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P1-FS Safety Function Guide

HITACHI INVERTER

SJ series P1

Functional safety option

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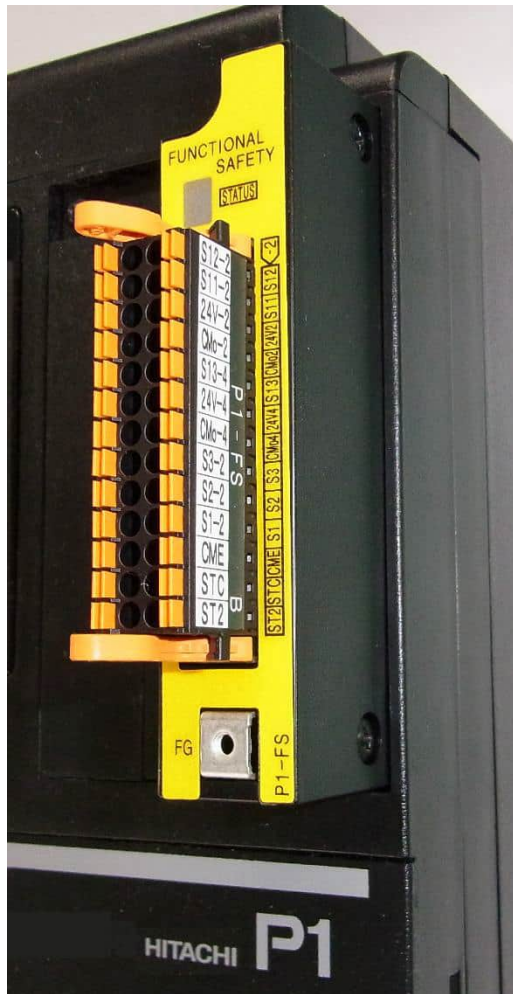
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For inquiry, please notify the number on the right

NT2582X

The picture is an example of installing P1-FS to SJ-P1.



S.1 Introduction

Thank you for purchasing Hitachi functional safety option for SJ Series type P1 (here after P1-FS).

This P1-FS Safety Function Guide describes the information about planning the installation, installing, commissioning, using and servicing the Safety function of the P1-FS with SJ-P1 inverter.

The information not described in the P1-FS Safety Function Guide must be referred to the Safety Function Guide and the User's Guide of the SJ-P1 inverter.

If there are any contents inconsistent between the Safety Function Guide or the User's Guide of the SJ-P1 inverter and this P1-FS Safety Function Guide, the instructions provided in this Safety Function Guide always have priority when the Safety function is used.

■P1-FS Safety Function Guide (this document)

The P1-FS Safety Function Guide provides the information necessary for handling the Safety function of the P1-FS with SJ-P1 inverter. Please make sure to read through this documentation as well as the Safety Function Guide and the User's Guide of the SJ-P1 inverter when using the Safety function of the P1-FS.

If future updates make any difference from the Basic Guide and the User's Guide, the description in the Safety Function Guide and P1-FS Safety Function Guide will have higher priority. Please make sure that the inverter is always used within the specification provided in the Safety Function Guides and the User's Guide of the SJ-P1 inverter. Additionally, please ensure to perform proper inspection and maintenance in order to prevent failures and risk before it happens.

You can request the data of those documents at any time from:

Hitachi industrial equipment systems Co.,Ltd., supplier or Hitachi inverter distributor

S.2 Precaution

■For the proper use of the inverter

Please read through the Safety Function Guide and the User's Guide of the SJ-P1 inverter as well as the Safety Function Guide (this document) to perfectly understand proper handling and safety precaution for the product to ensure safety and proper usage before operating the inverter and using the Safety function.

Before attempting installation, operation, maintenance, and inspection work of the safety related system, you should understand the essential knowledge of the functional safety as well as the knowledge of equipment, information of safety, caution and how to use and service the inverter.

■Cautions

No part of this documentation may be reproduced or revised in any form without the publisher's permission.

The contents in this documentation are subject to change without prior notice.

You "CANNOT DO" what is not described in this Safety Function Guide. In addition, do not operate the product in a manner not specified in the Safety Function Guide. An unexpected failure or accident may occur.

HITACHI (include inverter distributor) does not accept any liability for direct or indirect injury or damage caused by the handling, operation and maintenance in manners which are not specified in this Safety Function Guide.

If you find any unclear or incorrect description, missing description, misplaced or missing pages, or have a question concerning the contents of the Safety Function Guide, please contact Hitachi industrial equipment systems Co.,Ltd., supplier or Hitachi inverter distributor.

Please note that the Basic Guide, User's Guide, the Safety Function Guide and the manuals for each optional product to be used should be delivered to the end user of the inverter.

S.3 Relevant document

Document name	Document code
SJ Series P1 User's Guide	NT251X
SJ Series P1 Basic Guide	NT2511X
SJ Series P1 Safety Function Guide	NT2512X
SJ Series P1 Safety Function Guide Supplement	NTZ2512X
P1-FS Safety Function Guide (this documentation)	NT2582X
P1-FS Safety Function Guide Supplement	NTZ2582X

S.4 List of abbreviation and technical terms

A

Term/Abbreviation	Description
AWG	American wire gauge Standardized wire gauge used in North America

B

Term/Abbreviation	Description
Basic Guide	The documentation that provides basic information to handle the inverter

C

Term/Abbreviation	Description
CAT.	Category Structural Classification of the safety-related parts defined in EN ISO13849-1 (B,1,2,3,4)
CCF	Common Cause Failure (EN ISO 13849-1) Failure, which is the result of one or more events, causing concurrent failure of two or more separate channels in a multiple channel system, leading to failure of the Safety function
CE marking	A mandatory conformity marking for products sold within the European Economic Area.
Charge lamp	The lamp indicates power supply status of the main circuit of the inverter. Even after powered down, the internal voltage remains while the lamp lights.
Control power supply	Internal power supply necessary for powering up the logic board and configuring the inverter using operator keypad. Supplying power to R0T0 terminal or P+, P- terminal can power up the internal power supply.

*) Trademark

Some proper nouns such as product name or function names may be registered as trademark or registered trademark. Particularly this documentation does not describes ® mark or ™ mark.

C

Term/Abbreviation	Description
Common cause failure	In a redundant system, multiple channels can be simultaneously faulted by certain factors.

D

Term/Abbreviation	Description
Dangerous failure	Failure of a component and/or subsystem and/or system that plays a part in implementing the Safety function
DC	Diagnostic coverage (%) (EN ISO 13849-1)

E

Term/Abbreviation	Description
EMC	Electromagnetic compatibility

F

Term/Abbreviation	Description
Functional Safety	Reduce the risk of harm to an acceptable level via design changes or by applying appropriate safety measures

H

Term/Abbreviation	Description
HFT	Hardware fault tolerance (IEC61508)

I

Term/Abbreviation	Description
I/O	Input / Output
IGBT	Insulated gate bipolar transistor
Inverter model code	The model code written on the specification label of the inverter.

M

Term/Abbreviation	Description
Main power supply	Power supply necessary for operation of inverter
MFG No.	Manufacturing No.
MTTFd	Mean time to dangerous failure Expectation of the mean time to dangerous failure

O

Term/Abbreviation	Description
Operator keypad	The keypad mounted on the inverter used for configuration of parameters and monitoring of inverter's state

P

Term/Abbreviation	Description
PELV	Protected extra-voltage (EN/IEC60204)
PFD	Probability of dangerous failure on demand (IEC61508)
PFH	Average frequency of a dangerous failure [1/h] (EN/IEC61800-5-2)
PL	Performance level (a-e) (EN ISO 13849-1)
PLC	Programmable logic controller
PWM	Pulse width modulation

R

Term/Abbreviation	Description
Residual risk	Risk remaining after protective measures have been taken
Response time	Delay time inside of the inverter from a request of activation of a function until actual execution of the function
Risk	Probability and severity of hazard

S

Term/Abbreviation	Description
Safety Function	Safety functions to achieve safe state of system such as STO function defined in IEC61800-5-2.
Safety-Related System	Whole system including inverter, sensor, switch and safety relay etc. that achieves Safety function(s)
SELV	Safety extra-low voltage (EN/IEC60950)
SFF	Safe failure fraction (%) (IEC61508)

S

Term/Abbreviation	Description
Safety state	Safety function, STO etc. is operating correctly
SIL	Safety integrity level (1-3) (IEC61508)
SILCL	SIL claim limit (EN/IEC62061)
Sink logic	Signal is recognized as ON when current flows out from signal terminal. That may differ depending on systems
Source logic	A type of logic that signal is recognized as ON when current flows into the terminal. This logic may differ depending on region or system.
Specification label	The label affixed on the product, on which specification of the inverter is written
STO	Safe torque off (EN/IEC61800-5-2)
Stop category 0	A type of stop category defined in EN/IEC60204-1. Stopping by immediate removal of power to the machine actuator.

U

Term/Abbreviation	Description
User's Guide	The documentation that provides the detailed information to handle the inverter

V

Term/Abbreviation	Description
Validation	Confirmation by examination and provision of objective that the safety system meets the requirements set by the specification
Verification	Confirmation by examination and provision of objective evidence that the requirements have been fulfilled

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(Memo)

Chapter 1 Safety Precaution/Risk

1.1 Contents in this chapter

This chapter describes precautions for using the Safety function of the P1-FS with SJ-P1 inverter.

Before installation, wiring, operation, maintenance, inspection, please make sure to read through **the P1-FS Safety Function Guide, the Safety Function Guide and the User's Guide** of the SJ-P1 inverter and all the other documentations enclosed with the product.

1.2 Safety Precaution

	General warning indicates a potentially hazardous situation that, if not avoided, can result in serious injury or death, or damage to the equipment.
	This symbol indicates High voltage. It calls to your attention to items or operations that could be dangerous to you and other persons operating this equipment.

1.2.1 Planning

The persons who design, install and perform maintenance of safety-related system must have sufficient knowledge of the functional safety.

It is a responsibility of the manufacturer of safety-related system to perform risk analysis of the overall system and to apply appropriate measures accordingly.

1.2.2 Consideration

in Designing safety-related system



The P1-FS supports a holding function of STO state after release of Safety inputs depending on the setting parameters. Therefore disabling the holding function by setting parameters, after Safety inputs to the P1-FS are released, the SJ-P1 inverter becomes available to restart the motor operation. Please ensure to design a system so that the above-mentioned behavior does not lead to any unsafe situation.

Please note that P1-FS is delivered with the STO function being enabled not to allow initial drive commissioning without the need of configuring the Safety function first.

1.2.3 Installation

Installation must be performed by the competent electricians who have sufficient knowledge of the functional safety.

Ensure to use the P1-FS with the SJ-P1 inverter within the specified environmental condition including EMS environment.

1.2.4 Commissioning



The safety system must always be properly commissioned and verified/validated before it is considered safe.

1.2.5 Maintenance



The STO function does not cut the power supply to the inverter and the peripheral circuits, and does not provide any electrical isolation. Before maintenance, please ensure to separate the system/machine from main power supply lines and from the other devices which may supply any voltage (e.g. permanent magnetic motor, device including capacitors). Additionally, wait more than 15 minutes and check the charge lamp of the inverter, and then confirm that the voltage between P and N terminal is lower than 45V before performing maintenance.

A function test must be conducted at least once in a year.

1.2.6 Others



Never modify the products. Any modification immediately invalidates the conformities to the all applicable norms, and the product guarantee.

The precaution items provided in User's Guide of the SJ-P1 inverter are not always described in this chapter. Please ensure to read through and understand the precaution in the User's Guide before using the SJ-P1.

(Memo)

2

Chapter 2 Introduction to the Safety Function Guide

2.1 Contents in this chapter

This chapter describes the applicable product, required knowledge, target audience, purpose and general information of this documentation.

2.2 Applicable product

This documentation is only applicable to the SJ Series P1 inverter having the model code listed in the Safety Function Guide of P1 inverter 『Annex 1: EC declaration of conformity』.

2.3 Target audience

The Safety Function Guide is intended for qualified persons who design the safety application, plan the installation, install, commission and maintenance. Read through this documentation as well as the Safety Function Guide and the User's Guide of the SJ-P1 inverter before starting working on a safety-related application. The persons must have sufficient knowledge of functional safety.

2.4 Purpose of the Safety Function Guide

The purpose of this document is to provide information necessary to use the Safety function of the P1-FS with the SJ-P1 inverter.

2.5 Recommended readings

The P1-FS Safety Function Guide is based on the following standards. It is recommended to read and familiarize you with these standards before implementing safety-related systems.

- EN/IEC 61508 part 1-2: 2010 *Functional safety of electrical/electronic/programmable electronic safety-related system – Part 1-7*
- IEC 61800-5-2: 2016, *Adjustable speed electrical power drive system – Part 5-2: Safety requirements – Functional.*
- EN ISO 13849-1: 2015, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design.*
- EN/IEC 62061:2005+A2:2015, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems.*
- EN 60204-1:2016, *Safety of machinery – Electrical equipment of machines – Part 1: General requirement.*

Additionally, before starting the implementation of safety-related systems, it is highly recommended to read and understand the documentations listed in clause S.3.

For the standards with which the P1-FS with the SJ-P1 complies, please refer to Chapter 4

3

Chapter 3 Safety Related Information and Consideration

3.1 Contents in this chapter

This chapter describes safety-related information and considerations.

3.2 Requirement of Machinery Directive

In order to fulfill the requirements of the Machinery Directive, the all requirements in the applicable standards must be satisfied and P1-FS with the SJ-P1 inverters must be used in accordance with the instructions provided in this P1-FS Safety Function Guide, the Safety Function Guide and the User's Guide of the SJ-P1.

Before using the inverter, the risk assessment of whole system must be conducted and appropriate measures must be adopted.

3.3 Intentional misuse

The SJ-P1 is not designed to protect a machine against intentional misuse for Safety function.

3.4 Safety consideration

3.4.1 Safety function

The Safety functions of the P1-FS are functions equivalent to STO (Safe torque off), SS1 (Safe stop 1), SBC (Safe brake control), SLS (Safely-limited speed), SDI (Safe direction) or SSM (Safe speed monitor) defined in IEC61800-5-2.

3.4.2 Response time

The response time is defined as a time from input of Safety request to actual activation of Safety function.

Refer to chapter 4 for each Safety function.

A safety-related system must be designed in consideration of the above mentioned response time so that this delay time may not lead to any dangerous situation.

3.4.3 Self-Diagnosis of internal path

The P1-FS is equipped with the self-diagnosis function which detects a fault in the internal safety paths.

When an internal fault has been detected, the safety paths are maintained shut-off state regardless of the states of the Safety inputs to the P1-FS.

3.4.4 Safety Input

The Safety input of the P1-FS is redundant and the both inputs must be input. The two Safety inputs must be appropriately separated from each other. If only one of the inputs is used, the conformities to the applicable norms become invalid.



The P1-FS with the SJ-P1 inverter is equipped with a diagnosis function of input signal and line from an external device depending on the parameter settings. A system must be designed so that both of the Safety inputs are always given properly and simultaneously. As needed, please set the test pulse function for diagnosing external device which is able to detect a fault in Safety input lines.

3.4.5 Holding function of STO state



P1-FS supports a function to hold STO state even after releasing of Safety inputs depending on the parameter settings. Please consider it when designing a system and, if needed, prepare an external mechanism to avoid an unintentional restart of the system. For more detailed information, please refer to Chapter 4.

3.4.6 Internal state monitor output

Please use monitoring or completed signal outputs on SJ-P1 when it is required to monitor the internal state of P1-FS.

Please refer to Chapter 4 in this Guide.



Monitoring or completed signal outputs are NOT a safety-related signal, but a reference signal. These signals must not be used to activate another Safety function.

3.4.7 Periodical functional test

A periodical functional test to check proper functioning of the using Safety function must be performed at least once a year in order to maintain the intended SIL / PL.

Please refer to Chapter 10 for the details of the functional test.

3.4.8 Caution for using the Safety function



The Safety function does not cut the power supply to the inverter and the peripheral circuits, and does not provide any electrical isolation. Before maintenance, please ensure to separate the system/machine from main power supply lines and from the other devices which may supply any voltage (e.g. permanent magnetic motor, device including capacitors). Additionally, wait more than 15 minutes and check the charge lamp of the inverter, and then confirm that the voltage between P and N terminal is lower than 45V before performing maintenance.



STO outputs must be connected to ST1 and ST2 on the SJ-P1. The STO functionality is achieved only through the ST1 and ST2 connector of the SJ-P1 inverter.



With permanent magnet or synchronous reluctance motors, in case of a multiple IGBT power semiconductor failure, the inverter system can produce an alignment torque which maximally rotates the motor shaft below regardless of the activation of the STO function.

- $180/(p/2)$ degrees (with permanent magnet motors)
 - $180/p$ degrees (with synchronous reluctance motors)
- p denotes the number of pole.



SS1/SLS/SDI/SSM functions supported in P1-FS can be only applied to application in which motor shaft is not accelerated by external force when torque to motor is shut off.

4

Chapter 4 Safety Function

4.1 Contents in this chapter

This chapter describes the information about the Safety function of the P1-FS with SJ-P1.

4.2 Safety function

The Safety functions of the P1-FS with SJ-P1 are functions equivalent to below functions defined in EN/IEC 61800-5-2.

Safety function	Description
STO (Safe torque off)	It is equivalent to stop category 0 defined in EN/IEC60204-1.
SS1 (Safe stop 1)	It is equivalent to stop category 1 defined in EN/IEC60204-1.
SBC (Safe brake control)	It is output signal to control an external brake unit.
SLS (Safely-limited speed)	It prevents the motor from exceeding the specified speed limit.
SDI (Safe direction)	It prevents the motor shaft from moving in the unintended direction.
SSM (Safe speed monitor)	It provides an output signal to indicate whether the motor speed is below a specified limit

4.3 Applicable standard

The applicable standards are listed in the table below.

■ Applicable standard

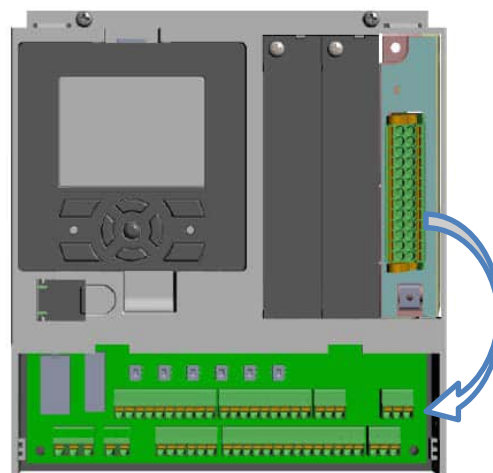
Standard	Remark
EN ISO/ISO 13849-1	CAT.4, PL e
IEC 61508, EN/IEC 61800-5-2, EN/IEC 62061	SIL 3, STO
EN/IEC 60204-1	Stop category 0, 1

4.4 How Safety function works

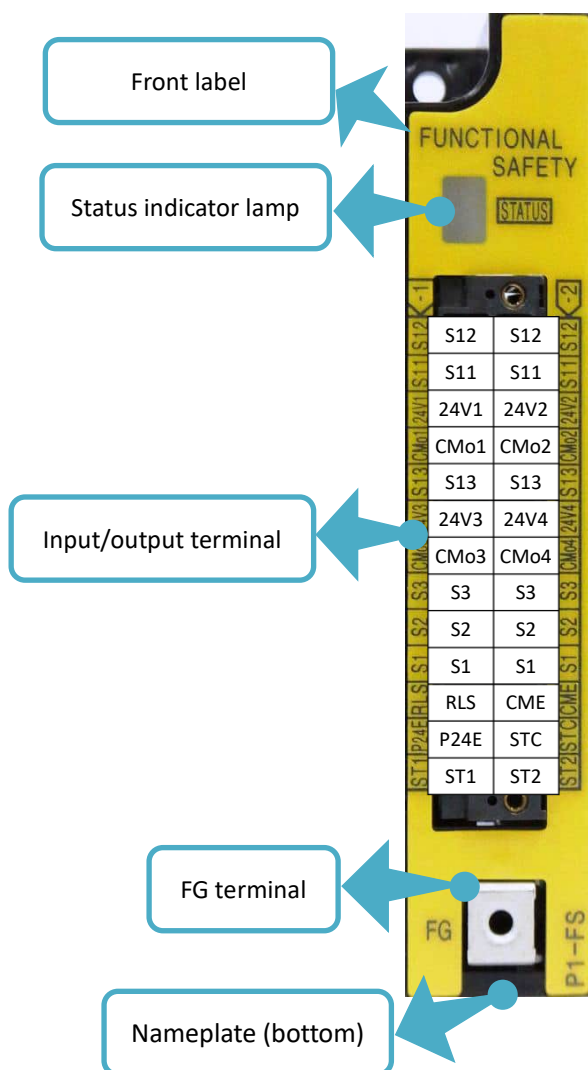
4.4.1 Installation of P1-FS and each part name of the product

■ Installation and wiring route

The P1-FS can only be installed on the far right slot of SJ-P1 whose version is 2.01 or later. Please check the version of SJ-P1 in advance. The version is written on upper right of the name plate of SJ-P1.



■ Appearance and each part name of the product



■ Terminal

The kinds of terminals on P1-FS are below.

The terminals on Path 1 are marked with -1. (Terminals on the left side).

The terminals on Path 2 are marked with -2. (Terminals on the right side).

Terminal symbol	Terminal name	Remarks
S1-1	Input terminal 1 to path 1	Input current:6mA
S1-2	Input terminal 1 to path 2	Input current:6mA
S2-1	Input terminal 2 to path 1	Input current:6mA
S2-2	Input terminal 2 to path 2	Input current:6mA
S3-1	Input terminal 3 to path 1	Input current:6mA
S3-2	Input terminal 3 to path 2	Input current:6mA
S11-1	Output terminal 11 on path 1	Output current:50mA
S11-2	Output terminal 11 on path 2	Output current:50mA
S12-1	Output terminal 12 on path 1	Output current:50mA
S12-2	Output terminal 12 on path 2	Output current:50mA
24V1-1 [24V-1 *1)]	24V power supply input terminal for output terminals 11 and 12 on path 1	Consumption current : 150mA
24V2-2 [24V-2 *1)]	24V power supply input terminal for output terminals 11 and 12 on path 2	Consumption current : 150mA
CMo1-1 [CMo-1 *1)]	Common terminal for output terminal 11 and 12 on path 1	
CMo2-2 [CMo-2 *1)]	Common terminal for output terminal 11 and 12 on path 2	
S13-1 [S13-3 *1)]	Common terminal for output terminal 13 on path 1	Output current:50mA
S13-2 [S13-4 *1)]	Common terminal for output terminal 13 on path 2	Output current:50mA
24V3-1 [24V-3 *1)]	24V power supply input terminal for output terminals 13 on path 1	Consumption current : 75mA
24V4-2 [24V-4 *1)]	24V power supply input terminal for output terminals 13 on path 2	Consumption current : 75mA
CMo3-1 [CMo-3 *1)]	Common terminal for output terminal 13 on path 1	
CMo4-2 [CMo-4 *1)]	Common terminal for output terminal 13 on path 2	

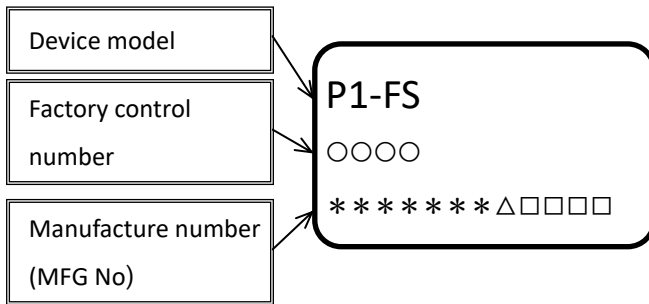
*1) These are the terminal symbols on the connector. They are different from the terminal symbols on the front label.

The following terminals are single terminals.

Terminal symbol	Terminal name	Remarks
P24E	24V power supply output terminal for input terminals	Allowed current:50mA
CME	Common terminal for input terminals	
RLS	Release terminal	Input current:6mA
ST1	STO1 output terminal	Connect to ST1 terminal on SJ-P1
ST2	STO2 output terminal	Connect to ST2 terminal on SJ-P1
STC	STO common terminal	Connect to STC terminal on SJ-P1
FG	Functional ground terminal	Connect to the functional ground

■ Name plate

The P1-FS name plate gives the following information.



■ Status indicator lamp

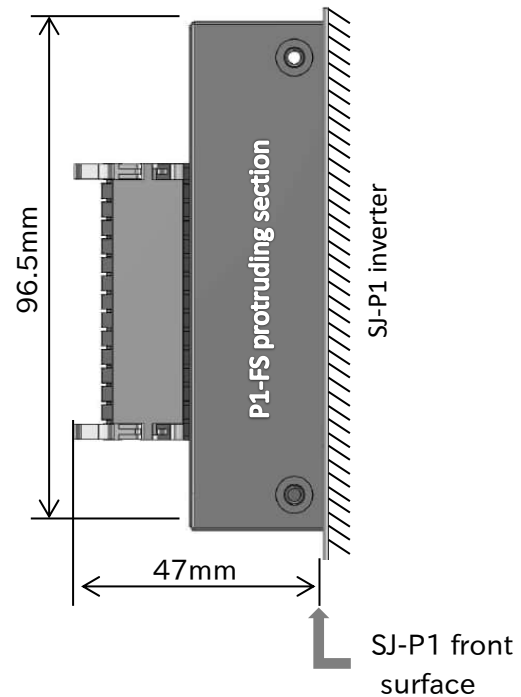
The status indicator lamp on the front side indicates the statuses of P1-FS. The statuses and the conditions are explained below.

Lamp status	Condition
OFF	P1-FS initial diagnosis error or power-off
ON	Normally activated P1-FS after the initial diagnosis was completed
Blinking	The P1-FS password still on its factory setting or during the SFS function

■ Dimensions after installation

The dimensions of the P1-FS after it is installed on the inverter are shown in the image below.

As shown on the image, a part of the P1-FS will stand out from the SJ-P1. Please pay attention when installing the device.



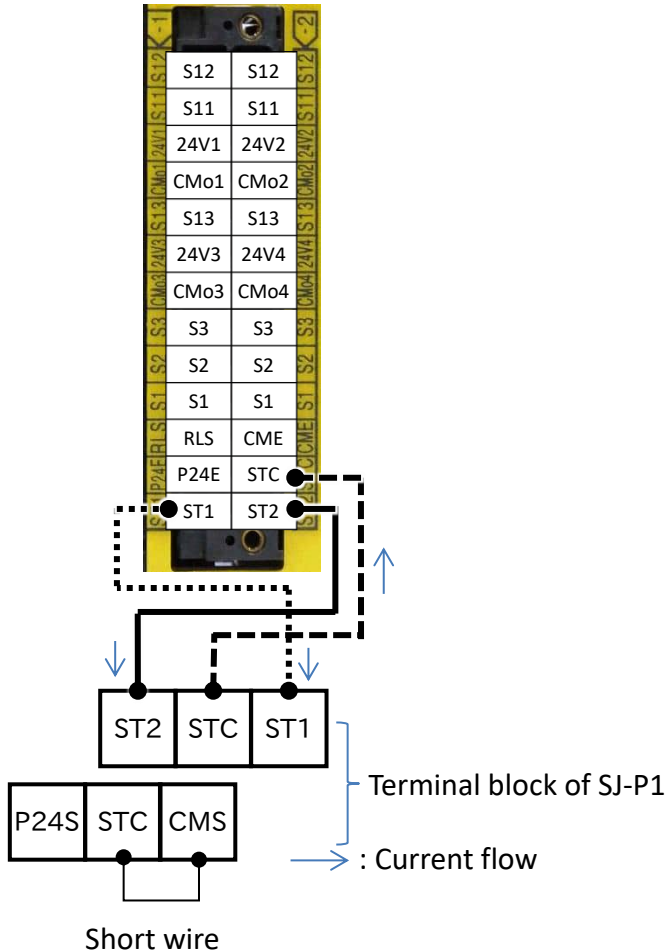
View from the right side of the SJ-P1

4.4.2 How to connect STO signals

Please refer to the wiring examples below for wirings on terminals.

■Wiring

e.g. Internal power supply + Source logic



*) Please connect between STC and CMS.

4.4.3 Input terminal

Input signals of Safety function are redundant inputs of terminal group -1 and terminal group -2.

When voltage is applied to each input, currents flow on each safety path inactivating the Safety function.

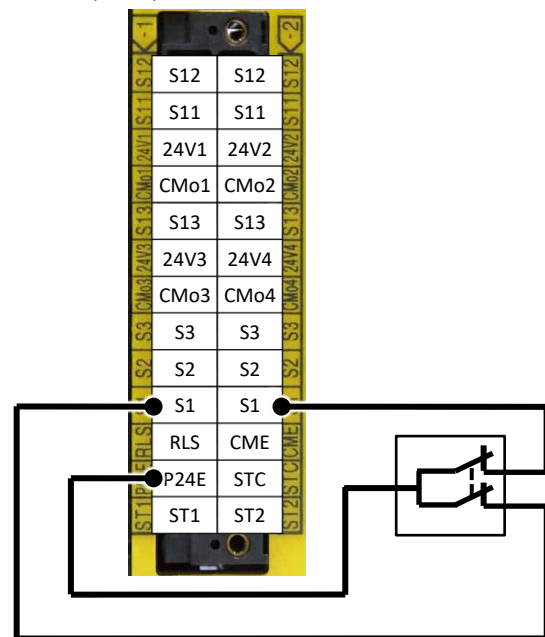
When voltage is removed from at least one of the redundant inputs, the Safety function is activated by the corresponding safety path.

The voltage source for input signals of safety function is selectable from the 24V power supply for input terminals (P24E) or an externally prepared DC24V power supply.

The external power supply must be SELV or PELV DC24V power supply.

An example of wiring the switch to input S1-1 and S1-2 is shown below.

■In case of use of the 24V power supply for input terminals (P24E)



■Selecting input terminal function

It can be set the input terminal function.

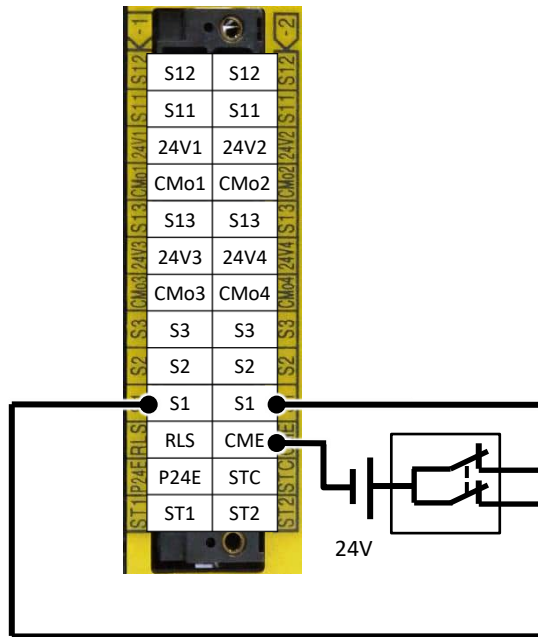
No.	Name	Related data
0-11	Safety Function Select Input 1	00:Invalid/01:STO-A/02:SS1-A/ 03:SBC-A/04:SLS-A/05:SDI-A/ 11:STO-B/12:SS1-B/13:SBC-B/ 14:SLS-B/15:SDI-B
0-12	Safety Function Select Input 2	
0-13	Safety Function Select Input 3	

■NO/NC switching function

NO/NC state can be switched only path 2.

No.	Name	Related data
0-31	Input arrangement 1	00:NC(path 1 and path 2) / 01:NC(path 1) and NO(path2)
0-32	Input arrangement 2	
0-33	Input arrangement 3	

■ In case of use of the external power supply



■ Setting input sensitivity

Signal level is completed after the input sensitivity time is passed from switching the signal level.

No.	Name	Related data
0-61	Input 1 sensitivity	0.001 to 1.000s
0-62	Input 2 sensitivity	
0-63	Input 3 sensitivity	

*) In case that malfunction occurs due to noise, please set the above parameters for a long time.

■ Setting allowed gap time

Allowed gap time is set for switching redundant input simultaneously. Mainly, the time difference between redundant inputs can be allowed when the redundant inputs are released.

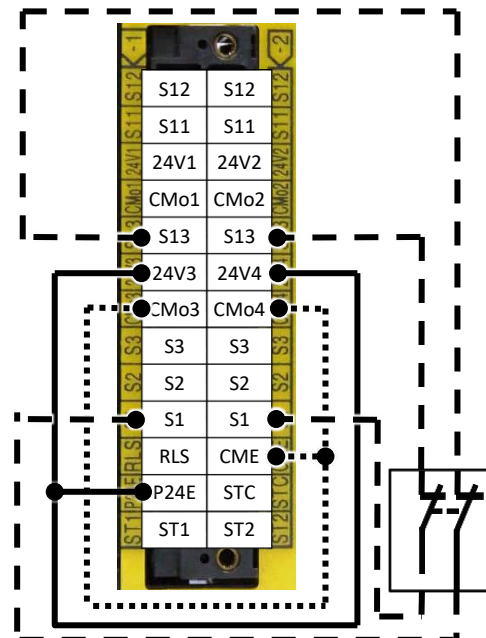
No.	Name	Related data
0-81	Input 1 gap time	0.001 to 1.000s
0-82	Input 2 gap time	
0-83	Input 3 gap time	

*) If the allowed gap time is short, the Safety function cannot be released.

■ Checking test pulse input

P1-FS can check the input terminals for test pulse from output terminal S13. The path error will occur if the test pulse is not recognized correctly.

No.	Name	Related data
0-51	Test pulse check 1	00:Inactivated / 01:Activated
0-52	Test pulse check 2	
0-53	Test pulse check 3	



4.4.4 Output terminal

Output signals of Safety function are redundant outputs of terminal group -1 and terminal group -2.

When the Safety function is inactivated, voltage is applied to each output and currents flow on each safety path.

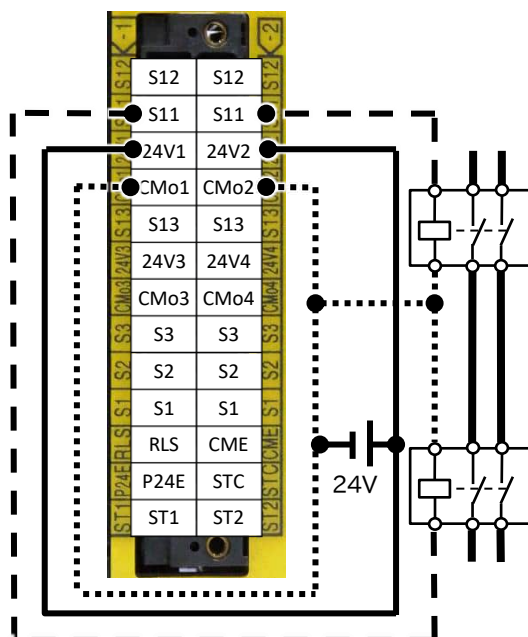
When the Safety function is activated, voltage is removed from each output and currents do not flow on each safety path.

When the monitoring and completed signals are activated, voltage is applied to each output and currents flow on each path. When the monitoring and completed signals are inactivated, voltage is removed from each output and currents do not flow on each path.

The voltage source for output signals of safety function is an externally prepared DC24V power supply. The external power supply must be SELV or PELV DC24V power supply.

Please connect between output terminal and corresponding common for checking the path if the output terminal is not used.

■Wiring



■Selecting output terminal function

It can be set the output terminal function.

No.	Name	Related data
0-11	Safety Function Select Output 1	00:None / 01:STO-A monitoring / 02:STO-A completed / 03:SS1-A monitoring / 04:SS1-A completed / 05:SBC-A control / 06:SL-A monitoring / 07:SDI-A monitoring / 08:SSM-A monitoring / 11:STO-B monitoring / 12:STO-B completed / 13:SS1-B monitoring / 14:SS1-B completed / 15:SBC-B control / 16:SL-B monitoring / 17:SDI-B monitoring / 18:SSM-B monitoring / 21:Internal error / 31:test pulse (only S13)
0-12	Safety Function Select Output 2	
0-13	Safety Function Select Output 3	

■NO/NC switching function

NO/NC state can be switched.

No.	Name	Related data
0-41	Output arrangement 1	00:NC(path 1 and path 2) /
0-42	Output arrangement 2	01:NC(path 1) and NO(path 2) /
0-43	Output arrangement 3	01:NO(path 1 and path 2)

■Setting output sensitivity

Signal level is completed after the output sensitivity time is passed from switching the signal level.

No.	Name	Related data
0-71	Output 1 sensitivity	0.001 to 1.000s
0-72	Output 2 sensitivity	
0-73	Output 3 sensitivity	

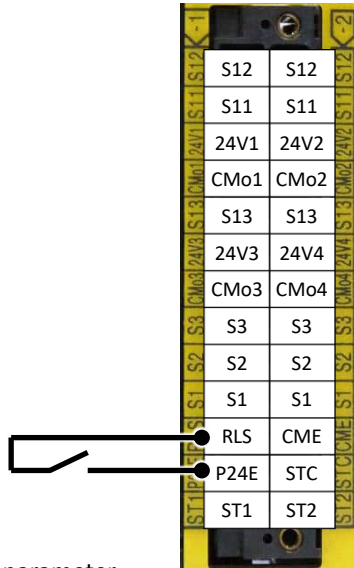
■Setting allowed gap time

Allowed gap time is set for delaying output of path 2.

No.	Name	Related data
0-91	Output 1 gap time	0.001 to 1.000s
0-92	Output 2 gap time	
0-93	Output 3 gap time	

4.4.5 Release terminal

The function release is activated when voltage is removed from release terminal after voltage is applied to release terminal and currents flow. Releasing by release signal is activated when the parameter [1-12]/[2-12] sets to 02:With release signal.



■Related parameter

No.	Name	Related data
1-12	STO-A release mode	00:Without release signal / 01:With safety signal / 02:With release signal
2-12	STO-B release mode	00:Without release signal / 01:With safety signal / 02:With release signal

4.4.6 Holding function of STO state

When the parameter [1-12]/[2-12] is set by 01:With safety signal or 02:With release signal, STO state can be held until releasing intentionally by safety signals or release signal after STO state is activated.

When the parameter [1-12]/[2-12] is set by 00:Without release signal, STO state can be released automatically after safety inputs are released. In this case, inverter starts to output the power to the motor automatically after safety inputs are released when the run command is input after releasing STO inputs or the run command is kept before releasing STO input. Considering the above-mentioned behavior, please apply at least one of the measures below in order to fulfill the requirement of EN60204-1:

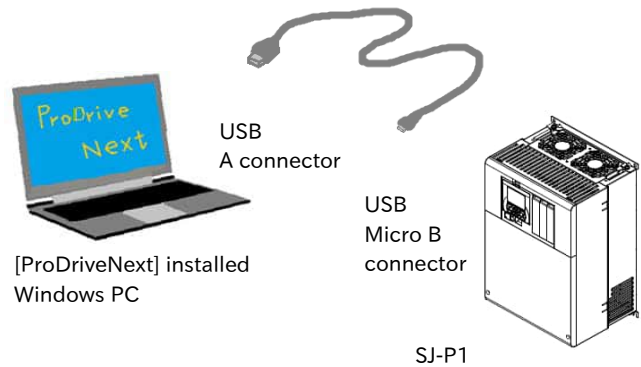
- (1) The RUN command is released simultaneously when the STO inputs are activated and then given when restart of the inverter is requested intentionally by an operator of the system.
- (2) The system is designed so that the safety inputs to P1-FS are released only when restart of the system is requested intentionally by an operator of the system.

■Related parameter

No.	Name	Related data
1-12	STO-A release mode	00:Without release signal / 01:With safety signal / 02:With release signal
2-12	STO-B release mode	00:Without release signal / 01:With safety signal / 02:With release signal

4.4.7 Parameter setting

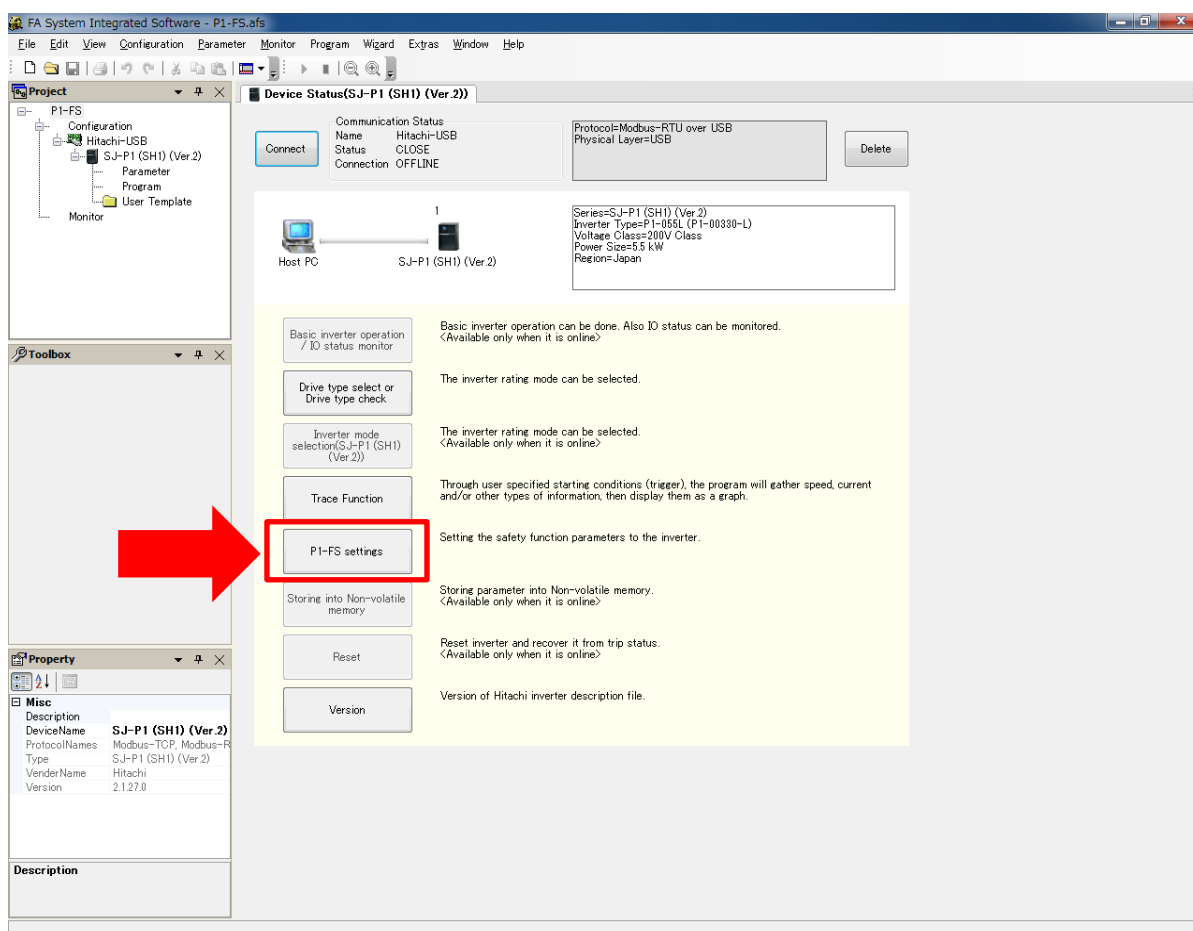
The parameters of safety function set to P1-FS are configured on PC software 'ProDriveNext' whose version is 2.3.22.0 or later. In this case, please check that the version of 'Hitachi Inverter Tool' is 2.1.28.1 or later. 'Hitachi Inverter Tool' is included in 'ProDriveNext'. Parameter setting to P1 should be set with the conventional parameter setting method (keypad, ProDriveNext, via communication).



※Please be sure to insert and fix P1-FS into the P1 slot (toward the far right).

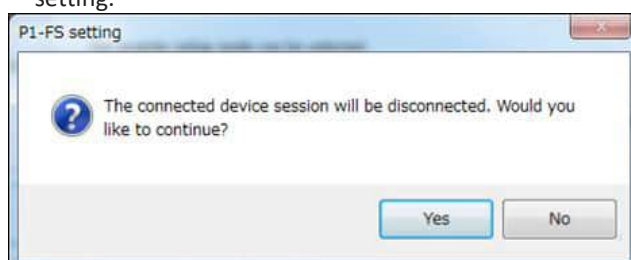
- From ProDriveNext launching to connection to P1-FS

[1] The following screen will be displayed after launching ProDriveNext and setting up the connection mode of online or offline.

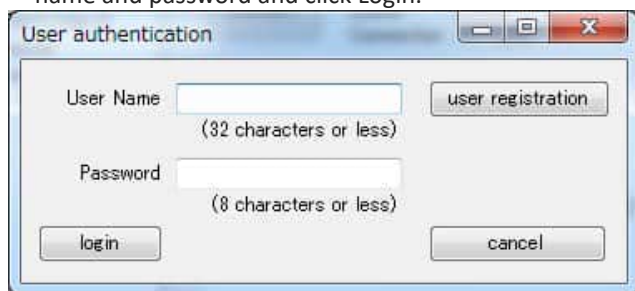


When the connection is online, go to [2]. When the connection is offline, go to [3].

[2] Click the P1-FS settings, the following confirmation screen will be displayed, click "Yes" to proceed to P1-FS setting.



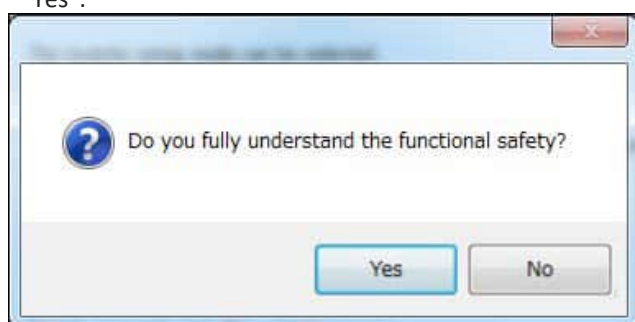
- [3] On the user authentication screen, enter the user name and password and click Login.



A dialog box titled "User authentication" with a blue header bar. It contains two text input fields: "User Name" (with a note "(32 characters or less)") and "Password" (with a note "(8 characters or less)"). There are four buttons: "user registration" (top right), "login" (bottom left), and "cancel" (bottom right). A "login" button is also present below the password field.

- *) If user registration is not completed, click the user registration and follow the procedure below.

- (1) Workers who handle the parameters must have sufficient knowledge of functional safety. If you fully understand the knowledge of functional safety, click "Yes".



A dialog box with a blue header bar. It contains a question mark icon and the text "Do you fully understand the functional safety?". At the bottom, there are two buttons: "Yes" and "No".

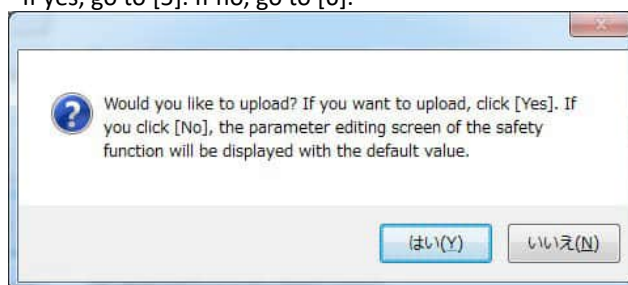
- (2) Enter the new user name and new password, enter the same password again as confirmation, and click "Login".



A dialog box titled "User registration" with a blue header bar. It contains three text input fields: "user name" (with a note "(32 characters or less)"), "password" (with a note "(8 characters or less)"), and "confirm password" (with a note "(8 characters or less)"). There are two buttons: "login" (bottom left) and "cancel" (bottom right).

- *) The number of registered users is one. If you register as a new user, the previous user information will be lost.

- [4] Select whether to upload (read out from P1-FS) the parameter information set to P1-FS. If yes, go to [5]. If no, go to [6].



A dialog box with a blue header bar. It contains a question mark icon and the text: "Would you like to upload? If you want to upload, click [Yes]. If you click [No], the parameter editing screen of the safety function will be displayed with the default value." At the bottom, there are two buttons: "はい(Y)" (Yes) and "いいえ(N)" (No).

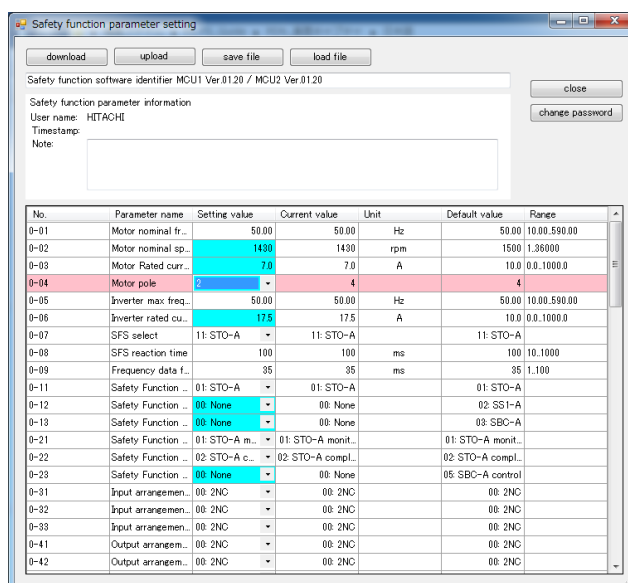
- [5] Enter the password to connect with P1-FS.

- *) This password is different from the user authentication password. The factory setting password set to P1-FS is [password].



A dialog box titled "Password input" with a blue header bar. It contains the text "Please input password." and a text input field for "Password" (with a note "(8 characters or less)"). There are two buttons: "OK" (bottom left) and "cancel" (bottom right).

- [6] The parameter editing screen is displayed.



A dialog box titled "Safety function parameter setting" with a blue header bar. It contains several buttons: "download", "upload", "save file", and "load file". Below these are fields for "Safety function software identifier MCU1 Ver.0120 / MCU2 Ver.0120", "User name: HITACHI", and "Timestamp:". There are also "close" and "change password" buttons. The main area is a table with the following data:

No.	Parameter name	Setting value	Current value	Unit	Default value	Range
0-01	Motor nominal fr...	50.00	50.00	Hz	50.00	10.00-590.00
0-02	Motor nominal sp...	1430	1430	rpm	1500	1.36000
0-03	Motor Rated curr...	7.0	7.0	A	10.0	0.0-1000.0
0-04	Motor pole	4	4		4	
0-05	Inverter max freq...	50.00	50.00	Hz	50.00	10.00-590.00
0-06	Inverter rated cu...	17.5	17.5	A	10.0	0.0-1000.0
0-07	SFS select	11: STO-A	11: STO-A		11: STO-A	
0-08	SFS reaction time	100	100	ms	100	10-1000
0-09	Frequency data f...	35	35	ms	35	1-100
0-11	Safety Function ...	01: STO-A	01: STO-A		01: STO-A	
0-12	Safety Function ...	00: None	00: None		02: SS1-A	
0-13	Safety Function ...	00: None	00: None		03: SBC-A	
0-21	Safety Function ...	01: STO-A m...	01: STO-A monit...		01: STO-A monit...	
0-22	Safety Function ...	02: STO-A c...	02: STO-A compl...		02: STO-A compl...	
0-23	Safety Function ...	00: None	00: None		05: SBC-A control	
0-31	Input arrangemen...	00: 2NC	00: 2NC		00: 2NC	
0-32	Input arrangemen...	00: 2NC	00: 2NC		00: 2NC	
0-33	Input arrangemen...	00: 2NC	00: 2NC		00: 2NC	
0-41	Output arrangem...	00: 2NC	00: 2NC		00: 2NC	
0-42	Output arrangem...	00: 2NC	00: 2NC		00: 2NC	

■ Parameter setting related function of P1-FS

No.	Parameter name	Setting value	Current value	Unit	Default value	Range
0-01	Motor nominal fr...	50.00	50.00	Hz	50.00	10.00.590.00
0-02	Motor nominal sp...	1430	1430	rpm	1500	1.36000
0-03	Motor Rated curr...	7.0	7.0	A	10.0	0.0.1000.0
0-04	Motor pole	2	4		4	
0-05	Inverter max freq...	50.00	50.00	Hz	50.00	10.00.590.00
0-06	Inverter rated cu...	17.5	17.5	A	10.0	0.0.1000.0
0-07	SFS select	11: STO-A	11: STO-A		11: STO-A	
0-08	SFS reaction time	100	100	ms	100	10.1000
0-09	Frequency data f...	35	35	ms	35	1.100
0-11	Safety Function ...	01: STO-A	01: STO-A		01: STO-A	
0-12	Safety Function ...	00: None	00: None		02: SS1-A	
0-13	Safety Function ...	00: None	00: None		03: SBC-A	
0-21	Safety Function ...	01: STO-A m...	01: STO-A monit...		01: STO-A monit...	
0-22	Safety Function ...	02: STO-A c...	02: STO-A compl...		02: STO-A compl...	
0-23	Safety Function ...	00: None	00: None		05: SBC-A control	
0-31	Input arrangemen...	00: 2NC	00: 2NC		00: 2NC	
0-32	Input arrangemen...	00: 2NC	00: 2NC		00: 2NC	
0-33	Input arrangemen...	00: 2NC	00: 2NC		00: 2NC	
0-41	Output arrangem...	00: 2NC	00: 2NC		00: 2NC	
0-42	Output arrangem...	00: 2NC	00: 2NC		00: 2NC	

On the parameter editing screen, when uploading of data is successful, identification information is displayed. By changing the setting value column and downloading, the internal parameters of P1-FS are updated.

■ Operation on parameter editing screen

By clicking the related button on the parameter editing screen, following operations are available.

Function	Outline
Parameter editing	Edit parameters
Download	Transfer the parameters to P1-FS
Upload	Acquire parameters from P1-FS
Save file	Save the data in text file
Read file	Read the data from text file
Change password	Change the password of the P1-FS

The cell where the uploaded information has been changed from the initial value is light blue, and the line changed from the current value by the operation of the cell is displayed in red.

■ Password change on P1-FS

By clicking change password on the parameter editing screen, the password on P1-FS can be changed.

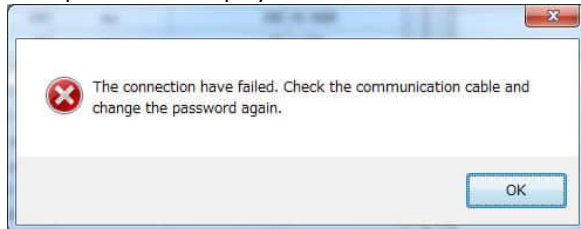
*) The factory password set on P1-FS is [password]. When the password is [password], P1-FS outputs the STO state and cannot drive the motor. In this case, the LED on P1-FS flashes at approximately 2 second cycle.

■ Troubleshooting for setting parameters to P1-FS

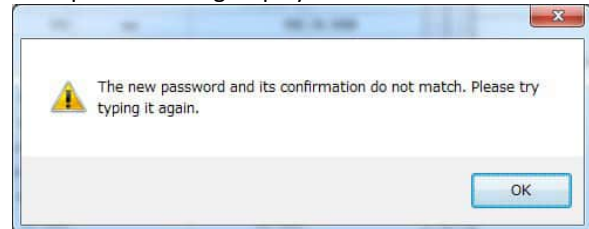
(1) An error is occurred

No.	message	Workaround
1	The connection have failed. Check the communication cable and try to download again.	Check the communication cable and try to communicate again.
2	The connection have failed. Check the communication cable and try to upload again.	
3	The connection have failed. Check the communication cable and change the password again.	
4	The password does not match. Please check the password and try to download again.	Confirm the password and try to communicate again
5	The password does not match. Please check the password and try to upload again.	
6	The password does not match. Confirm the password and try changing the password again.	
7	Failed to read the Safety function parameters.	Try to upload again. It may be improved by noise countermeasure of communication cable.
8	Failed to write the Safety function parameters.	Try to download again. It may be improved by noise countermeasure of communication cable.
9	Failed to write to the data flash.	
10	Failed to change the password.	
11	Failed to write to the data flash.	Confirm the inverter trying to access. It may be improved by noise countermeasure of communication cable.
12	The device model does not match.	
13	Safety function software version does not match.	Try to upload or download again. It may be improved by noise countermeasure of communication cable.
14	The disconnection have failed.	
15	Failed to disconnect the device.	Try to save the file again.
16	Failed to save the file.	The file may have been rewritten. In this case, it cannot be read.
17	Failed to read the file.	

Example of error displayed:No.3



Example of warning displayed:No.5



(2) A warning is occurred

No.	message	Workaround
1	Please enter the user name. (32 characters or less)	Perform the operation again according to the left message.
2	Please enter the password. (8 characters or less)	
3	Please enter a half-width alphanumeric character without spaces for the password.	
4	The user name or the password is incorrect. Please try again.	
5	The new password and its confirmation do not match. Please try typing it again.	
6	There is an error such as out of range in the setting value. Please correct the setting value and click download.	
7	There is an error such as out of range in the setting value. Please correct the setting value and click Save file.	
8	Please execute the Safety function setting after closing the {model name} editing screen.	
9	Some of uploaded parameter value are invalid. Please check the value of the Safety function parameters that are displayed in orange.	

4.4.8 List of parameters

■Parameters for P1-FS

No.	Name	Range	Default	Memo
0-01	Motor nominal frequency	0.00 to 590.00Hz	50.00	
0-02	Motor nominal speed	1 to 36000rpm (min ⁻¹)	1500	
0-03	Motor Rated current	0.0 to 1000.0A	10.0	
0-04	Motor pole	2/4/6/8/...../64	4	
0-05	Inverter max frequency	0.00 to 590.00Hz	50.00	
0-06	Inverter rated current ND	0.0 to 1000.0A	10.0	
0-07	SFS select	11:STO-A / 12:STO-B / 21:SS1-A / 22:SS1-B / 31:SBC-A / 32:SBC-B	11	
0-08	SFS reaction time	10 to 1000ms	100	
0-09	Frequency data filtering	1 to 100ms	35	
0-11	Safety Function Select Input 1	00:None / 01:STO-A / 02:SS1-A / 03:SBC-A / 04:SLS-A / 05:SDI-A / 11:STO-B / 12:SS1-B / 13:SBC-B / 14:SLS-B / 15:SDI-B	01	
0-12	Safety Function Select Input 2		02	
0-13	Safety Function Select Input 3		03	
0-21	Safety Function Select Output 1	00:None / 01:STO-A monitoring / 02:STO-A completed / 03:SS1-A monitoring / 04:SS1-A completed / 05:SBC-A control / 06:SLS-A monitoring / 07:SDI-A monitoring / 08:SSM-A monitoring / 11:STO-B monitoring / 12:STO-B completed / 13:SS1-B monitoring / 14:SS1-B completed / 15:SBC-B control / 16:SLS-B monitoring / 17:SDI-B monitoring / 18:SSM-B monitoring / 21:Internal error / 31:test pulse(only S13)	01	
0-22	Safety Function Select Output 2		02	
0-23	Safety Function Select Output 3		05	
0-31	Input arrangement 1	00:2NC / 01:1NC(path1) and 1NO(path2)	00	
0-32	Input arrangement 2	00:2NC / 01:1NC(path1) and 1NO(path2)	00	
0-33	Input arrangement 3	00:2NC / 01:1NC(path1) and 1NO(path2)	00	
0-41	Output arrangement 1	00:2NC / 01:1NC(path1) and 1NO(path2)/02:2NO	00	
0-42	Output arrangement 2	00:2NC / 01:1NC(path1) and 1NO(path2)/02:2NO	00	
0-43	Output arrangement 3	00:2NC / 01:1NC(path1) and 1NO(path2)/02:2NO	00	
0-51	Test pulse check 1	00:None / 01:Checking	00	
0-52	Test pulse check 2	00:None / 01:Checking	00	
0-53	Test pulse check 3	00:None / 01:Checking	00	
0-61	Input 1 sensitivity	0.001 to 1.000s	0.001	
0-62	Input 2 sensitivity	0.001 to 1.000s	0.001	
0-63	Input 3 sensitivity	0.001 to 1.000s	0.001	
0-71	Output 1 sensitivity	0.001 to 1.000s	0.001	
0-72	Output 2 sensitivity	0.001 to 1.000s	0.001	
0-73	Output 3 sensitivity	0.001 to 1.000s	0.001	
0-81	Input 1 gap time	0.001 to 1.000s	0.1	
0-82	Input 2 gap time	0.001 to 1.000s	0.1	
0-83	Input 3 gap time	0.001 to 1.000s	0.1	
0-91	Output 1 gap time	0.001 to 1.000s	0.001	
0-92	Output 2 gap time	0.001 to 1.000s	0.001	
0-93	Output 3 gap time	0.001 to 1.000s	0.001	

No.	Name	Range	Default	Memo
1-11	Keep Time after STO-A	0.00 to 3600.00s	1.00	
1-12	STO-A release mode	00:without release / 01:with safety signal / 02:with release signal	01	
1-21	SS1-A Zero frequency	0.10 to 10.00Hz	5.00	
1-22	SS1-A monitoring method	00:Time /01: Frequency	00	
1-23	SS1-A Active time	0.00 to 3600.00s	1.00	
1-24	SS1-A Min ramp time	0.00 to 3600.00s	1.00	
1-25	SS1-A Max ramp time	0.00 to 3960.00s	30.00	
1-26	SS1-A Wait Time	0.00 to 600.00s	1.00	
1-31	SBC-A Time linkage	00: SBC after STO/01: SBC before STO/ 02:SS1 then SBC after STO/03:SS1 then SBC before STO	00	
1-32	SBC-A Wait time after STO-A	0.00 to 3600.00s	1.00	
1-33	SBC-A Wait time before STO-A	0.00 to 10.00s	1.00	
1-34	SBC-A frequency	0.00 to 100.00Hz	0.00	
1-35	SBC-A STO-A release wait time	0.00 to 10.00s	0.00	
1-36	SBC-A release level	0.00 to 100.00%	100.00	
1-41	SLS-A frequency limit CCW/FW	0.00 to 590.00Hz	72.00	
1-42	SLS-A frequency limit CW/RV	0.00 to 590.00Hz	50.00	
1-43	SLS-A time delay	0.00 to 3600.00s	10.00	
1-51	SDI-A active mode	00:CW(RV)-limit/01:CCW(FW)-limit	00	
1-52	SDI-A time delay	0.00 to 3600.00s	10.00	
1-61	SSM-A frequency CCW/FW	0.00 to 590.00Hz	72.00	
1-62	SSM-A frequency CW/RV	0.00 to 590.00Hz	50.00	
2-11	Keep Time after STO-B	0.00 to 3600.00s	1.00	
2-12	STO-B release mode	00:without release / 01:with safety signal / 02:with release signal	01	
2-21	SS1-B Zero frequency	0.10 to 10.00Hz	5.00	
2-22	SS1-B monitoring method	00:Time /01: frequency	00	
2-23	SS1-B Active time	0.00 to 3600.00s	1.00	
2-24	SS1-B Min ramp time	0.00 to 3600.00s	1.00	
2-25	SS1-B Max ramp time	0.00 to 3960.00s	30.00	
2-26	SS1-B Wait Time	0.00 to 600.00s	1.00	
2-31	SBC-B Time linkage	00: SBC after STO/01: SBC before STO/ 02:SS1 then SBC after STO/03:SS1 then SBC before STO	00	
2-32	SBC-B Wait time after STO-B	0.00 to 3600.00s	1.00	
2-33	SBC-B Wait time before STO-B	0.00 to 10.00s	1.00	
2-34	SBC-B frequency	0.00 to 100.00Hz	0.00	
2-35	SBC-B STO-B release wait time	0.00 to 10.00s	0.00	
2-36	SBC-B release level	0.00 to 100.00%	100.00	
2-41	SLS-B frequency limit CCW/FW	0.00 to 590.00Hz	72.00	
2-42	SLS-B frequency limit CW/RV	0.00 to 590.00Hz	50.00	
2-43	SLS-B time delay	0.00 to 3600.00s	10.00	
2-51	SDI-B active mode	00:CW(RV)-limit/01:CCW(FW)-limit	00	
2-52	SDI-B time delay	0.00 to 3600.00s	10.00	
2-61	SSM-B frequency CCW/FW	0.00 to 590.00Hz	72.00	
2-62	SSM-B frequency CW/RV	0.00 to 590.00Hz	50.00	

■P1-FS related parameters on P1

No.	Name	Range	Default	Memo
oC-01	Safety option input display selection	00(Warning(with display))/ 01(Warning(without display))	00	
oC-10	SS1-A deceleration time setting	0.00 to 3600.00s	30.00	
oC-12	SLS-A deceleration time setting	0.00 to 3600.00s	30.00	
oC-14	SLS-A Speed upper limit(Forward)	0.00 to 590.00Hz	0.00	
oC-15	SLS-A Speed upper limit(Reverse)	0.00 to 590.00Hz	0.00	
oC-16	SDI-A deceleration time setting	0.00 to 3600.00s	30.00	
oC-18	SDI-A limited direction	00(limit)/01(invert)	00	
oC-20	SS1-B deceleration time setting	0.00 to 3600.00s	30.00	
oC-22	SLS-B deceleration time setting	0.00 to 3600.00s	30.00	
oC-24	SLS-B Speed upper limit(Forward)	0.00 to 590.00Hz	0.00	
oC-25	SLS-B Speed upper limit(Reverse)	0.00 to 590.00Hz	0.00	
oC-26	SDI-B deceleration time setting	0.00 to 3600.00s	30.00	
oC-28	SDI-B limited direction	00(limit)/01(invert)	00	

4.5 Functional description

4.5.1 STO function

■ How STO function works

The STO function can stop the output to the motor safely by keeping the STO state until the motor coasts to stop.

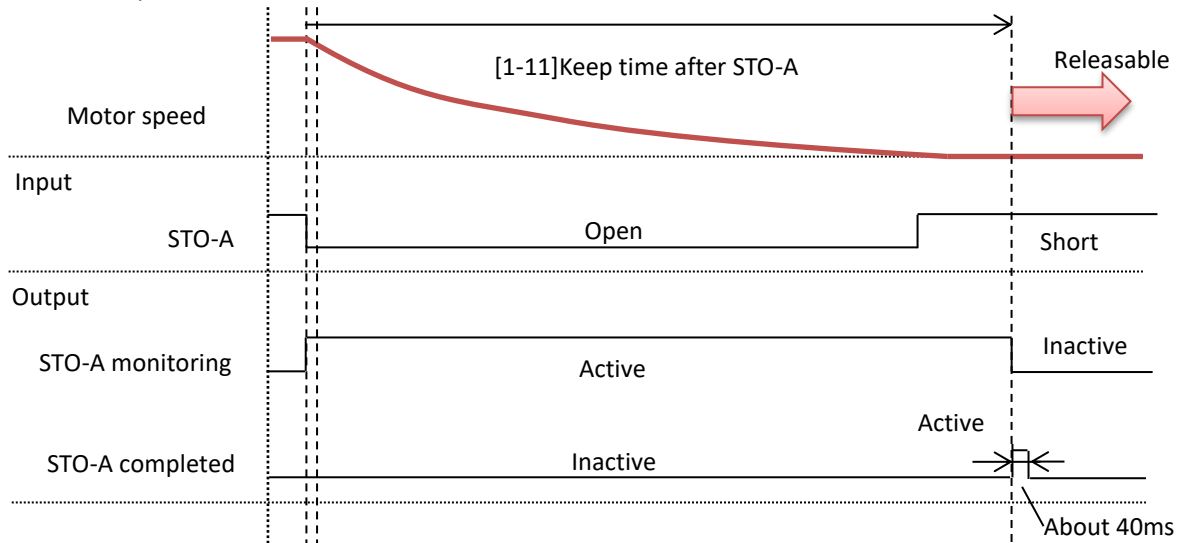
The STO function can be used by inputting STO-A or STO-B function individually.

When STO-A and STO-B are activated at the same time, STO-A is higher priority function.

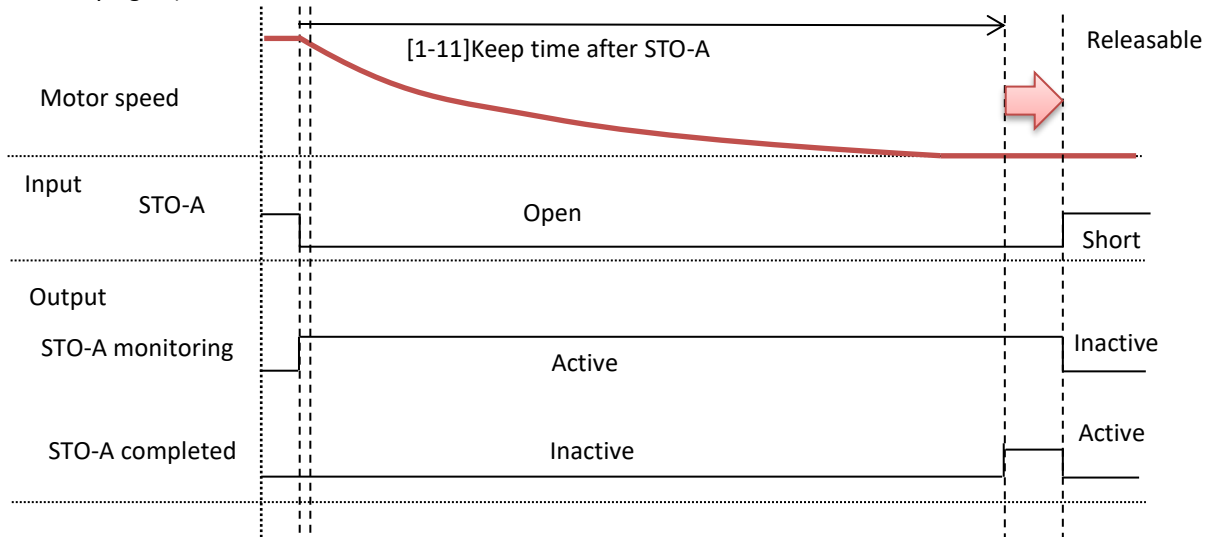
■ Related parameters

No.	Name	Related data
0-11	Safety Function Select Input 1	01:STO-A / 11:STO-B
0-12	Safety Function Select Input 2	
0-13	Safety Function Select Input 3	
0-21	Safety Function Select Output 1	01:STO-A monitoring / 02:STO-A completed / 11:STO-B monitoring / 12:STO-B completed
0-22	Safety Function Select Output 2	
0-23	Safety Function Select Output 3	
1-11	Keep Time after STO-A	0.00 to 3600.00s
1-12	STO-A release mode	00:without release / 01:with safety signal / 02:with release signal
2-11	Keep Time after STO-B	0.00 to 3600.00s
2-12	STO-B release mode	00:without release / 01:with safety signal / 02:with release signal

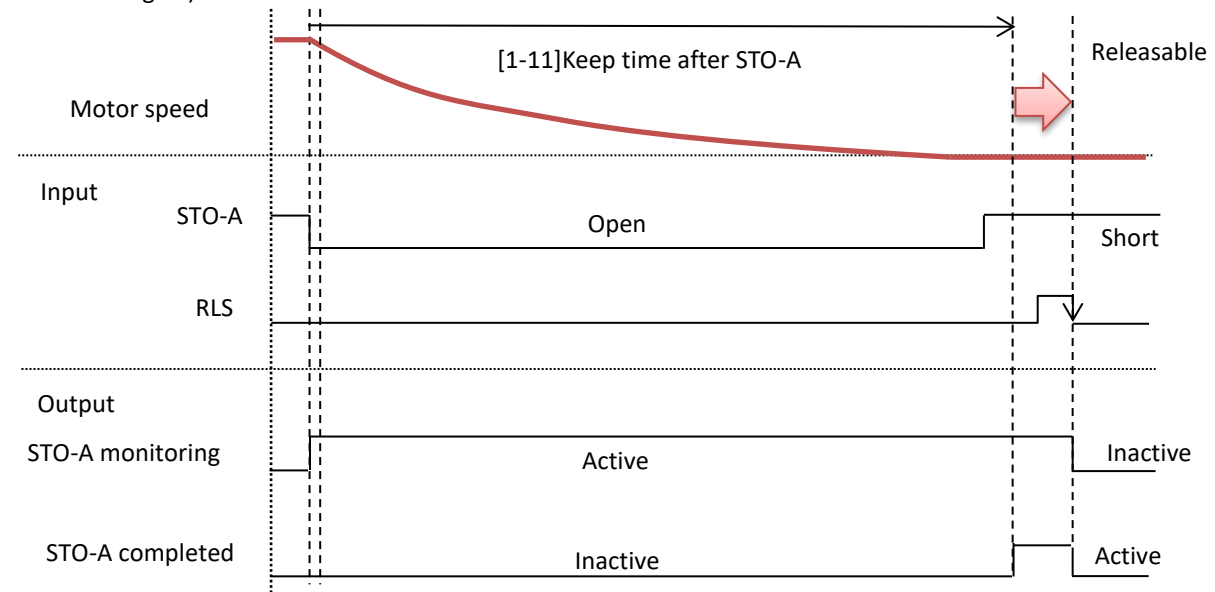
e.g. Case: [1-12]STO-A release mode = 00
(Without release):



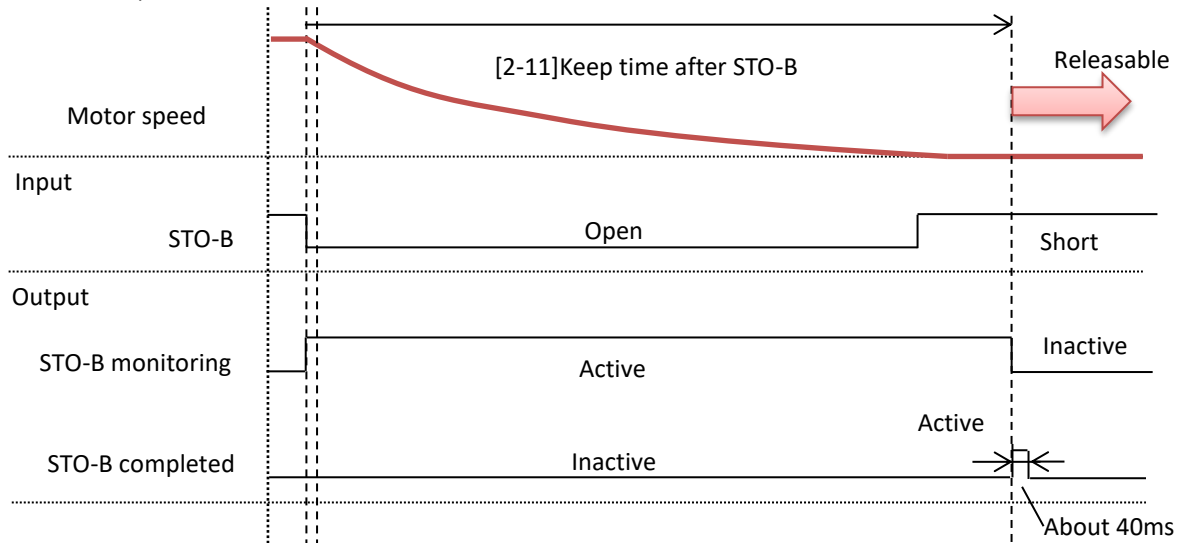
e.g. Case: [1-12]STO-A release mode = 01
(With safety signal):



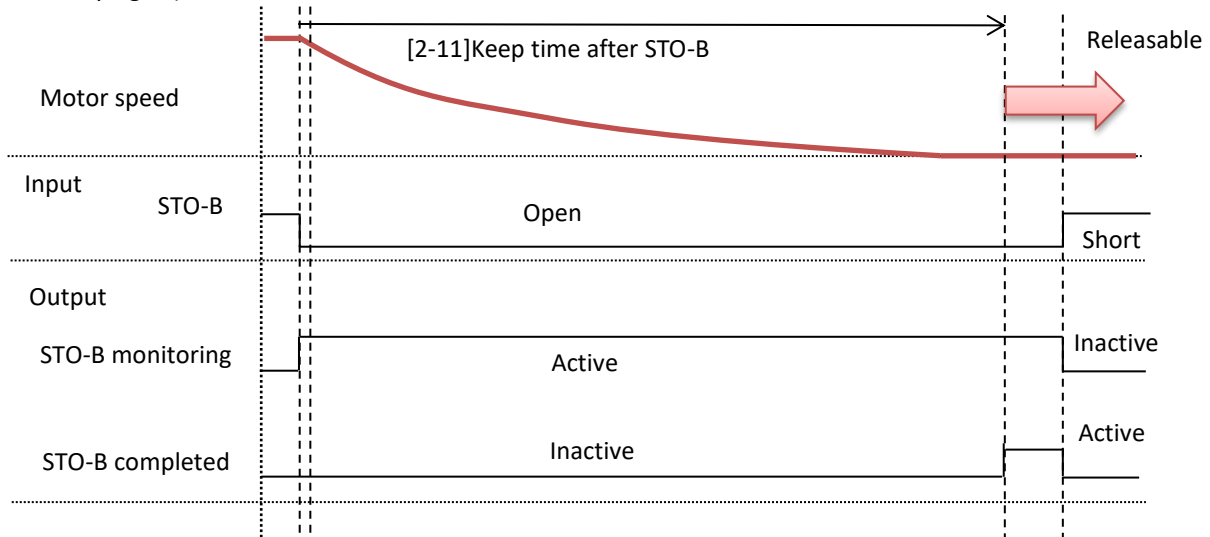
e.g. Case: [1-12]STO-A release mode = 02
(With release signal):



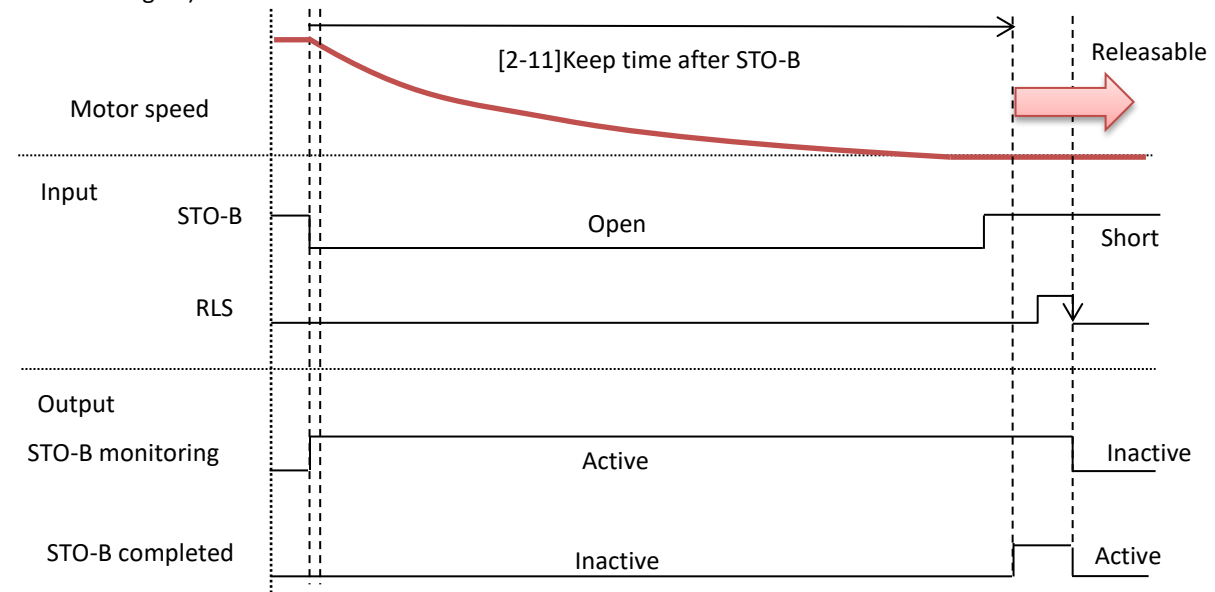
e.g. Case: [2-12]STO-B release mode = 00
(Without release):



e.g. Case: [2-12]STO-B release mode = 01
(With safety signal):



e.g. Case: [2-12]STO-B release mode = 02
(With release signal):



4.5.2 SS1 function

■ How SS1 function works

The SS1 function can decelerates the motor speed to stop by monitoring the time or speed until the motor speed to stop. Eventually, SS1 function transits to STO function.

The SS1 function can be used by inputting SS1-A or SS1-B function individually.

When SS1-A and SS1-B are activated at the same time, SS1-A is higher priority function.

The setting [1-12]STO-A release mode / [2-12]STO-B release mode is applied after transition to STO function. Releasing of SS1 function depends on the activation of SS1 signal input.

Deceleration time in the SS1 state is determined by Deceleration time [oC-10] or [oC-20] in the setting parameters of SJ-P1.

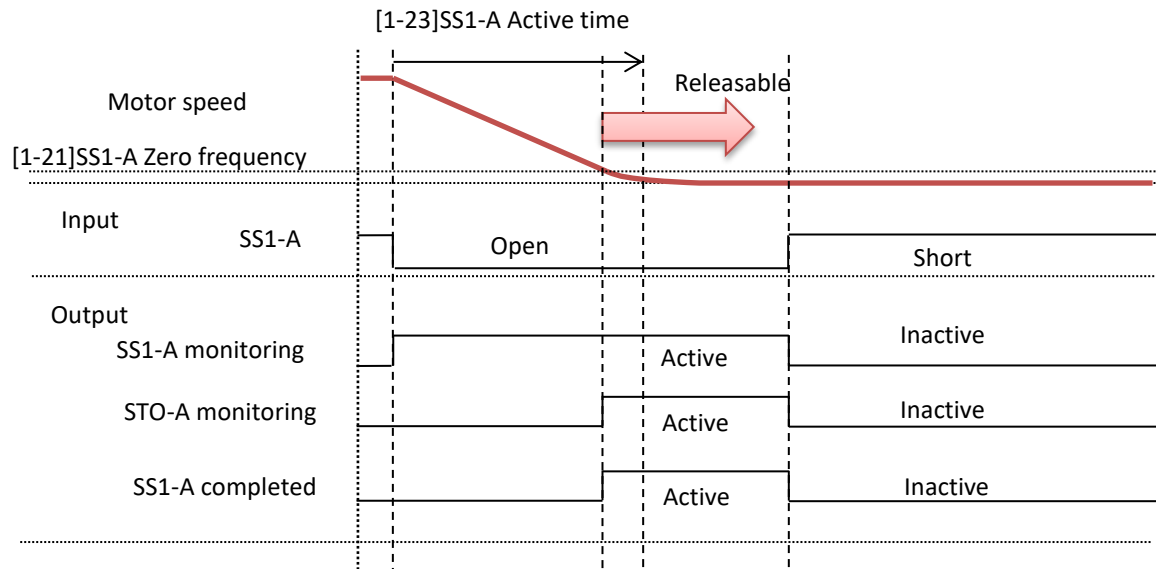
■ Related parameters

No.	Name	Related data
0-11	Safety Function Select Input 1	02:SS1-A / 12:SS1-B
0-12	Safety Function Select Input 2	
0-13	Safety Function Select Input 3	
0-21	Safety Function Select Output 1	01:STO-A monitoring / 02:STO-A completed / 03:SS1-A monitoring / 04:SS1-A completed / 11:STO-B monitoring / 12:STO-B completed / 13:SS1-B monitoring / 14:SS1-B completed
0-22	Safety Function Select Output 2	
0-23	Safety Function Select Output 3	
1-11	Keep time after STO-A	0.00 to 3600.00s
1-12	STO-A Release mode	00:Without release / 01:With safety signal / 02:With release signal
2-11	Keep time after STO-B	0.00 to 3600.00s
2-12	STO-B release mode	00:Without release / 01:With safety signal / 02:With release signal
1-21	SS1-A Zero frequency	0.10 to 10.00Hz
1-22	SS1-A monitoring method	00:Time /01:Frequency
1-23	SS1-A Active time	0.00 to 3600.00s
1-24	SS1-A Min ramp time	0.00 to 3600.00s
1-25	SS1-A Max ramp time	0.00 to 3960.00s
1-26	SS1-A Wait time	0.00 to 600.00s
2-21	SS1-B Zero frequency	0.10 to 10.00Hz
2-22	SS1-B monitoring method	00:Time /01:Frequency
2-23	SS1-B Active time	0.00 to 3600.00s
2-24	SS1-B Min ramp time	0.00 to 3600.00s
2-25	SS1-B Max ramp time	0.00 to 3960.00s
2-26	SS1-B Wait time	0.00 to 600.00s
0-07	SFS Select	11:STO-A / 12:STO-B / 21:SS1-A / 22:SS1-B / 31:SBC-A / 32:SBC-B

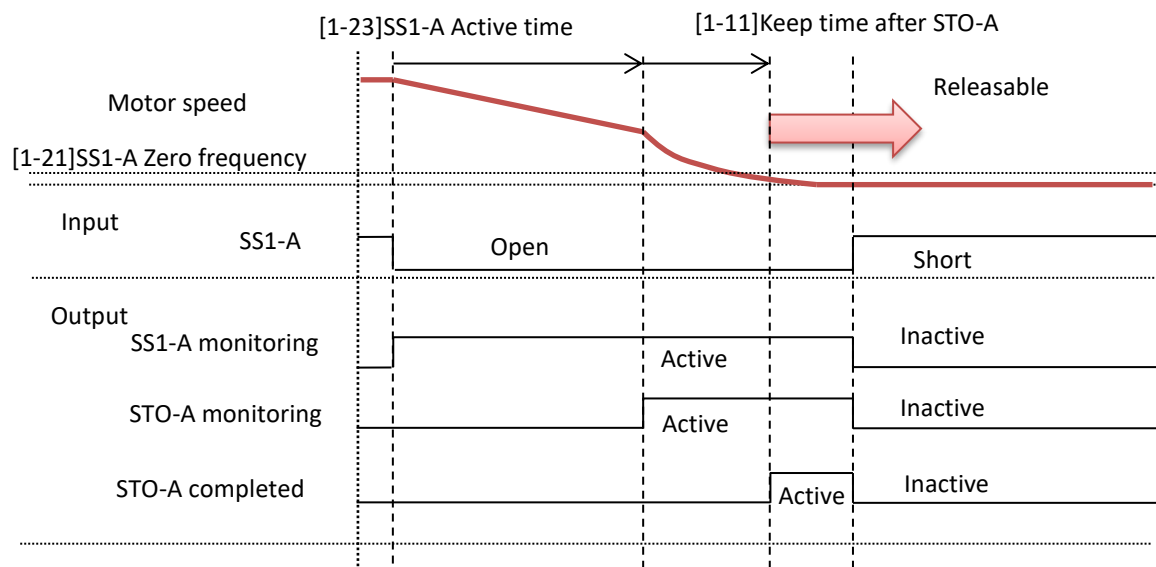
■ Related P1 parameters

No.	Name	Related data
oC-10	SS1-A Deceleration time	0.00 to 3600.00(s)
oC-20	SS1-B Deceleration time	0.00 to 3600.00(s)

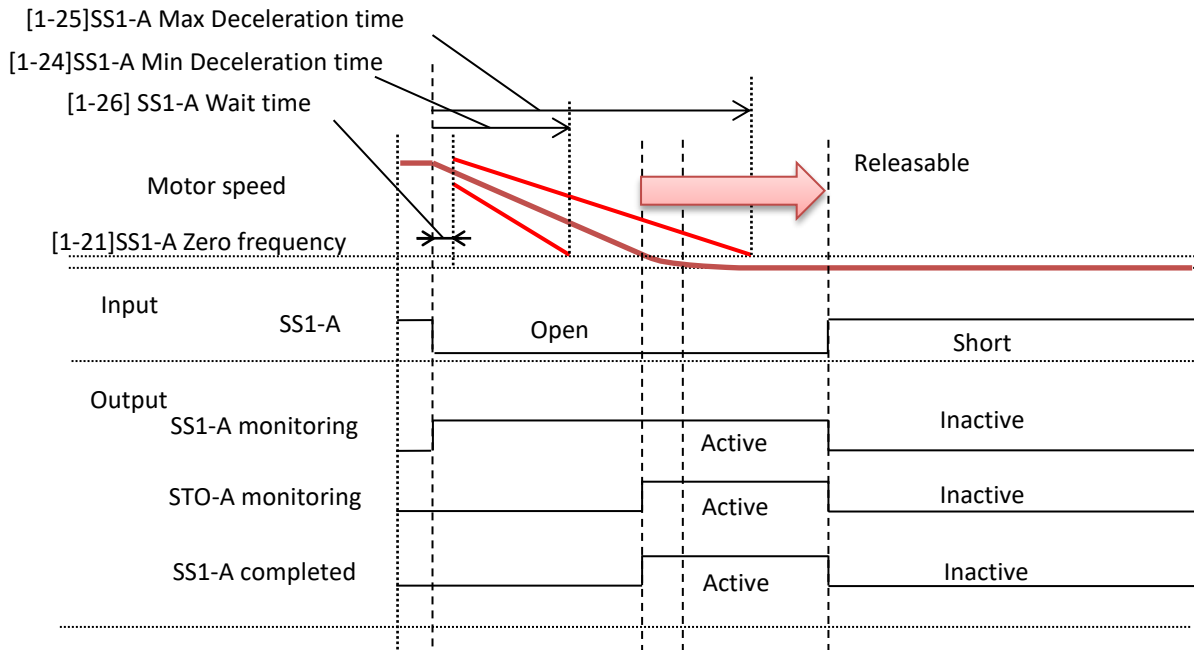
e.g. Case: SS1-A Action completed on time
 [1-22]SS1-A monitoring method=00(Time) and
 [1-12]STO-A Release mode =01(With safety signal):



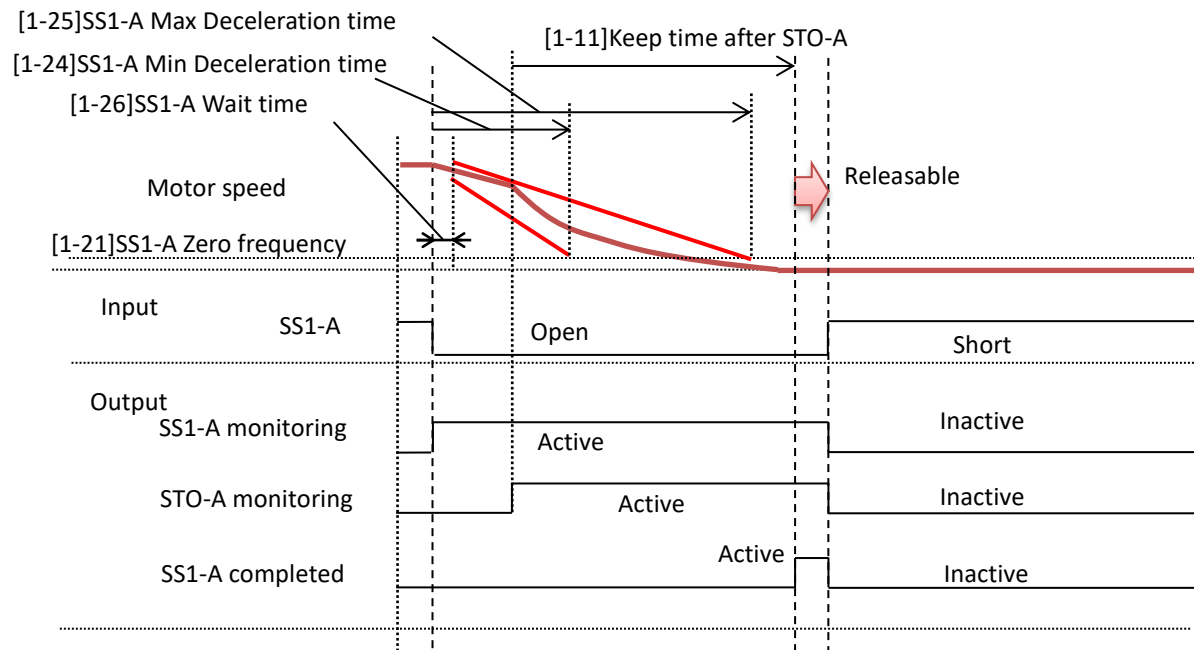
e.g. Case: SS1-A Action uncompleted on time
 [1-22]SS1-A monitoring method=00(Time),
 [1-12]STO-A release mode =01(With safety signal) and
 [0-07]SFS Select =11(STO-A):



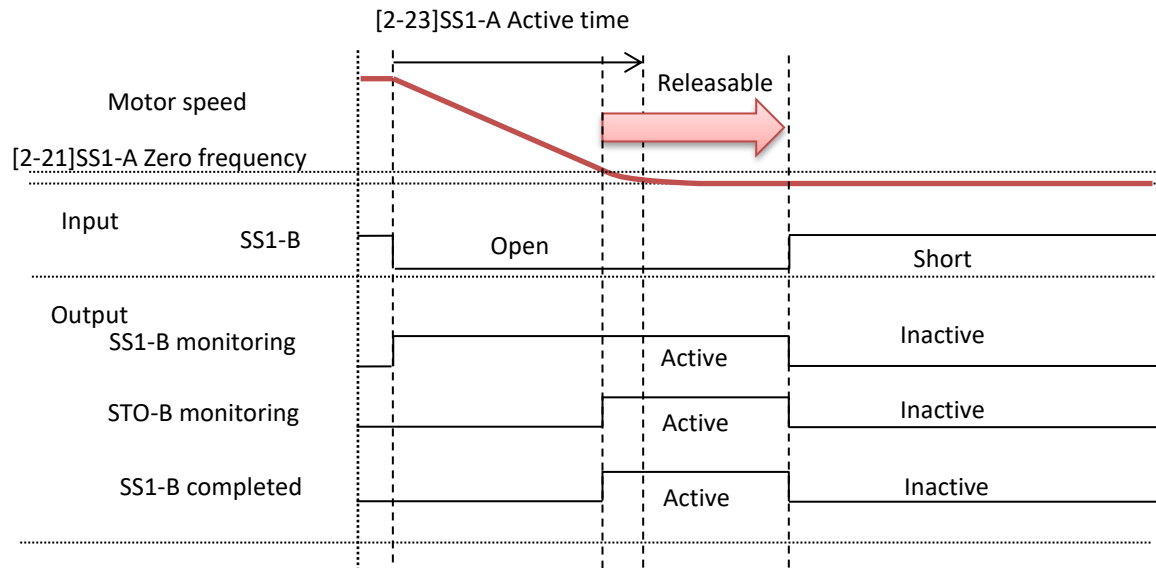
e.g. Case: SS1-A Action completed correctly
 [1-22]SS1-A monitoring method =01(Frequency) and [1-12]STO-A release mode =01(With safety signal):



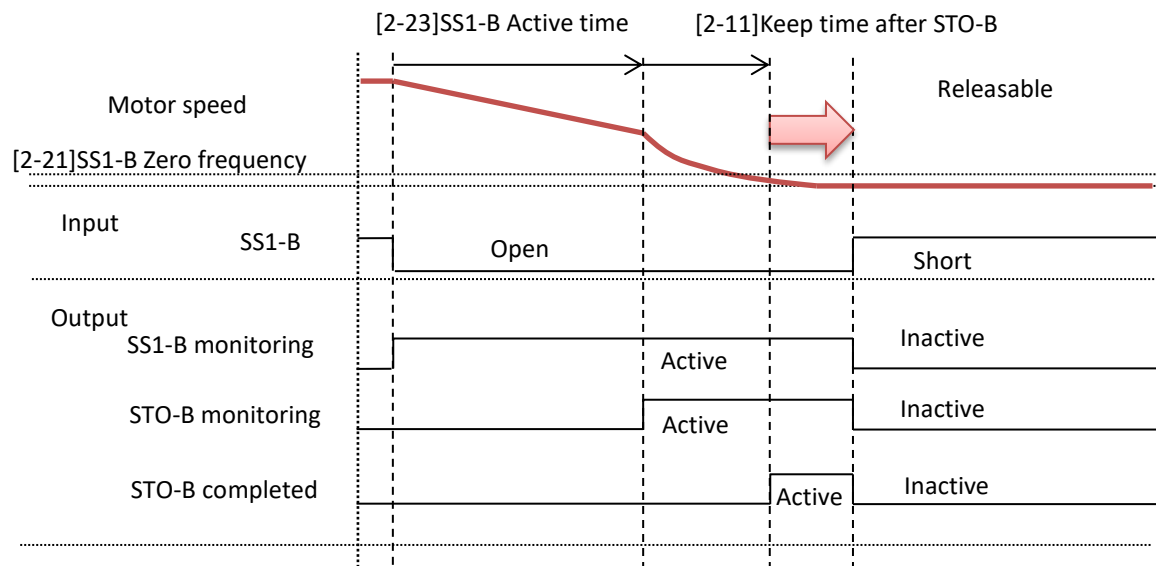
e.g. Case: SS1-A Action uncompleted correctly
 [1-22]SS1-A monitoring method=01(frequency),
 [1-12]STO-A release mode =01(With safety signal) and
 [0-07]SFS Select=11(STO-A):



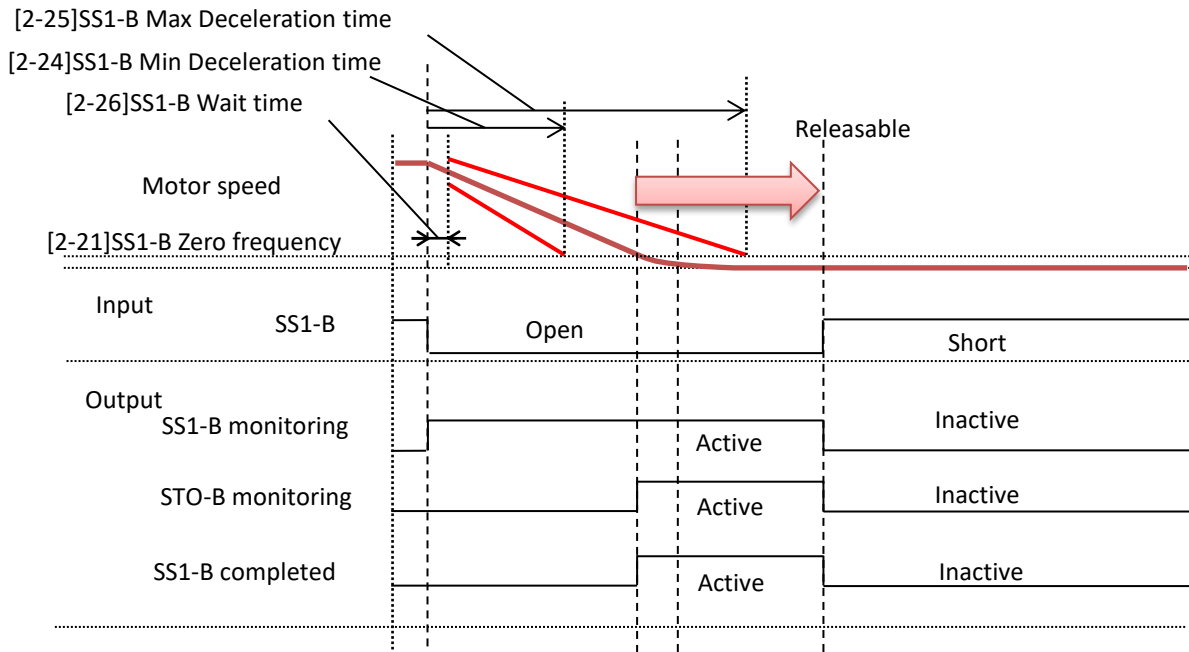
e.g. Case: SS1-B Action completed on time
 [2-22]SS1-B monitoring method=00(Time) and
 [2-12]STO-B release mode=01(With safety signal):



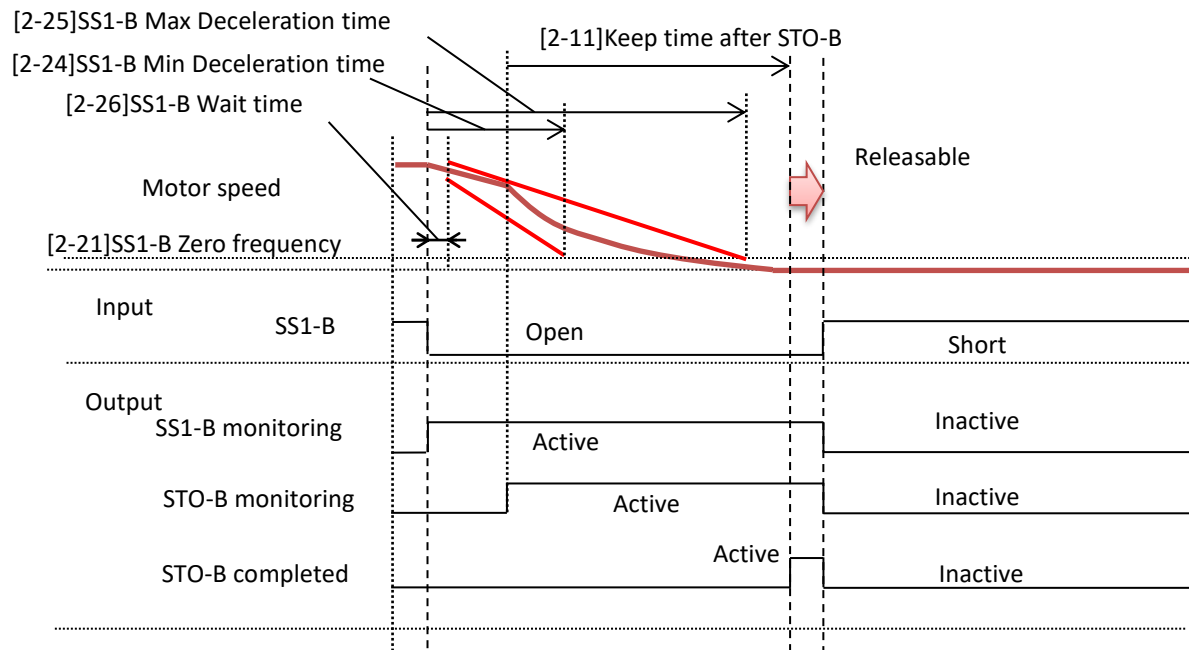
e.g. Case: SS1-B Action uncompleted on time
 [2-22]SS1-B monitoring method=00(Time),
 [2-12]STO-B release mode=01(With safety signal) and [0-07]SFS select=21(STO-B):



e.g. Case: SS1-B Action completed correctly
 [2-22]SS1-B monitoring method=01(Frequency) and [2-12]STO-B release mode=01(With safety signal):



e.g. Case: SS1-B Action uncompleted correctly
 [2-22]SS1-B monitoring method=01(Frequency),
 [2-12]STO-B release mode=01(With safety signal) and [0-07]SFS Select=21(STO-B):



4.5.3 SBC function

■ How SBC function works

The SBC function can control the break control signal and shut off the output to the motor. SBC function links STO function.

The SBC function can be used by inputting SBC-A or SBC-B function individually.

When SBC-A and SBC-B are activated at the same time, SBC-A is higher priority function.

Deceleration time in the SS1 state during SBC sequence is determined by Deceleration time [oC-10] or [oC-20] in the setting parameters of SJ-P1.

■ Related parameters

No.	Name	Related data
0-07	SFS Select	11:STO-A / 12:STO-B / 21:SS1-A / 22:SS1-B / 31:SBC-A / 32:SBC-B
0-11	Safety Function Select Input 1	03:SBC-A / 13:SBC-B
0-12	Safety Function Select Input 2	
0-13	Safety Function Select Input 3	
0-21	Safety Function Select Output 1	01:STO-A monitoring / 02:STO-A completed / 03:SS1-A monitoring / 04:SS1-A completed / 05:SBC-A Control / 11:STO-B monitoring / 12:STO-B completed / 13:SS1-B monitoring / 14:SS1-B completed / 15:SBC-B Control
0-22	Safety Function Select Output 2	
0-23	Safety Function Select Output 3	
1-11	Keep time after STO-A	0.00 to 3600.00s
1-12	STO-A Release mode	00:Without release / 01:With safety signal / 02:With release signal
2-11	Keep time after STO-B	0.00 to 3600.00s
2-12	STO-B release mode	00:Without release / 01:With safety signal / 02:With release signal
1-21	SS1-A Zero frequency	0.10 to 10.00Hz
1-22	SS1-A monitoring method	00:Time / 01:Frequency
1-23	SS1-A Active time	0.00 to 3600.00s
1-24	SS1-A Min ramp time	0.00 to 3600.00s
1-25	SS1-A Max ramp time	0.00 to 3960.00s
1-26	SS1-A Wait time	0.00 to 600.00s
1-31	SBC-A Time linkage	00: STO after SBC / 01: SBC after STO / 02: SS1, then STO after SBC / 03: SS1, then SBC after STO
1-32	SBC-A Wait time after STO-A	0.00 to 3600.00s
1-33	SBC-A Wait time before STO-A	0.00 to 10.00s
1-34	SBC-A Frequency	0.00 to 100.00Hz
1-35	SBC-A STO-A release wait time	0.00 to 10.00s
1-36	SBC-A release level	0.00 to 100.00%

The setting [1-12]STO-A release mode / [2-12]STO-B release mode is applied to STO function. Releasing of STO function during SBC function depends on the activation of SBC signal input.

Releasing of SBC control signal depends on the setting of [1-35] SBC-A STO-A release wait time / [2-35] SBC-B STO-B release wait time and [1-36] SBC-A release level / [2-36] SBC-B release level.

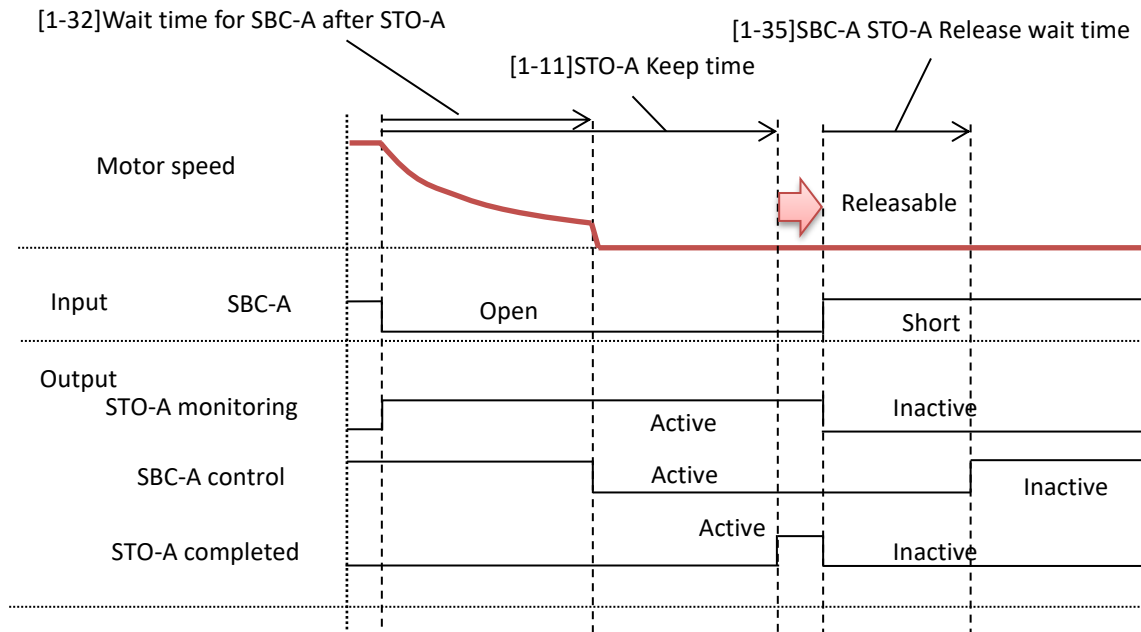
■ Related parameters (continuation)

No.	Name	Related data
2-21	SS1-B Zero frequency	0.10 to 10.00Hz
2-22	SS1-B monitoring method	00:Time / 01:Frequency
2-23	SS1-B Active time	0.00 to 3600.00s
2-24	SS1-B Min ramp time	0.00 to 3600.00s
2-25	SS1-B Max ramp time	0.00 to 3960.00s
2-26	SS1-B Wait time	0.00 to 600.00s
2-31	SBC-B Time linkage	00: STO after SBC / 01: SBC after STO / 02: SS1, then STO after SBC / 03: SS1, then SBC after STO
2-32	SBC-B Wait time after STO-B	0.00 to 3600.00s
2-33	SBC-B Wait time before STO-B	0.00 to 10.00s
2-34	SBC-B frequency	0.00 to 100.00Hz
2-35	SBC-B STO-B release wait time	0.00 to 10.00s
2-36	SBC-B release level	0.00 to 100.00%

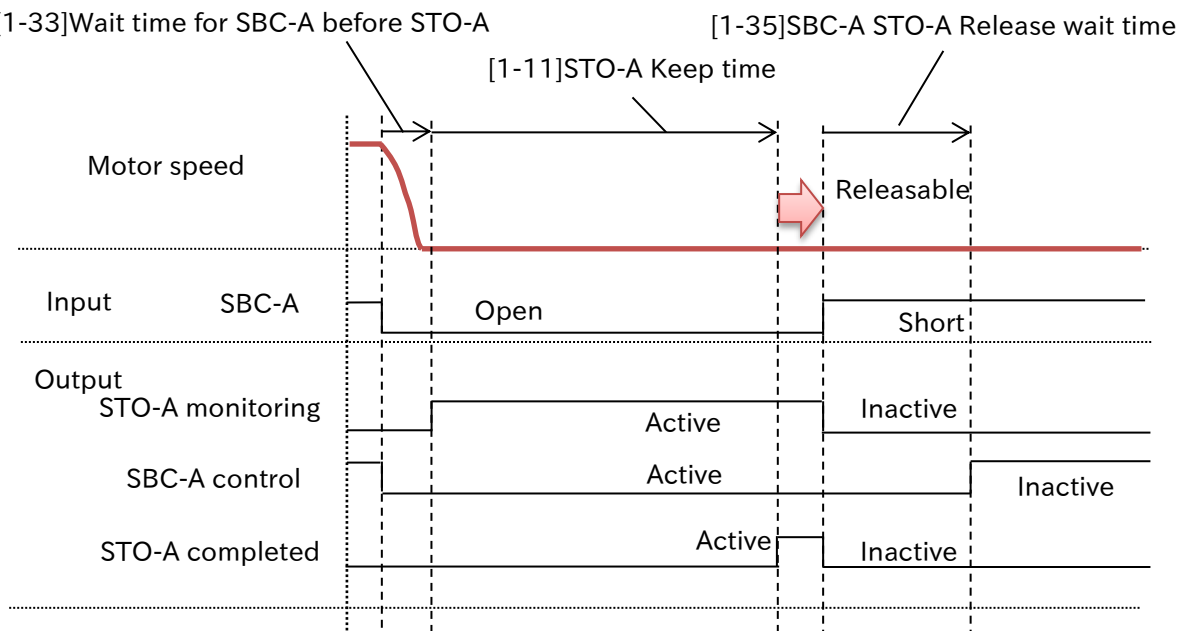
■ Related P1 parameters

No.	Name	Related data
oC-10	SS1-A Deceleration time	0.00 to 3600.00(s)
oC-20	SS1-B Deceleration time	0.00 to 3600.00(s)

e.g. Case: SBC-A activating after STO-A activating
 [1-31]SBC-A Time linkage=00(SBC after STO),
 [1-12]STO-A Release mode =01(With safety signal) and [1-36]SBC-A release level=0.00%:

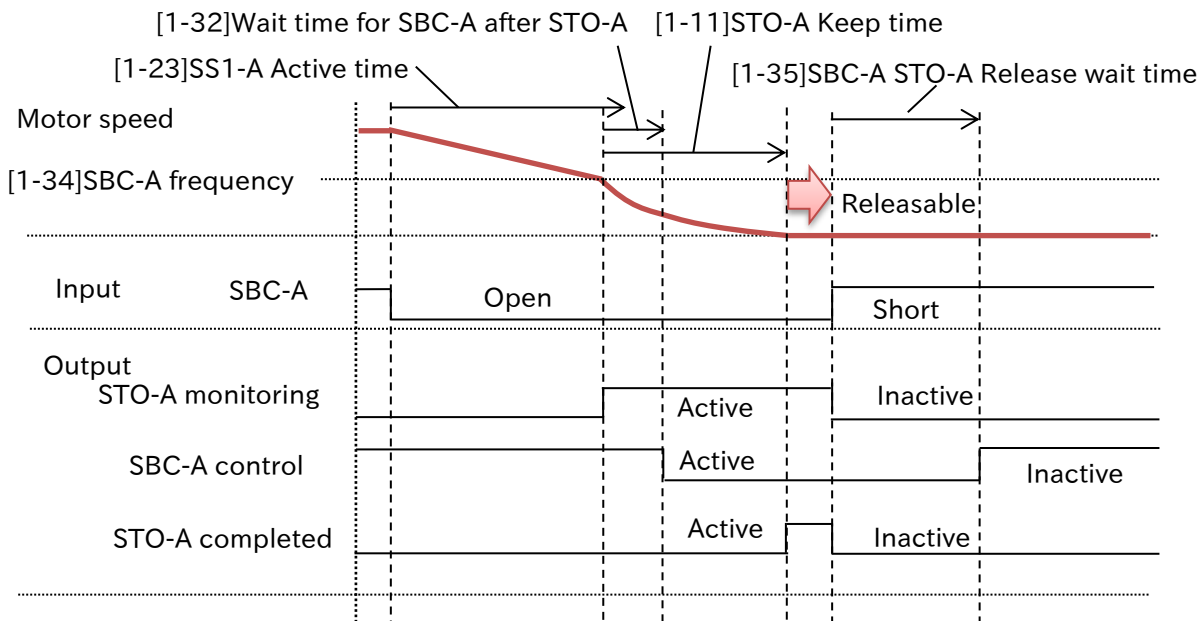


e.g. Case: SBC-A activating before STO-A activating
 [1-31]SBC-A Time linkage=01(SBC before STO),
 [1-12]STO-A Release mode =01(With safety signal) and [1-36]SBC-A release level=0.00%:



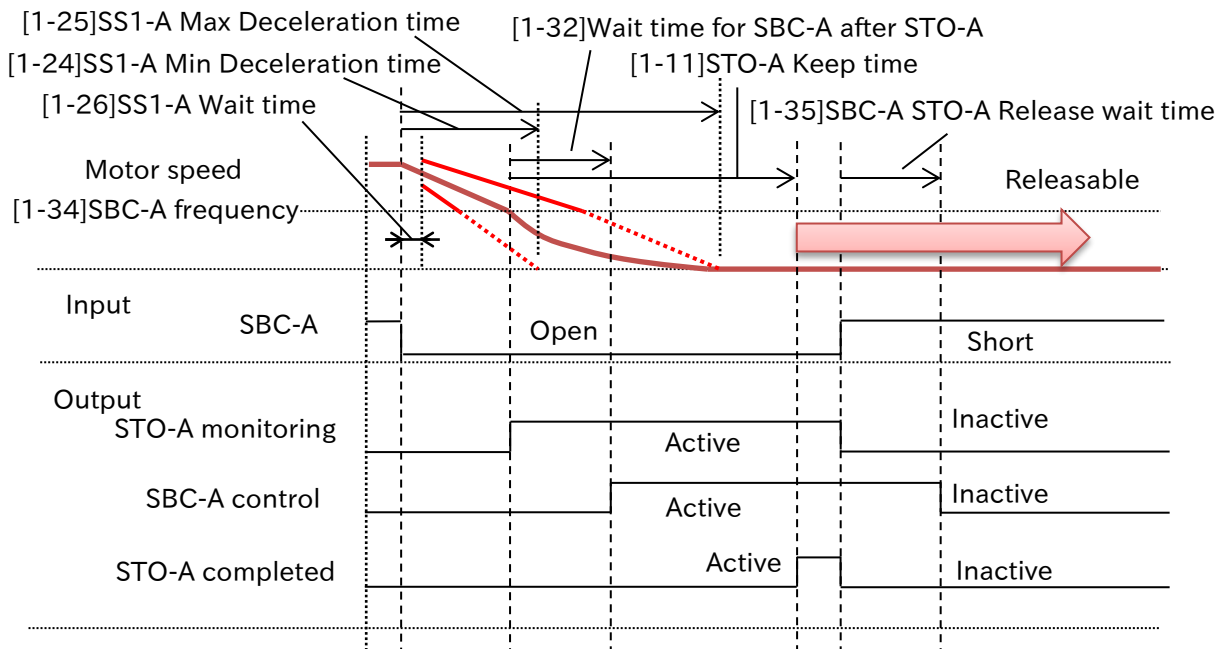
e.g. Case: SS1-A then SBC-A activating after STO-A activating

[1-31]SBC-A Time linkage=02(SS1, then SBC after STO), [1-22]SS1-A monitoring method=00(time), [1-12]STO-A Release mode =01(With safety signal) and [1-36]SBC-A release level=0.00%:



e.g. Case: SS1-A, then SBC-A activating after STO-A activating

[1-31]SBC-A Time linkage=02(SS1 then, SBC after STO), [1-22]SS1-A monitoring method= 01(frequency), [1-12]STO-A Release mode = 01(With safety signal) and [1-36]SBC-A release level=0.00%:



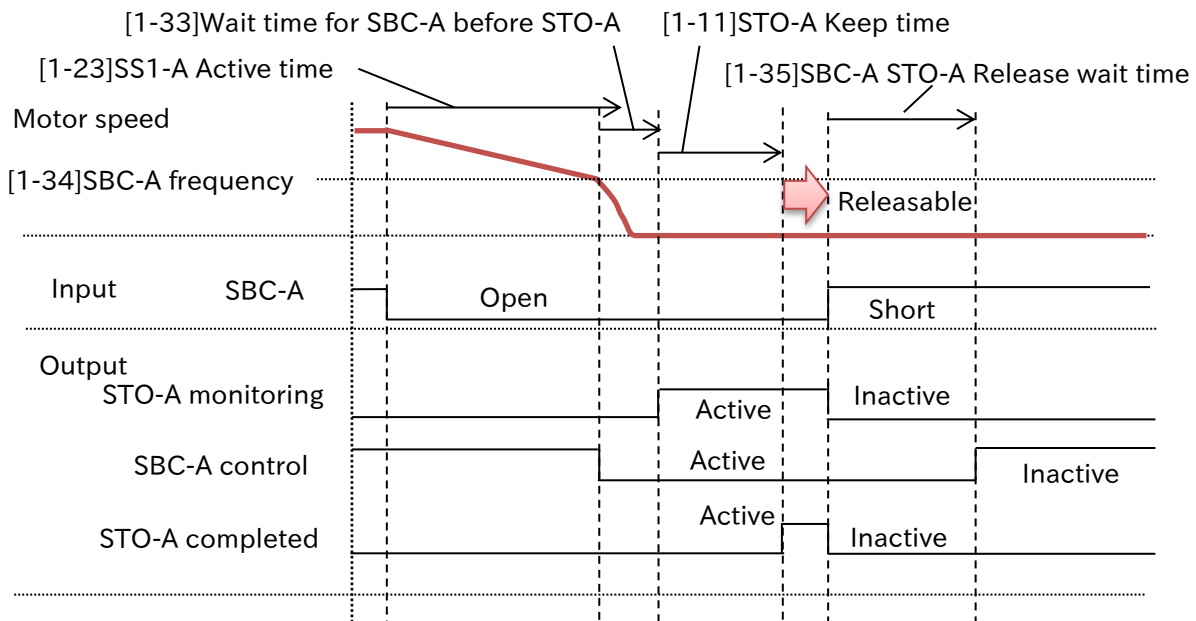
e.g. Case: SS1-A, then SBC-A activating before STO-A activating

[1-31]SBC-A Time linkage=03(SS1, then SBC before STO),

[1-22]SS1-A monitoring method=00(time),

[1-12]STO-A Release mode =01(With safety signal) and

[1-36]SBC-A release level=0.00%:



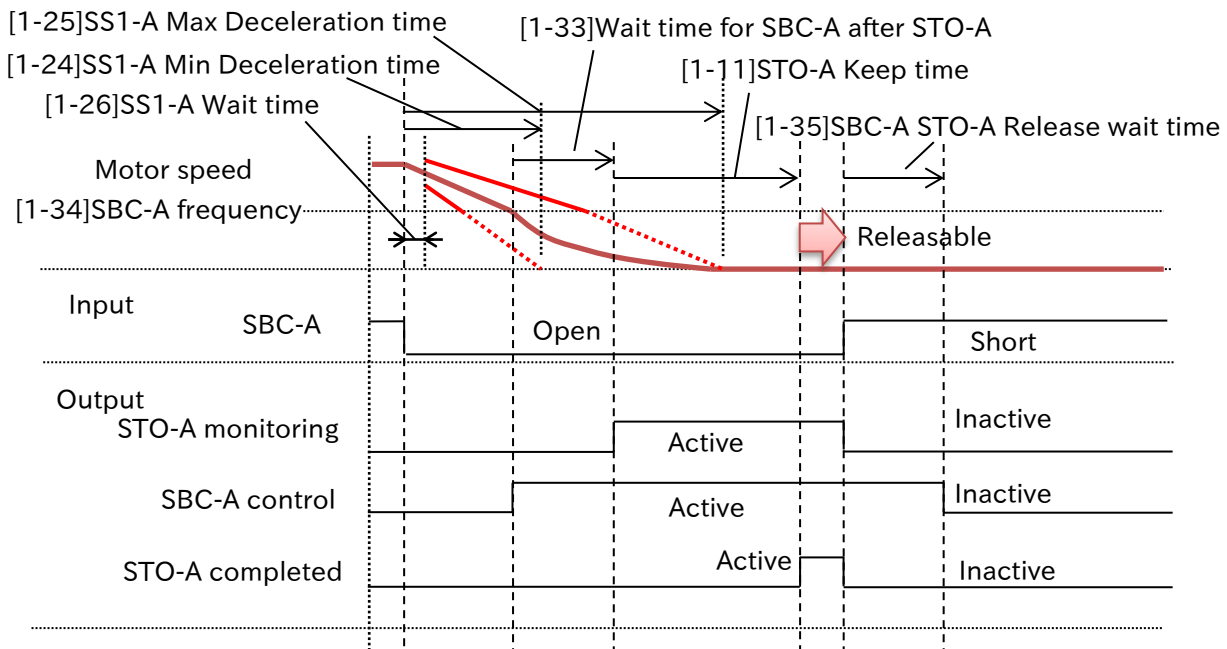
e.g. Case: SS1-A then SBC-A activating after STO-A activating

[1-31]SBC-A Time linkage=02(SS1, then SBC after STO), [1-

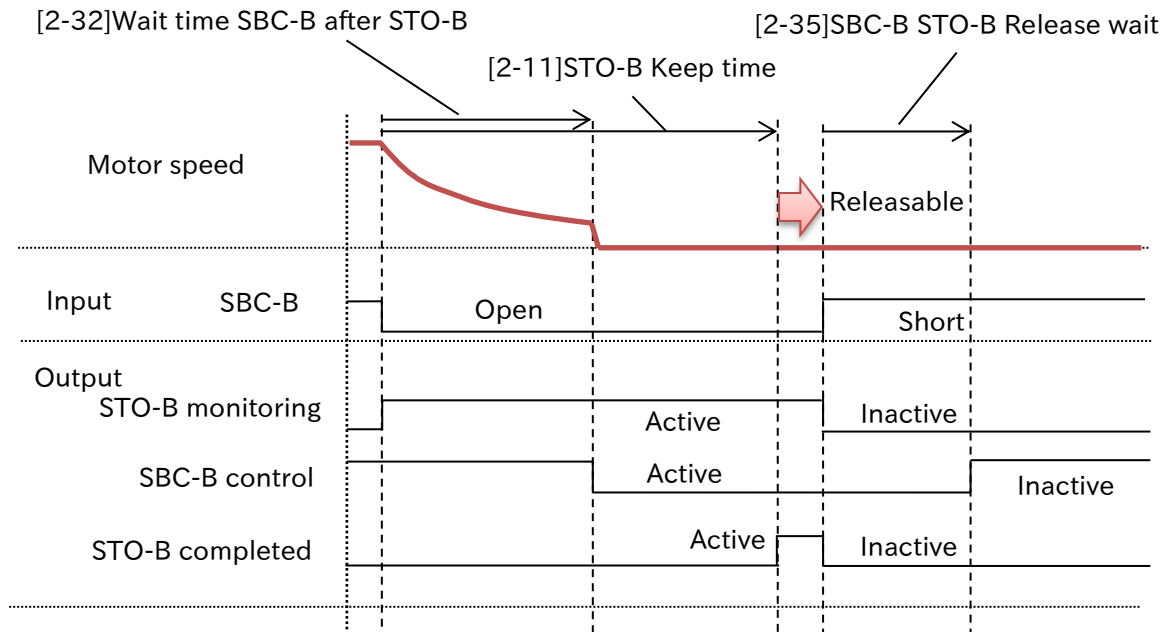
22]SS1-A monitoring method= 01(frequency), [1-12]STO-A

Release mode = 01(With safety signal) and [1-36]SBC-A

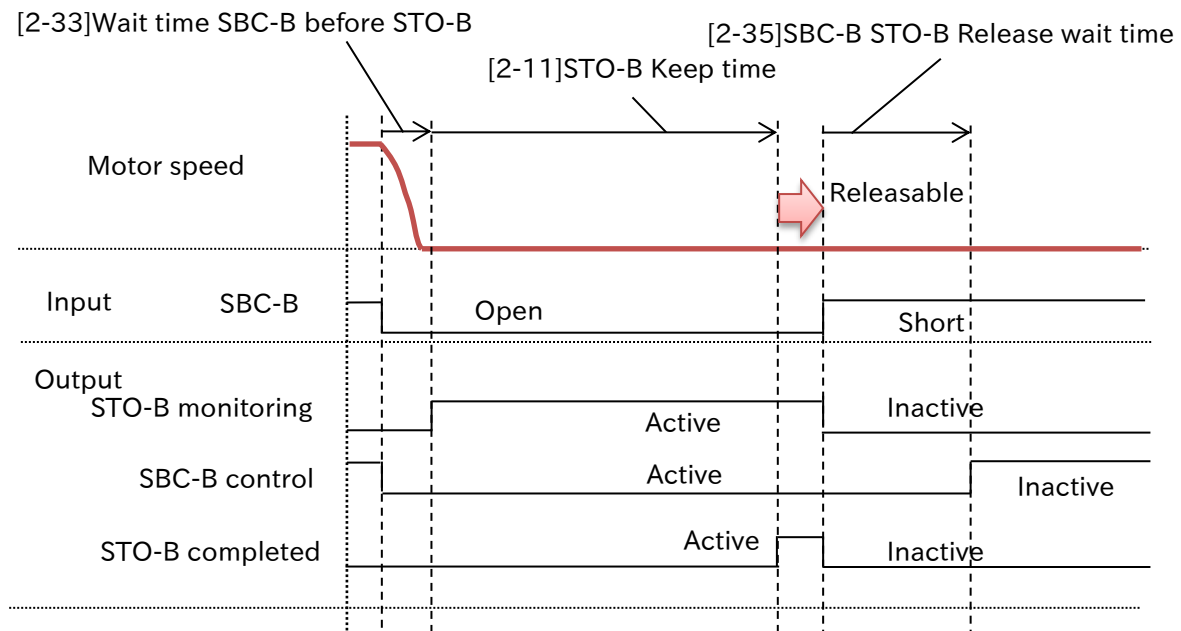
release level=0.00%:



e.g. Case: SBC-B activating after STO-B activating
 [2-31]SBC-B Time linkage=00(SBC after STO),
 [2-12]STO-B release mode=01(With safety signal) and
 [2-36]SBC-B release level =0.00%:



e.g. Case: SBC-B activating before STO-B activating
 [2-31]SBC-B Time linkage=01(SBC before STO), [2-12]STO-B release mode=01(With safety signal) and [2-36]SBC-B release level=0.00%:



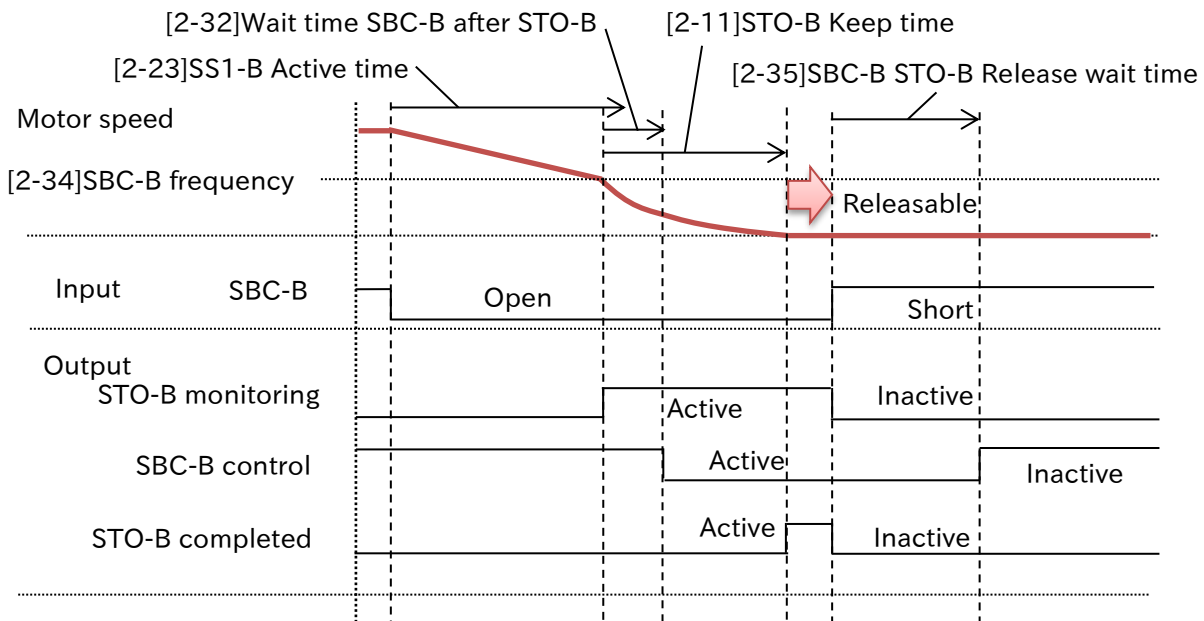
e.g. Case: SS1-B then SBC-B activating after STO-B activating

[2-31]SBC-B Time linkage=02(SS1 then SBC after STO),

[2-22]SS1-B monitoring method=00(Time),

[2-12]STO-B release mode=01(With safety signal) and

[2-36]SBC-B release level=0.00%:



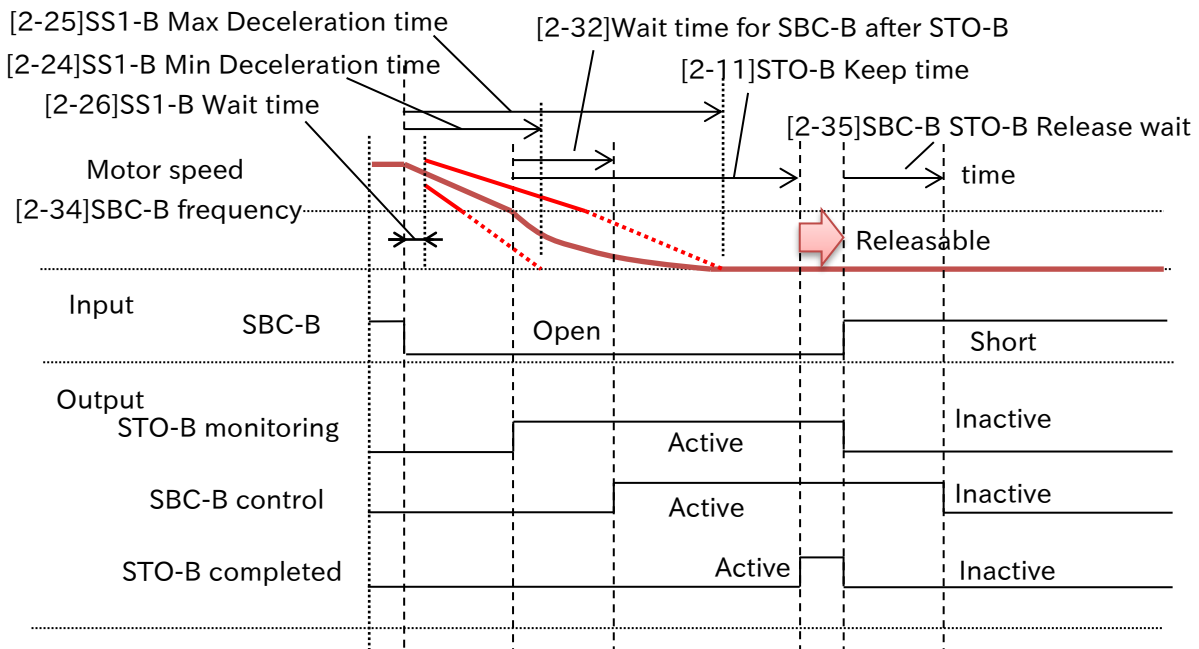
e.g. Case: SS1-B then SBC-B activating after STO-B activating

[2-31]SBC-B Time linkage=02(SS1 then SBC after STO),

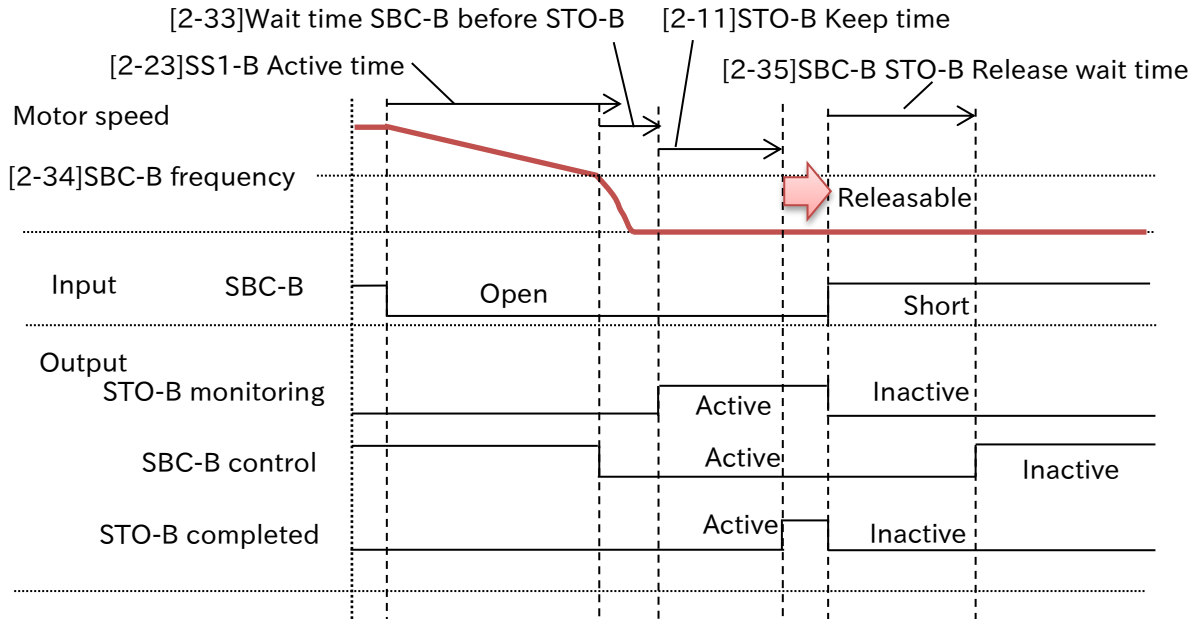
[2-22]SS1-B monitoring method=01(frequency),

[2-12]STO-B release mode=01(With safety signal) and

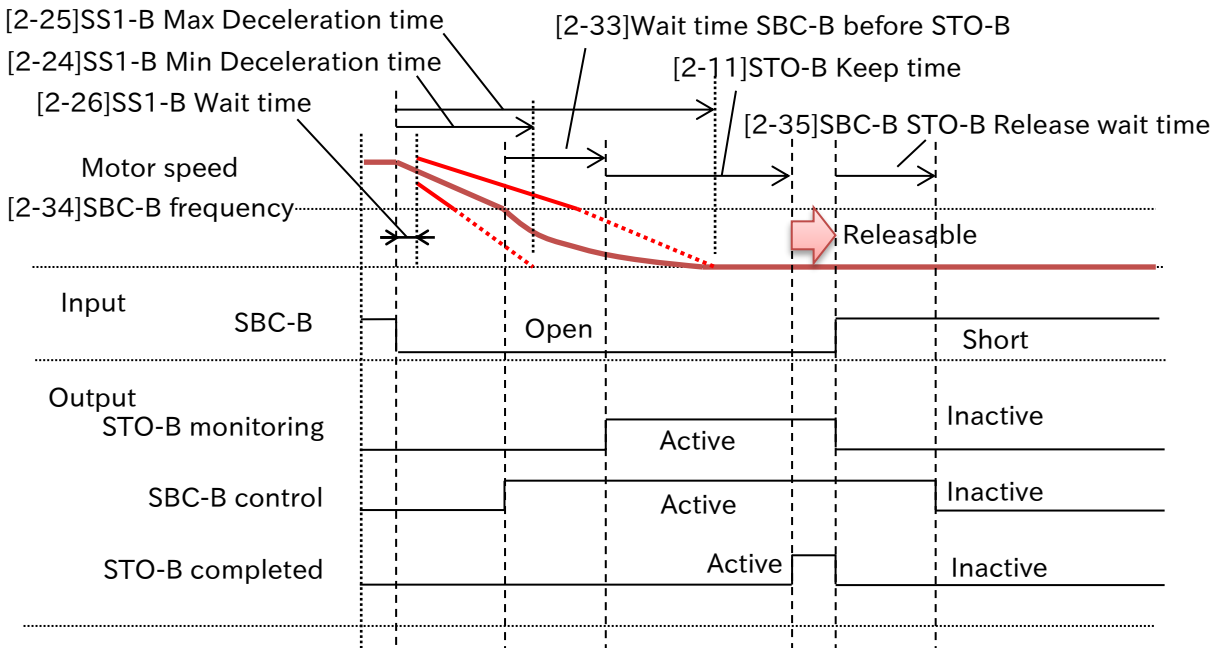
[2-36]SBC-B release level =0.00%:



e.g. Case: SS1-B then SBC-B before STO-B
 [2-31]SBC-B Time linkage=03(SS1 then SBC before STO),
 [2-22]SS1-B monitoring method=00(Time),
 [2-12]STO-B release mode=01(With safety signal) and
 [2-36]SBC-B release level =0.00%:



e.g. Case: SS1-B then SBC-B after STO-B
 [2-31]SBC-B Time linkage=02(SS1 then SBC after STO),
 [2-22]SS1-B monitoring method=01(frequency),
 [2-12]STO-B release mode=01(With safety signal) and
 [2-36]SBC-B release level =0.00%:



4.5.4 SLS function

■ How SLS function works

The SLS function can monitors that the motor speed does not exceed the determined speed safely during the inverter outputs to the motor.

The SLS function can be used by inputting SLS-A or SLS-B function individually.

When SLS-A and SLS-B are activated at the same time, SLS-A is higher priority function.

Releasing of SLS function depends on the activation of SLS signal input.

The speed upper limit in the SLS state is determined by speed limit [oC-14]/[oC-24] or [oC-15]/[oC-25] in the setting parameters of SJ-P1. Deceleration time in the SLS starting state is determined by Deceleration time [oC-12] or [oC-22] in the setting parameters of SJ-P1.

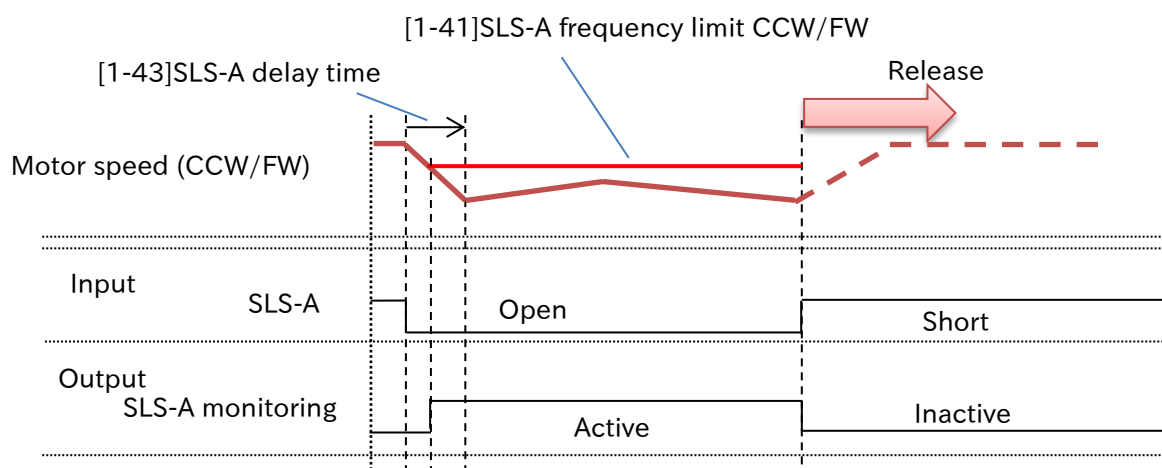
■ Related parameters

No.	Name	Related data
0-11	Safety Function Select Input 1	04:SLS-A / 14:SLS-B
0-12	Safety Function Select Input 2	
0-13	Safety Function Select Input 3	
0-21	Safety Function Select Output 1	06:SLS-A monitoring / 16:SLS-B monitoring
0-22	Safety Function Select Output 2	
0-23	Safety Function Select Output 3	
1-41	SLS-A Frequency limit CCW/FW	0.00 to 590.00Hz
1-42	SLS-A Frequency limit CW/RV	0.00 to 590.00Hz
1-43	SLS-A delay time	0.00 to 3600.00s
2-41	SLS-B Frequency limit CCW/FW	0.00 to 590.00Hz
2-42	SLS-B Frequency limit CW/RV	0.00 to 590.00Hz
2-43	SLS-B delay time	0.00 to 3600.00s
0-07	SFS Select	11:STO-A / 12:STO-B / 21:SS1-A / 22:SS1-B / 31:SBC-A / 32:SBC-B

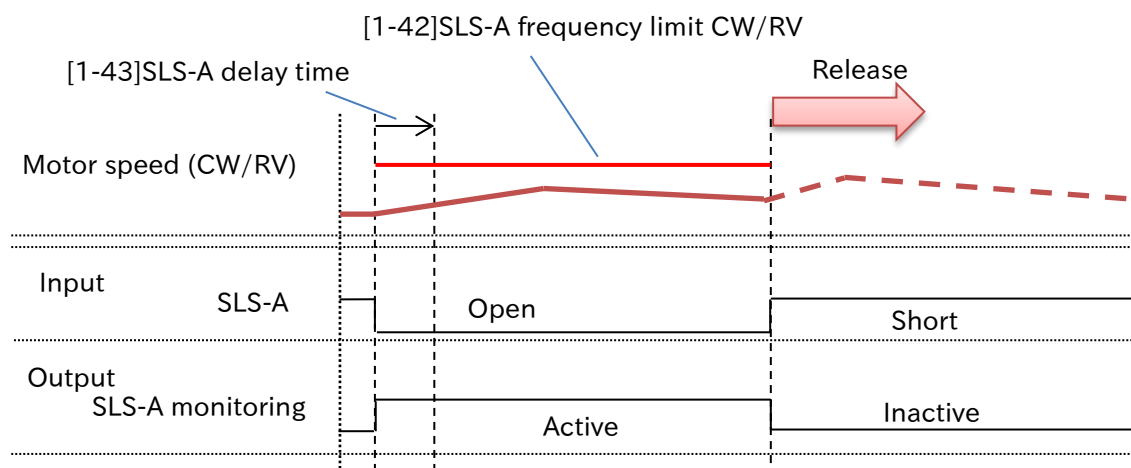
■ Related P1 parameters

No.	Name	Related data
oC-12	SLS-A Deceleration time	0.00 to 3600.00(s)
oC-14	SLS-A speed upper limit: CCR/FW	0.00 to 590.00(Hz)
oC-15	SLS-A speed upper limit: CR/RV	0.00 to 590.00(Hz)
oC-22	SLS-B Deceleration time	0.00 to 3600.00(s)
oC-24	SLS-B speed upper limit: CCR/FW	0.00 to 590.00(Hz)
oC-25	SLS-B speed upper limit :CR/RV	0.00 to 590.00(Hz)

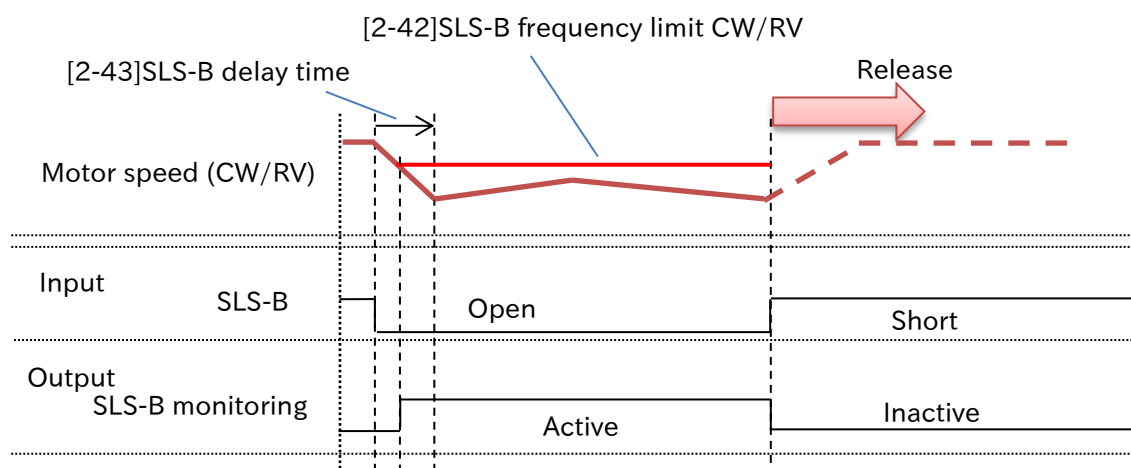
e.g. Case: SLS-A activating when the motor speed is over frequency limit and driving CCW/FW :



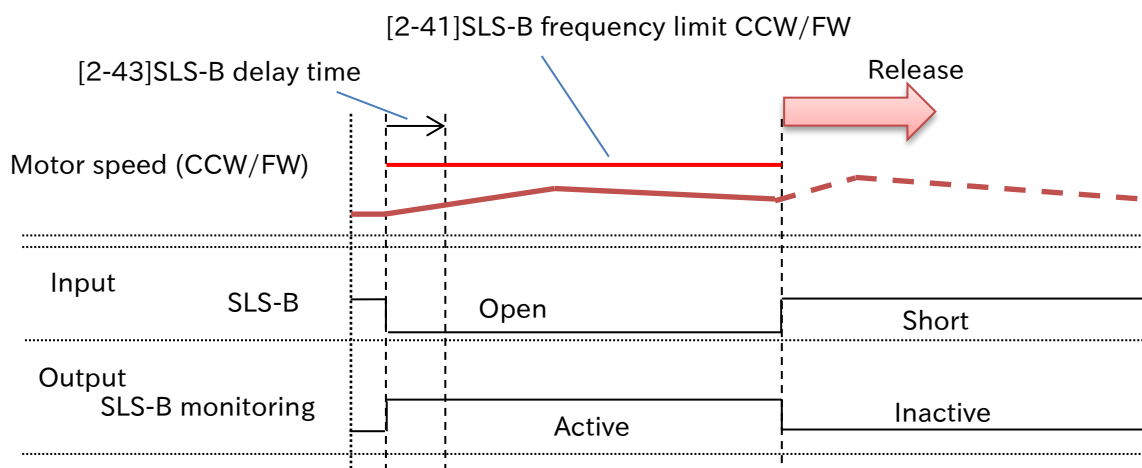
e.g. Case: SLS-A activating when the motor speed is under frequency limit and driving CW/RV:



e.g. Case: SLS-B activating when the motor speed is over frequency limit and driving CW/RV :



e.g. Case: SLS-B activating when the motor speed is under frequency limit and driving CCW/FW:



4.5.5 SDI function

■ How SDI function works

The SDI function can monitor that the motor driving direction does not perform the determined direction safely during the inverter outputs to the motor.

The SDI function can be used by inputting SDI-A or SDI-B function individually.

When SDI-A and SDI-B are activated at the same time, SDI-A is higher priority function.

Releasing of SDI function depends on the activation of SDI signal input.

The limit direction in the SDI state is determined by limit direction [oC-18] or [oC-28] in the setting parameters of SJ-P1. Deceleration time in the SDI starting state is determined by Deceleration time [oC-16] or [oC-26] in the setting parameters of SJ-P1.

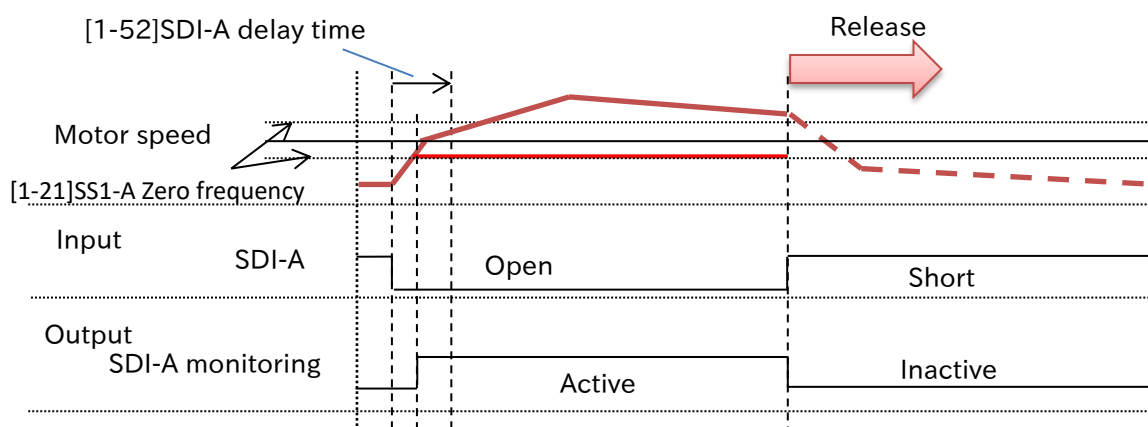
■ Related parameters

No.	Name	Related data
0-11	Safety Function Select Input 1	05:SDI-A / 15:SDI-B
0-12	Safety Function Select Input 2	
0-13	Safety Function Select Input 3	
0-21	Safety Function Select Output 1	07:SDI-A monitoring / 17:SDI-B monitoring
0-22	Safety Function Select Output 2	
0-23	Safety Function Select Output 3	
1-21	SS1-A Zero frequency	0.00 to 590.00Hz
1-51	SDI-A Active mode	00:limit CW(RV)/ 01:limit CCW(FW)
1-52	SDI-A delay time	0.00 to 3600.00s
2-21	SS1-B Zero frequency	0.00 to 590.00Hz
2-51	SDI-B Active mode	00:limit CW(RV)/ 01:limit CCW(FW)
2-52	SDI-B delay time	0.00 to 3600.00s
0-07	SFS Select	11:STO-A / 12:STO-B / 21:SS1-A / 22:SS1-B / 31:SBC-A / 32:SBC-B

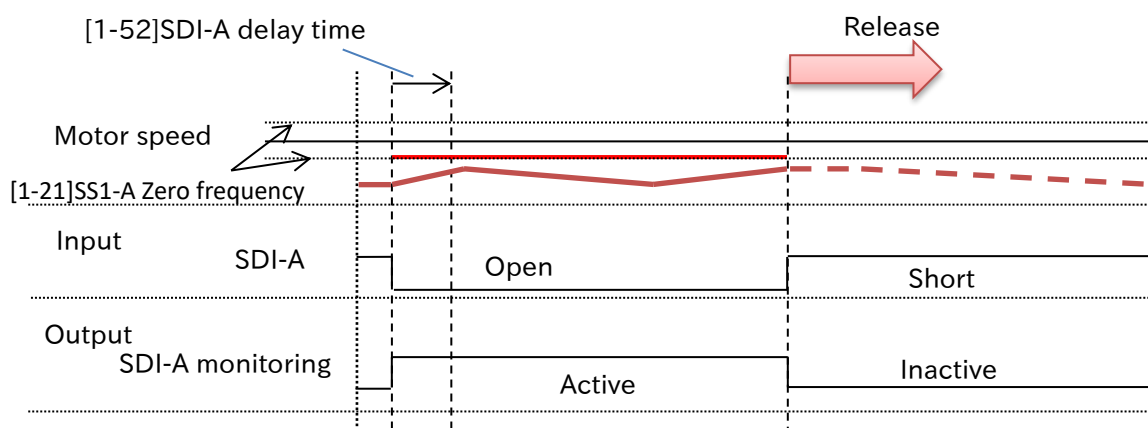
■ Related P1 parameters

No.	Name	Related data
oC-16	SDI-A Deceleration time	0.00 to 3600.00(s)
oC-18	SDI-A limit direction	00(limit)/01(reverse)
oC-26	SDI-B Deceleration time	0.00 to 3600.00(s)
oC-28	SDI-B limit direction	00(limit)/01(reverse)

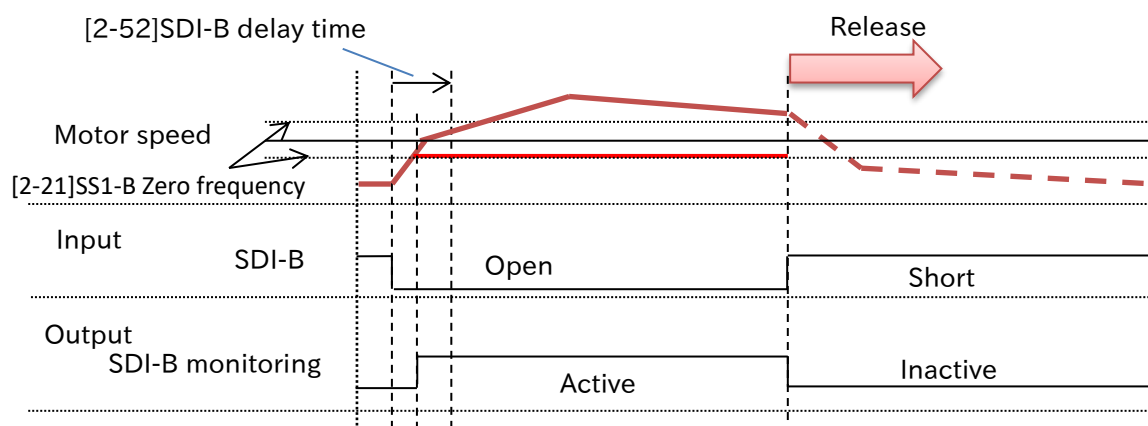
e.g. Case: [1-51]SDI-A Active mode=00: limit CW (RV) and driving limited direction (CW/RV):



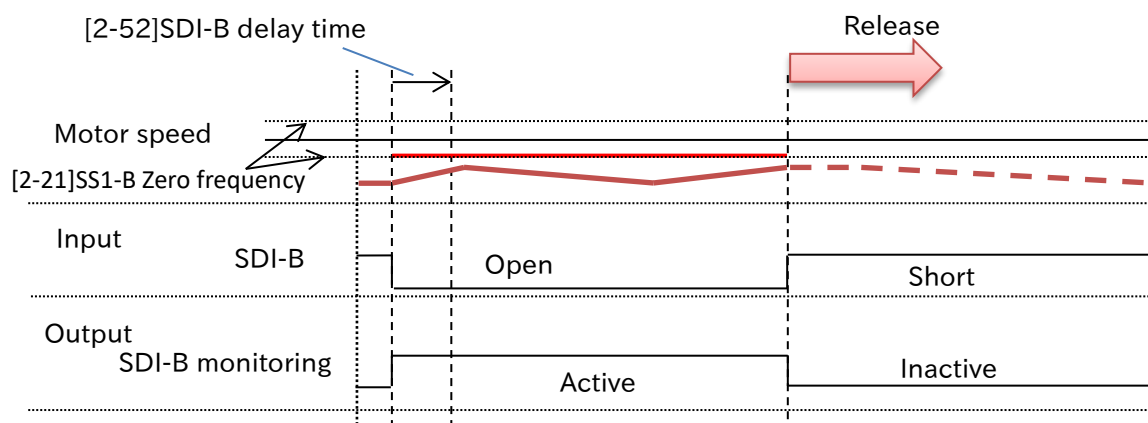
e.g. Case: [1-51]SDI-A Active mode=01: limit CCW (FW) and driving unlimited direction (CCW/FW):



e.g. Case: [2-51]SDI-B Active mode=00: limit CW (RV) and driving limited direction (CW/RV):



e.g. Case: [2-51]SDI-B Active mode=01: limit CCW(FW) and driving unlimited direction (CCW/FW):



4.5.6 SSM function

■ How SSM function works

The SSM function can activate a signal when the motor speed fall the determined speed during output.

If the SSM signal is oscillated, please adjust the output sensitivity of the assigned output terminal setting.

The SSM function can be used by outputting SSM-A or SSM-B function individually.

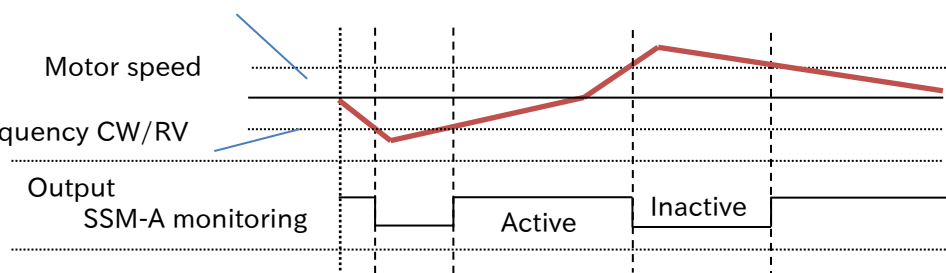
■ Related parameters

No.	Name	Related data
0-21	Safety Function Select Output 1	08:SSM-A monitoring / 18:SSM-B monitoring
0-22	Safety Function Select Output 2	
0-23	Safety Function Select Output 3	
0-71	Output 1 sensitivity	0.001 to 1.000s
0-72	Output 2 sensitivity	
0-73	Output 3 sensitivity	
1-61	SSM-A frequency CCW/FW	0.00 to 590.00Hz
1-62	SSM-A frequency CW/RV	0.00 to 590.00Hz
2-61	SSM-B frequency CCW/FW	0.00 to 590.00Hz
2-62	SSM-B frequency CW/RV	0.00 to 590.00Hz

e.g. Case: SSM-A activating:

[1-61]SSM-A frequency CCW/FW

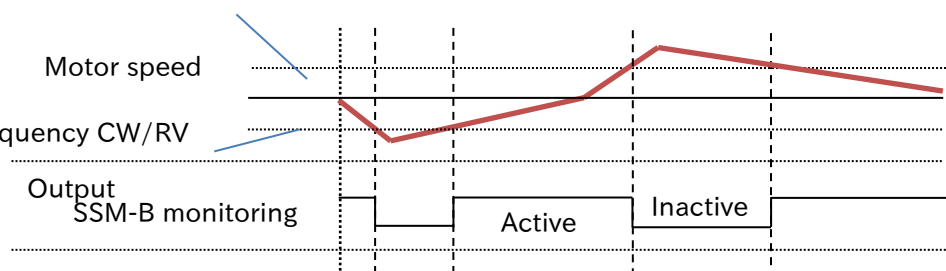
[1-62]SSM-A frequency CW/RV



e.g. Case: SSM-B activating:

[2-61]SSM-B frequency CCW/FW

[2-62]SSM-B frequency CW/RV

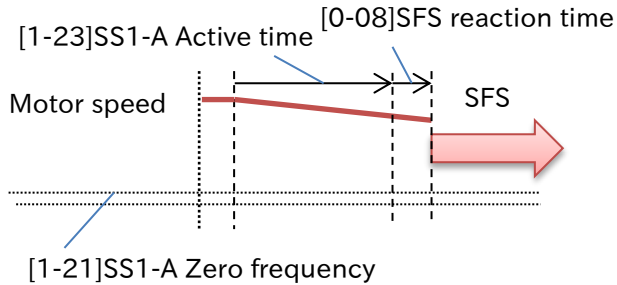


4.6 SFS function

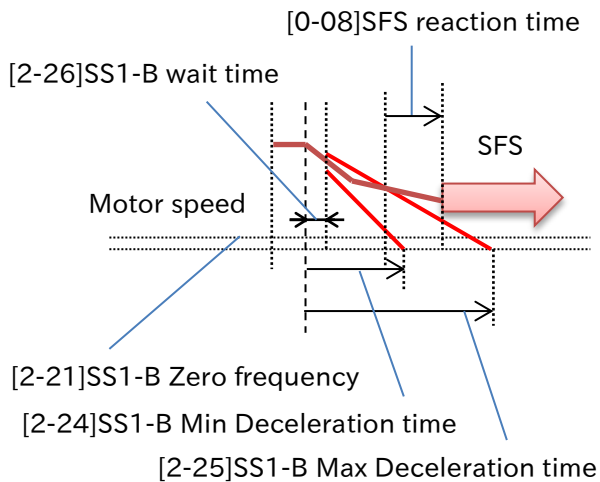
SFS function is activated during activating SS1, SLS and SDI when the detected speed is out of determined speed range.

■ Timing chart

e.g. Case: The SS1-A active time is passed, [1-22]SS1-A monitoring method=00(Time):

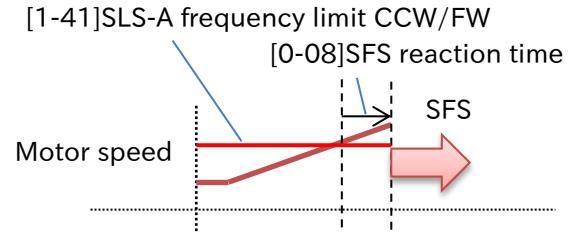


e.g. Case: The speed becomes out of range in SS1-B, [2-22]SS1-B monitoring method = 01 (speed):

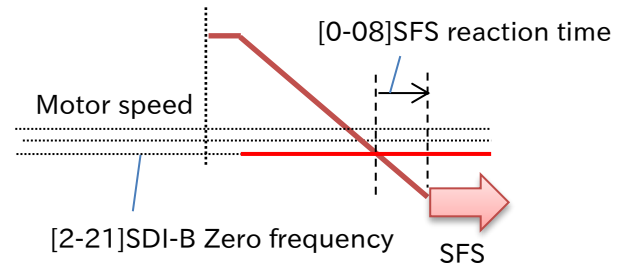


SFS function can be selectable from either STO/SS1/SBC.

e.g. Case: The speed becomes out of range SLS-A:



e.g. Case: The direction becomes out of range SDI-B, [2-51]SDI-B active mode=00 limit CW (RV):



4.7 Release of safety state

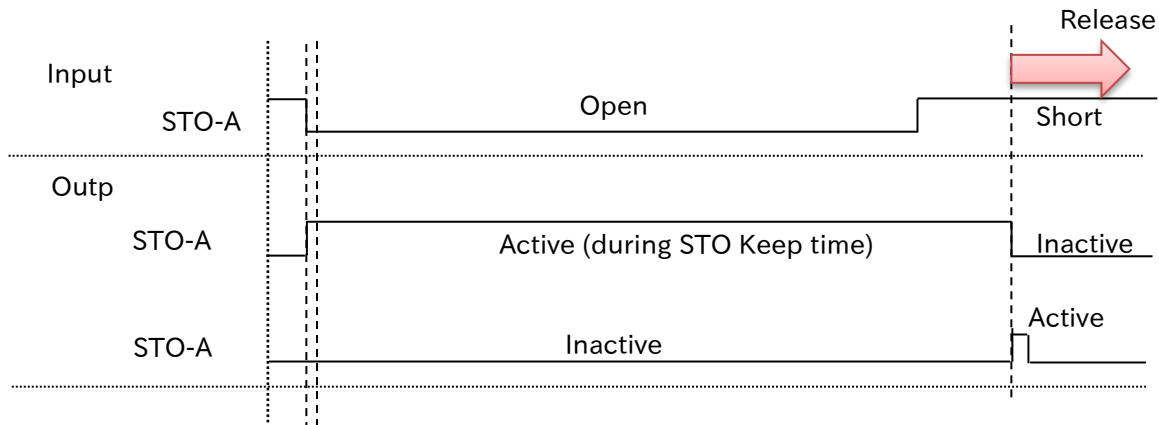
4.7.1 Release of STO (SS1/SBC)

Time chart of release of STO state is shown as below. Below example is as STO function. STO state is released by SS1 signal releasing after SS1 completed or SBC signal releasing after SBC completed.

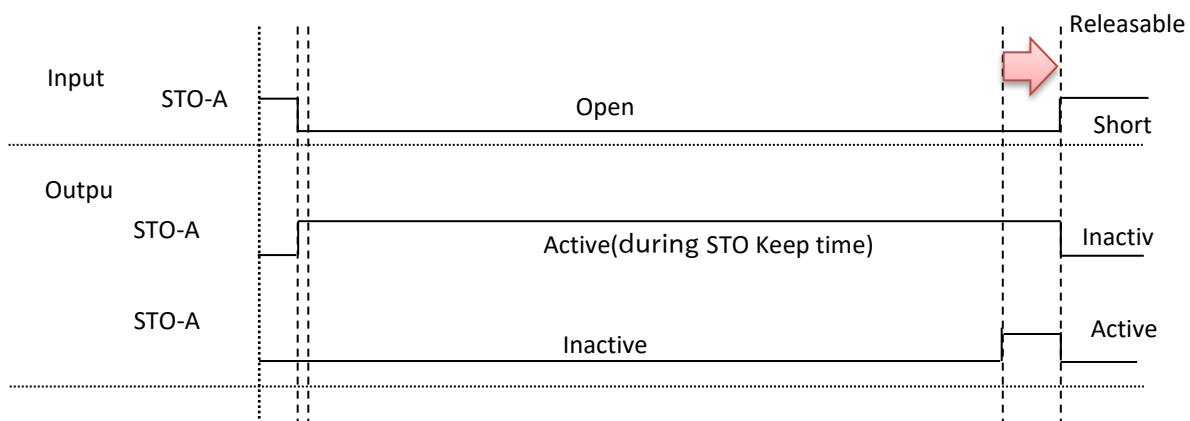
*) Setting of [1-12]STO-A Release mode is available to release the signal of '-A'. Setting of [2-12]STO-B Release mode is available to release the signal of '-B'.

■ Timing chart

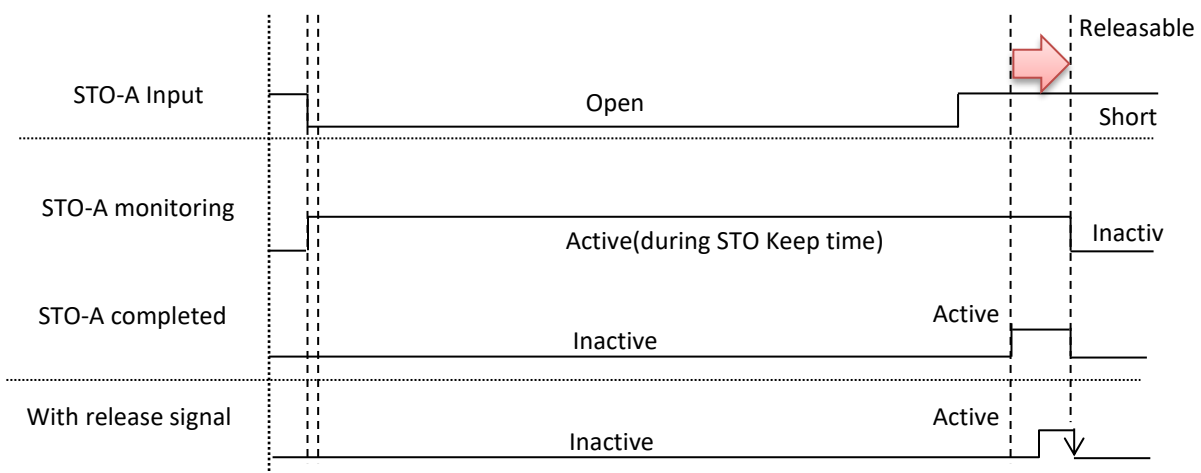
e.g. [1-12]STO-A Release Mode = 00(Without release):



e.g. [1-12]STO-A Release Mode = 01(With safety signal):



e.g. [1-12]STO-A Release Mode = 02(With release signal):



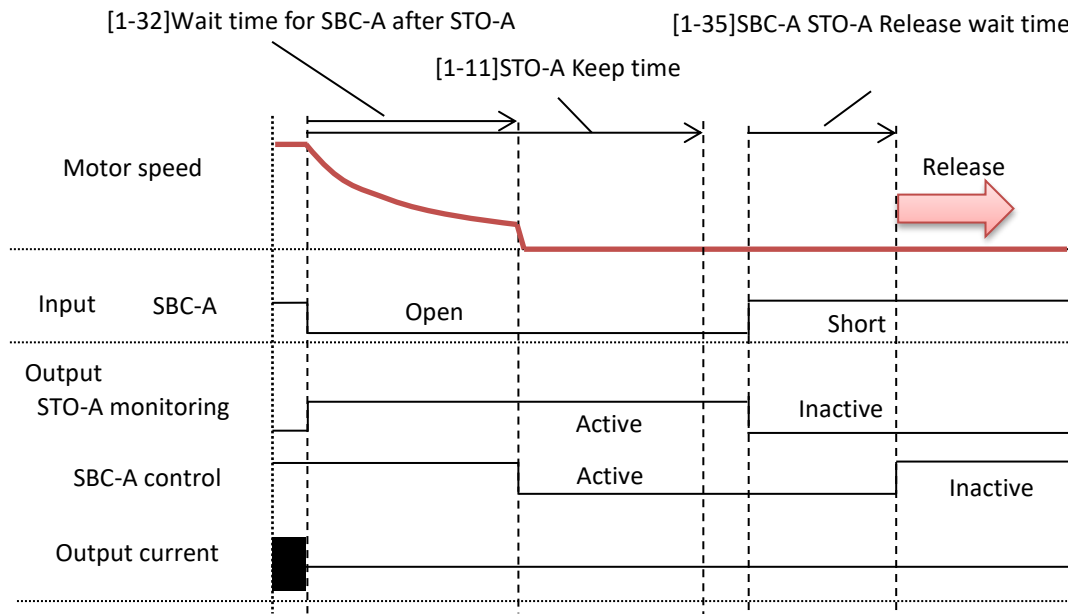
4.7.2 Release of SBC control signal

Time chart of release of SBC state is shown as below.

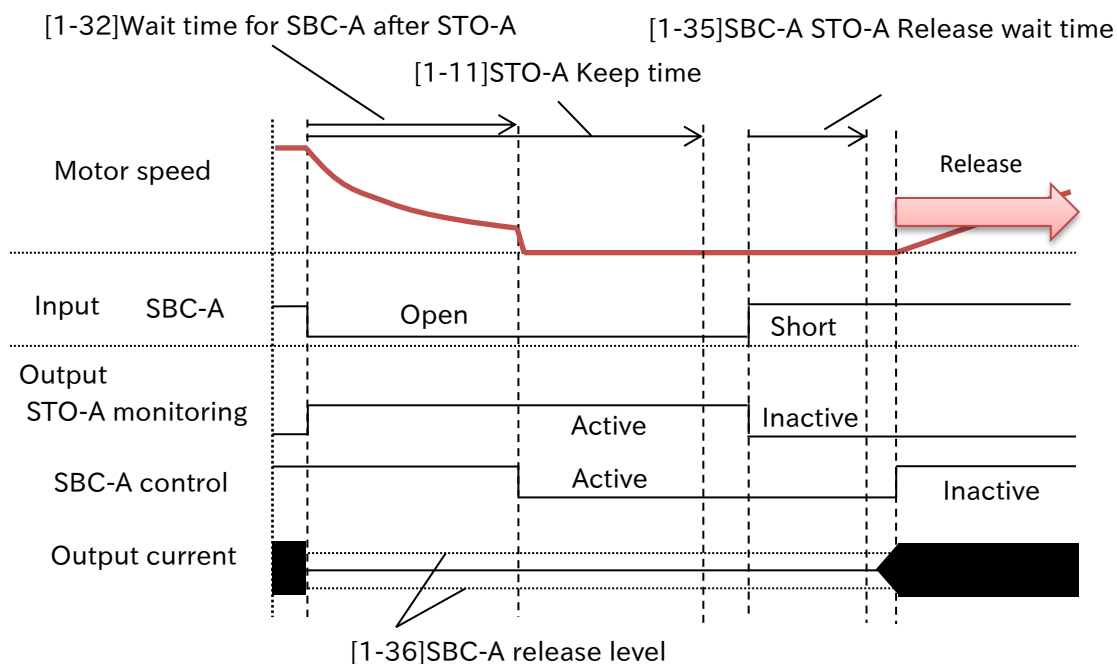
■ Timing chart

e.g. Case: SBC-A after STO-A,
[1-31]SBC-A Time linkage=00(SBC after STO),
[1-12]STO-A Release Mode =01(With safety signal) and
[1-36]SBC-A release level =0.00%:

*) Setting of [1-31]SBC-A Time linkage, [1-12]STO-A Release Mode and [1-36]SBC-A release level are available to release the signal of 'A'. Setting of [2-31]SBC-B Time linkage, [2-12]STO-B Release Mode and [2-36]SBC-B release level are available to release the signal of 'B'.



e.g. Case: SBC-A after STO-A,
[1-31]SBC-A Time linkage=00(SBC after STO),
[1-12]STO-A Release Mode =01(With safety signal) and
[1-36]SBC-A release level=20.00%:



4.7.3 Release of SLS/SDI

SLS/SDI function is released by releasing the corresponding input signal.

4.7.4 Release of SFS

SFS function is released by releasing the activated input SS1, SLS and SDI signal and releasing the activating STO/SBC in the same group (A or B).

4.8 Function of displaying state

The state can be displayed on the operator keypad of P1 by setting parameter [oC-01] to P1 as below.
The below data can be confirmed by monitoring parameter [dA-46] or [dA-47] on the operator keypad of P1.

■ Related displaying monitor and parameter

Name	parameter	data	contents
Safety-option input selection	[oC-01]	00	Warning is displayed. Activating Safety function as option is displayed in the upper right corner of the operation keypad.
		01	Warning is NOT displayed. Activating Safety function as option is NOT displayed in the upper right corner of the operation keypad.
Safety-option hardware monitor	[dA-46]	0000 to FFFF	Input and output state on P1-FS is displayed. For each bit of hexadecimal notation, 0 is OFF state and 1 is ON state. The hexadecimal number from right bit 0 to S1A, S2A, S3A, RLS-1, S1B, S2B, S3B, RLS-2, S11A, S12A, S13C, ST1, S11B, S12B, S13D, ST2.
Safety-option status monitor	[dA-47]	00 to 06	Activating Safety function as option is displayed in the upper right corner of the operation keypad. 00 (no Input)/ 01 (STO)/02 (SBC)/03 (SS1)/04 (SL)/05 (SDI)/06 (SSM)

■ Displaying error

Name	error	contents
FS option internal error	[E094]	This error is displayed when self-checking error is detected in the FS option.
FS option path 1 error	[E095]	This error is displayed when an error is detected on the safety path 1 in the FS option.
FS option path 2 error	[E096]	This error is displayed when an error is detected on the safety path 2 in the FS option.
FS option communication error	[E097]	This error is displayed when the communication error is detected between P1 and P1-FS.

4.9 Activation of Safety function

After completing wiring on P1-FS terminals, the Safety function is automatically activated when P1-FS is energized and established with P1. Any special key operation is not required.



The instructions in the User's Guide and Safety Function Guide are to be followed and "verification & validation" of a system is to be completed. Otherwise the system cannot be regarded as safe.

STO state is kept until setting parameters and password are completed.

5

Chapter 5 Planning Installation

5.1 Contents in this chapter

This chapter describes the items which must be taken into consideration for planning installation SJ-P1.

5.2 Requirement for designer and installer (installation supervisor)

Designers and installers (installation supervisor) who design and install safety-related system must have been trained to have the specialist knowledge of the essential principles for designing and installing safety-related systems.

Designers and those who maintenance safety-related system must have been trained to understand the cause and consequences of the common cause failure (CCF)

5.3 Installation environment

The product must be installed in a place where environmental condition such as temperature, humidity, corrosive gas, dust, vibration, is within the specification of the product without external environmental controls. Please refer to the User's Guide of SJ-P1 for the requirements and specification for installation as well as the environmental specification provided in chapter 11 in this documentation.

The P1-FS with the SJ-P1 must be installed in an enclosure (cabinet) having a protection rating of IP54 or higher for protection against conductive dust and contamination.

5.4 Electrical installation

5.4.1 General Requirement

Please follow the instruction provided in the User's Guide of SJ-P1 for electrical installation. If there is any conflict or different description in the User's Guide of SJ-P1 and this documentation, the description in this documentation shall be considered to have priority.

All of the cables and signal lines must be protected, routed and fixed appropriately.

5.4.2 Safety input

The two Safety inputs must be appropriately separated and protected from each other to avoid mutual interference. (E.g. separated cables, protection, double-shield cable)

The length of the cablings connected to terminals on P1-FS must be twenty (20) meters or shorter.

Please refer to the wiring examples in Chapter 4 for wirings on terminals.

At least one of the measures 1 to 3 below must be adapted to Safety input wirings for the protection against grounding fault:

1. Grounding Safety input signal power line
 - ♦ In case of use of the internal power supply
Ground CME terminal
 - ♦ In case of use of an external power supply
Use a power supply (PELV) which is grounded on CME terminal side.
2. A fail-safe cable routing (The requirement of ISO13849-2 table D.4 to be met. One of the following measures needs to be adopted)
 - ♦ Permanently connected (fixed) and protected against external damage, e.g. by cable ducting or
 - ♦ Use of separate multicore cable
 - ♦ Within an electrical enclosure, with both conductor and enclosure meeting the requirement of IEC 60204-1
 - ♦ Individually shielded with earth connection
3. Using an external device for grounding fault detection

In case of connecting a device applies diagnostic test pulses on STO input lines, the width of the test pulse (width of OFF pulse) must be 300us or shorter.

Host device (such as PLC) for inputting safety signals need to be able to ignore a test pulse width of 300 us.

5.4.3 Monitoring/completed signal

There are monitoring / completion output signals indicating the operating condition and internal fault detection condition.

The length of the cabling connected to ED+ and ED- terminals must be twenty (20) meters or shorter.

5.4.4 EMC

The system must only be used in the EMC environment that it is designed for, or necessary mitigations must be applied.

SJ-P1 must only be used within the EMC environment specified in IEC61800-5-2:2016, 2nd environment.

5.4.5 Routing the cables

Cabling of input and output of the Safety function must be physically and appropriately separated from the other signal cablings.

6

Chapter 6 Installation

6.1 Contents in this chapter

This chapter describes the items to be taken into consideration for installation.

6.2 Installation

The product must be installed as following the instructions provided in the Safety Function Guide and the User's Guide of SJ-P1 and this documentation.

In case of using any optional devices such as a fieldbus module, please read through the manuals of each optional device before working on the product.

Operation sequence of wiring example

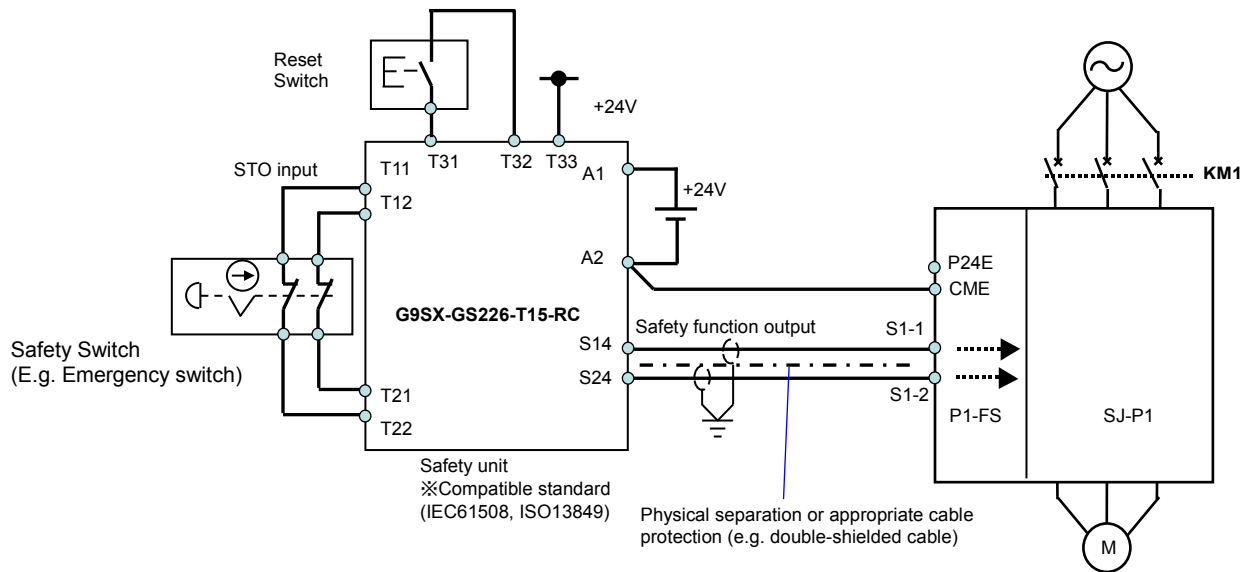
1. When the safety switch is pressed, Safety function signals are delivered to P1-FS and the Safety function is activated.
2. Even after the safety switch has been released, the safety inputs to the P1-FS are held by the safety unit.
3. After the operator of the system has confirmed the safety of human and the system, and then presses the reset switch, S1-1 and S1-2 inputs to P1-FS are released and Safety function is released.

6.3 Wiring example

The figure below is a wiring example under the following conditions.

- ♦ Use of an external power supply for safety signal inputs
- ♦ Reset/Release of safety signal inputs to P1-FS are controlled using the reset function of a safety unit

Wiring Example



6.4 External device

The all power supply connected to I/O terminal block must comply with SELV or PELV.

The signal lines to ST1 and ST2 terminals must be physically separated or appropriately protected.

The all devices used to deliver safety signals must comply with the function safety norms such as EN ISO 13849-1, IEC61508.

The configuration of all components used in any circuit other than an appropriately pre-approved safety module that interfaces with the Safety function terminals MUST be at least equivalent to PLe under EN ISO 13849-1 in order to be able to claim PLe for the combination of SJ-P1/P1-FS and external circuits.

The width of test pulse (OFF pulse) applied to input terminals must be 300us or shorter

The followings are the examples of the safety devices to be combined.

Example of Safety relay

Series	Model	Compatible norm
PNOZsigma	PNOZ s3 24VDC 2n/o	ISO13849-1 cat4, PL e / IEC 61511 SIL 3 EN IEC62061 SIL CL 3
3TK28	3TK2823-2CB30	ISO13849-1 cat4, PL e IEC 61508 SIL 3
PSR-SCP	PSR-SCP-24DC/ESD/4X1/30 -2981800	ISO13849-1 cat3/4, PL d/e IEC61508 SIL 3 / IEC62061 SIL CL 3
GS9A	301	ISO13849-1 cat4, SIL3
G9SX	GS226-T15-RC	IEC61508 SIL1-3
NE1A	SCPU01-V1	IEC61508 SIL3

7

Chapter 7 Commissioning

7.1 Contents in this chapter

This chapter describes the items to be considered for commissioning in the system including SJ-P1 and P1-FS.

7.2 Considerations

After completion of installation, commission of whole system must be conducted.

Commissioning of the system must be conducted by only competent electricians who have sufficient knowledge on functional, machine and process safety.



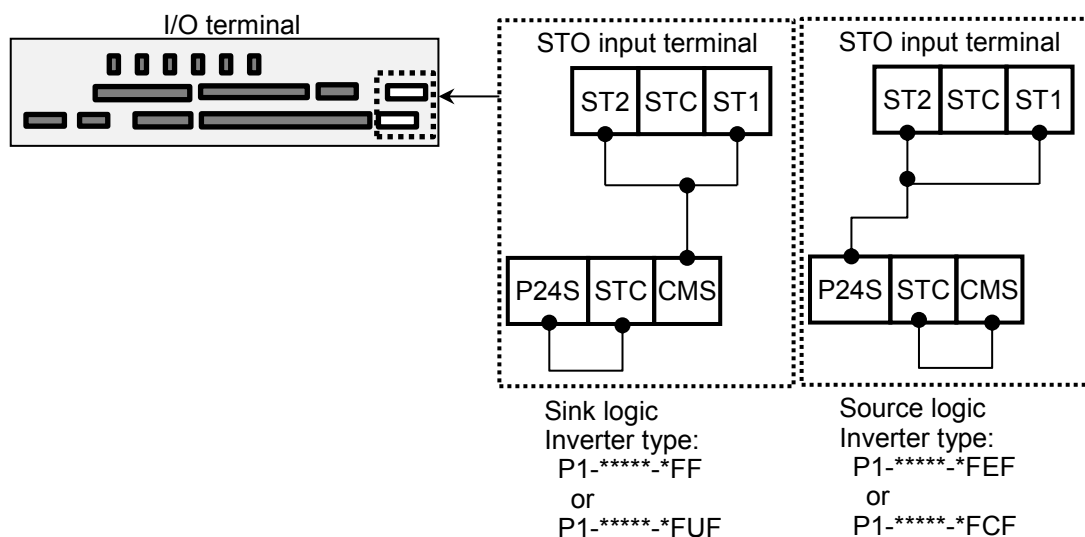
The system must not be considered safe until all the Safety functionality is verified and validated.

7.3 Enabling Safety function

P1-FS is properly installed in SJ Series P1 and it is automatically activated by supplying the power in accordance with this guide, SJ series P1's user guide and safety guide.

7.4 Disabling Safety function

To disable the Safety function, please install the short-wiring as shown in the figure below. (The same wiring condition as the factory default on SJ-P1)



*: Depending on the inverter type. Refer to the User's Guide of the SJ-P1.

8

Chapter 8 Verification and Validation

8.1 Contents in this chapter

This chapter describes information related to verification and validation of system.

8.2 Verification

It is to be verified that the system has achieved the required safety level and function.

8.3 Validation

It is the responsibility of machine manufacturer who uses safety devices and configure safety-related system to ensure that the required Safety functions have been achieved in the system.

A test plan for validation test must be prepared and validation test must be conducted in accordance with the test plan. The result of the validation test is to be documented in a report.

Validation test must be conducted when the following incidents occurs.

- (1) Start-up of the safety-related system (commissioning)
- (2) When a change which may affect the Safety function has been applied
- (3) After maintenance
- (4) In case that a periodical test is required by the applicable EU directive/standard or local standard.

In the validation test, it is to be confirmed that the Safety function of P1-FS with the SJ-P1 works as intended with the same procedure as the functional test.

Note: In order to maintain the intended functionality of the STO function, it is necessary to conduct a functional test at least once in a year. For the details of the functional test, please refer to Chapter 10.

8.4 Requirement for Validator

Validation of the system must be conducted by only competent electricians who have essential knowledge of the functional safety as well as the Safety function realized in the system.

The report of the validation must be completed by the above-mentioned competent electricians.

8.5 Residual Risk

The Safety functions are applied to reduce the recognized risk and hazardous conditions in the system.

It may not be always possible to eliminate the all potential risks and hazards.

Therefore, warning for the residual risks must be given to the operators.

9

Chapter 9 Error and Troubleshooting

9.1 Contents in this chapter

This chapter describes errors related to P1-FS and how to deal with them. For errors generated by SJ-P1 itself, refer to SJ-P1 User's Guide and Safety Guide.

9.2 Error

An error is generated when the internal diagnosis function detects a failure in the internal safety paths or when configured by related parameters. Please refer to the sections below for the error contents and their troubleshooting.

When P1-FS is used, [oA-30] to [oA-33] related to SJ-P1 error is invalid.

9.2.1 [E094] P1-FS internal error

An error is detected by the diagnostic function performed between the internal MCUs.

After generation of this error, the internal safety paths are held on STO state until powered down.

What to do

- When this error is generated, it is likely that a fault exists in the internal safety paths of the P1-FS.
- Please ensure to stop the operation of the system and shut off the power supply, and then conduct the functional test.
- Please ensure to shut off the power supply and power up or the parameters are rewritten. In case the status does not improve, P1-FS must be replaced.

9.2.2 [E095] P1-FS path 1 error

The error [E095] may be generated when an error is detected on path 1.

After generation of this error, the internal safety paths are held on STO state until powered down.

What to do

- When this error is generated, it is likely that a fault exists in the internal safety paths of the P1-FS.
- Please ensure to stop the operation of the system and shut off the power supply, and then conduct the functional test.
- Please ensure to shut off the power supply and power up or the parameters are rewritten. In case the status does not improve, P1-FS must be replaced.

9.2.3 [E096] P1-FS path 2 error

The error [E096] may be generated when an error is detected on path 2.

After generation of this error, the internal safety paths are held on STO state until powered down.

What to do

- When this error is generated, it is likely that a fault exists in the internal safety paths of the P1-FS.
- Please ensure to stop the operation of the system and shut off the power supply, and then conduct the functional test.
- Please ensure to shut off the power supply and power up or the parameters are rewritten. In case the status does not improve, P1-FS must be replaced.

9.2.4 [E097] P1-FS communication error

The error [E097] may be generated when communication between SJ-P1 and P1-FS is cut off or power supply to P1-FS cannot be established.

After generation of this error, the internal safety paths are held on STO state until powered down.

What to do

- When this error is generated, it is likely that a fault exists in the internal safety paths of the P1-FS.
- Please ensure to stop the operation of the system and shut off the power supply, and then conduct the functional test.
- Please ensure to shut off the power supply and power up or the parameters are rewritten. In case the status does not improve, P1-FS must be replaced.

9.3 Warning display

In case that a warning (one of [P-1A] / [P-2A] / [P-1b] / [P-2b] / [P-1C] / [P-2C]) is displayed on the operator keypad, it is possible that input state of ST1 and ST2 is inconsistent. Please check that the two STO inputs are given properly.

9.4 When internal fault found

Please contact the nearest Hitachi inverter distributor when it has been found a malfunction of the STO function.

10

Chapter 10 Maintenance

10.1 Contents in this chapter

This chapter describes the items related to maintenance.

10.2 Planning of maintenance

All maintenance on a safety system are safety critical.

You must plan and perform maintenance accordingly.

The P1-FS requires conducting the functional test at least once in a year. When planning maintenance of the system, this functional test must be considered.

10.3 Daily and periodical inspection

The P1-FS requires daily and periodical inspection in addition to the functional test of Safety function. Please perform inspections as instructed in the User's Guide of SJ-P1.

10.4 Periodical functional test

A periodical Safety functional test must be performed at least once in a year in order to maintain the intended safety performance level of Safety function.

This periodical Safety function test is one of the conditions for Safety function of P1-FS to meet PLe of EN ISO13849-1 and SIL 3 of IEC61800-5-2.

In the Safety function test, confirm that the set Safety function operates normally as described in this guide against input.

Functional test procedure:

- (1) Power up SJ-P1 installed with P1-FS and confirm that no error occurs in the initial test.
- (2) Set all inputs to the driving permitted state (both contacts ON (short circuit)) and start driving.
- (3) Redundant contacts OFF (open: safety state) assigned Safety function to redundant input terminals, confirm that the Safety function operates and the corresponding output signal operates.
- (4) Release the Safety function, when the other functions are assigned, perform the same confirmation to other terminals.

- In case that an error occurs, there may be a fault in the safety path of the P1-FS. In that case, stop using the inverter immediately and contact Hitachi inverter distributor.

Chapter 11 Specification and Technical data

11

11.1 Contents in this chapter

This chapter describes the specification related to P1-FS terminals and its technical data.

11.2 Recommended ferrule

I/O terminal block is a spring-cramp type. For safe wiring and reliability, it is recommended to use the following ferrules.

Wire size mm ² (AWG)	Model name of ferrule ^{*1, 2}	L1 [mm]	L2 [mm]	φd [mm]	φD [mm]	
0.25 (24)	AI 0,25-10YE	10	14.5	0.8	2.0	
0.34 (22)	AI 0,34-10TQ	10	14.5	0.8	2.0	
0.5 (20)	AI 0,5-10WH	10	16.0	1.1	2.5	
0.75 (18)	AI 0,75-10GY	10	16.0	1.3	3.4	

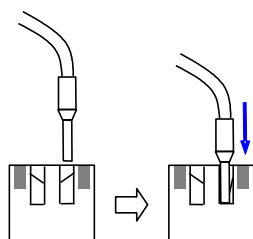
Note 1: Supplier: Phoenix contact
Crimping pliers: CRIPMFOX 6

Note 2: These specifications are different from the recommended ferrule terminals for the inverter.

■ Wiring connections

Insert

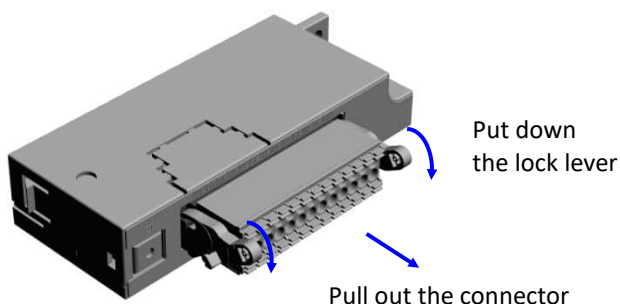
Insert the ferrule terminal into the P1-FS terminal block. It will be easy to insert without any tools if use the correct ferrule terminals.



Wire inserted

■ Methods to detach the connector

Put down the locking lever according to the arrow direction to unlock and pull out the connector, as showed below.



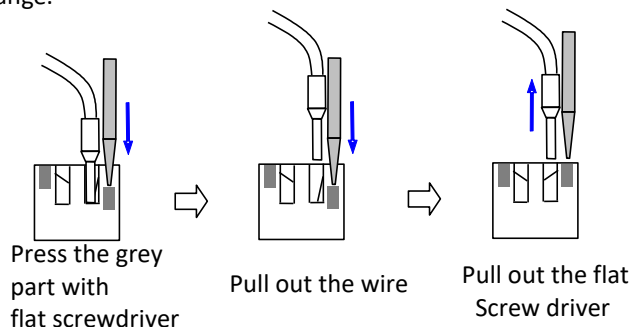
Pull out the wire

Press the grey part on P1-FS terminal block with flat screwdriver (width lower than 2.5mm) to open the wire port.

Press the flat screwdriver and pull out the wire or the ferrule terminal

Pull out the flat screwdriver.

The real color of the grey part on the terminal block is orange.



11.3 Electrical specification

Descriptions and specifications of the terminals are listed in the table below.

Terminal Symbol	Terminal Name	Description	Electrical Characteristics
S1-1	Input terminal 1 path 1	Input terminal 1 for the redundant paths	Input current: 6mA Input voltage : DC18V to DC27V *2)
S1-2	Input terminal 1 path 2		
S2-1	Input terminal 2 path 1	Input terminal 2 for the redundant paths	
S2-2	Input terminal 2 path 2		
S3-1	Input terminal 3 path 1	Input terminal 3 for the redundant paths	
S3-2	Input terminal 3 path 2		
P24E	24V power supply output terminal for input terminal	DC24V power supply output terminal for input terminal	Allowance current:50mA
CME	Common for input terminal	Common for input terminal	
RLS	Release terminal	Release terminal for Safety function.	Input current:6mA
ST1	STO1 terminal	Short to ST1 terminal on P1	
ST2	STO2 terminal	Short to ST2 terminal on P1	
STC	STO common terminal	Short to STC terminal on P1	
S11-1	Output terminal 11 on path 1	Output terminal 11 for the redundant paths	Output current: 50mA
S11-2	Output terminal 11 on path 2		
S12-1	Output terminal 12 on path 1	Output terminal 12 for the redundant paths	
S12-2	Output terminal 12 on path 2		
24V1-1 (24V-1) *1)	24V power supply input terminal for output terminal 11/12 on path 1	Power supply input terminal for output terminal 11/12 on path 1	Consumption current:150mA Input voltage : DC18V to DC27V *2)
24V2-2 (24V-2) *1)	24V power supply input terminal for output terminal 11/12 on path 2	Power supply input terminal for output terminal 11/12 on path 2	
CMo1-1 (CMo-1) *1)	Common for output terminal (11/12 path 1)	Common for output terminal (11/12 path 1)	
CMo2-2 (CMo-2) *1)	Common for output terminal (11/12 path 2)	Common for output terminal (11/12 path 2)	
S13-1 (S13-3) *1)	Output terminal 13 on path 1	Output terminal 13 for the redundant paths	Output current:50mA
S13-2 (S13-4) *1)	Output terminal 13 on path 2		
24V3-1 (24V-3) *1)	24V power supply input terminal for output terminal 13 on path 1	Power supply input terminal for output terminal 13 on path 1	Consumption current:75mA Input voltage : DC18V to DC27V *2)
24V4-2 (24V-4) *1)	24V power supply input terminal for output terminal 13 on path 2	Power supply input terminal for output terminal 13 on path 2	
CMo3-1 (CMo-3) *1)	Common for output terminal(13 path 1)	Common for output terminal (13 path 1)	
CMo4-2 (CMo-4) *1)	Common for output terminal(13 path 2)	Common for output terminal (13 path 2)	
FG	Functional ground terminal	Connect to the functional ground (The screw size is M3)	

Note: Corresponding to “Digital input type 1” defined in IEC61131-2

Length of cabling connected to the above terminals other than ST1, ST2, and STC must be twenty (20) meters or shorter. Length of cabling connected to ST1, ST2, and STC must be one (1) meters or shorter.

*1) These are the terminal symbols on the connector. They are different from the terminal symbols on the front label.

*2) In case of use of an external power supply, input voltage range is set from DC18V to 27V.

11.4 Safety function

The Safety function of P1-FS is equivalent to the function listed below.

Function	Item	Standard
STO	STO (Safe Torque Off)	EN/IEC61800-5-2
	Stop category 0	EN 60204-1
SS1	SS1 (Safe stop 1)	EN/IEC61800-5-2
	Stop category 1	EN 60204-1
SBC	SBC(Safe brake control)	EN/IEC61800-5-2
SLS	SLS(Safely-limited speed)	EN/IEC61800-5-2
SDI	SDI(Safe direction)	EN/IEC61800-5-2
SSM	SSM(Safe speed monitor)	EN/IEC61800-5-2

11.5 Response time

Item	Time
Response time of STO output	10ms max.
Response time of SBC signal	20ms max.

11.6 Safety-related parameters

Parameter	Value	Standard
PL	e	EN ISO/ISO 13849-1
CAT.	4	
MTTFd	100 years	
DCavg	99.6%	
SIL	3	IEC 61508 EN/IEC 61800-5-2 EN/IEC 62061
HFT	1	
SFF	99.9%	
PFH	4.08×10^{-11}	

11.7 Environmental specification

Ambient temperature	-10 to 50°C	
Storage temperature	-20 to 65°C	
Humidity	20 to 90%RH (No condensation)	
Vibration	*1)	5.9m/s ² (0.6G), 10 to 55Hz
	*2)	2.94m/s ² (0.3G), 10 to 55Hz
Location	Altitude 1,000m or less Indoors (No corrosive gasses or dust)	
Required protection rating of cabinet	IP54 or higher	

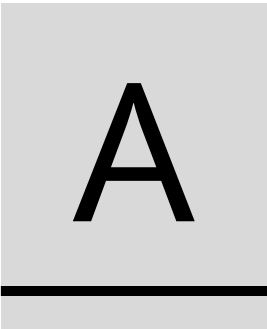
*1) P1-00044-L(P1-004L) to P1-01240-L(P1-220L)/
P1-00041-H(P1-007H) to P1-00620-H(P1-220H)

*2) P1-01530-L(P1-300L) to P1-02950-L(P1-550L)/
P1-00770-H(P1-300H) to P1-03160-H(P1-1320H)

11.8 Supported version

Item	Version
SJ-P1	2.01 or later
ProDriveNext	2.3.22.0 or later
Hitachi Inverter Tool	2.1.28.1 or later

Annex 1 EC Declaration of Conformity (Copy)



<Remark>

- Purpose of this chapter is to provide necessary information related to EC declaration of conformity
- The original version is available separately. Please contact Hitachi inverter distributor for the original.

EC DECLARATION OF CONFORMITY

We, Hitachi Industrial Equipment Systems Co., Ltd.

1-1 Higashinarashino 7-chome, Narashino-shi, Chiba 275-8611, Japan, declare in our sole responsibility that the following products conform to all the relevant provisions.

Product name: **P1-FS, Functional safety option for SJ-P1**

(Refer to DECLARATION OF CONFORMITY of SJ-P1 for Machinery Directive. Please make sure that the applicable models of SJ-P1 is in compliance with Machinery Directive.)

Authorized Representative: Hitachi Europe GmbH

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Council Directives: MD: 2006/42/EC (MD: Machinery Directive)
EMC: 2014/30/EU

Harmonized Standards: MD: EN 61800-5-2:2017 / IEC 61800-5-2:2016
EN ISO 13849-1:2015 / ISO13849-1:2015
EN 62061: 2005+A1:2013+A2:2015 / IEC 62061:2015
EMC: EN61800-3:2004 / A1:2012

Relevant Standard: IEC61508 Parts 1-7:2010
EN/IEC 61800-5-1:2007
EN/IEC 60204-1 (Stop Category 0, Stop Category 1)

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