



Programmable Controller

MELSEC iQ-R
series

MELSEC iQ-R
SIL2 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 programmable controller compliant with IEC 61508 SIL2 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 programmable controller.
 - When a load current exceeding the rated current or an overcurrent caused by a load short-circuit flows, modules operating in SIL2 mode detect an error and turn 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 programmable controller from an external device such as a personal computer connected to the SIL2 Process CPU, configure an interlock circuit in the program or external to the 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 SIL2 Process CPU in case of a communication failure due to poor contact of cables.
 - Do not use any "use prohibited" signals of modules as an I/O signal since they are used by the system. Do not write any data to the "use prohibited" areas in the buffer memory of modules. For the "use prohibited" signals, refer to the user's manual for each module. 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 a module operating in SIL2 mode detects an error in a safety communication path, it turns off outputs. However, the program does not automatically turn off outputs. Create a program that turns off outputs when an error is detected in a safety communication path. If safety communications are restored with outputs on, connected devices 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) Inputs from remote stations are not refreshed.
 - (2) All outputs from remote 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 an output module operating in SIL2 mode. Configure an external circuit for monitoring output signals that could cause a serious accident.

[Precautions for using redundant function modules]

- The optical transmitter and receiver of the redundant function module use laser diodes (class 1 in accordance with IEC 60825-1/JIS C6802). Do not look directly at a laser beam. Doing so may harm your eyes.
-

[Design 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. Keep a distance of 100mm or more between those cables.
 - When selecting external devices to be connected to modules that operate in SIL2 mode, consider the maximum inrush current described in the user's manual for each module. Exceeding the maximum inrush current may cause malfunction or failure of the module.
-

[Installation Precautions]

WARNING

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

[Installation Precautions]

CAUTION

- Use the programmable controller in an environment that meets the general specifications in the MELSEC iQ-R Module Configuration Manual. Failure to do so may result in electric shock, fire, malfunction, or damage to or deterioration of the product.
 - To mount a module with no module fixing hook, place the concave part(s) located at the bottom onto the guide(s) of the base unit, push in the module, and fix it with screw(s). Incorrect interconnection may cause malfunction, failure, or drop of the module.
 - When using the programmable controller in an environment of frequent vibrations, fix the module 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.
 - Do not directly touch any conductive parts and electronic components of the module, SD memory card, extended SRAM cassette, or connector. Doing so can cause malfunction or failure of the module.
 - Securely connect the cable connectors. Poor contact may cause malfunction.
-

[Wiring Precautions]

WARNING

- Shut off the external power supply (all phases) used in the system before installation and wiring. Failure to do so may result in electric shock or cause the module to fail or malfunction.
 - After installation and wiring, attach a blank cover module (RG60) to each empty slot and an included extension connector protective cover to the unused extension cable connector before powering on the system 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 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 signal 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 fire or failure.
 - Tighten the terminal screws or connector screws within the specified torque range. Undertightening can cause drop of the screw, short circuit, fire, or malfunction. Overtightening can damage the screw and/or module, resulting in drop, short circuit, fire, or malfunction.
 - 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 cables may swing or inadvertently be pulled, resulting in malfunction or damage to modules or cables. In addition, the weight of the cables may put stress on modules in an environment of strong vibrations and shocks. Do not clamp the extension cables with the jacket stripped. Doing so may change the characteristics of the cables, resulting in malfunction.
 - When disconnecting the cable from the module, do not pull the cable by the cable part. For the cable with connector, hold the connector part of the cable. 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. Keep a distance of 100mm or more between those cables.
- When an overcurrent caused by a failure of an external device or a 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.

[Precautions for using redundant function modules]

- For tracking cables to be used in the system, select the ones that meet the specifications in the MELSEC iQ-R CPU Module 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 will cause electric shock or malfunction.
 - 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 screws, connector screws, or module fixing screws. Failure to do so may result in electric shock. Tighten the screws within the specified torque range. Undertightening terminal screws or connector screws can cause drop of the screws or connectors, short circuit, fire, or malfunction. Overtightening can damage the screws or modules, resulting in drop of the screws or connectors, short circuit, fire, or malfunction. Undertightening module fixing screws can cause drop of the screws or modules. Overtightening can damage the screws or modules, resulting in drop of them.
-

[Startup and Maintenance Precautions]

CAUTION

- When performing online operations to the running SIL2 Process CPU such as program modification, device test, and operating status change (for example, from RUN to STOP) of the running programmable controller from an external device such as a personal computer connected, read relevant manuals carefully and ensure the safety before operation. The operations must be performed by qualified operators following the operating procedure that is predetermined at the design stage. Modifying a program while the SIL2 Process CPU is running (the online change) may cause corruption of the program depending on operating conditions. Fully understand the precautions described in the GX Works3 Operating Manual before operation.
 - Do not disassemble or modify the modules. Doing so may cause failure, malfunction, injury, or a fire. The warranty does not cover the products modified or repaired by anyone other than Mitsubishi Electric.
 - 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 programmable controller. Failure to do so may cause malfunction.
 - Shut off the external power supply (all phases) used in the system before mounting or removing the module. Failure to do so may cause the module to fail or malfunction.
 - After the first use of the product, do not perform each of the following operations more than 50 times (IEC 61131-2/JIS B 3502 compliant).
Exceeding the limit may cause malfunction.
 - Mounting/removing the module to/from the base unit
 - Inserting/removing the extended SRAM cassette to/from the CPU module
 - Mounting/removing the terminal block to/from the module
 - 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 module cases are made of resin, do not drop or apply strong shock to a module. Doing so may damage the module.
 - Shut off the external power supply (all phases) used in the system before mounting or removing the 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.
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[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 Mitsubishi Electric has declared Product's compliance with the international safety standards IEC61508, IEC61511, 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. Mitsubishi Electric is not liable for damages that could have been prevented by compliance with any applicable safety standard, regulation or law.
- (2) Mitsubishi Electric prohibits the use of Products with or in any application involving, and Mitsubishi Electric 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.
- (3) Mitsubishi Electric shall have no responsibility or liability for any problems involving programmable controller trouble and system trouble caused by DoS attacks, unauthorized access, computer viruses, and other cyberattacks.

INTRODUCTION

Thank you for purchasing the Mitsubishi Electric MELSEC iQ-R series programmable controllers.

This manual describes key points to configure a system compliant with SIL2 of the safety standard IEC 61508 using the programmable controllers.

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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RELEVANT MANUALS

Manual name [manual number]	Description	Available form
MELSEC iQ-R SIL2 Application Guide [SH-082013ENG] (this manual)	Overview of the system using the SIL2 Process CPU, system configuration method, and precautions for using the system	e-Manual PDF
MELSEC iQ-R CPU Module User's Manual (Startup) [SH-081263ENG]	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 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 CC-Link IE Field Network	Print book e-Manual PDF
MELSEC iQ-R I/O Module (With Diagnostic Functions) User's Manual (Startup) [SH-081619ENG]	Specifications, procedures before operation, installation, and wiring of the I/O module with diagnostic functions	Print book e-Manual PDF
MELSEC iQ-R I/O Module (With Diagnostic Functions) User's Manual (Application) [SH-081621ENG]	Functions, parameter settings, troubleshooting, I/O signals, and buffer memory of the I/O module with diagnostic functions	Print book e-Manual PDF
MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Startup) [SH-081485ENG]	Performance specifications, procedures before operation, wiring, operation examples, and offset/gain setting of the A/D converter module	Print book e-Manual PDF
MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application) [SH-081487ENG]	Functions, parameter settings, troubleshooting, I/O signals, and buffer memory of the A/D converter module	Print book e-Manual PDF
MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Startup) [SH-081489ENG]	Performance specifications, procedures before operation, wiring, operation examples, and offset/gain setting of the D/A converter module	Print book e-Manual PDF
MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application) [SH-081491ENG]	Functions, parameter settings, troubleshooting, I/O signals, and buffer memory of the D/A converter module	Print book e-Manual PDF
MELSEC iQ-R Channel Isolated Analog-Digital Converter Module SIL2 Diagnostic Function Block Library Reference [BCN-P5999-0889]	Details on the FB library to input/output data from/to a system with the R60AD8-G	e-Manual PDF
MELSEC iQ-R Channel Isolated Digital-Analog Converter Module SIL2 Diagnostic Function Block Library Reference [BCN-P5999-0894]	Details on the FB library to input/output data from/to a system with the R60DA8-G	e-Manual PDF



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

e-Manual has the following features:

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

TERMS

Unless otherwise specified, this manual uses the following terms.

Term	Description
Control system	A system that takes control and performs network communications in a redundant system
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	A tool used for setting up programmable controllers, programming, debugging, and maintenance.
Intelligent function module	A module that has functions other than input and output, such as an A/D converter module and D/A converter module
Master station	A station that controls the entire network on CC-Link IE Field Network. This station can perform cyclic transmission and transient transmission with all stations.
New control system	A system that has switched to control system from standby system after system switching
New standby system	A system that has switched to standby system from control system after system switching
Redundant function module	A module that configures a redundant system and is used with a Process CPU (redundant mode) or a SIL2 Process CPU. The redundant function module model name is R6RFM.
Redundant system	A system consisting of two systems that have same configuration (CPU module, power supply module, network module, and other modules). Even after an error occurs in one of the two system, the other system takes over the control of the entire system.
Remote device station	A station that exchanges I/O signals (bit data) and I/O data (word data) with CC-Link IE Field Network by cyclic transmission. This station responds to a transient transmission request from another station.
Remote I/O station	A station that exchanges I/O signals (bit data) with the master station of CC-Link IE Field Network by cyclic transmission
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 devices and risk evaluation
Safety communications	Communication service that performs send/receive processing in the safety layer of the safety communication protocol
Safety control	Device control by safety programs and safety data communications. When an error occurs, the device in operation is securely stopped.
Safety function	A function provided to protect a person from the hazards of devices
Safety measures	Measures for reducing risk
SIL	A safety level specified in IEC 61508:2010 and IEC 61511:2016. (The safety level is classified into four levels, SIL1 to SIL4.)
SIL2 function module	A module that performs safety control and must be used with a SIL2 Process CPU. This module can only be used with the SIL2 Process CPU. The SIL2 function module model name is R6PSFM.
SIL2 mode	An operation mode of the I/O module and the intelligent function module to perform safety input and output at the SIL2 level. For details on the SIL2 mode, refer to the following.  Manuals for the I/O module or intelligent function module used
SIL2 Process CPU	A module that performs both standard control and safety control and is used with a SIL2 function module. This module is also used with a redundant function module and configures a redundant system. The SIL2 Process CPU models include the R08PSFCPU, R16PSFCPU, R32PSFCPU, and R120PSFCPU.
Standard communications	Communications other than safety communications, such as cyclic transmission and transient transmission of CC-Link IE Field Network
Standard control	Device control by standard programs and standard data communications. Programmable controllers other than the IEC 61508 SIL2 compliant programmable controller perform only standard control. (This term is used to distinguish from safety control.)
Standby system	A backup system in a redundant system
System switching	A function which switches the systems between the control system and the standby system to continue operation of the redundant system when a failure or an error occurs in the control system
Target failure measure	A target value of reliability specified in IEC 61508:2010 and IEC 61511:2016 for each SIL level. There are two target failure measures depending on the operation frequency of the safety function, PFDavg and PFH.
Tracking cable	An optical fiber cable used to connect two redundant function modules in a redundant system

GENERIC TERMS AND ABBREVIATIONS

Unless otherwise specified, this manual uses the following generic terms and abbreviations.

Generic term and abbreviation	Description
A/D converter module	A MELSEC iQ-R series channel isolated analog-digital converter module
Analog converter module	An A/D converter module or a D/A converter module
D/A converter module	A MELSEC iQ-R series channel isolated digital-analog converter module
I/O module	An input module, an output module, an I/O combined module, and an interrupt module
I/O module with diagnostic functions	A MELSEC iQ-R series I/O module with diagnostic functions
Power supply module	A MELSEC iQ-R series power supply module
Safety input	An input signal to the IEC 61508 SIL2 compliant programmable controller for executing safety functions
Safety output	An output signal from the IEC 61508 SIL2 compliant programmable controller for executing safety functions

HOW TO USE THIS MANUAL

This manual describes points to be aware of when an application system compliant with the IEC 61508 SIL2 is configured using the SIL2 Process CPU and modules support the SIL2 mode.

It is user's responsibility to obtain a safety approval for the entire system.

This manual consists of the following chapters.

Chapter 1: Overview, risk assessment, and SIL

Chapter 2: Specifications and start-up procedure for each module used in the system using the SIL2 Process CPU

Chapter 3: Precautions for configuring an application

Chapter 4: Program examples for the system using the SIL2 Process CPU

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

1 OVERVIEW

1.1 Overview of IEC 61508 SIL2 Compliant Programmable Controller

The SIL2 Process CPU, SIL2 function module, and modules that are set to SIL2 mode are used when a customer builds safety applications up to SIL2 of IEC 61508 or IEC 61511.

Safety control and standard control programs can be simultaneously executed with the SIL2 Process CPU. In addition, in a system using the SIL2 Process CPU, both safety and standard communications can be performed on the same network.

The IEC 61508 SIL2 compliant programmable controller provides the following safety functions:

- The safety control for turning off safety outputs is executed with a customer-created program to shut off the power of the equipment that causes danger.
- If the programmable controller system cannot maintain a safe state due to a failure, safety outputs are turned off by the fail-safe processing to prevent the safety functions from being inoperable.

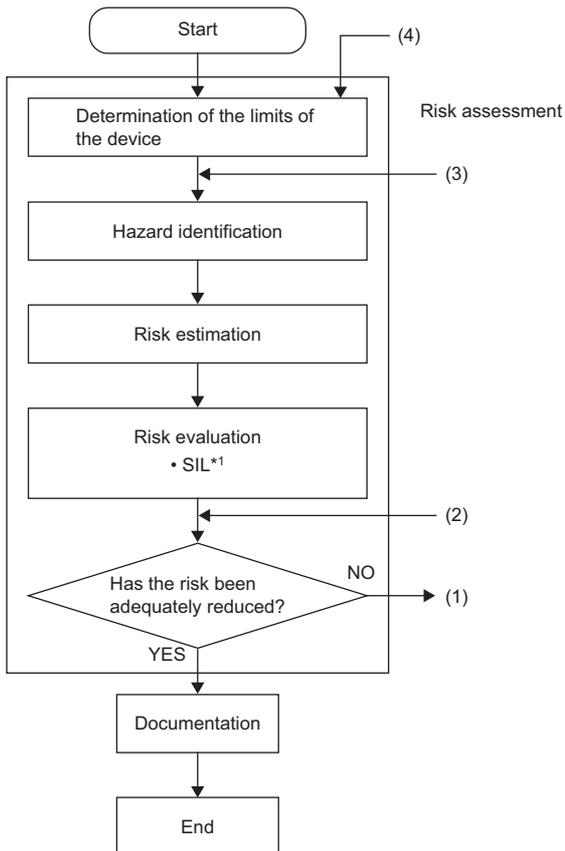
Redundant system configurations are available to provide the availability of the programmable controller. In a redundant system, if one system fails, the other system takes over and continues the control whenever possible. If the systems cannot be switched, the fail-safe operation described above is performed.

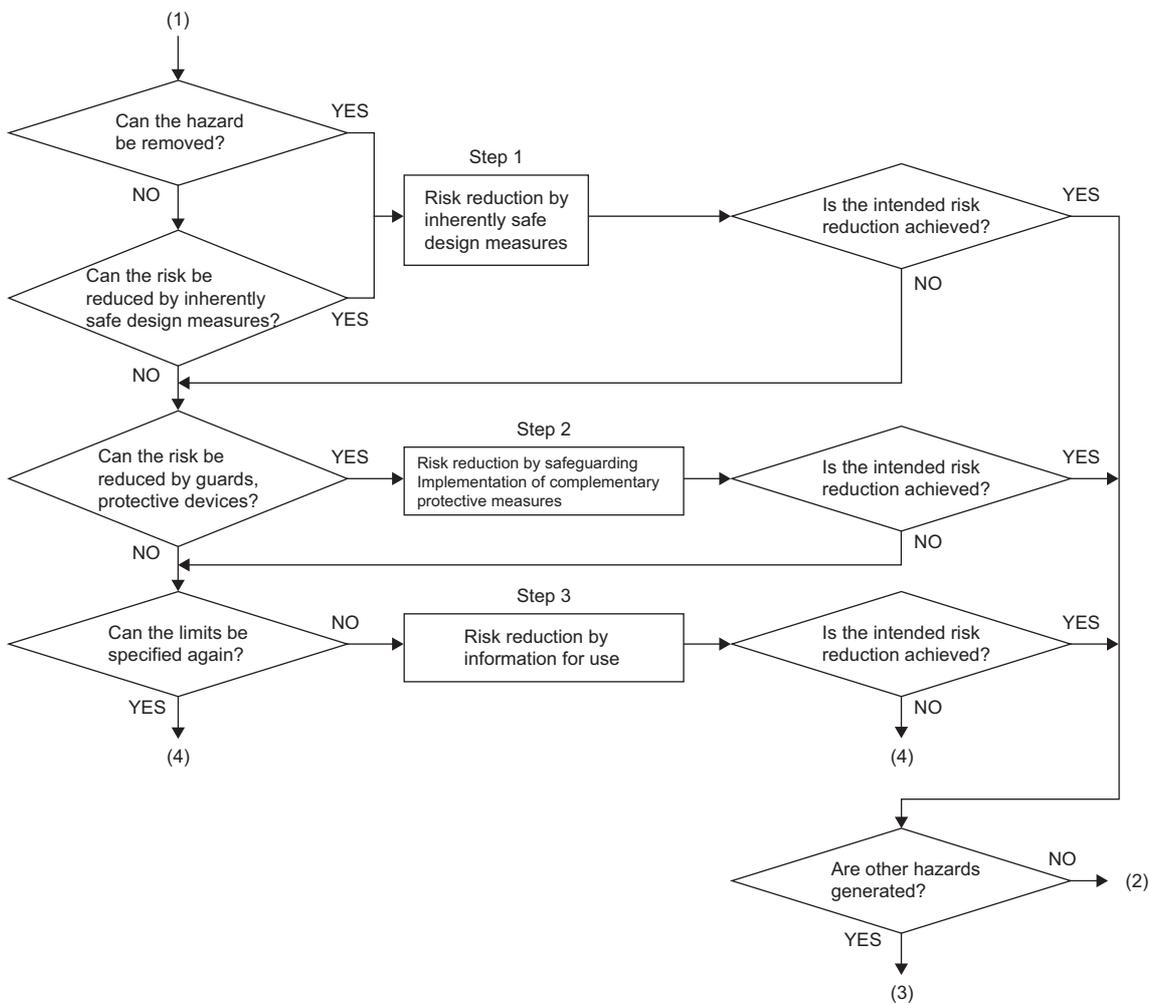
1.2 Risk Assessment and Risk Reduction

When using the SIL2 compliant programmable controller, perform risk assessment on target equipment and select appropriate SIL, as well as reduce the risk conforming to ISO 12100:2010, IEC 61508:2010, and IEC 61511:2016. This section describes the risk assessment and risk reduction.

Risk assessment

The risk assessment is to clarify potential hazards in a device and assess the degree of the hazards. The following shows the overview of the risk assessment and risk reduction procedures. For details, refer to ISO 12100:2010, IEC 61508:2010, and IEC 61511:2016.





(Reference: ISO 12100:2010)

*1 SIL is standardized as an index showing the safety level. (Page 18 Safety Level)

Risk reduction

As a result of the risk assessment, when the device is judged as unsafe, always perform the risk reduction by adding safety measures.

The measures for the risk reduction are standardized in ISO 12100:2010 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 or operating characteristics of the device.
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.

(Reference: ISO 12100:2010)

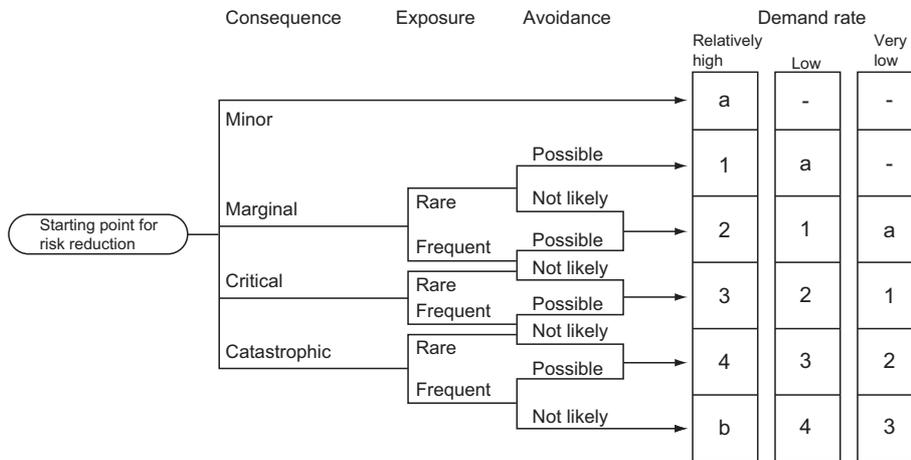
If ensuring the safety of devices by a single safe measure, combine and execute the multiple risk reduction measures until the devices are safe, according to the procedures above.

1.3 Safety Level

This section describes the overview of SIL which is an index showing the safety level.

SIL and target failure measure (PFDavg/PFH)

SIL is standardized by IEC 61508:2010 as an index showing the safety level. Use the following risk graph to 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 Each number stands for SIL1, SIL2, SIL3 and SIL4.
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.

(Reference: IEC 61508-5: 2010.)

To achieve the selected SIL, a safety system shall be configured according to the requirements for each SIL of IEC 61508:2010 and IEC 61511:2016. For example, values of PFDavg (target failure measure for low demand mode of operation^{*1}) and PFH (target failure measure for high demand mode or continuous mode of operation^{*1}) indicating failure rates when safety functions are nullified are specified according to SIL as the following table.

SIL	Low demand mode ^{*1}	High demand mode ^{*1} or continuous mode ^{*1}
4	$10^{-5} \leq \text{PFDavg} < 10^{-4}$	$10^{-9} \leq \text{PFH} < 10^{-8}$
3	$10^{-4} \leq \text{PFDavg} < 10^{-3}$	$10^{-8} \leq \text{PFH} < 10^{-7}$
2	$10^{-3} \leq \text{PFDavg} < 10^{-2}$	$10^{-7} \leq \text{PFH} < 10^{-6}$
1	$10^{-2} \leq \text{PFDavg} < 10^{-1}$	$10^{-6} \leq \text{PFH} < 10^{-5}$

(Reference: IEC 61508-1:2010 and IEC 61511:2016.)

*1 For the low demand mode, high demand mode, and continuous mode, refer to IEC 61508:2010 and IEC 61511:2016.

For the calculation method for PFDavg/PFH when the SIL2 compliant programmable controller is used, refer to the following.

☞ Page 45 Calculation of the target failure measure (PFDavg/PFH)

For details on the requirements for each SIL, refer to IEC 61508:2010 and IEC 61511:2016.

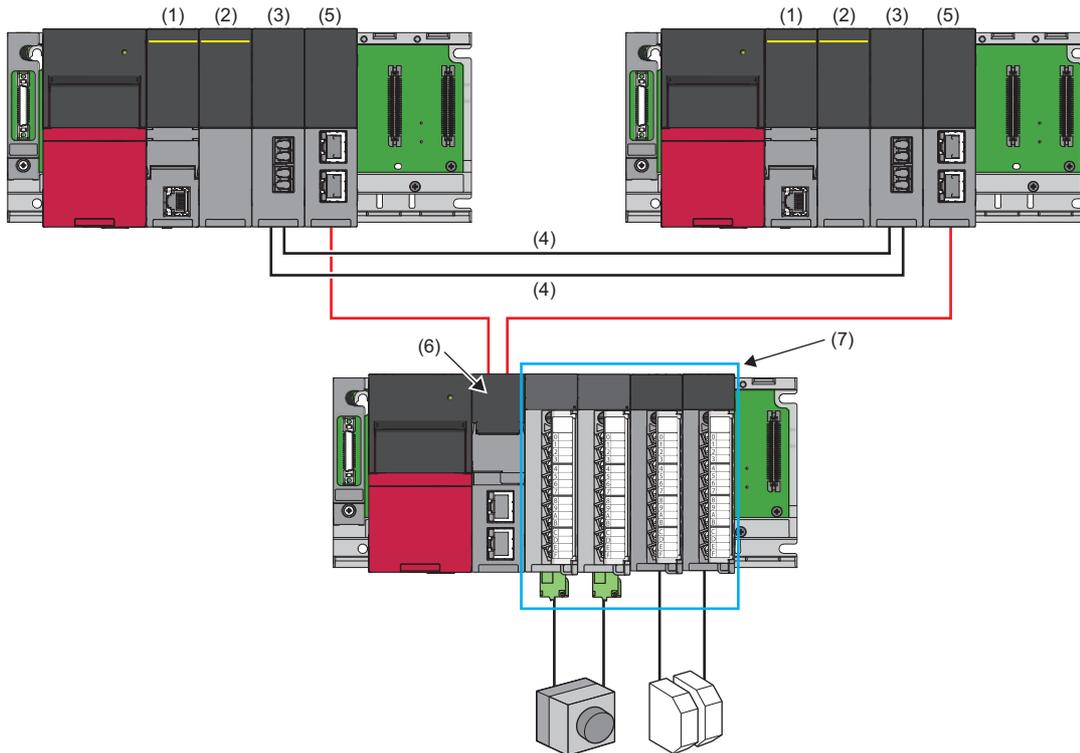
2 SYSTEM CONFIGURATION

2.1 System Using SIL2 Process CPU

Use the SIL2 Process CPU in combination with the SIL2 function module. Use this module also with the redundant function module as a pair to configure a redundant system.

Mount the modules on the slots from the CPU slot to slot number 1 in the order of the SIL2 Process CPU, SIL2 function module, and redundant function module.

Mount I/O modules and intelligent function modules set to SIL2 mode with the intelligent device station (remote head module) on CC-Link IE Field Network.



- (1) SIL2 Process CPU
- (2) SIL2 function module
- (3) Redundant function module
- (4) Tracking cable
- (5) CC-Link IE Field Network master/local module
- (6) Remote head module
- (7) Modules set to SIL2 mode*1

*1 For the modules set to SIL2 mode, refer to the following.

- 📖 MELSEC iQ-R Module Configuration Manual
- 📖 Manuals for the I/O module or the intelligent function module used

Point

- The mounting positions and order are as described above. They cannot be changed.
- The SIL2 Process CPU and the SIL2 function module must be of the same pair version. Check the pair version with the rating plate on the side of the module, special register, or buffer memory (SIL2 Process CPU: SD206, SIL2 function module: Un\G60). (📖 MELSEC iQ-R CPU Module User's Manual (Application))

System configuration for CC-Link IE Field Network

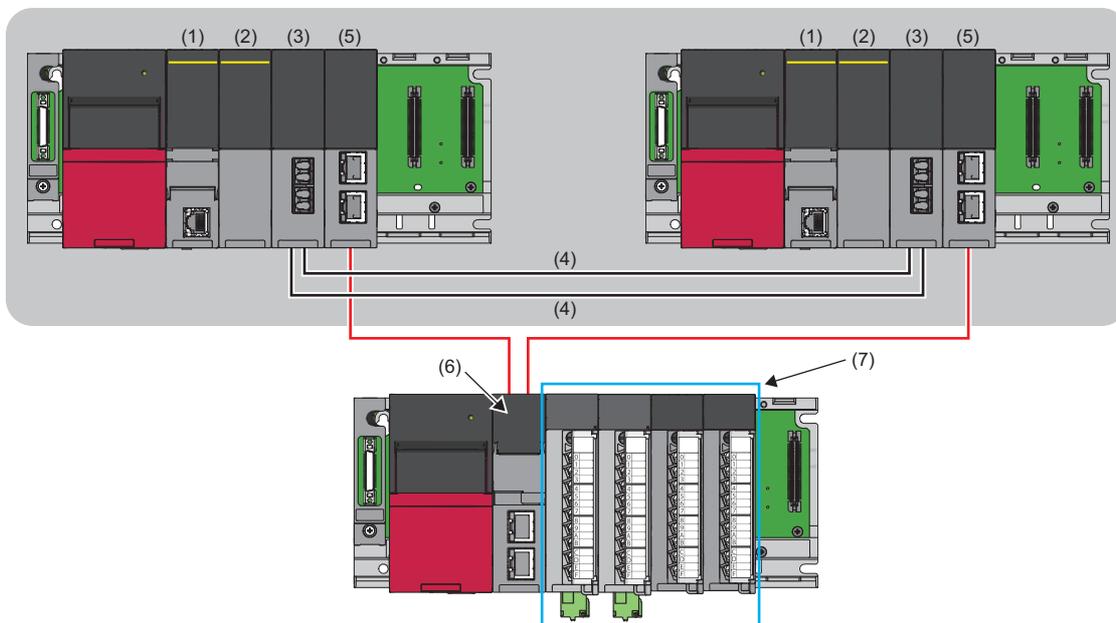
The following table lists types of system configuration for systems using the SIL2 Process CPU on CC-Link IE Field Network.

System configuration		Overview
Redundant specified station	Redundant master station	A redundant configuration of the master station is available.
Redundant configuration of entire network	Redundant line	A redundant configuration of the entire network including the master station and transmission path is available. The redundant line is configured in combination with the redundant master station and the redundant intelligent device station with remote head modules. When a communication error occurs in the master station, the control is continued by switching systems together with the network instead of switching the faulty station only. In addition, the time required for system switching is shorter than that for the redundant master station.

There are no restrictions on network topologies. However, the ring topology is recommended for a redundant system because the loopback function avoids system switching caused by a cable disconnection or a faulty station in a system.

Redundant master station

Mount a CC-Link IE Field Network master/local module on each of the base units of the control system and standby system. If an error occurs in the master station of the control system, the submaster station of the standby system takes over the control.



- (1) SIL2 Process CPU
- (2) SIL2 function module
- (3) Redundant function module
- (4) Tracking cable
- (5) CC-Link IE Field Network master/local module
- (6) Remote head module
- (7) Modules set to SIL2 mode



For the redundant master station, safety communications with a redundant intelligent device station (safety station) cannot be performed. To perform, configure the redundant line. (Page 21 Redundant line)

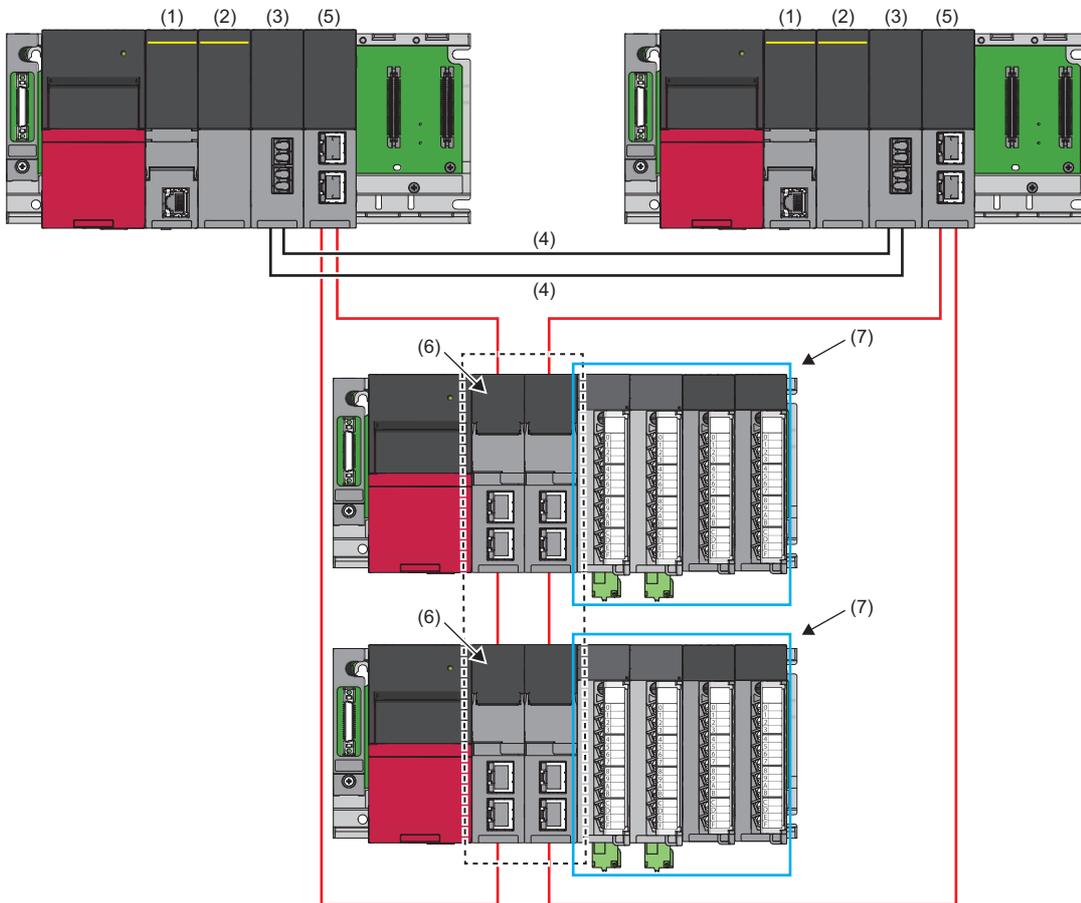
For details, refer to "Redundant System Function" in the following.

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

Redundant line

A redundant configuration of network lines is available.

Mount a CC-Link IE Field Network master/local module on each of the base units of the control system and standby system in the master station where a redundant configuration has been configured. Mount two remote head modules on each base unit of intelligent device stations for the redundant configuration of the remote head module. Connect the master station to the remote head modules of the control system and do the same for the standby system. With a redundant configuration of network lines, control is taken over by the standby system if an error occurs on the network of the control system.



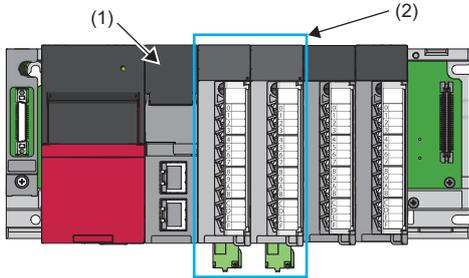
- (1) SIL2 Process CPU
- (2) SIL2 function module
- (3) Redundant function module
- (4) Tracking cable
- (5) CC-Link IE Field Network master/local module
- (6) Remote head module
- (7) Modules set to SIL2 mode

For details, refer to "Redundant System Function" in the following.

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

I/O module with diagnostic functions

For using the I/O module with diagnostic functions in SIL2 mode, two modules must be used as a pair as shown below.^{*1} Configure the settings using the engineering tool so that a module near the remote head module is handled as Main and another as Sub. Mount the Main and Sub modules on the consecutive slots on the same base.

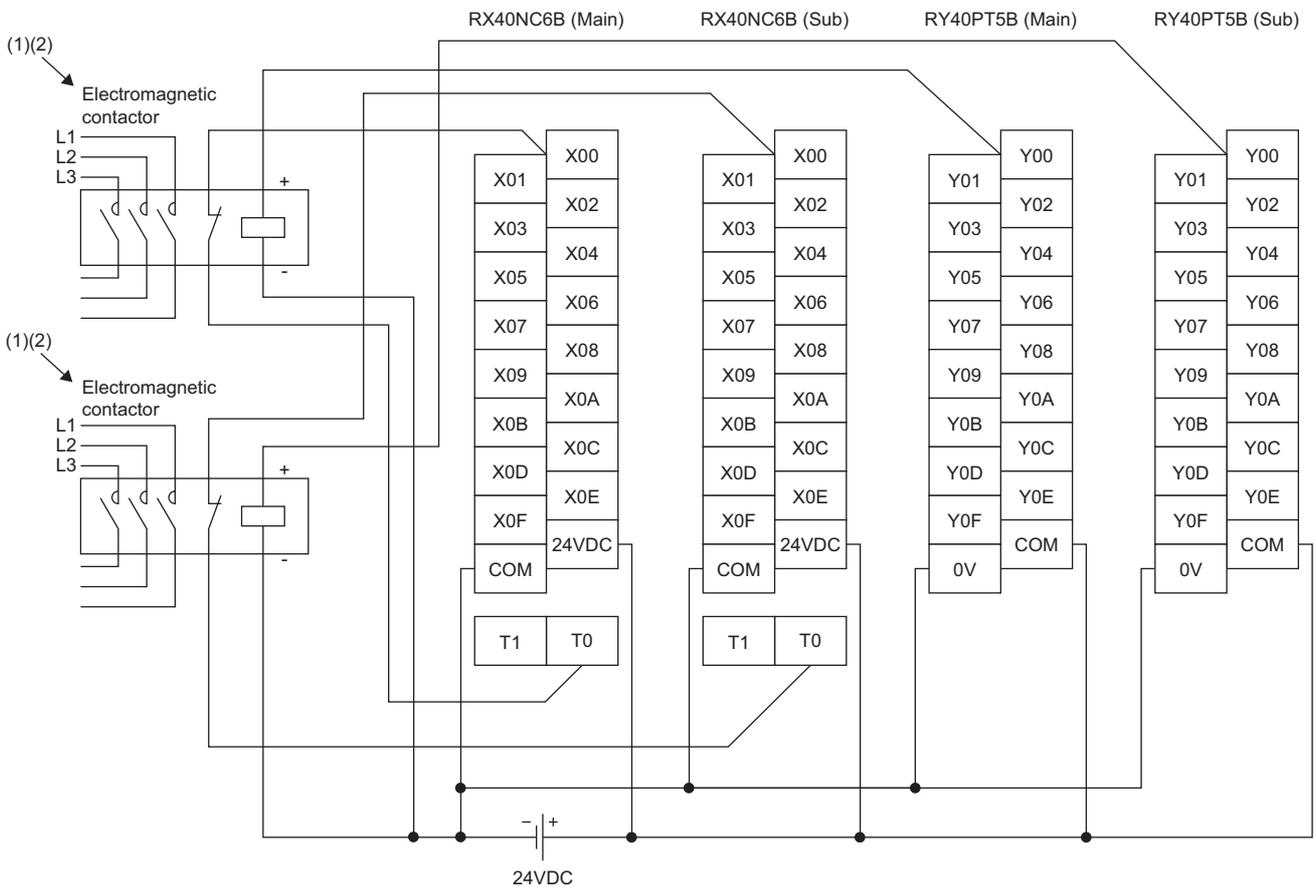


- (1) Remote head module
- (2) A pair of input modules with diagnostic functions set to SIL2 mode (RX40NC6B (Main) + RX40NC6B (Sub)) or a pair of output modules with diagnostic functions (RY40PT5B (Main) + RY40PT5B (Sub))

^{*1} Use modules with firmware version "02" or later. For details on how to check the firmware version, refer to the following manual.
 MELSEC iQ-R Module Configuration Manual

Wiring example

The following figure shows a wiring example of the input/output modules with diagnostic functions when the electromagnetic contactors are used.



- (1) Connect safety separation contacts (for turning off sub-normally-closed-contacts when main contacts are welded) of electromagnetic contactors between X00 to X0F (input) terminals and T0 and T1 (test output) terminals.
- (2) Connect the positive sides of electromagnetic contactors to Y00 to Y0F (output) terminals, and connect the negative sides of electromagnetic contactors to 0V terminals.



For double wiring, perform wiring on a terminal with the same terminal number in both Main and Sub.

To perform the input dark test, use test pulse output terminals (T0, T1) and connect the input device. Use the input terminals and test pulse output terminals of the input module with diagnostic functions in the following combinations.

- For the RX40NC6B (Main) and the RX40NC6B (Sub), wire even-numbered input terminals with T0 test pulse output terminals.
 - For the RX40NC6B (Main) and the RX40NC6B (Sub), wire odd-numbered input terminals with T1 test pulse output terminals.
-

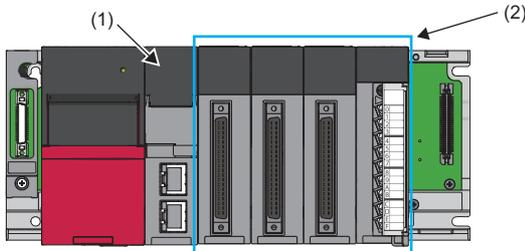
Analog converter module

This section describes the analog converter module in a system using the SIL2 Process CPU.

A/D converter module

To use the R60AD8-G in SIL2 mode, it is necessary to use the following four modules in combination: two R60AD8-G modules (SIL2 mode), one R60DA8-G module (normal mode), and one RY40PT5B module (normal mode).

Configure the settings of the R60AD8-G modules set to SIL2 mode using the engineering tool so that a module near the remote head module is handled as Main and another as Sub.



- (1) Remote head module
- (2) Two R60AD8-G modules (SIL2 mode), one R60DA8-G module (normal mode), and one RY40PT5B module (normal mode)

Point

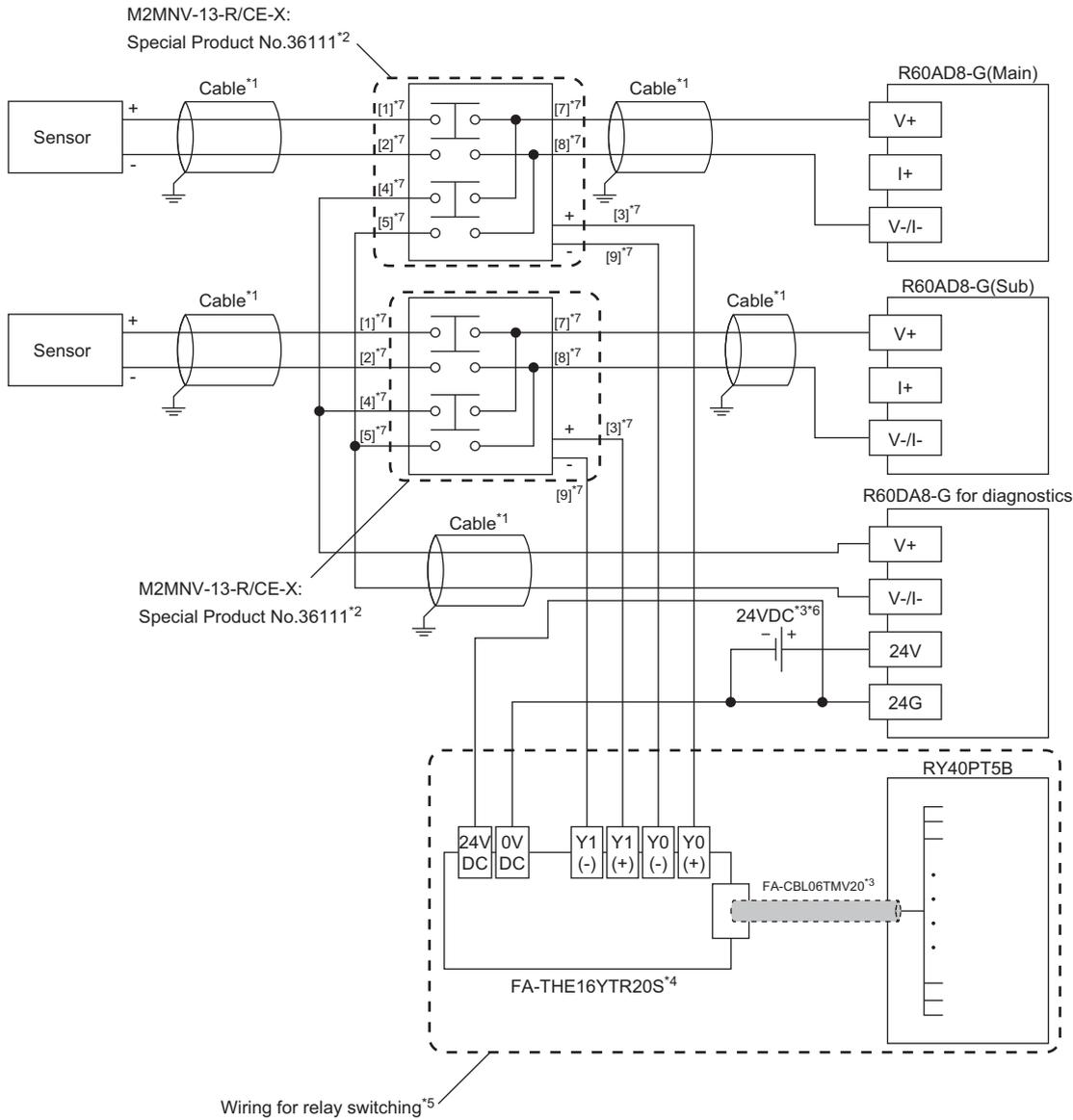
The system configuration for the A/D converter module requires the RY40PT5B set to normal mode. On the other hand, that for the D/A converter module requires the RY40PT5B-AS (SIL2 analog control output module). Ensure that the correct modules are used.

■Precautions

- In a system using the A/D converter module, A/D conversion circuit diagnostics is periodically executed. Note that while the A/D conversion circuit diagnostics is being executed, sensors and A/D converter modules are disconnected and sensor inputs are disabled at certain points in time during one SIL2 A/D conversion cycle.

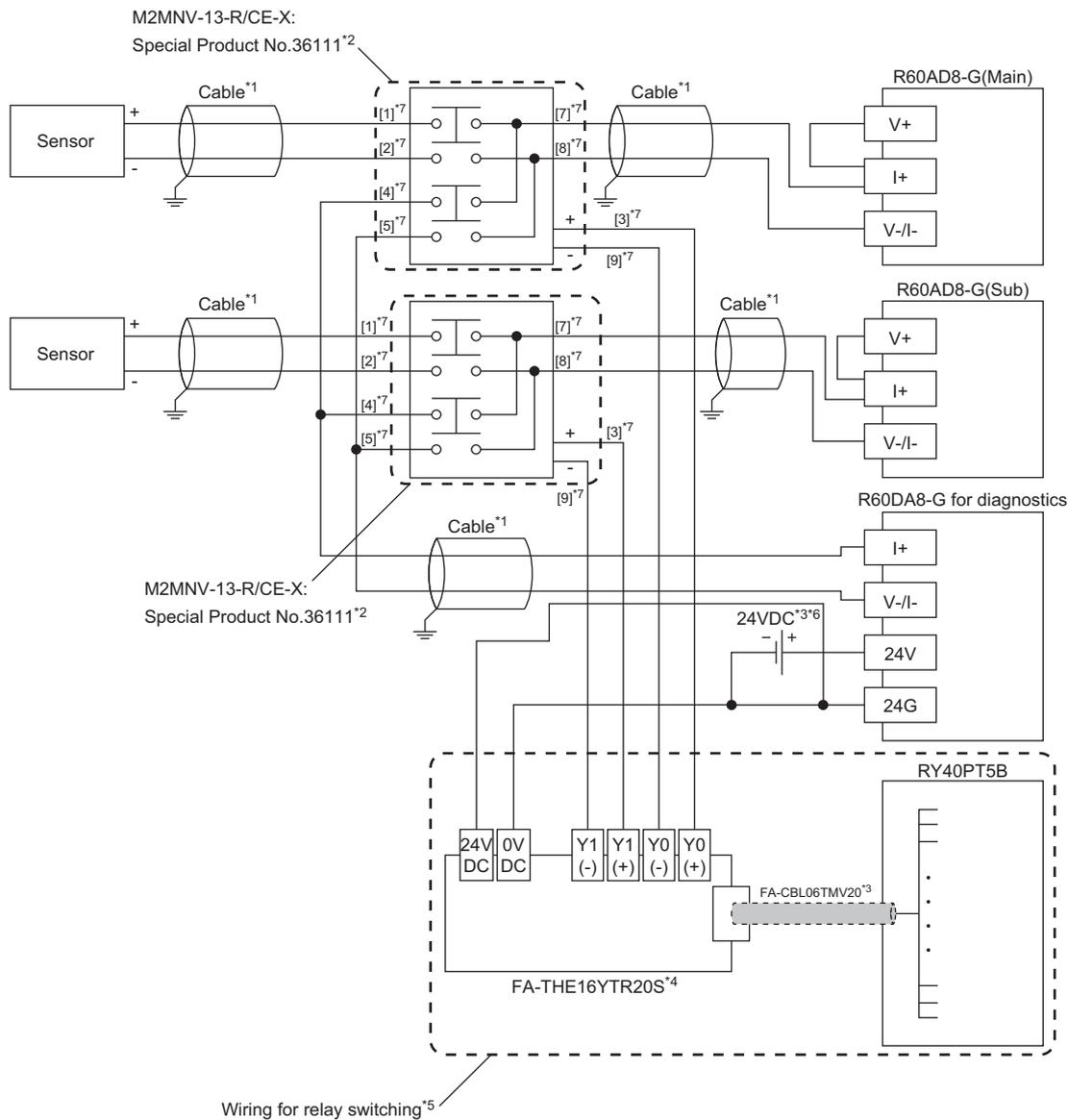
■Wiring examples

<Voltage input>



- *1 For the application below, use shielded cables and single point grounding for the shield.
 - Between a sensor and the M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60DA8-G for diagnostics and M2MNV-13-R/CE-X: Special Product No.36111
- *2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.
- *3 When the R60AD8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.
 - 📖 MELSEC iQ-R Module Configuration Manual
 - 📖 Safety Guidelines (This manual is included with the base unit.)
- *4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B.
- *5 For details on wiring for relay switching, refer to the following.
 - 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
- *6 Use an external power supply that satisfies the following conditions:
 - The overvoltage protection function is available.
 - The output voltage does not exceed 35VDC in single fault state.
- *7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

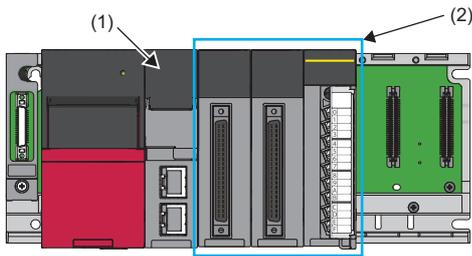
<Current input>



- *1 For the application below, use shielded cables and single point grounding for the shield.
 - Between a sensor and the M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60DA8-G for diagnostics and M2MNV-13-R/CE-X: Special Product No.36111
- *2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.
- *3 When the R60AD8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.
 - 📖 MELSEC iQ-R Module Configuration Manual
 - 📖 Safety Guidelines (This manual is included with the base unit.)
- *4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B.
- *5 For details on wiring for relay switching, refer to the following.
 - 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
- *6 Use an external power supply that satisfies the following conditions:
 - The overvoltage protection function is available.
 - The output voltage does not exceed 35VDC in single fault state.
- *7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

D/A converter module

To use the R60DA8-G in SIL2 mode, it is necessary to use the following three modules in combination: one R60DA8-G module (SIL2 mode), one R60AD8-G module (normal mode), and one RY40PT5B-AS module.



- (1) Remote head module
- (2) One R60DA8-G module (SIL2 mode), one R60AD8-G module (normal mode), and one RY40PT5B-AS module

Point

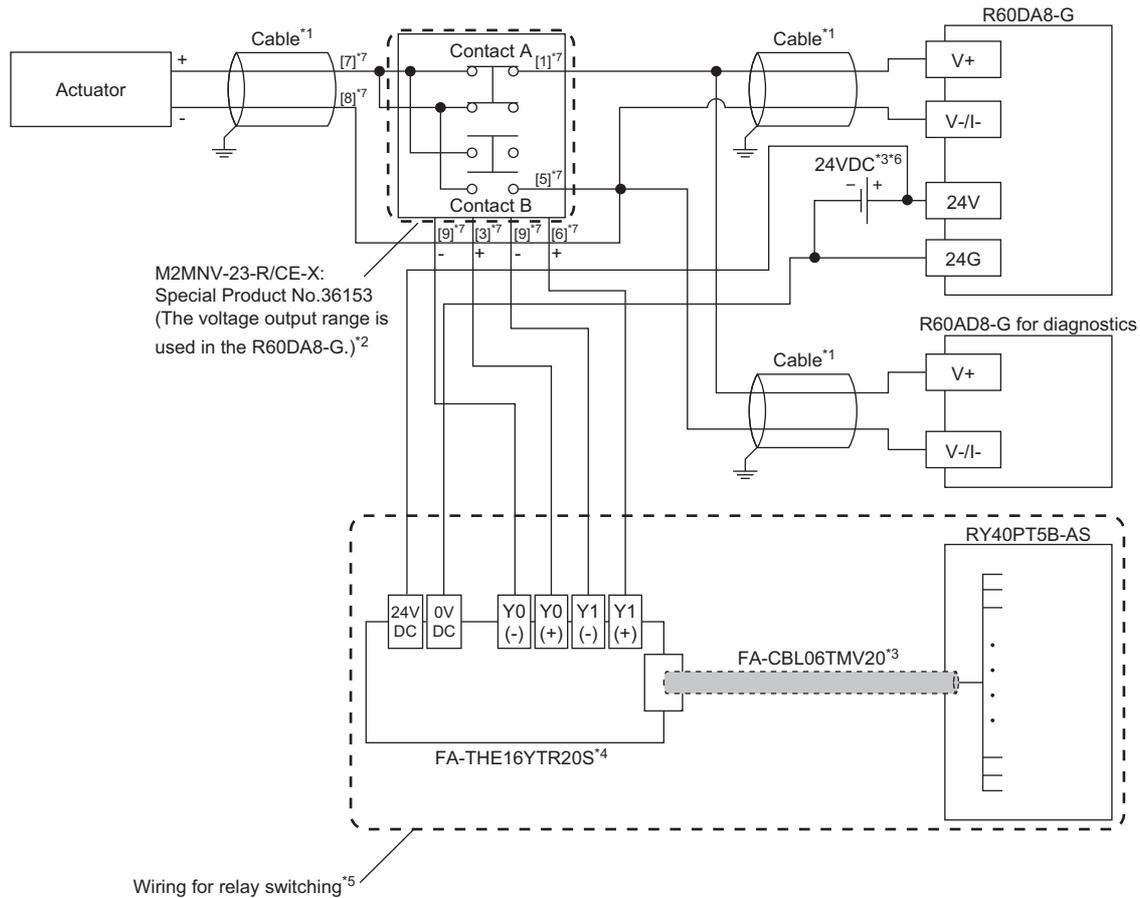
The system configuration for the D/A converter module requires the RY40PT5B-AS (SIL2 analog control output module). On the other hand, that for the A/D converter module requires the RY40PT5B set to normal mode. Ensure that the correct modules are used.

■Precautions

- Since the D/A converter module response is slow due to its nature, do not use it for the emergency shutdown system (ESD) output. Use the digital output module (the safety remote I/O module or output module with diagnostic functions) for ESD output.
- In a system using the D/A converter module, D/A conversion circuit diagnostics is periodically executed. Note that while the D/A conversion circuit diagnostics is being executed, external output devices and D/A converter module are disconnected and the external output devices cannot be operated at certain points in time during SIL2 D/A conversion cycles (40 cycles maximum).

■Wiring examples

<Voltage output>



*1 For the application below, use shielded cables and single point grounding for the shield.

- Between an actuator and M2MNV-23-R/CE-X: Special Product No.36153
- Between the R60DA8-G and M2MNV-23-R/CE-X: Special Product No.36153
- Between the R60AD8-G and M2MNV-23-R/CE-X: Special Product No.36153

*2 Install the M2MNV-23-R/CE-X: Special Product No.36153 and the programmable controller within the same control panel.

*3 When the R60DA8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.

- 📖 MELSEC iQ-R Module Configuration Manual
- 📖 Safety Guidelines (This manual is included with the base unit.)

*4 Since the M2MNV-23-R/CE-X: Special Product No.36153 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B-AS.

*5 For details on wiring for relay switching, refer to the following.

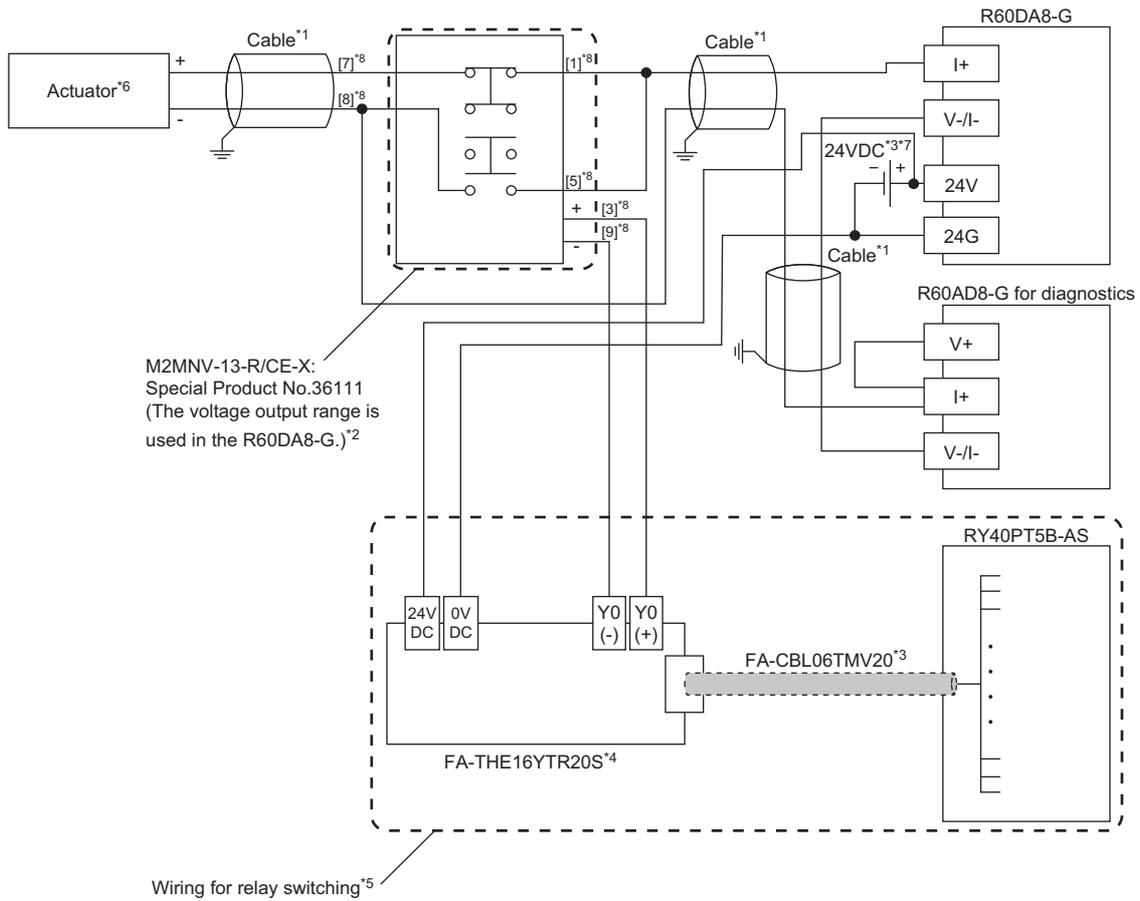
- 📖 MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)

*6 Use an external power supply that satisfies the following conditions:

- The overvoltage protection function is available.
- The output voltage does not exceed 35VDC in single fault state.

*7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

<Current output>

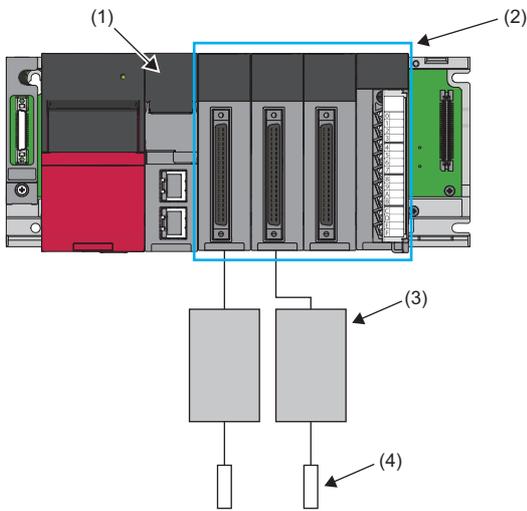


- *1 For the application below, use shielded cables and single point grounding for the shield.
 - Between an actuator and the M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60DA8-G and M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111
- *2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.
- *3 When the R60DA8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.
 - 📖 MELSEC iQ-R Module Configuration Manual
 - 📖 Safety Guidelines (This manual is included with the base unit.)
- *4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B-AS.
- *5 For details on wiring for relay switching, refer to the following.
 - 📖 MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)
- *6 When an internal load resistance value of the external device is less than 100Ω, connect the resistor in series so that the resistance value is 100Ω or more in total.
- *7 Use an external power supply that satisfies the following conditions:
 - The overvoltage protection function is available.
 - The output voltage does not exceed 35VDC in single fault state.
- *8 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

Temperature input

To enable the temperature input, use signal converters that convert signals from temperature sensors into analog signals that can be input to the R60AD8-G modules operating in SIL2 mode.

(1) and (2) in the following system configuration are the same as those in the system configuration for the A/D converter module. (☞ Page 24 A/D converter module).



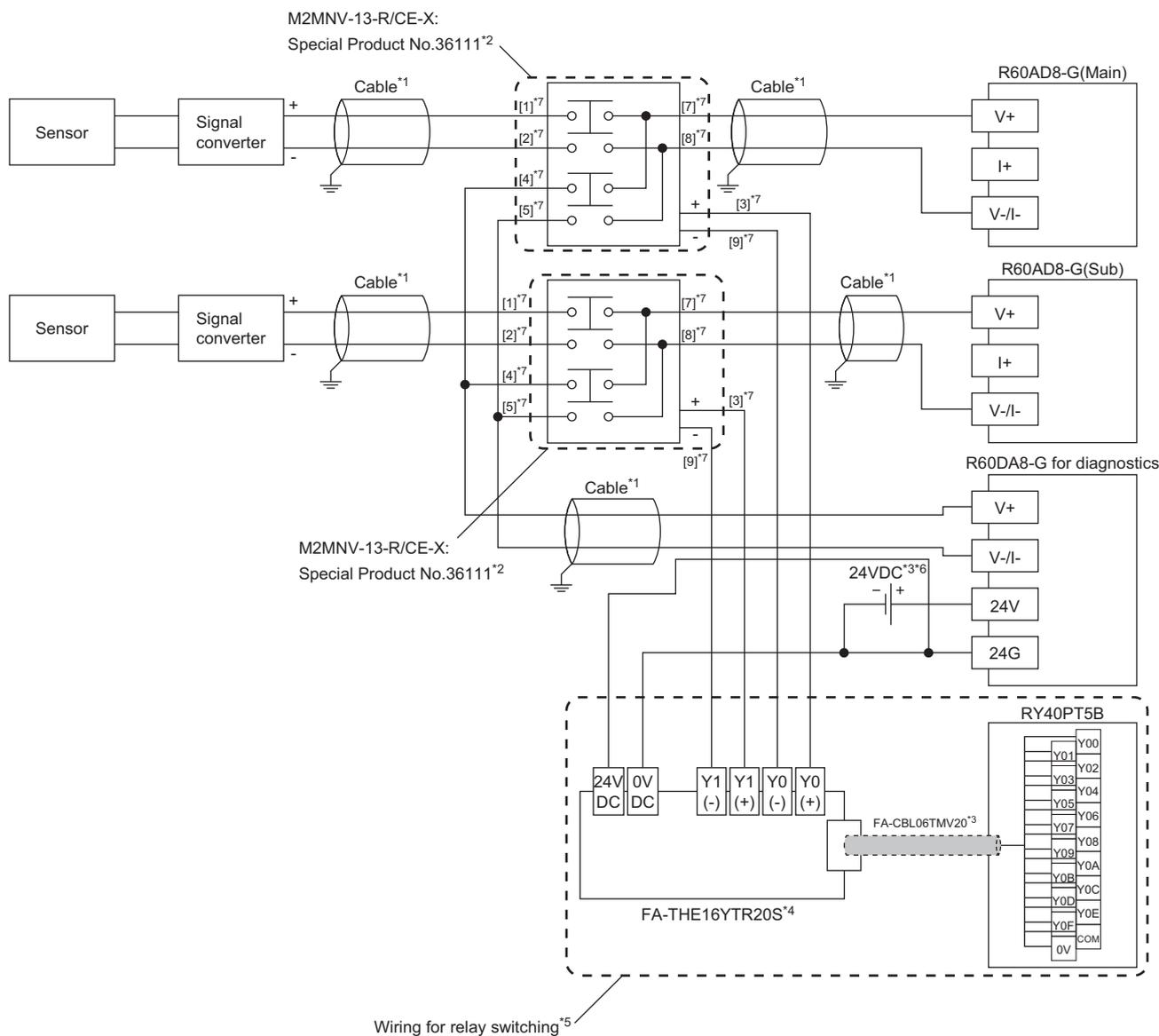
- (1) Remote head module
- (2) Two R60AD8-G modules (SIL2 mode), one R60DA8-G module (normal mode), and one RY40PT5B module (normal mode)
- (3) Signal converter
- (4) Temperature sensor

Point

Connecting signal converters to the R60AD8-G modules can configure a temperature input system that satisfies the SIL2 requirements. However, the customers have to verify the system operation and obtain the safety approval.

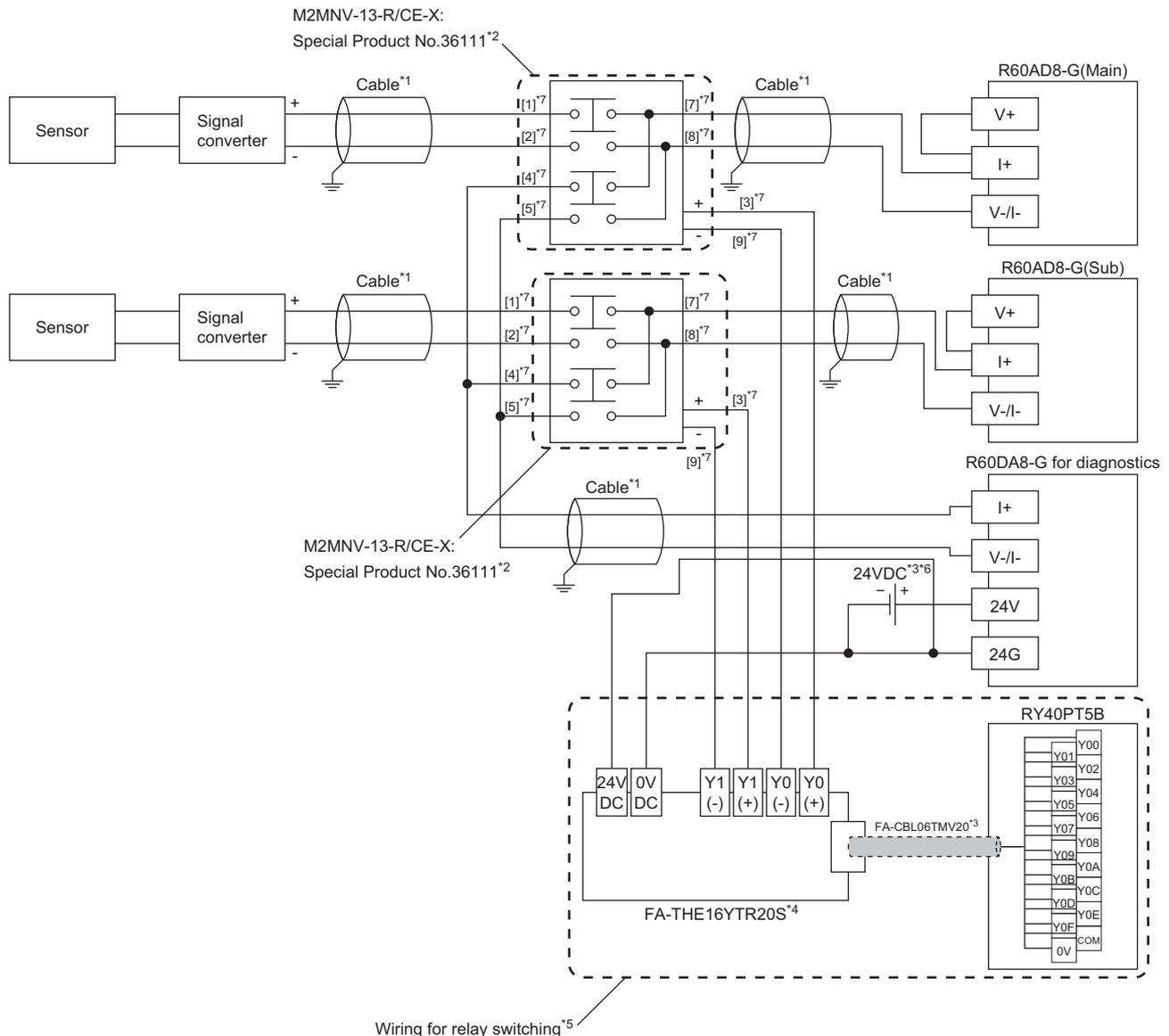
Wiring examples

■ Voltage input



- *1 For the application below, use shielded cables and single point grounding for the shield.
 - Between a sensor and the M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60DA8-G for diagnostics and M2MNV-13-R/CE-X: Special Product No.36111
- *2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.
- *3 When the R60AD8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.
 - 📖 MELSEC iQ-R Module Configuration Manual
 - 📖 Safety Guidelines (This manual is included with the base unit.)
- *4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B.
- *5 For details on wiring for relay switching, refer to the following.
 - 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
- *6 Use an external power supply that satisfies the following conditions:
 - The overvoltage protection function is available.
 - The output voltage does not exceed 35VDC in single fault state.
- *7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

■ Current input



*1 For the application below, use shielded cables and single point grounding for the shield.

- Between a sensor and the M2MNV-13-R/CE-X: Special Product No.36111
- Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111
- Between the R60DA8-G for diagnostics and M2MNV-13-R/CE-X: Special Product No.36111

*2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.

*3 When the R60AD8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.

- 📖 MELSEC iQ-R Module Configuration Manual
- 📖 Safety Guidelines (This manual is included with the base unit.)

*4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B.

*5 For details on wiring for relay switching, refer to the following.

- 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)

*6 Use an external power supply that satisfies the following conditions:

- The overvoltage protection function is available.
- The output voltage does not exceed 35VDC in single fault state.

*7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

2.2 System Start-up

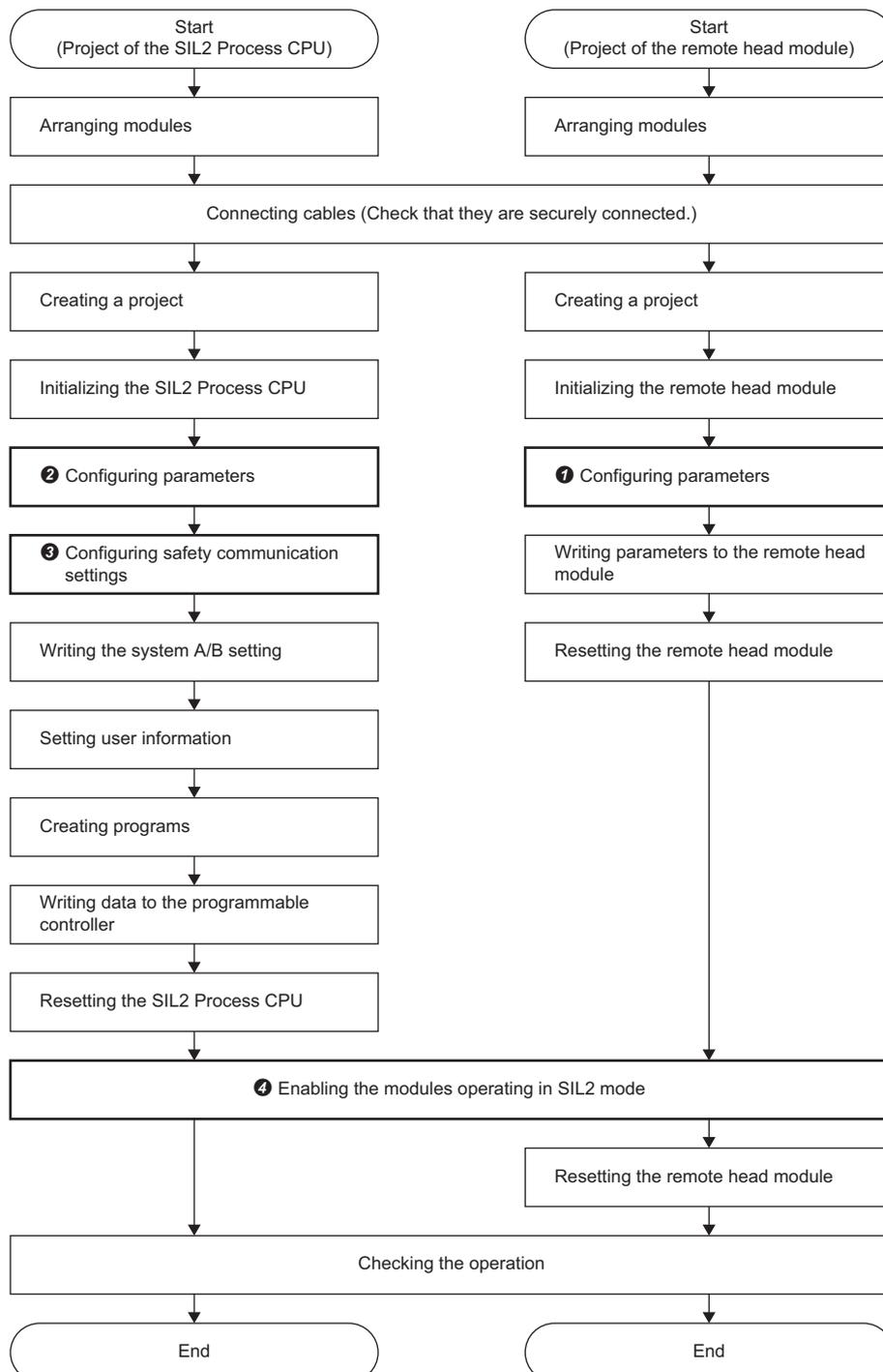
The safety standards conformance approval must be obtained for the customer with entire system. The system inspection is conducted for the entire system including safety components and programs.

Sample programs are shown in this manual. However, the safety standards approval is not obtained.

And all work for configuration of a system using the SIL2 Process CPU (such as design, installation, operation, and maintenance) has to be handled by qualified personnel with knowledge of safety standards, safety devices, and SIL2 compliant programmable controller.

Start-up procedure

For start-up of a system using the SIL2 Process CPU, the procedure for the project of the SIL2 Process CPU and for the project of the remote head module are available. For the settings of each module, refer to the manual for the module used.



Parameter settings for project of remote head module

Create a project of the remote head module and set the system parameters, CPU parameters, and module parameters of each module. (❶ in the flow chart on the previous page)

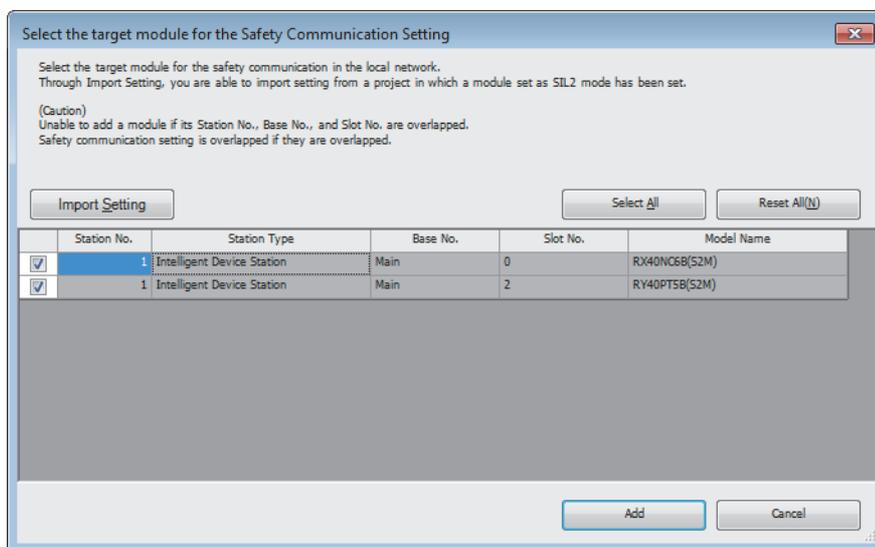
Parameter settings for project of SIL2 Process CPU

Create a project of the SIL2 Process CPU and set the system parameters, CPU parameters, and module parameters of each module. (❷ in the flow chart on the previous page)

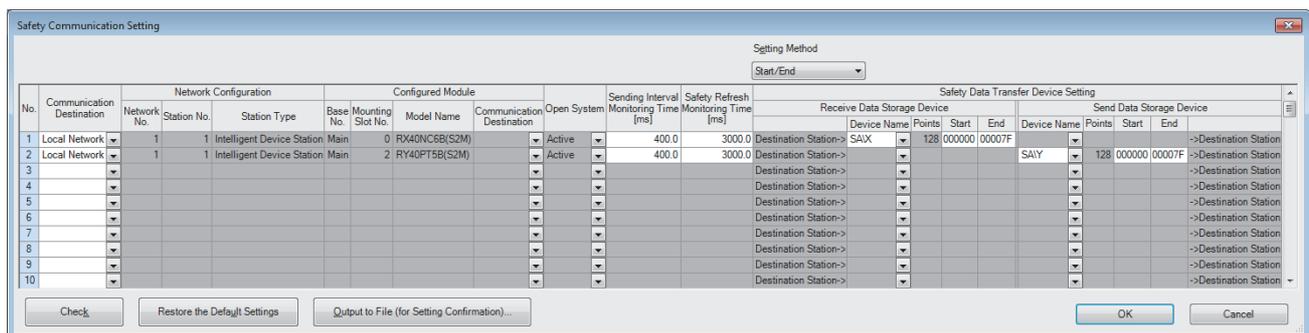
Safety communication settings

Import the parameter information on the modules set to SIL2 mode from the project of the remote head module created in ❶ and configure the safety communication settings. (❸ in the flow chart on the previous page)

1. Select a communication destination in the "Safety Communication Setting" window of the master station.
2. In the "Select the target module for the Safety Communication Setting" window, click the [Import Setting] button, select the project of the remote head module created in ❶, and add the information on the modules set to SIL2 mode.



3. Set "Sending Interval Monitoring Time", "Safety Refresh Monitoring Time", and "Safety Data Transfer Device Setting" for the modules set to SIL2 mode that are added to the safety communication settings.



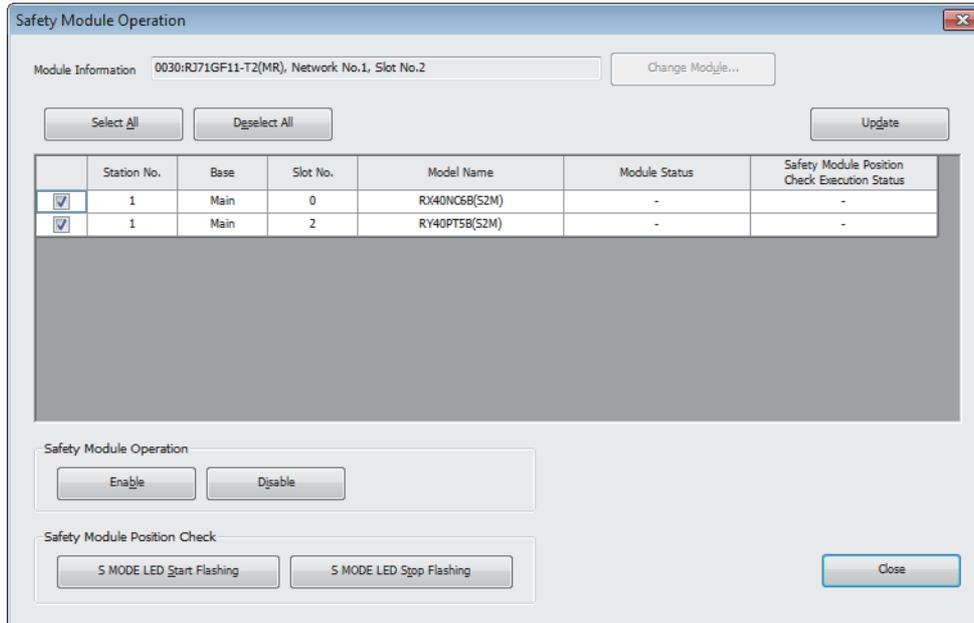
Enabling modules operating in SIL2 mode

Check the parameters set to SIL2 mode, and enable the safety module to enable the parameters. (④ in the flow chart on the previous page) Configure the safety communication settings first. The modules set in the safety communication settings are reflected in the "Safety Module Operation" window.

For details, refer to the manual for the module that operates in SIL2 mode.

1. Open the "Safety Module Operation" window. Check that the modules set to SIL2 mode are assigned to positions intended in the design phase, using the buttons in "Safety Module Position Check".

 [Online] ⇨ [Safety PLC Operation] ⇨ [Safety Module Operation]



2. Click the [Enable] button of "Safety Module Operation" in the "Safety Module Operation" window to enable set parameters.

Things to check at start-up

Connect a personal computer on which the engineering tool is installed to the SIL2 Process CPU when setting application programs and parameters. When starting up a new system or changing existing system, check the following.

Settings for network connection configuration

Check the parameter settings of the modules set to SIL2 mode at the site are configured as designed. Read the parameters of the remote head module mounted with the modules set to SIL2 mode to visually check if the parameters are consistent with the set values.

Open the "Safety Module Operation" window on the engineering tool. Check that the modules set to SIL2 mode are assigned to positions intended in the design phase, using the buttons in "Safety Module Position Check".

Enable the set parameters of the modules set to SIL2 mode by enabling the safety module.

For the setting procedure, refer to the following.

 Page 33 Start-up procedure

Also check if the SIL2 Process CPU at the site is installed in the designed position. Connect the SIL2 Process CPU with a personal computer on which the engineering tool is installed with an USB cable and check the consistency using verification with the programmable controller.

For the checking method, refer to the following.

 GX Works3 Operating Manual

Parameters and programs

Before writing parameters and programs to the programmable controller, check that they are configured as designed. For how to set parameters using the engineering tool, refer to the following.

 GX Works3 Operating Manual

For the definitions and setting ranges of each parameter, refer to the manual for the module used.

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

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

Checklist

Before starting operation, check if the system using the SIL2 Process CPU is correctly configured using the checklist.

For the check list, refer to the following.

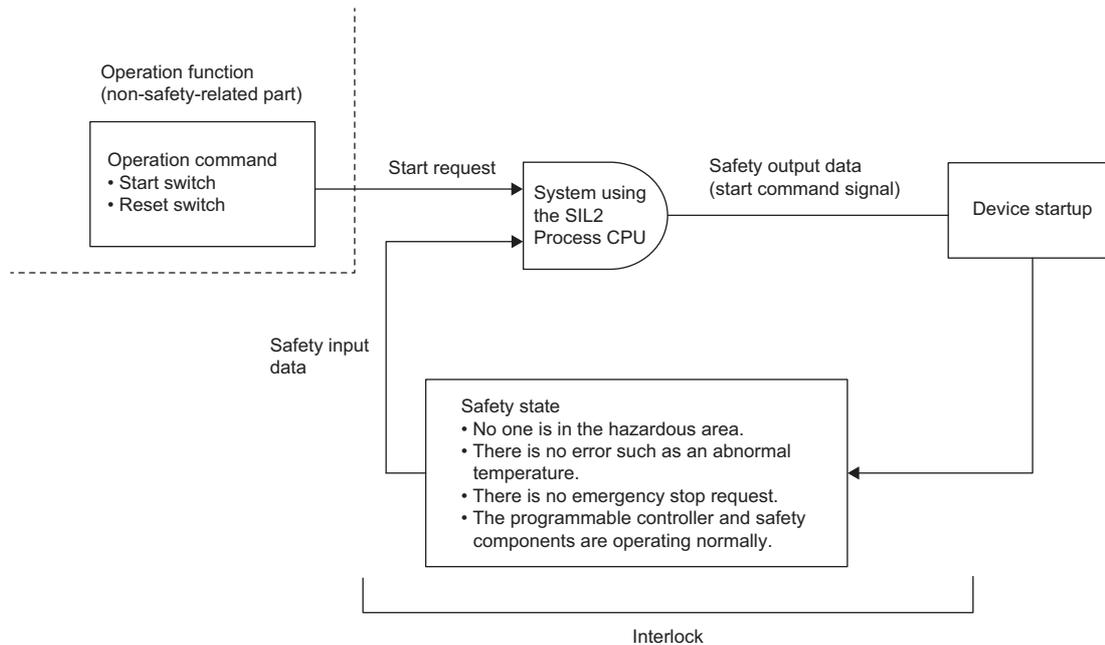
 Page 102 Checklist

Prerequisite for application program

Basic programming

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

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



Creating programs for realizing the safety functions

A program for safety functions is classified as a safety program. A safety program file is distinct from program files for standard programs that describe standard control.

For safety programs, use only safety devices, safety labels, standard/safety shared labels, instructions for safety measure, and safety function blocks, and safety functions.

For details on the devices and labels used in safety programs, refer to the following.

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

I/O data to be used in a program for realizing safety functions

Configure I/O data of a program for realizing safety functions using safety data. Determine the safety/non-safety of I/O data as follows.

■Safety data transfer device in safety communications with the modules set to SIL2 mode

The data in the safety data transfer device to be exchanged in safety communications between the SIL2 Process CPU and modules set to the SIL2 mode on CC-Link IE Field Network is safety data.

■Standard/safety shared label

The standard/safety shared label data are non-safety data. When using the standard/safety shared labels in a safety program, create the program so that the device operates only when safe state is secured. For example, if there are safety devices or safety labels to check safe state of input data from a connected safety device, combine the safety devices and safety labels to form an AND circuit.

Detecting errors in CC-Link IE Field Network

Errors occurred in 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 when an error is detected.

■Safety refresh communication status

The following table lists the names and numbers of special register areas for checking safety refresh communication status of 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 area 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 of the special register areas (safety refresh communication status)																																																																																																																																																									
Safety refresh communication status of each safety connection (1st module)	SA\SD1008 to SA\SD1015	<p>0: Safety communications normal, safety connection not used, own station</p> <p>1: Communication error</p> <ul style="list-style-type: none"> The communication status of safety stations connected to the 1st CC-Link IE Field Network module (the one whose start I/O number is stored in SD1904) is stored. A communication error means that the safety station is not in any of the communication states stored in SA\SD1104 to SA\SD1223. <table border="1"> <thead> <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> </thead> <tbody> <tr> <td>SA\SD1008</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\SD1009</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\SD1010</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\SD1011</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\SD1012</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\SD1013</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\SD1014</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\SD1015</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> <td></td> </tr> </tbody> </table> <p>1 to 120: Safety connection numbers —: Fixed to 0</p>		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\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																																																																																																																																												

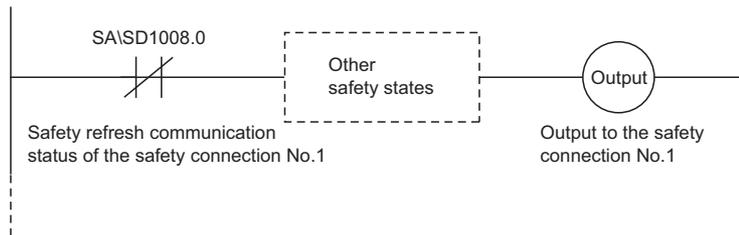
Name	No.	Description of bits of the special register areas (safety refresh communication status)
Safety refresh status of each safety connection (2nd module)	SA\SD1016 to SA\SD1023	0: Safety communications normal, safety connection not used, own station 1: Communication error <ul style="list-style-type: none"> The communication status of safety stations connected to the 2nd CC-Link IE Field Network module (the one whose start I/O number is stored in SD1905) is stored. A communication error means that the safety station is not in any of the communication states stored in SA\SD1104 to SA\SD1223. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Safety refresh status of each safety connection (3rd module)	SA\SD1024 to SA\SD1031	0: Safety communications normal, safety connection not used, own station 1: Communication error <ul style="list-style-type: none"> The communication status of safety stations connected to the 3rd CC-Link IE Field Network module (the one whose start I/O number is stored in SD1906) is stored. A communication error means that the safety station is not in any of the communication states stored in SA\SD1104 to SA\SD1223. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Safety refresh status of each safety connection (4th module)	SA\SD1032 to SA\SD1039	0: Safety communications normal, safety connection not used, own station 1: Communication error <ul style="list-style-type: none"> The communication status of safety stations connected to the 4th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1907) is stored. A communication error means that the safety station is not in any of the communication states stored in SA\SD1104 to SA\SD1223. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Safety refresh status of each safety connection (5th module)	SA\SD1040 to SA\SD1047	0: Safety communications normal, safety connection not used, own station 1: Communication error <ul style="list-style-type: none"> The communication status of safety stations connected to the 5th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1908) is stored. A communication error means that the safety station is not in any of the communication states stored in SA\SD1104 to SA\SD1223. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Safety refresh status of each safety connection (6th module)	SA\SD1048 to SA\SD1055	0: Safety communications normal, safety connection not used, own station 1: Communication error <ul style="list-style-type: none"> The communication status of safety stations connected to the 6th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1909) is stored. A communication error means that the safety station is not in any of the communication states stored in SA\SD1104 to SA\SD1223. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Safety refresh status of each safety connection (7th module)	SA\SD1056 to SA\SD1063	0: Safety communications normal, safety connection not used, own station 1: Communication error <ul style="list-style-type: none"> The communication status of safety stations connected to the 7th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1910) is stored. A communication error means that the safety station is not in any of the communication states stored in SA\SD1104 to SA\SD1223. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Safety refresh communication status of each safety connection (8th module)	SA\SD1064 to SA\SD1071	0: Safety communications normal, safety connection not used, own station 1: Communication error <ul style="list-style-type: none"> The communication status of safety stations connected to the 8th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1911) is stored. A communication error means that the safety station is not in any of the communication states stored in SA\SD1104 to SA\SD1223. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)

For details, refer to the following.

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

Program example

The following figure shows a program example for when a CC-Link IE Field Network error is detected in the first CC-Link IE Field Network master/local module on the base unit. In the following example, the safety refresh communication status of the safety connection number 1 is checked with SA\SD1008.0 and an output is performed to the safety connection number 1.



Clearing error in CC-Link IE Field Network

If a CC-Link IE Field Network error is detected, the special register areas for the safety station interlock status shown in the following table turn on. Create a program using safety station interlock status, which turns off safety outputs when an error is detected. For restarting communications on CC-Link IE Field Network, the special register areas for the safety station interlock release requests listed in the following table need to be turned on. Create a program that turns on the safety station interlock release requests by a manual operation such as pressing the reset button.

Safety station interlock status

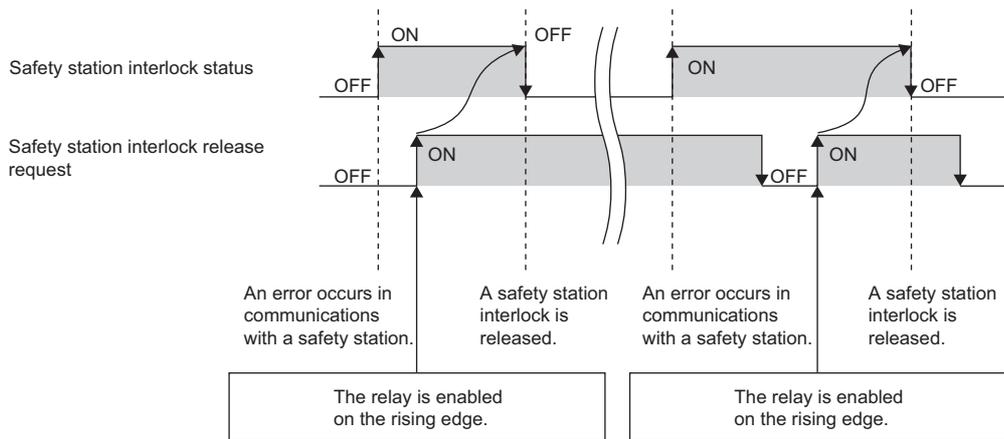
The following table lists the names and numbers of special register areas for checking safety station interlock status and interlock release request.

Name	No.	Description of bits of special register areas																																																																																																																																																										
Interlock status of each safety connection (1st module)	SA\SD1232 to SA\SD1239	<p>0: Not interlocked 1: Interlocked</p> <p>After safety communication error is detected and the safety connection is interlocked, the bit corresponding to the safety connection turns on.</p> <table border="1"> <thead> <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> </thead> <tbody> <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>—</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> </tbody> </table> <p>1 to 120: Safety connection numbers —: Fixed to 0</p>		b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0	SA\SD1232	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	SA\SD1233	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	SA\SD1234	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	SA\SD1235	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	SA\SD1236	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	SA\SD1237	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	SA\SD1238	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97	SA\SD1239	—	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113
	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0																																																																																																																																												
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SA\SD1233	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17																																																																																																																																												
SA\SD1234	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33																																																																																																																																												
SA\SD1235	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49																																																																																																																																												
SA\SD1236	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65																																																																																																																																												
SA\SD1237	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81																																																																																																																																												
SA\SD1238	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97																																																																																																																																												
SA\SD1239	—	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113																																																																																																																																											
Interlock release request for each safety connection (1st module)	SA\SD1240 to SA\SD1247	<p>0: Do not release the interlock. 1: Release the interlock.</p> <p>Turn off and on the bit corresponding to the safety connection to release the interlock. (The bit does not automatically turn off after execution is complete.)*¹</p> <table border="1"> <thead> <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> </thead> <tbody> <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>—</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> </tbody> </table> <p>1 to 120: Safety connection numbers —: Fixed to 0</p>		b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0	SA\SD1240	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	SA\SD1241	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	SA\SD1242	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	SA\SD1243	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	SA\SD1244	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	SA\SD1245	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	SA\SD1246	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97	SA\SD1247	—	—	—	—	—	—	—	—	—	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\SD1240	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1																																																																																																																																												
SA\SD1241	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17																																																																																																																																												
SA\SD1242	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33																																																																																																																																												
SA\SD1243	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49																																																																																																																																												
SA\SD1244	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65																																																																																																																																												
SA\SD1245	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81																																																																																																																																												
SA\SD1246	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97																																																																																																																																												
SA\SD1247	—	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113																																																																																																																																											
Interlock status of each safety connection (2nd module)	SA\SD1248 to SA\SD1255	<p>0: Not interlocked 1: Interlocked</p> <p>After safety communication error is detected and the safety connection is interlocked, the bit corresponding to the safety connection turns on.</p> <p>The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)</p>																																																																																																																																																										

Name	No.	Description of bits of special register areas
Interlock release request for each safety connection (2nd module)	SA\SD1256 to SA\SD1263	0: Do not release the interlock. 1: Release the interlock. Turn off and on the bit corresponding to the safety connection to release the interlock. (The bit does not automatically turn off after execution is complete.) ^{*1} The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock status of each safety connection (3rd module)	SA\SD1264 to SA\SD1271	0: Not interlocked 1: Interlocked After safety communication error is detected and the safety connection is interlocked, the bit corresponding to the safety connection turns on. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock release request for each safety connection (3rd module)	SA\SD1272 to SA\SD1279	0: Do not release the interlock. 1: Release the interlock. Turn off and on the bit corresponding to the safety connection to release the interlock. (The bit does not automatically turn off after execution is complete.) ^{*1} The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock status of each safety connection (4th module)	SA\SD1280 to SA\SD1287	0: Not interlocked 1: Interlocked After safety communication error is detected and the safety connection is interlocked, the bit corresponding to the safety connection turns on. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock release request for each safety connection (4th module)	SA\SD1288 to SA\SD1295	0: Do not release the interlock. 1: Release the interlock. Turn off and on the bit corresponding to the safety connection to release the interlock. (The bit does not automatically turn off after execution is complete.) ^{*1} The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock status of each safety connection (5th module)	SA\SD1296 to SA\SD1303	0: Not interlocked 1: Interlocked After safety communication error is detected and the safety connection is interlocked, the bit corresponding to the safety connection turns on. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock release request for each safety connection (5th module)	SA\SD1304 to SA\SD1311	0: Do not release the interlock. 1: Release the interlock. Turn off and on the bit corresponding to the safety connection to release the interlock. (The bit does not automatically turn off after execution is complete.) ^{*1} The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock status of each safety connection (6th module)	SA\SD1312 to SA\SD1319	0: Not interlocked 1: Interlocked After safety communication error is detected and the safety connection is interlocked, the bit corresponding to the safety connection turns on. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock release request for each safety connection (6th module)	SA\SD1320 to SA\SD1327	0: Do not release the interlock. 1: Release the interlock. Turn off and on the bit corresponding to the safety connection to release the interlock. (The bit does not automatically turn off after execution is complete.) ^{*1} The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock status of each safety connection (7th module)	SA\SD1328 to SA\SD1335	0: Not interlocked 1: Interlocked After safety communication error is detected and the safety connection is interlocked, the bit corresponding to the safety connection turns on. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock release request for each safety connection (7th module)	SA\SD1336 to SA\SD1343	0: Do not release the interlock. 1: Release the interlock. Turn off and on the bit corresponding to the safety connection to release the interlock. (The bit does not automatically turn off after execution is complete.) ^{*1} The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)

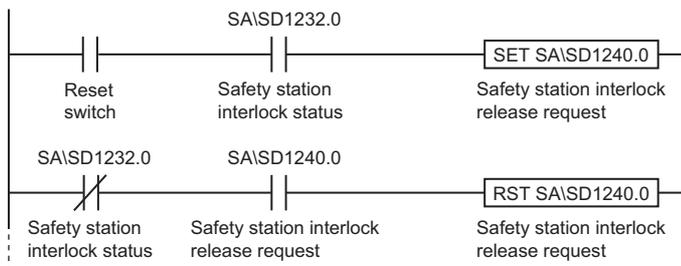
Name	No.	Description of bits of special register areas
Interlock status of each safety connection (8th module)	SA\SD1344 to SA\SD1351	0: Not interlocked 1: Interlocked After safety communication error is detected and the safety connection is interlocked, the bit corresponding to the safety connection turns on. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)
Interlock release request for each safety connection (8th module)	SA\SD1352 to SA\SD1359	0: Do not release the interlock. 1: Release the interlock. Turn off and on the bit corresponding to the safety connection to release the interlock. (The bit does not automatically turn off after execution is complete.)* ¹ The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)

*1 A safety station interlock release request is executed when the bit rises, and the interlock status is then released. To release the interlock again, it is necessary to turn the request off and on again. After eliminating the cause of any communication errors, turn on the request with the SIL2 Process CPU. When performing safety communications between SIL2 Process CPUs, perform this operation with both SIL2 Process CPUs.



Program example of releasing interlock

The following figure shows a program example for releasing a CC-Link IE Field Network interlock of the first CC-Link IE Field Network master/local module on the base unit. In the following example, the safety station interlock status of the safety connection number 1 is checked with SA\SD1232.0 and the interlock of the safety connection number 1 is released.



Safety I/O hold

By setting the safety I/O hold time, the time to detect safety communication timeout can be delayed and thus the output value can be held after systems are switched. While the safety I/O is held, the special register areas for safety I/O hold status listed in the following list turn on.

■ Safety I/O hold status

The following table lists the names and numbers of special register areas for checking safety I/O hold status of each safety connection.

Name	No.	Description of bits of special register areas																																																																																																																																																									
Safety I/O hold status of each safety connection (1st module)	SA\SD1600 to SA\SD1607	<p>0: Not holding safety I/O 1: Holding safety I/O</p> <p>The safety I/O hold status of safety stations connected to the 1st CC-Link IE Field Network module (the one whose start I/O number is stored in SD1904) is stored.</p> <table border="1"> <thead> <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> </thead> <tbody> <tr> <td>SA\SD1600</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\SD1601</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\SD1602</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\SD1603</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\SD1604</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\SD1605</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\SD1606</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\SD1607</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> </tbody> </table> <p>1 to 120: Safety connection numbers —: Fixed to 0</p>		b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0	SA\SD1600	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	SA\SD1601	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	SA\SD1602	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	SA\SD1603	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	SA\SD1604	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	SA\SD1605	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81	SA\SD1606	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97	SA\SD1607	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113
	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0																																																																																																																																											
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SA\SD1602	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33																																																																																																																																											
SA\SD1603	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49																																																																																																																																											
SA\SD1604	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65																																																																																																																																											
SA\SD1605	96	95	94	93	92	91	90	89	88	87	86	85	84	83	82	81																																																																																																																																											
SA\SD1606	112	111	110	109	108	107	106	105	104	103	102	101	100	99	98	97																																																																																																																																											
SA\SD1607	—	—	—	—	—	—	—	—	120	119	118	117	116	115	114	113																																																																																																																																											
Safety I/O hold status of each safety connection (2nd module)	SA\SD1608 to SA\SD1615	<p>0: Not holding safety I/O 1: Holding safety I/O</p> <p>The safety I/O hold status of safety stations connected to the 2nd CC-Link IE Field Network module (the one whose start I/O number is stored in SD1905) is stored. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)</p>																																																																																																																																																									
Safety I/O hold status of each safety connection (3rd module)	SA\SD1616 to SA\SD1623	<p>0: Not holding safety I/O 1: Holding safety I/O</p> <p>The safety I/O hold status of safety stations connected to the 3rd CC-Link IE Field Network module (the one whose start I/O number is stored in SD1906) is stored. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)</p>																																																																																																																																																									
Safety I/O hold status of each safety connection (4th module)	SA\SD1624 to SA\SD1631	<p>0: Not holding safety I/O 1: Holding safety I/O</p> <p>The safety I/O hold status of safety stations connected to the 4th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1907) is stored. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)</p>																																																																																																																																																									
Safety I/O hold status of each safety connection (5th module)	SA\SD1632 to SA\SD1639	<p>0: Not holding safety I/O 1: Holding safety I/O</p> <p>The safety I/O hold status of safety stations connected to the 5th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1908) is stored. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)</p>																																																																																																																																																									
Safety I/O hold status of each safety connection (6th module)	SA\SD1640 to SA\SD1647	<p>0: Not holding safety I/O 1: Holding safety I/O</p> <p>The safety I/O hold status of safety stations connected to the 6th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1909) is stored. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)</p>																																																																																																																																																									
Safety I/O hold status of each safety connection (7th module)	SA\SD1648 to SA\SD1655	<p>0: Not holding safety I/O 1: Holding safety I/O</p> <p>The safety I/O hold status of safety stations connected to the 7th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1910) is stored. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)</p>																																																																																																																																																									
Safety I/O hold status of each safety connection (8th module)	SA\SD1656 to SA\SD1663	<p>0: Not holding safety I/O 1: Holding safety I/O</p> <p>The safety I/O hold status of safety stations connected to the 8th CC-Link IE Field Network module (the one whose start I/O number is stored in SD1911) is stored. The bit arrangement of the safety connection number is the same as that of the 1st module. (Note that the SA\SD numbers differ.)</p>																																																																																																																																																									

For details, refer to the following.

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

3 PRECAUTIONS

3.1 Precautions for Developing Safety Requirements for Applications

Develop the safety requirements for applications based on the safety requirements specifications and architecture of the system considered by the customer. Include the following items in the safety requirements for applications.

- Requirements for each safety function
- Restrictions related to hardware and software when the SIL2 Process CPU and modules that support the SIL2 mode are used
- Requirements described in the safety plan created by the customer

3.2 Precautions for Designing Applications

Safety response time

The safety response time is a time taken from when a safety input turns off to when a safety output turns off through the SIL2 Process CPU.

For calculation of the response time of a system to be configured, refer to the following description.

 Page 97 Calculation Method of Safety Response Time

Calculation of the target failure measure (PFDavg/PFH)

The target failure measure (PFDavg/PFH) is a target value of reliability for each SIL level defined in IEC 61508:2010.

When a system is configured using SIL2 Process CPUs, one SIL2 application shall configure safety paths which include safety input devices through to safety output devices.

Calculate the PFDavg/PFH for each SIL2 application using the following formula. If a safety path goes through modules set to SIL2 mode multiple times, add PFDavg/PFH values as many times as the safety path goes through those modules.

$$\text{PFDavg/PFH} = (\text{PFDavg/PFH of A}) + (\text{PFDavg/PFH of B}) \times \alpha^{*5} + (\text{PFDavg/PFH of C}) \times \beta^{*5*6} + (\text{PFDavg/PFH of D}) + (\text{PFDavg/PFH of E})$$

Variable	Definition
A ^{*1}	SIL2 Process CPU (paired with SIL2 function module)
B ^{*2*4*7}	Module set to SIL2 mode to which safety input devices are connected
C ^{*2*4}	Module set to SIL2 mode to which safety output devices are connected
D ^{*3*4}	Safety input device
E ^{*3*4}	Safety output device

*1 When performing safety communications between SIL2 Process CPUs on a safety path, add PFDavg/PFH of the SIL2 Process CPU (paired with the SIL2 function module) performing safety communications on the safety path. Add no PFDavg/PFH of the SIL2 Process CPU (paired with the SIL2 function module) not performing safety communications on the safety path, even though it is on the same network.

*2 Use PFDavg/PFH of the module set to SIL2 mode used.

*3 For PFDavg and PFH, refer to the manuals for the safety components used.

*4 When a SIL2 application includes multiple safety input devices and safety output devices, add all PFDavg/PFH values of these devices and the modules set to SIL2 mode to which they are connected.

*5 When multiple inputs and outputs of a module set to SIL2 mode are used in a SIL2 application, multiply PFDavg/PFH of the module by the input points and output points.

*6 Add this value only when using the RY40PT5B.

*7 When using a temperature input system in a system using the SIL2 Process CPU, add PFDavg/PFH values of signal converters used.

The following table lists PFDavg/PFH of each module.

Module	Proof test interval*8		
	2 years	5 years	10 years
PFDavg of the SIL2 Process CPU (paired with SIL2 function module)*9	5.83×10^{-6}	2.08×10^{-5}	6.23×10^{-5}
PFDavg of the input module with diagnostic functions*9	8.70×10^{-6}	2.49×10^{-5}	6.06×10^{-5}
PFDavg of the output module with diagnostic functions*9	4.64×10^{-6}	1.26×10^{-5}	2.87×10^{-5}
PFDavg of the A/D converter module*9	2.48×10^{-5}	8.13×10^{-5}	—
PFDavg of the D/A converter module*9	7.28×10^{-4}	1.82×10^{-3}	—

Module	Proof test interval*8		
	2 years	5 years	10 years
PFH of the SIL2 Process CPU (paired with SIL2 function module)*9	7.61×10^{-10}	1.19×10^{-9}	1.90×10^{-9}
PFH of the input module with diagnostic functions*9	1.04×10^{-9}	1.26×10^{-9}	1.63×10^{-9}
PFH of the output module with diagnostic functions*9	5.46×10^{-10}	6.16×10^{-10}	7.35×10^{-10}
PFH of the A/D converter module*9	9.11×10^{-9}	1.04×10^{-8}	—
PFH of the D/A converter module*9	8.65×10^{-8}	8.66×10^{-8}	—

*8 Each proof test interval is the duration of product use.

*9 The PFDavg and PFH values are for when the module is used at the ambient temperature of 40°C.

Output value when an error is detected

When an error is detected in a system using the SIL2 Process CPU, the safety digital output turns off and safety analog output becomes 0V and 0mA.

Use of the monitor data of the engineering tool

Do not use the monitor data displayed in the engineering tool for operations related to the safety. (For example, do not start a device or reset the stop state based on the monitor data of the engineering tool.)

3.3 Precautions for Programming

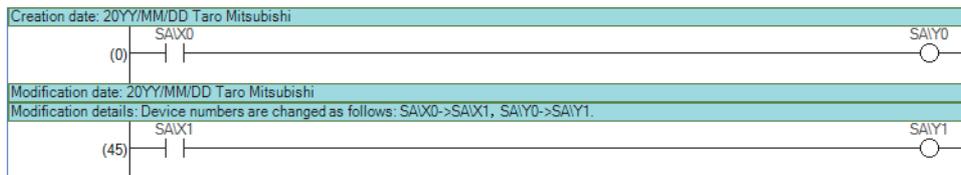
Restrictions related to application program development

Application programs have to be developed by qualified personnel with knowledge of safety standards, safety devices, and SIL2 compliant programmable controller.

When developing programs according to this manual, manage the version of the manual and always use the latest version.

Version management of engineering tool project files

Enter the created date and author at the beginning of a program using the statement function of the engineering tool. When modifying a program, manage the revision history. To manage the revision history, enter information (what changes are made when and by whom) at the modified location using the statement function.



Also manage the project data written to the SIL2 Process CPU by storing them to the hard disk of a personal computer or CDs.

User authentication

Define the user who handles the project and the access level and register the user information required for logon in the project and SIL2 Process CPU. For the user authentication function, refer to the following.

📖 GX Works3 Operating Manual

3.4 Precautions for Safety Functions Maintenance

Periodic inspection

Perform periodic inspections for ensuring the components such as the emergency stop switch and safety sensors are not faulty.

Perform diagnostics on the connected input devices and output devices as well as on the programmable controller to test the safety functions.

Safety operation mode while in operation

Set the safety operation mode of the SIL2 Process CPU to safety mode in actual operation. Switch the safety operation mode on the engineering tool window as follows: [Online] ⇒ [Safety PLC Operation] ⇒ [Safety Operation Mode Switch]. For details on how to switch the safety operation mode, refer to the following.

📖 GX Works3 Operating Manual

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

Safety data identify check for SIL2 Process CPU

Periodically check programs or parameters of the SIL2 Process CPU for unauthorized alteration, using the safety data identify check. When changing the safety operation mode to SAFETY MODE after writing safety programs and safety parameters to the SIL2 Process CPU, refer to information on the safety data identify check of the SIL2 Process CPU using the engineering tool and record the information separately.

- Periodically refer to the information on the safety data identify check to ensure that no unauthorized alterations take place.
- If an unauthorized alternation is found, stop operation. Restore the proper project using the 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 SIL2 Process CPU and project files of the engineering tool are protected by passwords 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

4 PROGRAM EXAMPLES

This chapter describes program examples of the system using the SIL2 Process CPU.

4.1 I/O Module with Diagnostic Functions

With the safety input device, this safety program stops the devices connected to the safety output devices. This program controls the start and stop of devices by turning on or off the main contact of the electromagnetic contactor which starts and stops of a device at the safety output device contact.

Connect a safety input device and safety output devices to the I/O modules with diagnostic functions that operates in SIL2 mode.

The SIL2 Process CPU turns on/off the safety output devices with program.

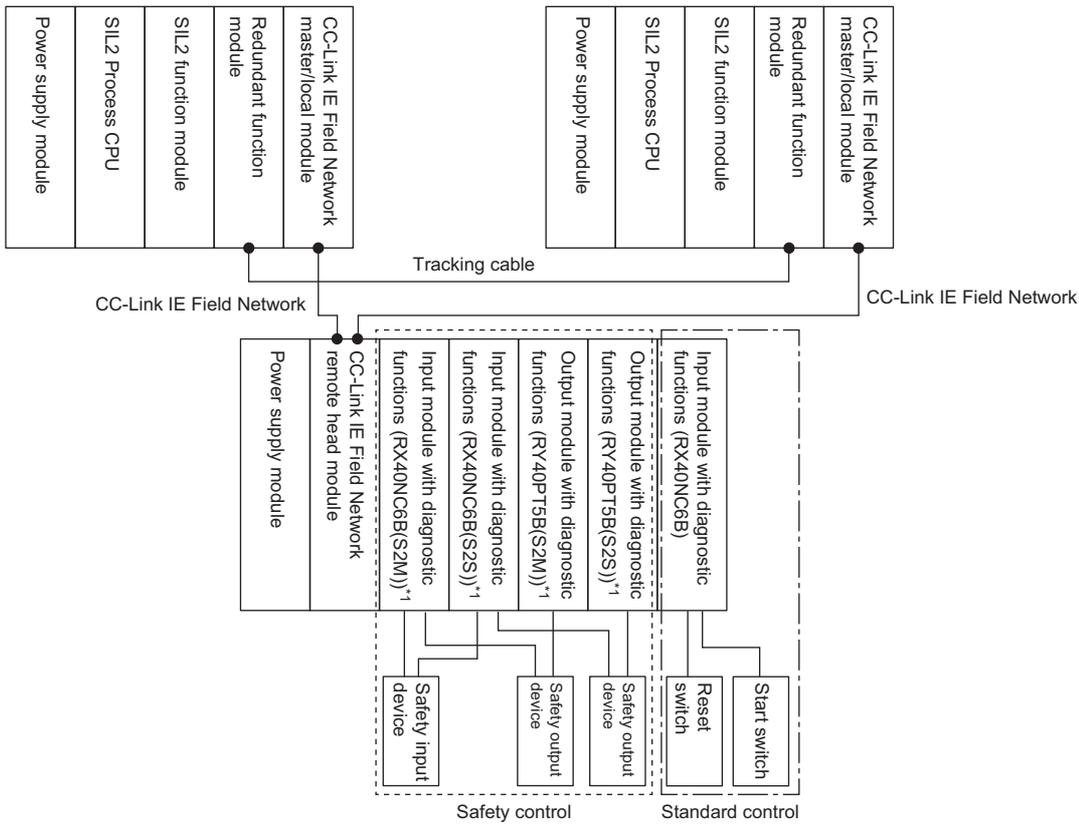
When the I/O modules with diagnostic functions detect an error with the diagnostics function, outputs to the safety output devices turn off independent of the program. In this case, regardless of the program, the outputs remain off until the error clear request is performed for a minor error, and until the I/O modules with diagnostic functions are reset for a moderate error.

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

- 1.** After ensuring safety (the input from the safety input device is on), the operator shall press the reset switch first. Pressing the start switch turns on the safety output device.
- 2.** When a safety output device is welded, input the safety output device (normally closed contact) to the input module with diagnostic functions to prevent starting, and check for welding.
- 3.** To avoid undesired operation of the reset switch and start switch at 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 to the safety output device when the input from the safety input device is turned off after the operation is started or when an error is detected in safety communications. Even when an error is detected in safety communications, the output is maintained within the time set in "Safety I/O Hold Time" of "CPU Parameter".

System configuration

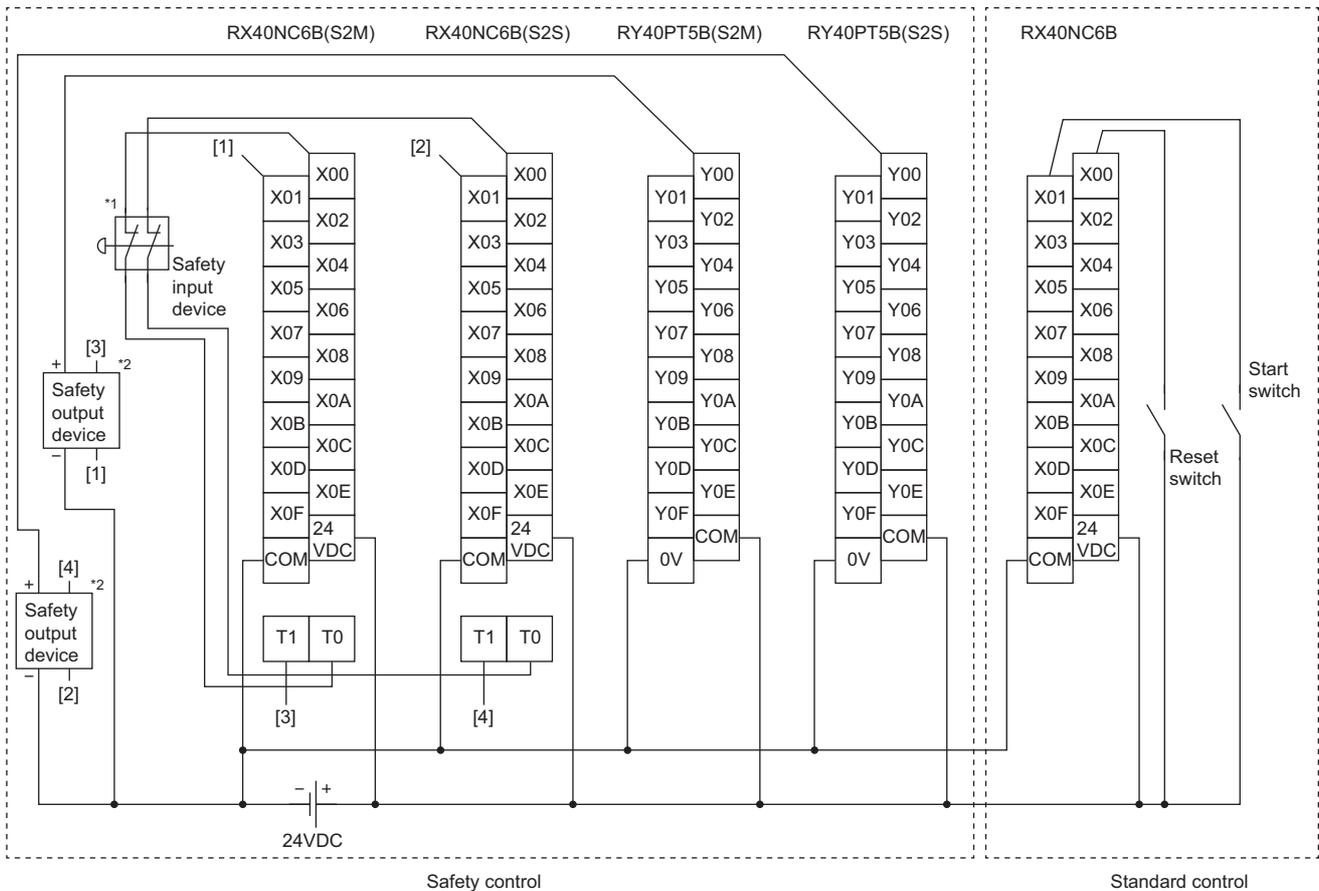
Configure the system with the redundant master station as shown below.



*1 The models to be selected in the engineering tool are S2M for Main, and S2S for Sub.

Wiring diagram

Wire the safety input device, safety output devices, reset switch, start switch, and I/O modules with diagnostic functions as shown below.



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

- *1 Connect a safety input device that has two normally closed contacts with direct opening mechanism between the input terminals and test pulse terminals.
- *2 Connect each normally closed contact of the safety output devices between the input terminal and test pulse terminal.

Parameter setting

This section describes the settings required for each module to run this program example. For setting items that are not described, use the default settings. For details on each parameter setting method, refer to the manual of the module used.

Parameter settings for the project of the remote head module

1. Set the following parameters in the network required setting.

- "Network No.": 1
- "Station No.": 2

 [CPU Parameter] ⇒ [Network Required Setting]

Item	Setting
Network No.	
Network No.	1
Station No.	
Station No.	2

2. Set the following parameters in the basic settings of the input module with diagnostic functions (RX40NC6B(S2M)).

- "Wiring input selection" of "X00" and "X01": "Redundant (NC/NC)"

 [Module Parameter] of the RX40NC6B(S2M) ⇒ [Basic Settings]

Item	X00	X01	X02	X03	X04
LED display settings during an error	Set the LED display method during an error condition				
LED display settings during an error	Do not display I/O error				
Input response time	Set the input response time of input signals in increments of one point.				
Input response time	10ms	10ms	10ms	10ms	10ms
Transmission interval monitoring time	Set the transmission interval monitoring time for safety data.				
Transmission interval monitoring time	400 ms				
Wiring input selection	Set the wiring method of inputs in increments of one point.				
Wiring input selection	Redundant (NC/N	Redundant (NC/N	Not used	Not used	Not used

3. Set the following parameters in the application settings of the input module with diagnostic functions (RX40NC6B(S2M)).

- "Redundant input discrepancy detection time" of "X00" and "X01": 10 × 10ms
- "Redundant input discrepancy detection settings" of "X02" to "X0F": "Enabled"
- "Input dark test execution setting" of "X02" to "X0F": "Do not perform"

 [Module Parameter] of the RX40NC6B(S2M) ⇒ [Application Settings]

Item	X00	X01	X02	X03	
Redundant input discrepancy detection function	This function identifies failures by monitoring redundant input signals for a				
Redundant input discrepancy detection settings	Disabled	Disabled	Enabled	Enabled	Enable
Redundant input discrepancy detection type	Discrepancy dete	Discrepancy dete	Discrepancy dete	Discrepancy dete	Discre
Auto recovery settings after discrepancy error	Not used				
Redundant input discrepancy detection time	10 x10ms	10 x10ms	1 x10ms	1 x10ms	1 x10n
Input dark test function	This function outputs test pulses to turn off the inputs that are on and dia				
Input dark test execution setting	Perform	Perform	Do not perform	Do not perform	Do not
Input dark test pulse OFF time	1ms				
Number of pulses output for input dark test	1 time				

4. Set the following parameters in the basic settings of the output module with diagnostic functions (RY40PT5B(S2M)).

- "Wiring output selection" of "Y00": "Double wiring (Source/Source)"

 [Module Parameter] of the RY40PT5B(S2M) ⇨ [Basic Settings]

Item	Y00	Y01	Y02	Y03
<input type="checkbox"/> LED display settings during an error	Set the LED display method during an error condition			
LED display settings during an error	Do not display I/O error			
<input type="checkbox"/> Transmission interval monitoring time	Set the transmission interval monitoring time for safety data.			
Transmission interval monitoring time	400 ms			
<input type="checkbox"/> Wiring output selection	Set the wiring method of outputs in increments of one point.			
Wiring output selection	Double wiring (Source/Source)	Not used	Not used	Not used

5. Set the following parameters in the application settings of the output module with diagnostic functions (RY40PT5B(S2M)).

- "Output dark test execution setting" of "Y01" to "Y0F": "Do not perform"

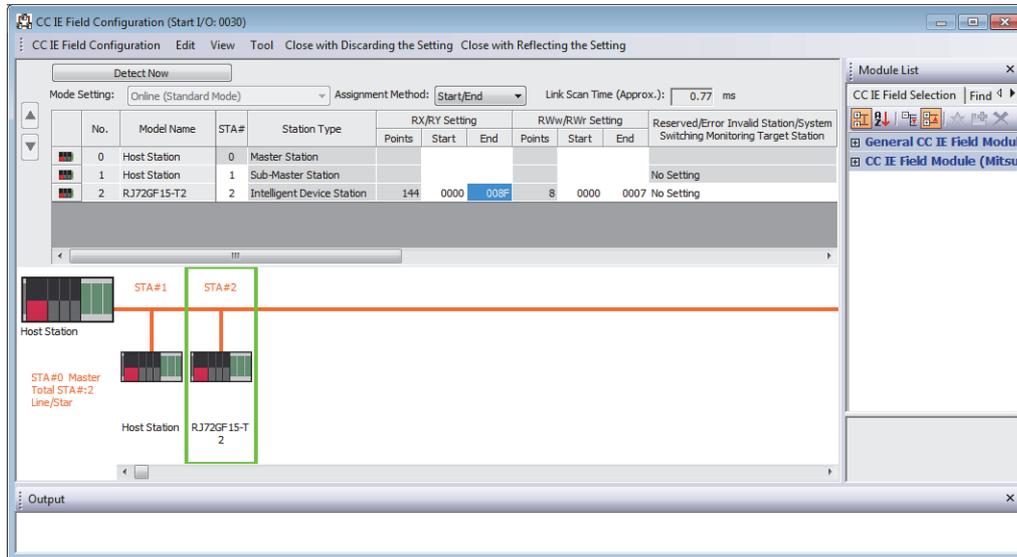
 [Module Parameter] of the RY40PT5B(S2M) ⇨ [Application Settings]

Item	Y00	Y01	Y02	Y03	Y04
<input type="checkbox"/> Output dark test function	This function outputs test pulses to turn off the outputs that are on and diagnoses				
Output dark test execution setting	Perform	Do not perform	Do not perform	Do not perform	Do not perform
Output dark test pulse OFF time	1ms	1ms	1ms	1ms	1ms
Number of pulses output for output dark test	1 time				

Parameter settings for the project of the SIL2 Process CPU

- Set the intelligent device station in the network configuration settings of the master/local module (RJ71GF11-T2). Set the intelligent device station to "RJ72GF15-T2". Then, change "End" of the RX/RX setting to "008F".

[Module Parameter] of the master/local module (RJ71GF11-T2) ⇒ [Basic Settings] ⇒ [Network Configuration Settings]



- Set the following parameters in the refresh settings of the master/local module (RJ71GF11-T2) as shown below.
 - Set "Device Name" under "Link Side" to "RX". Then, enter "00080" to "Start" and "0008F" to "End".
 - Set "Target" under "CPU Side" to "Specify Device". Then, set "Device Name" to "X" and enter "00080" to "Start".

[Module Parameter] of the master/local module (RJ71GF11-T2) ⇒ [Basic Settings] ⇒ [Refresh Setting]

No.	Link Side					CPU Side				
	Device Name	Points	Start	End		Target	Device Name	Points	Start	End
-	SB				↔					
-	Sw				↔					
1	RX	16	00080	0008F	↔	Specify Device	X	16	00080	0008F
2					↔					

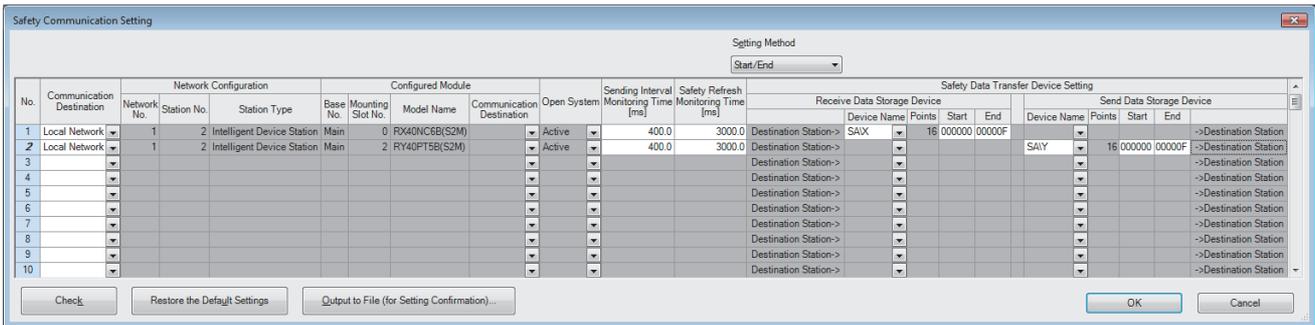
- Set "To Use or Not to Use the Safety Communication Setting" in the safety communication setting for the master/local module (RJ71GF11-T2) to "Use".

[Module Parameter] of the master/local module (RJ71GF11-T2) ⇒ [Application Settings] ⇒ [Safety Communication Setting]

Item	Setting
Safety Communication Setting	
To Use or Not to Use the Safety Communication Setting	Use
Safety Communication Setting	<Detailed Setting>

4. Double-click the [Detailed Setting] button in the safety communication setting for the master/local module (RJ71GF11-T2), and set the following.
 - Select "Communication Destination". In the "Select the target module for the Safety Communication Setting" window, click the [Import Setting] button to import the parameter information of the modules set to SIL2 mode from the project of the remote head module.
 - Select "SA\X" for "Device Name" in "Receive Data Storage Device" of the added input module with diagnostic functions (RX40NC6B(S2M)), and set "000000" for "Start" and "00000F" for "End".
 - Select "SA\Y" for "Device Name" in "Send Data Storage Device" of the added output module with diagnostic functions (RY40PT5B(S2M)), and set "000000" for "Start" and "00000F" for "End".

☞ [Module Parameter] of the master/local module (RJ71GF11-T2) ⇒ [Application Settings] ⇒ [Safety Communication Setting] ⇒ [Detailed Setting] button



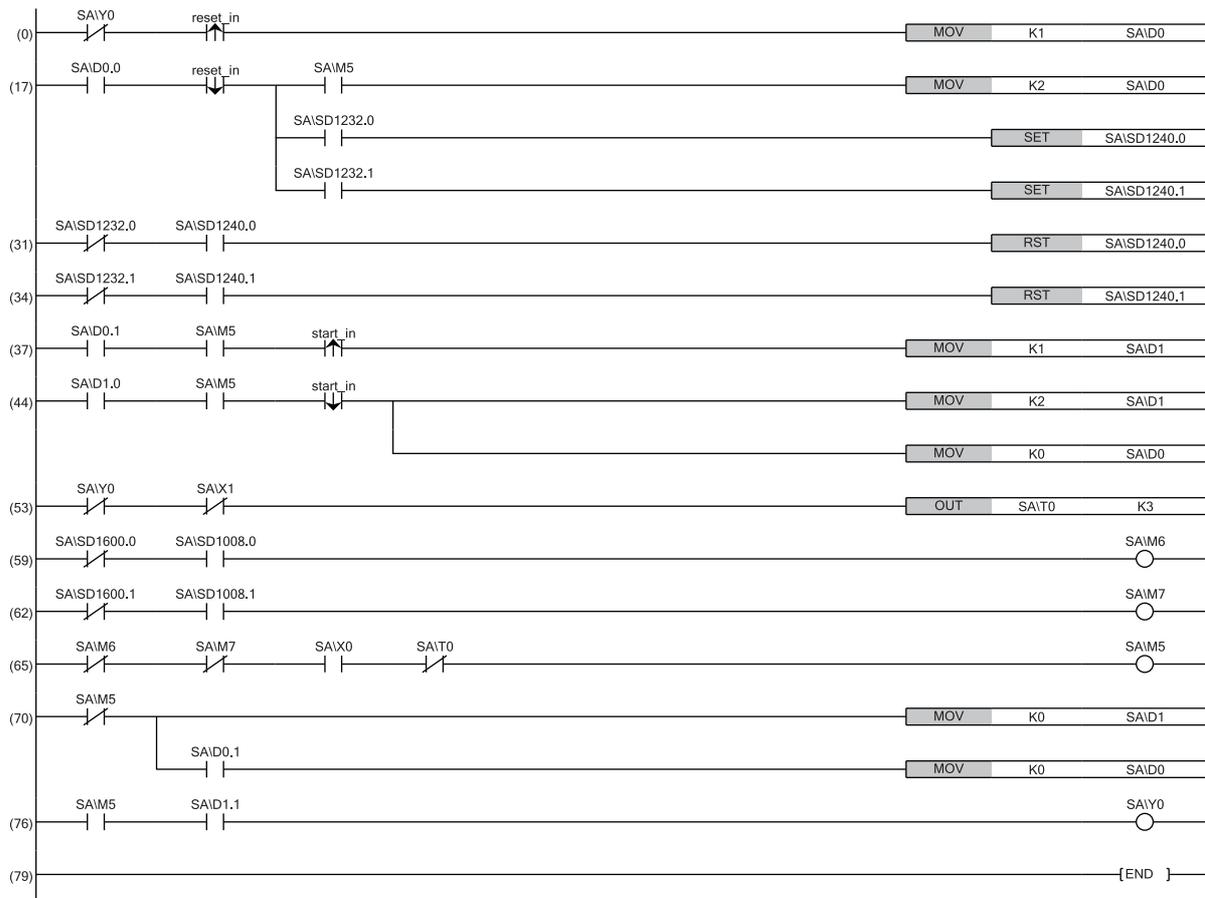
Safety devices and standard/safety shared labels to be used

Use the following safety devices and standard/safety shared labels for this program example.

Module	External device	Safety device and standard/safety shared label
RX40NC6B(S2M), RX40NC6B(S2S)	Safety input device	SA\X0
	Safety output device (for welding check)	SA\X1
RY40PT5B(S2M), RY40PT5B(S2S)	Safety output device	SA\Y0
RX40NC6B	Reset switch	reset_in
	Start switch	start_in

Program example

Create the following program as a safety program.



- (0) (17) The falling edge of the reset switch (on to off) is checked. When the safety status is on, the restart processing is completed. If the safety station is interlocked, turn on the safety station interlock release request.
- (31) (34) After the release of the safety station interlock is checked, turn off the safety station interlock release request.
- (37) (44) After the safety status (on) and the falling edge of the start switch (on to off) are checked, the start processing is completed.
- (53) When the output of the safety output device is off and the input from the normally closed contact of the safety input device is off, welding is detected,
- (59) (62) Insert an interlock so that a safety communication error is not detected while the safety I/O hold status of each safety connection is on even when the safety refresh status of each safety connection is on in a system switching.
- (65) The safety status turn on when the device is ready for start and operation.
- (70) When the safety status is off, the initial state of the start status and restart status is restored.
- (76) When the safety status is on and the start processing is complete, the output to the safety output device turns on.

■Way of using the safety user devices

The following table lists the safety user devices used in this program example.

Safety user device	Description
SAID0	<p>This is used as the restart status.</p> <ul style="list-style-type: none"> ❶ SAID0 = 0: The device is initial state or the start processing has been completed. ❷ SAID0 = 1 (SAID0.0: On): The reset switch is pressed. ❸ SAID0 = 2 (SAID0.1: On): The reset switch is released from the state of ❷ and the restart processing has been completed.
SAID1	<p>This is used as the start status.</p> <ul style="list-style-type: none"> ❶ SAID1 = 0: The device is initial state or the safety is not ensured. ❷ SAID1 = 1 (SAID1.0: On): The start switch is pressed. ❸ SAID1 = 2 (SAID1.1: On): The start switch is released from the state of ❷ and the start processing has been completed.
SAIM5	<p>This is used as the safety status.</p> <ul style="list-style-type: none"> ❶ SAIM5: On: Safety is ensured and device is ready for start and operation. ❷ SAIM5: Off: Safety is not ensured.
SAIM6	<p>This is used as the communication error status of the safety connection No.1.</p> <ul style="list-style-type: none"> ❶ SAIM6: On: A communication error has occurred in the safety connection No.1. ❷ SAIM6: Off: Communications are successful in the safety connection No.1.
SAIM7	<p>This is used as the communication error status of the safety connection No.2.</p> <ul style="list-style-type: none"> ❶ SAIM7: On: A communication error has occurred in the safety connection No.2. ❷ SAIM7: Off: Communications are successful in the safety connection No.2.

4.2 Analog Converter Module

This section describes an example of a program for the system using the analog converter module.

Point

Use the provided FBs to configure the system. (A system that satisfies the SIL2 requirements cannot be configured without using these FBs.)

For the settings to use the FBs, refer to the following.

☞ Page 81 Settings for using FBs

SIL2 diagnostic FB library

A SIL2 diagnostic FB library consists of the SIL2 safety program FB used in safety programs and the SIL2 standard program FB used in standard programs.

The SIL2 diagnostic FB library is used for building safety applications up to IEC 61508 Ed2.0 SIL2.

■A/D converter module

The following shows the SIL2 diagnostic FB library for the R60AD8-G.

Name	Used in	Description
M+SIL2ADG_ADConv_R	Safety program	Inputs data to a system using R60AD8-G modules.
M+SIL2ADG-IEF_WriteDAVal_R	Standard program	

■D/A converter module

The following shows the SIL2 diagnostic FB library for the R60DA8-G.

Name	Used in	Description
M+SIL2DAG_DAConv_R	Safety program	Outputs data from a system using R60DA8-G modules.
M+SIL2DAG-IEF_ReadADVal_R	Standard program	

Point

On the same network, up to 32 SIL2 diagnostic FB libraries (M+SIL2DAG_DAConv_R and M+SIL2DAG-IEF_ReadADVal_R) for the system using the R60DA8-G can be used. However, the number reduces when the REMFR, REMTO, REMFRD, and REMTOD instructions are simultaneously used to nodes on the same network because this usage of instructions requires separate channel numbers.

For the SIL2 diagnostic FB library, please consult your local Mitsubishi representative.

For how to register the SIL2 diagnostic FB library, refer to the following.

📖 GX Works3 Operating Manual

A/D converter module

This section describes an example of a program to operate the R60AD8-G in SIL2 mode.

Program overview

Operate the R60AD8-G in SIL2 mode with the following settings.

Module parameter		Description
Basic setting	A/D conversion enable/disable setting	CH1 to CH4: A/D conversion enable
	Input range setting	CH1: 0 to 10V CH2: 0 to 10V CH3: 0 to 20mA CH4: 4 to 20mA
Application setting	SIL2 A/D conversion cycle setting	2300ms

Point

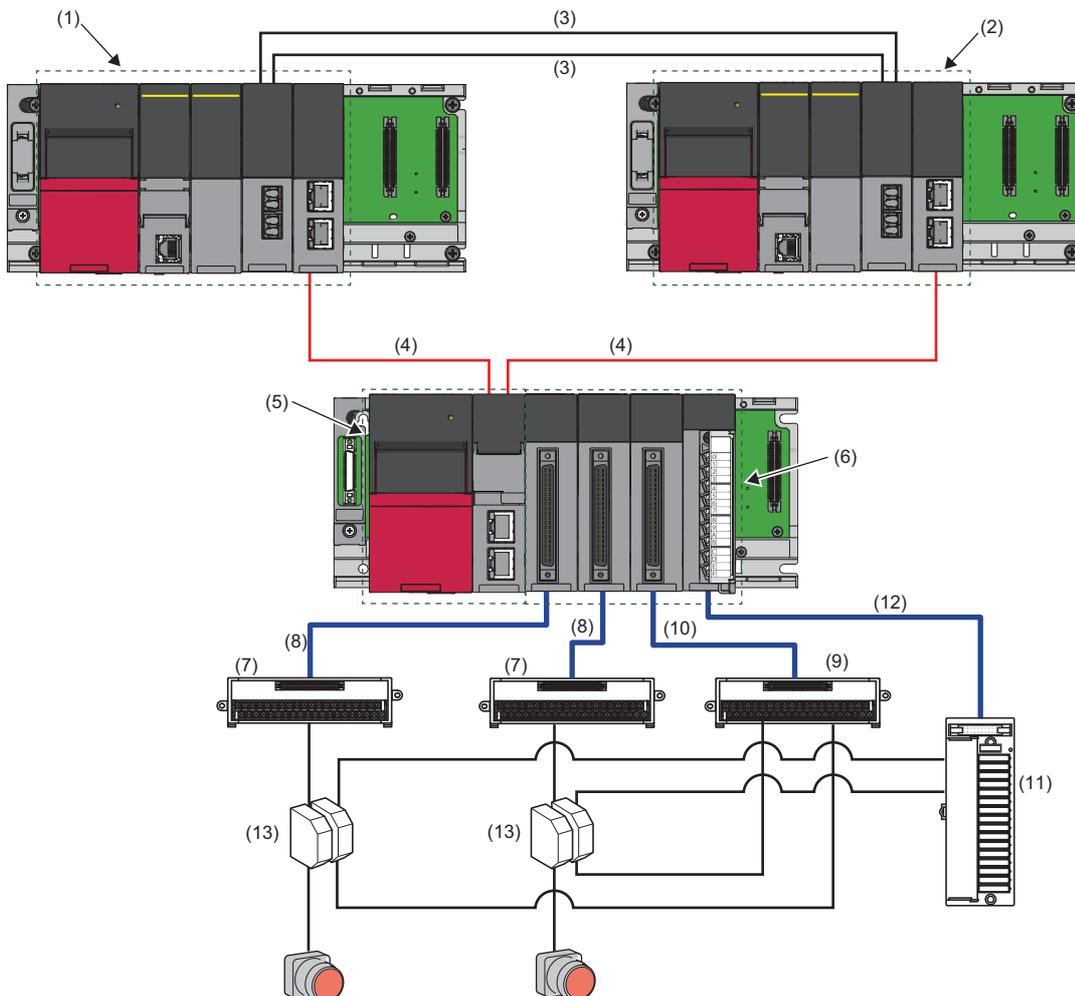
For the SIL2 A/D conversion cycle setting, refer to the following.

☞ Page 99 Calculation example for the SIL2 A/D conversion cycle setting

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

- When the safety refresh communication status is normal, digital operation values are obtained from CH1 to CH4 of the R60AD8-G and output to Digital obtained value (SA/D1030 to SA/D1033).
- If an error is detected with the double input discrepancy detection function or A/D conversion circuit diagnostic function, the digital obtained value of the error-detected channel will be the OFF value (equivalent to 0V/0mA).

System configuration



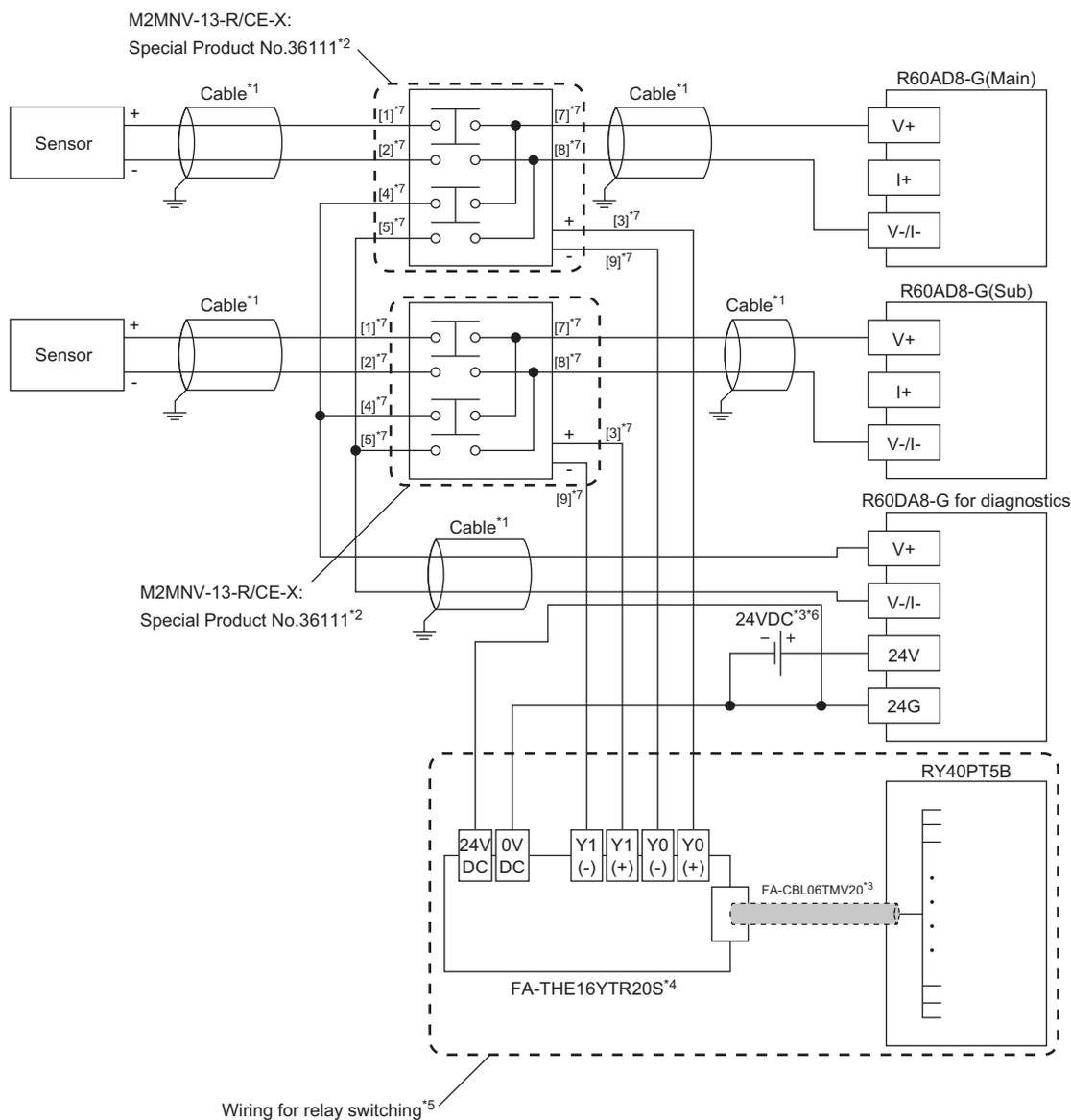
■List of components

No.	Name	Description
(1)	System A	<p>Composed of the following modules:</p> <ul style="list-style-type: none"> • RnPSFCPU • R6PSFM • R6RFM • RJ71GF11-T2 <p>■Precautions</p> <ul style="list-style-type: none"> • Each module has restrictions on use in a system on the system configuration diagram. For details, refer to the User's Manual (Application) for each module. • Mount the above modules on the same base unit. Place the modules in the following order: RnPSFCPU → R6PSFM → R6RFM → RJ71GF11-T2, starting from the right side of the power supply module.
(2)	System B	<p>Composed of the following modules:</p> <ul style="list-style-type: none"> • RnPSFCPU • R6PSFM • R6RFM • RJ71GF11-T2 <p>■Precautions</p> <ul style="list-style-type: none"> • Each module has restrictions on use in a system on the system configuration diagram. For details, refer to the User's Manual (Application) for each module. • Mount the above modules on the same base unit. Place the modules in the following order: RnPSFCPU → R6PSFM → R6RFM → RJ71GF11-T2, starting from the right side of the power supply module.
(3)	Tracking cable	Use cables that meet the specifications for the R6RFM. (MELSEC iQ-R CPU Module User's Manual (Startup))
(4)	CC-Link IE Field Network supporting cable	Use cables supporting CC-Link IE Field Network. (MELSEC iQ-R Ethernet/CC-Link IE User's Manual (Startup))
(5)	Remote head module	Use the RJ72GF15-T2. Note that the module has restrictions on use in a system on the system configuration diagram. For details, refer to the following. MELSEC iQ-R CC-Link IE Field Network Remote Head Module User's Manual (Application)
(6)	Module set	<p>Composed of the following modules:^{*1}</p> <ul style="list-style-type: none"> • R60AD8-G (Main) • R60AD8-G (Sub) • R60DA8-G for diagnostics • RY40PT5B <p>■Precautions</p> <ul style="list-style-type: none"> • When using the R60AD8-G in SIL2 mode, note that there is a restriction on the version. (MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)) • Mount the above modules on the same base unit. Place the modules in the following order: R60AD8-G (Main) → R60AD8-G (Sub) → R60DA8-G for diagnostics → RY40PT5B, starting from the right side of the remote head module.
(7)	Connector/terminal block converter module for the R60AD8-G	For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(8)	Connector/terminal block converter module connection cable for the R60AD8-G	Use a dedicated cable for connecting the R60AD8-G and the connector/terminal block converter module. For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(9)	Connector/terminal block converter module for the R60DA8-G for diagnostics	For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(10)	Connector/terminal block converter module connection cable for the R60DA8-G for diagnostics	Use a dedicated cable for connecting the R60DA8-G for diagnostics and the connector/terminal block converter module. For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(11)	FA-THE16YTR20S	This module is used to connect the relay switching RY40PT5B with the M2MNV-13-R/CE-X: Special Product No.36111. For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(12)	FA-CBL06TMV20	This cable is a special cable used to connect the RY40PT5B with the FA-THE16YTR20S. For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(13)	M2MNV-13-R/CE-X: Special Product No.36111	For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)

*1 Mount the R60AD8-G (Main) to slot number 0, R60AD8-G (Sub) to slot number 1, R60DA8-G for diagnostics to slot number 2, and RY40PT5B to slot number 3.

Wiring

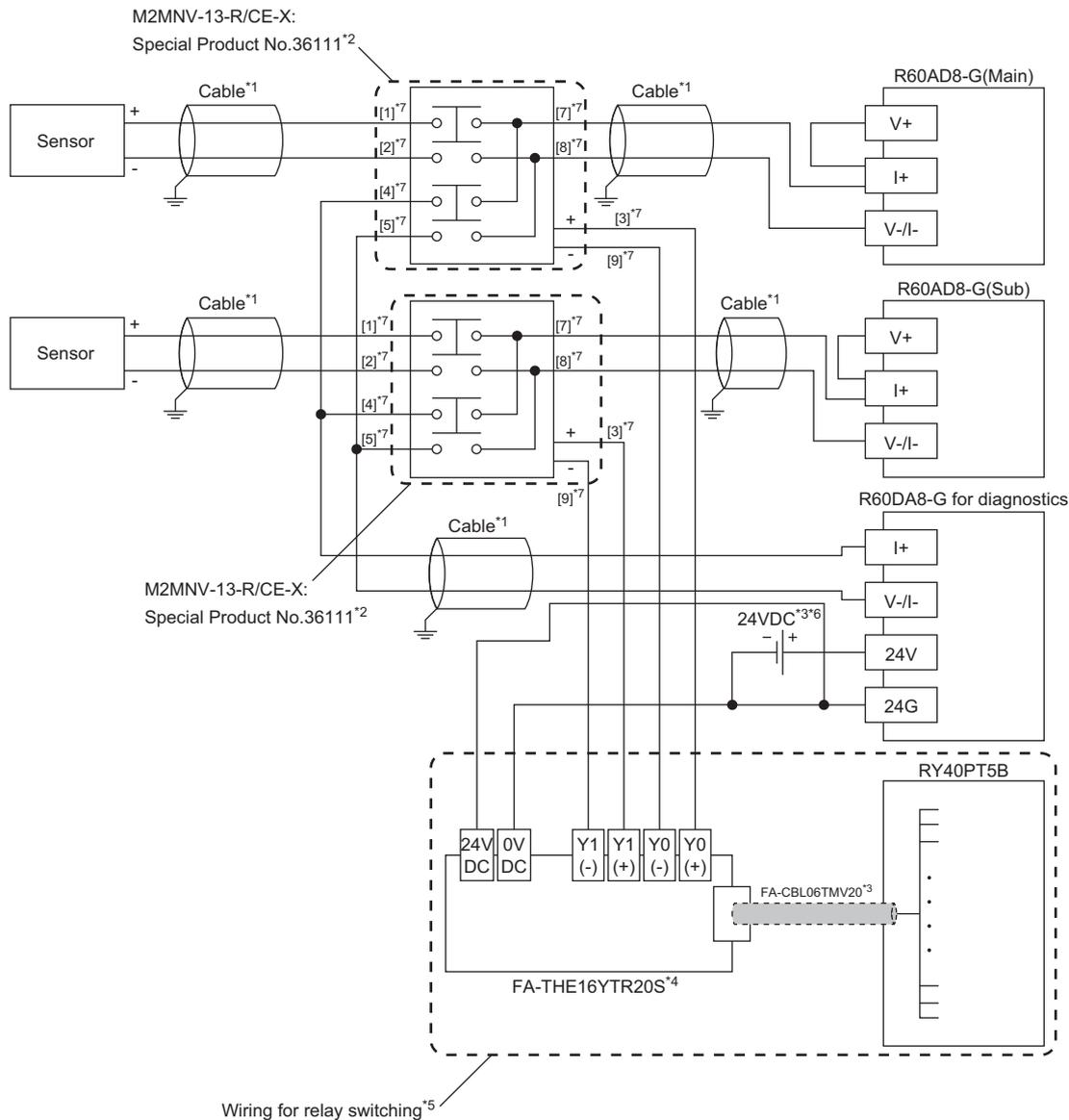
■ Voltage input



Wiring for relay switching^{*5}

- *1 For the application below, use shielded cables and single point grounding for the shield.
 - Between a sensor and the M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60DA8-G for diagnostics and M2MNV-13-R/CE-X: Special Product No.36111
- *2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.
- *3 When the R60AD8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.
 - 📖 MELSEC iQ-R Module Configuration Manual
 - 📖 Safety Guidelines (This manual is included with the base unit.)
- *4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B.
- *5 For details on wiring for relay switching, refer to the following.
 - 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
- *6 Use an external power supply that satisfies the following conditions:
 - The overvoltage protection function is available.
 - The output voltage does not exceed 35VDC in single fault state.
- *7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

■ Current input



*1 For the application below, use shielded cables and single point grounding for the shield.

- Between a sensor and the M2MNV-13-R/CE-X: Special Product No.36111
- Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111
- Between the R60DA8-G for diagnostics and M2MNV-13-R/CE-X: Special Product No.36111

*2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.

*3 When the R60AD8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.

📖 MELSEC iQ-R Module Configuration Manual

📖 Safety Guidelines (This manual is included with the base unit.)

*4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B.

*5 For details on wiring for relay switching, refer to the following.

📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)

*6 Use an external power supply that satisfies the following conditions:

- The overvoltage protection function is available.
- The output voltage does not exceed 35VDC in single fault state.

*7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

Program conditions

- A/D-conversion-enabled channels: CH1, CH2, CH3, and CH4
- Input ranges for each channel: 0 to 10V for CH1 and CH2, 0 to 20mA for CH3, and 4 to 20mA for CH4
- A/D conversion method for each channel: Sampling processing for CH1 to CH4

Procedures before operation

For the system configuration and parameter settings, refer to the following.

 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)

However, for the system configuration and program conditions described in this operation example, set parameters as follows instead.

■"CPU Parameter" for the SIL2 Process CPU

Item			Description
Redundant System Settings	Tracking Setting	Signal Flow Memory Tracking Setting	Transfer
	Tracking Device/Label Setting		Transfer collectively*1
Safety Function Setting	Safety Cycle Time		50.0ms

*1 When selecting "Detailed setting" here, set also "Tracking Block No.1 Auto Transfer Setting" and "Device/Label Detailed Setting".
( MELSEC iQ-R CPU Module User's Manual (Application))

■"Basic setting" of the master/local module

Item	Description																																																																										
Network configuration setting	<table border="1"> <thead> <tr> <th rowspan="2">No.</th> <th rowspan="2">Model Name</th> <th rowspan="2">STA#</th> <th rowspan="2">Station Type</th> <th colspan="3">RX/RX Setting</th> <th colspan="3">RWw/RWr Setting</th> <th rowspan="2">Reserved/Error Invalid Station/System Switching Monitoring Target Station</th> </tr> <tr> <th>Points</th> <th>Start</th> <th>End</th> <th>Points</th> <th>Start</th> <th>End</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Host Station</td> <td>0</td> <td>Master Station</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>Host Station</td> <td>1</td> <td>Sub-Master Station</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>No Setting</td> </tr> <tr> <td>2</td> <td>RJ72GF15-T2</td> <td>2</td> <td>Intelligent Device Station</td> <td>80</td> <td>0000</td> <td>004F</td> <td>8</td> <td>0000</td> <td>0007</td> <td>No Setting</td> </tr> </tbody> </table>	No.	Model Name	STA#	Station Type	RX/RX Setting			RWw/RWr Setting			Reserved/Error Invalid Station/System Switching Monitoring Target Station	Points	Start	End	Points	Start	End	0	Host Station	0	Master Station								1	Host Station	1	Sub-Master Station							No Setting	2	RJ72GF15-T2	2	Intelligent Device Station	80	0000	004F	8	0000	0007	No Setting																								
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Refresh settings	<table border="1"> <thead> <tr> <th rowspan="2">No.</th> <th colspan="4">Link Side</th> <th rowspan="2"></th> <th colspan="4">CPU Side</th> </tr> <tr> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> <th>Target</th> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> </tr> </thead> <tbody> <tr> <td>-</td> <td>SB</td> <td></td> <td></td> <td></td> <td>↔</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>-</td> <td>SW</td> <td></td> <td></td> <td></td> <td>↔</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>RY</td> <td>16</td> <td>00020</td> <td>0002F</td> <td>↔</td> <td>Specify Device</td> <td>Y</td> <td>16</td> <td>01000</td> <td>0100F</td> </tr> <tr> <td>2</td> <td>RWw</td> <td>8</td> <td>00000</td> <td>00007</td> <td>↔</td> <td>Specify Device</td> <td>W</td> <td>8</td> <td>00000</td> <td>00007</td> </tr> <tr> <td>3</td> <td>RY</td> <td>16</td> <td>00030</td> <td>0003F</td> <td>↔</td> <td>Specify Device</td> <td>Y</td> <td>16</td> <td>01010</td> <td>0101F</td> </tr> </tbody> </table>	No.	Link Side					CPU Side				Device Name	Points	Start	End	Target	Device Name	Points	Start	End	-	SB				↔						-	SW				↔						1	RY	16	00020	0002F	↔	Specify Device	Y	16	01000	0100F	2	RWw	8	00000	00007	↔	Specify Device	W	8	00000	00007	3	RY	16	00030	0003F	↔	Specify Device	Y	16	01010	0101F
No.	Link Side					CPU Side																																																																					
	Device Name	Points	Start	End		Target	Device Name	Points	Start	End																																																																	
-	SB				↔																																																																						
-	SW				↔																																																																						
1	RY	16	00020	0002F	↔	Specify Device	Y	16	01000	0100F																																																																	
2	RWw	8	00000	00007	↔	Specify Device	W	8	00000	00007																																																																	
3	RY	16	00030	0003F	↔	Specify Device	Y	16	01010	0101F																																																																	

■"Application setting" of the master/local module

Item	Description																																								
Safety communication setting	<table border="1"> <thead> <tr> <th colspan="10">Safety Data Transfer Device Setting</th> </tr> <tr> <th colspan="5">Receive Data Storage Device</th> <th colspan="5">Send Data Storage Device</th> </tr> <tr> <th></th> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> <th></th> </tr> </thead> <tbody> <tr> <td>Destination Station-></td> <td>SAID</td> <td>8</td> <td>0</td> <td>7</td> <td>SAID</td> <td>8</td> <td>10</td> <td>17</td> <td>->Destination Station</td> </tr> </tbody> </table>	Safety Data Transfer Device Setting										Receive Data Storage Device					Send Data Storage Device						Device Name	Points	Start	End	Device Name	Points	Start	End		Destination Station->	SAID	8	0	7	SAID	8	10	17	->Destination Station
Safety Data Transfer Device Setting																																									
Receive Data Storage Device					Send Data Storage Device																																				
	Device Name	Points	Start	End	Device Name	Points	Start	End																																	
Destination Station->	SAID	8	0	7	SAID	8	10	17	->Destination Station																																

■Module parameters for "R60AD8-G(S2M)"

Configure the following settings. For parameters other than the following, use the default values.

Module parameter	Description	
Basic setting	A/D conversion enable/disable setting	CH1 to CH4: A/D conversion enable
	Input range setting	CH1: 0 to 10V CH2: 0 to 10V CH3: 0 to 20mA CH4: 4 to 20mA
Application setting	SIL2 A/D conversion cycle setting	2300ms

Point

For the SIL2 A/D conversion cycle setting, refer to the following.

 Page 99 Calculation example for the SIL2 A/D conversion cycle setting

■Module parameters for "R60DA8-G"

Configure the following settings. For parameters other than the following, use the default values.

Module parameter		Description
Basic setting	D/A conversion enable/disable setting	CH1 to CH4: D/A conversion enable
	Output range setting	CH1: -10 to 10V CH2: -10 to 10V CH3: 4 to 20mA (Extension) CH4: 4 to 20mA (Extension)
Application setting	Input value shift amount	CH3: 4000 CH4: 4000
Refresh settings	Digital value	Set W0 to W7 to CH1 to CH8 in ascending channel number order.*1 Example) CH1: W0, CH2: W1, ..., CH7: W6, CH8: W7

*1 Because parameters in the refresh settings are used for the SIL2 standard program FB, all eight channels must be set. Missing parameters may cause malfunction.

■Attaching the SIL2 diagnostic FB library to programs

- Attach the SIL2 safety program FB to the safety program of the fixed scan execution type program.
- Attach the SIL2 standard program FB to the standard program of the scan execution type program.

Point

When more than one SIL2 safety program FB and SIL2 standard program FB are used, ensure that each FB has different instance name. If more than one FB with the same instance name exists, the FBs do not operate properly.

Devices to use

■SIL2 safety program FB

Device	Description
SAISD1008.0	Execution command. This device stores the safety refresh communication status of connection number 1 for slot 1 of the remote head module.
SAM1001	Module error clear
SAM1002	Start-up diagnostics skip request
SAM1003	Execution status
SAM1004	Normal completion
SAM1005	Error completion
SAM1010	System error
SAM1011 to SAM1014	Channel error: CH1 to CH4
SAID0000 to SAID0007	Safety communications receive area
SAID0010 to SAID0017	Safety communications send area
SAID130 to SAID133	Digital obtained value: CH1 to CH4
SAID1020	Error code
SAID1030 to SAID1037*1	Digital obtained value: CH1 to CH8
SAID1040	External device connection status
SAID1050 to SAID1057*1	Status code: CH1 to CH8

*1 Consecutive eight-word areas are required independent of the number of A/D-conversion-enabled channels.

■ SIL2 standard program FB

Device	Description
SM400	Execution command (always ON)
M1001	Execution status
M1002	Normal completion
W0	Digital value
Y1000 to Y1007*1	CH1 to CH8 Output enable/disable flag
Y1008 to Y100F*1	Use prohibited
Y1010 to Y101F*1	Relay control data

*1 Consecutive 16-bit areas are required independent of the number of A/D-conversion-enabled channels.

■ Standard/safety shared label

Device	Description
G_stNFB_ADConv	Used for o_stNFB_ADConv in the SIL2 safety program FB and for i_stNFB_ADConv in the SIL2 standard program FB, and stores the data from the SIL2 safety program FB to the SIL2 standard program FB.

■ Standard/safety shared label definition

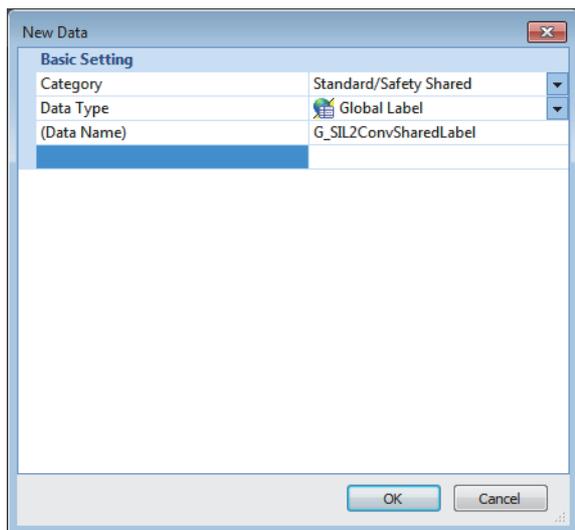
Follow the procedure below to define a standard/safety shared label.

The defined standard/safety shared label is used in the SIL2 safety program FB and SIL2 standard program FB.

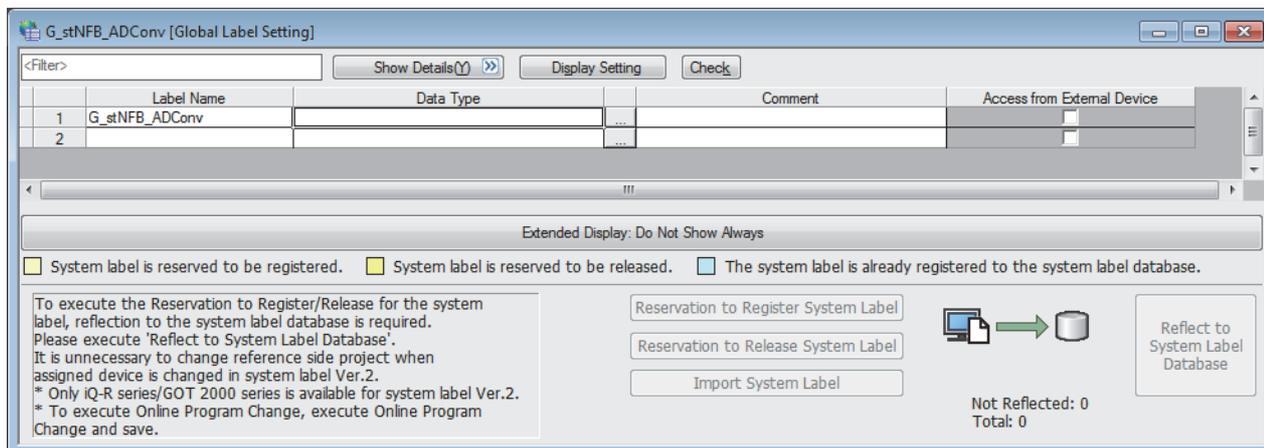
1. Open the "New Data" window.

[Navigation window] ⇒ [Label] ⇒ Right-click ⇒ [Add New Data]

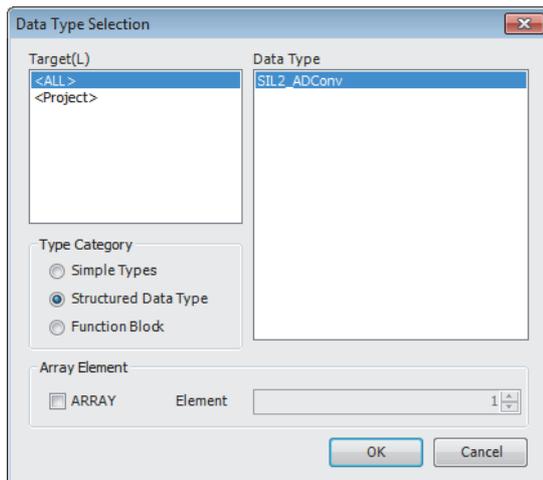
2. Set the following and click the [OK] button. Set any name in "Data Name" but it must not be duplicated with any other "Data Name".



3. Set "Label Name". Set any name in "Label Name" but it must not be duplicated with any other "Label Name".



4. Click the [...] button to display the "Data Type Selection" window.
5. Set the following and click the [OK] button.



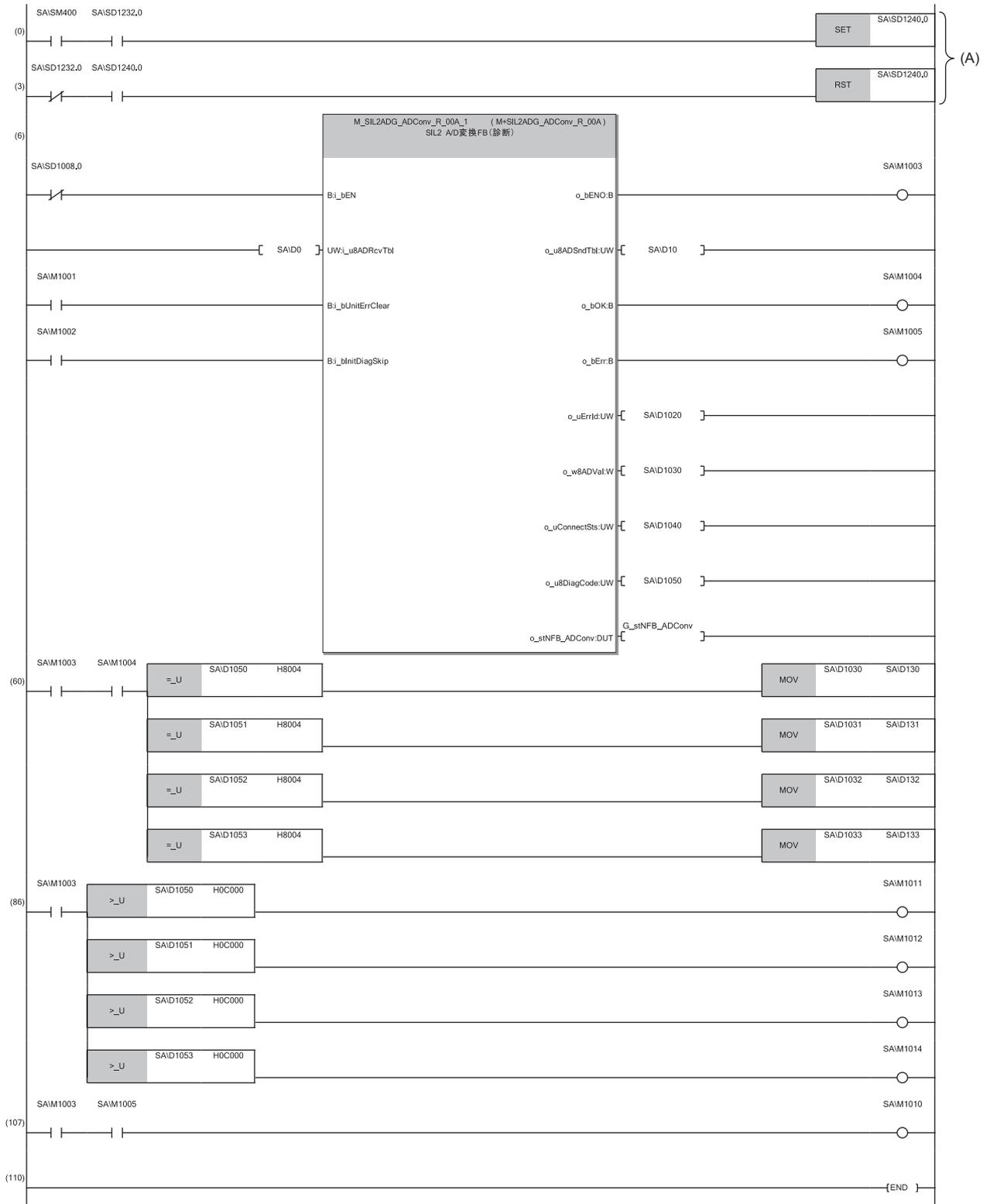
Point

When using more than one SIL2 diagnostic FB library, handle the SIL2 safety program FB and SIL2 standard program FB as a single set, and use them per-set basis. In addition, use a different standard/safety shared label for each set. (Page 84 Setting procedure for FBs)

Program examples

- When the safety refresh communication status is normal, digital operation values are obtained from CH1 to CH4 of the R60AD8-G and output to Digital obtained value (SAID1030 to SAID1033).
- To skip the start-up diagnostics, turn on Start-up diagnostics skip request (SAM1002).
- When Execution status (SAM1003) and Normal completion (SAM1004) of the SIL2 safety program FB are on, processing runs according to Status code (SAID1050 to SAID1053) of each channel. For channels whose Status code is Double input discrepancy detection function completed (8004H), processing for normal state runs. For channels whose Status code indicates an error (C001H or larger), Channel error (SAM1011 to SAM1014) turns on.
- Execution status (SAM1003) and Error completion (SAM1005) of the SIL2 safety program FB are on, System error (SAM1010) turns on.
- To clear the errors currently occurring, turn on Module error clear (SAM1001). Turn off SAM1001 after ensuring the errors are reset.

SIL2 safety program FB

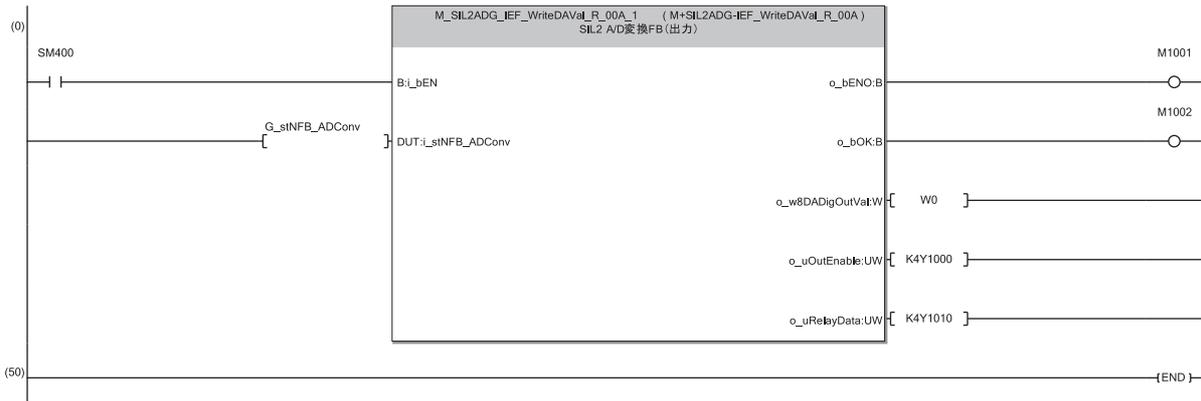


- (6) When SA\SD1008.0 (Safety refresh communication status of each safety connection (1st module)) is off (normal), the SIL2 safety program FB starts up. To clear the errors, turn on SA\M1001 (Module error clear). When the error clearing processing completes, o_bErr turns off and o_uErrId is cleared to 0. To skip the start-up diagnostics, turn on SA\M1002 prior to the start-up of the SIL2 safety program FB. Note that the skip is enabled only when the safety operation mode of the CPU module is TEST MODE.
- When i_bEN of the SIL2 safety program FB is on, SA\M1003 (Execution status) turns on.
- When the SIL2 safety program FB is completed successfully, SA\M1004 (Normal completion) turns on.
- When the SIL2 safety program FB is completed with an error, SA\M1005 (Error completion) turns on and the error code is stored in D1020 (Error code).
- When i_bEN of the SIL2 safety program FB is on, SA\D1040 (External device connection status) stores the connection status. While the corresponding channel is being diagnosed (while external devices are disconnected), the bit corresponding to the channel turns off.
- When either o_bOK or o_bErr of the SIL2 safety program FB turns on, devices from SA\D1050 to SA\D1057 (Status code: CH1 to CH8) store status codes.
- (60) When SA\D1050 to SA\D1053 (Status code: CH1 to CH4) are 8004H (Analog output read-back completed) while both SA\M1003 (Execution command ON) and SA\M1004 (SIL2 safety program FB ON) are on, the values in SA\D1030 to SA\D1033 (Digital obtained value) are stored into SA\D130 to SA\D133.
- (86) When SA\D1050 to SA\D1053 (Status code: CH1 to CH4) are C000H or larger while SA\M1003 (Execution command ON) is on, devices from SA\M1011 to SA\M1014 (Channel error: CH1 to CH4) turn on.
- (107) When both SA\M1003 (Execution command ON) and SA\M1005 (Error completion) are on, SA\M1010 (System error) turns on.

Point 

The program (A) is required to continue the safety communications after the systems are switched. When using the SIL2 safety program FB, include the program (A).

■SIL2 standard program FB



- (0) With SM400, i_bEN (Execution command) of the SIL2 standard program FB is always on.
 When i_bEN (Execution command) turns on, M1001 (Execution status) turns on.
 When the SIL2 standard program FB is completed successfully, M1002 (Normal completion) turns on.

Item	Description
Timing chart of I/O signals	<p>■Normal completion</p> <p>■Error completion</p>
Restrictions and precautions	<ul style="list-style-type: none"> To use this FB, set the master station and the intelligent device station. (MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)) The FB requires the configuration of the ladder for every input label.

D/A converter module

This section describes an example of a program to operate the R60DA8-G in SIL2 mode.

Program overview

Operate the R60DA8-G in SIL2 mode with the following settings.

Module parameter		Description
Basic setting	D/A conversion enable/disable setting	CH1 to CH4: D/A conversion enable
	Output range setting	CH1: 0 to 5V CH2: 0 to 5V CH3: 0 to 5V CH4: 0 to 5V
Application setting	SIL2 D/A conversion cycle setting	2500ms

Point

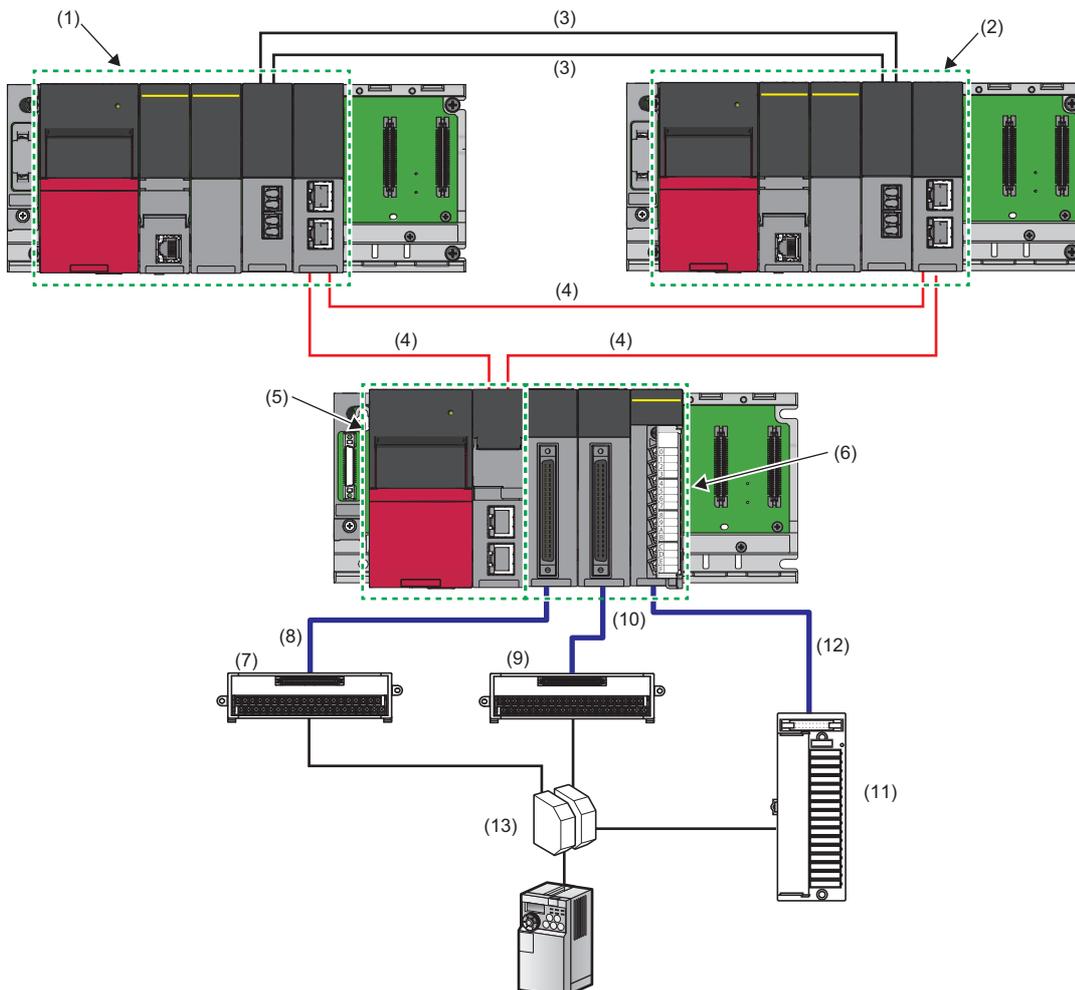
For the SIL2 D/A conversion cycle setting, refer to the following.

☞ Page 101 Calculation example for the SIL2 D/A conversion cycle setting

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

- When the safety refresh communication status is normal, digital operation values are obtained from CH1 to CH4 of the R60DA8-G and output to Digital obtained value (SA/D1100 to SA/D1103).
- For channels in which an analog output read-back discrepancy detection error or a D/A conversion circuit diagnostic error is detected, analog output is the OFF value (equivalent to 0V/0mA).

System configuration



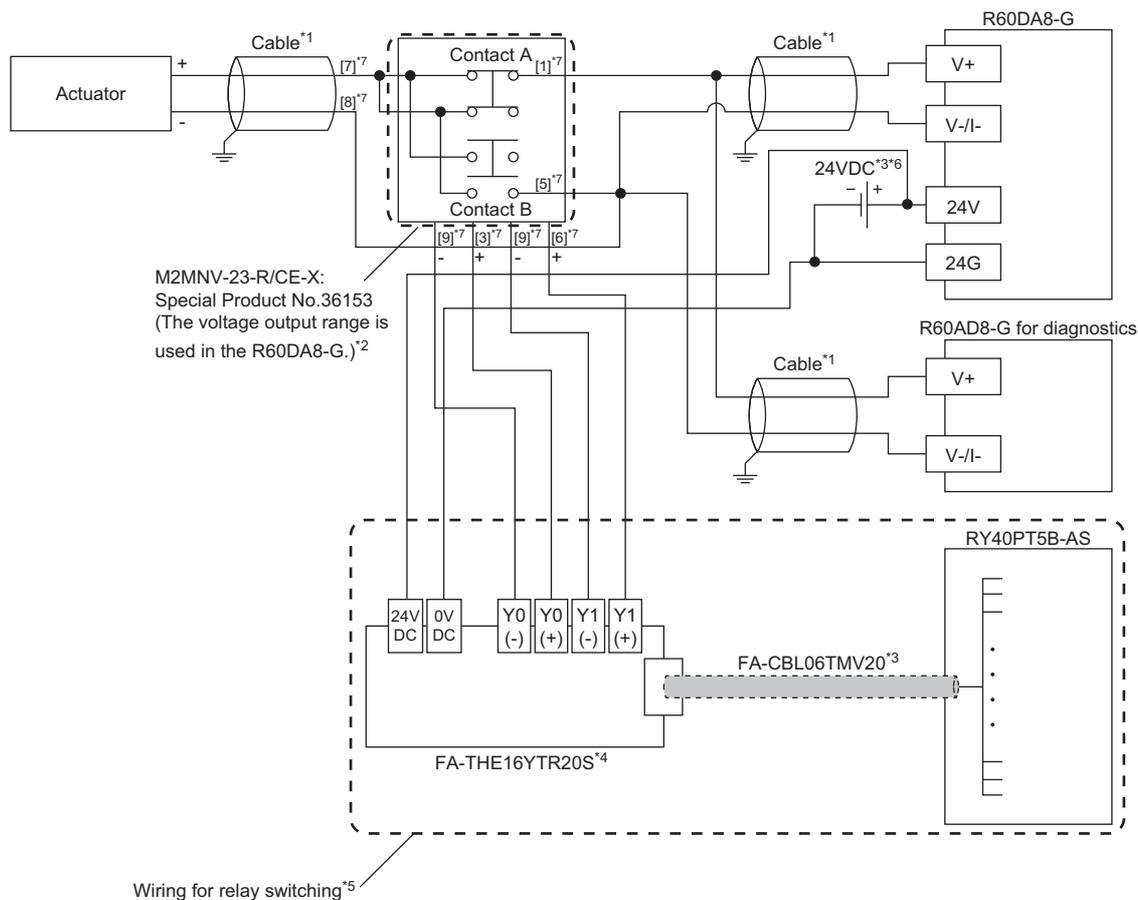
■List of components

No.	Name	Description
(1)	System A	<p>Composed of the following modules:</p> <ul style="list-style-type: none"> • RnPSFCPU • R6PSFM • R6RFM • RJ71GF11-T2 <p>■Precautions</p> <ul style="list-style-type: none"> • Each module has restrictions on use in a system on the system configuration diagram. For details, refer to the User's Manual (Application) for each module. • Mount the above modules on the same base unit. Place the modules in the following order: RnPSFCPU → R6PSFM → R6RFM → RJ71GF11-T2, starting from the right side of the power supply module.
(2)	System B	<p>Composed of the following modules:</p> <ul style="list-style-type: none"> • RnPSFCPU • R6PSFM • R6RFM • RJ71GF11-T2 <p>■Precautions</p> <ul style="list-style-type: none"> • Each module has restrictions on use in a system on the system configuration diagram. For details, refer to the User's Manual (Application) for each module. • Mount the above modules on the same base unit. Place the modules in the following order: RnPSFCPU → R6PSFM → R6RFM → RJ71GF11-T2, starting from the right side of the power supply module.
(3)	Tracking cable	Use cables that meet the specifications for the R6RFM. (MELSEC iQ-R CPU Module User's Manual (Startup))
(4)	CC-Link IE Field Network supporting cable	Use cables supporting CC-Link IE Field Network. (MELSEC iQ-R Ethernet/CC-Link IE User's Manual (Startup))
(5)	Remote head module	Use the RJ72GF15-T2. Note that the module has restrictions on use in a system on the system configuration diagram. For details, refer to the following. MELSEC iQ-R CC-Link IE Field Network Remote Head Module User's Manual (Application)
(6)	Module set	<p>Composed of the following modules:^{*1}</p> <ul style="list-style-type: none"> • R60DA8-G • R60AD8-G for diagnostics • RY40PT5B-AS <p>■Precautions</p> <ul style="list-style-type: none"> • When using the R60DA8-G in SIL2 mode, note that there is a restriction on the version. (MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)) • Mount the above modules on the same base unit. Place the modules in the following order: R60DA8-G → R60AD8-G for diagnostics → RY40PT5B-AS, starting from the right side of the remote head module.
(7)	Connector/terminal block converter module for the R60DA8-G	For details, refer to the following. MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)
(8)	Connector/terminal block converter module connection cable for the R60DA8-G	Use a dedicated cable for connecting the R60DA8-G and the connector/terminal block converter module. For details, refer to the following. MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)
(9)	Connector/terminal block converter module for the R60AD8-G for diagnostics	For details, refer to the following. MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)
(10)	Connector/terminal block converter module connection cable for the R60AD8-G for diagnostics	Use a dedicated cable for connecting the R60AD8-G for diagnostics and the connector/terminal block converter module. For details, refer to the following. MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)
(11)	FA-THE16YTR20S	This module is used to connect the relay switching RY40PT5B-AS with the analog switching module. For details, refer to the following. MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)
(12)	FA-CBL06TMV20	This cable is a special cable used to connect the RY40PT5B-AS with the FA-THE16YTR20S. For details, refer to the following. MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)
(13)	M2MNV-23-R/CE-X: Special Product No.36153 or M2MNV-13-R/CE-X: Special Product No.36111	For details, refer to the following. MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)

*1 Mount the R60DA8-G to slot number 0, R60AD8-G for diagnostics to slot number 1, and RY40PT5B-AS to slot number 2.

Examples of external wiring

■ Voltage output



*1 For the application below, use shielded cables and single point grounding for the shield.

- Between an actuator and the M2MNV-23-R/CE-X: Special Product No.36153
- Between the R60DA8-G and M2MNV-23-R/CE-X: Special Product No.36153
- Between the R60AD8-G and M2MNV-23-R/CE-X: Special Product No.36153

*2 Install the M2MNV-23-R/CE-X: Special Product No.36153 and the programmable controller within the same control panel.

*3 When the R60DA8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.

📖 MELSEC iQ-R Module Configuration Manual

📖 Safety Guidelines (This manual is included with the base unit.)

*4 Since the M2MNV-23-R/CE-X: Special Product No.36153 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B-AS.

*5 For details on wiring for relay switching, refer to the following.

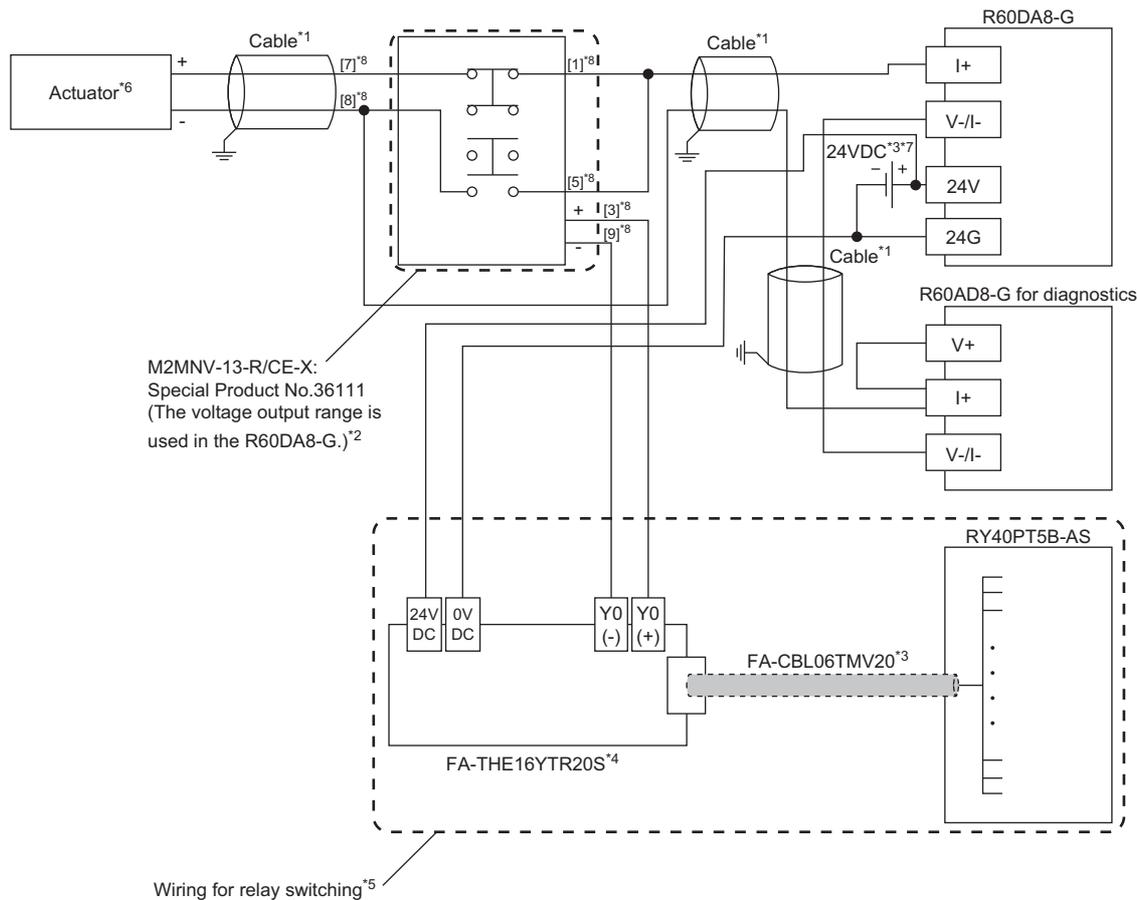
📖 MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)

*6 Use an external power supply that satisfies the following conditions:

- The overvoltage protection function is available.
- The output voltage does not exceed 35VDC in single fault state.

*7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

■ Current output



*1 For the application below, use shielded cables and single point grounding for the shield.

- Between an actuator and the M2MNV-13-R/CE-X: Special Product No.36111
- Between the R60DA8-G and M2MNV-13-R/CE-X: Special Product No.36111
- Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111

*2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.

*3 When the R60DA8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.

- 📖 MELSEC iQ-R Module Configuration Manual
- 📖 Safety Guidelines (This manual is included with the base unit.)

*4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B-AS.

*5 For details on wiring for relay switching, refer to the following.

- 📖 MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)

*6 When an internal load resistance value of the external device is less than 100Ω, connect the resistor in series so that the resistance value is 100Ω or more in total.

*7 Use an external power supply that satisfies the following conditions:

- The overvoltage protection function is available.
- The output voltage does not exceed 35VDC in single fault state.

*8 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

Program conditions

- D/A-conversion-enabled channels: CH1, CH2, CH3, and CH4
- Output range: 0 to 5V for all channels

Procedures before operation

For the system configuration and parameter settings, refer to the following.

MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)

However, for the system configuration and program conditions described in this operation example, set parameters as follows instead.

■"CPU Parameter" for the SIL2 Process CPU

Item			Description
Redundant System Settings	Tracking Setting	Signal Flow Memory Tracking Setting	Transfer
	Tracking Device/Label Setting		Transfer collectively* ¹
Safety Function Setting	Safety Cycle Time		50.0ms

*1 When selecting "Detailed setting" here, set also "Tracking Block No.1 Auto Transfer Setting" and "Device/Label Detailed Setting".
 MELSEC iQ-R CPU Module User's Manual (Application))

■"Basic setting" of the master/local module

Item	Description																																																																										
Network configuration setting	<table border="1"> <thead> <tr> <th rowspan="2">No.</th> <th rowspan="2">Model Name</th> <th rowspan="2">STA#</th> <th rowspan="2">Station Type</th> <th colspan="3">RX/RX Setting</th> <th colspan="3">RWw/RWr Setting</th> <th rowspan="2">Reserved/Error Invalid Station/System Switching Monitoring Target Station</th> </tr> <tr> <th>Points</th> <th>Start</th> <th>End</th> <th>Points</th> <th>Start</th> <th>End</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Host Station</td> <td>0</td> <td>Master Station</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>Host Station</td> <td>1</td> <td>Sub-Master Station</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>No Setting</td> </tr> <tr> <td>2</td> <td>RJ72GF15-T2</td> <td>2</td> <td>Intelligent Device Station</td> <td>80</td> <td>0000</td> <td>004F</td> <td>8</td> <td>0000</td> <td>0007</td> <td>No Setting</td> </tr> </tbody> </table>	No.	Model Name	STA#	Station Type	RX/RX Setting			RWw/RWr Setting			Reserved/Error Invalid Station/System Switching Monitoring Target Station	Points	Start	End	Points	Start	End	0	Host Station	0	Master Station								1	Host Station	1	Sub-Master Station							No Setting	2	RJ72GF15-T2	2	Intelligent Device Station	80	0000	004F	8	0000	0007	No Setting																								
No.	Model Name					STA#	Station Type	RX/RX Setting			RWw/RWr Setting			Reserved/Error Invalid Station/System Switching Monitoring Target Station																																																													
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2	RJ72GF15-T2	2	Intelligent Device Station	80	0000	004F	8	0000	0007	No Setting																																																																	
Refresh settings	<table border="1"> <thead> <tr> <th rowspan="2">No.</th> <th colspan="4">Link Side</th> <th rowspan="2"></th> <th colspan="4">CPU Side</th> </tr> <tr> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> <th>Target</th> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> </tr> </thead> <tbody> <tr> <td>-</td> <td>SB</td> <td></td> <td></td> <td></td> <td>↔</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>-</td> <td>SW</td> <td></td> <td></td> <td></td> <td>↔</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>RWr</td> <td>16</td> <td>0000</td> <td>000F</td> <td>↔</td> <td>Specify Device</td> <td>W</td> <td>16</td> <td>0100</td> <td>010F</td> </tr> <tr> <td>2</td> <td>RX</td> <td>16</td> <td>0001</td> <td>000F</td> <td>↔</td> <td>Specify Device</td> <td>X</td> <td>16</td> <td>0100</td> <td>010F</td> </tr> <tr> <td>3</td> <td>RY</td> <td>16</td> <td>0001</td> <td>000F</td> <td>↔</td> <td>Specify Device</td> <td>Y</td> <td>16</td> <td>0100</td> <td>010F</td> </tr> </tbody> </table>	No.	Link Side					CPU Side				Device Name	Points	Start	End	Target	Device Name	Points	Start	End	-	SB				↔						-	SW				↔						1	RWr	16	0000	000F	↔	Specify Device	W	16	0100	010F	2	RX	16	0001	000F	↔	Specify Device	X	16	0100	010F	3	RY	16	0001	000F	↔	Specify Device	Y	16	0100	010F
No.	Link Side					CPU Side																																																																					
	Device Name	Points	Start	End		Target	Device Name	Points	Start	End																																																																	
-	SB				↔																																																																						
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1	RWr	16	0000	000F	↔	Specify Device	W	16	0100	010F																																																																	
2	RX	16	0001	000F	↔	Specify Device	X	16	0100	010F																																																																	
3	RY	16	0001	000F	↔	Specify Device	Y	16	0100	010F																																																																	

■"Application setting" of the master/local module

Item	Description																																								
Safety communication setting	<table border="1"> <thead> <tr> <th colspan="10">Safety Data Transfer Device Setting</th> </tr> <tr> <th colspan="5">Receive Data Storage Device</th> <th colspan="5">Send Data Storage Device</th> </tr> <tr> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> <th></th> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> <th></th> </tr> </thead> <tbody> <tr> <td>Destination Station-></td> <td>SAID</td> <td>8</td> <td>0</td> <td>7</td> <td>SAID</td> <td>8</td> <td>10</td> <td>17</td> <td>->Destination Station</td> </tr> </tbody> </table>	Safety Data Transfer Device Setting										Receive Data Storage Device					Send Data Storage Device					Device Name	Points	Start	End		Device Name	Points	Start	End		Destination Station->	SAID	8	0	7	SAID	8	10	17	->Destination Station
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Device Name	Points	Start	End		Device Name	Points	Start	End																																	
Destination Station->	SAID	8	0	7	SAID	8	10	17	->Destination Station																																

■Module parameters for "R60DA8-G (S2M)"

Configure the following settings. For parameters other than the following, use the default values.

Module parameter	Description	
Basic setting	D/A conversion enable/disable setting	CH1 to CH4: D/A conversion enable
	Output range setting	CH1: 0 to 5V CH2: 0 to 5V CH3: 0 to 5V CH4: 0 to 5V
Application setting	SIL2 D/A conversion cycle setting	2500ms



For the SIL2 D/A conversion cycle setting, refer to the following.

Page 101 Calculation example for the SIL2 D/A conversion cycle setting

■Module parameters for "R60AD8-G"

Configure the following settings. For parameters other than the following, use the default values.

Module parameter	Description	
Basic setting	A/D conversion enable/disable setting	CH1 to CH4: A/D conversion enable
	Input range setting	CH1: 0 to 5V CH2: 0 to 5V CH3: 0 to 5V CH4: 0 to 5V
Refresh settings	Digital output value	Set W1000 to W1007 to CH1 to CH8 in ascending channel number order. Example) CH1: W1000, CH2: W1001, ..., CH7: W1006, CH8: W1007
	Digital operation value	Set W1008 to W100F to CH1 to CH8 in ascending channel number order. Example) CH1: W1008, CH2: W1009, ..., CH7: W100E, CH8: W100F

■Attaching the SIL2 diagnostic FB library to programs

- Attach the SIL2 safety program FB to the safety program of the fixed scan execution type program.
- Attach the SIL2 standard program FB to the standard program of the scan execution type program.

Point

When more than one SIL2 safety program FB and SIL2 standard program FB are used, ensure that each FB has different instance name. If more than one FB with the same instance name exists, the FBs do not operate properly.

Devices to use

■SIL2 safety program FB

Device	Description
SA\SD1008.0	Execution command. This device stores the safety refresh communication status of connection number 1 for slot 1 of the remote head module.
SA\SM1800	System switching signal
SA\M1001	Module error clear
SAM1002	Start-up diagnostics skip request
SAM1003	Circuit diagnostics execution setting
SAM1004	Circuit diagnostics start request
SAM1005	Execution status
SAM1006	Normal completion
SAM1007	Error completion
SAM1008	System switching signal latch
SA\M1009	D/A conversion circuit diagnostics waiting flag
SAM1010	System error
SAM1011 to SAM1018 ^{*3}	Channel error: CH1 to CH8
SAM1020 to SAM1035 ^{*2}	Output enable request: SA\M1020 to SA\M1027 correspond to Channel 1 to 8. SAM1028 to SAM1035 are not used.
SA\D0000 to SA\D0007	Safety communications receive area
SA\D0010 to SA\D0017	Safety communications send area
SA\D1100 to SA\D1107 ^{*1}	Digital value
SA\D1110	Circuit diagnostics request WAIT time
SA\D1020	Error code
SA\D1030 to SA\D1037 ^{*1}	Digital obtained value: CH1 to CH8
SA\D1040	External device connection status
SA\D1050 to SA\D1057 ^{*1}	Status code: CH1 to CH8

*1 Consecutive eight-word area is required regardless of the number of D/A-conversion-enabled channels.

*2 Consecutive 16-bit area is required regardless of the number of D/A-conversion-enabled channels.

*3 Consecutive eight-bit area is required regardless of the number of D/A-conversion-enabled channels.

■ SIL2 standard program FB

Device	Description
SM400	Execution command (always ON)
M1001	Execution status
M1002	Normal completion
M1003	Error completion
D1000	Target network number
D1001	Own station channel
D1002	Target station number
D1003	Target station start I/O number
D1010	Error code
W1000 to W1007* ¹	Digital output value of the R60AD8-G for diagnostics
W1008 to W100F* ¹	Digital operation value of the R60AD8-G for diagnostics
Y1009	Operating condition setting request of the R60AD8-G for diagnostics

*1 Consecutive eight-word area is required regardless of the number of D/A-conversion-enabled channels.

■ Standard/safety shared label

Device	Description
G_stStoN_DACConv	Used for i_stNFB_DACConv and o_stNFB_DACConv in the SIL2 safety program FB, and for i_stNFB_DACConv and o_stNFB_DACConv in the SIL2 standard program FB, and stores the data from the SIL2 safety program FB to SIL2 standard program FB.

■ Standard/safety shared label definition

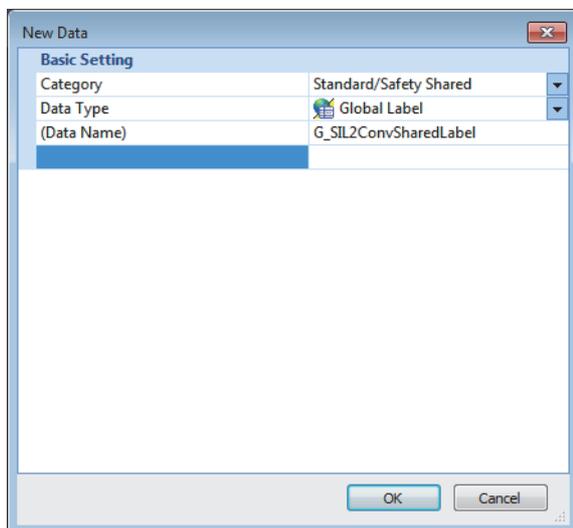
Follow the procedure below to define a standard/safety shared label.

The defined standard/safety shared label is used in the SIL2 safety program FB and SIL2 standard program FB.

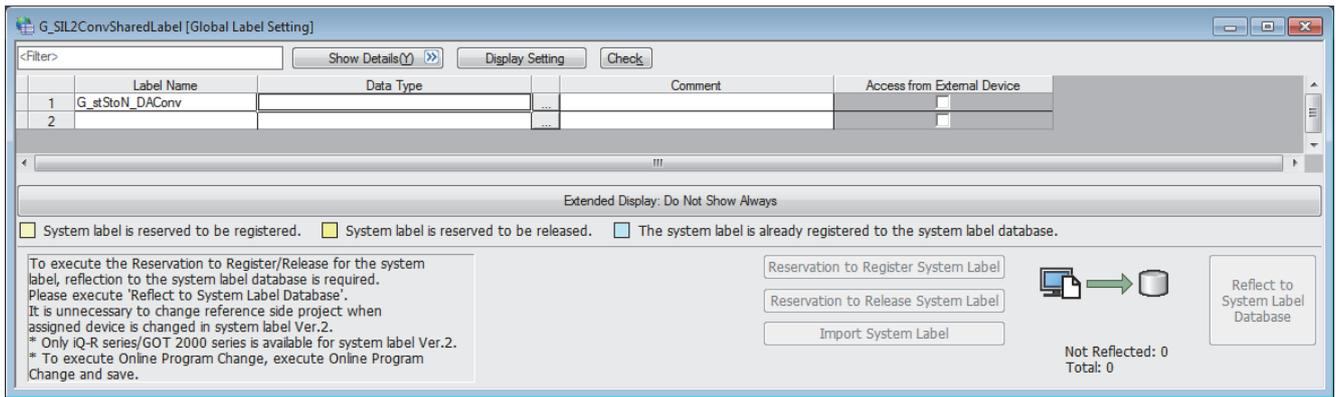
1. Open the "New Data" window.

 [Navigation window] ⇒ [Label] ⇒ Right-click ⇒ [Add New Data]

2. Set the following and click the [OK] button. Set any name in "Data Name" but it must not be duplicated with any other "Data Name".

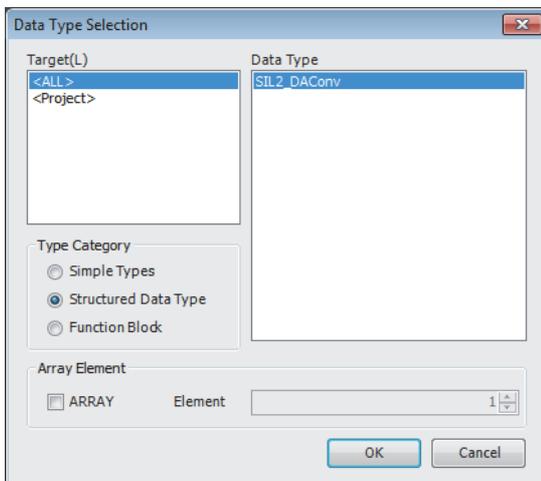


- Set "Label Name". Set any name in "Label Name" but it must not be duplicated with any other "Label Name".



- Click the [...] button to display the "Data Type Selection" window.

- Set the following and click the [OK] button.



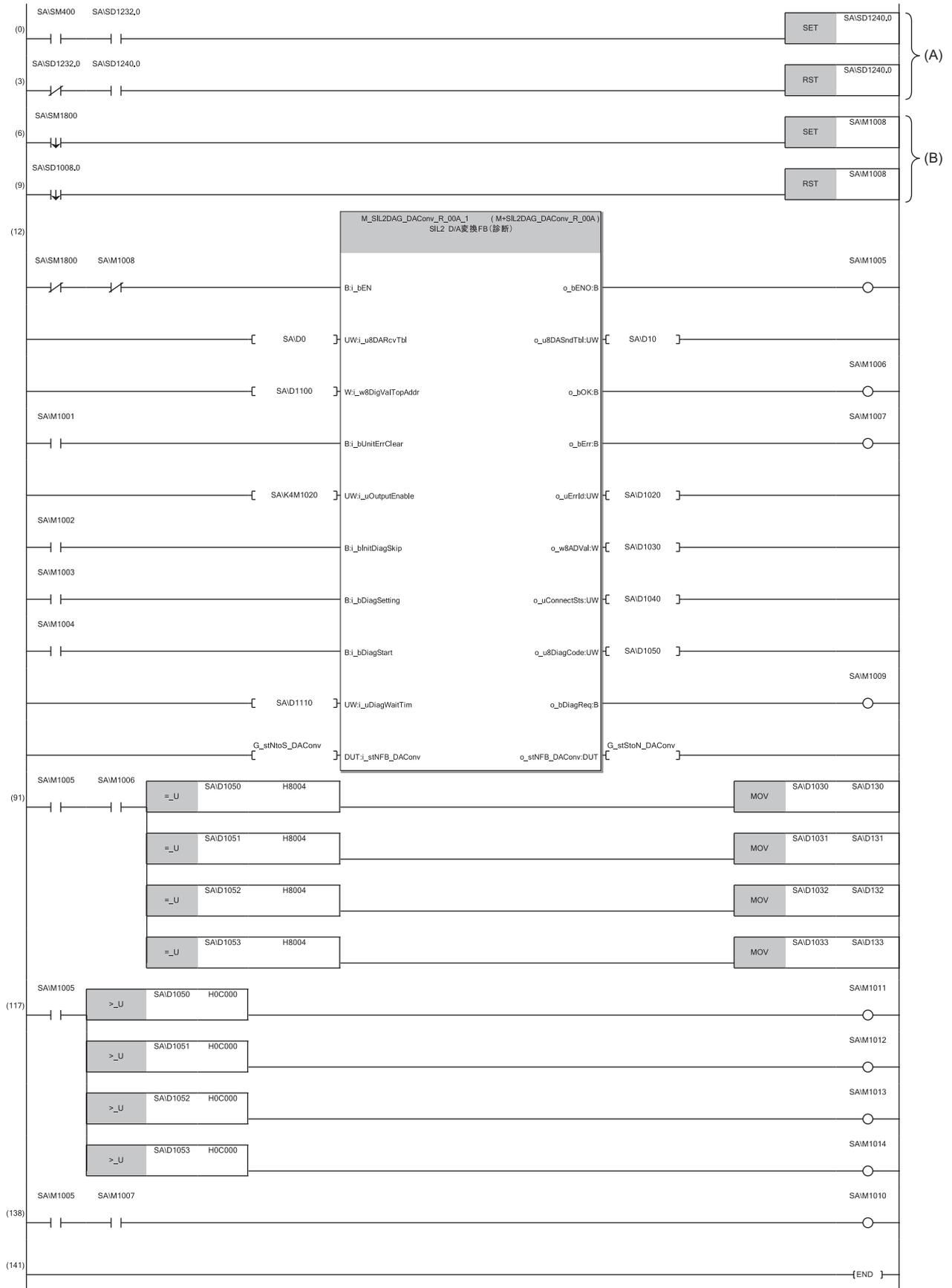
Point

When using more than one SIL2 diagnostic FB library, handle the SIL2 safety program FB and SIL2 standard program FB as a single set, and use them per-set basis. In addition, use a different standard/safety shared label for each set. (Page 84 Setting procedure for FBs)

Program examples

- When the safety refresh communication status is normal, digital values are output to CH1 to CH4 of the R60DA8-G.
- To skip the start-up diagnostics, turn on Start-up diagnostics skip request (SA\M1002).
- When Execution status (SA\M1005) and Normal completion (SA\M1006) of the SIL2 safety program FB are on, processing runs according to Status code (SA\D1050 to SA\D1053) of each channel. For channels whose Status code is Analog output read-back completed (8004H), processing for normal state runs. For channels whose Status code indicates an error (C001H or larger), Channel error (SA\M1011 to SA\M1014) turns on.
- Execution status (SA\M1005) and Error completion (SA\M1007) of the SIL2 safety program FB are on, System error (SA\M1010) turns on.
- To clear the errors currently occurring, turn on Module error clear (SA\M1001). Turn off SA\M1001 after ensuring the errors are reset.
- For a channel whose digital value output to the R60DA8-G is to be stopped, turn off Output enable request (SA\M1020 to SA\M1027). The channel whose Output enable request (SA\M1020 to SA\M1027) was turned off stops output of the digital value.
- To clear the errors currently occurring, turn off and on Execution status (M1001).

SIL2 safety program FB



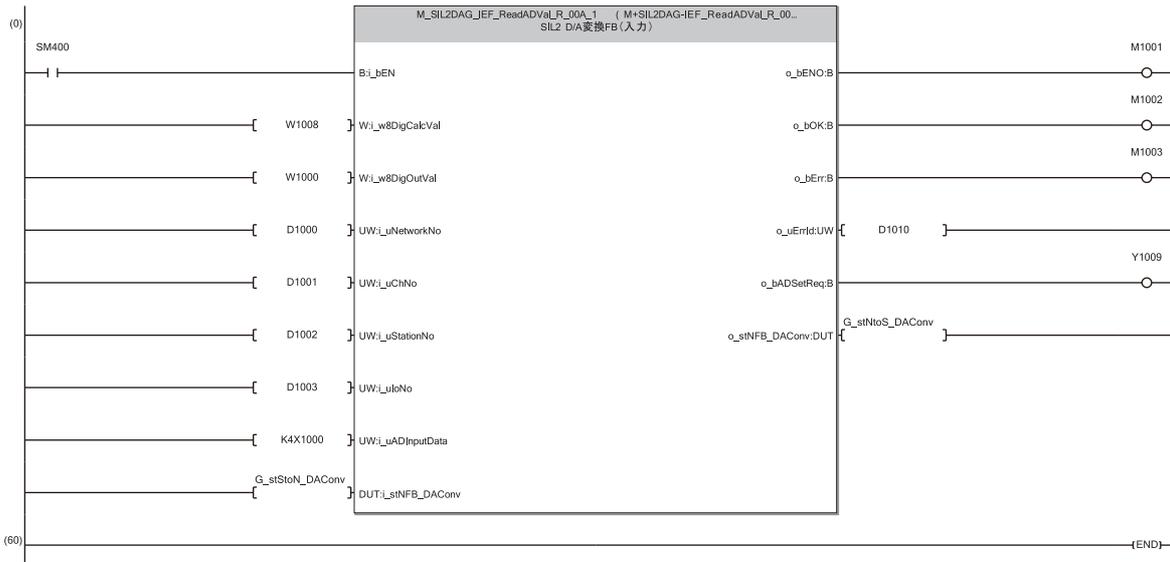
- (6) On the falling edge of SA\SM1800 (ON for only the first safety program execution after system switching (standby system to control system)), SA\M1008 (System switching signal latch) turns on.
- (9) On the falling edge of SA\SD1008.0 (Safety refresh communication status of each safety connection (1st module) becomes normal), SA\M1008 (System switching signal latch) turns off.
- (12) When both SA\SM1800 (ON for only the first safety program execution after system switching (standby system to control system)) and SA\M1008 (System switching signal latch) are off, the SIL2 safety program FB starts up.
 In SA\D1100 to SA\D1107 (Digital value CH1 to CH8), set values to be output.
 Turn on the devices (SA\M1020 to SA\M1035 (Output enable request)) corresponding to the channels for which the output is enabled.)
 To clear the errors, turn on SA\M1001 (Module error clear). When the error clearing processing completes, o_bErr turns off and o_uErrId is cleared to 0.
 To skip the start-up diagnostics, turn on SA\M1002 prior to the start-up of the SIL2 safety program FB. Note that the skip is enabled only when the safety operation mode of the CPU module is TEST MODE.
 To run the D/A conversion circuit diagnostics automatically, turn off SA\M1003 (Circuit diagnostics execution setting) prior to the start-up of the SIL2 safety program FB.
 When SA\M1003 is on (Manual), turn on SA\M1004 to start the D/A conversion circuit diagnostics. Note that SA\M1009 (D/A conversion circuit diagnostics waiting flag) must be turned on to start the diagnostics. To determine the timing to turn on SA\M1009, set SA\D1110 (Circuit diagnostics request WAIT time).
 When i_bEN of the SIL2 safety program FB is on, SA\M1005 (Execution status) turns on.
 When the SIL2 safety program FB is completed successfully, SA\M1006 (Normal completion) turns on.
 When the SIL2 safety program FB is completed with an error, SA\M1007 (Error completion) turns on and the error code is stored in D1020 (Error code).
 When i_bEN of the SIL2 safety program FB is on, the digital values obtained from the SIL2 standard program FB are output to SA\D1030 (Digital obtained value: CH1 to CH8).
 When i_bEN of the SIL2 safety program FB is on, SA\D1040 (External device connection status) stores the connection status. While the corresponding channel is being diagnosed (while external devices are disconnected), the bit corresponding to the channel turns off.
 When either o_bOK or o_bErr of the SIL2 safety program FB turns on, devices from SA\D1050 to SA\D1057 (Status code: CH1 to CH8) store status codes.
 When SA\M1003 (Circuit diagnostics execution setting) is turned on (Manual), SA\M1009 (D/A conversion circuit diagnostics waiting flag) turns on after a time specified in SA\D1110 (Circuit diagnostics request WAIT time).
- (91) When SA\D1050 to SA\D1053 (Status code: CH1 to CH4) are 8004H (Analog output read-back completed) while both SA\M1005 (Execution command ON) and SA\M1006 (SIL2 safety program FB ON) are on, the values in SA\D1030 to SA\D1033 (Digital obtained value) are stored into SA\D130 to SA\D133.
- (117) When SA\D1050 to SA\D1053 (Status code: CH1 to CH4) are C000H or larger while SA\M1005 (Execution command ON) is on, SA\M1011 to SA\M1014 (Channel error: CH1 to CH4) turn on.
- (138) When both SA\M1005 (Execution command ON) and SA\M1007 (Error completion) are on, SA\M1010 (System error) turns on.

Point

The program (A) is required to continue the safety communications after the systems are switched. When using the SIL2 safety program FB, include the program (A).

The program (B) is required to notify the SIL2 safety program FB of the operation timing after the systems are switched. When using the SIL2 safety program FB, include the program (B).

■SIL2 standard program FB



- (0) With SM400, i_bEN (Execution command) of the SIL2 standard program FB is always on.
 When i_bEN (Execution command) turns on, M1001 (Execution status) turns on.
 When the SIL2 standard program FB is completed successfully, M1002 (Normal completion) turns on.

Item	Description
Timing chart of I/O signals	<p>■Normal completion (Operation in common)</p> <p>■Normal completion (Operation when i_bDiagSetting (Circuit diagnostics execution setting) is off (automatic)).</p>
Restrictions and precautions	<ul style="list-style-type: none"> To use this FB, set the master station and the intelligent device station. (MELSEC iQ-R Channel Isolated Digital-Analog Converter Module User's Manual (Application)) The FB requires the configuration of the ladder for every input label.

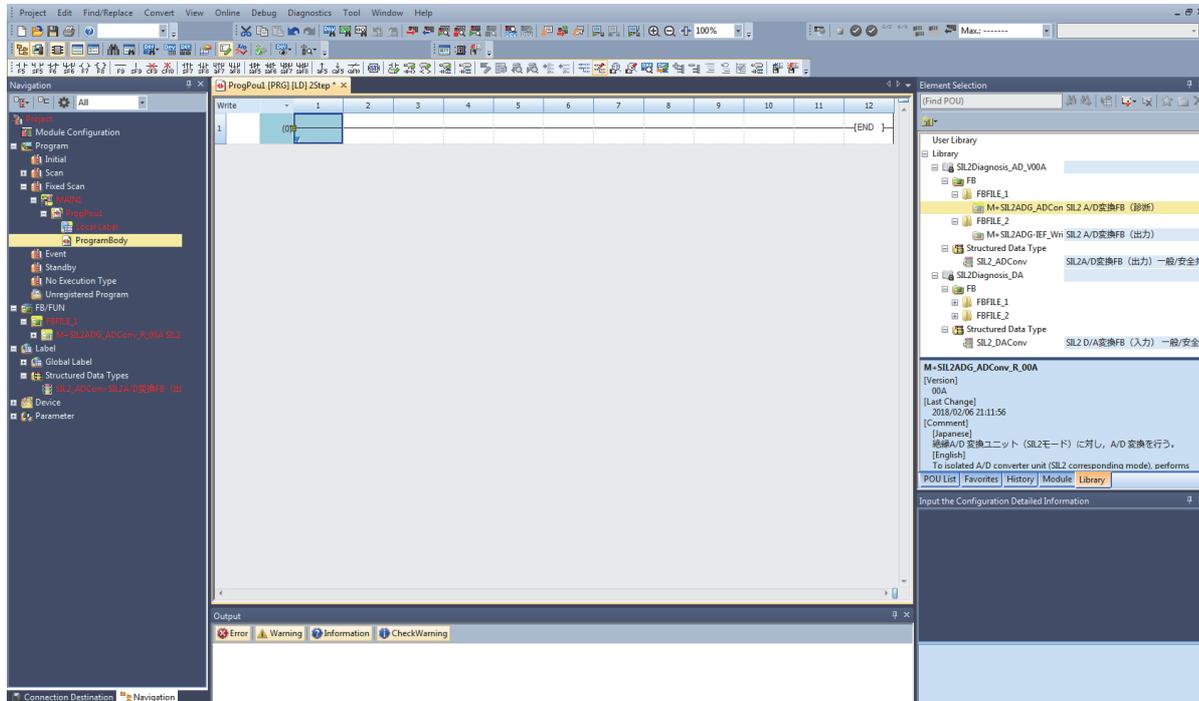
Settings for using FBs

When using the FB library for the analog input and analog output, attach both SIL2 safety program FB and SIL2 standard program FB.

Attaching the SIL2 safety program FB

Attach the SIL2 safety program FB to the safety program of the fixed scan execution type program.

1. Attach the SIL2 safety program FB to the safety program by dragging and dropping it.



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2. When the structure to be used does not exist, the structure is automatically registered when the FB is attached.



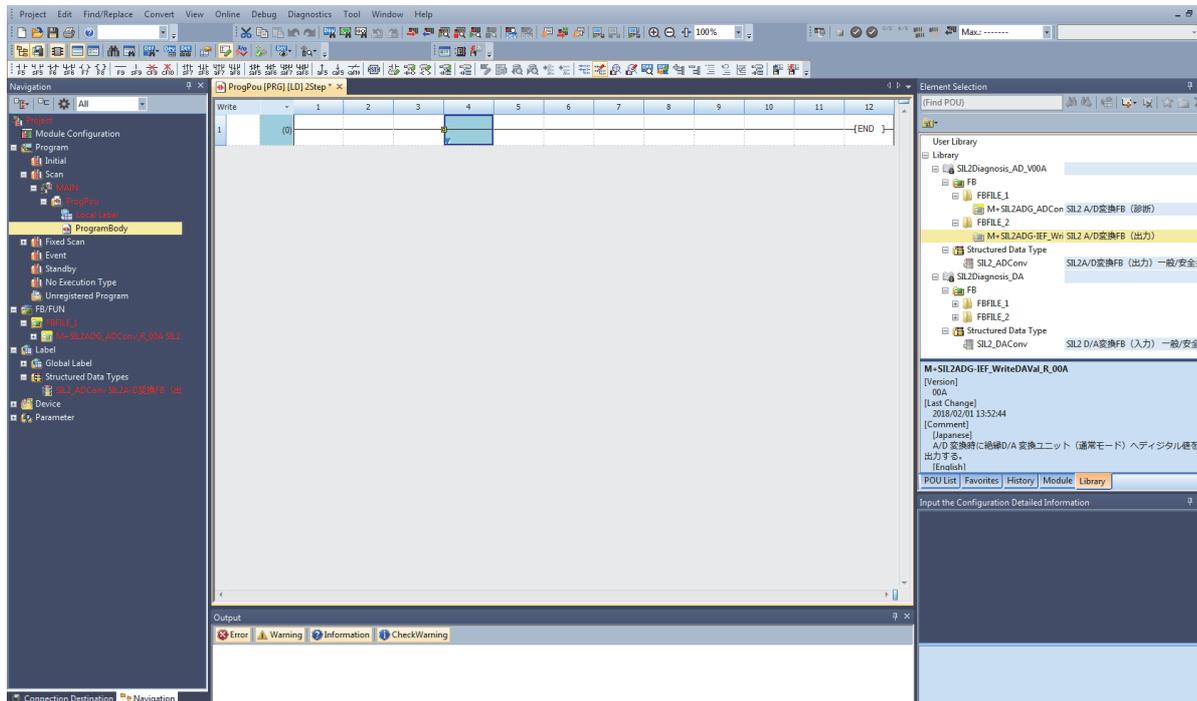
Point

When using more than one FB, set a different instance name for each FB. If more than one FB with the same instance name exists, the FBs do not operate properly.

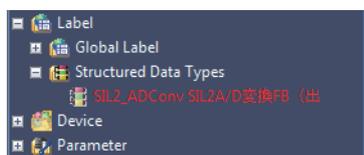
Attaching the SIL2 standard program FB

Attach the SIL2 standard program FB to the standard program of the scan execution type program.

1. Attach the SIL2 standard program FB to the standard program by dragging and dropping it.



2. When the structure to be used does not exist, the structure is automatically registered when the FB is attached.



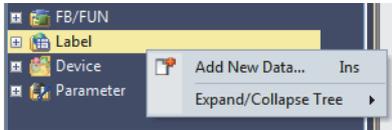
Point

When using more than one FB, set a different instance name for each FB. If more than one FB with the same instance name exists, the FBs do not operate properly.

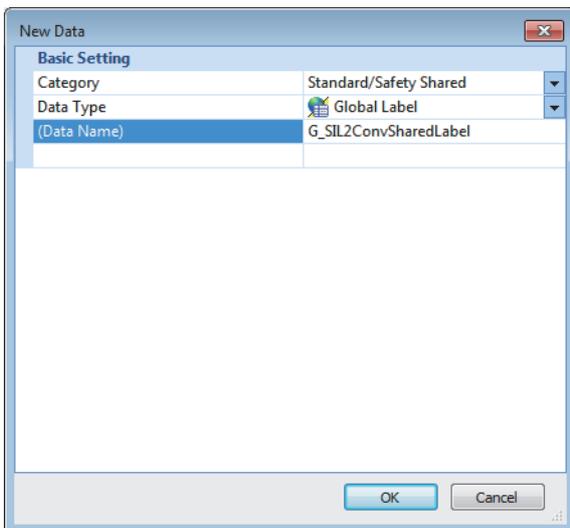
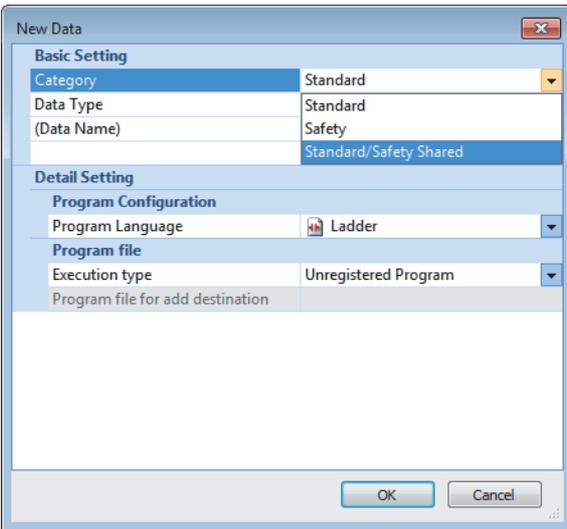
Standard/safety shared label definition

The standard/safety shared labels used by the SIL2 safety program FB and SIL2 standard program FB need to be defined. This section describes the procedure for editing the standard/safety shared labels.

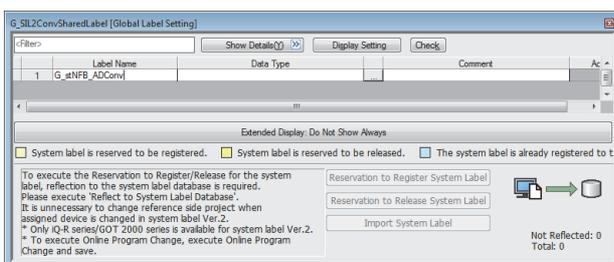
Since the standard/safety shared labels defined in this procedure are the data used by the FB, the system may not operate properly when the data is rewritten.



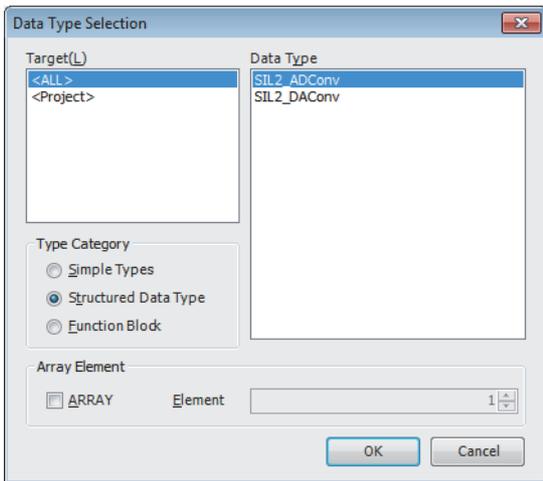
1. Right-click "Label" in the navigation window to display the menu.
2. Select "Add New Data" from the menu to open the window for creating new data.
3. Select the "Standard/Safety Shared" category.



4. Set a data name. The name can be any name, however, it must be unique. (Example: G_SIL2ConvSharedLabel)
5. Click the [OK] button to close the "New Data" window and display the label editor.



6. Set a label name. The name can be any name, however, it must be unique. (Example: G_stNFB_ADConv)
7. Click the [...] button to open the "Data Type Selection" window.



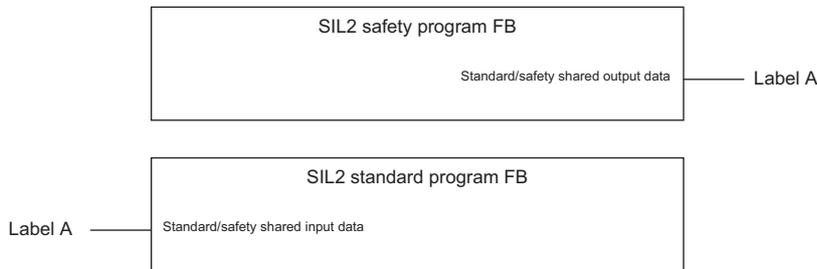
8. Select "Structured Data Type" in "Type Category" and select the suitable structure from "Data Type" compatible to the system to be used.
 - System using the A/D converter module: SIL2_ADConv (The number of labels to be defined in one system: 1)
 - System using the D/A converter module: SIL2_DACConv (The number of labels to be defined in one system: 2)

Setting procedure for FBs

■ System using the A/D converter module

Set the same label to the output label of the SIL2 safety program FB and input label of the SIL2 standard program FB.

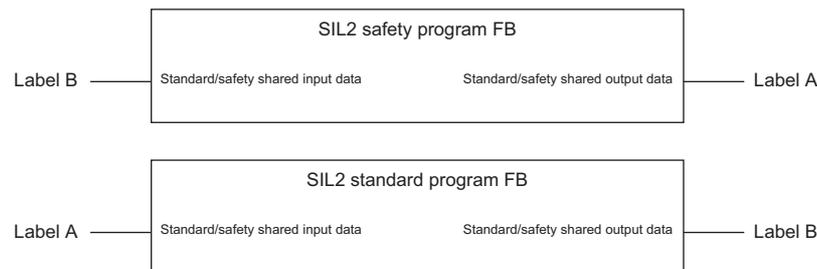
Assuming the name of the label to define is "Label A", set as shown below.



■ System using the D/A converter module

Set the same label to the output label of the SIL2 safety program FB and input label of the SIL2 standard program FB. Set another same label to the input label of the SIL2 safety program FB and output label of the SIL2 standard program FB.

Assuming the names of the label to define are "Label A" and "Label B", set as shown below.



Point

When using more than one SIL2 safety program FB and SIL2 standard program FB, handle one SIL2 safety program FB and one SIL2 standard program FB as a single set and use them per set. In addition, use a different standard/safety shared label for each set.

- Correct example

1st set: Label A and Label B, 2nd set: Label C and Label D

- Incorrect example (Duplicate Label A)

1st set: Label A and Label B, 2nd set: Label A and Label D

4.3 Temperature input system

This section describes an example of a program for a temperature input system using the A/D converter module.

A/D converter module (temperature input)

Program overview

Operate the R60AD8-G in SIL2 mode with the following settings. Signals must be input to the R60AD8-G via signal converters.

Module parameter		Description
Basic setting	A/D conversion enable/disable setting	CH1 to CH4: A/D conversion enable
	Input range setting	CH1: 4 to 20mA CH2: 4 to 20mA CH3: 4 to 20mA CH4: 4 to 20mA
Application setting	SIL2 A/D conversion cycle setting	2300ms

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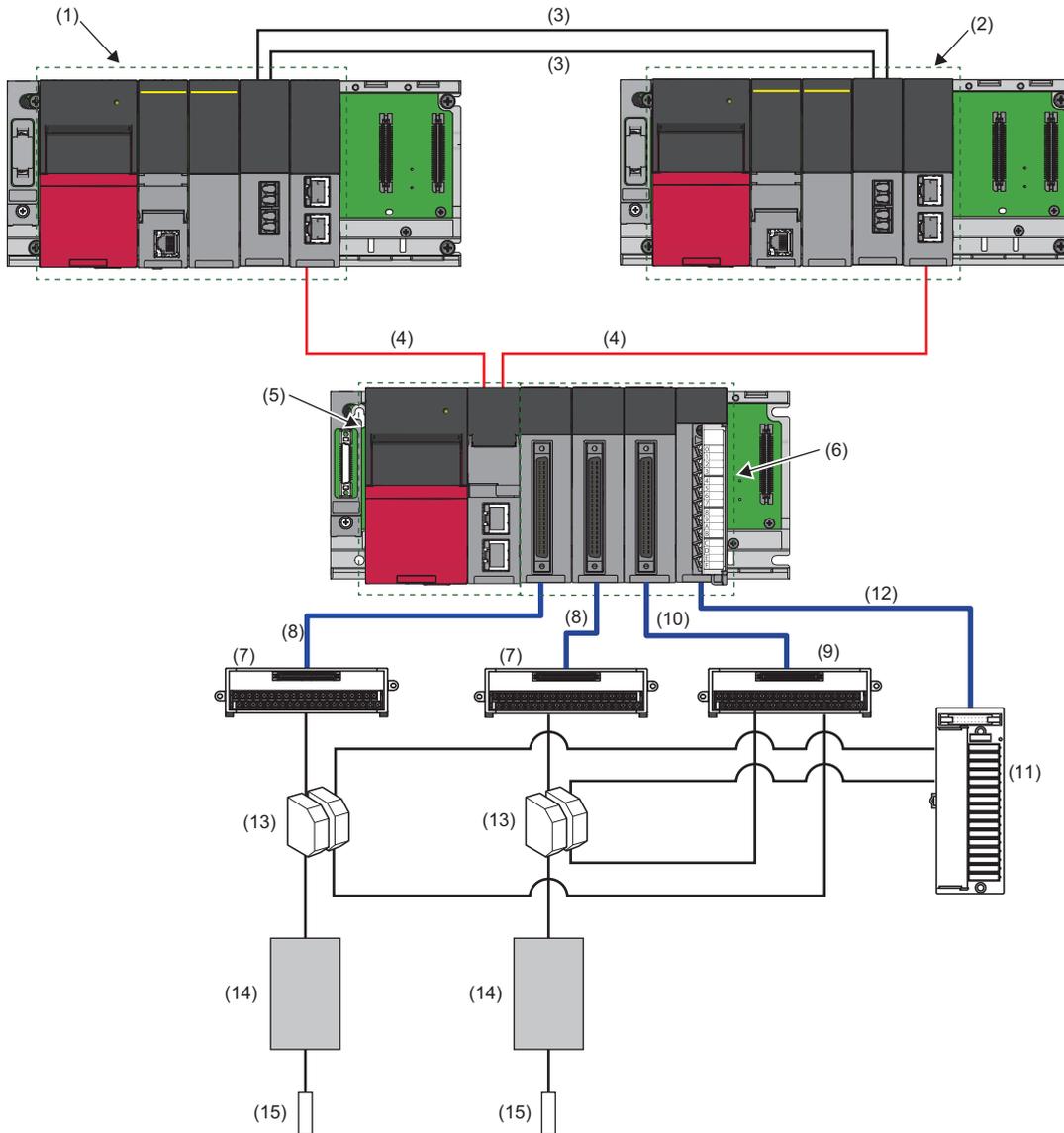
Point

For the SIL2 A/D conversion cycle setting, refer to the following.

 Page 99 Calculation example for the SIL2 A/D conversion cycle setting

For verification of the temperature input system that meets the SIL2 requirements, we use the MACX MCR-T-UI-UP-SP manufactured by PHOENIX CONTACT GmbH & Co. KG as the signal converter. For details on settings of the signal converter, contact PHOENIX CONTACT GmbH & Co. KG.

System configuration



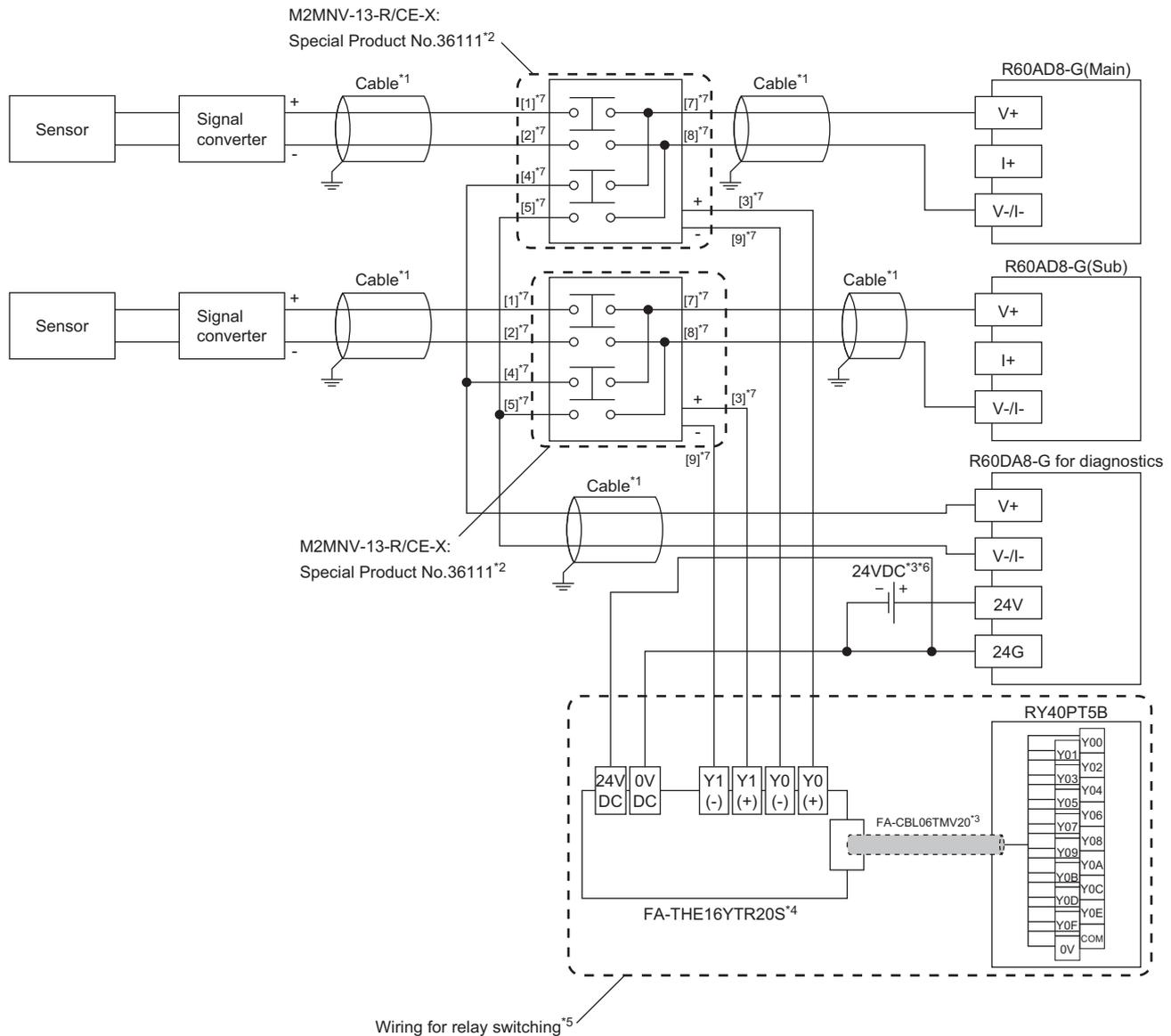
■List of components

No.	Name	Description
(1)	System A	<p>Composed of the following modules:</p> <ul style="list-style-type: none"> • RnPSFCPU • R6PSFM • R6RFM • RJ71GF11-T2 <p>■Precautions</p> <ul style="list-style-type: none"> • Each module has restrictions on use in a system on the system configuration diagram. For details, refer to the User's Manual (Application) for each module. • Mount the above modules on the same base unit. Place the modules in the following order: RnPSFCPU → R6PSFM → R6RFM → RJ71GF11-T2, starting from the right side of the power supply module.
(2)	System B	<p>Composed of the following modules:</p> <ul style="list-style-type: none"> • RnPSFCPU • R6PSFM • R6RFM • RJ71GF11-T2 <p>■Precautions</p> <ul style="list-style-type: none"> • Each module has restrictions on use in a system on the system configuration diagram. For details, refer to the User's Manual (Application) for each module. • Mount the above modules on the same base unit. Place the modules in the following order: RnPSFCPU → R6PSFM → R6RFM → RJ71GF11-T2, starting from the right side of the power supply module.
(3)	Tracking cable	Use cables that meet the specifications for the R6RFM. (MELSEC iQ-R CPU Module User's Manual (Startup))
(4)	CC-Link IE Field Network supporting cable	Use cables supporting CC-Link IE Field Network. (MELSEC iQ-R Ethernet/CC-Link IE User's Manual (Startup))
(5)	Remote head module	Use the RJ72GF15-T2. Note that the module has restrictions on use in a system on the system configuration diagram. For details, refer to the following. MELSEC iQ-R CC-Link IE Field Network Remote Head Module User's Manual (Application)
(6)	Module set	<p>Composed of the following modules:^{*1}</p> <ul style="list-style-type: none"> • R60AD8-G (Main) • R60AD8-G (Sub) • R60DA8-G for diagnostics • RY40PT5B <p>■Precautions</p> <ul style="list-style-type: none"> • When using the R60AD8-G in SIL2 mode, note that there is a restriction on the version. (MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)) • Mount the above modules on the same base unit. Place the modules in the following order: R60AD8-G (Main) → R60AD8-G (Sub) → R60DA8-G for diagnostics → RY40PT5B, starting from the right side of the remote head module.
(7)	Connector/terminal block converter module for the R60AD8-G	For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(8)	Connector/terminal block converter module connection cable for the R60AD8-G	Use a dedicated cable for connecting the R60AD8-G and the connector/terminal block converter module. For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(9)	Connector/terminal block converter module for the R60DA8-G for diagnostics	For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(10)	Connector/terminal block converter module connection cable for the R60DA8-G for diagnostics	Use a dedicated cable for connecting the R60DA8-G for diagnostics and the connector/terminal block converter module. For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(11)	FA-THE16YTR20S	This module is used to connect the relay switching RY40PT5B with the M2MNV-13-R/CE-X: Special Product No.36111. For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(12)	FA-CBL06TMV20	This cable is a special cable used to connect the RY40PT5B with the FA-THE16YTR20S. For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(13)	M2MNV-13-R/CE-X: Special Product No.36111	For details, refer to the following. MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(14)	Signal converter	Signal converter (MACX MCR-T-UI-UP-SP (manufactured by PHOENIX CONTACT GmbH & Co. KG))
(15)	Temperature sensor	Use thermocouples or RTDs that are commercially available.

*1 Mount the R60AD8-G (Main) to slot number 0, R60AD8-G (Sub) to slot number 1, R60DA8-G for diagnostics to slot number 2, and RY40PT5B to slot number 3.

Wiring

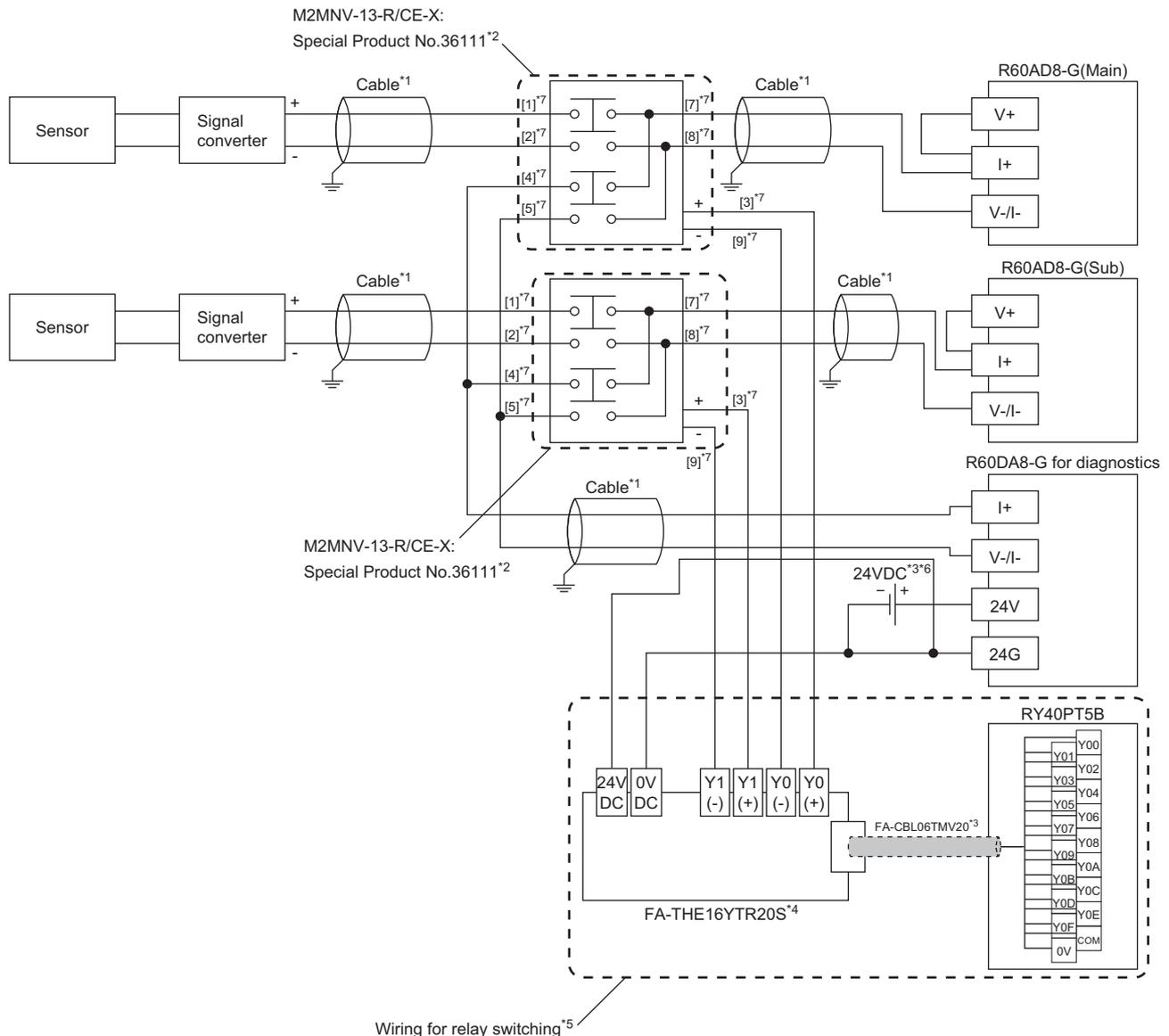
■ Voltage input



Wiring for relay switching^{*5}

- *1 For the application below, use shielded cables and single point grounding for the shield.
 - Between a sensor and the M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60DA8-G for diagnostics and M2MNV-13-R/CE-X: Special Product No.36111
- *2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.
- *3 When the R60AD8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.
 - 📖 MELSEC iQ-R Module Configuration Manual
 - 📖 Safety Guidelines (This manual is included with the base unit.)
- *4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B.
- *5 For details on wiring for relay switching, refer to the following.
 - 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
- *6 Use an external power supply that satisfies the following conditions:
 - The overvoltage protection function is available.
 - The output voltage does not exceed 35VDC in single fault state.
- *7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

■ Current input



- *1 For the application below, use shielded cables and single point grounding for the shield.
 - Between a sensor and the M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60AD8-G and M2MNV-13-R/CE-X: Special Product No.36111
 - Between the R60DA8-G for diagnostics and M2MNV-13-R/CE-X: Special Product No.36111
- *2 Install the M2MNV-13-R/CE-X: Special Product No.36111 and the programmable controller within the same control panel.
- *3 When the R60AD8-G must comply with EMC and Low Voltage Directives, refer to one of the following manuals.
 - 📖 MELSEC iQ-R Module Configuration Manual
 - 📖 Safety Guidelines (This manual is included with the base unit.)
- *4 Since the M2MNV-13-R/CE-X: Special Product No.36111 cannot receive 24V output signals, it cannot be connected directly to the RY40PT5B.
- *5 For details on wiring for relay switching, refer to the following.
 - 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
- *6 Use an external power supply that satisfies the following conditions:
 - The overvoltage protection function is available.
 - The output voltage does not exceed 35VDC in single fault state.
- *7 These numbers indicate the terminal numbers of the relay (M2MNV-13-R/CE-X).

Program conditions

- A/D-conversion-enabled channels: CH1, CH2, CH3, and CH4
- Input ranges: 4 to 20mA for CH1 to CH4
- A/D conversion method for each channel: Sampling processing for CH1 to CH4
- Measurement temperature range: -200.0°C to 850.0°C (This program example assumes the use of Pt100-RTDs (-200°C to 850°C) as temperature sensors.)
- Operation when the dual input discrepancy is detected: Setting upscale value (902.5°C) to temperature measurement values.*1

*1 This program example assumes that the temperature input system uses heating elements. Through the upscale processing, the system stops the heater if the temperature sensor fails. This keeps the system stable.

Procedures before operation

For the system configuration and parameter settings, refer to the following.

📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)

However, for the system configuration and program conditions described in this operation example, set parameters as follows instead.

■ "CPU Parameter" for the SIL2 Process CPU

Item			Description
Redundant System Settings	Tracking Setting	Signal Flow Memory Tracking Setting	Transfer
	Tracking Device/Label Setting		Transfer collectively*1
Safety Function Setting	Safety Cycle Time		50.0ms

*1 When selecting "Detailed setting" here, set also "Tracking Block No.1 Auto Transfer Setting" and "Device/Label Detailed Setting".
(📖 MELSEC iQ-R CPU Module User's Manual (Application))

■ "Basic setting" of the master/local module

Item	Description																																																																										
Network configuration setting	<table border="1"> <thead> <tr> <th rowspan="2">No.</th> <th rowspan="2">Model Name</th> <th rowspan="2">STA#</th> <th rowspan="2">Station Type</th> <th colspan="3">RX/RX Setting</th> <th colspan="3">RWw/RWr Setting</th> <th rowspan="2">Reserved/Error Invalid Station/System Switching Monitoring Target Station</th> </tr> <tr> <th>Points</th> <th>Start</th> <th>End</th> <th>Points</th> <th>Start</th> <th>End</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Host Station</td> <td>0</td> <td>Master Station</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>Host Station</td> <td>1</td> <td>Sub-Master Station</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>No Setting</td> </tr> <tr> <td>2</td> <td>RJ72GF15-T2</td> <td>2</td> <td>Intelligent Device Station</td> <td>80</td> <td>0000</td> <td>004F</td> <td>8</td> <td>0000</td> <td>0007</td> <td>No Setting</td> </tr> </tbody> </table>	No.	Model Name	STA#	Station Type	RX/RX Setting			RWw/RWr Setting			Reserved/Error Invalid Station/System Switching Monitoring Target Station	Points	Start	End	Points	Start	End	0	Host Station	0	Master Station								1	Host Station	1	Sub-Master Station							No Setting	2	RJ72GF15-T2	2	Intelligent Device Station	80	0000	004F	8	0000	0007	No Setting																								
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Refresh settings	<table border="1"> <thead> <tr> <th rowspan="2">No.</th> <th colspan="4">Link Side</th> <th rowspan="2"></th> <th colspan="4">CPU Side</th> </tr> <tr> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> <th>Target</th> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> </tr> </thead> <tbody> <tr> <td>-</td> <td>SB</td> <td></td> <td></td> <td></td> <td>↔</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>-</td> <td>SW</td> <td></td> <td></td> <td></td> <td>↔</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1</td> <td>RY</td> <td>16</td> <td>00020</td> <td>0002F</td> <td>↔</td> <td>Specify Device</td> <td>Y</td> <td>16</td> <td>01000</td> <td>0100F</td> </tr> <tr> <td>2</td> <td>RWw</td> <td>8</td> <td>00000</td> <td>00007</td> <td>↔</td> <td>Specify Device</td> <td>W</td> <td>8</td> <td>00000</td> <td>00007</td> </tr> <tr> <td>3</td> <td>RY</td> <td>16</td> <td>00030</td> <td>0003F</td> <td>↔</td> <td>Specify Device</td> <td>Y</td> <td>16</td> <td>01010</td> <td>0101F</td> </tr> </tbody> </table>	No.	Link Side					CPU Side				Device Name	Points	Start	End	Target	Device Name	Points	Start	End	-	SB				↔						-	SW				↔						1	RY	16	00020	0002F	↔	Specify Device	Y	16	01000	0100F	2	RWw	8	00000	00007	↔	Specify Device	W	8	00000	00007	3	RY	16	00030	0003F	↔	Specify Device	Y	16	01010	0101F
No.	Link Side					CPU Side																																																																					
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2	RWw	8	00000	00007	↔	Specify Device	W	8	00000	00007																																																																	
3	RY	16	00030	0003F	↔	Specify Device	Y	16	01010	0101F																																																																	

■ "Application setting" of the master/local module

Item	Description																																							
Safety communication setting	<table border="1"> <thead> <tr> <th colspan="10">Safety Data Transfer Device Setting</th> </tr> <tr> <th rowspan="2">Destination Station-></th> <th colspan="5">Receive Data Storage Device</th> <th colspan="4">Send Data Storage Device</th> </tr> <tr> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> <th>Device Name</th> <th>Points</th> <th>Start</th> <th>End</th> <th></th> </tr> </thead> <tbody> <tr> <td>SAID</td> <td>SAID</td> <td>8</td> <td>0</td> <td>7</td> <td>SAID</td> <td>8</td> <td>10</td> <td>17</td> <td>->Destination Station</td> </tr> </tbody> </table>	Safety Data Transfer Device Setting										Destination Station->	Receive Data Storage Device					Send Data Storage Device				Device Name	Points	Start	End	Device Name	Points	Start	End		SAID	SAID	8	0	7	SAID	8	10	17	->Destination Station
Safety Data Transfer Device Setting																																								
Destination Station->	Receive Data Storage Device					Send Data Storage Device																																		
	Device Name	Points	Start	End	Device Name	Points	Start	End																																
SAID	SAID	8	0	7	SAID	8	10	17	->Destination Station																															

■Module parameters for "R60AD8-G(S2M)"

Configure the following settings. For parameters other than the following, use the default values.

Module parameter	Description	
Basic setting	A/D conversion enable/disable setting	CH1 to CH4: A/D conversion enable
	Input range setting	CH1: 4 to 20mA CH2: 4 to 20mA CH3: 4 to 20mA CH4: 4 to 20mA
Application setting	Scaling enable/disable setting	CH1: Enable CH2: Enable CH3: Enable CH4: Enable
	Scaling upper limit value	CH1: 8500 CH2: 8500 CH3: 8500 CH4: 8500
	Scaling lower limit value	CH1: -2000 CH2: -2000 CH3: -2000 CH4: -2000
	SIL2 A/D conversion cycle setting	2300ms

Point

- Match the scaling upper/lower limit values to the ones in settings of the signal converter used.
- For the SIL2 A/D conversion cycle setting, refer to the following.

☞ Page 99 Calculation example for the SIL2 A/D conversion cycle setting

■Module parameters for "R60DA8-G"

Configure the following settings. For parameters other than the following, use the default values.

Module parameter	Description	
Basic setting	D/A conversion enable/disable setting	CH1 to CH4: D/A conversion enable
	Output range setting	CH1: 4 to 20mA (Extension) CH2: 4 to 20mA (Extension) CH3: 4 to 20mA (Extension) CH4: 4 to 20mA (Extension)
Application setting	Input value shift amount	CH1: 4000 CH2: 4000 CH3: 4000 CH4: 4000
Refresh settings	Digital value	Set W0 to W7 to CH1 to CH8 in ascending channel number order.*1 Example) CH1: W0, CH2: W1, ..., CH7: W6, CH8: W7

*1 Because parameters in the refresh settings are used for the SIL2 standard program FB, all eight channels must be set. Missing parameters may cause malfunction.

■Attaching the SIL2 diagnostic FB library to programs

- Attach the SIL2 safety program FB to the safety program of the fixed scan execution type program.
- Attach the SIL2 standard program FB to the standard program of the scan execution type program.

Point

When more than one SIL2 safety program FB and SIL2 standard program FB are used, ensure that each FB has different instance name. If more than one FB with the same instance name exists, the FBs do not operate properly.

Devices to use

■SIL2 safety program FB

Device	Description
SAISD1008.0	Execution command. This device stores the safety refresh communication status of connection number 1 for slot 1 of the remote head module.
SAM1001	Module error clear
SAM1002	Start-up diagnostics skip request
SAM1003	Execution status
SAM1004	Normal completion
SAM1005	Error completion
SAM1010	System error
SAM1011 to SAM1014	Channel error: CH1 to CH4
SAID0000 to SAID0007	Safety communications receive area
SAID0010 to SAID0017	Safety communications send area
SAID130 to SAID133	Digital obtained value: CH1 to CH4
SAID1020	Error code
SAID1030 to SAID1037* ¹	Digital obtained value: CH1 to CH8
SAID1040	External device connection status
SAID1050 to SAID1057* ¹	Status code: CH1 to CH8
SAID2000 to SAID2003	Upscale setting value: CH1 to CH4

*1 Consecutive eight-word areas are required independent of the number of A/D-conversion-enabled channels.

■SIL2 standard program FB

Device	Description
SM400	Execution command (always ON)
M1001	Execution status
M1002	Normal completion
W0	Digital value
Y1000 to Y1007* ¹	CH1 to CH8 Output enable/disable flag
Y1008 to Y100F* ¹	Use prohibited
Y1010 to Y101F* ¹	Relay control data

*1 Consecutive 16-bit areas are required independent of the number of A/D-conversion-enabled channels.

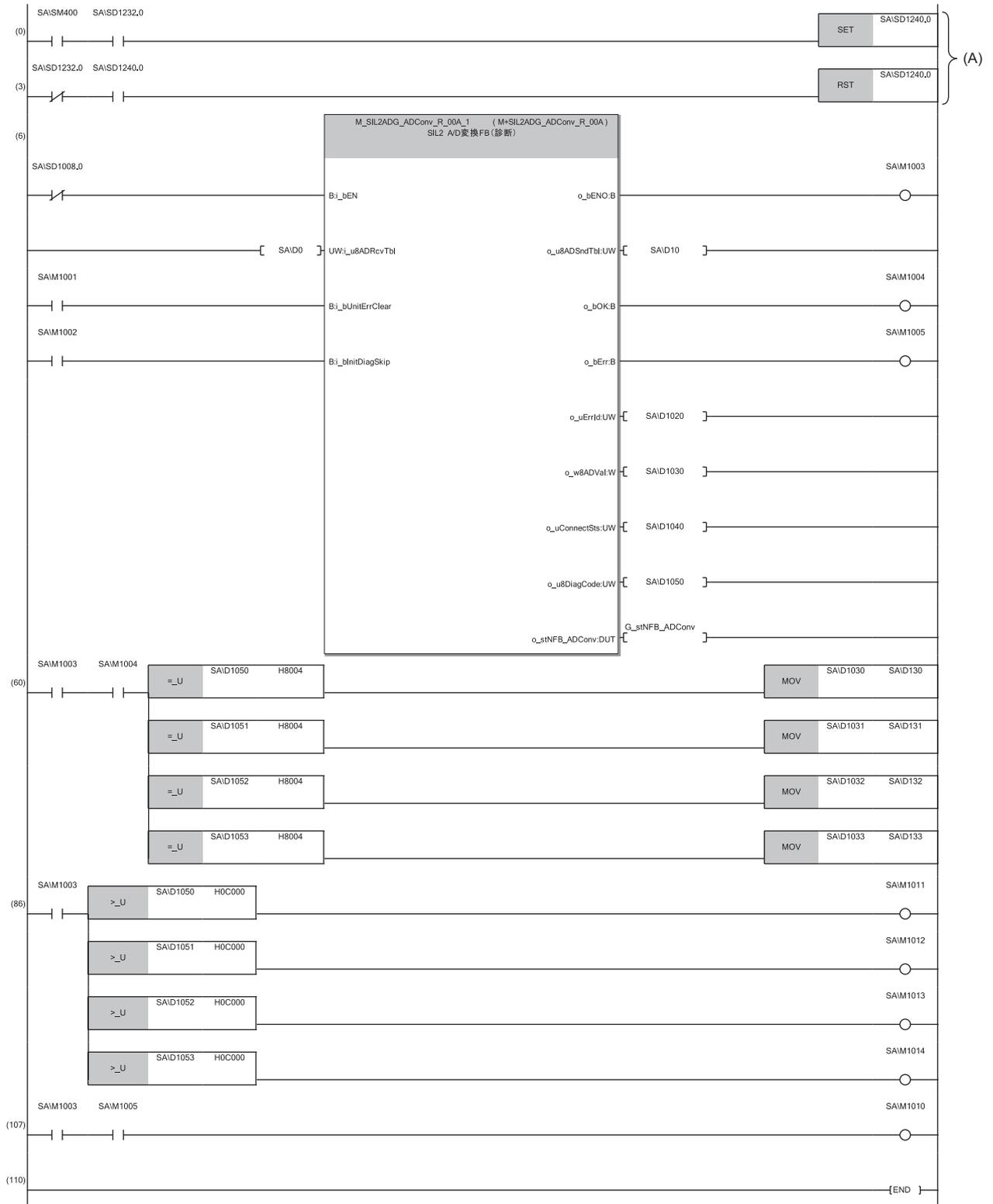
■Standard/safety shared label

Device	Description
G_stNFB_ADConv	Used for o_stNFB_ADConv in the SIL2 safety program FB and for i_stNFB_ADConv in the SIL2 standard program FB, and stores the data from the SIL2 safety program FB to the SIL2 standard program FB.

Program examples

- When the safety refresh communication status is normal, digital operation values are obtained from CH1 to CH4 of the R60AD8-G and output to Digital obtained value (SAID1030 to SAID1033).
- To skip the start-up diagnostics, turn on Start-up diagnostics skip request (SAM1002).
- When Execution status (SAM1003) and Normal completion (SAM1004) of the SIL2 safety program FB are on, processing runs according to Status code (SAID1050 to SAID1053) of each channel. For channels whose Status code is Double input discrepancy detection function completed (8004H), processing for normal state runs. For channels whose Status code indicates an error (C001H or larger), Channel error (SAM1011 to SAM1014) turns on.
- Execution status (SAM1003) and Error completion (SAM1005) of the SIL2 safety program FB are on, System error (SAM1010) turns on.
- To clear the errors currently occurring, turn on Module error clear (SAM1001). Turn off SAM1001 after ensuring the errors are reset.

SIL2 safety program FB

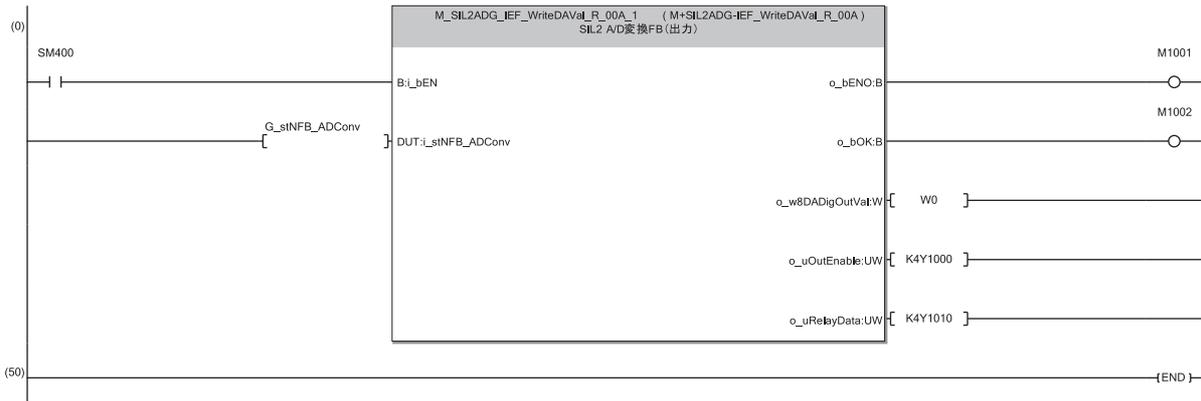


- (6) When SA\SD1008.0 (Safety refresh communication status of each safety connection (1st module)) is off (normal), the SIL2 safety program FB starts up. To clear the errors, turn on SA\M1001 (Module error clear). When the error clearing processing completes, o_bErr turns off and o_uErrId is cleared to 0. To skip the start-up diagnostics, turn on SA\M1002 prior to the start-up of the SIL2 safety program FB. Note that the skip is enabled only when the safety operation mode of the CPU module is TEST MODE.
- When i_bEN of the SIL2 safety program FB is on, SA\M1003 (Execution status) turns on.
- When the SIL2 safety program FB is completed successfully, SA\M1004 (Normal completion) turns on.
- When the SIL2 safety program FB is completed with an error, SA\M1005 (Error completion) turns on and the error code is stored in D1020 (Error code).
- When i_bEN of the SIL2 safety program FB is on, SA\D1040 (External device connection status) stores the connection status. While the corresponding channel is being diagnosed (while external devices are disconnected), the bit corresponding to the channel turns off.
- When either o_bOK or o_bErr of the SIL2 safety program FB turns on, devices from SA\D1050 to SA\D1057 (Status code: CH1 to CH8) store status codes.
- (60) When SA\D1050 to SA\D1053 (Status code: CH1 to CH4) are 8004H (Analog output read-back completed) while both SA\M1003 (Execution command ON) and SA\M1004 (SIL2 safety program FB ON) are on, the values in SA\D1030 to SA\D1033 (Digital obtained value) are stored into SA\D130 to SA\D133.
- (86) When SA\D1050 to SA\D1053 (Status code: CH1 to CH4) are C000H or larger while SA\M1003 (Execution command ON) is on, devices from SA\M1011 to SA\M1014 (Channel error: CH1 to CH4) turn on.
- (107) When both SA\M1003 (Execution command ON) and SA\M1005 (Error completion) are on, SA\M1010 (System error) turns on.

Point 

The program (A) is required to continue the safety communications after the systems are switched. When using the SIL2 safety program FB, include the program (A).

■SIL2 standard program FB



- (0) With SM400, i_bEN (Execution command) of the SIL2 standard program FB is always on.
 When i_bEN (Execution command) turns on, M1001 (Execution status) turns on.
 When the SIL2 standard program FB is completed successfully, M1002 (Normal completion) turns on.

Item	Description
Timing chart of I/O signals	<p>■Normal completion</p> <p>■Error completion</p>
Restrictions and precautions	<ul style="list-style-type: none"> To use this FB, set the master station and the intelligent device station. (LUMELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)) The FB requires the configuration of the ladder for every input label.

■Upscale processing

If an A/D converter module has failed, digital value becomes zero. When the upscale processing is needed, use the following programs.

- For setting upscale values (CH1 to CH4)



- For upscale value output (Upscale values are stored in the devices if the dual input discrepancy is detected in CH1 to CH4.)



APPENDICES

Appendix 1 Calculation Method of Safety Response Time

This section describes the calculation method of safety response time in a system using the SIL2 Process CPU.

From digital input to digital output

The safety response time is the maximum time taken from when the safety input of the RX40NC6B (intelligent device station (safety station)) turns off until the safety output of the RY40PT5B (intelligent device station (safety station)) turns off. The time includes an error detection time.

This maximum time is calculated by the following formula.

Intelligent device station (safety station) on the input side → Master station (safety station) → Intelligent device station (safety station) on the output side

$$(SCmst \times 3) + (S2cycin \times 2 + S2cycout \times 2.5) + (RMin + RMout) + SRin + SRout + (nin \times 2) + (nout \times 2)$$

Symbol	Description
SCmst	Safety cycle time of the master station (safety station) ^{*1}
S2cycin	Control cycle time of the input side (RX40NC6B (Main)) ^{*2}
S2cycout	Control cycle time of the output side (RY40PT5B (Main)) ^{*2}
RMin	Safety refresh monitoring time for the input connection of the master station (safety station) ^{*3} + Safety I/O hold time ^{*5}
RMout	Safety refresh monitoring time for the output connection of the master station (safety station) ^{*3} + Safety I/O hold time ^{*5}
SRin	Safety input response time for SIL2 mode ^{*2}
SRout	Safety output response time for SIL2 mode ^{*2}
nin	$RMin - (TMmstin \div 2) - TMrmtin + c$
nout	$RMout - TMmstout - (TMrmtout \div 2) + a$
a	$TMmstout - b$ (This value is effective only if a station set to Active is the RJ71GF11-T2. In other cases, the value is 0.)
b	The calculation result of $TMmstout \div 2$, which is rounded up to a multiple of the safety cycle time ^{*4}
c	$TMrmtin - d$ (This value is effective only if a station set to Passive is the RJ71GF11-T2, or RJ72GF15-T2 mounted with the RX40NC6B and RY40PT5B. In other cases, the value is 0.)
d	The calculation result of $TMrmtin \div 2$, which is rounded up to a multiple of the safety cycle time (control cycle time of the RX40NC6B (Main)). ^{*4}
TMmstin	Transmission interval monitoring time for the input connection of the master station (safety station) ^{*3}
TMmstout	Transmission interval monitoring time for the output connection of the master station (safety station) ^{*3}
TMrmtin	Transmission interval monitoring time of the input side (RX40NC6B (Main)) ^{*2}
TMrmtout	Transmission interval monitoring time of the output side (RY40PT5B (Main)). ^{*2}

*1 For the safety cycle time, refer to the following.

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

*2 For details, refer to the "Performance Specifications" of the following.

📖 MELSEC iQ-R I/O Module (With Diagnostic Functions) User's Manual (Application)

*3 For details, refer to the following.

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

*4 Calculation examples for b and d:

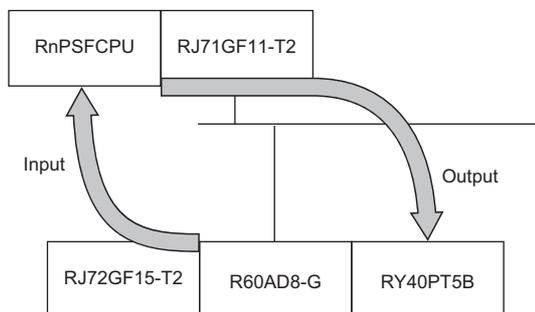
When transmission interval monitoring time = 24ms, and safety cycle time = 10ms, the calculation result is 20, rounded up $24 \div 2 = 12$ to a multiple of 10.

*5 For the safety I/O hold time, refer to the following.

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

From analog input to digital output

The safety response time is the maximum time taken from when a value satisfying a certain condition is detected in the analog safety input of the R60AD8-G (intelligent device station (safety station)) until the safety output of the RY40PT5B (intelligent device station (safety station)) turns off. The time includes an error detection time. This maximum time is calculated by the following formula.



Analog input = (SIL2 A/D conversion cycle) × 5 + (SCmst × 2) + (S2cycout × 2.5) + RMout + RMholdout + n_bkout × 2 + SRout

Symbol	Description
SCmst	Safety cycle time of the master station (safety station) ^{*1}
S2cycout	Control cycle time of the output side (modules set to SIL2 mode and Main) ^{*2}
RMout	Safety refresh monitoring time for the output connection of the master station (safety station) ^{*3}
RMholdout	Safety I/O hold time ^{*5}
n_bkout	RMout - TMmstout - (TMrmtout ÷ 2) + a
SRout	Safety output response time for SIL2 mode ^{*2}
a	TMmstout - b (This value is effective only if a station set to Active is the RJ71GF11-T2. In other cases, the value is 0.)
b	The calculation result of TMmstout ÷ 2, which is rounded up to a multiple of the safety cycle time ^{*4}
TMmstout	Transmission interval monitoring time for the output connection of the master station (safety station) ^{*3}
TMrmtout	Transmission interval monitoring time for the module (safety station) set to SIL2 mode Main of the output side ^{*2}

*1 For the safety cycle time, refer to the following.

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

*2 For details, refer to the following.

📖 MELSEC iQ-R I/O Module (With Diagnostic Functions) User's Manual (Application)

*3 For details, refer to the following.

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

*4 Calculation example for b:

When transmission interval monitoring time = 24ms, and safety cycle time = 10ms, the calculation result is 20, rounded up $24 \div 2 = 12$ to a multiple of 10.

*5 For the safety I/O hold time, refer to the following.

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

Response time until the digital output with the following conditions completes is 139007ms (= 2m 19.0s)

- SIL2 A/D conversion cycle: 25000ms
- SCmst: 50ms
- S2cycout: 2ms
- RMout: 1500ms
- RMholdout: 10s (10000ms)
- SRout: 2ms
- TMmstout: 400ms
- TMrmtout: 200ms

Calculation example for the SIL2 A/D conversion cycle setting

The SIL2 A/D conversion cycle is the time taken for the digital operation value to be stored in the safety device specified by the SIL2 diagnostic FB library, and it is set by the user.

Item	Setting range
SIL2 A/D conversion cycle setting	700 to 32767ms

The following shows the calculation example of the setting value for the SIL2 A/D conversion cycle.

$$(SCmst \times 10) + (RM \times 3) + (LS \times 16) + 372ms + (12ms \times CHad) + (SM \times 2)$$

Symbol	Description
SCmst	Safety cycle time of the master station (safety station) ^{*1}
RM	Safety refresh monitoring time ^{*2}
LS	Link scan time
CHad	Number of A/D conversion enabled channels
SM	Sequence scan time of the master station (safety station)

*1 For the safety cycle time, refer to the following.

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

*2 For the safety refresh monitoring time, refer to the following.

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

Assign the following conditions in the calculation formula.

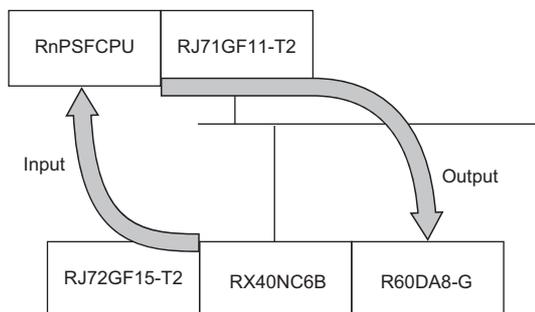
- SCmst: 50ms
- RM: 400ms
- LS: 2ms
- CHad: 8 (A/D conversion enabled for all channels)
- SM: 2ms

$$\begin{aligned} & (SCmst \times 10) + (RM \times 3) + (LS \times 16) + 372ms + (12ms \times CHad) + (SM \times 2) \\ &= (50ms \times 10) + (400ms \times 3) + (2ms \times 16) + 372ms + (12ms \times 8) + (2ms \times 2) \\ &= 2204ms \end{aligned}$$

With the above conditions, set "SIL2 A/D conversion cycle setting" to 2204ms or higher.

From digital input to analog output

The safety response time is the maximum time taken from when turning off of the digital input of the RX40NC6B (intelligent device station (safety station)) is detected until the analog safety output of the R60DA8-G (intelligent device station (safety station)) becomes a determined analog value. The time includes an error detection time. This maximum time is calculated by the following formula.



$$\text{Analog output} = (\text{SIL2 D/A conversion cycle}) \times 43 + (\text{SCmst} \times 1) + (\text{S2cycin} \times 2) + \text{RMin} + \text{RMholdin} + n_fwin \times 2 + \text{SRin}$$

Symbol	Description
SCmst	Safety cycle time of the master station (safety station) ^{*1}
S2cycin	Control cycle time of the output side (modules set to SIL2 mode and Main) ^{*2}
RMin	Safety refresh monitoring time for the input connection of the master station (safety station) ^{*3}
RMholdin	Safety I/O HOLD time ^{*5}
n_fwin	$\text{RMin} - (\text{TMmstin} \div 2) - \text{TMrmtin} + c$
SRin	Safety input response time for SIL2 mode ^{*2}
c	$\text{TMrmtin} - d$ (This value is effective only if a station set to Passive is the RJ71GF11-T2, or RJ72GF15-T2 mounted with the RX40NC6B and RY40PT5B. In other cases, the value is 0.)
d	The calculation result of $\text{TMrmtin} \div 2$, which is rounded up to a multiple of the safety cycle time (control cycle time of the module set to SIL2 mode and Main). ^{*4}
TMmstin	Transmission interval monitoring time for the input connection of the master station (safety station) ^{*3}
TMrmtin	Transmission interval monitoring time for the module (safety station) set to SIL2 mode and Main on the input connection ^{*2}

*1 For the safety cycle time, refer to the following.

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

*2 For details, refer to the following.

📖 MELSEC iQ-R I/O Module (With Diagnostic Functions) User's Manual (Application)

*3 For details, refer to the following.

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

*4 Calculation example for d:

When transmission interval monitoring time = 24ms, and safety cycle time = 10ms, the calculation result is 20, rounded up $24 \div 2 = 12$ to a multiple of 10.

*5 For the safety I/O hold time, refer to the following.

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

Response time until the analog output with the following conditions completes is 873756ms (= 14m 33.8s)

- SIL2 D/A conversion cycle: 20000ms
- SCmst: 50ms
- S2cycin: 2ms
- RMin: 1500ms
- RMholdin: 10s (10000ms)
- TMmstin: 400ms
- TMrmtin: 400ms
- SRin: 2ms

Calculation example for the SIL2 D/A conversion cycle setting

The SIL2 D/A conversion cycle is the time until completion of the analog output read-back function is set, and set by the user.

Item	Setting range
SIL2 D/A conversion cycle setting	2000 to 20000ms

To determining a value to set, calculate an approximate value using the following formulas. The value should be the same as the calculated one or larger.

Calculate the both formulas, and use the larger one for determining a value to set.

- $(SCmst \times 8) + (RM \times 3) + (LS \times 12) + 16ms + (CHda \times 2ms \times 2)$
- $(SM \times 80) + (SCmst \times 6) + (RM \times 2) + (LS \times 4) + 4ms$

Symbol	Description
SCmst	Safety cycle time of the master station (safety station) ^{*1}
RM	Safety refresh monitoring time ^{*2}
LS	Link scan time
CHda	Number of D/A conversion enabled channels
SM	Sequence scan time of the master station (safety station)

*1 For the safety cycle time, refer to the following.

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

*2 For the safety refresh monitoring time, refer to the following.

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

Assign the following conditions in the calculation formula.

- SCmst: 50ms
- RM: 400ms
- LS: 2ms
- CHda: 4 (D/A conversion enabled for CH1, CH2, CH3, CH8)
- SM: 100ms

Under this condition, the calculation formulas are:

- $(SCmst \times 8) + (RM \times 3) + (LS \times 12) + 16ms + (CHda \times 2ms \times 2) = (50ms \times 8) + (400ms \times 3) + (2ms \times 12) + 16ms + (4 \times 2ms \times 2) = 1656ms$
- $(SM \times 80) + (SCmst \times 6) + (RM \times 2) + (LS \times 4) + 4ms = (100ms \times 80) + (50ms \times 6) + (400ms \times 2) + (2ms \times 4) + 4ms = 9112ms$

The larger calculation value is 9112ms. In this case, set 9112ms or a longer time to the SIL2 D/A conversion cycle.

Appendix 2 Checklist

No.	Description	Reference	Check
Backup and version management of a file			
1	The created date and author are entered at the beginning of a program using the statement function of the engineering tool.	Page 47 Version management of engineering tool project files	<input type="checkbox"/>
2	When a program is modified, the date modified, name of the person who modified the program, and a description of the modification are entered at the modified location using the statement function.		<input type="checkbox"/>
3	The data written to programmable controller is stored on the hard disk of a personal computer or CD.		<input type="checkbox"/>
Checking the setting			
4	The settings of modules that operate in SIL2 mode at the site have been checked to ensure that they are set as designed.	Page 36 Settings for network connection configuration	<input type="checkbox"/>
5	The SIL2 Process CPU and modules that operate in SIL2 mode at the site have been checked to ensure that they are mounted on the position as configured in the settings.		<input type="checkbox"/>
6	The appropriate values are set to the transmission interval monitoring time and safety refresh monitoring time on CC-Link IE Field Network.	Page 97 Calculation Method of Safety Response Time	<input type="checkbox"/>
7	When the system is shifted to actual operation, the safety operation mode of the SIL2 Process CPU has been set to SAFETY MODE.	Page 48 Safety operation mode while in operation	<input type="checkbox"/>
Operation check			
8	All the functions in the application have been inspected.	—	<input type="checkbox"/>
9	The response time of the application has been inspected.	—	<input type="checkbox"/>
Checking write data			
10	Before data are written to the programmable controller, programs and parameter setting values have been checked to ensure that they are configured as intended by the designer.	Page 36 Parameters and programs	<input type="checkbox"/>
11	When a safety data identify check is performed with the engineering tool, the safety data of the SIL2 Process CPU and project file have been checked to ensure that they are identical.	Page 48 Safety data identify check for SIL2 Process CPU	<input type="checkbox"/>
Others			
12	LEDs of each module and the module diagnostic window of the engineering tool are checked for errors and no errors have found.	—	<input type="checkbox"/>
13	Programs are checked to ensure that the "use prohibited" signals in output signals from the SIL2 Process CPU to CC-Link IE Field Network master/local module are not inadvertently turned on/off. For the "use prohibited" signals, refer to the following. □ MELSEC iQ-R CC-Link IE Field Network User's Manual (Application)	—	<input type="checkbox"/>
14	The registered passwords are appropriately managed.	Page 48 Protecting data	<input type="checkbox"/>

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MEMO

REVISIONS

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

Revision date	*Manual number	Description
January 2019	SH(NA)-082013ENG-A	First edition
July 2019	SH(NA)-082013ENG-B	■Added or modified parts RELEVANT MANUALS, TERMS, GENERIC TERMS AND ABBREVIATIONS, Section 2.1, 3.2, 4.3, Appendix 1
November 2022	SH(NA)-082013ENG-C	■Added or modified parts CONDITIONS OF USE FOR THE PRODUCT, TERMS, Section 1.1, 3.2, 4.2, WARRANTY

Japanese manual number: SH-082012-D

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