INOVANCE

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SV680N-INT Series Servo Drive

Safety Guide

Industrial Automation

Intelligent Elevator

New Energy Vehicle

Industrial Robot

Rail Transit

Data code PS00009768A02

Preface

Introduction

This manual describes integrated STO and expansion safety functions.

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

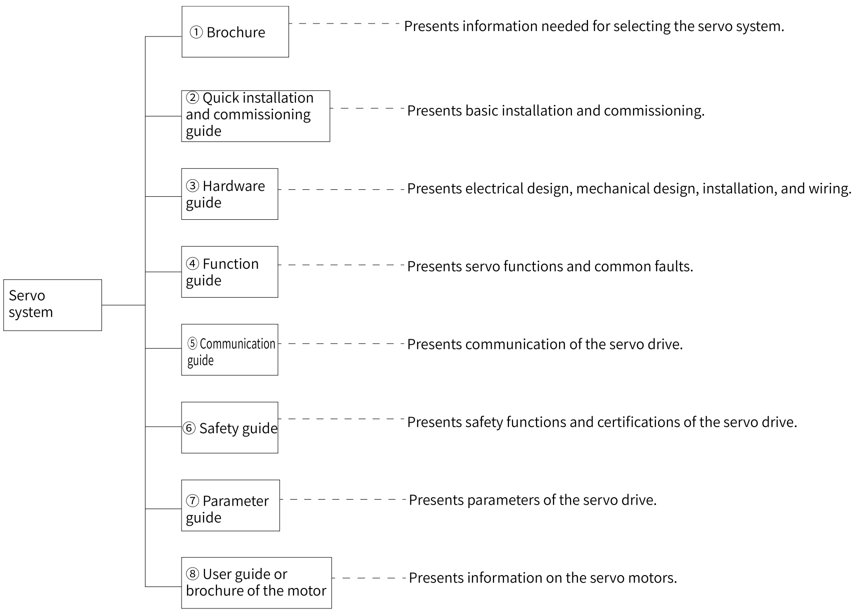
The safety drive enables a range of safety functions including SS1, SS2, SOS, SDI, SSM, SBC, STO, and SLS. These safety functions can be triggered through connection to external terminals (hereinafter "locally triggered safety functions") or through EtherCAT communication with the host controller (hereinafter "bus triggered safety functions"). The bus (namely, FSoE) triggered safety functions are only applicable to the SV680N-INT functional safety servo drive.

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.

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	19120347	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 Installation and Commissioning Quick 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 Guide	PS00015554	Introduces the functions and faults of the drive, including function overview, adjustment, basic servo functions and fault handling.
⑤	SV680-INT Series Servo Drive Communication Guide	PS00015535	Introduces the communication of the drive, including configuration of Modbus, CANopen, and EtherCAT communication.
⑥	SV680P-INT Series Servo Drive 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 Safety Guide	PS00009768	
⑦	SV680-INT Series Servo Drive Parameter Guide	PS00015555	Introduces the parameters of the drive, including a parameter list and description of parameters.
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	19120011	Introduces the product information, general specifications, motor selection, cable selection, and required standards of the motor.

Revision History

Date	Version	Description
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 http://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.

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

Fundamental Safety Instructions

Safety Precautions

- 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 usage.

Safety Levels and Definitions

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

Fundamental 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
⚠ WARNING • 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.
⚠ CAUTION • Check whether the packing 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
⚠ WARNING • 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.

CAUTION

- 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 the equipment 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

DANGER

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

WARNING

- 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 the equipment is installed in a cabinet or final assembly, a fireproof enclosure providing both electrical and mechanical protections 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.

CAUTION

- 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

DANGER

- 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.

WARNING

- 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.

CAUTION

- 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

DANGER
• 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.
WARNING
• 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
DANGER
• 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.
WARNING
• 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
DANGER
• 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.

WARNING • Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.
Repair
DANGER • 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.
WARNING • 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
WARNING • 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

Precautions for the dynamic brake

- Dynamic braking can only be used for emergency stop in case of failure and sudden power failure. Do not trigger failure or power failure frequently.
- Ensure that the dynamic braking function has an operation interval of more than 5 minutes at high speed, otherwise the internal dynamic braking circuit may be damaged.

- Dynamic braking is commonly used in rotating mechanical structures. For example, when a motor has stopped running, it keeps rotating due to the inertia of its load. In this case, this motor is in the regenerative state and short-circuit current passes through the dynamic brake. If this situation continues, the drive, and even the motor, may be burned.

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. • Do not touch terminals within 15 minutes after disconnecting the power supply to prevent the risk of electric shock. • Do not touch the heatsink with power ON to prevent the 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.

Function list

- 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 complies with stop category 0 of EN 60204-1. If the motor is running when the STO function is activated, it coasts to stop.
- Safe brake control (SBC)
  The SBC function provides a safe output signal for controlling external brake.
- 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 complies with stop category 1 of 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 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 SS2 function starts deceleration based on an input signal from an external device. After a preset period of time has elapsed or zero speed is achieved, the SOS function will be triggered. This function complies with stop category 2 of 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 DI or a safety bus.
  The combination of safety module, SV680 series servo drives, and safety motor supports safety functions (SS1-r/SS2/SOS/SLS/SDI/SSM) in compliance with PL e/Cat.3 and SIL3. The SBC/SS1/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.
- Controlling safety functions using a safety bus reduces wiring.

Caution

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

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_D	Probability of a dangerous Failure per Hour
PL	Performance Level
SC	Systematic capability
SIL	Safety integrity level

Terms and Abbreviations	Description
T_1	Test interval
DI	Digital input
DO	Digital output
PCB	Printed circuit board
MCU	Micro computer unit
FPGA	Field programmable gate array
MTTFd	Mean time to dangerous failure
STO	The safe torque off (STO) function brings the machine safely into a no-torque state and prevents it from unexpected start. If the motor is running when STO function is activated, it coasts to 0 RPM.

1.3 Safety Standards

Standards compliance

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

  EMC Directive 2014/30/ EU, EN 61800-3 2018

  Machinery Directive 2006/42/EC (Function Safety), IEC 61800-5-2
- 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 13849-2: 2012 EN IEC 62061: 2021 IEC 60204-1: 2016 (in extracts) EN 60204-1: 2018 (in extracts)
Electromagnetic compatibility (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 6100067:2015
LVD	IEC 6180051:2007/AMD1:2016 EN 6180051:2007/A1:2017

- Safety parameters

Item	Safety parameters
SIL	SIL3, IEC61508 Maximum SIL3, EN IEC62061
PFH_D	$PFH_D \leqslant 1.1 \times 10^{-9}$[1/h] (1.1% of SIL3)
Cat.	3, EN ISO 13849–1
PL	E, EN ISO 13849–1
MTTFd	904 years (high)
DCavg	$\geqslant$ 90% (medium)
T_1	20 years
HFT	1
SC	SC3
λ_S	2.2×10^{-7}/h
λ_{DD}	1.3×10^{-7}/h
λ_{DU}	2.7×10^{-9}/h
MTTR	0 hour
MRT	0 hour
Application mode	High demand or continuous mode
Device type	Type B
Safe speed accuracy	2197.98 rpm

λ_S means the failure rate of safe failure which brings the system into safe state.

λ_{DD} indicates the dangerous fault rate that can be diagnosed by the sub-system.

λ_{DU} indicates the failure rate of dangerous failure that can't be diagnosed by the diagnosis subsystem.

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.

1.4 Precautions for Use

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

Symbol	Signal word	Description	Consequences in case of disregard
Example:  DANGER  Hazardous voltage e.g. electric shock	DANGER	DANGER	Indicates that failure to comply with the notice will result in death or severe personal injuries
	WARNING	Warning	Indicates that failure to comply with the notice may result in death or severe personal injuries
	CAUTION	Caution	Indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage
	STOP	Stop	Indicates that failure to comply with the notice will result in equipment or environmental damage

Caution

- 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 and observe the following important precautions when using security features:

- 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).
- p: Number of motor pole pairs.

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.

Note

There are two ways to perform STO diagnosis:

- Power off and restart;
- Trigger and then cancel STO.

You can use either of them.

- **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 Drive Model and Nameplate

Model description

SV680	N	S	2R8	I	-	GINT
①	②	③	④	⑤		⑥

① **Product 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 communication type P: Pulse type + CANopen communication type	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 type (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 P 7 00001
① ② ③ ④ ⑤

① **Internal code** Article material code	③ **Year** 9: 2009 A: 2010 ... P: 2022 ... 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 010502024P700001 indicates the drive is manufactured in July, 2022.

2.2 Motor Model and Nameplate

Model description

MS1 H1 - 75B 30C B A3 3 1 R - *
① ② ③ ④ ⑤ ⑥ ⑦⑧⑨ ⑩

① **MS1 series servo motor**	④ **Rated speed (rpm)** One letter and two digits B: x 10 C: x 100 Example: 30C: 3,000 rpm	⑦ **Shaft Connection Mode** 3: Solid shaft, with key and threaded hole
② **Inertia and Capacity** H1: low inertia, small capacity H2: low inertia, medium capacity H3: medium inertia, medium capacity H4: medium inertia, small capacity	⑤ **Voltage Class (V)** B: 220 D: 380	⑧ **Brake, Reducer and Oil Seal[1]** 0: No oil seal and brake 1: With oil seal but no brake 2: No oil seal but with brake 4: With oil seal and brake

③ **Rated Power (W)** One letter and two digits B: x 10 C: x 100 Example: 75B: 750W	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 T3: 18-bit multi-turn absolute encoder	⑨ **Series** R: R series ⑩ **Cable Connection and Cooling** _: connector type, natural cooling -S[2]: flying leads type, natural cooling -F: Air cooling

Note

- [1]: The standard configuration of the motor in flange size 40 does not include the oil seal. Motors of other models carry the oil seal as standard.
- [2]: Motors (-S) with flying leads are only available in flange sizes 40/60/80.

Nameplate

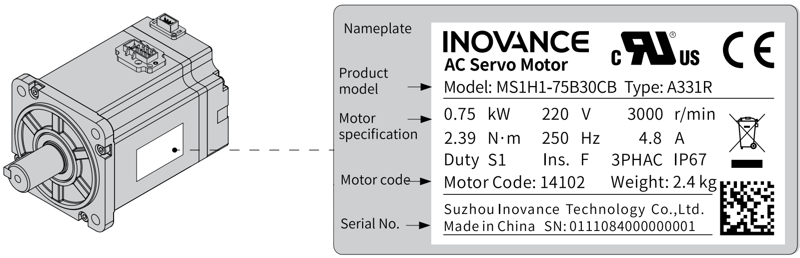


Figure 2-2 Model and Nameplate

2.3 Description of the Encoder Model

Model description

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, hole diameter, magnet diameter or gear modulus** 5: Ø5 62: Ø62 0.4: 0.4M	⑨ **Operating voltage (VDC)** 5: 5 30: 10 to 30

② **Product type** I: Incremental encoder A: Low inertia, medium capacity MI: Incremental magnetic encoder MA: Absolute magnetic encoder	⑥ **Resolution** 1024: 50–25000P/r B20: The single-turn resolution is 20. B20 M16: The single-turn resolution is 20 and multi-turn resolution is 16. B26 M16: The single-turn resolution is 26 and multi-turn resolution is 16.	⑩ **Sealing** Y: With sealing ring N: Without sealing ring E: Oil seal
③ **Enclosure dimensions** 35: Ø35 100: Ø100	⑦ **Output signal** B: A, B C: A, B, Z D: A, ¬A[1], B, ¬B E: A, ¬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: Customized
④ **Shaft structure** S: Solid H: Hollow M: Semi-hollow N: None C: Outer cone semi-hollow M: Inner cone semi-hollow R: Universal joint	⑧ **Circuit output mode** 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: Functional safety type Special vendor Q: Qunma photocell X: Photocell with slit D: Photocell customized J: High precision correction

Note

- Only the following three types of encoders have been evaluated and certified: EA33H6-B26M16-TH5N1T; EA45H8-B26M16-TH5N1T; and EA79R8-B26M16-TH5Y3-FS.
- ¬A represents non-A, ¬B represents non-B, and ¬Z represents non-Z.

2.4 Cable Models

Power cable model

S6-L-M 0 0 1 - 3.0 - INT
① ②③④ ⑤ ⑥

① **Cable type** S6-L-B/M: motion control power cable B: with brake M: without brake	③ **Cable Size (mm^2)** 0: Flange sizes 25/40/60/80 1: frame sizes 100/130/180 (drive rated current < 13 A) 2: frame size 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: U-shaped cable lug 1: Needle-shaped cable lug	④ **Connector type at motor side** 1: 9-core aviation connector 2: 6-core aviation connector 7: SDC-06T series aviation connector (front outlet)	⑥ **Special requirements** INT: Global version[1]

Note

[1]: The material of the global version cables complies with CE and UL certification.

Encoder cable model

S6-L-P 1 2 1 - 3.0 - INT
① ②③④ ⑤ ⑥

① **Cable type** S6-L-P: Motion control encoder cable	③ **Encoder** 2: Multi-turn absolute encoder	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** 1: 9-core aviation connector 4: SDC-06T series aviation connector (front outlet)	⑥ **Special requirements** INT: Global version[1]

Note

[1]: The material of the global version cables complies with CE and UL certification.

Communication cable model

S6N-L-T 00 - 3.0
① ② ③

① **Cable type** S6-L-T: Motion control communication cable S6N-L-T: IS620F motion control encoder cable (only for servo drive to PC communication cable)	② **Cable connection type** 00: Servo drive to PC communication cable 01: Servo drive network communication cable (CAN&485) 02: Servo drive to PLC communication cable 03: Servo drive communication termination resistor cable (CAN&485) 04: Servo drive network communication cable (EtherCAT)	③ **Cable length (m)** 3.0: 3 5.0: 5 10.0: 10

2.5 Components

2.5.1 Servo Drives in Size A and Size C (Rated Power 0.2 kW to 1.5 kW)

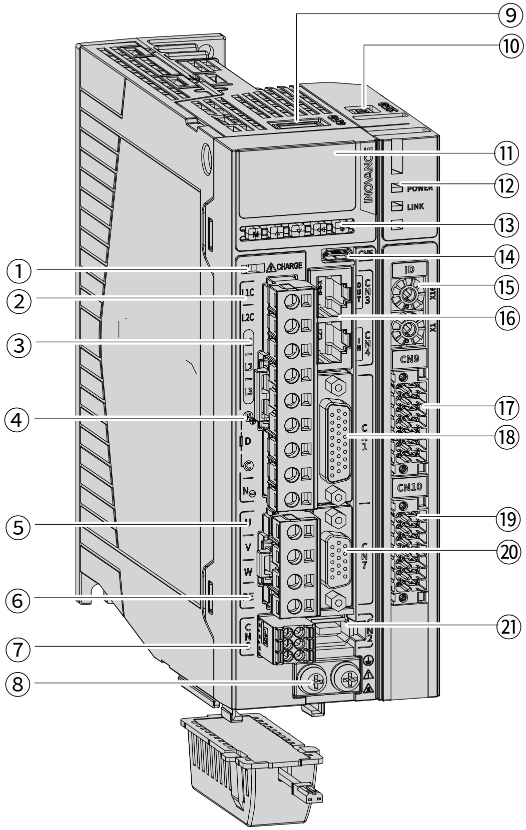


Figure 2-3 Components of servo drive in size A and size C

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

No.	Name	Description
①	CHARGE (bus voltage indicator)	When the indicator turns on, residual voltage may still be present in the internal capacitor of the servo unit, even if the power supply of the main circuit has been switched off. To prevent electric shock, do not touch the power supply terminals when this indicator lights up.
②	L1C, L2C (control circuit power input terminals)	Input the control circuit power supply according to the rated voltage class on the nameplate.

No.	Name	Description
③	L1, L2, L3 (main circuit power input terminals)[1]	Input the main circuit power supply according to the rated voltage class on the nameplate.
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.
⑤	U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
⑥	PE (grounding) terminal	Connected to the grounding terminal of the motor for grounding purpose.
⑦	CN8 (brake and PTC input terminal)	Used for wiring of the 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, see the corresponding function guide and hardware guide.
⑩	CN11 (24 V backup power input terminal)	When power failure occurs, the backup power supply can be connected for 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 Steady ON: FSoE is ready; flashing: communication is normal; OFF: FSoE is closed.
⑬	Keys	M: Switches parameters in sequence. ▲: Increases the value of the blinking bit. ▲: Decreases the value of the blinking bit. ◀◀: Shifts 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.

No.	Name	Description
⑭	CN5 communication terminal	Supports online upgrade and commissioning with the software tool when the drive is powered on. In USB mode, the terminal only supports download and upload of parameters, and drive firmware update; The terminal uses USB power supply. If there is a fault that cannot be completely reset, disconnect the USB power supply and control circuit power supply, and then power on again.
⑮	FSoE ID address setting knob	Sets ID address of the slave drive for FSoE communication. Address setting method: The number of the upper knob*16 + the number of the lower knob.
⑯	CN3, CN4 (EtherCAT communication terminals)	CN4 (IN): Connected to the master or the last slave device CN3 (OUT): Connected to the next slave device
⑰	Control terminal A of CN9 safety module	Control terminal A of the safety module
⑱	CN1 (control terminal)	Used by reference input signals and other I/O signals.
⑲	Control terminal B of CN10 safety module	Command input and output terminal B of the safety module
⑳	CN7 (encoder feedback terminal)	Supports communication-type encoders and pulse-type encoders. Supports gantry synchronization.
㉑	CN2 (encoder feedback terminal)	Supports communication-type encoders. Supports gantry synchronization.

Note

- The built-in braking resistor or jumper bar is not available in models S1R6 and S2R8. If an external braking resistor is needed for these models, connect it between terminals P⊕ and C.
- [1] When the main circuit power input terminals of drives with a voltage class of 200 V to 240 V are L1, L2, L3 (or any two among L1, L2, and L3 in case of single-phase power supplies). The main circuit power input terminals of drives with a voltage class of 380 V to 480 V are R, S, and T.

2.5.2 Servo Drives in Size D (Rated Power 1.5 kW to 3.0 kW)

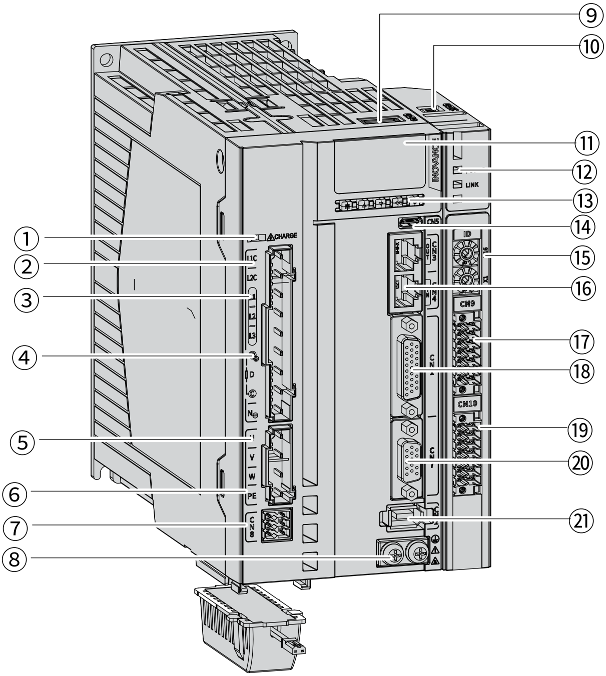


Figure 2-4 Components of servo drive in size D

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

No.	Name	Description
①	CHARGE (bus voltage indicator)	When the indicator turns on, residual voltage may still be present in the internal capacitor of the servo unit, even if the power supply of the main circuit has been switched off. To prevent electric shock, do not touch the power supply terminals when this indicator lights up.
②	L1C, L2C (control circuit power input terminals)	Input the control circuit power supply according to the rated voltage class on the nameplate.
③	L1, L2, L3 (main circuit power input terminals)[1]	Input the main circuit power supply according to the rated voltage class on the nameplate.

No.	Name	Description
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.
⑤	U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
⑥	PE (grounding) terminal	Connected to the grounding terminal of the motor for grounding purpose.
⑦	CN8 (brake and PTC input terminal)	Used for wiring of the 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, see the corresponding function guide and hardware guide.
⑩	CN11 (24 V backup power input terminal)	When power failure occurs, the backup power supply can be connected for 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 Steady ON: FSoE is ready; flashing: communication is normal; OFF: FSoE is closed.
⑬	Keys	M: Switches parameters in sequence. ▲: Increases the value of the blinking bit. ▲: Decreases the value of the blinking bit. ◀◀: Shifts 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 commissioning with the software tool when the drive is powered on. In USB mode, the terminal only supports download and upload of parameters, and drive firmware update; The terminal uses USB power supply. If there is a fault that cannot be completely reset, disconnect the USB power supply and control circuit power supply, and then power on again.

No.	Name	Description
⑮	FSoE ID address setting knob	Sets ID address of the slave drive for FSoE communication. Address setting method: The number of the upper knob*16 + the number of the lower knob.
⑯	CN3, CN4 (EtherCAT communication terminals)	CN4 (IN): Connected to the master or the last slave device CN3 (OUT): Connected to the next slave device
⑰	Control terminal A of CN9 safety module	Control terminal A of the safety module
⑱	CN1 (control terminal)	Used by reference input signals and other I/O signals.
⑲	Control terminal B of CN10 safety module	Command input and output terminal B of the safety module
⑳	CN7 (encoder feedback terminal)	Supports communication-type encoders and pulse-type encoders. Supports gantry synchronization.
㉑	CN2 (encoder feedback terminal)	Supports communication-type encoders. Supports gantry synchronization.

Note

- The built-in braking resistor or jumper bar is not available in models S1R6 and S2R8. If an external braking resistor is needed for these models, connect it between terminals P⊕ and C.
- [1] When the main circuit power input terminals of drives with a voltage class of 200 V to 240 V are L1, L2, L3 (or any two among L1, L2, and L3 in case of single-phase power supplies). The main circuit power input terminals of drives with a voltage class of 380 V to 480 V are R, S, and T.

2.5.3 Servo Drives in Size E (Rated Power 2.0 kW to 7.5 kW)

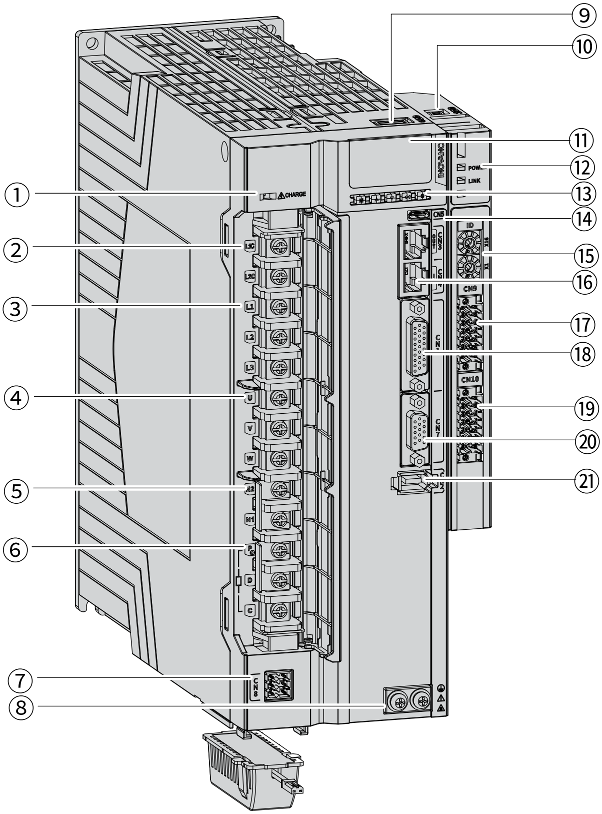


Figure 2-5 Components of servo drive in size E

Table 2–3 Description of components

No.	Name	Description
①	CHARGE (bus voltage indicator)	When the indicator turns on, residual voltage may still be present in the internal capacitor of the servo unit, even if the power supply of the main circuit has been switched off. To prevent electric shock, do not touch the power supply terminals when this indicator lights up.
②	L1C, L2C (control circuit power input terminals)	Input the control circuit power supply according to the rated voltage class on the nameplate.
③	L1, L2, L3 (main circuit power input terminals)[1]	Input the main circuit power supply according to the rated voltage class on the nameplate.

No.	Name	Description
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 bar 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)	Used for wiring of the 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, see the corresponding function guide and hardware guide.
⑩	CN11 (24 V backup power input terminal)	When power failure occurs, the backup power supply can be connected for 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 Steady ON: FSoE is ready; flashing: communication is normal; OFF: FSoE is closed.
⑬	Keys	M: Switches parameters in sequence. ▲: Increases the value of the blinking bit. ▲: Decreases the value of the blinking bit. ◀◀: Shifts 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 commissioning with the software tool when the drive is powered on. In USB mode, the terminal only supports download and upload of parameters, and drive firmware update; The terminal uses USB power supply. If there is a fault that cannot be completely reset, disconnect the USB power supply and control circuit power supply, and then power on again.

No.	Name	Description
⑮	FSoE ID address setting knob	Sets ID address of the slave drive for FSoE communication. Address setting method: The number of the upper knob*16 + the number of the lower knob.
⑯	CN3, CN4 (EtherCAT communication terminals)	CN4 (IN): Connected to the master or the last slave device CN3 (OUT): Connected to the next slave device
⑰	Control terminal A of CN9 safety module	Control terminal A of the safety module
⑱	CN1 (control terminal)	Used by reference input signals and other I/O signals.
⑲	Control terminal B of CN10 safety module	Command input and output terminal B of the safety module
⑳	CN7 (encoder feedback terminal)	Supports communication-type encoders and pulse-type encoders. Supports gantry synchronization.
㉑	CN2 (encoder feedback terminal)	Supports communication-type encoders. Supports gantry synchronization.

Note

- The built-in braking resistor or jumper bar is not available in models S1R6 and S2R8. If an external braking resistor is needed for these models, connect it between terminals P⊕ and C.
- [1] When the main circuit power input terminals of drives with a voltage class of 200 V to 240 V are L1, L2, L3 (or any two among L1, L2, and L3 in case of single-phase power supplies). The main circuit power input terminals of drives with a voltage class of 380 V to 480 V are R, S, and T.

2.6 List of Compatible Models

2.6.1 Selection of Functional Safety Drives and Motors

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

Safety drive				Safety motor				Safety encoder
Voltage class (V)	Size	Recommended drive model	H01.10	Brake-less motor model	Brake motor model	Flange size	Capacity (kW)	Safety encoder model
Ratings of MS1H1 (n_N=3000 rpm, n_{max} =7000 rpm) motors								
Single-phase/ Three-phase 220 V	A	S1R6	00002	MS1H1-05B30CB-S630Z-INT	MS1H1-05B30CB-S632Z-INT	40	0.05	EA33H6-B26M16-TH5N1T
				MS1H1-10B30CB-S630Z-INT	MS1H1-10B30CB-S632Z-INT	40	0.1	EA33H6-B26M16-TH5N1T
				MS1H1-20B30CB-S630R-INT	MS1H1-20B30CB-S632R-INT	60	0.2	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220 V		S2R8	00003	MS1H1-40B30CB-S630R-INT	MS1H1-40B30CB-S632R-INT	60	0.4	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220 V	C	S5R5	00005	MS1H1-55B30CB-S630R-INT	MS1H1-55B30CB-S632R-INT	80	0.55	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220 V		S5R5	00005	MS1H1-75B30CB-S630R-INT	MS1H1-75B30CB-S632R-INT	80	0.75	EA45H8-B26M16-TH5N1T
Single-phase/ Three-phase 220 V	C	S7R6	00006	MS1H1-10C30CB-S630R-INT	MS1H1-10C30CB-S632R-INT	80	1.0	EA45H8-B26M16-TH5N1T
Ratings of MS1H2 (n_N=3000 rpm, n_{max} =6000 rpm) motors								

Safety drive				Safety motor				Safety encoder
Voltage class (V)	Size	Recommended drive model	H01.10	Brake-less motor model	Brake motor model	Flange size	Capacity (kW)	Safety encoder model
Single-phase/ Three-phase 220 V	C	S7R6	00006	MS1H2-10C30CB-S631R-INT	MS1H2-10C30CB-S634R-INT	100	1.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V		T3R5	10001	MS1H2-10C30CD-S631R-INT	MS1H2-10C30CD-S634R-INT	100	1.0	EA79R8-B26M16-TH5Y3-FS
Single-phase/ Three-phase 220 V	D	S012	00007	MS1H2-15C30CB-S631R-INT	MS1H2-15C30CB-S634R-INT	100	1.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V	C	T5R4	10002	MS1H2-15C30CD-S631R-INT	MS1H2-15C30CD-S634R-INT	100	1.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 220 V	E	S018	00008	MS1H2-20C30CB-S631R-INT	MS1H2-20C30CB-S634R-INT	100	2.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V	D	T8R4	10003	MS1H2-20C30CD-S631R-INT	MS1H2-20C30CD-S634R-INT	100	2.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 220 V	E	S022	00009	MS1H2-25C30CB-S631R-INT	MS1H2-25C30CB-S634R-INT	100	2.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V	D	T8R4	10003	MS1H2-25C30CD-S631R-INT	MS1H2-25C30CD-S634R-INT	100	2.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 220 V	E	S022	00009	MS1H2-30C30CB-S631R-INT	MS1H2-30C30CB-S634R-INT	130	3.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V	D	T012	10004	MS1H2-30C30CD-S631R-INT	MS1H2-30C30CD-S634R-INT	130	3.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 220 V	E	S027	00010	MS1H2-40C30CB-S631R-INT	MS1H2-40C30CB-S634R-INT	130	4.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V		T017	10005	MS1H2-40C30CD-S631R-INT	MS1H2-40C30CD-S634R-INT	130	4.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 220 V		S027	00010	MS1H2-50C30CB-S631R-INT	MS1H2-50C30CB-S634R-INT	130	5.0	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V		T021	10006	MS1H2-50C30CD-S631R-INT	MS1H2-50C30CD-S634R-INT	130	5.0	EA79R8-B26M16-TH5Y3-FS

Safety drive				Safety motor				Safety encoder
Voltage class (V)	Size	Recommended drive model	H01.10	Brake-less motor model	Brake motor model	Flange size	Capacity (kW)	Safety encoder model
Ratings of MS1H3 (n_N=1500 rpm, n_{max} =4500 rpm) series motors								
Single-phase/ Three-phase 220 V	C	S7R6	00006	MS1H3-85B15CB-S631R-INT	MS1H3-85B15CB-S634R-INT	130	0.85	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V		T3R5	10001	MS1H3-85B15CD-S631R-INT	MS1H3-85B15CD-S634R-INT	130	0.85	EA79R8-B26M16-TH5Y3-FS
Single-phase/ Three-phase 220 V	D	S012	00007	MS1H3-13C15CB-S631R-INT	MS1H3-13C15CB-S634R-INT	130	1.3	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V	C	T5R4	10002	MS1H3-13C15CD-S631R-INT	MS1H3-13C15CD-S634R-INT	130	1.3	EA79R8-B26M16-TH5Y3-FS
Three-phase 220 V	D	S018	00008	MS1H3-18C15CB-S631R-INT	MS1H3-18C15CB-S634R-INT	130	1.8	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V	D	T8R4	10003	MS1H3-18C15CD-S631R-INT	MS1H3-18C15CD-S634R-INT	130	1.8	EA79R8-B26M16-TH5Y3-FS
Three-phase 220 V	E	S022	00009	MS1H3-29C15CB-S631R-INT	MS1H3-29C15CB-S634R-INT	180	2.9	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V		T012	10004	MS1H3-29C15CD-S631R-INT	MS1H3-29C15CD-S634R-INT	180	2.9	EA79R8-B26M16-TH5Y3-FS
Three-phase 220 V	E	S027	00010	MS1H3-44C15CB-S631R-INT	MS1H3-44C15CB-S634R-INT	180	4.4	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V	E	T017	10005	MS1H3-44C15CD-S631R-INT	MS1H3-44C15CD-S634R-INT	180	4.4	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V		T021	10006	MS1H3-55C15CD-S631R-INT	MS1H3-55C15CD-S634R-INT	180	5.5	EA79R8-B26M16-TH5Y3-FS
Three-phase 380 V		T026	10007	MS1H3-75C15CD-S631R-INT	MS1H3-75C15CD-S634R-INT	180	7.5	EA79R8-B26M16-TH5Y3-FS
Ratings of MS1H4 (n_N=3000 rpm, n_{max} =7000 rpm) motors								

Safety drive				Safety motor				Safety encoder
Voltage class (V)	Size	Recom mended drive model	H01.10	Brake-less motor model	Brake motor model	Flange size	Capacity (kW)	Safety encoder model
Single-phase/ Three-phase 220 V	A	S1R6	00002	MS1H4-10B30CB-S630Z-INT	MS1H4-10B30CB-S632Z-INT	40	0.1	EA33H6-B26M16-TH5N1T
				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	MS1H4-55B30CB-S634R-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

Table 2–5 Functional safety drives and compatible servo motors

Safety drive				Servo motor			
Voltage class (V)	Size	Recom mended drive model	H01.10	Brake-less motor model	Brake motor model	Flange size	Capacity (kW)
Ratings of MS1H1 (n_N=3000 rpm, n_{max} =7000 rpm) motors							
Single-phase/ Three-phase 220 V	A	S1R6	00002	MS1H1-05B30CB-A630Z-INT	MS1H1-05B30CB-A632Z-INT	40	0.05
				MS1H1-10B30CB-A630Z-INT	MS1H1-10B30CB-A632Z-INT	40	0.1
				MS1H1-20B30CB-A630R-INT	MS1H1-20B30CB-A632R-INT	60	0.2
Single-phase/ Three-phase 220 V		S2R8	00003	MS1H1-40B30CB-A630R-INT	MS1H1-40B30CB-A632R-INT	60	0.4

Safety drive				Servo motor			
Voltage class (V)	Size	Recommended drive model	H01.10	Brake-less motor model	Brake motor model	Flange size	Capacity (kW)
Single-phase/ Three-phase 220 V	C	S5R5	00005	MS1H1-55B30CB- A630R-INT	MS1H1-55B30CB- A632R-INT	80	0.55
Single-phase/ Three-phase 220 V		S5R5	00005	MS1H1-75B30CB- A630R-INT	MS1H1-75B30CB- A632R-INT	80	0.75
Single-phase/ Three-phase 220 V	C	S7R6	00006	MS1H1-10C30CB- A630R-INT	MS1H1-10C30CB- A632R-INT	80	1.0
Ratings of MS1H2 (n_N=3000 rpm, n_{max} =6000 rpm) motors							
Single-phase/ Three-phase 220 V	C	S7R6	00006	MS1H2-10C30CB-A631R-INT	MS1H2-10C30CB-A634R-INT	100	1.0
Three-phase 380 V		T3R5	10001	MS1H2-10C30CD-A631R-INT	MS1H2-10C30CD-A634R-INT	100	1.0
Single-phase/ Three-phase 220 V	D	S012	00007	MS1H2-15C30CB-A631R-INT	MS1H2-15C30CB-A634R-INT	100	1.5
Three-phase 380 V	C	T5R4	10002	MS1H2-15C30CD-A631R-INT	MS1H2-15C30CD-A634R-INT	100	1.5
Three-phase 220 V	E	S018	00008	MS1H2-20C30CB-A631R-INT	MS1H2-20C30CB-A634R-INT	100	2.0
Three-phase 380 V	D	T8R4	10003	MS1H2-20C30CD-A631R-INT	MS1H2-20C30CD-A634R-INT	100	2.0
Three-phase 220 V	E	S022	00009	MS1H2-25C30CB-A631R-INT	MS1H2-25C30CB-A634R-INT	100	2.5
Three-phase 380 V	D	T8R4	10003	MS1H2-25C30CD-A631R-INT	MS1H2-25C30CD-A634R-INT	100	2.5
Three-phase 220 V	E	S022	00009	MS1H2-30C30CB-A631R-INT	MS1H2-30C30CB-A634R-INT	130	3.0
Three-phase 380 V	D	T012	10004	MS1H2-30C30CD-A631R-INT	MS1H2-30C30CD-A634R-INT	130	3.0
Three-phase 220 V	E	S027	00010	MS1H2-40C30CB-A631R-INT	MS1H2-40C30CB-A634R-INT	130	4.0
Three-phase 380 V		T017	10005	MS1H2-40C30CD-A631R-INT	MS1H2-40C30CD-A634R-INT	130	4.0
Three-phase 220 V		S027	00010	MS1H2-50C30CB-A631R-INT	MS1H2-50C30CB-A634R-INT	130	5.0
Three-phase 380 V		T021	10006	MS1H2-50C30CD-A631R-INT	MS1H2-50C30CD-A634R-INT	130	5.0
Ratings of MS1H3 (n_N=1500 rpm, n_{max} =4500 rpm) series motors							

Safety drive				Servo motor			
Voltage class (V)	Size	Recommended drive model	H01.10	Brake-less motor model	Brake motor model	Flange size	Capacity (kW)
Single-phase/ Three-phase 220 V	C	S7R6	00006	MS1H3-85B15CB-A631R-INT	MS1H3-85B15CB-A634R-INT	130	0.85
Three-phase 380 V		T3R5	10001	MS1H3-85B15CD-A631R-INT	MS1H3-85B15CD-A634R-INT	130	0.85
Single-phase/ Three-phase 220 V	D	S012	00007	MS1H3-13C15CB-A631R-INT	MS1H3-13C15CB-A634R-INT	130	1.3
Three-phase 380 V	C	T5R4	10002	MS1H3-13C15CD-A631R-INT	MS1H3-13C15CD-A634R-INT	130	1.3
Three-phase 220 V	D	S018	00008	MS1H3-18C15CB-A631R-INT	MS1H3-18C15CB-A634R-INT	130	1.8
Three-phase 380 V	D	T8R4	10003	MS1H3-18C15CD-A631R-INT	MS1H3-18C15CD-A634R-INT	130	1.8
Three-phase 220 V	E	S022	00009	MS1H3-29C15CB-A631R-INT	MS1H3-29C15CB-A634R-INT	180	2.9
Three-phase 380 V		T012	10004	MS1H3-29C15CD-A631R-INT	MS1H3-29C15CD-A634R-INT	180	2.9
Three-phase 220 V	E	S027	00010	MS1H3-44C15CB-A631R-INT	MS1H3-44C15CB-A634R-INT	180	4.4
Three-phase 380 V	E	T017	10005	MS1H3-44C15CD-A631R-INT	MS1H3-44C15CD-A634R-INT	180	4.4
Three-phase 380 V		T021	10006	MS1H3-55C15CD-A631R-INT	MS1H3-55C15CD-A634R-INT	180	5.5
Three-phase 380 V		T026	10007	MS1H3-75C15CD-A631R-INT	MS1H3-75C15CD-A634R-INT	180	7.5
Ratings of MS1H4 (n_N=3000 rpm, n_{max} =7000 rpm) motors							
Single-phase/ Three-phase 220 V	A	S1R6	00002	MS1H4-10B30CB-A630Z-INT	MS1H4-10B30CB-A632Z-INT	40	0.1
				MS1H4-20B30CB-A631R-INT	MS1H4-20B30CB-A634R-INT	60	0.2
Single-phase/ Three-phase 220 V		S2R8	00003	MS1H4-40B30CB-A631R-INT	MS1H4-40B30CB-A634R-INT	60	0.4
Single-phase/ Three-phase 220 V	C	S5R5	00005	MS1H4-55B30CB-A631R-INT	MS1H4-55B30CB-A634R-INT	80	0.55
Single-phase/ Three-phase 220 V		S5R5	00005	MS1H4-75B30CB-A631R-INT	MS1H4-75B30CB-A634R-INT	80	0.75

Safety drive				Servo motor			
Voltage class (V)	Size	Recommended drive model	H01.10	Brake-less motor model	Brake motor model	Flange size	Capacity (kW)
Single-phase/ Three-phase 220 V	C	S7R6	00006	MS1H4-10C30CB-A631R-INT	MS1H4-10C30CB-A634R-INT	80	1.0

Note

The asterisk (*) indicates the encoder type, which can be S6 (26-bit multi-turn absolute encoder of functional safety type) or A6 (26-bit multi-turn absolute encoder).

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

2.6.2 Selection of Standard Drives and Motors

Servo motor				Servo drive SV680-INT series			
Models without brake	Models with Brake	Flange size (mm)	Capacity (kW)	Voltage class (V)	Size	Recommended drive model	Code
Ratings of MS1H1 (n_N=3000 rpm, n_{max} =7000 rpm) motors							
MS1H1-05B30CB-A3/A6/ S630Z-INT	MS1H1-05B30CB-A3/A6/ S632Z-INT	40	0.05	Single-phase/ Three-phase 200 V	A	S1R6	00002
MS1H1-10B30CB-A3/A6/ S630Z-INT	MS1H1-10B30CB-A3/A6/ S632Z-INT	40	0.1	Single-phase/ Three-phase 200 V			
MS1H1-20B30CB-A3/A6/ S630R-INT	MS1H1-20B30CB-A3/A6/ S632R-INT	60	0.2	Single-phase/ Three-phase 200 V			
MS1H1-40B30CB-A3/A6/ S630R-INT	MS1H1-40B30CB-A3/A6/ S632R-INT	60	0.4	Single-phase/ Three-phase 200 V		S2R8	00003
MS1H1-55B30CB-A3/A6/ S630R-INT	-	80	0.55	Single-phase/ Three-phase 200 V	C	S5R5	00005
MS1H1-75B30CB-A3/A6/ S630R-INT	MS1H1-75B30CB-A3/A6/ S632R-INT	80	0.75	Single-phase/ Three-phase 200 V		S5R5	00005

Servo motor				Servo drive SV680-INT series			
Models without brake	Models with Brake	Flange size (mm)	Capacity (kW)	Voltage class (V)	Size	Recommended drive model	Code
MS1H1-10C30CB-A3/A6/S630R-INT	MS1H1-10C30CB-A3/A6/S632R-INT	80	1.0	Single-phase/ Three-phase 200 V	C	S7R6	00006
Ratings of MS1H2 (n_N=3000 rpm, n_{max} =6000 rpm) motors							
MS1H2-10C30CB-A3/A6/S631R-INT	MS1H2-10C30CB-A3/A6/S634R-INT	100	1.0	Single-phase/ Three-phase 200 V	C	S7R6	00006
MS1H2-10C30CD-A3/A6/S631R-INT	MS1H2-10C30CD-A3/A6/S634R-INT	100	1.0	Three-phase 400 V		T3R5	10001
MS1H2-15C30CB-A3/A6/S631R-INT	MS1H2-15C30CB-A3/A6/S634R-INT	100	1.5	Single-phase/ Three-phase 200 V	D	S012	00007
MS1H2-15C30CD-A3/A6/S631R-INT	MS1H2-15C30CD-A3/A6/S634R-INT	100	1.5	Three-phase 400 V	C	T5R4	10002
MS1H2-20C30CB-A3/A6/S631R-INT	MS1H2-20C30CB-A3/A6/S634R-INT	100	2.0	Three-phase 200 V	E	S018	00008
MS1H2-20C30CD-A3/A6/S631R-INT	MS1H2-20C30CD-A3/A6/S634R-INT	100	2.0	Three-phase 400 V	D	T8R4	10003
MS1H2-25C30CB-A3/A6/S631R-INT	MS1H2-25C30CB-A3/A6/S634R-INT	100	2.5	Three-phase 200 V	E	S022	00009
MS1H2-25C30CD-A3/A6/S631R-INT	MS1H2-25C30CD-A3/A6/S634R-INT	100	2.5	Three-phase 400 V	D	T8R4	10003
MS1H2-30C30CB-A3/A6/S631R-INT	MS1H2-30C30CB-A3/A6/S634R-INT	130	3.0	Three-phase 200 V	E	S022	00009
MS1H2-30C30CD-A3/A6/S631R-INT	MS1H2-30C30CD-A3/A6/S634R-INT	130	3.0	Three-phase 400 V	D	T012	10004
MS1H2-40C30CB-A3/A6/S631R-INT	MS1H2-40C30CB-A3/A6/S634R-INT	130	4.0	Three-phase 200 V	E	S027	00010
MS1H2-40C30CD-A3/A6/S631R-INT	MS1H2-40C30CD-A3/A6/S634R-INT	130	4.0	Three-phase 400 V		T017	10005
MS1H2-50C30CB-A3/A6/S631R-INT	MS1H2-50C30CB-A3/A6/S634R-INT	130	5.0	Three-phase 200 V		S027	00010
MS1H2-50C30CD-A3/A6/S631R-INT	MS1H2-50C30CD-A3/A6/S634R-INT	130	5.0	Three-phase 400 V		T021	10006
Ratings of MS1H3 (n_N=1500 rpm, n_{max} =4500 rpm) series motors							
MS1H3-85B15CB-A3/A6/S631R-INT	MS1H3-85B15CB-A3/A6/S634R-INT	130	0.85	Single-phase/ Three-phase 200 V	C	S7R6	00006
MS1H3-85B15CD-A3/A6/S631R-INT	MS1H3-85B15CD-A3/A6/S634R-INT	130	0.85	Three-phase 400 V		T3R5	10001

Servo motor				Servo drive SV680-INT series			
Models without brake	Models with Brake	Flange size (mm)	Capacity (kW)	Voltage class (V)	Size	Recommended drive model	Code
MS1H3-13C15CB-A3/A6/ S631R-INT	MS1H3-13C15CB-A3/A6/ S634R-INT	130	1.3	Single-phase/ Three-phase 200 V	D	S012	00007
MS1H3-13C15CD-A3/A6/ S631R-INT	MS1H3-13C15CD-A3/A6/ S634R-INT	130	1.3	Three-phase 400 V	C	T5R4	10002
MS1H3-18C15CB-A3/A6/ S631R-INT	MS1H3-18C15CB-A3/A6/ S634R-INT	130	1.8	Three-phase 200 V	E	S018	00008
MS1H3-18C15CD-A3/A6/ S631R-INT	MS1H3-18C15CD-A3/A6/ S634R-INT	130	1.8	Three-phase 400 V	D	T8R4	10003
MS1H3-29C15CB-A3/A6/ S631R-INT	MS1H3-29C15CB-A3/A6/ S634R-INT	180	2.9	Three-phase 200 V	E	S022	00009
MS1H3-29C15CD-A3/A6/ S631R-INT	MS1H3-29C15CD-A3/A6/ S634R-INT	180	2.9	Three-phase 400 V	D	T012	10004
MS1H3-44C15CB-A3/A6/ S631R-INT	MS1H3-44C15CB-A3/A6/ S634R-INT	180	4.4	Three-phase 200 V	E	S027	00010
MS1H3-44C15CD-A3/A6/ S631R-INT	MS1H3-44C15CD-A3/A6/ S634R-INT	180	4.4	Three-phase 400 V		T017	10005
MS1H3-55C15CD-A3/A6/ S631R-INT	MS1H3-55C15CD-A3/A6/ S634R-INT	180	5.5	Three-phase 400 V	E	T021	10006
MS1H3-75C15CD-A3/A6/ S631R-INT	MS1H3-75C15CD-A3/A6/ S634R-INT	180	7.5	Three-phase 400 V		T026	10007
Ratings of MS1H4 (n_N=3000 rpm, n_{max} =7000 rpm) motors							
MS1H4-10B30CB-A3/A6/ S630Z-INT	MS1H4-10B30CB-A3/A6/ S632Z-INT	40	0.1	Single-phase/ Three-phase 200 V		S1R6	00002
MS1H4-20B30CB-A3/A6/ S631R-INT	MS1H4-20B30CB-A3/A6/ S634R-INT	60	0.2	Single-phase/ Three-phase 200 V	A	S1R6	00002
MS1H4-40B30CB-A3/A6/ S631R-INT	MS1H4-40B30CB-A3/A6/ S634R-INT	60	0.4	Single-phase/ Three-phase 200 V		S2R8	00003
MS1H4-55B30CB-A3/A6/ S631R-INT	-	80	0.55	Single-phase/ Three-phase 200 V		S5R5	00005
MS1H4-75B30CB-A3/A6/ S631R-INT	MS1H4-75B30CB-A3/A6/ S634R-INT	80	0.75	Single-phase/ Three-phase 200 V	C	S5R5	00005
MS1H4-10C30CB-A3/A6/ S631R-INT	MS1H4-10C30CB-A3/A6/ S634R-INT	80	1.0	Single-phase/ Three-phase 200 V	C	S7R6	00006

3 Operating Panel

3.1 Components

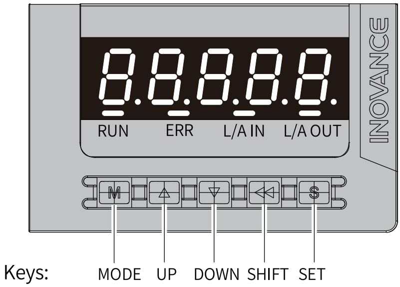


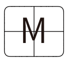
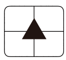
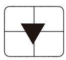
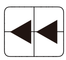
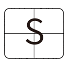
Figure 3-1 Appearance of the keypad

The keypad of the SV680-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	Appearance	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 saving parameter setpoints.

Indicators

Note

The description of Indicators is only available for model N.

OFF

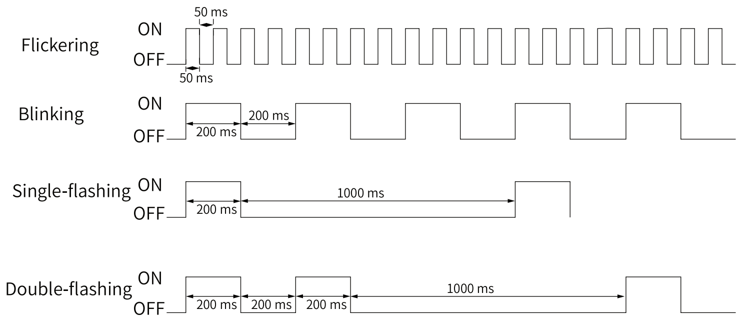


Figure 3-2 Description of indicator status

Table 3–2 Description of indicator status

Indicator	Status	Status indication
RUN	OFF	INIT state
	Flashing (ON for 200 ms/OFF for 200 ms)	Pre-operational
	Single flashing (ON for 200 ms/OFF for 1000 ms)	Safe-operational
	ON	Operational state
ERR	OFF	No network error
	Flashing (ON for 200 ms/OFF for 200 ms)	Communication setting error
	Single flashing (ON for 200 ms/OFF for 1000 ms)	Sync event error
	Double flashing (ON for 200 ms, OFF for 200 ms, ON for 200 ms, and OFF for 1000 ms)	Watchdog timeout

Indicator	Status	Status indication
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 action state of the physical layer of each port.
- The ERR indicator lights up red and the other three indicators light up green.

3.2 Display

The keypad 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. (decimal) YY: Offset within the parameter group (hexadecimal)

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 keypad can be used to display present or previous fault and alarm codes. For analysis and solutions to the faults and alarms, see Chapter "Troubleshooting".
- When a fault or alarm occurs, the keypad displays the corresponding fault or alarm code immediately. When multiple faults or alarms occur, the keypad displays the fault 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 alarms 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

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

Caution

- 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 can result in personal injury.
- Do not install the equipment in environments exposed to water splashes or corrosive gases. Failure to comply can result in equipment fault.
- Do not install the equipment near inflammable gases or combustible objects. Failure to comply can 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 servo drive, the interior surface of the control cabinet, and other machines. Failure to comply can 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 subject the equipment to strong shock. 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 and Handling

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 54*. The deliverables include the product, cushion, carton box, and screw bag, as shown in *"Figure 4–1 " on page 54* .
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	250.0	110.0	200.0	1.28
C	S5R5, S7R6, T3R5, T5R4	235.0	125.0	215.0	1.65
D	S012, T8R4, T012	235.0	150.0	225.0	2.15
E	S018, S022, S027, T017, T021, T026	320.0	170.0	280.0	4.05

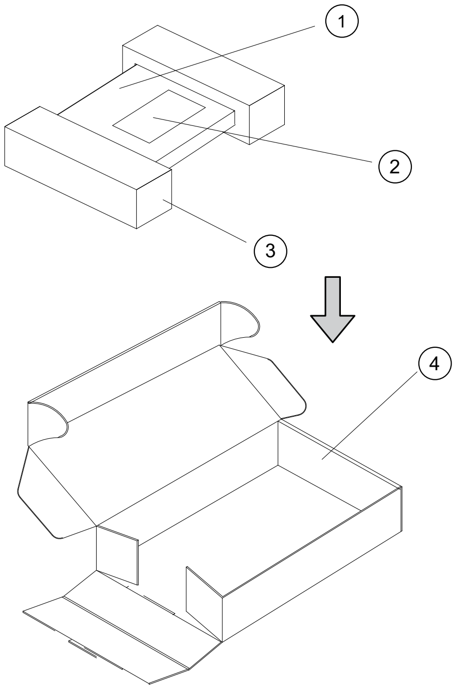


Figure 4-1 Contents inside the packing box

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

Table 4–2 Contents of the terminal accessory kit

Material Code	Name	Quantity
1504CK54	Cable set - Servo drive S6 - C74-DB26 connector kit (RoHS)	1
15210577	Pluggable terminal block - Connector - Spring clamp-type wiring - 9P - Black - With safety lock	1
15210648	Pluggable terminal block - Connector - Spring clamp wiring - 2x2P - Black-printing on both sides	1
15210695	Pluggable terminal block - Connector - Spring clamp-type wiring - 4P - Black	1
15211052	Pluggable terminal block - Connector - Spring clamp wiring-/3.5 mm - 2x3P - Black - 180° - Screen printed - RoHS	1
15220274	Jumper bar - 16A - Pluggable bridge	1
19024735	Labels - Labels for servo drive terminals	1
2120021	Plastic parts - Connector wiring key - For use with servo drive power connector	1
15212326	Pluggable terminal block - Connector - Spring clamp-type wiring -/-3.5 mm - 1x2P - Orange - 180° - RoHS	1
15212114	Pluggable terminal block - Connector - Spring clamp wiring-/-3.5 mm - 2x7P - Black - 180° - Push rod at both sides - RoHS	1
15212115	Pluggable terminal block - Connector - Spring clamp wiring - NA - 3.5 mm - 2x7P - Black - 180°-push rod at both sides - RoHS	1

Note

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

If you need to purchase the terminal accessory kit separately, contact Inovance. For the material code of the accessory kit for each model, see *"Table 4–3 " on page 55*.

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

Material Code	Name
98050843	Accessories (sale) - S6-C158-1- Terminal accessory kit for SV680N drives in size A (functional safety)
98050842	Accessories (sale) - S6-C159-1 - Terminal accessory kit for SV680N drives in size C/D (functional safety)
98050841	Accessories (sale)- S6-C160-1 - Terminal accessory kit for SV680N drives in size E (functional safety)

4.2 Installation Environment

Table 4–4 Environmental requirements

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>Ambient/Storage temperature</td><td>0°C to 55°C/-20°C to +70°C</td></tr>
<tr><td>Ambient/Storage humidity</td><td>Below 90% RH (without condensation)</td></tr>
<tr><td>Vibration</td><td>
<table>
<tr><th>Item</th><th>Test Condition</th></tr>
<tr><td>Test reference</td><td>IEC 60068-2-6 4.6</td></tr>
<tr><td>Condition</td><td>EUT is powered on and works normally.</td></tr>
<tr><td>Motion mode</td><td>Sinusoidal</td></tr>
<tr><td>Vibration amplitude/ Acceleration rate</td><td>-</td></tr>
<tr><td>$10\ \text{Hz} \leqslant f \leqslant 57\ \text{Hz}$</td><td>0.075 mm vibration amplitude</td></tr>
<tr><td>$57\ \text{Hz} < f \leqslant 150\ \text{Hz}$</td><td>1 g</td></tr>
<tr><td>Vibration duration</td><td>10 times on each of the three mutually perpendicular axes</td></tr>
<tr><td>Axis</td><td>X, Y, Z</td></tr>
<tr><td>Installation</td><td>According to the manufacturer's specifications</td></tr>
</table>
</td></tr>
<tr><td>Shock resistance</td><td>
<table>
<tr><th>Item</th><th>Test Condition</th></tr>
<tr><td>Test reference</td><td>IEC 60068-2-27 2008 Table 17</td></tr>
<tr><td>Condition</td><td>EUT is powered on and works normally.</td></tr>
<tr><td>Motion mode</td><td>Half-sine pulse</td></tr>
<tr><td>Shock amplitude/ Time</td><td>50 m/s^2 (5 g) for 30 ms</td></tr>
<tr><td>Number of shocks</td><td>3 per axis on each of three mutually perpendicular axes</td></tr>
<tr><td>Axis</td><td>±X, ±Y, ±Z</td></tr>
<tr><td>Installation</td><td>According to the manufacturer's specifications</td></tr>
</table>
</td></tr>
<tr><td>IP rating/Pollution degree (PD)</td><td>IP20;
PD2: free of corrosive or explosive gases; free of exposure to water, oil or chemicals; free of dust, salts or iron dust</td></tr>
<tr><td>Altitude</td><td>2000 m or below</td></tr>
<tr><td>Cooling method</td><td>Dry clean air (natural convection)</td></tr>
<tr><td>Others</td><td>Free of static electricity, strong electromagnetic fields, magnetic fields, or exposure to radioactivity</td></tr>
</table>

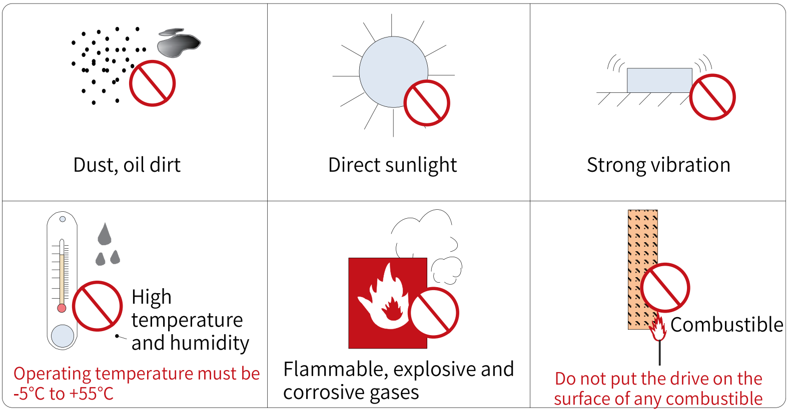


Figure 4-2 Environment requirements

4.3 Installation Clearance

Servo drives in different specifications require different installation clearances. It is recommended to reserve a clearance of at least 20 mm (0.39 in.) at both sides and a clearance of at least 80 mm (3.15 in.) above and below the drive for heat dissipation. Take the installation tolerance into account and reserve a clearance of at least 1 mm (0.04 in.) between every two servo drives.

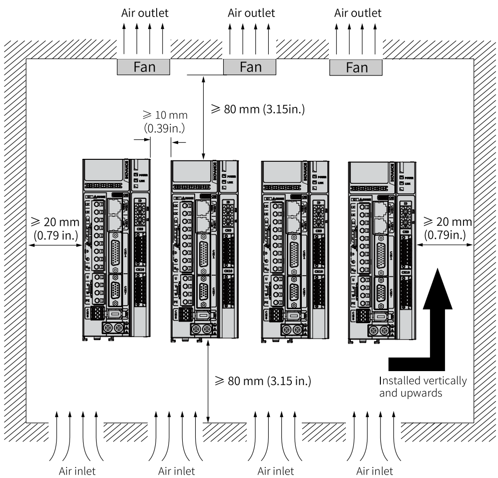


Figure 4-3 Clearance for side-by-side installation

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.

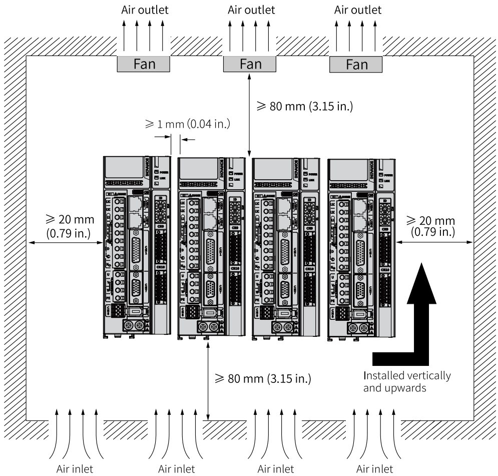


Figure 4-4 Clearance for compact installation

Servo drives in sizes C and D support close installation without derating.

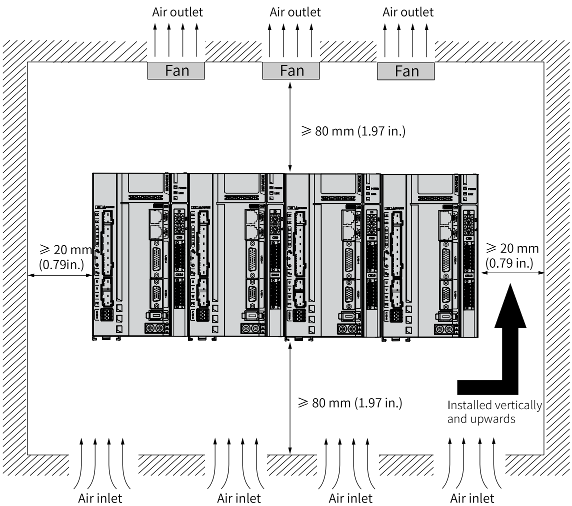


Figure 4-5 Close installation

4.4 Installation Dimensions

Servo Drives in Size A (Rated Power: 0.2 kW to 0.4 kW)

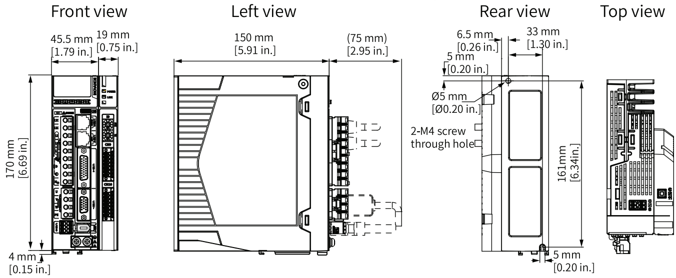


Figure 4-6 Dimension drawing of servo drives in size A

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

Weigh: 1.11 kg

Servo Drives in Size C (Rated Power: 0.75 kW to 1.5 kW)

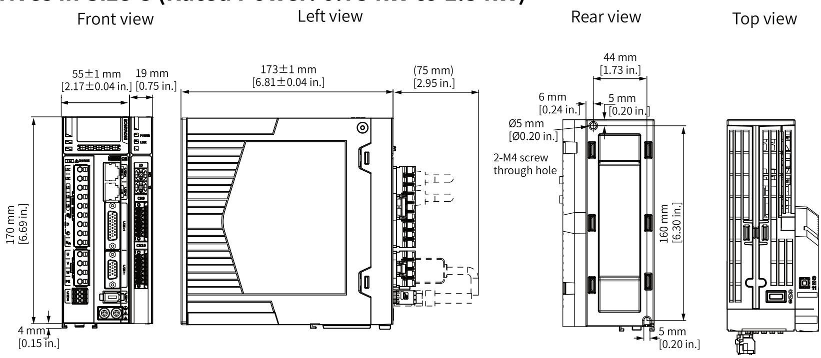


Figure 4-7 Dimension drawing of servo drives in size C

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)

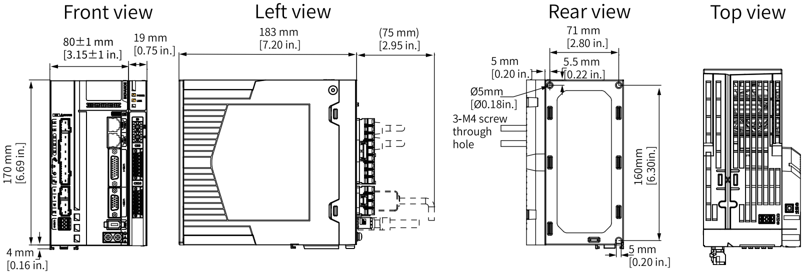


Figure 4-8 Dimension drawing of servo drives in size D

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)

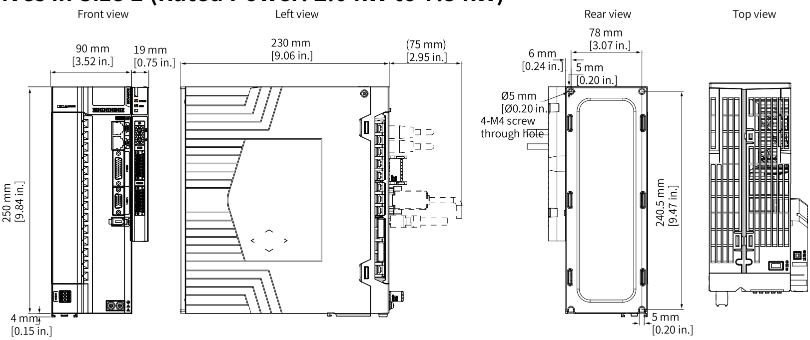


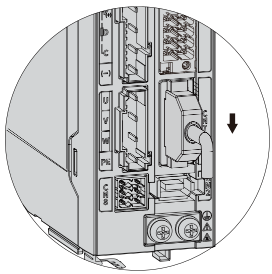
Figure 4-9 Dimension drawing of servo drives in size E

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
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	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.
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 in the direction of the arrow

5 Wiring

5.1 Wiring Precautions

Warning

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

- 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 electric shock.
- Connect an electromagnetic contactor between the input power supply and the main circuit power supply (R/S/T) of the drive to form a structure which allows independent power cutoff on the servo drive power supply 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.
- Route the main circuit cable away from the motor body to prevent the cable insulation from being damaged by an overheated motor. Failure to comply may result in personal injury or a fire.
- Use the ALM (fault) signal to cut off the main circuit power supply. A faulty braking transistor may overheat the regenerative 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 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 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 alarm or overtravel.
  - Ensure the positive/negative polarity of the 24 V power supply is correct. Otherwise, the load 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 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 care to prevent the 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 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.
  - Route the main circuit cable away from the motor body to prevent the cable insulation from being damaged by an overheated motor. Failure to comply may result in personal injury or a fire.
- Connect the 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 the cables or pull cables with excessive force. Failure to comply may result in cable damage, leading to electric shock.
- When connecting DO terminals to relays, ensure the polarity of the flywheel diode is correct. Wrong polarity can 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 10m respectively.
- Use a power supply filter to reduce the electromagnetic interference suffered by electronic devices surrounding the drive.

- Take proper shielding measures in the following locations to prevent equipment damage:
  - Locations that generate interference due to static electricity
  - Locations that generate strong electric field or magnetic field
  - Locations that may generate radioactive rays

5.2 Terminal Pin Layout of the Drive

This section only describes function terminals of the safety module.

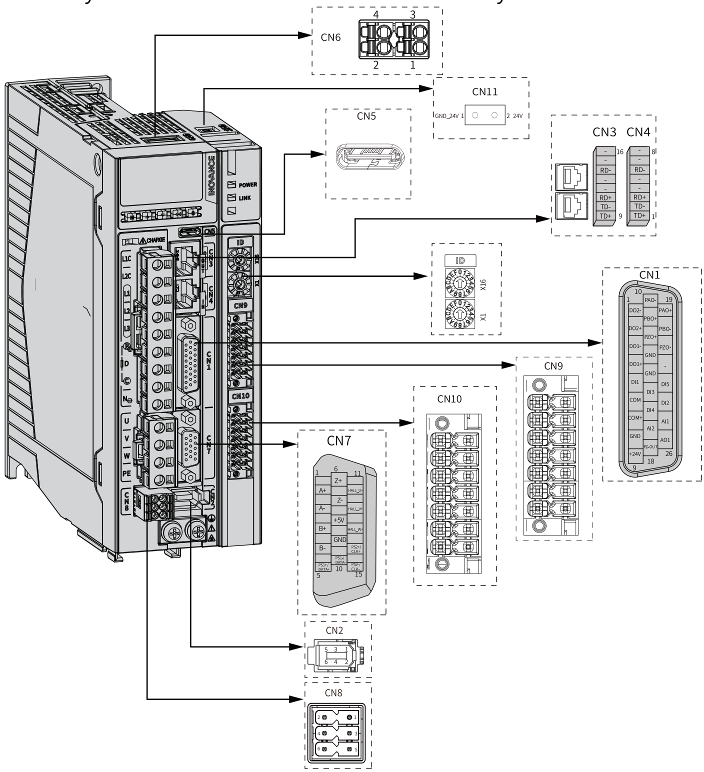


Figure 5-1 Terminal pin layout of the servo drive

Note

For descriptions of main circuit terminals, CN1, CN2, CN3 & CN4, CN5, CN6, CN7 and CN8, see section Wiring Terminals in the Hardware Guide. This manual describes only the components of the safety module: CN9, CN10, CN11 and FSoE ID address configuration knob.

5.3 FSoE Connection and Effective Mode

5.3.1 FSoE Network Connection and Setting

The hardware connection with Beckhoff safety master station is shown in *"Figure 5–2 " on page 65* . Various topologies such as tree and star topologies can be achieved.

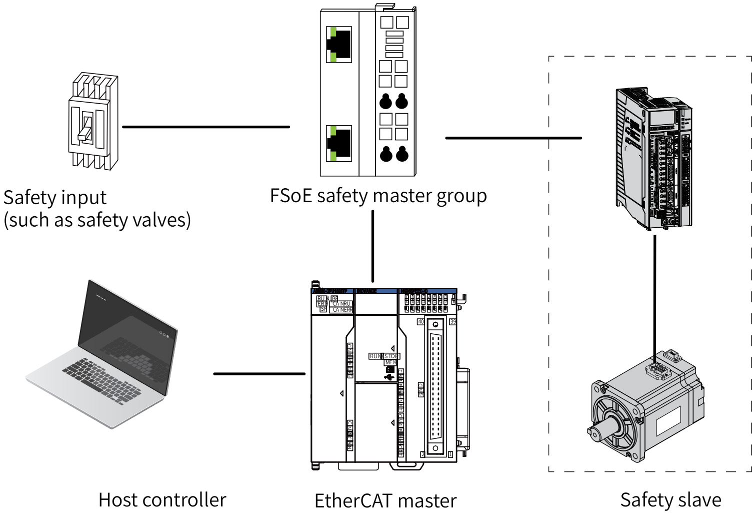


Figure 5-2 System network diagram

Note

Recommended master model: The safety drives can be used together with masters that support EL6900. All Beckhoff PLCs support the safety drives.

5.3.2 Knob Operating Method

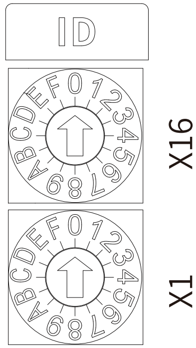


Figure 5-3 Detail view of the knob

Effective mode: Take effect upon next power-on.

Address setting method: The number of the upper knob*16 + the number of the lower knob.

5.4 CN6 STO Safety Terminal

Terminal Layout

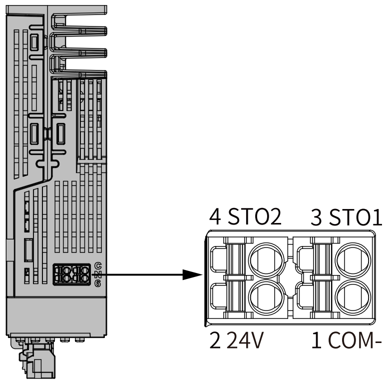


Table 5–1 Pin assignment

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.

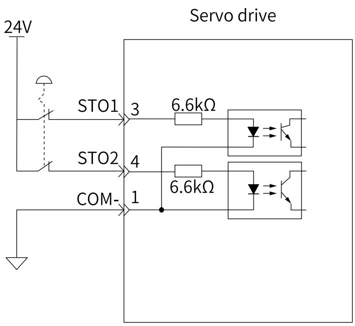
Description

- **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").

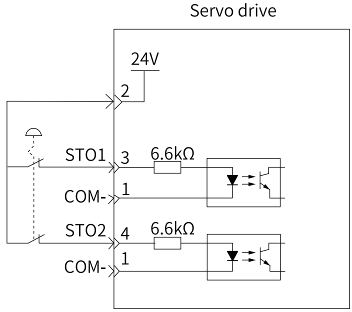
    The servo drive does not operate when the input states of STO1 or STO2 are different or are both "Low" ("0" or "L").
  - Electrical characteristics of Safety Request Input Signal are as follows:

Item	Characteristics	Description
Voltage range	24 VDC (±15%)	-
Input current	3.6 mA (Typ.)	This is the value per channel.
Standards of logic levels	"0" < 5 V, "1" > 15 V	-
Digital input impedance	6.6 kΩ	-

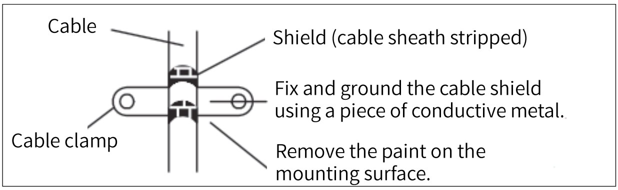
  - External 24 V



  - 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.

Cables	Description
Category	Low voltage, double-shielded or single-shielded twisted multi-pair cable
Maximum size	0.8 mm^2(18 AWG)
Minimum size	0.3 mm^2(28 AWG)
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	Structure	W×H×D (mm^3)
A	0.4 kW	Split-type structure	45.5 x 170 x 150
C	0.75 kW–1.5kW	Split-type structure	55 x 170 x 173
D	1.5 kW–3kW	Split-type structure	80 x 170 x 183
E	2 kW–7.5kW	Split-type structure	90 x 250 x 230

5.5 CN7 Encoder Terminal

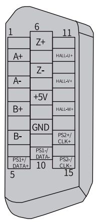
5.5.1 Terminal Layout

Note

- First encoder: Indicates the master encoder.
- Second encoder: Indicates the slave encoder when the fully closed loop function is used.

Terminal Layout

CN7



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-	1. PS- signal of the first encoder; 2. DATA- signal of the communication-type encoder; 3. 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+	1. PS+ signal of the first encoder; 2. DATA+ signal of the communication-type encoder; 3. Gantry synchronization signal	13	HALL_W+	Hall signal W
6	Z+	Encoder pulse phase Z±	14	PS2+/CLK+	1. PS± signal of the second encoder; 2. CLK± signal of the communication-type encoder
7	Z-		15	PS2-/CLK-	
8	+5 V	Encoder 5 V power supply (load current lower than 200 mA)	Enclosure	PE	Shield

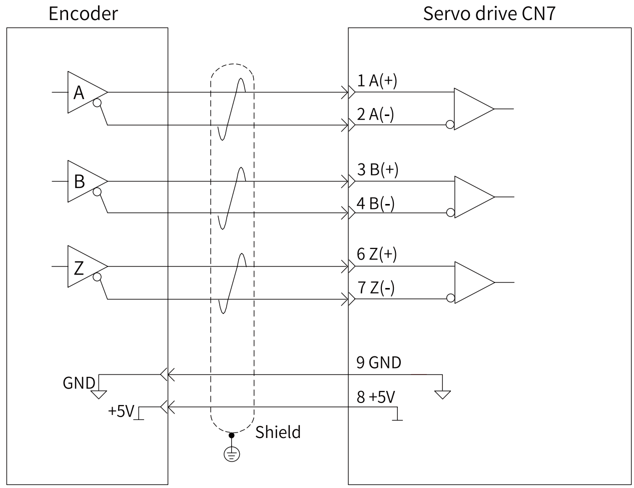
5.5.2 Wiring Examples

5.5.2.1 Communication with the First Encoder

Set H32.01 to 1 for an Inovance rotary motor or 0 for a direct drive motor or third-party motor.

Wiring of a pulse encoder

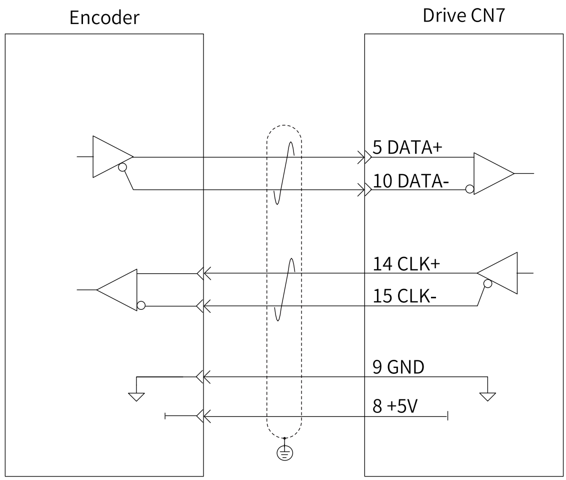
Use shielded twisted pairs to match the high input frequency.



- 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 linear encoder is 4 Mbps.
- The pulse input terminal of a phase A/B encoder supports open circuit detection.

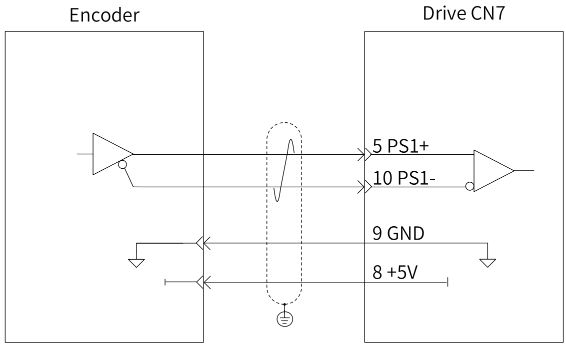
Wiring of Endat2.2/SSI/BISS-C encoder (first encoder)

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



Wiring of Inovance/TAMAGAWA/Nikon encoder (first encoder)

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

Suppose the current consumed by the motor encoder is higher than 200 mA,

you can select the cable based on the following formula.

$$L2=\frac{\triangle U_{max2}}{I_{encoder} x 2R_{unit}}$$

Where, △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.

5.5.2.2 Communication with the Second Encoder

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

Wiring of a pulse encoder

For details, see " *Wiring of a pulse encoder" on page 70*.

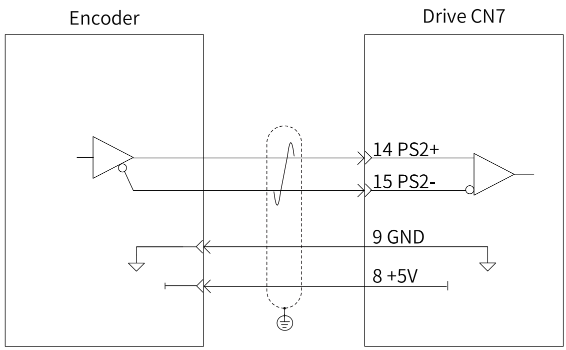
Wiring of Endat2.2/SSI/BISS-C encoder (second encoder)

The drive communicates with the first encoder normally, that is, the first encoder exists all the time. In the case of the 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 encoder (first encoder)" on page 71*.

Wiring of Inovance/TAMAGAWA/Nikon encoder (second encoder)

The drive communicates with the first encoder normally, that is, the first encoder exists all the time. In the case of the 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	Ω/km	Allowable Length (m)
26AWG (0.13 mm^2)	143	8.0
25 AWG (0.15 mm^2)	89.4	14.0
24 AWG (0.21 mm^2)	79.6	15.0
23 AWG (0.26 mm^2)	68.5	18.0
22 AWG (0.32 mm^2)	54.3	23.0
21 AWG (0.41 mm^2)	42.7	29.0

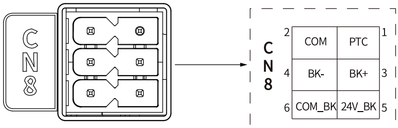
Suppose the current consumed by the motor encoder is higher than 200 mA, you can select the cable based on the following formula.

$$L2=\frac{\triangle U_{max2}}{I_{encoder}x2R_{unit}}$$

Where, $\triangle U$ 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.

5.6 Description of Brake and PTC Input Terminal (CN8)

5.6.1 Terminal Layout



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

5.6.2 Wiring Examples

5.6.2.1 PTC Wiring Example

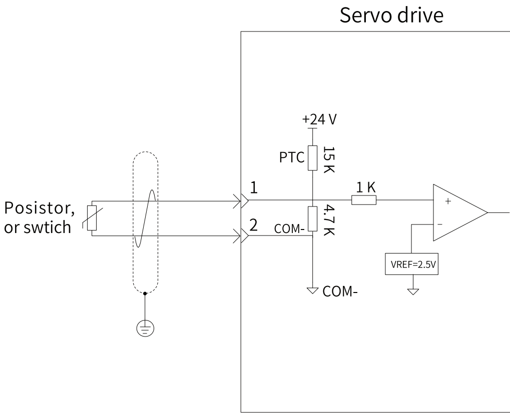


Figure 5-4 PTC wiring diagram

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.

5.6.2.2 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.

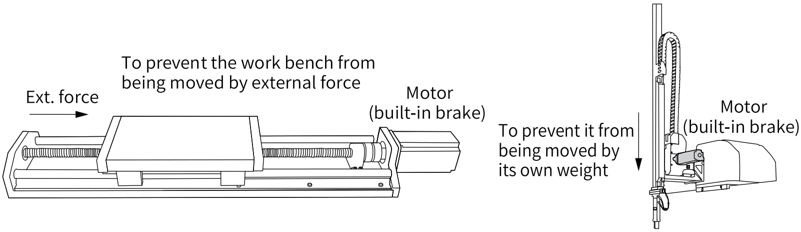
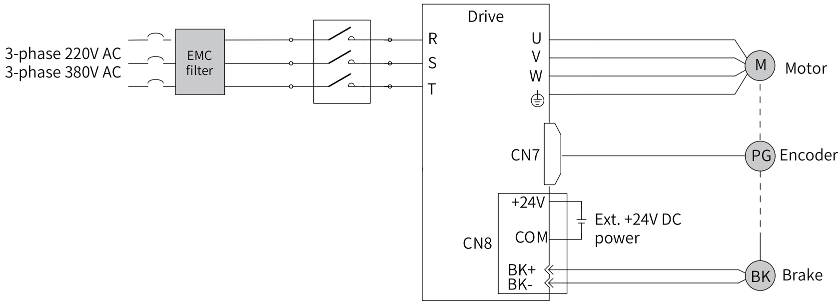


Figure 5-5 Application of the brake

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. Pay special attention when using magnetic sensors around the motor.

The connection of brake input signals is polarity-insensitive. Users need to prepare a 24 V 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 at least 21.6 V 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" on page 56*.
- 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.

5.7 Expansion Safety Function Terminals CN9 and CN10

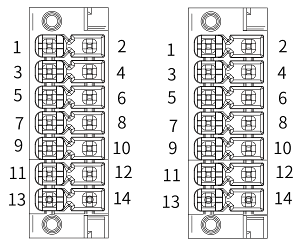


Figure 5-6 Assignment of CN9 and CN10 pins

Table 5–4 Assignment of CN9 pins

No.	Assignment	Function	No.	Assignment	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 input 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 terminal	14	-	-

Table 5–5 Assignment of CN10 pins

No.	Assignment	Function	No.	Assignment	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 input 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 terminal	14	-	-

Basic DI information

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

Basic DO information

Item	Description
Four dual-channel digital outputs	Maximum output current: 50 mA per channel Voltage: 24 VDC±15% (must be powered by SELV/PELV power supply)
Two common DO outputs	Maximum output current: DC 50 mA Maximum allowable external voltage: 30 VDC
Safety state	OFF
DO open/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.

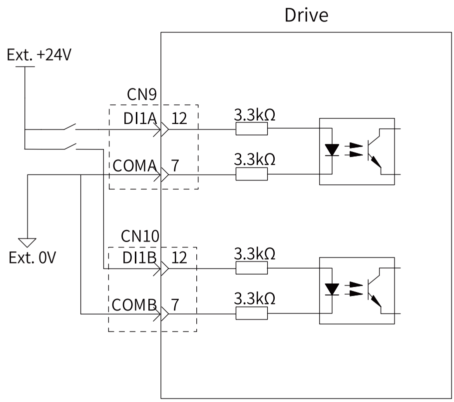
Wiring Precautions

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

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

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.

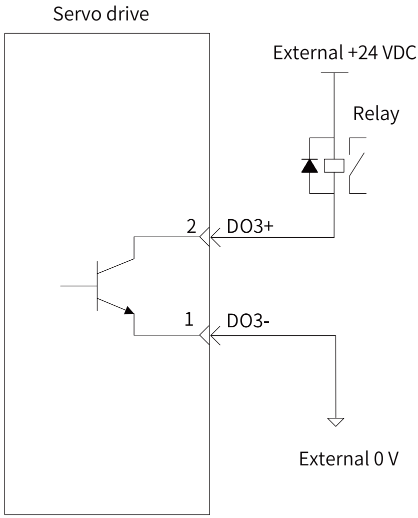


The safety DI is a sink-type input. Perform wiring according to the characteristics of the load circuit.

Common digital output

DO3 to DO6 circuits are the same. The following takes DO3 circuit as an example.

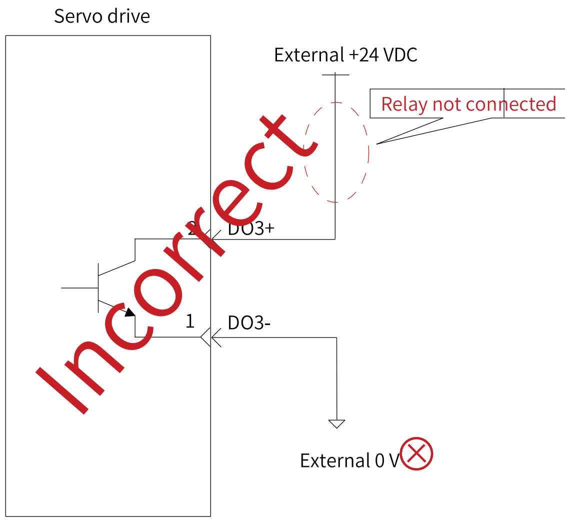
- **When the host controller provides relay input:**
  - **Correct wiring:**

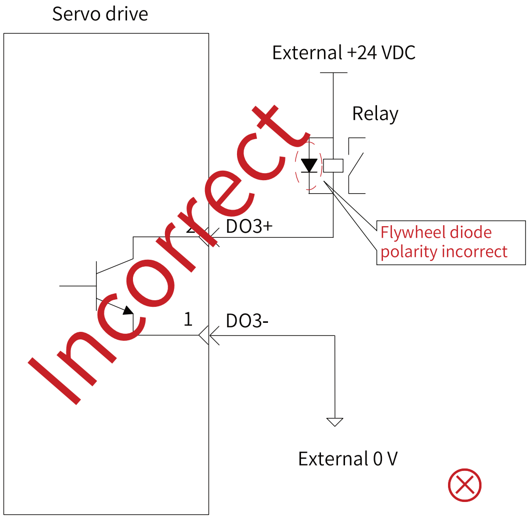


Note

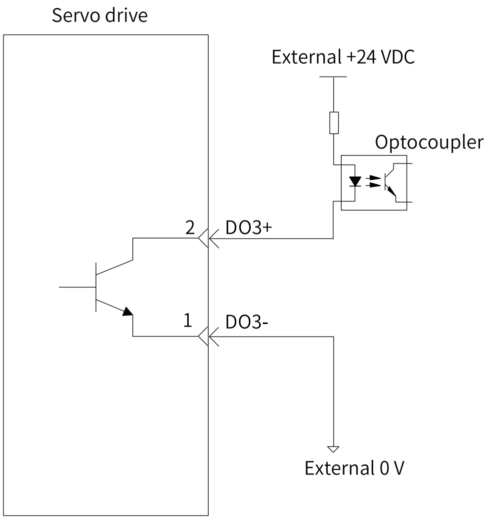
When the host controller provides relay input, a flywheel diode must be installed; otherwise, the DO terminals may be damaged.

- **Incorrect wiring:**

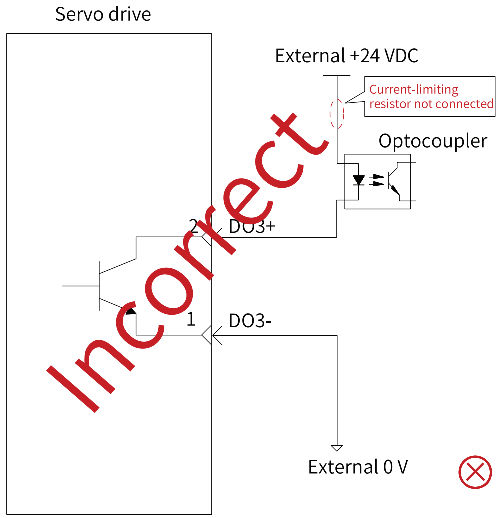




- **When the host controller adopts optocoupler input:**
  - **Correct wiring:**



  - **Incorrect wiring:**

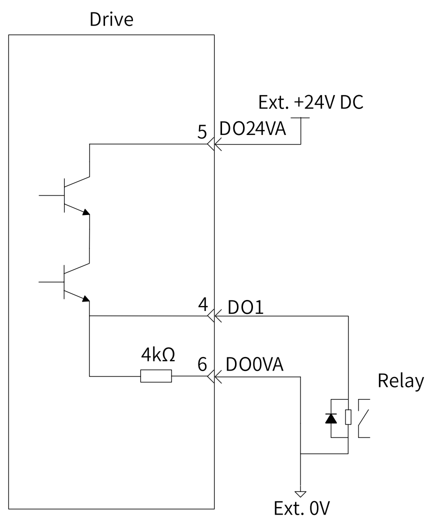


Safety digital output

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 source-type output. Perform wiring according to the characteristics of the load circuit.

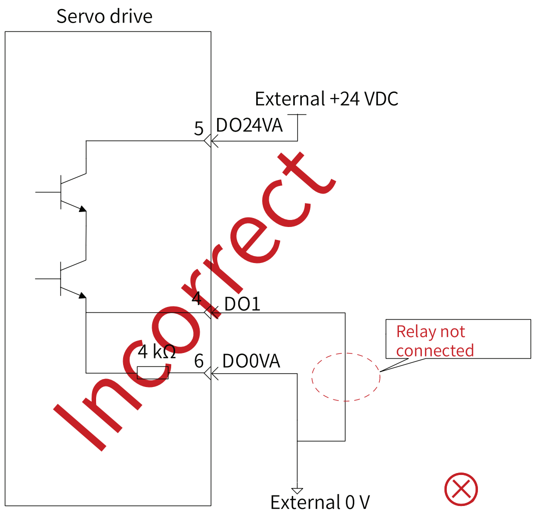
- When the host controller provides relay input:
  - **Correct wiring:**

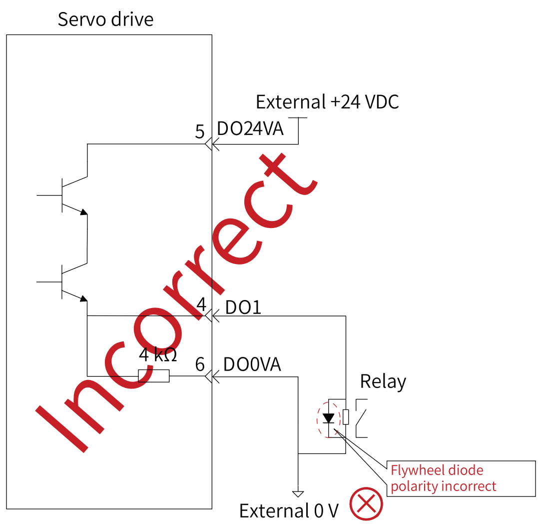


Note

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

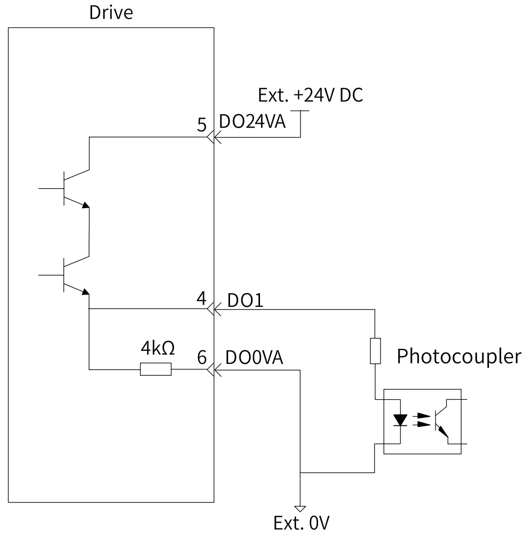
- **Incorrect wiring:**



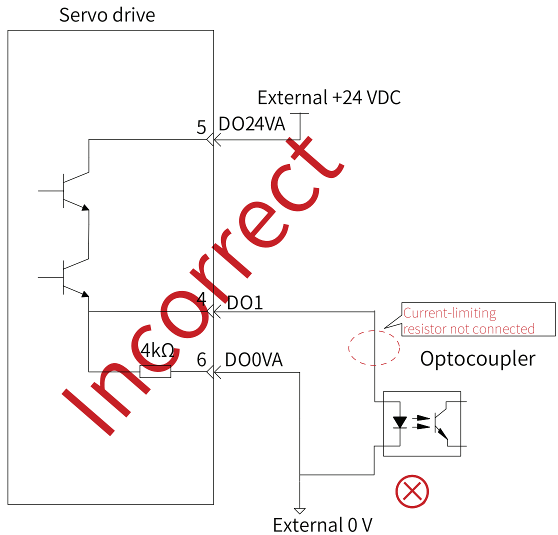


- **When the host controller adopts optocoupler input:**

- **Correct wiring:**



- **Incorrect wiring:**

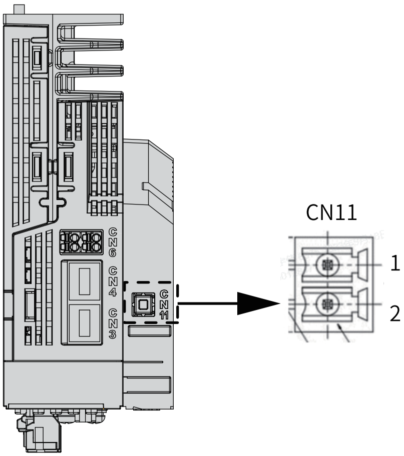


5.8 24 V Terminal (CN11)

Note

CN11 24 V backup power input terminal: It is only available in functional safety and backup power-enabled products.

Terminal Layout



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

Description

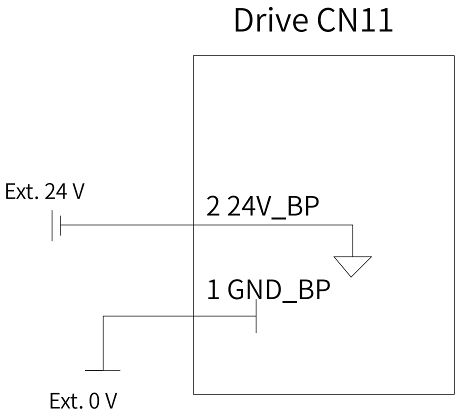
Models with backup power can have separate power supply to the control circuit. When the main circuit is not energized, 24V_BP supplies power to the control circuit to maintain functions like programming, parameter configuration in the software tool, and communication. The keypad of the drive shows "NRD.1"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

Table 5–6 Power input specifications

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

Wiring

The wiring mode is shown in the following figure.



6 Expansion Safety Function

6.1 General

The combination of the safety module, SV680N-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.

You can choose to trigger the safety functions either locally or through FSoE by setting parameter H20.01. The FSoE mode is only applicable to the SV680N-INT servo drive. For a pulse servo drive, you must choose the local mode.

Related parameters:

Parameter	Comm. Add.	Name	Value	Default	Unit	Change Mode	Page
H20.01	2020-02h	Safety function trigger selection	0: Local trigger 1: FSoE trigger	0	-	At stop	" H20_en.01" on page 223

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.

When you choose to trigger the safety functions through FSoE, you need to configure the PDO mapping. The RPDO transfers data from the master to the slave. You can control the triggering of a safety function by setting the bit in RPDO corresponding to the safety function. The TPDO feeds back data from the slave to the master. The safety module feeds back the current safety function state to the host controller through TPDO.

Note

- When the safety functions are configured to be locally triggered, the TPDO does not update;
- When the safety functions are triggered through FSoE, you cannot use local DIs and DOs.

Priority of safety functions

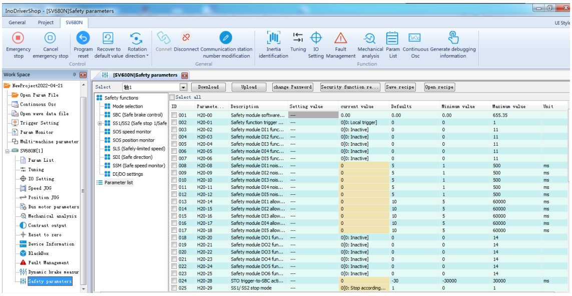
When several safety functions are activated simultaneously, the following priority applies:

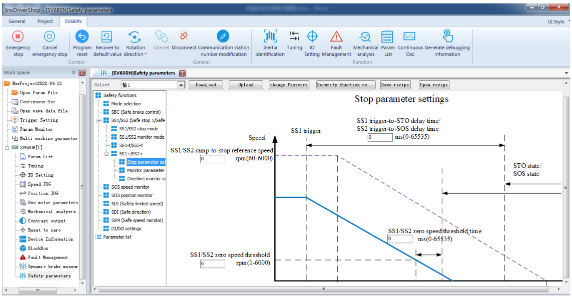
- STO has priority over SS1 and SS2.
- SLS/SDI/SSM are independent of each other.

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.

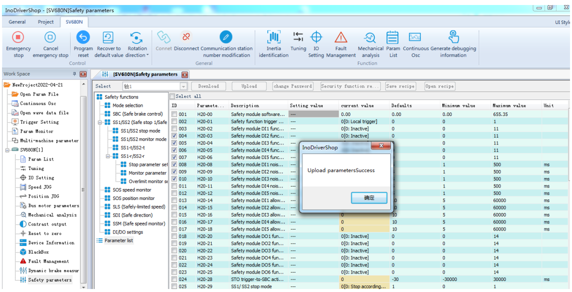
6.2 Software Parameter Configuration

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.



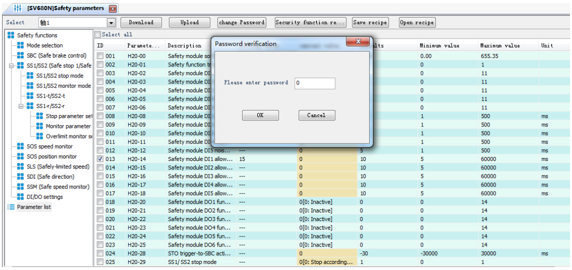


1. On the parameter list, select a parameter you want to configure and then click "Upload" to read the value of the selected parameter.

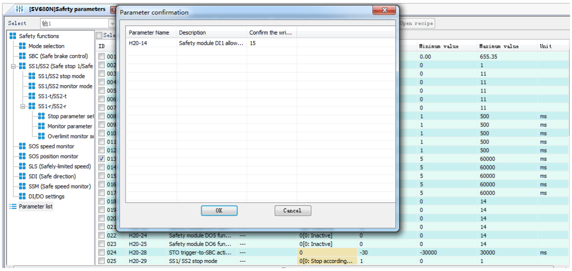


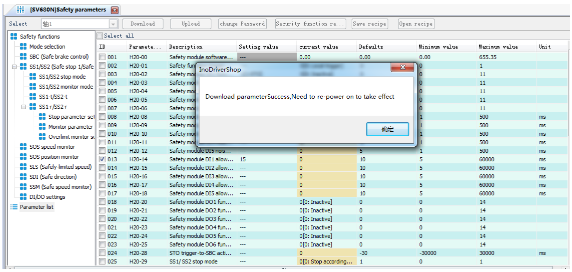
Any changes to any safety parameters take effect only at next power-on.

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).

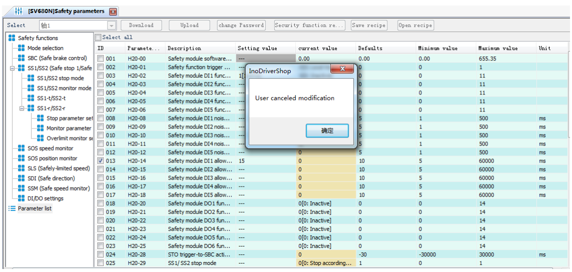


3. A confirmation dialog pops up. Make sure the value entered is correct and click "OK". The value is written into the safety module.

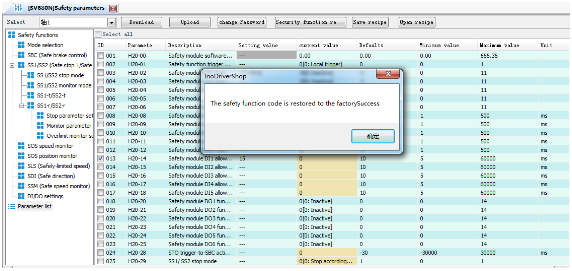




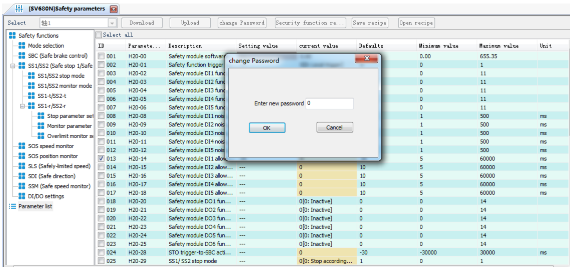
4. If you click "Cancel", or fail to click "OK" within 10 seconds, the tool prompts that the modification is canceled. The value will not be written into the safety module.



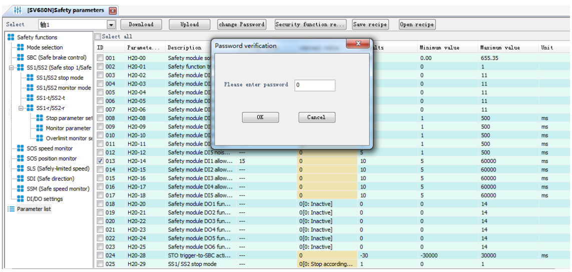
5. To reset the safety parameters, click "Security function restore factory".



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 H20.02.
11	DI2A	11	DI2B	You can configure the logic function of DI2 by setting H20.03.
10	DI3A	10	DI3B	You can configure the logic function of DI3 by setting H20.04.
9	DI4A	9	DI4B	You can configure the logic function of DI4 by setting H20.05.
8	DI5A	8	DI5B	You can configure the logic function of DI5 by setting H20.06.

Note

The logic 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. The safety module performs the corresponding safety function only when the DI input signal is 0 (OFF) and lasts for a period of time exceeding the DI noise reduction filter time.

Table 6–2 Noise reduction filter time of DI1 to DI5

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

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

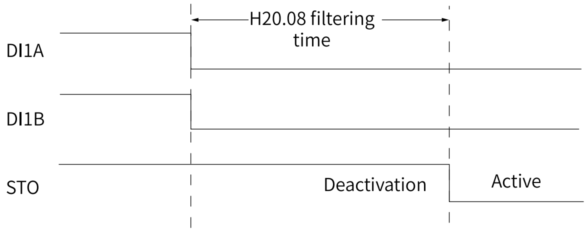


Figure 6-1 Diagram of DI1 noise reduction filter time H20.08

Note

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

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

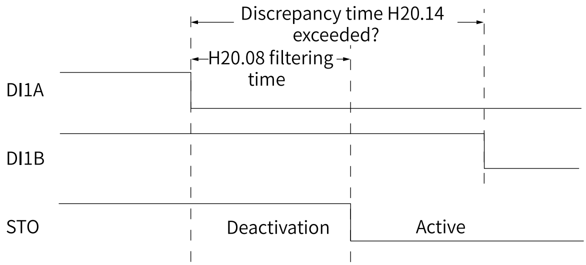


Figure 6-2 Checking for discrepancy at input signals of DI1

6.3.2 Safety DO Function

DO Function Selection

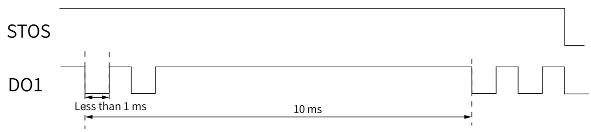
The safety module has six DO terminals, which are all set to 0 (Disabled) by default. DO3 and DO6 are non-safe DO circuits and cannot be used to configure SSM. You can assign each DI with a logic function using the software tool.

Terminal	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.

6.4 FSoE Function

6.4.1 Overview

The EtherCAT safety technology was developed according to IEC 61508, is approved by TÜV Süd Rail, and is standardized in IEC 61784-3. The protocol is suitable for safety applications with a safety integrity level up to SIL 3. FSoE data communication is performed in a question-and-answer manner. All data exchanges are initiated by the safety master, and additional data are incorporated to ensure integrity. During each safety cycle, the safety connection between the FSoE master and the FSoE slave is fully monitored. The security check, connection ID and watchdog time of every FSoE frame transmission will be checked.

The SV680N-INT servo drive with FSoE functional safety consists of a drive control part (main unit) and an extended part (functional safety module). The FSoE master communicates with the FSoE slave through the EtherCAT bus. The internal safety data of the FSoE slave is exchanged through a black channel. After the FSoE data embedded in the EtherCAT process data reaches the main unit of the servo drive, it is transmitted to the functional safety module through internal communication.

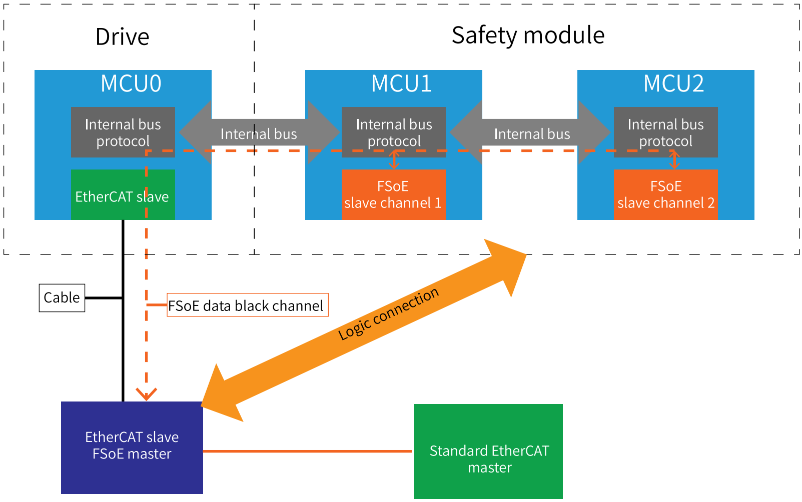


Figure 6-3 FSoE data transmission

6.4.2 Fixed Safety PDO Setting

- **PDO mapping for FSoE reception (170Ah)**

Index	Sub-index	Length (bit)	Name	Data type
E700h	1	8	FSoE master command	USINT
6640h	0	1	STO	BOOL
6650h	0	1	SS1 command	BOOL
6670h	0	1	SS2 command	BOOL
6668h	0	1	SOS1 command	BOOL
0000h	0	1	Reserved	BOOL
66D0h	0	1	SDIp command	BOOL
66D1h	0	1	SDIn command	BOOL
6632h	0	1	Error response	BOOL
6630h	0	1	Reset response	BOOL
6660h	0	1	SBC command	BOOL
6690h	1	1	SLS1 command	BOOL
6690h	2	1	SLS2 command	BOOL
6690h	3	1	SLS3 command	BOOL
6690h	4	1	SLS4 command	BOOL
0000h	0	1	Reserved	BOOL
0000h	0	1	Reserved	BOOL

Index	Sub-index	Length (bit)	Name	Data type
E700h	3	16	FFSoE master CRC_0	UINT
E700h	2	16	FSoE master connection ID	UINT

- **PDO mapping for FSoE transmission (1B0Ah)**

Index	Sub-index	Length (bit)	Name	Data type
E600h	1	8	FSoE slave command	USINT
6640h	0	1	STO activation	BOOL
66E0h	0	1	SSM state	BOOL
0000h	0	1	Reserved	BOOL
6668h	0	1	STO activation	BOOL
0000h	0	1	Reserved	BOOL
66D0h	0	1	SDIp activation	BOOL
66D1h	0	1	SDIn activation	BOOL
6632h	0	1	Error	BOOL
6630h	0	1	Reset	BOOL
6660h	0	1	SBC activation	BOOL
6690h	1	1	SLS1 command activation	BOOL
6690h	2	1	SLS2 command activation	BOOL
6690h	3	1	SLS3 command activation	BOOL
6690h	4	1	SLS4 command activation	BOOL
0000h	0	1	Reserved	BOOL
E601h	1	1	Safety connection state	BOOL
E600h	3	16	FFSoE slave CRC_0	UINT
E600h	2	16	FSoE slave connection ID	UINT

6.5 Safe Torque Off Function

6.5.1 Overview

For the STO function integrated in the drive, see the corresponding function guide and hardware guide. 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.

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

6.5.2 STO Triggered By Local Mode

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

Set H20.01 to 0: The safety function is triggered by the local DI, which means the safety function cannot be triggered through EtherCAT communication.

Table 6–4 Description of function No.

Code	Name	Description	Function
FunIN.1	STO command	STO trigger command	0: STO active 1: STO canceled
FunIN.11	ACK command	ACK trigger command	0: ACK canceled 1: ACK triggered
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 SBC function section for the sequence of STO and SBC.

Note

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

Related parameters:

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.02	2020-03h	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 223*
H20.03	2020-04h	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 224*
H20.04	2020-05h	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 224*
H20.05	2020-06h	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 225*

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.06	2020-07h	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 225*
H20.20	2020-15h	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 229*
H20.21	2020-16h	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 230*

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.22	2020-17h	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 231*
H20.23	2020-18h	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 231*

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.24	2020-19h	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 232*
H20.25	2020-1Ah	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 233*

6.5.3 STO Triggered by FSoE Mode

The safety bus of the safety module currently only supports EtherCAT communication.

To use the STO function through EtherCAT communication, you need to set the network connection, EtherCAT master, and safety CPU unit.

Set the value of parameter H20.01 to "1: FSoE trigger". In this case, the safety functions are no longer triggered by safety input signals.

When 6641h is set to "0", the drive automatically exits the STO state when the STO command is canceled.

When 6641h is set to "1", exiting the STO state not only requires the cancellation of STO command, but also the triggering of the Ack signal.

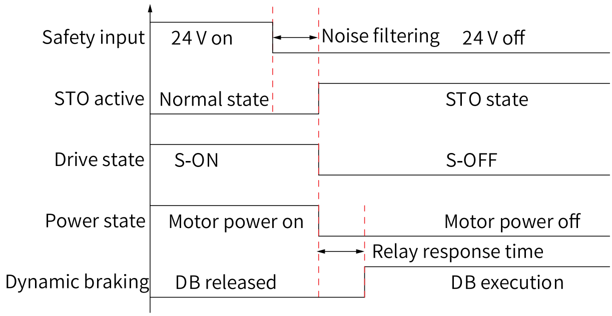
Related parameters:

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6630h	6630h	Restart Ack reset signal	0 to 1	0	-	Real time	" 6630h" on page 248
6640h	6640h	STO signal	0 to 1	0	-	Real time	" 6640h" on page 249
6641h	6641h	STO reset mode	0 to 1	0	-	Real time	" 6641h" on page 249

6.5.4 Sequence Diagrams

Operation sequence to enter safety state

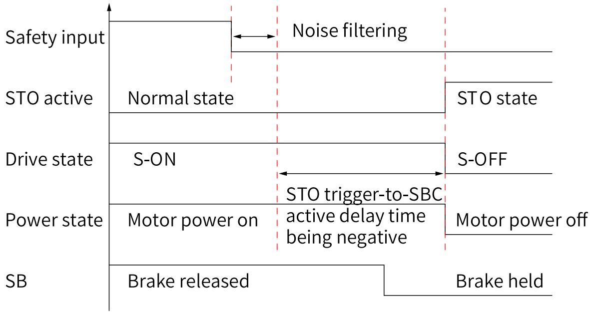
- When SBC is not enabled



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

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

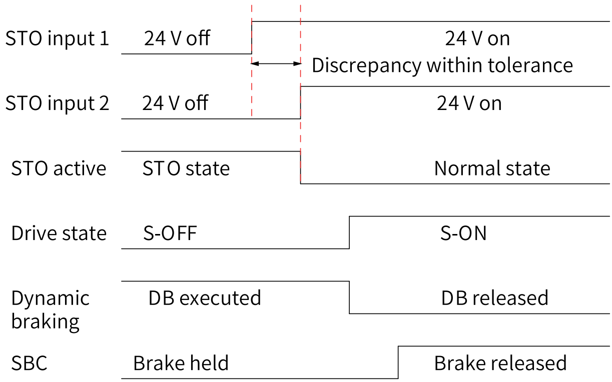
- When SBC is enabled
  When you set H20.28 to a negative value, the sequence of STO operations is shown in the following figure.



When SBC is activated before STO and the STO input command is active, the stop mode defined by H02.05 is executed first. When the delay defined by H20.28 elapses, the stop mode defined by H02.08 is triggered then.

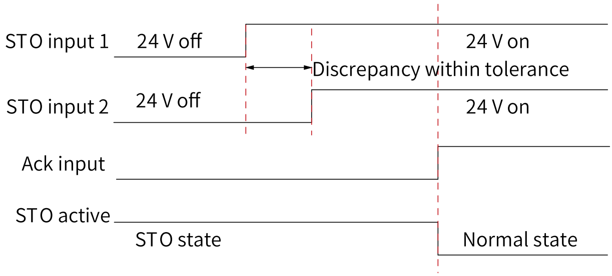
Reset sequence to exit STO safety state

- When 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 recovered. The S-ON operation can only be performed properly after STO state exits normally.

- When 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.

6.6 Safe Brake Control (SBC)

6.6.1 Overview

For SBC function of the SV680N-INT servo drives including a safety module, no external relay is needed to control ON and OFF of 24 V voltage to the brake motor. The BK+ and BK- pins of the brake motor can be connected to Pin3 and Pin4 of the CN8 terminal of the servo drive, respectively, as shown below.

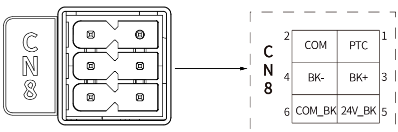


Figure 6-4 Description of CN8 pins

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

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 with SBC function is installed, Pin5 and Pin6 of CN8 need to be connected to an external 24V voltage; otherwise, the servo drive issues an alarm E631.0.

6.6.2 SBC Triggered By Local Mode

When the safety function is triggered by the local mode, "DI: FunIN2 (SBC)" enables the DI to trigger the SBC function, and "DO: FunOUT.2 (SBC active)" enables the DO to output SBC active signal.

Table 6–5 Description of function No.

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

Note

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

Related parameters:

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.03	2020-04h	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 224*
H20.04	2020-05h	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 224*
H20.05	2020-06h	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 225*
H20.06	2020-07h	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 225*

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.20	2020-15h	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 229*
H20.21	2020-16h	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 230*
H20.22	2020-17h	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 231*

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.23	2020-18h	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 231*
H20.24	2020-19h	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 232*
H20.25	2020-1Ah	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 233*

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H02.11	2002-0Ch	Motor speed threshold at brake output OFF in rotation state	20 to 3000	30	rpm	Real time	" H02_en.11" on page 221
H02.12	2002-0Dh	Delay from S-ON OFF to brake output OFF in rotation state	1 to 65535	500	ms	Real time	" H02_en.12" on page 221

6.6.3 SBC Triggered by FSoE Mode

To avoid damage to the motor caused by brake operation during high-speed rotation, the safety module SBC command does not trigger brake action immediately after it is enabled, but executes "Stop at servo-ON OFF" first.

When the motor speed is lower than the SBC zero speed threshold or the SBC delay expires, the safety module triggers the brake operation.

Parameters involved are shown below.

Related parameters:

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H02.11	2002-0Ch	Motor speed threshold at brake output OFF in rotation state	20 to 3000	30	rpm	Real time	" H02_en.11" on page 221
H02.12	2002-0Dh	Delay from S-ON OFF to brake output OFF in rotation state	1 to 65535	500	ms	Real time	" H02_en.12" on page 221
6660h	6660h	SBC signal	0 to 1	0	-	Real time	" 6660h" on page 252

6.6.4 Sequence Diagrams

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

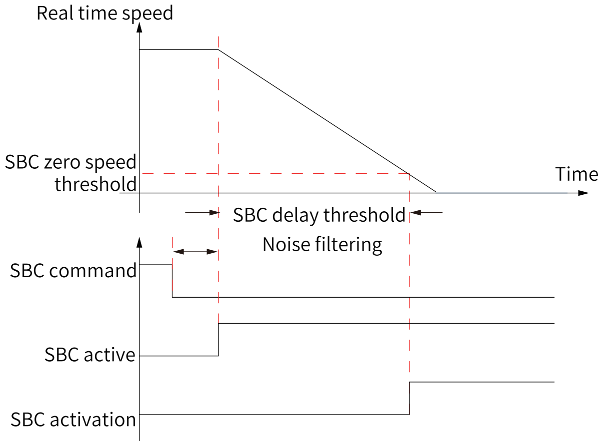


Figure 6-5 Response sequence of SBC execution

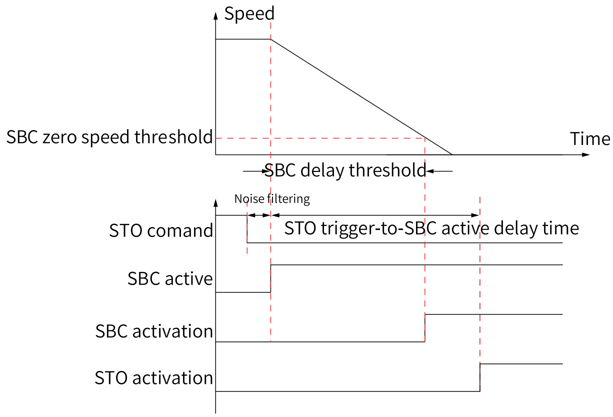
When the SBC command is activated after noise filtering, the "Stop at S-ON OFF" mode is executed. When the SBC zero speed threshold set by H02.11 is reached or the SBC delay threshold set by H02.12 expires, the safety module triggers the motor to brake. In this case, the motor rotor is locked and the 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 based on the application conditions of STO in different situations.

For example, in the vertical axis applications, to ensure that the load does not drop unexpectedly when the STO function is triggered, you can configure the SBC function to be activated before the PWM pulsing signal is blocked.

SBC activated before STO

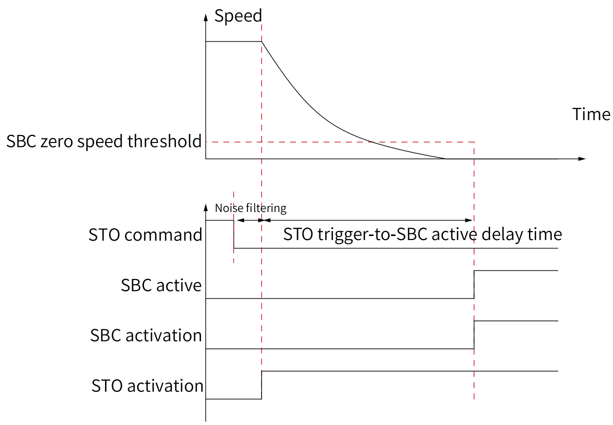


When the delay H20.28 from STO activation to SBC activation is negative, the servo drive performs deceleration after the safety module receives the STO trigger command.

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

The configuration value of H20.28 needs to cover the time required for the motor to decelerate from the maximum speed to 0 rpm, preventing the STO function from being activated before activation of SBC brake.

SBC activated after STO



When the delay 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 is reached.

6.7 Safe Stop 1 (SS1)

6.7.1 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 to stop” and “stop as defined by host controller”, which can be selected through parameter H20.29.

- When you select “ramp to stop”, the drive plans the stop command and stop the motor at the planned speed.
- When you select “stop as defined by host controller”, the host controller plans the stop command.
- When the pulse-type servo drive is used, you can only select “ramp to stop”. In this case, even if you select the “stop as defined by host controller”, the stop mode is forcibly set to “ramp to stop”.

If you choose to trigger safety function by the local mode, you can set H20.02...H20.06 and DI function to 3-SS1 to trigger SS1 through DI. When you choose to trigger safety function by the FSoE mode, you can trigger SS1 by controlling the bits in the RPDO corresponding to the SS1 command.

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

When SS1-t is selected, the drive switches to the STO status regardless of the motor speed after the delay time between triggering of SS1 and application of STO state elapsed. In this case, a safety motor is not required. When the safety motor is used, the drive switches to the STO status when the speed feedback is lower than the zero speed threshold and the duration exceeds the zero speed window time.

When SS1-r is selected, as it contains SS1-t, the drive switches 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 window time. 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 switches to the SS1 stop state and then enters STO sate if the SS1-t status switching condition is met.

6.7.2 SS1 Triggered By Local Mode

SS1 function trigger-related parameters

When the safety function is triggered by the local mode, "DI: FunIN.3 (SS1)" enables the DI to trigger the SS1 function, "DO: FunOUT.3 (SS1 Active)" enables the DO to output SS1 active signal, and "DO: FunOUT.13 (SS1-r active)" enables the DO to output SS1-r monitoring active signal.

Table 6–6 Description of function No.

Code	Name	Description	Function
FunIN.3	SS1 command	SS1 trigger command	0: SS1 active 1: SS1 canceled
FunOUT.3	SS1 Active	SS1-r active	0: SS1 stop state not applied 1: SS1 stop state applied
FunOUT.13	SS1-r Active	SS1-r active	0: SS1-r monitoring state not applied 1: SS1-r monitoring state applied

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 operation 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 of SS1 is triggered and recovered.

Note

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

SS1 stop-related parameters

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

- If you choose "0: Ramp to stop", the servo drive plans stop commands to control the motor to decelerate to stop according to the planned speed ramp.
- If you choose "1: Stop as defined by the host controller", the host controller plans the stop command to control the motor to decelerate to stop.
- When the pulse-type servo drive is used, you can only select "ramp to stop". If you choose "stop as defined by host controller", ramp-to-stop applies forcibly.

Related parameters:

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.29	2020-1Eh	SS1/SS2 stop mode	0: Ramp to stop 1: Stop as defined by host controller	1	-	At stop	" H20_en.29" on page 233

When the stop mode is set to "ramp to stop", set the ramp-to-stop speed through H20.30 and the deceleration time for ramp-to-stop through H20.31. After the time defined by H20.31 elapses, the motor speed decelerates from H20.30 to 0, as shown in the figure.

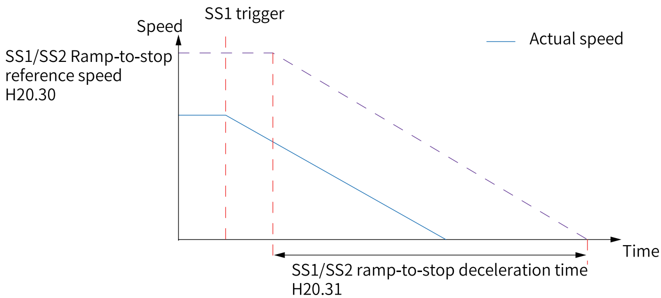


Figure 6-6 Motor speed during ramp-to-stop

Related parameters:

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.30	2020-1Fh	SS1/SS2 ramp-to-stop reference speed	60 to 6000	1000	rpm	At stop	" H20_en.30" on page 234
H20.31	2020-20h	SS1/SS2 ramp-to-stop deceleration time	1 to 65535	500	ms	At stop	" H20_en.31" on page 234

When the safety function is triggered by the local mode, you can set the delay from the moment SS1 is triggered to the moment the drive enters STO state through H20.33, the SS1 zero speed threshold by H20.34, and 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 used together with a safety encoder, the STO state applies in advance when the delay time after SS1 is triggered does not reach the setpoint of H20.33, the motor speed is lower than the setpoint of H20.34, and such state lasts for the time set by H20.35.

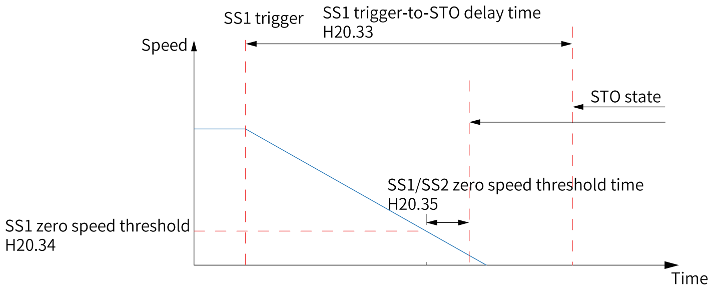


Figure 6-7 Safety function triggered by the local mode, motor speed changing

Related parameters:

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.33	2020-22h	SS1 trigger-to-STO delay/SS2 trigger-to-STO delay	0 to 65535	1000	ms	At stop	*" H20_en.33" on page 235*
H20.34	2020-23h	SS1/SS2 zero speed threshold	1 to 6000	10	rpm	At stop	*" H20_en.34" on page 235*
H20.35	2020-24h	SS1/SS2 zero speed window time	0 to 65535	0	ms	At stop	*" H20_en.35" on page 235*

SS1 function 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:

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.32	2020-21h	SS1 monitoring mode	0:SS1-t 1:SS1-r	0	-	At stop	*" H20_en.32" on page 234*

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

- You can set the delay time (starting from the time when SS1 is triggered) for ramp monitoring to be activated through H20.36. Speed ramp is monitored after the delay time elapsed.
- You can set the ramp monitoring reference speed through H20.37 and the ramp monitoring time through H20.38. 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 limit violation fault is reported.
- You can configure the time from triggering of the ramp limit to issuance of the alarm by H20.41. When the number of consecutive overruns of the deceleration ramp reaches the value of H20.41, a fault will be reported.
- You can configure the speed for stopping the ramp monitoring by H20.42. When the motor speed falls below the value of H20.42, the ramp monitoring is stopped.

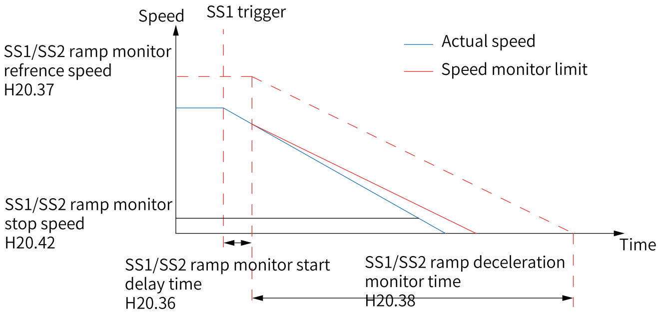


Figure 6-8 Motor speed when safety function is triggered

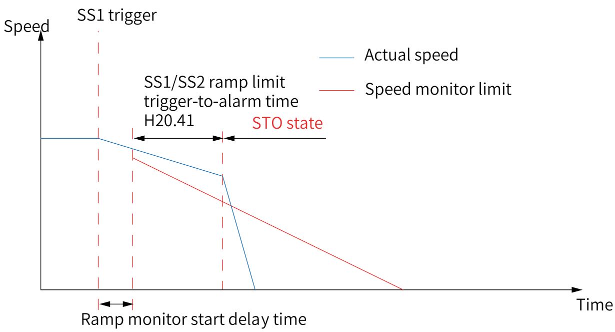


Figure 6-9 Motor speed when ramp limit is triggered

Related parameters:

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.36	2020-25h	SS1/SS2 ramp monitor start delay	5 to 65535	10	ms	At stop	" H20_en.36" on page 236
H20.37	2020-26h	SS1/SS2 ramp monitor reference speed	60 to 6000	1000	rpm	At stop	" H20_en.37" on page 236
H20.38	2020-27h	SS1/SS2 ramp deceleration monitoring time	1 to 65535	65535	ms	At stop	" H20_en.38" on page 236
H20.41	2020-2Ah	SS1/SS2 ramp limit trigger-to-alarm time	0 to 65535	5	ms	At stop	" H20_en.41" on page 237
H20.42	2020-2Bh	SS1/SS2 ramp monitor stop speed	0 to 6000	1	rpm	At stop	" H20_en.42" on page 237

6.7.3 SS1 Triggered By FSoE Mode

SS1 trigger-related parameters

6650h in the RPDO mapping is the object dictionary of SS1 trigger, and 6650h in the TPDO mapping is the object dictionary of SS1 state.

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6650.01h	6650-01h	SS1 signal	0 to 1	0	-	Real time	" 6650_en.01h" on page 250

You can use the object dictionary 6641h to set whether a Restart Ack signal is required when the STO state is reset. In the RPDO mapping, 6630h indicates the Restart Ack signal. If 6641h is set to 1, when SS1 is triggered and then reset, the Restart Ack signal must be written to 1 to recover from the STO state to the normal operation state.

Related parameters:

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6641h	6641h	STO reset mode	0 to 1	0	-	Real time	" 6641h" on page 249

SS1 stop-related parameters

You can configure the stop mode of SS1 by setting H20.29.

When you choose "Ramp to stop", you can configure the ramp-to-stop reference speed by setting H20.30 and the ramp-to-stop deceleration time by setting H20.31.

When you choose to trigger the safety functions through FSoE, you can configure the SS1 trigger-to-STO delay by setting 6651h, the SS1 zero speed threshold by setting 6653h, and the SS1 zero speed window time by setting 6654h.

Related parameters:

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6651.01h	6651-01h	SS1 trigger-to-STO delay	0 to 65535	1000	ms	Real time	" 6651_en.01h" on page 250
6653.01h	6653-01h	SS1 zero speed threshold	1 to 6000	10	rpm	Real time	" 6653_en.01h" on page 250
6654.01h	6654-01h	SS1 zero speed window time	0 to 65535	0	ms	Real time	" 6654_en.01h" on page 251

SS1 monitoring-related parameters

You can configure the SS1 monitoring mode by setting H20.32.

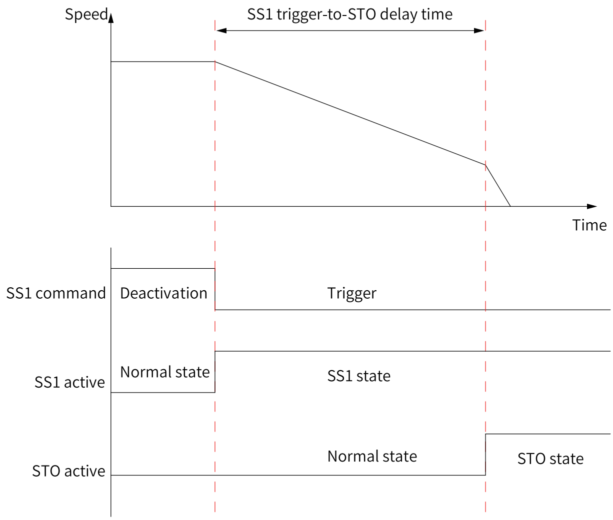
In case of SS1-r monitoring, when you choose to trigger the safety function through FSoE, you can configure the delay for starting the speed ramp monitoring by setting 6657h and the minimum SS1 deceleration limit by setting 6656h. You can configure the time from triggering the ramp limit to generating the alarm through H20.41, and the speed for stopping the ramp monitoring through H20.42.

Related parameters:

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6656.01 h	6656-01h	SS1 deceleration limit	0 to 4294967295	15	Encoder unit/ s^2	Real time	" 6656_en.01h" on page 251
6657.01 h	6657-01h	SS1 ramp monitor start delay	0 to 65535	10	ms	Real time	" 6657_en.01h" on page 251

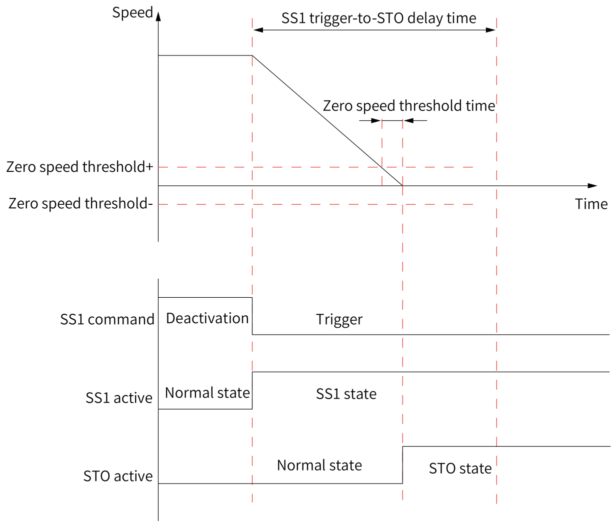
6.7.4 Sequence Diagrams

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



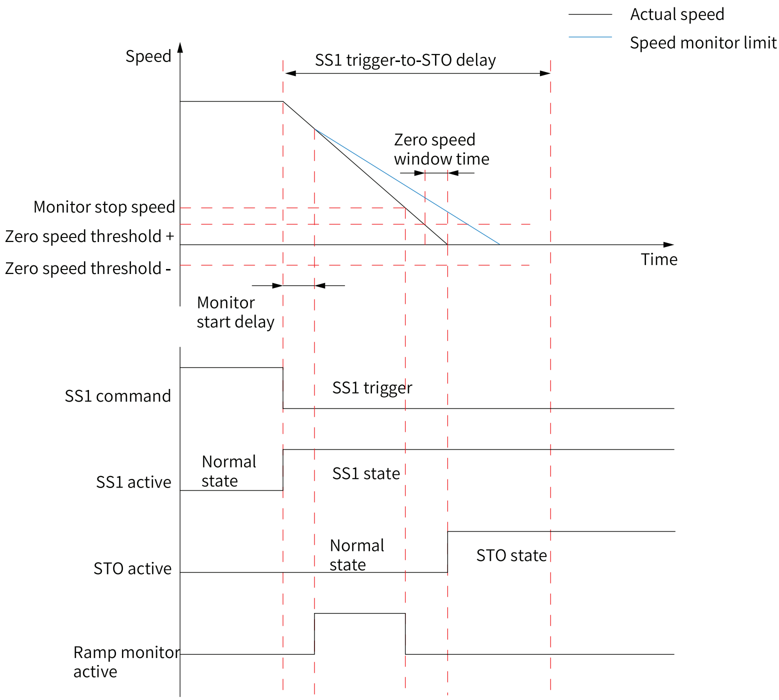
After SS1 is triggered, the SS1 command is canceled during the stop process of SS1. The drive continues to execute the stop process until the stop process is done.

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

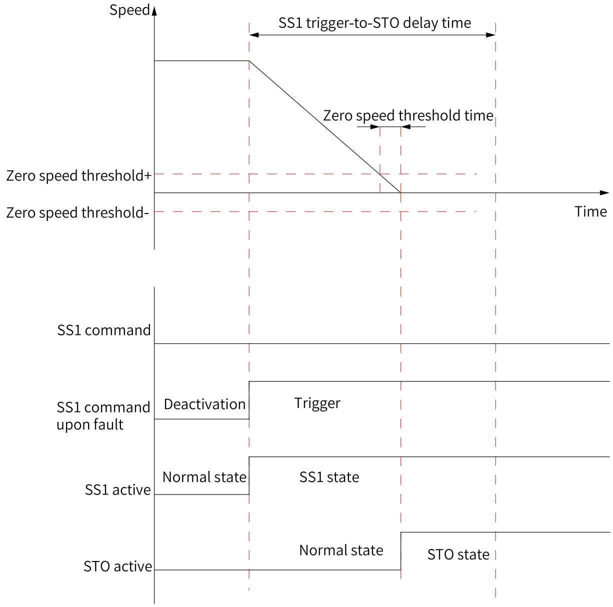


If the SS1 command is canceled after SS1 has been triggered, the SS1 stop state still remains until the delay time has elapsed or the zero speed conditions are met.

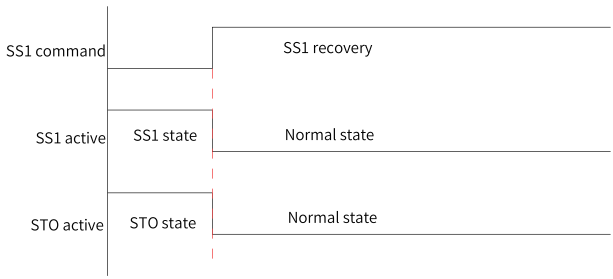
Starting SS1 speed ramp monitoring



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



SS1 recovery



6.8 Safe Stop 2 (SS2)

6.8.1 Overview

SS2 is used to activate the motor to decelerate to stop. It triggers SOS after a certain delay or the speed is lower than a certain threshold. The SS2 stop mode includes “ramp to stop” and “stop as defined by host controller”, which can be selected through H20.29. When you select “ramp to stop”, the drive plans the stop command and stop the motor at the planned speed. When you select “stop as defined by host controller", the host controller plans the stop commands. When the pulse-type servo drive is used, you can only select "ramp to stop", in this case, when you select "stop as defined by host controller", the stop mode is forcibly set to "ramp to stop". The SS2 function requires a safety encoder.

If you choose to trigger safety function by the local mode, you can set H20.02...H20.06 and DI function to 4-SS2 to trigger SS2 through DI. When you choose to trigger safety function by the FSoE mode, you can trigger SS2 by controlling the bits in the RPDO corresponding to the SS2 command.

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

When SS2-t is selected, the drive switches to SOS status after the delay time between triggering of SS2 and activation of the SOS state or when the speed feedback is lower than the zero speed threshold and the duration exceeds the zero speed window time.

When SS2-r is selected, as it contains SS2-t, the drive switches 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 window time. 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.

6.8.2 SS2 Triggered in Local Mode

SS2 function trigger-related parameters

The "DI: FunIN.4 (SS2)" enables the DI to trigger the SS2 function, "DO: FunOUT.4 (SS2 Active)" enables the DO to output SS2 active signal, and "DO: FunOUT.14 (SS2-r Active)" enables the DO to output SS2-r monitor active signal.

Table 6–7 Description of function No.

Code	Name	Function	Description
FunIN.4	SS2 command	SS2 trigger command	0: SS2 active 1: SS2 canceled
FunOUT.4	SS2 Active	SS2 activated	0: SS2 stop state not applied 1: SS2 stop state applied
FunOUT.14	SS2-r Active	SS2-r activated	0: SS2-r monitoring state not applied 1: SS2-r monitoring state applied

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 STO state to normal operation 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 of SS2 is triggered and recovered.

Note

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

SS2 stop-related parameters

You can configure the stop mode by setting H20.29. If you choose "0: Ramp to stop", the servo drive generates stop commands to control the motor to decelerate to stop according to the designated speed. If you choose "1: Stop as defined by the host controller", the host controller generates the stop command to control the motor to decelerate to stop. When the pulse-type servo drive is used, you can only select "ramp-to-stop". If you choose "1: Stop as defined by the host controller", ramp-to-stop applies forcibly.

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.29	2020-1Eh	SS1/SS2 stop mode	0: Ramp to stop 1: Stop as defined by host controller	1	-	At stop	*" H20_en.29" on page 233*

When the stop mode is set to "ramp-to-stop", set the ramp-to-stop speed through H20.30 and the deceleration time for ramp-to-stop through H20.31. After the time defined by H20.31 elapses, the motor speed decelerates from H20.30 to 0, as shown in the figure.

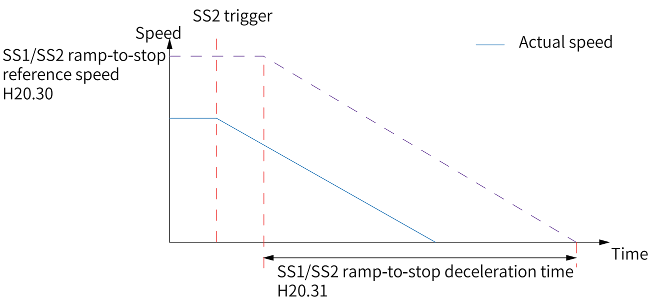


Figure 6-10 Motor speed during ramp-to-stop

Caution

In the CSP mode, the SS2 stop mode H20.29 is set to ramp-to-stop, and SS2 state is canceled during or after stop. Note that 607A of the host controller is aligned to 6064. Otherwise, alignment to 607A can cause a high speed or even alarm B01.2 upon exiting.

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.30	2020-1Fh	SS1/SS2 ramp-to-stop reference speed	60 to 6000	1000	rpm	At stop	" H20_en.30" on page 234
H20.31	2020-20h	SS1/SS2 ramp-to-stop deceleration time	1 to 65535	500	ms	At stop	" H20_en.31" on page 234

When the safety function is triggered in the local mode, you can set the delay from the moment SS2 is triggered to the moment the drive enters STO state through H20.33, set SS2 zero speed threshold by H20.34, and set SS2 zero speed window time through H20.35. If the delay after the SS2 is triggered reaches the value of H20.33, the drive switches to the SOS state regardless of the motor speed. If the delay 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.

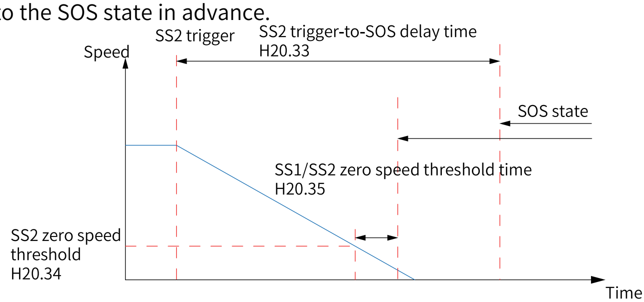


Figure 6-11 Safety function triggered by the local mode, motor speed changing

Related parameters:

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.33	2020-22h	SS1 trigger-to-STO delay/SS2 trigger-to-STO delay	0 to 65535	1000	ms	At stop	" H20_en.33" on page 235
H20.34	2020-23h	SS1/SS2 zero speed threshold	1 to 6000	10	rpm	At stop	" H20_en.34" on page 235
H20.35	2020-24h	SS1/SS2 zero speed window time	0 to 65535	0	ms	At stop	" H20_en.35" on page 235

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:

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.43	2020-2Ch	SS2 monitor mode	0: SS2-t 1: SS2-r	0	-	At stop	" H20_en.43" on page 237

In the SS2-r monitoring mode, after you choose to trigger the safety function locally, you can set the delay (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 elapsed.

You can set the ramp monitoring reference speed through H20.37 and the ramp monitoring time through H20.38. 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 configure the time from triggering the ramp limit to issuance of the alarm by setting H20.41. When the number of consecutive overruns of the deceleration ramp reaches the value of H20.41, a fault will be reported. You can configure the speed for stopping the ramp monitoring by setting H20.42. When the motor speed falls below the value of H20.42, the ramp monitoring is stopped.

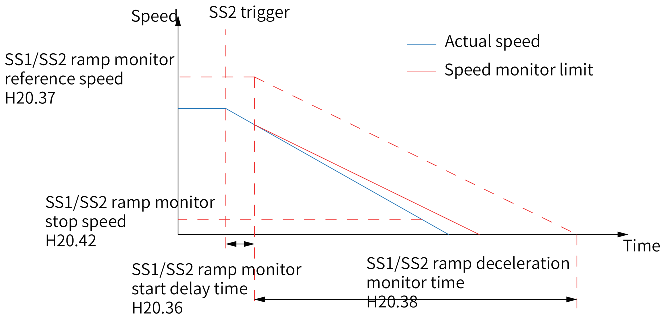


Figure 6-12 Motor speed when safety function is triggered

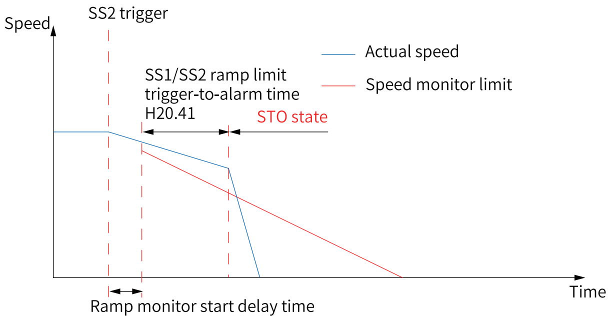


Figure 6-13 Motor speed when ramp limit is triggered

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.36	2020-25h	SS1/SS2 ramp monitor start delay	5 to 65535	10	ms	At stop	" H20_en.36" on page 236
H20.37	2020-26h	SS1/SS2 ramp monitor reference speed	60 to 6000	1000	rpm	At stop	" H20_en.37" on page 236
H20.38	2020-27h	SS1/SS2 ramp deceleration monitoring time	1 to 65535	65535	ms	At stop	" H20_en.38" on page 236

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
H20.41	2020-2Ah	SS1/SS2 ramp limit trigger-to-alarm time	0 to 65535	5	ms	At stop	" H20_en.41" on page 237
H20.42	2020-2Bh	SS1/SS2 ramp monitor stop speed	0 to 6000	1	rpm	At stop	" H20_en.42" on page 237

6.8.3 SS2 Triggered By FSoE Mode

SS2 function trigger-related parameters

When you trigger the safety function through FSoE mode, 6670h in the RPDO mapping is the object dictionary of SS2 triggering state, and 6670h in the TPDO mapping is the object dictionary of SS2 triggering state.

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6670.01h	6670-01h	SS2 signal	0 to 1	0	-	Real time	" 6670_en.01h" on page 253

You can use the object dictionary 6676h to set whether a Restart Ack signal is required when the SOS state is reset. In the RPDO mapping, 6630h indicates the Restart Ack signal. If 6676h is set to 1, when SS2 is triggered and then reset, the Restart Ack signal must be written to 1 to recover from the SOS state to the normal operation state.

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6676.01h	6676-01h	SS2 reset mode	0 to 1	0	-	Real time	" 6676_en.01h" on page 255

SS2 stop-related parameters

You can configure the stop mode of SS2 by setting H20.29.

When you choose "Ramp to stop", you can configure the ramp-to-stop reference speed by setting H20.30 and the ramp-to-stop deceleration time by setting H20.31.

When you choose to trigger the safety functions through FSoE, you can configure the SS2 trigger-to-SOS delay by setting 6671h, the SS2 zero speed threshold by setting 666Ch, and the SS2 zero speed window time by setting 6672h.

Caution

In the CSP mode, the SS2 stop mode H20.29 is set to ramp-to-stop, and SS2 state is canceled during or after stop. Note that 607A of the host controller is aligned to 6064. Otherwise, alignment to 607A can cause a high speed or even alarm B01.2 upon exiting.

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
666C.01h	666C-01h	SOS zero speed threshold	0 to 6000	10	rpm	Real time	"666C_en.01h" on page 253
6671.01h	6671-01h	SS2 trigger-to-STO delay	0 to 65535	10	ms	Real time	"6671_en.01h" on page 253
6672.01h	6672-01h	SS2 zero speed window time	0 to 65535	0	ms	Real time	"6672_en.01h" on page 254

SS2 function monitoring-related parameters

You can configure the SS2 monitoring mode by setting H20.43.

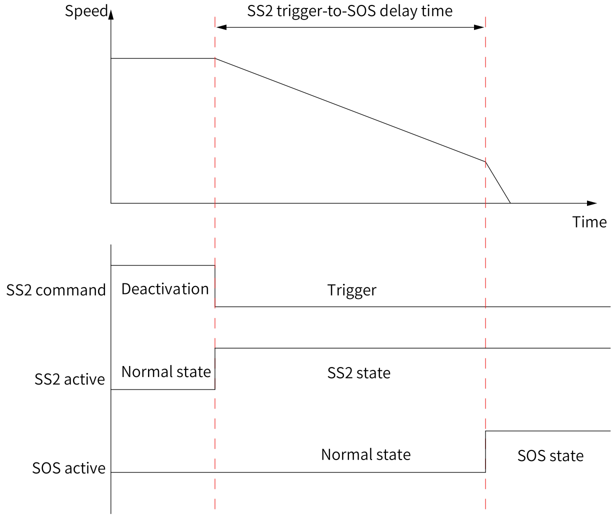
In case of SS2-r monitoring, when you choose to trigger the safety function through FSoE, you can configure the delay for starting the speed ramp monitoring by setting 6675h and the minimum SS2 deceleration limit by setting 6674h. You can configure the time from triggering the ramp limit to generating the alarm through H20.41, and the speed for stopping the ramp monitoring through H20.42.

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6674.01h	6674-01h	SS2 deceleration limit	0 to 4294967295	15	Encoder unit/s^2	Real time	"6674_en.01h" on page 254
6675.01h	6675-01h	SS2 ramp monitor start delay	0 to 65535	10	ms	Real time	"6675_en.01h" on page 254

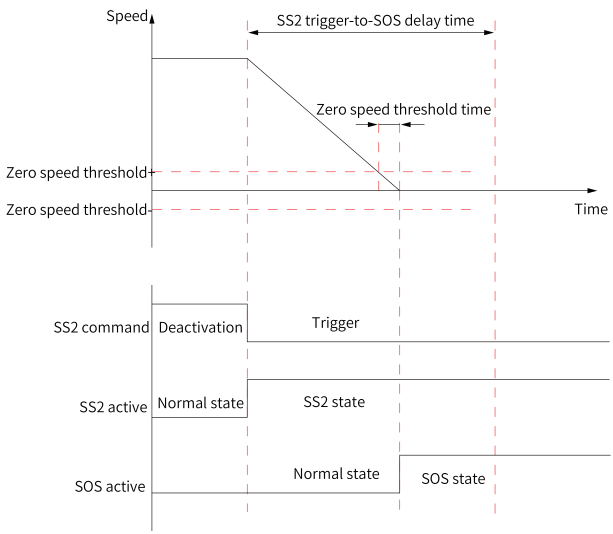
6.8.4 Sequence Diagrams

SS2 is triggered and the drive enters STO state after the delay time has elapsed.



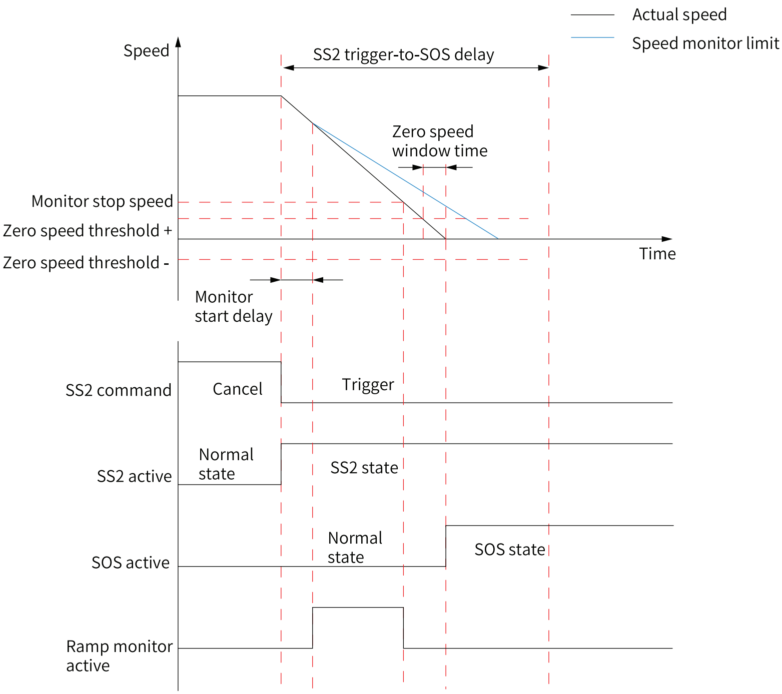
If the SS2 command is canceled after SS2 has been triggered, the SS2 state remains until the delay time has elapsed.

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

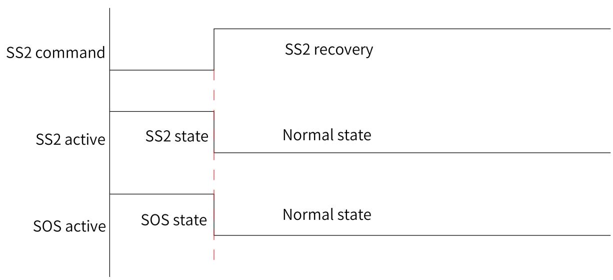


If the SS2 command is deselected after SS2 has been triggered, the SS2 state remains until the delay time has elapsed or the zero speed conditions are met.

Starting SS2 speed ramp monitor



SS2 recovery



6.9 Safe Operating Stop (SOS)

6.9.1 Overview

The SOS function monitors whether the speed and position of the motor at a standstill 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.

6.9.2 SOS Triggered By Local Mode

SOS trigger-related parameters

When you trigger the safety function by the local mode, DO: FunOUT.11 (SOS Active) enables the DO to output SOS active signal.

Table 6–8 Description of function No.

Code	Name	Description	Function
FunOUT.11	SOS Active	SOS active	0: SOS monitor state not applied 1: SOS monitor state applied

When any DI among DI1 to DI5 is assigned with “FunIN.11-Ack” and the DI corresponding to SS2 is triggered and recovered, the drive recovers from STO state to normal operation state only if the DI corresponding to the Ack function is triggered.

When no DI is assigned with Ack function, the drive returns to normal operation state after the corresponding DI of SS2 is triggered and recovered.

Note

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

SOS-related parameters

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

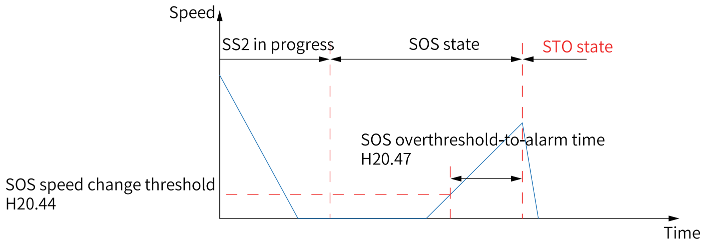


Figure 6-14 SOS speed change threshold

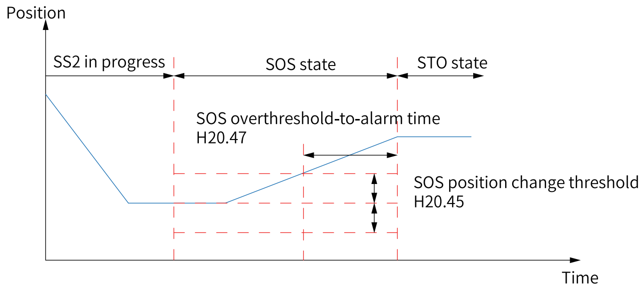


Figure 6-15 SOS position change threshold

Related parameters:

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.44	2020-2Dh	SOS speed change threshold	1 to 6000	10	rpm	At stop	*" H20_en.44" on page 238*
H20.45	2020-2Eh	SOS position change threshold	1 to 536870912	932067	Encoder unit	At stop	*" H20_en.45" on page 238*
H20.47	2020-30h	SOS overthreshold-to-alarm time	0 to 65535	5	ms	At stop	*" H20_en.47" on page 238*

6.9.3 SOS Triggered by FSoE Mode

SOS trigger-related parameters

When you trigger the safety function through FSoE mode, 6668h in the TPDO mapping is the object dictionary of SOS triggering state.

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6668.01h	6668-01h	SOS signal	0 to 1	0	-	Real time	*"6668_en.01h" on page 252*

You can use the object dictionary 6676h to set whether a Restart Ack signal is required when the SOS state is reset. In the RPDO mapping, 6630h indicates the Restart Ack signal. If 6676h is set to 1, when SS2 is triggered and then reset, the Restart Ack signal must be written to 1 to recover from the SOS state to the normal operation state.

Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6676.01h	6676-01h	SS2 reset mode	0 to 1	0	-	Real time	*"6676_en.01h" on page 255*

SOS-related parameters

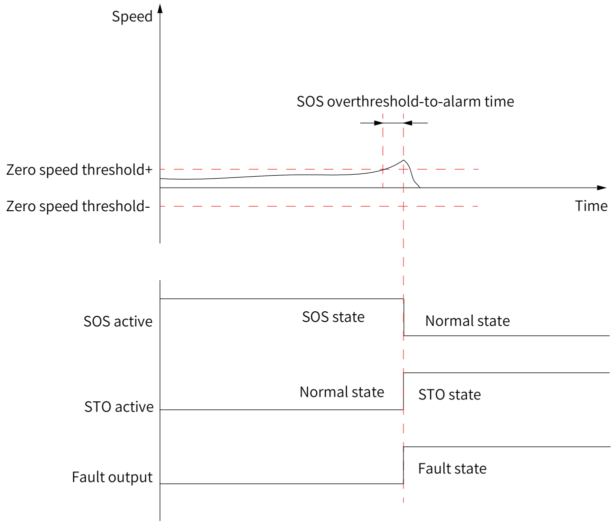
When you choose to trigger the safety functions through FSoE, you can configure the SOS zero position threshold by setting 666Ah and the SOS zero speed threshold by setting 666Ch. You can configure the SOS overthreshold-to-alarm time by setting H20.47.

Related parameters:

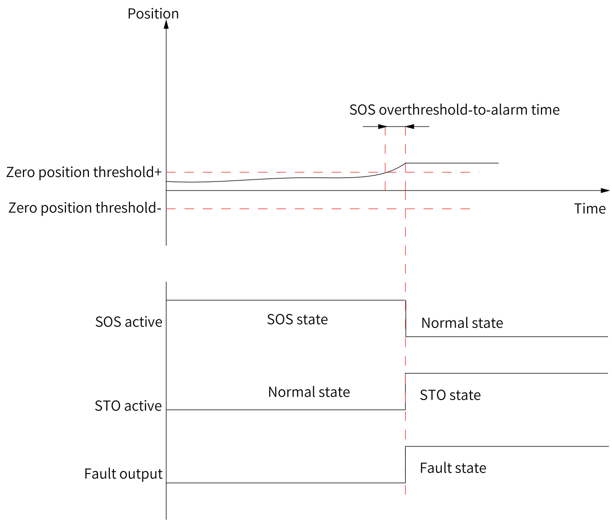
Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
666A.01h	666A-01h	SOS zero position threshold	0 to 536870912	932067	Encoder unit	Real time	*"666A_en.01h" on page 252*
666C.01h	666C-01h	SOS zero speed threshold	0 to 6000	10	rpm	Real time	*"666C_en.01h" on page 253*

6.9.4 Sequence Diagrams

SOS speed monitoring



SOS position monitoring



6.10 Safely-Limited Speed (SLS)

6.10.1Overview

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.

6.10.2SLS Triggered By Local Mode

The "DI: FunIN5 (SLS1)", "DI: FunIN6 (SLS2)", "DI: FunIN7 (SLS3)", and "DI: FunIN8 (SLS4)" are used to enable the DI to trigger SLS1, SLS2, SLS3, and SLS4 functions respectively. The "DO: FunOUT.5 (SLS1 active)", "DO: FunOUT.6 (SLS2 active)", "DO: FunOUT.7 (SLS3 active)" and "DO: FunOUT.8 (SLS4 active)" are used to enable the DO to output SLS1, SLS2, SLS3, and SLS4 active signals respectively.

Table 6–9 Description of function No.

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

Note

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

Related parameters:

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.02	2020-03h	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 223*
H20.03	2020-04h	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 224*
H20.04	2020-05h	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 224*

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.05	2020-06h	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 225*
H20.06	2020-07h	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 225*
H20.20	2020-15h	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 229*

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.21	2020-16h	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 230*
H20.22	2020-17h	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 231*
H20.23	2020-18h	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 231*

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.24	2020-19h	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 232*
H20.25	2020-1Ah	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 233*
H20.48	2020-31h	SLS switchover delay 1	0 to 65535	100	ms	At stop	*" H20_en.48" on page 239*
H20.49	2020-32h	SLS switchover delay 2	0 to 65535	100	ms	At stop	*" H20_en.49" on page 239*
H20.50	2020-33h	SLS switchover delay 3	0 to 65535	100	ms	At stop	*" H20_en.50" on page 239*
H20.51	2020-34h	SLS switchover delay 4	0 to 65535	100	ms	At stop	*" H20_en.51" on page 240*
H20.52	2020–35 h	SLS speed limit threshold 1	0 to 6000	1000	rpm	At stop	*" H20_en.52" on page 240*
H20.53	2020-36h	SLS speed limit threshold 2	0 to 6000	1000	rpm	At stop	*" H20_en.53" on page 240*

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.54	2020-37h	SLS speed limit threshold 3	0 to 6000	1000	rpm	At stop	*" H20_en.54" on page 240*
H20.55	2020-38h	SLS speed limit threshold 4	0 to 6000	1000	rpm	At stop	*" H20_en.55" on page 241*
H20.56	2020-39h	SLS speed limit active filter 1	0 to 65535	100	ms	At stop	*" H20_en.56" on page 241*
H20.57	2020-3Ah	SLS speed limit active filter 2	0 to 65535	100	ms	At stop	*" H20_en.57" on page 241*
H20.58	2020-3Bh	SLS speed limit active filter 3	0 to 65535	100	ms	At stop	*" H20_en.58" on page 241*
H20.59	2020-3Ch	SLS speed limit active filter 4	0 to 65535	100	ms	At stop	*" H20_en.59" on page 242*

6.10.3SLS Triggered by FSoE Mode

The SLS speed monitoring can be triggered in the following two ways.

1. You can set the delay from activation of the SLS command to starting of the SLS speed monitoring (6691h). When the delay has elapsed, the safety module will turn on the speed monitoring no matter whether the current speed of the servo motor is within the speed range.
2. You can also set the SLS filter time (6694h). It defines the filtering time for determining that the motor speed is within the SLS limit. When the SLS filter time is reached, the SLS speed monitoring will be activated no matter whether the delay elapses.

The object dictionary involved in the SLS function triggered through FSoE is as follows.

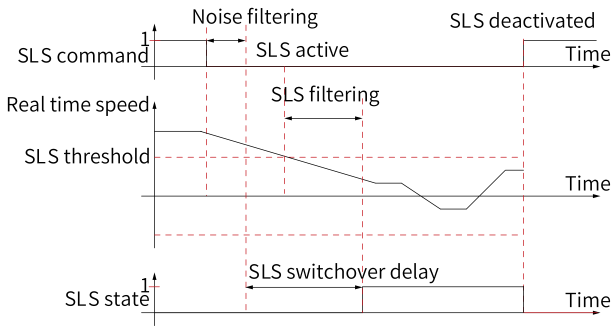
Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6690.01h	6690-01h	SLS1 signal	0 to 1	0	-	Real time	*" 6690_en.01h" on page 255*
6690.02h	6690-02h	SLS2 signal	0 to 1	0	-	Real time	*" 6690_en.02h" on page 255*
6690.03h	6690-03h	SLS3 signal	0 to 1	0	-	Real time	*" 6690_en.03h" on page 256*

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
6690.04h	6690-04h	SLS4 signal	0 to 1	0	-	Real time	" 6690_en.04h" on page 256
6691.01h	6691-01h	SLS switchover delay 1	0 to 65535	100	ms	Real time	" 6691_en.01h" on page 257
6691.02h	6691-02h	SLS switchover delay 2	0 to 65535	100	ms	Real time	" 6691_en.02h" on page 257
6691.03h	6691-03h	SLS switchover delay 3	0 to 65535	100	ms	Real time	" 6691_en.03h" on page 257
6691.04h	6691-04h	SLS switchover delay 4	0 to 65535	100	ms	Real time	" 6691_en.04h" on page 258
6693.01h	6693-01h	SLS speed limit threshold 1	0 to 6000	1000	rpm	Real time	" 6693_en.01h" on page 258
6693.02h	6693-02h	SLS speed limit threshold 2	0 to 6000	1000	rpm	Real time	" 6693_en.02h" on page 258
6693.03h	6693-03h	SLS speed limit threshold 3	0 to 6000	1000	rpm	Real time	" 6693_en.03h" on page 259
6693.04h	6693-04h	SLS speed limit threshold 4	0 to 6000	1000	rpm	Real time	" 6693_en.04h" on page 259
6694.01h	6694-01h	SLS speed limit active filter 1	0 to 65535	10	ms	Real time	" 6694_en.01h" on page 259
6694.02h	6694-02h	SLS speed limit active filter 2	0 to 65535	10	ms	Real time	" 6694_en.02h" on page 259
6694.03h	6694-03h	SLS speed limit active filter 3	0 to 65535	10	ms	Real time	" 6694_en.03h" on page 260
6694.04h	6694-04h	SLS speed limit active filter 4	0 to 65535	10	ms	Real time	" 6694_en.04h" on page 260

6.10.4Sequence Diagrams

Sequence for triggering SLS function

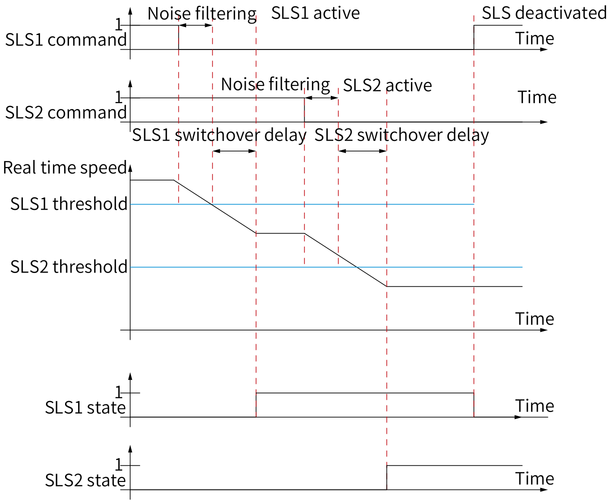


- When the SLS command is active, the speed of the servo motor must be lower than the SLS threshold before the SLS switchover delay expires; otherwise, the safety module can generate a SLS alarm.
- The safety module only monitors whether the motor speed and SLS switchover delay reach the thresholds. 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 host controller needs to send a signal to the drive to make the drive perform braking 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 higher preset speed.
- Conditions for SLS to enter the monitoring state:

  1. SLS switchover delay expired
  2. SLS speed limit filter time expired

Sequence for triggering multiple SLS

The SLS function enables monitoring of four different SLS target speed limits. When multiple SLS commands are active, the motor speed must be kept below the lowest SLS threshold; otherwise, the safety module will trigger an SLS alarm.



During normal operation of the servo drive, the SLS1 speed limit 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 again. 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 speed limit monitoring is turned on.

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

6.11 Safe Direction (SDI)

6.11.1Overview

The SDI 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 way for the servo drive to handle the SDI fault by setting the parameter H20.78.

The SDI function must be used with a safety motor.

6.11.2SDI Triggered By Local Mode

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

The "DI: FunIN9 (SDIp)" and "DI: FunIN10 (SDIn)" are used to enable the DI to trigger the SDIp and SDIn function respectively. The "DO: FunOUT.9 (SDIp active)" and "DO: FunOUT.10 (SDIn active)" are used to enable the DO to output SDIp and SDIn active signals respectively.

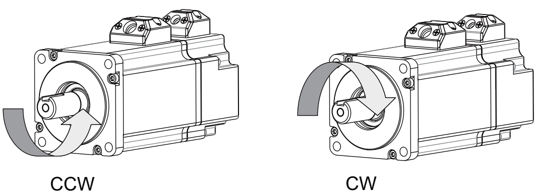
Table 6–10 Description of function No.

Code	Name	Description	Function
FunIN.9	SDIp command	SDIp trigger command	0: SDIp active, forward rotation prohibited 1: SDIp canceled, forward rotation allowed
FunIN.10	SDIn command	SDIn trigger command	0: SDIn active, reverse rotation prohibited 1: SDIn canceled, reverse rotation allowed
FunOUT.9	SDIp Status	SDIp status	0: SDIp inactive, motor not rotating forwardly 1: SDIp active, motor rotating forwardly
FunOUT.10	SDIn Status	SDIn state	0: SDIn inactive, motor not rotating reversely 1: SDIn active, motor rotating reversely

Note

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

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 forwardly and reversely.
1	0	1	0	The motor can only rotate forwardly.
0	1	0	1	The motor can only rotate reversely.
0	0	0	0	The motor is not allowed to rotate.

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:

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.02	2020-03h	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 223*
H20.03	2020-04h	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 224*

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.04	2020-05h	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 224*
H20.05	2020-06h	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 225*
H20.06	2020-07h	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 225*

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.20	2020-15h	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 229*
H20.21	2020-16h	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 230*
H20.22	2020-17h	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 231*

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.23	2020-18h	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 231*
H20.24	2020-19h	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 232*
H20.25	2020-1Ah	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 233*
H20.74	2020-4Bh	SDI zero position window	1 to 536870912	932067	Encoder unit	At stop	*" H20_en.74" on page 243*

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.76	2020-4Dh	SDI zero speed window	0 to 3000	10	rpm	At stop	" H20_en.76" on page 244
H20.77	2020 to 4Eh	SDI delay time	0 to 65535	0	ms	At stop	" H20_en.77" on page 244
H20.78	2020-4Fh	SDI fault response mode	0:STO 1:SS1-t	0	-	At stop	" H20_en.78" on page 244
H20.00	2020-01h	Functional safety module software version	0.00 to 655.35	0.00	-	N/A	" H20_en.00" on page 223
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 221

6.11.3SDI Function Triggered by FSoE Mode

The characteristics of the SDI function triggered through FSoE are the same as those of the SDI function triggered locally. The SDI function triggered through FSoE involves the following object dictionary configuration.

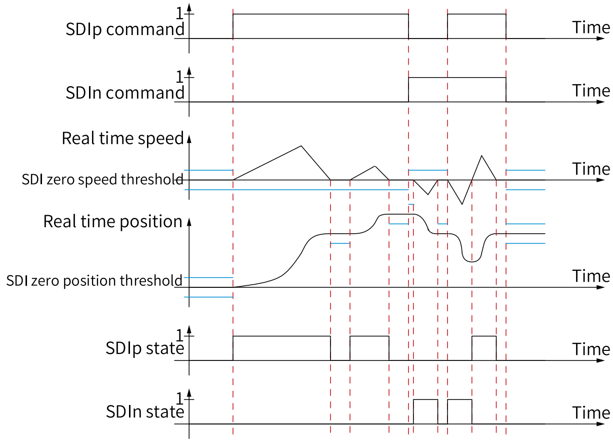
Related parameters:

Param.	Communication Address	Name	Setpoint	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 221
66D0h	66D0h	SDIp signal	0 to 1	0	-	Real time	" 66D0h" on page 260
66D1h	66D1h	SDIn signal	0 to 1	0	-	Real time	" 66D1h" on page 261
66D3h	66D3h	SDI zero position window	0 to 536870912	932067	Encoder unit	Real time	" 66D3h" on page 261
66D5h	66D5h	SDI zero speed window	0 to 3000	10	rpm	Real time	" 66D5h" on page 262

6.11.4Sequence Diagrams

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.



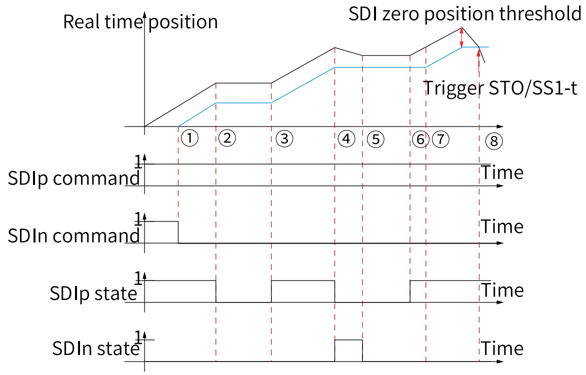
- The SDIp and SDIn states displayed by the safety module indicate the current rotational state of the servo motor, independent of the input SDI command state. When both SDIp and SDIn states are 0, it means the servo motor is stopped.
- When the SDIp command is deactivated, the motor can rotate in forward 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 sequence diagram is shown below.

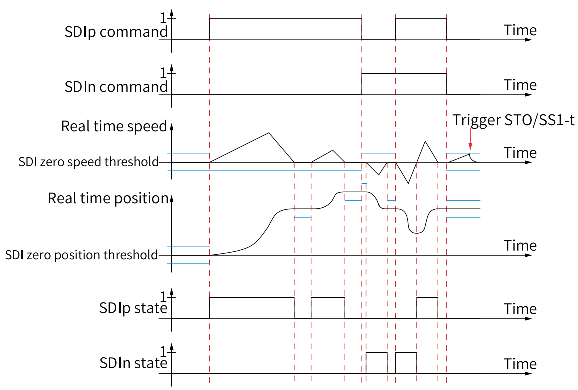
Stop according to the stop mode defined by H20.78 when the SDI zero position threshold is exceeded.



The sequence is described as follows:

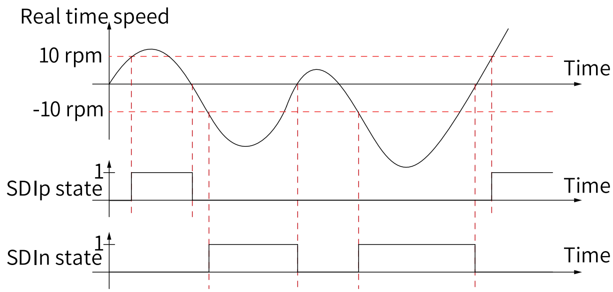
- ① The safety module receives an active SDIn command and starts monitoring whether the motor shaft rotates into the reverse direction. The motor rotates into the allowable forward direction.
- ② The motor stops rotating and the position feedback remains unchanged.
- ③ The motor continues to rotate into the allowable forward direction.
- ④ The motor rotates in the reverse direction, the safety module locks the maximum allowable reverse position threshold and checks whether the current position exceeds the maximum allowable value.
- ⑤ The motor stops before the maximum reverse position threshold is reached.
- ⑥ The motor continues to rotate in the allowable forward direction.
- ⑦ The motor returns to the position where the reverse position threshold was locked previously.
- ⑧ The zero position window is exceeded and the safety stop set by H20.78 is triggered.

Stop as defined by H20.78 when the zero speed threshold is exceeded.



Hysteresis speed

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



6.12 Safe Speed Monitor (SSM)

6.12.1Overview

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 state can be output through the local mode or through the TPDO status word of the EtherCAT safety bus.

6.12.2SSM Triggered By the Local Mode

When you trigger the safety function by the local mode, “FunOUT.12 (SSM Active)” enables the DO to output SSM active signal.

Table 6–11 Description of function No.

Code	Name	Description	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 DO is disconnected.
- ON (1): The 24V voltage of the corresponding DO is connected.

The SSM state can be output through DO.

Related parameters:

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.20	2020-15h	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 229*
H20.21	2020-16h	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 230*

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.22	2020-17h	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 231*
H20.23	2020-18h	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 231*
H20.24	2020-19h	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 232*

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.25	2020-1Ah	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 233
H20.70	2020-47h	SSM upper limit threshold	-6000 to +6000	200	rpm	At stop	" H20_en.70" on page 242
H20.71	2020-48h	SSM lower limit threshold	-6000 to +6000	-200	rpm	At stop	" H20_en.71" on page 243
H20.72	2020-49h	SSM hysteresis threshold	0 to 6000	10	rpm	At stop	" H20_en.72" on page 243

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 lower than the result of the upper limit minus the lower limit.
- The SSM hysteresis threshold is set by H20.72, and is valid for both local DO and FSoE output status words.

6.12.3SSM Output in FSoE Mode

The SSM hysteresis threshold is not planned in the object dictionary. To prevent the motor speed from fluctuating near the upper or lower SSM threshold, the SSM hysteresis threshold configured for the SSM function triggered locally adopts the value set by H20.72.

That is, the SSM hysteresis threshold set by H20.72 is active both in the local mode and in the FSoE mode.

The object dictionaries involved by the SSM safety bus are as follows:

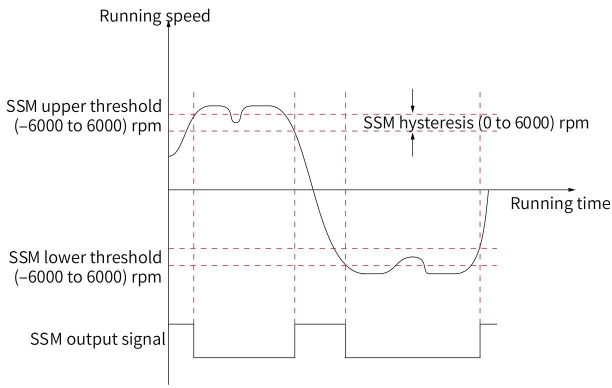
Related parameters:

Param.	Communication Address	Name	Setpoint	Default	Unit	Change Mode	Page
66E0.01h	66E0-01h	SSM state	0 to 1	0	-	N/A	*" 66E0_en.01h" on page 262*
66E2.01h	66E2-01h	SSM upper limit threshold	-6000 to +6000	200	rpm	Real time	*" 66E2_en.01h" on page 262*
66E4.01h	66E4-01h	SSM lower limit threshold	-6000 to +6000	-200	rpm	Real time	*" 66E4_en.01h" on page 262*

Note

- When the upper and lower limits of SSM are set to 0 at the same time, the SSM function is turned off and the SSM state 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.

6.12.4Sequence Diagrams



The purpose of the SSM hysteresis setting is to achieve a stable signal output when the motor speed is near the upper and 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 the difference between upper SSM threshold and 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 the sum of lower SSM threshold and hysteresis threshold, the SSM output is 1 again.

6.13 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.

6.13.1 Response Time for Triggering Local Mode

To trigger the safety functions through the local mode, you need to configure a safety DI with a certain safety function. Then you can trigger the corresponding safety function by controlling the safety DI. The response time from DI action to activation of the safety function 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]+2.5 ms
SLS	t_DI[1]+t_SLS[3] + 6.5 ms
SDI	t_DI[1]+t_SDI[4] + 6.5 ms
SOS	t_SOS[2] + 6.5 ms
SSM	4 ms

Note

- [1]: t_DI is the noise reduction filter time of the safety module DI, which is configured by 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 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).

6.13.2Response Time in FSoE Mode

When the safety function is triggered through the FSoE mode, the corresponding safety function is triggered by the control word of a certain safety function in the RPDO. The following table shows the time between function trigger and function execution.

Table 6–13 Response time during FSoE control

Function	Max. response time [7]
STO/SBC/SS1/SS2	2xt_ET[1] + 2 ms
SLS	2xt_ET[1]+ t_SLS[3] + 6.5 ms
SDI	2xt_ET[1]+ t_SDI [4] + 6.5 ms
SOS	T_SOS[2] + 6.5 ms
SSM	4xt_EPS[5] + 4xt_EFM[6

Note

- [1]: t_ET is the EtherCAT communication synchronization cycle. The setpoint is determined by the parameter configurations of the customer controller.
- [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 set by H20.48 to H20.51, which ranges from 0 ms to 65535 ms.
- [3]: t_SDI is the delay set by H20.77, which ranges from 0 ms to 65535 ms.
- [5] t_EPS is the communication cycle between the EtherCAT master and the FSoE slave. The setpoint is determined by the parameter configurations of the customer controller.
- [6]: t_EFM is the communication cycle between the EtherCAT master and the FSoE master. The setpoint is determined by the parameter configurations of the customer controller.
- [7]: Indicates the time interval between the safety function demand state and the safety function completion state (such as entering the safety state).

6.14 Fault Reset

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

1. 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).
2. For EtherCAT servo drives, enable the rising edge of the control word 6040h bit7 on the host controller to stop the keypad from displaying the fault.

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 Integrated STO Safety Function

7.1 Overview

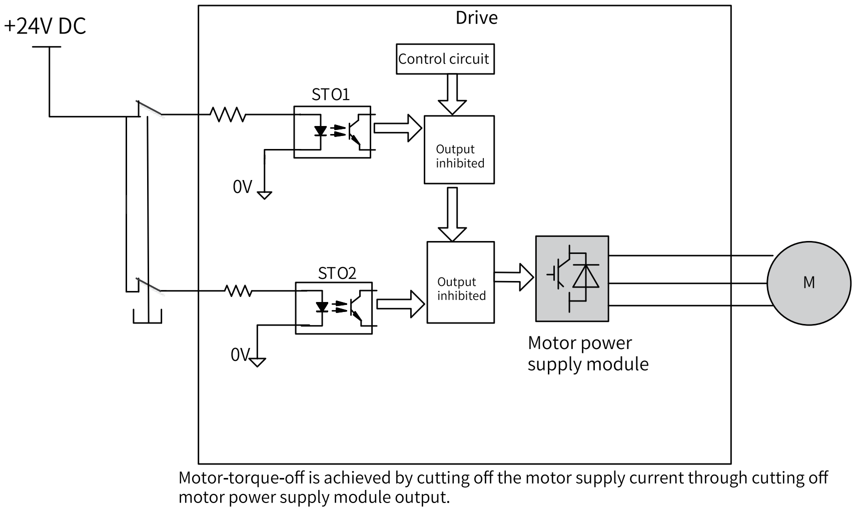


Figure 7-1 Schematics of the STO function

Safe Torque Off (STO) is a safety function that complies with IEC 61800-5-2:2016. It is integrated in 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	Prohibit
H	L	Prohibit
L	L	Prohibit

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. If the motor is running when STO function is activated, it coasts to stop.
Safe state	Disables the PWM gating signal of the drive.
Operation mode	High demand mode or continuous mode

7.2 Use of the STO Function

Use of the STO function

The keypad displays the STO function state and fault information.

See the following table to determine the cause of the faults and the measures 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	Status	Description	Cause	Solution
E150.0	STO function triggered normally	When H0A.21 is set to 1, the servo drive reports E150.0 fault code after STO is triggered.	When H0A.21 is set to 1, the servo drive reports E150.0 fault code after STO is triggered.	To exit from STO, both STO request commands need to be canceled, and fault reset is required to clear E150.0.
E150.1	Status of STO1 and STO2 inconsistent	Only one of STO1 and STO2 is in "Low" state, status of STO1 and STO2 are inconsistent.	The input states of STO1 and STO2 are inconsistent.	1. Ensure the requests for disconnecting the voltage of STO1 and STO2 are triggered simultaneously. 2. The input circuit is abnormal and a certain STO input signal is still in the"H" state after the 24 V signal is disconnected. Contact Inovance for technical support.
E150.2	STO activated	OV/UV of the 5V power supply is detected.	OV/UV of 5 V power supply	Restore the 5 V power supply to normal state. Contact Inovance for technical support.
E150.3	STO activated	The input circuit of STO works improperly.	The input circuit of STO works improperly.	Fix the input circuit fault. Contact Inovance for technical support.

Fault code	Status	Description	Cause	Solution
E150.4	STO activated	The buffer circuit of STO works improperly.	The buffer circuit of STO works improperly.	Fix the buffer circuit fault. Contact Inovance for technical support.
E150.5	STO activated	The STO terminal input is subject to noise.	The STO terminal input is in poor contact, which may lead to STO malfunction.	Check whether the input wiring of the STO terminal is normal and whether the external 24 V input voltage is stable.

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 signal DO output

When the 24 V voltage of STO1 and STO2 is cut off, the EDM DO signal is active. Otherwise, the EDM DO signal is inactive.

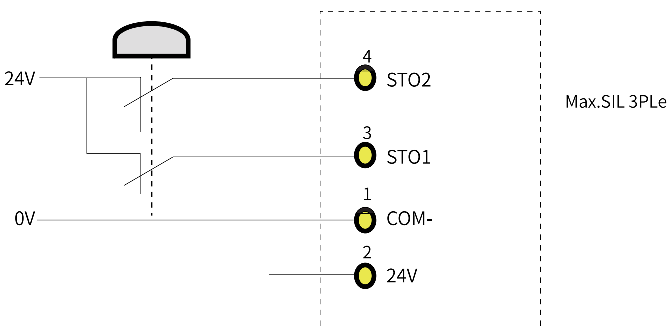
In this case, both STO1 and STO2 are filtered signals. When EDM is active, the PWM signal is blocked by the servo drive.

Signal Name	Symbol	Optocoupler logic			
Safety input	STO1	ON	ON	OFF	OFF
	STO2	ON	OFF	ON	OFF
EDM output	EDM	OFF	OFF	OFF	ON

Application Example

Example 1:

Emergency button（dual-contact）Class 3 ISO13849



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.

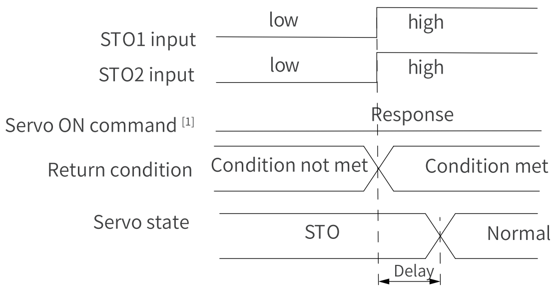


Figure 7-2 Return condition of external STO request state

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 both STO1 and STO2 are restored to 24 V at the same time, the servo ready output signal and the servo operation signal are activated after 400 ms. When the drive operates, the PWM drive signal is outputted.

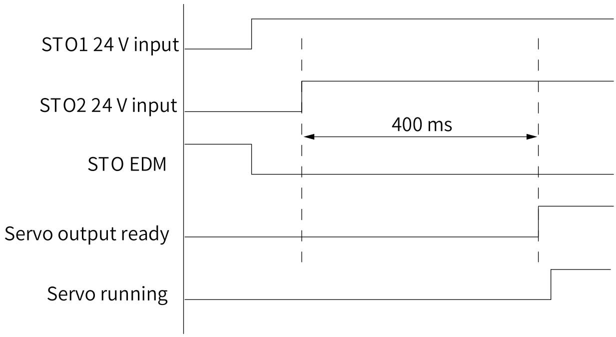
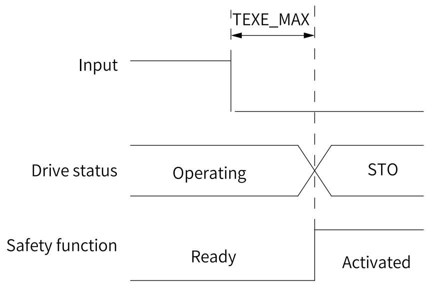


Figure 7-3 Servo drive reset sequence diagram

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.

8 Commissioning and Operation

8.1 Pre-operation Inspection

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

Table 8–1 Pre-operation checklist

No.	Item	Compli ance
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 (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 servo 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 encoder shield is reliably connected to the PE interface of the encoder.	□
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 regenerative 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 functions triggered locally (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 whether 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 allowed time, the safety module outputs the corresponding fault information.

Safety functions triggered through FSoE (H20.01=1)

1. Ensure that the wiring of the safety PLC and the servo drive is correct.
2. Beckhoff EL1904 module supports up to four channels of safety input, and the EL2904 module supports up to four channels of safety state output. Configure the RPDO corresponding to the input signal of the EL1904 and the TPDO corresponding to the output signal of the EL2904.
   For example, configure one channel of the EL1904 to STO PRDO and one channel of the EL2904 to STO TPDO.
3. Control ON and OFF of the input signal of the EL1904, observe whether the output signal of the EL2904 changes normally, and whether the servo drive reports any fault.
   For example, turn off the 24V input voltage corresponding to the STO of the EL1904 module and the drive enters the STO state, then observe whether the STO output state of the EL2904 module is active. Then restore the 24V input voltage and the drive exits the STO state, and observe whether the STO output state is inactive.

Note

In the above example, an Ack signal is not required for the drive to exit the STO state by default. As long as the STO command is canceled, the drive 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 the safety function (wiring, components, settings and so on).
  - 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, references to failure reports and resolution of failures. Any new acceptance tests performed due to changes or maintenance need to be logged into the logbook.

- Checklist

No.	Item	Compliance
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 circuit breaker.	☐
3	Check the STO circuit connections based on the circuit diagram.	☐
4	Check that the shield of the STO input cable is grounded to the drive frame.	☐

No.	Item	Compliance
5	Turn off the circuit breaker and switch the power supply on.	☐
5.1	Test the STO signal #1 when the motor stops: 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 stops: 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 send a start command to the drive. Ensure that the motor stays at a standstill and the keypad of the drive displays "E150.1".	☐
5.4	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".	☐

No.	Item	Compliance
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 checklists described below must be performed:

- at initial start-up of the safety function
- after any changes related to the safety function (wiring, components, settings, and so on.)
- 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, as required by the referred standards:

- 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, checksums, 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 615081 clause 6. The test procedures and report must be documented and signed by this person.

Validation checklists for start-up

Validation of the FSoE connection

1. Make sure that the EtherCAT communication is enabled.
2. Make sure that the FSoE address of the safety drive in the network is unique.
3. Make sure that the safety functions are configured to be triggered through FSoE.
4. Make sure that the FSoE-related PDOs on the master side are configured correctly.
5. Make sure the FSoE watchdog time is configured correctly.
6. Make sure that the FSoE SRA parameters are configured correctly.
7. Make sure that no faults or warnings are displayed on the operation panel.

Note

FSoE certification is in progress.

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 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 assigned with DI function 2.
- To reset No. 3 alarms, set H0d.01 to 1 or activate the DI assigned with DI function 2.

Note

- Some faults and alarms 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 fault/alarm code of the highest level.

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	Number of interrupts in the safety module FPGA incorrect	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 transmission 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 serial number not match	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 CRC error	No. 1	No	0x0751	0x37510751

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 assigned with the same function	No. 1	Yes	0x0124	0x01240124
	E124.1	Safety DI1 input circuit diagnosis exception	No. 1	Yes	0x0124	0x11240124
	E124.2	Safety DI2 input circuit diagnosis exception	No. 1	Yes	0x0124	0x21240124
	E124.3	Safety DI3 input circuit diagnosis exception	No. 1	Yes	0x0124	0x31240124
	E124.4	Safety DI4 input circuit diagnosis exception	No. 1	Yes	0x0124	0x41240124
	E124.5	Safety 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	Safety DO1 output circuit diagnosis exception	No. 1	Yes	0x0125	0x11250125
	E125.2	Safety DO2 output circuit diagnosis exception	No. 1	Yes	0x0125	0x21250125
	E125.4	Safety DO4 output circuit diagnosis exception	No. 1	Yes	0x0125	0x41250125
	E125.5	Safety DO5 output circuit diagnosis exception	No. 1	Yes	0x0125	0x51250125
E134	E134.1	Discrepancy at two input signals of safety 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 exception	No. 1	Yes	0x0150	0x11500150
	E150.2	Buffer 5 V voltage detection exception	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 limit violated	No. 1	Yes	0x0160	0x01600160
	E160.1	SLS2 limit violated	No. 1	Yes	0x0160	0x11600160
	E160.2	SLS3 limit violated	No. 1	Yes	0x0160	0x21600160
	E160.3	SLS4 limit violated	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. 2 resettable faults

Table 9–3 List of No. 2 resettable faults

Fault code	Fault subcode	Fault name	Fault level	Resettable	Error code (603Fh)	Aux. code (203Fh)
EE17	EE17.0	Unexpected FSoE command	No. 2	Yes	0x0E17	0x0E170E17
	EE17.1	Unknown FSoE command	No. 2	Yes	0x0E17	0x1E170E17
	EE17.2	FSoE invalid connection ID	No. 2	Yes	0x0E17	0x2E170E17
	EE17.3	FSoE CRC error	No. 2	Yes	0x0E17	0x3E170E17
	EE17.4	FSoE watchdog expired	No. 2	Yes	0x0E17	0x4E170E17
	EE17.5	FSoE invalid slave address	No. 2	Yes	0x0E17	0x5E170E17
	EE17.6	Invalid FSoE safety data	No. 2	Yes	0x0E17	0x6E170E17
	EE17.7	Invalid FSoE communication parameter length	No. 2	Yes	0x0E17	0x7E170E17
	EE17.8	Invalid FSoE communication parameter data	No. 2	Yes	0x0E17	0x8E170E17
	EE17.9	Invalid FSoE application program parameter length	No. 2	Yes	0x0E17	0x9E170E17
	EE17.A	Invalid FSoE application program parameter data	No. 2	Yes	0x0E17	0xAE170E17

No. 3 resettable alarms

Table 9–4 Resettable alarm list

Alarm 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 alarm	No. 3	Yes	0x0115	0x011150115
E116	E116.0	SLS overspeed alarm	No. 3	Yes	0x0116	0x011160116
	E116.1	SDI tolerance violation alarm	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	Check Method	Solution
1. The software is updated.	Check whether the software is updated.	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 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	Check Method	Solution
1. The software is updated.	Check whether the software is updated.	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 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	Check Method	Solution
1. The software is updated.	Check whether the software is updated.	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	Check Method	Solution
1. A FPGA error occurs.	Frequent power-off/on operations can lead to this fault.	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 scheduling time.

Cause	Check Method	Solution
The safety module has failed.	Frequent power-off/on operations can lead to this fault.	Replace the servo drive and safety module.

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

  The function numbers of the safety DI terminals are duplicated.

Cause	Check Method	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 check whether the feedback signal is correct.

Cause	Check Method	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI1 circuit is normal. • Disconnect and then reconnect the 24 V 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 oscilloscope in the software tool).	• 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: Safety DI2 input circuit diagnosis exception
  Cause:

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

Cause	Check Method	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI2 circuit is normal. • Disconnect and then reconnect the 24 V 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 oscilloscope in the software tool).	• 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: Safety DI3 input circuit diagnosis exception
  Cause:

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

Cause	Check Method	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI3 circuit is normal. • Disconnect and then reconnect the 24 V 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 oscilloscope in the software tool).	• 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: Safety DI4 input circuit diagnosis exception
  Cause:

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

Cause	Check Method	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI4 input circuit is normal. • Disconnect and then reconnect the 24 V 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 oscilloscope in the software tool).	• 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: Safety DI5 input circuit diagnosis exception
  Cause:

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

Cause	Check Method	Solution
The MCU sent a diagnostic signal. The feedback signal is incorrect.	• Check whether the DI5 input circuit is normal. • Disconnect and then reconnect the 24 V 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 oscilloscope in the software tool).	• 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	Check Method	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.	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 DO1 to detect whether the AD sampling value of the feedback signal is below 0.3 V.

Cause	Check Method	Solution
After the MCU sends a diagnostic pulse to DO1, the feedback voltage received by the MCU is not below 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 DO2 to detect whether the AD sampling value of the feedback signal is below 0.3 V.

Cause	Check Method	Solution
After the MCU sends a diagnostic pulse to DO2, the feedback voltage received by the MCU is not below 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 DO4 to detect whether the AD sampling value of the feedback signal is below 0.3 V.

Cause	Check Method	Solution
After the MCU sends a diagnostic pulse to DO4, the feedback voltage received by the MCU is not below 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	Check Method	Solution
After the MCU sends a diagnostic pulse to DO5, the feedback voltage received by the MCU is not below 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	Check Method	Solution
The fault code is reported when the difference between two inputs of DI1 exceeds the value of H20.14.	Observe whether the difference lasts longer than the setpoint of H20.14.	Ensure the difference does not last 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	Check Method	Solution
The fault code is reported when the difference between two inputs of DI2 exceeds the value of H20.15.	Observe whether the difference lasts longer than the setpoint of H20.15.	Ensure the difference does not last longer than the value 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	Check Method	Solution
The fault code is reported when the difference between two inputs of DI3 exceeds the value of H20.16.	Observe whether the difference lasts longer than the setpoint of H20.16.	Ensure the difference does not last 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	Check Method	Solution
The fault code is reported when the difference between two inputs of DI4 exceeds the value of H20.17.	Observe whether the difference lasts longer than the setpoint of H20.17.	Ensure the difference does not last 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	Check Method	Solution
The fault code is reported when the difference between two inputs of DI5 exceeds the value of H20.18.	Check whether the difference lasts longer than the setpoint of H20.18.	Ensure the difference does not last longer than the value of H20.18.

- E135.0: Chip 3.3 V 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	Check Method	Solution
The chip voltage is out of the range of 3.0 V to 3.6 V.	Check whether the power supply voltage of the chip is normal.	Replace the safety module.

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

  The chip diagnosis of the safety module failed.

Cause	Check Method	Solution
1. The CPU diagnosis of the chip failed.	Frequent power-off/on operations can lead to this fault.	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	Check Method	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.	Contact Inovance.

- E150.0: STO safety state applied
  Cause:

  The STO input protection applies (safety state).

Cause	Check Method	Solution
One or 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	Check Method	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. The STO fails.	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	Check Method	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:

  Short circuit occurs on the optocoupler in the upstream hardware circuit of STO.

Cause	Check Method	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	Check Method	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 signal is being disturbed, and the noise filtering condition defined by H0A.73 is not met.

Cause	Check Method	Solution
The STO terminal is in poor contact or the external 24 V input voltage is unstable, which may lead to malfunction of STO.	Check whether the 24 V input voltage of the STO terminal is unstable, leading to frequent restart.	Replace the 24 V power supply to ensure the STO terminal input voltage is stable.

- 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	Check Method	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.

- E151.1: SCI communication exception between two MCUs of the safety module

  Cause:

  SCI communication exception between two MCUs of the safety module

Cause	Check Method	Solution
The internal RS232 data interaction and communication of the safety board is faulty.	-	• Detect whether interference near the drive affects RS232 communication transmission. • If the problem persists after the power supply is restarted, contact Inovance.

- 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	Check Method	Solution
1. The software is updated.	Check whether the software is updated.	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 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.

- 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	Check Method	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	Check Method	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	Check Method	Solution
1. A non-safety encoder is used.	Check whether the encoder used is a non-safety encoder.	Use a safety encoder.
2. H00.00 is not set to 14102.	Check whether H00.00 is set to 14102.	Set H00.00 to 14102.

Cause	Check Method	Solution
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 functions not related to speed.
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.

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

  For non-EtherCAT models, the safety function is triggered through FSoE mode.

Cause	Check Method	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	Check Method	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	Check Method	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 SLS2 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	Check Method	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	Check Method	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	Check Method	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	Check Method	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	Check Method	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	Check Method	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	Check Method	Solution
1. The delay 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 from SS2 to SOS is set properly.	Reasonably set the delay 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:

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

Cause	Check Method	Solution
1. The SBC circuit is abnormal when the board 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.	The 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	Check Method	Solution
The encoder cable is connected loosely.	1. Check the encoder cable connection. 2. Check whether vibration on site is too strong, which loosens the encoder cable and even damages the encoder. 3. Replace with a new encoder cable. If the fault no longer occurs after cable replacement, it indicates 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	Check Method	Solution
1. The encoder is wired improperly.	Check the wiring of the encoder.	Connect the encoder cables according to the correct wiring diagram.
2. The encoder cable is connected loosely.	Check whether vibration on site is too strong, which loosens the encoder cable and even damages the encoder.	Re-connect encoder cables and ensure encoder terminals are connected securely.

Cause	Check Method	Solution
3. The encoder Z signal is being disturbed.	• 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 the drive stay in "rdy" state and rotate the motor shaft counterclockwise (CCW) manually. Then observe whether the value of H0b.17 (Electrical angle) increases/decreases smoothly. Turning one circle corresponds to five 0°–360° (for Z series motor). For X series motors, turning one circle corresponds to four 0–360°. • If H0b.17 changes abnormally when you rotate the motor shaft manually, 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.
4. The encoder is faulty.	• Replace with a new encoder cable. If the fault no longer occurs after cable replacement, it indicates 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.

Cause	Check Method	Solution
5. T2 interpolator does not support software reset.	If H00.04 starts with 208, the T2 interpolator applies.	Power on and off again. If the fault persists, continue troubleshooting based on steps 1 to 4.

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

  The encoder is faulty.

Cause	Check Method	Solution
The encoder is faulty.	1. Replace with a new encoder cable. If the fault no longer occurs after cable replacement, it indicates the original encoder cable is damaged. 2. Keep the motor in a fixed position, restart several times and observe the change of the electrical angle H0b.17 upon each restart, which should be within ±30°.	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	Check Method	Solution
An error occurs when writing the position offset after angle auto-tuning.	Replace with a new encoder cable. If the fault no longer occurs after cable replacement, it indicates the original encoder cable is damaged. Keep the motor in a fixed position, restart several times and observe the change of the electrical angle H0b.17 upon each restart, which should be within ±30°.	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 transmission delay too long
  Cause:

The set encoder data transmission delay exceeds one current cycle.

Cause	Check Method	Solution
1. H01.59 is set to an excessively high value.	Check whether the fault persists after restart.	Reduce the value of H01.59.
2. The number of encoder data bits is too long.		Replace with an encoder with lower number of 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	Check Method	Solution
The encoder disk is contaminated or other photoelectric devices are disturbed.	Check whether the fault persists after restart.	Contact Inovance.

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

  Difference between safety encoder master and slave positions too large

Cause	Check Method	Solution
Difference between safety encoder master and slave positions too large	Check whether the fault persists after restart.	Contact Inovance.

- 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	Check Method	Solution
Board-level signal interference, encoder disk contamination, chip peripherals exception.	Check the encoder surroundings for interference source.	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	Check Method	Solution
Difference between safety encoder master and slave sampled analog values too large	Check whether the fault persists after restart.	Contact Inovance.

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

  LDO or battery voltage is lower than 3.1 V.

Cause	Check Method	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 serial numbers not match
  Cause:

  SN counts of the master and slave are not equal.

Cause	Check Method	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	Check Method	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 the 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	Check Method	Solution
Board-level communication interference causes internal CRC failure, peripheral abnormality, and so on.	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	Check Method	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	Check Method	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	Check Method	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 safety encoder software version is not 264xx.
  - The CRC value of the safety encoder version number is abnormal.

Cause	Check Method	Solution
The safety encoder version (H00.04) is not 264xx.	Check whether the fault persists after restart.	Contact Inovance.
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.	• Check the wiring. • After power on and off for multiple times, if the fault persists, replace the encoder.

- EE17.0: FSoE unexpected command
  Cause:

  In the current state of FSoE communication, this command should not appear.

<table>
<tr><th>Cause</th><th>Check Method</th><th>Solution</th></tr>
<tr><td>1. In the reset state, the slave has received the Connection, Parameter, ProcessData, FailSafeData commands.</td><td rowspan="6">The keypad displays the fault code.</td><td rowspan="6">• Check whether the command sent by the safety master is wrong.
• Check whether the safety PDO data has been modified.</td></tr>
<tr><td>2. In the Session state, the slave has received the Parameter, ProcessData, FailSafeData commands.</td></tr>
<tr><td>3. In the Connection state, the slave has received ProcessData and FailSafeData commands.</td></tr>
<tr><td>4. In the Parameter state, the slave has received the Connection command.</td></tr>
<tr><td>5. In the Data state, the slave has received the Connection and Parameter commands.</td></tr>
<tr><td>6. In Session, Connection, and Parameter states, the number of safety PDUs sent is 0.</td></tr>
</table>

- EE17.1: Unknown FSoE command
  Cause:

  Unspecified command word appeared in FSoE communication.

Cause	Check Method	Solution
The slave has received commands other than reset, Session, Connection, Parameter, ProcessData, and FailSafeData.	The keypad displays the fault code.	• Check whether the command sent by the safety master is wrong. • Check whether the safety PDO data has been modified.

- EE17.2: FSoE invalid connection ID
  Cause:

  The ID of the connection established by the FSoE does not match the ID received.

Cause	Check Method	Solution
In Connection, Parameter, ProcessData, FailSafeData states, the connection ID is incorrect.	The keypad displays the fault code.	• Check whether the connection ID sent by the safety master is wrong. • Check whether the safety PDO data has been modified.

- EE17.3: FSoE CRC error
  Cause:

  The CRC value of the FSoE data frame does not match the calculated value.

Cause	Check Method	Solution
The CRC value received by the slave is inconsistent with the CRC value calculated by itself.	The keypad displays the fault code.	• Check whether the CRC sent by the safety master is wrong. • Check whether the safety PDO data has been modified.

- EE17.4: FSoE watchdog expired
  Cause:

  No data frame was received within the FSoE communication cycle.

Cause	Check Method	Solution
The slave failed to receive a data frame within the specified time.	The keypad displays the fault code.	• Check whether the safety master sends any data. • Check whether the watchdog is working properly. • Check whether the connection is disconnected.

- EE17.5: Invalid FSoE slave address
  Cause:

  The FSoE communication address does not meet the requirements.

Cause	Check Method	Solution
In the Connection state, the received slave address is inconsistent.	The keypad displays the fault code.	• Check whether the slave address sent from the safety master is correct. • Check whether the address of the slave is set correctly.

- EE17.6: Invalid FSoE safety data
  Cause:

  The FSoE communication parameters are incorrect or the connection fails. In this case, the safety data is invalid.

Cause	Check Method	Solution
In the Connection and Parameter state, the safety data received by the slave is invalid.	The keypad displays the fault code.	• Check whether the data sent by the safety master is wrong. • Check whether the safety data has been modified.

- EE17.7: Invalid FSoE communication parameter length
  Cause:

  The length and value of the FSoE communication parameters are out of the specified range.

Cause	Check Method	Solution
The length of the parameters received by the slave is inconsistent with that set by the slave.	The keypad displays the fault code.	• Check whether the length of data sent by the safety master is wrong. • Check whether the data has been modified.

- EE17.8: FSoE invalid communication parameter data
  Cause:

  FSoE communication parameter data is out of range.

Cause	Check Method	Solution
The watchdog time settings received by the slave are improper.	The keypad displays the fault code.	• Check whether the data sent by the safety master is wrong. • Check whether the data has been modified.

- EE17.9: Invalid FSoE application program parameter length
  Cause:

  The length of the FSoE communication application parameters does not match the preset value.

Cause	Check Method	Solution
The length of the application parameters received by the slave is inconsistent with that set by the slave.	The keypad displays the fault code.	• Check whether the data sent by the safety master is wrong. • Check whether the data has been modified.

- EE17.A: FSoE invalid application parameter data
  Cause:

  The FSoE communication application program parameter data is out of the range.

Cause	Check Method	Solution
The application parameters received by the slave are incorrect.	The keypad displays the fault code.	• Check whether the data sent by the safety master is wrong. • Check whether the data has been modified.

9.4 Solutions to Alarms

- E108.5: Parameter-write timeout
  Cause:

  The maximum allowable time has been exceeded when writing safety module parameters to EEPROM.

Cause	Check Method	Solution
EEPROM error	Power off and restart the drive to check whether parameter modification is activated.	• Power off and restart the drive, then try to modify parameters again. • Replace the safety module.

- E108.6: Parameter-read timeout
  Cause:

  The maximum allowable time has been exceeded when reading safety module parameters from EEPROM.

Cause	Check Method	Solution
EEPROM error	Power off and restart the drive to check whether parameter modification is activated.	• Power off and restart the drive, then try to modify parameters again. • Replace the safety module.

- E108.7: Parameter-write 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	Check Method	Solution
An error occurs when writing parameters to EEPROM.	Reset the fault and write safety module parameters again.	If the fault remains, it is recommended to replace the safety module.

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

  When the safety module reads data from EEPROM, the check on the data being read fails.

Cause	Check Method	Solution
When the safety module reads data from EEPROM, the check on the data being read fails.	Modify a certain 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 alarm
  Cause:

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

  2. The SSM hysteresis is equal to or higher than the difference between the upper limit and lower limit.

Cause	Check Method	Solution
1. The lower limit of SSM is equal to or higher than the upper limit.	Local mode: • Check whether the value of H20.71 is higher than or equal to the value of H20.70. • Check whether the value of H20.72 is higher than or equal to the difference between H20.70 and H20.71.	• Set SSM parameters properly. • The upper limit of SSM is higher than the lower limit.
2. The SSM hysteresis is equal to or higher than the difference between the upper limit and lower limit.	FSoE module: • Check whether the value of 66E4h is higher than or equal to the value of 66E2. • Check whether the value of H20.72 is higher than or equal to the difference between 66E2 and 66E4.	The SSM hysteresis is lower than the difference between the SSM upper limit and lower limit.

- E116.0: SLS overspeed warning

Cause:

The speed limit is exceeded during SLS speed limit monitoring.

Cause	Check Method	Solution
The speed limit is exceeded during SLS speed limit monitoring.	Check the fault log to see if the corresponding speed of E116.0 alarm code exceeds the limit of SLS.	Control the motor speed so that it does not exceed the SLS limit.

- E116.1: SDI out of tolerance alarm

  Cause:

  The limit is exceeded during SDI direction monitoring.

Cause	Check Method	Solution
The limit is exceeded during SDI direction monitoring. An alarm 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 of E116.1 alarm code 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 of SDI.

10 List of Parameters

10.1 Parameter Group H02

Param.	Communication Address	Name	Value Range	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 221
H02.11	2002-0Ch	Motor speed threshold at brake output OFF in rotation state	20 to 3000	30	RPM	Real time	" H02_en.11" on page 221
H02.12	2002-0Dh	Delay from S-ON OFF to brake output OFF in rotation state	1 to 65535	500	ms	Real time	" H02_en.12" on page 221

10.2 Parameter Group H0A

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H0A.73	200A-4Ah	STO 24 V disconnection filter time	1 to 5	5	ms	Real time	" H0A_en.73" on page 222
H0A.74	200A-4Bh	Tolerance filter time for two inconsistent STO channels	1 to 1000	100	ms	Real time	" H0A_en.74" on page 222
H0A.75	200A-4Ch	Servo OFF delay after STO triggered	0 to 25	20	ms	Real time	" H0A_en.75" on page 222

10.3 Parameter Group H20

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.00	2020 to 01h	Functional safety module software version	0.00 to 655.35	0.00	-	N/A	" H20_en.00" on page 223
H20.01	2020-02h	Safety function trigger mode	0: Triggered by local mode 1: Triggered by FSoE mode	0	-	At stop	" H20_en.01" on page 223
H20.02	2020-03h	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 223
H20.03	2020-04h	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 224
H20.04	2020-05h	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 224

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.05	2020-06h	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 225*
H20.06	2020-07h	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 225*
H20.08	2020-09h	Safety module DI1 noise reduction filter time	1 to 500	5	ms	At stop	*" H20_en.08" on page 226*
H20.09	2020-0Ah	Safety module DI2 noise reduction filter time	1 to 500	5	ms	At stop	*" H20_en.09" on page 226*
H20.10	2020 to 0Bh	Safety module DI3 noise reduction filter time	1 to 500	5	ms	At stop	*" H20_en.10" on page 227*
H20.11	2020-0Ch	Safety module DI4 noise reduction filter time	1 to 500	5	ms	At stop	*" H20_en.11" on page 227*

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.12	2020-0Dh	Safety module DI5 noise reduction filter time	1 to 500	5	ms	At stop	" H20_en.12" on page 227
H20.14	2020-0Fh	Safety module DI1 allowable discrepancy time	5 to 60000	10	ms	At stop	" H20_en.14" on page 228
H20.15	2020 to 10h	Safety module DI2 allowable discrepancy time	5 to 60000	10	ms	At stop	" H20_en.15" on page 228
H20.16	2020 to 11h	Safety module DI3 allowable discrepancy time	5 to 60000	10	ms	At stop	" H20_en.16" on page 228
H20.17	2020 to 12h	Safety module DI4 allowable discrepancy time	5 to 60000	10	ms	At stop	" H20_en.17" on page 229
H20.18	2020-13h	Safety module DI5 allowable discrepancy time	5 to 60000	10	ms	At stop	" H20_en.18" on page 229
H20.20	2020 to 15h	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 229

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.21	2020-16h	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 230*
H20.22	2020-17h	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 231*
H20.23	2020-18h	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 231*

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.24	2020-19h	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 232
H20.25	2020-1Ah	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 233
H20.28	2020-1Dh	STO-to-SBC activation delay	-30000 to +30000	-30	ms	At stop	" H20_en.28" on page 233
H20.29	2020-1Eh	SS1/SS2 stop mode	0: Ramp to stop 1: Stop as defined by host controller	1	-	At stop	" H20_en.29" on page 233
H20.30	2020-1Fh	SS1/SS2 ramp-to-stop reference speed	60 to 6000	1000	rpm	At stop	" H20_en.30" on page 234
H20.31	2020-20h	SS1/SS2 ramp-to-stop deceleration time	1 to 65535	500	ms	At stop	" H20_en.31" on page 234
H20.32	2020-21h	SS1monitor mode	0:SS1-t 1:SS1-r	0	-	At stop	" H20_en.32" on page 234

Param.	Communication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.33	2020-22h	SS1 trigger-to-STO delay/SS2 trigger-to-STO delay	0 to 65535	1000	ms	At stop	" H20_en.33" on page 235
H20.34	2020-23h	SS1/SS2 zero speed threshold	1 to 6000	10	rpm	At stop	" H20_en.34" on page 235
H20.35	2020-24h	SS1/SS2 zero speed window time	0 to 65535	0	ms	At stop	" H20_en.35" on page 235
H20.36	2020-25h	SS1/SS2 ramp monitor start delay	5 to 65535	10	ms	At stop	" H20_en.36" on page 236
H20.37	2020-26h	SS1/SS2 ramp monitor reference speed	60 to 6000	1000	rpm	At stop	" H20_en.37" on page 236
H20.38	2020-27h	SS1/SS2 ramp deceleration monitoring time	1 to 65535	65535	ms	At stop	" H20_en.38" on page 236
H20.41	2020-2Ah	SS1/SS2 ramp limit trigger-to-alarm time	0 to 65535	5	ms	At stop	" H20_en.41" on page 237
H20.42	2020-2Bh	SS1/SS2 ramp monitor stop speed	0 to 6000	1	RPM	At stop	" H20_en.42" on page 237
H20.43	2020-2Ch	SS2 monitor mode	0: SS2-t 1: SS2-r	0	-	At stop	" H20_en.43" on page 237
H20.44	2020-2Dh	SOS speed change threshold	1 to 6000	10	rpm	At stop	" H20_en.44" on page 238
H20.45	2020-2Eh	SOS position change threshold	1 to 536870912	932067	Encoder unit	At stop	" H20_en.45" on page 238

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.47	2020-30h	SOS overthres hold-to-alarm time	0 to 65535	5	ms	At stop	" H20_en.47" on page 238
H20.48	2020-31h	SLS switchover delay 1	0 to 65535	100	ms	At stop	" H20_en.48" on page 239
H20.49	2020-32h	SLS switchover delay 2	0 to 65535	100	ms	At stop	" H20_en.49" on page 239
H20.50	2020-33h	SLS switchover delay 3	0 to 65535	100	ms	At stop	" H20_en.50" on page 239
H20.51	2020-34h	SLS switchover delay 4	0 to 65535	100	ms	At stop	" H20_en.51" on page 240
H20.52	2020–35 h	SLS speed limit threshold 1	0 to 6000	1000	rpm	At stop	" H20_en.52" on page 240
H20.53	2020-36h	SLS speed limit threshold 2	0 to 6000	1000	rpm	At stop	" H20_en.53" on page 240
H20.54	2020-37h	SLS speed limit threshold 3	0 to 6000	1000	rpm	At stop	" H20_en.54" on page 240
H20.55	2020-38h	SLS speed limit threshold 4	0 to 6000	1000	rpm	At stop	" H20_en.55" on page 241
H20.56	2020-39h	SLS speed limit active filter 1	0 to 65535	100	ms	At stop	" H20_en.56" on page 241
H20.57	2020-3Ah	SLS speed limit active filter 2	0 to 65535	100	ms	At stop	" H20_en.57" on page 241
H20.58	2020-3Bh	SLS speed limit active filter 3	0 to 65535	100	ms	At stop	" H20_en.58" on page 241
H20.59	2020-3Ch	SLS speed limit active filter 4	0 to 65535	100	ms	At stop	" H20_en.59" on page 242
H20.60	2020-3Dh	SDI fault response mode	0:STO 1:SS1-t	0	-	At stop	" H20_en.60" on page 242
H20.70	2020-47h	SSM upper limit threshold	-6000 to +6000	200	rpm	At stop	" H20_en.70" on page 242

Param.	Commu nication Address	Name	Value Range	Default	Unit	Change Mode	Page
H20.71	2020 to 48h	SSM lower limit threshold	-6000 to +6000	-200	rpm	At stop	" H20_en.71" on page 243
H20.72	2020-49h	SSM hysteresis threshold	0 to 6000	10	rpm	At stop	" H20_en.72" on page 243
H20.74	2020-4Bh	SDI zero position window	1 to 536870912	932067	Encod er unit	At stop	" H20_en.74" on page 243
H20.76	2020-4Dh	SDI zero speed window	0 to 3000	10	rpm	At stop	" H20_en.76" on page 244
H20.77	2020-4Eh	SDI delay time	0 to 65535	0	ms	At stop	" H20_en.77" on page 244
H20.78	2020-4Fh	SDI fault response mode	0:STO 1:SS1-t	0	-	At stop	" H20_en.78" on page 244

10.4 Parameters in Group 6000

Param.	Commu nication Address	Name	Setpoint	Default	Unit	Change mode	Page
6620.01 h	6620-01h	Low 8 bits of safety control word	0 to 255	0	-	N/A	" 6620_en.01h" on page 245
6620.02 h	6620-02h	High 8 bits of safety control word	0 to 255	0	-	N/A	" 6620_en.02h" on page 245
6621.01 h	6621-01h	Low 8 bits of safety status word	0 to 255	0	-	N/A	" 6621_en.01h" on page 246
6621.02 h	6621-02h	High 8 bits of safety status word	0 to 255	0	-	N/A	" 6621_en.02h" on page 247
6630h	6630h	Restart Ack reset signal	0 to 1	0	-	Real time	" 6630h" on page 248
6632h	6632h	Fault state	0 to 1	0	-	Real time	" 6632h" on page 249
6640h	6640h	STO signal	0 to 1	0	-	Real time	" 6640h" on page 249

Param.	Communication Address	Name	Setpoint	Default	Unit	Change mode	Page
6641h	6641h	STO reset mode	0 to 1	0	-	Real time	" 6641h" on page 249
6650.01h	6650-01h	SS1 signal	0 to 1	0	-	Real time	" 6650_en.01h" on page 250
6651.01h	6651-01h	SS1 trigger-to-STO delay	0 to 65535	1000	ms	Real time	" 6651_en.01h" on page 250
6653.01h	6653-01h	SS1 zero speed threshold	1 to 6000	10	rpm	Real time	" 6653_en.01h" on page 250
6654.01h	6654-01h	SS1 zero speed window time	0 to 65535	0	ms	Real time	" 6654_en.01h" on page 251
6656.01h	6656-01h	SS1 deceleration limit	0 to 4294967295	15	Encoder unit/s^2	Real time	" 6656_en.01h" on page 251
6657.01h	6657-01h	SS1 ramp monitor start delay	0 to 65535	10	ms	Real time	" 6657_en.01h" on page 251
6660h	6660h	SBC signal	0 to 1	0	-	Real time	" 6660h" on page 252
6668.01h	6668-01h	SOS signal	0 to 1	0	-	Real time	" 6668_en.01h" on page 252
666A.01h	666A-01h	SOS zero position threshold	0 to 536870912	932067	Encoder unit	Real time	" 666A_en.01h" on page 252
666C.01h	666C-01h	SOS zero speed threshold	0 to 6000	10	rpm	Real time	" 666C_en.01h" on page 253
6670.01h	6670-01h	SS2 signal	0 to 1	0	-	Real time	" 6670_en.01h" on page 253
6671.01h	6671-01h	SS2 trigger-to-STO delay	0 to 65535	10	ms	Real time	" 6671_en.01h" on page 253
6672.01h	6672-01h	SS2 zero speed window time	0 to 65535	0	ms	Real time	" 6672_en.01h" on page 254
6674.01h	6674-01h	SS2 deceleration limit	0 to 4294967295	15	Encoder unit/s^2	Real time	" 6674_en.01h" on page 254
6675.01h	6675-01h	SS2 ramp monitor start delay	0 to 65535	10	ms	Real time	" 6675_en.01h" on page 254

Param.	Communication Address	Name	Setpoint	Default	Unit	Change mode	Page
6676.01h	6676-01h	SS2 reset mode	0 to 1	0	-	Real time	"6676_en.01h" on page 255
6690.01h	6690-01h	SLS1 signal	0 to 1	0	-	Real time	"6690_en.01h" on page 255
6690.02h	6690-02h	SLS2 signal	0 to 1	0	-	Real time	"6690_en.02h" on page 255
6690.03h	6690-03h	SLS3 signal	0 to 1	0	-	Real time	"6690_en.03h" on page 256
6690.04h	6690-04h	SLS4 signal	0 to 1	0	-	Real time	"6690_en.04h" on page 256
6691.01h	6691-01h	SLS switchover delay 1	0 to 65535	100	ms	Real time	"6691_en.01h" on page 257
6691.02h	6691-02h	SLS switchover delay 2	0 to 65535	100	ms	Real time	"6691_en.02h" on page 257
6691.03h	6691-03h	SLS switchover delay 3	0 to 65535	100	ms	Real time	"6691_en.03h" on page 257
6691.04h	6691-04h	SLS switchover delay 4	0 to 65535	100	ms	Real time	"6691_en.04h" on page 258
6693.01h	6693-01h	SLS speed limit threshold 1	0 to 6000	1000	rpm	Real time	"6693_en.01h" on page 258
6693.02h	6693-02h	SLS speed limit threshold 2	0 to 6000	1000	rpm	Real time	"6693_en.02h" on page 258
6693.03h	6693-03h	SLS speed limit threshold 3	0 to 6000	1000	rpm	Real time	"6693_en.03h" on page 259
6693.04h	6693-04h	SLS speed limit threshold 4	0 to 6000	1000	rpm	Real time	"6693_en.04h" on page 259
6694.01h	6694-01h	SLS speed limit active filter 1	0 to 65535	10	ms	Real time	"6694_en.01h" on page 259
6694.02h	6694-02h	SLS speed limit active filter 2	0 to 65535	10	ms	Real time	"6694_en.02h" on page 259
6694.03h	6694-03h	SLS speed limit active filter 3	0 to 65535	10	ms	Real time	"6694_en.03h" on page 260

Param.	Communication Address	Name	Setpoint	Default	Unit	Change mode	Page
6694.04h	6694-04h	SLS speed limit active filter 4	0 to 65535	10	ms	Real time	" 6694_en.04h" on page 260
66D0h	66D0h	SDIp signal	0 to 1	0	-	Real time	" 66D0h" on page 260
66D1h	66D1h	SDIn signal	0 to 1	0	-	Real time	" 66D1h" on page 261
66D3h	66D3h	SDI zero position window	0 to 536870912	932067	Encoder unit	Real time	" 66D3h" on page 261
66D5h	66D5h	SDI zero speed window	0 to 3000	10	rpm	Real time	" 66D5h" on page 262
66E0.01h	66E0-01h	SSM state	0 to 1	0	-	N/A	" 66E0_en.01h" on page 262
66E2.01h	66E2-01h	SSM upper limit threshold	-6000 to +6000	200	rpm	Real time	" 66E2_en.01h" on page 262
66E4.01h	66E4-01h	SSM lower limit threshold	-6000 to +6000	-200	rpm	Real time	" 66E4_en.01h" on page 262
E600.01h	E600-01h	FSoE slave command	0 to 255	0	-	N/A	" E600_en.01h" on page 263
E600.02h	E600-02h	FSoE slave connection ID	0 to 65535	0	-	N/A	" E600_en.02h" on page 263
E600.03h	E600-03h	FSoE slave CRC value	0 to 65535	0	-	N/A	" E600_en.03h" on page 263
E601.01h	E601-01h	FSoE connection status	0 to 1	0	-	N/A	" E601_en.01h" on page 264
E700.01h	E700-01h	FSoE master command	0 to 255	0	-	Real time	" E700_en.01h" on page 264
E700.02h	E700-02h	FSoE master connection ID	0 to 65535	0	-	Real time	" E700_en.02h" on page 264
E700.03h	E700-03h	FSoE master CRC value	0 to 65535	0	-	Real time	" E700_en.03h" on page 264
E901.01h	E901-01h	FSoE version	0 to 65535	0	-	N/A	" E901_en.01h" on page 265
E901.02h	E901-02h	FSoE safety address	0 to 65535	0	-	N/A	" E901_en.02h" on page 265
E901.03h	E901-03h	FSoE connection ID	0 to 65535	0	-	N/A	" E901_en.03h" on page 265

Param.	Communication Address	Name	Setpoint	Default	Unit	Change mode	Page
E901.04h	E901-04h	Watchdog time	0 to 65535	0	-	N/A	" E901_en.04h" on page 265
E901.06h	E901-06h	Connection type	0 to 65535	0	-	N/A	" E901_en.06h" on page 266
E901.07h	E901-07h	Communication parameter length	0 to 65535	0	-	N/A	" E901_en.07h" on page 266
E901.08h	E901-08h	Application layer parameter length	0 to 65535	0	-	N/A	" E901_en.08h" on page 266
E901.09h	E901-09h	SRA CRC	0 to 65535	0	-	N/A	" E901_en.09h" on page 267
F980.01h	F980-01h	FSoE address	0 to 255	0	-	N/A	" F980_en.01h" on page 267

11 Description of 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 to 3000

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 to 65535

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:

1 to 5

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:

0ms to 25ms

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

H20.00 **Safety module software version**

Hex:	2020-01h	Effective mode:	-
Min.:	0.00	Unit:	-
Max.:	655.35	Data Type:	UInt16
Default:	0.00	Change:	Unchangeable

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**

Hex:	2020-02h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop

Value Range:

0: Local trigger

1: FSoE trigger

Description

Sets the trigger of the safety function.

H20.02 **Safety module DI1 function selection**

Hex:	2020-03h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	11	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-04h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	11	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-05h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	11	Data Type:	UInt16

Default:	0	Change:	At stop

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

Hex:	2020-06h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	11	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-07h	Effective mode:	Upon the next power-on

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

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 reduction filter time

Hex:	2020-09h	Effective mode:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1 to 500

Description

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

H20.09 Safety module DI2 noise reduction filter time

Hex:	2020-0Ah	Effective mode:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1 to 500

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 reduction filter time

Hex:	2020-0Bh	Effective mode:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1 to 500

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 reduction filter time

Hex:	2020-0Ch	Effective mode:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1 to 500

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 reduction filter time

Hex:	2020-0Dh	Effective mode:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1ms to 500ms

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

Hex:	2020-0Fh	Effective mode:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5ms to 60000ms

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

Hex:	2020-10h	Effective mode:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5ms to 60000ms

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

Hex:	2020-11h	Effective mode:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5ms to 60000ms

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

Hex:	2020-12h	Effective mode:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5ms to 60000ms

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

Hex:	2020-13h	Effective mode:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5ms to 60000ms

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

Hex:	2020-15h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-16h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-17h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-18h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-19h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-1Ah	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	14	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-1Dh	Effective mode:	Upon the next power-on
Min.:	-30000	Unit:	ms
Max.:	30000	Data Type:	UInt16
Default:	-30	Change:	At stop

Value Range:

-30000ms to 30000ms

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

Hex:	2020-1Eh	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-

Max.:	1	Data Type:	UInt16
Default:	1	Change:	At stop

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

Hex:	2020-1Fh	Effective mode:	Upon the next power-on
Min.:	60	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop

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

Hex:	2020-20h	Effective mode:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	500	Change:	At stop

Value Range:

1ms to 65535ms

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/SS2 monitor mode

Hex:	2020-21h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop

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

Hex:	2020-22h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	1000	Change:	At stop

Value Range:

0ms to 65535ms

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

Hex:	2020-23h	Effective mode:	Upon the next power-on
Min.:	1	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

1rpm to 6000rpm

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

Hex:	2020-24h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	At stop

Value Range:

0ms to 65535ms

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

Hex:	2020-25h	Effective mode:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5ms to 65535ms

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

Hex:	2020-26h	Effective mode:	Upon the next power-on
Min.:	60	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop

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

Hex:	2020-27h	Effective mode:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	65535	Change:	At stop

Value Range:

1ms to 65535ms

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

Hex:	2020-2Ah	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

0ms to 65535ms

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

Hex:	2020-2Bh	Effective mode:	Upon the next power-on
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	1	Change:	At stop

Value Range:

0rpm to 6000rpm

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

Hex:	2020-2Ch	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-

Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop

Value Range:

0:SS2-t

1:SS2-r

Description

Sets the monitoring mode for SS2.

H20.44 SOS speed change threshold

Hex:	2020-2Dh	Effective mode:	Upon the next power-on
Min.:	1	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

1rpm to 6000rpm

Description

Sets the maximum allowable difference between motor speed and 0 rpm in SOS state.

H20.45 SOS position change threshold

Hex:	2020-2Eh	Effective mode:	Upon the next power-on
Min.:	1	Unit:	Encoder unit
Max.:	536870912	Data Type:	UInt16
Default:	932067	Change:	At stop

Value Range:

1 to 536870912

Description

Sets the maximum allowable variation of position feedback in SOS state.

H20.47 SOS overthreshold-to-alarm time

Hex:	2020-30h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

0ms to 65535ms

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

Hex:	2020-31h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0ms to 65535ms

Description

Sets the delay time from activation of SLS1 request command to activation of SLS1 monitoring.

H20.49 SLS2 switchover delay

Hex:	2020-32h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0ms to 65535ms

Description

Sets the delay time from activation of SLS2 request command to activation of SLS2 monitoring.

H20.50 SLS3 switchover delay

Hex:	2020-33h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0ms to 65535ms

Description

Sets the delay time from activation of SLS3 request command to activation of SLS3 monitoring.

H20.51 **SLS4 switchover delay**

Hex:	2020-34h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0ms to 65535ms

Description

Sets the delay time from activation of SLS4 request command to activation of SLS4 monitoring.

H20.52 **SLS1 threshold**

Hex:	2020-35h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop

Value Range:

0rpm to 6000rpm

Description

Sets the speed threshold for SLS1 monitoring.

H20.53 **SLS2 threshold**

Hex:	2020-36h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop

Value Range:

0rpm to 6000rpm

Description

Sets the speed threshold for SLS2 monitoring.

H20.54 **SLS3 threshold**

Hex:	2020-37h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop

Value Range:

0rpm to 6000rpm

Description

Sets the speed threshold for SLS3 monitoring.

H20.55 **SLS4 threshold**

Hex:	2020-38h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop

Value Range:

0rpm to 6000rpm

Description

Sets the speed threshold for SLS4 monitoring.

H20.56 **SLS1 filter time**

Hex:	2020-39h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0ms to 65535ms

Description

Sets the filtering time for determining that the motor speed is within the SLS1 limit.

H20.57 **SLS2 filter time**

Hex:	2020-3Ah	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0ms to 65535ms

Description

Sets the filtering time for determining that the motor speed is within the SLS2 limit.

H20.58 **SLS3 filter time**

Hex:	2020-3Bh	Effective mode:	Upon the next power-on

Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0ms to 65535ms

Description

Sets the filtering time for determining that the motor speed is within the SLS3 limit.

H20.59 **SLS4 filter time**

Hex:	2020-3Ch	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0ms to 65535ms

Description

Sets the filtering time for determining that the motor speed is within the SLS4 limit.

H20.60 **SLS fault response mode**

Hex:	2020-3Dh	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop

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**

Hex:	2020-47h	Effective mode:	Upon the next power-on
Min.:	-6000	Unit:	RPM
Max.:	6000	Data Type:	Int16
Default:	200	Change:	At stop

Value Range:

–6000 rpm to +6000 rpm

Description

Upper limit for SSM monitoring

H20.71 SSM lower limit

Hex:	2020-48h	Effective mode:	Upon the next power-on
Min.:	-6000	Unit:	RPM
Max.:	6000	Data Type:	Int16
Default:	-200	Change:	At stop

Value Range:

–6000 rpm to +6000 rpm

Description

Lower limit for SSM monitoring

H20.72 SSM hysteresis threshold

Hex:	2020-49h	Effective mode:	Upon the next power-on
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

0rpm to 6000rpm

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

Hex:	2020-4Bh	Effective mode:	Upon the next power-on
Min.:	1	Unit:	Encoder unit
Max.:	536870912	Data Type:	UInt32
Default:	932067	Change:	At stop

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

Hex:	2020-4Dh	Effective mode:	Upon the next power-on
Min.:	0	Unit:	RPM
Max.:	3000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

0rpm to 3000rpm

Description

Sets the speed threshold for stopping the monitoring.

(Velocity window for n=0)

H20.77 SDI delay time

Hex:	2020-4Eh	Effective mode:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	At stop

Value Range:

0ms to 65535ms

Description

Sets the delay time from activation of SDI command to activation of SDI monitoring.

H20.78 SDI fault response mode

Hex:	2020-4Fh	Effective mode:	Upon the next power-on
Min.:	0	Unit:	-
Max.:	1	Data Type:	UInt16
Default:	0	Change:	At stop

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.

11.4 6000h Object Dictionary

6620.01h Safety control word low 8 bits

Hex:	6620-01h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	255	Data Type:	UInt8
Default:	0	Change:	Unchangeable

Value Range:

0 to 255

Description

Reflects the current state of the RPDO control command issued by the host controller.

Variable PDO	Description
bit0	Displays STO command state 0: STO trigger command present 1: No STO trigger command
bit1	Displays SS1 command state 0: SS1 trigger command present 1: No SS1 trigger command
bit2	Displays SS2 command state 0: SS2 trigger command present 1: No SS2 trigger command
bit3	Displays SOS command state 0: SOS trigger command present 1: No SOS trigger command
bit5	Displays SDIp command state 0: SDIp trigger command present 1: No SDIp trigger command
bit6	Displays SDIn command state 0: SDIn trigger command present 1: No SDIn trigger command
bit7	Displays Ack fault state 0: No Ack command 1: Ack command present

6620.02h Safety control word high 8 bits

Hex:	6620-02h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	255	Data Type:	UInt8
Default:	0	Change:	Unchangeable

Value Range:
0 to 255
Description
Reflects the current state of the RPDO control command issued by the host controller.

Variable PDO	Description
bit0	Displays reset command state 0: No reset command 1: Reset command present
bit1	Displays SBC command state 0: SBC trigger command present 1: No SBC trigger command
bit2	Displays SLS1 command state 0: SLS1 trigger command present 1: No SLS1 trigger command
bit3	Displays SLS2 command state 0: SLS2 trigger command present 1: No SLS2 trigger command
bit4	Displays SLS3 command state 0: SLS3 trigger command present 1: No SLS3 trigger command
bit5	Displays SLS4 command state 0: SLS4 trigger command present 1: No SLS4 trigger command

6621.01h Safety status word low 8 bits

Hex:	6621-01h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	255	Data Type:	UInt8
Default:	0	Change:	Unchangeable

Value Range:
0 to 255

Description

Reflects the current TPDO state uploaded by the safety module.

Variable PDO	Description
bit0	Displays STO state 0: Non-STO state 1: STO state
bit1	Displays SSM state 0: The speed is within SSM limit range 1: The speed is out of SSM limit range
bit3	Displays SOS state 0: Non-SOS state 1: SOS state
bit5	Displays SDIp state 0: Motor is not in forward motion 1: Motor is in forward motion
bit6	Displays SDIn state 0: Motor is not in reverse motion 1: Motor is in reverse motion
bit7	Displays safety function fault state 0: Normal 1: Faulty

6621.02h Safety status word high 8 bits

Hex:	6621-02h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	255	Data Type:	UInt8
Default:	0	Change:	Unchangeable

Value Range:

0 to 255

Description

Reflects the current TPDO state uploaded by the safety module.

Variable PDO	Description
bit0	Displays reset state 0: Non-reset state 1: Reset state
bit1	Displays SBC state 0: Non-SBC state 1: SBC state
bit2	Displays SLS1 state 0: Non-SLS1 state 1: SLS1 state
bit3	Displays SLS2 state 0: Non-SLS2 state 1: SLS2 state
bit4	Displays SLS3 state 0: Non-SLS3 state 1: SLS3 state
bit5	Displays SLS4 state 0: Non-SLS4 state 1: SLS4 state
bit7	Displays FSoE connection status 0: Connection is normal 1: Connection is abnormal

6630h Restart Ack signal

Hex:	6630h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes reset command 0: Do not trigger reset 1: Trigger reset
TPDO	Displays reset state 0: Non-reset state 1: Reset state

6632h **Fault state**

Hex:	6632h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Variable PDO	Description
TPDO	Displays fault state 0: Non-faulty 1: Faulty

6640h **STO signal**

Hex:	6640h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes STO command 0: Trigger STO 1: Do not trigger STO
TPDO	Displays STO state 0: Non-STO state 1: STO state

6641h **STO reset mode selection**

Hex:	6641h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Select the STO reset mode.

Variable SDO	Description
SDO	STO reset mode selection 0: Restart Ack signal is not required 1: Restart Ack signal is required

6650.01h SS1 signal

Hex:	6650-01h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes SS1 command 0: Trigger SS1 1: Do not trigger SS1
TPDO	Displays SS1 state 0: Non-SS1 state 1: SS1 state

6651.01h SS1 trigger-to-STO delay time

Hex:	6651-01h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	1000	Change:	Real-time

Value Range:

0ms to 65535ms

Description

After SS1 is triggered, OD Index STO state after a period of time exceeding the value set by this parameter has elapsed.

6653.01h SS1 zero speed threshold

Hex:	6653-01h	Effective mode:	At stop
Min.:	1	Unit:	RPM
Max.:	6000	Data Type:	UInt32

Default:	10	Change:	Real-time

Value Range:

1rpm to 6000rpm

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.

6654.01h SS1 zero speed threshold time

Hex:	6654-01h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Real-time

Value Range:

0ms to 65535ms

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.

6656.01h SS1 deceleration limit

Hex:	6656-01h	Effective mode:	At stop
Min.:	0	Unit:	Encoder unit/s^2
Max.:	4294967295	Data Type:	UInt32
Default:	15	Change:	Real-time

Value Range:

0 encoder unit/s^2–4294967295 encoder unit/s^2

Description

Sets the minimum deceleration threshold for SS1 when ramp monitoring is performed.

6657.01h SS1 ramp monitor start delay time

Hex:	6657-01h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	Real-time

Value Range:

0ms to 65535ms

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.

6660h SBC signal

Hex:	6660h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes SBC command 0: SBC active 1: SBC deselected
TPDO	Displays SBC state 0: Normal state 1: SBC state

6668.01h SOS signal

Hex:	6668-01h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Variable PDO	Description
TPDO	Displays SOS state 0: Non-SOS state 1: SOS state

666A.01h SOS zero position threshold

Hex:	666A-01h	Effective mode:	At stop
Min.:	0	Unit:	Encoder unit
Max.:	536870912	Data Type:	UInt32

Default:	932067	Change:	Real-time

Value Range:
0 to 536870912
Description
Sets the maximum allowable variation of position feedback in SOS state.

666C.01h SOS zero speed threshold

Hex:	666C-01h	Effective mode:	At stop
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt32
Default:	10	Change:	Real time

Value Range:
0 to 6000
Description
Sets the maximum allowable difference between motor speed and 0 rpm in SOS state.

6670.01h SS2 signal

Hex:	6670-01h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:
0 to 1
Description

Variable PDO	Description
RPDO	Executes SS2 command 0: Trigger SS2 1: Do not trigger SS2
TPDO	Displays SS2 state 0: Non-SS2 state 1: SS2 state

6671.01h SS2 trigger-to-STO delay time

Hex:	6671-01h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	Real-time

Value Range:

0ms to 65535ms

Description

After SS2 is triggered, the drive enters the SOS state after a period of time exceeding the value set by this parameter has elapsed.

6672.01h SS2 zero speed threshold time

Hex:	6672-01h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Real-time

Value Range:

0ms to 65535ms

Description

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.

6674.01h SS2 deceleration limit

Hex:	6674-01h	Effective mode:	At stop
Min.:	0	Unit:	Encoder unit/s^2
Max.:	4294967295	Data Type:	UInt32
Default:	15	Change:	Real-time

Value Range:

0 encoder unit/s^2–4294967295 encoder unit/s^2

Description

Sets the minimum deceleration threshold for SS2 when ramp monitoring is performed.

6675.01h SS2 ramp monitor start delay time

Hex:	6675-01h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	Real-time

Value Range:

0ms to 65535ms

Description

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.

6676.01h SS2 reset mode selection

Hex:	6676-01h	Effective mode:	At stop
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Variable SDO	Description
SDO	SS2 reset mode 0: Restart Ack signal is not required upon SS2 reset 1: Restart Ack signal is required upon SS2 reset upon SS2 reset

6690.01h SLS1 signal

Hex:	6690-01h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes SLS1 command 0: SLS1 active 1: SLS1 deselected
TPDO	Displays SLS1 state 0: Normal state 1: SLS1 monitoring state

6690.02h SLS2 signal

Hex:	6690-02h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Displays SLS function state and executes SLS command.

Variable PDO	Description
RPDO	Executes SLS2 command 0: SLS2 active 1: SLS2 deselected
TPDO	Displays SLS2 state 0: Normal state 1: SLS2 monitoring state

6690.03h SLS3 signal

Hex:	6690-03h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Displays SLS function state and executes SLS command.

Variable PDO	Description
RPDO	Executes SLS3 command 0: SLS3 active 1: SLS3 deselected
TPDO	Displays SLS3 state 0: Normal state 1: SLS3 monitoring state

6690.04h SLS4 signal

Hex:	6690-04h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Displays SLS function state and executes SLS command.

Variable PDO	Description
RPDO	Executes SLS4 command 0: SLS4 active 1: SLS4 deselected
TPDO	Displays SLS4 state 0: Normal state 1: SLS4 monitoring state

6691.01h SLS1 switchover delay

Hex:	6691-01h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	Real-time

Value Range:

0ms to 65535ms

Description

Sets the delay time from activation of SLS1 request command to activation of SLS1 monitoring.

(Time delay to initiate SLS1 limits)

6691.02h SLS2 switchover delay

Hex:	6691-02h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	Real-time

Value Range:

0ms to 65535ms

Description

Sets the delay time from activation of SLS2 request command to activation of SLS2 monitoring.

6691.03h SLS3 switchover delay

Hex:	6691-03h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	Real-time

Value Range:

0ms to 65535ms

Description

Sets the delay time from activation of SLS3 request command to activation of SLS3 monitoring.

6691.04h SLS4 switchover delay

Hex:	6691-04h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	Real-time

Value Range:

0ms to 65535ms

Description

Sets the delay time from activation of SLS4 request command to activation of SLS4 monitoring.

6693.01h SLS1 threshold

Hex:	6693-01h	Effective mode:	At stop
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt32
Default:	1000	Change:	Real-time

Value Range:

0rpm to 6000rpm

Description

Sets the threshold for SLS1.

6693.02h SLS2 threshold

Hex:	6693-02h	Effective mode:	At stop
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt32
Default:	1000	Change:	Real-time

Value Range:

0rpm to 6000rpm

Description

Sets the threshold for SLS2.

6693.03h SLS3 threshold

Hex:	6693-03h	Effective mode:	At stop
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt32
Default:	1000	Change:	Real-time

Value Range:

0rpm to 6000rpm

Description

Sets the threshold for SLS3.

6693.04h SLS4 threshold

Hex:	6693-04h	Effective mode:	At stop
Min.:	0	Unit:	RPM
Max.:	6000	Data Type:	UInt32
Default:	1000	Change:	Real-time

Value Range:

0rpm to 6000rpm

Description

Sets the threshold for SLS4.

6694.01h SLS1 filter time

Hex:	6694-01h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	Real-time

Value Range:

0ms to 65535ms

Description

Sets the filter time within SLS1 window
(Time for speed within SLS1 window)

6694.02h SLS2 filter time

Hex:	6694-02h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	Real-time

Value Range:

0ms to 65535ms

Description

Sets the filter time within SLS2 window

6694.03h SLS3 filter time

Hex:	6694-03h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	Real-time

Value Range:

0ms to 65535ms

Description

Sets the filter time within SLS3 window

6694.04h SLS4 filter time

Hex:	6694-04h	Effective mode:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	Real-time

Value Range:

0ms to 65535ms

Description

Sets the filter time within SLS4 window

66D0h SDIp signal

Hex:	66D0h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Displays the forward rotation state of the motor and issues the SDI forward command.

Variable PDO	Description
RPDO	Executes SDIp monitoring function. 0: Forward rotation prohibited 1: Forward rotation allowed
TPDO	Indicates forward rotation state of the motor. 0: Motor is not in forward rotation 1: Motor is in forward rotation

66D1h SDIn signal

Hex:	66D1h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Real-time

Value Range:

0 to 1

Description

Displays the reverse rotation state of the motor and issues the SDI reverse command.

Variable PDO	Description
RPDO	Executes SDIn monitoring function. 0: Reverse direction is not allowed 1: Reverse direction is allowed
TPDO	Displays SDIn state 0: Motor is not running reversely 1: Motor is running reversely

66D3h SDI zero position threshold

Hex:	66D3h	Effective mode:	At stop
Min.:	0	Unit:	Encoder unit
Max.:	536870912	Data Type:	UInt32
Default:	932067	Change:	Real-time

Value Range:

0 to 536870912

Description

Sets the position window for stopping the monitoring.

66D5h **SDI zero speed threshold**

Hex:	66D5h	Effective mode:	At stop
Min.:	0	Unit:	RPM
Max.:	3000	Data Type:	UInt32
Default:	10	Change:	Real-time

Value Range:

0rpm to 3000rpm

Description

Zero speed threshold for SDI monitoring

66E0.01h **SSM state**

Hex:	66E0-01h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Unchangeable

Value Range:

0 to 1

Description

SSM can be implemented as a bit in the safety state.

Variable PDO	Description
TPDO	Displays SSM state 0: Motor speed out of SSM limit 1: Motor speed within SSM limit

66E2.01h **SSM upper limit**

Hex:	66E2-01h	Effective mode:	At stop
Min.:	-6000	Unit:	RPM
Max.:	6000	Data Type:	Int32
Default:	200	Change:	Real-time

Value Range:

–6000 rpm to +6000 rpm

Description

Upper limit for SSM monitoring

66E4.01h **SSM lower limit**

Hex:	66E4-01h	Effective mode:	At stop
Min.:	-6000	Unit:	RPM

Max.:	6000	Data Type:	Int32
Default:	-200	Change:	Real-time

Value Range:

–6000 rpm to +6000 rpm

Description

Lower limit for SSM monitoring

E600.01h FSoE slave command

Hex:	E600-01h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	255	Data Type:	UInt8
Default:	0	Change:	Unchangeable

Value Range:

0 to 255

Description

FSoE slave command

E600.02h FSoE slave connection ID

Hex:	E600-02h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

FSoE slave connection ID

E600.03h FSoE slave CRC value

Hex:	E600-03h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

FSoE slave CRC value

E601.01h FSoE connection status

Hex:	E601-01h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	1	Data Type:	Boolean
Default:	0	Change:	Unchangeable

Value Range:

0 to 1

Description

Variable PDO	Description
TPDO	Displays FSoE connection status 0: Connection is normal. 1: Connection is abnormal.

E700.01h FSoE master command

Hex:	E700-01h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	255	Data Type:	UInt8
Default:	0	Change:	Real-time

Value Range:

0 to 255

Description

FSoE master command

E700.02h FSoE master connection ID

Hex:	E700-02h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Real-time

Value Range:

0 to 65535

Description

FSoE master connection ID

E700.03h FSoE master CRC value

Hex:	E700-03h	Effective mode:	Real time
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16

Default: 0 Change: Real-time

Value Range:

0 to 65535

Description

FSoE master CRC value

E901.01h FSoE version

Hex:	E901-01h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

Supported FSoE version

E901.02h FSoE address

Hex:	E901-02h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

FSoE address

E901.03h PSoE connection ID

Hex:	E901-03h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

ID of connection between FSoE master and slave.

E901.04h Watchdog time

Hex:	E901-04h	Effective mode:	-

Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

Watchdog timeout

E901.06h Connection type

Hex:	E901-06h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

0: Master connection

1: Slave connection

E901.07h Communication parameter length

Hex:	E901-07h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

The length of the communication parameters in the parameter set.

E901.08h Application layer parameter length

Hex:	E901-08h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

The length of the application parameters in the parameter set.

E901.09h **SRA CRC**

Hex:	E901-09h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 65535

Description

CRC checksum of safety-related application parameter sets.

F980.01h **FSOE address**

Hex:	F980-01h	Effective mode:	-
Min.:	0	Unit:	-
Max.:	255	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 255

Description

FSoE slave address

12 Maintenance

12.1 Routine Maintenance Items

Standard operating conditions:

Average annual ambient temperature: 30°C Average load rate: ＜ 80% Daily operating time: ＜ 20 h

12.1.1Routine Checklist

Check the following items during routine inspection.

Table 12–1 Routine checklist

No.	Routine Checklist	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 inlet.	☐
6	There is no intrusion of unwanted object on the load end.	☐

12.1.2Routine Cleaning List

Check the following items during routine cleaning.

Table 12–2 Routine cleaning list

No.	Routine Cleaning List	Checked
1	Clean the dust on the equipment surface, especially the metallic dust.	☐
2	Keep the front end of the servo drive and the connectors clean.	☐

Note

- Switch off the power supply before cleaning the equipment. Clean the equipment with a blower gun or a piece of dry cloth.
- To prevent equipment discoloration or damage, do not use gasoline, diluents, alcohol, or acidic/alkaline detergent for cleaning.

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 sign of damage.	☐
4	The clamping units of terminal blocks are in place.	☐

12.2.2Periodic Maintenance List

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 Inovance agent before replacement to double check whether the part needs 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 to 5 years (20,000 h to 30,000 h)	
	Oil seal	5000 h	
	Encoder	3 to 5 years (20,000 h to 30,000 h)	
	Absolute encoder battery	Depends on the operating condition See the operation instructions for the encoder battery for details.	

Note

For standard environment, see section Requirements on Installation Environment in the relevant installation guide.

13 Certification and Standard Requirements

CE Certification

<table>
<tr><th>Directive</th><th colspan="2">Standard</th></tr>
<tr><td rowspan="2">EMC Directive
2014/30/EU</td><td>Servo drive</td><td rowspan="2">EN 61800-3
EN 61800-6-2
EN 61800-6-4
EN 55011</td></tr>
<tr><td>Servo motor</td></tr>
<tr><td rowspan="2">Low Voltage Directive
2014/35/EU</td><td>Servo drive</td><td>EN 61800-5-1</td></tr>
<tr><td>Servo motor</td><td>EN 60034-1
EN 60034-5</td></tr>
<tr><td rowspan="2">RoHS Directive
2011/65/EU</td><td>Servo drive</td><td rowspan="2">EN 50581</td></tr>
<tr><td>Servo motor</td></tr>
</table>

UL/cUL Certification

<table>
<tr><th>Certification</th><th colspan="2">Standard</th></tr>
<tr><td rowspan="2">UL/cUL Certification</td><td>Servo drive</td><td>UL61800-5-1
C22.2 No.274-17</td></tr>
<tr><td>Servo motor</td><td>UL 1004-1
UL 1004-6
CSA C22.2 No. 100-14</td></tr>
</table>

Note

The product complies with the latest directives and standards of CE, UL/cUL certifications.

KC Certification

Note

SV680XXXXXX-PINT is not KC-certified.

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.

13.1 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.

13.1.1Requirements 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.

Caution

- 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, if necessary, to prevent the radio interference generated by the drive.

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.

13.1.2Requirements 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" on page 56*.

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*.

13.2 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. 274-17 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

Warning

On-site installation of output terminals (such as P⊕, C, and NΘ) is not allowed.

- Terminals P⊕, C, and NΘ 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 cable for the main circuit is a class 2 600V indoor heat-resistant PVC cable with continuous maximum allowable temperature of 75 ° C. The following conditions are used as premises:
  - Ambient temperature: < 40°C.
  - Normal operating ratings

If the recommended cables for peripheral equipment or options are not suitable for the product, contact Inovance.

Cable selection

To comply with UL61800-5-1 and CSA C22.2 No. 274-17, 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 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	15	6	40
	S2R8	15	10	40

Drive Model		Circuit breaker (A)	Class J fuse (A)	Recommended inverse time lag breaker[1] (A)
Size C	S5R5	15	20	40
	S7R6	15	20	100
Size D	S012	20	20	100
Three-phase 200 V				
Size A	S1R6	15	6	40
	S2R8	15	6	40
Size C	S5R5	15	15	40
	S7R6	15	15	100
Size D	S012	20	20	100
Size E	S018	40	20	100
	S022	40	35	100
	S027	40	40	100
Three-phase 400 V				
Size C	3R5	15	6	100
	5R4	15	10	100
Size D	T8R4	20	15	100
	T012	20	20	100
Size E	T017	40	35	100
	T021	40	35	100
	T026	40	40	100

Note

[1]: It is recommended to use the inverse time circuit breaker for multiple servo drives connected in parallel.

13.3 KC Certification

Note

SV680XXXXXX-PINT is not KC-certified.

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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13.4 EAC Certification

The Eurasian Customs Union is an economic organization led by Russia, consisting of Russia, Kazakhstan, Belarus, Kyrgyzstan and Armenia. EAC-certified products can be exported directly to these five countries.

AC drives and motor products fall into the EAC DoC category, and are subject to EAC–Safety (CU TR 004/2011) LVE and EAC–EMC (CU TR 020/2011).

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

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 (Safety Functions) Standard IEC 61800-5-2

14 Appendix

14.1 Safety Module Working with Beckhoff Safety CPU Unit

The following is an example of the simple configuration for FSoE-triggered safety function, with a Beckhoff safety CPU and TwinCAT3 master.

Hardware

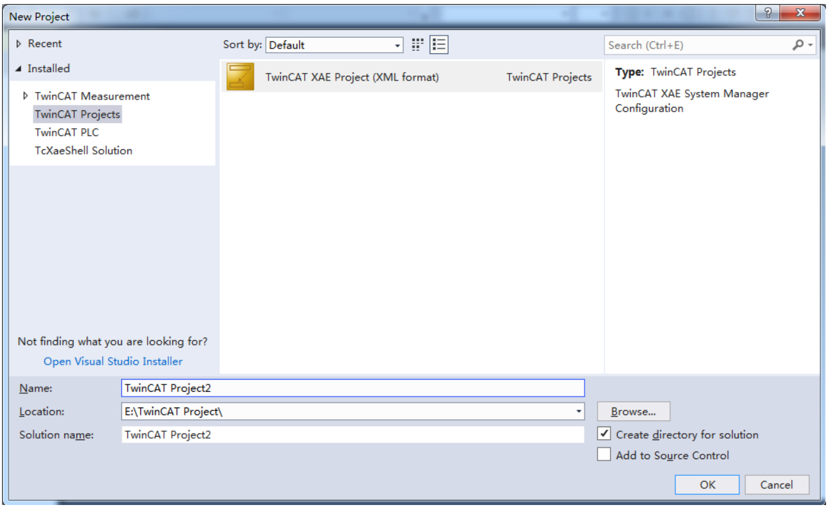
The Beckhoff safety CPU unit includes a logic sub-module EL6900, 4-channel DI sub-module EL1904, and 4-channel DO sub-module EL2904 which are connected to EtherCAT network through EtherCAT coupler EK1100. For FSoE network hardware wiring, see *"5.3.1 FSoE Network Connection and Setting" on page 65*.

The safety address must be set to the safety module and every module of the safety CPU unit. The safety address cannot be 0, and the safety address must be unique for every module of the system. You can set the safety address for the safety module through the knob.

Software

You can obtain TwinCAT3 at the official website of Beckhoff. The software version of TwinCAT must be 3.1.4024.1 or above when FSoE is used.

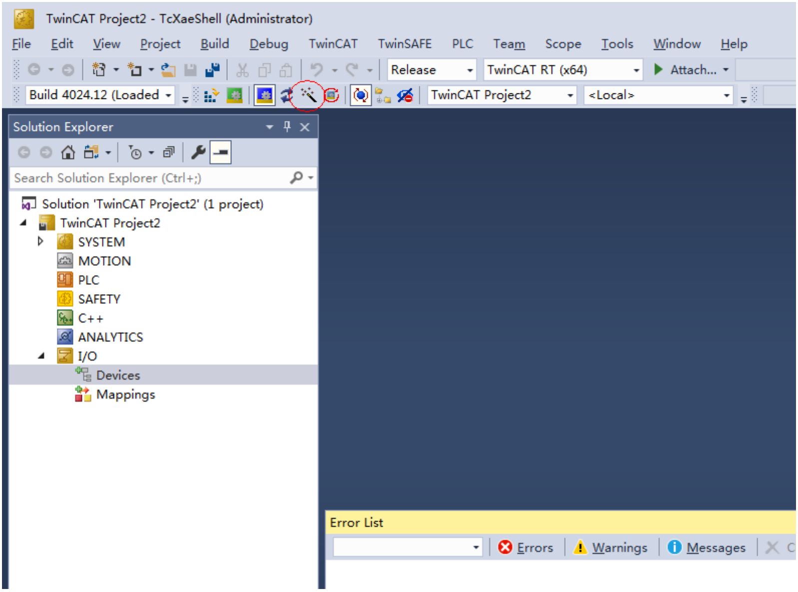
1. Copy the SV680N-INT EtherCAT configuration file (SV680_1Axis_04001_FSoE.xml) to the TwinCAT installation directory: TwinCAT\3.1\Config\Io\EtherCAT.
2. Open TwinCAT3 and Create a TwinCAT project.



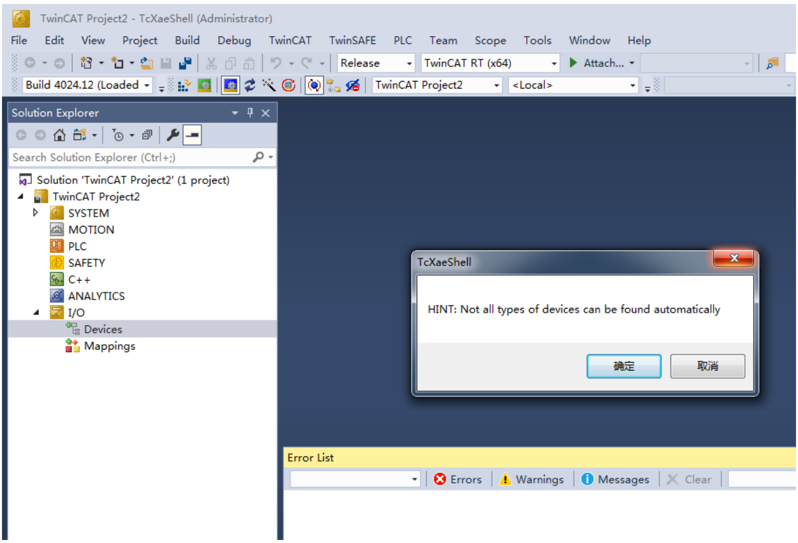
Search for devices.

1. Select 

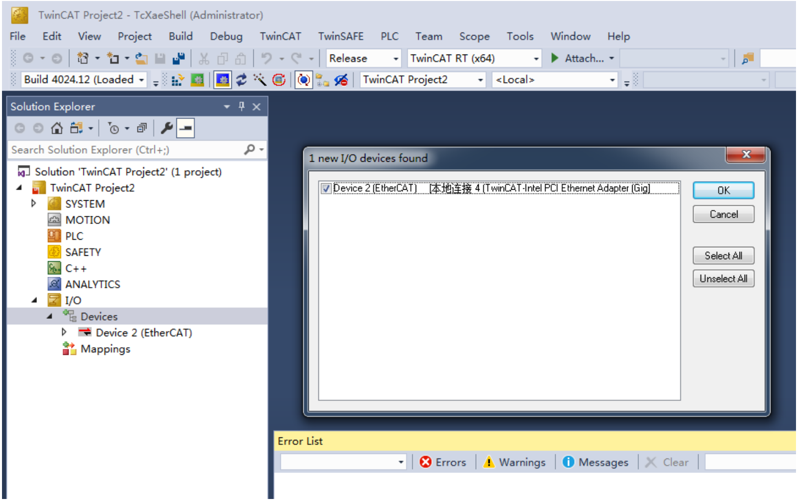
, and click  as shown below.



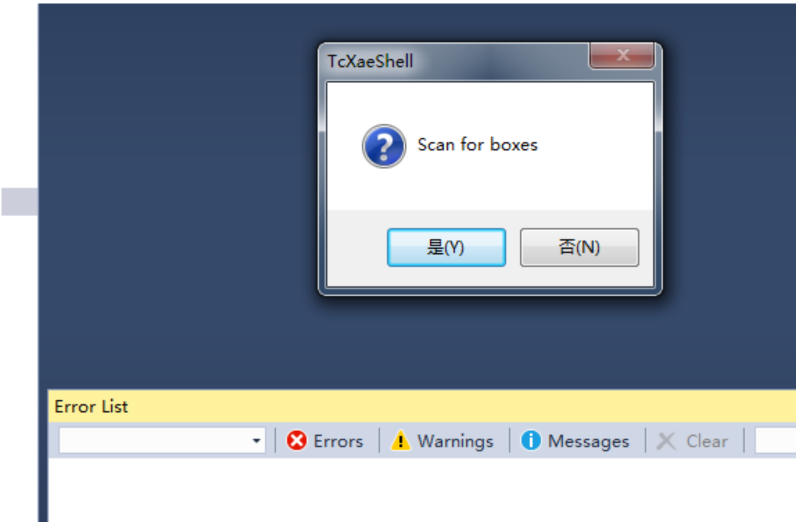
2. Click “OK”.



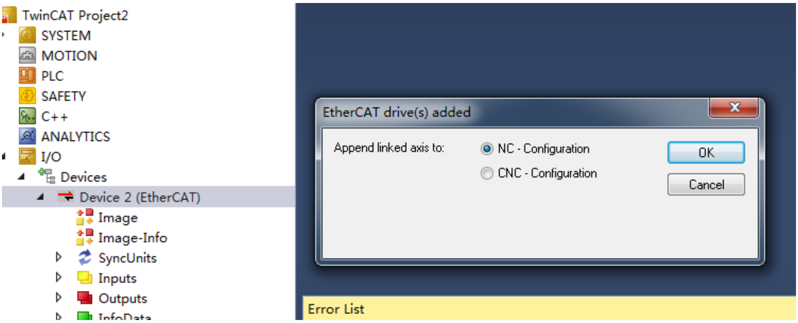
3. Click “OK”.



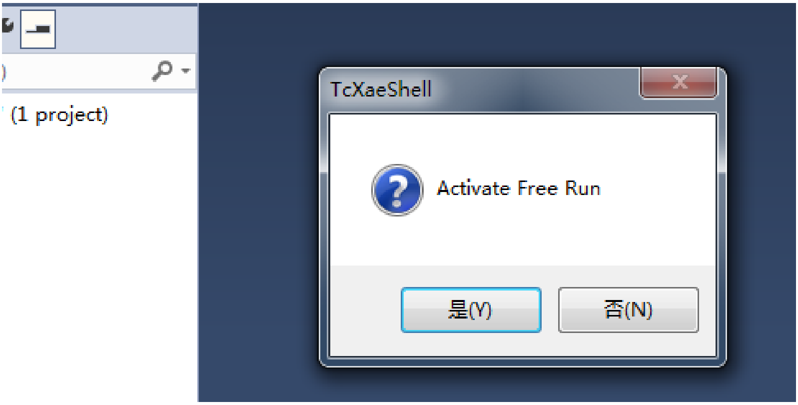
4. Click “Yes”.



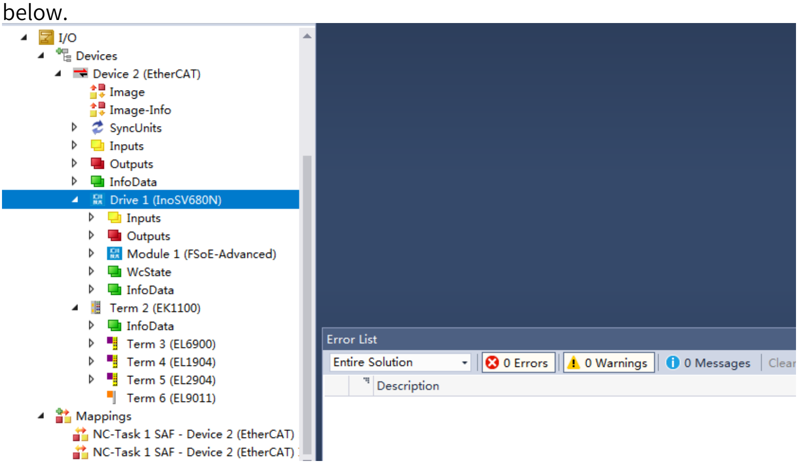
5. Click “OK”.



6. Click “No”.

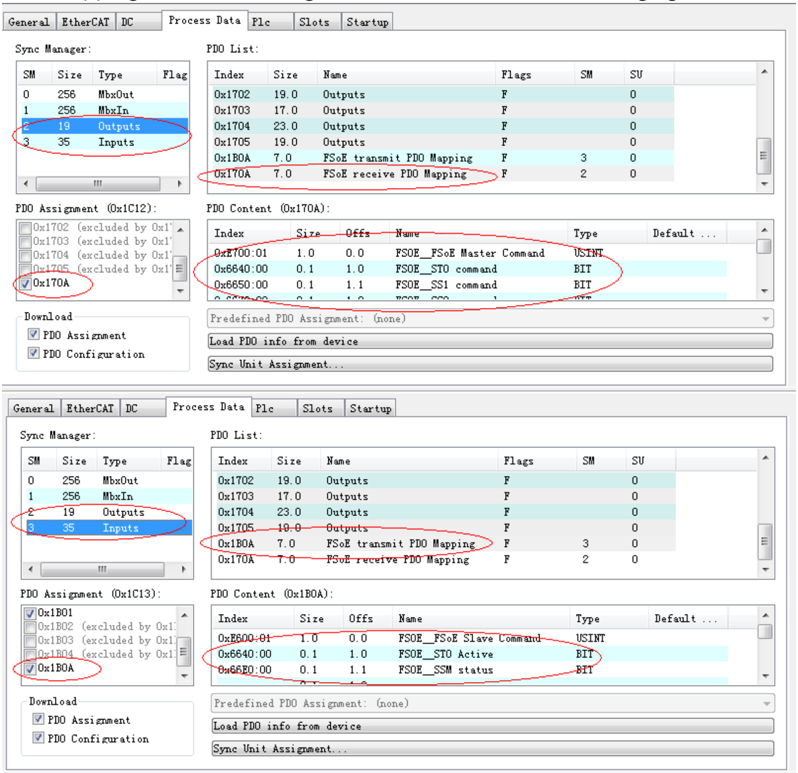


7. If device searching is done, the following devices should show: the SV680N-INT servo drive, safety module, Beckhoff EK1100, EL6900, EL1904 and EL2904, as shown below.



PDO Configuration

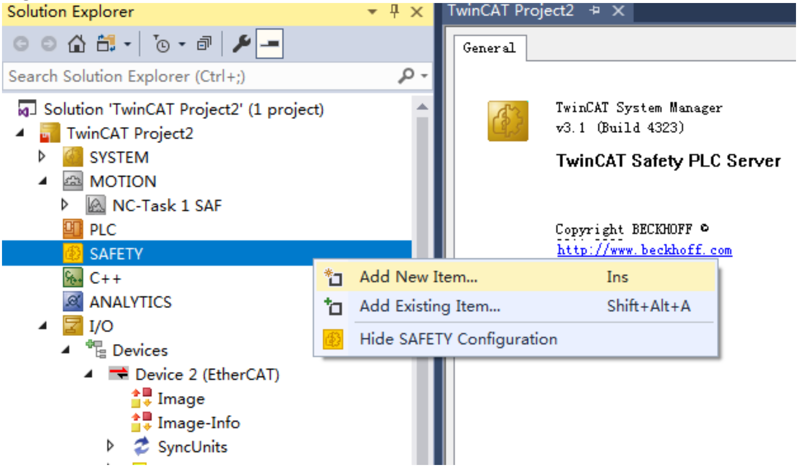
When using the FSoE function, you must check 0x170A and 0x1B0A for FSoE-specific PDO mapping in the PDO configuration, as shown in the following figure.



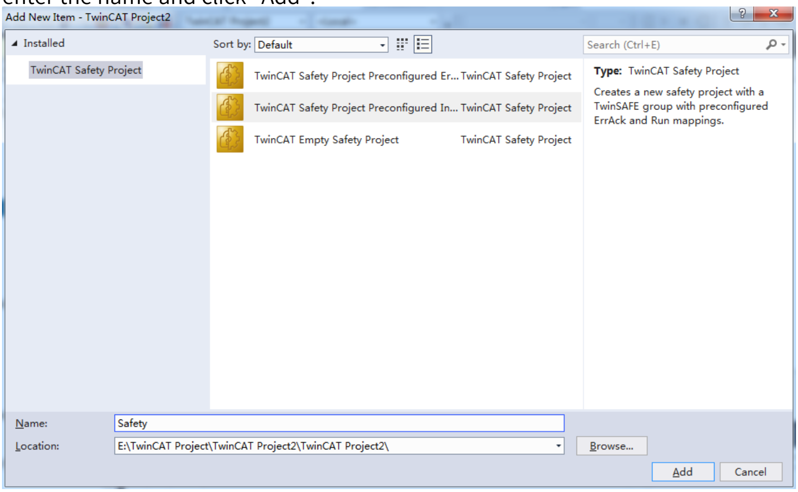
Safety hardware configuration

1. Create a safety project.

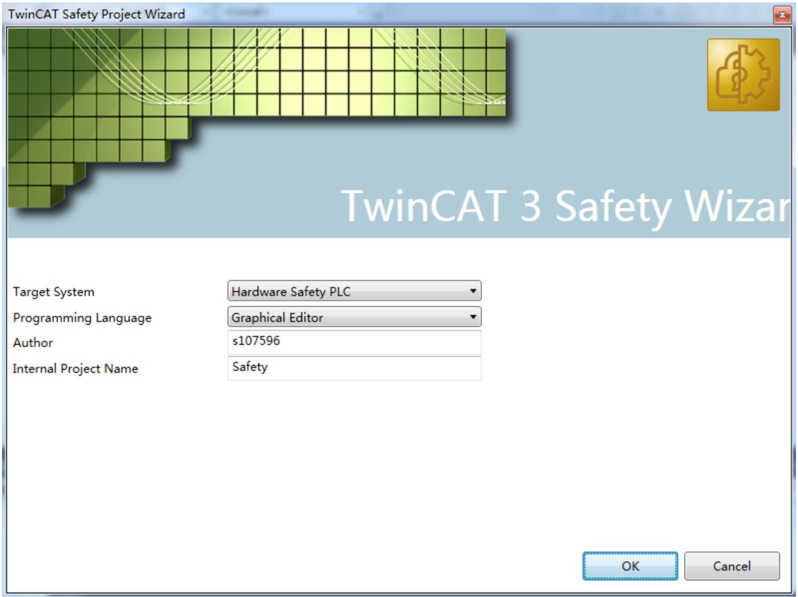
a. Right click "SAFETY" and select "Add New" Item.



b. In the pop-up dialog box, select "TwinCAT Safety Project Preconfigured In…", enter the name and click "Add".

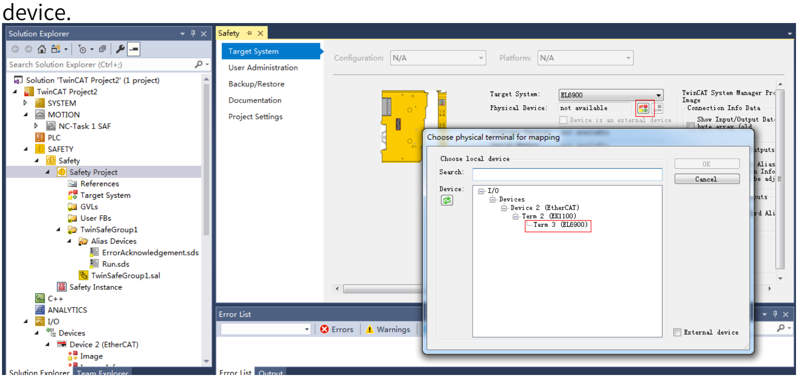


c. Click "OK".

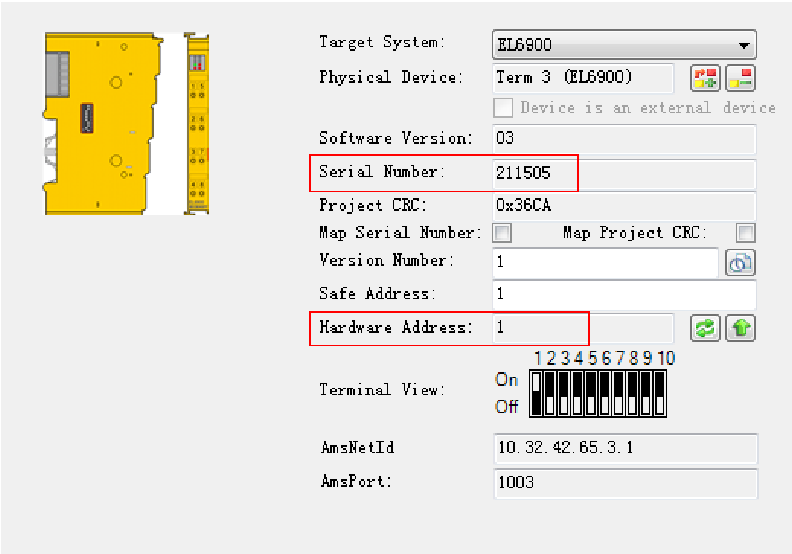


2. Set EL6900 as the safety logic module, do as follows.

a. Click “Target System”, then click  after “Physical device” to add the hardware device.

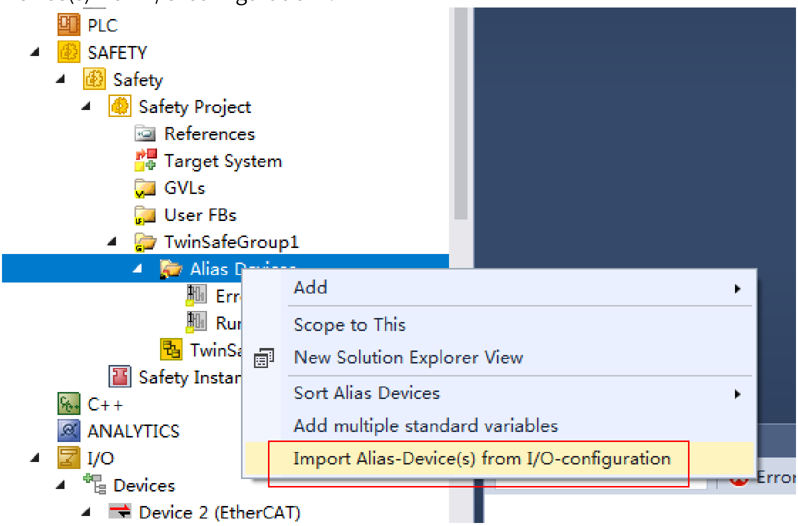


b. Check the serial number and hardware address of the EL6900 module.

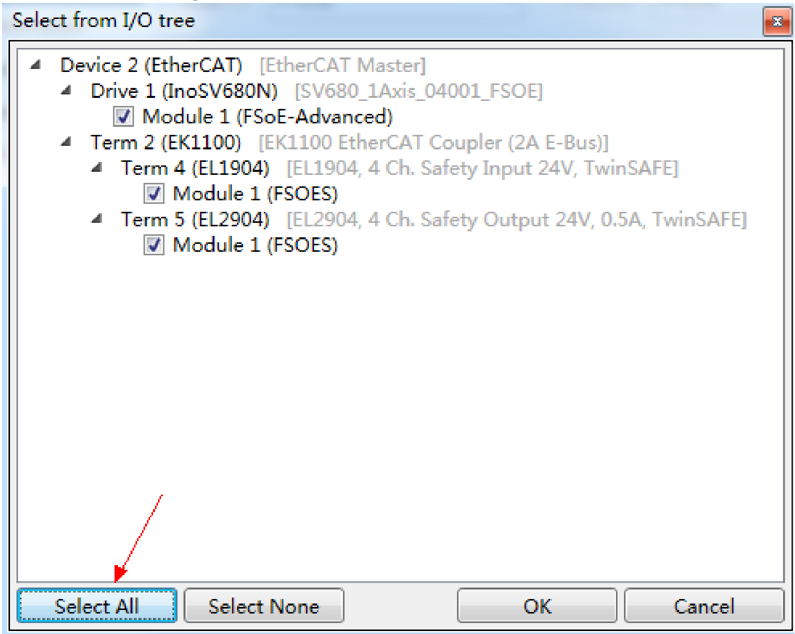


3.

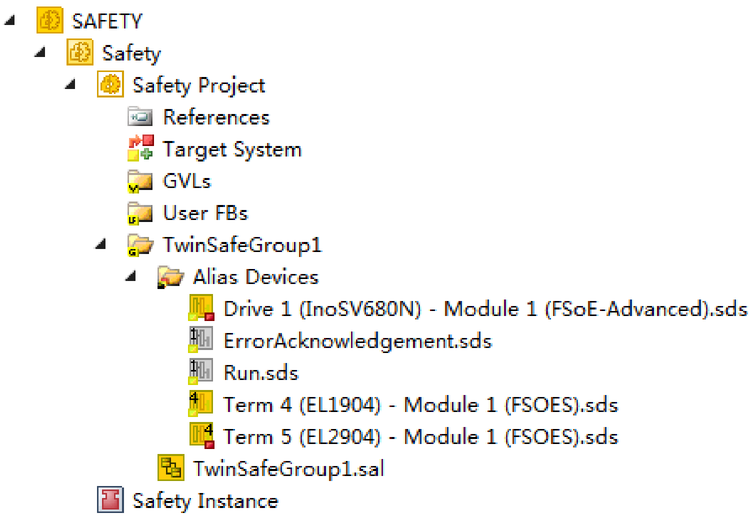
a. Expand "TwinSafeGroup1", right-click on "Alias Device" and select "Import Alias-Device(s) from I/O-configuration".



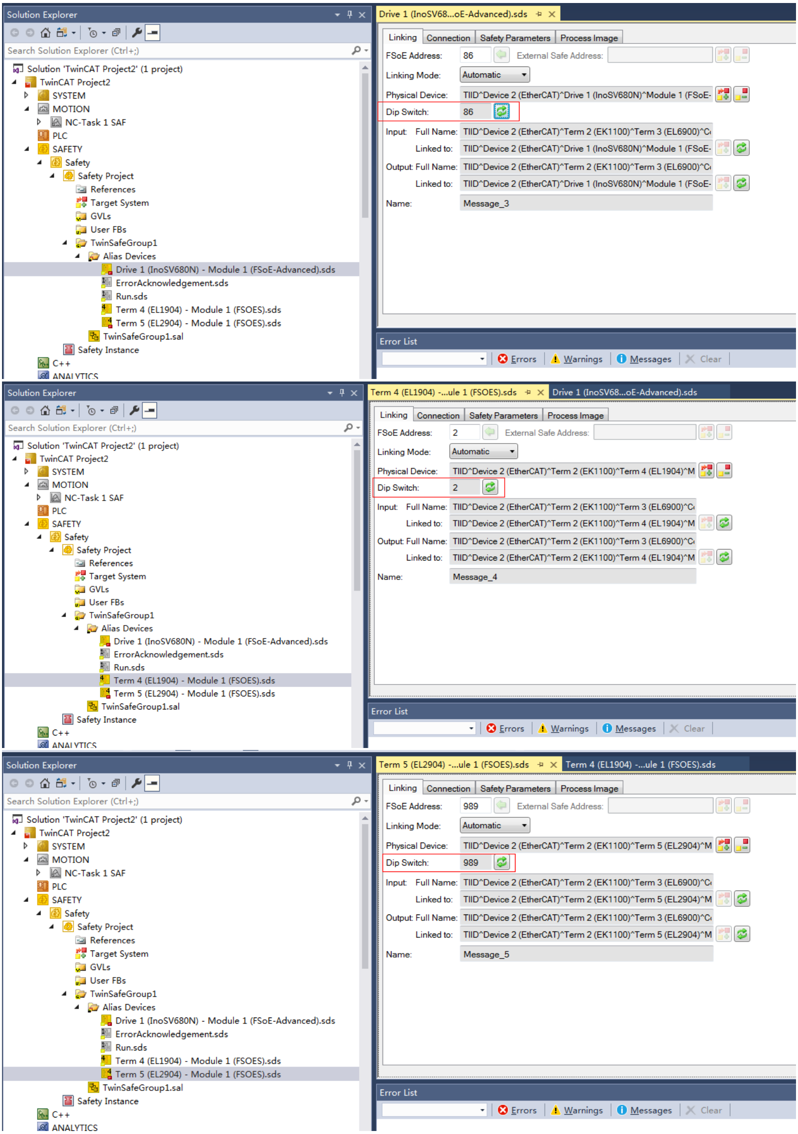
b. In the pop-up dialog, click "Select All" and then "OK".



c. Add safety I/O module and safety module under “Alias Devices”.



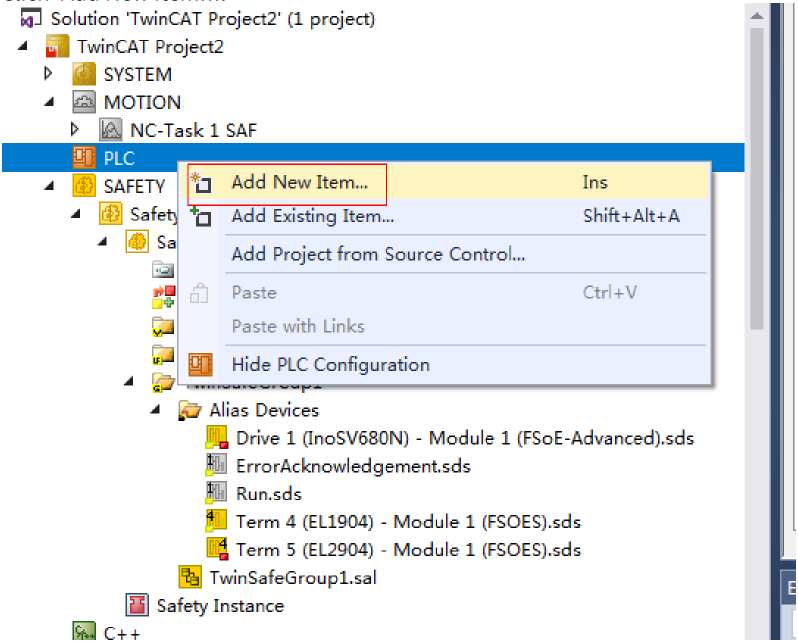
d. Check the FSoE address of the safety module and “Dip Switch” of the Beckhoff module.



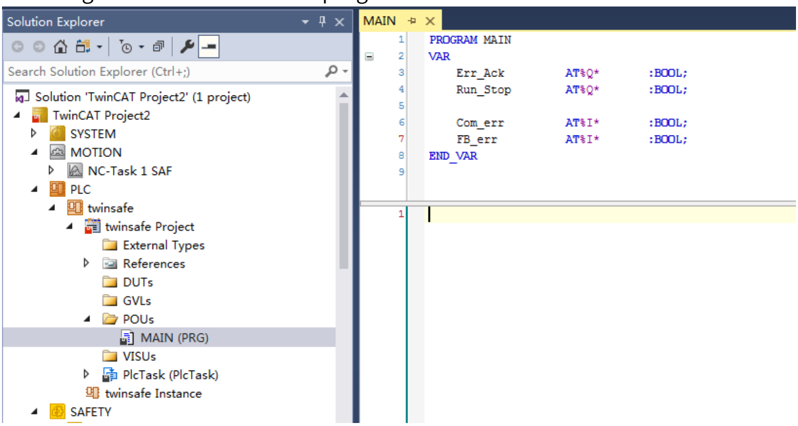
Safety program configuration

1. Add a PLC project.

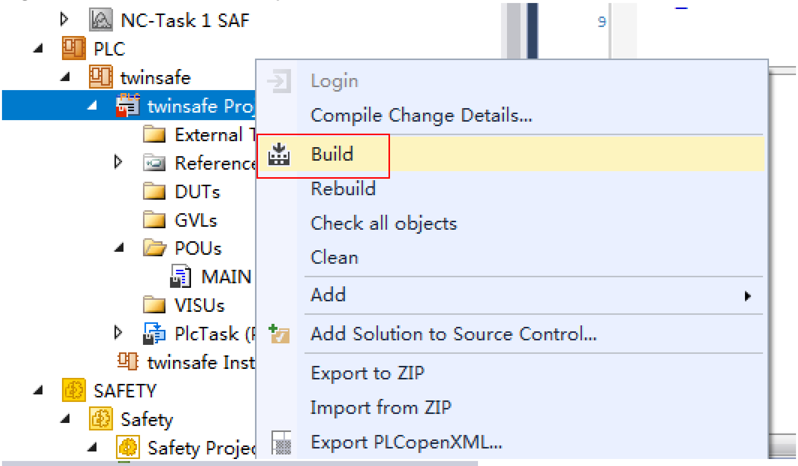
a. Click “Add New Item….”

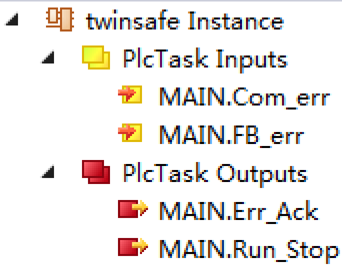


b. Select "Standard PLC Project", name the project as "twinsafe" and make the following statement in the main program area.



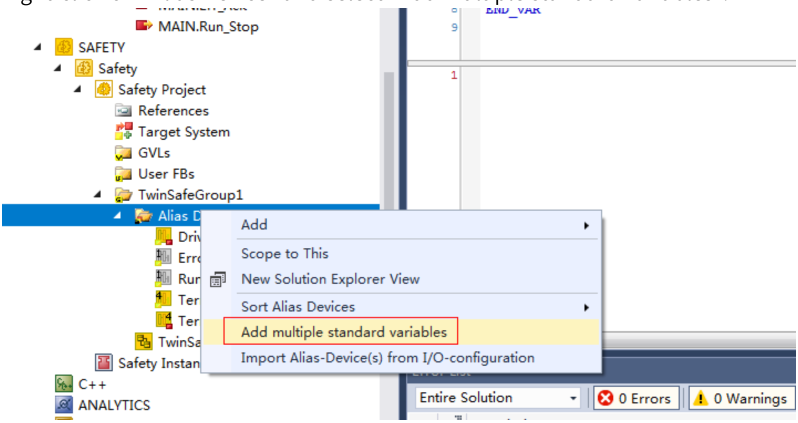
c. Right-click on "Twinsafe Project" and select "Build".



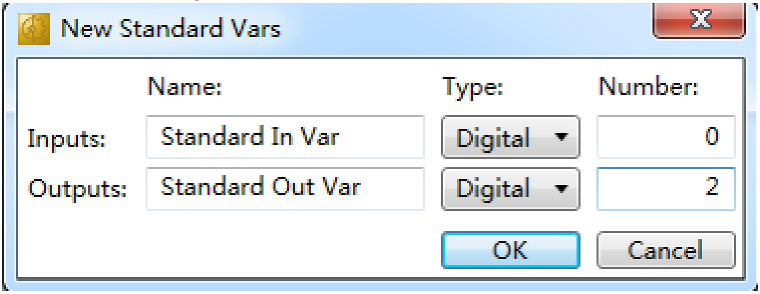


2. Add non-safety standard variables.

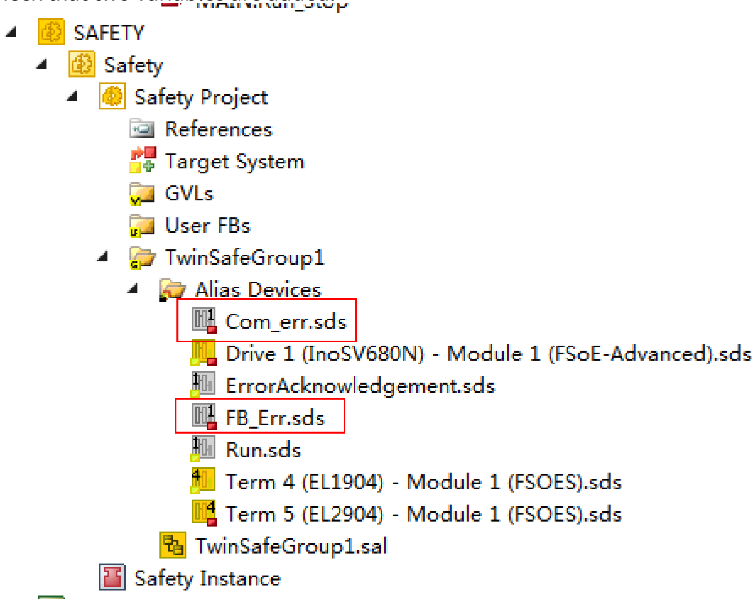
a. Right-click on "Alias Device" and select "Add multiple standard variables".



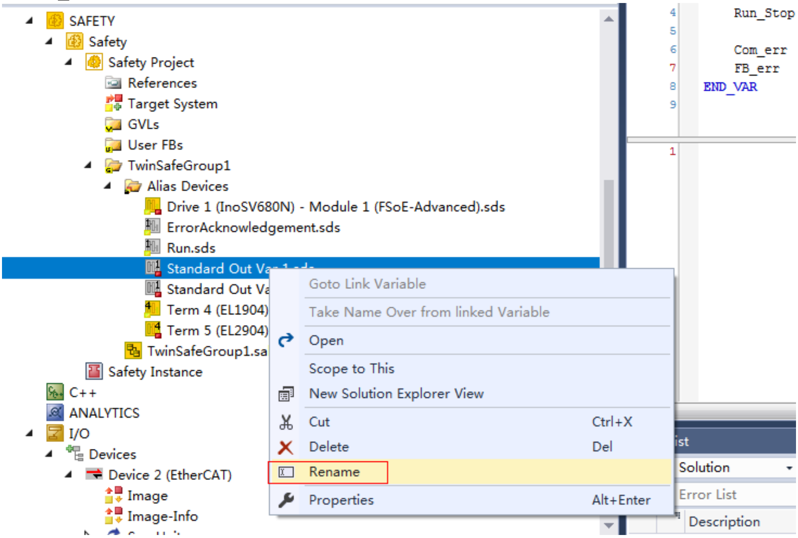
b. In the pop-up dialog, set the number of outputs to "2".



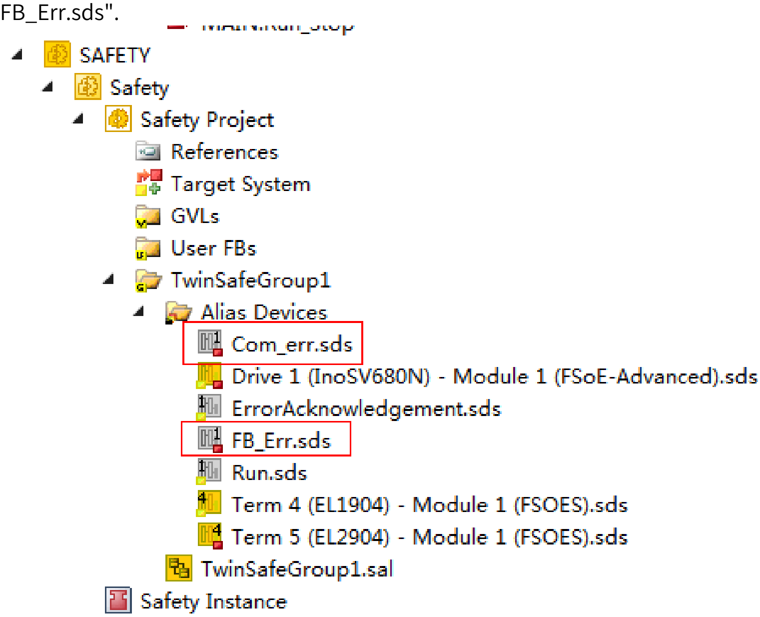
c. Check that two variables are added.



d. Right-click on "Standard Out Var 1.sds" and select "Rename" to rename it to "Com_err.sds"

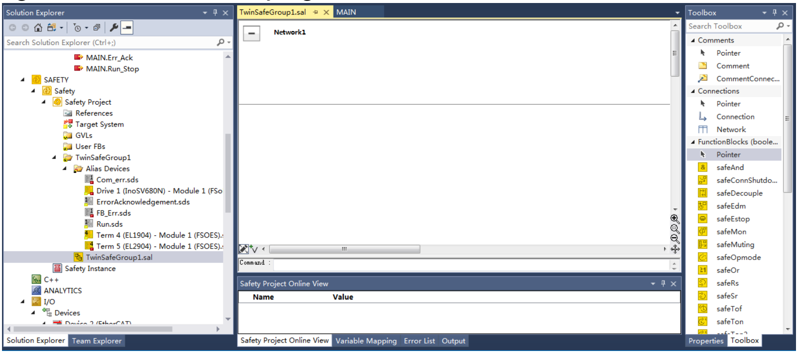


e. Right-click on "Standard Out Var 2.sds" and select "Rename" to rename it to "FB_Err.sds".

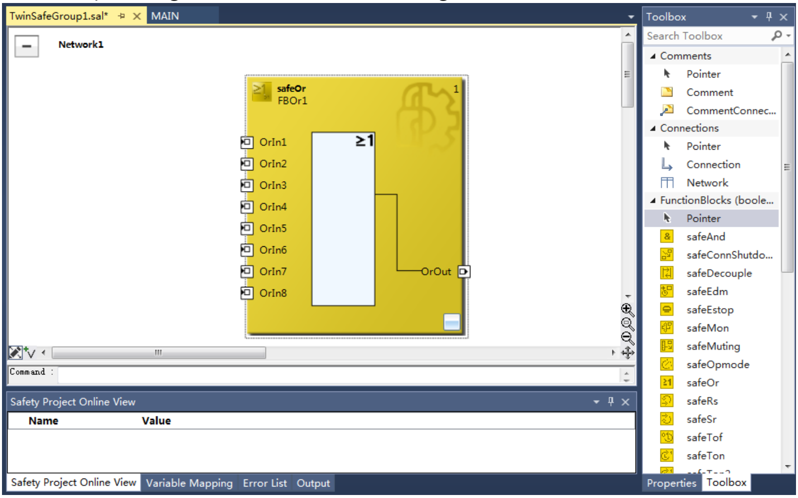


3. Write the safety program.

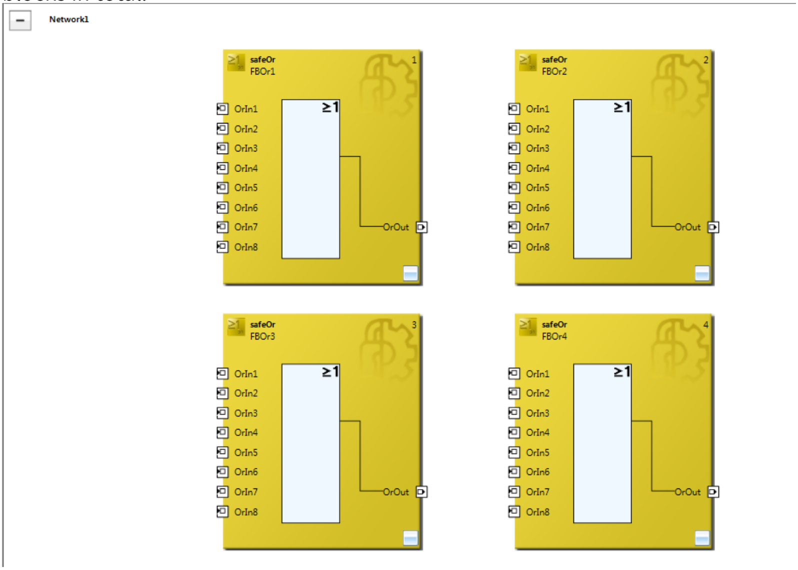
a. Double click "TwinSafeGroup1.sal" and use the safety function blocks on the right side to write the safety logic.



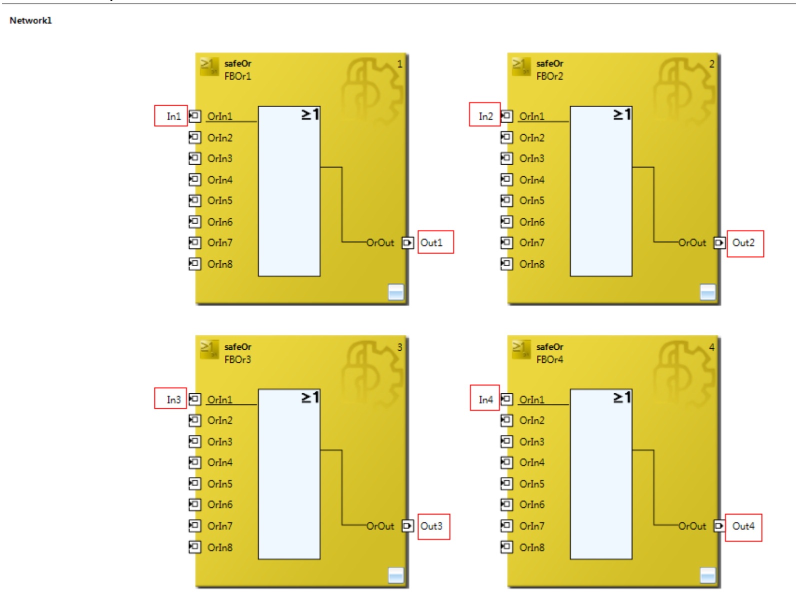
b. For example, drag "safeOr" block from the right side to "Network1".



c. Four safety DI inputs are used to trigger the safety function. There are four safeOr blocks in total.

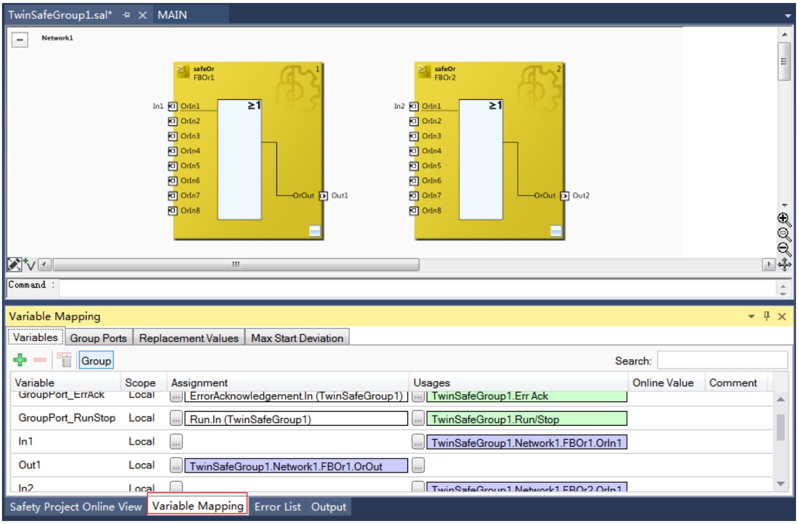


d. Define the pins as needed.

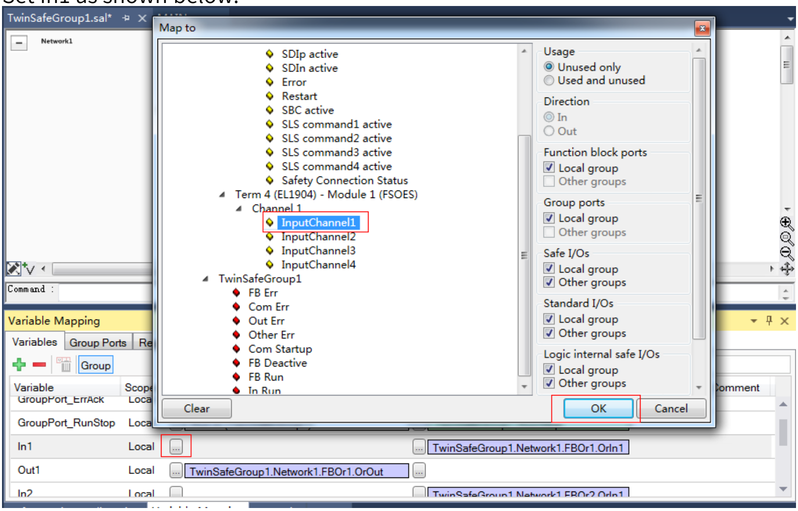


4. Link the safety program to the safety hardware.

a. Find “Variable Mapping”.

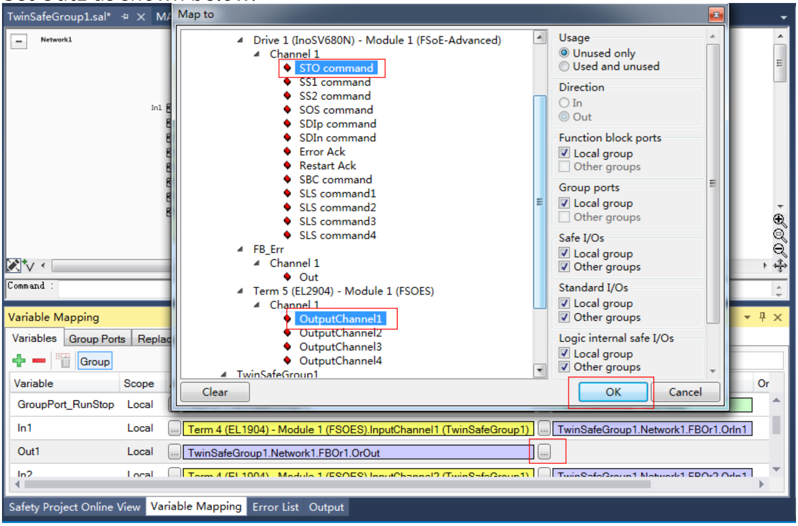


b. Set In1 as shown below.



c. Set In2 to "InputChannel2", In3 to "InputChannel3", and In4 to "InputChannel4", respectively.

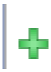
d. Set Out1 as shown below.

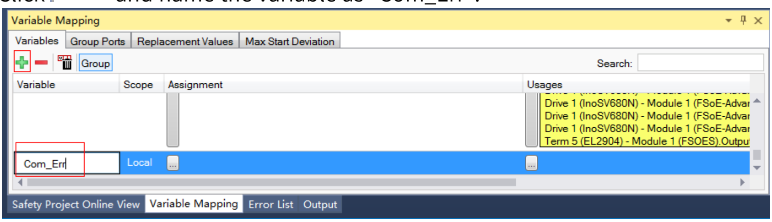


Use In1 to control the control word corresponding to STO and Out1 to indicate the state of In1.

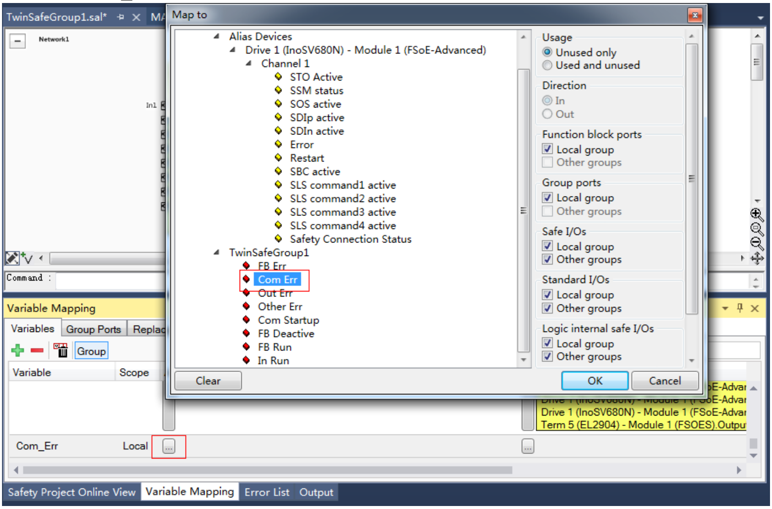
e. Set Out2 to "SS1 command" and "OutputChannel2", Out3 to "SS2 command" and "OutputChannel3", and Out4 to command corresponding to remaining bits of RPDO and "OutputChannel4", respectively.

f. Add two more variables. Follow the steps below to add the first variable.

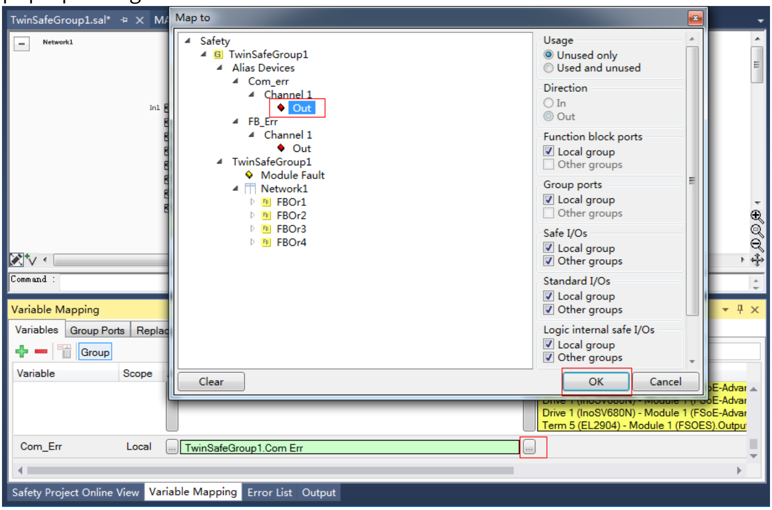
1). Click  and name the variable as "Com_Err".



2). Click the bottom left button highlighted in red box, and in the pop-up dialog select "Com_Err" and then click "OK".

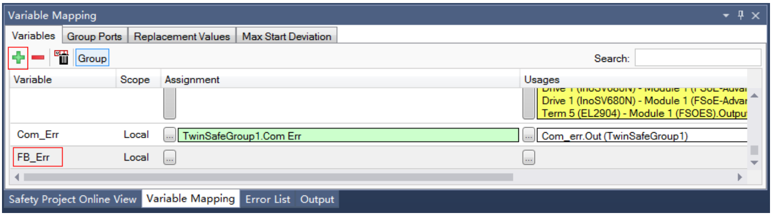


3). Click the bottom right browse button highlighted in red box, and in the pop-up dialog select "Out" and then click "OK".

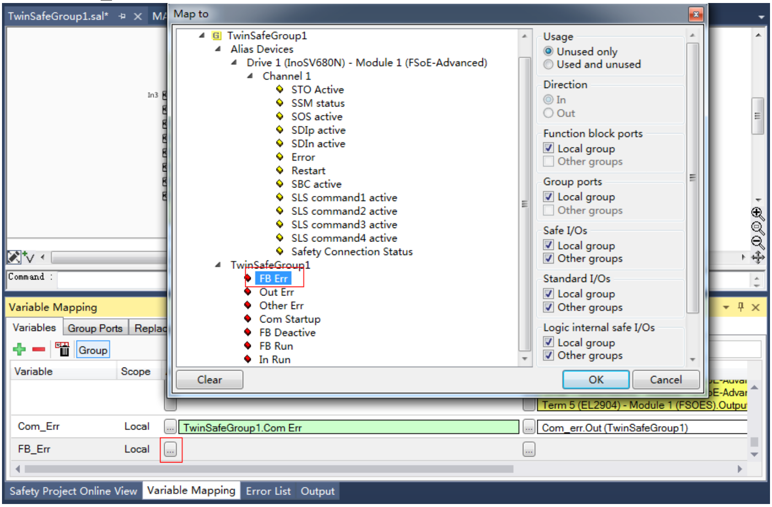


g. Follow the steps below to add the second variable.

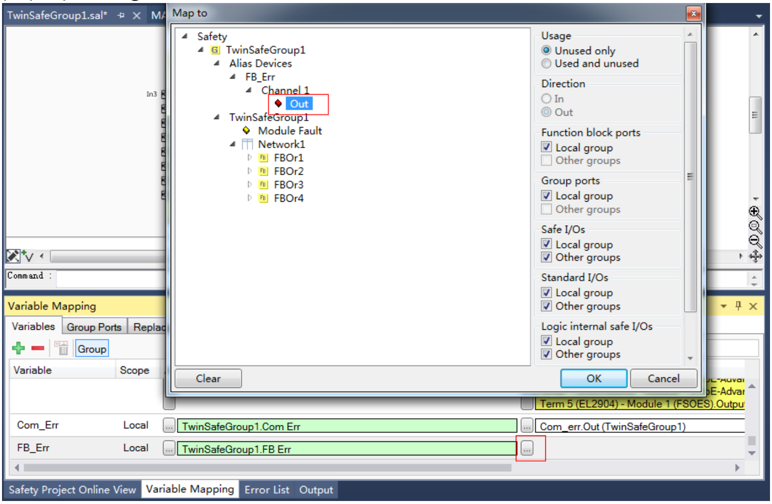
1). Click  and name the variable as "Com_Err".



2). Click the bottom left button highlighted in red box, and in the pop-up dialog select "FB_Err" and then click "OK".

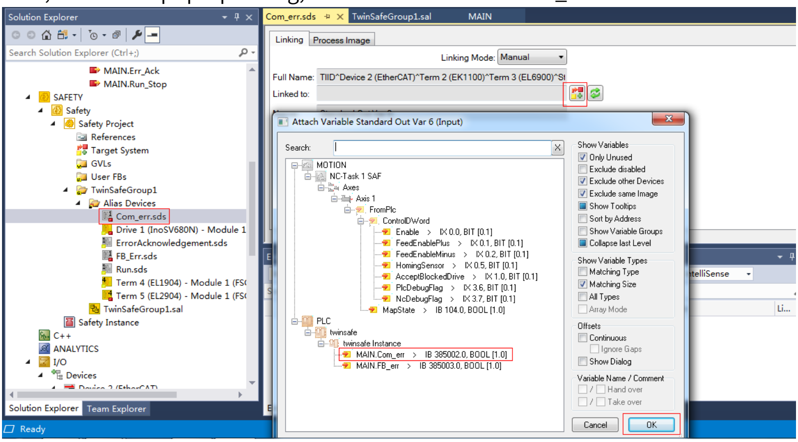


3). Click the bottom right browse button highlighted in red box, and in the pop-up dialog select "Out" and then click "OK".

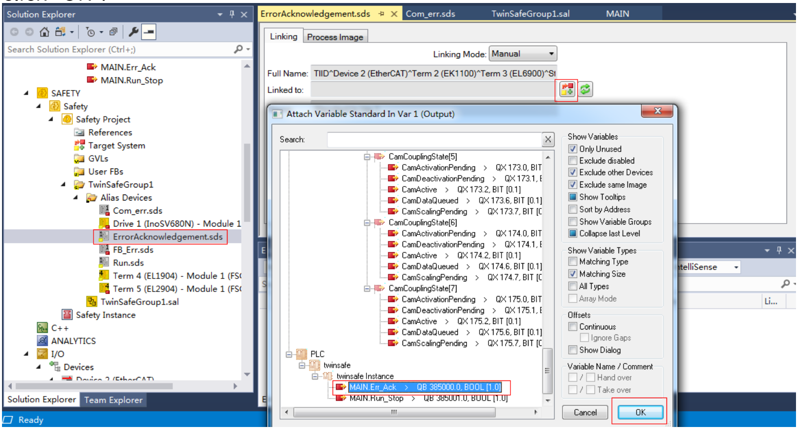


5. Link the non-safety standard variables added in step 2 to the variables in the PLC program.

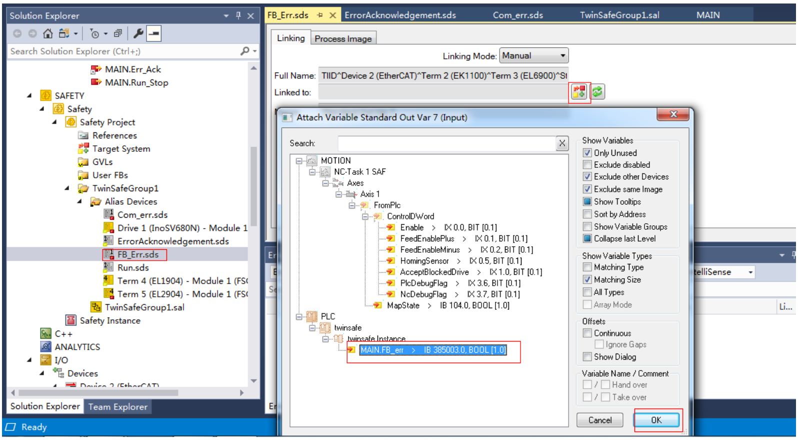
a. On the left side, double-click the variable "Com_err.sds". On the right side, click , and in the pop-up dialog, select the instance "Com_err" and click "OK".



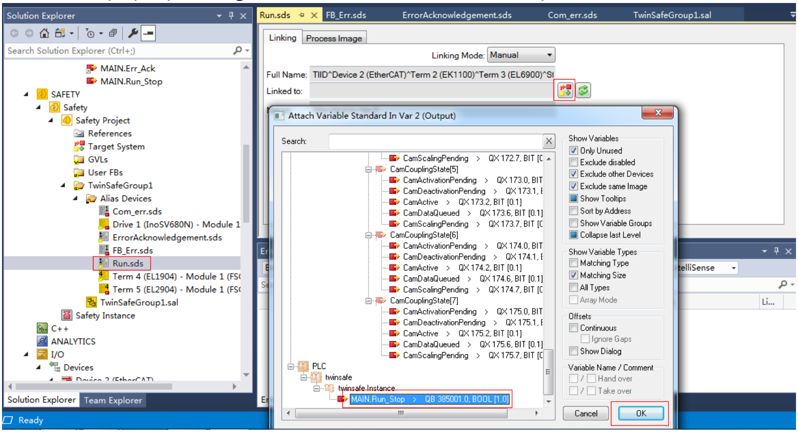
b. On the left side, double-click the variable "ErrorAcknowledgement.sds". On the right side, click , and in the pop-up dialog, select the instance "Err_Ack" and click "OK".



c. On the left side, double-click the variable "FB_Err.sds". On the right side, click , and in the pop-up dialog, select the instance "FB_err" and click "OK".

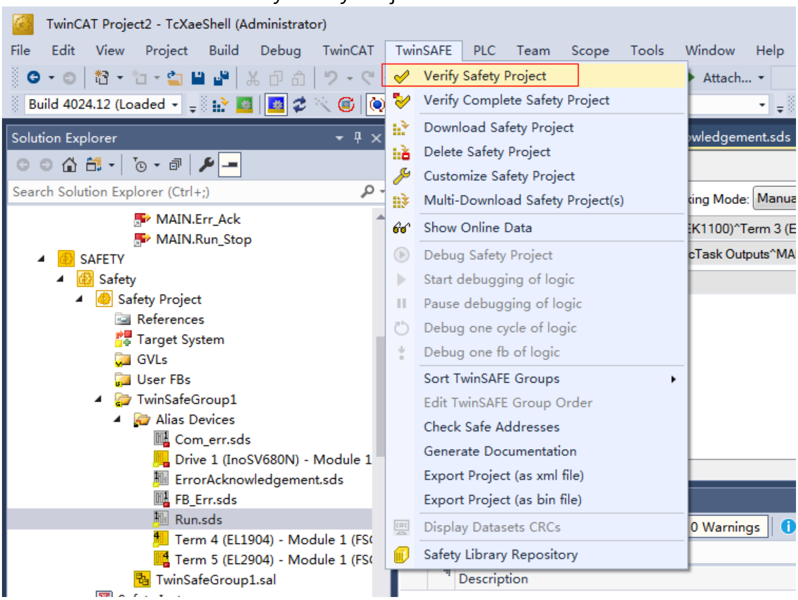


d. On the left side, double-click the variable "Run.sds". On the right side, click , and in the pop-up dialog, select the instance "Run_Stop" and click "OK".

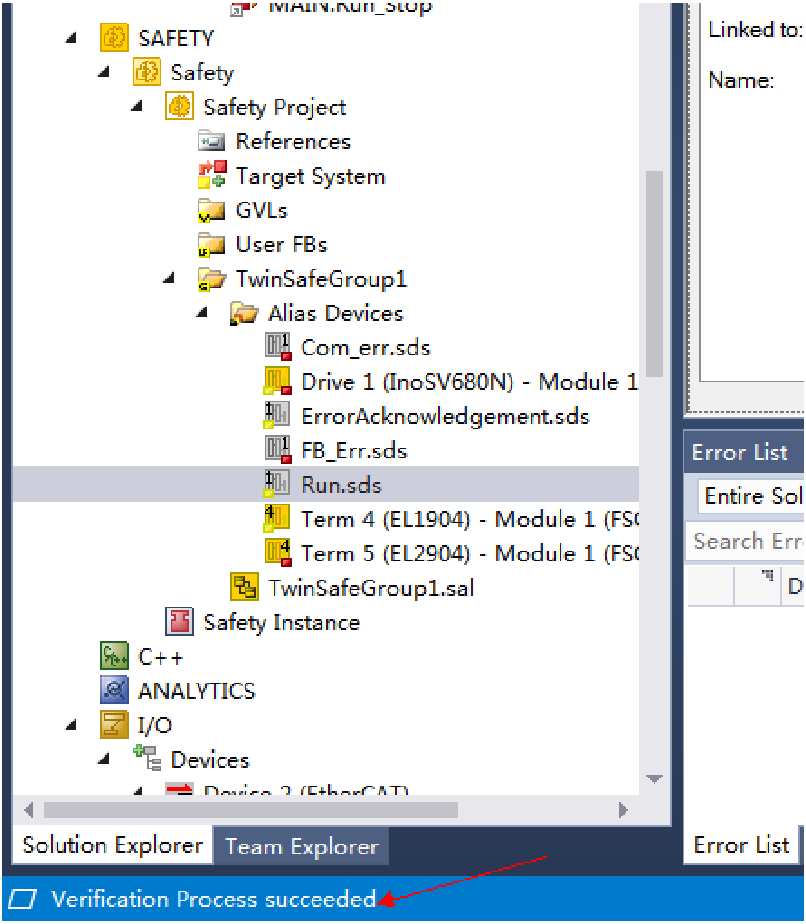


6. Verify the safety logic program.

a. Choose "TwinSAFE" > "Verify Safety Project".

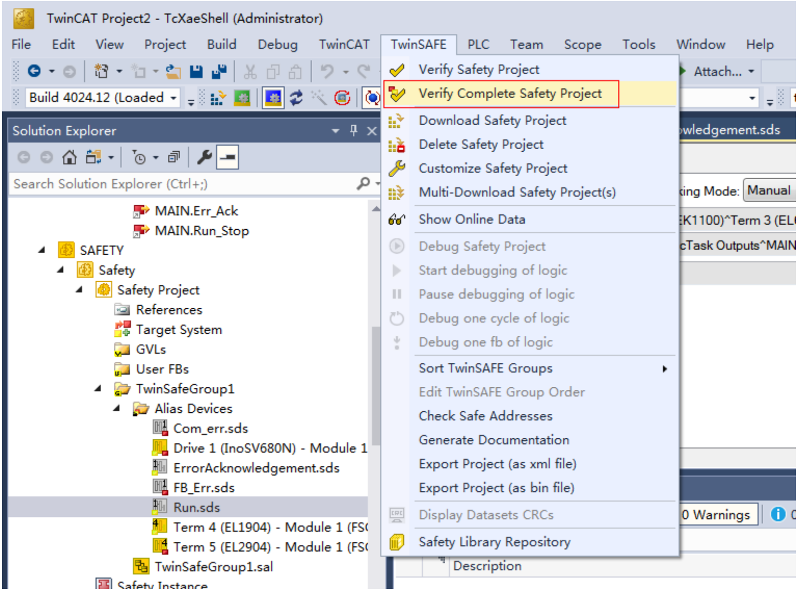


b. After verification is complete, check whether there is an error and whether the message "Verification Process succeeded" appears in the lower left corner. The following figure shows that the verification is successful.

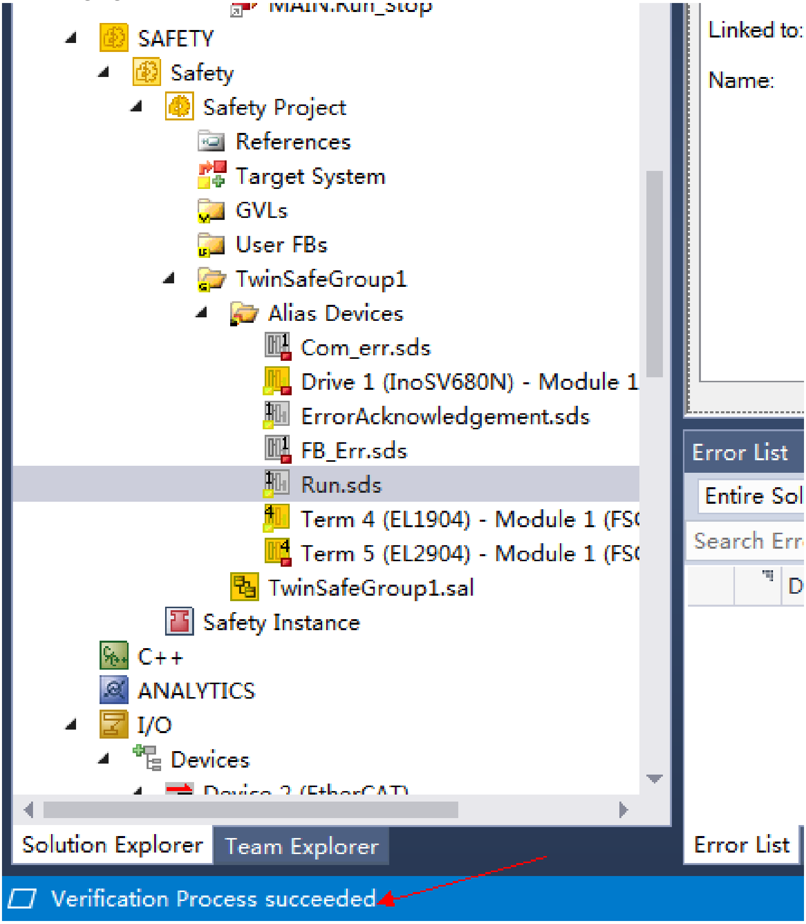


7. Verify the safety logic program and hardware modules.

a. Choose "TwinSAFE" > "Verify Complete Safety Project".

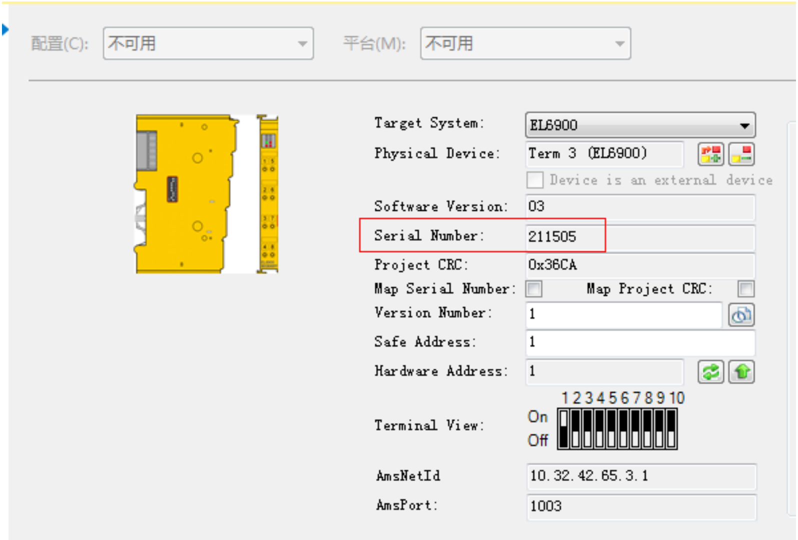


b. After verification is complete, check whether there is an error and whether the message "Verification Process succeeded" appears in the lower left corner. The following figure shows that the verification is successful.

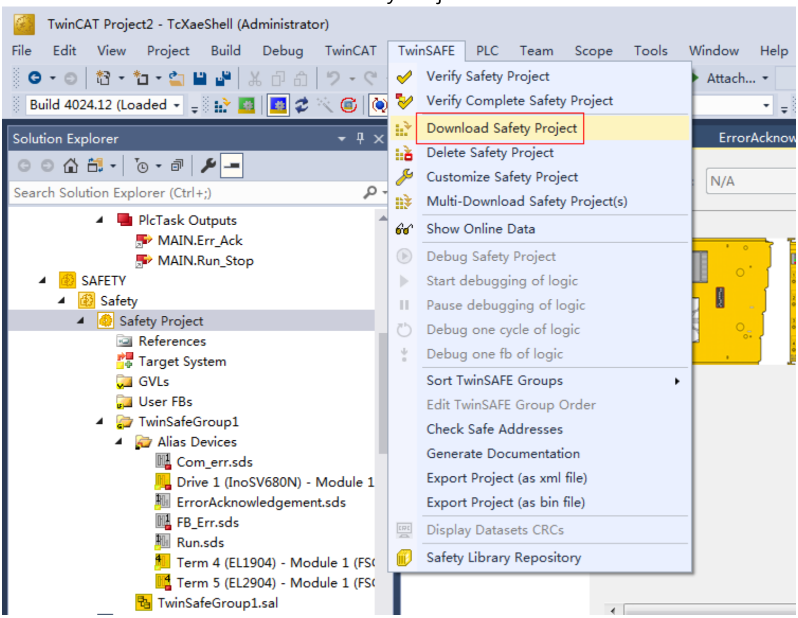


8. Download the safety program.

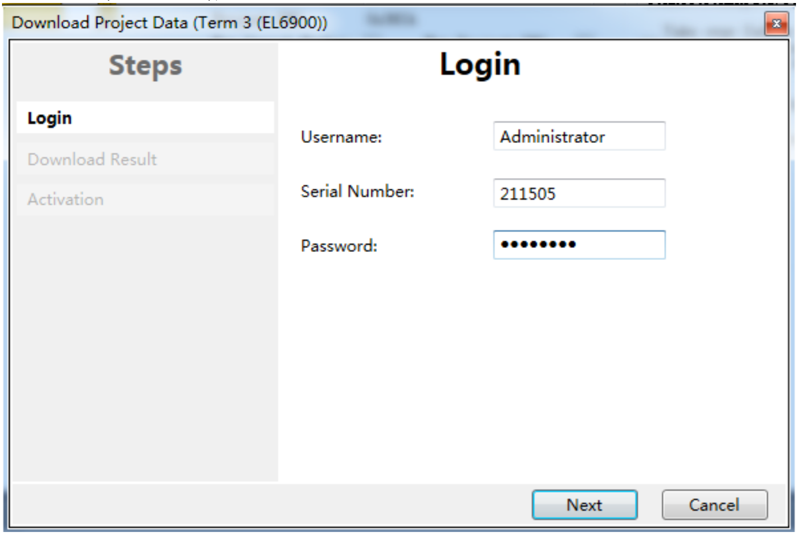
   a. Copy the Serial Number "211505".



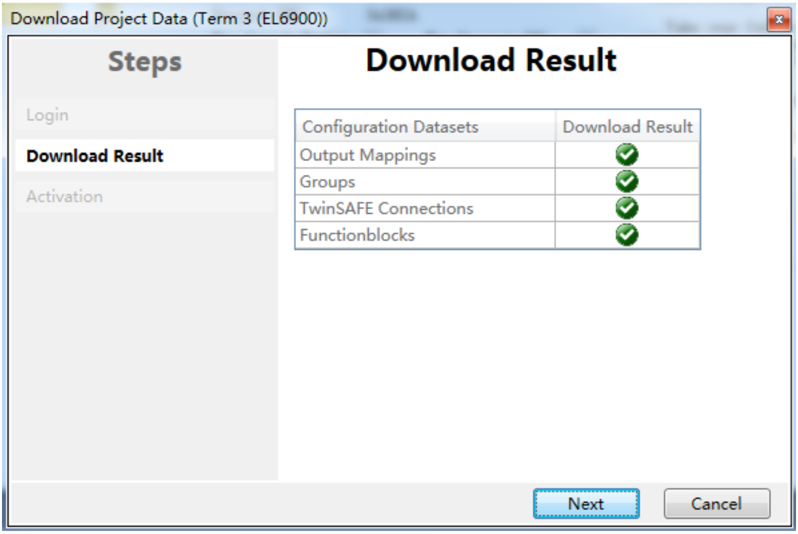
b. Choose "TwinSAFE" > "Download Safety Project".



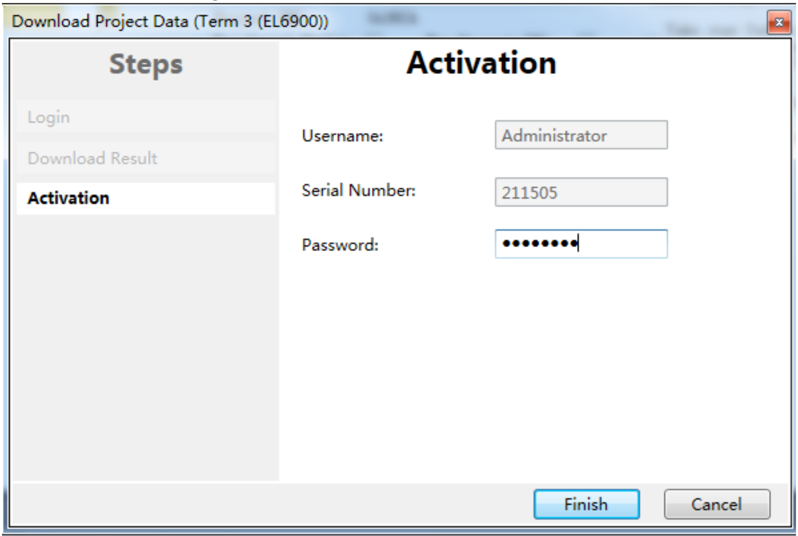
c. In the pop-up dialog, enter the Username (Administrator), Serial Number, and Password (TwinSAFE), then click "Next".



d. View the download result and click "Next".

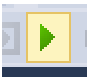


e. Enter the password again and click "Finish".



f. After completing all the above configurations, you can activate the hardware configuration and carry out safety function test.

Safety Function Test

1.  Click  to activate the configuration and the controller turns to the running mode.
2. Click  and then  to execute the PLC program.
3. As the safety program is downloaded and run for the first time, the communication is re-established. A communication error prompt is displayed. In this case, the value of expression Com_err is "TRUE".

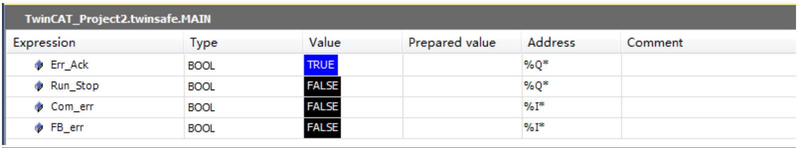
TwinCAT_Project2.twinsafe.MAIN

Expression	Type	Value	Prepared value	Address	Comment
Err_Ack	BOOL	FALSE		%Q*	
Run_Stop	BOOL	FALSE		%Q*	
Com_err	BOOL	TRUE		%I*	
FB_err	BOOL	FALSE		%I*	

Set the value of Err_Ack to "TRUE" and then "FALSE".

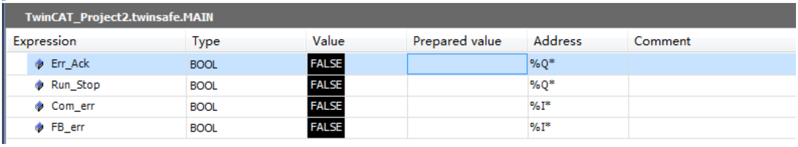
TwinCAT_Project2.twinsafe.MAIN

Expression	Type	Value	Prepared value	Address	Comment
Err_Ack	BOOL	FALSE	TRUE	%Q*	
Run_Stop	BOOL	FALSE		%Q*	
Com_err	BOOL	TRUE		%I*	
FB_err	BOOL	FALSE		%I*	



TwinCAT_Project2.twinsafe.MAIN

Expression	Type	Value	Prepared value	Address	Comment
Err_Ack	BOOL	TRUE		%Q*	
Run_Stop	BOOL	FALSE		%Q*	
Com_err	BOOL	FALSE		%I*	
FB_err	BOOL	FALSE		%I*	

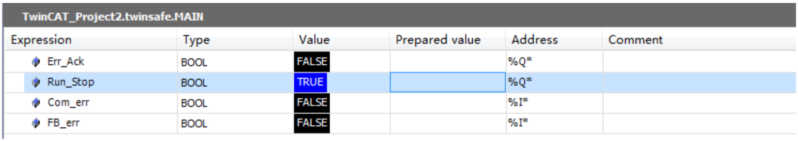


TwinCAT_Project2.twinsafe.MAIN

Expression	Type	Value	Prepared value	Address	Comment
Err_Ack	BOOL	FALSE		%Q*	
Run_Stop	BOOL	FALSE		%Q*	
Com_err	BOOL	FALSE		%I*	
FB_err	BOOL	FALSE		%I*	

The communication error is cleared.

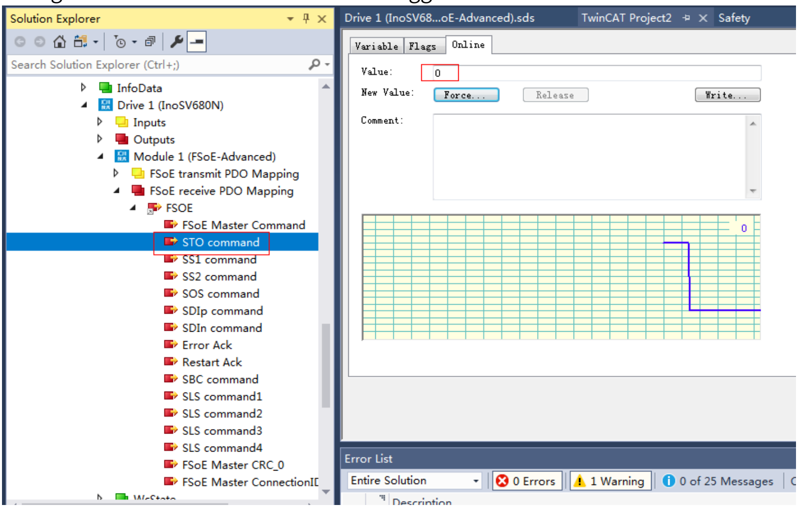
4. Run the safety program and set Run_Stop to "True".



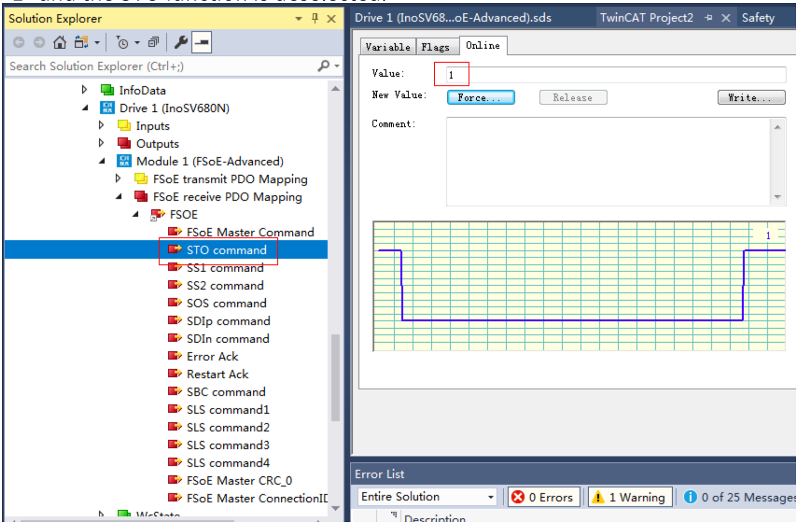
TwinCAT_Project2.twinsafe.MAIN

Expression	Type	Value	Prepared value	Address	Comment
Err_Ack	BOOL	FALSE		%Q*	
Run_Stop	BOOL	TRUE		%Q*	
Com_err	BOOL	FALSE		%I*	
FB_err	BOOL	FALSE		%I*	

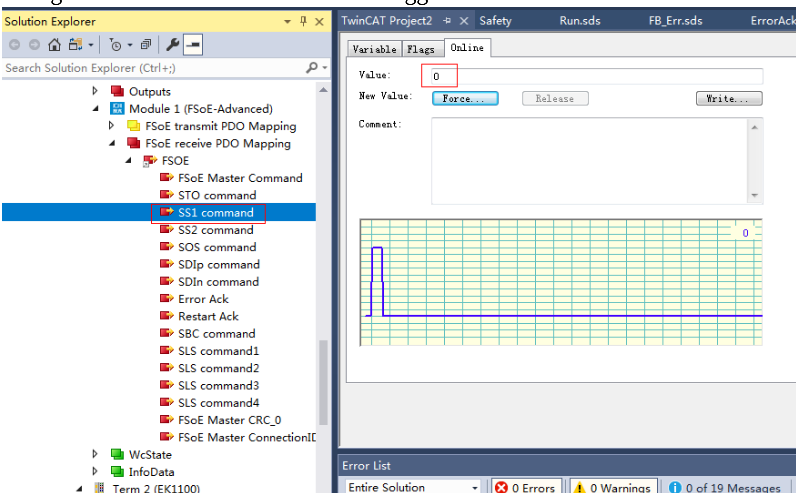
5. Disconnect the safety DI1. The bit in RPDO corresponding to STO command changes to "0" and the STO function is triggered.



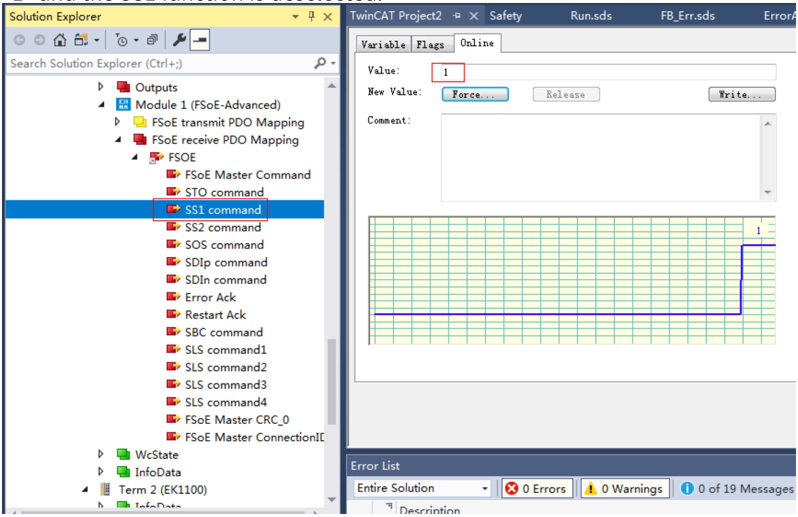
Restore the safety DI1. The bit in RPDO corresponding to STO command changes to "1" and the STO function is deselected.



6. Disconnect the safety DI2. The bit in RPDO corresponding to SS1 command changes to "0" and the SS1 function is triggered.

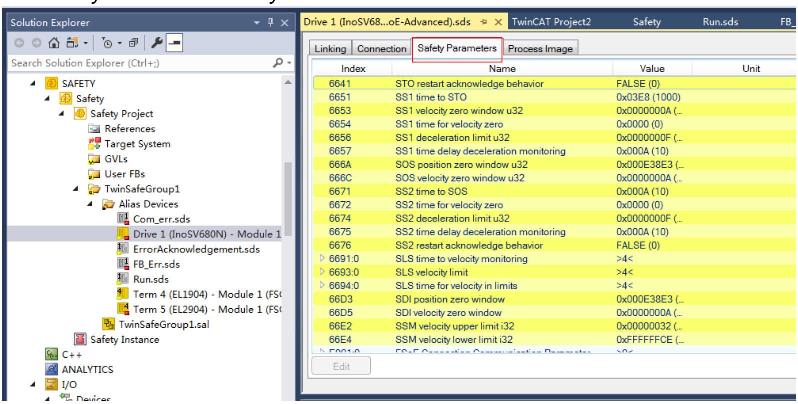


Restore the safety DI2. The bit in RPDO corresponding to SS1 command changes to "1" and the SS1 function is deselected.

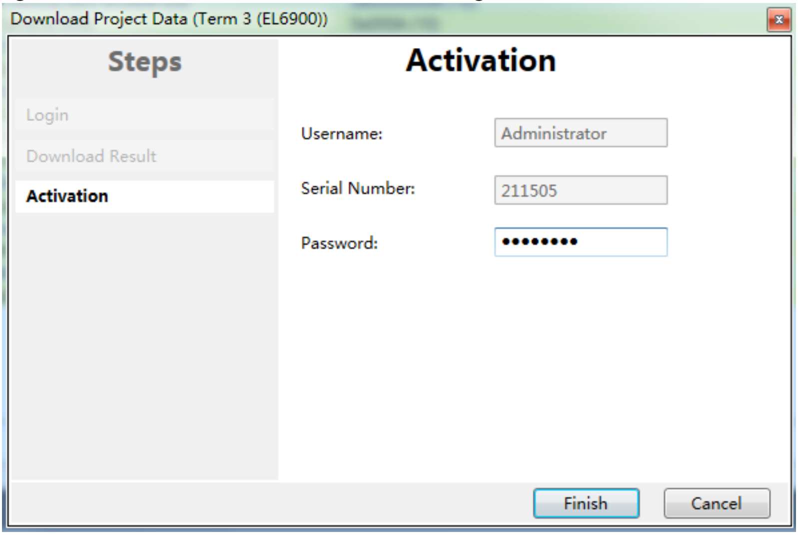


Modifying the Safety Object Dictionary

1. When modifying the safety object dictionary, you need to find the corresponding safety module under "SAFETY" menu, and modify the corresponding object dictionary under the "Safety Parameters" tab.



2. After the modification is completed, you need to download the safety program again, and then click  to activate the configuration.



14.2 DIDO Function Assignment

Table 14–1 DI Function Assignment

Setpoint	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

Setpoint	Name	Function Name	Description
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 14–2 DO Function Assignment

Setpoint	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
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 status	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

Note

The DI and DO functions can only be used in the local mode. The bus mode automatically shields the DI and DO functions, and will not diagnose whether the DI and DO hardware circuits fail.

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