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SV680 Series Servo Drive

Safety Guide

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

Data code 19011489 A00

Preface

Introduction

This safety functions manual is applicable to Inovance SV680 series functional safety servo drives and MS1 series functional safety motors (with 26-bit multi-turn absolute encoder).

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 SV680N 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 on product safety, mechanical and electrical installation, commissioning and maintenance, and safety parameters. Please read this manual carefully before use.

More Documents

Document Name	Data Code	Description
SV680P Series Servo Drive Selection Guide	19011487	Presents technical data and dimensions of the servo drive, and specifications and models of optional parts (installation accessories, cables, and periphery electrical parts).
SV680P Series Servo Drive Hardware Guide	19011484	Presents installation and wiring of the servo drive, including preparations before installation, unpacking inspection and transport, wiring, and routine maintenance.
SV680P Series Servo Drive Commissioning Guide	19011483	Presents servo commissioning, parameter descriptions, troubleshooting, including the operating panel, commissioning software, and commissioning process and procedure.
SV680P Series Servo Drive Function Guide	19011485	Presents function application, communication, fault codes, and parameters of the AC drive.
SV680P Series Servo Drive Communication Guide	19011486	Presents servo functions and parameters, including CANlink, CANopen, and Modbus communication configuration, fault descriptions, parameter descriptions, and communication cases.
SV680N Series Servo Drive Selection Guide	19011540	Presents technical data and dimensions of the servo drive, and specifications and models of optional parts (installation accessories, cables, and periphery electrical parts).

Document Name	Data Code	Description
SV680N Series Servo Drive Hardware Guide	19011539	Presents installation and wiring of the servo drive, including preparations before installation, unpacking inspection and transport, wiring, and routine maintenance.
SV680N Series Servo Drive Commissioning Guide	19011536	Presents servo commissioning, parameter descriptions, troubleshooting, including the operating panel, commissioning software, and commissioning process and procedure.
SV680N Series Servo Drive Function Guide	19011538	This guide introduces function application, communication, fault codes, and parameters of the AC drive.
SV680N Series Servo Drive Communication Guide	19011537	Presents servo functions and parameters, including CANlink, CANopen, and Modbus communication configuration, fault descriptions, parameter descriptions, and communication cases.

Revision History

Date	Version	Revision Description
June 2021	A00	First release

Document Acquisition

This manual is not delivered with the product. You can obtain the PDF version by visiting:

- *http://www.inovance.com*.

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 instructions may result in death, severe personal injuries, or equipment damage.
- "CAUTION", "WARNING", and "DANGER" items in the guide only indicate some of the precautions that need to be followed; they just supplement the safety precautions.
- Use this equipment according to the designated environment requirements. Damage caused by improper use is not covered by warranty.
- Inovance shall take no responsibility for any personal injuries or property damage caused by improper use.

Safety Levels and Definitions

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

General 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.

Unpacking

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

- Check whether the 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

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

- Handle the equipment with care during transportation and mind your steps to prevent personal injuries or equipment damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply may result in personal injuries.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply will result in equipment damage.
- Avoid storing or transporting the equipment in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing 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

- The equipment must be operated only by professionals with electrical knowledge.

- 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 devices with strong electromagnetic interference, such as a transformer, install a shielding device for the equipment to prevent malfunction.
- Install the equipment onto an incombustible object such as a metal. Keep the equipment away from combustible objects. Failure to comply will result in a fire.

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

Wiring

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

- Do not connect the input power supply to the output end of the equipment. Failure to comply will 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.

- During wiring, follow the proper electrostatic discharge (ESD) procedure, and wear an antistatic wrist strap. Failure to comply will damage the equipment or the internal circuits of the equipment.
- Use shielded twisted pairs for the control circuit. Connect the shield to the grounding terminal of the equipment for grounding purpose. Failure to comply will result in equipment malfunction.

Power-on

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

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

Operation

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

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

Maintenance

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

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

Repair

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

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

Disposal

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

Other Precautions

Dynamic brake

- The dynamic brake can only be used for emergency stop upon fault or power failure. Do not trigger faults or power failure frequently.
- The action interval of the dynamic brake function must be above 5 min during high-speed operation. Failure to comply may damage the internal dynamic braking circuit.
- A motor being driven by the load axis is in the generating state, which is common in rotary mechanical structures during dynamic braking stop. Under such state, a short circuit current will pass through the dynamic brake. If the motor keeps being driven by the load axis, smoke or flame may be generated from the drive, resulting in motor damage.

Safety Labels

For safe equipment operation and maintenance, comply with the safety labels on the equipment. Do not damage or remove the safety labels. See the following table for descriptions of the safety labels.

Safety Label	Description
	• Never fail to connect 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 heatsink with power ON to prevent the risk of burn.

1 Overview

1.1 Overview of Safety Functions

This manual only describes safety functions of the safety module on the safety drive. For the functions and hardware STO terminal (CN6) of the servo drive, see the supporting user manual.

List of safety functions

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

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

Characteristics of safety functions

- The safety functions are controlled by an external device through DI or through a safety bus.
  The combination of safety module, SV680 series servo drives, and safety motor supports safety functions (SS2/SOS/SSM/SDI/SLS/SS1-r) in compliance with PL e/ Cat.3 and SIL3. The SS2/SS1/SBC/SLS/SSM/SDI/SOS functions are not available when a non-safety motor is used.
- Controlling safety functions using a safety bus reduces wiring.

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

1.2 Terms and Abbreviations

Terms and Abbreviations	Description
Cat.	Category related to the safety level of control systems 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
PFHd	Probability of failure per hour
PL	Performance Level
SC	Systematic capability
SIL	Safety integrity level
T_1	Test Time Interval
DI	Digital input
DO	Digital output
PCB	Printed circuit board
MCU	Micro computer unit

Terms and Abbreviations	Description
FPGA	Field programmable gate array
MTTFd	Mean time to dangerous failure

1.3 Safety standards

Standards compliance

- North American standards (UL)
  UL 61800-5-1

  CSA C22.2 No. 274

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

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

  Machinery Directive 2006/42/EC (Safety Functions) Standard IEC 61800-5-2

- Safety standard

Model	Safety standard	Standard
SV680****S	Functional safety	IEC 61800-5-2: 2016 ISO 13849-1: 2015 IEC 61508: 2010, parts 1-7 EN 61800-5-2: 2017 EN ISO 13849-1: 2015 EN 62061: 2005 + AC: 2010 + A1: 2013 + A2: 2015 EN 61508: 2010, parts 1-7
	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
	LVD	IEC 61800-5-1:2016 EN 61800-5-1:2007+A1: 2017 (in extracts)

- Safety performance

Item	Performance
SIL	SIL3, IEC61508 SILCL3, IEC/EN62061
PFHd	PFHd≤0.16×10^{-7}[1/h] (16% of SIL3)

Item	Performance
Cat.	3, EN ISO 13849-1
PL	e, EN ISO 13849-1
MTTFd	441.3 years (high)
DCavg	Medium
T_1	10 years
HFT	1
SC	3
Application mode	High demand or continuous mode

1.4 Precautions for Use

General Safety Instructions

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

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

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

Table 1–1 Warnings, Cautions and Notes

Pictogram	Signal word	Meaning	Consequences in case of disregard
Example:  DANGER  Hazardous voltage e.g. electric shock	DANGER	Imminent danger	Severe or fatal injuries
	WARNINGS	Possible dangerous situation	Severe or fatal injuries
	CAUTION	Possible dangerous situation	Minor injuries
	STOP!	Possible high dangerous	Damage to the drive system or its environment

- 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 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 is required before starting operation. Read the following safety precautions, risk assessment information, and limitations before starting operation. Safety function: Use the safety function after properly understanding all of these information. Incorrect use of safety functions or use of safety functions that are not sufficient to meet the safety requirements of the site may result in personal injury.

Safety Precautions

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

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

disconnect the power or initiate a controlled rapid stop using other means such as dynamic or regenerative braking.

- 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 SV680 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. A separate mechanical brake must be used to secure the motor.
- SS1/SS2: Set the deceleration correctly considering factors such as equipment rigidity and moment of inertia. Incorrect or unreasonable settings may result in failure of deceleration to zero at the desired position or time.

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 observation function of this product.

Common residual risks in each function

- 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.
- The time to a safety observation error depends on parameter settings.

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. When servicing the servo/inverter, cut off the power supply and ensure that the servo/inverter is not powered.

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

- **Safely-limited speed (SLS)**
  - Speed monitoring function guarantees the servo motor speed, but it does not guarantee the actual machine safety speed. Set parameters so that the safe speed of the machine is the same as the safety speed of the specified motor.
  - Check if the speed of the monitored servo axis is the same as the actual speed by using a tachometer, etc. considering the speed includes an error caused by the command and encoder resolution.
  - The defect of the mechanical section such as slid of shaft and wanting of a timing belt, etc. is not covered. Be sure to eliminate the risk of mechanical section before operation.
  - After speed is over the limit, safety observation error (shut-off signal off) does not occur during the speed error detection time set by the parameter. Make sure that safety can be ensured during this period.
  - Adjust the speed limit considering the risk of speed acceleration from an acceptable safe speed to an unacceptable speed due to the system response time.
- **Safe operating stop (SOS)**
  This function is used in applications with external force loads such as vertical axis applications. Servo drive failure can cause axis position hold failure. Evaluate the impact on the system and take hazard reduction or control measures such as mechanical braking.
- **Safe speed monitor (SSM)**
  - Speed monitoring function guarantees the servo motor speed, but it does not guarantee the actual machine safety speed. Set parameters so that the safe speed of the machine is the same as the safety speed of the specified motor.
  - Check if the speed of the monitored servo axis is the same as the actual speed by using a tachometer, etc. considering the speed includes an error caused by the command and encoder resolution.
  - The defect of the mechanical section such as slid of shaft and wanting of a timing belt, etc. is not covered. Be sure to eliminate the risk of mechanical section before operation.
  - After speed is over the limit, safety observation error (shut-off signal off) does not occur during the speed error detection time set by the parameter. Make sure that safety can be ensured during this period.
  - Adjust the speed limit considering the risk of speed acceleration from an acceptable safe speed to an unacceptable speed due to the system response time.

2 Product Information

2.1 Nameplate and Model Number of the Servo Drive

Nameplate and model number

SV680 ① P ② S ③ 2R8 ④ I ⑤

① **Product series** SV680: SV680 series general general-purpose servo drive SV680L: SV680 series servo drive for direct-drive motors	④ **Rated output current**	⑤ **Model configuration** I: Standard type S: Functional safety type ...
② **Product type** N: Network type P: Pulse type F: Profinet (upcoming)	S: 220 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	
③ **Voltage class** S: 220 V T: 380 V	T: 380 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	

Figure 2-1 Servo drive nameplate

Encryption of the production serial number

01050202 4 H 7 00001
① ② ③ ④ ⑤

① **Internal code** Material code	③ **Year** 9: 2009 A: 2010 ... N: 2021 ... 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 010502024H700001 indicates the drive is manufactured in July, 2017.

2.2 Nameplate and Model of the Servo Motor

MS1 H1 - 75B 30C B A6 3 2 R
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

① **MS1 series servo motor**	④ **Rated speed (rpm)** Comprised of a letter and two digits B: x 10 C: x 100 Example: 30C: 3000 rpm	⑦ **Shaft connection mode** 3: Solid, with key and threaded hole
② **Inertia level** H1: Low inertia, small capacity H4: Medium inertia, small capacity	⑤ **Voltage class (V)** B: 220	⑧ **Brake, reducer and oil seal** 0: None 1: Oil seal 2: Brake 4: Oil seal+Brake
③ **Rated power (W)** Comprised of a letter and two digits B: x 10 C: x 100 Example: 75B: 750 W	⑥ **Encoder type** Comprised of a letter and a digit A6: 26-bit multi-turn absolute encoder S6: 26-bit multi-turn absolute encoder of functional safety type	⑨ **Sub-series number** R: R series

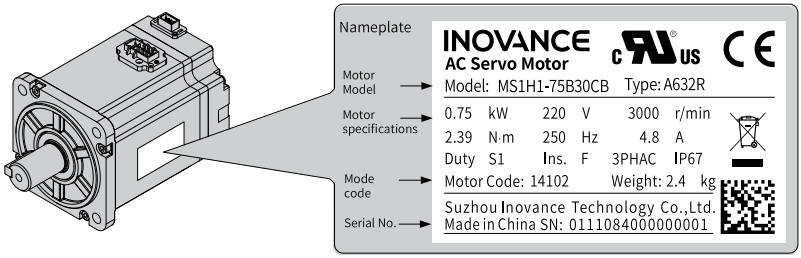


Figure 2-2 Servo motor nameplate

Note

The SV680P series servo drive can be used together with the motor equipped with a 26-bit absolute encoder.

2.3 Cable Models

Power cable model

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

① **Cable type** S6-L-M: Power cable for motion control	④ **Connector type on the motor side** 0: AMP 1: 9-pin aviation connector 2: 6-pin aviation connector 4: Middle series 4-pin aviation connector 5: Middle series 6-pin aviation connector 6: SM-PW series 6-pin aviation connector 7: SDC-06T series aviation connector (front outlet) 8: SDC-06T series aviation connector (rear outlet)	⑤ **Cable length (m)** 3.0: 3 m 5.0: 5 m 8.0: 8 m 10.0: 10 m
② **Connector type on the drive side** 0: U-type cable lug 1: Pin-type cable lug		⑥ **Special requirements** T: Flexible TS: Shielded and flexible S: Single-shielded TTS: Shielded and flexible (20,000,000 times)
③ **Cross sectional area (mm^2)** 0: Wire-saving encoder 1: Flange size 100/130/180 (rated current of the drive < 13 A) 2: 180 (rated current of the drive > 13 A) 3: 4 x 12AWG 4: 4 x 14AWG 5: 4 x 16AWG 6: 4 x 18AWG 7: 4 x 20AWG		⑦ **Customized or branded** YGS: Igus

Encoder cable model

S6-L-P ① 0 ② 0 ③ 0 ④ - 3.0 ⑤ - T ⑥ - X ⑦

① **Cable type** S6-L-P: Encoder cable for motion control	④ **Connector type on the motor side** 0: AMP 1: 9-pin aviation connector 2: 6-pin aviation connector 4: Middle series 4-pin aviation connector 5: Middle series 6-pin aviation connector 6: SM-PW series 6-pin aviation connector 7: SDC-07T series aviation connector (front outlet) 8: SDC-07T series aviation connector (rear outlet) 9: DB9 (two rows) - Ying Nuo A: DB15 (two rows) - RSF B: DB15 (two rows) - Renishaw C: DB15 (two rows) - Rongshu D: DB15 (three rows) - Inovance	⑤ **Cable length (m)** 3.0: 3 m 5.0: 5 m 8.0: 8 m 10.0: 10 m
② **Connector type on the drive side** 0: DB9 1: USB 2: DB15		⑥ **Special requirements** T: Flexible TS: Shielded and flexible TTS: Shielded and flexible (20,000,000 times)
③ **Encoder application mode** 0: Wire-saving encoder 1: Communication-type incremental encoder 2: Communication-type multi-turn absolute encoder 3: Grating 4: Magnetic grating		⑦ **Customized or branded** YGS: Igus

Communication cable model

S6N-L-T ① 00 ② - 3.0 ③

① **Cable type** S6-L-T: Communication cable for motion control S6N-L-T: Communication cable for IS620F motion control (only for servo drive to PC communication cable)	② **Communication cable connection type** 00: Servo drive to PC communication cable 01: Servo drive network communication cable (CAN&RS485) 02: Servo drive to PLC communication cable 03: Servo drive termination resistor cable (CAN&RS485) 04: Servo drive network communication cable (EtherCAT) 05: Servo drive network communication cable (Mechatrolink II) 06: Servo drive termination resistor cable (Mechatrolink II)	③ **Cable length (m)** 3.0: 3 m 5.0: 5 m 8.0: 8 m 10.0: 10 m

2.4 Components

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

SV680P series functional safety servo drives

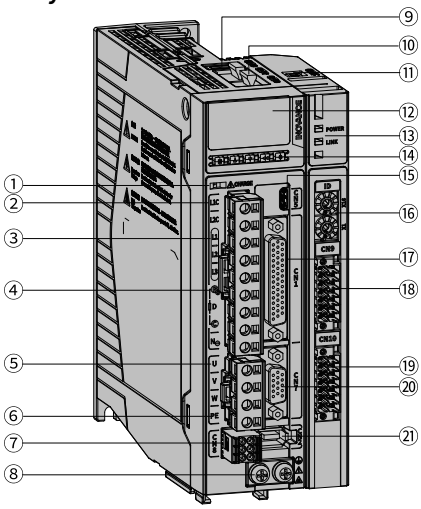


Figure 2-3 Components of servo drives in size A and size C

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

No.	Name	Description
①	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
②	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
③	L1, L2, L3T (main circuit power input terminals)	Power input terminals of the servo drive. See the nameplate for the rated voltage class.
④	P⊕, D, C (terminals for connecting external regenerative resistor)	Remove the jumper bar between terminals P⊕ and C before connecting an external regenerative resistor between terminals P⊕ and D.
	P⊕, N⊖ (servo bus terminals)	Used by the common DC bus for multiple servo drives.

No.	Name	Description
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)	Connected to brake and motor temperature feedback.
⑧	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
⑨	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose. For the description and function introduction of this terminal, see the corresponding function manual and hardware manual.
⑩	CN3, CN4 (communication terminals)	Connected to RS485 host controllers in parallel.
⑪	CN11 (24 V standby power input terminal)	When power failure occurs, the standby power functions to help commissioning.
⑫	LED display	The 5-digit 8-segment LED display is used to show servo system's running state and parameter setting.
⑬	Power supply indicator of the safety module	Power: When the safety module is connected and the power supply is normal, the indicator is on. LINK: Safety communication status indicator. Note: Since the P-type drive does not have FSoE, this indicator is not on.
⑭	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: Turns to the next page when the displayed number exceeds five digits) S: Saves modifications and enters the next menu.
⑮	CN5 (communication terminals)	Only supports online upgrade and software tool commissioning upon power on. Only supports parameter download/upload and firmware update in the USB mode. Supplied by USB power (If fault reset fails, disconnect the USB power supply and control circuit power supply of the drive, and perform a power cycling).
⑯	FSoE ID address setting knob	Sets ID address of the slave drive for FSoE communication. FSoE address setting method: The number of the upper knob*16 + the number of the lower knob.
⑰	CN1 (control terminal)	Used by reference input signals and other I/O signals.

No.	Name	Description
⑱	CN9 (safety module control terminal A)	Control terminal A of the safety module.
⑲	CN10 (safety module control terminal B)	Command input and output terminal B of the safety module.
⑳	CN7 (second encoder feedback terminal)	Supports communication encoder and pulse encoder.
㉑	Terminal for connecting DB9 encoder	Connected to the motor encoder terminal.

Note

- The built-in regenerative resistor or jumper bar is not available in models S1R6 and S2R8. If an external regenerative resistor is needed for these models, connect it between terminals P⊕ and C.
- [1] The main circuit power input terminals for 220 V servo drives are L1, L2, and L3. The main circuit power input terminals for 380 V servo drives are R, S, and T.

SV680N series functional safety servo drives

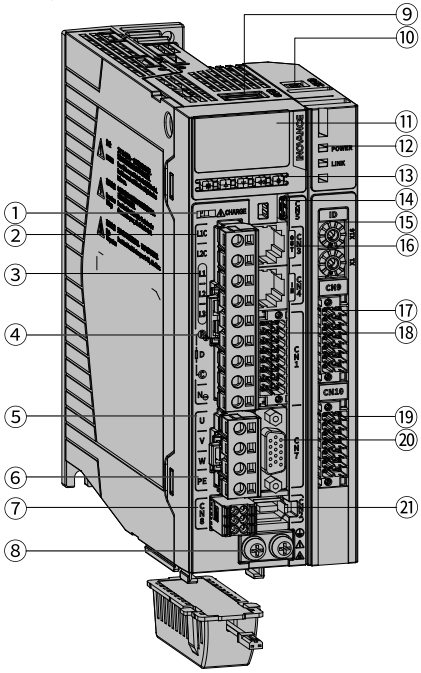


Figure 2-4 Components of servo drives in size A and size C

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

No.	Name	Description
①	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
②	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
③	L1, L2, L3 (main circuit power input terminals)[1]	Power input terminals of the servo drive. See the nameplate for the rated voltage class.

No.	Name	Description
④	P⊕, D, C (terminals for connecting external regenerative resistor)	Remove the jumper bar between terminals P⊕ and C before connecting an external regenerative resistor between terminals P⊕ and D.
	P⊕, N⊖ (servo bus terminals)	Used by the common DC bus for multiple servo drives.
⑤	U, V, W (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)	Connected to brake and motor temperature feedback.
⑧	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
⑨	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose. For the description and function introduction of this terminal, see the corresponding function manual and hardware manual.
⑩	CN11 (24 V standby power input terminal)	When power failure occurs, the standby power functions to help commissioning.
⑪	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: Turns to the next page when the displayed number exceeds five digits) S: Saves modifications and enters the next menu.
⑭	CN5 (communication terminals)	Only supports online upgrade and software tool commissioning upon power on. Only supports parameter download/upload and firmware update in the USB mode. Supplied by USB power (If fault reset fails, disconnect the USB power supply and control circuit power supply of the drive, and perform a power cycling).

No.	Name	Description
⑮	FSoE ID address setting knob	Sets ID address of the slave drive for FSoE communication. FSoE 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	CN9 (safety module control terminal A)	Control terminal A of the safety module.
⑱	CN1 (control terminal)	Used by reference input signals and other I/O signals.
⑲	CN10 (safety module control terminal B)	Command input and output terminal B of the safety module.
⑳	CN7 (second encoder feedback terminal)	Supports communication encoder and pulse encoder.
㉑	Terminal for connecting DB9 encoder	Connected to the motor encoder terminal.

Note

- The built-in regenerative resistor or jumper bar is not available in models S1R6 and S2R8. If an external regenerative resistor is needed for these models, connect it between terminals P⊕ and C.
- [1] The main circuit power input terminals for 220 V servo drives are L1, L2, and L3. The main circuit power input terminals for 380 V servo drives are R, S, and T.

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

SV680P series functional safety servo drives

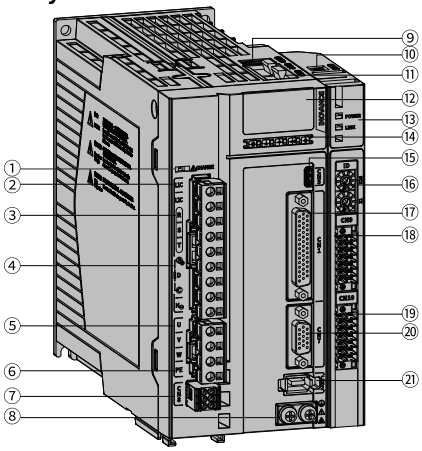


Figure 2-5 Components of servo drives in size D

Table 2–3 Description of components of servo drive in size D

No.	Name	Description
①	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
②	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
③	R, S, T (main circuit power input terminals)	Power input terminals of the servo drive. See the nameplate for the rated voltage class.
④	P⊕, D, C (terminals for connecting external regenerative resistor)	Remove the jumper bar between terminals P⊕ and C before connecting an external regenerative resistor between terminals P⊕ and D.
	P⊕, N⊖ (servo bus terminals)	Used by the common DC bus for multiple servo drives.
⑤	U, V, W (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.

No.	Name	Description
⑦	CN8 (brake and PTC input terminal)	Connected to brake and motor temperature feedback.
⑧	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
⑨	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose. For the description and function introduction of this terminal, see the corresponding function manual and hardware manual.
⑩	CN11 (24 V standby power input terminal)	When power failure occurs, the standby power functions to help commissioning.
⑪	CN3, CN4 (communication terminals)	Connected to RS485 host controllers in parallel.
⑫	LED display	The 5-digit 8-segment LED display is used to show servo system's running state and parameter setting.
⑬	Power supply indicator of the safety module	Power: When the safety module is connected and the power supply is normal, the indicator is on. LINK: Safety communication status indicator. Note: Since the P-type drive does not have FSoE, this indicator is not on.
⑭	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: Turns to the next page when the displayed number exceeds five digits) S: Saves modifications and enters the next menu.
⑮	CN5 (communication terminals)	Only supports online upgrade and software tool commissioning upon power on. Only supports parameter download/upload and firmware update in the USB mode. Supplied by USB power (If fault reset fails, disconnect the USB power supply and control circuit power supply of the drive, and perform a power cycling).
⑯	FSoE ID address setting knob	Sets ID address of the slave drive for FSoE communication. FSoE address setting method: The number of the upper knob*16 + the number of the lower knob.
⑰	CN1 (control terminal)	Used by reference input signals and other I/O signals.
⑱	CN9 (safety module control terminal A)	Control terminal A of the safety module.
⑲	CN10 (safety module control terminal B)	Command input and output terminal B of the safety module.

No.	Name	Description
⑳	CN7 (second encoder feedback terminal)	Supports communication encoder and pulse encoder.
㉑	Terminal for connecting DB9 encoder	Connected to the motor encoder terminal.

Note

- The built-in regenerative resistor or jumper bar is not available in models S1R6 and S2R8. If an external regenerative resistor is needed for these models, connect it between terminals P⊕ and C.
- [1] The main circuit power input terminals for 220 V servo drives are L1, L2, and L3. The main circuit power input terminals for 380 V servo drives are R, S, and T.

SV680N series functional safety servo drives

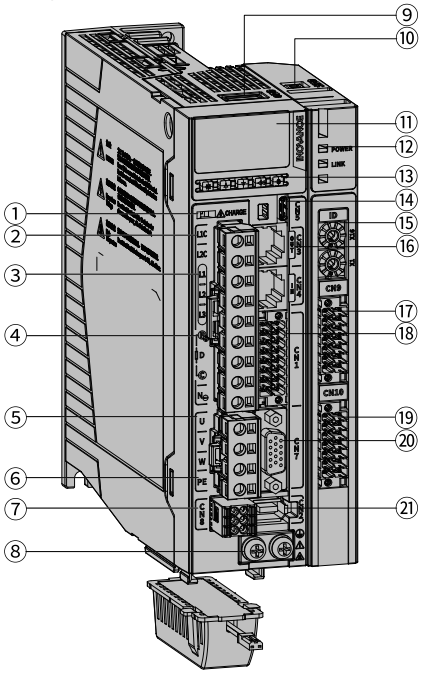


Figure 2-6 Components of servo drives in size D

Table 2–4 Description of components of servo drives in size D

No.	Name	Description
①	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
②	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
③	L1, L2, L3 (main circuit power input terminals)[1]	Power input terminals of the servo drive. See the nameplate for the rated voltage class.
④	P⊕, D, C (terminals for connecting external regenerative resistor)	Remove the jumper bar between terminals P⊕ and C before connecting an external regenerative resistor between terminals P⊕ and D.
	P⊕, N⊖ (servo bus terminals)	Used by the common DC bus for multiple servo drives.
⑤	U, V, W (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)	Connected to brake and motor temperature feedback.
⑧	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
⑨	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose. For the description and function introduction of this terminal, see the corresponding function manual and hardware manual.
⑩	CN11 (24 V standby power input terminal)	When power failure occurs, the standby power functions to help commissioning.
⑪	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.

No.	Name	Description
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: Turns to the next page when the displayed number exceeds five digits) S: Saves modifications and enters the next menu.
⑭	CN5 (communication terminals)	Only supports online upgrade and software tool commissioning upon power on. Only supports parameter download/upload and firmware update in the USB mode. Supplied by USB power (If fault reset fails, disconnect the USB power supply and control circuit power supply of the drive, and perform a power cycling).
⑮	FSoE ID address setting knob	Sets ID address of the slave drive for FSoE communication. FSoE 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	CN9 (safety module control terminal A)	Control terminal A of the safety module.
⑱	CN1 (control terminal)	Used by reference input signals and other I/O signals.
⑲	CN10 (safety module control terminal B)	Command input and output terminal B of the safety module.
⑳	CN7 (second encoder feedback terminal)	Supports communication encoder and pulse encoder.
㉑	CN2 (encoder connection terminal)	Connected to the motor encoder terminal.

Note

- The built-in regenerative resistor or jumper bar is not available in models S1R6 and S2R8. If an external regenerative resistor is needed for these models, connect it between terminals P⊕ and C.
- [1] The main circuit power input terminals for 220 V servo drives are L1, L2, and L3. The main circuit power input terminals for 380 V servo drives are R, S, and T.

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

SV680P series functional safety servo drives

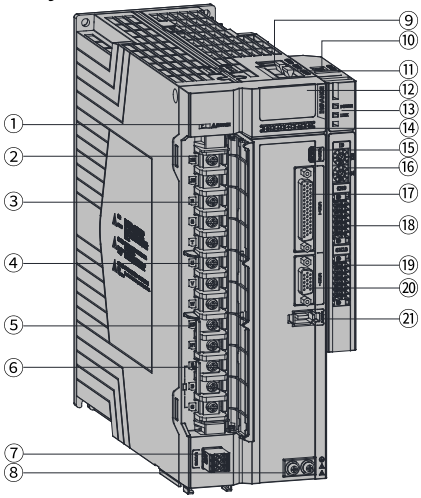


Figure 2-7 Components of servo drives in size E

Table 2–5 Description of components of servo drives in size E

No.	Name	Description
①	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
②	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
③	R, S, T (main circuit power input terminals)	Power input terminals of the servo drive. See the nameplate for the rated voltage class.
④	U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
⑤	N2, N1 (terminals for connecting external reactor)	Terminals N1 and N2 are jumpered by default. To suppress harmonics in the power supply, remove the jumper between terminals N1 and N2 first and connect an external DC reactor between terminals N1 and N2.
⑥	P⊕, D, C (terminals for connecting external regenerative resistor)	Remove the jumper bar between terminals P⊕ and D before connecting an external regenerative resistor between terminals P⊕ and C.

No.	Name	Description
⑦	CN8 (brake and PTC input terminal)	Connected to brake and motor temperature feedback.
⑧	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
⑨	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose. For the description and function introduction of this terminal, see the corresponding function manual and hardware manual.
⑩	CN11 (24 V standby power input terminal)	When power failure occurs, the standby power functions to help commissioning.
⑪	CN3, CN4 (communication terminals)	Connected to RS485 host controllers in parallel.
⑫	LED display	The 5-digit 8-segment LED display is used to show servo system's running state and parameter setting.
⑬	Power supply indicator of the safety module	Power: When the safety module is connected and the power supply is normal, the indicator is on. LINK: Safety communication status indicator. Note: Since the P-type drive does not support FSoE, this indicator is not on.
⑭	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: Turns to the next page when the displayed number exceeds five digits) S: Saves modifications and enters the next menu.
⑮	CN5 (communication terminals)	Only supports online upgrade and software tool commissioning upon power on. Only supports parameter download/upload and firmware update in the USB mode. Supplied by USB power (If fault reset fails, disconnect the USB power supply and control circuit power supply of the drive, and perform a power cycling).
⑯	FSoE ID address setting knob	Sets ID address of the slave drive for FSoE communication. FSoE address setting method: The number of the upper knob*16 + the number of the lower knob.
⑰	CN1 (control terminal)	Used by reference input signals and other I/O signals.
⑱	CN9 (safety module control terminal A)	Control terminal A of the safety module.
⑲	CN10 (safety module control terminal B)	Command input and output terminal B of the safety module.

No.	Name	Description
⑳	CN7 (second encoder feedback terminal)	Supports communication encoder and pulse encoder.
㉑	CN2 (encoder connection terminal)	Connected to the motor encoder terminal.

Note

[1]: The power input terminals of the 220 V servo drive's main circuit are L1, L2, and L3; and the power input terminals of the 380 V servo drive's main circuit are R, S, and T.

SV680N series functional safety servo drives

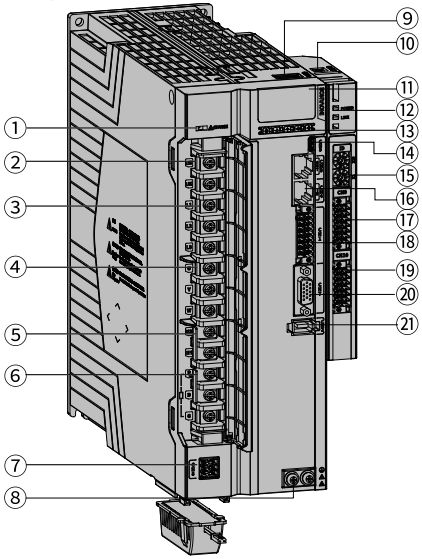


Figure 2-8 Components of servo drives in size E

Table 2–6 Description of components of servo drives in size E

No.	Name	Description
①	CHARGE (bus voltage indicator)	Indicates the electric charge is present in the bus capacitor. When the indicator turns on, charges possibly still exist in the internal capacitor of the servo unit, even if the power supply of the main circuit is OFF. To prevent electric shock, do not touch the power terminals when this indicator lights up.
②	L1C, L2C (control circuit power input terminals)	See the nameplate for the rated voltage class.
③	L1, L2, L3 (main circuit power input terminals)[1]	Power input terminals of the servo drive. See the nameplate for the rated voltage class.
④	U, V, W (terminals for connecting the servo motor)	Connected to U, V, and W phases of the servo motor.
⑤	N2, N1 (terminals for connecting external reactor)	Terminals N1 and N2 are jumpered by default. To suppress harmonics in the power supply, remove the jumper between terminals N1 and N2 first and connect an external DC reactor between terminals N1 and N2.
⑥	P⊕, D, C (terminals for connecting external regenerative resistor)	Remove the jumper bar between terminals P⊕ and D before connecting an external regenerative resistor between terminals P⊕ and C.
⑦	CN8 (brake and PTC input terminal)	Connected to brake and motor temperature feedback.
⑧	Servo drive grounding terminal	Connected to the grounding terminal of the power supply for grounding purpose.
⑨	CN6 (STO safety function terminal)	Connected to external functional safety signal for functional safety purpose. For the description and function introduction of this terminal, see the corresponding function manual and hardware manual.
⑩	CN11 (24 V standby power input terminal)	When power failure occurs, the standby power functions to help commissioning.
⑪	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.

No.	Name	Description
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: Turns to the next page when the displayed number exceeds five digits) S: Saves modifications and enters the next menu.
⑭	CN5 (communication terminals)	Only supports online upgrade and software tool commissioning upon power on. Only supports parameter download/upload and firmware update in the USB mode. Supplied by USB power (If fault reset fails, disconnect the USB power supply and control circuit power supply of the drive, and perform a power cycling).
⑮	FSoE ID address setting knob	Sets ID address of the slave drive for FSoE communication. FSoE 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	CN9 (safety module control terminal A)	Control terminal A of the safety module.
⑱	CN1 (control terminal)	Used by reference input signals and other I/O signals.
⑲	CN10 (safety module control terminal B)	Command input and output terminal B of the safety module.
⑳	CN7 (second encoder feedback terminal)	Supports communication encoder and pulse encoder.
㉑	CN2 (encoder connection terminal)	Connected to the motor encoder terminal.

Note

[1]: The power input terminals of the 220 V servo drive's main circuit are L1, L2, and L3; and the power input terminals of the 380 V servo drive's main circuit are R, S, and T.

2.5 Matching Between Servo Drive and Servo Motor

Table 2–7 Matching between SS1-r/SLS/SSM/SOS/SS2/SDI safety drive and safety motor

Servo motor (MS1**-******-*****)				Model of matching servo drive	
Model	Frame	Rated speed (rpm)	Maximum speed (rpm)	P type	N type
MS1H1-05B30CB-S630R	40	3000	7000	SV680PS1R6S	SV680NS1R6S
MS1H1-10B30CB-S630R				SV680PS1R6S	SV680NS1R6S
MS1H1-20B30CB-S630R	60			SV680PS1R6S	SV680NS1R6S
MS1H1-40B30CB-S630R				SV680PS2R8S	SV680NS2R8S
MS1H1-55B30CB-S630R	80			SV680PS5R5S	SV680NS5R5S
MS1H1-75B30CB-S630R				SV680PS5R5S	SV680NS5R5S
MS1H1-10C30CB-S630R				SV680PS7R6S	SV680NS7R6S
MS1H1-05B30CB-S632R	40	3000	7000	SV680PS1R6S	SV680NS1R6S
MS1H1-10B30CB-S632R				SV680PS1R6S	SV680NS1R6S
MS1H1-20B30CB-S632R	60			SV680PS1R6S	SV680NS1R6S
MS1H1-40B30CB-S632R				SV680PS2R8S	SV680NS2R8S
MS1H1-75B30CB-S632R	80			SV680PS5R5S	SV680NS5R5S
MS1H1-10C30CB-S632R				SV680PS7R6S	SV680NS7R6S
MS1H4-10B30CB-S630R	40	3000	7000	SV680PS1R6S	SV680NS1R6S
MS1H4-20B30CB-S631R	60			SV680PS1R6S	SV680NS1R6S
MS1H4-40B30CB-S631R				SV680PS2R8S	SV680NS2R8S
MS1H4-55B30CB-S631R	80			SV680PS5R5S	SV680NS5R5S
MS1H4-75B30CB-S631R				SV680PS5R5S	SV680NS5R5S
MS1H4-10C30CB-S631R				SV680PS7R6S	SV680NS7R6S

Servo motor (MS1**-******-*****)				Model of matching servo drive	
Model	Frame	Rated speed (rpm)	Maximum speed (rpm)	P type	N type
MS1H4-10B30CB-S630R	40	3000	7000	SV680PS1R6S	SV680NS1R6S
MS1H4-20B30CB-S631R	60			SV680PS1R6S	SV680NS1R6S
MS1H4-40B30CB-S631R				SV680PS2R8S	SV680NS2R8S
MS1H4-75B30CB-S631R	80			SV680PS5R5S	SV680NS5R5S
MS1H4-10C30CB-S631R				SV680PS7R6S	SV680NS7R6S

Table 2–8 Matching between SS1-t/STO/SBC safety drive and motor

Servo motor (MS1**-******-*****)				Model of matching servo drive	
Model	Frame	Rated speed (rpm)	Maximum speed (rpm)	P type	N type
MS1H1-05B30CB-*630R	40	3000	7000	SV680PS1R6S	SV680NS1R6S
MS1H1-10B30CB-*630R				SV680PS1R6S	SV680NS1R6S
MS1H1-20B30CB-*630R	60			SV680PS1R6S	SV680NS1R6S
MS1H1-40B30CB-*630R				SV680PS2R8S	SV680NS2R8S
MS1H1-55B30CB-*630R	80			SV680PS5R5S	SV680NS5R5S
MS1H1-75B30CB-*630R				SV680PS5R5S	SV680NS5R5S
MS1H1-10C30CB-*630R				SV680PS7R6S	SV680NS7R6S
MS1H1-05B30CB-*632R	40	3000	7000	SV680PS1R6S	SV680NS1R6S
MS1H1-10B30CB-*632R				SV680PS1R6S	SV680NS1R6S
MS1H1-20B30CB-*632R	60			SV680PS1R6S	SV680NS1R6S
MS1H1-40B30CB-*632R				SV680PS2R8S	SV680NS2R8S
MS1H1-75B30CB-*632R	80			SV680PS5R5S	SV680NS5R5S
MS1H1-10C30CB-*632R				SV680PS7R6S	SV680NS7R6S

Servo motor (MS1**-******-*****)				Model of matching servo drive	
Model	Frame	Rated speed (rpm)	Maximum speed (rpm)	P type	N type
MS1H4-10B30CB-*630R	40	3000	7000	SV680PS1R6S	SV680NS1R6S
MS1H4-20B30CB-*631R	60			SV680PS1R6S	SV680NS1R6S
MS1H4-40B30CB-*631R				SV680PS2R8S	SV680NS2R8S
MS1H4-55B30CB-*631R	80			SV680PS5R5S	SV680NS5R5S
MS1H4-75B30CB-*631R				SV680PS5R5S	SV680NS5R5S
MS1H4-10C30CB-*631R				SV680PS7R6S	SV680NS7R6S
MS1H4-10B30CB-*630R	40	3000	7000	SV680PS1R6S	SV680NS1R6S
MS1H4-20B30CB-*631R	60			SV680PS1R6S	SV680NS1R6S
MS1H4-40B30CB-*631R				SV680PS2R8S	SV680NS2R8S
MS1H4-75B30CB-*631R	80			SV680PS5R5S	SV680NS5R5S
MS1H4-10C30CB-*631R				SV680PS7R6S	SV680NS7R6S

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.

3 Keypad

3.1 Introduction to the Keypad

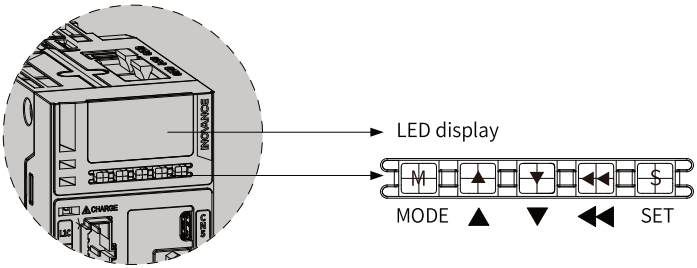


Figure 3-1 Magnified view of the keypad

The keypad of the SV680 series servo drives consists of an LED (5-digit, 8-segment) and five buttons. The keypad is used for value display, parameter setting, user password setting and general function execution. The following table takes parameter setting as an example to describe the general functions of the keys.

Table 3–1 Descriptions of keys

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

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 warnings 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 warning codes. For analysis and solutions to the faults and warnings, see Chapter "Troubleshooting".
- When a fault or warning occurs, the keypad displays the corresponding fault or warning code immediately. When multiple faults or warnings occur, the keypad displays the fault code of the highest fault level.
- You can select the previous fault/warning to be viewed through H0b.33 and view the code of the selected fault/warning in H0b.34.
- You can clear the latest 20 faults or warnings saved in the servo drive by setting H02.31 to "2".

For example, E941.0 is displayed as follows.

Display	Name	Description
	E941.0 Warning code	E: A fault or warning occurs on the servo drive. 941.0: Warning 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 Inspection

Check the following items upon unpacking.

Items	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 49*. The deliverables include the product, cushion, carton box, and screw bag, as shown in *"Figure 4–1 " on page 49* .
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 SV680*****S	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

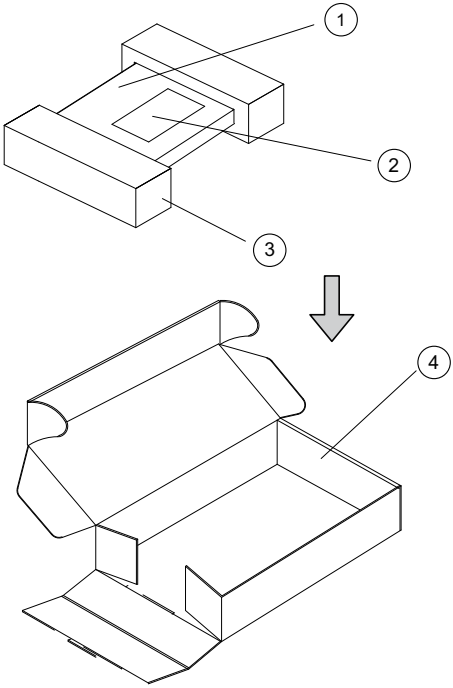


Figure 4-1 Contents inside the packing box

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

Table 4–2 Terminal accessory package list

Material Code	Name	Quantity	SV680P	SV680N
15210204	Plug-in terminal block-plug-spring clamp wiring-6P-black	1	✓	✓
15210577	Plug-in terminal block-plug-spring clamp wiring-9P-black-with safety lock	1	✓	✓
15210648	Plug-in terminal block-plug-spring clamp wiring-2*2P-green-printing on both sides	1	✓	✓
15210695	Plug-in terminal block-plug-spring clamp wiring-4P-black	1	✓	✓
15210857	Plug-in terminal block-plug-spring wiring-2*8P-black-yellow buckle	1	x	✓
15220274	Jumper bar-16A-pluggable bridge	1	✓	✓
19021377	Labels-labels for servo drive terminals	1	✓	✓
2120021	Plastic parts-plug wiring key-for use with servo drive power plug	1	✓	✓

Note

Note that the terminal accessories package list of SV680P is slightly different from that of SV680N, the actual product shall prevail.

If you need to purchase the terminal accessory package separately, please contact Inovance. For the material code of the accessory package for each model, see *"Table 4–3 " on page 50*.

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

Material Code	Name
98050571	Complete accessories (sale)-S6-C85-SV680P size A terminal accessory package
98050572	Complete accessories (sale)-S6-C82-SV680P size A terminal accessory package
98050573	Complete accessories (sale)-S6-C86-SV680P size B, C, D terminal accessory package
98050574	Complete accessories (sale)-S6-C83-SV680N size B, C, D terminal accessory package

Material Code	Name
98050575	Complete accessories (sale)-S6-C87-SV680N size E terminal accessory package
98050576	Complete accessories (sale)-S6-C84-SV680N size E terminal accessory package

4.2 Installation Environment

Table 4–4 Environment requirements

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>Ambient/Storage temperature</td><td>–5°C to +55°C/–40°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>See IEC 60068-2-6 4.6</td></tr>
<tr><td>Condition</td><td>EUT powered on, operating normally</td></tr>
<tr><td>Motion mode</td><td>Sinusoidal</td></tr>
<tr><td>Vibration amplitude/ Acceleration</td><td>-</td></tr>
<tr><td>10 Hz ⩽ f ⩽ 57 Hz</td><td>0.075 mm amplitude</td></tr>
<tr><td>57 Hz < f ⩽ 150 Hz</td><td>1 g</td></tr>
<tr><td>Duration of vibration</td><td>10 sweep cycles per axis on each of three mutually perpendicular axes</td></tr>
<tr><td>Axes</td><td>X, Y, Z</td></tr>
<tr><td>Detail of mounting</td><td>According to manufacturer's specification</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>See IEC 60068-2-27: 2008 Table 17</td></tr>
<tr><td>Condition</td><td>EUT powered on, operating 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) 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>Axes</td><td>±X, ±Y, ±Z</td></tr>
<tr><td>Detail of mounting</td><td>According to manufacturer's specification</td></tr>
</table>
</td></tr>
</table>

Item	Description
IP rating/Pollution degree	IP20; PD2: free of corrosive or explosive gases; free of exposure to water, oil or chemicals; free of dust, salts or iron dust
Altitude	2000 m or below
Cooling method	Dry clean air (natural convection)
Other	Free of static electricity, strong electromagnetic fields, magnetic fields, or exposure to radioactivity

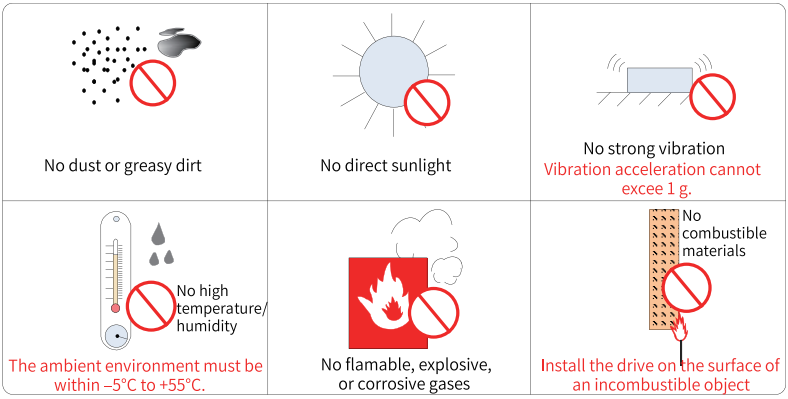


Figure 4-2 Environment requirements

4.3 Installation Clearance

Servo drives in different power ratings require different installation clearances. When installing multiple servo drives side by side, it is recommended to reserve a clearance of at least 20 mm (0.39 in.) between every two servo drives and a clearance of at least 80 mm (1.97 in.) above and below each servo drive for heat dissipation. Take the installation tolerance into account and reserve a distance of at least 1 mm (0.4 in.) between every two servo drives.

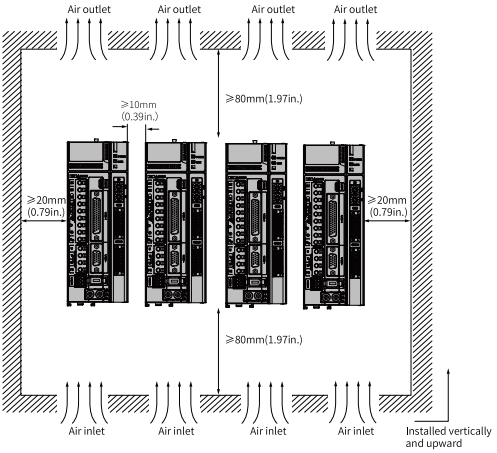


Figure 4-3 Clearance for side-by-side installation

Servo drives rated at 0.2 kW to 0.4 kW support compact installation, in which a clearance of at least 1 mm (0.04 in.) must be reserved between two servo drives.

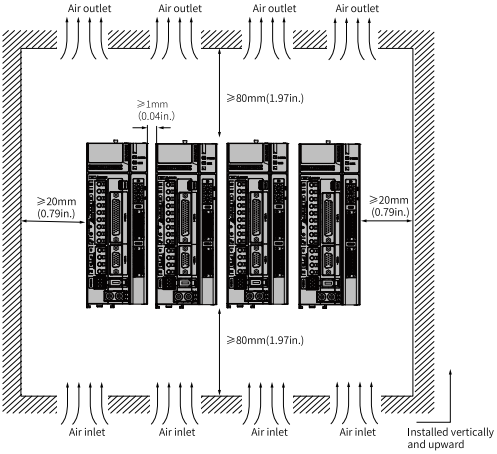


Figure 4-4 Clearance for compact installation

Servo drives rated at 0.75 kW to 7.5 kW support zero-clearance installation between two servo drives, without the need for derating.

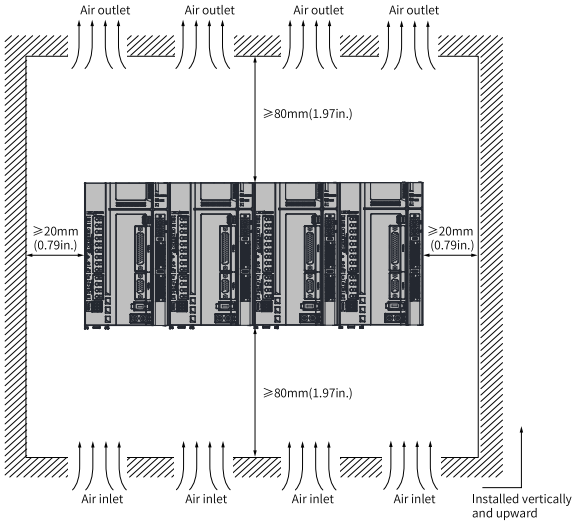


Figure 4-5 Zero-clearance installation

4.4 Installation Dimensions

Servo Drive in Size A (Rated Power: 0.2 kW to 0.4 kW): SV680PS1R6S, SV680PS2R8S

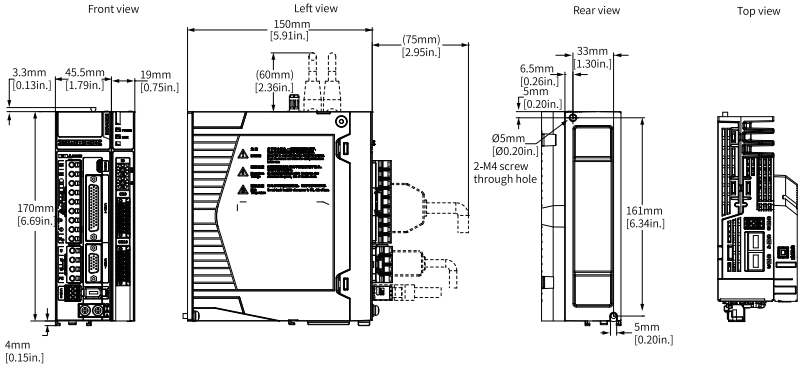


Figure 4-6 Dimension drawing of servo drive in size A

Fixing screws: 2–M4; recommended tightening torque: 1.2 N·m

Weigh: 1.11 kg

Servo Drive in Size A (Rated Power: 0.2 kW to 0.4 kW): SV680NS1R6S, SV680NS2R8S

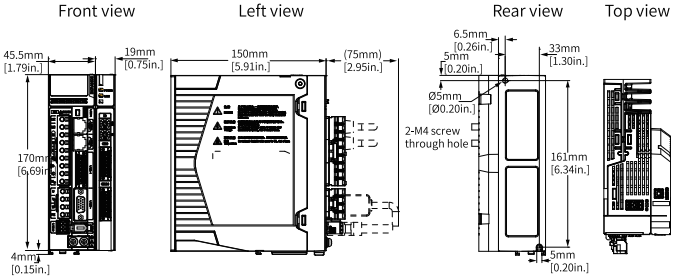


Figure 4-7 Dimension drawing of servo drive in size A

Fixing screws: 2–M4; recommended tightening torque: 1.2 N·m

Weigh: 1.11 kg

Servo Drive in Size C (Rated Power: 0.75 kW to 1.5 kW): SV680PS5R5S, SV680PS7R6S, SV680PT3R5S, SV680PT5R4S

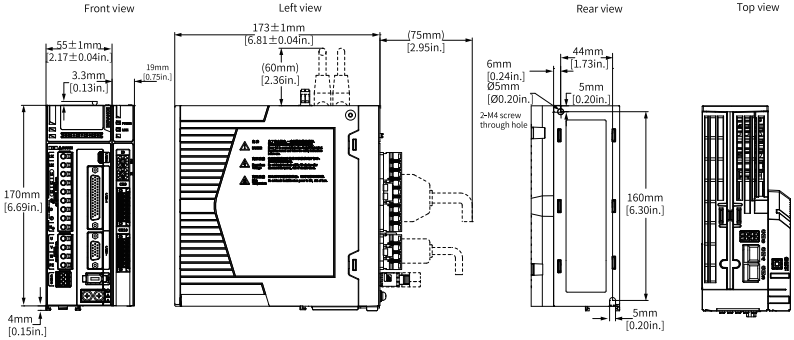


Figure 4-8 Dimension drawing of servo drive in size C

Fixing screws: 2–M4; recommended tightening torque: 1.2 N·m

Weigh: 1.45 kg

Servo Drives in Size C (Rated Power: 0.75 kW to 1.5 kW): SV680NS5R5S, SV680NS7R6S, SV680NT3R5S, SV680NT5R4S

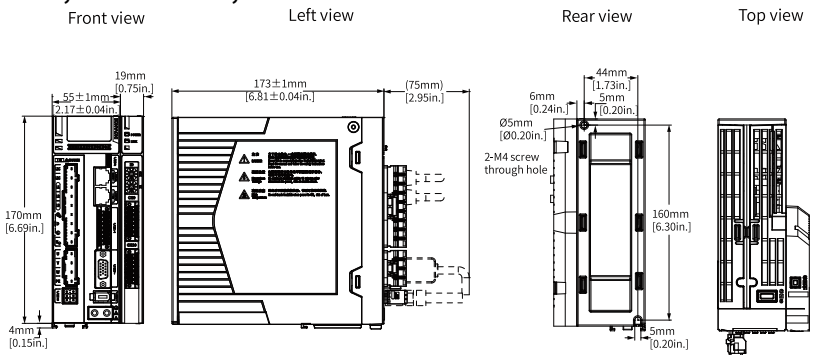


Figure 4-9 Dimension drawing of servo drives in size C

Fixing screws: 2–M4; recommended tightening torque: 1.2 N·m

Weigh: 1.45 kg

Servo Drive in Size D (Rated Power: 1.5 kW to 3.0 kW): SV680PS012S, SV680PT8R4S, SV680PT012S

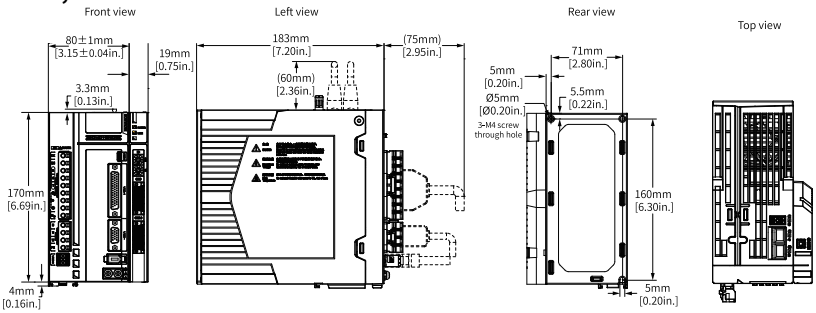


Figure 4-10 Dimension drawing of servo drive in size D

Fixing screws: 3–M4; recommended tightening torque: 1.2 N·m

Weigh: 1.8 kg

Servo Drive in Size D (Rated Power: 1.5 kW to 3.0 kW): SV680NS012S, SV680NT8R4S, SV680NT012S

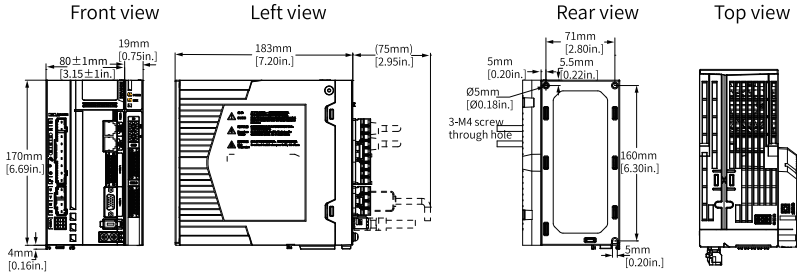


Figure 4-11 Dimension drawing of servo drive in size D

Fixing screws: 3–M4; recommended tightening torque: 1.2 N·m

Weigh: 1.95 kg

Servo Drive in Size E (Rated Power: 2.0 kW to 7.5 kW): SV680PS018S, SV680PS022S, SV680PS027S, SV680PT017S, SV680PT021S, SV680PT026S

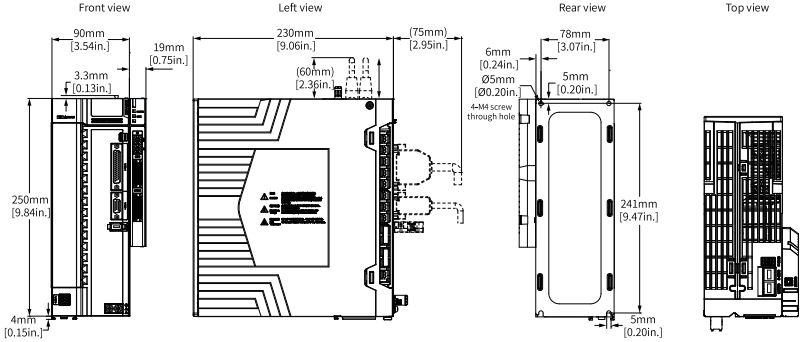


Figure 4-12 Dimension drawing of servo drive in size E

Fixing screws: 4–M4; recommended tightening torque: 1.2 N·m

Weigh: 3.75 kg

Servo Drive in Size E (Rated Power: 2.0 kW to 7.5 kW): SV680NS018S, SV680NS022S, SV680NS027S, SV680NT017S, SV680NT021S, SV680NT026S

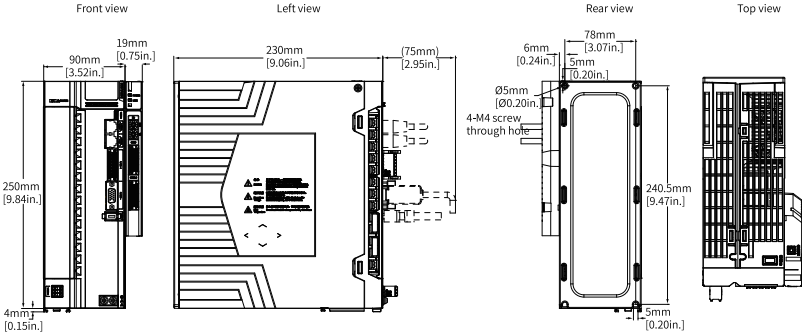


Figure 4-13 Dimension drawing of servo drive in size E

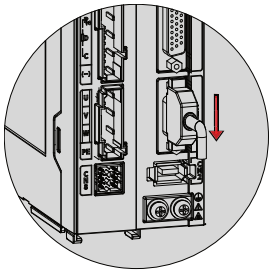
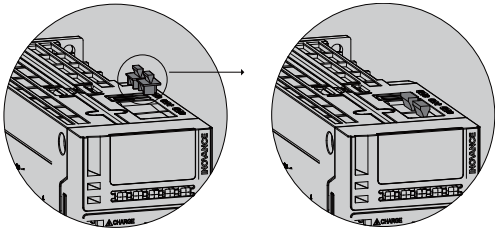
Fixing screws: 4–M4; recommended tightening torque: 1.2 N·m

Weigh: 3.75 kg

4.5 Installation Precautions

Table 4–5 Installation precautions

Item	Description
Installation method	• Install the servo drive vertically and upward to facilitate heat dissipation. For installation of multiple servo drives inside the cabinet, install them side by side. For dual-row installation, install an air guide plate. • Make sure the servo drive is installed vertically to the wall. Cool the servo drive down with natural convection or a cooling fan. Secure the servo drive to the mounting surface through two to four mounting holes (the number of mounting holes depends on the capacity of the servo drive). • Install the servo drive vertically to the wall, with its front (actual mounting face) facing the operator. • The mounting bracket (if needed) must be made of incombustible materials.
Cooling	As shown in *"4.3 Installation Clearance" on page 52*, reserve sufficient space around the servo drive to ensure a good heat dissipation through the cooling fan or natural convection. Take the heat dissipated by other devices inside the cabinet into consideration. Install a cooling fan to the upper part of the servo drive to avoid excessive temperature rise in a certain area, keeping an even temperature inside the control cabinet.
Grounding	Ground the grounding terminal properly. Failure to comply may result in electric shock or malfunction due to interference.

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

5 Wiring

5.1 Wiring Precautions

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.

- The specification and installation of external cables must comply with applicable local regulations.
- Observe the following requirements when the servo drive is used on a vertical axis.
  - Set the safety device properly to prevent the workpiece from falling upon warning or overtravel.
  - Ensure the positive/negative polarity of the 24 V power supply is correct. Otherwise, the 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 a warning 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 Servo Drive

This section only describes functional terminals of the safety module.

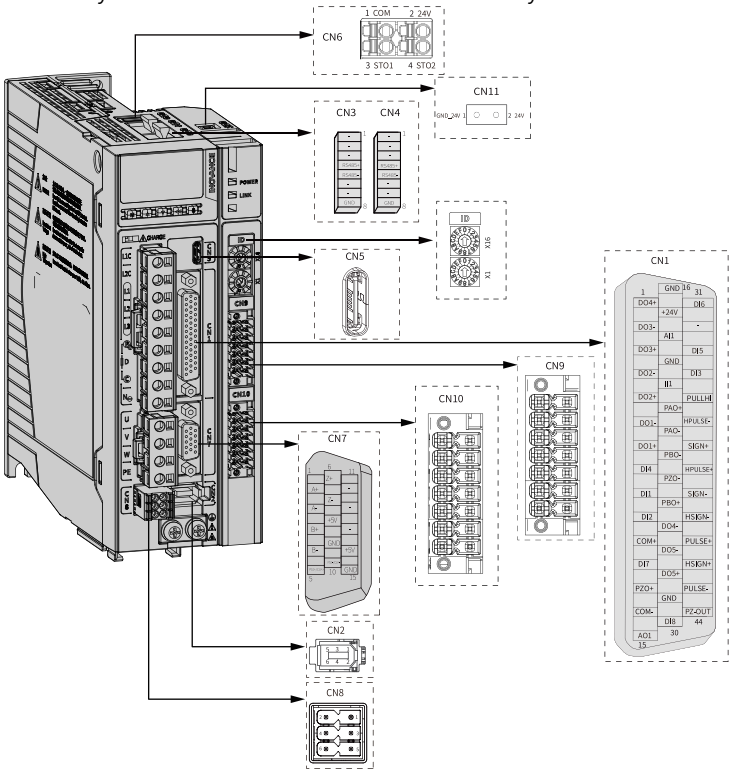


Figure 5-1 Terminal pin layout of the servo drive

Note

For the terminal distribution of main circuit of the servo drive and the description of CN1, CN2, CN3, CN4, CN5, CN6, CN7 and CN8 terminals, see the "Wiring" section of SV680P Series Servo Drives Hardware Guide or SV680N Series Servo Drives Hardware Guide. This manual only describes components included in the safety module, including CN9, CN10 and CN11 terminals, and FSoE ID setting knob.

5.3 FSoE Configuration

5.3.1 FSoE Connection and Setting

The hardware connection with Beckhoff safety master station is shown in *"Figure 5–2 " on page 63* . Various topologies such as tree and star topologies can be realized.

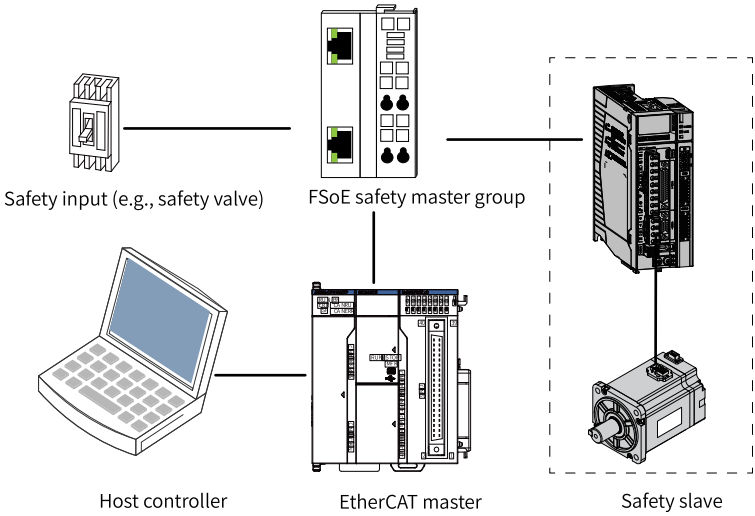


Figure 5-2 System network diagram

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 Working Mode

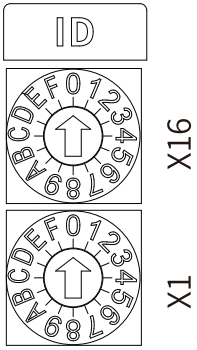


Figure 5-3 Enlarged view of knob

Effective mode: Take effect upon next power-on.

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

5.4 Control Terminal (CN9 and CN10)

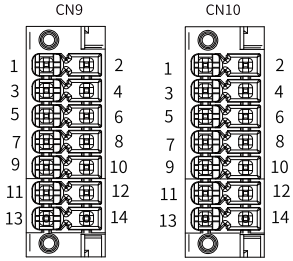


Figure 5-4 Description of pins of CN90 and CN10

Table 5–1 Description 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	DO1 and DO2 reference ground
7	COM	DIA reference ground	8	DI5A_IN	Safety DI5A input
9	DI4A_IN	Safety DI4A input	10	DI3A_IN	Safety DI3A input

No.	Assignment	Function	No.	Assign ment	Function
11	DI2A_IN	Safety DI2A input	12	DI1A_IN	Safety DI1A input
13	PE	Grounding terminal	14	-	-

Table 5–2 Description 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	DO4 and DO5 reference ground
7	COM	DIB reference ground	8	DI5B_IN	Safety DI5B input
9	DI4B_IN	Safety DI4B input	10	DI3B_IN	Safety DI3B input
11	DI2B_IN	Safety DI2B input	12	DI1B_IN	Safety DI1B input
13	PE	Grounding terminal	14	-	-

Basic DI information

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

Basic DO information

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

Item	Description
DO open circuit/OFF	Maximum output voltage: 2.4 V
The SSM state can be indicated by predefined parameters using DO1, DO2, DO4, and DO5.	

Note

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

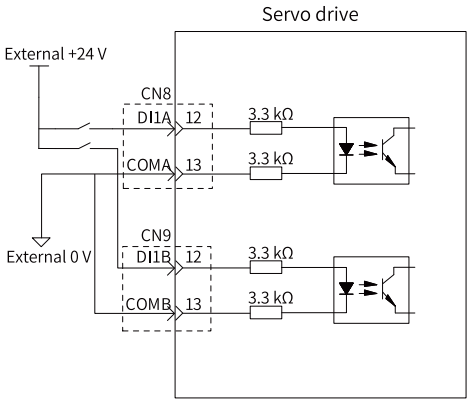
Wiring precautions

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

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

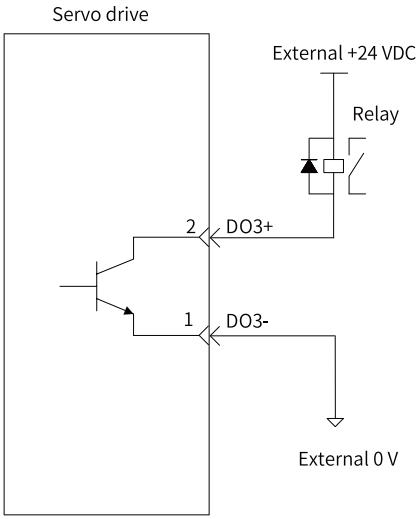


The safety DI is a drain input. Make reasonable wiring according to the characteristics of the load circuit.

Common digital output

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

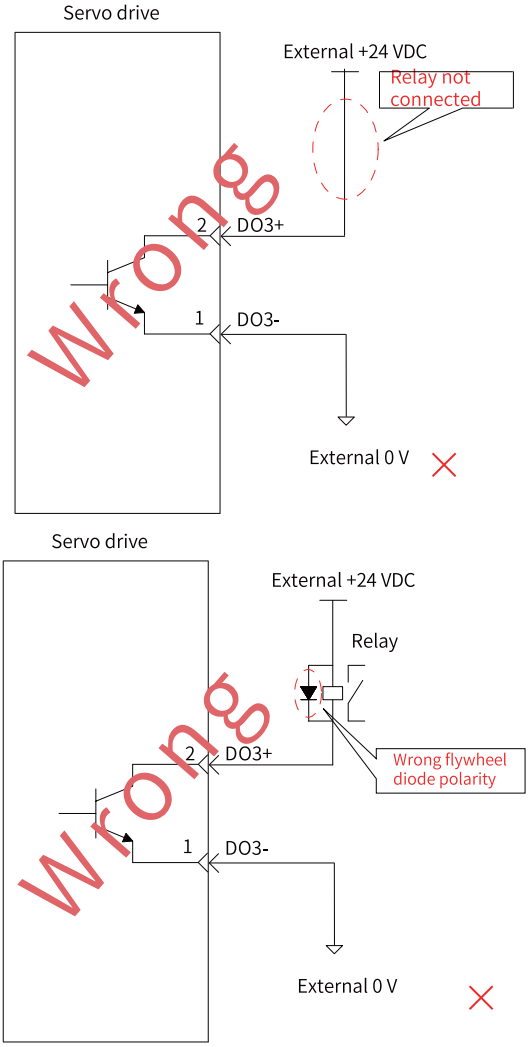
- **When the host controller provides relay input**
  - **Correct wiring:**



Note

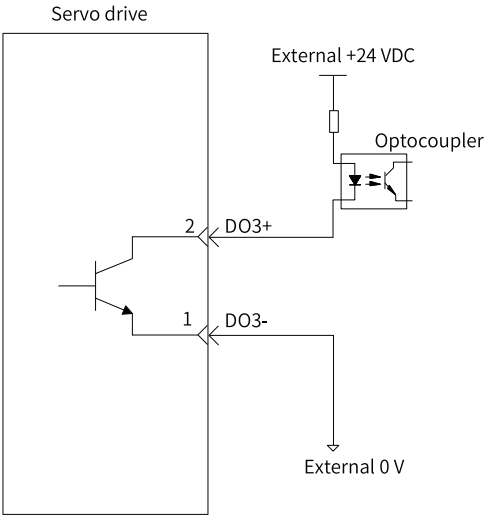
When the host controller provides relay input, a flywheel diode must be installed; otherwise, the DO terminals may be damaged.

- **Wrong wiring:**

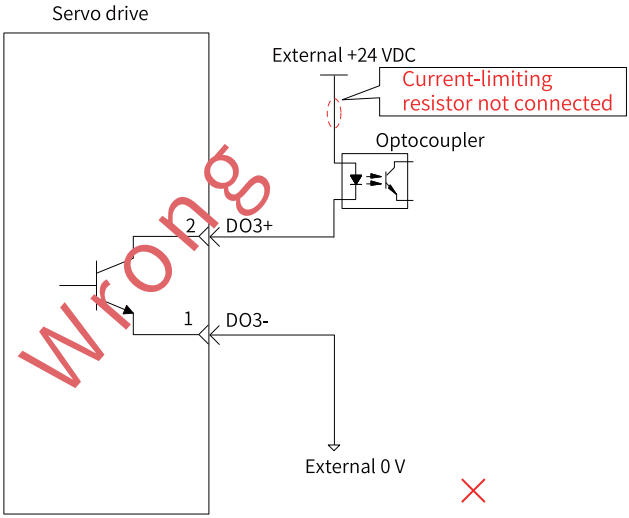


- **When the host controller provides optocoupler input**

- **Correct wiring:**



- **Wrong wiring:**

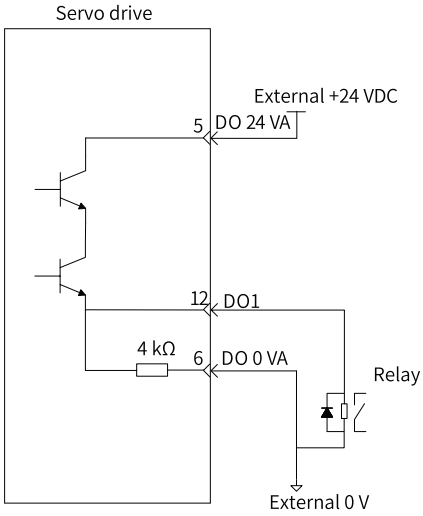


Safety digital output

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

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

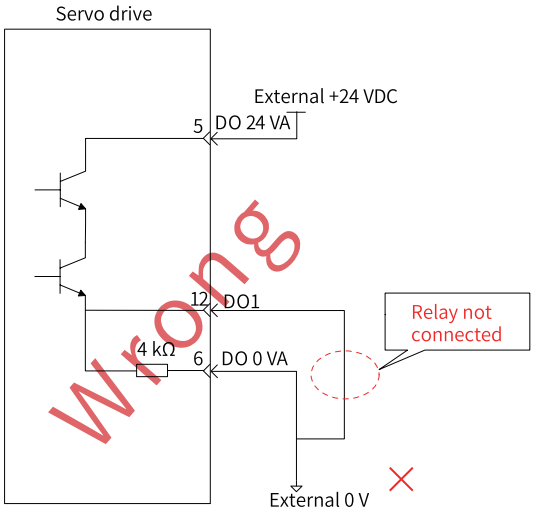
- When the host controller provides relay input
  - **Correct wiring:**

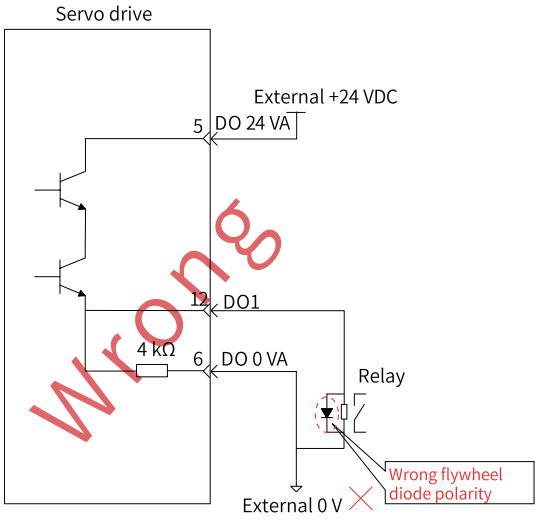


Note

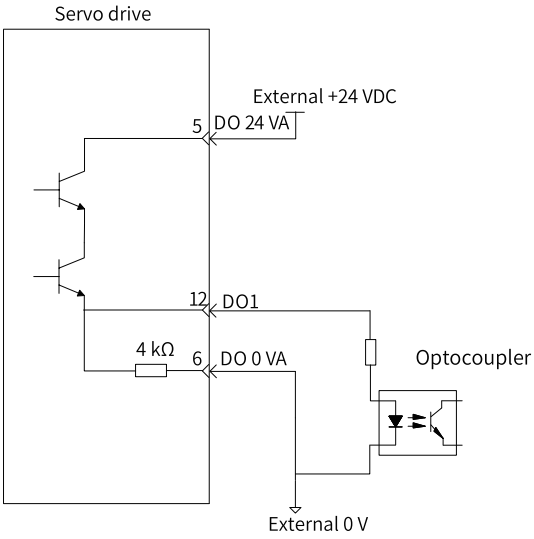
When the host controller provides relay input, a flywheel diode must be installed; otherwise, the DO terminals may be damaged.

  - **Wrong wiring:**

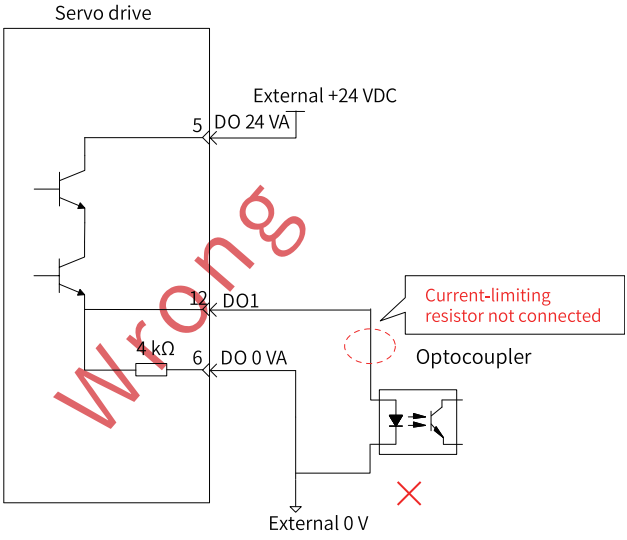




- **When the host controller provides optocoupler input**
  - **Correct wiring:**



- **Wrong wiring:**



6 Safety Functions

6.1 Overview

The combination of safety module, SV680 series servo drive and safety motor can realize the following safety functions.

Safety function	Description
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 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 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 drive provides a safe output signal for further processing.

The SS1-t function in STO, SBC, and SS1 can be used with non-safety motors, and other functions must be used with safety motors.

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 SV680N servo drive. For a pulse servo drive, you must choose the local mode.

Related parameters:

See *" H20.01" on page 168* for details.

When you choose to trigger the safety functions locally, you need to Set a safety DI with a certain safety function (such as STO, SS1, SS2). Then you can control the corresponding safety function by controlling ON and OFF of the DI. Also, you can configure a DO with a safety function (such as STO, SOS, SSM). When the corresponding safety function is triggered, the DO output is active.

When you choose to trigger the safety functions through FSoE, you need to configure the PDO mapping, including RPDO and TPDO. 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 transfers 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 you choose to trigger the safety functions through DI, the TPDO does not update;
- When you choose to trigger the safety functions through FSoE, the DI does not update.

Priority between safety functions

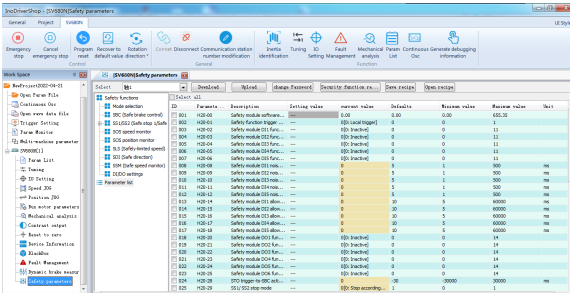
When several safety functions are activated simultaneously, the following priorities apply.

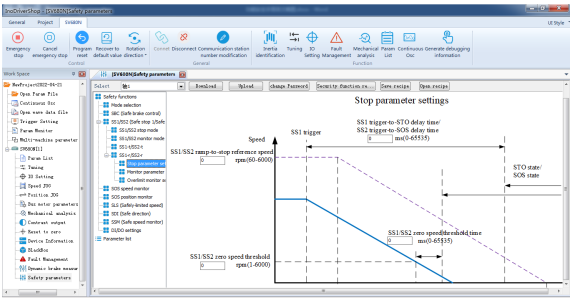
- STO takes precedence over SS1 and SS2.
- SLS, SDI, and SSM are independent of each other.

When one safety function overrides another, the request for the overridden safety function will not be canceled. Therefore, the overridden safety function is restarted after the overriding safety function is completed.

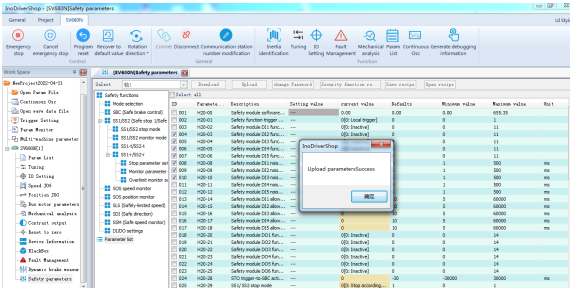
6.2 Parameter Configuration in InoDriverShop

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.



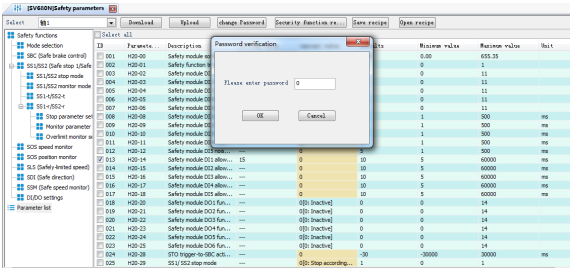


1. On the parameter list, select a parameter you want to configure and then click **Upload** to read the value of the selected parameter.

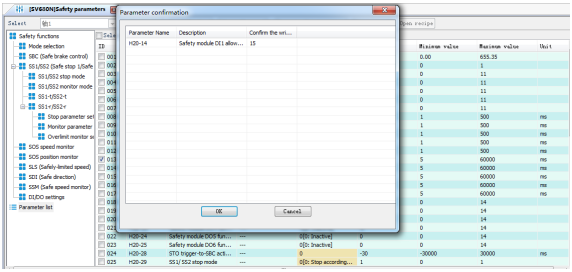


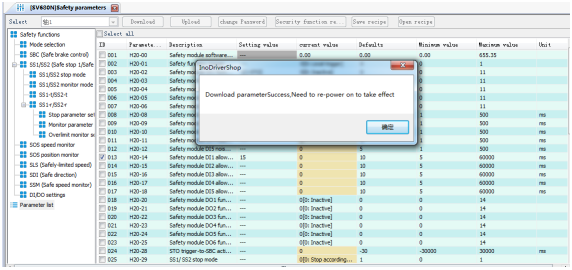
Any changes to any safety parameters take effect only at next power-on.

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).

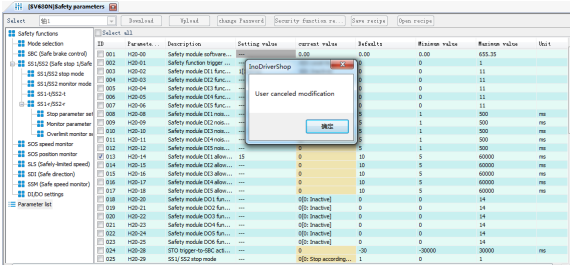


3. A confirmation dialog pops up. Make sure the value entered is correct and click **OK**. The value is written into the safety module.

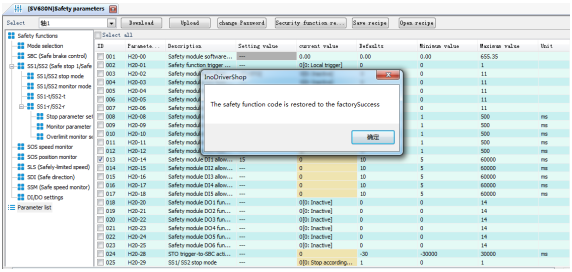




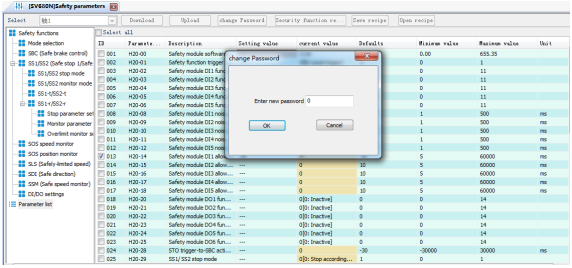
4. If you click **Cancel**, or fail to click **OK** within 10 seconds, the tool prompts that the modification is canceled. The value will not be written into the safety module.



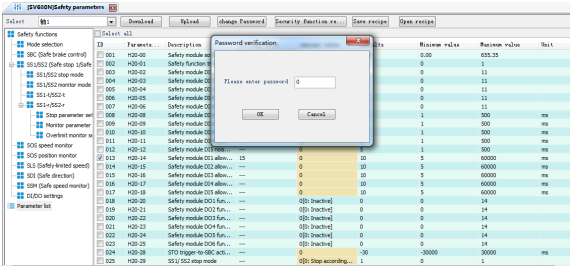
5. To reset the safety parameters, click **Security function restore factory**.



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 and DO Functions

6.3.1 Safety DI Function

DI function selection

The safety module includes five DIs. Each DI is configured to receive 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	Parameter Configuration
CN9		CN10		
12	DI1A	12	DI1B	You can configure the logic function of DI1 by setting parameter H20.02.
11	DI2A	11	DI2B	You can configure the logic function of DI2 by setting parameter H20.03.
10	DI3A	10	DI3B	You can configure the logic function of DI3 by setting parameter H20.04.
9	DI4A	9	DI4B	You can configure the logic function of DI4 by setting parameter H20.05.
8	DI5A	8	DI5B	You can configure the logic function of DI5 by setting parameter H20.06.

Note

The 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 provided to the safety module. Only when the DI input signal is 0 (OFF) and lasts for a period of time exceeding the DI noise rejection filter time, the safety module performs the corresponding safety function.

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

Parameter Configuration	Parameter Name
H20.08	Safety module DI1 noise rejection filter time
H20.09	Safety module DI2 noise rejection filter time
H20.10	Safety module DI3 noise rejection filter time
H20.11	Safety module DI4 noise rejection filter time
H20.12	Safety module DI5 noise rejection filter time

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

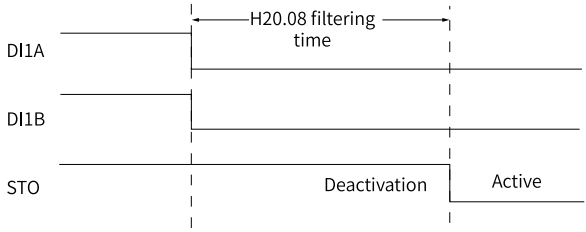


Figure 6-1 Diagram of DI1 noise rejection filter time H20.08

Note

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

Input discrepancy detection

When the function assigned to the DI is active, the safety module monitors whether the DI input signals 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 issues 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

Parameter Configuration	Parameter 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

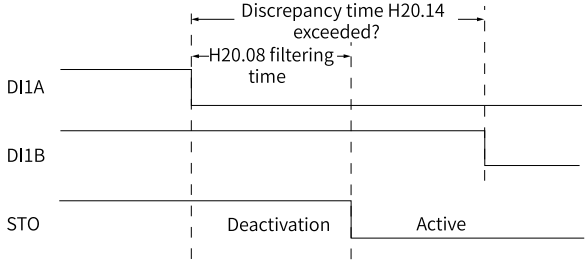


Figure 6-2 Checking for discrepancy at input signals of DI1

6.3.2 Safety DO Function

DO function selection

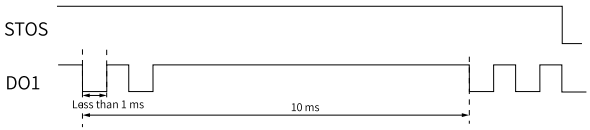
The safety module includes six DO terminals all default to 0 (inactive). DO3 and DO6 are non-safety circuits and cannot be assigned with SSM function. You can assign each of DO1 to DO6 with a logic function using the software tool.

Terminal	Pin No.	Name	Parameter Configuration
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

The safety module will also diagnose the DO circuit to ensure that the DO circuit can output signals normally. To ensure that the DO circuit diagnosis is performed correctly, a 24V voltage signal needs to be input to Pin5 and Pin6 of the CN9 and CN10 terminals.

As shown below, when DO1 is assigned with the STO function, the safety module will diagnose the DO1 output circuit when the STO function is active. The width of the diagnostic pulse is less than 1ms. When the pulse diagnostic feedback signal is abnormal, the servo drive issues an alarm E125.x, where x is the corresponding DO serial number.



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 command-and-response 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 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.

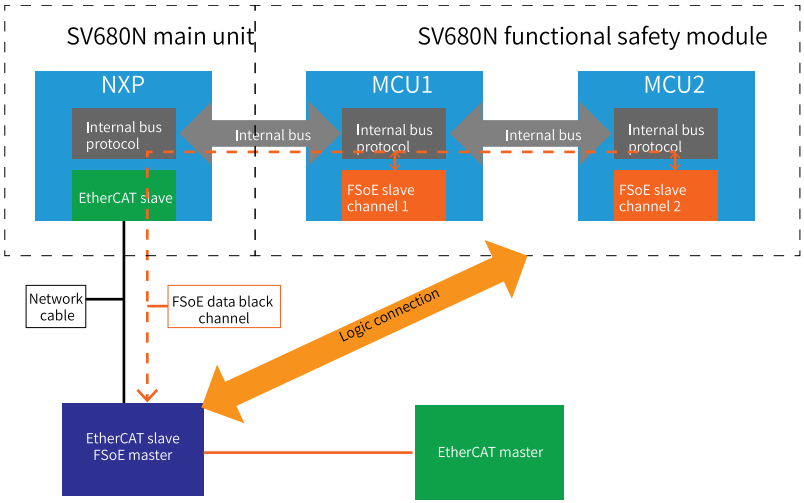


Figure 6-3 FSoE data transmission

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 Ack	BOOL
6630h	0	1	Restart Ack	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
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 active	BOOL
66E0h	0	1	SSM state	BOOL
0000h	0	1	Reserved	BOOL
6668h	0	1	STO active	BOOL
0000h	0	1	Reserved	BOOL
66D0h	0	1	SDIp active	BOOL
66D1h	0	1	SDIn active	BOOL
6632h	0	1	Error	BOOL
6630h	0	1	Restart	BOOL
6660h	0	1	SBC active	BOOL
6690h	1	1	SLS1 active	BOOL
6690h	2	1	SLS2 active	BOOL

Index	Sub-index	Length (bit)	Name	Data Type
6690h	3	1	SLS3 active	BOOL
6690h	4	1	SLS4 active	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 STO Function

6.5.1 Overview

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

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

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

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

6.5.2 STO Function Triggered Locally

To trigger the safety functions locally, the wiring of the DI of the safety module must be correct.

Set the value of parameter H20.01 to "0: Local trigger". In this case, the safety functions are no longer triggered through EtherCAT communication.

Table 6–4 Description of parameters

Parameter No.	Parameter Name	Description
FunIN.1	STO command	0: Activate 1: Deactivate
FunIN.11	ACK command	0: Deactivate 1: Activate
FunOUT.1	STO Active	0: Is not active 1: Is active

When no DI is configure with Ack, the drive automatically exits the STO state when the STO command is deselected.

When Ack is required, two DI terminals are used: one configured with STO and the other with Ack. In this case, exiting the STO state not only requires the deselection of STO command, but also the triggering of the Ack signal.

For the timing sequence of STO and SBC, see the section describing the SBC function.

Note

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

Related parameters:

See *" H20.02" on page 169* for details.

See *" H20.03" on page 169* for details.

See *" H20.04" on page 170* for details.

See *" H20.05" on page 170* for details.

See *" H20.06" on page 171* for details.

See *" H20.20" on page 174* for details.

See *" H20.21" on page 174* for details.

See *" H20.22" on page 175* for details.

See *" H20.23" on page 176* for details.

See *" H20.24" on page 176* for details.

See *" H20.25" on page 177* for details.

6.5.3 STO Function Triggered Through FSoE

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 deselected.

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

Related parameters:

See *" 6630h" on page 192* for details.

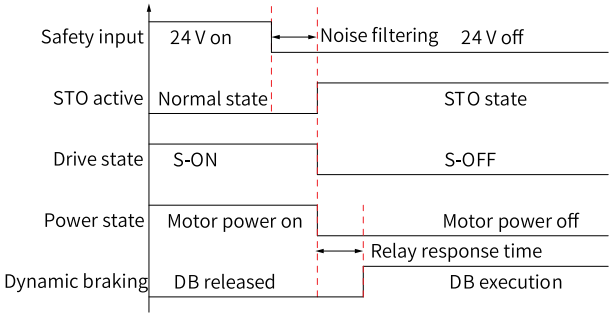
See *" 6640h" on page 193* for details.

See *" 6641h" on page 193* for details.

6.5.4 Sequence Diagram

Action sequence for entering a safe state

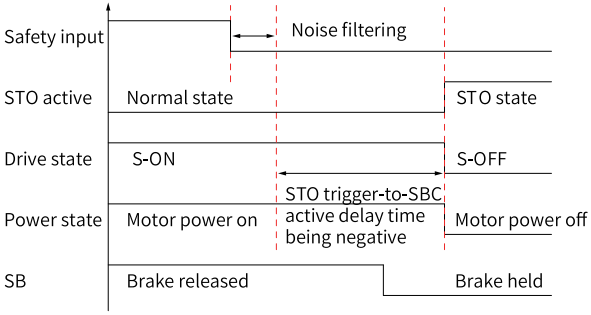
- When the SBC function is not enabled



When any one of the two STO safety inputs 1 and 2 turns to OFF, the safety module begins to transition to the STO state.

The stop mode of STO reuses the stop mode at NO.1 fault, and the drive performs dynamic brake actions according to the settings of parameter H02.08.

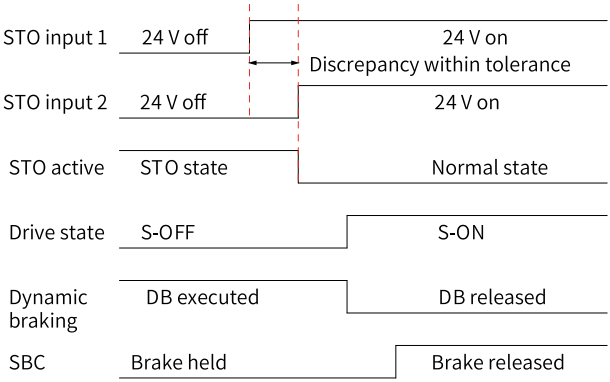
- When the SBC function is enabled
  Here we take the value of parameter H20.28 being set to a negative number as an example, the action sequence of STO is shown below.



If the SBC takes effect before the STO, the drive performs S-ON OFF stop when the STO input command takes effect. When the delay time set by parameter H20.28 has elapsed, the drive then triggers stop mode set by parameter H02.08.

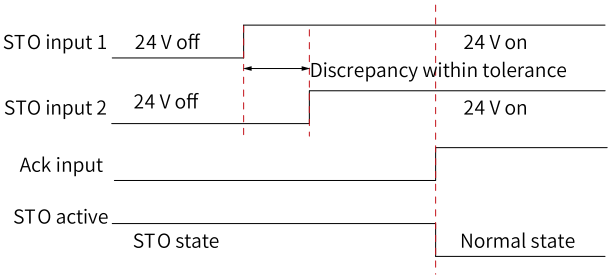
Reset sequence for exiting STO state

- Without requirement of Ack signal



When an Ack signal is not required, the drive automatically exits the STO state as long as the two 24 V signals of DI assigned with STO function are restored. After exiting the STO state, the servo drive can operate normally.

- With requirement of Ack signal



When an Ack signal is required, exiting the STO state not only requires the recovery of the two 24 V signals of DI assigned with STO function, but also the triggering of the Ack signal. After exiting the STO state, the servo drive can operate 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 the input of an Ack signal.

6.6 SBC Function

6.6.1 Overview

For SBC function of the SV680P/N 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.

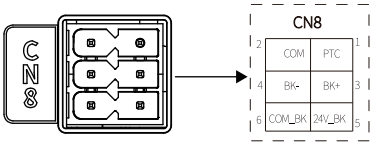


Figure 6-4 Description of CN8 pins

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

The safety module can directly control ON and OFF of the external 24 V voltage connected to Pin5 and Pin6 of the CN8 terminal and to the brake motor.

The SBC function is used in applications where the servo drive needs to maintain a safe position even when there is no current to the motor. The SBC prevents sagging of suspended or tensile loads (e.g. vertical axis applications such as lifts). No external relays or switching elements are required, as the SBC function is integrated inside 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 Function Triggered Locally

The parameter DI: FunIN2 (SBC) enables the DI to trigger the SBC function, and DO: FunOUT.2 (SBC Active) enables the DO to output that SBC function is active.

Table 6–5 Description of parameters

Parameter No.	Parameter Name	Description
FunIN.2	SBC command	0: Activate 1: Deactivate
FunOUT.2	SBC Active	0: Is not active 1: Is active

Note

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

Related parameters:

See *" H20.02" on page 169* for details.

See *" H20.03" on page 169* for details.

See *" H20.04" on page 170* for details.

See *" H20.05" on page 170* for details.

See *" H20.06" on page 171* for details.

See *" H20.20" on page 174* for details.

See *" H20.21" on page 174* for details.

See *" H20.22" on page 175* for details.

See *" H20.23" on page 176* for details.

See *" H20.24" on page 176* for details.

See *" H20.25" on page 177* for details.

See *" H02.11" on page 167* for details.

See *" H02.12" on page 168* for details.

6.6.3 SBC Function Triggered Through FSoE

Braking during high-speed rotation damages the motor. To avoid such damage, the brake will not be triggered immediately after the SBC command of the safety module takes effect. Instead, the drive executes S-ON OFF stop first.

When the motor speed drops below the SBC zero speed threshold, or the SBC delay time has elapsed, the safety module triggers the braking action.

The parameters involved in triggering SBC through FSoE are as follows.

Related parameters:

See *" H02.11" on page 167* for details.

See *" H02.12" on page 168* for details.

See *" 6660h" on page 195* for details.

6.6.4 Sequence Diagram

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

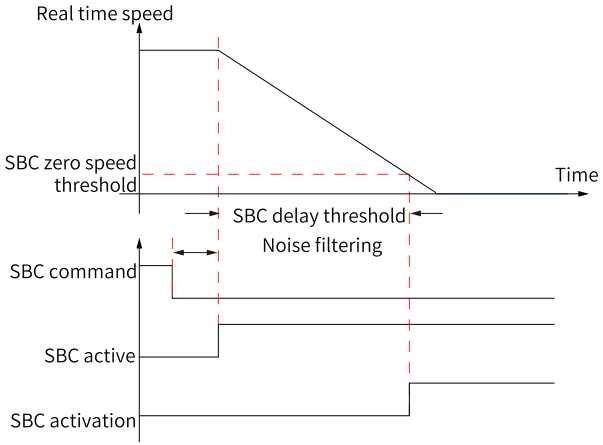


Figure 6-5 Response sequence of the SBC function execution

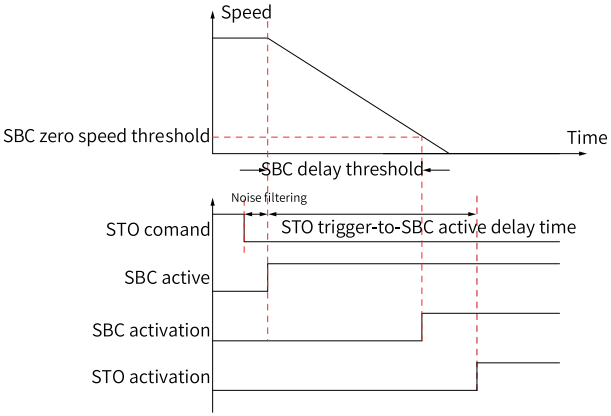
When the SBC command is determined as a valid signal after noise filtering, the S-ON OFF stop is executed. When the SBC zero speed threshold set by H02.11 is reached or the SBC delay threshold set by H02.12 expires, the safety module triggers the motor to brake. The motor rotor is held and the safety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

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

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

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

SBC taking effect before STO

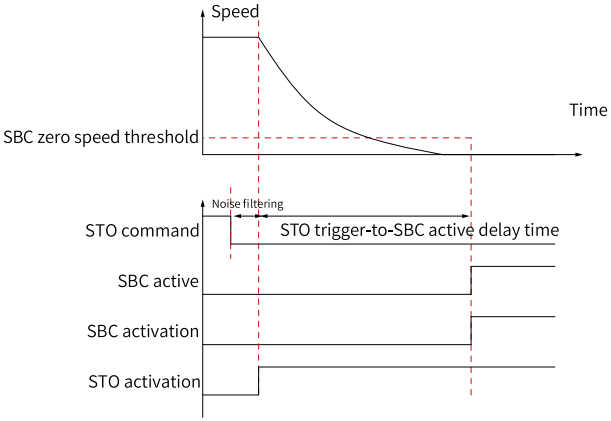


When the delay time H20.28 from STO activation to SBC activation is negative, the servo drive performs deceleration after the safety module receives the STO trigger command.

When the delay time 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 consider the time required for the motor to decelerate from the maximum speed to 0 rpm, so as to avoid that the STO takes effect before SBC takes effect.

SBC taking effect after STO



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

6.7 SS1 Function

6.7.1 Overview

The SS1 function enables the motor to decelerate to stop. After a preset delay time has elapsed or when the motor speed falls below a preset threshold, the STO function is triggered. The SS1 function can be implemented in two modes, including stop according to ramp and stop by host controller, which can be selected by setting parameter H20.29.

- If you choose "stop according to ramp", the servo drive issues stop instructions to control the motor to decelerate to stop according to the planned speed ramp.
- If you choose "stop by host controller", the host controller issues stop instructions to control the motor to decelerate to stop.
- When a pulse servo drive is used, you must choose "stop according to ramp". Even if you choose "stop by host controller", the motor will stop according to speed ramp.

When you choose to trigger safety functions locally, you can assign DI with SS1 function by setting parameters H20.02 to H20.06. In this case, the SS1 function can be triggered by DI. When you choose to trigger safety functions through FSoE, the SS1 function can be triggered by controlling a corresponding bit of SS1 command in the RPDO.

The SS1 function can monitor the stop process in two ways including SS1-t and SS1-r, which can be configured by setting the parameter H20.32. The SS1-r monitoring mode is applicable to safety motor only.

If SS1-t is selected, when the delay time from when the SS1 function is triggered to when the STO state is entered has elapsed, the drive switches to the STO state regardless of the motor speed. The SS1-t monitoring mode can be used for the non-safety motor. When used for a safety motor, the drive switches to the STO state when the motor speed feedback falls below the zero speed threshold for a period of time exceeding the zero speed threshold time.

The SS1-r covers the SS1-t. In other words, the drive switches to the STO state after the delay time has elapsed, or when the motor speed feedback falls below the zero speed threshold for a period of time exceeding the zero speed threshold time. The deceleration process is monitored based on a preset minimum deceleration. The actual deceleration of the motor must be larger than the preset minimum deceleration; otherwise, the drive reports a fault and enters the STO state.

The monitoring mode of some specific faults can be set to SS1-t. When the fault is triggered, the drive enters the SS1 state. When the SS1-t state switching conditions are met, the drive enters the STO state.

6.7.2 SS1 Function Triggered Locally

SS1 trigger-related parameters

The parameter DI: FunIN.3 (SS1) enables the DI to trigger the SS1 function, DO: FunOUT.3 (SS1 Active) enables the DO to output the SS1 function is active, and DO: FunOUT.13 (SS1-r Active) enables the DO to output the SS1-r monitoring is active.

Table 6–6 Description of parameters

Parameter No.	Parameter Name	Description
FunIN.3	SS1 command	0: Activate 1: Deactivate
FunOUT.3	SS1 Active	0: Is not active 1: Is active
FunOUT.13	SS1-r Active	0: Is not active 1: Is active

If any of DI1 to DI5 is configured with FunIN.11-Ack function, when the DI configured with SS1 function is triggered and then reset, the DI configured with the FunIN.11-Ack function must be triggered to restore from the STO state to the normal operation state.

If none of the DIs is configured with the FunIN.11-Ack function, when the DI configured with SS1 function is triggered and then reset, the drive directly restores normal operation from the STO state.

Note

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

SS1 stop-related parameters

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

- If you choose "0: Stop according to ramp", the servo drive issues stop instructions to control the motor to decelerate to stop according to the planned speed ramp.
- If you choose "1: Stop by host controller", the host controller issues stop instructions to control the motor to decelerate to stop.
- When a pulse servo drive is used, you must choose "stop according to ramp". Even if you choose "stop by host controller", the motor will stop according to speed ramp.

Related parameters:

See *" H20.29" on page 178* for details.

When you choose "stop according to ramp", you can configure the ramp-to-stop reference speed by setting parameter H20.30 and the ramp-to-stop deceleration time by setting parameter H20.31. After the time set by the parameter H20.31 has elapsed, the motor speed reduces from the speed set by the parameter H20.30 to 0, as shown in the figure below.

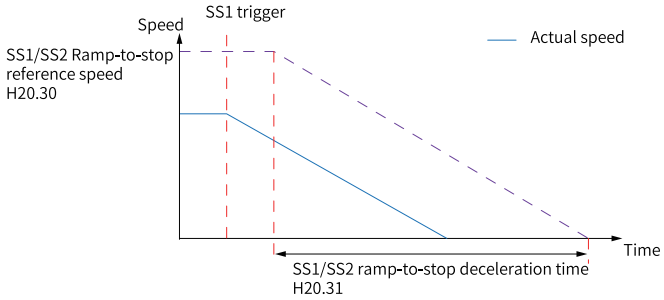


Figure 6-6 Motor speed in ramp-to-stop

Related parameters:

See *" H20.30" on page 178* for details.

See *" H20.31" on page 178* for details.

When you choose to trigger the safety functions locally, you can configure the SS1 trigger-to-STO delay time by setting parameter H20.33, the SS1 zero speed threshold by setting parameter H20.34, and the SS1 zero speed threshold time by setting parameter H20.35. When the delay time after the SS1 function is triggered reaches the value of H20.33, the drive switches to the STO state regardless of the motor speed.

When a safety encoder is used, if the delay time after the SS1 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 STO state in advance.

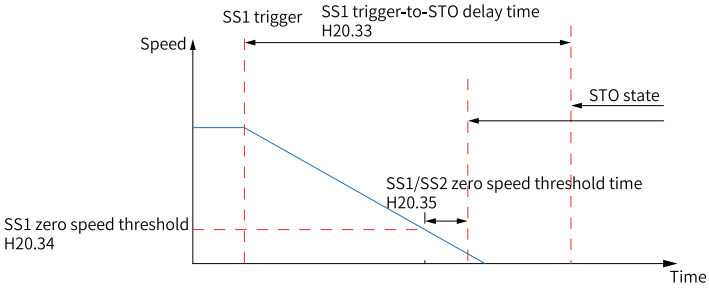


Figure 6-7 Variation in motor speed when safety function is triggered locally

Related parameters:

See *" H20.33" on page 179* for details.

See *" H20.34" on page 179* for details.

See *" H20.35" on page 180* for details.

SS1 monitoring-related parameters

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

- If you choose "0: SS1-t", the speed ramp will not be monitored during the deceleration process.
- If you choose "1: SS1-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:

See *" H20.32" on page 179* for details.

In case of SS1-r monitoring, when you choose to trigger the safety function locally:

- You can configure the delay time for staring the speed ramp monitoring by setting parameter H20.36. When the SS1 function is triggered, the monitoring of speed ramp starts after the preset delay time has elapsed.
- You can configure the reference speed for speed ramp monitoring by setting parameter H20.37 and the monitoring time by setting parameter H20.38. The minimum deceleration ramp of the motor is equal to the ratio of H20.37 to H20.38. The actual deceleration must be larger than the minimum deceleration; otherwise, a deceleration fault will be reported.
- You can configure the time from triggering of the ramp limit to issuance of the alarm by setting parameter 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 parameter H20.42. When the motor speed falls below the value of H20.42, the ramp monitoring is stopped.

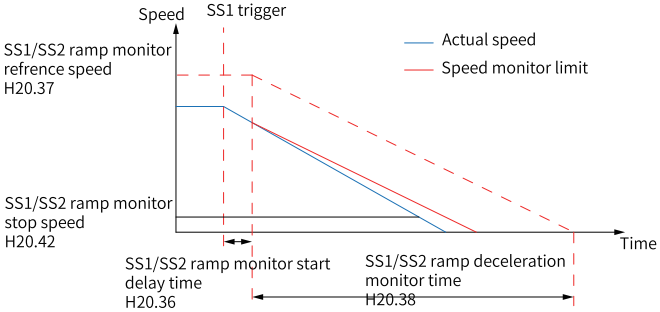


Figure 6-8 Speed of functional safety motor

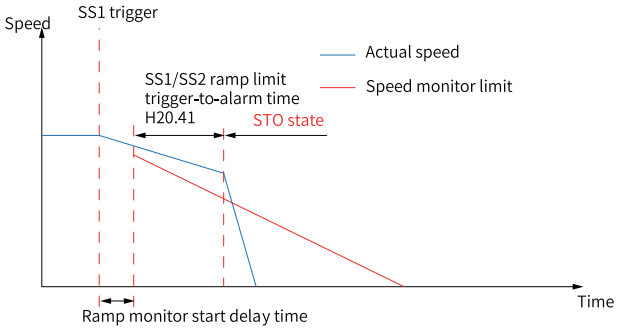


Figure 6-9 Motor speed for triggering ramp limit

Related parameters:

See *" H20.36" on page 180* for details.

See *" H20.37" on page 180* for details.

See *" H20.38" on page 181* for details.

See *" H20.41" on page 181* for details.

See *" H20.42" on page 181* for details.

6.7.3 SS1 Function Triggered Through FSoE

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:

See *" 6650h" on page 194* for details.

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 restore from the STO state to the normal operation state.

Related parameters:

See *" 6641h" on page 193* for details.

SS1 stop-related parameters

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

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

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

Related parameters:

See *" 6651h" on page 194* for details.

See *" 6653h" on page 194* for details.

See *" 6654h" on page 194* for details.

SS1 monitoring-related parameters

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

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

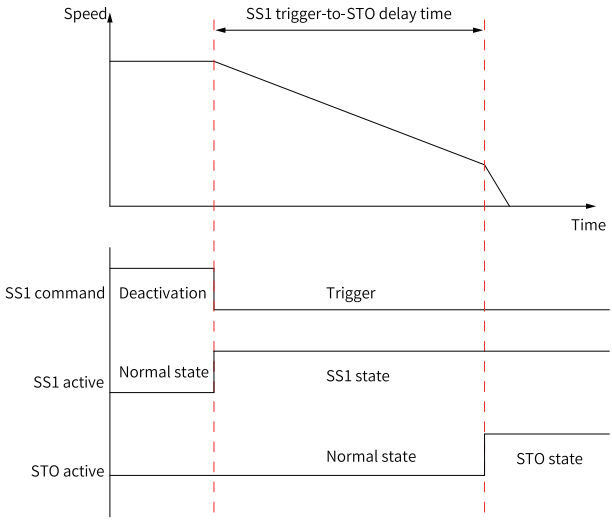
Related parameters:

See *" 6656h" on page 195* for details.

See *" 6657h" on page 195* for details.

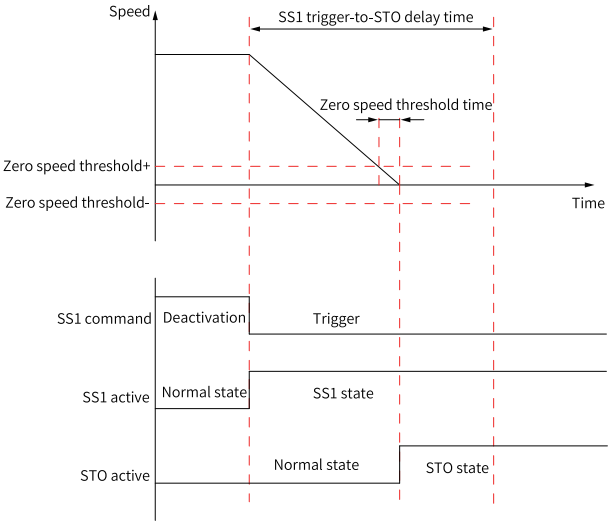
6.7.4 Sequence Diagram

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



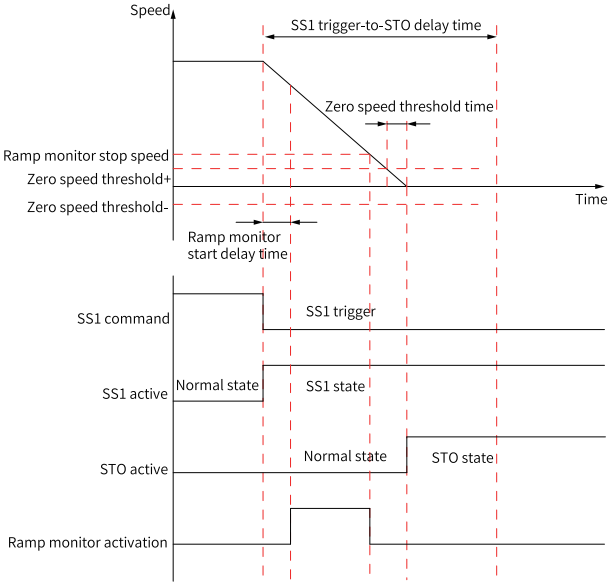
If the SS1 command is deselected after SS1 has been triggered, the drive will retain the SS1 stop state until the delay time has elapsed.

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

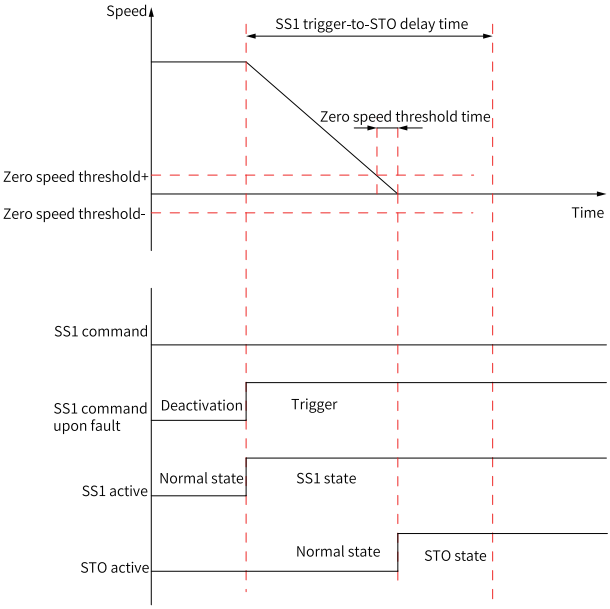


If the SS1 command is deselected after SS1 has been triggered, the drive will retain the SS1 stop state until the delay time has elapsed or the zero speed conditions are met.

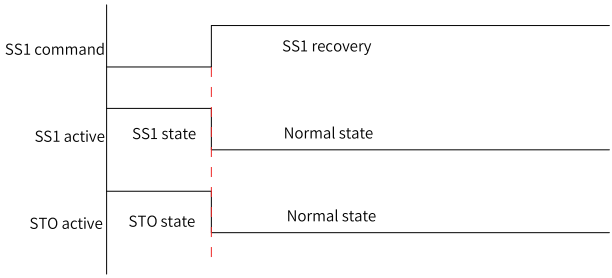
Starting SS1 speed ramp monitoring



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



SS1 reset



6.8 SS2 Function

6.8.1 Overview

The SS2 function operation motor to decelerate to stop. After a preset delay time has elapsed or when the motor speed falls below a preset threshold, the SOS function is triggered. The SS2 function can be implemented in two modes, including stop according to ramp and stop by host controller, which can be selected by setting parameter H20.29. If you choose "stop according to ramp", the servo drive issues stop instructions to control the motor to decelerate to stop according to the planned speed ramp. If you choose "stop by host controller", the host controller issues stop instructions to control the motor to decelerate to stop. When a pulse servo drive is used, you must choose "stop according to ramp". Even if you choose "stop by host controller", the motor will stop according to speed ramp. The SS2 function must be used with a safety encoder.

When you choose to trigger safety functions locally, you can assign DI with SS2 function by setting parameters H20.02 to H20.06. In this case, the SS1 function can be triggered by DI. When you choose to trigger safety functions through FSoE, the SS2 function can be triggered by controlling a corresponding bit of SS2 command in the RPDO.

The SS2 function can monitor the stop process in two ways including SS2-t and SS2-r, which can be configured by setting the parameter H20.43.

If SS2-t is selected, when the delay time from when the SS2 function is triggered to when the SOS state is entered has elapsed, the drive switches to the SOS state regardless of the motor speed. Or the drive switches to the SOS state when the motor speed feedback falls below the zero speed threshold for a period of time exceeding the zero speed threshold time.

The SS2-r covers the SS2-t. In other words, the drive switches to the SOS state after the delay time has elapsed, or when the motor speed feedback falls below the zero speed threshold for a period of time exceeding the zero speed threshold time. The

deceleration process is monitored based on a preset minimum deceleration. The actual deceleration of the motor must be larger than the preset minimum deceleration; otherwise, the drive reports a fault and enters the STO state.

6.8.2 SS2 Function Triggered Locally

SS2 trigger-related parameters

The parameter DI: FunIN.4 (SS2) enables the DI to trigger the SS2 function, DO: FunOUT.4 (SS2 Active) enables the DO to output that SS2 function is active, and DO: FunOUT.14 (SS2-r Active) enables the DO to output that SS2-r monitoring is active.

Table 6–7 Description of parameters

Parameter No.	Parameter Name	Description
FunIN.4	SS2 command	0: Activate 1: Deactivate
FunOUT.4	SS2 Active	0: Is active 1: Is not active
FunOUT.14	SS2-r Active	0: Is not active 1: Is active

If any of DI1 to DI5 is configured with FunIN.11-Ack function, when the DI configured with SS1 function is triggered and then reset, the DI configured with the FunIN.11-Ack function must be triggered to restore from the SOS state to the normal operation state. If none of the DIs is configured with the FunIN.11-Ack function, when the DI configured with SS1 function is triggered and then reset, the drive directly restores normal operation from the SOS state.

Note

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

SS2 stop-related parameters

You can configure the stop mode by setting parameter H20.29. If you choose “0: Stop according to ramp”, the servo drive issues stop instructions to control the motor to decelerate to stop according to the planned speed ramp. If you choose “1: Stop by host controller”, the controller issues stop instructions to control the motor to decelerate to stop. When a pulse servo drive is used, you must choose “stop according to ramp”. Even if you choose “stop by host controller”, the motor will stop according to speed ramp.

Related parameters:

See *" H20.29" on page 178* for details.

When you choose “stop according to ramp”, you can configure the ramp-to-stop reference speed by setting parameter H20.30 and the ramp-to-stop deceleration time by setting parameter H20.31. After the time set by the parameter H20.31 has elapsed, the motor speed reduces from the speed set by the parameter H20.30 to 0, as shown in the figure below.

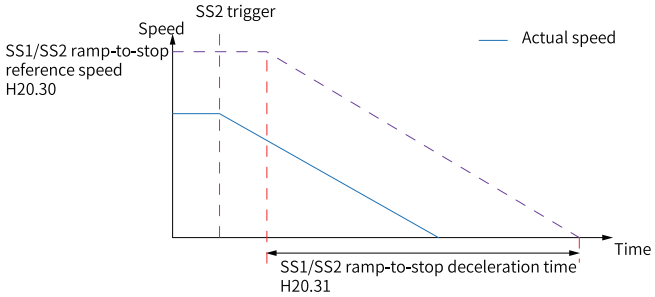


Figure 6-10 Motor speed in ramp-to-stop

Related parameters:

See *" H20.30" on page 178* for details.

See *" H20.31" on page 178* for details.

When you choose to trigger the safety functions locally, you can configure the SS2 trigger-to-SOS delay time by setting parameter H20.33, the SS2 zero speed threshold by setting parameter H20.34, and the SS2 zero speed threshold time by setting parameter H20.35. If the delay time after the SS2 function is triggered reaches the value of H20.33, the drive switches to the SOS state regardless of the motor speed. If the delay time after the SS2 function is triggered does not reach the value of H20.33 but the motor speed falls below the value of H20.34 for a period of time exceeding the value of H20.35, the drive switches to the SOS state in advance.

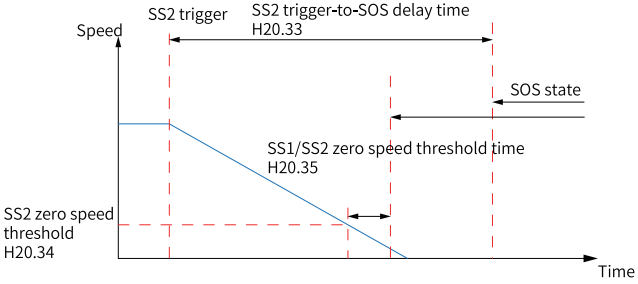


Figure 6-11 Variation in motor speed when safety function is triggered locally

Related parameters:

See " *H20.33" on page 179* for details.

See " *H20.34" on page 179* for details.

See " *H20.35" on page 180* for details.

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:

See " *H20.43" on page 182* for details.

In case of SS2-r monitoring, you can configure the delay time for staring the speed ramp monitoring by setting parameter H20.36. When the SS2 function is triggered, the monitoring of speed ramp starts after the preset delay time has elapsed.

You can configure the reference speed for speed ramp monitoring by setting parameter H20.37 and the monitoring time by setting parameter H20.38. The minimum deceleration ramp of the motor is equal to the ratio of H20.37 to H20.38. The actual deceleration must be larger than the minimum deceleration; otherwise, a deceleration fault will be reported.

You can configure the time from triggering of the ramp limit to issuance of the alarm by setting parameter 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 parameter H20.42. When the motor speed falls below the value of H20.42, the ramp monitoring is stopped.

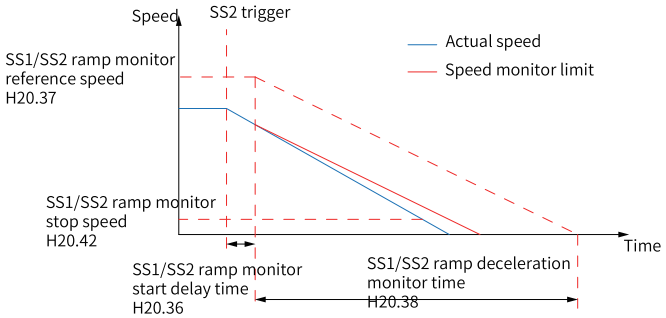


Figure 6-12 Speed of functional safety motor

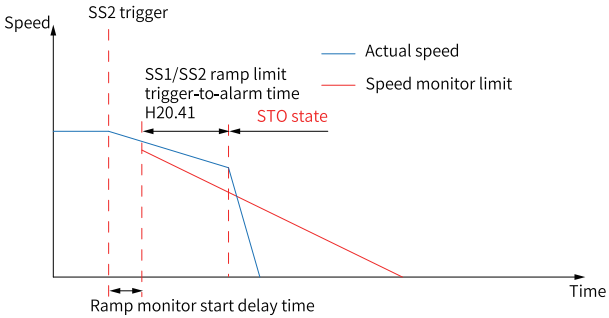


Figure 6-13 Motor speed for triggering ramp limit

Related parameters:

See *" H20.36" on page 180* for details.

See *" H20.37" on page 180* for details.

See *" H20.38" on page 181* for details.

See *" H20.41" on page 181* for details.

See *" H20.42" on page 181* for details.

6.8.3 SS2 Function Triggered Through FSoE

SS2 trigger-related parameters

6670h in the RPDO mapping is the object dictionary of SS2 trigger, and 6670h in the TPDO mapping is the object dictionary of SS2 state.

Related parameters:

See *" 6670h" on page 197* for details.

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 restore from the SOS state to the normal operation state.

Related parameters:

See *" 6676h" on page 198* for details.

SS2 stop-related parameters

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

When you choose “stop according to ramp”, you can configure the ramp-to-stop reference speed by setting parameter H20.30 and the ramp-to-stop deceleration time by setting parameter H20.31.

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

Related parameters:

See *" 666Ch" on page 196* for details.

See *" 6671h" on page 197* for details.

See *" 6672h" on page 197* for details.

SS2 monitoring-related parameters

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

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

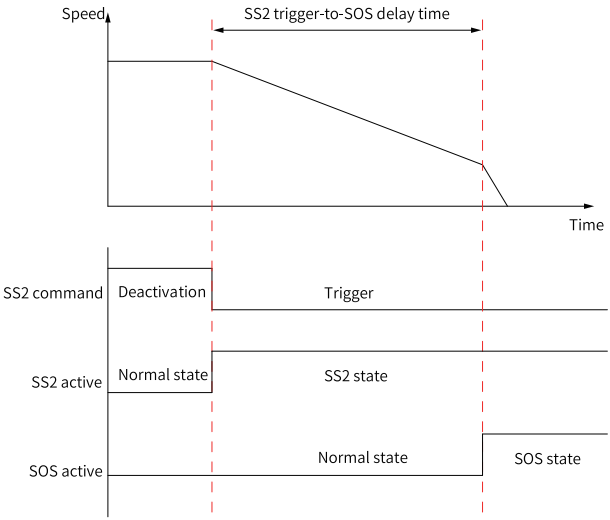
Related parameters:

See *" 6674h" on page 198* for details.

See *" 6675h" on page 198* for details.

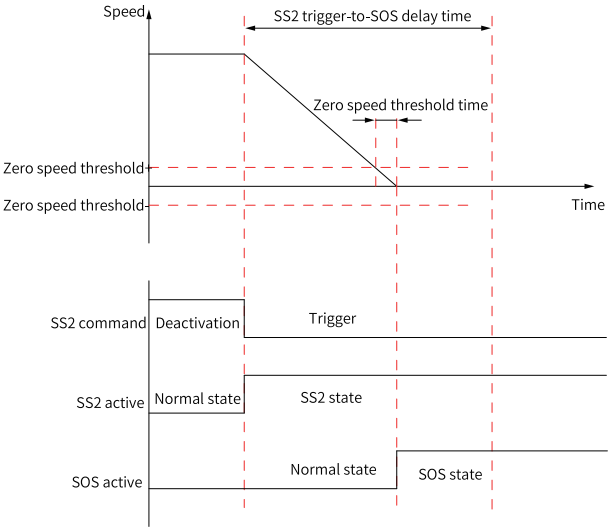
6.8.4 Sequence Diagram

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



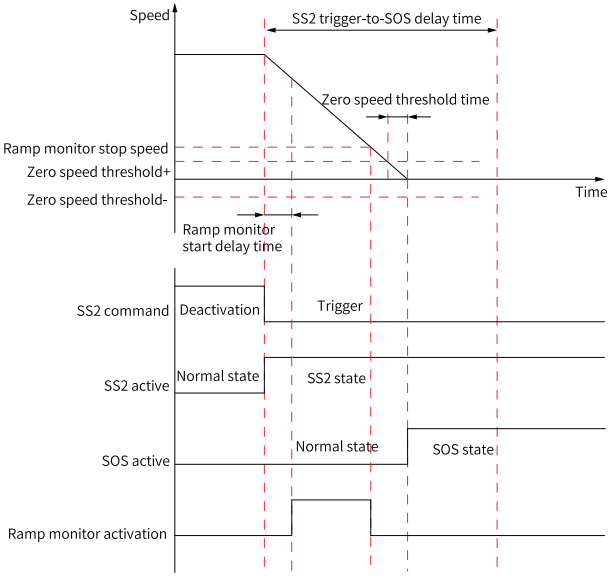
If the SS2 command is deselected after SS2 has been triggered, the drive will retain the SS2 state until the delay time has elapsed.

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

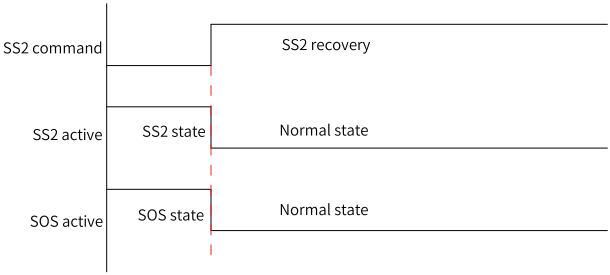


If the SS2 command is deselected after SS2 has been triggered, the drive will retain the SS2 state until the delay time has elapsed or the zero speed conditions are met.

Starting speed ramp monitoring of SS2



SS2 reset



6.9 SOS Function

6.9.1 Overview

The SOS function monitors whether the speed and position of the motor in a stationary state are within thresholds, ensuring that the motor is in a safe stop state while providing the power needed to maintain the external load. After SS2 is triggered, the drive switches from the SS2 state to the SOS state when the switching conditions are met. The SOS function must be used with 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 Function Triggered Locally

SOS trigger-related parameters

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

Table 6–8 Description of parameters

Parameter No.	Parameter Name	Description
FunOUT.11	SOS Active	0: Is not active 1: Is active

If any of DI1 to DI5 is configured with FunIN.11-Ack function, when the DI configured with SS1 function is triggered and then reset, the DI configured with the FunIN.11-Ack function must be triggered to restore from the SOS state to the normal operation state.

If none of the DIs is configured with the FunIN.11-Ack function, when the DI configured with SS1 function is triggered and then reset, the drive directly restores normal operation from the SOS state.

Note

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

SOS-related parameters

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

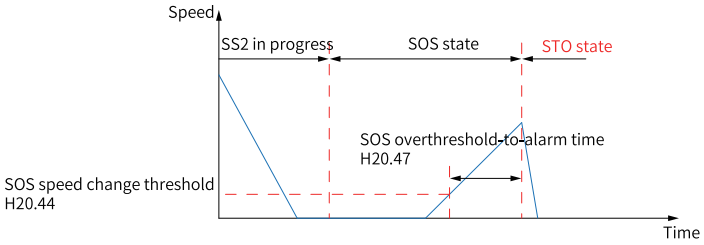


Figure 6-14 SOS speed change threshold

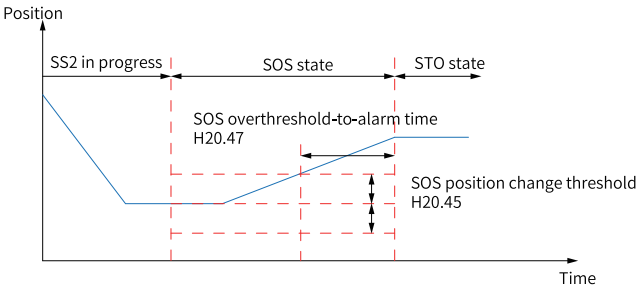


Figure 6-15 SOS position change threshold

Related parameters:

See *" H20.44" on page 182* for details.

See *" H20.45" on page 182* for details.

See *" H20.47" on page 182* for details.

6.9.3 SOS Function Triggered Through FSoE

SOS trigger-related parameters

6668h in the TPDO mapping is the object dictionary of SOS state.

Related parameters:

See *" 6668h" on page 196* for details.

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 restore from the SOS state to the normal operation state.

Related parameters:

See *" 6676h" on page 198* for details.

SOS-related parameters

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

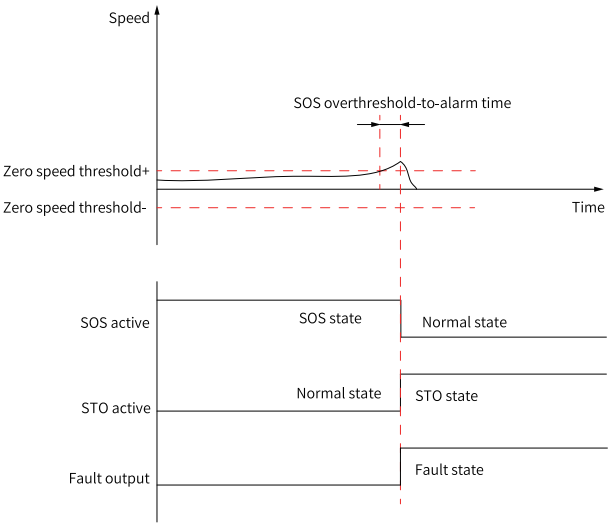
Related parameters:

See *" 666Ah" on page 196* for details.

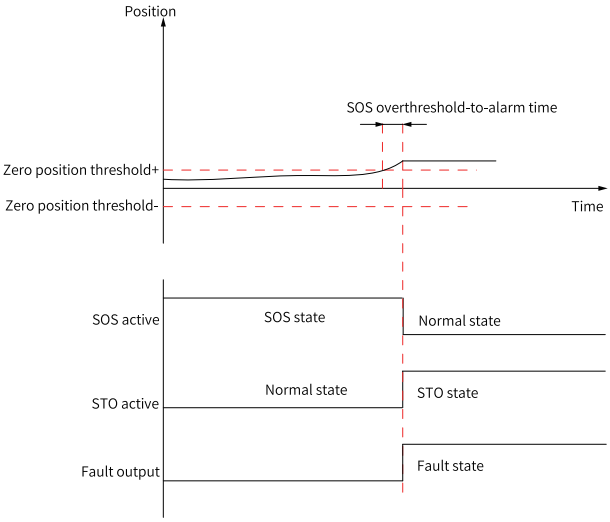
See *" 666Ch" on page 196* for details.

6.9.4 Sequence Diagram

SOS speed monitoring



SOS position monitoring



6.10 SLS Function

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 Function Triggered Locally

The parameter DI: FunIN5 (SLS1) enables the DI to trigger the SLS1 function, DI: FunIN6 (SLS2) enables the DI to trigger the SLS2 function, DI: FunIN7 (SLS3) enables the DI to trigger the SLS3 function, DI: FunIN8 (SLS4) enables the DI to trigger the SLS4 function, DO: FunOUT.5 (SLS1 Active) enables the DO to output that SLS1 is active, DO: FunOUT.6 (SLS2 Active) enables the DO to output that SLS6 is active, DO: FunOUT.7 (SLS3 Active) enables the DO to output that SLS3 is active, and DO: FunOUT.9 (SLS4 Active) enables the DO to output that SLS4 is active,

Table 6–9 Description of parameters

Parameter No.	Parameter Name	Description
FunIN.5	SLS1 command	0: Activate 1: Deactivate
FunIN.6	SLS2 command	0: Activate 1: Deactivate
FunIN.7	SLS3 command	0: Activate 1: Deactivate
FunIN.8	SLS4 command	0: Activate 1: Deactivate
FunOUT.5	SLS1 Active	0: Is not active 1: Is active
FunOUT.6	SLS2 Active	0: Is not active 1: Is active
FunOUT.7	SLS3 Active	0: Is not active 1: Is active
FunOUT.8	SLS4 Active	0: Is not active 1: Is active

Note

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

Related parameters:

See *" H20.02" on page 169* for details.
See *" H20.03" on page 169* for details.
See *" H20.04" on page 170* for details.
See *" H20.05" on page 170* for details.
See *" H20.06" on page 171* for details.
See *" H20.20" on page 174* for details.
See *" H20.21" on page 174* for details.
See *" H20.22" on page 175* for details.
See *" H20.23" on page 176* for details.
See *" H20.24" on page 176* for details.
See *" H20.25" on page 177* for details.
See *" H20.48" on page 183* for details.
See *" H20.49" on page 183* for details.
See *" H20.50" on page 183* for details.
See *" H20.51" on page 184* for details.
See *" H20.52" on page 184* for details.
See *" H20.53" on page 184* for details.
See *" H20.54" on page 184* for details.
See *" H20.55" on page 185* for details.
See *" H20.56" on page 185* for details.
See *" H20.57" on page 185* for details.
See *" H20.58" on page 185* for details.
See *" H20.59" on page 186* for details.

6.10.3SLS Function Triggered Through FSoE

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

1. You can set the delay time from activation of the SLS command to starting of the SLS speed monitoring. When the delay time has elapsed, the safety module will

turn on the speed monitoring regardless of whether the current speed of the servo motor is within the speed range.

2. You can also set the SLS filter time. 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 regardless of whether the delay time is reached.

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

Related parameters:

See *" 6690.01h" on page 199* for details.

See *" 6690.02h" on page 199* for details.

See *" 6690.03h" on page 199* for details.

See *" 6690.04h" on page 200* for details.

See *" 6691.01h" on page 200* for details.

See *" 6691.02h" on page 200* for details.

See *" 6691.03h" on page 201* for details.

See *" 6691.04h" on page 201* for details.

See *" 6693.01h" on page 201* for details.

See *" 6693.02h" on page 202* for details.

See *" 6693.03h" on page 202* for details.

See *" 6693.04h" on page 202* for details.

See *" 6694.01h" on page 202* for details.

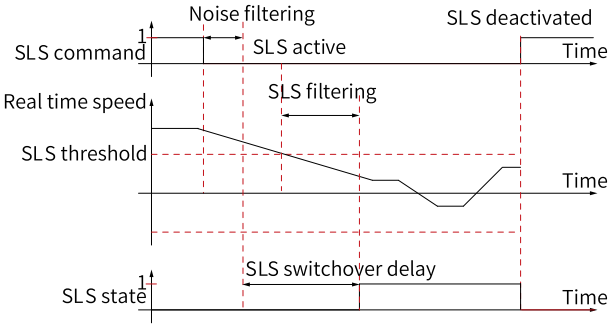
See *" 6694.02h" on page 203* for details.

See *" 6694.03h" on page 203* for details.

See *" 6694.04h" on page 203* for details.

6.10.4Sequence Diagram

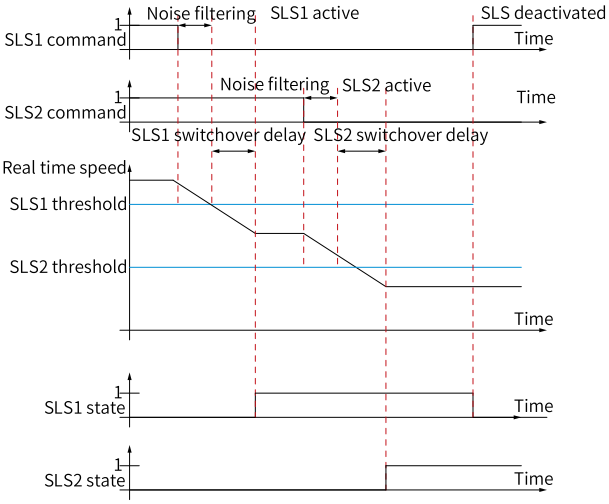
Sequence for single SLS command



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

Sequence for multiple SLS commands

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



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

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

6.11 SDI Function

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 Function Triggered Locally

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

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

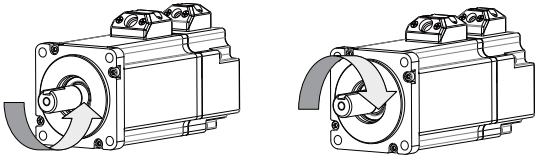
Table 6–10 Description of parameters

Parameter No.	Parameter Name	Description
FunIN.9	SDIp command	0: Activate, forward rotation prohibited 1: Deactivate, forward rotation allowed
FunIN.10	SDIn command	0: Activate, reverse rotation prohibited 1: Deactivate, reverse rotation allowed
FunOUT.9	SDIp Status	0: Is not active, motor not in forward rotation 1: Is active, motor in forward rotation
FunOUT.10	SDIn Status	0: Is not active, motor not in reverse rotation 1: Is active, motor in reverse rotation

Note

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

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 perform both forward and reverse rotation.
1	0	1	0	The motor can only perform forward rotation.
0	1	0	1	The motor can only perform reverse rotation.
0	0	0	0	The motor is not allowed to perform forward and reverse rotation.

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:

See *" H20.02" on page 169* for details.

See *" H20.03" on page 169* for details.

See *" H20.04" on page 170* for details.

See *" H20.05" on page 170* for details.

See *" H20.06" on page 171* for details.

See *" H20.20" on page 174* for details.

See *" H20.21" on page 174* for details.

See *" H20.22" on page 175* for details.

See *" H20.23" on page 176* for details.

See *" H20.24" on page 176* for details.

See *" H20.25" on page 177* for details.

See *" H20.74" on page 187* for details.

See *" H20.76" on page 187* for details.

See *" H20.77" on page 187* for details.

See *" H20.78" on page 188* for details.

See *" H02.02" on page 167* for details.

6.11.3SDI Function Triggered Through Safety Bus

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:

See *" H02.02" on page 167* for details.

See *" 66D0h" on page 203* for details.

See *" 66D1h" on page 204* for details.

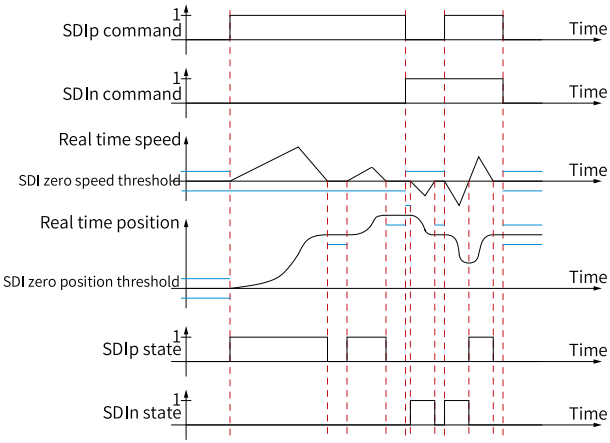
See *" 66D3h" on page 204* for details.

See *" 66D5h" on page 204* for details.

6.11.4Sequence Diagram

SDI control bit setting

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



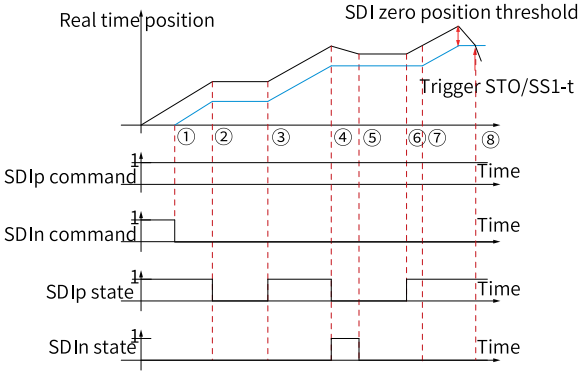
- The SDIp and SDIn states displayed by the safety module indicate the current rotational state of the servo motor, independent of whether the input SDI command is active or not. When both SDIp and SDIn states are 0, it means the servo motor is stopped.
- When the SDIp command is deactivated, the motor can rotate in forward direction, and when it is activated, the motor can only rotate in reverse direction.
- When the SDIn command is deactivated, the motor can rotate in reverse direction, and when it is activated, the motor can only rotate in forward direction.

SDI monitoring

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

The SDI monitoring diagram is shown below.

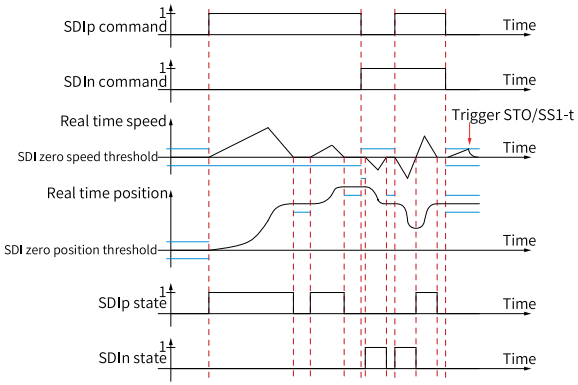
Stop according to H20.78 when the SDI zero position threshold is exceeded



The sequence is described as follows:

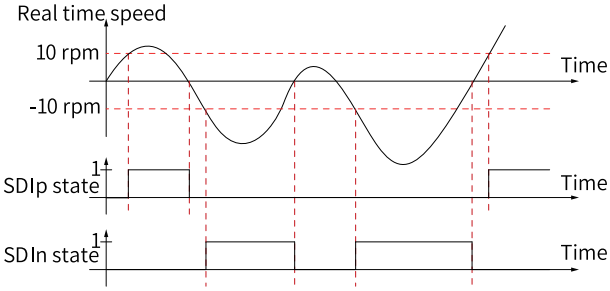
- ① The safety module receives an active SDIn command and starts monitoring whether the motor shaft rotates into the reverse direction. The motor rotates into the allowable forward direction.
- ② The motor stops rotating and the position feedback remains unchanged.
- ③ The motor continues to rotate into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

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



Hysteresis speed

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



6.12 SSM Function

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.

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

SSM is suitable for the realization of enabling access to the machine by way of local feedback. For example, protective doors can only be unlocked when the critical speeds fall below those specified.

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

6.12.2SSM State Output Through Local Mode

The SSM state can be output through DO.

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

Table 6–11 Description of parameters

Parameter No.	Parameter Name	Description
FunOUT.12	SSM Active	0: Out of SSM limit 1: Within SSM limit

Note

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

Related parameters:

See *" H20.20" on page 174* for details.

See *" H20.21" on page 174* for details.

See *" H20.22" on page 175* for details.

See *" H20.23" on page 176* for details.

See *" H20.24" on page 176* for details.

See *" H20.25" on page 177* for details.

See *" H20.70" on page 186* for details.

See *" H20.71" on page 186* for details.

See *" H20.72" on page 187* for details.

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.

6.12.3SSM State Output Through FSoE

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 the parameter H20.72.

That is, the SSM hysteresis threshold set by H20.72 will take effect for both the local mode and the FSoE mode.

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

Related parameters:

See *" 66E0h" on page 205* for details.

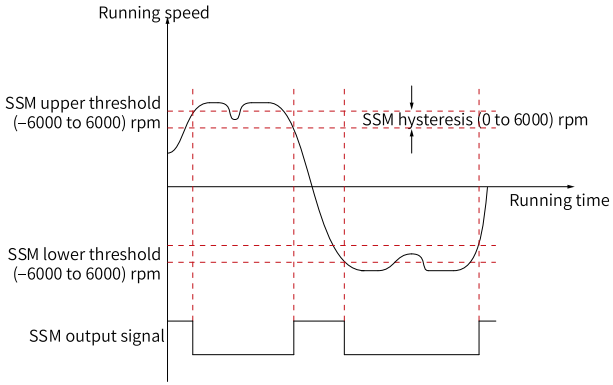
See *" 66E2h" on page 205* for details.

See *" 66E4h" on page 205* for details.

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 Diagram



The purpose of the SSM hysteresis setting is to achieve a more stable signal output when the motor speed is near the upper or lower SSM threshold. The SSM function

prevents the SSM output signal from jumping back and forth between 0 and 1 many times around the threshold due to the real-time fluctuation of the motor speed.

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

6.13 Safety Function Response Time

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 Safety Functions Locally

When you choose to trigger the safety functions locally, you need to configure a safety DI with a certain safety function. Then you can trigger the corresponding safety function by controlling the DI. The response time from the operation of DI to the activation of corresponding safety function is described in the following table.

Table 6–12 Response time for controlling safety functions through DI terminals

Function	Max. response time
STO/SBC (triggered by DI)/SS1/SS2	t_DI[1]+2.5ms
SOS overlimit/SLS overlimit/SDI overlimit[2]	M[3]*2 * t_M[4] + 1 ms
SSM (DO output)[5]	2 * t_M[4] + t_DO[6]

Note

- [1]: t_DI is the noise rejection filtering time of DI of the safety module, and is configured by parameters H20.08 to H20.12;
- [2]: Indicates the response time from the receipt of the encoder data by the safety module to the start of fault processing;
- [3]: M is the communication fault tolerance time;
- [4]: t_M is the safety monitoring cycle of the safety module, t_M = 0.25 ms;
- [5]: Indicates the response time from receipt of the encoder data by the safety module to the DO output;
- [6]: t_DO is the response time of the DO output of the safety module, the maximum value is 20 ms.

6.13.2Response Time for Triggering Safety Functions Through FSoE

When you choose to trigger the safety functions through FSoE, you need to trigger the safety functions through their control word in RPDO. The response time from the triggering of the safety function to the execution of safety function is described in the following table.

Table 6–13 Response time for controlling safety functions through FSoE

Function	Max. response time
STO/SBC (triggered by control word)/SS1/ SS2	2 * t_ET[1] + t_C[2]
SOS overlimit/SLS overlimit/SDI overlimit[3]	M[4]*2 * t_M[5] + 1 ms
SSM[6]	6 * t_ET[5] + t_C[2]

Note

- [1]: t_ET is the EtherCAT communication synchronization cycle;
- [2]: t_C is the internal communication time of the module, t_C = 2 ms;
- [3]: Indicates the response time from the receipt of the encoder data by the safety module to the start of fault processing;
- [4] : M is the communication fault tolerance time;
- [5]: t_M is the safety monitoring cycle of the safety module, t_M = 0.25 ms;
- [6]: Indicates the response time from the receipt of the encoder data by the safety module to the change of status word.

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 bit 7 of the control word 6040h through 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 Commissioning and Trial Run

7.1 Preliminary Check

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

Table 7–1 Checklist before running

Record	No.	Description
Wiring		
☐	1	The power input terminals (L1C, L2C, L1, L2, L3, R, S, T) of the servo drive are connected properly.
☐	2	The output terminals (U, V, W) of the servo drive are properly connected to the power cables (U, V, W) of the servo motor in correct phase sequence.
☐	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 signal wires of the servo drive are connected correctly. The external signal wires such as the brake and the limit switch are connected reliably.
☐	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.
Environment and Mechanical Conditions		
☐	1	No unwanted objects (such as cable terminals and metal chippings) that may cause short circuit are present inside or outside the servo drive.
☐	2	The servo drive and the external regenerative resistor are placed on incombustible objects.
☐	3	The servo motor is installed properly. The motor shaft is connected to the machine securely.
☐	4	The servo motor and the machine it is connected to are in good condition and ready to run.

7.2 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.

7.3 Verification and Validation

Contents of this chapter

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.

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.

- 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, etc.)
- after any maintenance work related to the safety function. The acceptance test must include at least the following steps:

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

Acceptance test reports

You must store the signed acceptance test reports in the logbook of the machine. The report must include, 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 61508-1 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.

8 Fault Handling

8.1 Fault and Warning Levels

Faults and warnings 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 warning

Note

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

Operating procedure:

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

Note

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

8.2 List of Fault and Warning Codes

The servo drive can output the fault/warning code of the highest level.

No. 1 non-resettable faults:

Table 8–1 List of No. 1 non-resettable faults

Fault Code	Display	Fault Name	Fault Type	Resettable
E101	E101.3	CRC error during safety parameter initialization	NO.1	No
	E101.4	Error in upper and lower limits verification during safety parameter initialization	NO.1	No
	E101.5	Address error in read/write operation after the number of parameters changes	NO.1	No
E104	E104.5	Abnormal safety module FPGA interrupt count	NO.1	No
	E104.6	Safety module FPGA interrupt timed out	NO.1	No
E145	E145.0	Safety module chip diagnosis failure	NO.1	No
	E145.1	Safety module program execution exception	NO.1	No
E154	E154.0	Speed-related functions enabled for non-safety encoder	NO.1	No
	E154.1	Incorrect selection of safety function trigger mode	NO.1	No
E750	E750.0	Excessive deviation of initial position between master and slave in encoder	NO.1	No
	E750.1	Excessive deviation of position between master and slave in encoder	NO.1	No
	E750.2	Excessive deviation of QEP between master and slave in encoder	NO.1	No
	E750.3	Excessive deviation of analog quantity between master and slave in encoder	NO.1	No
	E750.4	Encoder chip power supply diagnosis exception	NO.1	No
	E750.5	SN mismatch between master and slave in encoder	NO.1	No
	E750.6	Encoder chip diagnosis exception	NO.1	No
	E750.7	SPI communication exception inside encoder, no response from slave	NO.1	No
E751	E751.0	Safety module encoder CRC check error	NO.1	No
	E751.1	Excessive deviation between speeds calculated by MCU1 and MCU2 of safety module	NO.1	No
	E751.2	Safety module position 1 and 2 check error	NO.1	No
	E751.3	Safety encoder version number CRC error	NO.1	No

No. 1 resettable faults

Table 8–2 List of No. 1 resettable faults

Fault Code	Fault subcode	Fault Name	Fault Type	Resettable
E124	E124.0	Different DIs allocated with the same function	NO.1	Yes
	E124.1	DI1 input circuit diagnosis exception	NO.1	Yes
	E124.2	DI2 input circuit diagnosis exception	NO.1	Yes
	E124.3	DI3 input circuit diagnosis exception	NO.1	Yes
	E124.4	DI4 input circuit diagnosis exception	NO.1	Yes
	E124.5	DI5 input circuit diagnosis exception	NO.1	Yes
E125	E125.0	SSM assigned to non-safety DO	NO.1	Yes
	E125.1	DO1 output circuit diagnosis exception	NO.1	Yes
	E125.2	DO2 output circuit diagnosis exception	NO.1	Yes
	E125.4	DO4 output circuit diagnosis exception	NO.1	Yes
	E125.5	DO5 output circuit diagnosis exception	NO.1	Yes
E134	E134.1	Discrepancy at two input signals of DI1	NO.1	Yes
	E134.2	Discrepancy at two input signals of DI2	NO.1	Yes
	E134.3	Discrepancy at two input signals of DI3	NO.1	Yes
	E134.4	Discrepancy at two input signals of DI4	NO.1	Yes
	E134.5	Discrepancy at two input signals of DI5	NO.1	Yes
E135	E135.0	Chip 3.3V signal diagnosis exception	NO.1	Yes
E151	E151.0	SCI communication exception between servo drive and safety module	NO.1	Yes
	E151.1	SCI communication exception between two MCUs of the safety module	NO.1	Yes
E152	E152.0	Failure of parameter verification between two MCUs of the safety module	NO.1	Yes
	E152.1	Timeout for sending CRC between two MCUs of the safety module	NO.1	Yes
	E152.2	Timeout for safety module to get initial servo drive parameters	NO.1	Yes
E160	E160.0	SLS1 overspeed	NO.1	Yes
	E160.1	SLS2 overspeed	NO.1	Yes
	E160.2	SLS3 overspeed	NO.1	Yes
	E160.3	SLS4 overspeed	NO.1	Yes
E165	E165.0	SDIp exception	NO.1	Yes
	E165.1	SDIn exception	NO.1	Yes
E170	E170.0	SS1 deceleration ramp exception	NO.1	Yes
	E170.1	SS2 deceleration ramp exception	NO.1	Yes
	E170.2	SOS speed or position limit exceeded	NO.1	Yes
E631	E631.0	SBC brake circuit diagnosis exception	NO.1	Yes

No. 2 resettable faults

Table 8–3 List of No. 2 resettable faults

Fault Code	Display	Fault Name	Fault Type	Resettable
EE17	EE17.0	FSoE unexpected command	NO.2	Yes
	EE17.1	FSoE unknown command	NO.2	Yes
	EE17.2	FSoE invalid connection ID	NO.2	Yes
	EE17.3	FSoE CRC error	NO.2	Yes
	EE17.4	FSoE watchdog expired	NO.2	Yes
	EE17.5	FSoE invalid slave address	NO.2	Yes
	EE17.6	FSoE invalid FSoE safety data	NO.2	Yes
	EE17.7	FSoE invalid communication parameter length	NO.2	Yes
	EE17.8	FSoE invalid communication parameter data	NO.2	Yes
	EE17.9	FSoE invalid application parameter length	NO.2	Yes
	EE17.A	FSoE invalid application parameter data	NO.2	Yes

No. 3 resettable warnings

Table 8–4 No. 3 resettable warning list

Fault Code	Display	Name	Fault Type	Resettable
E108	E108.4	Safety module EEPROM write timed out	NO.3	Yes
	E108.5	Safety module EEPROM read timed out	NO.3	Yes
	E108.6	Safety module EEPROM write check error	NO.3	Yes
E115	E115.0	SSM parameter setting exception warning	NO.3	Yes
E116	E116.0	SLS overspeed warning	NO.3	Yes
	E116.1	SDI out of tolerance warning	NO.3	Yes

8.3 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	Confirming 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.	1. Check whether the control circuit (L1C, L2C) is in the process of power-off or instantaneous power failure occurs. 2. 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)	1. Restore safety parameters to default settings and write parameters again. 2. 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 rewrite parameters.
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	Confirming Method	Solution
1. The software is updated.	Check whether the software is updated.	Restore the safety parameters to default settings.
2. The voltage of the control circuit power supply drops instantaneously.	1. Check whether the control circuit (L1C, L2C) is in the process of power-off or instantaneous power failure occurs; 2. 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)	1. Restore safety parameters to default settings and write parameters again; 2. 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 rewrite parameters.
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	Confirming Method	Solution
1. The software is updated.	Check whether the software is updated.	Restore the 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: Abnormal safety module FPGA interrupt count
  Cause:

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

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

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

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

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

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

  The function numbers of the safety DI terminals are duplicated.

Cause	Confirming Method	Solution
One DI function cannot be reused by two or more DI terminals.	Check whether the same function number is selected for different DIs.	Ensure that the function 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	Confirming Method	Solution
The MCU has sent a diagnostic signal, and the feedback signal is incorrect.	1. Check whether the DI1 circuit is normal. 2. Disconnect and then reconnect the 24V input voltage of DI1, and observe whether the input signal of DI1 changes (You can sample and analyze the input signal of DI1 through the background software oscilloscope).	1. If the DI1 circuit is abnormal, shield DI1 by setting its function number to 0. 2. If it cannot be shielded, it is recommended to replace the safety control board.

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

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

Cause	Confirming Method	Solution
The MCU has sent a diagnostic signal, and the feedback signal is incorrect.	1. Check whether the DI2 circuit is normal. 2. Disconnect and then reconnect the 24V input voltage of DI2, and observe whether the input signal of DI2 changes (You can sample and analyze the input signal of DI2 through the background software oscilloscope).	1. If the DI2 circuit is abnormal, shield DI2 by setting its function number to 0. 2. If it cannot be shielded, it is recommended to replace the safety control board.

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

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

Cause	Confirming Method	Solution
The MCU has sent a diagnostic signal, and the feedback signal is incorrect.	1. Check whether the DI3 circuit is normal. 2. Disconnect and then reconnect the 24V input voltage of DI3, and observe whether the input signal of DI3 changes (You can sample and analyze the input signal of DI3 through the background software oscilloscope).	1. If the DI3 circuit is abnormal, shield DI3 by setting its function number to 0. 2. If it cannot be shielded, it is recommended to replace the safety control board.

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

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

Cause	Confirming Method	Solution
The MCU has sent a diagnostic signal, and the feedback signal is incorrect.	1. Check whether the DI4 circuit is normal. 2. Disconnect and then reconnect the 24V input voltage of DI4, and observe whether the input signal of DI4 changes (You can sample and analyze the input signal of DI4 through the background software oscilloscope).	1. If the DI4 circuit is abnormal, shield DI4 by setting its function number to 0. 2. If it cannot be shielded, it is recommended to replace the safety control board.

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

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

Cause	Confirming Method	Solution
The MCU has sent a diagnostic signal, and the feedback signal is incorrect.	1. Check whether the DI5 circuit is normal. 2. Disconnect and then reconnect the 24V input voltage of DI5, and observe whether the input signal of DI5 changes (You can sample and analyze the input signal of DI5 through the background software oscilloscope).	1. If the DI5 circuit is abnormal, shield DI5 by setting its function number to 0. 2. If it cannot be shielded, it is recommended to replace the safety control board.

- E125.0: SSM assigned to non-safety DO
  Cause:

  Check whether DO3 and DO6 are assigned with the SSM function.

Cause	Confirming Method	Solution
The SSM cannot use non-safety DO as signal output.	Check whether DO3 and DO6 are set to 12-SSM.	Do not assign DO3 and DO6 with SSM function.

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

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

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

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

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

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

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

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

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

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

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

Cause:

Check whether the two input signals of DI1 exceed the value of H20.14.

Cause	Confirming Method	Solution
The discrepancy at two input signals of DI1 exceeds the value of H20.14.	Check whether the discrepancy at two input signals of DI1 exceeds the value of H20.14.	Ensure that the discrepancy at two input signals of DI1 does not exceed the value of H20.14.

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

  Check whether the two input signals of DI2 exceed the value of H20.15.

Cause	Confirming Method	Solution
The discrepancy at two input signals of DI2 exceeds the value of H20.15.	Check whether the discrepancy at two input signals of DI2 exceeds the value of H20.15.	Ensure that the discrepancy at two input signals of DI2 does not exceed the value of H20.15.

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

  Check whether the two input signals of DI3 exceed the value of H20.16.

Cause	Confirming Method	Solution
The discrepancy at two input signals of DI3 exceeds the value of H20.16.	Check whether the discrepancy at two input signals of DI3 exceeds the value of H20.16.	Ensure that the discrepancy at two input signals of DI3 does not exceed the value of H20.16.

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

  Check whether the two input signals of DI4 exceed the value of H20.17.

Cause	Confirming Method	Solution
The discrepancy at two input signals of DI4 exceeds the value of H20.17.	Check whether the discrepancy at two input signals of DI4 exceeds the value of H20.17.	Ensure that the discrepancy at two input signals of DI4 does not exceed the value of H20.17.

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

  Check whether the two input signals of DI5 exceed the value of H20.18.

Cause	Confirming Method	Solution
The discrepancy at two input signals of DI5 exceeds the value of H20.18.	Check whether the discrepancy at two input signals of DI5 exceeds the value of H20.18.	Ensure that the discrepancy at two input signals of DI5 does not exceed the value of H20.18.

- E135.0: Chip 3.3V signal diagnosis exception
  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	Confirming 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	Confirming Method	Solution
1. The CPU diagnosis of the chip failed.	Power on and off repeatedly. The probability of failure is high.	Replace the servo drive and safety module.
2. The RAM diagnosis of the chip failed.		
3. The FLASH diagnosis of the chip failed.		
4. The software program has stack overflow problems.		

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

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

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

- 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	Confirming 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.

- 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	Confirming 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.	1. Check whether the control circuit (L1C, L2C) is in the process of power-off or instantaneous power failure occurs. 2. 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)	1. Restore safety parameters to default settings and write parameters again. 2. 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 rewrite parameters.
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	Confirming 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 drive parameters
  Cause:

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

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

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

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

Cause	Confirming Method	Solution
For non-EtherCAT models, the safety function trigger mode is selected as FSoE trigger	1. Check whether the servo drive is a EtherCAT model. 2. 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 overspeed
  Cause:

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

Cause	Confirming Method	Solution
The real-time speed feedback value exceeds the limit value of SLS1 after SLS1 monitoring is activated.	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 overspeed
  Cause:

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

Cause	Confirming 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 overspeed
  Cause:

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

Cause	Confirming 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 activated.

- E160.3: SLS4 overspeed
  Cause:

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

Cause	Confirming 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 activated.

- E165.0: SDIp exception
  Cause:

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

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

- E165.1: SDIn exception
  Cause:

  The motor cannot rotate in the reverse direction or the reverse rotation exceeds the limit.

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

- E170.0: SS1 deceleration ramp exception
  Cause:

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

Cause	Confirming 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	Confirming 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 limit exceeded
  Cause:

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

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

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

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

Cause	Confirming Method	Solution
1. The SBC circuit is diagnosed to be abnormal during power-on of the board.	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 cannot be held normally during the SBC release.	Diagnosis failed due to SBC brake circuit exception.	In case of the SBC circuit hardware failure, it is recommended to return it to the factory for maintenance.

- E750.0: Excessive deviation of initial position between master and slave in encoder
  Cause:

Cause	Confirming Method	Solution
The difference in initial position between master and slave in the encoder is too large.	Check whether the problem persists after power off and restart.	Return to the factory for maintenance.

- E750.1: Excessive deviation of position between master and slave in encoder
  Cause:

Cause	Confirming Method	Solution
The difference in position between master and slave is too large.	Check whether the problem persists after power off and restart.	Return to the factory for maintenance.

- E750.2: Excessive deviation of QEP between master and slave in encoder
  Cause:

  The difference in QEP count between master and slave is greater than two.

Cause	Confirming Method	Solution
Board-level communication interference, encoder disk pollution, chip peripheral exception etc.	Check for interference around the encoder.	Replace the motor or encoder.

- E750.3: Excessive analog deviation between master and slave in encoder
  Cause:

Cause	Confirming Method	Solution
The deviation of the analog sampling between the master and the slave in the encoder is too large.	Check whether the problem persists after power off and restart.	Return to the factory for maintenance.

- E750.4: Encoder chip power supply diagnosis exception

Cause:

LDO or battery voltage is lower than 3.1 V.

Cause	Confirming Method	Solution
The external power supply of the encoder is under voltage, the LDO device is damaged, or the battery voltage is low.	1. Check whether the battery is correctly connected. 2. Check whether the encoder is powered normally.	Replace the motor or encoder.

- E750.5: SN mismatch between master and slave in encoder
  Cause:

  The SN counts of the master and slave are not equal.

Cause	Confirming Method	Solution
The chip runs abnormally, or 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	Confirming Method	Solution
Chip exception	Check whether the chip is abnormal due to too high ambient temperature.	Replace the motor or encoder.

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

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

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

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

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

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

Cause	Confirming Method	Solution
1. The encoder cables are 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.	1. Check whether the servo drive and motor are properly grounded, and you can put a magnetic ring on the encoder to reduce the interference. 2. 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	Confirming 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 and 2 check error
  Cause:

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

Cause	Confirming 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 CRC value of the safety encoder version number is abnormal.

Cause	Confirming Method	Solution
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.	1. Check the wiring. 2. 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.

Cause	Confirming Method	Solution
1. In the reset state, the slave has received the Connection, Parameter, ProcessData, FailSafeData commands.	Fault code is displayed on the panel.	1. Check whether the command sent by the safety master is wrong. 2. Check whether the safety PDO data has been modified.
2. In the Session state, the slave has received the Parameter, ProcessData, FailSafeData commands.		
3. In the Connection state, the slave has received ProcessData and FailSafeData commands.		
4. In the Parameter state, the slave has received the Connection command.		
5. In the Data state, the slave has received the Connection and Parameter commands.		
6. In Session, Connection, and Parameter state, the number of security PDUs sent is 0.		

- EE17.1: FSoE unknown command
  Cause:

  Unspecified command word appeared in FSoE communication.

Cause	Confirming Method	Solution
The slave has received commands other than reset, Session, Connection, Parameter, ProcessData, and FailSafeData commands.	Fault code is displayed on the panel.	1. Check whether the command sent by the safety master is wrong. 2. 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	Confirming Method	Solution
In Connection, Parameter, ProcessData, FailSafeData state, the connection ID is an error.	Fault code is displayed on the panel.	1. Check whether the connection ID sent by the safety master is wrong. 2. 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	Confirming Method	Solution
The CRC value received by the slave is inconsistent with the CRC value calculated by itself.	Fault code is displayed on the panel.	1. Check whether the CRC sent by the safety master is wrong. 2. 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	Confirming Method	Solution
The slave failed to receive a data frame within the specified time.	Fault code is displayed on the panel.	1. Check whether the safety master sends any data. 2. Check whether the watchdog is working properly. 3. Check whether the connection is down.

- EE17.5: FSoE invalid slave address
  Cause:

  The FSoE communication address does not meet the requirements.

Cause	Confirming Method	Solution
In the Connection state, the received slave address is inconsistent.	Fault code is displayed on the panel.	1. Check whether the slave address sent from the safety master is correct. 2. Check whether the address of the slave is set correctly.

- EE17.6: FSoE invalid FSoE safety data
  Cause:

The FSoE communication parameters are incorrect or the connection fails, rendering the safety data invalid.

Cause	Confirming Method	Solution
In the Connection and Parameter state, the safety data received by the slave is invalid.	Fault code is displayed on the panel.	1. Check whether the data sent by the safety master is wrong. 2. Check whether the safety data has been modified.

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

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

Cause	Confirming Method	Solution
The length of the parameters received by the slave is inconsistent with that set by the slave.	Fault code is displayed on the panel.	1. Check whether the length of data sent by the safety master is wrong. 2. Check whether the data has been modified.

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

  FSoE communication parameter data is out of range.

Cause	Confirming Method	Solution
The watchdog time settings received by the slave are unreasonable.	Fault code is displayed on the panel.	1. Check whether the data sent by the safety master is wrong. 2. Check whether the data has been modified.

- EE17.9: FSoE invalid application parameter length
  Cause:

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

Cause	Confirming Method	Solution
The length of the application parameters received by the slave is inconsistent with that set by the slave.	Fault code is displayed on the panel.	1. Check whether the data sent by the safety master is wrong. 2. 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	Confirming Method	Solution
The application parameters received by the slave are incorrect.	Fault code is displayed on the panel.	1. Check whether the data sent by the safety master is wrong. 2. Check whether the data has been modified.

8.4 Solutions to Warnings

- E108.4: Safety module e2prom write timed out
  Cause:

  The write time of the parameter exceeds the maximum allowed time.

Cause	Confirming Method	Solution
e2prom error	Check whether the parameter modification takes effect after power off and restart.	1. Power off and restart, and retry to modify the parameters. 2. Replace the safety module.

- E108.5: Safety module e2prom read timed out
  Cause:

  The read time of the parameter exceeds the maximum allowed time.

Cause	Confirming Method	Solution
e2prom error	Check whether the parameter can be read normally after power off and restart.	1. Power off and restart, and retry to read the parameters. 2. Replace the safety module.

- E108.6: Safety module e2prom write check error
  Cause:

  After writing parameters into e2prom, the safety module will read the written parameters from e2prom again, and compare the read parameters with the written values. The comparison results do not match.

Cause	Confirming Method	Solution
e2prom parameter write exception	After fault reset, try to write parameters into the safety module again.	If rewrite fails again, replace the safety module.

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

  1. The SSM lower threshold is greater than or equal to the SSM upper threshold.

  2. The SSM hysteresis threshold is greater than or equal to the SSM upper threshold minus the SSM lower threshold.

Cause	Confirming Method	Solution
1. The SSM lower threshold is equal to or larger than the SSM upper threshold.	Local mode: 1. Check whether the value of H20.71 is greater than or equal to the value of H20.70. 2. Check whether the value of H20.72 is greater than or equal to H20.70 minus H20.71.	1. Set the SSM parameters properly. 2. Set the SSM upper threshold to be greater than the SSM lower threshold.
2. The SSM hysteresis threshold is greater than or equal to the SSM upper threshold minus the SSM lower threshold.	FSoE module: 1. Check whether the value of 66E4h is greater than or equal to the value of 66E2. 2. Check whether the value of H20.72 is greater than or equal to 66E2 minus 66E4.	Set the SSM hysteresis threshold to be smaller than the SSM upper threshold minus the SSM lower threshold.

- E116.0: SLS overspeed warning
  Cause:

  During the SLS monitoring, the motor speed exceeds the allowable speed limit.

Cause	Confirming Method	Solution
During the SLS monitoring, the motor speed exceeds the allowable speed limit	Check the fault record to see if the speed corresponding to the E116.0 warning code exceeds the allowable SLS speed limit.	Control the motor speed so that it does not exceed the SLS speed limit.

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

  During the SDI monitoring, the allowable value is exceeded.

Cause	Confirming Method	Solution
During the SDI monitoring, the allowable value is exceeded (A warning is issued when either of the zero speed threshold or the zero position threshold is exceeded.)	Check the fault record to see if the speed corresponding to the E116.1 warning code exceeds the allowable SDI zero speed threshold, and whether the rotation direction exceeds the allowable SDI zero speed position.	Control the motor speed so that it does not exceed the allowable SDI limit.

9 List of Parameters

9.1 Parameter Group H02

Param. No.	Communication Address	Name	Setting Range	Default	Unit	Change	Page
H02.02	0x0202	Rotation direction selection	0: Counterclockwise (CCW) as forward direction 1: Clockwise (CW) as forward direction	0	-	At stop	" H02.02" on page 167
H02.11	0x020B	Motor speed threshold at brake output OFF in rotating state	20 rpm to 3000 rpm	30	rpm	At once	" H02.11" on page 167
H02.12	0x020C	Delay from S-ON OFF to brake output OFF in rotation state	1 ms to 65535 ms	500	ms	At once	" H02.12" on page 168

9.2 Parameter Group H20

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
H20.00	0x2000	Safety module software version	0 to 655	0	-	Unchangeable	" H20.00" on page 168
H20.01	0x2001	Safety function trigger selection	0: Local trigger 1: FSoE trigger	0	-	At stop	" H20.01" on page 168

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
H20.02	0x2002	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	*" H20.02" on page 169*
H20.03	0x2003	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	*" H20.03" on page 169*
H20.04	0x2004	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	*" H20.04" on page 170*
H20.05	0x2005	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	*" H20.05" on page 170*

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
H20.06	0x2006	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	*" H20.06" on page 171*
H20.08	0x2008	Safety module DI1 noise rejection filter time	1 ms to 500 ms	5	ms	At stop	*" H20.08" on page 171*
H20.09	0x2009	Safety module DI2 noise rejection filter time	1 ms to 500 ms	5	ms	At stop	*" H20.09" on page 171*
H20.10	0x200A	Safety module DI3 noise rejection filter time	1 ms to 500 ms	5	ms	At stop	*" H20.10" on page 172*
H20.11	0x200B	Safety module DI4 noise rejection filter time	1 ms to 500 ms	5	ms	At stop	*" H20.11" on page 172*
H20.12	0x200C	Safety module DI5 noise rejection filter time	1 ms to 500 ms	5	ms	At stop	*" H20.12" on page 172*
H20.14	0x200E	Safety module DI1 allowable discrepancy time	5 ms to 60000 ms	10	ms	At stop	*" H20.14" on page 173*
H20.15	0x200F	Safety module DI2 allowable discrepancy time	5 ms to 60000 ms	10	ms	At stop	*" H20.15" on page 173*

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
H20.16	0x2010	Safety module DI3 allowable discrepancy time	5 ms to 60000 ms	10	ms	At stop	" H20.16" on page 173
H20.17	0x2011	Safety module DI4 allowable discrepancy time	5 ms to 60000 ms	10	ms	At stop	" H20.17" on page 173
H20.18	0x2012	Safety module DI5 allowable discrepancy time	5 ms to 60000 ms	10	ms	At stop	" H20.18" on page 174
H20.20	0x2014	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	" H20.20" on page 174
H20.21	0x2015	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	" H20.21" on page 174

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
H20.22	0x2016	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	*" H20.22" on page 175*
H20.23	0x2017	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	*" H20.23" on page 176*
H20.24	0x2018	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	*" H20.24" on page 176*

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
H20.25	0x2019	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	*" H20.25" on page 177*
H20.28	0x201C	STO trigger-to-SBC active delay time	–30000 ms to 30000 ms	–30	ms	At stop	*" H20.28" on page 178*
H20.29	0x201D	SS1/SS2 stop mode	0: Stop according to ramp 1: Stop by host controller	1	-	At stop	*" H20.29" on page 178*
H20.30	0x201E	SS1/SS2 ramp-to-stop reference speed	60 rpm to 6000 rpm	1000	rpm	At stop	*" H20.30" on page 178*
H20.31	0x201F	SS1/ SS2 ramp-to-stop deceleration time	1 ms to 65535 ms	500	ms	At stop	*" H20.31" on page 178*
H20.32	0x2020	SS1/SS2 monitor mode	0: SS1-t: 1: SS1-r	0	-	At stop	*" H20.32" on page 179*
H20.33	0x2021	SS1 trigger-to-STO delay time/ SS2 trigger-to-STO delay time	0 ms to 65535 ms	1000	ms	At stop	*" H20.33" on page 179*
H20.34	0x2022	SS1/ SS1 zero speed threshold	1 rpm to 6000 rpm	10	rpm	At stop	*" H20.34" on page 179*
H20.35	0x2023	SS1/SS2 zero speed threshold time	0 ms to 65535 ms	0	ms	At stop	*" H20.35" on page 180*

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
H20.36	0x2024	SS1/SS2 ramp monitor start delay time	5 ms to 65535 ms	10	ms	At stop	" H20.36" on page 180
H20.37	0x2025	SS1/SS2 ramp monitor reference speed	60 rpm to 6000 rpm	1000	rpm	At stop	" H20.37" on page 180
H20.38	0x2026	SS1/SS2 ramp deceleration monitor time	1 ms to 65535 ms	65535	ms	At stop	" H20.38" on page 181
H20.41	0x2029	SS1/SS2 ramp limit trigger-to-alarm time	0 ms to 65535 ms	5	ms	At stop	" H20.41" on page 181
H20.42	0x202A	SS1/SS2 ramp monitor stop speed	0 rpm to 6000 rpm	1	rpm	At stop	" H20.42" on page 181
H20.43	0x202B	SS2 monitor mode	0: SS2-t: 1: SS2-r	0	-	At stop	" H20.43" on page 182
H20.44	0x202C	SOS speed change threshold	1 rpm to 6000 rpm	10	rpm	At stop	" H20.44" on page 182
H20.45	0x202D	SOS position change threshold	1 to 536870912	932067	Encoder unit	At stop	" H20.45" on page 182
H20.47	0x202F	SOS overthreshold-to-alarm time	0 ms to 65535 ms	5	ms	At stop	" H20.47" on page 182
H20.48	0x2030	SLS1 switchover delay	0 ms to 65535 ms	100	ms	At stop	" H20.48" on page 183
H20.49	0x2031	SLS2 switchover delay	0 ms to 65535 ms	100	ms	At stop	" H20.49" on page 183
H20.50	0x2032	SLS3 switchover delay	0 ms to 65535 ms	100	ms	At stop	" H20.50" on page 183

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
H20.51	0x2033	SLS4 switchover delay	0 ms to 65535 ms	100	ms	At stop	*" H20.51" on page 184*
H20.52	0x2034	SLS1 threshold	0 rpm to 6000 rpm	1000	rpm	At stop	*" H20.52" on page 184*
H20.53	0x2035	SLS2 threshold	0 rpm to 6000 rpm	2000	rpm	At stop	*" H20.53" on page 184*
H20.54	0x2036	SLS3 threshold	0 rpm to 6000 rpm	3000	rpm	At stop	*" H20.54" on page 184*
H20.55	0x2037	SLS4 threshold	0 rpm to 6000 rpm	4000	rpm	At stop	*" H20.55" on page 185*
H20.56	0x2038	SLS1 filter time	0 ms to 65535 ms	100	ms	At stop	*" H20.56" on page 185*
H20.57	0x2039	SLS2 filter time	0 ms to 65535 ms	100	ms	At stop	*" H20.57" on page 185*
H20.58	0x203A	SLS3 filter time	0 ms to 65535 ms	100	ms	At stop	*" H20.58" on page 185*
H20.59	0x203B	SLS4 filter time	0 ms to 65535 ms	100	ms	At stop	*" H20.59" on page 186*
H20.60	0x203C	SLS fault response mode	0: STO 1: SS1-t	0	-	At stop	*" H20.60" on page 186*
H20.70	0x2046	SSM upper limit	–6000 rpm to 6000 rpm	200	rpm	At stop	*" H20.70" on page 186*
H20.71	0x2047	SSM lower limit	–6000 rpm to 6000 rpm	–200	rpm	At stop	*" H20.71" on page 186*
H20.72	0x2048	SSM hysteresis threshold	0 rpm to 6000 rpm	10	rpm	At stop	*" H20.72" on page 187*
H20.74	0x204A	SDI zero position threshold	1 to 536870912	932067	Encoder unit	At stop	*" H20.74" on page 187*
H20.76	0x204C	SDI zero speed threshold	0 rpm to 3000 rpm	10	rpm	At stop	*" H20.76" on page 187*
H20.77	0x204D	SDI delay time	0 ms to 65535 ms	0	ms	At stop	*" H20.77" on page 187*
H20.78	0x204E	SDI fault response mode	0: STO 1: SS1-t	0	-	At stop	*" H20.78" on page 188*

9.3 Parameter Group 6000

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
6620.01h	-	Safety control word low 8 bits	0 to 255	0	-	Unchangeable	*"6620.01h" on page 188*
6620.02h	-	Safety control word high 8 bits	0 to 255	0	-	Unchangeable	*"6620.02h" on page 189*
6621.01h	-	Safety status word low 8 bits	0 to 255	0	-	Unchangeable	*"6621.01h" on page 190*
6621.02h	-	Safety status word high 8 bits	0 to 255	0	-	Unchangeable	*"6621.02h" on page 191*
6630h	-	Restart Ack signal	0 to 1	0	-	At once	*"6630h" on page 192*
6632h	-	Error state	0 to 1	0	-	At once	*"6632h" on page 192*
6640h	-	STO signal	0 to 1	0	-	At once	*"6640h" on page 193*
6641h	-	STO restart mode selection	0 to 1	0	-	At once	*"6641h" on page 193*
6650h	-	SS1 signal	0 to 1	0	-	At once	*"6650h" on page 194*
6651h	-	SS1 trigger-to-STO delay time	0 ms to 65535 ms	1000	ms	At once	*"6651h" on page 194*
6653h	-	SS1 zero speed threshold	1 rpm to 6000 rpm	10	rpm	At once	*"6653h" on page 194*
6654h	-	SS1 zero speed threshold time	0 ms to 65535 ms	0	ms	At once	*"6654h" on page 194*
6656h	-	SS1 deceleration limit	0 encoder unit/s^2 to 4294967295 encoder unit/s^2	15	Encoder unit/s^2	At once	*"6656h" on page 195*
6657h	-	SS1 ramp monitor start delay time	0 ms to 65535 ms	10	ms	At once	*"6657h" on page 195*
6660h	-	SBC signal	0 to 1	0	-	At once	*"6660h" on page 195*
6668h	-	SOS signal	0 to 1	0	-	At once	*"6668h" on page 196*

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
666Ah	-	SOS zero position threshold	0 to 536870912	932067	Encoder unit	At once	" 666Ah" on page 196
666Ch	-	SOS zero speed threshold	1 rpm to 6000 rpm	10	rpm	At once	" 666Ch" on page 196
6670h	-	SS2 signal	0 to 1	0	-	At once	" 6670h" on page 197
6671h	-	SS2 trigger-to-STO delay time	0 ms to 65535 ms	10	ms	At once	" 6671h" on page 197
6672h	-	SS2 zero speed threshold time	0 ms to 65535 ms	0	ms	At once	" 6672h" on page 197
6674h	-	SS2 deceleration limit	0 encoder unit/s^2 to 4294967295 encoder unit/s^2	15	Encoder unit/s^2	At once	" 6674h" on page 198
6675h	-	SS2 ramp monitor start delay time	0 ms to 65535 ms	10	ms	At once	" 6675h" on page 198
6676h	-	SS2 restart mode selection	0 to 1	0	-	At once	" 6676h" on page 198
6690.01h	-	SLS1 signal	0 to 1	0	-	At once	" 6690.01h" on page 199
6690.02h	-	SLS2 signal	0 to 1	0	-	At once	" 6690.02h" on page 199
6690.03h	-	SLS3 signal	0 to 1	0	-	At once	" 6690.03h" on page 199
6690.04h	-	SLS4 signal	0 to 1	0	-	At once	" 6690.04h" on page 200
6691.01h	-	SLS1 switchover delay	0 ms to 65535 ms	100	ms	At once	" 6691.01h" on page 200
6691.02h	-	SLS2 switchover delay	0 ms to 65535 ms	100	ms	At once	" 6691.02h" on page 200
6691.03h	-	SLS3 switchover delay	0 ms to 65535 ms	100	ms	At once	" 6691.03h" on page 201
6691.04h	-	SLS4 switchover delay	0 ms to 65535 ms	100	ms	At once	" 6691.04h" on page 201

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
6693.01h	-	SLS1 threshold	0 rpm to 6000 rpm	1000	rpm	At once	*"6693.01h" on page 201*
6693.02h	-	SLS2 threshold	0 rpm to 6000 rpm	2000	rpm	At once	*"6693.02h" on page 202*
6693.03h	-	SLS3 threshold	0 rpm to 6000 rpm	3000	rpm	At once	*"6693.03h" on page 202*
6693.04h	-	SLS4 threshold	0 rpm to 6000 rpm	4000	rpm	At once	*"6693.04h" on page 202*
6694.01h	-	SLS1 filter time	0 ms to 65535 ms	10	ms	At once	*"6694.01h" on page 202*
6694.02h	-	SLS2 filter time	0 ms to 65535 ms	10	ms	At once	*"6694.02h" on page 203*
6694.03h	-	SLS3 filter time	0 ms to 65535 ms	10	ms	At once	*"6694.03h" on page 203*
6694.04h	-	SLS4 filter time	0 ms to 65535 ms	10	ms	At once	*"6694.04h" on page 203*
66D0h	-	SDIp signal	0 to 1	0	-	At once	*"66D0h" on page 203*
66D1h	-	SDIn signal	0 to 1	0	-	At once	*"66D1h" on page 204*
66D3h	-	SDI zero position threshold	1 to 536870912	932067	Encoder unit	At once	*"66D3h" on page 204*
66D5h	-	SDI zero speed threshold	0 rpm to 3000 rpm	10	rpm	At once	*"66D5h" on page 204*
66E0h	-	SSM state	0 to 1	0	-	Unchangeable	*"66E0h" on page 205*
66E2h	-	SSM upper limit	–6000 rpm to 6000 rpm	200	rpm	At once	*"66E2h" on page 205*
66E4h	-	SSM lower limit	–6000 rpm to 6000 rpm	-200	rpm	At once	*"66E4h" on page 205*
E600.01h	-	FSoE slave command	0 to 255	0	-	Unchangeable	*"E600.01h" on page 206*
E600.02h	-	FSoE slave connection ID	0 to 65535	0	-	Unchangeable	*"E600.02h" on page 206*
E600.03h	-	FSoE slave CRC value	0 to 65535	0	-	Unchangeable	*"E600.03h" on page 206*
E601.01h	-	FSoE connection status	0 to 1	0	-	Unchangeable	*"E601.01h" on page 206*
E700.01h	-	FSoE master command	0 to 255	0	-	At once	*"E700.01h" on page 207*

Parameter	Communication Address	Parameter Name	Setting Range	Default	Unit	Change	Page
E700.02h	-	FSoE master connection ID	0 to 65535	0	-	At once	" E700.02h" on page 207
E700.03h	-	FSoE master CRC value	0 to 65535	0	-	At once	" E700.03h" on page 207
E901.01h	-	FSoE version	0 to 65535	0	-	Unchangeable	" E901.01h" on page 207
E901.02h	-	FSoE address	0 to 65535	0	-	Unchangeable	" E901.02h" on page 208
E901.03h	-	FSoE connection ID	0 to 65535	0	-	Unchangeable	" E901.03h" on page 208
E901.04h	-	Watchdog time	0 to 65535	0	-	Unchangeable	" E901.04h" on page 208
E901.06h	-	Connection type	0 to 65535	0	-	Unchangeable	" E901.06h" on page 208
E901.07h	-	Communication parameter length	0 to 65535	0	-	Unchangeable	" E901.07h" on page 209
E901.08h	-	Application layer parameter length	0 to 65535	0	-	Unchangeable	" E901.08h" on page 209
E901.09h	-	SRA CRC	0 to 65535	0	-	Unchangeable	" E901.09h" on page 209
F980.01h	-	FSoE address	0 to 255	0	-	Unchangeable	" F980.01h" on page 209

10 Description of Parameters

10.1 H02 Basic Control Parameters

H02.02 Rotation direction selection

Address: 0x0202

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

Value Range:

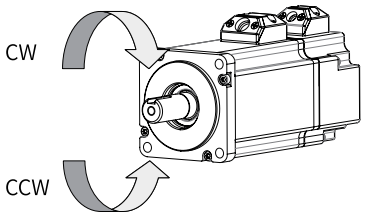
0: Counterclockwise (CCW) as forward direction

1: Clockwise (CW) as forward direction

Description

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

Setpoint	Direction of rotation	Remarks
0	CCW direction as forward direction	When a forward command is input, the motor rotates in CCW direction viewed from the motor shaft side, that is, the motor rotates counterclockwise.
1	CW direction as forward direction	When a forward command is input, the motor rotates in CW direction viewed from the motor shaft side, that is, the motor rotates clockwise.



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

Address: 0x020B

Min.:	20	Unit:	rpm
Max.:	3000	Data Type:	UInt16
Default:	30	Change:	At once

Value Range:

20 rpm to 3000 rpm

Description

Set the motor speed threshold when the brake output signal becomes OFF in motor rotating state.

See "Commissioning and Trial Run" chapter in SV680P Series Servo Drive Commissioning Guide.

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

Address:	0x020C		
Min.:	1	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	500	Change:	At once

Value Range:

1 ms to 65535 ms

Description

Sets the delay time from BK OFF to S-ON OFF when the motor is in rotating state.

10.2 H20 Safety Module Parameters

H20.00 Safety module software version

Address:	0x2000	Effective:	/
Min.:	0	Unit:	-
Max.:	655	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:

0 to 655

Description

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

H20.01 Safety function trigger selection

Address:	0x2001	Effective:	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 mode of triggering the safety function.

H20.02 Safety module DI1 function selection

Address:	0x2002	Effective:	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

Address:	0x2003	Effective:	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

Address:	0x2004	Effective:	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

Address:	0x2005	Effective:	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

Address:	0x2006	Effective:	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 rejection filter time

Address:	0x2008	Effective:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1 ms to 500 ms

Description

Sets the noise filter time of DI1 of the safety module. Only when the signal change of DI1 lasts continuously for a period of time exceeding the filter time, the safety module performs the corresponding safety function.

H20.09 Safety module DI2 noise rejection filter time

Address:	0x2009	Effective:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1 ms to 500 ms

Description

Sets the noise filter time of DI2 of the safety module. Only when the signal change of DI2 lasts for a period of time exceeding the filter time, the safety module performs the corresponding safety function.

H20.10 Safety module DI3 noise rejection filter time

Address:	0x200A	Effective:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1 ms to 500 ms

Description

Sets the noise filter time of DI3 of the safety module. Only when the signal change of DI3 lasts for a period of time exceeding the filter time, the safety module performs the corresponding safety function.

H20.11 Safety module DI4 noise rejection filter time

Address:	0x200B	Effective:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1 ms to 500 ms

Description

Sets the noise filter time of DI4 of the safety module. Only when the signal change of DI4 lasts continuously for a period of time exceeding the filter time, the safety module performs the corresponding safety function.

H20.12 Safety module DI5 noise rejection filter time

Address:	0x200C	Effective:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	500	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

1 ms to 500 ms

Description

Sets the noise filter time of DI5 of the safety module. Only when the signal change of DI5 lasts continuously for a period of time exceeding the filter time, the safety module performs the corresponding safety function.

H20.14 Safety module DI1 allowable discrepancy time

Address:	0x200E	Effective:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5 ms to 60000 ms

Description

If the discrepancy at two input signals of DI1 lasts for a period of time exceeding the time set by this parameter, fault E134.1 is reported.

H20.15 Safety module DI2 allowable discrepancy time

Address:	0x200F	Effective:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5 ms to 60000 ms

Description

If the discrepancy at two input signals of DI2 lasts for a period of time exceeding the time set by this parameter, fault E134.2 is reported.

H20.16 Safety module DI3 allowable discrepancy time

Address:	0x2010	Effective:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5 ms to 60000 ms

Description

If the discrepancy at two input signals of DI3 lasts for a period of time exceeding the time set by this parameter, fault E134.3 is reported.

H20.17 Safety module DI4 allowable discrepancy time

Address:	0x2011	Effective:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5 ms to 60000 ms

Description

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

H20.18 Safety module DI5 allowable discrepancy time

Address:	0x2012	Effective:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	60000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

5 ms to 60000 ms

Description

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

H20.20 Safety module DO1 function selection

Address:	0x2014	Effective:	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

Address:	0x2015	Effective:	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

Address:	0x2016	Effective:	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

Address:	0x2017	Effective:	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

Address:	0x2018	Effective:	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

Address:	0x2019	Effective:	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

Address:	0x201C	Effective:	Upon the next power-on
Min.:	–30000	Unit:	ms
Max.:	30000	Data Type:	Int16
Default:	–30	Change:	At stop

Value Range:

–30000 ms to 30000 ms

Description

Sets the delay time from the triggering of the STO function to output of the active SBC state. This parameter can be used to set the sequence of activation of STO and SBC.

H20.29 SS1/SS2 stop mode

Address:	0x201D	Effective:	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

Address:	0x201E	Effective:	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

Address:	0x201F	Effective:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	500	Change:	At stop

Value Range:

1 ms to 65535 ms

Description

Sets the time required to decelerate from the reference speed to 0. The deceleration is equal to reference speed/deceleration time.

H20.32 SS1 monitor mode

Address:	0x2020	Effective:	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

Address:	0x2021	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	1000	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

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

H20.34 SS1/ SS1 zero speed threshold

Address:	0x2022	Effective:	Upon the next power-on
Min.:	1	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:

1 rpm to 6000 rpm

Description

During SS1 deceleration, if the speed falls below the the value set by this parameter for a period of time exceeding the zero speed threshold time, the drive enters the STO state.
During SS2 deceleration, if the speed falls below the the value set by this parameter for a period of time exceeding the zero speed threshold time, the drive enters the SOS state.

H20.35 SS1/SS2 zero speed threshold time

Address:	0x2023	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	At stop

Value Range:
0 ms to 65535 ms
Description
During SS1 deceleration, if the speed falls below the zero speed threshold for a period of time exceeding the value set by this parameter, the drive enters the STO state.
During SS2 deceleration, if the speed falls below the zero speed threshold for a period of time exceeding the value set by this parameter, the drive enters the SOS state.

H20.36 SS1/SS2 ramp monitor start delay time

Address:	0x2024	Effective:	Upon the next power-on
Min.:	5	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:
5 ms to 65535 ms
Description
After SS1 is triggered, the speed ramp monitoring starts after a period of time set by this parameter has elapsed, which is only valid in SS1-r mode.
After SS2 is triggered, the speed ramp monitoring starts after a period of time set by this parameter has elapsed, which is only valid in SS2-r mode.

H20.37 SS1/SS2 ramp monitor reference speed

Address:	0x2025	Effective:	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

Address:	0x2026	Effective:	Upon the next power-on
Min.:	1	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	65535	Change:	At stop

Value Range:

1 ms to 65535 ms

Description

sets the time required to decelerate from the reference speed to 0 during ramp monitoring. Speed ramp monitoring threshold is equal to reference speed/ramp deceleration monitor time.

H20.41 SS1/SS2 ramp limit trigger-to-alarm time

Address:	0x2029	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	5	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

During the deceleration process of SS1, if the motor speed exceeds the ramp monitoring limit for a period of time exceeding the value set by this parameter, a fault is reported and the drive enters the STO state.

During the deceleration process of SS2, if the motor speed exceeds the ramp monitoring limit for a period of time exceeding the value set by this parameter, a fault is reported and the drive enters the STO state.

H20.42 SS1/SS2 ramp monitor stop speed

Address:	0x202A	Effective:	Upon the next power-on
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	1	Change:	At stop

Value Range:

0–6000

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

Address:	0x202B	Effective:	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

Address:	0x202C	Effective:	Upon the next power-on
Min.:	1	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	10	Change:	At stop

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

H20.45 SOS position change threshold

Address:	0x202D	Effective:	Upon the next power-on
Min.:	1	Unit:	Encoder unit
Max.:	5.36870912E8	Data Type:	UInt32
Default:	932067	Change:	At stop

Value Range:
1 to 5.36870912E8
Description
Sets the maximum allowable variation of position feedback in SOS state.

H20.47 SOS overthreshold-to-alarm time

Address:	0x202F	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16

Default: 5 Change: At stop

Value Range:

0 ms to 65535 ms

Description

In the SOS state, if the speed feedback or position feedback exceeds the threshold for a period of time exceeding the value set by this parameter, a fault will be reported.

H20.48 SLS1 switchover delay

Address:	0x2030	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

H20.49 SLS2 switchover delay

Address:	0x2031	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

H20.50 SLS3 switchover delay

Address:	0x2032	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

H20.51 SLS4 switchover delay

Address:	0x2033	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

H20.52 SLS1 threshold

Address:	0x2034	Effective:	Upon the next power-on
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	1000	Change:	At stop

Value Range:

0–6000

Description

Sets the speed threshold for SLS1 monitoring.

H20.53 SLS2 threshold

Address:	0x2035	Effective:	Upon the next power-on
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	2000	Change:	At stop

Value Range:

0–6000

Description

Sets the speed threshold for SLS2 monitoring.

H20.54 SLS3 threshold

Address:	0x2036	Effective:	Upon the next power-on
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	3000	Change:	At stop

Value Range:

0–6000

Description

Sets the speed threshold for SLS3 monitoring.

H20.55 SLS4 threshold

Address:	0x2037	Effective:	Upon the next power-on
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	4000	Change:	At stop

Value Range:

0–6000

Description

Sets the speed threshold for SLS4 monitoring.

H20.56 SLS1 filter time

Address:	0x2038	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

H20.57 SLS2 filter time

Address:	0x2039	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

H20.58 SLS3 filter time

Address:	0x203A	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

H20.59 SLS4 filter time

Address:	0x203B	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	100	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

H20.60 SLS fault response mode

Address:	0x203C	Effective:	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

Address:	0x2046	Effective:	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

Sets the upper limit for SSM monitoring.

H20.71 SSM lower limit

Address:	0x2047	Effective:	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
Sets the lower limit for SSM monitoring.

H20.72 SSM hysteresis threshold

Address:	0x2048	Effective:	Upon the next power-on
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:
0–6000
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 SSM threshold.

H20.74 SDI zero position threshold

Address:	0x204A	Effective:	Upon the next power-on
Min.:	1	Unit:	Encoder unit
Max.:	5.36870912E8	Data Type:	UInt32
Default:	932067	Change:	At stop

Value Range:
1 to 5.36870912E8
Description
Sets the position threshold for stop monitoring.

H20.76 SDI zero speed threshold

Address:	0x204C	Effective:	Upon the next power-on
Min.:	0	Unit:	rpm
Max.:	3000	Data Type:	UInt16
Default:	10	Change:	At stop

Value Range:
0 rpm to 3000 rpm
Description
Sets the speed threshold for stop monitoring.

H20.77 SDI delay time

Address:	0x204D	Effective:	Upon the next power-on
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	At stop

Value Range:

0 ms to 65535 ms

Description

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

H20.78 SDI fault response mode

Address:	0x204E	Effective:	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 operates in the forbidden direction after the SDI monitoring takes effect.

10.3 6000h FSoE Object Dictionary

6620.01h Safety control word low 8 bits

Address:	-	Effective:	/
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 command present 1: No STO command
bit1	Displays SS1 command state 0: SS1 command present 1: No SS1 command
bit2	Displays SS2 command state 0: SS2 command present 1: No SS2command
bit3	Displays SOS command state 0: SOS command present 1: No SOS command
bit5	Displays SDIp command state 0: SDIp command present 1: No SDIp command
bit6	Displays SDIn command state 0: SDIn command present 1: No SDIn command
bit7	Displays Ack command state 0: No Ack command 1: Ack command present

6620.02h Safety control word high 8 bits

Address:	-	Effective:	/
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 restart command state 0: No restart command 1: Restart command present
bit1	Displays SBC command state 0: SBC command present 1: No SBC command
bit2	Displays SLS1 command state 0: SLS1 command present 1: No SLS1 command
bit3	Displays SLS2 command state 0: SLS2 command present 1: No SLS2 command
bit4	Displays SLS3 command state 0: SLS3 command present 1: No SLS3 command
bit5	Displays SLS4 command state 0: SLS4 command present 1: No SLS4 command

6621.01h Safety status word low 8 bits

Address:	-	Effective:	/
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: Is not active 1: Is active
bit1	Displays SSM state 0: Motor speed beyond SSM limit 1: Motor speed within SSM limit
bit3	Displays SOS state 0: Is not active 1: Is active
bit5	Displays SDIp state 0: Motor not in forward motion 1: Motor in forward motion
bit6	Displays SDIn state 0: Motor not in reverse motion 1: Motor in reverse motion
bit7	Displays safety function fault state 0: No error pending 1: At least one error pending

6621.02h Safety status word high 8 bits

Address:	-	Effective:	/
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 restart state 0: Is not active 1: Active
bit1	Displays SBC state 0: Is not active 1: Is active
bit2	Displays SLS1 state 0: Is not active 1: Is active
bit3	Displays SLS2 state 0: Is not active 1: Is active
bit4	Displays SLS3 state 0: Is not active 1: Is active
bit5	Displays SLS4 state 0: Is not active 1: Is active
bit7	Displays FSoE connection state 0: Abnormal 1: Normal

6630h Restart Ack signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes restart command 0: Deactivate 1: Activate
TPDO	Displays restart state 0: Not restarted 1: Restarted

6632h Fault state

Address:	-	Effective:	At once

Min.: 0
Max.: 1
Default: 0
Unit: -
Data Type: BOOL
Change: At once

Value Range:

0 to 1

Description

Variable PDO	Description
TPDO	Displays error state 0: No error pending 1: At least one error pending

6640h STO signal

Address: -
Min.: 0
Max.: 1
Default: 0
Effective: At once
Unit: -
Data Type: BOOL
Change: At once

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes STO command 0: Activate 1: Deactivate
TPDO	Displays STO state 0: Is not active 1: Is active

6641h STO restart mode selection

Address: -
Min.: 0
Max.: 1
Default: 0
Effective: At once
Unit: -
Data Type: BOOL
Change: At once

Value Range:

0 to 1

Description

Variable SDO	Description
SDO	STO restart mode selection 0: Automatic restart for STO 1: Manual restart for STO

6650h SS1 signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes SS1 command 0: Activate 1: Deactivate
TPDO	Displays SS1 state 0: Is not active 1: Is active

6651h SS1 trigger-to-STO delay time

Address:	-	Effective:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	1000	Change:	At once

Value Range:

0 ms to 65535 ms

Description

After SS1 is triggered, the drive enters the STO state after a period of time exceeding the value set by this object dictionary has elapsed.

6653h SS1 zero speed threshold

Address:	-	Effective:	At stop
Min.:	1	Unit:	rpm
Max.:	6000	Data Type:	UInt32
Default:	10	Change:	At once

Value Range:

1 rpm to 6000 rpm

Description

During SS1 deceleration, if the speed falls below the the value set by this object dictionary for a period of time exceeding the zero speed threshold time, the drive enters the STO state.

6654h SS1 zero speed threshold time

Address:	-	Effective:	At stop

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

Value Range:

0 ms to 65535 ms

Description

During SS1 deceleration, if the speed falls below the zero speed threshold for a period of time exceeding the value set by this object dictionary, the drive enters the STO state.

6656h SS1 deceleration limit

Address:	-	Effective:	At stop
Min.:	0	Unit:	Encoder unit/s2
Max.:	4.294967295E9	Data Type:	UInt32
Default:	15	Change:	At once

Value Range:

0 to 4.294967295E9

Description

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

6657h SS1 ramp monitor start delay time

Address:	-	Effective:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At once

Value Range:

0 ms to 65535 ms

Description

After SS1 is triggered, the speed ramp monitoring starts after a period of time set by this object dictionary has elapsed, which is only valid in SS1-r mode.

6660h SBC signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes SBC command 0: Activate 1: Deactivate
TPDO	Displays SBC state 0: Is not active 1: Is active

6668h SOS signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Variable PDO	Description
TPDO	Displays SOS state 0: Is not active 1: Is active

666Ah SOS zero position threshold

Address:	-	Effective:	At stop
Min.:	0	Unit:	Encoder unit
Max.:	5.36870912E8	Data Type:	UInt32
Default:	932067	Change:	At once

Value Range:

0 to 5.36870912E8

Description

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

666Ch SOS zero speed threshold

Address:	-	Effective:	At stop
Min.:	1	Unit:	rpm
Max.:	6000	Data Type:	UInt32
Default:	10	Change:	At once

Value Range:

1 rpm to 6000 rpm

Description

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

6670h SS2 signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Variable PDO	Description
RPDO	Executes SS2 command 0: Activate 1: Deactivate
TPDO	Displays SS2 state 0: Is not active 1: Is active

6671h SS2 trigger-to-STO delay time

Address:	-	Effective:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At once

Value Range:

0 ms to 65535 ms

Description

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

6672h SS2 zero speed threshold time

Address:	-	Effective:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	At once

Value Range:

0 ms to 65535 ms

Description

During SS2 deceleration, if the speed is less than the zero speed threshold for a period of time exceeding the value set by this object dictionary, the drive enters the SOS state.

6674h SS2 deceleration limit

Address:	-	Effective:	At stop
Min.:	0	Unit:	Encoder unit/s2
Max.:	4.294967295E9	Data Type:	UInt32
Default:	15	Change:	At once

Value Range:

0 to 4.294967295E9

Description

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

6675h SS2 ramp monitor start delay time

Address:	-	Effective:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At once

Value Range:

0 ms to 65535 ms

Description

After SS2 is triggered, the speed ramp monitoring starts after a period of time set by this object dictionary has elapsed, which is only valid in SS2-r mode.

6676h SS2 restart mode selection

Address:	-	Effective:	At stop
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Variable SDO	Description
SDO	SS2 restart mode 0: Restart Ack signal not necessary for SS2 restart 1: Restart Ack signal necessary for SS2 restart

6690.01h SLS1 signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Displays SLS function state and executes SLS command.

Variable PDO	Description
RPDO	Executes SLS1 command 0: Activate 1: Deactivate
TPDO	Displays SLS1 state 0: Is not active 1: Is active

6690.02h SLS2 signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Displays SLS function state and executes SLS command.

Variable PDO	Description
RPDO	Executes SLS2 command 0: Activate 1: Deactivate
TPDO	Displays SLS2 state 0: Is not active 1: Is active

6690.03h SLS3 signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Displays SLS function state and executes SLS command.

Variable PDO	Description
RPDO	Executes SLS3 command 0: Activate 1: Deactivate
TPDO	Displays SLS3 state 0: Is not active 1: Is active

6690.04h SLS4 signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

Value Range:

0 to 1

Description

Displays SLS function state and executes SLS command.

Variable PDO	Description
RPDO	Executes SLS4 command 0: Activate 1: Deactivate
TPDO	Displays SLS4 state 0: Is not active 1: Is active

6691.01h SLS1 switchover delay

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

Value Range:

0 ms to 65535 ms

Description

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

6691.02h SLS2 switchover delay

Address:	-	Effective:	At stop

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

Value Range:
0 ms to 65535 ms
Description
Sets the delay time from activation of SLS2 command to activation of SLS2 monitoring.
See 6691.01h.

6691.03h SLS3 switchover delay

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

Value Range:
0 ms to 65535 ms
Description
Sets the delay time from activation of SLS3 command to activation of SLS3 monitoring.
See 6691.01h.

6691.04h SLS4 switchover delay

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

Value Range:
0 ms to 65535 ms
Description
Sets the delay time from activation of SLS4 command to activation of SLS4 monitoring.
See 6691.01h.

6693.01h SLS1 threshold

Address:	-	Effective:	At stop
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt32
Default:	1000	Change:	At once

Value Range:
0 rpm to 6000 rpm

Description
Sets the threshold for SLS1.

6693.02h SLS2 threshold

Address:	-	Effective:	At stop
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt32
Default:	2000	Change:	At once

Value Range:
0 rpm to 6000 rpm
Description
Sets the threshold for SLS2.

6693.03h SLS3 threshold

Address:	-	Effective:	At stop
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt32
Default:	3000	Change:	At once

Value Range:
0 rpm to 6000 rpm
Description
Sets the threshold for SLS3.

6693.04h SLS4 threshold

Address:	-	Effective:	At stop
Min.:	0	Unit:	rpm
Max.:	6000	Data Type:	UInt32
Default:	4000	Change:	At once

Value Range:
0 rpm to 6000 rpm
Description
Sets the threshold for SLS4.

6694.01h SLS1 filter time

Address:	-	Effective:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At once

Value Range:
0 ms to 65535 ms

Description

Sets the filter time for SLS1 command.

6694.02h SLS2 filter time

Address:	-	Effective:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At once

Value Range:

0 ms to 65535 ms

Description

Sets the filter time for SLS2 command.

6694.03h SLS3 filter time

Address:	-	Effective:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At once

Value Range:

0 ms to 65535 ms

Description

Sets the filter time for SLS3 command.

6694.04h SLS4 filter time

Address:	-	Effective:	At stop
Min.:	0	Unit:	ms
Max.:	65535	Data Type:	UInt16
Default:	10	Change:	At once

Value Range:

0 ms to 65535 ms

Description

Sets the filter time for SLS4 command.

66D0h SDIp signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

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 not in forward rotation 1: Motor in forward rotation

66D1h SDIn signal

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	At once

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 rotation prohibited 1: Reverse rotation allowed
TPDO	Indicates reverse rotation state of the motor. 0: Motor not in reverse rotation 1: Motor in reverse rotation

66D3h SDI zero position threshold

Address:	-	Effective:	At stop
Min.:	1	Unit:	Encoder unit
Max.:	5.36870912E8	Data Type:	UInt32
Default:	932067	Change:	At once

Value Range:

1 to 5.36870912E8

Description

Sets the zero position threshold for SDI monitoring.

66D5h SDI zero speed threshold

Address:	-	Effective:	At stop

Min.:	0	Unit:	rpm
Max.:	3000	Data Type:	UInt32
Default:	10	Change:	At once

Value Range:

0 rpm to 3000 rpm

Description

Sets the zero speed threshold for SDI monitoring.

66E0h SSM state

Address:	-	Effective:	/
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
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 beyond SSM limit 1: Motor speed within SSM limit

66E2h SSM upper limit

Address:	-	Effective:	At stop
Min.:	-6000	Unit:	rpm
Max.:	6000	Data Type:	Int32
Default:	200	Change:	At once

Value Range:

–6000 rpm to 6000 rpm

Description

Sets the upper limit for SSM monitoring.

66E4h SSM lower limit

Address:	-	Effective:	At stop
Min.:	-6000	Unit:	rpm
Max.:	6000	Data Type:	Int32
Default:	–200	Change:	At once

Value Range:

–6000 rpm to 6000 rpm

Description
Sets the lower limit for SSM monitoring.

E600.01h FSoE slave command

Address:	-	Effective:	/
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

Address:	-	Effective:	/
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

Address:	-	Effective:	/
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

Address:	-	Effective:	/
Min.:	0	Unit:	-
Max.:	1	Data Type:	BOOL
Default:	0	Change:	Unchangeable

Value Range:

0 to 1

Description

Variable PDO	Description
TPDO	Displays FSoE connection status 0: Abnormal 1: Normal

E700.01h FSoE master command

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	255	Data Type:	UInt8
Default:	0	Change:	At once

Value Range:

0 to 255

Description

FSoE master command

E700.02h FSoE master connection ID

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	At once

Value Range:

0 to 65535

Description

FSoE master connection ID

E700.03h FSoE master CRC value

Address:	-	Effective:	At once
Min.:	0	Unit:	-
Max.:	65535	Data Type:	UInt16
Default:	0	Change:	At once

Value Range:

0 to 65535

Description

PSoE master CRC value

E901.01h FSoE version

Address:	-	Effective:	/
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

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

Value Range:

0 to 65535

Description

FSoE safety address

E901.03h FSoE connection ID

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

Value Range:

0 to 65535

Description

Sets the ID of connection between FSoE master and slave.

E901.04h Watchdog time

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

Value Range:

0 to 65535

Description

Sets the watchdog timeout.

E901.06h Connection type

Address:	-	Effective:	/
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

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

Value Range:
0 to 65535
Description
Sets the length of the communication parameters in the parameter set.

E901.08h Application layer parameter length

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

Value Range:
0 to 65535
Description
Sets the length of the application parameters in the parameter set.

E901.09h SRA CRC

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

Value Range:
0 to 65535
Description
Sets the CRC checksum of safety-related application parameter sets.

F980.01h FSoE address

Address:	-	Effective:	/
Min.:	0	Unit:	-
Max.:	255	Data Type:	UInt16
Default:	0	Change:	Unchangeable

Value Range:
0 to 255
Description
FSoE slave address

11 Appendix

11.1 安全模块配合倍福安全CPU单元操作案例

The following takes the Beckhoff safety CPU unit with Beckhoff TwinCAT3 master as an example to describe the simple configuration for the safety module to trigger the safety functions through FSoE.

Hardware Configuration

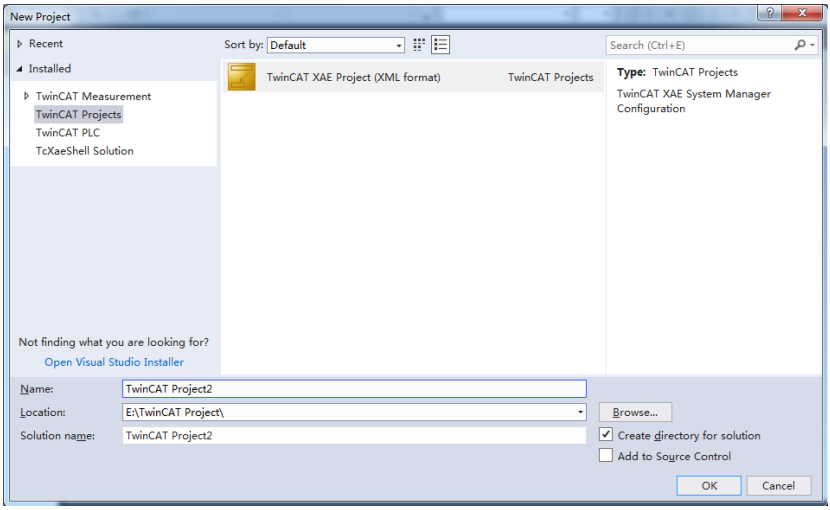
The Beckhoff safety CPU includes logic submodule EL6900, 4-channel digital input submodule EL1904 and 4-channel digital output submodule EL2904, which are connected to EtherCAT network through an EtherCAT coupler EK1100. See *"5.3.1 FSoE Connection and Setting" on page 63* for hardware wiring of FSoE network.

All modules of the Beckhoff safety CPU unit and the safety module must be each configured with a unique safety address, which cannot be 0. Set the safety address of the safety module using the knob.

Software Configuration

Twincat3 software is available on the Beckhoff's official website. To use the FSoE function, the TwinCAT software version must be 3.1.4024.1 or above.

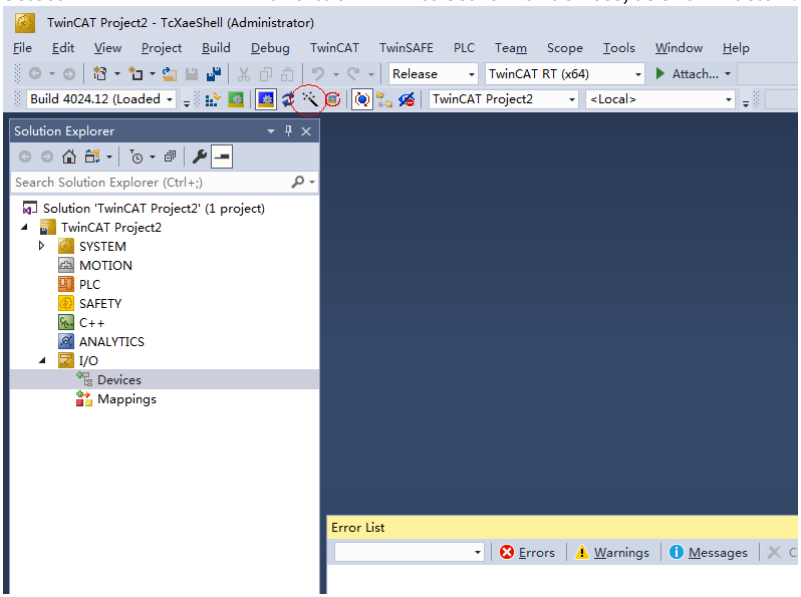
1. Copy EtherCAT configuration file of SV680N with FSoE function (SV680_1Axis_04001_FSoE.xml) to TwinCAT installation directory: TwinCAT\3.1\ config\IO \EtherCAT.
2. Open TwinCAT3 and create a new TwinCAT project.



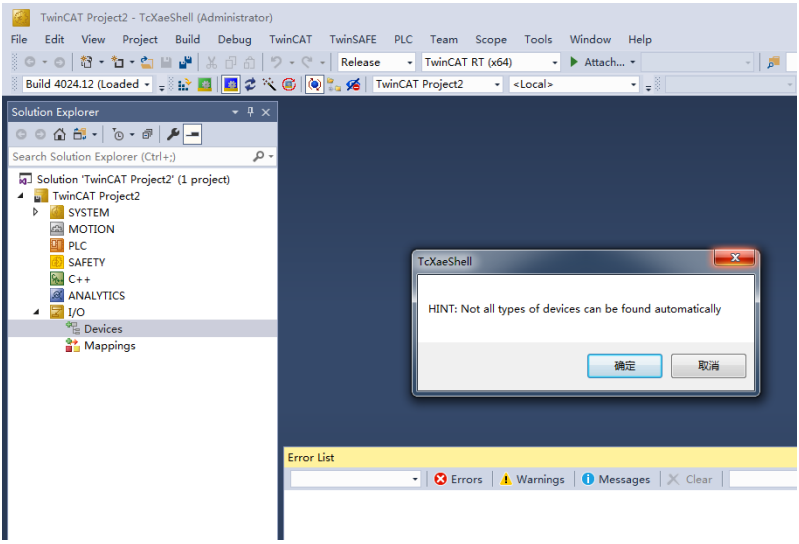
Device Search

1. Select 

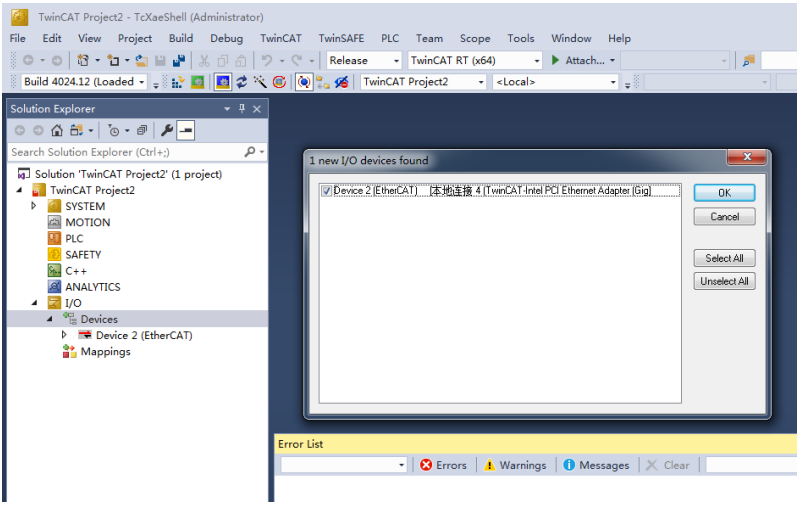
and click  to search for devices, as shown below.



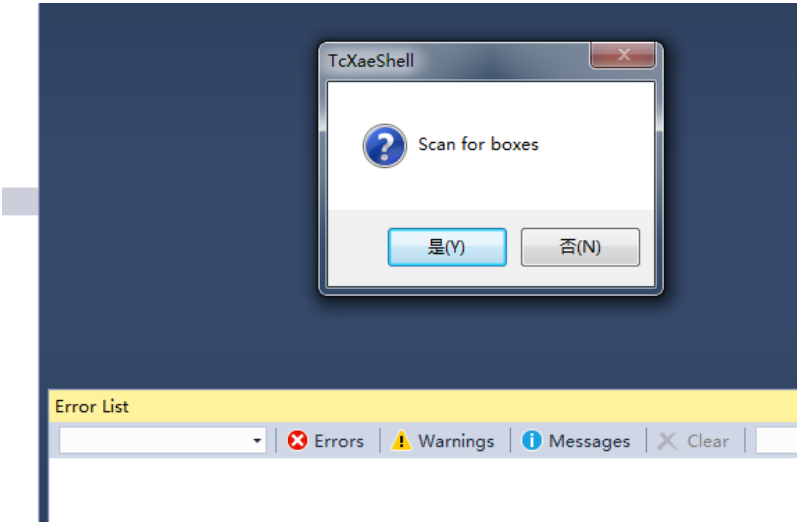
2. Click **OK**.



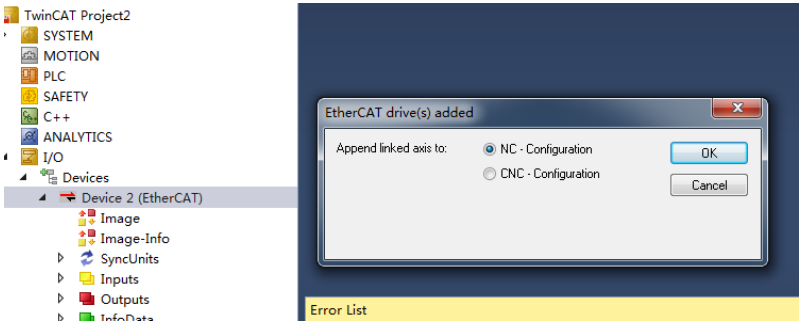
3. Click **OK**.



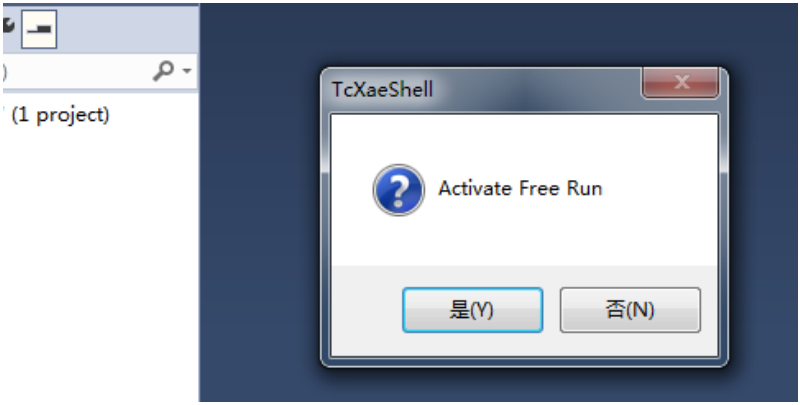
4. Click **Yes**.



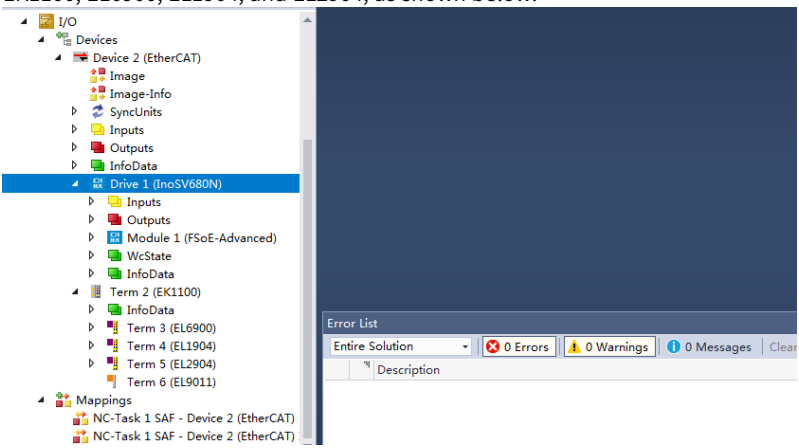
5. Click **OK**.



6. Click **No**.

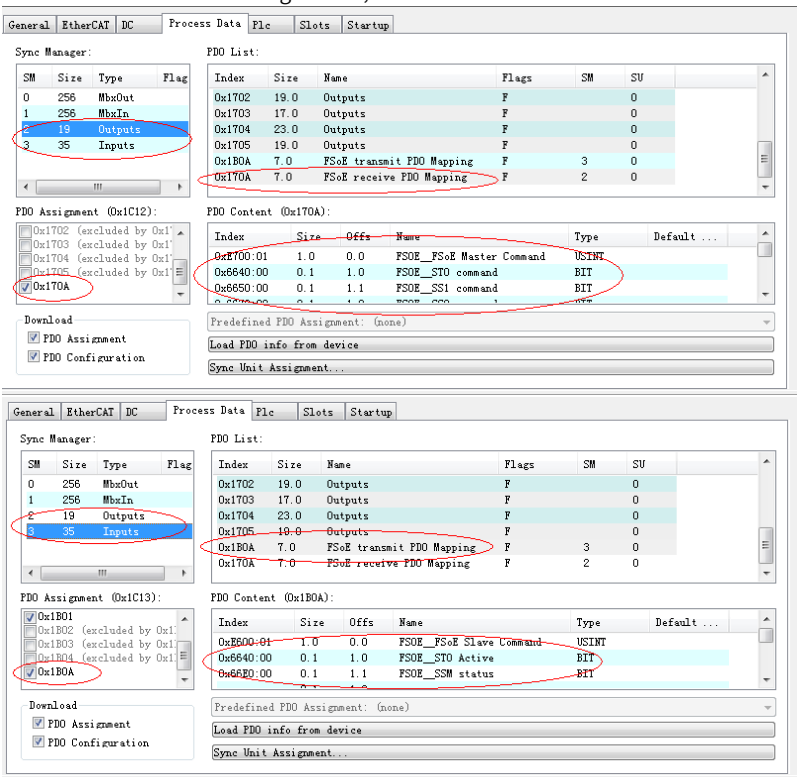


7. View the search results, including SV680N servo drive, safety module, Beckhoff EK1100, EL6900, EL1904, and EL2904, as shown below.



PDO Configuration

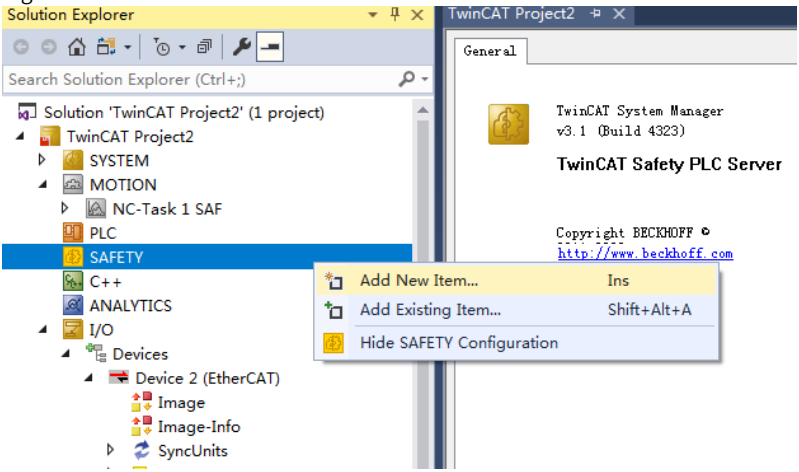
To use the FSoE function, the FSoE dedicated PDO mapping 0x170A and 0x1B0A must be checked in the PDO configuration, as shown below.



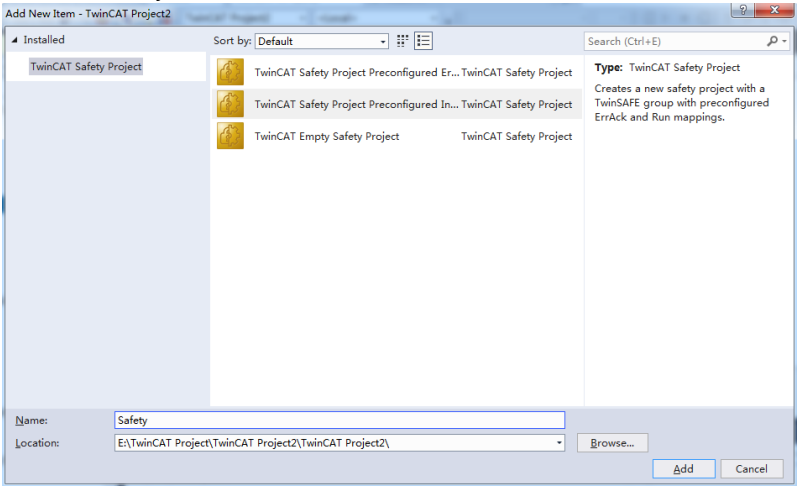
Safety Hardware Configuration

1. Create a safety project.

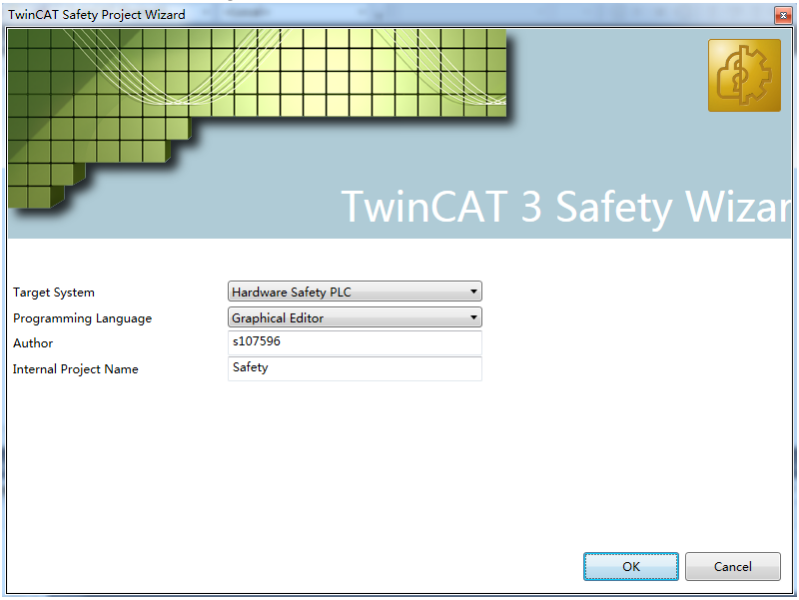
a. Right-click on **SAFETY** and select **Add New Item...**.



b. In the pop-up dialog, select **TwinCAT Safety Project Preconfigured In...**, set **Name** to "Safety" and click **Add**.

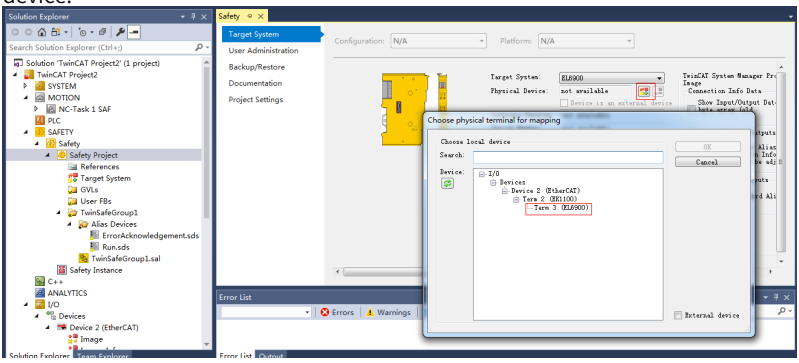


c. Keep the default settings and click **OK**.

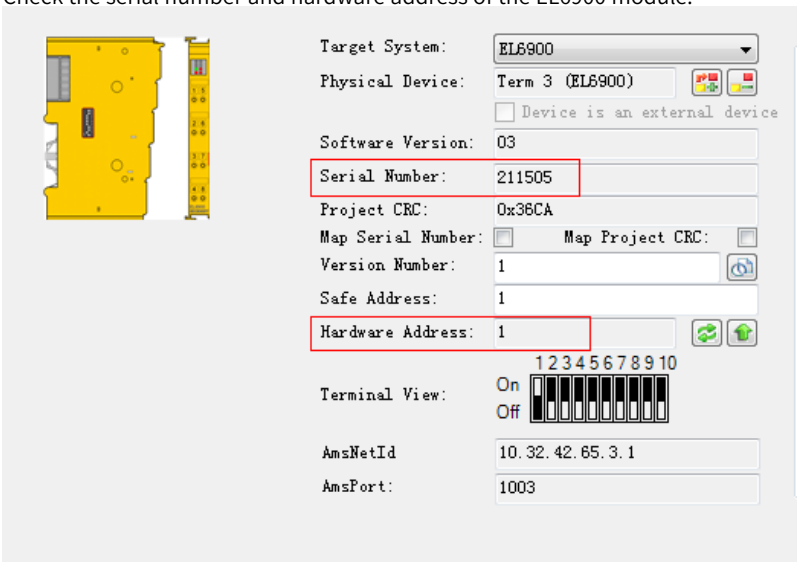


2. Set EL6900 as the safety logic module, do as follows.

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

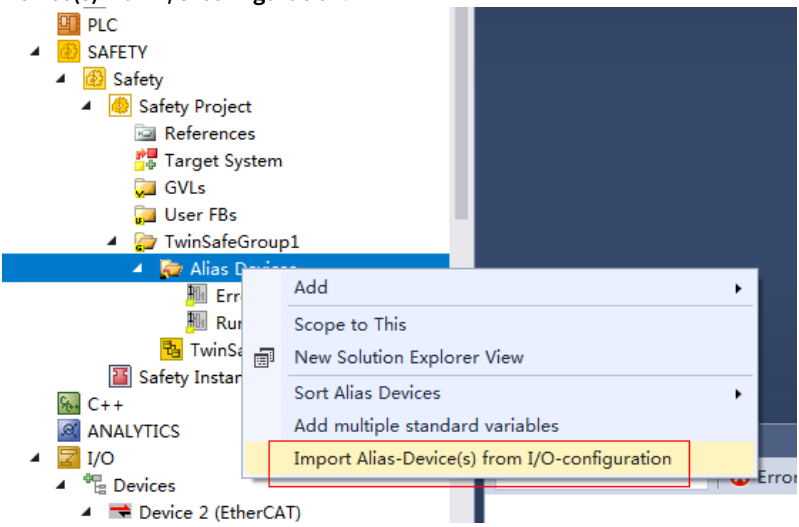


b. Check the serial number and hardware address of the EL6900 module.

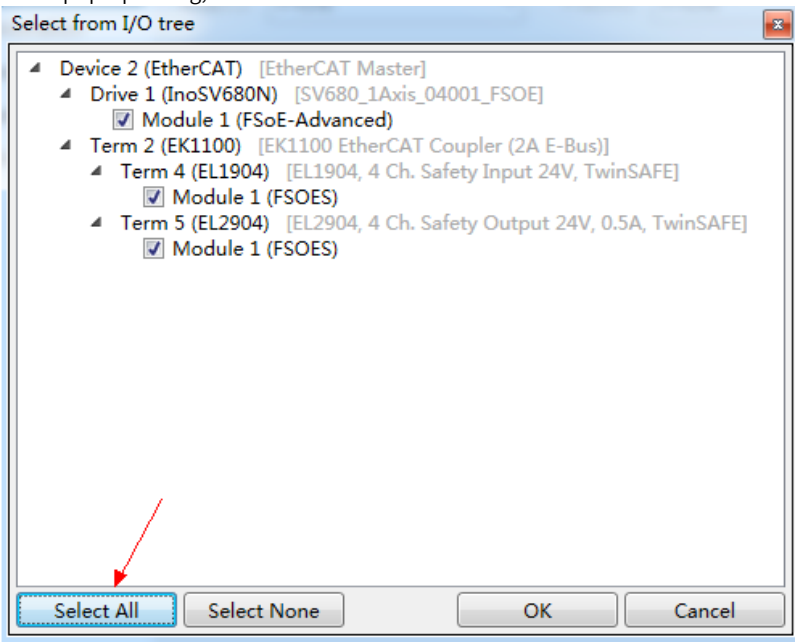


3.

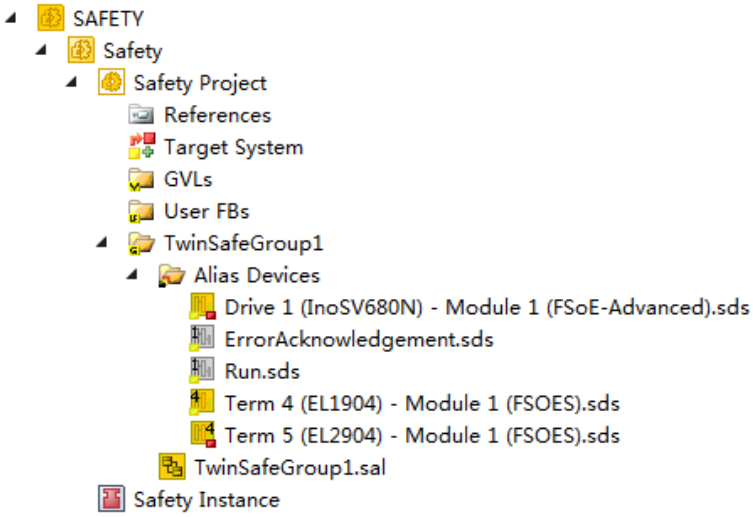
a. Expand **TwinSafeGroup1**, right-click on **Alias Device** and select **Import Alias-Device(s) from I/O-configuration**.



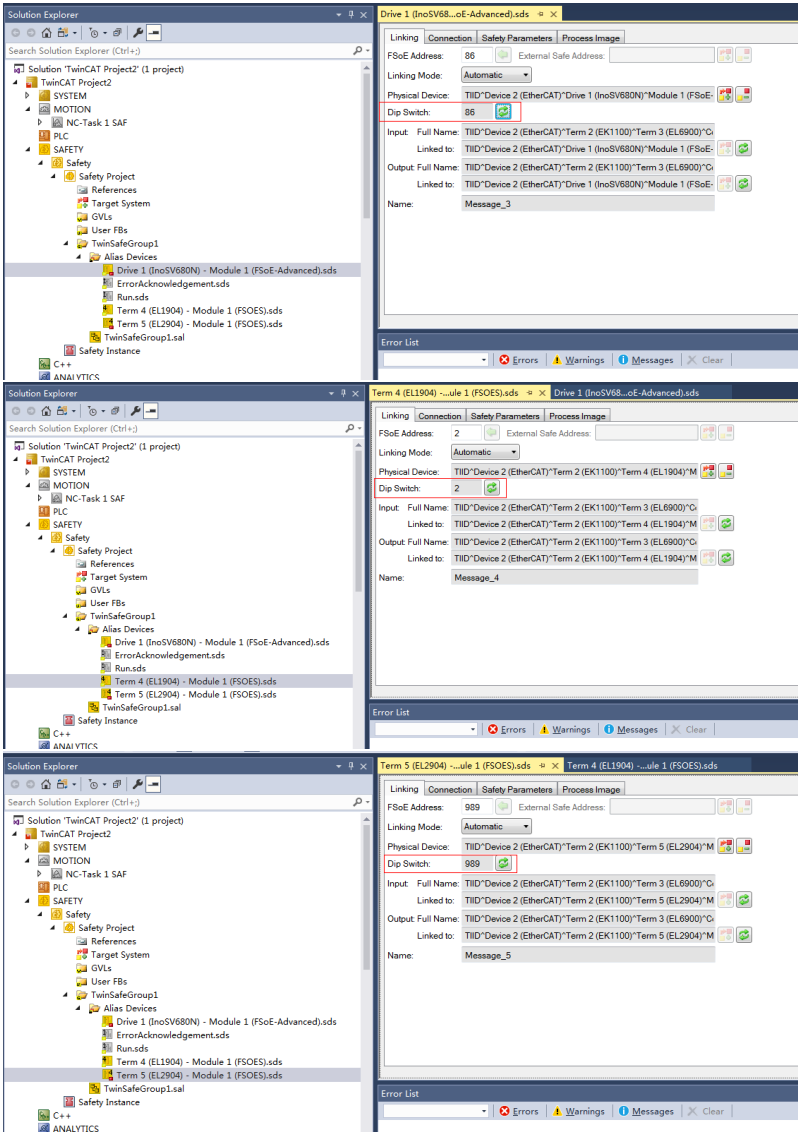
b. In the pop-up dialog, click **Select All** and then **OK**.



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



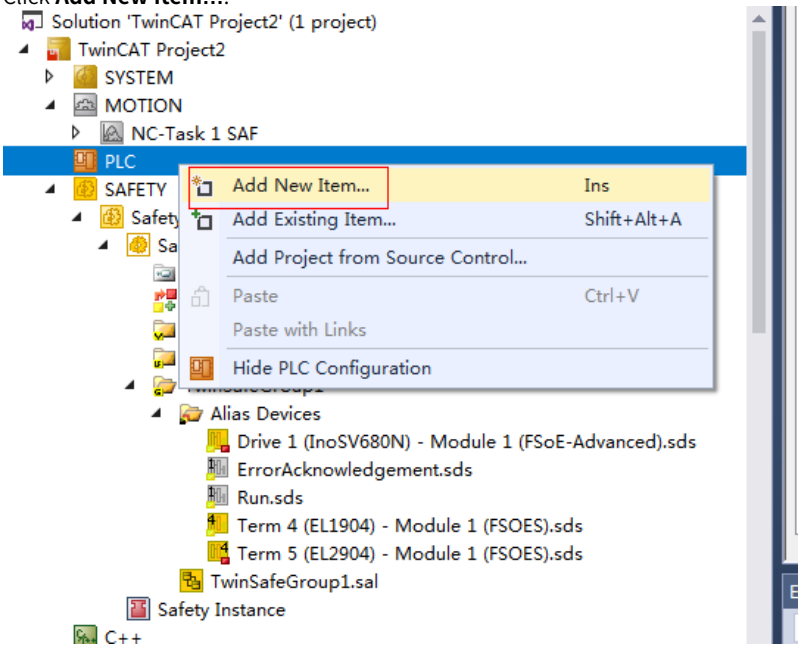
d. Check the **FSoE address** of the safety module and **Dip Switch** of the Beckhoof module.



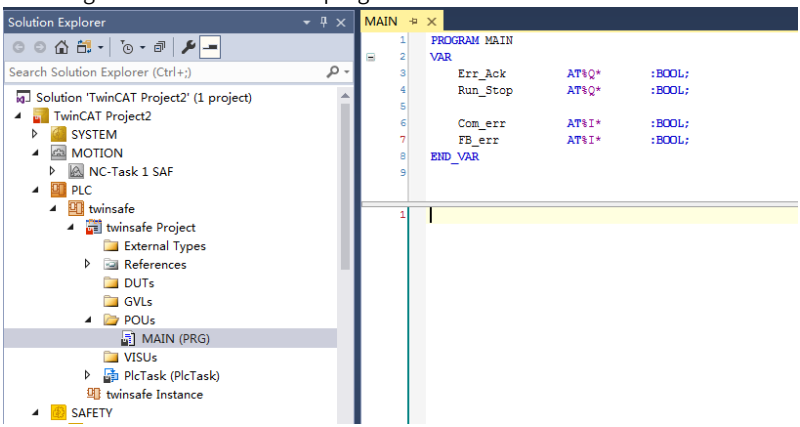
Safety Program Configuration

1. Add a PLC project.

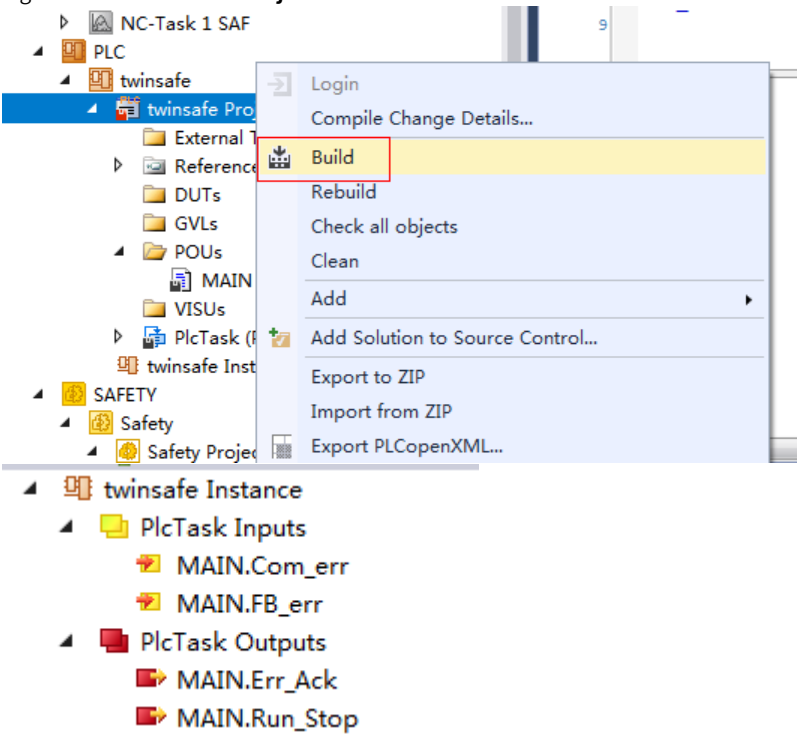
a. Click **Add New Item...**.



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

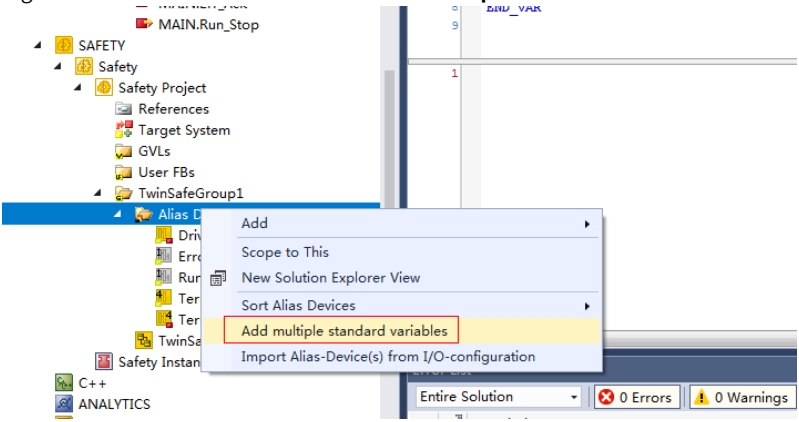


c. Right-click on **Twinsafe Project** and select **Build**.

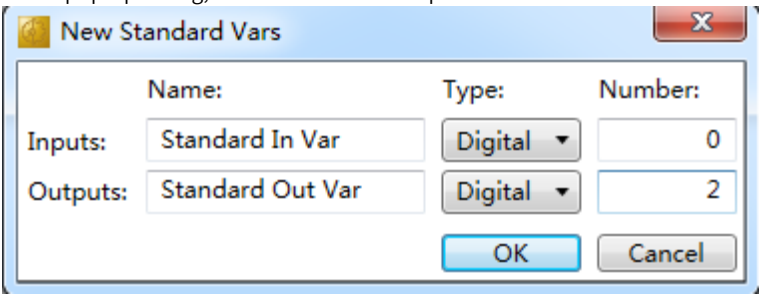


2. Add non-safety standard variables.

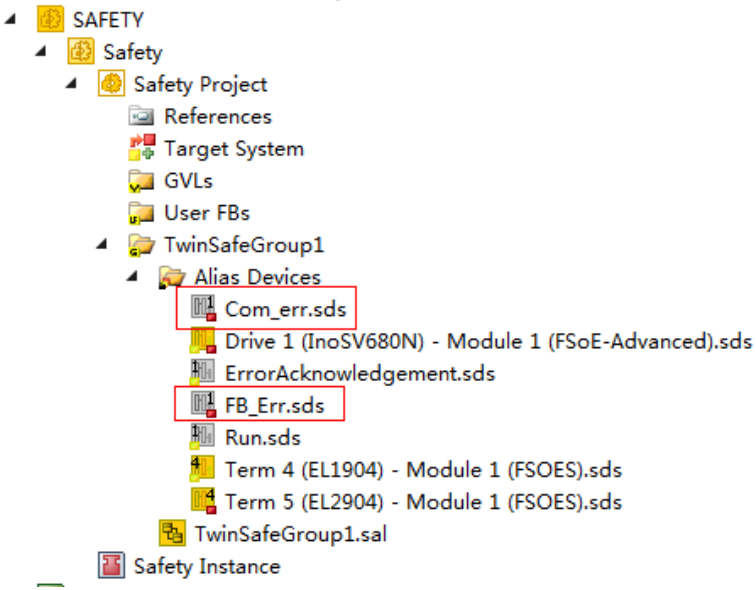
a. Right-click on **Alias Device** and select **Add multiple standard variables**.



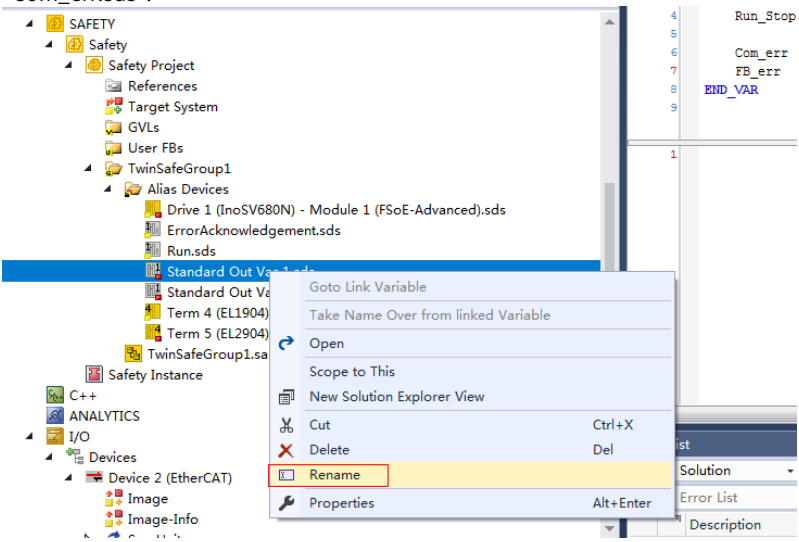
b. In the pop-up dialog, set the number of outputs to "2".



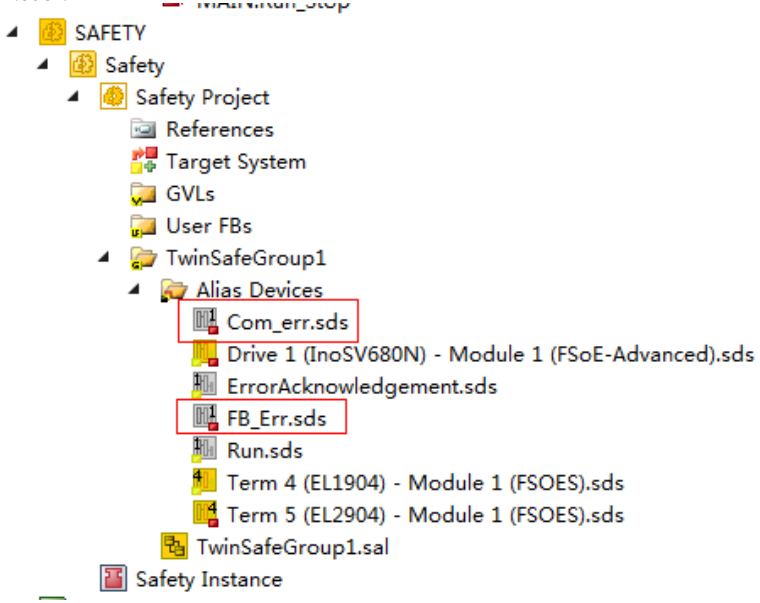
c. Check that two variables are added.



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

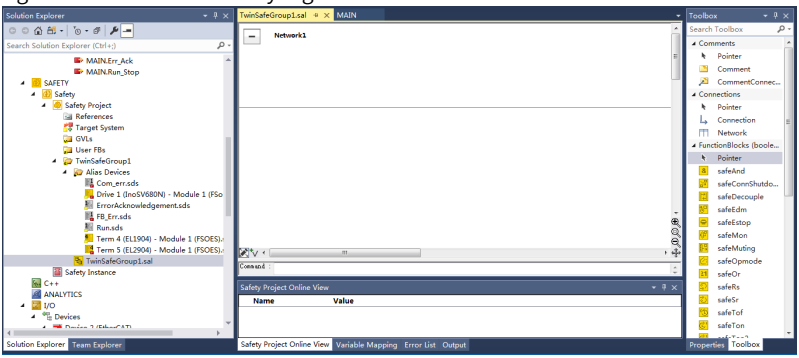


e. Right-click on **Standard Out Var 2.sds** and select **Rename** to rename it to "FB_Err.sds".

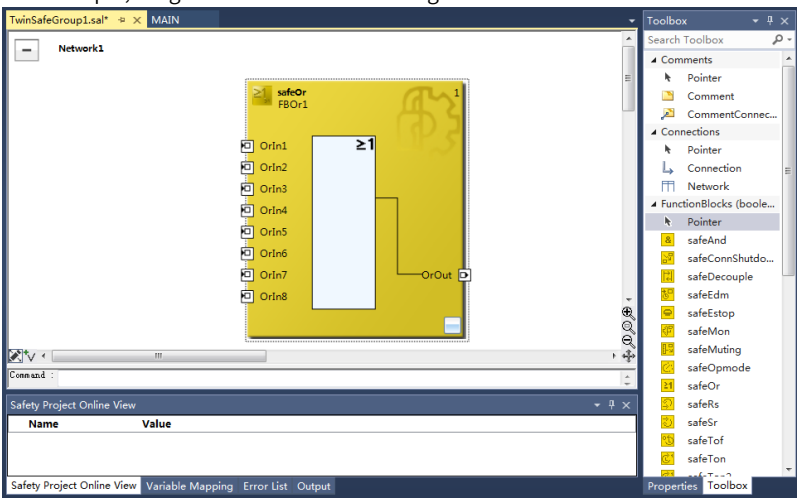


3. Write the safety program.

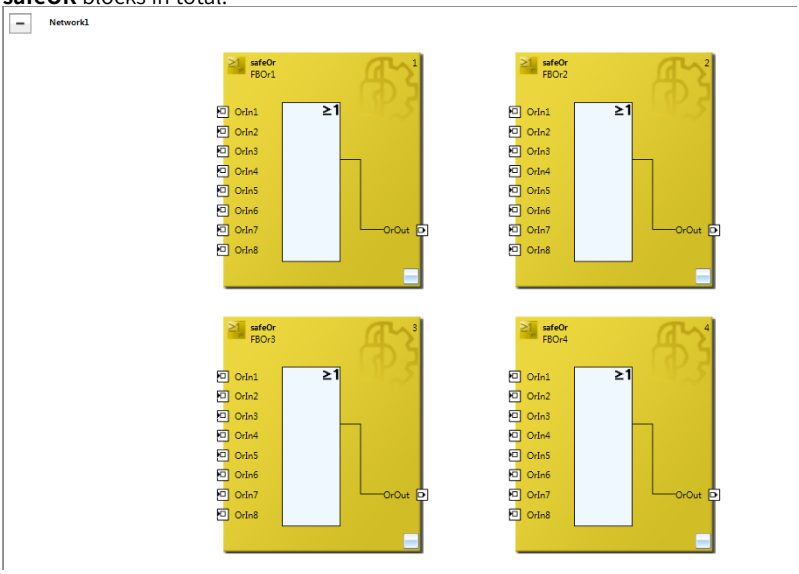
a. Double click "TwinSafeGroup1.sal" and use the safety function blocks on the right side to write the safety logic.



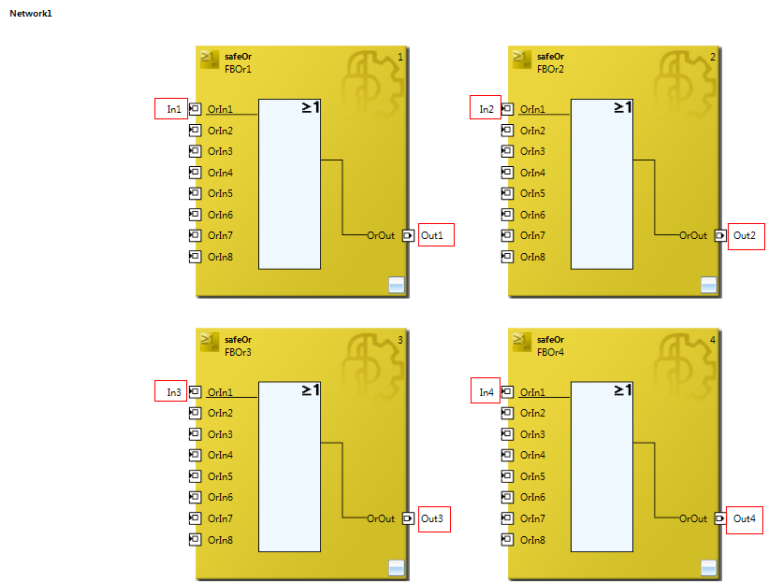
b. For example, drag **safeOr block** from the right side to **Network1**.



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

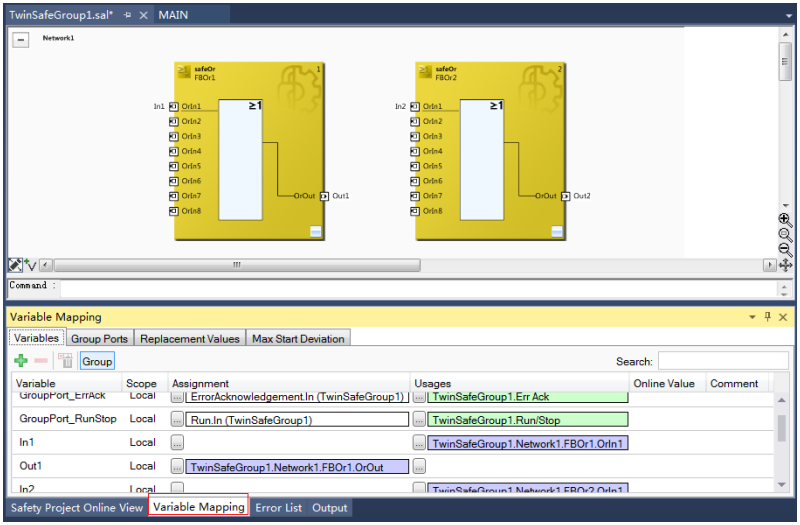


d. Define the pins as needed.

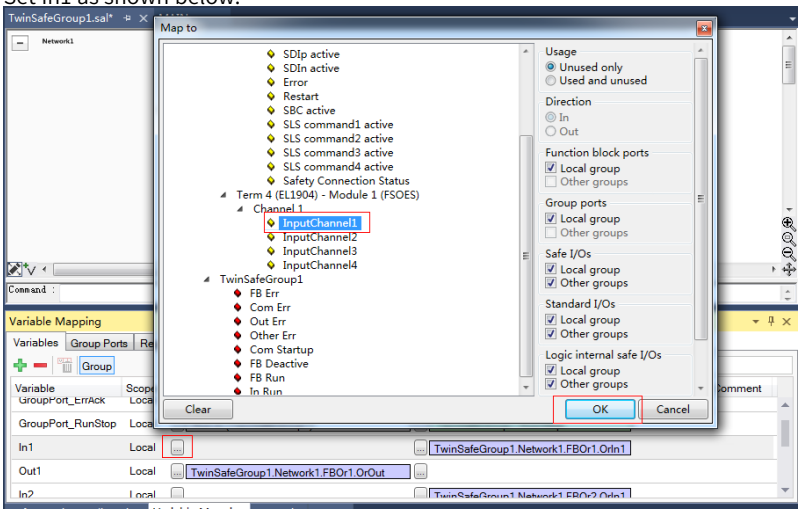


4. Link the safety program to the safety hardware.

a. Find **Variable Mapping**.

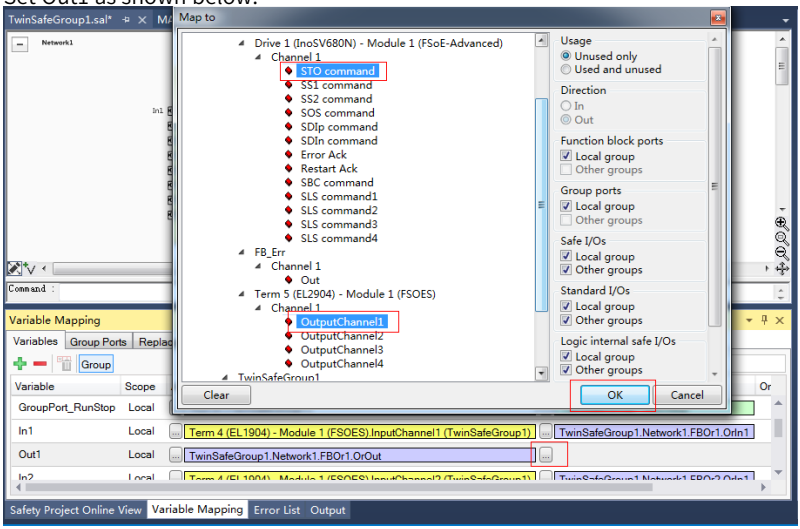


b. Set In1 as shown below.



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

d. Set Out1 as shown below.

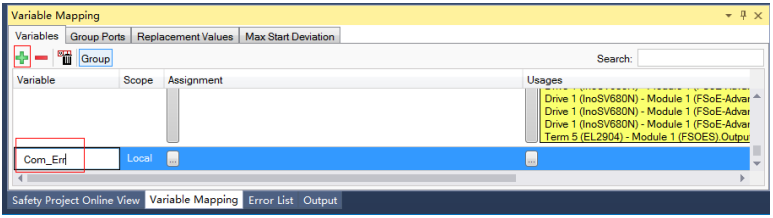


Use In1 to control the control word corresponding to STO and Out1 to indicate the state of In1.

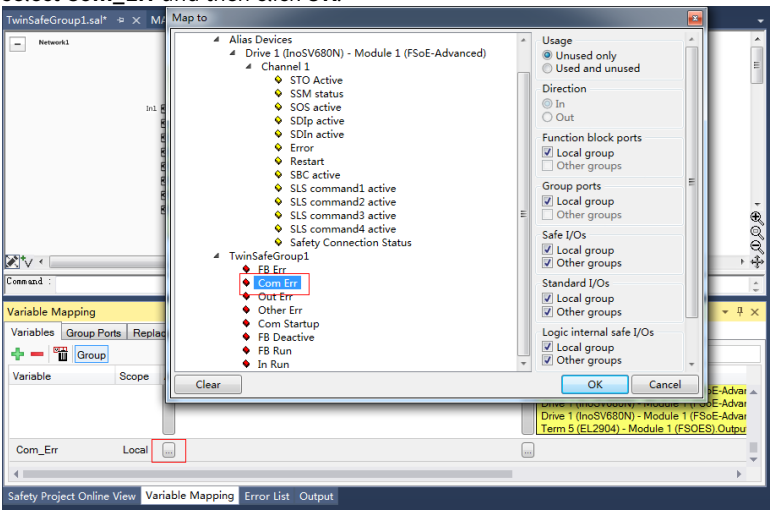
e. Set Out2 to "SS1 command" and "OutputChannel2", Out3 to "SS2 command" and "OutputChannel3", and Out4 to command corresponding to remaining bits of RPDO and "OutputChannel4", respectively.

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

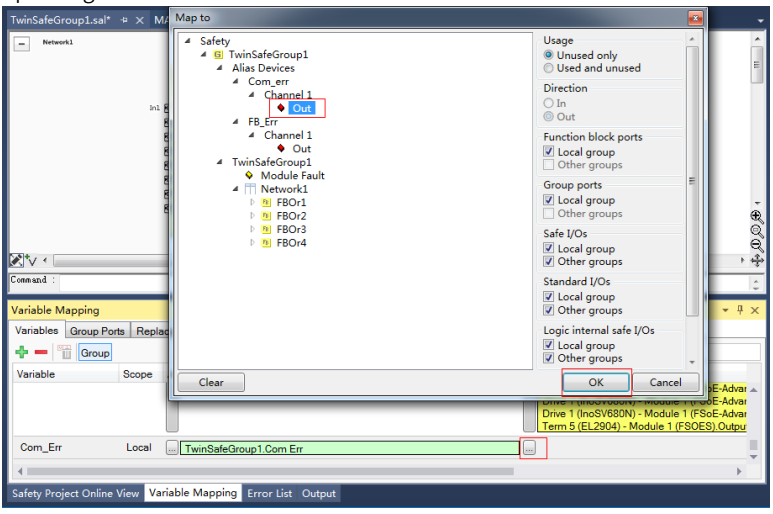
1). Click  and name the variable as "Com_Err".



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

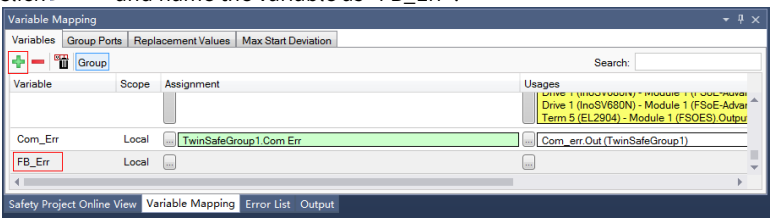


3). Click the bottom right browse button highlighted in red box, and in the pop-up dialog select **Out** and then click **OK**.

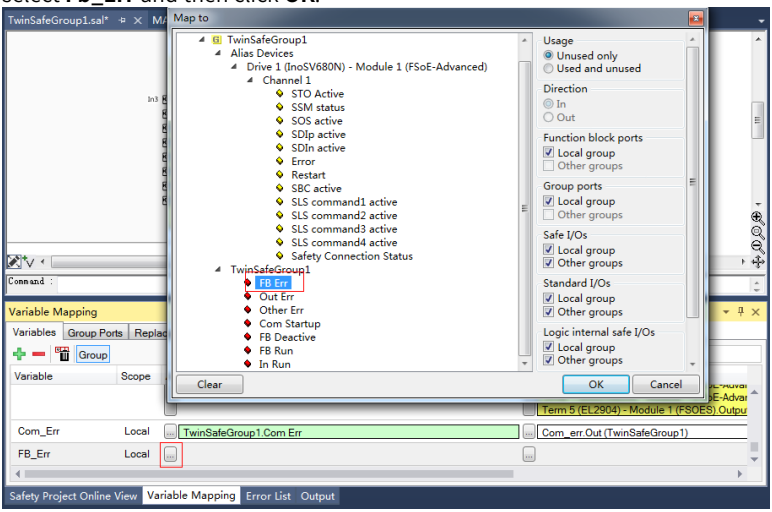


g. Follow the steps below to add the second variable.

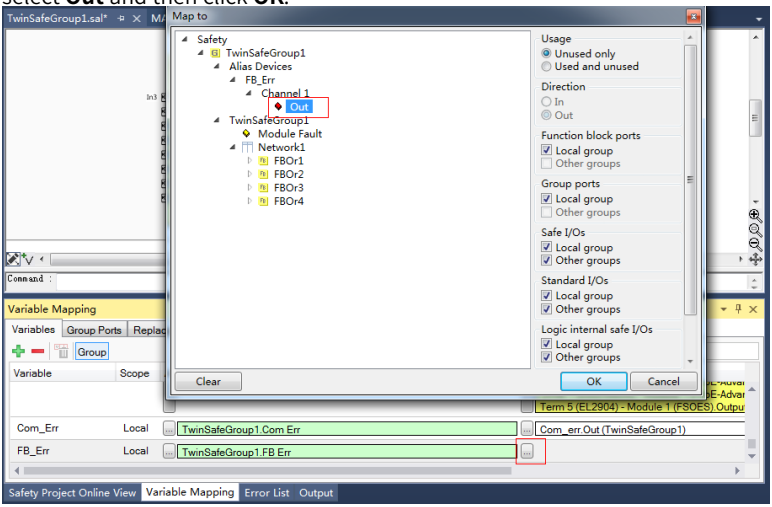
1). Click  and name the variable as "FB_Err".



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

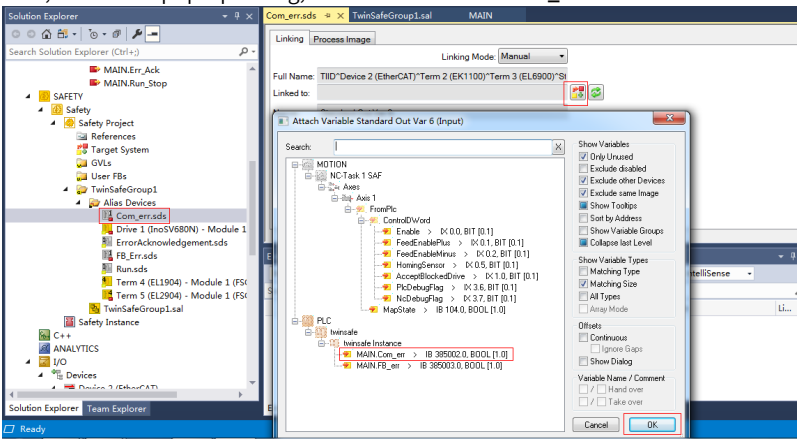


3). Click the bottom right button highlighted in red box, and in the pop-up dialog select **Out** and then click **OK**.



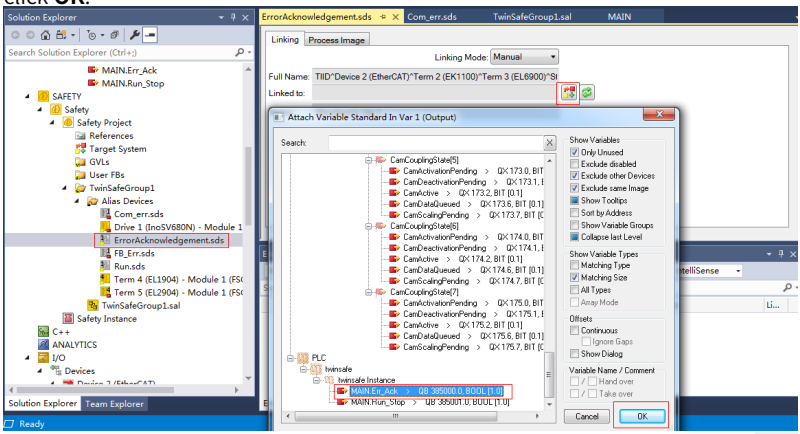
5. Link the non-safety variables added in step 2 to to the variables in the PLC program.

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**.

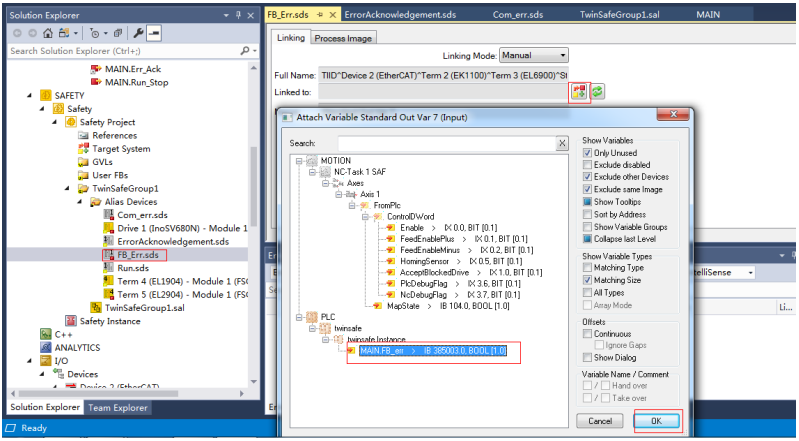


b. On the left side, double-click the variable **ErrorAcknowledgement.sds**; on the right side, click  ; and in the pop-up dialog, select the instance **Err_Ack** and

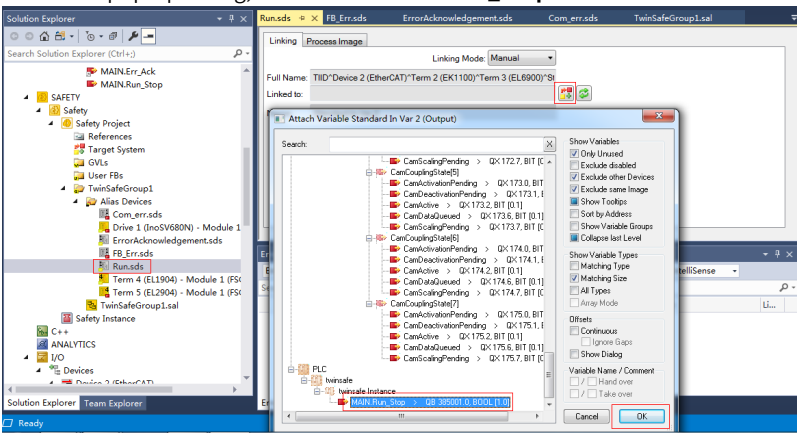
click **OK**.



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**.

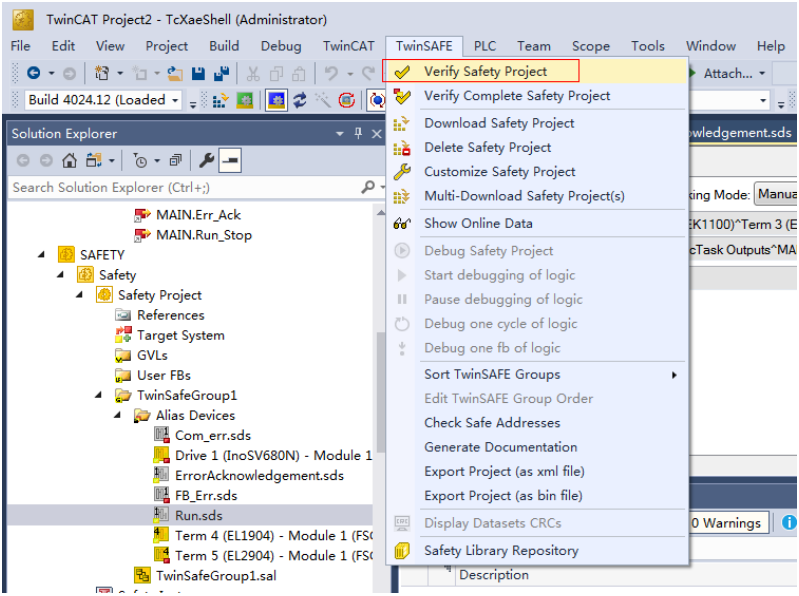


d. On the left side, double-click the variable **Run.sds**; on the right side, click  ; and in the pop-up dialog, select the instance **Run_Stop** and click **OK**.



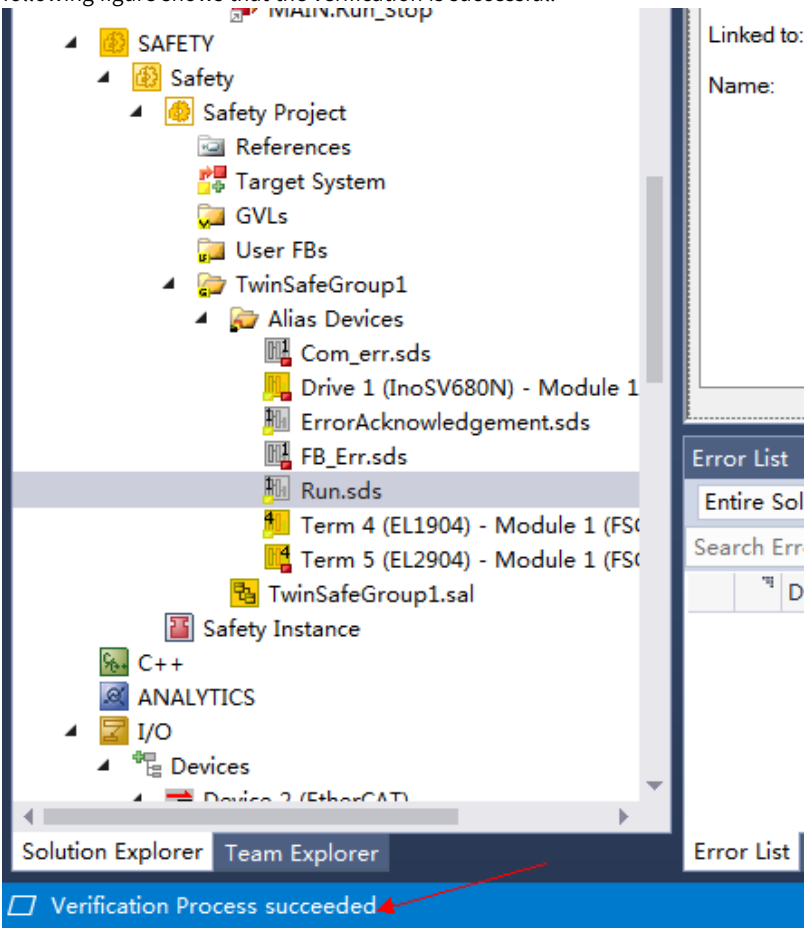
6. Verify the safety logic program.

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



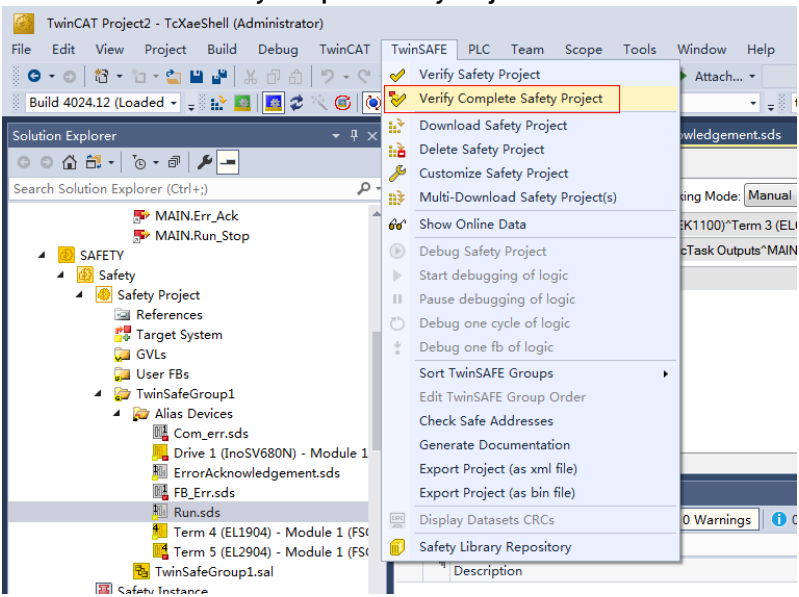
b. After verification is complete, check whether there is an error and whether the message "Verification Process succeeded" appears in the lower left corner. The

following figure shows that the verification is successful.



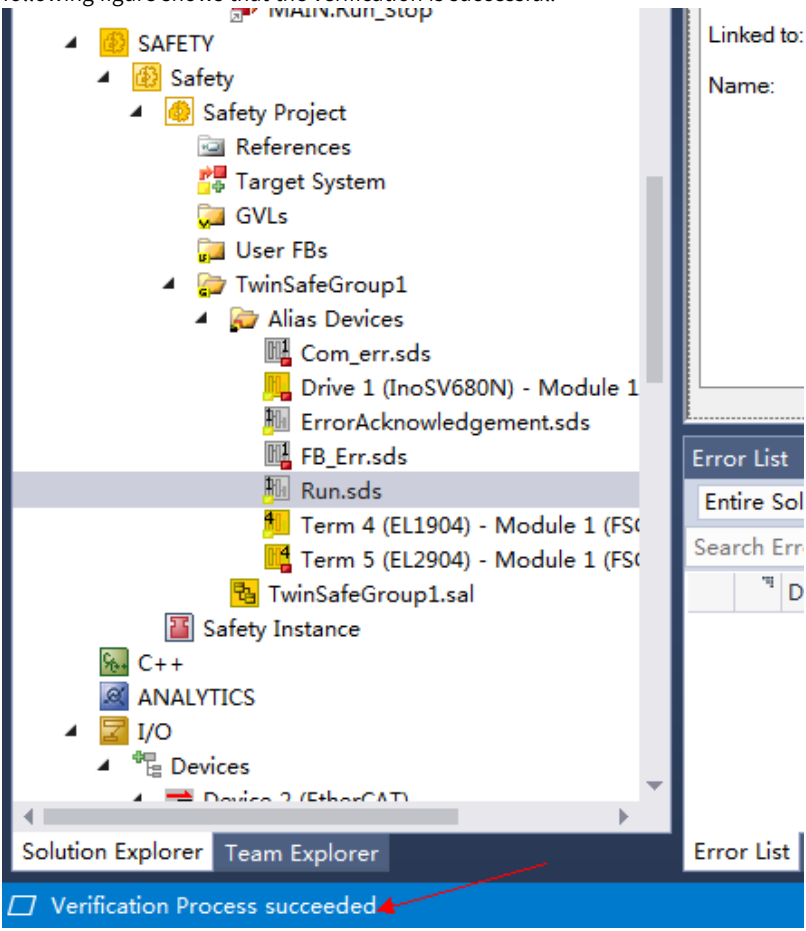
7. Verify the safety logic program and hardware modules.

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



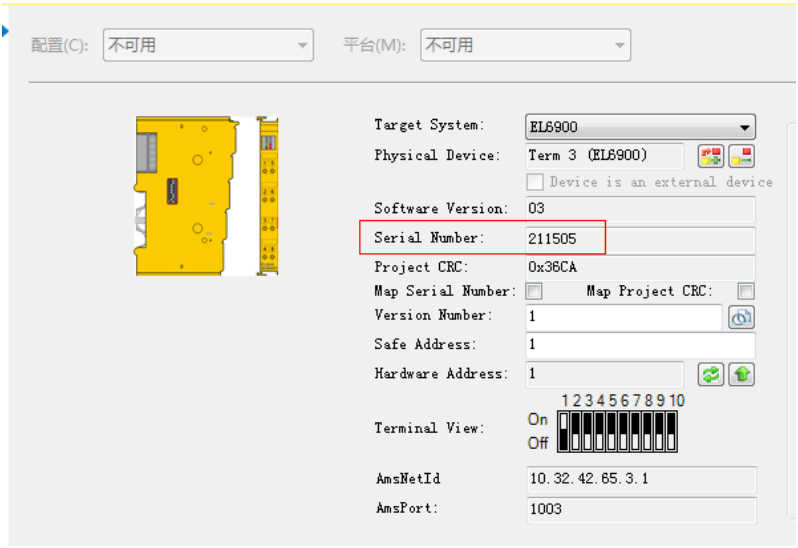
b. After verification is complete, check whether there is an error and whether the message "Verification Process succeeded" appears in the lower left corner. The

following figure shows that the verification is successful.

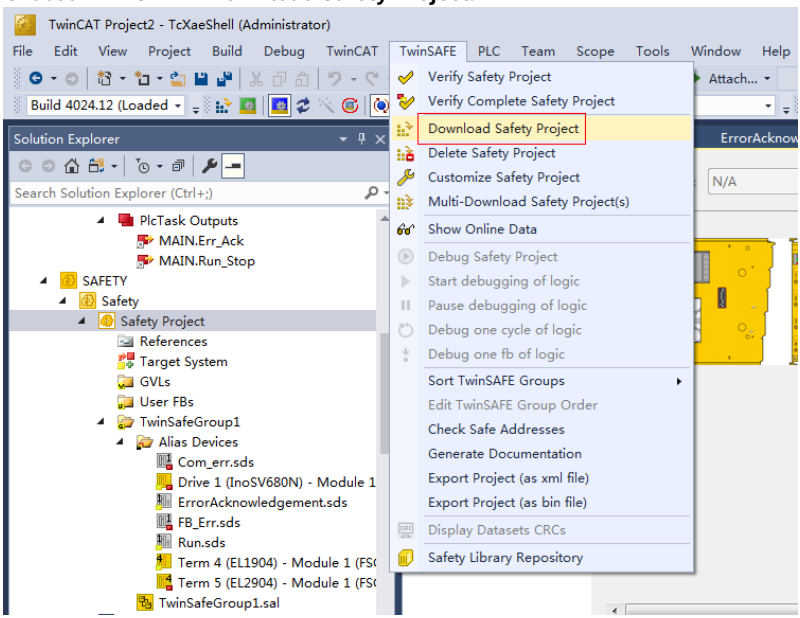


8. Download the safety program.

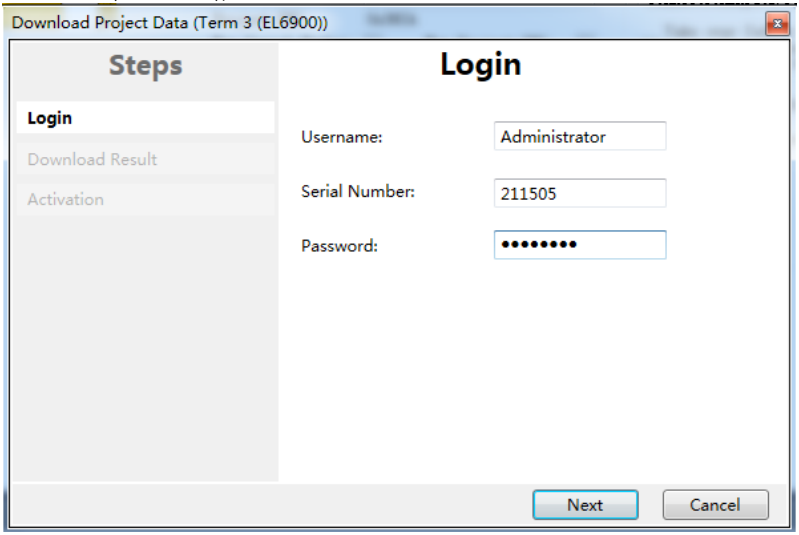
   a. Copy the **Serial Number** "211505".



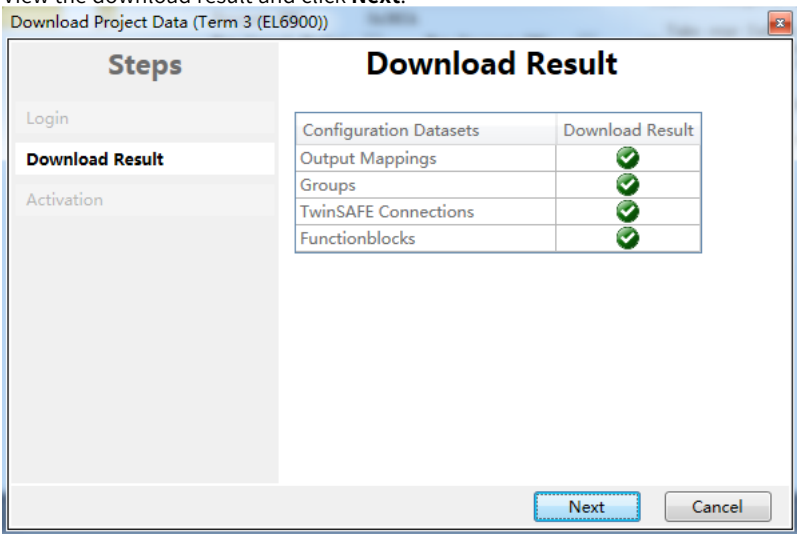
b. Choose **TwinSAFE** > **Download Safety Project**.



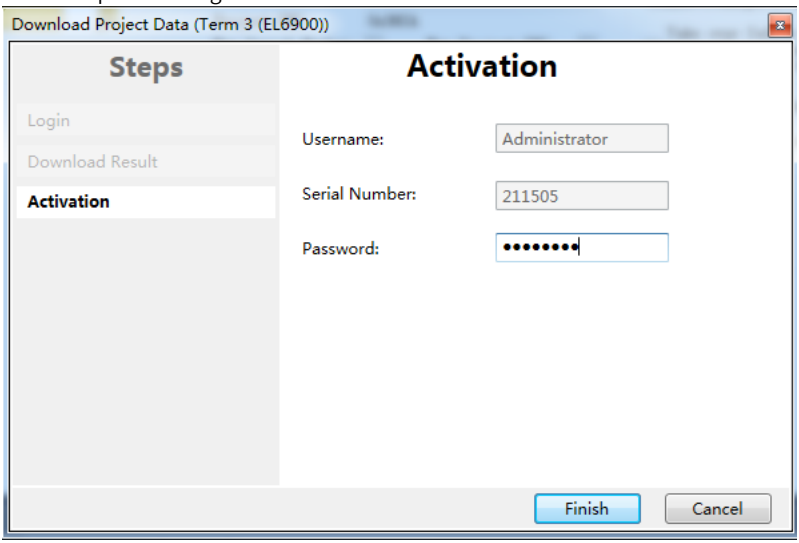
c. In the pop-up dialog, enter the **Username** (Administrator), **Serial Number**, and **Password** (TwinSAFE), then click **Next**.



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



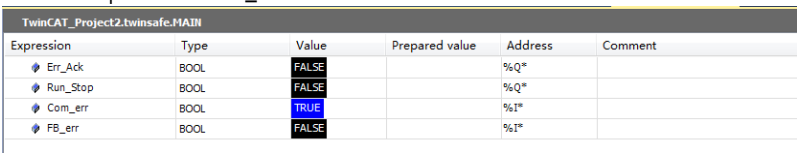
e. Enter the password again and click **Finish**.



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

Safety Function Test

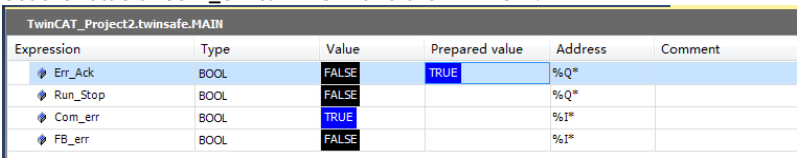
1. Click  to activate the configuration and the controller turns to the running mode  .
2. Click  and then  to execute the PLC program.
3. As the safety program is downloaded and run for the first time, the communication is re-established. A communication error prompt is displayed. In this case, the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



TwinCAT_Project2.twinsafe.MAIN

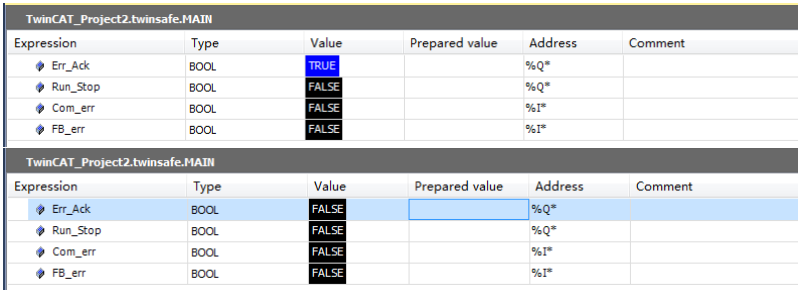
Expression	Type	Value	Prepared value	Address	Comment
Err_Ack	BOOL	FALSE		%Q*	
Run_Stop	BOOL	FALSE		%Q*	
Com_err	BOOL	TRUE		%I*	
FB_err	BOOL	FALSE		%I*	

Set the value of **Com_err** to "TRUE" and then "FALSE".



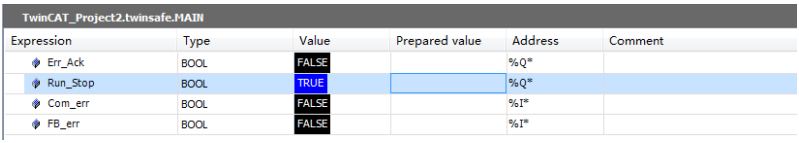
TwinCAT_Project2.twinsafe.MAIN

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*	

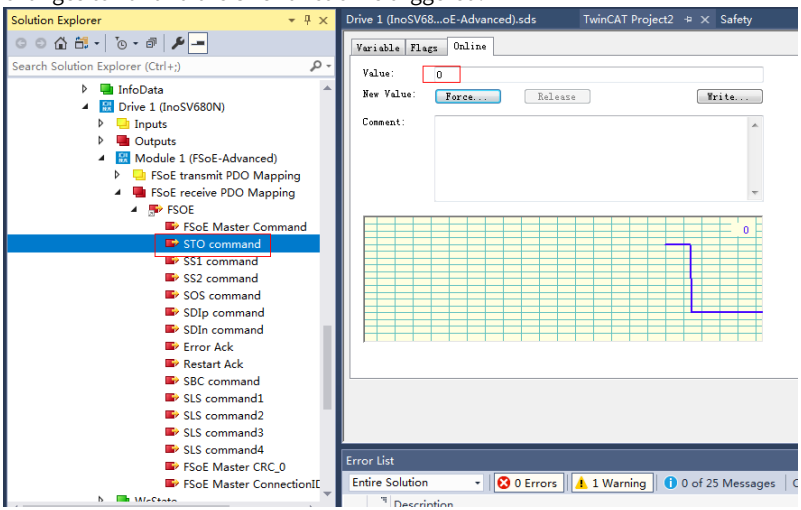


The communication error is cleared.

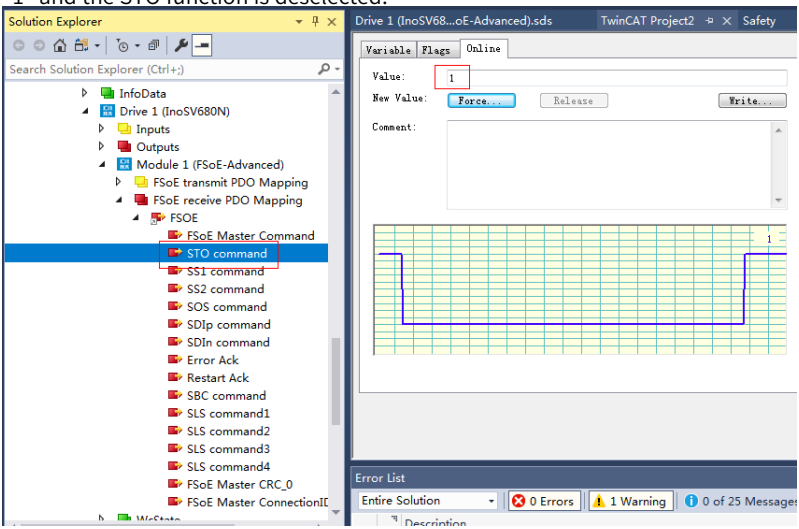
4. Run the safety program and set **Run_Stop** to "True".



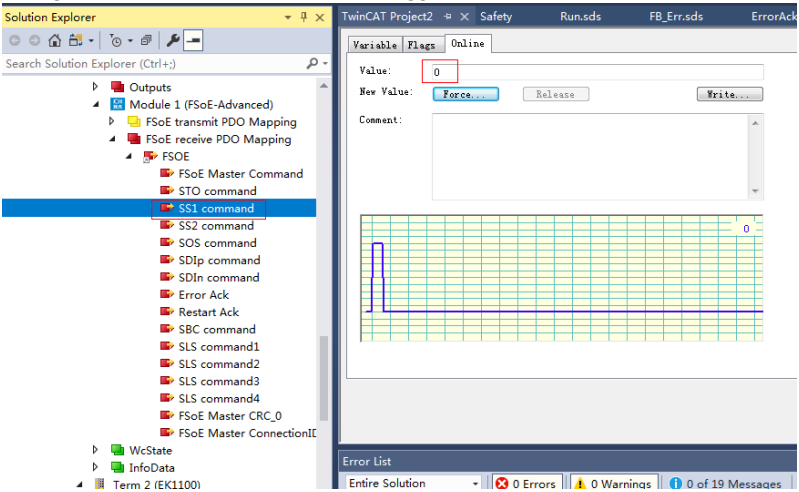
5. Disconnect the safety DI1. The bit in RPDO corresponding to STO command changes to "0" and the STO function is triggered.



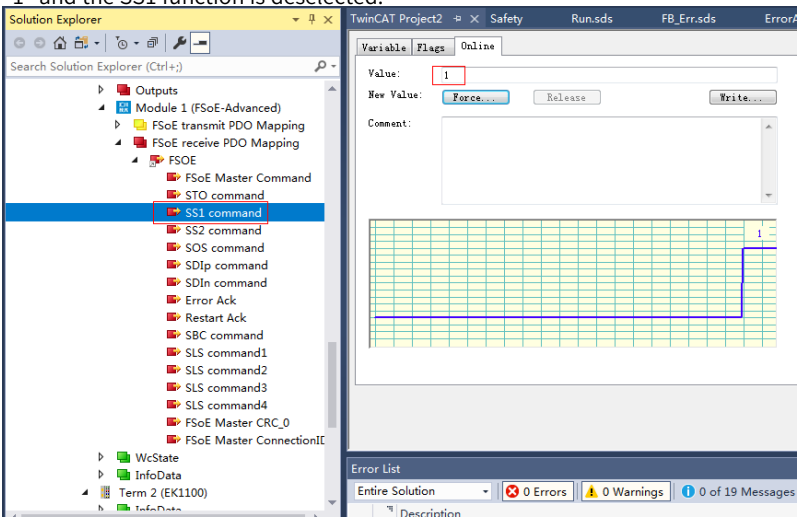
Restore the safety DI1. The bit in RPDO corresponding to STO command changes to "1" and the STO function is deselected.



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

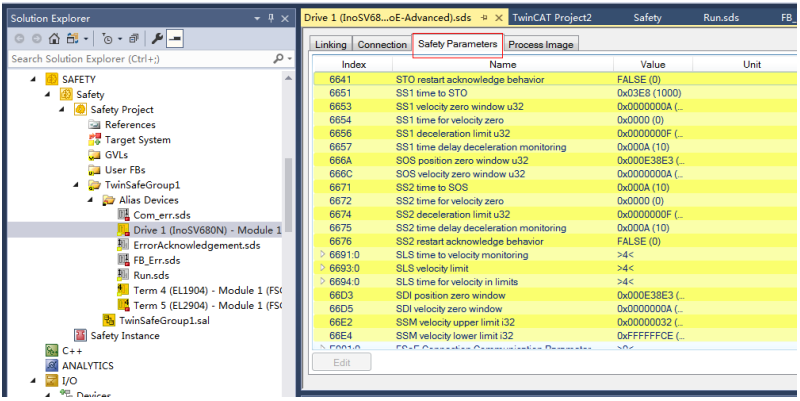


Restore the safety DI2. The bit in RPDO corresponding to SS1 command changes to "1" and the SS1 function is deselected.

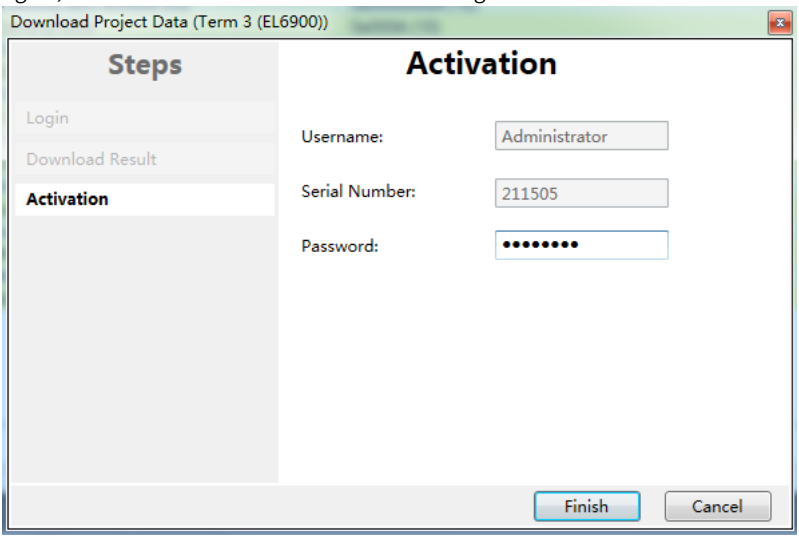


Modifying the Safety Object Dictionary

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.



11.2 DI/DO Function Definitions

Table 11–1 DI function definitions

Setpoint	Name	Description
01	STO command	0: Activate 1: Deactivate
02	SBC command	0: Activate 1: Deactivate
03	SS1 command	0: Activate 1: Deactivate
04	SS2 command	0: Activate 1: Deactivate
05	SLS1 command	0: Activate 1: Deactivate
06	SLS2 command	0: Activate 1: Deactivate
07	SLS3 command	0: Activate 1: Deactivate
08	SLS4 command	0: Activate 1: Deactivate
09	SDIp command	0: Activate, forward rotation prohibited 1: Deactivate, forward rotation allowed

Setpoint	Name	Description
10	SDIn command	0: Activate, reverse rotation prohibited 1: Deactivate, reverse rotation allowed
11	ACK command	0: Deactivate 1: Activate

Table 11–2 DO function definitions

Setpoint	Name	Description
01	STO Active	0: Is not active 1: Is active
02	SBC Active	0: Is not active 1: Is active
03	SS1 Active	0: Is not active 1: Is active
04	SS2 Active	0: Is not active 1: Is active
05	SLS1 Active	0: Is not active 1: Is active
06	SLS2 Active	0: Is not active 1: Is active
07	SLS3 Active	0: Is not active 1: Is active
08	SLS4 Active	0: Is not active 1: Is active
09	SDIp Status	0: Is not active, motor not in forward rotation 1: Is active, motor in forward rotation
10	SDIn Status	0: Is not active, motor not in reverse rotation 1: Is active, motor in reverse rotation
11	SOS Active	0: Is not active 1: Is active
12	SSM Active	0: Out of SSM limit 1: Within SSM limit
13	SS1-r Active	0: Is not active 1: Is active
14	SS2-r Active	0: Is not active 1: Is 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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