displays the time required for sampling processing.
I	No concurrency	Indicates the number of times of sampling in which data concurrency cannot be ensured because the *Variable read time* exceeds the *Variable read available time*.
J	Sampling exceeded	Displays the number of times variable sampling was omitted because sampling processing was not completed before the start of the next sampling processing.
K	Estimated collection time possible	Displays the maximum estimated time for recording in a variable log. The time available for recording varies depending on the percentage of variables whose values change.
L	Reset button	Resets the following values. *Variable change rate*, *Variable read available time*, *Variable read time*, *Sampling time*, *No concurrency* count, *Sampling exceeded* count, and *Estimated collection time possible*

● Automation Playback Operation Monitor (Project Unit Version Earlier Than 1.68)



Symbol	Item	Description
A	Automation playback	Displays the status of automation playback. When it is disabled, (B) and subsequent monitor values will not be displayed. Refer to *A-1-1 State Transitions for Automation Playback Function* on page A-2 for details on the status of automation playback.
B	Sampling setting in operation	Displays the setting name of the active sampling setting.
C	Variable log output setting during operation	Displays the setting name and sampling state of the variable log output setting during operation.
D	Sampling target variables	Displays the number and size of sampling target variables for the primary periodic task or periodic task.

Symbol	Item	Description
E	Sampling time ratio	Displays a stacked bar chart showing the average and exceeded sampling times for the primary periodic task or periodic task, where each bar has a length corresponding to its time percentage with the Sampling available time (Average) as 100%. The maximum value is displayed at the bottom of the bar. • Average Displays the average value of sampling time for the primary periodic task or periodic task in units of μs and as a percentage [%] of the Sampling available time (Average). • Max Displays the maximum value of sampling time for the primary periodic task or periodic task in units of μs. • Sampling available time (Average) Displays the value calculated from set period of primary periodic task or periodic task minus task execution time (average) in units of μs. • Excess This is the sampling time for the portion where the average value of sampling time for the primary periodic task or periodic task exceeds the Sampling available time (Average). A bar with a length corresponding to its time percentage is shown. The value is not shown.
F	Excess count	Displays the number of times the sampling processing for the variable was not executed due to the following factors. a. The sampling processing for the primary periodic task or periodic task did not complete before the next sampling process began. b. The number and size of the sampled variables exceeded the upper limit of the collection processing capacity.

6-3-2 Checking Variables and Memory Usage

You can check the number of sampling target variables and memory usage.

Checking the Number of Variables and Memory Usage of Each Variable (Ver. 1.65 or Later)

You can see the number of variables used and memory usage on the variable list in the **Select Sampling Target Variables** dialog box.

Version Information

The functions used in this procedure are available in project unit version 1.65 or later.

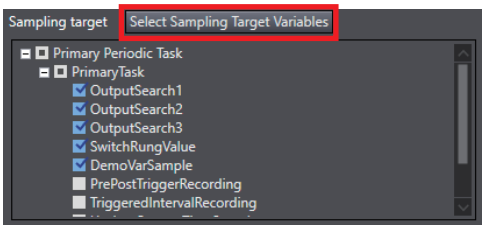
1 Double-click **Operation Settings** under **Configurations and Setup** – **Controller Setup** from the Multiview Explorer of the Sysmac Studio. Or right-click Operation Settings and select **Edit** from the menu.

2 In the **Operation Settings** tab page displayed in the Edit pane, click the **Automation Playback Settings** button.

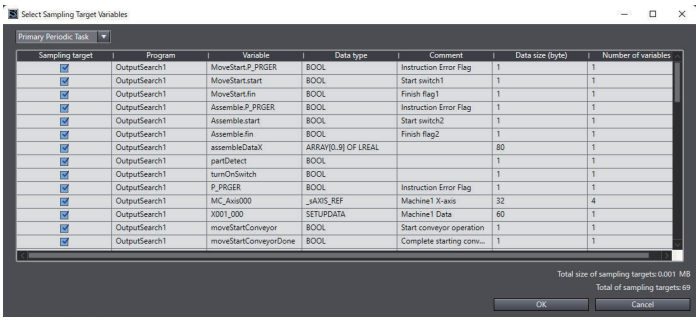
The **Automation Playback Settings** display opens.

3 Click **Sampling Setting 1** or **Sampling Setting 2**.
The sampling settings are displayed.

4 Click the **Select Sampling Target Variables** button.



The **Select Sampling Target Variables** dialog box is displayed.

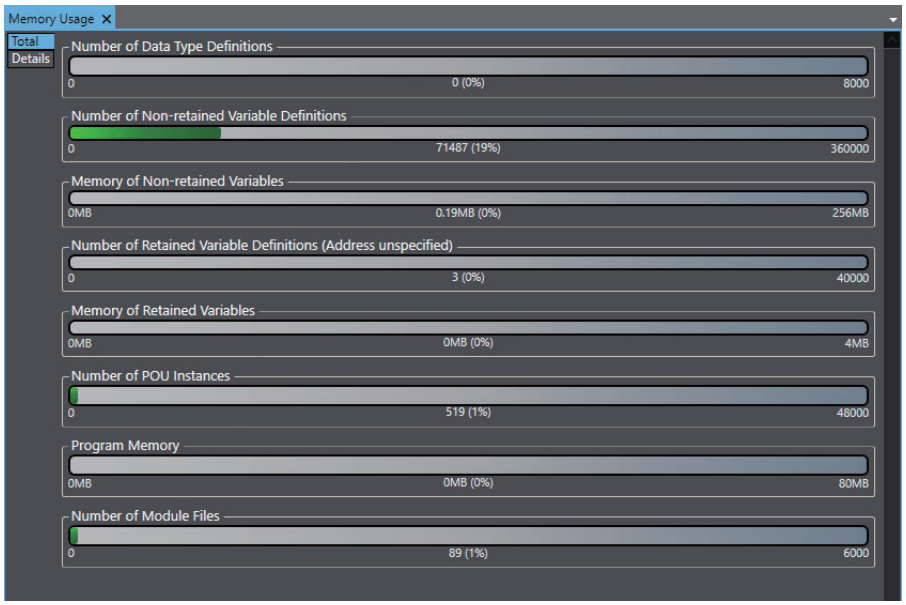


5 Check the information displayed in the dialog box.
Sort by the **Data size (byte)** column to see which variables have larger data sizes. You can also filter by program POU to see which variables are included in the program POU.
For more information on the **Select Sampling Target Variables** dialog box, refer to *Items on the Select Sampling Target Variables Dialog Box* on page 2-18.

Procedure for Checking the Number of Variables to Use in Program POUs and the Memory Usage

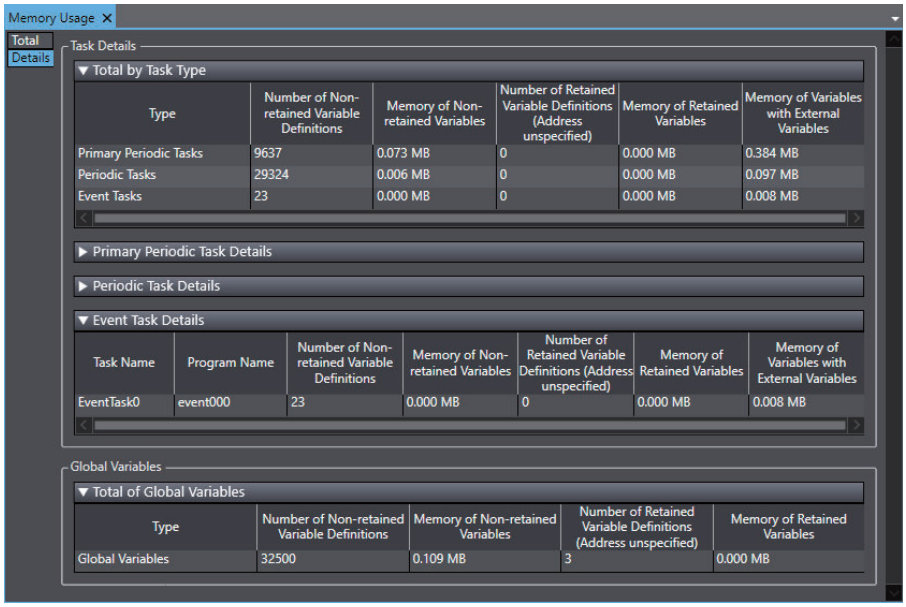
In the **Memory Usage** tab page in the Sysmac Studio, check the number of variables to use in program POUs assigned to tasks and the memory usage.

1 Select **Memory Usage** from the **Project** menu of the Sysmac Studio.
The **Memory Usage** tab page is displayed.



2 Click **Details**.

Detailed information is displayed.



3 Check each information.

Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for information on each item in the Details view.

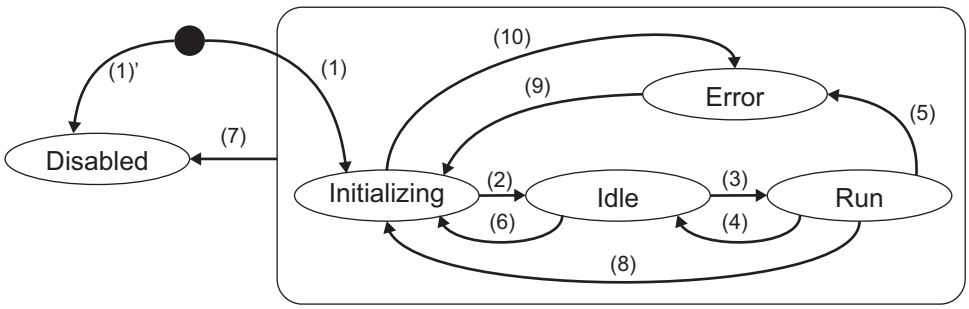
A

Appendices

A-1 State Transitions

A-1-1 State Transitions for Automation Playback Function

For the automation playback function, state transitions occur in the Controller as shown in the following state transition diagram.
You can check each transition state by the values of system-defined variables related to the automation playback function.



State	Value in _APB_Status.Status	Description
Disabled	0	Automation playback is set to **Do not use**[*1], or the simulator is started.
Initializing	1	Automation playback function is performing its initial processing.
Idle	2	Automation playback function completed the initial processing, but has not started sampling of variables.
Run	3	Automation playback function is running.
Error	4	An error in sampling of variables with the automation playback function occurs, or an unexpected error occurs in the automation playback function.

*1. This includes the state of the Controller that is set to **Do not use** for automation playback, until the Controller restarts after the setting configured to **Use** is transferred.

The conditions for transition to each state are as follows.

No.	Main transition conditions	Event to occur
1	A Controller that is set to **Use** for the automation playback is started.	
1'	A Controller that is set to **Do not use** for the automation playback function is started.	
2	Automation playback function completes its initial processing.	
3	The conditions for starting variable sampling (all of the following) are met. • Valid sampling settings are transferred to the Controller. • The Controller changes from PROGRAM Mode to RUN Mode. Or one of the following conditions is met. • Online editing is completed. • Change of the Controller's time information is completed with the Sysmac Studio.	• Variable Sampling Started (95730000 hex)

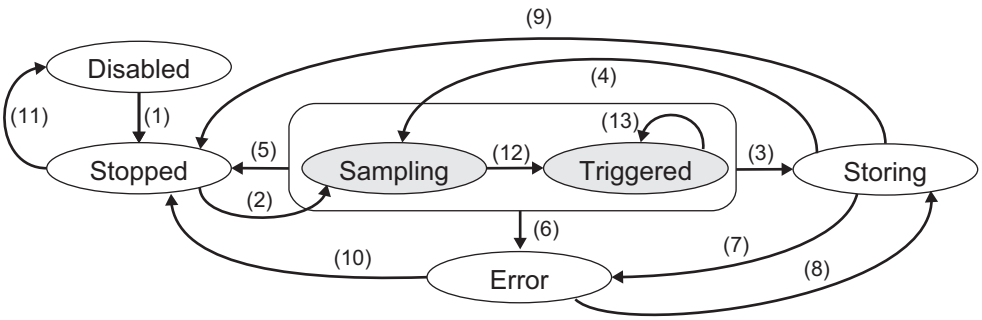
No.	Main transition conditions	Event to occur
4	One of the following conditions is met. *1 • The Controller changes to a state other than RUN Mode. • The user program or variable settings that were changed by online editing are reflected in the Controller. • A major fault level event occurred in the Controller. • Change of the Controller's time information is started with the Sysmac Studio.*2	
5	The following occurred with **Behavior after task period is exceeded** set to **Stop** in the variable log sampling setting. • Concurrency cannot be ensured in variable logs. • The system determines that there are periods in which sampling is not performed. • An unexpected error occurred in the automation playback function.	• No Variable Log Concurrency (64060000 hex) • Cycle with No Variable Sampling (64070000 hex)
6	The changed settings for the automation playback are transferred.	
7	**Do not use** setting for automation playback is transferred.	
8	The APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed. Or, **Setting Change during RUN Mode** is performed.	
9	The changed settings for the automation playback are transferred (including the transfer through **Setting Change during RUN Mode**), or the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed.	
10	An unexpected error occurred in the automation playback function.	

*1. The data for the variables that have been sampled is discarded. Do not perform any operations that meet these conditions during the period of obtaining variable log.

*2. This does not include changes of time information by referencing an NTP server or with the SetTime instruction. In addition, when time information is changed with the NTP or instruction, variable logs that cannot be read in the Sysmac Studio may be output depending on the output timing of the variable log.

A-1-2 State Transitions in Variable Log Output Based on the Pre/Post Trigger Method

For variable log output based on the pre/post trigger method, state transitions occur in the Controller as shown in the following state transition diagram. Note that sampling of variables is performed in states shown in gray in the diagram.



State	Value in _APB_LogStatus.Status	Description
Disabled	0	There is no variable log output setting based on the pre/post trigger method, or the sampling setting related to the variable log output setting based on the pre/post trigger method is disabled.
Stopped	1	Sampling of variables has stopped, so it is impossible to output variable logs.
Sampling	2	Sampling of variables is in progress.
Triggered	3	One of the conditions specified for **File save trigger** is met.
Storing	5	The variable log is being stored. Sampling of variables is stopped when the state changes to this state.
Error	6	Storing of the variable log has failed.

The conditions for transition to each state are as follows.

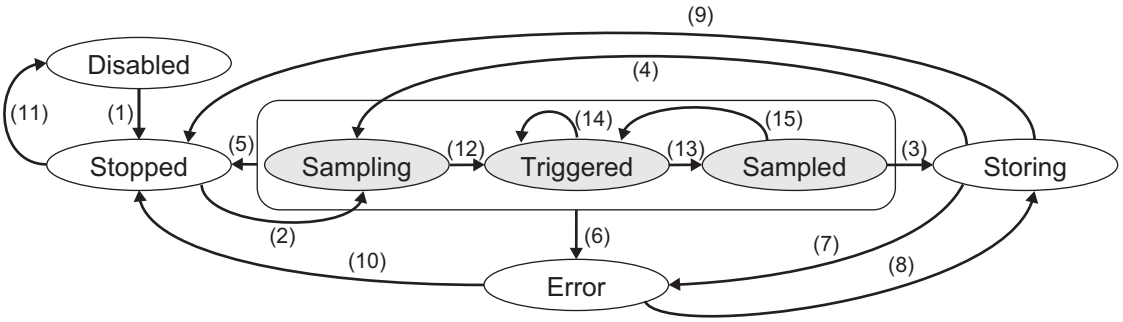
No.	Main transition conditions	Event to occur
1	Automation playback function enters an Idle state, or the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed.	
2	Automation playback function enters a Run state.	
3	The time specified for **Post-trigger sampling time** has elapsed. Or, the system determined that the time that target data can be saved in the memory of the CPU Unit is shorter than the sum of the **Pre-trigger sampling time** and **Post-trigger sampling time**.	
4	Output of the variable log file is completed.*1	• Variable Log Output Completed (95750000 hex)
5	Automation playback function enters an Idle state, or the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed. Or, **Setting Change during RUN Mode** is performed.	
6	Automation playback function enters an Error state.	
7	Output of the variable log has failed.	
8	All of the following were satisfied. • Error reset operation is performed. • The state of the automation playback function is not Error.	
9	The Controller changes to a state other than RUN Mode while the variable log file is being output, and output of the variable log is completed. *2 Or, **Setting Change during RUN Mode** is performed while the variable log file is being output, and output of the variable log is completed. *3	
10	Automation playback function enters an Idle state, or the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed. Or, **Setting Change during RUN Mode** is performed.	
11	The setting for automation playback is changed to **Do not use**, or the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed.	
12	One of the conditions specified for **File save trigger** is met.*4	
13	One of the conditions specified for **File save trigger** is met.	

*1. This includes cases where the sampling time is less than the set sampling time.

*2. If the Controller changes to a state other than RUN Mode during Storing, output of the variable log is not aborted and the state transition occurs after the variable log file is output.
*3. If variable log settings are changed and transferred during Storing, output of variable log is not aborted and the state transition occurs after the variable log file is output.
*4. This condition is valid even when the period of Sampling (execution period of sampling actual variables) is less than **Pre-trigger sampling time**. In this case, the variable log whose Sampling period is less than **Pre-trigger sampling time** will be output. No events will be generated.

A-1-3 State Transitions in Variable Log Output Based on the Start/Save Trigger Method

For variable log output based on the start/save trigger method, state transitions occur in the Controller as shown in the following state transition diagram. Note that sampling of variables is performed in states shown in gray in the diagram.



State	Value in _APB_LogStatus.Status	Description
Disabled	0	There is no variable log output setting based on the start/save trigger method, or the sampling setting related to the variable log output setting based on the start/save trigger method is disabled.
Stopped	1	Sampling of variables has stopped, so it is impossible to output variable logs.
Sampling	2	Sampling of variables is in progress.
Triggered	3	The condition specified for **Start trigger** is met.
Sampled	4	The time set for **Sampling time** has elapsed.
Storing	5	The variable log is being stored.
Error	6	Storing of the variable log has failed.

The conditions for transition to each state are as follows.

No.	Main transition conditions	Event to occur
1	Automation playback function enters an Idle state, or the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed.	
2	Automation playback function enters a Run state.	
3	One of the conditions set for **File save trigger** is met.	
4	Output of the variable log file is completed.*1	• Variable Log Output Completed (95750000 hex)
5	Automation playback function enters an Idle state, or the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed. Or, **Setting Change during RUN Mode** is performed.	

No.	Main transition conditions	Event to occur
6	Automation playback function enters an Error state.	
7	Output of the variable log has failed.	
8	All of the following were satisfied. • Error reset operation is performed. • The state of the automation playback function is not Error.	
9	The Controller changes to a state other than RUN Mode while the variable log file is being output, and output of the variable log is completed. *2 Or, **Setting Change during RUN Mode** is performed while the variable log file is being output, and output of the variable log is completed. *3	
10	Automation playback function enters an Idle state, or the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed. Or, **Setting Change during RUN Mode** is performed.	
11	The setting for automation playback function is changed to **Do not use**, or the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is executed.	
12	The condition specified for **Start trigger** is met.	
13	The time set for **Sampling time** has elapsed.	
14	The condition specified for **Start trigger** is met.*4	
15	The condition specified for **Start trigger** is met.*4	

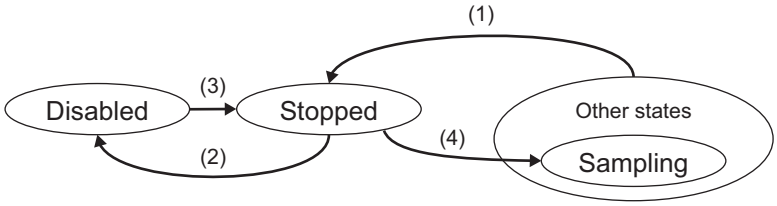
*1. This includes cases where the sampling time is less than the set sampling time.
*2. If the Controller changes to a state other than RUN Mode during Storing, output of the variable log is not aborted and the state transition occurs after the variable log file is output.
*3. If variable log settings are changed and transferred during Storing, output of variable log is not aborted and the state transition occurs after the variable log file is output.
*4. The variable log start time that can be output is updated.

Precautions for Correct Use

Automation playback function continues sampling the variables even after the state is changed to “Sampled.” Therefore, if you continue the operation in a Sampled state without the save trigger condition met, the old sampling data will be continuously overwritten, and depending on the timing at which the save trigger condition is met, the start time of the variable log may be shifted to a later time than when the start trigger condition is met. In such a case, make sure to promptly establish the save trigger condition.

A-1-4 Special Notes on State Transition of Variable Log Output

When the APB_ChangeSamplingSettings (Change Sampling Settings) instruction is used to switch the enabled sampling setting, the variable log output setting associated with that sampling setting is also switched accordingly, with the enabled setting being disabled and the disabled setting being enabled. Focusing on the state transition of variable log output, this is as shown in the diagram below.



State Transition of Variable Log Output Setting Associated with Enabled Sampling Setting

No.	State transition
1	Changes to Stopped with execution of the APB_ChangeSamplingSettings (Change Sampling Settings) instruction.
2	Changes to Disabled in the course of switch processing.

State Transition of Variable Log Output Setting Associated with Disabled Sampling Setting

No.	State transition
3	Changes from Disabled to Stopped in the course of switch processing.
4	Changes to Sampling thereafter.

A-2 Precautions for Online Editing

The following are precautions for automation playback when you perform online editing.

- If you perform online editing and have the changed user program and variable settings reflected in the Controller when sampling of the variables has started, the sampling of the variables stops. The sampling of variables will be resumed when the online editing is completed.
- The variables added during online editing are not included in the sampling target. To include the variables added during online editing in the sampling target, use the synchronization function of the Sysmac Studio to transfer the settings that contain those for automation playback to the Controller. For a CPU Unit with unit version 1.65 or later, when you add a variable in online editing and then execute setting change during RUN Mode, the variable added in online editing is also included in the sampling target.
- Before you perform online editing, such as during system startup, select the **Do not back up** option for **Project backup** by automation playback function. If you do not disable project backups, a project backup is generated each time you perform online editing and online editing will not be possible until the backup is complete.
  If you want to continue operating the system with the **Project backup** by automation playback set to **Do not back up**, make sure that the project file used to play the playback data is the same as the program running on the system.
  Refer to *2-5 Configuring the Setting to Back Up the Project for Playback* on page 2-33 for information on the setting to back up the project.

A-3 List of System-defined Variables for Automation Playback

The following is a list of system-defined variables for automation playback. Refer to the *NJ/NX-series CPU Unit Software User's Manual (Cat. No. W501)* for details on each system-defined variable.

Variable Name	Name	Description
_APB_Status	APB Service Status	Indicates the operating status of the automation playback service.
_APB_LogStatus	APB Log Output Status	Indicates the operating status of the variable log output for automation playback.
_APB_SysInfo (Unit version 1.68 or later)	APB System Information	Represents automation playback system information.
_APB_SmplInfo (Unit version 1.68 or later)	APB Sampling Information	Represents sampling statistics, variable log information, etc.
_APB_LogCfg (Unit version 1.68 or later)	APB Log Output Configuration	Represents automation playback variable log output configuration information.

A-4 Version Information for Automation Playback Functions

A-4-1 Relationship between Unit Versions of CPU Units and Sysmac Studio Versions

Supported models and unit versions for each function of the automation playback that can use in the Sysmac Studio are listed below.

Function	Model number	Unit version	Sysmac Studio version
Automation Playback Settings	NX502-1□00	Ver. 1.63 or later	Ver. 1.55 or higher
Automation Playback Operation Monitor			
Copying playback data			
Playing playback data			
Playback chart			
Output factor search			
Memory usage			

A-4-2 Functions That Were Added or Changed Due to Version Updates

The main functions of the automation playback that were added and changed due to version updates are listed below.

Function		Addition/ change	Unit version	Sysmac Studio version
Automation Playback Settings	Selection of individual variable to include in the sampling target	Addition	Ver. 1.65	Ver. 1.57
		Change	Ver. 1.68	Ver. 1.62
	Change of variable data collection settings in RUN Mode	Addition	Ver. 1.65	Ver. 1.57
	Display of estimated collection time possible	Addition	Ver. 1.68	Ver. 1.62
Automation Playback Operation Monitor	Addition of displayed items	Change	Ver. 1.68	Ver. 1.62
Playing playback data	Rotate video button	Addition	Ver. 1.68	Ver. 1.62
Total data size of variables	Upper limit 5 MB	Change	Ver. 1.65	Ver. 1.57
	Upper limit 10 MB	Change	Ver. 1.68	Ver. 1.62
Variable log file	Extension .bin2	Change	Ver. 1.68	Ver. 1.62
Events	• Upper Limit of Sampling Processing Capacity (64040000 hex) • Variable Log Save Not Possible (957A0000 hex)	Addition	Ver. 1.68	Ver. 1.62
System-defined variables	• _APB_SysInfo • _APB_SmplInfo • _APB_LogCfg	Addition	Ver. 1.68	Ver. 1.62

Version Information

- About the combination of variable log files and Sysmac Studio versions
  Variable log files with the extension .bin2 recorded in the CPU Unit with unit version 1.68 or later cannot be played using Sysmac Studio version 1.61 or lower.
  To record variable log files that can be played using Sysmac Studio version 1.61 or lower, make sure that the project transferred to the CPU Unit is project unit version earlier than 1.68.

Project unit version of projects in the Controller	Variable log file	Sysmac Studio version	
		Ver. 1.62 or higher	Ver. 1.61 or lower
Version 1.68 or later	Extension .bin2	Can be played	(Extension .bin2 cannot be read)
Version earlier than 1.68	Extension .bin	Can be played	Can be played

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OMRON Corporation **Industrial Automation Company**

Kyoto, JAPAN **Contact : www.ia.omron.com**

Regional Headquarters

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

OMRON ELECTRONICS LLC
2895 Greenspoint Parkway, Suite 200
Hoffman Estates, IL 60169 U.S.A.
Tel: (1) 847-843-7900 Fax: (1) 847-843-7787

OMRON ASIA PACIFIC PTE. LTD.
438B Alexandra Road, #08-01/02 Alexandra
Technopark, Singapore 119968
Tel: (65) 6835-3011 Fax: (65) 6835-3011

OMRON (CHINA) CO., LTD.
Room 2211, Bank of China Tower,
200 Yin Cheng Zhong Road,
PuDong New Area, Shanghai, 200120, China
Tel: (86) 21-6023-0333 Fax: (86) 21-5037-2388

Authorized Distributor:

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