SAFETY CONTROLLER BASIC COURSE

This course is intended for beginners of safety controllers who understand safety basics.
Click the Next button at the upper right of the screen to proceed to the next page.

Introduction Purpose of the Course

This course is intended for those using the MELSEC-WS series safety controller for the first time or having just started using it. This course describes basic knowledge of the MELSEC-WS series safety controller, the system configuration method using the Setting and Monitoring Tool for the safety controller, and the error check method.

Taking this course requires that you have completed the following courses or have equivalent knowledge.

- YOUR FIRST FACTORY AUTOMATION (SAFETY OF MACHINERY)

Introduction Course Structure

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

Chapter 1 - Safety Controller

This chapter provides the overview of the safety controller.

Chapter 2 - System Construction

This chapter describes the system configuration constructed in this course.

Chapter 3 - Connection Check of Safety Controller and Personal Computer

This chapter provides the setting method to connect a safety controller and personal computer and the check method.

Chapter 4 - New Project Creation

This chapter provides how to create projects for a safety controller.

Chapter 5 - Project Download

This chapter provides how to download projects to a safety controller and verify the projects.

Chapter 6 - Safety Controller Connection/Disconnection

This chapter provides how to connect and disconnect a safety controller.

Chapter 7 - System Operation Check

This chapter provides how to check the safety controller operation.

Final Test

6 sections in total (6 questions) Passing grade: 60% or higher.

Introduction How to Use This e-Learning Tool

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

Cautions for Use

Safety precautions

When you learn by using actual products, please carefully read the safety precautions in the corresponding manuals.

Precautions in this course

- The displayed screens of the software version that you use may differ from those in this course.
This course is for the following software version:

    - Setting and Monitoring Tool for the safety controller Version 1.3.0.245

Chapter 1 Safety Controller

This chapter provides the overview of the safety controller.

1.1 Safety Controller

1.2 Feature of Safety Controller

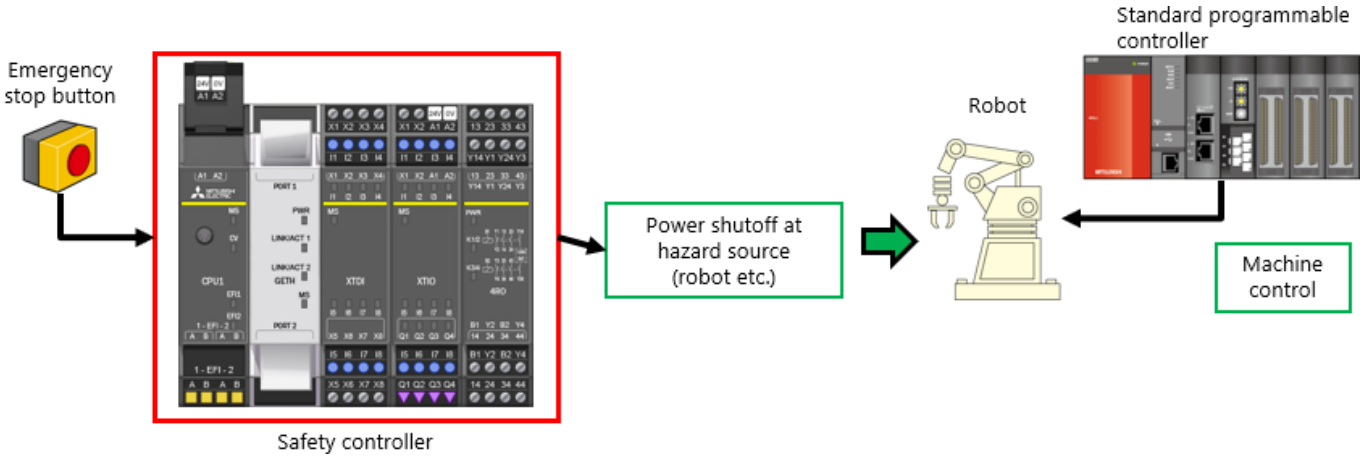
1.3 Basic Configuration of Safety Controller

1.4 Safety Control can be Easily Added to Existing MELSEC Programmable Controllers (CC-Link/Ethernet)

1.5 Summary of This Chapter

1.1 Safety Controller

The safety controller is a controller for safety control that conforms to international safety standards. When connected with a safety device, such as an emergency stop switch or light curtain, this programmable controller executes safety control by turning the safety output OFF with a user-created program to stop the power toward a source of hazard, such as a robot. Machine control of robots and conveyors, etc., is executed with standard programmable controllers in the conventional manner.

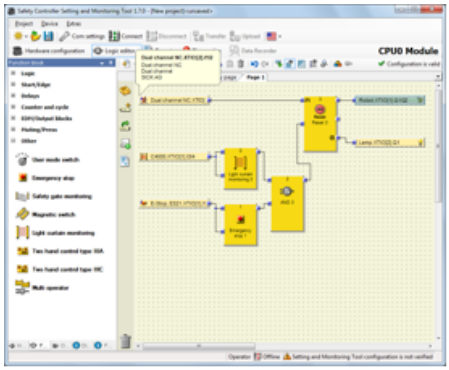


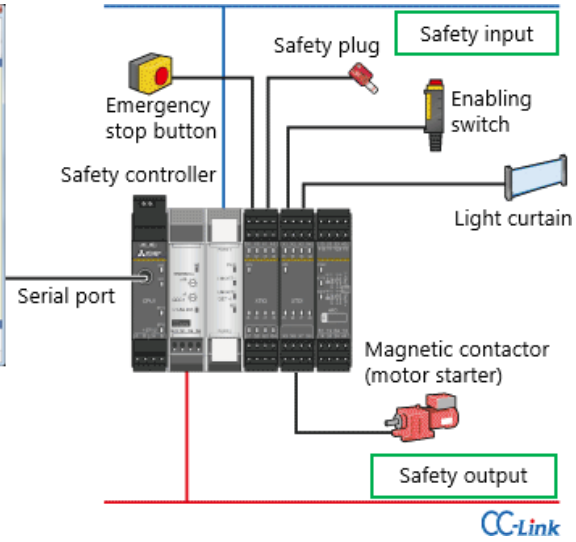
1.2 Features of Safety Controller

The safety controller is an expandable compact controller suitable for the safety control of small to medium-sized devices and systems.
Up to 12 I/O modules and 2 network interface modules can be connected.
The safety I/O can be expanded to 144 points (input: 96 points, output: 48 points).
The dedicated "Setting and Monitoring Tool" contains is equipped with function blocks for safety sensors and switch connections and even with safety-dedicated function blocks, facilitating safety system construction.
The "Setting and Monitoring Tool" can be downloaded in the Mitsubishi Electric FA site.

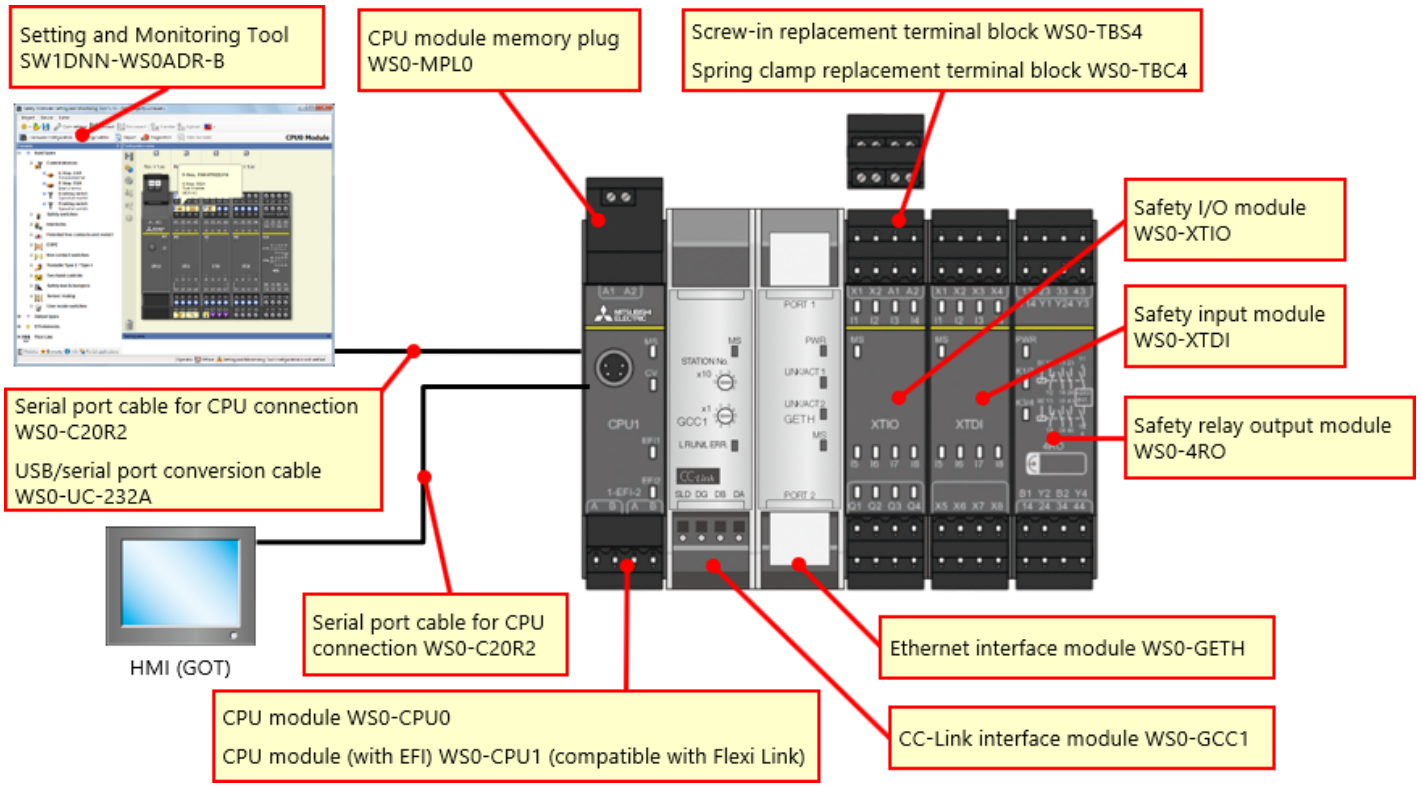
The safety controller complies with ISO 13849-1 PLe and IEC 61508 SIL3 safety standards.

■ Dedicated "Setting and Monitoring Tool"





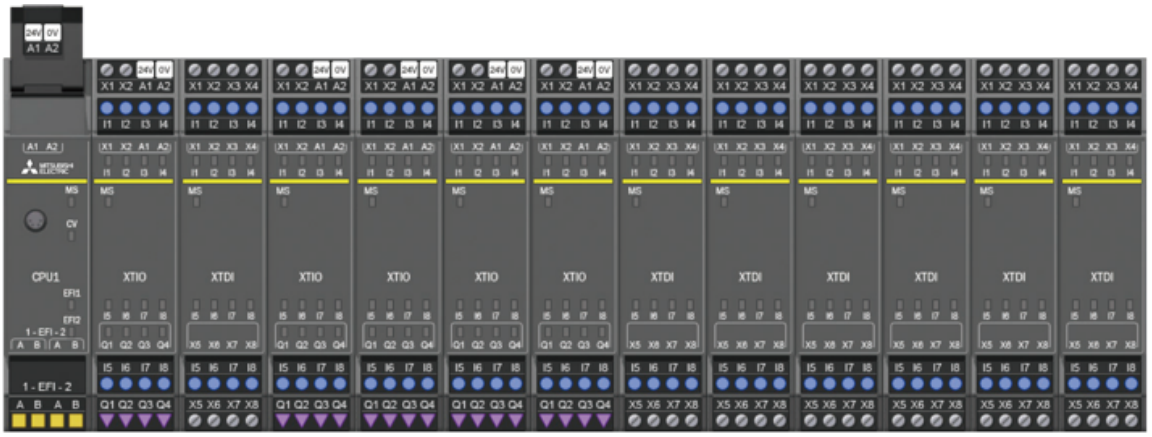
1.3 Basic Configuration of Safety Controller



1.3 Basic Configuration of Safety Controller

■ Compact safety controller with flexible expandability

- Up to 12 safety input modules and I/O modules, 4 safety relay output modules, and 2 network modules can be added.
- The number of I/O points can be expanded up to 144 (single input).
  Safety input: 96 points (single input) + safety output: 48 points (single output)

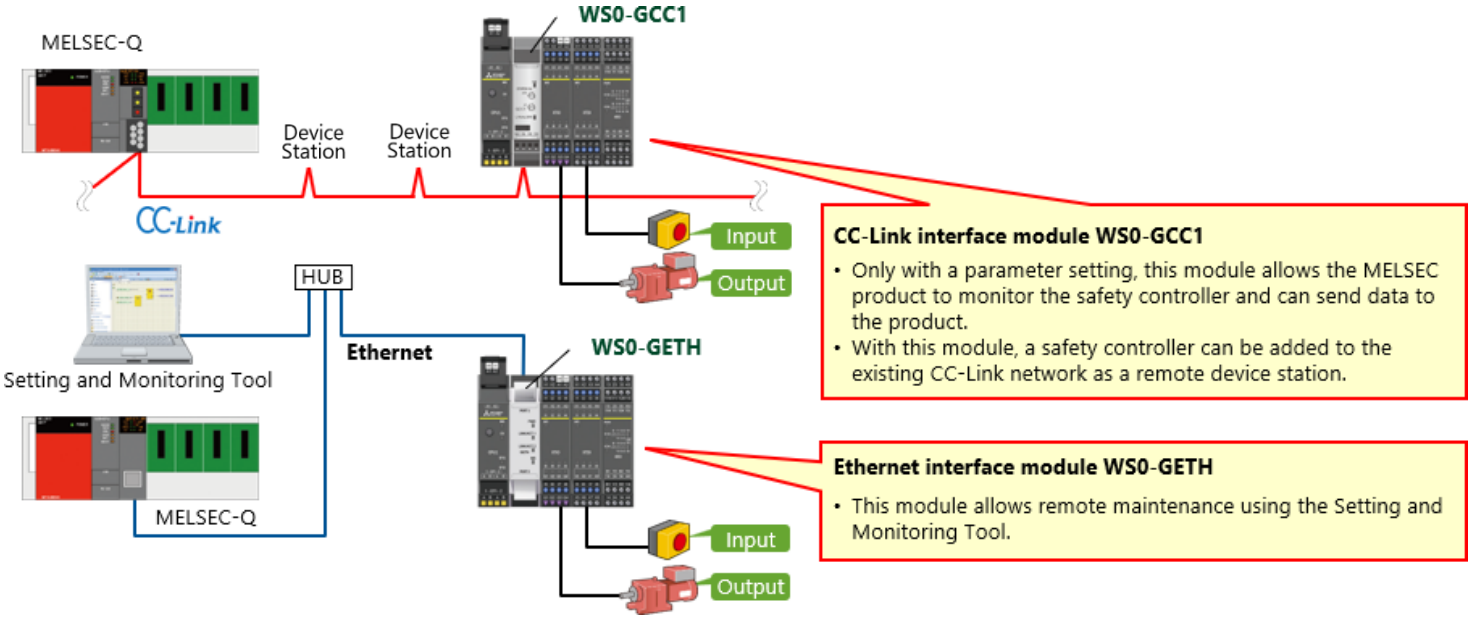


1.4 Safety Control can be Easily Added to Existing MELSEC Programmable Controllers (CC-Link/Ethernet)

With a safety controller connected to CC-Link, the existing MELSEC-Q/L programmable controller can execute safety control. Furthermore, operation status and error status of the safety controller can be monitored with the existing MELSEC-Q/L programmable controller.
Visualization in safety can be enhanced, and this improves the efficiency in identifying an emergency stop factor and investigating a faulty spot.

<Network interface-compatible function>

		CC-Link (WS0-GCC1)	Ethernet (WS0-GETH)
Programmable controller/personal computer	Monitoring information	○	○
	Data notification	○	○
Setting and Monitoring tool	Connection via network	-	○



CC-Link interface module WS0-GCC1

- Only with a parameter setting, this module allows the MELSEC product to monitor the safety controller and can send data to the product.
- With this module, a safety controller can be added to the existing CC-Link network as a remote device station.

Ethernet interface module WS0-GETH

- This module allows remote maintenance using the Setting and Monitoring Tool.

1.5 Summary

In this chapter, you have learned:

- Safety Controller
- Features of Safety Controller
- Basic Configuration of Safety Controller
- Safety Control can be Easily Added to Existing MELSEC Programmable Controllers (CC-Link/Ethernet)

Chapter 2 System Construction

This chapter describes the system configuration constructed in this course.

2.1 System Image

2.2 Wiring

2.3 Summary of This Chapter

2.1 System Image

This section describes the overview of the safety system used in this course.

■ **Part of an assembly line for automobile bodies**

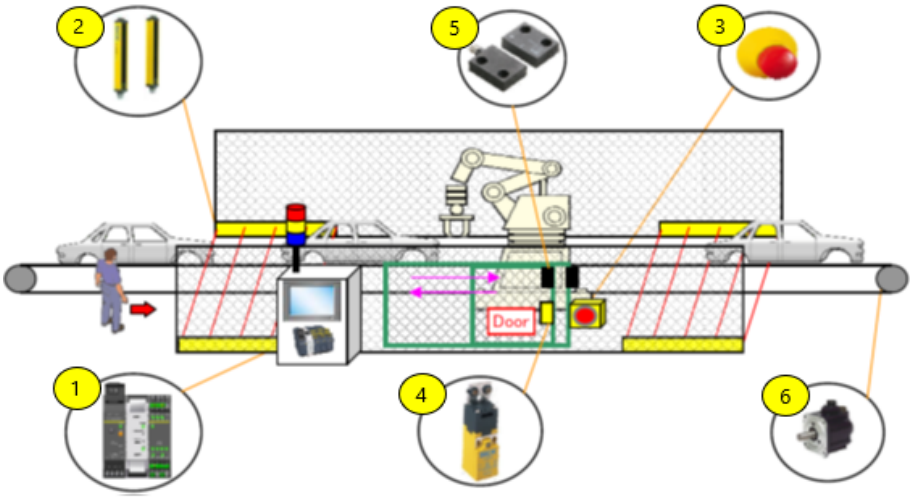


Figure. Application image

Set the following conditions to stop the production line safely.

- The light curtain is obstructed.
- The door opens.
- The emergency stop switch is pressed.

2.2 Wiring

This section shows a device wiring diagram.

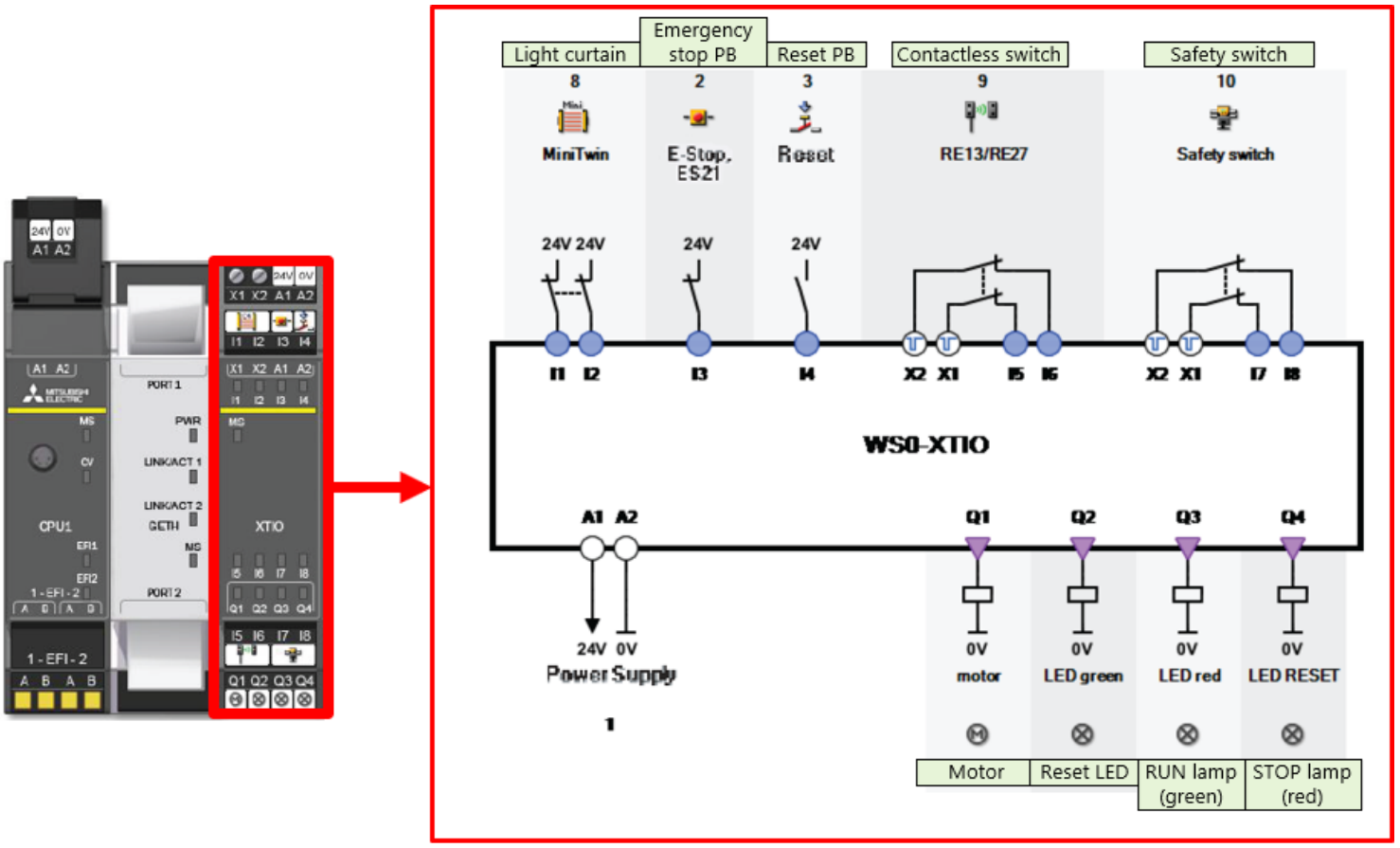


Figure. Device wiring

2.3 Summary

In this chapter, you have learned:

- System Image
- Wiring

Chapter 3 Connection Check of Safety Controller and Personal Computer

This chapter provides the setting method to connect a safety controller and personal computer and the check method.

3.1 Connecting Safety Controller and Personal Computer

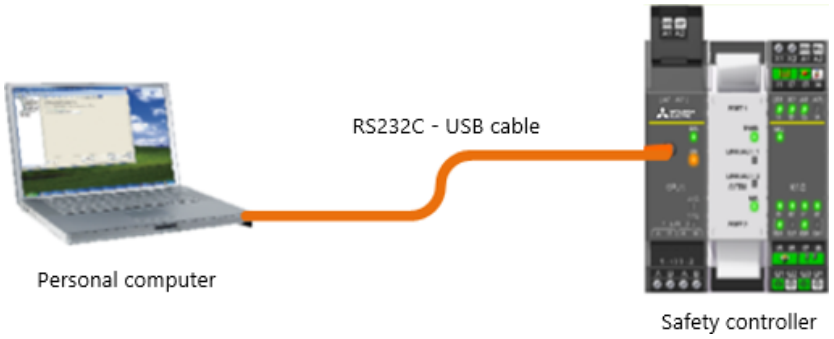
3.2 Operation on Setting and Monitoring Tool

3.3 Summary of This Chapter

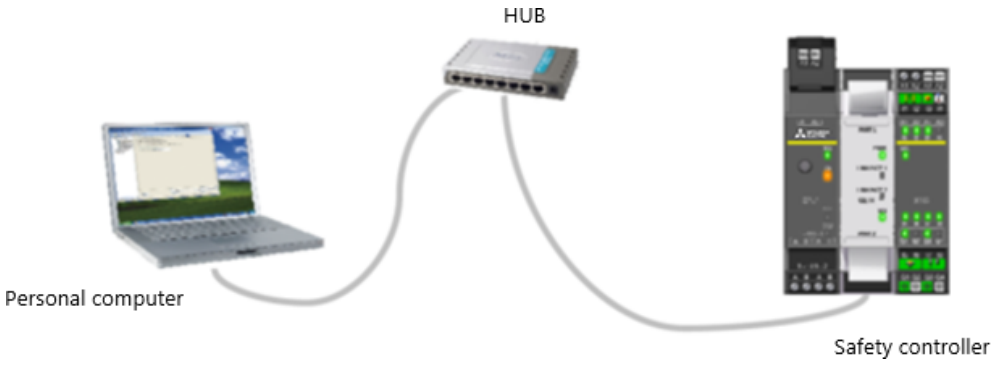
3.1 Connecting Safety Controller and Personal Computer

Connect a safety controller and personal computer in either of the following two ways.

■ RS232C connection



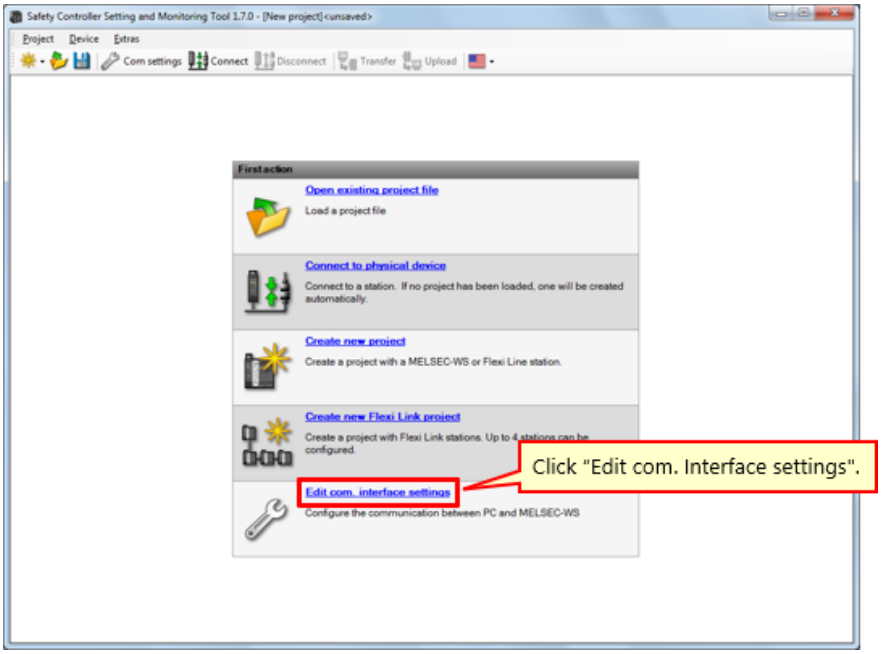
■ Ethernet connection



3.2 Operation on Setting and Monitoring Tool

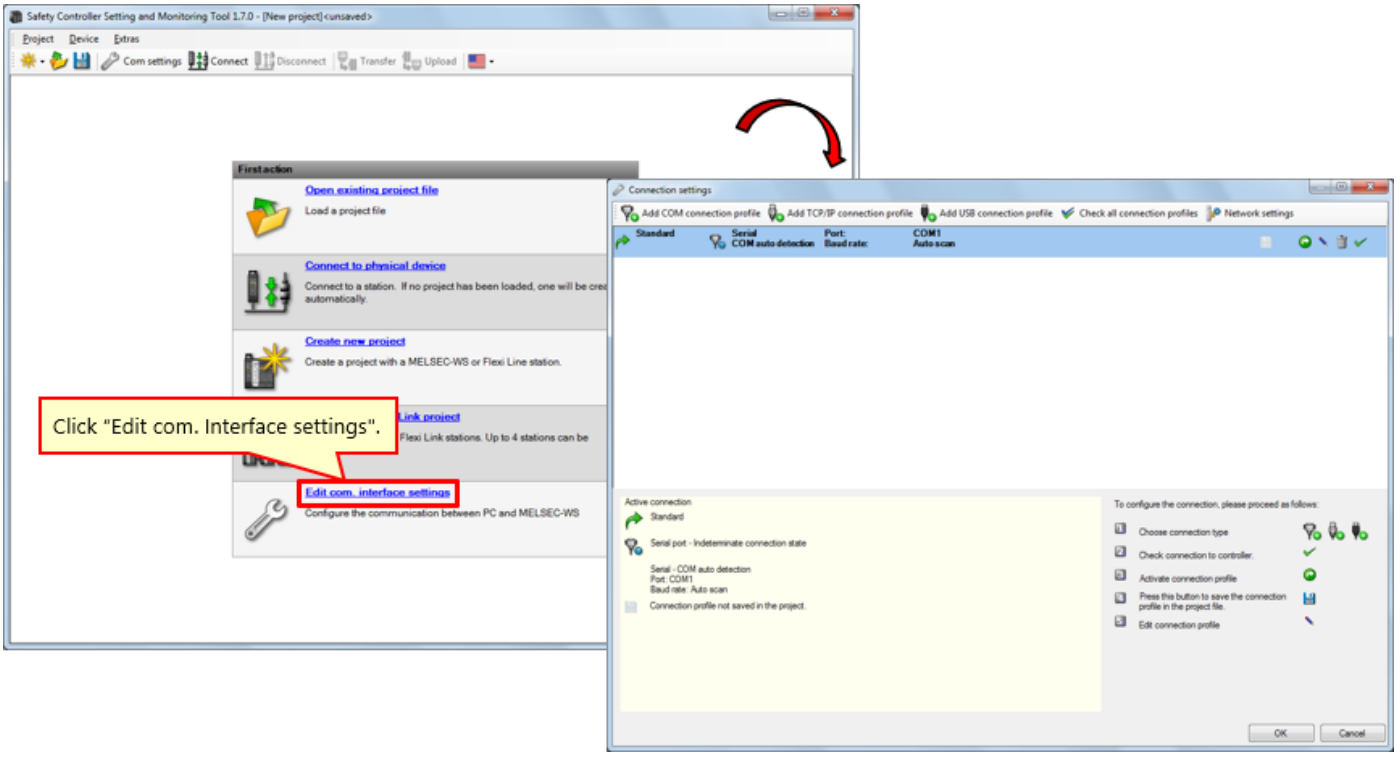
(1) Start the Setting and Monitoring tool for the safety controller.

* The following is for the RS232C connection.

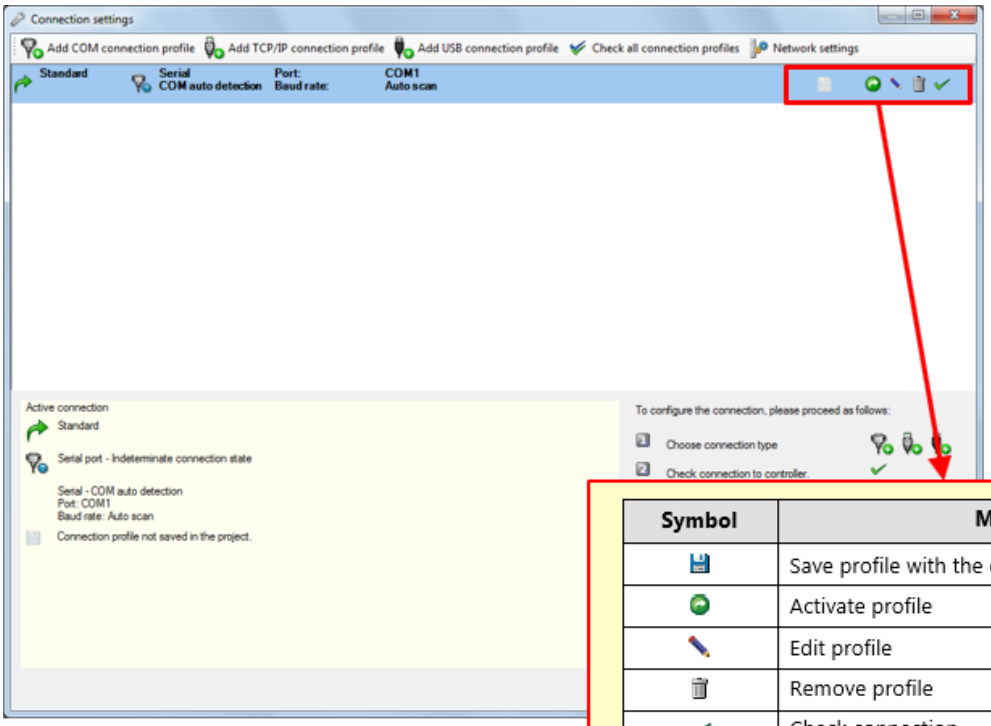


(2) Set a connection profile.

This section describes how to set a connection profile of a safety controller and personal computer.



(3) Check the connection profile.

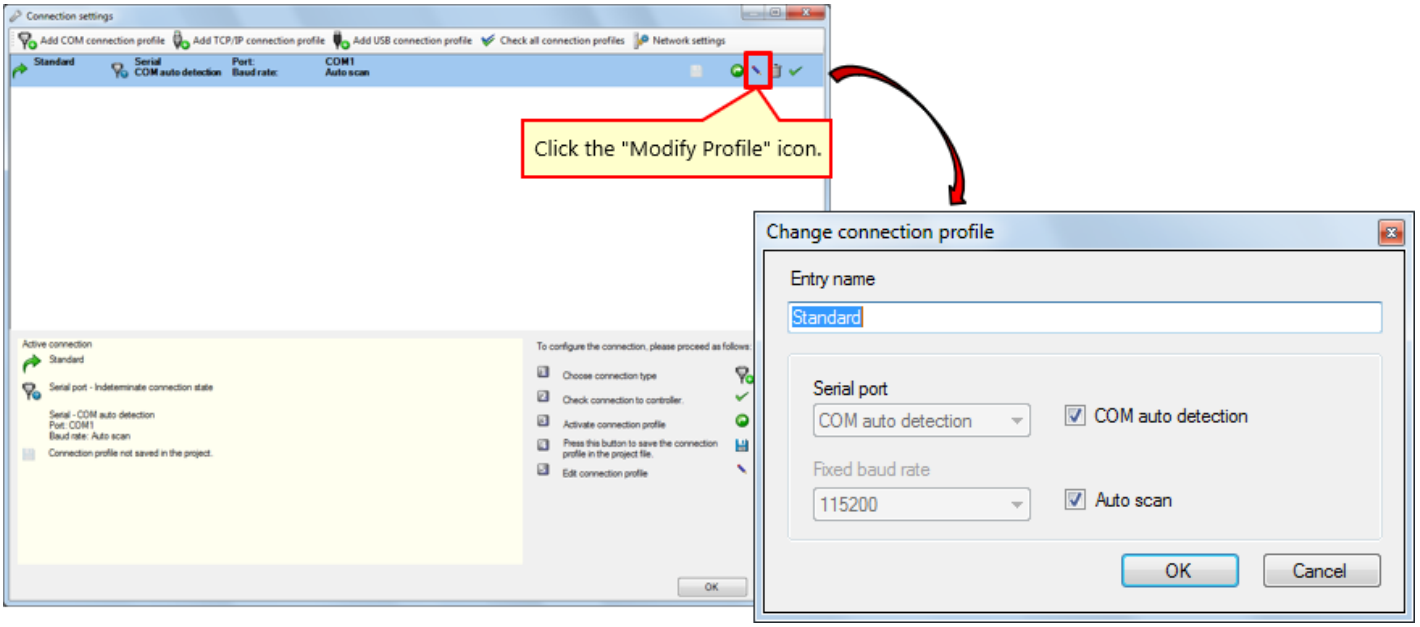


Symbol	Meaning
	Save profile with the current project
	Activate profile
	Edit profile
	Remove profile
	Check connection

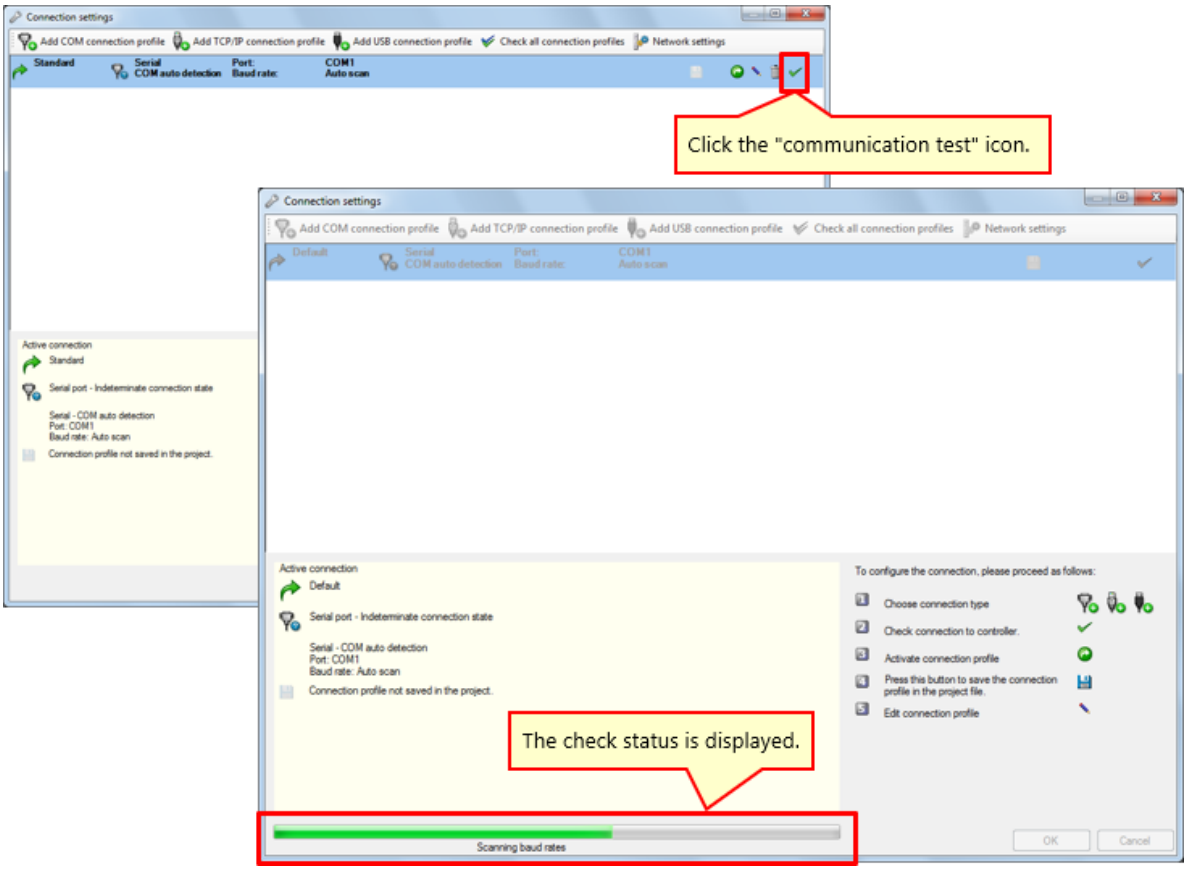
Symbols for editing the connection profiles in the Connection settings dialog box

(4) Edit the connection profile.

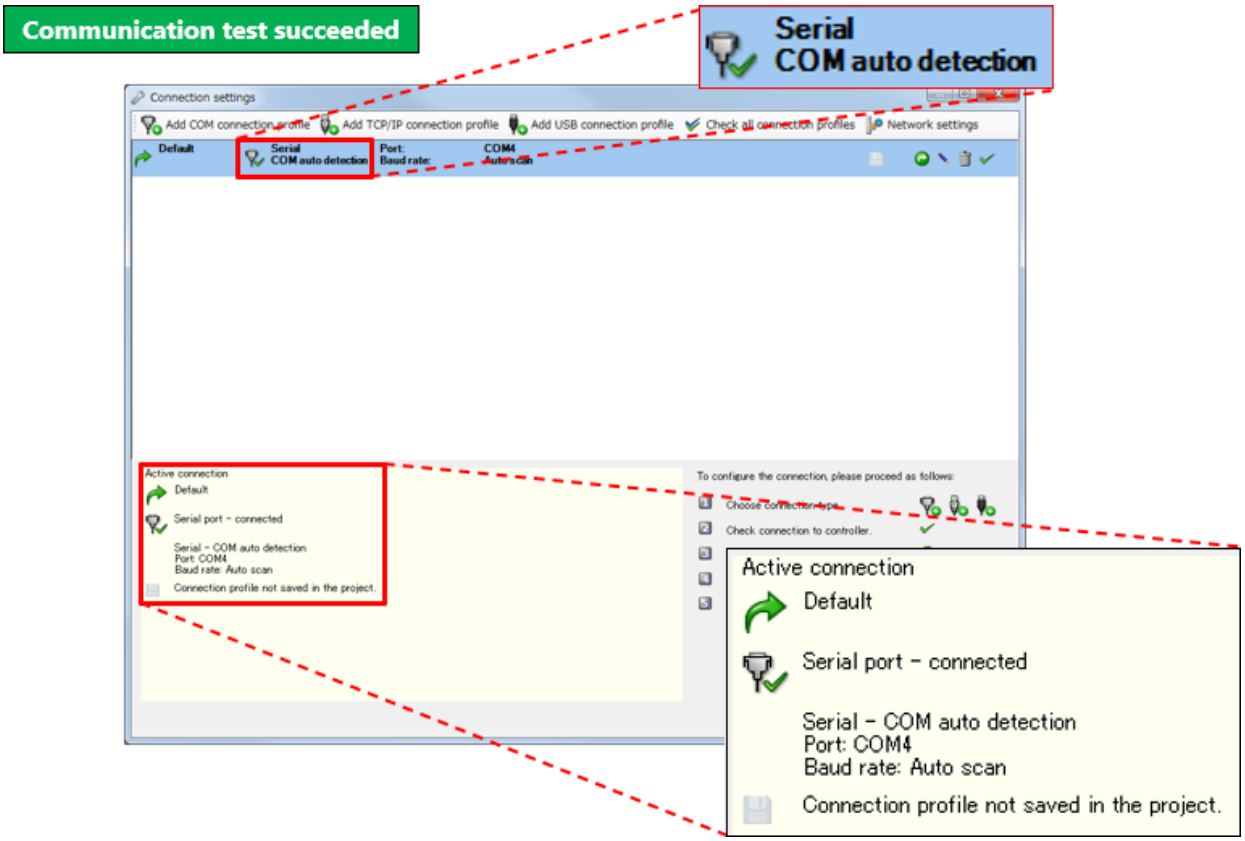
Select the "Modify Profile" icon.



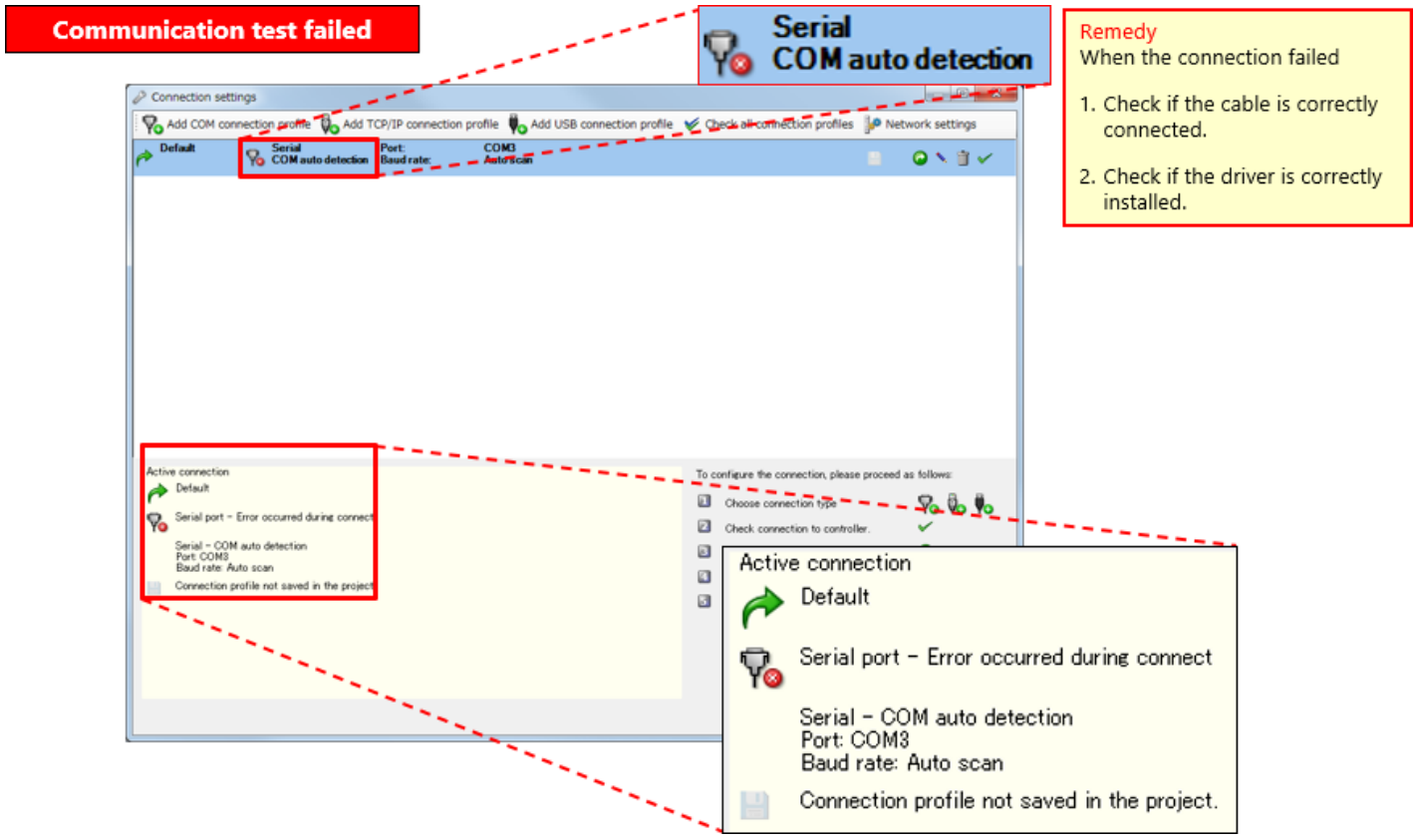
(5) Conduct a communication test.



(6) Check the communication test result (succeeded).



(7) Check the communication test result (failed).



3.3 Summary

In this chapter, you have learned:

- Connecting Safety Controller and Personal Computer
- Operation on the Setting and Monitoring Tool (Connection Profile Specification)

Chapter 4 New Project Creation

This chapter provides how to create projects for a safety controller.
Let's create a project with the system configuration described in Chapter 2.

4.1 New Project Creation

4.2 Hardware Setting

4.3 Pasting Elements and Setting Parameters

4.4 Tag Name Edit

4.5 Logic Creation

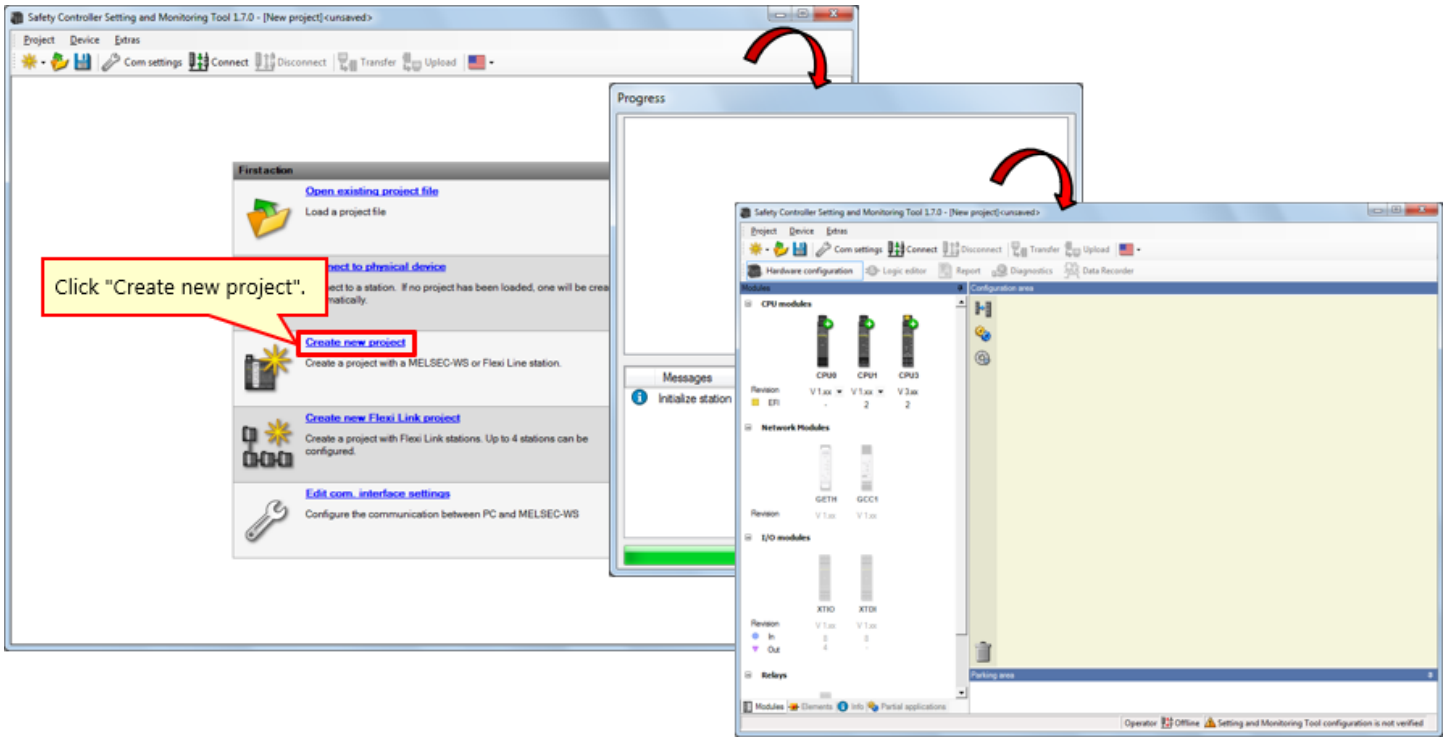
4.6 Project Simulation

4.7 Project Report Creation

4.8 Summary of This Chapter

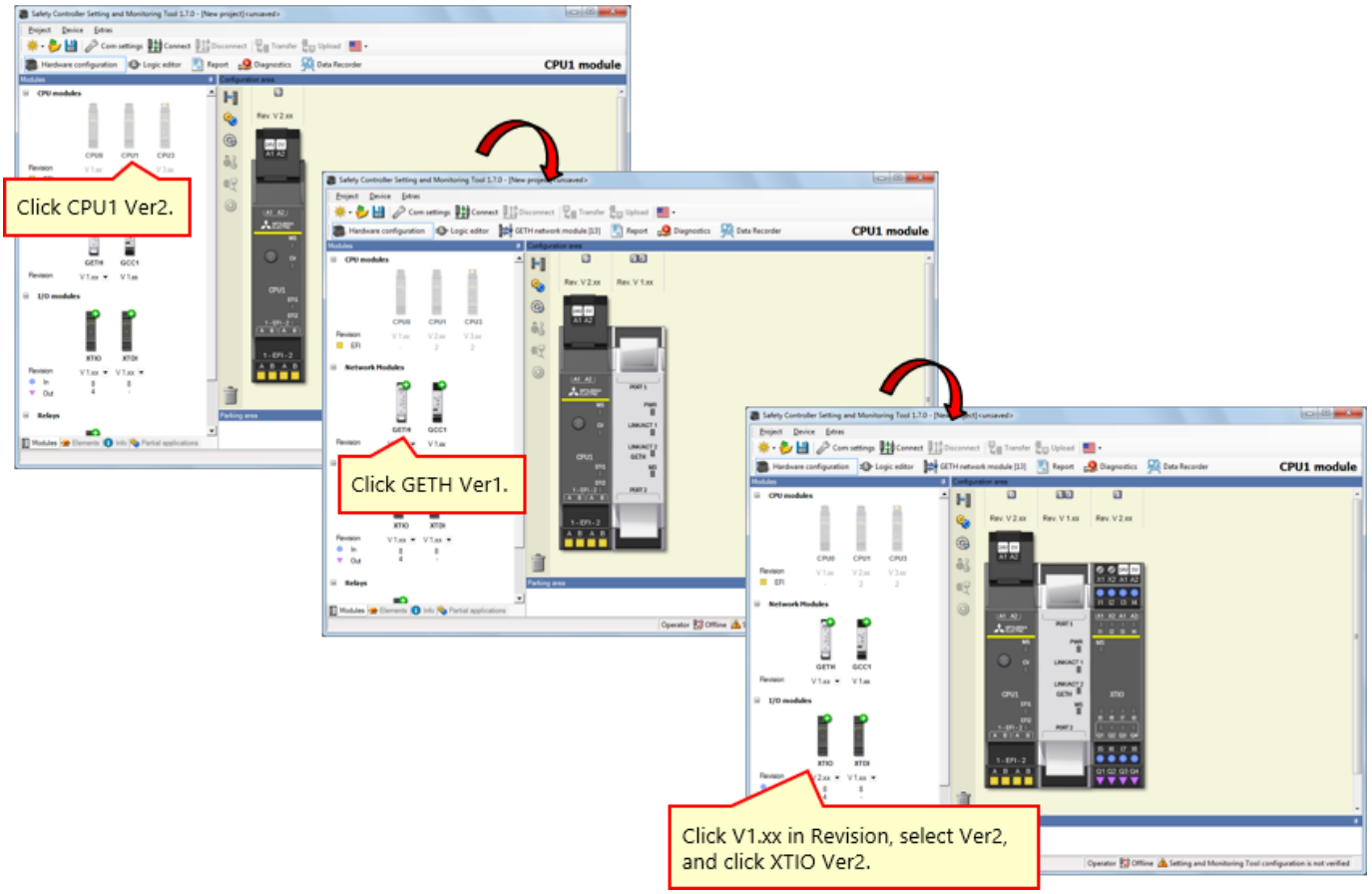
4.1 New Project Creation

Select "Create new project".



4.2 Hardware Setting

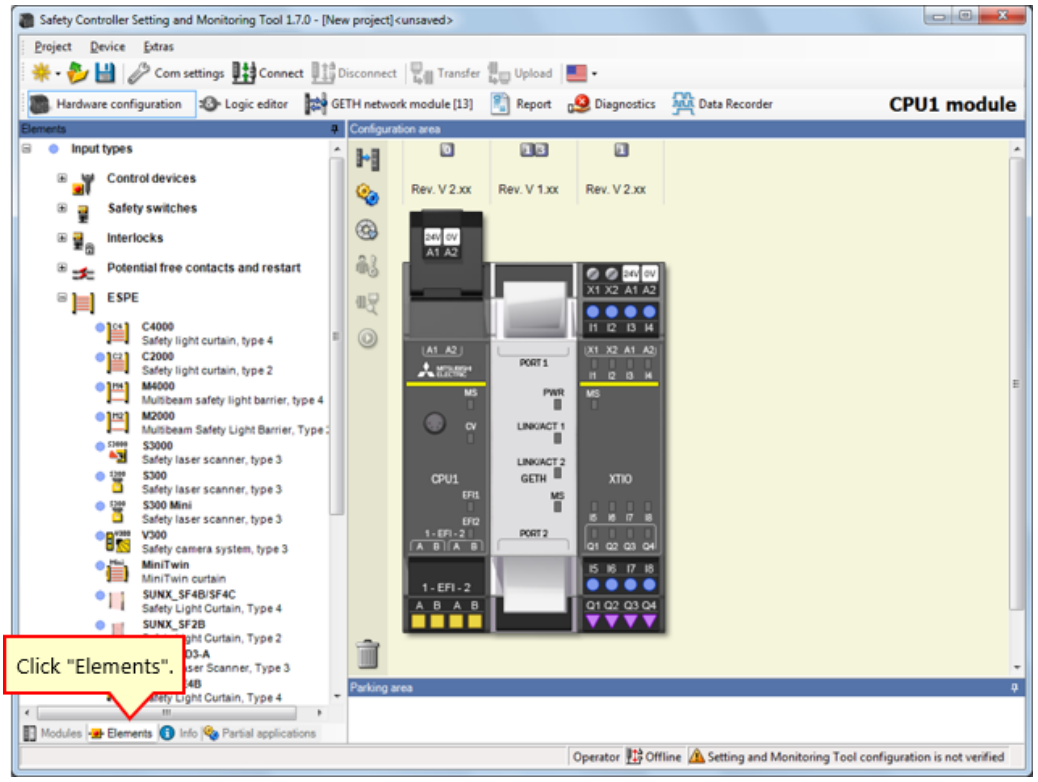
Select modules (CPU1, GETH, and XTIO) used in the hardware setting.
(Clicking the icon of a module pastes the module on the right edge.)



* In actual use, configure the settings according to the version of the device to be used.

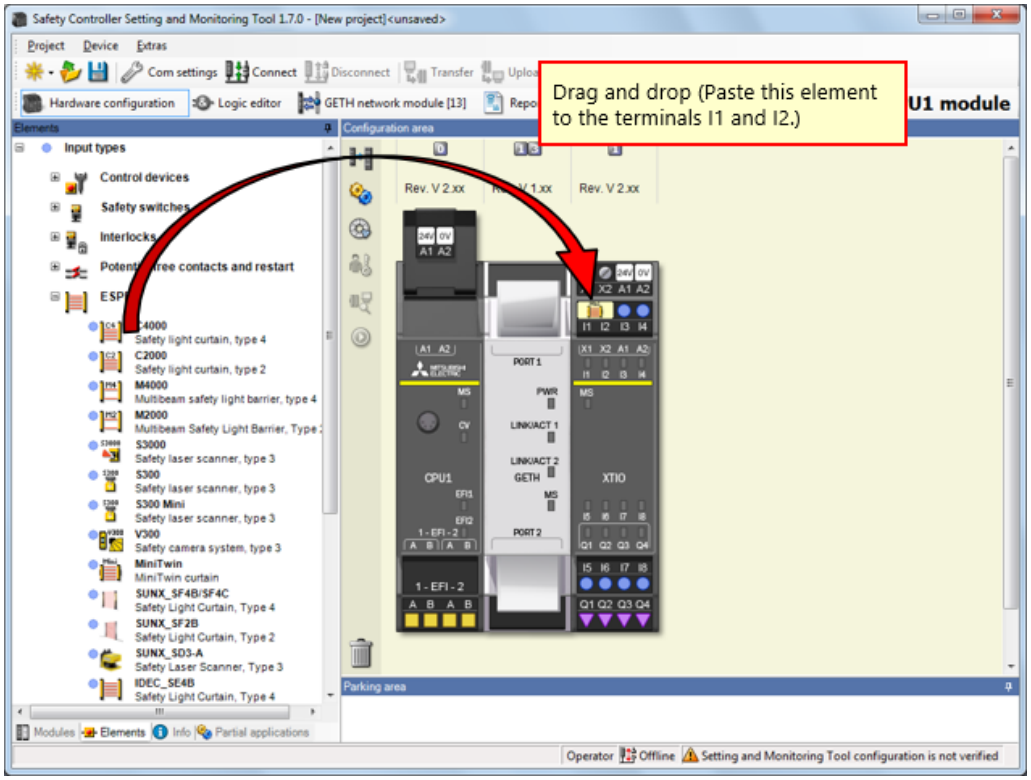
4.3 Pasting Elements and Setting Parameters

Set elements on the safety controller according to the device wiring.
→ Activate the "Elements" tag.



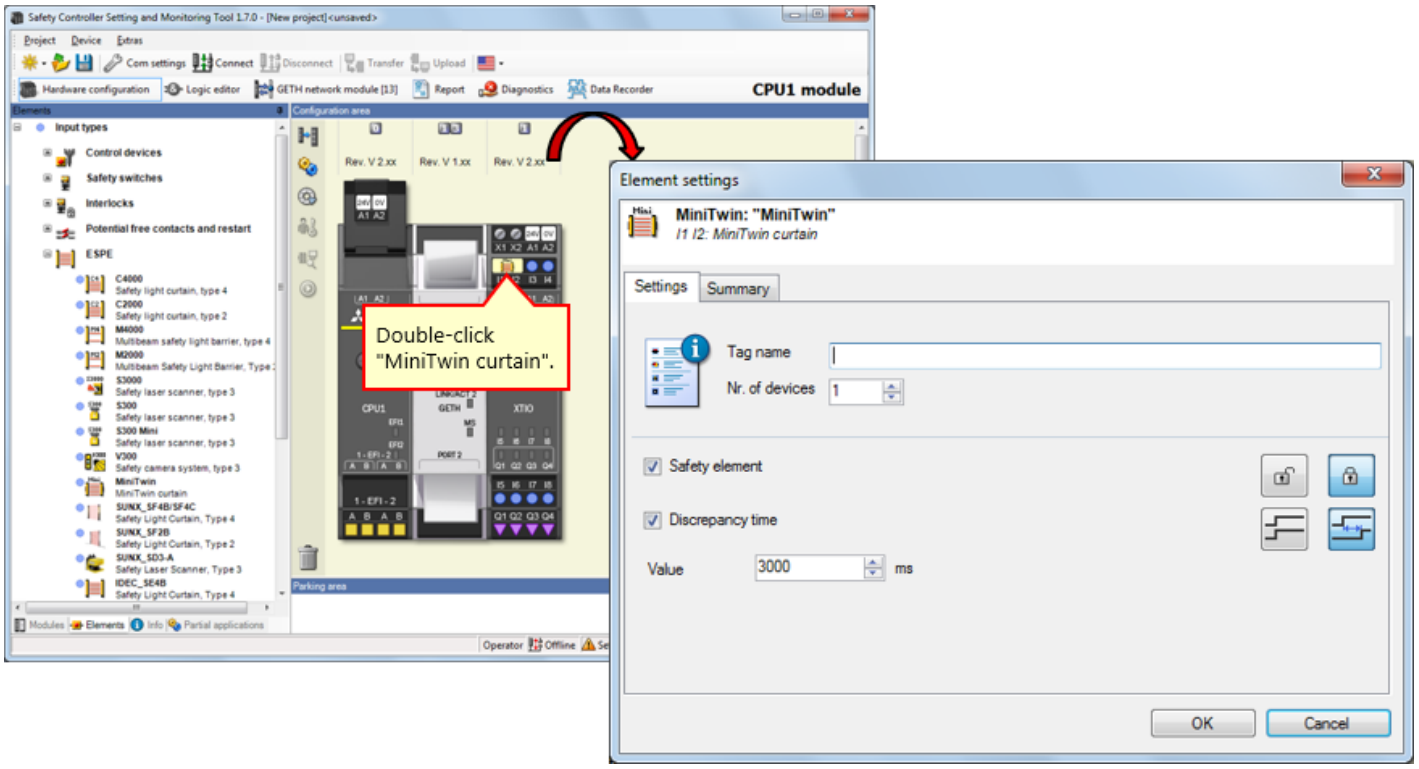
4.3.1 Pasting an Element of the Light Curtain

→ Select [Input types] - [ESPE], and paste [**MiniTwin, Safety light curtain**] to the **terminals I1 and I2**.



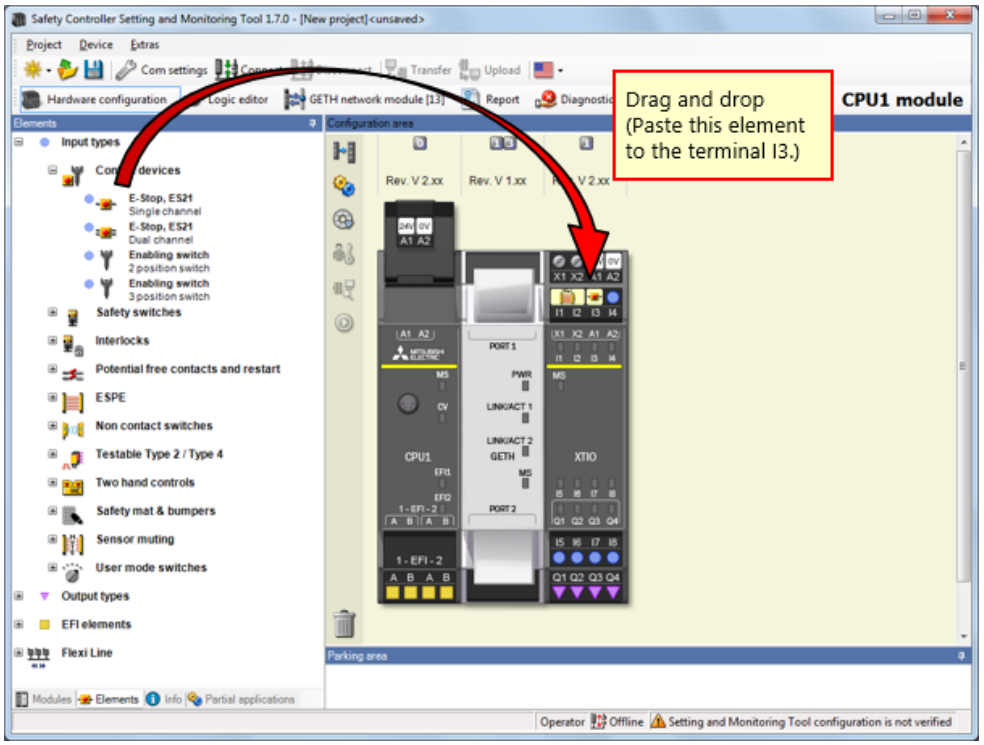
4.3.2 Setting the Parameter of the Light Curtain

Double-click the element of the light curtain to set the parameter.



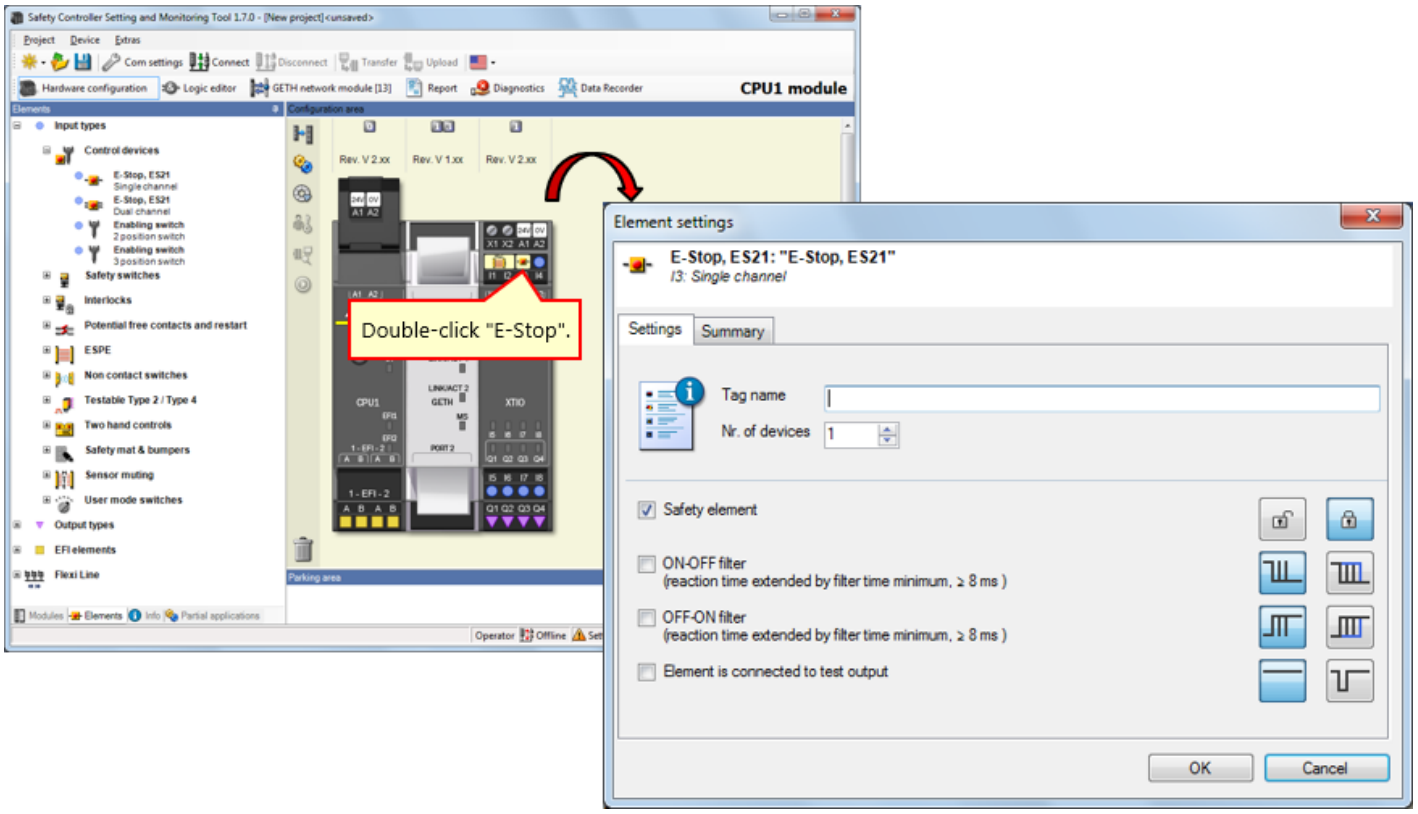
4.3.3 Pasting an Element of the Emergency Stop Push-Button Switch

Select [Input types] - [Control devices], and paste [**E-Stop, ES21, Single channel**] to the **terminal I3**.



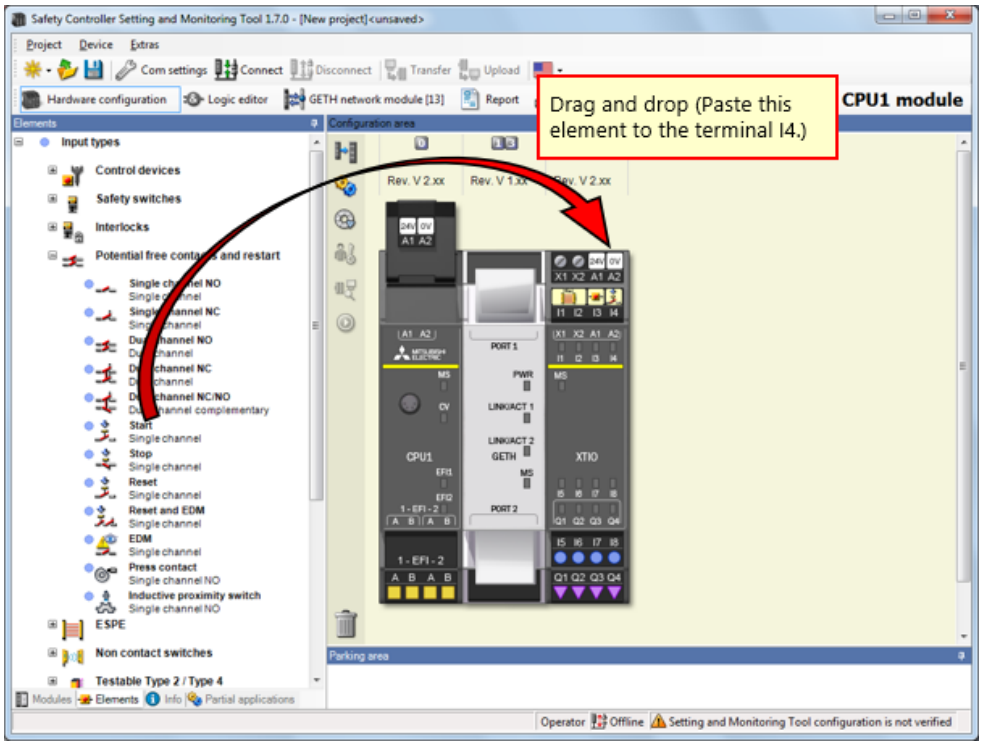
4.3.4 Setting the Parameter of the Emergency Stop Push-Button Switch

Double-click the element of the emergency stop push-button switch to set the parameter.



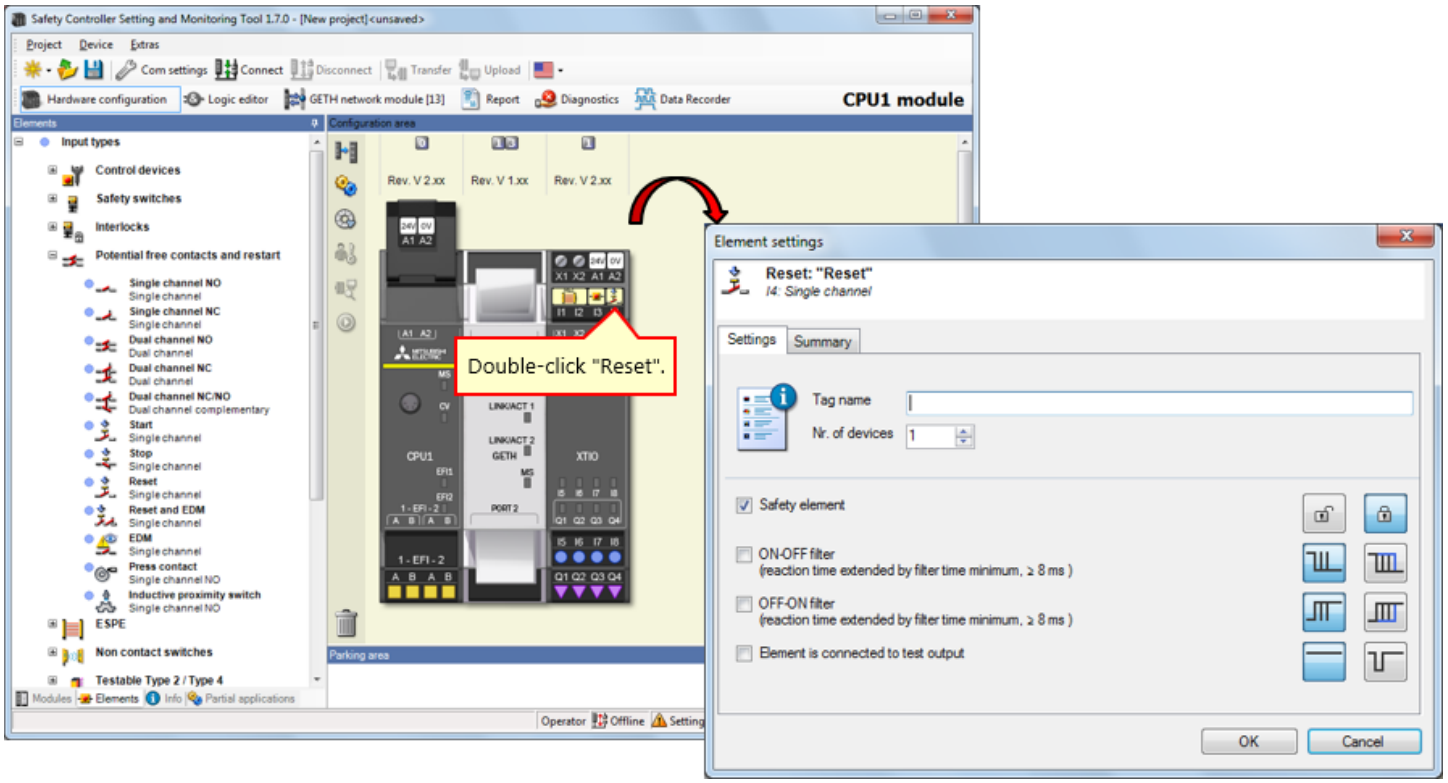
4.3.5 Pasting an Element of the Reset Switch

Select [Input types] - [Potential free contacts and restart], and paste [**Reset, Single channel**] to the **terminal I4**.



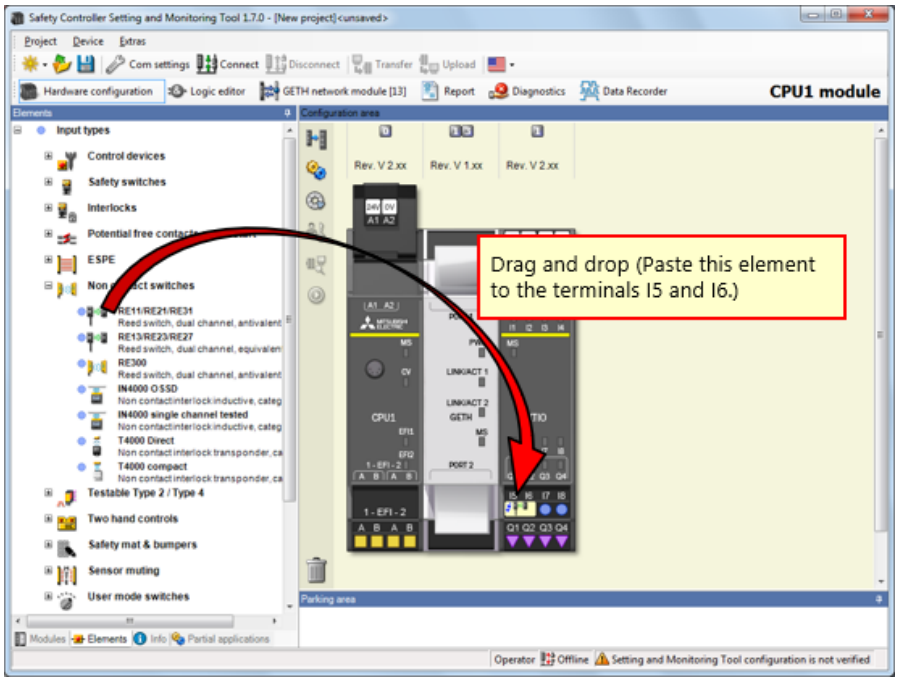
4.3.6 Setting the Parameter of the Reset Switch

Double-click the element of the reset switch to set the parameter.



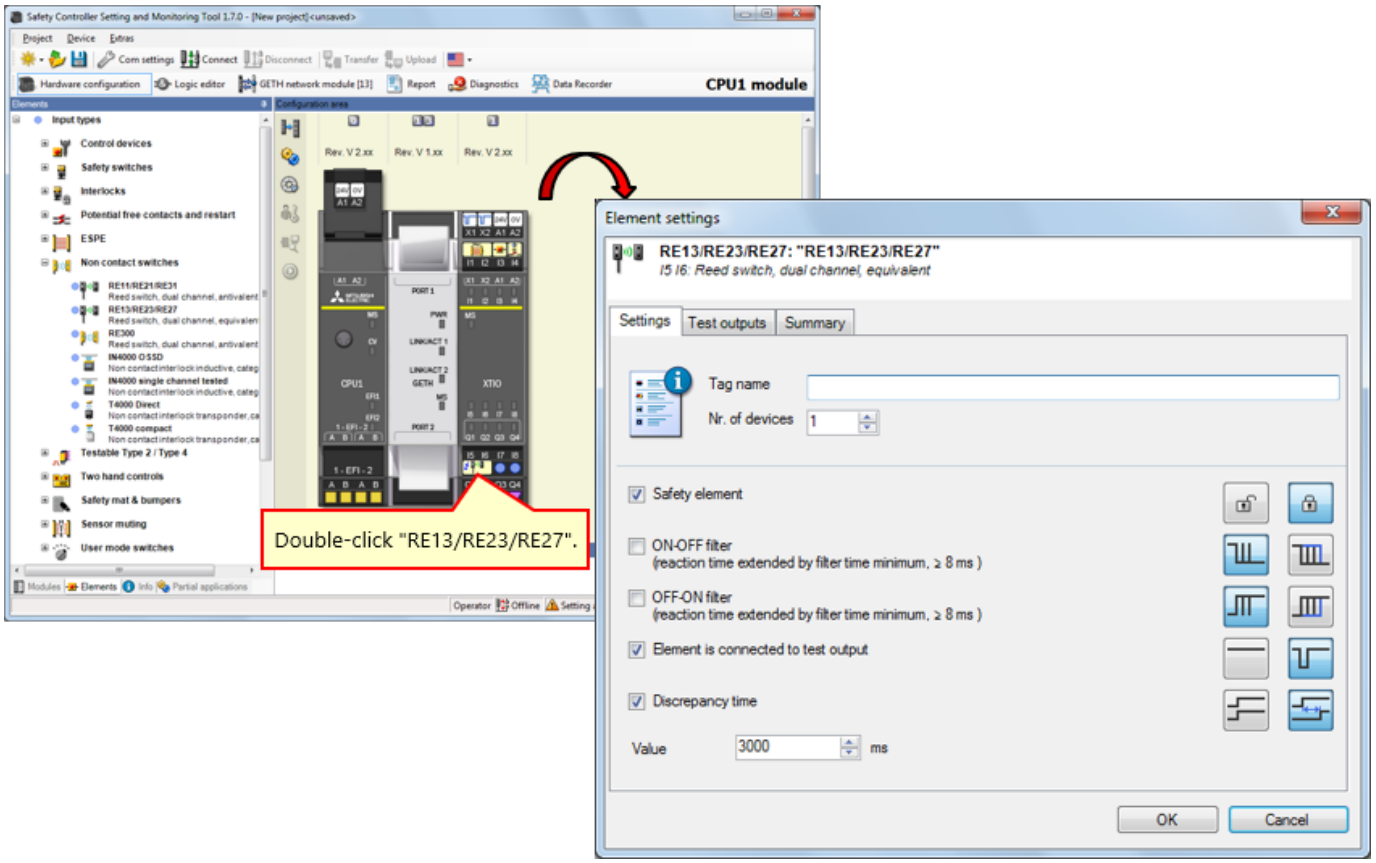
4.3.7 Pasting an Element of the Contactless Safety Door Switch

Select [Input types] - [Non contact switches], and paste [**RE13/RE23/RE27, Reed switch, dual channel, equivalent**] to the **terminals I5 and I6**.



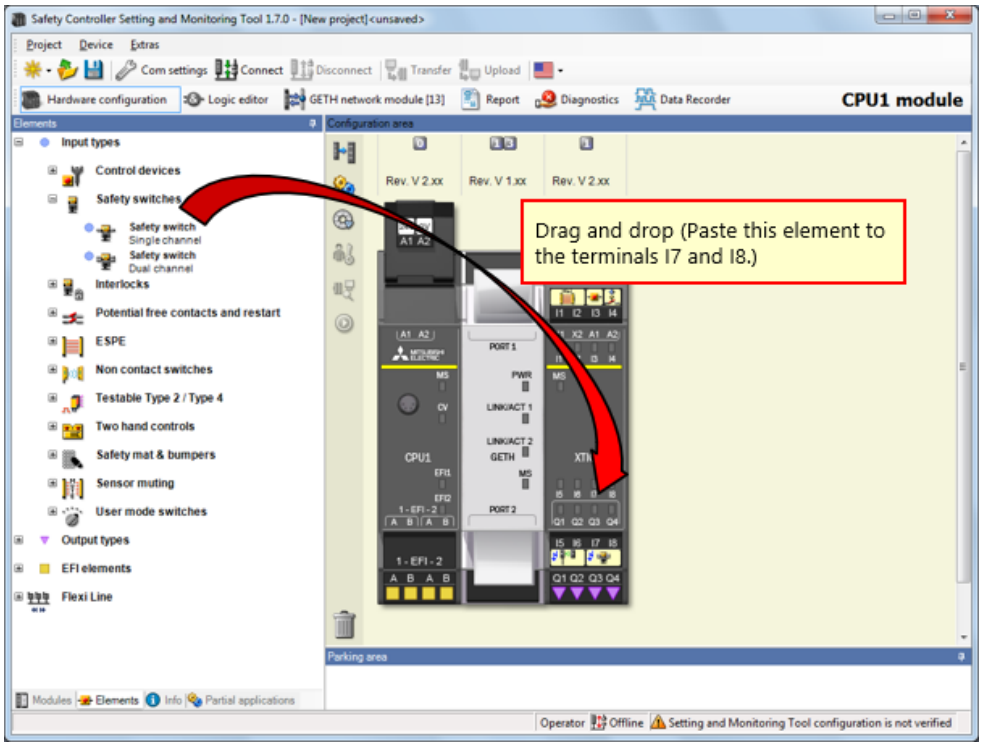
4.3.8 Setting the Parameter of the Contactless Safety Door Switch

Double-click the element of the contactless safety door switch to set the parameter.



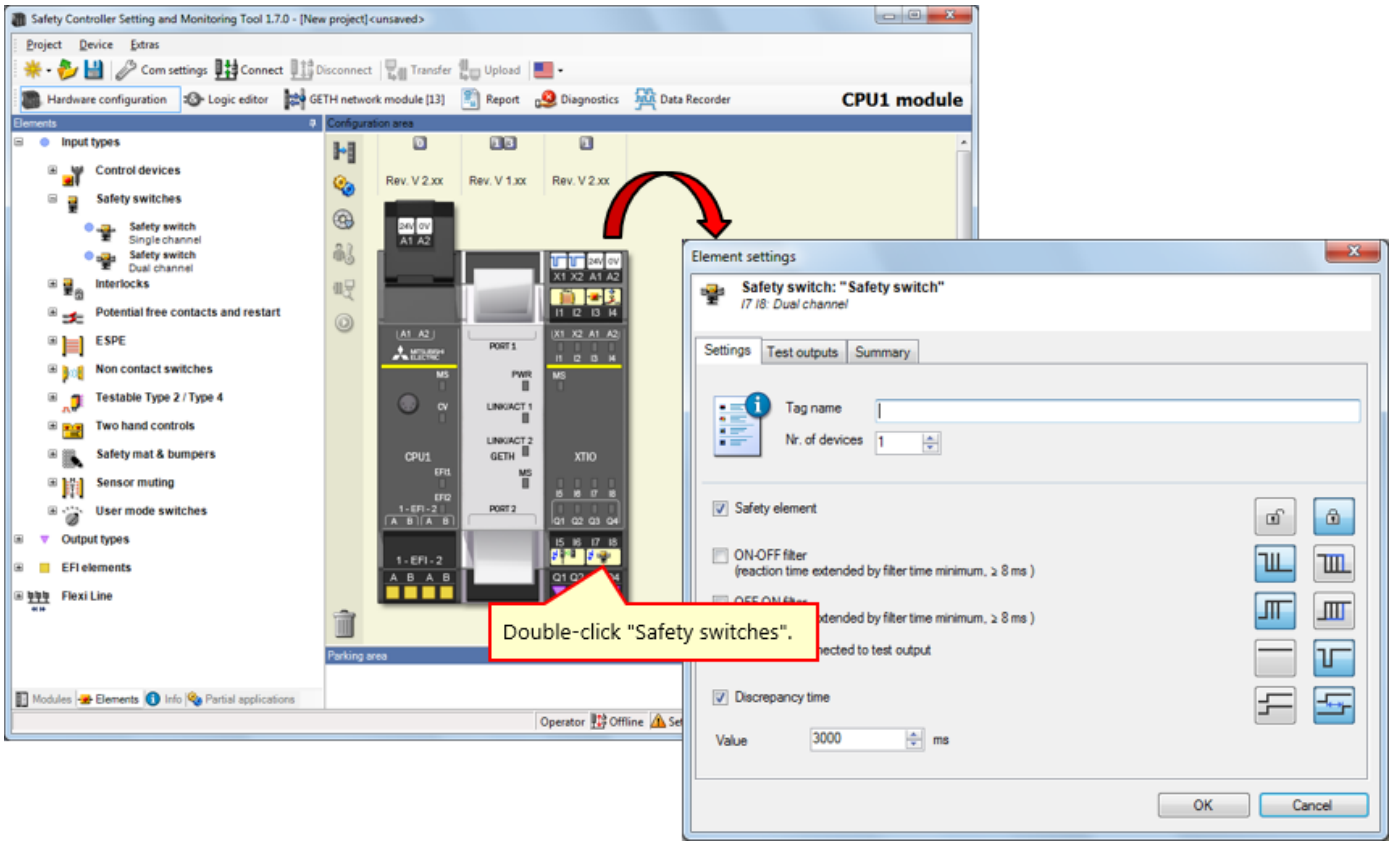
4.3.9 Pasting an Element of the Safety Door Switch

Set an element to the safety controller, like the real device.
→ Select [Input types] - [Safety switches], and paste [**Safety switches, Dual channel**] to the **terminals I7 and I8**.



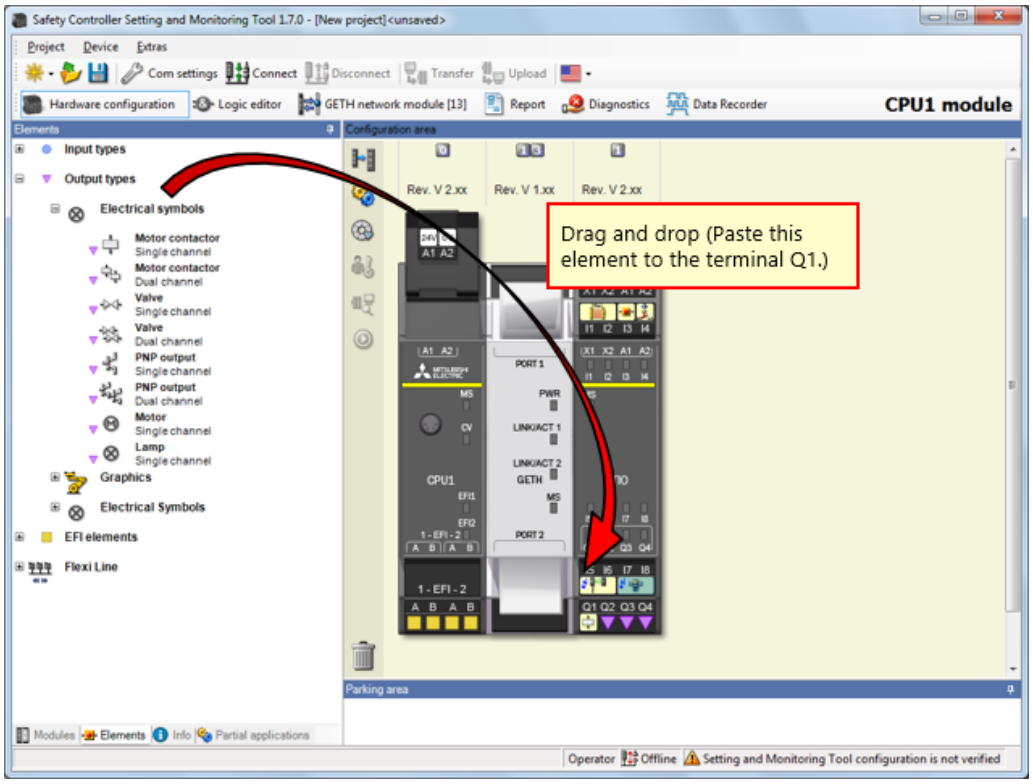
4.3.10 Setting the Parameter of the Safety Door Switch

Double-click the element of the safety door switch to set the parameter.



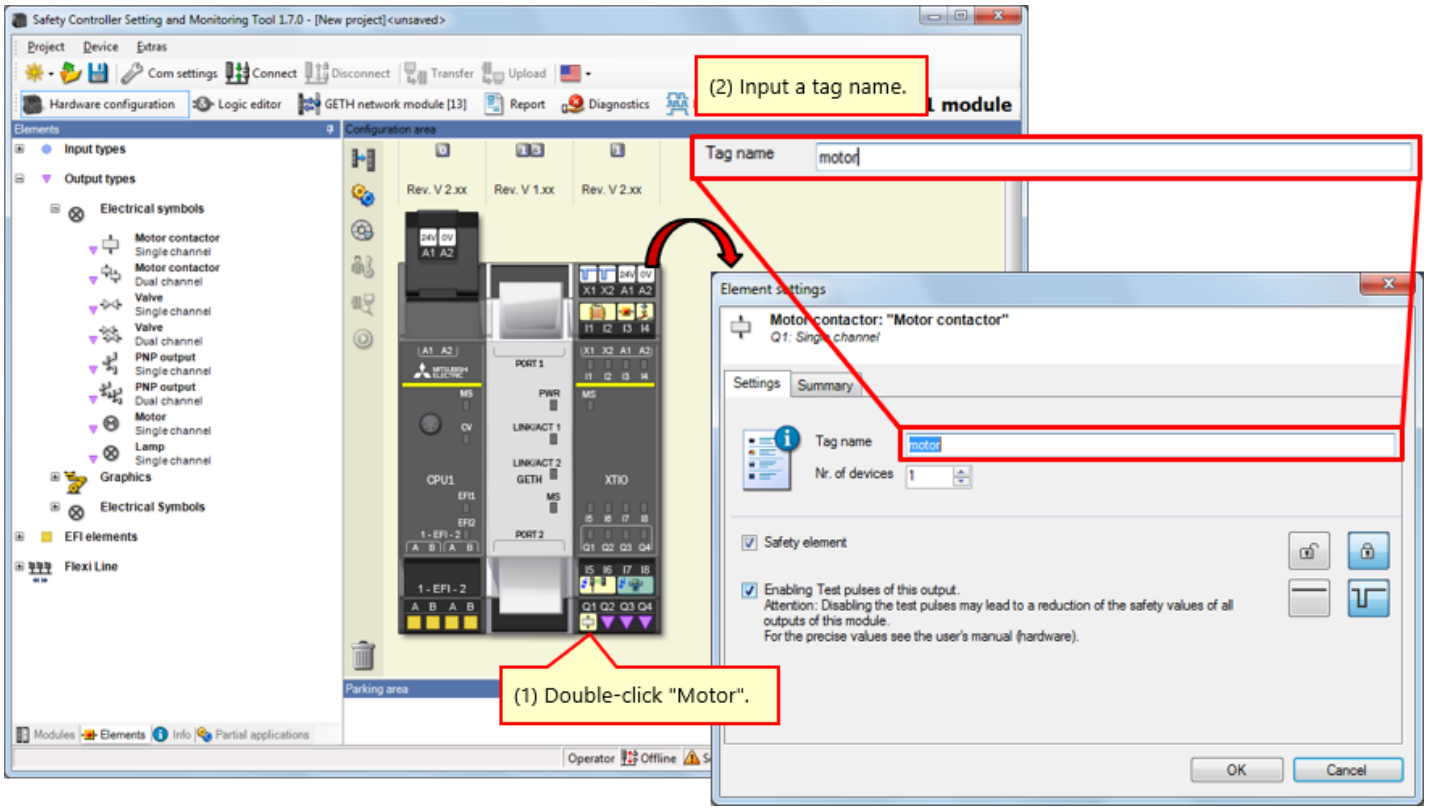
4.3.11 Pasting an Element of the Motor

Set an element to the safety controller, like the real device.
→ Select [Output types] - [Electrical symbols], and paste [**Motor contactor, Single channel**] to the **terminal Q1**.



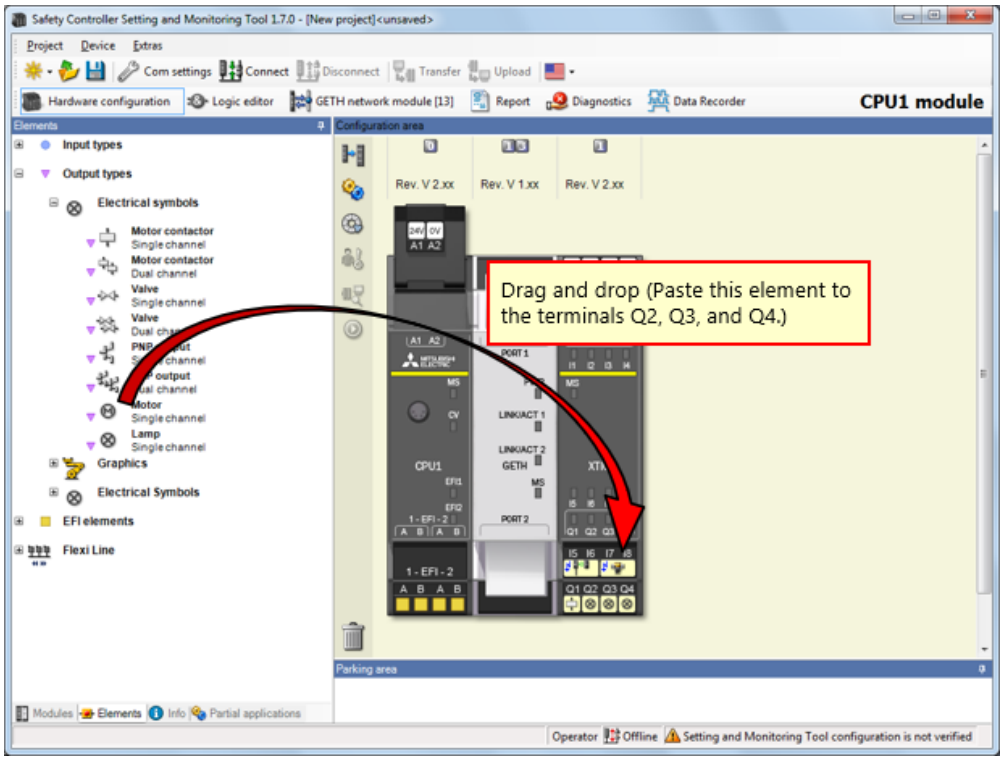
4.3.12 Setting the Parameter of the Motor

Double-click the element of the motor to set the parameter.



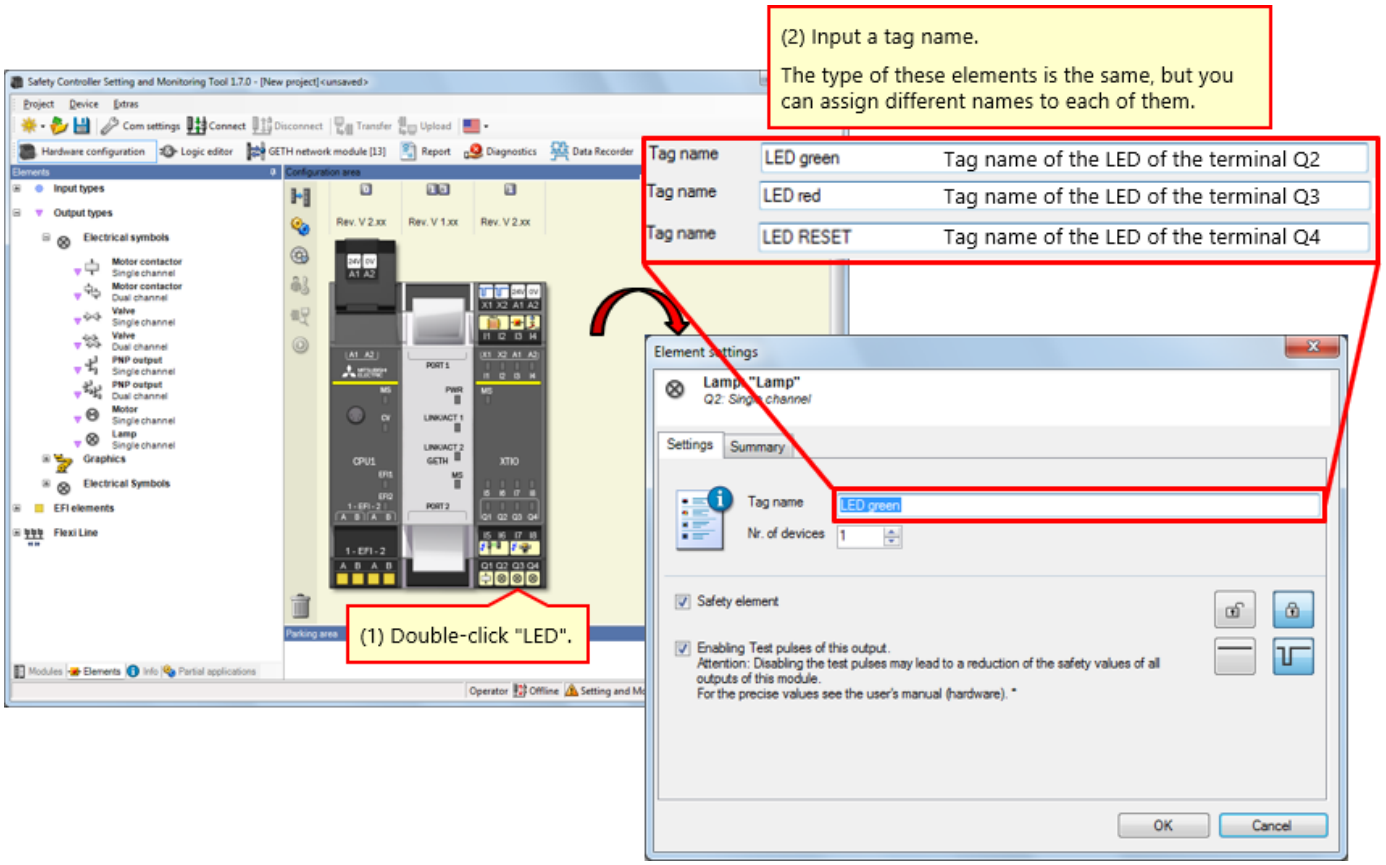
4.3.13 Pasting an Element of the Lamp

Set an element to the safety controller, like the real device.
→ Select [Output types] - [Electrical symbols], and paste [**Lamp, Single channel**] to the **terminals Q2, Q3, and Q4**.



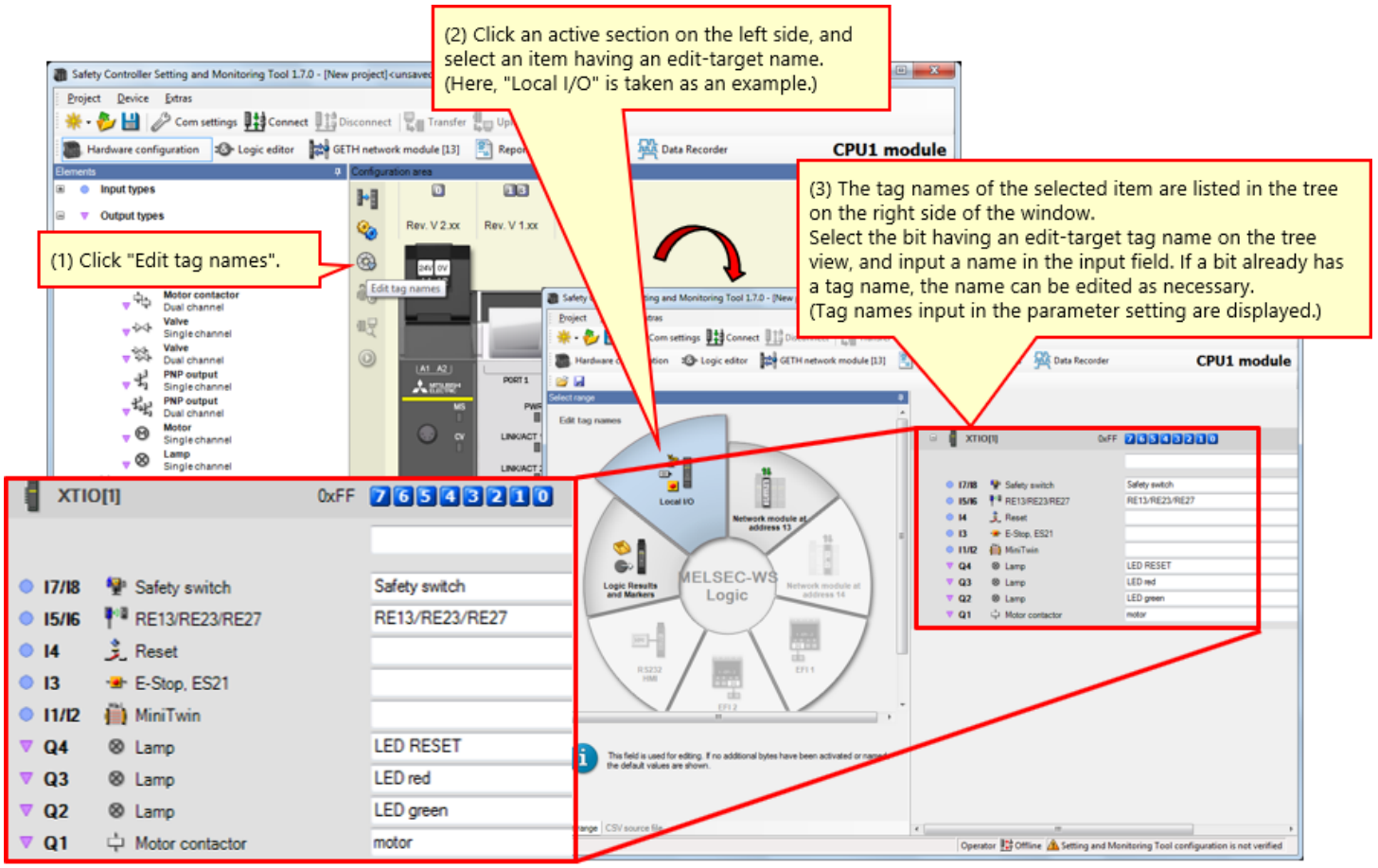
4.3.14 Setting the Parameter of the Lamp

Double-click the element of the lamp to set the parameter.



4.4 Tag Name Edit

Edit tag names as necessary.

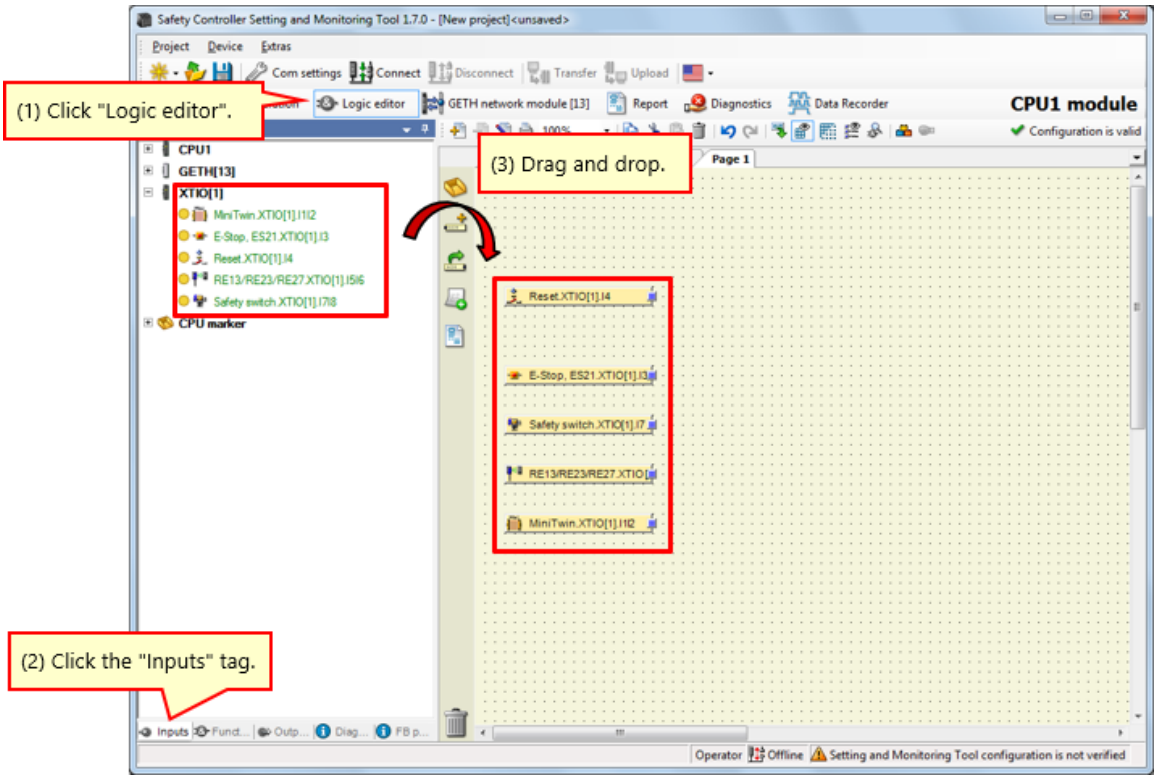


4.5 Logic Creation

Program on the Logic editor.

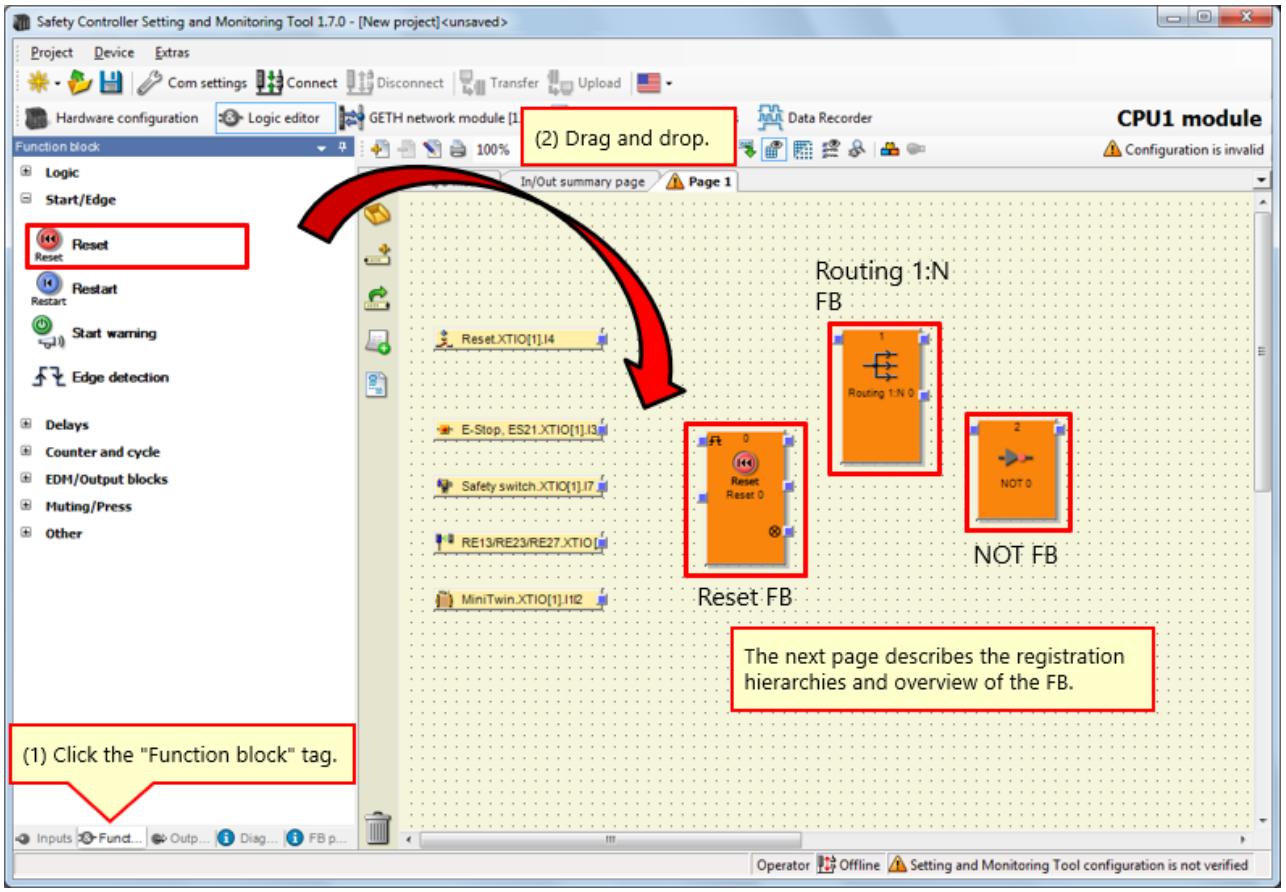
4.5.1 Programming (Pasting Inputs)

(1) Switch the view to the Logic editor view. → (2) Click the "Inputs" tag. → (3) Register the inputs.

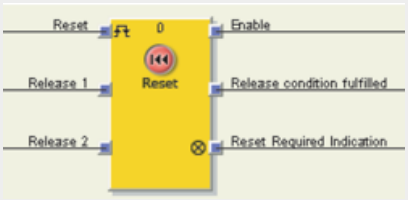
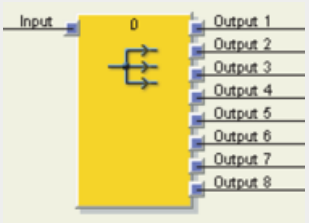
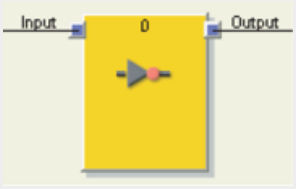


4.5.2 Programming (Pasting Function Blocks)

(1) Activate the "Function block" tag. → (2) Paste function blocks.

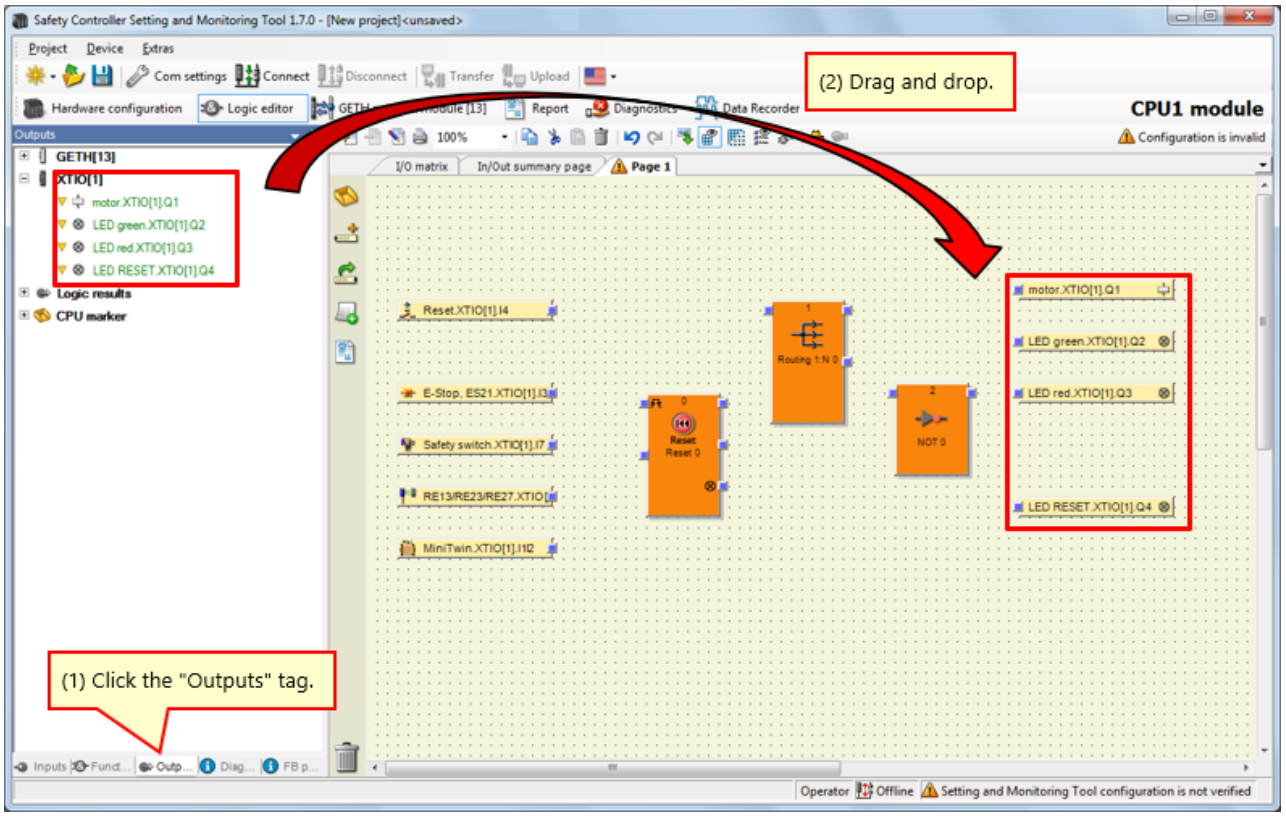


4.5.3 Description of FBs Used

FB used	Overview	Registration hierarchy
Reset FB 	FB for reset	[Start/Edge] - [Reset]
Routing 1:N FB 	The Routing 1: N function block passes an input signal from a preceding function block to up to eight output signals.	[Logic] - [Routing 1:N]
NOT FB 	The inverted input value applies at the output.	[Logic] - [NOT]

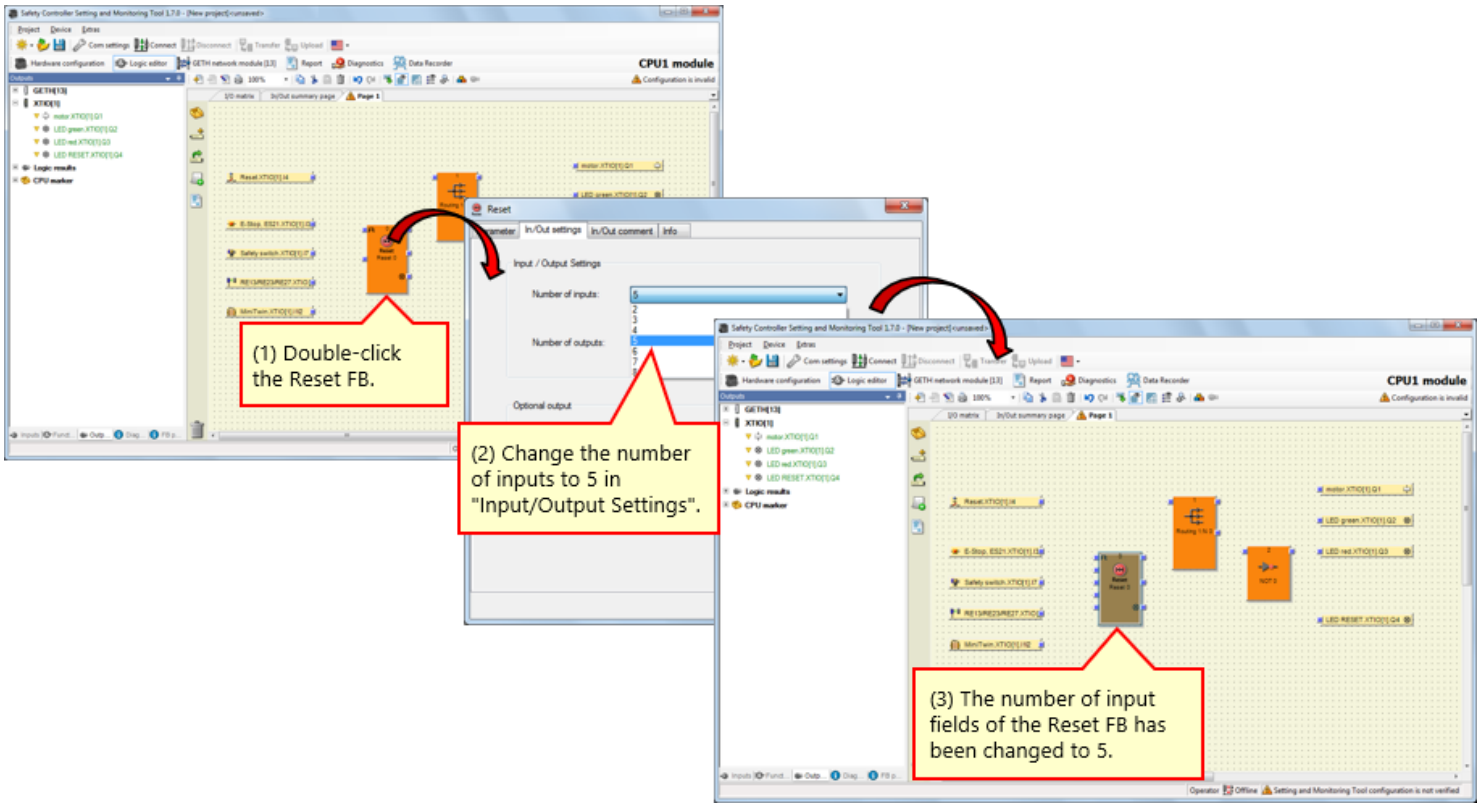
4.5.4 Programming (Pasting Outputs)

(1) Activate the "Outputs" tag. → (2) Register the outputs.



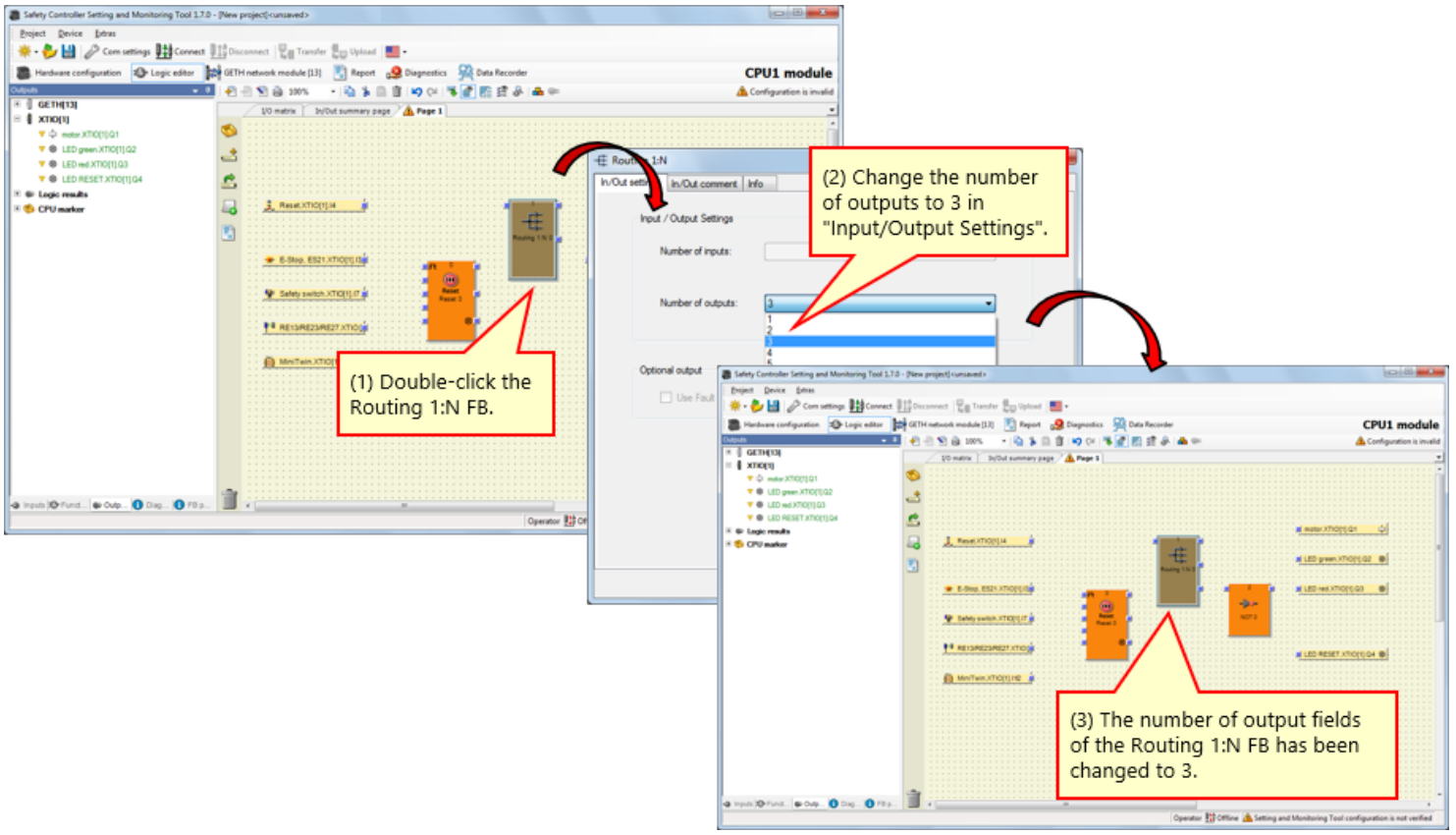
4.5.5 Programming (Changing the Number of Input Fields of Function Blocks)

→ Increase the number of input fields of the Reset function block.



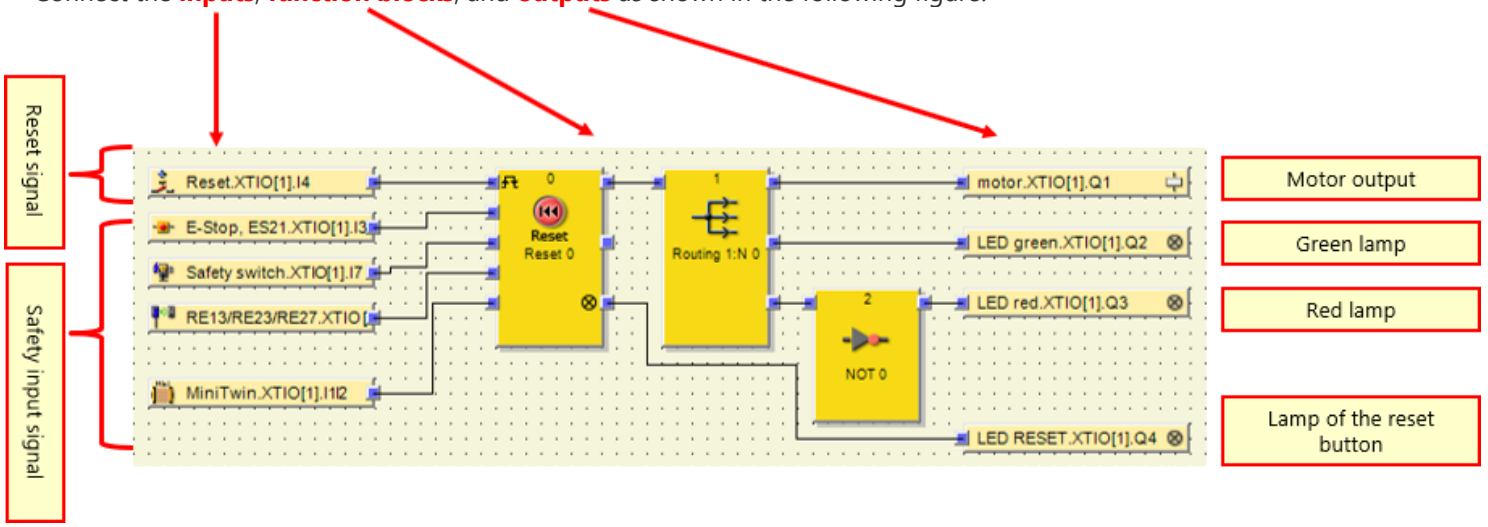
4.5.6 Programming (Changing the Number of Output Fields of Function Blocks)

→ Increase the number of output fields of the Routing function block.



4.5.7 Programming (Connecting Inputs, FBs, and Outputs)

→ Connect the **inputs**, **function blocks**, and **outputs** as shown in the following figure.



4.6 Project Simulation

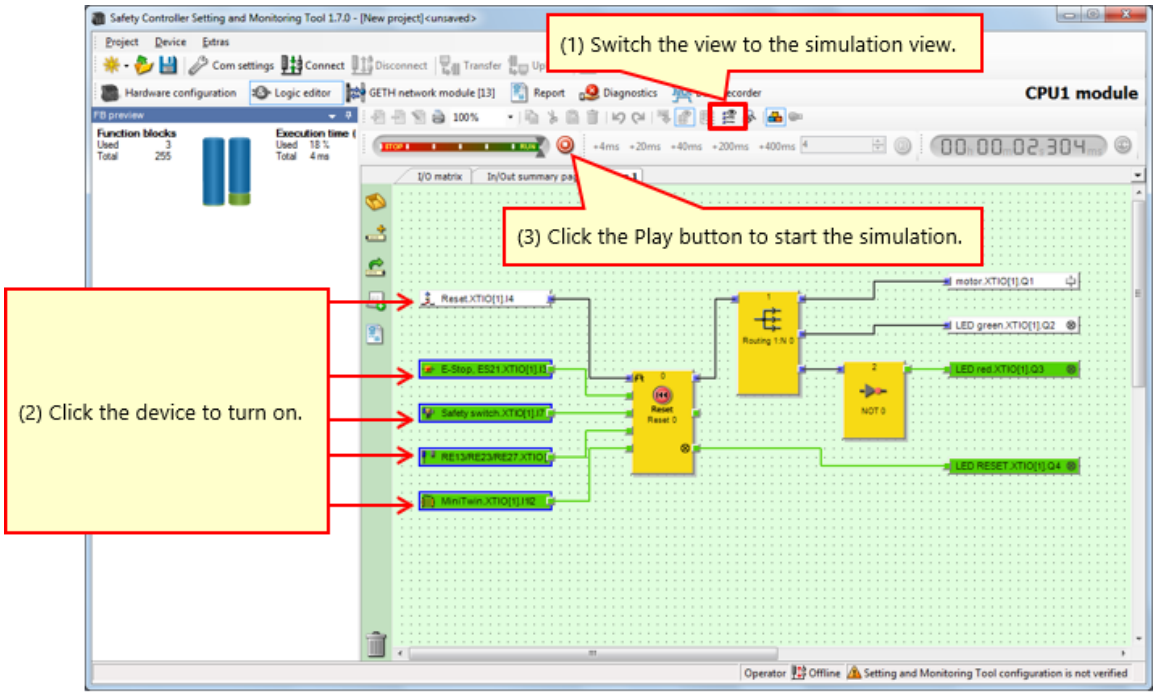


Figure. Simulation view

4.7 Project Report Creation

■ Report creation procedure

(1) Click the Report button to open the Report view.

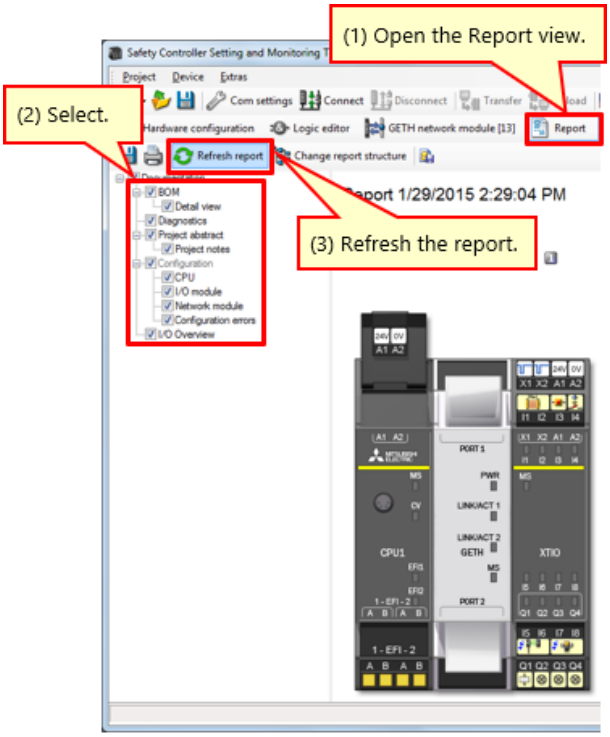
(2) Activate or deactivate the check boxes for the components that shall be included in the report in the selection list on the left-hand side.

(3) After you have completed your selection, click Refresh report. The report is now assembled and displayed in the right-hand window section.

■ How to save or print a report

The report can be printed or saved as PDF.

- To save the report as PDF, click the Save button.
- To print the report, click the Print button.
  A PDF preview of the report will be created that you can subsequently print.



Report view (part)

4.8 Summary

In this chapter, you have learned:

- New Project Creation
- Hardware Setting
- Pasting Elements and Setting Parameters
- Tag Name Edit
- Logic Creation
- Project Simulation
- Project Report Creation

Chapter 5 Project Download

This chapter provides how to download projects to a safety controller and verify the projects.

5.1 Connection with Safety Controller

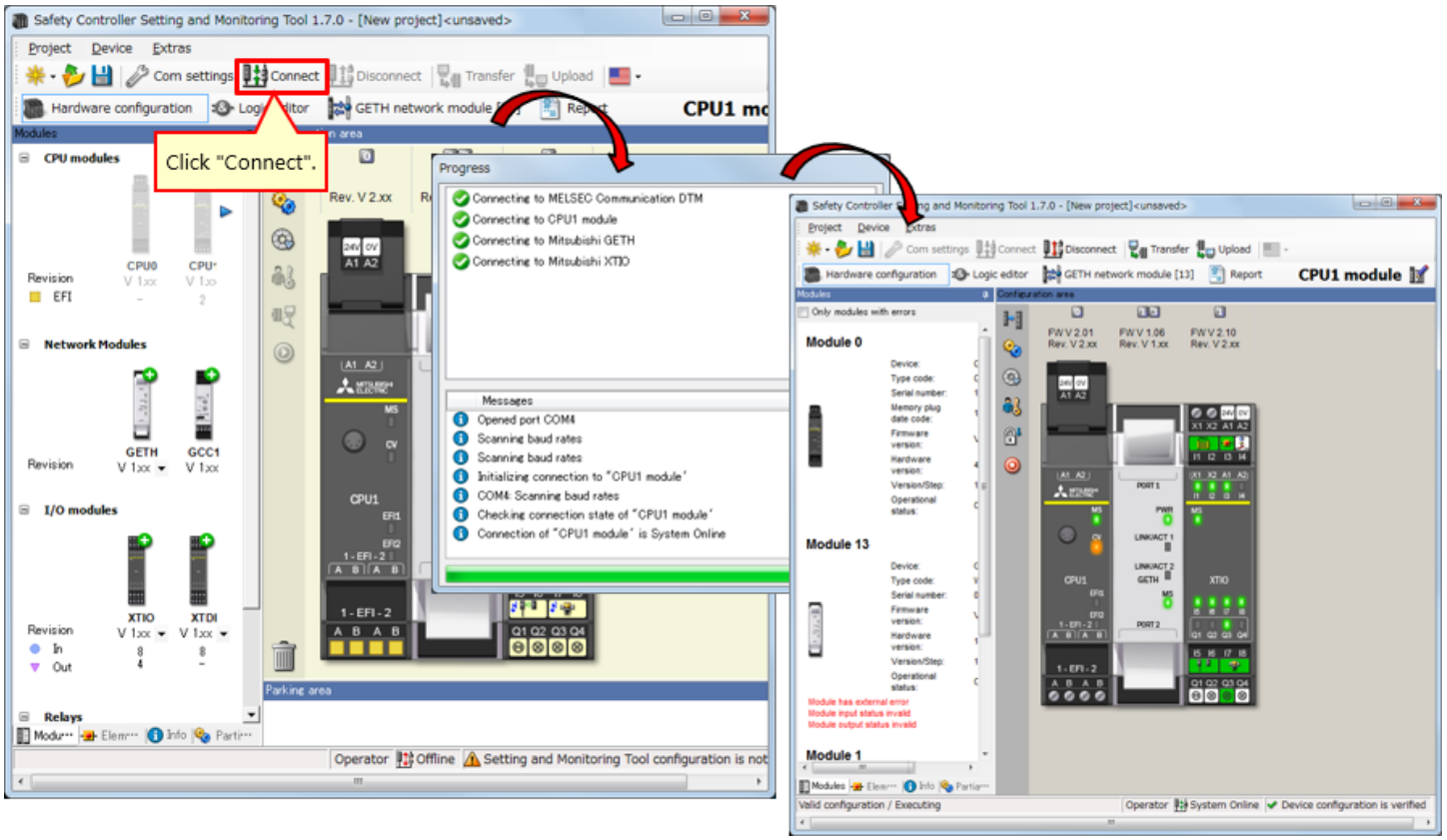
5.2 Project Download

5.3 Project Verification

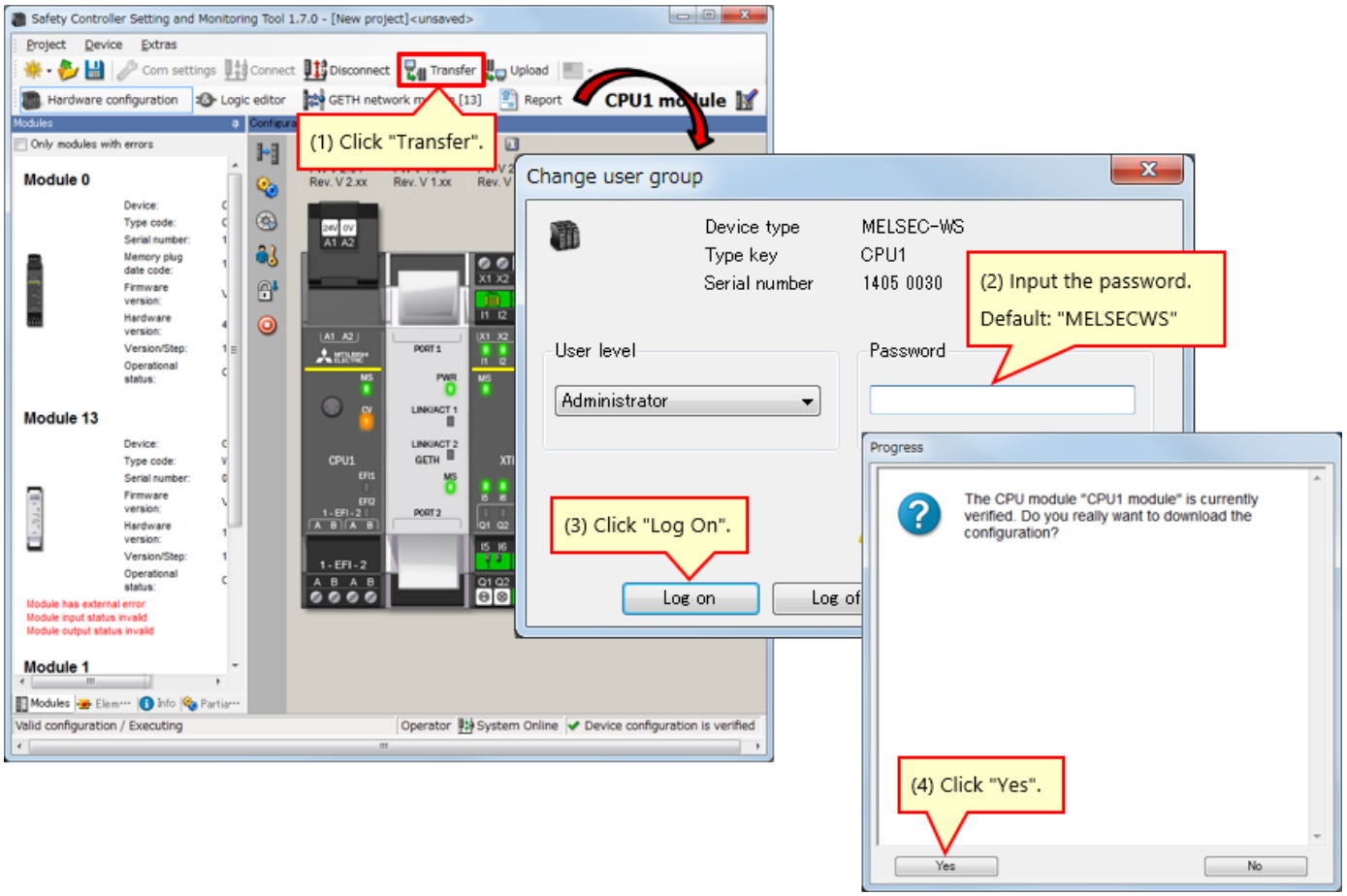
5.4 Project Comparison between Safety Controller and Tool

5.5 Summary of This Chapter

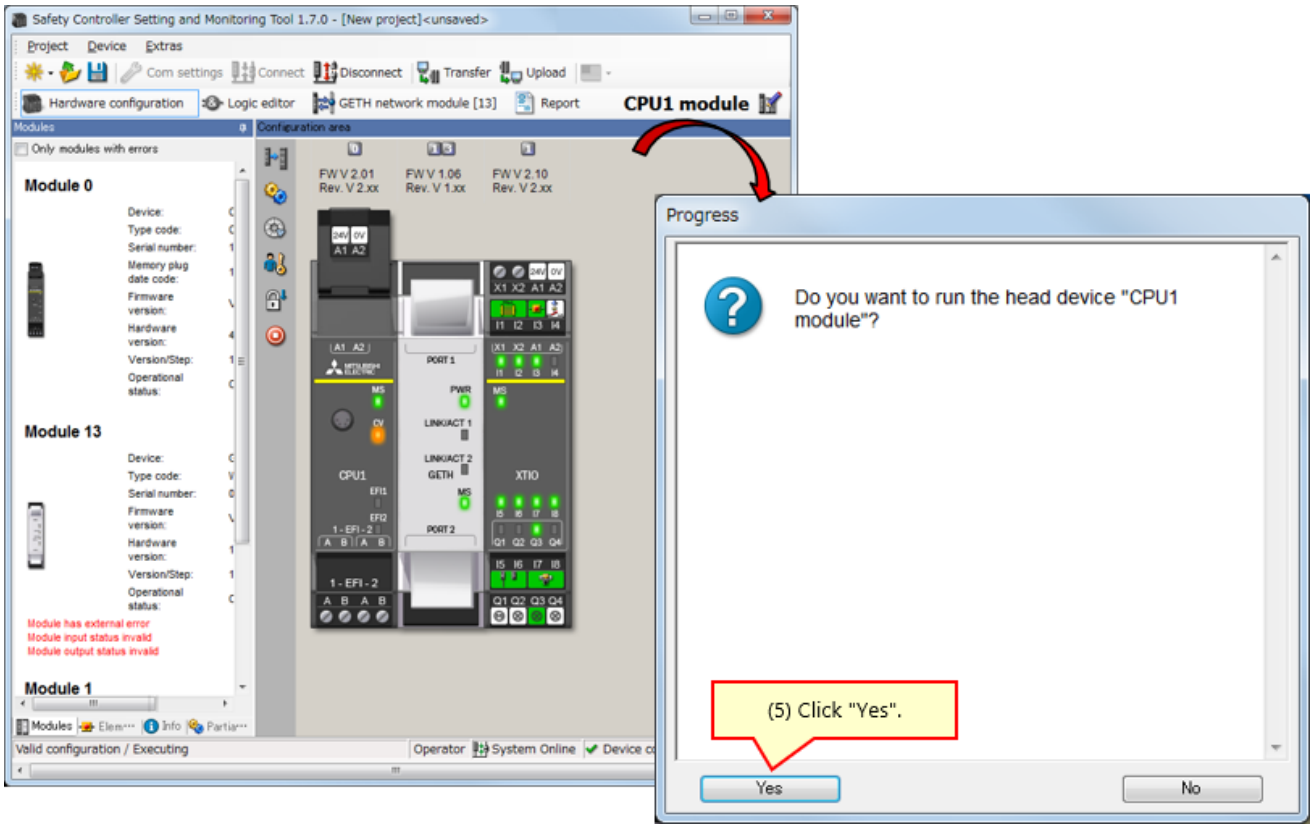
5.1 Connection with Safety Controller



5.2 Project Download

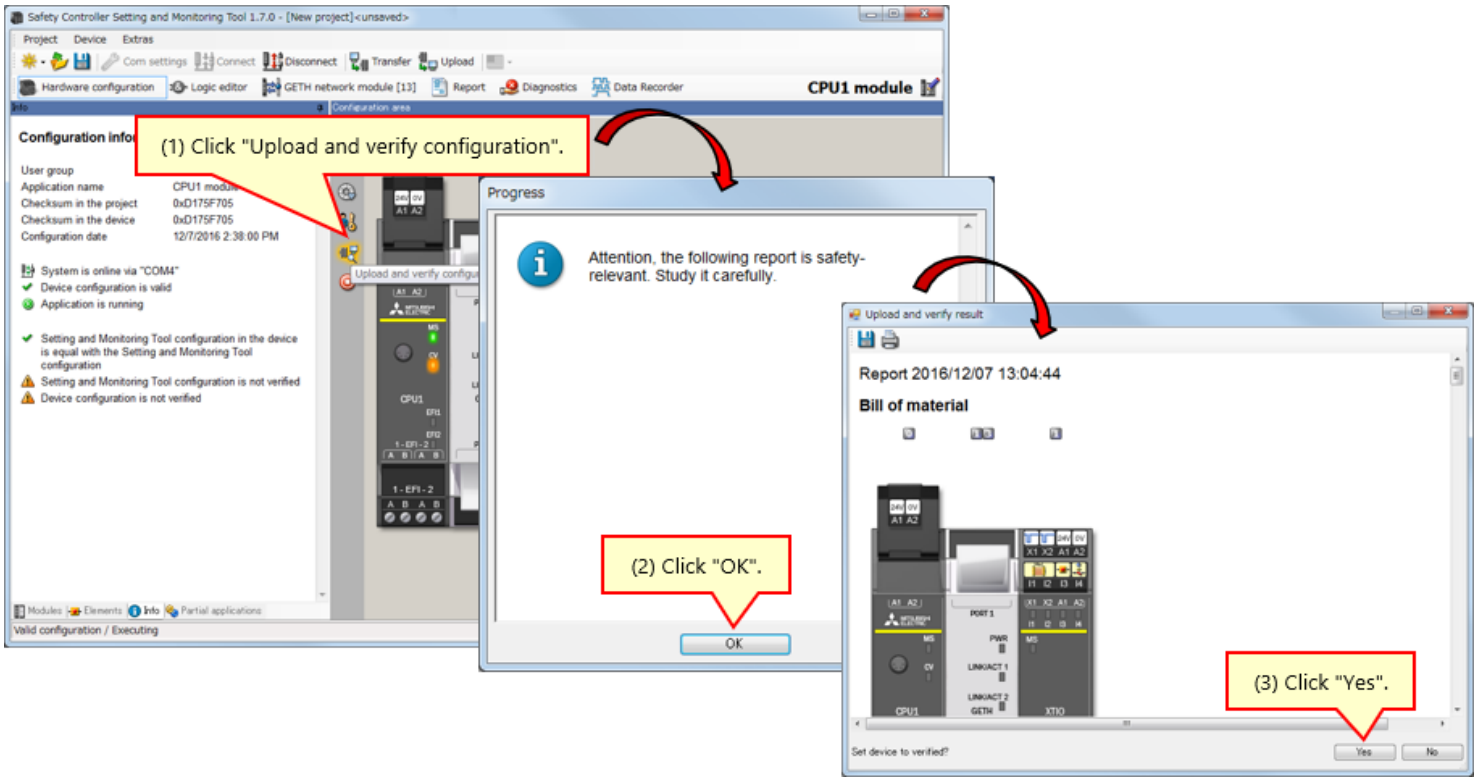


5.2 Project Download



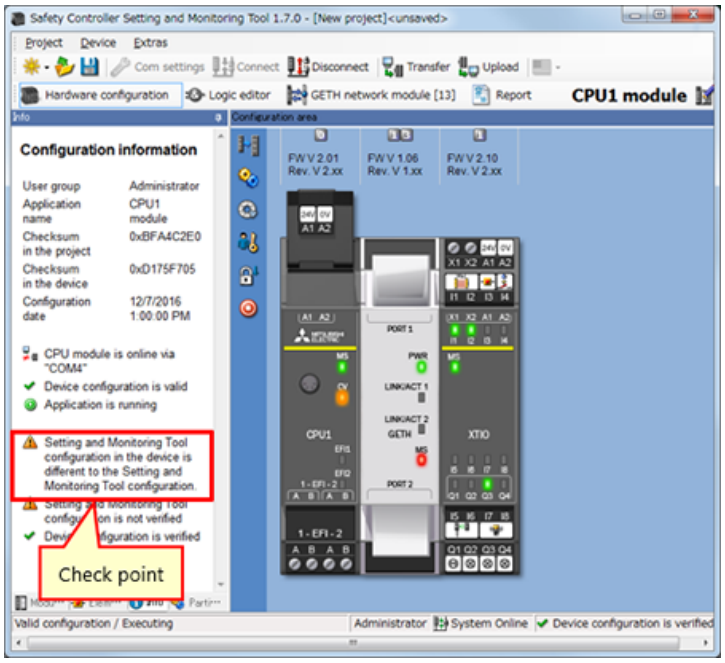
5.3 Project Verification

* If verification processing has not been completed, the CPU module remains in the STOP state at the next power-on.
  To run the CPU module at the next power-on, verification processing is required.

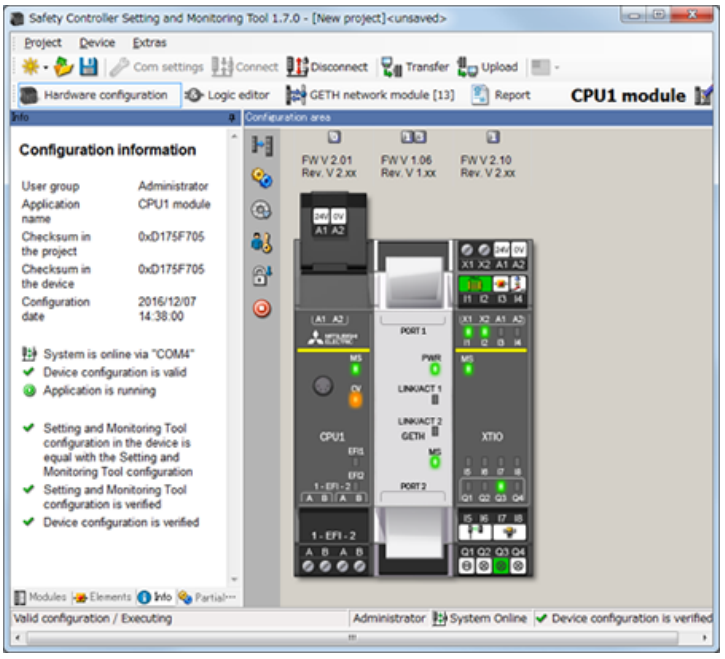


5.4 Project Comparison between Safety Controller and Tool

■ Mismatch



■ Match or verified



- If a verified project is downloaded, the verification-completed status is kept.
  Verifying the project again is not required.
- If a project that is not verified yet is downloaded, the verification is required.

5.5 Summary

In this chapter, you have learned:

- Connection with Safety Controller
- Project Download
- Project Verification
- Project Comparison between Safety Controller and Tool

Chapter 6 Safety Controller Connection/Disconnection

This chapter provides how to connect and disconnect a safety controller.

6.1 Connection with Safety Controller

6.2 Disconnection

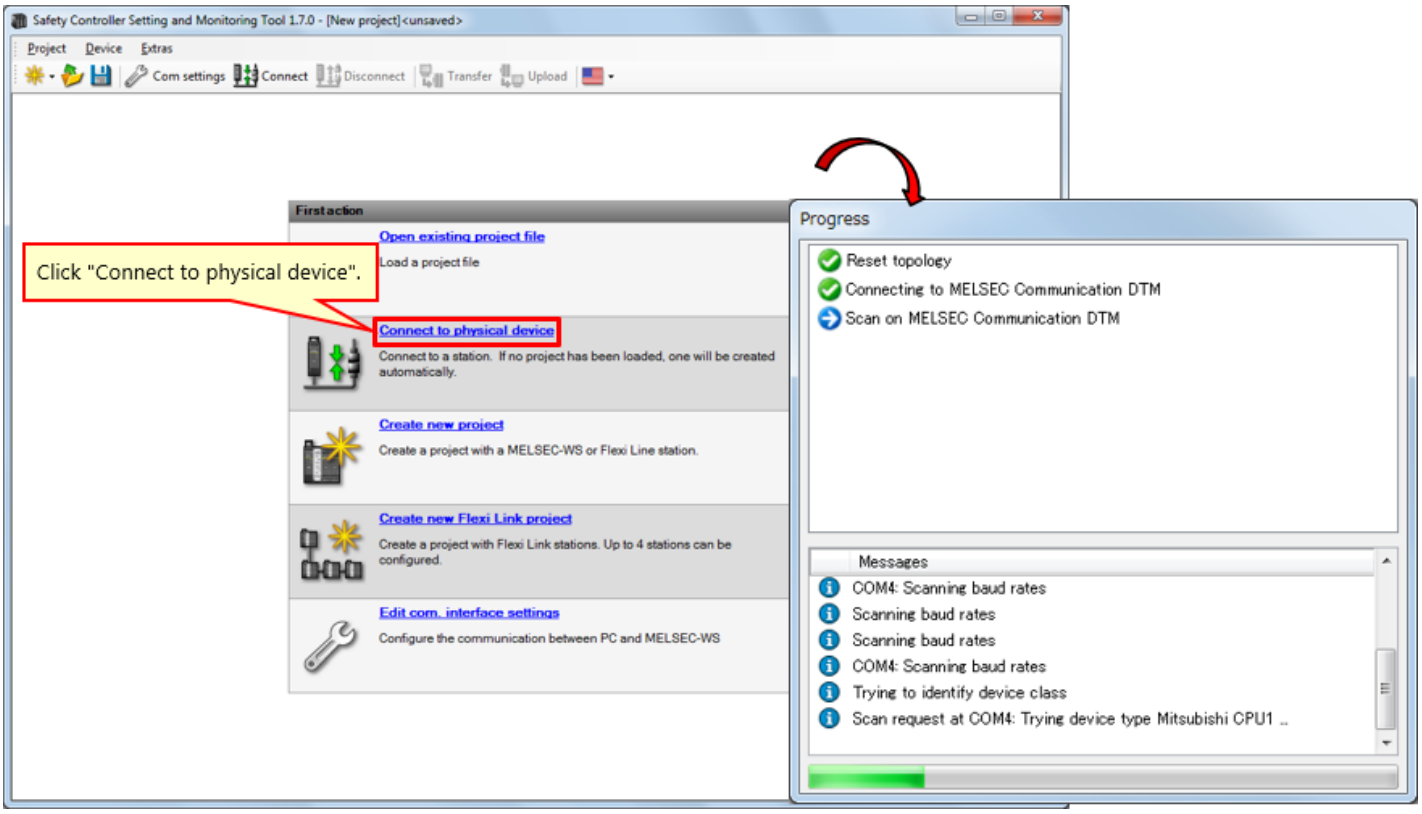
6.3 Reconnection

6.4 Summary of This Chapter

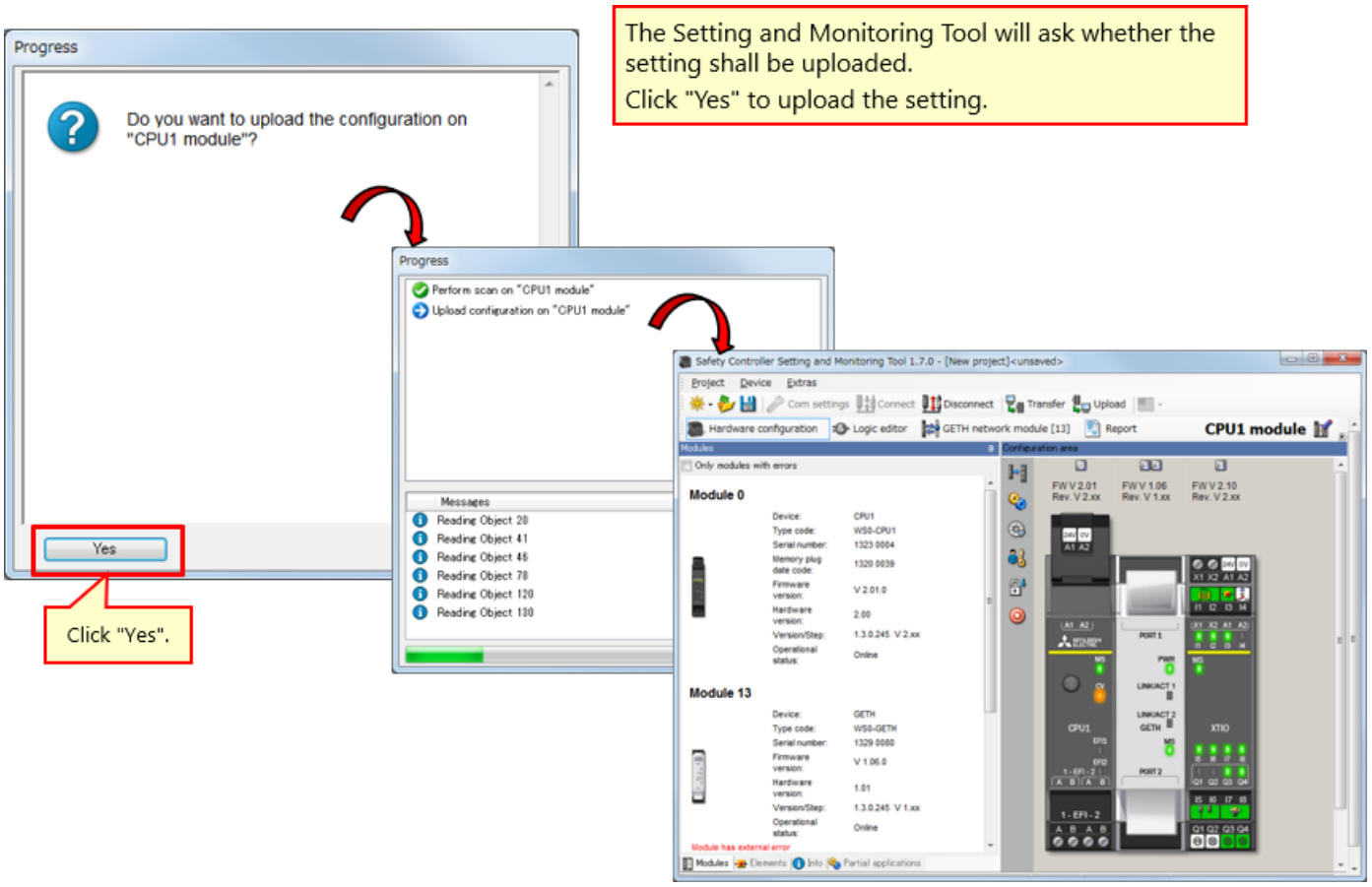
6.1 Connection with Safety Controller

Connect a safety controller and personal computer by RS-232, and power on the safety controller.
Then, start the Setting and Monitoring Tool, and select the following "Connect to physical device".

(1) Select Connect to physical device.



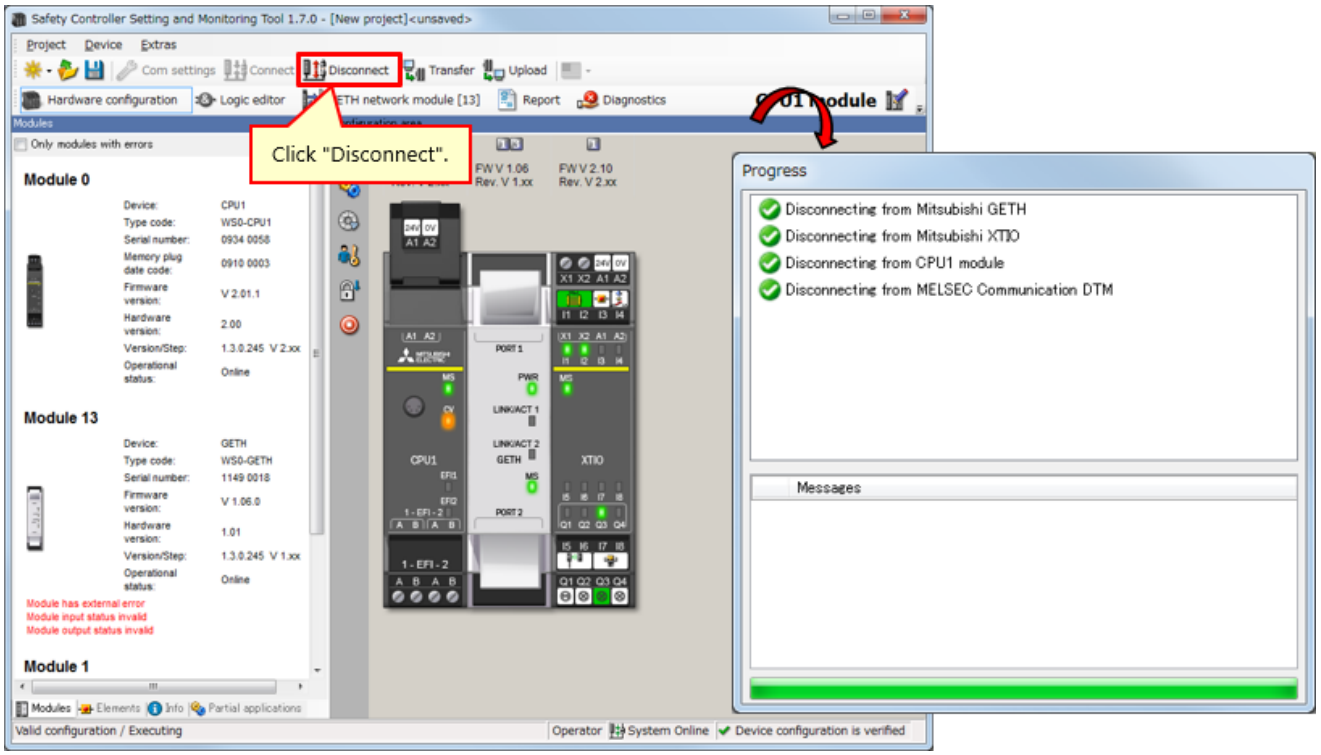
(2) Upload the setting.



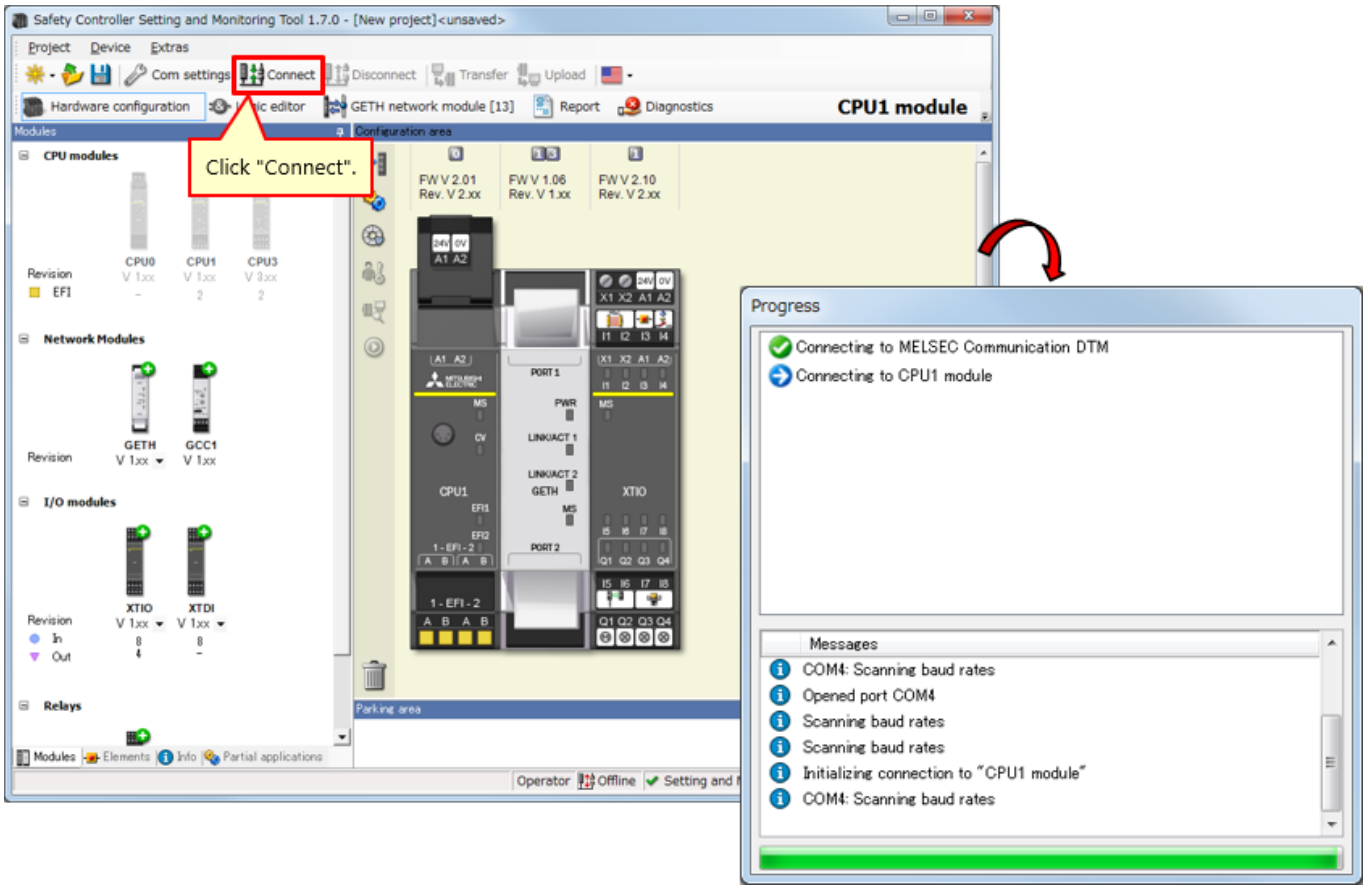
The Setting and Monitoring Tool will ask whether the setting shall be uploaded.
Click "Yes" to upload the setting.

6.2 Disconnection

To change the setting, activate the offline mode by clicking Disconnect.



6.3 Reconnection



* "Connect" can be selected when the tool is not connected with a controller.

6.4 Summary

In this chapter, you have learned:

- Connection with Safety Controller
- Disconnection
- Reconnection

Chapter 7 System Operation Check

This chapter provides how to check the safety controller operation.

7.1 System Operation Check

7.2 Program Description

7.3 Operating Safety Input Devices

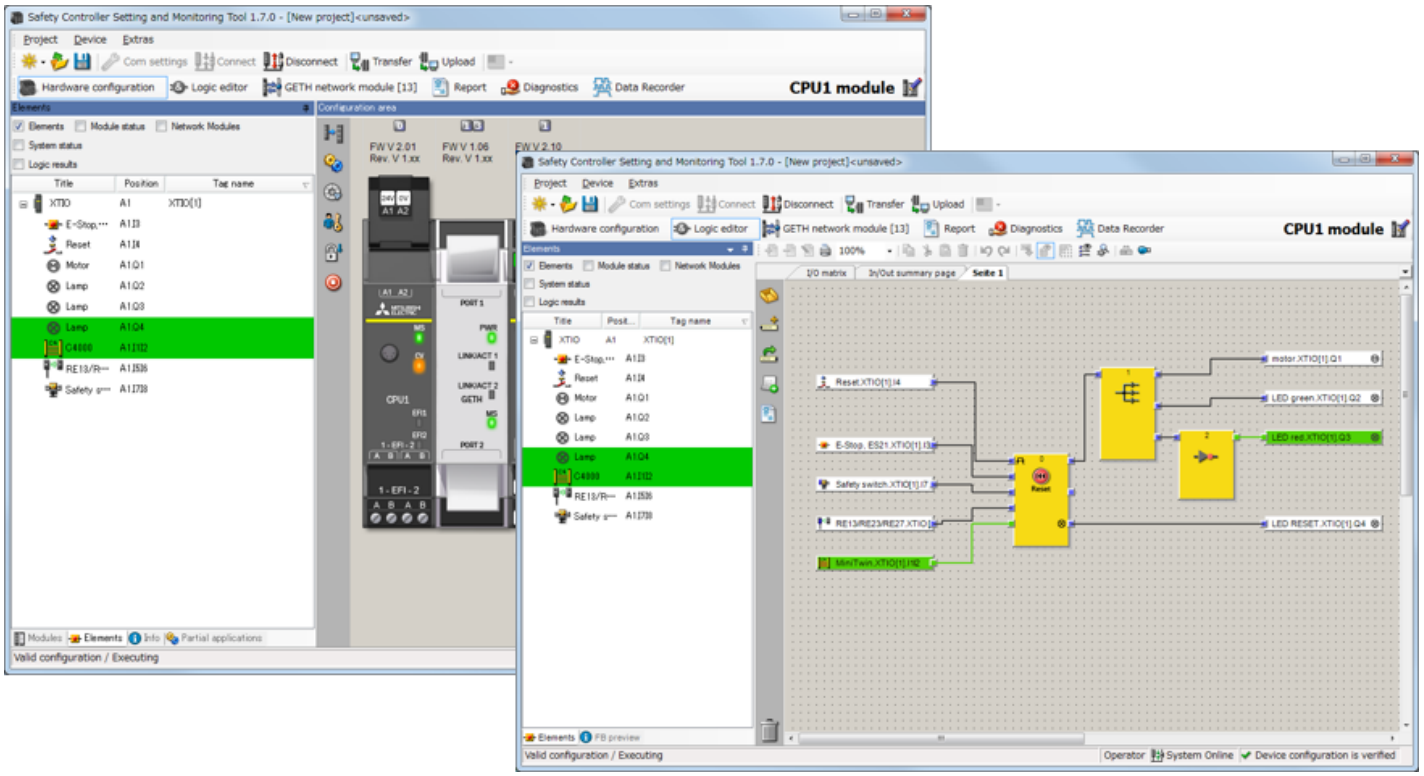
7.4 Transition of System Operating State

7.5 Program Description

7.6 Error Diagnostics

7.7 Summary of This Chapter

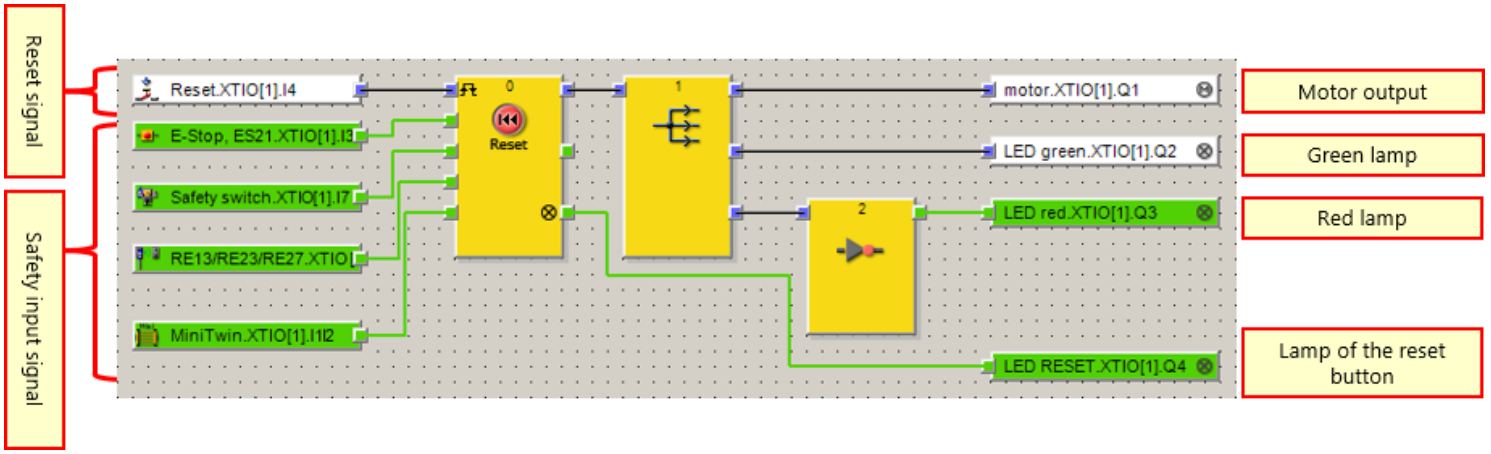
7.1 System Operation Check



7.2 Program Description

If no safety input device is operated and have malfunction after power-on of the safety controller, the components enter the following status.

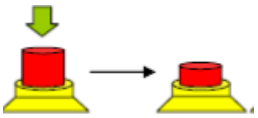
RUN lamp (= green lamp)	OFF
STOP lamp (= red lamp)	ON
Motor	Stop
Reset lamp	ON flashing



7.3 Operating Safety Input Devices

■ Operating the emergency stop switch

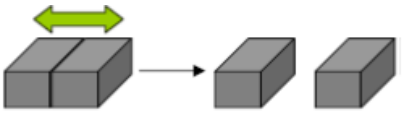
- Holding the emergency stop switch activates a trouble signal.
  → Press the emergency stop switch.
- After the emergency stop switch is restored, pressing the reset lamp or switch clears the trouble signal.
  → Restore the emergency stop switch.

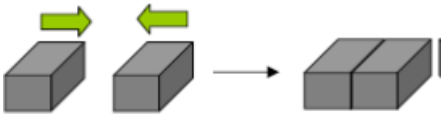


Application: To stop the operation of the hazard source when the emergency stop switch is pressed because danger is found

■ Operating the contactless safety switch

- Separating the pieces of the contactless safety switch activates a trouble signal.
- After the pieces of the contactless safety switch are brought closer, pressing the reset lamp or switch clears the trouble signal.



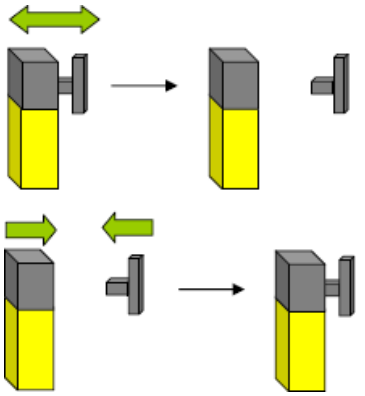


Application: To stop the operation of the hazard source when the door installed to the safety fence is opened

7.3 Operating Safety Input Devices

■ Operating the safety switch

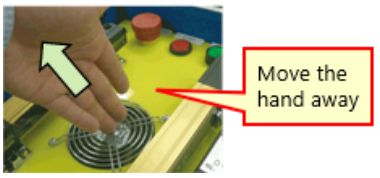
- Pulling out the safety switch activates a trouble signal.
  → Pull out the actuator from the safety door switch.
- After the safety switch is inserted back, pressing the reset lamp or switch clears the trouble signal.
  → Return the pulled-out actuator.



Application: To stop the operation of the hazard source when the door installed to the safety fence is opened

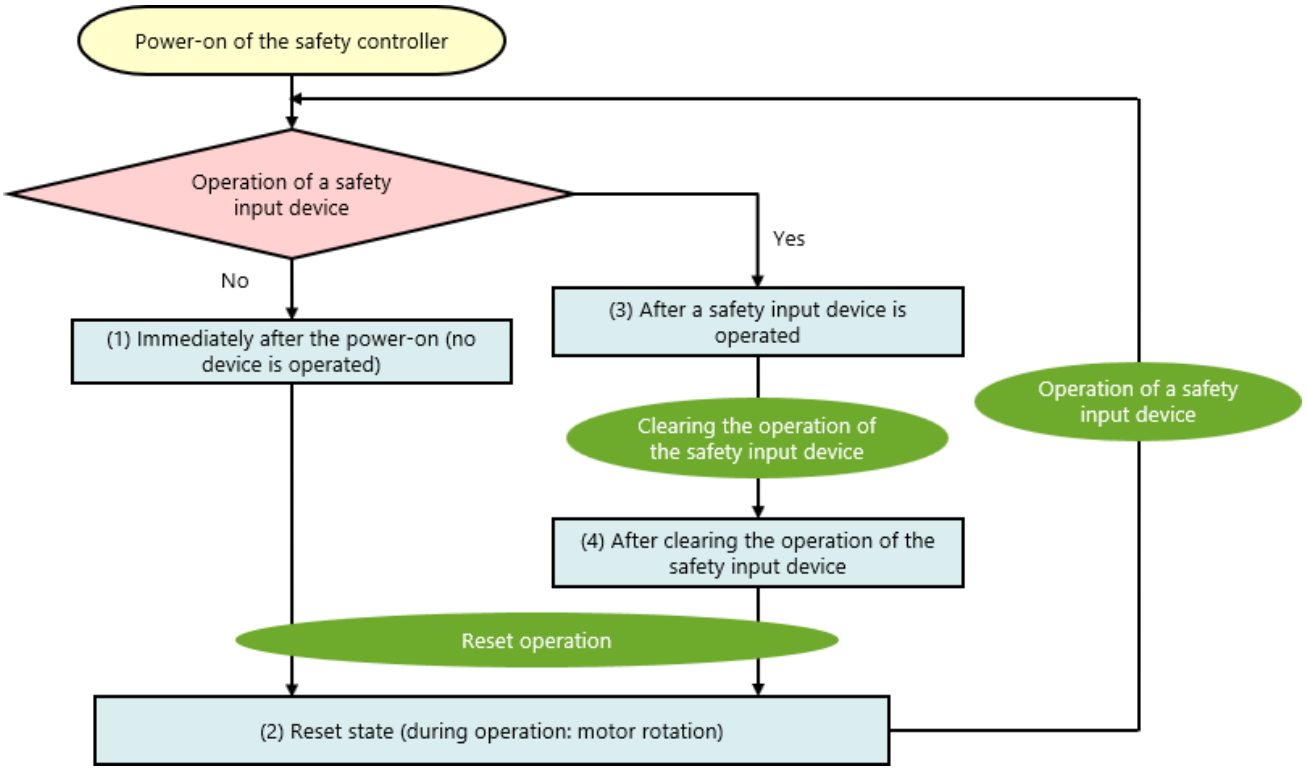
■ Operating the light curtain

- Obstructing the light beam of the light curtain by placing an object activates the trouble signal.
  → Obstruct the light beams of the light curtain.
- After the object obstructing the light beam of the light curtain is removed, pressing the reset lamp or switch clears the trouble signal.
  → Remove the object obstructing the light beam of the light curtain.



Application: To stop the operation of the hazard source when entry of an operator from an opening is detected

7.4 Transition of System Operating State

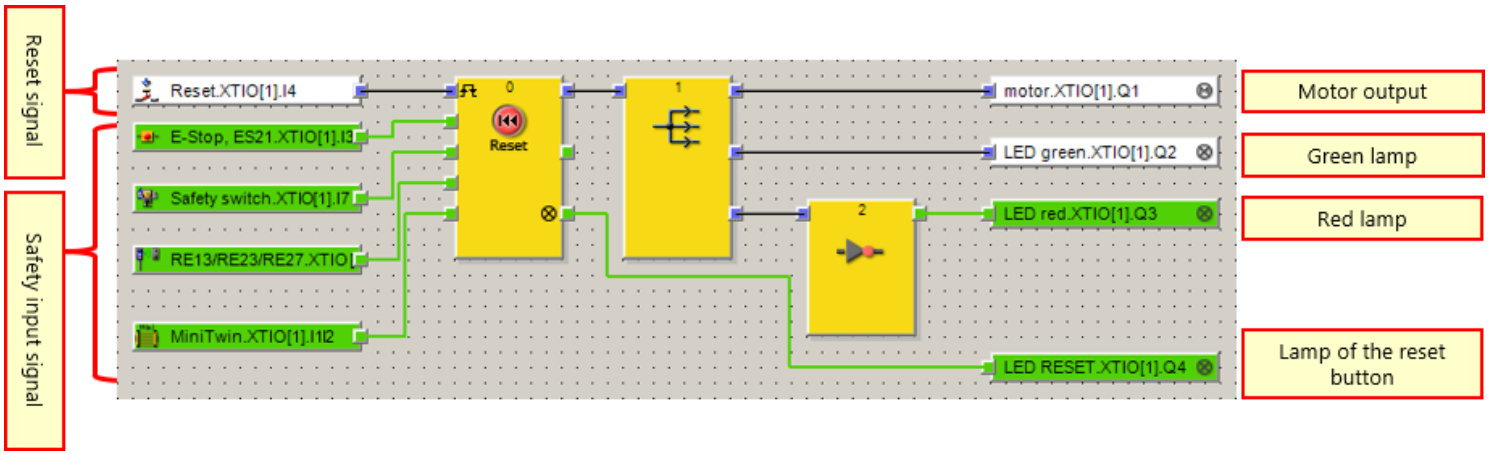


7.5 Program Description

7.5.1 Immediately after the power-on (no device is operated)

If no safety input device is operated and have malfunction after power-on of the safety controller, the components enter the following status.

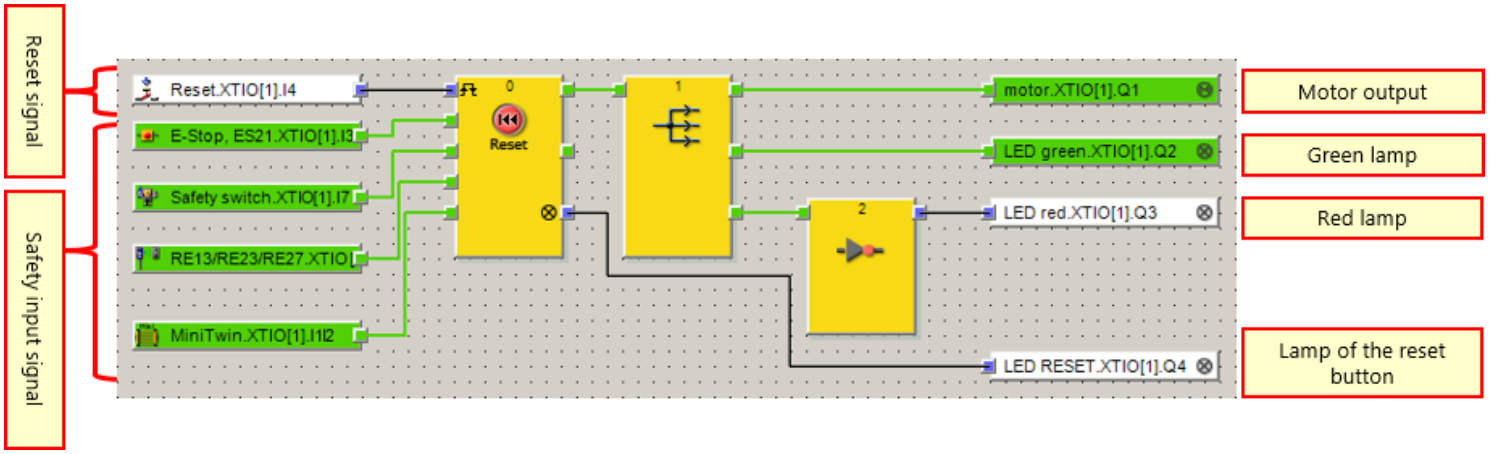
RUN lamp (= green lamp)	OFF
STOP lamp (= red lamp)	ON
Motor	Stop
Reset lamp	ON flashing



7.5.2 Reset state (during operation: motor rotation)

If no safety input device is operated and have malfunction, the following the components enter the following status when the reset switch is operated.

RUN lamp (= green lamp)	OFF → ON
STOP lamp (= red lamp)	ON → OFF
Motor	Stop → Rotation
Reset lamp	ON flashing → Off

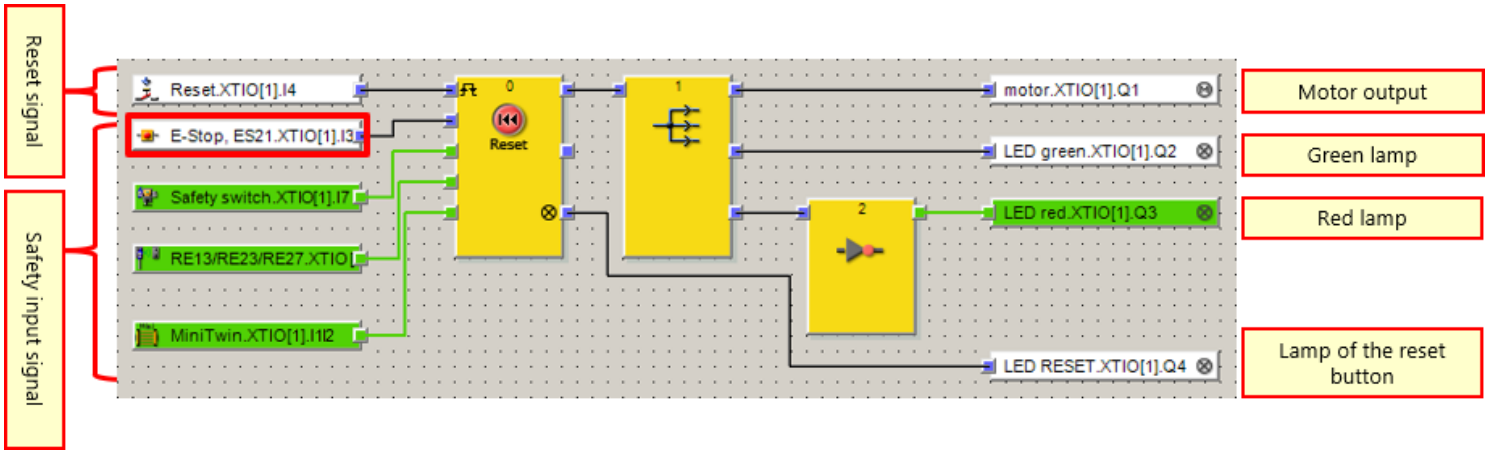


7.5.3 After a safety input device is operated

■ After operating the emergency stop switch

If the emergency stop switch is pressed during operation, the components enter the following status.

RUN lamp (= green lamp)	ON → OFF
STOP lamp (= red lamp)	OFF → ON
Motor	Rotation → Stop
Reset lamp	Off

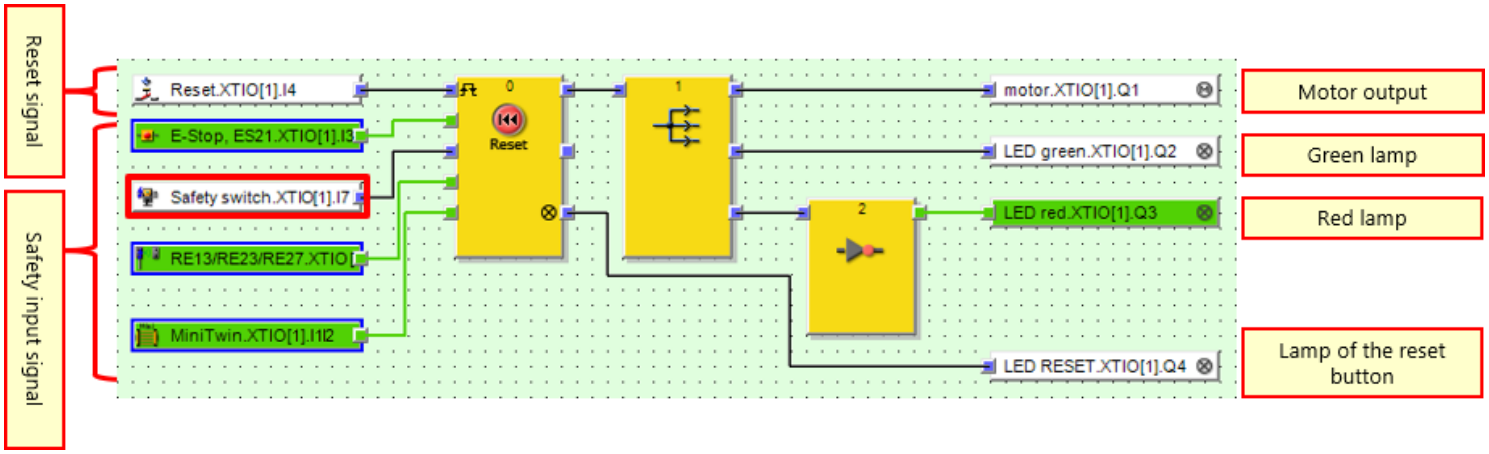


7.5.3 After a safety input device is operated

■ After operating the safety switch

If the actuator of the safety switch is pulled out during operation, the components enter the following status.

RUN lamp (= green lamp)	ON → OFF
STOP lamp (= red lamp)	OFF → ON
Motor	Rotation → Stop
Reset lamp	Off

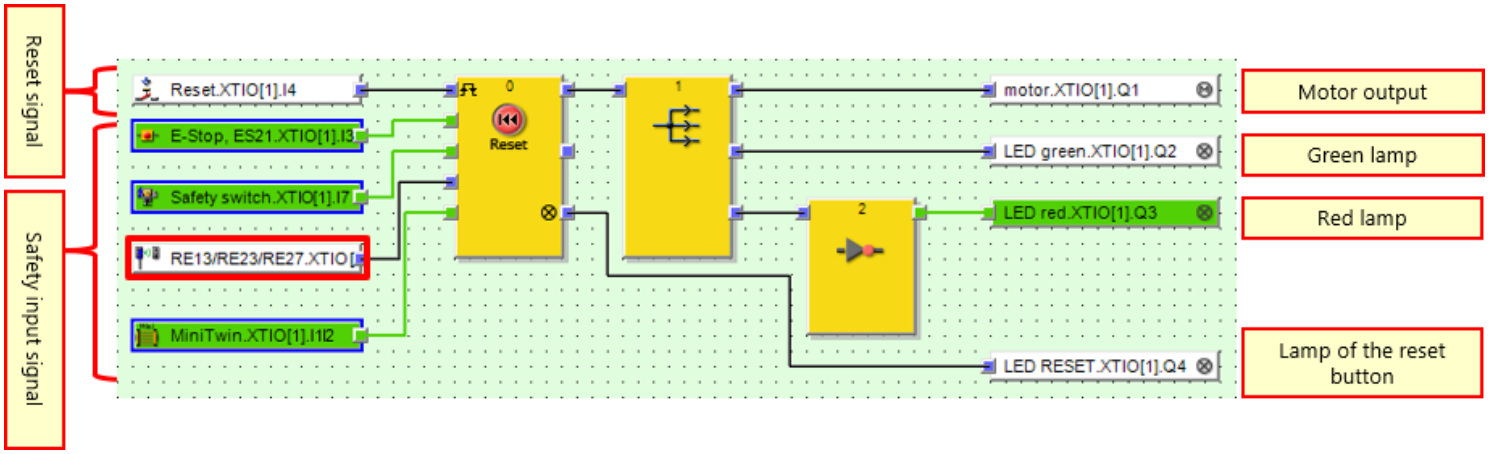


7.5.3 After a safety input device is operated

■ After operating the contactless safety switch

If the pieces of the contactless safety switch are separated during operation, the components enter the following status.

RUN lamp (= green lamp)	ON → OFF
STOP lamp (= red lamp)	OFF → ON
Motor	Rotation → Stop
Reset lamp	Off

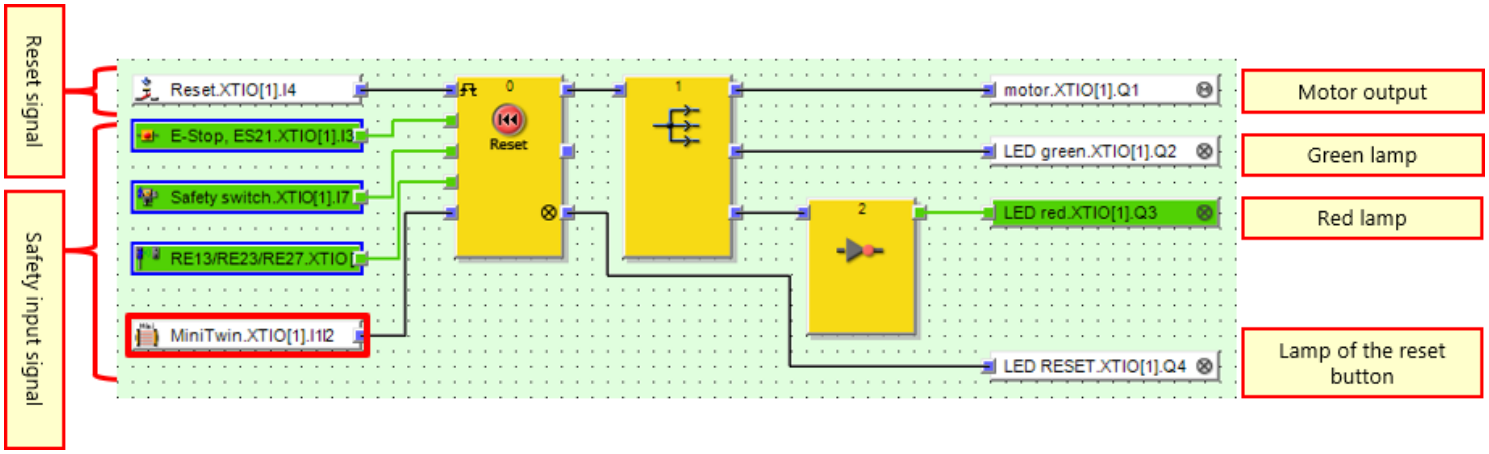


7.5.3 After a safety input device is operated

■ After operating the light curtain

If the light beam of the light curtain is obstructed during operation, the components enter the following status.

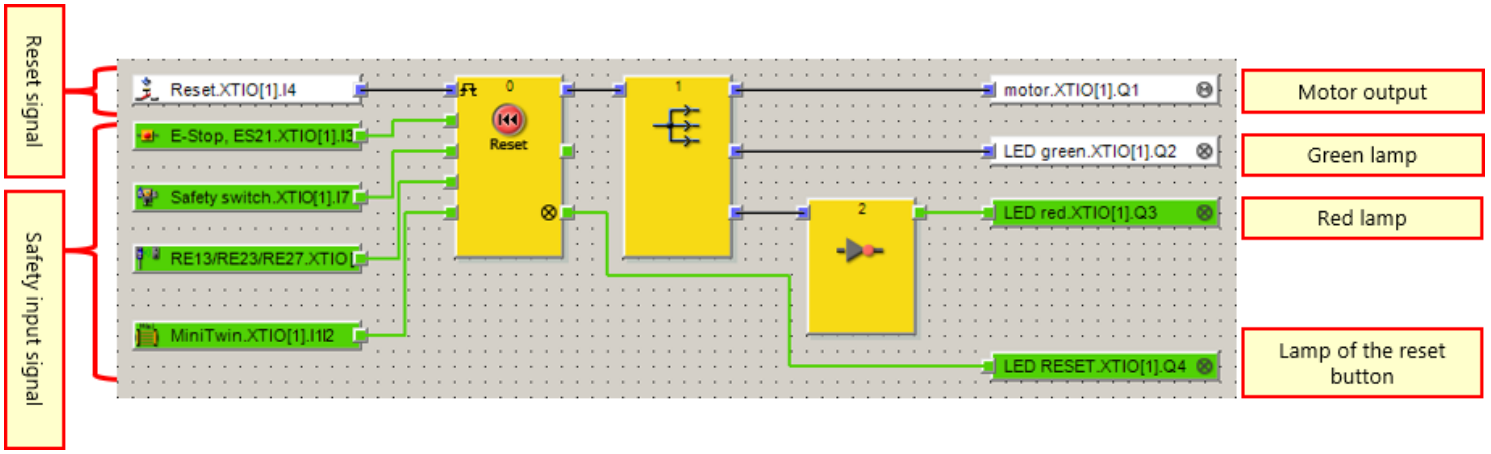
RUN lamp (= green lamp)	ON → OFF
STOP lamp (= red lamp)	OFF → ON
Motor	Rotation → Stop
Reset lamp	Off



7.5.4 After clearing the operation of the safety input device

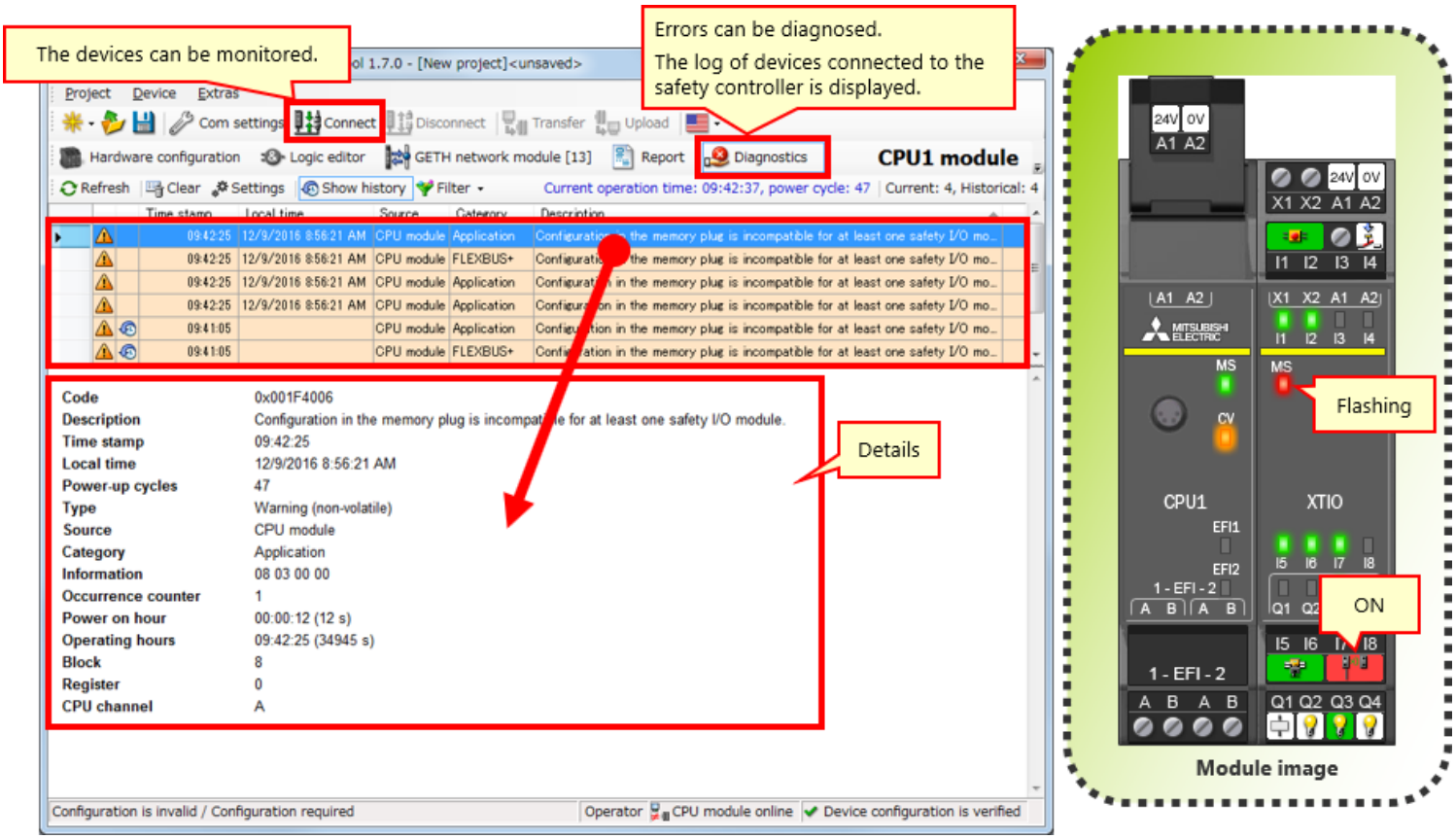
If a safety input device is operated and then the operation is cleared, the components enter the following status.

RUN lamp (= green lamp)	OFF
STOP lamp (= red lamp)	ON
Motor	Stop
Reset lamp	Off → ON flashing



7.6 Error Diagnostics

Diagnostic results and operation of the safety controller can be checked on the Setting and Monitoring Tool.



7.7 Summary

In this chapter, you have learned:

- System Operation Check
- Program Description
- Operating Safety Input Devices
- Transition of System Operating State
- Program Description
- Error Diagnostics

Test Final Test

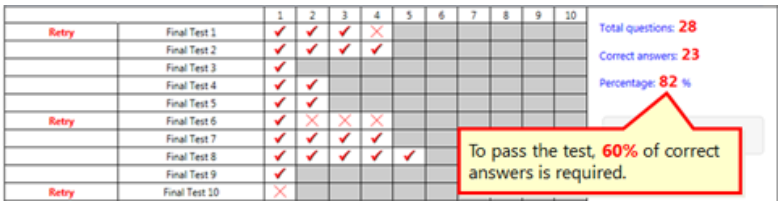
Now that you have completed all of the lessons of the **SAFETY CONTROLLER BASIC** Course, you are ready to take the final test. If you are unclear on any of the topics covered, please take this opportunity to review those topics.

There are a total of 6 questions (6 items) in this Final Test.

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

Score results

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



Test **Final Test 1**

In a safety controller (MELSEC-WS), "up to 10" safety I/O modules can be connected to a CPU module.

Q1

- ○
- ×

Test **Final Test 2**

The Setting and Monitoring Tool, a programming tool for the safety controller, is available for free.

Q1

- ○
- ×

Test **Final Test 3**

The programming language of the Setting and Monitoring Tool for the safety controller is "FBD".

Q1

- ○
- ×

Test **Final Test 4**

The report creation function of the Setting and Monitoring Tool for the safety controller can output hardware configurations and error histories to PDF files.

Q1

- ○
- ×

Test **Final Test 5**

The default password for the user level "Administrator", which is required for downloading projects in safety controllers, is "MELSECWS".

Q1

- ○
- ×

Test **Final Test 6**

The safety controller cannot be connected with a MELSEC-Q series programmable controller via a network and cannot monitor the operating status of the programmable controller.

Q1

- ○
- ×

Test **Final Test 1**

In a safety controller (MELSEC-WS), "up to 10" safety I/O modules can be connected to a CPU module.

Q1

○

× (selected)

Test **Final Test 2**

The Setting and Monitoring Tool, a programming tool for the safety controller, is available for free.

Q1

- ○
- ×

Test **Final Test 3**

The programming language of the Setting and Monitoring Tool for the safety controller is "FBD".

Q1

- ○
- ×

Test **Final Test 4**

The report creation function of the Setting and Monitoring Tool for the safety controller can output hardware configurations and error histories to PDF files.

Q1

- ○
- ×

Test **Final Test 5**

The default password for the user level "Administrator", which is required for downloading projects in safety controllers, is "MELSECWS".

Q1

- ○
- ×

Test **Final Test 6**

The safety controller cannot be connected with a MELSEC-Q series programmable controller via a network and cannot monitor the operating status of the programmable controller.

Q1

○

× (selected)

Test Score

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

		1	2	3	4	5	6	7	8	9	10
	Final Test 1	✓									
	Final Test 2	✓									
	Final Test 3	✓									
	Final Test 4	✓									
	Final Test 5	✓									
	Final Test 6	✓									

Total questions: **6**

Correct answers: **6**

Percentage: **100** %

Clear

You have completed the SAFETY CONTROLLER BASIC Course.

Thank you for taking this course.

We hope you enjoyed the lessons and the information you acquired in this course is useful for configuring systems in the future.

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

Review

Close