MITSUBISHI ELECTRIC

Mitsubishi Programmable Controller

MELSEC iQ-R series

MELSEC iQ-R
Safety Application Guide

SAFETY PRECAUTIONS

(Read these precautions before using this product.)

Before using MELSEC iQ-R series programmable controllers, please read the manuals for the product and the relevant manuals introduced in those manuals carefully, and pay full attention to safety to handle the product correctly.

In this manual, the safety precautions are classified into two levels: "⚠ WARNING" and "⚠ CAUTION".

⚠ **WARNING**	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠ **CAUTION**	Indicates that incorrect handling may cause hazardous conditions, resulting in minor or moderate injury or property damage.

Under some circumstances, failure to observe the precautions given under "⚠ CAUTION" may lead to serious consequences.

Observe the precautions of both levels because they are important for personal and system safety.

Make sure that the end users read this manual and then keep the manual in a safe place for future reference.

[Design Precautions]

⚠ WARNING

- When the safety programmable controller detects a fault in the external power supply or itself, it turns off all outputs in the safety system. Configure an external circuit to ensure that the power source of a hazard is shut off by turning off the outputs. Failure to do so may result in an accident.
- Configure short current protection circuits for safety relays and protection circuits, such as a fuse and breaker, external to the safety programmable controller.
- When a load current exceeding the rated current or an overcurrent caused by a load short-circuit flows, the safety remote I/O module detects an error and turns off all outputs. Note that if the overcurrent state continues for a long time, it may cause smoke and fire. To prevent this, configure an external safety circuit, such as a fuse.
- When changing data and operating status, and modifying program of the running safety programmable controller from an external device such as a personal computer connected to the Safety CPU, configure an interlock circuit in the program or external to the safety programmable controller to ensure that the entire system always operates safely. In addition, before performing online operations, determine corrective actions to be taken between the external device and Safety CPU in case of a communication failure due to poor contact of cables.
- Do not use any "use prohibited" signals as a remote I/O signal since they are used by the system. Do not write any data to the "use prohibited" areas in the remote register. For the "use prohibited" signals, refer to the MELSEC iQ-R CC-Link IE Field Network User's Manual (Application). Do not turn on or off these signals on a program since normal operations cannot be guaranteed. Doing so may cause malfunction of the programmable controller system.
- When the CC-Link IE Field Network remote I/O module (with safety functions) detects a CC-Link IE Field Network error, it turns off outputs. However, the program does not automatically turn off outputs. Create a program that turns off outputs when a CC-Link IE Field Network error is detected. If CC-Link IE Field Network is restored with outputs on, connected machines may suddenly operate, resulting in an accident.
- Create an interlock circuit which uses reset buttons so that the system does not restart automatically after executing safety functions and turning off outputs.

[Design Precautions]

⚠WARNING

- In the case of a communication failure in the network, the status of the error station will be as follows:
  (1) All inputs from remote I/O stations are turned off.
  (2) All outputs from remote I/O stations are turned off.
  Check the communication status information and configure an interlock circuit in the program to ensure that the entire system will operate safely. Failure to do so may result in an accident due to an incorrect output or malfunction.
- Outputs may remain on or off due to a failure of the CC-Link IE Field Network remote I/O module (with safety functions). Configure an external circuit for monitoring output signals that could cause a serious accident.

[Design Precautions]

⚠CAUTION

- Do not install the wiring for external devices or communication cables together with the main circuit lines or power cables. Keep a distance of 100mm or more between them. Failure to do so may result in malfunction due to noise.
- When selecting external devices to be connected to the CC-Link IE Field Network remote I/O module (with safety functions), consider the maximum inrush current described in the CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual.

[Installation Precautions]

⚠WARNING

- Shut off the external power supply (all phases) used in the system before mounting or removing a safety programmable controller. Failure to do so may result in electric shock or cause the module to fail or malfunction.

[Installation Precautions]

⚠CAUTION

- Use each module mounted on a base unit with a safety programmable controller in an environment that meets the general specifications in the MELSEC iQ-R Module Configuration Manual. Use the safety remote I/O module and standard remote I/O module in an environment that meets the general specifications in the corresponding manuals (CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual and CC-Link IE Field Network Remote I/O Module User's Manual Failure to do so may result in electric shock, fire, malfunction, or damage to or deterioration of the product.
- Fix the module and base unit with a screw. Tighten the screws within the specified torque range. Undertightening can cause drop of the screw, short circuit, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, or malfunction.
- Securely fix the safety remote I/O module and standard remote I/O module with a DIN rail or module fixing screws. Tighten the screws within the specified torque range. Undertightening can cause drop of the screw, short circuit, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, or malfunction.
- Do not directly touch any conductive parts and electronic components of the module. Doing so can cause malfunction or failure of the module.
- Connect the connector of each cable to the installing part securely. Poor contact may cause malfunction.

[Wiring Precautions]

⚠WARNING

- Shut off the external power supply (all phases) used in the system before wiring.
  Failure to do so may result in electric shock or cause the module to fail or malfunction.
- After installation and wiring, attach the included terminal cover to the module before turning it on for operation. Failure to do so may result in electric shock.

[Wiring Precautions]

⚠CAUTION

- Individually ground the FG and LG terminals of the programmable controller with a ground resistance of 100 ohms or less. Failure to do so may result in electric shock or malfunction.
- Use a solderless terminal with insulation sleeve for wiring of a terminal block. Use up to two solderless terminals for a single terminal.
- Use applicable solderless terminals and tighten them within the specified torque range. If any spade solderless terminal is used, it may be disconnected when the terminal screw comes loose, resulting in failure.
- Check the rated voltage and terminal layout before wiring to the module, and connect the cables correctly. Connecting a power supply with a different voltage rating or incorrect wiring may cause a fire or failure.
- Tighten a terminal block mounting screw, terminal screw, and module fixing screw within the specified torque range. If the terminal block mounting screw or terminal screw is too loose, it may cause a short circuit, fire, or malfunctions. If too tight, it may damage the screw and/or the module, resulting in a drop of the screw or module, a short circuit or malfunctions. If the module fixing screw is too loose, it may cause a drop of the screw or module. Overtightening the screw may cause a drop due to the damage of the screw or module.
- For the wire strip length, meet the specifications in a manual. The wire strip length is too long, it may cause the electric shock and short circuit between terminals due to spreading out the conductive part to the front of terminal block. The wire strip length is too short, it may cause the poor contact for the spring clamp terminal block.
- Observe the following precautions when the spring clamp terminal block tool is used. Failure to do so may cause the damage of the spring clamp terminal block or terminal block resin part.
  · Use the dedicated spring clamp terminal block tool.
  · Insert the spring clamp terminal block tool to the tool insertion opening vertically.
- Prevent foreign matter such as dust or wire chips from entering the module. Such foreign matter can cause a fire, failure, or malfunction.
- A protective film is attached to the top of the module to prevent foreign matter, such as wire chips, from entering the module during wiring. Do not remove the film during wiring. Remove it for heat dissipation before system operation.
- Place the cables in a duct or clamp them. If not, dangling cable may swing or inadvertently be pulled, resulting in damage to the module or cables or malfunction due to poor contact.
- When disconnecting the cable from the module, do not pull the cable by the cable part. For the cable connected to the terminal block, loosen the terminal screw. Pulling the cable connected to the module may result in malfunction or damage to the module or cable.

[Wiring Precautions]

⚠CAUTION

- Do not install the control lines or communication cables together with the main circuit lines or power cables. Failure to do so may result in malfunction due to noise.
- When an overcurrent caused by an error of an external device or a failure of the module flows for a long time, it may cause smoke and fire. To prevent this, configure an external safety circuit, such as a fuse.
- Programmable controllers must be installed in control panels. Connect the main power supply to the power supply module in the control panel through a relay terminal block. Wiring and replacement of a power supply module must be performed by qualified maintenance personnel with knowledge of protection against electric shock. For wiring, refer to the MELSEC iQ-R Module Configuration Manual.
- For Ethernet cables to be used in the system, select the ones that meet the specifications in the MELSEC iQ-R Ethernet/CC-Link IE User's Manual (Startup). If not, normal data transmission is not guaranteed.

[Startup and Maintenance Precautions]

⚠WARNING

- Do not touch any terminal while power is on. Doing so may lead to the electric shock.
- Correctly connect the battery connector. Do not charge, disassemble, heat, short-circuit, solder, or throw the battery into the fire. Also, do not expose it to liquid or strong shock. Doing so will cause the battery to produce heat, explode, ignite, or leak, resulting in injury and fire.
- Shut off the external power supply (all phases) used in the system before cleaning the module or retightening the terminal block mounting screws, terminal screws, or module fixing screws. Failure to do so may result in electric shock. Tighten the terminal block screws or connector screws within the specified torque range. If the terminal block mounting screw or terminal screw is too loose, it may cause a short circuit, fire, or malfunctions. If too tight, it may damage the screw and/or the module, resulting in a drop of the screw or module, a short circuit or malfunctions. If the module fixing screw is too loose, it may cause a drop of the screw or module. Overtightening the screw may cause a drop due to the damage of the screw or module.

[Startup and Maintenance Precautions]

⚠CAUTION

- The online operations performed from a PC to a running safety programmable controller (Program change when a safety CPU module is RUN, device test, and operating status change such as RUNSTOP switching) have to be executed after the manual has been carefully read and the safety has been ensured. Following the operating procedure predetermined at designing, the operation has to be performed by an instructed person. When changing a program while a safety CPU module is RUN (Write during RUN), it may cause a program breakdown in some operating conditions. Fully understand the precautions described in the GX Works3 Operating Manual before use.
- Do not disassemble or modify the module. Doing so may cause failure, malfunction, injury, or a fire.
- Use any radio communication device such as a cellular phone or PHS (Personal Handy-phone System) more than 25cm away in all directions from the module. Failure to do so may cause malfunction.
- Shut off the external power supply (all phases) used with the safety programmable controller before mounting or removing the module. Failure to do so may cause the module to fail or malfunction.
- Restrict the mounting/removal of a module, base unit, and terminal block up to 50 times (IEC 61131-2 compliant), after the first use of the product. Exceeding the limit may cause malfunction.
- Do not drop or apply shock to the battery to be installed in the module. Doing so may damage the battery, causing the battery fluid to leak inside the battery. If the battery is dropped or any shock is applied to it, dispose of it without using.
- Before handling the module, touch a conducting object such as a grounded metal to discharge the static electricity from the human body. Failure to do so may cause the module to fail or malfunction.
- Since the module case is made of resin, do not drop or apply any strong impact to the module. Doing so may damage the module.
- Shut off the external power supply (all phases) used in the system before mounting or removing a module. Failure to do so may cause the module to fail or malfunction.

Disposal precautions

⚠CAUTION

- When disposing of this product, treat it as industrial waste.
- When disposing of batteries, separate them from other wastes according to the local regulations. For details on battery regulations in EU member states, refer to the MELSEC iQ-R Module Configuration Manual.

[Transportation Precautions]

⚠CAUTION

- When transporting lithium batteries, follow the transportation regulations. For details on the regulated models, refer to the MELSEC iQ-R Module Configuration Manual.
- The halogens (such as fluorine, chlorine, bromine, and iodine), which are contained in a fumigant used for disinfection and pest control of wood packaging materials, may cause failure of the product. Prevent the entry of fumigant residues into the product or consider other methods (such as heat treatment) instead of fumigation. The disinfection and pest control measures must be applied to unprocessed raw wood.

CONDITIONS OF USE FOR THE PRODUCT

(1) Although MELCO has obtained the certification for Product's compliance to the international safety standards IEC61508, EN954-1/ISO13849-1 from TUV Rheinland, this fact does not guarantee that Product will be free from any malfunction or failure. The user of this Product shall comply with any and all applicable safety standard, regulation or law and take appropriate safety measures for the system in which the Product is installed or used and shall take the second or third safety measures other than the Product. MELCO is not liable for damages that could have been prevented by compliance with any applicable safety standard, regulation or law.

(2) MELCO prohibits the use of Products with or in any application involving, and MELCO shall not be liable for a default, a liability for defect warranty, a quality assurance, negligence or other tort and a product liability in these applications.
(a) power plants,
(b) trains, railway systems, airplanes, airline operations, other transportation systems,
(c) hospitals, medical care, dialysis and life support facilities or equipment,
(d) amusement equipments,
(e) incineration and fuel devices,
(f) handling of nuclear or hazardous materials or chemicals,
(g) mining and drilling,
(h) and other applications where the level of risk to human life, health or property are elevated.

INTRODUCTION

Thank you for purchasing the Mitsubishi MELSEC iQ-R series programmable controllers.
This manual describes the points to be concerned when configuring safety application that meets the safety standards using the safety programmable controller.
Before using this product, please read this manual and the relevant manuals carefully and develop familiarity with the functions and performance of the MELSEC iQ-R series programmable controller to handle the product correctly.
When applying the program and circuit examples provided in this manual to an actual system, ensure the applicability and confirm that it will not cause system control problems.
Please make sure that the end users read this manual.

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CONTENTS

RELEVANT MANUALS

Manual name	Description	Available form
MELSEC iQ-R Safety Application Guide [SH-081538ENG] (this manual)	Overview of safety systems, how to configure safety systems, examples of installation and wiring, and application programs.	e-Manual PDF
MELSEC iQ-R CPU Module User's Manual (Startup) [SH-081263ENG]	Performance specifications, procedures before operation, and troubleshooting of the CPU module	Print book e-Manual PDF
MELSEC iQ-R CPU Module User's Manual (Application) [SH-081264ENG]	Memory, functions, devices, and parameters of the CPU module	Print book e-Manual PDF
MELSEC iQ-R Ethernet/CC-Link IE User's Manual (Startup) [SH-081256ENG]	Specifications, procedures before operation, system configuration, wiring, and communication examples of Ethernet, CC-Link IE Controller Network, and the CC-Link IE Field Network	Print book e-Manual PDF
MELSEC iQ-R CC-Link IE Field Network User's Manual (Application) [SH-081259ENG]	Functions, parameter settings, programming, troubleshooting, I/O signals, and buffer memory of the CC-Link IE Field Network	Print book e-Manual PDF
CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual [SH-081449ENG]	Procedures required to use safety I/O modules, system configuration, parameter setting, functions, and troubleshooting.	Print book e-Manual PDF
CC-Link IE Field Network Remote I/O Module User's Manual [SH-081114ENG]	Procedures required to use I/O modules, system configuration, parameter setting, functions, and troubleshooting.	Print book e-Manual PDF

Point

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

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

TERMS

Unless otherwise specified, this manual uses the following terms.

Term	Description
CC-Link IE Field Network master/local module	The abbreviation for the RJ71GF11-T2 the CC-Link IE Field Network master/local module
Dark test	A function that diagnoses contacts including external devices by outputting an off pulse from the test pulse terminal when the input or output is on
Engineering tool	Another term for the software package for the MELSEC programmable controllers
Local station on the CC-Link IE Field Network	A station that performs cyclic transmission and transient transmission with the master station and other local stations on the CC-Link IE Field Network
Master station on the CC-Link IE Field Network	A station that controls the entire the CC-Link IE Field Network. Only one master station can be used in a network. This station can perform cyclic transmission and transient transmission with all stations on the CC-Link IE Field Network.
NC	A contact that is closed or in a conductive state, and opened by operation of the switch
NO	A contact that is open or in a non-conductive state, and closed by operation of the switch
Normally closed contact	Refer to the description of NC.
Normally open contact	Refer to the description of NO.
PL (performance level)	A safety level specified in ISO13849-1: 2006 (The safety level is classified into five levels, a to e.)
Remote device station (safety station) on the CC-Link IE Field Network	A station that exchanges I/O signals (bit data) with the master station by safety communications. This station can be used in a safety system.
Remote device station on the CC-Link IE Field Network	A station that exchanges I/O signals (bit data) and I/O data (word data) with another station by transient transmission. This station responds to a transient transmission request from another station. This station cannot be used in a safety system.
Remote I/O station on the CC-Link IE Field Network	A station that exchanges I/O signals (bit data) with the master station by cyclic transmission. This station cannot be used in a safety system.
Risk	The combination of the possibility and severity of harm (injury or illness) that may occur when exposed to a hazard
Risk assessment	Overall process comprising identification of the hazards of machines and risk evaluation
RWr	Remote register (read area for the CC-Link IE Field Network)
RWw	Remote register (write area for the CC-Link IE Field Network)
RX	Remote input (for the CC-Link IE Field Network)
RY	Remote output (for the CC-Link IE Field Network)
Safety application	A generic term for the applications that are controlled by the safety programmable controller for realizing the safety function
Safety communications	Communication service that performs send/receive processing in the safety layer of the safety communication protocol
Safety component	A component such as a fail-safe sensor and actuator
Safety control	Machine control by safety programs and safety data communications. When an error occurs, the machine in operation is securely stopped.
Safety CPU	A generic term for the R08SFCPU, R16SFCPU, R32SFCPU, and R120SFCPU. This module is used with a safety function module as a pair, and performs both standard control and safety control.
Safety cycle time	This is a time inserted to activate safety input and output, as well as the safety program.
Safety function	A function provided to protect a person from the hazards of machines
Safety function module	Another term for the R6SFM. This module is used with the Safety CPU as a pair and performs safety control. The module can only be paired with the Safety CPU.
Safety input	A generic term for the signals that are input to the safety programmable controller for realizing the safety function
Safety measures	Measures for reducing risk
Safety output	A generic term for the signals that are output from the safety programmable controller for realizing the safety function
Safety programmable controller	A generic term for the MELSEC iQ-R series modules that perform safety control (such as a Safety CPU, safety function module, or the CC-Link IE Field Network remote I/O module (with safety functions))
Safety remote I/O module	The abbreviation for the NZ2GFSS2-32D and NZ2EXSS2-8TE CC-Link IE Field Network remote I/O module (with safety functions)

Term	Description
Safety station on the CC-Link IE Field Network	A generic term for stations on the CC-Link IE Field Network, which perform safety communications and standard communications
Safety system	A system that execute the required safety function
SB	Link special relay. Bit data that indicates the operating status and data link status of a module on the CC-Link IE Field Network.
SIL	A safety level specified in IEC61508: 2010 (The safety level is classified into four levels, SIL1 to SIL4.)
Slave station on the CC-Link IE Field Network	A generic term for stations other than the master station on the CC-Link IE Field Network, such as a local station, remote I/O station, remote device station, intelligent device station, or intelligent device station (safety station)
Standard communications	Communications other than safety communications, such as cyclic transmission and transient transmission of the CC-Link IE Field Network
Standard control	Machine control by standard programs and standard data communications. Programmable controllers other than the safety programmable controller perform only standard control. (This term is used to distinguish from safety control.)
Standard CPU	A generic term for MELSEC iQ-R series CPU modules (other than Safety CPU) that perform standard control (This term is used to distinguish from the Safety CPU.)
Standard programmable controller	A generic term for MELSEQ-iQ-R series, MELSEC-Q series, MELSEC-L series, MELSEC-QnA series, MELSEC-A series, and MELSEC-FX series modules that perform standard control (This term is used to distinguish from a safety programmable controller.)
Standard remote I/O module	The abbreviation for a remote I/O module on the CC-Link IE Field Network where only standard inputs and outputs (not safety inputs and outputs) are connected (This term is used to distinguish from a safety remote I/O module.)
SW	Link special register. Word data that indicates the operating status and data link status of a module on the CC-Link IE Field Network.
Target failure measure	A target value of reliability specified in IEC61508:2010 for each SIL level. There are two target failure measures depending on the operation frequency of the safety function, PFDavg and PFH.

HOW TO USE THIS MANUAL

This manual describes the points to be concerned when configuring a safety application that meets the safety standards using the safety programmable controller.

Safety application configuration examples are provided in chapter 5 of this manual, but they have not obtained safety approvals. It is user's responsibility to obtain a safety approval for the entire safety system.

This manual consists of five chapters.

Chapter 1: Overview of the safety programmable controller

Chapter 2: Safety application that is configured using the safety programmable controller

Chapter 3: Risk assessment, SIL, and PL

Chapter 4: Precautions for using the safety programmable controller

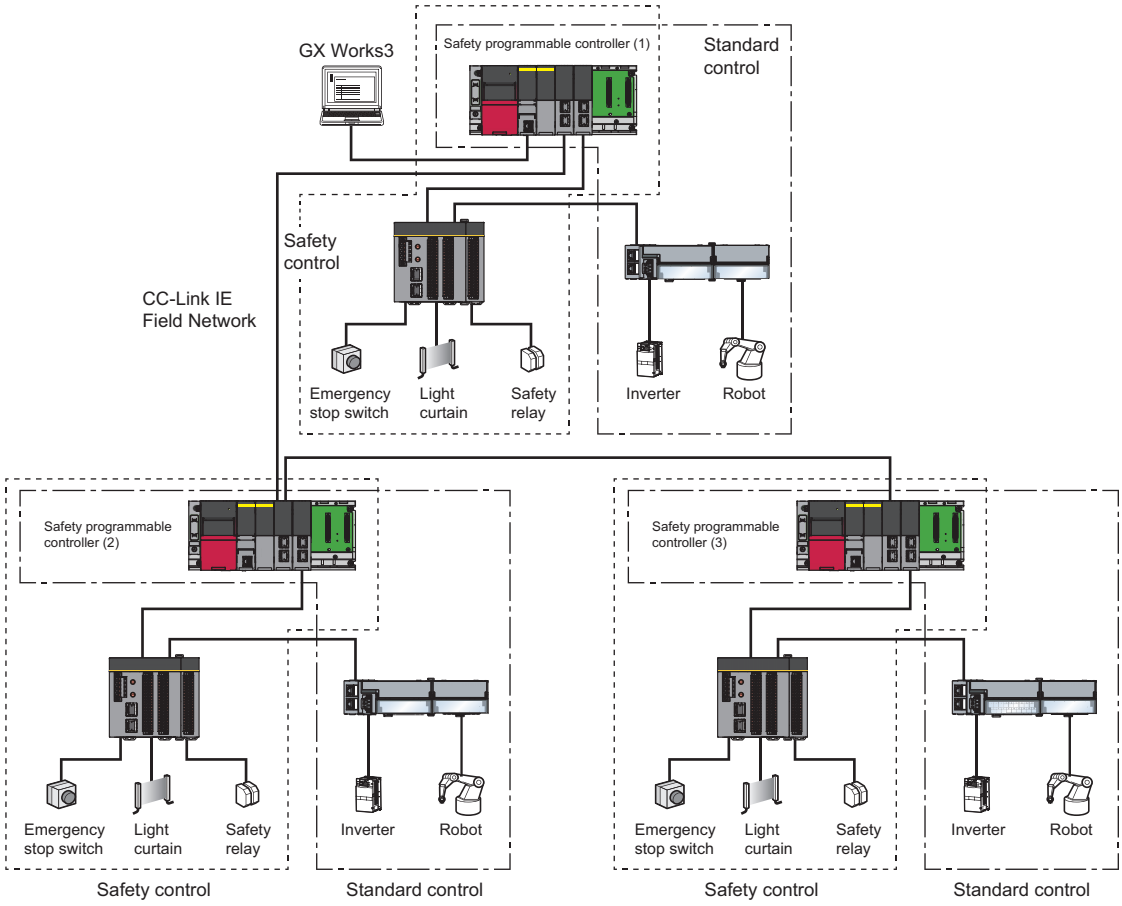
Chapter 5: Safety application configuration examples

For detailed specifications and functions of each module, refer to the relevant manuals.

1 OVERVIEW

Our safety programmable controllers obtained safety approval at the highest safety level that the programmable controller can obtain (ISO13849-1: 2006 Category 4 and PLe, IEC62061: 2012 SIL3, and IEC61508: 2010 SIL3).
The customer can use safety programmable controllers for configuring safety station with ISO13849-1: 2006 Category 4 and PLe, IEC62061: 2012 SIL3, and IEC61508: 2010 SIL3.
Safety control and standard control programs can be simultaneously executed under a safety CPU. Similarly, both safety and standard communications can be executed under a network.
System configuration for safety programmable controllers is shown below:

- Mount power supply module, safety CPU, safety function module, CC-Link IE Field Network master/local module on the main base unit.
- Connect CC-Link IE Field Network master/local module and safety remote I/O module by network.
- Connect personal computer installed engineering tools to safety CPU, when setting programs and parameters.



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2 APPLICATION EXAMPLE

Safety control for the entire line using a single safety programmable controller

The following shows an application image for the car welding line as an application example of the safety programmable controller. The safety programmable controller processes safety control of the entire line as a safety application, and processes line integrated control, which integrates processes as a standard application.

Configure the safety application operated by the safety programmable controller for the following purposes:

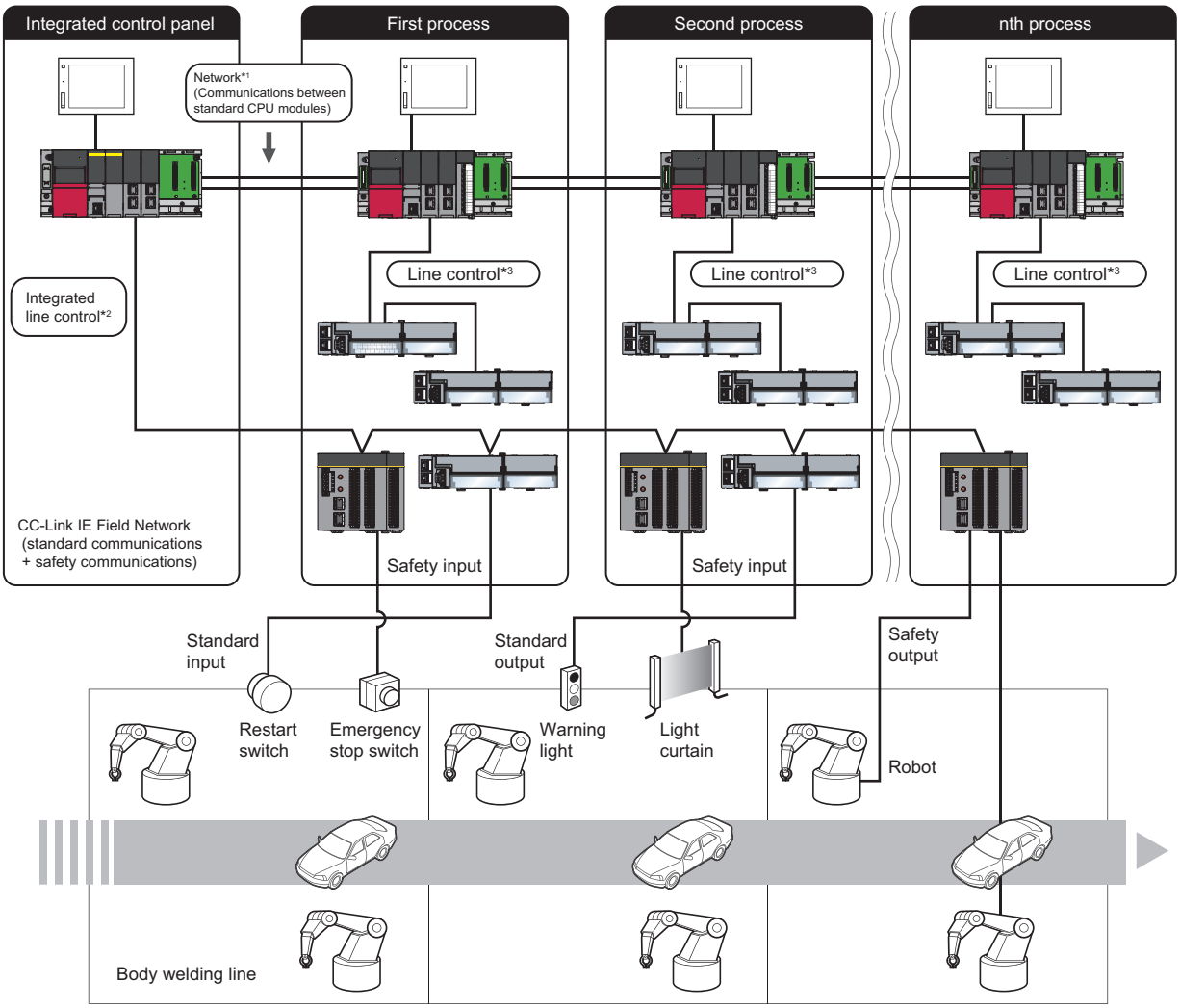
- When safe state signal is checked, supply power to the robots.
- When the safe state signal cannot be checked, cut off the power.
- The safe state signal can be checked using an emergency stop switch or a light curtain.

The safety application operated by the safety programmable controller operates as follows:

- Connect a safe state signal to the Safety remote I/O module.
- The safety remote I/O module sends the safe state signal to the safety CPU. The safety CPU processes safe state signal received with the safety program and sends safety output to the safety remote I/O module.
- The safety output cuts off the power to the robots.

The standard application operated by the safety programmable controller operates as follows:

- Perform communications between the standard programmable controller and standard CPU. Then, process integrated control on the lines.
- Connect the restart switch and warming light to a standard remote I/O module.
- Deliver the input of connected restart switch to the safety application.
- Receive a safe state signal from the safety application, and then control the warning lights.
- To perform integrated line control of the lines, communicate the input of the standard programmable controller and restart switch, the safe state signal, the operating status of standard control, and the like through communications between standard CPUs



*1 This is a network including the CC-Link IE Controller Network and Ethernet.
*2 This communicates with the CC-Link IE Field Network (standard communications + safety communications).
*3 This communicates with the CC-Link IE Field Network (standard communications).

Safety control for the entire line using multiple safety programmable controllers

The following shows an application image for the safety control linked between multiple manufacturing processes, as an application example of the safety programmable controller. The safety programmable controller processes controls linked between safety control and standard control at each process, and control processes. All processes should share safe state information from each process when connecting multiple manufacturing processes without physical separation. Share safe state information between safety programmable controllers allocated in each process, using safety communication functions between Safety CPUs.

Configure the safety application operated by the safety programmable controller for the following purposes:

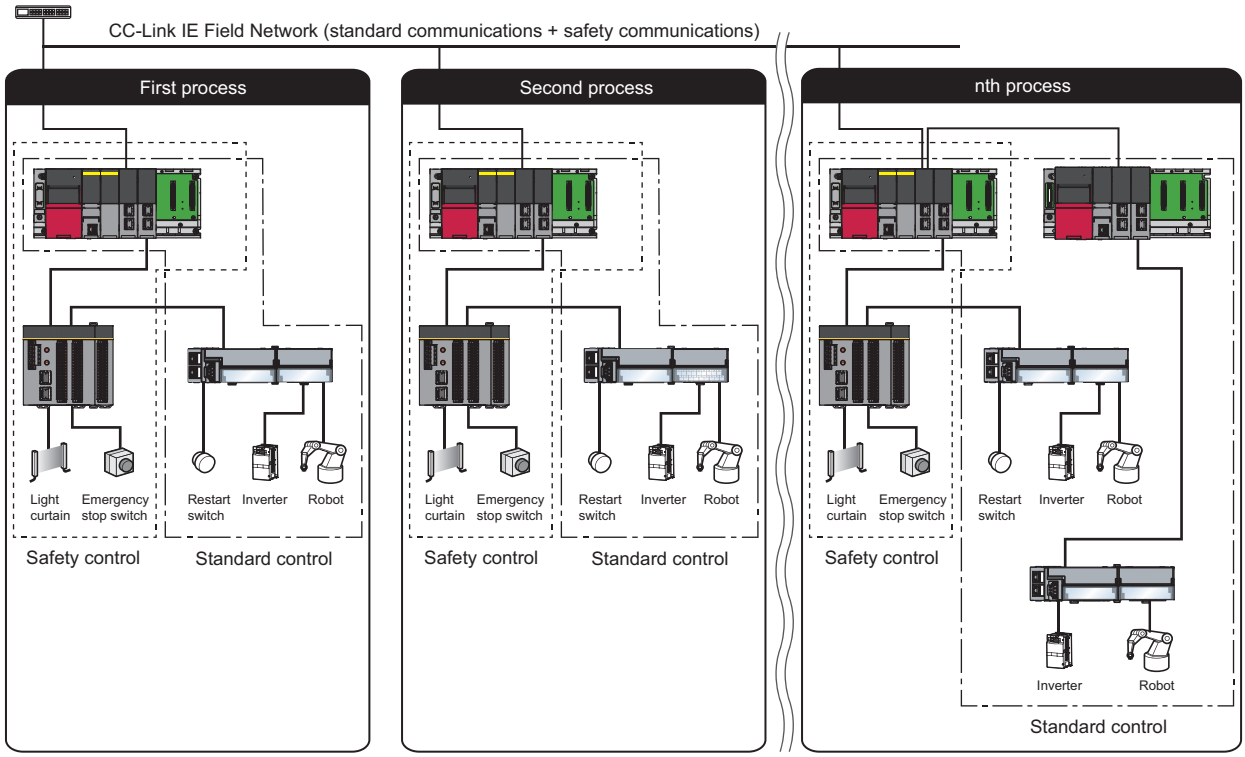
- When the safe state signal is checked, supply power to the robots.
- When safe state signal cannot be checked,, cut off the power.
- The safe state signal can be checked using an emergency stop switch or a light curtain.
- Configure the safety control linked with consecutive processes or the entire process using safety communications between Safety CPUs on the CC-Link IE Field Network.

The safety application operated by the safety programmable controller operates as follows:

- Connect a safe state signal to the safety remote I/O module.
- Connect the Safety CPUs at each process with the CC-Link IE Field Network.
- The safety remote I/O module sends the safe state signal to the Safety CPU.
- To perform emergency stop for consecutive processes or the entire line, send an emergency stop request to the Safety CPUs installed in the consecutive processes or the entire line through safety communications between Safety CPUs in CC-Link IE Field Network using the program.
- The Safety CPU processes the safe state signal received from the safety remote I/O module and an emergency stop request received by safety communications of the CC-Link IE Field Network using the safety program. Then it sends a safety output to the safety remote I/O module.
- The safety output cuts off the power to the robots.

The standard application operated by the safety programmable controller operates as follows:

- Connect restart switch, inverter, and robot to standard remote I/O module.
- Deliver input of connected restart switch to safety application.
- Perform communications to check operation status and operation instruction with inverter and robot.
- When a link is required for standard control of multiple or the same processes, send standard data through standard communications of the CC-Link IE Field Network.

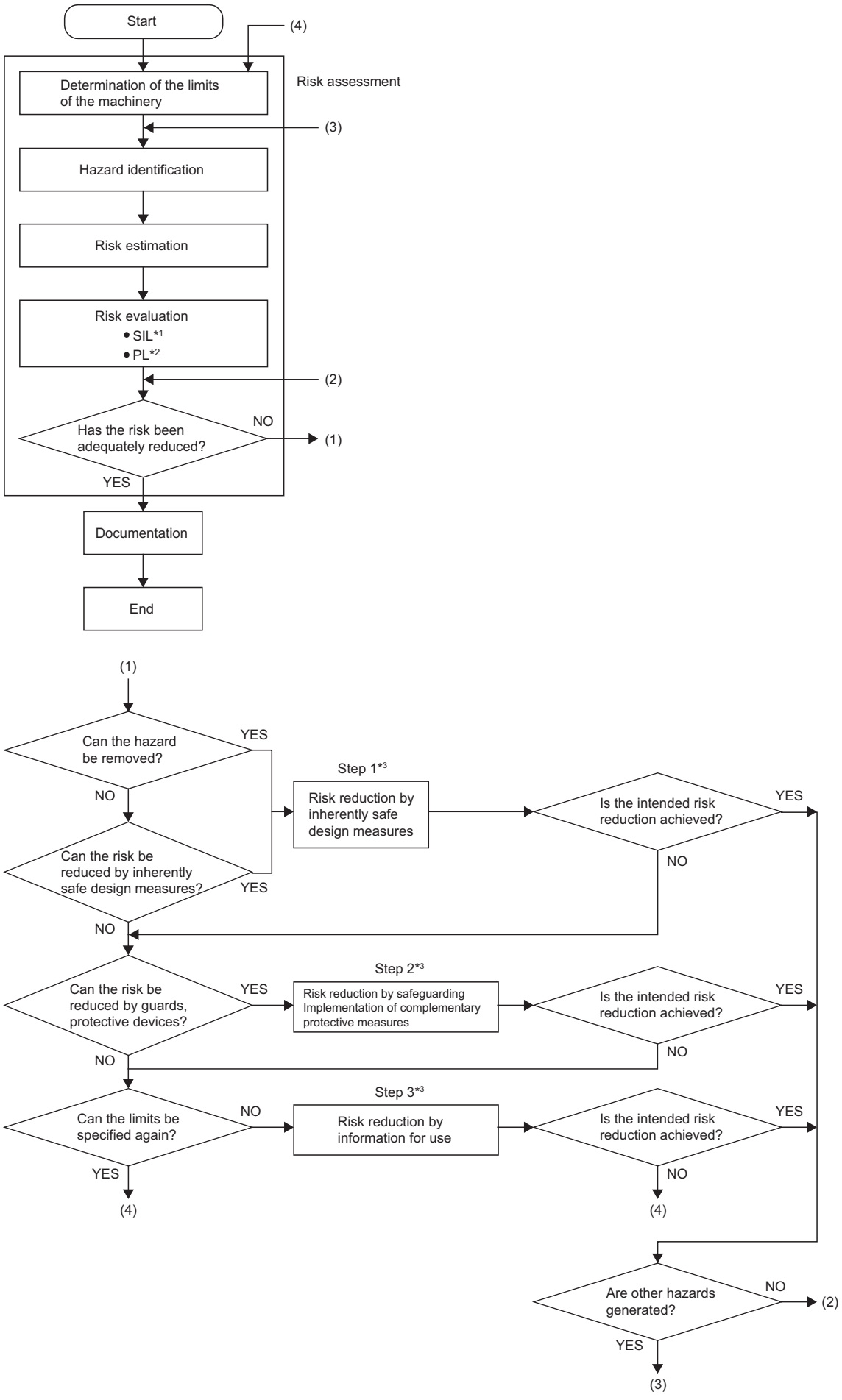


3 RISK ASSESSMENT AND SAFETY LEVEL

When using safety programmable controller, perform risk assessment on target equipment while observing ISO12100: 2010, and select appropriate SIL and PL, as well as reduce the risk conforming to ISO13849-1: 2006, IEC61508: 2010, and IEC62061: 2012.
This chapter describes the risk assessment, risk reduction, and overview of SIL and PL.

3.1 Risk Assessment

The risk assessment is to clarify potential hazards in a machine and assess the degree of the hazards.
The following shows a risk assessment and risk reduction procedures. These procedures are standardized in ISO12100: 2010 Safety of machinery -- General principles for design -- Risk assessment and risk reduction.



(For details, refer to ISO12100: 2010)

*1 SIL is standardized as an index showing the safety level. (☞ Page 22 SIL)
*2 SIL is standardized as an index showing the safety level. (☞ Page 23 PL)
*3 The risk is reduced by adding safety measures (☞ Page 21 Risk reduction).

Risk reduction

As a result of the risk assessment, when the machinery is judged as unsafe, the risk reduction must be performed by adding safety measures.

The measures for the risk reduction are standardized in ISO12100:2010 as described below.

Item		Description
Step 1	Risk reduction by inherently safe design measures	Inherently safe design measures eliminate hazards or reduce the associated risks by a suitable choice of design features of the machine itself and/or interaction between the exposed persons and the machine.
Step 2	Risk reduction by safeguarding and implementation of complementary protective measures	Taking into account the intended use and the reasonably foreseeable misuse, appropriately selected safeguarding and complementary protective measures can be used to reduce risk, when it is not practicable to eliminate a hazard, or reduce its associated risk sufficiently, using inherently safe design measures.
Step 3	Risk reduction by information for use	Where risks remain despite inherently safe design measures, safeguarding and the adoption of complementary protective measures, the residual risks shall be identified in the information for use.

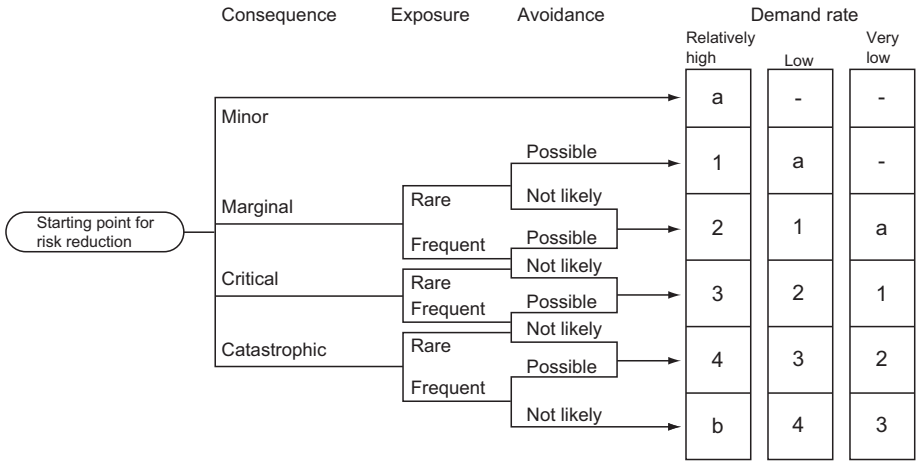
(For details, refer to ISO12100: 2010)

If ensuring the safety of machines by a single safe measure, combine and execute the multiple risk reduction measures until the machines are safe, according to the procedures above.

3.2 SIL

SIL and target failure measure (PFDavg/PFH)

SIL is standardized by IEC61508: 2010 and used in IEC62061: 2012, as an index showing the safety level. The following risk graph method can select a SIL .



Definition of symbols:

Symbol	Definition
—, a	No safety requirements
b	Not sufficient with a single safety-related system.
1, 2, 3, 4	Safety integrity level Stands for SIL1, SIL2, SIL3 and SIL4 respectively.

Probability of risk event occurrence	Definition
Frequent	The probability of unwanted event occurrence is relatively high and repeatedly occurs.
Moderate	The probability of unwanted event occurrence is relatively low and infrequently occurs.
Infrequent	The probability of unwanted event occurrence is extremely low and unlikely occurs.

(For details, refer to IEC61508-5:2010)

To achieve the selected SIL, a safety system shall be established according to the requirements for each SIL of the IEC61508: 2010. For example, the following table shows PFDavg (target failure measure for low demand mode of operation[*1]) and PFH (target failure measure for consecutive or high demand mode of operation[*1]) indicating failure rates when safety functions are nullified are specified according to the SIL level. Page 27 Calculation of the target failure measure (PFDavg/PFH) shows the calculation method for PFDavg/PFH when the safety programmable controller is used. For details on the requirements for each SIL, refer to SIL IEC61508: 2010.

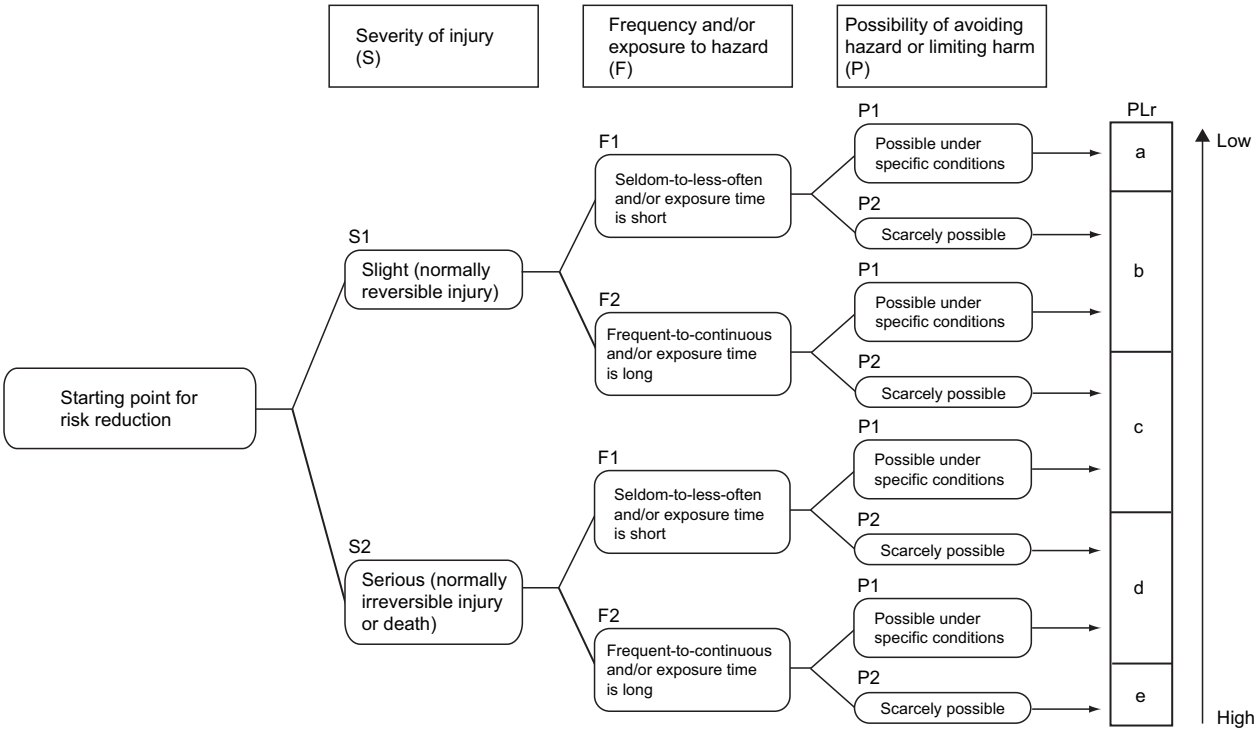
SIL	Low demand mode of operation[*1]	High demand mode of operation[*1]
4	$10^{-5} \leq$ PFDavg $< 10^{-4}$	$10^{-9} \leq$ PFH $< 10^{-8}$
3	$10^{-4} \leq$ PFDavg $< 10^{-3}$	$10^{-8} \leq$ PFH $< 10^{-7}$
2	$10^{-3} \leq$ PFDavg $< 10^{-2}$	$10^{-7} \leq$ PFH $< 10^{-6}$
1	$10^{-2} \leq$ PFDavg $< 10^{-1}$	$10^{-6} \leq$ PFH $< 10^{-5}$

(For details, refer to IEC61508-1: 2010)

*1 For the low and high demand modes of operation, refer to IEC61508: 2010.

3.3 PL

The performance level (PL) is specified in ISO13849-1: 2006. Assess the risks of machines without undergoing risk reduction measures by the safety system first, and then select a required performance level (PLr) for the safety systems. The following shows a risk graph to be used for the PLr selection.



(For details, refer to ISO13849-1: 2006)

To ensure the establishment of PLr for the PL of the safety system, establish a safety system by selecting a method and technique for the safety system.

Select PL based on (1) category, (2) average diagnostic coverage (DCavg), (3) mean time to dangerous failure (MTTFd), and (4) common cause failure (CCF).

Category

The category is a classification of safety function sustainability for the safety system. As shown in the following, categories can be classified into the items, according to the safety requirements and safety function sustainability.

The following table shows the requirements of standard for categories.

Category	Summary of requirements	Sustainability of safety functions	Features of the functions
B	• Achieve desired functions of the safety-related parts of the machine control systems.	• The occurrence of a fault can lead to loss of the safety functions.	Mainly characterized by selection of components
1	• Requirement of B shall apply. • Use well-tried and high-performance components.	• Similar to the category B, reliability of functions to ensure safety is high.	

Category	Summary of requirements	Sustainability of safety functions	Features of the functions
2	• Requirement of B shall apply. • Check safety functions at suitable intervals.	• The loss of the safety functions can be detected by the checks, however, the safety functions may be lose depends on the timing of the checks.	Mainly characterized by the system configuration method to ensure safety.
3	• Requirement of B shall apply. • A single fault does not lead to loss of the safety functions. • The single fault is detected whenever reasonably practicable.	• When a single fault occurs, the safety functions are always performed. • Some but not all faults will be detected. Accumulation of undetected faults can lead to loss of the safety functions.	
4	• Requirement of B shall apply. • A single fault can be detected when performing or before performing the safety functions • An accumulation of faults shall not lead to loss of the safety functions.	• When the faults occur the safety functions is always performed. • The faults will be detected in time to prevent loss of the safety functions.	

(For details, refer to ISO13849-1: 2006)

Mean Time to Dangerous Failure (MTTFd)

Failures can be divided into safe failure triggering the fail safe after the failure occurs and dangerous failure not triggering safety functions because of an inability to detect the failure. Mean Time to Dangerous Failure (MTTFd) means a mean time regarding dangerous failure.

The following shows the classifications of the MTTFd.

Notation	Scope of MTTFd
Low	3 years ≤ MTTFd < 10 years
Medium	10 years ≤ MTTFd < 30 years
High	30 years ≤ MTTFd ≤ 100 years

(For details, refer to ISO13849-1: 2006)

MTTFd can be calculated based on component failure rate and average number of operations per year.

If the values of devices used (average number of movements until 10% of the device undergoes dangerous failure) are known, calculate the MTTFd value using the following formula.

If the values are not known, refer to ISO13849-1: 2006 or ask the manufacturer.

$$MTTF_d = \frac{B_{10d}}{0.1 \times n_{op}}$$

$$n_{op} = \frac{d_{op} \times h_{op} \times 3600}{t_{cycle}}$$

- n_{op}: average number of operations per year (times/year)
- d_{op}: average number of days operated per year (days/year)
- h_{op}: average number of hours per day (hours/day)
- t_{cycle}: average hour per cycle (seconds/time)

For details on the calculation of the MTTFd value, refer to ISO13849-1: 2006.

Diagnostics coverage (DC) and average diagnostics coverage (DCavg)

The scope of the diagnostics coverage is the diagnostic ratio of the diagnostic method used for safety system components. It is defined based on the ratio of probabilities of dangerous failure to be detected at diagnostics and all dangerous failures. The standard specifies classification rules for how to determine which diagnostic scope shall be classified into either low, medium, or high as representative diagnostic methods, and also numerical values within the scope of diagnostics for classifications (low, medium, and high) For details on the DC estimation method, refer to ISO13849-1: 2006.

This indicates classification table for diagnostic scope.

Notation	Scope of DC
None	DC < 60%
Low	60% ≤ DC < 90%
Medium	90% ≤ DC < 99%
High	99% ≤ DC

(For details, refer to ISO13849-1: 2006)

When the safety system uses multiple components, use average diagnostics coverage (DCavg) as a mean value for diagnosis coverage (DC) for these components. The DCavg can be estimated based on the ratio of the sum total of the probability of dangerous failures to be detected at component diagnostics and the sum total of probability for all dangerous failures using the following formula.

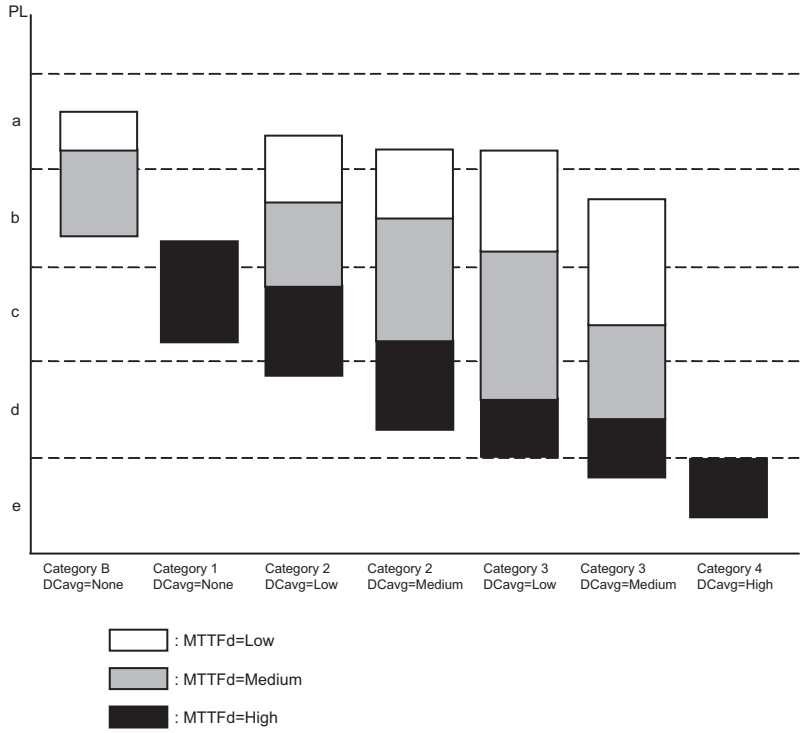
$$DC_{avg} = \frac{\frac{DC_1}{MTTF_{d1}} + \frac{DC_2}{MTTF_{d2}} + \cdots \frac{DC_N}{MTTF_{dN}}}{\frac{1}{MTTF_{d1}} + \frac{1}{MTTF_{d2}} + \cdots \frac{1}{MTTF_{dN}}}$$

- DCi: A component configuring safety system i (i = 1, ... , N)
- MTTFdi: A component configuring safety system i (i = 1, ... , N)

The relationship between low, medium, and high for the DCavg and figures shall follow the table above.

Selecting performance level

The following shows the relationship between PL and category, average diagnostics coverage (DCavg), and mean time to dangerous failure (MTTFd). Configure the safety system by selecting diagnostics methods to ensure achievement of the safety system PLr for the target machines.



(For details, refer to ISO13849-1: 2006)

■Common Cause Failure (CCF)

The CCF is a failure of multiple components caused by a single event. This includes environmental factors such as temperature and EMC, design failure, and software bags.

Quantify safety measures for CCF based on the Annexed table F, ISO13849-1: 2006. Add points specified in the table, if techniques and measures specified in the table are observed. Consider the measure for CCF of the safety system sufficient if it eventually earns 65 or more points.

Relationship between PL and SIL

As described in the following, the relationship between PL and the probability of dangerous failure per hour (PFHd) is specified in ISO13849-1: 2006.

PL	Probability of dangerous failure per hour (PFHd) (1/h)
a	$10^{-5} \leq PFHd < 10^{-4}$
b	$3 \times 10^{-6} \leq PFHd < 10^{-5}$
c	$10^{-6} \leq PFHd < 3 \times 10^{-6}$
d	$10^{-7} \leq PFHd < 10^{-6}$
e	$10^{-8} \leq PFHd < 10^{-7}$

Based on the results, relationship between PL and SIL is specified in ISO13849-1: 2006

PL	SIL High demand modes of operation/consecutive operation
a	N/A
b	1
c	1
d	2
e	3

For relationship between the category and SIL, refer to IEC62061: 2012.

4 PRECAUTIONS FOR USE OF SAFETY PROGRAMMABLE CONTROLLER

The safety standards conformance approval must be obtained for the customer with entire safety system.
The safety system inspection is made for the entire safety system including safety components and a program.
The sample program is shown in chapter 5. However, the safety standards approval is not obtained.
And all work for safety system configuration (e.g. design, installation, operation, and maintenance) has to be handled by the person who has a sufficient education concerning safety standards, safety devices, and safety programmable controller.

4.1 Precautions for Designing Safety Application

Response time

The response time is a time from the safety input off to the safety output off using the safety programmable controller.
The response time is needed for determining the safety distance for a safety system.
For calculation of the response time of a system to be configured, refer to the following description.
☞ Page 195 Calculating Safety Response Time for System Configured with a Safety CPU

Calculation of the target failure measure (PFDavg/PFH)

The target failure measure (PFDavg/PFH) is a target value of reliability for each SIL level standardized in IEC61508:2010. (Refer to ☞ Page 22 SIL)
When configuring the safety system using the safety programmable controller, a safety application shall configure a safety path, including a safety switch through the safety actuator. For example, if the following PFDavg/PFH for safety devices on the safety path does not meet the SIL required value described in Page 22 SIL and target failure measure (PFDavg/PFH), the safety application cannot reach the required SIL.
Calculate the PFDavg/PFH for each safety application using the following formula. If the safety path goes through the same safety device multiple times, add PFDavg/PFH for each safety device one time only.
PFDavg/PFH = (PFDavg/PFH of A) + (PFDavg/PFH of B) + (PFDavg/PFH of C) + (PFDavg/PFH of D) + (PFDavg/PFH of E)

Symbol	Definition
A*1	Safety CPU
B*2*4	Safety remote I/O module connected to safety input device
C*4	Safety remote I/O module connected to safety output device
D*3*4	Safety input device
E*3*4	Safety output device

*1 When performing safety communications between Safety CPUs on the safety path, add PFDavg/PFH for the Safety CPU performing safety communications on the safety path. Add no PFDavg/PFH for the Safety CPU not performing safety communications on the safety path, even if it is on the same network.
*2 When using an extension module (NZ2EXSS2-8TE) connected to the main module (NZ2GFSS2-32D) as a safety remote I/O module, perform the calculation using PFDavg/PFH connecting the extension module to the main module.
*3 For PFDavg of D and E, and PFH, refer to the manuals for the safety components used.
*4 When the safety application includes multiple safety switches or safety actuators, perform the calculation by adding all PFDavg/PFH for the safety remote I/O module, safety input device, and safety output device connected to the device.

This indicates PFDavg/PFH related to the safety programmable controller.

Module		PFDavg	PFH (/h)
PFDavg/PFH of the Safety CPU*5		1.02×10^{-5}	5.50×10^{-9}
PFDavg/PFH of the safety remote I/O module*6	Main module only (NZ2GFSS2-32D)	3.54×10^{-5}	3.55×10^{-9}
	Connecting extension module to the main module (NZ2GFSS2-32D + NZ2EXSS2-8TE)	4.66×10^{-5}	4.78×10^{-9}

*5 Proof test interval is 10 years (module replacement cycle)
*6 Proof test interval is 5 years (module replacement cycle)

Calculation examples are described as a line topology. However, calculation is possible using the methods described in this section regardless of the connection methods (such as line topology, star topology, or ring topology).

■When using a safety CPU and a safety remote I/O module (connecting extension module)

Connect the emergency stop switch to the main module of the safety remote I/O module. Connect the safety relay to the same extension module of the safety remote I/O module. Safety CPU controls safety relay on/off based on the input from emergency stop switch.

- PFDavg/PFH of A: PFDavg/PFH value of a Safety CPU on the safety path
- PFDavg/PFH of B: PFDavg/PFH value when connecting the extension module (B2) to the main module (B1)
- PFDavg/PFH of C: Do not add this to PFDavg/PFH, since it uses safety remote I/O module same as B (A safety device can be added for only once per safety path)
- PFDavg/PFH of D: PFDavg/PFH value of emergency stop switch
- PFDavg/PFH of E: PFDavg/PFH value of safety relay

PFD = (PFDavg of A) + (PFDavg of B1 and B2) + (PFDavg of D) + PFDavg of E)

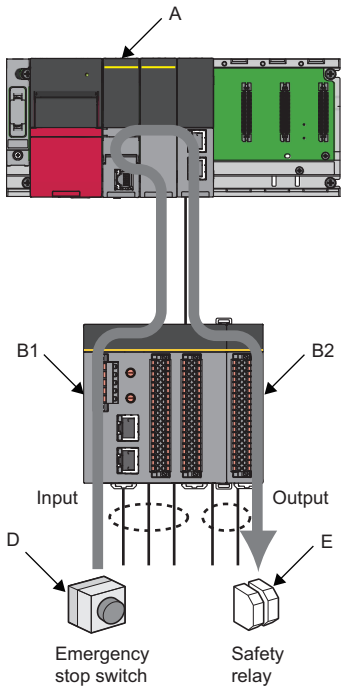
= (1.02×10^{-5}) + (4.66×10^{-5}) + (PFDavg of D) + (PFDavg of E)

= (5.68×10^{-5}) + (PFDavg of D) + (PFDavg of E)

PFH = (PFH of A) + PFH of B1 and B2) + (PFH of D) + (PFH of E)

= (5.50×10^{-9}) + (4.78×10^{-9}) + (PFH of D) + (PFH of E)

= (1.03×10^{-8}) + (PFH of D) + (PFH of E)



■Using a Safety CPU and two safety remote I/O modules (connecting the extension module to only one module)

Connect the emergency stop switch to the main module of the safety remote I/O module. Connect the safety relay to another extension module of the safety remote I/O module. Safety CPU controls the safety relay on/off according to the input from the emergency stop switch.

- PFDavg/PFH of A: PFDavg/PFH value of a Safety CPU on safety path
- PFDavg/PFHof B: PFDavg/PFH value of main module B, since only used for main module
- PFDavg/PFH of C: PFDavg/PFH value when mounting extension module (C2) on the main module (C1)
- PFDavg/PFH of D: PFDavg/PFH value of emergency stop switch
- PFDavg/PFH of E: PFDavg/PFH value of safety relay

PFD = (PFDavg of A) + (PFDavg of B) + (PFDavg of C1 and C2) + (PFDavg of D) + (PFDavg of E)

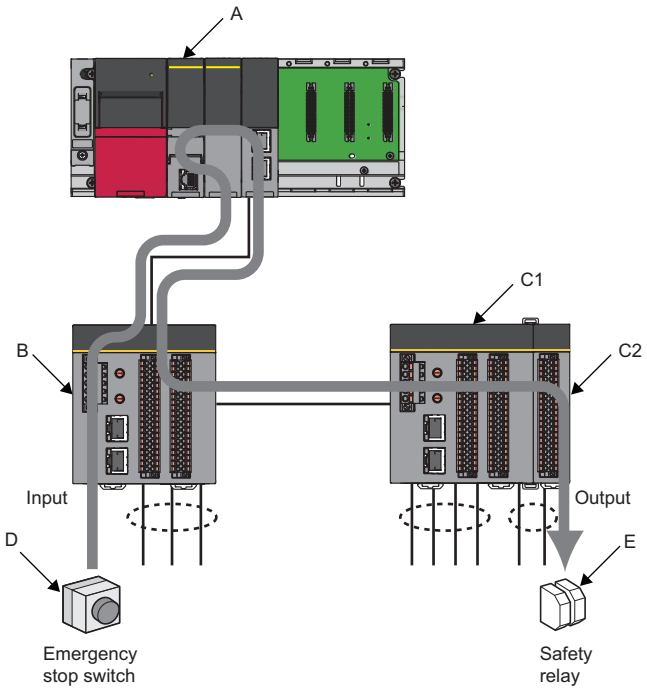
= (1.02×10^{-5}) + (3.54×10^{-5}) + (4.66×10^{-5}) + (PFDavg of D) + (PFDavg of E)

= (9.22×10^{-5}) + (PFDavg of D) + (PFDavg of E)

PFH = (PFH of A) + (PFH of B) + (PFH of C1 and C2) + (PFH of D) + (PFH of E)

= (5.50×10^{-9}) + (3.55×10^{-9}) + (4.78×10^{-9}) + (PFH of D) + (PFH of E)

= (1.38×10^{-8}) + (PFH of D) + (PFH of E)



■Using a Safety CPU and two safety remote I/O modules (connecting extension module to both modules)

Connect the emergency stop switch to the main module of the safety remote I/O module. Connect the safety relay to another extension module of the safety remote I/O module. Safety CPU controls safety relay on/off based on the input from emergency stop switch.

- PFDavg/PFH of A: PFDavg/PFH value of a Safety CPU on the safety path
- PFDavg/PFH of B: PFDavg/PFH value when connecting extension module (B2) on the main module (B1)
- PFDavg/PFH of C: PFDavg/PFH value when connecting extension module (C2) on the main module (C1)
- PFDavg/PFH of D: PFDavg/PFH value of the emergency stop switch
- PFDavg/PFH of E: PFDavg/PFH value of the safety relay

PFD = (PFDavg of A) + (PFDavg of B1 and B2) + (PFDavg of C1 and C2) + (PFDavg of D) + (PFDavg of E)

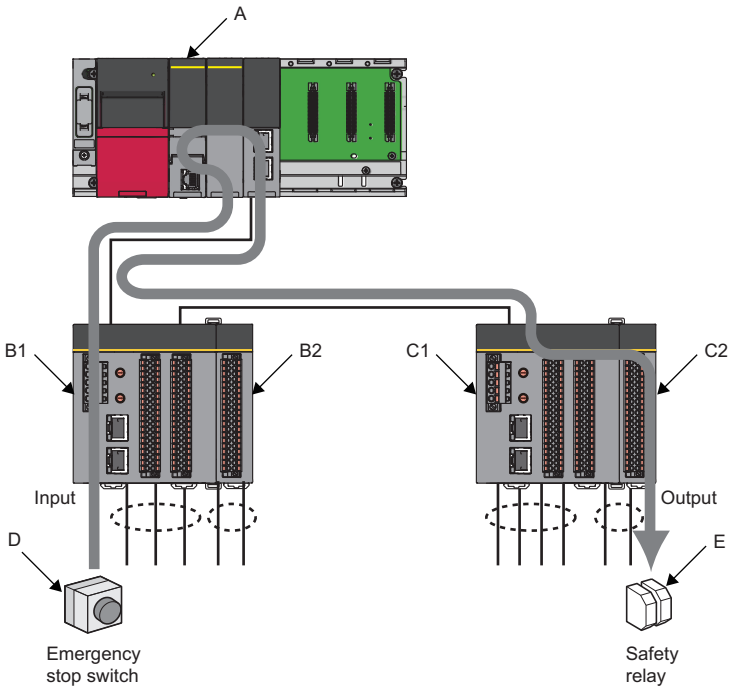
= (1.02×10^{-5}) + (4.66×10^{-5}) + (4.66×10^{-5}) + (PFDavg of D) + (PFDavg of E)

= (1.03×10^{-5}) + (PFDavg of D) + (PFDavg of E)

PFH = (PFH of A) + (PFH of B1 and B2) + (PFH of C1 and C2) + (PFH of D) + (PFH of E)

= (5.50×10^{-9}) + (4.78×10^{-9}) + (4.78×10^{-9}) + (PFH of D) + (PFH of E)

= (1.51×10^{-8}) + (PFH of D) + (PFH of E)



■Using two Safety CPUs and two safety remote I/O modules (connecting extension module to both modules)

Connect the emergency stop switch to the main module of the safety remote I/O module. Connect the safety relay to both of the extension modules of the safety remote I/O module. Safety CPU controls safety communications between Safety CPUs and safety relay on/off according to the input from the emergency stop switch.

- PFDavg/PFH of A: Sum total of the PFDavg/PFH values of two Safety CPUs (A1 and A2) on the safety path.
- PFDavg/PFH of B: PFDavg/PFH value when connecting extension module (B2) on the main module (B1)
- PFDavg/PFH of C: The safety relay is connected to the safety programmable controller (1) and (2), so that add PFDavg/PFH value of the safety remote I/O module that the safety relays are connected to. Note, however, that the safety relay connected to the safety programmable controller (1) is connected to the safety remote I/O module that is same as B. Therefore, adding the PFDavg/PFH of the safety programmable controller (1) safety remote I/O module to the PFDavg/PFH of C is unnecessary (A safety device can be added for only once per safety path). Therefore, the value becomes PFDavg/PFH value of the safety remote I/O module of the safety programmable controller (2). The PFDavg/PFH value of the safety remote I/O module of the safety programmable controller (2) becomes the PFDavg/PFH value when connecting the extension module (C2) to the main module (C1).
- PFDavg/PFH of D: PFDavg/PFH value of the emergency stop switch
- PFDavg/PFH of E: sum total of PFDavg/PFH value of two safety relays (E1 and E2) in safety application

PFD = (PFDavg of A1) + (PFDavg of A2) + (PFDavg of B1 and B2) + (PFDavg of C1 and C2) + (PFDavg of D) + (PFDavg of E1) + (PFDavg of E2)

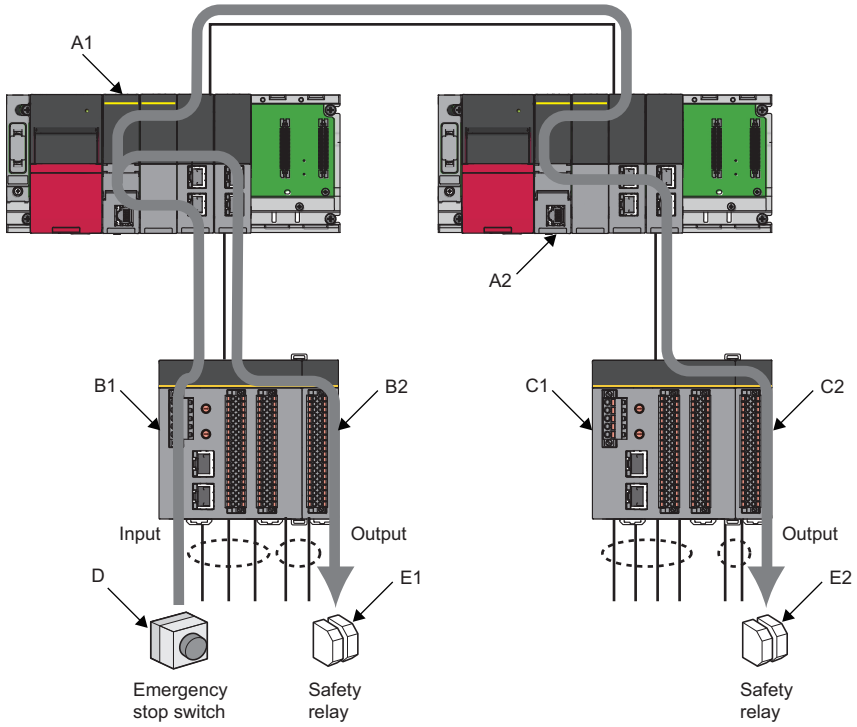
= (1.02×10^{-5}) + (1.02×10^{-5}) + (4.66×10^{-5}) + (4.66×10^{-5}) + (PFDavg of D) + (PFDavg of E1) + (PFDavg of E2)

= (1.14×10^{-4}) + (PFDavg of E1) + (PFDavg of E2)

PFH = (PFH of A1) + (PFH of A2) + (PFH of B1 and B2) + (PFH of C1 and C2) + (PFH of D) + (PFH of E1) + (PFH of E2)

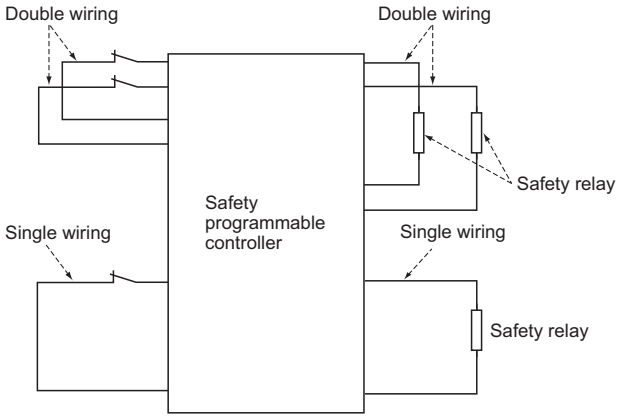
= (5.50×10^{-9}) + (5.50×10^{-9}) + (4.78×10^{-9}) + (4.78×10^{-9}) + (PFH of D) + (PFH of E1) + (PFH of E2)

= (2.06×10^{-8}) + (PFH of D) + (PFH of E1) + (PFH of E2)



Connecting safety components

Connect safety components according to the following safety level by dual wiring and single wiring.



Point

Use the doubling input signal to the CC-Link IE Field Network remote I/O module (with safety functions) with the following combinations of input terminals. For combinations other than the following, an error is detected by doubling input discrepancy detection.

{X0, X1}, {X2, X3}, {X4, X5}, {X6, X7}, {X8, X9}, {XA, XB}, {XC, XD}, {XE, XF}, {X10, X11}, {X12, X13}, {X14, X15}, {X16, X17}, {X18, X19}, {X1A, X1B}, {X1C, X1D}, {X1E, X1F}

To execute the input dark test, connect the safety components using a test pulse terminal.

Point

To execute the input dark test function, use the input terminals and test pulse terminals of the CC-Link IE Field Network remote I/O module (with safety functions) with the following combinations. Connecting to the incorrect test pulse terminal is identified as a disconnection and causes an error.

[Correct combination]

{X0, X2, X4, X6, X8, XA, XC, XE} and T0

{X1, X3, X5, X7, X9, XB, XD, XF} and T1

{X10, X12, X14, X16, X18, X1A, X1C, X1E} and T2

{X11, X13, X15, X17, X19, X1B, X1D, X1F} and T3

When not performing input dark test, the COM+ terminal can be used.

Point

Use the dual wiring for the CC-Link IE Field Network remote I/O module (with safety functions) with the following combinations of output terminals.

{Y0, Y1}, {Y2, Y3}, {Y4, Y5}, {Y6, Y7}

For specific wiring and setting methods, refer to Page 50 SAFETY APPLICATION CONFIGURATION EXAMPLES.

For details on dual wiring, single wiring, and input dark test, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

Remote register (RWr/RWw) of the safety remote I/O module

System uses 16 points each of the RWr/RWw to communicate with safety remote I/O module. Do not read/write data from/to the RWr/RWw to be used by the system. Writing data may cause malfunction of the safety programmable controller.
For relationship between the Safety CPU device and remote register, refer to Page 69 Relationship between devices in the Safety CPU and remote inputs/outputs.
For details, refer to the following.
📖 CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

Using the monitor data of the engineering tool

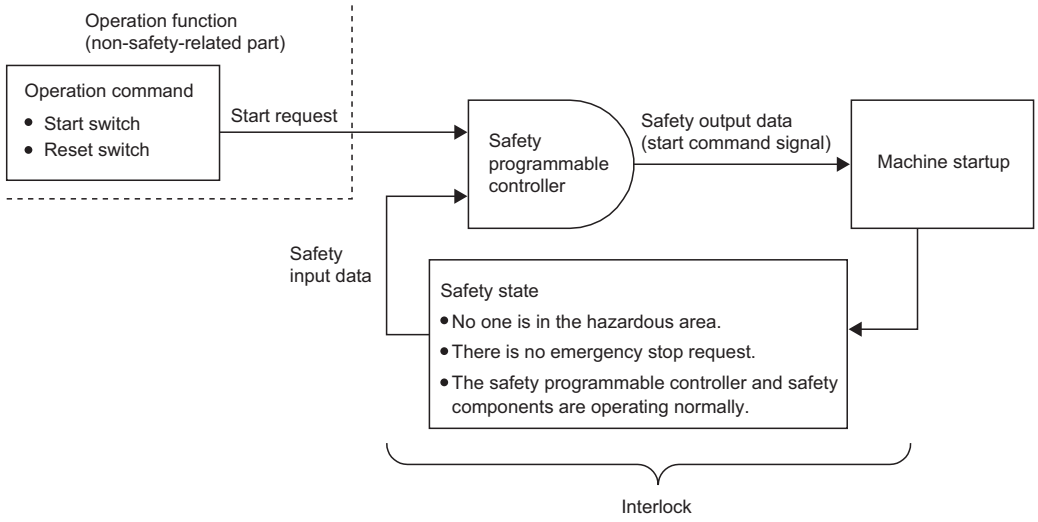
The monitor data to be displayed by the engineering tool should not be used for the operation related to the safety. (For example, the operations for the safety such as starting a machine or resetting the stop status should not be performed with checking the monitor data displayed on the engineering tool).

4.2 Precautions for Programming

Basic programming

Configure a program for realizing safety functions with attention to the following points.

- Program so that a machine is started only when safe state can be checked at the time the start switch is pressed.
- Program so that a machine is stopped if the safe state is not checked.
- Program so that a machine is started at the fall (on→off) of the signal of the start switch. The programming can prevent a machine from accidentally starting at the switch failure (such as contact welding, spring damage).
- To inhibit restart without manual operation after safety functions were performed and outputs were turned off, create an interlock program which uses a reset button for restart.



For specific program examples, refer to the following.

☞ Page 50 SAFETY APPLICATION CONFIGURATION EXAMPLES

Creating programs for realizing the safety functions

Configure a program for realizing the safety functions using a method different from the standard program describing standard control as a safety program.

Configure a safety program using safety devices, safety labels, standard/safety shared labels, instructions for safety measure, and safety FB/FUN.

Devices can be used for the following safety program.

Classification	Type	Device name	Symbol	Notation
Safety user device	Bit device	Safety input	SA\X	Hexadecimal
		Safety output	SA\Y	Hexadecimal
		Safety internal relay	SA\M	Decimal
		Safety link relay	SA\B	Hexadecimal
	Bit/word device	Safety timer	SA\T	Decimal
		Safety retentive timer	SA\ST	Decimal
		Safety counter	SA\C	Decimal
	Word device	Safety data register	SA\D	Decimal
		Safety link register	SA\W	Hexadecimal
Safety system device	Bit device	Safety special relay	SA\SM	Decimal
	Word device	Safety special register	SA\SD	Decimal
Constant	—	—	K	Decimal
			H	Hexadecimal

Local devices can be used for the following safety program.

- Safety internal relay (SA\M)
- Safety timer (SA\T, SA\ST)
- Safety counter (SA\C)
- Safety data register (SA\D)

Safety devices can be used in safety programs are read-only from the GOT. For details on these devices, refer to the GOT manual.

Labels can be used in safety programs are safety global labels, safety local labels, and standard/safety shared labels only.

The following indicates whether standard/safety program labels can be used or not.

R/W: readable and writable, —: not readable nor writable

Label type		Standard program	Safety program
Global label	Standard global label*1	R/W	—
	Standard/safety shared global label	R/W	R/W
	Safety global label*2	—	R/W
Local label	Standard local label*3	R/W	—
	Safety local label*4	—	R/W

*1 Global label selected "standard" in category
*2 Global label selected "safety" in category
*3 Local label defined as standard program
*4 Local label defined as safe program

Set capacity and number of points for safety device, safety label, and standard/safety shared label used by the Safety CPU from parameter setting window of the engineering tool.

For how to create a useable device/label, how to create safety program, programming method, and execution type of programs, refer to the following.

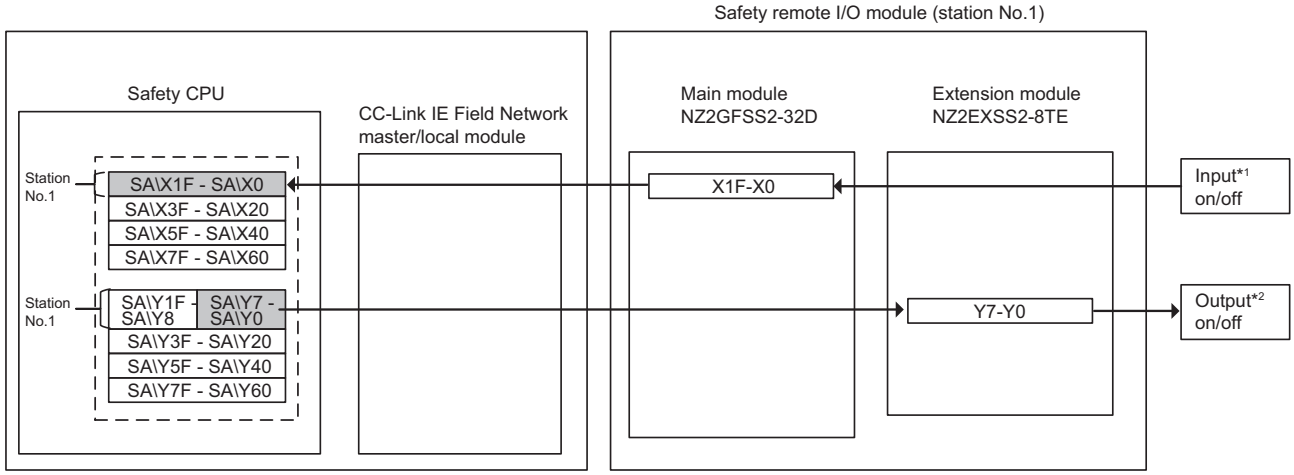
GX Works3 Operating Manual
MELSEC iQ-R CPU Module User's Manual (Application)

Programs to be used in a program for realizing safety functions

Configure input and output data of a program for realizing safety functions using safety data. Determine the safety/non-safety of input/output data as follows.

■Devices transferring safety data through safety communications with safety remote I/O module

The safety data of devices transferring safety data to be refreshed by safety communications with the safety remote I/O module is a safety data.



*1 These are input such as emergency stop switch, safety switch, and light curtains.

*2 These are the outputs such as power source of the robots.

User devices to be refreshed by communications with standard remote I/O module can be used only by standard program. When using standard remote I/O module inputs and outputs with safety program, use standard/safety shared label to deliver data between standard and safety programs. (☞ Page 37 Standard/safety shared label)

■Devices transferring safety data by safety communications between Safety CPUs

The safety data of devices transferring safety data to be refreshed by safety communications between Safety CPUs with the CC-Link IE Field Network is a safety data. For details, refer to the following.

📖 MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)

■Standard/safety shared label

This is a label to deliver data between safety program and standard program. The standard/safety shared label data are non-safety data. Input data from standard remote I/O module are input as non-safety data to safety program by standard/safety shared label, so that they cannot be used for safety control. Similarly, standard remote I/O module data output from safety program by standard/safety shared label are non-safety data. Therefore, they cannot be used for safety control.

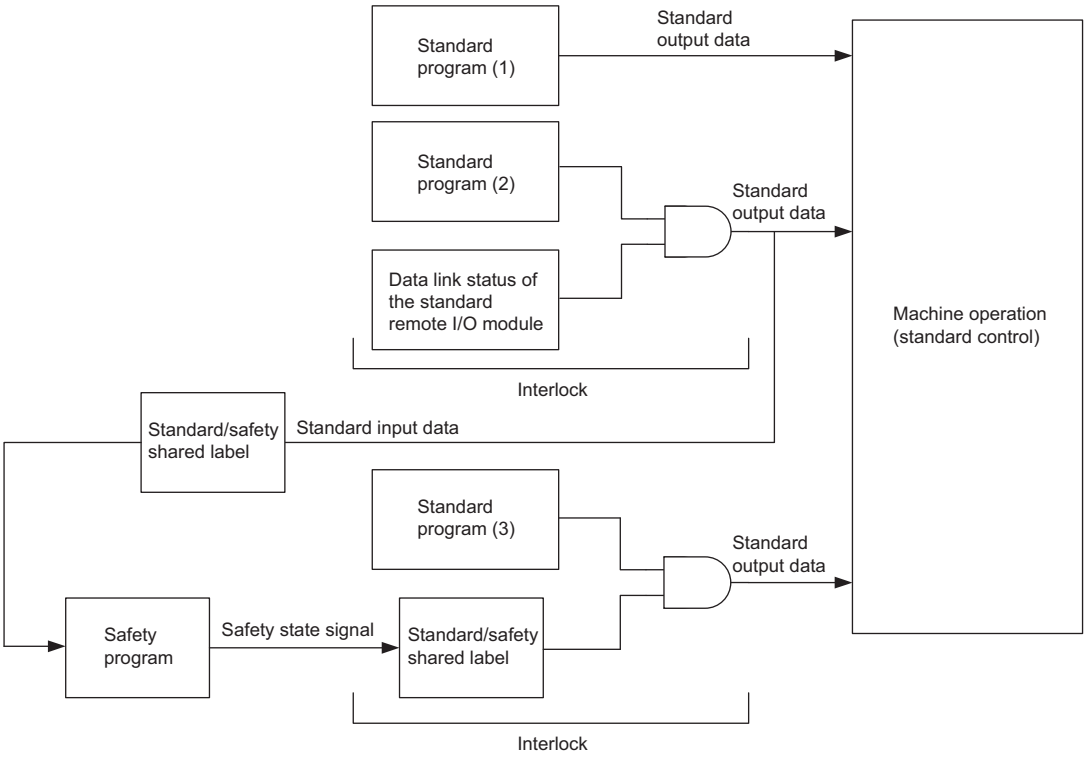
When a standard/safety shared label is used in a safety program, create the program so that the device operates only when safety state is secured. For example, if there are safety devices or safety labels to check safety status using an AND circuit such as an emergency stop switch connected to a safety remote I/O module and input data from a light curtain, combine the safety devices and safety labels to form an AND circuit.

The following shows application examples for standard/safety shared labels.

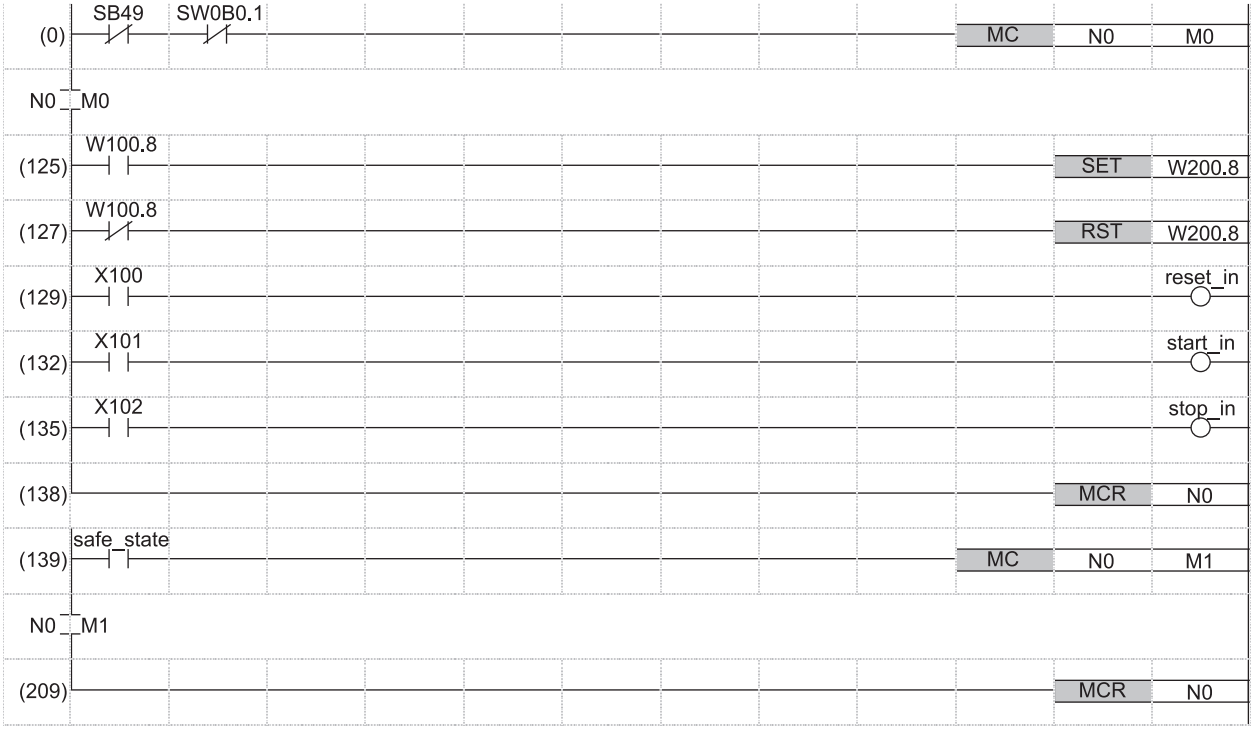
Start processing of standard program (1) without establishing interlock with other devices. Start processing of standard program (2) after establishing interlock with standard remote I/O module. In the following example, the standard data X100, X101, and X102 input from standard remote I/O module is delivered to safety program with standard/safety shared label. The safety program uses the start signal of the device "start_in" as part of an AND circuit together with the safety information "SA\M5". Start processing of standard program (3) after establishing interlock with standard remote I/O module. Also, in the following example, data same as safety information of safety program "SA\M5" is delivered to standard program with standard/safety shared label. The standard program uses "safe_state" to establish an interlock. These methods are used when desiring to start operation after completing safety check using the safety control.

For details on the described programs, refer to the following specific examples.

☞ Page 50 SAFETY APPLICATION CONFIGURATION EXAMPLES



• Standard program

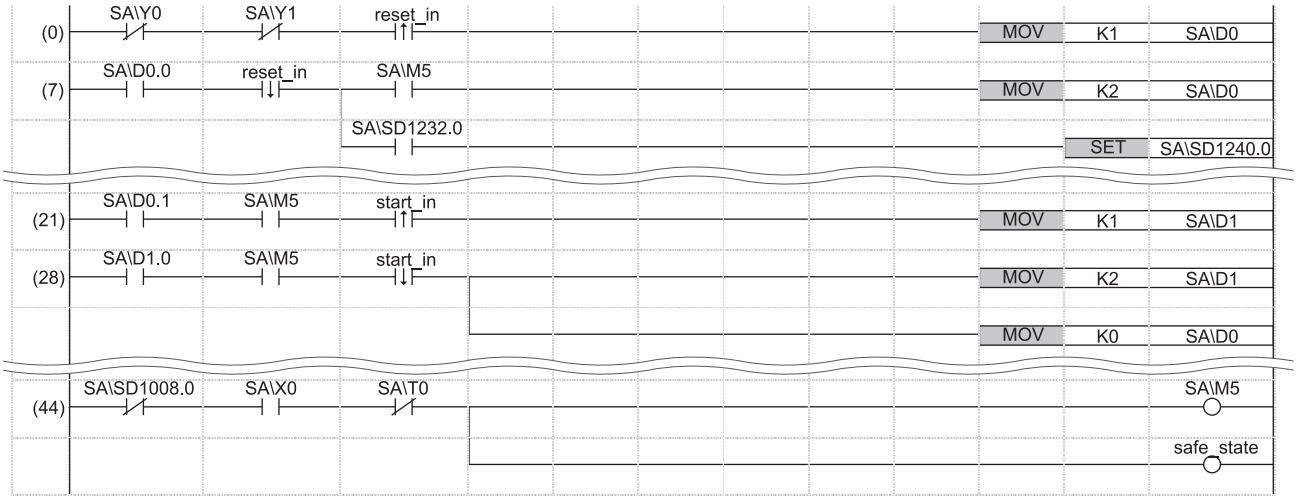


(0) Checking data link status on the station number 2 (standard remote I/O module)

(125) to (135) Write a program that establishes an interlock with standard remote I/O module.

(139) Checking safety status signal (safe_state)
Write a program that establishes an interlock with safety status signal.

• Safety program



(0) to (7) This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.

(21) to (28) This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.

(44) This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation.
This is a circuit to assign safety signals to the standard/safety shared label

For setting methods of the standard/safety shared label, refer to the following.

GX Works3 Operating Manual

For setting methods of the standard remote I/O module refresh communications, refer to the following.

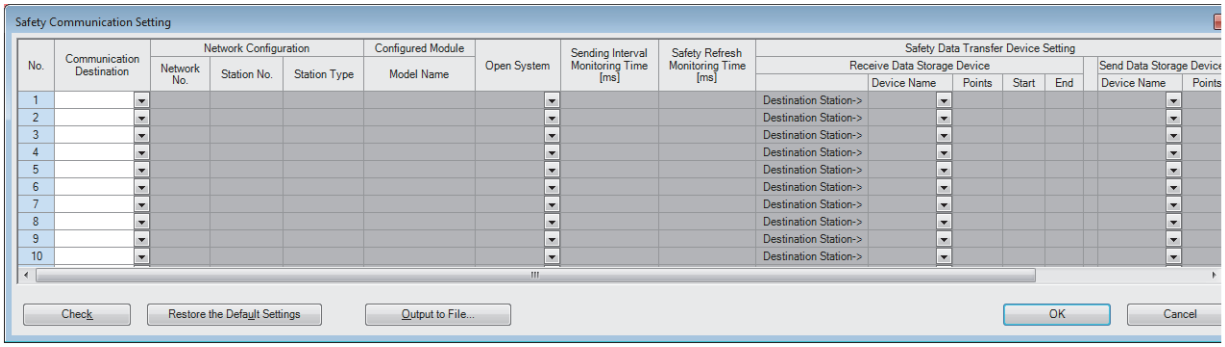
CC-Link IE Field Network Remote I/O Module User's Manual

Detecting errors in the CC-Link IE Field Network

Errors occurred in the CC-Link IE Field Network can be detected using safety refresh communication status. Create a program using safety refresh communication status, which turns off safety outputs in case of an error.

■Safety refresh communication status

The following shows the special register to check safety refresh communication status for each safety connection. If multiple CC-Link IE Field Network master/local modules are connected to the base unit, the number of the special register varies according to the number of modules connected. The safety connection number is the one displayed as "No" on the detailed setting window of the safety communication in the CC-Link IE Field Network master/local module.



Name	No.	Description of bits for the special registers (safety refresh communication status)
Safety refresh communication status of each safety connection (1st module)	SA\SD1008 to SA\SD1015	Description of bits of the following table 0: Normal safety communication, reserved safety connection 1: Safety communication error 1 to 120: Safety connection number —: Fixed to 0.
Safety refresh status of each safety connection (2nd module)	SA\SD1016 to SA\SD1023	Description of bits of the following table 0: Normal safety communication, reserved safety connection 1: Safety station communication error 1 to 120: Safety connection number -: Fixed to 0.

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1008	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1009	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1010	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1011	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1012	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1013	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1014	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1015	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1016	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1017	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1018	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1019	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1020	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1021	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1022	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1023	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

Name	No.	Description of bits for the special registers (safety refresh communication status)
Safety refresh status of each safety connection (3rd module)	SA\SD1024 to SA\SD1031	Description of bits of the following table 0: Normal safety communication, reserved safety connection 1: Safety station communication error 1 to 120: Safety connection number —: Fixed to 0.
Safety refresh status of each safety connection (4th module)	SA\SD1032 to SA\SD1039	Description of bits of the following table 0: Normal safety communication, reserved safety connection 1: Safety station communication error 1 to 120: Safety connection number —: Fixed to 0.
Safety refresh status of each safety connection (5th module)	SA\SD1040 to SA\SD1047	Description of bits of the following table 0: Normal safety communication, reserved safety connection 1: Safety station communication error 1 to 120: Safety connection number —: Fixed to 0.
Safety refresh status of each safety connection (6th module)	SA\SD1048 to SA\SD1055	Description of bits of the following table 0: Normal safety communication, reserved safety connection 1: Safety station communication error 1 to 120: Safety connection number —: Fixed to 0.

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1024	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1025	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1026	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1027	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1028	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1029	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1030	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1031	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1032	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1033	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1034	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1035	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1036	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1037	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1038	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1039	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1040	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1041	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1042	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1043	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1044	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1045	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1046	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1047	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1048	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1049	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1050	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1051	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1052	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1053	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1054	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1055	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

Name	No.	Description of bits for the special registers (safety refresh communication status)
Safety refresh status of each safety connection (7th module)	SA\SD1056 to SA\SD1063	Description of bits of the following table 0: Normal safety communication, reserved safety connection 1: Safety station communication error 1 to 120: Safety connection number —: Fixed to 0.
Safety refresh communication status of each safety connection (8th module)	SA\SD1064 to SA\SD1071	Description of bits of the following table 0: Normal safety communication, reserved safety connection 1: Safety station communication error 1 to 120: Safety connection number —: Fixed to 0.

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1056	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1057	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1058	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1059	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1060	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1061	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1062	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1063	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

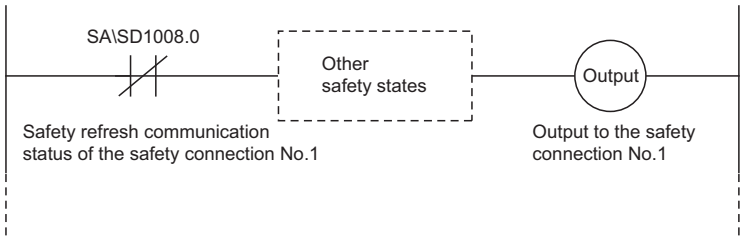
	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1064	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1065	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1066	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1067	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1068	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1069	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1070	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1071	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

For details, refer to the following.

📖 MELSEC iQ-R CPU Module User's Manual (Application)

■Program example

The program for handling the error detection for the first module of the CC-Link IE Field Network of CC-Link IE Field Network master/local module connected on the following base unit. Check safety refresh communication status with safety connection number 1 using SA\SD1008.0. The following is the program example that is used when outputting to the safety connection No.1.



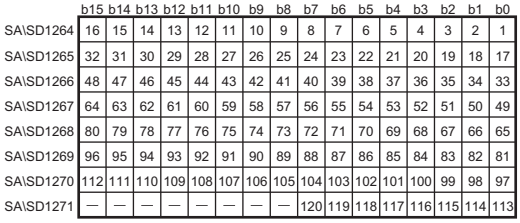
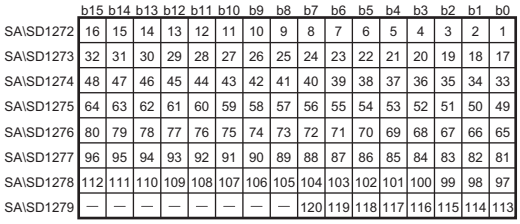
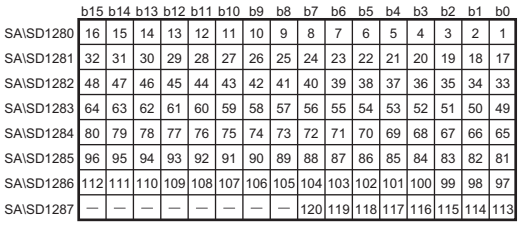
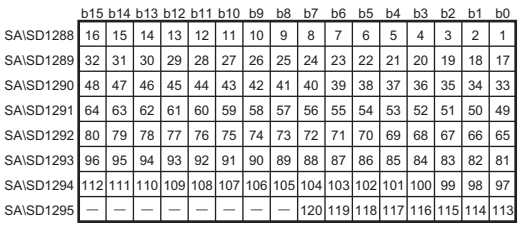
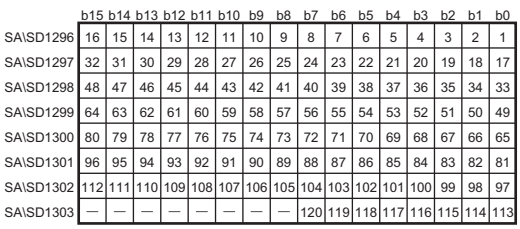
Clearing error in the CC-Link IE Field Network

If an error is detected in CC-Link IE Field Network, the following safety station interlock status. Create a program using safety station interlock status, which turns off safety outputs in case of an error. To restart communications on the CC-Link IE Field Network, it is required to turn on the safety station interlock release request. Create a program in which a safety station interlock release request is manually turned on (e.g. reset button).

■Safety station interlock status

The following table shows names and numbers of special registers for checking safety station interlock status and interlock release request.

<table>
<tr><th>Name</th><th>No.</th><th>Description of bits of special register</th></tr>
<tr><td>Interlock status of each safety connection (1st module)</td><td>SA\SD1232 to SA\SD1239</td><td>0: Not interlocked
1: Interlocked
<table><tr><th></th><th>b15</th><th>b14</th><th>b13</th><th>b12</th><th>b11</th><th>b10</th><th>b9</th><th>b8</th><th>b7</th><th>b6</th><th>b5</th><th>b4</th><th>b3</th><th>b2</th><th>b1</th><th>b0</th></tr><tr><td>SA\SD1232</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr><tr><td>SA\SD1233</td><td>32</td><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td></tr><tr><td>SA\SD1234</td><td>48</td><td>47</td><td>46</td><td>45</td><td>44</td><td>43</td><td>42</td><td>41</td><td>40</td><td>39</td><td>38</td><td>37</td><td>36</td><td>35</td><td>34</td><td>33</td></tr><tr><td>SA\SD1235</td><td>64</td><td>63</td><td>62</td><td>61</td><td>60</td><td>59</td><td>58</td><td>57</td><td>56</td><td>55</td><td>54</td><td>53</td><td>52</td><td>51</td><td>50</td><td>49</td></tr><tr><td>SA\SD1236</td><td>80</td><td>79</td><td>78</td><td>77</td><td>76</td><td>75</td><td>74</td><td>73</td><td>72</td><td>71</td><td>70</td><td>69</td><td>68</td><td>67</td><td>66</td><td>65</td></tr><tr><td>SA\SD1237</td><td>96</td><td>95</td><td>94</td><td>93</td><td>92</td><td>91</td><td>90</td><td>89</td><td>88</td><td>87</td><td>86</td><td>85</td><td>84</td><td>83</td><td>82</td><td>81</td></tr><tr><td>SA\SD1238</td><td>112</td><td>111</td><td>110</td><td>109</td><td>108</td><td>107</td><td>106</td><td>105</td><td>104</td><td>103</td><td>102</td><td>101</td><td>100</td><td>99</td><td>98</td><td>97</td></tr><tr><td>SA\SD1239</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>120</td><td>119</td><td>118</td><td>117</td><td>116</td><td>115</td><td>114</td><td>113</td></tr></table>1 to 120: Safety connection numbers
—: Fixed to 0.</td></tr>
<tr><td>Interlock release request for each safety connection (1st module)</td><td>SA\SD1240 to SA\SD1247</td><td>0: I/O interlock of safety station on CC-Link IE Field Network not released
1: I/O interlock of safety station on CC-Link IE Field Network released
<table><tr><th></th><th>b15</th><th>b14</th><th>b13</th><th>b12</th><th>b11</th><th>b10</th><th>b9</th><th>b8</th><th>b7</th><th>b6</th><th>b5</th><th>b4</th><th>b3</th><th>b2</th><th>b1</th><th>b0</th></tr><tr><td>SA\SD1240</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr><tr><td>SA\SD1241</td><td>32</td><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td></tr><tr><td>SA\SD1242</td><td>48</td><td>47</td><td>46</td><td>45</td><td>44</td><td>43</td><td>42</td><td>41</td><td>40</td><td>39</td><td>38</td><td>37</td><td>36</td><td>35</td><td>34</td><td>33</td></tr><tr><td>SA\SD1243</td><td>64</td><td>63</td><td>62</td><td>61</td><td>60</td><td>59</td><td>58</td><td>57</td><td>56</td><td>55</td><td>54</td><td>53</td><td>52</td><td>51</td><td>50</td><td>49</td></tr><tr><td>SA\SD1244</td><td>80</td><td>79</td><td>78</td><td>77</td><td>76</td><td>75</td><td>74</td><td>73</td><td>72</td><td>71</td><td>70</td><td>69</td><td>68</td><td>67</td><td>66</td><td>65</td></tr><tr><td>SA\SD1245</td><td>96</td><td>95</td><td>94</td><td>93</td><td>92</td><td>91</td><td>90</td><td>89</td><td>88</td><td>87</td><td>86</td><td>85</td><td>84</td><td>83</td><td>82</td><td>81</td></tr><tr><td>SA\SD1246</td><td>112</td><td>111</td><td>110</td><td>109</td><td>108</td><td>107</td><td>106</td><td>105</td><td>104</td><td>103</td><td>102</td><td>101</td><td>100</td><td>99</td><td>98</td><td>97</td></tr><tr><td>SA\SD1247</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>120</td><td>119</td><td>118</td><td>117</td><td>116</td><td>115</td><td>114</td><td>113</td></tr></table>1 to 120: Safety connection numbers
—: Fixed to 0.</td></tr>
<tr><td>Interlock status of each safety connection (2nd module)</td><td>SA\SD1248 to SA\SD1255</td><td>0: Not interlocked
1: Interlocked
<table><tr><th></th><th>b15</th><th>b14</th><th>b13</th><th>b12</th><th>b11</th><th>b10</th><th>b9</th><th>b8</th><th>b7</th><th>b6</th><th>b5</th><th>b4</th><th>b3</th><th>b2</th><th>b1</th><th>b0</th></tr><tr><td>SA\SD1248</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr><tr><td>SA\SD1249</td><td>32</td><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td></tr><tr><td>SA\SD1250</td><td>48</td><td>47</td><td>46</td><td>45</td><td>44</td><td>43</td><td>42</td><td>41</td><td>40</td><td>39</td><td>38</td><td>37</td><td>36</td><td>35</td><td>34</td><td>33</td></tr><tr><td>SA\SD1251</td><td>64</td><td>63</td><td>62</td><td>61</td><td>60</td><td>59</td><td>58</td><td>57</td><td>56</td><td>55</td><td>54</td><td>53</td><td>52</td><td>51</td><td>50</td><td>49</td></tr><tr><td>SA\SD1252</td><td>80</td><td>79</td><td>78</td><td>77</td><td>76</td><td>75</td><td>74</td><td>73</td><td>72</td><td>71</td><td>70</td><td>69</td><td>68</td><td>67</td><td>66</td><td>65</td></tr><tr><td>SA\SD1253</td><td>96</td><td>95</td><td>94</td><td>93</td><td>92</td><td>91</td><td>90</td><td>89</td><td>88</td><td>87</td><td>86</td><td>85</td><td>84</td><td>83</td><td>82</td><td>81</td></tr><tr><td>SA\SD1254</td><td>112</td><td>111</td><td>110</td><td>109</td><td>108</td><td>107</td><td>106</td><td>105</td><td>104</td><td>103</td><td>102</td><td>101</td><td>100</td><td>99</td><td>98</td><td>97</td></tr><tr><td>SA\SD1255</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>120</td><td>119</td><td>118</td><td>117</td><td>116</td><td>115</td><td>114</td><td>113</td></tr></table>1 to 120: Safety connection numbers
—: Fixed to 0.</td></tr>
<tr><td>Interlock release request for each safety connection (2nd module)</td><td>SA\SD1256 to SA\SD1263</td><td>0: I/O interlock of safety station on CC-Link IE Field Network not released
1: I/O interlock of safety station on CC-Link IE Field Network released
<table><tr><th></th><th>b15</th><th>b14</th><th>b13</th><th>b12</th><th>b11</th><th>b10</th><th>b9</th><th>b8</th><th>b7</th><th>b6</th><th>b5</th><th>b4</th><th>b3</th><th>b2</th><th>b1</th><th>b0</th></tr><tr><td>SA\SD1256</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr><tr><td>SA\SD1257</td><td>32</td><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td></tr><tr><td>SA\SD1258</td><td>48</td><td>47</td><td>46</td><td>45</td><td>44</td><td>43</td><td>42</td><td>41</td><td>40</td><td>39</td><td>38</td><td>37</td><td>36</td><td>35</td><td>34</td><td>33</td></tr><tr><td>SA\SD1259</td><td>64</td><td>63</td><td>62</td><td>61</td><td>60</td><td>59</td><td>58</td><td>57</td><td>56</td><td>55</td><td>54</td><td>53</td><td>52</td><td>51</td><td>50</td><td>49</td></tr><tr><td>SA\SD1260</td><td>80</td><td>79</td><td>78</td><td>77</td><td>76</td><td>75</td><td>74</td><td>73</td><td>72</td><td>71</td><td>70</td><td>69</td><td>68</td><td>67</td><td>66</td><td>65</td></tr><tr><td>SA\SD1261</td><td>96</td><td>95</td><td>94</td><td>93</td><td>92</td><td>91</td><td>90</td><td>89</td><td>88</td><td>87</td><td>86</td><td>85</td><td>84</td><td>83</td><td>82</td><td>81</td></tr><tr><td>SA\SD1262</td><td>112</td><td>111</td><td>110</td><td>109</td><td>108</td><td>107</td><td>106</td><td>105</td><td>104</td><td>103</td><td>102</td><td>101</td><td>100</td><td>99</td><td>98</td><td>97</td></tr><tr><td>SA\SD1263</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>—</td><td>120</td><td>119</td><td>118</td><td>117</td><td>116</td><td>115</td><td>114</td><td>113</td></tr></table>1 to 120: Safety connection numbers
—: Fixed to 0.</td></tr>
</table>

Name	No.	Description of bits of special register
Interlock status of each safety connection (3rd module)	SA\SD1264 to SA\SD1271	0: Not interlocked 1: Interlocked  1 to 120: Safety connection numbers —: Fixed to 0.
Interlock release request for each safety connection (3rd module)	SA\SD1272 to SA\SD1279	0: I/O interlock of safety station on CC-Link IE Field Network not released 1: I/O interlock of safety station on CC-Link IE Field Network released  1 to 120: Safety connection numbers —: Fixed to 0.
Interlock status of each safety connection (4th module)	SA\SD1280 to SA\SD1287	0: Not interlocked 1: Interlocked  1 to 120: Safety connection numbers —: Fixed to 0.
Interlock release request for each safety connection (4th module)	SA\SD1288 to SA\SD1295	0: I/O interlock of safety station on CC-Link IE Field Network not released 1: I/O interlock of safety station on CC-Link IE Field Network released  1 to 120: Safety connection numbers —: Fixed to 0.
Interlock status of each safety connection (5th module)	SA\SD1296 to SA\SD1303	0: Not interlocked 1: Interlocked  1 to 120: Safety connection numbers —: Fixed to 0.

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1264	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1265	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1266	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1267	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1268	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1269	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1270	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1271	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1272	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1273	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1274	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1275	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1276	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1277	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1278	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1279	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1280	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1281	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1282	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1283	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1284	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1285	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1286	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1287	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1288	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1289	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1290	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1291	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1292	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1293	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1294	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1295	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1296	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1297	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1298	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1299	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1300	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1301	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1302	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1303	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

Name	No.	Description of bits of special register
Interlock release request for each safety connection (5th module)	SA\SD1304 to SA\SD1311	0: I/O interlock of safety station on CC-Link IE Field Network not released 1: I/O interlock of safety station on CC-Link IE Field Network released b15 b14 b13 b12 b11 b10 b9 b8 b7 b6 b5 b4 b3 b2 b1 b0 SA\SD1304: 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 SA\SD1305: 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 SA\SD1306: 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 SA\SD1307: 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 SA\SD1308: 80 79 78 77 76 75 74 73 72 71 70 69 68 67 66 65 SA\SD1309: 96 95 94 93 92 91 90 89 88 87 86 85 84 83 82 81 SA\SD1310: 112 111 110 109 108 107 106 105 104 103 102 101 100 99 98 97 SA\SD1311: — — — — — — — — 120 119 118 117 116 115 114 113 1 to 120: Safety connection numbers —: Fixed to 0.
Interlock status of each safety connection (6th module)	SA\SD1312 to SA\SD1319	0: Not interlocked 1: Interlocked b15 b14 b13 b12 b11 b10 b9 b8 b7 b6 b5 b4 b3 b2 b1 b0 SA\SD1312: 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 SA\SD1313: 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 SA\SD1314: 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 SA\SD1315: 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 SA\SD1316: 80 79 78 77 76 75 74 73 72 71 70 69 68 67 66 65 SA\SD1317: 96 95 94 93 92 91 90 89 88 87 86 85 84 83 82 81 SA\SD1318: 112 111 110 109 108 107 106 105 104 103 102 101 100 99 98 97 SA\SD1319: — — — — — — — — 120 119 118 117 116 115 114 113 1 to 120: Safety connection numbers —: Fixed to 0.
Interlock release request for each safety connection (6th module)	SA\SD1320 to SA\SD1327	0: I/O interlock of safety station on CC-Link IE Field Network not released 1: I/O interlock of safety station on CC-Link IE Field Network released b15 b14 b13 b12 b11 b10 b9 b8 b7 b6 b5 b4 b3 b2 b1 b0 SA\SD1320: 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 SA\SD1321: 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 SA\SD1322: 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 SA\SD1323: 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 SA\SD1324: 80 79 78 77 76 75 74 73 72 71 70 69 68 67 66 65 SA\SD1325: 96 95 94 93 92 91 90 89 88 87 86 85 84 83 82 81 SA\SD1326: 112 111 110 109 108 107 106 105 104 103 102 101 100 99 98 97 SA\SD1327: — — — — — — — — 120 119 118 117 116 115 114 113 1 to 120: Safety connection numbers —: Fixed to 0.
Interlock status of each safety connection (7th module)	SA\SD1328 to SA\SD1335	0: Not interlocked 1: Interlocked b15 b14 b13 b12 b11 b10 b9 b8 b7 b6 b5 b4 b3 b2 b1 b0 SA\SD1328: 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 SA\SD1329: 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 SA\SD1330: 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 SA\SD1331: 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 SA\SD1332: 80 79 78 77 76 75 74 73 72 71 70 69 68 67 66 65 SA\SD1333: 96 95 94 93 92 91 90 89 88 87 86 85 84 83 82 81 SA\SD1334: 112 111 110 109 108 107 106 105 104 103 102 101 100 99 98 97 SA\SD1335: — — — — — — — — 120 119 118 117 116 115 114 113 1 to 120: Safety connection numbers —: Fixed to 0.
Interlock release request for each safety connection (7th module)	SA\SD1336 to SA\SD1343	0: I/O interlock of safety station on CC-Link IE Field Network not released 1: I/O interlock of safety station on CC-Link IE Field Network released b15 b14 b13 b12 b11 b10 b9 b8 b7 b6 b5 b4 b3 b2 b1 b0 SA\SD1336: 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 SA\SD1337: 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 SA\SD1338: 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 SA\SD1339: 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 SA\SD1340: 80 79 78 77 76 75 74 73 72 71 70 69 68 67 66 65 SA\SD1341: 96 95 94 93 92 91 90 89 88 87 86 85 84 83 82 81 SA\SD1342: 112 111 110 109 108 107 106 105 104 103 102 101 100 99 98 97 SA\SD1343: — — — — — — — — 120 119 118 117 116 115 114 113 1 to 120: Safety connection numbers —: Fixed to 0.

Name	No.	Description of bits of special register
Interlock status of each safety connection (8th module)	SA\SD1344 to SA\SD1351	0: Not interlocked 1: Interlocked 1 to 120: Safety connection numbers —: Fixed to 0.
Interlock release request for each safety connection (8th module)	SA\SD1352 to SA\SD1359	0: I/O interlock of safety station on CC-Link IE Field Network not released 1: I/O interlock of safety station on CC-Link IE Field Network released 1 to 120: Safety connection numbers —: Fixed to 0.

SA\SD1344 to SA\SD1351

	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1344	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1345	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1346	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1347	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1348	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1349	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1350	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1351	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

SA\SD1352 to SA\SD1359

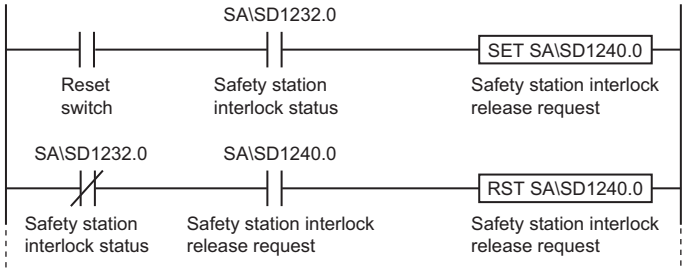
	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
SA\SD1352	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
SA\SD1353	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
SA\SD1354	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
SA\SD1355	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
SA\SD1356	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65
SA\SD1357	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81
SA\SD1358	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97
SA\SD1359	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113

For details, refer to the following.

MELSEC iQ-R CPU Module User's Manual (Application)

■Program example of releasing interlock

The following diagram shows a program for releasing interlock for the first module of the CC-Link IE Field Network of the CC-Link IE Field Network master/local module connected to the following base unit. The following diagram shows a program example used for checking safety station interlock status with safety connection No.1 using SA\SD1232.0 and releasing safety station interlock of safety connection No.1.



Sending interval monitoring time

Sending interval monitoring time is the time that the receiving station detects in each safety connection the following safety communication errors.

- Delay in safety data sending cycle due to an error on the sending station
- Loss of safety data in the transmission path due to influence such as noises

To set transmission interval monitoring time between the master station and safety remote I/O module of the MELSEC iQ-R series CC-Link IE Field Network master/local module, set the two poles of the safety station to perform safety communications to the active side and passive side so that all calculation formulas in (1) to (6) below can be satisfied.

■MELSEC iQ-R series CC-Link IE Field Network master/local module

- If the communication destination is a master station (safety station) or local station (safety station):

(1) Transmission interval monitoring time [ms] ≥ SCown × 3

(2) Transmission interval monitoring time [ms] ≥ SCoth × 2 + LS × 2

- If the communication destination is a safety remote I/O module:

(3) Transmission interval monitoring time [ms] ≥ SCown × 3

(4) Transmission interval monitoring time [ms] ≥ SRref × 2 + LS × 2

■Safety remote I/O module

(5) Transmission interval monitoring time [ms] ≥ SRref × 2

(6) Transmission interval monitoring time [ms] ≥ SCmst × 2 + LS × 2

SCown: Safety cycle time of the master station
SCoth: Safety cycle time of the communication destination
SCmst: Safety cycle time of the master station
SRref: Safety remote station refresh response processing time
LS: Link scan time

For specific examples, refer to the following.

☞ Page 195 Calculating Safety Response Time for System Configured with a Safety CPU, ☞ Page 203 Calculating Safety Response Time for System Connected to Multiple Safety CPUs

For details, refer to the following.

📖 MELSEC iQ-R CPU Module User's Manual (Application)
📖 CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

Safety refresh monitoring time

Safety refresh monitoring time is the time that the receiving station monitors in each connection to detect the following safety communication errors.

- Stopping of sending safety data due to an error on the sending station
- Stopping of safety communications due to an error on the transmission path, such as cable disconnection or hub failure

Set the safety refresh monitoring time to safety station (active side) so that the calculation formula described below can be met. The active side and the passive side use the same safety refresh monitoring time.

- Safety refresh monitoring time [ms] ≥ TMact + (TMpas ÷ 2) + (LS × 2) - a
- Safety refresh monitoring time [ms] ≥ (TMact ÷ 2) + TMpas + (LS × 2) - c
- Safety refresh monitoring time [ms] > TMact
- Safety refresh monitoring time [ms] > TMpas

TMact: Transmission interval monitoring time for a station set as Active
TMact: Transmission interval monitoring time for a station set as Passive
LS: Link scan time for the CC-Link IE Field Network
a: If a station is set to the active side is RJ71GF11-T2, then a = TMact - b. For other cases, a = 0.
b: Value rounds up the calculation results of the TMact ÷ 2 to a multiple of the safety cycle time of the master station.
c: If a station is set to the passive side is either RJ71GF11-T2 or NZ2GFSS2-32D, then c = TMpas - d. For other cases, a = 0.
d: Value rounds up the calculation results of the TMpas ÷ 2 to a multiple of the safety cycle time of the local station (if NZ2GFSS2-32D, safety refresh response processing time)

For specific examples, refer to the following.

☞ Page 195 Calculating Safety Response Time for System Configured with a Safety CPU, ☞ Page 203 Calculating Safety Response Time for System Connected to Multiple Safety CPUs

For details, refer to the following.

📖 MELSEC iQ-R CPU Module User's Manual (Application)

📖 CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

Safety timer

Do not use the same safety timer (as a coil) (OUT SA\T☐ instruction) more than one time in a safety program. If more than one time of the same safety timer (as a coil) (OUT SA\T☐ instruction) is described, they cannot be accurately measured, since each safety timer coil (OUT SA\T☐ instruction) updates the current value of the safety timer.

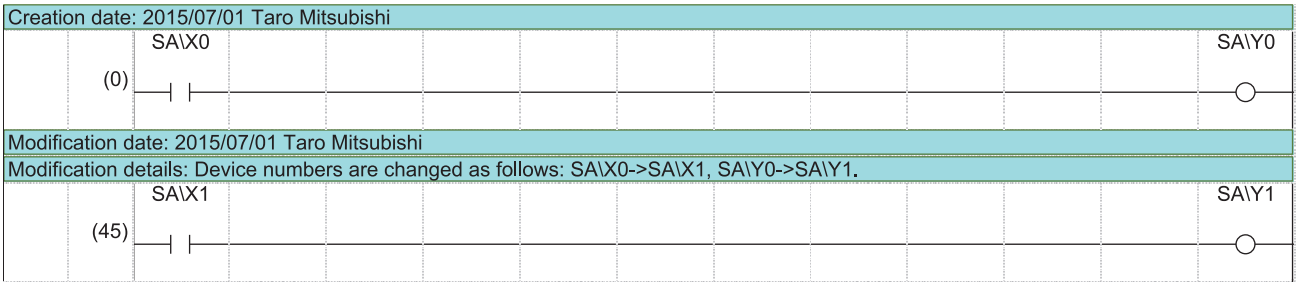
The maximum response accuracy of the safety timer is "safety cycle time + timer limit setting". If setting the timer with a shorter time than the safety cycle time, the contact turns on when performing safety time coil (OUT SA\T☐instructions).

For details, refer to the following.

📖 MELSEC iQ-R CPU Module User's Manual (Application)

Version management of engineering tool project file

Fill in the created date and author at the top of program using the statement function of engineering tool. When modifying a program, manage revision history. When managing revision history, write the date modified, your name, and description of the modification at the modified location using the statement function.



And manage the data which was written to the Safety CPU by storing the hard disk of personal computer or CD.

User authentication

Define the user who handles the corresponding project, then register the user information and authorization required for the logon in the project and Safety CPU. For the user authentication function, refer to the following.

📖 GX Works3 Operating Manual

4.3 Precautions for Startup

When starting up a new safety system or changing existing safety system, check the following points.

Checking network connection configuration

Check that the safety remote I/O module parameter setting at the actual site is set as designed. Read the safety remote I/O module parameters to visually check if the parameters are consistent with the set values. Also visually check the station number setting switch on safety remote I/O module.

Use the position check start command for the destination module from the parameter setting of the CC-Link IE Field Network master/local module to check if the safety remote I/O module is installed in the designed position. After setting the parameters of the safety remote I/O module, enable the set parameters by enabling the safety module. For safety remote I/O module setting procedure, refer to Page 50 SAFETY APPLICATION CONFIGURATION EXAMPLES.

Also check if the Safety CPU at the site is installed in the designed place. Connect personal computer with Safety CPU and engineering tool installed to verify using consistency with programmable controller.

For checking method with Safety CPU, refer to the following.

📖 GX Works3 Operating Manual

Checking before writing parameters and program

Check the parameters and program to be written are as designed before writing them to a programmable controller. For parameter settings using engineering tool, refer to the following.

📖 GX Works3 Operating Manual

For definitions and setting ranges of parameters of parameter settings using engineering tool, refer to the following.

📖 MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)

Usage of a checklist

Before starting operation, check if the safety system is correctly configured. (☞ Page 208 Checklist)

4.4 Precautions for Safety Functions Maintenance

Periodic inspection

Execute a periodic inspection to check whether the components such as emergency stop switch and safety sensor are not faulty. As well as diagnostics of the safety programmable controller, perform a test from the emergency stop request to machine stop as safety functions.

Module Replacement

For the safety programmable controller, execute the module/unit replacement according to the following replacement cycles.

Module	Module replacement cycle
Safety CPU	10 years
Safety function module	10 years
Safety remote I/O module	5 years

Also replace module/unit and devices other than described above, according to the replacement cycle shown in the following technical bulletin.

📖 Mitsubishi Electric TECHNICAL BULLETIN: Recommendation of preventive maintenance and inspection for MELSEC programmable controllers
No.FA-A-0018-A

Safety operation mode while in operation

Set the safety operation mode to safety mode when in operation. Safety operation mode can be switched on the engineering tool window from: [Online] → [Safety PLC Operation] → [Safety Operation Mode Switch]. For how to switch operation mode, refer to the following.

📖 GX Works3 Operating Manual
📖 MELSEC iQ-R CPU Module User's Manual (Application)

Safety data identify check for Safety CPU

Periodically check if Safety CPU program or parameter is unauthorizedly altered, using safety data identify check. When shifting to safety operation after writing the safety program and safety parameters to the Safety CPU, use an engineering tool to refer to the safety data identify check data, and record the data in a separate manner.

- Periodically refer to the engineering tool safety data identify check information to make sure that no unauthorized alterations take place.
- If unauthorized alternation is found, stop operation. Restore proper project using backup project file.

For the safety data identify check, refer to the following.

📖 MELSEC iQ-R CPU Module User's Manual (Application)

Protecting data

The project file and Safety CPU of the engineering tool are protected by the password required for user authentication. Manage the registered password properly and do not leak the password except authorized person to prevent the unauthorized access. For the user authentication function, refer to the following.

📖 GX Works3 Operating Manual

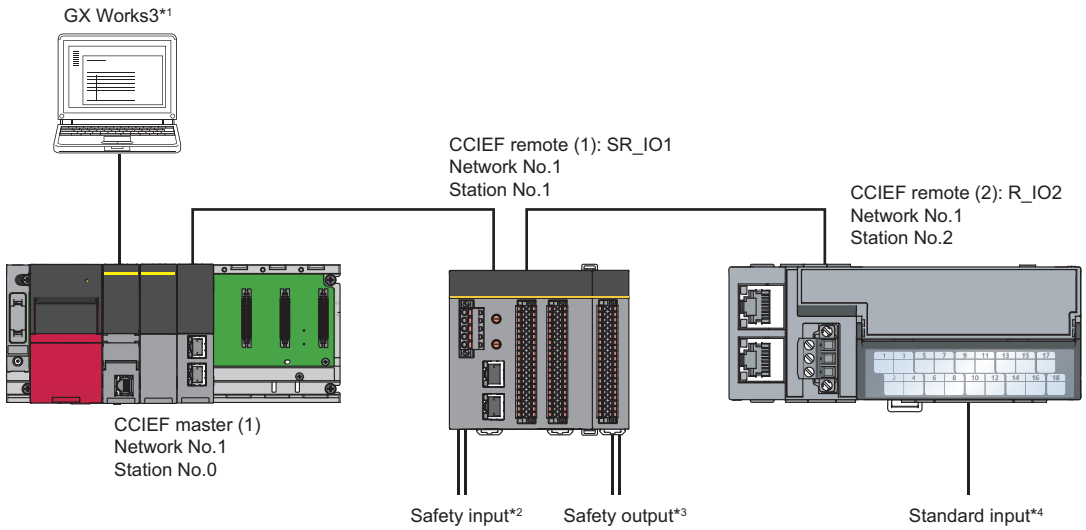
5 SAFETY APPLICATION CONFIGURATION EXAMPLES

This chapter describes a configuration example of a safety application using safety programmable controller.

5.1 System Configured by a Safety CPU

System configuration

This section describes a safety application using the following system configuration samples.



*1 This sets parameters and programs.
*2 They are safety input device such as emergency stop switch, safety switch, light curtain, laser scanner, and mat switch.
*3 They are safety output device such as safety relay and MC.
*4 They are general input device such as reset switch, start switch, and stop switch.

The following table shows definitions of the symbols used in this chapter.

Symbol	Definition
CCIEF master (1)	MELSEC iQ-R series CC-Link IE Field network master/local module (Master station number 0)
CCIEF remote (1)	Safety remote I/O module (station number 1)
CCIEF remote (2)	Standard remote I/O module (station number 2)

Network-related switch settings of module

Set network-related switches on modules as shown below.

Safety CPU

There is no network-related switch.

Safety function module

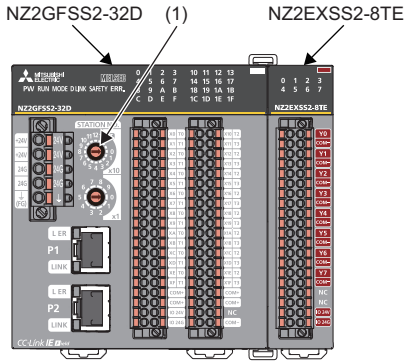
There is no network-related switch.

CC-Link IE Field Network master/local module

There is no network-related switch.

Safety remote I/O module

Set the station number setting switches.



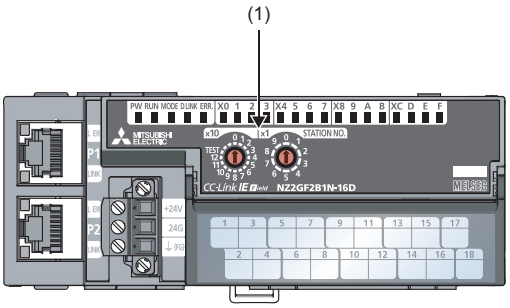
Switch number in the figure above.	Remote I/O module number	CCIEF remote (1) SR_IO1
(1)	Station number setting switch	1

Point

The setting value of the station number becomes valid when the module is powered on. Set the station number when the system is powered off.

Standard remote I/O module

Set the station number setting switches.



Switch number in the figure above.	Remote I/O	CCIEF remote (2) R_IO2
(1)	Station number setting switch	2

Point

The setting value of the station number becomes valid when the module is powered on. Set the station number when the system is powered off.

Parameter setting of the Safety CPU

Set Safety CPU parameters refer to the following.

Operating procedure

1. Create a new project and set user authentication.
2. Perform "Write User Data to PLC".

[Online] ⇨ [User Authentication] ⇨ [Write User Data to PLC]

3. Perform "Log on to PLC".

[Online] ⇨ [User Authentication] ⇨ [Log on to PLC]

4. Open the module configuration diagram and set system parameters.

"Navigation window" ⇨ "Module configuration diagram"

5. Set device/label memory capacity.

[CPU Parameter] ⇨ "Memory/Device Setting" ⇨ "Device/Label Memory Area Setting"

6. Set a safety cycle time.

[CPU parameter] ⇨ "Safety Function Setting"

For details on parameter setting method, refer to the following.

MELSEC iQ-R CPU Module User's Manual (Startup)
MELSEC iQ-R CPU Module User's Manual (Application)

User authentication settings

Safety CPU project requires user authentication setting using password. Add "Add New User" window to be displayed, when creating a new project. Add new users, then save the project according to the instruction given by the window.

To read or write data with Safety CPU of safety remote I/O module, logging on to programmable controller is required. If user information is not written on a programmable controller, select [Online] ⇨ [User Authentication] ⇨ [Write User Data to PLC] to write appropriate user information. Select [Online] ⇨ [User Authentication] ⇨ [Log on to PLC] to logon to programmable controller.

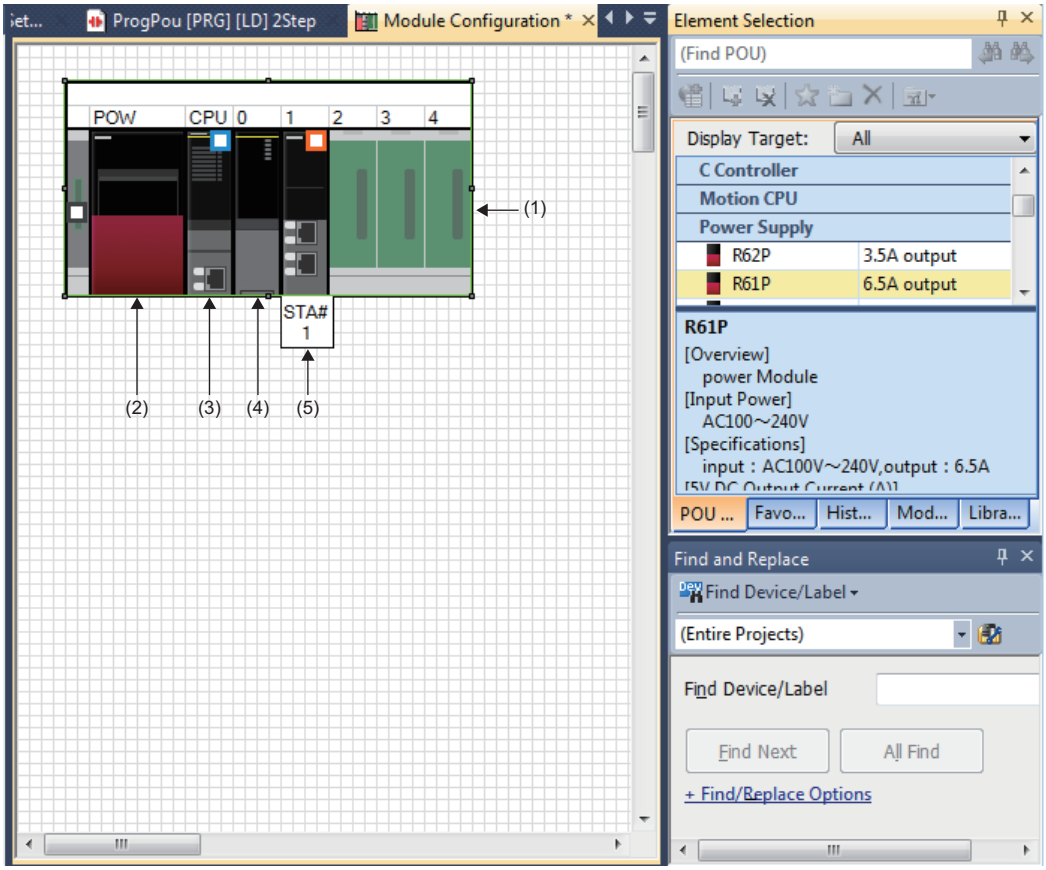
For details on user authentication setting method, refer to the following.

GX Works3 Operating Manual

Setting system parameters

Parameters can be set from [Module Configuration] to be displayed by double-clicking "Module Configuration" in [Navigation window]. Parameters can be set by allocating modules according to the configuration to be used. Parameters can be set by selecting a main base unit from the [Element Selection window] using the drag and drop command and allocating modules on the main base unit. The Safety CPU set when creating the project is displayed since the beginning at the module configuration. Allocate the safety function module from the "CPU extension" in the [Element Selection window].
Allocate program elements in the chart below, based on the following, and determine the parameters. Then, select [Tool] ⇨ [Check Parameter] from menu and check set parameters.

Window



Displayed items

Number	Module	Model Name
(1)	Main Base Unit	R35B
(2)	Power Supply	R61P
(3)	Safety CPU	Safety CPU model to be used
(4)	CPU extension	R6SFM
(5)	Network Module	RJ71GF11-T2

Setting safety device/safety label

Safety programs are described using safety devices. Before creating safety programs, set safety devices at device/label memory area setting of the Safety CPU.

■Setting device/label memory capacity

Set device area capacity to be used by safety programs according to the safety device to be used by the safety program. Set the total capacity of the safety device/label area, safety device area capacity, safety label area capacity, standard/safety shared label area capacity from the CPU parameter setting window of the Safety CPU for [Parameter] in the [Navigation window]. Set the parameters. Then, click the [Apply] button in the lower right of the window.

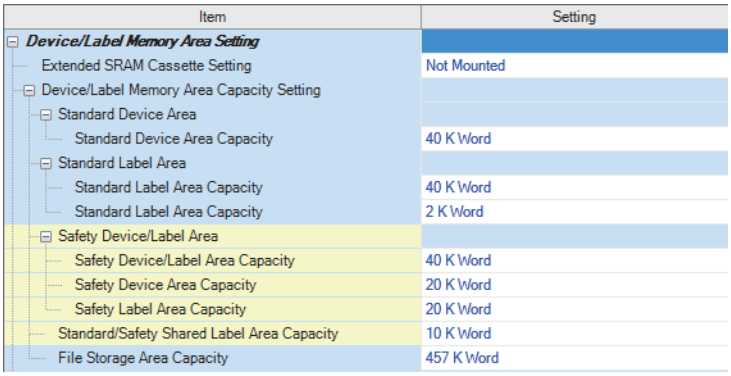
Set the capacities of the areas including the standard device area so that the total of these capacities will not exceed the total capacity of the Safety CPU.

For details on parameter setting method, refer to the following.

📖 GX Works3 Operating Manual

📖 MELSEC iQ-R CPU Module User's Manual (Application)

Displayed items



Item	Setting
Device/Label Memory Area Setting	
Extended SRAM Cassette Setting	Not Mounted
Device/Label Memory Area Capacity Setting	
Standard Device Area	
Standard Device Area Capacity	40 K Word
Standard Label Area	
Standard Label Area Capacity	40 K Word
Standard Label Area Capacity	2 K Word
Safety Device/Label Area	
Safety Device/Label Area Capacity	40 K Word
Safety Device Area Capacity	20 K Word
Safety Label Area Capacity	20 K Word
Standard/Safety Shared Label Area Capacity	10 K Word
File Storage Area Capacity	457 K Word

Displayed items

Item		Setting (default)
Safety Device/Label Area	Total capacity of the Safety Device/Label Area Capacity	40K words
	Safety Device Area Capacity	20K words
	Safety Label Area Capacity	20K words
	Standard/safety shared label area capacity	10K words

Setting details of device/label memory areas

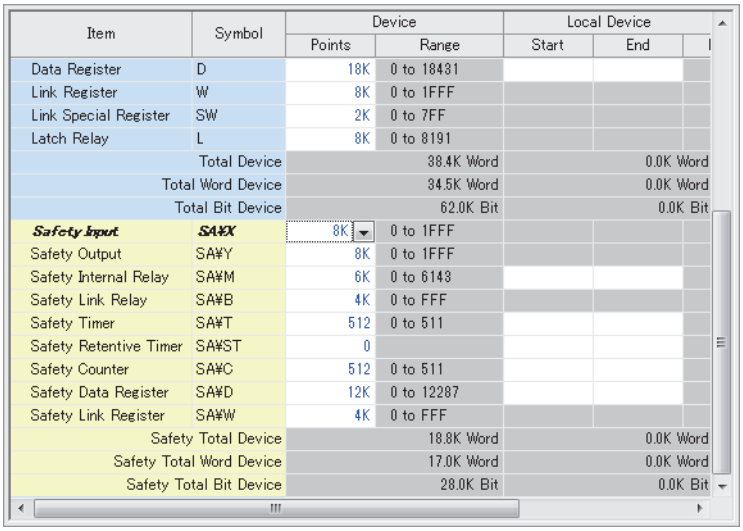
Open the detailed settings window from the [Detailed Setting] for the [Device Setting]. Then set the safety device points on the following screen. Set number of points so that the total of the points will not exceed the capacity of the device area. Set the parameters. Then, click the [Apply] button in the lower right of the window.

For details on parameter setting method, refer to the following.

GX Works3 Operating Manual

MELSEC iQ-R CPU Module User's Manual (Application)

Window



Item	Symbol	Device		Local Device		
		Points	Range	Start	End	
Data Register	D	18K	0 to 18431			
Link Register	W	8K	0 to 1FFF			
Link Special Register	SW	2K	0 to 7FF			
Latch Relay	L	8K	0 to 8191			
Total Device		38.4K Word		0.0K Word		
Total Word Device		34.5K Word		0.0K Word		
Total Bit Device		62.0K Bit		0.0K Bit		
Safety Input	SA¥X	8K	0 to 1FFF			
Safety Output	SA¥Y	8K	0 to 1FFF			
Safety Internal Relay	SA¥M	6K	0 to 6143			
Safety Link Relay	SA¥B	4K	0 to FFF			
Safety Timer	SA¥T	512	0 to 511			
Safety Retentive Timer	SA¥ST	0				
Safety Counter	SA¥C	512	0 to 511			
Safety Data Register	SA¥D	12K	0 to 12287			
Safety Link Register	SA¥W	4K	0 to FFF			
Safety Total Device		18.8K Word		0.0K Word		
Safety Total Word Device		17.0K Word		0.0K Word		
Safety Total Bit Device		28.0K Bit		0.0K Bit		

Displayed items

Item	Setting (default)
Safety Input (SA\X)	8K points (either 8K or 12K points can be selected.)*1
Safety Output (SA\Y)	8K points (either 8K or 12K points can be selected.)*1
Safety Internal Relay (SA\M)	6K points
Safety Link Relay (SA\B)	4K points
Safety Timer (SA\T)	512 points
Safety Retentive Timer (SA\ST)	0 points
Safety Counter (SA\C)	512 points
Safety Data Register (SA\D)	12K points
Safety Link Register (SA\W)	4K points

*1 When selecting 12K points, check the versions of the CPU module and the engineering tool. (MELSEC iQ-R CPU Module User's Manual (Application))

Setting safety functions

Set the safety cycle time, as a timing for executing safety programs and safety input/output. Set a "Safety Cycle Time" as an item in the safety function setting window from the CPU parameter setting window of the Safety CPU in the "Parameter" in the [Navigation window].

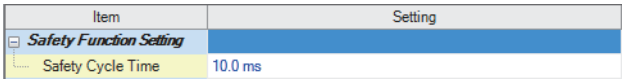
Set the parameters. Then, click the [Apply] button in the lower right of the window.

For details on parameter setting method, refer to the following.

GX Works3 Operating Manual

MELSEC iQ-R CPU Module User's Manual (Application)

Window



Displayed items

Item	Setting (default)
Safety Cycle Time	10ms

Parameter settings of CC-Link IE Field Network

Set parameters of the CC-Link IE Field Network according to the following procedure.

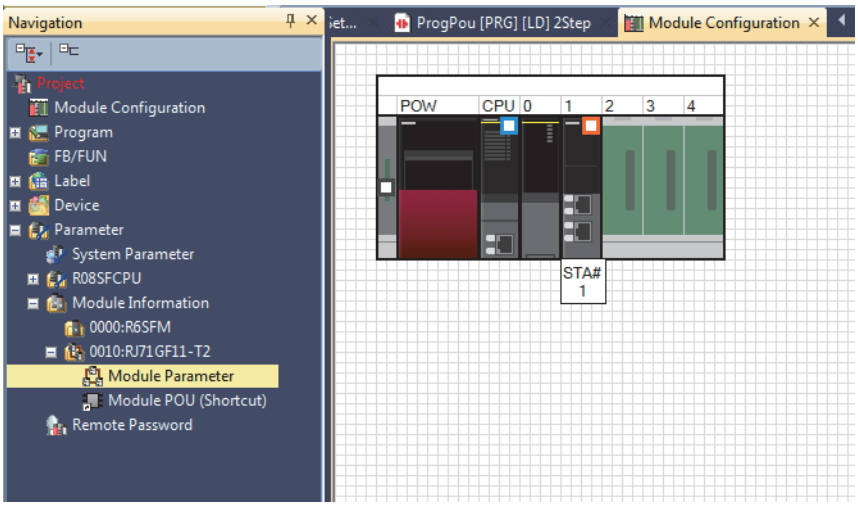
Operating procedure

1. Develop the CC-Link IE Field Network master/local module to set the ⇨ [Parameter] ⇨ [Module Information] ⇨ [Navigation window].
2. Double-click the "Module Parameter".
3. To set parameters, select a tree from either one of the three options: required setting, basic setting, and application setting.
4. Set parameters. Then, click the [Apply] button of the parameter setting window.
5. Check if safety remote I/O modules with set parameters is installed in the designed location using "Start of checking the module position" command.
6. Read parameter setting in the safety remote I/O module to visually check if the parameters are consistent with the set values.
7. Perform "Safety module validation" to be useable with set parameters.
8. Restart safety remote I/O module

For details on parameter setting method, refer to the following.

MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)

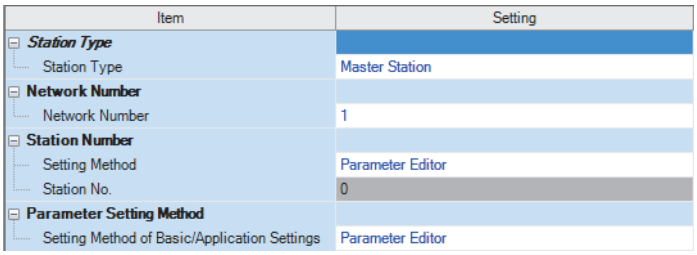
Window



Required Settings

Set the station type, network number, and parameters of the CC-Link IE Field Network master/local module. Display the required setting window. Then, select and input parameters according to the following description. Complete the input. Then, click the [Apply] button in the lower right of the window.

Window



Displayed items

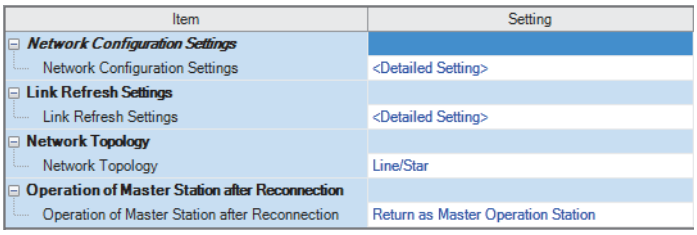
Setting classifications		CCIEF master (1)
Required Settings	Station Type	Master Station
	Network Number	1
	Setting Method for Station Numbers	Set parameters*1
	Station No.	0
	Parameter Setting Method	Set parameters*1

*1 Station number setting method and parameter setting method can be selected by setting "Parameter Editor" and "Program". Here, select the "Parameter Editor".

Basic Settings

Set CC-Link IE Field Network master/local module configuration of CC-Link IE Field Network master/local module, CC-Link IE Select and input parameters as shown below, after displaying basic setting window. Complete the input. Then, click the [Apply] button in the lower right of the window. When setting "Network Configuration Settings", double-click a line of the network configuration setting item window, or click right-side button to be displayed when selecting a line.

Window



Displayed items

Setting classifications		CCIEF master (1)
Basic settings	Network configuration settings	Refer to network configuration settings.
	Refresh setting	Refer to refresh setting.
	Network topology settings	Line topology, star topology, or both are used
	Operation setting when the master station is returned (settable only when setting the submaster station in a network configuration)	Return as master operation station

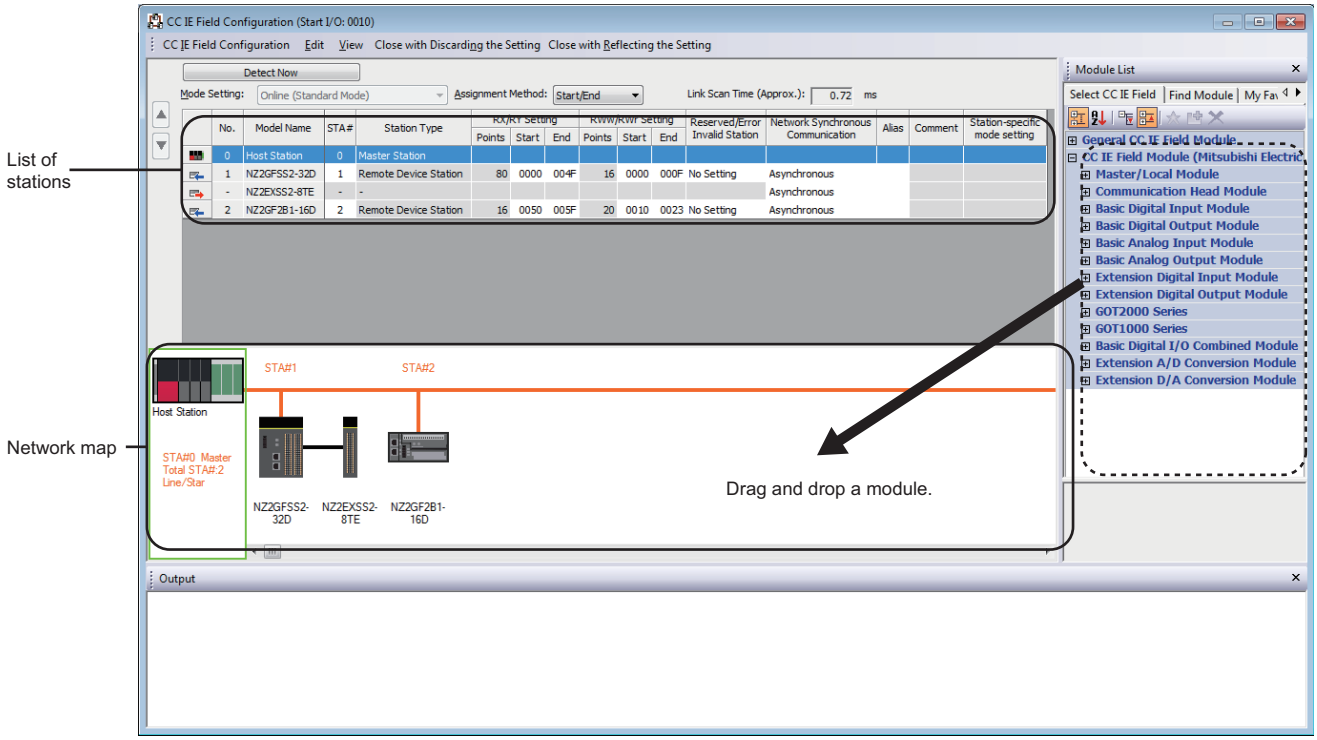
■Network configuration settings

Set the number of link device points and assignment of slave station to the master station.

Operating procedure

1. Select a module from "Module List", and drag and drop it to "List of Stations" or "Network Map".
2. Select and input parameters according to the following description.
3. Select "Close with Reflecting the Setting" and complete "Network Configuration Settings". If closing with "×" of the window, item will not be reflected.

Window



Displayed items

Item		Description			
Assignment Method		Number of points/Start			
Total number of slave stations		2			
Item		Range or value/value			
		CCIEF master (1)	CCIEF remote (1)		CCIEF remote (2)
Model Name		RJ71GF11-T2	NZ2GFSS2-32D	NZ2EXSS2-8TE	NZ2GF2B1-16D
STA#		0	1	(Unavailable)	2
Station type		Master station	Remote device station	(Unavailable)	Remote device station
RX/RY		(Unavailable)	Points: 80 Start: 0000 End: 004F	(Unavailable)	Points: 16 Start: 0050 End: 005F
RWr/RWw		(Unavailable)	Points: 16 Start: 0000 End: 000F	(Unavailable)	Points: 20 Start: 0010 End: 0023
Reserved/Error invalid station		No setting	No setting	(Unavailable)	No Setting
Network synchronous communication		Asynchronous	Asynchronous	Asynchronous	Asynchronous
Station information	Alias	(Blank)	(Blank)	(Blank)	(Blank)
	Comment	(Blank)	(Blank)	(Blank)	(Blank)

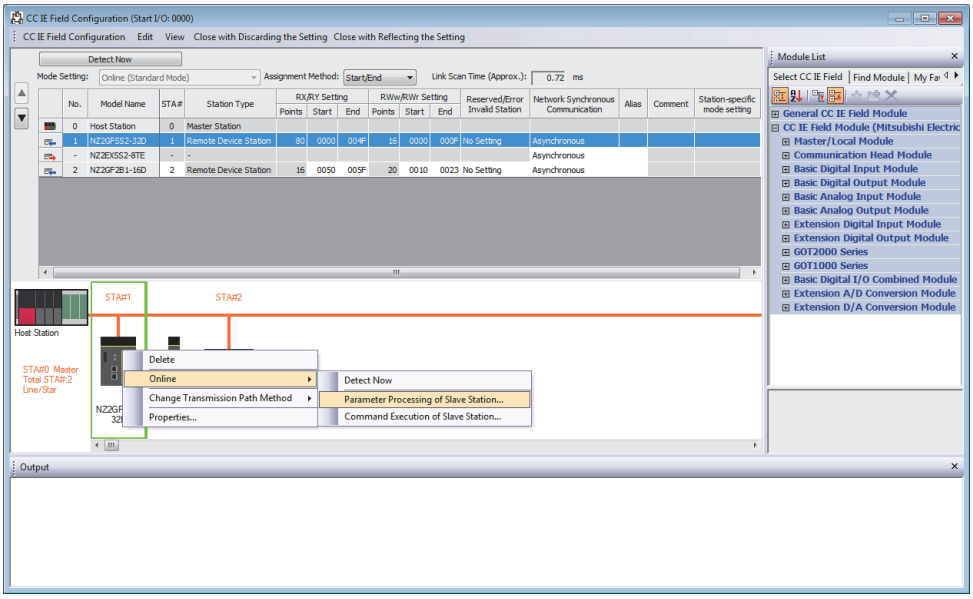
Set slave station parameters refer to the following. Complete the Network Configuration Settings for required and basic settings. Restart after writing parameters to Safety CPU. Then, set slave station parameters.

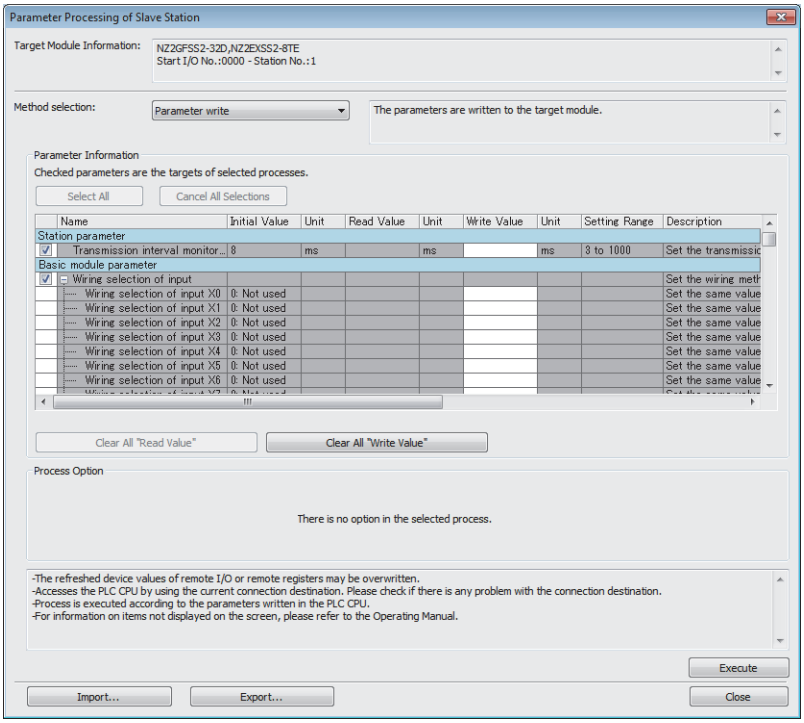
Operating procedure

1. Right-click slave station to be set at "List of Stations" or "Network Map".
2. Click [Online] ⇨ [Parameter Processing of Slave Station].
3. Select "Parameter Write" at parameter processing window of the slave station and input parameters to be set for write value column.
4. Click the [Execute] button and write the parameters.

For detailed parameter values, see explanations for standard input setting and specific cases.

Window





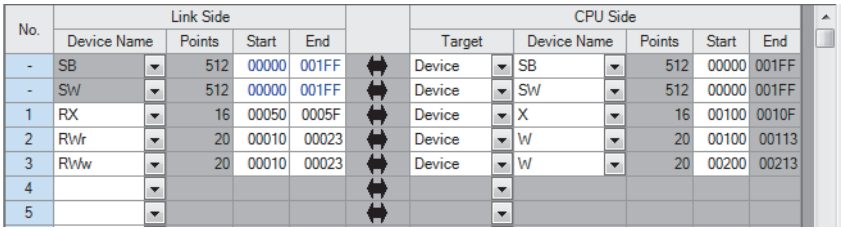
■Refresh settings

Set transfer range between link device of standard remote I/O module and Safety CPU devices.

Operating procedure

1. Select and input parameters according to the following description.
2. Click the [Apply] button and complete "Refresh Settings".

Window



No.	Link Side					CPU Side				
	Device Name	Points	Start	End		Target	Device Name	Points	Start	End
-	SB	512	00000	001FF		Device	SB	512	00000	001FF
-	SW	512	00000	001FF		Device	SW	512	00000	001FF
1	RX	16	00050	0005F		Device	X	16	00100	0010F
2	RWr	20	00010	00023		Device	W	20	00100	00113
3	RWw	20	00010	00023		Device	W	20	00200	00213
4										
5										

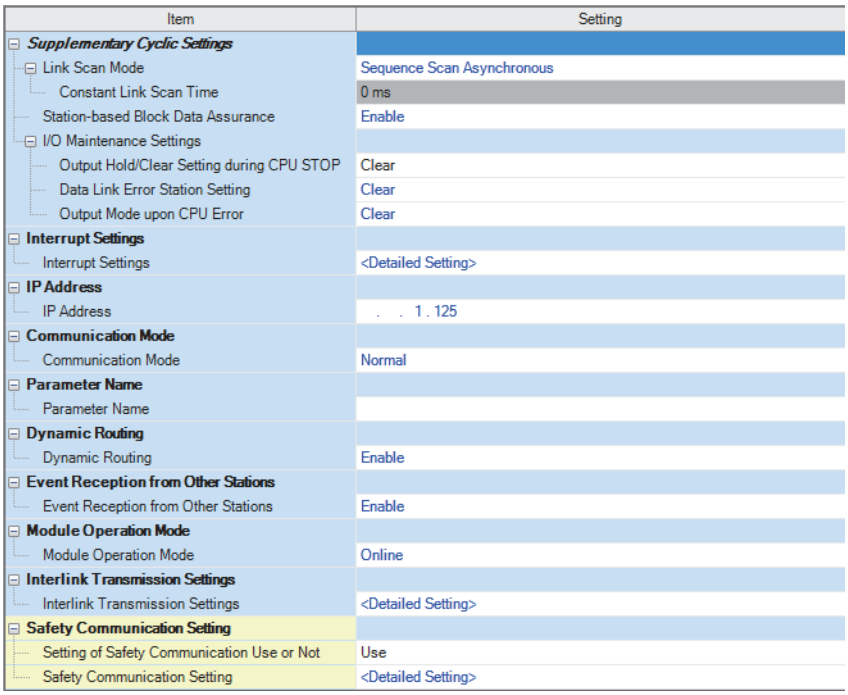
Displayed items

No	Link side				CPU side				
	Device name	Points	Start	End	Refresh destination	Device name	Number of points	Start	End
-	SB	512	00000	001FF	Device	SB	512	00000	001FF
-	SW	512	00000	001FF	Device	SW	512	00000	001FF
1	RX	16	00050	0005F	Designated device	X	16	00100	0010F
2	RWr	20	00010	00023	Designated device	W	20	00100	00113
3	RWw	20	00010	00023	Designated device	W	20	00200	00213

Application Settings

Set cyclic supplementary setting of the CC-Link IE Field Network master/local module and safety communication setting. Display "Application Settings" window. Then, select and input parameters according to the following description. Complete input. Then, click the [Apply] button in the lower right of the window. When setting "Safety Function Setting", double-click a line of the safety function setting in item window, or click the right-side button to be displayed when selecting line.

Window



Displayed items

Setting classifications		CCIEF master (1)
Application settings	Supplementary cyclic settings	Refer to supplementary cyclic settings.
	Interrupt settings	Do not set.
	IP address	Do not set.
	Communication mode	Normal
	Parameter name	(Blank)
	Dynamic routing settings	Enable
	Event reception from other stations	Enable
	Module operation mode	Online
	Interlink transmission settings	Do not set.
	Setting of safety communication use or not	Use
	Safety communication setting	Refer to "Safety Communication Setting".

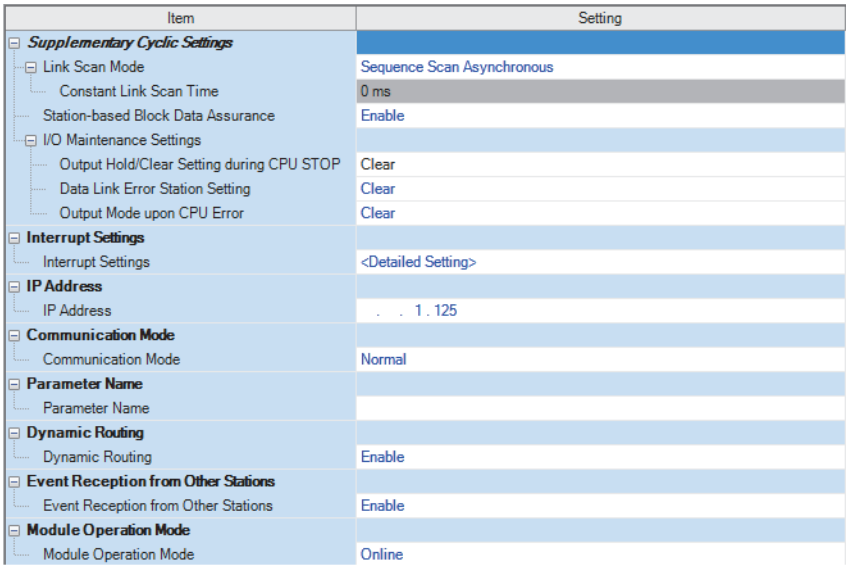
■Supplementary cyclic settings

Set link scan mode, station-based block data assurance, and input/output hold clear setting.

Operating procedure

1. Select and input parameters according to the following description.
2. Click the [Apply] button and complete "Supplementary Cyclic Settings".

Window



Item	Setting
Supplementary Cyclic Settings	
Link Scan Mode	Sequence Scan Asynchronous
Constant Link Scan Time	0 ms
Station-based Block Data Assurance	Enable
I/O Maintenance Settings	
Output Hold/Clear Setting during CPU STOP	Clear
Data Link Error Station Setting	Clear
Output Mode upon CPU Error	Clear
Interrupt Settings	
Interrupt Settings	<Detailed Setting>
IP Address	
IP Address	. . 1 . 125
Communication Mode	
Communication Mode	Normal
Parameter Name	
Parameter Name	
Dynamic Routing	
Dynamic Routing	Enable
Event Reception from Other Stations	
Event Reception from Other Stations	Enable
Module Operation Mode	
Module Operation Mode	Online

Displayed items

Item	Range/value
Link scan mode	Sequence scan asynchronous
Constant link scan time	(Unavailable)
Station-based block data assurance	Enable
Output Hold/Clear Setting during CPU STOP	Clear
Data Link Error Station Setting	Clear
Output Mode upon CPU Error	Clear

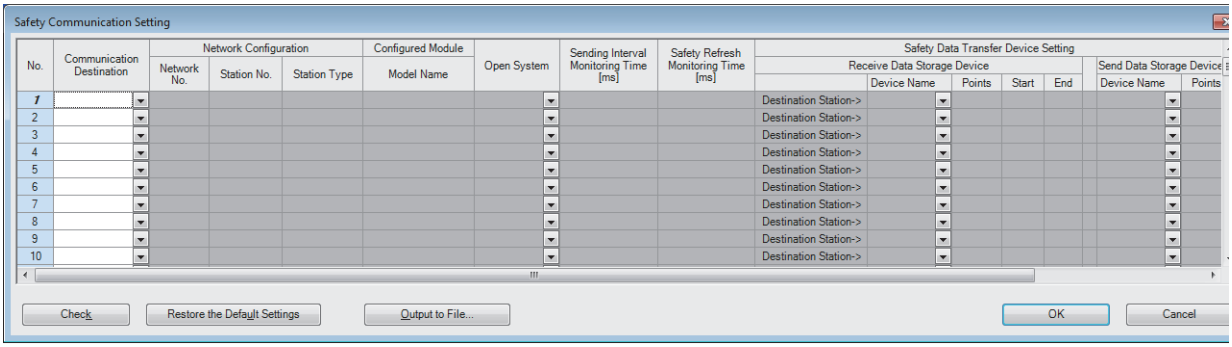
■Safety communication setting

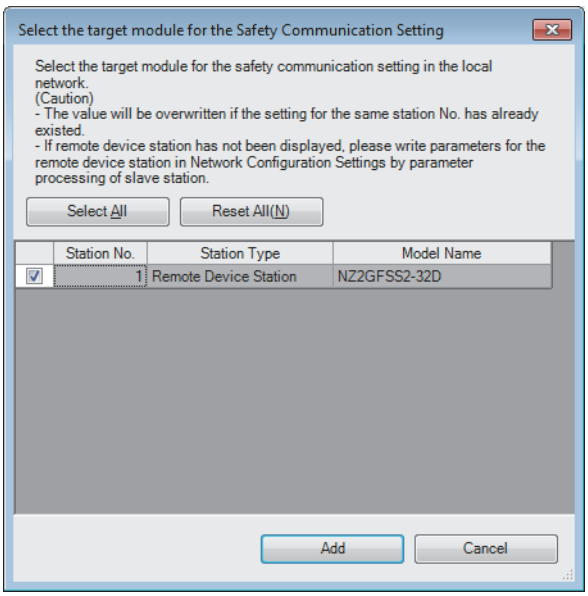
Set items related to safety communication function

Operating procedure

1. Set "Setting of Safety Communication Use or Not" to "Use" from "Application Settings" window and select detailed setting on "Safety Communication Setting".
2. Selecting own network as the party to communicate with in the "Safety Communication Setting" window displays "Select the target module for the Safety Communication Setting" window shown below. Then, select the target safety remote I/O module and import parameters using the [Add] button. (If target module is not displayed, set appropriate setting at Network Configuration Settings, including slave station parameter setting. Then, click the [Apply] button displayed in the lower right of the "Basic Settings" window).
3. Select and input parameters according to the following description.
4. Exit by clicking the [OK] button on "Safety Communication Setting" window.

Window





Displayed items

Item		Range/value
Module		CCIEF remote (1)
No.		1
Communication destination		Own network
Network configuration	Network number	1
	Station number	1
	Station type	Remote device station
Open system		Active
Transmission interval monitoring time		24 [ms]
Safety Refresh Monitoring Time		60 [ms]
Safety data transfer device setting	Receive data storage device	Device name: SA\X Points: 32 Start: 0000 End: 001F
	Send data storage device	Device name: SA\Y Points: 16 Start: 0000 End: 000F

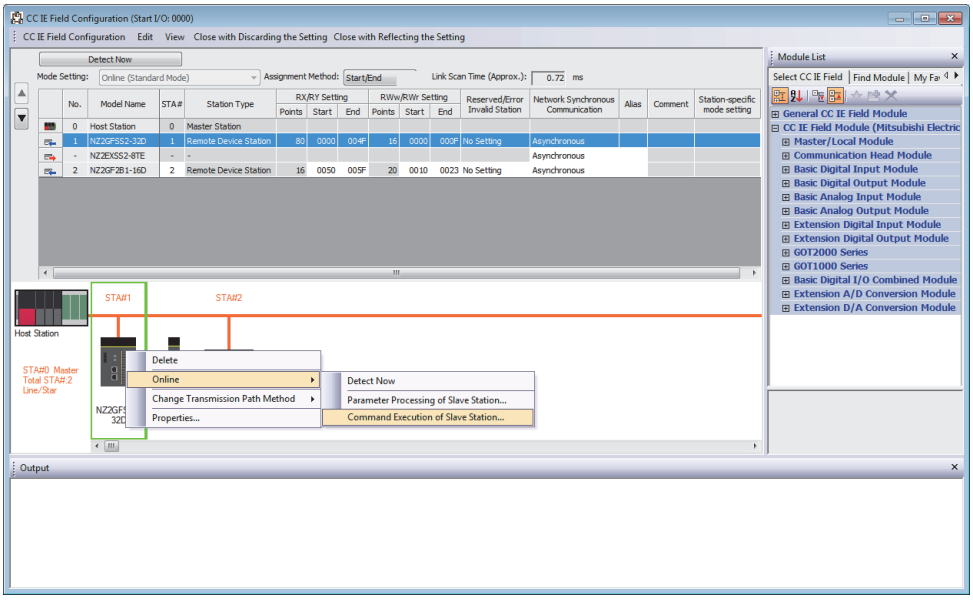
Checking the position of safety remote I/O module

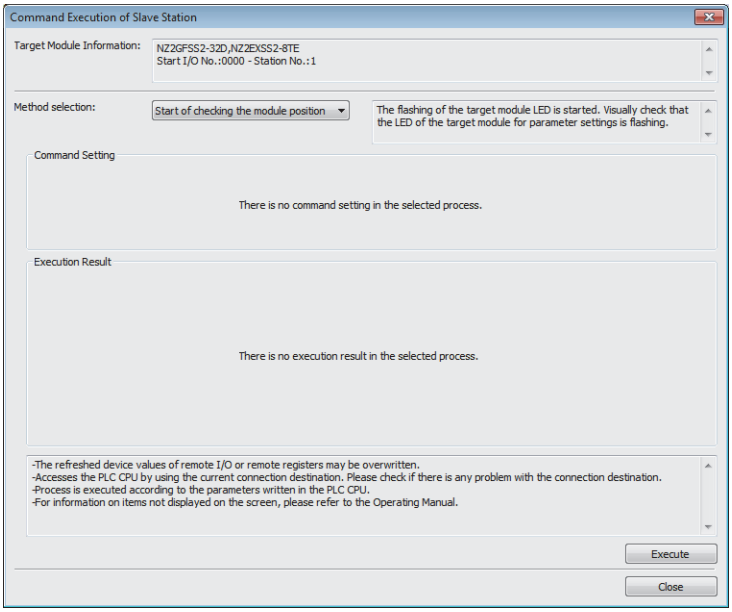
Check if the safety remote I/O module with set parameters is installed in the designed location using [Start of Checking the Module Position] function. Check all safety remote I/O modules according to the following procedure.

Operating procedure

1. Display "Detailed Setting" window in "Network Configuration Settings" of "Basic Settings window".
2. Display menu by right-clicking module to be confirmed as shown in the following, and display "Command Execution of Slave Station" window from "Command Execution of Slave Station".
3. For method of selection, select "Start of checking the module position" in method selection and click the [Execution] button. The [Safety LED] of safety remote I/O module executed command flashes
4. Visually check if safety remote I/O module with blinking [Safety LED] is installed in a desired position when designing.
5. Complete visual checking. Then, select "Stop of checking the module position" command in "Method selection" on the "Command Execution of Slave Station" window, and click the [Execution] button. The [Safety LED] of safety remote I/O module executed command flashing stops.

Window





Checking parameter settings

Read parameters in the safety remote I/O module to check if the parameters are consistent with the set values, according to the following procedure.

1. Display parameter processing window of the slave station of the safety remote I/O module to be checked.
2. Select "Parameter Read" in "Method selection". Then, click the [Execution] button.
3. Visually check read values if the parameters are consistent with the set values.

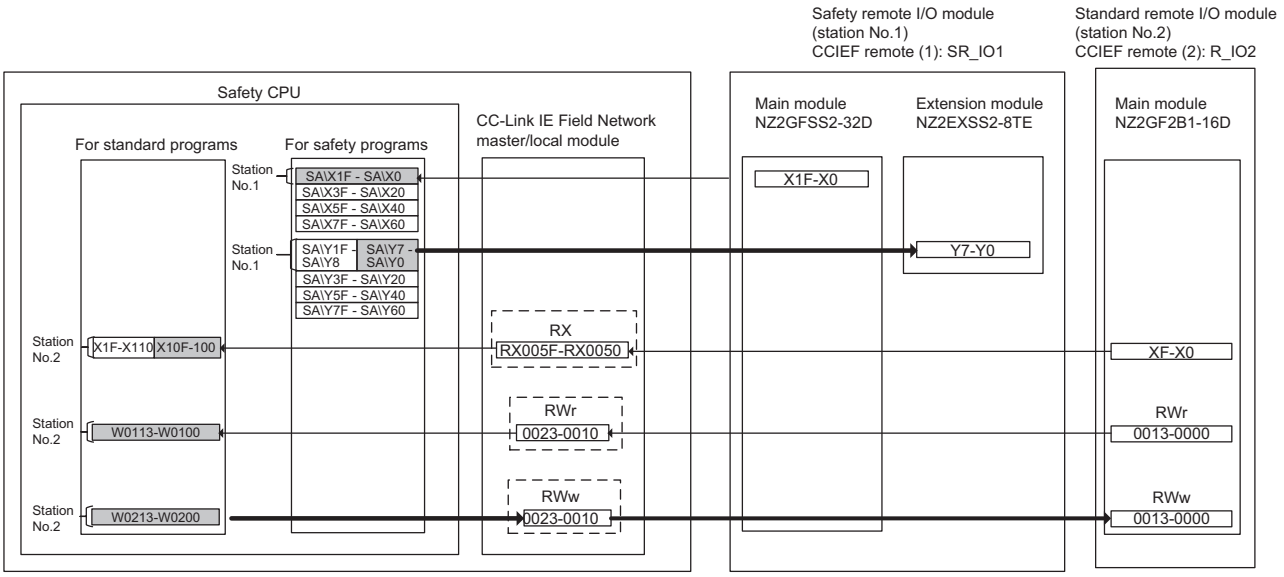
Validating safety module

Validate safety modules according to the following procedure to make the parameters available with set parameters.

1. Display "Command Execution of Slave Station" window of the safety remote I/O module to validate safety module.
2. Select "Safety module validation" in "Method selection". Then, click the [Execution] button.
3. Restart the safety remote I/O module according to checking window.

Relationship between devices in the Safety CPU and remote inputs/outputs

The following shows the relationship between the Safety CPU device, the inputs/outputs of safety remote I/O module, and the standard remote I/O module on the Page 57 Parameter settings of CC-Link IE Field Network. Use devices in shaded areas in the program to perform programming.



System uses 16 points each of the RWr/RWw to communicate with safety remote I/O module. Set 16 points each of the RWr/RWw according to Page 57 Parameter settings of CC-Link IE Field Network. Do not read/write data from/to the RWr/RWw to be used by the system. Writing data may cause malfunction of the safety programmable controller.

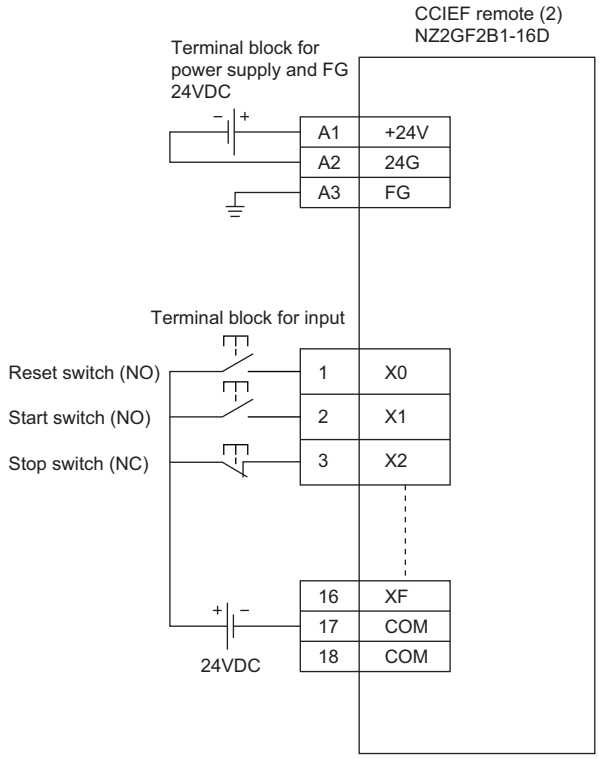
For details, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

Setting standard inputs

Wiring

Wiring example of reset switch, start switch, and stop switch to CC-Link IE Field Network remote I/O module (NZ2GF2B1-16D)



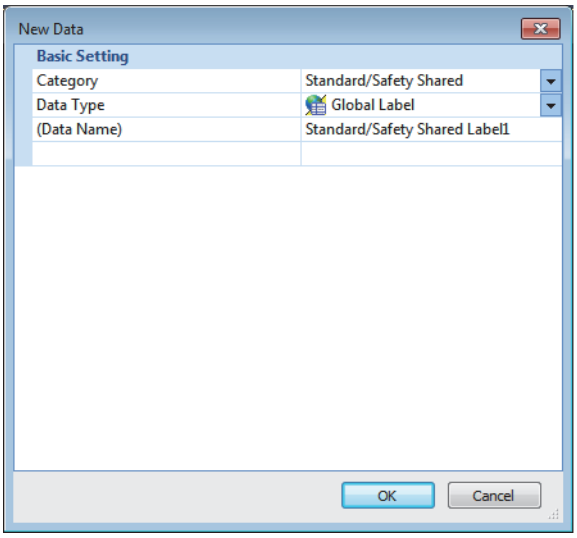
Parameter settings

Item	Description
Input response time	10ms
Output HOLD/CLEAR setting	CLEAR
Cyclic data update watch time setting	0
Mode switch	Automatical judgment mode
Initial operation setting	With initial processing
Synchronous input timing acquisition function	Invalid
Input off delay setting X0 to XF	0

Example of standard/safety shared label area capacity settings

Assign standard input reset signal (X100), start signal (X101), and stop signal (X102) to standard/safety shared label to deliver to safety program. Receive safety information data with the standard/safety shared label in the safety program. Right-click [Navigation window] ⇨ [Label] ⇨ [Global Label] to select [Add New Data], and set standard/safety shared label as following. Define standard/safety shared label as following.

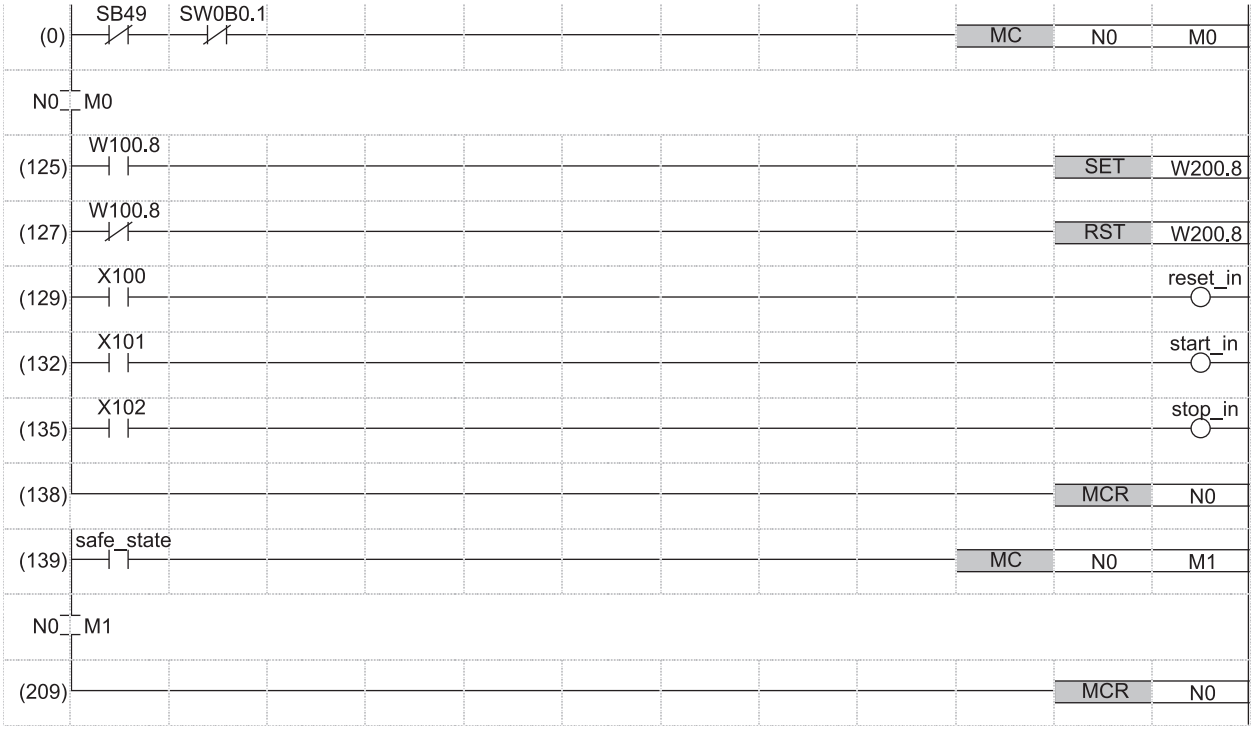
Window



Displayed items

Label name	Data type	Comment	Access from external devices
reset_in	Bit	(Blank)	☐ (unchecked)
start_in	Bit	(Blank)	☐ (unchecked)
stop_in	Bit	(Blank)	☐ (unchecked)
safe_state	Bit	(Blank)	☐ (unchecked)

Assign reset signals (X100), start signals (X101), and stop signals (X102) to standard/safety shared label for standard program as shown below. Use data of the standard/safety shared label (safe_state) assigned as a safety state signal in the safety program to interlock a part of the program. These methods are used when desiring to start operation after completing safety check using the safety control. The diagram does not show specific example of the programs to establish interlocking with the safety state signals. Set these standard program execution type to scan execution type.



(0)	Checking data link status on the station number 2 (standard remote I/O module)
(125)	Turn on the initial processing completion flag (RWw0.b8).
(127)	Turn off the initial processing completion flag (RWw0.b8).
(129) to (135)	Assign inputs from standard remote I/O module (X100, X101, and X102) to standard/safety shared label.
(139)	Checking safety status signal (safe_state) Write a program that establishes an interlock with safety status signal.

For label setting method, creating programs, and method for writing to programmable controllers, refer to the following.

GX Works3 Operating Manual

For methods creating parameters and programs of standard remote I/O module, refer to the following.

CC-Link IE Field Network Remote I/O Module User's Manual

Case examples

Emergency stop circuit

■Application overview

This safety application cuts off a power to robots using an emergency stop switch. This controls the start and stop of a robot by turning on or off the main contact of the contractor which opens and closes the power source of a robot at the safety relay contact.

Connect emergency stop switches and safety relays to safety programmable controllers.

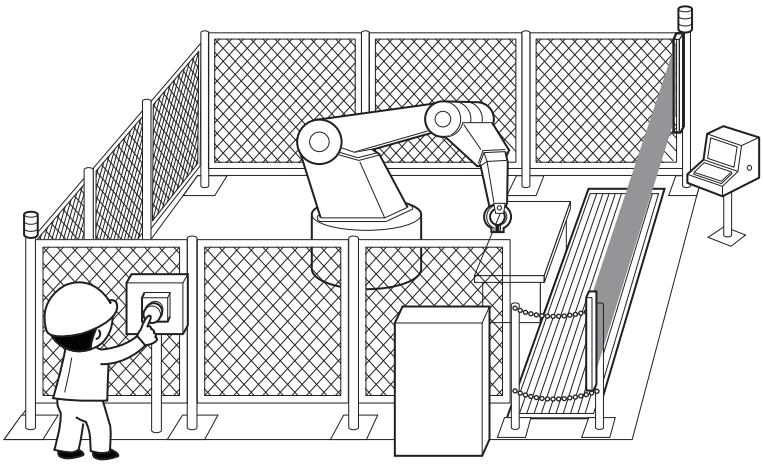
The Safety CPU controls on or off of the safety relays with program.

When the safety programmable controller detects an error by self-diagnostics, outputs to the safety relays turn off regardless the program.

In this case, the outputs remain off until the Safety CPU or safety remote I/O module is reset regardless the program, when outputs turns off by the self-diagnostics.

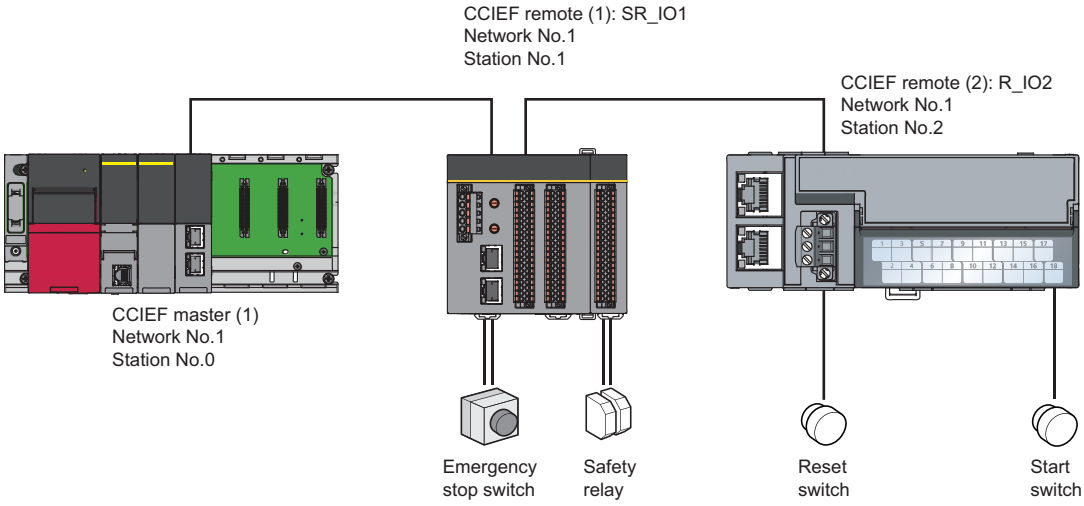
Configure the program so that the following functions can be achieved.

1. Check that safety is ensured (the emergency stop signal is on state). Then, the worker presses the reset switch first. Pressing the start switch turns on the safety relays.
2. When a safety relay is welded, input the safety relay (normally closed contact) to the safety programmable controller to prevent starting, and check for welding.
3. To avoid undesired operation of the reset switch and start switch at the welding or short-circuit, set the reset switch and start switch so that they are activated only when turned on and off.
4. Turn off the output of the safety relay, when input of the emergency stop switch is turned off after the operation is started or an error is detected in a safety remote I/O module.



(Partially quoted from "Safety Guide Book - the safety measures of machinery in the workplace": Nippon Electric Control Equipment Industries Association)

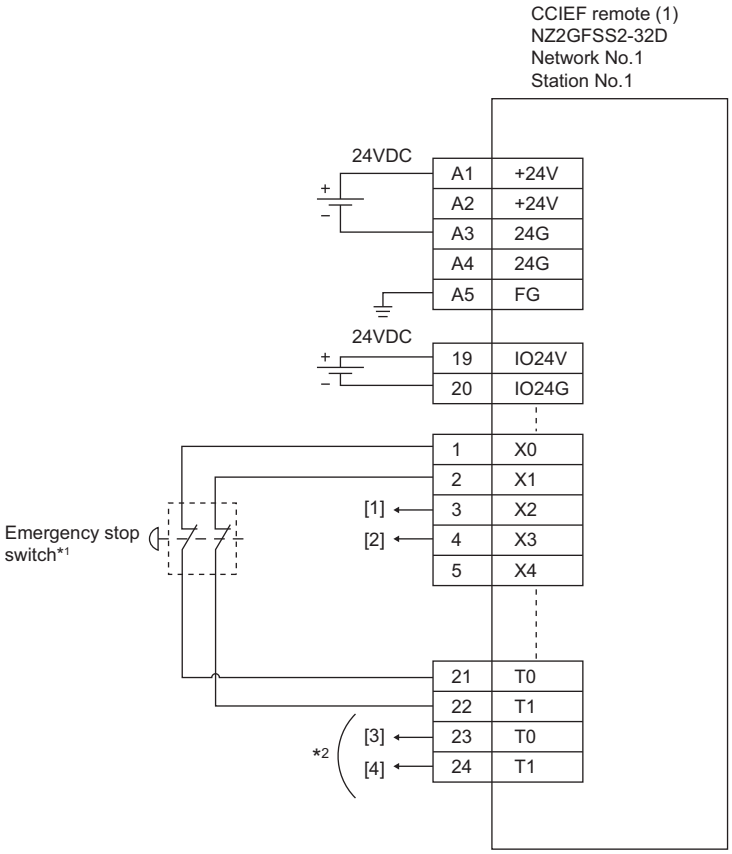
■Connection of safety devices



■Wiring diagram and parameter settings

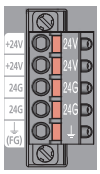
Connect the emergency stop switch and safety relay to safety remote I/O module as follows. For details on the terminal blocks, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

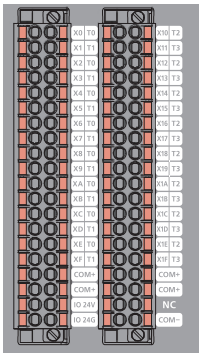


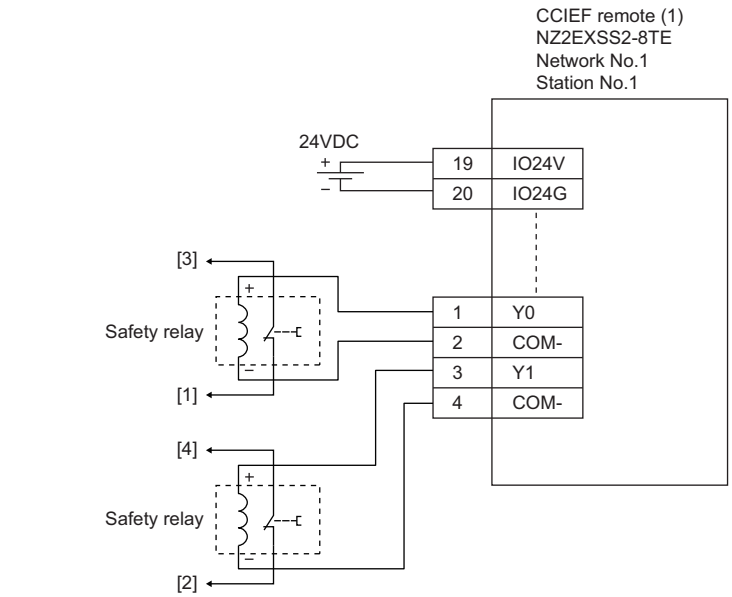
Terminal block for power supply and FG (input)

A1	+24V
A2	+24V
A3	24G
A4	24G
A5	FG

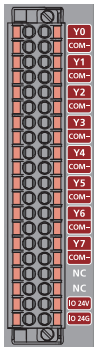


Spring clamp terminal block (input)





Spring clamp terminal block (output)



Above [1] to [4] are connected to the one with same numbers.

*1 Connect an emergency stop switch having two normally closed contacts with direct opening mechanism between input terminal and test pulse terminal.

*2 Connect normally closed contact of the safety relay between the input terminal and test pulse terminal.

For the emergency stop switches and the safety relays, set the parameters as follows.

Item	Setting details[*3]
Transmission interval monitoring time	24ms
Wiring selection of input X0	Double wiring (NC/NC)[*4]
Wiring selection of input X1	Double wiring (NC/NC)[*4]
Wiring selection of input X2	Double wiring (NC/NC)[*4]
Wiring selection of input X3	Double wiring (NC/NC)[*4]
Wiring selection of input X4 to X1F	Not used
Input response time X0[*1]	1ms
Input response time X1[*1]	1ms
Input response time X2[*1]	1ms
Input response time X3[*1]	1ms
Input response time X4[*1]	1ms
Input response time X5[*1]	1ms
Input response time X6 to X1F[*1]	1ms
Double input discrepancy detection setting X0_X1	Detect[*4]
Double input discrepancy detection setting X2_X3	Detect[*4]
Double input discrepancy detection setting X4_X5 to X1E_X1F	Do not detect[*4]
Double input discrepancy detection type X0_X1	Discrepancy detection time specified[*4]
Double input discrepancy detection type X2_X3	Discrepancy detection time specified[*4]
Double input discrepancy detection type X4_X5 to X1E_X1F	Discrepancy detection time not specified[*4]
Double input discrepancy auto recovery setting	Not used
Double input discrepancy detection time X0_X1 [*2]	10 (100ms)
Double input discrepancy detection time X2_X3 [*2]	10 (100ms)
Double input discrepancy detection time X4_X5 to X1E_X1F[*2]	1 (10ms)
Input dark test execution setting X0	Perform[*4]
Input dark test execution setting X1	Perform[*4]
Input dark test execution setting X2	Perform[*4]
Input dark test execution setting X3	Perform[*4]
Input dark test execution setting X4 to X1F	Do not perform[*4]
Input dark test pulse OFF time [*1]	400μs
Number of pulse output for input dark test	1 time
Ext. module 1_Wiring selection of output Y0	Double wiring (source/source)[*4]
Ext. module 1_Wiring selection of output Y1	Double wiring (source/source)[*4]
Ext. module 1_Wiring selection of output Y2 to Y7	Not used[*4]
Extension 1_Output dark test execution setting Y0	Perform[*4]
Extension 1_Output dark test execution setting Y1	Perform[*4]
Extension 1_Output dark test execution setting Y2 to Y7	Do not perform[*4]
Ext. module 1_Output dark test pulse off time Y0[*1]	1ms
Ext. module 1_Output dark test pulse off time Y1[*1]	1ms
Extension 1_Output dark test pulse off time Y2 to Y7[*1]	1ms
Extension 1_Number of pulse output for output dark test	1 time

*1 Adjust the values of input response time, input dark test pulse off time, and output dark test pulse off time according to the installation environment and wiring length.

*2 Set double input discrepancy detection time to 100ms for mechanical switches and 20ms for sensor inputs as standard.

*3 For details on setting range, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

*4 Always set the parameters like this for this case example.

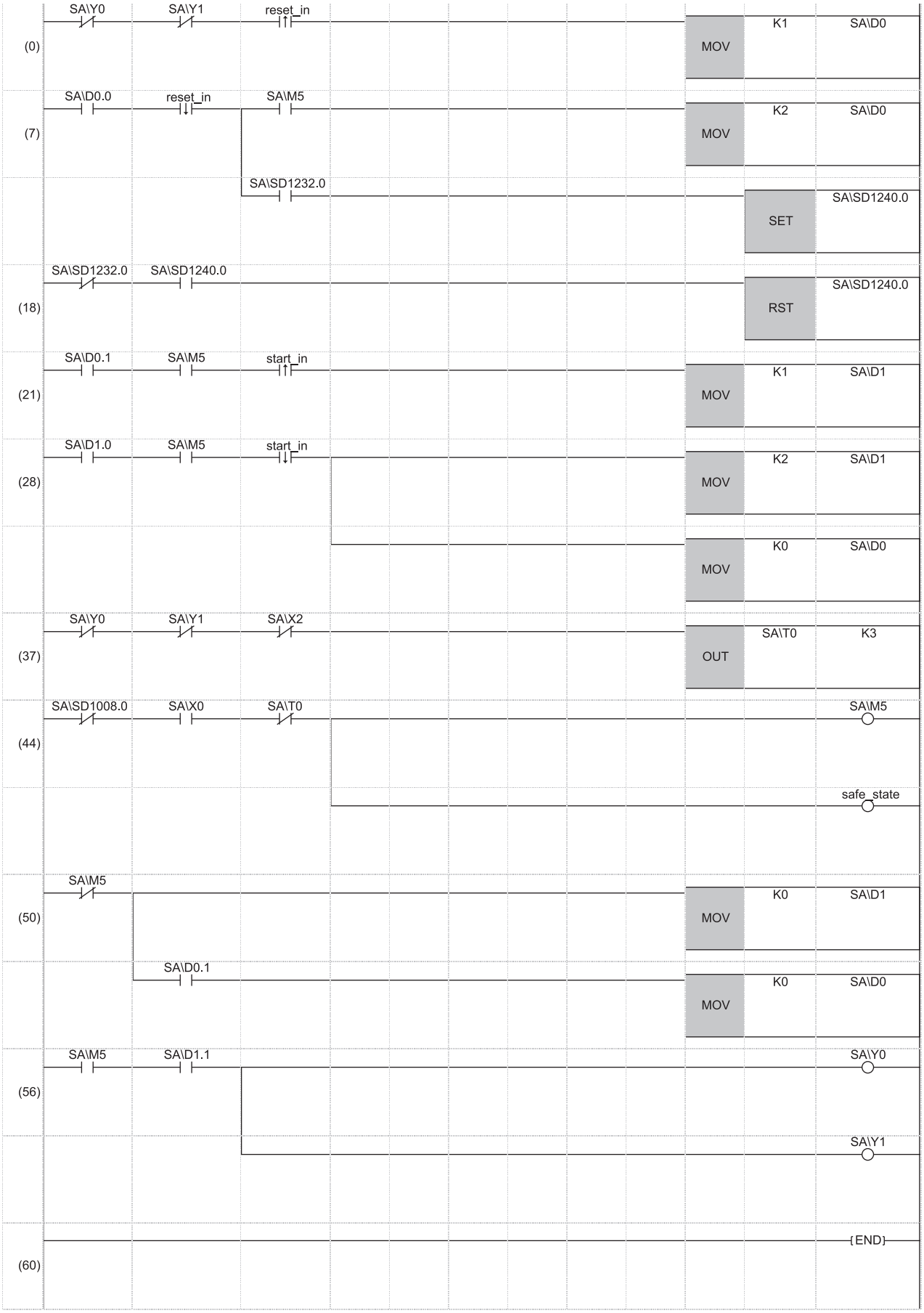
■Safety devices and safety labels to be used

Program safety program using safety devices and standard/safety shared labels shown below.

Module	External device	Safety device/safety label
SR_IO1	Emergency stop	SA\X0 or SA\X1
	Safety relay	SA\Y0 and SA\Y1
	Safety relay (check for welding)	SA\X2 or SA\X3
R_IO2	Reset switch	reset_in
	Start switch	start_in

■Program example

This is a safety program. For precautions for creating safety program and setting method, refer to Page 34 Precautions for Programming and Page 52 Parameter setting of the Safety CPU. The program performs the following processing.



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(18)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(21) to (28)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(37)	This is a circuit to check welding of the safety relay.
(44)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(50)	This is a circuit to cancel start/reset request, when not possible to check safety.
(56)	This is a circuit to control outputs to the safety relay.

The following shows the constant and safety user devices used in the program.

• Way of using the constant

K☐: indicates decimal number

Ex.

K1→ 1 of decimal number

• Way of using the safety user devices

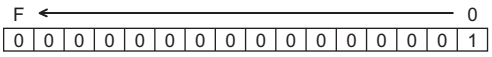
Safety user devices	Description
SA\D0	This is used as restart status. (1) SA\D0 = 0: Initial status or start processing completed (2) SA\D0 = 1: (SA/D0.0: ON): Reset switch pressed (3) SA\D0 = 2 (SA\D0.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\D1	This is used as start status. (1) SA\D1 = 0: Initial status or safety not checked (2) SA\D1 = 1 (SA\D1.0: ON): Reset switch pressed. (3) SA\D1 = 2 (SA\D1.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\T0	This indicates timer device. Times out after a lapse of the time specified at K☐.

• Way of using word device bit specification

SA\D☐.n: This indicates the nth bit of the word device SA\D☐

Ex.

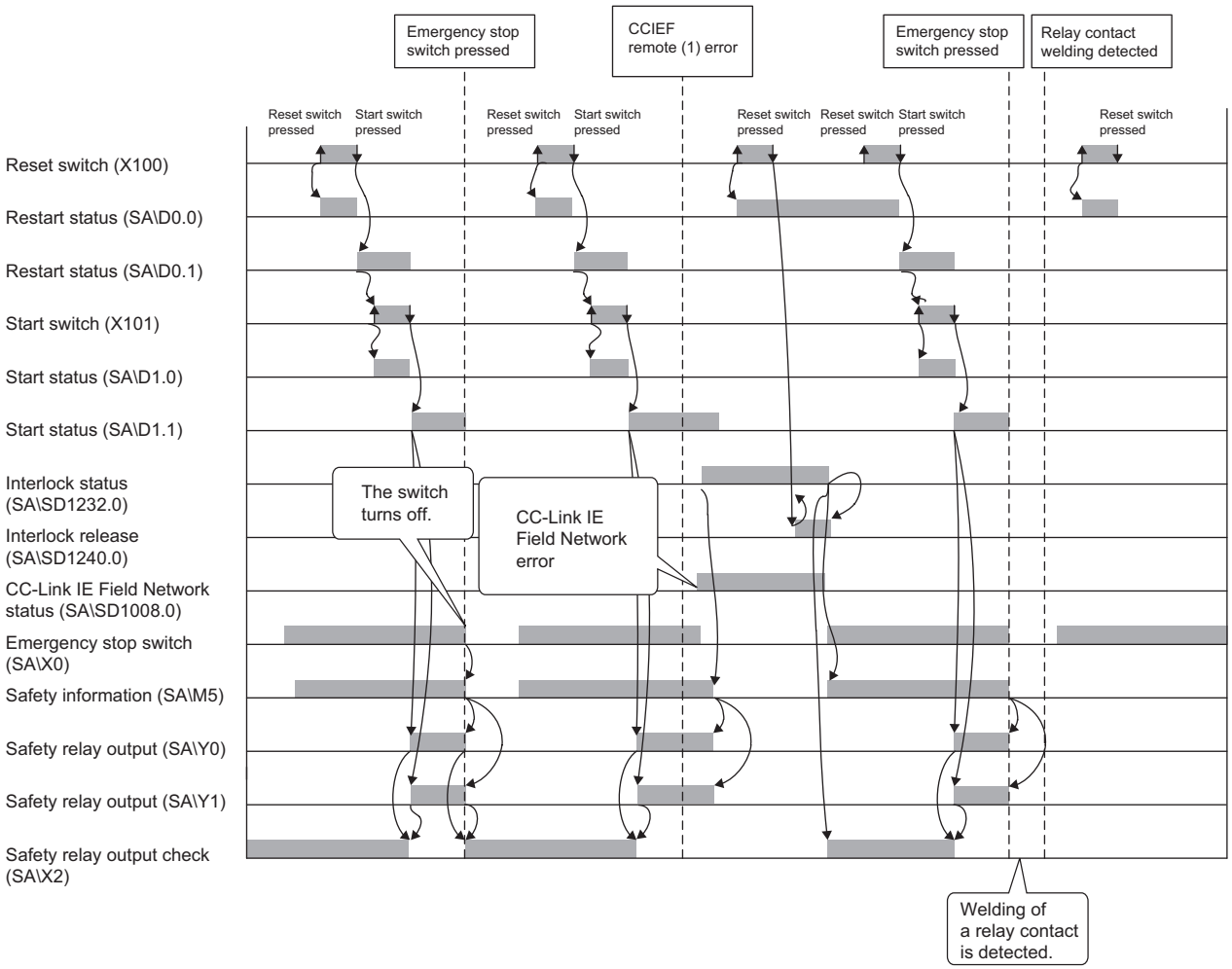
SA\D0.0 = 0 bits in SA\D0



For bit-specified word device, refer to the following.

📖 MELSEC iQ-R Programming Manual (Instructions, Standard Functions/Function Blocks)

■Timing chart

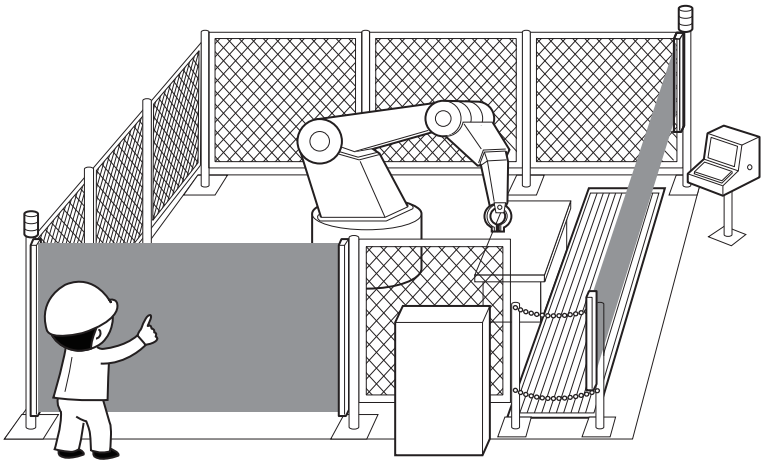


Entering detection and existence detection circuit 1

■Application overview

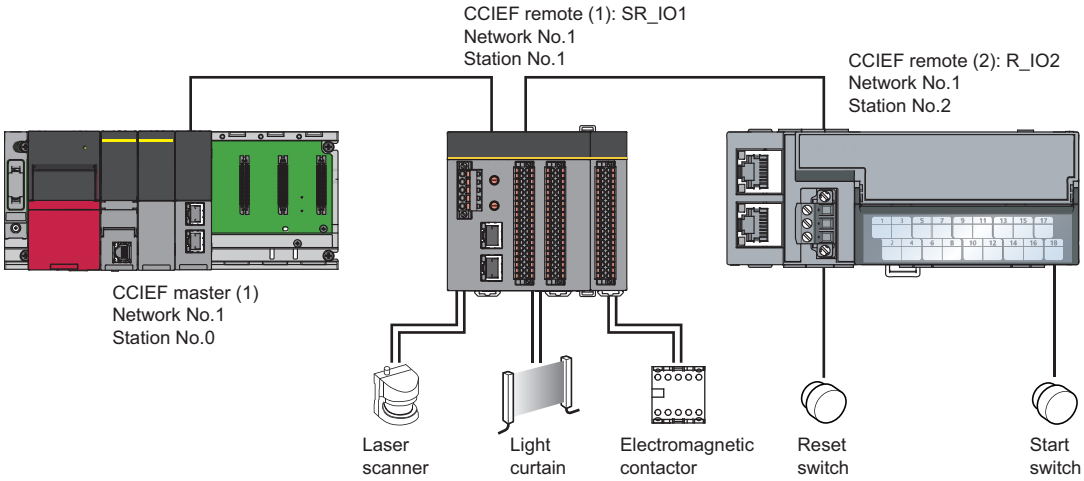
This application detects entering and existence of a person in a hazardous area and turns off the power source of a robot.
The entrance of a person to the hazardous area is detected with a light curtain. The existence of a person in the hazardous area is detected with a laser scanner. When the entrance or existence of the person has been detected, a robot is stopped. The robot cannot be started until the person leaves the hazardous area.
This controls the start and stop of a robot by turning on or off the main contact of the contractor which opens and closes the power source of a robot.
Connect the light curtain, laser scanner, and electromagnetic contactors to a safety programmable controller.
The Safety CPU turns on/off of the electromagnetic contactors with program.
When the safety programmable controller detects an error by self-diagnostics, outputs to the electromagnetic contactors turn off independent of the program.
In this case, the outputs remain off until the safety CPU module of CC-Link Safety remote I/O module is reset independent of the program.
Configure the program so that the following functions can be achieved.

1. After ensuring safety (the light curtain and laser scanner signals are both on), the operator shall press reset switch first. Pressing the start switch turns on the electromagnetic contactor.
2. When a safety electromagnetic contactor is welded, input the electromagnetic contactor (normally closed contact) to the safety programmable controller to prevent starting, and check for welding.
3. To avoid undesired operation of reset switch and start switch at welding or short-circuit, set reset switch and start switch so that they are activated only when turned on and off.
4. The electromagnetic contactor outputs are turned off when the light curtain signal or laser scanner signal is turned off or an error is detected in safety remote I/O module after the operation is started.



(Partially quoted from "Safety Guide Book - the safety measures of machinery in the workplace": Nippon Electric Control Equipment Industries Association)

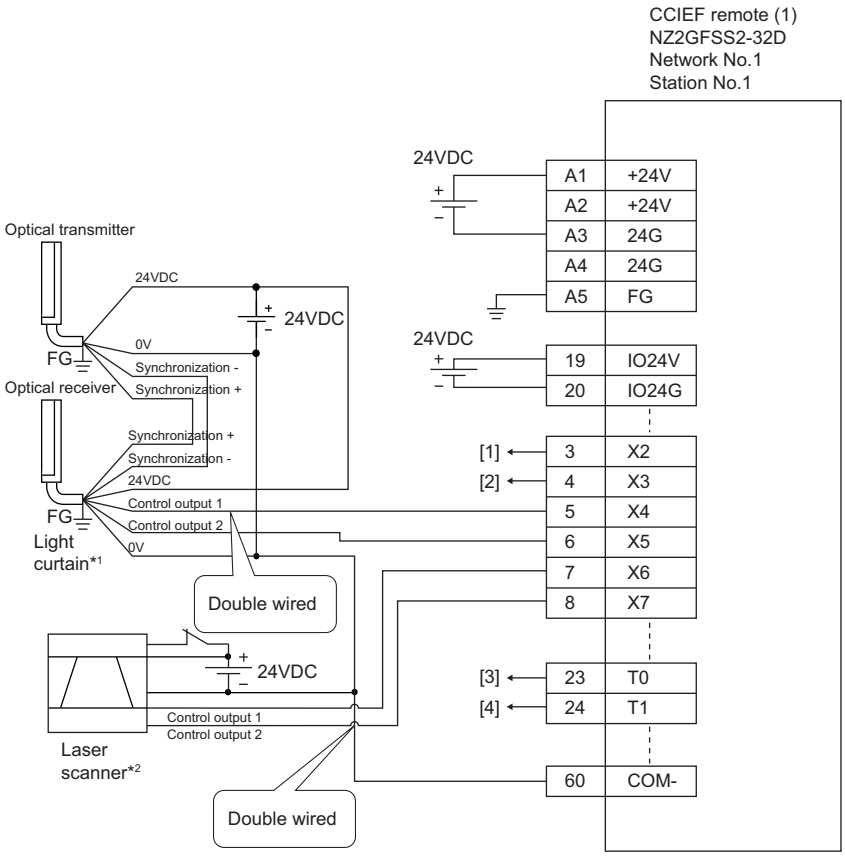
■Connection of safety devices



■Wiring diagram and parameter settings

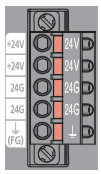
Connect the light curtain, laser scanner, and electromagnetic contactor to safety remote I/O module as follows. For details on terminal block details, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

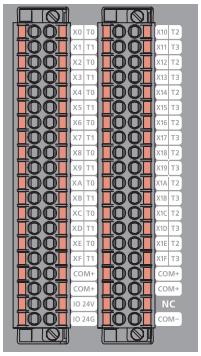


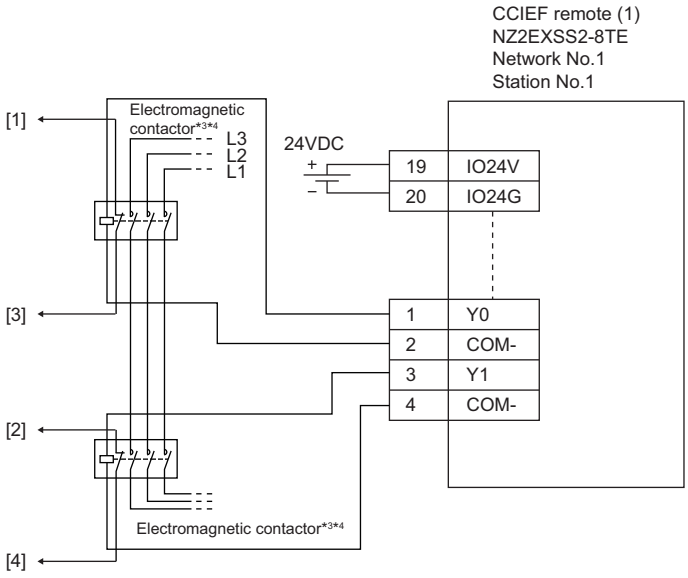
Terminal block for power supply and FG (input)

A1	+24V
A2	+24V
A3	24G
A4	24G
A5	FG

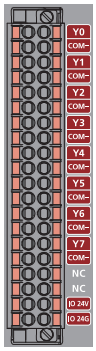


Spring clamp terminal block (input)





Spring clamp terminal block (output)



Above [1] to [4] are connected to the one with same numbers.

*1 Connect two points (PNP output) of the Type 4 light curtain control output to between input and COM.
*2 Connect two points (PNP output) of the Type 3 laser scanner control output to between input and COM.
*3 Use two electromagnetic contactors operatable by 24VDC and 0.5A.
*4 Connect normally closed contact of the safety relay between the input terminal and test pulse terminal.

For light curtains, laser scanners, and electromagnetic contactors, set the parameters as follows.

Item	Setting details[*3]
Sending Interval Monitoring Time	24ms
Wiring selection of input X2	Double wiring (NC/NC)[*4]
Wiring selection of input X3	Double wiring (NC/NC)[*4]
Wiring selection of input X4	Double wiring (NC/NC)[*4]
Wiring selection of input X5	Double wiring (NC/NC)[*4]
Wiring selection of input X6	Double wiring (NC/NC)[*4]
Wiring selection of input X7	Double wiring (NC/NC)[*4]
Wiring selection of input X0, X1, and X8 to X1F	Not used
Input response time X2[*1]	1ms
Input response time X3[*1]	1ms
Input response time X4[*1]	1ms
Input response time X5[*1]	1ms
Input response time X6[*1]	1ms
Input response time X7[*1]	1ms
Input response time X8[*1]	1ms
Input response time X9[*1]	1ms
Input response time X0, X1, and XA to X1F[*1]	1ms
Double input discrepancy detection setting X2_X3	Detect[*4]
Double input discrepancy detection setting X4_X5	Detect[*4]
Double input discrepancy detection setting X6_X7	Detect[*4]
Double input discrepancy detection setting X0, X1, and X8 to X1F	Do not detect[*4]
Double input discrepancy detection type X2_X3	Discrepancy detection time specified[*4]
Double input discrepancy detection type X4_X5	Discrepancy detection time specified[*4]
Double input discrepancy detection type X6_X7	Discrepancy detection time specified[*4]
Double input discrepancy detection type X0, X1, and X8 to X1F	Discrepancy detection time not specified[*4]
Auto recovery function at occurrence of a double input discrepancy error	Not used
Double input discrepancy detection time X2_X3 [*2]	10 (100ms)
Double input discrepancy detection time X4_X5 [*2]	2 (20ms)
Double input discrepancy detection time X6_X7 [*2]	2 (20ms)
Double input discrepancy detection time X0, X1, and X8 to X1F [*2]	1 (10ms)
Input dark test execution setting X2	Perform
Input dark test execution setting X3	Perform[*4]
Input dark test execution setting X4	Do not perform[*4]
Input dark test execution setting X5	Do not perform[*4]
Input dark test execution setting X6	Do not perform[*4]
Input dark test execution setting X7	Do not perform[*4]
Input dark test execution setting X0, X1, and X8 to X1F	Do not perform[*4]
Input dark test pulse OFF time[*1]	400μs
Number of pulse output for input dark test	1 time
Ext. module 1_Wiring selection of output Y0	Double wiring (source/source)[*4]
Ext. module 1_Wiring selection of output Y1	Double wiring (source/source)[*4]
Ext. module 1_Wiring selection of output Y2 to Y7	Not used[*4]
Ext. module 1_Wiring selection of output Y0	Perform[*4]
Ext. module 1_Wiring selection of output Y1	Perform[*4]
Ext. module 1_Wiring selection of output Y2 to Y7	Do not perform[*4]
Ext. module 1_Output dark test pulse off time Y0[*1]	1ms
Ext. module 1_Output dark test pulse OFF time Y1[*1]	1ms
Ext. module 1_Output dark test pulse OFF time Y2 to Y7[*1]	1ms
Ext. module 1_Number of pulse output for output dark test	1 time

*1 Adjust the values of input response time, input dark test pulse OFF time, and output dark test pulse OFF time according to the installation environment and wiring length.
*2 Set double input discrepancy detection time to 100ms for mechanical switches and 20ms for sensor inputs as standard.
*3 For details of setting range, refer to the following.
CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual
*4 Always set the parameters like this for this case example.

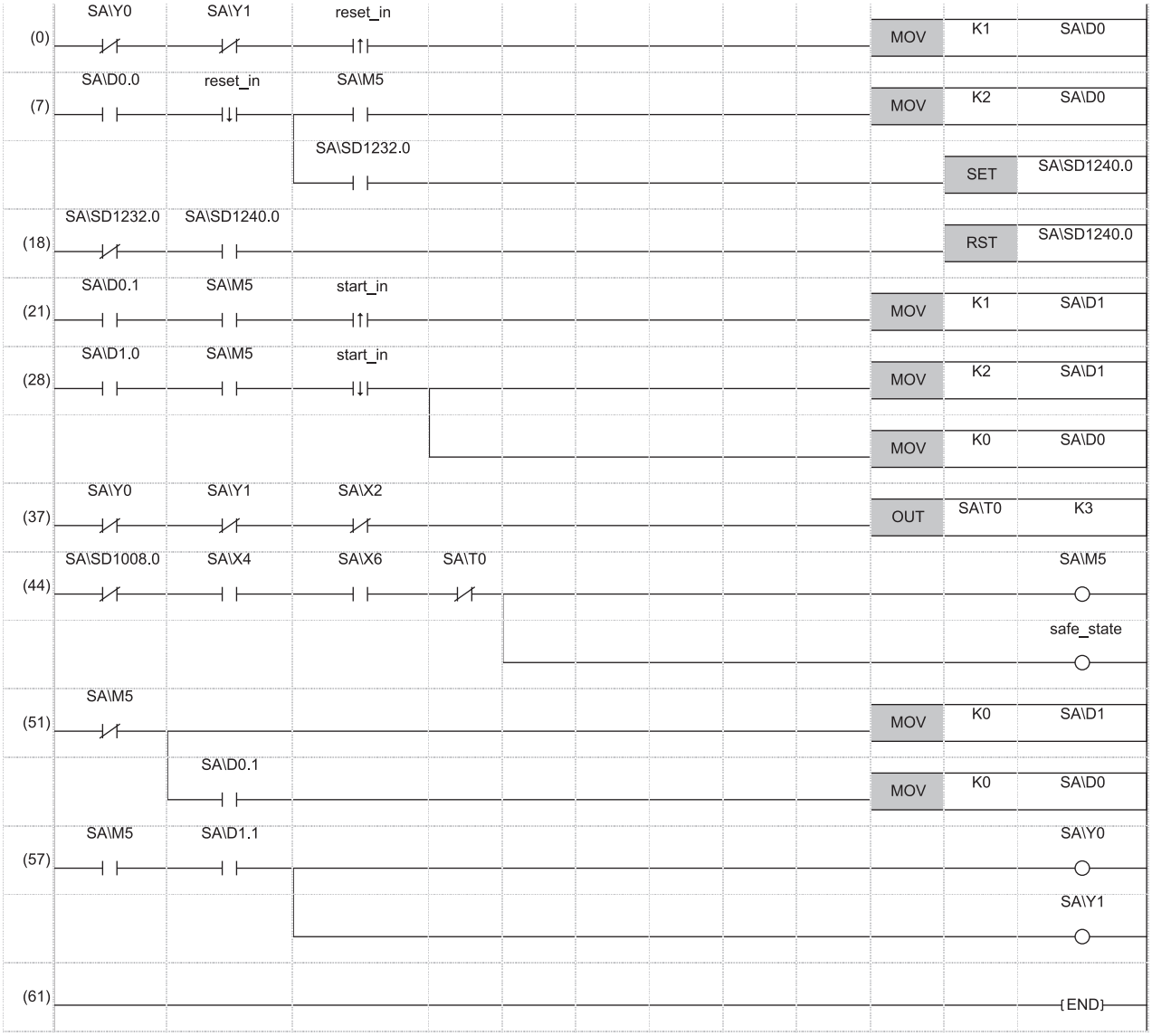
■Safety devices and safety labels to be used

Program safety program using safety devices and standard/safety shared labels shown below.

Module	External device	Safety device/safety label
SR_IO1	Light curtain	SA\X4 or SA\X5
	Laser scanner	SA\X6 or SA\X7
	Contactor	SA\Y0 and SA\Y1
	Contactor (check for welding)	SA\X2 or SA\X3
R_IO2	Reset switch	reset_in
	Start switch	start_in

■Program example

This is a safety program. For precautions for creating safety program and setting method, refer to Page 34 Precautions for Programming and Page 52 Parameter setting of the Safety CPU. The program performs the following processing.



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(18)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(21) to (28)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(37)	This is a circuit to check welding of the electromagnetic contactor.
(44)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(51)	This is a circuit to cancel start/reset request, when not possible to check safety.
(57)	This is a circuit to control outputs to the electromagnetic contactor.

The following shows the constant and safety user devices used in the program.

• Way of using the constant

K□: indicates decimal number

Ex.

K1→ 1 of decimal number

• Way of using the safety user devices

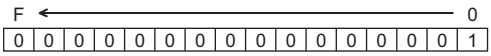
Safety user devices	Description
SA\D0	This is used as restart status. (1) SA\D0 = 0: Initial status or start processing completed (2) SA\D0 = 1: (SA/D0.0: ON): Reset switch pressed (3) SA\D0 = 2 (SA\D0.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\D1	This is used as start status. (1) SA\D1 = 0: Initial status or safety not checked (2) SA\D1 = 1 (SA\D1.0: ON): Reset switch pressed. (3) SA\D1 = 2 (SA\D1.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\T0	This indicates timer device. Times out after a lapse of the time specified at K□.

• Way of using word device bit specification

SA\D□.n: This indicates the nth bit of the word device SA\D□

Ex.

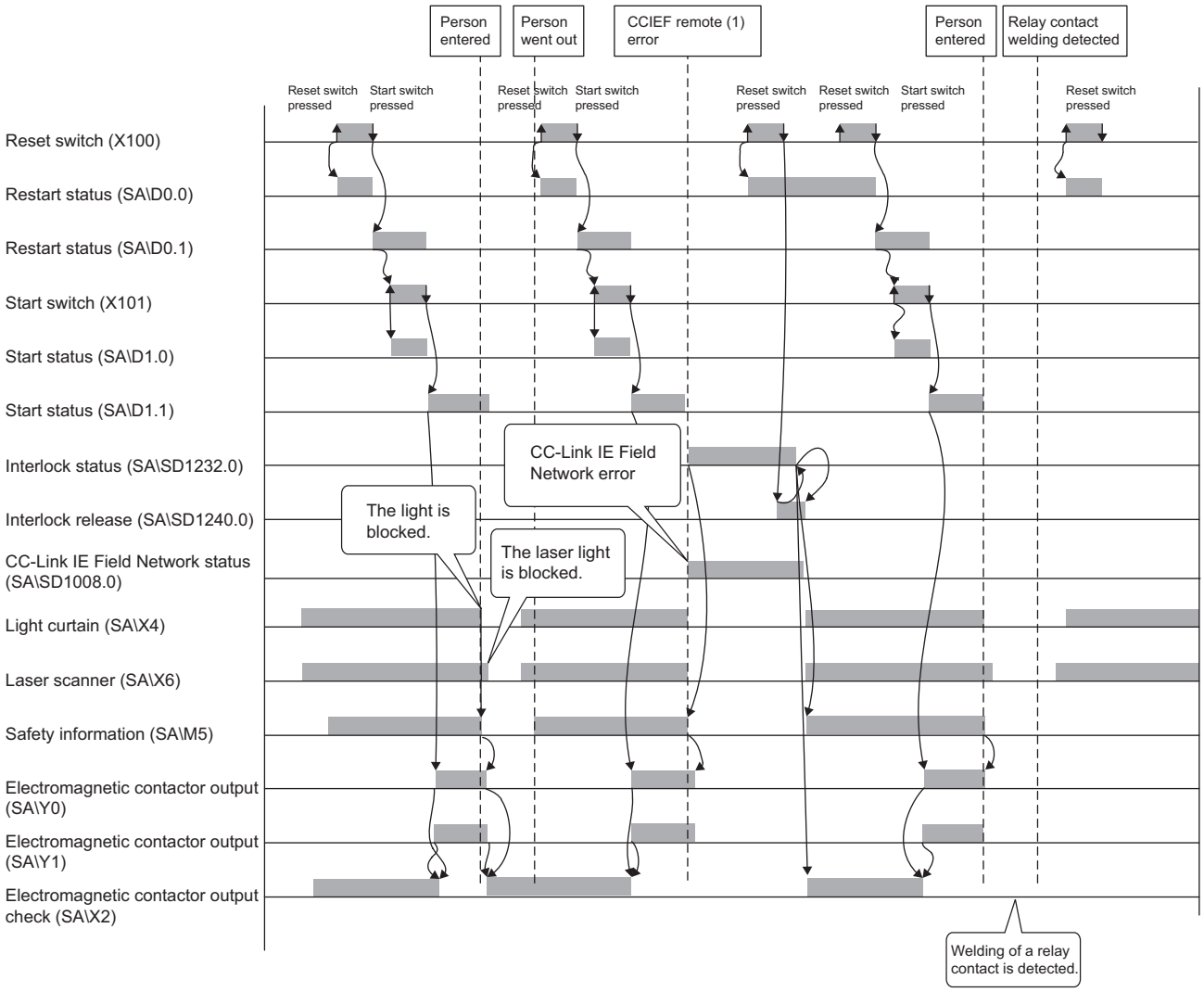
SA\D0.0 = 0 bits in SA\D0



For bit-specified word device, refer to the following.

📖 MELSEC iQ-R Programming Manual (Instructions, Standard Functions/Function Blocks)

■Timing chart

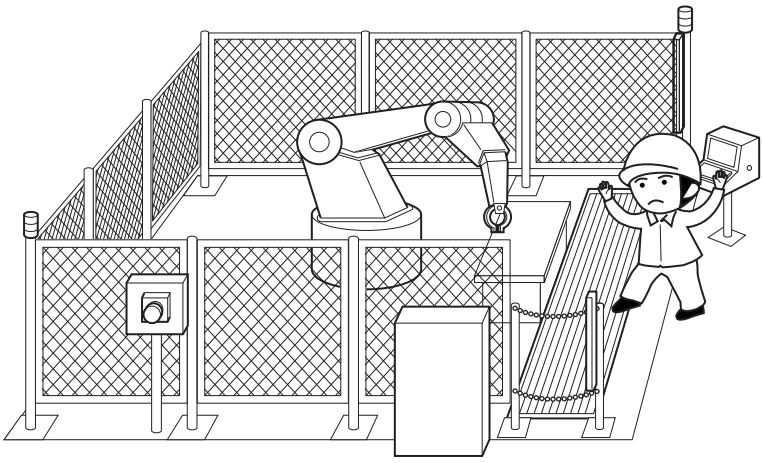


Entering detection and existence detection circuit 2

■Application overview

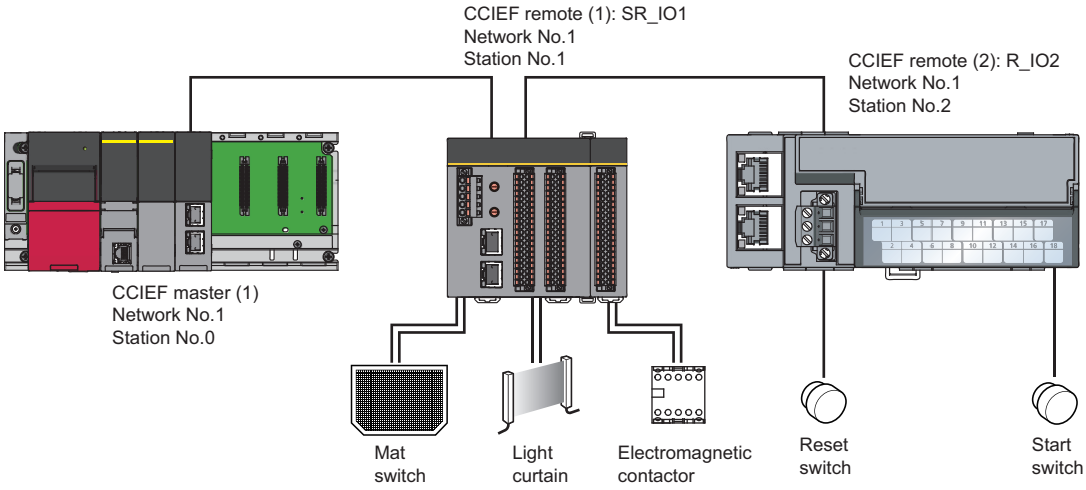
This application detects entering and existence of a person in a hazardous area and turns off the power source of a robot.
The entrance of the person to the hazardous area is detected with a light curtain. The existence of the person in the hazardous area is detected with a mat switch. When the entrance or existence of the person has been detected, a robot is stopped.
The robot cannot be started until the person leaves the hazardous area.
This controls the start and stop of a robot by turning on or off the main contact of the contractor which opens and closes the power source of a robot.
Connect the light curtain and electromagnetic contactors to a safety programmable controller.
Connect the relay between the mat switch and safety programmable controller.
The Safety CPU turns on/off of the electromagnetic contactors with program.
When the safety programmable controller detects an error by self-diagnostics, outputs to the electromagnetic contactors turn off independent of the program.
In this case, the outputs remain off until the safety CPU module of CC-Link Safety remote I/O module is reset independent of the program.
Configure the program so that the following functions can be achieved.

1. After ensuring safety (the light curtain and laser mat switch are both on), the operator shall press reset switch first. Pressing the start switch turns on the safety electromagnetic contactors.
2. When a safety electromagnetic contactor is welded, input the electromagnetic contactor (normally closed contact) to the safety programmable controller to prevent starting, and check for welding.
3. To avoid undesired operation of reset switch and start switch at welding or short-circuit, set reset switch and start switch so that they are activated only when turned on and off.
4. The electromagnetic contactor outputs are turned off when the light curtain signal or mat switch relay input is turned off or an error is detected in safety remote I/O module after the start.



(Partially quoted from "Safety Guide Book - the safety measures of machinery in the workplace": Nippon Electric Control Equipment Industries Association)

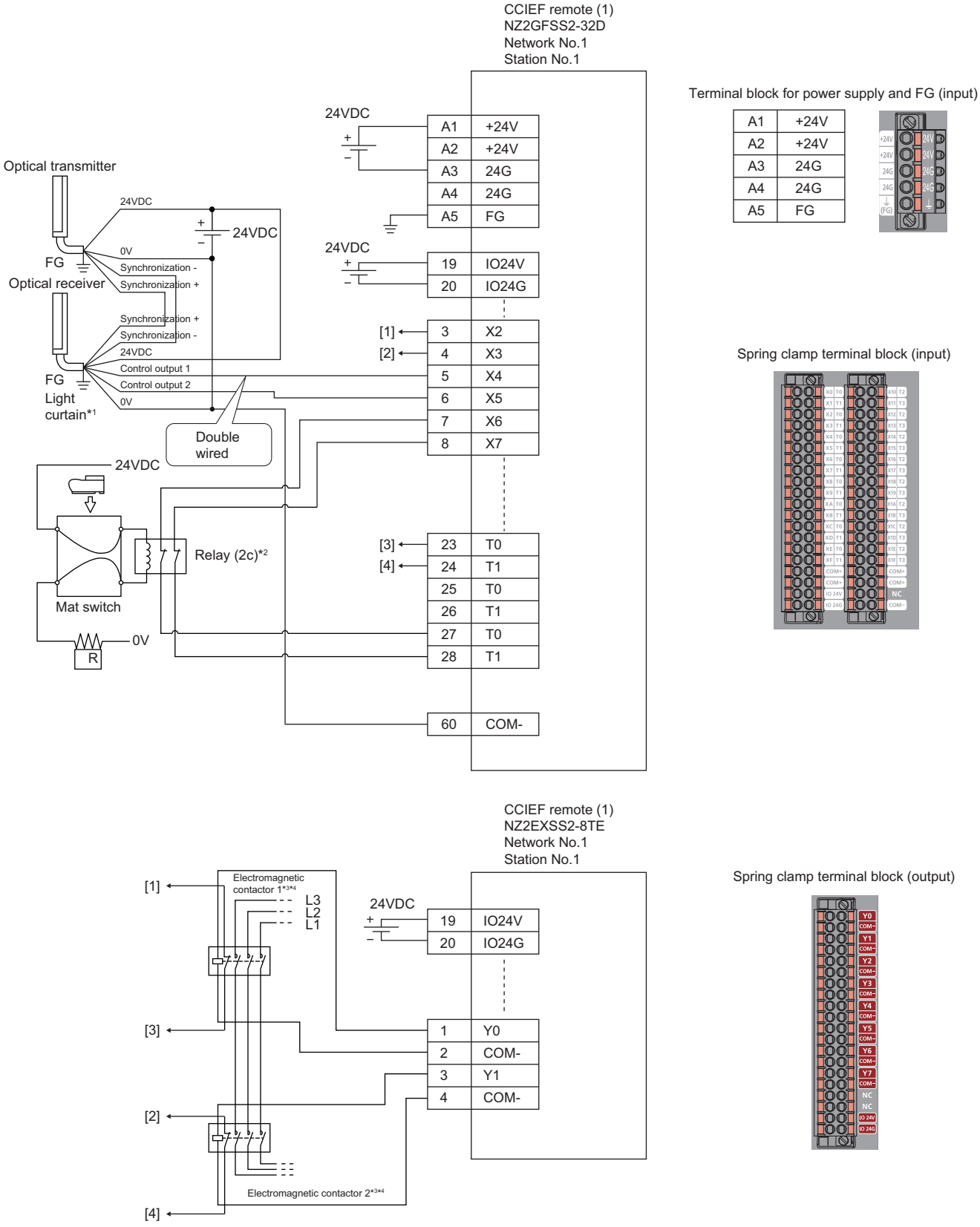
■Connection of safety devices



■Wiring diagram and parameter settings

Wire the light curtain, mat switch, and electromagnetic contactor to safety remote I/O module as follows. For details on terminal block details, refer to the following.

📖 CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual



Above [1] to [4] are connected to the one with same numbers.

*1 Connect two points (PNP output) of the Type 4 light curtain control output to between input and COM.
*2 Connect four-wire mat to the relay, and two relay contacts between the input terminal and test pulse terminal. Connect input terminal to NO side.
*3 Use two electromagnetic contactors operatable by 24VDC and 0.5A.
*4 Connect normally closed contact of the safety relay between the input terminal and test pulse terminal.

For light curtains, mat switches, and electromagnetic contactors, set the parameters as follows.

Item	Setting details*3
Sending Interval Monitoring Time	24ms
Wiring selection of input X2	Double wiring (NC/NC)*4
Wiring selection of input X3	Double wiring (NC/NC)*4
Wiring selection of input X4	Double wiring (NC/NC)*4
Wiring selection of input X5	Double wiring (NC/NC)*4
Wiring selection of input X6	Double wiring (NC/NC)*4
Wiring selection of input X7	Double wiring (NC/NC)*4
Wiring selection of input X0, X1, and X8 to X1F	Not used
Input response time X2*1	1ms
Input response time X3*1	1ms
Input response time X4*1	1ms
Input response time X5*1	1ms
Input response time X6*1	1ms
Input response time X7*1	1ms
Input response time X8*1	1ms
Input response time X9*1	1ms
Input response time X0, X1, and XA to X1F*1	1ms
Double input discrepancy detection setting X2_X3	Detect*4
Double input discrepancy detection setting X4_X5	Detect*4
Double input discrepancy detection setting X6_X7	Detect*4
Double input discrepancy detection setting X0, X1, and X8 to X1F	Do not detect*4
Double input discrepancy detection type X2_X3	Discrepancy detection time specified*4
Double input discrepancy detection type X4_X5	Discrepancy detection time specified*4
Double input discrepancy detection type X6_X7	Discrepancy detection time specified*4
Double input discrepancy detection type X0, X1, and X8 to X1F	Discrepancy detection time not specified*4
Double input discrepancy auto recovery setting	Not used
Double input discrepancy detection time X2_X3 *2	10 (100ms)
Double input discrepancy detection time X4_X5 *2	2 (20ms)
Double input discrepancy detection time X6_X7 *2	2 (20ms)
Double input discrepancy detection time X0, X1, and X8 to X1F *2	1 (10ms)
Input dark test execution setting X2	Perform*4
Input dark test execution setting X3	Perform*4
Input dark test execution setting X4	Do not perform*4
Input dark test execution setting X5	Do not perform*4
Input dark test execution setting X6	Perform*4
Input dark test execution setting X7	Perform*4
Input dark test execution setting X0, X1, and X8 to X1F	Do not perform*4
Input dark test pulse OFF time*1	400μs
Number of pulse output for input dark test	1 time
Ext. module 1_Wiring selection of output Y0	Double wiring (source/source)*4
Ext. module 1_Wiring selection of output Y1	Double wiring (source/source)*4
Ext. module 1_Wiring selection of output Y2 to Y7	Not used
Ext. module 1_Wiring selection of output Y0	Perform*4
Ext. module 1_Wiring selection of output Y1	Perform*4
Ext. module 1_Wiring selection of output Y2 to Y7	Do not perform*4
Ext. module 1_Output dark test pulse OFF time Y0*1	1ms
Ext. module 1_Output dark test pulse OFF time Y1*1	1ms

Item	Setting details[*3]
Ext. module 1_Output dark test pulse OFF time Y2 to Y7[*1]	1ms
Ext. module 1_Number of pulse output for output dark test	1 time

*1 Adjust the values of input response time, input dark test pulse off time, and output dark test pulse off time according to the installation environment and wiring length.

*2 Set double input discrepancy detection time to 100ms for mechanical switches and 10ms for sensor inputs as standard.

*3 For details on setting range, refer to the following.
CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

*4 Always set the parameters like this for this case example.

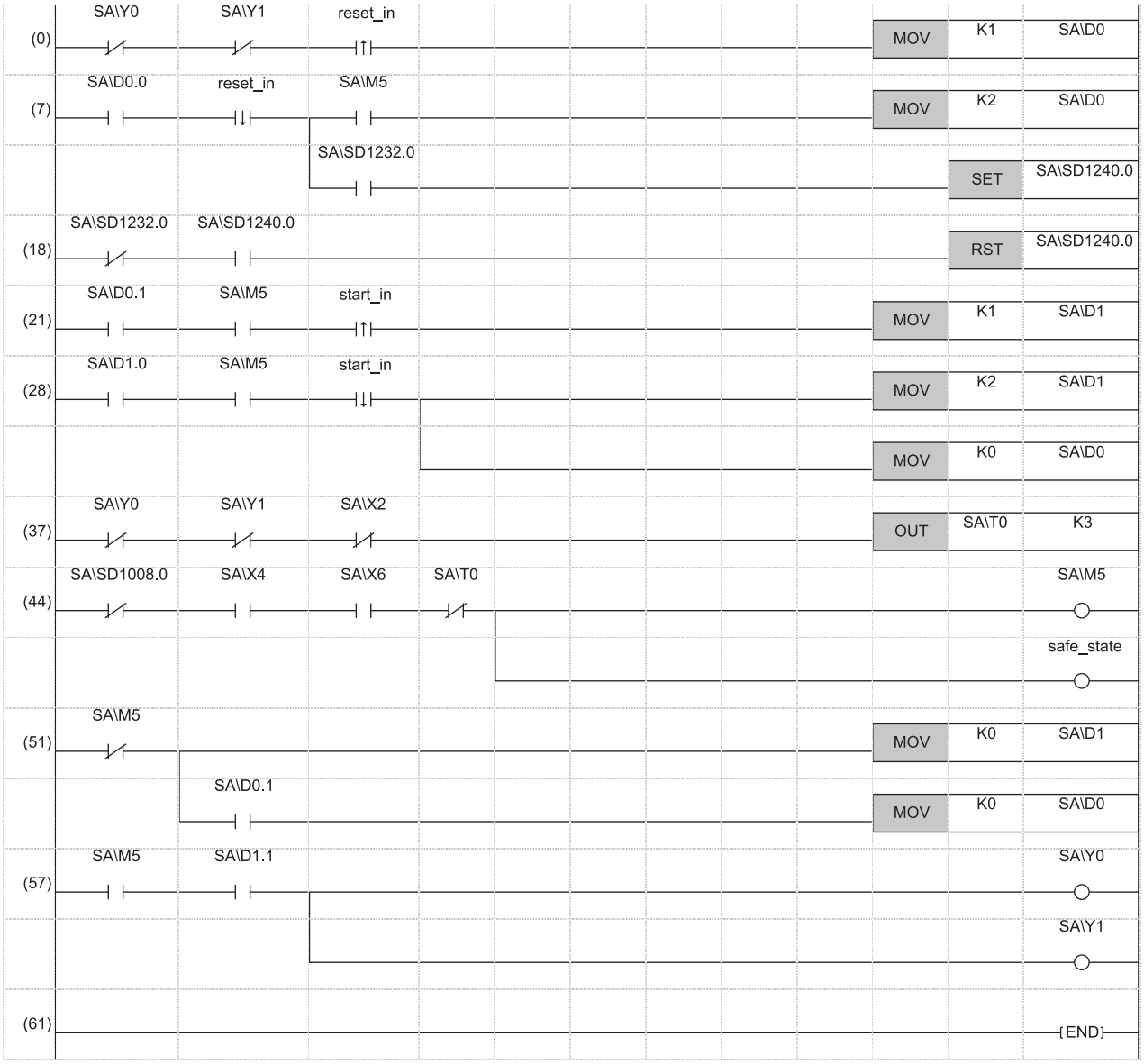
■Safety devices and safety labels to be used

Program safety program using safety devices and standard/safety shared labels shown below.

Module	External device	Safety device/safety label
SR_IO1	Light curtain	SA\X4 or SA\X5
	Mat switch	SA\X6 or SA\X7
	Contactor 1, 2	SA\Y0 and SA\Y1
	Contactor (check for welding)	SA\X2 or SA\X3
R_IO2	Reset switch	reset_in
	Start switch	start_in

■Program example

This is a safety program. For precautions for creating safety program and setting method, refer to Page 34 Precautions for Programming and Page 52 Parameter setting of the Safety CPU. The program performs the following processing.



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(18)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(21) to (28)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(37)	This is a circuit to check welding of the electromagnetic contactor.
(44)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(51)	This is a circuit to cancel start/reset request, when not possible to check safety.
(57)	This is a circuit to control outputs to the electromagnetic contactor.

The following shows the constant and safety user devices used in the program.

• Way of using the constant

K☐: indicates decimal number

Ex.

K1→ 1 of decimal number

• Way of using the safety user devices

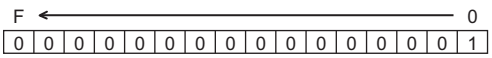
Safety user devices	Description
SA\D0	This is used as restart status. (1) SA\D0 = 0: Initial status or start processing completed (2) SA\D0 = 1: (SA/D0.0: ON): Reset switch pressed (3) SA\D0 = 2 (SA\D0.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\D1	This is used as start status. (1) SA\D1 = 0: Initial status or safety not checked (2) SA\D1 = 1 (SA\D1.0: ON): Reset switch pressed. (3) SA\D1 = 2 (SA\D1.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\T0	This indicates timer device. Times out after a lapse of the time specified at K☐.

• Way of using word device bit specification

SA\D☐.n: This indicates the nth bit of the word device SA\D☐

Ex.

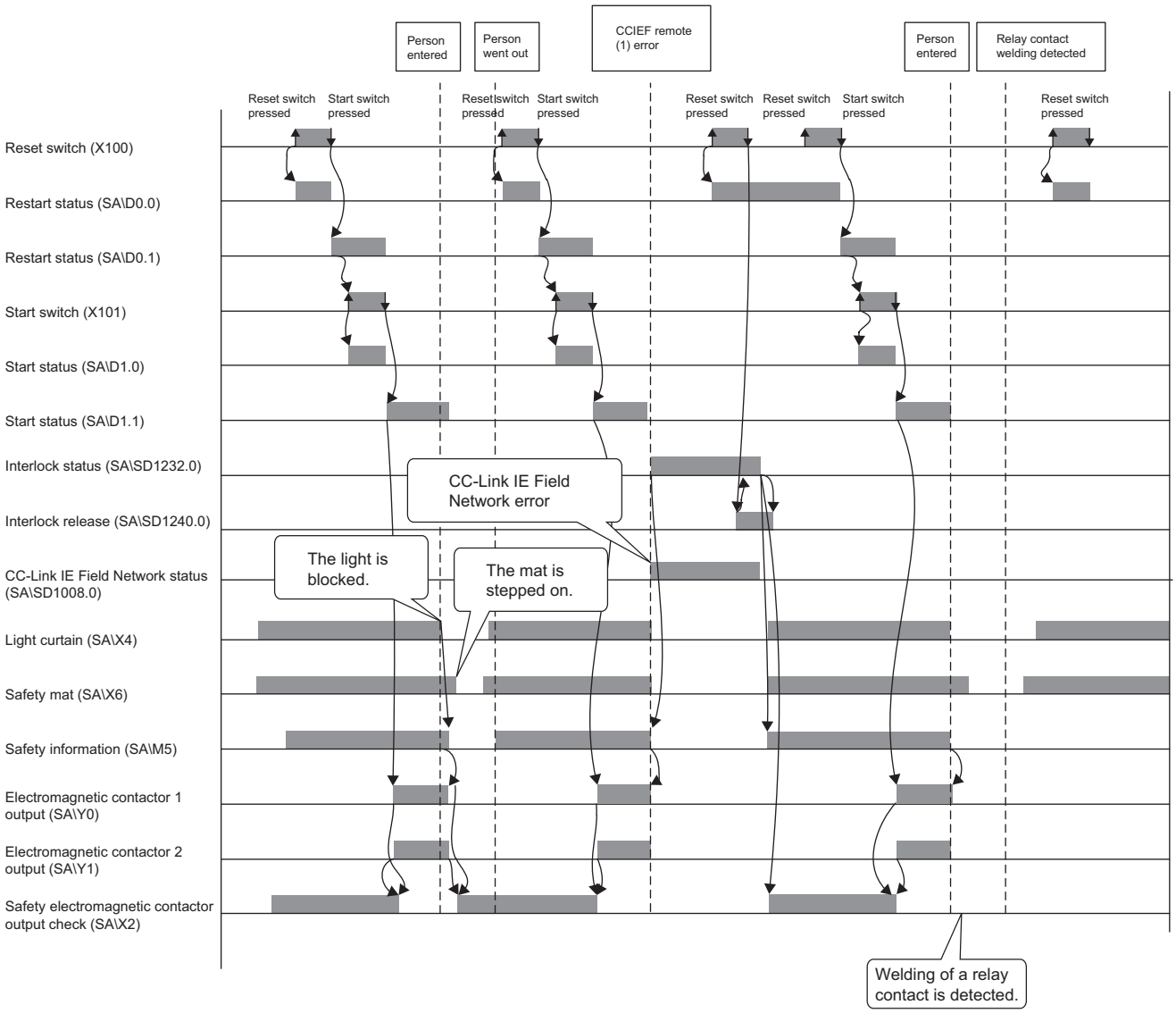
SA\D0.0 = 0 bits in SA\D0



For bit-specified word device, refer to the following.

MELSEC iQ-R Programming Manual (Instructions, Standard Functions/Function Blocks)

■Timing chart



Guide interlock circuit

■Safety application overview

This application prevents the guard from being opened until a robot is de-energized with the spring-lock safety switch on the guard of a safety barrier.

The safety switch is usually interlocked with spring. By applying a voltage to a solenoid, the interlock is released and the guard can be opened. The robot cannot be started while the interlock is released or the guard is open.

This section shows an example where the interlock of the safety switch is released by pressing the stop switch and the safety switch is re-interlocked by pressing the reset switch.

This controls the start and stop of a robot by turning on or off the main contact of the contractor which opens and closes the power source of a robot.

Connect the safety switch and electromagnetic contactors to a safety programmable controller.

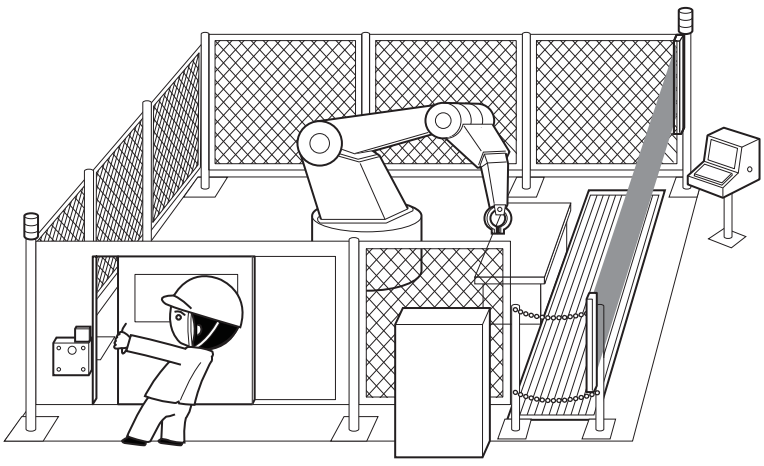
The Safety CPU turns on/off of the electromagnetic contactors with program.

When the safety programmable controller detects an error by self-diagnostics, outputs to the electromagnetic contactors turn off independent of the program.

In this case, the outputs remain off until the Safety CPU or safety remote I/O module is reset regardless the program, when outputs turns off by the self-diagnostics.

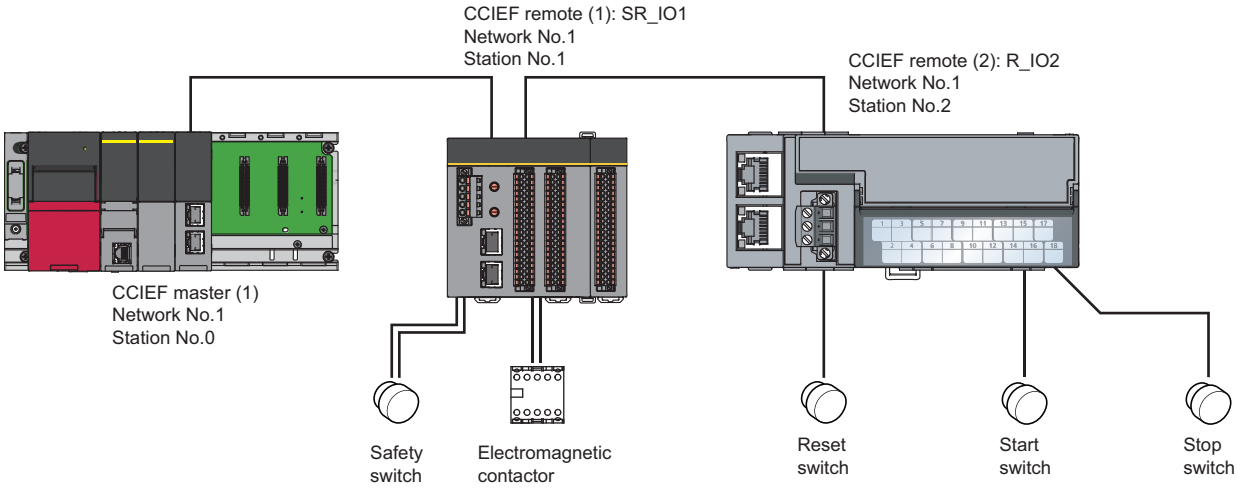
Configure the program so that the following functions can be achieved.

1. Check that safety is ensured (the safety switch is on state) and the operator presses the reset switch first. Pressing the start switch turns on the safety electromagnetic contactors.
2. When a safety electromagnetic contactor is welded, input the safety electromagnetic contactor (normally closed contact) to the safety programmable controller to prevent starting, and check for welding.
3. To avoid undesired operation of reset switch and start switch at welding or short-circuit, set reset switch and start switch so that they are activated only when turned on and off.
4. Pressing the stop switch turns off the electromagnetic contactor output. After that, release the interlock to the safety switch (the guard can be opened after the interlock is released).
5. Pressing the reset switch re-interlocks the safety switch.
6. When an error is detected in the safety remote I/O module after operation starts, outputs to the electromagnetic contactors turn off.



(Partially quoted from "Safety Guide Book - the safety measures of machinery in the workplace": Nippon Electric Control Equipment Industries Association)

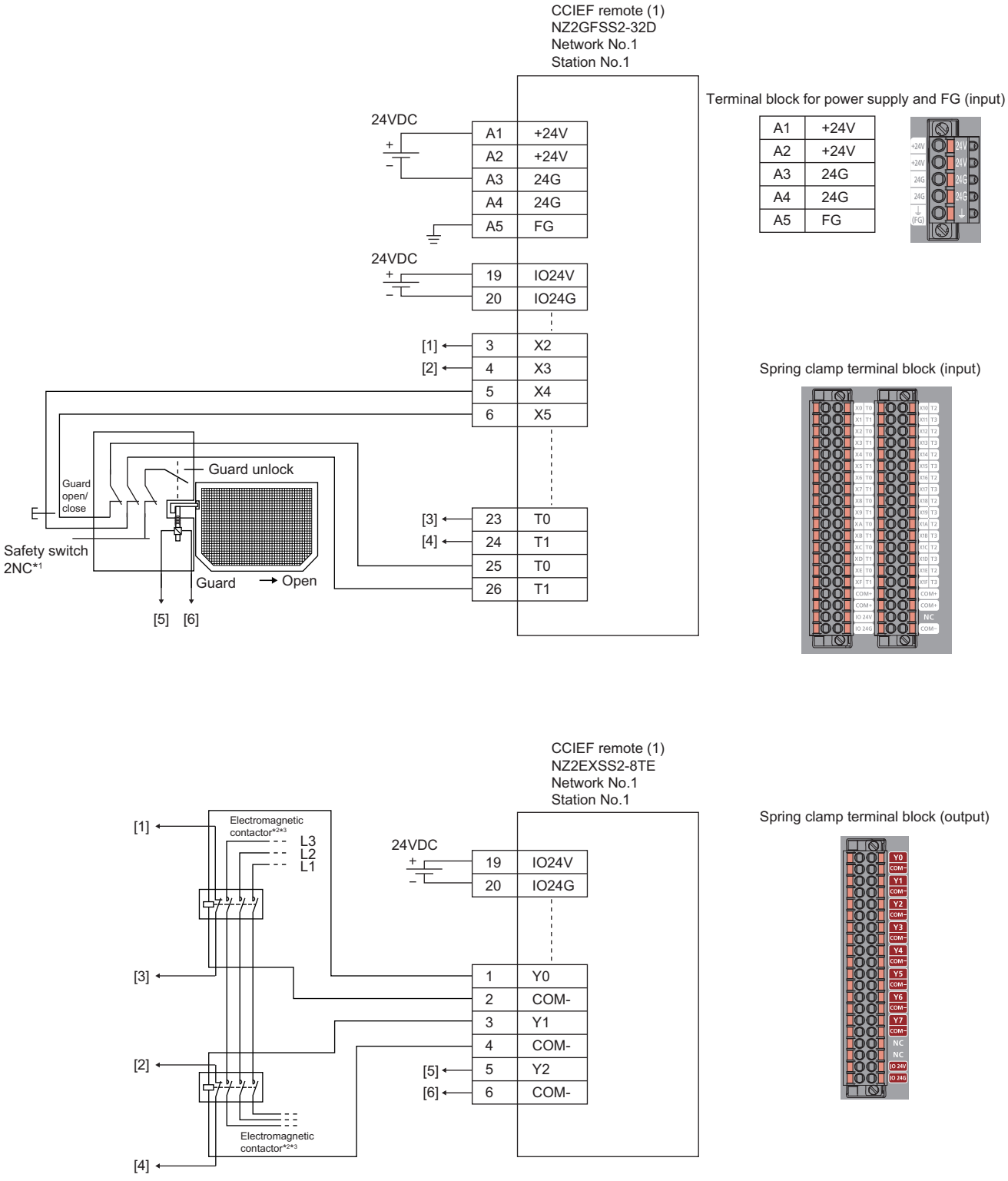
■ Connection of safety devices



■Wiring diagram and parameter settings

Wire the safety switch and electromagnetic contactor to safety remote I/O module as follows. For details on terminal block details, refer to the following.

📖 CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual



Above [1] to [6] are connected to the one with same numbers.

*1 Wire a safety switch having two normally closed contacts with direct opening action to input terminal and test pulse terminal, using a guard switch with an interlock.

*2 Use two electromagnetic contactors operatable by 24VDC and 0.5A.

*3 Connect normally closed contact of the safety relay between the input terminal and test pulse terminal.

This example shows when the guard open/close signal of the safety switch is input. When using a safety switch whose interlock status can be monitored, input the locking status signal to the safety remote I/O module as well.

For safety switch and electromagnetic contactors, set the parameters as follows.

Item	Setting details*3
Transmission interval monitoring time	24ms
Wiring selection of input X2	Double wiring (NC/NC)*4
Wiring selection of input X3	Double wiring (NC/NC)*4
Wiring selection of input X4	Double wiring (NC/NC)*4
Wiring selection of input X5	Double wiring (NC/NC)*4
Wiring selection of input X0, X1, and X6 to X1F	Not used
Input response time X2*1	1ms
Input response time X3*1	1ms
Input response time X4*1	1ms
Input response time X5*1	1ms
Input response time X6*1	1ms
Input response time X7*1	1ms
Input response time X8*1	1ms
Input response time X0, X1, and X9 to X1F*1	1ms
Double input discrepancy detection setting X2_X3	Detect*4
Double input discrepancy detection setting X4_X5	Detect*4
Double input discrepancy detection setting X0, X1, and X6 to X1F	Do not detect*4
Double input discrepancy detection type X2_X3	Discrepancy detection time specified*4
Double input discrepancy detection type X4_X5	Discrepancy detection time specified*4
Double input discrepancy detection type X0, X1, and X6 to X1F	Discrepancy detection time not specified*4
Double input discrepancy auto recovery setting	Not used
Double input discrepancy detection time X2_X3 *2	10 (100ms)
Double input discrepancy detection time X4_X5 *2	50 (500ms)
Double input discrepancy detection time X0, X1, and X6 to X1F *2	1 (10ms)
Input dark test execution setting X2	Perform*4
Input dark test execution setting X3	Perform*4
Input dark test execution setting X4	Perform*4
Input dark test execution setting X5	Perform*4
Input dark test execution setting X0, X1, and X6 to X1F	Do not perform*4
Input dark test pulse off time*1	400μs
Number of pulse output for input dark test	1 time
Extension 1_Wiring selection of output Y0	Double wiring (source/source)*4
Extension 1_Wiring selection of output Y1	Double wiring (source/source)*4
Extension 1_Wiring selection of output Y2	Single wiring*4
Extension 1_Wiring selection of output 3 to Y7	Not used*4
Extension 1_Output dark test execution setting Y0	Perform*4
Extension 1_Output dark test execution setting Y1	Perform*4
Extension 1_Output dark test execution setting Y2	Do not perform*4
Extension 1_Output dark test execution setting Y3 to Y7	Do not perform*4
Extension 1_Output dark test pulse off time Y0*1	1ms
Extension 1_Output dark test pulse off time Y1*1	1ms
Extension 1_Output dark test pulse off time Y2*1	1ms
Extension 1_Output dark test pulse off time Y3 to Y7*1	1ms
Extension 1_Number of pulse output for output dark test	1 time

*1 Adjust the values of input response time, input dark test pulse off time, and output dark test pulse off time according to the installation environment and wiring length.

*2 Set double input discrepancy detection time to 100ms for mechanical switches and 20ms for sensor inputs as standard.

*3 For details on setting range, refer the following manual.
CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

*4 Always set the parameters like this for this case example.

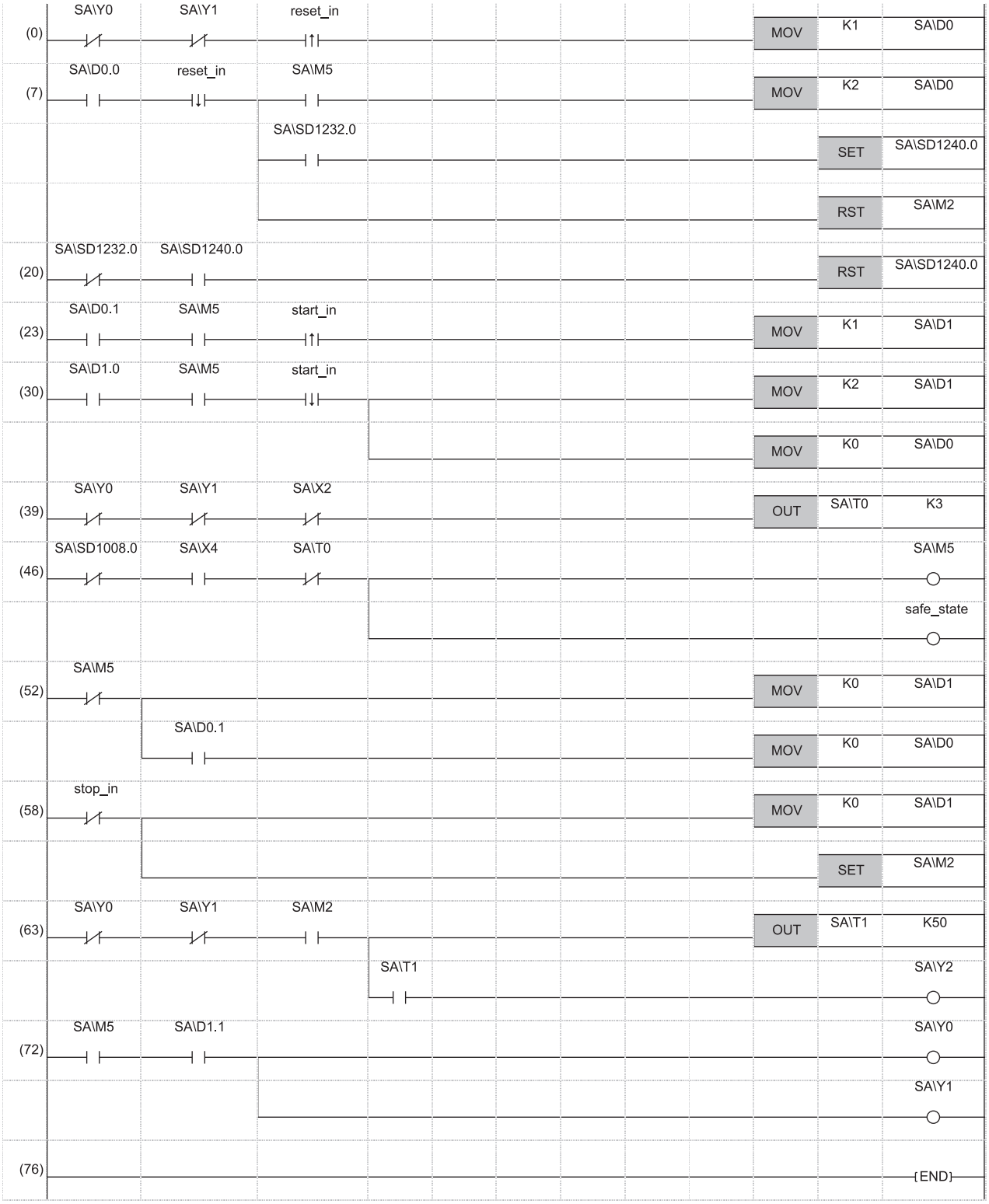
■Safety devices and safety labels to be used

Program safety program using safety devices and standard/safety shared labels shown below.

Module	External device	Safety device/safety label
SR_IO1	Safety switch	SA\X4 or SA\X5
	Release of interlock to safety switch	SA\Y2
	Contactor	SA\Y0 and SA\Y1
	Contactor (check for welding)	SA\X2 or SA\X3
R_IO2	Reset switch	reset_in
	Start switch	start_in
	Stop switch	stop_in

■Program example

This is a safety program. For precautions for creating safety program and setting method, refer to Page 34 Precautions for Programming and Page 52 Parameter setting of the Safety CPU. The program performs the following processing.



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(20)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(23) to (30)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(39)	This is a circuit to check welding of the electromagnetic contactor.
(46)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(52)	This is a circuit to cancel start/reset request, when not possible to check safety.
(58)	This is a circuit to process stop request.

(63) This is a circuit to cancel guide interlock.

(72) This is a circuit to control outputs to the electromagnetic contactor.

The following shows the constant and safety user devices used in the program.

• Way of using the constant

K☐: indicates decimal number

Ex.

K1→ 1 of decimal number

• Way of using the safety user devices

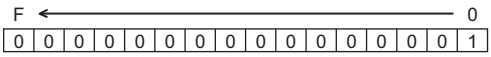
Safety user devices	Description
SA\D0	This is used as restart status. (1) SA\D0 = 0: Initial status or start processing completed (2) SA\D0 = 1: (SA/D0.0: ON): Reset switch pressed (3) SA\D0 = 2: (SA/D0.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\D1	This is used as start status. (1) SA\D0 = 0: Initial status or safety not checked (2) SA\D1 = 1 (SA\D1.0: ON): Start switch pressed (3) SA\D1 = 2 (SA\D1.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\T0	This indicates timer device. Times out after a lapse of the time specified at K☐

• Way of using word device bit specification

SA\D☐.n: This indicates the nth bit of the word device SA\D☐

Ex.

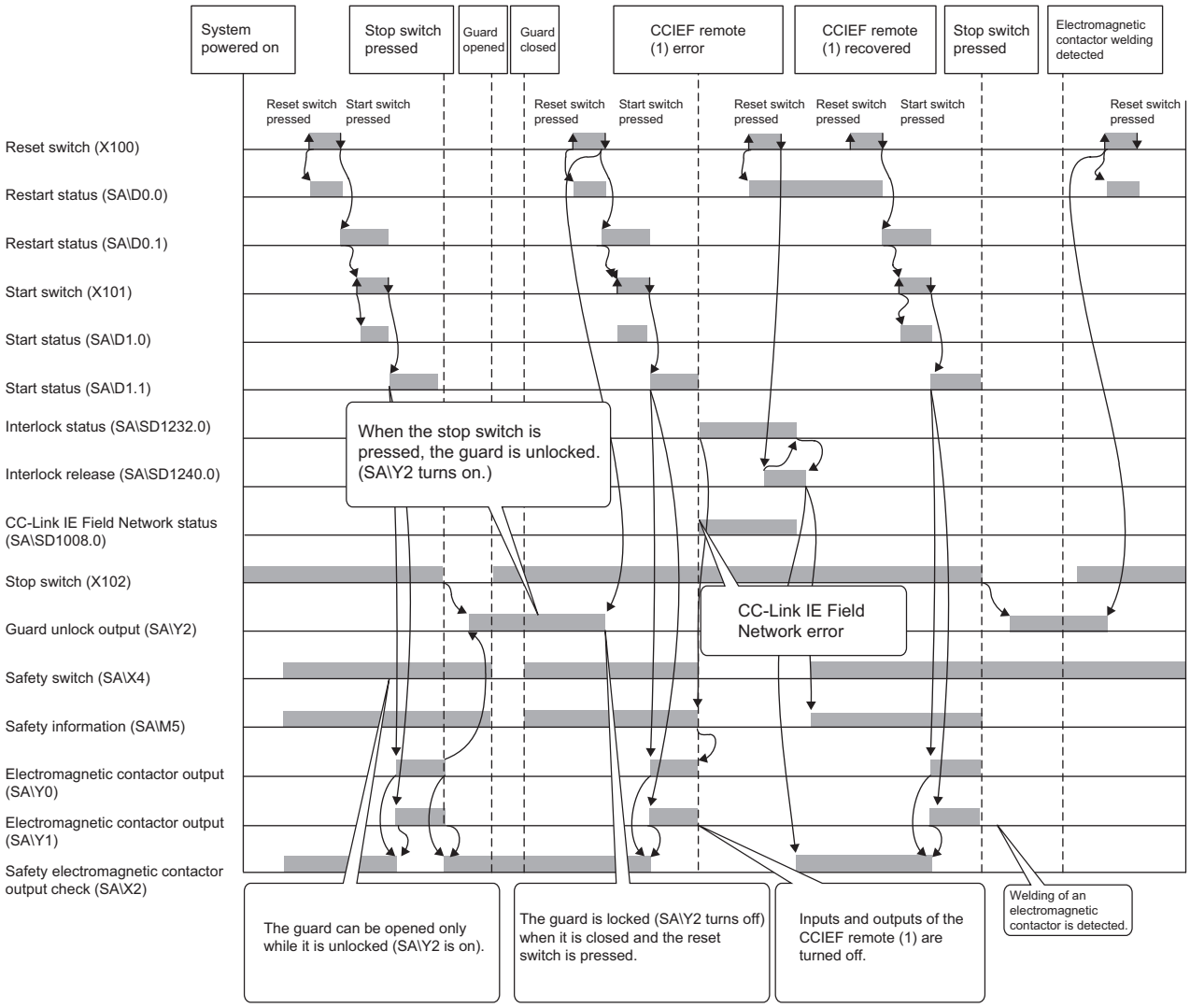
SA\D0.0 = 0 bits in SA\D0



For bit-specified word device, refer to the following.

MELSEC iQ-R Programming Manual (Instructions, Standard Functions/Function Blocks)

■Timing chart

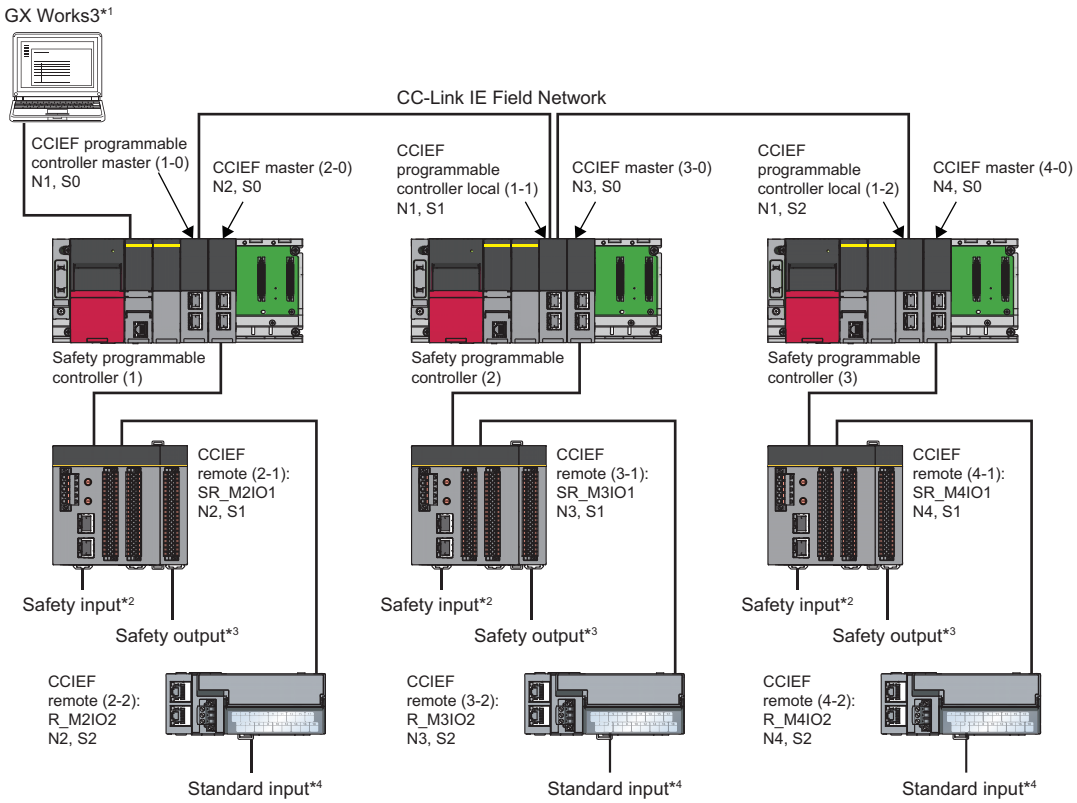


5.2 System to Which Multiple Safety CPUs are Connected

This section describes a configuration example of a safety application performs safety communications using three Safety CPUs.

System configuration

This section describes a safety application using the following system configuration.



In the figure above, "N" means network number, while "S" means station number. For example, "N1" means network number 1, while "S0" means station number 0.

*1 This sets parameters and programs.

*2 They are safety input device such as emergency stop switch, safety switch, light curtain, laser scanner, and mat switch.

*3 They are safety output device such as safety relay and MC.

*4 They are general input device such as reset switch, start switch, and stop switch.

The following table shows definitions of the symbols used in this chapter.

Symbol	Module name
CCIEF master (A-0) (A = 2, 3, 4)	MELSEC iQ-R series CC-Link IE Field Network master/local module (network number 2, 3, 4, station number 0) This is used when communicating with safety remote I/O module.
CCIEF remote (A-1) (A = 2, 3, 4)	Safety remote I/O module (network number 2, 3, 4, station number 1) This is a safety remote I/O module to be used for safety input/output.
CCIEF remote (A-2) (A = 2, 3, 4)	Standard remote I/O module (network number 2, 3, 4, station number 2) This is a standard remote I/O module to be used for standard input/output.
CCIEF programmable controller master (1-0)	MELSEC iQ-R series CC-Link IE Field Network master/local module (network number 0, station number 1) This is used when communicating between Safety CPUs.
CCIEF programmable controller local (1-1)	MELSEC iQ-R series CC-Link IE Field Network master/local module (network number 1, station number 1) This is used when communicating between Safety CPUs.
CCIEF programmable controller local (1-2)	MELSEC iQ-R series CC-Link IE Field Network master/local module (network number 2, station number 1) This is used when communicating between Safety CPUs.

Network-related switch settings of module

Set network-related switches on modules as following.

Safety CPU

There is no network-related switch.

Safety function module

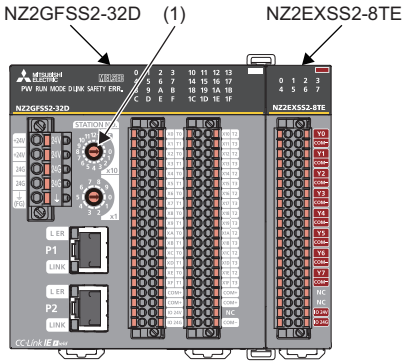
There is no network-related switch.

CC-Link IE Field Network master/local module

There is no network-related switch.

Safety remote I/O module

Set the station number setting switches.



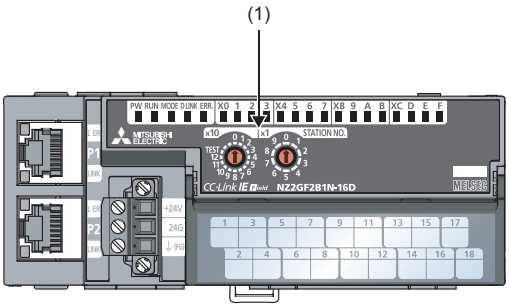
Switch number	Remote I/O module number	CCIEF remote (2-1) SR_M2IO1 (Network number 2)	CCIEF remote (3-1) SR_M3IO1 (Network number 3)	CCIEF remote (4-1) SR_MIO1 (Network number 4)
(1)	Station number setting switch	1	1	1

Point

The setting value of the station number becomes valid when the module is powered on. Set the station number when the system is powered off.

■Standard remote I/O module

Set the station number setting switches.



Switch number in the figure above.	Remote I/O	CCIEF remote (2-2) R_M2IO2 (Network number 2)	CCIEF remote (3-2) R_M3IO2 (Network number 3)	CCIEF remote (4-2) R_M4IO2 (Network number 4)
(1)	Station number setting switch	2	2	2

Point

The setting value of the station number becomes valid when the module is powered on. Set the station number when the system is powered off.

Parameter setting of the Safety CPU

Set Safety CPU parameters refer to the following.

Operating procedure

1. Create a new project and set user authentication.
2. Perform "Write User Data to PLC".

[Online] ⇨ [User Authentication] ⇨ [Write User Data to PLC]

3. Perform "Log on to PLC".

[Online] ⇨ [User Authentication] ⇨ [Log on to PLC]

4. Open the module configuration diagram and set system parameters.

"Navigation window" ⇨ "Module configuration diagram"

5. Set device/label memory capacity.

[CPU Parameter] ⇨ "Memory/Device Setting" ⇨ "Device/Label Memory Area Setting"

6. Set a safety cycle time.

[CPU parameter] ⇨ "Safety Function Setting"

For details on parameter setting method, refer to the following.

MELSEC iQ-R CPU Module User's Manual (Startup)
MELSEC iQ-R CPU Module User's Manual (Application)

User authentication settings

Safety CPU project requires user authentication setting using password. Add "Add New User" window to be displayed, when creating a new project. Add users. Then, save the project following the window.

To read or write data with Safety CPU of safety remote I/O module, logging on to programmable controller is required. If user information is not written on a programmable controller, select [Online] ⇨ [User Authentication] ⇨ [Write User Data to PLC] to write appropriate user information. Select [Online] ⇨ [User Authentication] ⇨ [Log on to PLC] to logon to programmable controller.

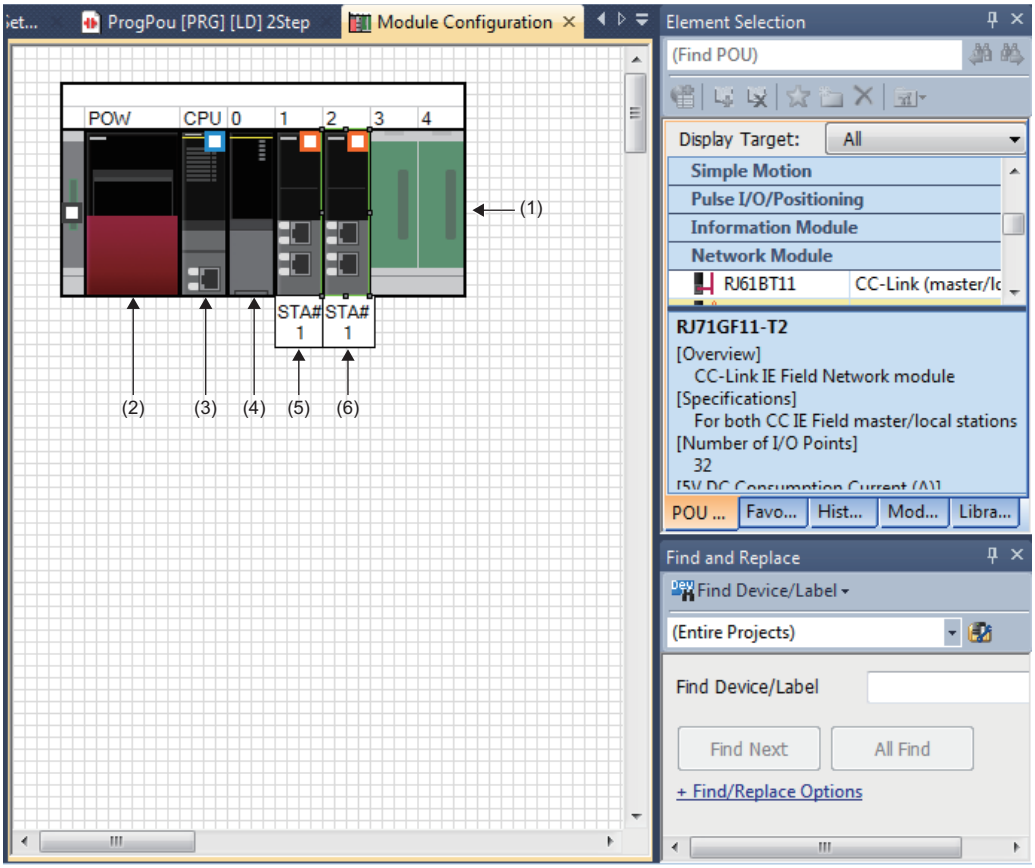
For details on user authentication setting method, refer to the following manual.

GX Works3 Operating Manual

Setting system parameters

Parameters can be set from [Module Configuration] to be displayed by double-clicking "Module Configuration" in [Navigation window]. Parameters can be set by allocating modules according to the configuration to be used. Parameters can be set by selecting a main base unit from the window to select program elements using the drag and drop command and allocating modules on the main base unit. The Safety CPU set when creating project is displayed since the beginning at the module configuration. Allocate the safety function module from the "CPU extension" in the [Element Selection window].
Allocate program elements in the chart below, based on the following, and determine the parameters. Then, select [Tool] ⇨ [Check Parameter] from menu and check set parameters.

Window



Displayed items

Number	Module	Model
(1)	Main Base Unit	R35B
(2)	Power Supply	R61P
(3)	Safety CPU	This is a model name of the Safety CPU.
(4)	CPU extension	R6SFM
(5)	Network Module	RJ71GF11-T2
(6)	Network Module	RJ71GF11-T2

Setting safety device/label

Safety programs are described using safety devices. Before creating safety programs, set safety devices at device/label memory area setting of the Safety CPU.

■Setting device/label memory capacity

Set device area capacity to be used by safety programs according to the safety device to be used by the safety program. Set the total capacity of the safety device/label area, safety device area capacity, safety label area capacity, standard/safety shared label area capacity from the CPU parameter setting window of the Safety CPU for [Parameter] in the [Navigation window]. Set the parameters. Then, click the [Apply] button in the lower right of the window.

Set the capacities of the areas including the standard device area so that the total of these capacities will not exceed the total capacity of the Safety CPU.

For details on parameter setting method, refer to the following.

📖 GX Works3 Operating Manual
📖 MELSEC iQ-R CPU Module User's Manual (Application)

Window

Item	Setting
⊟ *Device/Label Memory Area Setting*	
Extended SRAM Cassette Setting	Not Mounted
⊟ Device/Label Memory Area Capacity Setting	
⊟ Standard Device Area	
Standard Device Area Capacity	40 K Word
⊟ Standard Label Area	
Standard Label Area Capacity	40 K Word
Standard Label Area Capacity	2 K Word
⊟ Safety Device/Label Area	
Safety Device/Label Area Capacity	40 K Word
Safety Device Area Capacity	20 K Word
Safety Label Area Capacity	20 K Word
Standard/Safety Shared Label Area Capacity	10 K Word
File Storage Area Capacity	457 K Word

Displayed items

Item		Setting (default)
Safety Device/Label Area	Total capacity of the Safety Device/Label Area Capacity	40K words
	Safety Device Area Capacity	20K words
	Safety Label Area Capacity	20K words
	Standard/safety shared label area capacity	10K words

■Setting details of device/label memory areas

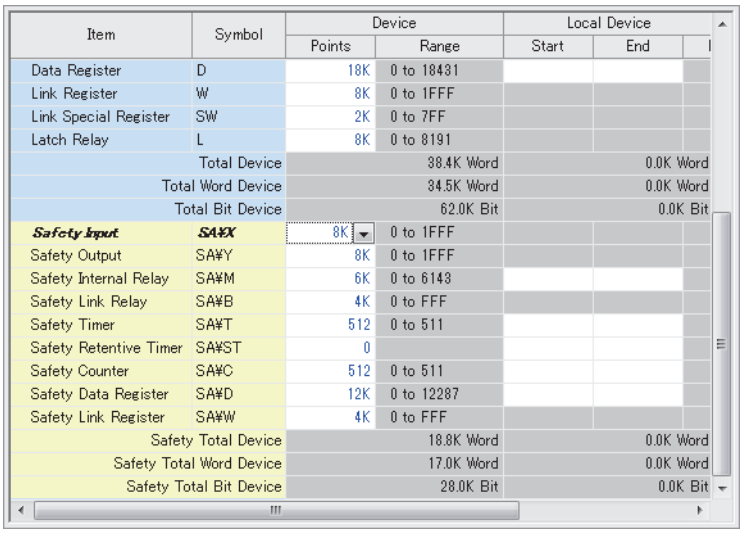
Open the detailed settings window from the [Detailed Setting] for the [Device Setting]. Then set the safety device points on the following screen. Set number of points so that the total of the points will not exceed the capacity of the device area. Set the parameters. Then, click the [Apply] button in the lower right of the window.

For details on parameter setting method, refer to the following.

📖 GX Works3 Operating Manual

📖 MELSEC iQ-R CPU Module User's Manual (Application)

Window



Item	Symbol	Device		Local Device		
		Points	Range	Start	End	
Data Register	D	18K	0 to 18431			
Link Register	W	8K	0 to 1FFF			
Link Special Register	SW	2K	0 to 7FF			
Latch Relay	L	8K	0 to 8191			
Total Device		38.4K Word		0.0K Word		
Total Word Device		34.5K Word		0.0K Word		
Total Bit Device		62.0K Bit		0.0K Bit		
Safety Input	SA¥X	8K	0 to 1FFF			
Safety Output	SA¥Y	8K	0 to 1FFF			
Safety Internal Relay	SA¥M	6K	0 to 6143			
Safety Link Relay	SA¥B	4K	0 to FFF			
Safety Timer	SA¥T	512	0 to 511			
Safety Retentive Timer	SA¥ST	0				
Safety Counter	SA¥C	512	0 to 511			
Safety Data Register	SA¥D	12K	0 to 12287			
Safety Link Register	SA¥W	4K	0 to FFF			
Safety Total Device		18.8K Word		0.0K Word		
Safety Total Word Device		17.0K Word		0.0K Word		
Safety Total Bit Device		28.0K Bit		0.0K Bit		

Displayed items

Item	Setting (default)
Safety input (SA\X)	8K points (either 8K or 12K points can be selected.)*1
Safety output (SA\Y)	8K points (either 8K or 12K points can be selected.)*1
Safety internal relay (SA\M)	6K points
Safety link relay (SA\B)	4K points
Safety timer (SA\T)	512 points
Safety retentive timer (SA\ST)	0 point
Safety counter (SA\C)	512 points
Safety data register (SA\D)	12K points
Safety link register (SA\W)	4K points

*1 When selecting 12K points, check the versions of the CPU module and the engineering tool. (📖MELSEC iQ-R CPU Module User's Manual (Application))

Setting safety functions

Set the safety cycle time, as a timing for executing safety programs and safety input/output. Set a "Safety Cycle Time" as an item in the safety function setting window from CPU parameter setting window of Safety CPU in the [Parameter] in the [Navigation window].

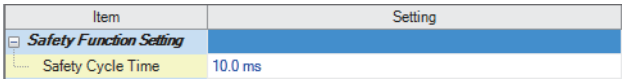
Set the parameters. Then, click the [Apply] button in the lower right of the window.

For details on parameter setting method, refer to the following.

GX Works3 Operating Manual

MELSEC iQ-R CPU Module User's Manual (Application)

Window



Displayed items

Item	Setting (default)
Safety Cycle Time	10ms

Parameter settings of CC-Link IE Field Network

Set parameters of the CC-Link IE Field Network according to the following procedure.

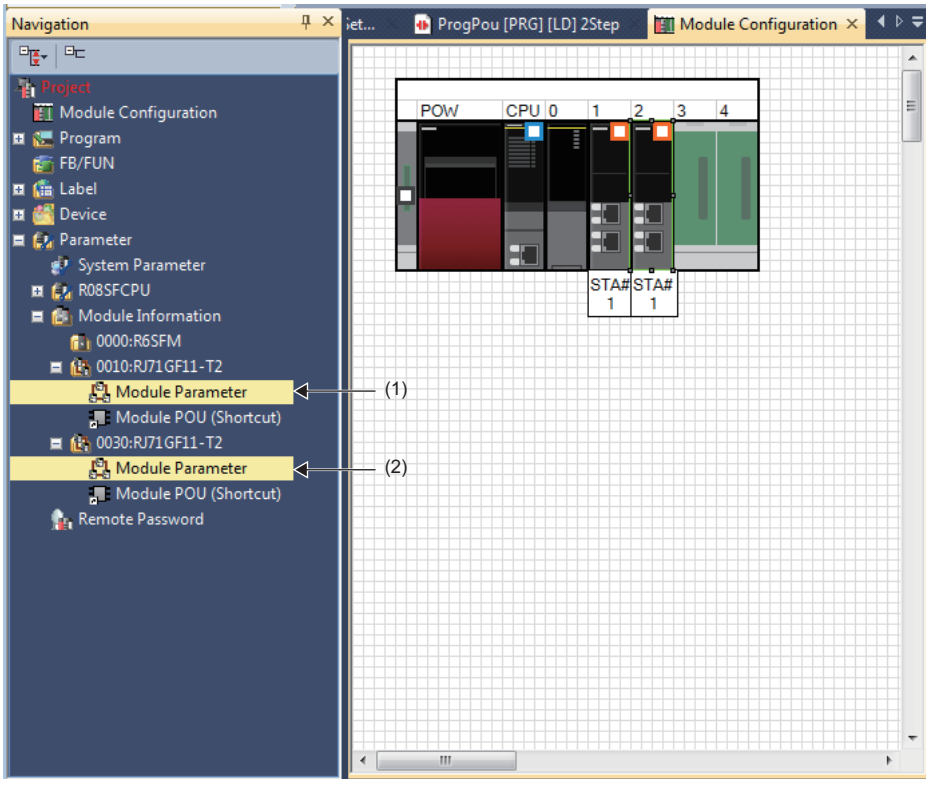
Operating procedure

1. Develop the CC-Link IE Field Network master/local module to set the ⇨ [Parameter] ⇨ [Module Information] ⇨ [Navigation window].
2. Double-click the"Module Parameter".
3. To set parameters, select a tree from either one of the three options: required setting, basic setting, and application setting.
4. Set parameters. Then, click the [Apply] button of the parameter setting window.
5. Check if safety remote I/O modules with set parameters is installed in the designed location using "Start of checking the module position" command.
6. Read parameter setting in the safety remote I/O module to visually check if the parameters are consistent with the set values.
7. Perform "Safety module validation" to be useable with set parameters.
8. Restart safety remote I/O module

For details on parameter setting method, refer to the following.

MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)

Window



(1) This is used when setting communications between Safety CPUs.
(2) This sets communications with safety remote I/O module.

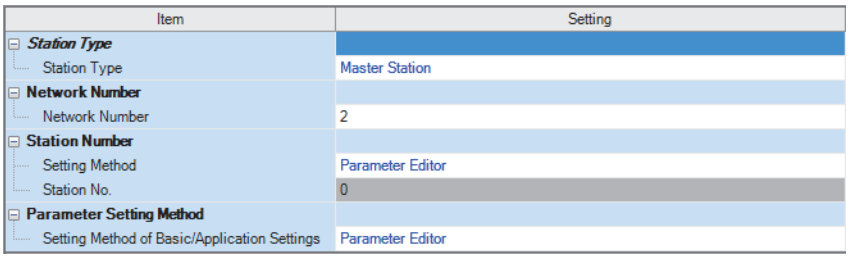
Communications between Safety CPU and safety and standard remote I/O module

This section describes network parameters setting required for communications between Safety CPU and safety remote I/O module and standard remote I/O module.

■Required Settings

Set the station type, network number, and parameters of the CC-Link IE Field Network master/local module. Display the required setting window. Then, select and input parameters according to the following description. Complete the input. Then, click the [Apply] button in the lower right of the window.

Window



Displayed items

Setting classifications		Safety programmable controller (1) CCIEF master (2-0)	Safety programmable controller (2) CCIEF master (3-0)	Safety programmable controller (3) CCIEF master (4-0)
Required Settings	Station type	Master station	Master station	Master station
	Network Number	2	3	4
	Setting Method	Set parameters*1	Set parameters*1	Set parameters*1
	Station number setting	0	0	0
	Parameter Setting Method	Set parameters*1	Set parameters*1	Set parameters*1

*1 Station number setting method and parameter setting can be selected by setting "Parameter Editor" and "Program". Here, set the "Parameter Editor".

■Basic setting

Set CC-Link IE Field Network master/local module configuration of CC-Link IE Field Network master/local module, CC-Link IE Display the basic setting window. Then, select and input parameters according to the following description. Complete the input. Then, click the [Apply] button in the lower right of the window. When setting Network Configuration Settings, double-click a line of the network configuration setting in item window, or click right-side button to be displayed when selecting line.

Window

Displayed items

Setting classifications		Safety programmable controller (1) CCIEF master (2-0)	Safety programmable controller (2) CCIEF master (3-0)	Safety programmable controller (3) CCIEF master (4-0)
Basic Settings	Network Configuration Settings	Refer to Network Configuration Settings.	Refer to Network Configuration Settings.	Refer to Network Configuration Settings.
	Refresh Settings	Refer to Refresh Setting.	Refer to Refresh Setting.	Refer to Refresh Setting.
	Network Topology	Line topology, star topology, or both are used	Line topology, star topology, or both are used	Line topology, star topology, or both are used
	Operation setting when the master station is returned (settable only when setting the submaster station in a network configuration)	Return as Master Operation Station	Return as Master Operation Station	Return as Master Operation Station

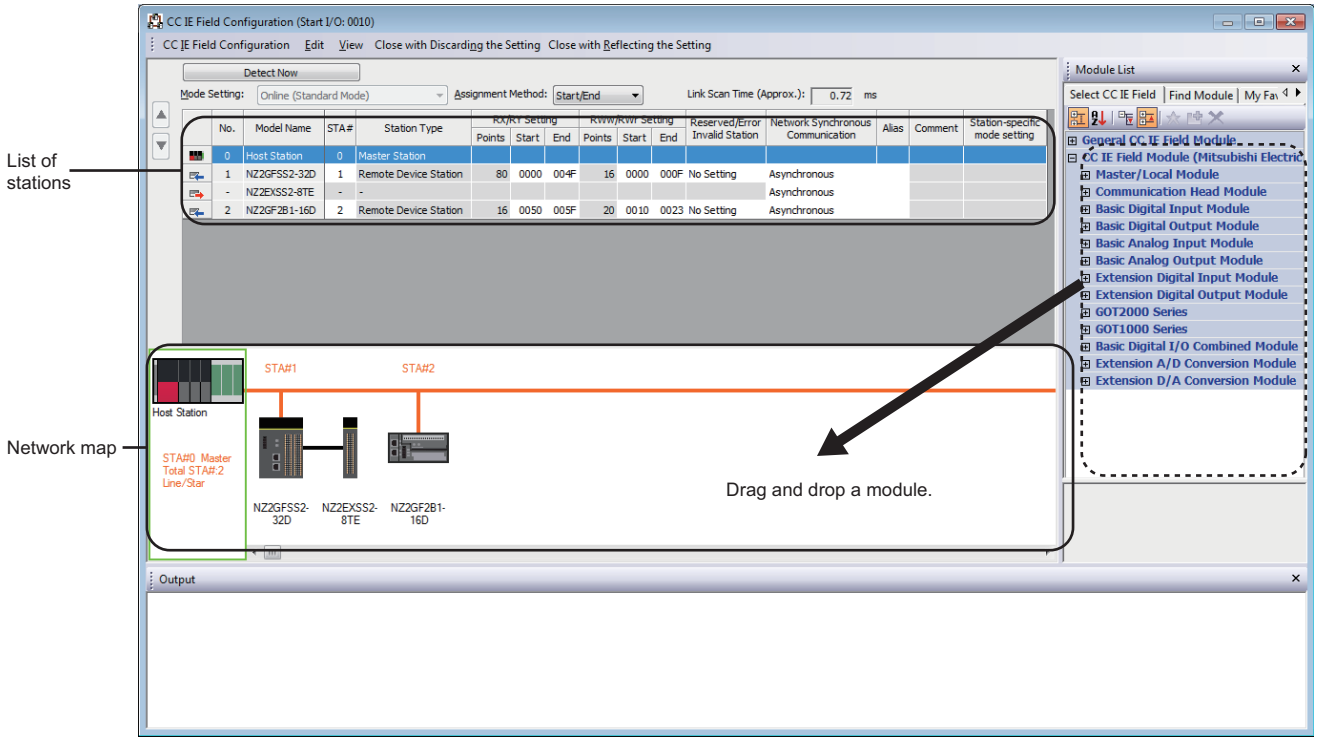
• Network Configuration Settings

Set link device points and assignment of slave station to the master station.

Operating procedure

1. Select module from "Module List", and drag and drop it to [List of Stations] or [Network Map].
2. Select and input parameters as shown below.
3. Select [Close with Reflecting the Setting] and complete "Network Configuration Settings". If closing "×" of the window, item will not be reflected.

Window



Displayed items

Item	Description
Assignment Method	Start/End
Total number of slave stations	2

Item		Range/value			
		CCIEF master (A-0)*1	CCIEF remote (A-1)*1		CCIEF remote (A-2)*1
Model		RJ71GF11-T2	NZ2GFSS2-32D	NZ2EXSS2-8TE	NZ2GF2B1-16D
STA#		0	1	(Unavailable)	2
Station type		Master station	Remote device station	(Unavailable)	Remote device station
RX/RY		(Unavailable)	Points: 80 Start: 0000 End: 004F	(Unavailable)	Points: 16 Start: 0050 End: 005F
RWr/RWw		(Unavailable)	Points: 16 Start: 0000 End: 000F	(Unavailable)	Points: 20 Start: 0010 End: 0023
Reserved/Error Invalid Station		No setting	No setting	(Unavailable)	No setting
Network synchronous communication		Asynchronous	Asynchronous	Asynchronous	Asynchronous
Station information	Alias	(Blank)	(Blank)	(Blank)	(Blank)
	Comment	(Blank)	(Blank)	(Blank)	(Blank)

*1 Network number 2, 3, and 4 are placed to A.

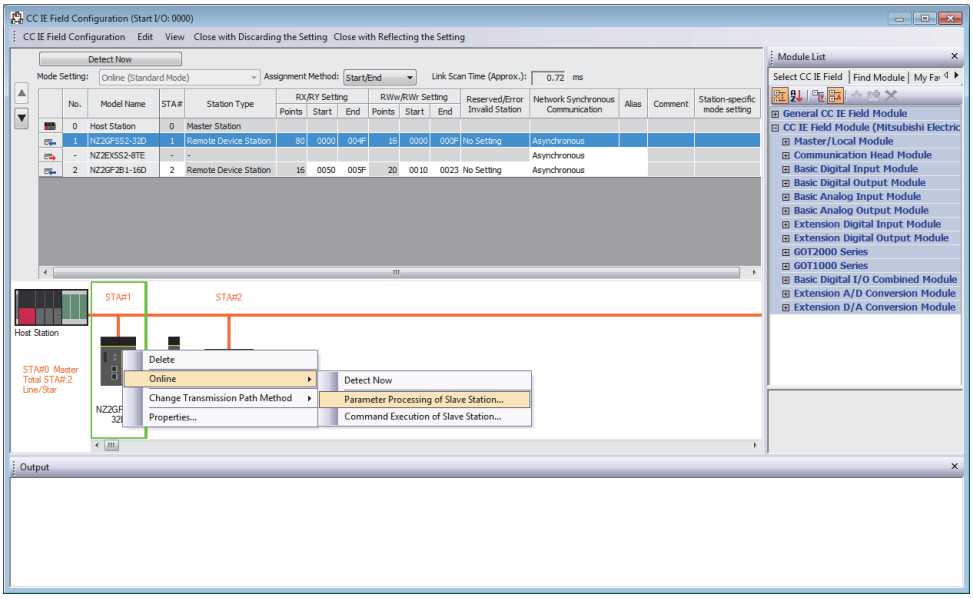
Set slave station parameters refer to the following. Before setting slave station parameters, complete network configuration setting for required and basic settings. Then, restart after writing parameters to the Safety CPU.

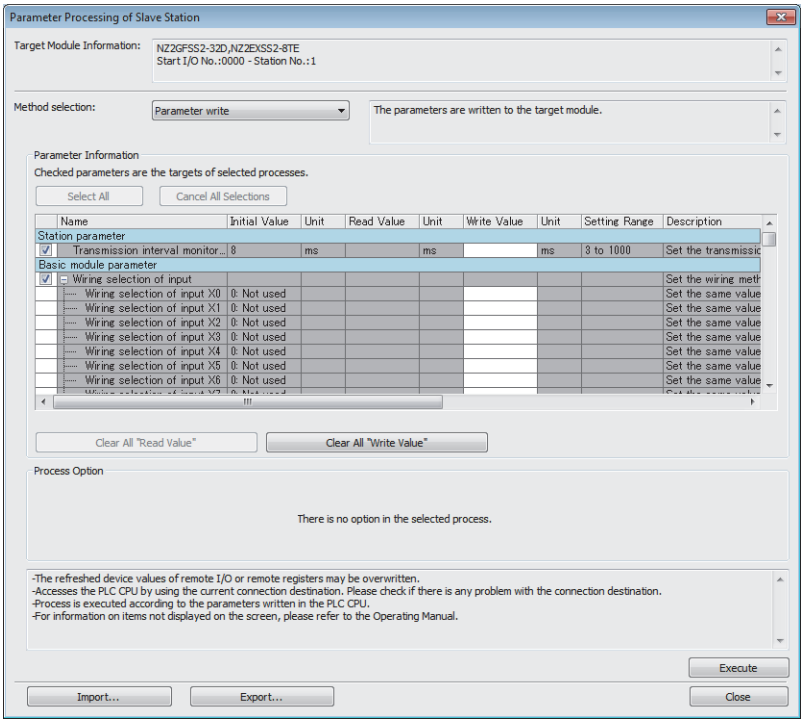
Operating procedure

1. Right-click slave station to be set at "List of Stations" or "Network Map".
2. Click "Online" ⇨ "Parameter Processing of Slave Station"
3. Select [Parameter Write] at parameter processing window of the slave station and input parameters to be set for write value column.
4. Press down Execute button to write.

For detailed parameter values, see explanations for standard input setting and specific cases.

Window





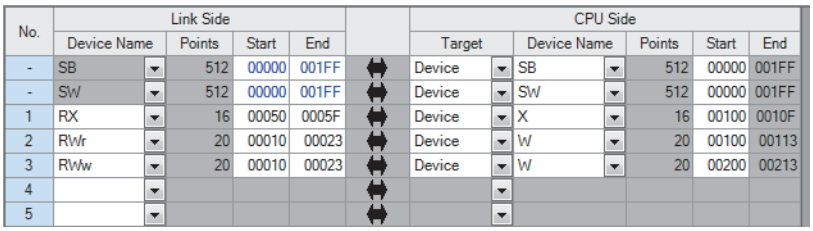
• Refresh Setting

Set transfer range between link device of standard remote I/O module and Safety CPU devices.

Operating procedure

1. Select and input parameters according to the following description.
2. Click the [Apply] button and complete "Refresh Settings".

Window



No.	Link Side					CPU Side				
	Device Name	Points	Start	End		Target	Device Name	Points	Start	End
-	SB	512	00000	001FF		Device	SB	512	00000	001FF
-	SW	512	00000	001FF		Device	SW	512	00000	001FF
1	RX	16	00050	0005F		Device	X	16	00100	0010F
2	RWr	20	00010	00023		Device	W	20	00100	00113
3	RWw	20	00010	00023		Device	W	20	00200	00213
4										
5										

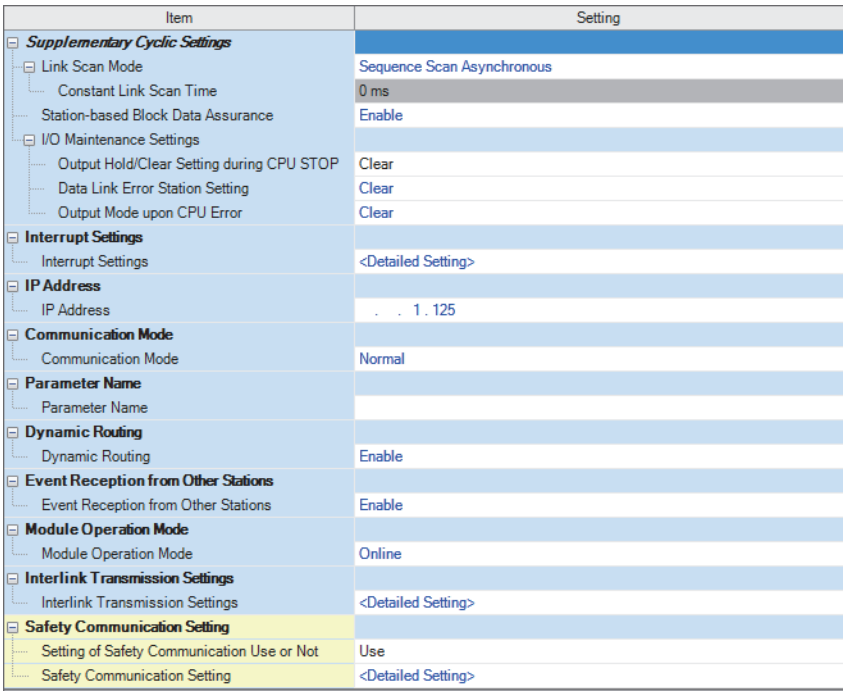
Displayed items

No	Link side				CPU side				
	Device name	Points	Start	End	Refresh Setting	Device Name	Points	Start	End
-	SB	512	00000	001FF	Designated device	SB	512	00000	001FF
-	SW	512	00000	001FF	Designated device	SW	512	00000	001FF
1	RX	16	00050	0005F	Designated device	X	16	00100	0010F
2	RWr	20	00010	00023	Designated device	W	20	00100	00113
3	RWw	20	00010	00023	Designated device	W	20	00200	00213

■Application Settings

Set cyclic supplementary setting of the CC-Link IE Field Network master/local module and safety communication setting. Display the "Application Settings" window. Then, select and input parameters according to the following description. Complete the input. Then, click the [Apply] button in the lower right of the window. When setting "Safety Function Setting", double-click a line of the safety function setting in item window, or click the right-side button to be displayed when selecting line.

Window



Displayed items

Setting classifications		Safety programmable controller (1) CCIEF master (2-0)	Safety programmable controller (2) CCIEF master (3-0)	Safety programmable controller (3) CCIEF master (4-0)
Application Settings	Supplementary Cyclic Settings	Refer to Supplementary Cyclic Settings.	Refer to Supplementary Cyclic Settings.	Refer to Supplementary Cyclic Settings.
	Interrupt settings	Do not set.	Do not set.	Do not set.
	IP address settings	Do not set.	Do not set.	Do not set.
	Communication mode	Normal	Normal	Normal
	Parameter name	(Blank)	(Blank)	(Blank)
	Dynamic routing	Enable	Enable	Enable
	Event reception from other stations	Enable	Enable	Enable
	Module operation mode	Online	Online	Online
	Interlink transmission settings	Do not set.	Do not set.	Do not set.
	Setting of safety communication use or not	Use	Use	Use
	Safety Communication Setting	Refer to Safety Communication Setting.	Refer to Safety Communication Setting.	Refer to Safety Communication Setting.

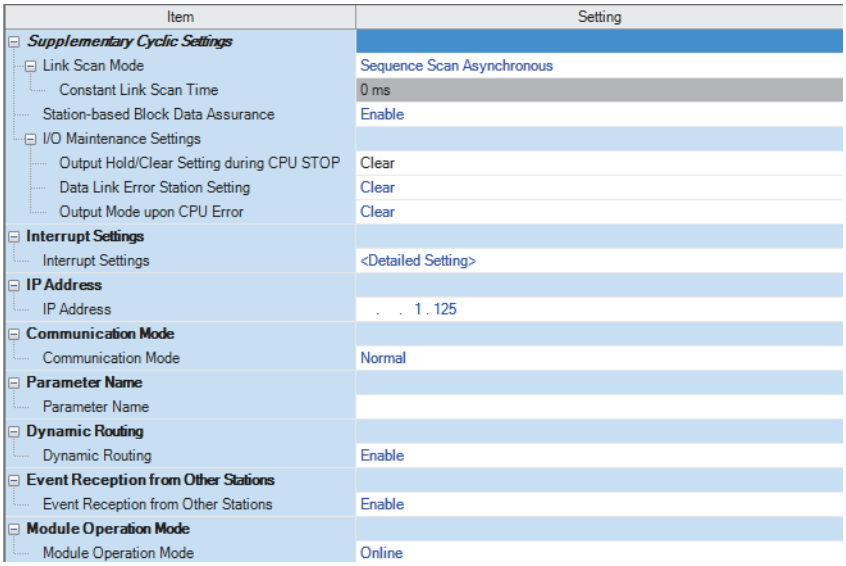
• Supplementary Cyclic Settings

Set link scan mode, station-based block data assurance, and input/output hold clear setting.

Operating procedure

1. Select and input parameters as shown below.
2. Click the [Apply] button and complete "Supplementary Cyclic Settings".

Window



Displayed items

Item	Range or value
Link scan mode	Sequence scan asynchronous
Constant link scan time	(Unavailable)
Station-based block data assurance	Enable
Output Hold/Clear Setting during CPU STOP	Clear
Data Link Error Station Setting	Clear
Output Mode upon CPU Error	Clear

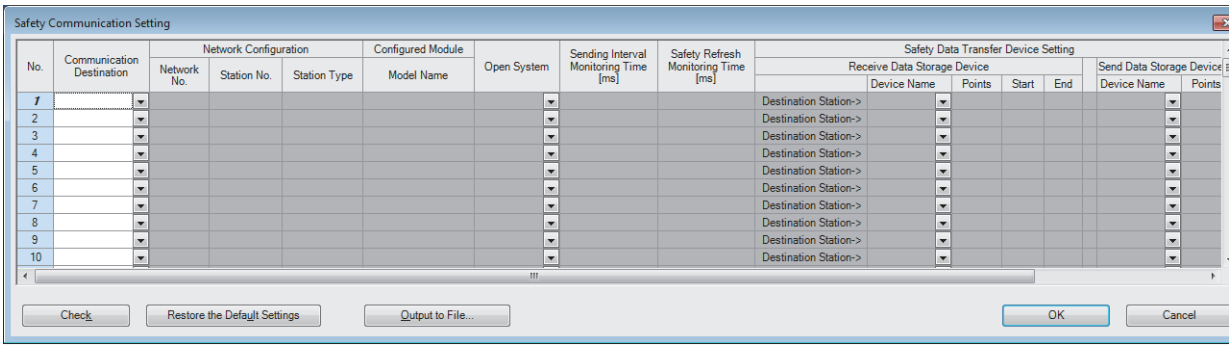
• Safety Communication Setting

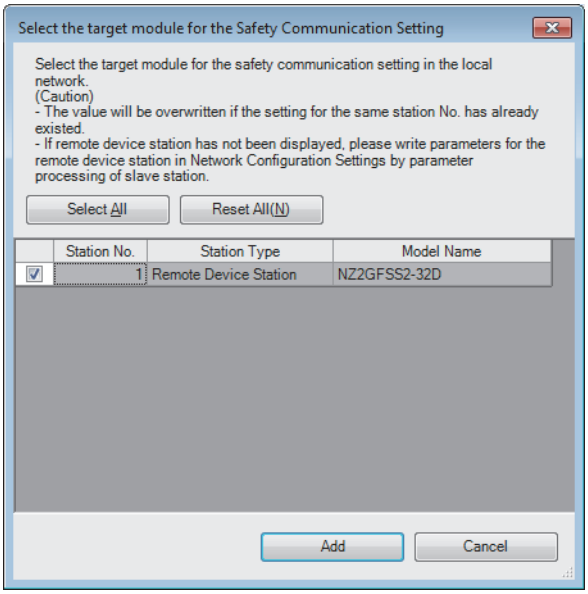
Set items related to safety communication function

Operating procedure

1. Set "Setting of Safety Communication Use or Not" to "Use" from "Application Settings" window and select detailed setting on "Safety Communication Setting".
2. Selecting own network as the party to communicate with in the "Safety Communication Setting" window displays "Select the target module for the Safety Communication Setting" window shown below. Then, select the target safety remote I/O module and import parameters using the [Add] button. (If target module is not displayed, set appropriate setting at Network Configuration Settings, including slave station parameter setting. Then, click the [Apply] button displayed in the lower right of the "Basic Settings" window).
3. Select and input parameters as shown below.
4. Exit by clicking the [OK] button on "Safety Communication Setting" window.

Window





Displayed items

Item		Range/value		
Module		CCIEF remote (2-0)	CCIEF remote (3-0)	CCIEF remote (4-0)
No.		1	1	1
Communication destination		Own network	Own network	Own network
Network configuration	Network number	2	3	4
	Station number	1	1	1
	Station type	Remote device station	Remote device station	Remote device station
Open system		Active	Active	Active
Transmission interval monitoring time		24ms	24ms	24ms
Safety refresh response processing time		60ms	60ms	60ms
Safety data transfer device setting	Receive data storage device	Device name: SA\X Points: 32 Start: 0000 End: 001F	Device name: SA\X Points: 32 Start: 0000 End: 001F	Device name: SA\X Points: 32 Start: 0000 End: 001F
	Send data storage device	Device name: SA\Y Points: 16 Start: 0000 End: 000F	Device name: SA\Y Points: 16 Start: 0000 End: 000F	Device name: SA\Y Points: 16 Start: 0000 End: 000F

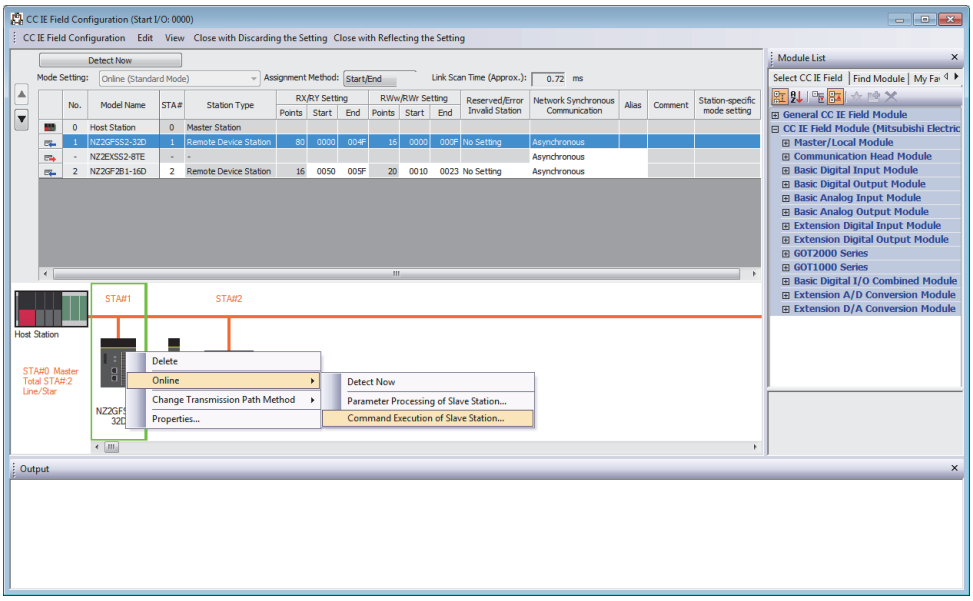
■Check position of safety remote I/O module

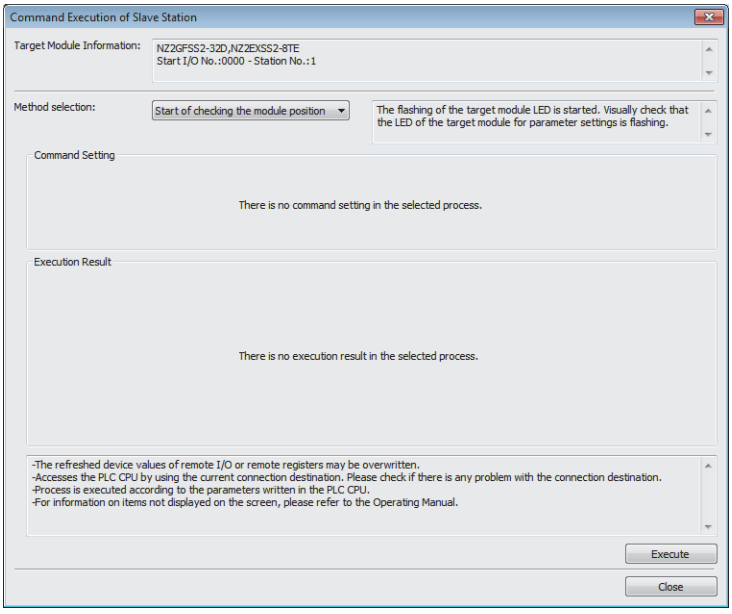
Check if safety remote I/O modules with set parameters is installed in the designed location using [Start of Checking the Module Position] function. Check all safety remote I/O modules, according to the following procedure.

Operating procedure

1. Display "Detailed Setting" window in "Network Configuration Settings" of "Basic Settings window".
2. Display menu by right-clicking module to be checked as shown below, and display slave station command execution window from "Command Execution of Slave Station".
3. For method of selection, select "Start of checking the module position" in method selection and click the [Execution] button. "Safety LED" of safety remote I/O module executed command flashes
4. Visually check if safety remote I/O module with blinking [Safety LED] is installed in a desired position when designing.
5. Complete visual checking. Then, select "Stop of checking the module position" command in "Method selection" on the "Command Execution of Slave Station" window, and click the [Execution] button. "Safety LED" of safety remote I/O module executed command flashing stops

Window





■Checking parameter setting

Read parameters in the safety remote I/O module to check if the parameters are consistent with the set values, according to the following procedure.

1. Display slave station parameter processing window of safety remote I/O module to be checked.
2. Select "Parameter Read" in method selection and click the "Execution" button.
3. Visually check read values if the parameters are consistent with the set values.

■Safety module validation

Validate safety modules according to the following procedure to make the parameters available with set parameters.

1. Display slave station command execution window of safety remote I/O module to validate safety module.
2. Select "Safety module validation" in "Method selection" and click the [Execution] button.
3. Restart the safety remote I/O module according to checking window.

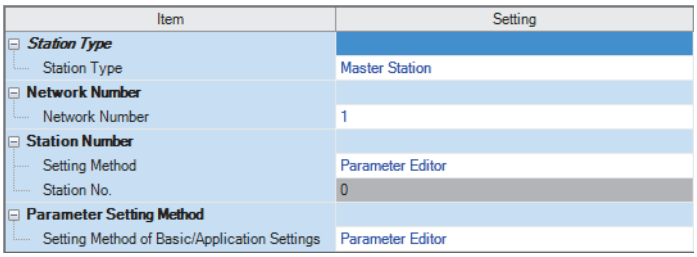
Communication between Safety CPUs

This indicates network parameter setting required for communications between Safety CPUs. This section describes both master and local station settings at a time.

■Required Settings

Set the station type, network number, and parameters of the CC-Link IE Field Network master/local module. Display the required setting window. Then, select and input parameters according to the following description. Complete the input. Then, click the [Apply] button in the lower right of the window.

Window



Displayed items

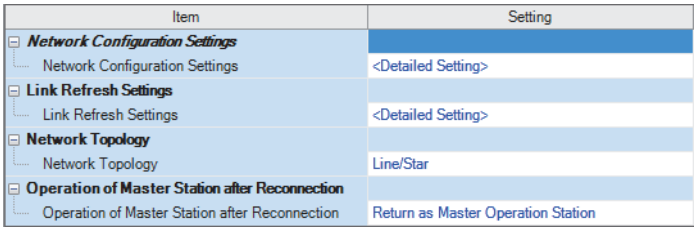
Setting classifications		CCIEF programmable controller Master (1-0)	CCIEF programmable controller Local (1-1)	CCIEF programmable controller Local (1-2)
Required Settings	Station type	Master station	Local station	Local station
	Network number	1	1	1
	Setting method for station numbers	Set parameters*1	Set parameters*1	Set parameters*1
	Station No.	0	1	2
	Parameter setting method	Set parameters*1	Set parameters*1	Set parameters*1

*1 Station number setting method and parameter setting can be selected by setting "Parameter Editor" and "Program". Here, set "Parameter Editor".

■Basic Settings

Set CC-Link IE Field Network master/local module configuration of CC-Link IE Field Network master/local module, CC-Link IE Display the basic setting window. Then, select and input parameters according to the following description. Complete the inputs. Then, click the [Apply] button in the lower right of the window. When setting the "Network Configuration Settings", double-click a line of the network configuration setting in item window, or click right-side button to be displayed when selecting line.

Window



Displayed items

Setting classifications		CCIEF programmable controller Master (1-0)	CCIEF programmable controller Local (1-1)	CCIEF programmable controller Local (1-2)
Basic settings	Network configuration settings	Refer to network configuration settings.	(Unavailable)	(Unavailable)
	Refresh settings	Do not set.	Do not set.	Do not set.
	Network topology	Line topology, star topology, or both are used	(Unavailable)	(Unavailable)
	Operation setting when the master station is returned (settable only when setting the submaster station in a network configuration)	Return as master operation station	(Unavailable)	(Unavailable)

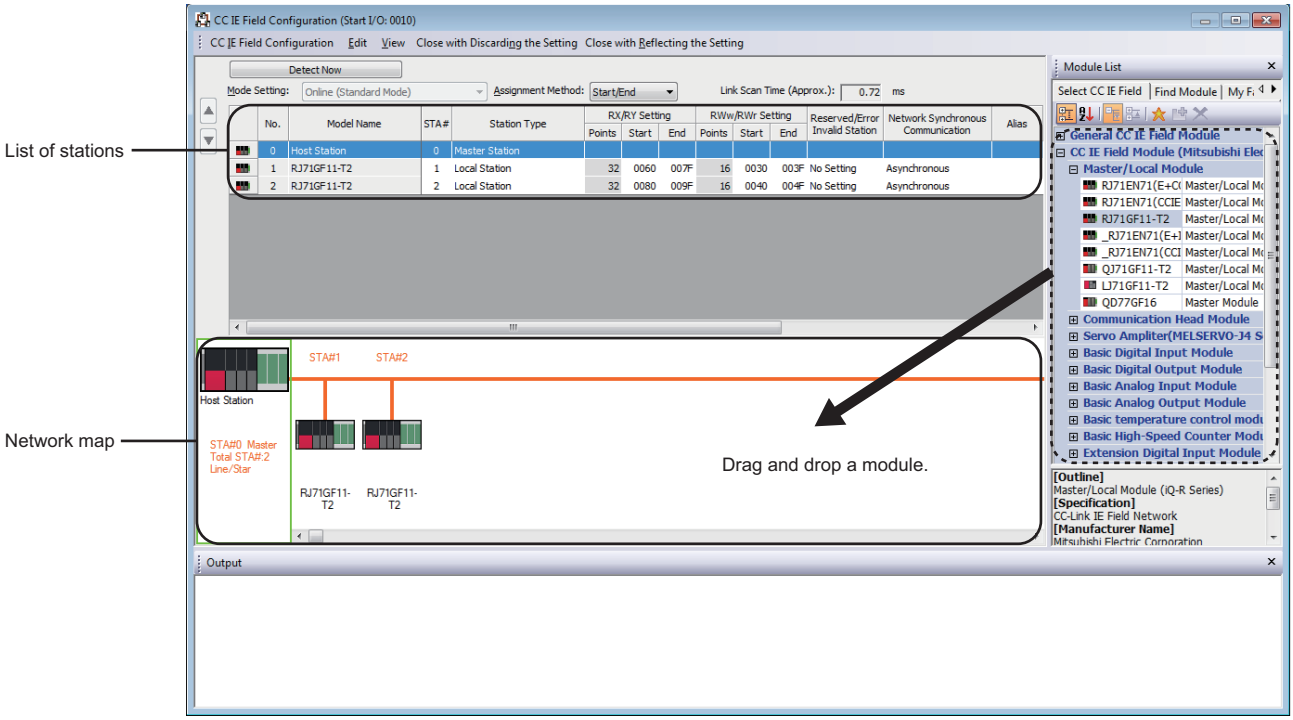
• Network configuration settings

Set link device points and assignment of slave station to the master station. If selecting "Local Station" in "Required Settings", setting is not possible.

Operating procedure

1. Select module from "Module List", and drag and drop it to [List of Stations] or [Network Map].
2. Select and input parameters according to the following description.
3. Select "Close with Reflecting the Setting" and complete "Network Configuration Settings". If closing "×" of the window, item will not be reflected.

Window



Displayed items

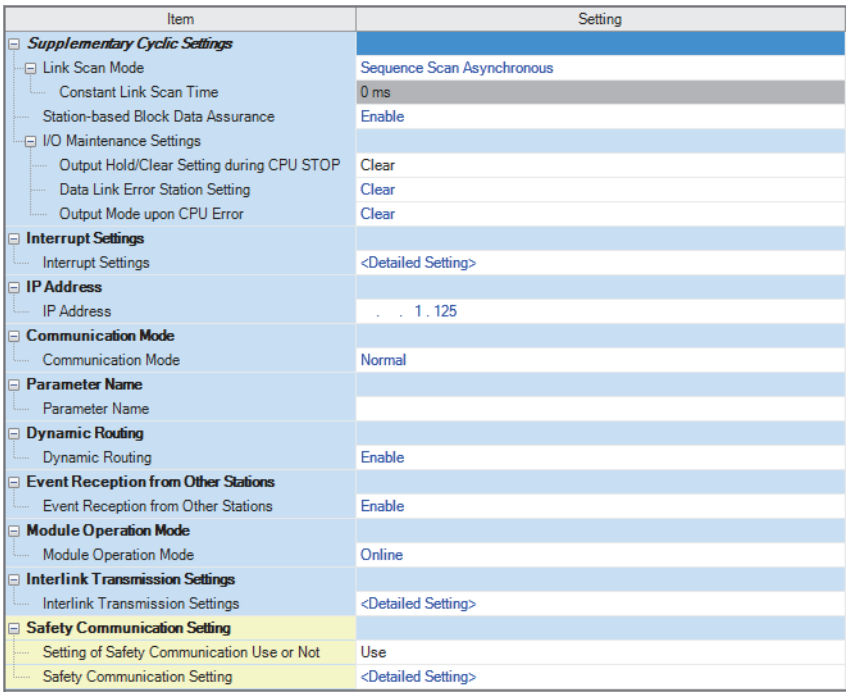
Item	Description
Assignment Method	Number of points/Start
Total number of slave stations	2

Item		Range/value		
		CCIEF programmable controller Master (1-0)	CCIEF programmable controller Local (1-1)	CCIEF programmable controller Local (1-2)
Model		RJ71GF11-T2	RJ71GF11-T2	RJ71GF11-T2
Station number		0	1	2
Station type		Master station	Local station	Local station
RX/RY		Points: (Unavailable) Start: (Unavailable) End: (Unavailable)	Points: 32 Start: 0060 End: 007F	Points: 32 Start: 0080 End: 009F
RWr/RWw		Points: (Unavailable) Start: (Unavailable) End: (Unavailable)	Points: 16 Start: 0030 End: 003F	Points: 16 Start: 0040 End: 004F
Reserved/error invalid station		No setting	No setting	No setting
Network synchronous communication		Asynchronous	Asynchronous	Asynchronous
Station information	Alias	(Blank)	(Blank)	(Blank)
	Comment	(Blank)	(Blank)	(Blank)

■Application settings

Set CC-Link IE Field Network master/local module cyclic supplementary setting and safety communication setting. Display the "Application Settings" window. Then, select and input parameters according to the following description. Complete the input. Then, click the [Apply] button in the lower right of the window. When setting "Safety Function Setting", double-click a line of the safety function setting in item window, or click right-side button to be displayed when selecting line.

Window



Displayed items

Setting classifications	Module	CCIEF programmable controller Master (1-0)	CCIEF programmable controller Local (1-1)	CCIEF programmable controller Local (1-2)
Application settings	Supplementary cyclic settings	Refer to Supplementary Cyclic Settings.	Refer to Supplementary Cyclic Settings.	Refer to Supplementary Cyclic Settings.
	Interrupt settings	Do not set.	Do not set.	Do not set.
	IP Address	Do not set.	(Unavailable)	(Unavailable)
	Communication mode	Normal	(Unavailable)	(Unavailable)
	Parameter name	(Blank)	(Blank)	(Blank)
	Dynamic routing	Enable	Enable	Enable
	Event reception from other stations	Enable	Enable	Enable
	Module operation mode	Online	Online	Online
	Interlink transmission settings	Do not set.	(Unavailable)	(Unavailable)
	Setting of safety communication use or not	Use	Use	Use
	Safety communication setting	Refer to "Safety Communication Setting".	Refer to "Safety Communication Setting".	Refer to "Safety Communication Setting".

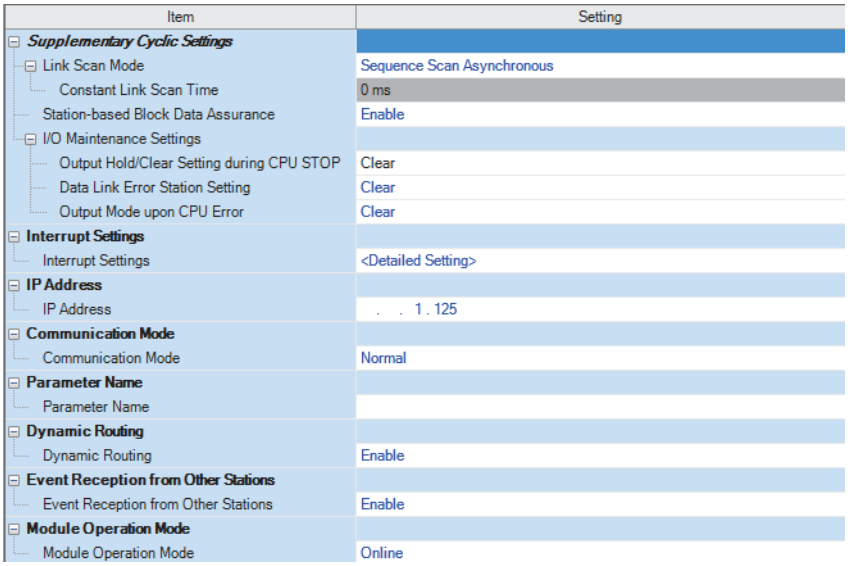
• Supplementary cyclic settings

Set link scan mode, station-based block data assurance, and input/output hold clear setting.

Operating procedure

1. Select and input parameters as shown below.
2. Click the [Apply] button and complete "Supplementary Cyclic Settings".

Window



Displayed items

Item	Range/value		
	CCIEF programmable controller Master (1-0)	CCIEF programmable controller Local (1-1)	CCIEF programmable controller Local (1-2)
Link scan mode	Sequence scan asynchronous	(Unavailable)	(Unavailable)
Constant link scan time	(Unavailable)	(Unavailable)	(Unavailable)
Station-based block data assurance	Enable	(Unavailable)	(Unavailable)
Output Hold/Clear Setting during CPU STOP	Clear	Clear	Clear
Data Link Error Station Setting	Clear	Clear	Clear
Output Mode upon CPU Error	Clear	Clear	Clear

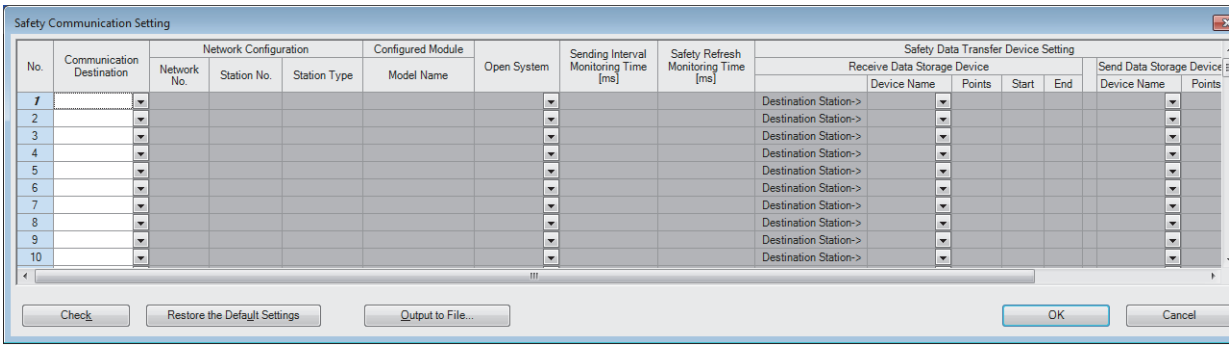
• Safety communication setting

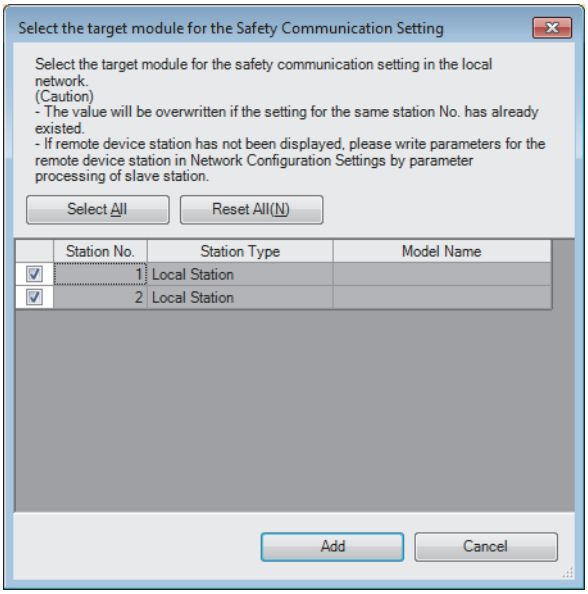
Set items related to safety communication function

Operating procedure

1. Set "Setting of Safety Communication Use or Not" to "Use" from "Application Settings" window and select detailed setting on "Safety Communication Setting".
2. Selecting own network as the party to communicate with in the "Safety Communication Setting" window displays "Select the target module for the Safety Communication Setting" window shown below. Then, select the target safety remote I/O module and import parameters using the [Add] button. (If target module is not displayed, set appropriate setting at Network Configuration Settings, including slave station parameter setting. Then, click the [Apply] button displayed in the lower right of the "Basic Settings" window).
3. Select and input parameters according to the following description.
4. Exit by clicking the [OK] button on "Safety Communication Setting" window.

Window





Displayed items

This indicates master station setting mounted on safety programmable controller (1).

Item		Safety programmable controller (1)	
		CCIEF programmable controller local (1-1)	CCIEF programmable controller local (1-2)
No.		1	2
Communication destination		Own network	Own network
Network configuration	Network number	1	1
	Station number	1	2
	Station type	Local station	Local station
Open system		Active	Active
Transmission interval monitoring time		24ms	24ms
Safety refresh response processing time		60ms	60ms
Safety data transfer device setting	Receive data storage device	Device name: SA\X Points: 128 Start: 0100 End: 017F	Device name: SA\X Points: 128 Start: 0180 End: 01FF
	Send data storage device	Device name: SA\Y Points: 128 Start: 0100 End: 017F	Device name: SA\Y Points: 128 Start: 0180 End: 01FF

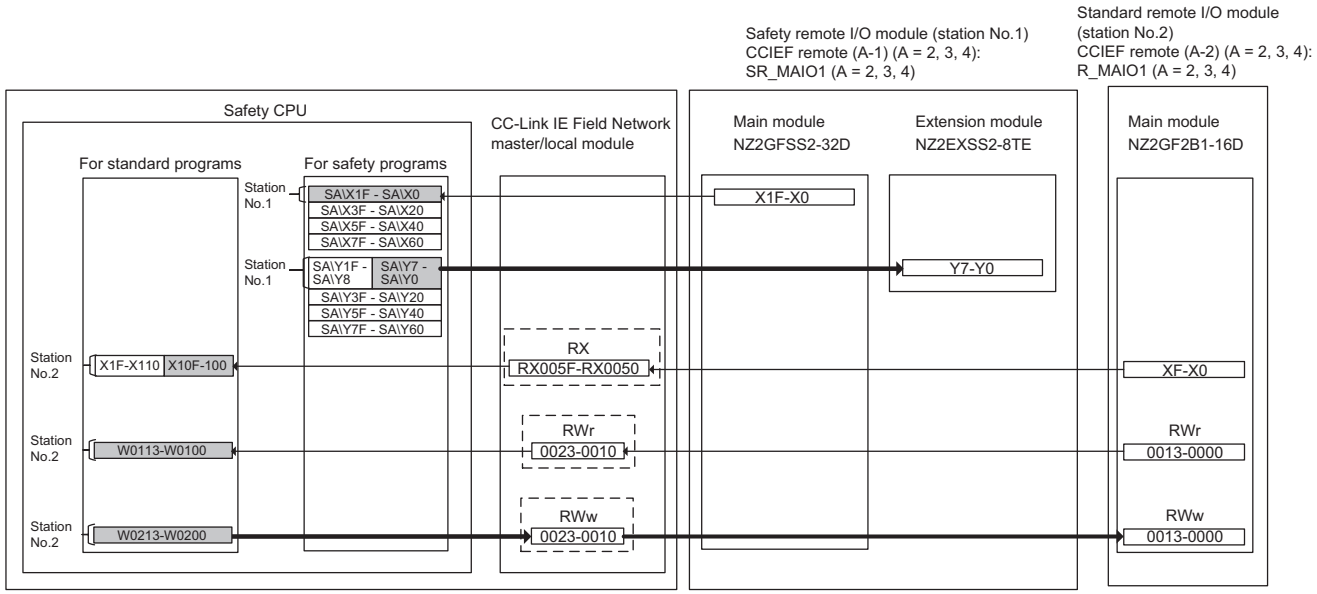
This indicates local station setting connected to the safety programmable controllers (2) and (3).

Item		Safety programmable controller (2)	Safety programmable controller (3)
		CCIEF programmable controller master (1-0)	CCIEF programmable controller master (1-0)
No.		1	1
Communication destination		Own network	Own network
Network Configuration	Network number	1	1
	Station number	0	0
	Station type	(Blank)	(Blank)
Open system		Passive	Passive
Transmission interval monitoring time		24ms	24ms
Safety refresh response processing time		60ms	60ms
Safety data transfer device setting	Receive data storage device	Device name: SA\X Points: 128 Start: 0100 End: 017F	Device name: SA\X Points: 128 Start: 0100 End: 017F
	Send data storage device	Device name: SA\Y Points: 128 Start: 0100 End: 017F	Device name: SA\Y Points: 128 Start: 0100 End: 017F

Relationship between devices in the Safety CPU and remote inputs/outputs

Relationship between devices in the Safety CPU and remote inputs/outputs

The following shows the relationship between the Safety CPU device, the inputs/outputs of safety remote I/O module, and the standard remote I/O module on Page 112 Parameter settings of CC-Link IE Field Network. Use devices in shaded areas in the program to perform programming.



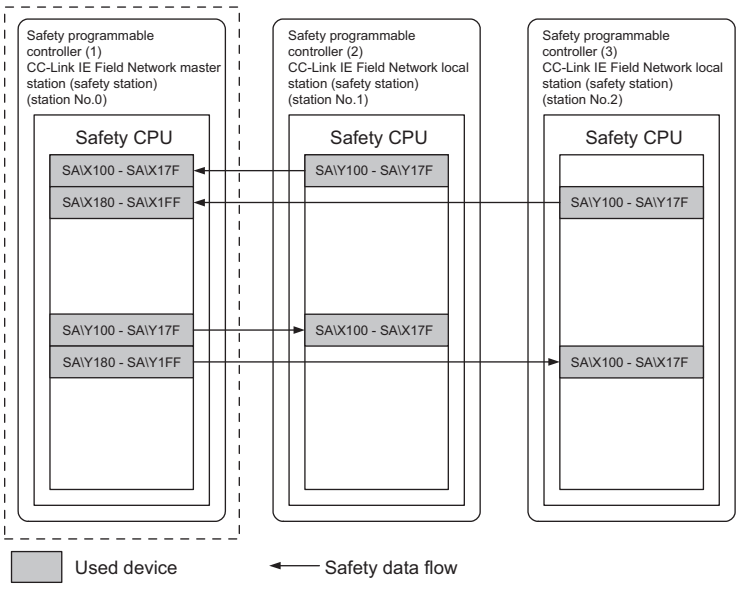
System uses 16 each of RWr/RWws to communicate with safety remote I/O module. Set 16 each of RWr/RWw according to Page 112 Parameter settings of CC-Link IE Field Network. Do not read/write data from/to RWr/RWw to be used by the system. Writing data may cause malfunction of safety programmable controller

For details on parameter setting method, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

Relationship of Devices Between Safety CPUs

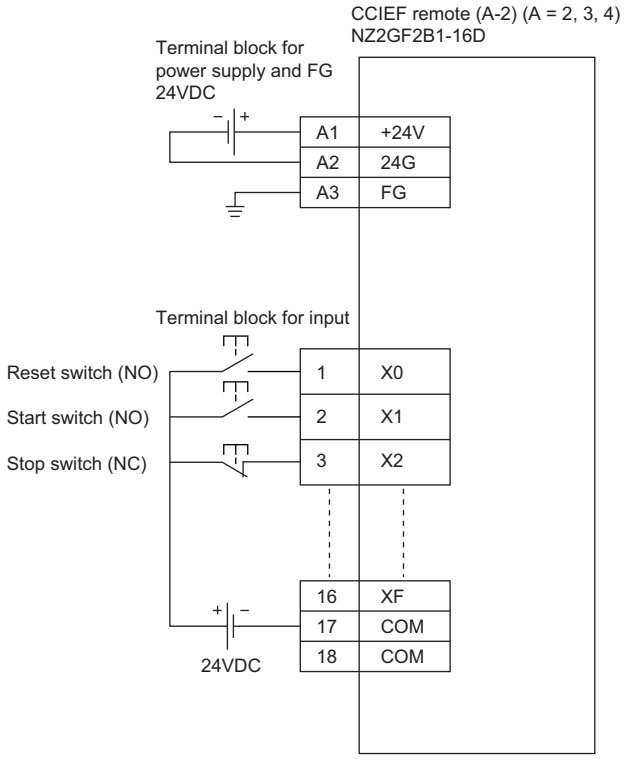
The following shows relationship of devices between the Safety CPUs on Page 112 Parameter settings of CC-Link IE Field Network. Use devices in shaded areas in the program.



Setting standard inputs

Wiring

Wiring example of reset switch, start switch, and stop switch to CC-Link IE Field Network remote I/O module (NZ2GF2B1-16D)



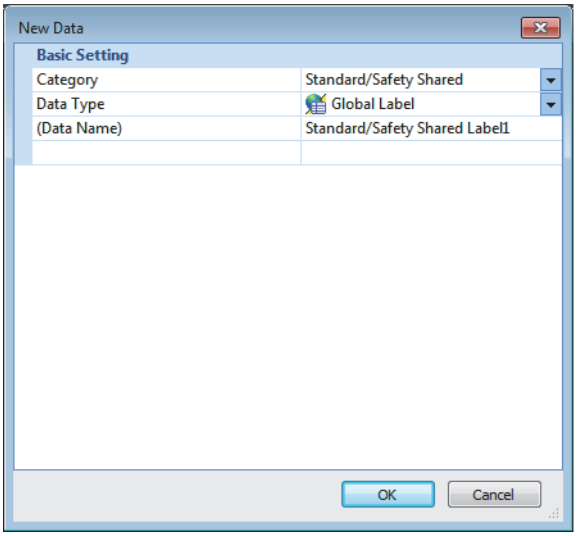
Example of parameter setting

Item	Description
Input response time	10ms
Output HOLD/CLEAR setting	CLEAR
Cyclic data update watch time setting	0
Mode switch	Automatical judgment mode
Initial operation setting	With initial processing
Synchronous input timing acquisition function	Invalid
Input off delay setting X0 to XF	0

Example of standard/safety shared label area capacity settings

Assign standard input reset signal (X100), start signal (X101), and stop signal (X102) to standard/safety shared label to deliver to safety program. Receive safety information data with the standard/safety shared label in the safety program. Perform standard/safety shared label setting for all safety programmable controllers (1) to (3). Right-click [Navigation window] ⇨ [Label] ⇨ [Global Label] to select [Add New Data], and set standard/safety shared label as following. Define standard/safety shared label as following.

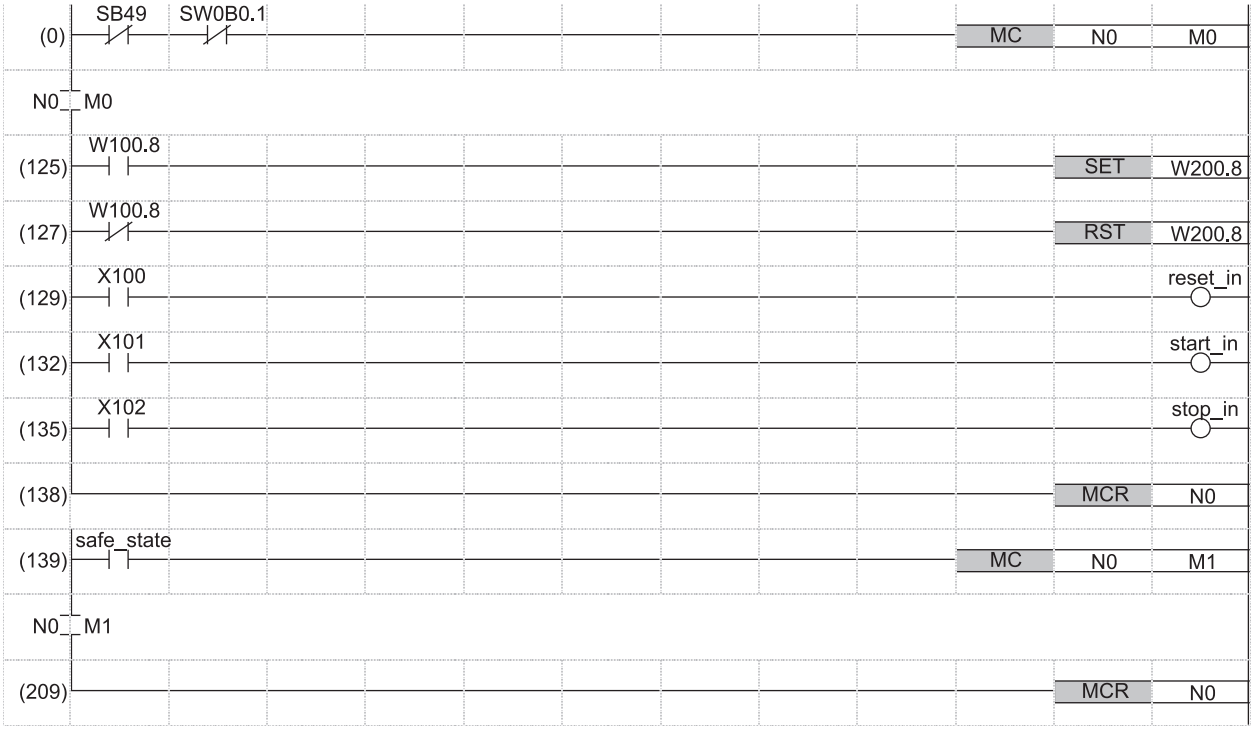
Window



Displayed items

Label name	Data type	Comment	Access from external devices
reset_in	Bit	(Blank)	☐ (unchecked)
start_in	Bit	(Blank)	☐ (unchecked)
stop_in	Bit	(Blank)	☐ (unchecked)
safe_state	Bit	(Blank)	☐ (unchecked)

Assign reset signals (X100), start signals (X101), and stop signals (X102) to standard/safety shared label for standard program as shown below. Use data of the standard/safety shared label (safe_state) assigned as a safety state signal in the safety program to interlock a part of the program. These methods are used when desiring to start operation after completing safety check using the safety control. The diagram does not show specific example of the programs to establish interlocking with the safety state signals. Set these standard program execution type to scan execution type.



(0)	Checking data link status on the station number 2 (standard remote I/O module)
(125)	Turn on the initial processing completion flag (RWw0.b8).
(127)	Turn off the initial processing completion flag (RWw0.b8).
(129) to (135)	Assign inputs from standard remote I/O module (X100, X101, and X102) to standard/safety shared label.
(139)	Checking safety status signal (safe_state) Write a program that establishes an interlock with safety status signal.

For label setting method, creating programs, and method for writing to programmable controllers, refer to the following.

GX Works3 Operating Manual

For methods creating parameters and programs of standard remote I/O module, refer to the following.

CC-Link IE Field Network Remote I/O Module User's Manual

Case examples

Emergency stop circuit (stop of the entire equipment)

■Application overview

This application uses a safety programmable controller in each process and cuts off a power to robots in all processes using an emergency stop switch in any process.

This controls the start and stop of a robot by turning on or off the main contact of the contractor which opens and closes the power source of a robot at the safety relay contact.

Connect emergency stop switches and safety relays to safety programmable controllers.

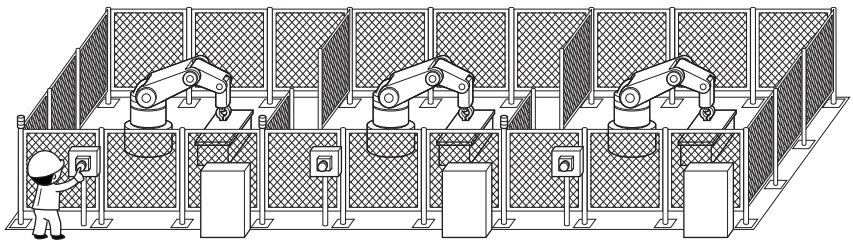
Connect Safety CPUs installed to each process with CC-Link IE Field Network. The Safety CPU turns on/off of the safety relays with program.

When the safety programmable controller detects an error by self-diagnostics, outputs to the safety relays turn off independent of the program.

In this case, the outputs remain off until the Safety CPU or safety remote I/O module is reset regardless the program, when outputs turns off by the self-diagnostics.

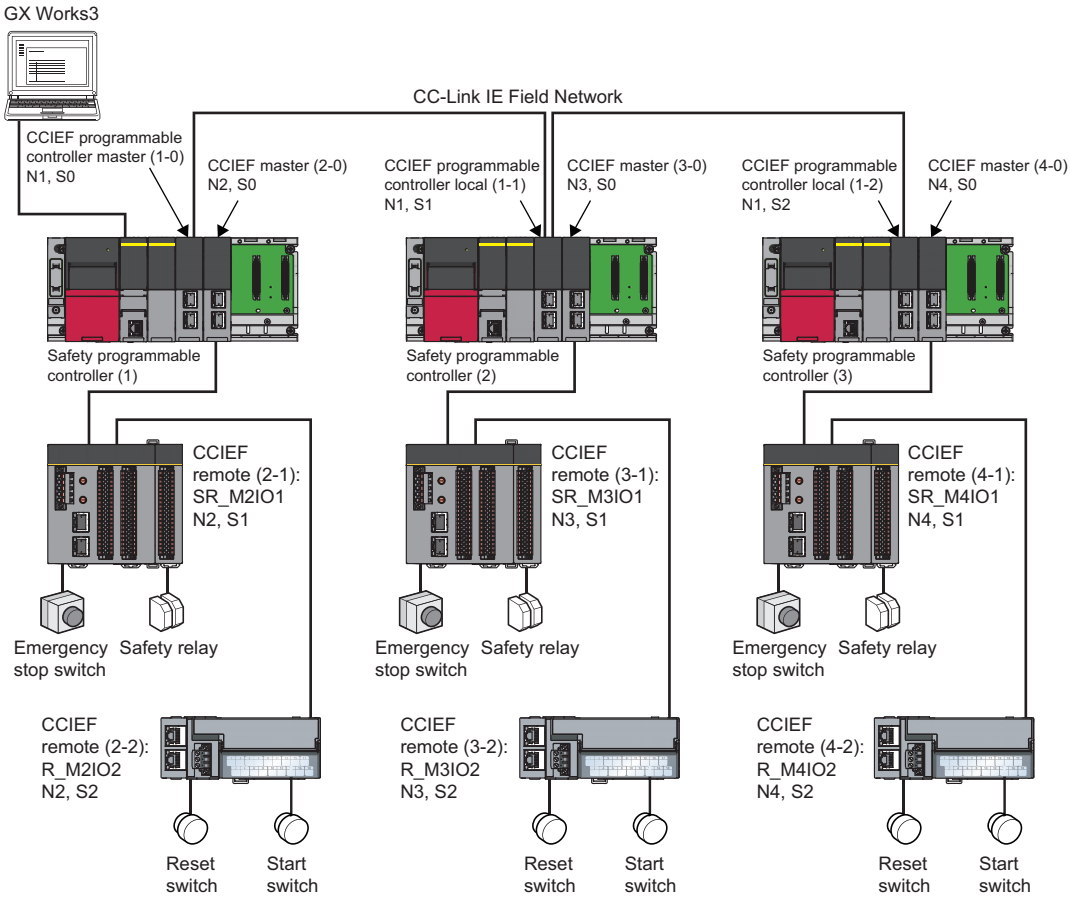
Configure the program so that the following functions can be achieved.

1. Check that safety is ensured (the emergency stop signal is on state) and that an emergency stop request is not received from another Safety CPU on CC-Link IE Field Network. The operator shall press the reset switch first. Pressing the start switch turns on the safety relays.
2. When a safety relay connected to the safety programmable controllers is welded, input the safety relay (normally closed contact) to the safety programmable controller to prevent starting, and check for welding.
3. To avoid undesired operation of the reset switch and start switch at the welding or short-circuit, set the reset switch and start switch so that they are activated only when turned on and off.
4. Outputs of the safety relays turn off when input of the emergency stop switch turns off, an emergency stop request is received from another safety programmable controller on the CC-Link IE Field Network, or an error is detected in a safety remote I/O module after the operation is started.
5. To stop the entire system, transfer the emergency stop request to other safety programmable controllers.



(Partially quoted from "Safety Guide Book - the safety measures of machinery in the workplace": Nippon Electric Control Equipment Industries Association)

■Connection of safety devices

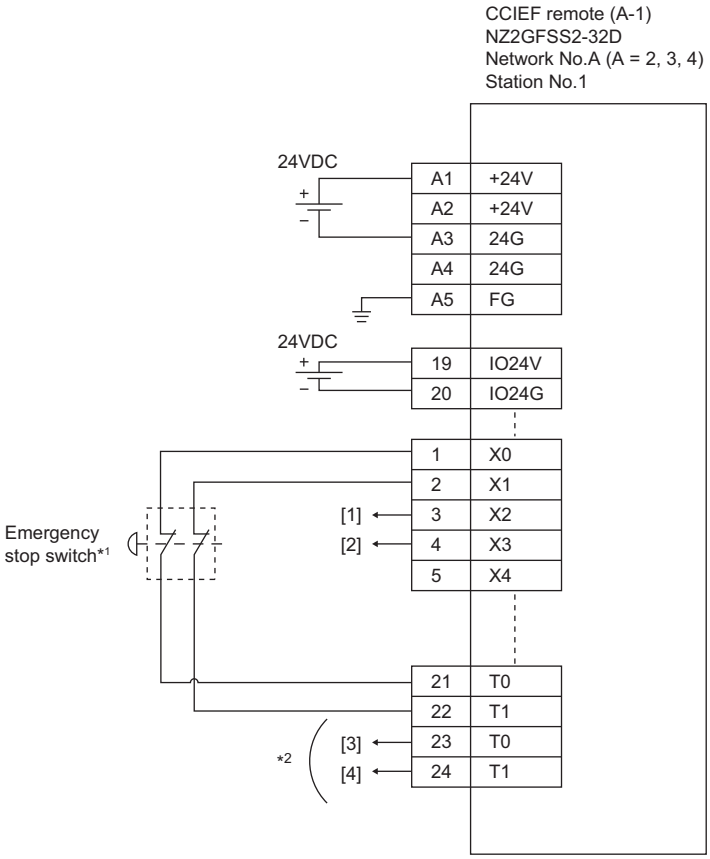


In the figure above, "N" means network number, while "S" means station number. For example, "N1" means network number 1, while "S0" means station number 0.

■Wiring diagram and parameter setting

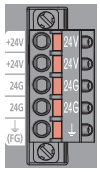
Wire the emergency stop switches and safety relays to safety remote I/O module of safety programmable controllers (1) to (3) as follows. For details on terminal block details, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

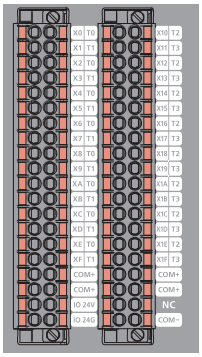


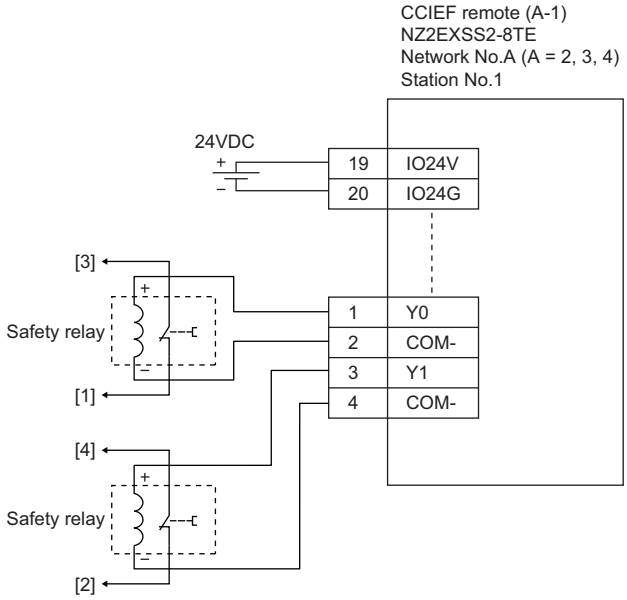
Terminal block for power supply and FG (input)

A1	+24V
A2	+24V
A3	24G
A4	24G
A5	FG

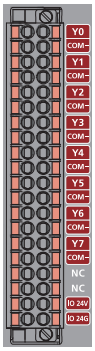


Spring clamp terminal block (input)





Spring clamp terminal block (output)



Network number 2, 3, and 4 are placed to A.

Above [1] to [4] are connected to the one with same numbers.

*1 Connect an emergency stop switch having two normally closed contacts with direct opening mechanism between input terminal and test pulse terminal.

*2 Connect normally closed contact of the safety relay between the input terminal and test pulse terminal.

For the emergency stop switches and the safety relays, set the parameters as follows.

Item	Setting details[*3]		
	SR_M2IO1	SR_M3IO1	SR_M4IO1
Transmission interval monitoring time	24ms	24ms	24ms
Wiring selection of input X 0	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X1	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X2	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X2	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X4 to X1F	Not used	Not used	Not used
Input response time X0[*1]	1ms	1ms	1ms
Input response time X1[*1]	1ms	1ms	1ms
Input response time X2[*1]	1ms	1ms	1ms
Input response time X3[*1]	1ms	1ms	1ms
Input response time X4[*1]	1ms	1ms	1ms
Input response time X5[*1]	1ms	1ms	1ms
Input response time X6[*1]	1ms	1ms	1ms
Double input discrepancy detection setting X0_X1	Detect[*4]	Detect[*4]	Detect[*4]
Double input discrepancy detection setting X2_X3	Detect[*4]	Detect[*4]	Detect[*4]
Double input discrepancy detection setting X4_X5 to X1E_X1F	Do not detect[*4]	Do not detect[*4]	Do not detect[*4]
Double input discrepancy detection type X0_X1	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]
Double input discrepancy detection type X2_X3	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]
Double input discrepancy detection type X4_X5 to X1E_X1F	Discrepancy detection time not specified[*4]	Discrepancy detection time not specified[*4]	Discrepancy detection time not specified[*4]
Double input discrepancy auto recovery setting	Not used	Not used	Not used
Double input discrepancy detection time X0_X1[*2]	10 (100ms)	10 (100ms)	10 (100ms)
Double input discrepancy detection time X2_X3[*2]	10 (100ms)	10 (100ms)	10 (100ms)
Double input discrepancy detection time X4_X5 to X1E_X1F[*2]	1 (10ms)	1 (10ms)	1 (10ms)
Input dark test execution setting X0	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X1	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X2	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X3	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X4 to X1F	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Input dark test pulse off time[*1]	400μs	400μs	400μs
Number of pulse output for input dark test	1 time	1 time	1 time
Extension 1_Wiring selection of output Y0	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]
Extension 1_Wiring selection of output Y1	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]
Extension 1_Output dark test execution setting Y2 to Y7	Not used[*4]	Not used[*4]	Not used[*4]
Extension 1_Output dark test execution setting Y0	Perform[*4]	Perform[*4]	Perform[*4]
Extension 1_Output dark test execution setting Y1	Perform[*4]	Perform[*4]	Perform[*4]
Extension 1_Output dark test execution setting Y2 to Y7	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Extension 1_Output dark test pulse off time Y0[*1]	1ms	1ms	1ms
Extension 1_Output dark test pulse off time Y1[*1]	1ms	1ms	1ms
Extension 1_Output dark test pulse off time Y2 to Y7[*1]	1ms	1ms	1ms

Item	Setting details*3		
	SR_M2IO1	SR_M3IO1	SR_M4IO1
Extension 1_Number of pulse output for output dark test	1 time	1 time	1 time

*1 Adjust the values of input response time, input dark test pulse off time, and output dark test pulse off time according to the installation environment and wiring length.

*2 Set double input discrepancy detection time to 100ms for mechanical switches and 20ms for sensor inputs as standard.

*3 For details on setting range, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

*4 Always set the parameters like this for this case example.

■Safety devices and safety labels to be used

Program safety program using safety devices and standard/safety shared labels shown below.

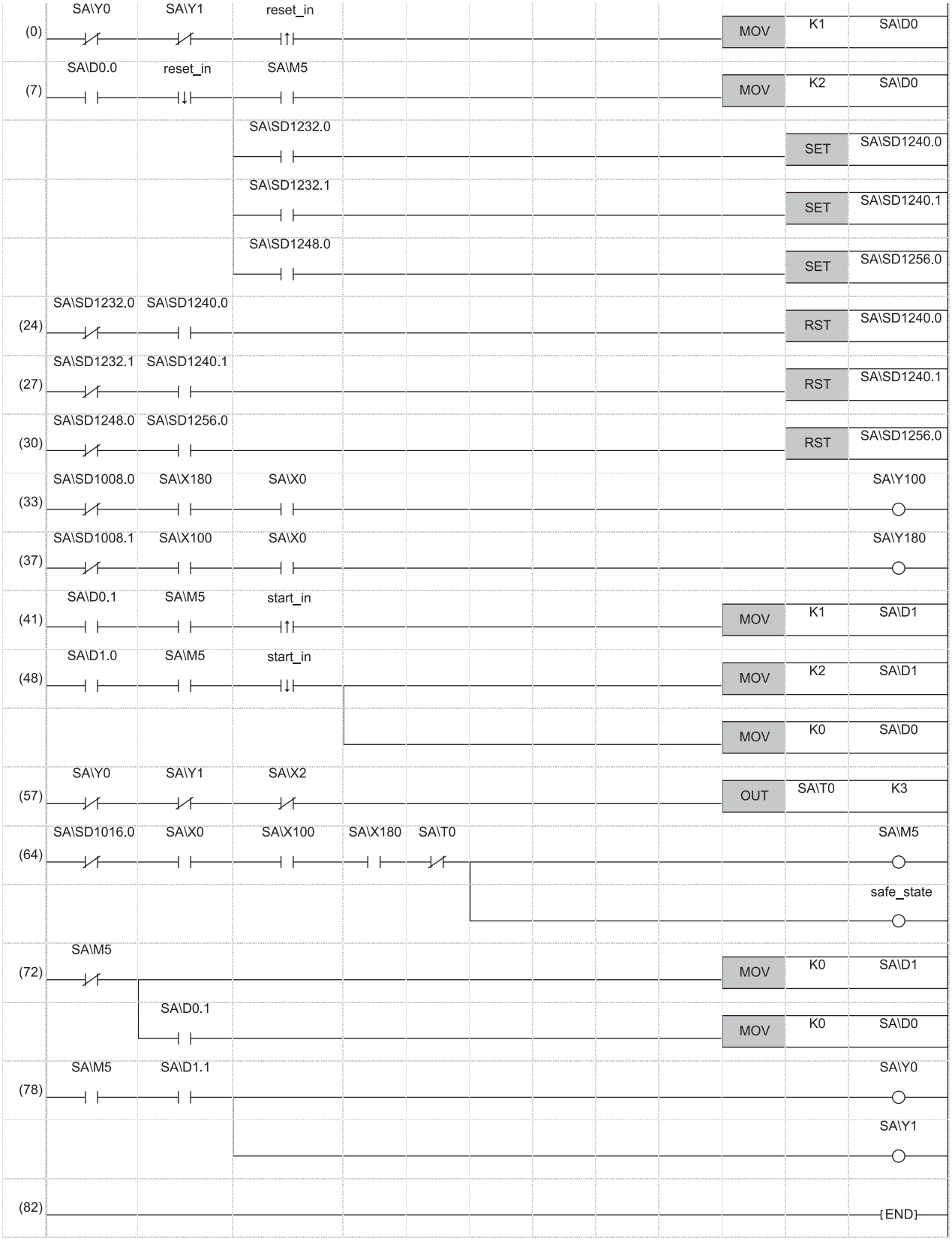
Safety programmable controller	Module	External device	Safety device/safety label
Safety programmable controller (1)	SR_M2IO1	Emergency stop switch	SA\X0 or SA\X1
		Safety relay	SA\Y0 and SA\Y1
		Safety relay (check for welding)	SA\X2 or SA\X3
	R_M2IO2	Reset switch	reset_in
		Start switch	start_in
	CCIEF programmable controller master (1-0)	Emergency stop request from safety programmable controller (2)	SA\X100
		Emergency stop request from safety programmable controller (3)	SA\X180
		Emergency stop request to safety programmable controller (2)	SA\Y100
		Emergency stop request to safety programmable controller (3)	SA\Y180
Safety programmable controller (2)	SR_M3IO1	Emergency stop switch	SA\X0 or SA\X1
		Safety relay	SA\Y0 and SA\Y1
		Safety relay (check for welding)	SA\X2 or SA\X3
	R_M3IO2	Reset switch	reset_in
		Start switch	start_in
	CCIEF programmable controller local (1-1)	Emergency stop request from safety programmable controller (1)	SA\X100
		Emergency stop request to safety programmable controller (1)	SA\Y100
Safety programmable controller (3)	SR_M4IO1	Emergency stop switch	SA\X0 or SA\X1
		Safety relay	SA\Y0 and SA\Y1
		Safety relay (check for welding)	SA\X2 or SA\X3
	R_M4IO2	Reset switch	reset_in
		Start switch	start_in
	CCIEF programmable controller local (1-2)	Emergency stop request from safety programmable controller (1)	SA\X100
		Emergency stop request to safety programmable controller (1)	SA\Y100

■Program example

This is a safety program. For precautions for creating safety program and setting method, refer to Page 34 Precautions for Programming and Page 107 Parameter setting of the Safety CPU. The program performs the following processing.

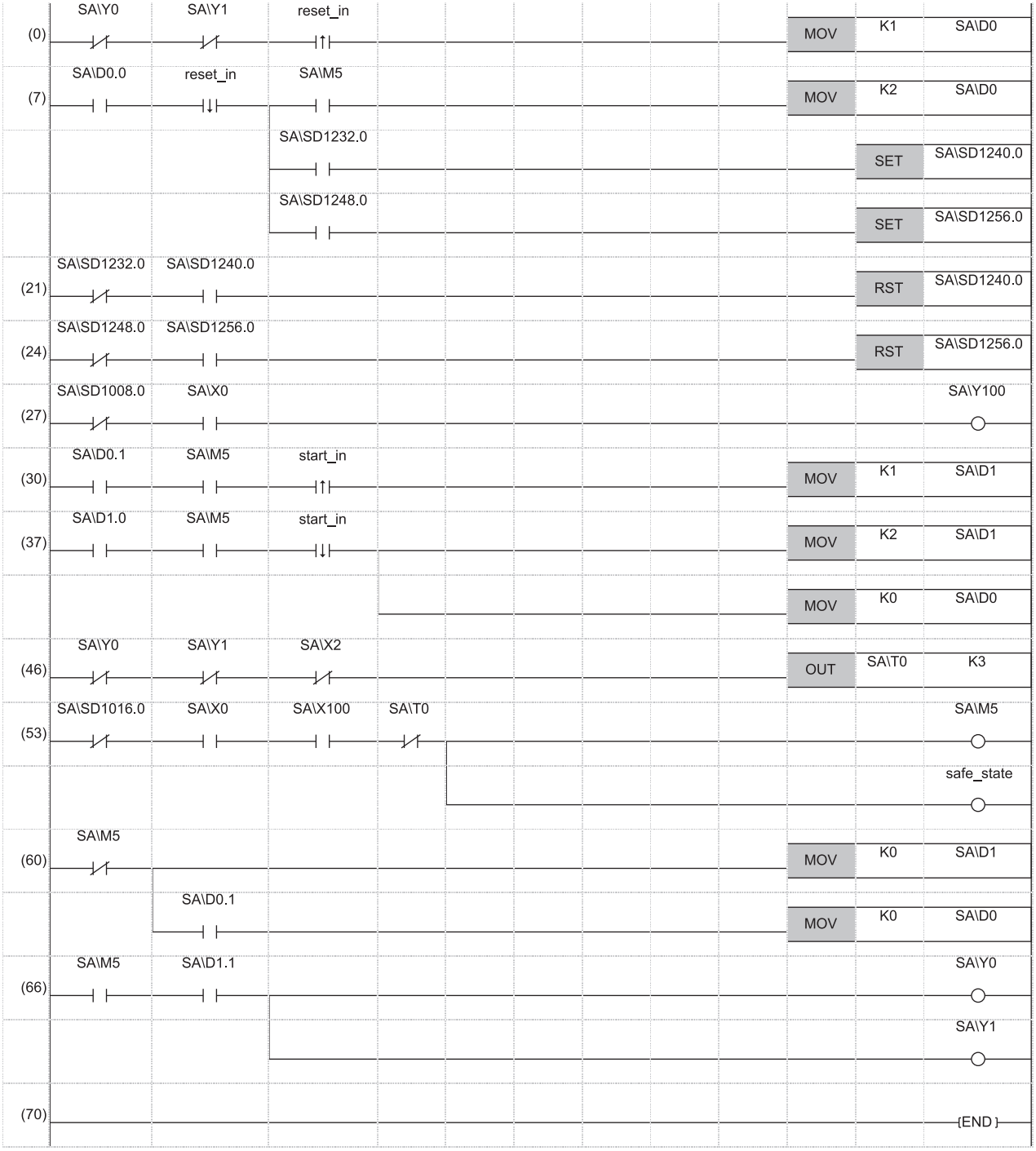
The following shows programs to be used for safety programmable controllers (1) to (3).

• Safety programmable controller (1)



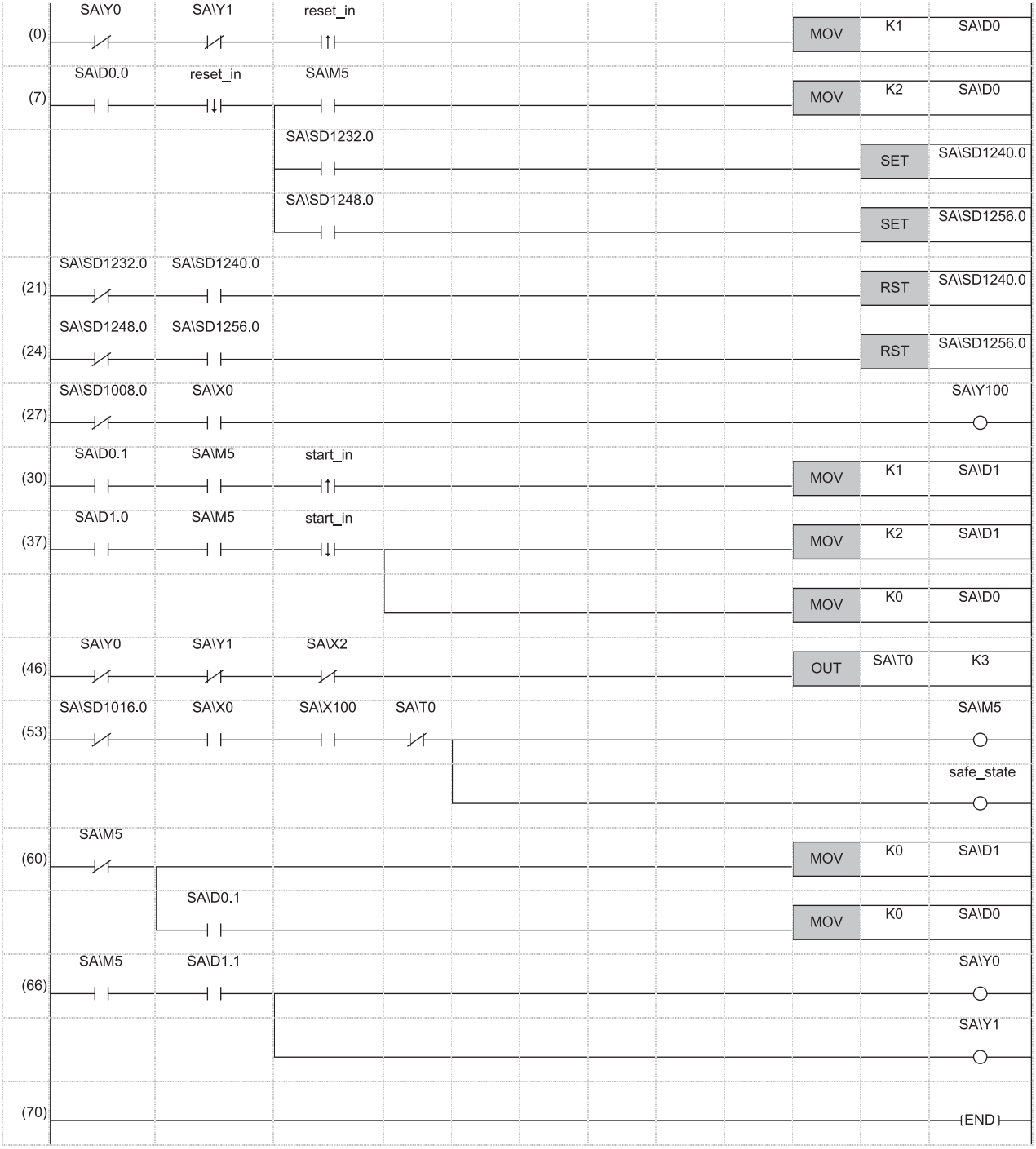
(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(24) to (30)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(33) to (37)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controllers (2) and (3).
(41) to (48)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(57)	This is a circuit to check welding of the safety relay.
(64)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(72)	This is a circuit to cancel start/reset request, when not possible to check safety.
(78)	This is a circuit to control outputs to the safety relay.

• Safety programmable controller (2)



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(21) to (24)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(27)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controller (1).
(30) to (37)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(46)	This is a circuit to check welding of the safety relay.
(53)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(60)	This is a circuit to cancel start/reset request, when not possible to check safety.
(66)	This is a circuit to control outputs to the safety relay.

• Safety programmable controller (3)



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(21) to (24)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(27)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controller (1).
(30) to (37)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(46)	This is a circuit to check welding of the safety relay.
(53)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(60)	This is a circuit to cancel start/reset request, when not possible to check safety.
(66)	This is a circuit to control outputs to the safety relay.

The following shows the constant and safety user devices used in the program.

• Way of using the constant

K☐: indicates decimal number

Ex.

K1→ 1 of decimal number

• Way of using the safety user devices

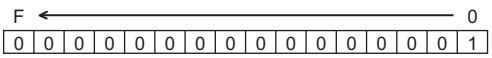
Safety user devices	Description
SA\D0	This is used as restart status. (1) SA\D0 = 0: Initial status or start processing completed (2) SA\D0 = 1: (SA/D0.0: ON): Reset switch pressed (3) SA\D0 = 2 (SA\D0.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\D1	This is used as start status. (1) SA\D1 = 0: Initial status or safety not checked (2) SA\D1 = 1 (SA\D1.0: ON): Reset switch pressed. (3) SA\D1 = 2 (SA\D1.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\T0	This indicates timer device. Times out after a lapse of the time specified at K☐.

• Way of using word device bit specification

SA\D☐.n: This indicates the nth bit of the word device SA\D☐

Ex.

SA\D0.0 = 0 bits in SA\D0

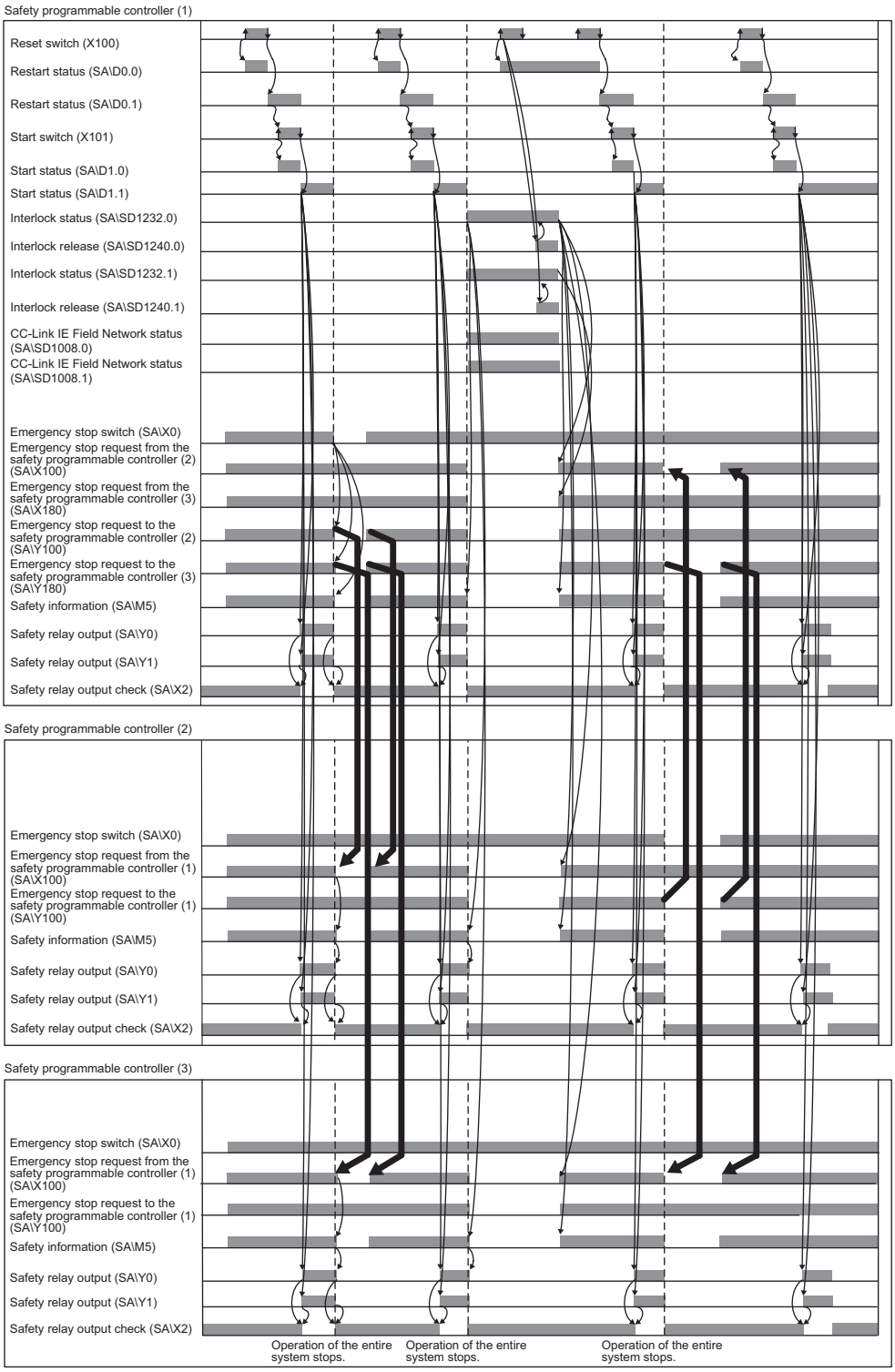


For bit-specified word device, refer to the following.

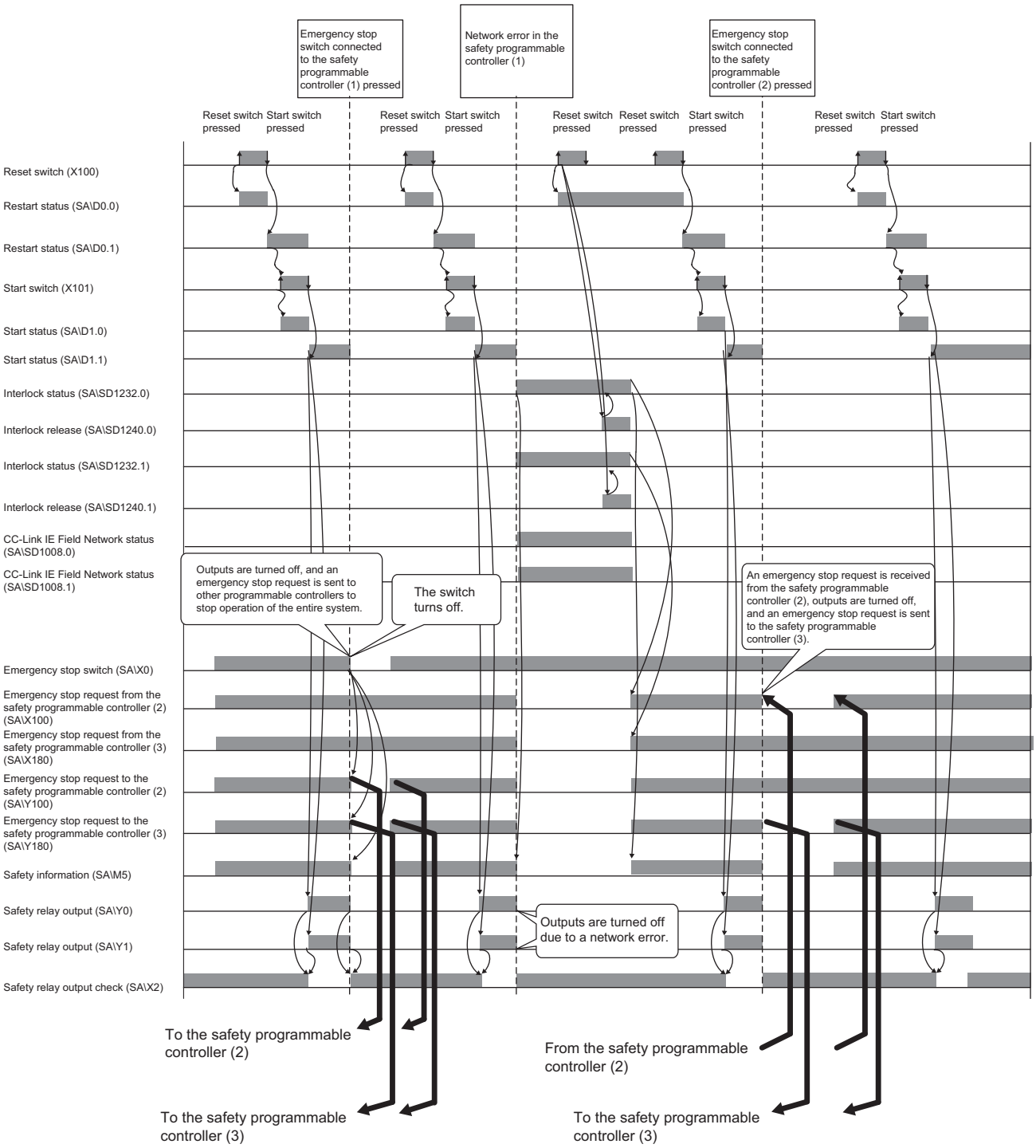
MELSEC iQ-R Programming Manual (Instructions, Standard Functions/Function Blocks)

■Timing chart

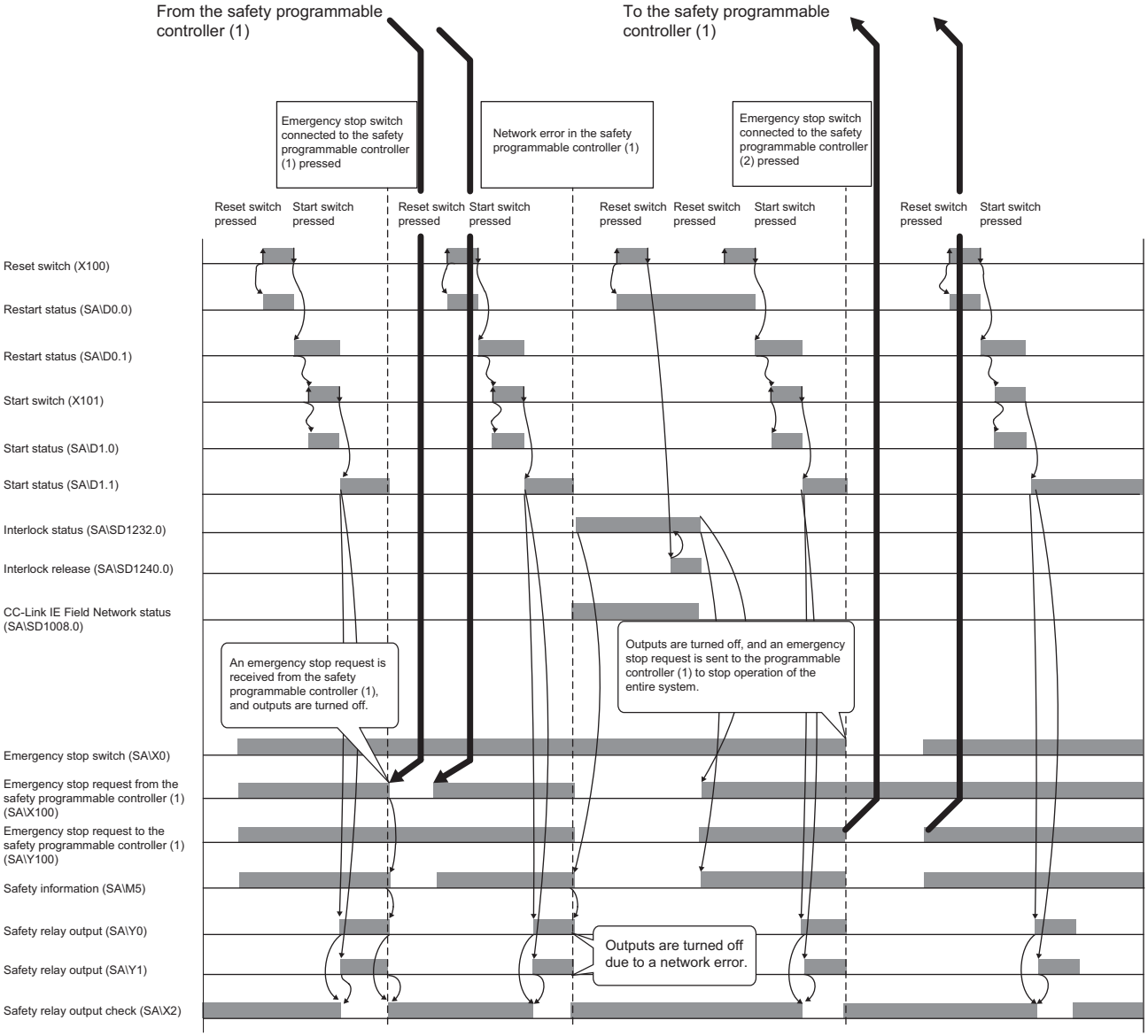
The following shows the entire timing chart when connecting three safety programmable controllers and enlarged timing charts for each safety programmable controller.



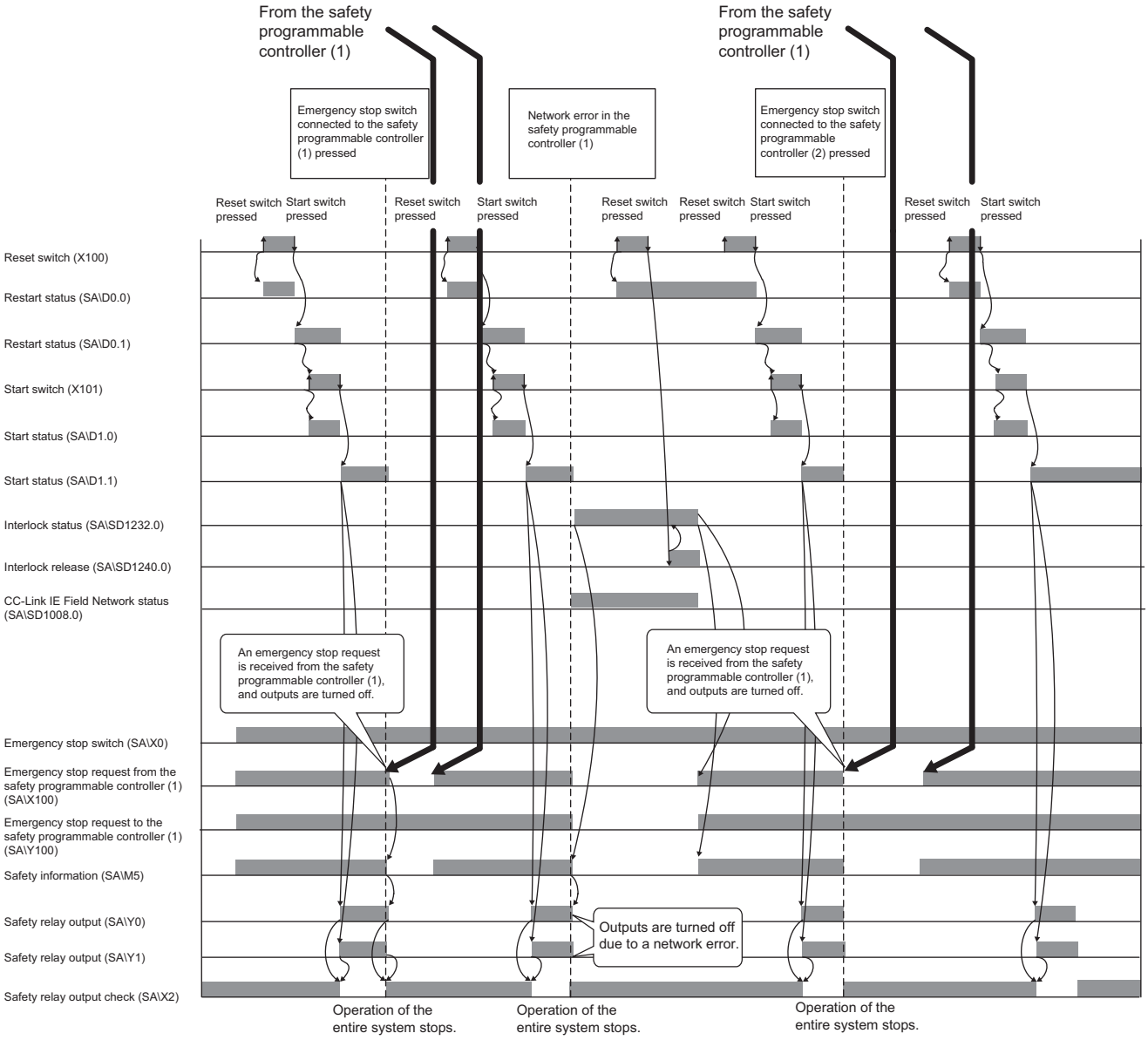
• Timing chart for safety programmable controller (1)



• Timing chart for safety programmable controller (2)



• Timing chart for safety programmable controller (3)

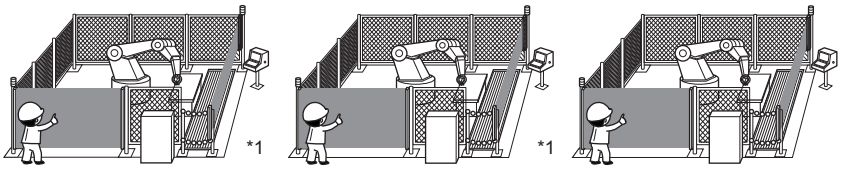


Entering detection and existence detection circuit 1

■Application overview

This application uses a safety programmable controller in each process and detect the entrance and existence of a person in a hazardous area and turns off the power source of a robot.
The entrance of a person to the hazardous area is detected with a light curtain. The existence of a person in the hazardous area is detected with a laser scanner. When the entrance or existence of a person has been detected, a robot is stopped. The robot cannot be started until the person leaves the hazardous area.
This controls the start and stop of a robot by turning on or off the main contact of the contractor which opens and closes the power source of a robot. Connect the light curtain, laser scanner, and electromagnetic contactors to a safety programmable controller.
Connect Safety CPUs installed to each process with CC-Link IE Field Network. The Safety CPU turns on/off of the electromagnetic contactors with program.
When the safety programmable controller detects an error by self-diagnostics, outputs to the electromagnetic contactors turn off independent of the program.
In this case, the outputs remain off until the safety CPU module of CC-Link Safety remote I/O module is reset independent of the program.
Configure the program so that the following functions can be achieved.

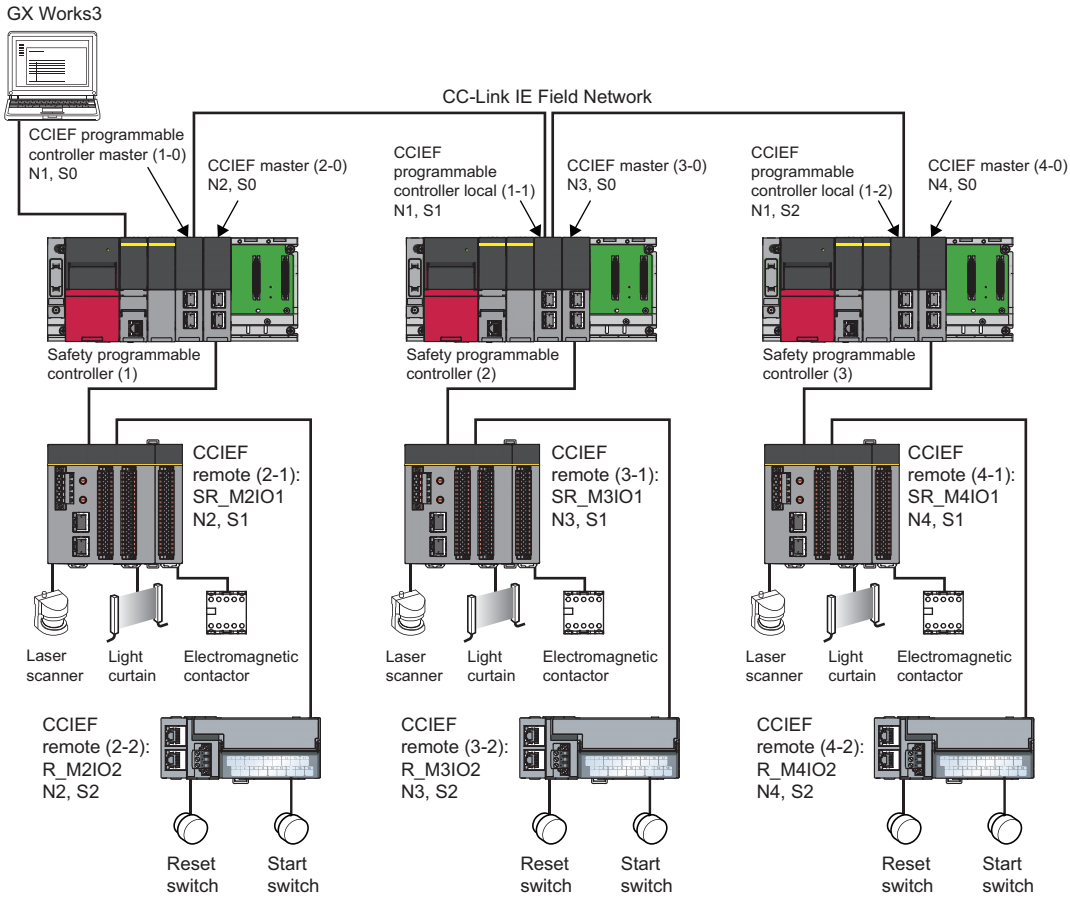
1. Check that safety is ensured (both of the light curtain and laser scanner signal are turned on) and when the entrance and existence of a person in a hazardous area is not detected by another Safety CPU on CC-Link IE Field Network, the worker shall press the reset switch first. Pressing the start switch turns on the electromagnetic contactors.
2. When an electromagnetic contactor connected to the safety programmable controller installed to the processes is welded, input the electromagnetic contactor (normally closed contact) to the safety programmable controller to prevent starting, and check for welding.
3. To avoid undesired operation of the reset switch and start switch at the welding or short-circuit, set the reset switch and start switch so that they are activated only when turned on and off.
4. Turn off the outputs of electromagnetic contactor, when light curtain signal or laser scanner signal is turned off after operation starts, when the entrance and existence in a hazardous area is detected by another Safety CPU on CC-Link IE Field Network, or when an error is detected on safety remote I/O module is detected.
5. To stop the entire system, transfer the emergency stop request to other Safety CPU.



*1 There is no guard between the processes. There is no barrier between the processes.

(Partially quoted from "Safety Guide Book - the safety measures of machinery in the workplace": Nippon Electric Control Equipment Industries Association)

■Connection of safety devices

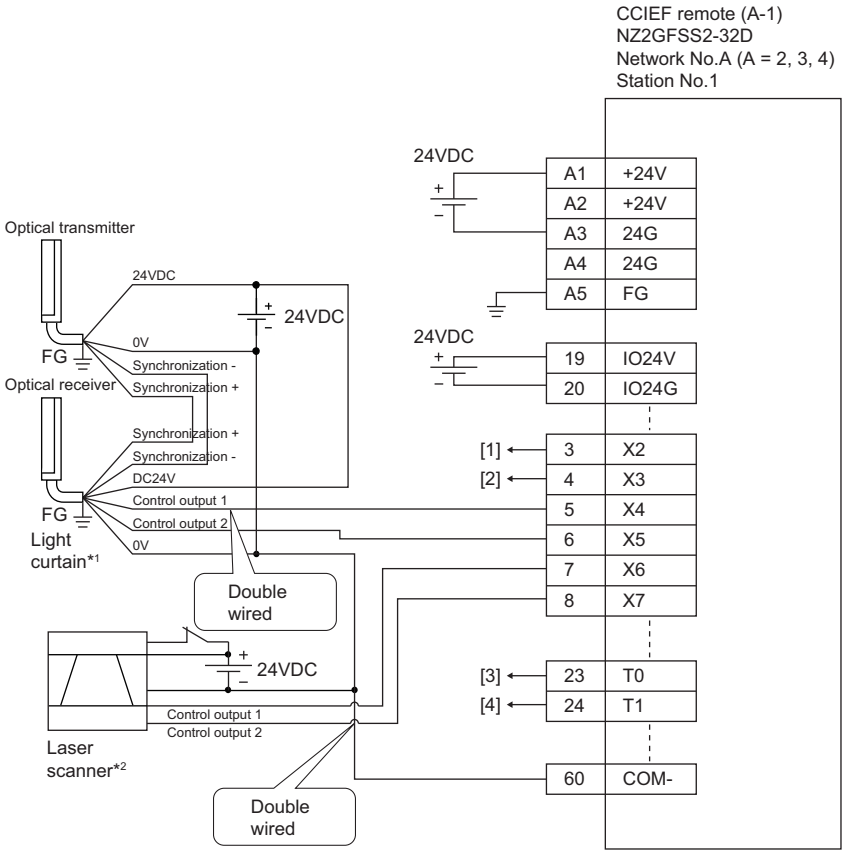


In the figure above, "N" means network number, while "S" means station number. For example, "N1" means network number 1, while "S0" means station number 0.

■Wiring diagram and parameter settings

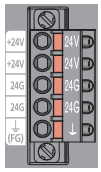
Wire the light curtain, laser scanner, and electromagnetic contactor to safety remote I/O module of safety programmable controllers (1) to (3) as follows. For details on terminal block details, refer to the following.

📖 CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

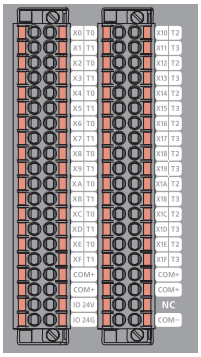


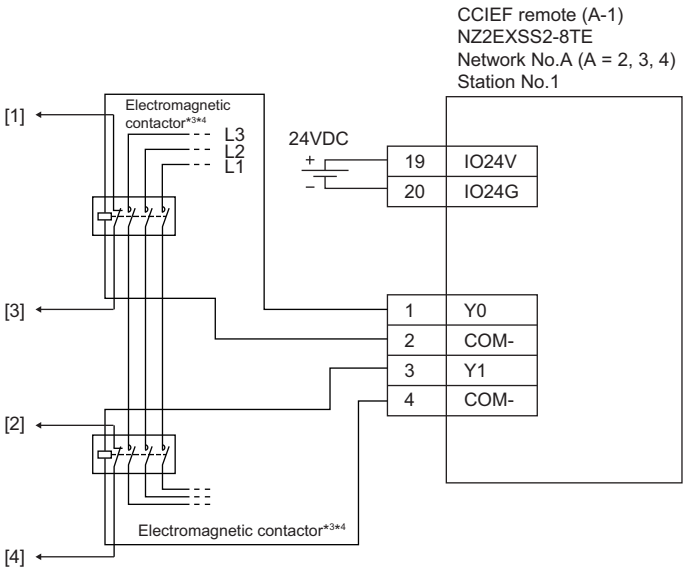
Terminal block for power supply and FG (input)

A1	+24V
A2	+24V
A3	24G
A4	24G
A5	FG

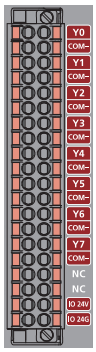


Spring clamp terminal block (input)





Spring clamp terminal block (output)



Network number 2, 3, and 4 are placed to A.

Above [1] to [4] are connected to the one with same numbers.

*1 Connect two points (PNP output) of the Type 4 light curtain control output to between input and COM.

*2 Connect two points (PNP output) of the Type 3 laser scanner control output to between input and COM.

*3 Use two electromagnetic contactors operatable by 24VDC and 0.5A.

*4 Connect normally closed contact of the safety relay between the input terminal and test pulse terminal.

For light curtains, laser scanners, and electromagnetic contactors, set the parameters as follows.

Item	Setting details[*3]		
	SR_M2IO1	SR_M3IO1	SR_M4IO1
Sending Interval Monitoring Time	24ms	24ms	24ms
Wiring selection of input X2	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X3	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X4	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X5	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X6	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X7	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X0, X1, and X8 to X1F	Not used	Not used	Not used
Input response time X2[*1]	1ms	1ms	1ms
Input response time X3[*1]	1ms	1ms	1ms
Input response time X4[*1]	1ms	1ms	1ms
Input response time X5[*1]	1ms	1ms	1ms
Input response time X6[*1]	1ms	1ms	1ms
Input response time X7[*1]	1ms	1ms	1ms
Input response time X8[*1]	1ms	1ms	1ms
Input response time X9[*1]	1ms	1ms	1ms
Input response time X0, X1, and XA to X1F[*1]	1ms	1ms	1ms
Double input discrepancy detection setting X2_X3	Detect[*4]	Detect[*4]	Detect[*4]
Double input discrepancy detection setting X4_X5	Detect[*4]	Detect[*4]	Detect[*4]
Double input discrepancy detection setting X6_X7	Detect[*4]	Detect[*4]	Detect[*4]
Double input discrepancy detection setting X0, X1, and X8 to X1F	Do not detect[*4]	Do not detect[*4]	Do not detect[*4]
Double input discrepancy detection type X2_X3	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]
Double input discrepancy detection type X4_X5	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]
Double input discrepancy detection type X6_X7	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]
Double input discrepancy detection type X0, X1, and X8 to X1F	Discrepancy detection time not specified[*4]	Discrepancy detection time not specified[*4]	Discrepancy detection time not specified[*4]
Double input discrepancy auto recovery setting	Not used	Not used	Not used
Double input discrepancy detection time X2_X3[*2]	10 (100ms)	10 (100ms)	10 (100ms)
Double input discrepancy detection time X4_X5[*2]	2 (20ms)	2 (20ms)	2 (20ms)
Double input discrepancy detection time X6_X7[*2]	2 (20ms)	2 (20ms)	2 (20ms)
Double input discrepancy detection time X0, X1, and X8 to X1F[*2]	1 (10ms)	1 (10ms)	1 (10ms)
Input dark test execution setting X2	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X3	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X4	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Input dark test execution setting X5	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Input dark test execution setting X6	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Input dark test execution setting X7	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Input dark test execution setting X0, X1, and X8 to X1F	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Input dark test pulse OFF time[*1]	400μs	400μs	400μs
Number of pulse output for input dark test	1 time	1 time	1 time
Ext. module 1_Wiring selection of output Y0	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]
Ext. module 1_Wiring selection of output Y1	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]
Ext. module 1_Wiring selection of output Y2 to Y7	Not used[*4]	Not used[*4]	Not used[*4]
Ext. module 1_Wiring selection of output Y0	Perform[*4]	Perform[*4]	Perform[*4]
Ext. module 1_Wiring selection of output Y1	Perform[*4]	Perform[*4]	Perform[*4]
Ext. module 1_Wiring selection of output Y2 to Y7	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]

Item	Setting details*3		
	SR_M2IO1	SR_M3IO1	SR_M4IO1
Ext. module 1_Output dark test pulse OFF time Y0*1	1ms	1ms	1ms
Ext. module 1_Output dark test pulse OFF time Y1*1	1ms	1ms	1ms
Ext. module 1_Output dark test pulse OFF time Y2 to Y7*1	1ms	1ms	1ms
Ext. module 1_Number of pulse output for output dark test	1 time	1 time	1 time

*1 Adjust the values of input response time, input dark test pulse OFF time, and output dark test pulse OFF time according to the installation environment and wiring length.

*2 Set double input discrepancy detection time to 100ms for mechanical switches and 20ms for sensor inputs as standard.

*3 For details of setting range, refer to the following.
CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

*4 Always set the parameters like this for this case example.

■Safety devices and safety labels to be used

Program safety program using safety devices and standard/safety shared labels shown below.

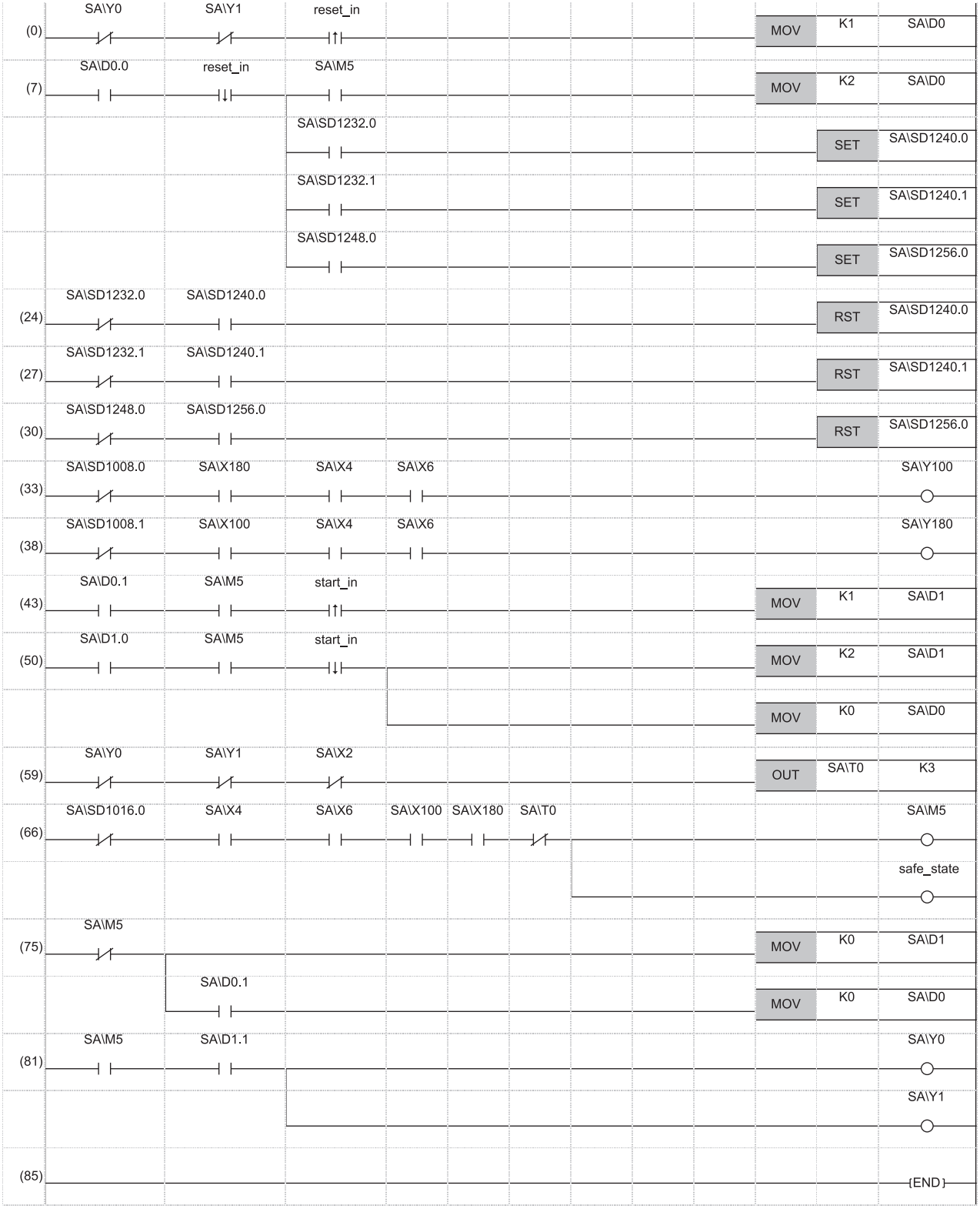
Safety programmable controller	Module	External device	Safety device/safety label
Safety programmable controller (1)	SR_M2IO1	Light curtain	SA\X4 or SA\X5
		Laser scanner	SA\X6 or SA\X7
		Contactor	SA\Y0 and SA\Y1
		Contactor (check for welding)	SA\X2 or SA\X3
	R_M2IO2	Reset switch	reset_in
		Start switch	start_in
	CCIEF programmable controller master (1-0)	Emergency stop request from safety programmable controller (2)	SA\X100
		Emergency stop request from safety programmable controller (3)	SA\X180
		Emergency stop request to safety programmable controller (2)	SA\Y100
		Emergency stop request to safety programmable controller (3)	SA\Y180
Safety programmable controller (2)	SR_M3IO1	Light curtain	SA\X4 or SA\X5
		Laser scanner	SA\X6 or SA\X7
		Contactor	SA\Y0 and SA\Y1
		Contactor (check for welding)	SA\X2 or SA\X3
	R_M3IO2	Reset switch	reset_in
		Start switch	start_in
	CCIEF programmable controller local (1-1)	Emergency stop request from safety programmable controller (1)	SA\X100
		Emergency stop request to safety programmable controller (1)	SA\Y100
Safety programmable controller (3)	SR_M4IO1	Light curtain	SA\X4 or SA\X5
		Laser scanner	SA\X6 or SA\X7
		Contactor	SA\Y0 and SA\Y1
		Contactor (check for welding)	SA\X2 or SA\X3
	R_M4IO2	Reset switch	reset_in
		Start switch	start_in
	CCIEF programmable controller local (1-2)	Emergency stop request from safety programmable controller (1)	SA\X100
		Emergency stop request to safety programmable controller (1)	SA\Y100

■Program example

This is a safety program. For precautions for creating safety program and setting method, refer to Page 34 Precautions for Programming and Page 107 Parameter setting of the Safety CPU. The program performs the following processing.

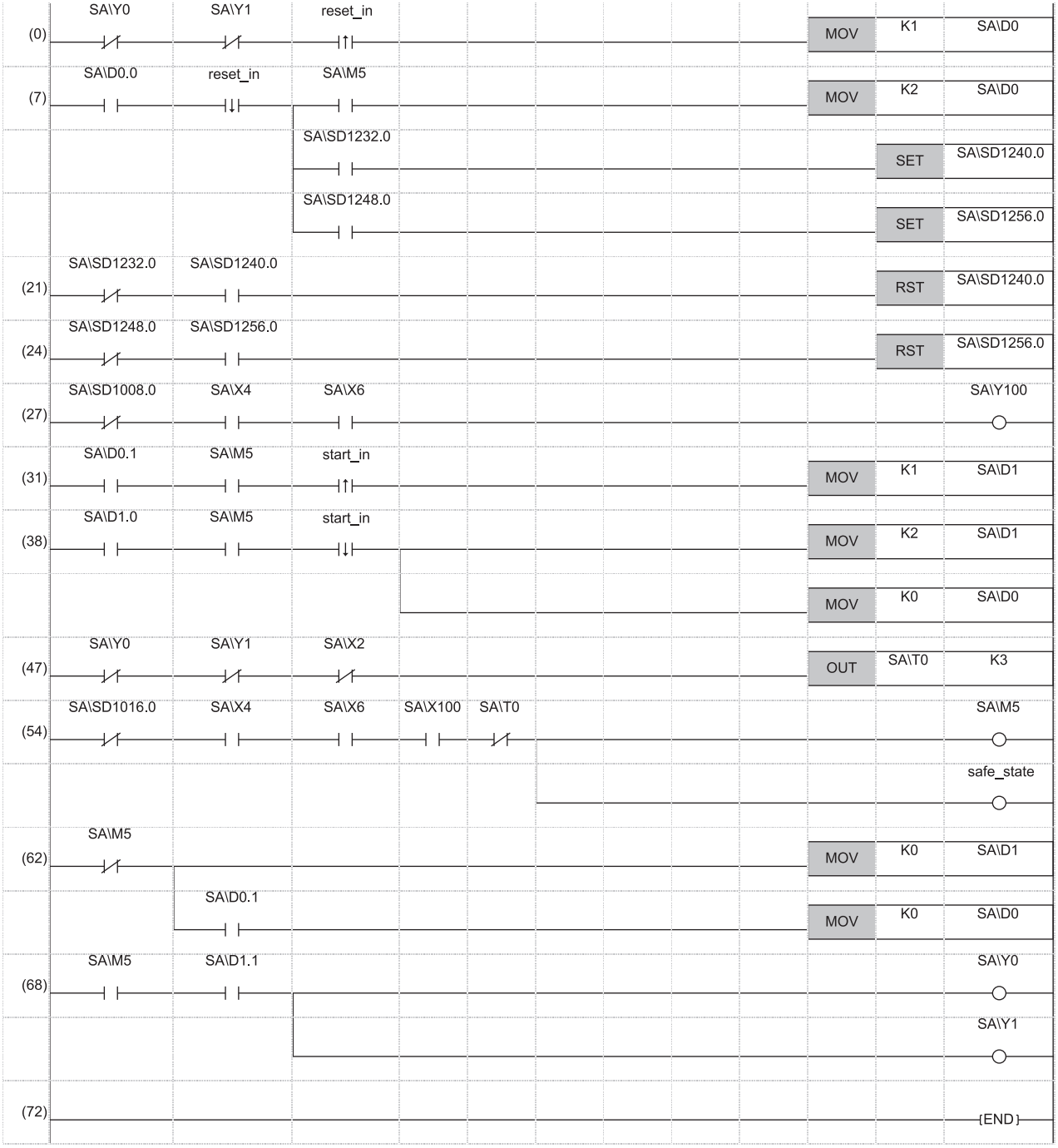
Programs to be used for safety programmable controllers (1) to (3)

• Safety programmable controller (1)



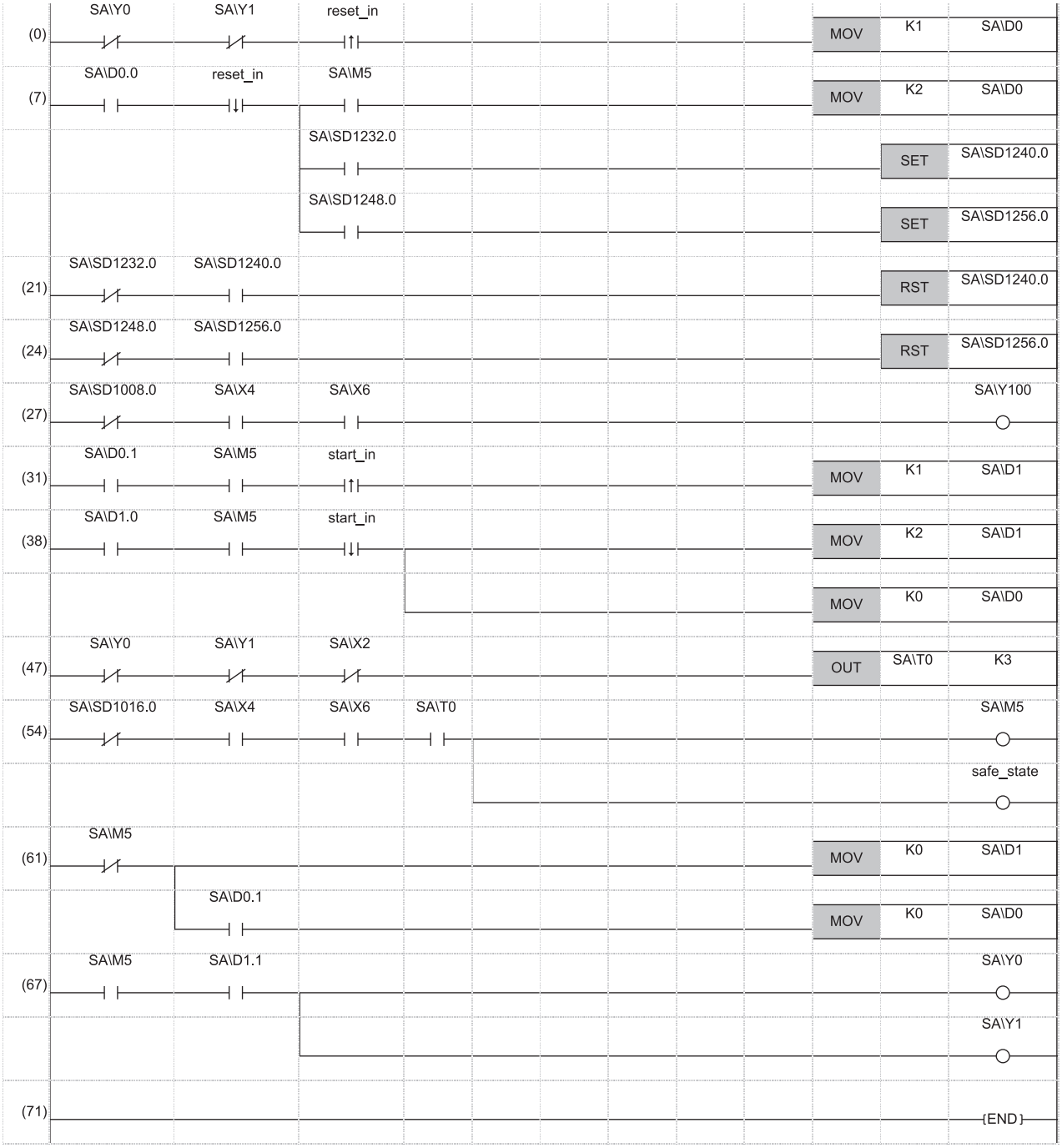
(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(24) to (30)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(33) to (38)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controllers (2) and (3).
(43) to (50)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(59)	This is a circuit to check welding of the electromagnetic contactor.
(66)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(75)	This is a circuit to cancel start/reset request, when not possible to check safety.
(81)	This is a circuit to control outputs to the electromagnetic contactor.

• Safety programmable controller (2)



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(21) to (24)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(27)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controller (1).
(31) to (38)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(47)	This is a circuit to check welding of the electromagnetic contactor.
(54)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(62)	This is a circuit to cancel start/reset request, when not possible to check safety.
(68)	This is a circuit to control outputs to the electromagnetic contactor.

• Safety programmable controller (3)



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(21) to (24)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(27)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controller (1).
(31) to (38)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(47)	This is a circuit to check welding of the electromagnetic contactor.
(54)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(61)	This is a circuit to cancel start/reset request, when not possible to check safety.
(67)	This is a circuit to control outputs to the electromagnetic contactor.

The following shows the constant and safety user devices used in the program.

• Way of using the constant

K☐: indicates decimal number

Ex.

K1→ 1 of decimal number

• Way of using the safety user devices

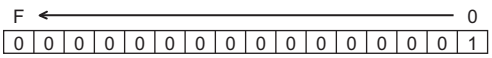
Safety user devices	Description
SA\D0	This is used as restart status. (1) SA\D0 = 0: Initial status or start processing completed (2) SA\D0 = 1: (SA/D0.0: ON): Reset switch pressed (3) SA\D0 = 2 (SA\D0.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\D1	This is used as start status. (1) SA\D1 = 0: Initial status or safety not checked (2) SA\D1 = 1 (SA\D1.0: ON): Reset switch pressed. (3) SA\D1 = 2 (SA\D1.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\T0	This indicates timer device. Times out after a lapse of the time specified at K☐.

• Way of using word device bit specification

SA\D☐.n: This indicates the nth bit of the word device SA\D☐

Ex.

SA\D0.0 = 0 bits in SA\D0

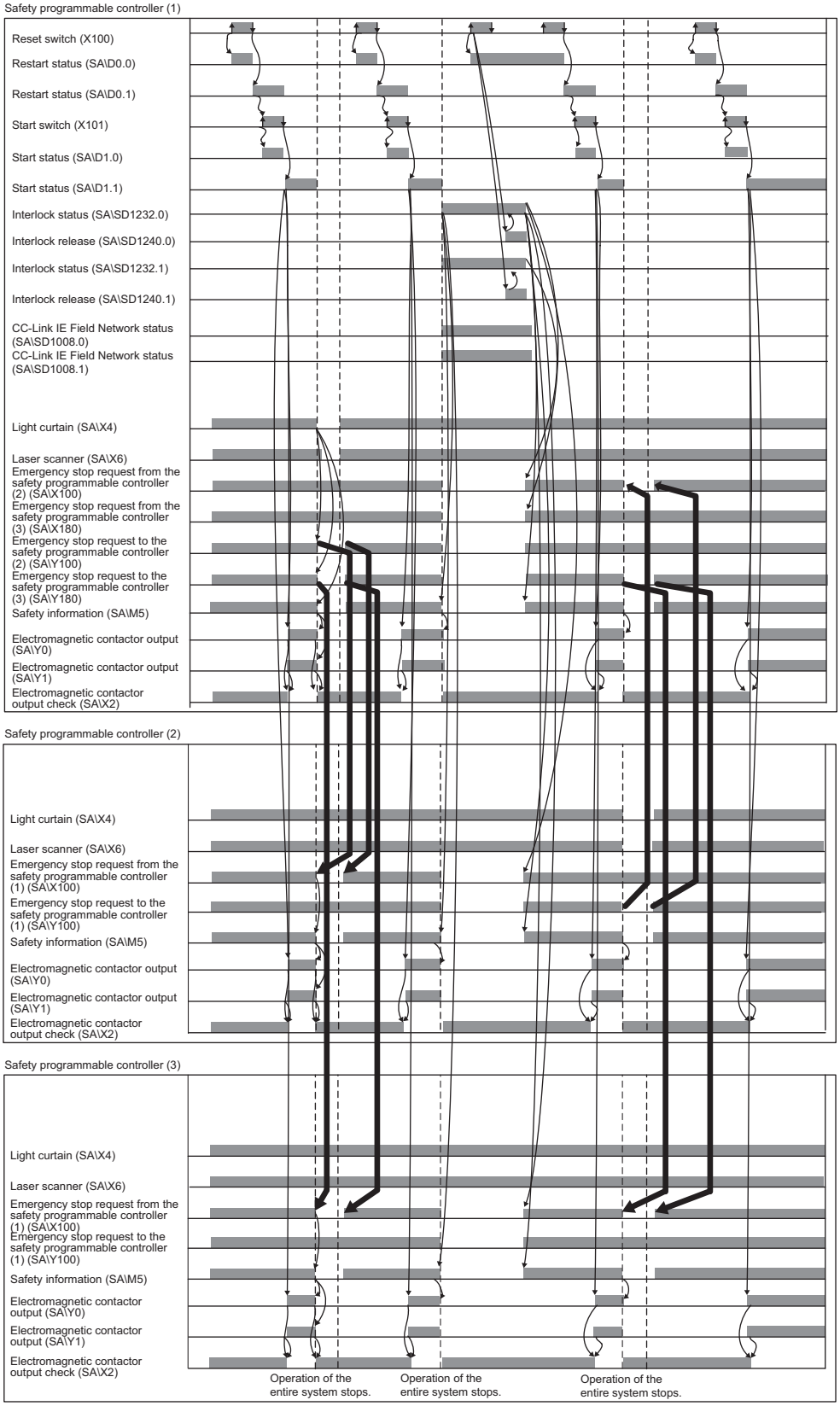


For bit-specified word device, refer to the following.

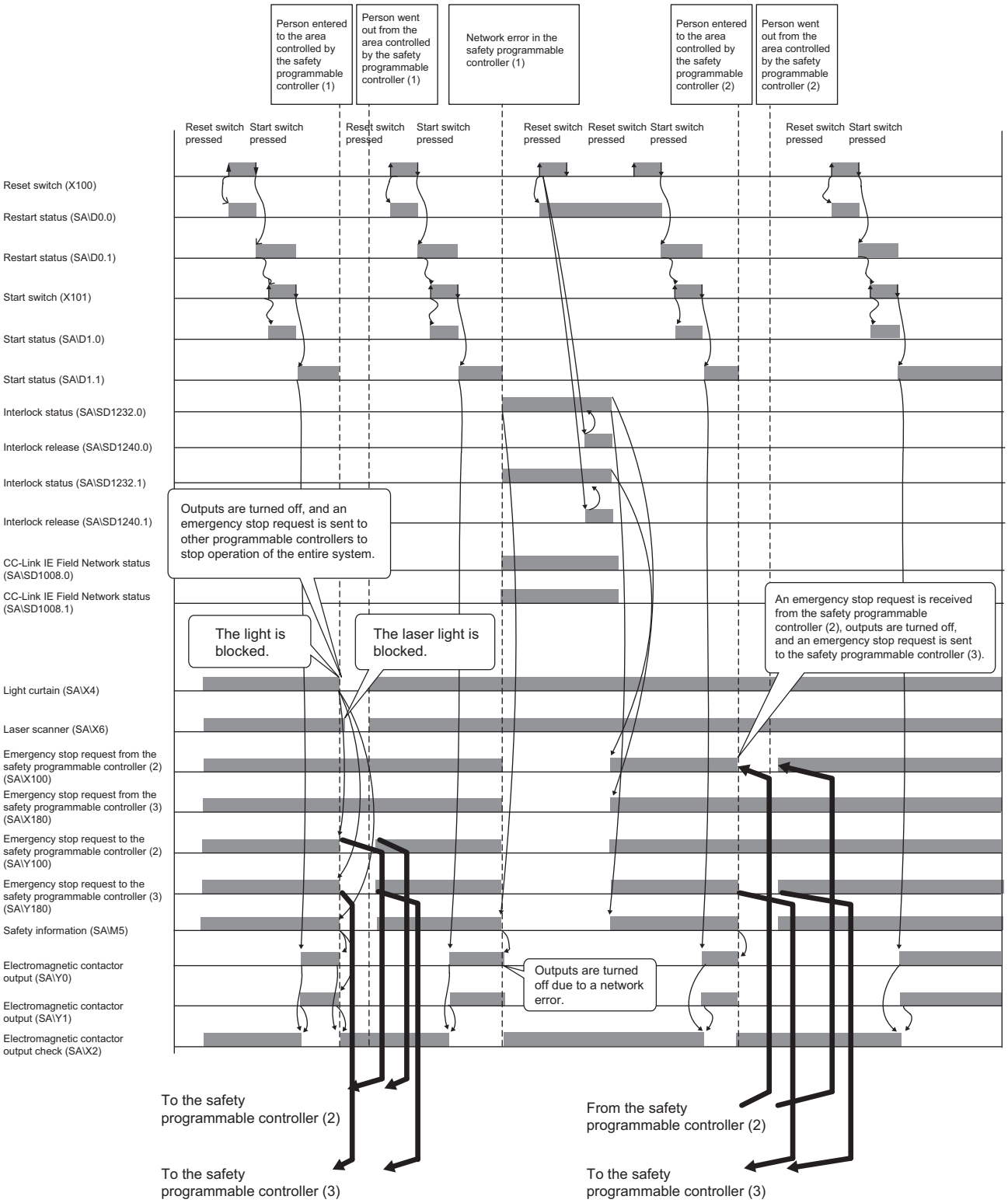
📖 MELSEC iQ-R Programming Manual (Instructions, Standard Functions/Function Blocks)

■Timing chart

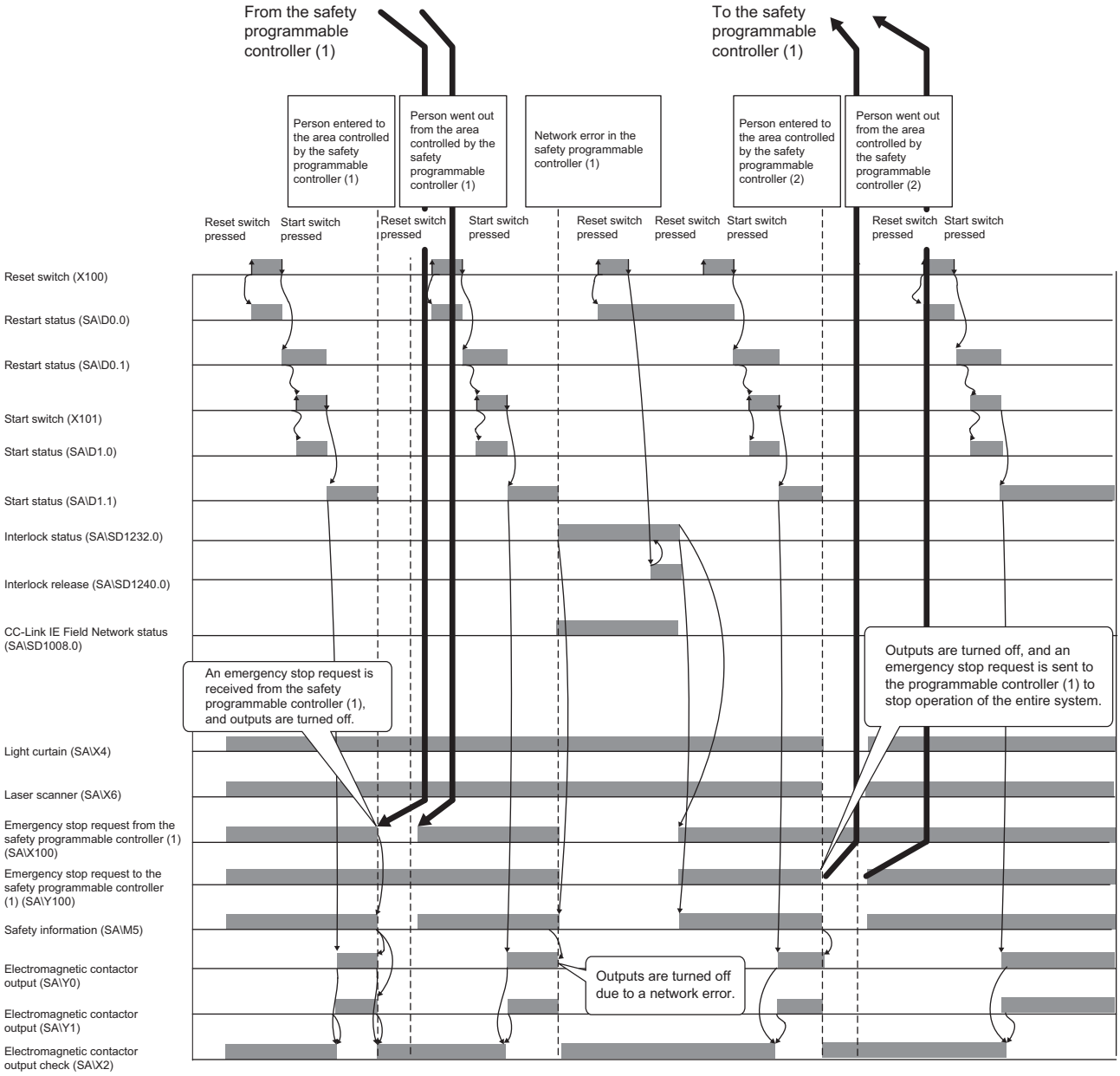
The following shows the entire timing chart when connecting three safety programmable controllers and enlarged timing charts for each safety programmable controller.



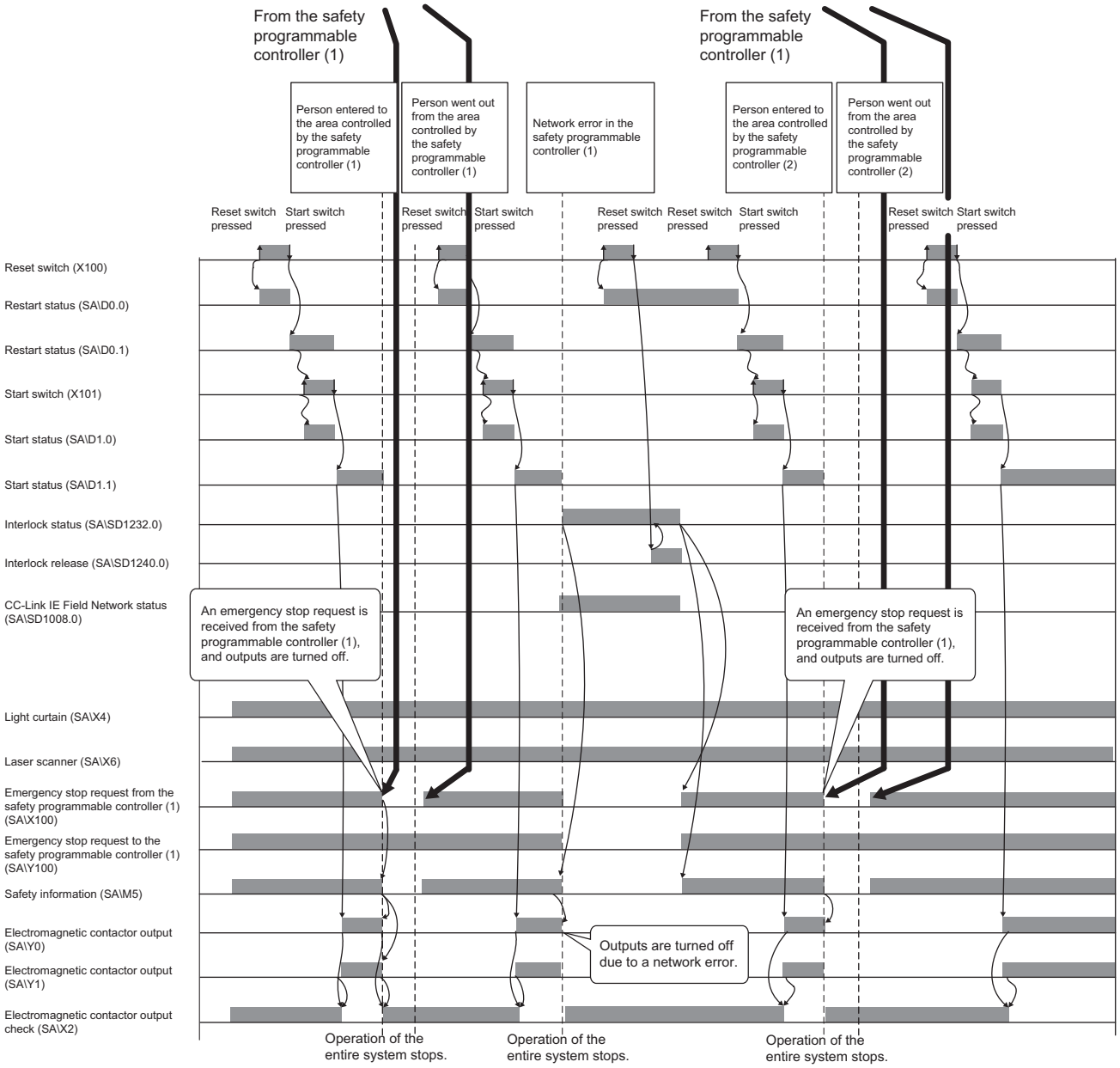
- Timing chart for safety programmable controller (1)



• Timing chart for safety programmable controller (2)



• Timing chart for safety programmable controller (3)

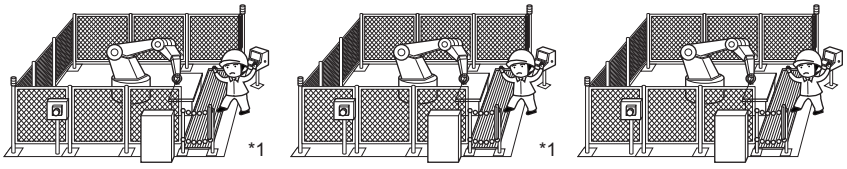


Entering detection and existence detection circuit 2

■Application overview

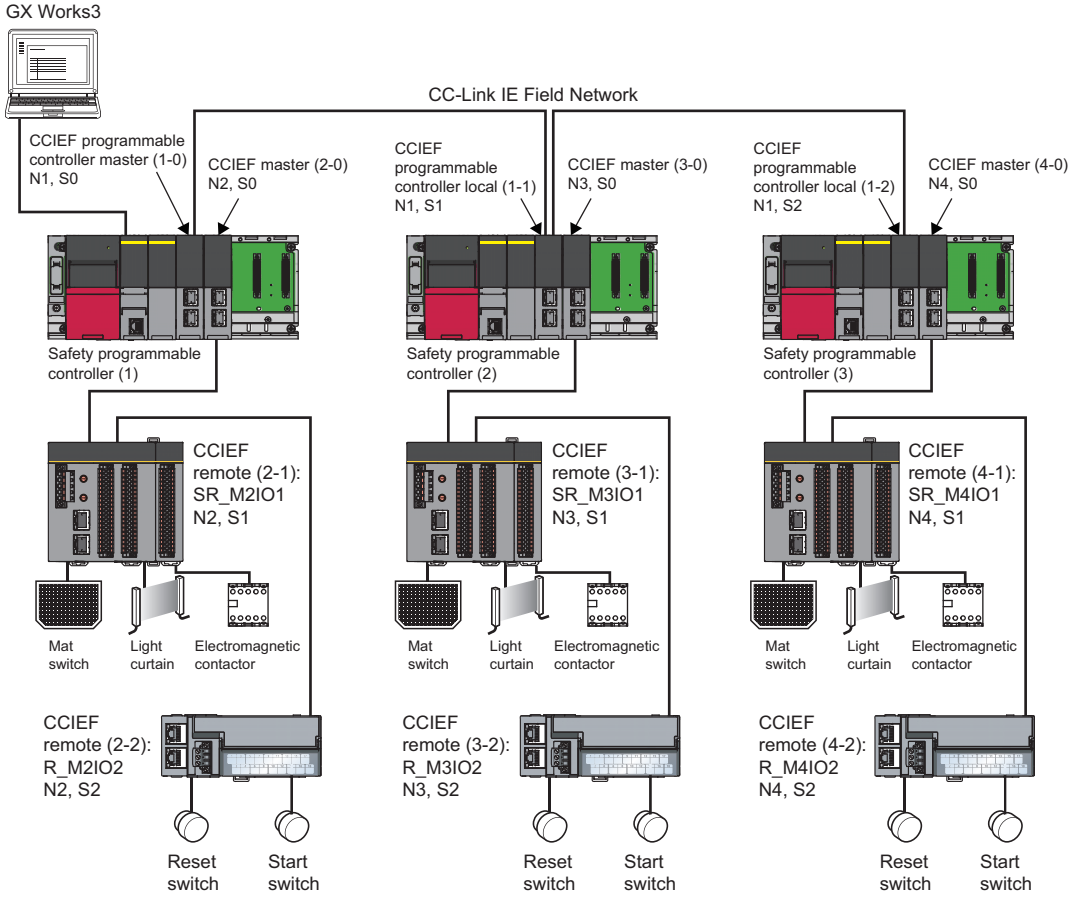
This application uses a safety programmable controller in each process and detect the entrance and existence of a person in a hazardous area by light curtain and mat switch installed to each process, and turns off the power source of a robot.
The entrance of person to the hazardous area is detected with a light curtain. The existence of person in the hazardous area is detected with a mat switch. When the entrance or existence of person has been detected, a robot is stopped.
The robot cannot be started until the person leaves the hazardous area.
This controls the start and stop of a robot by turning on or off the main contact of the contractor which opens and closes the power source of a robot.
Connect the light curtain and electromagnetic contactors to a safety programmable controller.
Connect the relay between the mat switch and safety programmable controller.
Connect Safety CPUs installed to each process with CC-Link IE Field Network.
The Safety CPU turns on/off of the electromagnetic contactors with program.
When the safety programmable controller detects an error by self-diagnostics, outputs to the electromagnetic contactors turn off independent of the program.
In this case, the outputs remain off until the safety CPU module of CC-Link Safety remote I/O module is reset independent of the program.
Configure the program so that the following functions can be achieved.

1. Check that safety is ensured (both of the light curtain and mat switch are turned on) and when the entrance and existence of a person in a hazardous area is not detected by another Safety CPU on CC-Link IE Field Network, the operator shall press the reset switch first. Pressing the start switch turns on the electromagnetic contactors.
2. When an electromagnetic contactor connected to the safety programmable controller is welded, input the electromagnetic contactor (normally closed contact) to the safety programmable controller to prevent starting, and check for welding.
3. To avoid undesired operation of the reset switch and start switch at the welding or short-circuit, set the reset switch and start switch so that they are activated only when turned on and off.
4. Turn off the outputs of electromagnetic contactor, when light curtain signal or mat switch relay input is turned off after starts, when the entrance and existence in a hazardous area is detected by another Safety CPU on CC-Link IE Field Network, or when an error is detected on safety remote I/O module is detected.
5. To stop the entire system, transfer the emergency stop request to other safety programmable controller.



*1 There is no guard between the processes. There is no barrier between the processes.
(Partially quoted from "Safety Guide Book - the safety measures of machinery in the workplace": Nippon Electric Control Equipment Industries Association)

■Connection of safety devices

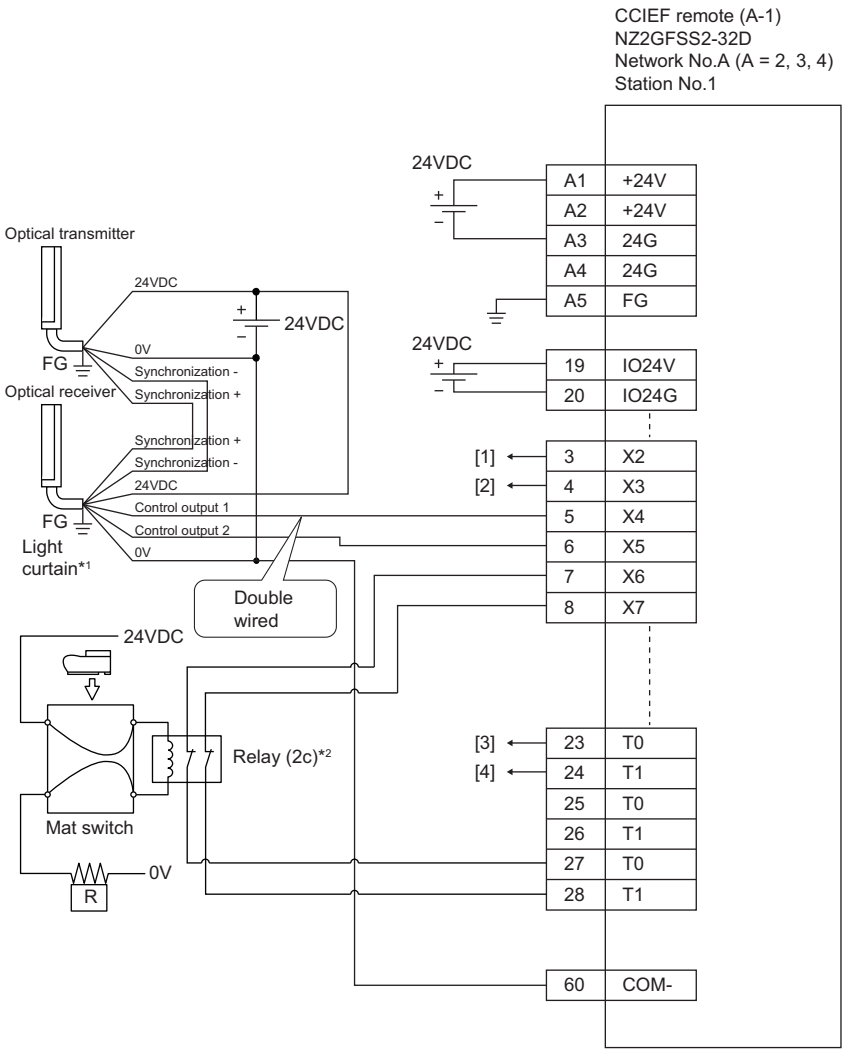


In the figure above, "N" means network number, while "S" means station number. For example, "N1" means network number 1, while "S0" means station number 0.

■Wiring diagram and parameter settings

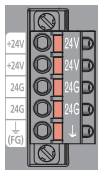
Wire the light curtain, mat switch, and electromagnetic contactor to safety remote I/O module of safety programmable controllers (1) to (3) as follows. For details on terminal block details, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

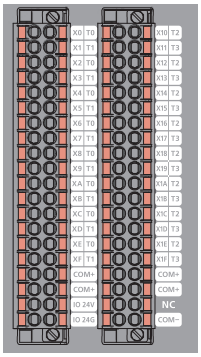


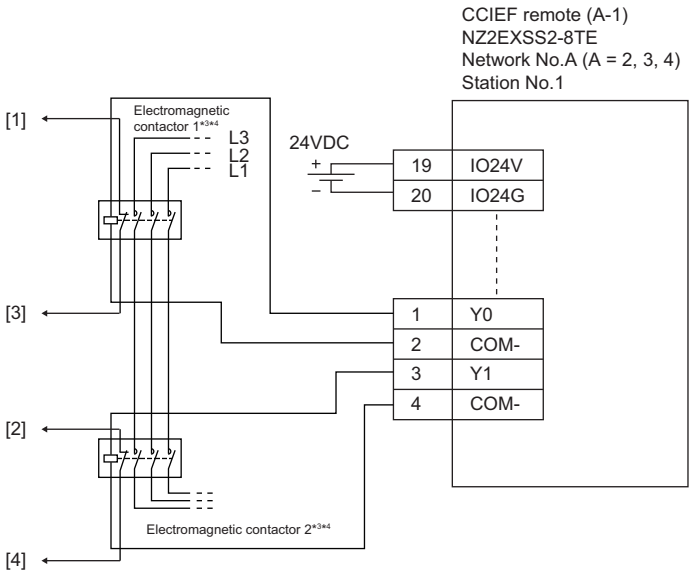
Terminal block for power supply and FG (input)

A1	+24V
A2	+24V
A3	24G
A4	24G
A5	FG

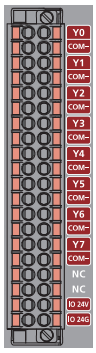


Spring clamp terminal block (input)





Spring clamp terminal block (output)



Network number 2, 3, and 4 are placed to A.

Above [1] to [4] are connected to the one with same numbers.

*1 Connect two points (PNP output) of the Type 4 light curtain control output to between input and COM.
*2 Connect four-wire mat to the relay, and two relay contacts between the input terminal and test pulse terminal. Connect input terminal to NO side.
*3 Use two electromagnetic contactors operatable by 24VDC and 0.5A.
*4 Connect normally closed contact of the safety relay between the input terminal and test pulse terminal.

For light curtains, mat switches, and electromagnetic contactors, set the parameters as follows.

Item	Setting details*3		
	SR_M2IO1	SR_M3IO1	SR_M4IO1
Sending Interval Monitoring Time	24ms	24ms	24ms
Wiring selection of input X2	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4
Wiring selection of input X3	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4
Wiring selection of input X4	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4
Wiring selection of input X5	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4
Wiring selection of input X6	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4
Wiring selection of input X7	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4	Double wiring (NC/NC)*4
Wiring selection of input X0, X1, and X8 to X1F	Not used	Not used	Not used
Input response time X2*1	1ms	1ms	1ms
Input response time X3*1	1ms	1ms	1ms
Input response time X4*1	1ms	1ms	1ms
Input response time X5*1	1ms	1ms	1ms
Input response time X6*1	1ms	1ms	1ms
Input response time X7*1	1ms	1ms	1ms
Input response time X8*1	1ms	1ms	1ms
Input response time X9*1	1ms	1ms	1ms
Input response time X0, X1, and XA to X1F*1	1ms	1ms	1ms
Double input discrepancy detection setting X2_X3	Detect*4	Detect*4	Detect*4
Double input discrepancy detection setting X4_X5	Detect*4	Detect*4	Detect*4
Double input discrepancy detection setting X6_X7	Detect*4	Detect*4	Detect*4
Double input discrepancy detection setting X0, X1, and X8 to X1F	Do not detect*4	Do not detect*4	Do not detect*4
Double input discrepancy detection type X2_X3	Discrepancy detection time specified*4	Discrepancy detection time specified*4	Discrepancy detection time specified*4
Double input discrepancy detection type X4_X5	Discrepancy detection time specified*4	Discrepancy detection time specified*4	Discrepancy detection time specified*4
Double input discrepancy detection type X6_X7	Discrepancy detection time specified*4	Discrepancy detection time specified*4	Discrepancy detection time specified*4
Double input discrepancy detection type X0, X1, and X8 to X1F	Discrepancy detection time not specified*4	Discrepancy detection time not specified*4	Discrepancy detection time not specified*4
Auto recovery function at occurrence of a double input discrepancy error	Not used	Not used	Not used
Double input discrepancy detection time X2_X3*2	10 (100ms)	10 (100ms)	10 (100ms)
Double input discrepancy detection time X4_X5*2	2 (20ms)	2 (20ms)	2 (20ms)
Double input discrepancy detection time X6_X7*2	2 (20ms)	2 (20ms)	2 (20ms)
Double input discrepancy detection time X0, X1, and X8 to X1F*2	1 (10ms)	1 (10ms)	1 (10ms)
Input dark test execution setting X2	Perform*4	Perform*4	Perform*4
Input dark test execution setting X3	Perform*4	Perform*4	Perform*4
Input dark test execution setting X4	Perform*4	Perform*4	Perform*4
Input dark test execution setting X5	Perform*4	Perform*4	Perform*4
Input dark test execution setting X6	Perform*4	Perform*4	Perform*4
Input dark test execution setting X7	Perform*4	Perform*4	Perform*4
Input dark test execution setting X0, X1, and X8 to X1F	Do not perform*4	Do not perform*4	Do not perform*4
Input dark test pulse OFF time*1	400μs	400μs	400μs
Number of pulse output for input dark test	1 time	1 time	1 time
Ext. module 1_Wiring selection of output Y0	Double wiring (source/source)*4	Double wiring (source/source)*4	Double wiring (source/source)*4

Item	Setting details[*3]		
	SR_M2IO1	SR_M3IO1	SR_M4IO1
Ext. module 1_Wiring selection of output Y1	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]
Ext. module 1_Wiring selection of output Y2 to Y7	Not used[*4]	Not used[*4]	Not used[*4]
Ext. module 1_Wiring selection of output Y0	Perform[*4]	Perform[*4]	Perform[*4]
Ext. module 1_Wiring selection of output Y1	Perform[*4]	Perform[*4]	Perform[*4]
Ext. module 1_Wiring selection of output Y2 to Y7	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Ext. module 1_Output dark test pulse OFF time Y0[*1]	1ms	1ms	1ms
Ext. module 1_Output dark test pulse OFF time Y1[*1]	1ms	1ms	1ms
Ext. module 1_Output dark test pulse OFF time Y2 to Y7[*1]	1ms	1ms	1ms
Ext. module 1_Number of pulse output for output dark test	1 time	1 time	1 time

*1 Adjust the values of input response time, input dark test pulse OFF time, and output dark test pulse OFF time according to the installation environment and wiring length.

*2 Set double input discrepancy detection time to 100ms for mechanical switches and 20ms for sensor inputs as standard.

*3 For details on setting range, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

*4 Always set the parameters like this for this case example.

■Safety devices and safety labels to be used

Program safety program using safety devices and standard/safety shared labels shown below.

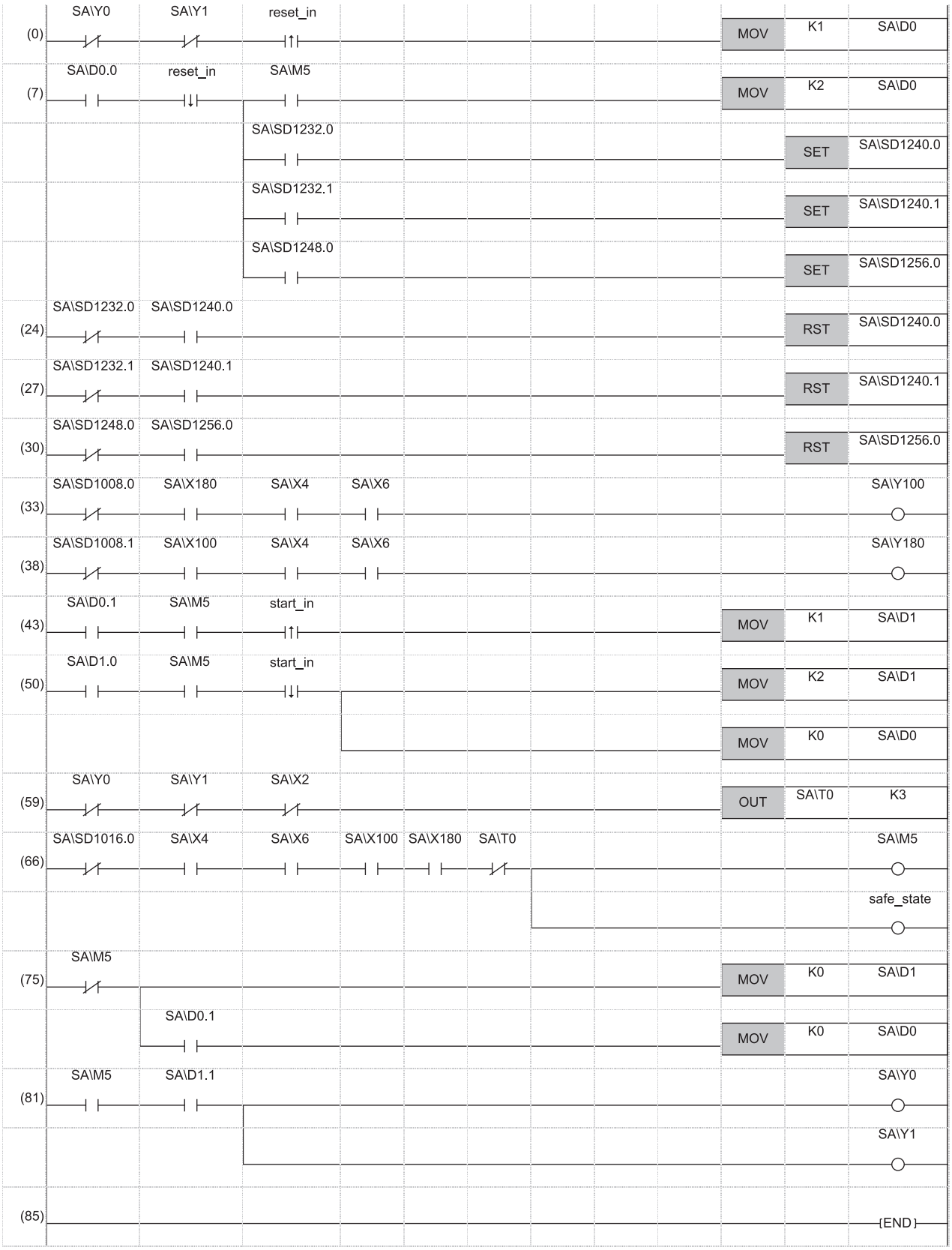
Safety programmable controller	Module	External device	Safety device/safety label
Safety programmable controller (1)	SR_M2IO1	Light curtain	SA\X4 or SA\X5
		Mat switch	SA\X6 or SA\X7
		Contactor 1, 2	SA\Y0 and SA\Y1
		Contactor (check for welding)	SA\X2 or SA\X3
	R_M2IO2	Reset switch	reset_in
		Start switch	start_in
	CCIEF programmable controller master (1-0)	Emergency stop request from safety programmable controller (2)	SA\X100
		Emergency stop request from safety programmable controller (3)	SA\X180
		Emergency stop request to safety programmable controller (2)	SA\Y100
		Emergency stop request to safety programmable controller (3)	SA\Y180
Safety programmable controller (2)	SR_M3IO1	Light curtain	SA\X4 or SA\X5
		Mat switch	SA\X6 or SA\X7
		Contactor 1, 2	SA\Y0 and SA\Y1
		Contactor (check for welding)	SA\X2 or SA\X3
	R_M3IO2	Reset switch	reset_in
		Start switch	start_in
	CCIEF programmable controller local (1-1)	Emergency stop request from safety programmable controller (1)	SA\X100
		Emergency stop request to safety programmable controller (1)	SA\Y100
Safety programmable controller (3)	SR_M4IO1	Light curtain	SA\X4 or SA\X5
		Mat switch	SA\X6 or SA\X7
		Contactor 1, 2	SA\Y0 and SA\Y1
		Contactor (check for welding)	SA\X2 or SA\X3
	R_M4IO2	Reset switch	reset_in
		Start switch	start_in
	CCIEF programmable controller local (1-2)	Emergency stop request from safety programmable controller (1)	SA\X100
		Emergency stop request to safety programmable controller (1)	SA\Y100

■Program example

This is a safety program. For precautions for creating safety program and setting method, refer to Page 34 Precautions for Programming and Page 107 Parameter setting of the Safety CPU. The program performs the following processing.

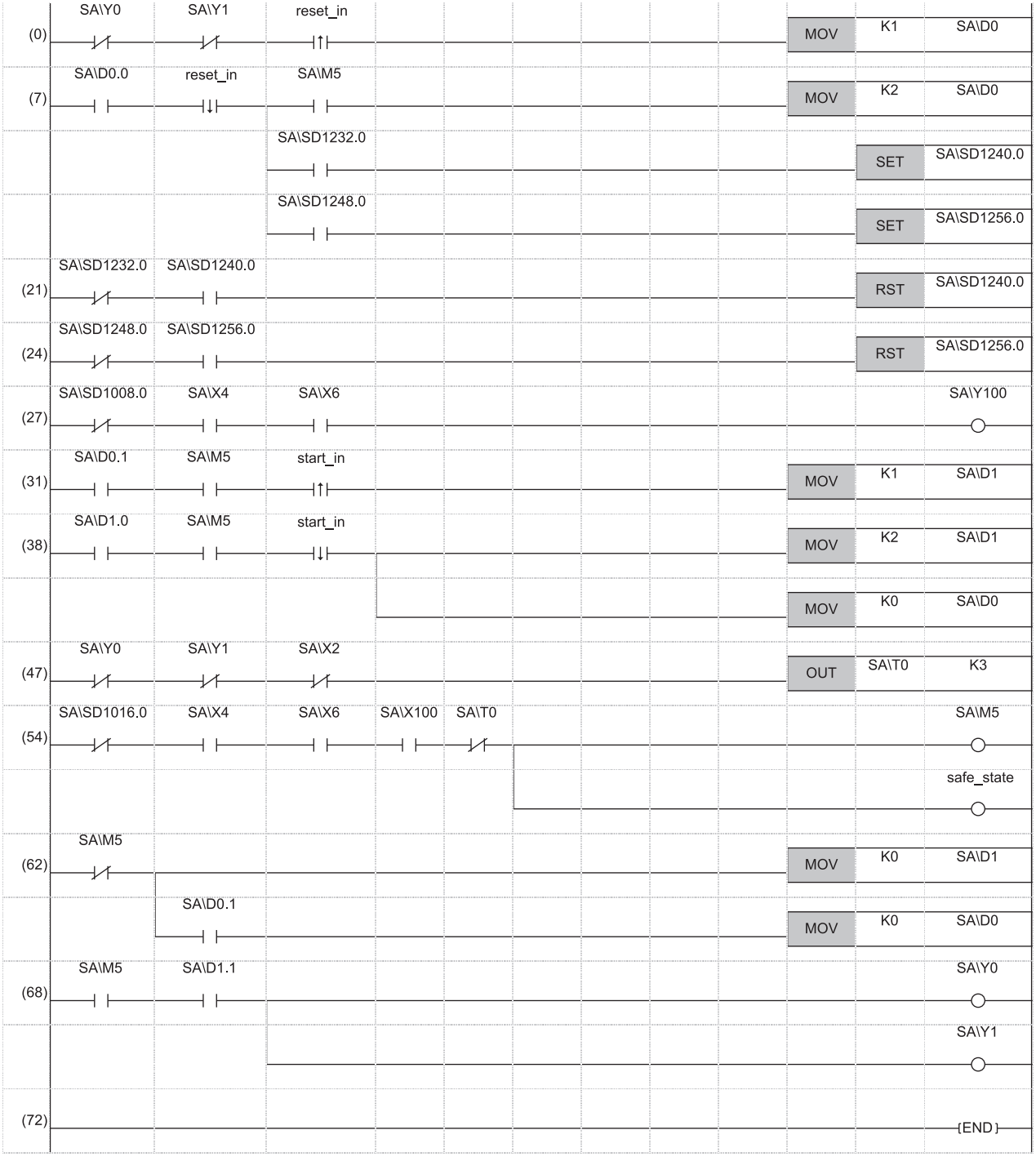
The following shows programs to be used for safety programmable controllers (1) to (3).

• Safety programmable controller (1)



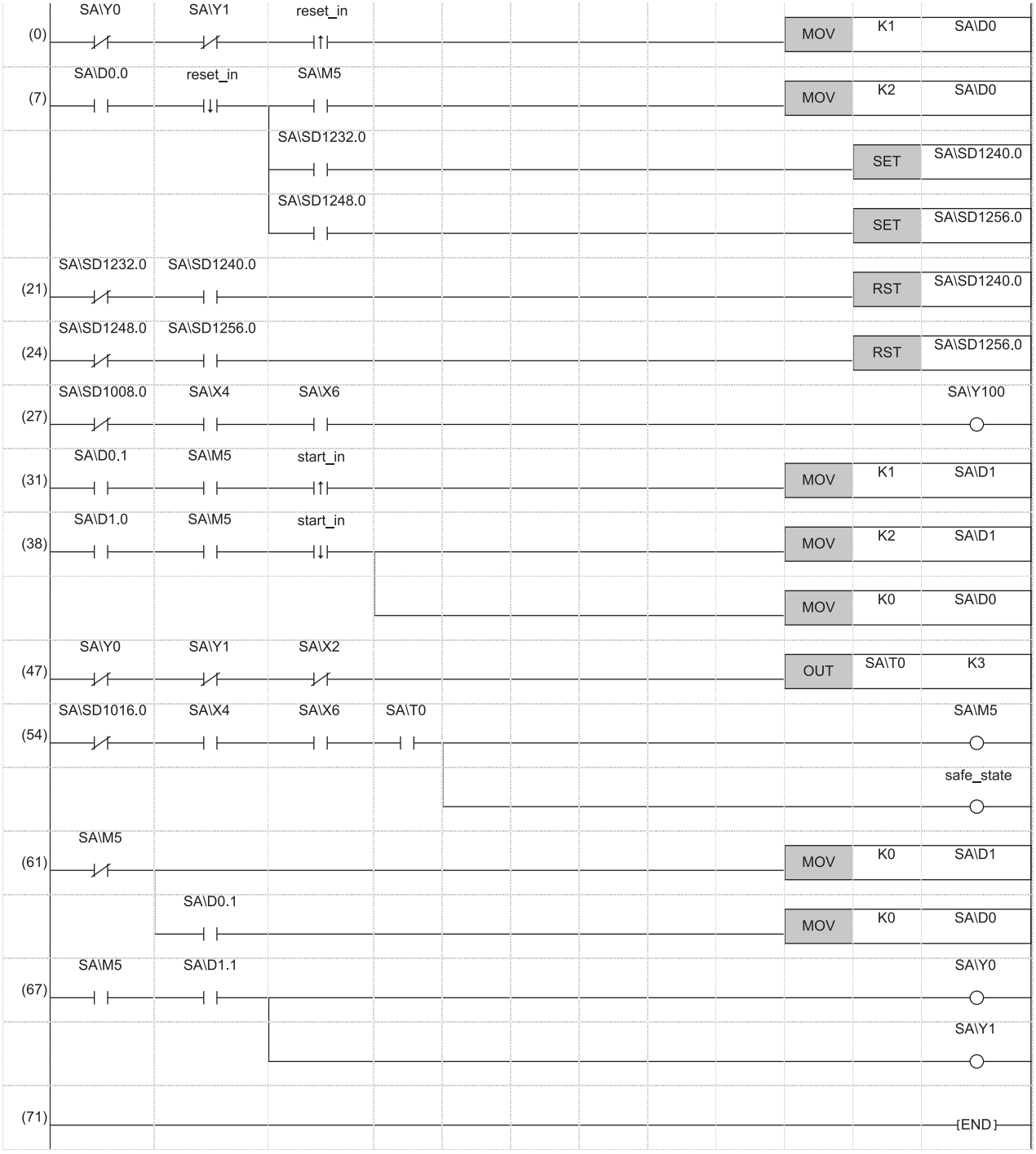
(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(24) to (30)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(33) to (38)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controllers (2) and (3).
(43) to (50)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(59)	This is a circuit to check welding of the electromagnetic contactor.
(66)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(75)	This is a circuit to cancel start/reset request, when not possible to check safety.
(81)	This is a circuit to control outputs to the electromagnetic contactor.

• Safety programmable controller (2)



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(21) to (24)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(27)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controller (1).
(31) to (38)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(47)	This is a circuit to check welding of the electromagnetic contactor.
(54)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(62)	This is a circuit to cancel start/reset request, when not possible to check safety.
(68)	This is a circuit to control outputs to the electromagnetic contactor.

• Safety programmable controller (3)



(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(21) to (24)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(27)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controller (1).
(31) to (38)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(47)	This is a circuit to check welding of the electromagnetic contactor.
(54)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(61)	This is a circuit to cancel start/reset request, when not possible to check safety.
(67)	This is a circuit to control outputs to the electromagnetic contactor.

The following shows the constant and safety user devices used in the program.

• Way of using the constant

K☐: indicates decimal number

Ex.

K1→ 1 of decimal number

• Way of using the safety user devices

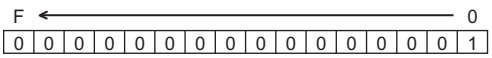
Safety user devices	Description
SA\D0	This is used as restart status. (1) SA\D0 = 0: Initial status or start processing completed (2) SA\D0 = 1: (SA/D0.0: ON): Reset switch pressed (3) SA\D0 = 2 (SA\D0.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\D1	This is used as start status. (1) SA\D1 = 0: Initial status or safety not checked (2) SA\D1 = 1 (SA\D1.0: ON): Reset switch pressed. (3) SA\D1 = 2 (SA\D1.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\T0	This indicates timer device. Times out after a lapse of the time specified at K☐.

• Way of using word device bit specification

SA\D☐.n: This indicates the nth bit of the word device SA\D☐

Ex.

SA\D0.0 = 0 bits in SA\D0

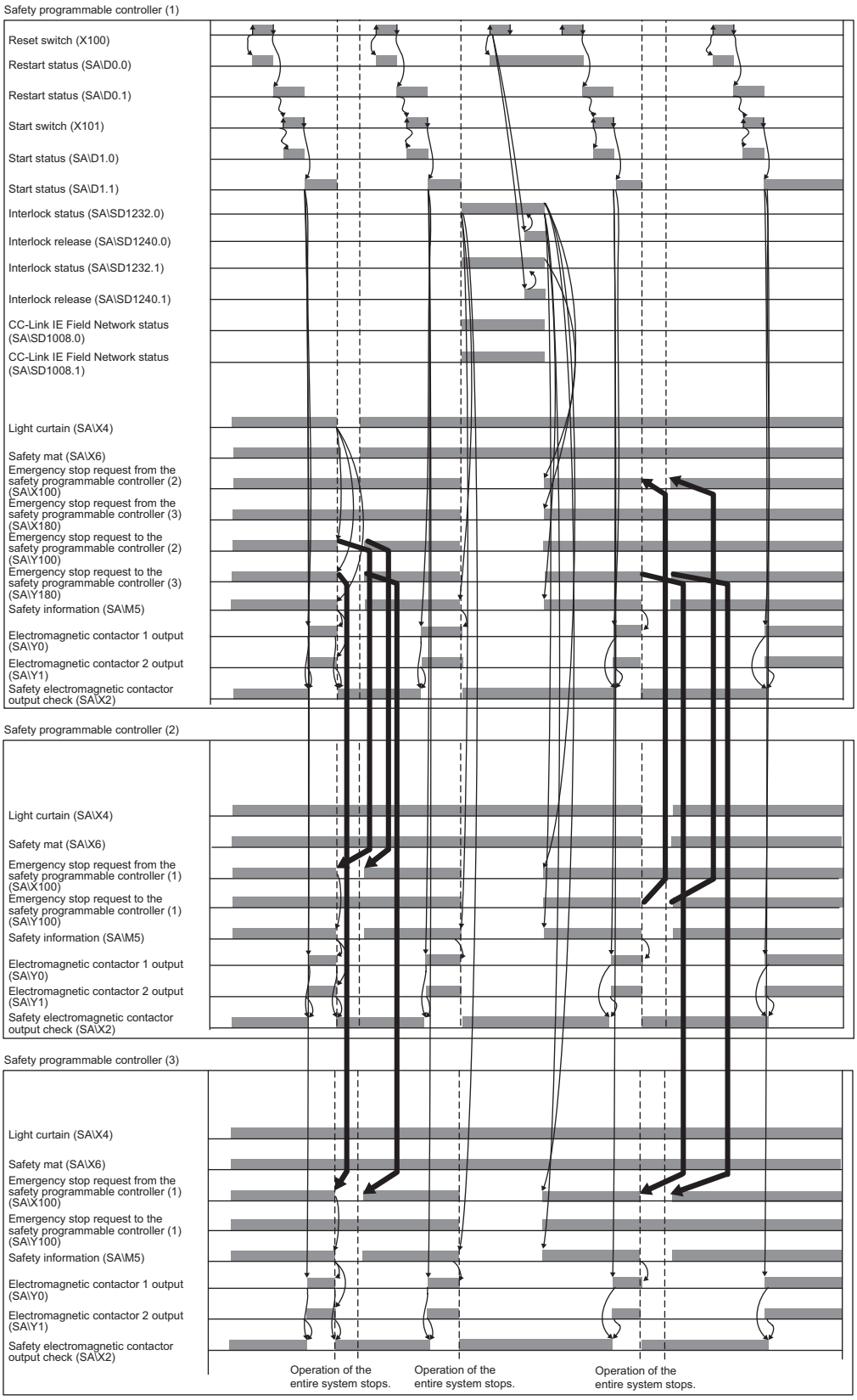


For bit-specified word device, refer to the following.

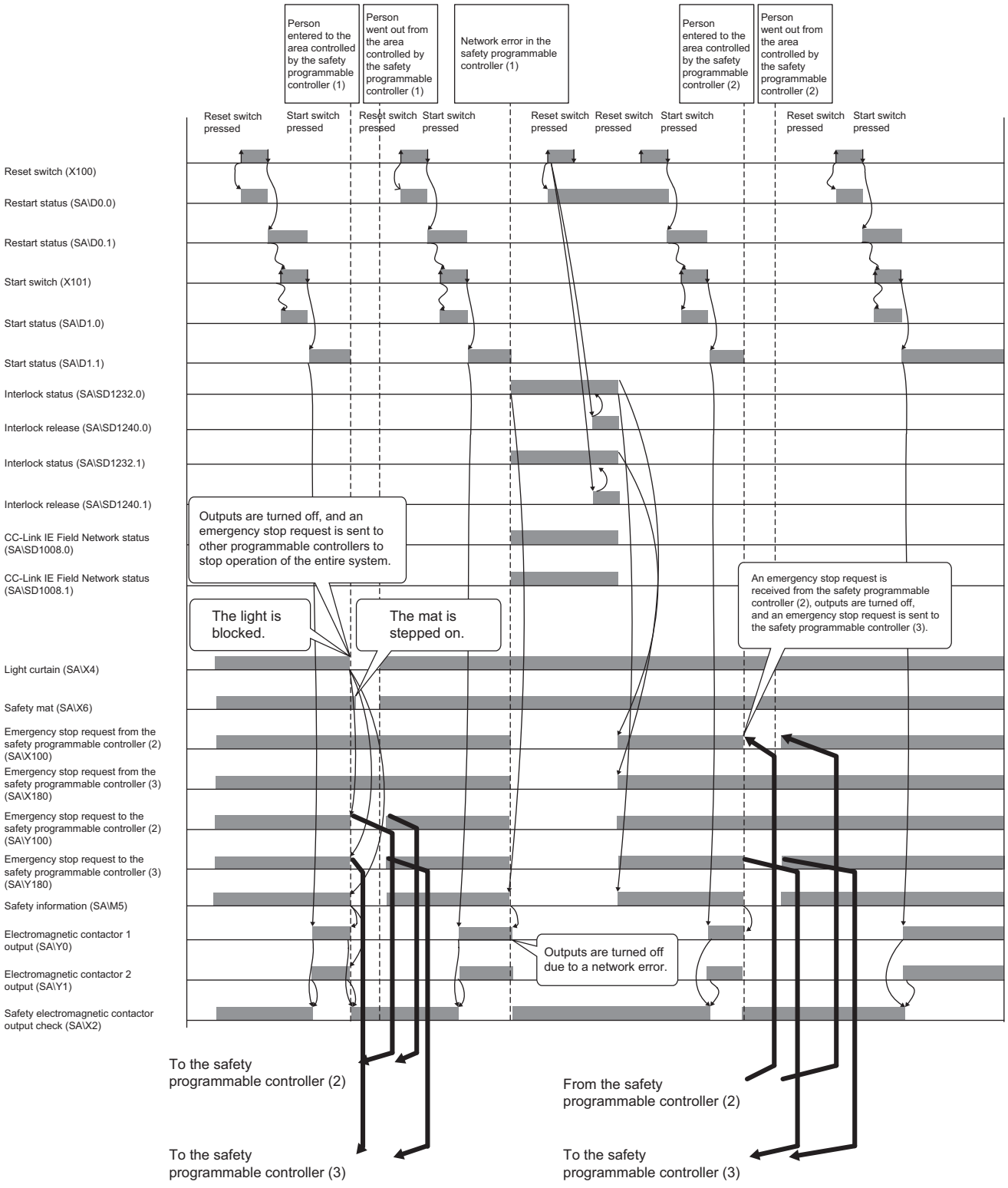
MELSEC iQ-R Programming Manual (Instructions, Standard Functions/Function Blocks)

■Timing chart

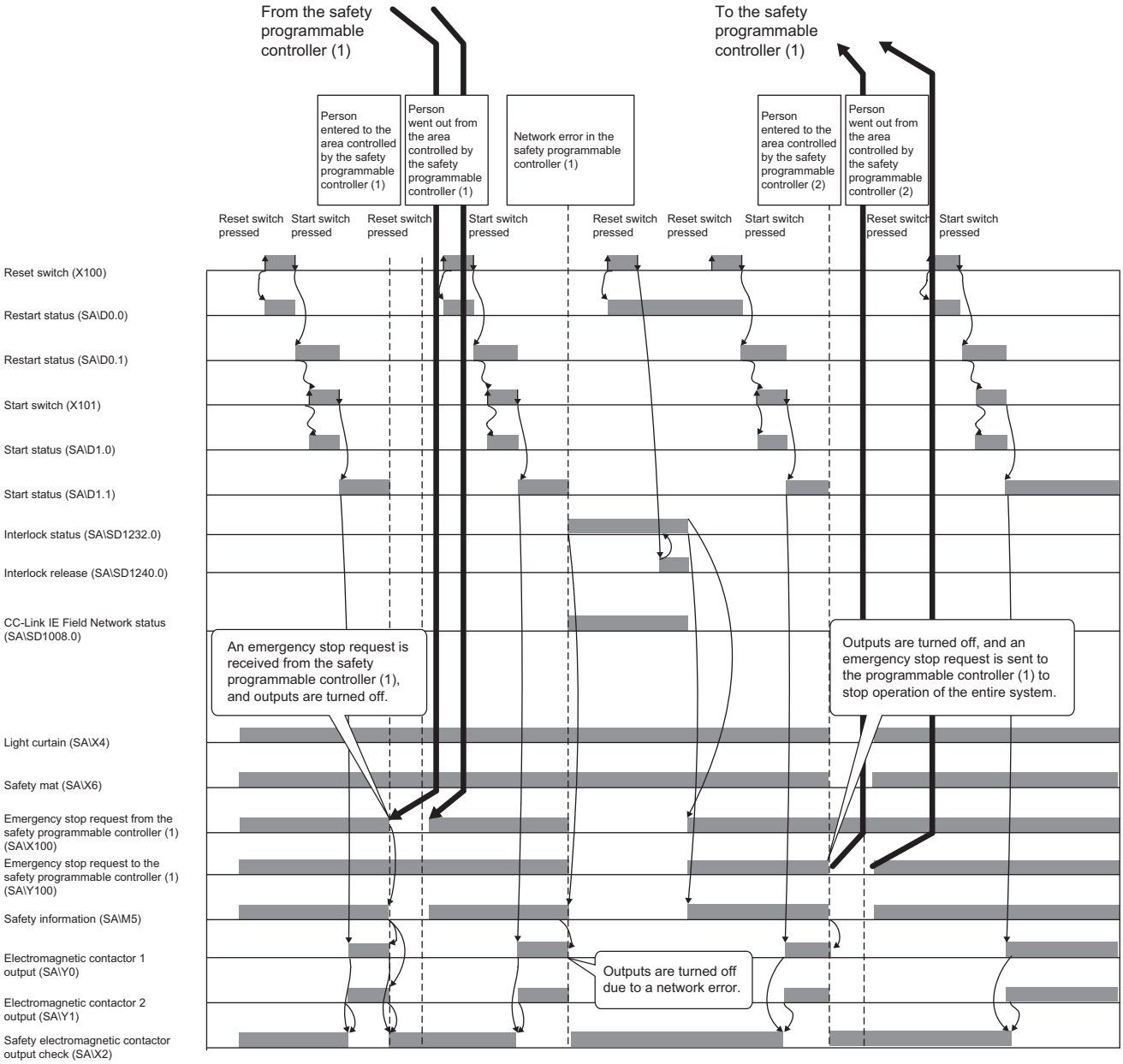
The following shows the entire timing chart when connecting three safety programmable controllers and enlarged timing charts for each safety programmable controller.



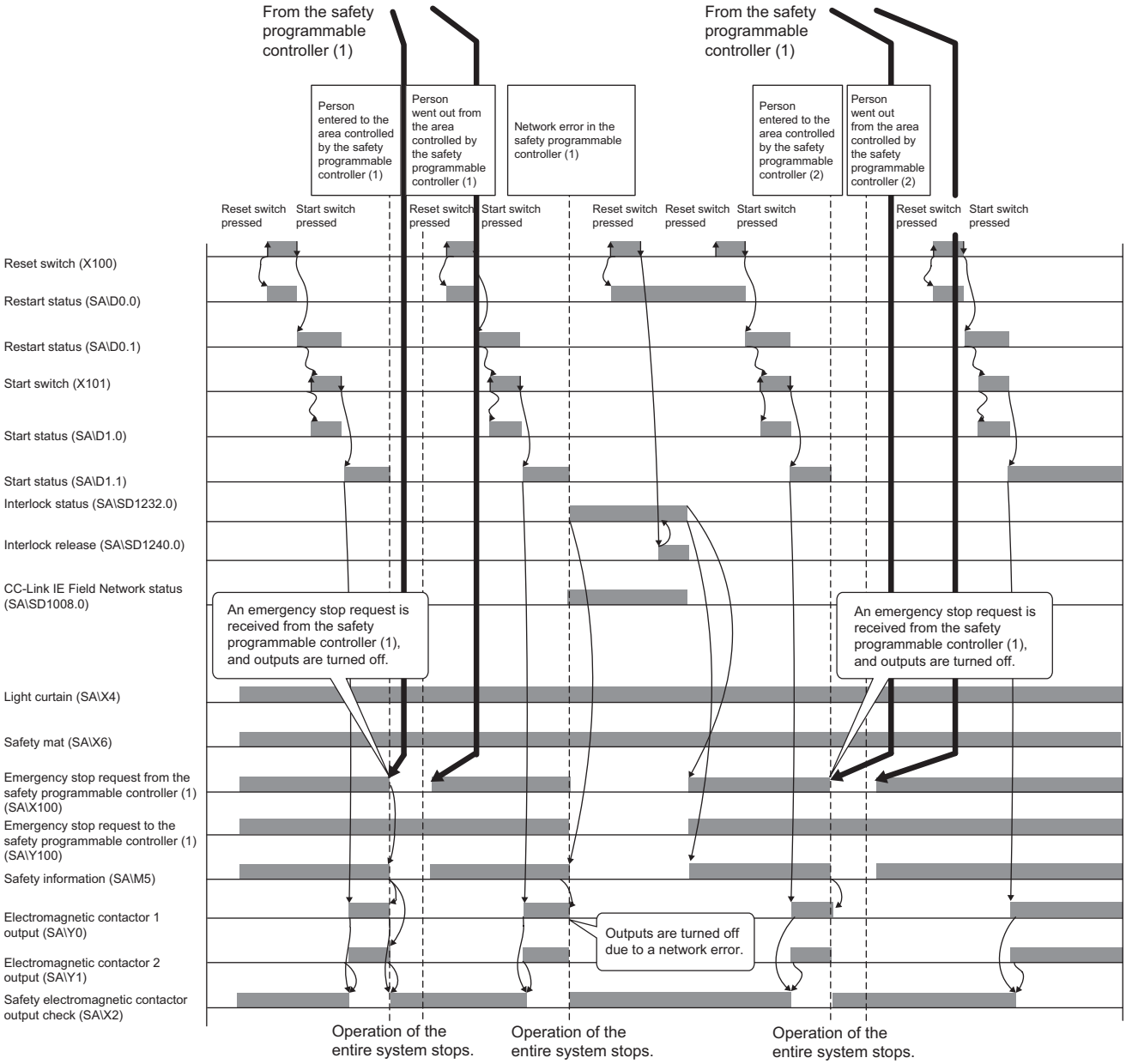
• Timing chart for safety programmable controller (1)



• Timing chart for safety programmable controller (2)



• Timing chart for safety programmable controller (3)

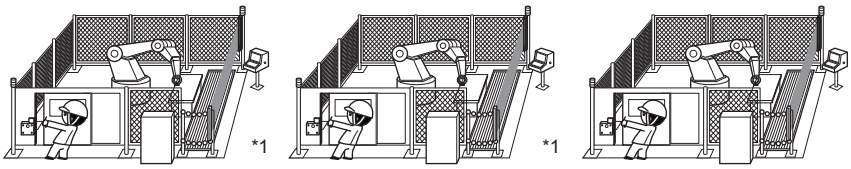


Guide interlock circuit

■Safety application overview

This application uses a safety programmable controller in each process and prevents the guard from being opened until a robot is de-energized with the spring-lock safety switch on the guard of a safety barrier.
The safety switch is usually interlocked with spring. By applying a voltage to a solenoid, the interlock is released and the guard can be opened. The robot cannot be started while the interlock is released or the guard is open.
This section shows an example where the interlock of the safety switch is released by pressing the stop switch and the safety switch is re-interlocked by pressing the reset switch.
This controls the start and stop of a robot by turning on or off the main contact of the contractor which opens and closes the power source of a robot.
Connect the safety switch and electromagnetic contactors to a safety programmable controller.
Connect Safety CPUs installed to each process with CC-Link IE Field Network. The Safety CPU turns on/off of the electromagnetic contactors with program. When the safety programmable controller detects an error by self-diagnostics, outputs to the electromagnetic contactors turn off independent of the program.
In this case, the outputs remain off until the Safety CPU or safety remote I/O module is reset regardless the program, when outputs turns off by the self-diagnostics.
Configure the program so that the following functions can be achieved.

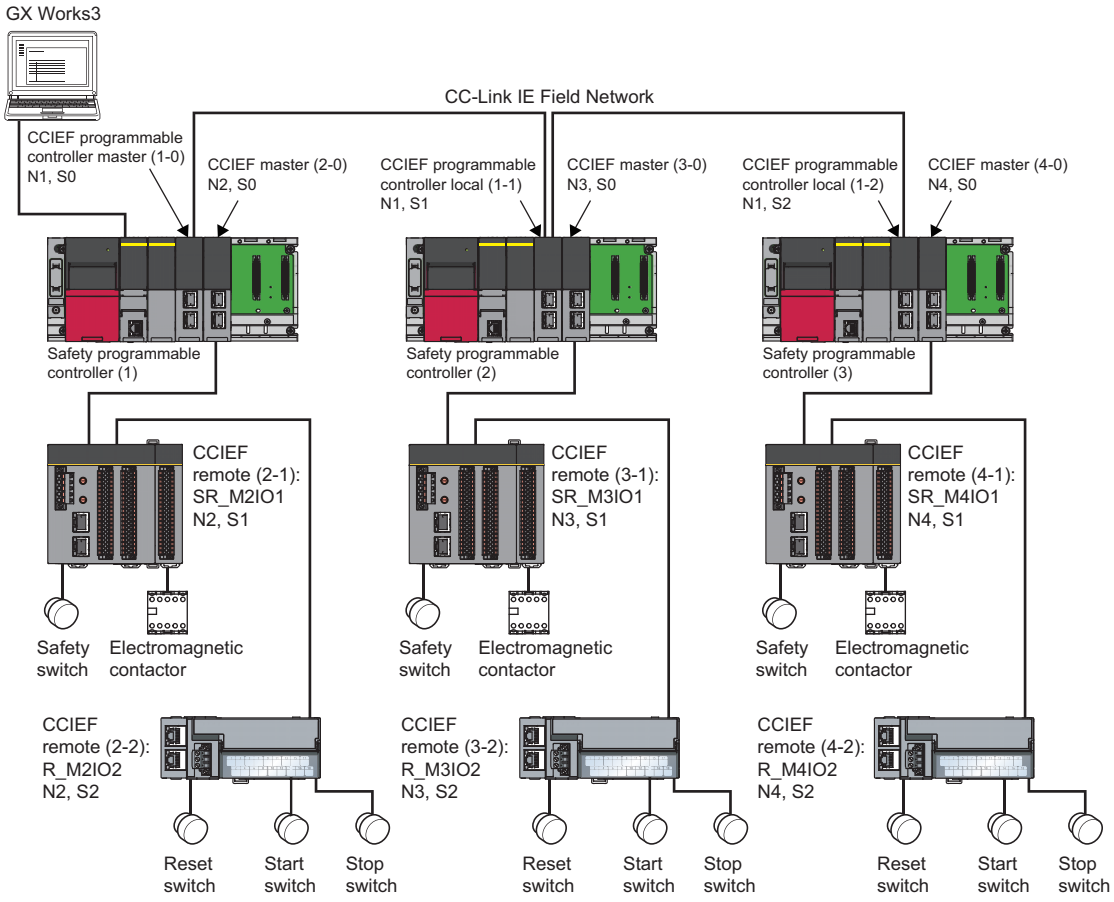
1. Check that safety is ensured (the safety switch is on state) and that safety switch is on state for another Safety CPU on CC-Link IE Field Network. The worker shall press the reset switch first. Pressing the start switch turns on the electromagnetic contactors.
2. When a safety electromagnetic contactor is welded, input the electromagnetic contactor (normally closed contact) to the safety programmable controller to prevent starting, and check for welding.
3. To avoid undesired operation of reset switch and start switch at welding or short-circuit, set reset switch and start switch so that they are activated only when turned on and off.
4. Pressing the stop switch turns off the electromagnetic contactor output. After that, release the interlock to the safety switch (the guard can be opened after the interlock is released).
5. Pressing the reset switch re-interlocks the safety switch.
6. If a safety switch on CC-Link IE Field Network is off state and when an error is detected in the safety remote I/O module after operation, turn off the electromagnetic contactor outputs.
7. To stop the entire system, transfer the emergency stop request to other Safety CPU.



*1 There is no guard between the processes. There is no barrier between the processes.

(Partially quoted from "Safety Guide Book — the safety measures of machinery in the workplace": Nippon Electric Control Equipment Industries Association)

■Connection of safety devices

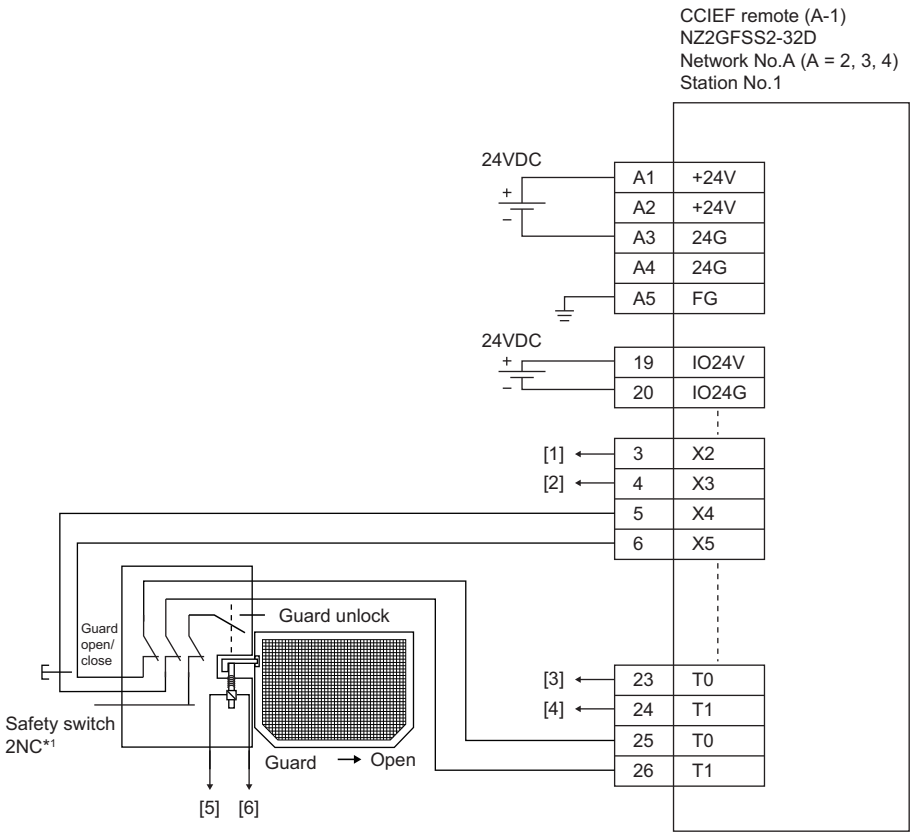


In the figure above, "N" means network number, while "S" means station number. For example, "N1" means network number 1, while "S0" means station number 0.

■Wiring diagram and parameter settings

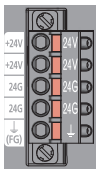
Wire the safety switch and electromagnetic contactor to safety remote I/O module of safety programmable controllers (1) to (3) as follows. For details on terminal block details, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

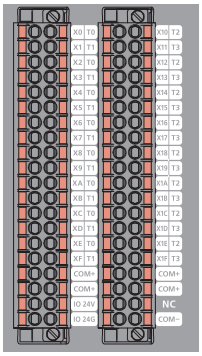


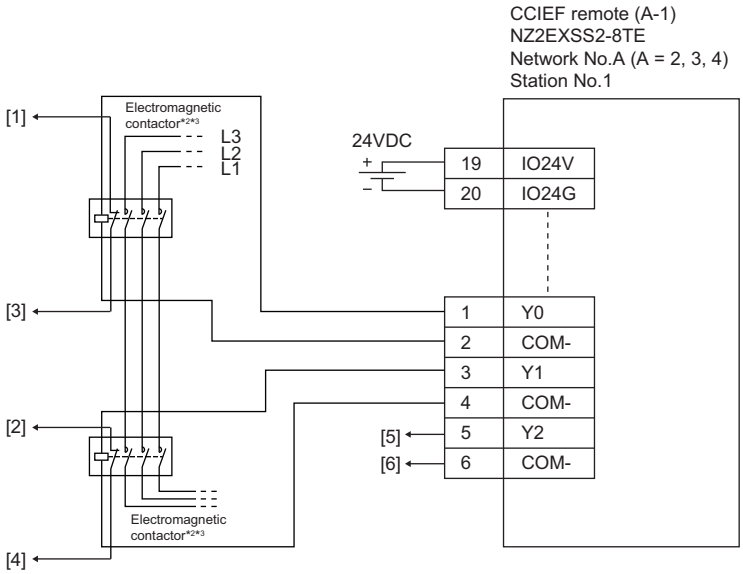
Terminal block for power supply and FG (input)

A1	+24V
A2	+24V
A3	24G
A4	24G
A5	FG

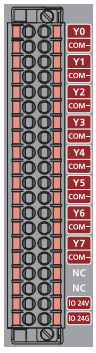


Spring clamp terminal block (input)





Spring clamp terminal block (output)



Network number 2, 3, and 4 are placed to A.

Above [1] to [6] are connected to the one with same numbers.

*1 Wire a safety switch having two normally closed contacts with direct opening action to input terminal and test pulse terminal, using a guard switch with an interlock.

*2 Use two electromagnetic contactors operatable by 24VDC and 0.5A.

*3 Connect normally closed contact of the safety relay between the input terminal and test pulse terminal.

This example shows when the guard open/close signal of the safety switch is input. When using a safety switch whose interlock status can be monitored, input the locking status signal to the safety remote I/O module as well.

For safety switch and electromagnetic contactors, set the parameters as follows.

Item	Setting details[*3]		
	SR_M2IO1	SR_M3IO1	SR_M4IO1
Transmission interval monitoring time	24ms	24ms	24ms
Wiring selection of input X2	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X2	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X2	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X2	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]	Double wiring (NC/NC)[*4]
Wiring selection of input X0, X1, and X6 to X1F	Not used	Not used	Not used
Input response time X2[*1]	1ms	1ms	1ms
Input response time X3[*1]	1ms	1ms	1ms
Input response time X4[*1]	1ms	1ms	1ms
Input response time X5[*1]	1ms	1ms	1ms
Input response time X6[*1]	1ms	1ms	1ms
Input response time X7[*1]	1ms	1ms	1ms
Input response time X8[*1]	1ms	1ms	1ms
Input response time X0, X1, and X9 to X1F[*1]	1ms	1ms	1ms
Double input discrepancy detection setting X2_X3	Detect[*4]	Detect[*4]	Detect[*4]
Double input discrepancy detection setting X4_X5	Detect[*4]	Detect[*4]	Detect[*4]
Double input discrepancy detection setting X0, X1, and X9 to X1F	Do not detect[*4]	Do not detect[*4]	Do not detect[*4]
Double input discrepancy detection type X2_X3	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]
Double input discrepancy detection type X4_X5	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]	Discrepancy detection time specified[*4]
Double input discrepancy detection type X0, X1, and X9 to X1F	Discrepancy detection time not specified[*4]	Discrepancy detection time not specified[*4]	Discrepancy detection time not specified[*4]
Double input discrepancy auto recovery setting	Not used	Not used	Not used
Double input discrepancy detection time X6_X7[*2]	10 (100ms)	10 (100ms)	10 (100ms)
Double input discrepancy detection time X4_X5[*2]	50 (500ms)	50 (500ms)	50 (500ms)
Double input discrepancy detection time X0, X1, and X9 to X1F[*2]	1 (10ms)	1 (10ms)	1 (10ms)
Input dark test execution setting X2	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X3	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X4	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X5	Perform[*4]	Perform[*4]	Perform[*4]
Input dark test execution setting X0, X1, and X9 to X1F	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Input dark test pulse off time[*1]	400μs	400μs	400μs
Number of pulse output for input dark test	1 time	1 time	1 time
Extension 1_Wiring selection of output Y0	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]
Extension 1_Wiring selection of output Y1	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]	Double wiring (source/source)[*4]
Extension 1_Wiring selection of output Y2	Single wiring[*4]	Single wiring[*4]	Single wiring[*4]
Ext. module 1_Wiring selection of output Y3 to Y7	Not used[*4]	Not used[*4]	Not used[*4]
Ext. module 1_Wiring selection of output Y0	Perform[*4]	Perform[*4]	Perform[*4]
Extension 1_Output dark test execution setting Y1	Perform[*4]	Perform[*4]	Perform[*4]
Extension 1_Output dark test execution setting Y2	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Extension 1_Output dark test execution setting Y3 to Y7	Do not perform[*4]	Do not perform[*4]	Do not perform[*4]
Extension 1_Output dark test pulse off time Y0[*1]	1ms	1ms	1ms
Extension 1_Output dark test pulse off time Y1[*1]	1ms	1ms	1ms
Extension 1_Output dark test pulse off time Y2[*1]	1ms	1ms	1ms
Extension 1_Output dark test pulse off time Y3 to Y7[*1]	1ms	1ms	1ms

Item	Setting details*3		
	SR_M2IO1	SR_M3IO1	SR_M4IO1
Extension 1_Number of pulse output for output dark test	1 time	1 time	1 time

*1 Adjust the values of input response time, input dark test pulse off time, and output dark test pulse off time according to the installation environment and wiring length.
*2 Set double input discrepancy detection time to 100ms for mechanical switches and 20ms for sensor inputs as standard.
*3 For details on setting range, refer to the following.
CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual
*4 Always set the parameters like this for this case example.

■Safety devices and safety labels to be used

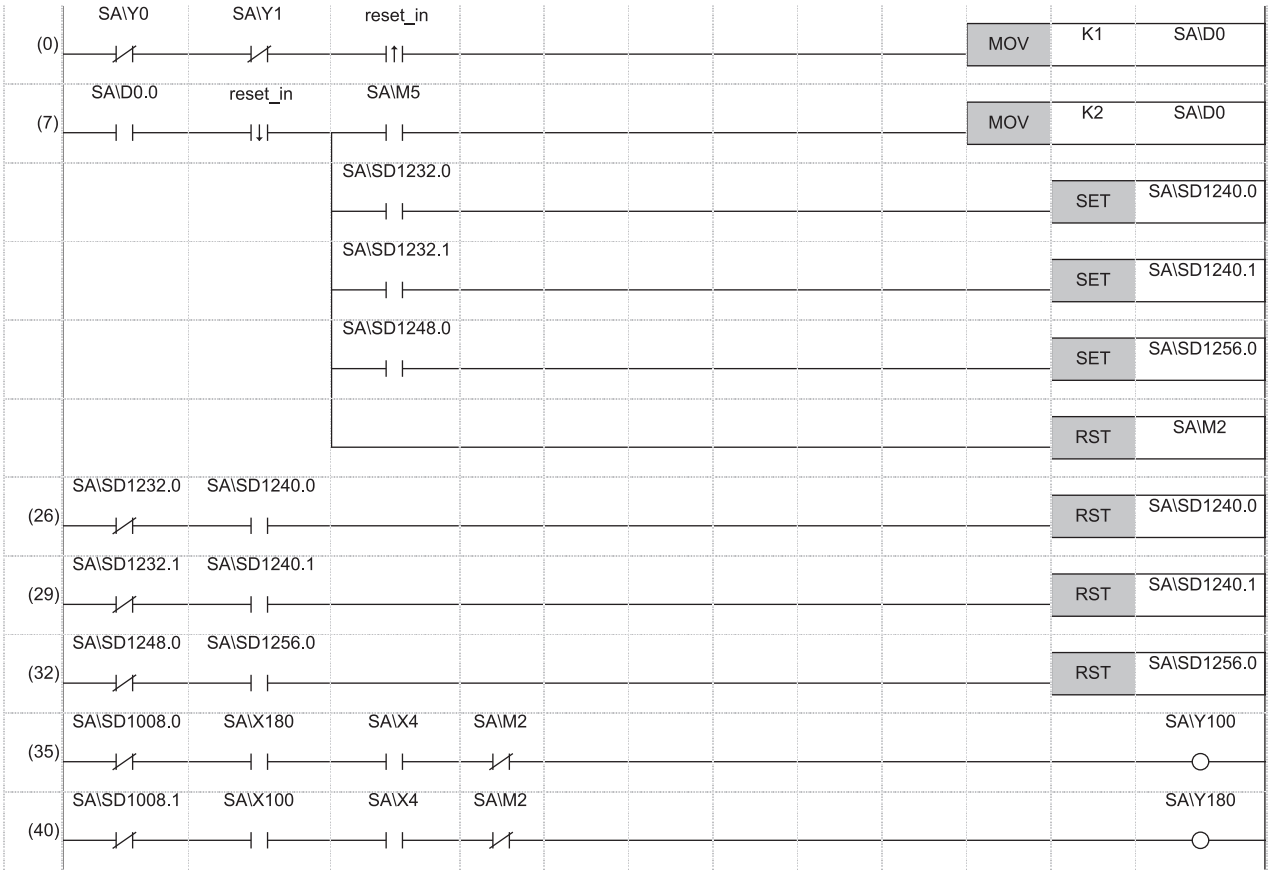
Program safety program using safety devices and standard/safety shared labels shown below.

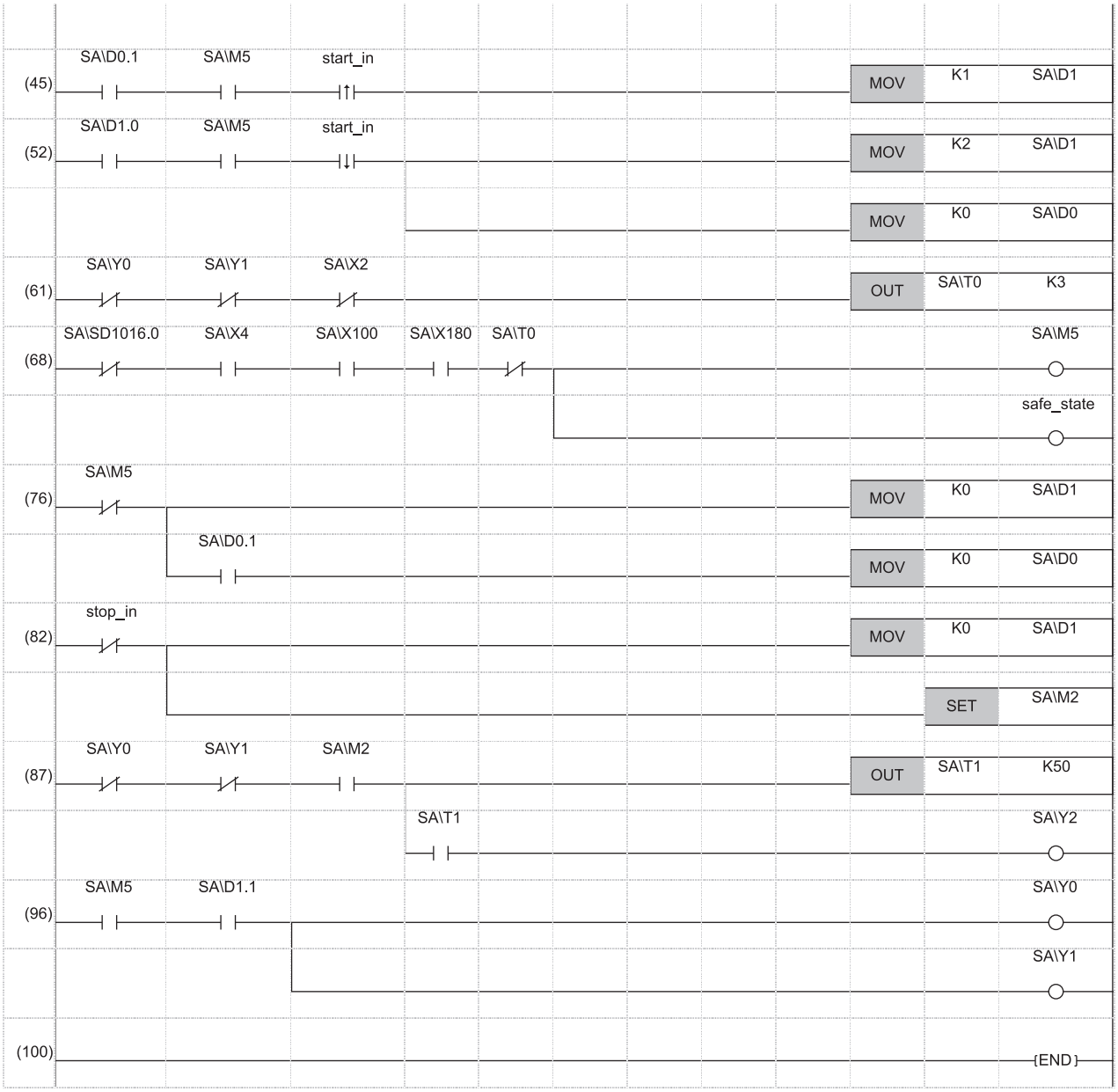
Safety programmable controller	Module	External device	Safety device/safety label
Safety programmable controller (1)	SR_M2IO1	Safety switch	SA\X4 or SA\X5
		Release of interlock to safety switch	SA\Y2
		Contactor	SA\Y0 and SA\Y1
		Contactor (check for welding)	SA\X2 or SA\X3
	R_M2IO2	Reset switch	reset_in
		Start switch	start_in
		Stop switch	stop_in
	CCIEF programmable controller master (1-0)	Emergency stop request from safety programmable controller (2)	SA\X100
		Emergency stop request from safety programmable controller (3)	SA\X180
		Emergency stop request to safety programmable controller (2)	SA\Y100
		Emergency stop request to safety programmable controller (3)	SA\Y180
Safety programmable controller (2)	SR_M3IO1	Safety switch	SA\X4 or SA\X5
		Release of interlock to safety switch	SA\Y2
		Contactor	SA\Y0 and SA\Y1
		Contactor (check for welding)	SA\X2 or SA\X3
	R_M3IO2	Reset switch	reset_in
		Start switch	start_in
		Stop switch	stop_in
	CCIEF programmable controller local (1-1)	Emergency stop request from safety programmable controller (1)	SA\X100
		Emergency stop request to safety programmable controller (1)	SA\Y100
Safety programmable controller (3)	SR_M4IO1	Safety switch	SA\X4 or SA\X5
		Release of interlock to safety switch	SA\Y2
		Contactor	SA\Y0 and SA\Y1
		Contactor (check for welding)	SA\X2 or SA\X3
	R_M4IO2	Reset switch	reset_in
		Start switch	start_in
		Stop switch	stop_in
	CCIEF programmable controller local (1-2)	Emergency stop request from safety programmable controller (1)	SA\X100
		Emergency stop request to safety programmable controller (1)	SA\Y100

■Program example

This is a safety program. For precautions for creating safety program and setting method, refer to Page 34 Precautions for Programming and Page 107 Parameter setting of the Safety CPU. The program performs the following processing.
The following shows programs to be used for safety programmable controllers (1) to (3).

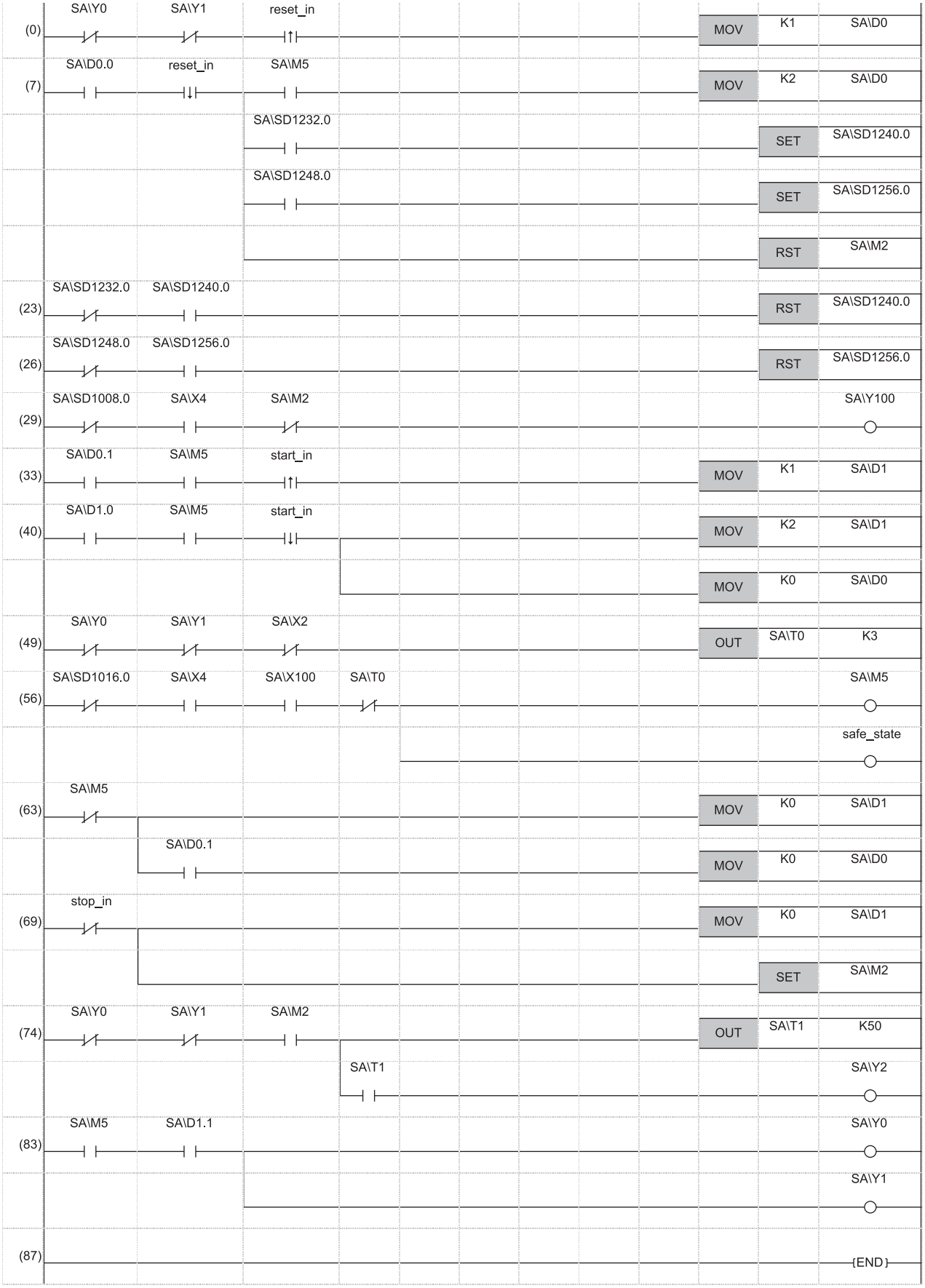
• Safety programmable controller (1)





(0) to (7)	This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.
(26) to (32)	This is a circuit to complete the interlocking process and cancel the request for interlocking.
(35) to (40)	This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controllers (2) and (3).
(45) to (52)	This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.
(61)	This is a circuit to check welding of the electromagnetic contactor.
(68)	This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.
(76)	This is a circuit to cancel start/reset request, when not possible to check safety.
(82)	This is a circuit to process stop request.
(87)	This is a circuit to cancel guide interlock.
(96)	This is a circuit to control outputs to the electromagnetic contactor.

• Safety programmable controller (2)



(0) to (7) This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.

(23) to (26) This is a circuit to complete the interlocking process and cancel the request for interlocking.

(29) This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controller (1).

(33) to (40) This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.

(49) This is a circuit to check welding of the electromagnetic contactor.

(56) This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.

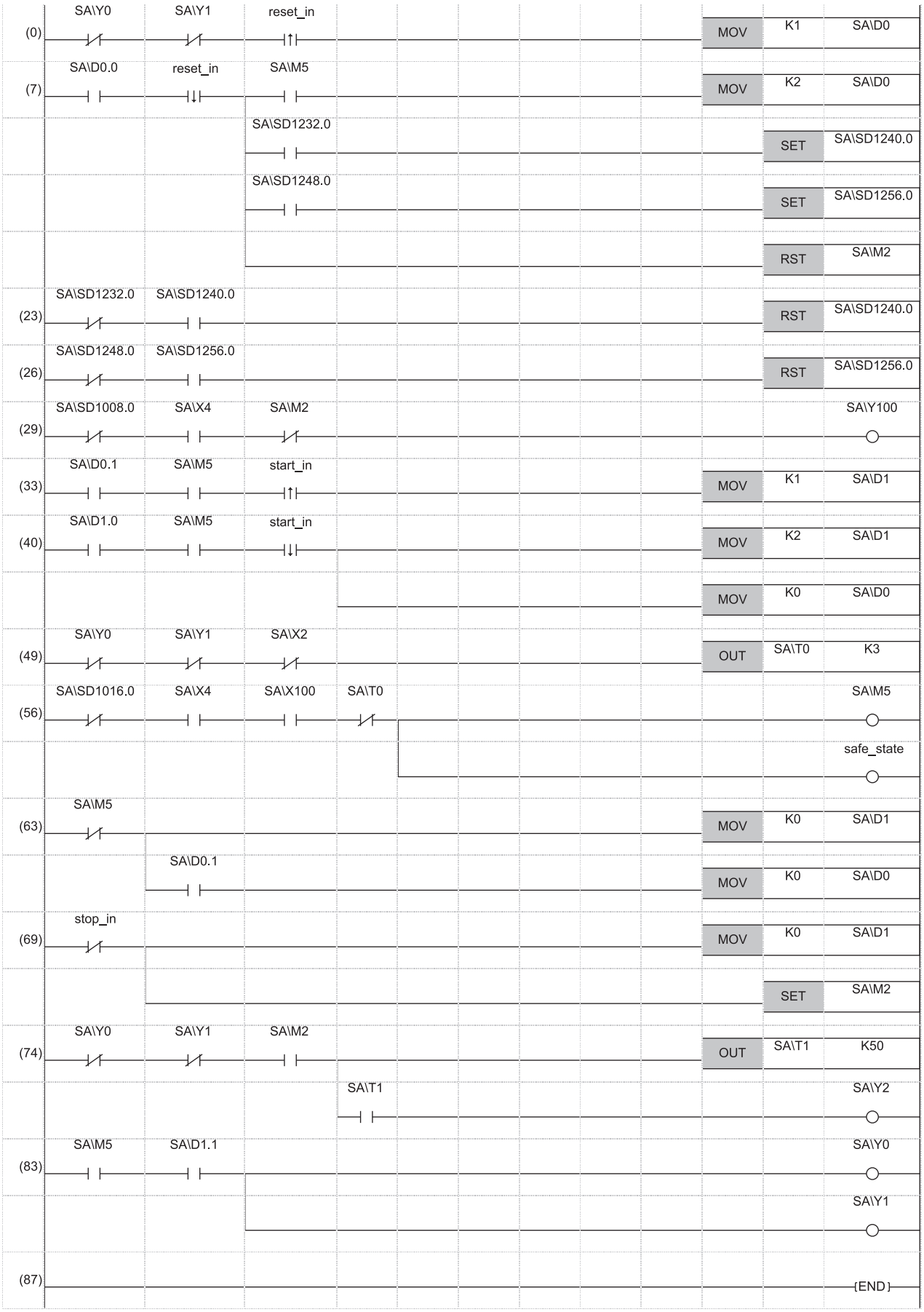
(63) This is a circuit to cancel start/reset request, when not possible to check safety.

(69) This is a circuit to process stop request.

(74) This is a circuit to cancel guide interlock.

(83) This is a circuit to control outputs to the electromagnetic contactor.

• Safety programmable controller (3)



(0) to (7) This is a circuit to check fall of the off of the reset switch, and release the interlock established in the CC-Link IE Field Network.

(23) to (26) This is a circuit to complete the interlocking process and cancel the request for interlocking.

(29) This is a circuit to notify emergency stop request to the Safety CPU of the safety programmable controller (1).

(33) to (40) This is a circuit to check fall of the off of the start switch, and accept a request to start the circuit.

(49) This is a circuit to check welding of the electromagnetic contactor.

(56) This is a circuit to check whether the robot is in a statue that allows starting or maintaining operation. This is a circuit to assign safety signals to the standard/safety shared label.

(63) This is a circuit to cancel start/reset request, when not possible to check safety.

(69) This is a circuit to process stop request.

(74) This is a circuit to cancel guide interlock.

(83) This is a circuit to control outputs to the electromagnetic contactor.

The following shows the constant and safety user devices used in the program.

• Way of using the constant

K☐: indicates decimal number

Ex.

K1→ 1 of decimal number

• Way of using the safety user devices

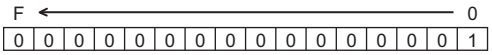
Safety user devices	Description
SA\D0	This is used as restart status. (1) SA\D0 = 0: Initial status or start processing completed. (2) SA\D0 = 1 (SA\D0.0: ON): Reset switch pressed. (3) SA\D0 = 2 (SA\D0.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\D1	This is used as restart status. (1) SA\D1 = 0: Initial status or safety not checked (2) SA\D1 = 1 (SA\D1.0: ON): Reset switch pressed. (3) SA\D1 = 2 (SA\D1.1: ON): Restart processing completed (reset switch released after pressed in (2))
SA\T0	This indicates timer device. Times out after a lapse of the time specified at K☐.

• Way of using word device bit specification

SA\D☐.n: This indicates the nth bit of the word device SA\D☐

Ex.

SA\D0.0 = 0 bits in SA\D0

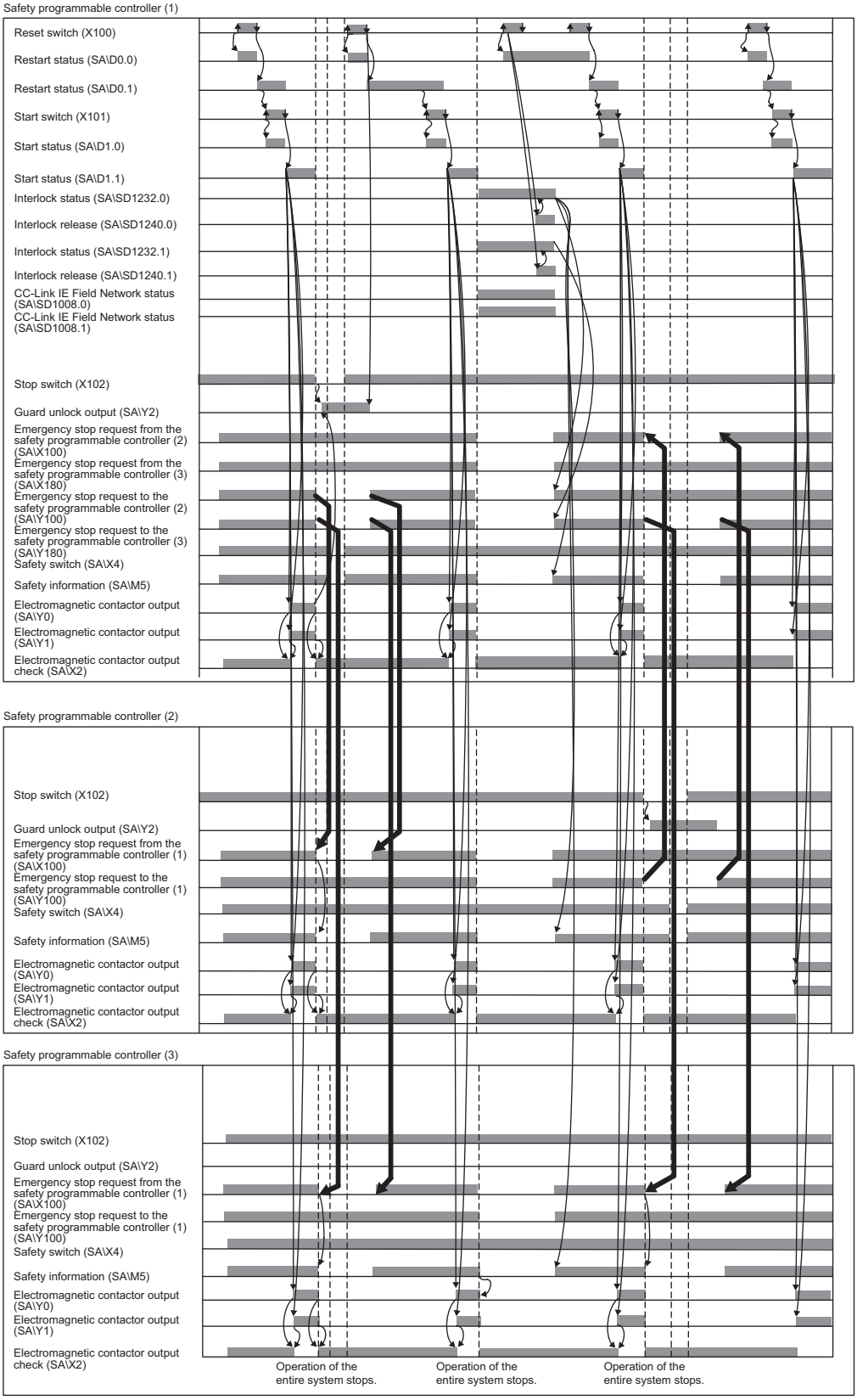


For bit-specified word device, refer to the following.

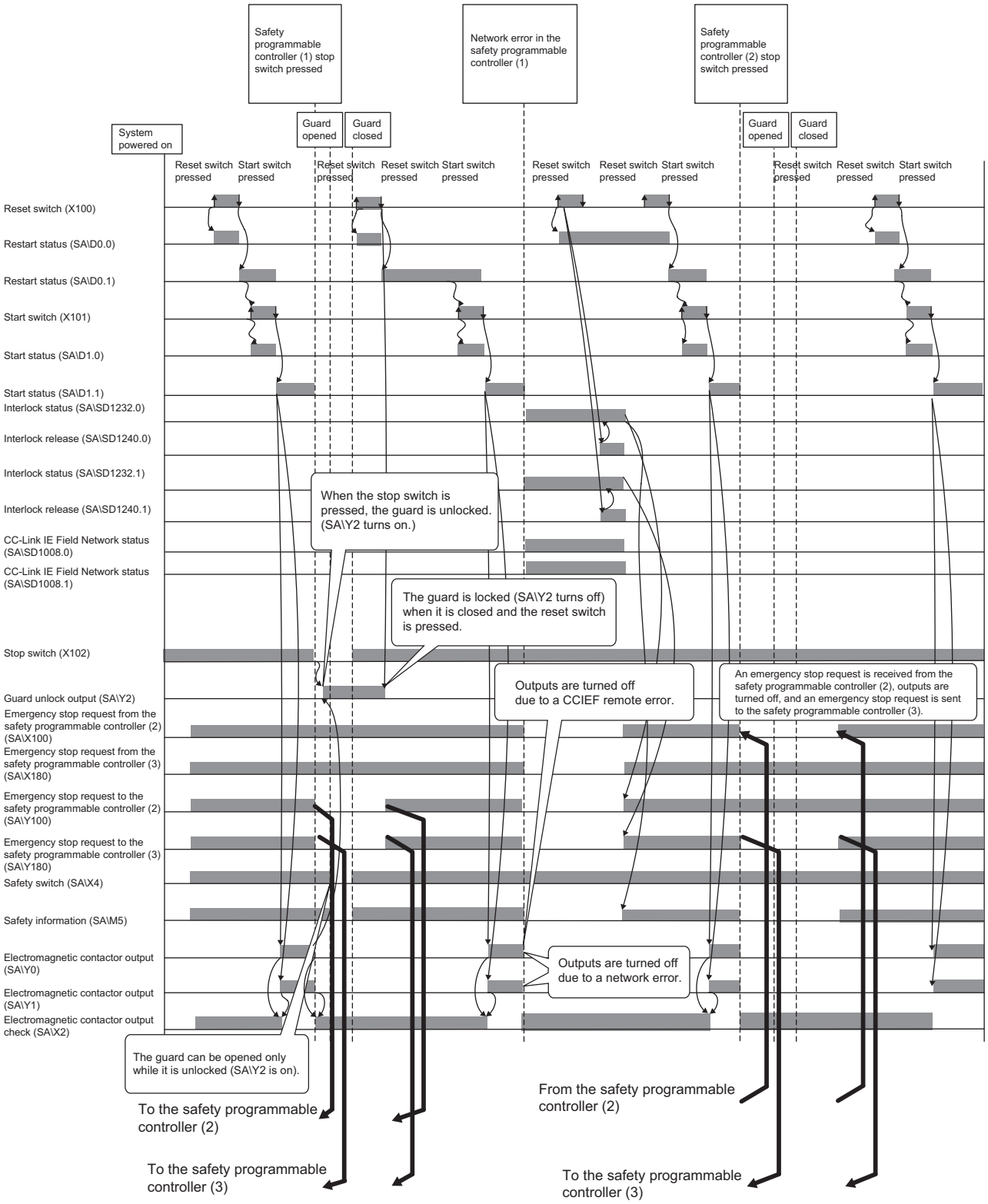
MELSEC iQ-R Programming Manual (Instructions, Standard Functions/Function Blocks)

■Timing chart

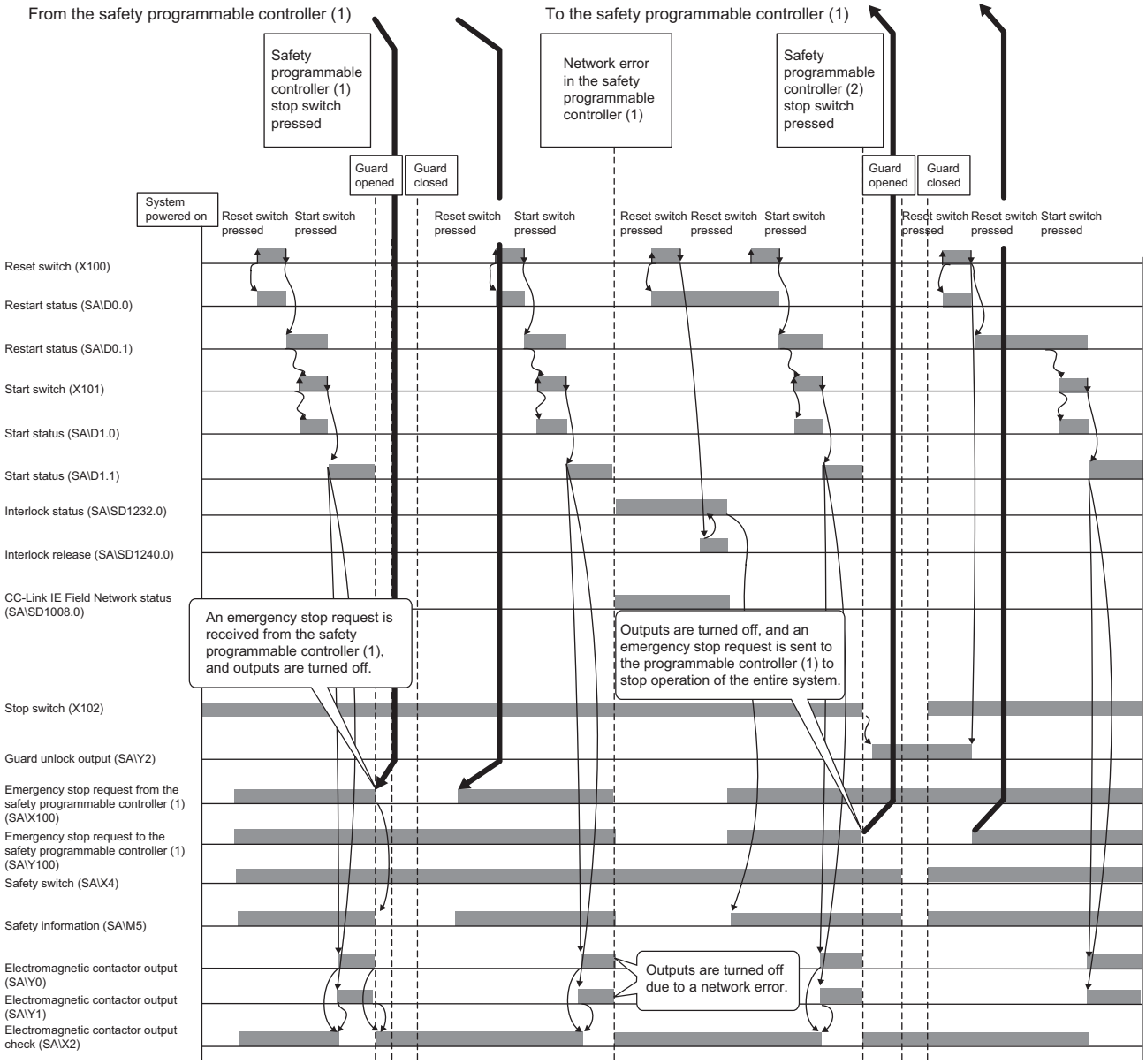
The following shows the entire timing chart when connecting three safety programmable controllers and enlarged timing charts for each safety programmable controller.



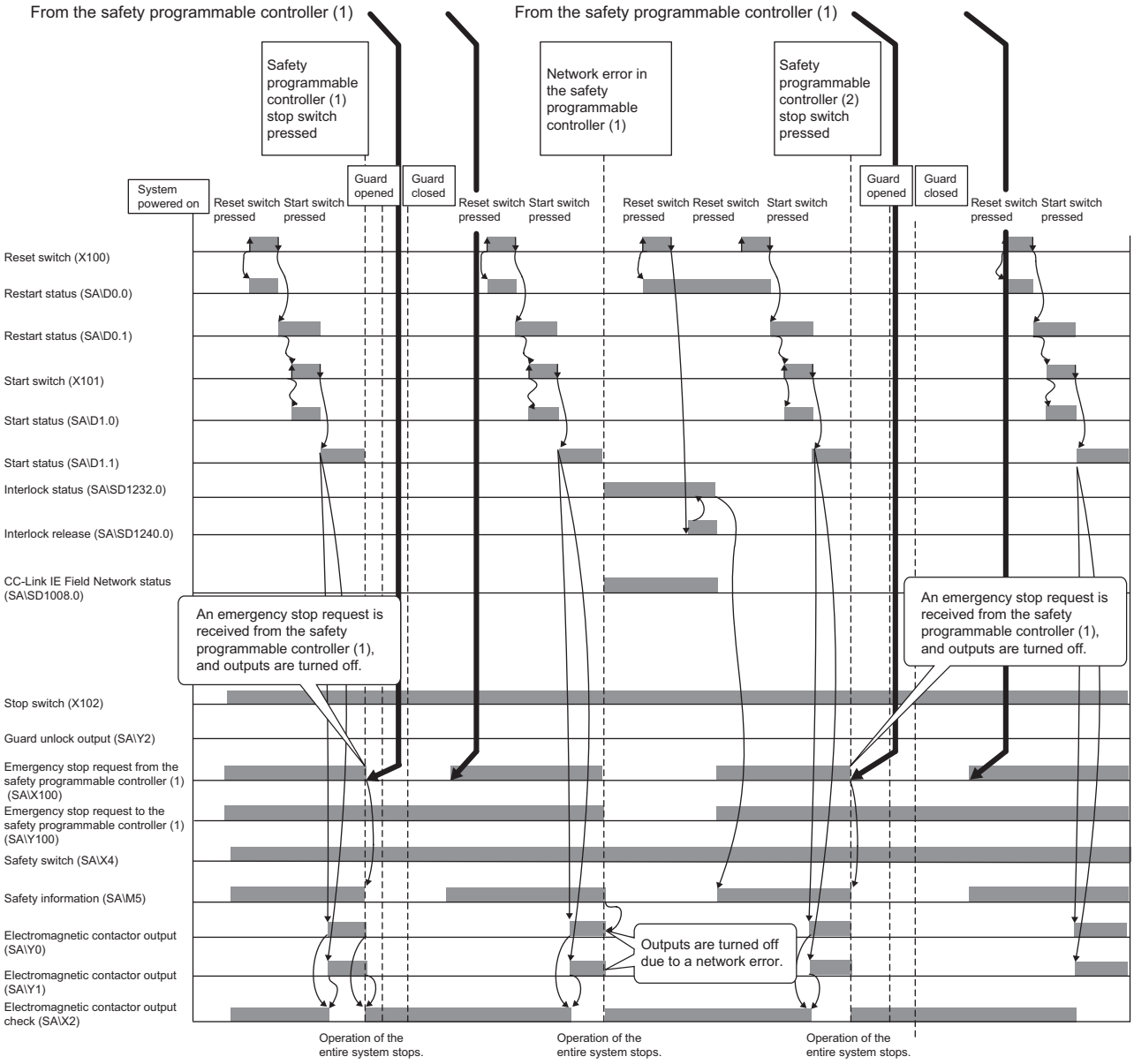
• Timing chart for safety programmable controller (1)



• Timing chart for safety programmable controller (2)



• Timing chart for safety programmable controller (3)

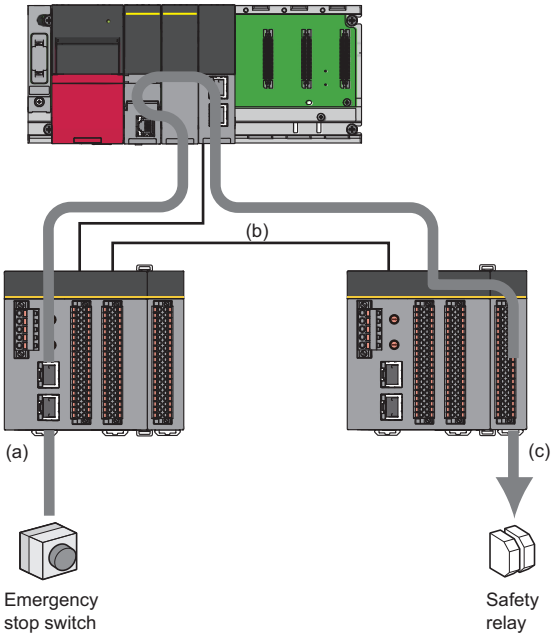


APPENDICES

Appendix 1 Calculating Safety Response Time for System Configured with a Safety CPU

This section explains the maximum value of safety response time for a system configured with a Safety CPU. For systems connected to multiple Safety CPUs, refer to Page 203 Calculating Safety Response Time for System Connected to Multiple Safety CPUs. The following example connects input equipment and output equipment to different safety remote I/O modules, however, even cases where connected to same safety remote I/O module, calculation of safety response time can be performed using method described here. As explained as a line topology, however, calculation is possible by methods described in this chapter regardless the connection methods such as line topology, star topology, or ring topology.

MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)



The maximum value of safety response time will be the sum of (a) to (c) of the following.

Item	Maximum value
(a) Input device response time	DT1
(b) Safety data transmission time (maximum value)	Transmission time of CC-Link IE Field Network from safety input to safety output
(c) Output device response time	DT2
Total	DT1 + DT2 + Safety data transmission time (maximum value)

Explanations of symbols and terminologies used for this chapter

- LS: CC-Link IE Field Network link scan time
- DT1, DT2: Response time of a sensor or output-target device. Check and add the following response time of the device used.
- Safety I/O refresh interval: Fixed scan interval in which a safety program is executed
- Sending Interval Monitoring Time: Time set for each safety connection for Safety CPU and safety remote I/O module

For details, refer to the following.

MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

- Safety refresh monitoring time: Time set for each safety connection with CC-Link IE Field Network parameters. For details, refer to the following.

MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)

- Refresh response processing time for safety remote I/O module: Safety remote station refresh response processing time For details, refer to the following.

CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

Method for calculating safety response time of CC-Link IE Field Network

CC-Link IE Field Network transmission time

The following shows a calculation formula for the transmission time of the CC-Link IE Field Network from safety input to safety output.

(SCcpu × 3) + (SRref × 4.5) + (RM × 2) + SRin + SRout + (n × 4)

SCcpu: Safety cycle time of the Safety CPU

SRref: Safety remote station refresh response processing time*1

RM: Safety refresh monitoring time

SRin: Safety remote I/O module input response time*1

SRout: Safety remote I/O module output response time*1

n: The smaller value of 1) and 2) below.

(1) RM - TMmst - (TMrmt ÷ 2) + a

(2) RM - (TMmst ÷ 2) - TMrmt + c

TMmst: Transmission interval monitoring time of the master station

TMrmt: Transmission interval monitoring time of the remote I/O module

a: If a station is set to the active side is RJ71GF11-T2, then a = TMmst - b. For other cases, a = 0.

b: Value rounds up the calculation results of the TMmst÷2 to a multiple of the safety cycle time of the master station.*2

c: If a station is set to the passive side is either RJ71GF11-T2 or NZ2GFSS2-32D, then c = TMrmt - d. For other cases, c = 0.

d: Value rounds up the calculation results of the TMrmt ÷ 2 to a multiple of the safety cycle time of the local station (if NZ2GFSS2-32D, safety refresh response processing time)*2

*1 For the safety remote I/O module used, refer to the user's manual.

*2 Calculation examples for b and d
When transmission interval monitoring time = 24ms, and safety cycle time = 10ms, the calculation result is 20, rounded up 24 ÷ 2 = 12 to a multiple of 10.

CC-Link IE Field Network transmission interval monitoring time

Transmission interval monitoring time is used for calculation of the CC-Link IE Field Network transmission time. This is the time that the receiving station detects in each connection the following safety communication errors.

- Delay in safety data sending cycle due to an error on the sending station
- Loss of safety data in the transmission path due to influence such as noises

To set transmission interval monitoring time between the master station and safety remote I/O module of the MELSEC iQ-R series CC-Link IE Field Network master/local module, set the two poles of the safety station to perform safety communications to the active side and passive side so that all calculation formulas in (1) to (6) below can be satisfied.

■MELSEC iQ-R series CC-Link IE Field Network master/local module

- If the communication destination is a master station (safety station) or local station (safety station):

(1) Transmission interval monitoring time [ms] ≥ SCown × 3

(2) Transmission interval monitoring time [ms] ≥ SCoth × 2 + LS × 2

- If the communication destination is a safety remote I/O module:

(3) Transmission interval monitoring time [ms] ≥ SCown × 3

(4) Transmission interval monitoring time [ms] ≥ SRref × 2 + LS × 2

■Safety remote I/O module

(5) Transmission interval monitoring time [ms] ≥ SRref × 2

(6) Transmission interval monitoring time [ms] ≥ SCmst × 2 + LS × 2

SCown: Safety cycle time of the master station
SCoth: Safety cycle time of the communication destination
SCmst: Safety cycle time of the master station
SRref: Safety remote station refresh response processing time
LS: Link scan time

Safety refresh monitoring time on CC-Link IE Field Network

Safety refresh monitoring time is used for calculation of the CC-Link IE Field Network transmission time. This is the time that the receiving station monitors in each connection to detect the following safety communication errors.

- Safety data sending stop due to an error on the sending station
- Safety communication stop due to an error on the transmission path, such as cable disconnection or hub failure

Set the safety refresh monitoring time with safety remote I/O module to safety stations (active side), so that the following calculation formulas can be satisfied. The active side and the passive side use the same safety refresh monitoring time.

- Safety refresh monitoring time [ms] ≥ TMact + (TMpas ÷ 2) + (LS × 2) - a
- Safety refresh monitoring time [ms] ≥ (TMact ÷ 2) + TMpas + (LS × 2) - c
- Safety refresh monitoring time [ms] > TMact
- Safety refresh monitoring time [ms] > TMpas

TMact: Transmission interval monitoring time for a station set to the active side
TMpas: Transmission interval monitoring time for a station set to the passive side
LS: Link scan time for the CC-Link IE Field Network
a: If a station is set to the active side is RJ71GF11-T2, then a = TMact - b. For other cases, a = 0.
b: Value rounds up the calculation results of the TMact ÷ 2 to a multiple of the safety cycle time of the master station.
c: If a station is set to the passive side is either RJ71GF11-T2 or NZ2GFSS2-32D, then c = TMpas - d. For other cases, c = 0.
d: Value rounds up the calculation results of the TMpas ÷ 2 to a multiple of the safety cycle time of the local station (if NZ2GFSS2-32D, safety refresh response processing time)

If time between a safety data reception and the next safety data reception on the receiving station exceeds the safety refresh monitoring time, the receiving station detects a safety monitoring timeout error and stops safety communication. The safety data to be received from the sending station is cleared in this case.

Point

When the safety CPU module detects a safety monitoring timeout error, check if the safety refresh monitoring time satisfies the formula above.

CC-Link IE Field Network link scan time (LS)

Calculation formula of the CC-Link IE Field Network link scan time (LS)[μs]

(When link scan mode is "Sequence Scan Asynchronous")

LS = {Total points assigned for cyclic transmission × 0.08 + (number of actually connected slave stations × Ka) + Kb + Kc + Kd}÷1000 + (Number of interrupt conditions in the interrupt setting) × 0.02 + (Total Ke of each unit)÷1000 + St[ms]

- Total points assigned for cyclic transmission: Total number of points assigned for cyclic transmission Calculate with formula below.

(Total set points of RX and RY) ÷ 4 + (total set points of RWr and RWw) × 4

- Number of connected slave stations: Number of slave stations connected in a network Number of actually connected stations, instead of set value as a parameter

If link scan mode is set to sequence scan synchronization, the link scan time becomes identical with that of the sequence scan. If the sequence scan synchronization is set, set "Constant Scan Setting" of "RAS Setting" as the CPU parameter and set the sequence scan interval to constant.

■Values of factors for each cyclic transmission mode

The following shows values of factors for each cyclic transmission mode

<table>
<tr><th rowspan="2">Item</th><th colspan="4">Cyclic transmission mode</th></tr>
<tr><th colspan="2">Normal mode*1</th><th colspan="2">High speed mode*1</th></tr>
<tr><td>Ka</td><td colspan="2">25.8</td><td colspan="2">· If data link faulty station setting is "Clear": 18.5
· If data link faulty station setting is "Hold": 9.75</td></tr>
<tr><td>Kb</td><td colspan="2">655</td><td colspan="2">168</td></tr>
<tr><td>Kc (Maximum transient processing time)</td><td colspan="2">160 + 60 × {number of slave stations set at [Basic Settings] - [Network Configuration Settings]}</td><td colspan="2">80 (if transient transmission is not performed: 0)</td></tr>
<tr><td>Kd (Maximum data link processing time when the station is disconnected from or returned to the network)</td><td colspan="4">• If firmware version of the master station is "04" or earlier;
9000 + Total number of ports used in the switching hub × 3000
(when switching hub is not used: 9000)
• If firmware version of the master station is "05" or earlier;
Number of disconnected station × 3500</td></tr>
<tr><td>St: Processing time between master and submaster stations when submaster function is used</td><td colspan="4">[{(RX/RY total number of set points) ÷ 4 + (RWr/RWw total number of set points) × 4} + 0.08 + 50] ÷ 1000
(when submaster function is not used: 0)</td></tr>
<tr><td rowspan="3">Ke (Processing time factor of module Ke)</td><td>Module</td><td>Value</td><td>Module</td><td>Value</td></tr>
<tr><td>RJ71GF11-T2</td><td>Safety communications not performed: 0
Safety communications performed:
Master station
(1.6 × Number of communication setting (1)*2 + (5.4 × Number of communication setting (2)*3 + 32
Local station
(1.7× Number of communication setting (3)*4) + 18</td><td>RJ71GF11-T2</td><td>Safety communications not performed: 0
Safety communications performed:
Master station
(0.8 × Number of communication setting (1)*2 + (4.1 × Number of communication setting (2)*3 + 23
[Local station]
(0.9× Number of communication setting (3)*4) + 9</td></tr>
<tr><td>Others</td><td>0</td><td>Others</td><td>0</td></tr>
</table>

*1 For details of standard and high speed modes, refer to the following.
MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)

*2 Number of local stations and safety communication settings

*3 Number of safety communication settings for remote device station

*4 Number of safety communication settings for master and other local stations

Calculation example for response time

The following shows calculation examples.

- Safety cycle time: 3ms (→SCcpu)
- Safety remote I/O module input response time: 1.4ms (→SRin)
- Safety remote I/O module output response time: 0.4ms (→SRout)
- Safety remote station refresh response processing time: 2ms

Calculation example of the CC-Link IE Field Network transmission time

Calculation example of CC-Link IE Field Network transmission time

■Calculation example of CC-Link IE Field Network link scan time (LS)

Link scan time (LS) is used for calculation of the CC-Link IE Field Network transmission time. (Condition: No communication error station exists)

For Ka to Ke, use values when the station is set to normal mode.

Total number of set points becomes 256, while RWr and RWw total number of set points becomes 320

Set transient transmission are switching hub to not used, and set submaster station to not set.

LS = [{(Total number of set points for RX and RY) ÷ 4 + (Total number of set points for RWr and RWw) × 4} × 0.08 + (Number of slave stations actually connected × Ka) + Kb + Kc + Kd] ÷1000 + (Number of interrupt conditions in the interrupt setting) × 0.02 + (Total Ke of each unit) ÷ 1000 + St [ms]

= {(256 ÷ 4 + 320 × 4) × 0.08 + (2 × 25.8) + 655 + 0 + 0} ÷ 1000 + 0 × 0.02 + 42.8 ÷ 1000 + 0

≒ 0.86 [ms]

■Calculation example of CC-Link IE Field Network transmission interval monitoring time

Transmission interval monitoring time is used for calculation of the CC-Link IE Field Network transmission time. According to Page 198 CC-Link IE Field Network transmission interval monitoring time, all calculation formulas in (1) to (4) below must be satisfied.

- Set the CC-Link IE Field Network master/local module (set in increments of 0.1ms).

(1) Transmission interval monitoring time ≥ SCown × 3 = 3 × 3 = 9 → 9 [ms]

(2) Transmission interval monitoring time ≥ SRref × 2 + LS × 2 = 2 × 2 = 0.86 × 2 = 5.72 → 5.8 [ms]

- Safety remote I/O module (set in increments of 0.1ms).

(3) Transmission interval monitoring time ≥ SRref × 2 = 2 × 2 = 4 [ms]

(4) Transmission interval monitoring time ≥ SCmst × 2 + LS × 2 = 3 × 2 + 0.86 × 2 = 7.72 → 8 [ms]

SCown: Safety cycle time of the master station
SCoth: Safety cycle time of the communication destination
SCmst: Safety cycle time of the master station
SRref: Safety remote station refresh response processing time
LS: Link scan time

Therefore, set the transmission interval monitoring time of the CC-Link IE Field Network master/local module to 9ms. Set the transmission interval monitoring time of the safety remote I/O module to 8ms.

■Calculation example of safety refresh monitoring time on CC-Link IE Field Network

Safety refresh monitoring time is used for calculation of the CC-Link IE Field Network transmission time. According to Page 199 Safety refresh monitoring time on CC-Link IE Field Network, all calculation formulas in (1) to (4) below must be satisfied.

(1) Safety refresh monitoring time ≥ TMact + (TMpas ÷ 2) + (LS × 2) - a = 9 + (8 ÷ 2) + (0.86 × 2) - (9 - 6) = 11.72 → 11.8 [ms]

(2) Safety refresh monitoring time ≥ (TMact ÷ 2) + TMpas + (LS × 2) - c = (9 ÷ 2) + 8 + (0.86 × 2)- (8 - 4) = 10.22 → 10.3 [ms]

(3) Safety refresh monitoring time > TMact = 9 [ms]

(4) Safety refresh monitoring time > TMpas = 8 [ms]

TMact: Transmission interval monitoring time for a station set to the active side
TMpas: Transmission interval monitoring time for a station set to the passive side
LS: Link scan time for the CC-Link IE Field Network
a: If a station is set to the active side is RJ71GF11-T2, then a = TMact - b. For other cases, a = 0.
b: Value rounds up the calculation results of the TMact ÷ 2 to a multiple of the safety cycle time of the master station.
c: If a station is set to the passive side is either RJ71GF11-T2 or NZ2GFSS2-32D, then c = TMpas - d. For other cases, c = 0.
d: Value rounds up the calculation results of the TMpas ÷ 2 to a multiple of the safety cycle time of the local station (if NZ2GFSS2-32D, safety refresh response processing time)

Set the safety refresh monitoring time to 11.8ms to satisfy all in (1) to (4) above.

■Calculation example of the safety data transmission time (maximum value)

The safety data transmission time (maximum value) is a transmission time of the CC Link IE Field Network from safety input to safety output.

The safety data transmission time (maximum value) = (SCcpu × 3) + (SRref × 4.5) + (RM × 2) + SRin + SRout + (n × 4) = 3 × 3 + 2 × 4.5 + 11.8 × 2 + 1.4 + 0.4 + 1.8 × 4 = 50.6

SCcpu: Safety cycle time of the Safety CPU
SRref: Safety remote station refresh response processing time
RM: Safety refresh monitoring time (☞ Page 202 Calculation example of safety refresh monitoring time on CC-Link IE Field Network)
SRin: Safety remote I/O module input response time SRout: safety remote I/O module output response time
n: This shall be 1.8, since it is (1) or (2) below, whichever smaller.
(1) RM - TMmst - (TMrmt ÷ 2) + a = 11.7 - 9 - (7.8 ÷ 2) + (9 - 6) = 1.8
(2) RM - (TMmst ÷ 2) - TMrmt + c = 11.7 - (9 ÷ 2) - 7.8 + (7.8 - 4) = 3.2
TMmst: transmission interval monitoring time of master station (☞ Page 201 Calculation example of CC-Link IE Field Network transmission interval monitoring time)
TMrmt: transmission interval monitoring time of safety remote I/O module (☞ Page 201 Calculation example of CC-Link IE Field Network transmission interval monitoring time)
a: If a station set to active side is RJ71GF11-T2, then a = TMmst - b. For other cases, a = 0.
b: Value rounds up the calculation results of the TMmst ÷ 2
c: If a station set to passive side is either RJ71GF11-T2 or Z2GFSS2-32D, then c = TMrmt - d For other cases, c = 0.
d: Value rounds up the calculation results of the TMrmt ÷ 2 to a multiple of the safety cycle time of the local station (if NZ2GFSS2-32D, safety refresh response processing time)

Calculation example of safety response time maximum value

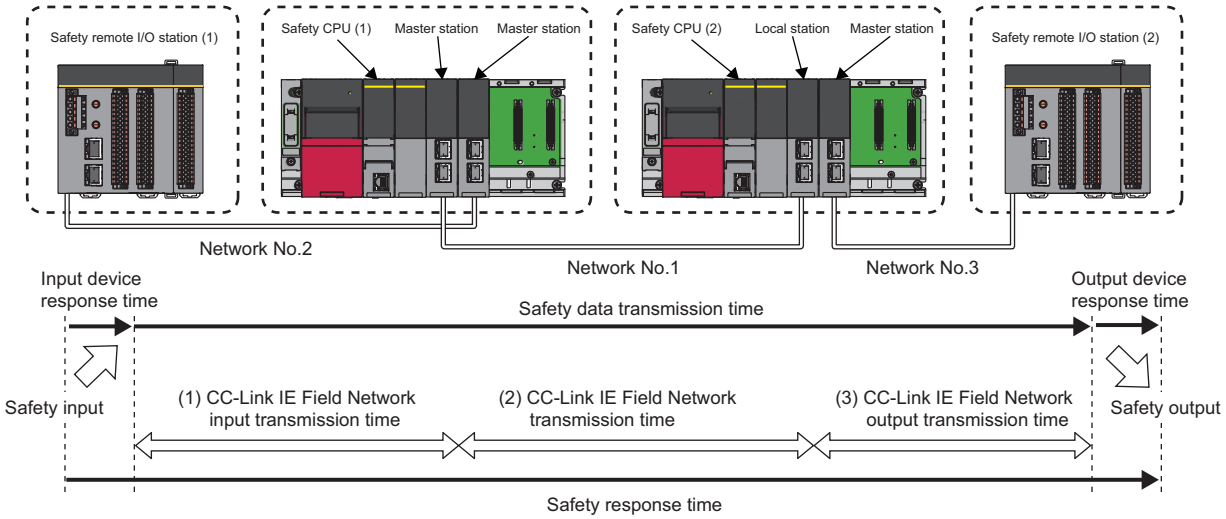
The following is the calculation example of safety response time (maximum value)

Safety response time (maximum value) = DT1 + DT2 + Safety data transmission time = DT1 + DT2 + 50.6 [ms]

Appendix 2 Calculating Safety Response Time for System Connected to Multiple Safety CPUs

This section describes the maximum value of safety response time for a system connected to multiple Safety CPUs using the CC-Link IE Field Network. As described as a line topology, however, calculation is possible by methods described here regardless of the connection methods such as line topology, star topology, or ring topology. For normal values, refer to the following.

MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)



The maximum value of safety response time will be the sum of (a) to (c) of the following.

Item	Maximum value
(a) Input device response time	DT1
(b) Safety data transmission time (maximum value)	Transmission time of CC-Link IE Field Network from safety input to safety output
(c) Output device response time	DT2
Total	DT1 + DT2 + Safety data transmission time (maximum value)

Explanations of symbols used for this chapter

- LS (1): CC-Link IE Field Network link scan time of Network Number 1
- LS (2): CC-Link IE Field Network link scan time of Network Number 2
- LS (3): CC-Link IE Field Network link scan time of Network Number 3
- DT1, DT2: Response time of a sensor or output-target control device. Check and add the following response time of the device used.

Method for calculating safety data transmission time of the CC-Link IE Field Network

Transmission time of the CC-Link IE Field Network

The following shows a calculation formula for the transmission time of the CC-Link IE Field Network from safety input to safety output.

Σ SCcpu × 3 + (SRref × 4.5) + Σ RM + SRin + SRout + Σ n × 2

Total value of the safety cycle time of the Σ SCcpu: Safety CPU on the safety path[*1]

SRref: Safety remote station refresh response processing time[*2]

ΣRM: Total value of safety refresh monitoring time of the safety communications[*3] on the safety path

SRin: Input response time of the safety remote I/O module[*2]

SRout: Output response time of the safety remote I/O module[*2]

Σn: Total value of the following values of safety communications[*3] on the safety path

n: The smaller value of 1) and 2) below.

(1) RM - TMmst - (TMoth ÷ 2) + a

(2) RM - (TMmst ÷ 2) - TMoth + c

RM: Safety refresh monitoring time on the communication path

TMmst: Transmission interval monitoring time of the master station

TMoth: transmission interval monitoring time of the local station or remote device station

a: If a station set to active side is RJ71GF11-T2, then a = TMmst - b. For other cases, a = 0.

b: Value rounds up the calculation results of the TMmst ÷ 2 to a multiple of the safety cycle time of the master station.[*4]

c: If a station set to passive side is either RJ71GF11-T2 or NZ2GFSS2-32D, then c = TMoth - d. For other cases, c = 0.

d: Value rounds up the calculation results of the TMoth ÷ 2 to a multiple of the safety cycle time of the local station (if NZ2GFSS2-32D, safety refresh response processing time)[*4]

*1 All Safety CPUs used for safety communications from safety input devices to safety output devices

*2 For the safety remote I/O module used, refer to the user's manual.

*3 Safety communications between safety remote I/O module with connected safety input device and Safety CPU, safety communications between safety remote I/O module with connected safety input device and Safety CPU, and safety communications between Safety CPUs installed in between.

*4 Calculation examples for b and d
When transmission interval monitoring time = 24 ms, and safety cycle time = 10ms, the calculation result is 20, rounded up 24 ÷ 2 = 12 to a multiple of 10.

For details, refer to the following.

📖 CC-Link IE Field Network Remote I/O Module (With Safety Functions) User's Manual

Transmission interval monitoring time of the CC-Link IE Field Network

Transmission interval monitoring time is used for calculation of the CC-Link IE Field Network transmission time. For calculation method, refer to the following.

☞ Page 198 CC-Link IE Field Network transmission interval monitoring time

Safety refresh monitoring time on CC-Link IE Field Network

Safety refresh monitoring time is used for calculation of the CC-Link IE Field Network transmission time. For calculation method, refer to the following.

☞ Page 199 Safety refresh monitoring time on CC-Link IE Field Network

Link scan time of the CC-Link IE Field Network (LS)

Link scan time is used for calculation of the CC-Link IE Field Network transmission time. (☞ Page 200 CC-Link IE Field Network link scan time (LS))

Calculation example for response time

The following shows calculation examples.

- Safety cycle time of the Safety CPU (1): 3ms (→SCcpu)
- Safety cycle time of the Safety CPU (2): 3ms (→SCcpu)
- Input response time of the safety remote I/O module: 1.4ms (→SRin)
- Output response time of the safety remote I/O module: 0.4ms (→SRout)
- Safety remote station refresh response processing time: 2ms

Calculation example of CC-Link IE Field Network transmission time

Calculation example of CC-Link IE Field Network transmission time

■Calculation example of the link scan time (LS) of the CC-Link IE Field Network

Link scan time (LS) is used for calculation of the CC-Link IE Field Network transmission time. The following shows calculation example of network number 1 (Condition: No communication error station exists.)

For Ka to Ke, use values when the station is set to normal mode.

For network number 1, total number of set points becomes 256, while RWr and RWw total number of set points becomes 320

Set transient transmission and switching hub to not used, and set submaster station to not set.

LS = [{(Total number of set points for RX and RY) ÷ 4 + (Total number of set points for RWr and RWw) × 4} × 0.08 + (Number of slave stations actually connected × Ka) + Kb + Kc + Kd] ÷1000 + (Number of interrupt conditions in the interrupt setting) × 0.02 + (Total Ke of each unit) ÷ 1000 + St [ms]

= {(256 ÷ 4 + 320 × 4) × 0.08 + (2 × 25.8) + 655 + 0 + 0} ÷ 1000 + 0 × 0.02 + (33.6 + 19.7 ÷ 1000 + 0

≒0.85 [ms]

The following shows a calculation example for network number 2 and 3 (Condition: No communication error station exists)

For Ka to Ke, use values when the station is set to normal mode.

For network number 2 and 3, total number of set points becomes 128, while RWr and RWw total number of set points becomes 160

Set transient transmission and switching hub to not used, and set submaster station to not set.

LS (2) = LS (3) = [{(total number of set points for RX and RY) ÷ 4 + (total number of set points for RWr and RWw) × 4} × 0.08 + (number actually connected slave stations × Ka) + Kb + Kc + Kd] ÷ 1000 + (number of interrupt conditions in the interrupt setting) × 0.02 + (total Ke of each unit) ÷ 1000 + St [ms]

= {(128 ÷ 4 + 160 × 4) × 0.08 + (1 × 25.8) + 655 + 0 + 0} ÷ 1000 + 0 × 0.02 + 37.4 ÷ 1000 + 0 ≒ 0.78 [ms]

■Calculation example of the transmission interval monitoring time of the CC-Link IE Field Network

Transmission interval monitoring time is used for calculation of the CC-Link IE Field Network transmission time.

- Transmission interval monitoring time between MELSEC iQ-R series CC-Link IE Field Network master/local modules
  According to Page 204 Transmission interval monitoring time of the CC-Link IE Field Network, all calculation formulas in (1) to (2) below must be satisfied. Set this in increments of 0.1ms.

(1) Transmission interval monitoring time ≥ SCown × 3 = 3 × 3 = 9 → 9 [ms]

(2) Transmission interval monitoring time ≥ SCoth × 2 + LS × 2 = 3 × 2 = 0.85 × 2 = 7.7 [ms]

SCown: Safety cycle time of the master station
SCoth: Safety cycle time of the communication destination
LS: Link scan time

Therefore, set the transmission interval monitoring time of the CC-Link IE Field Network master/local module to 9ms.

- A transmission interval monitoring time between the master station of master/local module on the MELSEC iQ-R Series CC-Link IE Field Network and safety remote I/O module.

According to Page 204 Transmission interval monitoring time of the CC-Link IE Field Network, all calculation formulas in (1) to (4) below must be satisfied. Set this in increments of 0.1ms.

· Set the CC-Link IE Field Network master/local module (set in increments of 0.1ms).

(1) Transmission interval monitoring time ≥ SCown × 3 = 3 × 3 = 9 → 9 [ms]

(2) Transmission interval monitoring time ≥ SRref × 2 + LS × 2 = 2 × 2 + 0.78 × 2 = 5.56 → 5.6 [ms]

· Safety remote I/O module (set in increments of 0.1ms).

(3) Transmission interval monitoring time ≥ SRref × 2 = 2 × 2 = 4 [ms]

(4) Transmission interval monitoring time ≥ SCmst × 2 + LS × 2 = 3 × 2 + 0.78 × 2 = 7.56 → 8 [ms]

SCown: Safety cycle time of the master station
SCoth: Safety cycle time of the communication destination
SCmst: Safety cycle time of the master station
SRref: Safety remote station refresh response processing time
LS: Link scan time

Therefore, set the transmission interval monitoring time of the CC-Link IE Field Network master/local module to 9ms. Set the transmission interval monitoring time of the safety remote I/O module to 8ms.

■Calculation example of safety refresh monitoring time on CC-Link IE Field Network

Safety refresh monitoring time is used for calculation of the CC-Link IE Field Network transmission time. The following shows calculation example of network number 1. According to Page 204 Safety refresh monitoring time on CC-Link IE Field Network, all calculation formulas in (1) to (4) below must be satisfied.

(1) Safety refresh monitoring time ≥ TMact + (TMpas ÷ 2) + (LS × 2) - a = 9 + (9 ÷ 2) + (0.85 × 2) - (9 - 6) = 12.2 [ms]

(2) Safety refresh monitoring time ≥ (TMact ÷ 2)+ TMpas + (LS × 2) - c = (9 ÷ 2) + 9 + (0.85 × 2) - (8 - 4) = 12.2 [ms]

(3) Safety refresh monitoring time > TMact = 9 [ms]

(4) Safety refresh monitoring time > TMpas = 9 [ms]

TMact: Transmission interval monitoring time for a station set to the active side
TMpas: Transmission interval monitoring time for a station set to the passive side
LS: Link scan time for the CC-Link IE Field Network
a: If a station is set to the active side is RJ71GF11-T2, then a = TMact - b. For other cases, a = 0.
b: Value rounds up the calculation results of the TMact ÷ 2 to a multiple of the safety cycle time of the master station.
c: If a station is set to the passive side is either RJ71GF11-T2 or NZ2GFSS2-32D, then c = TMpas - d. For other cases, c = 0.
d: Value rounds up the calculation results of the TMpas ÷ 2 to a multiple of the safety cycle time of the local station (if NZ2GFSS2-32D, safety refresh response processing time)

Set the safety refresh monitoring time to 12.2ms to satisfy all in (1) to (4) above.

The following shows a calculation example for network number 2 and 3. According to Page 204 Safety refresh monitoring time on CC-Link IE Field Network, all calculation formulas in (1) to (4) below must be satisfied.

(1) Safety refresh monitoring time ≥ TMact + (TMpas ÷ 2) + (LS × 2) - a = 9 + (8 ÷ 2) + (0.78 × 2) - (9 - 6) = 11.56 → 11.6 [ms]

(2) Safety refresh monitoring time ≥ (TMact ÷ 2)+ TMpas + (LS × 2) - c = (9 ÷ 2) + 8 + (0.78 × 2) - (8 - 4) = 10.06 → 10.1 [ms]

(3) Safety refresh monitoring time > TMact = 9 [ms]

(4) Safety refresh monitoring time > TMpas = 8 [ms]

TMact: Transmission interval monitoring time for a station set to the active side
TMpas: Transmission interval monitoring time for a station set to the passive side
LS: Link scan time for the CC-Link IE Field Network
a: If a station is set to the active side is RJ71GF11-T2, then a = TMact - b. For other cases, a = 0.
b: Value rounds up the calculation results of the TMact ÷ 2 to a multiple of the safety cycle time of the master station.
c: If a station is set to the passive side is either RJ71GF11-T2 or NZ2GFSS2-32D, then c = TMpas - d. For other cases, c = 0.
d: Value rounds up the calculation results of the TMpas ÷ 2 to a multiple of the safety cycle time of the local station (if NZ2GFSS2-32D, safety refresh response processing time)

Therefore, the safety refresh monitoring time shall be set to: 11.6ms.

■Calculation example of the safety data transmission time (maximum value)

The safety data transmission time (maximum value) is a transmission time of the CC Link IE Field Network from safety input to safety output.

Safety data transmission time (maximum value) = (Σ SCcpu × 3) + (SRref × 4.5) + Σ RM + SRin + SRout + (Σ n × 2) = (3 + 3) × 3 + (2 × 4.5) + (12.2 + 11.6 + 11.6) + 1.4 + 0.4 + (1.7 + 1.6 + 1.6) × 2 = 74.0

ΣSCcpu: Total value of the safety cycle time of the Safety CPU on the safety path (sum total of safety cycle time of the Safety CPU (1) and Safety CPU (2))
SRref: Safety remote station refresh response processing time
ΣRM: Safety refresh monitoring time of the safety communications on the safety path (☞ Page 207 Calculation example of safety refresh monitoring time on CC-Link IE Field Network)
SRin: Safety remote I/O module input response time SRout: safety remote I/O module output response time
n: This shall be 1.8, since it is (1) or (2) below, whichever smaller.
(1) RM - TMmst - (TMoth ÷ 2) + a = 12.2 - 9 - (9 ÷ 2) + (9 - 6) = 1.7
(2) RM - (TMmst ÷ 2) - TMoth + c = 12.2 - (9 ÷ 2) - 9 + (9 - 6) = 1.7
TMmst: transmission interval monitoring time of master station (☞ Page 205 Calculation example of CC-Link IE Field Network transmission time)
TMoth: transmission interval monitoring time of the local station or remote device station (☞ Page 205 Calculation example of CC-Link IE Field Network transmission time)
a: If a station set to active side is RJ71GF11-T2, then a = TMmst - b. For other cases, a = 0.
b: Value rounds up the calculation results of the TMmst ÷ 2
c: If a station set to passive side is either RJ71GF11-T2 or Z2GFSS2-32D, then c = TMoth - d For other cases, c = 0.
d: Value rounds up the calculation results of the TMoth ÷ 2 to a multiple of the safety cycle time of the local station (if NZ2GFSS2-32D, safety refresh response processing time)

Calculation example of the maximum value of the safety response time

The following shows a calculation example for safety response time (maximum value)

Safety response time (maximum value) = DT1 + DT2 + Safety data transmission time = DT1 + DT2 + 74.0 [ms]

Appendix 3 Checklist

No	Description	Reference	Check
Backup and version management of a file			
1	The created date and author are entered at the top of the program using the statement function of the engineering tool.	Page 39 Detecting errors in the CC-Link IE Field Network	☐
2	When modifying the program, date modified, author, and a description of the modification are entered at the modified location using the statement function.	Page 39 Detecting errors in the CC-Link IE Field Network	☐
3	The data written to programmable controller is stored on the hard disk of a personal computer or CD.	Page 39 Detecting errors in the CC-Link IE Field Network	☐
Checking the setting			
4	The main body setting of the safety remote I/O module on the site was checked that was set as designed.	Page 48 Checking network connection configuration	☐
5	The Safety CPU or safety remote I/O module on the site was checked to ensure that is installed in the desired position.	Page 48 Checking network connection configuration	☐
6	The appropriate values are set to safety refresh monitoring time, safety cycle time, and transmission interval monitoring time for the CC-Link IE Field Network.	Page 195 Calculating Safety Response Time for System Configured with a Safety CPU Page 203 Calculating Safety Response Time for System Connected to Multiple Safety CPUs	☐
7	When the safety system is shifted to actual operation, safety CPU operation mode was set to SAFETY MODE.	Page 49 Safety operation mode while in operation	☐
Operation check			
8	All safety application functions (e.g. emergency stop function and restart interlock) were inspected.	—	☐
9	The response time of the safety application was inspected.	—	☐
Checking write data			
10	Before writing the data to the programmable controller, were program and parameter setting values checked to ensure that they are configured as desired?	Page 48 Checking before writing parameters and program	☐
11	When performing a safety data identify check for the engineering tool, the data were checked to ensure that the safety data identify check information for the Safety CPU and safety data identify check information for the project file were identical.	Page 49 Safety data identify check for Safety CPU	☐
Others			
12	It was checked that there are no errors with the LEDs on the module and the engineering tool diagnostics window.	—	☐
13	In the output signals from the Safety CPU module to the CC-Link IE Field Network master/local module on the program, the [use prohibited] signal was checked to ensure that it was not mistakenly turned on or off. For the [use prohibited] signals, refer to the following. 📖 MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)	—	☐
14	The registered passwords were appropriately managed.	Page 49 Protecting data	☐

INDEX

MEMO

REVISIONS

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

Revision date	*Manual number	Description
August 2015	SH(NA)-081538ENG-A	First edition
April 2016	SH(NA)-081538ENG-B	■Added or modified parts Section 5.1, 5.2

Japanese manual number SH-081537-B

WARRANTY

Please confirm the following product warranty details before using this product.

1. Limited Warranty and Product Support.

a. Mitsubishi Electric Company ("MELCO") warrants that for a period of eighteen (18) months after date of delivery from the point of manufacture or one year from date of Customer's purchase, whichever is less, Mitsubishi MELSEC Safety programmable logic controllers (the "Products") will be free from defects in material and workmanship.

b. At MELCO's option, for those Products MELCO determines are not as warranted, MELCO shall either repair or replace them or issue a credit or return the purchase price paid for them.

c. For this warranty to apply:

(1) Customer shall give MELCO (i) notice of a warranty claim to MELCO and the authorized dealer or distributor from whom the Products were purchased, (ii) the notice shall describe in reasonable details the warranty problem, (iii) the notice shall be provided promptly and in no event later than thirty (30) days after the Customer knows or has reason to believe that Products are not as warranted, and (iv) in any event, the notice must given within the warranty period;

(2) Customer shall cooperate with MELCO and MELCO's representatives in MELCO's investigation of the warranty claim, including preserving evidence of the claim and its causes, meaningfully responding to MELCO's questions and investigation of the problem, grant MELCO access to witnesses, personnel, documents, physical evidence and records concerning the warranty problem, and allow MELCO to examine and test the Products in question offsite or at the premises where they are installed or used; and

(3) If MELCO requests, Customer shall remove Products it claims are defective and ship them to MELCO or MELCO's authorized representative for examination and, if found defective, for repair or replacement. The costs of removal, shipment to and from MELCO's designated examination point, and reinstallation of repaired or replaced Products shall be at Customer's expense.

(4) If Customer requests and MELCO agrees to effect repairs onsite at any domestic or overseas location, the Customer will pay for the costs of sending repair personnel and shipping parts. MELCO is not responsible for any re-commissioning, maintenance, or testing on-site that involves repairs or replacing of the Products.

d. Repairs of Products located outside of Japan are accepted by MELCO's local authorized service facility centers ("FA Centers"). Terms and conditions on which each FA Center offers repair services for Products that are out of warranty or not covered by MELCO's limited warranty may vary.

e. Subject to availability of spare parts, MELCO will offer Product repair services for (7) years after each Product model or line is discontinued, at MELCO's or its FA Centers' rates and charges and standard terms in effect at the time of repair. MELCO usually produces and retains sufficient spare parts for repairs of its Products for a period of seven (7) years after production is discontinued.

f. MELCO generally announces discontinuation of Products through MELCO's Technical Bulletins. Products discontinued and repair parts for them may not be available after their production is discontinued.

2. Limits of Warranties.

a. MELCO does not warrant or guarantee the design, specify, manufacture, construction or installation of the materials, construction criteria, functionality, use, properties or other characteristics of the equipment, systems, or production lines into which the Products may be incorporated, including any safety, fail-safe and shut down systems using the Products.

b. MELCO is not responsible for determining the suitability of the Products for their intended purpose and use, including determining if the Products provide appropriate safety margins and redundancies for the applications, equipment or systems into which they are incorporated.

c. Customer acknowledges that qualified and experienced personnel are required to determine the suitability, application, design, construction and proper installation and integration of the Products. MELCO does not supply such personnel.

d. MELCO is not responsible for designing and conducting tests to determine that the Product functions appropriately and meets application standards and requirements as installed or incorporated into the end-user's equipment, production lines or systems.

e. MELCO does not warrant any Product:

(1) repaired or altered by persons other than MELCO or its authorized engineers or FA Centers;

(2) subjected to negligence, carelessness, accident, misuse, or damage;

(3) improperly stored, handled, installed or maintained;

(4) integrated or used in connection with improperly designed, incompatible or defective hardware or software;

(5) that fails because consumable parts such as batteries, backlights, or fuses were not tested, serviced or replaced;

(6) operated or used with equipment, production lines or systems that do not meet applicable and commensurate legal, safety and industry-accepted standards;

(7) operated or used in abnormal applications;

(8) installed, operated or used in contravention of instructions, precautions or warnings contained in MELCO's user, instruction and/or safety manuals, technical bulletins and guidelines for the Products;

(9) used with obsolete technologies or technologies not fully tested and widely accepted and in use at the time of the Product's manufacture;

(10) subjected to excessive heat or moisture, abnormal voltages, shock, excessive vibration, physical damage or other improper environment; or

(11) damaged or malfunctioning due to Acts of God, fires, acts of vandals, criminals or terrorists, communication or power failures, or any other cause or failure that results from circumstances beyond MELCO's control.

f. All Product information and specifications contained on MELCO's website and in catalogs, manuals, or technical information materials provided by MELCO are subject to change without prior notice.

g. The Product information and statements contained on MELCO's website and in catalogs, manuals, technical bulletins or other materials provided by MELCO are provided as a guide for Customer's use. They do not constitute warranties and are not incorporated in the contract of sale for the Products.
h. These terms and conditions constitute the entire agreement between Customer and MELCO with respect to warranties, remedies and damages and supersede any other understandings, whether written or oral, between the parties. Customer expressly acknowledges that any representations or statements made by MELCO or others concerning the Products outside these terms are not part of the basis of the bargain between the parties and are not factored into the pricing of the Products.
i. THE WARRANTIES AND REMEDIES SET FORTH IN THESE TERMS ARE THE EXCLUSIVE AND ONLY WARRANTIES AND REMEDIES THAT APPLY TO THE PRODUCTS.
j. MELCO DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

3. Limits on Damages.

a. MELCO'S MAXIMUM CUMULATIVE LIABILITY BASED ON ANY CLAIMS FOR BREACH OF WARRANTY OR CONTRACT, NEGLIGENCE, STRICT TORT LIABILITY OR OTHER THEORIES OF RECOVERY REGARDING THE SALE, REPAIR, REPLACEMENT, DELIVERY, PERFORMANCE, CONDITION, SUITABILITY, COMPLIANCE, OR OTHER ASPECTS OF THE PRODUCTS OR THEIR SALE, INSTALLATION OR USE SHALL BE LIMITED TO THE PRICE PAID FOR PRODUCTS NOT AS WARRANTED.
b. Although MELCO has obtained the certification for Product's compliance to the international safety standards IEC61508 and EN954-1/ISO13849-1 from TUV Rheinland, this fact does not guarantee that Product will be free from any malfunction or failure. The user of this Product shall comply with any and all applicable safety standard, regulation or law and take appropriate safety measures for the system in which the Product is installed or used and shall take the second or third safety measures other than the Product. MELCO is not liable for damages that could have been prevented by compliance with any applicable safety standard, regulation or law.
c. MELCO prohibits the use of Products with or in any application involving power plants, trains, railway systems, airplanes, airline operations, other transportation systems, amusement equipments, hospitals, medical care, dialysis and life support facilities or equipment, incineration and fuel devices, handling of nuclear or hazardous materials or chemicals, mining and drilling, and other applications where the level of risk to human life, health or property are elevated.
d. MELCO SHALL NOT BE LIABLE FOR SPECIAL, INCIDENTAL, CONSEQUENTIAL, INDIRECT OR PUNITIVE DAMAGES, FOR LOSS OF PROFITS, SALES, OR REVENUE, FOR INCREASED LABOR OR OVERHEAD COSTS, FOR DOWNTIME OR LOSS OF PRODUCTION, FOR COST OVERRUNS, OR FOR ENVIRONMENTAL OR POLLUTION DAMAGES OR CLEAN-UP COSTS, WHETHER THE LOSS IS BASED ON CLAIMS FOR BREACH OF CONTRACT OR WARRANTY, VIOLATION OF STATUTE, NEGLIGENCE OR OTHER TORT, STRICT LIABILITY OR OTHERWISE.
e. In the event that any damages which are asserted against MELCO arising out of or relating to the Products or defects in them, consist of personal injury, wrongful death and/or physical property damages as well as damages of a pecuniary nature, the disclaimers and limitations contained in these terms shall apply to all three types of damages to the fullest extent permitted by law. If, however, the personal injury, wrongful death and/or physical property damages cannot be disclaimed or limited by law or public policy to the extent provided by these terms, then in any such event the disclaimer of and limitations on pecuniary or economic consequential and incidental damages shall nevertheless be enforceable to the fullest extent allowed by law.
f. In no event shall any cause of action arising out of breach of warranty or otherwise concerning the Products be brought by Customer more than one year after the cause of action accrues.
g. Each of the limitations on remedies and damages set forth in these terms is separate and independently enforceable, notwithstanding the unenforceability or failure of essential purpose of any warranty, undertaking, damage limitation, other provision of these terms or other terms comprising the contract of sale between Customer and MELCO.

4. Delivery/Force Majeure.

a. Any delivery date for the Products acknowledged by MELCO is an estimated and not a promised date. MELCO will make all reasonable efforts to meet the delivery schedule set forth in Customer's order or the purchase contract but shall not be liable for failure to do so.
b. Products stored at the request of Customer or because Customer refuses or delays shipment shall be at the risk and expense of Customer.
c. MELCO shall not be liable for any damage to or loss of the Products or any delay in or failure to deliver, service, repair or replace the Products arising from shortage of raw materials, failure of suppliers to make timely delivery, labor difficulties of any kind, earthquake, fire, windstorm, flood, theft, criminal or terrorist acts, war, embargoes, governmental acts or rulings, loss or damage or delays in carriage, acts of God, vandals or any other circumstances reasonably beyond MELCO's control.

5. Choice of Law/Jurisdiction.

These terms and any agreement or contract between Customer and MELCO shall be governed by the laws of the State of New York without regard to conflicts of laws. To the extent any action or dispute is not arbitrated, the parties consent to the exclusive jurisdiction and venue of the federal and state courts located in the Southern District of the State of New York. Any judgment there obtained may be enforced in any court of competent jurisdiction.

6. Arbitration.

Any controversy or claim arising out of, or relating to or in connection with the Products, their sale or use or these terms, shall be settled by arbitration conducted in accordance with the Center for Public Resources (CPR) Rules for Non-Administered Arbitration of International Disputes, by a sole arbitrator chosen from the CPR's panels of distinguished neutrals. Judgment upon the award rendered by the Arbitrator shall be final and binding and may be entered by any court having jurisdiction thereof. The place of the arbitration shall be New York City, New York. The language of the arbitration shall be English. The neutral organization designated to perform the functions specified in Rule 6 and Rules 7.7(b), 7.8 and 7.9 shall be the CPR.

TRADEMARKS

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

SH(NA)-081538ENG-B(1604)MEE
MODEL: RNSFCPU-APPLI-E

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