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SV680P-INT Series Servo Drive

Functional Safety Guide

Industrial Automation | Intelligent Elevator | New Energy Vehicle | Industrial Robot | Rail Transit

Data code PS00009740A06

Preface

Introduction

This manual describes integrated STO and expansion safety functions.

The SV680N-INT drive comes with Integrated STO as a standard feature.

The safety drive enables a range of safety functions including SS1, SS2, SOS, SDI, SSM, SBC, STO, and SLS. These safety functions can be triggered through connection to external terminals (hereinafter “locally triggered safety functions”).

The safety functions can protect the operator from the danger of moving parts of the machine, improving the personnel safety.

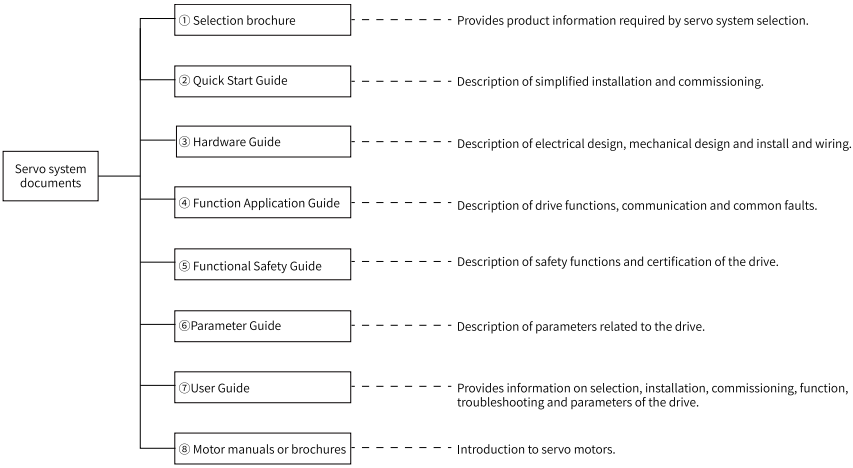
This manual provides information concerning product safety, mechanical and electrical installation, commissioning and maintenance, and safety parameters. Please read this manual carefully before use.

Note

- The drawings in the manual are shown for description only and may not match the product you purchased.
- The instructions are subject to change due to product upgrade, specification modification as well as efforts to increase the accuracy and convenience of the manual.

More documents

The documents related to the drive are shown in the following figure and table.



No.	Name	Data Code	Description
1	SV680-INT Series Flagship Servo Drive	19120362	Provides instructions on product selection, including the list of supporting components, technical data on the drive, and the selection guide of cables.
2	SV680-INT Series Servo Drive Quick Start Guide	PS00015536	Describes the model number, installation, terminals and quick commissioning and operation of the drive.
3	SV680-INT Series Servo Drive Hardware Guide	PS00015494	Describes technical data, installation, terminals, required certificates and standards and solutions to common EMC problems of the drive.
4	SV680-INT Series Servo Drive Function Application Guide	PS00015554	Introduces the functions and faults of the drive, including function overview, adjustment, communication, basic servo functions and fault handling.
5	SV680P-INT Series Servo Drive Functional Safety Guide	PS00009740	Describes the safety function and related certifications and standards, wiring, commissioning process, troubleshooting and parameters of the drive.
	SV680N-INT Series Servo Drive Functional Safety Guide	PS00009768	
6	SV680-INT Series Servo Drive Parameter Guide	PS00015555	Introduces the parameters of the drive, including a parameter list and description of parameters.
7	SV680-INT Series Servo Drive User Guide	PS00018006	Provides information on selection, installation, commissioning, function, troubleshooting and parameters of the equipment.
8	MS1-R Series Servo Motor Selection Guide	PS00004605	Introduces the product information, general specifications, motor selection, cable selection, and required certificates and standards of the servo motor.
	MS1-R Series Servo Motor Installation Guide	PS00005407	Describes installation of the motor, including an installation flowchart, unpacking and transportation, mechanical installation, and electrical installation.
	Direct Drive Motor Module Platform And Drive	19120355	Introduces the product information, general specifications, motor selection, cable selection, and required standards of the motor.

Revision History

Date	Version	Description
2025–04	A06	**Modifications:** • Updated Section 1.3 Safety Standards and Specifications. • Minor corrections.
2024–12	A05	**Added new contents:** Added content on H20.80. **Modifications:** • Updated content on H20.01. • Updated Section 6.1 Overview of safety Features. • Updated content on H20.01 and H20.80. **Note:** To use new and changed functions of this revision, the safety module software version (H20-00) must be 1.20 or higher.
2024–10	A04	• Updated the name of the manual. • Updated Section Selection List. • Minor corrections.
2024–08	A03	• Made minor corrections. • Updated content on parameters. • Updated UL certification requirements for servo drive power cable selection.
2024–05	A02	Minor corrections.
2024–03	A01	Minor corrections.
2023–08	A00	First release.

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version in the following way:

- Visit *www.inovance.com*, go to Support > Download, search by keyword, and then download the PDF file.
- Scan the QR code on the product with your mobile phone.
- Scan the QR code below to install the app, where you can search for and download manuals.

Scope of standard functions

This guide describes function applications. The function scope described in the guide may be different from those of the delivered system.

The system may run functions not described in the guide. If necessary, contact the sales personnel.

The guide does not provide all details on all product models. It does not describe all problems that may be present during device installation, operation and maintenance and their countermeasures. The equipment manufacturer shall provide instructions of the functions added or modified by it.

Warranty

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is not caused by improper operation of the user. You will be charged for any repair work after the warranty period expires.

Within the warranty period,maintenance fee will be charged for the following damage:

- Damage caused by operations not following the instructions in the user guide
- Damage caused by fire, flood, or abnormal voltage
- Damage caused by unintended use of the product
- Damage caused by use beyond the specified scope of application of the product
- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

The maintenance fee is charged according to the latest Price List of Inovance. If otherwise agreed upon, the terms and conditions in the agreement shall prevail.

For details, see the Product Warranty Card.

Table of Contents

Safety Instructions

Disclaimer

- This chapter presents essential safety instructions for a proper use of the equipment. Before operating the equipment, read through the guide and comprehend all the safety instructions. Failure to comply with the safety precautions may result in death, serious injury, or equipment damage.
- "CAUTION", "WARNING", and "DANGER" items in the guide only indicate some of the precautions that need to be followed; they just supplement the safety precautions.
- Use this equipment according to the designated environment requirements. Damage caused by improper use is not covered by warranty.
- Inovance shall take no responsibility for any personal injuries or property damage caused by improper use.

Safety Levels and Definitions

	Indicates that failure to comply with the notice will result in death or severe personal injuries.
	Indicates that failure to comply with the notice may result in death or severe personal injuries.
	Indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage.

Safety Instructions

- Drawings in the guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified first, and then perform operations in accordance with the instructions.
- The drawings in the guide are shown for illustration only and may be different from the product you purchased.
- Users must take mechanical precautions to protect personal safety and wear protective equipment, such as anti-smashing shoes, safety clothing, safety glasses, protective gloves, and protective sleeves.

Unpacking

- Do not install the equipment if you find damage, rust, or signs of use on the equipment or accessories upon unpacking.
- Do not install the equipment if you find water seepage or missing or damaged components upon unpacking.
- Do not install the equipment if you find the packing list does not conform to the equipment you received.

- Check whether the package is intact and whether there is damage, water seepage, dampness, and deformation before unpacking.
- Unpack the package by following the unpacking sequence. Do not strike the package violently.
- Check whether there is damage, rust, or injuries on the surface of the equipment and equipment accessories before unpacking.
- Check whether the package contents are consistent with the packing list before unpacking.

Storage and Transportation

- Large-scale or heavy equipment must be transported by qualified professionals using specialized hoisting equipment. Failure to comply may result in personal injuries or equipment damage.
- Before hoisting the equipment, ensure the equipment components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injuries or equipment damage.
- Never stand or stay below the equipment when the equipment is being hoisted by the hoisting equipment.
- When hoisting the equipment with a steel rope, ensure the equipment is hoisted at a constant speed without suffering from vibration or shock. Do not turn the equipment over or let the equipment stay hanging in the air. Failure to comply may result in personal injuries or equipment damage.

- Handle the equipment with care during transportation and mind your steps to prevent personal injuries or equipment damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply may result in personal injuries.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply will result in equipment damage.
- Avoid storing or transporting the equipment in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing this product for more than three months. Long-term storage requires stricter protection and necessary inspections.
- Pack the equipment strictly before transportation. Use a sealed box for long-distance transportation.
- Never transport the equipment with other equipment or materials that may harm or have negative impacts on this equipment.

Installation

- The equipment must be operated only by professionals with electrical knowledge. Non-professionals are not allowed.

- Read through the guide and safety instructions before installation.
- Do not install this equipment in places with strong electric or magnetic fields.
- Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply will result in mechanical hazards.
- Do not wear loose clothes or accessories during installation. Failure to comply may result in an electric shock.
- When installing the equipment in a closed environment (such as a cabinet or casing), use a cooling device (such as a fan or air conditioner) to cool the environment down to the required temperature. Failure to comply may result in equipment over-temperature or a fire.
- Do not retrofit the equipment.
- Do not fiddle with the bolts used to fix equipment components or the bolts marked in red.
- When this product is installed in a cabinet or terminal equipment, protection measures such as a fireproof enclosure, electrical enclosure, or mechanical enclosure must be provided. The IP rating must meet IEC standards and local laws and regulations.
- Before installing equipments with strong electromagnetic interference, such as a transformer, install a shielding equipment for the equipment to prevent malfunction.
- Install the equipment onto an incombustible object such as a metal. Keep the equipment away from combustible objects. Failure to comply will result in a fire.

- Cover the top of the equipment with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the equipment and causing faults. After installation, remove the cloth or paper on the top of the equipment to prevent over-temperature caused by poor ventilation due to blocked ventilation holes.
- Resonance may occur when the equipment operating at a constant speed executes variable speed operations. In this case, install the vibration-proof rubber under the motor frame or use the vibration suppression function to reduce resonance.

Wiring

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Before wiring, cut off all the power supplies of the equipment. and wait for at least the time designated on the equipment warning label before further operations because residual voltage still exists after power-off. After waiting for the designated time, measure the DC voltage in the main circuit to ensure the DC voltage is within the safe voltage range. Failure to comply will result in an electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board with power ON. Failure to comply will result in an electric shock.
- Check that the equipment is grounded properly. Failure to comply can result in electric shock.

- Do not connect the input power supply to the output end of the equipment. Failure to comply can result in equipment damage or even a fire.
- When connecting a drive to the motor, check that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Cables used for wiring must meet cross sectional area and shielding requirements. The shield of the cable must be reliably grounded at one end.
- Fix the terminal screws with the tightening torque specified in the user guide. Improper tightening torque may overheat or damage the connecting part, resulting in a fire.
- After wiring is done, check that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply may result in an electric shock or equipment damage.

- Follow the proper electrostatic discharge (ESD) procedure and wear an anti-static wrist strap to perform wiring. Failure to comply may result in damage to the equipment or to the internal circuit of the product.
- Use shielded twisted pairs for the control circuit. Connect the shield to the grounding terminal of the equipment for grounding purpose. Failure to comply will result in equipment malfunction.

Power-on

- Before power-on, check that the equipment is installed properly with reliable wiring and the motor can be restarted.
- Check that the power supply meets equipment requirements before power-on to prevent equipment damage or a fire.
- After power-on, do not open the cabinet door or protective cover of the equipment, touch any terminal, or disassemble any unit or component of the equipment. Failure to comply will result in an electric shock.

- Perform a trial run after wiring and parameter setting to ensure the equipment operates safely. Failure to comply may result in personal injuries or equipment damage.
- Before power-on, check that the rated voltage of the equipment is consistent with that of the power supply. Failure to comply may result in a fire.
- Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injuries.

Operation

- The equipment must be operated only by professionals. Failure to comply will result in death or personal injuries.
- Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply will result in an electric shock.

- Do not touch the equipment casing, fan, or resistor with bare hands to feel the temperature. Failure to comply may result in personal injuries.
- Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.

Maintenance

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not maintain the equipment with power ON. Failure to comply will result in an electric shock.
- Before maintenance, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.
- In case of a permanent magnet motor, do not touch the motor terminals immediately after power-off because the motor terminals will generate induced voltage during rotation even after the equipment power supply is off. Failure to comply will result in an electric shock.

- Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.

Repair

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not repair the equipment with power ON. Failure to comply will result in an electric shock.
- Before inspection and repair, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.

- Submit the repair request according to the warranty agreement.
- When the fuse is blown or the circuit breaker or earth leakage current breaker (ELCB) trips, wait for at least the time designated on the equipment warning label before power-on or further operations. Failure to comply may result in death, personal injuries or equipment damage.
- When the equipment is faulty or damaged, the troubleshooting and repair work must be performed by professionals that follow the repair instructions, with repair records kept properly.
- Replace quick-wear parts of the equipment according to the replacement instructions.
- Do not use damaged equipment. Failure to comply may result in death, personal injuries, or severe equipment damage.
- After the equipment is replaced, check the wiring and set parameters again.

Disposal

- Dispose of retired equipment in accordance with local regulations and standards. Failure to comply may result in property damage, personal injuries, or even death.
- Recycle retired equipment by observing industry waste disposal standards to avoid environmental pollution.

Additional Precautions

Cautions for Motor Grounding

For applications such as welding machines, connect the PE cable of the motor to the screws of the cast component of the drive. Failure to comply may result in damage to the motor.

Effect of the electromagnetic field on implants

- The motor may harm a nearby person who wears a medical implant.

- The electromagnetic field may cause malfunction of the medical Implant (such as the heartbeat starter) being used.

Safety label

For safe equipment operation and maintenance, comply with the safety labels on the equipment. Do not damage or remove the safety labels. The following table describes the meaning of the safety labels.

Safety label	Description
	• Never fail to connect the protective earth (PE) terminal. Read through the guide and follow the safety instructions before use. • Never fail to connect Protective Earth (PE) terminal. Read the manual and follow the safety instructions before use. • Do not touch terminals within 15 minutes after disconnecting the power supply to prevent the risk of electric shock. • Do not touch terminals with 15 minutes after Disconnect the power. Risk of electrical shock. • Do not touch the heatsink with power ON to prevent the risk of burn. • Do not touch the heatsink when power is ON. Risk of burn.

1 General

1.1 List of Safety Functions

Different from a standard drive, a safety-integrated drive can run without additional external components.

The functional safety drive can use the following safety functions

- Safe torque off (STO)
  The STO function immediately shuts off the torque or force output of the motor based on an input signal from an external device. This function corresponds to stop category 0 of IEC/EN 60204-1. If the motor is running when the STO function is activated, it coasts to a stop.
- Safe brake control (SBC)
  The SBC function provides a safe output for controlling external brakes.
- Safe stop 1 (SS1)
  The SS1 function starts deceleration based on an input signal from an external device. After a preset period of time elapses or zero speed is achieved, the STO function will be triggered. This function corresponds to stop category 1 of IEC/EN 60204-1.
  - SS1-t time-monitored SS1
    The motor decelerates to stop according to the input signal of the external device. Then STO is executed after the designated delay time elapsed.
  - SS1-r ramp-monitored SS1
    The motor decelerates to stop according to the input signal of the external device. The deceleration slope is monitored against the specified range. STO is executed when the motor speed is lower than the set limit.
- Safe stop 2 (SS2)
  The SS1 function starts deceleration based on an input signal from an external device. After a preset period of time elapses or zero speed is achieved, the SOS function will be triggered. This function corresponds to stop category 2 of IEC/EN 60204-1.
- Safe operating stop (SOS)
  The SOS function monitors whether the motor stops within the prescribed range for the stop position. The drive is in the closed-loop control mode, and can therefore withstand external forces.
- Safely-limited speed (SLS)
  The SLS function monitors whether the motor speed exceeds a preset speed limit. When the speed is over the limit, torque of the motor will be shut off immediately.
- Safe direction (SDI)

The SDI function prevents the motor shaft from moving in an unintended direction. If the motor rotates in an impermissible direction, the drive stops the motor as quickly as possible.

- Safe speed monitor (SSM)
  The SSM function provides a safe output signal to indicate whether the motor speed is below a prescribed limit to identify, for example, a standstill. The servo provides a safe output signal for further processing.

Safety function characteristics

- The expansion safety functions are controlled by an external device through the local DI. The combination of safety module, SV680P-INT series servo drives, and safety motor supports safety functions (SS1-r/SS1-t/SS2/SOS/SLS/SDI/SSM) in compliance with PL e/ Cat.3 and SIL3. The SS1-r/SS2/SOS/SLS/SDI/SSM features are not available when the safety motor is not used.
- Integrated STO can be triggered by the CN6 terminal on the panel of the drive.
- When using a pulse type servo drive, you can only control the safety functions through the local mode.

Safety functions SS1-r/SS2/SOS/SLS/SDI/SSM require the use of a safety motor, That does not apply to basic safety functions (STO/SBC/SS1-t).

1.2 Terms and Abbreviations

Terms and Abbreviations	Description
Cat.	Safety category It includes B, 1, 2, 3, and 4.
CCF	Common cause failure
DCavg	Average diagnostic coverage (%)
DTI	Diagnostic test interval time
SFF	Safe failure fraction
HFT	Hardware fault tolerance
PFH	Probability of a dangerous Failure per Hour
PL	Performance Level
SC	Systematic capability
SIL	Safety integrity level
T_1	Proof test interval

Terms and Abbreviations	Description
DI	Digital inputs
DO	Digital output
PCB	Printed circuit board
MCU	Micro computer unit
FPGA	Field programmable gate array
MTTFd	Mean time to dangerous failure
SRA	Safety Related Application Parameter
nSRA	Non-SRA parameters
STO	The safe torque off (STO) function brings the machine safely into a no-torque state and prevents it from unexpected start. When the STO function is activated, the servo drive stops according to the preset stop mode (H02.08).

1.3 Safety Standards

Standards compliance

- EC directives and standards
  Low Voltage Directive 2014/35/EU Standard EN 61800-5-1

  EMC Directive 2014/30/EU Standard EN 61800-3: 2018

  Machinery Directive 2006/42/EC (Functional Safety) Standards EN 61800-5-2:2007 and EN 61800-5-2:2017

- Safety standard

Safety standard	Reference
Functional safety	IEC 61508: 2010 ISO 13849-1: 2015 ISO 13849-2: 2012 IEC 62061: 2021 EN 61508: 2010 EN ISO 13849-1: 2015 EN ISO 13849-1: 2023 EN ISO 13849-2: 2012 EN IEC 62061:2021+A1:2024 IEC 60204-1:2016,clause 9.2.2 (Stop Category 0, Stop Category 1, Stop Category 2) EN 60204-1 2018, clause 9.2.2 (Stop Category 0, Stop Category 1, Stop Category 2)
EMC	IEC 61800-5-2: 2016 IEC 61800-3: 2017 IEC 61326-3-1: 2017 IEC 61000-6-7: 2014 EN 61800-5-2: 2017 EN IEC 61800-3: 2018 EN 61326-3-1: 2017 EN 61000-6-7:2015
LVD	IEC 61800-5-1:2007/AMD1:2016 EN 61800-5-1:2007/AMD1:2017

- Safety data

  SV680 series products coming with STO only.

Item	Safety data
SIL	SIL3, IEC 61508 Maximum SIL3, EN IEC 62061
PFH	STO: PFH $\leqslant 0.73\times10^{-9}$[1/h] (0.73% of SIL3)
Cat.	3, EN ISO 13849-1
PL	e, EN ISO 13849-1
DTI	STO: $\leqslant$ 10 ms
MTTFd	645.64 years
DCavg	$\geqslant$90% (medium)
T_1	20 years
mission time	20 years
HFT	1
SC	SC3
MTTR	0 hour
MRT	0 hour

Item	Safety data
Application mode	High demand or continuous mode
Device type	Type B

SV680 series products coming with safe torque off (STO)/safe brake control (SBC)/safe stop 1 (SS1)/safe operating stop (SOS)/safe stop 2 (SS2)/safe limited speed (SLS)/safe speed monitor (SSM) function/safe direction (SDI).

Item	Safety data
SIL	SIL3, IEC 61508 Maximum SIL3, EN IEC 62061
PFH	SS1-t/SBC/STO: PFH ⩽ 6.55×10^{-9}[1/h] (6.55% of SIL3) SS1-r/SS2/SLS/SSM/SDI: PFH ⩽ 19.8×10^{-8}[1/h] (19.8% of SIL3) When all safety features are activated simultaneously: PFH ⩽ 19.8×10^{-9}[1/h] (19.8% of SIL3)
Cat.	3, EN ISO 13849-1
PL	e, EN ISO 13849-1
DTI	STO/SS1/SS2/SOS/SLS/SDI/SSM: ⩽ 20 ms SBC: ⩽ 150 ms per channel
MTTFd	SS1-t/SBC/STO: 639.59 years SS1-r/SS2/SLS/SSM/SDI: 324.24 years
DCavg	⩾90% (medium)
T1	20 years
mission time	20 years
HFT	1
SC	SC3
MTTR	0 hour
MRT	0 hour
Application mode	High demand or continuous mode
Device type	Type B
Safe speed accuracy	2197.98 rpm

Note

- See ISO13849-2: 2012 for failure modes of devices.
- Failure sharing of different failure modes of each device.
- See SN29500 for failure rate of each device.
- The average maximum ambient temperature is 55 °C.
- To know more about the λ_{DD} and λ_{DU} of each safety function, contact Inovance technical support staff.

1.4 Precautions for Use

General Safety Instructions

The chapter contains the warning symbols used in this manual and the safety instructions which you must obey when you install or connect an option module to a drive or inverter. If you ignore the safety instructions, injury, death or damage can occur. Read this chapter before you start the installation.

Any illustrations, photographs, or examples used in this manual are provided as examples only and may not apply to all products to which this manual is applicable.

The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual.

Table 1–1 Warnings, Cautions and Notes

Pictogram	Signal word	Meaning	Consequences in case of disregard
Example:  General hazards  Special hazards e.g. electric shock	DANGER	DANGER	Indicates that failure to comply with the notice will result in death or severe personal injuries
	WARNINGS	Warning	Indicates that failure to comply with the notice may result in death or severe personal injuries
	CAUTION	Note	Indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage
	STOP	Prohibit	Indicates that failure to comply with the notice will result in equipment or environmental damage

- High attention is required for electrical installation and at the system design to avoid hazards either in normal operation or in the event of equipment malfunction.
- System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. They must read the operating instruction and this safety information.

It is the responsibility of the machine builder/OEM/system integrator to make sure that the essential health and safety function requirements specified in the Machinery Directive are met. Risk analysis and risk assessment is needed before using a product. Make sure that adequate measures are taken to eliminate/reduce the relating risks and components chosen must meet the safety requirements.

This section describes the information that needs to be noted before starting operation. Read the following safety precautions, risk assessment information, and limitations before starting operation.

Safety function: Use the safety function after properly understanding all of these information. Incorrect use of safety functions or use of safety functions that are not sufficient to meet the safety requirements of the site may result in personal injury.

Safety Precautions

Carefully read the following important precautions and observe them when using the safety function.

- STO function is not intended as a replacement for the emergency stop function (E-stop). If only the STO function is triggered, with no extra measures taken, the power supply cannot be cut off in emergencies and high-current parts of the motor and drive are still energized, incurring the risk of electric shock or other risks result in electric energy. Therefore maintenance work on electrical parts of the drive or motor can only be carried out after isolating the drive system from the main supply.
- Depending on the standards and requirements for a particular application, it may be possible to use STO as an integral part of an E-stop system. However, its main purpose is for use in a dedicated safety control arrangement whose purpose is to prevent any hazard from occurring, without the use of an E-stop.
- An E-stop is often provided in a machine to allow for unexpected situations where an operator sees a hazard and can take action to prevent an accident.
- The design requirement for an E-stop differs from that of a safety interlock. Generally, the E-stop is required to be independent from any complex or "intelligent" control. It may use purely electromechanical devices to either disconnect the power or initiate a controlled rapid stop using other means such as dynamic or regenerative braking.

Note

- The design of safety-related systems requires specialist knowledge. To ensure that a complete control system is safe, it is necessary for the whole system to be designed according to recognized safety principles. The use of individual sub-systems such as drives with STO function, which are intended for safety-related applications, does not in itself ensure that the complete system is safe.
- The STO function can be used to stop the drive in emergency stop situations.
- In processes without personnel protection, it is recommended not to stop the drive by using the STO function. If a drive running is stopped by using STO, the drive performs a coast-to-stop. If this is not acceptable, the system should be stopped using the correct mode instead of the STO function.
- This publication is a guide to the application of Inovance SV660 series safety functions, and also on the design of safety-related systems for machinery control.
- It is the responsibility of the designer of the end product or application to ensure that it is safe and in compliance with the relevant regulations.

Risk Assessment

- When using the safety functions, perform risk assessment on the servo system in advance. Make sure that the safety integrity level of the standards is met.
- The following residual risks can be present even when the safety functions operate. Therefore, safety must always be given consideration during risk assessment.
- If external forces (such as gravitational force with a vertical axis) are applied when the safety functions are operating, the motor will rotate due to the action of these external forces. Therefore, you must use a separate mechanical brake to secure the motor.

Note

In the case of failure of multiple IGBTs, regardless of whether the STO function is enabled, the servo drive can generate an alignment torque. This torque can cause the motor shaft to rotate within a range of up to 180/p (for a synchronous reluctance motor, the range is 180/2p).

To ensure safety, users should decide all the risk assessments and residual risks in the entire machine equipment. A company and individual who constructed the safety related system must take full responsibility for installation and commissioning of the system. Additionally, when complying with a European machinery directive, the system must acquire safety standards certification as a whole.

Perform all risk assessments and safe level certification to the machine or the system as a whole. It is recommended that a Certification Body final safety certification of the system be used.

The following shows residual risks concerning the safety function of this product.

Common residual risks

- At the shipment to end-users, check the settings of safety related components with programming tools and monitored/displayed contents on display and record and save the setting data concerning the safety observation function and the programming tools you used. Perform them using a check sheet, etc.
- The safety will not be ensured such as in assembling machine until installing, wiring, and adjustment are completed properly. Install, wire, and adjust your system referring to installation guide for each unit.
- Only qualified personnel are authorized to install, start-up, repair or adjust the machines in which these components are installed. Only trained engineers should install and operate the equipment.
- Separate the wiring for safety observation function from other signal wiring.
- Protect the cables with appropriate ways (routing them in a cabinet, using a cable guard, etc.).
- We recommend using a switch, relay, sensor, etc. which comply with safety standards. When using a switch, relay, sensor, etc. which do not comply with safety standards, perform a safety confirmation.
- Keep the required clearance/creepage distance depending on voltage you use.

Residual risks in each function

- **Safe torque off (STO)**
  This function only cuts off the torque of the motor, and does not cut off the power supply of the servo/inverter. Before servicing the servo/inverter, cut off the power supply and ensure that the servo/inverter are not energized.

  You must conduct STO diagnosis every three month by powering off and powering on the drive once, or running the STO function once.

- **Safe brake control (SBC)**
  This function guarantees only that power to mechanic break is properly supplied and abrasion of the brake cannot be detected. Check this function regularly that the mechanic brake can operate. Evaluate whether the holding force of the mechanical brake meets the application requirements. Incorrect use may result in abrasion of brake and personal injury.

- **Safely-limited speed (SLS)**
  - Speed monitoring function guarantees the servo motor speed, but it does not guarantee the actual machine safety speed. Set parameters so that the safe speed of the machine is the same as the safety speed of the specified motor.
  - Check if the speed of the monitored servo axis is the same as the actual speed by using a tachometer, etc. considering the speed includes an error caused by the command and encoder resolution.

- The defect of the mechanical section such as slid of shaft and wanting of a timing belt, etc. is not covered. Be sure to eliminate the risk of mechanical section before operation.
- After speed is over the limit, safety observation error (shut-off signal off) does not occur during the speed error detection time set by the parameter. Make sure that safety can be ensured during this period.
- Adjust the speed limit considering the risk of speed acceleration from an acceptable safe speed to an unacceptable speed due to the system response time.

- **Safe operating stop (SOS)**
  This function is used in applications with external force loads such as vertical axis applications. Servo drive failure can cause axis position hold failure. Evaluate the impact on the system and take hazard reduction or control measures such as mechanical braking.

- **Safe speed monitor (SSM)**
  - Speed monitoring function guarantees the servo motor speed, but it does not guarantee the actual machine safety speed. Set parameters so that the safe speed of the machine is the same as the safety speed of the specified motor.
  - Check if the speed of the monitored servo axis is the same as the actual speed by using a tachometer, etc. considering the speed includes an error caused by the command and encoder resolution.
  - The defect of the mechanical section such as slid of shaft and wanting of a timing belt, etc. is not covered. Be sure to eliminate the risk of mechanical section before operation.
  - After speed is over the limit, safety observation error (shut-off signal off) does not occur during the speed error detection time set by the parameter. Make sure that safety can be ensured during this period.
  - Adjust the speed limit considering the risk of speed acceleration from an acceptable safe speed to an unacceptable speed due to the system response time.

2 Product Information

2.1 Nameplate and Model Number of the Servo Drive

Description of the Model

SV680 ① P ② S ③ 2R8 ④ S ⑤ - GINT ⑥

1 **Series** SV680: SV680 general-purpose servo drive	4 **Rated output current**		5 **Model configuration** I: Standard type S: Functional safety type
2 **Product Type** N: EtherCAT P: Pulse + CANopen	S: 200 V	1R6: 1.6 A 2R8: 2.8 A 5R5: 5.5 A 7R6: 7.6 A 012: 12.0 A 018: 18.0 A 022: 22.0 A 027: 27.0 A	6 **Model configuration** GINT: General (global version) PINT: Backup power supply (global version)
3 **Voltage class** S: 200 V T: 400 V	T: 400 V	3R5: 3.5 A 5R4: 5.4 A 8R4: 8.4 A 012: 12.0 A 017: 17.0 A 021: 21.0 A 026: 26.0 A	

Nameplate

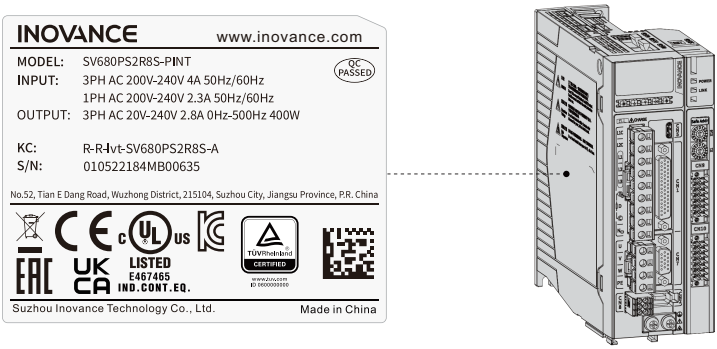


Figure 2-1 Nameplate

Encryption of the production serial number

01050202 4 S 7 00001
① ② ③ ④ ⑤

1 **Internal code** Equipment material code	3 **Year** 9: 2009 A: 2010 ... S: 2024 ... Note: I/L/O/Q is not used.	5 **Lot number** 00001: 1st in current month 00002: 2nd in current month 00003: 3rd in current month ... Range: 00001 to 99999
2 **Manufacturer code** 4: Suzhou Inovance	4 **Month** 1: January 2: February ... A: October B: November C: December	

Example: The S/N 010502024S700001 indicates the drive is manufactured in July, 2024.

Version

SV680 series products coming with STO only.

Model	Board	Version	
SV680XXXXXI(a)	Driver board	Hardware	B00
	Control board	Hardware	A05
		Software	0001.20

SV680 series products coming with safe torque off (STO)/safe brake control (SBC)/safe stop 1 (SS1)/safe operating stop (SOS)/safe stop 2 (SS2)/safe limited speed (SLS)/safe speed monitor (SSM) function/safe direction (SDI).

Model	Board	Version	
SV680XXXXXS(a)	Driver board	Hardware	B00
	Control board	Hardware	A05
		Software	0001.20
	Safety module	Hardware	A11
		Software	0001.20

2.2 Motor Information

Description of the Model

MS1 H1 - 75B 30C B A3 3 1 R - INT
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

1 **MS1 series servo motor**	2 **Inertia and Capacity** H1: low inertia, small capacity H2: low inertia, medium capacity H3: medium inertia, medium capacity H4: medium inertia, small capacity	3 **Rated Power (W)** One letter and two digits B: x 10 C: x 100 Example: 75B: 750 W
4 **Rated speed (rpm)** One letter and two digits B: x 10 C: x 100 Example: 30C: 3,000 rpm	5 **Voltage Class (V)** B: 220 D: 380	6 **Encoder Type** One letter and one digit A6: 26-bit multi-turn absolute encoder S6: 26-bit multi-turn absolute encoder of functional safety type A3: 23-bit multi-turn absolute encoder
7 **Shaft Connection Mode** 3: Solid shaft, with key and threaded hole	8 **Brake, reducer, oil seal** 0: No oil sealing and brake 1: With oil sealing but no brake 2: No oil sealing but with brake 4: With oil sealing and brake	9 **Series** R: R version
		10 **Non-standard Features** INT: Global version

Nameplate

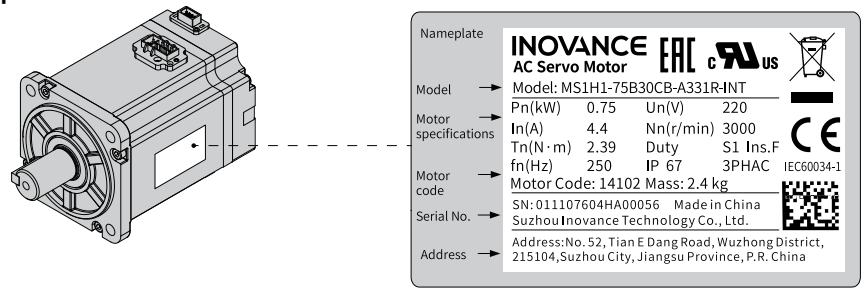


Figure 2-2 Model Number and Nameplate

Note

For models with A3/A6/S6 encoders, a CE/UL/EAC certification mark will be printed on the nameplate.

2.3 Model Number of the Encoder

Description of the Model

E I 35 S 5 - 1024 - B C 30 Y 3 ** - **
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫ ⑬

1 **Sensor**	5 **Shaft Diameter, Hoe Diameter, Magnet Diameter or Gear Modulus** 5: Ø5 62: Ø62 0.4: 0.4M	9 **Operating Voltage (VDC)** 5: 5 30: 10–30
2 **Type** I: Incremental A: Low inertia, medium capacity MI: Incremental magnetic MA: Absolute magnetic	6 **Resolution** 1024: 50–25000P/r B20: single-turn resolution is 20 B20 M16: single-turn resolution is 20, and multi-turn resolution is 16 B26 M16: single-turn resolution is 26, and multi-turn resolution is 16	10 **Sealing** Y: With sealing ring N: Without sealing ring E: With oil seal

3 **Housing Dimensions** 35: Ø35 100: Ø100	7 **Output Signal** B: A, B C: A, B, Z D: A, A[1], B, B E: A, B, B, Z, Z *P: Magnetic pole *T: Weton protocol *A: CANopen protocol *V: DeviceNet protocol *M: Modbus protocol *ML: EtherCAT protocol *J: EtherNet/IP protocol *L: Powerlink protocol *N: Profinet protocol *O: Profisafe protocol *Q: Profibus DP protocol *S: SSI protocol *I: BISS protocol Note: * represents the number of pole pairs, including 2, 3, 4, 6, 8, 10, 12, 16, and 24; if the * is missing, it indicates that the data is unavailable.	11 **Lead Type** 1: Side, rectangular receptacle 2: Rear, rectangular receptacle 3: Side, cable 4: Rear, cable 5: Custom
4 **Shaft Structure** S: Solid H: Hollow M: Semi-hollow N: None C: Outer cone semi-hollow M: Inner cone semi-hollow R: cross coupling	8 **Circuit Output** A: Operational amplifier R: Complementary C: Open-collector V: Voltage 3D: Drive 26C31 5D: Drive 3487 6D: Drive 7272 7D: Drive WX H: Drive WX P: Drive Profibus data interface S: Drive RS422 N: Drive CAN E: Drive Ethernet	12 **Operating Temperature (°C)** _/T: -10 °C to +110 °C 12 **Encoder Type** _: General S: Wiring-saving Z: Single-turn incremental No.: 2, 3, ..., N+1 FS: Special safety model Special Vendor Q: Qunma photocell X: Photocell with slit D: Photocell customization J: High precision correction

Note

- Only the following encoders are evaluated and certified: EA33H6-B26M16-TH5N1T, EA45H8-B26M16-TH5N1T and EA79R8-B26M16-TH5Y3-FS.
- [1]: ¬A represents non-A, and ¬B and ¬Z are non-B, and non-Z.

2.4 Model Number of Cables

Description of power cables

S6-L-M - 0 0 1 - 3.0 - T - INT
① ② ③ ④ ⑤ ⑥ ⑦

1 **Cable Type** S6-L-B/M: motion control power cable B: with brake M: without brake	3 **Motor Power** 0: Frames 25, 40, 60, 80 1: Frames 100, 130, 180 (drive rated current < 13 A) 2: 180 (drive rated current > 13 A)	5 **Cable Length (m)** 3.0: 3 5.0: 5 10.0: 10
2 **Connector type at drive side** 0: Spade tongue terminal 1: Pin terminal	4 **Connector type at motor side** 0: 6-core plastic connector 1: 9-core military-spec connector 2: 6-core military-spec connector 7: SDC-06T series connector (front outgoing) 8: SDC-06T series connector (rear outgoing)	6 **Special requirements** _: Fixed cable T: Drag chain ⩾ 10 million times
		7 **Version** INT: global version*

Note

The material of the global version cables complies with CE and UL certification.

Description of encoder cables

S6-L-P - 1 2 1 - 3.0 - T - INT
① ② ③ ④ ⑤ ⑥ ⑦

1 **Cable Type** S6-L-P: encoder cable	3 **Encoder** 2: Multi-turn absolute	5 **Cable Length (m)** 3.0: 3 5.0: 5 10.0: 10
2 **Connector type at drive side** 1: USB	4 **Connector type at motor side** 0: 9-core plastic connector 1: 9-core military-spec connector 4: SDC-06T series connector (front outgoing) 5: SDC-06T series connector (rear outgoing)	6 **Special requirements** _: Fixed cable T: Drag chain ⩾ 10 million times
		7 **Version** INT: global version*

Note

The material of the global version cables complies with CE and UL certification.

Model number of communication cables

S6-L-T ① - 02 ② - 0.3 ③

1 **Cable Type** S6-L-T: Motion control communication cable	2 **Cable type** 02: Drive-PLC communication cable 04: Servo drive network communication cable (CAT.5E&PROFINET) 07: Servo drive network communication cable (CAT6A&PROFINET) 08: Servo drive network communication cable (CAT7&PROFINET)	3 **Cable Length (m)** 0.3: 0.3 2.0: 2 ...

2.5 Components

Sizes A and C Drives (rated power: 0.2 kW to 1.5 kW)

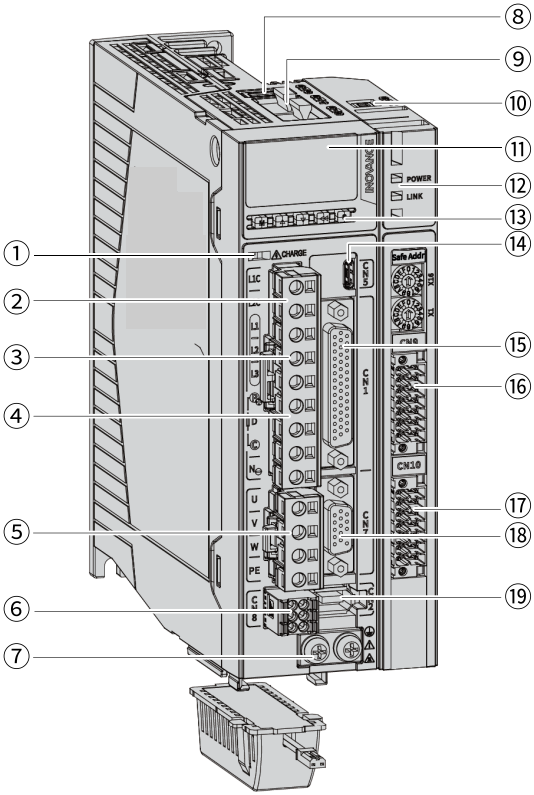


Figure 2-3 Components

Table 2–1 Description of components of servo drive in sizes A and C

No.	Name	Description
1	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
2	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.

No.	Name	Description
3	L1, L2, L3 (main circuit power input terminals)	Power input terminals of the servo drive. See the nameplate for the rated voltage class.
4	P ⊕ , D, C (terminals for connecting external braking resistor)	Remove the jumper bar between terminals P⊕ and C before connecting an external braking resistor between terminals P ⊕ and D.
	P ⊕ , N ⊖ (servo bus terminals)	Used by the common DC bus for multiple servo drives.
5	U, V, W and PE (terminals for connecting the servo motor)	Connected to U, V, and W phases and the grounding terminal of the servo motor.
6	CN8 (brake and PTC input terminal)	Connected to brake and motor temperature feedback.
7	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
8	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose. For the description and function introduction of this terminal, refer to the corresponding function manual and hardware manual.
9	CN3, CN4 (communication terminals)	Connected to RS485 host controllers in parallel.
10	CN11 (24 V standby power input terminal)	When power failure occurs, the standby power functions to help commissioning.
11	LED display	The 5-digit 8-segment LED display is used to show servo system's running state and parameter setting.
12	Power supply indicator of the safety module	Power: When the safety module is connected and the power supply is normal, the indicator is on. Link: Safety communication status indicator. Note: Since the P-type drive does not have FSoE, this indicator is not on.
13	Keys	M: Switches parameters in sequence. ▲: Increases the value of the blinking bit. ▲: Decreases the value of the blinking bit. ◀◀ : Used to shift the blinking bit leftwards (Hold down: Turning to the next page when the displayed number exceeds five digits). S: Saves modifications and enters the next menu.
14	CN5 communication terminal	Supports online upgrade and background commissioning when the drive is powered on. In USB mode, the terminal only supports download and upload of parameters, and driver firmware update; The terminal uses USB power supply. If there is a fault that cannot be completely reset, disconnect the USB power supply and drive control power, and then power on again.

No.	Name	Description
15	CN1 (control terminal)	Used by reference input signals and other I/O signals.
16	CN9 (safety module control terminal A)	Control terminal A of the safety module.
17	CN10 (safety module control terminal B)	Command input and output terminal B of the safety module.
18	CN7 (encoder feedback terminal)	Supports communication encoder and pulse encoder. Supports gantry synchronization.
19	CN2 (encoder feedback terminal)	Supports communication-type encoders. Supports gantry synchronization.

Note

- Built-in braking resistors or jumper bars are not included in S1R6 and S2R8 models. Connect an external braking resistor between terminals P ⊕ and C if needed.
- [1] The power input terminals of the 200V–240V servo drive's main circuit are L1, L2, and L3, you can use any two of which for single-phase input; and the power input terminals of the 380–480V servo drive's main circuit are R, S, and T.

Size D drives (rated power: 1.5 kW to 3.0 kW)

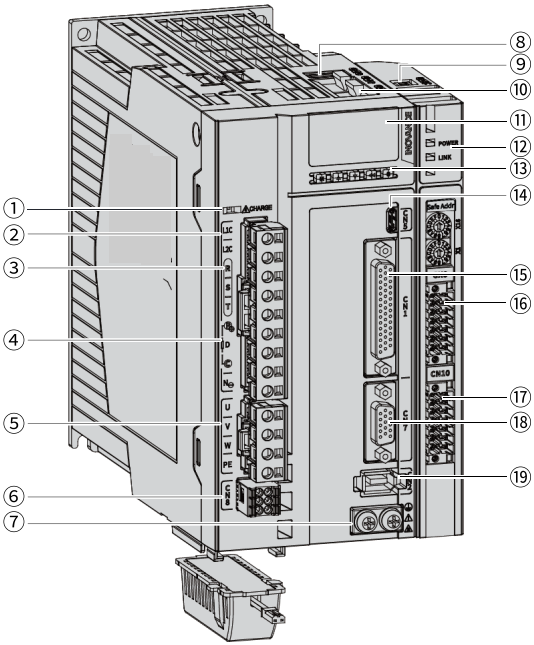


Figure 2-4 Components of servo drives in size D

Table 2–2 Description of components of servo drives in size D

No.	Name	Description
1	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
2	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
3	R, S, T (main circuit power input terminals)	Power input terminals of the servo drive. See the nameplate for the rated voltage class.
4	P ⊕ , D, C (terminals for connecting external braking resistor)	Remove the jumper bar between terminals P ⊕ and D before connecting an external braking resistor between terminals P ⊕ and C.
	P ⊕ , N ⊖ (servo bus terminals)	Used by the common DC bus for multiple servo drives.

No.	Name	Description
5	U, V, W and PE (terminals for connecting the servo motor)	Connected to U, V, and W phases and the grounding terminal of the servo motor.
6	CN8 (brake and PTC input terminal)	Connected to brake and motor temperature feedback.
7	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
8	CN6 STO safety function terminal	Connected to external functional safety signal for functional safety purpose. For the description and function introduction of this terminal, refer to the corresponding function manual and hardware manual.
9	CN11 (24 V standby power input terminal)	When power failure occurs, the standby power functions to help commissioning.
10	CN3, CN4 (communication terminals)	Connected to RS485 host controllers in parallel.
11	LED display	The 5-digit 8-segment LED display is used to show servo system's running state and parameter setting.
12	Power supply indicator of the safety module	Power: When the safety module is connected and the power supply is normal, the indicator is on. Link: Safety communication status indicator. Note: Since the P-type drive does not have FSoE, this indicator is not on.
13	Keys	M: Switches parameters in sequence. ▲: Increases the value of the blinking bit. ▲: Decreases the value of the blinking bit. ◀◀: Used to shift the blinking bit leftwards (Hold down: Turning to the next page when the displayed number exceeds five digits). S: Saves modifications and enters the next menu.
14	CN5 communication terminal	Supports online upgrade and background commissioning when the drive is powered on. In USB mode, the terminal only supports download and upload of parameters, and driver firmware update; The terminal uses USB power supply. If there is a fault that cannot be completely reset, disconnect the USB power supply and drive control power, and then power on again.
15	CN1 (control terminal)	Used by reference input signals and other I/O signals.
16	CN9 (safety module control terminal A)	Control terminal A of the safety module.
17	CN10 (safety module control terminal B)	Command input and output terminal B of the safety module.

No.	Name	Description
18	CN7 (encoder feedback terminal)	Supports communication encoder and pulse encoder. Supports gantry synchronization.
19	CN2 (encoder feedback terminal)	Supports communication-type encoders. Supports gantry synchronization.

Note

- Built-in braking resistors or jumper bars are not included in S1R6 and S2R8 models. Connect an external braking resistor between terminals P ⊕ and C if needed.
- [1] The power input terminals of the 200V–240V servo drive's main circuit are L1, L2, and L3, you can use any two of which for single-phase input; and the power input terminals of the 380–480V servo drive's main circuit are R, S, and T.

Size E Drives (rated power: 2.0 kW to 7.5 kW)

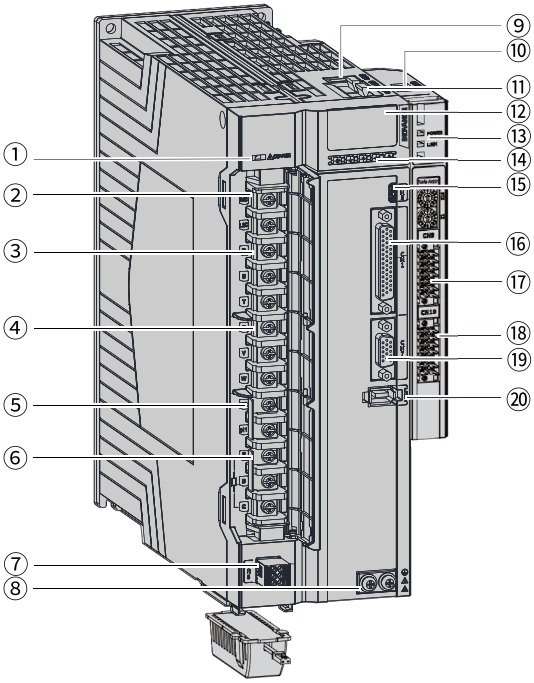


Figure 2-5 Components of servo drives in size E

Table 2–3 Description of components of servo drives in size E

No.	Name	Description
1	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
2	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
3	R, S, T (main circuit power input terminals)	Power input terminals of the servo drive. See the nameplate for the rated voltage class.
4	U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
5	N2, N1 (terminals for connecting external reactor)	Terminals N1 and N2 are jumpered by default. To suppress harmonics in the power supply, remove the jumper between terminals N1 and N2 first and connect an external DC reactor between terminals N1 and N2.
6	P ⊕ , D, C (terminals for connecting external braking resistor)	Remove the jumper bar between terminals P ⊕ and D before connecting an external braking resistor between terminals P ⊕ and C.
7	CN8 (brake and PTC input terminal)	Connected to brake and motor temperature feedback.
8	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
9	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose. For the description and function introduction of this terminal, refer to the corresponding function manual and hardware manual.
10	CN11 (24 V standby power input terminal)	When power failure occurs, the standby power functions to help commissioning.
11	CN3, CN4 (communication terminals)	Connected to RS485 host controllers in parallel.
12	LED display	The 5-digit 8-segment LED display is used to show servo system's running state and parameter setting.
13	Power supply indicator of the safety module	Power: When the safety module is connected and the power supply is normal, the indicator is on. Link: Safety communication status indicator. Note: Since the P-type drive does not have FSoE, this indicator is not on.

No.	Name	Description
14	Keys	M: Switches parameters in sequence. ▲: Increases the value of the blinking bit. ▲: Decreases the value of the blinking bit. ◀◀: Used to shift the blinking bit leftwards (Hold down: Turning to the next page when the displayed number exceeds five digits). S: Saves modifications and enters the next menu.
15	CN5 communication terminal	Supports online upgrade and background commissioning when the drive is powered on. In USB mode, the terminal only supports download and upload of parameters, and driver firmware update; The terminal uses USB power supply. If there is a fault that cannot be completely reset, disconnect the USB power supply and drive control power, and then power on again.
16	CN1 (control terminal)	Used by reference input signals and other I/O signals.
17	CN9 (safety module control terminal A)	Control terminal A of the safety module.
18	CN10 (safety module control terminal B)	Command input and output terminal B of the safety module.
19	CN7 (encoder feedback terminal)	Supports communication encoder and pulse encoder. Supports gantry synchronization.
20	CN2 (encoder feedback terminal)	Supports communication-type encoders. Supports gantry synchronization.

Note

- Built-in braking resistors or jumper bars are not included in S1R6 and S2R8 models. Connect an external braking resistor between terminals P ⊕ and C if needed.
- [1] The power input terminals of the 200V–240V servo drive's main circuit are L1, L2, and L3, you can use any two of which for single-phase input; and the power input terminals of the 380–480V servo drive's main circuit are R, S, and T.

2.6 Selection Table

2.6.1 Selection List [Functional Safety]

Table 2–4 Functional safety drives and compatible functional safety motors

Drive				Motor				
Voltage Class	Size	Recommended Drive Model	H01.10 No.	Motor without Brake	Motor with Brake	Flange Size (mm)	Capacity (kW)	Built-in Safety Encoder
MS1H1 (n_N= 3000 rpm, n_{max}=7000 rpm) series ratings								
Single-phase/ Three-phase 220	A	S1R6	00002	MS1H1-05B30CB-S630R-INT	MS1H1-05B30CB-S632R-INT	40	0.05	EA33H6-B26M16-TH5N1T
				MS1H1-10B30CB-S630R-INT	MS1H1-10B30CB-S632R-INT	40	0.1	EA33H6-B26M16-TH5N1T
				MS1H1-20B30CB-S631R-INT	MS1H1-20B30CB-S634R-INT	60	0.2	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220		S2R8	00003	MS1H1-40B30CB-S631R-INT	MS1H1-40B30CB-S634R-INT	60	0.4	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220	C	S5R5	00005	MS1H1-55B30CB-S631R-INT	-	80	0.55	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220		S5R5	00005	MS1H1-75B30CB-S631R-INT	MS1H1-75B30CB-S634R-INT	80	0.75	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220	C	S7R6	00006	MS1H1-10C30CB-S631R-INT	MS1H1-10C30CB-S634R-INT	80	1.0	EA45H8-B26M16-TH5N1T
MS1H2 (n_N= 3000 rpm, n_{max}= 6000 rpm) series ratings								

Drive				Motor				
Voltage Class	Size	Recommended Drive Model	H01.10 No.	Motor without Brake	Motor with Brake	Flange Size (mm)	Capacity (kW)	Built-in Safety Encoder
Single-phase/ Three-phase 220	C	S7R6	00006	MS1H2-10C30CB-S631R-INT	MS1H2-10C30CB-S634R-INT	100	1.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 400		T3R5	10001	MS1H2-10C30CD-S631R-INT	MS1H2-10C30CD-S634R-INT	100	1.0	EA79R8-B26M16-TH5Y3-FS
Single-phase/ Three-phase 220	D	S012	00007	MS1H2-15C30CB-S631R-INT	MS1H2-15C30CB-S634R-INT	100	1.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 400	C	T5R4	10002	MS1H2-15C30CD-S631R-INT	MS1H2-15C30CD-S634R-INT	100	1.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 200	E	S018	00008	MS1H2-20C30CB-S631R-INT	MS1H2-20C30CB-S634R-INT	100	2.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 400	D	T8R4	10003	MS1H2-20C30CD-S631R-INT	MS1H2-20C30CD-S634R-INT	100	2.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 200	E	S022	00009	MS1H2-25C30CB-S631R-INT	MS1H2-25C30CB-S634R-INT	100	2.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 400	D	T012	10004	MS1H2-25C30CD-S631R-INT	MS1H2-25C30CD-S634R-INT	100	2.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 200	E	S022	00009	MS1H2-30C30CB-S631R-INT	MS1H2-30C30CB-S634R-INT	130	3.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 400	D	T012	10004	MS1H2-30C30CD-S631R-INT	MS1H2-30C30CD-S634R-INT	130	3.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 200	E	S027	00010	MS1H2-40C30CB-S631R-INT	MS1H2-40C30CB-S634R-INT	130	4.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 400		T017	10005	MS1H2-40C30CD-S631R-INT	MS1H2-40C30CD-S634R-INT	130	4.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 200		S027	00010	MS1H2-50C30CB-S631R-INT	MS1H2-50C30CB-S634R-INT	130	5.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 400		T021	10006	MS1H2-50C30CD-S631R-INT	MS1H2-50C30CD-S634R-INT	130	5.0	EA79R8-B26M16-TH5Y3-FS

Drive				Motor				
Voltage Class	Size	Recommended Drive Model	H01.10 No.	Motor without Brake	Motor with Brake	Flange Size (mm)	Capacity (kW)	Built-in Safety Encoder
MS1H3 (n_N=1500 rpm, n_{max}= 4500 rpm) series ratings								
Single-phase/ Three-phase 220	C	S7R6	00006	MS1H3-85B15CB-S631R-INT	MS1H3-85B15CB-S634R-INT	130	0.85	EA79R8-B26M16-TH5Y3-FS
Three-phase 400		T3R5	10001	MS1H3-85B15CD-S631R-INT	MS1H3-85B15CD-S634R-INT	130	0.85	EA79R8-B26M16-TH5Y3-FS
Single-phase/ Three-phase 220	D	S012	00007	MS1H3-13C15CB-S631R-INT	MS1H3-13C15CB-S634R-INT	130	1.3	EA79R8-B26M16-TH5Y3-FS
Three-phase 400	C	T5R4	10002	MS1H3-13C15CD-S631R-INT	MS1H3-13C15CD-S634R-INT	130	1.3	EA79R8-B26M16-TH5Y3-FS
Three-phase 200	D	S018	00008	MS1H3-18C15CB-S631R-INT	MS1H3-18C15CB-S634R-INT	130	1.8	EA79R8-B26M16-TH5Y3-FS
Three-phase 400	D	T8R4	10003	MS1H3-18C15CD-S631R-INT	MS1H3-18C15CD-S634R-INT	130	1.8	EA79R8-B26M16-TH5Y3-FS
Three-phase 200	E	S022	00009	MS1H3-29C15CB-S631R-INT	MS1H3-29C15CB-S634R-INT	180	2.9	EA79R8-B26M16-TH5Y3-FS
Three-phase 400		T012	10004	MS1H3-29C15CD-S631R-INT	MS1H3-29C15CD-S634R-INT	180	2.9	EA79R8-B26M16-TH5Y3-FS
Three-phase 200	E	S027	00010	MS1H3-44C15CB-S631R-INT	MS1H3-44C15CB-S634R-INT	180	4.4	EA79R8-B26M16-TH5Y3-FS
Three-phase 400	E	T017	10005	MS1H3-44C15CD-S631R-INT	MS1H3-44C15CD-S634R-INT	180	4.4	EA79R8-B26M16-TH5Y3-FS
Three-phase 400		T021	10006	MS1H3-55C15CD-S631R-INT	MS1H3-55C15CD-S634R-INT	180	5.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 400		T026	10007	MS1H3-75C15CD-S631R-INT	MS1H3-75C15CD-S634R-INT	180	7.5	EA79R8-B26M16-TH5Y3-FS
MS1H4 (n_N= 3000 rpm, n_{max}=7000 rpm) series ratings								

Drive				Motor				
Voltage Class	Size	Recommended Drive Model	H01.10 No.	Motor without Brake	Motor with Brake	Flange Size (mm)	Capacity (kW)	Built-in Safety Encoder
Single-phase/ Three-phase 220 V	A	S1R6	00002	MS1H4-05B30CB-S630R-INT	MS1H4-05B30CB-S632R-INT	40	0.05	EA33H6-B26M16-TH5N1T
Single-phase/ Three-phase 220 V		S1R6	00002	MS1H4-10B30CB-S630R-INT	MS1H4-10B30CB-S632R-INT	40	0.1	EA33H6-B26M16-TH5N1T
Single-phase/ Three-phase 220 V		S1R6	00002	MS1H4-05B30CB-S631R-INT	MS1H4-05B30CB-S634R-INT	40	0.05	EA33H6-B26M16-TH5N1T
Single-phase/ Three-phase 220 V		S1R6	00002	MS1H4-10B30CB-S631R-INT	MS1H4-10B30CB-S634R-INT	40	0.1	EA33H6-B26M16-TH5N1T
Single-phase/ Three-phase 220 V		S1R6	00002	MS1H4-20B30CB-S631R-INT	MS1H4-20B30CB-S634R-INT	60	0.2	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220 V		S2R8	00003	MS1H4-40B30CB-S631R-INT	MS1H4-40B30CB-S634R-INT	60	0.4	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220 V	C	S5R5	00005	MS1H4-55B30CB-S631R-INT	-	80	0.55	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220 V		S5R5	00005	MS1H4-75B30CB-S631R-INT	MS1H4-75B30CB-S634R-INT	80	0.75	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220 V	C	S7R6	00006	MS1H4-10C30CB-S631R-INT	MS1H4-10C30CB-S634R-INT	80	1.0	EA45H8-B26M16-TH5N1T

Note

Safety functions SS1-r/SLS/SSM/SOS/SS2/SDI require the use of a safety motor, while safety functions SS1-t/STO/SBC do not.

2.6.2 Selection List [Standard]

Motors with a 26-bit encoder

Servo motor				Servo drive SV680-INT (standard)			
Models without brake	Models with Brake	Frame (mm)	Capacity (W) (kW)	Voltage class (V)	Size	Recommended Model	No.
MS1H1 (n_N= 3000 rpm, n_{max}=7000 rpm) series ratings							
MS1H1-05B30CB-A6/ S630R-INT	MS1H1-05B30CB-A6/ S632R-INT	40	0.05	Single-phase/ Three-phase 220 V	A	S1R6	00002
MS1H1-10B30CB-A6/ S630R-INT	MS1H1-10B30CB-A6/ S632R-INT	40	0.1	Single-phase/ Three-phase 220 V			
MS1H1-20B30CB-A6/ S631R-INT	MS1H1-20B30CB-A6/ S634R-INT	60	0.2	Single-phase/ Three-phase 220 V			
MS1H1-40B30CB-A6/ S631R-INT	MS1H1-40B30CB-A6/ S634R-INT	60	0.4	Single-phase/ Three-phase 220 V		S2R8	00003
MS1H1-55B30CB-A6/ S631R-INT	-	80	0.55	Single-phase/ Three-phase 220 V	C	S5R5	00005
MS1H1-75B30CB-A6/ S631R-INT	MS1H1-75B30CB-A6/ S634R-INT	80	0.75	Single-phase/ Three-phase 220 V		S5R5	00005
MS1H1-10C30CB-A6/ S631R-INT	MS1H1-10C30CB-A6/ S634R-INT	80	1.0	Single-phase/ Three-phase 220 V	C	S7R6	00006
MS1H2 (n_N= 3000 rpm, n_{max}= 6000 rpm) series ratings							
MS1H2-10C30CB-A6/ S631R-INT	MS1H2-10C30CB-A6/ S634R-INT	100	1.0	Single-phase/ Three-phase 220 V	C	S7R6	00006
MS1H2-10C30CD-A6/ S631R-INT	MS1H2-10C30CD-A6/ S634R-INT	100	1.0	Three-phase 380 V		T3R5	10001
MS1H2-15C30CB-A6/ S631R-INT	MS1H2-15C30CB-A6/ S634R-INT	100	1.5	Single-phase/ Three-phase 220 V	D	S012	00007
MS1H2-15C30CD-A6/ S631R-INT	MS1H2-15C30CD-A6/ S634R-INT	100	1.5	Three-phase 380 V	C	T5R4	10002
MS1H2-20C30CB-A6/ S631R-INT	MS1H2-20C30CB-A6/ S634R-INT	100	2.0	Three-phase 220 V	E	S018	00008
MS1H2-20C30CD-A6/ S631R-INT	MS1H2-20C30CD-A6/ S634R-INT	100	2.0	Three-phase 380 V	D	T8R4	10003

Servo motor				Servo drive SV680-INT (standard)			
Models without brake	Models with Brake	Frame (mm)	Capacity (W) (kW)	Voltage class (V)	Size	Recommended Model	No.
MS1H2-25C30CB-A6/ S631R-INT	MS1H2-25C30CB-A6/ S634R-INT	100	2.5	Three-phase 220 V	E	S022	00009
MS1H2-25C30CD-A6/ S631R-INT	MS1H2-25C30CD-A6/ S634R-INT	100	2.5	Three-phase 380 V	D	T012	10004
MS1H2-30C30CB-A6/ S631R-INT	MS1H2-30C30CB-A6/ S634R-INT	130	3.0	Three-phase 220 V	E	S022	00009
MS1H2-30C30CD-A6/ S631R-INT	MS1H2-30C30CD-A6/ S634R-INT	130	3.0	Three-phase 380 V	D	T012	10004
MS1H2-40C30CB-A6/ S631R-INT	MS1H2-40C30CB-A6/ S634R-INT	130	4.0	Three-phase 220 V	E	S027	00010
MS1H2-40C30CD-A6/ S631R-INT	MS1H2-40C30CD-A6/ S634R-INT	130	4.0	Three-phase 380 V		T017	10005
MS1H2-50C30CB-A6/ S631R-INT	MS1H2-50C30CB-A6/ S634R-INT	130	5.0	Three-phase 220 V		S027	00010
MS1H2-50C30CD-A6/ S631R-INT	MS1H2-50C30CD-A6/ S634R-INT	130	5.0	Three-phase 380 V		T021	10006
MS1H3 (n_N=1500 rpm, n_{max}= 4500 rpm) series ratings							
MS1H3-85B15CB-A6/ S631R-INT	MS1H3-85B15CB-A6/ S634R-INT	130	0.85	Single-phase/ Three-phase 220 V	C	S7R6	00006
MS1H3-85B15CD-A6/ S631R-INT	MS1H3-85B15CD-A6/ S634R-INT	130	0.85	Three-phase 380 V		T3R5	10001
MS1H3-13C15CB-A6/ S631R-INT	MS1H3-13C15CB-A6/ S634R-INT	130	1.3	Single-phase/ Three-phase 220 V	D	S012	00007
MS1H3-13C15CD-A6/ S631R-INT	MS1H3-13C15CD-A6/ S634R-INT	130	1.3	Three-phase 380 V	C	T5R4	10002
MS1H3-18C15CB-A6/ S631R-INT	MS1H3-18C15CB-A6/ S634R-INT	130	1.8	Three-phase 220 V	E	S018	00008
MS1H3-18C15CD-A6/ S631R-INT	MS1H3-18C15CD-A6/ S634R-INT	130	1.8	Three-phase 380 V	D	T8R4	10003
MS1H3-29C15CB-A6/ S631R-INT	MS1H3-29C15CB-A6/ S634R-INT	180	2.9	Three-phase 220 V	E	S022	00009
MS1H3-29C15CD-A6/ S631R-INT	MS1H3-29C15CD-A6/ S634R-INT	180	2.9	Three-phase 380 V	D	T012	10004
MS1H3-44C15CB-A6/ S631R-INT	MS1H3-44C15CB-A6/ S634R-INT	180	4.4	Three-phase 220 V	E	S027	00010

Servo motor				Servo drive SV680-INT (standard)			
Models without brake	Models with Brake	Frame (mm)	Capacity (W) (kW)	Voltage class (V)	Size	Recommended Model	No.
MS1H3-44C15CD-A6/ S631R-INT	MS1H3-44C15CD-A6/ S634R-INT	180	4.4	Three-phase 380 V	E	T017	10005
MS1H3-55C15CD-A6/ S631R-INT	MS1H3-55C15CD-A6/ S634R-INT	180	5.5	Three-phase 380 V		T021	10006
MS1H3-75C15CD-A6/ S631R-INT	MS1H3-75C15CD-A6/ S634R-INT	180	7.5	Three-phase 380 V		T026	10007
MS1H4 (n_N= 3000 rpm, n_{max}=7000 rpm) series ratings							
MS1H4-05B30CB-A6/ S630R-INT	MS1H4-05B30CB-A6/ S632R-INT	40	0.05	Single-phase/ Three-phase 220 V	A	S1R6	00002
MS1H4-10B30CB-A6/ S630R-INT	MS1H4-10B30CB-A6/ S632R-INT	40	0.1	Single-phase/ Three-phase 220 V		S1R6	00002
MS1H4-05B30CB-A6/ S631R-INT	MS1H4-05B30CB-A6/ S634R-INT	40	0.05	Single-phase/ Three-phase 220 V		S1R6	00002
MS1H4-10B30CB-A6/ S631R-INT	MS1H4-10B30CB-A6/ S634R-INT	40	0.1	Single-phase/ Three-phase 220 V		S1R6	00002
MS1H4-20B30CB-A6/ S631R-INT	MS1H4-20B30CB-A6/ S634R-INT	60	0.2	Single-phase/ Three-phase 220 V		S1R6	00002
MS1H4-40B30CB-A6/ S631R-INT	MS1H4-40B30CB-A6/ S634R-INT	60	0.4	Single-phase/ Three-phase 220 V		S2R8	00003
MS1H4-55B30CB-A6/ S631R-INT	-	80	0.55	Single-phase/ Three-phase 220 V	C	S5R5	00005
MS1H4-75B30CB-A6/ S631R-INT	MS1H4-75B30CB-A6/ S634R-INT	80	0.75	Single-phase/ Three-phase 220 V		S5R5	00005
MS1H4-10C30CB-A6/ S631R-INT	MS1H4-10C30CB-A6/ S634R-INT	80	1.0	Single-phase/ Three-phase 220 V	C	S7R6	00006

Note

Models of drives:

- S: 220 V voltage class
- T: 380 V voltage class
- 1R6: 1.6 A rated output current, 2R8: 2.8 A rated output current..., 026: 26 A rated output current, 027: 27 A rated output current

3 Operating Panel

3.1 Components

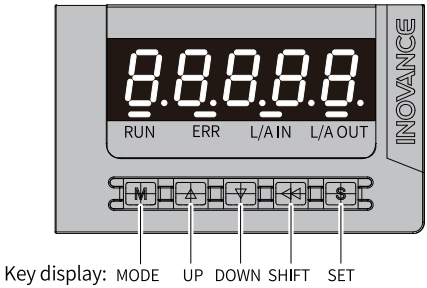


Figure 3-1 Magnified view of the keypad

The operation panel of the SV680N-INT Series servo drive consists of a 5-digit, 8-segment LED screen, 5 keys and 4 status indicators. The keypad is used for value display, parameter setting, user password setting and general function execution.

Keys

The following table takes parameter setting as an example to describe the general functions of the keys.

Table 3–1 Descriptions of keys

Name	Illustration	Description
MODE		Switches among different modes. Returns to the previous menu.
UP		Increases the value of the blinking digit for the LED.
DOWN		Decreases the value of the blinking digit for the LED.
SHIFT		Shifts the blinking digit for the LED. You can view the high digits of the number consisting of more than 5 digits.
SET		Switches to the lower-level menu. Executes commands such as storing parameter setting value.

Indicators

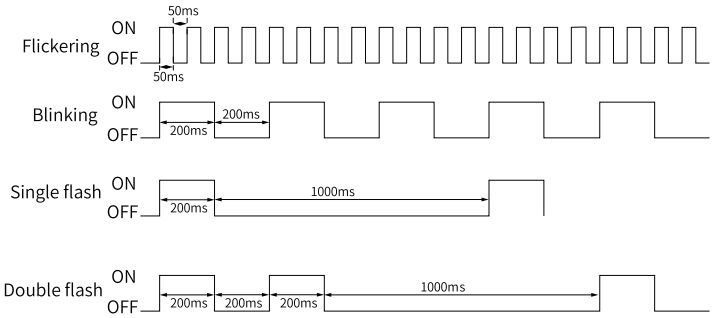


Figure 3-2 Description of indicators

Table 3–2 Description of indicators

Indicator	state	Status Indication
RUN	OFF	Initialization.
	Blinking (on for 200 ms/off for 200 ms)	Pre-Operational.
	Single flash (on for 200 ms/off for 1000 ms)	Safe-Operational.
	ON	Operational.
ERR	OFF	No Network error.
	Blinking (on for 200 ms/off for 200 ms)	Communication setting error.
	Single flash (on for 200 ms/off for 1000 ms)	Sync event error.
	Double flash (on for 200 ms and off for 200 ms, and then on for 200 ms and off for 1000 ms)	Watchdog timeout.
L/A IN indicator[1] L/A OUT indicator	OFF	Link is not established.
	Flickering (on for 50 ms/off for 50 ms)	Link is established. A data transceiving signal is present.
	ON	Link is established. No data transceiving signal is present.

Note

- [1]: L/A IN and L/A OUT indicate the Link state and operation state of the physical layer of each port.
- The ERR light is red when on and the other three indicator lights are green when on.

3.2 Panel Display

The operation panel can display the parameters and faults of the servo drive.

- Parameter display: Displays parameters and their setpoints
- Fault display: Displays faults and alarms that occurred on the servo drive.

Parameter Display

Display	Name	Description
HXX.YY	Parameter	XX: Parameter group No. (Hexadecimal) YY: Offset within the parameter group (decimal)

For example, "H02.00" is displayed as follows.

Display	Name	Description
	H02.00	02: Parameter group No. 00: Offset within the parameter group

Fault Display

- The panel displays the active or history faults and warning codes. For troubleshooting, see section “Troubleshooting" in *SV680-INT Series Servo Drive Function Guide*.
- When a fault or alarm occurs, the operating panel displays the corresponding fault or alarm code immediately. When multiple faults or errors occur, the keypad displays the fault or error code of the highest fault level.
- You can select the previous fault/alarm to be viewed through H0b.33 and view the code of the selected fault/alarm in H0b.34.
- You can clear the latest 20 faults or warnings saved in the servo drive by setting H02.31 to 2.

For example, E941.0 is displayed as follows:

Display	Name	Description
	E941.0 Alarm code	E: A fault or alarm occurs on the servo drive. 941.0: Alarm code

4 Installation

Note

Read through the safety instructions in Chapter "Fundamental Safety Instructions". Failure to comply may result in serious consequences.

- Observe the installation direction described in this chapter. Failure to comply may result in equipment fault or damage.
- Do not install or operate damaged or defective equipment. Failure to comply will result in personal injury.
- Do not install the equipment in environments exposed to water splashes or corrosive gases. Failure to comply will result in equipment fault.
- Do not install the equipment near inflammable gases or combustible objects. Failure to comply will result in a fire or electric shock.
- Install the equipment inside a fire-proof cabinet that provides electrical protection. Failure to comply may result in a fire.
- Ensure the specified clearance is reserved among the drive, the interior surface of the control cabinet, and other machines. Failure to comply will result in a fire or equipment fault.
- Do not put heavy objects on the equipment. Failure to comply may result in personal injury or equipment damage.
- Do not impose large impact on the equipment. Failure to comply may result in equipment damage.
- Do not block the air inlet/outlet of the equipment or allow unwanted objects to fall into the equipment. Failure to comply may result in a fire or equipment fault.

4.1 Unpacking Inspection

Check the following items upon unpacking.

Item	Description
Check whether the delivered product is consistent with your order.	Check whether the servo drive model and specifications comply with your order. See the dimensions of the packing box in *"Table 4–1 " on page 53*. The deliverables include the product, cushion, carton box, and screw bag, as shown in *"Figure 4–1 " on page 53* .
Check whether the product is intact.	Check whether the product delivered is in good condition. If there is any missing or damage, contact Inovance or your supplier immediately.

Table 4–1 Dimensions of the outer packing box

Size	Model	Outer Width (mm)	Outer Height (mm)	Outer Depth (mm)	Weight (kg)
A	S1R6, S2R8	240	193	105	1.28
C	S5R5, S7R6, T3R5, T5R4	230	223	120	1.65
D	S012, T8R4, T012	240	223	145	2.15
E	S018, S022, S027, T017, T021, T026	325	285	165	4.05

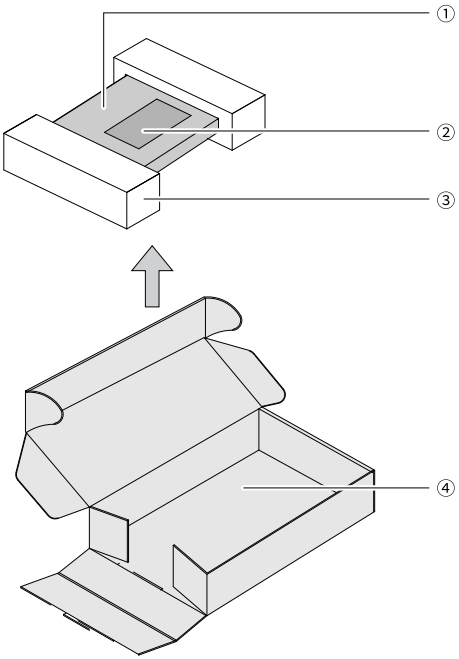


Figure 4-1 Contents inside the packing box

No.	Name
1	Product
2	Terminal accessory package
3	Cushion
4	Carton box

Table 4–2 Terminal accessory package list

Material Code	Name	Quantity
15210577	Plug-in terminal block-plug-spring clamp wiring-9P-black-with safety lock	1
15210648	Plug-in terminal block-plug-spring clamp wiring-2*2P-black-printing on both sides	1
15210695	Plug-in terminal block-plug-spring clamp wiring-4P-black	1
15211052	Plug-in terminal block-plug-spring clamp wiring-3.5mm-2*3P-black-180°-screen printed-RoHS	1
15220274	Jumper bar-16A-pluggable bridge	1
19024735	Labels-labels for servo drive terminals	1
2120021	Plastic parts-plug wiring key-for use with servo drive power plug	1
15212326	Plug-in terminal block-plug-spring clamp wiring-/-3.5mm-1*2P-Orange-180°-RoHS	1
15212114	Plug-in terminal station - plug-and-spring wire-/-3.5mm-2*7P - black-180° - push bar at both sides RoHs	1
15212115	Plug-in terminal station - plug-and-spring wire - NA-3.5mm-2*7P - black-180° - push bar at both sides RoHs	1

Caution

Note that the terminal accessories package list of SV680 is slightly different from that of SV680N.

If you need to purchase the terminal accessory package separately, please contact Inovance. For the material code of the accessory package for each model, see *"Table 4–3 " on page 54*.

Table 4–3 Material code of the accessory package for each model

Material Code	Name
98050838	Accessories (sale)-S6-C158-SV680P size A terminal accessory kit (functional safety)
98050836	Accessories (sale)-S6-C159-SV680P size C/D terminal accessory kit (functional safety)
98050834	Accessories (sale)-S6–C160-SV680P size E terminal accessory kit (functional safety)

4.2 Installation Environment Requirements

Table 4–4 Environment requirements

Item	Requirement
Installation location	Indoor
Grid overvoltage	Overvoltage category (OVC) III
Altitude	The maximum altitude is 2000 m. • For altitudes not higher than 1000 m, derating is not required • Derating is required for altitudes above 1000 m (derate 1% for every additional 100 m) • For altitudes above 2000 m, contact Inovance.
Temperature	• Mounting/Operating temperature: 0°C to +55°C For temperatures between 0°C to 45°C, derating is not required. For temperatures above 45°C, derate 2% for every additional 1°C. • Storage/Transportation temperature: -40°C to +70°C. • To improve the reliability of the machine, use the servo drive in environments without dramatic temperature change. • When installing the servo drive into an enclosed environment such as a control cabinet, use a cooling fan or air conditioner to keep the temperature of the inlet air below 45°C. Failure to comply will result in over-temperature or a fire. • Install the drive on the surface of an incombustible object and leave sufficient surrounding space for heat dissipation. • Take measures to prevent the servo drive from being frozen.
Environment humidity	Below 90% RH (no condensation)
Storage humidity	Below 90% RH (no condensation)
Vibration resistance	Operation: • 5 Hz–8.4 Hz: 3.5 mm displacement • 8.4 Hz–200 Hz: 1g Product package: • 5 Hz–100 Hz: 0.01g^2/Hz • 200 Hz: 0.001g^2/Hz • Grms = 1.14 g
Impact resistance	Below 19.6 m/s^2

Item	Requirement
IP rating	IP20 Note: excluding terminals (IP00)
Environment	Pollution Degree 2 and below Install the servo drive in a place that meets the following requirements: • Free from direct sunlight, dust, corrosive gas, explosive and inflammable gas, oil mist, vapor, water drop, salt corrosion, and radioactive materials. • Not prone to vibration and away from equipment such as punch presses • Free from unwanted objects such as metal powder, oil, and water inside the servo drive • Do not use the equipment in vacuum.

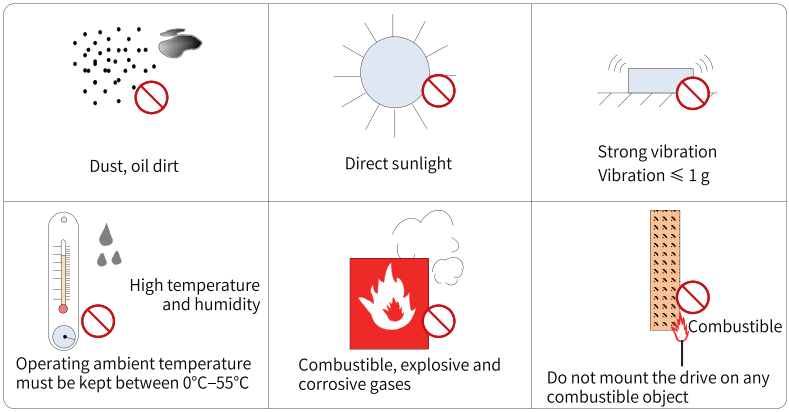


Figure 4-2 Environment requirements

4.3 Installation Clearance

Servo drives in different specifications require different installation clearances. It is recommended to reserve a clearance of at least 10 mm (0.39 in.) between two drives, and a horizontal clearance of at least 20 mm (0.79 in.) and a vertical clearance of 80 mm (3.15 in.) between the drive and cabinet for heat dissipation. Take the installation tolerance into account and reserve a distance of at least 1 mm (0.04 in.) between every two servo drives.

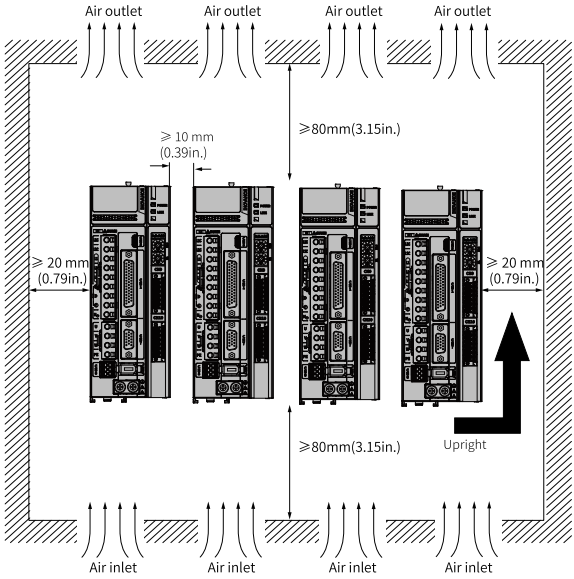


Figure 4-3 Clearance for side-by-side installation

Servo drives in size A support compact installation, in which a clearance of at least 1 mm (0.04 in.) must be reserved between every two drives.

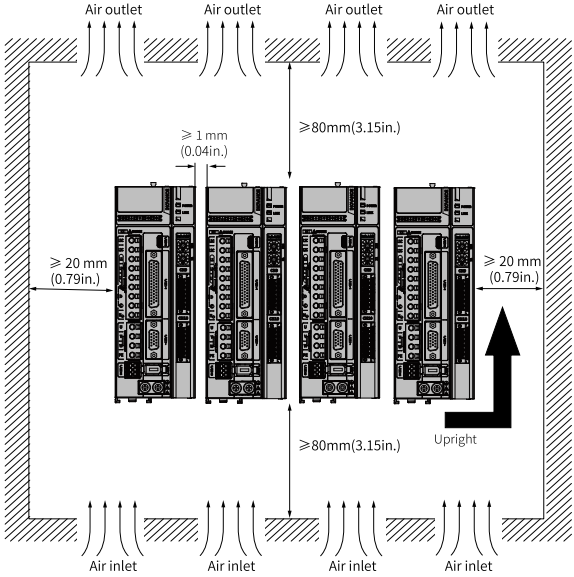


Figure 4-4 Clearance for compact installation

Servo drives in sizes C and D support zero-clearance installation without derating.

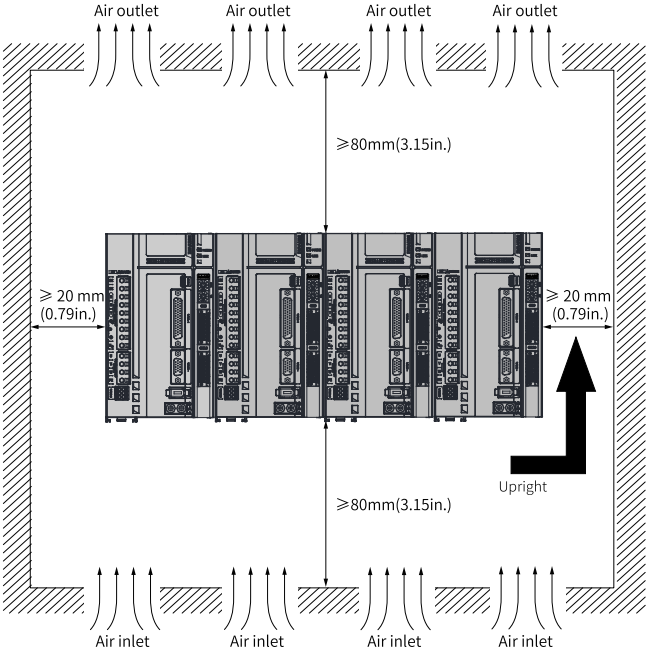


Figure 4-5 Zero-clearance installation

4.4 Safety Dimensions

Size A Drives (rated power: 0.2 kW to 0.4 kW)

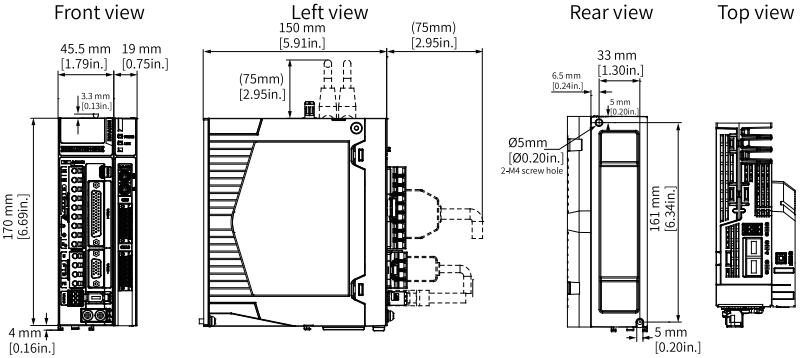


Figure 4-6 Dimensions of Size A

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.11 kg

Size C drives (rated power: 0.75 kW to 1.5 kW)

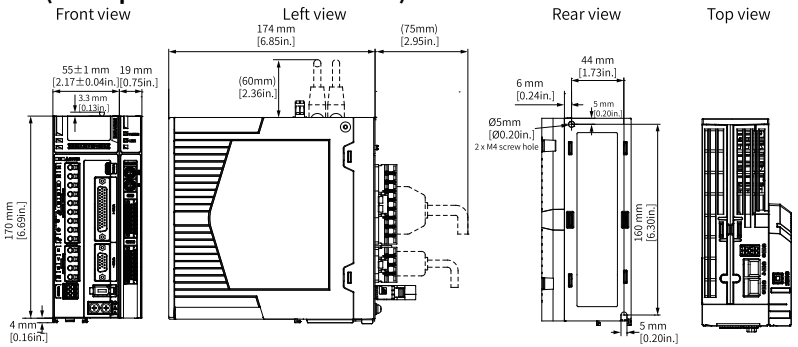


Figure 4-7 Dimensions of Size C

Fixing screw: 2 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.45 kg

Servo drives in size D (rated power: 1.5 kW to 3.0 kW)

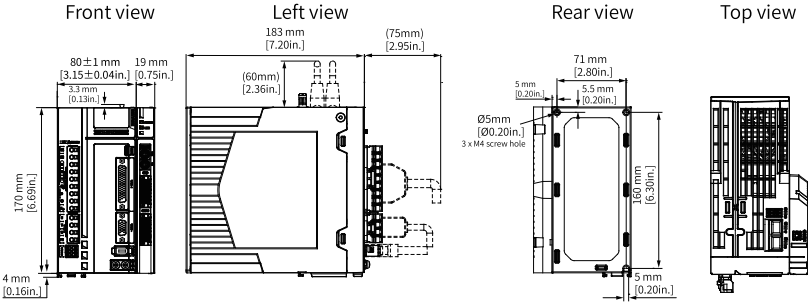


Figure 4-8 Dimensions of Size D

Fixing screw: 3 × M4; recommended tightening torque: 1.2 N·m

Weigh: 1.95 kg

Servo drives in size E (rated power: 2.0 kW to 7.5 kW)

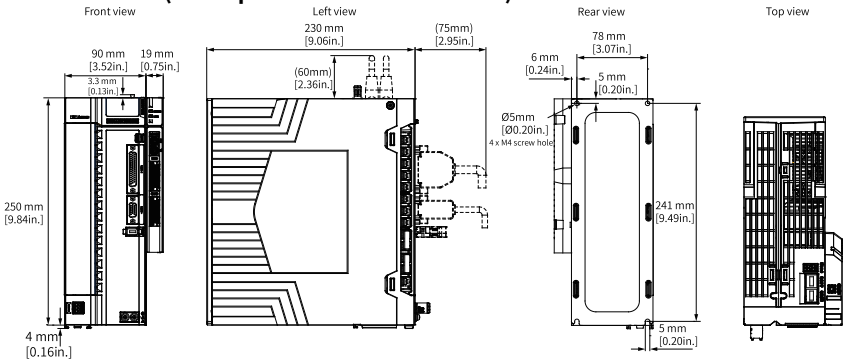


Figure 4-9 Dimensions of Size E

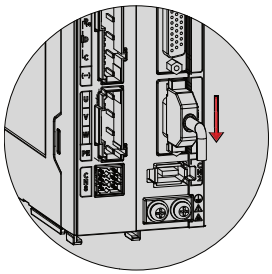
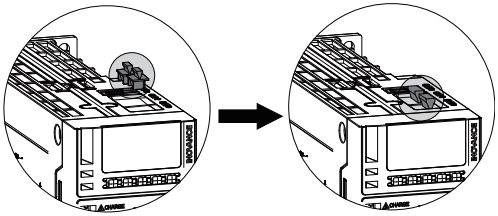
Fixing screw: 4 × M4; recommended tightening torque: 1.2 N·m

Weigh: 3.75 kg

4.5 Installation Precautions

Table 4–5 Installation Precautions

Item	Description
Installation Method	• Install the servo drive vertically and upward to facilitate heat dissipation. For installation of multiple servo drives inside the cabinet, install them side by side. For dual-row installation, install an air guide plate. • Make sure the servo drive is installed vertically to the wall. Cool the servo drive down with natural convection or a cooling fan. Secure the servo drive to the mounting surface through two to four mounting holes (the number of mounting holes depends on the capacity of the servo drive). • Install the servo drive vertically to the wall, with its front (actual mounting face) facing the operator. • The mounting bracket (if needed) must be made of incombustible materials.
Cooling	As shown in *"4.3 Installation Clearance" on page 56*, reserve sufficient space around the servo drive to ensure a good heat dissipation through the cooling fan or natural convection. Take the heat dissipated by other devices inside the cabinet into consideration. Install a cooling fan to the upper part of the servo drive to avoid excessive temperature rise in a certain area, keeping an even temperature inside the control cabinet.
Grounding	Ground the grounding terminal properly. Failure to comply may result in electric shock or malfunction due to interference.

Item	Description
Wiring requirements	As shown in the figure below, route the servo drive cables downwards to prevent liquid from flowing into the servo drive along the cables.  Route the cable connected downwards.
Dust-proof cover (included in the standard configuration)	Insert the dust-proof cover into the communication port (CN3/CN4) not in use. This is to prevent unwanted objects, such as solids or liquids, from falling into the servo drive and resulting in faults. Each servo drive is delivered with two dust-proof covers inserted into the communication ports by default. You can place an order for more dust-proof covers as needed (model: NEX-02-N2B; manufacturer: PINGOOD).  **Note:** • Dust-proof cover: Prevents unwanted objects, such as solids or liquids, from falling into the servo drive and resulting in faults. • Dust-proof covers are delivered along with the servo drive. Keep the dust-proof covers in a proper place.

4.6 Installing the Drive

The servo drive supports backplate mounting only.

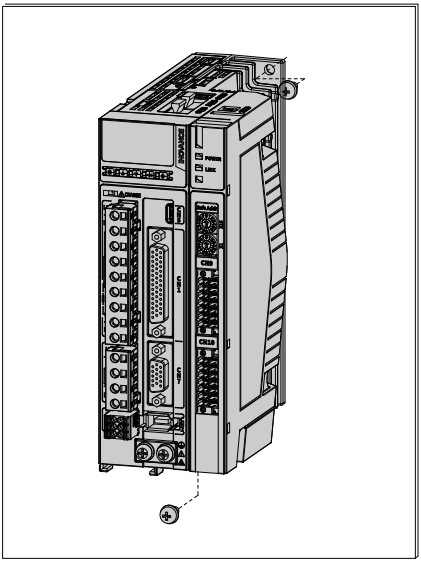


Figure 4-10 Backplate mounting

Note

- Servo drives in sizes A and C are secured by two screws, with one screw on the top and the other one at the bottom.
- Servo drives in size D are secured by three screws, with two screws on the top and another one at the bottom.
- Servo drives in size E are secured by four screws, with two screws on the top and the other two at the bottom.
- M4 screw, tightening torque: 1.2 N · m

5 Wiring

5.1 Wiring Precautions

Read through the safety instructions in Chapter "Fundamental Safety Instructions". Failure to comply may result in serious consequences.

- Do not use the power from IT system for the drive. Use the power from TN/TT system for the drive. Failure to comply may result in an electric shock.
- Connect a electromagnetic contactor between the input power supply and the main circuit power supply of the servo drive (R, S and T) to form a structure which allows independent power cutoff on the servo drive power side. This is to prevent fire accident caused by continuous high current generated upon fault.
- Check that the input power supply of the drive is within the specified voltage range. Failure to comply may result in faults.
- Do not connect the output terminals U, V, and W of the drive to a three-phase power supply. Failure to comply may result in physical injury or a fire.
- Do not connect the motor terminals U, V, and W to a mains power supply. Failure to comply may result in physical injury or a fire.
- The main circuit cable must be away from the motor so that its insulation will not be damaged by high temperature of the motor surface.
- Use the ALM (fault) signal to cut off the main circuit power supply. A faulty braking transistor may overheat the braking resistor and lead to a fire.
- Connect the PE terminal of the drive to the PE terminal of the control cabinet. Failure to comply may result in an electric shock.
- Ground the entire system properly. Failure to comply may result in equipment malfunction.
- After the power supply is cut off, residual voltage is still present in the internal capacitor of the drive, wait for at least 15 min before further operations. Failure to comply may result in an electric shock.

Caution

- The specification and installation of external cables must comply with applicable local regulations.
- Observe the following requirements when the servo drive is used on a vertical axis.
  - Set the safety device properly to prevent the workpiece from falling upon warning or overtravel.
  - Ensure the positive/negative polarity of the 24 V power supply is correct. Otherwise, the axis may fall and cause personal injury or equipment damage.
- Observe the following requirements during wiring of the power supply and main circuit:
  - When the main circuit terminal is a connector, remove the connector from the servo drive before wiring.
  - Insert one cable into one cable terminal of the connector. Do not insert multiple cables into one cable terminal.
  - When inserting cables, take enough care to prevent the cable conductor burrs from being short circuited to the neighboring cable.
  - Insulate the connecting part of the power supply terminals to prevent electric shock.
  - Do not connect a 220 V servo drive to a 380 V power supply directly.
  - Install safety devices such as a circuit breaker to prevent short circuit in external circuits. Failure to comply may result in a fire.
  - Cut off the main circuit power supply and switch off the S-ON signal after an alarm signal is detected.
  - The main circuit cable must be away from the motor so that its insulation will not be damaged by high temperature of the motor surface.
- Connect the servo drive to the motor directly. Do not use an electromagnetic contactor during wiring. Failure to comply may result in equipment fault.
- Do not put heavy objects onto cables or pull cables with excessive force. Failure to comply may result in cable damage, leading to an electric shock.
- When connecting DO terminals to relays, ensure the polarity of the flywheel diode is correct. Wrong polarity will result in equipment damage or signal output failure.
- Keep a distance of at least 30 cm between main circuit cables and I/O signal cables/encoder cables. Failure to comply may result in equipment malfunction.
- Use twisted pairs or multi-conductor shielded twisted pairs as the I/O signal cable or encoder cable. Failure to comply may result in equipment malfunction.
- The maximum wiring lengths of the I/O signal cable and the encoder cable are 3 m and 10 m respectively.
- Use a power supply filter to reduce the electromagnetic interference on electronic devices surrounding the servo drive.
- Take proper shielding measures in the following locations to prevent equipment damage:

- Locations with interference caused by static electricity
- Locations with strong electric field or magnetic field
- Locations with radioactive rays

5.2 Drive Terminals

This section only describes functional terminals of the safety module.

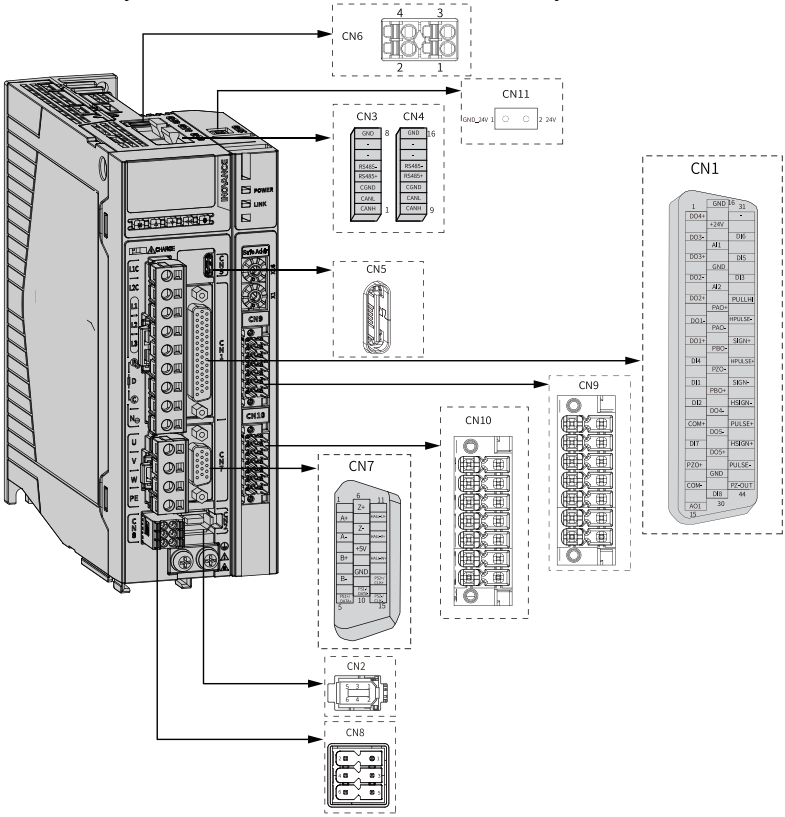


Figure 5-1 Terminal pin layout of the servo drive

Note

For descriptions of main circuit terminals, CN1, CN2, CN3&CN4, CN5, CN6, CN7 and CN8, see section Terminals in SV680-INT Series Servo Drive Hardware Guide. This manual describes only the components of the safety module: CN9, CN10, CN11.

5.3 CN6 STO Terminal

5.3.1 CN6 STO Safety Terminal

Terminal Arrangement

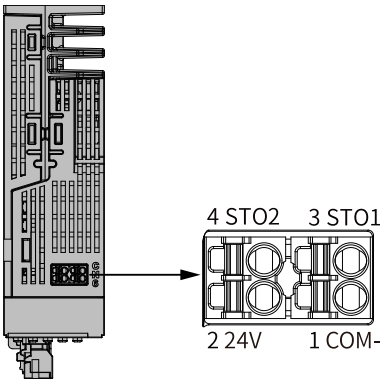


Table 5–1 Pin assignment

Pin No.	Description	Description
1	COM–	STO reference ground
2	24 V	Internal 24V power supply
3	STO1	Control input for STO1
4	STO2	Control input for STO2

Two isolated inputs are configured to dual-channel inputs of the STO function: STO1/STO2.

To facilitate commissioning, additional pin with supply voltage (+24V) is integrated. The bridging of the 24 V terminal to STO1/STO2 is needed in case the safety circuit is installed but no STO function is needed.

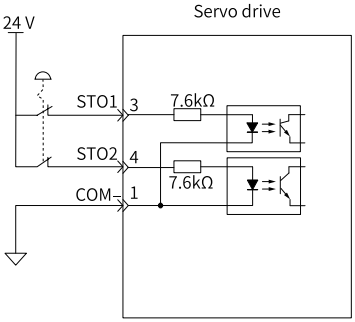
Description

- **Electrical specifications and connection of the input circuit**
  This section describes the characteristics of the input signals assigned to the CN6 connectors.
  - Specifications
    The servo drive operates normally only when the input states of STO1 and STO2 are both "High" ("1" or "H").

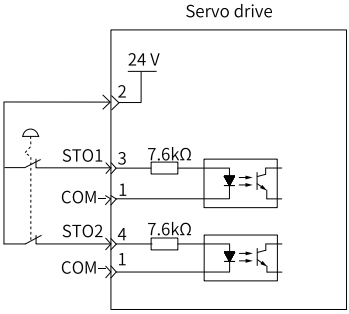
    The servo drive does not operate when the input states of STO1 or STO2 are different or are both "Low" ("0" or "L").
  - Electrical characteristics of Safety Request Input Signal are as follows:

Item	Characteristics	Description
Voltage range	24 VDC (±15%)	-
Input current	3.6 mA (Typ.)	The input current of STO1 and STO2.
Standards of logic levels	“0” < 5 V, “1” > 15 V	-
Digital input impedance	6.6 kΩ	-

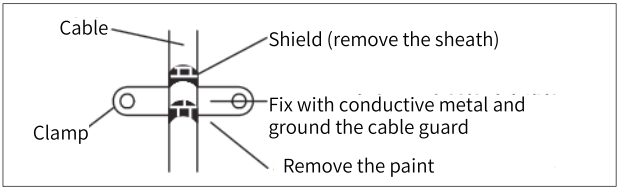
- Connection example of external 24 V



- Connection example of internal 24 V



- **EMC requirements**
  - To avoid short circuit between two adjacent conductors, either use cable with shield connected to the protective bonding circuit on each separate conductor, or use flat cables with one earthed conductor between each signal conductor.
  - Double-shielded or single-shielded twisted multi-pair cable is strongly recommended.
  - Fix and ground the cable shield using a piece of conductive metal.
    Example of cable clamp:



- The maximum allowable cable length between the drive and the activation switch is 30 m.

- **Other requirements**
  - All wiring must be well protected, routed and clamped where practicable.
  - It must be assured that there is no pulling or pinching on the cable when installing.
  - For cabling the DI inputs of the STO, to avoid common cause failure in the cables, the two channels must be routed through two well-apart routes, or the cable must be protected with double-shielded methods.

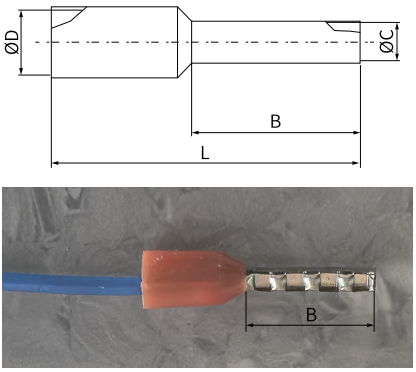
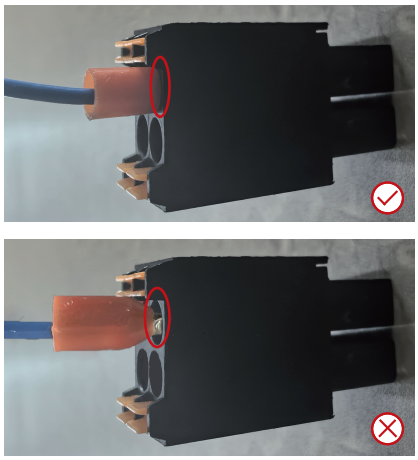
Cable	Description
Category	Low voltage, double-shielded or single-shielded twisted multi-pair cable
Maximum size	0.8 mm^2 (18AWG)
Minimum size	0.3 mm^2 (28AWG)
Maximum length	The max. distance between STO input and the operating contact is 30 m

Applicable servo drives

STO applies to the following servo drives:

Size	Power Range (kW)	Structure	W×H×D (mm^3)
A	0.2 to 0.4	Split-type structure	45.5 x 170 x 150
C	0.75 to 1.5	Split-type structure	55 x 170 x 173
D	1.5 to 3	Split-type structure	80 x 170 x 183
E	2 to 7.5	Split-type structure	90 x 250 x 230

5.3.2 Wiring Precautions and Requirements

Pre-Inspection	Installation
	
Tubular terminal contact area (B) ⩽ 8 mm	Connect the terminal in place so that the contact area is not exposed.

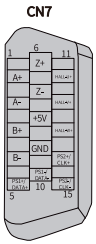
5.4 CN7 Encoder Terminal

5.4.1 Terminal Arrangement

Note

- First encoder: The master encoder.
- Second encoder: The slave encoder when the fully closed loop feature is used.

Terminal Arrangement



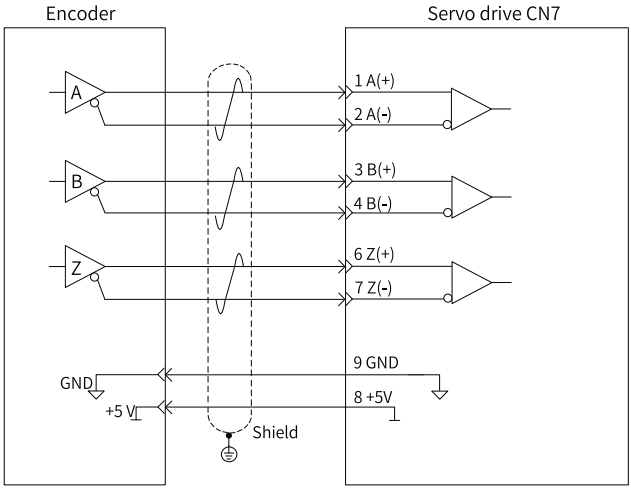
Pin No.	Terminal Definition	Description	Pin No.	Terminal Definition	Description
1	A+	Encoder pulse phase A±	9	GND	Power supply reference ground
2	A–		10	PS1-/DATA-	• PS- signal of the first encoder • DATA- signal of the communication encoder • Gantry synchronization signal
3	B+	Encoder pulse phase B±	11	HALL_U+	Hall signal U
4	B–		12	HALL_V+	Hall signal V
5	PS1+/DATA+	• PS+ signal of the first encoder • DATA+ signal of the communication encoder • Gantry synchronization signal	13	HALL_W+	Hall signal W
6	Z+	Encoder pulse phase Z±	14	PS2+/CLK+	• PS+/- signals of the second encoder • CLK+/- signals of the communication encoder
7	Z-		15	PS2-/CLK-	
8	+5 V	Encoder 5 V power supply (load current lower than 200 mA)	Enclosure	PE	Shield

5.4.2 Wiring Example

5.4.2.1 Communication with the First Encoder

Wiring of ABZ incremental encoder (TTL signal)

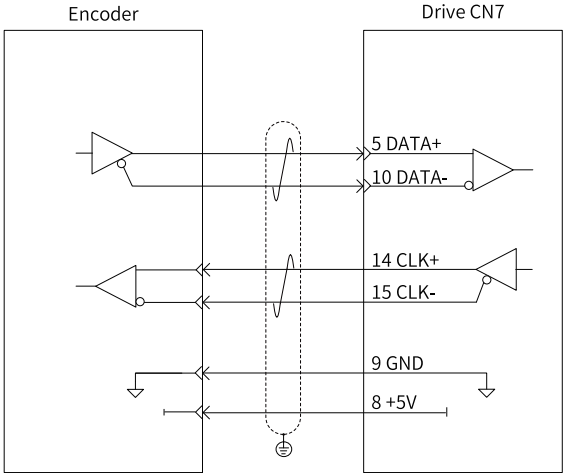
Use shielded twisted pairs to match the high input frequency.



- To reduce noise interference, connect the reference ground of the external encoder to the GND of the drive. Use shielded cables and connect the shield to the CN7 terminal enclosure.
- The input mode of the external encoder is differential input.
- The maximum pulse frequency supported by a phase A/B encoder is 4 Mpps.
- The pulse input terminal of a phase A/B encoder supports open circuit detection.

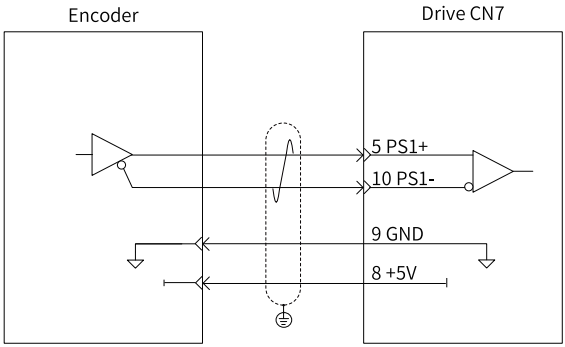
Wiring of Endat2.2/SSI/BiSS-C master encoder

The drive sends a clock signal to the master encoder, which exchanges data with the servo drive through a DATA signal.



Wiring of Inovance/TAMAGAWA/Nikon master encoder

The master encoder interacts with the servo drive through PS1+ and PS1-.



Suppose the current consumed by the motor encoder is 200 mA, you can select the cable based on the following recommendations.

Table 5–2 Recommended cable between the servo drive and linear motor encoder

Cable Size	Line Resistance	Allowable Length
26AWG (0.13 mm^2)	143 Ω/km	8.0 m
25AWG (0.15 mm^2)	89.4 Ω/km	14.0 m
24AWG (0.21 mm^2)	79.6 Ω/km	15.0 m
23AWG (0.26 mm^2)	68.5 Ω/km	18.0 m
22AWG (0.32 mm^2)	54.3 Ω/km	23.0 m
21AWG (0.41 mm^2)	42.7 Ω/km	29.0 m

If the consumption current of the motor encoder is higher than 200 mA, you can calculate the allowable cable length according to the following formula.

$$L2=\frac{\triangle U_{max2}}{I_{Encoder} x 2R_{Unit}}$$

△U is 0.5 V, $I_{encoder}$ represents the current consumed by the encoder (see the encoder user guide for details), and R_{unit} represents the unit resistance (Ω/km) of the cable. L2 is the allowable cable length (in m).

5.4.2.2 Communication with the Second Encoder

The second encoder is connected to the CN7 port (H0F.06 = 1) by default.

Wiring of ABZ incremental encoder (TTL signal)

For details, see *" Wiring of ABZ incremental encoder (TTL signal)" on page 70*.

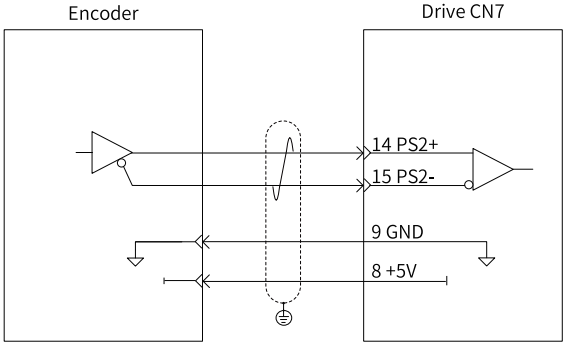
Wiring of Endat2.2/SSI/BiSS-C second encoder

The drive communicates with the first encoder normally, that is, the first encoder exists all the time. In the case of the Endat2.2/SSI/BiSS-C second encoder, the drive sends clock signals to the encoder and the encoder exchanges data with the drive through DATA signals.

For details, see *" Wiring of Endat2.2/SSI/BiSS-C master encoder" on page 71*.

Wiring of Inovance/TAMAGAWA/Nikon second encoder

The drive communicates with the first encoder normally, that is, the first encoder exists all the time. In the case of the Inovance/TAMAGAWA/Nikon second encoder, the encoder exchanges data with the drive through PS2+ and PS2- signals.



Suppose the current consumed by the motor encoder is 200 mA, you can select the cable based on the following recommendations.

Table 5–3 Recommended cable between the servo drive and linear motor encoder

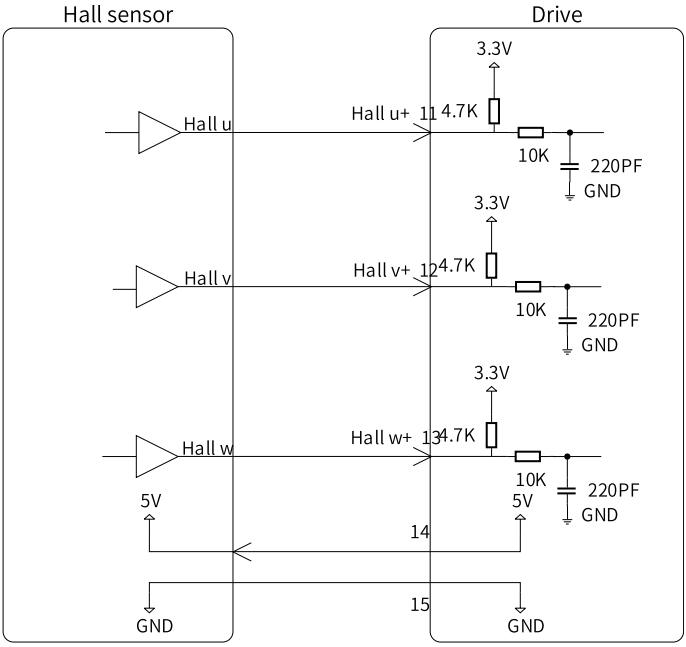
Cable Size	Line Resistance	Allowable Length
26AWG (0.13 mm^2)	143 Ω/km	8.0 m
25AWG (0.15 mm^2)	89.4 Ω/km	14.0 m
24AWG (0.21 mm^2)	79.6 Ω/km	15.0 m
23AWG (0.26 mm^2)	68.5 Ω/km	18.0 m
22AWG (0.32 mm^2)	54.3 Ω/km	23.0 m
21AWG (0.41 mm^2)	42.7 Ω/km	29.0 m

If the consumption current of the motor encoder is higher than 200 mA, you can calculate the allowable cable length according to the following formula.

$$L2=\frac{\triangle U_{max2}}{I_{Encoder} \times 2R_{Unit}}$$

△U is 0.5 V, $I_{encoder}$ represents the current consumed by the encoder (see the encoder user guide for details), and R_{unit} represents the unit resistance (Ω/km) of the cable. L2 is the allowable cable length (in m).

5.4.2.3 Connection with the Hall Sensor

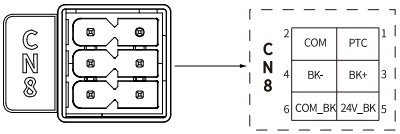


Note

1. To reduce noise interference, connect the reference ground of the sensor to the GND of the drive. Use shielded cables and connect the shield to the CN7 terminal enclosure.
2. The input mode of the Hall sensor is single ended input.
3. The total load current cannot exceed 200 mA when No. 8 and No. 14 pins are used together.
4. When the input mode of the external Hall sensor is differential input, see the instructions of the encoder signal adapter box.

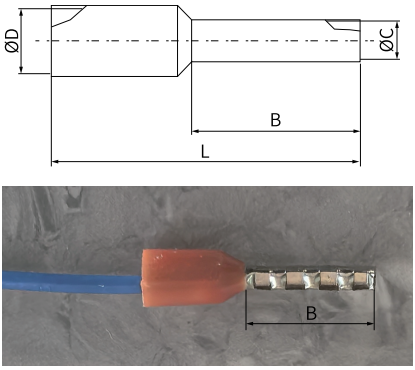
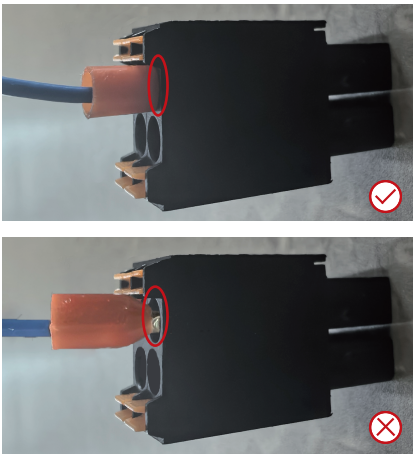
5.5 CN8 Brake and PTC Input Terminals

5.5.1 Terminal Arrangement



Pin No.	Description	Description	Pin No.	Description	Description
1	PTC	Motor temperature feedback input	2	COM–	Onboard 24V, COM
3	BK+	Brake+	4	BK-	Brake–
5	24V_BK	External power supply for the brake	6	COM_BK	Brake 24V, COM

5.5.2 Wiring Precautions and Requirements

Pre-Inspection	Installation
	
Tubular terminal contact area (B) ⩽ 8 mm	Connect the terminal in place so that the contact area is not exposed.

5.5.3 Wiring Example

5.5.3.1 PTC Wiring Example

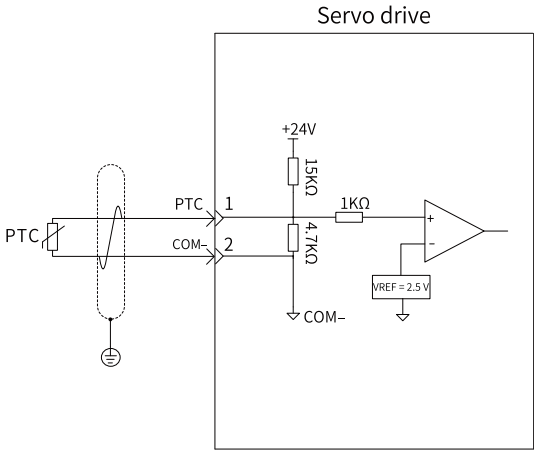


Figure 5-2 PTC wiring diagram

Note

- The resistance range triggering PTC circuit overtemperature operation is 1.8 kΩ to 3.85 kΩ. When selecting PTC, note that the PTC resistance value must be less than 1.8 kΩ when the PTC does not operate, and larger than 3.85 kΩ when the PTC operates for overtemperature.
- Only switching thermistors are supported. Connect the shielded cable between the servo drive and the motor properly during wiring.

5.5.3.2 Brake Wiring Examples

The brake is used to prevent the motor shaft from moving and lock the position of the motor and the motion part when the drive is in the non-operational status.

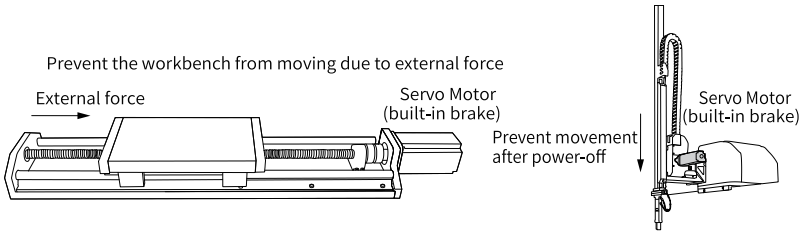
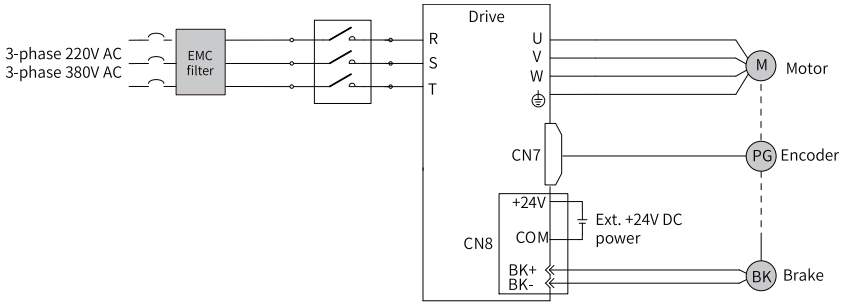


Figure 5-3 Application of the brake

Caution

- Use the built-in brake for position-lock purpose only. Do not use this brake for any other purposes (such as braking) other than position-lock in the stop state.
- The brake coil has no polarity.
- Switch off the S-ON signal after the motor stops.
- When the motor with brake runs, the brake may generate a click sound, which does not affect its function.
- When brake coils are energized (the brake is released), flux leakage may occur on the shaft end.
- Keep away from the area around the motor when using a magnetic sensor.

The connection of the motor brake input signal has no polarity. You need to prepare a separate 24 V power supply to ensure that the control power supply is separate from the brake power supply. The following figure shows the standard wiring of the brake signals (BK) and the brake power supply.



Pay attention to the following precautions during wiring:

When determining the length of the motor brake cable, take full account the voltage drop caused by cable resistance. The input voltage must be 24 V±10% to enable the brake to work properly.

Note

- In the standard environment, the number of brake outputs at the drive side can reach at least 5 million. For details on the standard environment, see *"4.2 Installation Environment Requirements" on page 55*.
- The brake must not share the power supply with other electrical devices. This is to prevent a malfunction of the brake due to a drop in the voltage or current when other electrical devices work in tandem.
- Use cables with a cross-sectional area above 0.5 mm^2.

5.6 Expansion Safety Function Terminals CN9&CN10

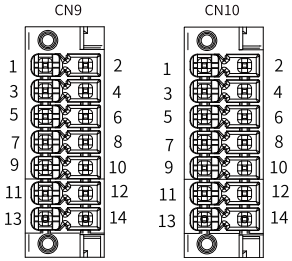


Figure 5-4 Description of pins of CN90 and CN10

Table 5–4 Description of CN9 pins

No.	Description	Function	No.	Description	Function
1	DO3-	Common DO3 output (-)	2	DO3+	Common DO3 output (+)
3	DO2	Safety DO2 output	4	DO1	Safety DO1 output
5	DO24VA	24 V power supply of DO1 and DO2	6	DO0VA	Output reference ground of DO1 and DO2
7	COM	DIA reference ground	8	DI5A_IN	Safety DI5A input
9	DI4A_IN	Safety DI4A input	10	DI3A_IN	Safety DI3A input
11	DI2A_IN	Safety DI2A input	12	DI1A_IN	Safety DI1A input
13	PE	Grounding	14	-	-

Table 5–5 Description of CN10 pins

No.	Description	Function	No.	Description	Function
1	DO6-	Common DO6 output (-)	2	DO6+	Common DO6 output (+)
3	DO5	Safety DO5 output	4	DO4	Safety DO4 output
5	DO24VB	24 V power supply of DO4 and DO5	6	DO0VB	Output reference ground of DO4 and DO5
7	COM	DIB reference ground	8	DI5B_IN	Safety DI5B input
9	DI4B_IN	Safety DI4B input	10	DI3B_IN	Safety DI3B input
11	DI2B_IN	Safety DI2B input	12	DI1B_IN	Safety DI1B input
13	PE	Grounding	14	-	-

Basic DI information

Item	Description
Five dual-channel digital inputs	Voltage: 24 V DC±15% (must be powered by SELV/PELV power supply)
Assignment of logic levels	low level: "0" < 3 V High level: "1" > 15 V
Switches contact	Only supports normally closed switch contact
Current consumption of single DI	10 mA max (dual channel)
Maximum allowable cable length between drive and safety switch	30 m

Basic DO information

Item	Description
Four single-channel digital outputs	Maximum output current: 50 mA per channel Voltage: 24 V DC±15% (must be powered by SELV/PELV power supply)
Two common DO outputs	Maximum output current: DC 50 mA Maximum allowable external voltage: DC 30 V
Safe state	OFF
DO open circuit/OFF	Maximum output voltage: 2.4 V
Maximum allowable cable length between drive and safety switch	30 m
The status of SSM can be indicated by predefined parameters using DO1, DO2, DO4, and DO5	

Note

Open/OFF means the DO is in open circuit state, and closed/ON means the DO can conduct output current.

Wiring Precautions

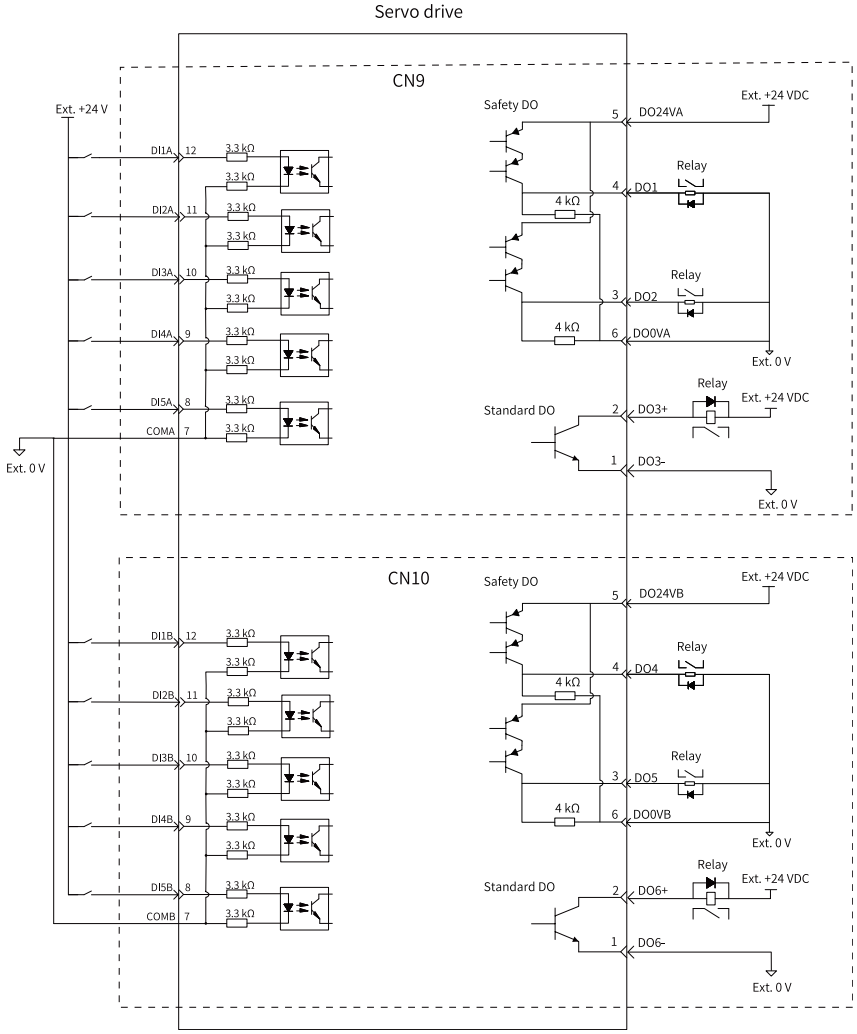
DI Wiring Requirements
Care must be taken in wiring to avoid introducing 24V and DI short circuit failures. The following recommended method or method with equivalent effect may be used. Do as follows: • Insert 0 V between 24 V and DI signal line using a flat cable. • Use shielded wires for 24 V and DI respectively, with the shield connected to PE.
Care must be taken in wiring to avoid introducing short circuit failure between the dual channels (DIxA and DIxB) of the same DI. The following recommended method or method with equivalent effect may be used. Do as follows: • Insert 0 V between DIxA and DIxB signal lines using a flat cable. • Use shielded wires for DIxA and DIxB respectively, with the shield connected to PE.
Care must be taken in wiring to avoid introducing short circuit failure between different DIs (DIx and DIy). The following recommended method or method with equivalent effect may be used. Do as follows: • Insert 0 V between 24 V and DI signal line using a flat cable. • Use shielded wires for DIx and DIy respectively, with the shield connected to PE.

DO Wiring Requirements
Care must be taken in wiring to avoid introducing 24V and DO short circuit failures. The following recommended method or method with equivalent effect may be used. Do as follows: • Insert 0 V between 24 V and DO signal line using a flat cable. • Use shielded wires for 24 V and DO respectively, with the shield connected to PE.
Care must be taken in wiring to avoid introducing short circuit failure between different DOs (DOx and DOy). The following recommended method or method with equivalent effect may be used. Do as follows: • Insert 0 V between DOx and DOy signal lines using a flat cable. • Use shielded wires for DOx and DOy respectively, with the shield connected to PE.

Note

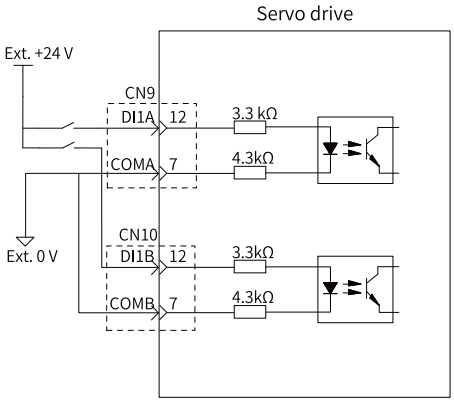
For basic information about DI/DO, see *" Basic DI information" on page 79* and *" Basic DO information" on page 79*.

System wiring diagram of CN9 and CN10



Safety Digital Input

The circuits for DI1 to DI5 are the same. When DI1A and DI1B are connected at the same time, a safety DI is formed. The following description takes DI1 circuit as an example.

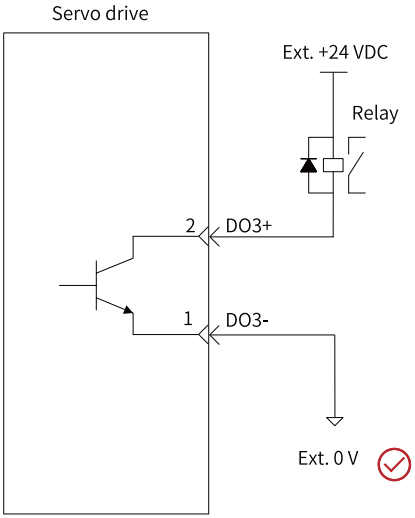


The safety DI is a source type input. Please make reasonable wiring according to the characteristics of the load circuit.

Common Digital Output

The circuits for DO3 and DO6 the same. The following description takes DO3 circuit as an example.

- **The host controller provides relay input.**
  - **Correct wiring:**

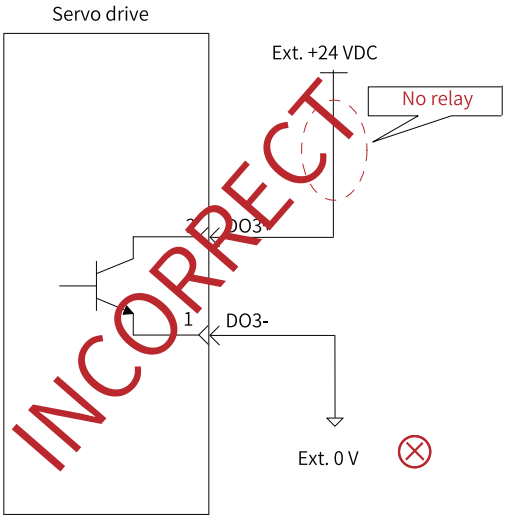


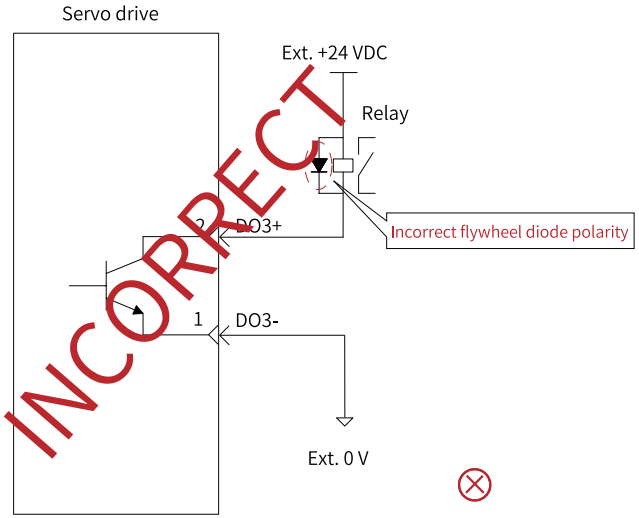
Note

When the host controller provides relay input, a flywheel diode must be installed; otherwise, the DO terminals may be damaged.

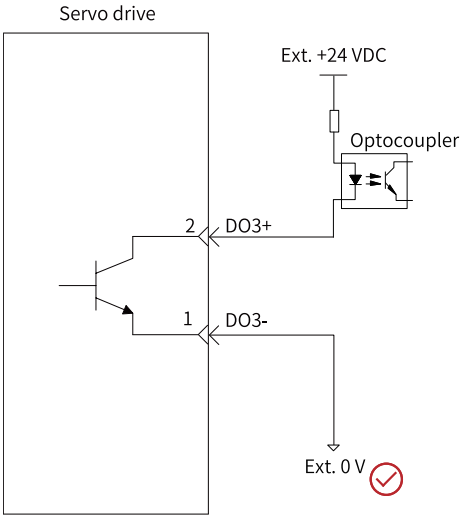
For the external voltage and current range of the DO, see *" Basic DO information" on page 79*.

- **Wrong wiring:**

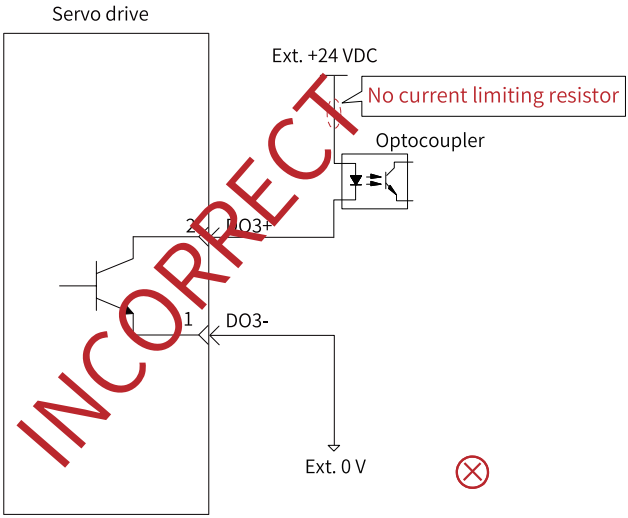




- **The host controller provides optocoupler input:**
  - **Correct wiring:**



  - **Wrong wiring:**

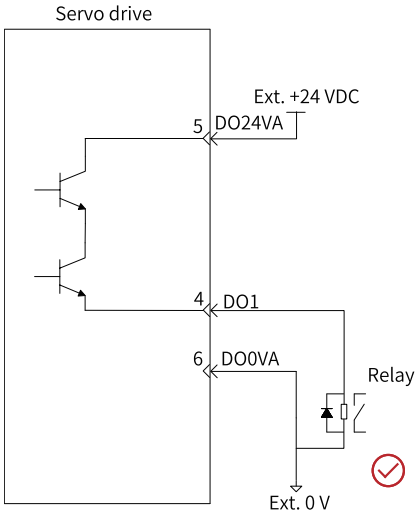


Safety Digital Output

The circuits for DO1, DO2, DO4, and DO5 are the same. The following description takes DO1 circuit as an example.

The safety DO is a drain output. Please make reasonable wiring according to the characteristics of the load circuit.

- The host controller provides relay input.
  - **Correct wiring:**

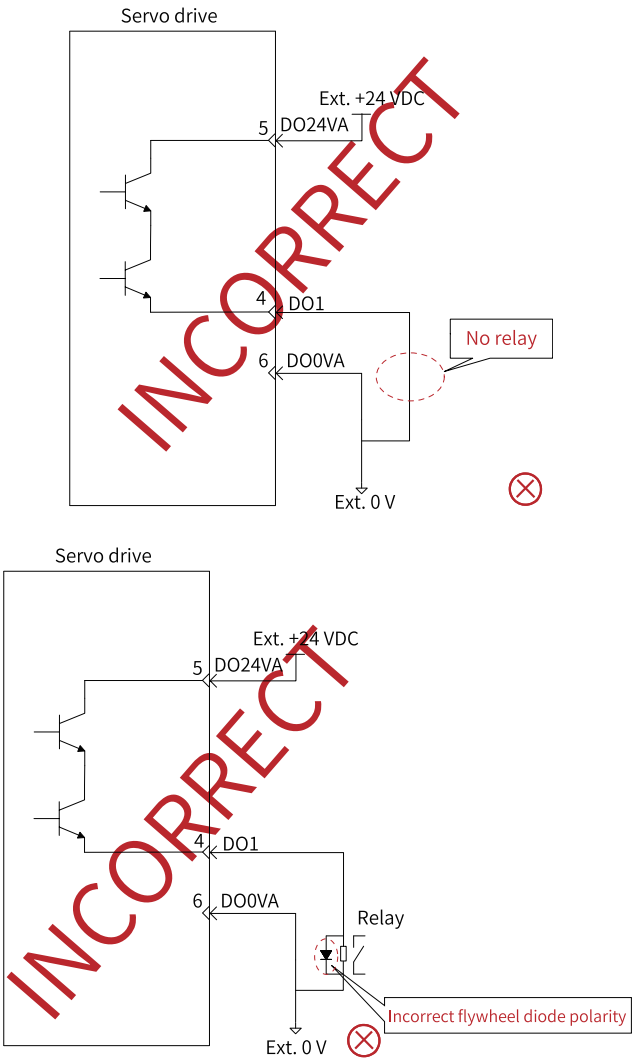


Note

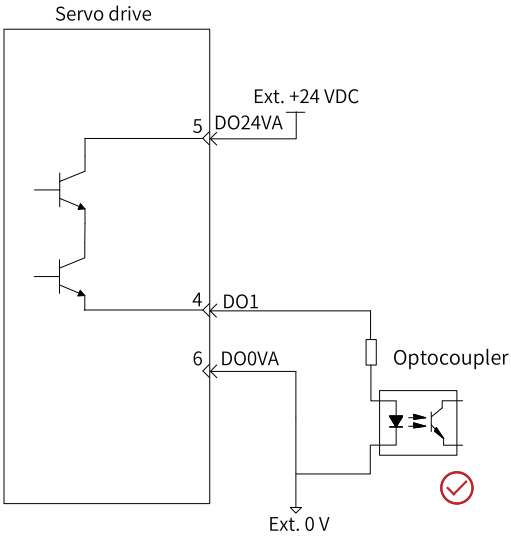
When the host controller provides relay input, a flywheel diode must be installed; otherwise, the DO terminals may be damaged.

For the external voltage and current range of the DO, see *" Basic DO information" on page 79*.

- **Wrong wiring:**



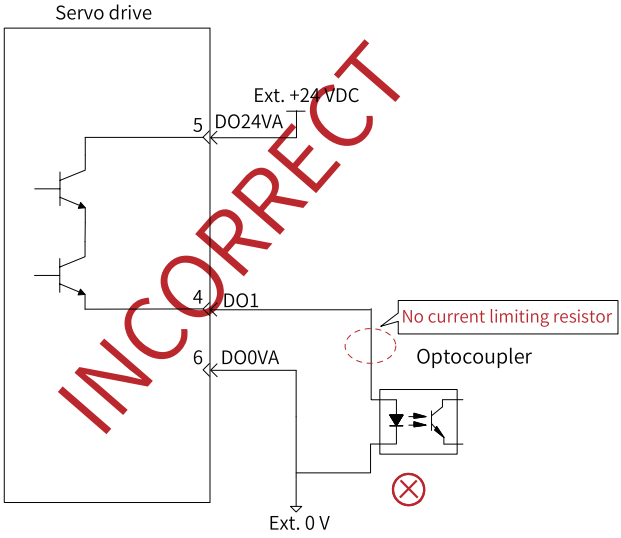
- **The host controller provides optocoupler input:**
  - **Correct wiring:**



Note

Minimum current limiting resistor resistance R = (External power supply specification 24–0.75–0.75–Vf specification of optocoupler)/If specification of optocoupler.

- **Wrong wiring:**

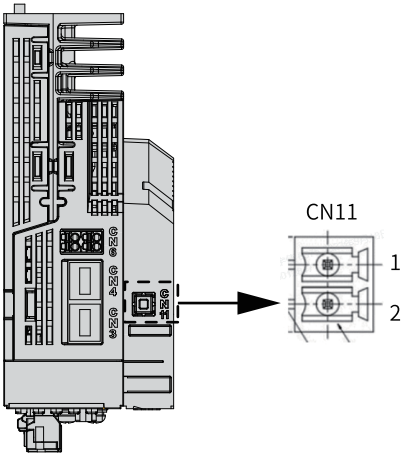


5.7 CN11 24V Terminal

Note

The CN11 24 V standby power input terminal is only available in functional safety and standby power-enabled products.

Terminal Arrangement



Pin No.	Descrip tion	Description	Pin No.	Descrip tion	Description
1	GND_BP	0 V input of the backup power supply	2	24V_BP	24 V input of the backup power supply

Description

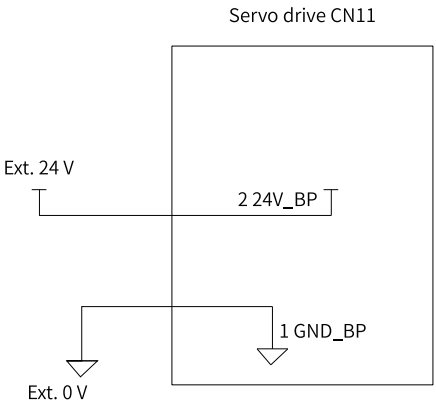
Models with backup power can have separate power supply to the control circuit. When the main circuit is not energized, 24V BP supplies power to the control circuit to maintain functions like programming, parameter configuration in the software tool, and communication. The operating panel of the drive shows "nrd.1" under this circumstance.

Table 5–6 Power input specifications

Item	Specification
Power input range	Voltage: 24 V DC±15% (must be SELV/PELV power supply)
Power of the external power supply	⩾ 50 W

Wiring

As shown in the following figure.



6 Expansion Safety Functions

6.1 General

The combination of the safety module, SV680P-INT drive and safety motor can achieve the following safety functions:

Safety Function	Function
STO	The STO function immediately shuts off the torque or force output of the motor based on an input signal from an external device. This function corresponds to stop category 0 of IEC/EN 60204-1. If the motor is running when the STO function is activated, it coasts to a stop.
SBC	The SBC function provides a safe output for controlling external brakes.
SS1	The SS1 function starts deceleration based on an input signal from an external device. After a preset period of time elapses or zero speed is achieved, the STO function will be triggered. This function corresponds to stop category 1 of IEC/EN 60204-1.
SS2	The SS1 function starts deceleration based on an input signal from an external device. After a preset period of time elapses or zero speed is achieved, the SOS function will be triggered. This function corresponds to stop category 2 of IEC/EN 60204-1.
SOS	The SOS function monitors whether the motor stops within the prescribed range for the stop position. The drive is in the closed-loop control mode, and can therefore withstand external forces.
SLS	The SLS function monitors whether the motor speed exceeds a preset speed limit. When the speed is over the limit, torque of the motor will be shut off immediately.
SDI	The SDI function prevents the motor shaft from moving in an unintended direction. If the motor rotates in an impermissible direction, the drive stops the motor as quickly as possible.
SSM	The SSM function provides a safe output signal to indicate whether the motor speed is below a prescribed limit to identify, for example, a standstill. The servo provides a safe output signal for further processing.

Different from other functions, the SS1-t function in STO, SBC, and SS1 can be used with a non-safety motor.

- When using a safety motor, the SS1-r/SS2/SOS/SLS/SDI/SSM function is allowed after setting H20.80 = 1.
- H20.80 can only be set to 0 when no safety motor is used.

Note

- Software version of H20.00 = 1.10: By reading the safety encoder software version number of H00.04, the safety motor position feedback monitoring is automatically turned on.
- safety module software version of H20.00 = 1.20 and above : Enable safety motor position feedback monitoring by setting safety parameter H20-80 = 1.

To use safety functions of the safety module related to speed and position, you must use an Inovance S6 motor and set H20-80 = 1.

You must set H20.01 to the local mode.

You can only choose the local mode when a pulse-type servo drive is used.

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.01	Safety function trigger selection	0: Locally triggered 1: FSoE triggered-SRA 3: FSoE triggered-nSRA	0	-	At stop	*"H20_en.01" on page 205*

When the local mode triggers the safety function, you can configure the safety DI to a safety function (such as STO, SS1 or SS2) and control the function through on and off of the safety DI. You can also configure the DO to a safety function (such as STO, SOS, or SSM). The DO output is active when the corresponding safety function is triggered.

Note

When the safety functions are configured to be locally triggered, the TPDO does not update.

Priority of safety functions

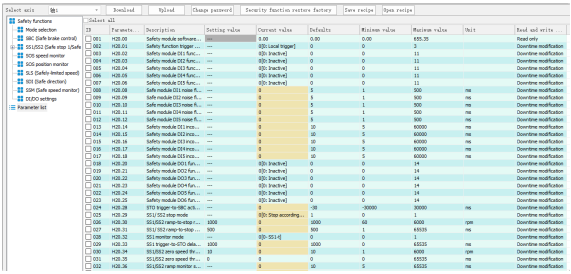
When several safety functions are activated simultaneously, the following priority applies:

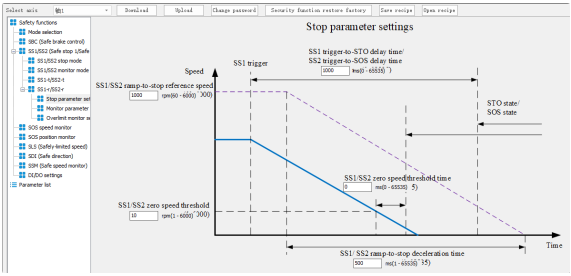
- STO has priority over SS1 and SS2.
- SLS/SDI/SSM are independent of each other.

When a safety function overrides another, this does not cancel the request for the overridden safety function. Therefore, the overridden safety function is restarted after other safety functions are completed.

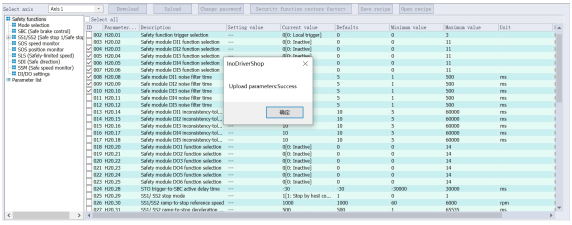
6.2 Software Parameter Configuration

You can configure the safety parameters in "InoDriverShop" tool on the parameter list or on the graphic user interface of corresponding safety function. The object dictionary cannot be configured.



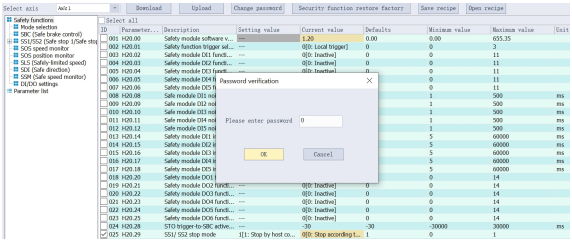


1. On the parameter list, select a parameter you want to configure and then click Upload to read the value of the selected parameter.

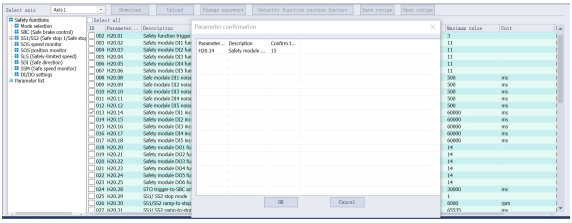


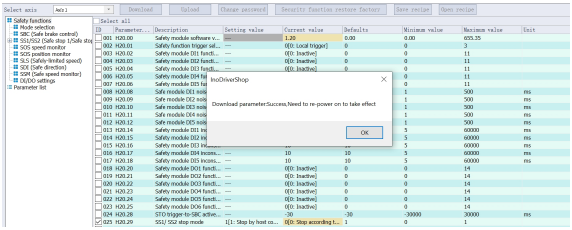
Any changes to any safety parameters take effect only at next power-on.

2. Enter a value for the safety parameter and click Download. A password verification dialog pops up. In the pop-up dialog, enter the password (Default:11111).

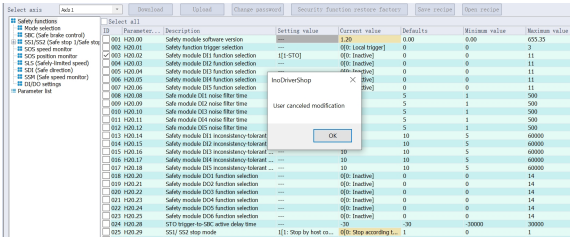


3. A confirmation dialog pops up. Make sure the value entered is correct and click OK. The value is written into the safety module.

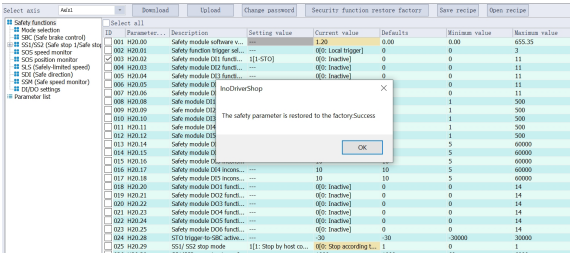




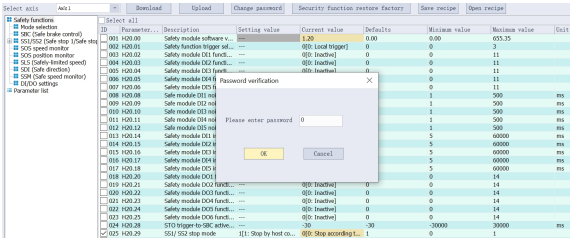
4. If you click Cancel, or fail to click OK within 10 seconds, you are prompted that the modification is canceled. The value will not be written into the safety module.



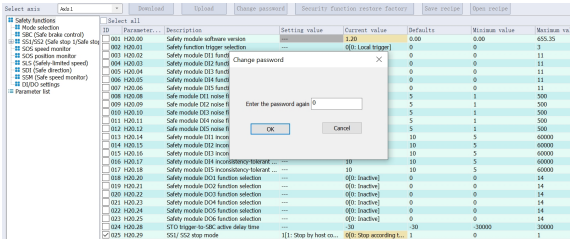
5. To reset the safety parameters, click **Safety function restore factory**.



6. To change the safety password, click **Change password**. In the pop-up password verification dialog, enter the current password. The verification is passed. Then in the pop-up new password dialog, enter the new password (range: 1 to 65535).



7. The confirm password dialog pops up and then enter the new password again. Make sure the new password and the confirm password are the same.
   If they are different, the password change fails.



6.3 Safety DI/DO Function

6.3.1 Safety DI Function

DI Function Selection

The safety module includes five DIs. Each DI is configured to receive two input signals through two channels A and B, and default to 0 (OFF). You can assign each DI with a logic function using the software tool.

Table 6–1 Logic function selection of DI1 to DI5

Pin No.	Name	Pin No.	Name	Configure parameters.
CN9		CN10		
12	DI1A	12	DI1B	You can configure the logic function of DI1 by setting parameter H20.02.
11	DI2A	11	DI2B	You can configure the logic function of DI2 by setting parameter H20.03.
10	DI3A	10	DI3B	You can configure the logic function of DI3 by setting parameter H20.04.
9	DI4A	9	DI4B	You can configure the logic function of DI4 by setting parameter H20.05.
8	DI5A	8	DI5B	You can configure the logic function of DI5 by setting parameter H20.06.

Note

The logical function configuration of each DI must be unique.

DI Input Filtering

To avoid false triggering of safety functions caused by external noise interference, five DI input filter parameters are added to the safety module. Only when the DI input signal is 0 (OFF) and lasts for a period of time exceeding the DI noise rejection filter time, the safety module performs the corresponding safety function.

Table 6–2 Noise Rejection Filter Time of DI1 to DI5

Configure parameters.	Name
H20.08	Safety module DI1 noise rejection filter time, in 1 ms
H20.09	Safety module DI2 noise rejection filter time, in 1 ms
H20.10	Safety module DI3 noise rejection filter time, in 1 ms
H20.11	Safety module DI4 noise rejection filter time, in 1 ms
H20.12	Safety module DI5 noise rejection filter time, in 1 ms

For example, DI1 is assigned with the STO function. The filtering time from when the DI1 receives an input 0 (OFF) to when the STO function is triggered is set by the parameter H20.08.

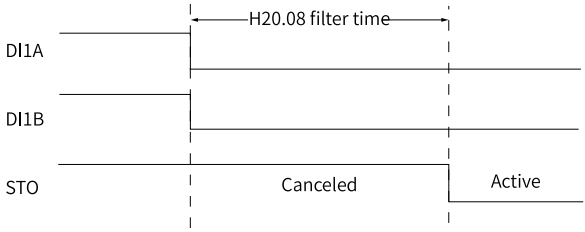


Figure 6-1 Diagram of DI1 noise rejection filter time H20.08

Note

- OFF (0): The 24V voltage of the corresponding DI is off.
- ON (1): The 24V voltage of the corresponding DI is off.

Input Discrepancy Detection

When the function assigned to the DI is active, the safety module monitors whether the signals input to the DI are consistent. If discrepancy exists between the input signals and the discrepancy lasts for a period of time exceeding the allowable discrepancy time, the servo drive issue an alarm E134.x, with x indicating the DI number.

You can configure the following parameters to monitor the discrepancy at input signals of the five DIs.

Table 6–3 Parameter for monitoring discrepancy at input signals of DI1 to DI5

Configure parameters.	Name
H20.14	Safety module DI1 allowable discrepancy time, unit: 1 ms
H20.15	Safety module DI2 allowable discrepancy time, unit: 1 ms
H20.16	Safety module DI3 allowable discrepancy time, unit: 1 ms
H20.17	Safety module DI4 allowable discrepancy time, unit: 1 ms
H20.18	Safety module DI5 allowable discrepancy time, unit: 1 ms

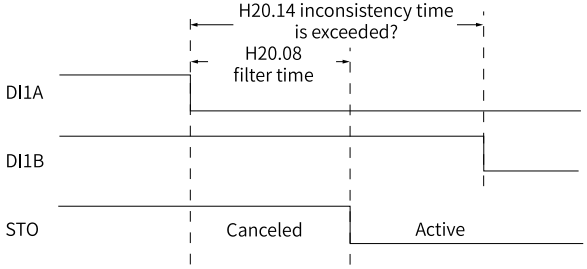


Figure 6-2 Checking for discrepancy at input signals of DI1

Note

The safety DI is mainly used together with the safety DO. For wiring of the safety DI function, see *"5.6 Expansion Safety Function Terminals CN9&CN10" on page 78*.

6.3.2 Safety DO Function

DO Function Selection

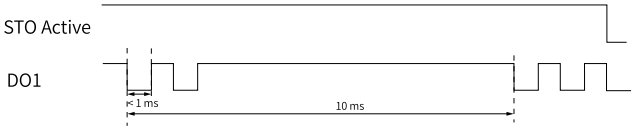
The safety module has six DO terminals, which are all set to 0-Disabled by default. DO3 and DO6 are non-safe DO circuits and cannot be used to configure SSM. You can assign each DI with a logic function using the software tool.

terminals	Pin No.	Name	Configure parameters.
CN9	4	DO1	You can configure the logic function of DO1 by setting parameter H20.20.
	3	DO2	You can configure the logic function of DO2 by setting parameter H20.21.
	1&2	DO3	You can configure the logic function of DO3 by setting parameter H20.22.
CN10	4	DO4	You can configure the logic function of DO4 by setting parameter H20.23.
	3	DO5	You can configure the logic function of DO5 by setting parameter H20.24.
	1&2	DO6	You can configure the logic function of DO6 by setting parameter H20.25.

DO output diagnosis

To ensure that the DO circuit is able to output the signal properly, the safety module will diagnose the DO circuit. To perform DO circuit diagnosis, you need to input 24 V voltage signals to pins 5 and 6 of the CN9 and CN10 terminals.

The following figure shows that when DO1 is configured to STO, the safety module will diagnose the DO1 output circuit when STO is active. The width of the diagnostic pulse is less than 1 ms. When the pulse diagnosis feedback signal is abnormal, the servo drive issues an E125.x alarm, where x is the DO serial number.



Note

- For safety DOs (DO1, DO2, DO4, DO5), the maximum DO output voltage is 2.6 V when the DO does not output, that is, the DO output is in an off state. To prevent malfunction, pay attention to the operation voltage threshold of the external electrical device at the load side of the safety DO.
- The safety DO cannot be used as an EDM signal in the STO function. For details, see *" EDM DO signal" on page 156*.
- The safety DO is mainly used together with the safety DI. For wiring of the safety DO function, see *"5.6 Expansion Safety Function Terminals CN9&CN10" on page 78*.

6.4 Safe Torque Off (STO) Function

6.4.1 Overview

For the STO function integrated in the drive, please refer to the corresponding function manual and hardware manual. This chapter only introduces the STO function of the safety module.

The STO function cuts off the input current of the motor to stop it according to an input signal from the safety controller.

When the STO function is triggered, the servo drive turns off the S-RDY signal and enters the safe state.

The safety module can be configured to trigger the STO function in either of the following ways.

Remember to power off and on the drive every three months or trigger the STO through the safety module, so that STO can be reset periodically.

6.4.2 STO Triggered by Local Mode

In order to use the input signal function of the safety module properly, the DI cable must be connected correctly.

Set H20.01 to 0 to trigger the safety function by a local DI.

Table 6–4 Description of function No.

Code	Name	Function Name	Function
FunIN.1	STO command	STO trigger command	0: STO active 1: STO deselected
FunIN.11	ACK command	ACK trigger command	0: ACK deselected 1: ACK trigger
FunOUT.1	STO Active	STO active	0: Normal state 1: STO state

Ack function not selected for DI: STO status exits automatically when the STO command is canceled.

Ack function is selected for DI: Two DI terminals are used, one configured as STO and one configured as Ack. You can exit the STO state only when the STO command is canceled, and the Ack command is triggered.

See the section on SBC for the sequence of STO and SBC.

Note

- OFF (0): The 24V voltage of the corresponding DI is off.
- ON (1): The 24V voltage of the corresponding DI is off.

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.02	Safety module DI1 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	"H20_en.02" on page 205
H20.03	Safety module DI2 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	"H20_en.03" on page 206
H20.04	Safety module DI3 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	"H20_en.04" on page 207
H20.05	Safety module DI4 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	"H20_en.05" on page 207

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.06	Safety module DI5 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp10: SDIn 11: Ack	0	-	At stop	*"H20_en.06" on page 208*
H20.20	Safety module DO1 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*"H20_en.20" on page 211*
H20.21	Safety module DO2 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*"H20_en.21" on page 212*

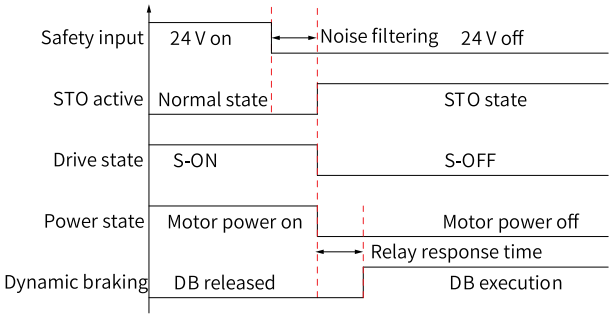
Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.22	Safety module DO3 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*"H20_en.22" on page 213*
H20.23	Safety module DO4 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*"H20_en.23" on page 213*

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.24	Safety module DO5 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	"H20_en.24" on page 214
H20.25	Safety module DO6 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	"H20_en.25" on page 215

6.4.3 Sequence Diagram

Operation sequence to enter safe state

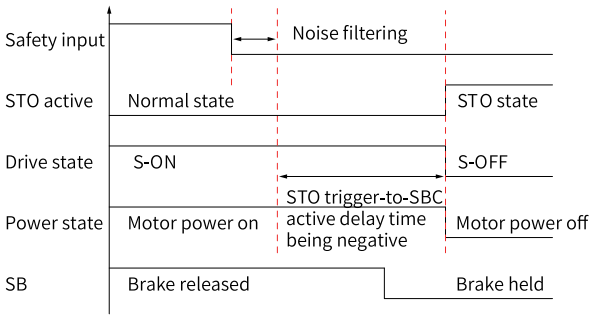
- SBC is not enabled



The safety module starts to shift to STO status when any of the STO inputs 1 and 2 is turned into OFF.

The STO stop mode reuses the stop mode for No. 1 faults. Dynamic braking will operate based on the setting of H02.08.

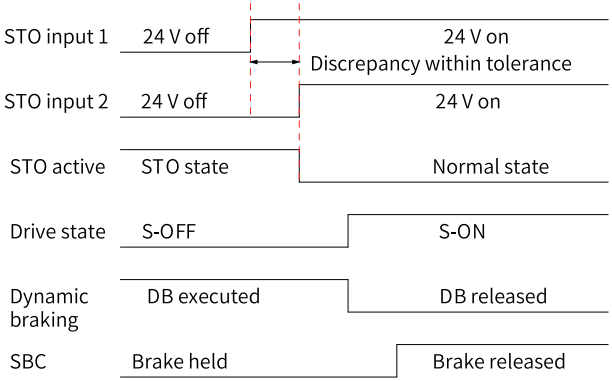
- SBC is enabled
  When you set H20.28 to a negative value, the sequence of STO operations is shown in the following figure.



When SBC is activated before STO and the STO input command is effective, perform S-OFF first as set by H02.05. After the delay of H20.28 elapsed, trigger the No.1 fault stop mode.

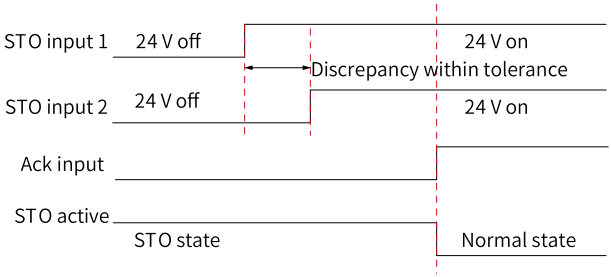
Reset sequence to exit STO safe state

- Ack signal is not required



When the Ack signal is not required, the STO state can exit automatically as long as the 24 V DI input signal of two STOs are restored. After STO status exits, the S-ON operation can be performed normally.

- Ack signal is required



When an Ack signal is required, exiting the STO state not only needs the recovery of the 24V voltage, but also a trigger for an Ack signal. The S-ON operation can only be performed properly after STO state exits normally.

Note

The STO function is triggered even if the safety module is in faulty state. After the fault cause is eliminated and the fault reset is performed, the safety module automatically exits the STO state without requiring an Ack input signal.

6.5 Safe Brake Control (SBC) Function

6.5.1 Overview

For models coming with a safety module, SBC needs not an external relay to control the on and off of the 24 V voltage of the brake motor. The BK+ and BK- pins of the brake motor can be respectively connected to Pin3 and Pin4 of the CN8 terminal on the drive, as shown in the following figure.

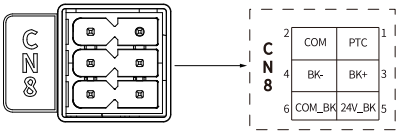


Figure 6-3 Description of CN8 pins

Pin No.	Description	Description	Pin No.	Description	Description
1	PTC	Motor temperature feedback input	2	COM–	Onboard 24 V COM
3	BK+	Brake+	4	BK-	Brake–
5	24V_BK	External power supply for the brake	6	COM_BK	Brake 24 V COM

The safety module can directly control the on and off of the 24 V voltage connected to Pin5 and Pin6 of CN8.

The SBC applies to situations where the servo drive must remain in a safe position even if the motor is not energized. The SBC prevents the droop of suspended or stretched loads (for example, a hoist). No external relay or switch is required, as the feature is integrated in the drive.

Note

- The SBC function cannot detect mechanical wear or damage to the motor brake.
- When the SBC function is enabled or a safety brake motor is installed, Pin5 and Pin6 of CN8 need to be connected to an external 24V±10% voltage; otherwise, the servo drive issues an alarm E631.0.

6.5.2 SBC Triggered by Local Mode

When you choose to trigger the safety function locally, DI: FunIN2 is SBC command, DO: FunOUT.2 is SBC active, and DO: FunOUT.2 is SBC active.

Table 6–5 Description of function No.

Code	Name	Function Name	Function
FunIN.2	SBC command	SBC trigger command	0: SBC active 1: SBC deselected
FunOUT.2	SBC Active	SBC active	0: Normal state 1: SBC state

Note

- OFF (0): The 24V voltage of the corresponding DI is disconnected.
- ON (1): The 24V voltage of the corresponding DI is connected.

Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode	Page
H20.02	-	Safety module DI1 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	" H20_en.02" on page 205
H20.03	-	Safety module DI2 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	" H20_en.03" on page 206
H20.04	-	Safety module DI3 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	" H20_en.04" on page 207
H20.05	-	Safety module DI4 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	" H20_en.05" on page 207

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode	Page
H20.06	-	Safety module DI5 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	*" H20_en.06" on page 208*
H20.20	-	Safety module DO1 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.20" on page 211*
H20.21	-	Safety module DO2 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.21" on page 212*

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode	Page
H20.22	-	Safety module DO3 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.22" on page 213*
H20.23	-	Safety module DO4 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.23" on page 213*
H20.24	-	Safety module DO5 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.24" on page 214*

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode	Page
H20.25	-	Safety module DO6 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.25" on page 215*
H02.11	2002-0Ch	Motor speed threshold at brake output OFF in rotation state	20 rpm to 3000 rpm	30	rpm	Real-time	*" H02_en.11" on page 203*
H02.12	2002-0Dh	Delay from S-ON OFF to brake output OFF in rotation state	1 ms–65535 ms	500	ms	Real-time	*" H02_en.12" on page 203*

6.5.3 Sequence Diagram

The response sequence of the SBC function execution is shown below.

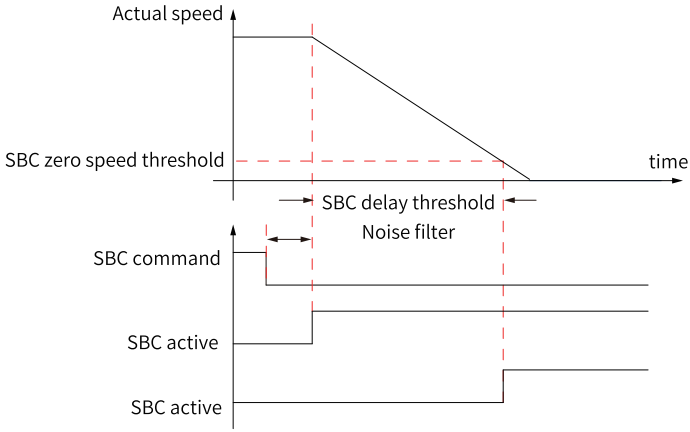


Figure 6-4 Response sequence of SBC function execution

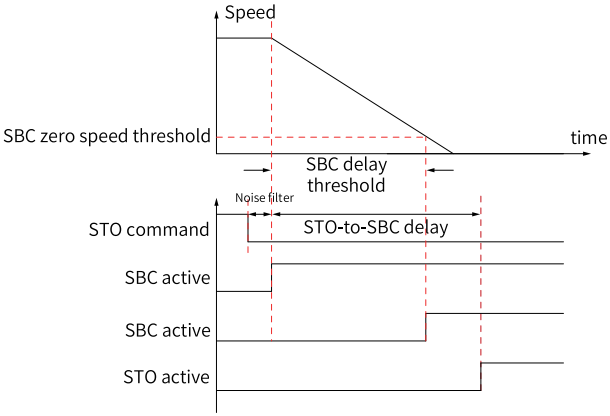
When the SBC command is determined as a valid signal after noise filtering, the S-ON OFF stop is executed. When the SBC zero speed threshold set by H02.11 is reached or the SBC delay threshold set by H02.12 expires, the safety module triggers the motor to brake. The motor rotor is held and the safety module outputs SBC active state.

In addition to being triggered by the SBC command, the SBC function can also be triggered by the STO function.

The sequence of STO and SBC functions can be configured considering the application conditions of STO in different situations.

For example, for the vertical axis application, you may that the load will not drop abnormally when the STO function is triggered. In this case, you can configure the SBC function to take effect before STO is activated.

SBC taking effect before STO



The negative value of H20-28 indicates that the STO takes effect after the SBC. The positive value indicates that the STO takes effect before the SBC. After the safety module receives the STO-triggered command, the servo drive decelerates first.

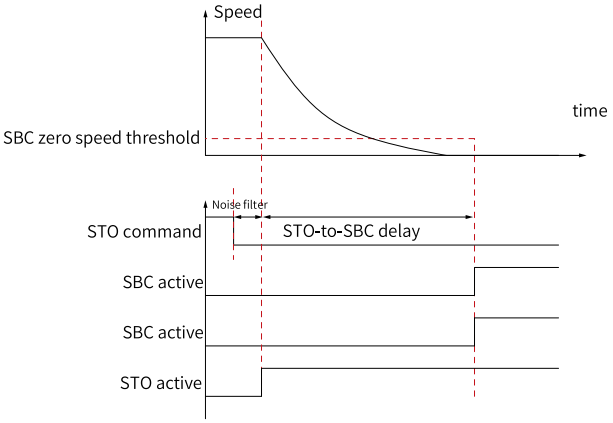
When the delay time or the SBC zero speed threshold is reached, the SBC brake takes effect and the motor rotor is held.

The value of H20.28 needs to consider the time required for the motor to decelerate from the maximum speed to 0 rpm, so as to avoid that the STO takes effect before SBC takes effect.

Note

If STO-to-SBC delay time has not reached, but the delay time after the SBC takes effect reaches the setpoint of H02.10, the servo drive will cut off the motor control power before the STO state takes effect. For vertical axis applications, if you want no falling-off risk on the load side, you also need to consider the value of H02.10.

SBC taking effect after STO



When the delay time H20.28 from STO activation to SBC activation is positive, after the safety module receives the STO trigger command, the drive cuts off the S-ON signal and performs coast-to-stop, and triggers the SBC function when the delay time is reached.

6.6 Safe Stop 1 (SS1) Function

6.6.1 Overview

SS1 is used to activate motor deceleration stop. It triggers STO after a certain delay or the speed is lower than a certain threshold. The SS1 stop mode includes ramp stop and host controller planned stop, which can be selected through parameter H20.29.

- When you select ramp stop, the servo drive will plan the stop command and stop the motor at the planned speed.
- When you select host controller planned stop, stop command planning does not occur inside the servo drive, but the host controller.
- When the pulse-type servo drive is used, you can only select ramp stop. When you select the host controller planned stop, the stop mode is forced to ramp stop.

If you choose to trigger safety function locally, you can set parameters H20.02 to H20.06 and set DI function to 3-SS1 to trigger SS1 through DI.

SS1 stop monitoring includes two modes: SS1-t and SS1-r, which can be selected through parameter H20.32. When SS1-r is selected, the safety motor must be used.

When SS1-t is selected, the drive is switched to STO status regardless of the motor speed after the delay time between SS1 is triggered and the drive enters STO state elapsed. A safety motor is not required. When the safety motor is used, the drive is switched to STO status when the speed feedback is lower than the zero speed threshold and the duration exceeds the zero speed time window.

When SS1-r is selected, since it contains SS1-t, the drive is switched to STO status after the delay time elapsed or when the speed feedback is lower than the zero speed threshold and the duration exceeds the zero speed time window. At the same time, the deceleration process is monitored, and the minimum deceleration speed is set. The actual deceleration must be larger than the monitoring threshold. If the actual deceleration is smaller than the set monitoring ramp range, a fault is reported and the STO status is activated.

The response mode for certain faults can be set to SS1-t. If the fault is triggered, the drive is switched to the SS1 stop state and then enters STO sate if the SS1-t status switching condition is met.

6.6.2 SS1 Triggered by Local Mode

SS1 trigger-related parameters

When you choose to trigger the safety function locally, DI: FunIN.3 is SS1 command, DO: FunOUT.3 is SS1 active, and DO: FunOUT.13 is SS1-r active.

Table 6–6 Description of function No.

Code	Name	Function Name	Function
FunIN.3	SS1 command	SS1 trigger command	0: SS1 active 1: SS1 deselected
FunOUT.3	SS1 Active	SS1 active	0: SS1 inactive 1: SS1 stop state
FunOUT.13	SS1-r Active	SS1-r active	0: SS1-r inactive 1: SS1-r active state

When any DI in DI1 to DI5 is configured to FunIN.11-Ack and after the DI corresponding to SS1 is triggered and recovered, the drive recovers from STO state to normal operational state only if the DI corresponding to the Ack function is triggered.

When no DI is configured to Ack function, the drive returns to normal operation state after the corresponding DI is triggered and recovered.

Note

- OFF (0): The 24V voltage of the corresponding DI is disconnected.
- ON (1): The 24V voltage of the corresponding DI is connected.

SS1 stop-related parameters

You can select the SS1 stop mode through H20.29.

- When you select ramp stop, the servo drive will plan the stop command and stop the motor at the planned speed.

- When you select host controller planned stop, stop command planning does not occur inside the servo drive, but the host controller.
- When the pulse-type servo drive is used, you can only select ramp stop. When you select the host controller planned stop, the stop mode is forced to ramp stop.

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.29	SS1/SS2 stop mode	0: Stop according to ramp 1: Stop by host controller	1	-	At stop	"H20_en.29" on page 215

When the stop mode is selected as ramp stop, set the ramp stop reference speed through parameter H20.30 and the ramp stop deceleration time through H20.31. The motor speed decreases from H20.30 to 0 after the time set by H20.31, as shown in the figure.

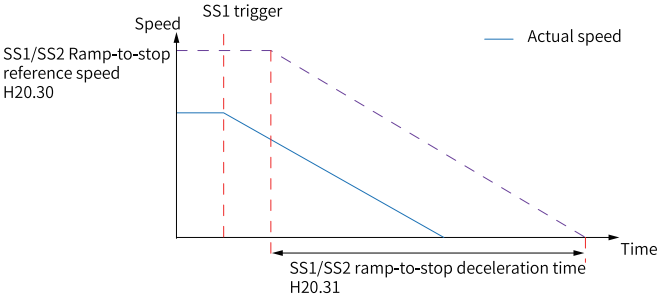


Figure 6-5 Motor speed during ramp stop

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.30	SS1/SS2 ramp-to-stop reference speed	60 rpm to 6000 rpm	1000	rpm	At stop	"H20_en.30" on page 216
H20.31	SS1/ SS2 ramp-to-stop deceleration time	1 ms–65535 ms	500	ms	At stop	"H20_en.31" on page 216

When the safety function is triggered in the local mode, you can set the delay time between SS1 is triggered and the drive enters STO state through parameter H20.33, set SS1 zero speed threshold by H20.34 and set SS1 zero speed window time by H20.35. When the delay time after SS1 is triggered reaches the setpoint of H20.33, the drive is switched to STO state regardless of the motor speed.

When the safety encoder is used, the drive is switched to the STO state if the delay time does not reach the setpoint of H20.33, but the motor speed is lower than the setpoint of H20.34, and the duration reaches the setpoint of H20.35.

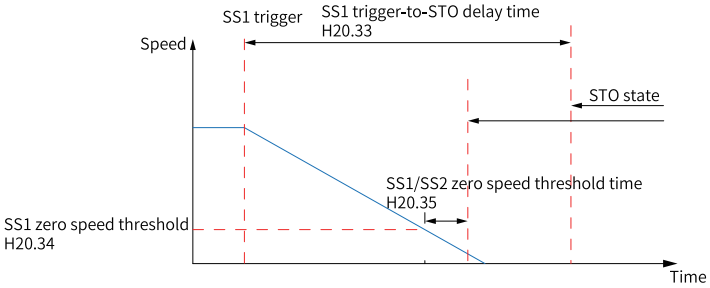


Figure 6-6 Safety function triggered locally, motor speed change

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.33	SS1 trigger-to-STO delay time/SS2 trigger-to-STO delay time	0 ms–65535 ms	1000	ms	At stop	"H20_en.33" on page 217
H20.34	SS1/ SS1 zero speed threshold	1 rpm to 6000 rpm	10	rpm	At stop	"H20_en.34" on page 217
H20.35	SS1/SS2 zero speed threshold time	0 ms–65535 ms	0	ms	At stop	"H20_en.35" on page 217

SS1 monitoring-related parameters

You can select the SS1 monitoring mode through H20.32.

- The speed ramp during deceleration is not monitored when "0-SS1-t" is selected.
- When "1-SS1-r" is selected, the speed ramp during deceleration is monitored. The actual deceleration must be greater than the set minimum deceleration.

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.32	SS1 monitor mode	0:SS1-t 1:SS1-r	0	-	At stop	"H20_en.32" on page 216

In SS1-r monitoring mode, when the safety function is triggered in the local mode:

- You can set the delay time (starting from the time when SS1 is triggered) for ramp monitoring to be activated through parameter H20.36. Speed ramp is monitored after the delay time elapsed.
- You can set the ramp monitoring reference speed through parameter H20.37, set the ramp monitoring time by H20.38, and the ratio between H20.37 and H20.38 corresponds to the motor's minimum deceleration ramp. The actual deceleration must be greater than the minimum deceleration speed, otherwise a deceleration overrun fault is reported.
- You can set the duration from SS1 triggers ramp limit to an alarm is issued through parameter H20.41. A fault is reported when the number of deceleration overruns exceeds the setpoint of H20.41.
- You can set the speed when SS1 ramp monitoring stops through H20.42 and stop ramp monitoring when the motor speed is lower than the setpoint of H20.42.

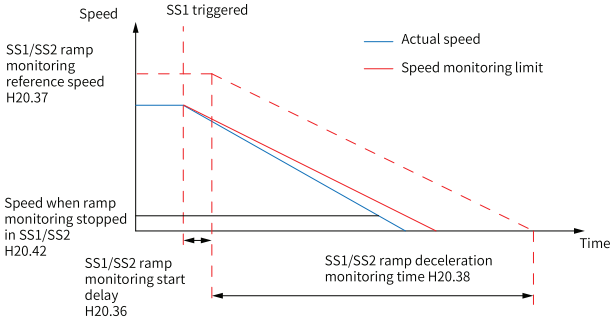


Figure 6-7 Motor speed when safety function is triggered

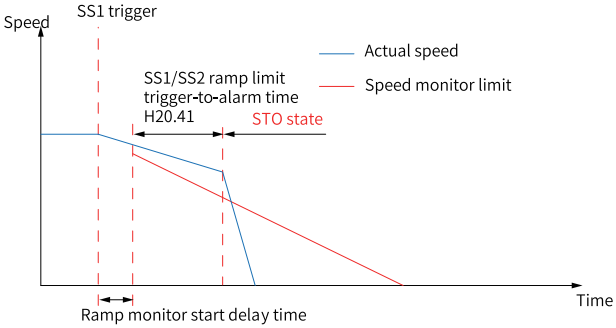


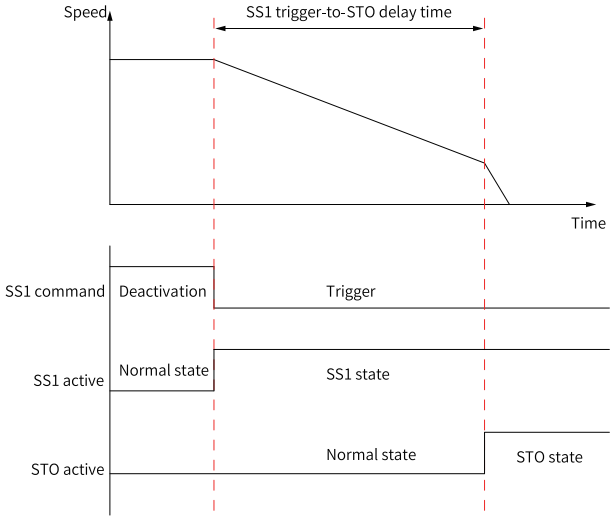
Figure 6-8 Motor speed when ramp limit is triggered

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.36	SS1/SS2 ramp monitor start delay time	5 ms–65535 ms	10	ms	At stop	"H20_en.36" on page 218
H20.37	SS1/SS2 ramp monitor reference speed	60 rpm to 6000 rpm	1000	rpm	At stop	"H20_en.37" on page 218
H20.38	SS1/SS2 ramp deceleration monitor time	1 ms–65535 ms	65535	ms	At stop	"H20_en.38" on page 218
H20.41	SS1/SS2 ramp limit trigger-to-alarm time	0 ms–65535 ms	5	ms	At stop	"H20_en.41" on page 219
H20.42	SS1/SS2 ramp monitor stop speed	0 rpm to 6000 rpm	1	rpm	At stop	"H20_en.42" on page 219

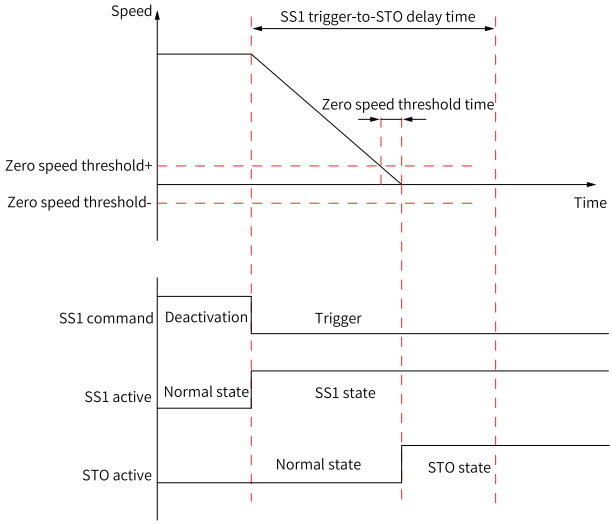
6.6.3 Sequence Diagram

SS1 is triggered and the drive enters STO state after a delay time has elapsed



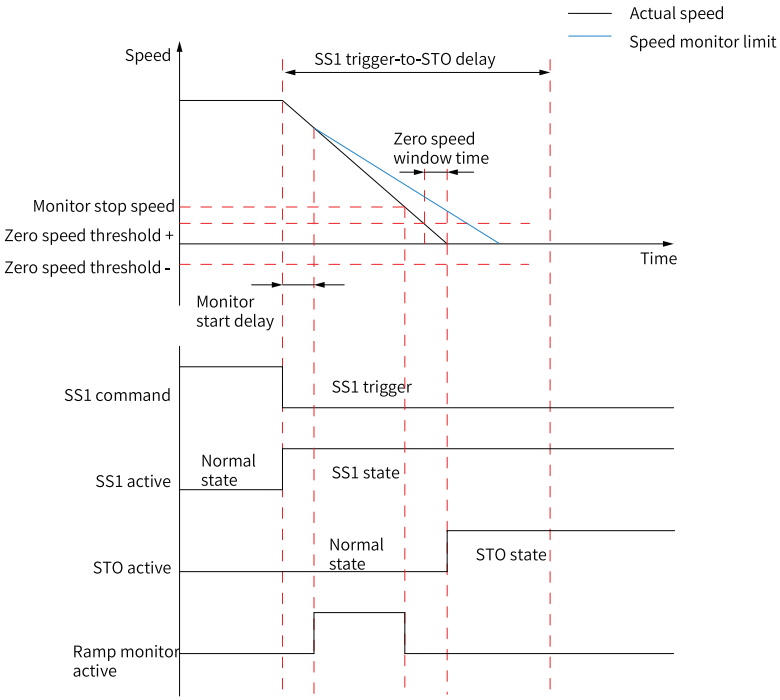
After SS1 is triggered, if you cancel an SS1 command during SS1 stop, the drive will continue to finish the stop process.

SS1 is triggered and the drive enters STO state when the speed meets zero speed conditions

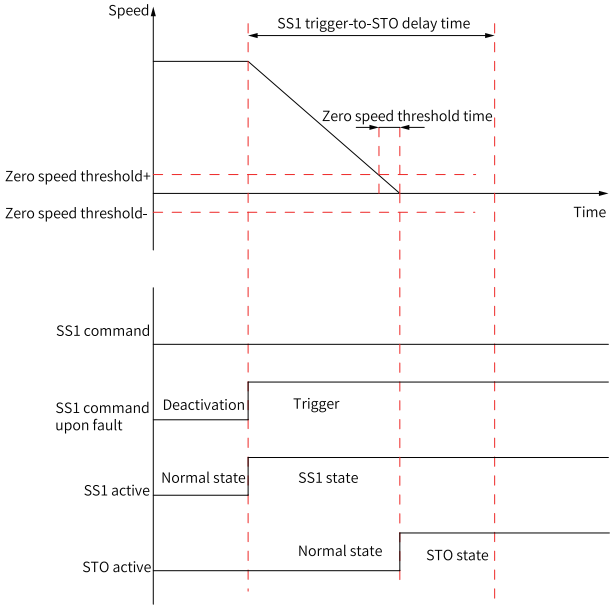


If the SS1 command is canceled after SS1 has been triggered, the drive will retain the SS1 state until the delay time has elapsed or the zero speed conditions are met.

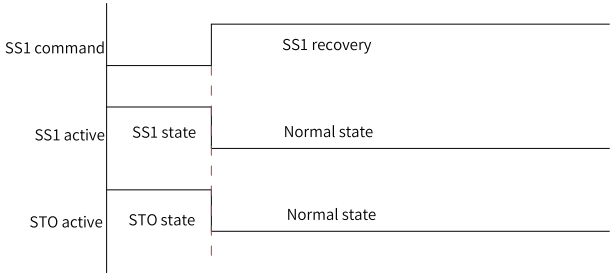
Starting SS1 speed ramp monitoring



SS1-t is triggered by fault and the drive enters STO state when the speed meets zero speed conditions



SS1 reset



6.7 Safe Stop 2 (SS2) Function

6.7.1 Overview

SS2 is used to activate motor deceleration stop. It triggers SOS after a certain delay or the speed is lower than a certain threshold. The SS2 stop mode includes ramp stop and host controller planned stop, which can be selected through parameter H20.29. When you select ramp stop, the servo drive will plan the stop command and stop the motor at the planned speed. When you select host controller planned stop, stop command planning does not

occur inside the servo drive, but the host controller. When the pulse-type servo drive is used, you can only select ramp stop. When you select the host controller planned stop, the stop mode is forced to ramp stop. The SS2 function requires a safety encoder.

If you choose to trigger safety function locally, you can set parameters H20.02 to H20.06 and set DI function to 4-SS2 to trigger SS2 through DI.

SS2 stop monitoring includes two modes: SS2-t and SS2-r, which can be selected through parameter H20.43.

When SS2-t is selected, the drive is switched to SOS status after the delay time between SS2 is triggered and the drive enters SOS state elapsed or when the speed feedback is lower than the zero speed threshold and the duration exceeds the zero speed time window.

When SS2-r is selected, since it contains SS2-t, the drive is switched to SOS status after the delay time elapsed or when the speed feedback is lower than the zero speed threshold and the duration exceeds the zero speed time window. At the same time, the deceleration process is monitored, and the minimum deceleration speed is set. The actual deceleration must be larger than the monitoring threshold. If the actual deceleration is smaller than the set monitoring ramp range, a fault is reported and the STO status is activated.

6.7.2 SS2 Triggered by Local Mode

SS2 trigger-related parameters

When you choose to trigger the safety function locally, DI: FunIN.4 is SS2 command, DO: FunOUT.4 is SS2 active, and DO: FunOUT.14 is SS2-r active.

Table 6–7 Description of function No.

Code	Name	Function Name	Function
FunIN.4	SS2 command	SS2 trigger command	0: SS2 active 1: SS2 deselected
FunOUT.4	SS2 Active	SS2 active	0: SS2 inactive 1: SS2 stop state
FunOUT.14	SS2-r Active	SS2-r active	0: SS2-r inactive 1: SS2-r active

When any DI in DI1 to DI5 is configured to FunIN.11-Ack and after the DI corresponding to SS2 is triggered and recovered, the drive recovers from SOS state to normal operational state only if the DI corresponding to the Ack function is triggered. When no DI is configured to Ack function, the drive returns to normal operation state after the corresponding DI is triggered and recovered.

Note

- OFF (0): The 24V voltage of the corresponding DI is off.
- ON (1): The 24V voltage of the corresponding DI is off.

SS2 stop-related parameters

When you select ramp stop, the servo drive will plan the stop command and stop the motor at the planned speed. When you select host controller planned stop, stop command planning does not occur inside the servo drive, but the host controller. When the pulse-type servo drive is used, you can only select ramp stop. When you select the host controller planned stop, the stop mode is forced to ramp stop.

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.29	SS1/SS2 stop mode	0: Stop according to ramp 1: Stop by host controller	1	-	At stop	*"H20_en.29" on page 215*

When the stop mode is selected as ramp stop, set the ramp stop reference speed through parameter H20.30 and the ramp stop deceleration time through H20.31. The motor speed decreases from H20.30 to 0 after the time set by H20.31, as shown in the figure.

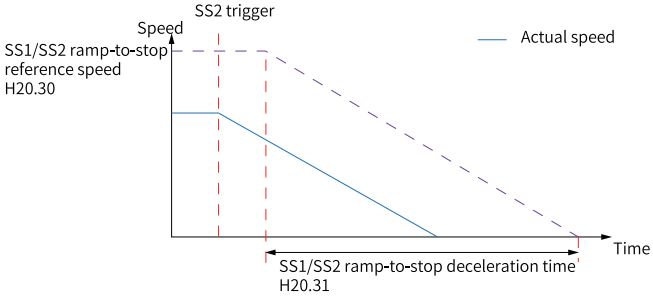


Figure 6-9 Motor speed during ramp stop

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.30	SS1/SS2 ramp-to-stop reference speed	60 rpm to 6000 rpm	1000	rpm	At stop	"H20_en.30" on page 216
H20.31	SS1/ SS2 ramp-to-stop deceleration time	1 ms–65535 ms	500	ms	At stop	"H20_en.31" on page 216

When the safety function is triggered in the local mode, you can set the delay time between SS2 is triggered and the drive enters SOS state through parameter H20.33, set SS2 zero speed threshold by H20.34 and set SS2 zero speed window time by H20.35. If the delay time after the SS2 function is triggered reaches the value of H20.33, the drive switches to the SOS state regardless of the motor speed. If the delay time after the SS2 function is triggered does not reach the value of H20.33 but the motor speed falls below the value of H20.34 for a period of time exceeding the value of H20.35, the drive switches to the SOS state in advance.

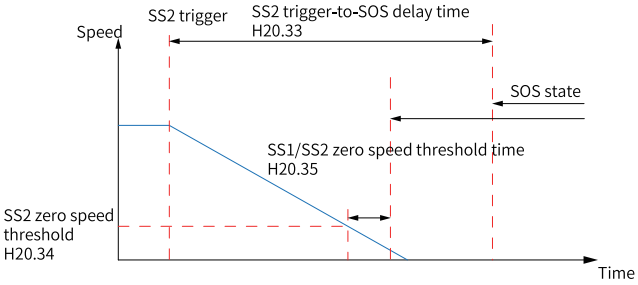


Figure 6-10 Safety function triggered locally, motor speed change

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.33	SS1 trigger-to-STO delay time/SS2 trigger-to-STO delay time	0 ms–65535 ms	1000	ms	At stop	"H20_en.33" on page 217
H20.34	SS1/ SS1 zero speed threshold	1 rpm to 6000 rpm	10	rpm	At stop	"H20_en.34" on page 217
H20.35	SS1/SS2 zero speed threshold time	0 ms–65535 ms	0	ms	At stop	"H20_en.35" on page 217

SS2 monitoring-related parameters

You can configure the SS2 monitoring mode by setting parameter H20.43. If you choose "0: SS2-t", the speed ramp will not be monitored during the deceleration process; if you choose "1: SS2-r", the speed ramp will be monitored during the deceleration process and the actual deceleration of the motor must be larger than the preset minimum deceleration.

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.43	SS2 monitor mode	0:SS2-t 1:SS2-r	0	-	At stop	"H20_en.43" on page 219

In Ss2-r monitoring mode, after you choose to trigger the safety function locally, you can set the delay time (starting from the time when SS2 is triggered) for ramp monitoring to be activated through parameter H20.36. Speed ramp is monitored after the delay time elapsed.

You can set the ramp monitoring reference speed through parameter H20.37, set the ramp monitoring time by H20.38, and the ratio between H20.37 and H20.38 corresponds to the motor's minimum deceleration ramp. The actual deceleration must be greater than the minimum deceleration speed, otherwise a deceleration overrun fault is reported.

You can set the duration from SS2 triggers ramp limit to an alarm is issued through parameter H20.41. A fault is reported when the number of deceleration overruns exceeds the setpoint of H20.41. You can set the speed when SS2 ramp monitoring stops through H20.42 and stop ramp monitoring when the motor speed is lower than the setpoint of H20.42.

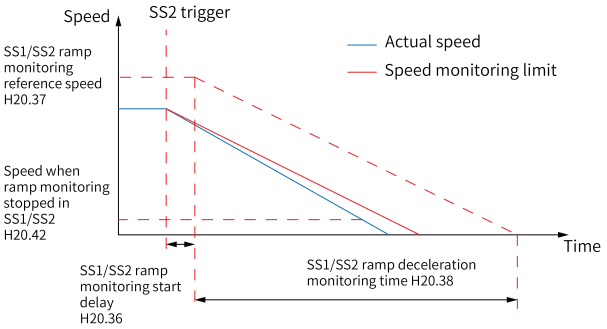


Figure 6-11 Motor speed when safety function is triggered

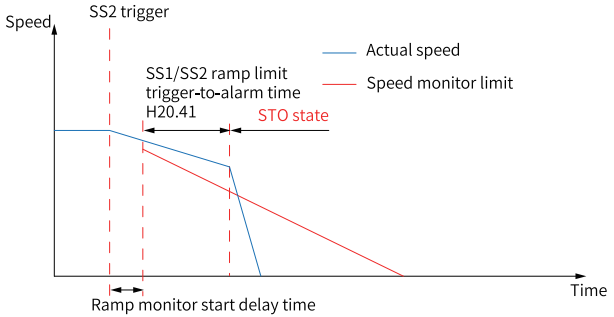


Figure 6-12 Motor speed when ramp limit is triggered

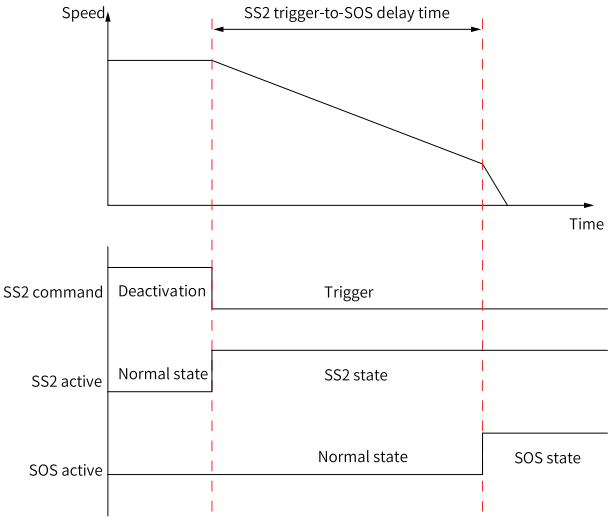
Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.36	SS1/SS2 ramp monitor start delay time	5 ms–65535 ms	10	ms	At stop	*"H20_en.36" on page 218*
H20.37	SS1/SS2 ramp monitor reference speed	60 rpm to 6000 rpm	1000	rpm	At stop	*"H20_en.37" on page 218*
H20.38	SS1/SS2 ramp deceleration monitor time	1 ms–65535 ms	65535	ms	At stop	*"H20_en.38" on page 218*

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.41	SS1/SS2 ramp limit trigger-to-alarm time	0 ms–65535 ms	5	ms	At stop	"H20_en.41" on page 219
H20.42	SS1/SS2 ramp monitor stop speed	0 rpm to 6000 rpm	1	rpm	At stop	"H20_en.42" on page 219

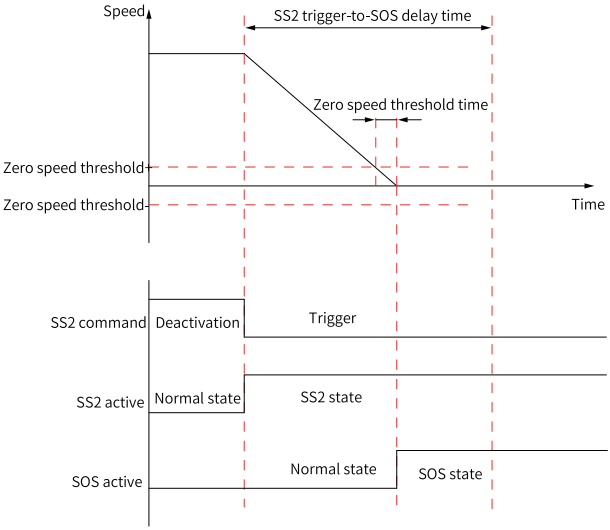
6.7.3 Sequence Diagram

SS2 is triggered and the drive enters SOS state after a delay time has elapsed



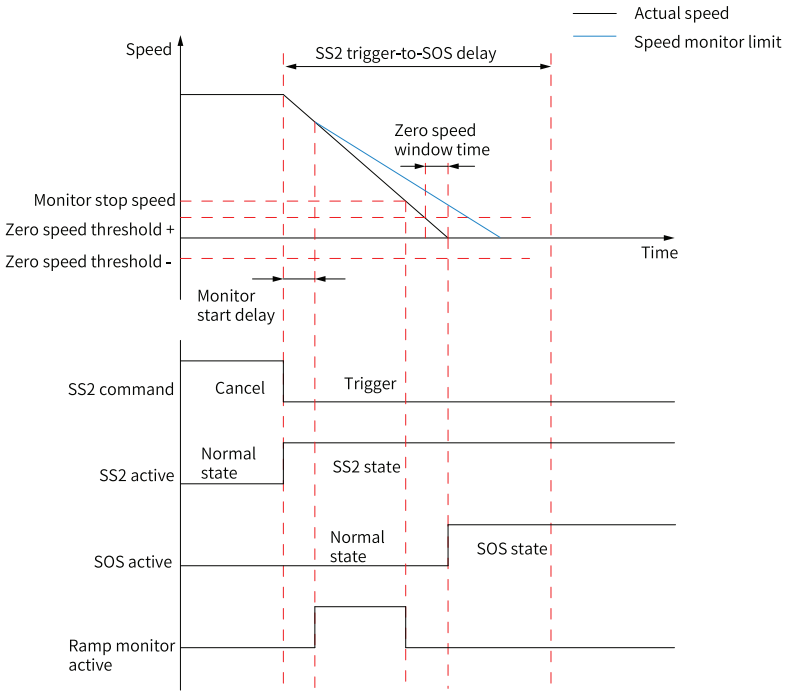
If the SS2 command is canceled after SS2 has been triggered, the drive will retain the SS2 state until the delay time has elapsed.

SS2 is triggered and the drive enters SOS state when the speed meets zero speed conditions

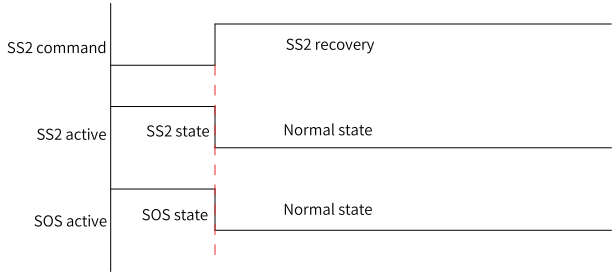


If the SS2 command is canceled after SS2 has been triggered, the drive will retain the SS2 state until the delay time has elapsed or the zero speed conditions are met.

Starting SS2 speed ramp monitoring



SS2 reset



6.8 Safe Operation Stop (SOS) Function

6.8.1 Overview

The SOS function monitors whether the speed and position of the motor in a stationary state are within thresholds, ensuring that the motor is in a safe stop state while providing the power needed to maintain the external load. After SS2 is triggered, the drive switches

from the SS2 state to the SOS state when the switching conditions are met. The SOS function requires a safety encoder.

In the SOS state, the position and speed of the motor will be monitored. When the position or speed of the motor exceeds the threshold, a fault will be reported and the drive will enter the STO state.

Note

Do not send any command to the servo drive when SOS monitoring is effective. Otherwise, the drive has to respond to the accumulated commands after the SOS monitoring state exits.

6.8.2 SOS Triggered by Local Mode

SOS trigger-related parameters

The parameter DO: FunOUT.11 (SOS Active) enables the DO to output that SOS function is active.

Table 6–8 Description of function No.

Code	Name	Function Name	Function
FunOUT.11	SOS Active	SOS active	0: SOS inactive 1: SOS active

When any DI in DI1 to DI5 is configured to FunIN.11-Ack and after the DI corresponding to SS2 is triggered and recovered, the drive recovers from SOS state to normal operational state only if the DI corresponding to the Ack function is triggered.

When no DI is configured to Ack function, the drive returns to normal operation state after the corresponding DI is triggered and recovered.

Note

- OFF (0): The 24V voltage of the corresponding DI is disconnected.
- ON (1): The 24V voltage of the corresponding DI is connected.

SOS-related parameters

You can configure the SOS speed change threshold by setting parameter H20.44, the SOS position change threshold by H20.45, and the SOS overthreshold-to-alarm time by H20.47.

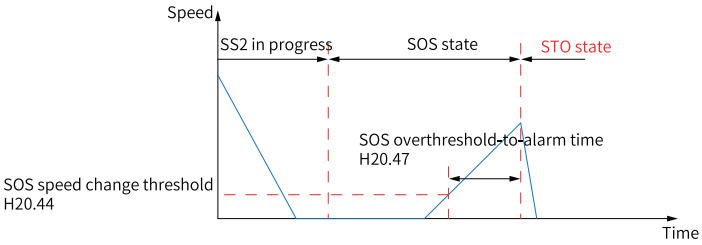


Figure 6-13 SOS speed change threshold

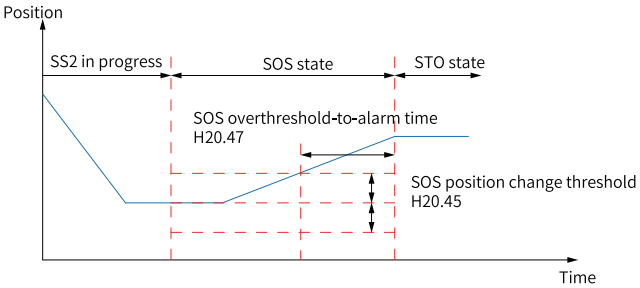


Figure 6-14 SOS position change threshold

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.44	SOS speed change threshold	1 rpm to 6000 rpm	10	rpm	At stop	*" H20_en.44" on page 220*
H20.45	SOS position change threshold	1 to 536870912	932067	encoder unit	At stop	*" H20_en.45" on page 220*
H20.47	SOS overthreshold-to-alarm time	0 ms–65535 ms	5	ms	At stop	*" H20_en.47" on page 220*

6.8.3 Sequence Diagram

SOS speed monitoring overrun

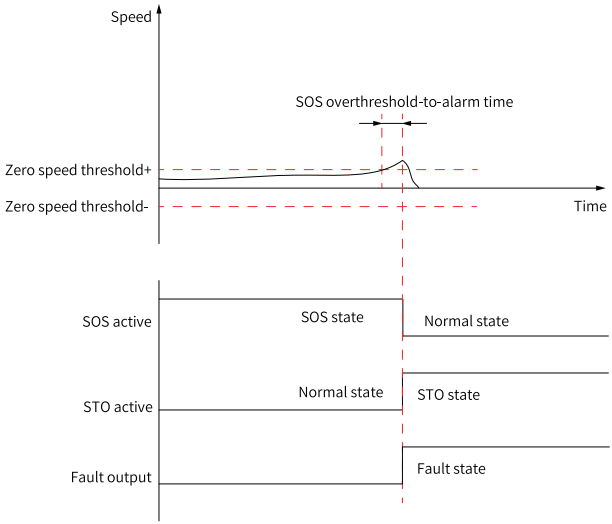


Figure 6-15 SOS speed monitoring timing diagram

SOS position monitoring overrun

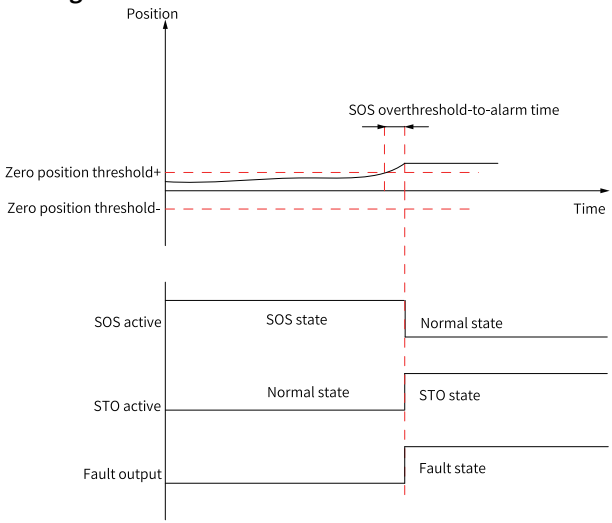


Figure 6-16 SOS position monitoring timing diagram

6.9 Safe Limit Speed (SLS) Function

6.9.1 Overview

When the SLS function is active, the safety module monitors whether the motor speed exceeds the SLS threshold. Once the allowable speed is exceeded, the servo drive responds in a preset way. You can configure the way for the servo drive to handle the SLS fault by setting the parameter H20.60.

There are four SLS thresholds and you can switch monitoring of these these thresholds during operation.

The SLS function is suitable for motors that can be dangerous due to overspeed.

6.9.2 SLS Triggered by Local Mode

The parameter DI: FunIN5 (SLS1) enables the DI to trigger the SLS1 function, DI: FunIN6 (SLS2) enables the DI to trigger the SLS2 function, DI: FunIN7 (SLS3) enables the DI to trigger the SLS3 function, DI: FunIN8 (SLS4) enables the DI to trigger the SLS4 function, DO: FunOUT.5 (SLS1 Active) enables the DO to output that SLS1 is active, DO: FunOUT.6 (SLS2 Active) enables the DO to output that SLS6 is active, DO: FunOUT.7 (SLS3 Active) enables the DO to output that SLS3 is active, and DO: FunOUT.8 (SLS4 Active) enables the DO to output that SLS4 is active.

Table 6–9 Description of function No.

Code	Name	Function Name	Function
FunIN.5	SLS1 command	SLS1 trigger command	0: SS1 active 1: SS1 deselected
FunIN.6	SLS2 command	SLS2 trigger command	0: SS2 active 1: SS2 deselected
FunIN.7	SLS3 command	SLS3 trigger command	0: SS3 active 1: SS3 deselected
FunIN.8	SLS4 command	SLS4 trigger command	0: SS4 active 1: SS4 deselected
FunOUT.5	SLS1 Active	SLS1 active	0: Normal state 1: SLS1 monitoring state
FunOUT.6	SLS2 Active	SLS2 active	0: Normal state 1: SLS2 monitoring state
FunOUT.7	SLS3 Active	SLS3 active	0: Normal state 1: SLS3 monitoring state
FunOUT.8	SLS4 Active	SLS4 active	0: Normal state 1: SLS4 monitoring state

Note

- OFF (0): The 24V voltage of the corresponding DI is disconnected.
- ON (1): The 24V voltage of the corresponding DI is connected.

Related parameters:

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.02	Safety module DI1 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	*" H20_en.02" on page 205*
H20.03	Safety module DI2 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	*" H20_en.03" on page 206*
H20.04	Safety module DI3 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	*" H20_en.04" on page 207*

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.05	Safety module DI4 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	"H20_en.05" on page 207
H20.06	Safety module DI5 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	"H20_en.06" on page 208
H20.20	Safety module DO1 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	"H20_en.20" on page 211

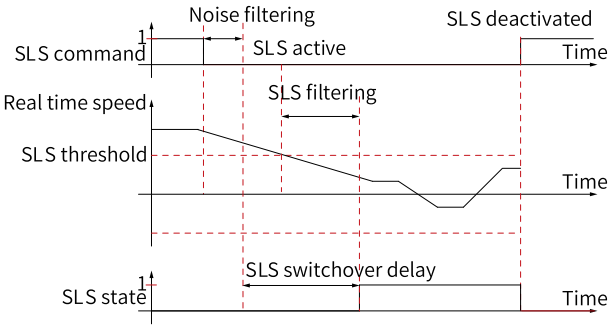
Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.21	Safety module DO2 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*"H20_en.21" on page 212*
H20.22	Safety module DO3 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*"H20_en.22" on page 213*
H20.23	Safety module DO4 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*"H20_en.23" on page 213*

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.24	Safety module DO5 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	"H20_en.24" on page 214
H20.25	Safety module DO6 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	"H20_en.25" on page 215
H20.48	SLS1 switchover delay	0 ms–65535 ms	100	ms	At stop	"H20_en.48" on page 221
H20.49	SLS2 switchover delay	0 ms–65535 ms	100	ms	At stop	"H20_en.49" on page 221
H20.50	SLS3 switchover delay	0 ms–65535 ms	100	ms	At stop	"H20_en.50" on page 221
H20.51	SLS4 switchover delay	0 ms–65535 ms	100	ms	At stop	"H20_en.51" on page 222
H20.52	SLS1 threshold	0 rpm to 6000 rpm	1000	rpm	At stop	"H20_en.52" on page 222
H20.53	SLS2 threshold	0 rpm to 6000 rpm	1000	rpm	At stop	"H20_en.53" on page 222
H20.54	SLS3 threshold	0 rpm to 6000 rpm	1000	rpm	At stop	"H20_en.54" on page 222

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.55	SLS4 threshold	0 rpm to 6000 rpm	1000	rpm	At stop	"H20_en.55" on page 223
H20.56	SLS1 filter time	0 ms–65535 ms	100	ms	At stop	"H20_en.56" on page 223
H20.57	SLS2 filter time	0 ms–65535 ms	100	ms	At stop	"H20_en.57" on page 223
H20.58	SLS3 filter time	0 ms–65535 ms	100	ms	At stop	"H20_en.58" on page 223
H20.59	SLS4 filter time	0 ms–65535 ms	100	ms	At stop	"H20_en.59" on page 224

6.9.3 Sequence Diagram

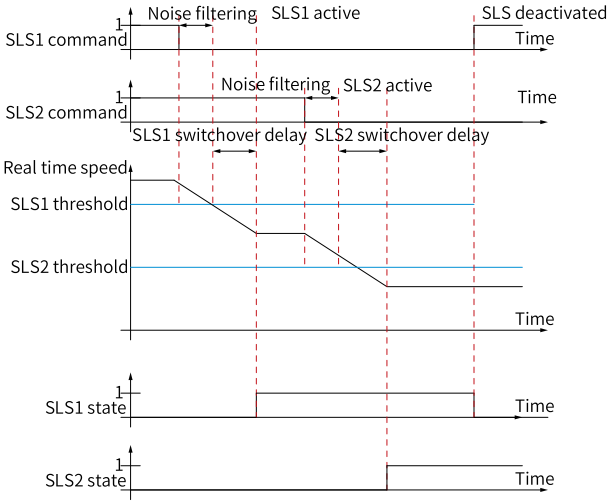
Sequence of SLS triggering



- When the SLS command is active, the speed of the servo motor must be below the SLS threshold before the SLS switchover delay expires; otherwise, the safety module will issue an SLS alarm.
- The safety module only monitors whether the motor speed and SLS switchover delay reach the thresholds. It will not actively send deceleration commands to the servo drive. To make the motor speed fall below the SLS threshold within the SLS switchover delay, the servo drive must be controlled externally for deceleration.
- When the SLS command is canceled, the SLS monitoring function is turned off, and the servo drive can immediately continue to run at a larger preset speed.

Sequence of multiple SLS triggering

The safety module enables monitoring for four different SLS thresholds. When multiple SLS commands are all active, the motor speed must be kept below the smallest SLS threshold; otherwise, the safety module will issue an SLS alarm.



During normal operation of the servo drive, the SLS1 monitoring is triggered. Before the SLS1 switchover delay expires, the motor speed needs to be kept below the SLS1 threshold. After the SLS1 switchover delay expires, the SLS1 monitoring is turned on. During the SLS1 monitoring, the SLS2 monitoring is triggered. Before the SLS2 switchover delay expires, the motor speed needs to be kept below the SLS2 threshold. After the SLS2 switchover delay expires, the SLS2 monitoring is turned on.

In this case, both SLS1 and SLS2 monitoring are executed at the same time. The smaller one of the SLS1 and SLS2 thresholds is used. When the SLS1 command is canceled, the SLS1 monitoring is turned off.

6.10 Safe Direction (SDI) Function

6.10.1Overview

The SDI (safe direction) function prevents the motor shaft from moving in an unintended direction.

When the SDIp input command is active, the safety module monitors whether the motor shaft moves in the prohibited forward direction; when the SDIn input command is active, the safety module monitors whether the motor shaft moves in the prohibited reverse direction.

When the motor shaft moves in an unexpected direction and exceeds the allowable threshold, the safety module triggers the corresponding stop alarm. You can configure the stop mode for the SDI fault by setting the parameter H20.78.

The SDI function must be used with a safety motor.

6.10.2SDI Triggered by Local Mode

The SDI function controlled by the DI involve the following parameter configurations.

The parameter DI: FunIN9 (SDIp) enables the DI to trigger the SS2 function, DI: FunIN10 (SDIn) enables the DI to trigger the SDIn function, DO: FunOUT.9 (SDIp Active) enables the DO to output that SDIp is active, and DO: FunOUT.10 (SDIn Active) enables the DO to output that SDIn is active.

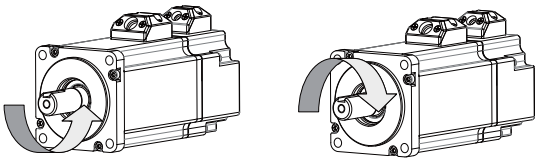
Table 6–10 Description of function No.

Code	Name	Function Name	Function
FunIN.9	SDIp command	SDIp trigger command	0: Active, forward rotation prohibited 1: Canceled, forward rotation allowed
FunIN.10	SDIn command	SDIn trigger command	0: Active, reverse rotation prohibited 1: Canceled, reverse rotation allowed
FunOUT.9	SDIp Status	SDIp state	0: Inactive, motor is not rotating forward 1: Active, motor is rotating forward
FunOUT.10	SDIn Status	SDIn state	0: Inactive, motor is not rotating reversely 1: Active, motor is rotating reversely

Note

- OFF (0): The 24V voltage of the corresponding DI is off.
- ON (1): The 24V voltage of the corresponding DI is off.

From the perspective of the motor load side, clockwise rotation of the motor is abbreviated as CW, and counterclockwise rotation is abbreviated as CCW, as shown below.



The logical relationship between SDI command and state is as follows.

SDI command		SDI state		Description
SDIp	SDIn	SDIp	SDIn	
1	1	-	-	The motor can rotate both forward and reversely.
1	0	1	0	The motor can only rotate forward.
0	1	0	1	The motor can only rotate reversely.
0	0	0	0	The motor is not allowed to rotate reversely.

Note

0: Inactive, meaning that the 24V voltage of the corresponding DI is off;

1: Active, meaning that the 24V voltage of the corresponding DI is on.

Related parameters:

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode	Page
H20.02	-	Safety module DI1 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	*" H20_en.02" on page 205*
H20.03	-	Safety module DI2 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	*" H20_en.03" on page 206*

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode	Page
H20.04	-	Safety module DI3 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	*" H20_en.04" on page 207*
H20.05	-	Safety module DI4 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	*" H20_en.05" on page 207*
H20.06	-	Safety module DI5 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	*" H20_en.06" on page 208*

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode	Page
H20.20	-	Safety module DO1 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.20" on page 211*
H20.21	-	Safety module DO2 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.21" on page 212*
H20.22	-	Safety module DO3 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.22" on page 213*

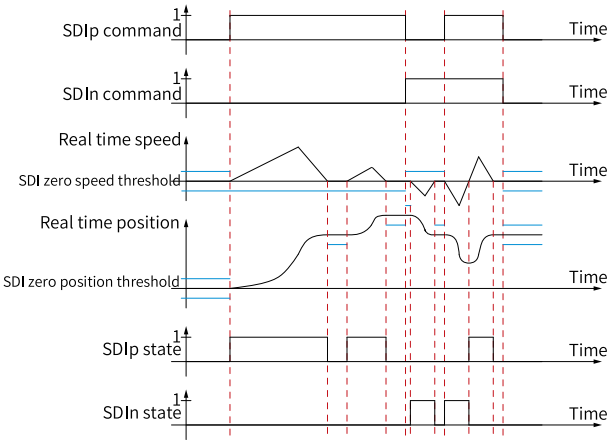
Parameter	Communication Address	Name	Value	Default	Unit	Change Mode	Page
H20.23	-	Safety module DO4 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	" H20_en.23" on page 213
H20.24	-	Safety module DO5 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	" H20_en.24" on page 214
H20.25	-	Safety module DO6 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	" H20_en.25" on page 215
H20.74	-	SDI zero position threshold	1 to 536870912	932067	encoder unit	At stop	" H20_en.74" on page 225

Parameter	Communication Address	Name	Value	Default	Unit	Change Mode	Page
H20.76	-	SDI zero speed threshold	0 rpm to 3000 rpm	10	rpm	At stop	" H20_en.76" on page 226
H20.77	-	SDI delay time	0 ms–65535 ms	0	ms	At stop	" H20_en.77" on page 226
H20.78	-	SDI fault response mode	0:STO 1:SS1-t	0	-	At stop	" H20_en.78" on page 226
H20.00	-	Safety module software version	0.00 to 655.35	0.00	-	Unchangeable	" H20_en.00" on page 205
H02.02	2002-03h	Rotation direction selection	0: Counterclockwise (CCW) as forward direction 1: Clockwise (CW) as forward direction	0	-	At stop	" H02_en.02" on page 203

6.10.3Sequence Diagram

SDI control bit setting

You can control rotation direction of the motor by setting the SDI control bit. The permissible rotation direction is given by SDI positive (SDIp) and SDI negative (SDIn) control bits.



- The SDIp and SDIn states displayed by the safety module indicate the current rotational state of the servo motor, independent of whether the input SDI command is active or not. When both SDIp and SDIn states are 0, it means the servo motor is stopped.

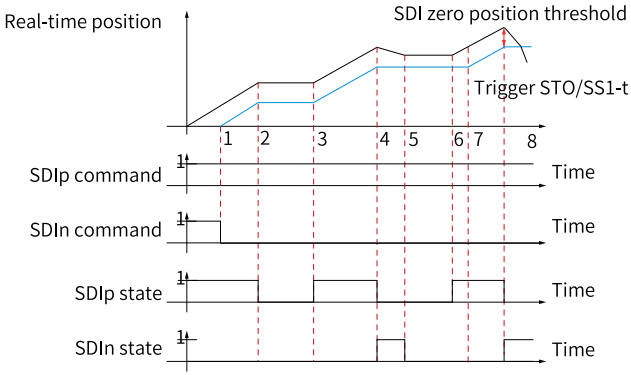
- When the SDIp command is deactivated, the motor can rotate in forward direction, and when it is activated, the motor can only rotate in reverse direction.
- When the SDIn command is deactivated, the motor can rotate in reverse direction, and when it is activated, the motor can only rotate in forward direction.

SDI monitoring

When the SDI zero position threshold or SDI zero speed threshold is exceeded, the stop mode defined by H02.78 is triggered.

The SDI monitoring diagram is shown below.

Stop according to H20.78 when the SDI zero position threshold is exceeded



The sequence is described as follows:

1. The safety module receives an active SDIn command and starts monitoring whether the motor shaft rotates into the reverse direction. The motor rotates into the allowable forward direction.

2. The motor stops rotating and the position feedback remains unchanged.

3. The motor continues to rotate into the allowable forward direction.

4. The motor rotates into the reverse direction, the safety module locks the maximum allowed reverse position threshold and checks whether the current position exceeds the maximum allowed value.

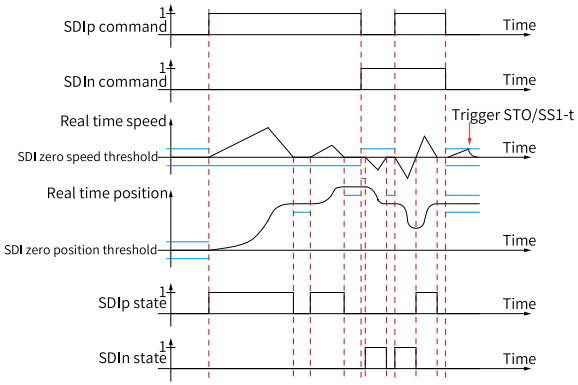
5. The motor stops before the maximum reverse position threshold is reached.

6. The motor continues to rotate into the allowable forward direction.

7. The motor returns to the position it was in when the reverse position threshold was locked.

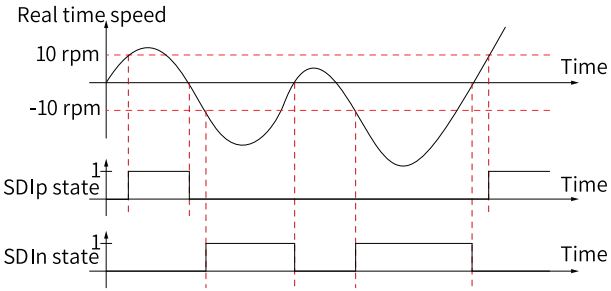
8. The zero position threshold is exceeded and the safety stop set by H20.78 is triggered.

Stop according to H20.78 when the SDI zero speed threshold is exceeded



Hysteresis speed

To avoid the SDIp and SDIn states jumping back and forth near zero speed, the safety module is configured with a hysteresis speed of 10 rpm. Only when the speed exceeds ±10rpm, the corresponding SDI state value changes to 1.



6.11 Safe Speed Monitor (SSM) Function

6.11.1Overview

The SSM function provides a safe output signal to indicate whether the motor speed is below a prescribed limit to identify, for example, a standstill. The safety module provides a safe output signal for further processing.

The SSM monitors whether the motor speed is within the limit threshold. The safety module does not trigger any stop response when the motor speed exceeds the SSM limit threshold.

The SSM applies to enabling through feedback in the local mode, such as unlocking the protective door at a speed lower than the critical speed.

The SSM status can be output only in the local mode.

6.11.2SSM Triggered Locally

The parameter DO: FunOUT.12 (SSM Active) enables the DO to output that SSM function is active.

Table 6–11 Description of function No.

Code	Name	Function Name	Function
FunOUT.12	SSM Active	SSM active	0: Out of SSM limit 1: Within SSM limit

Note

- OFF (0): The 24V voltage of the corresponding DI is disconnected.
- ON (1): The 24V voltage of the corresponding DI is connected.

The parameters for safety DO controlling SSM are as follows:

Related parameters:

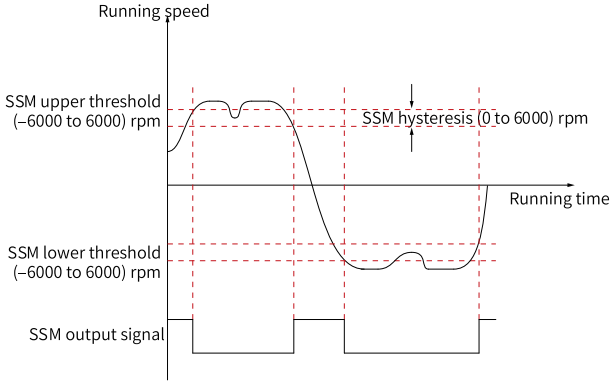
Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.20	Safety module DO1 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	"H20_en.20" on page 211
H20.21	Safety module DO2 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	"H20_en.21" on page 212
H20.23	Safety module DO4 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	"H20_en.23" on page 213

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.24	Safety module DO5 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	"H20_en.24" on page 214
H20.70	SSM upper limit	–6000 rpm to 6000 rpm	200	rpm	At stop	"H20_en.70" on page 224
H20.71	SSM lower limit	–6000 rpm to 6000 rpm	-200	rpm	At stop	"H20_en.71" on page 225
H20.72	SSM hysteresis threshold	0 rpm to 6000 rpm	10	rpm	At stop	"H20_en.72" on page 225

Note

- When the upper and lower limits of SSM are set to 0 at the same time, the SSM function can be disabled, and the SSM status is always inactive.
- The upper limit of the SSM must be greater than the lower limit, and the hysteresis threshold of the SSM must be less than the upper limit minus the lower limit.
- The SSM hysteresis threshold is set by parameter H20.72, and is valid for both local DO and FSoE output status words.

6.11.3Sequence Diagram



The purpose of the SSM hysteresis setting is to achieve a more stable signal output when the motor speed is near the upper or lower SSM threshold. The SSM function prevents the SSM output signal from jumping back and forth between 0 and 1 several times around the threshold due to the real-time fluctuation of the motor speed.

- When the motor speed is within the upper and lower SSM thresholds, the SSM output is 1.
- When the motor speed exceeds the upper SSM threshold, the SSM output is 0.
- When the motor speed drops below upper SSM threshold minus hysteresis threshold, the SSM output is 1 again.
- When the motor speed drops below the lower SSM threshold, the SSM output is 0.
- When the motor speed increases to lower SSM threshold + hysteresis threshold, the SSM output is 1 again.

6.12 Safety Function Response Time

Caution

Set the parameters correctly to achieve the desired response time and ensure the accumulation of diagnostic test interval (DTI) and safety function response time can meet the safety requirements of the system.

6.12.1 Response time When Triggering Local Mode

When the local mode triggers the safety function, configure the safety DI to a safety function and trigger the corresponding safety function by controlling the safety DI. The

response time from DI operation to the time when the safety function take effect is shown in the following table.

Table 6–12 Response time during terminal control

Function	Max. response time[5]
STO/SBC/SS1/SS2	t_DI[1]+2.5ms
SLS	t_DI[1]+t_SLS[3] + 6.5ms
SDI	t_DI[1]+t_SDI[4] + 6.5ms
SOS	t_SOS[2] + 6.5ms
SSM	4 ms

Note

[1]: t_DI is the noise removal filter time of the safety module DI, which is configured by parameters H20.08 to H20.12, with setpoints ranging from 1 ms to 500 ms.

[2]: t_SOS is the filter time set by H20.47, which ranges from 0 ms to 65535 ms.

[3]: t_SLS is the delay time set by parameters H20.48 to H20.51, which ranges from 0 ms to 65535 ms.

[4]: t_SDI is the delay time set by H20.77, which ranges from 0 ms to 65535 ms.

[5]: Indicates the time interval between the safety function demand state and the safety function completion state (such as entering the safety state).

6.13 Fault reset

When the resettable safety function fault occurs, you can stop the keypad from displaying the fault using the fault reset function.

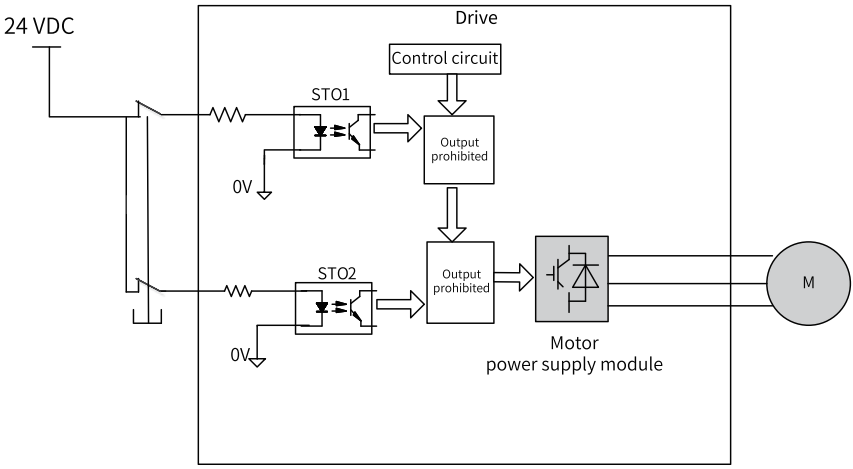
To stop the keypad from displaying the fault/warning, set H0d.01 (Fault reset) to 1 or activate the DI terminal assigned with DI function 2 (FunIN.2: ALM- RST, fault and warning reset).

For No. 1 and No. 2 resettable faults, turn off the S-ON signal before resetting the faults.

When a non-resettable safety function fault occurs, the power must be restarted to stop the fault display.

7 STO Integration

7.1 Overview



By cutting off the output of the motor supply module, the power supply current and torque of the motor is off.

Figure 7-1 Schematics of the STO function

Safe Torque Off (STO) is a safety function that complies with IEC 61800-5-2:2016. It is built into Inovance SV680-INT series servo drives.

Remember to perform a power cycle of the drive every three months or trigger the STO through disconnecting the 24V input of CN6, so that STO can be reset periodically.

The STO function inhibits the control signal of the power semiconductors on the drive output end, preventing the drive from generating torque at the motor shaft end.

The STO function prevents movement of the motor by two redundant external hardware signals (STO1 and STO2) that block the PWM signals from being outputted to the power layer of the servo drive. STO1 and STO2 input signals must be both active to allow the servo drive to operate normally.

See the following table for the STO function.

STO1 Input	STO2 Input	PWM Signal
H	H	Normal
L	H	Prohibited
H	L	Prohibited
L	L	Prohibited

STO (safe torque)	
Description	Cuts off the power of the motor.
Description	The safe torque off (STO) function brings the machine safely into a no-torque state and prevents it from unexpected start. When the STO function is activated, the servo drive stops according to the preset stop mode (H02.08).
Safe state	Disables the PWM gating signal of the drive.
Operation mode	High demand mode or continuous mode

7.2 Function Use and Monitoring

Function Use

The keypad displays the STO function state and error information.

See the following table to identify the cause of a fault and the action to be taken. Contact Inovance technical support if the fault persists after corrective actions listed in the following table are taken.

Fault codes related to the STO function are listed in the following table:

Fault Code	Fault code name	Description	Cause	Corrective Action
E150.0	STO safety state applied	The STO input protection applies (safety state).	STO is triggered because either or both of two 24 V inputs are disconnected.	There is no need to take any corrective actions. After the STO terminal is back to normal, clear the fault using the fault reset function. Check whether the 24 V power supply for the STO is stable. Tighten the cables that are loose or disconnected. Replace the servo drive.
E150.1	STO input state abnormal	The single-channel input of STO is ineffective.	1. STO input power supply is abnormal.	Check whether the 24 V power supply for the STO is stable. Tighten the cables that are loose or disconnected.
			2. STO input resistor is abnormal.	Replace the servo drive.
			3. STO is ineffective.	Replace the servo drive.
E150.2	Buffer 5 V supply error	The MCU monitors the 5 V power supply of the PWM Buffer to detect whether overvoltage or undervoltage occurs. If the voltage is abnormal, E150.2 occurs.	The 5 V voltage supplied to the STO Buffer is abnormal due to undervoltage or overvoltage.	Replace the servo drive.

Fault Code	Fault code name	Description	Cause	Corrective Action
E150.3	STO input circuit hardware diagnosis	The photocoupler of the front hardware circuit for STO input is inspected. If the photocoupler is short-circuited, the servo will display E150.3.	Direct connection occurs on the upstream optocoupler of STO1 or STO2.	Replace the servo drive.
E150.4	STO activated	An error occurs on the PWM buffer integrated circuit during initialization detection upon power-on (the PWM signal cannot be blocked).	STO buffer power-on detection abnormal	Replace the servo drive.
E150.5	STO input signal interference	The STO input signal is interfered with, but the interference does not meet the noise filtering conditions set in H0A.73.	Poor contact of the STO terminal or unstable external 24V input voltage may lead to STO misoperation or malfunction.	Replace the 24V power supply.

Note

- For a motor with brake, if either STO1 or STO2 closes, the drive will be disabled within 30 ms (STO response time).
- For a motor without brake, if either STO1 or STO2 closes, the drive will be disabled within 5 ms (STO response time).

EDM DO signal

When STO1 and STO2 input 24V voltage are cut off, the EDM DO signal is active, otherwise the EDM DO signal is inactive.

At this time, STO1 and STO2 are filtered signals. When EDM is active, the servo drive blocks the PWM signal.

Signal Name	Mark	Photo coupler logic			
Safety input	STO1	ON	ON	OFF	OFF
	STO2	ON	OFF	ON	OFF
EDM output	EDM	OFF	OFF	OFF	ON

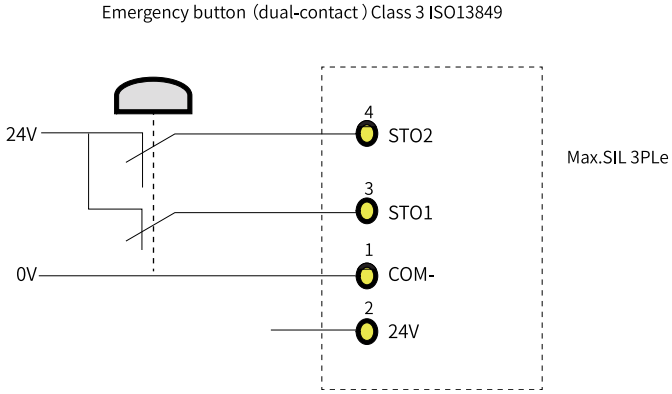
Note

The DO output of this EDM is only a monitoring signal to detect whether a safety function is triggered, not a safety signal output.

The EDM state of the integrated STO can only be output through the non-safe DO output of the drive, not through the DO output on the safety module.

Application Example of Safety Function

Example 1:



7.3 Fault reset

The exceptional operation refers to the durations of power-on and initialization, and how to return from the STO state.

- The PWM buffer is disabled as the enable terminal is pulled up during power-on, so the PWM signal is inhibited.
- The PWM buffer is disabled as the enable terminal is pulled up during initialization of the MCU, so the PWM signal is inhibited. Such condition is cleared and servo drive works normally after initialization is done.
- When all of the following conditions are met, the servo system that enters the safe state through the STO function can be back to normal with the safe state cleared after auto-reset of the drive.
  - The input state of the STO request must be "high".
  - The servo ON or servo RUN command must be inactive.
  - No dangerous faults exist.

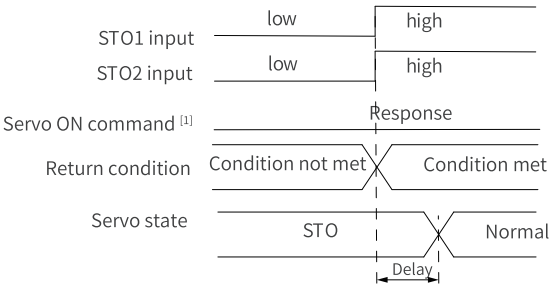


Figure 7-2 Return condition of external STO request state

Note

[1]: The servo ON command is a servo-enabled command, not an internal servo-enabled state.

- When STO_IN (STO1 or STO2 input) is restored to 24 V, the EDM and servo ready signals are immediately reset to 0. When STO1 and STO2 are restored to 24V at the same time, the servo ready to output signal and servo operational signal are activated after 400 milliseconds. Servo operation is PWM drive signal output.

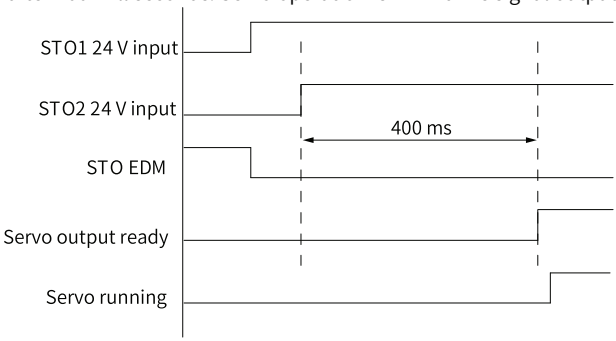
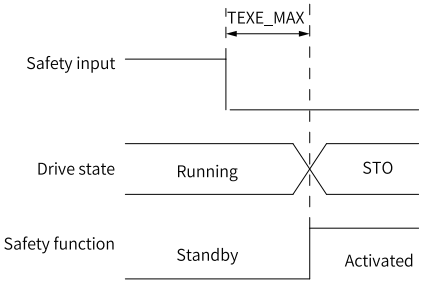


Figure 7-3 Servo drive reset timing diagram

7.4 Safety Function Response Time

The STO function prevents movement of the motor by two redundant external hardware signals (STO1 and STO2) that block the PWM signals from being outputted to the power layer of the servo drive. STO1 and STO2 input signals must be both active to allow the servo drive to operate normally.

If either one or both signals are set to "Low" level, the PWM signals will be blocked within 30 ms[1].



Note

[1]: The typical response time is 30 ms. The maximum response time is 100 ms, given the discrete type of the electronic device.

8 Commissioning and Operation

8.1 Pre-operation Inspection

Check the following items before operating the servo drive and the motor.

Table 8–1 Checklist before operation

No.	Item	Yes
Wiring		
1	The power input terminals (L1C, L2C, L1, L2, L3, R, S, T) of the servo drive are connected properly.	☐
2	The main circuit cables (U, V, W) of the motor are connected to the U/V/W terminals of the drive correctly.	☐
3	No short circuit exists in the power input terminals (L1C, L2C, L1, L2, L3, R, S, T) or main circuit output terminals (U, V, W) of the servo drive.	☐
4	The control signal cables, such as the brake signal cable and overtravel protection signal cable, are connected properly.	☐
5	The servo drive and motor are grounded properly.	☐
6	The stress suffered by the cable is within the specified range.	☐
7	All the wiring terminals are insulated properly.	☐
8	The shield layer of the encoder cable is reliably connected with the PE terminal on the drive.	☐
Environment and Mechanical Conditions		
1	There are no unwanted objects (such as cable terminals and metal chippings) that may cause short circuit of the signal cable and power cable inside or outside the servo drive.	☐
2	The servo drive and the external braking resistor are placed on incombustible objects.	☐
3	The motor is installed properly. The motor shaft is connected to the machine securely.	☐
4	The motor and the machine it is connected to are in good condition and ready to run.	☐

8.2 Trial Run

Safety function in local mode control (H20.01 = 0)

1. Ensure that the wiring of the DI and DO of the safety module is correct. The DO requires an external 24V input voltage.
2. Use the software tool to configure the functions of DI and DO, for example, set DI1 to 1-STO.

3. Control the DI input voltage, observe whether the DO state changes normally and the servo drive reports any fault.
   For example, disconnect the 24V input voltage of DI1 assigned with the STO function and observe whether the STO state indicated by DO1 is active. Then restore the 24V input voltage of DI1 and observe whether the STO state output by DO1 is inactive.
4. The DI of the safety module adopts dual-channel (A&B) control. The safety function can be executed when either of the two channels is active. The safety module monitors whether there is discrepancy at the two input signals. If the discrepancy lasts for a period of time exceeding the preset allowable time, the safety module outputs the corresponding fault information.

Note

In the above example, an ACK signal is not required for the safety motor to exit the STO state by default. As long as the STO command is canceled, the safety motor automatically exits the STO state.

8.3 Verification and validation

Overview

This chapter describes verification and validation of the implemented safety functionality.

Verification and validation produce documented proof of the compliance of the implementation with specified safety requirements.

Basic requirements

- Technical staff must be trained to understand the requirements and principles of designing and operating safety-related systems.
- Person performing the maintenance must be trained to understand the requirements and principles of designing and operating safety-related systems.
- Operators must be trained to understand the requirements and principles of designing and operating safety-related systems.
- The safety-related circuit on the control board that fails to operate must be replaced with a new one as it is not repairable.

Commissioning Checklist

- Start-up test and validation
  IEC 61508, EN/IEC 62061 and EN ISO 13849 require the final assembler of the equipment to verify the operation of the safety function through acceptance testing. This acceptance test is described in the drive manual. The testing of optional safety features is described in the corresponding manuals.

The acceptance test must be performed:

- at initial start-up of the safety function
- After any changes related to safety functions (wiring, assembly, settings, or other related operations)
- after any maintenance work related to the safety function.

The acceptance test of the safety function must be carried out by an authorized person with expertise and knowledge of the safety function. The test must be documented and signed by the test staff.

Signed acceptance test reports must be stored in the logbook of the machine. The report shall include documentation of start-up activities and test results, fault reports, and troubleshooting records. Any new acceptance tests performed due to changes or maintenance need to be logged into the logbook.

- Checklist

Table 8–2 Checklist of integrated STO output

No.	Item	Yes
1	Ensure that the drive runs and stops freely during commissioning.	☐
2	Stop the drive (if running), switch the input power supply off and isolate the drive from the power line by a disconnector.	☐
3	Check the STO circuit connections against the circuit diagram.	☐
4	Check that the shield of the STO input cable is grounded to the drive frame.	☐
5	Close the disconnector and switch the power supply on.	☐
5.1	Test the STO signal #1 when the motor is stopped: Set STO1 and STO2 to "H". Send a stop command to the drive (if running) and wait until the motor shaft is at standstill. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal #1 and send a start command to the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	☐
5.2	Set STO1 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	☐
5.3	Test the STO signal #2 when the motor is stopped: Set STO1 and STO2 to H. Send a stop command to the drive (if running) and wait until the motor shaft is at standstill. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal #2 and give a start command for the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	☐

No.	Item	Yes
5.4	Set STO2 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	☐
6.1	Test the STO channel 1 when the motor is running: Set STO1 and STO2 to H. Start the drive and ensure the motor is running. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal 1. Ensure that the motor stops and the drive trips. Reset the fault and try to start the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	☐
6.2	Set STO1 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	☐
6.3	Test the STO channel 2 when the motor is running: Set STO1 and STO2 to H. Start the drive and ensure the motor is running. Awake the STO function by de-energizing (low state or open-circuit) the STO input signal 2. Ensure that the motor stops and the drive trips. Reset the fault and try to start the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	☐
6.4	Set STO2 to "H" and disable the ON/RUN command of the drive. Then, reset the drive automatically and enable ON/RUN command of the drive. Finally, check whether the motor runs normally.	☐
7	Document and sign the acceptance test report which verifies that the safety function is safe and acceptable for operation.	☐

Verifying the achieved SIL/PL level

Verification of the functional safety system demonstrates and ensures that the implemented safety system meets the requirements specified for the system in the safety requirements specification phase.

The most convenient way to verify the required SIL/PL level reached with the implemented system is to use a specific safety calculator software.

Validation procedure

Inovance ensures that the functionality of all the required safety functions has been appropriately verified and validated.

Caution

- The system must not be considered safe until all safety functions are validated.
- The acceptance test must be performed to each safety function.

The acceptance test using the start-up checklist described below must be performed:

- at initial start-up of the safety function
- after any changes related to the safety function (wiring, components, settings, etc.)
- after any maintenance work related to the safety function. The acceptance test must include at least the following steps:

  1. having an acceptance test plan
  2. testing all commissioned functions for proper operation
  3. testing all used inputs for proper operation
  4. testing all used outputs for proper operation
  5. documenting all acceptance tests performed
  6. testing person signing and archiving the acceptance test report for further reference.

Acceptance test reports

You must store the signed acceptance test reports in the logbook of the machine. The report must include the following:

- description of the safety application (including a figure)
- a description and revisions of safety components that are used in the safety application
- a list of all safety functions that are used in the safety application
- a list of all safety related parameters and their values (the drive STO has no safety-related parameters, but listing the non-safety related parameter and its setting is recommended)
- documentation of start-up activities, references to failure reports and resolution of failures
- the test results for each safety function, check, date of the tests and confirmation by the test personnel.

You must store any new acceptance test reports performed due to changes or maintenance in the logbook of the machine.

Competence

The acceptance test of the safety function must be carried out by a competent person with expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6. The test procedures and report must be documented and signed by this person.

Validation of safety functions

Once the system is fully configured and wired for the safety functions, and the startup safety check has been done, you must do the following functional test procedure for each safety function:

- Have the system at the Operational state when the safety function is requested.
- Make sure that the acknowledgment method has been configured as suitable for the application (for example, manual or automatic acknowledgment).
- Activate the safety function by requesting it with the designated trigger device.
- Verify that the desired functionality takes place.
- Document the test results to the acceptance test report.
- Sign and file the acceptance test report.

9 Troubleshooting

9.1 Fault and Alarm Levels

Faults and alarms of the servo drive are divided into three levels based on severity: No. 1 > No. 2 > No. 3, as shown below.

- No. 1 non-resettable fault
- No. 1 resettable fault
- No. 2 resettable fault
- No. 3 resettable alarm

Note

"Resettable" means the keypad stops displaying the fault/alarm once a "Reset signal" is input.

Operating procedure:

- To stop the keypad from displaying the fault/alarm, set H0d.01 (Fault reset) to 1 or activate the DI terminal assigned with DI function 2 (FunIN.2: ALM- RST, fault and alarm reset).
- To reset No. 1 and No. 2 faults, switch off the S-ON signal, and then set H0d.01 to 1 or activate the DI terminal allocated with DI function 2.
- To reset No. 3 alarms, set H0d.01 to 1 or activate the DI terminal allocated with DI function 2.

Note

- Some faults and warnings can be reset only after the fault causes are rectified by modifying the settings. However, a reset operation does not necessarily activate the modifications to settings.
- For modifications activated at next power-on (R, S, T/L1C, L2C), perform a power cycle.
- For modifications activated after stop, switch off the S-ON signal. The servo drive can operate normally only after modifications are activated.

9.2 List of Fault and Alarm Codes

The servo drive can output the current highest-level fault/alarm code.

No. 1 non-resettable faults:

Table 9–1 List of No. 1 non-resettable faults

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code (603Fh)	Aux. Code (203Fh)
E101	E101.3	CRC error during safety parameter initialization	No.1	No	0x0101	0x31010101
	E101.4	Error in upper and lower limits verification during safety parameter initialization	No.1	No	0x0101	0x41010101
	E101.5	Address error in read/write operation after the number of parameters changes	No.1	No	0x0101	0x51010101
E104	E104.5	The number of interrupts in the safety module FPGA is abnormal	No.1	No	0x0104	0x51040104
	E104.6	Safety module FPGA interrupt timed out	No.1	No	0x0104	0x61040104
E145	E145.0	Safety module chip diagnosis failure	No.1	No	0x0145	0x01450145
	E145.1	Safety module program execution exception	No.1	No	0x0145	0x11450145
E154	E154.0	Speed-related functions enabled for non-safety encoder	No.1	No	0x0154	0x01540154
	E154.1	Incorrect selection of safety function trigger mode	No.1	No	0x0154	0x11540154
E740	E740.0	Encoder communication timeout	No.1	No	0x7305	0x07400740
	E740.2	Encoder communication error	No.1	No	0x7305	0x27400740
	E740.3	Absolute encoder single-turn calculation error	No.1	No	0x7305	0x37400740
	E740.6	Encoder write error	No.1	No	0x7305	0x67400740
	E740.9	Encoder data transmit delay too long	No.1	No	0x7305	0x97400740

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code (603Fh)	Aux. Code (203Fh)
E750	E750.0	Deviation of master QEP and subdivision quadrant too large (over 2 pulses)	No.1	No	0x0750	0x07500750
	E750.1	Difference between safety encoder master and slave positions too large	No.1	No	0x0750	0x17500750
	E750.2	QEP difference between encoder master and slave too large	No.1	No	0x0750	0x27500750
	E750.3	Difference between safety encoder master and slave analog values too large	No.1	No	0x0750	0x37500750
	E750.4	Encoder chip power supply diagnosis exception	No.1	No	0x0750	0x47500750
	E750.5	Encoder master and slave SN mismatch	No.1	No	0x0750	0x57500750
	E750.6	Encoder chip diagnosis exception	No.1	No	0x0750	0x67500750
	E750.7	Encoder SPI communication error, no response from slave	No.1	No	0x0750	0x77500750
E751	E751.0	Safety module encoder CRC check error	No.1	No	0x0751	0x07510751
	E751.1	Excessive deviation between speeds calculated by MCU1 and MCU2 of safety module	No.1	No	0x0751	0x17510751
	E751.2	Safety module position 1 & 2 check error	No.1	No	0x0751	0x27510751
	E751.3	Safety encoder version number CRC error	No.1	No	0x0751	0x37510751

Note

The E154.0 alarm will only be triggered when the safety module software version is H20.00 = 1.10, and when H20.00 = 1.20 and above, E154.0 has been deleted.

No. 1 resettable faults:

Table 9–2 List of No. 1 resettable faults

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code (603Fh)	Aux. Code (203Fh)
E124	E124.0	Different DIs allocated with the same function	No.1	Yes	0x0124	0x01240124
	E124.1	DI1 input circuit diagnosis exception	No.1	Yes	0x0124	0x11240124
	E124.2	DI2 input circuit diagnosis exception	No.1	Yes	0x0124	0x21240124
	E124.3	DI3 input circuit diagnosis exception	No.1	Yes	0x0124	0x31240124
	E124.4	DI4 input circuit diagnosis exception	No.1	Yes	0x0124	0x41240124
	E124.5	DI5 input circuit diagnosis exception	No.1	Yes	0x0124	0x51240124
E125	E125.0	SSM assigned with non-safety DO serial number	No.1	Yes	0x0125	0x01250125
	E125.1	DO1 output circuit diagnosis exception	No.1	Yes	0x0125	0x11250125
	E125.2	DO2 output circuit diagnosis exception	No.1	Yes	0x0125	0x21250125
	E125.4	DO4 output circuit diagnosis exception	No.1	Yes	0x0125	0x41250125
	E125.5	DO5 output circuit diagnosis exception	No.1	Yes	0x0125	0x51250125
E134	E134.1	Discrepancy at two input signals of DI1	No.1	Yes	0x0134	0x11340134
	E134.2	Discrepancy at two input signals of DI2	No.1	Yes	0x0134	0x21340134
	E134.3	Discrepancy at two input signals of DI3	No.1	Yes	0x0134	0x31340134
	E134.4	Discrepancy at two input signals of DI4	No.1	Yes	0x0134	0x41340134
	E134.5	Discrepancy at two input signals of DI5	No.1	Yes	0x0134	0x51340134
E135	E135.0	Chip 3.3V signal diagnosis exception	No.1	Yes	0x0135	0x01350135

Fault Code	Fault subcode	Fault Name	Fault level	Resettable	Error code (603Fh)	Aux. Code (203Fh)
E150	E150.0	STO safety state applied	No.1	Yes	0x0150	0x01500150
	E150.1	STO input state abnormal	No.1	Yes	0x0150	0x11500150
	E150.2	Buffer 5 V supply error	No.1	Yes	0x0150	0x21500150
	E150.3	STO input circuit hardware diagnosis failure	No.1	Yes	0x0150	0x31500150
	E150.4	PWM Buffer hardware diagnosis failure	No.1	Yes	0x0150	0x41500150
	E150.5	STO input signal interference	No.1	Yes	0x0150	0x51500150
E151	E151.0	SCI communication exception between servo drive and safety module	No.1	Yes	0x0151	0x01510151
	E151.1	SCI communication exception between two MCUs of the safety module	No.1	Yes	0x0151	0x11510151
E152	E152.0	Failure of parameter verification between two MCUs of the safety module	No.1	Yes	0x0152	0x01520152
	E152.1	Timeout for sending CRC between two MCUs of the safety module	No.1	Yes	0x0152	0x11520152
	E152.2	Timeout for safety module to get initial servo parameters	No.1	Yes	0x0152	0x21520152
E160	E160.0	SLS1 exceeded	No.1	Yes	0x0160	0x01600160
	E160.1	SLS2 exceeded	No.1	Yes	0x0160	0x11600160
	E160.2	SLS3 exceeded	No.1	Yes	0x0160	0x21600160
	E160.3	SLS4 exceeded	No.1	Yes	0x0160	0x31600160
E165	E165.0	SDIp exception	No.1	Yes	0x0165	0x01650165
	E165.1	SDIn exception	No.1	Yes	0x0165	0x11650165
E170	E170.0	SS1 deceleration ramp exception	No.1	Yes	0x0170	0x01700170
	E170.1	SS2 deceleration ramp exception	No.1	Yes	0x0170	0x11700170
	E170.2	SOS speed or position exceeds limit	No.1	Yes	0x0170	0x21700170
E631	E631.0	SBC brake circuit diagnosis exception	No.1	Yes	0x0631	0x06310631

No. 3 resettable warnings

Table 9–3 Resettable Alarm List

Warning code	Alarm subcode	Name	Fault level	Resettable	Error code (603Fh)	Aux. Code (203Fh)
E108	E108.5	Safety module EEPROM write timed out	No.3	Yes	0x0108	0x51080108
	E108.6	Safety module EEPROM read timed out	No.3	Yes	0x0108	0x61080108
	E108.7	Safety module EEPROM write check error	No.3	Yes	0x0108	0x71080108
	E108.8	Safety module EEPROM read check error	No.3	Yes	0x0108	0x81080108
E115	E115.0	SSM parameter setting exception warning	No.3	Yes	0x0115	0x011150115
E116	E116.0	SLS overspeed warning	No.3	Yes	0x0116	0x011160116
	E116.1	SDI out of tolerance warning	No.3	Yes	0x0116	0x111160116

9.3 Solutions to Faults

- E101.3: CRC error during safety parameter initialization
  Cause:

  The CRC value of the safety parameters is abnormal, which generally occurs after software update.

Cause	Troubleshooting	Solution
1. The software is updated.	Check whether the software is upgraded.	Restore safety parameters to default settings.
2. The voltage of the control circuit power supply drops instantaneously.	• Check whether the control circuit (L1C, L2C) is in the process of power-off or instantaneous power failure occurs. • Measure whether the input voltage of the control circuit cable on the non-drive side is within the following range: 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: -10% to +10% (342 V to 484 V)	• Restore safety parameters to default settings and write parameters again. • Increase the power supply capacity or replace the power supply with a power supply of higher capacity. Restore the safety parameters to default settings and write the parameters again.

Cause	Troubleshooting	Solution
3. Instantaneous power failure occurs when saving parameters.	Check whether instantaneous power failure occurs when saving parameters.	Power on again, restore the safety parameters to default settings and write parameters again.
4. The number of write operations within a certain period of time exceeds the limit.	Check whether parameters are updated frequently through the host controller.	Change the parameter writing method and write parameters again.
5. The safety module has failed.	If the fault persists though parameters are restored to default settings and the servo drive is powered off and on repeatedly, the safety module is faulty.	Replace the safety module.

- E101.4: Error in upper and lower limits verification during safety parameter initialization
  Cause:

  1. The total number of the safety parameters changes, which generally occurs after software update.

  2. Values of the safety parameters exceed the limit, which generally occurs after software update.

Cause	Troubleshooting	Solution
1. The software is updated.	Check whether the software is upgraded.	Restore safety parameters to default settings.
2. The voltage of the control circuit power supply drops instantaneously.	• Check whether the control circuit (L1C, L2C) is in the process of power-off or instantaneous power failure occurs. • Measure whether the input voltage of the control circuit cable on the non-drive side is within the following range: 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: -10% to +10% (342 V to 484 V)	• Restore safety parameters to default settings and write parameters again. • Increase the power supply capacity or replace the power supply with a power supply of higher capacity. Restore the safety parameters to default settings and write the parameters again.
3. Instantaneous power failure occurs when saving parameters.	Check whether instantaneous power failure occurs when saving parameters.	Power on again, restore the safety parameters to default settings and write parameters again.

Cause	Troubleshooting	Solution
4. The number of write operations within a certain period of time exceeds the limit.	Check whether parameters are updated frequently through the host controller.	Change the parameter writing method and write parameters again.
5. The safety module has failed.	If the fault persists though parameters are restored to default settings and the servo drive is powered off and on repeatedly, the safety module is faulty.	Replace the safety module.

- E101.5: Address error in read/write operation after the number of parameters changes
  Cause:

  The total number of the safety parameters changes, which generally occurs after software update.

Cause	Troubleshooting	Solution
1. The software is updated.	Check whether the software is upgraded.	Restore safety parameters to default settings.
2. The safety module has failed.	If the fault persists though parameters are restored to default settings and the servo drive is powered off and on repeatedly, the safety module is faulty.	Replace the safety module.

- E104.5: The number of interrupts in the safety module FPGA is abnormal
  Cause:

  The number of interrupts detected in 1 ms is less than four.

Cause	Troubleshooting	Solution
1. The FPGA is abnormal.	Power on and off repeatedly. The probability of failure is high.	Replace the servo drive and safety module.
2. The interrupt pin includes dry joint.		
3. The connection between the servo drive and the safety module is abnormal.		

- E104.6: Safety module FPGA interrupt timed out
  Cause:

  The FPGA interrupt is running longer than the interrupt dispatch time.

Cause	Troubleshooting	Solution
The safety module has failed.	Power on and off repeatedly. The probability of failure is high.	Replace the servo drive and safety module.

- E124.0: Different DIs allocated with the same function
  Cause:

  The function numbers of the safety DI terminals are duplicated.

Cause	Troubleshooting	Solution
One DI function cannot be reused by two or more DI terminals.	Check whether the same number is selected for different DIs.	Ensure that the number is unique.

- E124.1: DI1 input circuit diagnosis exception
  Cause:

  Send a diagnostic signal to DI1 to detect whether the feedback signal is correct.

Cause	Troubleshooting	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI1 circuit is normal. • Disconnect and then reconnect the 24V input voltage of DI1, and observe whether the input signal of DI1 changes (You can sample and analyze the input signal of DI1 through the background software oscilloscope).	• If the DI1 circuit is abnormal, shield DI1 by setting its function number to 0. • If it cannot be shielded, it is recommended to replace the safety control board.

- E124.2: DI2 input circuit diagnosis exception
  Cause:

  Send a diagnostic signal to DI2 to detect whether the feedback signal is correct.

Cause	Troubleshooting	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI2 circuit is normal. • Disconnect and then reconnect the 24V input voltage of DI2, and observe whether the input signal of DI2 changes (You can sample and analyze the input signal of DI2 through the background software oscilloscope).	• If the DI2 circuit is abnormal, shield DI2 by setting its function number to 0. • If it cannot be shielded, it is recommended to replace the safety control board.

- E124.3: DI3 input circuit diagnosis exception
  Cause:

  Send a diagnostic signal to DI3 to detect whether the feedback signal is correct.

Cause	Troubleshooting	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI3 circuit is normal. • Disconnect and then reconnect the 24V input voltage of DI3, and observe whether the input signal of DI3 changes (You can sample and analyze the input signal of DI3 through the background software oscilloscope).	• If the DI3 circuit is abnormal, shield DI3 by setting its function number to 0. • If it cannot be shielded, it is recommended to replace the safety control board.

- E124.4: DI4 input circuit diagnosis exception
  Cause:

  Send a diagnostic signal to DI4 to detect whether the feedback signal is correct.

Cause	Troubleshooting	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI4 circuit is normal. • Disconnect and then reconnect the 24V input voltage of DI4, and observe whether the input signal of DI4 changes (You can sample and analyze the input signal of DI4 through the background software oscilloscope).	• If the DI4 circuit is abnormal, shield DI4 by setting its function number to 0. • If it cannot be shielded, it is recommended to replace the safety control board.

- E124.5: DI5 input circuit diagnosis exception
  Cause:

  Send a diagnostic signal to DI5 to detect whether the feedback signal is correct.

Cause	Troubleshooting	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI5 circuit is normal. • Disconnect and then reconnect the 24V input voltage of DI5, and observe whether the input signal of DI5 changes (You can sample and analyze the input signal of DI5 through the background software oscilloscope).	• If the DI5 circuit is abnormal, shield DI5 by setting its function number to 0. • If it cannot be shielded, it is recommended to replace the safety control board.

- E125.0: SSM assigned with non-safety DO serial number
  Cause:

Check whether SSM is assigned to DO3 and DO6.

Cause	Troubleshooting	Solution
The SSM cannot use non-safety DO as signal output.	Check whether the function numbers of DO3 and DO6 are set to 12: SSM-active.	Do not assign the function numbers of DO3 and DO6 as SSM functions.

- E125.1: DO1 output circuit diagnosis exception
  Cause:

  When DO1 is active, the MCU sends a diagnostic pulse to DO5 to detect whether the AD sampling value of the feedback signal is below 0.3 V.

Cause	Troubleshooting	Solution
After the MCU sends a diagnostic pulse to DO1, the feedback voltage received by the MCU is not below the expected 0.3 V.	Execute fault reset to check whether the fault can be cleared. If the fault persists, check whether there is leakage current in the DO1 output circuit.	Shield DO1, and the safety module no longer detects whether there is a leakage current risk in DO1.

- E125.2: DO2 output circuit diagnosis exception
  Cause:

  When DO2 is active, the MCU sends a diagnostic pulse to DO5 to detect whether the AD sampling value of the feedback signal is below 0.3 V.

Cause	Troubleshooting	Solution
After the MCU sends a diagnostic pulse to DO2, the feedback voltage received by the MCU is not below the expected 0.3 V.	Execute fault reset to check whether the fault can be cleared. If the fault persists, check whether there is leakage current in the DO2 output circuit.	Shield DO2, and the safety module no longer detects whether there is a leakage current risk in DO2.

- E125.4: DO4 output circuit diagnosis exception
  Cause:

  When DO4 is active, the MCU sends a diagnostic pulse to DO5 to detect whether the AD sampling value of the feedback signal is below 0.3 V.

Cause	Troubleshooting	Solution
After the MCU sends a diagnostic pulse to DO4, the feedback voltage received by the MCU is not below the expected 0.3 V.	Execute fault reset to check whether the fault can be cleared. If the fault persists, check whether there is leakage current in the DO4 output circuit.	Shield DO4, and the safety module no longer detects whether there is a leakage current risk in DO4.

- E125.5: DO5 output circuit diagnosis exception
  Cause:

When DO5 is active, the MCU sends a diagnostic pulse to DO5 to detect whether the AD sampling value of the feedback signal is below 0.3 V.

Cause	Troubleshooting	Solution
After the MCU sends a diagnostic pulse to DO5, the feedback voltage received by the MCU is not below the expected 0.3 V.	Execute fault reset to check whether the fault can be cleared. If the fault persists, check whether there is leakage current in the DO5 output circuit.	Shield DO5, and the safety module no longer detects whether there is a leakage current risk in DO5.

- E134.1: Discrepancy at two input signals of DI1
  Cause:

  Check whether the DI1 input signal exceeds the value of H20.14.

Cause	Troubleshooting	Solution
The fault code is reported when the difference between two inputs of safety DI1 exceeds the value of H20.14.	Observe whether the difference lasts longer than the setpoint of H20.14.	Ensure the difference does not lasts longer than the value of H20.14.

- E134.2: Discrepancy at two input signals of DI2
  Cause:

  Check whether the DI2 input signal exceeds the value of H20.15.

Cause	Troubleshooting	Solution
The fault code is reported when the difference between two inputs of safety DI2 exceeds the value of H20.15.	Check whether the difference lasts longer than the setpoint of H20.15.	Ensure the difference does not last longer than the setpoint of H20.15.

- E134.3: Discrepancy at two input signals of DI3
  Cause:

  Check whether the DI3 input signal exceeds the value of H20.16.

Cause	Troubleshooting	Solution
The fault code is reported when the difference between two inputs of safety DI3 exceeds the value of H20.16.	Observe whether the difference lasts longer than the setpoint of H20.16.	Ensure the difference does not lasts longer than the value of H20.16.

- E134.4: Discrepancy at two input signals of DI4
  Cause:

  Check whether the DI4 input signal exceeds the value of H20.17.

Cause	Troubleshooting	Solution
The fault code is reported when the difference between two inputs of safety DI4 exceeds the value of H20.17.	Check whether the difference lasts longer than the setpoint of H20.17.	Ensure the difference does not lasts longer than the value of H20.17.

- E134.5: Discrepancy at two input signals of DI5
  Cause:

  Check whether the DI5 input signal exceeds the value of H20.18.

Cause	Troubleshooting	Solution
The fault code is reported when the difference between two inputs of safety DI5 exceeds the value of H20.18.	Observe whether the difference lasts longer than the setpoint of H20.18.	Ensure the difference does not lasts longer than the value of H20.18.

- E135.0: Chip 3.3V signal diagnosis error
  Cause:

  The two chips diagnose whether the supply voltage of each other is within the allowed range of 3.0 V to 3.6 V.

Cause	Troubleshooting	Solution
The chip voltage is out of the range of 3.0 V to 3.6 V.	Perform a power cycle to check if the fault is eliminated.	Replace the servo drive.

- E145.0: Safety module chip diagnosis failure
  Cause:

  The chip diagnosis of the safety module failed.

Cause	Troubleshooting	Solution
1. The CPU diagnosis of the chip failed.	Power on and off repeatedly. The probability of failure is high.	Replace the servo drive and safety module.
2. The RAM diagnosis of the chip failed.		
3. The FLASH diagnosis of the chip failed.		
4. The software program has stack overflow problems.		

- E145.1: Safety module program execution exception
  Cause:

  The internal program execution of the safety module is abnormal and the 16 kHz interrupt function is not executed.

Cause	Troubleshooting	Solution
The internal program execution of the safety module is abnormal and the 16 kHz interrupt function is not executed.	The fault still exists after power off and restart.	Return to the factory for maintenance.

- E150.0: STO safety state applied
  Cause:

  The STO input protection applies (safety state).

Cause	Troubleshooting	Solution
Two 24 V inputs are disconnected simultaneously, triggering the STO function.	1. Check whether the STO function is activated.	There is no need to take any corrective actions. After the STO terminal is back to normal, clear the fault using the fault reset function.
	2. Check whether the STO power supply is normal.	Check whether the 24 V power supply for the STO is stable. Tighten the cables that are loose or disconnected.
	3. The fault persists after preceding causes are rectified.	Replace the servo drive.

- E150.1: STO input state abnormal
  Cause:

  The single-channel input of STO is ineffective.

Cause	Troubleshooting	Solution
1. STO input power supply is abnormal.	Check whether the STO power supply is normal.	Check whether the 24 V power supply for the STO is stable. Tighten the cables that are loose or disconnected.
2.STO input resistor is abnormal.	After STO is triggered, only one STO signal is sent to MCU after the 24 V power supply is cut off due to input resistor drift.	Replace the servo drive.
3. STO is ineffective	The fault persists after preceding causes are rectified.	Replace the servo drive.

- E150.2: Buffer 5 V voltage detection error
  Cause:

The MCU monitors the 5 V power supply of the PWM Buffer to detect whether overvoltage or undervoltage occurs. If the voltage is abnormal, E150.2 occurs.

Cause	Troubleshooting	Solution
The 5 V voltage supplied to the STO Buffer is abnormal due to undervoltage or overvoltage.	Check whether the fault can be removed by a restart. If not, the 5V voltage supplied to the Buffer is abnormal.	Replace the servo drive.

- E150.3: STO input circuit hardware diagnosis failure
  Cause:

  The photocoupler of the front hardware circuit for STO input is inspected. If the photocoupler is short-circuited, the servo will display E150.3.

Cause	Troubleshooting	Solution
Short circuit occurs on the upstream optocoupler of STO1 or STO2.	The fault persists and the keypad displays E150.3 after restart.	Replace the servo drive.

- E150.4: PWM buffer hardware detection failure
  Cause:

  An error occurs on the PWM Buffer integrated circuit during initialization detection upon power-on (the PWM signal cannot be blocked).

Cause	Troubleshooting	Solution
STO Buffer power-on test error	The fault persists and the keypad displays E150.4 after restart.	Replace the servo drive.

- E150.5: STO input signal interference
  Cause:

  The STO input signal is interfered with, but the interference does not meet the noise filtering conditions set in H0A.73.

Cause	Troubleshooting	Solution
Poor contact of the STO terminal or unstable external 24V input voltage may lead to STO misoperation or malfunction.	Check whether the 24V input voltage of the STO terminal is unstable and disconnected repeatedly.	Replace the 24V power supply.

- E151.0: SCI communication exception between servo drive and safety module
  Cause:

  The NXP chip diagnoses in real time whether the heartbeat of the InoBus communication with the main MCU is normal.

Cause	Troubleshooting	Solution
The heartbeat detection between the servo drive and the safety module is abnormal.	Check whether the hardware connection between the servo drive and the board is normal.	Ensure that the physical connection between the board and the servo drive is normal.

- E152.0: Failure of parameter verification between two MCUs of the safety module
  Cause:

  The CRC values of the safety parameters read from the EEPROM by the dual MCUs of the safety module are inconsistent.

Cause	Troubleshooting	Solution
1. The software is updated.	Check whether the software is upgraded.	Restore safety parameters to default settings.
2. The voltage of the control circuit power supply drops instantaneously.	• Check whether the control circuit (L1C, L2C) is in the process of power-off or instantaneous power failure occurs. • Measure whether the input voltage of the control circuit cable on the non-drive side is within the following range: 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V servo drive: Effective value: 380 V to 440 V Allowable deviation: -10% to +10% (342 V to 484 V)	• Restore safety parameters to default settings and write parameters again. • Increase the power supply capacity or replace the power supply with a power supply of higher capacity. Restore the safety parameters to default settings and write the parameters again.
3. Instantaneous power failure occurs when saving parameters.	Check whether instantaneous power failure occurs when saving parameters.	Power on again, restore the safety parameters to default settings and write parameters again.
4. The safety module has failed.	If the fault persists though parameters are restored to default settings and the servo drive is powered off and on repeatedly, the safety module is faulty.	Replace the safety module.

- E152.1: Timeout for sending CRC between two MCUs of the safety module
  Cause:

  When the two MCUs of the safety module are powered on for communication, the sending of the CRC times out.

Cause	Troubleshooting	Solution
1. The communication between MCU1 and MCU2 of the safety module is disturbed.	Check for interference around the safety module.	Reduce interference around the safety module.
2. The safety module has failed.	Check whether replacing the safety module solves the problem.	Replace the safety module.

- E152.2: Timeout for safety module to get initial servo parameters
  Cause:

  When the safety module and the servo drive are powered on for communication, the security module has timed out to obtain the initial parameters of the servo drive.

Cause	Troubleshooting	Solution
1. The communication between the safety module and the servo drive is disturbed.	Check whether the connection between the safety module and the servo drive is normal.	Connect the safety module and servo drive correctly.
2. The safety module has failed.	Check whether replacing the safety module solves the problem.	Replace the safety module.

- E154.0: Speed-related functions enabled for non-safety encoder
  Cause:

  The speed-related safety functions are enabled when a non-safety encoder is used, or when a safety encoder is used but H00.00 is not set to 14102.

Cause	Troubleshooting	Solution
1. A non-safety encoder is used.	Check whether the encoder used is a non-safety encoder.	Use a safety encoder.
2. A safety encoder is used but H00.00 is not set to 14102.	Check whether H00.00 is set to 14102.	Set H00.00 to 14102.
3. When a non-safety encoder is used, the DI is set to speed-related functions.	When a non-safety encoder is used, check whether the DI is set to speed-related functions.	When a non-safety encoder is used, set the DI to speed-irrelated functions.
4. When a non-safety encoder is used, the DI is set to SS1 and the monitoring mode is set to SS1-r.	When a non-safety encoder is used, check whether the DI is set to SS1 and the monitoring mode is set to SS1-r.	When a non-safety encoder is used and the DI is set to SS1, set the monitoring mode to SS1-t.

Note

The E154.0 alarm will only be triggered when the safety module software version is H20.00 = 1.10, and when H20.00 = 1.20 and above, E154.0 has been deleted.

- E154.1: Incorrect selection of safety function trigger mode
  Cause:

  For non-EtherCAT models, the safety function trigger mode is selected as FSoE trigger.

Cause	Troubleshooting	Solution
For non-EtherCAT models, the safety function trigger mode is selected as FSoE trigger	• Check whether the servo drive is a EtherCAT model. • Check whether the safety function trigger mode is selected as FSoE trigger.	For non-EtherCAT models, select the safety function trigger mode as local trigger.

- E160.0: SLS1 exceeded
  Cause:

  The speed feedback real-time value exceeds the limit value of SLS1 after SLS1 monitoring is active.

Cause	Troubleshooting	Solution
The speed feedback real-time value exceeds the limit value of SLS1 after SLS1 monitoring is active.	When the stop mode upon SLS fault is STO, check the fault record to see if the corresponding speed exceeds the limit value of SLS1 when the SLS1 fault occurs.	Control the motor speed so that it does not exceed the limit value of SLS1 after SLS1 monitoring is active.

- E160.1: SLS2 exceeded
  Cause:

  The speed feedback real-time value exceeds the limit value of SLS2 after SLS2 monitoring is active.

Cause	Troubleshooting	Solution
The speed feedback real-time value exceeds the limit value of SLS2 after SLS2 monitoring is active.	When the stop mode upon SLS fault is STO, check the fault record to see if the corresponding speed exceeds the limit value of SLS2 when the SLS3 fault occurs.	Control the motor speed so that it does not exceed the limit value of SLS2 after SLS2 monitoring is active.

- E160.2: SLS3 exceeded
  Cause:

The speed feedback real-time value exceeds the limit value of SLS3 after SLS3 monitoring is active.

Cause	Troubleshooting	Solution
The speed feedback real-time value exceeds the limit value of SLS3 after SLS3 monitoring is active.	When the stop mode upon SLS fault is STO, check the fault record to see if the corresponding speed exceeds the limit value of SLS3 when the SLS3 fault occurs.	Control the motor speed so that it does not exceed the limit value of SLS3 after SLS3 monitoring is active.

- E160.3: SLS4 exceeded
  Cause:

  The speed feedback real-time value exceeds the limit value of SLS4 after SLS4 monitoring is active.

Cause	Troubleshooting	Solution
The speed feedback real-time value exceeds the limit value of SLS4 after SLS4 monitoring is active.	When the stop mode upon SLS fault is STO, check the fault record to see if the corresponding speed exceeds the limit value of SLS4 when the SLS4 fault occurs.	Control the motor speed so that it does not exceed the limit value of SLS4 after SLS4 monitoring is active.

- E165.0: SDIp exception
  Cause:

  The motor cannot move in the positive direction or the positive movement exceeds the limit.

Cause	Troubleshooting	Solution
The motor moves in the positive direction when not allowed to do so, or the positive movement exceeds the limit.	When the stop mode upon SDI fault is STO, check the fault record to see if the positive rotation speed at the time of fault exceeds the zero speed window of SDI or if the positive rotation position exceeds the zero position window of SDI.	When positive movement is prohibited, ensure that the motor does not exceed the allowable conditions for positive movement.

- E165.1: SDIn exception
  Cause:

  The motor cannot move in the negative direction or the negative movement exceeds the limit.

Cause	Troubleshooting	Solution
The motor moves in the negative direction when not allowed to do so, or the negative movement exceeds the limit.	When the stop mode upon SDI fault is STO, check the fault record to see if the negative rotation speed at the time of fault exceeds the zero speed window of SDI or if the negative rotation position exceeds the zero position window of SDI.	When negative movement is prohibited, ensure that the motor does not exceed the allowable conditions for negative movement.

- E170.0: SS1 deceleration ramp exception
  Cause:

  After SS1 deceleration ramp monitoring is started, the actual deceleration ramp exceeds the preset monitoring threshold.

Cause	Troubleshooting	Solution
The deceleration and monitoring threshold are not properly set, and the actual deceleration ramp exceeds the monitoring threshold.	Check whether the preset deceleration is within the monitoring threshold range.	Reasonably set the SS1 deceleration and ramp monitoring threshold to ensure that the deceleration is within the monitoring threshold range.

- E170.1: SS2 deceleration ramp exception
  Cause:

  After SS2 deceleration ramp monitoring is started, the actual deceleration ramp exceeds the preset monitoring threshold.

Cause	Troubleshooting	Solution
The deceleration and monitoring threshold are not properly set, and the actual deceleration ramp exceeds the monitoring threshold.	Check whether the preset deceleration is within the monitoring threshold range.	Reasonably set the SS2 deceleration and ramp monitoring threshold to ensure that the deceleration is within the monitoring threshold range.

- E170.2: SOS speed or position exceeds limit
  Cause:

  In the SOS state, the actual speed or position change exceeds the preset monitoring threshold.

Cause	Troubleshooting	Solution
1. The delay time from SS2 to SOS is set too short, as a result the position and speed monitoring to start before the motor stops.	Check whether the delay time from SS2 to SOS is set properly.	Reasonably set the delay time from SS2 to SOS.
2. The speed and position monitoring threshold settings of SOS are unreasonable.	Check whether the speed and position monitoring thresholds of the SOS are properly set.	Reasonably set the speed and position monitoring thresholds of SOS.
3. The load is too large, resulting in insufficient motor output to maintain the position.	Check whether the motor model is proper.	Select a proper motor model.

- E631.0: SBC brake circuit diagnosis exception
  Cause:

  The brake circuit is faulty or the external 24V voltage is abnormal.

Cause	Troubleshooting	Solution
1. The SBC circuit is abnormal when the card is powered on.	Check whether the 24 V voltage of the SBC is normal.	Ensure that the 24 V voltage of the SBC is normal.
2. The brake is abnormal during SBC brake release.	SBC brake circuit is faulty.	In case of the SBC circuit hardware failure, it is recommended to return it to the factory for maintenance.

- E740.0: Encoder communication timeout
  Cause:

  Communication timeout occurs on the absolute encoder.

Cause	Troubleshooting	Solution
The encoder cable is loosened.	1. Check the encoder cable connections. 2. Check whether vibration on site is too strong, which loosens the encoder cable and even damages the encoder. 3. Use a new encoder cable. If the fault disappears, the original encoder cable is damaged.	1. Check whether the encoder version (H00.04) is set properly. 2. Check whether the servo drive software version (H01.00). 3. Check the encoder cable connections. 4. Replace the servo motor.

- E740.2: Encoder communication error

Cause:

A communication error occurs on the RX side of the encoder.

Cause	Troubleshooting	Solution
1. The encoder is wired improperly.	Check encoder wiring.	Connect the encoder cables according to the correct wiring diagram.
2. The encoder cable connections become loose.	Check for strong vibration, which loosens the encoder cable and even damages the encoder.	Re-connect encoder cables and ensure encoder terminals are connected securely.
3. The encoder Z signal is interfered with.	• Check the field cable layout: Check whether ambient devices are generating disturbance and whether multiple disturbance sources such as variable-frequency devices are present inside the cabinet. • Make servo drive stay in "Rdy" status and rotate motor shaft counterclockwise (CCW) manually and observer whether H0b.17 (feedback pulse counter) increases/ decreases smoothly. Turning one circle corresponds to five 0°–360° (for Z series motors). For X series motors, turning one circle corresponds to four 0°–360°. • If H0b.17 changes abnormally during motor rotating, the encoder is faulty. • If no alarm is reported during motor shaft rotating but an alarm is reported during servo drive running, interference may exist.	• It is recommended to use the cables provided by Inovance. • If a customized cable is used, check whether this cable is a shielded twisted pair cable that complies with the specifications. • Route the motor cables and encoder cables through different routes. Ensure the servo motor and servo drive are grounded properly. • Check whether the connectors at both ends of the encoder are in good contact and whether any pin retracts.

Cause	Troubleshooting	Solution
4. The encoder is faulty.	• Use a new encoder cable. If the fault disappears, the original encoder cable is damaged. • Keep the motor in a certain position, power on the system several times and observe the change of H0b.17 (Electrical angle). The electrical angle deviation should be within ±30° when the motor position does not change.	• Use a new encoder cable. • If the fault persists after the encoder cable is replaced, the encoder may be faulty. In this case, replace the servo motor.
5. The T2 interpolator does not support software reset.	If H00.04 starts with 208, the T2 interpolator is used.	Power up and down again. If the error still exists, continue to troubleshoot according to steps 1 to 4.

- E740.3: Absolute encoder single-turn calculation error
  Cause:

  Internal fault of the encoder.

Cause	Troubleshooting	Solution
The encoder is faulty.	1. Use a new encoder cable. If the fault disappears, the original encoder cable is damaged. 2. Keep the motor in a certain position, power on the system several times and observe the change of H0b.17 (Electrical angle). The electrical angle deviation should be within ±30° when the motor position does not change.	1. Check whether the encoder version (H00.04) is proper. 2. Check whether the encoder cable is proper. 3. Replace the motor.

- E740.6: Encoder data write error
  Cause:

  The attempt to write the encoder data fails.

Cause	Troubleshooting	Solution
An error occurs when writing the position offset after angle auto-tuning.	Use a new encoder cable. If the fault disappears, the original encoder cable is damaged. Keep the motor in a certain position, power on the system several times and observe the change of H0b.17 (Electrical angle). The electrical angle deviation should be within ±30° when the motor position does not change.	Use a new encoder cable. If the fault persists after the encoder cable is replaced, the encoder may be faulty. In this case, replace the servo motor.

- E740.9: Encoder data transmit delay is too long
  Cause:

  The encoder data transmit delay is set to exceed one current loop period.

Cause	Troubleshooting	Solution
1. The value of H01.59 is set too large.	Check if the fault persists after a power cycle.	Decrease the value of H01.59.
2. Too many encoder data bits.		Use an encoder with fewer data bits.

- E750.0: Deviation of master QEP and subdivision quadrant too large (over 2 pulses)
  Cause:

  Deviation of master QEP and subdivision quadrant too large (over 2 pulses).

Cause	Troubleshooting	Solution
The encoder disk is contaminated or other photoelectric devices are disturbed.	Check if the fault persists after a power cycle.	Return to the factory for maintenance.

- E750.1: Difference between safety encoder master and slave positions too large
  Cause:

  Difference between safety encoder master and slave positions too large

Cause	Troubleshooting	Solution
Difference between safety encoder master and slave positions too large	Check if the fault persists after a power cycle.	Return to the factory for maintenance.

- E750.2: QEP difference between encoder master and slave too large
  Cause:

  The difference between QEP counts of the master and slave is greater than 2.

Cause	Troubleshooting	Solution
Board-level signal interference, encoder disk contamination, external chip fault.	Check the encoder surroundings for interference.	Replace the motor or encoder.

- E750.3: Difference between safety encoder master and slave analog values too large
  Cause:

  Difference between safety encoder master and slave sampled analog values too large

Cause	Troubleshooting	Solution
Difference between safety encoder master and slave sampled analog values too large	Check if the fault persists after a power cycle.	Return to the factory for maintenance.

- E750.4: Encoder chip power supply diagnosis exception
  Cause:

  LDO or battery voltage is lower than 3.1 V.

Cause	Troubleshooting	Solution
The external power supply of the encoder is under voltage, the LDO device is damaged, and the battery voltage is low	• Check whether the battery is correctly connected. • Check whether the encoder is powered normally.	Replace the motor or encoder.

- E750.5: Encoder master and slave SN mismatch
  Cause:

  SN counts of the master and slave are not equal.

Cause	Troubleshooting	Solution
The chip runs abnormally, and the master and slave do not exchange data normally.	Check whether the chip is abnormal due to too high ambient temperature.	Replace the motor or encoder.

- E750.6: Encoder chip diagnosis exception
  Cause:

  The flash, RAM, and chip of the master or slave are diagnosed faulty.

Cause	Troubleshooting	Solution
Chip exception	Check whether the chip is abnormal due to too high ambient temperature.	Replace the motor or encoder.

- E750.7: Encoder SPI communication error, no response from slave
  Cause:

The slave failed to receive the command word from the master, or the master failed to receive the reply frame from the slave.

Cause	Troubleshooting	Solution
Board-level communication interference causes internal CRC failure, peripheral abnormality, etc.	Check whether the chip is abnormal due to too high ambient temperature.	Replace the motor or encoder.

- E751.0: Safety module encoder CRC error
  Cause:

  1. The SN increment received by the safety module is abnormal.

  2. The CRC value calculated by the safety module is inconsistent with the received CRC value.

Cause	Troubleshooting	Solution
1. The encoder cable is abnormal.	Check whether the encoder cables are normal.	Check whether encoder cables are connected properly.
2. The communication with encoder suffers from interference.	Check for interference around the encoder cables.	• Check whether the servo drive and motor are properly grounded, and you can put a magnetic ring on the encoder to reduce the interference. • Replace the motor or encoder.

- E751.1: Excessive deviation between speeds calculated by MCU1 and MCU2 of safety module
  Cause:

  The deviation between the speeds calculated by MCU1 and MCU2 exceeds the threshold.

Cause	Troubleshooting	Solution
1. The communication between MCU1 and MCU2 of the safety module is disturbed.	Check for interference around the safety module.	Reduce interference around the safety module.
2. The safety module has failed.	Check whether replacing the safety module solves the problem.	Replace the safety module.

- E751.2: Safety module position 1 & 2 check error
  Cause:

The deviation between position 1 and position 2 received by the safety module exceeds the threshold.

Cause	Troubleshooting	Solution
The safety encoder is faulty.	Check whether replacing the safety encoder solves the problem.	Replace the safety encoder.

- E751.3: Safety encoder version number CRC error
  Cause:
  - The software version number of the safety encoder is not 264xx.
  - The CRC value of the safety encoder version number is abnormal.

Cause	Troubleshooting	Solution
Safety encoder version (H00.04) is not 264xx.	Check if the fault persists after a power cycle.	Return the motor to the factory for maintenance.
The CRC value of the safety encoder version number is wrong.	1. Check the wiring. 2. After power on and off for multiple times, if the fault persists, the encoder is faulty. 3. Check for interference around the encoder cable.	• If the cable is connected improperly, replace the cable or re-connect the cable. • After power on and off for multiple times, if the fault persists, replace the encoder.

9.4 Solutions to Alarms

- E108.5: Safety module EEPROM write timed out
  Cause:

  Parameter write time exceeds the limit.

Cause	Troubleshooting	Solution
EEPROM abnormal	Power off and restart the drive to check if the modifications to safety parameters take effect.	• Power off and restart the drive. • Replace the safety module.

- E108.6: Safety module EEPROM read timed out
  Cause:

  The parameter read time exceeds the limit.

Cause	Troubleshooting	Solution
EEPROM abnormal	Power off and restart the drive to check if safety parameters can be read.	• Power off and restart the drive. • Replace the safety module.

- E108.7: Safety module EEPROM write check error
  Cause:

When the safety module function is written to EEPROM, it is read again from EEPROM and compared with the value to be written. The comparison does not match.

Cause	Troubleshooting	Solution
EEPROM write error	Reset the fault and write again.	If the fault remains, it is recommended to replace the safety module.

- E108.8: Safety module EEPROM read check error
  Cause:

  The check on the data read in EEPROM fails.

Cause	Troubleshooting	Solution
The check on the data read in EEPROM fails.	Modify the safety module parameter, power off and on the servo drive again and check whether the modification is saved.	If the modification is not saved and the fault persists after the servo drive is powered off and on repeatedly, replace the servo drive.

- E115.0: SSM parameter setting error warning
  Cause:

  1. The lower limit of SSM is equal to or larger than the upper limit.

  2. The SSM hysteresis is equal to or larger than the upper limit minus the lower limit.

Cause	Troubleshooting	Solution
The lower limit of SSM is equal to or larger than the upper limit.	Local mode: • Check whether the value of H20.71 is greater than or equal to the value of H20.70. • Check whether the value of H20.72 is greater than or equal to H20.70 minus H20.71.	• Set SSM parameters properly. • The upper limit of SSM is greater than the lower limit.
2. The SSM hysteresis is equal to or larger than the upper limit minus the lower limit.	FSoE module: • Whether the setpoint of 66E4h is greater than or equal to 66E2. • Whether the setpoint of H20.72 is greater than or equal to 66E2 minus 66E4.	The SSM hysteresis is smaller than the upper limit of SSM minus lower limit.

- E116.0: SLS overspeed warning
  Cause:

  The speed limit is exceeded during SLS speed limit monitoring.

Cause	Troubleshooting	Solution
The speed limit is exceeded during SLS speed limit monitoring.	Check the fault log to see if the corresponding speed exceeds the limit of SLS.	Control the motor speed so that it does not exceed the limit.

- E116.1: SDI out of tolerance warning
  Cause:

  The limit is exceeded during SDI direction monitoring.

Cause	Troubleshooting	Solution
The limit is exceeded during SDI direction monitoring. A warning is issued if either the zero-speed window or zero position window exceeds the limit.	Check the fault log to see if the corresponding speed exceeds the SDI zero-speed window or the motor rotational direction exceeds the zero position window allowed by SDI.	Control the motor speed so that it does not exceed the limit.

10 List of Safety Parameters

10.1 H02 Parameters

Param.	Object Dictionary	Name	Value	Default	Unit	Change Mode	Page
H02.02	2002-03h	Rotation direction selection	0: Counterclockwise (CCW) as forward direction 1: Clockwise (CW) as forward direction	0	-	At stop	*" H02_en.02" on page 203*
H02.11	2002-0Ch	Motor speed threshold at brake output OFF in rotation state	20 rpm to 3000 rpm	30	RPM	Real-time	*" H02_en.11" on page 203*
H02.12	2002-0Dh	Delay from S-ON OFF to brake output OFF in rotation state	1ms to 65535ms	500	ms	Real-time	*" H02_en.12" on page 203*

10.2 H0A Parameters

Param.	Object Dictionary	Name	Value	Default	Unit	Change Mode	Page
H0A.73	200A-4Ah	STO 24 V disconnection filter time	1ms to 5ms	5	ms	Real-time	*" H0A_en.73" on page 204*
H0A.74	200A-4Bh	Filter time for two inconsistent STO channels	1ms to 1000ms	100	ms	Real-time	*" H0A_en.74" on page 204*
H0A.75	200A-4Ch	Servo OFF delay after STO triggered	0ms to 25ms	20	ms	Real-time	*" H0A_en.75" on page 204*

10.3 H20 Parameters

Before apply any safety function, ensure that it is enabled on the drive.

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.00	Safety module software version	0.00 to 655.35	0.00	-	Unchangeable	" H20_en.00" on page 205
H20.01	Safety function trigger selection	0: Locally triggered 1: FSoE triggered-SRA 3: FSoE triggered-nSRA	0	-	At stop	" H20_en.01" on page 205
H20.02	Safety module DI1 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	" H20_en.02" on page 205
H20.03	Safety module DI2 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	" H20_en.03" on page 206

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.04	Safety module DI3 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	" H20_en.04" on page 207
H20.05	Safety module DI4 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	" H20_en.05" on page 207
H20.06	Safety module DI5 function selection	0: Inactive 1: STO 2: SBC 3: SS1 4: SS2 5: SLS1 6: SLS2 7: SLS3 8: SLS4 9: SDIp 10: SDIn 11: Ack	0	-	At stop	" H20_en.06" on page 208
H20.08	Safety module DI1 noise rejection filter time	1 ms–500 ms	5	ms	At stop	" H20_en.08" on page 208
H20.09	Safety module DI2 noise rejection filter time	1 ms–500 ms	5	ms	At stop	" H20_en.09" on page 208
H20.10	Safety module DI3 noise rejection filter time	1 ms–500 ms	5	ms	At stop	" H20_en.10" on page 209
H20.11	Safety module DI4 noise rejection filter time	1 ms–500 ms	5	ms	At stop	" H20_en.11" on page 209
H20.12	Safety module DI5 noise rejection filter time	1 ms–500 ms	5	ms	At stop	" H20_en.12" on page 209

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.14	Safety module DI1 allowable discrepancy time	5 ms–60000 ms	10	ms	At stop	" H20_en.14" on page 210
H20.15	Safety module DI2 allowable discrepancy time	5 ms–60000 ms	10	ms	At stop	" H20_en.15" on page 210
H20.16	Safety module DI3 allowable discrepancy time	5 ms–60000 ms	10	ms	At stop	" H20_en.16" on page 210
H20.17	Safety module DI4 allowable discrepancy time	5 ms–60000 ms	10	ms	At stop	" H20_en.17" on page 211
H20.18	Safety module DI5 allowable discrepancy time	5 ms–60000 ms	10	ms	At stop	" H20_en.18" on page 211
H20.20	Safety module DO1 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	" H20_en.20" on page 211
H20.21	Safety module DO2 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	" H20_en.21" on page 212

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.22	Safety module DO3 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.22" on page 213*
H20.23	Safety module DO4 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.23" on page 213*
H20.24	Safety module DO5 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 12: SSM Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	*" H20_en.24" on page 214*

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.25	Safety module DO6 function selection	0: Inactive 1: STO Active 2: SBC Active 3: SS1 Active 4: SS2 Active 5: SLS1 Active 6: SLS2 Active 7: SLS3 Active 8: SLS4 Active 9: SDIp Active 10: SDIn Active 11: SOS Active 13: SS1-r Active 14: SS2-r Active	0	-	At stop	" H20_en.25" on page 215
H20.28	STO trigger-to-SBC active delay time	-30000 ms–30000 ms	-30	ms	At stop	" H20_en.28" on page 215
H20.29	SS1/SS2 stop mode	0: Stop according to ramp 1: Stop by host controller	1	-	At stop	" H20_en.29" on page 215
H20.30	SS1/SS2 ramp-to-stop reference speed	60 rpm to 6000 rpm	1000	rpm	At stop	" H20_en.30" on page 216
H20.31	SS1/ SS2 ramp-to-stop deceleration time	1 ms–65535 ms	500	ms	At stop	" H20_en.31" on page 216
H20.32	SS1 monitor mode	0:SS1-t 1:SS1-r	0	-	At stop	" H20_en.32" on page 216
H20.33	SS1 trigger-to-STO delay time/SS2 trigger-to-STO delay time	0 ms–65535 ms	1000	ms	At stop	" H20_en.33" on page 217
H20.34	SS1/ SS1 zero speed threshold	1 rpm to 6000 rpm	10	rpm	At stop	" H20_en.34" on page 217
H20.35	SS1/SS2 zero speed threshold time	0 ms–65535 ms	0	ms	At stop	" H20_en.35" on page 217
H20.36	SS1/SS2 ramp monitor start delay time	5 ms–65535 ms	10	ms	At stop	" H20_en.36" on page 218
H20.37	SS1/SS2 ramp monitor reference speed	60 rpm to 6000 rpm	1000	rpm	At stop	" H20_en.37" on page 218
H20.38	SS1/SS2 ramp deceleration monitor time	1 ms–65535 ms	65535	ms	At stop	" H20_en.38" on page 218
H20.41	SS1/SS2 ramp limit trigger-to-alarm time	0 ms–65535 ms	5	ms	At stop	" H20_en.41" on page 219
H20.42	SS1/SS2 ramp monitor stop speed	0 rpm to 6000 rpm	1	rpm	At stop	" H20_en.42" on page 219
H20.43	SS2 monitor mode	0:SS2-t 1:SS2-r	0	-	At stop	" H20_en.43" on page 219
H20.44	SOS speed change threshold	1 rpm to 6000 rpm	10	rpm	At stop	" H20_en.44" on page 220

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.45	SOS position change threshold	1 to 536870912	932067	encoder unit	At stop	" H20_en.45" on page 220
H20.47	SOS overthreshold-to-alarm time	0 ms–65535 ms	5	ms	At stop	" H20_en.47" on page 220
H20.48	SLS1 switchover delay	0 ms–65535 ms	100	ms	At stop	" H20_en.48" on page 221
H20.49	SLS2 switchover delay	0 ms–65535 ms	100	ms	At stop	" H20_en.49" on page 221
H20.50	SLS3 switchover delay	0 ms–65535 ms	100	ms	At stop	" H20_en.50" on page 221
H20.51	SLS4 switchover delay	0 ms–65535 ms	100	ms	At stop	" H20_en.51" on page 222
H20.52	SLS1 threshold	0 rpm to 6000 rpm	1000	rpm	At stop	" H20_en.52" on page 222
H20.53	SLS2 threshold	0 rpm to 6000 rpm	1000	rpm	At stop	" H20_en.53" on page 222
H20.54	SLS3 threshold	0 rpm to 6000 rpm	1000	rpm	At stop	" H20_en.54" on page 222
H20.55	SLS4 threshold	0 rpm to 6000 rpm	1000	rpm	At stop	" H20_en.55" on page 223
H20.56	SLS1 filter time	0 ms–65535 ms	100	ms	At stop	" H20_en.56" on page 223
H20.57	SLS2 filter time	0 ms–65535 ms	100	ms	At stop	" H20_en.57" on page 223
H20.58	SLS3 filter time	0 ms–65535 ms	100	ms	At stop	" H20_en.58" on page 223
H20.59	SLS4 filter time	0 ms–65535 ms	100	ms	At stop	" H20_en.59" on page 224
H20.60	SLS fault response mode	0:STO 1:SS1-t	0	-	At stop	" H20_en.60" on page 224
H20.70	SSM upper limit	–6000 rpm to 6000 rpm	200	rpm	At stop	" H20_en.70" on page 224
H20.71	SSM lower limit	–6000 rpm to 6000 rpm	-200	rpm	At stop	" H20_en.71" on page 225
H20.72	SSM hysteresis threshold	0 rpm to 6000 rpm	10	rpm	At stop	" H20_en.72" on page 225
H20.74	SDI zero position threshold	1 to 536870912	932067	encoder unit	At stop	" H20_en.74" on page 225
H20.76	SDI zero speed threshold	0 rpm to 3000 rpm	10	rpm	At stop	" H20_en.76" on page 226
H20.77	SDI delay time	0 ms–65535 ms	0	ms	At stop	" H20_en.77" on page 226

Parameter	Name	Value	Default	Unit	Change Mode	Page
H20.78	SDI fault response mode	0:STO 1:SS1-t	0	-	At stop	*" H20_en.78" on page 226*
H20.80	Speed/Position monitoring setting	0: No speed and position monitoring 1: Use safety motor and speed and position monitoring	0	-	At stop	*" H20_en.80" on page 226*

11 Description of Safety Parameters

11.1 H02 Basic Control Parameters

H02.02 Rotation direction selection

Hex:	2002-03h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop

Value Range:

0: Counterclockwise (CCW) as forward direction
1: Clockwise (CW) as forward direction

Description

Defines the forward direction of the motor when viewed from the motor shaft side.

H02.11 Motor speed threshold at brake output OFF in rotation state

Hex:	2002-0Ch	Effective mode:	Real-time
Min.:	20	Unit:	rpm
Max.:	3000	Data Type:	UInt16
Default:	30	Change:	Real-time

Value Range:

20 rpm to 3000 rpm

Description

Defines the motor speed threshold when brake (BK) output is OFF in the rotation state.

H02.12 Delay from S-ON OFF to brake output OFF in rotation state

Hex:	2002-0Dh	Effective mode:	Real-time
Min.:	1	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	500	Change:	Real-time

Value Range:

1 ms–65535 ms

Description

Defines the delay from the moment the S-ON signal is OFF to the moment the brake (BK) output is OFF in the rotation state.

11.2 H0A Fault and Protection Parameters

H0A.73 STO 24 V disconnection filter time

Hex:	200A-4Ah	Effective mode:	Real time
Min.:	1	Unit:	ms
Max.:	5	Data Type:	UInt16
Default:	5	Change:	Real-time

Value Range:

1ms to 5ms

Description

Defines the filter time from the moment when STO2 is disconnected from the 24 V power supply to the moment when the STO status is displayed or E150.0 is reported.

H0A.74 Filter time for two inconsistent STO channels

Hex:	200A-4Bh	Effective mode:	Real time
Min.:	1	Unit:	ms
Max.:	1000	Data Type:	UInt16
Default:	100	Change:	Real-time

Value Range:

1ms to 1000ms

Description

Defines the filter time from the moment when STO2 is input with different voltage to the moment when E150.1 is reported.

H0A.75 Servo OFF delay after STO triggered

Hex:	200A-4Ch	Effective mode:	Real-time
Min.:	0	Unit:	ms
Max.:	25	Data Type:	UInt16
Default:	20	Change:	Real-time

Value Range:

0 ms–25 ms

Description

Defines filter time from the moment when the STO status is displayed or E150.0/ E150.1 is reported to the moment when the servo drive is off.

11.3 H20 Functional Safety Parameters

Note

It is recommended to verify the safety function when you are configuring the safety parameters.

H20.00 Safety module software version

Min.:	0.00	Unit:	-
Max.:	655.35	Data Type:	UInt16
Default:	0.00	Change:	Unchangeable
Effective mode:	-		

Value Range:

0.00 to 655.35

Description

Displays the software version of the safety module and consists of two decimal places.

H20.01 Safety function trigger selection

Min.:	0	Unit:	-
Max.:	3	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Locally triggered

1: FSoE triggered-SRA

3: FSoE triggered-nSRA

Description

Sets the trigger of the safety function.

H20-01=1: The FSoE safety bus that supports SRA parameters, adapted to the safety PLC that supports SRA parameters, such as Beckhoff EL6900/EL6910.

H20-01=3: The FSoE safety bus without SRA parameters, adapted to safety PLCs that do not support SRA parameters, such as Pilz's safety PLCs.

H20.02 Safety module DI1 function selection

Min.:	0	Unit:	-
Max.:	11	Data Type:	UInt16
Default:	0	Change:	At stop

Effective mode: Upon the next power-on

Value Range:

0: Inactive
1: STO
2: SBC
3: SS1
4: SS2
5: SLS1
6: SLS2
7: SLS3
8: SLS4
9: SDIp
10: SDIn
11: Ack

Description

Assigns function to DI1 terminal of the safety module.

H20.03 Safety module DI2 function selection

Min.:	0	Unit:	-
Max.:	11	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO
2: SBC
3: SS1
4: SS2
5: SLS1
6: SLS2
7: SLS3
8: SLS4
9: SDIp
10: SDIn
11: Ack

Description

Assigns function to DI2 terminal of the safety module.

H20.04 **Safety module DI3 function selection**

Min.:	0	Unit:	-
Max.:	11	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO
2: SBC
3: SS1
4: SS2
5: SLS1
6: SLS2
7: SLS3
8: SLS4
9: SDIp
10: SDIn
11: Ack

Description

Assigns function to DI3 terminal of the safety module.

H20.05 **Safety module DI4 function selection**

Min.:	0	Unit:	-
Max.:	11	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO
2: SBC
3: SS1
4: SS2
5: SLS1
6: SLS2
7: SLS3
8: SLS4
9: SDIp
10: SDIn
11: Ack

Description

Assigns function to DI4 terminal of the safety module.

H20.06 Safety module DI5 function selection

Min.:	0	Unit:	-
Max.:	11	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO
2: SBC
3: SS1
4: SS2
5: SLS1
6: SLS2
7: SLS3
8: SLS4
9: SDIp
10: SDIn
11: Ack

Description

Assigns function to DI5 terminal of the safety module.

H20.08 Safety module DI1 noise rejection filter time

Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

1 ms–500 ms

Description

Sets the noise filter time of DI1 of the safety module. Only when the signal change of DI1 is continuously maintained above the filter time, the safety module performs the corresponding safety function.

H20.09 Safety module DI2 noise rejection filter time

Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16

Default:	5	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

1 ms–500 ms

Description

Sets the noise filter time of DI2 of the safety module. Only when the signal change of DI2 is continuously maintained above the filter time, the safety module performs the corresponding safety function.

H20.10 Safety module DI3 noise rejection filter time

Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

1 ms–500 ms

Description

Sets the noise filter time of DI3 of the safety module. Only when the signal change of DI3 is continuously maintained above the filter time, the safety module performs the corresponding safety function.

H20.11 Safety module DI4 noise rejection filter time

Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

1 ms–500 ms

Description

Sets the noise filter time of DI4 of the safety module. Only when the signal change of DI4 is continuously maintained above the filter time, the safety module performs the corresponding safety function.

H20.12 Safety module DI5 noise rejection filter time

Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
1 ms–500 ms
Description
Sets the noise filter time of DI5 of the safety module. Only when the signal change of DI5 is continuously maintained above the filter time, the safety module performs the corresponding safety function.

H20.14 Safety module DI1 allowable discrepancy time

Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
5 ms–60000 ms
Description
If the discrepancy at two input signals of DI1 lasts for a period of time exceeding the time set by this parameter, fault E134.1 is reported.

H20.15 Safety module DI2 allowable discrepancy time

Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
5 ms–60000 ms
Description
If the discrepancy at two input signals of DI2 lasts for a period of time exceeding the time set by this parameter, fault E134.2 is reported.

H20.16 Safety module DI3 allowable discrepancy time

Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
5 ms–60000 ms
Description
If the discrepancy at two input signals of DI3 lasts for a period of time exceeding the time set by this parameter, fault E134.3 is reported.

H20.17 **Safety module DI4 allowable discrepancy time**

Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

5 ms–60000 ms

Description

If the discrepancy at two input signals of DI4 lasts for a period of time exceeding the time set by this parameter, fault E134.4 is reported.

H20.18 **Safety module DI5 allowable discrepancy time**

Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

5 ms–60000 ms

Description

If the discrepancy at two input signals of DI5 lasts for a period of time exceeding the time set by this parameter, fault E134.5 is reported.

H20.20 **Safety module DO1 function selection**

Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO Active
2: SBC Active
3: SS1 Active
4: SS2 Active
5: SLS1 Active
6: SLS2 Active
7: SLS3 Active
8: SLS4 Active
9: SDIp Active
10: SDIn Active
11: SOS Active
12: SSM Active
13: SS1-r Active
14: SS2-r Active

Description

Assigns function to DO1 terminal of the safety module.

H20.21 Safety module DO2 function selection

Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO Active
2: SBC Active
3: SS1 Active
4: SS2 Active
5: SLS1 Active
6: SLS2 Active
7: SLS3 Active
8: SLS4 Active
9: SDIp Active
10: SDIn Active
11: SOS Active
12: SSM Active
13: SS1-r Active
14: SS2-r Active

Description

Assigns function to DO2 terminal of the safety module.

H20.22 Safety module DO3 function selection

Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO Active
2: SBC Active
3: SS1 Active
4: SS2 Active
5: SLS1 Active
6: SLS2 Active
7: SLS3 Active
8: SLS4 Active
9: SDIp Active
10: SDIn Active
11: SOS Active
13: SS1-r Active
14: SS2-r Active

Description

Assigns function to DO3 terminal of the safety module.

This DO is a non-safety DO circuit and cannot be configured with SSM function.

H20.23 Safety module DO4 function selection

Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO Active
2: SBC Active
3: SS1 Active
4: SS2 Active
5: SLS1 Active
6: SLS2 Active
7: SLS3 Active
8: SLS4 Active
9: SDIp Active
10: SDIn Active
11: SOS Active
12: SSM Active
13: SS1-r Active
14: SS2-r Active

Description

Assigns function to DO4 terminal of the safety module.

H20.24 Safety module DO5 function selection

Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO Active
2: SBC Active
3: SS1 Active
4: SS2 Active
5: SLS1 Active
6: SLS2 Active
7: SLS3 Active
8: SLS4 Active
9: SDIp Active
10: SDIn Active
11: SOS Active
12: SSM Active
13: SS1-r Active
14: SS2-r Active

Description

Assigns function to DO5 terminal of the safety module.

H20.25 Safety module DO6 function selection

Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0: Inactive
1: STO Active
2: SBC Active
3: SS1 Active
4: SS2 Active
5: SLS1 Active
6: SLS2 Active
7: SLS3 Active
8: SLS4 Active
9: SDIp Active
10: SDIn Active
11: SOS Active
13: SS1-r Active
14: SS2-r Active

Description

Assigns function to DO6 terminal of the safety module.
This DO is a non-safety DO circuit and cannot be configured with SSM function.

H20.28 STO trigger-to-SBC active delay time

Min.:	-30000	Unit:	ms
Max.:	30000	Data Type:	UInt16
Default:	-30	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

-30000 ms–30000 ms

Description

Sets the delay time from the triggering of the STO function to output of the active SBC state. This parameter can be used to set the sequence of activation of STO and SBC.

H20.29 SS1/SS2 stop mode

Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	1	Change:	At stop

Effective mode:	Upon the next power-on		

Value Range:

0: Stop according to ramp

1: Stop by host controller

Description

Sets the stop mode for SS1/SS2.

H20.30 SS1/SS2 ramp-to-stop reference speed

Min.:	60	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

60 rpm to 6000 rpm

Description

Sets the reference speed for deceleration to stop. The deceleration is equal to reference speed/deceleration time.

H20.31 SS1/ SS2 ramp-to-stop deceleration time

Min.:	1	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	500	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

1 ms–65535 ms

Description

Sets the time required to decelerate from the reference speed to 0. The deceleration is equal to reference speed/deceleration time.

H20.32 SS1 monitor mode

Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0:SS1-t

1:SS1-r

Description
Sets the monitoring mode for SS1.

H20.33 SS1 trigger-to-STO delay time/SS2 trigger-to-STO delay time

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	1000	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
0 ms–65535 ms
Description
After SS1 is triggered, the drive enters the STO state after a period of time exceeding the value set by this parameter has elapsed.
After SS2 is triggered, the drive enters the SOS state after a period of time exceeding the value set by this parameter has elapsed.

H20.34 SS1/ SS1 zero speed threshold

Min.:	1	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
1 rpm to 6000 rpm
Description
During SS1 deceleration, if the speed falls below the the value set by this parameter for a period of time exceeding the zero speed threshold time, the drive enters the STO state.
During SS2 deceleration, if the speed falls below the the value set by this parameter for a period of time exceeding the zero speed threshold time, the drive enters the SOS state.

H20.35 SS1/SS2 zero speed threshold time

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
0 ms–65535 ms

Description

During SS1 deceleration, if the speed falls below the zero speed threshold for a period of time exceeding the value set by this parameter, the drive enters the STO state.

During SS2 deceleration, if the speed falls below the zero speed threshold for a period of time exceeding the value set by this parameter, the drive enters the SOS state.

H20.36 SS1/SS2 ramp monitor start delay time

Min.:	5	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

5 ms–65535 ms

Description

After SS1 is triggered, the speed ramp monitoring starts after a period of time set by this parameter has elapsed, which is only valid in SS1-r mode.

After SS2 is triggered, the speed ramp monitoring starts after a period of time set by this parameter has elapsed, which is only valid in SS2-r mode.

H20.37 SS1/SS2 ramp monitor reference speed

Min.:	60	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

60 rpm to 6000 rpm

Description

Sets the reference speed for calculating the range of ramp monitoring. Speed ramp monitoring threshold is equal to reference speed/ramp deceleration monitor time.

H20.38 SS1/SS2 ramp deceleration monitor time

Min.:	1	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	65535	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
1 ms–65535 ms
Description
sets the time required to decelerate from the reference speed to 0 during ramp monitoring. Speed ramp monitoring threshold is equal to reference speed/ramp deceleration monitor time.

H20.41 SS1/SS2 ramp limit trigger-to-alarm time

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	5	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
0 ms–65535 ms
Description
During the deceleration process of SS1, if the motor speed exceeds the ramp monitoring limit for a period of time exceeding the value set by this parameter, a fault is reported and the drive enters the STO state.
During the deceleration process of SS2, if the motor speed exceeds the ramp monitoring limit for a period of time exceeding the value set by this parameter, a fault is reported and the drive enters the STO state.

H20.42 SS1/SS2 ramp monitor stop speed

Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	1	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:
0 rpm to 6000 rpm
Description
During the deceleration process of SS1, when the motor speed falls below the value set by this parameter, the ramp monitoring is stopped.
During the deceleration process of SS2, when the motor speed falls below the value set by this parameter, the ramp monitoring is stopped.

H20.43 SS2 monitor mode

Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop

Effective mode:	Upon the next power-on		

Value Range:

0:SS2-t

1:SS2-r

Description

Sets the monitoring mode for SS2.

H20.44 SOS speed change threshold

Min.:	1	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

1 rpm to 6000 rpm

Description

Sets the maximum allowable difference between motor speed and 0 rpm in SOS state.

H20.45 SOS position change threshold

Min.:	1	Unit:	encoder unit
Max.:	536870912	Data Type:	UInt16
Default:	932067	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

1 to 536870912

Description

Sets the maximum allowable variation of position feedback in SOS state.

H20.47 SOS overthreshold-to-alarm time

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	5	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

In the SOS state, if the speed feedback or position feedback exceeds the threshold for a period of time exceeding the value set by this parameter, a fault will be reported.

H20.48 SLS1 switchover delay

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

Sets the delay time from activation of SLS1 request command to activation of SLS1 monitoring.

H20.49 SLS2 switchover delay

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

Sets the delay time from activation of SLS2 request command to activation of SLS2 monitoring.

H20.50 SLS3 switchover delay

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

Sets the delay time from activation of SLS3 request command to activation of SLS3 monitoring.

H20.51 **SLS4 switchover delay**

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

Sets the delay time from activation of SLS4 request command to activation of SLS4 monitoring.

H20.52 **SLS1 threshold**

Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 rpm to 6000 rpm

Description

Sets the speed threshold for SLS1 monitoring.

H20.53 **SLS2 threshold**

Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 rpm to 6000 rpm

Description

Sets the speed threshold for SLS2 monitoring.

H20.54 **SLS3 threshold**

Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 rpm to 6000 rpm

Description

Sets the speed threshold for SLS3 monitoring.

H20.55 SLS4 threshold

Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 rpm to 6000 rpm

Description

Sets the speed threshold for SLS4 monitoring.

H20.56 SLS1 filter time

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

Sets the filtering time for determining that the motor speed is within the SLS1 limit.

H20.57 SLS2 filter time

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

Sets the filtering time for determining that the motor speed is within the SLS2 limit.

H20.58 SLS3 filter time

Min.:	0	Unit:	ms

Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

Sets the filtering time for determining that the motor speed is within the SLS3 limit.

H20.59 SLS4 filter time

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

Sets the filtering time for determining that the motor speed is within the SLS4 limit.

H20.60 SLS fault response mode

Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0:STO

1:SS1-t

Description

Sets the mode for stopping the motor when its speed exceeds the speed limit after the SLS monitoring takes effect.

H20.70 SSM upper limit

Min.:	-6000	Unit:	rpm
Max.:	6000	Data Type:	Int16
Default:	200	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

–6000 rpm to 6000 rpm

Description

Upper limit for SSM monitoring

H20.71 SSM lower limit

Min.:	-6000	Unit:	rpm
Max.:	6000	Data Type:	Int16
Default:	-200	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

–6000 rpm to 6000 rpm

Description

Lower limit for SSM monitoring

H20.72 SSM hysteresis threshold

Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 rpm to 6000 rpm

Description

Sets the hysteresis threshold of SSM monitoring to avoid the SSM output jumping too frequently when the speed fluctuates near the upper or lower threshold.

H20.74 SDI zero position threshold

Min.:	1	Unit:	encoder unit
Max.:	536870912	Data Type:	UInt32
Default:	932067	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

1 to 536870912

Description

Sets the position threshold for stopping the monitoring.
(Position window for stop position)

H20.76 SDI zero speed threshold

Min.:	0	Unit:	rpm
Max.:	3000	Data Type:	UInt16
Default:	10	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 rpm to 3000 rpm

Description

Sets the speed threshold for stopping the monitoring.
(Velocity window for n=0)

H20.77 SDI delay time

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0 ms–65535 ms

Description

Sets the delay time from activation of SDI command to activation of SDI monitoring.

H20.78 SDI fault response mode

Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop
Effective mode:	Upon the next power-on		

Value Range:

0:STO
1:SS1-t

Description

Sets the mode for stopping the motor when it runs in the forbidden direction after the SDI monitoring takes effect.

H20.80 Speed/Position monitoring setting

Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop

Effective mode: Upon the next power-on

Value Range:

0: No speed and position monitoring

1: Use safety motor and speed and position monitoring

Description

Enable/disable safety functions related to speed and position monitoring. This parameter can only be set to 0 when using a non-safety motor.

12 Maintenance

12.1 Routine Maintenance

Standard operating conditions:

The standard environmental conditions are as follows: Average ambient temperature: 30°C Average load rate: Below 80% Daily operating time: Below 20 hours

12.1.1Routine Checklist

Check the following items during routine inspection.

Table 12–1 Routine checklist

No.	Item	Checked
1	The ambient temperature and humidity are normal. There is no dust or unwanted objects in the servo drive.	☐
2	There is no abnormal vibration or noise.	☐
3	The voltage of the power supply is normal.	☐
4	There is no strange smell.	☐
5	There are no fibers adhered to the air vent.	☐
6	There is no intrusion of unwanted objects on the load end.	☐

12.1.2Routine Cleaning List

Clear the following items listed in the table.

Table 12–2 Routine cleaning list

No.	Routine cleaning list	Checked
1	Clean the dust, especially the metallic dust on the surface of the equipment.	☐
2	Keep the front end of the servo drive and the connectors clean.	☐

Note

- Before cleaning, switch off the power supply and clean with an air gun or a piece of dry cloth.
- Do not use gasoline, dilutes, alcohol, or acid or alkaline detergent to prevent enclosure discolor or damage.

12.2 Regular Checklist

12.2.1Regular Checklist

Table 12–3 Regular checklist

No.	Item	Checked
1	The screws used to fix the couplings between devices are in place.	☐
2	There is no sign of overtemperature.	☐
3	Terminal blocks are in good condition without any sign of damage.	☐
4	The clamping units of terminal blocks are in place.	☐

12.2.2Periodic Maintenance

The electrical and electronic parts inside the servo drive may be mechanically worn out and degraded. To keep the servo drive and servo motor in good condition, perform parts replacement based on the replacement cycles listed in the following table. Contact Inovance or your Inovance agent to check whether the parts need to be replaced.

Object	Type	Standard Replacement Interval	Remarks
Drive	Power bus capacitor	About 8 years (ambient temperature: 30°C; load rate: 80%; uptime per day: 20 hours; standard environment[1])	The standard replacement interval is for reference only. If any device/component works improperly before the replacement interval expires, replace it immediately.
	Fan	5 years (ambient temperature: 30°C; load rate: 80%; uptime per day: 20 hours; standard environment[1])	
	Control circuit aluminum electrolytic capacitor	About 10 years (ambient temperature: 30°C; load rate: 80%; uptime per day: 20 hours; standard environment[1])	
	Pre-charge relay	100000 operations (depending on the operating conditions)	
	Pre-charge resistor	20000 operations (depending on the operating conditions)	
	Dynamic brake relay	About 1000 times (rated motor speed; interval: 5 min; inertia: 20 times)	
	Dynamic brake resistor		
Motor	Bearing	3 years to 5 years (20,000 hours to 30,000 hours)	
	Oil seal	5000 h	
	Encoder	3 years to 5 years (20,000 hours to 30,000 hours)	
	Absolute encoder battery	Depends on the operating condition See the operation instructions for the encoder battery for details.	

Note

[1]: For information on standard environment see Section "Installation Environment Requirements".

13 Standards Compliance

13.1 Compliance List

CE Certification

reference	Standard	
EMC command 2014/30/EU	Servo drive	EN 61800-3 EN 61800-6-2 EN 61800-6-4 EN 55011
	Servo motor	
Low Voltage Directive 2014/35/EU	Servo drive	EN 61800-5-1
	Servo motor	EN 60034-1 EN 60034-5
RoHS Directive 2011/65/EU	Servo drive	-
	Servo motor	

UL/cUL Certification

Certification	Standard	
UL/cUL Certification	Servo drive	UL61800-5-1 C22.2 No.274
	Servo motor	UL 1004-1 UL 1004-6 CSA C22.2 No. 100-14

KC Certification

Certification	Standard	
KC Certification	Servo drive	KN 61800-3 (Ver 2014.06) (IEC 61800-3 Ver 2012.03)

Others

The SV680-INT series servo drive meets the requirements of EAC, UKCA and functional safety certification.

Certification	Standard	
EAC Certification	Servo drive	TP TC 004/2011 TP TC 020/2011

13.2 CE Certification

Figure 13-1 CE Marking

- The CE mark indicates compliance with the Low Voltage Directive LVD), Electromagnetic Compatibility (EMC), and Restriction of Hazardous Substances (RoHS) directives.
- The CE mark is required for engaging in commercial business (production, importation, and distribution) in Europe.
- The drive complies with LVD, EMC, and RoHS directives and carries the CE mark.
- Machines and devices integrated with this drive must also comply with CE requirements for distribution in Europe.
- The integrator who integrates this drive into other products and attaches CE mark to the final assembly has the responsibility of ensuring compliance with CE certification.

13.2.1Requirements for Compliance with EMC

The drive is applicable to the first environment and second environment and complies with EMC directive 2014/30/EU and standard EN 61800-3.

As required by EMC Directive 2014/30/EU and standard EN IEC 61800-3, install an EMC filter on the input side of the drive and use shielded cables on the output side. Ensure the filter is grounded properly and the shield of the output cable is grounded 360 degrees.

When applied in the first environment, the drive may generate radio interference. In addition to the CE compliance requirements described in this chapter, take additional measures to prevent radio interference if necessary.

Introduction to EMC standards

Electromagnetic compatibility (EMC) describes the ability of electrical and electronic devices or systems to work properly in the electromagnetic environment without introducing electromagnetic interferences that disturb the operation of other local devices or systems. In other words, EMC includes two aspects: 1) The electromagnetic interference generated by a device during normal operation cannot exceed a certain limit. 2) The device must have sufficient immunity to the electromagnetic interference in the environment.

EN 61800-3 defines the following two types of environments.

- First environment: Environment that includes domestic premises, and establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes
- Second environment: Environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes

Devices are divided into the following four categories based on the intended application environment.

- Category C1: a Power drive system (PDS) with the rated voltage less than 1000 V, intended for use in the first environment.
- Category C2 equipment: PDS with rated voltage less than 1000 V, which is neither a plug-in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by professionals.
- Category C3 equipment: PDS with rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment.
- Category C4 equipment: PDS with rated voltage equal to or above 1000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

13.2.2Requirements for Compliance with LVD

The drive has been tested in accordance with EN61800-5-1 to determine compliance with LVD. Observe the following requirements to enable machines and devices integrated with this drive to comply with LVD.

Installation location

Install the drive in a place with overvoltage category III and pollution degree 1 or 2 as specified by EN61800-5-1.

Installation Environment

For requirements of the installation environment, see *"4.2 Installation Environment Requirements" on page 55*.

Protection

The drive must be installed in a fireproof cabinet with doors that provide effective electrical and mechanical protection. The installation must conform to local and regional laws and regulations and relevant IEC standards.

IP20-rated drives intended to be installed inside the cabinet must be installed in a structure that prevents intrusion of unwanted objects from the top and the front.

Main Circuit Cable Requirements

For wiring requirements of the main circuit terminals, see "SV680-INT Series Servo Drive Hardware Guide".

Requirements of protective devices

To comply with EN 61800-5-1, install a fuse/circuit breaker on the input side of the drive to prevent accidents caused by short circuit in the internal circuit.

For recommended fuse and circuit breaker models, see "SV680-INT Series Servo Drive Hardware Guide".

13.3 UL/cUL Certification

Figure 13-2 UL/cUL marking

The UL/cUL mark commonly applies to products sold in the United States and Canada. Products with UL/cUL mark have been inspected and assessed by the UL organization. To pass UL/cUL certification, main built-in components of electrical products must also be UL certified.

The drive has been tested in accordance with UL 61800–5–1 and CSA C22.2 No. 274 to determine compliance with UL/cUL standards. Observe the following requirements to enable machines and devices integrated with this drive to comply with UL/cUL standards.

Installation location

Install the drive in a place with overvoltage category III and pollution degree 1 or 2 as specified by UL61800–5–1.

Ambient temperature

According to the protection level, the ambient temperature must be maintained within the following range:

Ambient temperature for open-type drives: 0°C to 50°C.

Installation requirements

Installation requirements for open-type drives:

SV680-INT series servo drives are open-type drives that must be installed in a fireproof cabinet with the housing that provides effective electrical and mechanical protection. The installation must conform to local laws and regulations and related NEC requirements.

Main Circuit Cable Requirements

On-site installation of output terminals (such as P ⊕ , C, and N ⊖) is not allowed.

- Terminals P ⊕ , C, and N ⊖ are used to connect optional parts. Do not connect these terminals to an AC power supply.
- To protect the main circuit, separate and cover the surface that may come into contact with the main circuit.
- The control circuit is the internal safety extra-low voltage (SELV) circuit that must be strictly insulated and isolated from other circuits. Make sure that the control circuit is connected to the external SELV circuit.
- Prevent foreign matters from entering the wiring part of the terminal block.
- Do not solder the twisted conductors.
- The tightening torque may vary with terminals. Tighten terminal screws with the specified tightening torque. You can use the torque screwdriver, ratchet, or wrench.
- When using an electric screwdriver to tighten terminal screws, set a low speed to prevent damage to the terminal screws.
- Tighten the terminal screws with an angle not higher than 5°. Failure to comply may damage the terminal screws.

Wiring requirements of the control circuit

Observe the requirements in UL508 during wiring.

Cable requirements

Cable dimensions must be compliant with requirements in NEC (National Electric Code) and CEC (Canadian Electrical Code) Part I and local regulations.

- Use cables with copper conductors.
- The recommended cables for the main circuit are 600 V Class 2 heat-resistant indoor PVC cables that can work under temperature of 75°C continuously. Requirements:
  - Ambient temperature: < 40°C
  - Normal operating ratings

If the recommended cable specifications for peripheral devices or optional parts exceed the applicable cable specification range, contact Inovance.

Cable selection

To comply with UL61800-5-1 and CSA C22.2 No. 274, power cables used for the drive must meet the following requirements:

- Compliant with NEC, Table 310-16 of NFPA70.
- Comprised of copper conductors with a rated temperature not lower than 75°C (167°F).
- Cable size must be 14AWG or higher.
- With a rated voltage not lower than the rated voltage of the servo drive.
- It is recommended to use cables compliant with UL758 Style 2517 and Style 2586 as motor main circuit cables.

Requirements of protective devices

To comply with UL61800-5-1, install a fuse/circuit breaker on the input side of the drive to prevent accidents caused by short circuit in the internal circuit.

Install sufficient protective devices against short circuit in branch circuits according to applicable regulations and this guide. The drive is applicable to circuits with a rated breaking capacity lower than 5kA and 65 kA and a maximum voltage of 480 VAC (class 400 V).

Note

All breaker protective devices must be UL-certified.

For the SV680-INT drive applied in North America, the recommended protective devices are as follows:

Table 13–1 Recommended protective devices

Drive Model		Circuit breaker (A)	Class J fuse (A)	Recommended inverse time lag breaker[1] (A)
Single-phase 200 V				
Size A	S1R6	5	6	40
	S2R8	10	10	40
Size C	S5R5	15	20	40
	S7R6	15	20	100
Size D	S012	20	20	100
Three-phase 200 V				
Size A	S1R6	5	6	40
	S2R8	10	6	40
Size C	S5R5	15	15	40
	S7R6	15	15	100
Size D	S012	20	20	100
Size E	S018	30	20	100
	S022	30	35	100
	S027	40	40	100
Three-phase 400 V				

Drive Model		Circuit breaker (A)	Class J fuse (A)	Recommended inverse time lag breaker[1] (A)
Size C	3R5	15	6	100
	5R4	15	10	100
Size D	T8R4	20	15	100
	T012	20	20	100
Size E	T017	30	35	100
	T021	30	35	100
	T026	40	40	100

Note

[1]: It is recommended to use an inverse time circuit breaker for a parallel multi-drive system.

13.4 KC Certification

Figure 13-3 KC Certification Mark

The KC mark indicates compliance with ROK standards related to safety (KC) and EMC (KCC).

- The KC mark is required for engaging in commercial business (production, importation, and distribution) in the ROK.
- Machines and devices integrated with this drive must also comply with KC requirements for distribution in the ROK.
- The integrator who integrates this drive into other products and attaches KC mark to the final assembly has the responsibility of ensuring compliance with KC certification.
- Observe the following requirements to enable machines and devices integrated with this drive to comply with KC standards.

Appllicant Suzhou Inovance Technology Co., Ltd.
AC Servo Drive
Model SV680 series
Made In China
Manufacturer
Suzhou Inovance Technology Co.,Ltd.

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13.5 UKCA Certification

Products exported to Great Britain must carry a UKCA mark. However, the products with the CE mark can still be exported to the United Kingdom.

13.6 Functional Safety Certification

EC directives and standards

EMC Directive 2014/30/EU Standard EN 61800-3: 2018

Machinery Directive 2006/42/EC (Safety Functions) Standard IEC 61800-5-2

DIDO Function Assignment [safety parameter configuration]

This section introduces the configuration of DI and DO functions of the safety module. You need to operate on the safety parameter interface of InoDriverShop. The initial password is "111111".

Table –2 DI Function Assignment

Value	Name	Function Name	Description
01	STO command	STO trigger command	0: STO active 1: STO deselected
02	SBC command	SBC trigger command	0: SBC active 1: SBC deselected
03	SS1 command	SS1 trigger command	0: SS1 active 1: SS1 deselected
04	SS2 command	SS2 trigger command	0: SS2 active 1: SS2 deselected
05	SLS1 command	SLS1 trigger command	0: SLS1 active 1: SLS1 deselected
06	SLS2 command	SLS2 trigger command	0: SLS2 active 1: SLS2 deselected
07	SLS3 command	SLS3 trigger command	0: SLS3 active 1: SLS3 deselected
08	SLS4 command	SLS4 trigger command	0: SLS4 active 1: SLS4 deselected
09	SDIp command	SDIp trigger command	0: Active, forward rotation prohibited 1: Canceled, forward rotation allowed
10	SDIn command	SDIn trigger command	0: Active, reverse rotation prohibited 1: Canceled, reverse rotation allowed
11	ACK command	ACK trigger command	0: ACK deselected 1: ACK active

Table –3 DO Function Assignment

Value	Name	Function Name	Description
01	STO Active	STO active	0: Normal state 1: STO state
02	SBC Active	SBC active	0: Normal state 1: SBC state
03	SS1 Active	SS1 active	0: SS1 inactive 1: SS1 stop state
04	SS2 Active	SS2 active	0: SS2 inactive 1: SS2 stop state

Value	Name	Function Name	Description
05	SLS1 Active	SLS1 active	0: Normal state 1: SLS1 monitoring state
06	SLS2 Active	SLS2 active	0: Normal state 1: SLS2 monitoring state
07	SLS3 Active	SLS3 active	0: Normal state 1: SLS3 monitoring state
08	SLS4 Active	SLS4 active	0: Normal state 1: SLS4 monitoring state
09	SDIp Status	SDIp state	0: Inactive, motor is not rotating forward 1: Active, motor is rotating forward
10	SDIn Status	SDIn state	0: Inactive, motor is not rotating reversely 1: Active, motor is rotating reversely
11	SOS Active	SOS active	0: SOS inactive 1: SOS active
12	SSM Active	SSM active	0: Out of SSM limit 1: Within SSM limit
13	SS1-r Active	SS1-r active	0: SS1-r inactive 1: SS1-r active state
14	SS2-r Active	SS2-r active	0: SS2-r inactive 1: SS2-r active

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