

SANMOTION

AC SERVO SYSTEMS

R

3E Model Safety

TYPE S

Instruction Manual

SANYODENKI

The fifth edition (E)

- p.1-3
 - Block diagram is corrected.
- p.1-5
 - Supported encoder information is added.
- p.1-7
 - Added conditions for achieving safety levels in the notes.
 - Updated lineup.
- p.4-31
 - Added note for using self diagnosis function.
- p.5-17
 - Added the section "5.2.3 Operation trace/operation scroll monitor list".
- p.7-2
 - Alarm contents of alarm code display 9C were described in detail.
- p.9-4 to 9-7
 - Block diagram is corrected.

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Safety Precautions

Safety precautions are according to servo amplifier instruction manual. Please read this User Manual and its appendix carefully prior to installation, operation, maintenance or inspection and perform all tasks according to the instructions provided here. A good understanding of this equipment, its safety information as well as all Warnings / Cautions is also necessary before using.

■ Warning Symbol

	Denotes immediate hazards that will probably cause severe bodily injury or death as a result of incorrect operation.
	Denotes immediate hazards which will probably cause severe bodily injury or death as a result of incorrect operation.
	Denotes hazards which could cause bodily injury and product or property damage as a result of incorrect operation.

 **Caution** Even those hazards denoted by this symbol could lead to a serious accident. Make sure to strictly follow these safety precautions.

■ Prohibited, Mandatory Symbols

	Indicates actions that must not be allowed to occur / prohibited actions.
	Indicates actions that must be carried out / mandatory actions.

Safety Precautions

■ Attention in use



Warning

- ◆ Do not use this device in explosive environment.
Injury or fire could otherwise result.
- ◆ Do not perform any wiring, maintenance or inspection when the device is hot-wired.
After switching the power off, wait at least 15 minutes before performing these tasks.
Electric shock or damage could otherwise result.
- ◆ The protective ground terminal (⊕) should always be grounded to the unit or control board. The ground terminal of the motor should always be connected to the protective ground terminal (⊕) of the amplifier.
Electric shock could otherwise result.
- ◆ Do not touch the inside of the amplifier.
Electric shock could otherwise result.
- ◆ Do not damage the cable, do not apply unreasonable stress to it, do not place heavy items on it, and do not insert it in between objects.
Electric shock could otherwise result.
- ◆ Do not touch the rotating part of the motor during operation.
Bodily injury could otherwise result.



Caution

- ◆ Use the amplifier and motor together in the specified combination.
Fire or damage to the device could otherwise result.
- ◆ Only technically qualified personnel should transport, install, wire, operate, or perform maintenance and inspection on this device.
Electric shock, injury or fire could otherwise result.
- ◆ Do not expose the device to water, corrosive or flammable gases, or any flammable material.
Fire or damage to the device could otherwise result.
- ◆ Be careful of the high temperatures generated by the amplifier/motor and the peripherals.
Burn could otherwise result.
- ◆ Do not touch the radiation fin of the amplifier, the regenerative resistor, or the motor while the device is powered up, or immediately after switching the power off, as these parts generate excessive heat.
Burn could otherwise result.
- ◆ In terms of designing safety systems using the Safe Torque Off function, personnel who have expertise of relevant safety standard are supposed to do that job with good understanding of this instruction manual.
Injury or damage to the device could otherwise result.
- ◆ Please read the User Manual carefully before installation, operation, maintenance or inspection, and perform these tasks according to the instructions.
Electric shock, injury or fire could otherwise result.
- ◆ Do not use the amplifier or the motor outside their specifications.
Electric shock, injury or damage to the device could otherwise result.
- ◆ Regenerative resistor has instantaneous capacity. Contact our offices if the instantaneous regenerative power could be high as the result of high-inertia moment or high-velocity rotation.

Safety Precautions

■ Storage



Prohibited

- ◆ Do not store the device where it could be exposed to rain, water, toxic gases or other liquids.
Damage to the device could otherwise result.



Mandatory

- ◆ Store the device where it is not exposed to direct sunlight, and within the specified temperature and humidity ranges {- 20°C to + 65°C, below 90% RH (non-condensing)).
Damage to the device could otherwise result.
- ◆ Please contact our office if the amplifier is to be stored for a period of 3 years or longer. The capacity of the electrolytic capacitors decreases during long-term storage, and could cause damage to the device.
Damage to the device could otherwise result.
- ◆ Please contact our office if the amplifier is to be stored for a period of 3 years or longer. Confirmations such as bearings and the brakes are necessary.

Safety Precautions

■ Transportation



Caution

- ◆ When handling or moving this equipment, do not hold the device by the cables, the motor shaft or detector portion.
Damage to the device or bodily injury could otherwise result.
- ◆ Keep in mind that it is dangerous at the time of conveyance if it falls and overturns.
Bodily injury could otherwise result.



Mandatory

- ◆ Follow the directions written on the outside box. Excess stacking could result in collapse.
Bodily injury could otherwise result.
- ◆ Use eyebolt of the motor only for transporting itself. Do not use for transportation of machinery combined with the motor.
Damage to the device or bodily injury could otherwise result.

Safety Precautions

■ Installation



Caution

- ◆ Do not stand on the device or place heavy objects on top of it.
Bodily injury could otherwise result.
- ◆ Make sure the mounting orientation is correct.
Fire or damage to the device could otherwise result.
- ◆ Do not drop this device or subject it to excessive shock of any kind.
Damage to the device could otherwise result.
- ◆ Do not obstruct the air intake and exhaust vents, and keep them free of debris and foreign matter.
Fire could otherwise result.
- ◆ Consult the User Manual regarding the required distance inside the amplifier disposition.
Fire or damage to the device could otherwise result.
- ◆ Open the box only after checking its top and bottom location.
Bodily injury could otherwise result.
- ◆ Verify that the products correspond to the order sheet/packing list.
Injury or damage could result.
- ◆ Take care of falling or overturning of the device during installation.
Use eyebolts of the motor if supplied.
Bodily injury could otherwise result.
- ◆ Install the device on a metal or other non-flammable support.
Fire could otherwise result.
- ◆ Make the collision safety device strong enough to resist the maximum output of the system.
Bodily injury could otherwise result.

Safety Precautions

■ Wiring

Caution

- ◆ Wiring connections must be secure.
Bodily injury could otherwise result.
- ◆ Wiring should be completed based on the Wiring Diagram or the User Manual.
Electric shock or fire could otherwise result.
- ◆ Wiring should follow electric equipment technical standards and indoor wiring regulations.
An electrical short or fire could otherwise result.
- ◆ Do not connect a commercial power supply to the U, V or W terminals of the servo motor.
Fire or damage to the device could otherwise result.
- ◆ Install a safety device such as a breaker to prevent external wiring short-circuits.
Fire could otherwise result.
- ◆ Do not bind or band the power cable, input/output signal cable and/or encoder cable together or pass through the same duct or conduit.
This action will cause faulty operation.
- ◆ Must add the surge absorbing diode if inductive load as relay connect to the control signal output of the amplifier. Please take care of polarity of the diode that will be cause of failure.
- ◆ Do not connect DC90V or AC power to the DC24V Brake of the servo motor. Also, do not connect AC400V to the AC200V Fan of the servo motor.
An electrical short or fire could otherwise result.
- ◆ Please design a sequence that included braking delay time because the surge-absorbing component for the relay of holding brake of the servo motor gives braking delay time.
Injury or load falling could otherwise result.

Mandatory

- ◆ Install an external emergency stop circuit that can stop the device and cut off the power instantaneously. Install an external protective circuit to the amplifier to cut off the power from the main circuit in the case of an alarm.
Motor runaway, bodily injury, burnout, fire and secondary damages could otherwise result.

Safety Precautions

■ Operation

Caution

- ◆ Do not perform extensive adjustments to the device as they may result in unstable operation.
Bodily injury could otherwise result.
- ◆ Trial runs should be performed with the motor in a fixed position, separated from the mechanism. After verifying successful operation, install the motor on the mechanism.
Bodily injury could otherwise result.
- ◆ The holding brake is not to be used as a safety stop for the mechanism. Install a safety stop device on the mechanism.
Bodily injury could otherwise result.
- ◆ In the case of an alarm, first remove the cause of the alarm, and then verify safety. Next, reset the alarm and restart the device.
Bodily injury could otherwise result.
- ◆ Check that input power supply voltage is keeping a specification range.
Damage to the device could otherwise result.
- ◆ Avoid getting close to the device, as a momentary power outage could cause it to suddenly restart (although it is designed to be safe even in the case of a sudden restart).
Bodily injury could otherwise result.
- ◆ Do not use motor or amplifier which is defective or failed and damaged by fire.
Injury or fire could otherwise result.
- ◆ In the case of any irregular operation, stop the device immediately.
Electric shock, injury or fire could otherwise result.
- ◆ When using the servo motor in vertical axis, provide safety devices to prevent falls during the work that will cause an alarm condition.
Injury or damage could result.

Prohibited

- ◆ The built-in brake is intended to secure the motor; do not use it for regular control.
Damage to the brake could otherwise result.
Damage to the device could otherwise result.
- ◆ Keep the motor's encoder cables away from static electricity and high voltage.
Damage to the device could otherwise result.
- ◆ Standard specification servo amplifiers have a dynamic brake resistor. Do not rotate the motor continuously from the outside when the amplifier is not powered on, because the dynamic brake resistor will heat up, and can be dangerous.
Fire or burn could otherwise result.
- ◆ Absolutely do not apply voltage more than the spec to the amplifier because overvoltage will be cause of part failure.
Damage to the device or bodily injury could otherwise result.
- ◆ Avoid frequent on and off power supply.
Inner parts might get premature failure in case of repeating ON/OFF of power supply 30 times or more per day, otherwise 5 times or more per hour.

Safety Precautions

Mandatory

- ◆ Install an external emergency stop circuit that can stop the device and cut off the power instantaneously. Install an external protective circuit to the amplifier to cut off the power from the main circuit in the case of an alarm.
Motor runaway, bodily injury, burnout, fire and secondary damages could otherwise result.
- ◆ There is no safeguard on the motor. Use an over-voltage safeguard, short-circuit breaker, overheating safeguard, and emergency stop to ensure safe operation.
Injury or fire could otherwise result.
- ◆ Operate within the specified temperature and humidity range.
Servo Amplifier
Temperature 0°C to 55°C
Humidity below 90% RH (non-condensing).
Servo Motor
Temperature 0°C to 40°C
Humidity below 90% RH (non-condensing).}
Burnout or damage to the device could otherwise result.

Safety Precautions

■ Maintenance • Inspection



Caution

- ◆ Some parts of the servo amplifier (electrolytic capacitor, cooling fan, lithium battery for encoder, fuse and relay kinds) can deteriorate with long-term use. Please contact our offices for replacements.
Damage to the device could otherwise result.
- ◆ Do not touch or get close to the terminal while the device is powered up.
Electric shock could otherwise result.
- ◆ Be careful during maintenance and inspection, as the body of the amplifier becomes hot.
Burn could otherwise result.
- ◆ Please contact your distributor or sales office if repairs are necessary.
Disassembly could render the device inoperative.
Damage to the device could otherwise result.



Prohibited

- ◆ Do not overhaul the device.
Fire or electric shock could otherwise result.
- ◆ Do not measure the insulation resistance and the pressure resistance.
Damage to the device could otherwise result.
- ◆ Absolutely do not unplug the connector while the device is powered up because hot plug will give damaged by surge to component.
Electric shock or damage could otherwise result.
- ◆ Do not remove the nameplate cover attached to the device.

Safety Precautions

■ Disposal



Mandatory

- ◆ If the amplifier or the motor is no longer in use, it should be discarded as industrial waste.

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1. Function and composition

1.1 Summary

This instruction manual describes safety function of "SANMOTION R 3E Model Safety" servo amplifier. "SANMOTION R 3E Model Safety" servo amplifier is the model expanding safety function by adding functional safety module to lateral of the servo amplifier equipping Safe-Torque-Off function. Its function as servo amplifier is same with the servo amplifier equipping Safe-Torque-Off function.

Model	Model number	Specification
Standard servo amplifier	RS3□□□□□□0	Model of no safety function applying.
SANMOTION R 3E Model	RS3□□□□□□2 RS3□□□□□□4	Model of equipping Safe-Torque-Off function. Delay time of torque off is selectable by end digit of model number.
SANMOTION R 3E Model Safety	RS3□□□□□□C RS3□□□□□□E	Model of expanding safety function by adding functional safety module to lateral of the servo amplifier equipping Safe-Torque-Off function.

Function expansion is available with all amplifier capacity of 200/400 VAC input type. Moreover, analog/pulse input type, parallel/serial interface type with built-in positioning function and EtherCAT interface type are available.

- ✓ In this instruction manual, product is classified according to model name in table above.

1.1.1 Servo amplifier instruction manual

For detail of specification/function except safety function, refer instruction manuals below.

Instruction manual	Power supply	Current capacity	Interface type
M0010630	100/200 VAC	10A to 300A	Analog/pulse input type
M0011114	200 VAC	600A	
M0011758	400 VAC	25A to 300A	
M0012169	400 VAC	800A	
M0011696	100/200 VAC	10A to 300A	EtherCAT interface
	200 VAC	600A	
	400 VAC	25A to 300A	
	400 VAC	800A	
M0012314	100/200 VAC	10A to 300A	Parallel/serial interface type with built-in positioning function
	200 VAC	600A	
	400 VAC	25A to 300A	
	400 VAC	800A	

- ✓ In this instruction manual, servo amplifier manuals are referred. For use of "SANMOTION R 3E Model Safety" servo amplifier equipping functional safety module, please prepare this manual and another above.

1.2 Safety function summary

1.2 Safety function summary

1.2.1 Safety function

Safety functions supported by this system are shown below.

- 1) STO (Safe Torque Off)
Shut down a power supply to motor, by opening contact (off) of safety input signal.
- 2) SS1 (Safe Stop 1)
Start deceleration, by opening contact (off) of safety input signal. STO function will be performed after set time spends from motor stop state (less than 50min⁻¹) detection.
- 3) SS2 (Safe Stop 2)
Start deceleration, by opening contact (off) of safety input signal. SOS function will be performed after set time spends from motor stop state (less than 50min⁻¹) detection.
- 4) SOS (Safe Operation Stop)
This function monitors that servo motor stays in the set area from stop position. STO function will be performed if motor rotates exceeding set area.
In case that safety function is SOS, position is monitored based on the position of stopping when contact (off) of safety input signal was opened. In case that safety function is SS2, position is monitored based on the position of motor stop.
- 5) SLS (Safely-Limited Speed)
This function monitors that servo motor rotation speed is kept in the set velocity range. STO function will be performed if motor rotates exceeding set range.
✓ The functions except STO are not able to use with torque control.

1.2.2 Safety output function

Safety output functions supported by this system are shown below.

- 1) SSM (Safe Speed Monitor)
This signal output informs that servo motor rotation speed is kept in the set velocity range.
- 2) SBC (Safe Brake Control)
This signal output is for a holding brake control.
✓ To use output signal as safety output, make valid a diagnosis function of output signal.
For detail of diagnosis function, refer the section "4.5.3 Safety output diagnosis".

1.2.3 Monitor output function

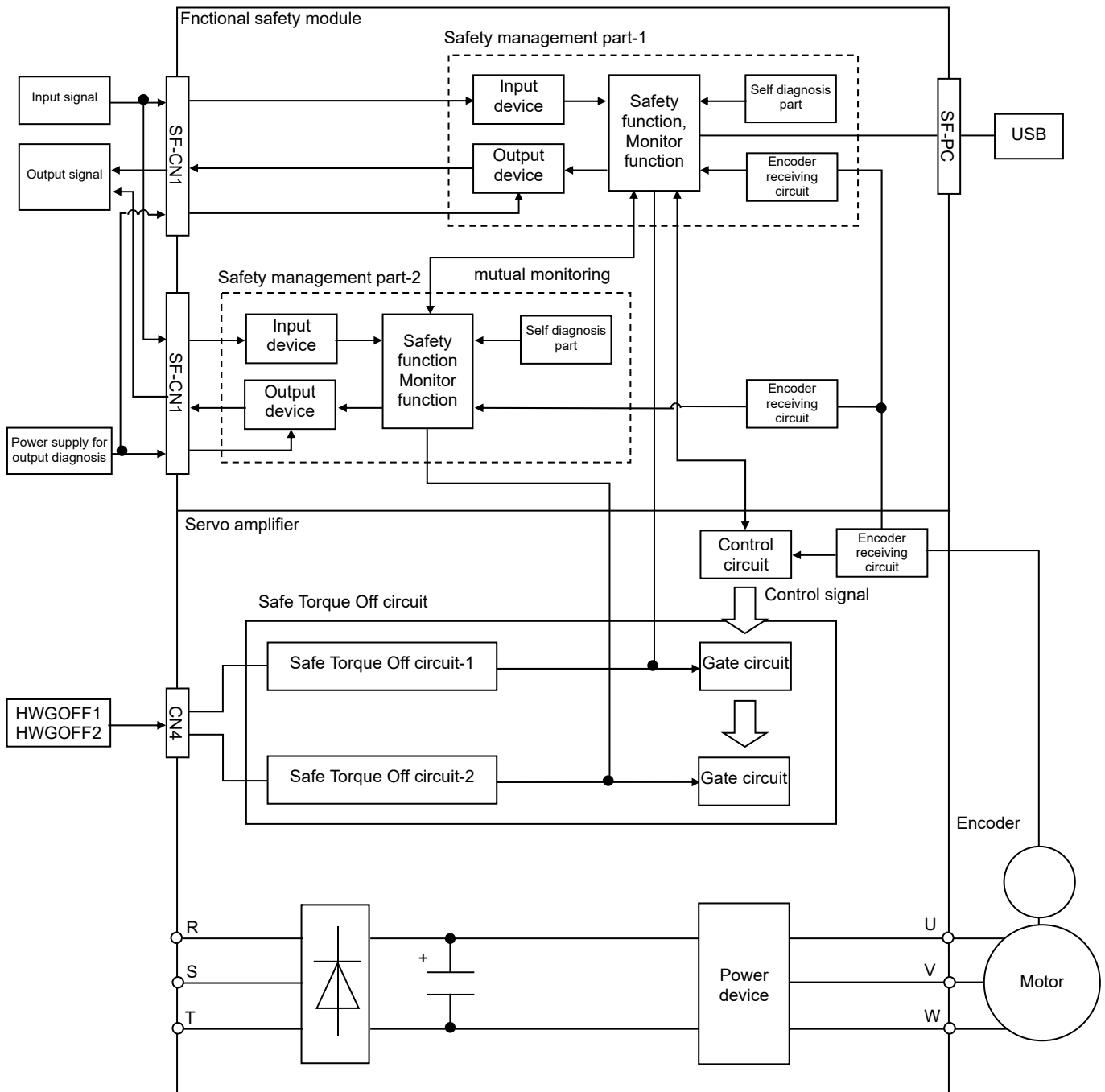
Monitor output functions supported by this system are shown below.

- a) INM
This is a status monitor output of safety input.
- b) STA
This is a monitor output of safety function operating status.
✓ Alarm or during warning are not included. (Output will be ON.)
- c) STO
This is a monitor output of Safe Torque Off operating status.
✓ Alarm or during warning (velocity monitor warning, position monitor warning, safety function warning) are included. (Output will be OFF.)
✓ In case that output signal is used as monitor output, diagnosis of output signal is not required.
For detail of diagnosis function, refer the section "4.5.3 Safety output diagnosis".

1. Function and composition

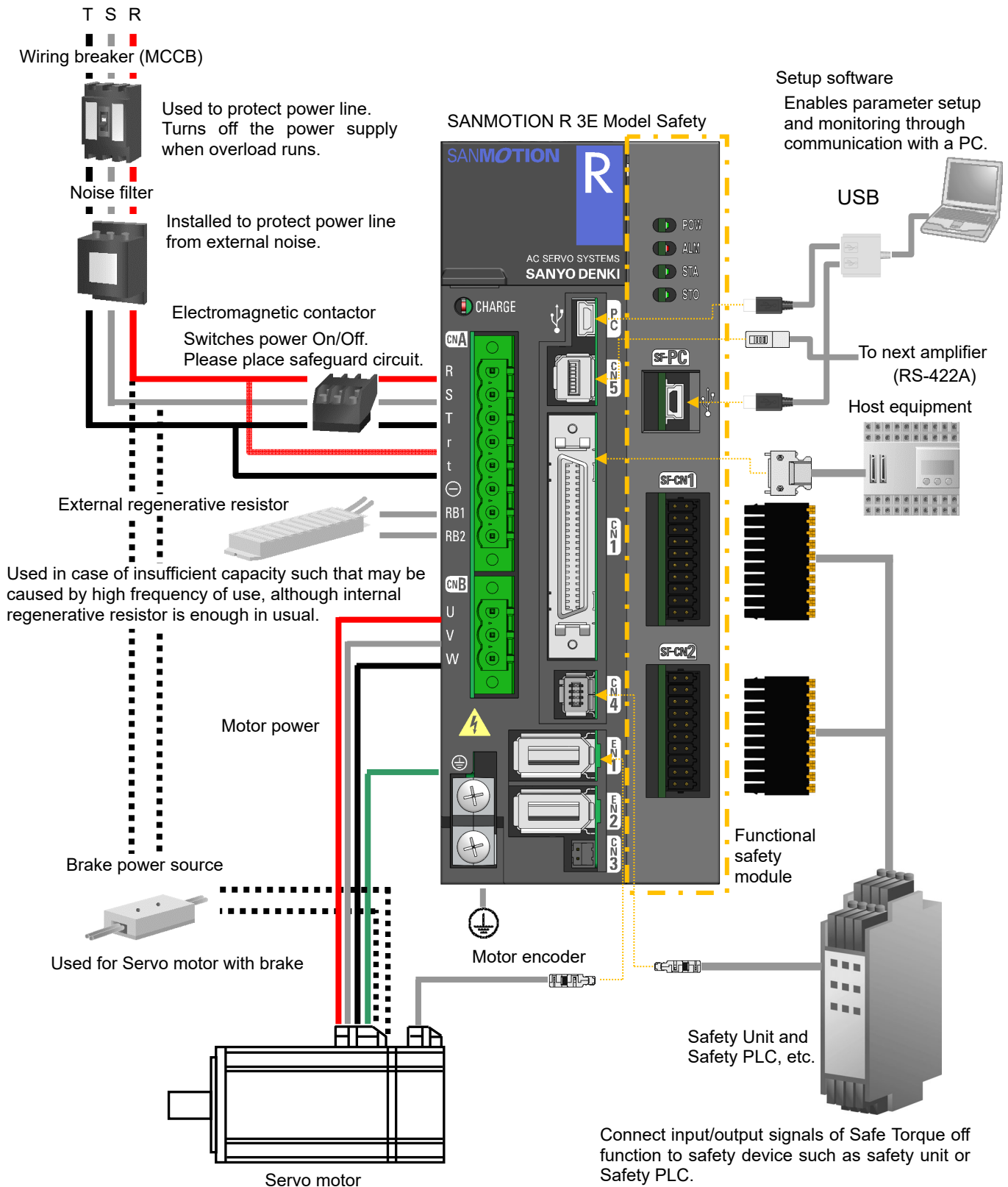
1.3 Function block diagram

Safety functions are operated via safety input terminal of SF-CN1 and SF-CN2.



1.4 System components

1.4 System components



- ✓ When servo amplifier side STO function is not used, connect the short-circuit plug for safety function, model number AL-00849548-02, to CN4.

1. Function and composition

1.5 Product specification

1.5.1 Standard specification

Item		Specification
Input power voltage		100/200 VAC type, 400 VAC type
Interface		Analog / pulse input type, EtherCAT interface type Parallel/serial interface type with built-in positioning function
Combination motor		R series, AC servo motor
Combination encoder		Battery-less absolute encoder (HA035, GAER) Single-turn absolute encoder Battery backup absolute encoder (PA035(M40, M50)) Wire-saving incremental encoder
Power source for safety input		24 VDC $\pm$ 10% Internal impedance: 5.6 k Ω
Power source for safety output		24 VDC $\pm$ 10% Maximum current value: 50 mA
Environmental specification	Operating ambient temperature	0 to +55°C
	Storage temperature	-20 to +65°C
	Operating/Storage humidity	90%RH or less (without condensation)
	Elevation	1000 m or less
	Vibration / Shock	4.9 m/s ² / 19.6 m/s ²

- ✓ Use SELV power source to Power source for safety input / Power source for safety output.
SELV (Safety Extra-Low Voltage) power source:
Its voltage between wires or potential difference from ground is less than 42.2 V peak or 60 VDC.
And its structure avoids danger caused by an electric potential difference for protection.
- ✓ Linear motor is not applied.
- ✓ For a use of the motor except R series, please consult us.
- ✓ EnDat2.2 encoder of Heidenhain made is not applied.
- ✓ Safety function is available with full-closed system, but velocity/position monitoring in safety condition is performed to a motor encoder.
- ✓ For detailed spec of servo amplifier, refer the instruction manuals.
For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".

1.5 Product specification

1.5.2 Outline dimensions

Item		Specification				
Model number		RS3E01 RS3A01	RS3E02 RS3A02	RS3E03 RS3A03	RS3A05	RS3A07
Outline dimensions (H × W × D) [mm]		160 × 60 × 130	160 × 60 × 130	160 × 60 × 130	160 × 105 × 130	160 × 115 × 190
Mass [kg]	Without built-in regenerative resistor	0.8	0.8	0.9	1.6	2.4
	With built-in regenerative resistor	0.9	0.9	1.0	1.7	2.6

Item		Specification			
Model number		RS3A10	RS3A15	RS3A30	RS3W60
Outline dimensions (H × W × D) [mm]		205 × 120 × 220	205 × 120 × 220	205 × 220 × 220	380 × 250 × 292
Mass [kg]	Without built-in regenerative resistor	4.3	4.9	9.9	18.1
	With built-in regenerative resistor	4.3	5.1	-	-

Item		Specification				
Model number		RS3C02	RS3C05	RS3C10	RS3C15	RS3C30
Outline dimensions (H × W × D) [mm]		205 × 95 × 235	205 × 120 × 235	205 × 195 × 235	375 × 220 × 217	375 × 270 × 222
Mass [kg]	Without built-in regenerative resistor	-	-	-	11.1	18.1
	With built-in regenerative resistor	2.6	4.8	8.6	-	-

Item		Specification
Model number		RS3D80
Outline dimensions (H × W × D) [mm]		380×400×315
Mass [kg]	Without built-in regenerative resistor	32.5

1. Function and composition

1.5.3 Safety specification

Item			Safety performance	
Safety I/O	Input device	Input points	2 systems (sink/source) with 5 points each	
		Mismatch detection time	10s	
		Diagnosis cycle	10min.	
		Off shot pulse width	Less than 1ms	
	Output device	Output points	2 systems (source) with 3 points each	
		Diagnosis cycle	10min.	
Safety performance	Mean Time to Dangerous Failure		MTTFd ≥ 100 [year]	
	Dangerous failure rate	STO	PFH = 1.39 × 10 ⁻⁸ [1/h]	
		SS1, SS2, SLS, SOS, SSM, SBC	PFH = 3.74 × 10 ⁻⁸ [1/h]	
	Diagnostic coverage		DC ≥ 97 [%]	
	Response performance		Less than 13ms	
	Hardware fault tolerance		HFT = 1	
	Sub system type		Type B	
	Mission time		10 years	
Safety function	IEC/EN61800-5-2		EN61508 IEC/EN62061	ISO13849-1:2015 EN ISO13849-1:2015
	STO		SIL3 / SILCL3	PL e, category 3
	SS1			
	SS2			
	SLS			
	SOS			
Safety output function	SBC		SIL3 / SILCL3	PL e, category 3
	SSM			

- ✓ Safety performance of safety output function is in case that diagnosis function of output terminal is valid. For detail of diagnosis function, refer the section "4.5.3 Safety output diagnosis".
- ✓ The above safety levels (SIL3/SILCL3, PL e category 3) can be achieved when our encoder codes H, P, R, S (motor model number 12th digits: ◇) are used. Other combinations may not satisfy the above safety specifications.

R 2 AA ○○ ○○○ △ □ ◇ ○○ △ □

◆ Absolute encoder (Standard specification)

Name (Code)	Encoder code in motor model number	Single-turn resolution	Multi-turn resolution	Transfer method
Single-turn absolute encoder (PA035S)	H	131,072 (17 bit)	—	Half-duplex asynchronous 2.5 Mbps
Battery backup absolute encoder (PA035C)	P	2.5 Mbps	65,536 (16bit)	Half-duplex asynchronous 2.5 Mbps
Battery-less absolute encoder (HA035, GAE)	R	131,072 (17 bit)	65,536 (16bit)	Half-duplex asynchronous 2.5 Mbps

◆ Incremental encoder (Standard specification)

Name (Code)	Encoder code in motor model number	Division number (Number of pulse)
Wire-saving incremental encoder (PP031H)	S	8,000 (2,000 P/R)

1.5 Product specification

1.5.4 Power Unit Model Number

	RS3	P	□	△	○○○	XX
Series name	RS3... "SANMOTION R" 3E Model series					
Unit type	PA... Power unit (with external generative resistor)					
Input power voltage	A... Main circuit power 200 VAC / Control power 200 VAC B... Main circuit power 200 VAC / Control power 200 VAC, 24 VDC C... Main circuit power 400 VAC / Control power 24 VDC					
Regenerative method	A... Resistive regeneration / External regenerative resistor type R... Power supply regeneration / External resistive regenerative option					
Power unit capacity	270...27 kW, 370...37 Kw, 550...55 kW					
Specification identification	00 or None... Standard specifications 2 digits indication... Special specifications					

- ✓ For detailed spec of model number code (shown as "○") which is not specified above, refer a servo amplifier instruction manual.
For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".

1. Function and composition

1.5.5 Servo Amplifier Model number

Servo amplifier series

RS3···"SANMOTION R" 3E Model series

Input power voltage

A···200 VAC / E···100 VAC / C···400 VAC / W···280 VDC (600A only)

D···560 VDC (800A only)

Servo amplifier capacity

Input power voltage	01	02	03	05	07	10	15	30	60	80
100 VAC	10A	20A	30A	-	-	-	-	-	-	-
200 VAC	10A	20A	30A	50A	75A	100A	150A	300A	-	-
400 VAC	-	25A	-	50A	-	100A	150A	300A	-	-
280 VDC	-	-	-	-	-	-	-	-	600A	-
560 VDC	-	-	-	-	-	-	-	-	-	800A

Servo motor type

A···Rotary motor

Encoder type

	EN1 (Only for motor encoder)	EN2 (For motor encoder or external incremental encoder)
0	Absolute encoder	—
1	Absolute encoder	Absolute encoder
2	Absolute encoder	Incremental encoder
8	Incremental encoder	—
9	Incremental encoder	Absolute encoder
A	Incremental encoder	Incremental encoder

Interface type

A···Analog/pulse input, sink type general output
 B···Analog/pulse input, source type general output
 H···EtherCAT interface
 C···Parallel interface type with built-in positioning function
 F···Serial interface type with built-in positioning function

Option-1

A···Built-in regenerative resistor/ Built-in DB resistor
 L···Without regenerative resistor/ Built-in DB resistor
 M···Without regenerative resistor/ Without DB resistor

Option-2

Code	Safe Torque Off		Functional safety module	Remarks
	Function	Delay circuit		
0	N/A	-	N/A	SANMOTION R 3E Model (with Safe-Torque-Off function)
2	Equipped	N/A	N/A	
4	Equipped	Equipped	N/A	
C	Equipped	N/A	Equipped	SANMOTION R 3E Model Safety
E	Equipped	Equipped	Equipped	

- ✓ For detailed spec of model number code (shown as "O") which is not specified above, refer a servo amplifier instruction manual.
 For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".

1.6 Risk assessment

This servo amplifier individually satisfies the safety standards written in manual. However, to use each safety functions, please perform risk assessment as a whole mechanism of customer, and keep safety. Be sure to perform a safety system setting and entrustment, with customer responsibility. Moreover, to apply EC Machinery Directive, safety standards certification is required as a whole system. For final safety proof of system, we recommend third-party certificate. Residual risk of this product is shown below.

1.6.1 Residual risk

Risk as below exists even if safety function is working. Be sure to be able to keep safety through risk assessment even if risks below happen.

- 1) Safety system design using safety function shall be performed by the person having training against concerned safety standards, with understanding of this instruction manual.
- 2) For servo motor, motor power will be shut down when safety function works while rotation, but rotation continues for a while by inertia. Safety system shall be designed as avoiding danger until servo motor stops completely. (for STO use)
- 3) Servo motor will be rotated forcibly by gravity if using at vertical axis etc. Please prepare stop method such as mechanical brake. As note, servo brake circuit, dynamic brake circuit, holding brake excitation signal of servo amplifier and holding brake of servo motor are not safety related part.
✓ SBC output from functional safety module is safety function.
- 4) When short circuit between phases of servo motor occurs caused by power device (IC) failure etc, servo motor will rotate in range of 180 degree maximum by electric angle, and it may continued servo motor excitation. Be sure to use with judgement that above action won't go danger. For R series motor, electric angle 180 degree is equal to 1/10 to 1/8 rotation of motor shaft.
- 5) Power input for servo amplifier won't shut down even if safety function will be worked. At the time of maintenance or inspection etc of servo amplifier, electric shock could otherwise result, input power shall be shut down before work.
- 6) Wiring for functional safety module shall be divided and leave from the other wiring. Also, the wiring shall be protected with applicable way something.
- 7) It is recommended that the device (switch, relay and sensor) connecting to safety I/O is applying to safety standards. For use of the device not applying to safety standards, please perform safety proof by customer own.
- 8) The time to error detection of velocity/position monitoring depends on set value of the "Group0 ID01: Error detection time (EDT)". Servo motor rotation will continue until set value of error detection time is past. Confirm that it is able to keep safety until detection time passing from error occurrence.
- 9) The time to transit to safety state from open (off) the safety input depends on set value of the "Group# ID03: Safety function starting wait time (SFWT#)".
- 10) The velocity/position monitoring function is the function monitoring a motor encoder, not guarantee a velocity/position of machine. Set each monitoring levels as to be a velocity/position of machine in a safety range.
- 11) Error detection time is set with 1ms unit. The error shorter than this value is not able to detect.

1. Function and composition

- 12) During SOS or SLS function is performed, servo motor will rotate to detect encoder failure, in range of ± 0.1 degree by mechanical angle. Use SOS or SLS function only with judgement that above action won't go danger.
- 13) SBC output is the signal controlling an operation timing of holding brake. Be sure to confirm previously that power for holding brake is provided correct. Moreover, brake wear cannot detect so periodically confirm that holding brake is able to work well, please.

Installation

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2. Installaion

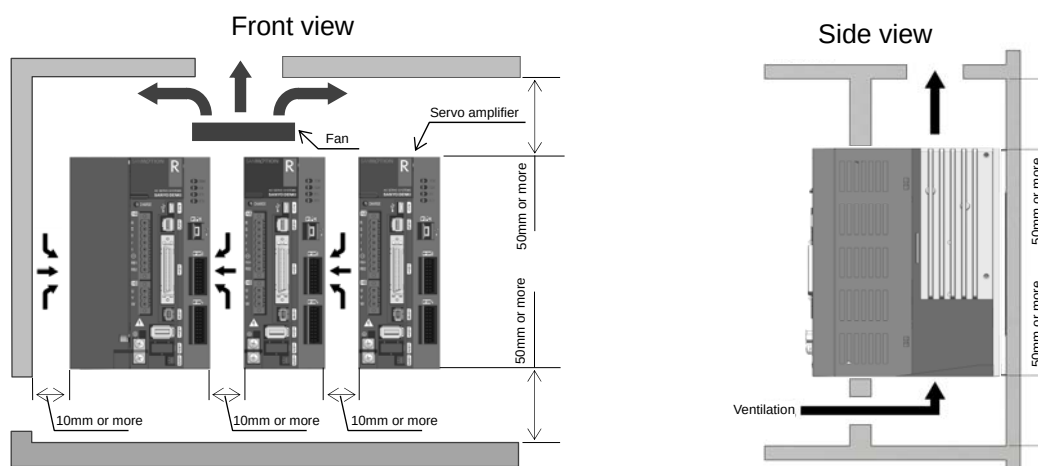
2.1 Installation

2.1.1 How to install

Precaution of installation and how to install are according to the instruction manual of servo amplifier. For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".

2.1.2 Arrangement within the cabinet

- Leave at least 50 mm space above and below the servo amplifier to ensure unobstructed airflow from the inside of the servo amplifier and the radiator. If heat gets trapped around the servo amplifier, use a cooling fan to create airflow.
- Make sure the temperature around the servo amplifier does not exceed 55° C. For longevity and reliability purposes it is recommended to keep the temperature below 40° C.
- Leave at least 10 mm space on both sides of the servo amplifier to ensure unobstructed airflow from the heat sinks on the side and from the inside of the servo amplifier.
- For RS3□02·RS3□03·RS3□05, a cooling fan is attached at the side. Therefore, it is recommended that the servo amplifier be mounted in an arrangement as shown below.



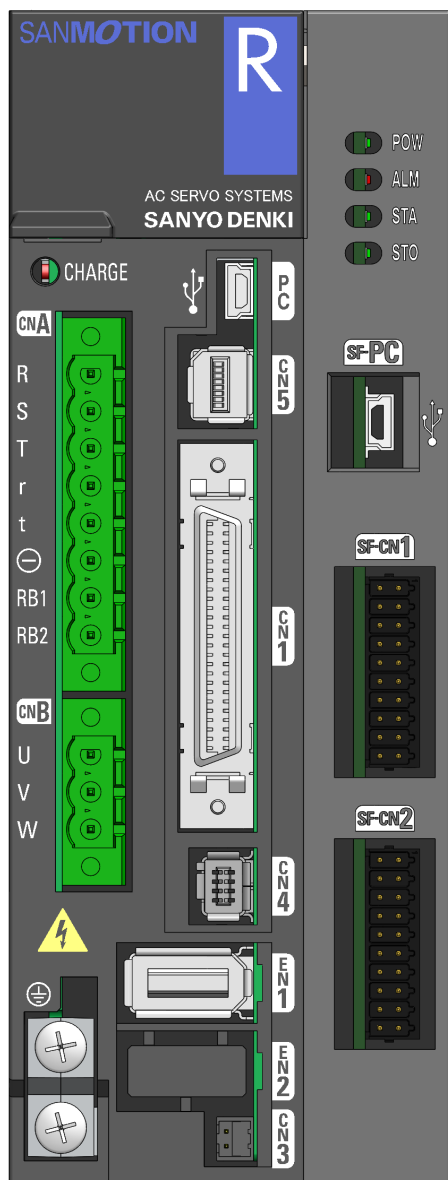
Wiring

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3.5 Off shot pulse for self diagnosis with safety device	3-4

3. Wiring

3.1 Connector and signal wiring

Connect safety I/O signals to each connector of SF-CN1 and SF-CN2.



■ SF-CN1

Number	Abbreviation	Abbreviation	Number
A1	NC	SFOA1-POW	B1
A2	SFOA1	SFOA1-DIAG	B2
A3	SFOB1-POW	SFOB1	B3
A4	SFOB1-DIAG	SFOC1-POW	B4
A5	SFOC1	SFOC1-DIAG	B5
A6	SFIA1	SFIA1-COM	B6
A7	SFIB1	SFIB1-COM	B7
A8	SFIC1	SFID1	B8
A9	SFIE1	SFIC1-COM	B9
A10	NC	NC	B10

■ SF-CN2

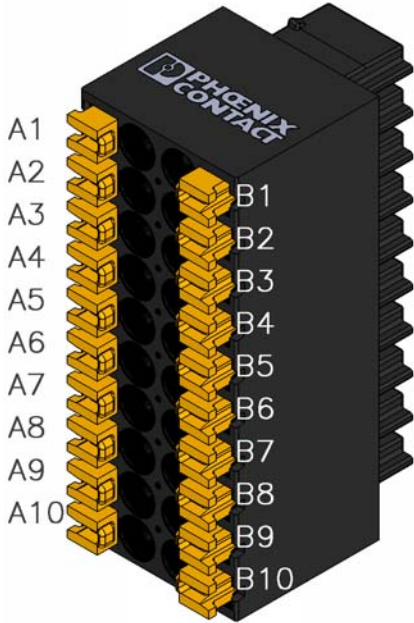
Number	Abbreviation	Abbreviation	Number
A1	NC	SFOA2POW	B1
A2	SFOA2	SFOA2-DIAG	B2
A3	SFOB2-POW	SFOB2	B3
A4	SFOB2-DIAG	SFOC2-POW	B4
A5	SFOC2	SFOC2-DIAG	B5
A6	SFIA2	SFIA2-COM	B6
A7	SFIB2	SFIB2-COM	B7
A8	SFIC2	SFID2	B8
A9	SFIE2	SFIC2-COM	B9
A10	NC	NC	B10

- ✓ STO function is able to perform through CN4 even if functional safety module is attached. Refer the servo amplifier instruction manual for how to wire CN4. For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".
When servo amplifier side STO function is not used, connect the short-circuit plug for safety function, model number AL-00849548-02 to CN4.
- ✓ For function setting of SFIA to SFIC and SFOA to SFOC, refer the section "5.1.2 Parameter detail".

3.2 SF-CN1, 2 connectors

3.2 SF-CN1, 2 connectors

Connector pin arrangement
(Cable insertion side)

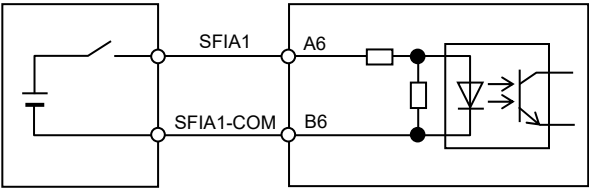


Connector	Specification
Model number	DFMC 0,5/10-ST-2,54
Manufacturer	Phoenix contact
Applicable wire size	AWG26~AWG20
Part number	AL-Y0012189-01

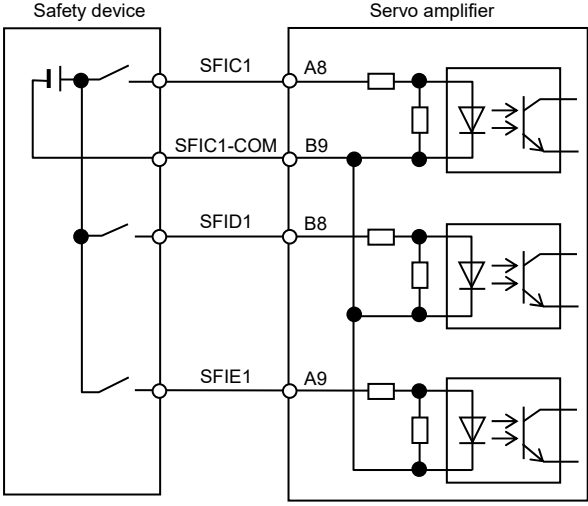
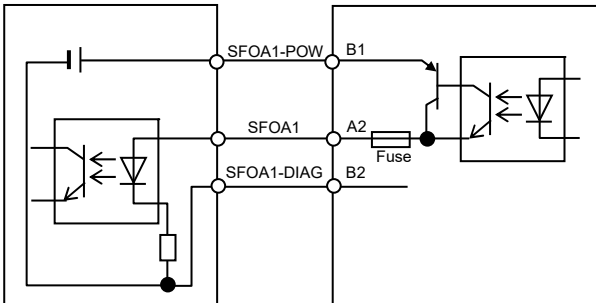
- ✓ Use cable within length of 10m.

Wiring

3.3 Connection circuit

Abbreviation	Terminal number	Name	Function	Status at safety function valid
SFIA1 SFIA1-COM	A6 B6	Safety input A	Performs safety function selected by Group1 ID00 "Safety input A function selection". Connects to relay or open-collector transistor circuit. Power source voltage : 24 VDC$\pm$10% Internal impedance : 5.6kΩ 	Open
SFIA2 SFIA2-COM				
SFIB1 SFIB1-COM	A7 B7	Safety input B	Performs safety function selected by Group1 ID00 "Safety input B function selection". ✓ Connection circuit is same as Safety input A.	Open
SFIB2 SFIB2-COM				

3. Wiring

Abbreviation	Terminal number	Name	Function	Status at safety function valid
SFIC1 SFID1 SFIE1 SFIC1-COM	A8 B8 A9 B9	Safety input C Safety input D Safety input E	Performs safety function selected by Group1 ID00 "Safety input C function selection". Connects to relay or open-collector transistor circuit. Power source voltage : 24 VDC$\pm$10% Internal impedance : 5.6kΩ 	Open
SFIC2 SFID2 SFIE2 SFIC2-COM				
SFOA1-POW SFOA1	B1 A2	Safety output A	Outputs signal selected by Group1 ID01 "Safety output A function selection". Connects to relay or open-collector transistor circuit. Power source voltage range (Uext) : 24 VDC$\pm$10% Maximum current value : 50mA Maximum voltage drop at ON (between pin B1-A2) : Max. 1.5 V (with 50 mA) 	Open
SFOA1-DIAG SFOA2-DIAG				
	B2	Safety output A diagnosis terminal	✓ For use as safety output, connect the safety output diagnosis terminal to ground of power source for safety output.	

3.4 Safety output terminal

Abbreviation	Terminal number	Name	Function	Status at safety function valid
SFOB1-POW SFOB1	A3 B3	Safety output B	Outputs signal selected by Group2 ID01 "Safety output B function selection". ✓ Connection circuit is same as Safety output A.	Open
SFOB2-POW SFOB2				
SFOB1-DIAG	A4	Safety output B diagnosis terminal		
SFOB2-DIAG				
SFOC1-POW SFOC1	B4 A5	Safety output C	Outputs signal selected by Group3 ID01 "Safety output C function selection". ✓ Connection circuit is same as Safety output A.	Open
SFOC2-POW SFOC2				
SFOC1-DIAG	B5	Safety output C diagnosis terminal		
SFOC2-DIAG				
NC	A1 A10 B10	(Unused)	Unused terminal. Do not connect.	-

- ✓ Make safety I/O signal dual, and connect to 2 systems of SF-CN1 and SF-CN2.
- ✓ Use SELV power source, 24 VDC $\pm$ 10%, to power source for interface.
- ✓ For output of SBC or SSM signal, connect each safety output A to C diagnosis terminal to ground of power source for safety output, and set "01: Enable" to "Safety output diagnosis function selection".

3.4 Safety output terminal

3 channels safety output apply as below.

Safety output	Specification
SFOA	• Status output (INM) of SFIA terminal. • Operating status output (STA) of safety function set to SFIA terminal. • Status output (STO) of STO. • SBC signal output
SFOB	• Status output (INM) of SFIB terminal. • Operating status output (STA) of safety function set to SFIB terminal. • Status output (STO) of STO. • SBC signal output
SFOC	• Status output (INM) of combining SFIC, SFID and SFIE terminals. • Operating status output (STA, STO) of SLS function. • Status output (STO) of STO. • SBC signal output • SSM signal output

- ✓ SSM signal is not able to output through SFOA or SFOB output.

3.5 Off shot pulse for self diagnosis with safety device

For the use of safety device (safety unit, safety sensor etc) having off shot pulse for self diagnosis, use the safety device supporting off shot pulse width less than 1ms.

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Safety function

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4. Safety function

4.1 Start up

To use safety function correct, in case that turn power ON at first or after replacement, confirm safety function works correctly following below steps.

- ✓ If it is used with wrong connection of I/O signals etc, safety function won't work correct and may cause of danger condition.

4.1.1 Preparation

Install servo amplifier/servo motor and wire each cables of power, servo motor encoder etc. About methods of "Installation" and "Wiring", refer servo amplifier instruction manual.

- ✓ For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".

4.1.2 Safety I/O signal wiring

Safety I/O signal shall be connected to host device according to the chapter "3. Wiring" in this manual.

4.1.3 Confirmation of safety I/O signal operation

Please confirm safety I/O signal operation according to steps below.

- 1) After turning on control power, confirm no alarm is indicated at display part of upper front of servo amplifier. When alarm is indicated, refer the chapter "7. Troubleshooting" in this manual, or servo amplifier instruction manual.
- 2) Perform this confirmation steps with condition of factory setting. However if any of safety I/O terminals are not used, set "00: NONE (function invalid)" to a corresponded safety I/O function selection parameter.

- ✓ For detail of each safety I/O function selection parameter, refer the section "5.1.2 Parameter detail".
- ✓ Initial setting of safety I/O in factory settings are below.

Safety I/O output	Factory setting	Detail
SFIA, SFIB	STO	Safe Torque Off
SFIC (SFID, SFIE)	SLS	Safely-Limited Speed
SFOA, SFOB, SFOC	INM	Safety input status output

- 3) Check that a safety output works as below according to ON/OFF switching of a safety input.
If not, check wiring.

Steps	Safety input		Safety output
	SFIA1	SFIA2	SFOA1 / SFOA2
	SFIB1	SFIB2	SFOB1 / SFOB2
	SFIC1	SFIC2	SFOC1 / SFOC2
	SFID1	SFID2	
	SFIE1	SFIE2	
1	ON	ON	ON
2	OFF	ON	OFF
3	OFF	OFF	OFF
4	ON	ON	ON
5	ON	OFF	OFF
6	OFF	OFF	OFF

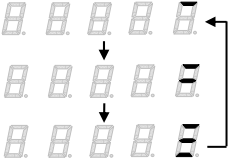
4.1 Start up

- ✓ For safety I/O, ON state is closing contact, and OFF state is opening contact.
- ✓ Safety output will be OFF when either of safety input becomes OFF. To turn safety output ON again, both safety input turn OFF once, and then turn ON.
- ✓ When the condition mismatching input logic continue 10s or more, alarm 96 occurs.

4.1.4 Confirmation of safety function operation

Please confirm safety function operation according to steps below.

Checks that STO (Safe Torque Off) function works correct, by SFIA input.

Steps	Operation	Judgement
1	Turns main circuit power ON.	
2	Turns all safety input for use ON.	
3	Perform servo ON.	Servo motor is excited.
4	Turns SFIA input OFF.	Servo motor excitation is canceled. LED lights as below. 
5	Turn SFIA input ON, and then perform servo ON.	Servo motor is excited.

- ✓ For safety input operation, change 2 channels at same timing. When the condition mismatching input logic continue 10s or more, alarm 96 occurs.

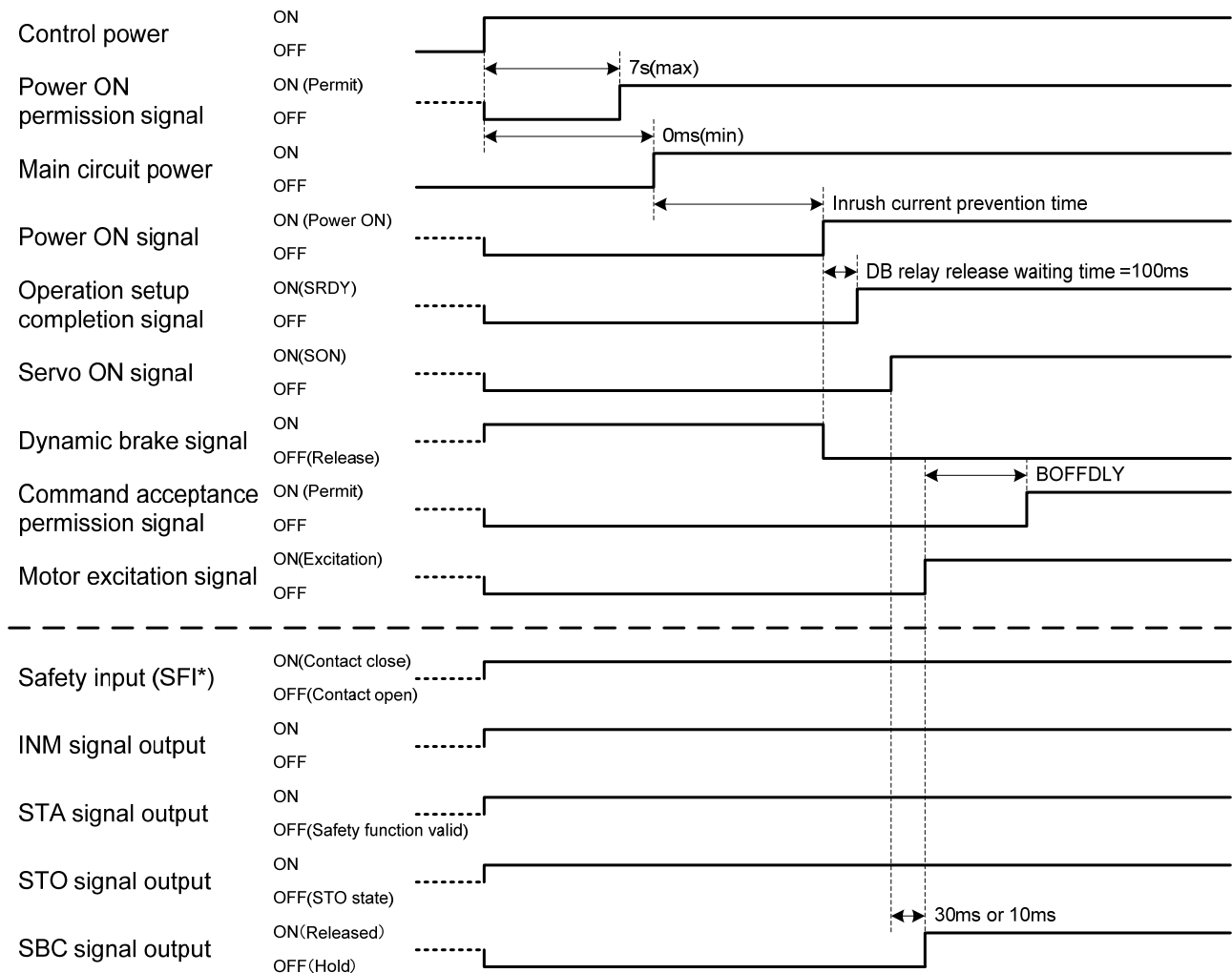
4.1.5 Record for start up

When inspection/maintenance has performed at servo amplifier start up/replacement, it is recommended that check result recording after performing "Confirmation of safety I/O signal operation" and "Confirmation of safety function operation".

4. Safety function

4.2 Power ON sequence

a) Turn control power ON with safety input ON (contact open) condition



- ✓ It takes 7s maximum to output Power ON permission signal.
- ✓ When turning on the power with the Servo ON signal turned on, it will start up in safe torque off state. Turn on the Servo ON signal after turning on the Operation setup completion signal.

Safety function

4



- | Safety function | State of STA |
|--------------------|--------------|
| STO | OFF |
| SS1, SS2, SOS, SLS | ON |

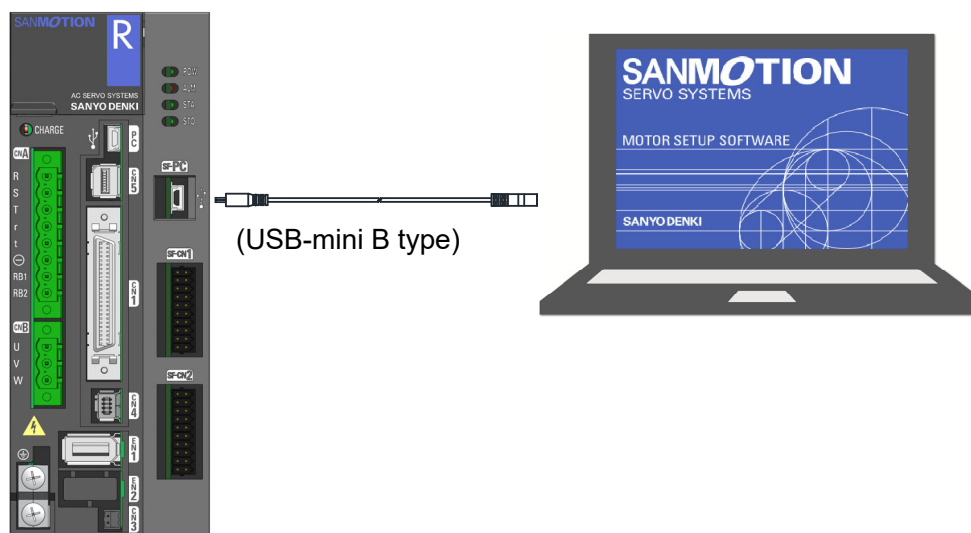
- | Safety function | State of STO |
|--------------------|--------------|
| STO, SS1, SS2, SOS | OFF |
| SLS | ON |

4. Safety function

4.3 Parameter setting

4.3.1 Connection

Connect PC and servo amplifier as below via commercial USB cable. To set safety parameters, connect USB cable to SF-PC connector at functional safety module.



- ✓ Safety parameters are not able to set if connecting to PC connector in servo amplifier.

4.3.2 Setup software

Parameters in functional safety module are set through SANMOTION MOTOR SETUP software. Applicable setup software version is 111.001 or later.

- ✓ Please download "SANMOTION MOTOR SETUP SOFTWARE" from our Website.
- ✓ For detail of SANMOTION MOTOR SETUP software, refer the instruction manual of SANMOTION MOTOR SETUP software: M00010842.

4.3.3 Parameter editing authority

It is able to select either "Browse mode" or "Edit mode" by the parameter editing authority selecting function. For editing parameters, select "Edit mode". Password entering window opens after selecting "Edit mode" so enter a password and activate "Edit mode".

- ✓ In a factory setting, "Browse mode" is set to the parameter editing authority, and "0000" is set to password. To switch to "Edit mode", enter "0000" at password entering.
- ✓ Parameter editing function is able to limit by using "Browse mode" even if password is "0000".
- ✓ When parameter editing is not required, select "Browse mode" and avoid undesired parameter change.

4.3.4 Password setting

Set password by 4 digits number through password setting window.

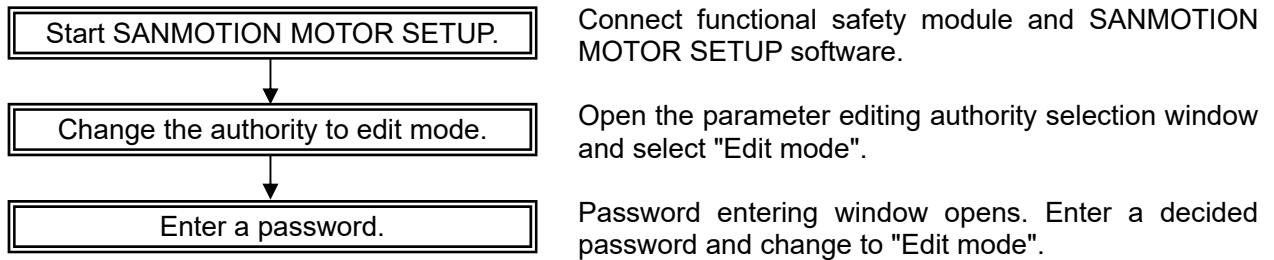
- ✓ Be sure to set password to protect parameters.
- ✓ Keep an entered password as not lost.

4.3 Parameter setting

4.3.5 Parameter setting

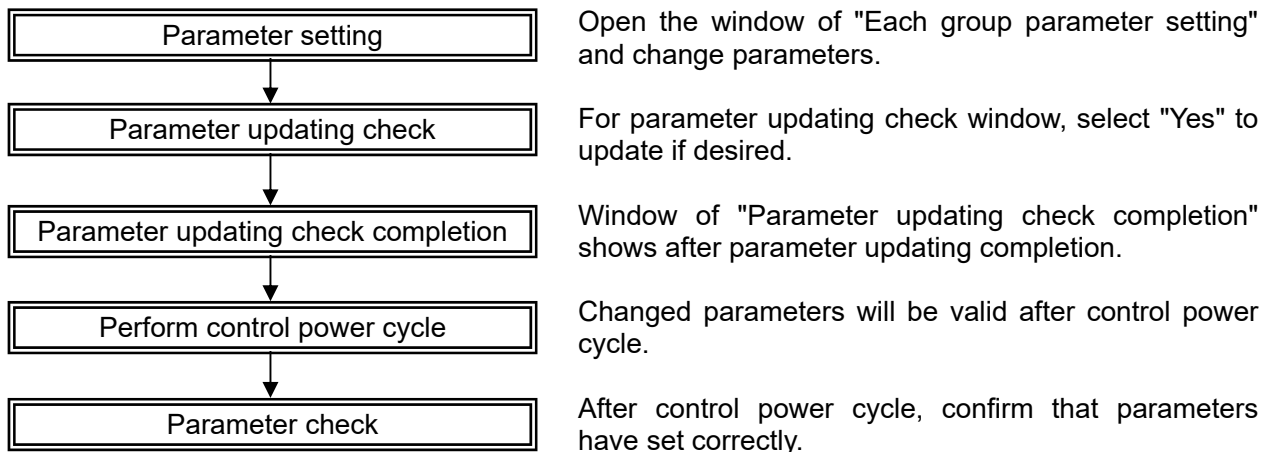
Please set safety parameters according to steps below.

1) Parameter editing authority change



- ✓ Be sure to set password to limit undesired change of parameters.
- ✓ In a factory setting, "0000" is set to password. Enter "0000" for password entering window to allow parameter change.

2) Parameter change



- ✓ Control power cycle is required for that changed safety parameters become valid.
- ✓ If control power is shutted while parameter changing, it may not changed parameter correctly. If not changed, perform parameter change again.
- ✓ Parameter change shall be performed by the person having training against the safety standards.

4.3.6 Parameter initialization

Factory setting parameter is able to restore by performing function of "Parameter initialization" in SANMOTION MOTOR SETUP software.

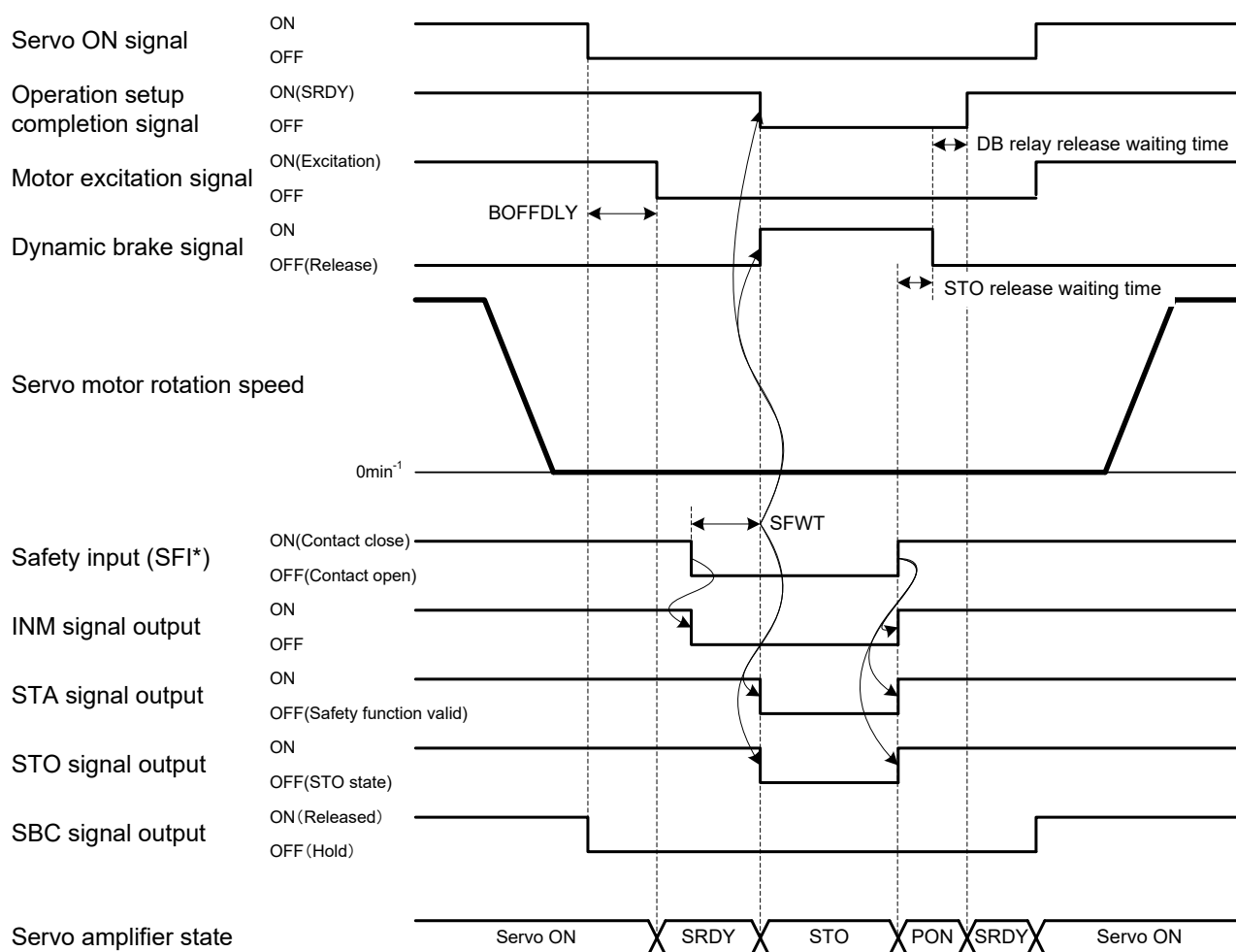
4. Safety function

4.4 Safety function (Each functions, priority of simultaneous performing etc)

4.4.1 STO (Safe Torque Off)

a) Operation sequence

When safety input is changed to OFF (contact open), power supply for servo motor shut down after passing "Safety function starting wait time (SFWT)" and transit to STO state. In this state, servo ready signal is changed to OFF, and servo ON signal is prohibited.

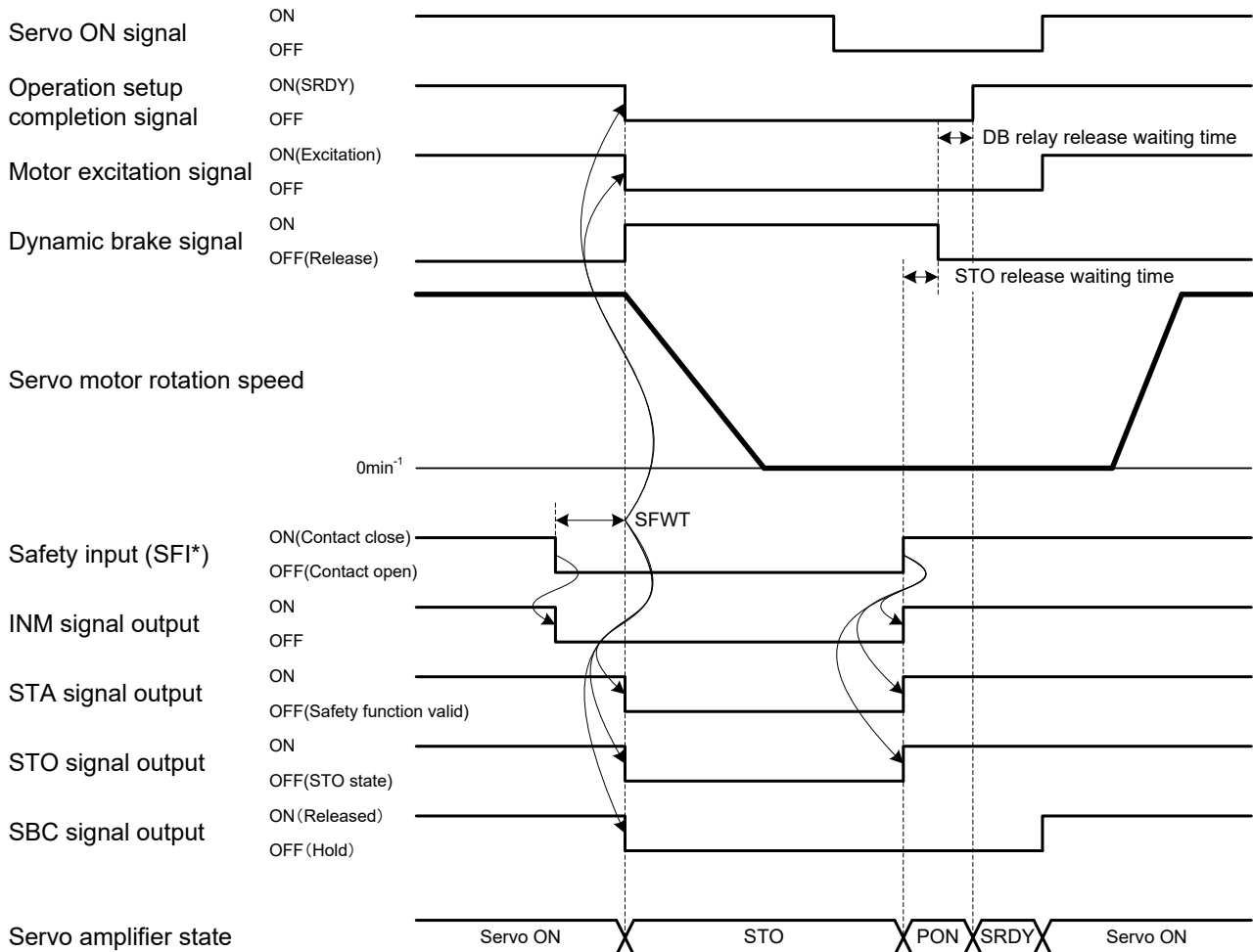


- ✓ STO function shall be performed with the condition of servo OFF and servo motor stop.
- ✓ STO function is able to perform through the terminal of SFIA or SFIB. For the use, set "01: STO function" to "Safety input A function selection (SFIAFUNC)" or "Safety input B function selection (SFIBFUNC)".
- ✓ For a detail of each parameters, refer the section "5.1.2 Parameter detail".
- ✓ BOFFDLY is GroupB ID04 "Delay Time of Releasing Holding Brake", in servo amplifier. For a detail, refer the instruction manual of each servo amplifiers. For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".

4.4 Safety function (Each functions, priority of simultaneous performing etc)

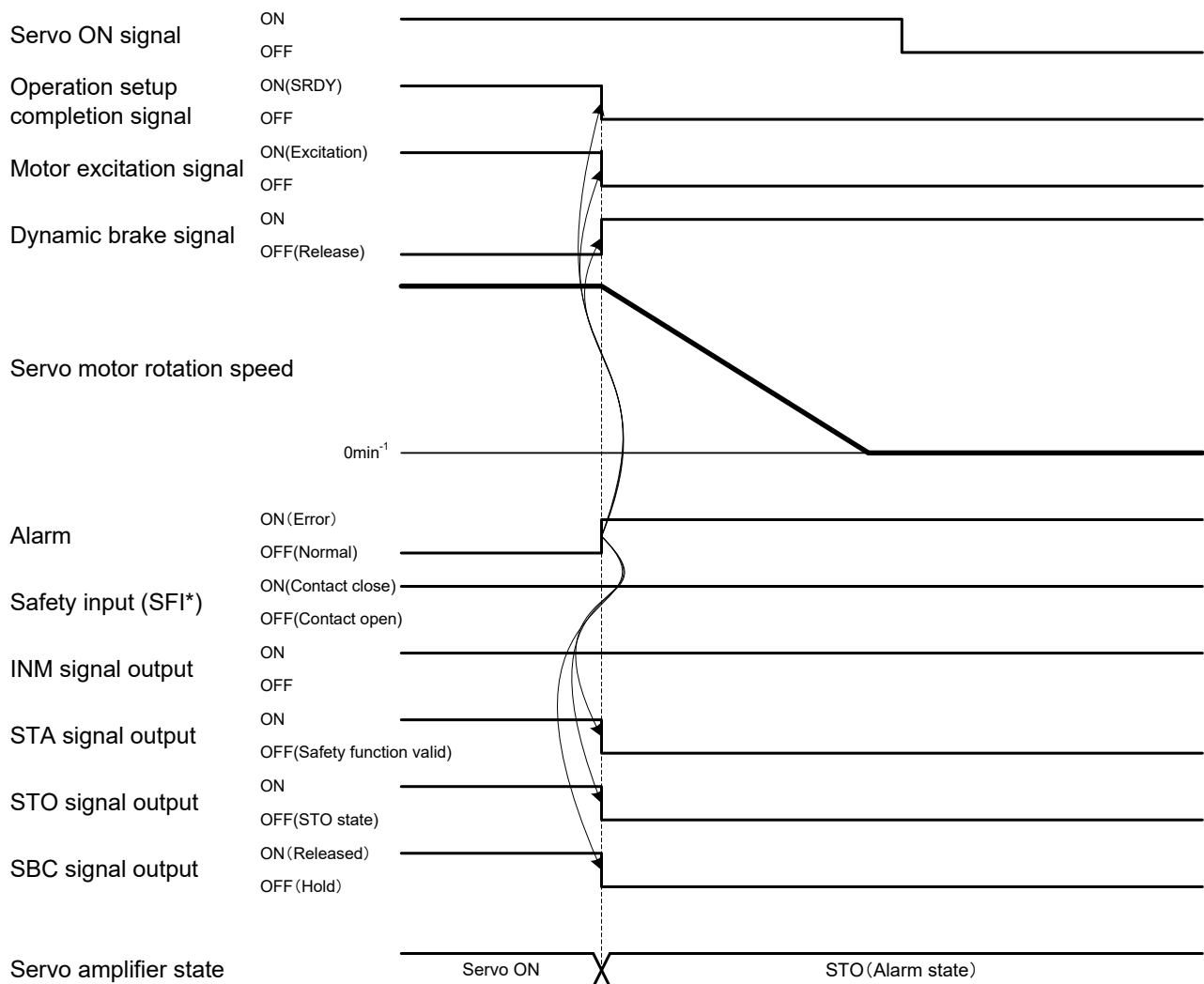
- b) In case that STO function is performed during motor rotation

When STO function is performed during motor rotation, transits to STO state after passing "Safety function starting wait time (SFWT)" and stops servo motor by dynamic brake. To return from STO state and start again motor operation, change safety input to ON (contact close), and then change servo ON input to ON after turn OFF once.



4. Safety function

- c) In case that error is detected
STO function works also if functional safety module detects error by self diagnosis function.



- ✓ For a detail of alarms, refer the chapter "7. Troubleshooting".

a) Status output

Safety input	Status	INM		STA		STO	
		ON	OFF	ON	OFF	ON	OFF
ON	Normal state	✓		✓		✓	
	Alarm state	✓		✓			✓
OFF	Safe state (STO)		✓		✓		✓
	Alarm state		✓	✓			✓

- ✓ In to alarm state, STO function works.

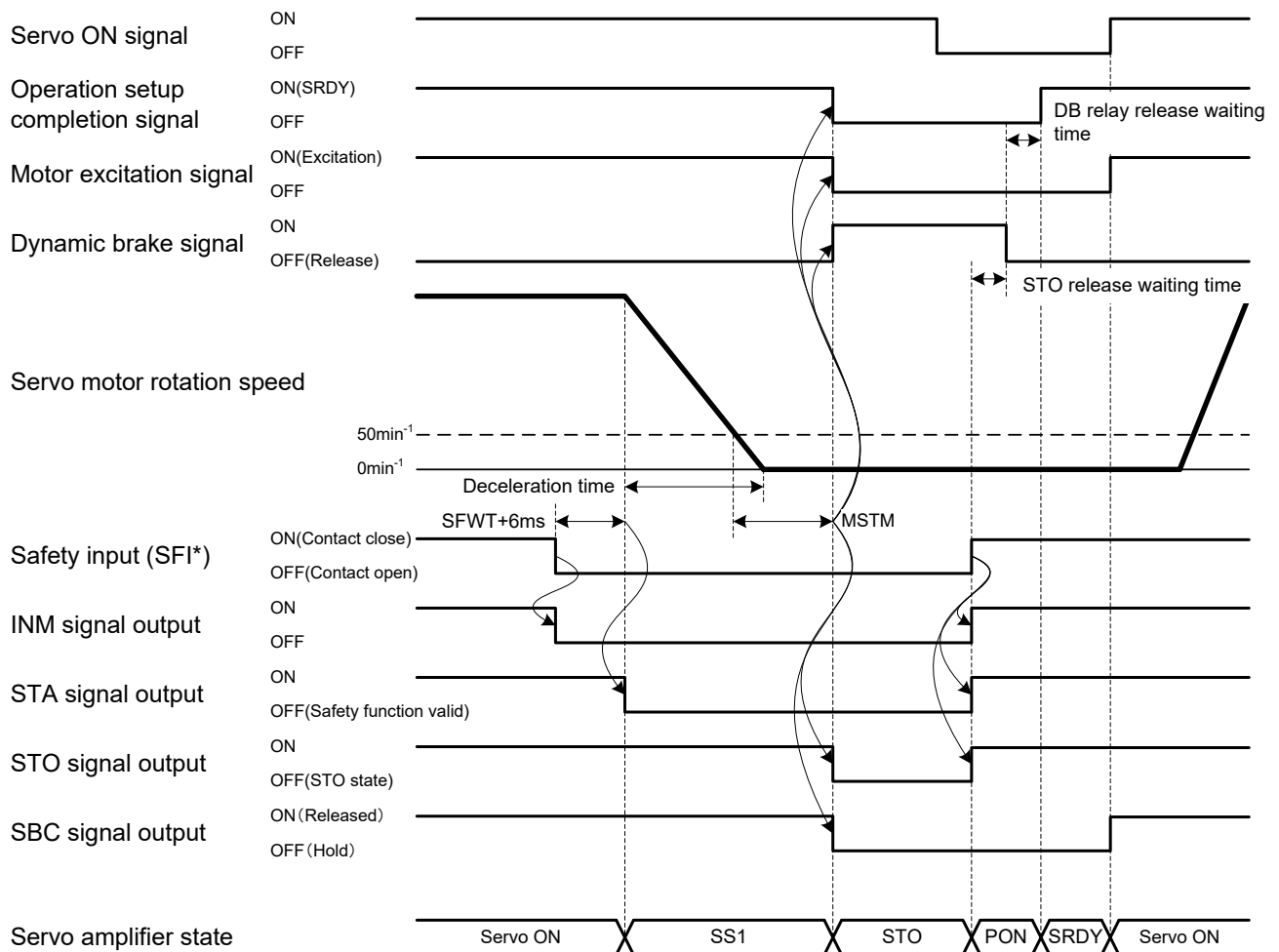
4.4 Safety function (Each functions, priority of simultaneous performing etc)

4.4.2 SS1 (Safe Stop 1)

a) Operation sequence

When safety input is changed to OFF (contact open), starts the deceleration according to the rate calculated with specified "Deceleration time constant (TVCDEC)" after passing "Safety function starting wait time (SFWT) + 6ms". After deceleration completion, transits to STO state after passing "Motor stop detection wait time (MSTM)".

To return from STO state and start again motor operation, change safety input to ON (contact close), and then change servo ON input to ON after turn OFF once.

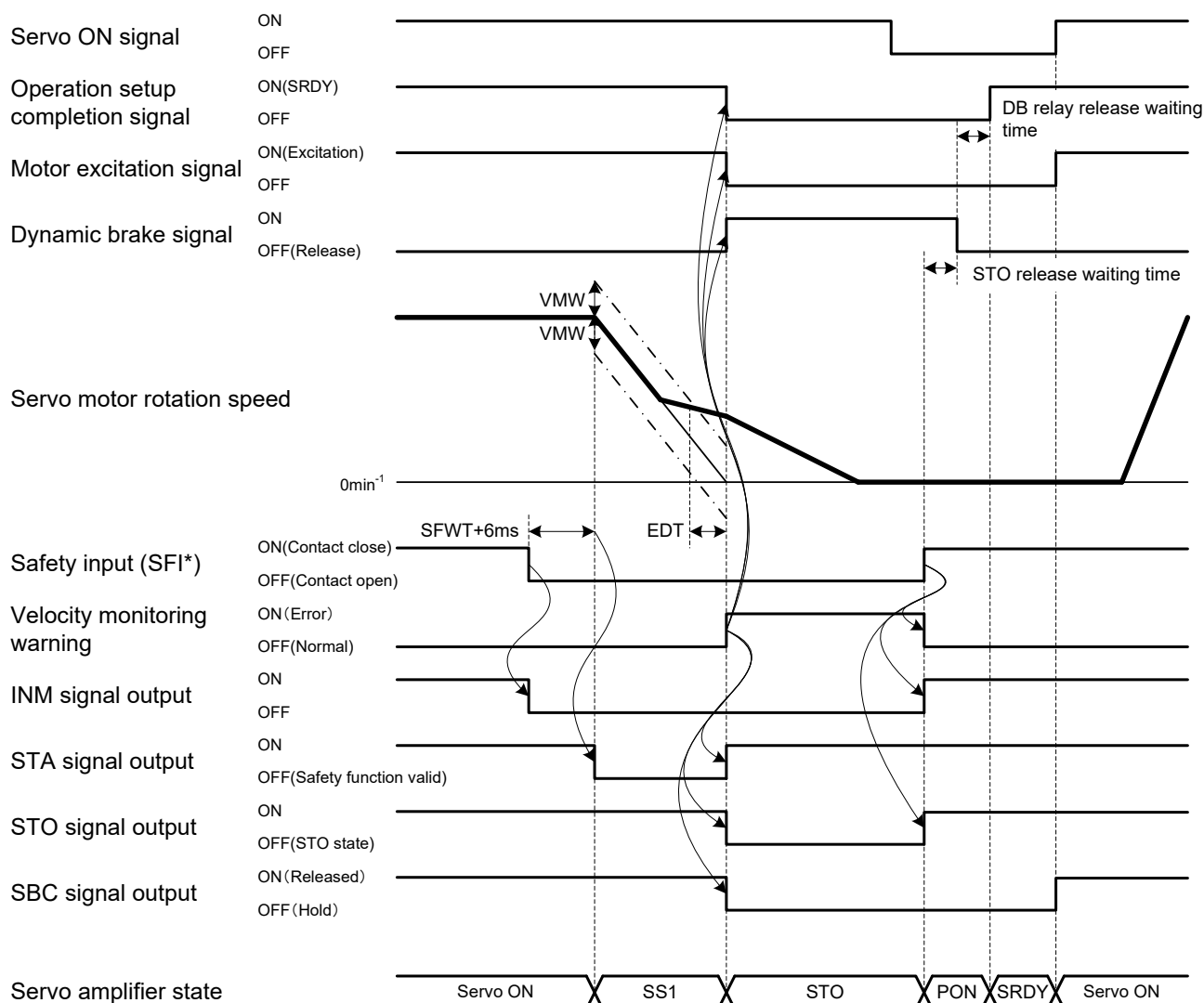


- ✓ SS1 function is able to perform through the terminal of SFIA or SFIB. For the use, set "02: SS1 function" to "Safety input A function selection (SFIAFUNC)" or "Safety input B function selection (SFIBFUNC)".
- ✓ For a detail of each parameters, refer the section "5.1.2 Parameter detail".
- ✓ Deceleration time is able to calculate by following formula.

$$\text{Deceleration time} = \text{Velocity at deceleration start} \times (\text{TVCDEC}^* / 1000\text{min}^{-1})$$

4. Safety function

- b) In case that velocity monitoring warning is detected
During deceleration stop, monitors velocity with specified "Velocity monitoring width (VMW)". When velocity deviation continues exceeding "Velocity monitoring width" during "Error detection time (EDT)", it transits to STO state and outputs a velocity monitoring warning.



- ✓ Velocity monitoring warning is kept while safety input OFF or servo ON input ON, after detection. To clear the warning, change safety input ON and change servo ON input OFF.
- ✓ It is the same when safety input is changed to ON while decelerating.
- ✓ For a detail of alarms/warnings, refer the chapter "7. Troubleshooting".

c) Status output

Safety input	Status	INM		STA		STO	
		ON	OFF	ON	OFF	ON	OFF
ON	Normal state	✓		✓		✓	
	Alarm/warning state	✓		✓			✓
OFF	While decelerating		✓		✓	✓	
	Safe state (STO)		✓		✓		✓
	Alarm/warning state		✓	✓			✓

- ✓ In to alarm/warning state, STO function works.
- ✓ "Warning" means "velocity monitoring warning" or "safety function warning".

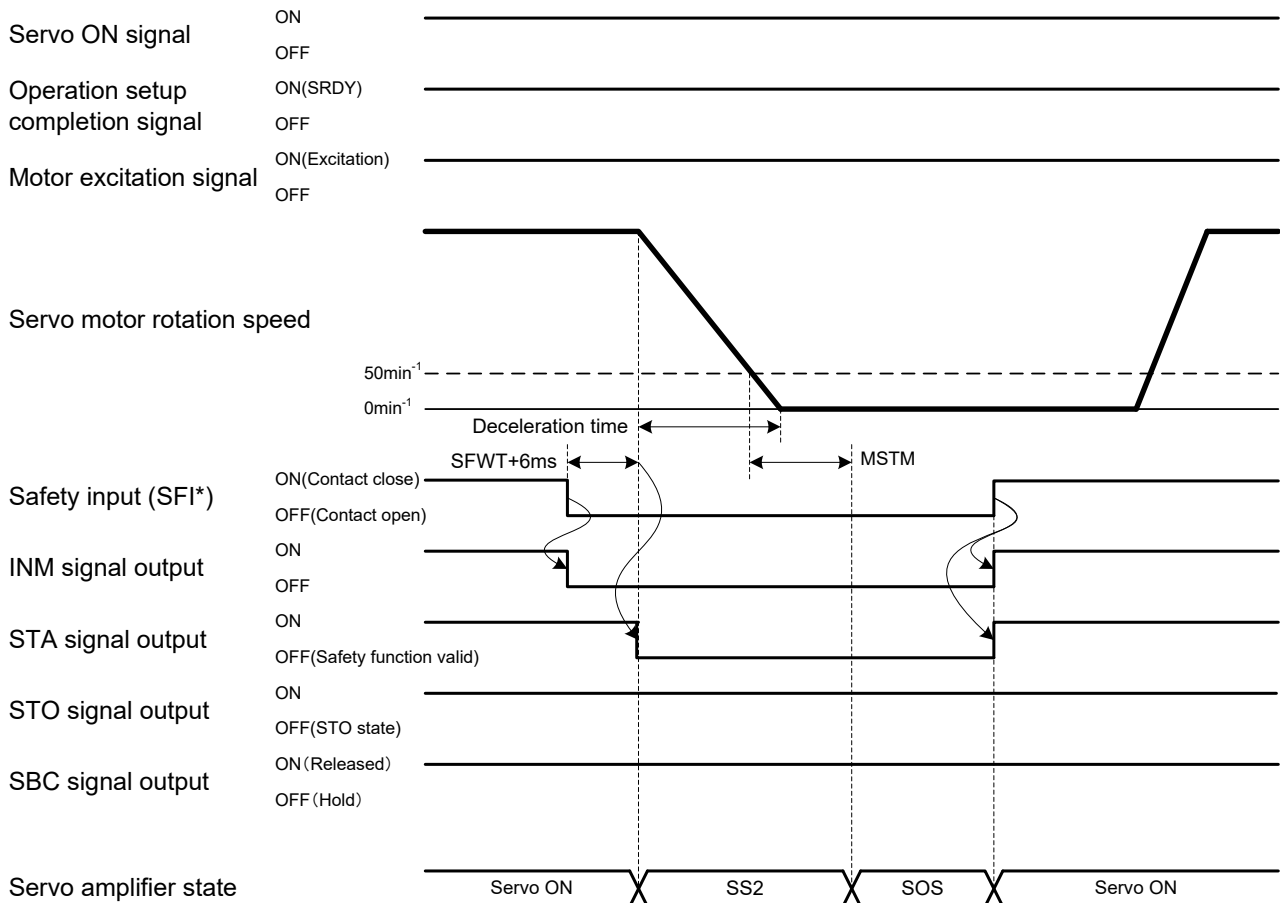
4.4 Safety function (Each functions, priority of simultaneous performing etc)

4.4.3 SS2 (Safe Stop 2)

a) Operation sequence

When safety input is changed to OFF (contact open), starts the deceleration according to the rate calculated with specified "Deceleration time constant (TVCDEC)" after passing "Safety function starting wait time (SFWT) + 6ms". After deceleration completion, performs SOS function (Safe Operating Stop) after passing "Motor stop detection wait time (MSTM)".

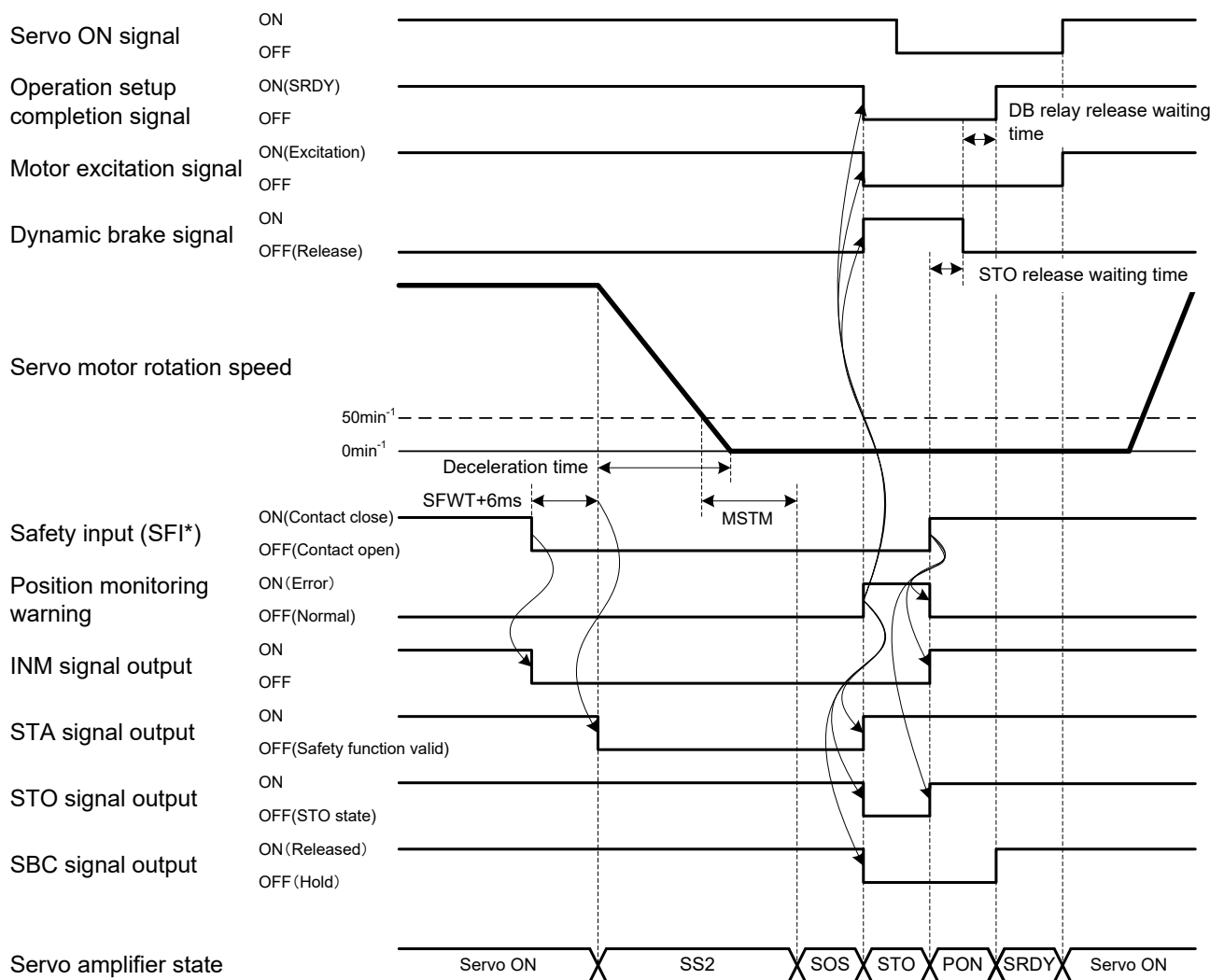
To return from SOS state and start again motor operation, change safety input to ON (contact close).



- ✓ SS2 function is able to perform through the terminal of SFIA or SFIB. For the use, set "03: SS2 function" to "Safety input A function selection (SFIAFUNC)" or "Safety input B function selection (SFIBFUNC)".
- ✓ For a safety, external command is not acceptable while SS2 function performing and till SS2 function is canceled by turning ON safety input.
- ✓ For a detail of each parameters, refer the section "5.1.2 Parameter detail".

4. Safety function

- b) In case that velocity monitoring warning is detected
During deceleration stop, monitors velocity with specified "Velocity monitoring width (VMW)". When velocity deviation continues exceeding "Velocity monitoring width" during "Error detection time (EDT)", it transits to STO state and outputs a velocity monitoring warning.
- ✓ For timing chart, refer the section "4.4.2 SS1 function".
- c) In case that position monitoring warning is detected
During SOS state, monitors position with specified "Position monitoring width (SOSMV)". When velocity deviation continues exceeding "Position monitoring width" during "Error detection time (EDT)", it transits to STO state and outputs a position monitoring warning.



- ✓ For a detail of position monitoring warning detection, refer the section "4.4.4 SOS function".
- ✓ Position monitoring warning is kept while safety input OFF or servo ON input ON, after detection. To clear the warning, change safety input ON and change servo ON input OFF.
- ✓ For a detail of alarms/warnings, refer the chapter "7. Troubleshooting".

4.4 Safety function (Each functions, priority of simultaneous performing etc)

d) Status output

Safety input	Status	INM		STA		STO	
		ON	OFF	ON	OFF	ON	OFF
ON	Normal state	✓		✓		✓	
	Alarm/warning state	✓		✓			✓
OFF	While decelerating		✓		✓	✓	
	Safe state (SOS)		✓		✓	✓	
	Alarm/warning state		✓	✓			✓

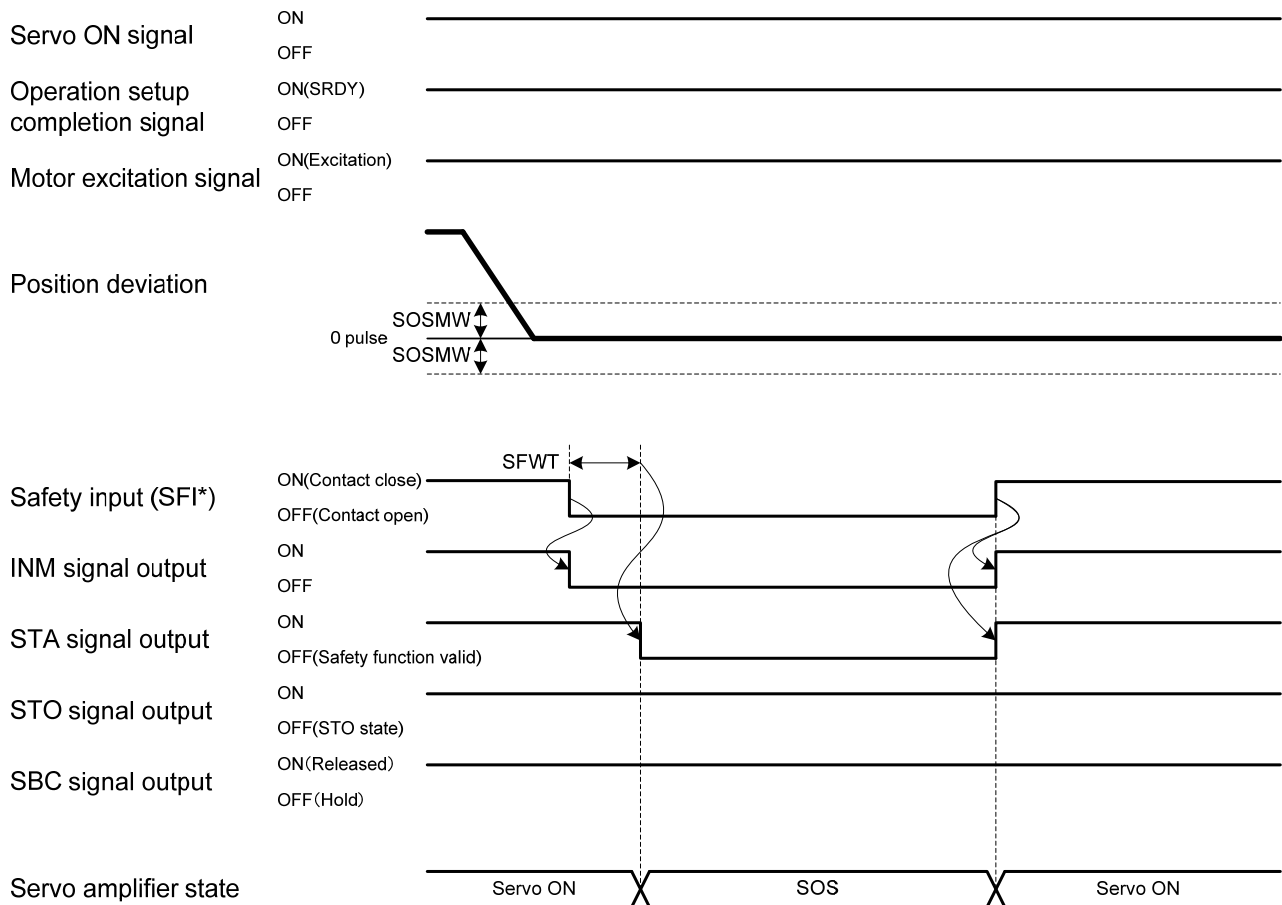
- ✓ In to alarm/warning state, STO function works.
- ✓ "Warning" means "velocity monitoring warning", "position monitoring warning" or "safety function warning".

4. Safety function

4.4.4 SOS (Safe Operating Stop)

a) Operation sequence

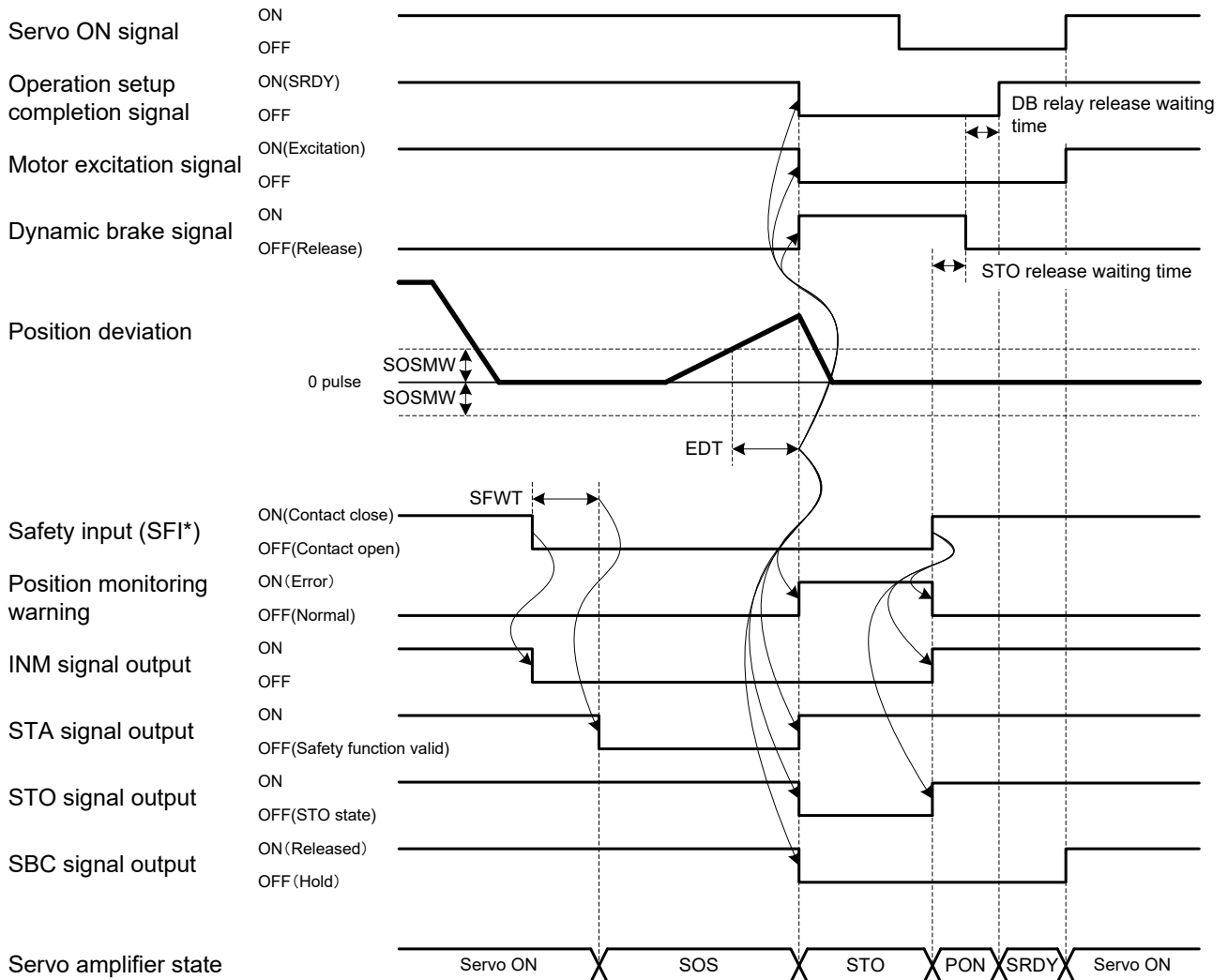
When safety input is changed to OFF (contact open), starts "safety position monitoring" after passing "Safety function starting wait time (SFWT)". To return from SOS state and start again motor operation, change safety input to ON (contact close).



- ✓ SOS function is able to perform through the terminal of SFIA or SFIB. For the use, set "04: SOS function" to "Safety input A function selection (SFIAFUNC)" or "Safety input B function selection (SFIBFUNC)".
- ✓ For a detail of each parameters, refer the section "5.1.2 Parameter detail".

4.4 Safety function (Each functions, priority of simultaneous performing etc)

- b) In case that error is detected
During SOS state, monitors position deviation with specified "Position monitoring width". When position deviation continues exceeding "Position monitoring width (SOSMW)" during "Error detection time (EDT)", it transits to STO state and outputs a position monitoring warning.



- ✓ For a detail of each parameters, refer the section "5.1.2 Parameter detail".
- ✓ Position monitoring warning is kept while safety input OFF or servo ON input ON, after detection. To clear the warning, change safety input ON and change servo ON input OFF.
- ✓ For a detail of alarms/warnings, refer the chapter "7. Troubleshooting".

c) Status output

Safety input	Status	INM		STA		STO	
		ON	OFF	ON	OFF	ON	OFF
ON	Normal state	✓		✓		✓	
	Alarm/warning state	✓		✓			✓
OFF	Safe state (SOS)		✓		✓	✓	
	Alarm/warning state		✓	✓			✓

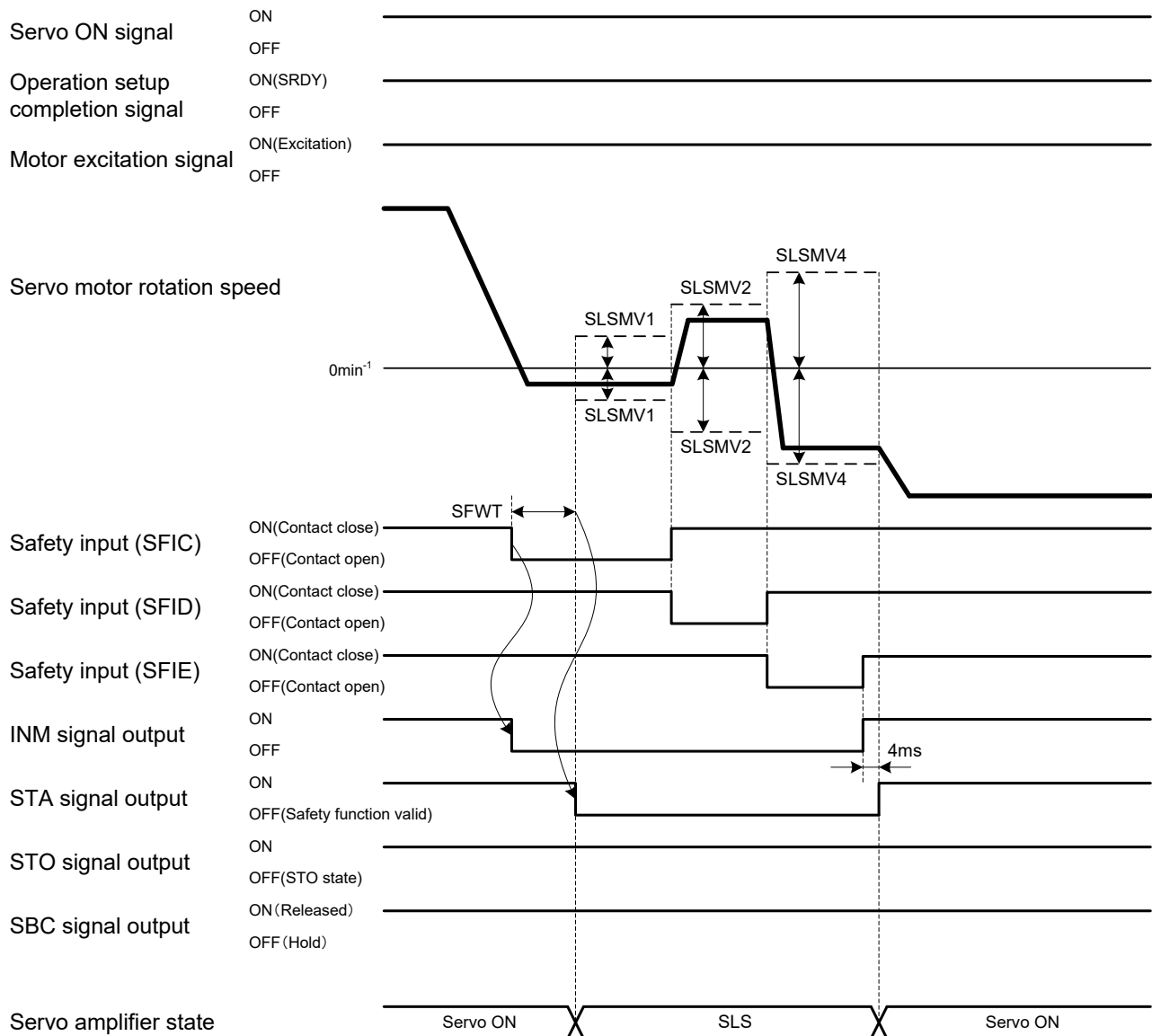
- ✓ In to alarm/warning state, STO function works.
- ✓ "Warning" means "position monitoring warning" or "safety function warning".

4. Safety function

4.4.5 SLS (Safely-Limited Speed)

a) Operation sequence

When safety input is changed to OFF (contact open), starts "safety velocity monitoring" after passing "Safety function starting wait time (SFWT)". When safety input is changed to ON (contact close), stops "SLS function (Safely-Limited Speed)" and it is able to start normal operation again.



- ✓ SLS function is able to perform through the terminals from SFIC to SFIE. For the use, set "10: SLS function" to "Safety input C function selection (SFICFUNC)". Moreover, to extend a selection range of safe velocity monitoring width through the terminal of SFIA or SFIB, set "05: SLS/SSM function" to "Safety input A function selection (SFIAFUNC)" or "Safety input B function selection SFIBFUNC)".
- ✓ For a detail of each parameters, refer the section "5.1.2 Parameter detail".

4.4 Safety function (Each functions, priority of simultaneous performing etc)

b) Safe velocity monitoring width selection

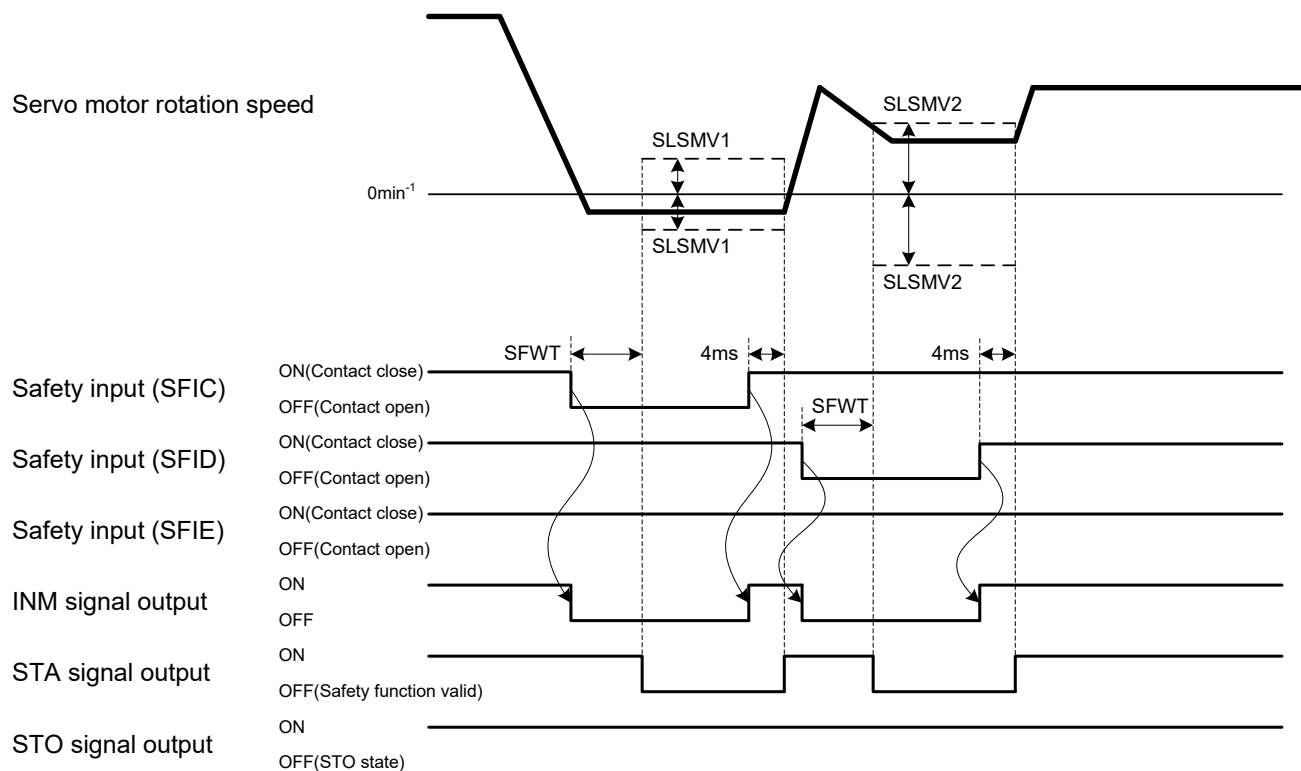
Normally, level of "Safe velocity monitoring (SLSMV)" is able to select up to 7 stages, with 3-input combination of SFIC to SFIE. It is able to extend up to 31 stages by setting "05: SLS/SSM function" to the "Safety input function selection" of SFIA and SFIB.

Below shows the combinations of an input state, and a safe velocity monitoring width setting parameter to be selected.

SFIC	SFID	SFIE	SFIA	SFIB	Safe velocity monitoring width (SLSMV)
ON	ON	ON	ON / Function invalid	ON / Function invalid	Safe velocity monitoring function invalid
OFF	ON	ON	ON / Function invalid	ON / Function invalid	SLSMV1
ON	OFF	ON	ON / Function invalid	ON / Function invalid	SLSMV2
OFF	OFF	ON	ON / Function invalid	ON / Function invalid	SLSMV3
ON	ON	OFF	ON / Function invalid	ON / Function invalid	SLSMV4
OFF	ON	OFF	ON / Function invalid	ON / Function invalid	SLSMV5
ON	OFF	OFF	ON / Function invalid	ON / Function invalid	SLSMV6
OFF	OFF	OFF	ON / Function invalid	ON / Function invalid	SLSMV7
ON	ON	ON	OFF (Function valid)	ON / Function invalid	SLSMV8
OFF	ON	ON	OFF (Function valid)	ON / Function invalid	SLSMV9
ON	OFF	ON	OFF (Function valid)	ON / Function invalid	SLSMV10
OFF	OFF	ON	OFF (Function valid)	ON / Function invalid	SLSMV11
ON	ON	OFF	OFF (Function valid)	ON / Function invalid	SLSMV12
OFF	ON	OFF	OFF (Function valid)	ON / Function invalid	SLSMV13
ON	OFF	OFF	OFF (Function valid)	ON / Function invalid	SLSMV14
OFF	OFF	OFF	OFF (Function valid)	ON / Function invalid	SLSMV15
ON	ON	ON	ON / Function invalid	OFF (Function valid)	SLSMV16
OFF	ON	ON	ON / Function invalid	OFF (Function valid)	SLSMV17
ON	OFF	ON	ON / Function invalid	OFF (Function valid)	SLSMV18
OFF	OFF	ON	ON / Function invalid	OFF (Function valid)	SLSMV19
ON	ON	OFF	ON / Function invalid	OFF (Function valid)	SLSMV20
OFF	ON	OFF	ON / Function invalid	OFF (Function valid)	SLSMV21
ON	OFF	OFF	ON / Function invalid	OFF (Function valid)	SLSMV22
OFF	OFF	OFF	ON / Function invalid	OFF (Function valid)	SLSMV23
ON	ON	ON	OFF (Function valid)	OFF (Function valid)	SLSMV24
OFF	ON	ON	OFF (Function valid)	OFF (Function valid)	SLSMV25
ON	OFF	ON	OFF (Function valid)	OFF (Function valid)	SLSMV26
OFF	OFF	ON	OFF (Function valid)	OFF (Function valid)	SLSMV27
ON	ON	OFF	OFF (Function valid)	OFF (Function valid)	SLSMV28
OFF	ON	OFF	OFF (Function valid)	OFF (Function valid)	SLSMV29
ON	OFF	OFF	OFF (Function valid)	OFF (Function valid)	SLSMV30
OFF	OFF	OFF	OFF (Function valid)	OFF (Function valid)	SLSMV31

4. Safety function

- ✓ To switch multiple safety inputs, they shall be changed at once.
Quits "SLS function (Safely-Limited Speed)" once if all inputs are detected ON 4ms or longer during switching.
After that, "safe velocity monitoring" will start again after passing "Safety function starting wait time (SFWT)" if any input OFF is detected.



4.4 Safety function (Each functions, priority of simultaneous performing etc)

c) In case that error is detected

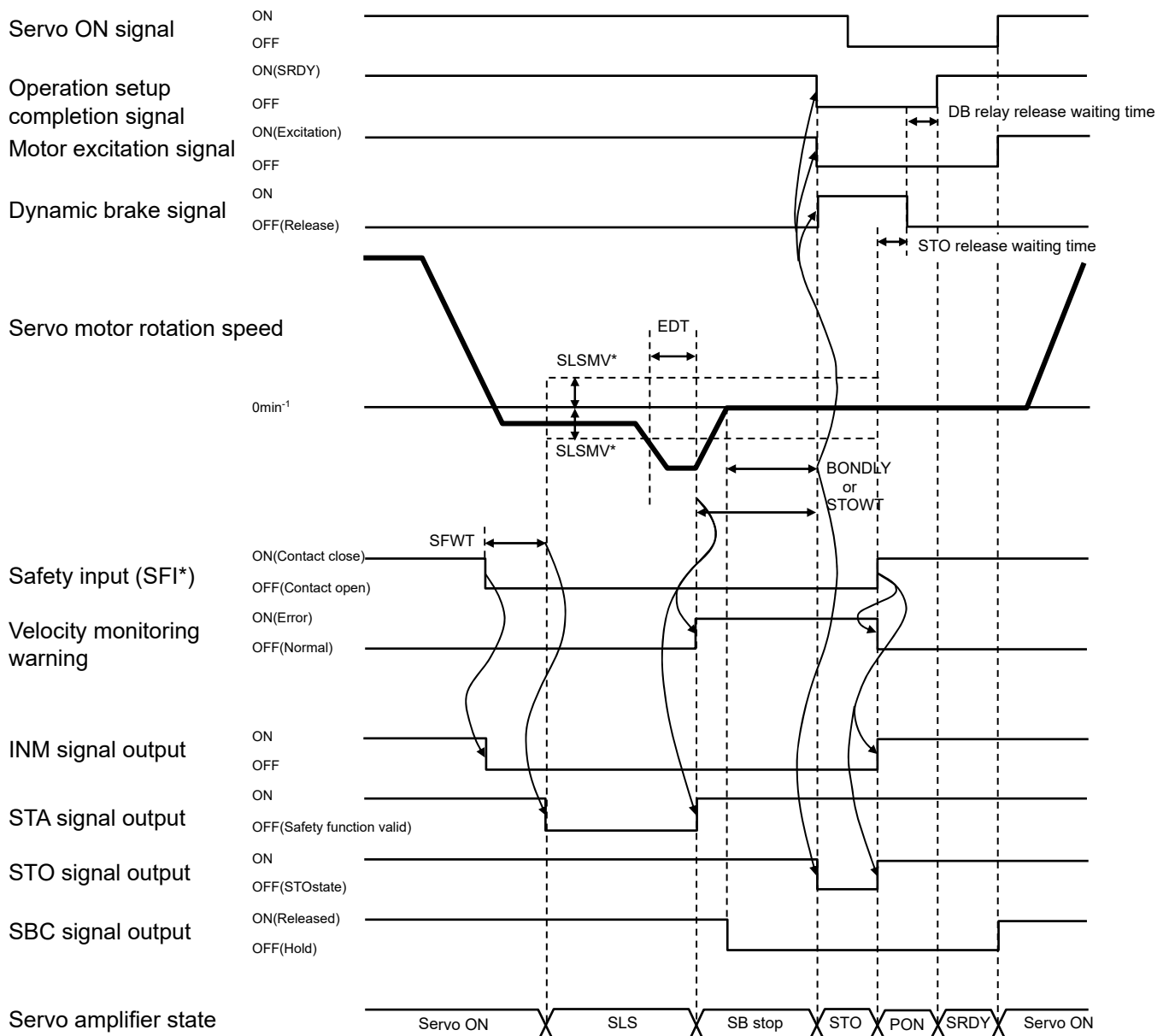
If safe velocity monitoring error is detected, servo motor stops with the operation selected at "Forced stop operation selection at error detection (SLSSTOP)".

1) Servo brake stop

It stops servo motor with servo brake operation when servo motor rotation speed exceeds "Safe velocity monitoring width (SLSMV)".

✓ Below cases are applied.

- "00: ACTEMR" is selected at Group3 ID05 in a functional safety module, and "00: SERVO-BRAKE" is selected at GroupB ID02 in a servo amplifier.
- "01: SB" is selected at Group3 ID05 in a functional safety module.



- ✓ Velocity monitoring warning is detected after exceeding "Safe velocity monitoring width (SLSMV)" and passing "Error detection time (EDT)".

4. Safety function

- ✓ The time switching to STO state from velocity monitoring warning detection depends on shorter time of either "Time till servo brake stop + BONDLY" or "STO delay time at error detection (STOWT)".
- ✓ BONDLY is GroupB ID03 "Delay Time of Engaging Holding Brake", in servo amplifier. For a detail, refer the instruction manual of each servo amplifiers. For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".
- ✓ Velocity monitoring warning is kept while safety input OFF or servo ON input ON, after detection. To clear the warning, change safety input ON and change servo ON input OFF.
- ✓ For a detail of alarms/warnings, refer the chapter "7. Troubleshooting".

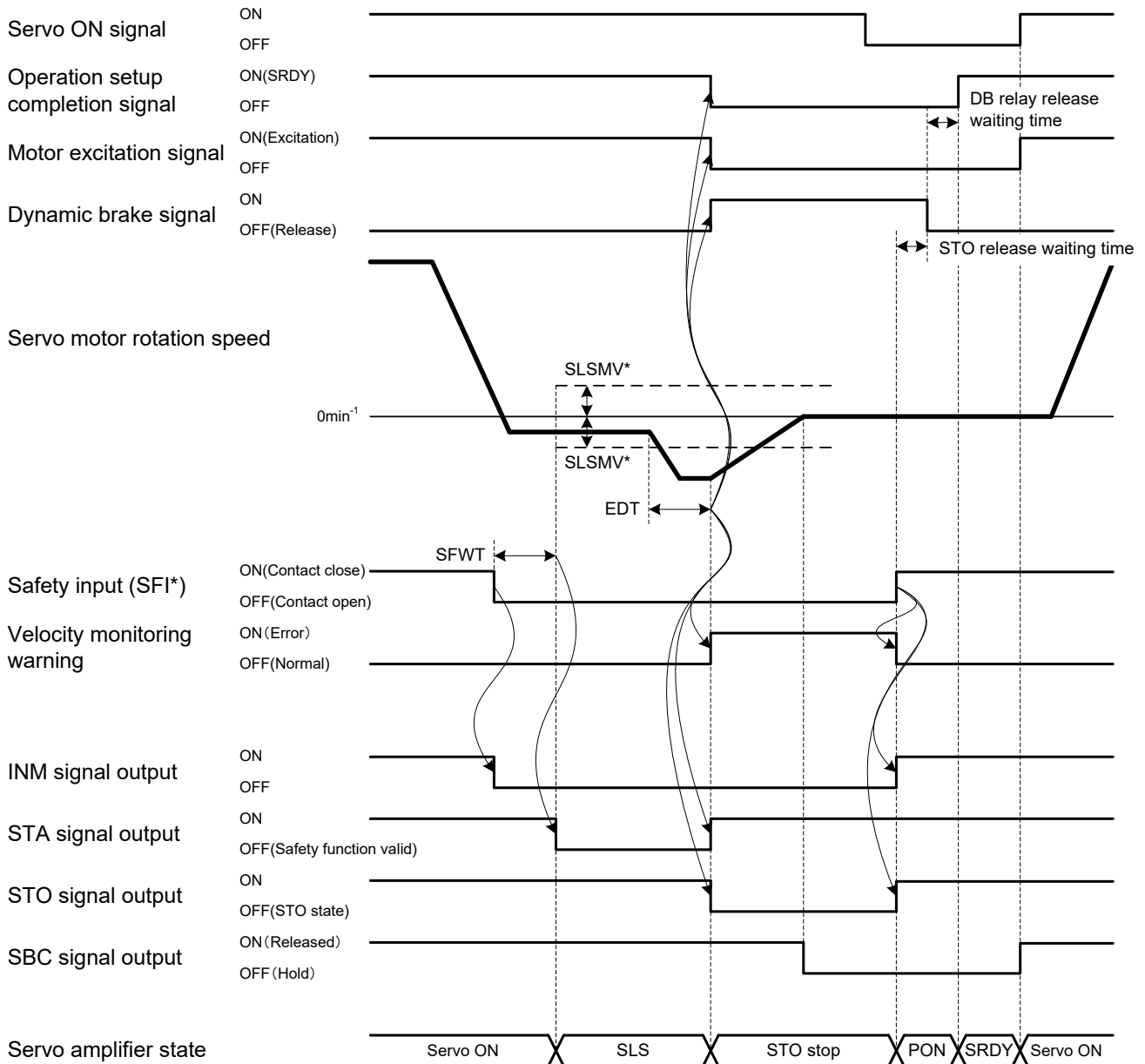
4.4 Safety function (Each functions, priority of simultaneous performing etc)

2) Dynamic brake stop

It stops servo motor with dynamic brake operation when servo motor rotation speed exceeds "Safe velocity monitoring width (SLSMV)".

✓ Below cases are applied.

- "00: ACTEMR" is selected at Group3 ID05 in a functional safety module, and "01: DYNAMIC-BRAKE" is selected at GroupB ID02 ACTEMR in a servo amplifier.
- "02: DYNAMIC-BRAKE" is selected at Group3 ID05 in a functional safety module.



- ✓ Velocity monitoring warning is detected after exceeding "Safe velocity monitoring width (SLSMV)" and passing "Error detection time (EDT)".
- ✓ Velocity monitoring warning is kept while safety input OFF or servo ON input ON, after detection. To clear the warning, change safety input ON and change servo ON input OFF.
- ✓ For a detail of alarms/warnings, refer the chapter "7. Troubleshooting".

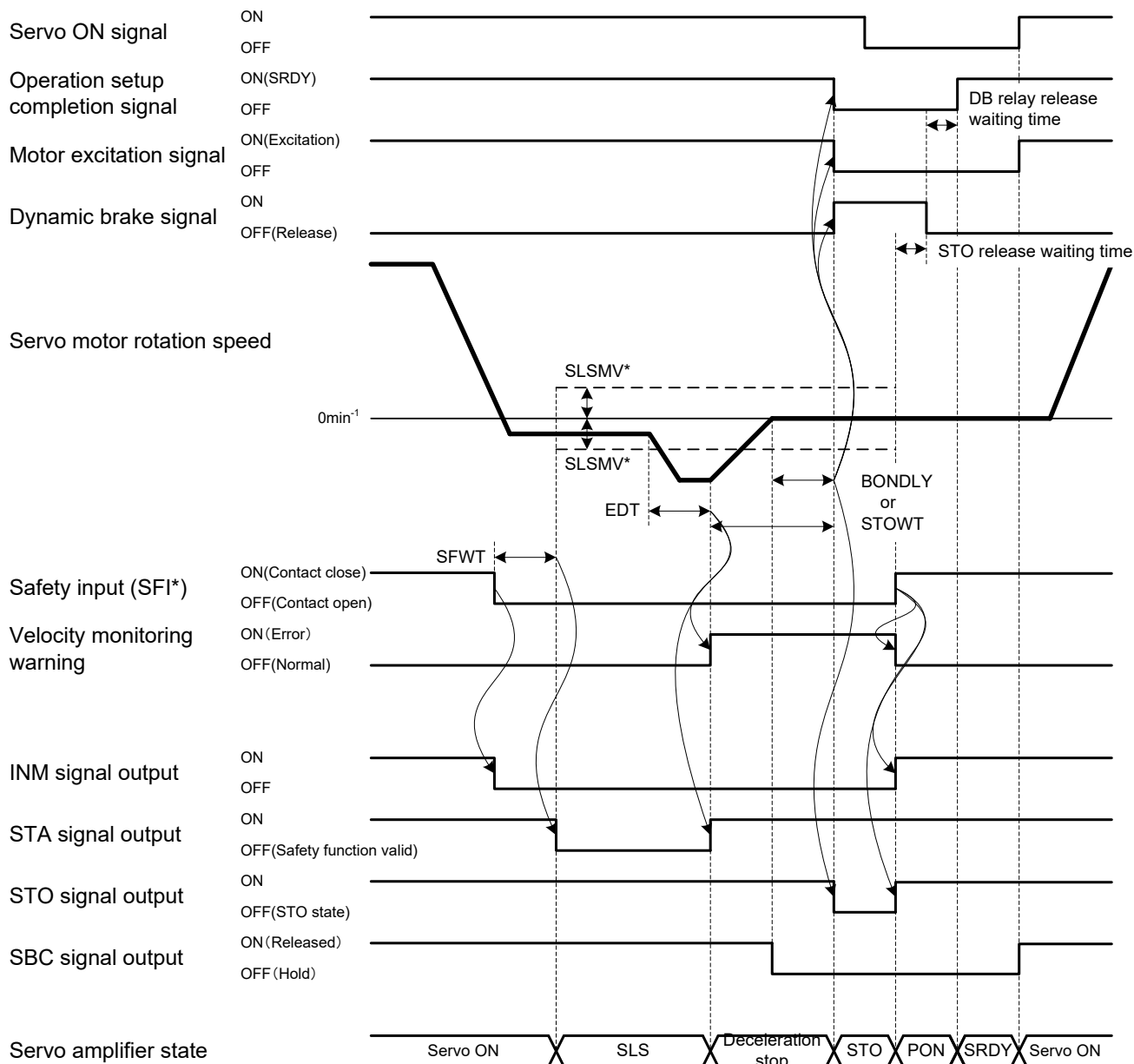
4. Safety function

3) Deceleration stop

It stops servo motor with deceleration stop operation when servo motor rotation speed exceeds "Safe velocity monitoring width (SLSMV)".

✓ Below cases are applied.

- "00: ACTEMR" is selected at Group3ID05 in a functional safety module, and "03: DEC-STOP" is selected at GroupB ID02 ACTEMR in a servo amplifier.
- "03: DEC-STOP" is selected at Group3 ID05 in a functional safety module.



- ✓ Velocity monitoring warning is detected after exceeding "Safe velocity monitoring width (SLSMV)" and passing "Error detection time (EDT)".
- ✓ The time switching to STO state from velocity monitoring warning detection depends on shorter time of either "Time till deceleration stop + BONDLY" or "STO delay time at error detection (STOWT)".
- ✓ BONDLY is GroupB ID03 "Delay Time of Engaging Holding Brake", in servo amplifier. For a detail, refer the instruction manual of each servo amplifiers.

4.4 Safety function (Each functions, priority of simultaneous performing etc)

- ✓ Deceleration time at deceleration stop depends on GroupB ID16 "Deceleration Time Constant at Emergency Stopping (EMRDEC)", in servo amplifier. For a detail, refer the instruction manual of each servo amplifiers.
- ✓ For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".
- ✓ Velocity monitoring warning is kept while safety input OFF or servo ON input ON, after detection. To clear the warning, change safety input ON and change servo ON input OFF.
- ✓ For a detail of alarms/warnings, refer the chapter "7. Troubleshooting".

d) Status output

Safety input	Status	INM		STA		STO	
		ON	OFF	ON	OFF	ON	OFF
ON	Normal state	✓		✓		✓	
	Alarm/warning state	✓		✓			✓
OFF	Safe state (SLS)		✓		✓	✓	
	While stopping at warning detection (Servo brake stop or deceleration stop)		✓	✓		✓	
	Alarm/warning state		✓	✓			✓

- ✓ In to alarm/warning state, STO function works.
- ✓ "Warning" means "velocity monitoring warning", "position monitoring warning" or "safety function warning".

4. Safety function

4.4.6 Priority of safety function

This functional safety module is able to startup safety functions triple at once, so each safety functions are given priorities. Priority of each safety functions are as follows: (High) STO > SS1 > SS2 > SOS > SLS (Low). Below shows behavior with set of multiple safety functions.

- a) Perform the other safety function while STO works

Condition	Behavior
Perform the other safety function	Keeps STO state, and the other safety functions don't work.

- ✓ To release a safety state, change all safety inputs ON and change servo ON input OFF, once.

- b) Perform the other safety function while SS1 works

2nd condition	Behavior
Perform STO function	STO takes priority, and switch to STO state even if while decelerating.
Perform SS1 via another input	Continues SS1 function operation in use.
Perform SS2 via another input	Continues SS1 function operation in use.
Perform SOS via another input	Continues SS1 function operation in use.
Perform SLS via another input	Continues SS1 function operation in use. However, if motor rotation speed during SLS function exceeded "Safe velocity monitoring width (SLSMV)", velocity monitoring warning is detected.

- ✓ To release a safety state, change all safety inputs ON and change servo ON input OFF, once.

- c) Perform the other safety function while SS2 works

2nd condition	Behavior
Perform STO function	STO takes priority, and switch to STO state even if while decelerating or SOS.
Perform SS1 via another input	Continues SS2 function operation in use. However, switches to STO state after motor stop.
Perform SS2 via another input	Continues SS2 function operation in use.
Perform SOS via another input	Continues SS2 function operation in use. Position monitoring warning after motor stop is detected by SOSMVA. (SFIA has priority.)
Perform SLS via another input	Continues SS2 function operation in use. However, if motor rotation speed during SLS function exceeded "Safe velocity monitoring width (SLSMV)", velocity monitoring warning is detected.

- ✓ Even if the safety input in first turned OFF change to ON, safety state (STO, SOS or SLS) for that input is continued during the other safety input turned OFF later is OFF.

4.4 Safety function (Each functions, priority of simultaneous performing etc)

- d) Perform the other safety function while SOS works

2nd condition	Behavior
Perform STO function	STO takes priority, and switch to STO state.
Perform SS1 via another input	SS1 takes priority, and switch to STO state.
Perform SS2 via another input	Keeps SOS state.
Perform SOS via another input	Continues SOS function operation in use. However, position monitoring warning is detected by SOSMVA. (SFIA has priority.)
Perform SLS via another input	Continues SOS state but velocity monitoring warning by SLS function also starts simultaneously.

- ✓ Even if the safety input in first turned OFF change to ON, safety state (STO, SOS or SLS) for that input is continued during the other safety input turned OFF later is OFF.

- e) Perform the other safety function while SLS works

2nd condition	Behavior
Perform STO function	STO takes priority, and switch to STO state.
Perform SS1 via another input	SS1 takes priority, and switch to STO state after deceleration stop.
Perform SS2 via another input	SS1 takes priority, and switch to SOS state after deceleration stop.
Perform SOS via another input	Continues SLS state but SOS function also started simultaneously. If position deviation during SOS function exceeded "Position monitoring width (SOSMV)", position monitoring warning is detected.

- ✓ Even if the safety input in first turned OFF change to ON, safety state (STO or SOS) for that input is continued during the other safety input turned OFF later is OFF.

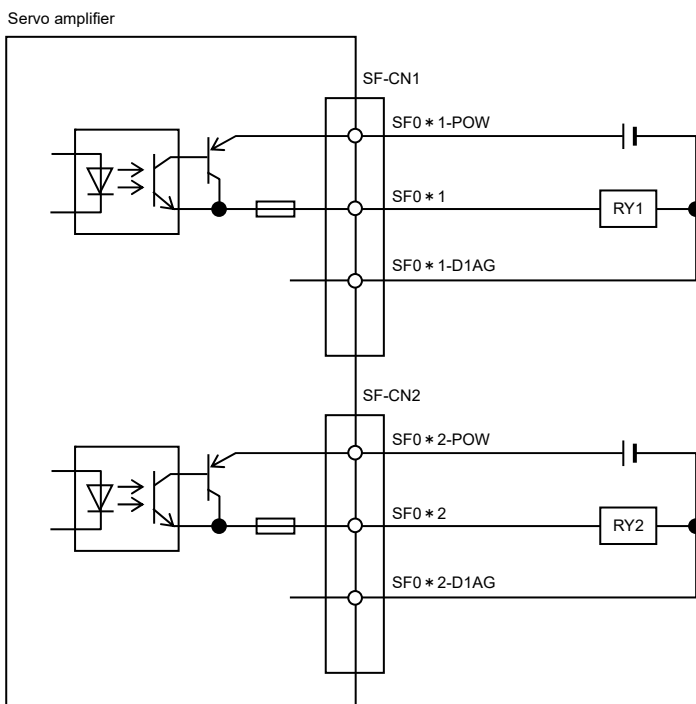
4. Safety function

4.5 Safety output

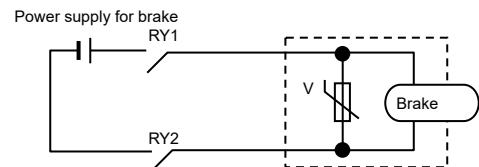
4.5.1 SBC (Safe Brake Control)

Outputs a holding brake control signal at "while servo OFF", "while transit to servo ON state from servo OFF" or "while transit to servo OFF state from servo ON state".

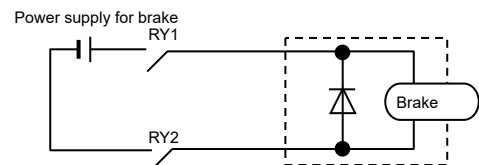
- ✓ SBC signal is able to output through terminal of SFOA, SFOB or SFOC. For the use, set "04: SBC function" to "Safety output A function selection (SFOAFUNC)", "Safety output B function selection (SFOBFUNC)" or "Safety output C function selection (SFOCFUNC)".
Do not select NONE (Function disabling) to the safety input function selection to be applied.
- ✓ For a detail of each parameters, refer the section "5.1.2 Parameter detail".
- ✓ For an output timing, refer the operation sequence for each functions.



◆ Circuit using varistor



◆ Circuit using diode

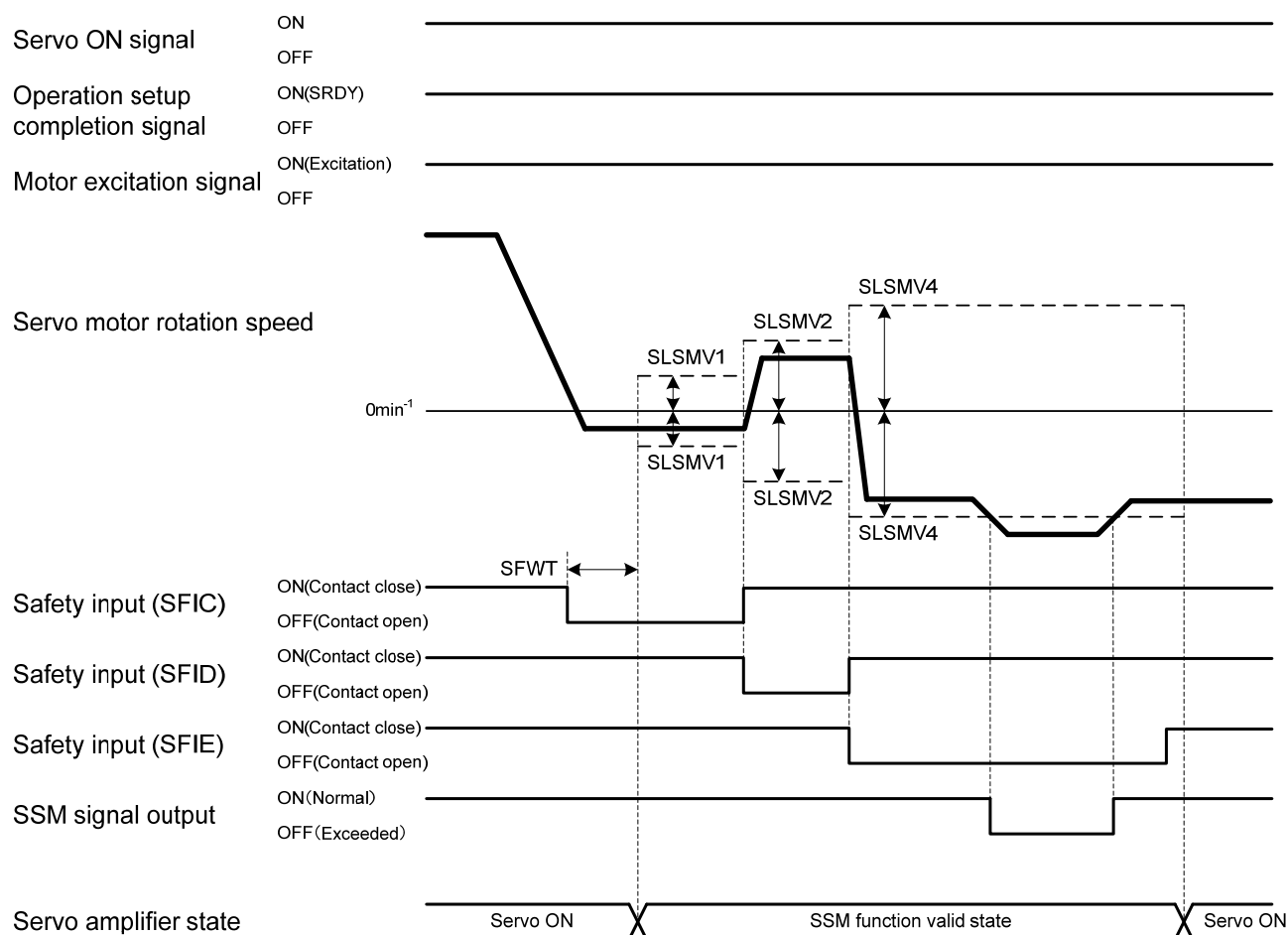


4.5 Safety output

4.5.2 SSM (Safe Speed Monitor)

a) Operation sequence

SSM signal is output when actual velocity is within the "Safe velocity monitoring level" selected by 3-input combination of SFIC to SFIE. It is able to extend up to 31 stages by setting "05: SLS/SSM function" to the "Safety input function selection" of SFIA and SFIB.



- ✓ SSM signal is able to output through SFOC terminal. For the use, set "11: SSM function" to "Safety input C function selection (SFICFUNC)". SLS function and SSM function are not able to use simultaneously. It cannot output through the terminals of SFOA or SFOB.
- ✓ "Safe velocity monitoring level (SLSMV)" is shared with SLS function.
- ✓ For a detail of each parameters, refer the section "5.1.2 Parameter detail".

4. Safety function

b) Status output

Safety input	Status	INM		STA		STO	
		ON	OFF	ON	OFF	ON	OFF
ON	Normal state	✓		✓		✓	
	Alarm/warning state	✓		✓			✓
OFF	Safe state (SLS)		✓		✓		✓
	While velocity exceeding		✓	✓		✓	
	Alarm/warning state		✓	✓			✓

- ✓ In to alarm/warning state, STO function works.

4.5.3 Safety output diagnosis

To use SBC output function and SSM function as safety output, self diagnosis of safety output signal is required. Below shows the way to be valid a self diagnosis function.

- Connect the terminal of safety output diagnosis to ground of power supply for safety output.
- Set "01: Enable" to "Safety output diagnosis function selection".
- ✓ If safety output diagnosis function change to valid without wiring from terminal of safety output diagnosis, alarm 97 will occur.
- ✓ Factory setting of "Safety output diagnosis function selection" is "00: Disable".
- ✓ For the use as a monitoring output, wiring from terminal of safety output diagnosis is not required.
- ✓ When the safety output diagnosis function is enabled, OFF pulse less than 1 [ms] is periodically output from the terminal of safety output. Please construct the system so that connected equipment is not affected by OFF pulse.

4.6 Monitor output

4.6.1 Safety input state monitor output (INM)

Outputs a status of applicable safety input.

- ✓ Safety input state output is able to output through the terminals of SFOA, SFOB or SFOC. For the use, set "01: INM output" to "Safety output A function selection (SFIAFUNC)", "Safety output B function selection (SFIBFUNC)" or "Safety output C function selection (SFICFUNC)".
- ✓ From SFOC terminal, outputs a combination result of states of terminals of SFIC, SFID and SFIE. Below shows an out put state.

SFIC	SFID	SFIE	SFOC
ON	ON	ON	OFF
OFF	ON	ON	
ON	OFF	ON	
OFF	OFF	ON	
ON	ON	OFF	
OFF	ON	OFF	
ON	OFF	OFF	
OFF	OFF	OFF	

- ✓ For an output timing, refer the operation sequence for each functions.

4.6.2 Performing safety function monitor output (STA)

Outputs a status of the performing safety function set to applied safety input.

- ✓ Performing safety function monitor output is able to output through the terminals of SFOA, SFOB or SFOC. For the use, set "02: STA output" to "Safety output A function selection (SFOAFUNC)", "Safety output B function selection (SFOBFUNC)" or "Safety output C function selection (SFOCFUNC)".
- ✓ For an output timing, refer the operation sequence for each functions.

4.6.3 Safe Torque Off status monitor output (STO)

Outputs a STO status.

- ✓ Safe Torque Off status monitor output is able to output through the terminals of SFOA, SFOB or SFOC. For the use, set "03: STO output" to "Safety output A function selection (SFOAFUNC)", "Safety output B function selection (SFOBFUNC)" or "Safety output C function selection (SFOCFUNC)".
- ✓ For an output timing, refer the operation sequence for each functions.

4. Safety function

4.7 Self diagnosis function

4.7.1 Self diagnosis of safety I/O signal

Safety input circuit and safety output circuit in a servo amplifier perform self diagnosis periodically whether they work correct. If error is detected, it transit to STO state soon, and cannot return to normal state until performing control power cycle.

- ✓ Self diagnosis of safety output is performed when diagnosis function is valid. For a detail of diagnosis, refer the section "4.5.3 Safety output diagnosis".

4.7.2 Self diagnosis of encoder

For the condition that servo motor is stopping with SOS/SLS function valid, motor rotates within ± 0.1 degree of mechanical angle from stop position, to diagnose encoder failure. If encoder error is detected by this diagnosis function, it transit to STO state soon, and cannot return to normal state until performing control power cycle. Moreover, to avoid wrong detection of position monitoring error, set "Position monitoring width" as exceeding the value above.

Below shows a relation of representative encoder resolution and minimum set value.

Encoder type	Encoder division/resolution	" Position monitoring width" minimum set value
Incremental encoder	2000P/R (8000P/R, 4-multiplied)	3 pulse
	10000P/R (40000P/R, 4-multiplied)	12 pulse
Absolute encoder	17bit (131072 division)	37 pulse
	20bit (1048576 division)	292 pulse

For except above, use as "Position monitoring width $\geq$ encoder resolution $\times$ (0.1 degree/360 degree)".

- ✓ For incremental encoder, use 4-multiplied value.
- ✓ To use SOS/SLS function, previously confirm that servo motor behavior within range above is not to be danger.
- ✓ When enabling the encoder self-diagnosis function, perform servo tuning of the servo amplifier in advance.
- ✓ When operating with analog velocity command input or analog torque compensation command, perform analog speed command offset adjustment, analog torque compensation command offset adjustment and Group8 ID:01 "Analog velocity, torque command input dead zone" adjustment of the servo amplifier beforehand. Group 8 ID: 01 "Analog velocity and torque command input dead zone". The encoder failure diagnosis operates when the command input is zero.
- ✓ If the encoder is moved by an external force during encoder self-diagnosis operation, the movement range during diagnosis may exceed ± 0.1 degree.

4.8 Periodic diagnosis

This servo amplifier performs periodic failure diagnosis by self diagnosis function against safety circuit. So, periodic diagnosis against safety circuit by customer is not required.

Parameter

5.1 Parameter setting	5-1
5.1.1 Parameter list	5-1
5.1.2 Parameter detail	5-4
5.2 Monitor function	5-15
5.2.1 Monitor list	5-15
5.2.2 Monitor detail	5-15
5.2.3 Operation trace/operation scroll monitor list	5-17

5. Parameter

5.1 Parameter setting

5.1.1 Parameter list

Below shows the parameter list sorted to Group each. It is able to change parameters to any value by the SANMOTION MOTOR SETUP software. After changing set value, perform control power cycle of servo amplifier.

Moreover if all parameters are desired to return to standard set value, it is able to perform by "Parameter initialisation function" of the SANMOTION MOTOR SETUP software.

■ Group list

Group	Sorting
Group0	Common parameter setting
Group1	Parameter setting for safety input A
Group2	Parameter setting for safety input B
Group3	Parameter setting for safety input C

■ Safety parameter Group0 "Common parameter setting"

ID	Symbol	Name	Default	Unit	Setting range
00	AXIS	Setup software communication axis selection	0A: #A	—	01 to 0F
01	EDT	Error detection time	100	ms	1 to 1000

■ Safety parameter Group1 "Parameter setting for safety input A"

ID	Symbol	Name	Default	Unit	Setting range
00	SFIAPUNC	Safety input A function selection	01: STO	—	00 to 05
01	SFOAFUNC	Safety output A function selection	01: INM	—	00 to 04
02	SFOADIAG	Safety output A diagnosis function selection	00: Disable	—	00 to 01
03	TVCDECA	Deceleration time constant A	1000	ms	0 to 16000
04	SFWTA	Safety function starting wait time A	10	ms	10 to 700
05	MSTMA	Motor stop detection wait time A	100	ms	10 to 1000
06	VMWA	Velocity monitoring width A	50	min ⁻¹	1 to 32767
07	SOSMWA	Position monitoring width A	131072	pulse	1 to 2147483647

■ Safety parameter Group2 "Parameter setting for safety input B"

ID	Symbol	Name	Default	Unit	Setting range
00	SFIBFUNC	Safety input B function selection	01: STO	—	00 to 05
01	SFOBFUNC	Safety output B function selection	01: INM	—	00 to 04
02	SFOBDIAG	Safety output B diagnosis function selection	00: Disable	—	00 to 01
03	TVCDECB	Deceleration time constant B	1000	ms	0 to 16000
04	SFWTB	Safety function starting wait time B	10	ms	10 to 700
05	MSTM B	Motor stop detection wait time B	100	ms	10 to 1000
06	VMWB	Velocity monitoring width B	50	min ⁻¹	1 to 32767
07	SOSMWB	Position monitoring width B	131072	pulse	1 to 2147483647

■ Safety parameter Group3 "Parameter setting for safety input C"

ID	Symbol	Name	Default	Unit	Setting range
00	SFICFUNC	Safety input C function selection	10: SLS	—	00,10 to 11
01	SFOCFUNC	Safety output C function selection	01: INM	—	00 to 04
02	SFOBDIAG	Safety output C diagnosis function selection	00: Disable	—	00 to 01
03	SFWTC	Safety function starting wait time C	10	ms	10 to 700
04	STOWT	STO delay time at error detection	700	ms	10 to 10000
05	SLSSTOP	Forced stop operation selection at error detection	00: ACTEMR	—	00 to 03

5.1 Parameter setting

ID	Symbol	Name	Default value	Unit	Setting range
10	SLSMV1	Safe velocity monitoring width 1	100	min ⁻¹	1 to 32767
11	SLSMV2	Safe velocity monitoring width 2	100	min ⁻¹	1 to 32767
12	SLSMV3	Safe velocity monitoring width 3	100	min ⁻¹	1 to 32767
13	SLSMV4	Safe velocity monitoring width 4	100	min ⁻¹	1 to 32767
14	SLSMV5	Safe velocity monitoring width 5	100	min ⁻¹	1 to 32767
15	SLSMV6	Safe velocity monitoring width 6	100	min ⁻¹	1 to 32767
16	SLSMV7	Safe velocity monitoring width 7	100	min ⁻¹	1 to 32767
17	SLSMV8	Safe velocity monitoring width 8	100	min ⁻¹	1 to 32767
18	SLSMV9	Safe velocity monitoring width 9	100	min ⁻¹	1 to 32767
19	SLSMV10	Safe velocity monitoring width 10	100	min ⁻¹	1 to 32767
1A	SLSMV11	Safe velocity monitoring width 11	100	min ⁻¹	1 to 32767
1B	SLSMV12	Safe velocity monitoring width 12	100	min ⁻¹	1 to 32767
1C	SLSMV13	Safe velocity monitoring width 13	100	min ⁻¹	1 to 32767
1D	SLSMV14	Safe velocity monitoring width 14	100	min ⁻¹	1 to 32767
1E	SLSMV15	Safe velocity monitoring width 15	100	min ⁻¹	1 to 32767
1F	SLSMV16	Safe velocity monitoring width 16	100	min ⁻¹	1 to 32767
20	SLSMV17	Safe velocity monitoring width 17	100	min ⁻¹	1 to 32767
21	SLSMV18	Safe velocity monitoring width 18	100	min ⁻¹	1 to 32767
22	SLSMV19	Safe velocity monitoring width 19	100	min ⁻¹	1 to 32767
23	SLSMV20	Safe velocity monitoring width 20	100	min ⁻¹	1 to 32767
24	SLSMV21	Safe velocity monitoring width 21	100	min ⁻¹	1 to 32767
25	SLSMV22	Safe velocity monitoring width 22	100	min ⁻¹	1 to 32767
26	SLSMV23	Safe velocity monitoring width 23	100	min ⁻¹	1 to 32767
27	SLSMV24	Safe velocity monitoring width 24	100	min ⁻¹	1 to 32767
28	SLSMV25	Safe velocity monitoring width 25	100	min ⁻¹	1 to 32767
29	SLSMV26	Safe velocity monitoring width 26	100	min ⁻¹	1 to 32767
2A	SLSMV27	Safe velocity monitoring width 27	100	min ⁻¹	1 to 32767
2B	SLSMV28	Safe velocity monitoring width 28	100	min ⁻¹	1 to 32767
2C	SLSMV29	Safe velocity monitoring width 29	100	min ⁻¹	1 to 32767
2D	SLSMV30	Safe velocity monitoring width 30	100	min ⁻¹	1 to 32767
2E	SLSMV31	Safe velocity monitoring width 31	100	min ⁻¹	1 to 32767

■ Safety parameter Group4 "Parameter setting for drive recorder"

ID	Symbol	Name	Default value	Unit	Setting range
00	SAMPDIV	Drive recorder sampling interval	20	—	0 to 65535
01	SAMPNUM	Drive recorder sampling point	00: 256point	—	00 to 02
02	TRGCHSEL	Drive recorder trigger channel selection	83: DIGITAL_4	—	00 to 83
03	TRGEDGSEL	Drive recorder trigger edge selection	00: POS_EDGE	—	00 to 02
04	TRGHPOS	Drive recorder trigger horizontal position	80	%	0 to 100
05	TRGLVL	Drive recorder trigger level	1	—	-9223372036852678655 to 9223372036852678654
06	CH1SEL	Drive recorder analog CH1 selection	00: STATUS	—	00 to 08, FF
07	CH2SEL	Drive recorder analog CH2 selection	01: SF-CN1MON	—	00 to 08, FF
08	CH3SEL	Drive recorder analog CH3 selection	02: SF-CN2MON	—	00 to 08, FF
09	CH4SEL	Drive recorder analog CH4 selection	03: APMON	—	00 to 08, FF
0A	CH5SEL	Drive recorder analog CH5 selection	05: VMON	—	00 to 08, FF
0B	CH6SEL	Drive recorder analog CH6 selection	06: VCMON	—	00 to 08, FF
0C	DCH1SEL	Drive recorder digital CH1 selection	00: SF11A	—	00 to 15, FF

5. Parameter

ID	Symbol	Name	Default value	Unit	Setting range
0D	DCH2SEL	Drive recorder digital CH2 selection	10: SACT	—	00 to 15,FF
0E	DCH3SEL	Drive recorder digital CH3 selection	14: SSM	—	00 to 15,FF
0F	DCH4SEL	Drive recorder digital CH4 selection	15: ALARM	—	00 to 15,FF

5.1 Parameter setting

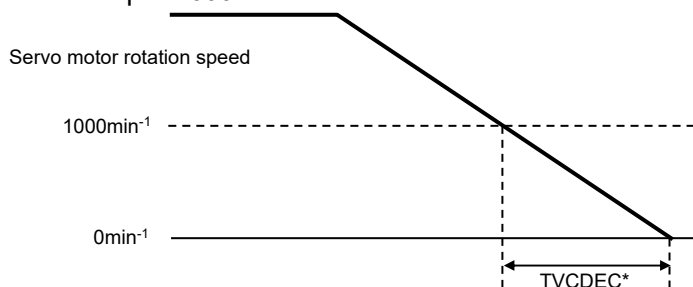
5.1.2 Parameter detail

■ Safety parameter Group0 "Common parameter setting"

ID	Contents																																																
00	Setup software communication axis selection [AXIS]					Setting range		Unit	Default																																								
						01 to 0F		—	0A																																								
	■ Selects axis number communicating with the setup software. ◆ Setup software identifies servo amplifiers by this number. So, assign unique number to servo amplifier each for multiple servo amplifier connection.																																																
	<table><tr><th colspan="2">Selection</th><th colspan="2">Selection</th><th colspan="2">Selection</th><th colspan="2">Selection</th><th colspan="2">Selection</th></tr><tr><td>01</td><td>#1</td><td>04</td><td>#4</td><td>07</td><td>#7</td><td>0A</td><td>#A</td><td>0D</td><td>#D</td></tr><tr><td>02</td><td>#2</td><td>05</td><td>#5</td><td>08</td><td>#8</td><td>0B</td><td>#B</td><td>0E</td><td>#E</td></tr><tr><td>03</td><td>#3</td><td>06</td><td>#6</td><td>09</td><td>#9</td><td>0C</td><td>#C</td><td>0F</td><td>#F</td></tr></table>										Selection		Selection		Selection		Selection		Selection		01	#1	04	#4	07	#7	0A	#A	0D	#D	02	#2	05	#5	08	#8	0B	#B	0E	#E	03	#3	06	#6	09	#9	0C	#C	0F
Selection		Selection		Selection		Selection		Selection																																									
01	#1	04	#4	07	#7	0A	#A	0D	#D																																								
02	#2	05	#5	08	#8	0B	#B	0E	#E																																								
03	#3	06	#6	09	#9	0C	#C	0F	#F																																								
01	Error detection time [EDT]					Setting range		Unit	Default																																								
						0 to 1000		ms	100																																								
	■ Sets an error detection delay time. Sets a delay time till velocity monitoring error detection at performing SS1/SS2/SLS function. Moreover sets a delay time till position monitoring error detection at performing SS2/SOS function.																																																

5. Parameter

■ Safety parameter Group1 "Parameter setting for safety input A"

ID	Contents																								
00	Safety input A function selection [SFIAFUNC]	Setting range	Unit	Default																					
		00 to 05	—	01: STO																					
	■ Selects a safety function performed by safety input A (SFIA).																								
	<table><thead><tr><th colspan="2">Selection</th><th>Contents</th></tr></thead><tbody><tr><td>00</td><td>NONE</td><td>Function invalid</td></tr><tr><td>01</td><td>STO</td><td>Safe Torque Off function</td></tr><tr><td>02</td><td>SS1</td><td>Safe Stop 1 function</td></tr><tr><td>03</td><td>SS2</td><td>Safe Stop 2 function</td></tr><tr><td>04</td><td>SOS</td><td>Safe Operating Stop function</td></tr><tr><td>05</td><td>SLS/SSM</td><td>Safely-Limited Speed/ Safe Speed Monitor function</td></tr></tbody></table>				Selection		Contents	00	NONE	Function invalid	01	STO	Safe Torque Off function	02	SS1	Safe Stop 1 function	03	SS2	Safe Stop 2 function	04	SOS	Safe Operating Stop function	05	SLS/SSM	Safely-Limited Speed/ Safe Speed Monitor function
	Selection		Contents																						
00	NONE	Function invalid																							
01	STO	Safe Torque Off function																							
02	SS1	Safe Stop 1 function																							
03	SS2	Safe Stop 2 function																							
04	SOS	Safe Operating Stop function																							
05	SLS/SSM	Safely-Limited Speed/ Safe Speed Monitor function																							
◆ Wiring is not required if "00: NONE" is set.																									
◆ When "05: SLS/SSM" is set, it works as the safety function selected at Group3 ID00 "Safety input C function selection".																									
01	Safety output A function selection [SFOAFUNC]	Setting range	Unit	Default																					
		00 to 04	—	01: INM																					
	■ Selects a function outputting through the safety output A (SFOA).																								
	<table><thead><tr><th colspan="2">Selection</th><th>Contents</th></tr></thead><tbody><tr><td>00</td><td>NONE</td><td>Function invalid</td></tr><tr><td>01</td><td>INM</td><td>Safety input status monitor output</td></tr><tr><td>02</td><td>STA</td><td>Safety function operating status monitor output</td></tr><tr><td>03</td><td>STO</td><td>Safe Torque Off status monitor output</td></tr><tr><td>04</td><td>SBC</td><td>Safety brake output</td></tr></tbody></table>				Selection		Contents	00	NONE	Function invalid	01	INM	Safety input status monitor output	02	STA	Safety function operating status monitor output	03	STO	Safe Torque Off status monitor output	04	SBC	Safety brake output			
	Selection		Contents																						
00	NONE	Function invalid																							
01	INM	Safety input status monitor output																							
02	STA	Safety function operating status monitor output																							
03	STO	Safe Torque Off status monitor output																							
04	SBC	Safety brake output																							
◆ Wiring is not required if "00: NONE" is set.																									
02	Safety output A diagnosis function selection [SFOADIAG]	Setting range	Unit	Default																					
		00 to 01	—	00: Disable																					
	■ Selects valid/invalid of diagnosis function for the safety output A (SFOA).																								
	<table><thead><tr><th colspan="2">Selection</th><th>Contents</th></tr></thead><tbody><tr><td>00</td><td>Disable</td><td>Function invalid</td></tr><tr><td>01</td><td>Enable</td><td>Function valid</td></tr></tbody></table>				Selection		Contents	00	Disable	Function invalid	01	Enable	Function valid												
	Selection		Contents																						
00	Disable	Function invalid																							
01	Enable	Function valid																							
◆ When "04: SBC" is set to Group1 ID01 "Parameter setting for safety output A [SFOAFUNC]", perform a self diagnosis function of SFOA by selecting "01: Enable".																									
03	Deceleration time constant A [TVCDECA]	Setting range	Unit	Default																					
		0 to 16000	ms	1000																					
	■ This is the parameter limiting deceleration in SS1/SS2 function operation. Sets the deceleration time per 1000min ⁻¹ .																								
																									

5.1 Parameter setting

ID	Contents			
04	Safety function starting wait time A [SFWTA]	Setting range	Unit	Default
		10 to 700	ms	10
	■ Sets a time until a safety function starts from that the safety input A (SFIA) is changed to OFF (contact open). ◆ When "00: STO", "01: SS1", "02: SS2" or "03: SOS" is set to Group1 ID00 "Safety input A function selection [SFIAFUNC]", safety function is performed after passing set time of this parameter. This function is invalid if "04: SLS/SSM" is set.			
05	Motor stop detection wait time A [MSTMA]	Setting range	Unit	Default
		10 to 1000	ms	100
	■ Sets a time until motor stop state detection after deceleration, at performing SS1/SS2 function. ◆ Transits to STO state after passing a time of this parameter from deceleration stop, at performing SS1 function. ◆ Transits to SOS state after passing a time of this parameter from deceleration stop, at performing SS2 function.			
06	Velocity monitoring width A [VMWA]	Setting range	Unit	Default
		1 to 32767	min ⁻¹	50
	■ Sets a velocity monitoring width while SS1/SS2 function valid. When velocity deviation exceeds a range of this parameter set value, it detects a velocity monitoring error and shuts motor power down. (STO state)			
07	Position monitoring width A [SOSMWA]	Setting range	Unit	Default
		1 to 2147483647	pulse	131072
	■ Sets a position monitoring width while SOS function valid. When a deviation until current position from SOS function started position exceeds a range of this parameter set value, it detects a position monitoring error and shuts motor power down. (STO state)			

5. Parameter

■ Safety parameter Group2 "Parameter setting for safety input B"

ID	Contents																								
00	Safety input B function selection [SFIBFUNC]	Setting range	Unit	Default																					
		00 to 05	—	01: STO																					
	■ Selects a safety function performed by safety input B (SFIB).																								
	<table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>NONE</td><td>Function invalid</td></tr><tr><td>01</td><td>STO</td><td>Safe Torque Off function</td></tr><tr><td>02</td><td>SS1</td><td>Safe Stop 1 function</td></tr><tr><td>03</td><td>SS2</td><td>Safe Stop 2 function</td></tr><tr><td>04</td><td>SOS</td><td>Safe Operating Stop function</td></tr><tr><td>05</td><td>SLS/SSM</td><td>Safely-Limited Speed/ Safe Speed Monitor function</td></tr></table>				Selection		Contents	00	NONE	Function invalid	01	STO	Safe Torque Off function	02	SS1	Safe Stop 1 function	03	SS2	Safe Stop 2 function	04	SOS	Safe Operating Stop function	05	SLS/SSM	Safely-Limited Speed/ Safe Speed Monitor function
	Selection		Contents																						
00	NONE	Function invalid																							
01	STO	Safe Torque Off function																							
02	SS1	Safe Stop 1 function																							
03	SS2	Safe Stop 2 function																							
04	SOS	Safe Operating Stop function																							
05	SLS/SSM	Safely-Limited Speed/ Safe Speed Monitor function																							
◆ Wiring is not required if "00: NONE" is set.																									
◆ When "05: SLS/SSM" is set, it works as the safety function selected at Group3 ID00 "Safety input C function selection".																									
01	Safety output B function selection [SFOBFUNC]	Setting range	Unit	Default																					
		00 to 04	—	01: INM																					
	■ Selects a function outputting through the safety output B (SFOB).																								
	<table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>NONE</td><td>Function invalid</td></tr><tr><td>01</td><td>INM</td><td>Safety input status monitor output</td></tr><tr><td>02</td><td>STA</td><td>Safety function operating status monitor output</td></tr><tr><td>03</td><td>STO</td><td>Safe Torque Off status monitor output</td></tr><tr><td>04</td><td>SBC</td><td>Safety brake output</td></tr></table>				Selection		Contents	00	NONE	Function invalid	01	INM	Safety input status monitor output	02	STA	Safety function operating status monitor output	03	STO	Safe Torque Off status monitor output	04	SBC	Safety brake output			
	Selection		Contents																						
00	NONE	Function invalid																							
01	INM	Safety input status monitor output																							
02	STA	Safety function operating status monitor output																							
03	STO	Safe Torque Off status monitor output																							
04	SBC	Safety brake output																							
◆ Wiring is not required if "00: NONE" is set.																									
02	Safety output B diagnosis function selection [SFOBDIAG]	Setting range	Unit	Default																					
		00 to 01	—	00: Disable																					
	■ Selects valid/invalid of diagnosis function for the safety output B (SFOB).																								
	<table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>Disable</td><td>Function invalid</td></tr><tr><td>01</td><td>Enable</td><td>Function valid</td></tr></table>				Selection		Contents	00	Disable	Function invalid	01	Enable	Function valid												
	Selection		Contents																						
00	Disable	Function invalid																							
01	Enable	Function valid																							
◆ When "04: SBC" is set to Group1 ID02 "Parameter setting for safety output B [SFOBFUNC]", perform a self diagnosis function of SFOB by selecting "01: Enable".																									
03	Deceleration time constant B [TVCDECB]	Setting range	Unit	Default																					
		0 to 16000	ms	1000																					
	■ This is the parameter limiting deceleration in SS1/SS2 function operation. Sets the deceleration time per 1000min ⁻¹ .																								

5.1 Parameter setting

ID	Contents			
04	Safety function starting wait time B [SFWTB]	Setting range	Unit	Default
		10 to 700	ms	10
	■ Sets a time until a safety function starts from that the safety input B (SFIB) is changed to OFF (contact open). ◆ When "00: STO", "01: SS1", "02: SS2" or "03: SOS" is set to Group2 ID00 "Safety input B function selection [SFIBFUNC]", safety function is performed after passing set time of this parameter. This function is invalid if "04: SLS/SSM" is set.			
05	Motor stop detection wait time B [MSTMB]	Setting range	Unit	Default
		10 to 1000	ms	100
	■ Sets a time until motor stop state detection after deceleration, at performing SS1/SS2 function. ◆ Transits to STO state after passing a time of this parameter from deceleration stop, at performing SS1 function. ◆ Transits to SOS state after passing a time of this parameter from deceleration stop, at performing SS2 function.			
06	Velocity monitoring width B [VMWB]	Setting range	Unit	Default
		1 to 32767	min ⁻¹	50
	■ Sets a velocity monitoring width while SS1/SS2 function valid. When velocity deviation exceeds a range of this parameter set value, it detects a velocity monitoring error and shuts motor power down. (STO state)			
07	Position monitoring width B [SOSMWB]	Setting range	Unit	Default
		1 to 2147483647	pulse	131072
	■ Sets a position monitoring width while SOS function valid. When a deviation until current position from SOS function started position exceeds a range of this parameter set value, it detects a position monitoring error and shuts motor power down. (STO state)			

5. Parameter

■ Safety parameter Group3 "Parameter setting for safety input C"

ID	Contents																				
00	Safety input C function selection [SFICFUNC]	Setting range	Unit	Default																	
		00, 10 to 11	—	10: SLS																	
	■ Selects a safety function performed by safety input C (SFIC)/ D (SFID)/ E (SFIE).																				
	<table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>NONE</td><td>Function invalid</td></tr><tr><td>10</td><td>SLS</td><td>Safely-Limited Speed function</td></tr><tr><td>11</td><td>SSM</td><td>Safe Speed Monitor function</td></tr></table>				Selection		Contents	00	NONE	Function invalid	10	SLS	Safely-Limited Speed function	11	SSM	Safe Speed Monitor function					
Selection		Contents																			
00	NONE	Function invalid																			
10	SLS	Safely-Limited Speed function																			
11	SSM	Safe Speed Monitor function																			
◆ Wiring is not required if "00: NONE" is set.																					
01	Safety output C function selection [SFOCFUNC]	Setting range	Unit	Default																	
		00 to 04	—	01: INM																	
	■ Selects a function outputting through the safety output C (SFOC).																				
	<table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>NONE</td><td>Function invalid</td></tr><tr><td>01</td><td>INM</td><td>Safety input status monitor output</td></tr><tr><td>02</td><td>STA</td><td>Safety function operating status monitor output</td></tr><tr><td>03</td><td>STO</td><td>Safe Torque Off status monitor output</td></tr><tr><td>04</td><td>SBC</td><td>Safety brake output</td></tr></table>				Selection		Contents	00	NONE	Function invalid	01	INM	Safety input status monitor output	02	STA	Safety function operating status monitor output	03	STO	Safe Torque Off status monitor output	04	SBC
Selection		Contents																			
00	NONE	Function invalid																			
01	INM	Safety input status monitor output																			
02	STA	Safety function operating status monitor output																			
03	STO	Safe Torque Off status monitor output																			
04	SBC	Safety brake output																			
◆ Wiring is not required if "00: NONE" is set.																					
◆ When "11: SSM" is set to Group3 ID00 "Parameter setting for safety input C [SFICFUNC]", "Safe Speed range output (SSM)" is output regardless of selection above.																					
02	Safety output C diagnosis function selection [SFOCDIAG]	Setting range	Unit	Default																	
		00 to 01	—	00: Disable																	
	■ Selects valid/invalid of diagnosis function for the safety output C (SFOC).																				
	<table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>Disable</td><td>Function invalid</td></tr><tr><td>01</td><td>Enable</td><td>Function valid</td></tr></table>				Selection		Contents	00	Disable	Function invalid	01	Enable	Function valid								
Selection		Contents																			
00	Disable	Function invalid																			
01	Enable	Function valid																			
◆ When "11: SSM" is set to Group3 ID00 "Parameter setting for safety input C [SFICFUNC]" and "04: SBC" is set to Group3 ID01 "Parameter setting for safety output C [SFOCFUNC]", perform a self diagnosis function of SFOC by selecting "01: Enable".																					
03	Safety function starting wait time C [SFWTC]	Setting range	Unit	Default																	
		10 to 700	ms	10																	
■ Sets a time until a safety function starts from that the safety input C (SFIC) is changed to OFF (contact open).																					
04	STO delay time at error detection [STOWT]	Setting range	Unit	Default																	
		10 to 10000	ms	700																	
■ Sets a delay time until a forced stop operation starts after detecting velocity monitoring error.																					
◆ Forced stop operation stops motor with the operation which is selected in Group3 ID05 "Forced stop operation selection at error detection".																					

5.1 Parameter setting

ID	Contents																		
05	Forced stop operation selection at error detection [SLSSTOP]	Setting range	Unit	Default															
		00 to 03	—	00: ACTEMR															
	■ Selects stop operation at velocity monitoring error detection.																		
	<table><tr><th colspan="2">Selection</th><th>Contents</th></tr><tr><td>00</td><td>ACTEMR</td><td>According to a set value of GroupB ID02 "Forced stop operation" in a servo amplifier.</td></tr><tr><td>01</td><td>SERVO-BRAKE</td><td>Stops motor by servo brake operation</td></tr><tr><td>02</td><td>DYNAMIC-BRAKE</td><td>Stops motor by dynamic brake operation</td></tr><tr><td>03</td><td>DEC-STP</td><td>Stops motor by deceleration stop operation</td></tr></table>				Selection		Contents	00	ACTEMR	According to a set value of GroupB ID02 "Forced stop operation" in a servo amplifier.	01	SERVO-BRAKE	Stops motor by servo brake operation	02	DYNAMIC-BRAKE	Stops motor by dynamic brake operation	03	DEC-STP	Stops motor by deceleration stop operation
	Selection		Contents																
00	ACTEMR	According to a set value of GroupB ID02 "Forced stop operation" in a servo amplifier.																	
01	SERVO-BRAKE	Stops motor by servo brake operation																	
02	DYNAMIC-BRAKE	Stops motor by dynamic brake operation																	
03	DEC-STP	Stops motor by deceleration stop operation																	
◆ Deceleration time constant at deceleration stop selection is according to a set value of GroupB ID16 "Forced stop operation" in a servo amplifier.																			

5. Parameter

10
to
2E

ID	Contents					
10 to 2E	Safe velocity monitoring width [SLSMV1 to SLSMV31]	Setting range	Unit	Default		
		1 to 32767	min ⁻¹	100		
	■ Sets a safe velocity monitoring width.					
	◆ It is able to set that 31 stages safe velocity monitoring width.					
	◆ It is able to select safe velocity monitoring width up to 7 stages (SLSMV1 to 7), with combination of safety inputs: C, D and E.					
	◆ It is able to extend selection of safe velocity monitoring width up to 31 stages by setting "05: SLS/SSM" to Group1 ID00 "Safety input A function selection [SFIAFUNC]" and Group2 ID00 "Safety input B function selection [SFIBFUNC]".					
	SFIC	SFID	SFIE	SFIA	SFIB	Safe velocity monitoring width
	ON	ON	ON	ON※1	ON※1	Safe velocity limiting function Invalid
	OFF	ON	ON	ON※1	ON※1	SLSMV1
	ON	OFF	ON	ON※1	ON※1	SLSMV2
	OFF	OFF	ON	ON※1	ON※1	SLSMV3
	ON	ON	OFF	ON※1	ON※1	SLSMV4
	OFF	ON	OFF	ON※1	ON※1	SLSMV5
	ON	OFF	OFF	ON※1	ON※1	SLSMV6
	OFF	OFF	OFF	ON※1	ON※1	SLSMV7
	ON	ON	ON	OFF※2	ON※1	SLSMV8
	OFF	ON	ON	OFF※2	ON※1	SLSMV9
	ON	OFF	ON	OFF※2	ON※1	SLSMV10
	OFF	OFF	ON	OFF※2	ON※1	SLSMV11
	ON	ON	OFF	OFF※2	ON※1	SLSMV12
	OFF	ON	OFF	OFF※2	ON※1	SLSMV13
	ON	OFF	OFF	OFF※2	ON※1	SLSMV14
	OFF	OFF	OFF	OFF※2	ON※1	SLSMV15
	ON	ON	ON	ON※1	OFF※2	SLSMV16
	OFF	ON	ON	ON※1	OFF※2	SLSMV17
	ON	OFF	ON	ON※1	OFF※2	SLSMV18
	OFF	OFF	ON	ON※1	OFF※2	SLSMV19
	ON	ON	OFF	ON※1	OFF※2	SLSMV20
	OFF	ON	OFF	ON※1	OFF※2	SLSMV21
	ON	OFF	OFF	ON※1	OFF※2	SLSMV22
	OFF	OFF	OFF	ON※1	OFF※2	SLSMV23
	ON	ON	ON	OFF※2	OFF※2	SLSMV24
	OFF	ON	ON	OFF※2	OFF※2	SLSMV25
	ON	OFF	ON	OFF※2	OFF※2	SLSMV26
	OFF	OFF	ON	OFF※2	OFF※2	SLSMV27
	ON	ON	OFF	OFF※2	OFF※2	SLSMV28
OFF	ON	OFF	OFF※2	OFF※2	SLSMV29	
ON	OFF	OFF	OFF※2	OFF※2	SLSMV30	
OFF	OFF	OFF	OFF※2	OFF※2	SLSMV31	
※1 In case that safety input is ON (contact close) or it selects except "05: SLS/SSM" at safety input function selection.						
※2 In case that it selects "05: SLS/SSM" at safety input function selection.						

5.1 Parameter setting

- Safety parameter Group4 "Parameter setting for drive recorder"
 - Drive recorder data of functional safety module can display 1 time past only.
 - Data will be cleared after power OFF.
 - For functional safety module, there is no limit of saving number of times.

ID	Contents																																																		
00	Drive recorder sampling interval [SAMPDIV]	Setting range	Unit	Default																																															
		0 to 65535	—	20																																															
	■ Sets a sampling interval of drive recorder. ◆ Minimum sampling interval (Ts) is fixed to 448μs with analog/pulse train interface type, and fixed to 500μs with EtherCAT interface type and parallel/serial interface type with built-in positioning function. ◆ Sets the value n shown as "T=Ts*n" for sampling interval T. ◆ Drive recorder stops if 0 is set.																																																		
01	Drive recorder sampling point [SAMPNUM]	Setting range	Unit	Default																																															
		00 to 02	—	00: 256point																																															
	■ Selects total data amount per 1 channel which is to be recorded in a drive recorder. ◆ Larger the data amount, smaller the recordable channel numbers. <table><tr><th colspan="2">Selection</th><th colspan="2">Contents</th></tr><tr><td>00</td><td>256point</td><td colspan="2">6 channels</td></tr><tr><td>01</td><td>512point</td><td colspan="2">3 channels</td></tr><tr><td>02</td><td>1024point</td><td colspan="2">1 channel</td></tr></table>				Selection		Contents		00	256point	6 channels		01	512point	3 channels		02	1024point	1 channel																																
Selection		Contents																																																	
00	256point	6 channels																																																	
01	512point	3 channels																																																	
02	1024point	1 channel																																																	
02	Drive recorder trigger channel selection [TRGCHSEL]	Setting range	Unit	Default																																															
		00 to 83	—	83: DIGITAL 4																																															
	■ Selects the channel to be trigger condition in a drive recorder. ◆ It is able to set not only analog channel but also digital channel. <table><tr><th colspan="2">Selection</th><th colspan="2">Contents</th><th colspan="2">Selection</th><th colspan="2">Contents</th></tr><tr><td>00</td><td>ANALOG 1</td><td>Analog, CH1</td><td>05</td><td>ANALOG 6</td><td colspan="2">Analog, CH6</td><td></td></tr><tr><td>01</td><td>ANALOG 2</td><td>Analog, CH2</td><td>80</td><td>DIGITAL 1</td><td colspan="2">Digital, CH1</td><td></td></tr><tr><td>02</td><td>ANALOG 3</td><td>Analog, CH3</td><td>81</td><td>DIGITAL 2</td><td colspan="2">Digital, CH2</td><td></td></tr><tr><td>03</td><td>ANALOG 4</td><td>Analog, CH4</td><td>82</td><td>DIGITAL 3</td><td colspan="2">Digital, CH3</td><td></td></tr><tr><td>04</td><td>ANALOG 5</td><td>Analog, CH5</td><td>83</td><td>DIGITAL 4</td><td colspan="2">Digital, CH4</td><td></td></tr></table>				Selection		Contents		Selection		Contents		00	ANALOG 1	Analog, CH1	05	ANALOG 6	Analog, CH6			01	ANALOG 2	Analog, CH2	80	DIGITAL 1	Digital, CH1			02	ANALOG 3	Analog, CH3	81	DIGITAL 2	Digital, CH2			03	ANALOG 4	Analog, CH4	82	DIGITAL 3	Digital, CH3			04	ANALOG 5	Analog, CH5	83	DIGITAL 4	Digital, CH4	
Selection		Contents		Selection		Contents																																													
00	ANALOG 1	Analog, CH1	05	ANALOG 6	Analog, CH6																																														
01	ANALOG 2	Analog, CH2	80	DIGITAL 1	Digital, CH1																																														
02	ANALOG 3	Analog, CH3	81	DIGITAL 2	Digital, CH2																																														
03	ANALOG 4	Analog, CH4	82	DIGITAL 3	Digital, CH3																																														
04	ANALOG 5	Analog, CH5	83	DIGITAL 4	Digital, CH4																																														
03	Drive recorder trigger edge selection [TRGEDGSEL]	Setting range	Unit	Default																																															
		00 to 02	—	00: POS_EDGE																																															
	■ Sets a trigger edge condition on a drive recorder. <table><tr><th colspan="2">Selection</th><th colspan="2">Contents</th></tr><tr><td>00</td><td>POS_EDGE</td><td colspan="2">↑ edge</td></tr><tr><td>01</td><td>NEG_EDGE</td><td colspan="2">↓ edge</td></tr><tr><td>02</td><td>BOTH_EDGE</td><td colspan="2">↑ edge or ↓ edge</td></tr></table>				Selection		Contents		00	POS_EDGE	↑ edge		01	NEG_EDGE	↓ edge		02	BOTH_EDGE	↑ edge or ↓ edge																																
Selection		Contents																																																	
00	POS_EDGE	↑ edge																																																	
01	NEG_EDGE	↓ edge																																																	
02	BOTH_EDGE	↑ edge or ↓ edge																																																	
04	Drive recorder trigger horizontal position [TRGHPOS]	Setting range	Unit	Default																																															
		0 to 100	%	80																																															
■ Sets a trigger horizontal position on a drive recorder. ◆ It is set as percentage [0-100%] from sampling start against total sampling time.																																																			

5. Parameter

ID	Contents			
05	Drive recorder trigger level [TRGLVL]	Setting range	Unit	Default
		-9223372036854775808 to 9223372036854775807	—	1
		■ Sets a trigger level on a drive recorder.		
06	Drive recorder analog CH1 selection [CH1SEL]	Setting range	Unit	Default
07	Drive recorder analog CH2 selection [CH2SEL]	00 to 08	—	00: STATUS
		Setting range	Unit	Default
08	Drive recorder analog CH3 selection [CH3SEL]	00 to 08	—	01: SF-CN1MON
		Setting range	Unit	Default
		00 to 08	—	02: SF-CN2MON
09	Drive recorder analog CH4 selection [CH4SEL]	Setting range	Unit	Default
		00 to 08	—	03: APMON
0A	Drive recorder analog CH5 selection [CH5SEL]	Setting range	Unit	Default
		00 to 08	—	05: VMON
0B	Drive recorder analog CH6 selection [CH6SEL]	Setting range	Unit	Default
		00 to 08	—	06: VCMON
		■ Selects the data to be measured as analog channel, on a drive recorder. ◆ It shares of 2 channel data if a data listed below is set. ● Current position data ● Absolute encoder PS data monitor ✓ CH2 setting is invalid if absolute encoder PS data is set to CH1. Or, when 1024point is selected for sampling point, a data listed above is invalid even if selected. ◆ Do not set FF because it is dedicated for manufacturer only.		
Selection		Contents		
00	STATUS	Functional safety module status monitor		
01	SF-CN1MON	SF-CN1 safety I/O monitor		
02	SF-CN2MON	SF-CN2 safety I/O monitor		
03	APMON	Current position monitor		
04	ABSPS	Absolute encoder PS data monitor		
05	VMON	Velocity monitor		
06	VCMON	Velocity command monitor		
07	SLSLVL	Velocity monitoring level		
08	ENCERRCNT	Encoder communication error counter		
FF	RSV	Manufacturer dedicated monitor mode		

5.1 Parameter setting

ID	Contents			
0C	Drive recorder digital CH1 selection [DCH1SEL]	Setting range	Unit	Default
		00 to 15	—	00: SF11A
0D	Drive recorder digital CH2 selection [DCH2SEL]	Setting range	Unit	Default
		00 to 15	—	10: SACT
0E	Drive recorder digital CH3 selection [DCH3SEL]	Setting range	Unit	Default
		00 to 15	—	14: SSM
	Drive recorder digital CH4 selection [DCH4SEL]	Setting range	Unit	Default
		00 to 15	—	15: ALARM
0F	■ Selects the data to be measured as digital channel, on a drive recorder. ◆ Do not set FF because it is dedicated for manufacturer only.			
	Selection		Contents	
	00	SF11A	SF-CN1 safety input monitor A	
	01	SF11B	SF-CN1 safety input monitor B	
	02	SF11C	SF-CN1 safety input monitor C	
	03	SF11D	SF-CN1 safety input monitor D	
	04	SF11E	SF-CN1 safety input monitor E	
	05	SFO1A	SF-CN1 safety output monitor A	
	06	SFO1B	SF-CN1 safety output monitor B	
	07	SFO1C	SF-CN1 safety output monitor C	
	08	SF12A	SF-CN2 safety input monitor A	
	09	SF12B	SF-CN2 safety input monitor B	
	0A	SF12C	SF-CN2 safety input monitor C	
	0B	SF12D	SF-CN2 safety input monitor D	
	0C	SF12E	SF-CN2 safety input monitor E	
	0D	SFO2A	SF-CN2 safety output monitor A	
	0E	SFO2B	SF-CN2 safety output monitor B	
	0F	SFO2C	SF-CN2 safety output monitor C	
	10	SACT	While motor excitation	
	11	STA	Safety function operating status monitor output	
	12	STO	Safe Torque Off status monitor output	
	13	SBC	Safety brake output	
	14	SSM	Safe Speed range output	
15	ALARM	Alarm status output		
FF	RSV	Manufacturer dedicated monitor mode		

5. Parameter

5.2 Monitor function

5.2.1 Monitor list

ID	Symbol	Name	Unit
00	STATUS	Functional safety module status monitor	---
01	SF-CN1MON	SF-CN1 safety I/O monitor	---
02	SF-CN2MON	SF-CN2 safety I/O monitor	---
03	APMON	Current position monitor	Pulse
04	ABSPS	Absolute encoder PS data monitor	Pulse
05	VMON	Velocity monitor	min ⁻¹
06	VCMON	Velocity command monitor	min ⁻¹
07	SLSVL	Velocity monitoring level	min ⁻¹
08	ENCERRCNT	Encoder communication error counter	times/hour

5.2.2 Monitor detail

ID	Contents					Unit
00	STATUS	Functional safety module status monitor				---
	Indicates an internal status of functional safety module.					
	Code	Status				
	0	Normal state (Safety function invalid)				
	1	Safety function performing state				
	2	Safe Torque Off state				
	3	Alarm or Warning state				
01	SF-CN1MON	SF-CN1 safety I/O monitor				---
	Indicates a state of safety input/output for SF-CN1 connector. State is ON (contact close) for bit =1, OFF (contact open) for bit =0.					
	Bit	3	2	1	0	
	Function	SFID1	SFIC1	SFIB1	SFIA1	
	Bit	7	6	5	4	
	Function	SFOC1	SFOB1	SFOA1	SFIE1	
02	SF-CN2MON	SF-CN2 safety I/O monitor				---
	Indicates a state of safety input/output for SF-CN2 connector. State is ON (contact close) for bit =1, OFF (contact open) for bit =0.					
	Bit	3	2	1	0	
	Function	SFID2	SFIC2	SFIB2	SFIA2	
	Bit	7	6	5	4	
	Function	SFOC2	SFOB2	SFOA2	SFIE2	
03	APMON	Current position monitor				Pulse
	Indicates a motor encoder current position decided to the position at control power ON as origin. It is free run counter, so it will be opposite polarity maximum value if current position is exceeded display range.					
	Display range					
	-2147483648 to 2147483647					

5.2 Monitor function

ID	Contents		Unit
04	ABSPS	Absolute encoder PS data monitor	Pulse
	Indicates a lower 24bit of absolute encoder position data. (Actual display range differs depending on encoder spec.)		
	Display range		
	0 to 00FFFFFF		
05	VMON	Velocity monitor	min ⁻¹
	Indicates a servo motor rotation speed.		
	Display range		
	-32768 to 32767		
06	VCMON	Velocity command monitor	min ⁻¹
	Indicates avelocity command value.		
	Display range		
	-32768 to 32767		
07	SLSLVL	Velocity monitoring level	min ⁻¹
	Indicates a current monitoring level while SLS function performing.		
	Display range		
	0 to 32767		
08	ENCERRCNT	Encoder communication error counter	times/hour
	Indicates a count of communication error occurring against encoder per hour.		
	Display format		
	0 to 65535		

5. Parameter

5.2.3 Operation trace/operation scroll monitor list

The following table shows the data that can be monitored by the operation trace/scroll function in the setup software.

(1) Analog CH setting monitor list

Selection		Description
00	STATUS	Functional safety module status monitor
01	SF-CN1MON	SF-CN1 safety input/output monitor
02	SF-CN2MON	SF-CN2 safety input/output monitor
03	APMON	Current position monitor
04	ABSPS	Absolute encoder PS data monitor
05	VMON	Velocity monitor
06	VCMON	Velocity command monitor
07	SLSLVL	Velocity monitoring level
08	ENCERRCNT	Encoder communication error counter
FF	RSV	Manufacturer dedicated monitor mode

(2) Digital CH setting monitor list

Selection		Description
00	SFI1A	SF-CN1 safety input monitor A
01	SFI1B	SF-CN1 safety input monitor B
02	SFI1C	SF-CN1 safety input monitor C
03	SFI1D	SF-CN1 safety input monitor D
04	SFI1E	SF-CN1 safety input monitor E
05	SFO1A	SF-CN1 safety output monitor A
06	SFO1B	SF-CN1 safety output monitor B
07	SFO1C	SF-CN1 safety output monitor C
08	SFI2A	SF-CN2 safety input monitor A
09	SFI2B	SF-CN2 safety input monitor B
0A	SFI2C	SF-CN2 safety input monitor C
0B	SFI2D	SF-CN2 safety input monitor D
0C	SFI2E	SF-CN2 safety input monitor E
0D	SFO2A	SF-CN2 safety output monitor A
0E	SFO2B	SF-CN2 safety output monitor B
0F	SFO2C	SF-CN2 safety output monitor C
10	SACT	While motor excitation
11	STA	Safety function execution monitor output
12	STO	Safe-torque-off status monitor output
13	SBC	Safety brake output
14	SSM	Safe velocity range output
15	ALARM	Alarm status output
FF	RSV	Manufacturer dedicated monitor mode

✓ Refer the section 5.2.2 for detail.

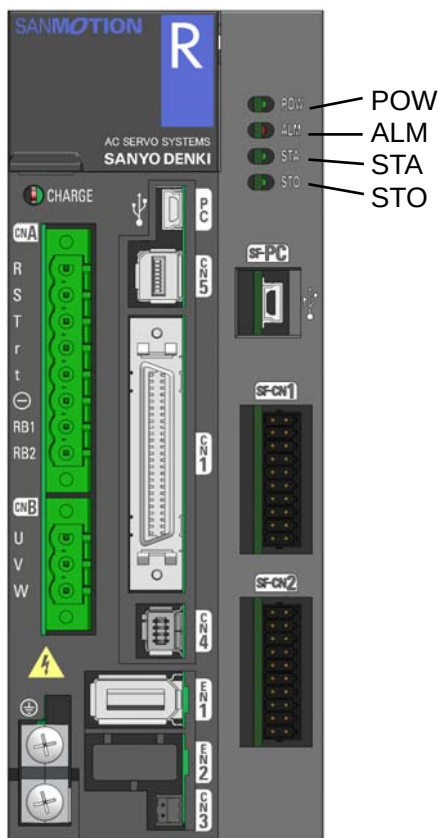
Display

6.1 Display	6-1
-------------------	-----

6. Display

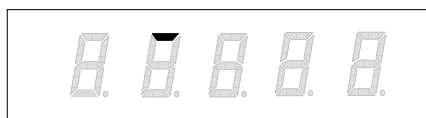
6.1 Display

Condition of functional safety module is shown by each LEDs below.



LED	Color	Description
POW	Green	Lights while servo amplifier control power is supplied.
ALM	Red	Lights or blinks while functional safety module is detecting alarm/warning.
STA	Green	Blinks for normal state, and Lights for while safety function performing.
STO	Green	Lights while STO state.

- ✓ While alarm detection, indicates an alarm code to 7-segment LED of servo amplifier.
- ✓ While warning detection, indicates an warning state to 7-segment LED as below.



Relation of functional safety module condition and LED condition is shown in table below.

Condition	POW		ALM			STA			STO	
	Light off	Light on	Light off	Blink	Light on	Light off	Blink	Light on	Light off	Light on
Power shutdown	✓		✓			✓			✓	
While initialization		✓	✓			✓			✓	
Safety function OFF (Normal state)		✓	✓				✓		✓	
While safety function performing		✓	✓					✓	✓※1	
While alarm or warning		✓		✓			✓			✓
Failure		✓			✓			✓		✓

※1 Lights if STO is selected as safety function.

Lights after motor stop if SS1 is selected as safety function.

Troubleshooting

7.1 List.....	7-1
7.2 Detail	7-3

7. Troubleshooting

Name and content of alarm/warning detected by functional safety module are shown below.
Content of alarm/warning is able to confirm with SANMOTION MOTOR SETUP software.

7.1 List

Name/content/stop-operation at detection in a warning/alarm are listed below.

Warning list

Name	Detail code	Content
Velocity monitoring warning	01	■ Velocity error during SS1/SS2 function performing • Velocity command exceeded a velocity monitoring width (VMW). • Servo motor rotation speed exceeded a velocity monitoring width (VMW).
	03	
	05	
	02	■ Velocity error during SLS function performing • Velocity command exceeded a safe velocity monitoring width (VMW). • Servo motor rotation speed exceeded a safe velocity monitoring width (VMW).
	04	
	06	
Position monitoring warning	08	■ Position deviation error during SOS function performing • Position deviation exceeded a position monitoring width (SOSMV).
	09	
Safety function warning	0B	■ SS1, SS2 or SOS could not perform correctly and stopped forcefully.

- ✓ When velocity monitoring warning during SLS function performing (detail code:02,04,06) is detected, servo motor stops with the stop operation selected at Group3 ID05 "Forced stop operation selection at error detection".
- ✓ To return from warning state, change servo ON input to OFF, and change all safety inputs (SFIA/B/C/D/E) to ON (contacts close).
- ✓ It is able to check a detail code by alarm history display of SANMOTION MOTOR SETUP software connected to functional safety module.

Alarm list

	Alarm code					Alarm name	Alarm content
	Display	Detail code	3bit output				
			Bit7	Bit6	Bit5		
Connection	08	-	0	0	0	Functional safety module failure	■ Connection error for functional safety module
	09	3D	0	0	0	Functional safety module communication error	■ Serial communication error between functional safety module and servo amplifier
	0A	3D	0	0	0	Functional safety module error	■ Self diagnosis error at startup caused by connection between functional safety modules
Functional safety module	96	10	1	0	0	Safety input (SFIA) error	■ Mismatch of CH1/CH2 logics on SFIA input ■ SFIA input circuit failure
		11				Safety input (SFIB) error	■ Mismatch of CH1/CH2 logics on SFIB input ■ SFIB input circuit failure
		12				Safety input (SFIC) error	■ Mismatch of CH1/CH2 logics on SFIC input ■ SFIC input circuit failure
		13				Safety input (SFID) error	■ Mismatch of CH1/CH2 logics on SFID input ■ SFID input circuit failure
		14				Safety input (SFIE) error	■ Mismatch of CH1/CH2 logics on SFIE input ■ SFIE input circuit failure
	97	18	1	0	0	Safety output (SFOA) error	■ SFOA output circuit failure
		19				Safety output (SFOB) error	■ SFOB output circuit failure
		1A				Safety output (SFOC) error	■ SFOC output circuit failure

- ✓ It is able to check a detail code by alarm history display of SANMOTION MOTOR SETUP software connected to functional safety module.
- ✓ Stops motor by dynamic brake operation when alarms above are detected.
- ✓ All alarms above are not able to clear by alarm reset. To release an alarm state, perform control power cycle.

7.1 List

	Alarm code					Alarm name	Alarm content
	Display	Detail code	3bit output				
			Bit7	Bit6	Bit5		
Functional safety module	98	20	1	0	0	Encoder Connector 1 Disconnection	Incremental encoder signal line break Power supply line break
		21				Encoder Connector 2 Disconnection	Incremental encoder signal line break Power supply line break
		22				Incremental encoder receiving circuit error	Failure of incremental encoder receiving circuit
		23				Absolute encoder receiving circuit error	Failure of absolute encoder receiving circuit
		24				Encoder receiving data error 1	Encoder receiving data error
		25				Encoder receiving data error 2	Incremental encoder receiving data error
	99	27	1	0	0	Position feedback monitoring error	Encoder failure Power line break
	9A	28	1	0	0	5V power overvoltage	Overvoltage of 5V power
		29				5V power undervoltage	Undervoltage of 5V power
	9B	2A	1	0	0	Functional safety module power error 1	Overvoltage of functional safety module internal power
		2B				Functional safety module power error 2	Overvoltage of functional safety module internal power
		2C				Functional safety module power error 3	Overvoltage of functional safety module internal power
		2D				Functional safety module power error 4	Undervoltage of functional safety module internal power
	9C	30	1	0	0	System error	CPU error
		31					ROM error
		32					RAM error
		33					Data flash ROM error
		34					Peripheral register error
		35					Stack pointer error
		36					Sequence monitor error
		37					Redundancy monitor error
		38					FPGAinterface error
		39					FPGA register error
		3A					Control cycle error
		3B					Firmware error
		3D					Amplifier-CPU interface error
		3E					FPGA CRC error
		3F					Synchronous signal error
	9D	0A	1	0	0	Safe Torque Off function error	Failure of Safe Torque Off circuit

- ✓ It is able to check a detail code by alarm history display of SANMOTION MOTOR SETUP software connected to functional safety module.
- ✓ Stops motor by dynamic brake operation when alarms above are detected.
- ✓ All alarms above are not able to clear by alarm reset. To release an alarm state, perform control power cycle.
- ✓ For a detail of alarm not written in this instruction manual, refer the instruction manual of each servo amplifiers. For manual number of each servo amplifier, refer the section "1.1.1 Servo amplifier instruction manual".

7. Troubleshooting

7.2 Detail

■ Alarm code 08 (Functional safety module failure)

- Connection error for functional safety module

Status at the time of alarm	Cause		
	1	2	3
Issued during operation.	✓	✓	✓



◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Contact failure of servo amplifier and functional safety module.	■ Replace the servo amplifier.
3	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

■ Alarm code 09 (Functional safety module communication error)

- Serial communication error between functional safety module and servo amplifier

Status at the time of alarm	Cause		
	1	2	3
Issued during operation.	✓	✓	✓



◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Contact failure of servo amplifier and functional safety module.	■ Replace the servo amplifier.
3	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

■ Alarm code 0A (Functional safety module error)

- Self diagnosis error at startup caused by connection between functional safety modules

Status at the time of alarm	Cause		
	1	2	3
Issued when control power is turned ON.	✓	✓	✓



◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Contact failure of servo amplifier and functional safety module.	■ Replace the servo amplifier.
3	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

- Alarm code 96 (Safety input error)
 - Mismatch of CH1/CH2 logics on SFIA - SFIE input
 - SFIA – SFIE input circuit failure



Status at the time of alarm	Cause			
	1	2	3	4
Issued after control power ON.	✓	✓	✓	✓
Issued when safety function works/cancels.	✓	✓	✓	✓

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Connection failure of any of safety input signal SFIA - SFIE.	■ Check the wiring conditions of safety input signal to SF-CN1 or SF-CN2 connector.
2	■ For CH1/CH2 logics of any of safety input signal SFIA - SFIE, it continues mismatch condition 10s or more.	■ To switch safety input ON/OFF, change CH1/CH2 simultaneously.
3	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
4	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

- Alarm code 97 (Safety output error)
 - SFOA - SFOC output circuit failure



Status at the time of alarm	Cause		
	1	2	3
Issued after control power ON.	✓		✓
Issued after control power ON, after a while.		✓	
Issued when safety function works/cancels.	✓		✓

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Internal circuit failure of any of safety output signal SFOA - SFOC.	■ Replace the servo amplifier.
2	■ Although "01: Enable" is set to diagnosis function selection of safety output circuit, but there is no connection to the terminal for safety output diagnosis.	■ Change diagnosis function selection of each safety output signals to invalid. Or, connect wire to the terminal of safety output diagnosis.
3	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

- ✓ Internal circuit failure of safety output signal is detect just when diagnosis function of safety output circuit SFOA - SFOC is valid. Diagnosis function of safety output circuit is able to select at Group1-3 ID02 "Safety output A-C diagnosis function selection".

7. Troubleshooting

- Alarm code 98 (Encoder receiving error)
 - Incremental encoder signal line or power supply line break
 - Failure of incremental encoder receiving circuit
 - Failure of absolute encoder receiving circuit
 - Encoder receiving data error
 - Incremental encoder receiving data error



Status at the time of alarm	Cause				
	1	2	3	4	5
Issued after control power ON.	✓	✓	✓	✓	✓
Issued during operation.	✓	✓	✓	✓	✓

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Encoder cable is not connect to encoder connector (EN1).	■ Connect encoder cable to encoder connector (EN1). ■ Check the wiring conditions of encoder connector.
2	■ Although EN2 is selected for motor encoder but encoder cable is not connect to encoder connector (EN2).	■ Connect encoder cable to encoder connector (EN2). ■ Check the wiring conditions of encoder connector.
3	■ Encoder failure	■ Replace the servo motor.
4	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
5	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

- Alarm code 99 (Position feedback monitoring error)
 - Encoder failure
 - Power line break



Status at the time of alarm	Cause		
	1	2	3
Issued during safety function operation.	✓	✓	✓

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Encoder failure	■ Replace the servo motor.
2	■ Servo motor power disconnection	■ Check the power cable of servo motor and correct it if improper. ■ Replace the servo motor.
3	■ Motor shaft is locked mechanically.	■ Confirm release of holding brake.

- Alarm code 9A (5V power error)
 - Overvoltage or undervoltage of 5V power



Status at the time of alarm	Cause	
	1	2
Issued after control power ON.	✓	✓
Issued during operation.	✓	✓

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

7.2 Detail

- Alarm code 9B (Functional safety module power error)
 - Overvoltage or undervoltage of functional safety module



Status at the time of alarm	Cause	
	1	2
Issued after control power ON.	✓	✓
Issued during operation.	✓	✓

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

- Alarm code 9C (System error)
 - System error of functional safety module
 - Memory error
 - Firmware error



Status at the time of alarm	Cause	
	1	2
Issued after control power ON.	✓	✓
Issued during operation.	✓	✓

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

- Alarm code 9D (Safe Torque Off function error)
 - Failure of Safe Torque Off circuit



Status at the time of alarm	Cause	
	1	2
Issued after control power ON.	✓	✓
Issued during operation.	✓	✓

◆ Corrective actions

	Cause	Investigation and corrective actions
1	■ Defect in internal circuit of servo amplifier.	■ Replace the servo amplifier.
2	■ Malfunction due to noise.	■ Confirm proper grounding of the amplifier. ■ Add ferrite core or similar countermeasures to against noise.

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Outer dimensions

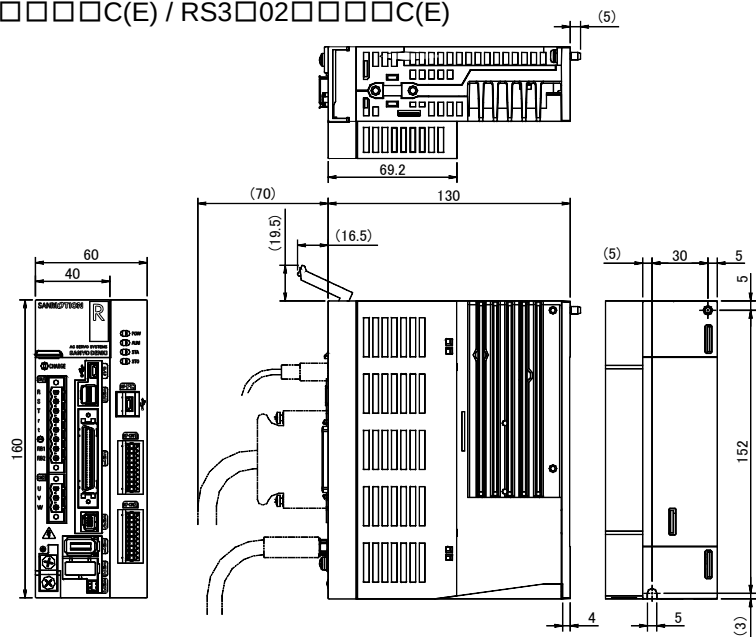
8.1 200V / 100V type	8-1
8.2 400V type	8-5

8. Outer dimensions

Below shows outer dimensions of "SANMOTION R 3E Model Safety" servo amplifier.

8.1 200V / 100V type

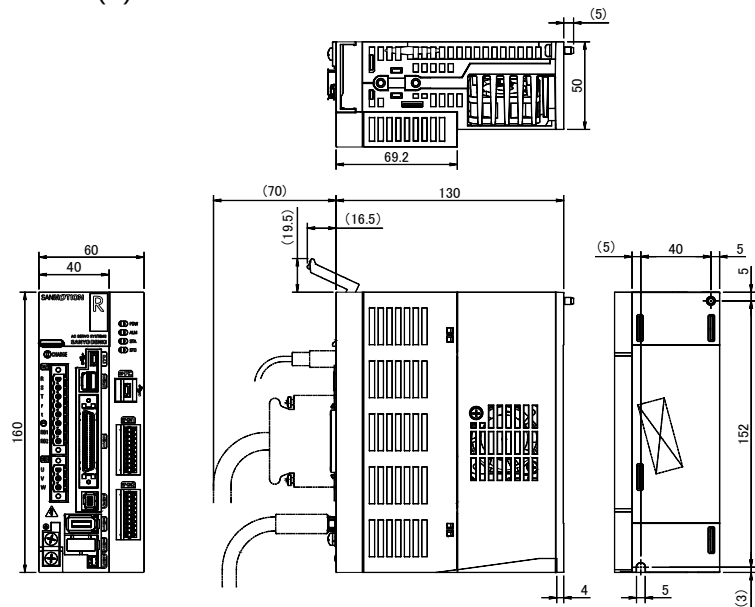
- RS3□01□□□□C(E) / RS3□02□□□□C(E)



Size	
Height (H)	160mm
Width (W)	60mm
Depth (D)	130mm

✓ Increases 20mm for width against standard servo amplifier.

- RS3□03□□□□C(E)

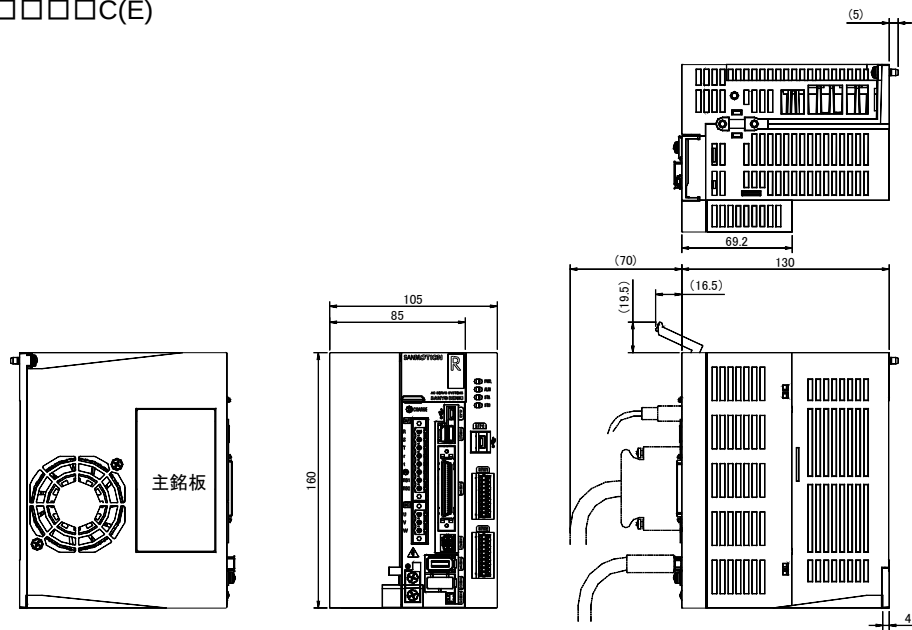


Size	
Height (H)	160mm
Width (W)	60mm
Depth (D)	130mm

✓ Increases 10mm for width against standard servo amplifier.

8.1 200V / 100Vtype

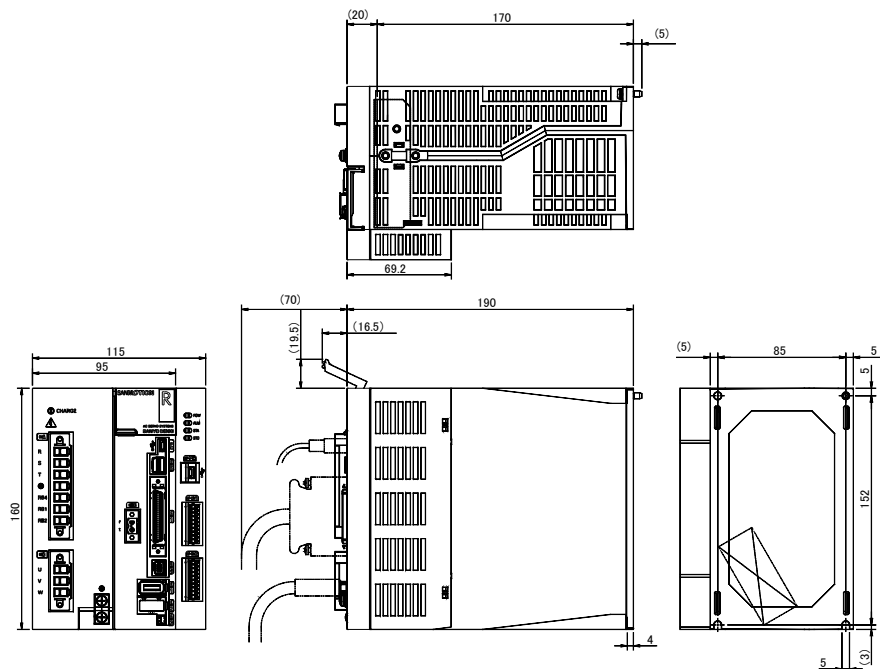
■ RS3A05□□□□C(E)



Size	
Height (H)	160mm
Width (W)	105mm
Depth (D)	130mm

✓ Increases 20mm for width against standard servo amplifier.

■ RS3A07□□□□C(E)

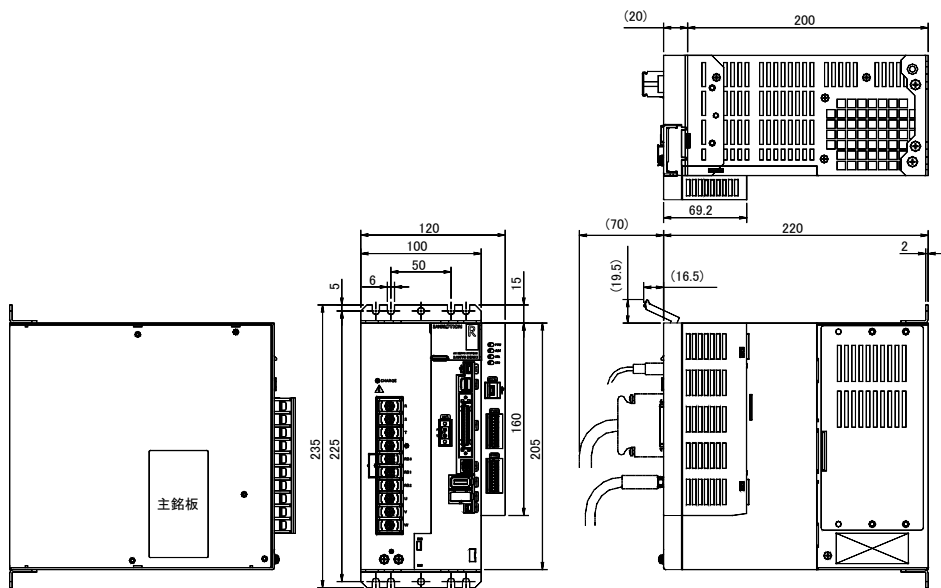


Size	
Height (H)	160mm
Width (W)	115mm
Depth (D)	190mm

✓ Increases 20mm for width against standard servo amplifier.

8. Outer dimensions

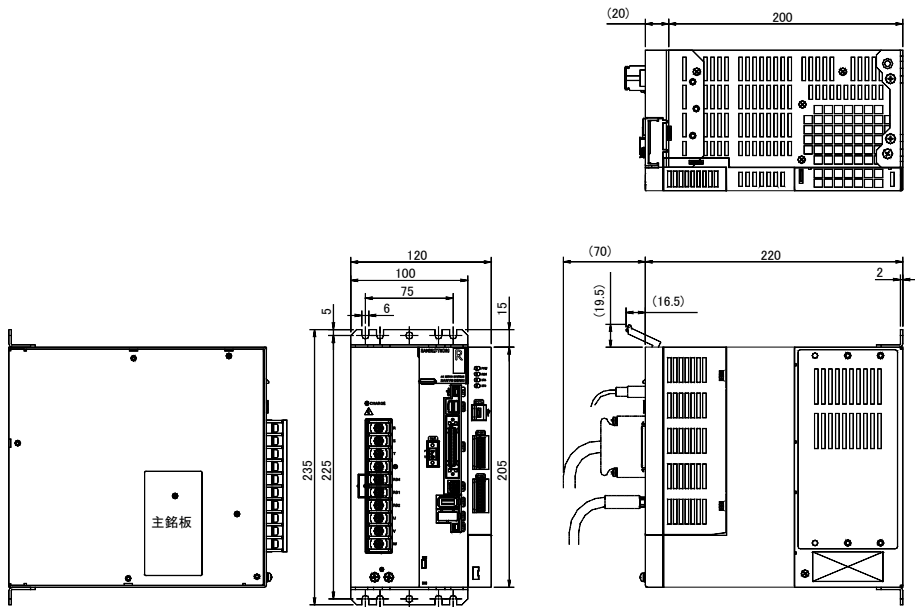
■ RS3A10□□□□C(E)



Size	
Height (H)	205mm
Width (W)	120mm
Depth (D)	220mm

✓ Increases 20mm for width against standard servo amplifier.

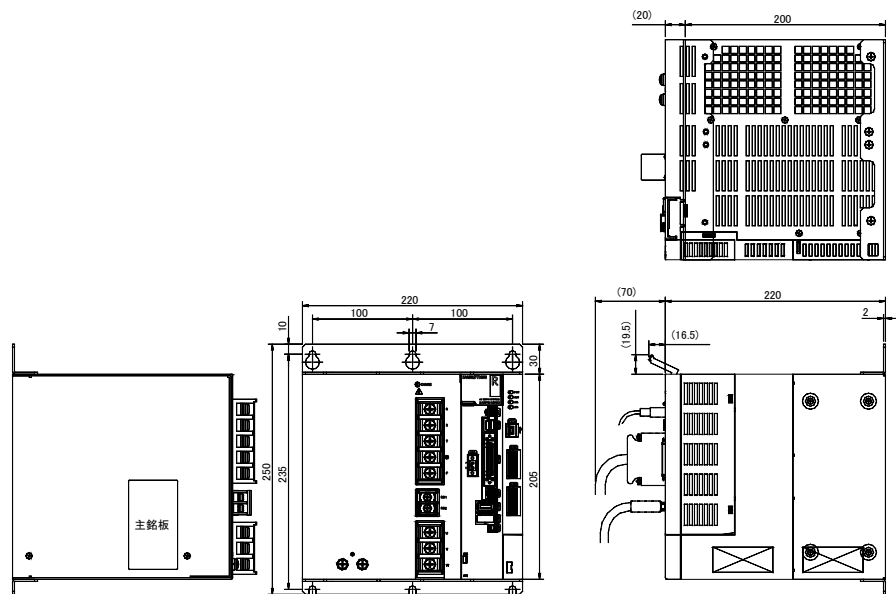
■ RS3A15□□□□C(E)



Size	
Height (H)	205mm
Width (W)	120mm
Depth (D)	220mm

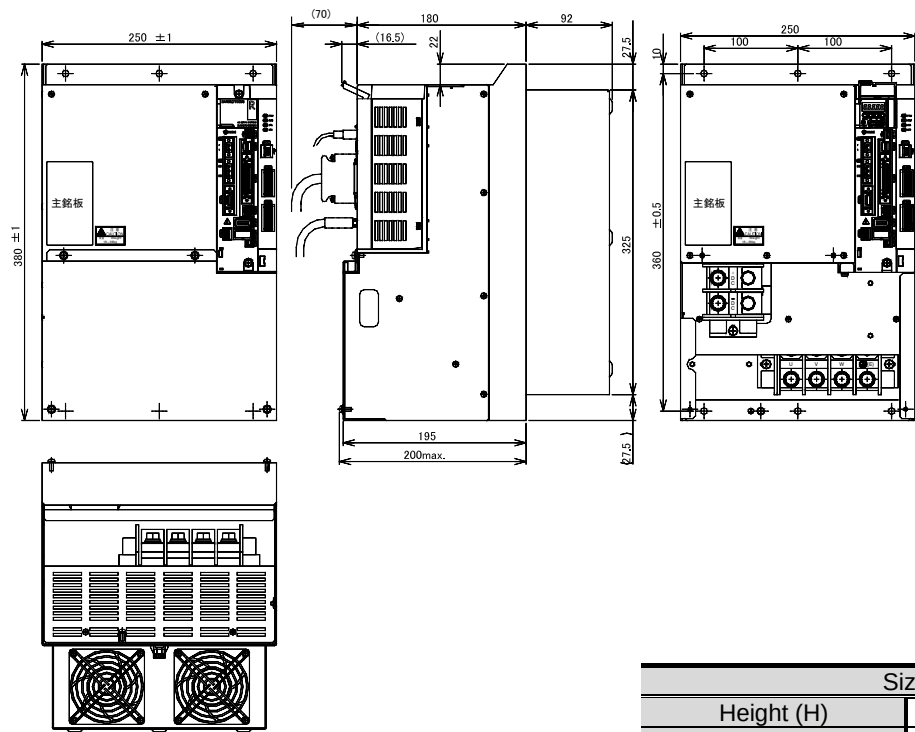
8.1 200V / 100Vtype

■ RS3A30□□□□C(E)



Size	
Height (H)	205mm
Width (W)	220mm
Depth (D)	220mm

■ RS3W60□□□□C(E)



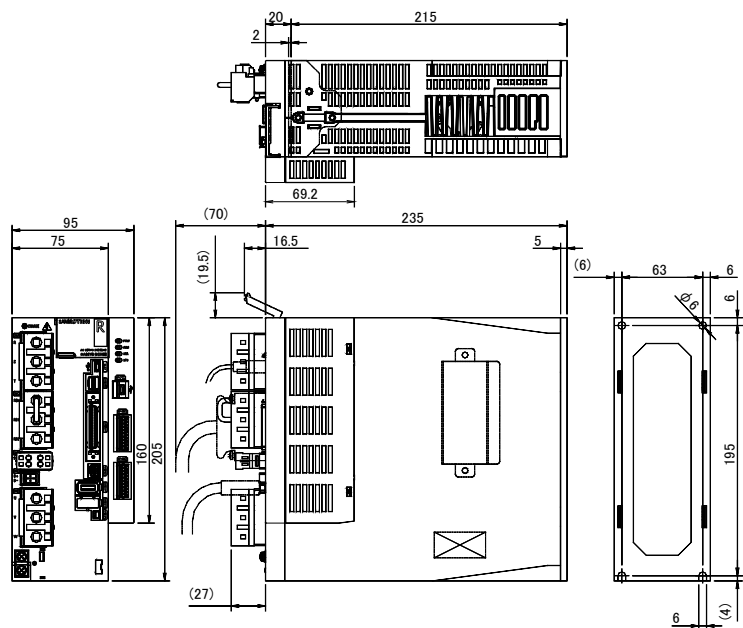
Size	
Height (H)	380mm
Width (W)	250mm
Depth (D)	292mm

Outer dimensions

8. Outer dimensions

8.2 400V type

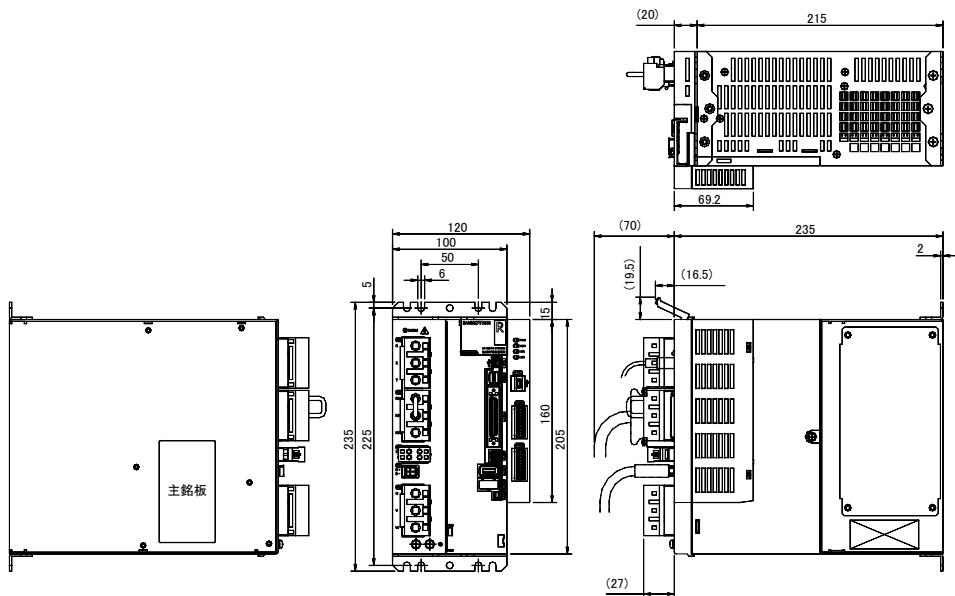
■ RS3C02□□□□C(E)



Size	
Height (H)	205mm
Width (W)	95mm
Depth (D)	235mm

✓ Increases 20mm for width against standard servo amplifier.

■ RS3C05□□□□C(E)

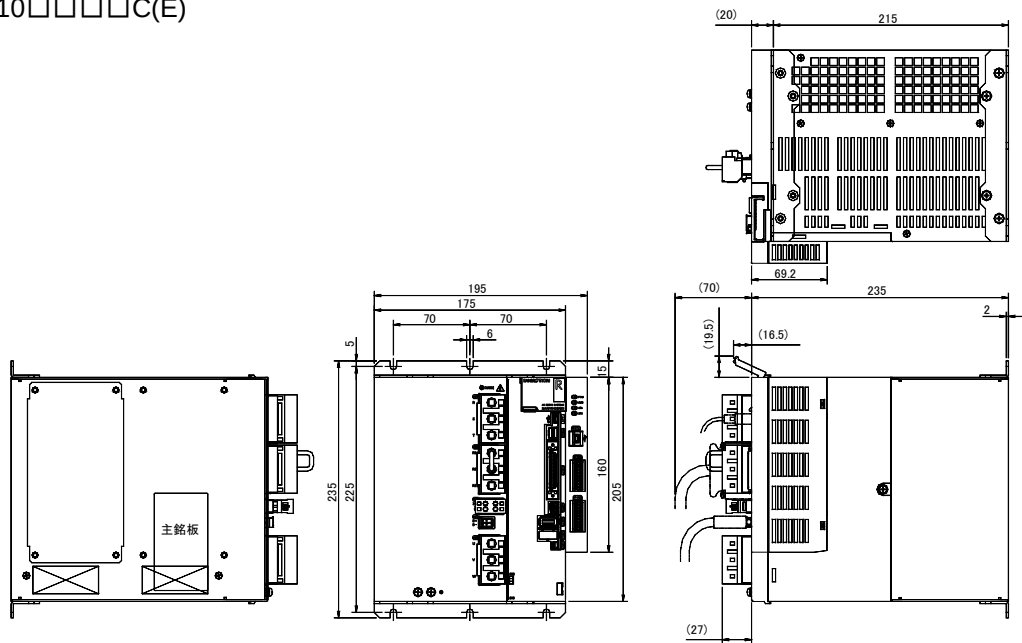


Size	
Height (H)	205mm
Width (W)	120mm
Depth (D)	235mm

✓ Increases 20mm for width against standard servo amplifier.

8.2 400V type

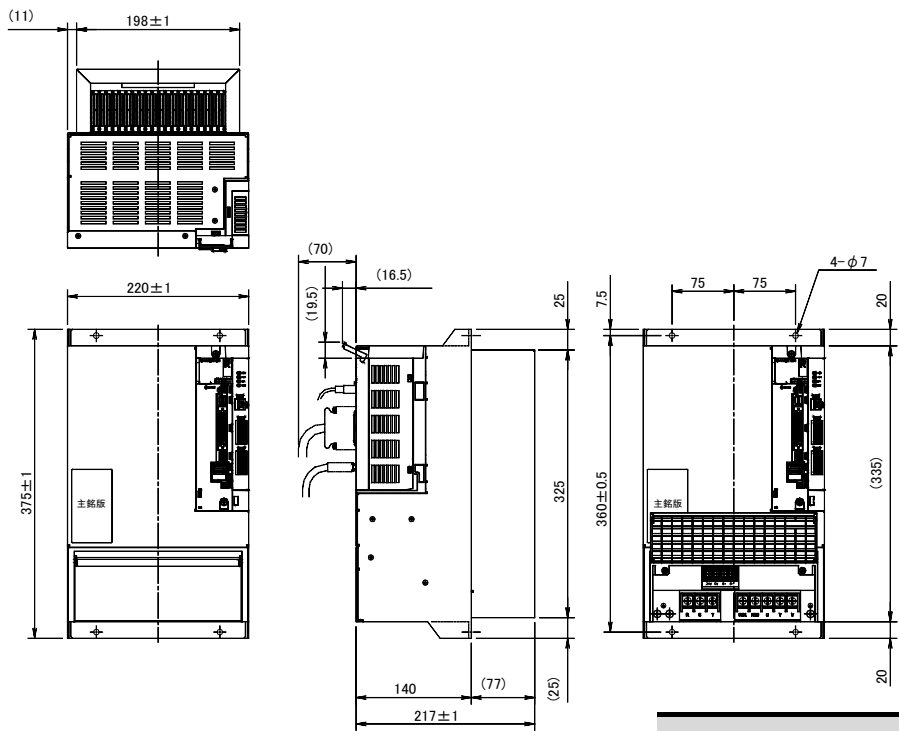
■ RS3C10□□□□C(E)



Size	
Height (H)	205mm
Width (W)	195mm
Depth (D)	235mm

✓ Increases 20mm for width against standard servo amplifier.

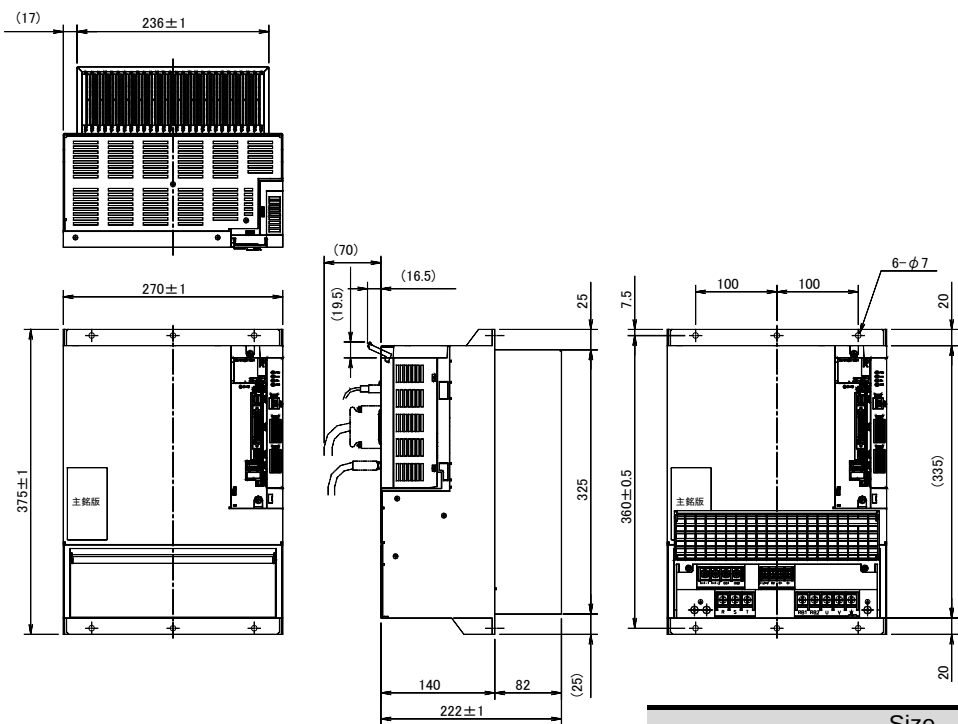
■ RS3C15□□□□C(E)



Size	
Height (H)	375mm
Width (W)	220mm
Depth (D)	217mm

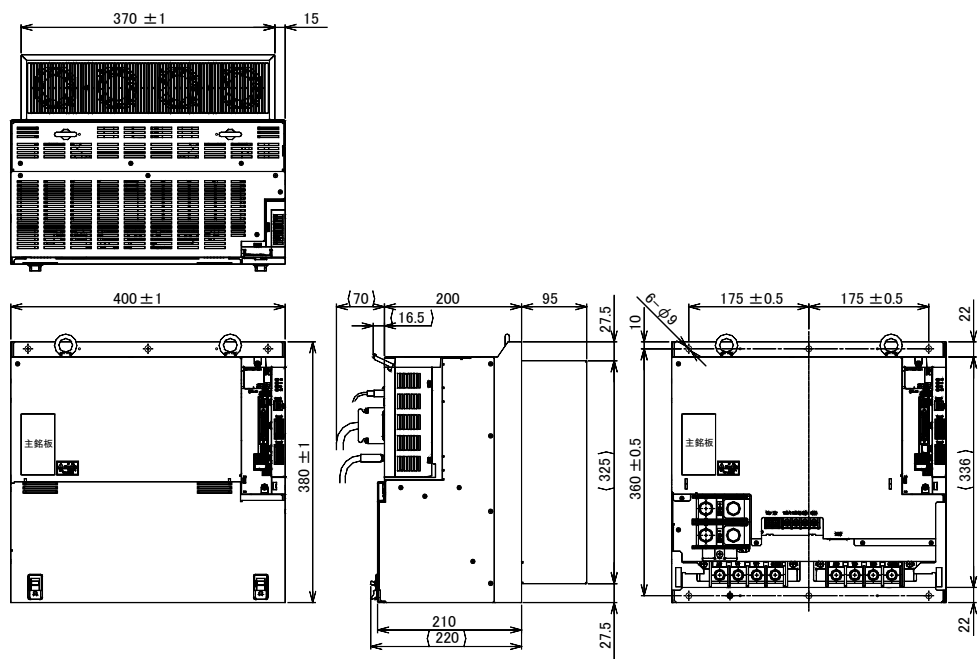
8. Outer dimensions

■ RS3C30□□□□C(E)



Size	
Height (H)	375mm
Width (W)	270mm
Depth (D)	222mm

■ RS3D80□□□□C(E)



Size	
Height (H)	380mm
Width (W)	400mm
Depth (D)	315mm

Standards Conformity

9.1 Standards Conformity	9-1
9.1.1 Standards Conformity	9-1
9.1.2 Over-voltage Category, Protection Grade, Pollution Level	9-2
9.1.3 Connection and installation	9-2
9.1.4 UL File Number	9-2
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9.2.1 Conformity verification test	9-3
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9. Standards Conformity

9.1 Standards Conformity

9.1.1 Standards Conformity

Applicable laws and Regulations		Standard code	Certificate authorities
Class	Detailed class		
UL/c-UL standards	-	UL61800-5-1	UL (Underwriters Laboratories inc.) 
Electrical safety	Low Voltage Directive: LVD (2014/35/EU)	IEC61800-5-1 EN61800-5-1	TÜV (TÜV SÜD Japan, Ltd.) 
Functional safety	Generic Functional Safety	EN61508	TÜV (TÜV SÜD Japan, Ltd.)  (Blue octagon)
	Functional safety standards: FS (2006/42/EC)	IEC62061 EN62061	
	Functional safety standards: FS (2006/42/EC)	ISO13849-1 EN ISO13849-1	
	Functional safety standards: FS (2006/42/EC)	IEC61800-5-2 EN61800-5-2	
EMC	EMC directive (2014/30/EU)	IEC61800-3 EN61800-3	
		IEC61000-6-4 EN61000-6-4	
		IEC61000-6-2 EN61000-6-2	
		EN55011 (Group1 Class A)	
	Functional safety EMC	IEC61326-3-1 EN61326-3-1	
		IEC61000-6-7 EN61000-6-7	
KC mark		KS C 9610-6-2 KS C 9610-6-4	Ministry of Science, ICT & Future Planning 
RoHS Directive (2011/65/EU as amended by (EU)2015/863)		IEC 63000:2018 EN 63000:2018	—

Note 1) Category of this standard is C2.

Warning: In a domestic environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.

9.1 Standards Conformity

9.1.2 Over-voltage Category, Protection Grade, Pollution Level

- The "over-voltage category" of servo amplifier is "III" (EN61800-5-1). For the interface, use a DC power supply with reinforced and insulated input and outputs.
- Make sure to install the servo amplifier in your control panel in an environment where the pollution level specified in EN61800-5-1 and IEC664 is no less than 2 (pollution level 1, 2). The protection grade of servo amplifiers are IP2X for 50A or less and IP1X for 100A or more. The control panel installation configuration (under IP54) must exclude exposure to water, oil, carbon, dust, etc.

9.1.3 Connection and installation

Be careful of connection and installation as follows.

- ✓ Always ground the protective earth terminals of the servo amplifier to the power supply earth.
- ✓ When connecting grounding wire to the protective earth terminal, always connect one wire in one terminal; never connect jointly with multiple wires or terminals.
- ✓ When connecting the leakage stopper, make sure to connect the protective earth terminal to the power supply earth.
- ✓ Connect earthing wire by using a crimping terminal with insulated tube, so that the connected wire will not touch the neighboring terminals.
- ✓ For wire relays, use a fixed terminal block to connect wires; never connect wires directly.
- ✓ Connect an EMC filter to the input power supply of the unit.
- ✓ Use an EN/ IEC-standard compatible no-fuse Circuit breaker and electromagnetic contactor.
- ✓ Wiring for main circuit power shall be designed as protection circuit, to break power at alarm.

9.1.4 UL File Number

The UL file number is as follows. Can check from the website of UL.
<http://www.ul.com/database/>

- The UL file number of servo amplifier: E179775

9. Standards Conformity

9.2 Compliance with EN Directives

We implement the conformity verification test of "Low Voltage Directive" and "an EMC command" in a certificate authority so that a user's CE Marking acquisition can be performed easily, and servo amplifier CE Marking is done based on the published certificate of attestation.

9.2.1 Conformity verification test

The following conformity verification tests are implemented.

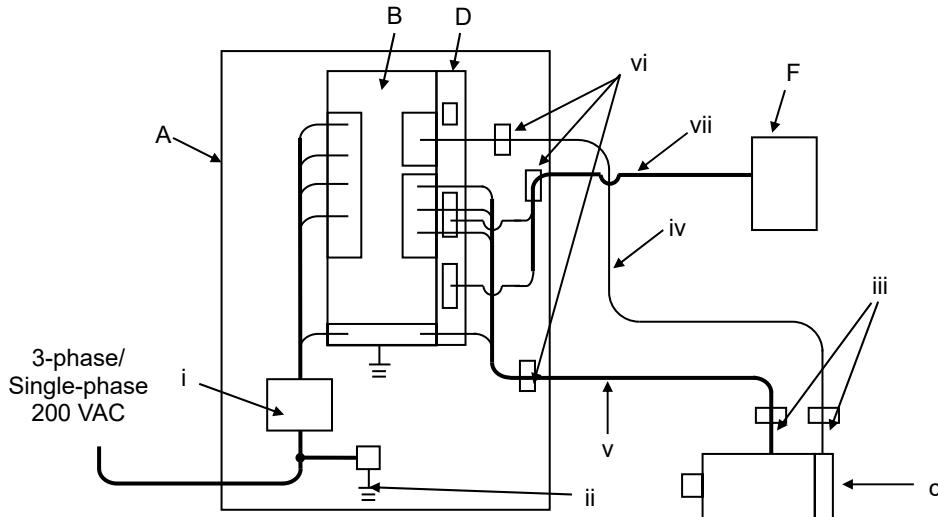
Directive classification	Classification	Test	Test standard
Low voltage Directive (Servo amplifier)	—	—	EN61800-5-1
Low voltage Directive (Servo motor)	—	Rotating electrical machines- Part1: Rating and performance	EN60034-1
		Rotating electrical machines-Part5: Classification of degrees of protection provided by enclosures of rotating electrical machines (IP code)	EN60034-5
EMC Directive (Servo amplifier, servo motor)	Emission	Conducted emission	EN55011
		Radiated emission	EN55011
	Immunity	Electrostatic discharge immunity	EN61000-4-2
		Radiated electromagnetic field immunity	EN61000-4-3
		Electrical first transient/ burst immunity	EN61000-4-4
		Conducted disturbance immunity	EN61000-4-6
		Surge immunity	EN61000-4-5
		Voltage Dips & Interruptions immunity	EN61000-4-11
		Adjustable speed electrical power drive system	EN61800-3
		Safety of machinery	EN62061 (Annex E)
Machinery Directive (Servo amplifier)	—	—	EN ISO13849-1:2015
			EN62061 EN61800-5-2

9.2 Compliance with EN Directives

9.2.2 EMC Installation Requirements

For the installation requirements, in our company the verification test is implemented by the following installations and measures methods, as machines and configurations differ depending on customers' needs. This servo amplifier has been authorized to display CE marking based on the recognition certificate issued by a certifying authority. Customers are instructed to perform the final conformity tests for all instruments and devices in use.

■ 200V Input

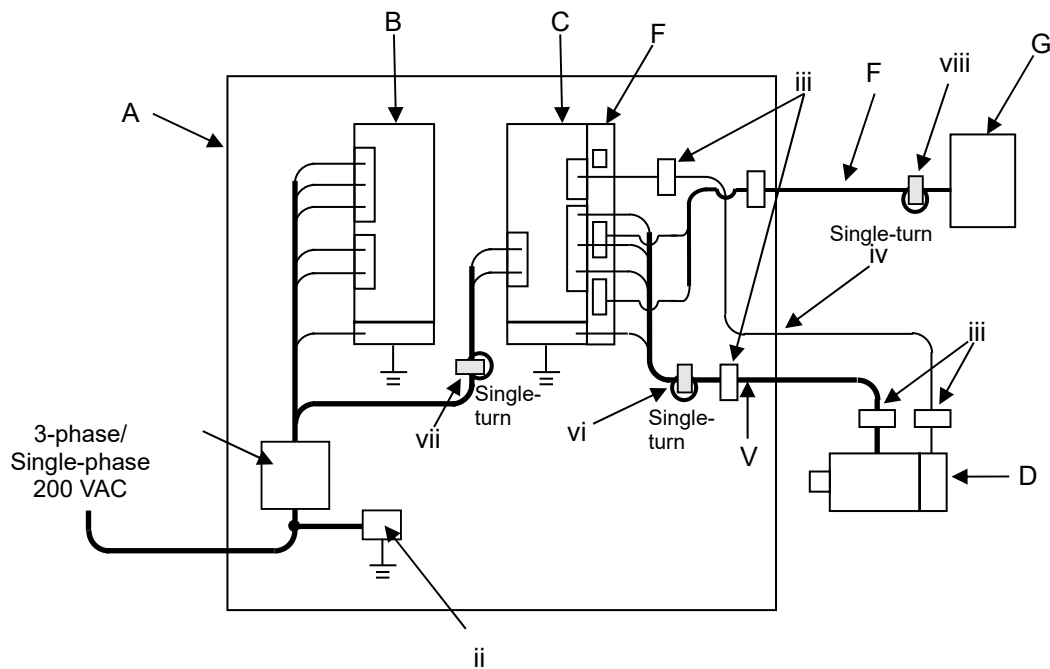


No.	Name	Remarks
A	Control panel	-
B	Servo amplifier	-
C	Servo motor	-
i	Noise filter (Recommended prevention components)	RS3A01 to RS3A07: HF3030C-SZA: SOSHIN ELECTRIC Co. Ltd. Rated voltage/rated current: Line-Line 480V AC / 30A RS3A10 to RS3A15: 3SUPF-CH40M-F: OKAYA ELECTRIC INDUSTRIES CO., LTD. Rated voltage/rated current: Line-Line 500V AC / 40A RS3A30: 3SUPF-CH80M-F: OKAYA ELECTRIC INDUSTRIES CO., LTD. Rated voltage/rated current: Line-Line 500V AC / 40A
ii	Surge-absorber (Recommended prevention components)	LV275DI-U4: OKAYA ELECTRIC INDUSTRIES CO.,LTD.
iii	Clamp grounding	-
iv	Encoder cable	Shield cable
v	Servo motor power cable	Shield cable

- ✓ Use metallic materials for the door and main body of control panel.
- ✓ Use EMI gasket so that there is zero clearance between the door and control panel. Install EMI gasket uniformly to the contact points between door and main body of control panel to confirm their conductivity.
- ✓ Ground the noise filter frame to the control panel.
- ✓ Use shield cables for motor power line and encoder cable. Clamp grounding of shield at the frame of control panel and equipment.
- ✓ Use conducting metal P-clip or U-clip to ground and clamp shielded wire, and fix it directly with metal screws. Do not ground by soldering electric wire to shielded wire.
- ✓ Wire servo amplifier at a short distance from the secondary side of noise filter, and wire the primary side and secondary side of noise filter separately.

9. Standards Conformity

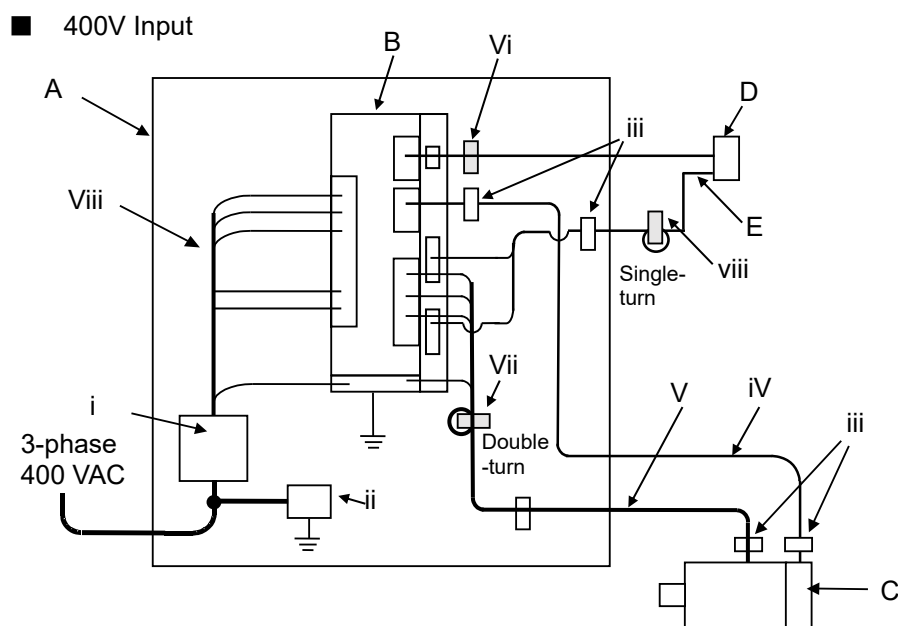
■ 200V Input (600A)



No.	Name	Remarks
A	Control panel	-
B	Power unit	-
C	Amplifier unit	-
D	Servo motor	-
i	Noise filter (Recommended prevention components)	3SUPF-CH150M-F: OKAYA ELECTRIC INDUSTRIES CO., LTD. Rated voltage/rated current: Line-Line 500V AC / 150A
ii	Surge-absorber (Recommended prevention components)	LV275DI-U4: OKAYA ELECTRIC INDUSTRIES CO.,LTD.
iii	Clamp grounding	-
iv	Encoder cable	Shield cable
v	Servo motor power cable	Shield cable

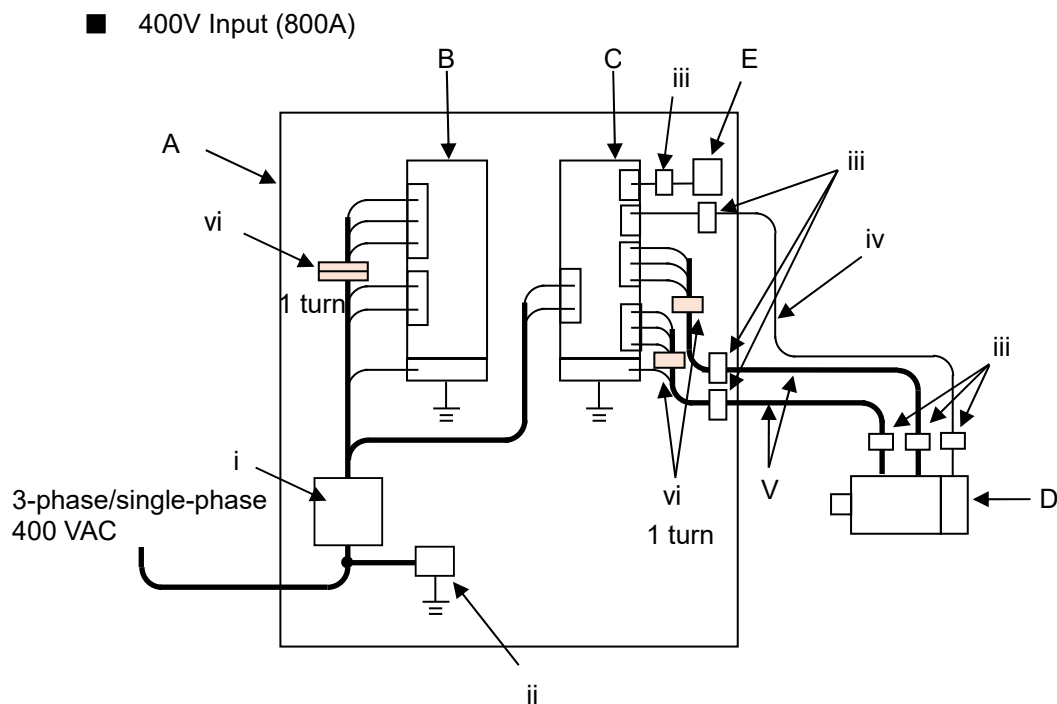
- ✓ Use metallic materials for the door and main body of control panel.
- ✓ Use EMI gasket so that there is zero clearance between the door and control panel. Install EMI gasket uniformly to the contact points between door and main body of control panel to confirm their conductivity.
- ✓ Ground the noise filter frame to the control panel.
- ✓ Use shield cables for motor power line and encoder cable. Clamp grounding of shield at the frame of control panel and equipment.
- ✓ Use conducting metal P-clip or U-clip to ground and clamp shielded wire, and fix it directly with metal screws. Do not ground by soldering electric wire to shielded wire.
- ✓ Wire servo amplifier at a short distance from the secondary side of noise filter, and wire the primary side and secondary side of noise filter separately.

9.2 Compliance with EN Directives



No.	Name	Remarks
A	Control panel	-
B	Servo amplifier	-
C	Servo motor	-
D	Host device	-
i	Noise filter (Recommended prevention components)	RS3C02: HF3010C-SZA: SOSHIN ELECTRIC Co. Ltd. Rated voltage/rated current: Line-Line 500V AC / 10A RS3C05: HF3020C-SZA: SOSHIN ELECTRIC Co. Ltd. Rated voltage/rated current: Line-Line 500V AC / 20A RS3C10: HF3030C-SZA: SOSHIN ELECTRIC Co. Ltd. Rated voltage/rated current: Line-Line 500V AC / 30A RS3C15/30: HF3100C-SZC: SOSHIN ELECTRIC Co. Ltd. Rated voltage/rated current: Line-Line 500V AC / 100A
ii	Surge-absorber (Recommended prevention components)	LV480DI-U4: OKAYA ELECTRIC INDUSTRIES CO.,LTD.
iii	Clamp grounding	-
iv	Encoder cable	Shield cable
v	Servo motor power cable	Shield cable
vi	Sleeve Ferrite Clamp	RS3C02/05/10: GRFC-13 (KITAGAWA INDUSTRIES CO., LTD.)
vii	Split Ferrite Core	RS3C02: E04SR401938 (SEIWA ELECTRIC MFG CO., Ltd.)
viii	Ring core	RS3C15/30: RC5075Y (SOSHIN ELECTRIC Co. Ltd.)

- ✓ Use metallic materials for the door and main body of control panel.
- ✓ Use EMI gasket so that there is zero clearance between the door and control panel. Install EMI gasket uniformly to the contact points between door and main body of control panel to confirm their conductivity.
- ✓ Ground the noise filter frame to the control panel.
- ✓ Use shield cables for motor power line and encoder cable. Clamp grounding of shield at the frame of control panel and equipment.
- ✓ Use conducting metal P-clip or U-clip to ground and clamp shielded wire, and fix it directly with metal screws. Do not ground by soldering electric wire to shielded wire.
- ✓ Wire servo amplifier at a short distance from the secondary side of noise filter, and wire the primary side and secondary side of noise filter separately.
- ✓ Avoid putting each cables redundant at cabinet inside.



No.	Name	Remarks
A	Control panel	—
B	Power unit	—
C	Amplifier unit	—
D	Servo motor	—
E	Upper device	—
i	Noise filter (Recommended prevention components)	HF3200C-SZB-4DEDE: SOSHIN ELECTRIC Co. Ltd. Rated voltage/rated current: Line-Line 500V AC / 200A
ii	Surge-absorber (Recommended prevention components)	LV480DI-U4: OKAYA ELECTRIC INDUSTRIES CO.,LTD.
iii	Clamp grounding	—
iv	Encoder cable	Shield cable
v	Servo motor power cable	Shield cable
vi	Sleeve Ferrite Clamp	RC1100Y: SOSHIN ELECTRIC Co. Ltd.
vii	Split Ferrite Core	E04SR401938: SEIWA ELECTRIC MFG CO. Ltd.

- ✓ Use metallic materials for the door and main body of control panel.
- ✓ Use EMI gasket so that there is zero clearance between the door and control panel. Install EMI gasket uniformly to the contact points between door and main body of control panel to confirm their conductivity.
- ✓ Ground the noise filter frame to the control panel.
- ✓ Use shield cables for motor power line and encoder cable. Clamp grounding of shield at the frame of control panel and equipment.
- ✓ Use conducting metal P-clip or U-clip to ground and clamp shielded wire, and fix it directly with metal screws. Do not ground by soldering electric wire to shielded wire.
- ✓ Wire a power unit at a short distance from the secondary side of noise filter, and wire the primary side and secondary side of noise filter separately.
- ✓ Avoid putting each cables redundant at cabinet inside.

9.2 Compliance with EN Directives

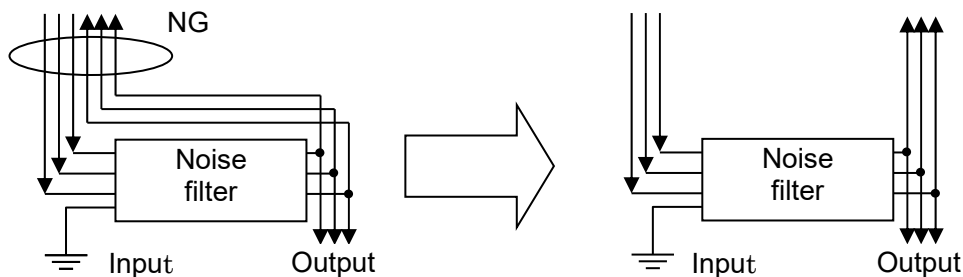
9.2.3 Precautions for noise filter connection

Precautions for noise filter mounting and wiring

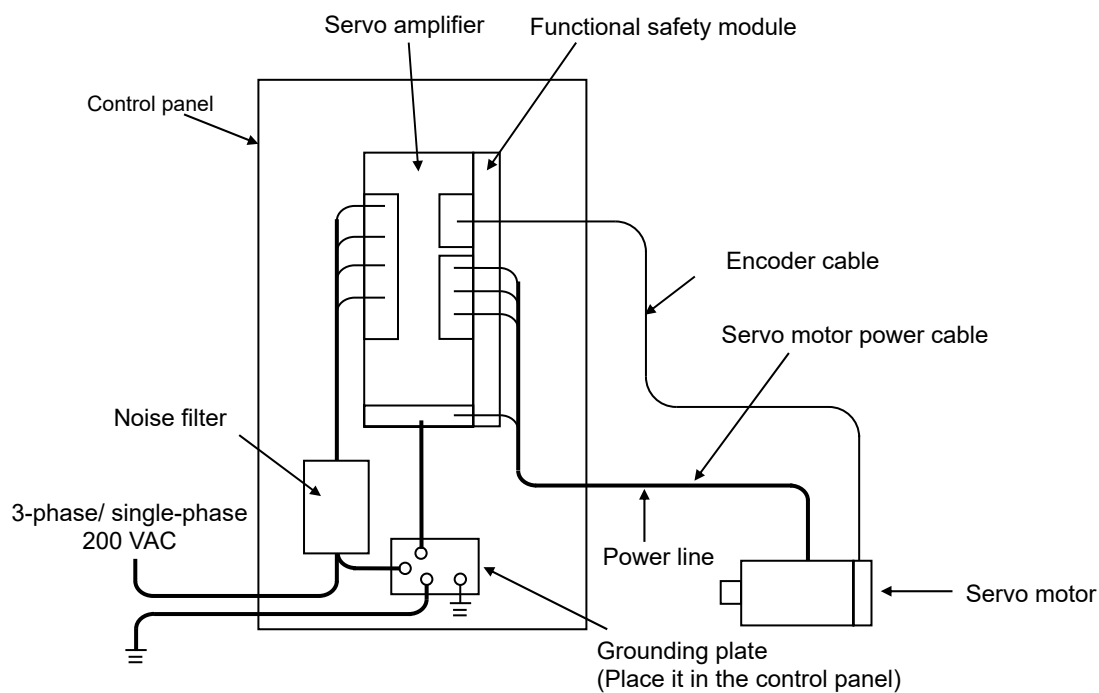
See below precautions for mounting and wiring when noise filter is used.

Do not bundle with input line and output line of noise filter. (Earth line also.)

Avoid that go through a same duct. (It might reduce effect of filter, and noise might come around through that point.)



Each of earth line shall be connected to grounding plate in a control panel by single-point. Also in case of multi axes construction in same control panel, grounding by single-point.



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Release	
Revision A	May. 2017
Revision B	Jun. 2019
Revision C	Jun. 2021
Revision D	May. 2023
Revision E	Sep. 2023



■ECO PRODUCTS

Sanyo Denki's ECO PRODUCTS are designed with the concept of lessening impact on the environment in the process from product development to waste. The product units and packaging materials are designed for reduced environmental impact. We have established our own assessment criteria on the environmental impacts applicable to all processes, ranging from design to manufacture.

■Precautions For Adoption

Failure to follow the precautions on the right may cause moderate injury and property damage, or in some circumstances, could lead to a serious accident.

Always follow all listed precautions.



Cautions

- Read the accompanying Instruction Manual carefully prior to using the product.
- If applying to medical devices and other equipment affecting people's lives please contact us beforehand and take appropriate safety measures.
- If applying to equipment that can have significant effects on society and the general public, please contact us beforehand.
- Do not use this product in an environment where vibration is present, such as in a moving vehicle or shipping vessel.
- Do not perform any retrofitting, re-engineering, or modification to this equipment.
- The Products presented in this Instruction Manual are meant to be used for general industrial applications. If using for special applications related to aviation and space, nuclear power, electric power, submarine repeaters, etc., please contact us beforehand.

* For any question or inquiry regarding the above, contact our Sales Department.

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