MITSUBISHI ELECTRIC

Programmable Controller

MELSEC iQ-R series

MELSEC iQ-R Safety Function Block Reference

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.

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

CONDITIONS OF USE FOR THE PRODUCT

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

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

INTRODUCTION

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

This manual describes the programming using the safety FBs.

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 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 Safety Function Block Reference [BCN-P5999-0815] (this manual)	Specifications of the safety FBs	e-Manual PDF
GX Works3 Operating Manual [SH-081215ENG]	System configuration, parameter settings, and online operations of GX Works3	e-Manual PDF

Point

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
GX Works3	The product name of the software package for the MELSEC programmable controllers
NC	A contact that is normally closed or in a conductive state, and opened by operation of the switch
NO	A contact that is normally open or in a non-conductive state, and closed by operation of the switch
Performance Level (PL)	A safety level specified in ISO 13849-1: 2015 (The safety level is classified into five levels, a to e.)
Risk	Degree of hazards, which is the combination of the possibility and severity of harm (injury or illness) that may occur when exposed to a hazard
Safety application	A generic term for the applications that are controlled by the safety programmable controller for realizing the safety functions
Safety communications	Communication service that performs send/receive processing in the safety layer of the safety communication protocol
Safety control	Machine control by safety programs and safety data communications. When an error occurs, the machine in operation is securely stopped.
Safety CPU	A generic term for the R08SFCPU, R16SFCPU, R32SFCPU, and R120SFCPU. This module is used with a safety function module as a pair, and performs both standard control and safety control.
Safety data	Data exchanged through safety communications
Safety device	A device that can be used in safety programs
Safety function module	Another name for the R6SFM. This module is used with the Safety CPU as a pair and performs safety control. The module can only be paired with the Safety CPU.
Safety functions	A function provided to protect a person from the hazards of machines
Safety input	A generic term for the signals that are input to the safety programmable controller for realizing the safety function
Safety output	A generic term for the signals that are output from the safety programmable controller for realizing the safety function
Safety programmable controller	A generic term for the MELSEC iQ-R series modules that perform safety control (such as a Safety CPU, safety function module, CC-Link IE Field Network remote I/O module (with safety functions))
Safety related system	A system that executes the required safety function
Safety remote I/O module	An abbreviation for the NZ2GFSS2-32D and NZ2EXSS2-8TE CC-Link IE Field Network remote I/O module (with safety functions).
Safety station	A generic term for a station that performs safety communications and standard communications
SIL	A safety level specified in IEC 61508: 2010 (The safety level is classified into four levels, SIL1 to SIL4.)

1 OVERVIEW

Safety FBs are the manufacturer offer function blocks that received the certification of ISO 13849-1:2015 PLe, IEC 62061:2012 SIL3, and IEC 61508:2010 SIL3. The safety FBs can be used with the MELSEC iQ-R series safety CPUs.

Improving the productivity and the maintainability of a safety program

The major functions used in programming safety applications are provided as the safety FB library. A safety program becomes simple by using the safety FBs, and the productivity and maintainability of the safety program are improved. Moreover, efficiency of debug and verification for a safety program is also improved.

The high safe level application using the safety certified FB

Since the safety FB received the safety certification, a user can build a safety application which is in compliance with ISO 13849-1:2006 PLe, IEC 62061:2012 SIL3, and IEC 61508:2010 SIL3. A user can develop an advanced safety application using the safety FBs, and it becomes easy to get the safety certification of user's safety application from an inspector.

Improving the reliability of the safety program

Since users cannot read the inside logic of the safety FBs, the users cannot customize or modify them. Therefore, the safety FBs cannot be intentionally modified by an intentional or mistaken operation and the reliability of a safety feature of a program will improve. Also, a safety FB used is whether the certified one or not can be identified by its name because the safety FBs and their name cannot be created and changed by a user.

Displaying a diagnostic code

The diagnostic code includes error codes and status codes. When a safety FB detects an internal error (including out of range of parameters and invalid static Reset), it displays an error code. When no error is detected, a safety FB displays a status code. Diagnostic codes are useful in knowing the operating status of the safety FBs and debugging.

Combination with a ladder

Safety FBs can be used within a ladder diagram. By combining a popular ladder and the certified safety functions, a user can make a safe and highly flexible safety program.

MEMO

2 GENERAL SPECIFICATIONS

2.1 List of Safety FBs

The following lists the safety FBs provided.

Name[*1]	Function	Description	Reference
M+SF_2HAND2_R_01A	Two-hand switch Type II	This FB provides the two-hand control functionality.	Page 16 M+SF_2HAND2_R
M+SF_2HAND3_R_01A	Two-hand switch Type III	This FB provides the two-hand control functionality (Fixed specified time difference is 500ms).	Page 20 M+SF_2HAND3_R
M+SF_EDM_R_01A	External device monitor	This FB controls a safety output and monitors controlled actuators, e.g. subsequent contactors.	Page 24 M+SF_EDM_R
M+SF_ENBLSW_R_01A	Enable switch	This FB evaluates the signals of an enable switch with three positions.	Page 30 M+SF_ENBLSW_R
M+SF_ESPE_R_01A	Light curtain (ESPE)	This FB is a safety-related FB for monitoring electro-sensitive protective equipment (ESPE).	Page 35 M+SF_ESPE_R
M+SF_ESTOP_R_01A	Emergency stop	This FB is a safety-related FB for monitoring an emergency stop button. This FB can be used for emergency switch off functionality (stop category 0).	Page 39 M+SF_ESTOP_R
M+SF_GLOCK_R_01A	Guard lock and interlocking	This FB controls an entrance to a hazardous area via an interlocking guard with guard locking ("four state interlocking").	Page 43 M+SF_GLOCK_R
M+SF_GMON_R_01A	Guard monitoring	This FB monitors the relevant safety guard. There are two independent input parameters for two switches at the safety guard coupled with a time difference (i_dMonitoringTime) for closing the guard.	Page 49 M+SF_GMON_R
M+SF_MODSEL_R_01A	Mode selector	This FB selects the system operation mode, such as manual, automatic, semi-automatic.	Page 55 M+SF_MODSEL_R
M+SF_MUTE2_R_01A	Muting with 2 sensors	Muting is the intended suppression of the safety function. (e.g., light barriers) In this FB, parallel muting with two muting sensors is specified.	Page 61 M+SF_MUTE2_R
M+SF_MUTE2-2_R_00A	Muting with 2 sensors 2	Muting is the intended suppression of the safety function. (e.g., light barriers) In this FB, parallel muting with two muting sensors is specified. The effective time of the muting control can be set to be unlimited.	Page 68 M+SF_MUTE2-2_R
M+SF_MUTEP_R_01A	Parallel muting	In this FB, parallel muting with four muting sensors is specified.	Page 76 M+SF_MUTEP_R
M+SF_MUTEP-2_R_00A	Parallel muting 2	In this FB, parallel muting with four muting sensors is specified. The effective time of the muting control can be set to be unlimited.	Page 89 M+SF_MUTEP-2_R
M+SF_MUTES_R_01A	Sequential muting	In this FB, sequential muting with four muting sensors is specified.	Page 103 M+SF_MUTES_R
M+SF_MUTES-2_R_00A	Sequential muting 2	In this FB, sequential muting with four muting sensors is specified. The effective time of the muting control can be set to be unlimited.	Page 111 M+SF_MUTES-2_R
M+SF_OUTC_R_01A	Output control	Control of a safety output with a signal from the functional application and a safety signal with optional startup inhibits.	Page 119 M+SF_OUTC_R
M+SF_TSSEN_R_01A	Testable safety sensor	This FB detects, for example, the loss of the sensing unit detection capability, the response time exceeding that specified, and static ON signal in single-channel sensor systems. It can be used for external testable safety sensors.	Page 125 M+SF_TSSEN_R
M+SF_EQUI_R_01A	Dual input (NC+NC or NO+NO)	This FB converts two equivalent bit inputs (both NO or NC) to one bit with discrepancy time monitoring. This FB output shows the result of the evaluation of both channels.	Page 133 M+SF_EQUI_R
M+SF_ANTI_R_01A	Dual input (NO+NC)	This FB converts two antivalent bit inputs (NO/NC pair) to one bit output with discrepancy time monitoring. This FB output shows the result of the evaluation of both channels.	Page 138 M+SF_ANTI_R

*1 FB version information such as "_01A", which is displayed at the end of an FB name, is omitted hereinafter.

Point

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

For how to register the FB library, see the following.

📖 GX Works3 Operating Manual

2.2 Common Specifications

This section describes the common specifications to each safety FB. The following table lists the general input/output specifications of the safety FBs. Variables other than i_bS_In and o_bS_Out are all used under the same names, data types, default values, specifications, and functions for the safety FB use. For details on each name, data type, default value, specification, and function of the safety input-output variables other than those described in the figure below, see the description of individual safety FB.

```
                        M+SF_○○_R
(1) ─── B: i_bActivate          o_bReady: B ─── (6)
(2) ─── B: i_bS_In              o_bS_Out: B ─── (7)
(3) ─── B: i_bS_StartReset      o_bError: B ─── (8)
(4) ─── B: i_bS_AutoReset    o_wDiagCode: W ─── (9)
(5) ─── B: i_bReset
```

⚠ WARNING

Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.

Labels

■Input labels

No.	Name	Data type	Default value	Description and variable value
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. Default value is OFF. OFF: All output variables are set to the default values. ON: The safety FB is active. For details, see the following. ☞ Page 11 Whether safety FBs are active or not
(2)	i_bS_In	—	—	Safety input signals to the safety FB. For details on each name, data type, default value, specification, and function, see the individual safety FB.
(3)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. OFF (= default value): Manual reset when the safety FB is activated. ON: Automatic reset when the safety FB is activated. For details on the function, see the following. ☞ Page 11 Reset selection
(4)	i_bS_AutoReset	Bit*	OFF	Selection of a reset method for an input signal (i_bS_In) reset to ON. OFF (= default value): Manual reset when an emergency stop button is released. ON: Automatic reset when an emergency stop button is released. For details on the function, see the following. ☞ Page 11 Reset selection
(5)	i_bReset	Bit	OFF	Reset input. (This function is only active on a signal change from OFF to ON. This input can be used for different purposes.) • Reset of the error that occurred in the safety FB. • Manual reset in setting i_bS_StartReset and i_bS_AutoReset to OFF. • Additional safety FB-specific reset functions. For details on the function, see the following. ☞ Page 11 Securing of input signal Reset

■Output labels

No.	Name	Data type	Default value	Description and variable value
(6)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. OFF: The safety FB is not activated. ON: The safety FB is activated. For details on the function, see the following. ☞ Page 11 Whether safety FBs are active or not
(7)	o_bS_Out	—	—	Safety output signals from the safety FB. For details on each name, data type, default value, specification, and function, see the individual safety FB.
(8)	o_bError	Bit	OFF	Error flag. OFF: Indicates that an error has not occurred and the safety FB is in another state. ON: Indicates that an error has occurred and the safety FB is in an error state. For details on the function, see the following. ☞ Page 11 Safety FB status check
(9)	o_wDiagCode	Word [signed]	0	Diagnostic code. (An error code or status code is indicated in hexadecimal.) When an error occurs (o_bError=ON): Indicates an error code. When no error occurs (o_bError=OFF): Indicates a status code. For details on the function, see the following. ☞ Page 11 Safety FB status check

2.3   General Functions

Whether safety FBs are active or not

Input signal, i_bActivate, sets whether to activate a safety FB or not. In addition, whether the safety FB is active or not can be checked with output signal, o_bReady. If i_bActivate is OFF, all values of the output signals are set to the default values. Inputting the signal of the safety refresh communication status for CC-Link IE Field Network inactivates the safety FB when an error occurs in the safety station and then prevents unnecessary signals from outputting.

Reset selection

A reset method of safety FBs can be selected from i_bS_StartReset (after safety FBs are activated) and i_bS_AutoReset (after safety inputs are restored).

■Manual reset

In this method, a safety output signal is not set to ON immediately even though safety input signals are correctly set. By changing i_bReset safety input signal from OFF to ON while the safety input signals are correctly set, the safety output signal is set to ON.

■Automatic reset

In this method, a safety output signal is immediately set to ON when safety input signals are correctly set.

⚠ WARNING

The automatic reset can only be activated if it is ensured that no hazard can occur when a safety FB is activated (with i_bS_StartReset input) or a safety input is set (with i_bS_AutoReset input). (Also, the manual reset switched from the automatic reset or the automatic reset switched from the manual reset can be activated.)

Therefore, the use of automatic reset requires implementation of other systems or application measures to ensure that unexpected (or unintended) startup does not occur.

Securing of input signal Reset

To prevent a machine startup in the event of switch failures (contact welding, damaged springs), the safety FB can only be activated when Reset input signal is set to ON. If Reset remains ON without detecting that it is set to ON, the safety FB detects an error.

Safety FB status check

The current status of safety FBs can be checked with output signal, o_wDiagCode (hexadecimal number). If an error occurs in the safety FB, o_bError output signal is set to ON and an error code is output to o_wDiagCode. If more than one error occurs, only the error code corresponding to the error detected at first is output. If an error does not occur in the safety FB, o_bError output signal is OFF and a status code is output to o_wDiagCode.

⚠ WARNING

Take action against error messages and perform reset operations properly.

# 2.4 Generic State Diagram

The safety FB state transitions according to the state diagram described in the safety FB specifications. However, a program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, the state transition does not occur. The following shows how to read the state diagram.
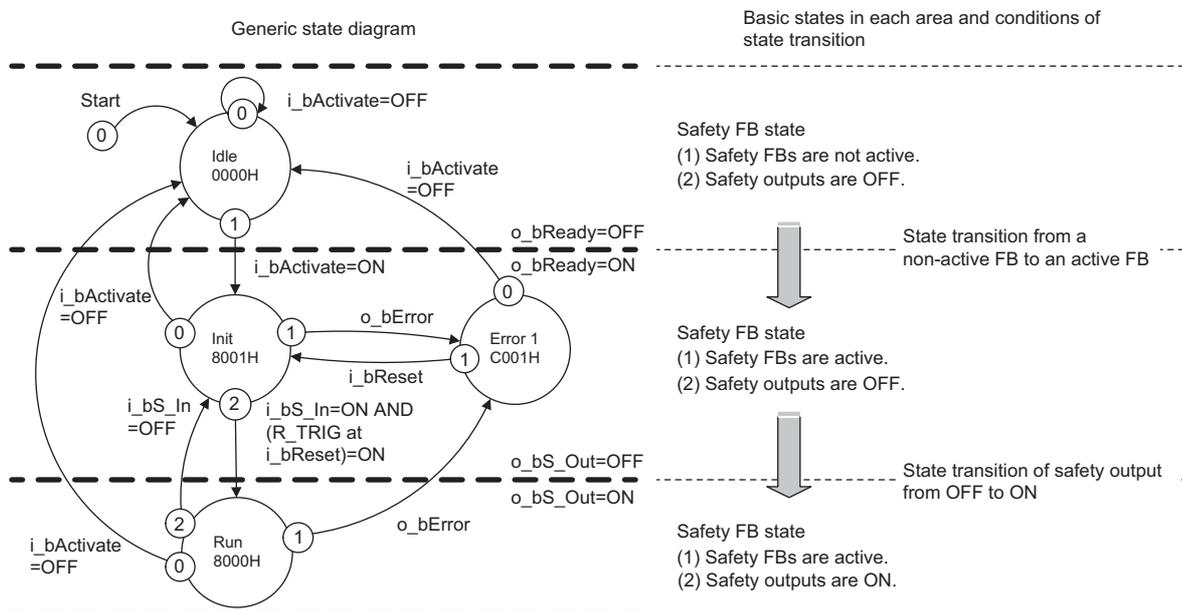

Basic way to read the state diagram

- The state name and diagnostic code are indicated in the circle.
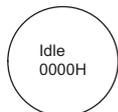
The state name is "Idle", and the diagnosis code is "0000H".

- The arrows connecting two circles indicate the direction of the state transition. Also, the transition conditions are described near the arrows. When there are multiple transition destination states, the circled numbers indicate the transition priority when multiple transition conditions are satisfied simultaneously. (0 is the highest priority.)
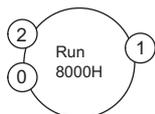
There are three transition destination states from the Run state depending on the condition. The transition priority is in the following order: 8000H → 0000H, 8000H → C001H, and 8000H → 8001H.
- If i_bActivate input signal is set to OFF, any state transitions to the Idle state.
- Meaning of transition state symbols
  · AND, OR, XOR, and NOT: Logical operators
  · R_TRIG at signal: The signal is changed from OFF to ON
  · F_TRIG at signal: The signal is changed from ON to OFF
- Variable name with no ON/OFF specification on the state diagram indicates that the variable is ON.

2.5 How to Register the Safety FB Library to a Project

For details, refer to the following.
📖 GX Works3 Operating Manual

2.6 Copying and Pasting a Ladder containing a Safety FB

A program containing a safety FB cannot be selected to copy/paste on the navigation window. Select a ladder block and copy/paste it.

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3 PRECAUTIONS

3.1 Precautions for System Design

Validation for the overall system

Please note that you must carry out a validation every time you make a safety-related modification to your overall system.
Check the following;
- The safety devices are connected to the correct safety sensors and actuators in your safety application.
- The safety remote I/O modules and safety input/output devices have been parameterized correctly.
- The variables have been linked to the safety sensors and actuators correctly (single channel or dual channel).
- Line control (short-circuit and cable break monitoring) is implemented in your application if it is required in your application.
- Variables of the safety FB are connected to proper data.

Error and diagnostic code

The safety FB has an internal state, which transitions depending on a change in the input signal. The value for this state is output as a diagnostic code (o_wDiagCode). When an error is detected in the safety FB, the error flag (o_bError) is set to ON. If error information for the safety FB is required for your application, use these values for programming.

3.2 Precautions for Management

Project data management

Manage and operate the project data properly. A system manager has to back up the project and save the backup data so that the data restoration is always possible.

MEMO

4 SAFETY FB SPECIFICATIONS

4.1 M+SF_2HAND2_R

Overview

Item	Description
Function name	Two-hand switch Type Ⅱ
Functional overview	This FB provides the two-hand control functionality (see ISO 13851, Type Ⅱ).
Symbol	

```
                      M+SF_2HAND2_R
(1) ——— B: i_bActivate              o_bReady: B ——— (4)
(2) ——— B: i_bS_Button1      o_bS_TwoHand_Out: B ——— (5)
(3) ——— B: i_bS_Button2              o_bError: B ——— (6)
                                o_wDiagCode: W ——— (7)
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_Button1	Bit*	OFF	Input of button 1 (for category 3 or 4: two antivalent contacts) OFF: Button 1 released. ON: Button 1 actuated.
(3)	i_bS_Button2	Bit*	OFF	Input of button 2 (for category 3 or 4: two antivalent contacts) OFF: Button 2 released. ON: Button 2 actuated.

■Output labels

No.	Variable name	Data type	Default value	Description
(4)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(5)	o_bS_TwoHand_Out	Bit*	OFF	Safety output signal. OFF: No correct two-hand operation. ON: i_bS_Button1 and i_bS_Button2 inputs are ON and no error occurred. Correct two-hand operation.
(6)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(7)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

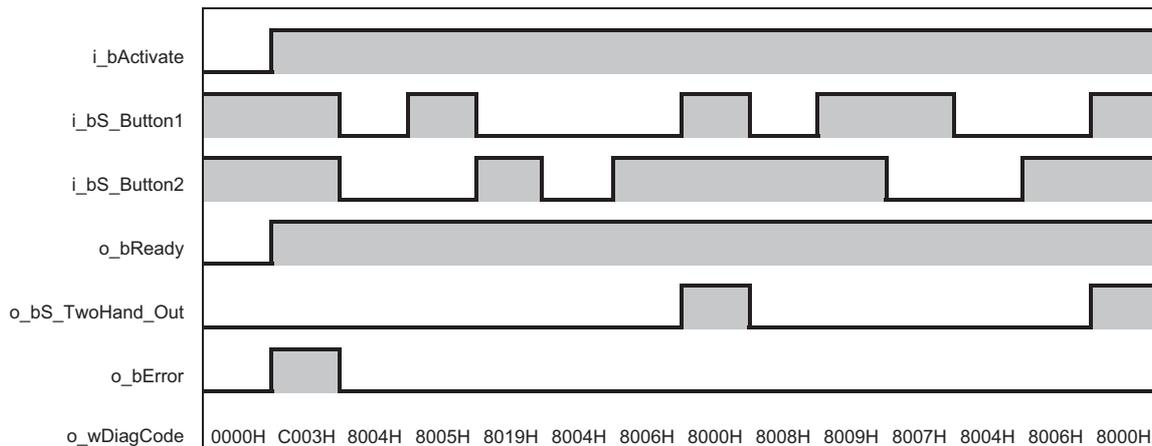Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.

FB details

This FB provides the two-hand control functionality according to ISO 13851, Section 4 Type Ⅱ. If i_bS_Button1 and i_bS_Button2 are set to ON in correct sequence, then o_bS_TwoHand_Out output will also be set to ON. The FB also controls the release of both buttons before setting output o_bS_TwoHand_Out again to ON.

State diagram

State transition of M+SF_2HAND2_R

Note: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_2HAND2_R

i_bActivate	
i_bS_Button1	
i_bS_Button2	
o_bReady	
o_bS_TwoHand_Out	
o_bError	
o_wDiagCode	0000H C003H 8004H 8005H 8019H 8004H 8006H 8000H 8008H 8009H 8007H 8004H 8006H 8000H

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_TwoHand_Out	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Error 1 B1	i_bS_Button1 was ON on FB activation.	Release i_bS_Button1 and i_bS_Button2.
C002H	Error 1 B2	i_bS_Button2 was on at the FB activation.	
C003H	Error 1 B1&B2	The signals at i_bS_Button1 and i_bS_Button2 were ON on FB activation.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_TwoHand_Out: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	Buttons Actuated	The both buttons actuated correctly. The safety output is enabled. • o_bReady: ON • o_bS_TwoHand_Out: ON • o_bError: OFF	None.
8001H	Init	The FB is active, but in the Init state. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Actuate i_bS_Button1 or i_bS_Button2.
8004H	Buttons Released	No button is actuated. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Actuate i_bS_Button1 or i_bS_Button2.

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
8005H	Button 1 Actuated	Only Button 1 is actuated. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button1, or actuate i_bS_Button2.
8006H	Button 2 Actuated	Only Button 2 is actuated. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button2, or actuate i_bS_Button1.
8007H	Button 2 Released	The safety output was enabled and is disabled again. i_bS_Button1 is ON and i_bS_Button2 is OFF after disabling the safety output. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button1.
8008H	Button 1 Released	The safety output was enabled and is disabled again. i_bS_Button1 is OFF and i_bS_Button2 is ON after disabling the safety output. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button2.
8009H	Locked Off	The safety output was enabled and is disabled again. i_bS_Button1 is ON and i_bS_Button2 is also ON after disabling the safety output. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button1 and i_bS_Button2.
8019H	Locked On	Incorrect actuation of the buttons. Waiting for release of both buttons. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	

⚠ **WARNING**

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables

4.2 M+SF_2HAND3_R

Overview

Item	Description
Function name	Two-hand switch Type Ⅲ
Functional overview	This FB provides the two-hand control functionality (see ISO 13851, Type Ⅲ. Fixed specified time difference is 500ms).
Symbol	

```
                    M+SF_2HAND3_R
(1) ──── B: i_bActivate          o_bReady: B ──── (4)
(2) ──── B: i_bS_Button1    o_bS_TwoHand_Out: B ──── (5)
(3) ──── B: i_bS_Button2         o_bError: B ──── (6)
                              o_wDiagCode: W ──── (7)
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_Button1	Bit*	OFF	Input of button 1 (for category 3 or 4: two antivalent contacts) OFF: Button 1 released. ON: Button 1 actuated.
(3)	i_bS_Button2	Bit*	OFF	Input of button 2 (for category 3 or 4: two antivalent contacts) OFF: Button 2 released. ON: Button 2 actuated.

■Output labels

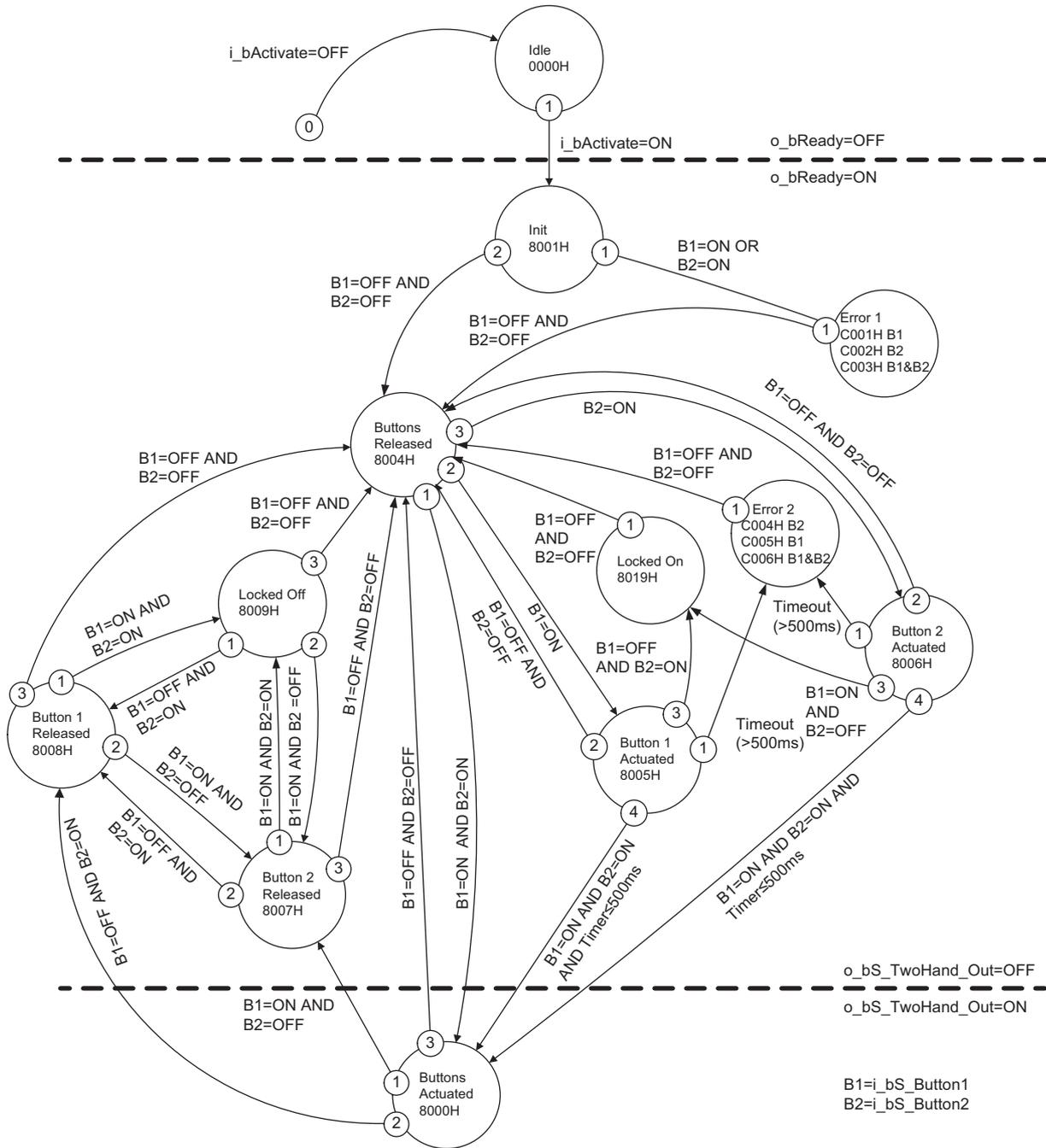| No.	Variable name	Data type	Default value	Description
(4)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(5)	o_bS_TwoHand_Out	Bit*	OFF	Safety output signal. OFF: No correct two-hand operation. ON: i_bS_Button1 and i_bS_Button2 inputs are ON and no error occurred. Correct two-hand operation.
(6)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(7)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.

FB details

This FB provides the two-hand control functionality according to ISO 13851, Section 4 Type Ⅲ. If i_bS_Button1 and i_bS_Button2 are set to ON in correct sequence, then o_bS_TwoHand_Out output will also be set to ON. The FB also controls the release of both buttons before setting output o_bS_TwoHand_Out again to ON.
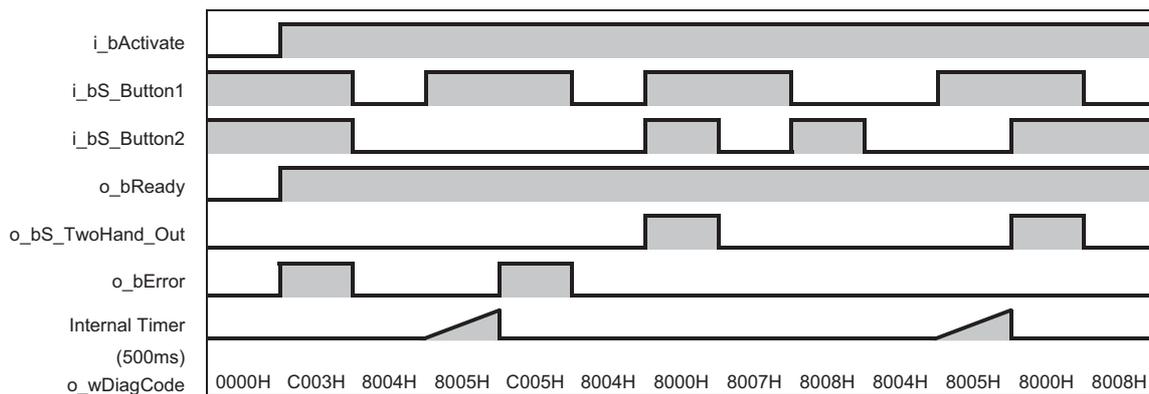
State diagram

State transition of M+SF_2HAND3_R

Note: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_2HAND3_R

A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the InternalTimer elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_TwoHand_Out	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Error 1 B1	i_bS_Button1 was ON on FB activation.	Release i_bS_Button1 and i_bS_Button2.
C002H	Error 1 B2	i_bS_Button2 was ON on FB activation.	
C003H	Error 1 B1&B2	The signals at i_bS_Button1 and i_bS_Button2 were ON on FB activation.	
C004H	Error 2 B2	i_bS_Button1 was OFF and i_bS_Button2 was ON after 500ms in state 8005H or 8006H.	Release i_bS_Button1 and i_bS_Button2. If the safety cycle time is long, the safety input refresh is delayed and an error may occur. Set the shorter value to the safety cycle time.
C005H	Error 2 B1	i_bS_Button1 was ON and i_bS_Button2 was also ON after 500ms in state 8005H or 8006H. This state is only possible when the states of the inputs (S_Button1 and S_Button2) change from divergent to convergent (both ON) simultaneously when the timer elapses (500ms) at the same cycle.	
C006H	Error 2 B1&B2	i_bS_Button1 was ON and i_bS_Button2 was also ON after 500ms in state 8005H or 8006H. This state is only possible when the states of the inputs (S_Button1 and S_Button2) change from divergent to convergent (both ON) simultaneously when the timer elapses (500ms) at the same cycle.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_TwoHand_Out: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	Buttons Actuated	The both buttons actuated correctly. The safety output is enabled. • o_bReady: ON • o_bS_TwoHand_Out: ON • o_bError: OFF	None.
8001H	Init	The FB is active, but in the Init state. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Actuate i_bS_Button1 or i_bS_Button2.
8004H	Buttons Released	No button is actuated. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Actuate i_bS_Button1 or i_bS_Button2.
8005H	Button 1 Actuated	Only Button 1 is actuated. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button1, or actuate i_bS_Button2.
8006H	Button 2 Actuated	Only Button 2 is actuated. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button2, or actuate i_bS_Button1.
8007H	Button 2 Released	The safety output was enabled and is disabled again. i_bS_Button1 is ON and i_bS_Button2 is OFF after disabling the safety output. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button1.
8008H	Button 1 Released	The safety output was enabled and is disabled again. i_bS_Button1 is OFF and i_bS_Button2 is ON after disabling the safety output. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button2.
8009H	Locked Off	The safety output was enabled and is disabled again. i_bS_Button1 is ON and i_bS_Button2 is also ON after disabling the safety output. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	Release i_bS_Button1 and i_bS_Button2.
8019H	Locked On	Incorrect actuation of the buttons. Waiting for release of both buttons. • o_bReady: ON • o_bS_TwoHand_Out: OFF • o_bError: OFF	

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
• A failure in safety devices and emergency stop devices
• Wiring and status of a safety remote I/O module and a safety programmable controller
• Programming logic, the memory allocation of safety devices, and the connections of safety FB variables

4.3 M+SF_EDM_R

Overview

Item	Description
Function name	External device monitor
Functional overview	This FB monitors connected actuators such as safety contactors and safety relays (contactors and relays with force-guided contacts) and controls outputs.
Symbol	

```
                        M+SF_EDM_R
(1) ——— B: i_bActivate            o_bReady: B    ——— (8)
(2) ——— B: i_bS_OutControl      o_bS_EDM_Out: B  ——— (9)
(3) ——— B: i_bS_EDM1                o_bError: B   ——— (10)
(4) ——— B: i_bS_EDM2            o_wDiagCode: W   ——— (11)
(5) ——— D: i_dMonitoringTime
(6) ——— B: i_bS_StartReset
(7) ——— B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_OutControl	Bit*	OFF	Control signal from the preceding safety FBs. Typical function block signals from the library (e.g., M+SF_ESTOP_R, M+SF_ESPE_R, and/or others). OFF: Disable safety output (o_bS_EDM_Out). ON: Enable safety output (o_bS_EDM_Out).
(3)	i_bS_EDM1	Bit*	OFF	Feedback signal of the first connected actuator. (NC contact) OFF: Feedback signals are set to OFF. ON: Feedback signals are set to ON.
(4)	i_bS_EDM2	Bit*	OFF	Feedback signal of the second connected actuator. (NC contact) OFF: Feedback signals are set to OFF. ON: Feedback signals are set to ON.
(5)	i_dMonitoringTime	Double word [signed]	0	Maximum permissible time (in increments of 10ms) from the status of whether o_bS_EDM_Out is ON or OFF until when i_bS_EDM1 and i_bS_EDM2 are set to ON or OFF correctly. Range: Fixed values from 0 to 60000 (0 to 600000ms = 10min)
(6)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(7)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(8)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(9)	o_bS_EDM_Out	Bit*	OFF	Controls the actuator. The result is monitored by feedback signals i_bS_EDM1 and i_bS_EDM2. OFF: Disable connected actuators. ON: Enable connected actuators.
(10)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(11)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.

FB details

Whether the i_bS_EDM1, i_bS_EDM2, and o_bS_EDM_Out are set to ON or OFF properly depends on the following conditions in the table below.

Variable name	Initial state (connected actuators not activated)	Connected actuators activated.
i_bS_EDM1, i_bS_EDM2	ON	OFF
o_bS_EDM_Out	OFF	ON

Set i_bS_EDM1 and i_bS_EDM2 to ON in the initial state. The connected actuator will be activated (o_bS_EDM_Out=ON) if i_bS_EDM1 and i_bS_EDM2 are set to ON when i_bS_OutControl is set to ON. (The connected actuator is changed to the error status if i_bS_EDM1 or i_bS_EDM2 is set to OFF.)

After the connected actuator is activated (o_bS_EDM_Out=ON), i_dMonitoringTime monitors that i_bS_EDM1 and i_bS_EDM2 are set to OFF. If i_bS_EDM1 and i_bS_EDM2 are not set to OFF after the i_dMonitoringTime period, the connected actuator will not be activated (o_bS_EDM_Out=OFF) and be changed to the error status.

After the connected actuator is not activated (o_bS_EDM_Out=OFF), i_dMonitoringTime monitors that i_bS_EDM1 and i_bS_EDM2 are set to ON. If i_bS_EDM1 and i_bS_EDM2 are not set to ON after the i_dMonitoringTime period, the connected actuator will be changed to the error status.

⚠ WARNING

- The actuators used in the safety function should be selected from the safety level specified in the risk analysis.
- For i_dMonitoringTime, select a proper value and verify it depending on the application of the user.

State diagram

State transition of M+SF_EDM_R

i_bActivate=OFF

Idle
0000H

0

1

o_bReady=OFF

o_bReady=ON

i_bActivate=ON

0>i_dMonitoringTime OR
i_dMonitoringTime > 60000

i_bReset=ON AND
(R_TRIG at i_bReset)=OFF AND
i_bS_StartReset=OFF

Parameter
Error
C005H

1

Init
8001H

2

1

Reset
Error 1
C001H

1

0=< i_dMonitoringTime=< 60000
AND (R_TRIG at i_bReset)=ON

3

4

i_bReset=OFF

(R_TRIG at i_bReset)=ON AND
(R_TRIG at i_bS_OutControl)=ON
AND i_bS_StartReset=OFF

(i_bReset=ON AND
(R_TRIG at i_bReset)=OFF AND
i_bS_EDM1=ON AND i_bS_EDM2=ON)
OR
((R_TRIG at i_bReset)=ON AND
(R_TRIG at
(i_bS_EDM1 AND / OR i_bS_EDM2)=ON)*2

InitError
C111H

1

i_bReset=OFF

(R_TRIG at i_bReset)=ON OR
i_bS_StartReset=ON

Reset
Error 21/22/23
C011H
C021H
C031H

1

(R_TRIG at i_bReset)=ON
AND i_bS_EDM1=ON
AND i_bS_EDM2=ON

2

1

i_bReset=OFF

i_dMonitoringTime Over
AND NOT i_bS_EDM1 AND / OR
NOT i_bS_EDM2*3

EDM
Error 11/12/13
C010H
C020H
C030H

(i_bReset=ON AND
(R_TRIG at i_bReset)=OFF
AND i_bS_EDM1=ON AND i_bS_EDM2=ON)
OR
((R_TRIG at i_bReset)=ON
AND (R_TRIG at
(i_bS_EDM1 AND / OR i_bS_EDM2)=ON))*4

EDM
Error 21/22/23
C040H
C050H
C060H

1

2

Output
disable
8010H
Start Timer

2

1

i_bS_OutControl =ON AND
(i_bS_EDM1 AND / OR
i_bS_EDM2)=OFF*1

3

(R_TRIG at i_bReset)=ON
AND i_bS_EDM1=ON
AND i_bS_EDM2=ON

(R_TRIG at i_bReset)=ON
AND
R_TRIG at i_bS_EDM1=OFF
AND R_TRIG at
i_bS_EDM2=OFF

Reset
Error 41/42/43
C071H
C081H
C091H

1

Reset
Error 31/32/33
C041H
C051H
C061H

1

i_bReset=OFF

i_bS_OutControl=ON

i_bS_OutControl=OFF

i_bReset=ON AND
(R_TRIG at i_bReset)=OFF

EDM
Error 31/32/33
C070H
C080H
C090H

2

1

i_bReset=OFF

o_bS_EDM_Out=OFF

o_bS_EDM_Out=ON

Output
Enable
8000H
Start Timer

2

1

i_dMonitoringTime is Over AND
(i_bS_EDM1=ON OR i_bS_EDM2=ON)

Note: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

*1   The following table lists the condition details on the transition from 8010H to C010H, C020H, or C030H.

State transition	Condition of transition
8010H → C010H	i_bS_OutControl=ON AND i_bS_EDM1=OFF
8010H → C020H	i_bS_OutControl=ON AND i_bS_EDM2=OFF
8010H → C030H	i_bS_OutControl=ON AND S_EDM2=OFF AND i_bS_EDM1=OFF

*2   The following table lists the condition details on the transition from C010H/C020H/C030H to C011H/C021H/C031H.

State transition	Condition of transition
C010H → C011H	(i_bReset=ON AND (R_TRIG at i_bReset)=OFF AND i_bS_EDM1=ON AND i_bS_EDM2=ON) OR R_TRIG at i_bReset=ON AND R_TRIG at i_bS_EDM1=ON
C020H → C021H	(i_bReset=ON AND (R_TRIG at i_bReset)=OFF AND i_bS_EDM1=ON AND i_bS_EDM2=ON) OR R_TRIG at i_bReset=ON AND R_TRIG at i_bS_EDM2=ON
C030H → C031H	(i_bReset=ON AND (R_TRIG at i_bReset)=OFF AND i_bS_EDM1=ON AND i_bS_EDM2=ON) OR R_TRIG at i_bReset=ON AND R_TRIG at i_bS_EDM1=ON AND R_TRIG at i_bS_EDM2=ON

*3   The following table lists the condition details on the transition from 8010H to C040H, C050H, or C060H.

State transition	Condition of transition
8010H → C040H	i_dMonitoringTime Over AND i_bS_EDM1=OFF
8010H → C050H	i_dMonitoringTime Over AND i_bS_EDM2=OFF
8010H → C060H	i_dMonitoringTime Over AND i_bS_EDM2=OFF AND i_bS_EDM1=OFF

*4   The following table lists the condition details on the transition from C040H/C050H/C060H to C041H/C051H/C061H

State transition	Condition of transition
C040H → C041H	(i_bReset=ON AND (R_TRIG at i_bReset)=OFF AND i_bS_EDM1=ON AND i_bS_EDM2=ON) OR R_TRIG at i_bReset=ON AND R_TRIG at i_bS_EDM1=ON
C050H → C051H	(i_bReset=ON AND (R_TRIG at i_bReset)=OFF AND i_bS_EDM1=ON AND i_bS_EDM2=ON) OR R TRIG at i_bReset=ON AND R TRIG at i bS EDM2=ON
C060H → C061H	(i_bReset=ON AND (R_TRIG at i_bReset)=OFF AND i_bS_EDM1=ON AND i_bS_EDM2=ON) OR R_TRIG at i_bReset=ON AND R_TRIG at i_bS_EDM1=ON AND R_TRIG at i_bS_EDM2=ON

Typical timing diagram

■For M+SF_EDM_R (i_bS_StartReset=OFF)
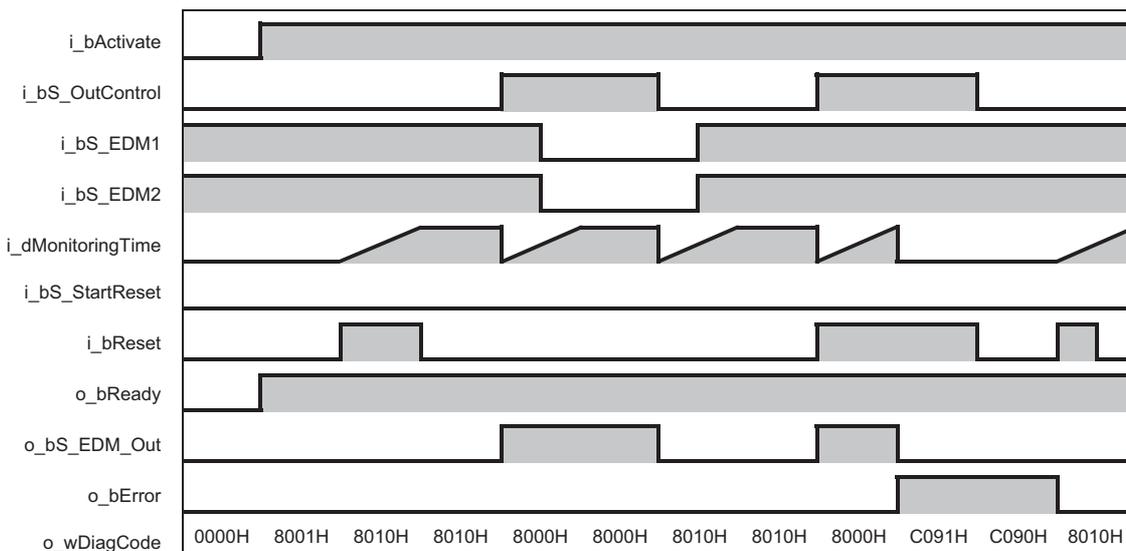
A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dMonitoringTimer elapsed time is stopped. The measurement of the i_dMonitoringTimer elapsed time continues until the time configured in safety FB input signal "i_dMonitoringTime", even after i_bS_EDM1 and i_bS_EDM2 are set to ON or OFF properly according to the status of whether o_bS_EDM_Out is ON or OFF.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_EDM_Out	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset signal in state 8001H.	Set i_bReset to OFF.
C005H	Parameter Error	The value of i_dMonitoringTime is out of range.	Set the value of i_dMonitoringTime within the range.
C011H	Reset Error 21/22/23	Static i_bReset signal or rising trigger at i_bS_EDM and i_bReset at the same time in state C010H/C020H/C030H.	Set i_bReset to OFF. Check the wiring of i_bReset and i_bS_EDM.
C021H			
C031H			
C041H	Reset Error 31/32/33	Static i_bReset signal or rising trigger at i_bS_EDM and i_bReset at the same time in state C040H/C050H/C060H.	
C051H			
C061H			
C071H	Reset Error 41/42/43	Static i_bReset signal in state C070H/C080H/C090H.	Set i_bReset to OFF.
C081H			
C091H			
C010H	EDM Error 11	The signal at i_bS_EDM1 is not valid in the initial actuator state. In state 8010H, i_bS_EDM1 signal is OFF when enabling i_bS_OutControl.	Set i_bS_EDM to ON (default value), and set i_bReset to ON.
C020H	EDM Error 12	The signal at i_bS_EDM2 is not valid in the initial actuator state. In state 8010H, i_bS_EDM2 signal is OFF when enabling i_bS_OutControl.	
C030H	EDM Error 13	The signals at i_bS_EDM1 and i_bS_EDM2 are not valid in the initial actuator states. In state 8010H, i_bS_EDM1 and i_bS_EDM2 signals are OFF when enabling i_bS_OutControl.	
C040H	EDM Error 21	The signal at i_bS_EDM1 is not valid in the initial actuator state. In state 8010H, i_bS_EDM1 signal is OFF and the monitoring time has elapsed.	
C050H	EDM Error 22	The signal at i_bS_EDM2 is not valid in the initial actuator state. In state 8010H, i_bS_EDM2 signal is OFF and the monitoring time has elapsed.	
C060H	EDM Error 23	The signals at i_bS_EDM1 and i_bS_EDM2 are not valid in the initial actuator states. In state 8010H, i_bS_EDM1 and i_bS_EDM2 signals are OFF and the monitoring time has elapsed.	
C070H	EDM Error 31	The signal at i_bS_EDM1 is not valid in the actuator switching state. In state 8000H, i_bS_EDM1 signal is ON and the monitoring time has elapsed.	Check a failure and the behavior of the actuator, the wiring, and the status of the safety remote I/O module. After the check, set i_bReset to ON.
C080H	EDM Error 32	The signal at i_bS_EDM2 is not valid in the actuator switching state. In state 8000H, i_bS_EDM2 signal is ON and the monitoring time has elapsed.	
C090H	EDM Error 33	The signals at i_bS_EDM1 and i_bS_EDM2 are not valid in the actuator switching state. In state 8000H, i_bS_EDM1 and i_bS_EDM2 signals are ON and the monitoring time has elapsed.	
C111H	Init Error	Similar signals at i_bS_OutControl and i_bReset (R_TRIG at same cycle) detected (maybe a programming error).	Check the wiring, and after the check, set i_bReset to ON.

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_EDM_Out: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8001H	Init	The FB activation startup inhibit is active. (i_bS_Starti_bReset=OFF) • o_bReady: ON • o_bS_EDM_Out: OFF • o_bError: OFF	Set i_bReset to ON.
8010H	Output Disable	EDM control is not active. Timer starts when state is entered. • o_bReady: ON • o_bS_EDM_Out: OFF • o_bError: OFF	Set i_bS_OutControl to ON.
8000H	Output Enable	EDM control is active. Timer starts when state is entered. • o_bReady: ON • o_bS_EDM_Out: OFF • o_bError: OFF	None.

⚠ **WARNING**

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
• A failure in safety devices and emergency stop devices
• Wiring and status of a safety remote I/O module and a safety programmable controller
• Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
• Setting of i_bS_StartReset

4.4　M+SF_ENBLSW_R

Overview

Item	Description
Function name	Enable switch
Functional overview	This FB evaluates the signals of an enable switch with three positions.
Symbol	

```
                    M+SF_ENBLSW_R
(1) ──── B: i_bActivate              o_bReady: B ──── (7)
(2) ──── B: i_bS_SafetyActive   o_bS_EnableSw_Out: B ──── (8)
(3) ──── B: i_bS_EnableSwCh1          o_bError: B ──── (9)
(4) ──── B: i_bS_EnableSwCh2      o_wDiagCode: W ──── (10)
(5) ──── B: i_bS_AutoReset
(6) ──── B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_SafetyActive	Bit*	OFF	Confirmation of the safe mode (limitation of the speed or the power of motion, limitation of the range of motion). OFF: Safe mode is not active. ON:　Safe mode is active.
(3)	i_bS_EnableSwCh1	Bit*	OFF	Signal of contacts E1 and E2 of the connected enable switch. (☞ Page 31 FB details) OFF: Contacts E1 and E2 signals are set to OFF. ON:　Contacts E1 and E2 signals are set to ON.
(4)	i_bS_EnableSwCh2	Bit*	OFF	Signal of contacts E3 and E4 of the connected enable switch. (☞ Page 31 FB details) OFF: Contacts E3 and E4 signals are set to OFF. ON:　Contacts E3 and E4 signals are set to ON.
(5)	i_bS_AutoReset	Bit*	OFF	Selection of a reset method for the input signal reset to ON. For details, see the following. ☞ Page 11 General Functions
(6)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(7)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(8)	o_bS_EnableSw_Out	Bit*	OFF	Safety output. OFF: Disables manual operation using enable switches. ON: Enables manual operation using enable switches.
(9)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(10)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.

FB details

This FB supports the function that enables manual operations by selecting the operating mode (i_bS_SafetyActive is set to ON) and using enable switches with three positions. The operating mode must be selected outside this FB. The status of enable switch contacts (The contact E1+E2 must be connected to i_bS_EnableSwCh1. The contact E3+E4 must be connected to i_bS_EnableSwCh2.) is monitored and position change and the current position of enable switches are detected. The manual operation can be enabled by this FB whose o_bS_EnableSw_Out is set to ON, after a move from position 1 to position 2. With other switching directions or positions, the manual operation is not enabled when o_bS_EnableSw_Out is OFF.

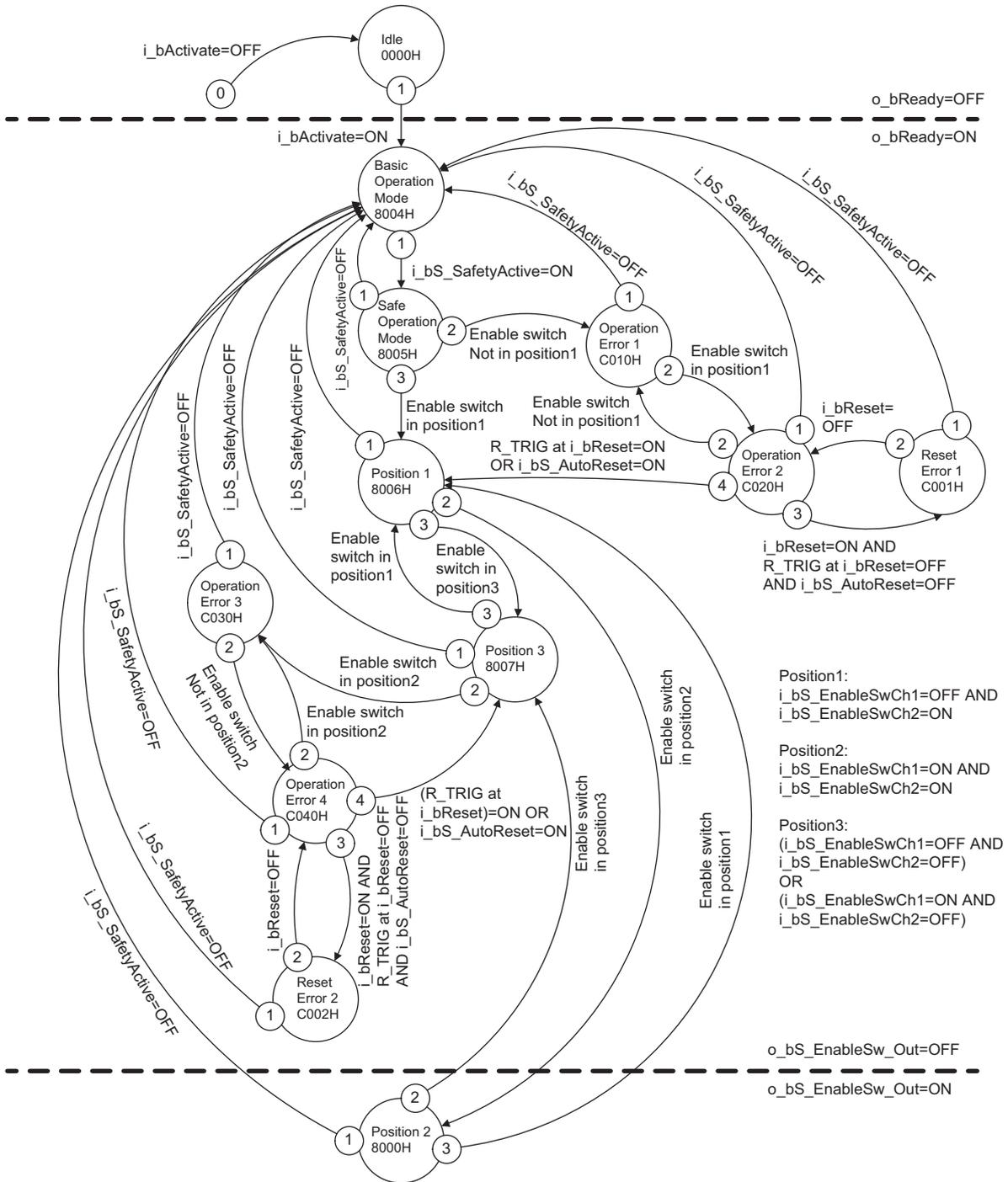| Status of enable switch contacts	Position 1 (Not pressed)	Position 2 (Mid position)	Position 3 (Past mid position)
Contacts E1+E2 status	OFF	ON	OFF
Contacts E3+E4 status	ON	ON	OFF

When returning from position 3 to position 1, the enabling function is not activated. The status of the contacts E1+E2 set to ON and contacts E3+E4 set to OFF does not exist as a contact status for the enable switch with three positions. If the status is detected, the status refers to position 3.

⚠ WARNING

In order to meet the requirements of IEC 60204 Section 9.2.4, the user shall use a suitable switching device. In addition, the user must ensure that the relevant operating mode (IEC 60204 Section 9.2.3) is selected in the application. (Automatic operation must be disabled in this operating mode using appropriate measures).
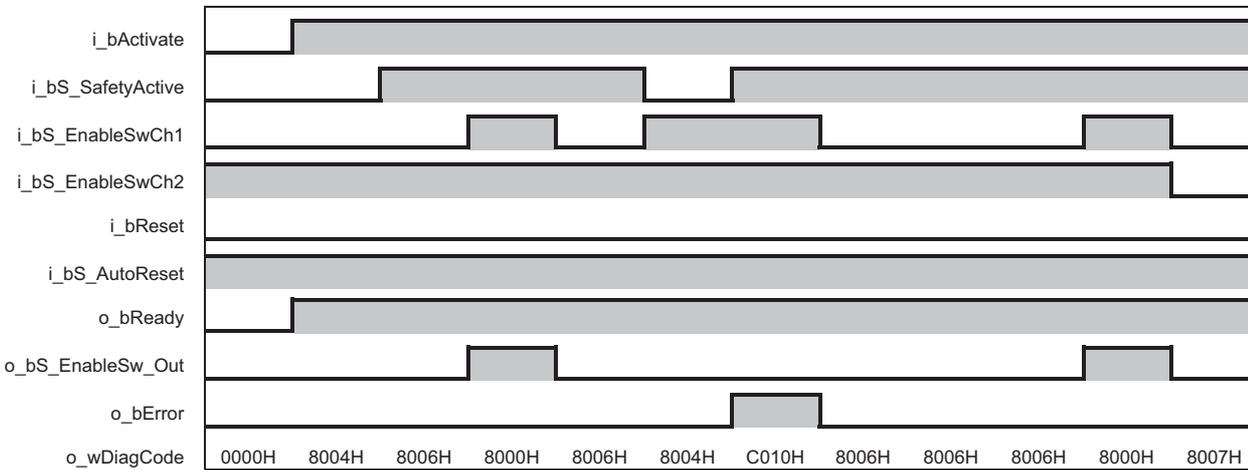
State diagram

State transition of M+SF_ENBLSW_R

i_bActivate=OFF

Idle
0000H

0

1

o_bReady=OFF

o_bReady=ON

i_bActivate=ON

Basic
Operation
Mode
8004H

i_bS_SafetyActive=OFF

i_bS_SafetyActive=OFF

i_bS_SafetyActive=OFF

i_bS_SafetyActive=ON

i_bS_SafetyActive=OFF

Safe
Operation
Mode
8005H

Enable switch
Not in position1

Operation
Error 1
C010H

Enable switch
in position1

Enable switch
Not in position1

Enable switch
in position1

i_bReset=
OFF

Operation
Error 2
C020H

Reset
Error 1
C001H

R_TRIG at i_bReset=ON
OR i_bS_AutoReset=ON

Enable switch
in position1

Position 1
8006H

i_bReset=ON AND
R_TRIG at i_bReset=OFF
AND i_bS_AutoReset=OFF

Enable
switch in
position1

Enable
switch in
position3

Operation
Error 3
C030H

Position 3
8007H

Enable switch
in position2

Position1:
i_bS_EnableSwCh1=OFF AND
i_bS_EnableSwCh2=ON

Position2:
i_bS_EnableSwCh1=ON AND
i_bS_EnableSwCh2=ON

Position3:
(i_bS_EnableSwCh1=OFF AND
i_bS_EnableSwCh2=OFF)
OR
(i_bS_EnableSwCh1=ON AND
i_bS_EnableSwCh2=OFF)

Enable switch
in position2

Enable switch
Not in position2

Operation
Error 4
C040H

(R_TRIG at
i_bReset)=ON OR
i_bS_AutoReset=ON

Enable switch
in position3

Enable switch
in position2

i_bReset=OFF

i_bReset=ON AND
R_TRIG at i_bReset=OFF
AND i_bS_AutoReset=OFF

Reset
Error 2
C002H

Enable switch
in position1

i_bS_SafetyActive=OFF

i_bS_SafetyActive=OFF

o_bS_EnableSw_Out=OFF

o_bS_EnableSw_Out=ON

Position 2
8000H

Note: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

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Typical timing diagram

■For M+SF_ENBLSW_R (i_bS_AutoReset=OFF)
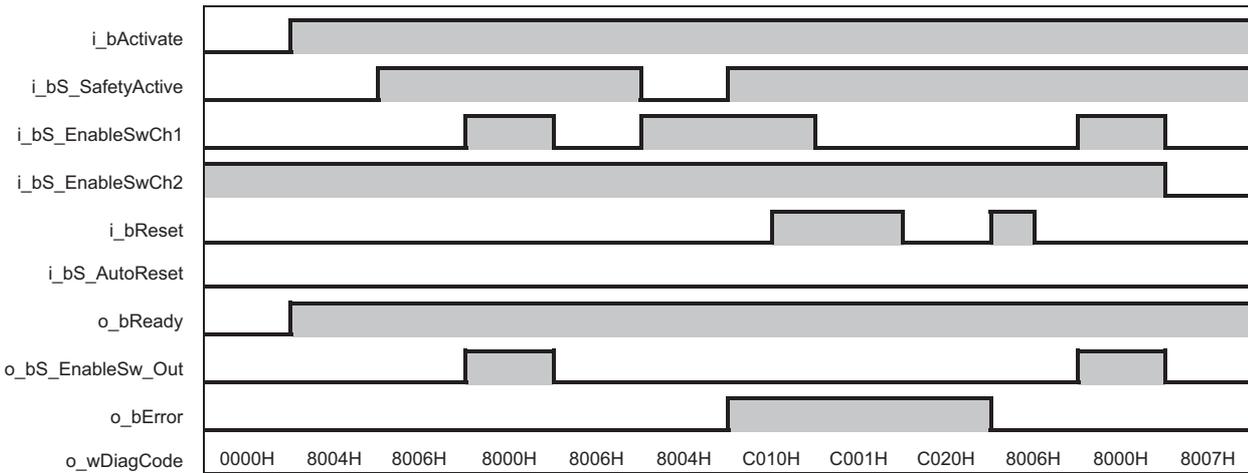
■For M+SF_ENBLSW_R (i_bS_AutoReset=ON)

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_EnableSw_Out	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset signal detected in state C020H.	Set i_bReset to OFF. Check the wiring and devices related to i_bReset signal. Set i_bS_SafetyActive to OFF.
C002H	Reset Error 2	Static i_bReset signal detected in state C040H.	
C010H	Operation Error 1	Enable switch not in position 1 during activation of i_bS_SafetyActive.	Set the switch to position 1, and set i_bS_SafetyActive to OFF.
C020H	Operation Error 2	Enable switch in position 1 after C010H.	Set the switch to position 1, and set i_bS_SafetyActive to OFF or set i_bReset to ON.
C030H	Operation Error 3	Enable switch in position 2 after position 3.	
C040H	Operation Error 4	Enable switch not in position 2 after C030H.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_EnableSw_Out: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8004H	Basic Operation Mode	Safe operation mode is not active. • o_bReady: ON • o_bS_EnableSw_Out: OFF • o_bError: OFF	Activate the safe operation mode by setting i_bS_SafetyActive to ON.
8005H	Safe Operation Mode	Safe operation mode is active. • o_bReady: ON • o_bS_EnableSw_Out: OFF • o_bError: OFF	Set the switch to position 1. Check a failure of the enable switch, wiring, and state of the safety remote I/O module.
8006H	Position 1	Safe operation mode is active and the enable switch is in position 1. • o_bReady: ON • o_bS_EnableSw_Out: OFF • o_bError: OFF	Set the switch to position 2.
8007H	Position 3	Safe operation mode is active and the enable switch is in position 3. • o_bReady: ON • o_bS_EnableSw_Out: OFF • o_bError: OFF	Set the switch to position 1, or i_bS_SafetyActive to OFF.
8000H	Position 2	Safe operation mode is active and the enable switch is in position 2. • o_bReady: ON • o_bS_EnableSw_Out: ON • o_bError: OFF	None.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
 • Setting of i_bS_AutoReset

4.5 M+SF_ESPE_R

Overview

Item	Description
Function name	Light curtain (ESPE)
Functional overview	This FB is a safety-related FB for monitoring electro-sensitive protective equipment (ESPE). This FB can be used for emergency switch off functionality (stop category 0).
Symbol	

```
                    M+SF_ESPE_R
(1) ──── B: i_bActivate          o_bReady: B ──── (6)
(2) ──── B: i_bS_ESPE_In      o_bS_ESPE_Out: B ──── (7)
(3) ──── B: i_bS_StartReset        o_bError: B ──── (8)
(5) ──── B: i_bS_AutoReset     o_wDiagCode: W ──── (9)
(5) ──── B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_ESPE_In	Bit*	OFF	The input signal from ESPE. OFF: The input signal from i_bS_ESPE_In is set to OFF. (Example: Light shielding of light curtain) ON: The input signal from i_bS_ESPE_In is set to ON. (Example: Light passing through light curtain)
(3)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(4)	i_bS_AutoReset	Bit*	OFF	Selection of a reset method for the input signal (i_bS_ESPE_In) reset to ON. For details, see the following. ☞ Page 11 General Functions
(5)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(6)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(7)	o_bS_ESPE_Out	Bit*	OFF	Safety output OFF: Safety output disabled. ON: Safety output enabled.
(8)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(9)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.

FB details

This FB is a safety-related FB for monitoring ESPE. The function is identical to S+ESTOP. o_bS_ESPE_Out output signal is set to OFF as soon as i_bS_ESPE_In input is set to OFF. o_bS_ESPE_Out output signal is set to ON only if i_bS_ESPE_In input is set to ON and a reset occurs. If the automatic reset is selected for i_bS_StartReset and i_bS_AutoReset, reset is not required.

⚠ WARNING

- The enable signal (o_bS_ESPE_Out) may only control the process directly if this does not adversely affect the safety function. In this regard, validate the entire path of the safety function, including the startup behavior of the process to be controlled.
- The ESPE must be selected in respect of the product standards IEC 61496-1, -2 and -3 and ISO 13849-1.

State diagram

State transition of M+SF_ESPE_R
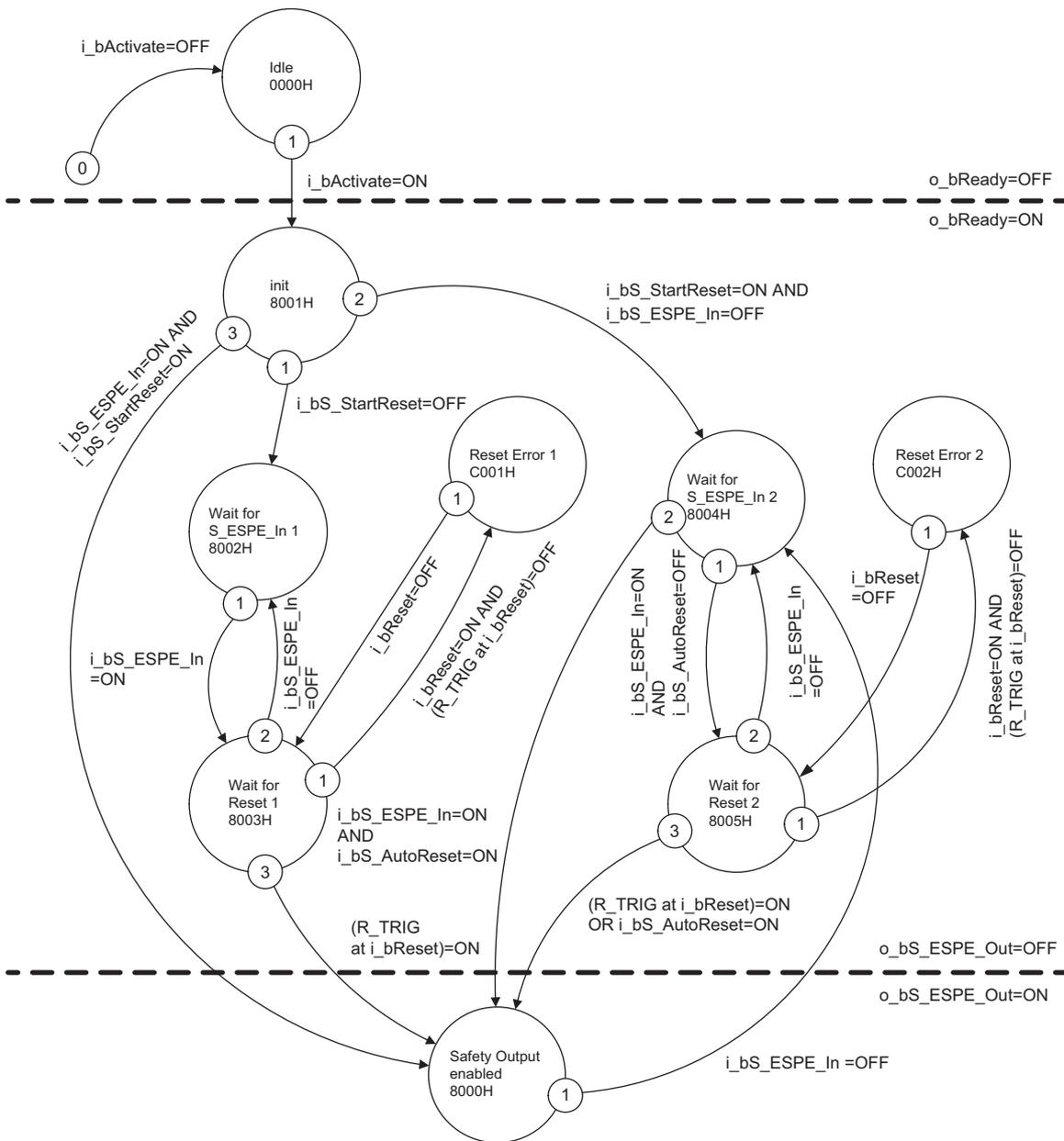
Note: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_ESPE_R (i_bS_StartReset=OFF, i_bS_AutoReset=OFF)

i_bActivate										
i_bS_ESPE_In										
i_bReset										
o_bReady										
o_bS_ESPE_Out										
o_bError										
o_wDiagCode	0000H	8002H	8003H	8000H	8000H	8004H	8005H	8000H	8000H	0000H

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_ESPE_Out	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	i_bReset is ON while waiting for i_bS_ESPE_In=ON.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C002H	Reset Error 2	i_bReset is ON while waiting for i_bS_ESPE_In=ON.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) All outputs are set to OFF. Set o_wDiagCode to 0. • o_bReady: OFF • o_bS_ESPE_Out: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8001H	Init	Activation is ON. The FB was enabled. • o_bReady: ON • o_bS_ESPE_Out: OFF • o_bError: OFF	Wait for i_bS_ESPE_In=ON.
8002H	Wait for S_ESPE_In 1	The safety function is active. (i_bS_StartReset=OFF) • o_bReady: ON • o_bS_ESPE_Out: OFF • o_bError: OFF	
8003H	Wait for Reset 1	Activation is ON. i_bS_ESPE_In=ON (i_bS_StartReset=OFF) • o_bReady: ON • o_bS_ESPE_Out: OFF • o_bError: OFF	Wait for a rising trigger of i_bReset.
8004H	Wait for S_ESPE_In 2	The safety function is active. (i_bS_StartReset=ON) • o_bReady: ON • o_bS_ESPE_Out: OFF • o_bError: OFF	Wait for i_bS_ESPE_In=ON.
8005H	Wait for Reset 2	The safety function is active. i_bS_ESPE_In=ON • o_bReady: ON • o_bS_ESPE_Out: OFF • o_bError: OFF	Wait for a rising trigger of i_bReset.
8000H	Safety Output Enabled	The safety function is not active. The safety input and the safety output are ON. • o_bReady: ON • o_bS_ESPE_Out: ON • o_bError: OFF	None.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
 • Setting of i_bS_StartReset and i_bS_AutoReset

4.6　M+SF_ESTOP_R

Overview

Item	Description
Function name	Emergency stop
Functional overview	This FB is a safety-related FB for monitoring an emergency stop button. This FB can be used for emergency switch off functionality (stop category 0).
Symbol	

```
                        M+SF_ESTOP_R
(1) ———  B: i_bActivate            o_bReady: B      ——— (6)
(2) ———  B: i_bS_EStopIn       o_bS_EStop_Out: B    ——— (7)
(3) ———  B: i_bS_StartReset         o_bError: B     ——— (8)
(4) ———  B: i_bS_AutoReset       o_wDiagCode: W     ——— (9)
(5) ———  B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_EStopIn	Bit*	OFF	The input signal from an emergency stop button. OFF: The input signal from an emergency stop button is set to OFF. (An emergency stop button is engaged.) ON: The input signal from an emergency stop button is set to ON. (An emergency stop button is not engaged.)
(3)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(4)	i_bS_AutoReset	Bit*	OFF	Selection of a reset method for the input signal reset to ON. For details, see the following. ☞ Page 11 General Functions
(5)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(6)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(7)	o_bS_EStop_Out	Bit*	OFF	Safety output. OFF: Safety output disabled. ON:　Safety output enabled.
(8)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(9)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.

FB details

o_bS_EStop_Out output signal is set to OFF as soon as i_bS_EStopIn input is set to OFF. o_bS_EStop_Out output signal is set to ON only if i_bS_EStopIn input is set to ON and a reset occurs. If the automatic reset is selected for i_bS_StartReset and i_bS_AutoReset, reset is not required.

⚠ WARNING

The signal (o_bS_EStop_Out) may only control the process directly if this does not adversely affect the safety function. In this regard, validate the entire path of the safety function, including the startup behavior of the process to be controlled.

State diagram

State transition of M+SF_ESTOP_R

Note: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_ESTOP_R (i_bS_StartReset=OFF, i_bS_AutoReset=OFF)

i_bActivate										
i_bS_EStopIn										
i_bReset										
o_bReady										
o_bS_EStop_Out										
o_bError										
o_wDiagCode	0000H	8002H	8003H	8000H	8000H	8004H	8005H	8000H	8000H	0000H

■For M+SF_ESTOP_R (i_bS_StartReset=ON, i_bS_AutoReset=OFF)

i_bActivate										
i_bS_EStopIn										
i_bReset										
o_bReady										
o_bS_EStop_Out										
o_bError										
o_wDiagCode	0000H	8000H	8004H	8005H	8000H	8000H	8004H	8005H	8000H	8000H

■For M+SF_ESTOP_R (i_bS_StartReset=OFF, i_bS_AutoReset=ON)

i_bActivate										
i_bS_EStopIn										
i_bReset										
o_bReady										
o_bS_EStop_Out										
o_bError										
o_wDiagCode	0000H	8002H	8003H	8000H	8000H	8004H	8000H	8004H	8000H	8000H

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_EStop_Out	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	i_bReset is ON while waiting for i_bS_EStopIn=ON.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C002H	Reset Error 2	i_bReset is ON while waiting for i_bS_EStopIn=ON.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) All outputs are set to OFF. Set o_wDiagCode to 0. • o_bReady: OFF • o_bS_EStop_Out: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8001H	Init	Activation is ON. The FB was enabled. • o_bReady: ON • o_bS_EStop_Out: OFF • o_bError: OFF	Wait for i_bS_EStopIn=ON.
8002H	Wait for S_EStopIn 1	The safety function is active. (i_bS_StartReset=OFF) • o_bReady: ON • o_bS_EStop_Out: OFF • o_bError: OFF	
8003H	Wait for Reset 1	The safety function is active. i_bS_EStopIn=ON (i_bS_StartReset=OFF) • o_bReady: ON • o_bS_EStop_Out: OFF • o_bError: OFF	Wait for a rising trigger of i_bReset.
8004H	Wait for S_EStopIn 2	The safety function is active. (i_bS_StartReset=ON) • o_bReady: ON • o_bS_EStop_Out: OFF • o_bError: OFF	Wait for i_bS_EStopIn=ON.
8005H	Wait for Reset 2	The safety function is active. • o_bReady: ON • o_bS_EStop_Out: OFF • o_bError: OFF	Wait for a rising trigger of i_bReset.
8000H	Safety Output Enabled	The safety function is not active. The safety input and the safety output are ON. • o_bReady: ON • o_bS_EStop_Out: ON • o_bError: OFF	None.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
 • Setting of i_bS_StartReset and i_bS_AutoReset

4.7 M+SF_GLOCK_R

Overview

Item	Description
Function name	Guard lock and interlocking
Functional overview	This FB controls an entrance to a hazardous area via an interlocking guard with guard locking ("four state interlocking").
Symbol	

```
                    M+SF_GLOCK_R
(1) ——— B: i_bActivate           o_bReady: B ——— (9)
(2) ——— B: i_bS_GuardMon      o_bS_GuardLocked: B ——— (10)
(3) ——— B: i_bS_SafetyActive   o_bS_UnlockGuard: B ——— (11)
(4) ——— B: i_bS_GuardLock             o_bError: B ——— (12)
(5) ——— B: i_bUnlockRequest      o_wDiagCode: W ——— (13)
(6) ——— B: i_bS_StartReset
(7) ——— B: i_bS_AutoReset
(8) ——— B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_GuardMon	Bit*	OFF	Monitors the guard interlocking. OFF: Guard open. ON: Guard closed.
(3)	i_bS_SafetyActive	Bit*	OFF	Status of the hazardous area, e.g., based on speed monitoring or safe time off delay. OFF: Machine in "non-safe" state. ON: Machine in safe state.
(4)	i_bS_GuardLock	Bit*	OFF	Status of the mechanical guard locking OFF: Guard is not locked. ON: Guard is locked.
(5)	i_bUnlockRequest	Bit	OFF	Operator intervention - request to unlock the guard. OFF: No request. ON: Request made.
(6)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(7)	i_bS_AutoReset	Bit*	OFF	Selection of a reset method for the input signal reset to ON. For details, see the following. ☞ Page 11 General Functions
(8)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions Also used to request the guard to be locked again. The quality of the signal must conform to a manual reset device.

■Output labels

No.	Variable name	Data type	Default value	Description
(9)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(10)	o_bS_GuardLocked	Bit*	OFF	Interface to hazardous area which must be stopped. OFF: No safe state. ON: Safe state. (The guard is closed and locked, so that the machine can be operated.)
(11)	o_bS_UnlockGuard	Bit*	OFF	Signal to unlock the guard. OFF: Close guard. ON: Unlock guard.
(12)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(13)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.

FB details

This FB controls the guard lock and monitors the position of the guard and the lock. This FB can be used with a mechanical locked switch. The operator requests to get access to the hazardous area. The guard can only be unlocked when the hazardous area is in a safe state. The guard can be locked if the guard is closed. The machine can be started when the guard is closed and the guard is locked. An open guard or unlocked guard will be detected in the event of a safety-critical situation.

Ex.

Operation sequence for guardlock

No.	I/O	Operation
Sequence 1	—	Request to get the hazardous area to a safe state - not part of this FB
Sequence 2	In	Feedback from applicable hazardous area that it is in a safe state (via i_bS_SafetyActive)
Sequence 3	In	Operator request to unlock the guard (i_bUnlockRequest input=ON)
Sequence 4	Out	Output the signal unlocking the guard to the switch (by setting o_bS_UnlockGuard to ON).
Sequence 5	In	The signal that enables the guard to be unlocked is input from the switch (by setting i_bS_GuardLock input to OFF), which enables the guard to be opened. (o_bS_GuardLocked is set to OFF)
Sequence —	—	Operator opens the guard.
Sequence 6	In	Check if the guard is closed again. (by setting i_bS_GuardMon to ON)
Sequence 7	In	Feedback from operator to restart the hazardous area (i_bUnlockRequest)
Sequence 8	Out	Lock the guard. (o_bS_UnlockGuard)
Sequence 9	In	Check if guard is locked. (i_bS_GuardLock)
Sequence 10	Out	Hazardous area can operate again. (o_bS_GuardLocked=ON) (If i_bS_AutoReset is OFF, reset is required with i_bReset input.)
Sequence 11	—	Restart the operation in the hazardous area.

Sequence 1, 2

i_bS_SafetyActive
=ON

M+SF_GLOCK+R

Sequence 3, 4

o_bS_UnlockGuard
=ON

M+SF_GLOCK+R

i_bUnlockRequest
=ON

Sequence 5

i_bS_GuardLock
=OFF

o_bS_GuardLocked
=OFF

M+SF_GLOCK+R

Sequence -

i_bS_GuardMon
=OFF

M+SF_GLOCK+R

Sequence 6

i_bS_GuardMon
=ON

M+SF_GLOCK+R

Sequence 7, 8

o_bS_UnlockGuard
=OFF

M+SF_GLOCK+R

i_bUnlockRequest
=OFF

Sequence 9

i_bS_GuardLock
=ON

M+SF_GLOCK+R

Sequence 10, 11

o_bS_GuardLocked
=ON

M+SF_GLOCK+R

i_bReset

State diagram

State transition of M+SF_GLOCK_R

Note: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_GLOCK_R

i_bActivate	
i_bS_GuardMon	
i_bS_SafetyActive	
i_bS_GuardLock	
i_bUnlockRequest	
i_bS_StartReset	
i_bS_AutoReset	
i_bReset	
o_bReady	
o_bS_GuardLocked	
o_bS_UnlockGuard	
o_bError	
o_wDiagCode	0000H 8001H 8000H 8000H 8000H 8013H 8012H 8013H 8011H 8003H 8000H 8000H 8014H 8014H 8003H C003H 8003H 8000H

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_GuardLocked	OFF
o_bS_UnlockGuard	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset detected in state 8001H. (i_bS_StartReset=OFF)	Set i_bReset to OFF. Check the devices and wiring of i_bReset.
C002H	Reset Error 2	Static i_bReset detected in state 8014H.	
C003H	Reset Error 3	Static i_bReset detected in state 8003H.	
C004H	Safety Lost	Safety lost, guard opened or guard unlocked.	Set i_bS_SafetyActive to ON and set i_bReset to ON. Check the hazardous area is in a safe state.

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (initial state) • o_bReady: OFF • o_bS_GuardLocked: OFF • o_bS_UnlockGuard: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	Guard Closed and Locked	Guard is locked. The safety function is not requested for the machine in a safe area. The machine can be operated normally in the safe area. • o_bReady: ON • o_bS_GuardLocked: ON • o_bS_UnlockGuard: OFF • o_bError: OFF	None.
8001H	Init	The FB was activated and initiated. • o_bReady: ON • o_bS_GuardLocked: OFF • o_bS_UnlockGuard: OFF • o_bError: OFF	Close and lock the guard, and set i_bReset to ON.
8003H	Wait for Reset	Door is closed and locked, now waiting for operator reset. • o_bReady: ON • o_bS_GuardLocked: OFF • o_bS_UnlockGuard: OFF • o_bError: OFF	Set i_bReset to ON.
8011H	Wait for Operator	Waiting for operator to either unlock request or reset. • o_bReady: ON • o_bS_GuardLocked: OFF • o_bS_UnlockGuard: OFF • o_bError: OFF	Close and lock the guard, and set i_bReset to ON. Or, release the lock.
8012H	Guard Open and Unlocked	Lock is released and guard is open. • o_bReady: ON • o_bS_GuardLocked: OFF • o_bS_UnlockGuard: ON • o_bError: OFF	Close the guard.
8013H	Guard Closed but Unlocked	Lock is released but guard is closed. • o_bReady: ON • o_bS_GuardLocked: OFF • o_bS_UnlockGuard: ON • o_bError: OFF	Lock the guard.
8014H	Safety Return	Return of i_bS_SafetyActive signal, now waiting for operator acknowledge. • o_bReady: ON • o_bS_GuardLocked: OFF • o_bS_UnlockGuard: OFF • o_bError: OFF	Set i_bReset to ON.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
• A failure in safety devices and emergency stop devices
• Wiring and status of a safety remote I/O module and a safety programmable controller
• Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
• Setting of i_bS_StartReset and i_bS_AutoReset

4.8 M+SF_GMON_R

Overview

Item	Description
Function name	Guard monitoring
Functional overview	This FB monitors the relevant safety guard. There are two independent input parameters for two switches at the safety guard coupled with a time difference (i_dMonitoringTime) for closing the guard.
Symbol	

```
                    M+SF_GMON_R
(1) ——— B :i_bActivate            o_bReady: B  ——— (8)
(2) ——— B :i_bS_GuardSwitch1   o_bS_GuardMon: B ——— (9)
(3) ——— B :i_bS_GuardSwitch2       o_bError: B  ——— (10)
(4) ——— D :i_dDiscrepancyTime   o_wDiagCode: W  ——— (11)
(5) ——— B :i_bS_StartReset
(6) ——— B :i_bS_AutoReset
(7) ——— B :i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_GuardSwitch1	Bit*	OFF	Guard switch1 input. OFF: Guard is open. ON:　Guard is closed.
(3)	i_bS_GuardSwitch2	Bit*	OFF	Guard switch2 input. OFF: Guard is open. ON:　Guard is closed.
(4)	i_dDiscrepancyTime	Double word [signed]	0	Configures the monitored discrepancy time between i_bS_GuardSwitch1 and i_bS_GuardSwitch2 (in increments of 10ms) for closing the guard. Range: Fixed values from 0 to 60000 (0 to 600000ms = 10min)
(5)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(6)	i_bS_AutoReset	Bit*	OFF	Selection of a reset method for the input signal reset to ON. For details, see the following. ☞ Page 11 General Functions
(7)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(8)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(9)	o_bS_GuardMon	Bit*	OFF	Output indicating the status of the guard. OFF: Guard is not active. ON:　Both i_bS_GuardSwitches are ON, no error and acknowledgment. Guard is active.
(10)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(11)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.

FB details

The FB requires two inputs indicating the guard position for safety guards with two switches (according to ISO 14119), i_dDiscrepancyTime input and i_bReset input. If the safety guard has only one switch, i_bS_GuardSwitch1 and i_bS_GuardSwitch2 inputs must be the same signal. The monitoring time (i_dDiscrepancyTime) is the maximum time required for both switches to respond when closing the safety guard.

When opening the safety guard, both i_bS_GuardSwitch1 and i_bS_GuardSwitch2 inputs should switch to OFF. o_bS_GuardMon output switches to OFF as soon as one of the switches is set to OFF. When closing the safety guard, both i_bS_GuardSwitch1 and i_bS_GuardSwitch2 inputs should switch to ON. This FB monitors the symmetry of the switching behavior of both switches. o_bS_GuardMon output remains OFF if only one of the contacts has completed an open/close process. The behavior of o_bS_GuardMon output depends on the time difference between the switching inputs. The discrepancy time is monitored as soon as the values of both i_bS_GuardSwitch1/i_bS_GuardSwitch2 inputs differ. If i_dDiscrepancyTime has elapsed, but the inputs still differ, o_bS_GuardMon output remains OFF. If the second corresponding i_bS_GuardSwitch1/i_bS_GuardSwitch2 input switches to ON within the value specified for i_dDiscrepancyTime input, o_bS_GuardMon output is set to ON following acknowledgment. i_bS_StartReset and i_bS_AutoReset inputs shall only be activated if it is ensured that no hazardous situation can occur when a safety programmable controller is started.

⚠ WARNING

- Connect the two signals/switches of a safeguard to i_bS_GuardSwitch1 and i_bS_GuardSwitch2 independently in your application. If you have a single signal/switch, connect the same signal to both FB variables.
- The time value for the i_dDiscrepancyTime parameter should be determined and validated according to your application and its risk analysis. This variable should be connected to the 0ms constant if both signal inputs (i_bS_GuardSwitch1 and i_bS_GuardSwitch2) are connected to the same signal in your application.

State transition of M+SF_GMON_R
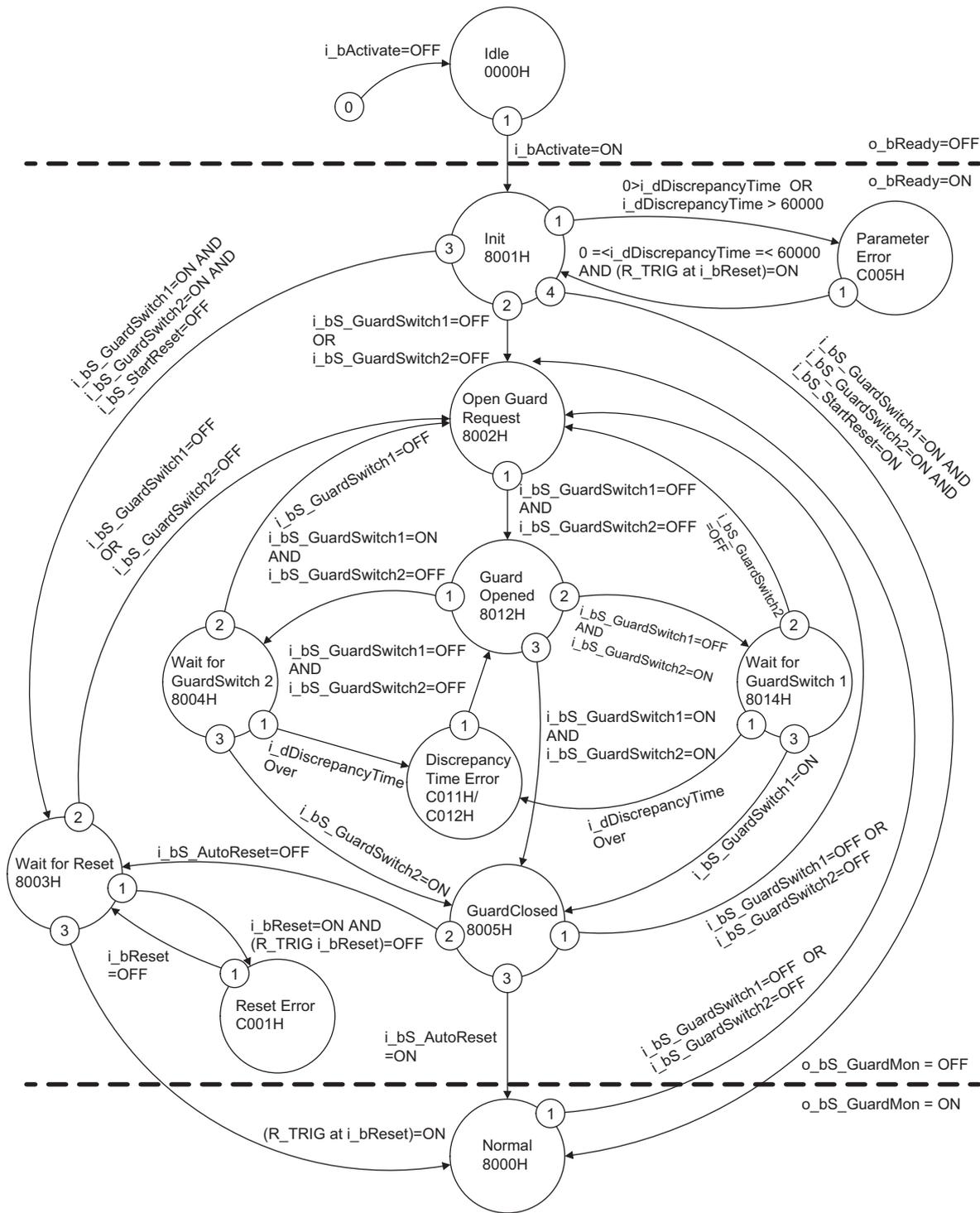
Note: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_GMON_R
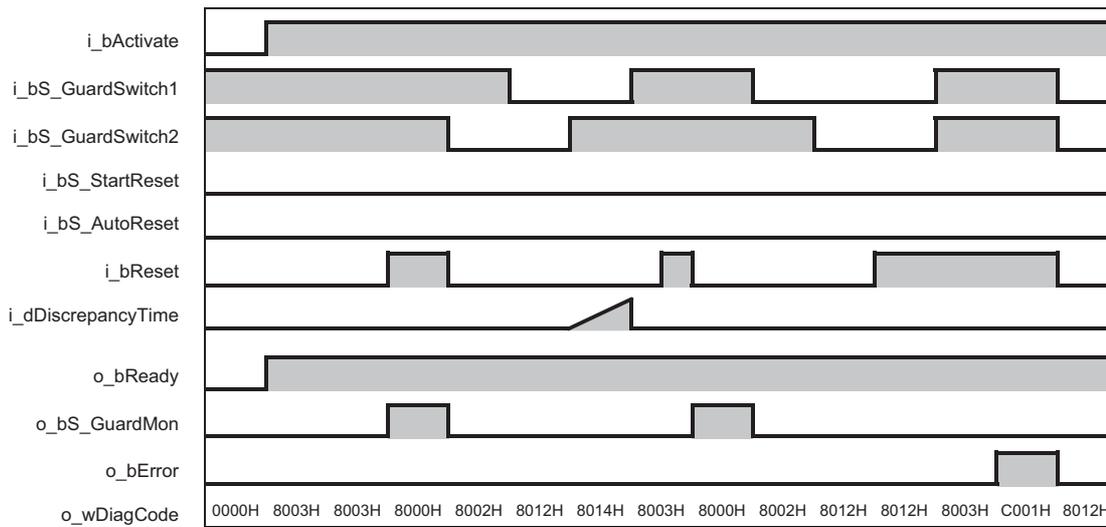
A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dDiscrepancyTime elapsed time is stopped.

■For M+SF_GMON_R
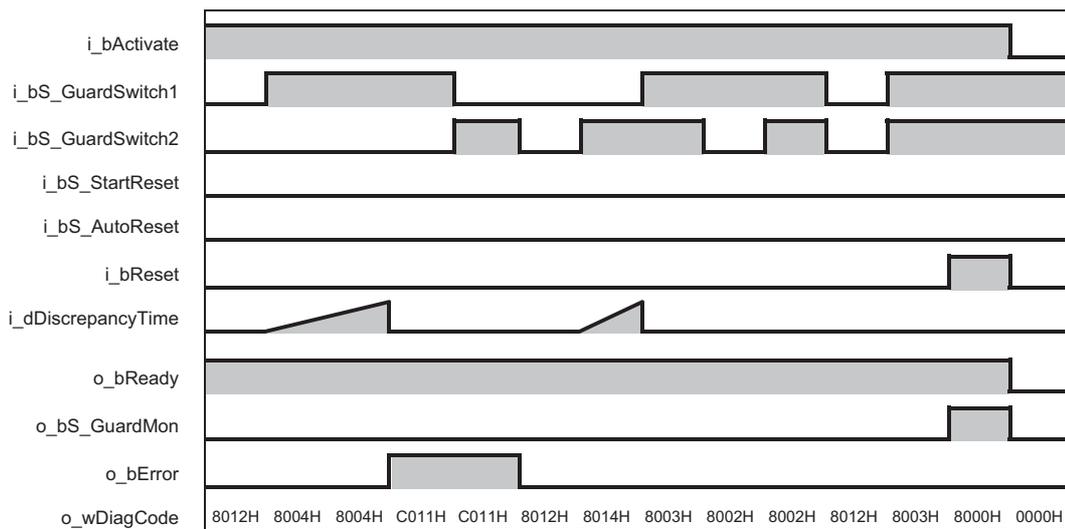
A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dDiscrepancyTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_GuardMon	OFF
o_bError	ON

For the corrective actions, see the following.

☞ Page 53 List of error codes

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error	Static i_bReset detected in state 8003H.	Set i_bReset to OFF. Check the devices and wiring of i_bReset.
C005H	Parameter Error	i_dDiscrepancyTime is out of range.	Set i_dDiscrepancyTime within the range.
C011H	DiscrepancyTime Error 1	i_dDiscrepancyTime elapsed in state 8004H. (i_bS_GuardSwitch1=ON, i_bS_GuardSwitch2=OFF)	Set i_bS_GuardSwitch1 and i_bS_GuardSwitch2 to OFF. • Check a failure of the switches of the guard. • When the guard is closed with no failure, check the state, parameter and wiring of the safety remote I/O module. • Check the i_dDiscrepancyTime.
C012H	DiscrepancyTime Error 2	i_dDiscrepancyTime elapsed in state 8014H. (i_bS_GuardSwitch1=OFF, i_bS_GuardSwitch2=ON)	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (initial state) All output signals are set to OFF. • o_bReady: OFF • o_bS_GuardMon: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	Normal	Safety guard closed and Safe state acknowledged. • o_bReady: ON • o_bS_GuardMon: ON • o_bError: OFF	None.
8001H	Init	The FB has been activated. • o_bReady: ON • o_bS_GuardMon: OFF • o_bError: OFF	Close the guard.
8002H	Open Guard Request	Complete switching sequence required. At least one switch was OFF. • o_bReady: ON • o_bS_GuardMon: OFF • o_bError: OFF	Open the guard completely. When the guard is open completely, check the switch, wiring and the safety remote I/O module.
8003H	Wait for Reset	Waiting for rising trigger at Reset. • o_bReady: ON • o_bS_GuardMon: OFF • o_bError: OFF	Set i_bReset to ON.
8012H	Guard Opened	Guard completely opened. • o_bReady: ON • o_bS_GuardMon: OFF • o_bError: OFF	Close the guard.
8004H	Wait for GuardSwitch 2	Guard not completely closed. i_bS_GuardSwitch1 has been switched to ON - waiting for i_bS_GuardSwitch2; discrepancy timer started. • o_bReady: ON • o_bS_GuardMon: OFF • o_bError: OFF	Close the guard completely.
8014H	Wait for GuardSwitch 1	Guard not completely closed. i_bS_GuardSwitch2 has been switched to ON - waiting for i_bS_GuardSwitch1; discrepancy timer started. • o_bReady: ON • o_bS_GuardMon: OFF • o_bError: OFF	
8005H	Guard Closed	Guard closed. Waiting for i_bReset, if i_bS_AutoReset=OFF. • o_bReady: ON • o_bS_GuardMon: OFF • o_bError: OFF	Set i_bReset to ON.

⚠ **WARNING**

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.

- A failure in safety devices and emergency stop devices
- Wiring and status of a safety remote I/O module and a safety programmable controller
- Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
- Setting of i_bS_StartReset and i_bS_AutoReset

4.9   M+SF_MODSEL_R

Overview

Item	Description
Function name	Mode selector
Functional overview	This FB selects the system operation mode, such as manual, automatic, and semi-automatic.
Symbol	

```
                        M+SF_MODSEL_R
(1) ──────   B: i_bActivate            o_bReady: B     ──── (15)
(2) ──────   B: i_bS_Mode0          o_bS_Mode0Sel: B   ──── (16)
(3) ──────   B: i_bS_Mode1          o_bS_Mode1Sel: B   ──── (17)
(4) ──────   B: i_bS_Mode2          o_bS_Mode2Sel: B   ──── (18)
(5) ──────   B: i_bS_Mode3          o_bS_Mode3Sel: B   ──── (19)
(6) ──────   B: i_bS_Mode4          o_bS_Mode4Sel: B   ──── (20)
(7) ──────   B: i_bS_Mode5          o_bS_Mode5Sel: B   ──── (21)
(8) ──────   B: i_bS_Mode6          o_bS_Mode6Sel: B   ──── (22)
(9) ──────   B: i_bS_Mode7          o_bS_Mode7Sel: B   ──── (23)
(10) ─────   B: i_bS_Unlock        o_bS_AnyModeSel: B  ──── (24)
(11) ─────   B: i_bS_SetMode             o_bError: B   ──── (25)
(12) ─────   B: i_bAutoSetMode       o_wDiagCode: W    ──── (26)
(13) ─────   D: i_dModeMonitorTime
(14) ─────   B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_Mode0	Bit*	OFF	Input 0 from mode selector switch. OFF: Mode 0 is not requested by operator. ON: Mode 0 is requested by operator.
(3)	i_bS_Mode1	Bit*	OFF	Input 1 from mode selector switch
(4)	i_bS_Mode2	Bit*	OFF	Input 2 from mode selector switch
(5)	i_bS_Mode3	Bit*	OFF	Input 3 from mode selector switch
(6)	i_bS_Mode4	Bit*	OFF	Input 4 from mode selector switch
(7)	i_bS_Mode5	Bit*	OFF	Input 5 from mode selector switch
(8)	i_bS_Mode6	Bit*	OFF	Input 6 from mode selector switch
(9)	i_bS_Mode7	Bit*	OFF	Input 7 from mode selector switch
(10)	i_bS_Unlock	Bit*	OFF	Locks the selected mode. OFF: The actual o_bS_ModeXSel output is locked. (A change of any i_bS_ModeX input does not lead to a change in o_bS_ModeXSel output even in the event of a rising edge of i_bS_SetMode.) ON: The selected o_bS_ModeXSel output is not locked. (A mode selection change is possible.)
(11)	i_bS_SetMode	Bit*	OFF	Sets the selected mode. • i_bAutoSetMode=OFF OFF: Any change to new i_bS_ModeX=ON is not confirmed. ON (Activated only when i_bS_SetMode is set to ON): A change to new i_bS_ModeX is confirmed. • i_bAutoSetMode=ON Constant OFF (i_bS_SetMode is not required.)
(12)	i_bAutoSetMode	Bit	OFF	Parameterizes the acknowledgment mode. OFF: A change in mode must be acknowledged by the operator via i_bS_SetMode. ON: A valid change of i_bS_ModeX input to another i_bS_ModeX automatically leads to a change in o_bS_ModeXSel without operator acknowledgment via i_bS_SetMode (as long as this is not locked by i_bS_Unlock).
(13)	i_dModeMonitorTime	Double word [signed]	0	Maximum permissible time for changing the selection input (in increments of 10ms). Range: Fixed values from 0 to 60000 (0 to 600000ms = 10min)

No.	Variable name	Data type	Default value	Description
(14)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(15)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(16)	o_bS_Mode0Sel	Bit*	OFF	Indicates that mode 0 is selected and acknowledged. OFF: Mode 0 is not selected or not active. ON:　Mode 0 is selected and active.
(17)	o_bS_Mode1Sel	Bit*	OFF	Indicates that mode 1 is selected and acknowledged.
(18)	o_bS_Mode2Sel	Bit*	OFF	Indicates that mode 2 is selected and acknowledged.
(19)	o_bS_Mode3Sel	Bit*	OFF	Indicates that mode 3 is selected and acknowledged.
(20)	o_bS_Mode4Sel	Bit*	OFF	Indicates that mode 4 is selected and acknowledged.
(21)	o_bS_Mode5Sel	Bit*	OFF	Indicates that mode 5 is selected and acknowledged.
(22)	o_bS_Mode6Sel	Bit*	OFF	Indicates that mode 6 is selected and acknowledged.
(23)	o_bS_Mode7Sel	Bit*	OFF	Indicates that mode 7 is selected and acknowledged.
(24)	o_bS_AnyModeSel	Bit*	OFF	Indicates that any of the 8 modes is selected and acknowledged. OFF: No i_bS_ModeX is selected. ON:　One of the 8 i_bS_ModeX is selected and active.
(25)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(26)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.

FB details

This FB selects the system operation mode, such as manual, automatic, and semi-automatic. The default state is changed to the ModeChanged state (8005H), where all o_bS_ModeXSel and o_bS_AnyModeSel are OFF, after the activation of the FB.

For the transition from the ModeChanged to ModeSelected state, the following conditions are required.

- i_bAutoSetMode=OFF

When i_bS_SetMode is set to ON, the new i_bS_ModeX input leads to an o_bS_ModeXSel output.

- i_bAutoSetMode=ON

The new i_bS_ModeX input automatically leads to a new o_bS_ModeXSel output.

The transition from the ModeChanged to ModeSelected state is only valid, if one i_bS_ModeX is ON. In addition, the transition from one i_bS_ModeX input (only one i_bS_ModeX from i_bS_Mode0 to i_bS_Mode7 is ON) to ModeSelected state (8000H) is not monitored by a timer.

If the FB is in the ModeSelected state, the simultaneously occurrence of a new i_bS_ModeX input (higher priority) and the OFF i_bS_Unlock signal (lower priority) leads to the ModeChanged state.

The i_bS_ModeX input parameters, which are not used for mode selection, should be called with the default value OFF to simplify program verification. i_bAutoSetMode input shall only be activated if it is ensured that no hazardous situation can occur when the safety programmable controller is started.

State diagram

State transition of M+SF_MODSEL_R
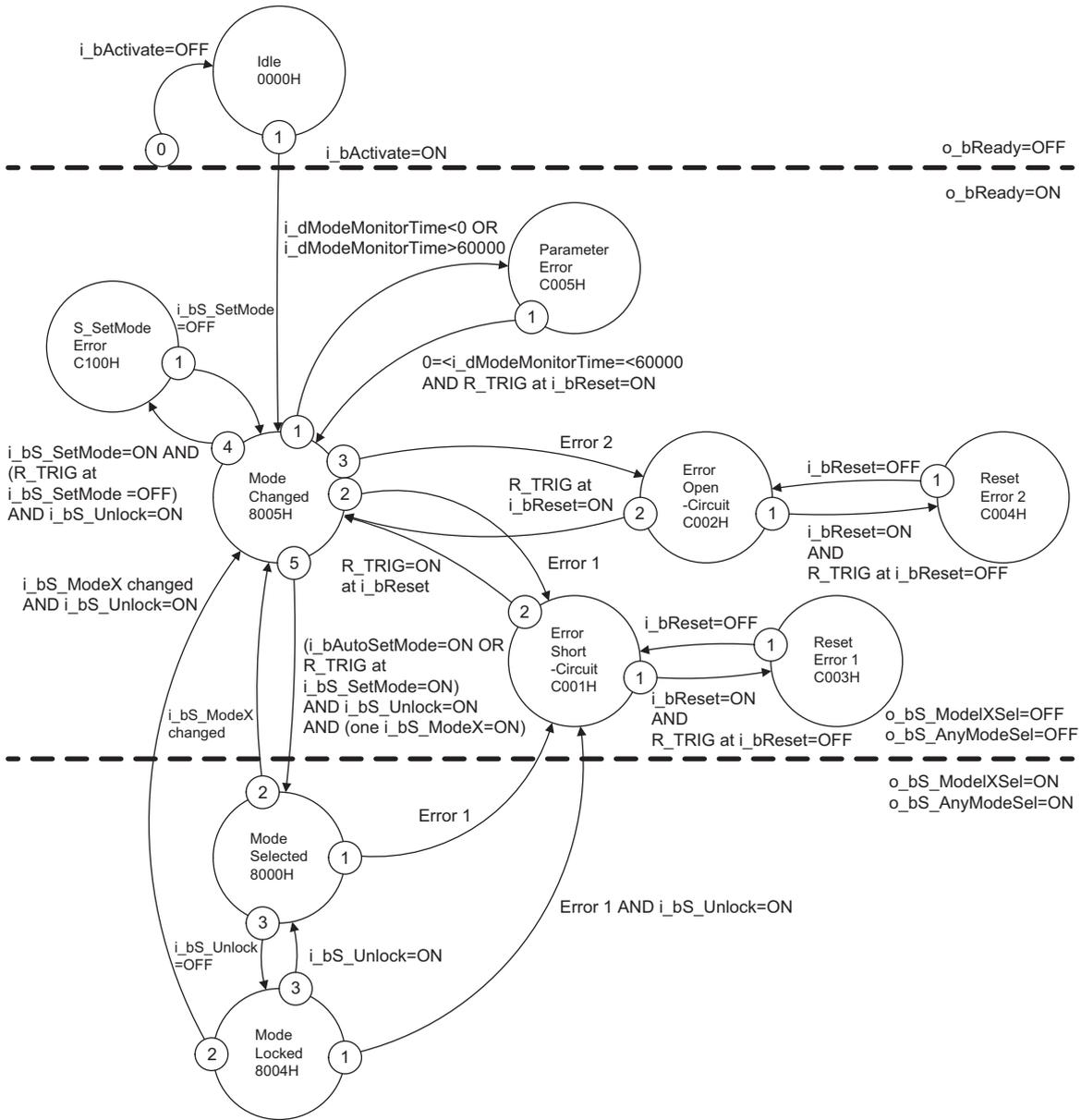
Note 1: Error 1: More than one i_bS_ModeX=ON is selected at the same time.
Error 2: The i_bS_ModeX=OFF state remains for longer than i_dModeMonitorTime.

Note 2: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_MODSEL_R (i_bAutoSetMode=OFF) Valid change in Mode input with acknowledgment
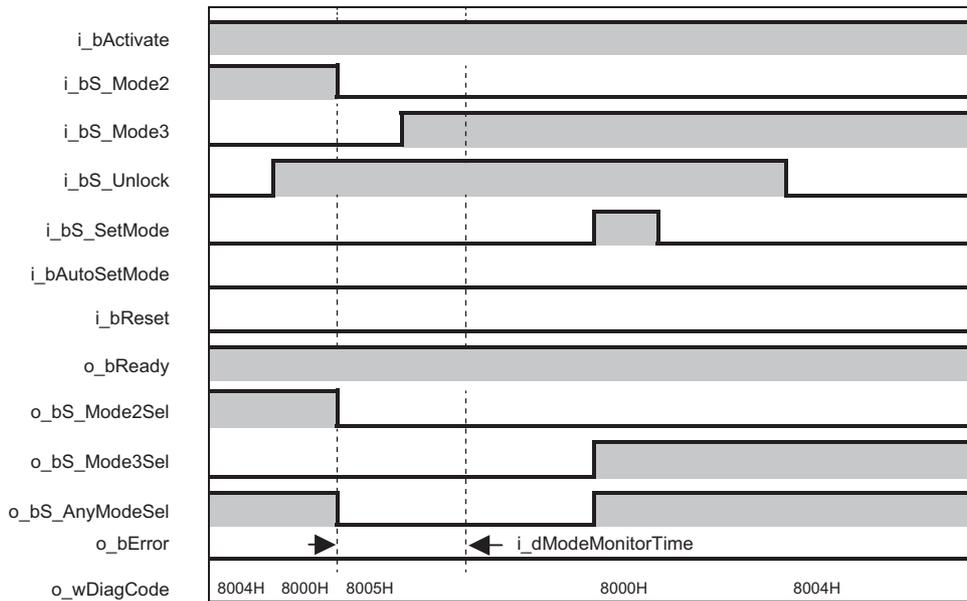
A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dModeMonitorTime elapsed time is stopped.

■For M+SF_MODSEL_R (i_bAutoSetMode=OFF) Error condition 2 at Mode inputs (All i_bS_ModeX=OFF after i_dModeMonitorTime).
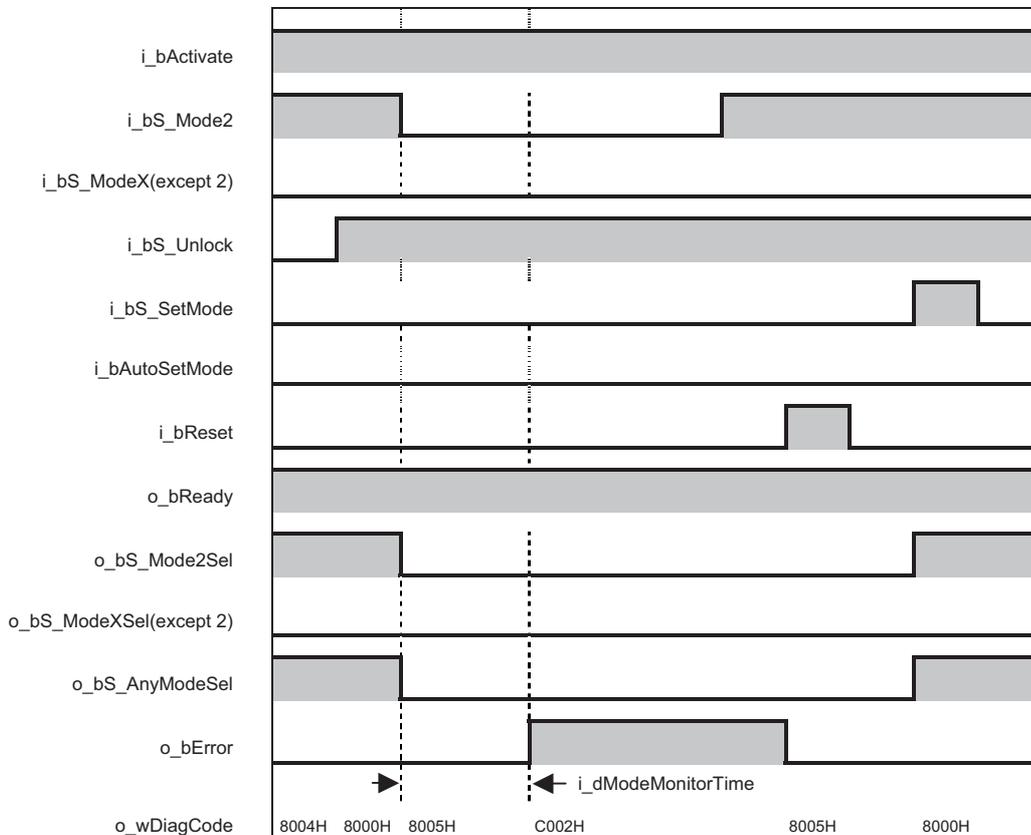
A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dModeMonitorTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_Mode0Sel to o_bS_Mode7Sel	OFF
o_bS_AnyModeSel	OFF
o_bError	ON

For the corrective actions, see the following.

☞ Page 59 List of error codes

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Error Short-circuit	The FB detected that two or more i_bS_ModeX=ON.	Set only one i_bS_ModeX to ON and set i_bReset to ON. Check the connection and wiring related to i_bReset.
C002H	Error Open-circuit	The FB detected that all i_bS_ModeX=OFF: The period following a falling i_bS_ModeX trigger exceeds i_dModeMonitorTime.	Set only one i_bS_ModeX to ON and set i_bReset to ON. Check the connection and wiring related to i_bReset. Check the value of i_dModeMonitorTime.
C003H	Reset Error 1	Static i_bReset signal detected in state C001H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C004H	Reset Error 2	Static i_bReset signal detected in state C002H.	
C005H	Parameter Error	The value of i_dModeMonitorTime is out of range (0 to 60000).	Set a proper value to i_dModeMonitorTime. Set i_bReset to ON.
C100H	S_SetMode Error	Static i_bS_SetMode signal detected with i_bS_Unlock=ON in state 8005H.	Set i_bS_SetMode to OFF. Check the devices and wiring related to i_bReset.

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (initial state) • o_bReady: OFF • o_bS_Mode0Sel to o_bS_Mode7Sel: OFF • o_bS_AnyModeSel: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8005H	ModeChanged	State after activation or when i_bS_ModeX has changed (unless locked) or after Reset of an error state. • o_bReady: ON • o_bS_Mode0Sel to o_bS_Mode7Sel: OFF • o_bS_AnyModeSel: OFF • o_bError: OFF	Select a mode after setting i_bS_Unlock to ON, and set i_bS_SetMode to ON.
8000H	ModeSelected	Valid mode selection, but not yet locked. • o_bReady: ON • o_bS_Mode0Sel to o_bS_Mode7Sel: [1] • o_bS_AnyModeSel: ON • o_bError: OFF	Lock the selected mode by setting i_bS_Unlock to OFF.
8004H	ModeLocked	Valid mode selection is locked. • o_bReady: ON • o_bS_Mode0Sel to o_bS_Mode7Sel: [1] • o_bS_AnyModeSel: ON • o_bError: OFF	To change the mode, set i_bS_Unlock to ON.

[1] Set only one signal to ON.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
- A failure in safety devices and emergency stop devices
- Wiring and status of a safety remote I/O module and a safety programmable controller
- Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
- Setting of i_bAutoSetMode

4.10 M+SF_MUTE2_R

Overview

Item	Description
Function name	Muting with 2 sensors
Functional overview	Muting is the intended suppression of the safety function. In this FB, parallel muting with two muting sensors is specified.
Symbol	

```
                    M+SF_MUTE2_R
(1) ——— B: i_bActivate             o_bReady: B        ——— (11)
(2) ——— B: i_bS_AOPD_In         o_bS_AOPD_Out: B      ——— (12)
(3) ——— B: i_bS_MutingSw_11   o_bS_MutingActive: B    ——— (13)
(4) ——— B: i_bS_MutingSw_12          o_bError: B      ——— (14)
(5) ——— B: i_bS_MutingLamp       o_wDiagCode: W       ——— (15)
(6) ——— D: i_dDiscTimeEntry
(7) ——— D: i_dMaxMutingTime
(8) ——— B: i_bMutingEnable
(9) ——— B: i_bS_StartReset
(10) —— B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_AOPD_In	Bit*	OFF	OSSD (safety output) signal from AOPD (Active opto-electronic protective devices). OFF: Protection field interrupted ON: Protection field not interrupted
(3)	i_bS_MutingSw_11	Bit*	OFF	Status of muting sensor 11. OFF: Muting sensor 11 is not actuated. ON: Workpiece actuates muting sensor 11.
(4)	i_bS_MutingSw_12	Bit*	OFF	Status of muting sensor 12. OFF: Muting sensor 12 is not actuated. ON: Workpiece actuates muting sensor 12.
(5)	i_bS_MutingLamp	Bit*	OFF	Indicates operation of the muting lamp. OFF: Muting lamp failure ON: Muting lamp no failure
(6)	i_dDiscTimeEntry	Double word [signed]	0	Max. discrepancy time for i_bS_MutingSw_11 and i_bS_MutingSw_12 entering muting gate. Increments of 10ms. Range: Fixed values from 0 to 400 (0 to 4000ms = 4sec)
(7)	i_dMaxMutingTime	Double word [signed]	0	Maximum time to complete muting sequence, timer started when first muting sensor is actuated. Increments of 10ms. Range: Fixed values from 0 to 60000 (0 to 600000ms = 10min)
(8)	i_bMutingEnable	Bit	OFF	Command by the control system that enables the start of the muting function when needed by the machine cycle. After the start of the muting function, this signal can be switched OFF. OFF: Muting not enabled ON: Start of Muting function enabled
(9)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(10)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(11)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(12)	o_bS_AOPD_Out	Bit*	OFF	Safety output, indicates status of the muted guard. OFF: AOPD protection field interrupted and muting not active. ON: AOPD protection field not interrupted or muting active.
(13)	o_bS_MutingActive	Bit*	OFF	Indicates status of muting process. OFF: Muting not active ON: Muting active
(14)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(15)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.
- While the muting is active, do not change the value of i_dMaxMutingTime. When changing the value, turn OFF i_bActivate before changing.

FB details

Muting is the intended suppression of the safety function. This is required, e.g., when transporting a workpiece into the danger zone without causing the machine to stop. Muting is triggered by muting sensors. The use of two muting sensors and correct integration into the production sequence must ensure that no persons enter the danger zone while the light curtain is muted. Muting sensors can be push buttons, proximity switches, photoelectric barriers, limit switches, etc. which do not have to be failsafe. Active muting mode must be indicated by indicator lights (the muting lamp).

There are sequential and parallel muting procedures. In this FB, parallel muting with two muting sensors is used. The positioning of the sensors must conform to IEC 62046 as shown in the figure. The FB can be used in both directions, forward and backward. However, the actual direction cannot be identified. The muting should be enabled with the i_bMutingEnable signal by the process control when there is no manipulation in the danger zone.

The FB input parameters include the signals of the two muting sensors (i_bS_MutingSw_11 and i_bS_MutingSw_12), the OSSD signal (i_bS_AOPD_In) from the "active opto-electronic protective device", as well as two parameterizable times (i_dDiscTimeEntry and i_dMaxMutingTime).

While both of the two muting sensors are ON, muting is active and o_bS_AOPD_Out is set to ON, although i_bS_AOPD_In is OFF.

■Example for M+SF_MUTE2_R with two reflecting light barriers

Figure	Description
	If reflection light barriers are used as muting sensors, they are generally arranged diagonally. In general, this arrangement of reflection light barriers as muting sensors requires only two light barriers, and only i_bS_MutingSw_11 (MS_11) and i_bS_MutingSw_12 (MS_12) are allocated.

State diagram

State transition of M+SF_MUTE2_R

Note 1: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Note 2: Within muting substates, transitions due to Error Muting sequence (priority 1), Error Timer (priority 2), Safety demand AOPD (priority 3) or Error Muting lamp (priority 4) have higher priority than transitions to Muting substates (priority 5). If the FB is in the timing error state, the simultaneous occurrence of C006H and C007H lead to the C006H state.

Note 3: Muting condition 1-6 and wrong muting sequences are shown in the following.
   • Muting conditions: ☞ Page 64 Muting conditions
   • Wrong muting sequences: ☞ Page 64 Wrong muting sequences

Note 4: Time parameter error (condition of transition from 8001H to C005H) is detected in either of the following two cases.
   1) i_dDiscTimeEntry has been set to a value less than 0ms or greater than 4 seconds. (0 > i_dDiscTimeEntry OR i_dDiscTimeEntry > 400)
   2) i_dMaxMutingTime has been set to a value less than 0ms or greater than 10min. (0 > i_dMaxMutingTime OR i_dMaxMutingTime > 60000)

Muting conditions

No.	State transition	Condition/action
1	8000H→8011H	MS_11 is the first entry switch actuated: Start timer i_dDiscTimeEntry and i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF
2	8000H→8311H	MS_12 is the first entry switch actuated: Start timer i_dDiscTimeEntry and i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF AND MS_12=OFF→ON
3	8011H→8012H	MS_12 is the second entry switch actuated: Stop timer i_dDiscTimeEntry. i_bMutingEnable=ON AND MS_11=ON AND MS_12=OFF→ON
4	8311H→8012H	MS_11 is the second entry switch actuated: Stop timer i_dDiscTimeEntry. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=ON
5	8000H→8012H	Both entry switches actuated in the same cycle: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF→ON
6	8012H→8000H	Both switches released in same cycle or MS_11 and MS_12 released consecutively: Stop timer i_dMaxMutingTime. MS_11=OFF OR MS_12=OFF

Wrong muting sequences

Status	Wrong muting sequences
8000H	MS_11=OFF→ON AND MS_12=ON AND MS_12=OFF→ON not yet
	MS_12=OFF→ON AND MS_11=ON AND MS_11=OFF→ON not yet
	(MS_11=ON AND MS_11=OFF→ON not yet) AND (MS_12=ON AND MS_12=OFF→ON not yet)
	i_bMutingEnable=OFF AND MS_11=OFF→ON
	i_bMutingEnable=OFF AND MS_12=OFF→ON
8011H	i_bMutingEnable=OFF OR MS_11=OFF
8311H	i_bMutingEnable=OFF OR MS_12=OFF
8012H	None.

Typical timing diagram

■For M+SF_MUTE2_R (i_bS_StartReset=OFF)
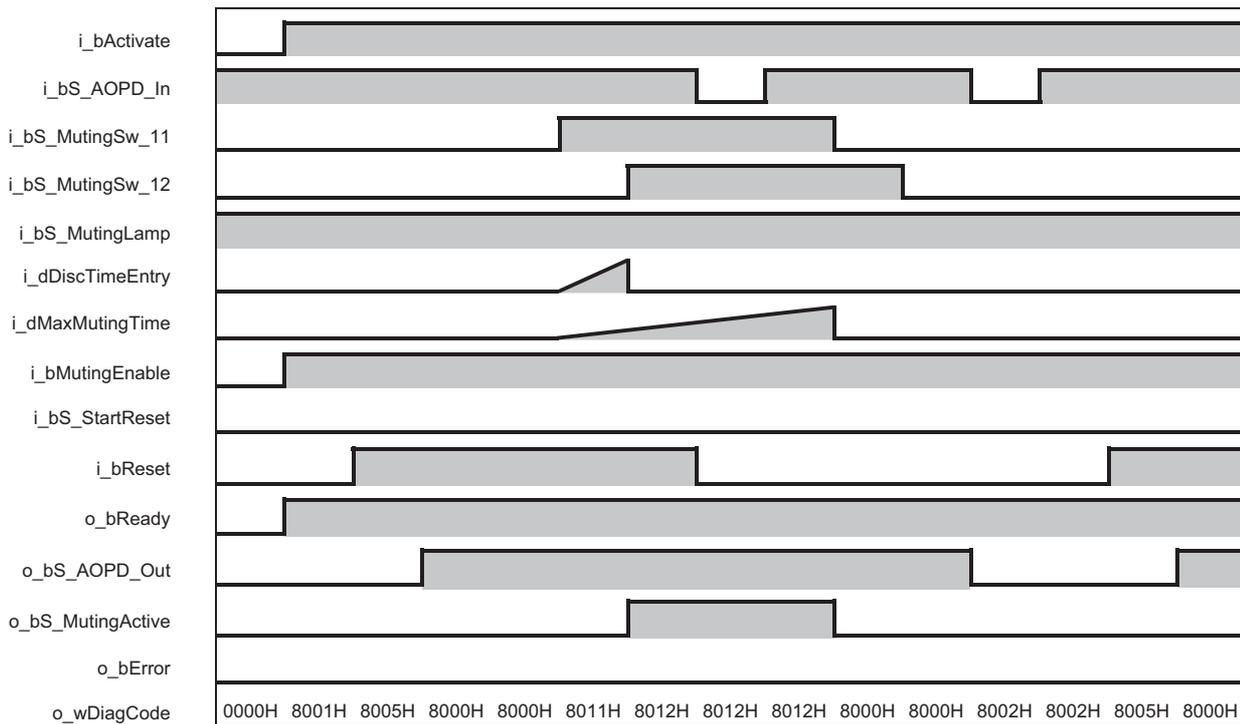
| | 0000H | 8001H | 8005H | 8000H | 8000H | 8011H | 8012H | 8012H | 8012H | 8000H | 8000H | 8002H | 8002H | 8005H | 8000H |

A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dDiscTimeEntry and i_dMaxMutingTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_AOPD_Out	OFF
o_bS_MutingActive	OFF
o_bError	ON

For the corrective actions, see the following.

☞ Page 66 List of error codes

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset condition detected after FB activation in state 8001H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C003H	Error Muting Lamp	Error detected in muting lamp.	Set i_bReset to ON. Check the devices and wiring related to i_bReset.
CYx4H C004H to CF34H	Error Muting Sequence	Error detected in muting sequence in state 8000H, 8011H, or 8311H. (☞ Page 64 Wrong muting sequences) Y = Status in the sequence C0x4H = Error occurred in state 8000H C1x4H = Error occurred in state 8011H C2x4H = Error occurred in state 8311H CFx4H = i_bMutingEnable=OFF The states of wrong muting sequences including i_bMutingEnable=OFF are always changed to CFx4H when i_bMutingEnable is set to OFF. (Never changed to other states.) x = Status of the sensors when error occurred CY04H: Both SW=OFF CY14H: i_bS_MutingSw_11=ON CY24H: i_bS_MutingSw_12=ON CY34H: Both SW=ON	Set both muting switches to OFF and set i_bReset to ON. Check the devices and wiring related to i_bReset.
C005H	Parameter Error	i_dDiscTimeEntry or i_dMaxMutingTime value out of range.	Set a proper value to the parameter and set i_bReset to ON.
C006H	Error Timer MaxMuting	Timing error. Active muting time exceeds i_dMaxMutingTime.	Set both muting switches to OFF and set i_bReset to ON. Check the actual muting status.
C007H	Error Timer MS11_12	Timing error. Discrepancy time for switching i_bS_MutingSw_11 and i_bS_MutingSw_12 > i_dDiscTimeEntry.	
C010H	Reset Error 2	Static i_bReset condition detected in state 8002H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C020H	Reset Error 3	Static i_bReset condition detected in state C003H.	
C030H	Reset Error 4	Static i_bReset condition detected in state CYx4H.	
C040H	Reset Error 5	Static i_bReset condition detected in state C006H.	
C050H	Reset Error 6	Static i_bReset condition detected in state C007H.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	AOPD Free	Muting not active and no safety demand from AOPD. If timers from subsequent muting are still running, they are stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	None. (Starting muting is possible.)
8001H	Init	The FB was activated. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON.
8002H	Safety Demand AOPD	Safety demand detected by AOPD and muting not active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON after the completion of safety demand.
8005H	Safe	The safety function is active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Wait the completion of safety demand.
8011H	Muting Start 1	Muting sequence is in the starting phase after rising trigger of i_bS_MutingSw_11. Monitoring of i_dDiscTimeEntry and i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	Set both muting sensors to ON within i_dDiscTimeEntry. Complete muting within i_dMaxMutingTime.
8311H	Muting Start 2	Muting sequence is in the starting phase after rising trigger of i_bS_MutingSw_12. Monitoring of i_dDiscTimeEntry and i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	
8012H	Muting Active	Muting sequence is active in either of the following cases: • When both i_bS_MutingSw_12 and i_bS_MutingSw_11 have been actuated in serial. • When both i_bS_MutingSw_11 and i_bS_MutingSw_12 have been actuated in the same cycle. Monitoring of i_dDiscTimeEntry is stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
• A failure in safety devices and emergency stop devices
• Wiring and status of a safety remote I/O module and a safety programmable controller
• Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
• Setting of i_bS_StartReset

4.11 M+SF_MUTE2-2_R

Overview

Item	Description
Function name	Muting with 2 sensors 2
Functional overview	Muting is the intended suppression of the safety function. In this FB, parallel muting with two muting sensors is specified. The effective time of the muting control can be set to be unlimited.
Symbol	

```
                        M+SF_MUTE2-2_R
(1) ──── B: i_bActivate              o_bReady: B ──── (11)
(2) ──── B: i_bS_AOPD_In          o_bS_AOPD_Out: B ──── (12)
(3) ──── B: i_bS_MutingSw_11    o_bS_MutingActive: B ──── (13)
(4) ──── B: i_bS_MutingSw_12             o_bError: B ──── (14)
(5) ──── B: i_bS_MutingLamp          o_wDiagCode: W ──── (15)
(6) ──── D: i_dDiscTimeEntry
(7) ──── D: i_dMaxMutingTime
(8) ──── B: i_bMutingEnable
(9) ──── B: i_bS_StartReset
(10) ─── B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_AOPD_In	Bit*	OFF	OSSD (safety output) signal from AOPD (Active opto-electronic protective devices). OFF: Protection field interrupted ON:　Protection field not interrupted
(3)	i_bS_MutingSw_11	Bit*	OFF	Status of muting sensor 11. OFF: Muting sensor 11 is not actuated. ON:　Workpiece actuates muting sensor 11.
(4)	i_bS_MutingSw_12	Bit*	OFF	Status of muting sensor 12. OFF: Muting sensor 12 is not actuated. ON:　Workpiece actuates muting sensor 12.
(5)	i_bS_MutingLamp	Bit*	OFF	Indicates operation of the muting lamp. OFF: Muting lamp failure ON:　Muting lamp no failure
(6)	i_dDiscTimeEntry	Double word [signed]	0	Max. discrepancy time for i_bS_MutingSw_11 and i_bS_MutingSw_12 entering muting gate. Increments of 10ms. Range: Fixed values from 0 to 400 (0 to 4000ms = 4sec)
(7)	i_dMaxMutingTime	Double word [signed]	0	Maximum time to complete muting sequence, timer started when first muting sensor is actuated. Increments of 10ms. ■Range: • 0 to 60000 (0 to 600000ms = 10min) • -1 (Unlimited muting time)* *:　The muting time cannot be set to be unlimited without additional precautions being taken. When i_dMaxMutingTime is set to be unlimited, conduct a risk analysis and take additional measures.
(8)	i_bMutingEnable	Bit	OFF	Command by the control system that enables the start of the muting function when needed by the machine cycle. After the start of the muting function, this signal can be switched OFF. OFF: Muting not enabled ON:　Start of Muting function enabled
(9)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(10)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(11)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(12)	o_bS_AOPD_Out	Bit*	OFF	Safety output, indicates status of the muted guard. OFF: AOPD protection field interrupted and muting not active. ON: AOPD protection field not interrupted or muting active.
(13)	o_bS_MutingActive	Bit*	OFF	Indicates status of muting process. OFF: Muting not active ON: Muting active
(14)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(15)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  - The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  - If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.
- When i_dMaxMutingTime is set to be unlimited, take additional measures to ensure that no one can access the danger zone while the muting is in operation.
- While the muting is active in a long cycle, ensure that muting sensors are functioned properly.
- While the muting is active, do not change the value of i_dMaxMutingTime. When changing the value, turn OFF i_bActivate before changing.
- The muting time cannot be set to be unlimited without additional precautions being taken. When the muting time is set to be unlimited, take additional measures to ensure that no one can access the danger zone while muting is active.
- Ensure that each application conforms to an appropriate risk analysis and risk avoidance strategy.
- Never use the muting function for transporting persons into the hazardous area.

FB details

Muting is the intended suppression of the safety function. This is required, e.g., when transporting a workpiece into the danger zone without causing the machine to stop. Muting is triggered by muting sensors. The use of two muting sensors and correct integration into the production sequence must ensure that no persons enter the danger zone while the light curtain is muted. Muting sensors can be push buttons, proximity switches, photoelectric barriers, limit switches, etc. which do not have to be failsafe. Active muting mode must be indicated by indicator lights (the muting lamp).

There are sequential and parallel muting procedures. In this FB, parallel muting with two muting sensors is used. The positioning of the sensors must conform to IEC 62046 as shown in the figure. The FB can be used in both directions, forward and backward. However, the actual direction cannot be identified. The muting should be enabled with the i_bMutingEnable signal by the process control when there is no manipulation in the danger zone.

The FB input parameters include the signals of the two muting sensors (i_bS_MutingSw_11 and i_bS_MutingSw_12), the OSSD signal (i_bS_AOPD_In) from the "active opto-electronic protective device", as well as two parameterizable times (i_dDiscTimeEntry and i_dMaxMutingTime).

While both of the two muting sensors are ON, muting is active and o_bS_AOPD_Out is set to ON, although i_bS_AOPD_In is OFF.
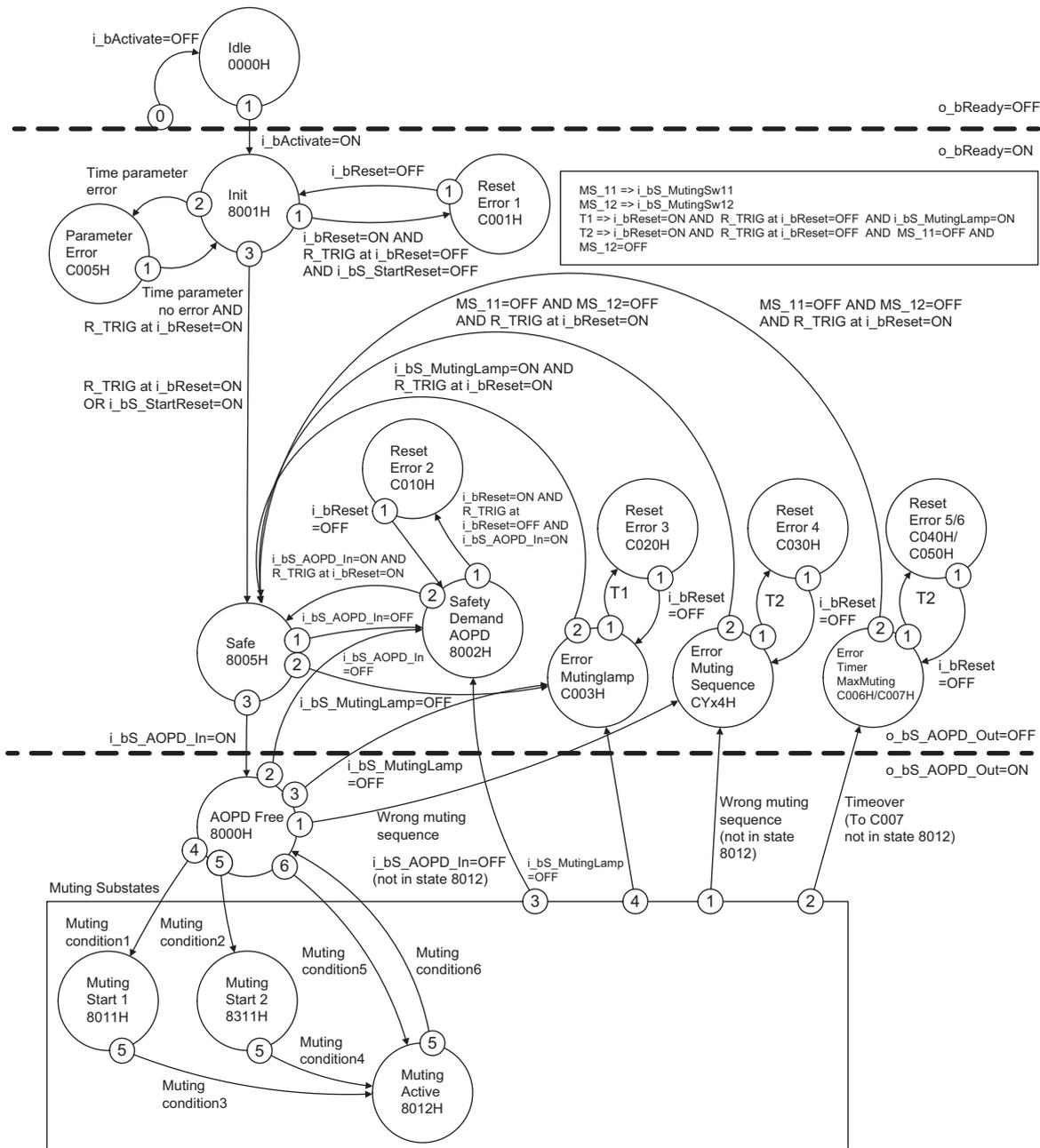
When i_dMaxMutingTime is set to -1, the effective time of the muting control is unlimited.

■Example for M+SF_MUTE2-2_R with two reflecting light barriers

Figure	Description
	If reflection light barriers are used as muting sensors, they are generally arranged diagonally. In general, this arrangement of reflection light barriers as muting sensors requires only two light barriers, and only i_bS_MutingSw_11 (MS_11) and i_bS_MutingSw_12 (MS_12) are allocated.

State diagram

State transition of M+SF_MUTE2-2_R

Note 1: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Note 2: Within muting substates, transitions due to Error Muting sequence (priority 1), Error Timer (priority 2), Safety demand AOPD (priority 3) or Error Muting lamp (priority 4) have higher priority than transitions to Muting substates (priority 5). If the FB is in the timing error state, the simultaneous occurrence of C006H and C007H lead to the C006H state.

Note 3: Muting condition 1-6 and wrong muting sequences are shown in the following.
- Muting conditions: ☞ Page 72 Muting conditions
- Wrong muting sequences: ☞ Page 72 Wrong muting sequences

Note 4: Time parameter error (condition of transition from 8001H to C005H) is detected in either of the following two cases.
1) i_dDiscTimeEntry has been set to a value less than 0ms or greater than 4 seconds. (0 > i_dDiscTimeEntry OR i_dDiscTimeEntry > 400)
2) i_dMaxMutingTime has been set to a value less than 0ms or greater than 10min. (0 > i_dMaxMutingTime OR i_dMaxMutingTime > 60000). Time parameter error is not detected when i_dMaxMutingTime is set to -1.

Note 5: Timeover (transition from within muting substate to C006H) is not detected in the following situation:
- i_dMaxMutingTime is set to -1.

Muting conditions

No.	State transition	Condition/action
1	8000H→8011H	MS_11 is the first entry switch actuated: Start timer i_dDiscTimeEntry and i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF
2	8000H→8311H	MS_12 is the first entry switch actuated: Start timer i_dDiscTimeEntry and i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF AND MS_12=OFF→ON
3	8011H→8012H	MS_12 is the second entry switch actuated: Stop timer i_dDiscTimeEntry. i_bMutingEnable=ON AND MS_11=ON AND MS_12=OFF→ON
4	8311H→8012H	MS_11 is the second entry switch actuated: Stop timer i_dDiscTimeEntry. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=ON
5	8000H→8012H	Both entry switches actuated in the same cycle: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF→ON
6	8012H→8000H	Both switches released in same cycle or MS_11 and MS_12 released consecutively: Stop timer i_dMaxMutingTime. MS_11=OFF OR MS_12=OFF

Wrong muting sequences

Status	Wrong muting sequences
8000H	MS_11=OFF→ON AND MS_12=ON AND MS_12=OFF→ON not yet
	MS_12=OFF→ON AND MS_11=ON AND MS_11=OFF→ON not yet
	(MS_11=ON AND MS_11=OFF→ON not yet) AND (MS_12=ON AND MS_12=OFF→ON not yet)
	i_bMutingEnable=OFF AND MS_11=OFF→ON
	i_bMutingEnable=OFF AND MS_12=OFF→ON
8011H	i_bMutingEnable=OFF OR MS_11=OFF
8311H	i_bMutingEnable=OFF OR MS_12=OFF
8012H	None.

Typical timing diagram

■For M+SF_MUTE2-2_R (i_bS_StartReset=OFF)
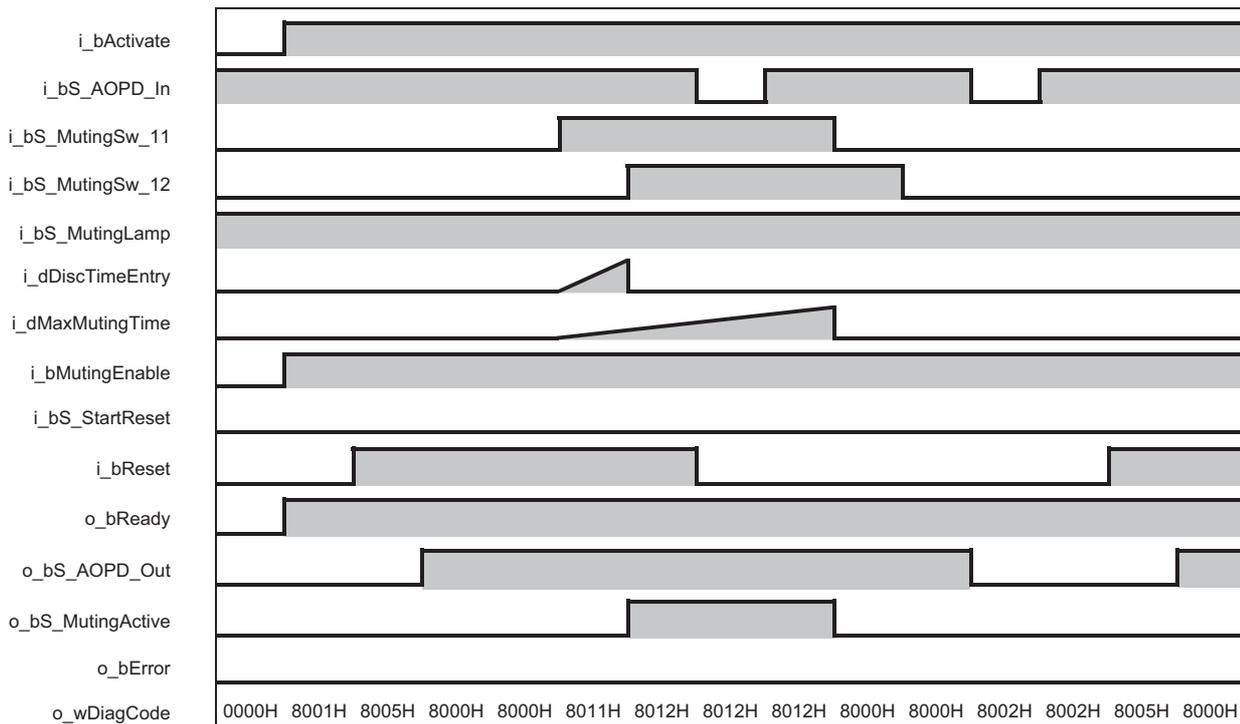
A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dDiscTimeEntry and i_dMaxMutingTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_AOPD_Out	OFF
o_bS_MutingActive	OFF
o_bError	ON

For the corrective actions, see the following.

☞ Page 74 List of error codes

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset condition detected after FB activation in state 8001H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C003H	Error Muting Lamp	Error detected in muting lamp.	Set i_bReset to ON. Check the devices and wiring related to i_bReset.
CYx4H C004H to CF34H	Error Muting Sequence	Error detected in muting sequence in state 8000H, 8011H, or 8311H. (☞ Page 72 Wrong muting sequences) Y = Status in the sequence C0x4H = Error occurred in state 8000H C1x4H = Error occurred in state 8011H C2x4H = Error occurred in state 8311H CFx4H = i_bMutingEnable=OFF The states of wrong muting sequences including i_bMutingEnable=OFF are always changed to CFx4H when i_bMutingEnable is set to OFF. (Never changed to other states.) x = Status of the sensors when error occurred CY04H: Both SW=OFF CY14H: i_bS_MutingSw_11=ON CY24H: i_bS_MutingSw_12=ON CY34H: Both SW=ON	Set both muting switches to OFF and set i_bReset to ON. Check the devices and wiring related to i_bReset.
C005H	Parameter Error	i_dDiscTimeEntry or i_dMaxMutingTime value out of range.	Set a proper value to the parameter and set i_bReset to ON.
C006H	Error Timer MaxMuting	Timing error. Active muting time exceeds i_dMaxMutingTime.	Set both muting switches to OFF and set i_bReset to ON. Check the actual muting status.
C007H	Error Timer MS11_12	Timing error. Discrepancy time for switching i_bS_MutingSw_11 and i_bS_MutingSw_12 > i_dDiscTimeEntry.	
C010H	Reset Error 2	Static i_bReset condition detected in state 8002H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C020H	Reset Error 3	Static i_bReset condition detected in state C003H.	
C030H	Reset Error 4	Static i_bReset condition detected in state CYx4H.	
C040H	Reset Error 5	Static i_bReset condition detected in state C006H.	
C050H	Reset Error 6	Static i_bReset condition detected in state C007H.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	AOPD Free	Muting not active and no safety demand from AOPD. If timers from subsequent muting are still running, they are stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	None. (Starting muting is possible.)
8001H	Init	The FB was activated. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON.
8002H	Safety Demand AOPD	Safety demand detected by AOPD and muting not active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON after the completion of safety demand.
8005H	Safe	The safety function is active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Wait the completion of safety demand.
8011H	Muting Start 1	Muting sequence is in the starting phase after rising trigger of i_bS_MutingSw_11. Monitoring of i_dDiscTimeEntry and i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	Set both muting sensors to ON within i_dDiscTimeEntry. Complete muting within i_dMaxMutingTime.
8311H	Muting Start 2	Muting sequence is in the starting phase after rising trigger of i_bS_MutingSw_12. Monitoring of i_dDiscTimeEntry and i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	
8012H	Muting Active	Muting sequence is active in either of the following cases: • When both i_bS_MutingSw_12 and i_bS_MutingSw_11 have been actuated in serial. • When both i_bS_MutingSw_11 and i_bS_MutingSw_12 have been actuated in the same cycle. Monitoring of i_dDiscTimeEntry is stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
 • Setting of i_bS_StartReset

4.12 M+SF_MUTEP_R

Overview

Item	Description
Function name	Parallel muting
Functional overview	Muting is the intended suppression of the safety function. In this FB, parallel muting with four muting sensors is specified.
Symbol	

```
                          M+SF_MUTEP_R
(1) ──────  B: i_bActivate              o_bReady: B ──── (14)
(2) ──────  B: i_bS_AOPD_In          o_bS_AOPD_Out: B ──── (15)
(3) ──────  B: i_bMutingSw_11      o_bS_MutingActive: B ──── (16)
(4) ──────  B: i_bMutingSw_12              o_bError: B ──── (17)
(5) ──────  B: i_bMutingSw_21           o_wDiagCode: W ──── (18)
(6) ──────  B: i_bMutingSw_22
(7) ──────  B: i_bS_MutingLamp
(8) ──────  D: i_dDiscTime11_12
(9) ──────  D: i_dDiscTime21_22
(10) ─────  D: i_dMaxMutingTime
(11) ─────  B: i_bMutingEnable
(12) ─────  B: i_bS_StartReset
(13) ─────  B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_AOPD_In	Bit*	OFF	OSSD (safety output) signal from AOPD (Active opto-electronic protective devices). OFF: Protection field interrupted ON: Protection field not interrupted
(3)	i_bMutingSw_11	Bit	OFF	Status of muting sensor 11. OFF: Muting sensor 11 is not actuated. ON: Workpiece actuates muting sensor 11.
(4)	i_bMutingSw_12	Bit	OFF	Status of muting sensor 12. OFF: Muting sensor 12 is not actuated. ON: Workpiece actuates muting sensor 12.
(5)	i_bMutingSw_21	Bit	OFF	Status of muting sensor 21. OFF: Muting sensor 21 is not actuated. ON: Workpiece actuates muting sensor 21.
(6)	i_bMutingSw_22	Bit	OFF	Status of muting sensor 22. OFF: Muting sensor 22 is not actuated. ON: Workpiece actuates muting sensor 22.
(7)	i_bS_MutingLamp	Bit*	OFF	Indicates operation of the muting lamp. OFF: Muting lamp failure ON: Muting lamp no failure
(8)	i_dDiscTime11_12	Double word [signed]	0	Max. discrepancy time for i_bMutingSw_11 and i_bMutingSw_12 entering muting gate. Increments of 10ms. Range: Fixed values from 0 to 400 (0 to 4000ms = 4sec)
(9)	i_dDiscTime21_22	Double word [signed]	0	Max. discrepancy time for i_bMutingSw_21 and i_bMutingSw_22 entering muting gate. Increments of 10ms. Range: Fixed values from 0 to 400 (0 to 4000ms = 4sec)
(10)	i_dMaxMutingTime	Double word [signed]	0	Maximum time to complete muting sequence, timer started when first muting sensor is actuated. Increments of 10ms. Range: Fixed values from 0 to 60000 (0 to 600000ms = 10min)
(11)	i_bMutingEnable	Bit	OFF	Command by the control system that enables the start of the muting function when needed by the machine cycle. After the start of the muting function, this signal can be switched OFF. OFF: Muting not enabled ON: Start of Muting function enabled.
(12)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(13)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(14)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(15)	o_bS_AOPD_Out	Bit*	OFF	Safety output, indicates status of the muted guard. OFF: AOPD protection field interrupted and muting not active. ON: AOPD protection field not interrupted or muting active.
(16)	o_bS_MutingActive	Bit*	OFF	Indicates status of muting process. OFF: Muting not active ON: Muting active
(17)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(18)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

4

⚠ **WARNING**

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- Safe input must be connected to i_bMutingSw_11/12/21/22 depending on the safety requirements. Input appropriate signals depending on the safety requirements of the application.
- A short circuit in the muting sensor signals or a functional application error to supply these signals are not detected by this FB but interpreted as incorrect muting sequence. However, this condition should not lead to unwanted muting. The user should take care to include this in his risk analysis.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
   · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
   · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.
- While the muting is active, do not change the value of i_dMaxMutingTime. When changing the value, turn OFF i_bActivate before changing.
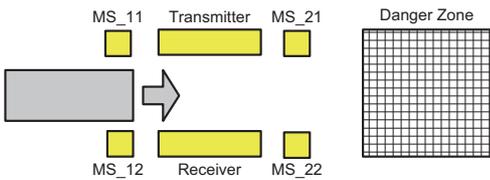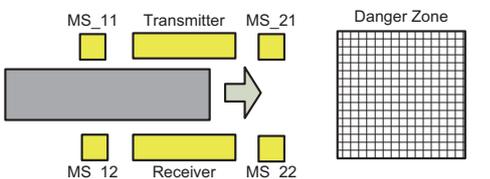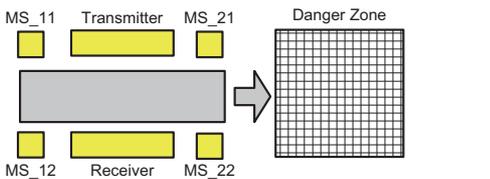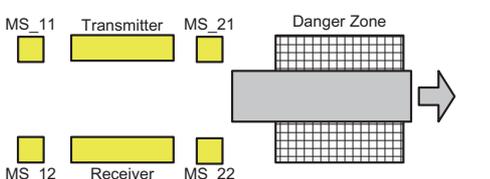
FB details

Muting is the intended suppression of the safety function. This is required, e.g., when transporting a workpiece into the danger zone without causing the machine to stop. Muting is triggered by muting sensors. The use of two or four muting sensors and correct integration into the production sequence must ensure that no persons enter the danger zone while the light curtain is muted. Muting sensors can be proximity switches, photoelectric barriers, limit switches, etc. which do not have to be failsafe. Active muting mode must be indicated by indicator lights (the muting lamp).

There are sequential and parallel muting procedures. In this FB, parallel muting with four muting sensors is used. The FB can be used in both directions, forward and backward. The muting should be enabled with the i_bMutingEnable signal by the process control when there is no manipulation in the danger zone.
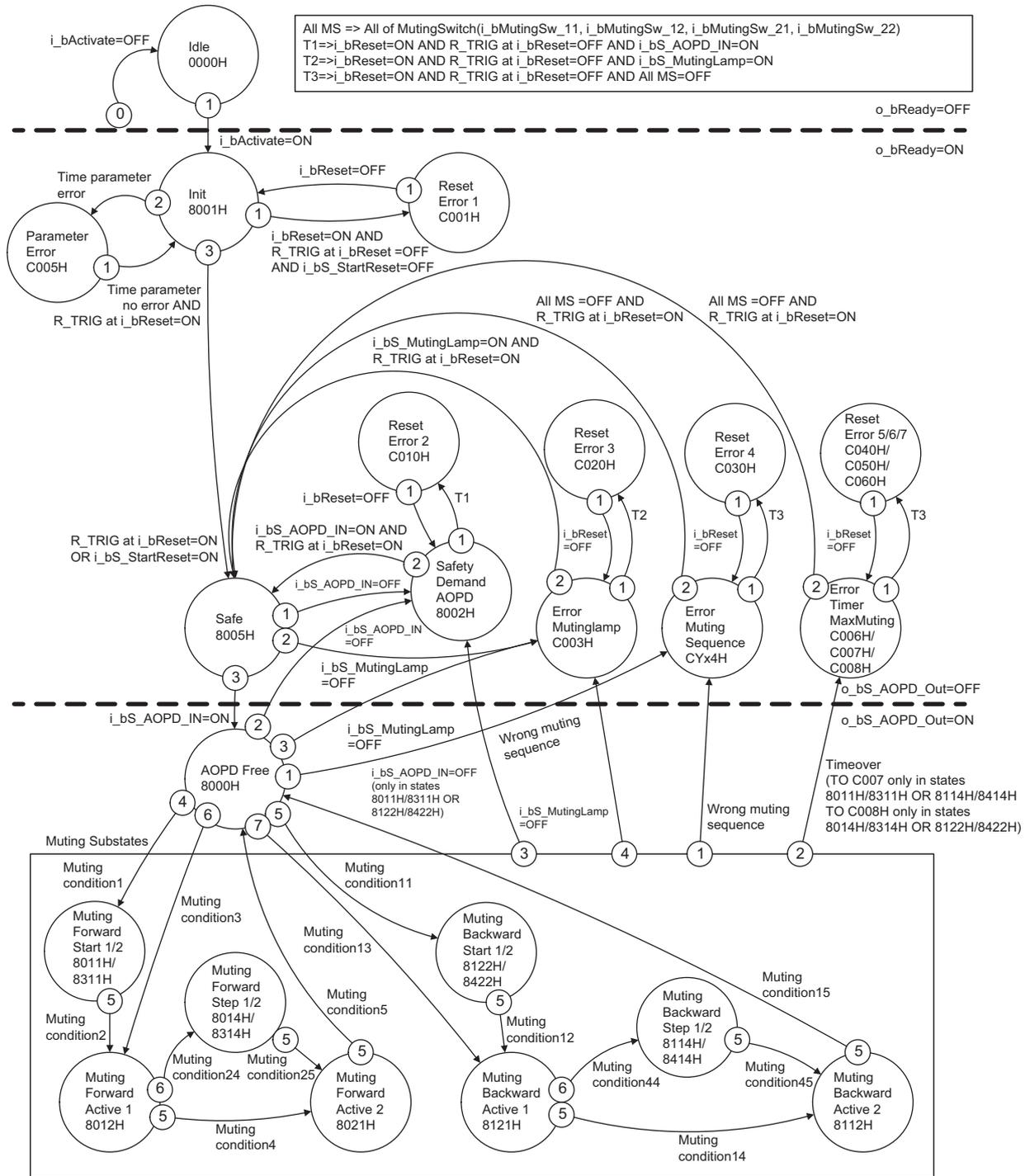
The FB input parameters include the signals of the four muting sensors (i_bMutingSw_11 to i_bMutingSw_22), the OSSD signal (i_bS_AOPD_In) from the "active opto-electronic protective device", as well as three parameterizable times (i_dDiscTime11_12, i_dDiscTime21_22, and i_dMaxMutingTime). For forward direction, from when both i_bMutingSw_11 and i_bMutingSw_12 turn ON to when i_bMutingSw_21 or i_bMutingSw_22 turns OFF after both of them turn ON, muting is active (i_bS_AOPD_In=OFF is ignored and o_bS_AOPD_Out turns ON). For backward direction, from when both i_bMutingSw_21 and i_bMutingSw_22 turn ON to when i_bMutingSw_11 or i_bMutingSw_12 turns OFF after both of them turn ON, muting is active.

■Example for M+SF_MUTEP_R in forward direction with four sensors

Figure	Description
	If the muting sensors i_bMutingSw_11 (MS_11) and i_bMutingSw_12 (MS_12) are activated by passage of a workpiece within the time set in i_dDiscTime11_12, muting mode is activated. (o_bS_MutingActive=ON)
	Muting mode remains active as long as MS_11 and MS_12 are activated by a workpiece. The workpiece may pass through the light curtain without causing a machine stop.
	Before muting sensors MS_11 and MS_12 are disabled, muting sensors i_bMutingSw_21 (MS_21) and i_bMutingSw_22 (MS_22) must be activated. This ensures that muting mode remains active. The time discrepancy between switching of MS_21 and MS_22 is monitored by the time i_dDiscTime21_22.
	Muting mode is terminated if either muting sensor MS_21 or MS_22 is disabled by the workpiece. The maximum time for muting mode to be active is the i_dMaxMutingTime.

State diagram

State transition of M+SF_MUTEP_R

All MS => All of MutingSwitch(i_bMutingSw_11, i_bMutingSw_12, i_bMutingSw_21, i_bMutingSw_22)
T1=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND i_bS_AOPD_IN=ON
T2=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND i_bS_MutingLamp=ON
T3=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND All MS=OFF

i_bActivate=OFF

Idle
0000H

o_bReady=OFF

o_bReady=ON

i_bActivate=ON

Time parameter error

Init
8001H

i_bReset=OFF

Reset Error 1
C001H

Parameter Error
C005H

i_bReset=ON AND R_TRIG at i_bReset =OFF AND i_bS_StartReset=OFF

Time parameter no error AND R_TRIG at i_bReset=ON

All MS =OFF AND R_TRIG at i_bReset=ON

All MS =OFF AND R_TRIG at i_bReset=ON

i_bS_MutingLamp=ON AND R_TRIG at i_bReset=ON

Reset Error 2
C010H

Reset Error 3
C020H

Reset Error 4
C030H

Reset Error 5/6/7
C040H/ C050H/ C060H

i_bReset=OFF

T1

T2

T3

T3

i_bS_AOPD_IN=ON AND R_TRIG at i_bReset=ON

Safety Demand AOPD
8002H

i_bReset =OFF

i_bReset =OFF

i_bReset =OFF

R_TRIG at i_bReset=ON OR i_bS_StartReset=ON

i_bS_AOPD_IN=OFF

Error Mutinglamp
C003H

Error Muting Sequence
CYx4H

Error Timer MaxMuting
C006H/ C007H/ C008H

Safe
8005H

i_bS_AOPD_IN =OFF

i_bS_MutingLamp =OFF

o_bS_AOPD_Out=OFF

o_bS_AOPD_Out=ON

i_bS_AOPD_IN=ON

i_bS_MutingLamp =OFF

Wrong muting sequence

AOPD Free
8000H

i_bS_AOPD_IN=OFF (only in states 8011H/8311H OR 8122H/8422H)

i_bS_MutingLamp =OFF

Wrong muting sequence

Timeover (TO C007 only in states 8011H/8311H OR 8114H/8414H TO C008H only in states 8014H/8314H OR 8122H/8422H)

Muting Substates

Muting condition1

Muting condition11

Muting Forward Start 1/2
8011H/ 8311H

Muting condition3

Muting condition13

Muting Backward Start 1/2
8122H/ 8422H

Muting condition2

Muting Forward Step 1/2
8014H/ 8314H

Muting condition5

Muting condition12

Muting condition15

Muting Backward Step 1/2
8114H/ 8414H

Muting Forward Active 1
8012H

Muting condition24

Muting condition25

Muting Forward Active 2
8021H

Muting Backward Active 1
8121H

Muting condition44

Muting condition45

Muting Backward Active 2
8112H

Muting condition4

Muting condition14

Note 1: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Note 2: Within muting substates, transitions due to Error Muting sequence (priority 1), Error Timer (priority 2), Safety demand AOPD (priority 3), or Error Muting lamp (priority 4) have higher priority than transitions to Muting substates (priority 5 or 6).
If the FB is in the timing error state, the simultaneous occurrence of C006H and C007H or C006H and C008H leads to C006H.

Note 3: Muting condition 1-6 and wrong muting sequences are shown in the following.
• Muting conditions: ☞ Page 81 Muting conditions (forward direction), ☞ Page 82 Muting conditions (backward direction)
• Wrong muting sequences: ☞ Page 83 Wrong muting sequences

Note 4: Time parameter error (condition of transition from 8001H to C005H) is detected in one of the following three cases.
1) i_dDiscTime11_12 has been set to a value less than 0ms or greater than 4 seconds. (0 > i_dDiscTime11_12 OR i_dDiscTime11_12 > 400)
2) i_dDiscTime21_22 has been set to a value less than 0ms or greater than 4 seconds. (0 > i_dDiscTime21_22 OR i_dDiscTime21_22 > 400)
3) i_dMaxMutingTime has been set to a value less than 0ms or greater than 10min. (0 > i_dMaxMutingTime OR i_dMaxMutingTime > 60000)

Muting conditions (forward direction)

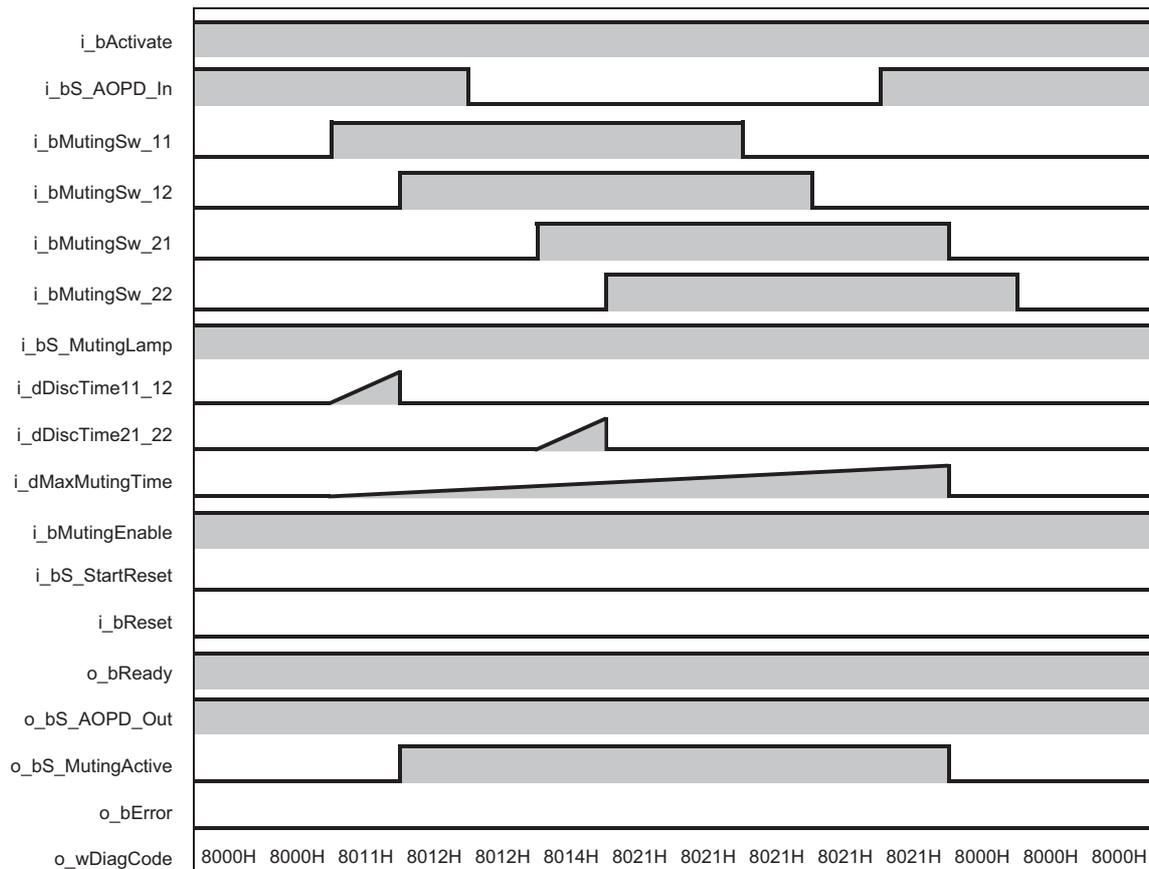| No.	State transition	Condition/action
1	8000H→8011H	MS_11 is the first entry switch actuated: Start timers i_dMaxMutingTime and i_dDiscTime11_12. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF
	8000H→8311H	MS_12 is the first entry switch actuated: Start timers i_dMaxMutingTime and i_dDiscTime11_12. i_bMutingEnable=ON AND MS_11=OFF AND MS_12=OFF→ON AND MS_21=OFF AND MS_22=OFF
2	8011H→8012H	MS_12 is the second entry switch actuated: Stop timer i_dDiscTime11_12. i_bMutingEnable=ON AND MS_11=ON AND MS_12=OFF→ON AND MS_21=OFF AND MS_22=OFF
	8311H→8012H	MS_11 is the second entry switch actuated: Stop timer i_dDiscTime11_12. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=ON AND MS_21=OFF AND MS_22=OFF
3	8000H→8012H	Both entry switches actuated in the same cycle: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF→ON AND MS_21=OFF AND MS_22=OFF
4	8012H→8021H	All switches actuated: MS_11=ON AND MS_12=ON AND MS_21=ON AND MS_22=ON
24	8012H→8014H	MS_21 is the first exit switch actuated: Start timer i_dDiscTime21_22. MS_11=ON AND MS_12=ON AND MS_21=OFF→ON AND MS_22=OFF
	8012H→8314H	MS_22 is the first exit switch actuated: Start timer i_dDiscTime21_22. MS_11=ON AND MS_12=ON AND MS_21=OFF AND MS_22=OFF→ON
25	8014H→8021H	MS_22 is the second exit switch actuated: Stop timer i_dDiscTime21_22. MS_11=ON AND MS_12=ON AND MS_21=ON AND MS_22=OFF→ON
	8314H→8021H	MS_21 is the second exit switch actuated: Stop timer i_dDiscTime21_22. MS_11=ON AND MS_12=ON AND MS_21=OFF→ON AND MS_22=ON
5	8021H→8000H	One of the exit switches released: Stop timer i_dMaxMutingTime. MS_11=OFF AND MS_12=OFF AND (MS_21=ON→OFF OR MS_22=ON→OFF)

4

Muting conditions (backward direction)

No.	State transition	Condition/action
11	8000H→8122H	MS_21 is the first entry switch actuated: Start timers i_dMaxMutingTime and i_dDiscTime21_22. i_bMutingEnable=ON AND MS_21=OFF→ON AND MS_22=OFF AND MS_11=OFF AND MS_12=OFF
	8000H→8422H	MS_22 is the first entry switch actuated: Start timers i_dMaxMutingTime and i_dDiscTime21_22. i_bMutingEnable=ON AND MS_21=OFF AND MS_22=OFF→ON AND MS_11=OFF AND MS_12=OFF
12	8122H→8121H	MS_22 is the second entry switch actuated: Stop timer i_dDiscTime21_22. i_bMutingEnable=ON AND MS_21=ON AND MS_22=OFF→ON AND MS_11=OFF AND MS_12=OFF
	8422H→8121H	MS_21 is the second entry switch actuated: Stop timer i_dDiscTime21_22. i_bMutingEnable=ON AND MS_21=OFF→ON AND MS_22=ON AND MS_11=OFF AND MS_12=OFF
13	8000H→8121H	Both entry switches actuated in the same cycle: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_21=OFF→ON AND MS_22=OFF→ON AND MS_11=OFF AND MS_12=OFF
14	8121H→8112H	All switches actuated: MS_21=ON AND MS_22=ON AND MS_11=ON AND MS_12=ON
44	8121H→8114H	MS_11 is the first exit switch actuated: Start timer i_dDiscTime11_12. MS_21=ON AND MS_22=ON AND MS_11=OFF→ON AND MS_12=OFF
	8121H→8414H	MS_12 is the first exit switch actuated: Start timer i_dDiscTime11_12. MS_21=ON AND MS_22=ON AND MS_11=OFF AND MS_12=OFF→ON
45	8114H→8112H	MS_12 is the second exit switch actuated: Stop timer i_dDiscTime11_12. MS_21=ON AND MS_22=ON AND MS_11=ON AND MS_12=OFF→ON
	8414H→8112H	MS_11 is the second exit switch actuated: Stop timer i_dDiscTime11_12. MS_21=ON AND MS_22=ON AND MS_11=OFF→ON AND MS_12=ON
15	8112H→8000H	One of the exit switches released: Stop timer i_dMaxMutingTime. MS_21=OFF AND MS_22=OFF AND (MS_11=ON→OFF OR MS_12=ON→OFF)

Wrong muting sequences

Status	Wrong muting sequences
8000H	When muting sequence starts, i_bMutingEnable=OFF
	(MS_11=ON OR MS_12=ON) AND (MS_21=ON OR MS_22=ON)
	MS_11=OFF→ON AND MS_12=ON AND undetected MS_12=OFF→ON
	MS_12=OFF→ON AND MS_11=ON AND undetected MS_11=OFF→ON
	MS_21=OFF→ON AND MS_22=ON AND undetected MS_22=OFF→ON
	MS_22=OFF→ON AND MS_21=ON AND undetected MS_21=OFF→ON
	(MS_11=ON AND undetected MS_11=OFF→ON) AND (MS_12=ON AND undetected MS_12=OFF→ON)
	(MS_21=ON AND undetected MS_21=OFF→ON) AND (MS_22=ON AND undetected MS_22=OFF→ON)
8011H	i_bMutingEnable=OFF OR MS_11=OFF OR MS_21=ON OR MS_22=ON
8311H	i_bMutingEnable=OFF OR MS_12=OFF OR MS_21=ON OR MS_22=ON
8012H	MS_11=OFF OR MS_12=OFF
8021H	MS_11=OFF→ON OR MS_12=OFF→ON
	(MS_11=ON OR MS_12=ON) AND (MS_21=ON→OFF OR MS_22=ON→OFF)
	(MS_11=ON→OFF OR MS_12=ON→OFF) AND (MS_21=ON→OFF OR MS_22=ON→OFF)
8014H	MS_11=OFF OR MS_12=OFF OR MS_21=OFF
8314H	MS_11=OFF OR MS_12=OFF OR MS_22=OFF
8122H	i_bMutingEnable=OFF OR MS_11=ON OR MS_12=ON OR MS_21=OFF
8422H	i_bMutingEnable=OFF OR MS_11=ON OR MS_12=ON OR MS_22=OFF
8121H	MS_21=OFF OR MS_22=OFF
8112H	MS_21=OFF→ON OR MS_22=OFF→ON
	(MS_21=ON OR MS_22=ON) AND (MS_11=ON→OFF OR MS_12=ON→OFF)
	(MS_11=ON→OFF OR MS_12=ON→OFF) AND (MS_21=ON→OFF OR MS_22=ON→OFF)
8114H	MS_21=OFF OR MS_22=OFF OR MS_11=OFF
8414H	MS_21=OFF OR MS_22=OFF OR MS_12=OFF

Typical timing diagram

■For M+SF_MUTEP_R (i_bS_StartReset=OFF, forward direction)

o_wDiagCode	8000H	8000H	8011H	8012H	8012H	8014H	8021H	8021H	8021H	8021H	8021H	8000H	8000H	8000H

A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dDiscTime11_12, i_dDiscTime21_22, and i_dMaxMutingTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_AOPD_Out	OFF
o_bS_MutingActive	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset condition detected after FB activation in state 8001H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C003H	Error Muting Lamp	Error detected in muting lamp.	Set i_bReset to ON. Check the devices and wiring related to i_bReset.
CYx4H C004H to CFF4H	Error Muting Sequence	Error detected in muting sequence in state 8000H, 8011H, 8311H, 8012H, 8021H, 8014H, 8314H, 8122H, 8422H, 8121H, 8112H, 8114H, or 8414H. Y = Status in the sequence (6 states for forward and 6 states for backward direction). C0x4H = Error occurred in state 8000H C1x4H = Error occurred in state Forward 8011H C2x4H = Error occurred in state Forward 8311H C3x4H = Error occurred in state Forward 8012H C4x4H = Error occurred in state Forward 8014H C5x4H = Error occurred in state Forward 8314H C6x4H = Error occurred in state Forward 8021H C7x4H = Error occurred in state Backward 8122H C8x4H = Error occurred in state Backward 8422H C9x4H = Error occurred in state Backward 8121H Cax4H = Error occurred in state Backward 8114H Cbx4H = Error occurred in state Backward 8414H Ccx4H = Error occurred in state Backward 8112H CFx4H = i_bMutingEnable=OFF The states of wrong muting sequences (☞ Page 83 Wrong muting sequences) including i_bMutingEnable=OFF are always changed to CFx4H when i_bMutingEnable is set to OFF. (Never changed to other states.) x = Status of the sensors when error occurred (MS_11, MS_12, MS_21, MS_22 in order) CY04H=OFF, OFF, OFF, OFF CY14H=ON, OFF, OFF, OFF CY24H=OFF, ON, OFF, OFF CY34H=ON, ON, OFF, OFF CY44H=OFF, OFF, ON, OFF CY54H=ON, OFF, ON, OFF CY64H=OFF, ON, ON, OFF CY74H=ON, ON, ON, OFF CY84H=OFF, OFF, OFF, ON CY94H=ON, OFF, OFF, ON CYA4H=OFF, ON, OFF, ON CYB4H=ON, ON, OFF, ON CYC4H=OFF, OFF, ON, ON CYD4H=ON, OFF, ON, ON CYE4H=OFF, ON, ON, ON CYF4H=ON, ON, ON, ON	Set all muting switches to OFF and set i_bReset to ON. Check the devices and wiring related to i_bReset.
C005H	Parameter Error	i_dDiscTime11_12, i_dDiscTime21_22 or i_dMaxMutingTime value out of range.	Set all values of i_dDiscTime11_12, i_dDiscTime21_22, and i_dMaxMutingTime within the setting range, and set i_bReset to ON.
C006H	Error Timer MaxMuting	Timing error. Active muting time exceeds i_dMaxMutingTime.	Set all muting switches to OFF and set i_bReset to ON. Check the muting situation in the process.
C007H	Error Timer MS11_12	Timing error. Discrepancy time for switching i_bMutingSw_11 and i_bMutingSw_12 > i_dDiscTime11_12.	
C008H	Error Timer MS21_22	Timing error. Discrepancy time for switching i_bMutingSw_21 and i_bMutingSw_22 > i_dDiscTime21_22.	

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C010H	Reset Error 2	Static i_bReset condition detected after FB activation in state 8002H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C020H	Reset Error 3	Static i_bReset condition detected after FB activation in state C003H.	
C030H	Reset Error 4	Static i_bReset condition detected after FB activation in state CYx4H.	
C040H	Reset Error 5	Static i_bReset condition detected after FB activation in state C006H.	
C050H	Reset Error 6	Static i_bReset condition detected after FB activation in state C007H.	
C060H	Reset Error 7	Static i_bReset condition detected after FB activation in state C008H.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	AOPD Free	Muting not active and no safety demand from AOPD. If timers from subsequent muting are still running, they are stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	None. (Starting muting is possible.)
8001H	Init	The FB was activated. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON.
8002H	Safety Demand AOPD	Safety demand detected by AOPD and muting not active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON after the completion of safety demand.
8005H	Safe	The safety function is active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Wait the completion of safety demand.
8011H	Muting Forward Start 1	Muting forward sequence is in starting phase after rising trigger of i_bMutingSw_11. Monitoring of i_dDiscTime11_12 is activated. Monitoring of i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	Set both muting switches (i_bMutingSw_11 and i_bMutingSw_12) to ON. Complete muting within i_dMaxMutingTime.
8311H	Muting Forward Start 2	Muting forward sequence is in starting phase after rising trigger of i_bMutingSw_12. Monitoring of i_dDiscTime11_12 is activated. Monitoring of i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
8012H	Muting Forward Active 1	Muting forward sequence is active when both i_bMutingSw_11 and i_bMutingSw_12 have been actuated in the same cycle or in serial. Monitoring of i_dDiscTime11_12 is stopped. Monitoring of i_dMaxMutingTime is activated, when transition came directly from state 8000H. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.
8014H	Muting Forward Step 1	Muting forward sequence is active. i_bMutingSw_21 is the first exit switch actuated. Monitoring of i_dDiscTime21_22 is started. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Set both muting switches (i_bMutingSw_21 and i_bMutingSw_22) to ON. Complete muting within i_dMaxMutingTime.
8314H	Muting Forward Step 2	Muting forward sequence is active. i_bMutingSw_22 is the first exit switch actuated. Monitoring of i_dDiscTime21_22 is started. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	
8021H	Muting Forward Active 2	Muting forward sequence is still active. Both i_bMutingSw_21 and i_bMutingSw_22 are actuated and the monitoring of i_dDiscTime21_22 is stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.
8122H	Muting Backward Start 1	Muting backward sequence is in starting phase after rising trigger of i_bMutingSw_21. Monitoring of i_dDiscTime21_22 is activated. Monitoring of i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	Set both muting switches (i_bMutingSw_21 and i_bMutingSw_22) to ON. Complete muting within i_dMaxMutingTime.
8422H	Muting Backward Start 2	Muting backward sequence is in starting phase after rising trigger of i_bMutingSw_22. Monitoring of i_dDiscTime21_22 is activated. Monitoring of i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	
8121H	Muting Backward Active 1	Muting backward sequence is active when both i_bMutingSw_21 and i_bMutingSw_22 have been actuated in the same cycle or in serial. Monitoring of i_dDiscTime21_22 is stopped. Monitoring of i_dMaxMutingTime is activated, when transition came directly from state 8000H. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.
8114H	Muting Backward Step 1	Muting backward sequence is active. i_bMutingSw_11 is the first exit switch actuated. Monitoring of i_dDiscTime11_12 is started. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Set both muting switches (i_bMutingSw_11 and i_bMutingSw_12) to ON. Complete muting within i_dMaxMutingTime.
8414H	Muting Backward Step 2	Muting backward sequence is active. i_bMutingSw_12 is the first exit switch actuated. Monitoring of i_dDiscTime11_12 is started. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	

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o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
8112H	Muting Backward Active 2	Muting backward sequence is still active. Both exit switches i_bMutingSw_11 and i_bMutingSw_12 are actuated and the monitoring of i_dDiscTime11_12 is stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.

⚠ **WARNING**

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
 • Setting of i_bS_StartReset

4.13　M+SF_MUTEP-2_R

Overview

Item	Description
Function name	Parallel muting 2
Functional overview	Muting is the intended suppression of the safety function. In this FB, parallel muting with four muting sensors is specified. The effective time of the muting control can be set to be unlimited.
Symbol	

```
                    M+SF_MUTEP-2_R
(1) ———  B: i_bActivate          o_bReady: B  ——— (14)
(2) ———  B: i_bS_AOPD_In      o_bS_AOPD_Out: B  ——— (15)
(3) ———  B: i_bMutingSw_11  o_bS_MutingActive: B  ——— (16)
(4) ———  B: i_bMutingSw_12          o_bError: B  ——— (17)
(5) ———  B: i_bMutingSw_21       o_wDiagCode: W  ——— (18)
(6) ———  B: i_bMutingSw_22
(7) ———  B: i_bS_MutingLamp
(8) ———  D: i_dDiscTime11_12
(9) ———  D: i_dDiscTime21_22
(10) ——  D: i_dMaxMutingTime
(11) ——  B: i_bMutingEnable
(12) ——  B: i_bS_StartReset
(13) ——  B: i_bReset
```

4

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_AOPD_In	Bit*	OFF	OSSD (safety output) signal from AOPD (Active opto-electronic protective devices). OFF: Protection field interrupted ON: Protection field not interrupted
(3)	i_bMutingSw_11	Bit	OFF	Status of muting sensor 11. OFF: Muting sensor 11 is not actuated. ON: Workpiece actuates muting sensor 11.
(4)	i_bMutingSw_12	Bit	OFF	Status of muting sensor 12. OFF: Muting sensor 12 is not actuated. ON: Workpiece actuates muting sensor 12.
(5)	i_bMutingSw_21	Bit	OFF	Status of muting sensor 21. OFF: Muting sensor 21 is not actuated. ON: Workpiece actuates muting sensor 21.
(6)	i_bMutingSw_22	Bit	OFF	Status of muting sensor 22. OFF: Muting sensor 22 is not actuated. ON: Workpiece actuates muting sensor 22.
(7)	i_bS_MutingLamp	Bit*	OFF	Indicates operation of the muting lamp. OFF: Muting lamp failure ON: Muting lamp no failure
(8)	i_dDiscTime11_12	Double word [signed]	0	Max. discrepancy time for i_bMutingSw_11 and i_bMutingSw_12 entering muting gate. Increments of 10ms. Range: Fixed values from 0 to 400 (0 to 4000ms = 4sec)
(9)	i_dDiscTime21_22	Double word [signed]	0	Max. discrepancy time for i_bMutingSw_21 and i_bMutingSw_22 entering muting gate. Increments of 10ms. Range: Fixed values from 0 to 400 (0 to 4000ms = 4sec)
(10)	i_dMaxMutingTime	Double word [signed]	0	Maximum time to complete muting sequence, timer started when first muting sensor is actuated. Increments of 10ms. ■Range: • 0 to 60000 (0 to 600000ms = 10min) • -1 (Unlimited muting time)* *: The muting time cannot be set to be unlimited without additional precautions being taken. When i_dMaxMutingTime is set to be unlimited, conduct a risk analysis and take additional measures.
(11)	i_bMutingEnable	Bit	OFF	Command by the control system that enables the start of the muting function when needed by the machine cycle. After the start of the muting function, this signal can be switched OFF. OFF: Muting not enabled ON: Start of Muting function enabled.
(12)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(13)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(14)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(15)	o_bS_AOPD_Out	Bit*	OFF	Safety output, indicates status of the muted guard. OFF: AOPD protection field interrupted and muting not active. ON: AOPD protection field not interrupted or muting active.
(16)	o_bS_MutingActive	Bit*	OFF	Indicates status of muting process. OFF: Muting not active ON: Muting active
(17)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(18)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- Safe input must be connected to i_bMutingSw_11/12/21/22 depending on the safety requirements. Input appropriate signals depending on the safety requirements of the application.
- A short circuit in the muting sensor signals or a functional application error to supply these signals are not detected by this FB but interpreted as incorrect muting sequence. However, this condition should not lead to unwanted muting. The user should take care to include this in his risk analysis.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  - The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  - If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.
- When i_dMaxMutingTime is set to be unlimited, take additional measures to ensure that no one can access the danger zone while the muting is in operation.
- While the muting is active in a long cycle, ensure that muting sensors are functioned properly.
- While the muting is active, do not change the value of i_dMaxMutingTime. When changing the value, turn OFF i_bActivate before changing.
- The muting time cannot be set to be unlimited without additional precautions being taken. When the muting time is set to be unlimited, take additional measures to ensure that no one can access the danger zone while muting is active.
- Ensure that each application conforms to an appropriate risk analysis and risk avoidance strategy.
- Never use the muting function for transporting persons into the hazardous area.
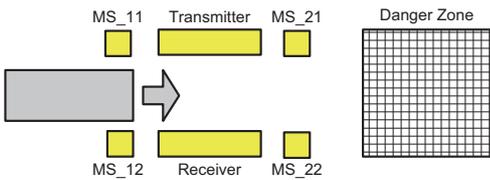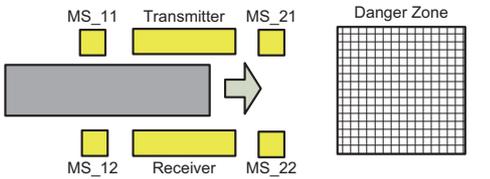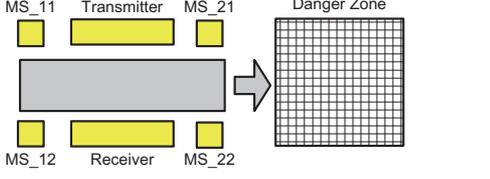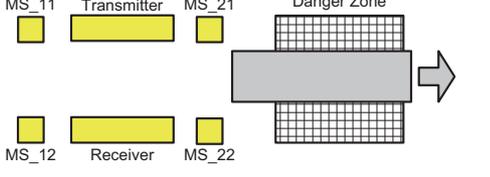
FB details

Muting is the intended suppression of the safety function. This is required, e.g., when transporting a workpiece into the danger zone without causing the machine to stop. Muting is triggered by muting sensors. The use of two or four muting sensors and correct integration into the production sequence must ensure that no persons enter the danger zone while the light curtain is muted. Muting sensors can be proximity switches, photoelectric barriers, limit switches, etc. which do not have to be failsafe. Active muting mode must be indicated by indicator lights (the muting lamp).

There are sequential and parallel muting procedures. In this FB, parallel muting with four muting sensors is used. The FB can be used in both directions, forward and backward. The muting should be enabled with the i_bMutingEnable signal by the process control when there is no manipulation in the danger zone.

The FB input parameters include the signals of the four muting sensors (i_bMutingSw_11 to i_bMutingSw_22), the OSSD signal (i_bS_AOPD_In) from the "active opto-electronic protective device", as well as three parameterizable times (i_dDiscTime11_12, i_dDiscTime21_22, and i_dMaxMutingTime). For forward direction, from when both i_bMutingSw_11 and i_bMutingSw_12 turn ON to when i_bMutingSw_21 or i_bMutingSw_22 turns OFF after both of them turn ON, muting is active (i_bS_AOPD_In=OFF is ignored and o_bS_AOPD_Out turns ON). For backward direction, from when both i_bMutingSw_21 and i_bMutingSw_22 turn ON to when i_bMutingSw_11 or i_bMutingSw_12 turns OFF after both of them turn ON, muting is active.
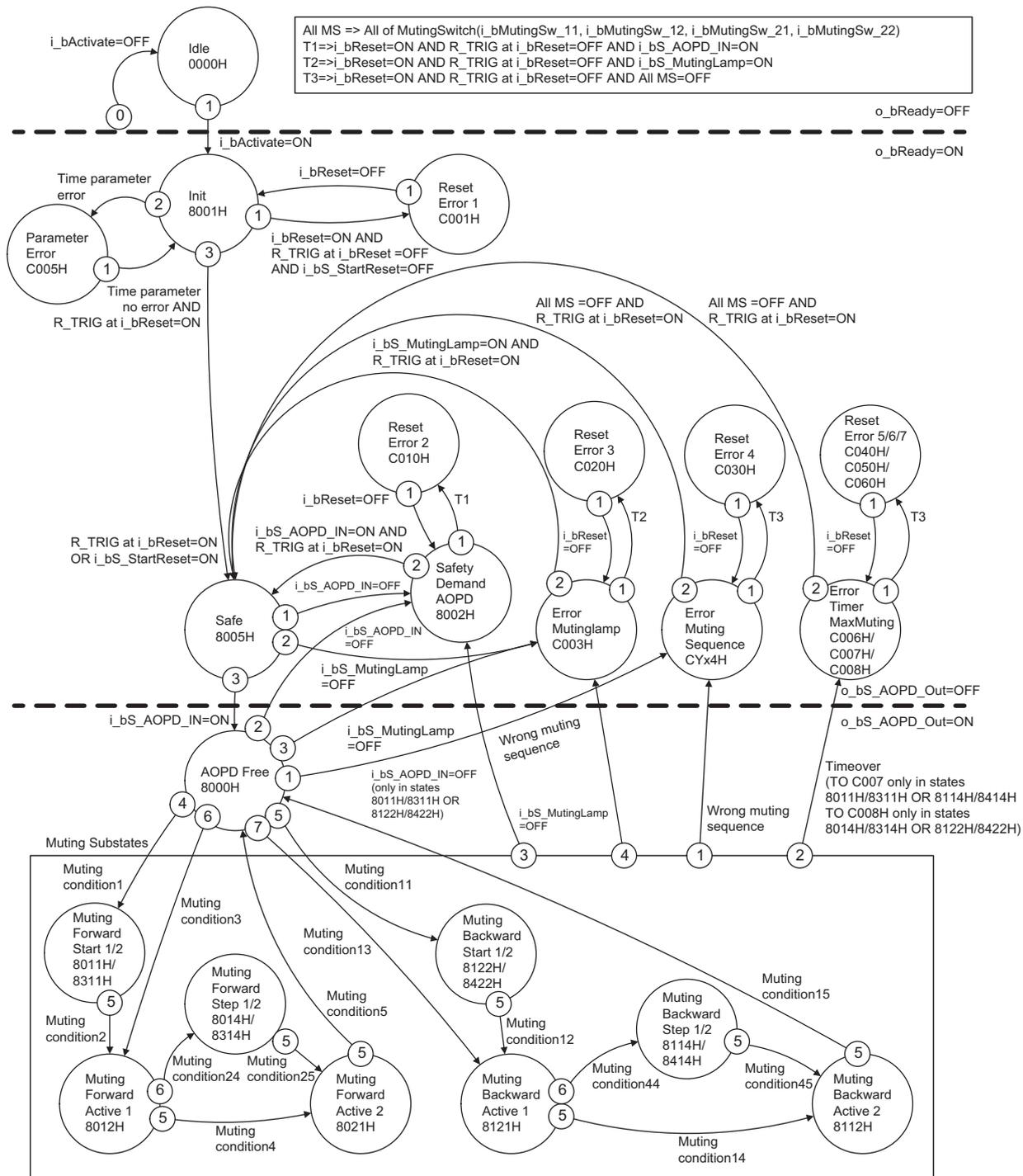
When i_dMaxMutingTime is set to -1, the effective time of the muting control is unlimited.

■Example for M+SF_MUTEP-2_R in forward direction with four sensors

Figure	Description
	If the muting sensors i_bMutingSw_11 (MS_11) and i_bMutingSw_12 (MS_12) are activated by passage of a workpiece within the time set in i_dDiscTime11_12, muting mode is activated. (o_bS_MutingActive=ON)
	Muting mode remains active as long as MS_11 and MS_12 are activated by a workpiece. The workpiece may pass through the light curtain without causing a machine stop.
	Before muting sensors MS_11 and MS_12 are disabled, muting sensors i_bMutingSw_21 (MS_21) and i_bMutingSw_22 (MS_22) must be activated. This ensures that muting mode remains active. The time discrepancy between switching of MS_21 and MS_22 is monitored by the time i_dDiscTime21_22.
	Muting mode is terminated if either muting sensor MS_21 or MS_22 is disabled by the workpiece. The maximum time for muting mode to be active is the i_dMaxMutingTime.

State diagram

State transition of M+SF_MUTEP-2_R

All MS => All of MutingSwitch(i_bMutingSw_11, i_bMutingSw_12, i_bMutingSw_21, i_bMutingSw_22)
T1=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND i_bS_AOPD_IN=ON
T2=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND i_bS_MutingLamp=ON
T3=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND All MS=OFF

Note 1: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Note 2: Within muting substates, transitions due to Error Muting sequence (priority 1), Error Timer (priority 2), Safety demand AOPD (priority 3), or Error Muting lamp (priority 4) have higher priority than transitions to Muting substates (priority 5 or 6).
 If the FB is in the timing error state, the simultaneous occurrence of C006H and C007H or C006H and C008H leads to C006H.

Note 3: Muting condition 1-6 and wrong muting sequences are shown in the following.
 • Muting conditions: ☞ Page 95 Muting conditions (forward direction), ☞ Page 96 Muting conditions (backward direction)
 • Wrong muting sequences: ☞ Page 97 Wrong muting sequences

Note 4: Time parameter error (condition of transition from 8001H to C005H) is detected in one of the following three cases.
 1) i_dDiscTime11_12 has been set to a value less than 0ms or greater than 4 seconds. (0 > i_dDiscTime11_12 OR i_dDiscTime11_12 > 400)
 2) i_dDiscTime21_22 has been set to a value less than 0ms or greater than 4 seconds. (0 > i_dDiscTime21_22 OR i_dDiscTime21_22 > 400)
 3) i_dMaxMutingTime has been set to a value less than 0ms or greater than 10min. (0 > i_dMaxMutingTime OR i_dMaxMutingTime > 60000). Time parameter error is not detected when i_dMaxMutingTime is set to -1.

Note 5: Timeover (transition from within muting substate to C006H) is not detected in the following situation:
    • i_dMaxMutingTime is set to -1.

Muting conditions (forward direction)

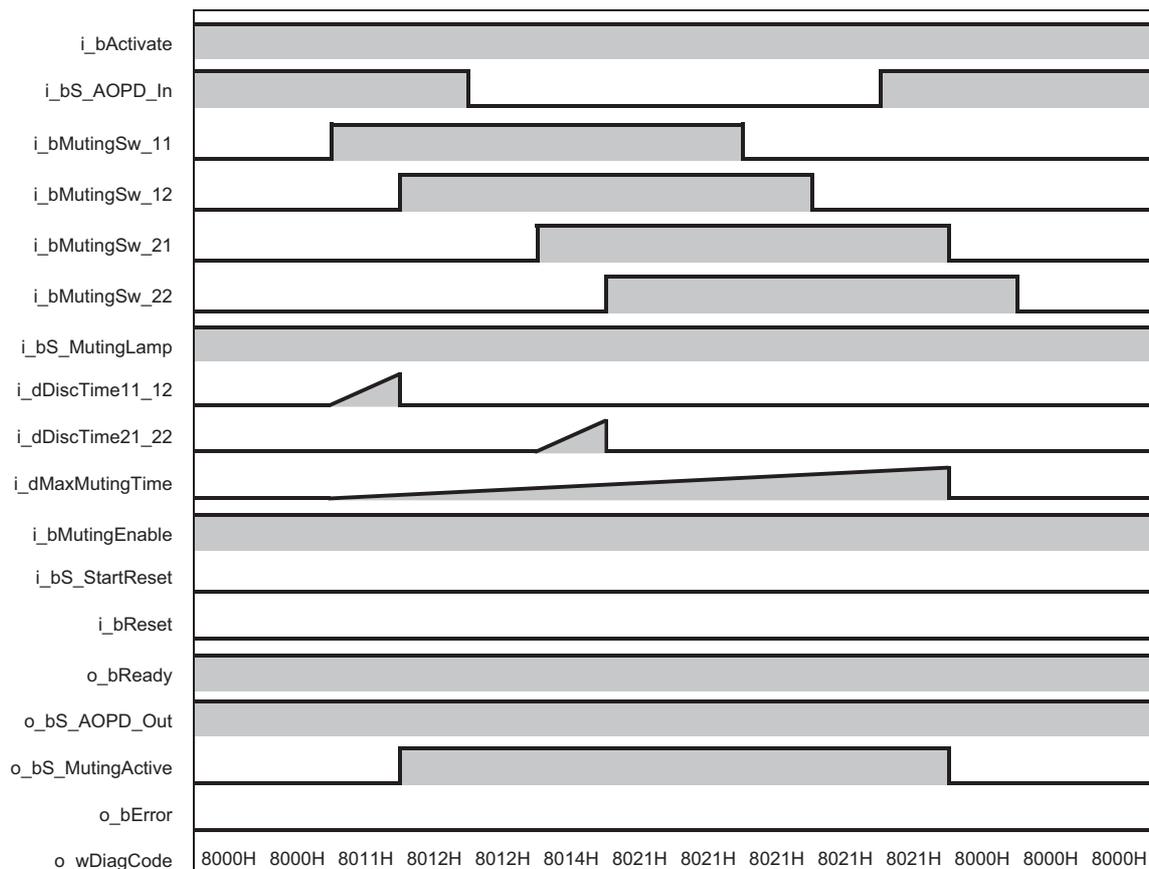| No.	State transition	Condition/action
1	8000H→8011H	MS_11 is the first entry switch actuated: Start timers i_dMaxMutingTime and i_dDiscTime11_12. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF
	8000H→8311H	MS_12 is the first entry switch actuated: Start timers i_dMaxMutingTime and i_dDiscTime11_12. i_bMutingEnable=ON AND MS_11=OFF AND MS_12=OFF→ON AND MS_21=OFF AND MS_22=OFF
2	8011H→8012H	MS_12 is the second entry switch actuated: Stop timer i_dDiscTime11_12. i_bMutingEnable=ON AND MS_11=ON AND MS_12=OFF→ON AND MS_21=OFF AND MS_22=OFF
	8311H→8012H	MS_11 is the second entry switch actuated: Stop timer i_dDiscTime11_12. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=ON AND MS_21=OFF AND MS_22=OFF
3	8000H→8012H	Both entry switches actuated in the same cycle: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF→ON AND MS_21=OFF AND MS_22=OFF
4	8012H→8021H	All switches actuated: MS_11=ON AND MS_12=ON AND MS_21=ON AND MS_22=ON
24	8012H→8014H	MS_21 is the first exit switch actuated: Start timer i_dDiscTime21_22. MS_11=ON AND MS_12=ON AND MS_21=OFF→ON AND MS_22=OFF
	8012H→8314H	MS_22 is the first exit switch actuated: Start timer i_dDiscTime21_22. MS_11=ON AND MS_12=ON AND MS_21=OFF AND MS_22=OFF→ON
25	8014H→8021H	MS_22 is the second exit switch actuated: Stop timer i_dDiscTime21_22. MS_11=ON AND MS_12=ON AND MS_21=ON AND MS_22=OFF→ON
	8314H→8021H	MS_21 is the second exit switch actuated: Stop timer i_dDiscTime21_22. MS_11=ON AND MS_12=ON AND MS_21=OFF→ON AND MS_22=ON
5	8021H→8000H	One of the exit switches released: Stop timer i_dMaxMutingTime. MS_11=OFF AND MS_12=OFF AND (MS_21=ON→OFF OR MS_22=ON→OFF)

Muting conditions (backward direction)

No.	State transition	Condition/action
11	8000H→8122H	MS_21 is the first entry switch actuated: Start timers i_dMaxMutingTime and i_dDiscTime21_22. i_bMutingEnable=ON AND MS_21=OFF→ON AND MS_22=OFF AND MS_11=OFF AND MS_12=OFF
	8000H→8422H	MS_22 is the first entry switch actuated: Start timers i_dMaxMutingTime and i_dDiscTime21_22. i_bMutingEnable=ON AND MS_21=OFF AND MS_22=OFF→ON AND MS_11=OFF AND MS_12=OFF
12	8122H→8121H	MS_22 is the second entry switch actuated: Stop timer i_dDiscTime21_22. i_bMutingEnable=ON AND MS_21=ON AND MS_22=OFF→ON AND MS_11=OFF AND MS_12=OFF
	8422H→8121H	MS_21 is the second entry switch actuated: Stop timer i_dDiscTime21_22. i_bMutingEnable=ON AND MS_21=OFF→ON AND MS_22=ON AND MS_11=OFF AND MS_12=OFF
13	8000H→8121H	Both entry switches actuated in the same cycle: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_21=OFF→ON AND MS_22=OFF→ON AND MS_11=OFF AND MS_12=OFF
14	8121H→8112H	All switches actuated: MS_21=ON AND MS_22=ON AND MS_11=ON AND MS_12=ON
44	8121H→8114H	MS_11 is the first exit switch actuated: Start timer i_dDiscTime11_12. MS_21=ON AND MS_22=ON AND MS_11=OFF→ON AND MS_12=OFF
	8121H→8414H	MS_12 is the first exit switch actuated: Start timer i_dDiscTime11_12. MS_21=ON AND MS_22=ON AND MS_11=OFF AND MS_12=OFF→ON
45	8114H→8112H	MS_12 is the second exit switch actuated: Stop timer i_dDiscTime11_12. MS_21=ON AND MS_22=ON AND MS_11=ON AND MS_12=OFF→ON
	8414H→8112H	MS_11 is the second exit switch actuated: Stop timer i_dDiscTime11_12. MS_21=ON AND MS_22=ON AND MS_11=OFF→ON AND MS_12=ON
15	8112H→8000H	One of the exit switches released: Stop timer i_dMaxMutingTime. MS_21=OFF AND MS_22=OFF AND (MS_11=ON→OFF OR MS_12=ON→OFF)

Wrong muting sequences

Status	Wrong muting sequences
8000H	When muting sequence starts, i_bMutingEnable=OFF
	(MS_11=ON OR MS_12=ON) AND (MS_21=ON OR MS_22=ON)
	MS_11=OFF→ON AND MS_12=ON AND undetected MS_12=OFF→ON
	MS_12=OFF→ON AND MS_11=ON AND undetected MS_11=OFF→ON
	MS_21=OFF→ON AND MS_22=ON AND undetected MS_22=OFF→ON
	MS_22=OFF→ON AND MS_21=ON AND undetected MS_21=OFF→ON
	(MS_11=ON AND undetected MS_11=OFF→ON) AND (MS_12=ON AND undetected MS_12=OFF→ON)
	(MS_21=ON AND undetected MS_21=OFF→ON) AND (MS_22=ON AND undetected MS_22=OFF→ON)
8011H	i_bMutingEnable=OFF OR MS_11=OFF OR MS_21=ON OR MS_22=ON
8311H	i_bMutingEnable=OFF OR MS_12=OFF OR MS_21=ON OR MS_22=ON
8012H	MS_11=OFF OR MS_12=OFF
8021H	MS_11=OFF→ON OR MS_12=OFF→ON
	(MS_11=ON OR MS_12=ON) AND (MS_21=ON→OFF OR MS_22=ON→OFF)
	(MS_11=ON→OFF OR MS_12=ON→OFF) AND (MS_21=ON→OFF OR MS_22=ON→OFF)
8014H	MS_11=OFF OR MS_12=OFF OR MS_21=OFF
8314H	MS_11=OFF OR MS_12=OFF OR MS_22=OFF
8122H	i_bMutingEnable=OFF OR MS_11=ON OR MS_12=ON OR MS_21=OFF
8422H	i_bMutingEnable=OFF OR MS_11=ON OR MS_12=ON OR MS_22=OFF
8121H	MS_21=OFF OR MS_22=OFF
8112H	MS_21=OFF→ON OR MS_22=OFF→ON
	(MS_21=ON OR MS_22=ON) AND (MS_11=ON→OFF OR MS_12=ON→OFF)
	(MS_11=ON→OFF OR MS_12=ON→OFF) AND (MS_21=ON→OFF OR MS_22=ON→OFF)
8114H	MS_21=OFF OR MS_22=OFF OR MS_11=OFF
8414H	MS_21=OFF OR MS_22=OFF OR MS_12=OFF

Typical timing diagram

■For M+SF_MUTEP-2_R (i_bS_StartReset=OFF, forward direction)

A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dDiscTime11_12, i_dDiscTime21_22, and i_dMaxMutingTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_AOPD_Out	OFF
o_bS_MutingActive	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset condition detected after FB activation in state 8001H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C003H	Error Muting Lamp	Error detected in muting lamp.	Set i_bReset to ON. Check the devices and wiring related to i_bReset.
CYx4H C004H to CFF4H	Error Muting Sequence	Error detected in muting sequence in state 8000H, 8011H, 8311H, 8012H, 8021H, 8014H, 8314H, 8122H, 8422H, 8121H, 8112H, 8114H, or 8414H. Y = Status in the sequence (6 states for forward and 6 states for backward direction). C0x4H = Error occurred in state 8000H C1x4H = Error occurred in state Forward 8011H C2x4H = Error occurred in state Forward 8311H C3x4H = Error occurred in state Forward 8012H C4x4H = Error occurred in state Forward 8014H C5x4H = Error occurred in state Forward 8314H C6x4H = Error occurred in state Forward 8021H C7x4H = Error occurred in state Backward 8122H C8x4H = Error occurred in state Backward 8422H C9x4H = Error occurred in state Backward 8121H Cax4H = Error occurred in state Backward 8114H Cbx4H = Error occurred in state Backward 8414H Ccx4H = Error occurred in state Backward 8112H CFx4H = i_bMutingEnable=OFF The states of wrong muting sequences (☞ Page 97 Wrong muting sequences) including i_bMutingEnable=OFF are always changed to CFx4H when i_bMutingEnable is set to OFF. (Never changed to other states.) x = Status of the sensors when error occurred (MS_11, MS_12, MS_21, MS_22 in order) CY04H=OFF, OFF, OFF, OFF CY14H=ON, OFF, OFF, OFF CY24H=OFF, ON, OFF, OFF CY34H=ON, ON, OFF, OFF CY44H=OFF, OFF, ON, OFF CY54H=ON, OFF, ON, OFF CY64H=OFF, ON, ON, OFF CY74H=ON, ON, ON, OFF CY84H=OFF, OFF, OFF, ON CY94H=ON, OFF, OFF, ON CYA4H=OFF, ON, OFF, ON CYB4H=ON, ON, OFF, ON CYC4H=OFF, OFF, ON, ON CYD4H=ON, OFF, ON, ON CYE4H=OFF, ON, ON, ON CYF4H=ON, ON, ON, ON	Set all muting switches to OFF and set i_bReset to ON. Check the devices and wiring related to i_bReset.
C005H	Parameter Error	i_dDiscTime11_12, i_dDiscTime21_22 or i_dMaxMutingTime value out of range.	Set all values of i_dDiscTime11_12, i_dDiscTime21_22, and i_dMaxMutingTime within the setting range, and set i_bReset to ON.
C006H	Error Timer MaxMuting	Timing error. Active muting time exceeds i_dMaxMutingTime.	Set all muting switches to OFF and set i_bReset to ON. Check the muting situation in the process.
C007H	Error Timer MS11_12	Timing error. Discrepancy time for switching i_bMutingSw_11 and i_bMutingSw_12 > i_dDiscTime11_12.	
C008H	Error Timer MS21_22	Timing error. Discrepancy time for switching i_bMutingSw_21 and i_bMutingSw_22 > i_dDiscTime21_22.	

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C010H	Reset Error 2	Static i_bReset condition detected after FB activation in state 8002H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C020H	Reset Error 3	Static i_bReset condition detected after FB activation in state C003H.	
C030H	Reset Error 4	Static i_bReset condition detected after FB activation in state CYx4H.	
C040H	Reset Error 5	Static i_bReset condition detected after FB activation in state C006H.	
C050H	Reset Error 6	Static i_bReset condition detected after FB activation in state C007H.	
C060H	Reset Error 7	Static i_bReset condition detected after FB activation in state C008H.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	AOPD Free	Muting not active and no safety demand from AOPD. If timers from subsequent muting are still running, they are stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	None. (Starting muting is possible.)
8001H	Init	The FB was activated. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON.
8002H	Safety Demand AOPD	Safety demand detected by AOPD and muting not active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON after the completion of safety demand.
8005H	Safe	The safety function is active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Wait the completion of safety demand.
8011H	Muting Forward Start 1	Muting forward sequence is in starting phase after rising trigger of i_bMutingSw_11. Monitoring of i_dDiscTime11_12 is activated. Monitoring of i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	Set both muting switches (i_bMutingSw_11 and i_bMutingSw_12) to ON. Complete muting within i_dMaxMutingTime.
8311H	Muting Forward Start 2	Muting forward sequence is in starting phase after rising trigger of i_bMutingSw_12. Monitoring of i_dDiscTime11_12 is activated. Monitoring of i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
8012H	Muting Forward Active 1	Muting forward sequence is active when both i_bMutingSw_11 and i_bMutingSw_12 have been actuated in the same cycle or in serial. Monitoring of i_dDiscTime11_12 is stopped. Monitoring of i_dMaxMutingTime is activated, when transition came directly from state 8000H. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.
8014H	Muting Forward Step 1	Muting forward sequence is active. i_bMutingSw_21 is the first exit switch actuated. Monitoring of i_dDiscTime21_22 is started. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Set both muting switches (i_bMutingSw_21 and i_bMutingSw_22) to ON. Complete muting within i_dMaxMutingTime.
8314H	Muting Forward Step 2	Muting forward sequence is active. i_bMutingSw_22 is the first exit switch actuated. Monitoring of i_dDiscTime21_22 is started. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	
8021H	Muting Forward Active 2	Muting forward sequence is still active. Both i_bMutingSw_21 and i_bMutingSw_22 are actuated and the monitoring of i_dDiscTime21_22 is stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.
8122H	Muting Backward Start 1	Muting backward sequence is in starting phase after rising trigger of i_bMutingSw_21. Monitoring of i_dDiscTime21_22 is activated. Monitoring of i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	Set both muting switches (i_bMutingSw_21 and i_bMutingSw_22) to ON. Complete muting within i_dMaxMutingTime.
8422H	Muting Backward Start 2	Muting backward sequence is in starting phase after rising trigger of i_bMutingSw_22. Monitoring of i_dDiscTime21_22 is activated. Monitoring of i_dMaxMutingTime is activated. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	
8121H	Muting Backward Active 1	Muting backward sequence is active when both i_bMutingSw_21 and i_bMutingSw_22 have been actuated in the same cycle or in serial. Monitoring of i_dDiscTime21_22 is stopped. Monitoring of i_dMaxMutingTime is activated, when transition came directly from state 8000H. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.
8114H	Muting Backward Step 1	Muting backward sequence is active. i_bMutingSw_11 is the first exit switch actuated. Monitoring of i_dDiscTime11_12 is started. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Set both muting switches (i_bMutingSw_11 and i_bMutingSw_12) to ON. Complete muting within i_dMaxMutingTime.
8414H	Muting Backward Step 2	Muting backward sequence is active. i_bMutingSw_12 is the first exit switch actuated. Monitoring of i_dDiscTime11_12 is started. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
8112H	Muting Backward Active 2	Muting backward sequence is still active. Both exit switches i_bMutingSw_11 and i_bMutingSw_12 are actuated and the monitoring of i_dDiscTime11_12 is stopped. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
- A failure in safety devices and emergency stop devices
- Wiring and status of a safety remote I/O module and a safety programmable controller
- Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
- Setting of i_bS_StartReset

4.14 M+SF_MUTES_R

Overview

Item	Description
Function name	Sequential muting
Functional overview	Muting is the intended suppression of the safety function (e.g., light barriers). In this FB, sequential muting with four muting sensors is specified.
Symbol	

```
                    M+SF_MUTES_R
(1) ———— B: i_bActivate            o_bReady: B ———— (12)
(2) ———— B: i_bS_AOPD_In       o_bS_AOPD_Out: B ———— (13)
(3) ———— B: i_bMutingSw_11   o_bS_MutingActive: B ———— (14)
(4) ———— B: i_bMutingSw_12            o_bError: B ———— (15)
(5) ———— B: i_bMutingSw_21        o_wDiagCode: W ———— (16)
(6) ———— B: i_bMutingSw_22
(7) ———— B: i_bS_MutingLamp
(8) ———— D: i_dMaxMutingTime
(9) ———— B: i_bMutingEnable
(10) ——— B: i_bS_StartReset
(11) ——— B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_AOPD_In	Bit*	OFF	OSSD (safety output) signal from AOPD (Active opto-electronic protective devices). OFF: Protection field interrupted ON: Protection field not interrupted
(3)	i_bMutingSw_11	Bit	OFF	Status of muting sensor 11. OFF: Muting sensor 11 is not actuated. ON: Workpiece actuates muting sensor 11.
(4)	i_bMutingSw_12	Bit	OFF	Status of muting sensor 12. OFF: Muting sensor 12 is not actuated. ON: Workpiece actuates muting sensor 12.
(5)	i_bMutingSw_21	Bit	OFF	Status of muting sensor 21. OFF: Muting sensor 21 is not actuated. ON: Workpiece actuates muting sensor 21.
(6)	i_bMutingSw_22	Bit	OFF	Status of muting sensor 22. OFF: Muting sensor 22 is not actuated. ON: Workpiece actuates muting sensor 22.
(7)	i_bS_MutingLamp	Bit*	OFF	Indicates operation of the muting lamp. OFF: Muting lamp failure ON: Muting lamp no failure
(8)	i_dMaxMutingTime	Double word [signed]	0	Maximum time to complete muting sequence, timer started when first muting sensor is actuated. Increments of 10ms. Range: Fixed values from 0 to 60000 (0 to 600000ms = 10min)
(9)	i_bMutingEnable	Bit	OFF	Command by the control system that enables the start of the muting function when needed by the machine cycle. After the start of the muting function, this signal can be switched OFF. OFF: Muting not enabled ON: Start of Muting function enabled
(10)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(11)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(12)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(13)	o_bS_AOPD_Out	Bit*	OFF	Safety output, indicates status of the muted guard. OFF: AOPD protection field interrupted and muting not active. ON: AOPD protection field not interrupted or muting active.
(14)	o_bS_MutingActive	Bit*	OFF	Indicates status of muting process. OFF: Muting not active ON: Muting active
(15)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(16)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- Safe input must be connected to i_bMutingSw_11/12/21/22 depending on the safety requirements. Input appropriate signals depending on the safety requirements of the application.
- A short circuit in the muting sensor signals or a functional application error to supply these signals are not detected by this FB but interpreted as incorrect muting sequence. However, this condition should not lead to unwanted muting. The user should take care to include this in his risk analysis.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.
- While the muting is active, do not change the value of i_dMaxMutingTime. When changing the value, turn OFF i_bActivate before changing.
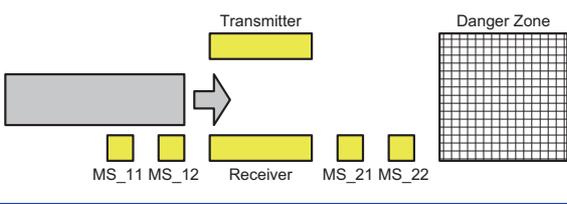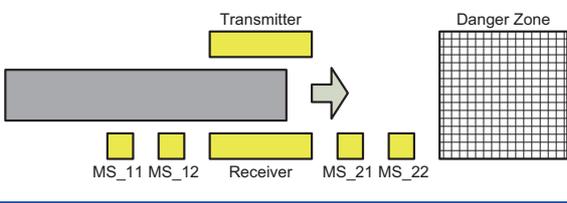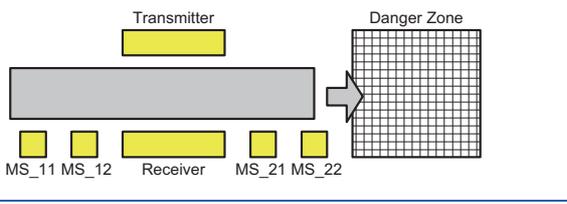
FB details

Muting is the intended suppression of the safety function. This is required, e.g., when transporting a workpiece into the danger zone without causing the machine to stop. Muting is triggered by muting sensors. The use of two or four muting sensors and correct integration into the production sequence must ensure that no persons enter the danger zone while the light curtain is muted. Muting sensors can be proximity switches, photoelectric barriers, limit switches, etc. which do not have to be failsafe. Active muting mode must be indicated by indicator lights (the muting lamp).

There are sequential and parallel muting procedures. In this FB, sequential muting with four muting sensors is used. An explanation for transporting of workpieces in forward direction is provided in the table below. The FB can be used in both directions, forward and backward. The muting should be enabled with the i_bMutingEnable signal by the process control when there is no manipulation in the danger zone.

The FB input parameters include the signals of the four muting sensors (i_bMutingSw_11 to i_bMutingSw_22) as well as the OSSD signal (i_bS_AOPD_In) from the "active opto-electronic protective device". For forward direction, from when both i_bMutingSw_11 and i_bMutingSw_12 turn ON to when only i_bMutingSw_22 is ON after i_bMutingSw_21 and i_bMutingSw_22 sequentially turn ON, muting is active (i_bS_AOPD_In=OFF is ignored and o_bS_AOPD_Out turns ON). For backward direction, from when both i_bMutingSw_21 and i_bMutingSw_22 turn ON to when only i_bS_Muting_11 is ON after i_bMutingSw_11 and i_bMutingSw_12 turn ON, muting is active.

■Example for M+SF_MUTES_R in forward direction with four sensors

Figure	Description
	If the muting sensor i_bMutingSw_11 (MS_11) and then i_bMutingSw_12 (MS_12) are activated by passage of a workpiece, the muting mode is activated.
	Muting mode remains active as long as MS_11 and MS_12 are activated by a workpiece. The workpiece may pass through the light curtain without causing a machine stop.
	Before muting sensors MS_11 and MS_12 are disabled, muting sensors i_bMutingSw_21 (MS_21) and i_bMutingSw_22 (MS_22) must be activated. This ensures that muting mode remains active.
	Muting mode is terminated if only muting sensor MS_22 is activated by a workpiece.

State diagram

State transition of M+SF_MUTES_R

All MS => All of MutingSwitch(i_bMutingSw_11, i_bMutingSw_12, i_bMutingSw_21, i_bMutingSw_22)
T1=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND i_bS_AOPD_IN=ON
T2=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND i_bS_MutingLamp=ON
T3=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND All MS=OFF

Note 1: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Note 2: Within muting substates, transitions due to Error Muting sequence (priority 1), Error Timer (priority 2), Safety demand AOPD (priority 3) or Error Muting lamp (priority 4) have higher priority than transitions to Muting substates (priority 5).

Note 3: Muting condition 1-3/11-13 and Wrong muting sequences are shown in the following.
   • Muting conditions 1-3 (☞ Page 107 Muting conditions (forward direction))
   • Muting conditions 11-13 (☞ Page 107 Muting conditions (backward direction))
   • Wrong muting sequences (☞ Page 107 Wrong muting sequences)

Note 4: Time parameter error (condition of transition from 8001H to C005H) is detected in the following case.
   1) i_dMaxMutingTime has been set to a value less than 0ms or greater than 10min. (0 > i_dMaxMutingTime OR i_dMaxMutingTime > 60000)

Muting conditions (forward direction)

| No.	State transition	Condition/action
1	8000H→8011H	MS_11 is the first entry switch actuated: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF
2	8011H→8012H	MS_12 is the second entry switch actuated: i_bMutingEnable=ON AND MS_11=ON AND MS_12=OFF→ON AND MS_21=OFF AND MS_22=OFF
3	8012H→8000H	MS_21 is the first exit switch released: Stop timer i_dMaxMutingTime. MS_11=OFF AND MS_12=OFF AND MS_21=ON→OFF AND MS_22=ON

Muting conditions (backward direction)

No.	State transition	Condition/action
11	8000H→8122H	MS_22 is the first entry switch actuated: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF→ON
12	8122H→8112H	MS_21 is the second entry switch actuated: i_bMutingEnable=ON AND MS_11=OFF AND MS_12=OFF AND MS_21=OFF→ON AND MS_22=ON
13	8112H→8000H	MS_12 is the first exit switch actuated: Stop timer i_dMaxMutingTime. MS_11=ON AND MS_12=ON→OFF AND MS_21=OFF AND MS_22=OFF

Wrong muting sequences

Status	Wrong muting sequences
8000H	i_bMutingEnable=OFF AND MS_11=OFF→ON
	i_bMutingEnable=OFF AND MS_22=OFF→ON
	MS_12=ON OR MS_21=ON
	MS_11=ON AND MS_22=ON
8011H	i_bMutingEnable=OFF OR MS_11=OFF OR MS_21=ON OR MS_22=ON
8012H	MS_11=OFF→ON OR MS_12=OFF→ON OR MS_22=ON→OFF
	MS_11=ON AND MS_12=ON→OFF
	(MS_11=ON OR MS_12=ON) AND MS_21=ON→OFF
	(MS_11=OFF OR MS_12=OFF) AND MS_21=ON AND MS_22=OFF
	(MS_11=OFF OR MS_12=OFF OR MS_21=OFF) AND MS_22=OFF→ON
	MS_11=OFF AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF
	MS_11=ON AND (MS_12=OFF OR MS_21=OFF) AND MS_22=ON
	MS_11=OFF AND MS_12=ON AND MS_21=OFF AND MS_22=ON
	MS_21=OFF→ON AND MS_22=OFF→ON
	MS_11=ON→OFF AND MS_12=ON→OFF
	MS_12=ON→OFF AND MS_21=ON→OFF
	MS_11=OFF AND MS_12=ON AND MS_21=OFF
8112H	MS_11=ON→OFF OR MS_21=OFF→ON OR MS_22=OFF→ON
	MS_21=ON→OFF AND MS_22=ON
	MS_12=ON→OFF AND (MS_21=ON OR MS_22=ON)
	MS_11=OFF AND MS_12=ON AND (MS_21=OFF OR MS_22=OFF)
	MS_11=OFF→ON AND (MS_12=OFF OR MS_21=OFF OR MS_22=OFF)
	MS_11=OFF AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF
	MS_11=ON AND (MS_12=OFF OR MS_21=OFF) AND MS_22=ON
	MS_11=ON AND MS_12=OFF AND MS_21=ON AND MS_22=OFF
	MS_11=OFF→ON AND MS_12=OFF→ON
	MS_21=ON→OFF AND MS_22=ON→OFF
	MS_12=ON→OFF AND MS_21=ON→OFF
	MS_12=OFF AND MS_21=ON AND MS_22=OFF
8122H	i_bMutingEnable=OFF OR MS_11=ON OR MS_12=ON OR MS_22=OFF

Typical timing diagram

■For M+SF_MUTES_R (forward direction)
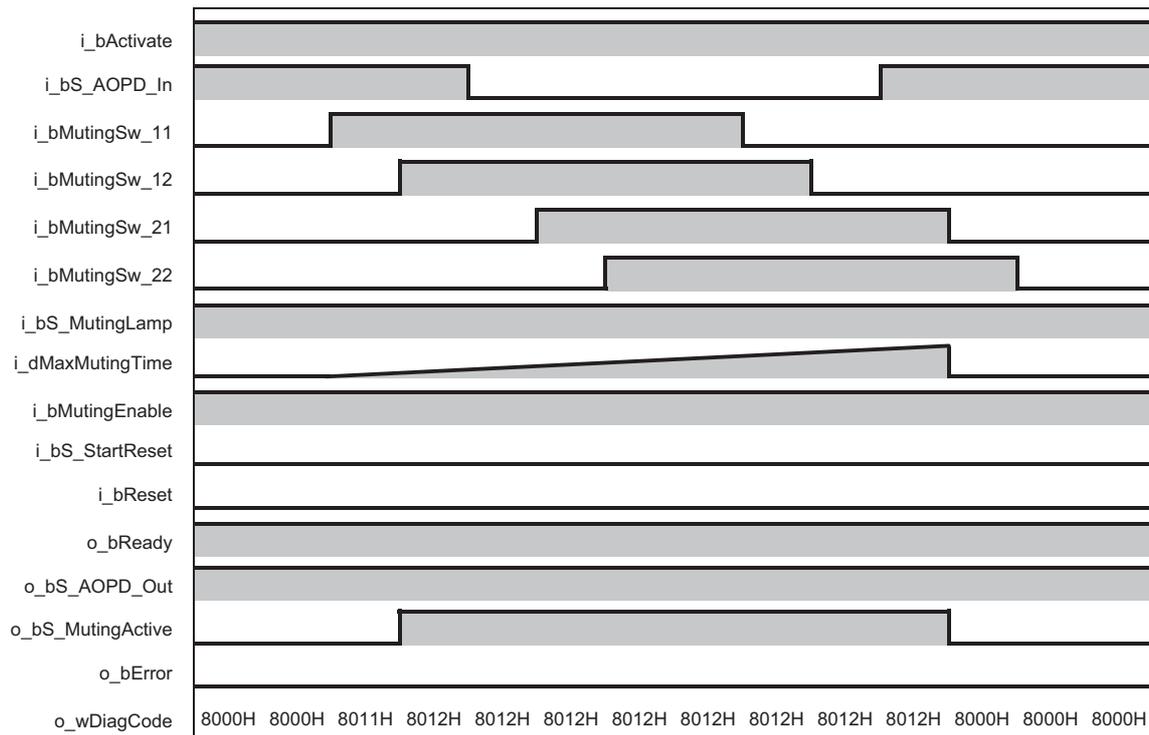
A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dMaxMutingTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_AOPD_Out	OFF
o_bS_MutingActive	OFF
o_bError	ON

For the corrective actions, see the following.

☞ Page 109 List of error codes

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset condition detected after FB activation.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C003H	Error Muting Lamp	Error detected in muting lamp.	Set i_bReset to ON. Check the devices and wiring related to i_bReset.
C005H	Parameter Error	i_dMaxMutingTime value out of range.	Set a proper value to the parameter and set i_bReset to ON.
C006H	Error Timer MaxMuting	Timing error. Active muting time exceeds i_dMaxMutingTime.	Set all muting switches to OFF and set i_bReset to ON. Check the muting situation in the process.
C010H	Reset Error 2	Static i_bReset condition detected at 8002H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C020H	Reset Error 3	Static i_bReset condition detected at C003H.	
C030H	Reset Error 4	Static i_bReset condition detected at CYx4H.	
C040H	Reset Error 5	Static i_bReset condition detected at C006H.	
CYx4H C004H to CFF4H	Error Muting Sequence	Error detected in muting sequence in state 8000H, 8011H, 8012H, 8112H, or 8122H. Y = Status in the sequence (2 states for forward and 2 states for backward direction). C0x4H = Error occurred in state 8000H C1x4H = Error occurred in state Forward 8011H C2x4H = Error occurred in state Forward 8012H C3x4H = Error occurred in state Backward 8122H C4x4H = Error occurred in state Backward 8112H CFx4H = i_bMutingEnable=OFF The states of wrong muting sequences (☞ Page 107 Wrong muting sequences) including i_bMutingEnable=OFF are always changed to CFx4H when i_bMutingEnable is set to OFF. (Never changed to other states.) x = Status of the sensors when error occurred (MS_11, MS_12, MS_21, MS_22) CY04H=OFF, OFF, OFF, OFF CY14H=ON, OFF, OFF, OFF CY24H=OFF, ON, OFF, OFF CY34H=ON, ON, OFF, OFF CY44H=OFF, OFF, ON, OFF CY54H=ON, OFF, ON, OFF CY64H=OFF, ON, ON, OFF CY74H=ON, ON, ON, OFF CY84H=OFF, OFF, OFF, ON CY94H=ON, OFF, OFF, ON CYA4H=OFF, ON, OFF, ON CYB4H=ON, ON, OFF, ON CYC4H=OFF, OFF, ON, ON CYD4H=ON, OFF, ON, ON CYE4H=OFF, ON, ON, ON CYF4H=ON, ON, ON, ON	Set all muting switches to OFF and set i_bReset to ON. Check the devices and wiring related to i_bReset.

4

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	AOPD Free	Muting not active and no safety demand from AOPD. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	None. (Starting muting is possible.)
8001H	Init	The FB has been activated. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON.
8002H	Safety Demand AOPD	Safety demand detected by AOPD and muting not active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON after the completion of safety demand.
8005H	Safe	The safety function is active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Wait the completion of safety demand.
8011H	Muting Forward Start	Muting forward sequence is in the starting phase and no safety demand. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	• Set both muting switches (i_bMutingSw_11 and i_bMutingSw_12) to ON. • Complete muting within i_dMaxMutingTime.
8012H	Muting Forward Active	Muting forward sequence is active. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.
8112H	Muting Backward Active	Muting backward sequence is active. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	
8122H	Muting Backward Start	Muting backward sequence is in starting phase and no safety demand. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	• Set both muting switches (i_bMutingSw_21 and i_bMutingSw_22) to ON. • Complete muting within i_dMaxMutingTime.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
 • Setting of i_bS_StartReset

4.15 M+SF_MUTES-2_R

Overview

Item	Description
Function name	Sequential muting 2
Functional overview	Muting is the intended suppression of the safety function (e.g., light barriers). In this FB, sequential muting with four muting sensors is specified. The effective time of the muting control can be set to be unlimited.
Symbol	

```
                      M+SF_MUTES-2_R
(1) ───── B: i_bActivate          o_bReady: B ───── (12)
(2) ───── B: i_bS_AOPD_In      o_bS_AOPD_Out: B ───── (13)
(3) ───── B: i_bMutingSw_11  o_bS_MutingActive: B ───── (14)
(4) ───── B: i_bMutingSw_12          o_bError: B ───── (15)
(5) ───── B: i_bMutingSw_21       o_wDiagCode: W ───── (16)
(6) ───── B: i_bMutingSw_22
(7) ───── B: i_bS_MutingLamp
(8) ───── D: i_dMaxMutingTime
(9) ───── B: i_bMutingEnable
(10) ───── B: i_bS_StartReset
(11) ───── B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_AOPD_In	Bit*	OFF	OSSD (safety output) signal from AOPD (Active opto-electronic protective devices). OFF: Protection field interrupted ON: Protection field not interrupted
(3)	i_bMutingSw_11	Bit	OFF	Status of muting sensor 11. OFF: Muting sensor 11 is not actuated. ON: Workpiece actuates muting sensor 11.
(4)	i_bMutingSw_12	Bit	OFF	Status of muting sensor 12. OFF: Muting sensor 12 is not actuated. ON: Workpiece actuates muting sensor 12.
(5)	i_bMutingSw_21	Bit	OFF	Status of muting sensor 21. OFF: Muting sensor 21 is not actuated. ON: Workpiece actuates muting sensor 21.
(6)	i_bMutingSw_22	Bit	OFF	Status of muting sensor 22. OFF: Muting sensor 22 is not actuated. ON: Workpiece actuates muting sensor 22.
(7)	i_bS_MutingLamp	Bit*	OFF	Indicates operation of the muting lamp. OFF: Muting lamp failure ON: Muting lamp no failure
(8)	i_dMaxMutingTime	Double word [signed]	0	Maximum time to complete muting sequence, timer started when first muting sensor is actuated. Increments of 10ms. ■Range: • 0 to 60000 (0 to 600000ms = 10min) • -1 (Unlimited muting time)[*] *: The muting time cannot be set to be unlimited without additional precautions being taken. When i_dMaxMutingTime is set to be unlimited, conduct a risk analysis and take additional measures.
(9)	i_bMutingEnable	Bit	OFF	Command by the control system that enables the start of the muting function when needed by the machine cycle. After the start of the muting function, this signal can be switched OFF. OFF: Muting not enabled ON: Start of Muting function enabled
(10)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions

No.	Variable name	Data type	Default value	Description
(11)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(12)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(13)	o_bS_AOPD_Out	Bit*	OFF	Safety output, indicates status of the muted guard. OFF: AOPD protection field interrupted and muting not active. ON: AOPD protection field not interrupted or muting active.
(14)	o_bS_MutingActive	Bit*	OFF	Indicates status of muting process. OFF: Muting not active ON: Muting active
(15)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(16)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- Safe input must be connected to i_bMutingSw_11/12/21/22 depending on the safety requirements. Input appropriate signals depending on the safety requirements of the application.
- A short circuit in the muting sensor signals or a functional application error to supply these signals are not detected by this FB but interpreted as incorrect muting sequence. However, this condition should not lead to unwanted muting. The user should take care to include this in his risk analysis.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.
- When i_dMaxMutingTime is set to be unlimited, take additional measures to ensure that no one can access the danger zone while the muting is in operation.
- While the muting is active in a long cycle, ensure that muting sensors are functioned properly.
- While the muting is active, do not change the value of i_dMaxMutingTime. When changing the value, turn OFF i_bActivate before changing.
- The muting time cannot be set to be unlimited without additional precautions being taken. When the muting time is set to be unlimited, take additional measures to ensure that no one can access the danger zone while muting is active.
- Ensure that each application conforms to an appropriate risk analysis and risk avoidance strategy.
- Never use the muting function for transporting persons into the hazardous area.

FB details

Muting is the intended suppression of the safety function. This is required, e.g., when transporting a workpiece into the danger zone without causing the machine to stop. Muting is triggered by muting sensors. The use of two or four muting sensors and correct integration into the production sequence must ensure that no persons enter the danger zone while the light curtain is muted. Muting sensors can be proximity switches, photoelectric barriers, limit switches, etc. which do not have to be failsafe. Active muting mode must be indicated by indicator lights (the muting lamp).

There are sequential and parallel muting procedures. In this FB, sequential muting with four muting sensors is used. An explanation for transporting of workpieces in forward direction is provided in the table below. The FB can be used in both directions, forward and backward. The muting should be enabled with the i_bMutingEnable signal by the process control when there is no manipulation in the danger zone.

The FB input parameters include the signals of the four muting sensors (i_bMutingSw_11 to i_bMutingSw_22) as well as the OSSD signal (i_bS_AOPD_In) from the "active opto-electronic protective device". For forward direction, from when both i_bMutingSw_11 and i_bMutingSw_12 turn ON to when only i_bMutingSw_22 is ON after i_bMutingSw_21 and i_bMutingSw_22 sequentially turn ON, muting is active (i_bS_AOPD_In=OFF is ignored and o_bS_AOPD_Out turns ON). For backward direction, from when both i_bMutingSw_21 and i_bMutingSw_22 turn ON to when only i_bS_Muting_11 is ON after i_bMutingSw_11 and i_bMutingSw_12 turn ON, muting is active.

When i_dMaxMutingTime is set to -1, the effective time of the muting control is unlimited.

■Example for M+SF_MUTES-2_R in forward direction with four sensors

Figure	Description
	If the muting sensor i_bMutingSw_11 (MS_11) and then i_bMutingSw_12 (MS_12) are activated by passage of a workpiece, the muting mode is activated.
	Muting mode remains active as long as MS_11 and MS_12 are activated by a workpiece. The workpiece may pass through the light curtain without causing a machine stop.
	Before muting sensors MS_11 and MS_12 are disabled, muting sensors i_bMutingSw_21 (MS_21) and i_bMutingSw_22 (MS_22) must be activated. This ensures that muting mode remains active.
	Muting mode is terminated if only muting sensor MS_22 is activated by a workpiece.

State diagram

State transition of M+SF_MUTES-2_R

All MS => All of MutingSwitch(i_bMutingSw_11, i_bMutingSw_12, i_bMutingSw_21, i_bMutingSw_22)
T1=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND i_bS_AOPD_IN=ON
T2=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND i_bS_MutingLamp=ON
T3=>i_bReset=ON AND R_TRIG at i_bReset=OFF AND All MS=OFF

Note 1: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Note 2: Within muting substates, transitions due to Error Muting sequence (priority 1), Error Timer (priority 2), Safety demand AOPD (priority 3) or Error Muting lamp (priority 4) have higher priority than transitions to Muting substates (priority 5).

Note 3: Muting condition 1-3/11-13 and Wrong muting sequences are shown in the following.
　　　　• Muting conditions 1-3 (☞ Page 115 Muting conditions (forward direction))
　　　　• Muting conditions 11-13 (☞ Page 115 Muting conditions (backward direction))
　　　　• Wrong muting sequences (☞ Page 115 Wrong muting sequences)

Note 4: Time parameter error (condition of transition from 8001H to C005H) is detected in the following case.
　　　　1) i_dMaxMutingTime has been set to a value less than 0ms or greater than 10min. (0 > i_dMaxMutingTime OR i_dMaxMutingTime > 60000). Time parameter error is not detected when i_dMaxMutingTime is set to -1.

Note 5: Timeover (transition from within muting substate to C006H) is not detected in the following situation:
　　　　• i_dMaxMutingTime is set to -1.

Muting conditions (forward direction)

| No.	State transition	Condition/action
1	8000H→8011H	MS_11 is the first entry switch actuated: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF→ON AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF
2	8011H→8012H	MS_12 is the second entry switch actuated: i_bMutingEnable=ON AND MS_11=ON AND MS_12=OFF→ON AND MS_21=OFF AND MS_22=OFF
3	8012H→8000H	MS_21 is the first exit switch released: Stop timer i_dMaxMutingTime. MS_11=OFF AND MS_12=OFF AND MS_21=ON→OFF AND MS_22=ON

Muting conditions (backward direction)

No.	State transition	Condition/action
11	8000H→8122H	MS_22 is the first entry switch actuated: Start timer i_dMaxMutingTime. i_bMutingEnable=ON AND MS_11=OFF AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF→ON
12	8122H→8112H	MS_21 is the second entry switch actuated: i_bMutingEnable=ON AND MS_11=OFF AND MS_12=OFF AND MS_21=OFF→ON AND MS_22=ON
13	8112H→8000H	MS_12 is the first exit switch actuated: Stop timer i_dMaxMutingTime. MS_11=ON AND MS_12=ON→OFF AND MS_21=OFF AND MS_22=OFF

Wrong muting sequences

Status	Wrong muting sequences
8000H	i_bMutingEnable=OFF AND MS_11=OFF→ON
	i_bMutingEnable=OFF AND MS_22=OFF→ON
	MS_12=ON OR MS_21=ON
	MS_11=ON AND MS_22=ON
8011H	i_bMutingEnable=OFF OR MS_11=OFF OR MS_21=ON OR MS_22=ON
8012H	MS_11=OFF→ON OR MS_12=OFF→ON OR MS_22=ON→OFF
	MS_11=ON AND MS_12=ON→OFF
	(MS_11=ON OR MS_12=ON) AND MS_21=ON→OFF
	(MS_11=OFF OR MS_12=OFF) AND MS_21=ON AND MS_22=OFF
	(MS_11=OFF OR MS_12=OFF OR MS_21=OFF) AND MS_22=OFF→ON
	MS_11=OFF AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF
	MS_11=ON AND (MS_12=OFF OR MS_21=OFF) AND MS_22=ON
	MS_11=OFF AND MS_12=ON AND MS_21=OFF AND MS_22=ON
	MS_21=OFF→ON AND MS_22=OFF→ON
	MS_11=ON→OFF AND MS_12=ON→OFF
	MS_12=ON→OFF AND MS_21=ON→OFF
	MS_11=OFF AND MS_12=ON AND MS_21=OFF
8112H	MS_11=ON→OFF OR MS_21=OFF→ON OR MS_22=OFF→ON
	MS_21=ON→OFF AND MS_22=ON
	MS_12=ON→OFF AND (MS_21=ON OR MS_22=ON)
	MS_11=OFF AND MS_12=ON AND (MS_21=OFF OR MS_22=OFF)
	MS_11=OFF→ON AND (MS_12=OFF OR MS_21=OFF OR MS_22=OFF)
	MS_11=OFF AND MS_12=OFF AND MS_21=OFF AND MS_22=OFF
	MS_11=ON AND (MS_12=OFF OR MS_21=OFF) AND MS_22=ON
	MS_11=ON AND MS_12=OFF AND MS_21=ON AND MS_22=OFF
	MS_11=OFF→ON AND MS_12=OFF→ON
	MS_21=ON→OFF AND MS_22=ON→OFF
	MS_12=ON→OFF AND MS_21=ON→OFF
	MS_12=OFF AND MS_21=ON AND MS_22=OFF
8122H	i_bMutingEnable=OFF OR MS_11=ON OR MS_12=ON OR MS_22=OFF

Typical timing diagram

■For M+SF_MUTES-2_R (forward direction)
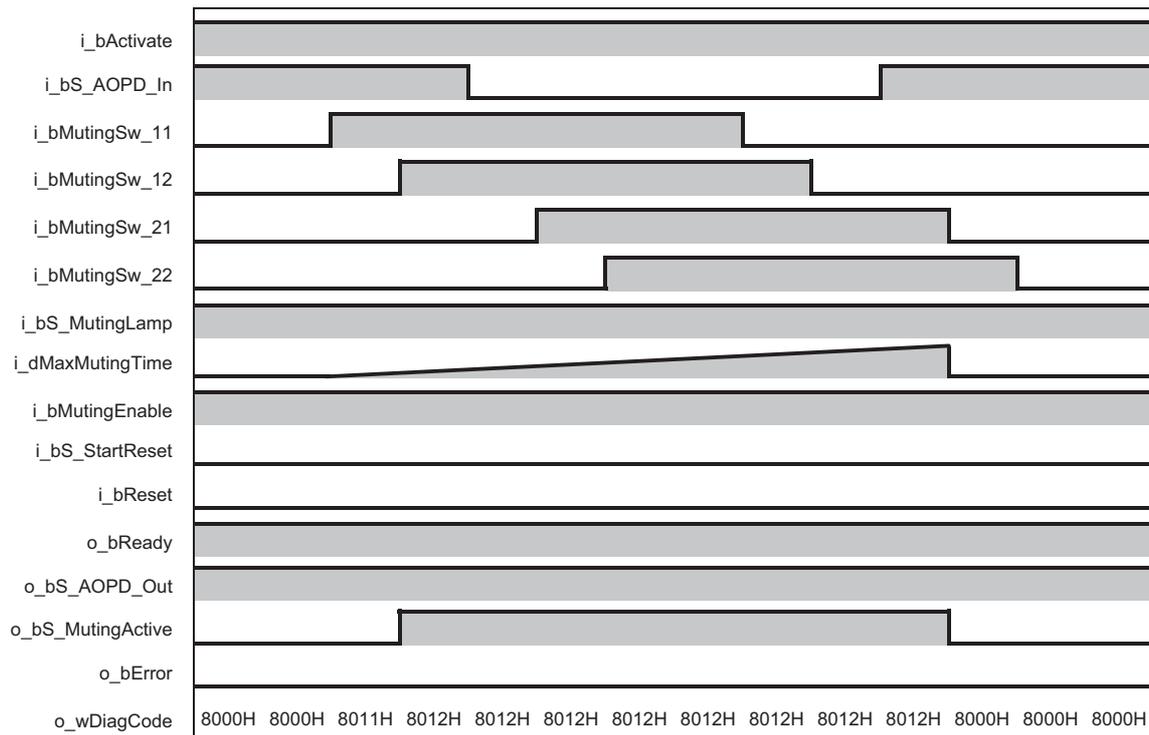
A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dMaxMutingTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_AOPD_Out	OFF
o_bS_MutingActive	OFF
o_bError	ON

For the corrective actions, see the following.

☞Page 117 List of error codes

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset condition detected after FB activation.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C003H	Error Muting Lamp	Error detected in muting lamp.	Set i_bReset to ON. Check the devices and wiring related to i_bReset.
C005H	Parameter Error	i_dMaxMutingTime value out of range.	Set a proper value to the parameter and set i_bReset to ON.
C006H	Error Timer MaxMuting	Timing error. Active muting time exceeds i_dMaxMutingTime.	Set all muting switches to OFF and set i_bReset to ON. Check the muting situation in the process.
C010H	Reset Error 2	Static i_bReset condition detected at 8002H.	Set i_bReset to OFF. Check the devices and wiring related to i_bReset.
C020H	Reset Error 3	Static i_bReset condition detected at C003H.	
C030H	Reset Error 4	Static i_bReset condition detected at CYx4H.	
C040H	Reset Error 5	Static i_bReset condition detected at C006H.	
CYx4H C004H to CFF4H	Error Muting Sequence	Error detected in muting sequence in state 8000H, 8011H, 8012H, 8112H, or 8122H. Y = Status in the sequence (2 states for forward and 2 states for backward direction). C0x4H = Error occurred in state 8000H C1x4H = Error occurred in state Forward 8011H C2x4H = Error occurred in state Forward 8012H C3x4H = Error occurred in state Backward 8122H C4x4H = Error occurred in state Backward 8112H CFx4H = i_bMutingEnable=OFF The states of wrong muting sequences (☞ Page 115 Wrong muting sequences) including i_bMutingEnable=OFF are always changed to CFx4H when i_bMutingEnable is set to OFF. (Never changed to other states.) x = Status of the sensors when error occurred (MS_11, MS_12, MS_21, MS_22) CY04H=OFF, OFF, OFF, OFF CY14H=ON, OFF, OFF, OFF CY24H=OFF, ON, OFF, OFF CY34H=ON, ON, OFF, OFF CY44H=OFF, OFF, ON, OFF CY54H=ON, OFF, ON, OFF CY64H=OFF, ON, ON, OFF CY74H=ON, ON, ON, OFF CY84H=OFF, OFF, OFF, ON CY94H=ON, OFF, OFF, ON CYA4H=OFF, ON, OFF, ON CYB4H=ON, ON, OFF, ON CYC4H=OFF, OFF, ON, ON CYD4H=ON, OFF, ON, ON CYE4H=OFF, ON, ON, ON CYF4H=ON, ON, ON, ON	Set all muting switches to OFF and set i_bReset to ON. Check the devices and wiring related to i_bReset.

4

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8000H	AOPD Free	Muting not active and no safety demand from AOPD. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	None. (Starting muting is possible.)
8001H	Init	The FB has been activated. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON.
8002H	Safety Demand AOPD	Safety demand detected by AOPD and muting not active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Set i_bReset to ON after the completion of safety demand.
8005H	Safe	The safety function is active. • o_bReady: ON • o_bS_AOPD_Out: OFF • o_bS_MutingActive: OFF • o_bError: OFF	Wait the completion of safety demand.
8011H	Muting Forward Start	Muting forward sequence is in the starting phase and no safety demand. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	• Set both muting switches (i_bMutingSw_11 and i_bMutingSw_12) to ON. • Complete muting within i_dMaxMutingTime.
8012H	Muting Forward Active	Muting forward sequence is active. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	Complete muting within i_dMaxMutingTime.
8112H	Muting Backward Active	Muting backward sequence is active. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: ON • o_bError: OFF	
8122H	Muting Backward Start	Muting backward sequence is in starting phase and no safety demand. • o_bReady: ON • o_bS_AOPD_Out: ON • o_bS_MutingActive: OFF • o_bError: OFF	• Set both muting switches (i_bMutingSw_21 and i_bMutingSw_22) to ON. • Complete muting within i_dMaxMutingTime.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
 • Setting of i_bS_StartReset

4.16 M+SF_OUTC_R

Overview

Item	Description
Function name	Output control
Functional overview	Control of a safety output with a signal from the standard application and a safety signal with optional startup inhibits.
Symbol	

```
                    M+SF_OUTC_R
(1) ——— B: i_bActivate          o_bReady: B  ——— (8)
(2) ——— B: i_bS_SafeControl   o_bS_OutControl: B ——— (9)
(3) ——— B: i_bProcessControl      o_bError: B  ——— (10)
(4) ——— B: i_bStaticControl    o_wDiagCode: W  ——— (11)
(5) ——— B: i_bS_StartReset
(6) ——— B: i_bS_AutoReset
(7) ——— B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_SafeControl	Bit*	OFF	Safety output signals from other FB libraries. OFF: Safety output signals from other FB libraries are OFF. ON: Safety output signals from other FB libraries are ON.
(3)	i_bProcessControl	Bit	OFF	Control signal from the standard application. OFF: Request to set i_bS_OutControl to OFF. ON: Request to set i_bS_OutControl to ON.
(4)	i_bStaticControl	Bit	OFF	Optional conditions for process control. (Constant) OFF: Dynamic change at i_bProcessControl (OFF to ON) required after FB activation or triggered safety function. ON: No dynamic change at i_bProcessControl (OFF to ON) required after FB activation or triggered safety function. If i_bProcessControl is set to ON, safety output is set to ON.
(5)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(6)	i_bS_AutoReset	Bit*	OFF	Selection of a reset method for the input signal reset to ON. For details, see the following. ☞ Page 11 General Functions
(7)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(8)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(9)	o_bS_OutControl	Bit*	OFF	Controls connected actuators. OFF: Disable connected actuators. ON: Enable connected actuators.
(10)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(11)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.

FB details

This FB is an output driver for a safety output. The safety output is controlled via M+SF_OUTC_R using a signal from the standard application (i_bProcessControl) and a signal from the safety application (i_bS_SafeControl).

■Optional conditions for process control (i_bProcessControl).

i_bStaticControl is able to set the option of an additional function start (i_bProcessControl OFF to ON) following the FB activation or feedback of the safe signal.

- i_bStaticControl=OFF: An additional function start (i_bProcessControl OFF to ON) is required following FB activation or feedback of the safe signal (i_bS_SafeControl). A static ON signal at i_bProcessControl does not set i_bS_OutControl to ON.
- i_bStaticControl=ON: An additional function start (i_bProcessControl OFF to ON) is not required following FB activation or feedback of the safe signal (i_bS_SafeControl). The static ON signal at i_bProcessControl sets i_bS_OutControl to ON if the other conditions have been met.

⚠ WARNING

Safe data (e.g. emergency stop demand) must not connect to i_bProcessControl. You are responsible for planning the behavior of the stop functions according to the result of your risk analysis for the safety function.
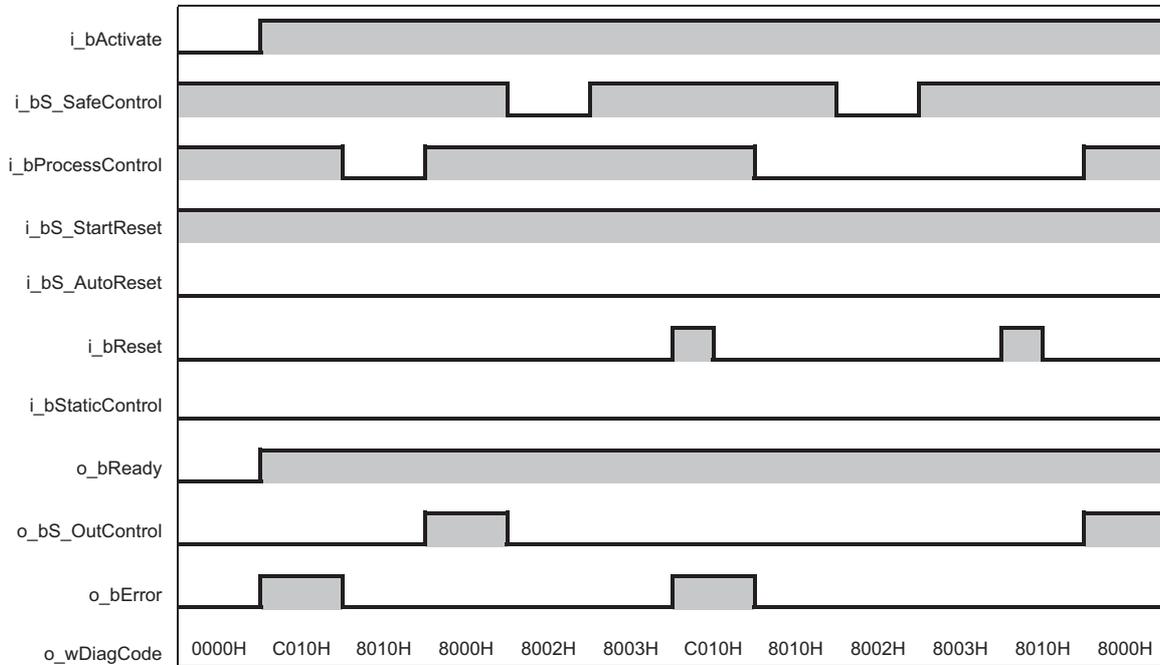
State diagram

State transition of M+SF_OUTC_R

i_bActivate=OFF

Idle
0000H

1

i_bActivate=ON

o_bReady=OFF

- -

o_bReady=ON

0

(R_TRIG at i_bReset)=ON
AND (R_TRIG at i_bProcessControl)=ON

i_bReset=ON AND
R_TRIG at i_bReset=OFF
AND i_bStartReset=OFF

Init
Error
C111H

1

2

Init
8001H

1

1

Reset
Error 1
C001H

i_bReset=OFF

i_bReset=OFF

3

R_TRIG at i_bReset=ON
OR i_bStartReset=ON

(i_bReset=ON AND (R_TRIG at i_bReset)=OFF)
AND i_bAutoReset=OFF

Reset
Error 2
C002H

2

1

i_bReset=OFF

i_bS_SafeControl=ON

1

Safe
8002H

Lock
8003H

4

1

i_bS_SafeControl=OFF

3

i_bReset=OFF

1

Control
Error
C010H

1

i_bProcessControl
=OFF

(R_TRIG at i_bReset)=ON
AND (R_TRIG at
i_bProcessControl)=ON

Lock
Error
C211H

R_TRIG at i_bProcessControl
AND i_bProcessControl=OFF
AND i_bProcessControl=ON
AND i_bStaticControl =OFF

(R_TRIG at i_bReset)=ON
OR i_bAutoReset=ON

Output
disable
8010H

1

i_bS_SafeControl=OFF

2

3

i_bS_SafeControl=ON AND
(R_TRIG at i_bProcessControl=ON
OR
(i_bStaticControl=ON AND
i_bProcessControl=ON))

i_bProcessControl=OFF

i_bS_SafeControl=OFF

o_bS_OutControl = OFF

- -

o_bS_OutControl = ON

2

Output
Enable
8000H

1

Note: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_OUTC_R (i_bS_StartReset=OFF and i_bS_AutoReset=OFF)
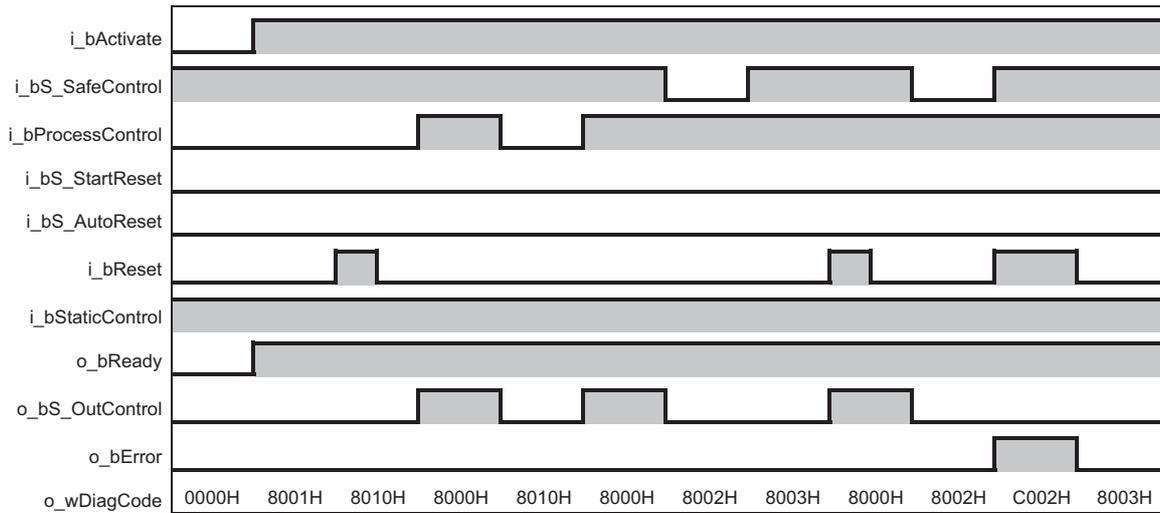
■For M+SF_OUTC_R (i_bS_StartReset=ON and i_bS_AutoReset=OFF)

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_OutControl	OFF
o_bError	ON

For the corrective actions, see the following.

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Reset Error 1	Static i_bReset signal in state 8001H.	Set i_bReset to OFF. Check the devices and wiring of i_bReset.
C002H	Reset Error 2	Static i_bReset signal in state 8003H.	
C010H	Control Error	Static signal at i_bProcessControl in state 8010H.	Set i_bProcessControl to OFF. Check the setting of i_bStaticControl.
C111H	Init Error	Simultaneous rising trigger at i_bReset and i_bProcessControl in state 8001H.	Set i_bReset to OFF. Check the independence between i_bProcessControl and i_bReset.
C211H	Lock Error	Simultaneous rising trigger at i_bReset and i_bProcessControl in state 8003H.	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (initial state) All outputs are set to OFF. • o_bReady: OFF • o_bS_OutControl: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8001H	Init	The FB activation startup inhibit is active. • o_bReady: ON • o_bS_OutControl: OFF • o_bError: OFF	i_bReset required.
8002H	Safe	Triggered safety FB. Safety outputs are disabled. i_bS_SafeControl=OFF • o_bReady: ON • o_bS_OutControl: OFF • o_bError: OFF	i_bS_SafeControl required.
8003H	Lock	Safety function startup inhibit is active. • o_bReady: ON • o_bS_OutControl: OFF • o_bError: OFF	i_bReset required.
8010H	Output Disable	Process control is not active and safety is disabled. • o_bReady: ON • o_bS_OutControl: OFF • o_bError: OFF	i_bProcessControl required.
8000H	Output Enable	Process control is active and safety is enabled. • o_bReady: ON • o_bS_OutControl: ON • o_bError: OFF	None.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
 • Setting of i_bS_StartReset and i_bS_AutoReset

Application example

An application example of M+SF_OUTC_R is shown below.
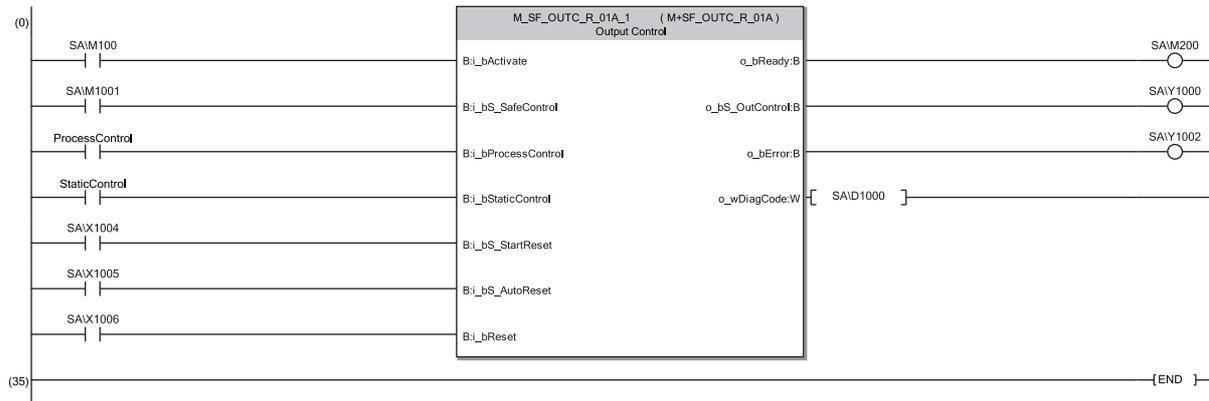
■Labels

• Input labels

Variable name	Allocated device/label	Description
i_bActivate	SA\M100	Activation of the safety FB
i_bS_SafeControl	SA\M1001	Safety status (status of the emergency stop button and ESPE)
i_bProcessControl	ProcessControl (standard/safety shared label)	Functional restart input from standard programmable controller (via a standard input)
i_bStaticControl	StaticControl (standard/safety shared label)	Optional conditions for process control
i_bS_StartReset	SA\X1004	Reset method for the activated safety FB
i_bS_AutoReset	SA\X1005	Reset method for the input signal reset to ON
i_bReset	SA\X1006	Reset switch

• Output labels

Variable name	Allocated device/label	Description
o_bReady	SA\M200	Status of whether the safety FB is activated or not.
o_bS_OutControl	SA\Y1000	Control of actuator
o_bError	SA\Y1002	Error flag
o_wDiagCode	SA\D1000	Diagnostic code

4.17 M+SF_TSSEN_R

Overview

Item	Description
Function name	Testable safety sensor
Functional overview	This FB can be used for external testable safety sensors (ESPE: electro-sensitive protective equipment, such as a light beam).
Symbol	

```
                    M+SF_TSSEN_R
(1) ——— B: i_bActivate            o_bReady: B    ——— (9)
(2) ——— B: i_bS_OSSD_In         o_bS_OSSD_Out: B ——— (10)
(3) ——— B: i_bStartTest          o_bS_TestOut: B ——— (11)
(4) ——— D: i_dTestTime         o_bTestPossible: B ——— (12)
(5) ——— B: i_bNoExternalTest   o_bTestExecuted: B ——— (13)
(6) ——— B: i_bS_StartReset             o_bError: B ——— (14)
(7) ——— B: i_bS_AutoReset         o_wDiagCode: W ——— (15)
(8) ——— B: i_bReset
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_OSSD_In	Bit*	OFF	Status of sensor output, e.g., light curtain. OFF: Safety sensor in test state or demand for safety-related response. ON: Sensor in the state for normal operating conditions.
(3)	i_bStartTest	Bit	OFF	Input to start sensor test. Set o_bS_TestOut and start the internal time monitoring function in the FB. OFF: No test requested ON: Test requested
(4)	i_dTestTime	Double word [signed]	0	Test time of safety sensor. (Increments of 10ms) Range: Fixed values from 0 to 15 (0 to 150ms)
(5)	i_bNoExternalTest	Bit	OFF	Indicates if external manual sensor test is supported. OFF: The external manual sensor test is supported. Only after a complete manual sensor switching sequence, an automatic test is possible again after a faulty automatic sensor test. ON: The external manual sensor test is not supported. An automatic test is possible again without a manual sensor switching sequence after faulty automatic sensor test.
(6)	i_bS_StartReset	Bit*	OFF	Selection of a reset method for the activated (first time) safety FB. For details, see the following. ☞ Page 11 General Functions
(7)	i_bS_AutoReset	Bit*	OFF	Selection of a reset method for the input signal reset to ON. For details, see the following. ☞ Page 11 General Functions
(8)	i_bReset	Bit	OFF	Reset input. For details, see the following. ☞ Page 11 General Functions

■Output labels

No.	Variable name	Data type	Default value	Description
(9)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(10)	o_bS_OSSD_Out	Bit*	OFF	Safety output indicating the status of the ESPE. OFF: The sensor has a safety-related action request or test error. ON: The sensor has no safety-related action request and no test error.
(11)	o_bS_TestOut	Bit*	ON	Coupled with the test input of the sensor. OFF: Test request issued ON: No test request
(12)	o_bTestPossible	Bit	OFF	Feedback signal to the process. OFF: An automatic sensor test is not possible. ON: An automatic sensor test is possible.
(13)	o_bTestExecuted	Bit	OFF	A positive signal edge indicates the successful execution of the automatic sensor test. OFF: An automatic sensor test was not executed yet, an automatic sensor test is active, or an automatic sensor test was faulty. ON: A sensor test was executed successfully.
(14)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(15)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

• Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
• A safety program is executed as a fixed scan execution type program.
• A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
 · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
 · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.

FB details

Type 2 ESPE shall have a means of periodic testing to detect a hazardous fault (e.g., loss of sensing unit detection capability, response time exceeding that specified).

The test shall verify that each light beam operates in the manner specified by the supplier. The test signal shall simulate the actuation of the sensing device and the duration of the periodic test shall not exceed 150ms. The upper limit of test time is set by the i_dTestTime parameter, and the FB monitors the test time and detects an error.

⚠ WARNING

• The ESPE must be selected in respect of the product standards IEC 61496-1, -2 and -3 and ISO 13849-1.
• In order to use this FB, the ESPE shall be provided with suitable input facilities (e.g., terminals) and the test functions.
• Perform the sensor test at appropriate intervals on applications.

Automatic test sequence

1. i_bStartTest=ON: o_bS_TestOut=OFF. Start monitoring time.

2. o_bS_TestOut signal stops the light of sensors. (Monitoring of i_dTestTime started for the first time)

3. i_bS_OSSD_In changes from ON to OFF. (Monitoring of i_dTestTime started for the second time)

4. o_bS_TestOut changes from OFF to ON.

5. Restart the light of sensors.

6. i_bS_OSSD_In changes from OFF to ON.

7. Stop monitoring time

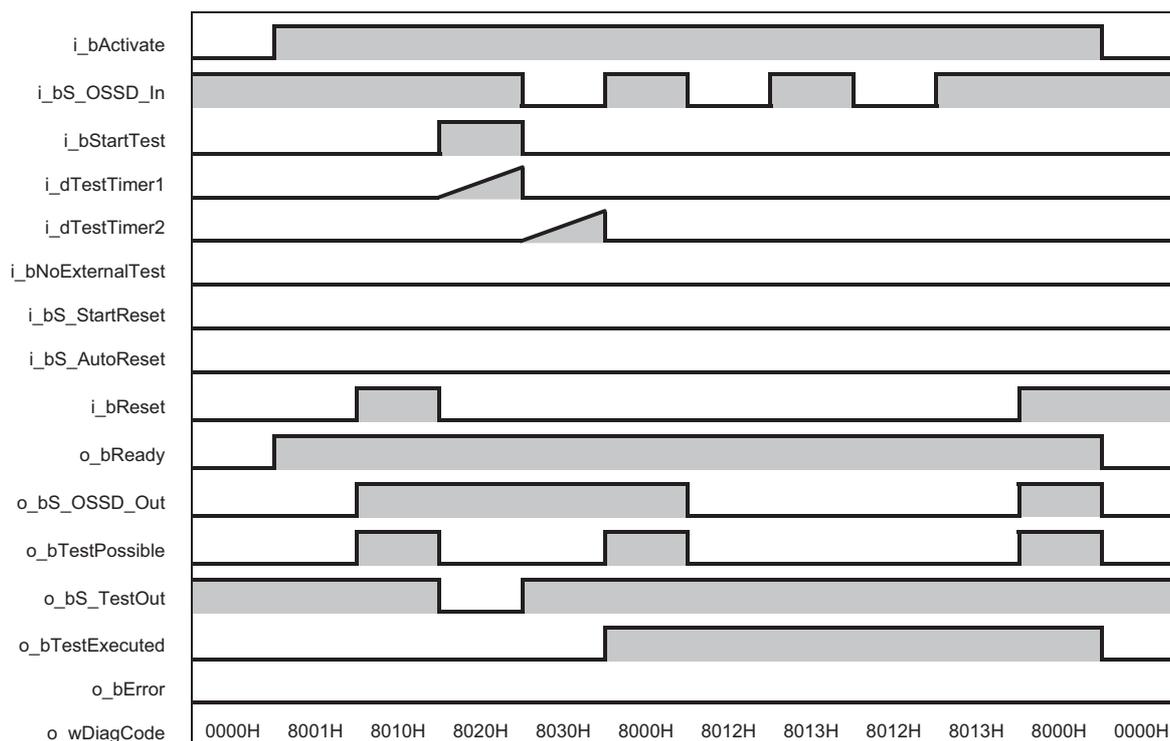**8.** o_bS_OSSD_Out is set to ON during testing.

State diagram

State transition of M+SF_TSSEN_R
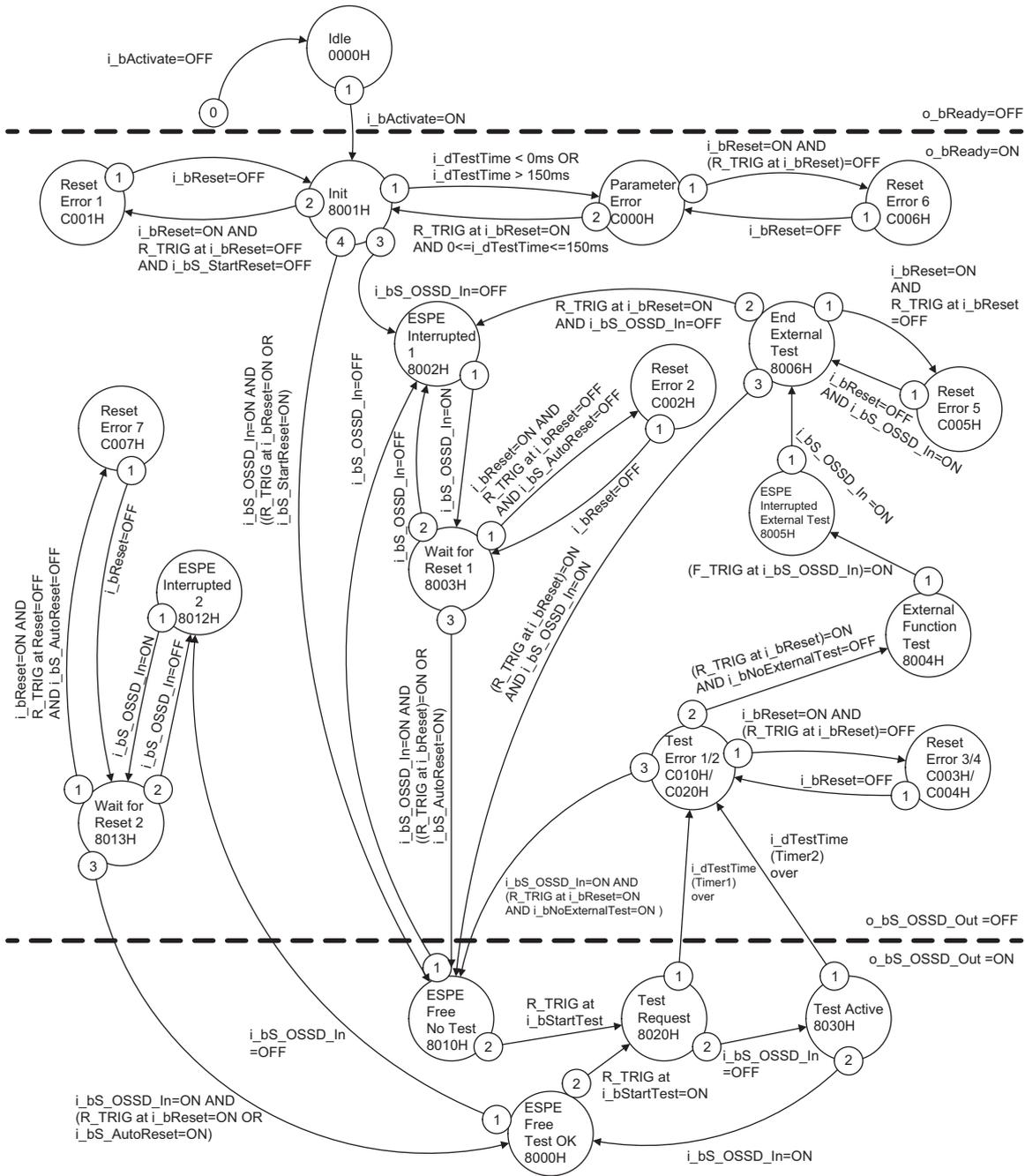
Note 1: The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_TSSEN_R

A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dTestTimer1 and i_dTestTimer2 elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_OSSD_Out	OFF
o_bS_TestOut	ON
o_bTestPossible	OFF
o_bTestExecuted	OFF
o_bError	ON

The C007H output signal is excluded from the signals in the list. For the output signal status and corrective actions of C007H, see the following.

☞ Page 129 List of error codes

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C000H	Parameter Error	Invalid value at the i_dTestTime parameter. Values between 0ms to 150ms are possible.	Set a proper value for i_dTestTime.
C001H	Reset Error 1	Static i_bReset condition detected after FB activation.	Set i_bReset to OFF. Check the wiring and devices related to i_bReset signal.
C002H	Reset Error 2	Static i_bReset condition detected in state 8003H.	
C003H	Reset Error 3	Static i_bReset condition detected in state C010H.	
C004H	Reset Error 4	Static i_bReset condition detected in state C020H.	
C005H	Reset Error 5	Static i_bReset condition detected in state 8006H.	
C006H	Reset Error 6	Static i_bReset condition detected in state C000H.	
C007H	Reset Error 7	Static i_bReset condition detected in state 8013H. • o_bReady: ON • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: ON • o_bError: ON	
C010H	Test Error 1	i_bS_OSSD_In is not set to OFF during the testing time. (State 8020H)	Check the connected sensors. Remove the error and set i_bReset to ON. Note: Repeat the automatic test and re-evaluate the result of this repeat test.
C020H	Test Error 2	i_bS_OSSD_In is not set to ON during the testing time. (State 8030H)	

List of status codes (no error)

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8001H	Init	Activation has been detected by the FB. • o_bReady: ON • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: OFF • o_bError: OFF	Set i_bS_OSSD_In and i_bReset to ON.
8002H	ESPE Interrupted 1	The FB has detected a safety demand. The switch has not been automatically tested yet. • o_bReady: ON • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: OFF • o_bError: OFF	Reset the safety demand for the connected safeguard by resetting the interruption of the sensors. Check a failure or an error of the sensor.
8003H	Wait for Reset 1	Wait for rising trigger of i_bReset after state 8002H. • o_bReady: ON • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: OFF • o_bError: OFF	Set i_bReset to ON.

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
8004H	External Function Test	The automatic sensor test was faulty. An external manual sensor test is necessary. (i_bNoExternalTest is OFF.) A negative signal (i_bS_OSSD_In) edge at the sensor is required. • o_bReady: ON • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: OFF • o_bError: OFF	Generate a safety demand (e.g. across the beam of the sensor).
8005H	ESPE Interrupted External Test	The automatic sensor test was faulty. An external manual sensor test is necessary. (i_bNoExternalTest is OFF.) An ON feedback signal (i_bS_OSSD_In) from the sensor is required. • o_bReady: ON • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: OFF • o_bError: OFF	Remove the safety demand from the sensor.
8006H	End External Test	The external manual test is complete. • o_bReady: ON • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: OFF • o_bError: OFF	Set i_bReset to ON.
8010H	ESPE Free No Test	The FB has not detected a safety demand. (The sensor has not been tested automatically.) • o_bReady: ON • o_bS_OSSD_Out: ON • o_bS_TestOut: ON • o_bTestPossible: ON • o_bTestExecuted: OFF • o_bError: OFF	Execute the automatic test by setting i_bS_StartReset to ON.
8020H	Test Request	The automatic sensor test is active. The light of sensors is stopped (o_bS_TestOut is set to OFF), and the testing time to wait for the OFF OSSD signal of sensors (i_bS_OSSD_In is set to OFF) is monitored (first time). • o_bReady: ON • o_bS_OSSD_Out: ON • o_bS_TestOut: OFF • o_bTestPossible: OFF • o_bTestExecuted: OFF • o_bError: OFF	None.
8030H	Test Active	The automatic sensor test is active. The light of sensors is restarted (o_bS_TestOut is set to ON), and the testing time to wait for the ON OSSD signal of sensors (i_bS_OSSD_In is set to ON.) is monitored (second time). • o_bReady: ON • o_bS_OSSD_Out: ON • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: OFF • o_bError: OFF	
8000H	ESPE Free Test OK	The FB has not detected a safety demand. (The sensor was automatically tested.) • o_bReady: ON • o_bS_OSSD_Out: ON • o_bS_TestOut: ON • o_bTestPossible: ON • o_bTestExecuted: ON • o_bError: OFF	None. In order to carry out the automatic sensor test again, change i_bStartTest from OFF to ON.

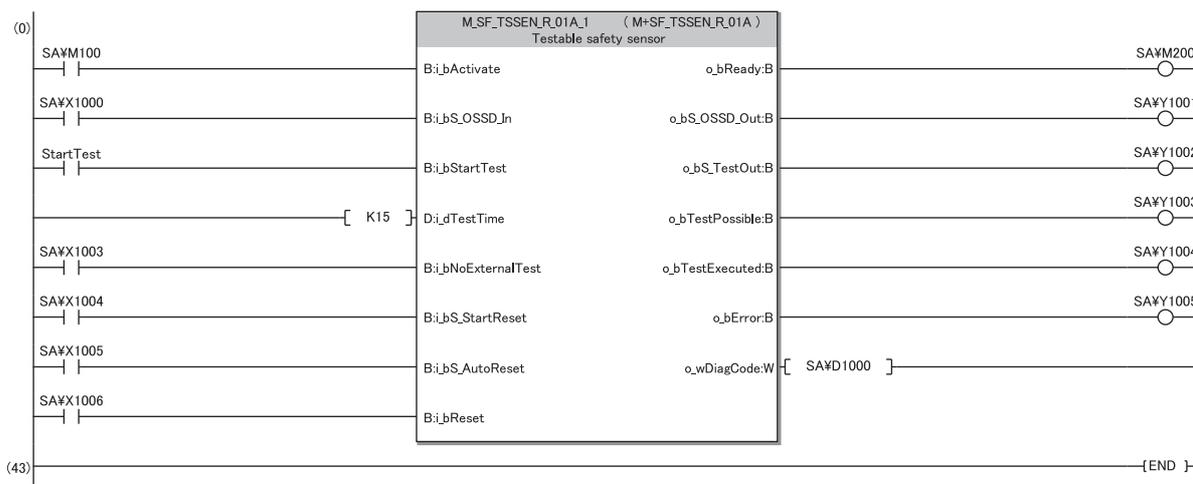| o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
8012	ESPE Interrupted 2	The FB has detected a safety demand from the sensor at the status 8000H or 8013H. The switch was automatically tested. • o_bReady: ON • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: ON • o_bError: OFF	Reset the safety demand for the connected safeguard by resetting the interruption of the sensors. Check a failure or an error of the sensor.
8013	Wait for Reset 2	Wait for rising trigger of i_bReset after state 8012H. • o_bReady: ON • o_bS_OSSD_Out: OFF • o_bS_TestOut: ON • o_bTestPossible: OFF • o_bTestExecuted: ON • o_bError: OFF	Set i_bReset to ON.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables
 • Setting of i_bS_StartReset and i_bS_AutoReset

4

Application example

An application example of M+SF_TSSEN_R is shown below.

■Labels

• Input labels

Variable name	Allocated device/label	Description
i_bActivate	SA\M100	Activation of the safety FB
i_bS_OSSD_In	SA\X1000	Light curtain output signal
i_bStartTest	StartTest (standard/safety shared label)	Start test switch (standard control input)
i_dTestTime	K15	Test time of safety sensor
i_bNoExternalTest	SA\X1003	Manual sensor test status
i_bS_StartReset	SA\X1004	Reset method for the activated safety FB
i_bS_AutoReset	SA\X1005	Reset method for the input signal reset to ON
i_bReset	SA\X1006	Reset switch

• Output labels

Variable name	Allocated device/label	Description
o_bReady	SA\M200	Status of whether the safety FB is activated or not.
o_bS_OSSD_Out	SA\Y1001	Light curtain safety demand considering the test
o_bS_TestOut	SA\Y1002	Automatic sensor test request
o_bTestPossible	SA\Y1003	Possibility of an automatic test
o_bTestExecuted	SA\Y1004	Result of an automatic test
o_bError	SA\Y1005	Error flag
o_wDiagCode	SA\D1000	Diagnostic code

4.18 M+SF_EQUI_R

Overview

Item	Description
Function name	Dual input (NC+NC or NO+NO])
Functional overview	This FB converts two equivalent bit inputs (both NO or NC) to one bit with discrepancy time monitoring. This FB output shows the result of the evaluation of both channels.
Symbol	

```
                    M+SF_EQUI_R
(1) ——— B: i_bActivate            o_bReady: B ——— (5)
(2) ——— B: i_bS_ChannelA   o_bS_EquivalentOut: B ——— (6)
(3) ——— B: i_bS_ChannelB          o_bError: B ——— (7)
(4) ——— D: i_dDiscrepancyTime  o_wDiagCode: W ——— (8)
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_ChannelA	Bit*	OFF	Safety input signal A OFF: Contact A OFF ON: Contact A ON
(3)	i_bS_ChannelB	Bit*	OFF	Safety input signal B OFF: Contact B OFF ON: Contact B ON
(4)	i_dDiscrepancyTime	Double word [signed]	0	Configures the monitoring time for discrepancy status of i_bS_ChannelA and i_bS_ChannelB (in increments of 10ms). Range: Fixed values from 0 to 60000 (0 to 600000ms = 10min)

■Output labels

No.	Variable name	Data type	Default value	Description
(5)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(6)	o_bS_EquivalentOut	Bit*	OFF	Safety output signal. OFF: Either i_bS_ChannelA or i_bS_ChannelB, or both of them are set to OFF. Or, both i_bS_ChannelA and i_bS_ChannelB are set to ON, but the time is out of the monitoring time of i_dDiscrepancyTime. ON: Both i_bS_ChannelA and i_bS_ChannelB have been set to ON within the monitoring time of i_dDiscrepancyTime.
(7)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(8)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.

FB details

o_bS_EquivalentOut is set to ON or OFF as below depending on the status of i_bS_ChannelA and i_bS_ChannelB.

No.	i_bS_ChannelA status	i_bS_ChannelB status	o_bS_EquivalentOut output value
1	OFF	OFF	OFF
2	OFF	ON	OFF
3	ON	OFF	OFF
4	ON	ON	ON

If the status of numbers 2 and 3 listed in the table above continues beyond i_dDiscrepancyTime, the safety FB detects an error and the status becomes error.

State diagram

State transition of M+SF_EQUI_R
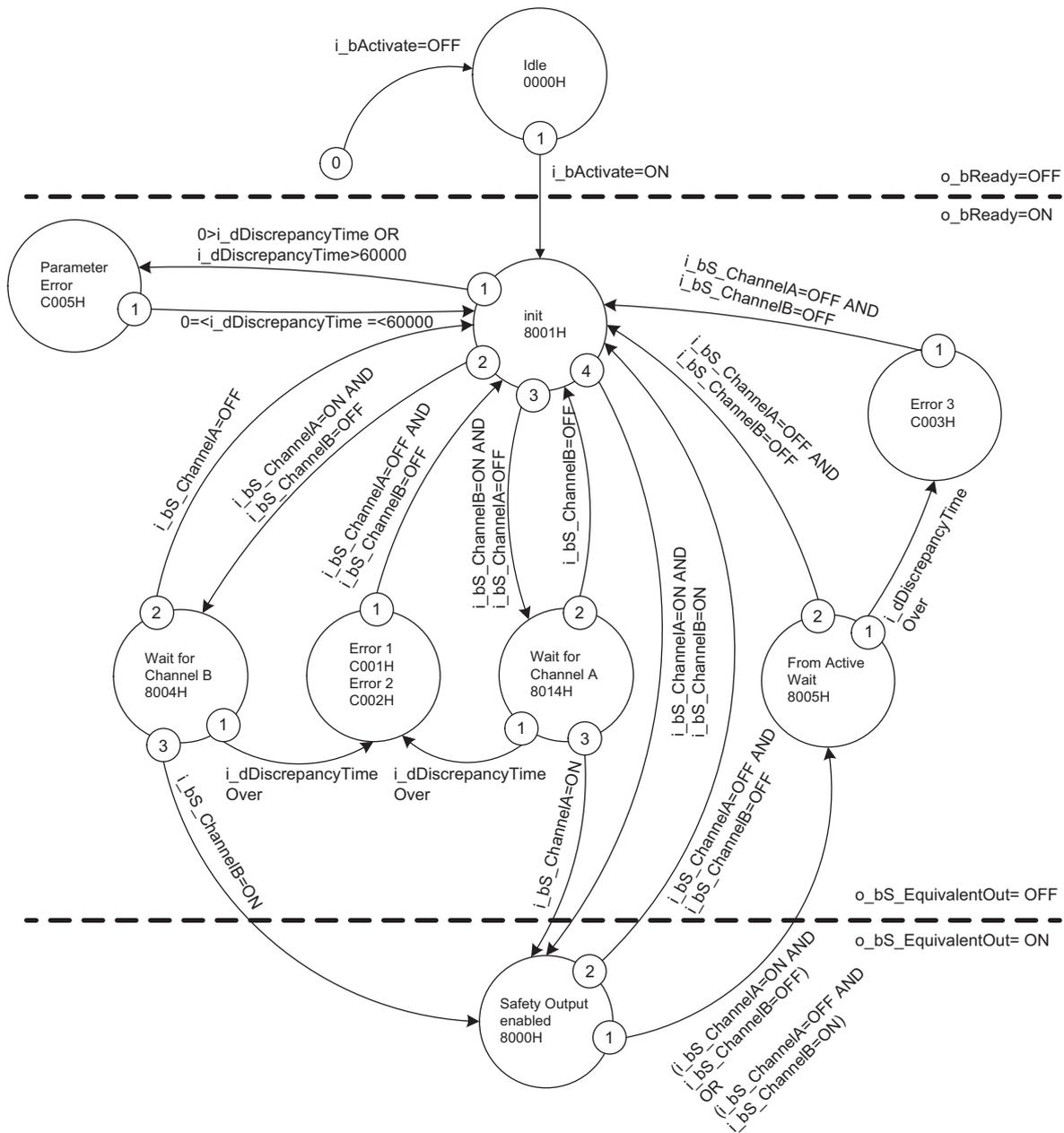
Note 1:   The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_EQUI_R
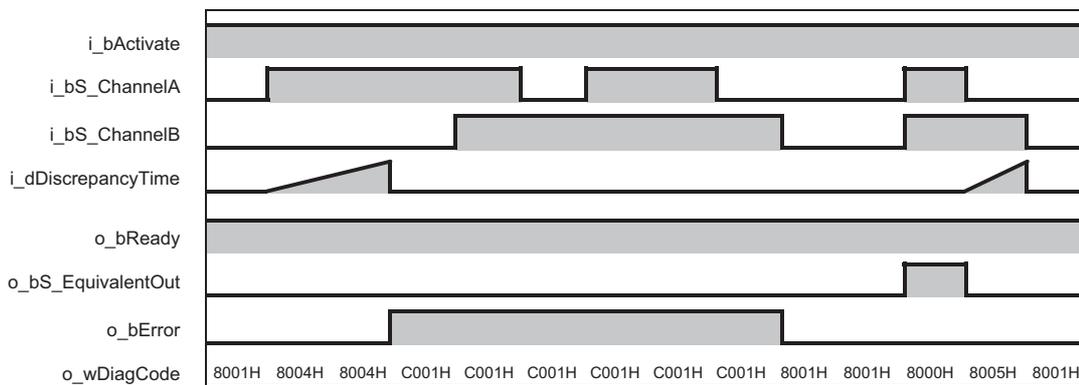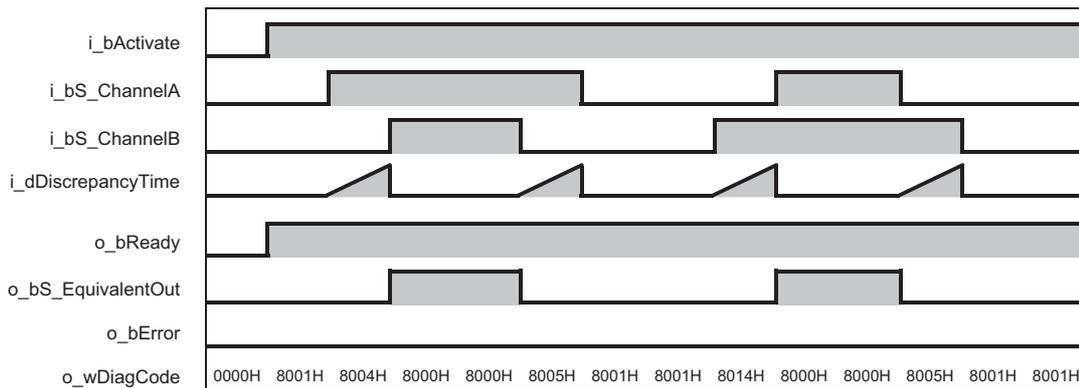
A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dDiscrepancyTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_EquivalentOut	OFF
o_bError	ON

For the corrective actions, see the following.

☞ Page 136 List of error codes

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Error 1	i_bS_ChannelA has been switched to ON. Switching i_bS_ChannelB to ON has been waited for, but it has not been switched within the setting value of i_dDiscrepancyTime.	Review the i_dDiscrepancyTime setting value. Set both i_bS_ChannelA and i_bS_ChannelB to OFF.
C002H	Error 2	i_bS_ChannelB has been switched to ON. Switching i_bS_ChannelA to ON has been waited for, but it has not been switched within the setting value of i_dDiscrepancyTime.	
C003H	Error 3	Both i_bS_ChannelA and i_bS_ChannelB are ON and then either one of both has been switched to OFF. Switching the other one to OFF has been waited for, but it has not been switched within the setting value of i_dDiscrepancy Time.	
C005H	Parameter Error	The i_dDiscrepancyTime value is out of the setting range.	Configure the i_dDiscrepancyTime value within the setting range.

List of status codes (no error)

| o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_EquivalentOut: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8001H	Init	The FB is active. Activation is ON. • o_bReady: ON • o_bS_EquivalentOut: OFF • o_bError: OFF	Wait for i_bS_ChannelA and i_bS_ChannelB to be set to ON.
8000H	Safety Output Enabled	The safety output is ON. • o_bReady: ON • o_bS_EquivalentOut: ON • o_bError: OFF	None.
8004H	Wait for Channel B	i_bS_ChannelA is ON and i_bS_ChannelB is OFF. State change of i_bS_ChannelB to ON is being waited for. • o_bReady: ON • o_bS_EquivalentOut: OFF • o_bError: OFF	Set i_bS_ChannelB to ON.
8014H	Wait for Channel A	i_bS_ChannelA is OFF and i_bS_ChannelB is ON. State change of i_bS_ChannelA to ON is being waited for. • o_bReady: ON • o_bS_EquivalentOut: OFF • o_bError: OFF	Set i_bS_ChannelA to ON.
8005H	From Active Wait	Both i_bS_ChannelA and i_bS_ChannelB are ON and then either one of both has been switched to OFF. • o_bReady: ON • o_bS_EquivalentOut: OFF • o_bError: OFF	Set both i_bS_ChannelA and i_bS_ChannelB to OFF.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
• A failure in safety devices and emergency stop devices
• Wiring and status of a safety remote I/O module and a safety programmable controller
• Programming logic, the memory allocation of safety devices, and the connections of safety FB variables

Application example

An application example of M+SF_EQUI_R is shown below.
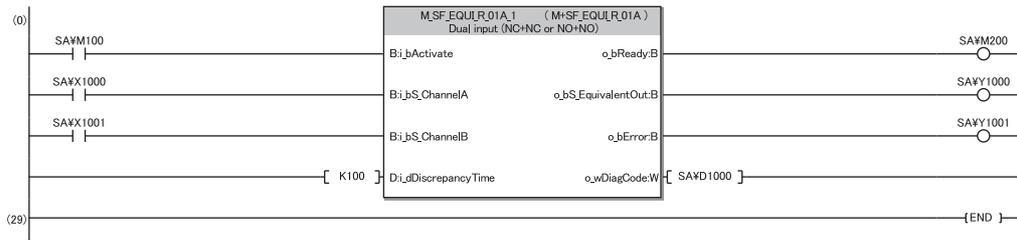
■Labels

• Input labels

Variable name	Allocated device/label	Description
i_bActivate	SA\M100	Activation of the safety FB
i_bS_ChannelA	SA\X1000	Safety input signal A
i_bS_ChannelB	SA\X1001	Safety input signal B
i_dDiscrepancyTime	K100	Max. discrepancy time for i_bS_ChannelA and i_bS_ChannelB

• Output labels

Variable name	Allocated device/label	Description
o_bReady	SA\M200	Status of whether the safety FB is activated or not.
o_bS_EquivalentOut	SA\Y1000	Safety output signal
o_bError	SA\Y1001	Error flag
o_wDiagCode	SA\D1000	Diagnostic code

4.19 M+SF_ANTI_R

Overview

Item	Description
Function name	Dual input (NO+NC)
Functional overview	This FB converts two antivalent bit inputs (NO/NC pair) to one bit output with discrepancy time monitoring. The FB output shows the result of the evaluation of both channels.
Symbol	

```
                        M+SF_ANTI_R
(1) ───── B: i_bActivate              o_bReady: B ───── (5)
(2) ───── B: i_bS_ChannelNC    o_bS_AntivalentOut: B ───── (6)
(3) ───── B: i_bS_ChannelNO           o_bError: B ───── (7)
(4) ───── D: i_dDiscrepancyTime     o_wDiagCode: W ───── (8)
```

Labels

■Input labels

No.	Variable name	Data type	Default value	Description
(1)	i_bActivate	Bit	OFF	Activation of the safety FB. For details, see the following. ☞ Page 11 General Functions
(2)	i_bS_ChannelNC	Bit*	OFF	Safety input signal (NC contact) OFF: NC contact open ON: NC contact closed
(3)	i_bS_ChannelNO	Bit*	OFF	Safety input signal (NO contact) OFF: NO contact open ON: NO contact closed
(4)	i_dDiscrepancyTime	Double word [signed]	0	Configures the monitoring time for consistent status of i_bS_ChannelNC and i_bS_ChannelNO (increments of 10ms). Range: Fixed values from 0 to 60000 (0 to 600000ms = 10min)

■Output labels

No.	Variable name	Data type	Default value	Description
(5)	o_bReady	Bit	OFF	Status of whether the safety FB is activated or not. For details, see the following. ☞ Page 11 General Functions
(6)	o_bS_AntivalentOut	Bit*	OFF	Safety output signal. OFF: Status other than i_bS_ChannelNC=ON or i_bS_ChannelNO=OFF. Or, i_bS_ChannelNC has been set to ON and i_bS_ChannelNO has been set to OFF, but the time is out of the monitoring time of i_dDiscrepancyTime. ON: i_bS_ChannelNC has been set to ON and i_bS_ChannelNO has been set to OFF within the monitoring time of i_dDiscrepancyTime.
(7)	o_bError	Bit	OFF	Error flag. For details, see the following. ☞ Page 11 General Functions
(8)	o_wDiagCode	Word [signed]	0	Diagnostic code. For details, see the following. ☞ Page 11 General Functions

⚠ WARNING

- Use safety data for connecting the variable whose data type is "Bit*" to input-output circuits.
- A safety program is executed as a fixed scan execution type program.
- A safety program is executed at a fixed cycle according to a set safety cycle time. The safety FB that monitors the time must meet the following requirements.
  · The timeout processing may be delayed by the safety cycle time by executing the safety program. Set the safety cycle time so the delay by the safety cycle time does not pose a hazard.
  · If the program is executed exceeding the safety cycle processing time, the timeout may be delayed. Ensure that an abnormality does not occur during operation.

FB details

o_bS_AntivalentOut is set to ON or OFF as below depending on the status of i_bS_ChannelNC and i_bS_ChannelNO.

No.	i_bS_ChannelNC status	i_bS_ChannelNO status	o_bS_AntivalentOut output value
1	OFF	OFF	OFF
2	OFF	ON	OFF
3	ON	OFF	ON
4	ON	ON	OFF

If the status of numbers 1 and 4 listed in the table above continues beyond i_dDiscrepancyTime, the safety FB detects an error and the status becomes error.
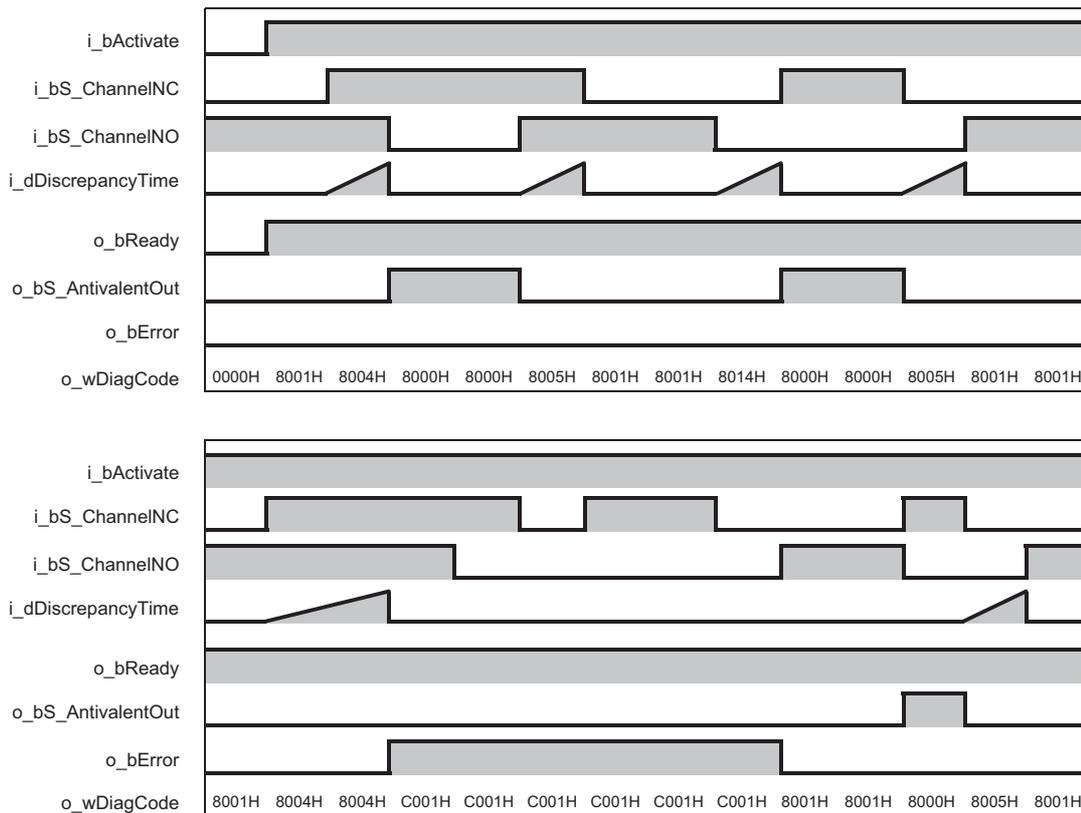
State diagram

State transition of M+SF_ANTI_R
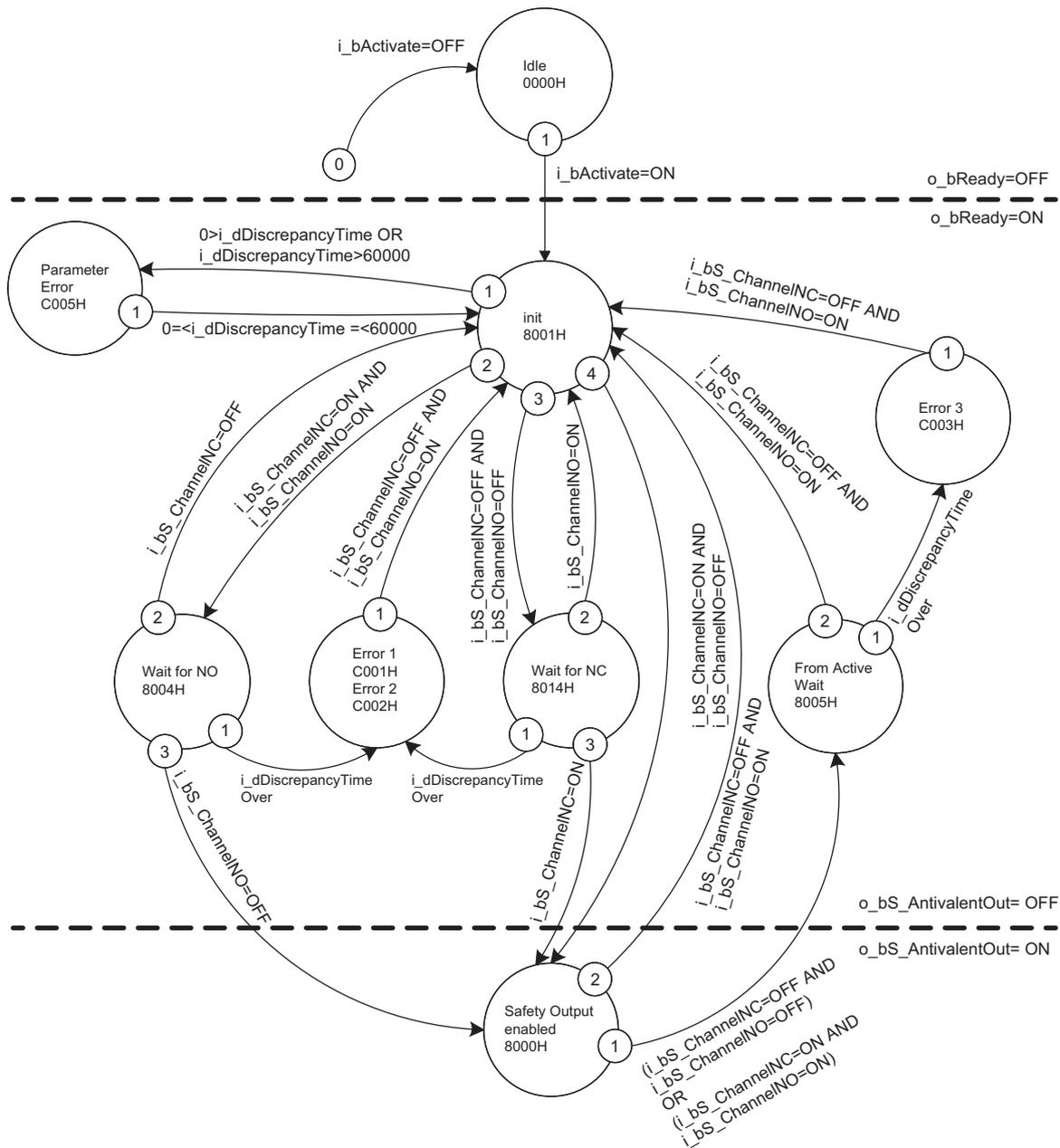
Note 1:   The transition from any state to the Idle state due to i_bActivate=OFF is not shown. However these transitions have the highest priority (0).

Typical timing diagram

■For M+SF_ANTI_R

i_bActivate													
i_bS_ChannelNC													
i_bS_ChannelNO													
i_dDiscrepancyTime													
o_bReady													
o_bS_AntivalentOut													
o_bError													
o_wDiagCode	0000H	8001H	8004H	8000H	8000H	8005H	8001H	8001H	8014H	8000H	8000H	8005H	8001H	8001H

i_bActivate													
i_bS_ChannelNC													
i_bS_ChannelNO													
i_dDiscrepancyTime													
o_bReady													
o_bS_AntivalentOut													
o_bError													
o_wDiagCode	8001H	8004H	8004H	C001H	C001H	C001H	C001H	C001H	C001H	8001H	8001H	8000H	8005H	8001H

A program operation is suspended while the operation status of the CPU module is in STOP or PAUSE. Consequently, measurement of the i_dDiscrepancyTime elapsed time is stopped.

Error behavior

In the event of an error, the output signals behave as listed below.

Output signal	Status
o_bReady	ON
o_bS_AntivalentOut	OFF
o_bError	ON

For the corrective actions, see the following.

☞ Page 141 List of error codes

List of error codes

o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
C001H	Error 1	i_bS_ChannelNC has been switched to ON. Switching i_bS_ChannelNO to OFF has been waited for, but it has not been switched within the setting value of i_dDiscrepancyTime.	Review the i_dDiscrepancyTime setting value. Set i_bS_ChannelNC to OFF and i_bS_ChannelNO to ON.
C002H	Error 2	i_bS_ChannelNO has been switched to OFF. Switching i_bS_ChannelNC to ON has been waited for, but it has not been switched within the setting value of i_dDiscrepancyTime.	
C003H	Error 3	A state where i_bS_ChannelNC=ON and i_bS_ChannelNO=OFF has been switched to the state where both are ON or OFF. Switching the state to the one where i_bS_ChannelNC=OFF and i_bS_ChannelNO=ON has been waited for, but it has not been changed within the setting value of i_dDiscrepancy Time.	
C005H	Parameter Error	The i_dDiscrepancyTime value is out of the setting range.	Configure the i_dDiscrepancyTime value within the setting range.

List of status codes (no error)

| o_wDiagCode (Hexadecimal)	State name	Description, output setting	Action
0000H	Idle	The FB is not active. (Initial state) • o_bReady: OFF • o_bS_AntivalentOut: OFF • o_bError: OFF	Initialize the FB by setting i_bActivate to ON.
8001H	Init	The FB is active. Activation is ON. • o_bReady: ON • o_bS_AntivalentOut: OFF • o_bError: OFF	Wait for i_bS_ChannelNC to be set to ON and i_bS_ChannelNO to be set to OFF.
8000H	Safety Output Enabled	The safety output is ON. • o_bReady: ON • o_bS_AntivalentOut: ON • o_bError: OFF	None.
8004H	Wait for NO	i_bS_ChannelNC is ON and i_bS_ChannelNO is also ON. State change of i_bS_ChannelNO to OFF is being waited for. • o_bReady: ON • o_bS_AntivalentOut: OFF • o_bError: OFF	Set i_bS_ChannelNO to OFF.
8014H	Wait for NC	i_bS_ChannelNC is OFF and i_bS_ChannelNO is also OFF. State change of i_bS_ChannelNC to ON is being waited for. • o_bReady: ON • o_bS_AntivalentOut: OFF • o_bError: OFF	Set i_bS_ChannelNC to ON.
8005H	From Active Wait	A state where i_bS_ChannelNC=ON and i_bS_ChannelNO=OFF has been switched to the state where both are ON or OFF. • o_bReady: ON • o_bS_AntivalentOut: OFF • o_bError: OFF	Set i_bS_ChannelNC to OFF and i_bS_ChannelNO to ON.

⚠ WARNING

Please do the above actions when the FB detects an error or is in an unexpected state. However, when the situation is still not corrected, please check the following.
 • A failure in safety devices and emergency stop devices
 • Wiring and status of a safety remote I/O module and a safety programmable controller
 • Programming logic, the memory allocation of safety devices, and the connections of safety FB variables

Application example

An application example of M+SF_ANTI_R is shown below.
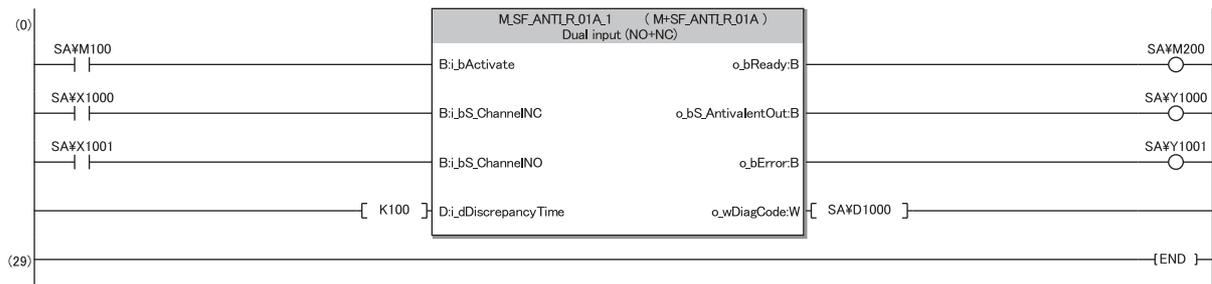
■Labels

• Input labels

Variable name	Allocated device/label	Description
i_bActivate	SA\M100	Activation of the safety FB
i_bS_ChannelNC	SA\X1000	Safety input signal (NC contact)
i_bS_ChannelNO	SA\X1001	Safety input signal (NO contact)
i_dDiscrepancyTime	K100	Max. consistent time for i_bS_ChannelNC and i_bS_ChannelNO

• Output labels

Variable name	Allocated device/label	Description
o_bReady	SA\M200	Status of whether the safety FB is activated or not.
o_bS_AntivalentOut	SA\Y1000	Safety output signal
o_bError	SA\Y1001	Error flag
o_wDiagCode	SA\D1000	Diagnostic code

APPENDIX

Appendix 1   Approximate Number of Steps

This section lists the approximate number of steps of safety FBs.

Name	Approximate number of steps[1]
M+SF_2HAND2_R	202
M+SF_2HAND3_R	298
M+SF_EDM_R	426
M+SF_ENBLSW_R	206
M+SF_ESPE_R	130
M+SF_ESTOP_R	130
M+SF_GLOCK_R	195
M+SF_GMON_R	257
M+SF_MODSEL_R	325
M+SF_MUTE2_R	470
M+SF_MUTE2-2_R	498
M+SF_MUTEP_R	896
M+SF_MUTEP-2_R	929
M+SF_MUTES_R	570
M+SF_MUTES-2_R	602
M+SF_OUTC_R	152
M+SF_TSSEN_R	397
M+SF_EQUI_R	226
M+SF_ANTI_R	226

[1] The number of steps of a safety FB included in a program varies depending on the CPU module used, I/O definition, and GX Works3 option settings ("Optimize the Number of Steps.").
For the options setting of GX Works3, refer to the following.
📖 GX Works3 Operating Manual

A

MEMO

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INSTRUCTION INDEX

REVISIONS

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

Revision date	*Manual number	Description
March 2017	BCN-P5999-0815-A	First edition
July 2017	BCN-P5999-0815-B	■Added or modified parts Section 4.10, 4.11, 4.12, 4.14, 4.15, 4.16
November 2018	BCN-P5999-0815-C	■Added or modified parts Section 2.1, 4.11, 4.13, 4.15

Japanese manual number: BCN-P5999-0814-C

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BCN-P5999-0815-C(1811)
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