MITSUBISHI ELECTRIC

Programmable Controller

MELSEC iQ-R series

MELSEC iQ-R Channel Isolated Analog-Digital Converter Module SIL2 Diagnostic Function Block Library Reference

CONTENTS

1 OVERVIEW

This manual describes the FB library to input or output data from or to a system with the R60AD8-G.

1.1 FB Library List

The following table lists the FB library in this manual. The FB library consists of the SIL2 safety program FB, which is used by safety programs, and the SIL2 standard program FB, which is used by standard programs.
This FB library has obtained the safety approval and can be used for building safety applications up to IEC61508 Ed2.0 SIL2.

Name	Used by	Description
M+SIL2ADG_ADConv_R	Safety program	They input data to a system with the R60AD8-G.
M+SIL2ADG-IEF_WriteDAVal_R	Standard program	

For the FB library, please consult your local Mitsubishi representative.
For how to register the FB library, refer to the GX Works3 Operating Manual.

1.2 System Configuration

To use the FB library in this manual, configure a SIL2 analog input system. For the configuration of the SIL2 analog input system, refer to the following.
MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)

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2 DETAILS OF THE FB LIBRARY

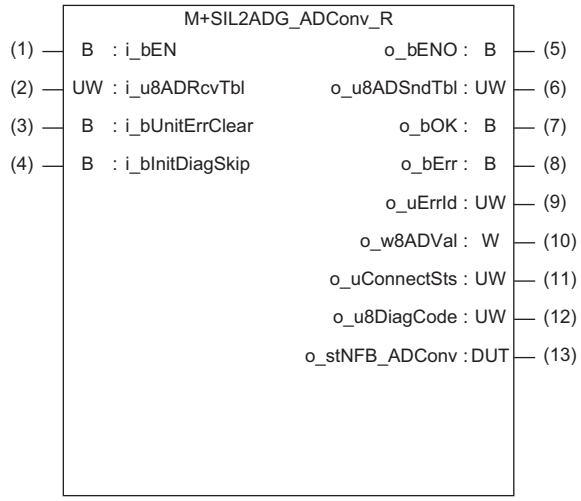
This chapter describes the details of the FB library.

2.1 M+SIL2ADG_ADConv_R

Name

M+SIL2ADG_ADConv_R

Overview

Item	Description
Functional overview	Obtains digital operation values from the R60AD8-G in SIL2 mode.
Symbol	

Labels to use

■Input labels

No.	Variable name	Name	Data type	Scope	Description
(1)	i_bEN	Execution command	Bit	On or off	On: The FB is activated. Off: The FB is not activated. Set 'Safety refresh communication status of each safety connection (1st module)' (SA\SD1008 to SA\SD1015)*1 for the intelligent device station where the R60AD8-G (Main) is mounted. For details on the safety special register, refer to the following. 📖 MELSEC iQ-R CPU Module User's Manual (Application) For a setting example of this input label, refer to the following. 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)
(2)	i_u8ADRcvTbl	Safety communications receive area	Word [unsigned]	Valid device range	The label sets the start device of the receive data storage device (8 words) for the safety communication setting.
(3)	i_bUnitErrClear	Module error clear	Bit	On or off	Turn on this label to clear an occurring error. Turn off this label after the error is cleared.
(4)	i_bInitDiagSkip	Start-up diagnostics skip request	Bit	On or off	The label selects whether start-up diagnostics is to be performed or not. This option is available only if the safety operation mode of the SIL2 Process CPU is in TEST MODE. If the mode is not in TEST MODE, the diagnostics is performed regardless of this setting. • On: No start-up diagnostics is performed. • Off: Start-up diagnostics is performed.

*1 For details on the safety special register (2nd module or later), refer to the following.
📖 MELSEC iQ-R CPU Module User's Manual (Application)

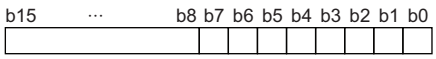
Restriction

Do not change the following input labels during operation of the SIL2 diagnostic FB library (while i_bEN is on). Doing so may cause abnormal operation of the SIL2 diagnostic FB library due to the following reasons.

- i_u8ADRcvTbl: Because this area is used by the SIL2 diagnostic FB library
- i_bInitDiagSkip: Because this label may function improperly

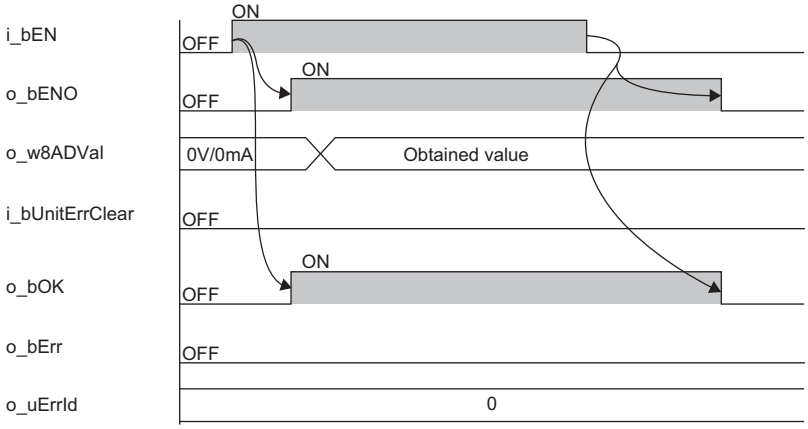
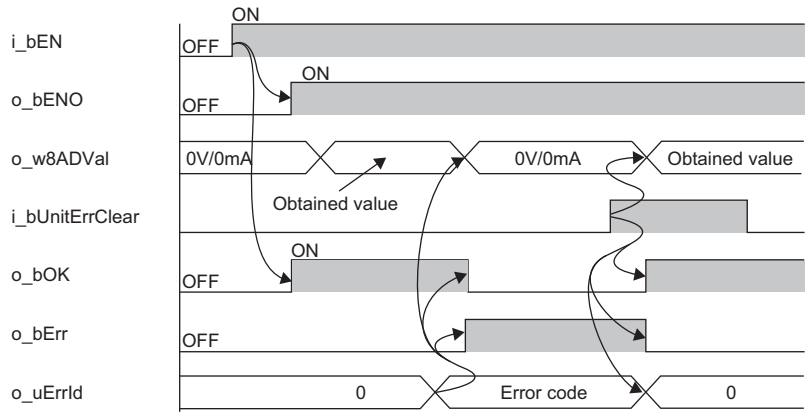
■Output labels

No.	Variable name	Name	Data type	Default value	Description
(5)	o_bENO	Execution status	Bit	Off	On: The execution command is on. Off: The execution command is off.
(6)	o_u8ADSndTbl	Safety communications send area	Word [unsigned]	0	The label sets the start device of the send data storage device (8 words) for the safety communication setting.
(7)	o_bOK	Normal completion	Bit	Off	The on state indicates that the FB processing has been completed successfully.
(8)	o_bErr	Error completion	Bit	Off	The on state indicates that the FB processing has been completed with an error.
(9)	o_uErrId	Error code	Word [unsigned]	0	The error code is stored at error completion.
(10)	o_w8ADVal	Digital obtained value	Word [signed]	0	Digital operation values obtained from the R60AD8-G (Main) and the R60AD8-G (Sub) are averaged and output. This label specifies a safety device area for the CH1 output destination. For CH2 and subsequent channels, 7 words of safety device areas are assigned and numbered sequentially starting from the next area of that specified for CH1. Areas of 8 words are required as the output destination regardless of the number of A/D conversion enabled channels.

No.	Variable name	Name	Data type	Default value	Description
(11)	o_uConnectSts	External device connection status	Word [unsigned]	0	The label indicates the connection status between the R60AD8-G and a sensor. b0 to b7 correspond to CH1 to CH8. b8 to b15 are not used.  • On: Connected • Off: Disconnected
(12)	o_u8DiagCode	Status code	Word [unsigned]	0	A status code for each channel is stored. This label specifies a safety device area for the CH1 storage location. For CH2 and subsequent channels, safety device areas are assigned and numbered sequentially starting from the next area of that specified for CH1. Areas of 8 words are required as the storage location regardless of the number of A/D conversion enabled channels.
(13)	o_stNFB_ADConv	Standard/safety shared output data	Structure	—	Data from a SIL2 safety program FB to a SIL2 standard program FB is stored. For details, refer to the following. 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)

FB details

Item	Description	
Relevant devices	Channel isolated analog-digital converter module	R60AD8-G (SIL2 mode)
	CPU module	MELSEC iQ-R series SIL2 Process CPU (redundant mode)
	Engineering tool	GX Works3 Version 1.045X or later
Language to use	Ladder diagram	
Number of steps	5541 steps The number of steps of the FB embedded in a program depends on the CPU module used, the input/output definitions, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.	
FB dependence	M+SIL2ADG-IEF_WriteDAVal_R	
Functional description	• Turning on i_bEN (execution command) causes o_bENO (execution status) to be turned on to get digital operation values from the R60AD8-G. Channels set to A/D conversion enabled by a module parameter of the R60AD8-G will be the target. • The FB stores the status code in o_u8DiagCode (status code) depending on the status of each channel. • The FB gets the module parameters from the R60AD8-G on the first start-up. If it cannot get correct parameters within 20 seconds, it turns off o_bOK (normal completion) and turns on o_bErr (error completion), stores an error code in o_uErrId (error code), and does not perform the subsequent operations. • After getting the module parameters correctly, the FB performs start-up diagnostics. During the start-up diagnostics, it stores 0 in o_w8ADVal (digital obtained value). In addition, in o_uConnectSts (external device connection status), the FB turns off a bit of the channel where the start-up diagnostics is in progress, and turns on bits of the other channels. If a system error is detected at the start-up diagnostics, it turns off o_bOK (normal completion) and turns on o_bErr (error completion), stores an error code in o_uErrId (error code), and does not perform subsequent operations. Also, if an error for each channel is detected, it stores a status code in o_u8DiagCode (status code) of the relevant channel. Note that if the safety operation mode of the SIL2 Process CPU is in TEST MODE and i_bInitDiagSkip (start-up diagnostics skip request) is on, subsequent operations are started without the start-up diagnostics. • After the operations up to the start-up diagnostics are completed, double input discrepancy detection is performed at every SIL2 A/D conversion cycle. During double input discrepancy detection, o_uConnectSts (external device connection status) of the relevant channel is turned on. If the double input discrepancy detection finds the input normal, a digital operation value obtained from the R60AD8-G is stored in o_w8ADVal (digital obtained value). If it finds the input faulty, a value equivalent to 0V/0mA is stored in o_w8ADVal (digital obtained value). Also, if "Duplicated input mismatch automatic recovery setting" of the module parameter is enabled and if the number of correct double inputs detected is equal to or exceeds the number specified by "Duplicated input mismatch automatic return count" of the module parameter, the FB decides that the system has recovered from the double input discrepancy error and clears the error. • A/D conversion circuit diagnostics is started at every A/D conversion circuit diagnostic cycle. Until the A/D conversion circuit diagnostics for all the relevant channels are finished, double input discrepancy detection and A/D conversion circuit diagnostics are performed alternately at every SIL2 A/D conversion cycle. During the A/D conversion circuit diagnostics, the FB turns off o_uConnectSts (external device connection status) of the relevant channel and stores the last value in o_w8ADVal (digital obtained value). If it detects an A/D conversion circuit diagnostic error for each channel, a value equivalent to 0V/0mA is stored in o_w8ADVal (digital obtained value). • By turning on i_bUnitErrClear (module error clear), the FB clears an occurring error (except an A/D conversion circuit diagnostic error). Note that if the status code (o_u8DiagCode) is set to 0000H (Idle), 8001H (Start-up), or □1□□H (Processing interrupted), the error clear is not performed. If i_bUnitErrClear (module error clear) remains on after the status code (o_u8DiagCode) changes, the error clear is performed.	
FB compilation method	Subroutine type	
FB operation	Arbitrary execution type	
Application example	📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)	

Item	Description
Timing chart of I/O signals	■When the operation is completed successfully  ■When the operation is completed with an error 
Restrictions and precautions	• To use this FB, configure the master station and the intelligent device station. (📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)) • The FB requires the configuration of the ladder for every input label.

List of error codes

Error code	Description
0200H	Indicates a module parameter error.
0201H	Indicates the state in which diagnostics is not possible.
FFFFH	Indicates a module error in the R60AD8-G.

For handling errors corresponding to these error codes, refer to the following.

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

List of status codes

Status code	Status name	Description
0000H	Idle	The FB is disabled (initial status).
8001H	Start-up	The FB is in the start-up status.
8002H	A/D conversion disabled	A/D conversion is disabled.
8003H	Double input discrepancy detection in progress	Double input is being verified.
8004H	Double input discrepancy detection function completed	The double input discrepancy detection function is completed.
8005H	A/D conversion circuit diagnostics in progress	A/D conversion circuit diagnostics is being performed.
8006H	A/D conversion circuit diagnostics completed successfully	The result of A/D conversion circuit diagnostics is valid.
C001H	Double input discrepancy error	The verification of double input is inconsistent.
C002H	A/D conversion circuit diagnostic error	The verification of A/D conversion circuit diagnostics is inconsistent.
C010H	SIL2 A/D conversion cycle set value error	The value set for "SIL2 A/D conversion cycle setting" of the module parameter is out of range.
C011H	A/D conversion circuit diagnostic cycle set value error	The value set for "A/D conversion circuit diagnostics cycle setting" of the module parameter is out of range.
C020H	Double input discrepancy detection count error	The value set for "Duplicated input mismatch detection count" of the module parameter is out of range.
C021H	Double input discrepancy auto recovery count error	The value set for "Duplicated input mismatch automatic return count" of the module parameter is out of range.
C030H	Target module error	The destination module of safety communications is not the R60AD8-G.
C031H	Safety communication error	Safety communications with the destination module cannot be performed properly.
□1□□H	Processing interrupted	The processing is interrupted. □ stores a status code when it is interrupted. (If the processing is interrupted when the code is double input discrepancy detection function completed (8004H), the status code is set to 8104H.) All statuses except 'Idle' (status code: 0000H) shift to 'Processing interrupted' when i_bEN is turned off. At this time, the 8th bit of the status code turns on (the status code becomes □1□□H). When i_bEN is turned on, the 8th bit of the status code turns off (the status code becomes □0□□H), and the status returns to a previous one, which is indicated by the status code (□0□□H).

For handling statuses corresponding to these status codes, refer to the following.

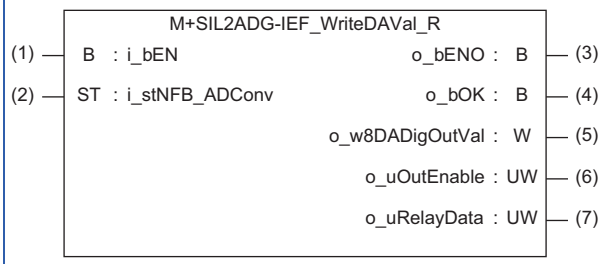
MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)

2.2 M+SIL2ADG-IEF_WriteDAVal_R

Name

M+SIL2ADG-IEF_WriteDAVal_R

Overview

Item	Description
Functional overview	Outputs digital values to the R60DA8-G (normal mode) and relay control signals to the RY40PT5B.
Symbol	

Labels to use

■Input labels

No.	Variable name	Name	Data type	Scope	Description
(1)	i_bEN	Execution command	Bit	On or off	On: The FB is activated. Off: The FB is not activated.
(2)	i_stNFB_ADConv	Standard/safety shared input data	Structure	—	The label specifies standard/safety shared data. For details, refer to the following. 📖 MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)

Restriction

Do not change the following input label during operation of the SIL2 diagnostic FB library (while i_bEN is on).
Doing so may cause abnormal operation of the SIL2 diagnostic FB library due to the following reason.

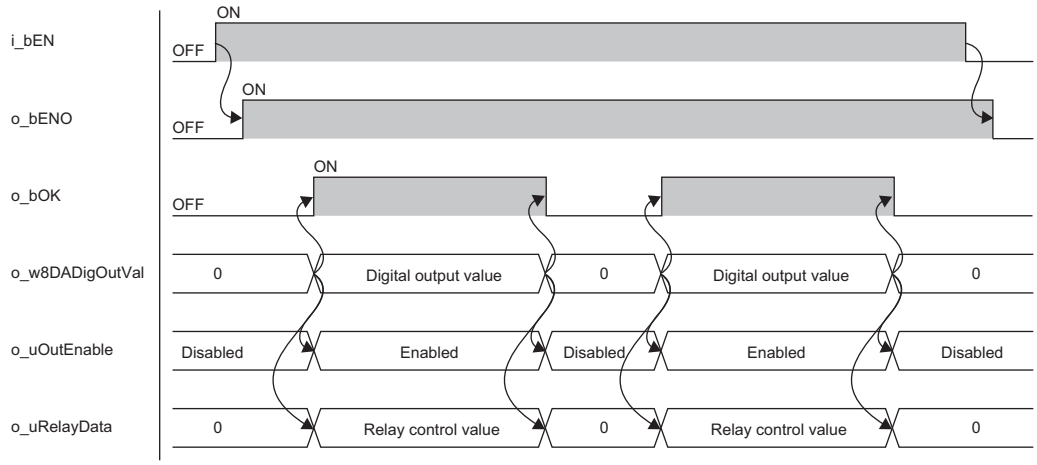
• i_stNFB_ADConv: Because this area is used by the SIL2 diagnostic FB library

■Output labels

No.	Variable name	Name	Data type	Default value	Description
(3)	o_bENO	Execution status	Bit	Off	On: The execution command is on. Off: The execution command is off.
(4)	o_bOK	Normal completion	Bit	Off	The on state indicates that the FB processing has been completed successfully.
(5)	o_w8DADigOutVal	Digital value	Word [signed]	0	The label sets the device assigned to CH1 to CH8 Digital value of the R60DA8-G for diagnostics. Areas of 8 words are required regardless of the number of D/A conversion enabled channels.
(6)	o_uOutEnable	D/A output enable/ disable setting	Word [unsigned]	0	The label sets the device assigned to Y00 to Y0F of the R60DA8-G for diagnostics in a word type.*1
(7)	o_uRelayData	Relay control signal	Word [unsigned]	0	The label sets the device assigned to Y00 to Y0F of the RY40PT5B in a word type.*1

*1 If the assigned device is a type of bit, it must be set up as a word-type device.

FB details

Item	Description	
Relevant devices	Channel isolated digital-analog converter module	R60DA8-G (normal mode)
	CPU module	MELSEC iQ-R series SIL2 Process CPU (redundant mode)
	Engineering tool	GX Works3 Version 1.045X or later
Language to use	Ladder diagram	
Number of steps	29 steps The number of steps of the FB embedded in a program depends on the CPU module used, the input/output definitions, and the options setting of GX Works3. For the options setting of GX Works3, refer to the GX Works3 Operating Manual.	
FB dependence	M+SIL2ADG_ADConv_R	
Functional description	If i_bEN (execution command) is on, a digital output value is output to o_w8DADigOutVal (digital value), D/A output enable/disable setting is output to o_uOutEnable (D/A output enable/disable setting), and a relay control value is output to o_uRelayData (relay control signal), according to the commands from the SIL2 safety program FB.	
FB compilation method	Subroutine type	
FB operation	Arbitrary execution type	
Application example	MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)	
Timing chart of I/O signals		
Restrictions and precautions	• To use this FB, configure the master station and the intelligent device station. (MELSEC iQ-R Channel Isolated Analog-Digital Converter Module User's Manual (Application)) • The FB requires the configuration of the ladder for every input label.	

APPENDIX

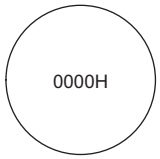
Appendix 1 Status Transition Diagram

This section shows a status transition diagram on o_u8DiagCode (status code) of M+SIL2ADG_ADConv_R.

How to read the status transition diagram

■Large circle

Large circles on the status transition diagram indicate the status codes of M+SIL2ADG_ADConv_R.



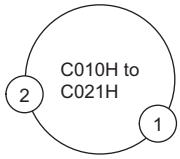
For instance, the figure above represents a status code of 0000H (Idle).

For the status code, refer to the following.

☞ Page 9 List of status codes

■Arrow connecting large circles, small circle

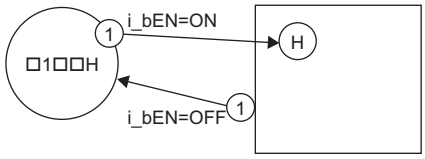
- An arrow connecting two large circles indicates a direction of status transition. Transition conditions are described near the arrow.
- A number in a small circle indicates the priority of transition, for cases when a status has multiple transition directions and multiple transition conditions are satisfied simultaneously. (A smaller number has a higher priority.)



■'Processing interrupted'

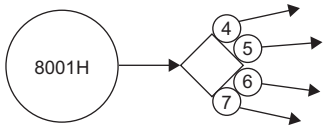
All statuses except 'Idle' (status code: 0000H) shift to 'Processing interrupted' when i_bEN is turned off. At this time, the 8th bit of the status code turns on (the status code becomes □1□□H).

When i_bEN is turned on while the status is 'Processing interrupted' (status code: □1□□H), the 8th bit of the status code turns off and the status returns to the previous one (represented by 'H' in the figure below).



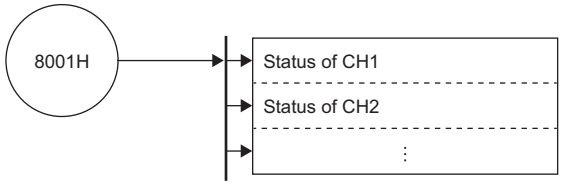
■Selection point

The status transitions from 'Status common to all channels' (Start-up (status code: 8001H)) to the selection point. A condition of each channel determines to which direction the status shifts from this selection point.

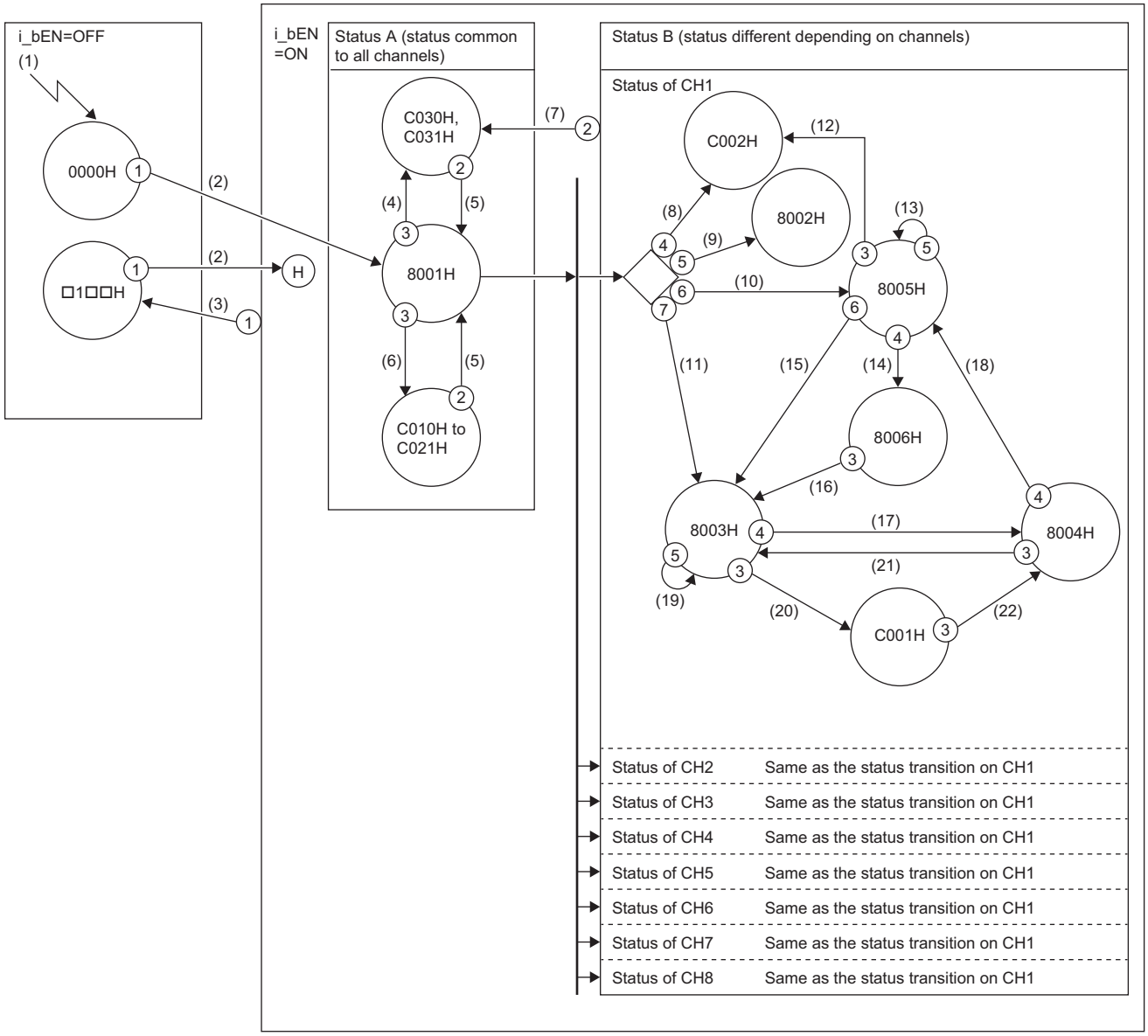


■Parallel

The status transitions from 'Status common to all channels' (Status A) to 'Status different depending on channels' (Status B).



Status transition diagram



No.	Description
(1)	Power ON
(2)	i_bEN = ON
(3)	i_bEN = OFF
(4)	Safety communication error or module type inconsistent
(5)	Error clear
(6)	Module parameter value out of the range
(7)	Safety communication error
(8)	Start-up completed and an error was detected in the previous circuit diagnostics.
(9)	Start-up completed and A/D conversion disabled
(10)	Start-up completed, A/D conversion enabled, and start-up diagnostics enabled
(11)	Start-up completed, A/D conversion enabled, and start-up diagnostics disabled
(12)	SIL2 A/D conversion cycle has elapsed and an error is detected in the circuit diagnostics.
(13)	SIL2 A/D conversion cycle has elapsed and the start-up diagnostics is being performed.
(14)	No error is detected in the circuit diagnostics.
(15)	SIL2 A/D conversion cycle has elapsed and the A/D conversion circuit diagnostics is being performed.
(16)	SIL2 A/D conversion cycle has elapsed.
(17)	Double input is consistent.

No.	Description
(18)	The circuit diagnostics is being performed and SIL2 A/D conversion cycle has elapsed.
(19)	Double input discrepancy count is within the allowable range and SIL2 A/D conversion cycle has elapsed.
(20)	Double input discrepancy count exceeds the limit.
(21)	Status other than the circuit diagnostics in progress and SIL2 A/D conversion cycle has elapsed.
(22)	Either of the following conditions • The auto recovery setting is enabled and double input consistency count reaches the number necessary for auto recovery. • Error clear

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INSTRUCTION INDEX

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REVISIONS

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

Revision date	*Manual number	Description
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Japanese manual number: BCN-P5999-0888-A

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