INOVANCE

Advanced User Guide

SV660N Series Servo Drive

User Guide

A00

Data code 19011236

Preface

Thank you for purchasing the SV660N series servo drive developed by Inovance.

The SV660N series high-performance AC servo drive covers a power range from 200 W to 7.5 kW. It supports EtherCAT communication protocol and carries Ethernet communication interfaces to work with the host controller in achieving a networked operation of multiple servo drives.

The SV660N series servo drive supports stiffness level setting, inertia auto-tuning and vibration suppression to simplify the operation process. It allows a quiet and stable operation through cooperating with the MS1 series medium- and small-inertia high-response servo motor configured with a 23-bit single-turn absolute encoder or 23-bit multi-turn absolute encoder.

The SV660N series servo drive aims to deliver fast and accurate control in automation equipment such as semi-conductor manufacturing equipment, chip mounters, PCB punching machines, transport machineries, food processing machineries, machine tools, and transmission machineries.

This user guide provides product information and instructions on installation, wiring, commissioning, and fault diagnosis. First-time users must read through this user guide. For concerns regarding product functions or performance, contact Inovance for technical support.

Safety Instructions
◆ The drawings in the user 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 described in the user guide. ◆ The drawings in the user guide are shown for descriptions only and may not match the product you purchased. ◆ This user guide is subject to change without notice due to product upgrade, specification modifications as well as efforts to improve the accuracy and convenience of the user guide. ◆ If the user guide is damaged or lost, contact our regional agents or customer service centers to order the user guide. ◆ Contact our customer service centers for concerns during use.

Unpacking Inspection

Check the following items upon unpacking.

Items	Description
Check whether the delivered product complies with your order.	Check whether the motor model and specifications shown on the packing box comply with your order.
Check whether the product is intact.	Check whether the overall appearance of the product is intact. If there is any part missing or damaged, contact Inovance or your supplier immediately.

Revision History

Date	Version	Description
January 2020	A00	First edition

Standards Compliance

- The SV660N series servo drive and the MS1 series servo motor have passed CE certification and comply with the following international standards.

Certification	Mark	Directive		Standard	
CE certification	CE	EMC directive	2014/30/EU	Servo drive	EN 61800-3 IEC 61800-3 IEC 61800-5-2
				Servo motor	EN 60034-1
		LVD directive	2014/35/EU	Servo drive	EN 61800-5-1 IEC 61800-5-1
				Servo motor	EN 60034-1
		RoHS directive	2011/65/EU	EN 50581	

NOTE

- The preceding certification are complied with only when the EMC-related electrical installation requirements described in this user guide are observed.
- The integrator who integrates this drive into other products and attaches the CE mark to the final assembly has the responsibility of ensuring compliance with CE standards and the European Norm.
- For more information on product certifications, contact our agents or sales representatives.

Contents

Safety Instructions

Safety Precautions

1) Before installing, using, and maintaining this equipment, read the safety information and precautions thoroughly, and comply with them during operations.
2) To ensure the safety of humans and equipment, follow the signs on the equipment and all the safety instructions in this user guide.
3) "CAUTION", "WARNING", and "DANGER" items in the user guide do not indicate all safety precautions that need to be followed; instead, they just supplement the safety precautions.
4) Use this equipment according to the designated environment requirements. Damage caused by improper usage is not covered by warranty.
5) Inovance shall take no responsibility for any personal injuries or property damage caused by improper usage.

Safety Levels and Definitions

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

Safety Instructions

Unpacking
CAUTION ◆ Check whether the packing is intact and whether there is damage, water seepage, damp, and deformation. ◆ Unpack the package by following the package sequence. Do not hit the package with force. ◆ Check whether there are damage, rust, or injuries on the surface of the equipment or equipment accessories. ◆ Check whether the number of packing materials is consistent with the packing list.
WARNING ◆ Do not install the equipment if you find damage, rust, or indications of use on the equipment or accessories. ◆ Do not install the equipment if you find water seepage, component missing or damage upon unpacking. ◆ Do not install the equipment if you find the packing list does not conform to the equipment you received.

Storage and Transportation
CAUTION
◆ Store and transport this equipment based on the storage and transportation requirements for humidity and temperature. ◆ Avoid transporting the equipment in environments such as water splashing, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration. ◆ Avoid storing this 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 this equipment with other equipment or materials that may harm or have negative impacts on this equipment.
WARNING
◆ Use professional loading and unloading equipment to carry large-scale or heavy equipment. ◆ When carrying this equipment with bare hands, hold the equipment casing firmly with care to prevent parts falling. Failure to comply may result in personal injuries. ◆ Handle the equipment with care during transportation and mind your step to prevent personal injuries or equipment damage. ◆ Never stand or stay below the equipment when the equipment is lifted by hoisting equipment.
Installation
WARNING
◆ Thoroughly read the safety instructions and user guide before installation. ◆ Do not modify this equipment. ◆ Do not rotate the equipment components or loosen fixed bolts (especially those marked in red) on equipment components. ◆ Do not install this equipment in places with strong electric or magnetic fields. ◆ When this equipment is installed in a cabinet or final equipment, protection measures such as a fireproof enclosure, electrical enclosure, or mechanical enclosure must be provided. The IP rating must meet IEC standards and local laws and regulations.
DANGER
◆ Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed by only professionals. ◆ Installation, wiring, maintenance, inspection, or parts replacement must be performed by only experienced personnel who have been trained with necessary electrical information. ◆ Installation personnel must be familiar with equipment installation requirements and relevant technical materials. ◆ Before installing equipment with strong electromagnetic interference, such as a transformer, install an electromagnetic shielding device for this equipment to prevent malfunctions.

Wiring

DANGER

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed by only professionals.
- Never perform wiring at power-on. Failure to comply will result in an electric shock.
- Before wiring, cut off all equipment power supplies. Wait at least 15 minutes before further operations because residual voltage exists after power-off.
- Make sure that the equipment is well grounded. Failure to comply will result in an electric shock.
- During wiring, follow the proper electrostatic discharge (ESD) procedures, and wear an antistatic wrist strap. Failure to comply will result in damage to internal equipment circuits.

WARNING

- Never connect the power cable to output terminals of the equipment. Failure to comply may cause equipment damage or even a fire.
- When connecting a drive with the motor, make sure that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Wiring cables must meet diameter and shielding requirements. The shielding layer of the shielded cable must be reliably grounded at one end.
- After wiring, make sure that no screws are fallen and cables are exposed in the equipment.

Power-on

DANGER

- Before power-on, make sure that the equipment is installed properly with reliable wiring and the motor can be restarted.
- Before power-on, make sure that the power supply meets equipment requirements to prevent equipment damage or even a fire.
- At power-on, unexpected operations may be triggered on the equipment. Therefore, stay away from the equipment.
- After power-on, do not open the cabinet door and protective cover of the equipment. Failure to comply will result in an electric shock.
- Do not touch any wiring terminals at power-on. Failure to comply will result in an electric shock.
- Do not remove any part of the equipment at power-on. Failure to comply will result in an electric shock.

Operation

DANGER

- Do not touch any wiring terminals during operation. Failure to comply will result in an electric shock.
- Do not remove any part of the equipment during operation. Failure to comply will result in an electric shock.
- Do not touch the equipment shell, fan, or resistor for temperature detection. Failure to comply will result in heat injuries.
- Signal detection must be performed by only professionals during operation. Failure to comply will result in personal injuries or equipment damage.

WARNING

- Prevent metal or other objects from falling into the device during operation. Failure to comply may result in equipment damage.
- Do not start or stop the equipment using the contactor. Failure to comply may result in equipment damage.

Maintenance

DANGER

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed by only professionals.
- Do not maintain the equipment at power-on. Failure to comply will result in an electric shock.
- Before maintenance, cut off all equipment power supplies and wait at least 15 minutes.

WARNING

- Perform daily and periodic inspection and maintenance for the equipment according to maintenance requirements and keep a maintenance record.

Repair

DANGER

- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed by only professionals.
- Do not repair the equipment at power-on. Failure to comply will result in an electric shock.
- Before inspection and repair, cut off all equipment power supplies and wait at least 15 minutes.

WARNING

- Require for repair services according to the product warranty agreement.
- When the equipment is faulty or damaged, require professionals to perform troubleshooting and repair by following repair instructions and keep a repair record.
- Replace quick-wear parts of the equipment according to the replacement guide.
- Do not operate damaged equipment. Failure to comply may result in worse damage.
- After the equipment is replaced, perform wiring inspection and parameter settings again.

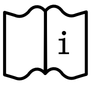
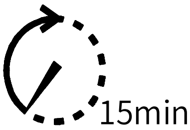
Disposal

WARNING

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

Safety Signs

- Description of safety signs in the user guide

	Read the user guide before installation and operation.
	Reliably ground the system and equipment.
	Danger!
	High temperature!
	Prevent personal injuries caused by machines.
	High voltage!
	Wait xx minutes before further operations.

- Description of safety signs on the equipment

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

Safety Sign	Description
	Never fail to connect the Protective Earth(PE) terminal. Read the user guide and follow the safety instructions before use. To prevent the risk of electric shock, do not touch terminals within 15 minutes after cutting off the power supply. To prevent the risk of burning, do not touch the heatsink when the power supply is ON.

1 Product Information

1.1 Introduction to the Servo Drive

1.1.1 Nameplate and Model Number

SV 660 N S 2R8 I - FH

Code	Product Family
SV	Servo

Code	Product Series
660	660 series

Code	Product Type
N	Network type

Code	Voltage Class
S	220 V
T	380 V

Symbol	1R6	2R8	3R5	5R4	5 R 5	6R6
Rated output current	1.6 A	2.8 A	3.5 A	5.4 A	5.5 A	6.6 A
Symbol	7R6	8R4	012	017	021	026
Rated output current	7.6 A	8.4 A	12 A	17 A	21 A	26 A

Code	Installation Mode
I	Baseplate installation (standard)

Code	Customized Function
None	Standard
FH	High protection
FS	STO function

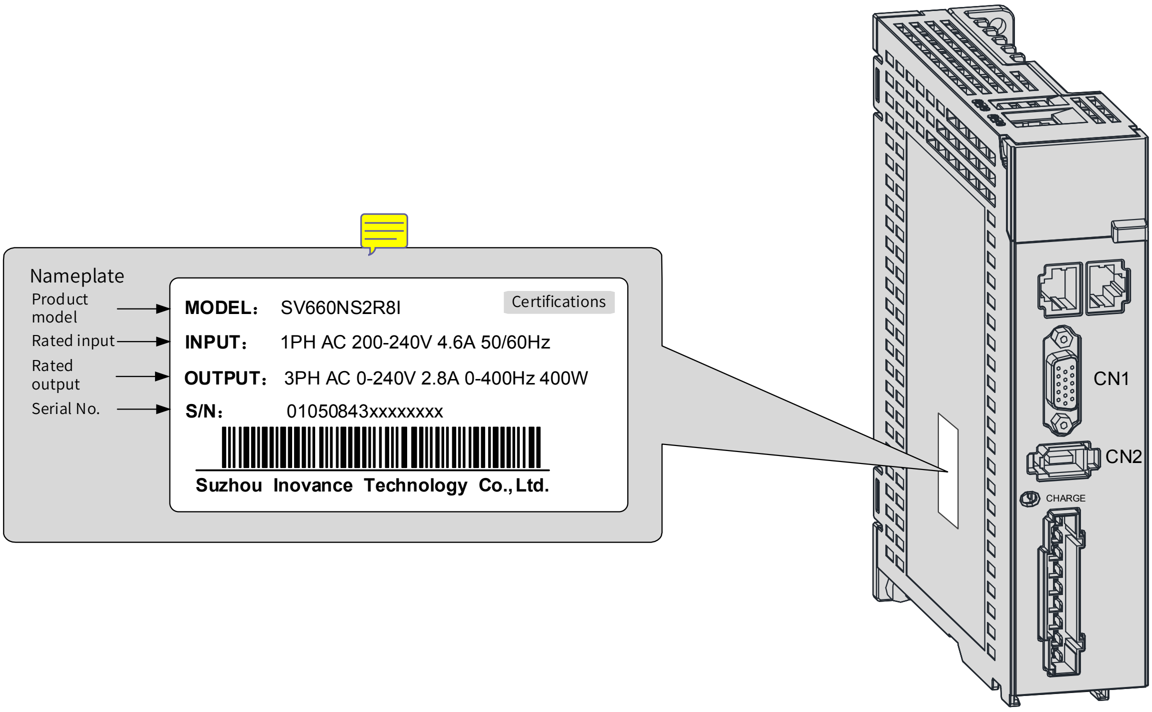


Figure 1-1 Nameplate and model number

1.1.2 Components

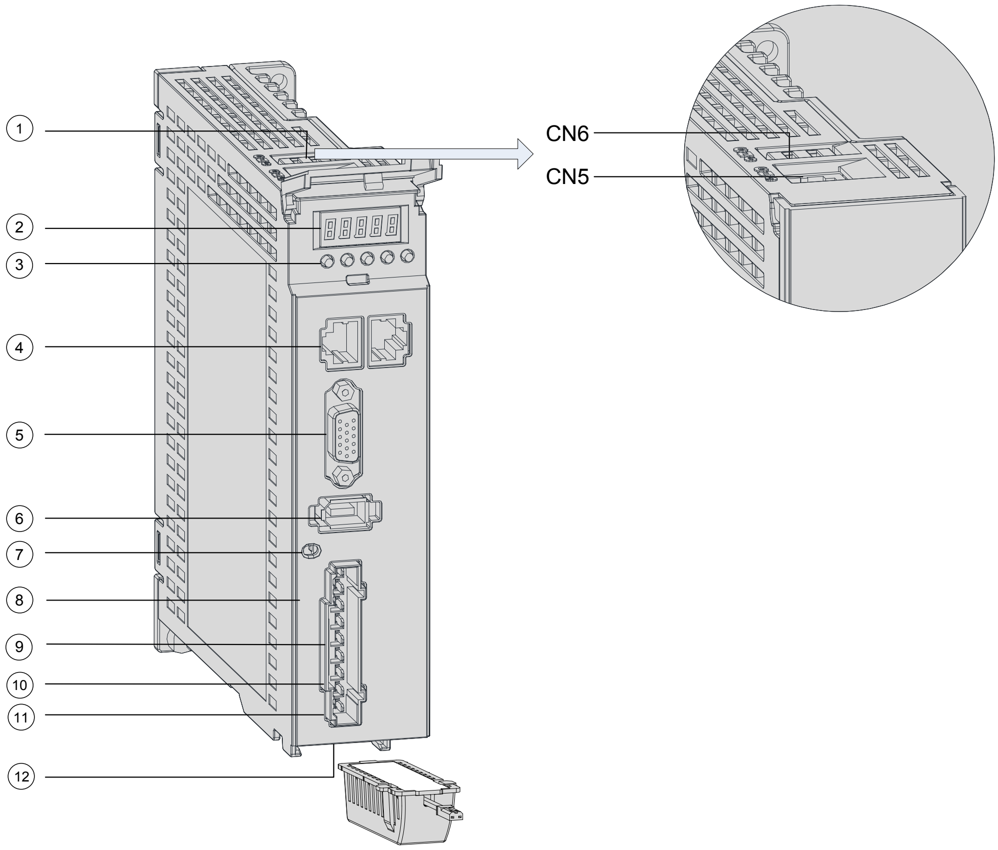


Figure 1-2 Layout of servo drives in size A

No.	Name	Description
1	Terminals CN6 and CN5	CN6: Functional safety terminal mainly used for functional safety purpose and connected to the external functional safety signal CN5: Software tool communication port
2	LED display	A five-digit LED display used to show the servo drive running status and parameter settings
3	Operation buttons	MODE: Used to switch parameters in sequence. △ : Used to increase the value of the blinking digit. ▽ : Used to decrease the value of the blinking digit. ◁◁ : Used to shift the blinking digit leftwards. (Hold down: Turning the page when the displayed number exceeds five digits) SET: Used to save modifications and enter the next menu.
4	CN3, CN4 (EtherCAT communication terminals)	CN3 (IN): Connected to the master or the last slave device. CN4 (OUT): Connected to the next slave device.
5	CN1 (Control terminal)	Used by reference input signal and other I/O signals.
6	CN2 (Encoder connecting terminal)	Connected to motor encoder terminals.

No.	Name	Description
7	CHARGE (Bus voltage indicator)	Used to indicate that the bus capacitor carries electric charge. When this indicator lights up, it indicates the electric charge may be still present in the internal capacitor of the servo unit even if the main circuit power supply is cut off. To prevent electrical shock, do not touch the power terminals when this indicator lights up.
8	L1, L2 (Power input terminals)	See the nameplate for the power input of rated voltage class.
	P, N (DC bus terminals)	Used as the common DC bus for multiple servo drives.
9	P, C (Terminals for connecting external regenerative resistor)	Connected between P and C when an external regenerative resistor is needed.
10	U, V, W (Servo motor connecting terminals)	Connected to U, V, and W phases of the servo motor.
11	PE (Grounding terminal)	Connected to the grounding terminal of the power supply and the motor.
12	Battery location	Used to hold the battery box of an absolute encoder.

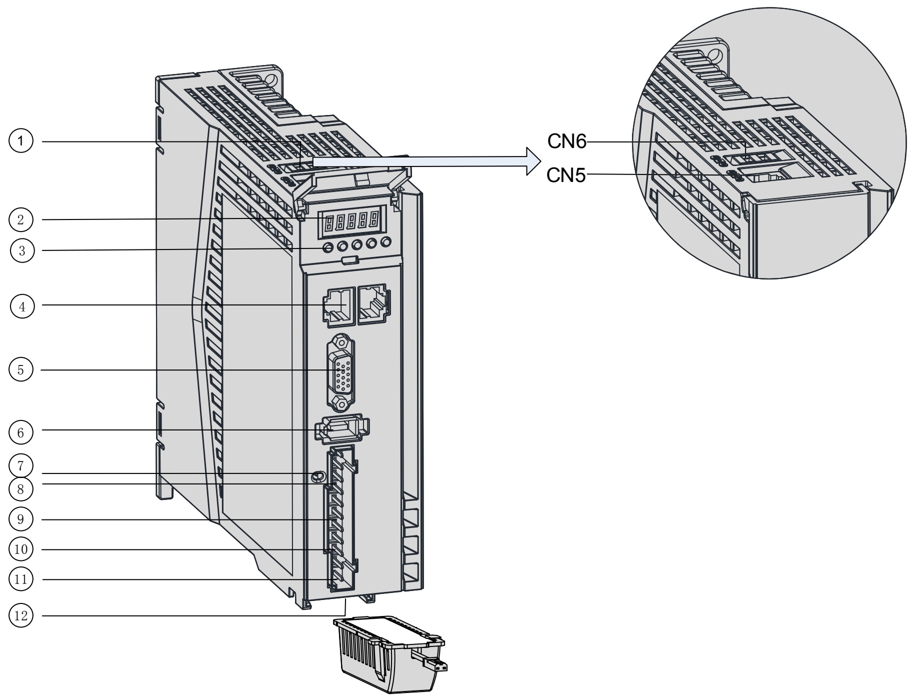


Figure 1-3 Layout of servo drives in size B

SN	Name	Description
1	CN6, CN5 terminals	CN6: Functional safety terminal mainly used for functional safety purpose and connected to external functional safety signal CN5: Software tool communication port
2	LED display	A five-digit LED display used to show the servo drive running status and parameter settings

SN	Name	Description
3	Operation buttons	MODE: Used to switch parameters in sequence. △ : Used to increase the value of the blinking digit. ▽ : Used to decrease the value of the blinking digit. ◁ ◁ : Used to shift the blinking digit leftwards. (Hold down: Turning the page when the displayed number exceeds five digits) SET: Used to save modifications and enter the next menu.
4	CN3, CN4 (EtherCAT communication terminals)	CN3 (IN): Connected to the master or the last slave device. CN4 (OUT): Connected to the next slave device.
5	CN1 (Control terminal)	Used for reference input signal and other I/O signals.
6	CN2 (Encoder connecting terminal)	Connected to motor encoder terminals.
7	CHARGE (Bus voltage indicator)	Used to indicate that the bus capacitor carries electric charge. When this indicator lights up, it indicates the electric charge may be still present in the internal capacitor of the servo unit even if the main circuit power supply is cut off. To prevent electrical shock, do not touch the power terminals when this indicator lights up.
8	L1, L2, L3 (Power input terminals)	See the nameplate for the power input of the rated voltage class. Note: 750 W servo drives: Single-phase 220 V input, with 220 V power supply connected to L1 and L2 850 W servo drives: Single-phase/Three-phase 220 V input, with 220 V power supply connected to L1, L2, and L3 during three-phase input or connected to any two phases among L1, L2, and L3 during single-phase input (derate 80%)
	P, N (DC bus terminals)	Used as the common DC bus for multiple servo drives.
9	P, D, C (Terminals for connecting external regenerative resistor)	Connected between P and C when an external regenerative resistor is needed (Remove the jumper bar between P and D first).
10	U, V, W (Servo motor connecting terminals)	Connected to U, V, and W phases of the servo motor.
11	PE (Grounding terminal)	Connected to the grounding terminals of the power supply and the motor.
12	Battery location	Used to hold the battery box of an absolute encoder.

NOTE

- Built-in regenerative resistors or jumper bars are not included in S1R6 and S2R8 models. If an external regenerative resistor is needed, connect it between terminals P and C.
- To connect an external regenerative resistor to S5R5 models, remove the jumper bar between terminals P and D first and connect the resistor between terminals P and C.

1.1.3 Technical Specifications

1 Electrical specifications

■ Single-phase 220 V servo drives

Item	Size A		Size B
Servo drive model: SV660N	S1R6	S2R8	S5R5
Continuous output current (Arms)	1.6	2.8	4.8
Maximum output current (Arms)	5.8	10.1	16.9
Main circuit power supply	Single-phase 200–240 VAC, -10% to +10%, 50/60 Hz		
Control circuit power supply	Single-phase 200–240 VAC, -10% to +10%, 50/60 Hz		
Braking function	External regenerative resistor available in size A Built-in regenerative resistor ~~available~~ in size B		

■ Three-phase 220 V servo drives

Item	Size B	Size C	Size D
Servo drive model: SV660N	S6R6	S7R6	S012
Continuous output current (Arms)	6.6	7.6	11.6
Maximum output current (Arms)	16.5	23	32
Main circuit power supply	Three-phase 200–240 VAC, -10% to +10%, 50/60 Hz		
Control circuit power supply	Single-phase 200 VAC–240 VAC, +10 to –10%, 50/60 Hz		
Braking function	Built-in regenerative resistor		

■ Three-phase 380 V servo drives

Item	Size C		Size D		Size E		
Servo drive model: SV660N	T3R5	T5R4	T8R4	T012	T017	T021	T026
Continuous output current (Arms)	3.5	5.4	8.4	11.9	16.5	20.8	25.7
Maximum output current (Arms)	11	14	20	29.75	41.25	52.12	64.25
Main circuit power supply	Three-phase 380–440 VAC, -10% to +10%, 50/60 Hz						
Control circuit power supply	Single-phase 380–440 VAC, -10% to +10%, 50/60 Hz						
Braking function	Built-in regenerative resistor						

2 General specifications

Item			Description
Basic specification	Control mode		IGBT PWM control, sine wave current drive mode 220 V, 380 V: Single-phase/Three-phase full bridge rectification
	Encoder feedback		Serial incremental type: 23-bit or 20-bit 23-bit absolute encoder
	Conditions for use	Operating/Storage temperature [1]	0°C to 55°C (If the ambient temperature exceeds 45°C , derate 10% for every additional 5°C .)/-20°C to +70°C
		Operating/Storage humidity	Below 90% RH (without condensation)
		Vibration/Impact resistance level	4.9 m/s^2, 19.6 m/s^2
		IP rating	IP20 (Terminals (IP00) excluded)
		Pollution degree	PD2
		Altitude	Below 1000 m
Speed/ Torque control mode	Performance	Speed control range	1:6000 (The lower limit of the speed control range acts as the condition for non-stop at rated torque load.)
		Speed loop bandwidth	2.5 kHz
		Torque control accuracy (Repetitiveness)	±2%
		Soft startup time	0s to 65s (The acceleration and deceleration can be set separately.)
	Input signal	Speed reference	Source of network-type references: EtherCAT communication Local mode and local multi-speed supported
		Torque reference	
Position control mode	Performance	Positioning time	1 ms to 10 ms
	Input signal	Position reference	Source of network-type references: EtherCAT communication Local mode supported
	Digital input (DI) signal	Signal allocation change available	5 DIs
			P-OT (Positive limit switch) N-OT (Negative limit switch) HomeSwitch (Home switch) TouchProbe1 (Touch probe 1) TouchProbe2 (Touch probe 2)
	Digital output (DO) signal	Signal allocation change available	3 DOs With-load capacity: 50 mA Voltage range: 5 V to 30 V
			S-RDY: Servo ready TGON: Motor rotation output Comparison output, brake output, DB output (above 3 kW), EDM output

Item			Description
Built-in functions	Overtravel (OT) prevention		Stop immediately when P-OT and N-OT activated
	Protective functions		Protections against overcurrent, overvoltage, undervoltage, overload, main circuit detection error, heatsink overheat, overspeed, encoder error, CPU error, and parameter error
	LED display		Main power CHARGE indicator, 5-digit LED display
	Vibration suppression		Five notches (including two adaptive notches), 50 Hz to 5000 Hz
	Communication function	Connection protocol	RS232
		Communication protocol	EtherCAT
		Multi-station communication	Maximum number of slaves: 255
		Axis address setting	No physical knob, set to 0 to 255 by software
		Functions	Including status display, user parameter setting, monitoring information display, fault tracking display, jog and auto-tuning, and speed/torque reference signal observation
	Others		Gain auto-tuning, fault log, jog

3 Technical specifications of EtherCAT communication

Item		Specifications
Basic performance of EtherCAT slave station	Communication protocol	EtherCAT protocol
	Available services	CoE (PDO, SDO)
	Synchronization mode	DC - Distributed clock
	Physical layer	100BASE-TX
	Baud rate	100 Mbit/s (100Base-TX)
	Duplex mode	Full duplex
	Topological structure	Ring and linear
	Transmission medium	Shielded Cat 5e network cable or better
	Transmission distance	Less than 100 m between two nodes (with proper environment and proper cables)
	Number of slaves	65535 by protocol, equal to or less than 100 in actual use
	EtherCAT frame length	44 bytes to 1498 bytes
	Process data	A maximum of 1486 bytes per Ethernet frame
	Synchronous jitter of two slaves	< 1 μs
	Refresh time	About 30 μs for 1000 DI/DOs About 100 μs for 100 servo axes Different refresh time for different interfaces
	Communication code error rate	10^{-10} Ethernet standard
EtherCAT configuration unit	Number of FMMU units	8
	Number of storage synchronization management units	8
	Process data RAM	8 KB
	Distributed clock	64-bit
	EEPROM capacity	32 Kbit Initialization data written through EtherCAT master

[1] Install the servo drive in environments that meet the allowable ambient temperature range. When it is installed inside an electric cabinet, the temperature inside the cabinet must also be within this range.

4 Basic functions

The servo drive functions are listed as follows. See details in corresponding chapters.

Function	Description
Cyclic synchronous position mode	The host controller generates position references and sends the references cyclically through the bus. The servo drive performs positioning process.
Cyclic synchronous velocity mode	The host controller generates speed references and sends the references cyclically through the bus. The servo drive performs speed tracing.
Cyclic synchronous torque mode	The host controller generates torque references and sends the references cyclically through the bus. The servo drive performs torque output.
Profile position mode	The host controller sets parameters through the bus, and the servo drive generates position references and performs positioning process.
Profile velocity mode	The host controller sets parameters through the bus, and the servo drive generates speed references and performs speed tracing.
Profile torque mode	The host controller sets parameters through the bus, and the servo drive generates torque references and performs torque output.
Homing mode	The host controller selects the homing mode through parameters, and the servo drive performs homing automatically with the position feedback set to the preset value.
Touch probe function	Latches the position information when an external DI signal or the motor phase-Z signal changes.
High-resolution encoder	The encoder is of high performance with resolution up to 8388608 PPR.
Mechanical characteristics analysis	Analyzes the resonance frequency and mechanical system characteristics through a PC installed with Inovance software tool.
Gain auto-tuning	Generates gain parameters automatically to match present working condition through just one parameter.
Gain switchover	Different gains can be applied, stopped or switched through external terminals during running.
Torque disturbance observation	Automatically estimates the disturbance torque suffered by the system to perform compensation and reduce vibration.
Resonance suppression	Sets filter characteristics automatically to suppress mechanical system vibration after detecting the resonance point.
Torque reference filter	Suppresses the mechanical resonance generated during high-speed response of the servo drive.
Position first-order low-pass function	Enables smooth acceleration and deceleration.
Torque limit	Limits the output torque of the servo motor.
Speed limit	Limits the servo motor speed.
External regenerative resistor	Intends to be used in cases where the braking capacity of the built-in regenerative resistor is insufficient.
Input signal selection	Defines input functions such as emergency stop to corresponding pins.
Fault log	Contains the latest ten faults or used to clear the previous faults.
Status display	Displays the servo drive status through five LEDs.
External I/O display	Displays ON/OFF status of external I/O signals.

Function	Description
Forced output of output signals	Implements forced signal output unrelated to the servo drive status and detects the wiring of output signals.
Trial run mode	Runs the servo motor directly through the keypad, removing the need for a start signal.
Inovance software tool	Used to execute parameter settings, trial run and status display through a PC.
Warning code output	Outputs a four-bit warning code when a warning occurs.
High-speed position comparison output	Outputs a DO signal with designated width after the servo drive reaches the preset target position.
Black box function	Captures the data before and after the designated condition, and cooperates with the software tool to read the data for further analysis.

1.1.4 Specifications of the Regenerative Resistor

Servo Drive Model		Built-in Regenerative Resistor		Minimum Allowable Resistance (Ω)	Max. Braking Energy Absorbed by Capacitor
		Resistance (Ω)	Power (W)		
Single-phase 220 V	SV660NS1R6I	-	-	50	9
	SV660NS2R8I	-	-	45	18
	SV660NS5R5I	50	50	40	26
Three-phase 220 V	SV660NS6R6I	50	50	40	26

NOTE

Select the external regenerative resistor according to actual operating conditions.

1.2 Introduction to the Servo Motor

1.2.1 Motor Nameplate and Model Number

MS1 H1 - 20B 30C B - A3 3 1 Z - S

Code	Product Family
M	Motor

Code	Product Type
S	Servo：Servo motor

Code	Product Generation
1	1st generation

Code	Type
H	Motor with max. speed larger than rated speed
V	Motor with max. speed equal to rated speed

Code	Type
1	Low inertia, small capacity
2	Low inertia, medium capacity
3	Medium inertia, medium capacity
4	Medium inertia, small capacity

Code	Rated Power (W)
Comprised of a number and a letter	
B	x10
C	x100
Example: 40B: 400 W	

Code	Rated Speed (RPM)
Comprised of a number and a letter	
B	x10
C	x100
Example: 30C: 3000 RPM	

Code	Subseries No.
None	Terminal type, natural ventilation
S	Lead wire type, natural ventilation

Code	Subseries No.
Z	Z series

Code	Brake, ~~Reducer,~~ Oil Sealing
0	None
1	Oil sealing
2	Brake
4	Oil sealing + Brake

Code	Shaft Connection Mode
1	Plain shaft
3	Solid, with key and threaded hole

Code	Encoder Type
Comprised of a number and a letter	
A3	23-bit multi-turn absolute encoder
U3	23-bit single-turn encoder

Code	Voltage Class
B	220 V
D	380 V

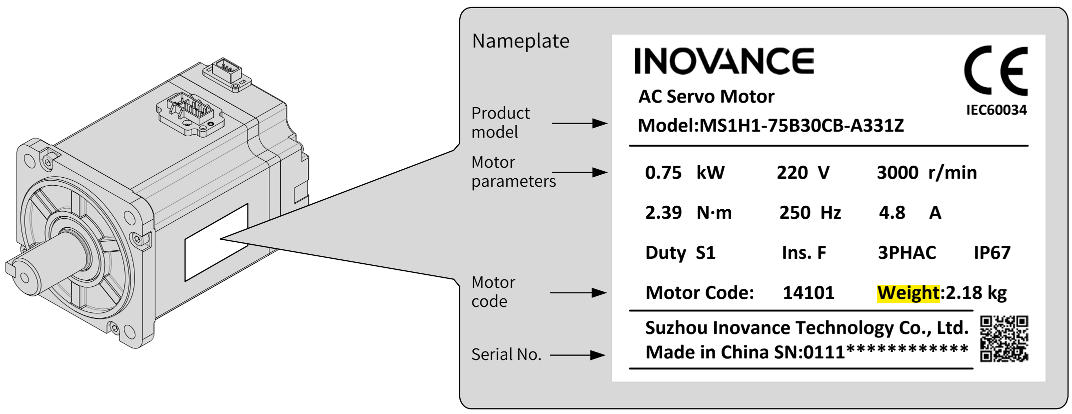


Figure 1-4 Motor model and nameplate

NOTE

- The preceding information only applies to motors in 40\60\80 frame sizes.
- The SV660N series servo drive can work with a motor installed with a 23-bit singl-turn absolute encoder or a 23-bit multi-turn absolute encoder.

1.2.2 Components

■ Terminal-type motor components

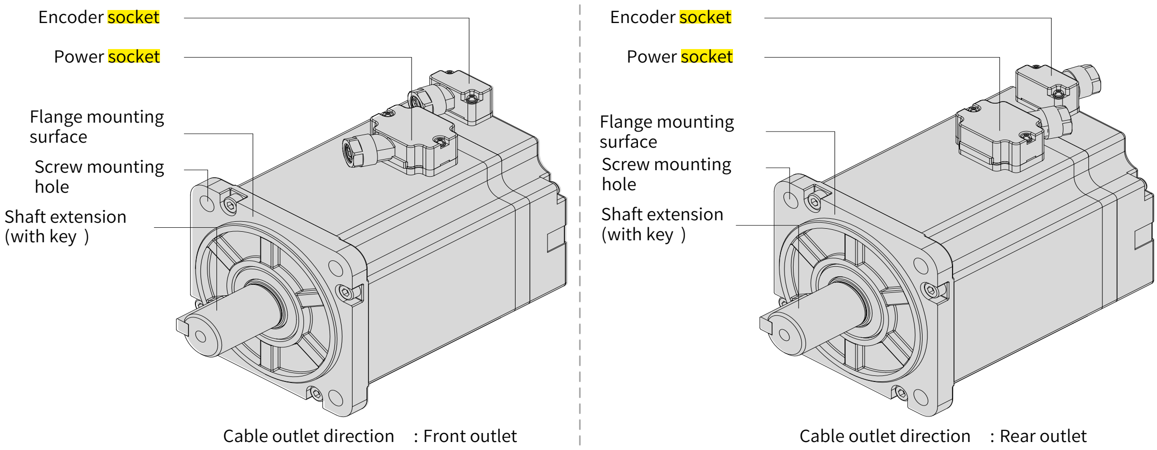


Figure 1-5 MS1 series terminal-type motor components

■ Lead wire-type motor components

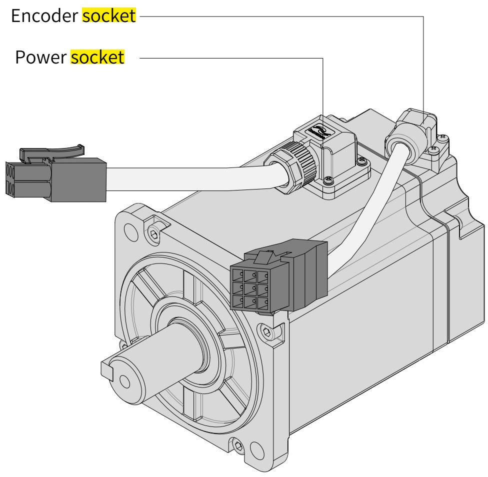


Figure 1-6 MS1 series lead wire-type motor components

1.2.3 Technical Specifications

1 Specifications of mechanical characteristic parameters of the motor

Item	Description
Duty type	Continuous
Vibration level	V15
Insulation resistance	500 VDC, above 10 MΩ
Ambient operating temperature	0° C to 40° C
Excitation mode	Permanent magnetic
Installation mode	Flange
Heat resistance level	Level F
Insulation voltage	1500 VAC, 1 min (200 V) 1800 VAC, 1 min (400 V)
IP rating of the enclosure	H1: IP67 (except the through shaft part and connectors) H4: IP67 (except the through shaft part and connectors)
Ambient operating humidity	20% to 80% (without condensation)
Rotating direction	Rotating counterclockwise (CCW) when viewed from the load side at the forward run command

2 Motor ratings

Model	Rated Output (kW)[1]	Rated Torque (N·m)	Max. Torque (N·m)	Rated Current (Arms)	Max. Current (Arms)
MS1H1-10B30CB	0.1	0.32	1.12	1.3	4.7
MS1H1-20B30CB	0.2	0.64	2.24	1.5	5.8
MS1H1-40B30CB	0.4	1.27	4.46	2.8	10.1
MS1H4-40B30CB	0.4	1.27	4.46	2.8	10.1
MS1H1-75B30CB	0.75	2.39	8.36	4.8	16.9
MS1H4-75B30CB	0.75	2.39	8.36	4.8	16.9
MS1H3-85B15CB	0.85	5.39	13.5	6.60	16.5
Model	**Rated Speed (RPM)**	**Max. Speed (RPM)**	**Torque Coefficient (N·m/Arms)**	**Rotor Inertia (10^{-4}kg.m^2)**	**Voltage (V)**
MS1H1-10B30CB	3000	6000	0.26	0.041 (0.043)[2]	220 V
MS1H1-20B30CB			0.46	0.207 (0.220)[2]	
MS1H1-40B30CB			0.53	0.376 (0.390)[2]	
MS1H4-40B30CB			0.53	0.657 (0.667)[2]	
MS1H1-75B30CB			0.58	1.38 (1.43)[2]	
MS1H4-75B30CB			0.58	2 (2.012)[2]	
MS1H3-85B15CB	1500	3000	0.91	13.3 (14)[2]	

[1] The motor with oil sealing must be derated 10% during use.

[2] Parameters inside the brackets "()" are for motors with brake.

NOTE

- ◆ The items and torque-speed characteristic values in the preceding table are obtained in cases where the motor is working with Inovance servo drive and the armature coil temperature is 20° C.
- ◆ The characteristic parameter values in the preceding table are obtained in cases where the motor is installed with the following heatsink:
  MS1H1/MS1H4: 250 mm x 250 mm x 6 mm (aluminum)

3 Motor overload characteristics

Load Ratio (%)	Running Time (s)
120	230
130	80
140	40
150	30
160	20
170	17
180	15
190	12
200	10
210	8.5
220	7
230	6
240	5.5
250	5
300	3

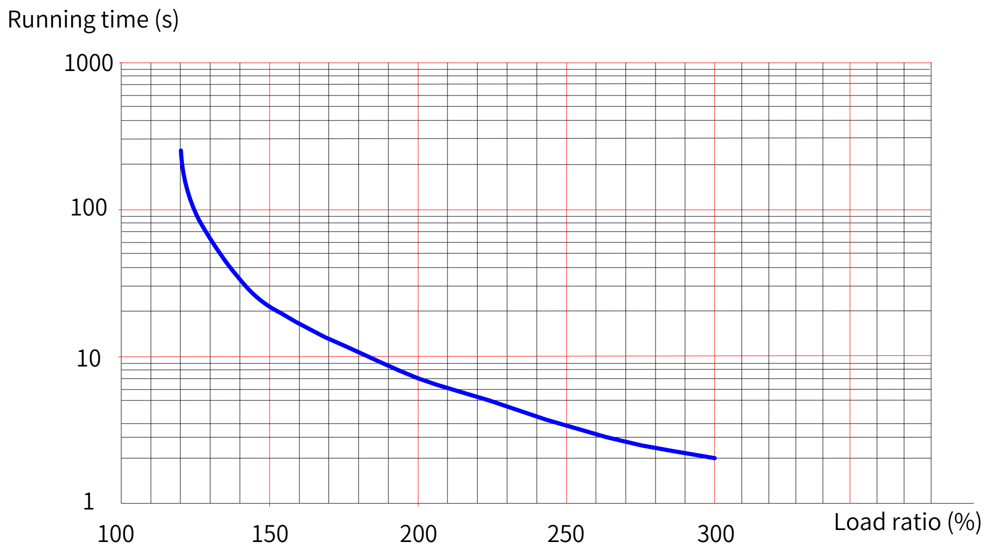


Figure 1-7 Motor overload curve

NOTE

The maximum torque of H1 and H4 models are three times the rated torque.

4 Allowable radial and axial loads of the motor

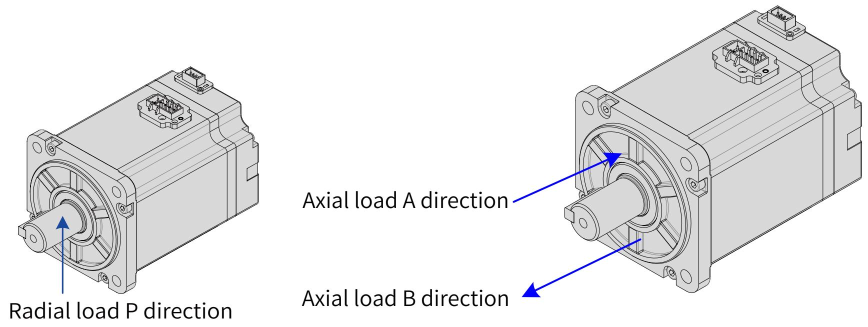


Figure 1-8 Radial and axial loads

Motor Model	Allowable Radial Load (N)	Allowable Axial Load (N)
MS1H1-10B30CB	78	54
MS1H1-20B30CB	245	74
MS1H1-40B30CB	245	74
MS1H4-40B30CB	245	74
MS1H1-75B30CB	392	147
MS1H4-75B30CB	392	147
MS1H3-85B15CB	686	196

5 Electrical specifications for the motor with brake

Motor Model	Holding Torque (N·m)	Supply Voltage (VDC) (±10%)	Release Time (ms)	Close Time (ms)	Backlash (°)
MS1H1-05B/10B	0.32	24	≤ 20	≤ 35	< 1.7
MS1H1-20B/40B	1.5	24	≤ 20	≤ 50	< 1.5
MS1H4-40B	1.5	24	≤ 20	≤ 50	< 1.5
MS1H*-75B	2.5	24	≤ 20	≤ 60	< 1.7
MS1H3-85B	12	24	60	120	≤ 0.5

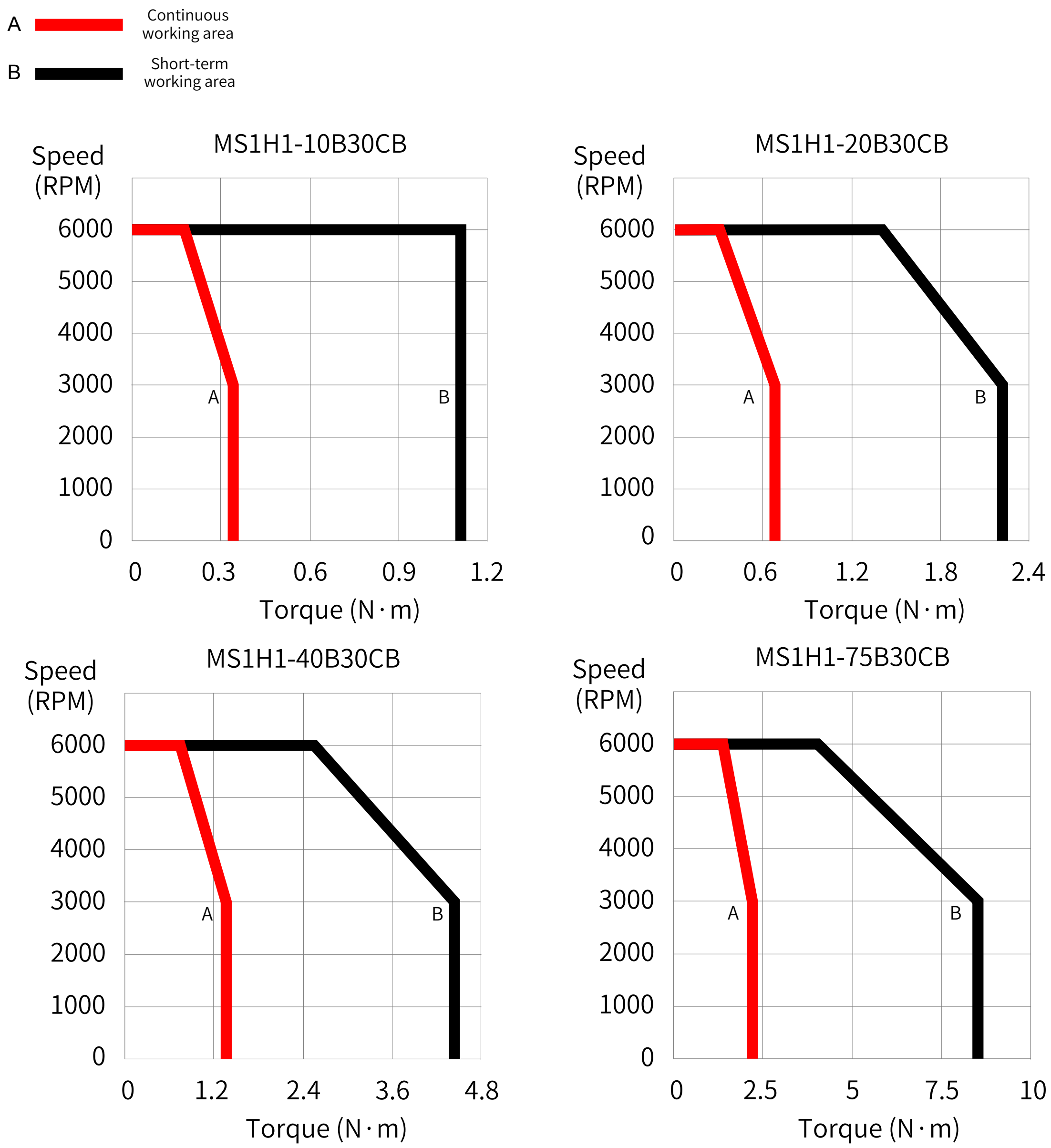
NOTE

◆ The brake cannot share the same power supply with other electrical devices. This is to prevent malfunction of the brake due to voltage or current drop caused by other working devices.

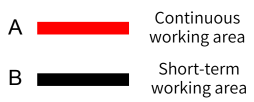
◆ It is recommended to use cables of 0.5 mm^2 and above.

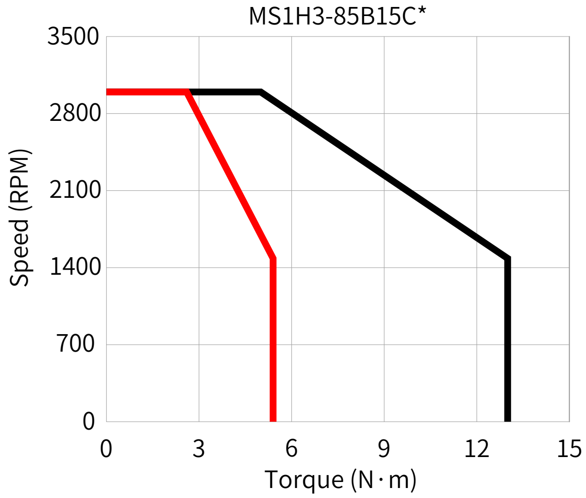
6 Motor torque-speed characteristics

■ MS1H1 (low inertia, small capacity)

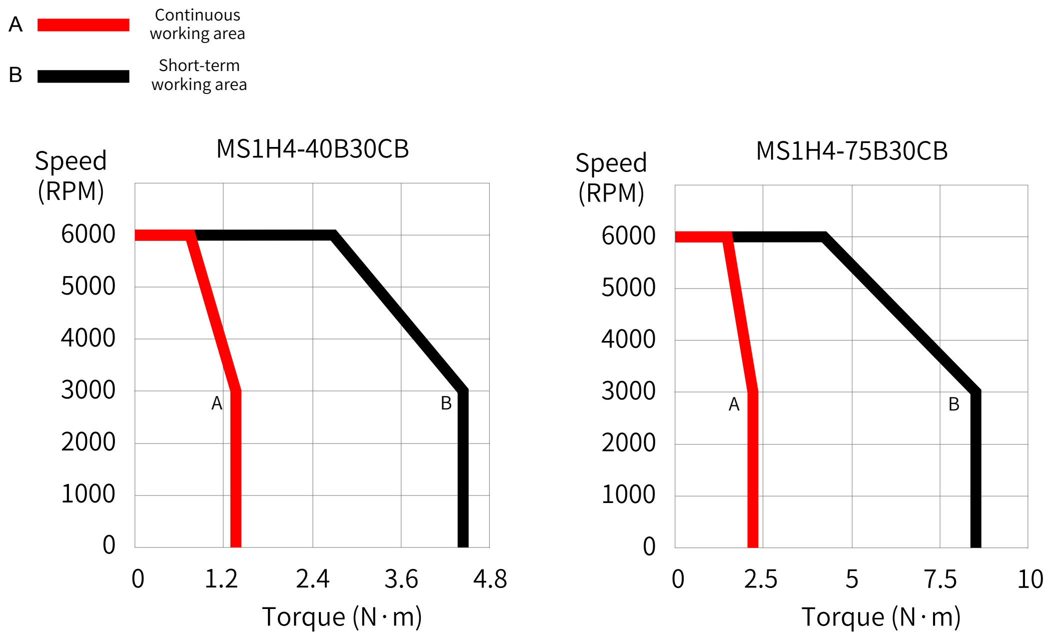


■ MS1H3 (medium inertia, medium capacity)



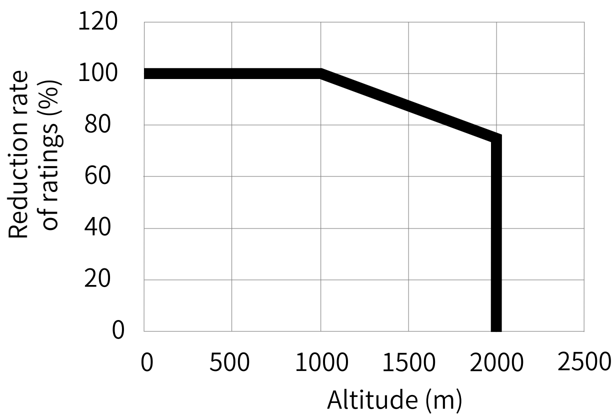


■ MS1H4 (medium inertia, small capacity)

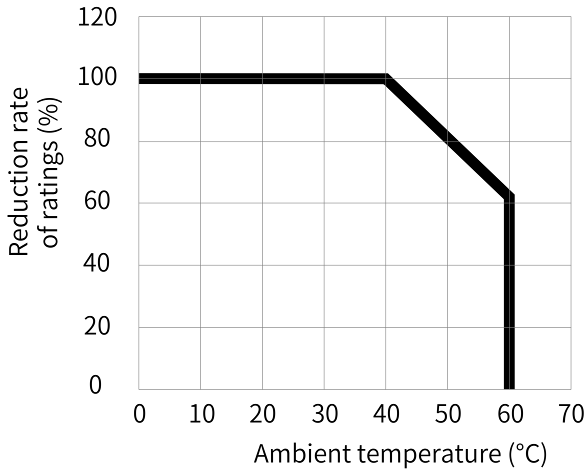


7 Derating characteristics

■ Derating curve for altitude



■ Derating curve for high temperature



1.3 Servo System Configurations

■ 220 V:

Rated Speed	Maximum Speed	Capacity	Servo Motor Model		Motor Frame	Servo Drive Model SV660N****I		Size of the Servo Drive	Servo Drive SN (H01-02)
						Single-Phase 220 VAC	Three-Phase 220 VAC		
3000 RPM	6000 RPM	50 W	MS1H1 (Low inertia, small capacity)	05B30CB	40	S1R6		A	00002
		200 W		20B30CB	60	S1R6		A	00002
		400 W		40B30CB	60	S2R8		A	00003
		550 W		55B30CB	80	S5R5		B	00005
		750 W		75B30CB	80	S5R5		B	00005
		1000 W		10C30CB	80	S7R6		C	00006
		1000 W	MS1H2 (Low inertia, medium capacity)	10C30CB	100	S7R6		C	00006
	5000 RPM	1500 W		15C30CB	100	S012		D	00007
1500 RPM	3000 RPM	850 W	MS1H3 (Medium inertia, medium capacity)	85B15CB	130	S6R6		B	60005
						S7R6		C	00006
		1300 W		13C15CB	130	S012		D	00007
3000 RPM	6000 RPM	400 W	MS1H4 (Medium inertia, small capacity)	40B30CB	60	S2R8		A	00003
		750 W		75B30CB	80	S5R5		A	00005

NOTE

◆ S6R6 models support single-phase 220 V power supply. Derate to 70% upon single-phase input.

◆ S7R6 and S012 models support single-phase 220 V power supply. Derating is not required upon single-phase input.

■ 380 V:

Rated Speed	Maxiumum Speed	Capacity	Servo Motor Model		Motor Frame	Servo Drive Model SV660N****I Three-phase 380 VAC	Size of the Servo Drive	Servo Drive SN (H01-02)
3000 RPM	6000 RPM	1000 W	MS1H2 (Low inertia, medium capacity)	10C30CD	100	T5R4	C	10002
	5000 RPM	1500 W		15C30CD	100	T5R4	C	10002
		2000 W		20C30CD	100	T8R4	D	10003
		2500 W		25C30CD	100	T8R4	D	10003
		3000 W		30C30CD	130	T012	D	10004
		4000 W		40C30CD	130	T017	E	10005
		5000 W		50C30CD	130	T017	E	10005
1500 RPM	3000 RPM	850 W	MS1H3 (medium inertia, medium capacity)	85B15CD	130	T3R5	C	10001
		1300 W		13C15CD	130	T5R4	C	10002
		1800 W		18C15CD	130	T8R4	C	10003
		2900 W		29C15CD	180	T012	D	10004
		4400 W		44C15CD	180	T017	E	10005
		5500 W		55C15CD	180	T021	E	10006
		7500 W		75C15CD	180	T026	E	10007

1.4 Cable Models

Table 1-1 Cables for MS1 terminal-type (Z) motors with front cable outlet

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M107-3.0	S6-L-M107-5.0	S6-L-M107-10.0
Power cable (with brake)	S6-L-B107-3.0	S6-L-B107-5.0	S6-L-B107-10.0
Absolute encoder cables	S6-L-P124-3.0	S6-L-P124-5.0	S6-L-P124-10.0
Incremental encoder cables	S6-L-P114-3.0	S6-L-P114-5.0	S6-L-P114-10.0

Table 1-2 Cables for MS1 terminal-type (Z) motors with rear cable outlet

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M108-3.0	S6-L-M108-5.0	S6-L-M108-10.0
Power cable (with brake)	S6-L-B108-3.0	S6-L-B108-5.0	S6-L-B108-10.0
Absolute encoder cables	S6-L-P125-3.0	S6-L-P125-5.0	S6-L-P125-10.0
Incremental encoder cables	S6-L-P115-3.0	S6-L-P115-5.0	S6-L-P115-10.0

Table 1-3 Flexible cables for MS1 terminal-type (Z) motors with front cable outlet

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M107-3.0-T	S6-L-M107-5.0-T	S6-L-M107-10.0-T
Power cable (with brake)	S6-L-B107-3.0-T	S6-L-B107-5.0-T	S6-L-B107-10.0-T
Absolute encoder cables	S6-L-P124-3.0-T	S6-L-P124-5.0-T	S6-L-P124-10.0-T
Incremental encoder cables	S6-L-P114-3.0-T	S6-L-P114-5.0-T	S6-L-P114-10.0-T

Table 1-4 Flexible cables for MS1 terminal-type motors with rear cable outlet

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M108-3.0-T	S6-L-M108-5.0-T	S6-L-M108-10.0-T
Power cable (with brake)	S6-L-B108-3.0-T	S6-L-B108-5.0-T	S6-L-B108-10.0-T
Absolute encoder cables	S6-L-P125-3.0-T	S6-L-P125-5.0-T	S6-L-P125-10.0-T
Incremental encoder cables	S6-L-P115-3.0-T	S6-L-P115-5.0-T	S6-L-P115-10.0-T

Table 1-5 Cables for MS1 lead wire-type (S) motors with front cable outlet

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M100-3.0	S6-L-M100-5.0	S6-L-M100-10.0
Power cable (with brake)	S6-L-B100-3.0	S6-L-B100-5.0	S6-L-B100-10.0
Absolute encoder cables	S6-L-P120-3.0	S6-L-P120-5.0	S6-L-P120-10.0
Incremental encoder cable	S6-L-P110-3.0	S6-L-P110-5.0	S6-L-P110-10.0

Table 1-6 Flexible cables for MS1 lead wire-type (S) motors with front cable outlets

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M100-3.0-T	S6-L-M100-5.0-T	S6-L-M100-10.0-T
Power cable (with brake)	S6-L-B100-3.0-T	S6-L-B100-5.0-T	S6-L-B100-10.0-T
Absolute encoder cables	S6-L-P120-3.0-T	S6-L-P120-5.0-T	S6-L-P120-10.0-T
Incremental encoder cable	S6-L-P110-3.0-T	S6-L-P110-5.0-T	S6-L-P110-10.0-T

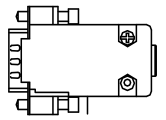
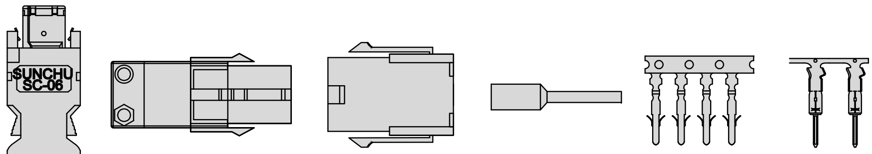
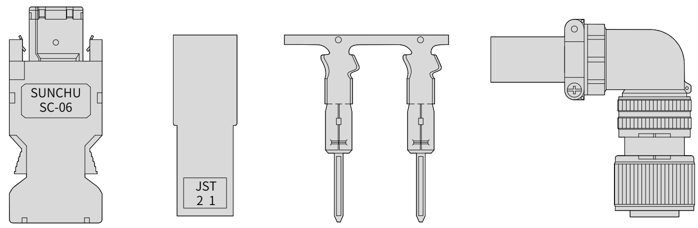
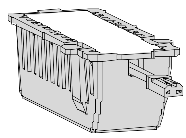
Table 1-7 Cables for MS1H3 motors

Cable Type	Cable Length (m)		
	3.0	5.0	10.0
Power cable (without brake)	S6-L-M111-3.0	S6-L-M111-5.0	S6-L-M111-10.0
Power cable (with brake)	S6-L-B111-3.0	S6-L-B111-5.0	S6-L-B111-10.0
Absolute encoder cables	S6-L-P121-3.0	S6-L-P121-5.0	S6-L-P121-10.0
Incremental encoder cable	S6-L-P111-3.0	S6-L-P111-5.0	S6-L-P111-10.0

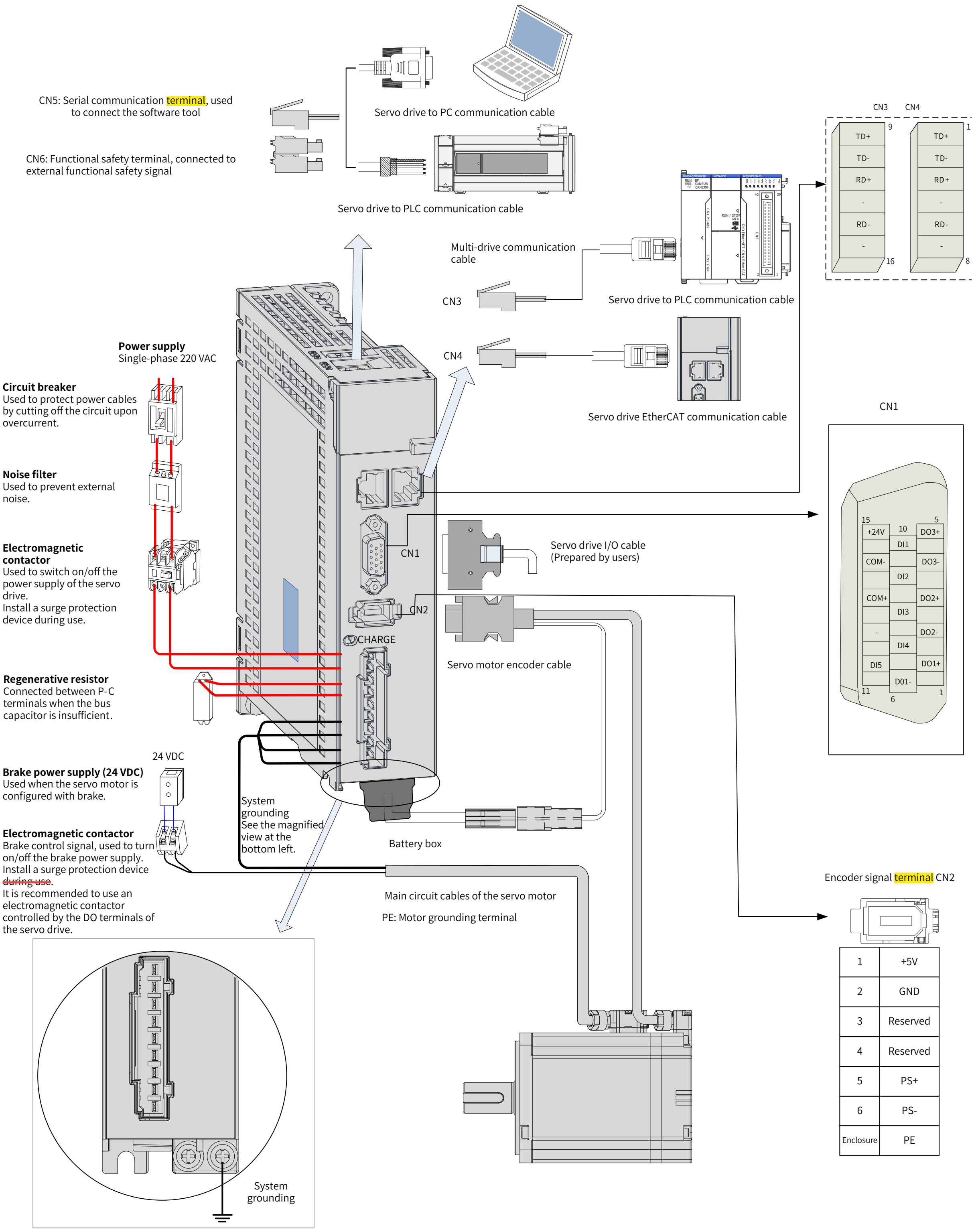
1.5 Communication Cable Options

Model	Description
S6-L-T00-3.0	Cable for communication between the servo drive and PC
S6-L-T04-0.3	Cable for parallel communication of multiple servo drives
S6-L-T03-0.0	Cable for communication between the servo drive and the host controller

1.6 Connector Kit

Connector Kit	Outline Drawing
S6-C6	 (DB15C plug)
S6-C26	 6-pin male; 9-pin connector; Pin base; Insulated terminal; Crimping terminal
S6-C29	 6-pin male; Base; Crimping terminal; Aviation plug
S6-C36	

1.7 Servo System Wiring Diagram



The servo drive is directly connected to an industrial power supply, with no isolation such as a transformer. To prevent cross electric shock, install a fuse or a circuit breaker on the input power supply. The servo drive is not configured with the built-in protective grounding circuit. For the sake of safety, install a residual current device (RCD) to provide protections against overload and short circuit or install a specialized RCD to match the protective grounding.

Do not run or stop the motor by using the electromagnetic contactor. As a high-inductance device, the motor may generate high voltage instantaneously, which may damage the contactor.

Pay attention to the power capacity when connecting an external control power supply or a 24 VDC power supply, especially when the power supply is used to power up multiple servo drives or brakes. Insufficient power supply will lead to insufficient supply current, resulting in failure of the servo drive or the brake. The brake must be powered by a 24 VDC power supply, and the brake power must match the motor model and meet the brake power requirements.

2 Installation

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

CAUTION	
	◆ Abide by the installation direction described in this chapter. Failure to comply may result in device faults or damages. ◆ Do not run a damaged or defective device. Failure to comply will result in physical injuries. ◆ Do not install the device in an environment exposed to water or corrosive matters. Failure to comply will result in device faults. ◆ Do not install the device near combustible gases or combustible materials. Failure to comply will result in a fire or electric shock. ◆ Install the device inside a fire-proof cabinet with electrical protections. Failure to comply may result in a fire. ◆ Ensure the specified spacing is reserved between the servo drive and the interior surface of the electric cabinet and other machines. Failure to comply will result in a fire or device faults. ◆ Do not put heavy objects on the device. Failure to comply may result in physical injuries or device damages. ◆ Do not exert large impact force on the device. Failure to comply may result in device damages. ◆ Do not block the air inlet/outlet port of the servo drive, or allow foreign matters to fall into the device. Failure to comply may result in a fire or device faults.

2.1 Installation of the Servo Drive

2.1.1 Installation Location

■ Install the servo drive into a cabinet free from sunlight and rain.

■ Install the servo drive in a place that meets the following requirements:

a) Free from corrosive and inflammable gases and combustible materials, such as the hydrogen sulfide, chlorine, anmonia, sulphur gas, chloridize gas, acid, soda and salt

b) Free from high temperature, humidity, dusts and metal powders

c) Free from vibration

d) Pollution degree: PD2

2.1.2 Environment Conditions

Table 2-1 Installation environment

Item	Description
Ambient operating temperature	0°C –55°C (The average load ratio cannot exceed 80% when the ambient temperature is within 45°C to 55°C .) (non-freezing)
Ambient operating humidity	Below 90% RH (without condensation)
Storage temperature	-20°C to +70°C (non-freezing)
Storage humidity	Below 90% RH (without condensation)
Vibration	Below 4.9 m/s^2
Impact	Below 19.6 m/s^2
IP rating	IP20
Altitude	Below 1000 m

2.1.3 Dimension Drawings

■ Size A: SV660NS1R6I, SV660NS2R8I

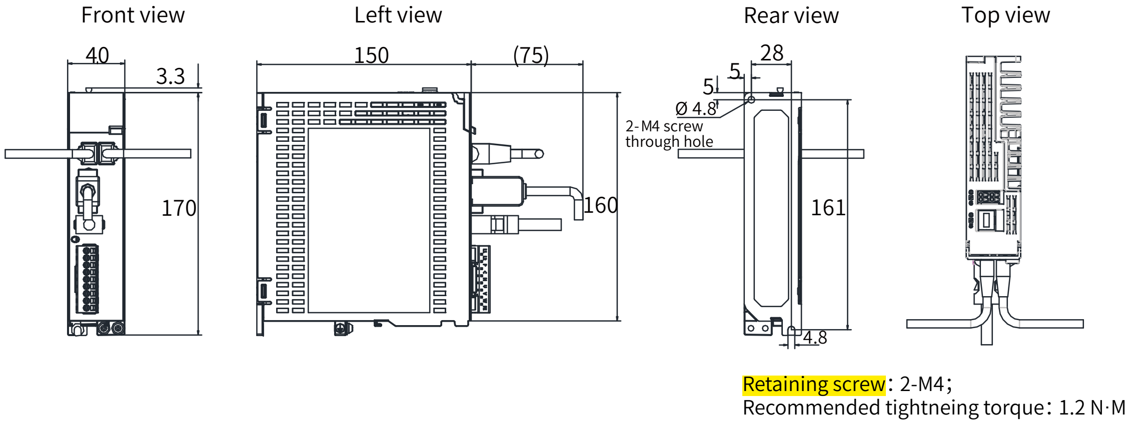


Figure 2-1 Outline dimensions of size A (unit: mm)

■ Size B: SV660NS5R5I, SV660NS6R6I

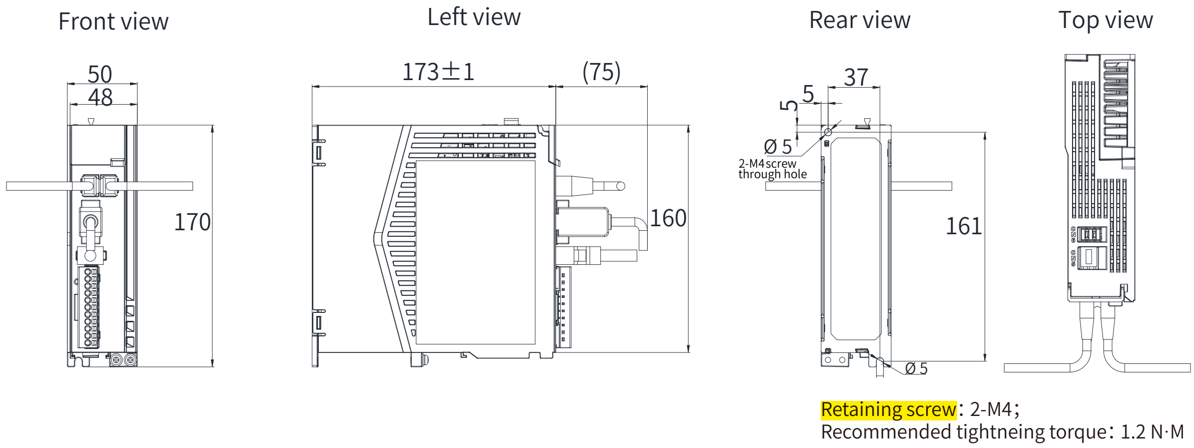


Figure 2-2 Outline dimensions of size B (unit: mm)

■ Size C：SV660NS7R6I, SV660NT3R5I, SV660NT5R4I

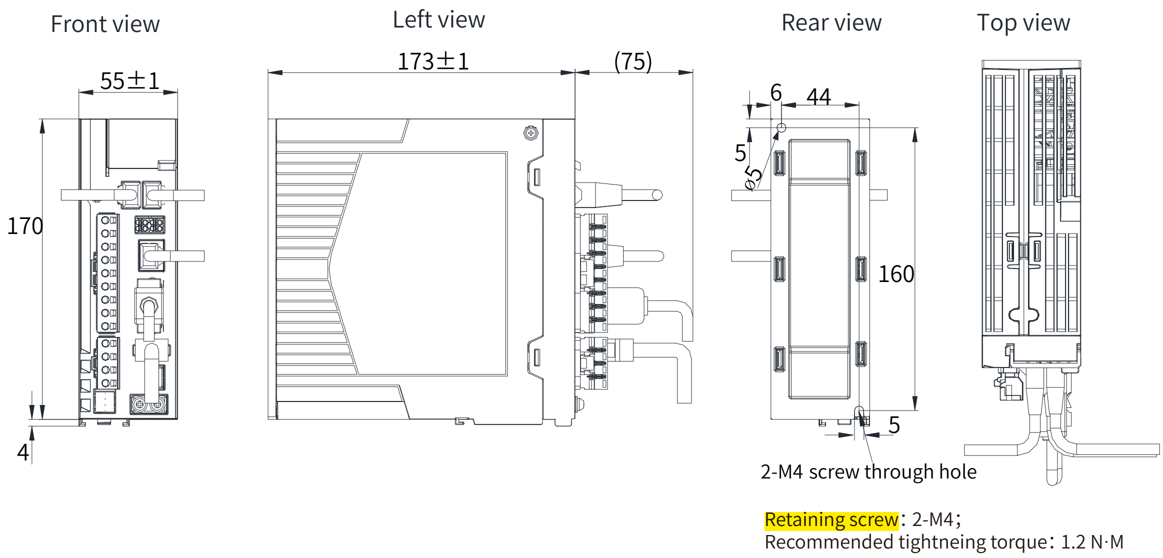


Figure 2-3 Outline dimensions of size C (unit: mm)

■ Size D：SV660NS012I, SV660NT8R4I, SV660NT012I

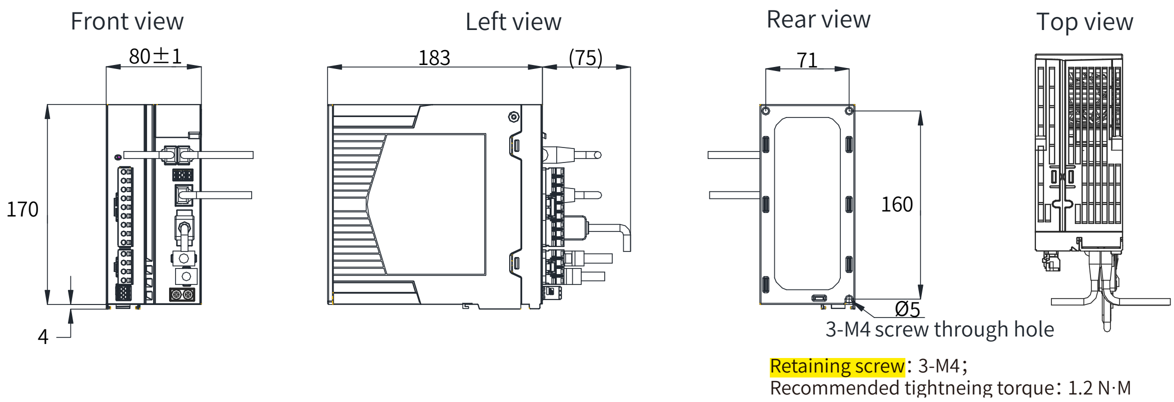


Figure 2-4 Outline dimensions of size D (unit: mm)

■ Size E：SV660NT017I, SV660NT021I, SV660NT026I

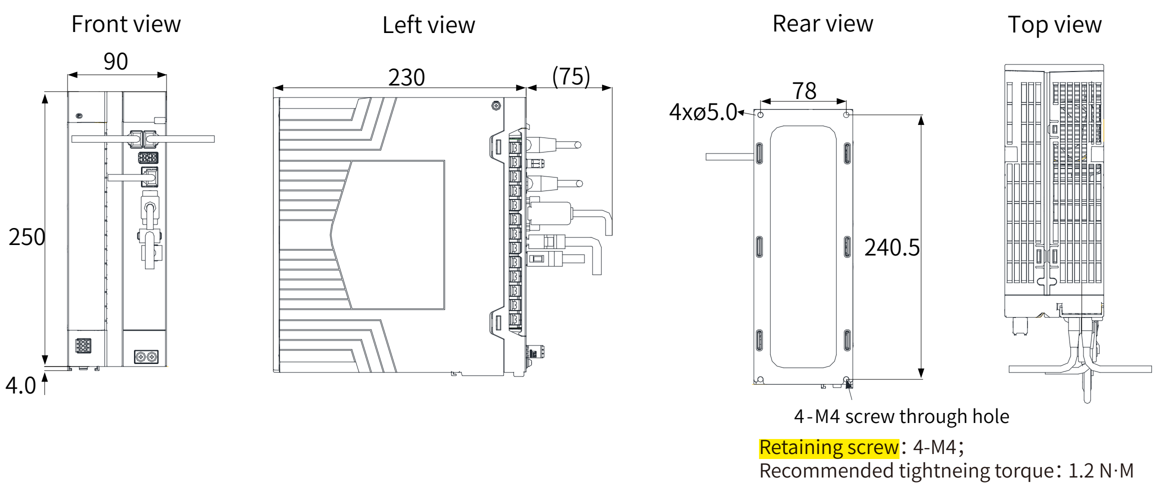


Figure 2-5 Outline dimensions of size E (unit: mm)

2.1.4 Installation

■ Installation Method

Ensure the servo drive is installed vertically to the wall, with its front (actual mounting side) facing the operator. Cool the servo drive down with natural convection or a cooling fan. Fix the servo drive securely on the mounting surface through two to four mounting holes (number of mounting holes depends on the capacity of the servo drive).

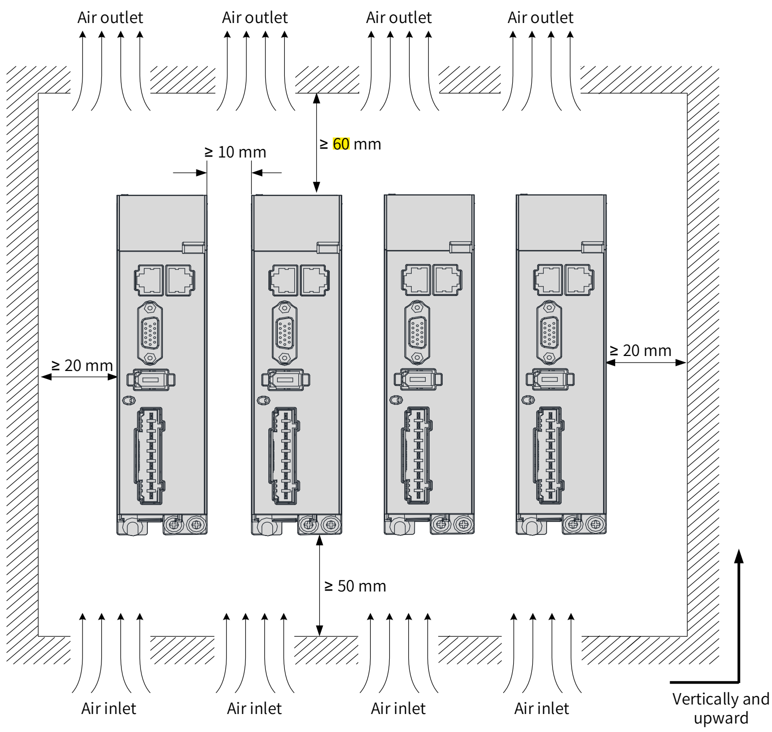
■ Cooling

As shown in Figure 2-3, reserve sufficient space around the servo drive to ensure proper cooling by the cooling fan or natural convection. Install the cooling fan on the upper part of the servo drive to avoid excessive temperature rise in a certain region and maintain an even temperature inside the electric cabinet.

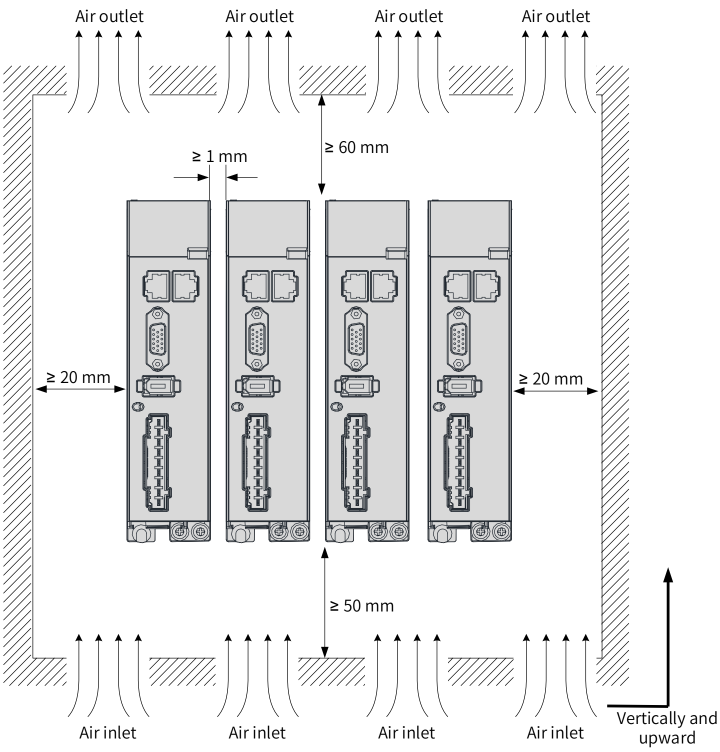
■ Installation

When installing multiple servo drives side by side, reserve a clearance of at least 10 mm between two servo drives and at least 50 mm above and below each servo drive for heat dissipation purpose.

In compact installation, take the installation tolerance into account and reserve a clearance of at least 1 mm between every two servo drives. In this case, derate to below 75% of the actual load ratio during use.



Regular installation



Compact installation

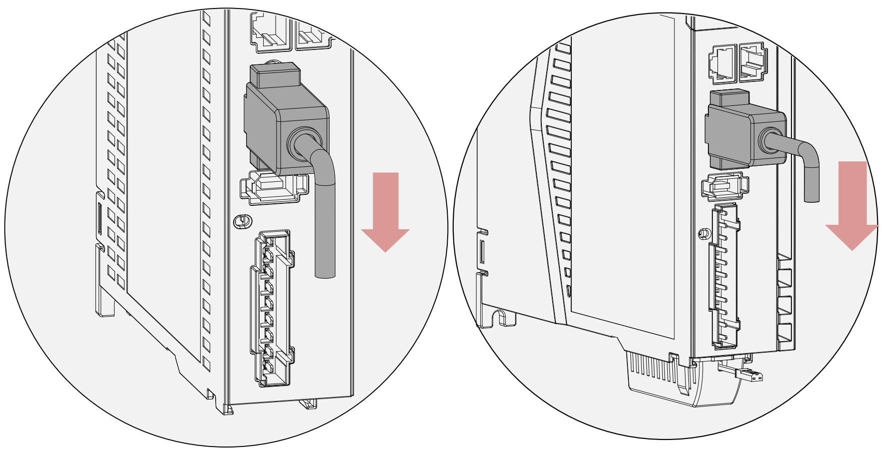
Figure 2-6 Installation of the servo drive

■ Grounding

The grounding terminal must be grounded properly. Failure to comply may cause electric shock or malfunction due to interference.

■ Cable Direction

As shown in the following figure, route the servo drive cables with outlet facing downwards to prevent any liquid from flowing into the servo drive.



Route the cable downwards

Route the cable downwards

Figure 2-7 Cable layout of servo drives in size A and size B

■ Dust-proof cover

Insert the dust-proof cover into the idle CN5 port. This is to prevent foreign objects (such as solids or liquids) from falling into the servo drive and causing faults.

Each servo drive is equipped with two dust-proof covers in standard configuration. Such dust-proof covers can be purchased separately as needed (model: NEX-02-N2B; manufacturer: PINGOOD).

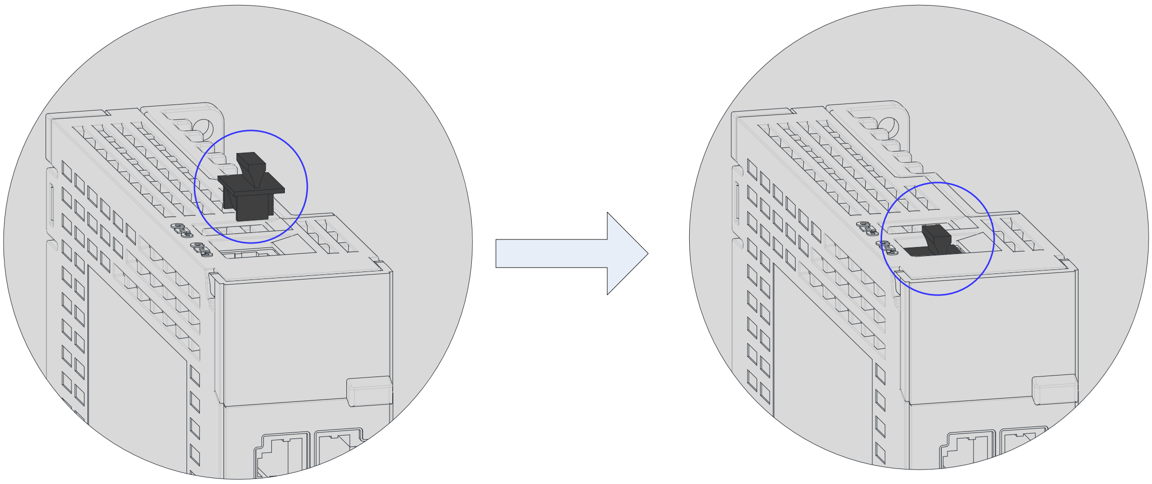


Figure 2-8 Mounting of the dust-proof cover

NOTE

◆ Dust-proof cover: Prevents foreign objects (such as solids or liquids) from falling into the product and causing faults.

◆ The dust-proof cover is delivered along with the servo drive. Keep the dust-proof cover in a proper place.

2.2 Installation of the Servo Motor

2.2.1 Installation Location

- Install the servo motor in a place free from corrosive and inflammable gases and combustible materials, such as the hydrogen sulfide, chlorine, anmonia, sulphur gas, chloridize gas, acid, soda and salt.
- Use the servo motor with oil sealing when the motor is used in a place with grinding fluids, oil mists, iron powders or cuttings.
- Install the servo motor away from heating sources such as a heating stove.
- Do not use the servo motor in an enclosed environment. Running in an enclosed environment may cause motor overheat, shortening its service life.

2.2.2 Environment Conditions

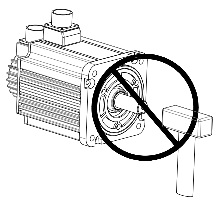
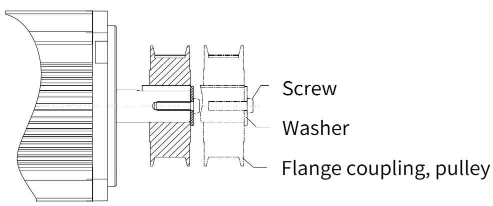
Table 2-2 Installation environment

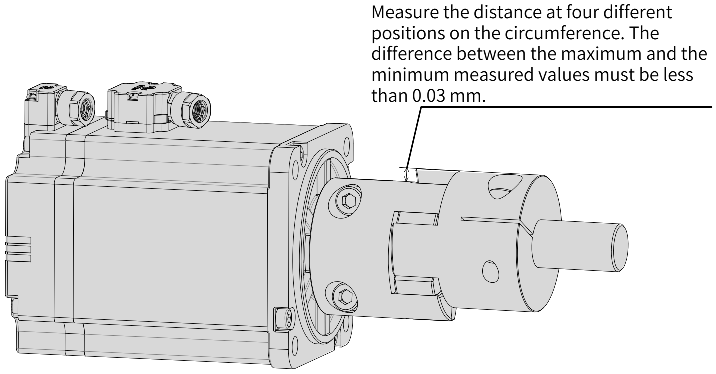
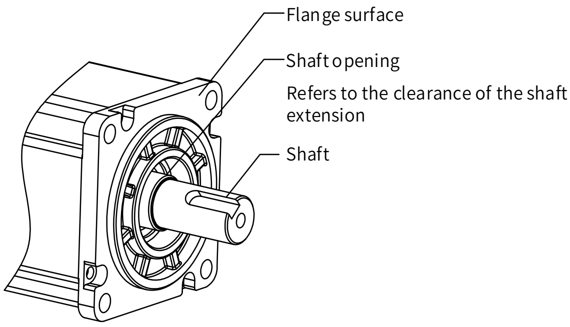
Item	Description
Ambient temperature	0°C to 40°C (non-freezing)
Ambient humidity	20% to 80% RH (without condensation)
Storage temperature	-20°C to +60°C (peak temperature: 80°C for 72 hours)
Storage humidity	20% to 90% RH (without condensation)
Vibration	Below 49 m/s^2
Impact	Below 490 m/s^2

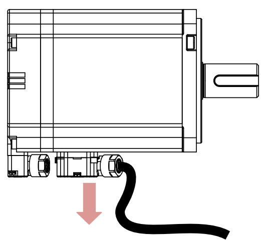
Item	Description
IP rating	H1: IP67 (shaft opening excluded, with power cables and encoder connectors connected properly) H4: IP67 (shaft opening excluded, with power cables and encoder connectors connected properly)
Altitude	Below 1000 m (derating required for altitude above 1000 m)

2.2.3 Installation Precautions

Table 2-3 Installation instructions

Item	Description
Rust-proof treatment	◆ Wipe up the anti-rust agent applied at the motor shaft extension before installing the servo motor, and then take rust-proof treatment.
Encoder	◆ Do not strike the shaft extension during installation. Failure to comply will damage the encoder.  ◆ Use the screw hole at the shaft end when mounting a pulley to the servo motor shaft with a keyway. ◆ To fit the pulley, insert a double-end screw into the screw hole of the shaft. ◆ Put a washer on the surface of the coupling end, and then use a nut to push the pulley in. ◆ For the servo motor shaft with a keyway, use the screw hole at the shaft end. ◆ For the servo motor shaft without a keyway, use friction coupling or similar methods. ◆ When removing the pulley, use a pulley remover to protect the shaft from suffering severe impact from the load. ◆ To ensure safety, install a protective cover or similar device on the rotary area such as the pulley mounted on the shaft. 

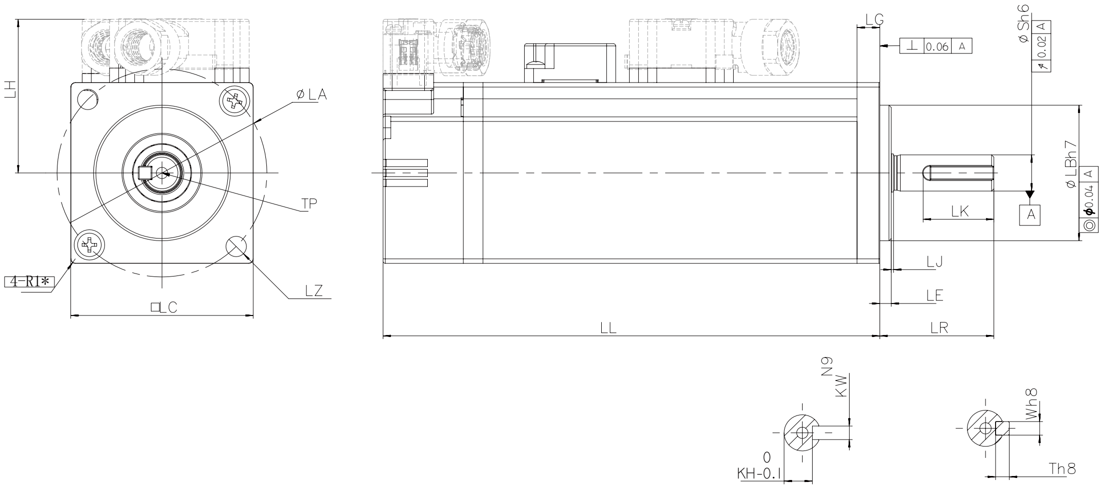
<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>Alignment</td><td>◆ When connecting the servo motor to a machine, use a coupling and keep the motor shaft center and the machine shaft center in the same line.
◆ Make sure the servo motor fulfills the required alignment precision (as shown in the following figure). Failure to comply will result in vibration or damage the bearing and the encoder.

</td></tr>
<tr><td>Installation direction</td><td>◆ The servo motor can be installed horizontally or vertically.</td></tr>
<tr><td>Counter-measures against oil and liquid</td><td>◆ Do not submerge the motor/cable in water or oil.
◆ Check the IP rating of the servo motor when the application location is exposed to water drops (except the shaft opening).


◆ Mount the motor with cable connecting terminal facing downwards if the application location is exposed to liquid. This is to prevent the liquid from flowing into the motor along the cable (as shown in the following figure).

◆ In environments where the shaft opening is exposed to oil drops, use a motor with oil sealing.
◆ Observe the following requirements when using a motor with oil sealing:
1) Make sure the oil level is lower than the oil sealing lip during use.
2) Avoid oil accumulation on the oil sealing lip when the motor is installed vertically upward.</td></tr>
<tr><td>Stress of cables</td><td>◆ Do not bend or apply tension to the cables, especially the signal cables whose core wire is only 0.2 mm or 0.3 mm in thickness. Do not pull the cables too tight during wiring.</td></tr>
</table>

Item	Description
Connectors	◆ Observe the following requirements: 1) When connecting the connectors, make sure there is no waste or sheet metal inside the connector. 2) Connect the connector to the main circuit cable side of the servo motor first, and ensure the grounding cable of the main circuit is connected properly. If the connector is connected to the encoder cable side first, the encoder may become faulty due to the potential difference between PE terminals. 3) Ensure the pins are correctly arranged during wiring. 4) Do not strike the connector as they are made up of resins. 5) When moving a servo motor with cables connected, hold the servo motor by its main body instead of by the cable. Failure to comply may damage the connector or cable. 6) If flexible cables are used, do not apply stress on the connector during wiring. Failure to comply may damage the connector.

2.2.4 Dimension Drawings

1 Flange frame: 40



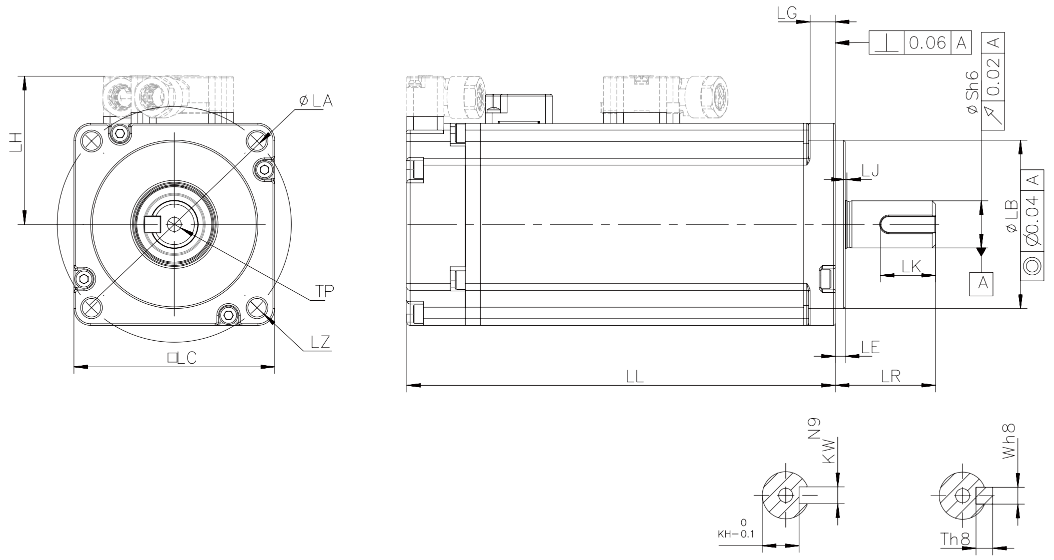
Dimensions of the shaft end

Dimensions of the shaft end with key

Motor Model	LL	LC	LR	LA	LZ	LH	LG	LE	LJ
MS1H1-10B30CB-**30Z	77.5	40	25±0.5	46	2-ϕ4.5	34	5	2.5±0.5	0.5±0.35
MS1H1-10B30CB-**32Z	109	40	25±0.5	46	2-ϕ4.5	34	5	2.5±0.5	0.5±0.35
Motor Model	S	LB	TP	LK	KH	KW	W	T	Weight (kg)
MS1H1-10B30CB-**30Z	8	30	M3x6	15.5	6.2	3	3	3	0.45
MS1H1-10B30CB-**32Z	8	30	M3x6	15.5	6.2	3	3	3	0.64

NOTE	◆ The unit for the dimensions in the preceding table is "mm". ◆ Angle R of the front end cover of Z (terminal-type) series motor in frame 40 is R1. ◆ The tightening torque for screws on the terminal is 0.19 N·m to 0.21 N·m, violation of which may damage the terminal.

2 Flange frame: 60



Dimensions of the shaft end

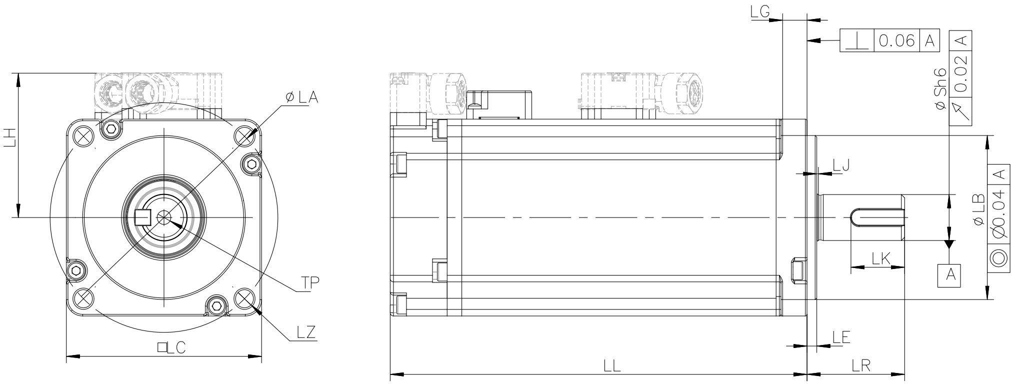
Dimensions of the shaft end with key

Motor Model	LL	LC	LR	LA	LZ	LH	LG	LE	LJ
MS1H1-20B30CB-**31Z	72.5	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
MS1H1-20B30CB-**34Z	100	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
MS1H1-40B30CB-**31Z	91	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
MS1H1-40B30CB-**34Z	119	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
MS1H4-40B30CB-**31Z	105	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
MS1H4-40B30CB-**34Z	128	60	30±0.5	70	4-ϕ5.5	44	7.5	3±0.5	0.5±0.35
Motor Model	S	LB	TP	LK	KH	KW	W	T	Weight (kg)
MS1H1-20B30CB-**31Z	14	50	M5x8	16.5	11	5	5	5	0.78
MS1H1-20B30CB-**34Z	14	50	M5x8	16.5	11	5	5	5	1.16
MS1H1-40B30CB-**31Z	14	50	M5x8	16.5	11	5	5	5	1.11
MS1H1-40B30CB-**34Z	14	50	M5x8	16.5	11	5	5	5	1.48
MS1H4-40B30CB-**31Z	14	50	M5x8	16.5	11	5	5	5	1.27
MS1H4-40B30CB-**34Z	14	50	M5x8	16.5	11	5	5	5	1.62

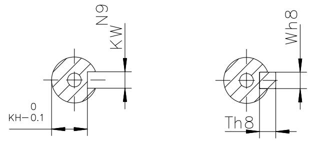
NOTE

- ◆ The unit for the dimensions in the preceding table is "mm".
- ◆ The tightening torque for screws on the terminal is 0.19 N · m to 0.21 N · m, violation of which may damage the terminal.

3 Flange frame: 80



Aviation plug



Dimension of the shaft end

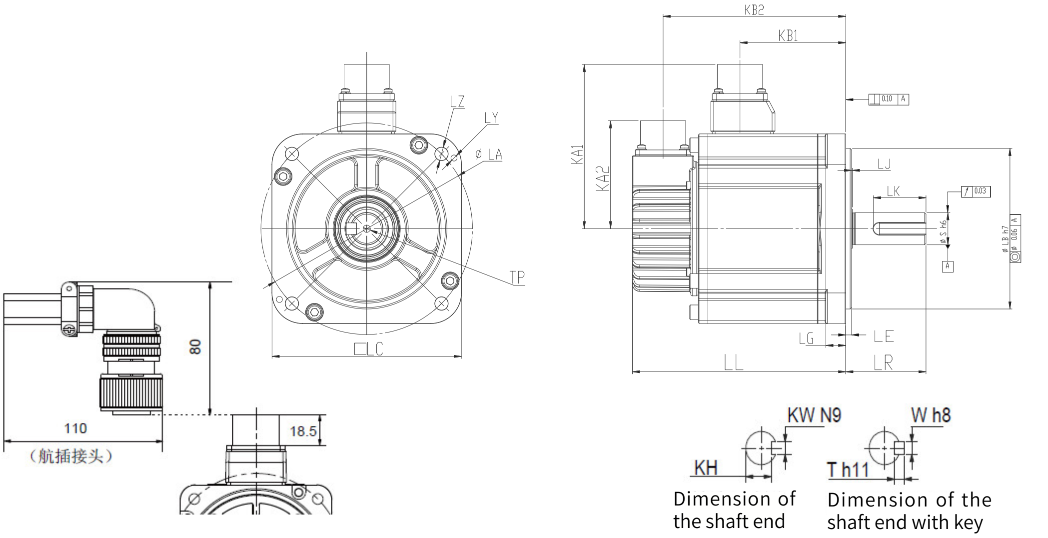
Dimension of the shaft end with key

Motor Model	LL	LC	LR	LA	LZ	LH	LG	LE	LJ
MS1H1-75B30CB-**31Z	107	80	35±0.5	90	4-ϕ7	54	7.7	3±0.5	0.5±0.35
MS1H1-75B30CB-**34Z	140	80	35±0.5	90	4-ϕ7	54	7.7	3±0.5	0.5±0.35
MS1H4-75B30CB-**31Z	117.5	80	35±0.5	90	4-ϕ7	54	7.7	3±0.5	0.5±0.35
MS1H4-75B30CB-**34Z	147.5	80	35±0.5	90	4-ϕ7	54	7.7	3±0.5	0.5±0.35
Motor Model	S	LB	TP	LK	KH	KW	W	T	Weight (kg)
MS1H1-75B30CB-**31Z	19	70	M6x20	25	15.5	6	6	6	2.18
MS1H1-75B30CB-**34Z	19	70	M6x20	25	15.5	6	6	6	2.82
MS1H4-75B30CB-**31Z	19	70	M6x20	25	15.5	6	6	6	2.40
MS1H4-75B30CB-**34Z	19	70	M6x20	25	15.5	6	6	6	3.04

NOTE

- ◆ The unit for the dimensions in the preceding table is "mm".
- ◆ The tightening torque for screws on the terminal is 0.19 N·m to 0.21 N·m, violation of which may damage the terminal.

4 Flange frame: 130

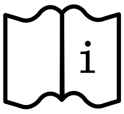


Motor Model	LC	LL	LR	LA	LZ	LY	KA1	KB1	KA2	KB2	LG
MS1H3- 85B15CB-****Z	130	146 (182)	55±1	145	4-Φ9	2-M5	103	72.5	74	125 (161)	14
Motor Model	LE	LJ	LB	S	TP	LK	KH	KW	W	T	Weight (kg)
MS1H3- 85B15CB-****Z	4	0.5±0.75	110	22	M6x20	36	18-0.2	8	8	7	7 (8)

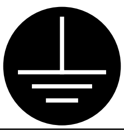
NOTE

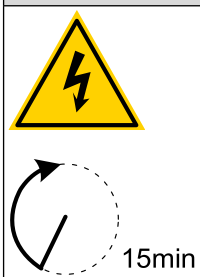
- The unit for the dimensions in the preceding table is "mm".
- Values in the brackets "()" are for the motor with holding brake.

3 Wiring

WARNING	
	◆ Read through the safety instructions in *"Safety Instructions"*. Failure to comply may result in serious consequences.

WARNING	
	◆ Feed the servo drive with power from grounded (TN/TT) systems. Failure to comply may result in electric shock. ◆ Connect an electromagnetic contactor between the input power supply and the main circuit power supply of the servo drive (L1 and L2 for single-phase servo drives; L1, L2, and L3 for three-phase servo drives) to form a structure that allows independent power cutoff on the servo drive power side. This is to prevent fire accidents caused by continuous large current upon fault. ◆ Ensure the input power supply of the servo drive is within the specified voltage range. Otherwise, the servo drive may become faulty. ◆ Do not connect output terminals U, V, and W of the servo drive to a three-phase power supply. Failure to comply may cause physical injuries or fire accidents. ◆ Do not connect the motor connecting terminals U, V, and W to a mains frequency power supply. Failure to comply may cause physical injuries or fire accidents. ◆ Use the ALM (fault signal) to cut off the main circuit power supply. When the braking transistor is faulty, the regenerative resistor may be overheated, leading to a fire accident.

WARNING	
	◆ Connect the PE terminal of the servo drive to the PE terminal of the control cabinet. Failure to comply may cause electric shock. ◆ Ensure the entire system is grounded. Otherwise, malfunction may occur on the servo drive.

WARNING	
	◆ After cutting off the power supply, wait for at least 15 minutes before further operations because residual voltage is still present in the internal capacitor after power-off. Failure to comply may result in electric shock.

CAUTION	
	◆ The specifications and installation method of external cables must comply with applicable local regulations. ◆ Abide by the following requirements when applying the servo drive on a vertical axis. 1) Set the safety device properly to prevent the workpiece from falling under such status as warning and overtravel. 2) Ensure the polarity of the 24 V power supply is correct. Otherwise, the shaft may fall and cause physical injuries or damage the servo drive. ◆ Abide by the following requirements when wiring the power supply and the main circuit: 1) When the main circuit terminal is a connector, remove the connector from the servo drive before wiring. 2) Insert one cable to one terminal of the connector. Do not insert multiple cables to one cable terminal. 3) Insert the cable with enough care to prevent the conductor burrs from being short circuited to the neighboring cable. 4) Insulate the connecting part of the power terminals to prevent electric shock. 5) Do not connect a 220 V servo drive to a 380 V power supply directly. 6) Install safety devices such as a circuit breaker to prevent fire accidents caused by short-circuit in external circuits. 7) Cut off the main circuit power supply and switch from S-ON to S-OFF after a warning signal is detected. ◆ Connect the servo drive to the motor directly. Do not use an electromagnetic contactor during wiring. Failure to comply may cause faults. ◆ Do not put heavy objects onto the cables or pull the cable with large force. Otherwise electric shock may occur due to cable damage. ◆ When connecting DO terminals to relays, ensure the polarity of the flywheel diode is connected correctly. Otherwise, the servo drive will be damaged and the signal output may be abnormal. ◆ Reserve a clearance of at least 30 cm between main circuit cables and I/O signal/encoder cables. Failure to comply may cause malfunction of the servo drive. ◆ Use twisted pair cables or multi-core shielded twisted cables as the I/O signal/encoder cables. Failure to comply may cause malfunction of the servo drive. ◆ The maximum wiring length of the I/O signal cable and the encoder cable is 3 m and 20 m respectively. ◆ Use a noise filter to reduce the electromagnetic interference on electronic devices surrounding the servo drive. ◆ To prevent damage to the servo drive, take proper shielding measures when the servo drive is used in the following application locations: 1) Locations suffering from interferences caused by static electricity 2) Locations suffering from strong electric field or strong magnetic field 3) Locations with radioactive rays

3.1 Terminal Pin Layout

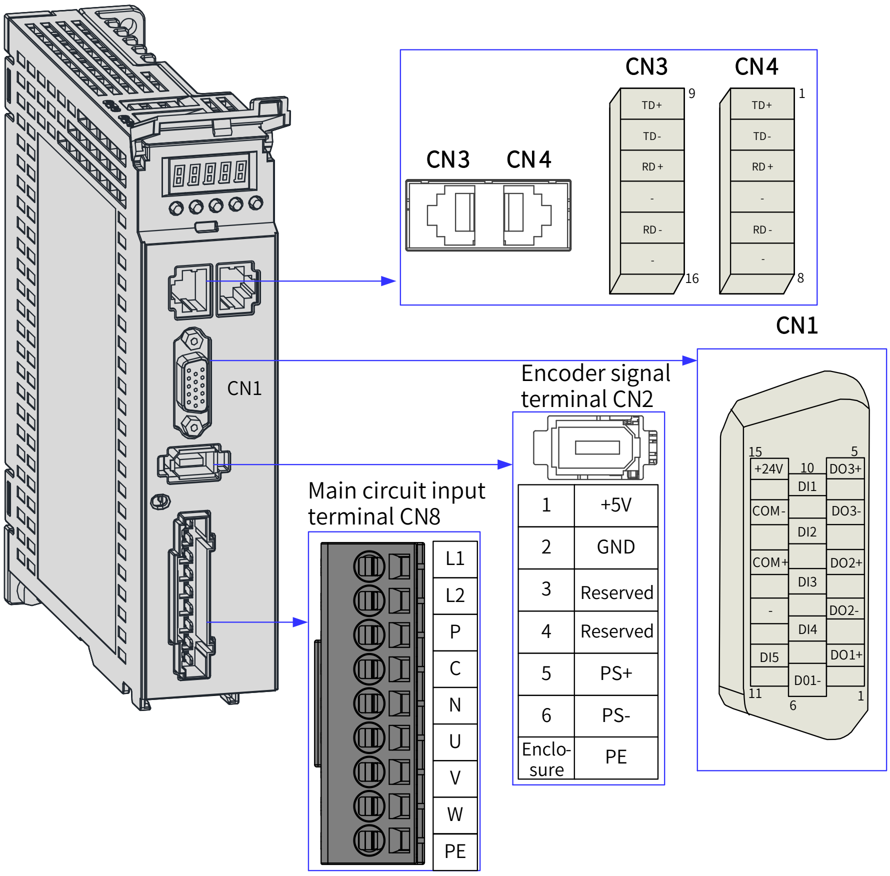


Figure 3-1 Terminal pin layout of servo drives in size A

The preceding figure shows the pin layout of the servo drive terminals.

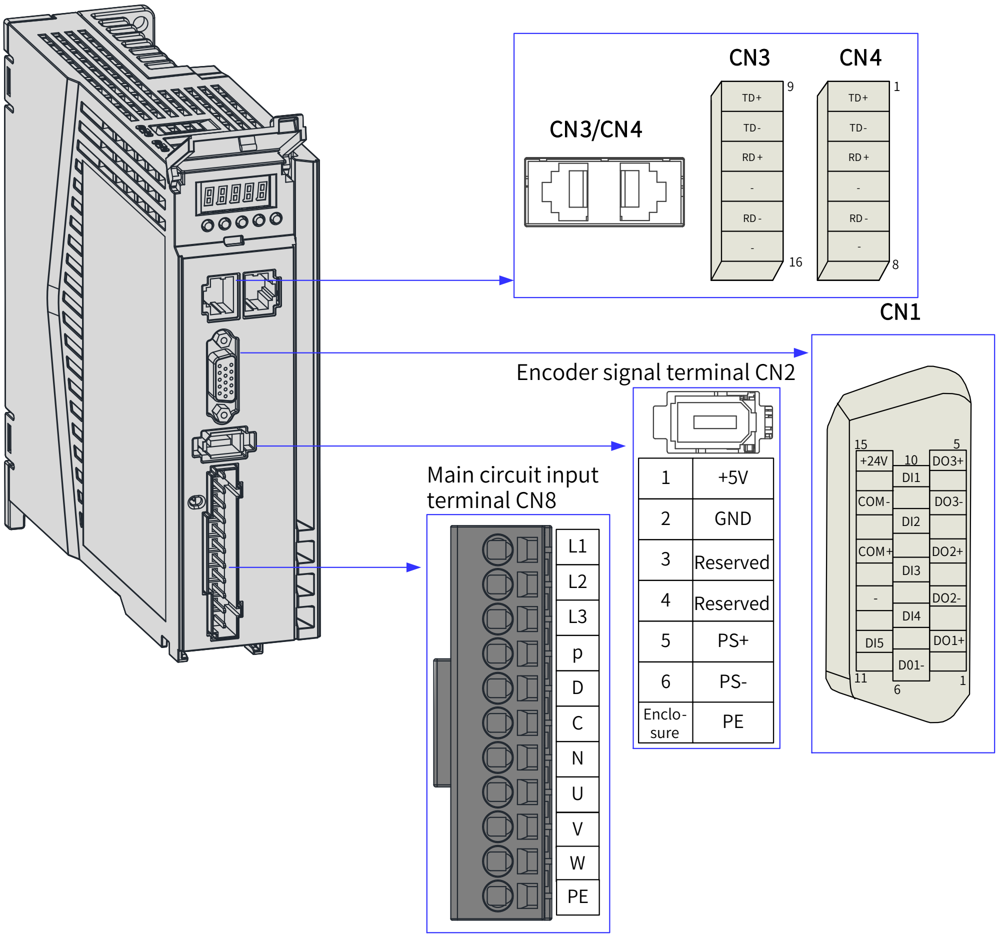


Figure 3-2 Terminal pin layout of servo drives in size B

The preceding figure shows the pin layout of the servo drive terminals.

3.2 Wiring of the Main Circuit

3.2.1 Main Circuit Terminals

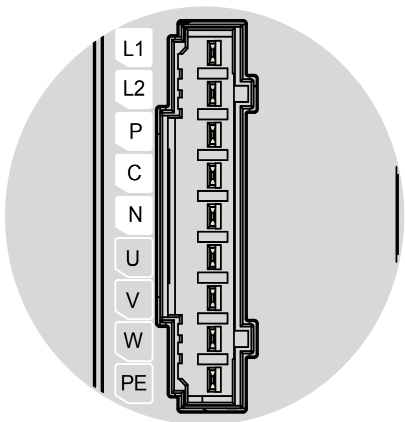


Figure 3-3 Main circuit terminal pin layout of servo drives in size A

Table 3-1 Names and functions of main circuit terminals of servo drives in size A

No.	Component Name	Description
1	L1, L2 (Power input terminals)	See the nameplate for the control circuit power input of the rated voltage class.
2	P, N (DC bus terminals)	Used as the common DC bus for multiple servo drives.
	P, C (Terminals for connecting external regenerative resistor)	Connected between P and C when an external regenerative resistor is needed.
3	U, V, W (Servo motor connecting terminals)	Connected to U, V, and W phases of the servo motor.
4	PE (Grounding terminal)	Connected to the grounding terminals of the power supply and the motor.

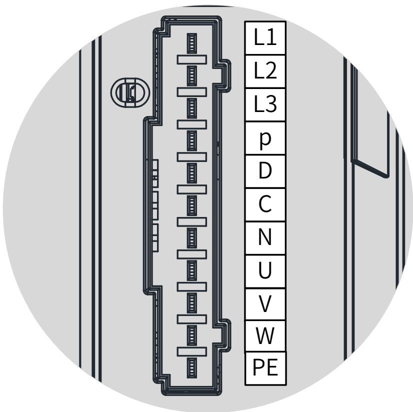


Figure 3-4 Main circuit terminal pin layout of servo drives in size B

Table 3-2 Names and functions of main circuit terminals of servo drives in size B

No.	Component Name	Description
1	L1, L2, L3 (Power input terminals)	See the nameplate for the power input of the rated voltage class. Note: ◆ 750 W servo drives: Single-phase 220 V input, with 220 V power supply connected to L1 and L2 ◆ 850 W servo drives: Single-phase/Three-phase 220 V input, with 220 V power supply connected to L1, L2, and L3 during three-phase input or connected to any two phases among L1, L2, and L3 during single-phase input (derate 80%)
2	P, N (DC bus terminals)	Used as the common DC bus for multiple servo drives.
	P, D, C (Terminals for connecting external regenerative resistor)	An external regenerative resistor is connected between P and C as needed. The servo drive in size B is equipped with a built-in regenerative resistor and terminals P and D are shorted by default.
3	U, V, W (Servo motor connecting terminals)	Connected to U, V, and W phases of the servo motor.
4	PE (Grounding terminal)	Connected to the grounding terminals of the power supply and the motor.

3.2.2 Wiring Example of the Regenerative Resistor

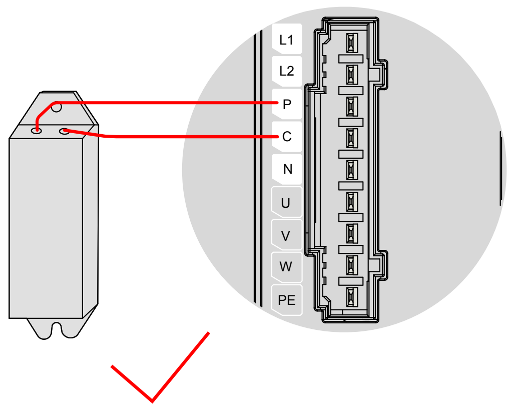


Figure 3-5 Connection of the external regenerative resistor

WARNING

Abide by the following requirements when connecting the external regenerative resistor:

- ◆ Remove the jumper between P and D before using the external regenerative resistor. Failure to comply will cause overcurrent and damage the braking transistor.
- ◆ Do not connect the external regenerative resistor to the positive/negative pole of the bus directly. Failure to comply will damage the servo drive and cause a fire.
- ◆ Do not select any resistor with resistance lower than the minimum permissible value. Failure to comply will result in E201 (Overcurrent) or damage the servo drive.
- ◆ Make sure parameters H02-25 (Regenerative resistor setting), H02-26 (Power of external regenerative resistor) and H02-27 (Resistance of external regenerative resistor) are set properly before use.
- ◆ Install the external regenerative resistor on incombustible objects such as metal.

3.2.3 ~~Recommended Models and~~ Specifications of Main Circuit Cables

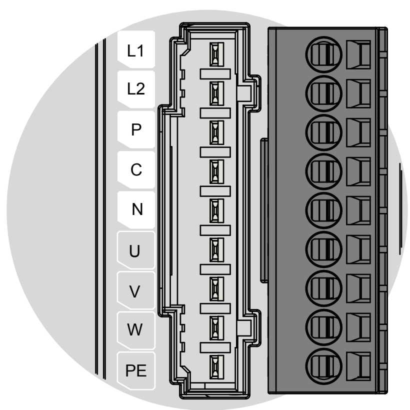


Figure 3-6 Main circuit terminal block of the servo drive

Table 3-3 Current specifications of the servo drive

Servo Drive Model SV660N****I		Rated Input Current (A)	Rated Output Current (A)	Maximum Output Current (A)
SIZE-A	S1R6	2.3	1.6	5.8
	S2R8	4.0	2.8	10.1
SIZE-B	S5R5	7.9 (Single-phase)	5.5	16.9
	S6R6	3.7 (Three-phase)	6.6	16.5
SIZE C	S7R6	5.1	7.6	23
	T3R5	2.4	3.5	11
	T5R4	3.6	5.4	14
SIZE D	S012	8.0	11.6	32
	T8R4	5.6	8.4	20
	T012	8.0	11.9	29.75
SIZE E	T017	12.0	16.5	41.25
	T021	16.0	20.8	52.12
	T026	21.0	25.7	64.25

Table 3-4 Recommended main circuit cables ~~and models~~

No.	Series	Servo Drive Model	Rated Input Current (In)	L1, L2		Rated Output Current (Out)	U, V, W		PE	
				mm^2	AWG		mm^2	AWG	mm^2	AWG
Single-phase 220 V										
1	Size A	SV660NS1R6I	2.30	2x0.5	20	1.60	2x0.5	20	0.50	20
2		SV660NS2R8I	4.00	2x0.5	20	2.80	2x0.5	20	0.50	20
3	Size B	SV660NS5R5I	7.90	2x0.75	18	5.50	2x0.75	18	0.75	18
Three-phase 220 V										
4	Size B	SV660NS6R6I	3.70	2x0.75	18	6.60	2x0.75	18	0.75	18

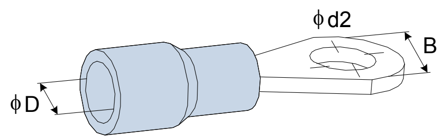
See *"3.2.5 Precautions for Main Circuit Wiring"* for details.

Table 3-5 Recommended grounding cable lug of the main circuit

Servo Drive Model SV660N****I		PE
Size A	S1R6	TVR 2-4
	S2R8	TVR 2-4
Size B	S5R5	TVR 2-4
	S6R6	TVR 2-4

Reference data for recommended cable lugs (Manufacturer: Suzhou Yuanli Metal Enterprise Co., Ltd)

Table 3-6 Dimensions and outline drawing of the grounding cable lug

Cable Lug Model		D (mm)	d2 (mm)	B (mm)	Outline Drawing
TVR	2-4	4.5	4.3	8.5	

Use the following types of cables for the main circuit.

Table 3-7 Recommended main circuit cables

Cable Type		Allowable Temperature (°C)
Model	Name	
PVC	General PVC cable	-
IV	PVC cable with a rated voltage of 600 V	60
HIV	Special PVC cable with heat-resistance capacity	75

For three-cable applications, the relation between AWG specification and the allowable current is shown in the following table.

Note that the values listed in the table cannot be exceeded during use.

Table 3-8 Specifications for three-cable applications

AWG Specification	Nominal Cross Sectional Area (mm^2)	Allowable Current in Different Ambient Temperatures (A)		
		30°C	40°C	50°C
20	0.519	8	7	6
19	0.653	9	8	7
18	0.823	13	11	9
16	1.31	18	15	12
14	2.08	26	23	20
12	3.31	32	28	26
10	5.26	48	43	38
8	8.37	70	65	55
6	13.3	95	85	75

3.2.4 Power Supply Wiring Example

■ Single-phase 220 V models: SV660NS1R6I, SV660NS2R8I, and SV660NS5R5I

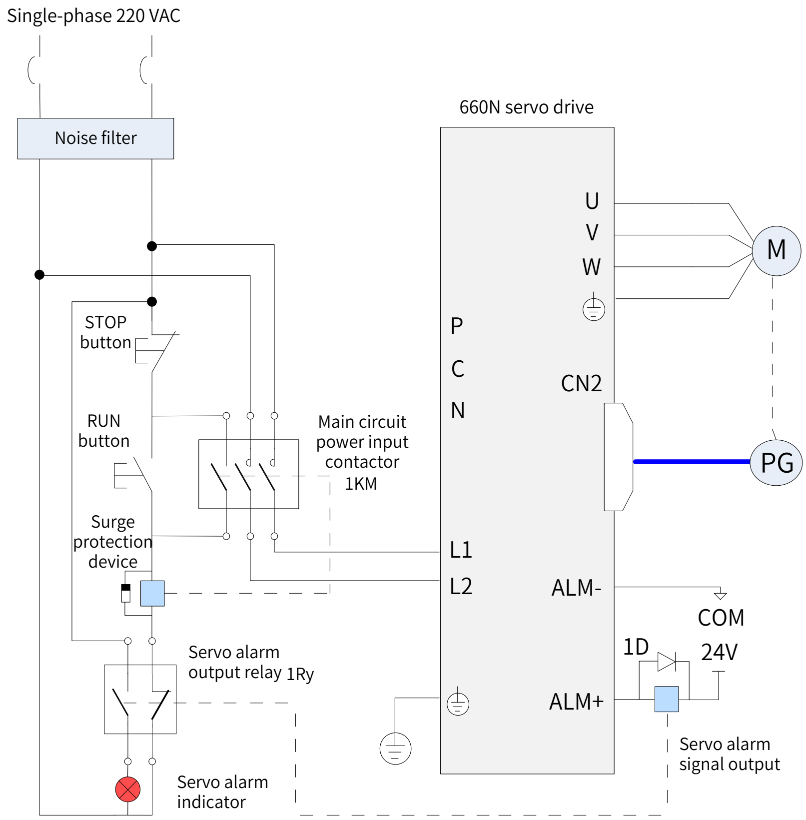


Figure 3-7 Main circuit wiring of single-phase 220 V models

NOTE

- 1KM: Electromagnetic contactor; 1Ry: Relay; 1D: Flywheel diode
- DO is set as alarm output (ALM+/-). When the servo drive alarms, the power supply will be cut off automatically. SV660NS1R6 and SV660NS2R8 are not configured with a built-in regenerative resistor, connect an external regenerative resistor between P and C as needed.

- Three-phase 220 V Models: SV660NS6R6I

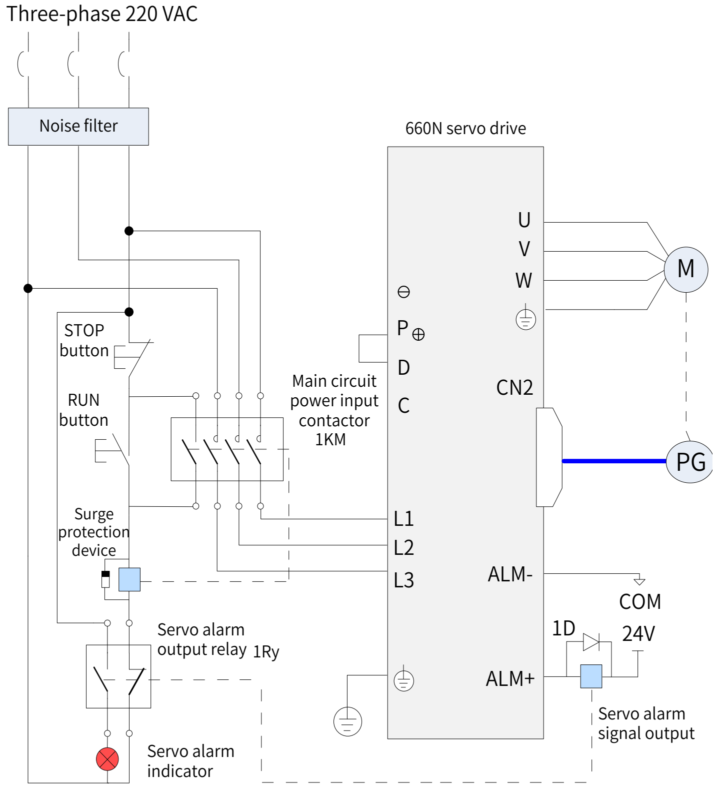


Figure 3-8 Main circuit wiring of three-phase 220 V models

NOTE

- 1KM: Electromagnetic contactor; 1Ry: Relay; 1D: Flywheel diode
- DO is set as alarm output (ALM+/-). When the servo drive alarms, the power supply will be cut off automatically and the alarm indicator will be turned on.

3.2.5 Precautions for Main Circuit Wiring

- Do not connect the input power cables to the output terminals U, V and W. Failure to comply will damage the servo drive.
- When cables are bundled in a duct, the cooling effect will be deteriorated. In this case, take the reduction ratio of the allowable current into consideration.
- When the temperature inside the cabinet is higher than the temperature limit of the cable, it is recommended to use a Teflon cable with a higher temperature limit. As the surface of regular cables may be easily hardened and cracked under a low temperature, take thermal insulation measures for cables laid in a low-temperature environment.
- The bending radius of a cable must be 10 times longer than its outer diameter to prevent the internal conductor from breaking due to long-time bending.
- Use cables with a rated voltage above 600 VAC and rated temperature above 75° C. Under 30° C ambient temperature and normal cooling conditions, the allowable current density of the cable cannot exceed 8 A/mm^2 when the total current is below 50 A, or 5 A/mm^2 when the total current is above 50 A. The allowable current density (A/mm^2) can be adjusted based on the following formula in the case of high ambient temperature or bundled cables.

Allowable current density = 8 x Reduction coefficient of conductor current-carrying density x Current correction coefficient

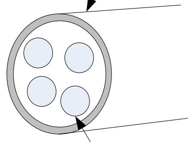


Table 3-9 Reduction coefficient of current-carrying density of the conductor

Number of Cables in the Same Duct	Current Reduction Coefficient
Less than 3	0.7
4	0.63
5–6	0.56
7–15	0.49

- Do not bundle power cables and signal cables together or route them through the same duct. Power cables and signal cables must be separated by a distance of at least 30 cm to prevent interference.
- High voltage may be still present in the servo drive when the power supply is cut off. Do not touch the power terminals within 5 minutes after power-off.
- Do not turn on/off the power supply frequently. If frequent ON/OFF is required, ensure the time interval is at least one minute. The capacitor in the main circuit will be charged with a large current for 0.2 seconds upon power on. Turning on/off the power supply frequently will deteriorate the performance of the main circuit components inside the servo drive.
- Use a grounding cable with the same cross sectional area as the main circuit cable. If the cross sectional area of the main circuit cable is less than 1.6 mm^2, use a grounding cable with a cross sectional area of 2.0 mm^2.
- Ground the servo drive properly.
- Do not power on the servo drive when any screw of the terminal block or any cable is loosened. Failure to comply may cause a fire.

3.2.6 Specifications of Main Circuit Options

The recommended circuit breakers and electromagnetic contactors are listed in the following table.

Table 3-10 Recommended circuit breakers and electromagnetic contactors

Main Circuit Power Supply	Servo Drive Model	Recommended Circuit Breaker		Recommended Contactor	
		Current (A)	Schneider Model	Current (A)	Schneider Model
Single-phase 220 V	SV660NS1R6I	4	OSMC32N3C4	9	LC1 D09
	SV660NS2R8I	6	OSMC32N3C6	9	LC1 D09
	SV660NS5R5I	6	OSMC32N3C6	9	LC1 D09
Three-phase 220 V	SV660NS6R6	6	OSMC32N3C6	9	LC1 D09

3.3 Connection of the Servo Drive and Servo Motor Power Cables

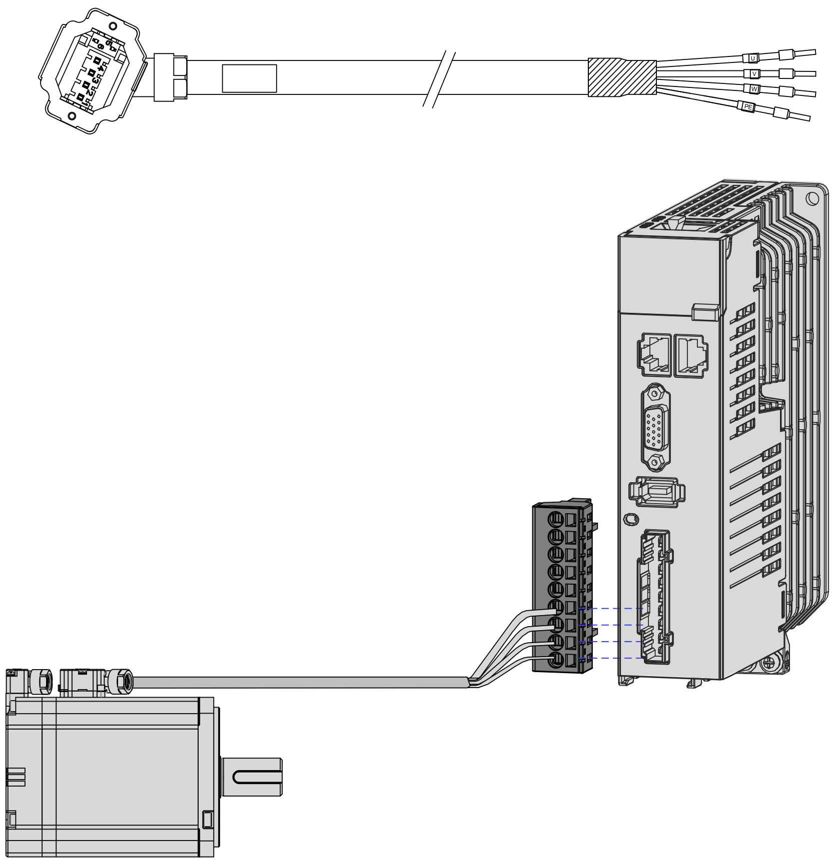
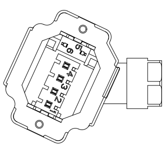
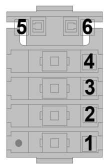


Figure 3-9 Example of the wiring between the servo drive and the servo motor

Table 3-11 Connectors for power cables on servo motor side

<table>
<tr><th>Outline Drawing of the Connector</th><th>Terminal Pin Layout</th><th>Applicable Motor Frame [Note]</th></tr>
<tr><td></td><td>Black 6-pin connector

<table>
<tr><th>Pin No.</th><th colspan="2">Signal Name</th><th>Color</th></tr>
<tr><td>1</td><td colspan="2">PE</td><td>Yellow/Green</td></tr>
<tr><td>2</td><td colspan="2">W</td><td>Red</td></tr>
<tr><td>3</td><td colspan="2">V</td><td>Black</td></tr>
<tr><td>4</td><td colspan="2">U</td><td>White</td></tr>
<tr><td>5</td><td>Brake</td><td rowspan="2">Polarity insensitive</td><td>Brown</td></tr>
<tr><td>6</td><td>Brake</td><td>Blue</td></tr>
</table></td><td>Terminal-type motor:
40
60
80</td></tr>
</table>

NOTE

- ◆ The motor frame refers to the width of the mounting flange.
- ◆ Power cable colors are subject to the colors of the actual product. The cable colors mentioned in this user guide refer to Inovance's cable colors.

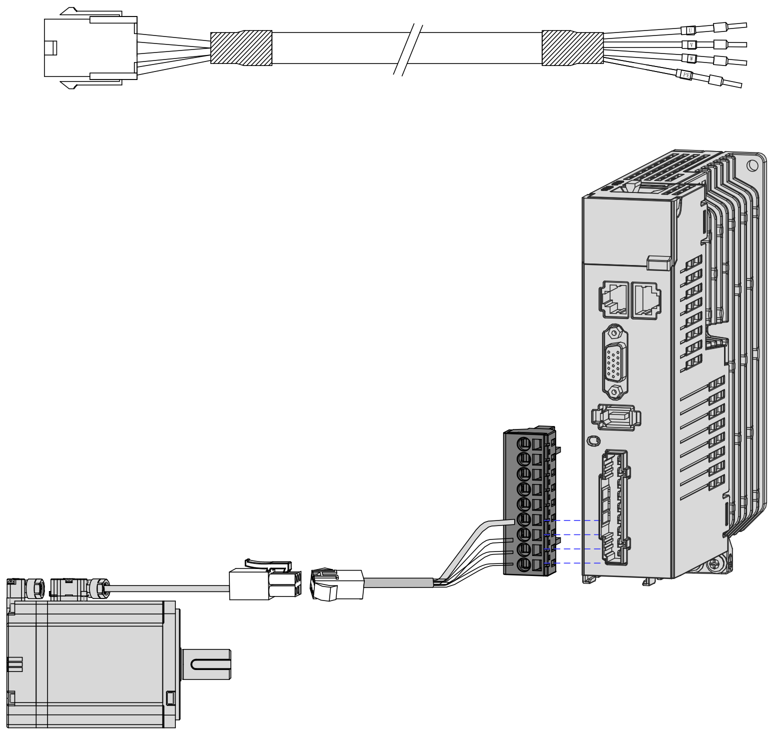
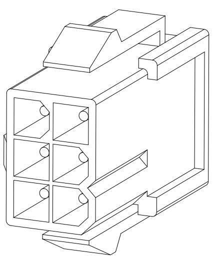
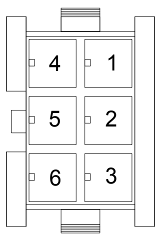


Figure 3-10 Example of the wiring between the servo drive and the servo motor

Table 3-12 Connectors for power cables on servo motor side

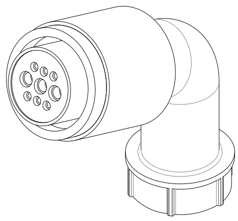
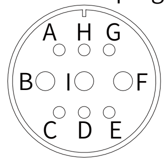
<table>
<tr><th>Outline Drawing of the Connector</th><th>Terminal Pin Layout</th><th>Applicable Motor Frame [Note]</th></tr>
<tr><td></td><td>Black 6-pin connector


<table>
<tr><th>Pin No.</th><th>Signal Name</th><th>Color</th></tr>
<tr><td>1</td><td>U</td><td>White</td></tr>
<tr><td>2</td><td>V</td><td>Black</td></tr>
<tr><td>4</td><td>W</td><td>Red</td></tr>
<tr><td>5</td><td>PE</td><td>Yellow/Green</td></tr>
<tr><td>3</td><td rowspan="2">Brake
(polarity insensitive)</td><td rowspan="2"></td></tr>
<tr><td>6</td></tr>
</table>
Recommendations:
Plastic housing: MOLEX-50361736
Terminal: MOLEX-39000061</td><td>Lead wire-type motor:
40
60
80</td></tr>
</table>

NOTE

- ◆ The motor frame refers to the width of the mounting flange.
- ◆ Power cable colors are subject to the colors of the actual product. The cable colors mentioned in this user guide refer to Inovance's cable colors.

Table 3-13 Connectors for power cables on servo motor side

<table>
<tr><th>Outline Drawing of the Connector</th><th>Terminal Pin Layout</th><th>Applicable Motor Frame</th></tr>
<tr><td></td><td>MIL-DTL-5015 series 3108E20-18S aviation plug
20-18
aviation plug


<table>
<tr><th colspan="2">New Structure</th><th colspan="2">Old Structure</th><th rowspan="2">Color</th></tr>
<tr><th>Pin No.</th><th>Signal Name</th><th>Pin No.</th><th>Signal Name</th></tr>
<tr><td>B</td><td>U</td><td>B</td><td>U</td><td>Blue</td></tr>
<tr><td>I</td><td>V</td><td>I</td><td>V</td><td>Black</td></tr>
<tr><td>F</td><td>W</td><td>F</td><td>W</td><td>Red</td></tr>
<tr><td>G</td><td>PE</td><td>G</td><td>PE</td><td>Yellow/ Green</td></tr>
<tr><td>C</td><td rowspan="2">Brake (polarity insensitive)</td><td></td><td></td><td></td></tr>
<tr><td>E</td><td></td><td></td><td></td></tr>
</table></td><td>100
130</td></tr>
</table>

3.4 Connection of the Servo Drive and Servo Motor Encoder Cables

1 Installing the absolute encoder battery box

- The S6-C36 battery box contains the following items:

One plastic box

One 3.6 V/2600 mAh battery

Terminal block and crimping terminal

- Installing the battery box:

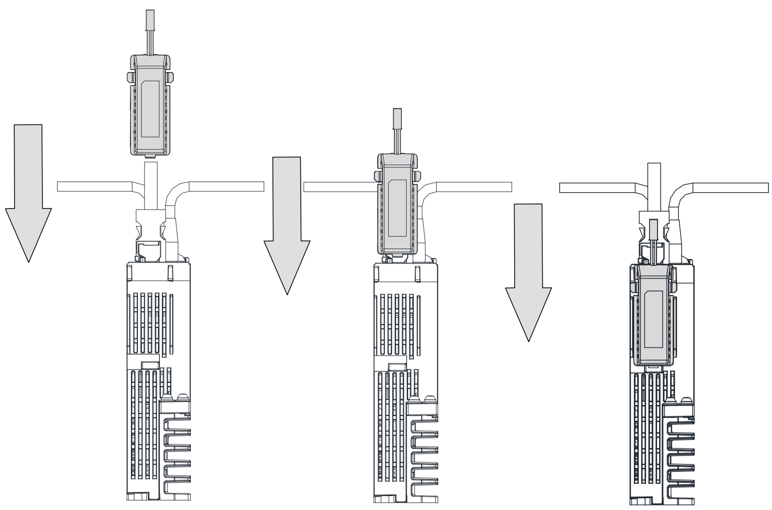
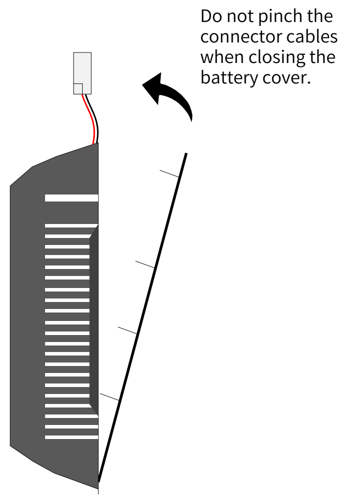


Figure 3-11 Installation of the absolute encoder battery box (Bottom view)

■ Removing the battery box

The battery may have leakage liquids after a long-time use. It is recommended to replace the battery every two years. Remove the battery box in steps in reverse to those in the preceding figure.

When closing the battery box cover, do not pinch the connector cables.



CAUTION

Improper use of the battery may result in battery leakage, corroding the components or causing battery explosion. Observe the following requirements during use:

- Insert the battery with correct +/- polarity.
- Leaving a battery in constant use or no longer useful inside the device can cause liquid leakage. The electrolyte inside the battery is corrosive and conductive, not only corroding surrounding components but also giving rise to the danger of short circuit. Therefore, replace the battery periodically (recommended interval: every 2 years).
- Do not disassemble the battery because the internal electrolyte may spread out and cause physical injuries.
- Do not throw a battery into the fire or heat up the battery. Failure to comply may cause an explosion.
- Do not short circuit the battery or strip off the battery tube. If terminals + and - of the battery come into contact with the metal, a large current will be generated, not only deteriorating the battery power but also incurring the risk of explosion due to violent overheating.
- This battery is non-rechargeable.
- Dispose of the retired battery according to local regulations.

- Selecting the battery model

Select an appropriate battery according to the following table.

Table 3-14 Description of the absolute encoder battery

Battery Model and Specifications	Items	Ratings			Condition
		Minimum Value	Typical Value	Maximum Value	
Output: 3.6 V, 2500 mAh Recommended manufacturer and model: Shenzhen Jieshun LS14500	External battery voltage (V)	3.2	3.6	5	In standby mode[2]
	Circuit fault voltage (V)	-	2.6	-	In standby mode
	Battery warning voltage (V)	2.85	3	3.15	-
	Current consumed by circuit (μA)	-	2	-	In normal status[1]
		-	10	-	In standby mode, shaft static
		-	80	-	In standby mode, shaft rotating
	Ambient operation temperature (°C)	0	-	40	Same as that required by the motor
	Ambient storage temperature (°C)	-20	-	60	

The preceding data is obtained under 20°C ambient temperature.

[1] During normal operation, the absolute encoder supports single-turn or multi-turn data counting and data transmitting/receiving. A well-connected encoder will, upon switch-on of the servo drive, enter normal operation status and transmit/receive data after a delay of 5s. Switching from standby mode to normal operation mode upon power-on requires the motor to rotate at a speed less than 10 RPM. Otherwise, the servo drive reports E740 (Encoder fault), In this case, you need to power on the servo drive again.

[2] Standby mode means the servo drive is not powered on and the absolute encoder can perform multi-turn counting by utilizing external battery power. In this case, the data transmitting/ receiving stops.

- Design life of the battery

The following calculation only covers the current consumed by the encoder.

Suppose that the servo drive works normally for T1 in a day, the motor rotates for T2 after the servo drive is powered off, and the motor stops rotating for T3 after power-off (unit: hour (h)).

Example:

Table 3-15 Design life of the absolute encoder battery

Item	Working Time 1	Working Time 2
Days of working in different operating conditions in 1 year (day)	313	52
T1 (hour H)	8	0
T2 (hour H)	0.1	0
T3 (hour H)	15.9	24

Capacity consumed in 1 year = (8 h x 2 μA + 0.1 h x 80 μA + 15.9 h x 10 μA) x 313 + (0 h x 2 μA + 0 h x 80 μA +24 h x 10 μA) x 52 ≈ 70 mAH

Design life = Battery capacity/Annual consumption = 2600 mAH/70 mAH = 37.1 years

2 Connecting the absolute encoder

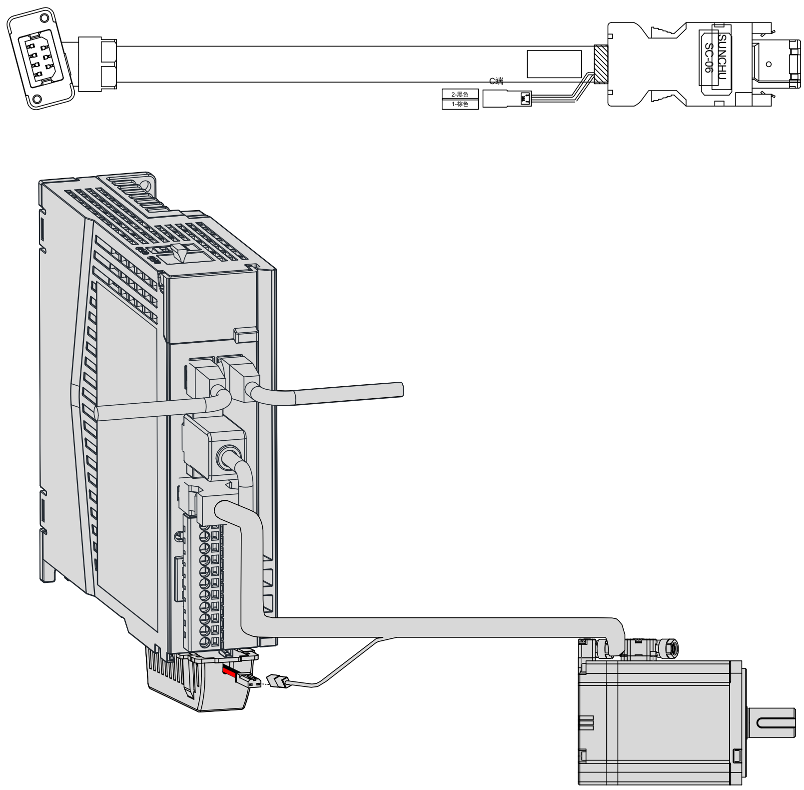
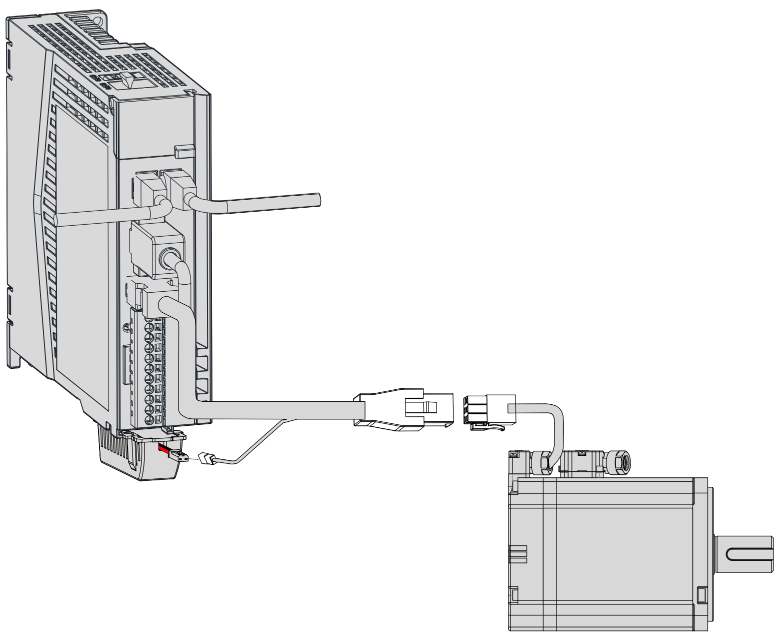


Figure 3-12 Wiring example of absolute encoder signals[1]

[1] The preceding figure shows the wiring diagram of absolute encoder cables, which is similiar to that of incremental encoder (without a battery box) cables. ~~Incremental encoder cables need to be purchased separately.~~

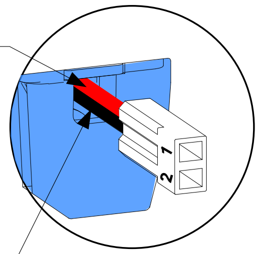
NOTE

The encoder cable color is subject to the color of the actual product. The cable colors mentioned in this user guide refer to Inovance's cable colors.



Lead wires of the battery box:

Pin No.	Color	Definition
1	Red	Power supply (+)



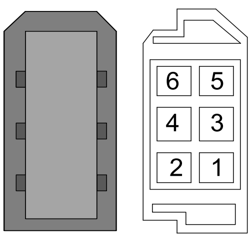
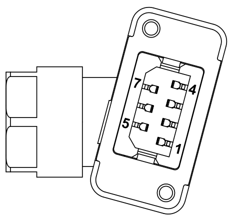
Pin No.	Color	Definition
2	Black	Power supply (-)

Figure 3-13 Color of the lead wires of the absolute encoder battery

NOTE

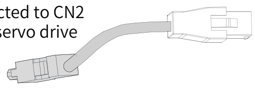
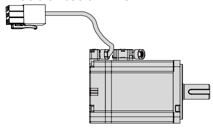
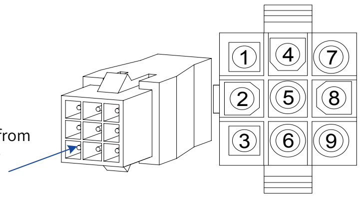
- Store the battery in environments within the required temperature range and ensure reliable contact and sufficient battery power. Failure to comply may cause encoder data loss.
- Model of the battery box (battery included): S6-C36

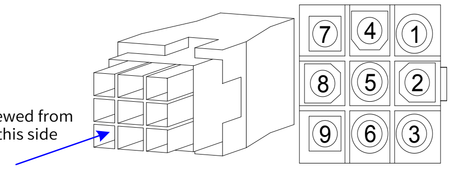
Table 3-16 Cable connectors of the terminal-type motor encoder

<table>
<tr><th colspan="2">Outline Drawing and Pin Layout of the Connector</th><th rowspan="2">Applicable Motor Frame [1]</th></tr>
<tr><th>Servo Drive Side</th><th>Motor Side</th></tr>
<tr><td>6-pin male
(Left: connecting side
Right: soldering side)

<table>
<tr><th>Pin No.</th><th>Signal Name</th><th>Color</th><th>Type</th></tr>
<tr><td>1</td><td>+5V</td><td>Red</td><td rowspan="2">Twisted pair</td></tr>
<tr><td>2</td><td>GND</td><td>Orange</td></tr>
<tr><td>5</td><td>PS+</td><td>Blue</td><td rowspan="2">Twisted pair</td></tr>
<tr><td>6</td><td>PS-</td><td>Purple</td></tr>
<tr><td>Enclosure</td><td>PE</td><td>-</td><td>-</td></tr>
</table></td>
<td>7-pin connector

<table>
<tr><th>Pin No.</th><th>Signal Name</th><th>Color</th><th>Type</th></tr>
<tr><td>1</td><td>PS+</td><td>Blue</td><td rowspan="2">Twisted pair</td></tr>
<tr><td>2</td><td>PS-</td><td>Purple</td></tr>
<tr><td>3</td><td>DC+</td><td>Brown</td><td rowspan="2">Twisted pair</td></tr>
<tr><td>4</td><td>DC-</td><td>Black</td></tr>
<tr><td>5</td><td>+5V</td><td>Red</td><td rowspan="2">Twisted pair</td></tr>
<tr><td>6</td><td>0V</td><td>Orange</td></tr>
<tr><td>7</td><td>PE</td><td>-</td><td>-</td></tr>
</table></td>
<td>Terminal-type motor:
40
60
80</td></tr>
</table>

[1] The motor frame refers to the width of the mounting flange.

Table 3-17 Cable connectors of the lead wire-type motor encoder (9-pin connector)

<table>
<tr><th colspan="2">Outline Drawing and Pin Layout of the Connector</th><th>Applicable Motor Frame [1]</th></tr>
<tr><td>
</td><td>
</td><td rowspan="2">Lead wire-type motor:
40 (lead wire-type)
60 (lead wire-type)
80 (lead wire-type)</td></tr>
<tr><td>9-pin connector


<table>
<tr><th>Pin No.</th><th>Signal Name</th><th>Type</th></tr>
<tr><td>1</td><td>Battery (+)</td><td rowspan="2">-</td></tr>
<tr><td>4</td><td>Battery (-)</td></tr>
<tr><td>3</td><td>PS+</td><td rowspan="2">Twisted pair</td></tr>
<tr><td>6</td><td>PS-</td></tr>
<tr><td>9</td><td>+5V</td><td rowspan="3">-</td></tr>
<tr><td>8</td><td>GND</td></tr>
<tr><td>7</td><td>Shield</td></tr>
</table>
Recommendations:
Plastic housing: AMP 172161-1
Terminal: AMP 770835-1</td>
<td>

<table>
<tr><th>Pin No.</th><th>Signal Name</th><th>Color</th><th>Type</th></tr>
<tr><td>1</td><td>Battery (+)</td><td>Blue</td><td rowspan="4">Twisted pair</td></tr>
<tr><td>4</td><td>Battery (-)</td><td>Blue and black</td></tr>
<tr><td>3</td><td>PS+</td><td>Yellow</td></tr>
<tr><td>6</td><td>PS-</td><td>Yellow and black</td></tr>
<tr><td>9</td><td>+5V</td><td>Red</td><td rowspan="3">-</td></tr>
<tr><td>8</td><td>GND</td><td>Black</td></tr>
<tr><td>7</td><td>Shield</td><td>-</td></tr>
</table></td></tr>
</table>

[1] The motor frame refers to the width of the mounting flange.

3.5 Connection of the Control Signal Terminal CN1

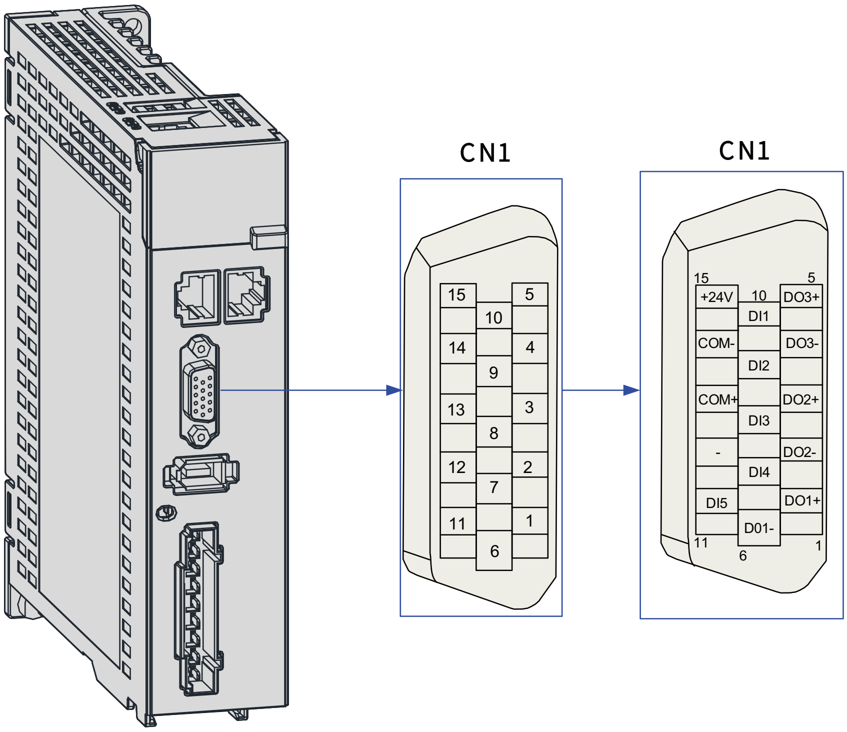


Figure 3-14 Pin layout of CN1 terminal connector

CN1 terminal: Plastic housing of the plug on the cable side: DB15P (SZTDK), black housing
Core: HDB15P (SZTDK)

NOTE

◆ It is recommended to use 24AWG to 26AWG cables.

3.5.1 DI/DO signals

Table 3-18 Description of DI/DO signals

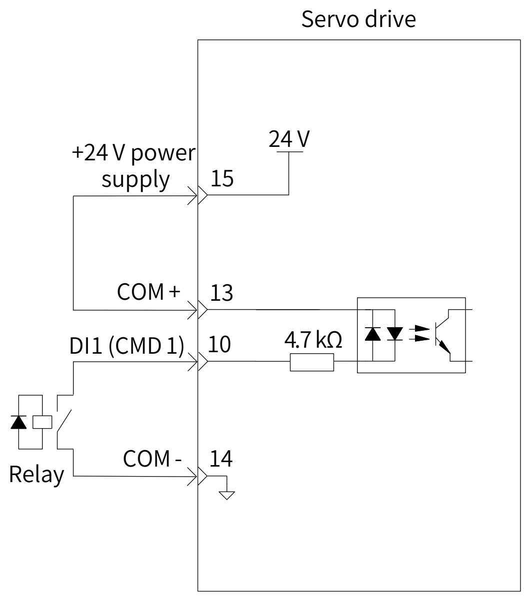
Signal Name		Function	Pin No.	Function
General	DI1	P-OT	10	Positive limit switch
	DI2	N-OT	9	Negative limit switch
	DI3	HomeSwitch	8	Home switch
	DI4	TouchProbe2	7	Touch probe 2
	DI5	TouchProbe1	11	Touch probe 1
	+24V		15	Internal 24 V power supply, voltage range: 20 V to 28 V, maximum output current: 200 mA
	COM-		14	
	COM+		13	Power input terminal (12 V to 24 V)
	DO1+	S-RDY+	1	Servo ready
	DO1-	S-RDY-	6	
	DO2+	ALM+	3	Fault
	DO2-	ALM-	2	
	DO3+	BK+	5	Brake
	DO3-	BK-	4	

1 DI circuit

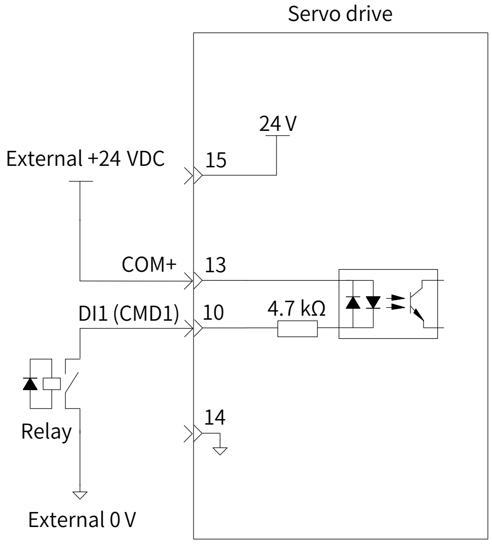
DI1 to DI5 circuits are the same. The following description takes DI1 circuit as an example.

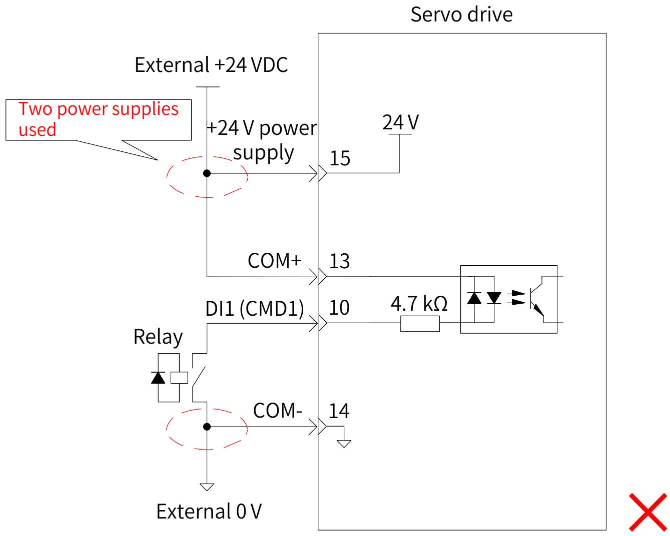
1) The host controller provides relay output.

■ For use of the internal 24 V power supply of the servo drive



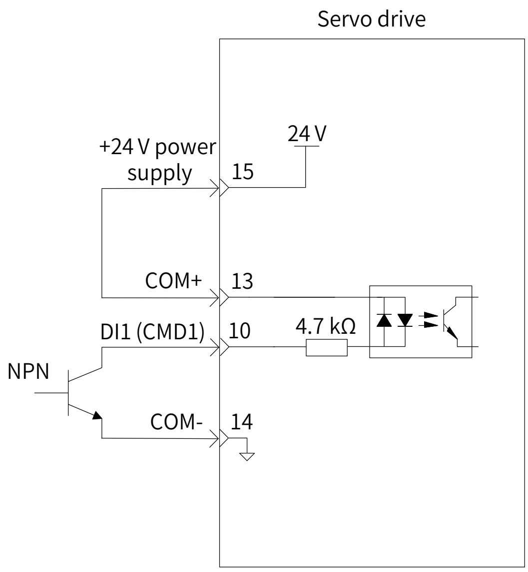
■ For use of an external power supply

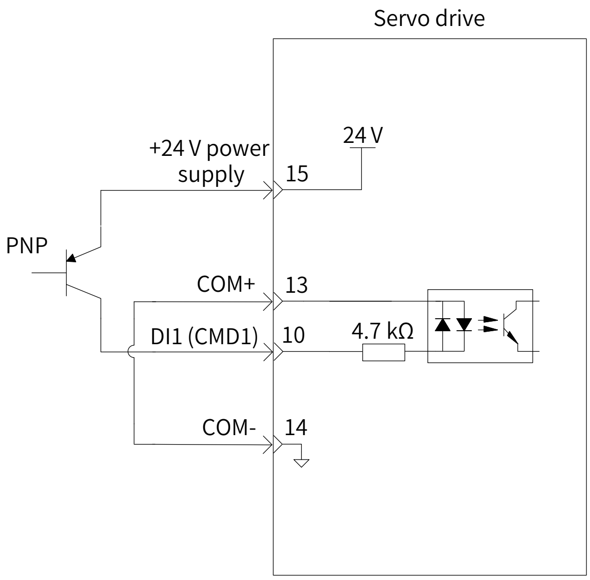




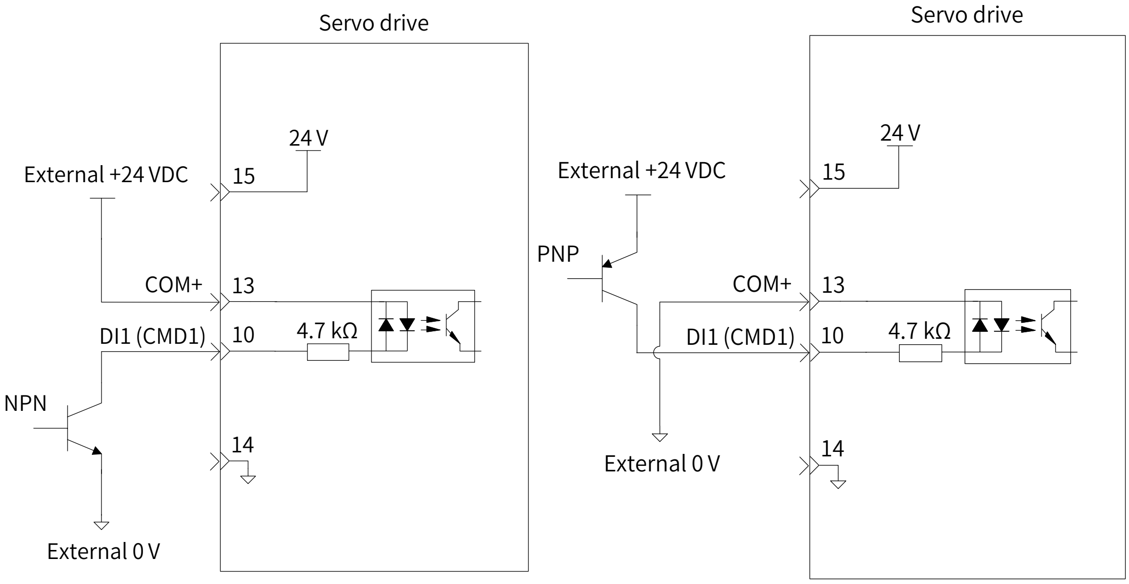
2) The host controller provides open-collector output.

■ For use of the internal 24 V power supply of the servo drive





■ For use of an external power supply



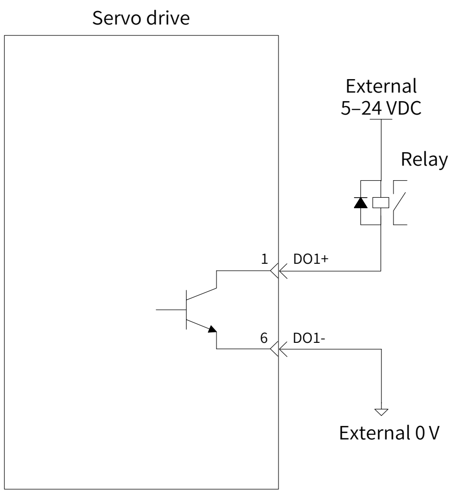
NOTE

PNP and NPN input cannot be used mixedly.

2 DO circuit

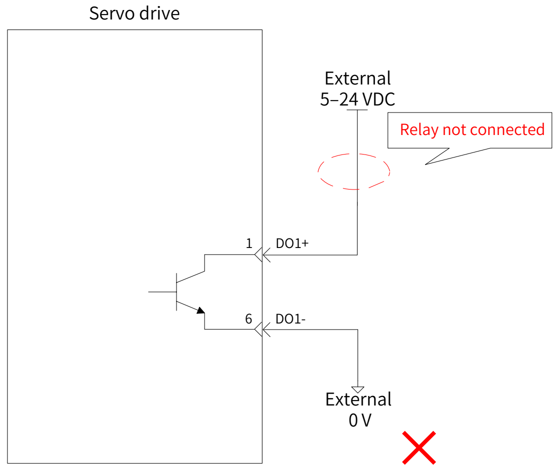
DO1 to DO5 circuits are the same. The following description takes DO1 circuit as an example.

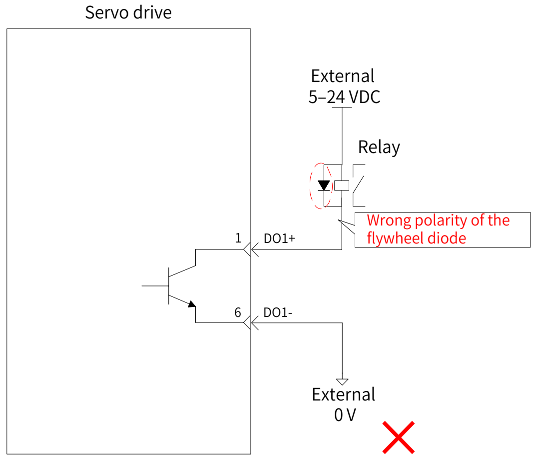
1) The host controller provides relay input.



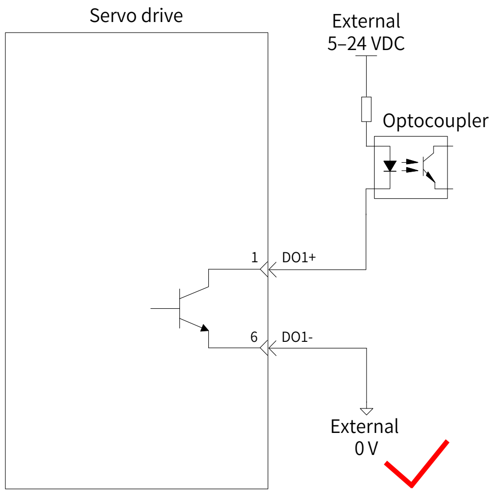
NOTE

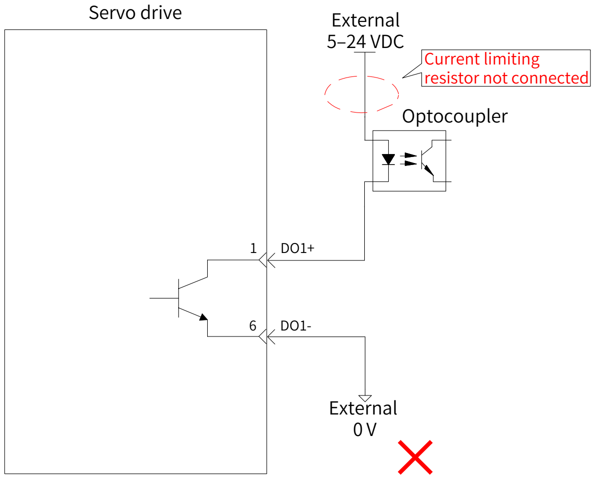
When the host controller provides relay input, a flywheel diode must be installed. Otherwise, the DO terminals may be damaged.





2) The host controller provides optocoupler input.





The maximum allowable voltage and current of the ~~optocoupler~~ output circuit inside the servo drive are as follows:

- Voltage: 30 VDC
- Current: DC 50 mA

3.5.2 Wiring of the Brake

The brake is used to prevent the servo motor shaft from rotating during non-operating status of the servo drive. This is to keep the motor and the mechanical motion part in locked position.

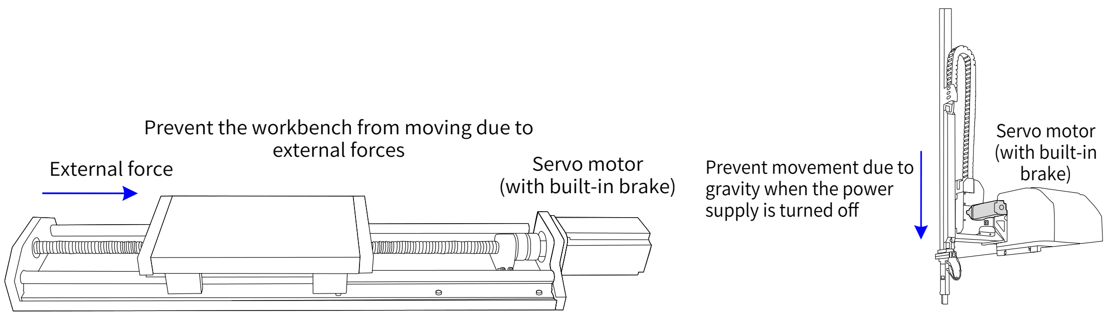


Figure 3-15 Application of the brake

CAUTION	
	◆ Use the built-in brake for position-lock in the stop state only. ◆ The brake coil has no polarity. ◆ Cut off the S-ON signal after the servo motor stops. ◆ When the servo motor with built-in brake runs, the brake may generate clattering sound. Such sound does not affect the motor functions. ◆ When brake coils are energized (brake released), magnetic flux leakage may occur at the shaft end. Be cautious when using magnetic sensors around the servo motor.

The connection of the motor brake input signal has no polarity. Users need to prepare a 24 V external power supply. The following figure shows the standard wiring of the brake signal (BK) and the brake power supply.

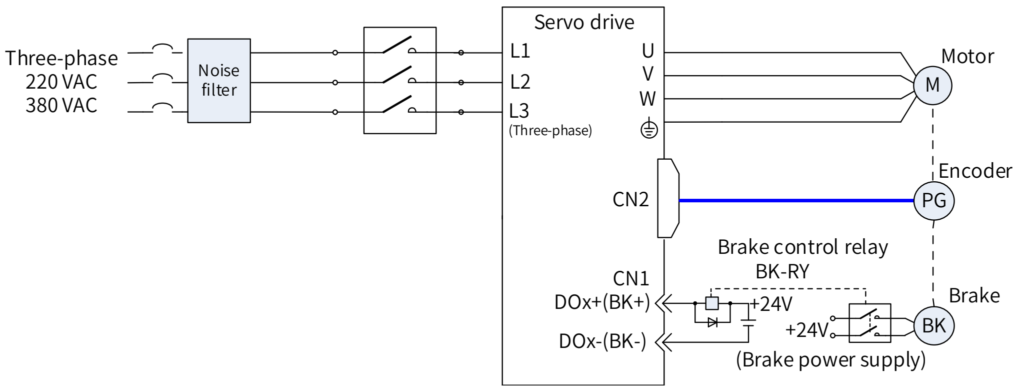


Figure 3-16 Wiring of the brake

Pay attention to the following precautions during wiring:

■ When deciding the length of the motor brake cable, take the voltage drop caused by cable resistance into consideration. The input voltage must be at least 21.6 V to enable the brake to work properly. The following table lists brake specifications of Inovance servo motors.

Table 3-19 Brake specifications

Motor Model	Holding Torque (N·m)	Supplied Voltage (VDC)±10%	Release Time (ms)	Close Time (ms)	Backlash (°)
MS1H1-10B	0.3	24	≤ 20	≤ 35	< 1.7
MS1H1-20B/40B	1.5	24	≤ 20	≤ 50	< 1.5
MS1H4-40B	1.5	24	≤ 20	≤ 50	< 1.5
MS1H*-75B	2.5	24	≤ 20	≤ 60	< 1.7
MS1H3-85B	12	24	60	120	≤ 0.5

NOTE

◆ The brake cannot share the same power supply with other electrical devices. This is to prevent malfunction of the brake due to voltage or current drop caused by other working devices.

◆ It is recommended to use cables of 0.5 mm^2 and above.

3.6 Wiring of Communication Signals CN3/CN4

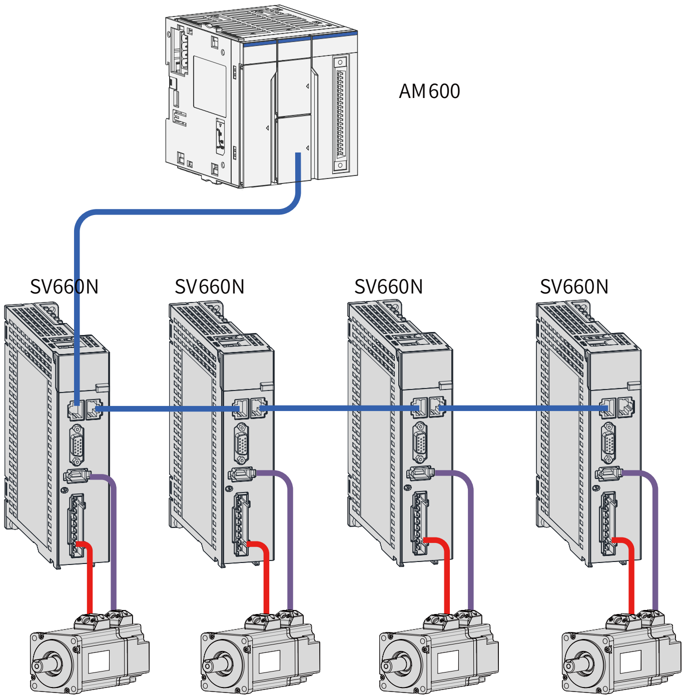


Figure 3-17 Networking topology

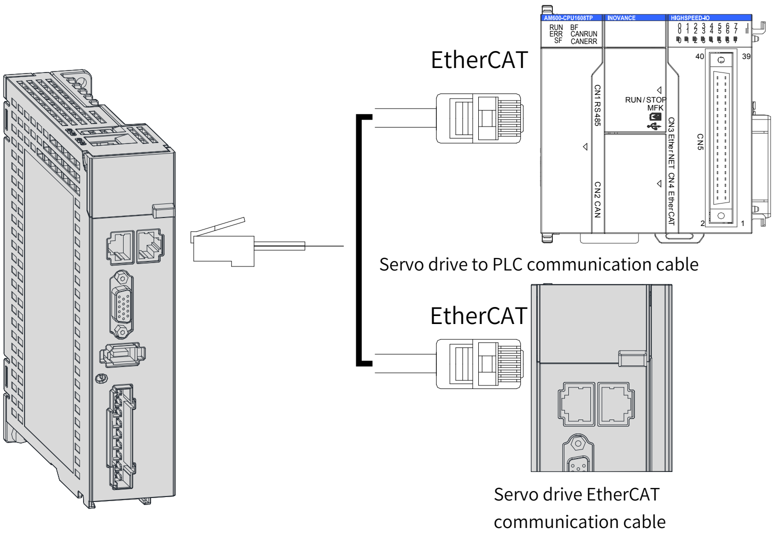
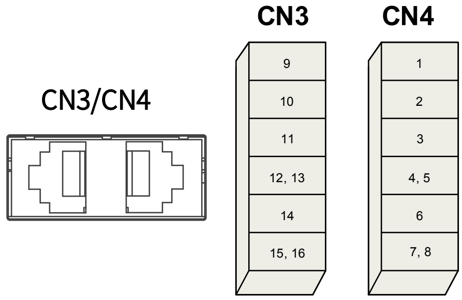


Figure 3-18 Wiring of communication cables

3.6.1 Pin Definition of the Communication Signal Connector

Communication signal connectors (CN3 and CN4) are EtherCAT interface connectors. CN3 (IN) is connecction to the connecting terminal of the master. CN4 (OUT) is connected to the next slave device.

Table 3-20 Pin definition of the communication signal connector

Pin No.	Definition	Description	Terminal Pin Layout
1	TD+	Data transmitting (+)	
2	TD-	Data transmitting (-)	
3	RD+	Data receiving (+)	
4 and 5	-	-	
6	RD-	Data receiving (-)	
7 and 8	-	-	
9	TD+	Data transmitting (+)	
10	TD-	Data transmitting (-)	
11	RD+	Data receiving (+)	
12 and 13	-	-	
14	RD-	Data receiving (-)	
15 and 16	-	-	

3.6.2 Selection of Communication Cables

■ Principle for cable selection

Cable Specifications	Supplier	
0.2 m to 10 m	Inovance	
Above 10 m	Haituo	

■ Basic information of Inovance EtherCAT communication cables

Cable models are shown in the following figure.

S6-L-T04-3.0

Symbol	Product Series
S6	S6 series

Symbol	Meaning
L	Line

Symbol	Meaning
T	Communication cable

Symbol	Meaning
04	Multi-drive EtherCAT communication cable

Cable Length (unit: m)

Symbol	Length	Symbol	Length
0.2	0.2 m	2.0	2.0 m
0.3	0.3 m	3.0	3.0 m
0.5	0.5 m	5.0	5.0 m
1.0	1.0 m	10.0	10.0 m

■ Cable ordering information

Material Code	Cable Model	Length (m)	
15040261	S6-L-T04-0.3	0.3	
15040262	S6-L-T04-3.0	3.0	
15041960	S6-L-T04-0.2	0.2	
15041961	S6-L-T04-0.5	0.5	
15041962	S6-L-T04-1.0	1.0	
15041963	S6-L-T04-2.0	2.0	
15041964	S6-L-T04-5.0	5.0	
15041965	S6-L-T04-10.0	10.0	

■ Specifications

Item	Description
UL certification	UL-compliant
Cat 5e cable	Cat 5e cable
Double shield	Braided shield (coverage: 85%), aluminum foil shield (coverage: 100%)
Environment adaptability	Ambient temperature: -30°C to +60°C , resistant to industrial oil and corrosive acid and alkali
EMC test standard	GB/T 24808-2009

3.6.3 Communication Connection with PC (RS232 Communication)

Connect the servo drive and the PC by using the PC communication cable as shown below. It is recommended to use the common communication interface RS232.

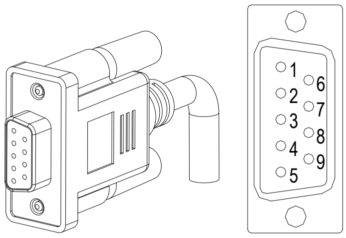
Figure 3-19 Outline drawing of the PC communication cable

Table 3-21 Connection relation between the servo drive and PC communication cable pins

RJ45 on Servo Drive Side (A)		DB9 on PC Side (B)	
Signal Name	Pin No.	Signal Name	Pin No.
RS232-TXD	6	PC-RXD	2
RS232-RXD	7	PC-TXD	3
GND	8	GND	5
PE (shield)	Enclosure	PE (shield)	Enclosure

The definition of DB9 terminal on PC side is shown in the following table.

Table 3-22 Pin definition of DB9 ("B" in the Figure 3-19) on PC side

Pin No.	Definition	Description	Terminal Pin Layout
2	PC-RXD	PC receiving end	
3	PC-TXD	PC transmitting end	
5	GND	Ground	
Enclosure	PE	Shield	

If the host controller provides only the USB interface, use the serial-to-USB cable for conversion.

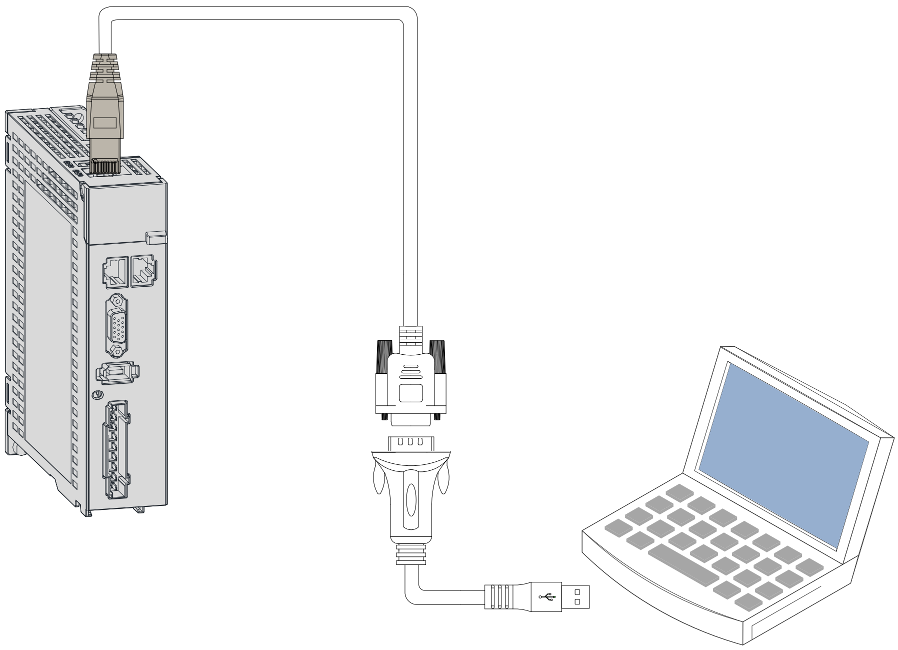


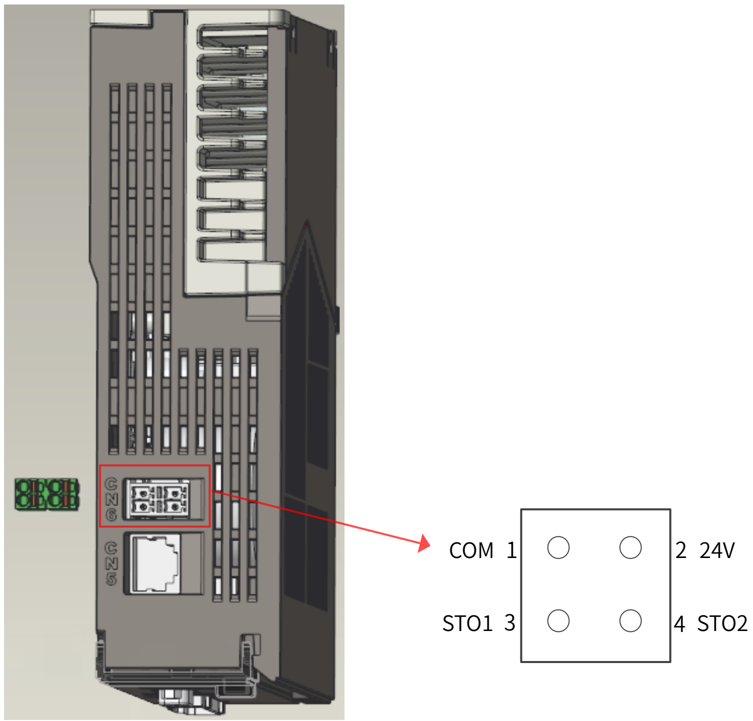
Figure 3-20 Serial-to-USB conversion

Recommendation:
Manufacture: Z-TEK
Model: ZE551A, equipped with a 0.8 m USB extension cable
Chip model: FT232

3.7 Definition and Connection of STO terminal

This section describes the definition and function of the I/O connecting terminal (CN6) for safe torque off (STO).

1 Terminal layout



1) Pin map of the input connector

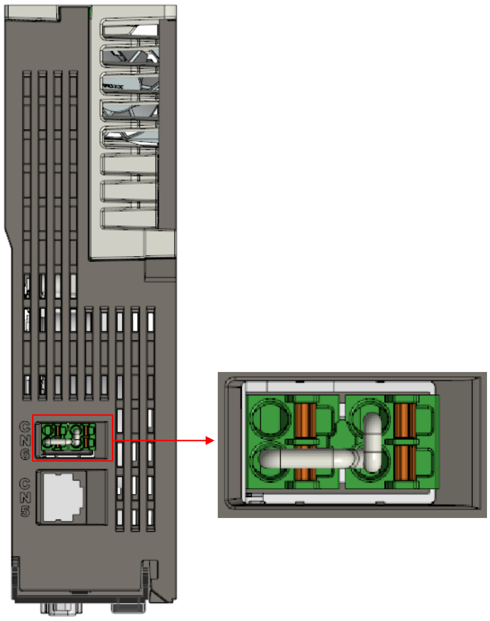
Terminal	Pin No.	Name	Value	Description
CN6	1	COM	0 V	STO reference ground
	2	24V	24 V	24 V power supply ~~for commissioning~~
	3	STO1	-	Control input for STO1
	4	STO2	-	Control input for STO2

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

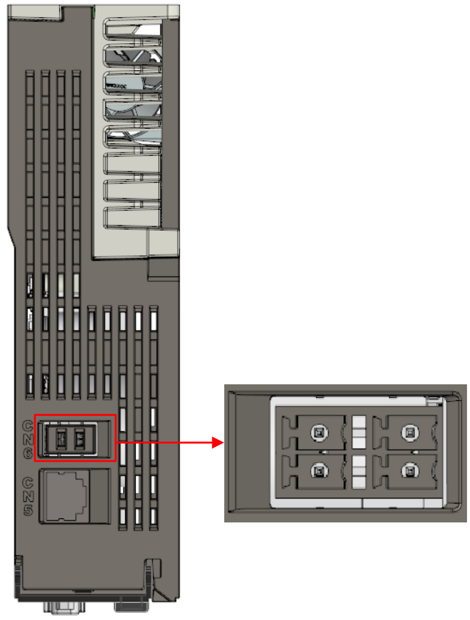
3) To make it more user-friendly during commissioning, an additional pin with supply voltage (+24V) is integrated. The bridging of the 24 volts is needed in case the safety circuit is installed but no STO function is needed.

NOTE

Remove the short-circuit jumper when STO is needed in actual applications.



24V shorted to STO1/STO2



Short-circuit jumper removed in normal use

2 Electrical specifications and connections of the input circuit

This section describes the characteristics of the input signals assigned to the CN6 connector.

- Specifications

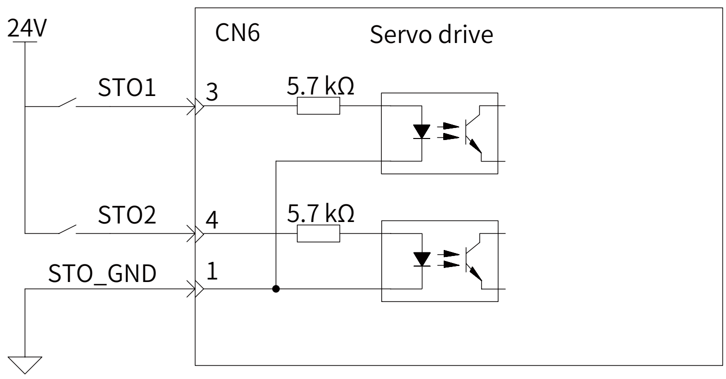
The servo drive can operate normally only if the input status of STO1 and STO2 are both "1" or "H".

If the input status of either STO1 or STO2 (or both) is "0" or "L", the servo drive cannot run.

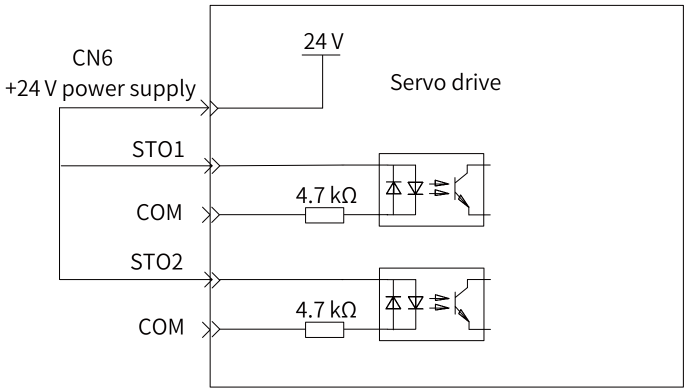
- Electrical characteristics of the safety request input signal

Items	Characteristics	Description
Voltage range	24 VDC (±15%)	-
Input current	4 mA (Typ.)	Value per channel
Standards of logic levels	"0"< 3 V, "1" >15 V	-
Digital input impedance	5.78 kΩ	-

- Example of external 24 V connection



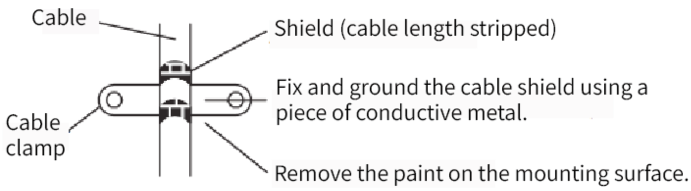
- Example of internal 24 V connection



3 EMC requirements

- To avoid short circuit between two adjacent conductors, either use a shielded cable with its shield connected to the protective ground or a flat cable with one earthed conductor between each signal conductor.
- Double-shielded or single-shielded twisted multi-pair cables are strongly recommended.
- Fix and ground the cable shield using a piece of conductive metal.

Example of cable clamp:



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

4 Additional requirements

- All cables must be well protected, routed and clamped where practicable.
- Ensure that there is no pulling or pinching on the cables during installation.
- For cabling the DIs of the STO, to avoid the faults that commonly occur on the cables, route the two channels through two separate routes, or the cable must be protected with double-shielded methods.

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

3.8 Anti-interference Measures for Electrical Wiring

Take the following measures to suppress interference:

- Ensure the length of the reference input cable and the encoder cable is below 3 m and 20 m respectively.
- Use a thick cable as the grounding cable (above 2.0 mm^2).

1) It is recommended to adopt D class (or higher) grounding (grounding resistance below 100 Ω).

2) Adopt single-point grounding.

■ Use a noise filter to prevent radio frequency interferences. In domestic applications or an unfavorable environment with strong power noise interference, install a noise filter on the input side of the power cable.

■ To prevent malfunction due to electromagnetic interference, take the following measures:

1) Install the host controller and the noise filter near the servo drive.

2) Install a surge protection device on the relay, solenoid and electromagnetic contactor coils.

3) Separate the electrical circuit from the electronic circuit during wiring and keep a distance of at least 30 cm between them. Do not put these cables in the same duct or bundle them together.

4) Do not share the same power supply with an electric welder or electrical discharge machine. When the servo drive is placed near a high-frequency generator, install a noise filter on the input side of the power cable.

3.8.1 Anti-interference Wiring Example and Grounding

The servo drive uses high-speed switch elements in the main circuit. The switch noise may affect the normal operation of the system due to different peripheral wiring and grounding of the servo drive. Therefore, the servo drive must be properly wired and grounded. A noise filter can be added if necessary.

1 Anti-interference wiring example

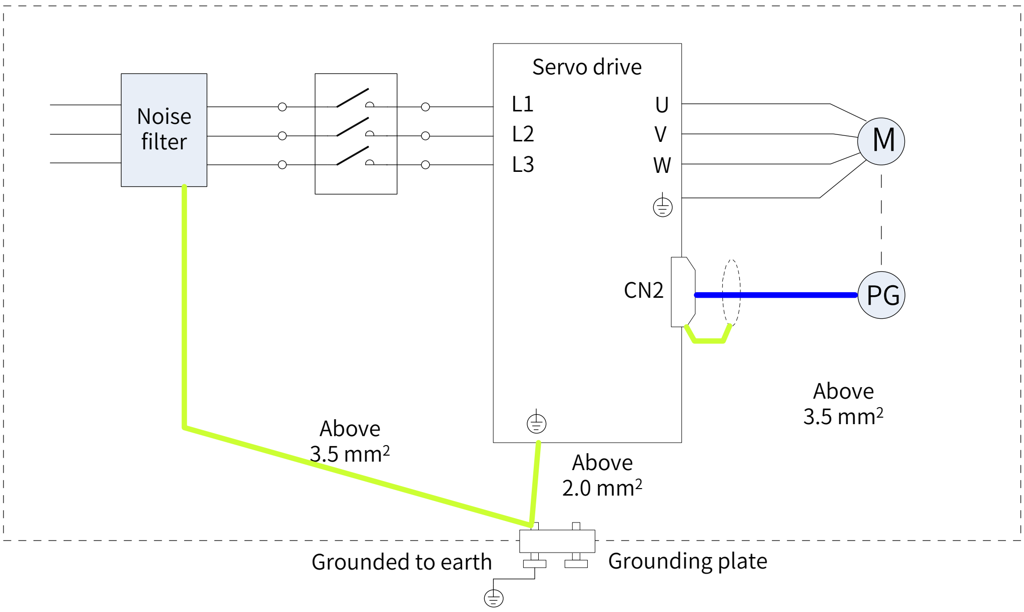


Figure 3-21 Anti-interference wiring example

For the grounding cable connected to the enclosure, use a cable of at least 3.5 mm^2 (braided copper cables recommended).

If a noise filter is used, abide by the precautions described in "3.8.2 Instructions for Use of the Noise Filter".

2 Grounding

To prevent potential electromagnetic interferences, ground properly according to following instructions.

1) Grounding the motor enclosure

Connect the grounding terminal of the servo motor to the PE terminal of the servo drive and ground the PE terminal properly to reduce potential electromagnetic interferences.

2) Grounding the encoder cable shield

Ground both ends of the encoder cable shield.

3.8.2 Instructions for Use of the Noise Filter

To prevent interference from power cables and reduce impact of the servo drive to other sensitive devices, install a noise filter on the input side of the power supply according to the magnitude of the input current. In addition, install a noise filter on the power cable part of peripheral devices if necessary. To ensure the filtering effect, abide by the following requirements when installing and wiring the noise filter.

■ Do not put the input and output cables of the noise filer in the same duct or bundle them together.

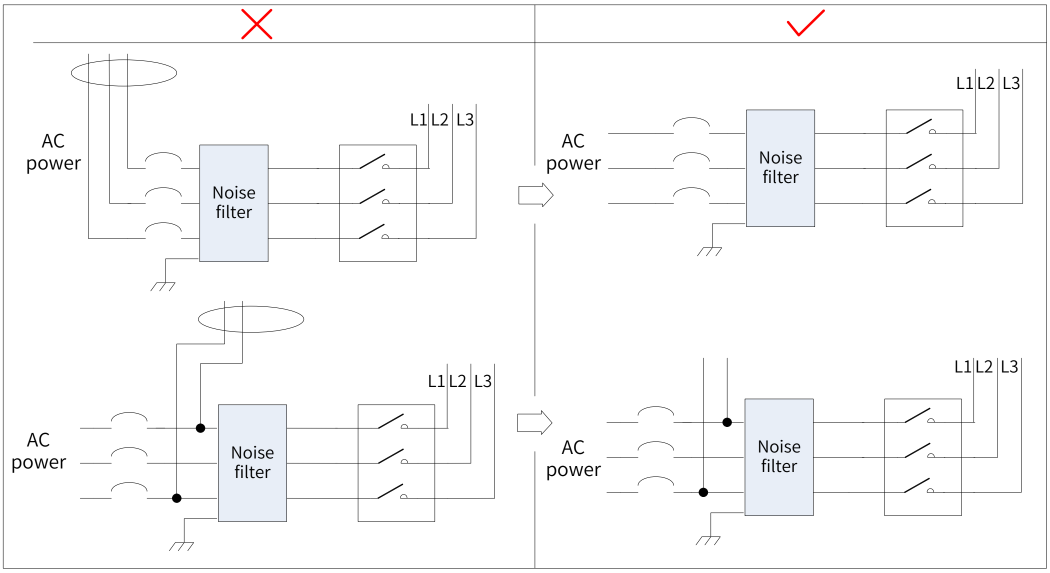


Figure 3-22 Separate routing of input and output cables of the noise filter

■ Do not put the grounding cable and the power output cable of the noise filer in the same duct.

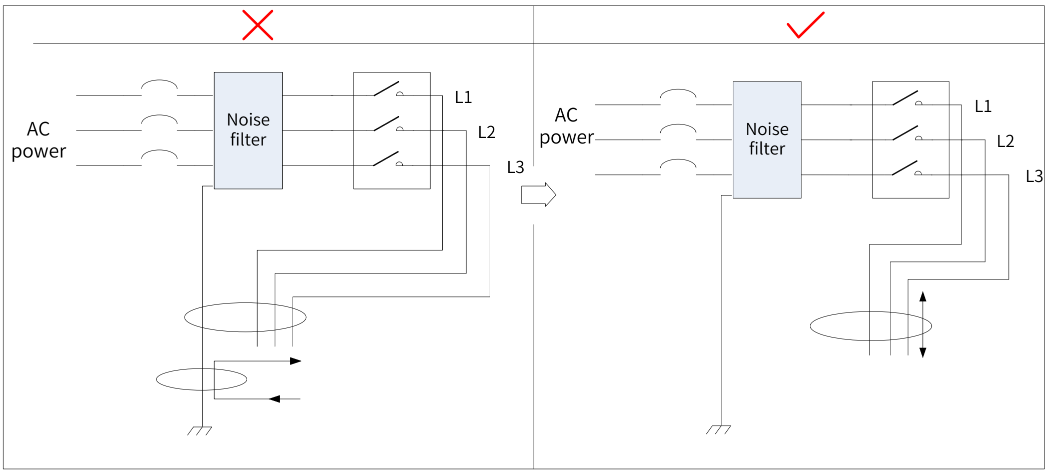


Figure 3-23 Separate routing of the grounding cable and the power output cable

■ Use a separate, thick grounding cable as short as possible for the noise filter. Do not share the same grounding cable with other grounding devices.

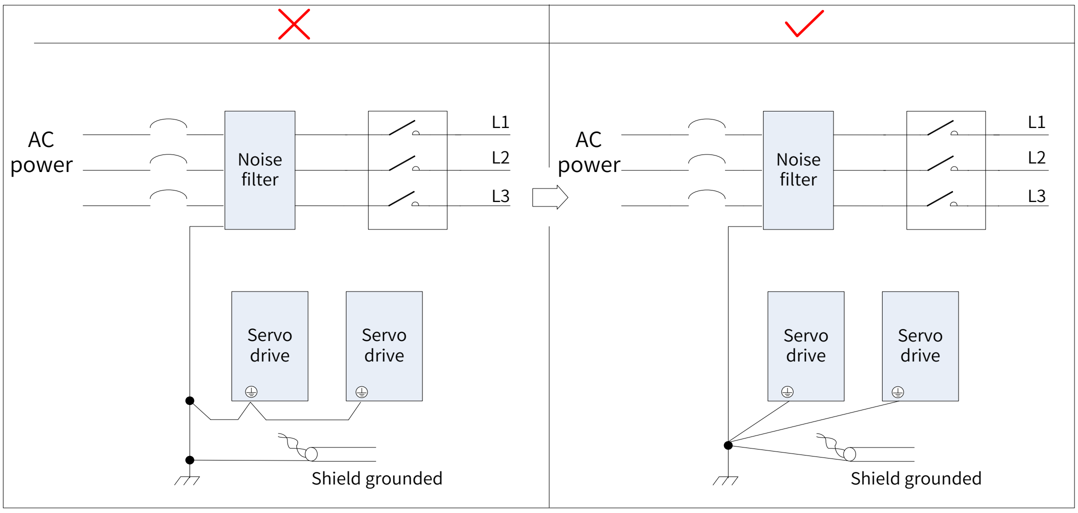


Figure 3-24 Single-point grounding

- Ground the noise filter installed inside the control cabinet.

If the noise filter and the servo drive are installed in the same control cabinet, fix the noise filter and the servo drive on the same metal plate. Make sure the contact part is in good conductive condition and well connected, and ground the metal plate properly.

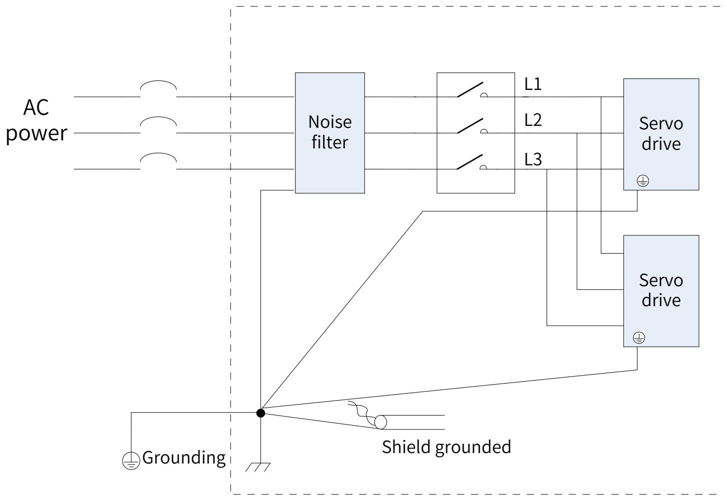


Figure 3-25 Grounding cable of the noise filter

3.9 Precautions for Use of Cables

- Do not bend or apply any tension to cables. The conductor of a signal cable is only 0.2 mm or 0.3 mm in diameter. Handle the cables carefully to prevent fracture.
- In cases where cables need to be moved, use flexible cables. Ordinary cables may be easily damaged after being bent for a long time. Cables configured together with small-power servo motors do not fit for drag chains.

If a cable drag chain is used, make sure the following requirements are fulfilled:

- The bending radius of the cable must be 10 times longer than its outer diameter.
- Do not fix or bundle the cables inside the cable drag chain. The cables can be bundled and fixed only at the two fixed ends of the cable drag chain.
- Do not wind or twist the cables.

- Ensure the space factor inside the cable drag chain is below 60%.
- Do not use cables with different sizes together. This is to prevent thin cables from being crushed by thick cables. If thick and thin cables need to be used together, use a spacer plate to separate them.

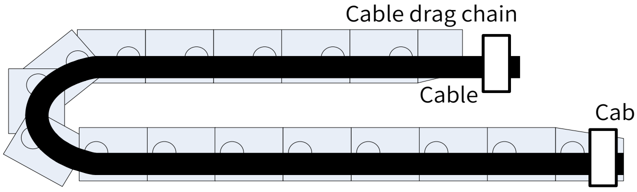


Figure 3-26 Cable drag chain

4 Keypad Display and Operations

4.1 Introduction to the Keypad

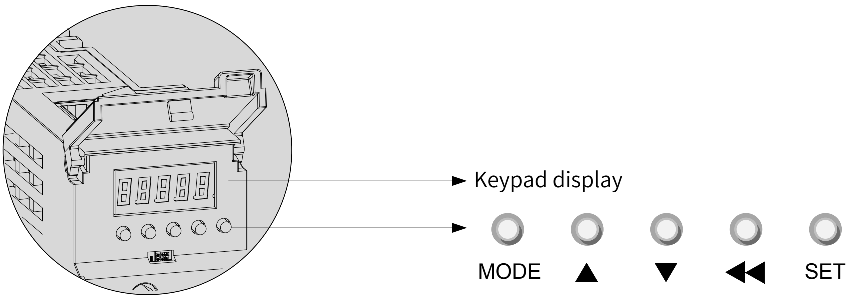


Figure 4-1 Appearance of the LED keypad

The keypad on the SV660N servo drive consists of five LEDs and five push buttons. The keypad is used for data display, parameter settings, password settings and general function executions. When the keypad is used for parameter settings, the functions of the push buttons are described as follows.

Table 4-1 Functions of keys

Name	Symbol	Description
MODE	MODE	Used to switch the mode and return to the previous menu.
UP	▲	Used to increase the value of the blinking digit.
DOWN	▼	Used to decrease the value of the blinking digit.
SHIFT	◀◀	Used to shift the blinking digit to view the high digits of a number consisting of more than 5 digits.
SET	SET	Used to enter the next menu and store parameter settings.

4.2 Display

The keypad displays the status, parameters, faults, and monitored information during servo drive running.

- Status display: current servo drive status, such as servo ready or running
- Parameter display: parameters and their set values
- Fault display: faults and warnings that occur on the servo drive
- Monitoring display: present running parameters of the servo drive

4.2.1 Transition Relation Between Keypad Display and Operation Objects

The mapping relation between the parameter (decimal) displayed by the keypad and the object dictionary operated by the host controller (hexadecimal, "Index" and "Sub-index") is as follows:

Object dictionary index = 0x2000 + Parameter group number

Object dictionary sub-index = Hexadecimal offset within the parameter group + 1

Example:

Display	Object Dictionary Operated by the Host Controller
H00-00	2000-01h
H00-01	2000-02h
...	...
H01-09	2001-0Ah
H01-10	2001-0Bh
...	...
H02-15	2002-10h

NOTE

The following describes the displayed content and parameter settings on the keypad (decimal) side, which are different from those displayed on the software tool (hexadecimal). Make necessary conversions when performing operations through the software tool on the host controller.

4.2.2 Display Mode Switchover

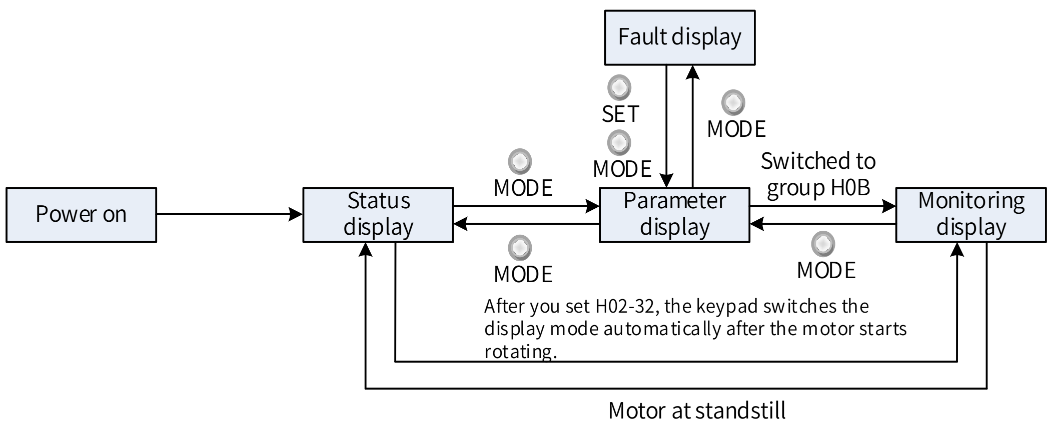
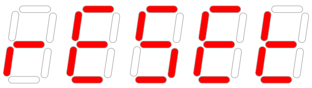
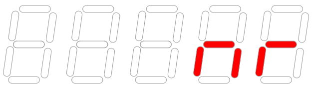
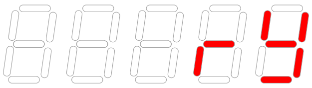
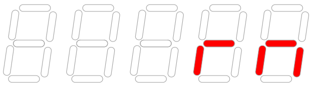
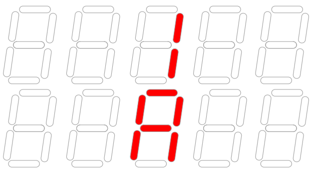
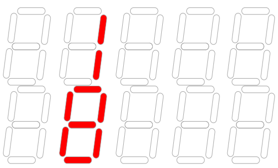
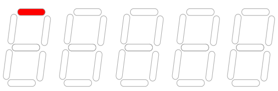
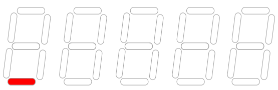


Figure 4-2 Switchover between different types of display

- After power-on, the keypad enters status display mode.
- Press MODE to switch between different modes, as shown in the preceding figure.
- In status display mode, set H02-32 (Default keypad display) and select the parameter to be monitored. When the motor rotates, the keypad automatically switches to monitoring display. After the motor stops, the keypad automatically reverts to status display.
- In parameter display mode, set parameters in group H0B to select the parameters to be pre-monitored, and the keypad switches to the monitoring display mode.
- Once a fault occurs, the keypad enters the fault display mode immediately, and all five LEDs blink. Press SET to stop blinking, and then press MODE to switch to the parameter display mode.

4.2.3 Status Display

Display	Name	Display Condition	Meaning
	reset (servo initialization)	Upon power-on	The servo drive is in initialization or reset status. After initialization or reset is done, the servo drive automatically switches to other status.
	nr (servo not ready)	Initialization done, but servo drive not ready	The main circuit is not powered on, and the servo drive is not ready to run. See "9 Troubleshooting" for details.
	ry (servo ready)	Servo drive ready	The servo drive is ready to run and waits for the S-ON signal to be sent by the host controller.
	rn (servo running)	S-ON signal activated	The servo drive is running.
	1–A (control mode)	-	Displays present running mode of the servo drive in hexadecimal digits. 1: Profile position control 3: Profile velocity mode 4: Profile torque mode 6: Homing mode 8: Cyclic synchronous position mode 9: Cyclic synchronous velocity mode A: Cyclic synchronous torque mode
	1–8 (communication status)	-	Displays the status of the slave EtherCAT state machine in the form of characters. 1: Initializing 2: Pre-running 4: Safe running 8: Running
	- CN4 (connection indication)	EtherCAT output connected successfully	Solid OFF: No communication connection is detected in the physical layer. Solid ON: Communication connection is detected in the physical layer.
	- CN3 (connection indication)	EtherCAT input connected successfully	

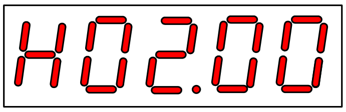
4.2.4 Parameter Display

The SV660N servo drive parameters are divided into 14 groups based on parameter functions. The parameter can be located quickly based on the group it belongs to. See "11.2 List of Object Groups" to view the parameter table.

■ Display of the parameter group

Display	Name	Description
HXX.YY	Parameter group	XX: Parameter group No. (decimal) YY: Parameter No. (hexadecimal)

For example, H02-00 is displayed as follows.

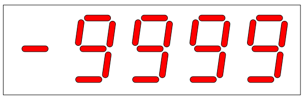
Display	Name	Description
	Parameter H02-00	02: Parameter group No. 00: Parameter No.

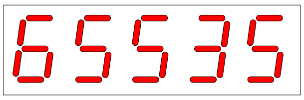
■ Display of the negative numbers and the data in different lengths

1) Signed number of 4 digits and below or unsigned number of 5 digits and below

Such numbers are displayed in a single page (five LEDs). For the signed number, the highest bit "-" indicates the negative symbol.

For example, -9999 and 65535 are displayed as follows.





2) Signed number of more than 4 digits or unsigned number of more than 5 digits

Such numbers are displayed from low to high digits through several pages with each page displaying five digits. The display mode is shown in the following figure (current page + value on current page). Hold down  for more than 2s to switch to the next page.

For example, -1073741824 is displayed as follows.

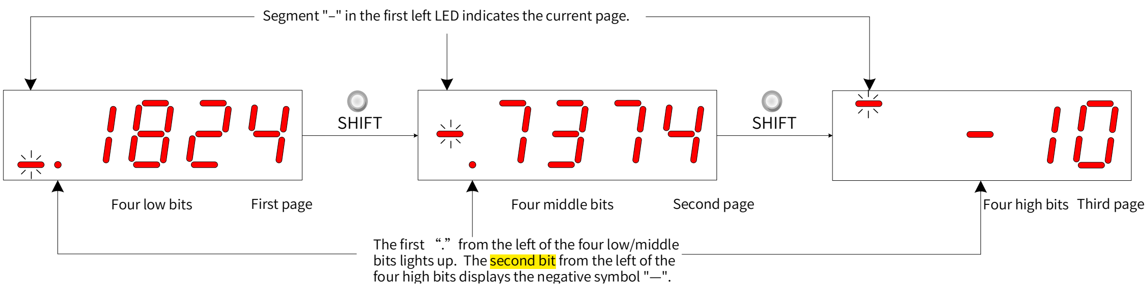


Figure 4-3 Display of "-1073741824"

For example, 1073741824 is displayed as follows.

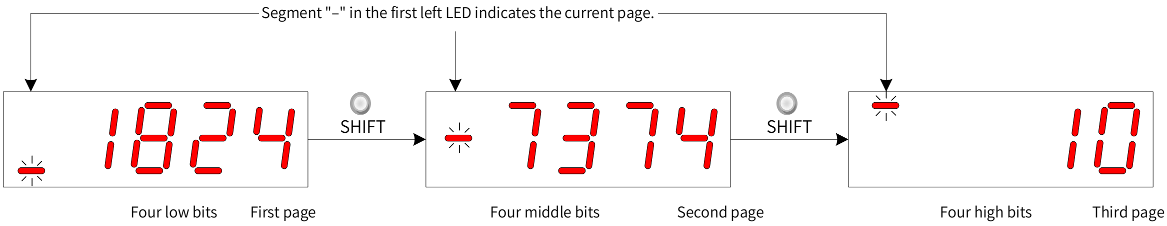
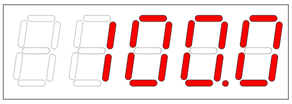


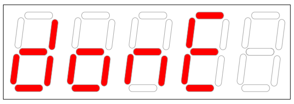
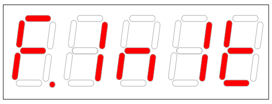
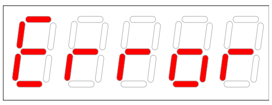
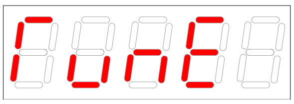
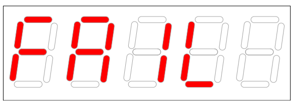
Figure 4-4 Display of "1073741824"

■ Decimal point display

The segment "." of the ones position indicates the decimal point, and this segment does not blink.

Display	Name	Description
	Decimal point	100.0

■ Parameter setting display

Display	Name	Display Condition	Meaning
	Done (parameter setting completed)	Parameter setting done	The parameter value is set and stored in the servo drive. The servo drive is ready to execute other operations.
	F.InIt (parameter restored to default setting)	Parameter initialization in progress (H02-31 = 1).	The servo drive is in the process of parameter initialization. After parameter initialization is done, switch on the control power supply again.
	Error (wrong password)	User password (H02-30) applied and wrong password entered	The password entered is wrong. Enter the password again.
	TunE	One-button tuning enabled	The one-button tuning is in progress.
	FAIL	One-button tuning failed	The one-button tuning fails.

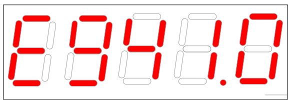
4.2.5 Fault Display

■ The keypad can display present or previous faults and warnings. For analysis and solutions to the faults and warnings, see "9 Troubleshooting".

■ When an individual fault or warning occurs, the keypad displays the present fault or warning code immediately. When multiple faults or warnings occur, the keypad displays the warning code of the highest level.

- Set the fault record to be viewed in H0B-33 (Fault record). View the selected fault or warning code in H0B-34.
- Set H02-31 (Parameter initialization) to 2 (Clear fault records) to clear the latest 10 faults or warnings stored in the servo drive.

For example, E941.0 is displayed as follows.

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

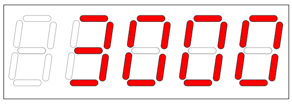
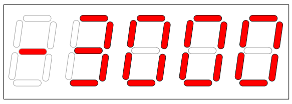
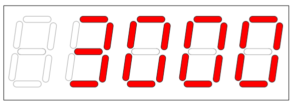
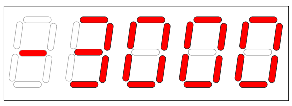
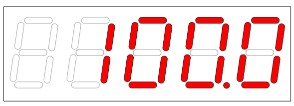
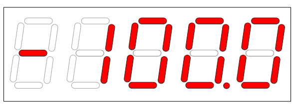
4.2.6 Monitoring Display

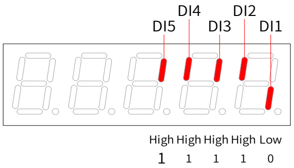
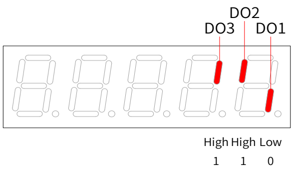
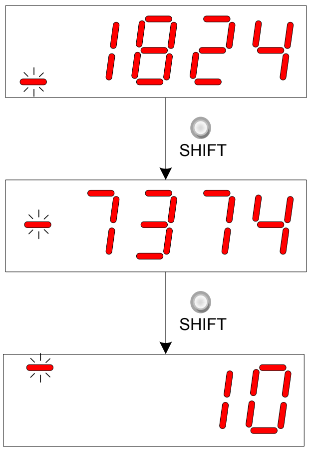
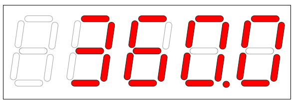
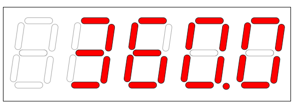
Group H0B: Displays parameters used for monitoring the running state of the servo drive.

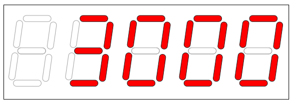
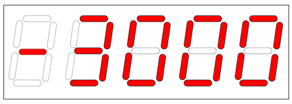
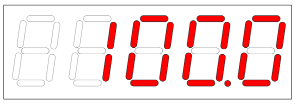
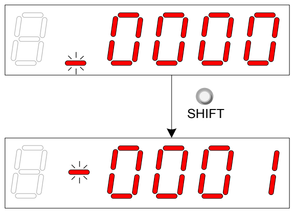
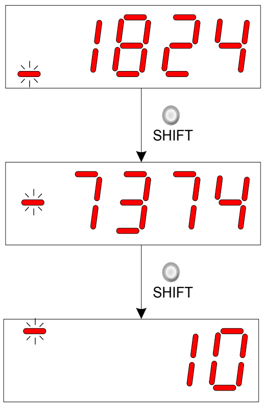
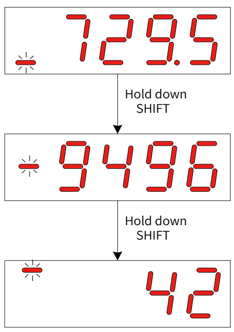
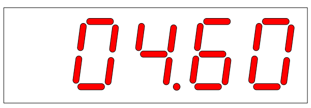
Set H02-32 (Default keypad display). After the servo motor runs, the keypad switches from servo status display mode to parameter display mode and displays the parameter No. defined by H02-32 in group H0B.

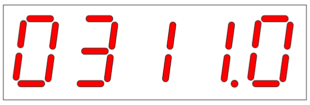
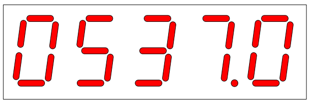
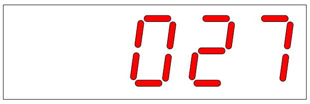
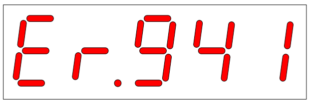
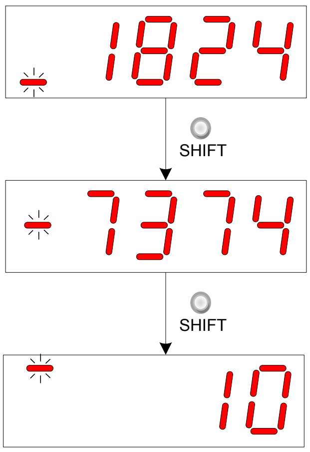
For example, if H02-32 is set to 00, the keypad displays the value of H0B-00 when the servo motor speed is not 0 RPM.

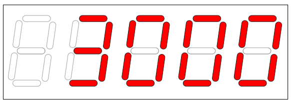
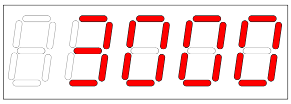
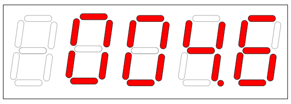
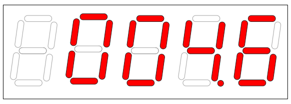
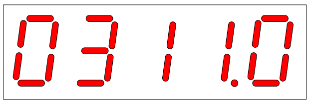
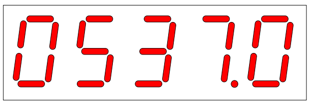
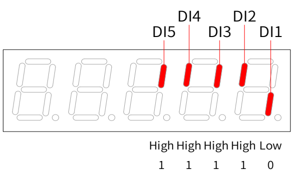
The monitoring display of group H0B is as follows.

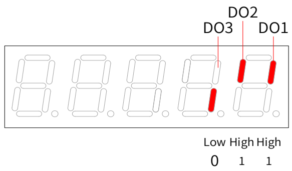
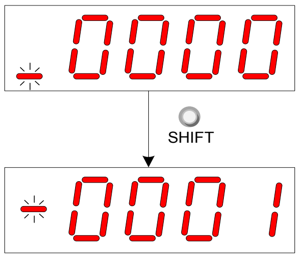
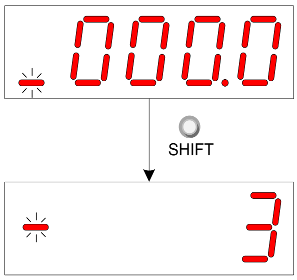
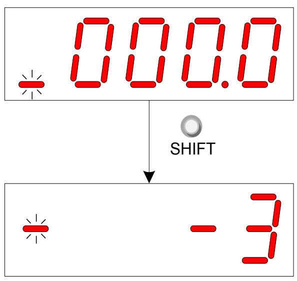
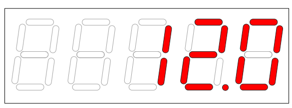
Para. No.	Name	Unit	Meaning	Display Example
H0B-00	Actual motor speed	RPM	Displays actual motor speed after round-off in unit of 1 RPM.	Display of 3000 RPM:  Display of -3000 RPM: 
H0B-01	Speed reference	RPM	Displays present speed reference of the servo drive.	Display of 3000 RPM:  Display of -3000 RPM: 
H0B-02	Internal torque reference	0.1%	Displays the percentage of the actual motor output torque to the rated motor torque.	Display of 100.0%:  Display of -100.0%: 

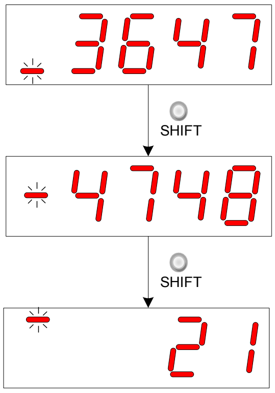
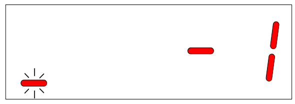
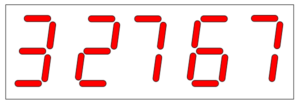
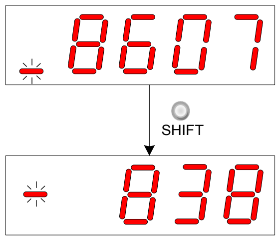
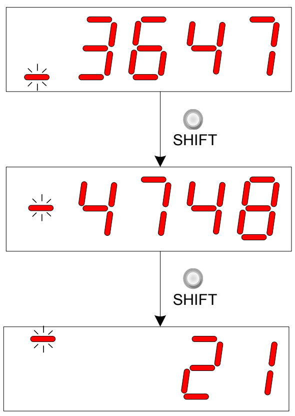
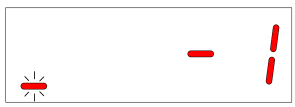
Para. No.	Name	Unit	Meaning	Display Example
H0B-03	Monitored DI status	-	Displays the corresponding level status of five DIs: Upper LED segment turned on: High level (indicated by "1") Lower LED segment turned on: Low level (indicated by "0") The value of H0B-03 read by the software tool is a decimal number.	In cases where DI1 is low level and DI2 to DI5 are high level, the corresponding binary value is 11110, and the value of H0B-03 read by the software tool is 0x001E, the corresponding display is as follows. 
H0B-05	Monitored DO status	-	Displays the corresponding level status of the three DOs: Upper LED segment turned on: High level (indicated by "1") Lower LED segment turned on: Low level (indicated by "0") The value of H0B-05 read by the software tool is a decimal number.	In cases where DO1 is low level and DO2 to DO3 are high level, the corresponding binary value is 110, and the value of H0B-05 read by the software tool is 0x0006, the corresponding display is as follows. 
H0B-07	Absolute position counter (32-bit decimal value)	Reference unit	Displays the absolute position of the motor (reference unit).	Display of 1073741824 referent units: 
H0B-09	Mechanical angle	0.1°	Displays the present mechanical angle of the motor.	Display of 360.0° : 
H0B-10	Rotation angle (Electrical angle)	0.1°	Displays the present electrical angle of the motor.	Display of 360.0° : 

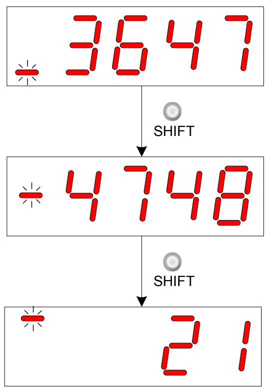
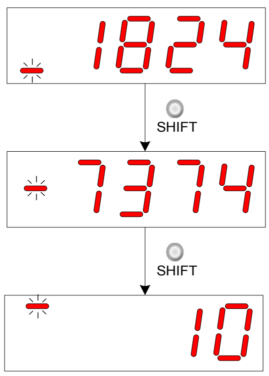
Para. No.	Name	Unit	Meaning	Display Example
H0B-11	Speed information corresponding to the input position reference	RPM	Displays the speed corresponding to the position reference in a single control cycle.	Display of 3000 RPM:  Display of -3000 RPM: 
H0B-12	Average load ratio	0.1%	Displays the percentage of the average load torque to the rated motor torque.	Display of 100.0%: 
H0B-15	Encoder position deviation counter (32-bit decimal value)	Encoder unit	Deviation of the encoder position = Sum of input position references (encoder unit) - Sum of pulses fed back by the encoder (encoder unit)	Display of 10000 encoder units: 
H0B-17	Feedback pulse counter (32-bit decimal value)	Encoder unit	Counts and displays the number of servo motor encoder pulses (encoder unit). Note: When an absolute motor is used, H0B-17 only shows the low 32-bit value of the motor position feedback. To obtain the actual motor position feedback, view H0B-77 and H0B-79.	Display of 1073741824 encoder units: 
H0B-19	Total power-on time (32-bit decimal value)	0.1s	Counts and displays the total power-on time of the servo drive.	Display of 429496729.5s: 
H0B-24	RMS value of phase current	0.1 A	Displays the RMS value of the servo motor phase current.	Display of 4.60 A: 

Para. No.	Name	Unit	Meaning	Display Example
H0B-26	Bus voltage	0.1 V	Displays the main circuit DC bus voltage between P and -.	Display of 311.0 V rectified from 220 VAC:  Display of 537.0 V rectified from 380 VAC: 
H0B-27	Power module temperature	° C	Displays the temperature of the power module inside the servo drive.	Display of 27°C : 
H0B-33	Fault log	-	Displays the previous fault to be viewed. 0: Present fault 1: Last fault 2: 2nd to last fault … 9: 9th to last fault	0-Display of present fault: 
H0B-34	Fault code of the selected fault.	-	Displays the fault code defined by H0B-33. When there is no fault, H0B-34 displays "Er.000".	If H0B-33 = 0, H0B-34 = Er.941, the present fault code will be 941. Corresponding display: 
H0B-35	Time stamp of the selected fault	s	Displays the total operating time of the servo drive when the fault defined by H0B-35 occurs. When there is no fault, H0B-35 displays "0".	If H0B-34 = Er.941, and H0B-35 = 107374182.4, the present fault code will be 941 and the total operating time of the servo drive is 107374182.4s when the fault occurs. 

Para. No.	Name	Unit	Meaning	Display Example
H0B-37	Motor speed upon occurrence of the selected fault	RPM	Displays the servo motor speed when the fault defined by H0B-37 occurred When there is no fault, H0B-37 displays "0".	Display of 3000 RPM:  Display of -3000 RPM: 
H0B-38	Motor phase U current upon occurrence of the selected fault	0.1 A	Displays the RMS value of phase U winding current of the servo motor when the fault defined by H0B-38 occurred. When there is no fault, H0B-38 displays "0".	Display of 4.60 A: 
H0B-39	Motor phase V current upon occurrence of the selected fault	0.1 A	Displays the RMS value of phase V winding current of the servo motor when the fault defined by H0B-39 occurred. When there is no fault, H0B-39 displays "0".	Display of 4.60 A: 
H0B-40	Bus voltage upon occurrence of the selected fault	V	Displays the DC bus voltage of the main circuit when the fault defined by H0B-40 occurred. When there is no fault, H0B-40 displays "0".	Display of 311.0 V rectified from 220 VAC:  Display of 537.0 V rectified from 380 VAC: 
H0B-41	Input terminal status upon occurrence of the selected fault	-	Displays the high/low level status of the five DIs when the fault defined by H0B-41 occurred. The viewing method is the same as that of H0B-03. When there is no fault, all the DIs are displayed as low level by H0B-41, and the corresponding hexadecimal value is "0".	In cases where the value of H0B-41 read by the software tool is 0x0001, and the corresponding binary code is 0000 0000 0000 0001 . 

Para. No.	Name	Unit	Meaning	Display Example
H0B-43	Output terminal status upon occurrence of the selected fault	-	Displays the high/low level status of the three DOs when the fault defined by H0B-34 occurred. The viewing method is the same as that of H0B-05. When there is no fault, all the DOs are displayed as low level by H0B-43, and the corresponding decimal value is "0".	Display of H0B-43 = 0x0003: 
H0B-53	Position deviation counter (32-bit decimal value)	Reference unit	Position deviation = Sum of input position references (reference unit) - Sum of pulses fed back by the encoder (reference unit)	Display of 10000 reference units: 
H0B-55	Actual motor speed	0.1 RPM	Displays the actual motor speed in unit of 0.1 RPM.	Display of 3000.0 RPM:  Display of -3000.0 RPM: 
H0B-57	Control power voltage	0.1 V	Displays the control power DC voltage.	Display of 12.0 V: 

Para. No.	Name	Unit	Meaning	Display Example
H0B-58	Mechanical absolute position (low 32 bits)	Encoder unit	Displays the mechanical absolute position (low 32 bits) when an absolute encoder is used.	Display of 2147483647 encoder units: 
H0B-60	Mechanical absolute position (high 32 bits)	Encoder unit	Displays the mechanical absolute position (high 32 bits) when an absolute encoder is used.	Display of "-1" encoder unit: 
H0B-70	Number of the absolute encoder revolutions	Rev	Displays the present number of revolutions of an absolute encoder.	Display of 32767: 
H0B-71	Single-turn position feedback of an absolute encoder	Encoder unit	Displays the single-turn position feedback of an absolute encoder.	Display of 8388607 encoder units: 
H0B-77	Absolute encoder position (low 32 bits)	Encoder unit	Displays the absolute position (low 32 bits) of the motor when an absolute encoder is used.	Display of 2147483647 encoder units: 
H0B-79	Absolute encoder position (high 32 bits)	Encoder unit	Displays the absolute position (high 32 bits) of the motor when an absolute encoder is used.	Display of "-1" encoder unit: 

Para. No.	Name	Unit	Meaning	Display Example
H0B-81	Single-turn position feedback of the load in rotation mode (low 32 bits)	Encoder unit	Displays the position feedback of the mechanical load (low 32 bits) when the absolute system works in rotation mode.	Display of 2147483647 encoder units: 
H0B-83	Single-turn position feedback of the load in rotation mode (high 32 bits)	Encoder unit	Displays the position feedback of the mechanical load (high 32 bits) when the absolute system works in rotation mode.	Display of 1 encoder unit: 
H0B-85	Single-turn position of the load in rotation mode	Reference unit	Displays the absolute mechanical position when the absolute system works in rotation mode.	Display of 1073741824 referent units: 

4.3 Parameter Setting

Parameter settings can be performed through the keypad. For details on parameters, see "11.2 List of Object Groups". The following figure shows how to change from position control mode to speed control mode after the power supply is switched on.

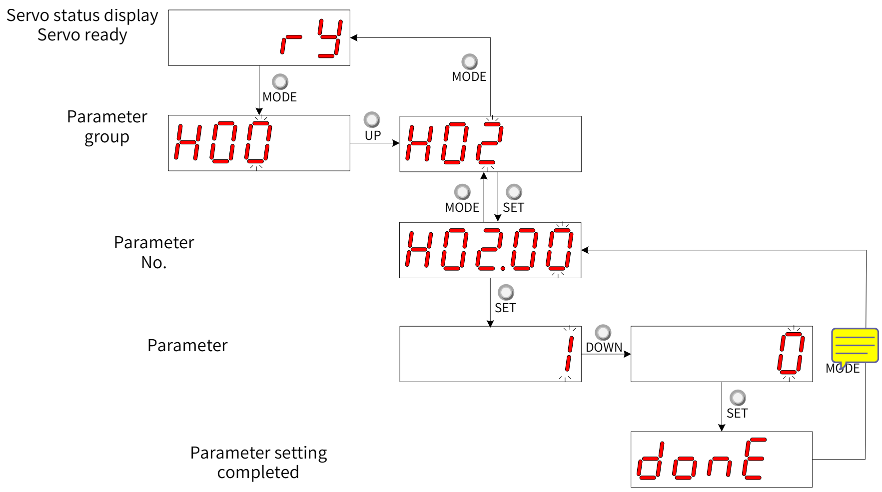


Figure 4-5 Procedures for parameter setting

- MODE : Used to switch the keypad display mode and return to the previous menu.
- "▲"/"▼": Used to increase or decrease the value of the blinking digit.
- "◀◀": Used to shift the blinking digit.
- " SET ": Used to save present setting values or switch to the next menu.

After parameter setting is done, that is, "Done" is displayed on the keypad, press MODE to return to parameter group display (interface of "H02-00").

4.4 User Password

After user password (H02-30) is enabled, only the authorized user can perform parameter settings; other operators can only view the parameter.

- Setting the user password

The following figure shows how to set the password to "00001".

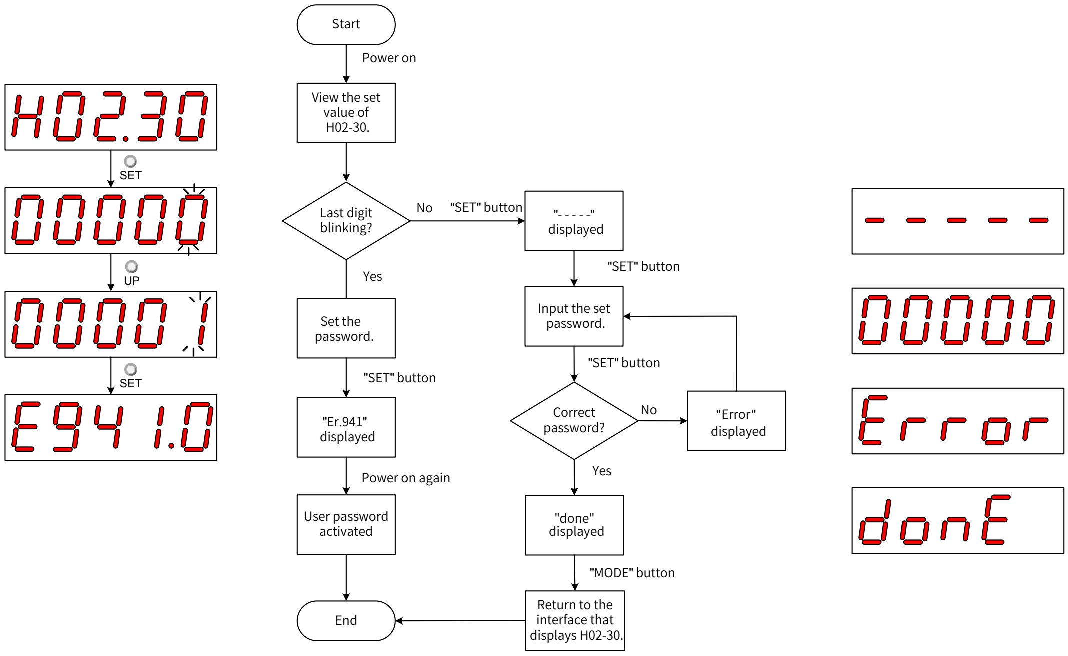


Figure 4-6 Procedures for user password setting

To change the user password, input the present password first to authorize the access to parameter setting, and then enter H02-30 again to set a new password according to the method described in the preceding figure.

NOTE

If the last digit does not blink, the present password is protected. If the last digit blinks, no password is set or a correct password has been entered.

- Canceling user password

Enter the set user password, and set H02-30 to "00000" to cancel user password.

4.5 General Functions

4.5.1 Jog

CAUTION

The jog function requires the S-ON signal to be deactivated. Otherwise, jogging cannot be executed.

Users can perform trial running on the servo motor and the servo drive through jogging.

■ Operating process

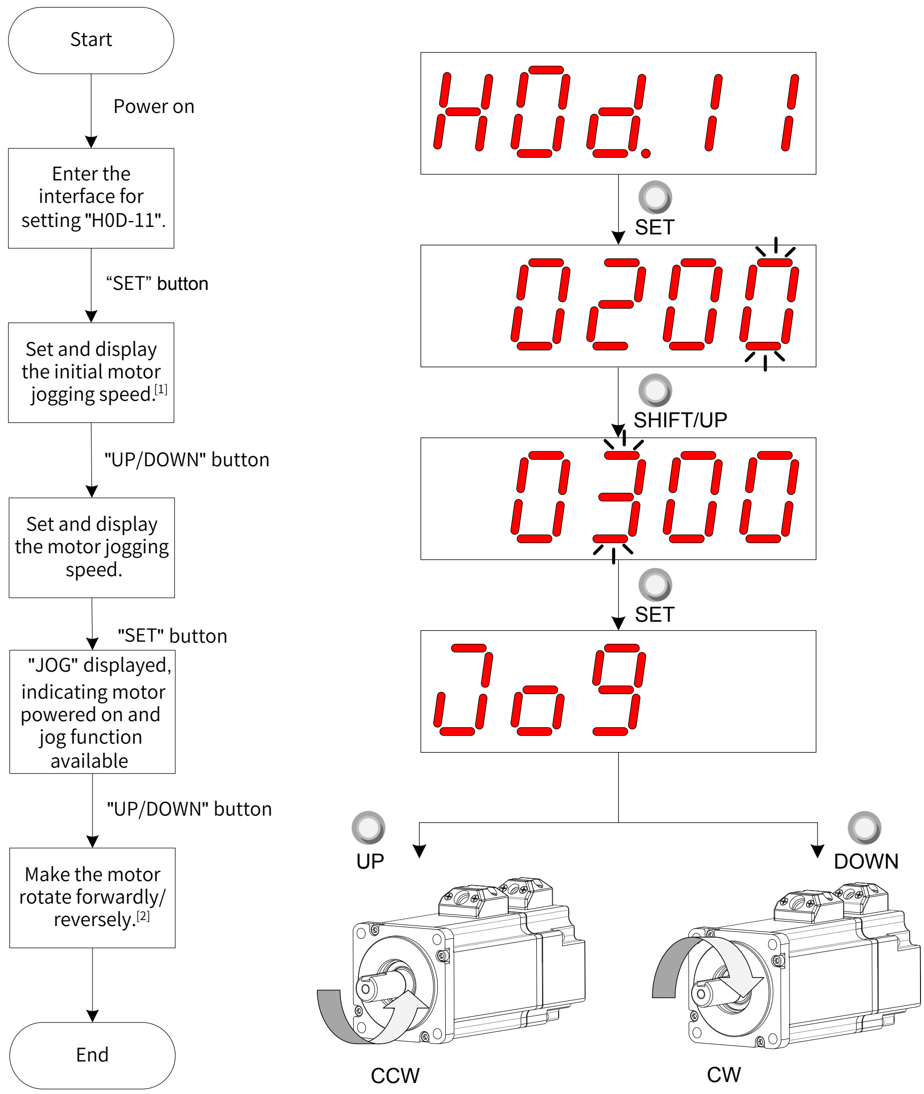


Figure 4-7 Procedures for setting the jog function

[1] Press ▲ or ▼ to increase or decrease the motor jogging speed. After exiting from the jog mode, the motor reverts to the initial speed.

[2] Press ▲ or ▼ to make the servo motor rotate in forward or reverse direction. After you release the button, the servo motor stops immediately.

- Exiting from jog

Press MODE to exit from the jogging status and return to the previous menu.

4.5.2 Forced DI/DO Signals

There are five DI signals and three DO signals on terminal CN1 of SV660N. Users can allocate the DI/DO function and terminal logic to parameters in group H03/H04 by using the keypad (or host controller communication), so that the host controller can control corresponding servo functions through the DI or the DO signal output by the servo drive.

The servo drive also provides forced DI/DO function. The forced DI can be used to test the DI function of the servo drive, and the forced DO can be used to check the DO signal connection between the host controller and the servo drive.

- Definition of DI/DO functions

Code	Name	Function	Description	Remarks
Consisting of two digits which indicate the terminal function				
Input signal function description				
01	S-ON	Servo ON	Invalid - Servo motor disabled in local mode Valid - Servo motor enabled in local mode	The S-ON function is only valid in non-bus control mode. The logic of the corresponding terminal must be set to level valid.
02	ALM-RST	Fault reset	Valid: Fault reset under local mode Invalid: Fault not reset under local mode	This function is valid only in non-bus control mode. It is recommended that the logic of the corresponding terminal be set to level valid.
14	P-OT	Positive limit switch	Valid - Forward drive inhibited Invalid - Forward drive permitted	When the mechanical movement is beyond the movable range, the overtravel prevention will be implemented. It is recommended that the logic of the corresponding terminal be set to level valid.
15	N-OT	Negative limit switch	Valid - Reverse drive inhibited Invalid - Reverse drive permitted	When the mechanical movement is beyond the movable range, the overtravel prevention will be implemented. It is recommended that the logic of the corresponding terminal be set to level valid.
31	HomeSwitch	Home switch	Invalid - Mechanical load beyond the home switch range Valid - Mechanical load within the home switch range	The logic of the corresponding terminal must be set to level valid.
34	EmergencyStop	Emergency stop	Valid: Position locked after stop at zero speed Invalid: Current running status not affected	It is recommended that the logic of the corresponding terminal be set to level valid.

Code	Name	Function	Description	Remarks
38	TouchProbe1	Touch probe 1	Invalid - Probe not triggered Valid - Probe can be triggered	The probe logic is only related to the probe function (60B8h) instead of the terminal logic.
39	TouchProbe2	Touch probe 2	Invalid - Probe not triggered Valid - Probe can be triggered	The probe logic is only related to the probe function (60B8h) instead of the terminal logic.
Output signal function description				
01	S-RDY	Servo ready	Valid - Servo ready Invalid - Servo not ready	The servo drive is ready to run.
02	TGON	Motor rotating	Invalid - Absolute value of the filtered motor speed smaller than the value of H06-16. Valid - Absolute value of the filtered motor speed reaching the value of H06-16.	-
09	BRK	Brake output	Valid: Brake signal outputted Invalid: Brake signal not outputted	-
10	WARN	Warning	Valid - Warning occurs on the servo drive Invalid - No warning occurs on the servo drive or the warning has been reset	-
11	ALM	Fault	Valid - Fault occurs on the servo drive Invalid - No fault occurs on the servo drive or the fault has been reset	-
25	CMP	Position comparison	Valid: Servo drive passing the target position comparison point Invalid: Servo drive not passing the target position comparison point	-
32	EDM	Safety status	Valid: STO function triggered Invalid: STO function not triggered	The EDM will output valid signals only when the 24 V input voltages for STO1 and STO2 are disconnected simutaneously.

1 Forced DI signal

When this function is enabled, all DI levels will be controlled by H0D-18 (Forced DI value).

■ Operating process

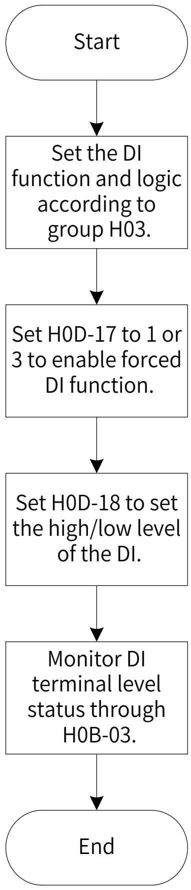


Figure 4-8 Procedures for forced DI signal setting

☆ Related parameters:

Parameter No.		Name	Value Range	Function	Setting Condition	Effective Time	Default
Keypad	Software Tool						
H0D-17	200D-12h	Forced DI/DO selection	0: No operation 1: Forced DI enabled, forced DO disabled 2: Forced DO enabled, forced DI disabled 3: Forced DI and DO enabled 4: Bus forced DO	This parameter is used to select the forced DI/ DO function.	During running	Immediately	0

H0D-18 is used to set the forced DI level. The keypad display is in hexadecimal, after being converted to binary, the number "1" indicates high level and the number "0" indicates low level.

The DI logic is defined by parameters in group H03. H0B-03 is used to monitor the DI level status. The keypad displays the level, and the value of H0B-03 (Monitored DI signal) read by the software tool is a decimal number.

■ Example

To activate the DI function allocated to DI1 and deactivate DI functions allocated to DI2 to DI5, set as follows (logic of all the five DIs being "low level valid"):

As the number "1" indicates high level and "0" indicates low level, the binary value is "11110", which correspond to the hexadecimal number "1E". Therefore, set the value of H0D-18 (Forced DI value) to "1E" through the keypad.

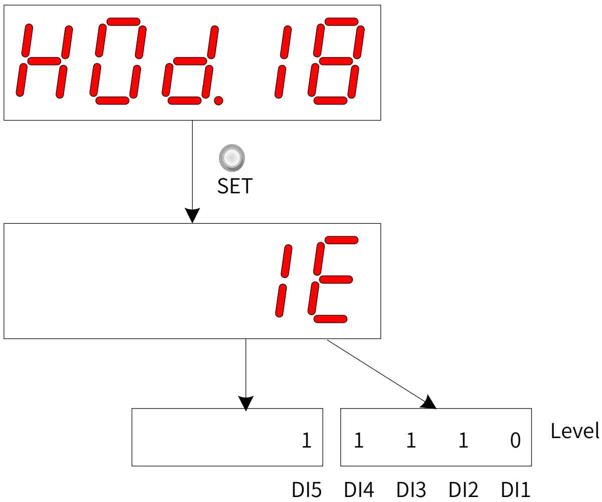


Figure 4-9 Description of H0D-18 setting

■ Monitoring the DI level status through H0B-03

If the DI function is normal, the displayed value of H0B-03 is always the same as that of H0D-18.

In this case, DI1 is displayed as low level and DI2 to DI9 are displayed as high level on the keypad, and the value of H0B-03 read by the software tool is 1E (hexadecimal). The keypad display is as follows.

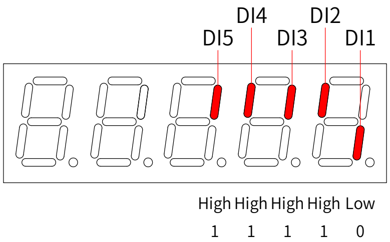


Figure 4-10 DI level status corresponding to H0B-03

■ Exit

The forced DI function is not retentive upon power-off. Normal DIs apply after restart, or you can set H0D-17 (Forced DI/DO selection) to 0 (No operation) to return to the normal DI mode.

2 Forced DO signal

After this function is enabled, all DO levels are controlled by H0D-19 (Forced DO value).

CAUTION	
	In cases where the servo motor is used for vertical motion, if the brake output signal (FunOUT.9: BK, brake output) is active, the brake will be released and the load may fall. Therefore, take protective measures on the machine to prevent falling.

■ Operating process

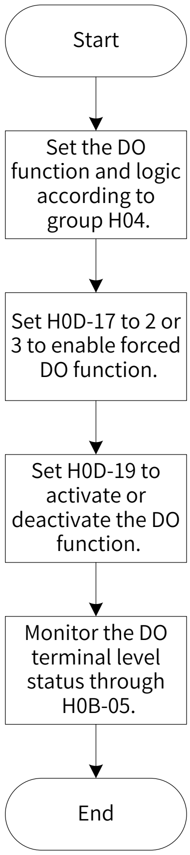


Figure 4-11 Procedures for forced DO signal setting

H0D-19 (Forced DO value) is used to set whether the forced DO function is valid. The keypad displays the value in hexadecimal, after being converted to binary, the number "1" indicates the DO function is valid and "0" indicates the DO function is invalid.

Parameters in group H04 are used to set the DO logic. H0B-05 is used to monitor the DO level status. The keypad displays the level, and the value of H0B-05 (Monitored DO signal) read by the software tool is a decimal number.

Example: To activate the DO function allocated to DO1 and deactivate DO functions allocated to DO2 and DO5, set as follows:

As the number "1" indicates the DO function is valid and "0" indicates the DO function is invalid, the binary value will be "110", which corresponds to the hexadecimal number "6". Therefore, set H0D-19 (Forced DO value) to 6 through the keypad.

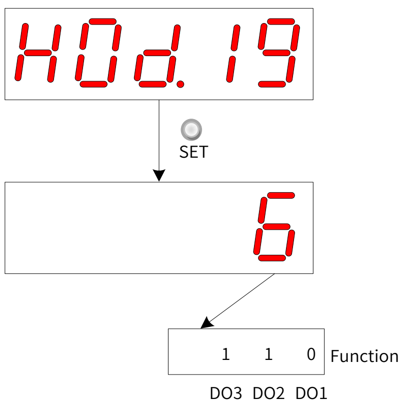


Figure 4-12 Description of H0D-19 setting

- Monitoring the DO level status through H0B-05

If the logic of all the three DO terminals are active at low level, the DO1 is high level and DO2 to DO5 terminals are low level, and the corresponding binary number is "001". In this case, the value of H0B-05 (Monitored DO signal) read by the software tool is 1 (decimal). The keypad display is as follows.

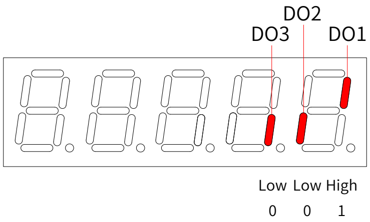


Figure 4-13 Display of H0B-05 when all DOs are "low level valid"

If the logic of all the three DOs are active at high level, the DO1 terminal is low level and DO2 to DO5 terminals are high level, the corresponding binary number is "110", and the value of H0B-05 (Monitored DO signal) read by the software tool is 6 (decimal). The keypad display is as follows.

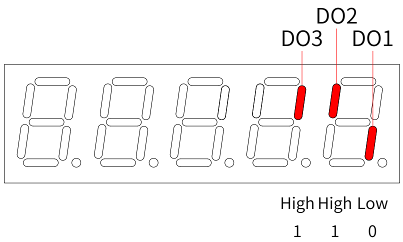


Figure 4-14 Display of H0B-05 when all DOs are "high level valid"

- Exit

The forced DO function is not retentive upon power-off. Normal DOs apply after restart, or you can set H0D-17 (Forced DI/DO selection) to 0 (No operation) to return to the normal DO mode.

3 Forced DO signals controlled by the bus

After this function is enabled, all DO signal levels are controlled by 60FE-01h (Physical output).

In cases where the servo motor is used for vertical motion, if the brake output signal (FunOUT.9: BK, brake output) is active, the brake will be released and the load may fall. Therefore, take protective measures on the machine to prevent falling.

■ Operating process

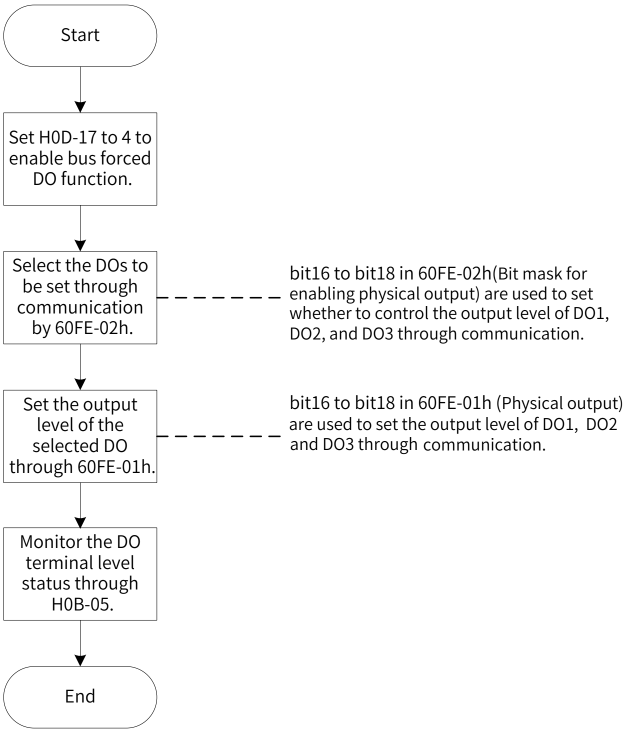


Figure 4-15 Procedures for bus forced DO signal setting

When 200D-12h is set to 4, 60FE (Digital output) can be used to forcibly set the DO level through the bus.

Bit	Related DO	Physical output enabled: 60FE-02h	Physical output: 60FE-01h
16	DO1	1: DO1 forced output enabled	DO1 forced output (0: OFF, 1: ON)
17	DO2	1: DO2 forced output enabled	DO2 forced output (0: OFF, 1: ON)
18	DO3	1: DO3 forced output enabled	DO3 forced output (0: OFF, 1: ON)

When 200D-12h is set to 4 and any bit in bit16 to bit18 of 60FE-02h is 1, the corresponding forced DO is OFF.

H0B-05 is used to monitor the DO level status. The keypad displays the level, and the value of H0B-05 (Monitored DO signal) read by the software tool is a decimal number.

Example: To make the output level of DO1 to DO3 be forcibly set by the bus, in which DO1 outputs low level and DO2 to DO3 output high level, set as follows:

Set 200D-12h to 4, 60FE-02h to 0x00070000 and 60FE-01 to 0x00060000, and monitor the DO level status through H0B-05 (Monitored DO signal). The keypad display is as follows.

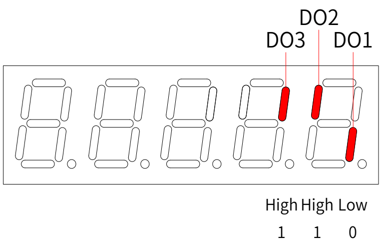


Figure 4-16 Display of H0B-05 when DO signals are controlled by the bus

- Exit

The bus-controlled forced DO signal is not retentive upon power-off. Normal DOs apply after restart, or you can set H0D-17 (Forced DI/DO selection) to 0 (No operation) to return to the normal DO mode.

5 Commissioning and Operation

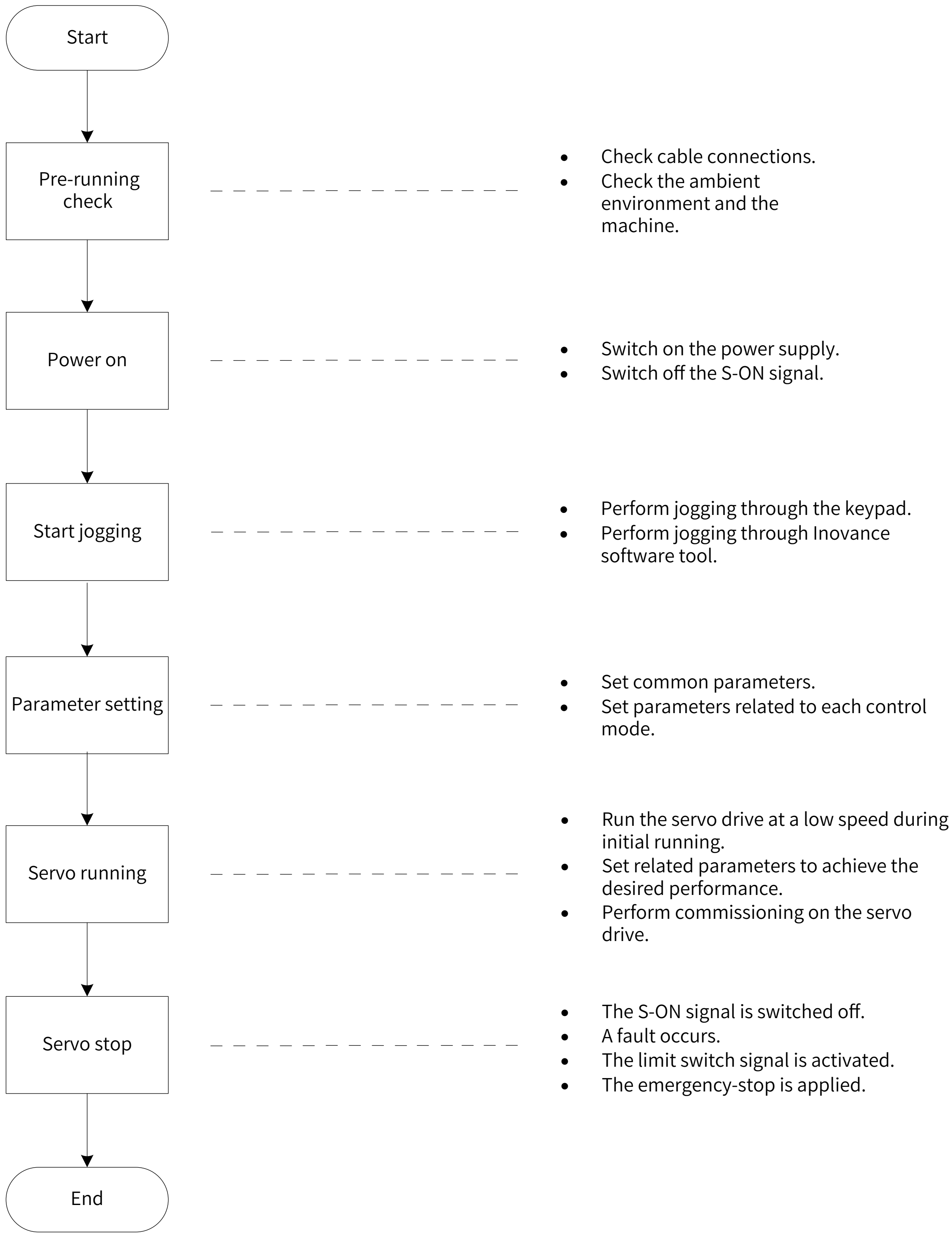


Figure 5-1 Flowchart for servo drive settings

5.1 Pre-running Check

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

Table 5-1 Checklist before running

Record	SN	Description
Wiring		
☐	1	The power input terminals ((L1, L2)/(L1, L2, L3)) of the servo drive are connected properly.
☐	2	The servo motor UVW cables are connected in the correct phase sequence at both ends.
☐	3	No short circuit exists in the power input terminals ((L1, L2)/(L1, L2, L3)) and main circuit output terminals (U, V, W) of the servo drive.
☐	4	The control signal cables such as brake and limit switches are connected properly.
☐	5	The servo drive and the servo motor are grounded properly.
☐	6	The cable tension is within the permissible range.
☐	7	The connecting terminals are well insulated.
Environment and Mechanical Conditions		
☐	1	No foreign objects (such as the cable end or metal filings) which may cause short circuit exist inside or outside the servo drive.
☐	2	The servo drive and the external regenerative resistor are placed on inflammable objects.
☐	3	The servo motor installation and the shaft and mechanical connections are reliable.
☐	4	The servo motor and the machine that the servo motor is connected to are ready to run.

5.2 Power-on

- Switching on the input power supply

The input power terminals of single-phase 220 V models are L1 and L2.

After switching on the input power supply, if the bus voltage indicator is in normal status and the keypad displays "reset" → "ry" in sequence, it indicates the servo drive is ready to run and waits for the S-ON signal to be sent from the host controller.

If the keypad keeps displaying "nr", see *"9 Troubleshooting"* for solutions.

If the keypad displays the fault code, see *"9 Troubleshooting"* for solutions.

- Deactivating the S-ON signal

5.3 Jog

Perform jogging to check whether the servo motor can rotate properly without abnormal vibration or noise. The jog function can be enabled through the keypad (jogging in speed mode/jogging in position mode) and Inovance software tool (jogging in speed mode).

NOTE

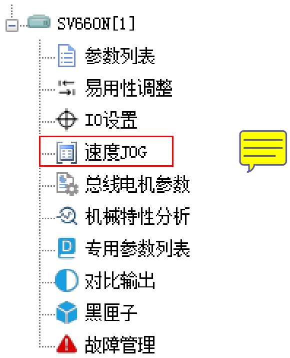
The acceleration/deceleration time constant of the speed/position reference can be set through H06-12 (2006-0Dh) during jogging.

■ Through the keypad (jogging in speed mode)

Enter the jogging in speed mode by setting H0D-11 through the keypad, and the keypad displays the default jogging speed, which can be modified by pressing ▲ / ▼. Press SET to enter the jogging status, and the keypad displays "JOG". Power on the servo motor, and hold down ▲ / ▼ to switch between forward and reverse jog as needed. Press MODE to exit from the jog mode.

■ Through Inovance servo commissioning software (jogging in speed mode)

Open the "Speed JOG" interface (as indicated by the red square frame in the following figure) in the software tool and set the jog speed. After switching the servo status to ON, press the forward/reverse arrow displayed on the interface to switch between forward and reverse jog as needed.



■ Through the keypad (jogging in position mode)

Enter the jogging in position mode by setting H0D-08 through the keypad, and the keypad displays the default jogging speed, which can be modified by pressing ▲ / ▼. Press SET to enter the jogging status, and the keypad displays "JOG-P". Power on the servo motor, and hold down ▲ / ▼ to switch between forward and reverse jog as needed. Press MODE to exit from the jog mode.

☆ Related parameters:

H06-12	Name	Acceleration ramp time of jog speed			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
2006-0Dh	Access	RW	Mapping	Yes	Related Mode	All	Data Range	0 to 65535 (ms)	Default	10
Used to set the time constant for the servo motor to accelerate from 0 RPM to 1000 RPM.										

5.4 General Parameter Settings

5.4.1 Rotation Direction

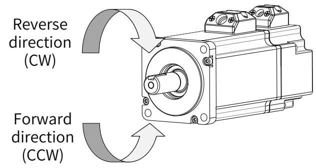
Set H02-02 (2002-03h) (Rotation direction) to change the motor rotation direction without changing the polarity of the input reference.

☆ Related parameters:

H02-02	Name	Rotation direction			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	Uint16
2002-03h	Access	RW	Mapping	-	Related Mode	All	Data Range	0–1	Default	0

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

Value	Rotation direction	Remarks
0	CCW as the forward direction	CCW direction as the forward direction when forward run command is input, indicating the motor rotates in CCW direction when viewed from the motor axis side
1	CW as the forward direction	CW direction as the forward direction when forward run command is input, indicating the motor rotates in CW direction when viewed from motor axis side



The value change of H02-02 (2002-03h) does not affect the pulse output form and the positive/negative attribute of monitoring parameters.

The "Forward drive" and rotation direction in the overtravel prevention function is the same as the setting in H02-02 (2002-03h).

5.4.2 Brake Settings

The brake is used to prevent the servo motor shaft from rotating during non-operating status of the servo drive. This is to keep the motor and the mechanical motion part in locked position.

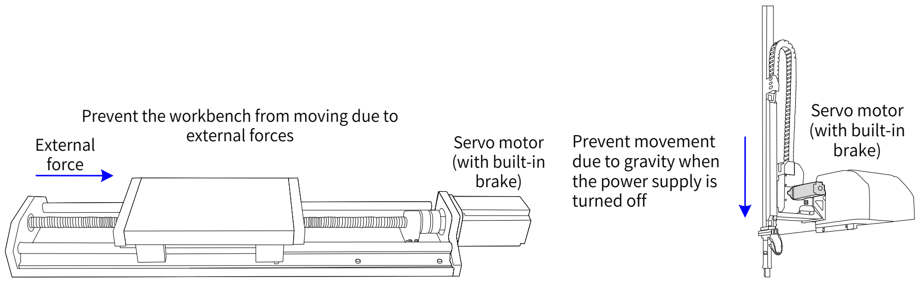


Figure 5-2 Application of the motor brake

CAUTION

- Use the built-in brake for position-lock in the stop state only.
- The brake coil has no polarity.
- After the servo motor stops, switch off the S-ON signal.
- When the servo motor with built-in brake runs, the brake may generate clattering sound. Such sound does not affect the motor functions.
- When brake coils are energized (the brake is released), magnetic flux leakage may occur at the shaft end. Pay special attention when using magnetic sensors around the servo motor.

1 Brake connection

The connection of the motor brake input signal has no polarity. Users need to prepare a 24 V power supply. The following figure shows the standard wiring of the brake signal (BK) and motor brake power supply.

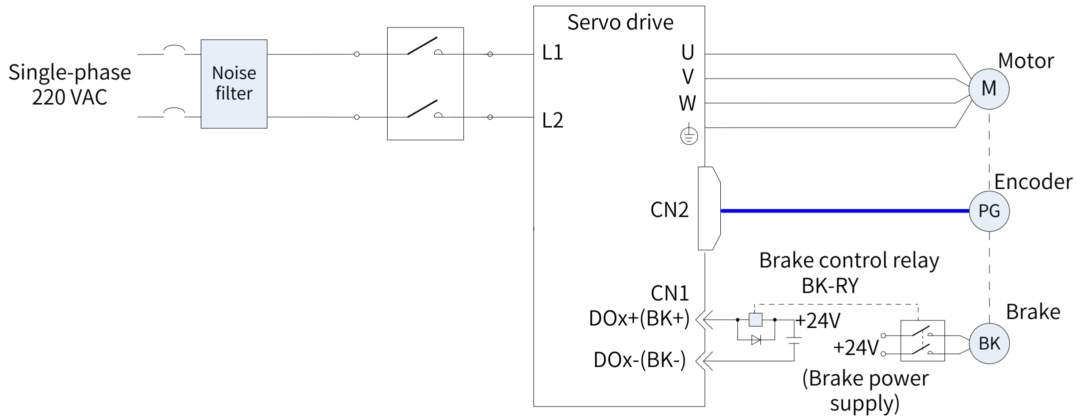


Figure 5-3 Wiring of the motor brake

Pay attention to the following precautions during wiring:

When deciding the length of the cable on the motor brake side, take the voltage drop caused by cable resistance into consideration. The input voltage must be at least 21.6 V to enable the brake to work properly. The following table lists brake specifications of Inovance MS1 series servo motors.

Table 5-2 Brake specifications

Motor Model	Holding Torque (Nm)	Supply Voltage (±10%) (VDC)	Resistance (Ω) ±7%	Supply Current Range (A)	Release Time (ms)	Close Time (ms)
MS1H1-10B	0.32	24	96	0.23–0.27	20	35
MS1H1-20B/40B	1.3	24	89.5	0.25–0.34	20	50
MS1H4-40B	1.3	24	89.5	0.25–0.34	20	50
MS1H1-75B	2.5	24	72	0.40–0.57	25	60
MS1H4-75B	2.5	24	50.1	0.40–0.57	25	60
MS1H3-85B	12	24	21.3	0. 95–1.33	60	120

NOTE

- ◆ Do not share the same brake power supply with other devices. This is to prevent brake malfunction due to voltage or current drop resulted from other working devices.
- ◆ It is recommended to use cables of 0.5 mm^2 and above.

2 Brake software setting

For the servo motor with brake, allocate function 9 (FunOUT.9: BK, brake output) to a certain DO, and set the valid logic of this DO.

Related function No.

Function No.	Name	Function	Description
FunOUT.9	BK	Brake output	Invalid: The brake power supply is switched on, the brake acts, and the motor stays in position lock state. Valid: The brake power supply is switched off, the brake is released, and the motor can rotate.

Depending on the present state of the servo drive, the working time sequence of the brake mechanism can be divided into brake time sequence in normal servo status and brake time sequence in servo fault status.

3 Brake time sequence in normal servo status

The brake time sequence in normal servo status is divided into the following two conditions:

Motor at standstill: The actual motor speed is less than 20 RPM.

Motor rotating: The actual motor speed is equal to or higher than 20 RPM.

■ Motor at standstill

If the S-ON signal is OFF, and the present motor speed is less than 20 RPM, the servo drive acts according to the brake time sequence in motor at standstill.

CAUTION	
	◆ After the brake output signal changes from ON to OFF, do not input a position/speed/torque reference within the time defined by 2009-0Ah/2000-34h. Otherwise, reference loss or running error may occur. ◆ When the motor drives a vertical axis, the load may move slightly due to the gravity or external force. For the motor at standstill, if the S-ON signal is off, the brake output will be off immediately. However, within the time defined by H02-10 (2002-0Bh), the motor is still energized to prevent the mechanical motion part from moving due to the gravity or external force.

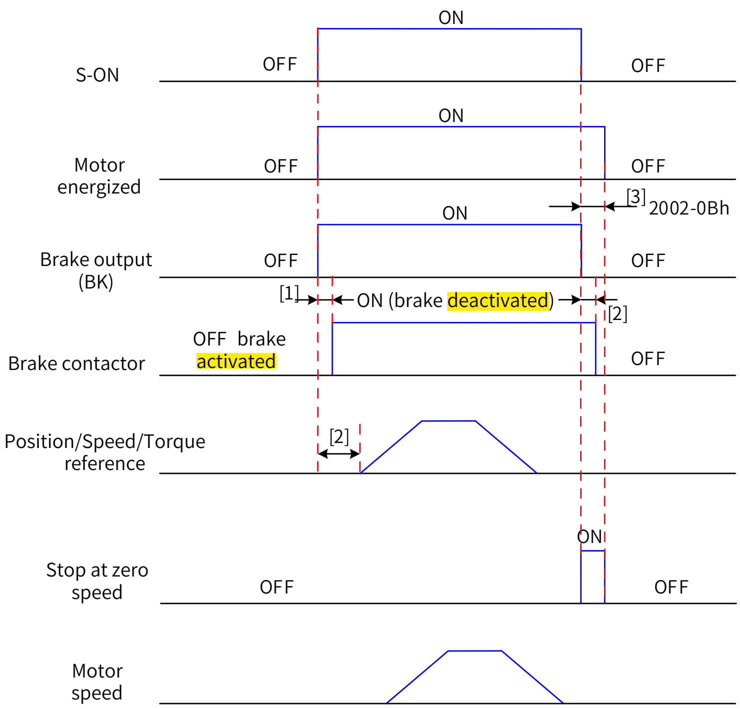


Figure 5-4 Brake time sequence in motor static status

[1] For the brake ~~triggering~~ delay time, see the motor specifications in "5 Electrical specifications for the motor with brake".

[2] The time interval from the moment when brake output becomes ON to the moment when the command is input must be larger than the time defined by 2009-0Ah/2000-34h.

[3] For the motor at standstill (motor speed less than 20 RPM), when the S-ON signal is turned off, the brake output signal is set to OFF. You can set the delay from brake output OFF to motor de-energized through 2002-0Bh.

☆ Related parameters:

H02-09	Name	Delay from brake output ON to command received			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
2002-0Ah	Access	RW	Mapping	-	Related Mode	All	Data Range	0–500 (ms)	Default	250
Defines the delay from the moment the brake output signal becomes ON to the moment when the servo drive starts to receive input commands after power-on. Within the time defined by 2002-0Ah, the servo drive does not receive position/speed/torque references.										

H02-10	Name	Delay from brake output OFF to motor de-energized			Setting Condition & Effective Time	Any condition & Immediately	Data Structure	-	Data Type	Uint16
2002-0Bh	Access	RW	Mapping	-	Related Mode	All	Data Range	50–1000 (ms)	Default	150
Defines the delay from the moment the brake output signal becomes OFF to the moment when the motor enters de-energized status.										

■ Motor rotating

If the S-ON signal is OFF and present motor speed is equal to or higher than 20 RPM, the servo drive acts according to the brake time sequence in motor rotating status.

CAUTION

- After the S-ON signal changes from OFF to ON, do not input a position/speed/torque reference within the time defined by 2009-0Ah/2000-34h. Otherwise, reference loss or running error may occur.
- If the S-ON signal becomes OFF during servo motor rotating, the servo motor enters ramp-to-stop state as defined by 6085h, but the brake output signal becomes OFF only after one of the following conditions is met:

1) The motor has decelerated to the value defined by 2002-0Ch (Motor speed threshold at brake output OFF in rotation state) when the time defined by 2002-0Dh (Delay from S-ON OFF to brake output OFF in rotation state) is not reached.
2) The time defined by 2002-0Dh is reached, but the motor speed is still higher than the value of 2002-0Ch.

- After the brake output signal changes from ON to OFF, the motor remains in energized state within the time defined by 2002-0B to prevent the mechanical motion part from moving due to the gravity or external force.

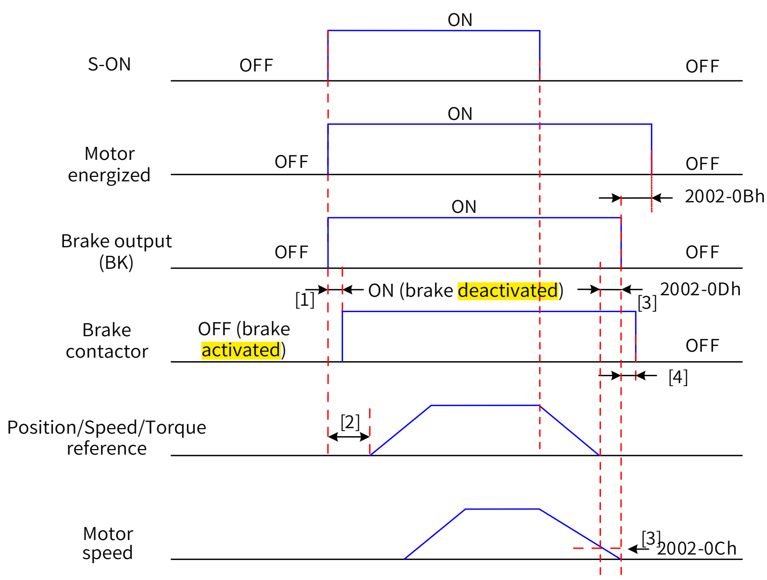


Figure 5-5 Brake time sequence at motor rotating

[1] For the delay of brake contactor actions, see *"5 Electrical specifications for the motor with brake"* for details.

[2] The time interval from the moment when brake output becomes ON to the moment when the command is input must be larger than the value defined by 2009-0Ah/2000-34h.

[3] When the S-ON signal is switched off during motor rotating, you can set the delay for brake output OFF by 2002-0Ch and 2002-0Dh.

[4] The motor enters de-energized state only after the time defined by 2002-0Bh elapses upon brake output OFF.

☆ Related parameters:

<table>
<tr><td>H02-11</td><td>Name</td><td colspan="3">Motor speed threshold at brake output OFF in rotation state</td><td>Setting Condition & Effective time</td><td>Any condition & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>2002-0Ch</td><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>20–3000 (RPM)</td><td>Default</td><td>30</td></tr>
<tr><td colspan="11">Defines the motor speed threshold when the brake output signal becomes OFF during motor rotating.</td></tr>
</table>

<table>
<tr><td>H02-12</td><td>Name</td><td colspan="3">Delay from S-ON OFF to brake output OFF in rotation status</td><td>Setting Condition & Effective Time</td><td>Any condition & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>2002-0Dh</td><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>1–1000 (ms)</td><td>Default</td><td>500</td></tr>
<tr><td colspan="11">Defines the delay from the moment the brake output signal becomes OFF to the moment when the S-ON signal becomes OFF during motor rotating.</td></tr>
</table>

■ Brake time sequence in quick stop

The states after quick stop can be divided into de-energized or position-lock depending on the stop mode. For the de-energized state (605Ah < 4), the brake output condition is the same as the brake time sequence in normal servo status (motor rotating).

■ Brake time sequence in fault status

The servo faults are classified into level 1 faults (No.1) and level 2 (No.2) faults. For details, see *"9 Troubleshooting"*. The brake time sequences in fault status are categorized into the following two situations:

1) No. 1 faults:

When a No. 1 fault occurs and the brake is enabled, the stop mode upon No. 1 fault is forced to "DB stop, keeping DB state", but the brake output condition is the same as the brake time sequence in normal servo status (motor rotating).

2) No. 2 faults:

When a No. 2 fault occurs and the brake is enabled, the stop mode is forced to "Ramp to stop, keeping DB state", but the brake output condition is the same as the brake time sequence in normal servo status (motor rotating).

NOTE

◆ Recommended setting value:
When the brake is applied, the setting value of 6085h (Stop deceleration) must meet the following requirement:
Deceleration time < 2002-0Dh
If the preceding requirement cannot be fulfilled, the deceleration command will be based on 2002-0Dh.

5.4.3 Regenerative Resistor Settings

When the motor torque direction is opposite to the speed direction, the energy is transmitted from the motor to the servo drive, causing bus voltage rise. Once the bus voltage rises to the braking threshold, the surplus energy must be consumed by a regenerative resistor. Otherwise, the servo drive will be damaged.

The regenerative resistor can be a built-in or an external one. However, a built-in regenerative resistor cannot be used together with an external regenerative resistor. The following table lists the specifications of the regenerative resistor.

Table 5-3 Specifications of the regenerative resistor for SV660N series servo drive

Servo Drive Model	Specifications of Built-in Regenerative Resistor			Min. Permissible Resistance of External Regenerative Resistor (2002-16h) (Ω)
	Resistance (Ω)	Power (W)	Processable Power P_a(W)	
SV660NS1R6I	-	-	-	50
SV660NS2R8I	-	-	-	45
SV660NS5R5I	50	50	25	40
SV660NS6R6I	50	50	25	40

The models S1R6 and S2R8 do not have the built-in regenerative resistor. Users need to prepare an external regenerative resistor as needed.

■ No external load torque

The energy at braking of reciprocating motor movement is converted into electric energy and fed back to the bus capacitor. When the bus voltage rises above the braking voltage threshold, the regenerative resistor will consume the excessive feedback energy. The following figure takes no-load running from 3000 RPM to 0 RPM as an example to show the motor speed curve.

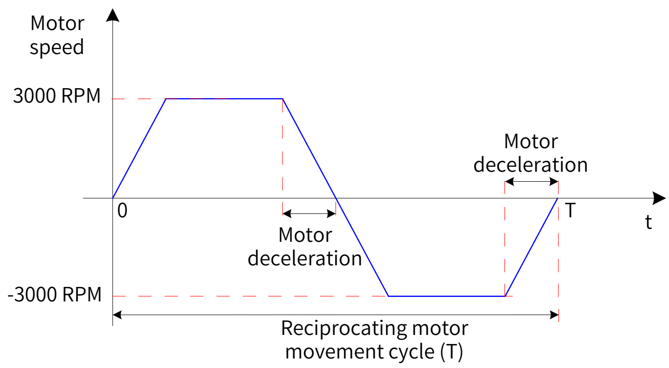


Figure 5-6 Motor speed curve without external load torque

■ Energy data

The following table lists the energy data generated during no-load running of a 220 V motor from 3000 RPM to 0 RPM.

Capacity	Servo Motor Model MS1H*-*******-*****		Rotor Inertia J (10^{-4}kgm^2)	Braking Energy E_O (J) Generated from 3000 RPM to 0 RPM	Max. Braking Energy Absorbed by Capacitor E_C (J)
100 W	H1 (low inertia, small capacity)	10B30CB	0.048	0.237	9
200 W		20B30CB	0.163	0.806	9
400 W		40B30CB	0.25	1.237	18
750 W		75B30CB	1.43	6.435	26
400 W	H4 (medium inertia, small capacity)	40B30CB	0.667	3.301	18
750 W		75B30CB	2.012	10.063	26
850 W	H3 (medium inertia, medium capacity)	85B15CB	14	76.725	26

If the time needed by the whole braking process is known (T), you can determine whether an external regenerative resistor is needed and and the power of the resistor (if needed) by using the following flowchart and formula.

■ Regenerative resistor selection

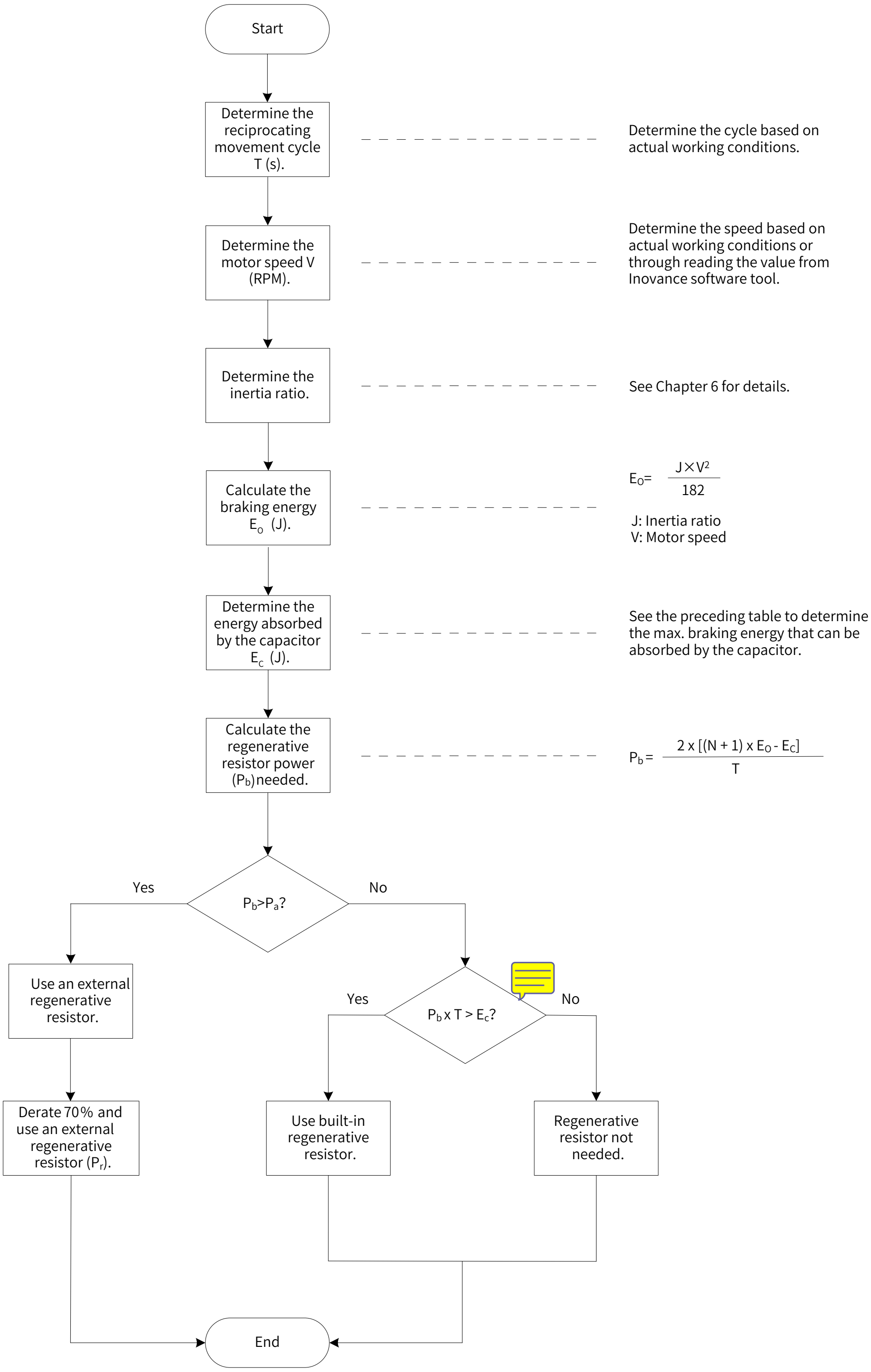


Figure 5-7 Flowchart for selecting regenerative resistor

NOTE

- Assume that the load inertia is N times the motor inertia, the braking energy is (N + 1) x E_O when the motor decelerates from 3000 RPM to 0 RPM, the energy consumed by the regenerative resistor will be (N+1) x E_O - E_C (unit: J) after deducting the energy (E_C) absorbed by the capacitor. Assume the reciprocating movement period is T, the regenerative resistor power needed will be 2 x [(N + 1) x E_O - E_C]/T.
- Determine whether to use the regenerative resistor according to the preceding flowchart and set H02-25 (Regenerative resistor type) accordingly.
- The resistor with aluminum housing is recommended.

☆ Related parameters

Parameter No.		Name	Value Range	Function	Setting Condition	Effective Time	Default
2002h	1A	Regenerative resistor type	0- Reserved 1: External, natural ventilation 2: External, forced air cooling 3: No regenerative resistor needed	Defines the mode of absorbing and releasing the braking energy.	At stop	Immediately	3

Take the H1 series 750 W model as an example. Assume the reciprocating movement period (T) is 2s, the maximum speed is 3000 RPM, and the load inertia is four times the motor inertia, the required regenerative resistor power will be as follows:

$$P_b = \frac{2x[(N+1) \text{ x } E_O - E_C]}{T} = \frac{2x[(4+1)x6.4-9]}{2} = 23\text{ W}$$

The calculated value is smaller than the processable capacity (P_a = 25 W) of the built-in regenerative resistor, so a built-in regenerative resistor is sufficient.

If the inertia ratio in preceding example is changed to 10 times the motor inertia, and other conditions remain the same, the required regenerative resistor power will be as follows:

$$P_b = \frac{2x[(N+1) \text{ x } E_O - E_C]}{T} = \frac{2x[(10+1)x6.4-9]}{2} = 61.4\text{ W}$$

The calculated value is larger than the processable capacity (P_a = 25 W) of the built-in regenerative resistor, so an external regenerative resistor is required. The recommended power of the external regenerative resistor is E_O/(1 - 70%) = 204.6 W.

1) Connection and setting of the regenerative resistor

■ For use of an external regenerative resistor

Use the external regenerative resistor with 70% derated, that is, $P_r = P_b$/(1 - 70%), and ensure the regenerative resistor is larger than the minimum permissible resistance. Remove the jumper between P and D, and connect the external regenerative resistor between terminals P and C.

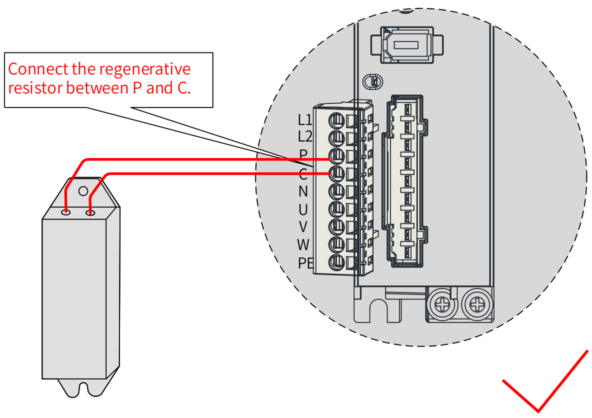


Figure 5-8 Connection of an extenal regenerative resistor

See "Table 3-4 Recommended main circuit cables and models" for cable information on terminals P and C.

Set 2002-1Ah to 1 or 2 based on the cooling mode of the regenerative resistor and set the following parameters properly.

☆ Related parameters

Parameter No.		Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
2002h	16h	Minimum permissible resistance of regenerative resistor	Non-settable	-	Displays the minimum permissible resistance of the external regenerative resistor.	At display	-	Model dependent
2002h	1Bh	Power of external regenerative resistor	1–65535	W	Defines the power of the external regenerative resistor actually used. Note: The power of the external regenerative resistor used cannot be smaller than the calculated value of the braking power.	At stop	Immediately	Model dependent
2002h	1Ch	Resistance of external regenerative resistor	1–1000	Ω	Defines the resistance of the external regenerative resistor actually used. Note: The resistance of the external regenerative resistor (2002-1Ch) used cannot be smaller than the minimum permissible resistance of regenerative resistor (2002-16h). Otherwise, Er.922.0 will occur.	At stop	Immediately	Model dependent

CAUTION

- ◆ Set the resistance (2002-1Ch) and power (2002-1Bh) of the external regenerative resistor properly. Improper settings will impact the performance.
- ◆ When an external regenerative resistor is used, ensure the resistance of the external regenerative resistor is larger than the minimum permissible resistance.
- ◆ In a natural ambient environment, when the regenerative resistor is used at its rated power rather than the processable power (average value), the temperature of the resistor will rise to above 120° C during continuous braking. To ensure safety, cool the resistor down by forced air cooling or use a resistor with a thermal switch. For load characteristics of the regenerative resistor, contact the manufacturer.

Set the heat dissipation coefficient based on the heat dissipation condition of the external regenerative resistor.

☆ Related parameters:

Parameter No.		Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
2002h	19h	Resistor heat dissipation coefficient	10–100	%	Used to set resistor heat dissipation coefficient when an external regenerative resistor is used. The value cannot be larger than 30% when natural ventilation is used. The value cannot be larger than 50% when forced air cooling is used.	At stop	Immediately	30

NOTE

- The larger the heat dissipation coefficient is, the better the braking efficiency is.
- When $P_b < P_a$ and $P_b \times T > E_C$, use the built-in regenerative resistor. In this case, set H02-25 to 0.
- When $P_b \times T < E_C$, no regenerative resistor is required because the bus capacitor is sufficient to absorb the braking energy. In this case, set 2002-1Ah to 3.

2) External load torque exist and motor staying in generating state

When the motor torque direction is the same with the axis rotating direction, the motor outputs energy ~~to the outside~~. In some special applications where the motor torque output is opposite to the rotating direction, the motor is in power generating status and feeds the electric energy back to the servo drive.

When the load is in continuous power-generating status, it is recommended to adopt the common DC bus mode.

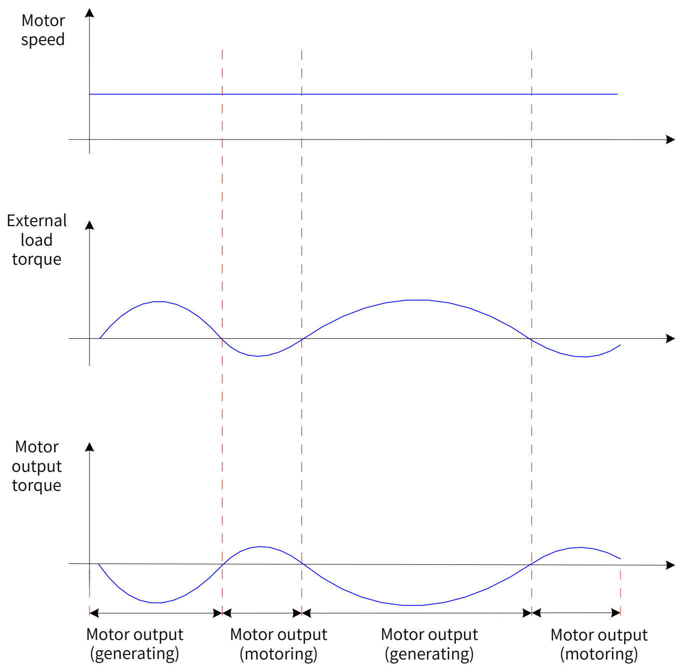


Figure 5-9 Example of the curve under the existence of external load torque

Take the H1 series 750 W model (rated torque 2.39 N·m) as an example. When the external load torque is 60% of the rated torque and the motor speed is 1500 RPM, the power fed back to the servo drive is: (60% x 2.39) x (1500 x 2π/60) = 225 W. As the regenerative resistor is derated by 70%, the power of the external regenerative resistor is: 225/(1 - 70%) = 750 W, with resistance being 50 Ω.

5.5 Servo Running

1) Switch on the S-ON signal.

When the servo drive is ready to run, the keypad displays "rn", but if there is no command input, the servo motor will not rotate and stay in the locked state.

2) After a command is input, the servo motor starts running.

Table 5-4 Operation of the servo drive

Record	No.	Description
☐	1	At initial running, set an appropriate reference to make the motor run at a low speed and check whether the motor rotates properly.
☐	2	Observe whether the motor rotates in the correct direction. If the rotation direction is opposite to the expected direction, check the input reference and reference direction.
☐	3	If the rotation direction is correct, observe the actual motor speed in 200B-01h and average load ratio in 200B-0Dh through the keypad or Inovance software tool.
☐	4	After checking the preceding running conditions, set related parameters properly to adapt the motor to actual working conditions.
☐	5	Perform commissioning on the servo drive according to the instructions in Chapter 6.

3) Power-on sequence

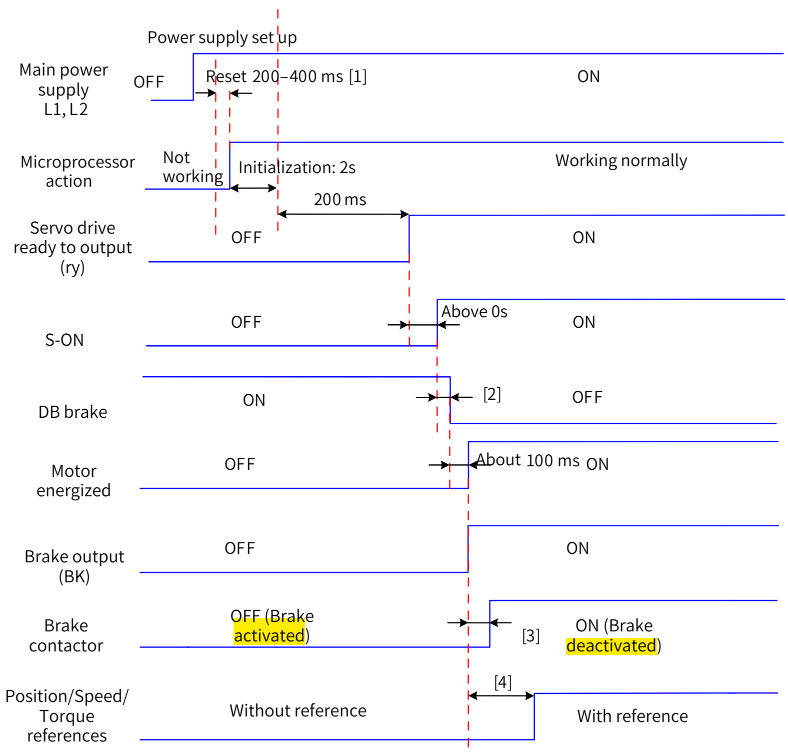


Figure 5-10 Power-on sequence

[1] The reset time is determined by the setup time of the +5V power of the microprocessor.

[2] The DB brake is included in the standard configuration.

[3] For the delay of brake contactor actions, see "5 Electrical specifications for the motor with brake" for details.

[4] When the brake function is not enabled, the command delay time is invalid.

4) Time sequence for stop upon warning or fault

■ Fault 1: Coast to stop, keeping de-energized state

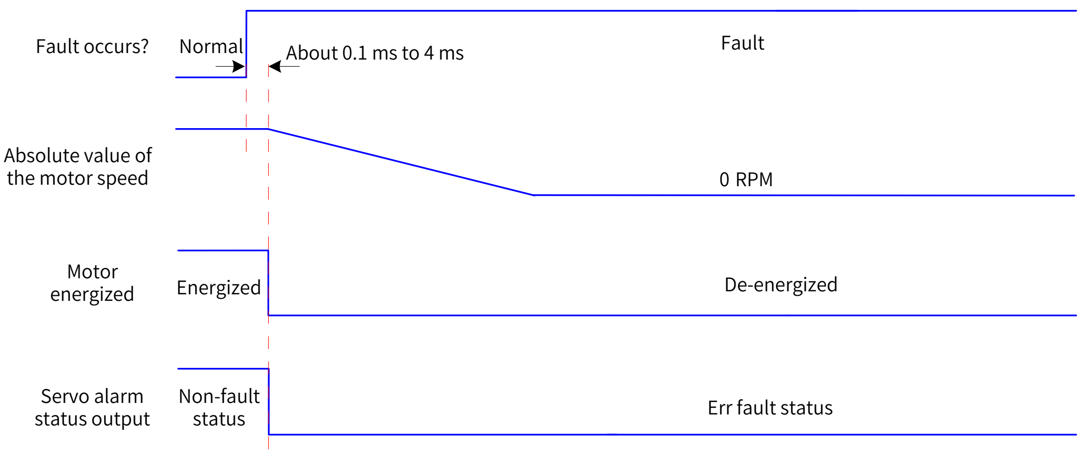


Figure 5-11 Time sequence of "coast to stop, keeping de-energized state" at No. 1 fault

■ Fault 1 (without brake): DB stop, keeping de-energized state

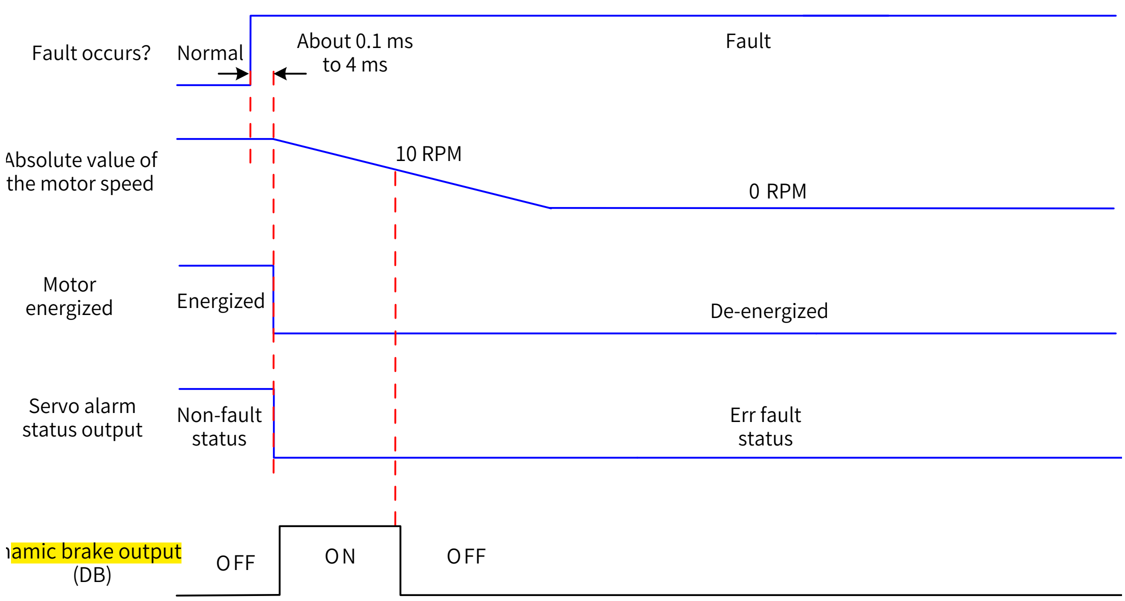


Figure 5-12 Time sequence of "DB stop, keeping de-energized state" at No. 1 fault

■ Fault 1 (with brake): DB stop, keeping DB state

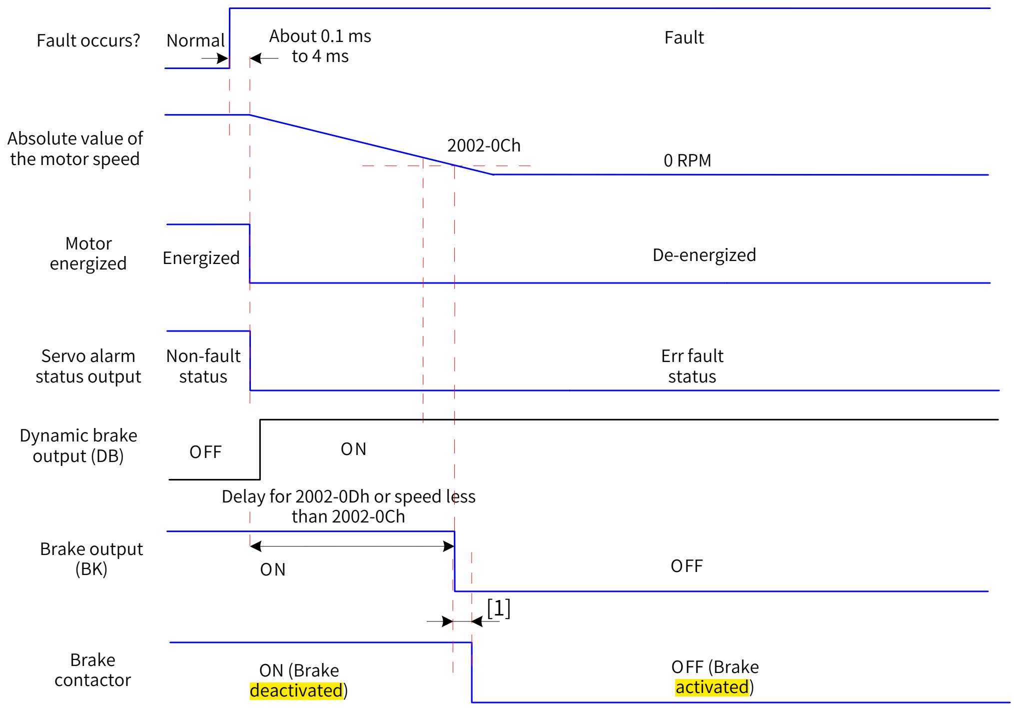


Figure 5-13 Time sequence of "DB stop, keeping DB state" at No. 1 fault (with brake)

[1] For the delay of brake contactor actions, see "5 Electrical specifications for the motor with brake" for details.

■ Fault 1: Without brake, DB stop, keeping DB state

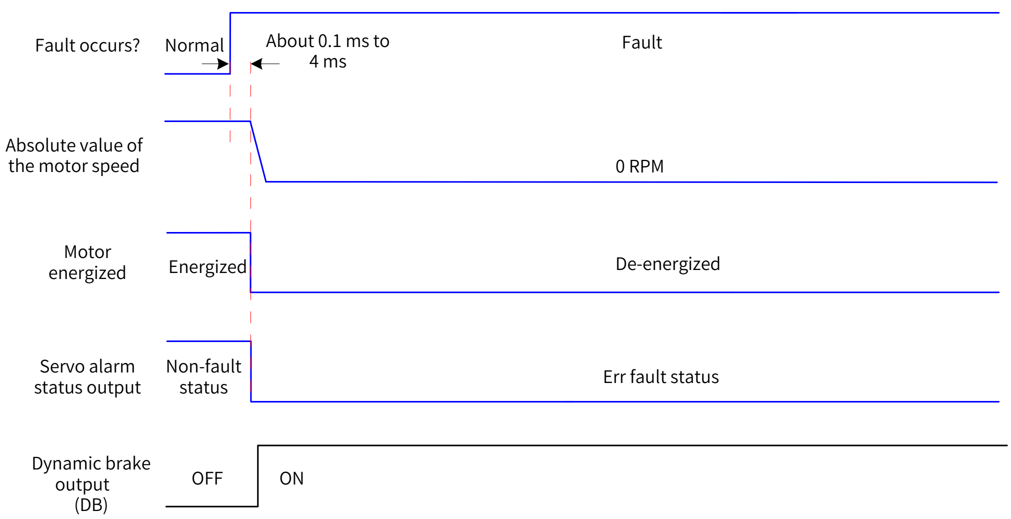


Figure 5-14 Time sequence of "DB stop, keeping DB state" at No. 1 fault

■ Fault 2

Without brake, ramp to stop, keeping de-energized state, same as "coast to stop upon No. 1 fault"

Without brake, DB stop, keeping DB state[1]

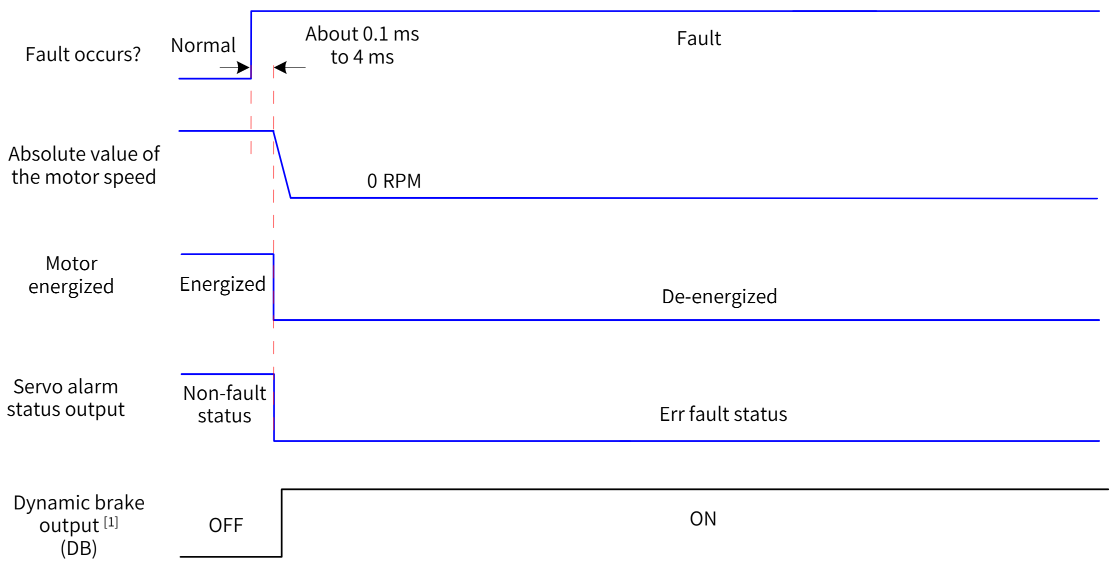


Figure 5-15 Time sequence of "Coast to stop, keeping de-energized state" at No. 2 fault

[1] After DB is enabled.

■ Fault 2: Without brake, ramp to stop or stop at emergency torque, keeping de-energized/DB state[1]

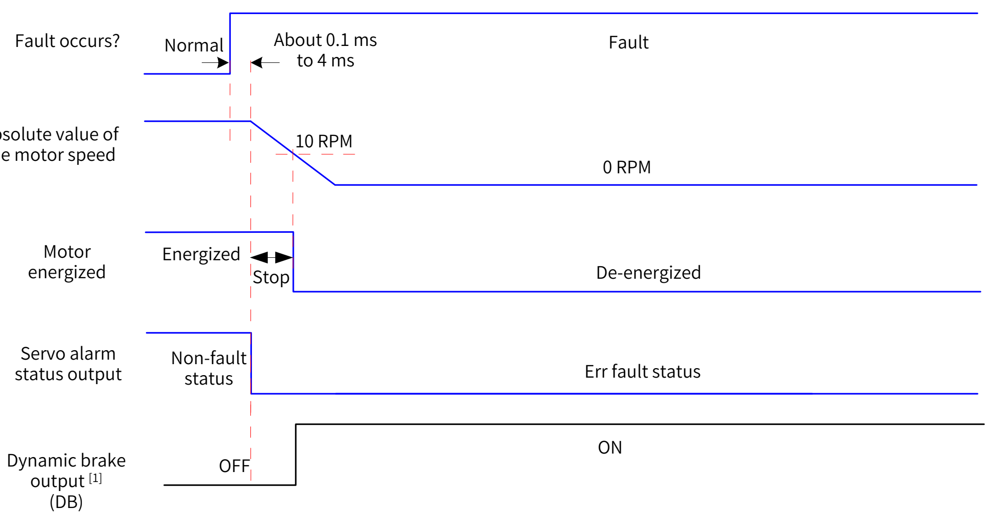


Figure 5-16 Time sequence of "Ramp to stop or stop at emergency stop torque, keeping de-energized state" at No. 2 fault (without brake)

[1] After DB is enabled.

■ Fault 2 (with brake): Ramp to stop, keeeping DB state

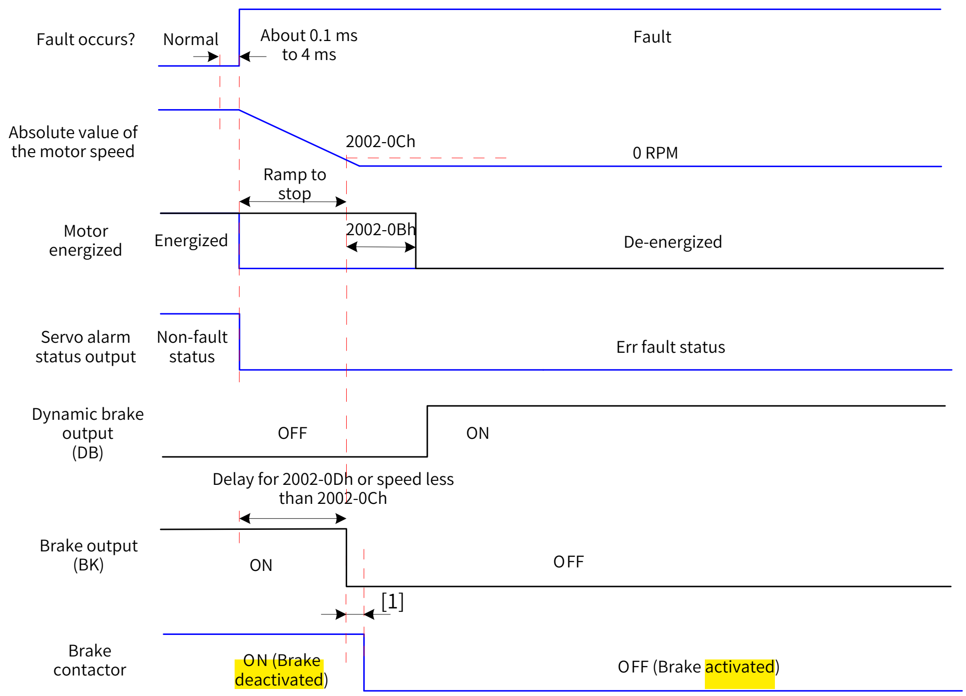


Figure 5-17 Time sequence of "Ramp to stop, keeping DB state" at No. 2 fault (with brake)

[1] For the delay of brake contact actions, see *"5 Electrical specifications for the motor with brake"* for details.

When a No. 3 warning occurs on the servo drive, such as Er.950.0 (Forward overtravel warning) and Er.952.0 (Reverse overtravel warning), the servo drive stops as shown in the following figure.

■ Overtravel warning

Stop at zero speed as defined by 6085h if the brake is enabled, keeping position lock state.

Stop at zero speed if the brake is not enabled, keeping position lock state.

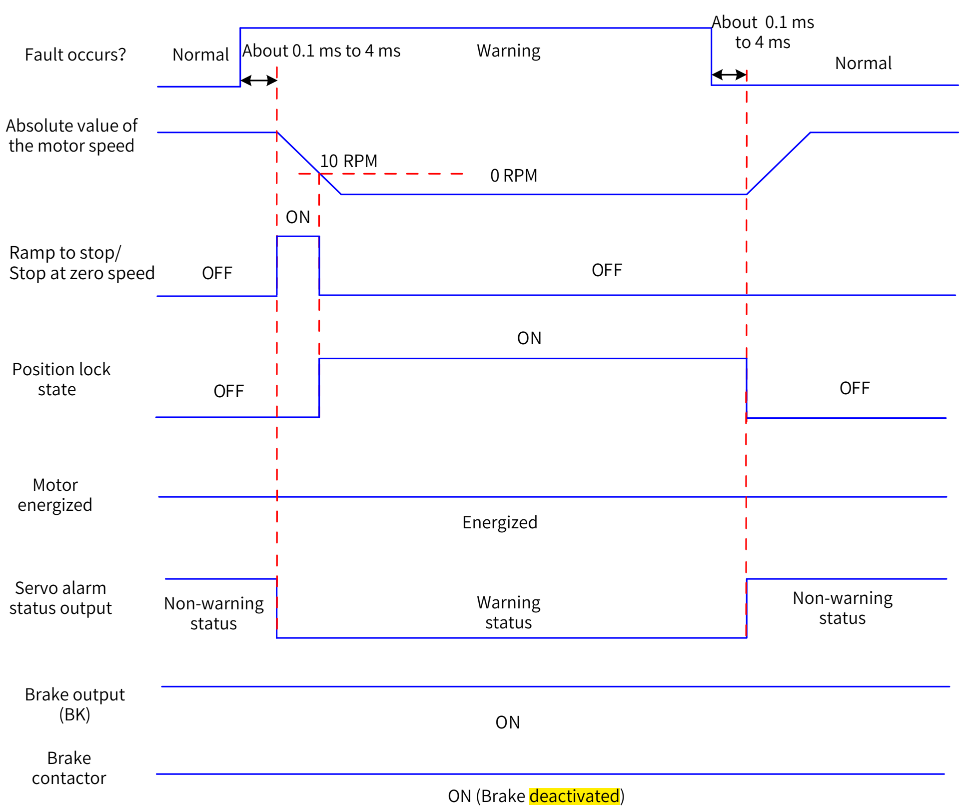


Figure 5-18 Time sequence for warnings that cause stop

Except Er.950 and Er.952, the other warnings do not affect the servo running status. The time sequence upon occurrence of these warnings is as follows:

■ Warnings that do not cause stop

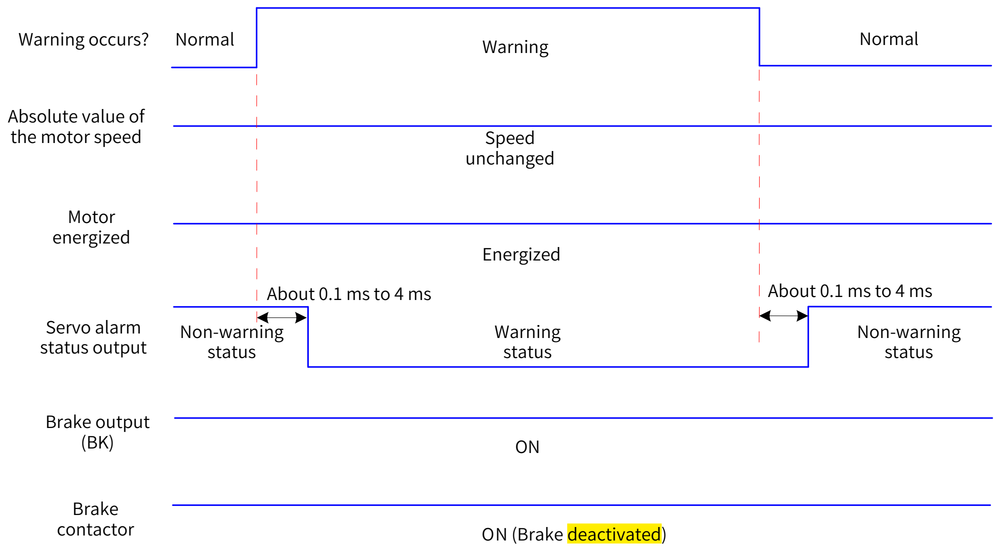


Figure 5-19 Time sequence at warnings that do not cause stop

■ Fault reset

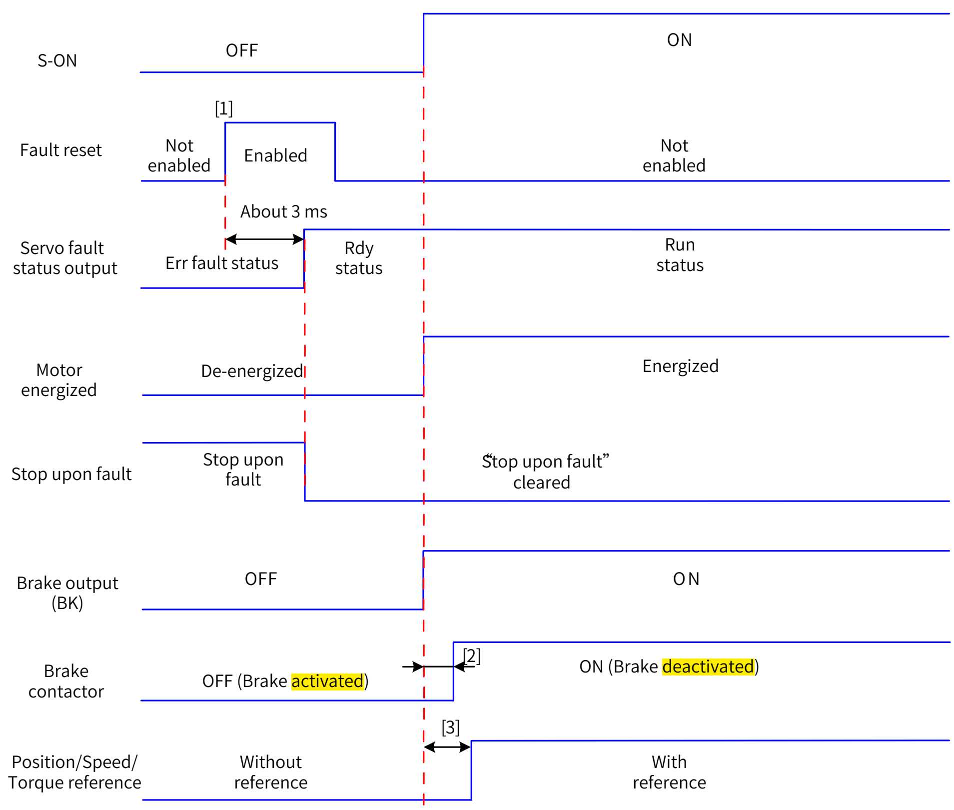


Figure 5-20 Time sequence of fault reset

[1] The fault reset signal is edge-triggered.

[2] For the delay of brake contactor actions, see "5 Electrical specifications for the motor with brake" for details.

[3] The command delay is invalid when the brake is not enabled.

5.6 Servo Stop

The stop modes can be coast to stop, stop at zero speed, ramp to stop, stop at emergency torque, and DB braking. The stop states can be de-energized state, position lock state, and DB state. See the following table for details.

Table 5-5 Comparison of stop modes

Stop Mode	Description	Feature
Coast to stop	The servo motor is de-energized and decelerates to 0 gradually. The deceleration time is affected by the mechanical inertia and friction.	This mode features smooth deceleration and small mechanical impact, but the deceleration process is slow.
Stop at zero speed	The servo motor decelerates immediately to 0 RPM and stops.	This mode features quick deceleration and fast deceleration process, but the mechanical impact is large.
Ramp to stop	The servo motor decelerates to 0 smoothly upon position/speed/torque references.	This mode features smooth and controllable deceleration process with small mechanical impact.
Stop at emergency torque	The servo drive outputs a reverse braking torque to stop the motor.	This mode features quick deceleration and fast deceleration process, but the mechanical impact is large.
DB braking	The servo motor works in dynamic braking status.	This mode features quick deceleration and fast deceleration process, but the mechanical impact is large.

Table 5-6 Comparison of stop states

Stop States	Description
De-energized state	The motor is de-energized after it stops rotating, and the motor shaft can be rotated freely.
Position Lock state	The motor shaft is locked and cannot be rotated freely after the motor stops rotating.
DB state	The motor is de-energized after it stop rotating, and the motor shaft cannot be rotated freely.

The servo drive will stop under the following situations:

■ S-ON OFF

Switch off the S-ON signal through communication, and the servo drive stops according to the stop mode at S-ON OFF.

☆ Related parameters:

605Ch	Name	Stop mode at S-ON OFF			Setting Condition & Effective Time	Any condition & At stop	Data Structure	-	Data Type	int16
	Access	RW	Mapping	No	Related Mode	All	Data Range	-4 to 1	Default	0

Defines the deceleration mode of the servo motor from rotating to stop and the servo motor state after stop at S-ON OFF.

Value	Stop mode
-4	Ramp to stop as defined by 6085h, keeping DB state
-3	Stop at zero speed, keeping DB state
-2	Ramp to stop under all modes, keeping DB state
-1	DB stop, keeping DB statusstate
0	Coast to stop, keeping de-energized state
1	Ramp to stop under all modes, keeping de-energized state

Set a proper stop mode according to the mechanical state and running requirement.

After the brake output is enabled, the stop mode at S-ON off is forcibly set to "Ramp to stop as defined by 6085h, keeping DB state".

■ Stop at fault occurrence

The stop mode varies with the fault type. See "9 Troubleshooting" for details.

☆ Related parameters:

H02-08	Name	Stop mode at No. 1 fault			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
2002-09h	Access	RW	Mapping	RPDO	Related Mode	All	Data Range	0–2	Default	2

Defines the deceleration mode of the servo motor from rotating to stop and the servo motor state after stop at No. 1 fault.

Value	Stop mode
0	Coast to stop, keeping de-energized state
1	DB stop, keeping de-energized state
2	DB stop, keeping DB state

After the brake output is enabled, the stop mode at No. 1 fault is forcicly set to "DB stop, keeping DB state".

■ Stop at overtravel

Definition of terms:

"Overtravel": The distance of the mechanical movement exceeds the designed range of safe movement.

"Stop at overtravel": When the moving part moves beyond the range of safe movement, the limit switch outputs a level change, and the servo drive forces the motor to stop.

☆ Related parameters:

H02-07	Name	Stop mode at overtravel			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
2002-08h	Access	RW	Mapping	-	Related Mode	All	Data Range	0–7	Default	1

Defines the deceleration mode of the servo motor from rotating to stop and the servo motor state after stop at overtravel.

Value	Stop mode
0	Coast to stop, keeping de-energized state
1	Stops at zero speed, keeping position lock state
2	Stop at zero speed, keeping de-energized state
3	Ramp to stop as defined by 6085h, keeping de-energized state
4	Ramp to stop as defined by 6085h, keeping position lock state
5	DB stop, keeping de-energized state
6	DB stop, keeping DB state
7	Not responding to overtravel

When the servo motor drives a vertical axis, for the sake of safety, set 2002-08h to 1 to make the motor shaft stay in position lock state after overtravel occurs.

After the brake output is enabled, the stop mode at overtravel is forcibly set to "Stop as defined by 6085h, keeping position lock state".

If the servo motor enters overtravel state when driving a vertical axis, the workpiece may fall. To prevent such risks, set 2002-08h to 1. When the workpiece moves linearly, connect the limit switch to prevent mechanical damage. In overtravel status, input a reverse run command to make the motor (workpiece) run in the reverse direction.

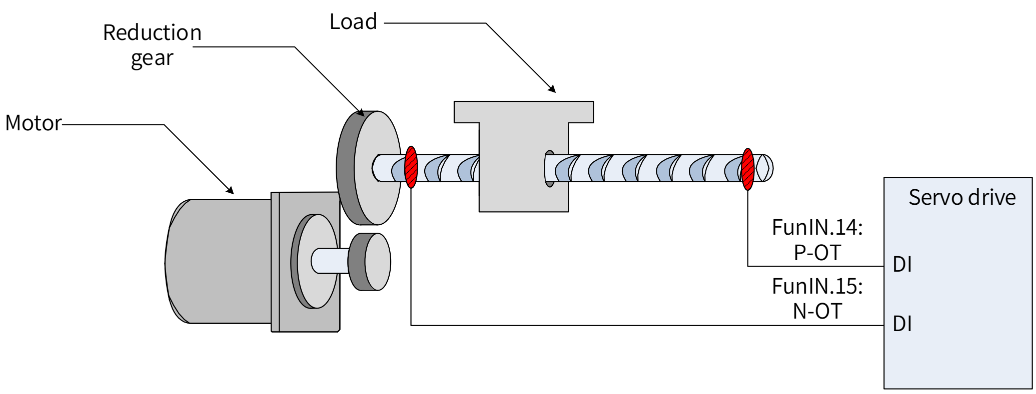


Figure 5-21 Installation of limit switches

To use the limit switch, allocate function 14 (FunIN.14: P-OT, positive limit switch) and function 15 (FunIN.15: N-OT, negative limit switch) to two DIs of the servo drive and set the valid logic of this DI. This is to enable the servo drive to receive the level signals input from the limit switch. The servo drive enables or cancels the stop-at-overtravel state based on the DI level status.

☆ Related parameters:

Function No.	Name	Function	Description
FunIN.14	P-OT	Positive limit switch	When the mechanical movement is beyond the movable range, the overtravel prevention function will be applied. Invalid: Forward drive permitted Valid: Forward drive inhibited

Function No.	Name	Function	Description
FunIN.15	N-OT	Negative limit switch	When the mechanical movement is beyond the movable range, the overtravel prevention function will be applied. Invalid: Reverse drive permitted Valid: Reverse drive inhibited

■ Emergency stop

The emergency stop can be implemented through the following means:

DI function 34 (FunIN.34: EmergencyStop)

200D-06h (Emergency stop)

☆ Related function No.:

Function No.	Name	Function	Description
FunIN.34	EmergencyStop	Braking	Invalid: The servo drive stays in present running state. Valid: The servo drive stops according to the stop mode defined by 605Ah.

☆ Related parameters

<table>
<tr><td>H0D-05</td><td>Name</td><td colspan="3">Emergency stop</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>200D-06h</td><td>Access</td><td>RW</td><td>Mapping</td><td>-</td><td>Related Mode</td><td>-</td><td>Data Range</td><td>0–1</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Operations upon emergency stop:
<table><tr><th>Value</th><th>Description</th></tr><tr><td>0</td><td>No operation</td></tr><tr><td>1</td><td>Emergency stop enabled</td></tr></table>When H0D-05 is enabled, the servo drive will stop in the stop mode defined by 605Ch regardless of the running state.</td></tr>
</table>

■ Quick stop

Quick stop applies when bit2 (Quick stop) in the control word 6040h is set to 0 (Valid). The quick stop mode is defined by 605Ah.

<table>
<tr><td rowspan="2">605Ah</td><td>Name</td><td colspan="3">Quick stop mode</td><td>Setting Condition & Effective Time</td><td>Any condition & At stop</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>All</td><td>Data Range</td><td>0–7</td><td>Default</td><td>2</td></tr>
<tr><td colspan="11">Defines the deceleration mode of the servo motor from rotating to stop and the servo motor state after quick stop.
<table><tr><th>Value</th><th>Stop mode</th></tr><tr><td>0</td><td>Coast to stop, keeping de-energized state</td></tr><tr><td>1</td><td>Ramp to stop as defined by 6084h/609Ah (HM), keeping de-energized state</td></tr><tr><td>2</td><td>Ramp to stop as defined by 6085h, keeping de-energized state</td></tr><tr><td>3</td><td>Stop at emergency torque, keeping de-energized state</td></tr><tr><td>4</td><td>N/A</td></tr><tr><td>5</td><td>Ramp to stop as defined by 6084h/609Ah (HM), keeping position lock state</td></tr><tr><td>6</td><td>Ramp to stop as defined by 6085h, keeping position lock state</td></tr><tr><td>7</td><td>Stop at emergency-stop torque, keeping position lock state</td></tr></table>When the brake is enabled and the set value of 605Ah is less than 4, the stop mode is forced to "Ramp to stop as defined by 6085h, keeping de-energized state".</td></tr>
</table>

■ Halt

The halt function applies when bit8 in the control word 6040h is set to 1 (Valid). The halt mode is defined by 605Dh.

605Dh	Name	Halt mode			Setting Condition & Effective Time	Any condition & At stop	Data Structure	VAR	Data Type	int16
	Access	RW	Mapping	No	Related Mode	All	Data Range	1–3	Default	1

Defines the deceleration mode of the servo motor from rotating to stop and the servo motor state after halt.

PP/PV/HM mode:

Value	Stop mode
1	Ramp to stop as defined by 6084h/609Ah (HM), keeping position lock state
2	Ramp to stop as defined by 6085h, keeping position lock state
3	Stop at emergency-stop torque, keeping position lock state

PT mode:

Value	Stop mode
1/2/3	Ramp to stop as defined by 6087h, keeping position lock state

CAUTION

The acceleration/deceleration time cannot be set to a too small value. Otherwise, the stop distance may be too long, causing the risk of collision.

5.7 Conversion Factor Setting

Gear ratio refers to the motor displacement (in encoder unit) corresponding to the load shaft displacement of one reference unit.

The gear ratio is comprised of the numerator 6091-01h and denominator 6091-02h. It determines the proportional relation between the load shaft displacement (in reference unit) and the motor displacement (in encoder unit), as shown below.

Motor displacement = Load shaft displacement x Gear ratio

The motor is connected to the load through the reducer and other mechanical transmission mechanism. Therefore, the gear ratio is related to the mechanical reduction ratio, mechanical dimensions and motor resolution. The calculation formula is as follows.

$$\text{Gear ratio} = \frac{\text{Encoder resolution}}{\text{Load shaft resolution}}$$

Index 6091h	Name	Gear ratio			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint32
	Access	-	Mapping	Yes	Related Mode	All	Data Range	OD data range	Default	OD default value

Defines the proportional relation between the load shaft displacement designated by the user and the motor shaft displacement.

The relation between motor position feedback (encoder unit) and load shaft position feedback (reference unit) is as follows.

Motor position feedback = Load shaft position feedback x Gear ratio

The relation between the motor speed (RPM) and the load shaft speed (reference unit/s) is as follows.

$$\text{Motor speed (RPM)} = \frac{\text{Load shaft speed x Gear ratio 6091h}}{\text{Encoder resolution}} \times 60$$

The relation between motor acceleration (RPM/ms) and the load shaft speed (reference unit/s^2) is as follows.

$$\text{Motor acceleration} = \frac{\text{Load shaft acceleration x Gear ratio 6091h}}{\text{Encoder resolution}} \times \frac{1000}{60}$$

Sub-index 0h	Name	Number of sub-indexes of the gear ratio			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	No	Related Mode	-	Data Range	-	Default	2

Sub-index 1h	Name	Motor resolution			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	-	Data Range	1 to (2^{32}-1)	Default	Depending on encoder resolution

Sub-index 2h	Name	Shaft resolution			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	-	Data Range	1 to (2^{32}-1)	Default	1

Take the ball screw as an example:

Minimum reference unit fc = 1 mm

Lead pB = 10 mm/r

Reduction ratio n = 5:1

Inovance 20-bit serial encoder motor resolution P = 1048576 (PPR)

The position factor is calculated as follows:

$$\text{Position factor} = \frac{\text{Motor resolution P x n}}{\text{PB}}$$

$$= \frac{1048576 \times 5}{10}$$

$$= \frac{5242880}{10}$$

$$= 524288$$

Therefore, 6091-1h = 524288, 6091-2h = 1, which means when the load shaft displacement is 1 mm, the motor displacement is 524288.

Reduce the values of 6091-1h and 6091-2h to a point where there is no common divisor, and take the final value.

6 Gain Tuning

6.1 Overview

Set the gain parameters of the servo drive to proper values so that the servo drive can drive the motor as quick and accurate as possible based on internal references or commands sent from the host controller.

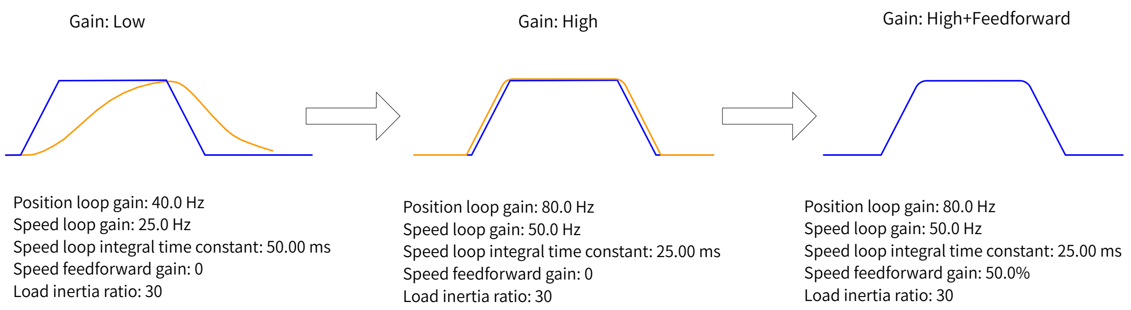


Figure 6-1 Example of gain settings

The gain is defined by the combination of multiple mutually-affected parameters (including position loop gain, speed loop gain, filter and inertia ratio). Set these parameters to proper values to keep a balanced performance.

NOTE

Perform a trial run through jogging before gain tuning to ensure the motor can work normally.

The following figure shows the general process of gain tuning.

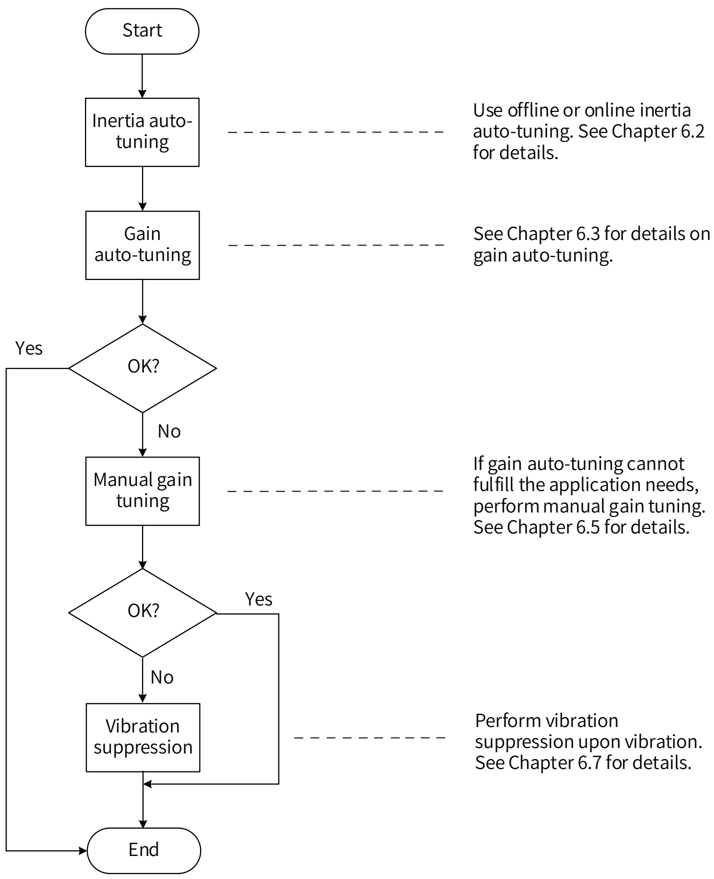


Figure 6-2 Process of gain adjustment

Table 6-1 Gain tuning process

Process of Gain Tuning			Description	Reference
1	Inertia auto-tuning	Offline	The servo drive calculates the inertia ratio automatically.	6.2.1
		Online	The host controller sends a command to make the motor rotate, and the servo drive calculates the inertia ratio in real time.	6.2.2
2	Gain auto-tuning		The servo drive automatically generates the values of gain parameters that match the inertia ratio (the inertia ratio must be set correctly).	6.3/6.4
3	Manual gain tuning	Basic gain	If the gain auto-tuning cannot fulfill the application needs, adjust the auto-tuned values manually.	6.5.1
		Reference filter	Filters the position, speed, and torque references.	6.5.3
		Feedforward gain	Improves the following performance.	6.5.4
		Pseudo differential regulator	Improves the anti-interference capacity in the low frequency range through adjusting the speed loop control mode.	6.5.5
		Torque disturbance observer	Improves the capacity in resisting the torque disturbance.	6.5.6
4	Vibration suppression	Mechanical resonance	The mechanical resonance is suppressed through the notch.	6.7.1
		Low-frequency resonance	The low-frequency resonance is suppressed through the filter.	6.7.2

6.2 Inertia Auto-tuning

The load inertia ratio (2008-10h) is calculated by using the following formula.

$$\text{Load inertia ratio} = \frac{\text{Total mechanical load inertia}}{\text{Motor inertia}}$$

The load inertia ratio is a critical parameter of the servo system. A proper inertia ratio facilitates the commissioning process.

The load inertia ratio can be set manually or set automatically through inertia auto-tuning of the servo drive.

The servo drive supports two inertia auto-tuning methods:

1) Offline inertia auto-tuning

Enable the "Inertia auto-tuning function (200D-03h)", and make the motor rotate by pressing SET on the keypad to perform inertia auto-tuning. This auto-tuning mode does not involve the host controller.

2) Online inertia auto-tuning

The host controller sends the auto-tuning command to the servo drive, and the servo motor executes inertia auto-tuning. This kind of auto-tuning mode involves the host controller.

> NOTE
>
> ◆ The following requirements must be met to ensure correct calculation of the load inertia ratio:
> 1) The actual maximum motor speed is higher than 150 RPM.
> 2) The actual acceleration rate during acceleration/deceleration is higher than 3000 RPM/s.
> 3) The load torque is stable without dramatic changes.
> 4) The actual inertia ratio does not exceed 120.
>
> ◆ If the actual inertia ratio is large but the gain is low, the motor may not be able to reach the maximum speed and the acceleration rate required as motor actions are slowed down. In this case, increase the speed loop gain (2008-01h) and perform auto-tuning again.
>
> ◆ If vibration occurs during auto-tuning, stop inertia auto-tuning immediately and reduce the gain.
>
> ◆ Inertia auto-tuning may fail if the backlash of the transmission mechanism is too large.

6.2.1 Offline Inertia Auto-tuning

1) In parameter display mode, switch to H0D-02 and press SET to enable offline inertia auto-tuning.

☆ Related parameters:

<table>
<tr><td rowspan="2">H0D-02</td><td>Name</td><td colspan="3">Offline inertia auto-tuning</td><td>Setting Condition</td><td>During running</td><td>Related Mode</td><td>-</td></tr>
<tr><td>Value Range</td><td>-</td><td>Unit</td><td>-</td><td>Effective Time</td><td>Immediately</td><td>Default</td><td>-</td></tr>
<tr><td colspan="9">In parameter display mode, switch to H0D-02 and press SET on the keypad to enable offline inertia auto-tuning.</td></tr>
</table>

Confirm the following items before performing offline inertia auto-tuning:

The motor stroke must meet the following requirements:

■ A stroke of more than one revolutions in either forward or reverse direction is available between the mechanical limit switches.

Before performing offline inertia auto-tuning, ensure the limit switches are installed on the machine and a stroke of more than one revolutions is reserved for the motor. This is to prevent overtravel during auto-tuning.

■ The required number of revolutions (H09-09) is fulfilled.

View the value of H09-06 (Maximum speed of inertia auto-tuning), H09-07 (Time constant for accelerating to the maximum speed during inertia auto-tuning), and H09-09 (Number of motor revolutions for a single inertia auto-tuning) to ensure the motor stroke, based on where it stops, is larger than the value of H09-09. If the motor stroke is smaller than the value of H09-09, decrease the value of H09-06 or H09-07 until the requirement is met.

2) Press ▲ / ▼ to execute offline auto-tuning.

To stop the servo drive, release ▲ / ▼. To start auto-tuning again, press ▲ / ▼ again. The running direction at start is determined by ▲ / ▼. For applications requiring unidirectional movement, set H09-05 (Offline inertia auto-tuning mode) to 1 (Unidirectional).

Increase the stiffness level (H09-01) of the servo drive properly so that the actual motor speed can reach the value defined by H09-06 (Maximum speed for inertia auto-tuning).

The following figure shows the process of offline inertia auto-tuning.

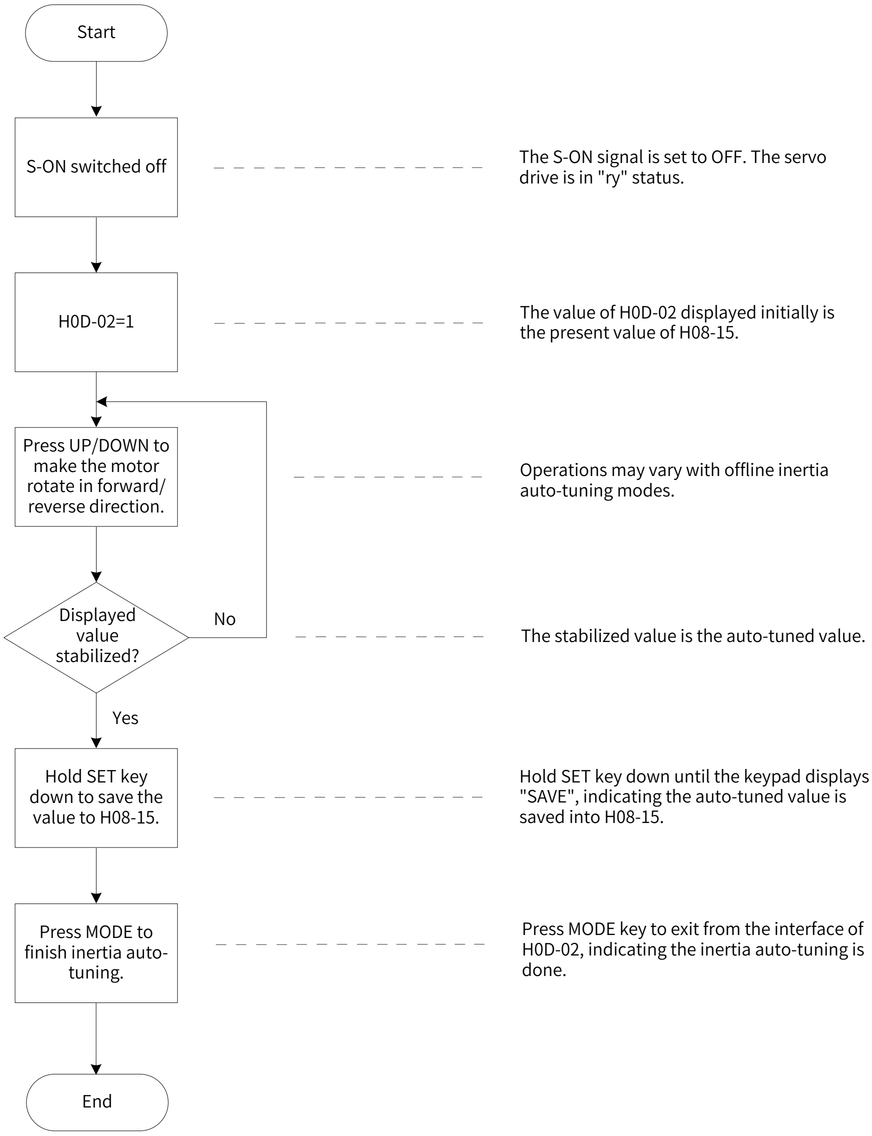


Figure 6-3 Process of offline inertia auto-tuning

☆ Related parameters

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-05	Offline inertia auto-tuning mode	0: Bidirectional auto-tuning 1: Unidirectional auto-tuning	-	Defines the offline inertia auto-tuning mode.	At stop	Immedia-tely	0
H09-06	Maximum speed of inertia auto-tuning	100 to 1000	RPM	Defines the maximum speed reference for offline inertia auto-tuning.	At stop	Immedia-tely	500
H09-07	Time constant for accelerating to the maximum speed during inertia auto-tuning	20 to 800	ms	Defines the time needed for the motor to accelerating from 0 RPM to 1000 RPM.	At stop	Immedia-tely	125
H09-08	Interval after a single inertia auto-tuning	50 to 10000	ms	Defines the interval between two consecutive speed references.	At stop	Immedia-tely	800
H09-09	Number of motor revolutions for a single inertia auto-tuning	15 to 10000	0.01 r	Defines the maximum number of revolutions.	-	-	100

6.2.2 Online Auto-tuning

The servo drive supports online inertia auto-tuning. The following figure shows the process of online inertia auto-tuning.

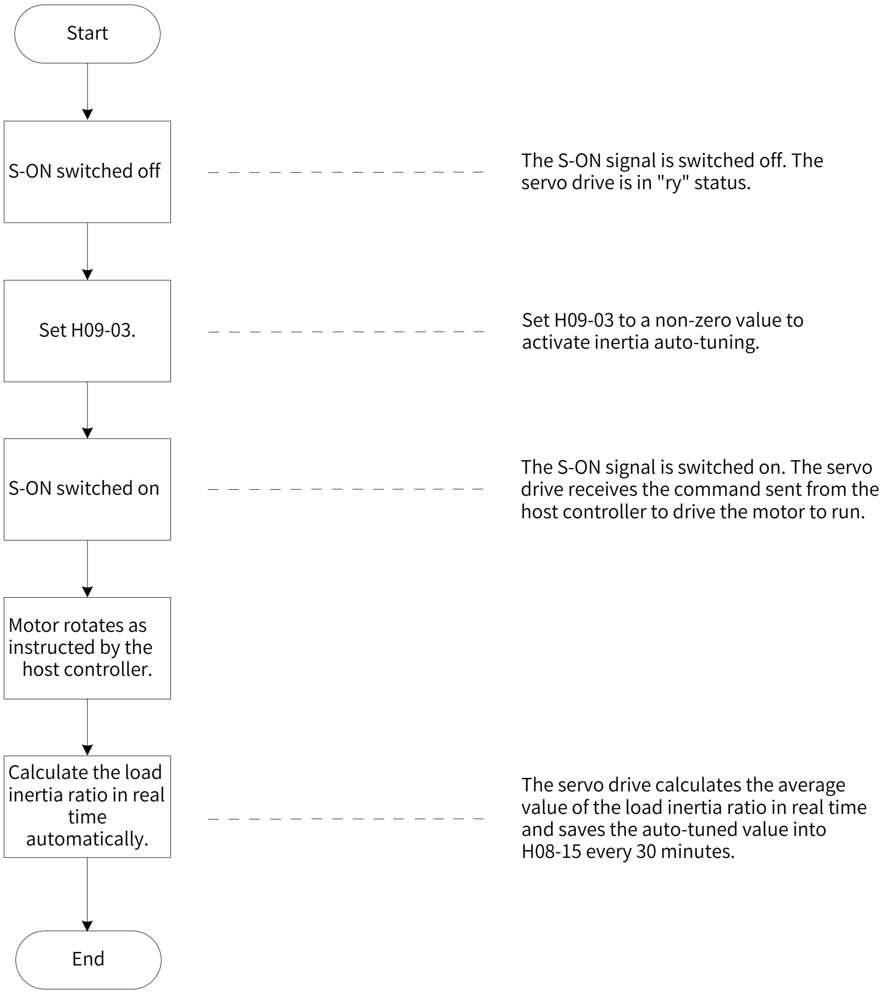


Figure 6-4 Process of online inertia auto-tuning

NOTE

- ◆ Different values of H09-03 indicate different updating speeds of the load inertia ratio (H08-15) in real time.
1) H09-03 = 1: Applicable to applications where the actual load inertia ratio rarely changes, such as machine tools and wood carving machines.
2) H09-03 = 2: Applicable to applications where the load inertia ratio changes slowly.
3) H09-03 = 3: Applicable to applications where the actual inertia ratio changes rapidly, such as transportation manipulators.
- ◆ Do not use online inertia auto-tuning in applications involving hitting against limit switches and press fitting.

Related parameters

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-03	Online inertia auto-tuning mode	0: Disabled 1: Enabled, changing slowly 2: Enabled, changing normally 3: Enabled, changing quickly	-	Defines the online inertia auto-tuning mode.	During running	Immediately	0

6.3 Instructions for ETune Operations

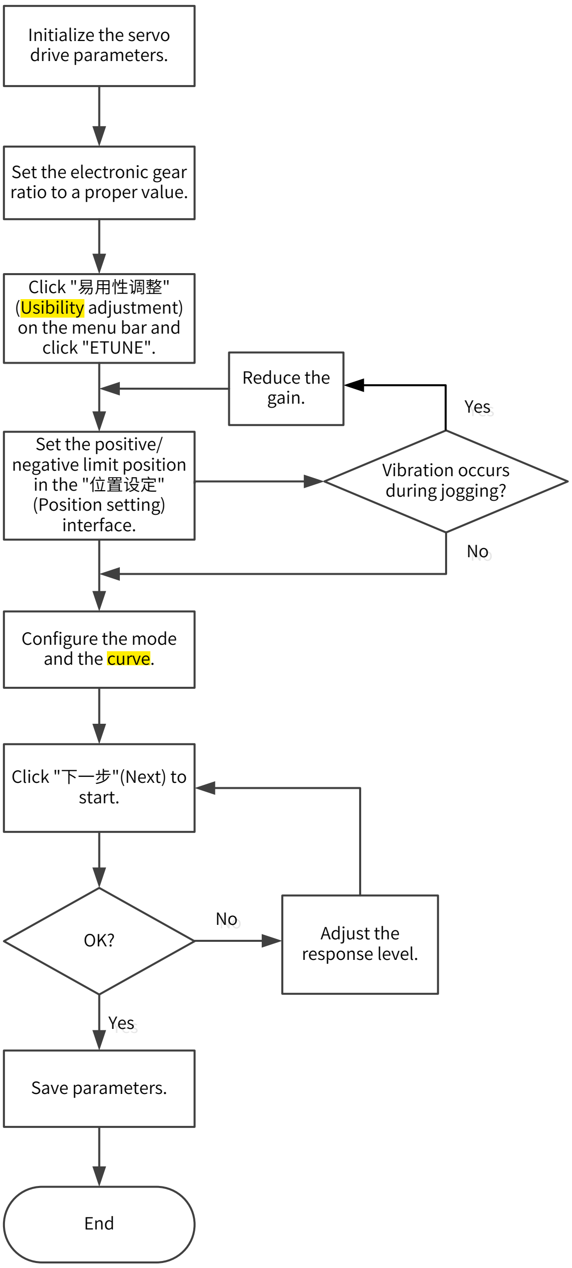
6.3.1 Overview

The ETune is a wizard-type function used to guide users to set corresponding curve trajectories and response parameters for auto-tuning. After the curve trajectories and response parameters are set, the servo drive performs auto-tuning to generate the optimal gain parameters. The auto-tuned parameters can be saved and exported as a recipe for use in other devices of the same model.

The ETune function is intended to be used in applications featuring small load inertia changes.

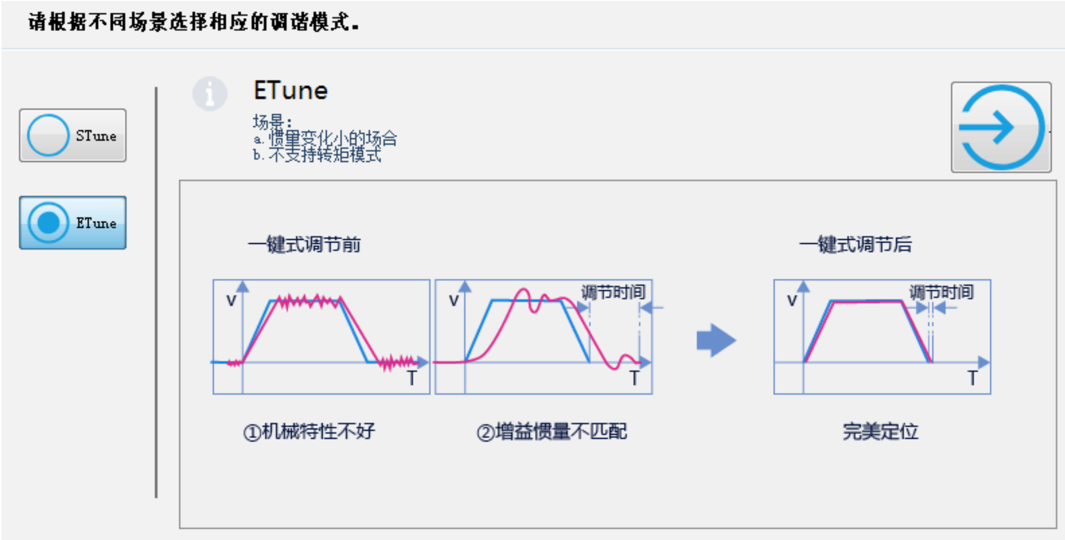
6.3.2 Description of Operations

1 Operation flowchart



2 Detailed descriptions

1) Click " 易用性调整 " (Usibility adjustment) on the software tool, and click "ETune".



2) There are two running modes, which can be selected according to the motion direction allowed by the machine. In " 往复正反 " (Forward/Reverse reciprocating)mode, the motor keeps reciprocating within the positive and negative limits. In " 单向正转 " (Unidirectional forward run) mode, the motor keeps running forwardly and takes the difference between the positive and negative limits as the maximum distance for a single action. The same applies to " 单向反转 " (Unidirectional reverse run) mode.

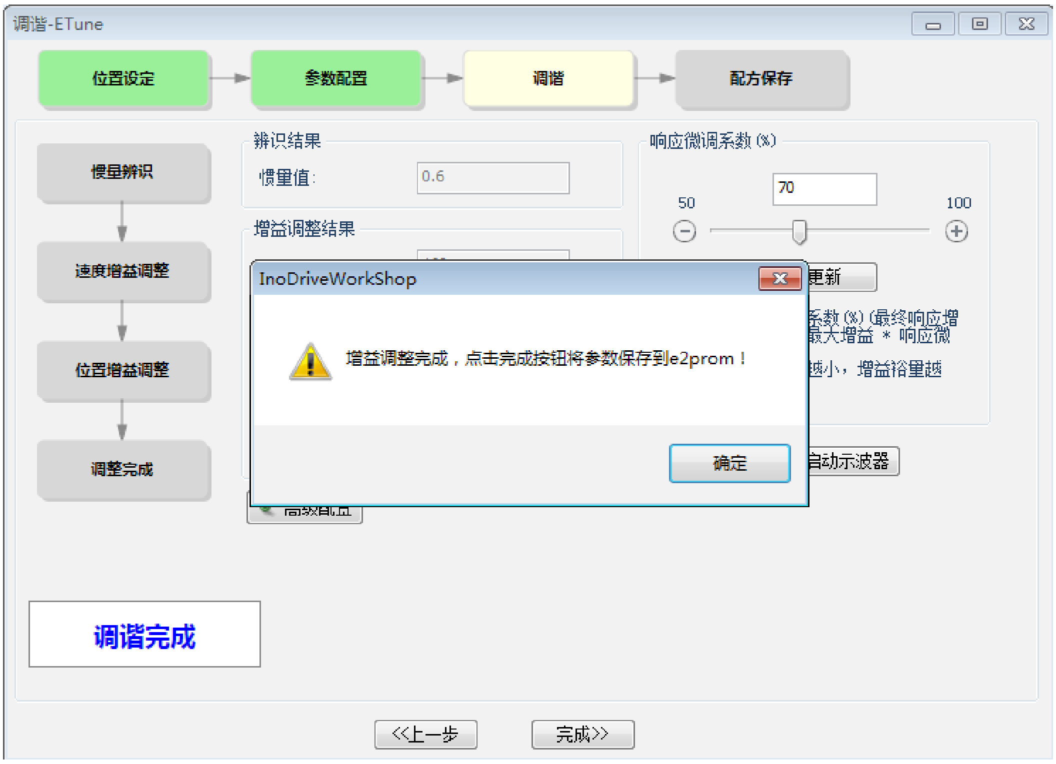
3) Designate the positive and negative limits allowed by the motor, and the difference between the positive and negative limits defines the position reference pulses for the motor, which is also the value before multiplication/division by the electronic gear ratio.
To set the limit, click " 伺服使能 ON" (S-ON) in JOG, and click " 正转 " (Forward) to make the motor moves to the positive limit. Next, click " 设定正转极限 " (Set forward limit). Follow the same procedures for setting the negative limit and click " 伺服使能 OFF" (S-OFF). You can also enter the

positive/negative limit position directly. The difference between the positive and negative limits must be larger than 1/8 of one revolution. The larger the value of the limit position, the better the adaptability of the auto-tuned parameters, and the longer time will ETune adjustment take.

4) Click " 下一步 " (Next) to switch to the mode parameter setting interface. The adjustment mode is divided into " 定位模式 " (Positioning mode) and " 轨迹模式 " (Trajectory mode). The inertia ratio auto-tuning is optional. If you choose not to perform inertia auto-tuning, set the correct inertia ratio (the value of the inertia ratio can be modified directly).
Adjust the response level and position filter time constant based on the servo response performance required by different applications and the position reference noise during actual motion. Then, configure the running curve and set the maximum speed, acceleration/deceleration time and interval for auto-tuning.

5) Click " 下一步 " (Next) to start auto-tuning. If you choose to perform inertia auto-tuning, the servo drive will perform inertia auto-tuning based on the set curve. After auto-tuning is done, the servo drive starts gain tuning automatically. If you choose not to perform inertia auto-tuning on the Start interface, the servo drive starts gain tuning directly ~~after started~~.

6) During gain tuning, if you modify the final response and click " 更新 " (Update), gain tuning will be continued based on the fine-tuning coefficient required. After gain tuning is done, you can click " 完成 " (Done) to save the parameters to EEPROM and export the parameters as a recipe file.



6.3.3 Precautions

- The maximum speed and acceleration/deceleration time of the running curve can be set based on actual needs. You can also increase the acceleration/deceleration time properly to enable quick positioning after auto-tuning is done.
- If the acceleration/deceleration time is set to a too small value, overload may occur. In this case, increase the acceleration/deceleration time properly.
- For vertical axis applications, take anti-drop measures before execution and set the stop mode upon fault to "Stop at zero speed".

- For the ball screw applications, if the adjustment time is too long, shorten the stroke length.

6.3.4 Troubleshooting

Fault Symptom	Cause	Measure
Er661: Auto-tuned gain values too low	1) The vibration cannot be suppressed.	1) Enable vibration suppression manually to eliminate the vibration.
	2) The positioning overshoot is too large.	2) Check whether the positioning threshold is too low. Increase the acceleration/deceleration time and lower the response level.
	3) The reference suffers from noise disturbance.	3) Modify the electronic gear ratio to improve the reference resolution, or increase the reference filter time constant in the " 参数配置 " (Parameter configuration) interface.
	4) The current fluctuates.	4) Check whether the machine suffers periodic fluctuation.
Er600: Inertia auto-tuning failure	1) The vibration cannot be suppressed.	1) Enable vibration suppression manually to eliminate the vibration and perform ETune again.
	2) The auto-tuned values fluctuate dramatically.	2) Increase the maximum running speed and decrease the acceleration/deceleration time. For the ball screw applications, shorten the stroke length.
	3) The load mechanical connectors become loose or offset occurs to the machine.	3) Check for the mechanical fault.
	4) Interruption occurs due to the fault that occurs during auto-tuning.	4) Clear the fault and perform ETune again.
	5) The position reference filter time is set to a too large value.	5) Decrease the set values of H05-04 to H05-06, and perform ETune again.

6.4 Instructions for STune Operations

6.4.1 Overview

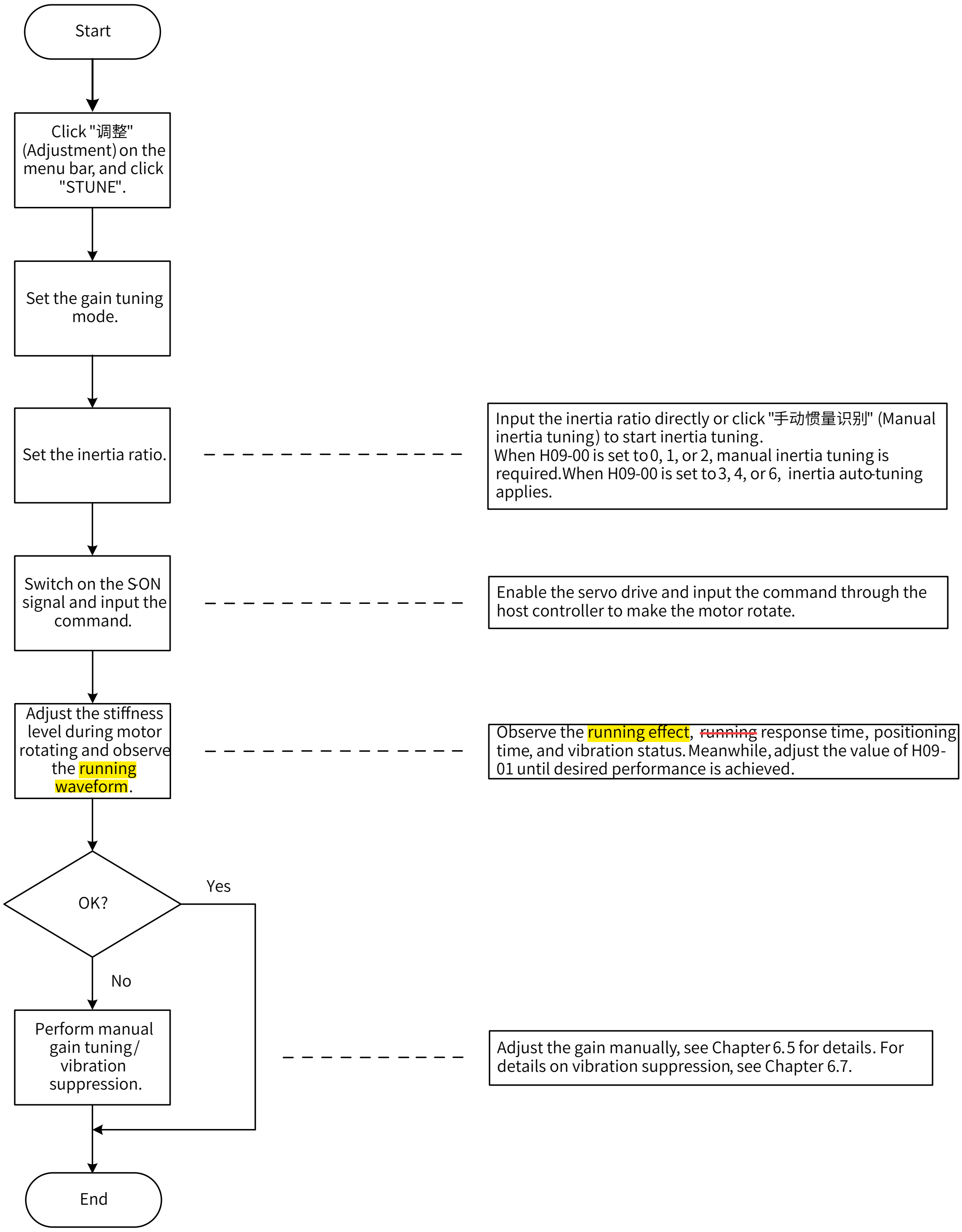
STune refers to gain auto-tuning based on the set stiffness level. It aims to fulfill the requirements of rapidity and stability.

The STune function is intended to be used in applications featuring small load inertia changes.

CAUTION	
	Ensure the load inertia ratio is accurate before performing gain auto-tuning.

6.4.2 Description of Operations

1) Operation flowchart



2) Detailed description

The auto-tuning mode can be set through the keypad or the software tool.

a) Select the auto-tuning mode. If H09-00 is set to 0, 1, or 2, set the inertia ratio before stiffness adjustment. If the inertia is unknown, perform manual inertia tuning. If vibration occurs, reduce the stiffness level before manual inertia tuning. If H09-00 is set to 3, 4, or 6, the inertia ratio needs no setting. You can perform tuning through the wizard-type interface.

Mode	Name	Applicable Occasion
0	Invalid	Manual gain tuning is needed.

Mode	Name	Applicable Occasion
1	Standard stiffness table mode	Gain auto-tuning is performed based on the set stiffness level.
2	Positioning mode	Gain auto-tuning is performed based on the set stiffness level. This mode is applicable to occasions requiring quick positioning.
3	Interpolation mode+Inertia auto-tuning	Gain auto-tuning is performed based on the set stiffness level. Inertia auto-tuning is performed to suppress vibration. This mode is applicable to multi-axis interpolation.
4	Regular mode+Inertia auto-tuning	Gain auto-tuning is performed based on the set stiffness level. Inertia auto-tuning is performed to suppress vibration.
6	Quick positioning mode+Inertia auto-tuning	Gain auto-tuning is performed based on the set stiffness level. Inertia auto-tuning is performed to suppress vibration. This mode is applicable to occasions requiring quick positioning.

b) Adjust the stiffness level gradually during load running. The present stiffness level will be written to the servo drive automatically. Keep monitoring the running waveform during modifying the stiffness level (modify by one level each time) until the desired performance is delivered.

6.4.3 Precautions

The setting range of H09-01 (Stiffness level selection) is 0 to 41. The level 0 indicates the weakest stiffness and lowest gain and level 41 indicates the strongest stiffness and highest gain. The following table lists the stiffness levels for different load types.

Table 6-2 Application range of different stiffness levels (for reference only)

Recommended Stiffness Level	Type of Load Mechanism
Level 4 to level 8	Large-scale machineries
Level 8 to level 15	Applications with low stiffness such as the conveyor
Level 15 to level 20	Applications with high stiffness such as the ball screw and direct-connected motor

The servo drive supports five gain auto-tuning modes.

CAUTION

- If H09-00 (Gain auto-tuning mode) is set to 3, 4, or 6, the servo drive will suppress the vibration and perform inertia auto-tuning automatically within 5 min (or other time defined by H09-37) after power-on or stiffness level setting, and then it exits from auto-tuning. The inertia auto-tuning function, once deactivated, cannot be activated again by setting H09-09 to 3, 4, or 6.
- In applications with slow acceleration/deceleration, large vibration, and unstable mechanical connections, do not set H09-00 to 3, 4, or 6.
- The gain of modes 4 and 6 defined by H09-00 is weaker than other modes under the same stiffness level.
- In applications where the inertia does not change, set H09-03 (Online inertia auto-tuning mode) to 1 (Enabled, changing slowly). In applications where the inertia changes quickly, set H09-03 to 3 (Enabled, changing quickly).

■ Gain auto-tuning mode (H09-00 = 1)

The values of the 1st group of gain parameters (H08-00 to H08-02, H07-05) are updated automatically according to the stiffness level defined by H09-01 and saved into the corresponding parameters.

Table 6-3 Parameters updated during gain auto-tuning

Para. No.	Name
H08-00	Speed loop gain
H08-01	Speed loop integral time constant
H08-02	Position loop gain
H07-05	Filter time constant of torque reference

■ Positioning mode (H09-00 = 2)

On the basis of Table 6-3, the value of the 2nd group of gain parameters (H08-03 to H08-05, H07-06) are also updated automatically according to the stiffness level defined by H09-01 and saved into the corresponding parameters. In addition, the stiffness level of the position loop gain in the 2nd group of gain parameters is higher than that in the 1st group of gain parameters by one level.

Table 6-4 Parameters updated automatically in the positioning mode

Para. No.	Name	Description
H08-03	2nd speed loop gain	-
H08-04	2nd speed loop integral time constant	If H08-04 is set to 512.00 ms, the 2nd speed loop integral action is invalid, and only proportional control is used in the speed loop.
H08-05	2nd position loop gain	-
H07-06	Filter time constant of the 2nd torque reference	-

The parameters related to speed feedforward are fixed to certain values.

Table 6-5 Parameters with fixed values in the positioning mode

Para. No.	Name	Value
H08-19	Speed feedforward gain	30.0%
H08-18	Speed feedforward filter time constant	0.50 ms

Parameters related to gain switchover are fixed to certain values.

Gain switchover is enabled automatically in the positioning mode.

Para. No.	Name	Value	Description
H08-08	2nd gain mode	1	In the positioning mode, switchover between the 1st gain (H08-00 to H08-02, H07-05) and the 2nd gain (H08-03 to H08-05, H07-06) is activated. In other modes, the original setting is used.
H08-09	Gain switchover condition	10	In the positioning mode, gain switchover can be activated only if H08-09 is set to 10. In other modes, the original setting is used.
H08-10	Gain switchover delay	5.0 ms	In the positioning mode, the gain switchover delay is 5.0 ms. In other modes, the original setting is used.
H08-11	Gain switchover level	50	In the positioning mode, the gain switchover level is 50. In other modes, the original setting is used.
H08-12	Gain switchover hysteresis	30	In the positioning mode, the gain switchover hysteresis is 30. In other modes, the original setting is used.

CAUTION

- In the gain auto-tuning mode, the parameters updated automatically along with H09-01 and those with fixed values cannot be modified manually. If you need to modify these parameters, set H09-00 to 0 to exit from the gain auto-tuning mode first.

6.5 Manual Gain Tuning

6.5.1 Basic Parameters

When gain auto-tuning cannot fulfill the application needs, perform manual gain tuning.

The servo system provides three control loops, which are position loop, speed loop, and current loop from external to internal. The ~~block diagram for~~ basic control is shown in the following figure.

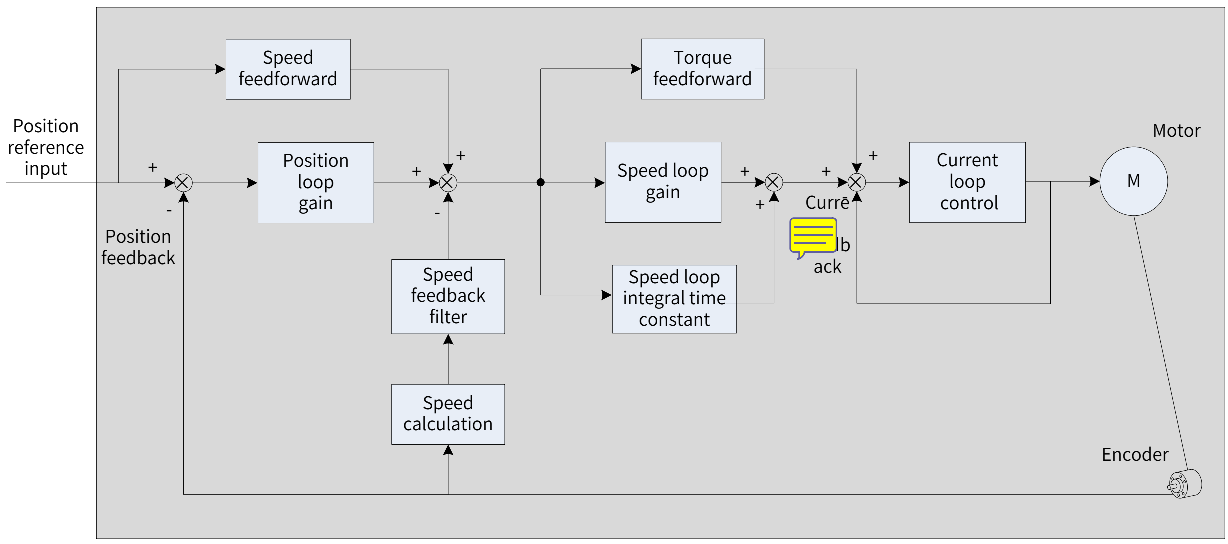


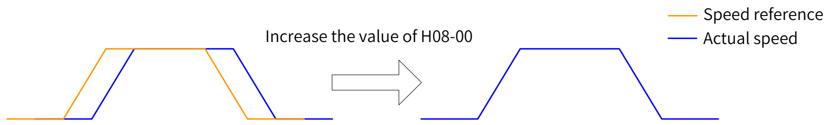
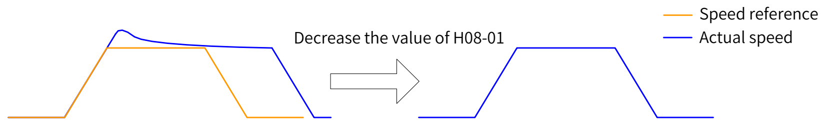
Figure 6-5 Manual gain tuning

The response level of the inner loop must be higher than that of the outer loop. Otherwise, the system may become unstable.

The default gain of the current loop is already designed with the highest level of response, removing the need for adjustment. You only need to adjust the position loop gain, speed loop gain and other auxiliary gains. When executing gain tuning in the position control mode, increase the speed loop gain as well after increasing the position loop gain, and ensure the response level of the position loop is lower than that of the speed loop to keep the system stable.

The following table shows how to adjust the basic gain parameters.

Table 6-6 Adjustment of gain parameters

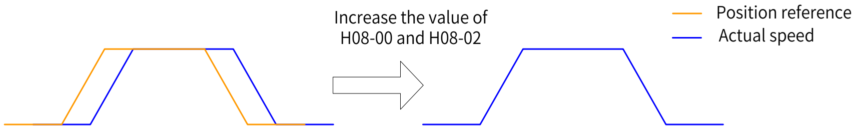
Step	Para. No.	Name	Description
1	H08-00	Speed loop gain	◆ Parameter function: It determines the maximum frequency of the speed loop in following the varying speed references. If the average load inertia ratio (H08-15) is set properly, the maximum following frequency of the speed loop can be equal to the value of H08-00 (Speed loop gain).  ◆ Adjustment method: Increase the value of H08-00 without incurring noise or vibration. This helps shorten the positioning time and improve speed stability and following characteristics. If noise occurs, decrease the value of H08-00. If mechanical vibration occurs, enable the resonance suppression function (see "6.7 Vibration Suppression").
2	H08-01	Speed loop integral time constant	◆ Parameter function: It eliminates the speed loop deviation.  ◆ Adjustment method: Select the value according to the following formula: 500 ≤ H08-00 x H08-01 ≤ 1000 For example, if H08-00 is set to 40.0 Hz, H08-01 must meet the following condition: 12.50 ms ≤ H08-01 ≤ 25.00 ms Decreasing the value of H08-01 strengthens the integral effect and shortens the positioning time, but a too small value may cause mechanical vibration. Do not set H08-01 to a too large value. Otherwise, the speed loop deviation cannot be cleared to zero. When H08-01 is set to 512.00 ms, the integral action is deactivated.

<table>
<tr><th>Step</th><th>Para. No.</th><th>Name</th><th>Description</th></tr>
<tr><td>3</td><td>H08-02</td><td>Position loop gain</td><td>

◆ Parameter function:

It determines the maximum frequency of the position loop in following the varying position references.

Maximum following ~~angle~~ frequency of position loop = H08-02



◆ Adjustment method:

To ensure system stability, the maximum following frequency of the speed loop must be 3 to 5 times the maximum following frequency of the position loop.

$$3 \le \frac{2 \times \pi \times H8\text{-}00}{H08\text{-}02} \le 5$$

For example, when H08-00 is set to 40.0 Hz, the position loop must meet the following condition:
50.2 Hz ≤ H08-02 ≤ 83.7 Hz

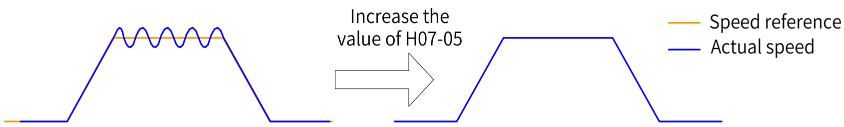
Adjust the setting based on the positioning time. Increasing the value of H08-02 shortens the acceleration time and improves the anti-interference capacity of a static motor.

Do not set H08-02 to a too large value. Otherwise, system instability or oscillation may occur.

</td></tr>
<tr><td>4</td><td>H07-05</td><td>Filter time constant of torque reference</td><td>

◆ Parameter function:

It eliminates the high-frequency noise and suppresses mechanical resonance.



◆ Adjustment method:

Ensure the cutoff frequency of the torque reference low-pass filter is higher than 4 times the maximum following frequency of the speed loop.

$$\frac{1000}{2 \times \pi \times H07\text{-}05} \ge (H08\text{-}00) \times 4$$

For example, when H08-00 is set to 40.0 Hz, the set value of H07-05 must be less than or equal to 1.00 ms.

If vibration occurs when you increase the value of H08-00, adjust the value of H07-05 to suppress vibration. For details, see *"6.7 Vibration Suppression"*.

Do not set H07-05 to a too large value. Otherwise, the responsiveness of the current loop may be weakened.

To suppress vibration upon stop, increase the value of H08-00 and decrease the value of H07-05.

If strong vibration occurs upon motor stop, decrease the value of H07-05.

</td></tr>
</table>

☆ Related parameters

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-00	Speed loop gain	0.1 to 2000.0	Hz	Defines the proportional gain of the speed loop.	During running	Immediately	40.0
H08-01	Speed loop integral time constant	0.15 to 512.00	ms	Defines the integral time constant of the speed loop.	During running	Immediately	19.89

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-02	Position loop gain	0.0 to 2000.0	Hz	Defines the proportional gain of the position loop.	During running	Immediately	64.0
H07-05	Filter time constant of torque reference	0.00 to 30.00	ms	Defines the filter time constant of the torque reference.	During running	Immediately	0.79

6.5.2 Gain Switchover

Gain switchover, which is available only in position and speed control modes, can be triggered by the internal status of the servo drive or by an external DI. The following actions can be achieved through gain switchover.

- Switching to the lower gain at motor standstill (servo ON) to suppress vibration
- Switching to the higher gain at motor standstill to shorten the positioning time
- Switching to the higher gain at motor running to achieve better reference tracking performance
- Switching between different gain settings through an external signal to fit different conditions of the load devices

1 H08-08 = 0

The first group of gain parameters (H08-00 to H08-02, H07-05) are used, but proportional/proportional and integral control can be switched through DI function 3 (FunIN.3: GAIN_SEL, gain switchover) for the speed loop.

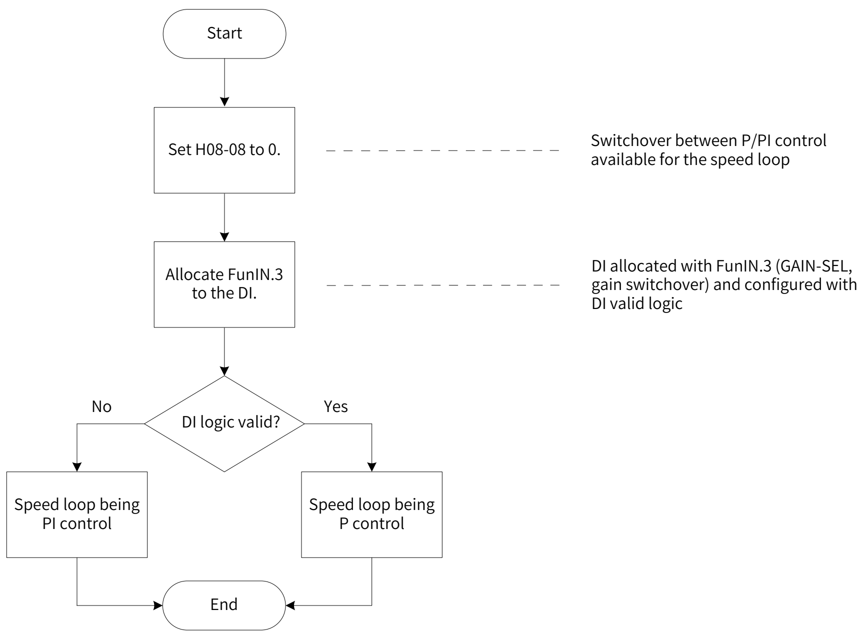


Figure 6-6 Gain switchover flowchart (H08-08 = 0)

2 H08-08 = 1

Switchover between 1st group of gain parameters (H08-00 to H08-02, H07-05) and 2nd group of gain parameters (H08-03 to H08-05, H07-06) is activated based on the setting of H08-09 (Gain switchover condition).

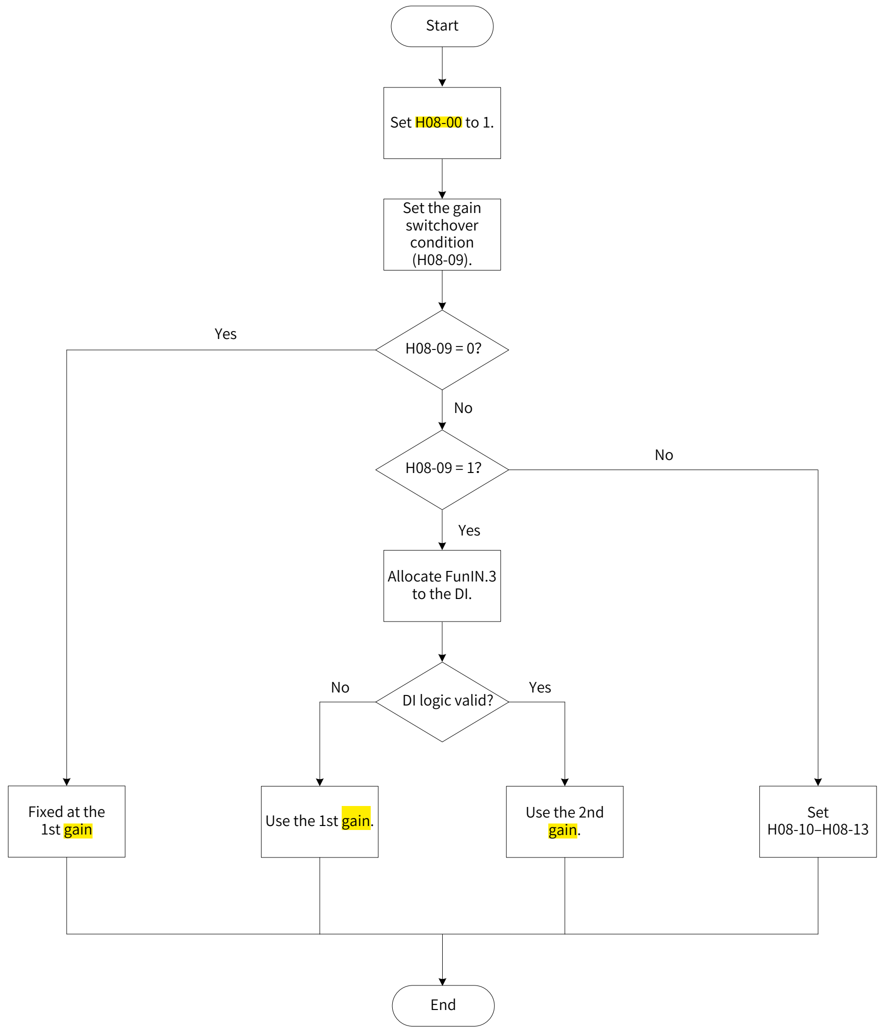
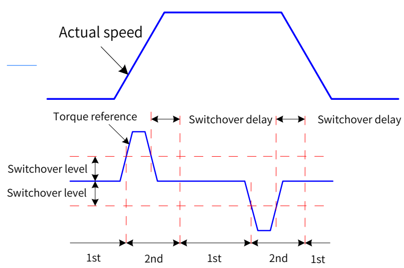
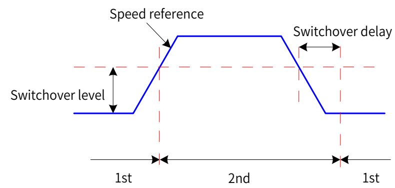
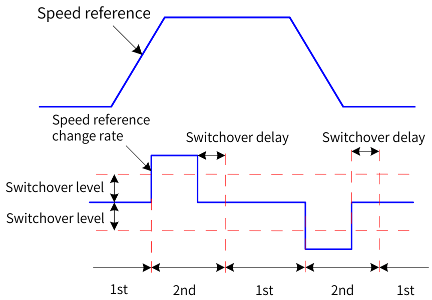
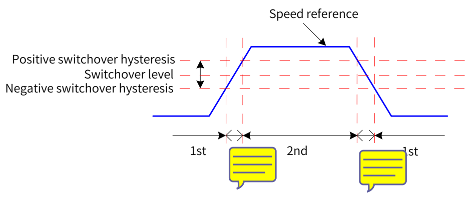
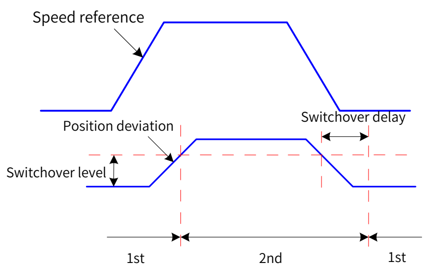
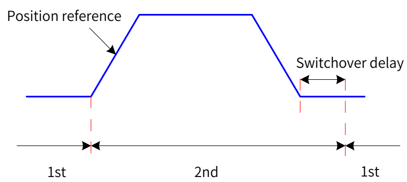
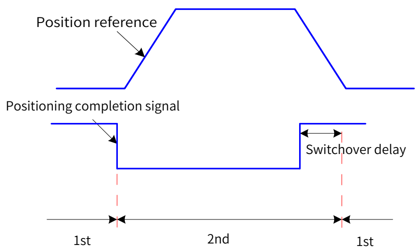


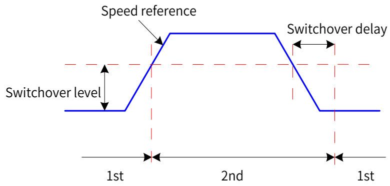
Figure 6-7 Gain switchover flowchart (H08-08 = 1)

There are 11 conditions for gain switchover. The following table describes the diagrams and related parameters of different conditions.

Table 6-7 Description of gain switchover conditions

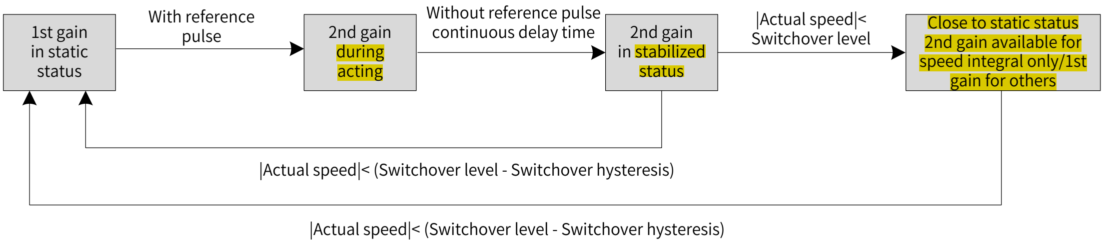
Gain Switchover Condition			Related Parameters		
H08-09	Condition	Diagram	Delay (H08-10)	Gain switchover level (H08-11)	Gain switchover hysteresis (H08-12)
0	Fixed at 1st gain	-	Invalid	Invalid	Invalid
1	Switchover by external DI	-	Invalid	Invalid	Invalid
2	Torque reference		Valid	Valid (%)	Valid (%)

Gain Switchover Condition			Related Parameters		
H08-09	Condition	Diagram	Delay (H08-10)	Gain switchover level (H08-11)	Gain switchover hysteresis (H08-12)
3	Speed reference		Valid	Valid	Valid
4	Speed reference change rate		Valid	Valid (10 RPM/s)	Valid (10 RPM/s)
5	Speed reference threshold		Invalid	Valid (RPM)	Valid (RPM)
6	Position deviation		Valid	Valid (encoder unit)	Valid (encoder unit)
7	Position reference		Valid	Invalid	Invalid
8	Positioning completed		Valid	Invalid	Invalid

Gain Switchover Condition			Related Parameters		
H08-09	Condition	Diagram	Delay (H08-10)	Gain switchover level (H08-11)	Gain switchover hysteresis (H08-12)
9	Actual speed		Valid	Valid (RPM)	Valid (RPM)
10	Position reference + Actual speed	See the following note for details.	Valid	Valid (RPM)	Valid (RPM)

NOTE

H08-10 (Gain switchover delay) is valid only during switching from the 2nd gain to the 1st gain.



☆ Related parameters:

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-08	2nd gain mode	0: Fixed at the 1st gain, P/PI switchover through external DI 1: Gain switchover based on H08-09	-	Defines the mode of the 2nd gain.	During running	Immedi-ately	1
H08-09	Gain switchover condition	0: Fixed at the 1st gain 1: Switchover through external DI 2: Torque reference too large 3: Speed reference too large 4: Speed reference change rate too large 5: Speed reference threshold 6: Position deviation too large 7: Position reference available 8: Positioning completed 9: Actual speed too large 10: Position reference + Actual speed	-	Defines the gain switchover condition.	During running	Immedi-ately	0
H08-10	Gain switchover delay	0 to 10	-	Defines the gain switchover delay.	During running	Immedi-ately	5.0
H08-11	Gain switchover level	1 to 1000	Based on the switchover condition	Defines the gain switchover level.	During running	Immedi-ately	50

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-12	Gain switchover hysteresis	0 to 20000	Based on the switchover condition	Defines the gain switchover hysteresis.	During running	Immedi-ately	30
H08-13	Position gain switchover time	0.0 to 100.0	ms	Defines the gain switchover time of the position loop.	During running	Immedi-ately	3.0

6.5.3 Comparison of Filters

Name	Function	Applicable Occasion	Impact of Excessive Filter
Pulse input pin filter	Ensures the pulse number received by the servo drive is accurate by preventing interference.	The system wiring does not comply with specifications. The ambient interference is strong.	The number of pulses received by the servo drive is smaller than those sent from the host controller.
Position reference filter	Filters the position references (encoder unit) divided or multiplied by the electronic gear ratio to smoothen the running process of the motor and reduce the impact on the machine.	The acceleration/deceleration process is not performed on the position references sent from the host controller. The pulse frequency is low. The electronic gear ratio is larger than 10.	The response delay is prolonged.
Analog input filter	Prevents motor command fluctuation due to unstable analog input voltage and reduce the motor malfunction due to interference signals.	The system wiring does not comply with specifications. The ambient interference is strong.	The response delay is prolonged.

6.5.4 Feedforward Gain

1 Speed Feedforward

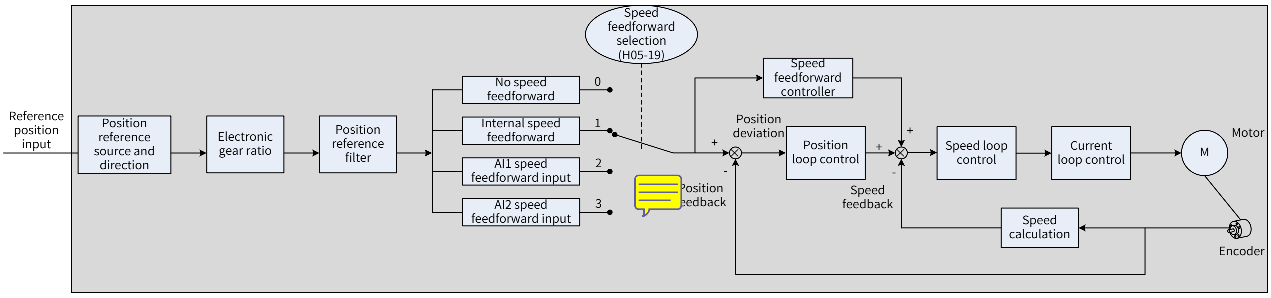


Figure 6-8 Operating procedures for speed feedforward control

Speed feedforward can be applied to the position control mode. When position control or full closed-loop is used, the speed feedforward function can be used to improve speed reference responsiveness and reduce the position deviation during constant speed.

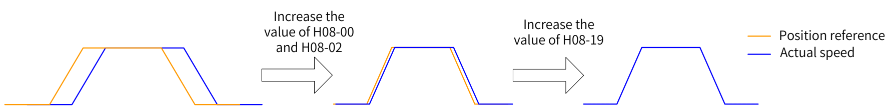
Operating procedures for speed feedforward are as follows.

1) Setting the speed feedforward signal source

Set H05-19 to a non-zero value to enable speed feedforward, and the corresponding signal source will be selected.

<table>
<tr><th>Para. No.</th><th>Name</th><th>Value Range</th><th>Description</th></tr>
<tr><td rowspan="2">H05-19</td><td rowspan="2">Speed feedforward control selection</td><td>0: No speed feedforward</td><td>-</td></tr>
<tr><td>1: Internal speed feedforward</td><td>Defines the speed information corresponding to the position reference (encoder unit) as the speed feedforward signal source.</td></tr>
</table>

2) Setting the speed feedforward parameters (including H08-19 and H08-18)

<table>
<tr><th>Para. No.</th><th>Name</th><th>Description</th></tr>
<tr><td>H08-18</td><td>Speed feedforward filter time constant</td><td rowspan="2">

◆ Parameter function:
Increasing the value of H08-19 improves the responsiveness but may cause speed overshoot during acceleration/deceleration.
Decreasing the value of H08-18 suppresses speed overshoot during acceleration/deceleration. Increasing the value of H08-18 not only suppresses the noise in the case of long position reference update period, long drive control period and uneven position reference pulse frequency, but also suppresses jitter of the positioning completion signal.
◆ Adjustment method:
Set H08-18 to a fixed value, and then increase the value of H08-19 gradually from 0 to a certain value at which speed feedfoward reaches the required effect.
Adjust H08-18 and H08-19 repeatedly until reaching a well balanced performance.</td></tr>
<tr><td>H08-19</td><td>Speed feedforward gain</td></tr>
</table>

2 Torque feedforward

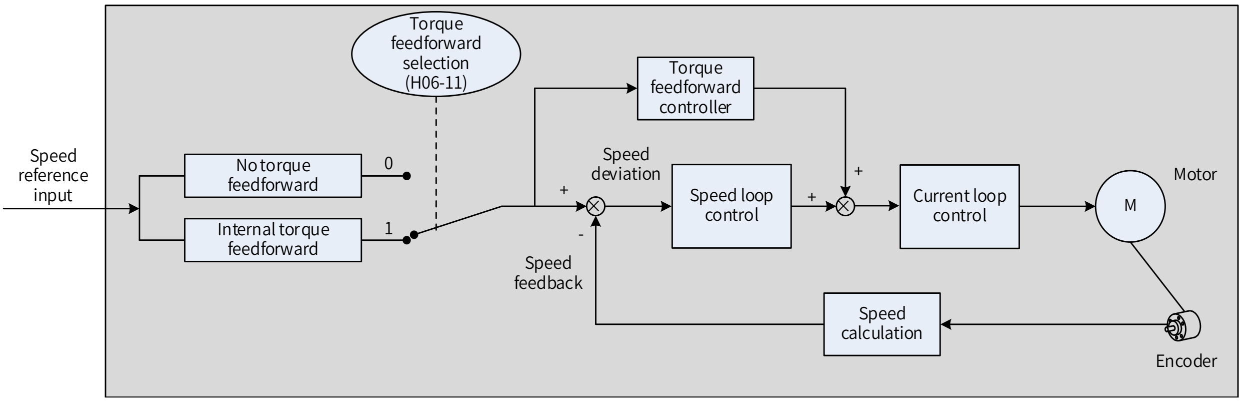


Figure 6-9 Operating procedures for torque feedforward control

The torque feedforward used in the position control mode improves torque reference responsiveness and decreases the position deviation during acceleration/deceleration at a constant speed.

The torque feedforward used in the speed control mode improves torque reference responsiveness and decreases the position deviation during constant speed.

Operating procedures for torque feedforward are as follows.

1) Setting the torque feedforward signal source

Set H06-11 to 1 to enable speed feedforward, and the corresponding signal source will be selected.

Para. No.	Name	Value Range	Description
H06-11	Torque feedforward control selection	0: No torque feedforward	-
		1: Internal torque feedforward	Defines the speed reference as the torque feedforward signal source. In the position control mode, the speed reference is output from the position controller.

2) Setting torque feedforward parameters

Para. No.	Name	Description
H08-20	Torque feedforward filter time constant	Parameter function: Increasing the value of H08-21 improves the responsiveness but may cause speed overshoot during acceleration/deceleration. Decreasing the value of H08-20 suppresses overshoot during acceleration/deceleration. Increasing the value of H08-20 suppresses the noise. Adjustment method: Keep H08-20 to the default value, and then increase the value of H08-21 gradually from 0 to a certain value at which torque feedforward reaches the required effect. Adjust H08-20 and H08-21 repeatedly until reaching a well balanced performance.
H08-21	Torque feedforward gain	For details, see "6.5.4 Feedforward Gain".

6.5.5 Pseudo Derivative Feedback and Feedforward Control

In the non-torque control mode, pseudo derivative feedback and feedforward (PDFF) control can be used to adjust the speed loop control mode.

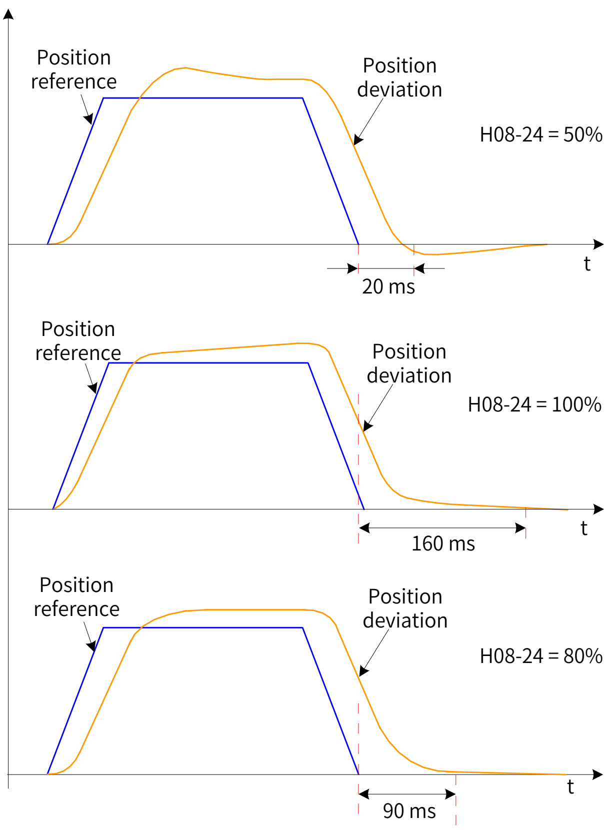


Figure 6-10 Example

PDFF control enhances the anti-interference capacity of the speed loop and improves the performance in following the speed reference through adjustment of the speed loop control mode.

Para. No.	Name	Description
H08-24	PDFF control coefficient	◆ Parameter function: It adjusts the control mode of the speed loop in non-torque control mode. ◆ Adjustment method: Do not set H08-24 to a too small value. Otherwise, the speed loop response may be slowed down. When speed feedback overshoot occurs, decrease the value of H08-24 gradually from 100.0 to a certain value at which the PDFF control achieves the desired effect. When H08-24 is set to 100.0, the speed loop control mode does not change and the default proportional integral control is used.

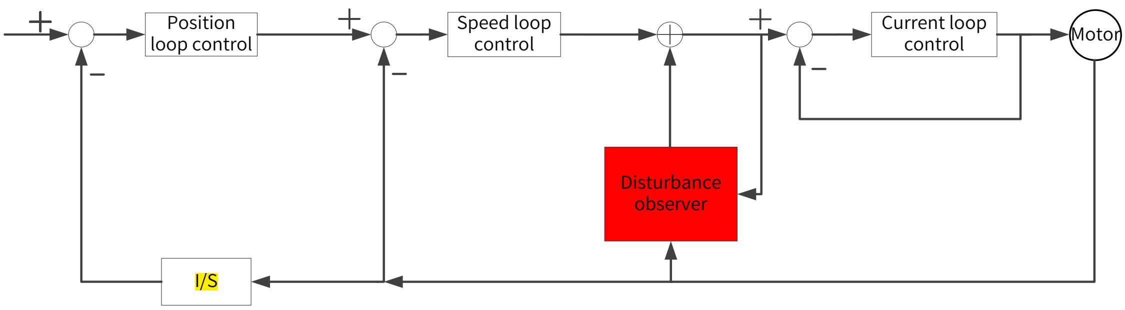
6.5.6 Torque Disturbance Observation

This function is intended to be used in the non-torque control mode.

1 Disturbance observer 1

The disturbance observer is used to observe external disturbance. The disturbance within the frequency range can be observed and suppressed through the cutoff frequency and compensation setting.

Position of the disturbance observer 1 in the function block diagram is shown in the following figure.



NOTE

◆ 1/S: Integral element

Para. No.	Name	Description
H08-31	Disturbance observation cutoff frequency	The higher the cutoff frequency is, the more easily will the vibration occur.
H08-32	Disturbance observation compensation coefficient	Defines the compensation percentage for observation.
H08-33	Disturbance observation inertia correction coefficient	Set this parameter only if the set inertia does not fit the actual conditions. The acting inertia is the result of multiplying the value of H08-33 by the set inertia. It is recommended to use the default value of H08-33.

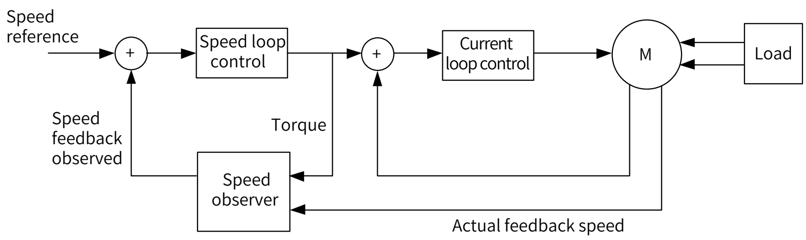
☆ Related parameters

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H08-31	Disturbance observation cutoff frequency	10 to 1700	1 Hz	Defines the cutoff frequency for disturbance observation.	During running	Immediately	600
H08-32	Disturbance observation compensation coefficient	0 to 100	1%	Defines the compensation percentage for disturbance observation.	During running	Immediately	0
H08-33	Disturbance observation inertia correction coefficient	1 to 10000	1%	Defines the coefficient for correcting the disturbance observation inertia.	During running	Immediately	100

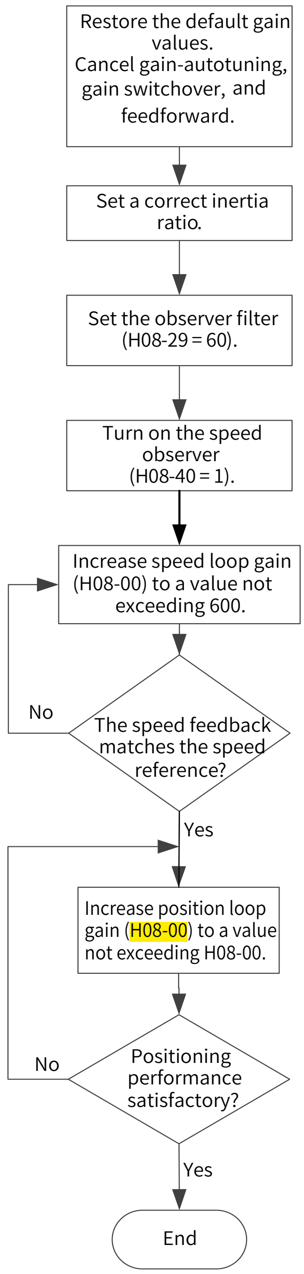
6.5.7 Speed observer

The speed observer is intended to be used in applications with small load/inertia changes. It facilitates quick positioning through improving the responsiveness and filtering high frequencies.

The block diagram for the speed observer is as follows.



1 Commissioning procedures



2 Related parameters:

Para. No.	Name	Min. Unit	Value Range	Default	Setting Condition	Effective Time
H08-00	Speed loop gain	0.1 Hz	1 to 20000	40	During running	Immediately
H08-27	Speed observation cutoff frequency	1 Hz	10 to 2000	170	During running	Immediately
H08-28	Speed observation inertia correction coefficient	1%	10 to 10000	100	During running	Immediately
H08-29	Speed observation filter time	0.01 ms	0 to 2000	80	During running	Immediately
H08-40	Speed observation selection	1	0 to 1	0	During running	Immediately

CAUTION

- Before using the speed observer, set H08-15 (Load inertia ratio) to a proper value or perform inertia auto-tuning. A wrong inertia ratio will cause vibration.
- Setting H08-27, H08-28, or H08-29 to a too small or too large value will cause motor vibration.

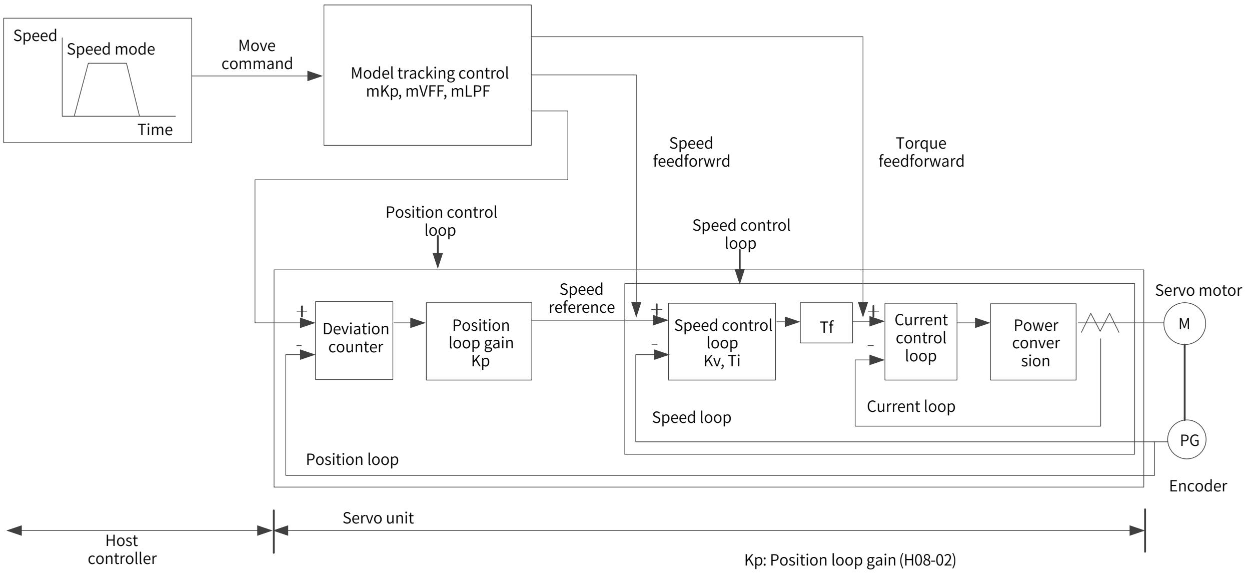
6.5.8 Model Tracking

The model tracking control, which is only available in the position control mode, can be used to improve the responsiveness and shorten the positioning time.

Parameters used by model tracking are normally set automatically through ITune or ETune along with the gain parameters. However, manual tuning is needed in the following situations:

- The auto-tuned results cannot fulfill the application needs.
- Improving the responsiveness takes priority over the auto-tuned values.
- Customized parameters for the gain or model tracking control are needed.

The block diagram for model tracking control is as follows.



Kp: Position loop gain (H08-02)

Kv: Speed loop gain (H08-00)

Ti: Speed loop integral time constant (H08-01)

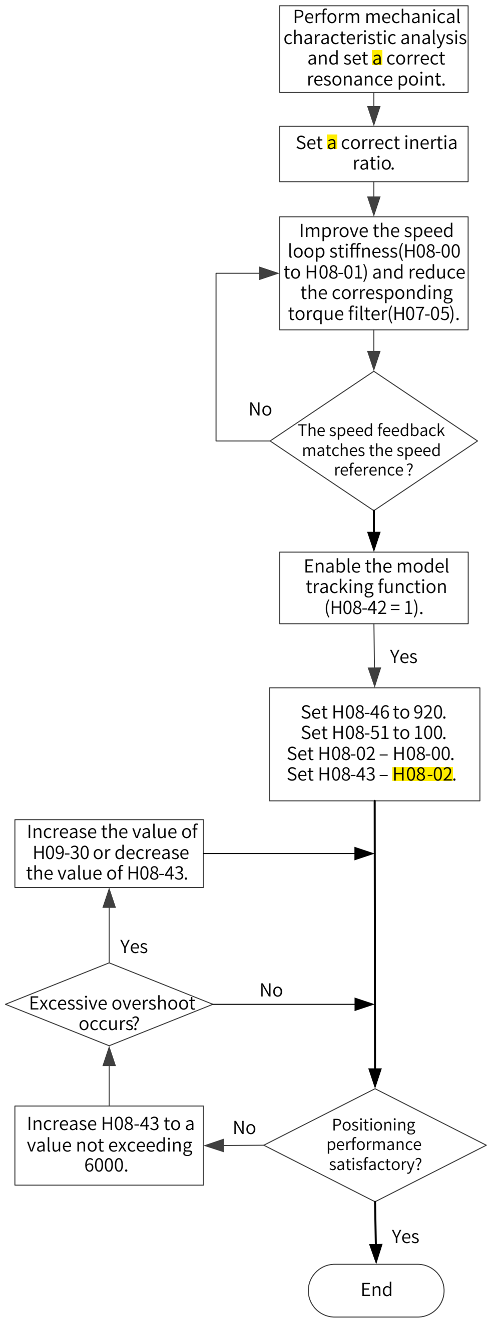
Tf: Torque reference filter time constant (H07-05)

mKp: Model tracking control gain (H08-43)

mVFF: Model tracking control speed feedforward compensation (H08-46)

mLPF: Model filter time (H08-51)

1 Commissioning procedures



2 Related parameters

Para. No.	Name	Min. Unit	Value Range	Default	Setting Condition	Effective Time
H07-05	Torque reference filter time constant	0.01 ms	0 to 3000	79	During running	Immediately
H08-00	Speed loop gain	0.1 Hz	1 to 20000	400	During running	Immediately
H08-01	Speed loop integral time constant	0.01 ms	15 to 51200	1989	During running	Immediately
H08-02	Position loop gain	0.1 Hz	1 to 20000	640	During running	Immediately
H08-42	Model control selection	1	0 to 1	0	At stop	Immediately

Para. No.	Name	Min. Unit	Value Range	Default	Setting Condition	Effective Time
H08-43	Model gain	0.1	0 to 10000	400	During running	Immediately
H08-46	Feedforward gain	1	0 to 1024	950	During running	Immediately
H08-51	Model filter time 2	0.01 ms	0 to 2000	0	During running	Immediately

CAUTION

Ensure the set inertia is accurate. Otherwise, motor vibration may occur.

6.5.9 Friction Compensation

The friction compensation is used to reduce the impact of the friction on the running effect during mechanical transmission. Use different positive/negative compensation values according to the running direction.

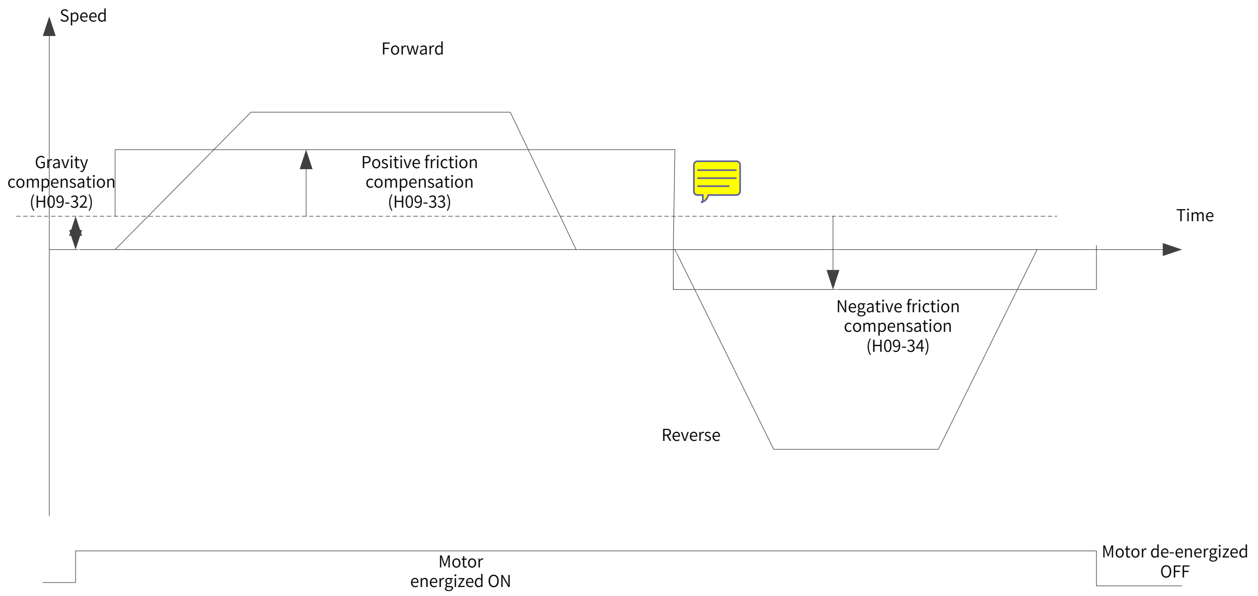
NOTE

◆ Friction compensation is valid only in the position control mode.

☆ Related parameters

Para. No.	Para. Name	Value Range	Function
H09-32	Gravity compensation	–100% to +100.0%	Defines the constant compensation torque of vertical gravity load.
H09-33	Positive friction compensation	–100% to +100.0%	Defines the friction compensation for the position reference in forward direction.
H09-34	Negative friction compensation	-100.0% to +100%	Defines the friction compensation for the position reference in reverse direction.
H09-35	Friction compensation speed threshold	0 RPM to 30.0 RPM	Defines the running speed after friction resistance.
H09-36	Friction compensation speed selection	0: Speed reference 1: Model speed (valid when the model function is enabled) 2: Speed feedback	Defines the source of the speed threshold.

The diagram for friction compensation is as follows.



NOTE

◆ When the speed is less than the speed threshold, static friction applies. When the speed exceeds the speed threshold, dynamic friction applies. The compensation direction is determined by the direction of the actual position reference. Forward direction requires positive compensation value. Reverse direction requires negative compensation value.

6.6 Parameter Adjustment in Different Control Modes

Perform parameter adjustment in the sequence of "Inertia auto-tuning" => "Gain auto-tuning" => "Manual gain tuning".

6.6.1 Parameter Adjustment in the Position Control Mode

1) Obtain the value of H08-15 (Load inertia ratio) through inertia auto-tuning.
2) Gain parameters in the position control mode are listed in the following tables.

■ 1st group of gain parameters

Para. No.	Name	Function	Default
H07-05	Torque reference filter time constant	Defines the filter time constant of the torque reference.	0.79 ms
H08-00	Speed loop gain	Defines the proportional gain of the speed loop.	40.0 Hz
H08-01	Speed loop integral time constant	Defines the integral time constant of the speed loop.	19.89 ms
H08-02	Position loop gain	Defines the proportional gain of the position loop.	64.0 Hz

■ 2nd group of gain parameters

Para. No.	Name	Function	Default
H07-06	2nd torque reference filter time constant	Defines the filter time constant of the ~~2nd~~ torque reference.	0.79 ms
H08-03	2nd speed loop gain	Defines the proportional gain of the speed loop.	40.0 Hz

Para. No.	Name	Function	Default
H08-04	2nd speed loop integral time constant	Defines the integral time constant of the speed loop.	20.00 ms
H08-05	2nd position loop gain	Defines the proportional gain of the position loop.	64.0 ms
H08-08	2nd gain mode	Defines the mode of the 2nd gain.	1
H08-09	Gain switchover condition	Defines the gain switchover condition.	0
H08-10	Gain switchover delay	Defines the gain switchover delay.	5.0 ms
H08-11	Gain switchover level	Defines the gain switchover level.	50
H08-12	Gain switchover hysteresis	Defines the gain switchover hysteresis.	30
H08-13	Position gain switchover time	Defines the gain switchover time of the position loop.	3.0 ms

■ Common gain

Para. No.	Name	Function	Default
H08-18	Speed feedforward filter time constant	Defines the filter time constant of the speed feedforward signal.	0.50 ms
H08-19	Speed feedforward gain	Defines the speed feedforward gain.	0.0%
H08-20	Torque feedforward filter time constant	Defines the filter time constant of the torque feedforward signal.	0.50 ms
H08-21	Torque feedforward gain	Defines the torque feedforward gain.	0.0%
H08-22	Speed feedback filter selection	Defines the speed feedback filter function.	0
H08-23	Cutoff frequency of speed feedback low-pass filter	Defines the cutoff frequency of the first-order low-pass filter for speed feedback.	4000 Hz
H08-24	PDFF control coefficient	Defines the coefficient of the PDFF controller.	100.0%
H09-30	Torque disturbance compensation gain	Defines the gain of disturbance torque compensation.	0.0%
H09-31	Filter time constant of torque disturbance observer	Defines the filter time constant of the disturbance observer.	0.5 ms
H09-04	Suppression mode for low-frequency resonance	Defines the mode of suppressing low-frequency resonance.	0
H09-38	Frequency for suppressing low-frequency resonance	Defines the frequency of the filter used to suppress low-frequency resonance.	100.0 Hz
H09-39	Low-frequency resonance filter setting	Used to set the low-frequency resonance filter.	2
H0A-16	Position deviation threshold in low-frequency resonance	Defines the position deviation threshold (in pulses) which can be judged as low-frequency resonance.	0.0005 Rev

3) Perform gain auto-tuning to obtain the initial values of the 1st gain (or 2nd gain) and common gain.

■ Adjust the following gain parameters manually.

Para. No.	Name	Function
H07-05	Filter time constant of torque reference	Defines the filter time constant of the torque reference.
H08-00	Speed loop gain	Defines the proportional gain of the speed loop.
H08-01	Speed loop integral time constant	Defines the integral time constant of the speed loop.
H08-02	Position loop gain	Defines the proportional gain of the position loop.

H08-19	Speed feedforward gain	Defines the speed feedforward gain.

6.6.2 Parameter Adjustment in the Speed Control Mode

Parameter adjustment in the speed control mode is the same as that in the position control mode except for the position loop gain (H08-02 and H08-05). See section "6.6.1 Parameter Adjustment in the Position Control Mode" for details.

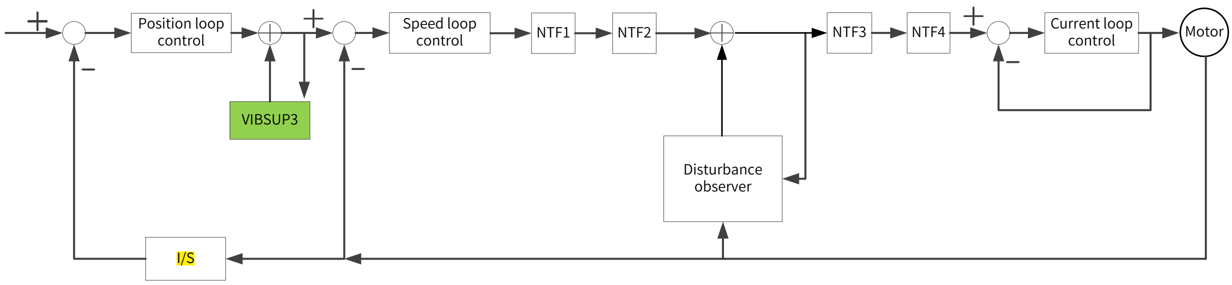
6.6.3 Parameter Adjustment in the Torque Control Mode

Parameter adjustment in the torque control mode are differentiated based on the following conditions:

- If the actual speed reaches the speed limit, the adjustment method is the same as that described in section 6.6.2.
- If the actual speed does not reach the speed limit, the adjustment method is the same as that described in section 6.6.2, except for the position/speed loop gain and speed loop integral time constant.

6.7 Vibration Suppression

The block diagram for vibration control is as follows.



- NTF1–4: 1st notch to 4th notch
- VIBSUP3: Suppression of medium- and low-frequency vibration featuring a frequency lower than 300 Hz
- 1/S: Integral element

☆ Related parameters

Para. No.	Name	Default	Unit	Min. Value	Max. Value	Setting Condition	Effective Time
H08-53	Medium- and low-frequency jitter suppression frequency 3	0	0.1 Hz	0	6000	During running	Immediately
H08-54	Medium- and low-frequency jitter suppression compensation 3	0	1%	0	200	During running	Immediately
H08-56	Medium- and low-frequency jitter suppression phase modulation 3	300	1%	0	1600	During running	Immediately
H08-59	Medium- and low-frequency jitter suppression frequency 4	0	0.1 Hz	0	3000	During running	Immediately

Para. No.	Name	Default	Unit	Min. Value	Max. Value	Setting Condition	Effective Time
H08-60	Medium- and low-frequency jitter suppression compensation 4	0	1%	0	200	During running	Immediately
H08-61	Medium- and low-frequency jitter suppression phase modulation 4	100	1%	0	600	During running	Immediately

NOTE

- Vibration suppression phase modulation coefficient: synchronous phase adjustment of the compensation value ~~and vibration~~. It is recommended to use the default value. Adjustment is needed only when the compensation phase deviates sharply from the vibration phase.
- Vibration suppression frequency: Defines the vibration frequency to be suppressed.
- Vibration suppression compensation coefficient: Defines the magnitude of the suppression compensation.

6.7.1 Suppression of Mechanical Resonance

The resonance frequency is present in the mechanical system. When the gain increases, resonance may occur near the resonance frequency, disabling further increase of the gain.

Mechanical resonance can be suppressed in the following two methods:

1) Torque reference filter (H07-05, H07-06)

To suppress the mechanical resonance, set the filter time constant to allow the torque reference to be attenuated in the frequency range above the cutoff frequency.

Filter cutoff frequency fc (Hz) = 1/[2 x H07-05 (ms) x 0.001]

2) Notch

The notch reduces the gain at certain frequencies to suppress the mechanical resonance. After the vibration is suppressed by the notch, you can continue to increase the gain. The operating principle of the notch is shown in the following figure.

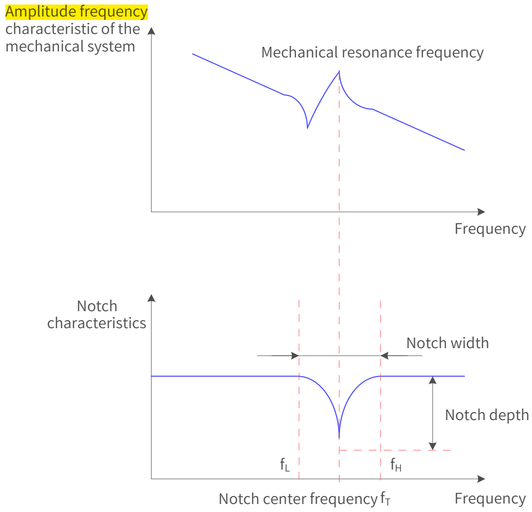


Figure 6-11 Operating principle of the notch

A total of four notches can be used, and each is defined by three parameters: frequency, width level, and depth level. Parameters of the 1st and 2nd manual notches are set manually by the user. Parameters of the 3rd and 4th notches can be either set manually or set automatically after being configured as the adaptive notch (H09-02 = 1 or 2).

Table 6-8 Description of the notch

Item	Manual Notch		Manual/Adaptive Notch	
	1st Notch	2nd Notch	3rd Notch	4th Notch
Frequency	H09-12	H09-15	H09-18	H09-21
Width level	H09-13	H09-16	H09-19	H09-22
Depth level	H09-14	H09-17	H09-20	H09-23

NOTE

- ◆ When the "frequency" is the default value (4000 Hz), the notch is invalid.
- ◆ The adaptive notch is preferred for resonance suppression. The manual notch can be used in cases where the adaptive notch cannot deliver desired performance.

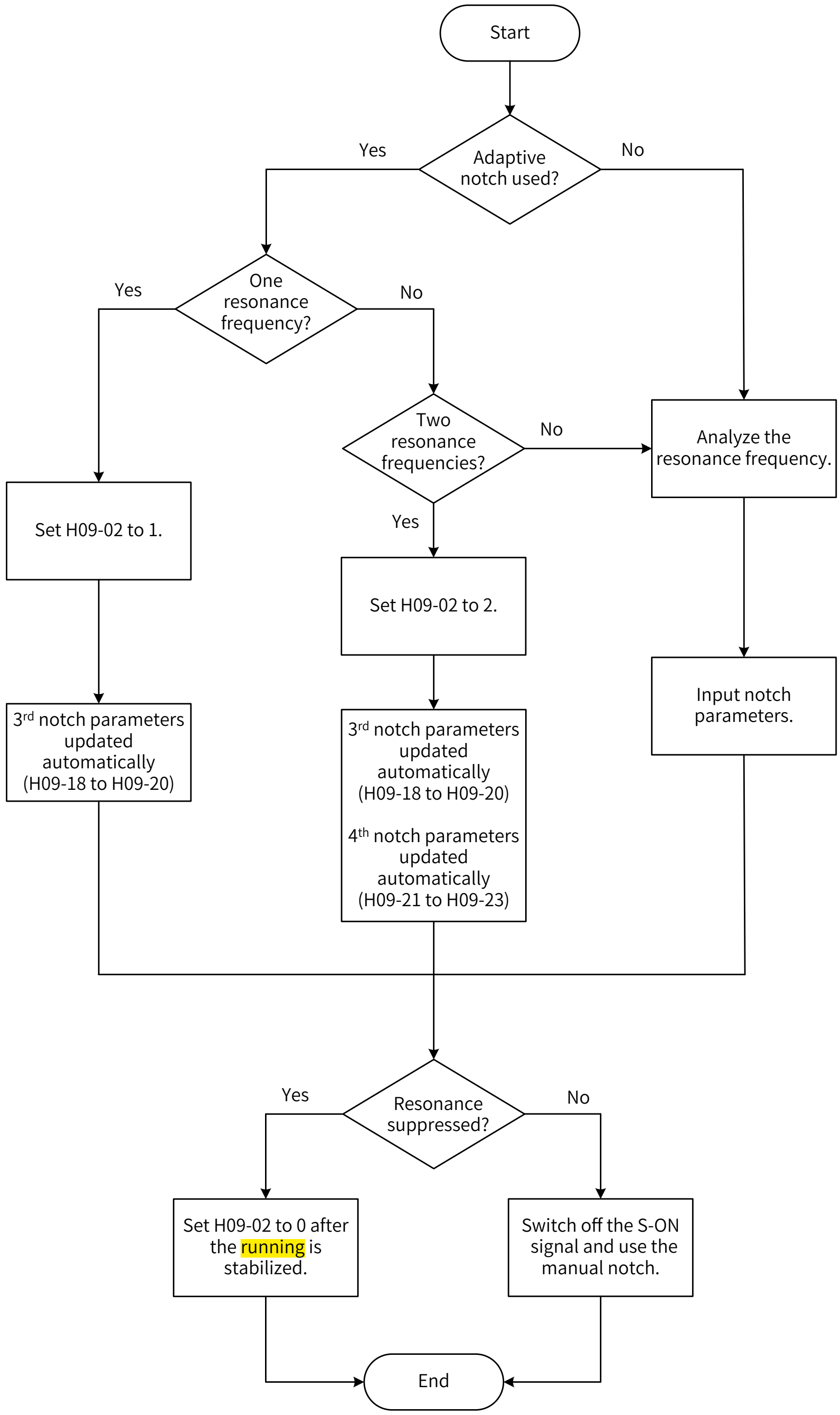


Figure 6-12 Steps for setting the adaptive notch

■ Steps for setting the adaptive notch

1) Set H09-02 (Adaptive notch mode) to 1 or 2 based on the number of resonance frequency points.

2) When resonance occurs, set H09-02 to 1 to enable one adaptive notch first. If new resonance occurs after the gain is adjusted, set H09-02 to 2 to enable two adaptive notches.

3) The parameters of the 3rd or 4th notch are updated automatically during running, and the values are automatically stored to the corresponding parameters in group H09 every 30 minutes.

4) If the resonance is suppressed, it indicates the adaptive notch functions well. After the servo drive keeps stable for a certain period, set H09-02 to 0 to keep the parameters of the adaptive notch fixed to the latest values. This is to prevent notch parameters from being updated to the wrong values, causing malfunction of the servo drive and exacerbating vibration.

5) If the vibration cannot be suppressed, switch off the S-ON signal.

6) If there are more than two resonance frequencies, use both the adaptive notch and manual notch to suppress the resonance or use all the four notches as manual notches (H09-02 = 0).

NOTE

◆ When adaptive notch is applied, if the S-OFF signal is activated within 30 min, the notch parameters will not be stored into the corresponding parameter numbers.

◆ When the resonance frequency is below 300 Hz, the suppression effect of the adaptive notch may be degraded.

■ Procedures for using the manual notch:

1) Step 1: Analyze the resonance frequency.

2) Step 2: When using the manual notch, set the frequency to the actual resonance frequency, which is obtained by using the following methods:

a) Use the "Mechanical characteristic analysis" function in the software tool.

b) Calculate the resonance frequency based on the motor phase current displayed on the oscilloscope interface of the software tool.

c) Set H09-02 (Adaptive notch mode) to 3. The servo drive detects the resonance frequency and stores the detection result in H09-24 (Auto-tuned resonance frequency) automatically after start.

3) Step 3: Input the resonance frequency obtained in step 1 into the parameter of the selected notch, and input the width level and depth level of this notch.

4) If the resonance is suppressed, it indicates the notch functions well and you can continue adjusting the gain. If new resonance occurs, repeat steps 1 and 2.

5) If the vibration cannot be suppressed, switch off the S-ON signal.

■ Width level of the notch

The width level indicates the ratio of the notch width to the center frequency of the notch.

$$\text{Notch width level} = \frac{f_H - f_L}{f_T}$$

In which:

f_T: Center frequency of the notch, which is also the mechanical resonance frequency

f_H-f_L: Notch width, indicating the frequency width whose amplitude attenuation rate is -3 dB in relative to the notch center frequency

The default value 2 applies to general applications.

■ Depth Level of the notch

The notch depth level indicates the ratio of the input to the output at the center frequency.

When the depth level is 0, the input is completely suppressed at the center frequency. When the depth level is 100, the input can be fully received at the center frequency. Therefore, the smaller the depth level is, the larger the notch depth is, and the stronger the suppression effect will be. Note that a too small depth level may lead to system oscillation.

NOTE

◆ If the amplitude frequency characteristic curve obtained through the mechanical characteristic analysis tool does not have obvious spike but vibration does occur in actual operations, it indicates the gain limit of the servo drive may be reached, which causes the vibration. Such vibration is not mechanical resonance and can be suppressed only by reducing the gain or the torque reference filter time.

Their relation is shown in the following figure.

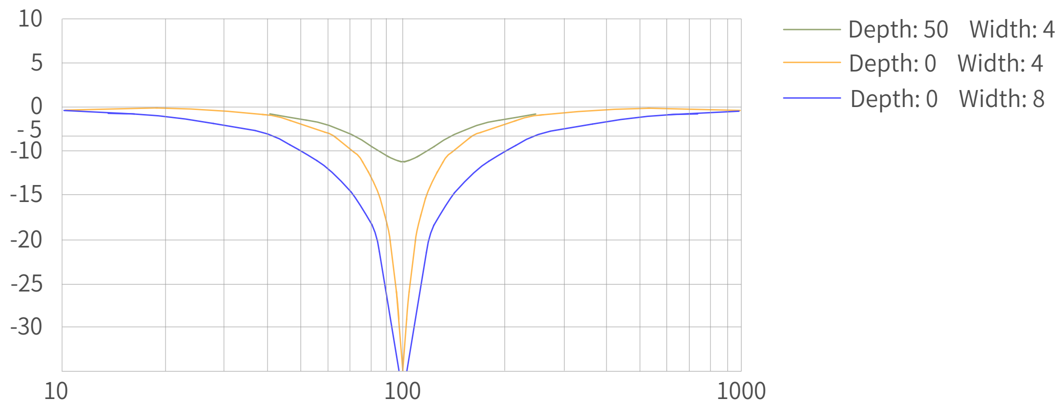


Figure 6-13 Notch frequency characteristics

☆ Related parameters

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-02	Selection of adaptive notch mode	0: Parameters of the 3rd and 4th notches not longer updated 1: One adaptive notch activated, parameters of the 3rd notch updated in real time based on the vibration condition 2: Two adaptive notches activated, parameters of the 3rd and 4th notches updated in real time based on the vibration condition 3: Resonance frequency tested only, displayed in H09-24 4: Adaptive notch cleared, parameters of the 3rd and 4th notches restored to default settings	-	Defines the working mode of the adaptive notch.	During running	Immediately	0
H09-12	Frequency of the 1st notch	50 to 4000	Hz	Defines the frequency of the 1st notch.	During running	Immediately	4000
H09-13	Width level of the 1st notch	0 to 10	-	Defines the width level of the 1st notch.	During running	Immediately	2
H09-14	Depth level of the 1st notch	0 to 99	-	Defines the attenuation level of the 1st notch.	During running	Immediately	0
H09-15	Frequency of the 2nd notch	50 to 4000	Hz	Defines the frequency of the 2nd notch.	During running	Immediately	4000
H09-16	Width level of the 2nd notch	0 to 10	-	Defines the width level of the 2nd notch.	During running	Immediately	2

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-17	Depth level of the 2nd notch	0 to 99	-	Defines the attenuation level of the 2nd notch.	During running	Immediately	0
H09-18	Frequency of the 3rd notch	50 to 4000	Hz	Defines the frequency of the 3rd notch.	During running	Immediately	4000
H09-19	Width level of the 3rd notch	0 to 10	-	Defines the width level of the 3rd notch.	During running	Immediately	2
H09-20	Depth level of the 3rd notch	0 to 99	-	Defines the attenuation level of the 3rd notch.	During running	Immediately	0
H09-21	Frequency of the 4th notch	50 to 4000	Hz	Defines the frequency of the 4th notch.	During running	Immediately	4000
H09-22	Width level of the 4th notch	0 to 10	-	Defines the width level of the 4th notch.	During running	Immediately	2
H09-23	Depth level of the 4th notch	0 to 99	-	Defines the attenuation level of the 4th notch.	During running	Immediately	0
H09-24	Auto-tuned resonance frequency	-	Hz	Displays the auto-tuned resonance frequency when H09-02 is set to 3.	-	-	0

6.7.2 Low Frequency Suppression at the Mechanical End

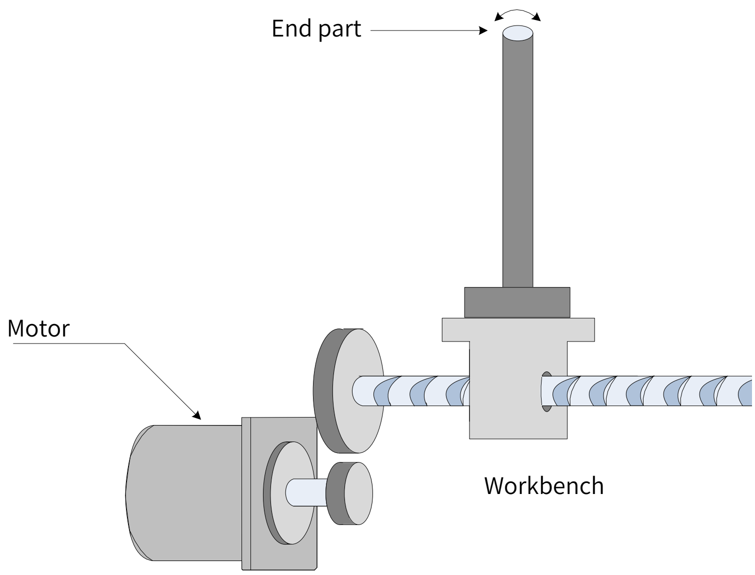


Figure 6-14 Low frequency vibration at the mechanical end

If the mechanical load end is long and heavy, vibration may easily occur on this part during emergency stop, affecting the positioning effect. Such vibration is called low frequency resonance as its frequency is generally within 100 Hz, which is smaller than the mechanical resonance frequency mentioned in *"6.7.1 Suppression of Mechanical Resonance"*. Use the low frequency resonance suppression function to alleviate such vibration.

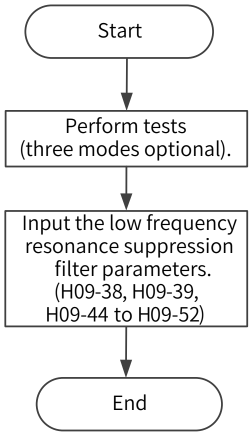


Figure 6-15 Procedures for setting low frequency resonance suppression filter

First, collect the position deviation waveform in the motor positioning mode by using the oscilloscope function of the software tool and calculate the position deviation fluctuation frequency, which is the low frequency resonance frequency. Next, input H09-38 (or H09-44) and H09-49 manually, and keep the values of other parameters to their default values. Observe the suppression effect after using the low frequency resonance suppression filter.

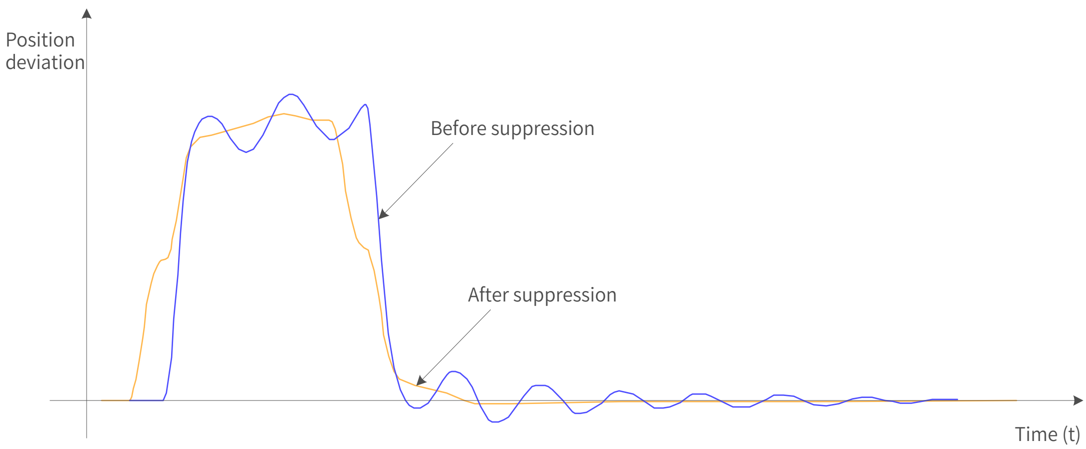


Figure 6-16 Effect of low frequency resonance suppression

☆ Related parameters

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-38	Low-frequency resonance suppression frequency	1.0 to 100.0	Hz	Defines the frequency for suppressing the low frequency resonance at the mechanical end.	During running	Immediately	100.0
H09-39	Low-frequency resonance suppression	0 to 3	-	Defines the low frequency resonance suppression level.	During running	Immediately	2
H09-44	Frequency of low-frequency resonance suppression 2 at the mechanical end	0 to 200.0	Hz	Defines the frequency for the 2nd group of low frequency resonance suppression. If H09-44 is set to 0, this function is disabled.	During running	Immediately	0
H09-45	Response of low-frequency resonance suppression 2 at the mechanical end	0.01 to 10.00	Hz	Defines the response of the 2nd group of low frequency resonance suppression. Increasing the value of H09-45 can reduce the delay caused by suppression and improve the responsiveness. Note that setting H09-45 to a too large value may incur vibration.	During running	Immediately	1.00

Para. No.	Name	Value Range	Unit	Function	Setting Condition	Effective Time	Default
H09-47	Width of low-frequency resonance suppression 2 at the mechanical end	0 to 2.00	Hz	Defines the width of the 2nd group of low frequency resonance suppression. Increase the value of H09-47 in cases where the vibration frequency changes during running.	During running	Immediately	1.00
H09-49	Frequency of low-frequency resonance suppression 3 at the mechanical end	0 Hz to 200.0 Hz	Hz	Defines the frequency of the 3rd group of low frequency resonance suppression. If H09-49 is set to 0, this function is disabled.	During running	Immediately	0
H09-50	Response of low-frequency resonance suppression 3 at the mechanical end	0.01 to 2.00	Hz	Defines the response of the 3rd group of low frequency resonance suppression. Increasing the value of H09-50 can reduce the delay caused by suppression and improve the responsiveness. Note that setting H09-50 to a too large value may incur vibration.	During running	Immediately	1.00
H09-52	Width of the low-frequency resonance suppression 3 at the mechanical end	0 to 2.00	Hz	Defines the width of the 3rd group of low frequency resonance suppression. Increase the value of H09-52 in cases where the vibration frequency changes during running.	During running	Immediately	1.00

6.8 Mechanical Characteristic Analysis

6.8.1 Overview

The mechanical characteristic analysis is used to determine the mechanical resonance point and system bandwidth. An analysis of response characteristics up to 8 kHz is available and three modes including mechanical characteristics, speed open loop and speed closed loop are supported.

6.8.2 Operating Procedures

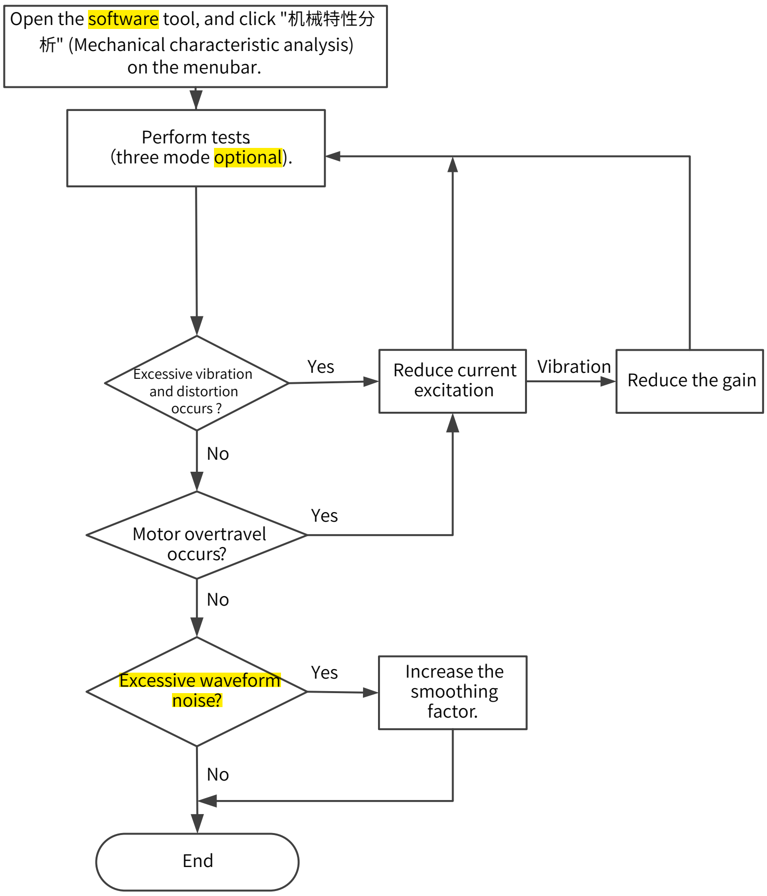


Figure 6-17 Operating procedures for mechanical characteristic analysis

NOTE

- To avoid strong vibration during test, set the current excitation to 10% during initial execution.
- The analysis waveform may be distorted if the current excitation is too small.
- If the vibration generated during the test cannot be eliminated by reducing the current excitation, the possible causes and solutions are as follows:
  1) The gain is too high. Reduce the speed gain or set the notch based on the auto-tuned resonance point.
  2) The inertia is too large. Set a correct inertia.
- After setting the notch, the waveform under mechanical characteristic test mode is the same with that before the setting, but the speed closed loop and open loop modes will be attenuated.

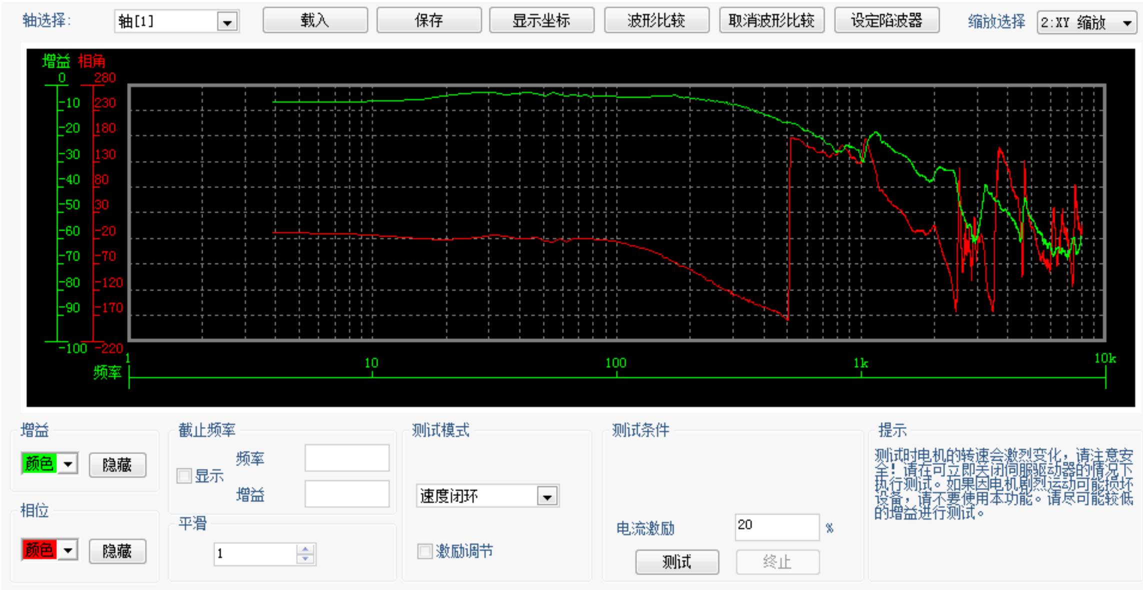


Figure 6-18 Example of the waveform

7 Control Mode

The servo system consists of three major parts: servo drive, servo motor, and encoder.

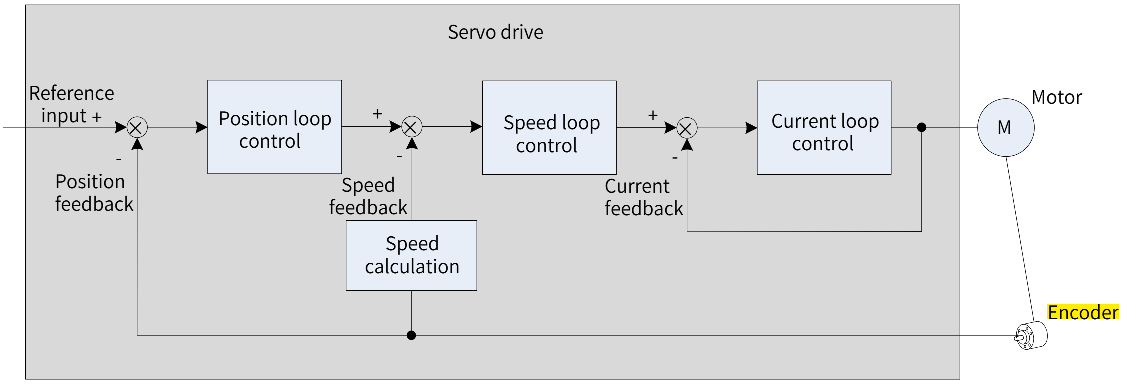


Figure 7-1 Structure of a basic servo system

The servo drive, which is the core of a servo system, serves to perform accurate position, speed and torque control on a servo motor. It supports four control modes, namely position control, speed control, torque control, and hybrid (combination among position, speed and torque) control. Position control is the most important mode of a servo system.

Descriptions of the control modes are as follows:

- Position control
  In the position control mode, the target position of a motor is determined by the sum of position references, and the motor speed is determined by the position reference frequency. The servo drive performs quick and accurate position and speed control through the encoder installed on the motor or an external encoder (full closed-loop control). The position control mode mainly applies to applications requiring positioning control, such as the manipulator, SMT machine, engraving and milling machine (pulse sequence reference), and CNC machine tool.
- Speed control
  In the speed control mode, the servo drive performs quick and accurate speed control through the speed reference sent through communication. The speed control mode mainly applies to application requiring speed control or where a host controller is used for position control or the commands sent from the host controller are used as the speed references for the servo drive, such as the engraving and milling machine.
- Torque control
  In the torque control mode, the motor current is in linear relationship with the torque. Therefore, torque control is implemented through current control. The output torque of the motor is controlled by the torque reference sent through communication. The torque control mode mainly applies in applications requiring strict tension control. For example, in winding/unwinding devices, torque references are used to prevent the material from being affected by the change in the winding radius.

7.1 Servo Drive State Setting

Follow the process stipulated in the standard 402 protocol when operating the SV660N servo drive. Failure to comply may cause the servo drive to run in the wrong state.

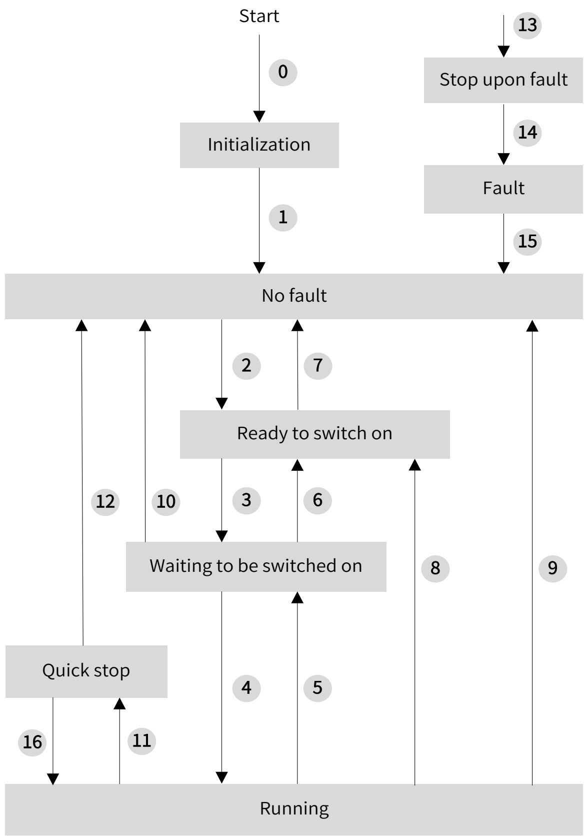


Figure 7-2 CiA402 state machine switchover

See the following table for the descriptions of different states.

Initialization	Initialization of the servo drive and internal self-check are done. The servo drive parameters cannot be set. The driving functions cannot be executed.
No fault	No fault exists in the servo drive or the fault has been cleared. The servo drive parameters can be set.
Ready to switch on	The servo drive is ready to run. The servo drive parameters can be set.
Wait to switch on	The servo drive is waiting to be switched on. The servo drive parameters can be set.
Running	The servo drive is running properly and a certain running mode has been enabled. The motor is energized and starts to rotate when the reference is not 0. Only the parameter whose attribute is "modifiable during running" can be set.
Quick stop	Quick stop is activated and the servo drive is in the process of quick stop. Only the parameter whose attribute is "modifiable during running" can be set.
Stop upon fault	A fault occurs and the servo drive is in the process of stop upon fault. Only the parameter whose attribute is "modifiable during running" can be set.
Fault	The stop process is done and all the driving functions are disabled. Parameters of the servo drive can be modified for troubleshooting.

Switchover between the control commands and states

CiA402 State Switchover		Control Word 6040h	bit0 to bit9[1] of Status Word 6041h
0	Power-on → Initialization	Natural transition, control command not required	0x0000
1	Initialization → No fault	Natural transition, control command not required If an error occurs during initialization, the servo drive directly goes to state 13.	0x0250/0x270
2	No fault -> Ready to switch on	0x0006	0x0231
3	Ready to switch on -> Wait to switch on	0x0007	0x0233
4	Wait to switch on-> Running	0x000F	0x0237
5	Running -> Wait to switch on	0x0007	0x0233
6	Wait to switch on -> Ready to switch on	0x0006	0x0231
7	Ready to switch on -> No fault	0x0000	0x0250
8	Running -> Ready to switch on	0x0006	0x0231
9	Running -> No fault	0x0000	0x0250
10	Wait to switch on -> No fault	0x0000	0x0250
11	Running -> Quick stop	0x0002	0x0217
12	Quick stop -> No fault	Set 605A to a value between 0 to 3. Natural transition will be performed after stop and no control command is required.	0x0250
13	-> Stop upon fault	Once a fault occurs in any state other than "fault", the servo drive automatically switches to the stop-upon-fault state, requiring no control command.	0x021F
14	Stop upon fault -> Fault	Natural transition is performed after stop and no control command is required.	0x0218
15	Fault -> No fault	0x80 Bit7 is rising edge-triggered. If the value of bit7 is 1, other control commands are invalid.	0x0250
16	Quick stop -> Running	Set 605A to a value between 5 to 7. 0x0F will be sent upon stop.	0x0237

NOTE

bit10 to bit15 of 6041h are related to the running state of the servo drive, and their values are represented as 0 in the preceding table. For details on the state of these bits, view the running modes of the servo drive.

7.1.1 Control Word 6040h

Index 6040h	Name	Control word			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 65535	Default	0

6040h is used to set the control command.

bit	Name	Description
0	Switch on	1: Valid, 0: Invalid
1	Enable voltage	1: Valid, 0: Invalid
2	Quick stop	0: Valid, 1: Invalid
3	Enable operation	1: Valid, 0: Invalid
4 to 6	Operation mode-specific	Related to the servo drive modes.
7	Fault reset	0: Invalid 0 -> 1: Fault reset is implemented for faults and warnings that can be reset. 1: Other control commands are invalid. 1 -> 0: Invalid
8	Halt	1: Valid, 0: Invalid
9	Operation mode-specific	Related to the servo drive modes.
10	Reserved	Undefined
11 to 15	Manufacturer-specific	Defined by the manufacturer.

Note:

- All bits in a control word constitute a control command. One bit is meaningless if it is set separately.
- The meaning of bit0 to bit3 and bit7 are the same in each mode of the servo drive. The servo drive switches to the preset status according to the CiA402 state machine only when control words are sent in sequence. Each command corresponds to a certain status.
- The meanings of bit4 to bit6 vary with each mode. For details, see parameters related to each mode.
- The bit9 is not defined.

7.1.2 Status Word 6041h

<table>
<tr><td rowspan="2">Index
6041h</td><td>Name</td><td colspan="3">Status word</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>-</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Shows the servo drive status.</td></tr>
</table>

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="2">ms</td><td colspan="2">osm</td><td>ila</td><td>tr</td><td>rm</td><td>ms</td><td>w</td><td>sod</td><td>qs</td><td>ve</td><td>f</td><td>oe</td><td>so</td><td>rtso</td></tr>
<tr><td colspan="8">MSB</td><td colspan="8">LSB</td></tr>
</table>

Description:
ms=manufacturEr-specific； omS=operation mode sPecific； iLa=internal limit actIve；
tr=target rEach； rm=remote； w=warning； sod=switch on disabled； qs=quick stop； ve=voltage enabled； f=fault； oe=operation enabled； so=switch on； rtso=ready to switch on

bit	Name	Description
0	Ready to switch on	1: Valid, 0: Invalid
1	Switch on	1: Valid, 0: Invalid
2	Operation enabled	1: Valid, 0: Invalid
3	Fault	1: Valid, 0: Invalid
4	Voltage enabled	1: Valid, 0: Invalid
5	Quick stop	0: Valid, 1: Invalid
6	Switch on disabled	1: Valid, 0: Invalid
7	Warning	1: Valid, 0: Invalid
8	Manufacturer-specific	Undefined
9	Remote	1: Valid, control word activated 0: Invalid
10	Target reach	1: Valid, 0: Invalid
11	Internal limit active	1: Valid, 0: Invalid
12 to 13	Operation mode specific	Related to the servo drive modes.
14	Manufacturer-specific	Undefined
15	Home find	1: Valid, 0: Invalid

Binary Value	Description
xxxx xxxx x0xx 0000	Not ready to switch on
xxxx xxxx x1xx 0000	Switch on disabled
xxxx xxxx x01x 0001	Ready to switch on
xxxx xxxx x01x 0011	Switched on
xxxx xxxx x01x 0111	Operation enabled
xxxx xxxx x00x 0111	Quick stop active
xxxx xxxx x0xx 1111	Fault reaction active
xxxx xxxx x0xx 1000	Fault

Note:

- The meanings of bit0 to bit9 are the same in each mode of the servo drive. After control commands in 6040h are sent in sequence, the servo drive returns a certain status.
- The meanings of bit12 to bit13 vary with the servo drive modes. For details, see parameters related to each mode.
- The meanings of bit10, bit11, and bit15 are the same in each mode of the servo drive and indicate the servo drive status after a certain control mode is implemented.

7.2 Servo Mode Setting

7.2.1 Introduction to Servo Drive Modes

The SV660N supports seven modes, as defined in 6502h.

<table>
<tr><td rowspan="2">Index 6502h</td><td>Name</td><td colspan="3">Supported drive modes</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>UINT32</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>No</td><td>Related Mode</td><td>-</td><td>Value Range</td><td>-</td><td>Default</td><td>0x000003ADh</td></tr>
<tr><td colspan="11">Shows the servo drive modes supported.
<table>
<tr><td>bit</td><td>Description</td><td>Support or Not
(0: Not support
1: Support)</td></tr>
<tr><td>0</td><td>Profile Position Mode (PP)</td><td>1</td></tr>
<tr><td>1</td><td>Velocity Mode (VL)</td><td>0</td></tr>
<tr><td>2</td><td>Profile Velocity Mode (PV)</td><td>1</td></tr>
<tr><td>3</td><td>Profile Torque Mode (PT)</td><td>1</td></tr>
<tr><td>4</td><td>N/A</td><td>0</td></tr>
<tr><td>5</td><td>Homing Mode (HM)</td><td>1</td></tr>
<tr><td>6</td><td>Interpolated Position Mode (IP)</td><td>0</td></tr>
<tr><td>7</td><td>Cyclic Synchronous Position Mode (CSP)</td><td>1</td></tr>
<tr><td>8</td><td>Cyclic Synchronous Velocity Mode (CSV)</td><td>1</td></tr>
<tr><td>9</td><td>Cyclic Synchronous Torque Mode (CST)</td><td>1</td></tr>
<tr><td>10 to 31</td><td>Defined by the manufacturer</td><td>Reserved</td></tr>
</table>
If the device supports 6502h, you can get the supported servo drive modes through 6502h.</td></tr>
</table>

The pre-running mode of the servo drive is set in 6060h. The present running mode of the servo drive can be viewed in the object dictionary 6061h.

■ 6060h (Modes of operation)

<table>
<tr><td rowspan="2">Index
6060h</td><td>Name</td><td colspan="3">Modes of Operation</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int 8</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 10</td><td>Default</td><td>0</td></tr>
</table>

Defines the mode of servo drive operation.

Value	Modes of Operation	
0	N/A	Reserved
1	Profile Position Mode (PP)	See "7.6 Profile Position (PP) Mode"
2	N/A	Reserved
3	Profile Velocity Mode (PV)	See "7.7 Profile Velocity Mode (PV)"
4	Profile Torque Mode (PT)	See "7.8 Profile Torque Mode (PT)"
5	N/A	Reserved
6	Homing Mode (HM)	See "7.9 Homing Mode (HM)"
7	Interpolated Position Mode (IP)	Not supported
8	Cyclic Synchronous Position Mode (CSP)	See "7.3 Cyclic Synchronous Position Mode (CSP)"
9	Cyclic Synchronous Velocity Mode (CSV)	See "7.4 Cyclic Synchronous Velocity (CSV) Mode"
10	Cyclic Synchronous Torque Mode (CST)	See "7.5 Cyclic Synchronous Torque Mode (CST)"

If an unsupported operation mode is set through SDO, an SDO error will be returned. For details, see "11.2 List of Object Groups".

If an operation mode not supported is set through PDO, this operation mode is invalid.

■ 6061h (Modes of operation display)

<table>
<tr><td rowspan="2">Index
6061h</td><td>Name</td><td colspan="3">Modes of operation display</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int 8</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 10</td><td>Default</td><td>0</td></tr>
</table>

Displays the present operation mode of the servo drive.

Value	Modes of Operation	
0	N/A	Reserved
1	Profile Position Mode (PP)	See "7.6 Profile Position (PP) Mode"
2	N/A	Reserved
3	Profile Velocity Mode (PV)	See "7.7 Profile Velocity Mode (PV)"
4	Profile Torque Mode (PT)	See "7.8 Profile Torque Mode (PT)"
5	N/A	Reserved
6	Homing Mode (HM)	See "7.9 Homing Mode (HM)"
7	Interpolated Position Mode (IP)	Not supported
8	Cyclic Synchronous Position Mode (CSP)	See "7.3 Cyclic Synchronous Position Mode (CSP)"
9	Cyclic Synchronous Velocity Mode (CSV)	See "7.4 Cyclic Synchronous Velocity (CSV) Mode"
10	Cyclic Synchronous Torque Mode (CST)	See "7.5 Cyclic Synchronous Torque Mode (CST)"

7.2.2 Communication Cycle

SV660N series servo drives support a synchronization cycle of 125 μs (or an integral multiple of 125 μs).

7.3 Cyclic Synchronous Position Mode (CSP)

In this mode, the host controller generates the position references and sends the target position to the servo drive cyclically. The position control, speed control, and torque control are performed by the servo drive.

7.3.1 Configuration Block Diagram

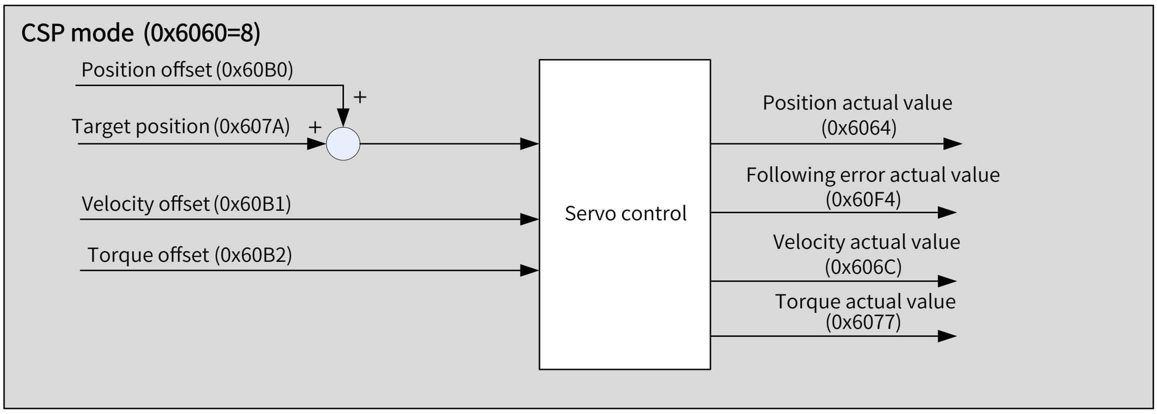


Figure 7-3 Cyclic synchronous position mode

7.3.2 Related Objects

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
6040	00	Control word	RW	UINT16	-	0 to 65535	0
6041	00	Status word	RO	UINT16	-	-	0
6060	00	Modes of operation	RW	INT8	-	0 to 10	0
6061	00	Modes of operation display	RO	INT8	-	-	0
6064	00	Position actual value	RO	INT32	Position unit	-	-
606C	00	Velocity actual value	RO	INT32	Position unit/s	-	-
607A	00	Target position	RW	INT32	Position unit	-2^{31} to $+(2^{31}-1)$	0
607E	00	Polarity	RW	UINT8	-	0 to 255	0
60B0	00	Position offset	RW	INT32	Position unit	-2^{31} to $+(2^{31}-1)$	0
60B1	00	Velocity offset	RW	INT32	Velocity unit/s	-2^{31} to $+(2^{31}-1)$	0
60B2	00	Torque offset	RW	INT16	0.1%	–3000 to +3000	0

7.3.3 Related Function Settings

1 Position deviation monitoring function

☆ Related parameters

Index 6065h	Name	Following error window			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	UINT 32
	Access	RW	Mapping	RPDO	Related Mode	PP HM CSP	Value Range	0 to (2^{32}-1) (position unit)	Default	3145728
Defines the threshold of excessive position deviation (position unit). If 6065h is set to a too large value, the warning threshold of excessive position deviation will be 2147483647 encoder units.										

Index 6066h	Name	Following error time out			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	UINT 16
	Access	RW	Mapping	RPDO	Related Mode	PP HM CSP	Value Range	0 to 65535 (ms)	Default	0
Defines the threshold of excessive position deviation (position unit). If the position deviation exceeds the threshold of excessive position deviation and such status persists after the time defined by 6066h elapses, EB00.0 (Excessive position deviation) will occur.										

2 Position reference polarity

You can change the position reference direction through setting the position reference polarity.

☆ Related parameters

Index 607Eh	Name	Polarity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint8
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 255	Default	0
Defines the polarity of the position, speed, and torque reference.										

Bit	Description
7	Position polarity 0: Multiply by 1 1: Multiply by -1 CSP: Invert the position reference (607Ah + 60B0h)

7.3.4 Recommended Configuration

The basic configuration for the CSP mode is described in the following table.

RPDO	TPDO	Description
6040: Control word	6041: Status word	Mandatory
607A: Target position	6064: Position actual value	Mandatory
6060: Modes of operation	6061: Modes of operation display	Optional

7.3.5 Related Parameters

<table>
<tr><td rowspan="2">Index 6040h</td><td>Name</td><td colspan="3">Control word</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 65535</td><td>Default</td><td>0</td></tr>
</table>

Defines the control commands.

bit	Name	Description
0	Switch on	1: Valid, 0: Invalid
1	Enable voltage	1: Valid, 0: Invalid
2	Quick stop	0: Valid, 1: Invalid
3	Enable operation	1: Valid, 0: Invalid

The CSP mode only supports the absolute position references.

<table>
<tr><td rowspan="2">Index 6041h</td><td>Name</td><td colspan="3">Status word</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>-</td><td>Default</td><td>0</td></tr>
</table>

Shows the servo drive status.

bit	Name	Description
0	Ready to switch on	1: Valid, 0: Invalid
1	Switch on	1: Valid, 0: Invalid
2	Operation enabled	1: Valid, 0: Invalid
3	Fault	1: Valid, 0: Invalid
4	Voltage enabled	1: Valid, 0: Invalid
5	Quick stop	0: Valid, 1: Invalid
6	Switch on disabled	1: Valid, 0: Invalid
7	Warning	1: Valid, 0: Invalid
8	Manufacturer-specific	Undefined
9	Remote	1: Valid, control word activated 0: Invalid
10	Target reach	Not supported, always being 1
11	Internal limit active	0: Position reference within the limit 1: Position reference beyond the limit
12	Drive follow the command value	Not supported, always being 1
13	Following error	0: EB00.0 (Excessive position deviation) not reported 1: EB00.0 (Excessive position deviation) reported
14	Manufacturer-specific	Undefined
15	Home find	0: Homing not completed 1: Homing completed

<table>
<tr><td rowspan="2">Index 607Ah</td><td>Name</td><td colspan="3">Target position</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PP CSP</td><td>Value Range</td><td>-2^{31} to $+(2^{31}-1)$ (position unit)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the target position in PP mode and CSP mode.
In CSP mode, 607Ah represents the absolute target position. In PP mode, 607Ah represents either incremental position or absolute position as defined by the control word.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 60B0h</td><td>Name</td><td colspan="3">Position offset</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>CSP</td><td>Value Range</td><td>-2^{31} to $+(2^{31}-1)$ (position unit)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the position offset in CSP mode.
The sum of 607Ah and 60B0h determines the target position of the servo drive.
Target position = 607Ah + 60B0h</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 60B1h</td><td>Name</td><td colspan="3">Velocity offset</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>CSP/CSV</td><td>Value Range</td><td>-2^{31} to $+(2^{31}-1)$ (velocity unit/s)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the external velocity feedforward signal of EtherCAT in the CSP mode (activated when 2005-14h is set to 2). 60B1h can be used to reduce the position deviation during positioning. After the positioning is done, set the velocity offset to 0. Failure to comply will cause deviation between the positioning target position and position feedback.
You can set both the velocity offset and the velocity reference offset in the CSP mode through 60B1h.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 60B2h</td><td>Name</td><td colspan="3">Torque offset</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>CSP/CSV/CST</td><td>Value Range</td><td>–3000 to +3000 (0.1%)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the external torque feedforward signal of EtherCAT in CSP and CSV modes (activated when 2006-0Ch is set to 2).
You can set both the torque reference and the torque reference offset in CST mode through 60B2h.</td></tr>
</table>

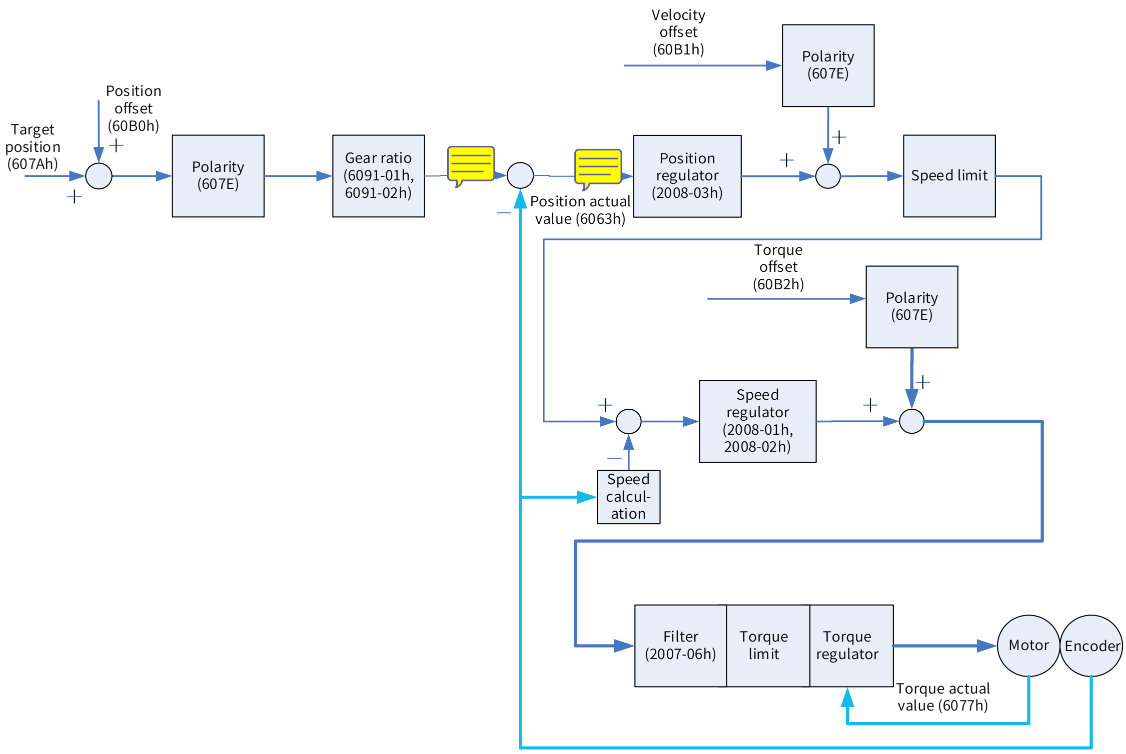
<table>
<tr><td rowspan="2">Index 6064h</td><td>Name</td><td colspan="3">Position actual value</td><td>Setting Condition & Effective Time</td><td>At display</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int32</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>- (position unit)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Shows the absolute position feedback (position unit).
In the case of an absolute encoder used in the rotary mode, 6064h shows the single-turn position feedback (position unit) of the mechanical load.</td></tr>
</table>

Index 606Ch	Name	Velocity actual value			Setting Condition & Effective Time	At display	Data Structure	VAR	Data Type	int 32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	(unit: velocity unit/s)	Default	-
Shows the actual speed feedback value (velocity unit/s).										

Index 6077h	Name	Torque actual value			Setting Condition & Effective Time	At display	Data Structure	VAR	Data Type	int16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	(unit: 0.1%)	Default	-
Shows the internal torque feedback of the servo drive. The value 100.0% corresponds to the rated motor torque.										

Index 60F4h	Name	Following error actual value			Setting Condition & Effective Time	At display	Data Structure	VAR	Data Type	INT32
	Access	RO	Mapping	TPDO	Related Mode	PP HM CSP	Value Range	(unit: position unit)	Default	-
Shows the position deviation (position unit).										

7.3.6 Function Block Diagram



7.4 Cyclic Synchronous Velocity (CSV) Mode

In this mode, the host controller sends the target speed to the servo drive using cyclic synchronization. Speed control and torque control are performed by the servo drive.

7.4.1 Configuration Block Diagram

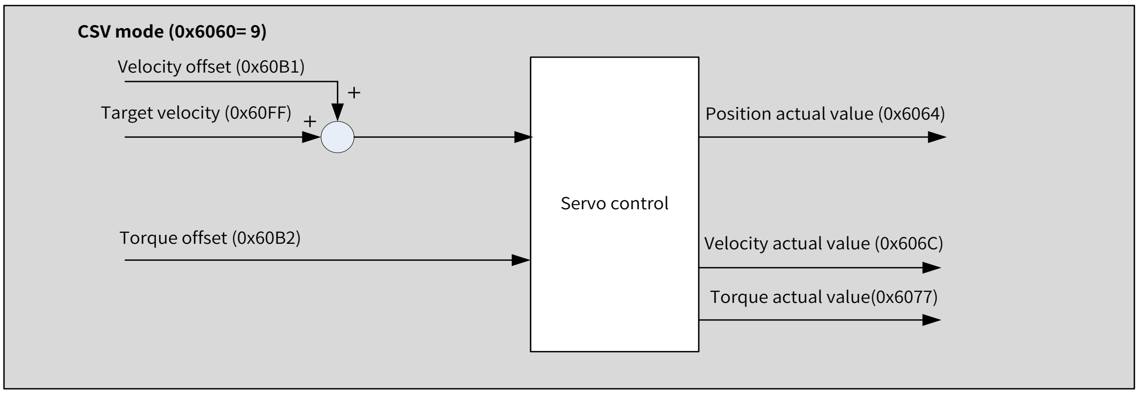


Figure 7-4 CSV mode

7.4.2 Related Objects

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
6040	00	Control word	RW	UINT16	-	0 to 65535	0
6041	00	Status word	RO	UINT16	-	-	0
6060	00	Modes of operation	RW	INT8	-	0 to 10	0
6061	00	Modes of operation display	RO	INT8	-	-	0
6064	00	Position actual value	RO	INT32	Position unit	-	-
606C	00	Velocity actual value	RO	INT32	Velocity unit/s	-	-
60B1	00	Velocity offset	RW	INT32	Velocity unit/s	-2^{31} to $+(2^{31}-1)$	0
60B2	00	Torque offset	RW	INT16	0.1%	–3000 to +3000	0
60FF	00	Target velocity	RW	INT32	Velocity unit/s	-2^{31} to $+(2^{31}-1)$	0

7.4.3 Related Function Settings

1 Velocity reference polarity

You can change the velocity reference direction through setting the velocity reference polarity.

☆ Related parameters

Index 607Eh	Name	Polarity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint8
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 255	Default	0

Defines the polarity of the position, speed, and torque reference.

Bit	Description
6	Velocity reference polarity 0: Multiply by 1 1: Multiply by -1 CSP: Invert the velocity offset 60B1h CSV: Invert the speed reference (60FFh + 60B1h)

7.4.4 Recommended Configuration

The basic configuration of the CSV mode is described in the following table.

RPDO	TPDO	Description
6040: Control word	6041:Status word	Mandatory
60FF: Target velocity		Mandatory
	6064: Position actual value	Optional
	606C: Velocity actual value	Optional
6060: Modes of operation	6061: Modes of operation display	Optional

7.4.5 Related Parameters

Index 6040h	Name	Control word			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 65535	Default	0

Defines the control command.

bit	Name	Description
0	Switch on	1: Valid, 0: Invalid
1	Enable voltage	1: Valid, 0: Invalid
2	Quick stop	0: Valid, 1: Invalid
3	Enable operation	1: Valid, 0: Invalid

Index 6041h	Name	Status word			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	-	Default	0

Shows the servo drive status.

bit	Name	Description
0	Ready to switch on	1: Valid, 0: Invalid
1	Switch on	1: Valid, 0: Invalid
2	Operation enabled	1: Valid, 0: Invalid
3	Fault	1: Valid, 0: Invalid
4	Voltage enabled	1: Valid, 0: Invalid
5	Quick stop	0: Valid, 1: Invalid
6	Switch on disabled	1: Valid, 0: Invalid
7	Warning	1: Valid, 0: Invalid
8	Manufacturer-specific	Undefined
9	Remote	1: Valid, control word activated 0: Invalid
10	Target reach	Not supported, always being 1
11	Internal limit active	0: Position feedback within the limit 1: Position feedback over the limit
12	Drive follow the command value	Not supported, always being 1
13	Following error	Not supported, always being 0
14	Manufacturer-specific	Undefined
15	Home find	0: Homing not completed 1: Homing completed

Index 60B1h	Name	Velocity offset			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	int32
	Access	RW	Mapping	RPDO	Related Mode	CSP/CSV	Value Range	-2^{31} to $+(2^{31}-1)$ (velocity unit/s)	Default	0

Defines the speed reference offset in CSV mode. After setting the velocity offset, the following formula applies:

Target speed = 60FFh + 60B1h

Index 60B2h	Name	Torque offset			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	int16
	Access	RW	Mapping	RPDO	Related Mode	CSP/CSV/CST	Value Range	–3000 to +3000 (0.1%)	Default	0

Defines the external torque feedforward signal of the EtherCAT in CSV mode (activated when 2006-0Ch is set to 2).

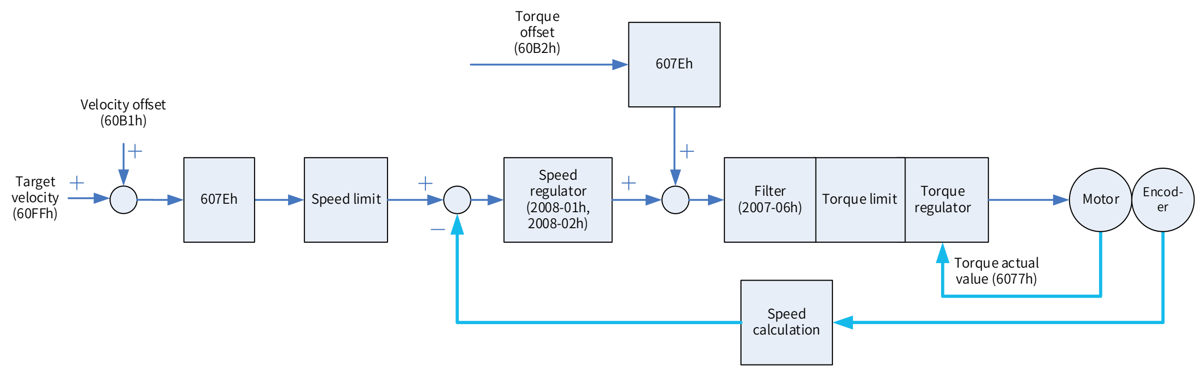
<table>
<tr><td rowspan="2">Index 6064h</td><td>Name</td><td colspan="3">Position actual value</td><td>Setting Condition & Effective Time</td><td>At display</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int32</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>- (unit: position unit)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Represents the absolute position feedback (position unit).
In the case of an absolute encoder used in the rotary mode, 6064h represents the single-turn position feedback (position unit) of the mechanical load.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 606Ch</td><td>Name</td><td colspan="3">Velocity actual value</td><td>Setting Condition & Effective Time</td><td>At display</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int 32</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>(unit: velocity unit/s)</td><td>Default</td><td>-</td></tr>
<tr><td colspan="11">Represents the speed feedback value (velocity unit/s).</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 6077h</td><td>Name</td><td colspan="3">Torque actual value</td><td>Setting Condition & Effective Time</td><td>At display</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int16</td></tr>
<tr><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>(0.1%)</td><td>Default</td><td>-</td></tr>
<tr><td colspan="11">Represents the internal torque feedback of the servo drive.
The value 100.0% corresponds to the rated motor torque.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 60FFh</td><td>Name</td><td colspan="3">Target velocity</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>YES</td><td>Related Mode</td><td>PV/CSV</td><td>Value Range</td><td>-2^{31} to $+(2^{31}-1)$ (Velocity unit/s)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the target speed in PV and CSV modes.
The maximum running speed of the motor in CSV mode is determined by the maximum motor speed.</td></tr>
</table>

7.4.6 Function Block Diagram



7.5 Cyclic Synchronous Torque Mode (CST)

In this mode, the host controller sends the target torque to the servo drive using cyclic synchronization. Torque control is performed by the servo drive.

7.5.1 Configuration Block Diagram

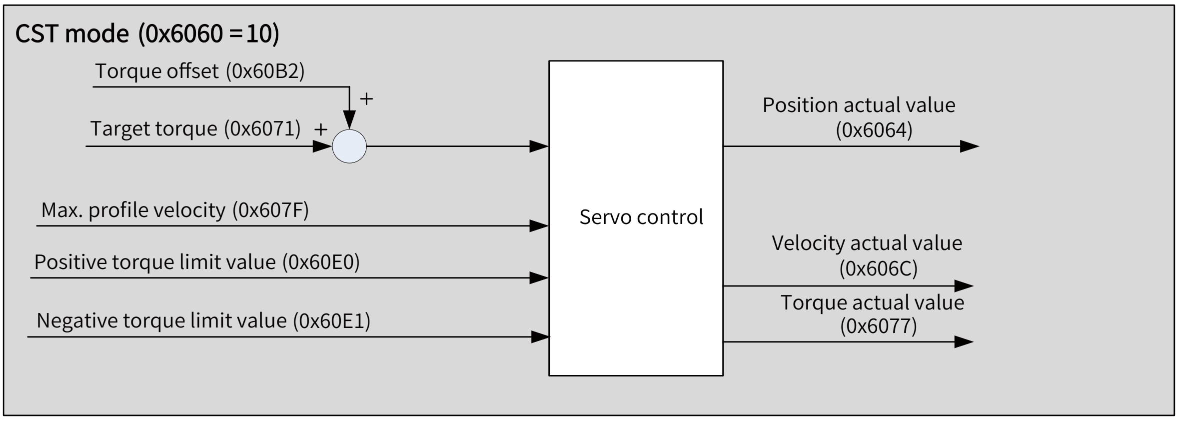


Figure 7-5 SCT mode

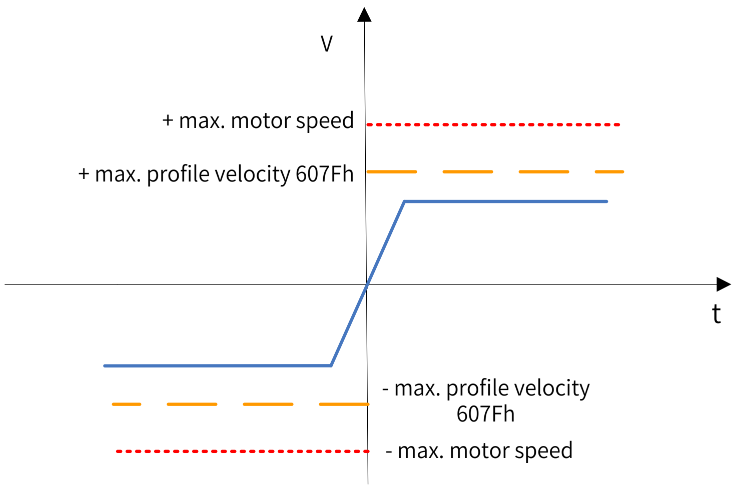
7.5.2 Related Objects

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
6040	00	Control word	RW	UINT16	-	0 to 65535	0
6041	00	Status word	RO	UINT16	-	-	0
6060	00	Modes of operation	RW	INT8	-	0 to 10	0
6061	00	Modes of operation display	RO	INT8	-	-	0
6071	00	Target torque	RW	INT16	0.1%	–3000 to +3000	0
6072	00	Max torque	RW	UINT16	0.1%	0 to 3000	3000
6074	00	Torque demand value	RO	INT16	0.1%	–3000 to +3000	0
6077	00	Torque actual value	RO	INT16	0.1%	–3000 to +3000	0
607F	00	Max profile velocity	RW	UINT32	Velocity unit/s	0 to (2^{32}–1)	104857600
60B2	00	Torque offset	RW	INT16	0.1%	–3000 to +3000	0
60E0	00	Positive torque limit value	RW	UINT16	0.1%	0 to 3000	3000
60E1	00	Negative torque limit value	RW	UINT16	0.1%	0 to 3000	3000

7.5.3 Related Function Settings

1 Speed Limit in the torque control mode

In the torque control mode, 607Fh can be used to limit the maximum speed in forward/reverse running. Note that the maximum speed cannot exceed the maximum running speed allowed by the motor.

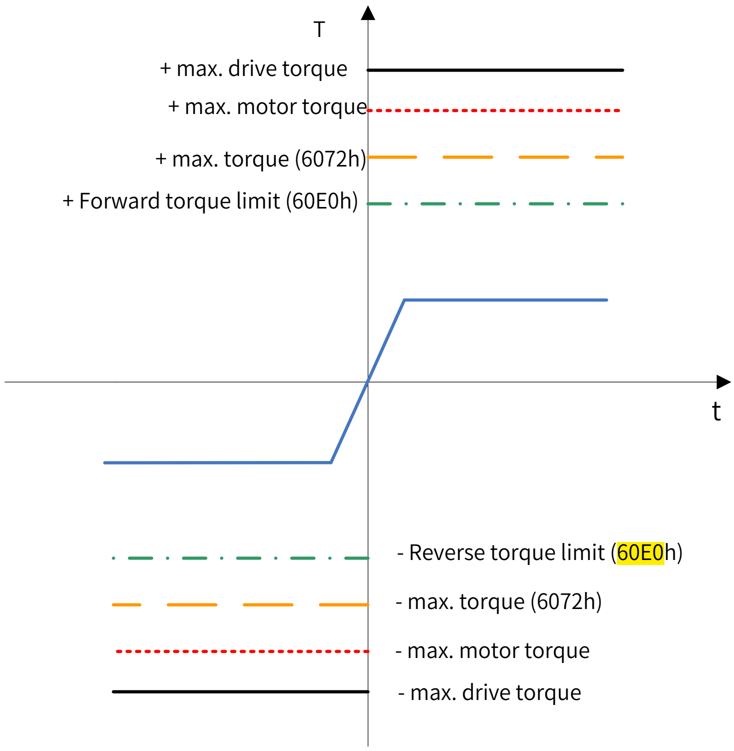


☆ Related parameters

<table>
<tr><td rowspan="2">Index 607Fh</td><td>Name</td><td colspan="3">Max. profile velocity</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>UINT32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PP PV PT HM CST</td><td>Value Range</td><td>0 to (2^{32}–1) (Velocity unit/s)</td><td>Default</td><td>104857600</td></tr>
<tr><td colspan="11">Defines the speed limit in PP, PV, PT, HM and CST modes.</td></tr>
</table>

2 Torque limit

To protect the mechanical devices, you can limit the torque references of the servo drive in the position, speed, and torque control modes by setting 6072h (Max torque), 60E0h (Positive torque limit value), and 60E1h (Negative torque limit value). Note that the maximum torque allowed by the servo drive cannot be exceeded.



☆ Related parameters

Index 6072h	Name	Max. torque value			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 3000 (0.1%)	Default	3000
Defines the maximum torque limit of the servo drive when running in the forward/reverse direction.										

Index 60E0h	Name	Positive torque limit value			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 3000 (0.1%)	Default	3000
Defines the maximum torque limit of the servo drive when running in the forward direction.										

Index 60E1h	Name	Negative torque limit value			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 3000 (0.1%)	Default	3000
Defines the maximum torque limit of the servo drive when running in the reverse direction.										

3 Torque reference polarity

You can change the torque reference direction through setting the torque reference polarity.

<table>
<tr><td rowspan="2">Index
607Eh</td><td>Name</td><td colspan="3">Polarity</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint8</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 255</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the polarity of the position, speed, and torque reference.
<table><tr><td>Bit</td><td>Description</td></tr><tr><td>5</td><td>Torque reference polarity:
0: Multiply by 1
1: Multiply by -1
CSP CSV: Invert torque offset 60B2h
CST: Invert the torque reference (6071h + 60B2h)</td></tr></table></td></tr>
</table>

7.5.4 Recommended Configuration

The basic configuration of cyclic synchronous torque (CST) mode is described in the following table.

RPDO	TPDO	Description
6040: Control word	6041:Status word	Mandatory
6071: Target torque		Mandatory
	6064: Position actual value	Optional
	606C: Velocity actual value	Optional
	6077: Torque actual value	Optional
6060: Modes of operation	6061: Modes of operation display	Optional

7.5.5 Related Parameters

<table>
<tr><td rowspan="2">Index
6040h</td><td>Name</td><td colspan="3">Control word</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 65535</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the control command.
<table><tr><td>bit</td><td>Name</td><td>Description</td></tr><tr><td>0</td><td>Switch on</td><td>1: Valid, 0: Invalid</td></tr><tr><td>1</td><td>Enable voltage</td><td>1: Valid, 0: Invalid</td></tr><tr><td>2</td><td>Quick stop</td><td>0: Valid, 1: Invalid</td></tr><tr><td>3</td><td>Enable operation</td><td>1: Valid, 0: Invalid</td></tr></table></td></tr>
</table>

Index 6041h	Name	Status word			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	-	Default	0
Shows the servo drive status.										

bit	Name	Description
0	Ready to switch on	1: Valid, 0: Invalid
1	Switch on	1: Valid, 0: Invalid
2	Operation enabled	1: Valid, 0: Invalid
3	Fault	1: Valid, 0: Invalid
4	Voltage enabled	1: Valid, 0: Invalid
5	Quick stop	0: Valid, 1: Invalid
6	Switch on disabled	1: Valid, 0: Invalid
7	Warning	1: Valid, 0: Invalid
8	Manufacturer-specific	Undefined
9	Remote	1: Valid, control word activated 0: Invalid
10	Target reach	Not supported, always being 1
11	Internal limit active	0: Position feedback within the limit 1: Position feedback over the limit
12	Drive follow the command value	Not supported, always being 1
13	Following error	Not supported, always being 0
14	Manufacturer-specific	Undefined
15	Home find	0: Homing not completed 1: Homing completed

Index 6071h	Name	Target torque			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	int16
	Access	RW	Mapping	RPDO	Related Mode	PT/CST	Value Range	–3000 to +3000 (0.1%)	Default	0

Defines the target torque in PT and CST modes.

The value 100.0% corresponds to the rated motor torque.

Index 6074h	Name	Torque demand value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	int16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (0.1%)	Default	-

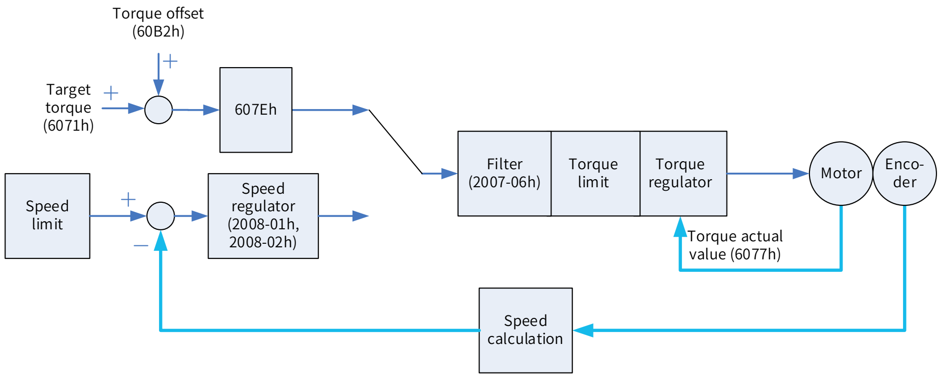
Shows the torque reference output value during running.

The value 100.0% corresponds to the rated motor torque.

Index 6077h	Name	Torque actual value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	int16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (0.1%)	Default	-
Shows the actual torque output of the servo drive. The value 100.0% corresponds to the rated motor torque.										

Index 60B2h	Name	Torque offset			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	int16
	Access	RW	Mapping	RPDO	Related Mode	CSP/CSV/CST	Value Range	–3000 to +3000 (0.1%)	Default	0
Defines the torque offset in CST mode. After offset, the following formula applies: Target torque = 6071h + 60B2h										

7.5.6 Function Block Diagram



7.6 Profile Position (PP) Mode

The PP mode mainly applies to point-to-point positioning. In PP mode, the host controller defines the target position, running speed, increasing deceleration, and deceleration. The position profile generator inside the servo drive generates the position curve based on settings. The servo drive executes position control, speed control, and torque control.

7.6.1 Configuration Block Diagram

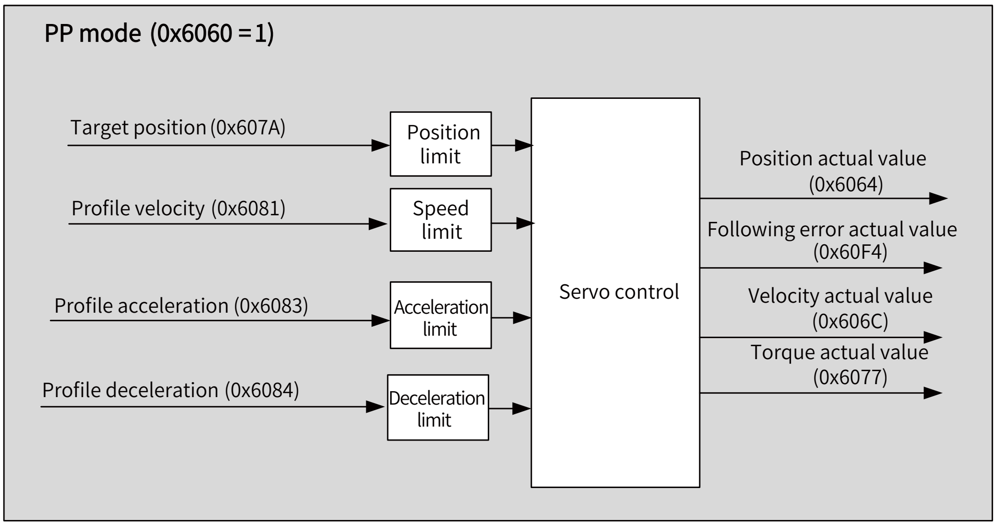
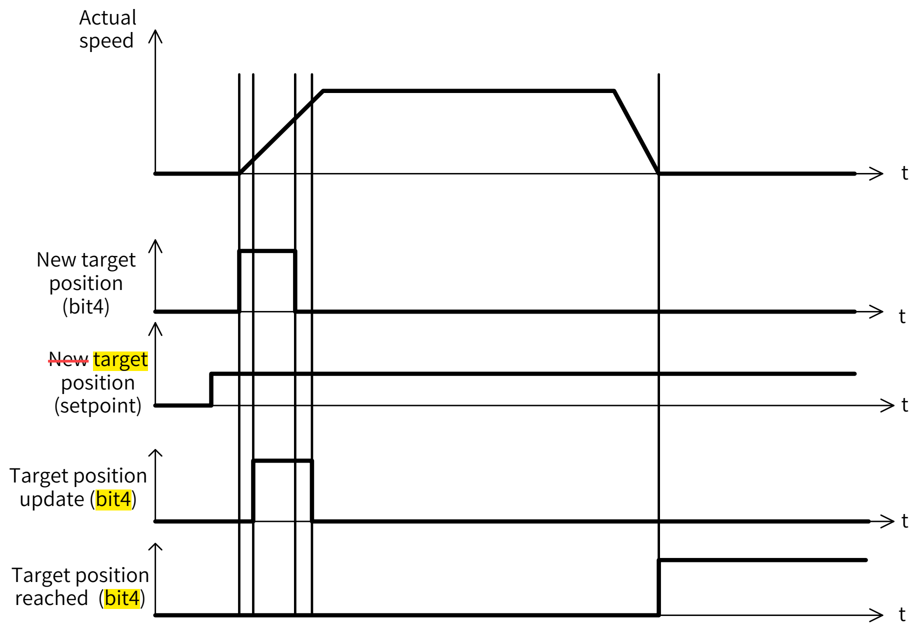


Figure 7-6 PP mode

In PP mode, the target position is triggered and activated based on the time sequence of bit4 of the control word (New set-point) and bit12 of the status word (Set-point acknowledge).

The controller sets the New set-point bit to 1 to inform the servo drive of the new target position. The servo drive, after receiving the new target position, sets the Set-point acknowledge to 1. After the controller sets the New set-point to 0 again, if the servo drive can receive the new target position, the Set-point acknowledge bit will be set to 0. Otherwise, it is kept to 1.



The linkage mode of the position reference is determined by bit5 (Change set immediately) of the control word. When bit5 is set to 1, sequential linkage applies between position references. When bit5 is set to 0, linkage applies between position references after passing zero~~, which is called single-point mode~~.

1 Sequential mode:

The target position of present segment is in the process of positioning. After the new target position is generated, the controller sets the New set-point bit to 1, and the servo drive performs positioning based on the new target position.

In sequential mode, the time sequence of bit4 of the control word (New set-point) and bit12 of the status word (Set-point acknowledge) is as follows.

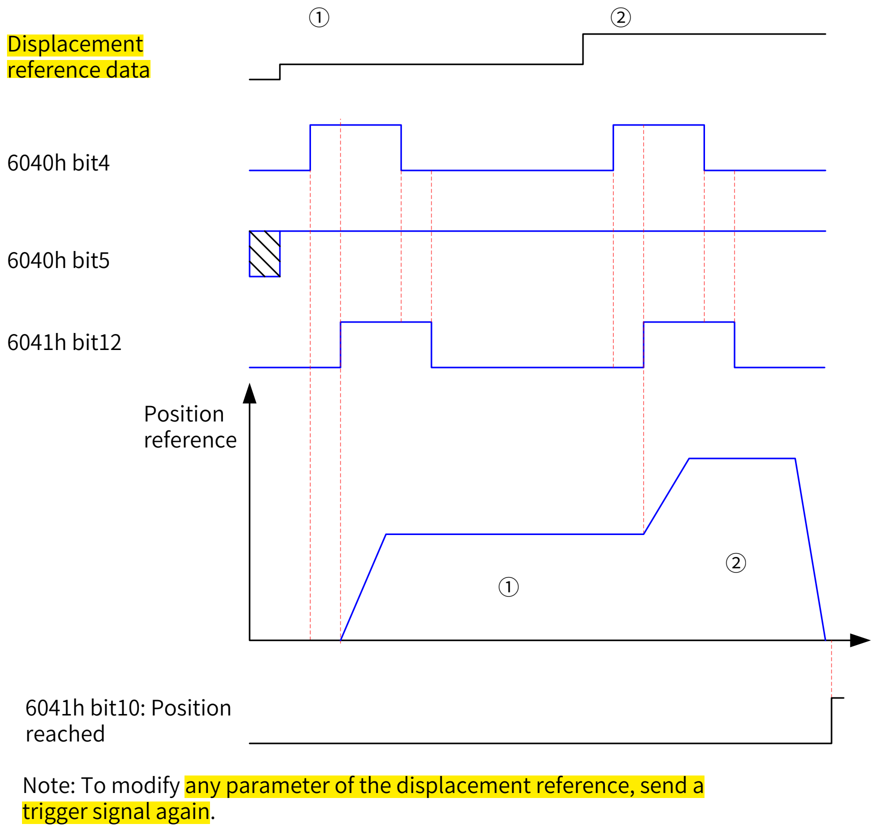
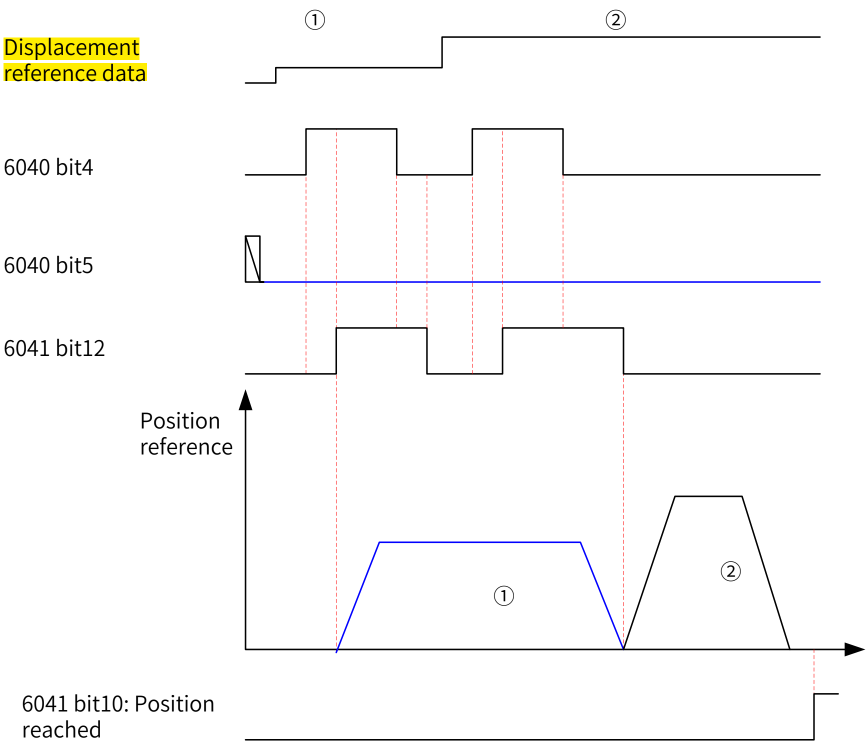


Figure 7-7 Time sequence in sequential mode

2 Single-point mode:

The target position of present segment is in the process of positioning. After the new target position is generated, the controller sets the New set-point bit to 1, and the servo drive performs positioning based on the new target position after the position reference of present segment is transmitted.

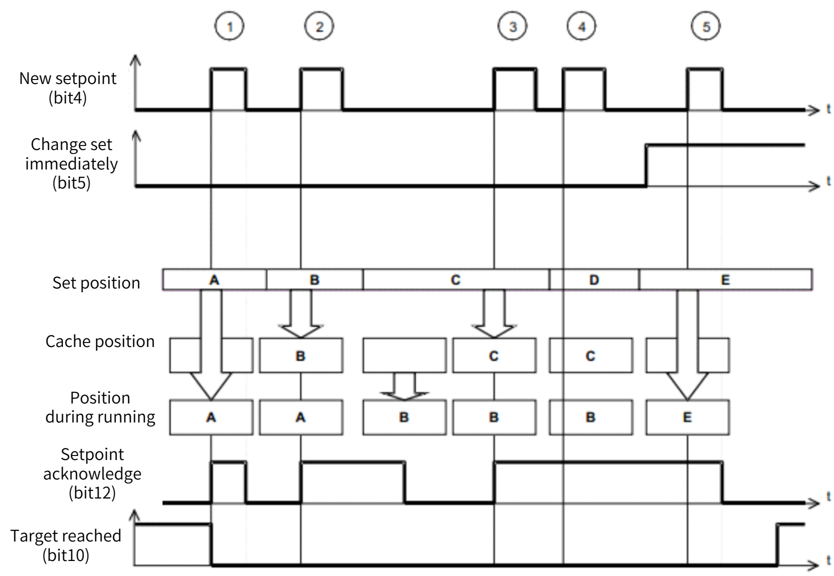
The time sequence of bit4 of the control word (New set-point) and bit12 of the status word (Set-point acknowledge) is as follows.



Note: To modify any parameter of the displacement reference, send a trigger signal again.

Figure 7-8 Time sequence in the single-point mode

In the single-point mode, the servo drive supports cache of one target position, which means the servo drive can cache a new segment of target position when the present target position is running. The time sequence is as follows.



① : If the cache position is empty, the set position will be executed immediately.

②③ : If the present position reference is running, the new set position will be stored in the cache. After present position reference is transmitted, the cache value starts running. After the cache is empty, a new set value can be received.

④⑤ : The new setpoint cannot be received if the cache is full. In this case, you can set the attribute bit (Change set immediately) of the setpoint to 1 to activate the setpoint.

7.6.2 Related Objects

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
6040	00	Control word	RW	UINT16	-	0 to 65535	0
6041	00	Status word	RO	UINT16	-	-	0
6060	00	Modes of operation	RW	INT8	-	0 to 10	0
6061	00	Modes of operation display	RO	INT8	-	-	0
6064	00	Position actual value	RO	INT32	Position unit	-	-
607A	00	Target position	RW	INT32	Position unit	-2^{31} to $(2^{31}-1)$	0
6081	00	Profile velocity	RW	UINT32	Velocity unit/s	0 to $(2^{32}-1)$	1747627
6083	00	Profile acceleration	RW	UINT32	Acceleration unit/s^2	0 to $(2^{32}-1)$	1747626667
6084	00	Profile deceleration	RW	UINT32	Acceleration unit/s^2	0 to $(2^{32}-1)$	1747626667
607F	00	Max. profile velocity	RW	UINT32	Velocity unit/s	0 to $(2^{32}-1)$	104857600

7.6.3 Related Function Settings

1 Positioning completed

Positioning completed: When the position deviation fulfills the set condition, the positioning process is done. In this case, the servo drive sets the status word, and the host controller, once receives the signal, confirms that the positioning is done.

☆ Related parameters

<table>
<tr><td rowspan="2">Index 6067h</td><td>Name</td><td colspan="3">Position window</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint 32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PP</td><td>Value Range</td><td>0 to $(2^{32}-1)$ (position unit)</td><td>Default</td><td>734</td></tr>
<tr><td colspan="11">Defines the threshold for position arrival.
When the position deviation is within ±6067h, and the time reaches the value defined by 6068h, the servo drive considers the position is reached and sets bit10 of 6041h to 1.
This flag bit is valid only when the S-ON signal is valid in PP mode.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 6068h</td><td>Name</td><td colspan="3">Position window time</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint 16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PP</td><td>Value Range</td><td>0 to 65535 (ms)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the time window for judging position arrival.</td></tr>
</table>

CAUTION

The position arrival threshold only reflects the threshold of the absolute position deviation value when the positioning completed signal is active. It is unrelated to the positioning accuracy.

2 Position deviation monitoring

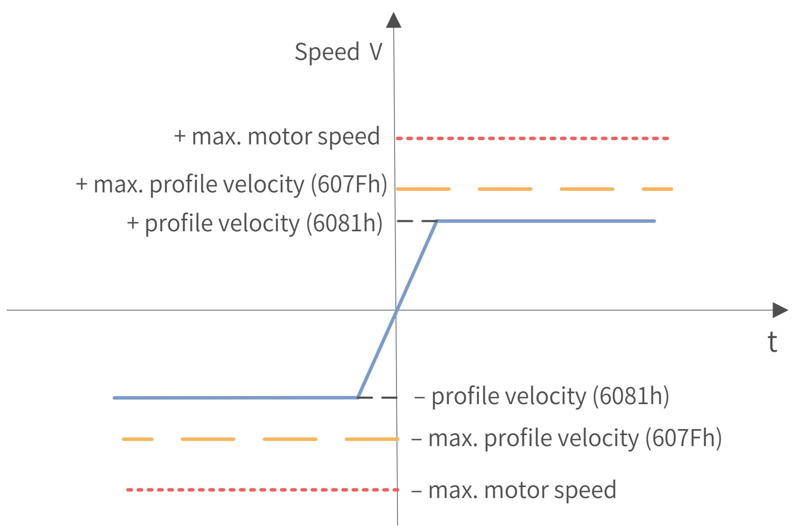
☆ Related parameters

<table>
<tr><td rowspan="2">Index 6065h</td><td>Name</td><td colspan="3">Following error window</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>UINT 32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PP HM CSP</td><td>Value Range</td><td>0 to (2^{32}–1) (position unit)</td><td>Default</td><td>3145728</td></tr>
<tr><td colspan="11">Defines the threshold of excessive position deviation (position unit).
If 6065h is set to a too large value, the warning threshold of excessive position deviation will be 2147483647 encoder units.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 6066h</td><td>Name</td><td colspan="3">Following error time out</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>UINT 16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PP HM CSP</td><td>Value Range</td><td>0 to 65535 (ms)</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the threshold of excessive position deviation (position unit).
If the position deviation exceeds the warning threshold of excessive position deviation and such status persists after the time defined by 6066h elapses, EB00.0 (Excessive position deviation) will occur.</td></tr>
</table>

3 Speed limit

In PP mode, 607Fh can be used to limit the maximum speed in forward/reverse running. Note that the maximum speed cannot exceed the maximum running speed allowed by the motor.



☆ Related parameters

Index 607Fh	Name	Max. profile velocity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	UINT32
	Access	RW	Mapping	RPDO	Related Mode	PP/PV/PT/HM/CST	Value Range	0 to (2^{32}-1) (Velocity unit/s)	Default	104857600
Defines the speed limit in PP, PV, PT, and CST modes.										

4 Acceleration limit

In PP mode, the change rate of the position reference can be limited through the acceleration limit.

☆ Related parameters

Index 60C5h	Name	Max. acceleration			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 4294967295 (acceleration unit/s^2)	Default	2147483647
Defines the maximum limit value of acceleration. In PP mode, if the value of 6083h exceeds that of 60C5h, the value of 60C5h will be used. For 60C5h, the set value 0 will be forcibly changed to 1.										

Index 60C6h	Name	Max. deceleration			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 4294967295 (acceleration unit/s^2)	Default	2147483647
Defines the maximum limit value of deceleration. In PP mode, if the value of 6084h exceeds that of 60C6h, the value of 60C6h will be used. For 60C6h, the set value 0 will be forcibly changed to 1.										

5 Polarity

You can change the position reference direction through setting the position reference polarity.

☆ Related parameters:

Index 607Eh	Name	Polarity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint8
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 255	Default	0

Defines the polarity of the position, speed, and torque reference.

Bit	Description
7	Position reference polarity 0: Multiply by 1 1: Multiply by -1 PP: Invert the target position 607Ah

7.6.4 Recommended Configuration

The basic configuration for PP mode is described in the following table.

RPDO	TPDO	Description
6040: Control word	6041:Status word	Mandatory
607A: Target velocity	6064: Position actual value	Mandatory
6081: Profile velocity	-	Mandatory
6083: Profile acceleration	-	Optional
6084: Profile deceleration	-	Optional
6060: Modes of operation	6061: Modes of operation display	Optional

7.6.5 Related Parameters

<table>
<tr><td rowspan="2">Index 6040h</td><td>Name</td><td colspan="3">Control word</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 65535</td><td>Default</td><td>0</td></tr>
</table>

Defines the control commands.

bit	Name	Description
0	Switch on	1: Valid, 0: Invalid
1	Enable voltage	1: Valid, 0: Invalid
2	Quick stop	0: Valid, 1: Invalid
3	Enable operation	1: Valid, 0: Invalid
4	New set-point	0 -> 1: Trigger new target position 1 -> 0: Clear bit12 of the status word
5	Change set immediately	0: Target position cannot be updated immediately 1: Target position can be updated immediately
6	abs/rel	0: Target position being absolute position reference 1: Target position being relative position reference
8	Halt	0: Keep present running state 1: Halt

Index 6041h	Name	Status word			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	-	Default	0

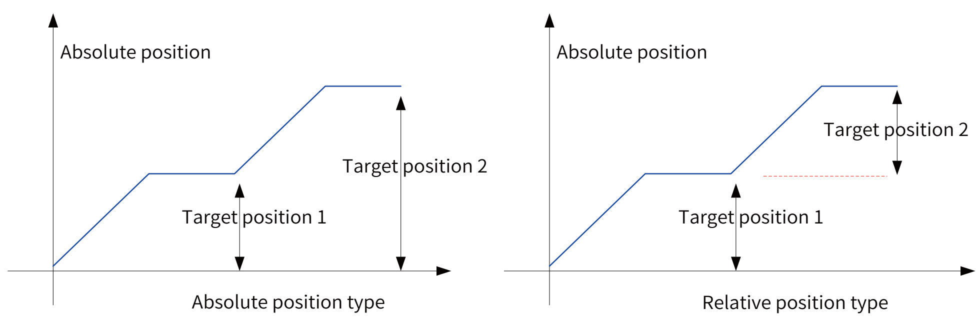
Shows the servo drive status.

bit	Name	Description
0	Ready to switch on	1: Valid, 0: Invalid
1	Switch on	1: Valid, 0: Invalid
2	Operation enabled	1: Valid, 0: Invalid
3	Fault	1: Valid, 0: Invalid
4	Voltage enabled	1: Valid, 0: Invalid
5	Quick stop	0: Valid, 1: Invalid
6	Switch on disabled	1: Valid, 0: Invalid
7	Warning	1: Valid, 0: Invalid
8	Manufacturer-specific	Undefined
9	Remote	1: Valid, control word activated 0: Invalid
10	Target reached	0: Target position not reached 1: Target position reached
11	Internal limit active	0: Position reference within the limit 1: Position reference over the limit
12	Set-point acknowledge	0: Set-point can be updated 1: Set-point cannot be updated
13	Following error	0: EB00.0 (Excessive position deviation) not reported 1: EB00.0 (Excessive position deviation) reported
14	Manufacturer-specific	Undefined
15	Home find	0: Homing not completed 1: Homing completed

Index 607Ah	Name	Target position			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	int32
	Access	RW	Mapping	RPDO	Related Mode	PP CSP	Value Range	-2^{31} to $+(2^{31}-1)$ (position unit)	Default	0

Defines the target position of the servo drive in PP mode.

The target position type (absolute or relative) can be designated through bit6 of 6040h in PP mode.

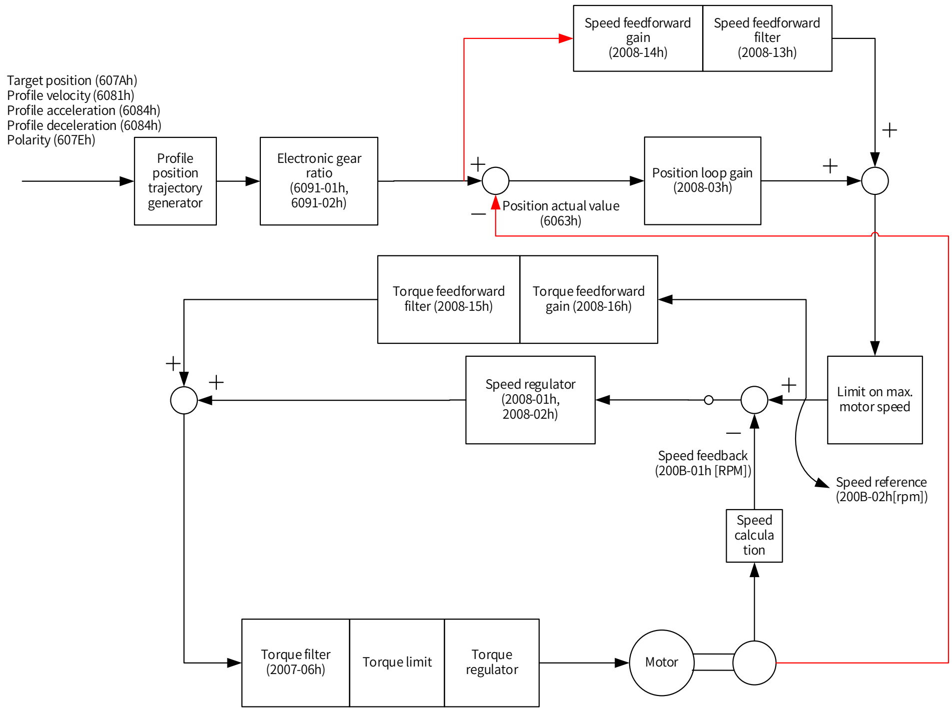


<table>
<tr><td rowspan="2">Index 6081h</td><td>Name</td><td colspan="3">Profile velocity</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>UINT32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PP</td><td>Value Range</td><td>0 to (2^{32}-1) (velocity unit/s)</td><td>Default</td><td>174762</td></tr>
<tr><td colspan="11">Defines the constant running speed for the target position in PP mode.
$$\text{Motor speed (RPM)} = \frac{\text{6081h x 6091h (Gear ratio)}}{\text{Encoder resolution}} \times 60$$</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 6083h</td><td>Name</td><td colspan="3">Profile acceleration</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>UINT32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PP PV</td><td>Value Range</td><td>0 to (2^{32}-1) (acceleration unit/s^2)</td><td>Default</td><td>17476266667</td></tr>
<tr><td colspan="11">Defines the position reference acceleration in PP mode.
In PP mode, if the value of 6083h exceeds that of 60C5h, the value of 60C5h will be used.
For 6083h, the set value 0 will be forcibly changed to 1.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index 6084h</td><td>Name</td><td colspan="3">Profile deceleration</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>UINT32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PP PV</td><td>Value Range</td><td>0 to (2^{32}-1) (acceleration unit/s^2)</td><td>Default</td><td>17476266667</td></tr>
<tr><td colspan="11">Defines the position reference deceleration in PP mode.
In PP mode, if the value of 6084h exceeds that of 60C6h, the value of 60C6h will be used.
For 6084h, the set value 0 will be forcibly changed into 1.</td></tr>
</table>

7.6.6 Function Block Diagram



7.7 Profile Velocity Mode (PV)

In PV mode, the host controller sends the target speed, acceleration, and deceleration commands to the servo drive. The servo drive generates the speed reference curve and executes speed control and torque control.

7.7.1 Configuration Block Diagram

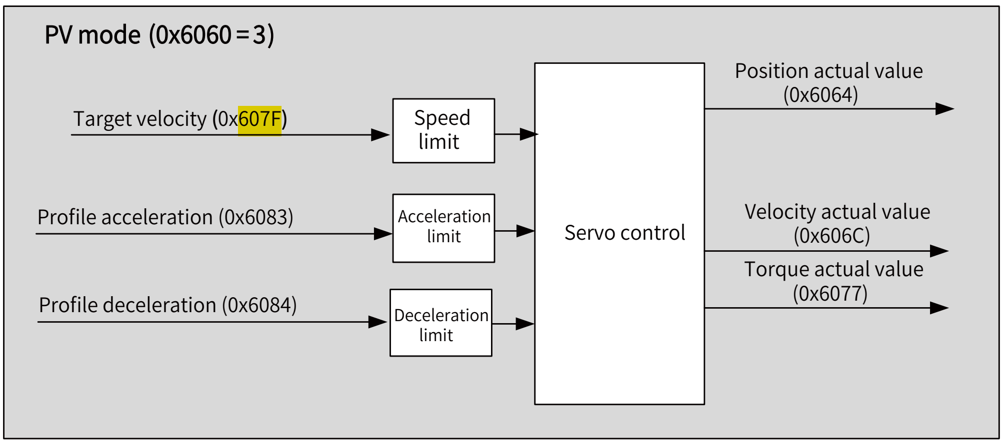


Figure 7-9 PV mode

7.7.2 Related Objects

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
6040	00	Control word	RW	UINT16	-	0 to 65535	0
6041	00	Status word	RO	UINT16	-	-	0
6060	00	Modes of operation	RW	INT8	-	0 to 10	0

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
6061	00	Modes of operation display	RO	INT8	-	-	0
606C	00	Velocity actual value	RO	INT32	Velocity unit/s	-	-
606D	00	Velocity window	RW	UINT16	RPM	0 to 65535	10
606E	00	Velocity window time	RW	UINT16	ms	0 to 65535	0
606F	00	Velocity threshold	RW	UINT16	RPM	0 to 0xFFFF	10
6070	00	Velocity threshold time	RW	UINT16	ms	0 to 65535	0
607F	00	Max. profile velocity	RW	UINT32	Velocity unit/s	0 to (2^{32}-1)	104857600
6083	00	Profile acceleration	RW	UINT32	Acceleration unit/s^2	0 to (2^{32}-1)	1747626667
6084	00	Profile deceleration	RW	UINT32	Acceleration unit/s^2	0 to (2^{32}-1)	1747626667
60FF	00	Target velocity	RW	INT32	Velocity unit/s	-2^{31} to $+(2^{31}-1)$	0

7.7.3 Related Function Settings

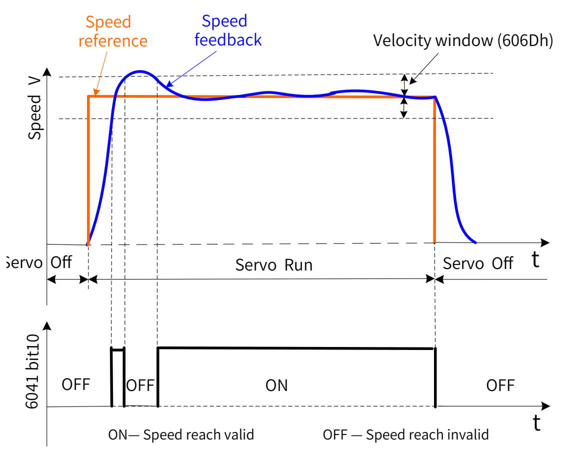
1 Speed arrival monitoring

Speed arrival monitoring is used to confirm whether the speed reference of the servo drive matches the speed feedback of the motor.

☆ Related parameters

<table>
<tr><td rowspan="2">Index 606Dh</td><td>Name</td><td colspan="3">Velocity window</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint 16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PV</td><td>Value Range</td><td>0 to 65535 (RPM)</td><td>Default</td><td>10</td></tr>
<tr><td rowspan="2">Index 606Eh</td><td>Name</td><td colspan="3">Velocity window time</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint 16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>PV</td><td>Value Range</td><td>0 to 65535 (ms)</td><td>Default</td><td>0</td></tr>
</table>

606Dh is used to set the threshold for speed arrival. 606Eh is used to set the window time for speed arrival.



If the difference value between the speed reference and speed feedback is within ±606D and the time reaches the value defined by 606E, the speed is reached, and bit10 (target reached) of 6041h is set to 1.

This flag bit is valid only when the servo drive is enabled in PV mode.

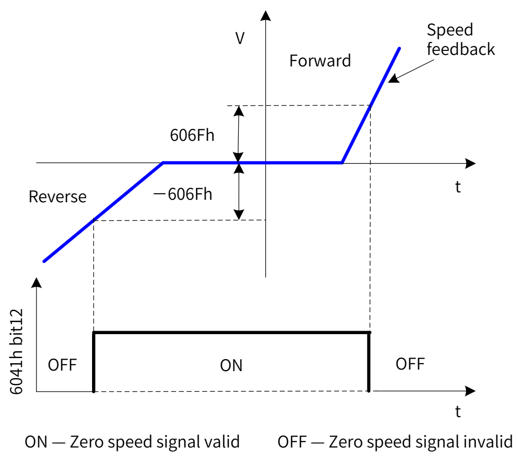
2 Zero speed monitoring

Zero speed monitoring is used to confirm whether the absolute value of motor speed feedback is less than the set threshold. If yes, the motor is approaching static state (zero speed).

☆ Related parameters

Index 606Fh	Name	Velocity threshold			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint 16
	Access	RW	Mapping	RPDO	Related Mode	PV	Value Range	0 to 65535 (RPM)	Default	10
Index 6070h	Name	Velocity threshold time			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint 16
	Access	RW	Mapping	RPDO	Related Mode	PV	Value Range	0 to 65535 (ms)	Default	0

Defines the threshold for zero speed.

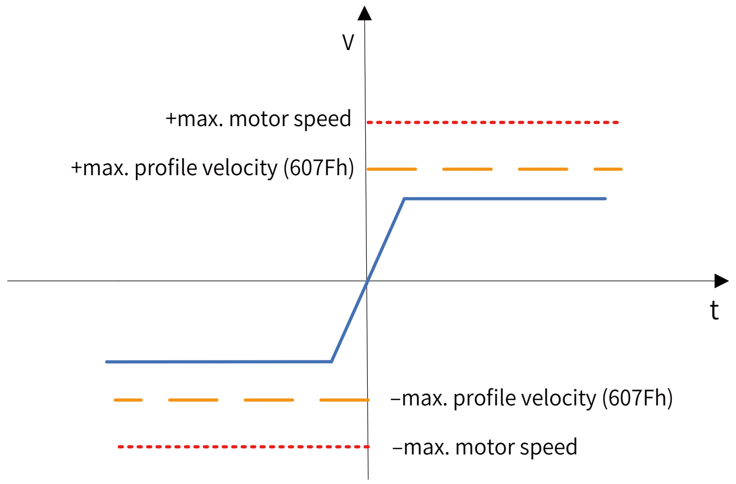


When the speed feedback is within ±606F and the time defined by 6070 is reached, ~~it indicates the motor speed is 0, and~~ bit12 of 6041 is set to 1.

This flag bit is valid only in PV mode.

3 Speed limit

In PV mode, 607Fh can be used to limit the maximum speed in forward/reverse running. Note that the maximum speed cannot exceed the maximum running speed allowed by the motor.



☆ Related parameters

Index 607Fh	Name	Max profile velocity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	UINT32
	Access	RW	Mapping	RPDO	Related Mode	PP PV PT HM CST	Value Range	0 to (2^{32}-1) (Velocity unit/s)	Default	104857600
Defines the speed limit in PP, PV, PT, and torque control modes.										

4 Acceleration limit

In PV mode, the change rate of the speed reference can be limited through acceleration limit.

Index 60C5h	Name	Max. acceleration			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 4294967295 (acceleration unit/s^2)	Default	2147483647
Defines the maximum limit value of acceleration. In PP mode, if the value of 6083h exceeds that of 60C5h, the value of 60C5h will be used. For 60C5h, the set value 0 will be forcibly changed to 1.										

Index 60C6h	Name	Max deceleration			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 4294967295 (acceleration unit/s^2)	Default	2147483647
Defines the maximum limit value of deceleration. In PP mode, if the value of 6084h exceeds that of 60C6h, the value of 60C6h will be used. For 60C6h, the set value 0 will be forcibly changed to 1.										

5 Polarity

You can change the velocity reference direction through setting the velocity reference polarity.

☆ Related parameters

<table>
<tr><td rowspan="3">Index
607Eh</td><td>Name</td><td colspan="3">Polarity</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint8</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 255</td><td>Default</td><td>0</td></tr>
<tr><td colspan="10">Defines the polarity of the position, speed, and torque reference.
<table><tr><th>Bit</th><th>Description</th></tr><tr><td>6</td><td>Velocity reference polarity
0: Multiply by 1
1: Multiply by -1
PV: Invert the target torque 60FFh</td></tr></table></td></tr>
</table>

7.7.4 Recommended Configuration

The basic configuration for PV mode is described in the following table.

RPDO	TPDO	Description
6040: Control word	6041:Status word	Mandatory
60FF: Target Velocity		Mandatory
	6064: Position actual value	Optional
	606C: Velocity actual value	Optional
6083: Profile acceleration		Optional
6084: Profile deceleration		Optional
6060: Modes of operation	6061: Modes of operation display	Optional

7.7.5 Related Parameters

<table>
<tr><td rowspan="3">Index
6040h</td><td>Name</td><td colspan="3">Control word</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 65535</td><td>Default</td><td>0</td></tr>
<tr><td colspan="10">Defines the control command.
<table><tr><th>bit</th><th>Name</th><th>Description</th></tr><tr><td>0</td><td>Switch on</td><td>1: Valid, 0: Invalid</td></tr><tr><td>1</td><td>Enable voltage</td><td>1: Valid, 0: Invalid</td></tr><tr><td>2</td><td>Quick stop</td><td>0: Valid, 1: Invalid</td></tr><tr><td>3</td><td>Enable operation</td><td>1: Valid, 0: Invalid</td></tr><tr><td>8</td><td>Halt</td><td>0: Keep present running state
1: Halt</td></tr></table></td></tr>
</table>

Index 6041h	Name	Status word			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	-	Default	0

Shows the servo drive status.

bit	Name	Description
0	Ready to switch on	1: Valid, 0: Invalid
1	Switch on	1: Valid, 0: Invalid
2	Operation enabled	1: Valid, 0: Invalid
3	Fault	1: Valid, 0: Invalid
4	Voltage enabled	1: Valid, 0: Invalid
5	Quick stop	0: Valid, 1: Invalid
6	Switch on disabled	1: Valid, 0: Invalid
7	Warning	1: Valid, 0: Invalid
8	Manufacturer-specific	Undefined
9	Remote	1: Valid, control word activated 0: Invalid
10	Target reached	0: Target velocity not reached 1: Target velocity reached
11	Internal limit active	0: Position feedback within the limit 1: Position feedback over the limit
12	Speed	0: Speed not being 0 1: Speed being 0
13	N/A	No meaning, always being 0
14	Manufacturer-specific	Undefined
15	Home find	0: Homing not completed 1: Homing completed

Index 60FFh	Name	Target velocity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	int32
	Access	RW	Mapping	Yes	Related Mode	PV CSV	Value Range	-2^{31} to $+(2^{31}-1)$ (velocity unit/s)	Default	0

Defines the target speed in PV and CSV modes.

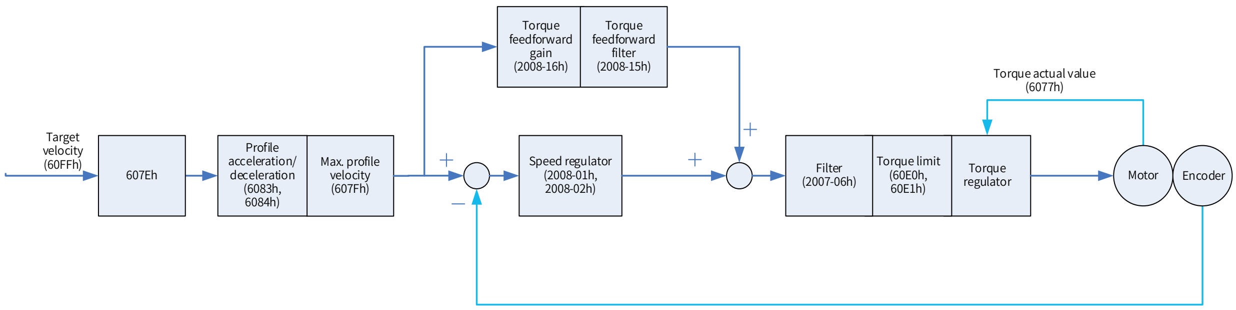
Index 6083h	Name	Profile acceleration			Setting Condition & Effective Time	During running Immediately	Data Structure	VAR	Data Type	UINT32
	Access	RW	Mapping	RPDO	Related Mode	PP PV	Value Range	0 to $(2^{32}-1)$ (acceleration unit/s^2)	Default	17476266667

Defines the speed reference acceleration in PV mode.

For 6083h, the set value 0 will be forcibly changed to 1.

Index 6084h	Name	Profile deceleration			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	UINT32
	Access	RW	Mapping	RPDO	Related Mode	PP/PV	Value Range	0 to (2^{32}-1) (acceleration unit/s^2)	Default	17476266667
Defines the speed reference deceleration in PV mode. For 6084h, the set value 0 will be forcibly changed to 1.										

7.7.6 Function Block Diagram



7.8 Profile Torque Mode (PT)

In PT mode, the host controller sends the target torque defined by 6071h and the torque slope defined by 6087h to the servo drive. The servo drive generates the torque reference curve and executes torque control.

7.8.1 Configuration Block Diagram

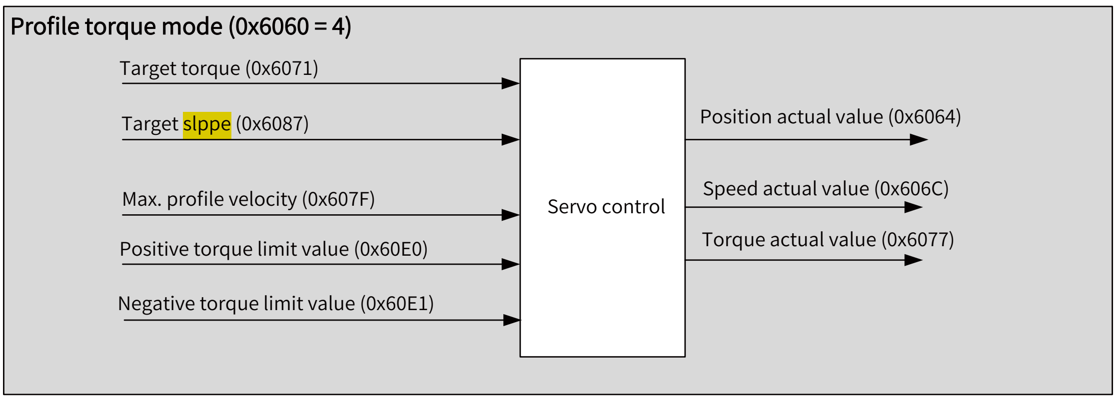


Figure 7-10 PT mode

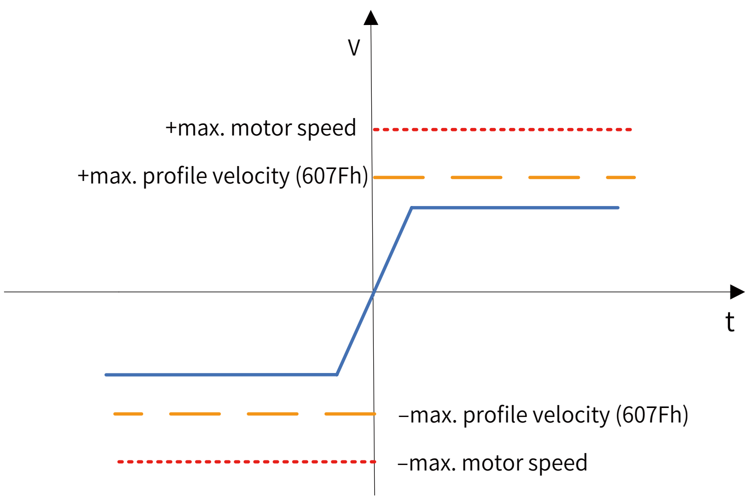
7.8.2 Related Objects

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
6040	00	Control word	RW	UINT16	-	0 to 65535	0
6041	00	Status word	RO	UINT16	-	-	0
6060	00	Modes of operation	RW	INT8	-	-	0
6061	00	Modes of operation display	RO	INT8	-	-	0
6071	00	Target torque	RW	INT16	0.1%	–3000 to +3000	0
6072	00	Max. torque	RW	UINT16	0.1%	0 to 3000	3000
6074	00	Torque demand value	RO	INT16	0.1%	-	-
6077	00	Torque actual value	RO	INT16	0.1%	-	-
6087	00	Torque slope	RW	UINT32	0.1%/s	0 to (2^{32}–1)	2^{32}–1
607F	00	Max. profile velocity	RW	UINT32	Velocity unit/s	0 to (2^{32}–1)	104857600
60E0	00	Positive torque limit value	RW	UINT16	0.1%	0 to 3000	3000
60E1	00	Negative torque limit value	RW	UINT16	0.1%	0 to 3000	3000

7.8.3 Related Function Settings

1 Speed Limit in the torque control mode

In the torque control mode, 607Fh can be used to limit the maximum speed in forward/reverse running. Note that the maximum speed cannot exceed the maximum running speed allowed by the motor.

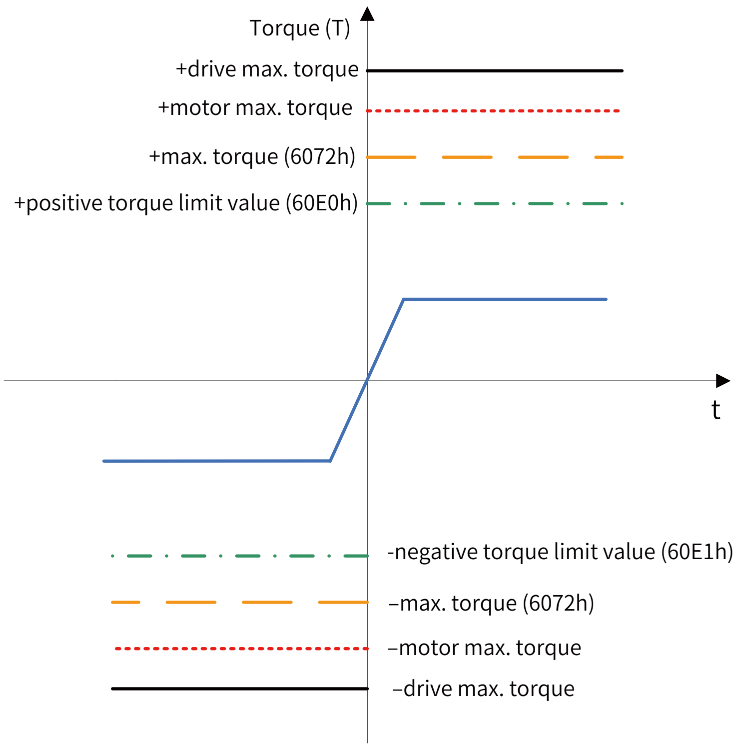


☆ Related parameters

Index 607Fh	Name	Max. profile velocity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	UINT32
	Access	RW	Mapping	RPDO	Related Mode	PP PV PT HM CST	Value Range	0 to (2^{32}-1) (velocity unit/s)	Default	104857600
Defines the speed limit in PP, PV, PT, and CST modes.										

2 Torque limit

To protect the mechanical devices, you can limit the torque references of the servo drive in the position, speed, and torque control modes by setting 6072h (Max. torque), 60E0h (Positive torque limit value), and 60E1h (Negative torque limit value). Note that the maximum torque allowed by the servo drive cannot be exceeded.



☆ Related parameters

Index 6072h	Name	Max. torque			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 3000 (0.1%)	Default	3000
Defines the maximum torque limit of the servo drive when running in the forward/reverse direction.										

<table>
<tr><td rowspan="2">Index
60E0h</td><td>Name</td><td colspan="3">Positive torque limit value</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 3000 (unit: 0.1%)</td><td>Default</td><td>3000</td></tr>
<tr><td colspan="11">Defines the maximum torque limit of the servo drive when running in the forward direction.</td></tr>
</table>

<table>
<tr><td rowspan="2">Index
60E1h</td><td>Name</td><td colspan="3">Negative torque limit value</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 3000 (unit: 0.1%)</td><td>Default</td><td>3000</td></tr>
<tr><td colspan="11">Defines the maximum torque limit of the servo drive when running in the reverse direction.</td></tr>
</table>

3 Torque reference polarity

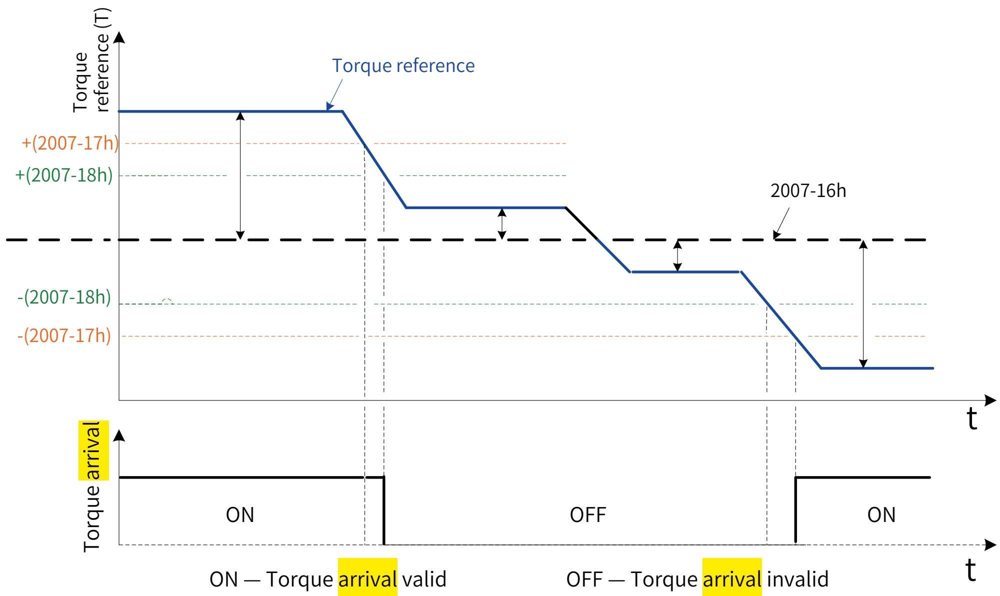
You can change the torque reference direction through setting the torque reference polarity.

☆ Related parameters

<table>
<tr><td rowspan="2">Index
607Eh</td><td>Name</td><td colspan="3">Polarity</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint8</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>0 to 255</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the polarity of the position, speed, and torque reference.
<table><tr><th>Bit</th><th>Description</th></tr><tr><td>5</td><td>Torque reference polarity:
0: Multiply by 1
1: Multiply by -1
CSP CSV: Invert the torque offset 60B2h
CST: Invert the torque reference (6071h + 60B2h)</td></tr></table></td></tr>
</table>

4 Torque arrival monitoring

Torque arrival monitoring is used to determine whether the torque reference value reaches the set torque base value. If yes, a corresponding torque reached signal will be output to the host controller.



If the absolute difference value between the torque reference and 2007-16h (Base value for torque reached) is larger than 2007-17h (Torque output value when torque arrival DO signal turned on), the torque reached signal is valid. Otherwise, the original status applies.

If the absolute difference value between the torque reference and 2007-16h (Base value for torque reached) is smaller than 2007-17h (Threshold of valid torque arrival), the torque reached signal is invalid. Otherwise, the original status applies.

☆ Related parameters:

Sub-index 16h	Name	Base value for torque reached			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PT	Value Range	0 to 300.0 (unit: %)	Default	0

Sub-index 17h	Name	Threshold of torque reached valid			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PT	Value Range	0 to 300.0 (unit: %)	Default	20.0

Sub-index 18h	Name	Threshold of torque reached invalid			Setting Condition & Effective Time	During running & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	PT	Value Range	0 to 300.0 (unit: %)	Default	10.0

7.8.4 Related Parameters

Index 6040h	Name	Control word			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 65535	Default	0

Defines the control command.

bit	Name	Description
0	Switch on	1: Valid, 0: Invalid
1	Enable voltage	1: Valid, 0: Invalid
2	Quick stop	0: Valid, 1: Invalid
3	Enable operation	1: Valid, 0: Invalid
8	Halt	0: Keep present running state 1: Halt

Index 6041h	Name	Status word			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	-	Default	0

Shows the servo drive status.

bit	Name	Description
0	Ready to switch on	1: Valid, 0: Invalid
1	Switch on	1: Valid, 0: Invalid
2	Operation enabled	1: Valid, 0: Invalid
3	Fault	1: Valid, 0: Invalid
4	Voltage enabled	1: Valid, 0: Invalid
5	Quick stop	0: Valid, 1: Invalid
6	Switch on disabled	1: Valid, 0: Invalid
7	Warning	1: Valid, 0: Invalid
8	Manufacturer-specific	Undefined
9	Remote	1: Valid, control word activated 0: Invalid
10	Target reached	0: Target torque not reached 1: Target torque reached
11	Internal limit active	0: Position feedback within the limit 1: Position feedback over the limit
12 to 14	N/A	No meaning, always being 0
15	Home find	0: Homing not completed 1: Homing completed

Index 6071h	Name	Target torque			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	int16
	Access	RW	Mapping	RPDO	Related Mode	PT CST	Value Range	–3000 to +3000 (0.1%)	Default	0

Defines the target torque in PT and CST modes.

The value 100.0% corresponds to the rated motor torque.

Index 6074h	Name	Torque demand value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	int16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (0.1%)	Default	-
Represents the torque reference output value during running. The value 100.0% corresponds to the rated motor torque.										

Index 6077h	Name	Torque actual value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	int16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (0.1%)	Default	-
Represents the actual torque output of the servo drive. The value 100.0% corresponds to the rated motor torque.										

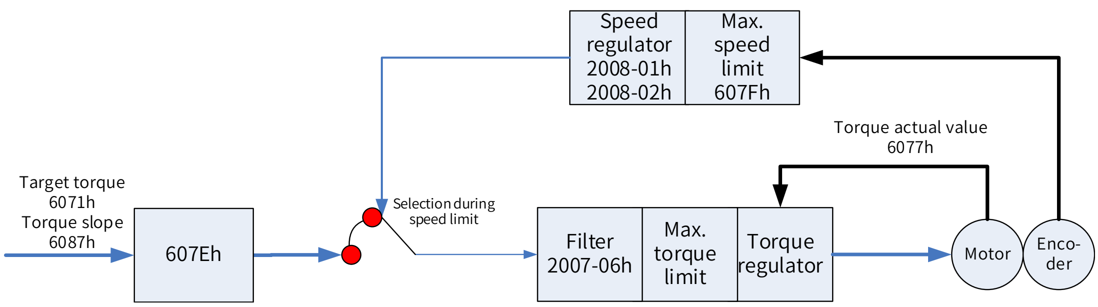
Index 6087h	Name	Torque slope			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	UINT32
	Access	RW	Mapping	RPDO	Related Mode	PT CST	Value Range	0 to (2^{32}–1) (0.1%/s)	Default	2^{32}-1
Defines the acceleration (torque increment per second) of the torque reference in PT mode. For 6087h, the set value 0 will be forcibly changed to 1.										

7.8.5 Recommended Configuration

The basic configuration for the PT mode is described in the following table.

RPDO	TPDO	Description
6040: Control word	6041:Status word	Mandatory
6071: Target torque		Mandatory
6087: Torque slope		Optional
	6064: Position actual value	Optional
	606C: Velocity actual value	Optional
	6077: Torque actual value	Optional
6060: Modes of operation	6061: Modes of operation display	Optional

7.8.6 Function Block Diagram



7.9 Homing Mode (HM)

The homing mode is used to search for the mechanical home and determine the position relation between the mechanical home and mechanical zero.

- Mechanical home: a fixed position on the machine, which can correspond to a certain home switch or a motor Z signal.
- Mechanical zero: absolute zero position on the machine

After homing is done, the motor stops at the mechanical home. The relation between the mechanical home and mechanical zero is defined by 607Ch.

Mechanical home = Mechanical zero + 607Ch (Home offset)

When 607Ch is 0, the mechanical home overlaps with the mechanical zero.

7.9.1 Configuration Block Diagram

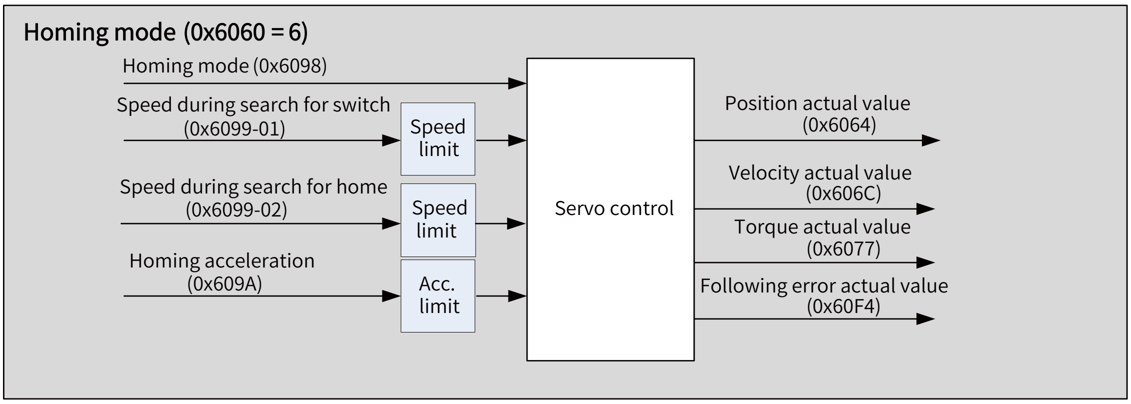


Figure 7-11 HM mode

7.9.2 Related Objects

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
6040	00	Control word	RW	UINT16	-	0 to 65535	0
6041	00	Status word	RO	UINT16	-	-	0
6060	00	Modes of operation	RW	INT8	-	0 to 10	0
6061	00	Modes of operation display	RO	INT8	-	0 to 10	0
6064	00	Position actual value	RO	INT32	Position unit	-	-
6098	00	Homing method	RW	INT8	-	1 to 35	1
6099	01	Speed during search for switch	RW	UINT32	Velocity unit/s	0 to (2^{32}–1)	1747627
	02	Speed during search for zero	RW	UINT32	Velocity unit/s	10 to (2^{32}–1)	174763
609A	00	Homing acceleration	RW	UINT32	Acceleration unit/s^2	0 to (2^{32}–1)	1747626667

Index (hex)	Sub-index (hex)	Name	Access	Data Type	Unit	Value Range	Default
607C	00	Home offset	RW	INT32	Position unit	-2^{31} to $+(2^{31}-1)$	0
2005	24	Timeout	RW	UINT16	10 ms	100 to 65535	50000

7.9.3 Related Function Settings

1 Homing timeout

When the homing duration exceeds the value defined by 2005-24h (Duration limit of homing), the servo drive reports E601.0 (Homing timeout).

E601.0 can be used to determine whether the homing speed, the set acceleration value, and connections of the switch signal and homing signal are proper.

☆ Related parameters

<table>
<tr><td rowspan="2">Index
2005-24h</td><td>Name</td><td colspan="3">Duration limit of homing</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>UINT 16</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>HM</td><td>Value Range</td><td>0 to 65535 (100 ms)</td><td>Default</td><td>50000</td></tr>
<tr><td colspan="11">Defines the duration of homing and used to detect E601.0 (Homing timeout).</td></tr>
</table>

2 Current position calculation method

After homing, the calculation method for the present mechanical position can be defined by 60E6h.

<table>
<tr><td rowspan="2">Index
60E6h</td><td>Name</td><td colspan="3">Actual position calculation method</td><td>Setting Condition & Effective Time</td><td>During running & Immediately</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>Uint8</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>NO</td><td>Related Mode</td><td>HM</td><td>Value Range</td><td>0 to 1</td><td>Default</td><td>0</td></tr>
<tr><td colspan="11">Defines the calculation method for the mechanical position after homing.
<table>
<tr><th>Value</th><th>Actual position calculation method</th></tr>
<tr><td>0</td><td>Absolute position homing
After homing is done, the following formula applies:
6064h (Position actual value) = 607Ch (Home offset)</td></tr>
<tr><td>1</td><td>Relative position homing
After homing is done, the following formula applies:
6064h (Position actual value) = Present position feedback value + 607Ch (Home offset)</td></tr>
</table>
After homing is triggered, the modification of 60E6h will be blocked.</td></tr>
</table>

Index 607Ch	Name	Home offset			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	int32
	Access	RW	Mapping	RPDO	Related Mode	HM	Value Range	-2^{31} to $+(2^{31}-1)$ (position unit)	Default	0
Defines the physical distance between the mechanical zero and the motor home in homing mode. The home offset takes effect on the condition that the homing operation is done upon power-on and bit15 of 6041h is set to 1. The home offset has the following effect: ◆ It determines the present position after homing based on 60E6h. ◆ If 607Ch is set to a value beyond the limit defined by 607Dh (Software position limit), Er.D10 (Improper homing offset setting) will occur.										

3 Position deviation monitoring

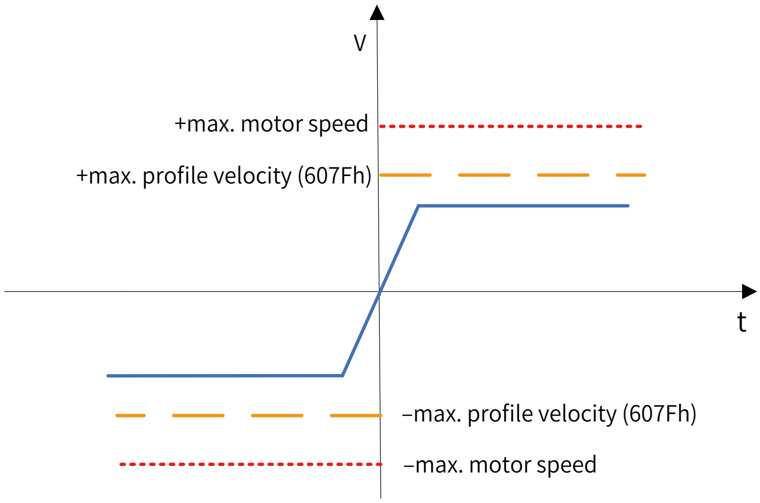
☆ Related parameters

Index 6065h	Name	Following error window			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	UINT 32
	Access	RW	Mapping	RPDO	Related Mode	PP HM CSP	Value Range	0 to $(2^{32}-1)$ (position unit)	Default	3145728
Defines the threshold of excessive position deviation (position unit). For 6065h, a set value beyond 2147483647 will be forcibly changed to 2147483647.										

Index 6066h	Name	Following error time out			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	UINT 16
	Access	RW	Mapping	RPDO	Related Mode	PP HM CSP	Value Range	0 to 65535 (ms)	Default	0
Defines the time threshold of excessive position deviation. When the position deviation (position unit) exceeds ±6065h and such status persists after the time defined by 6066h elapses, EB00.0 (Excessive position deviation) will occur.										

4 Speed limit

In the homing mode, 607Fh can be used to limit the maximum speed in forward/reverse running. Note that the maximum speed cannot exceed the maximum running speed allowed by the motor.



☆ Related parameters

Index 607Fh	Name	Max profile velocity			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	UINT32
	Access	RW	Mapping	RPDO	Related Mode	PP/PV/PT/HM/CST	Value Range	0 to (2^{32}–1) (velocity unit/s)	Default	104857600
Defines the speed limit in PP, PV, PT, HM and CST modes.										

5 Acceleration limit

In the homing mode, the change rate of the position reference can be limited through the acceleration limit.

☆ Related parameters

Index 60C5h	Name	Max. acceleration			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint32
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 4294967295 (acceleration unit/s^2)	Default	2147483647
Defines the maximum limit of acceleration. In the homing mode, if the value of 6083h exceeds that of 60C5h, the value of 60C5h will be used. For 60C5h, the set value 0 will be forcibly changed to 1.										

7.9.4 Homing Operation

■ Homing mode

1) 6098h = 1

Mechanical home: Z signal

Deceleration point: negative limit switch (N-OT)

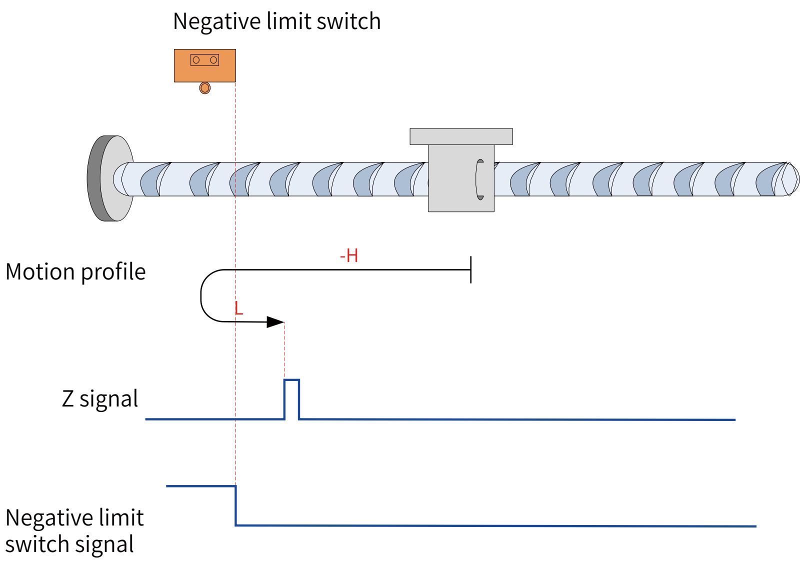


Figure 7-12 N-OT signal inactive at start

Note: In the figure, "H" represents 6099-1h (Speed during search for switch), and "L" represents 6099-2h (Speed during search for zero).

The N-OT signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. After reaching the rising edge of the N-OT signal, the motor decelerates and changes to run in the forward direction at ~~a~~ low speed until it stops at the first Z signal upon reaching the falling edge of the N-OT signal.

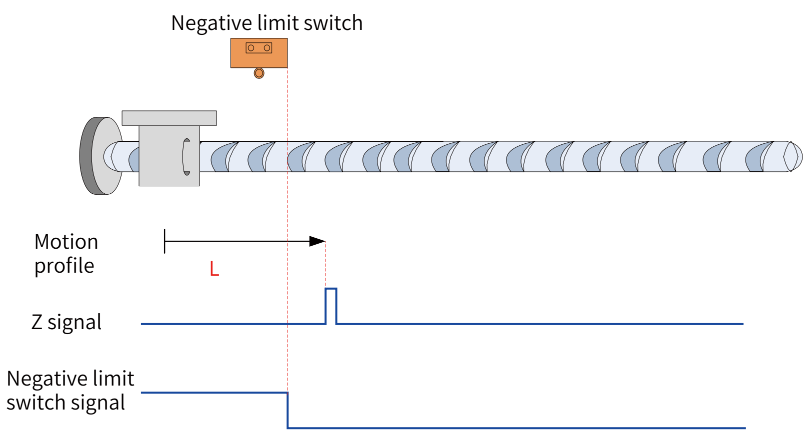


Figure 7-13 N-OT signal active at start

The N-OT signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the N-OT signal, the motor stops at the first Z signal.

2) 6098h = 2

Home: Z signal

Deceleration point: positive limit switch (P-OT)

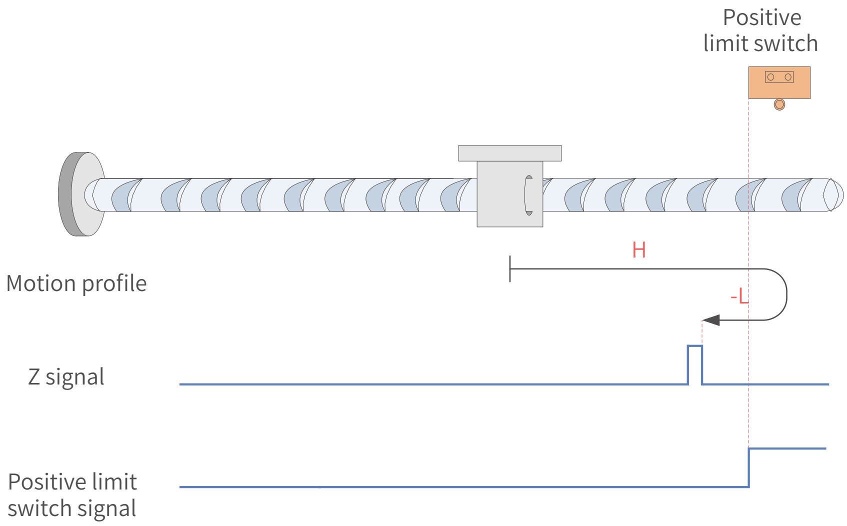


Figure 7-14 P-OT signal inactive at start

The P-OT signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. After reaching the rising edge of the P-OT signal, the motor decelerates and changes to run in the reverse direction at ~~a~~ low speed until it stops at the first Z signal upon reaching the falling edge of the P-OT signal.

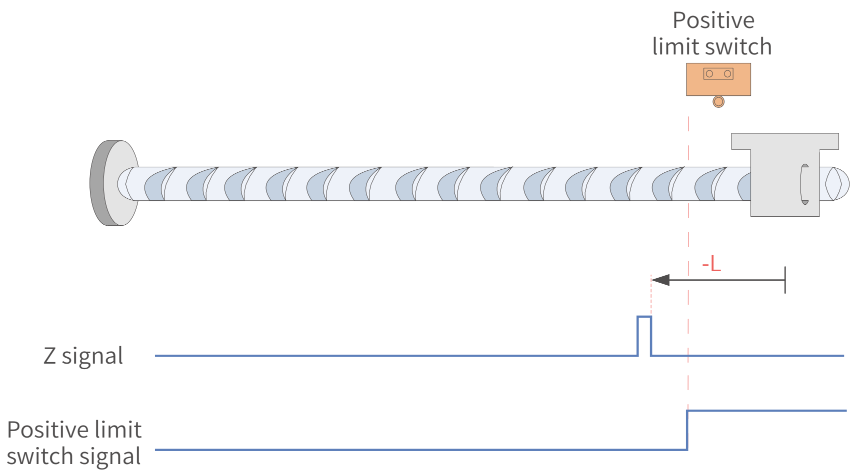


Figure 7-15 P-OT signal active at start

The P-OT signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the P-OT signal, the motor stops at the first Z signal.

3) 6098h = 3

Home: Z signal

Deceleration point: home switch (HW)

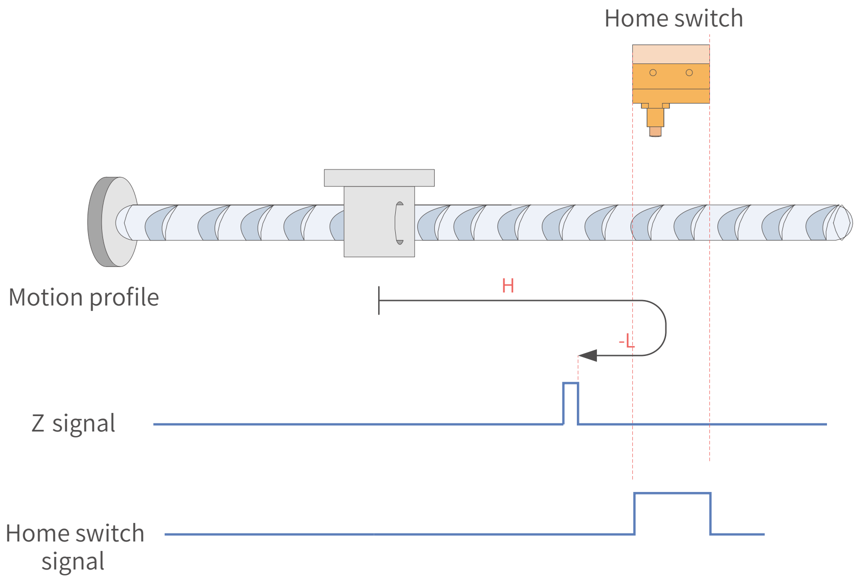


Figure 7-16 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at ~~a~~ low speed until it stops at the first Z signal upon reaching the falling edge of the HW signal.

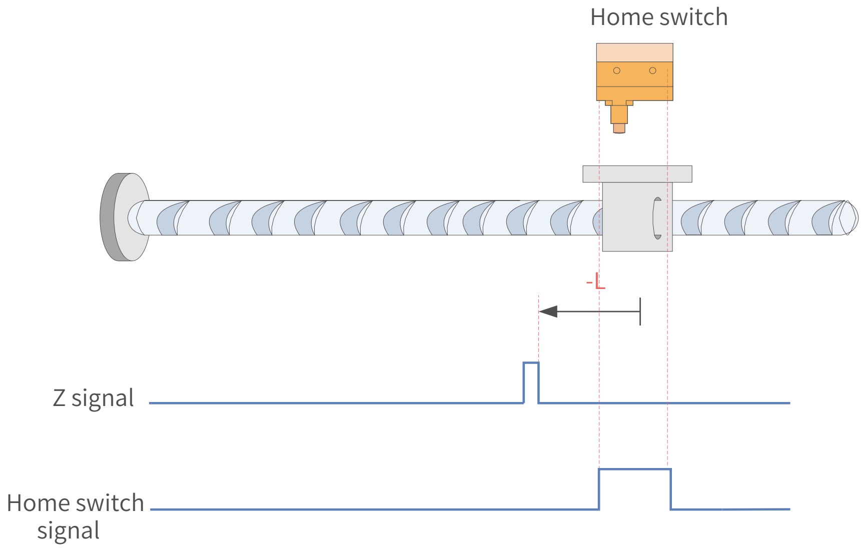


Figure 7-17 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor stops at the first Z signal.

4) 6098 = 4

Home: Z signal

Deceleration point: home switch (HW)

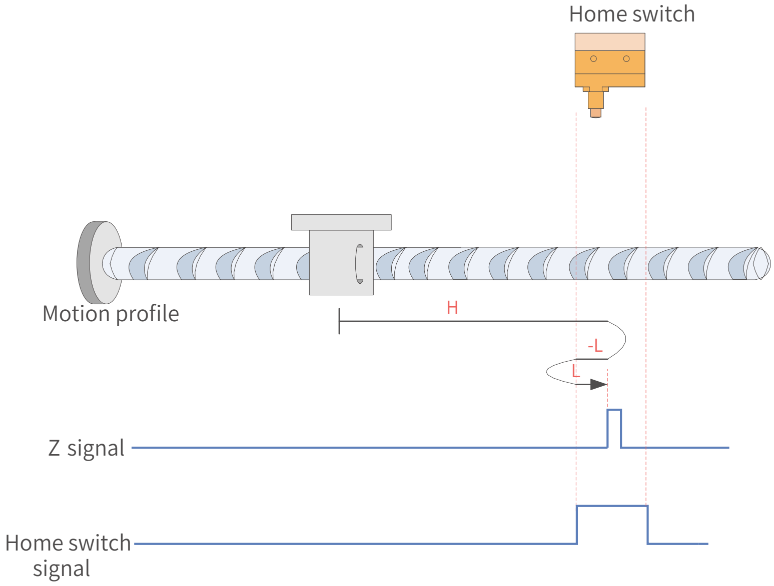


Figure 7-18 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction at ~~a~~ low speed. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the forward direction until it stops at the first Z signal upon reaching the rising edge of the HW signal again.

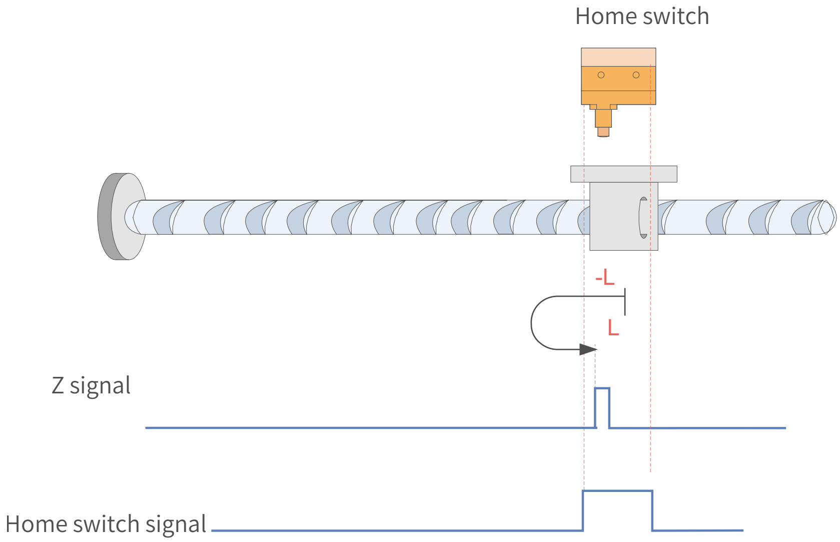


Figure 7-19 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor decelerates and changes to run in the forward direction until it stops at the first Z signal upon reaching the rising edge of the HW signal.

5) 6098h = 5

Home: Z signal

Deceleration point: home switch (HW)

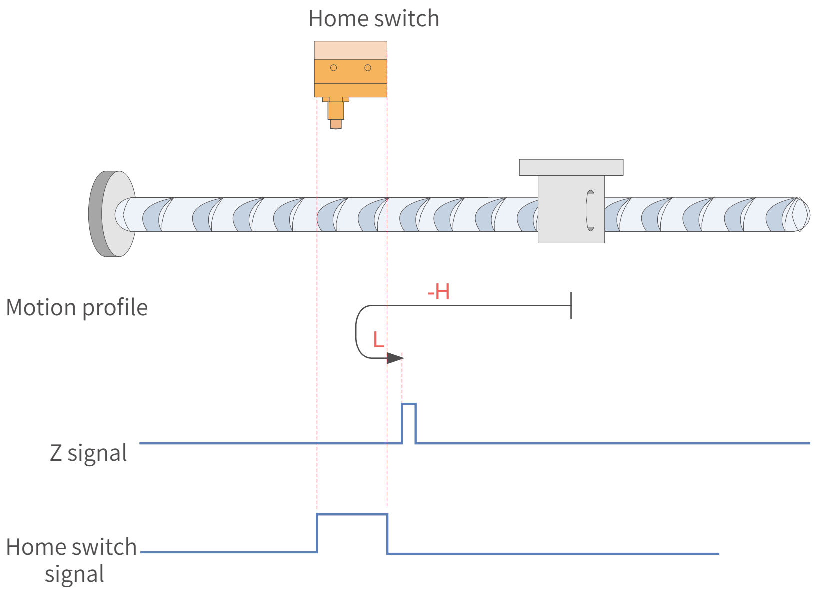


Figure 7-20 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction at ~~a~~ low speed until it stops at the first Z signal upon reaching the falling edge of the HW signal.

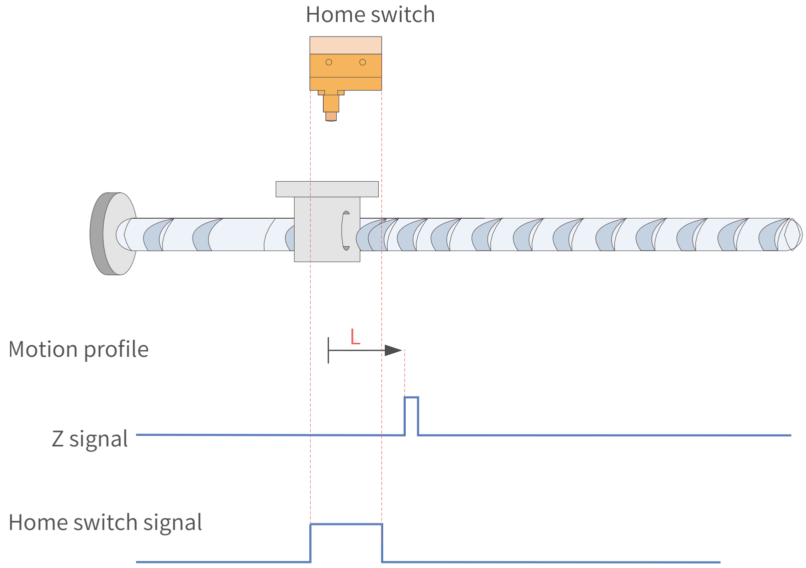


Figure 7-21 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor stops at the first Z signal.

6) 6098 = 6

Home: Z signal

Deceleration point: home switch (HW)

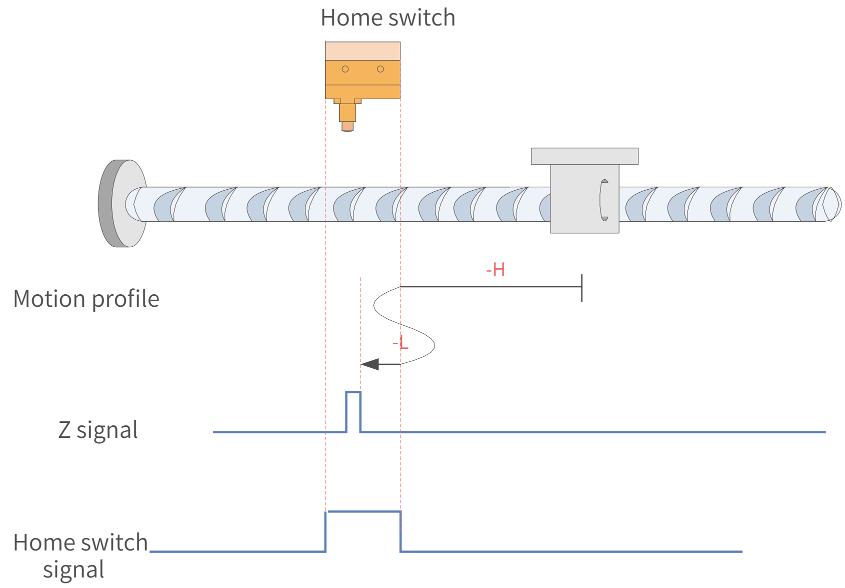


Figure 7-22 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction at ~~a~~ low speed. Then, after reaching the falling edge of the HW signal, the motor changes to run in the reverse direction until it stops at the first Z signal upon reaching the rising edge of the HW signal again.

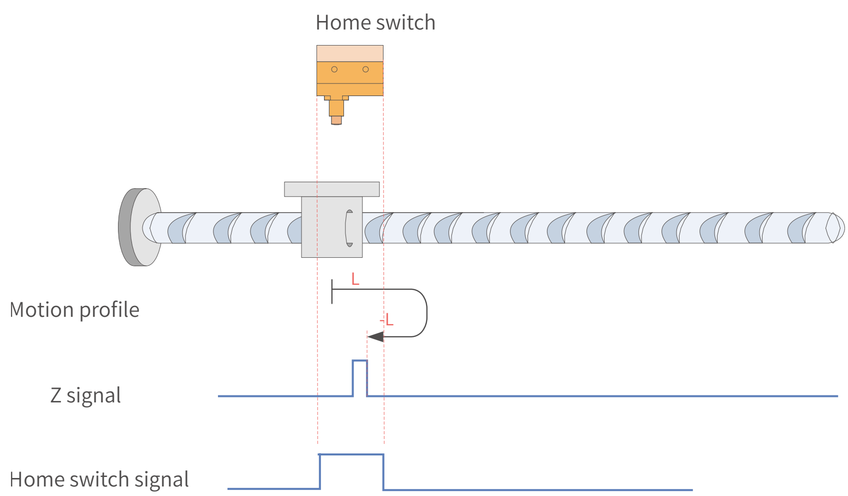


Figure 7-23 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction until it stops at the first Z signal upon reaching the rising edge of HW signal

7) 6098 = 7

Home: Z signal

Deceleration point: home switch (HW)

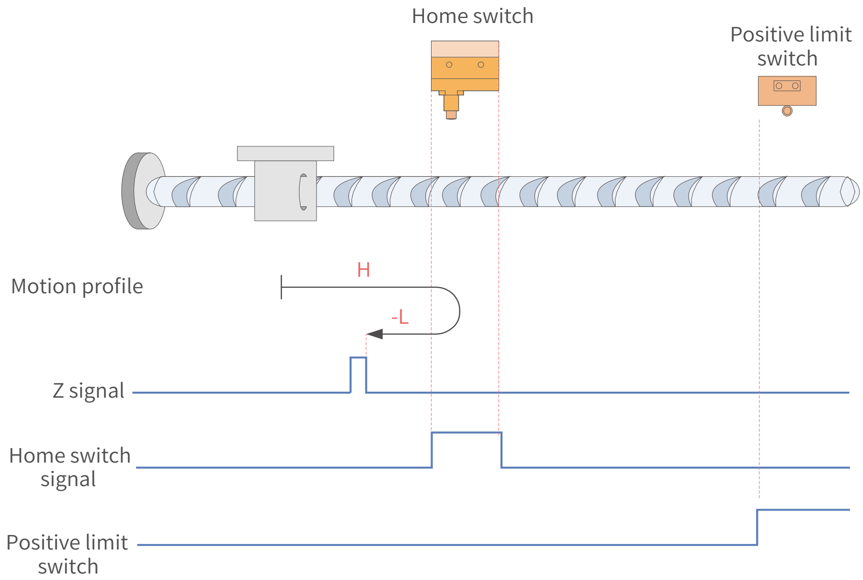


Figure 7-24 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and changes to run in the reverse direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor stops at the first Z signal.

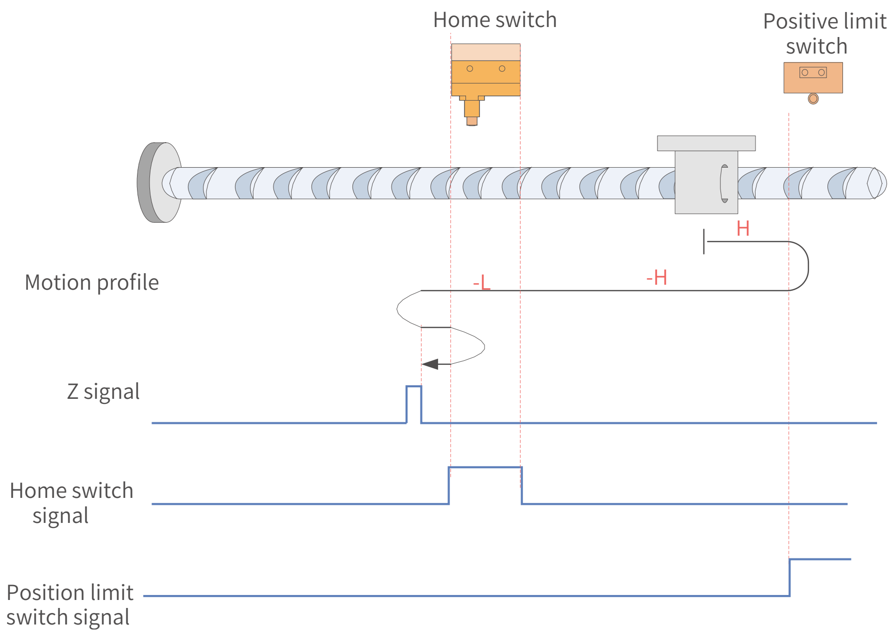


Figure 7-25 HW signal inactive at homing start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the reverse direction. After reaching the rising edge of the HW signal, the motor decelerates and runs in the reverse direction at ~~a~~ low speed. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the forward direction until it decelerates and changes to run in the reverse direction again upon reaching the rising edge of HW signal. Finally, the motor stops at the first Z signal after reaching the falling edge of the HW signal again.

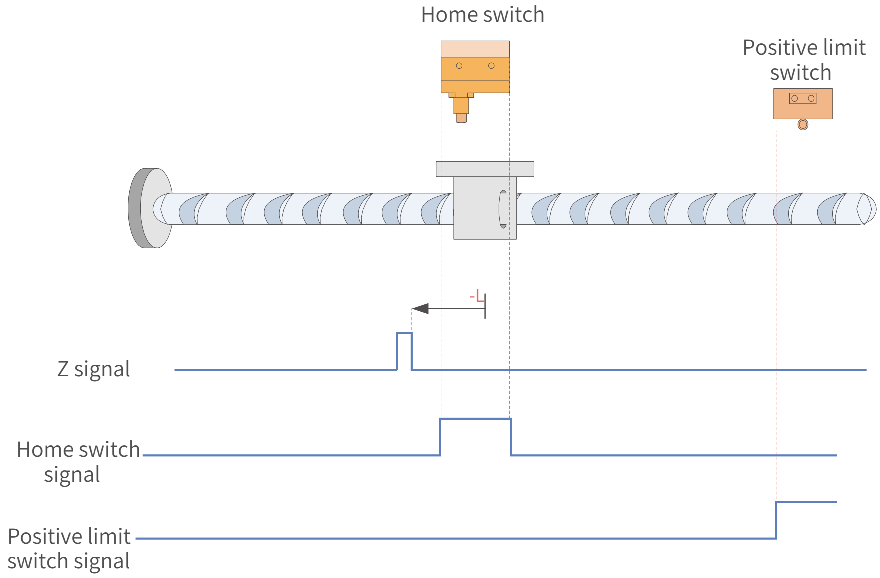


Figure 7-26 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor stops at the first Z signal.

8) 6098 = 8

Home: Z signal

Deceleration point: home switch (HW)

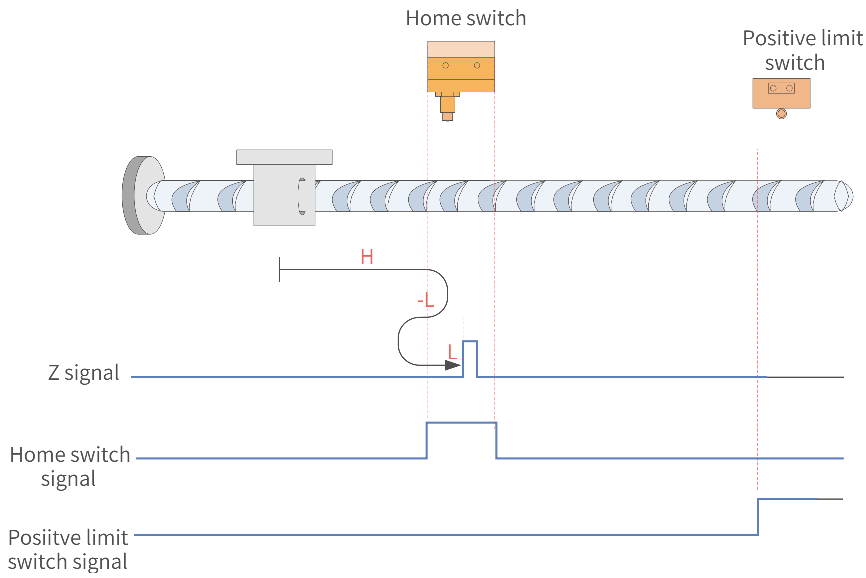


Figure 7-27 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and changes to run in the reverse direction at ~~a~~ low speed after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor changes to run in the forward direction at ~~a~~ low speed until it stops at the first Z signal upon reaching the rising edge of the HW signal.

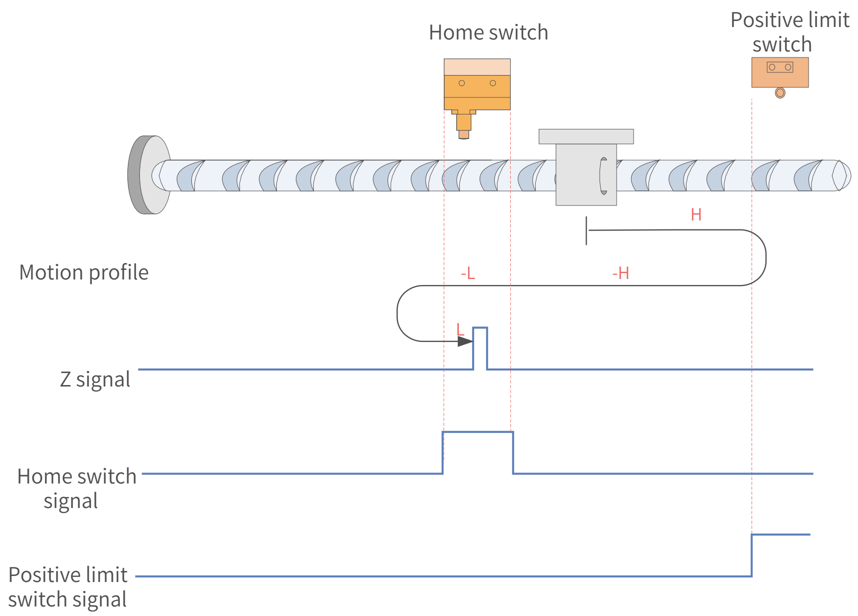


Figure 7-28 HW signal inactive at homing start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the reverse direction. After reaching the rising edge of HW signal, the motor decelerates and runs in the reverse direction. Then, after reaching the falling edge of the HW signal, the motor changes to run in the forward direction until it stops at the first motor Z signal upon reaching the rising edge of the HW signal.

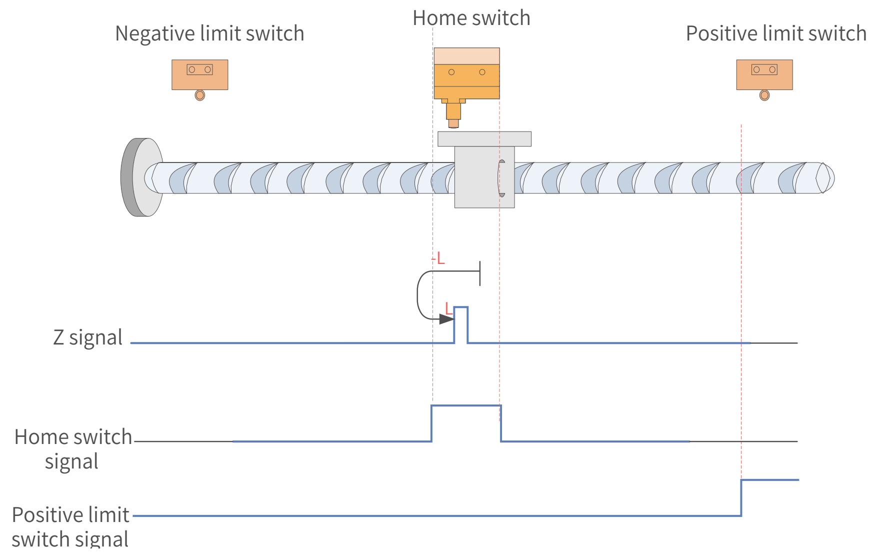


Figure 7-29 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of HW signal, the motor changes to run in the forward direction until it stops at the first Z signal upon reaching the rising edge of HW signal.

9) 6098 = 9

Home: Z signal

Deceleration point: home switch (HW)

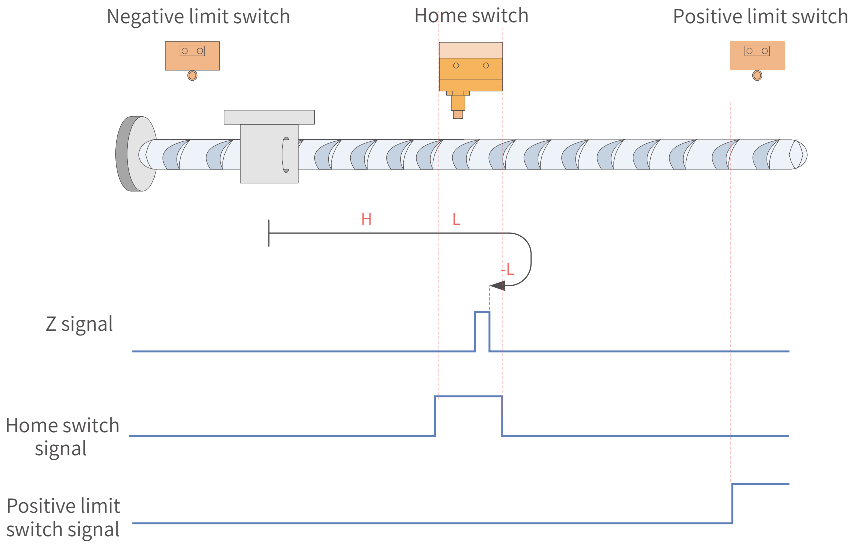


Figure 7-30 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and runs in the forward direction at ~~a~~ low speed after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor changes to run in the reverse direction at ~~a~~ low speed until it stops at the first Z signal upon reaching the rising edge of the HW signal again.

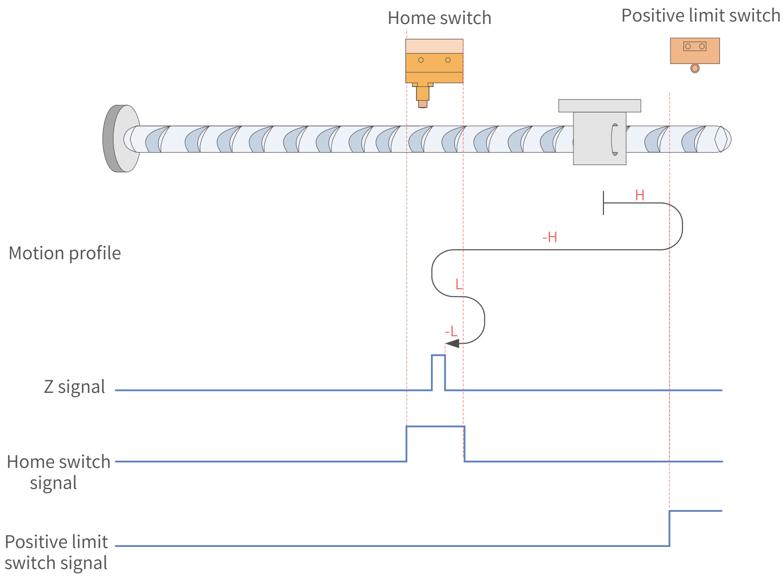


Figure 7-31 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the reverse direction. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction again. Then after reaching the falling edge of the HW signal, the motor changes to run in the reverse direction at ~~a~~ low speed. Finally, the motor stops at the first Z signal upon reaching the rising edge of HW signal again.

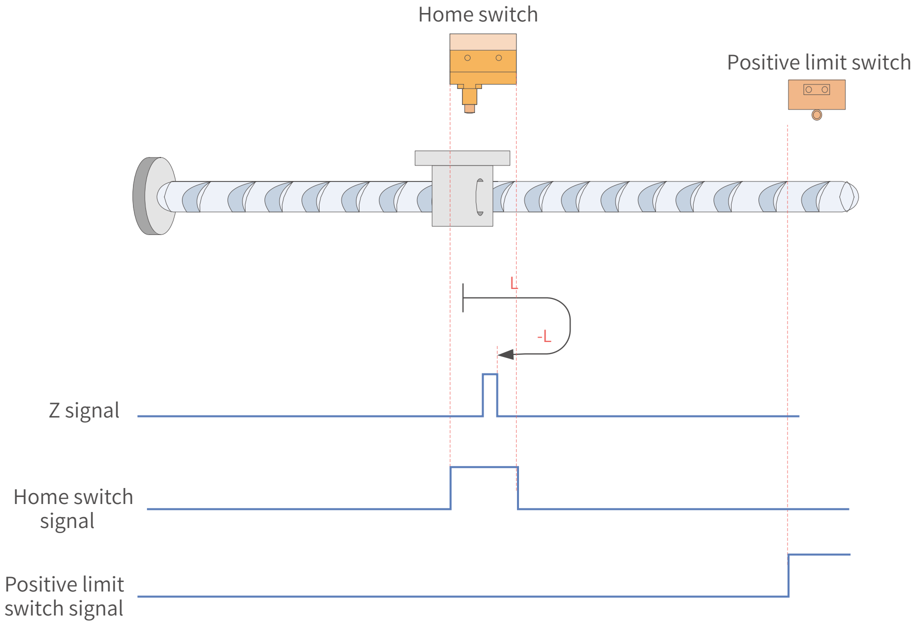


Figure 7-32 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor changes to run in the reverse direction until it stops at the first Z signal upon reaching the rising edge of the HW signal.

10) 6098 = 10

Home: Z signal

Deceleration point: home switch (HW)

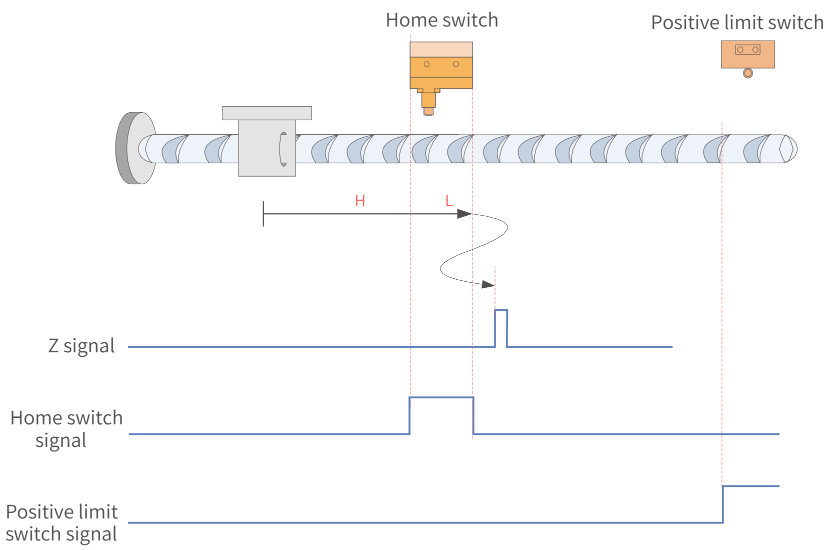


Figure 7-33 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and runs in the forward direction at ~~a~~ low speed upon reaching the rising edge of HW signal. After reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction until it decelerates and changes to run in the forward direction again after reaching the rising edge of the HW signal. Finally, it stops at the first Z signal upon reaching the falling edge of the HW signal again.

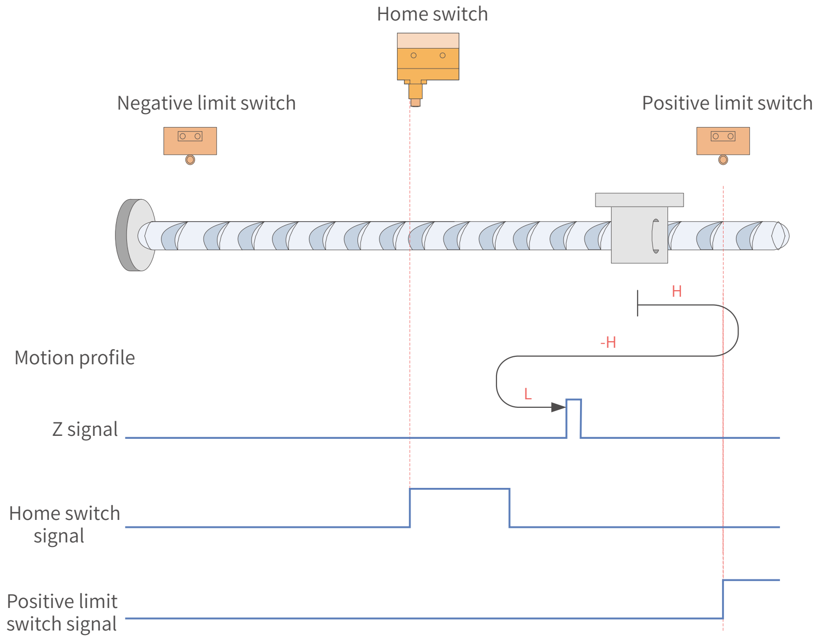


Figure 7-34 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the reverse direction. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction until it stops at the first Z signal upon reaching the falling edge of the HW signal.

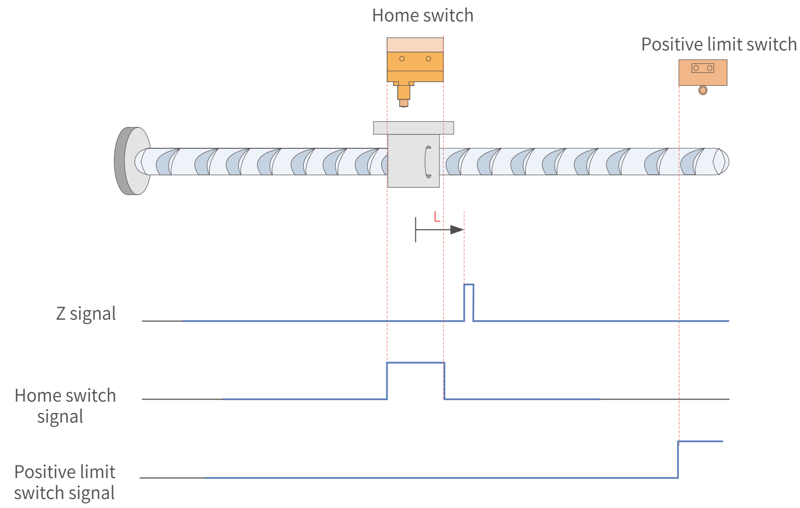


Figure 7-35 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of HW signal, the motor stops at the first Z signal.

11) 6098 = 11

Home: Z signal

Deceleration point: home switch (HW)

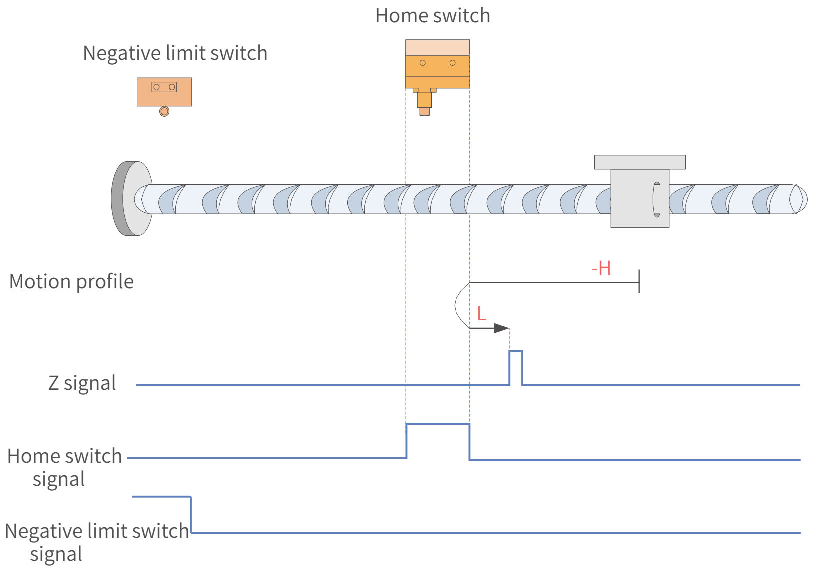


Figure 7-36 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and changes to run in the forward direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor stops at the first Z signal.

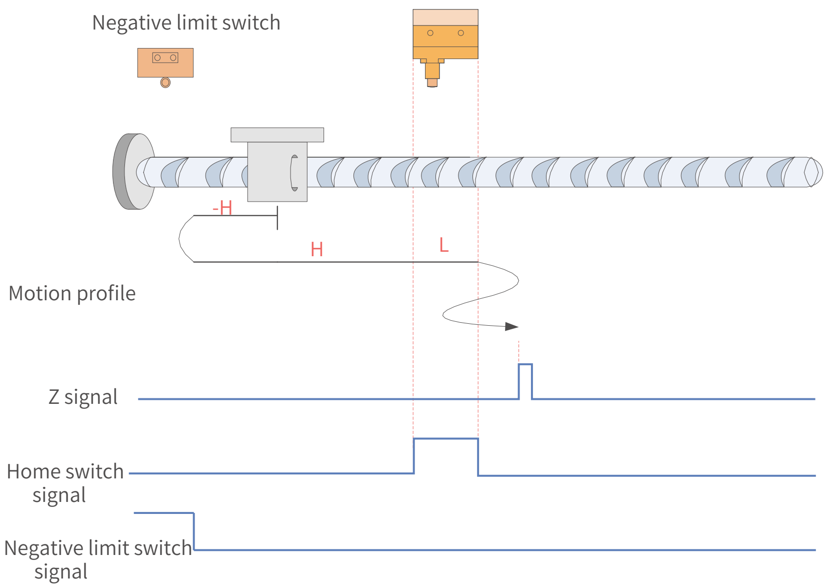


Figure 7-37 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the forward direction. After reaching the rising edge of the HW signal, the motor decelerates and runs in the forward direction. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction until reaching the rising edge of the HW signal where it decelerates and changes to run in the forward direction. Finally, the motor stops at the first Z signal upon reaching the falling edge of the HW signal again.

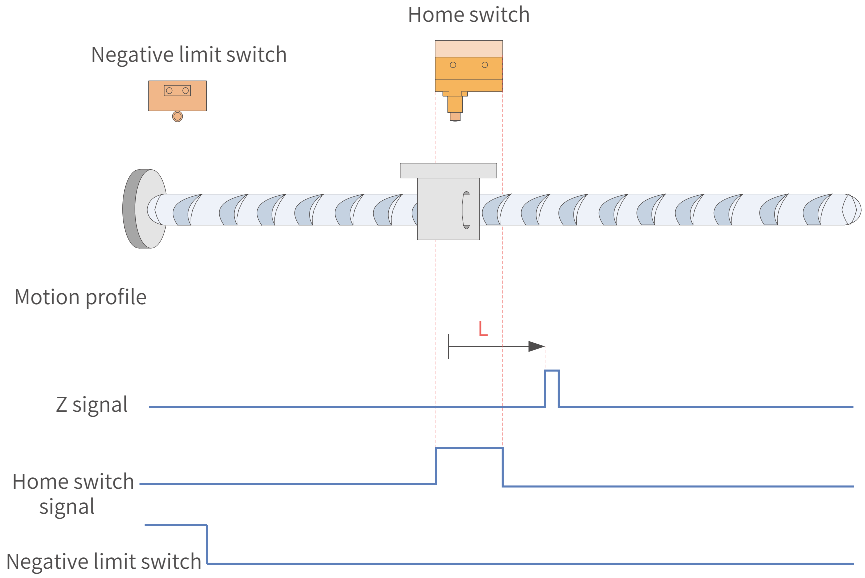


Figure 7-38 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor stops at the first Z signal.

12) 6098 = 12

Home: Z signal

Deceleration point: home switch (HW)

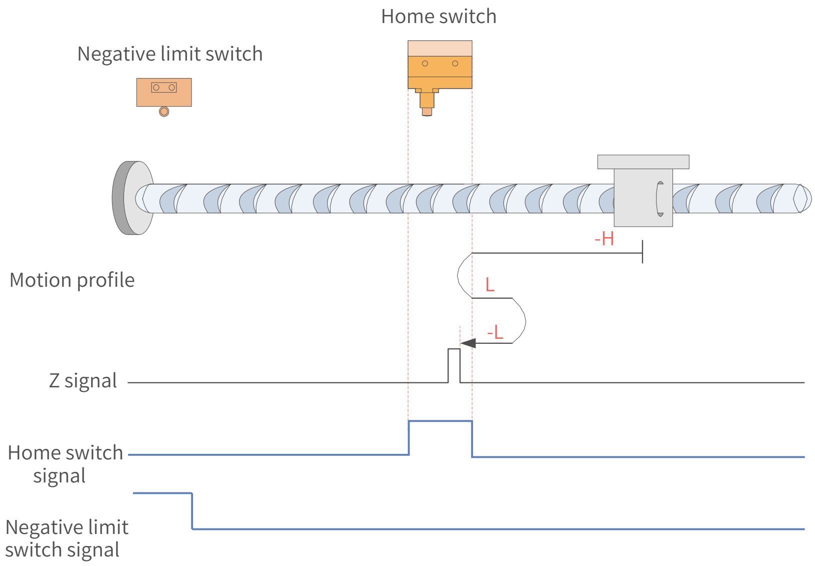


Figure 7-39 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and changes to run in the forward direction at ~~a~~ low speed after reaching the rising edge of the HW signal. Then, after reaching the falling edge of HW signal, the motor changes to run in the reverse direction until it stops at the first Z signal upon reaching the rising edge of the HW signal again.

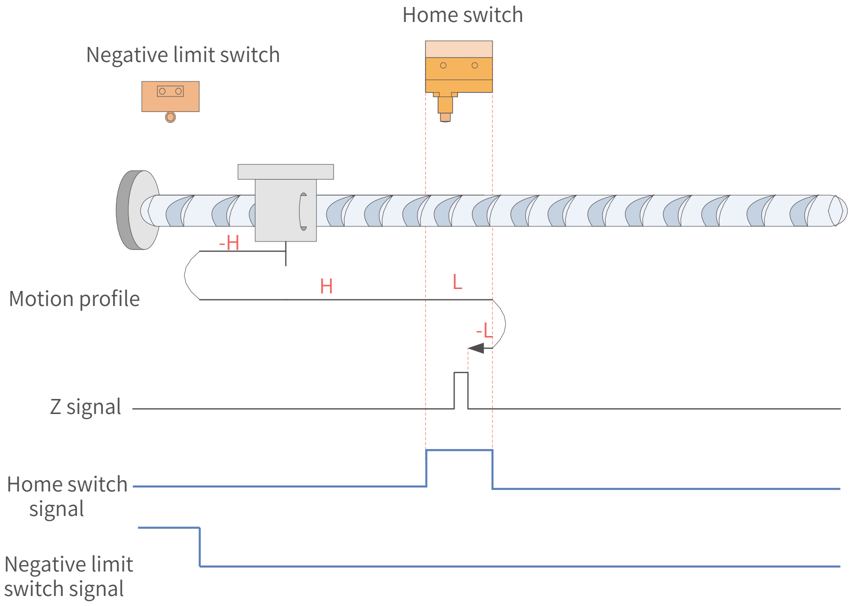


Figure 7-40 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the forward direction. After reaching the rising edge of HW signal, the motor decelerates and runs in the forward direction at ~~a~~ low speed. Then, after reaching the falling edge of HW signal, the motor changes to run in the reverse direction until it stops at the first Z signal upon reaching the rising edge of the HW signal again.

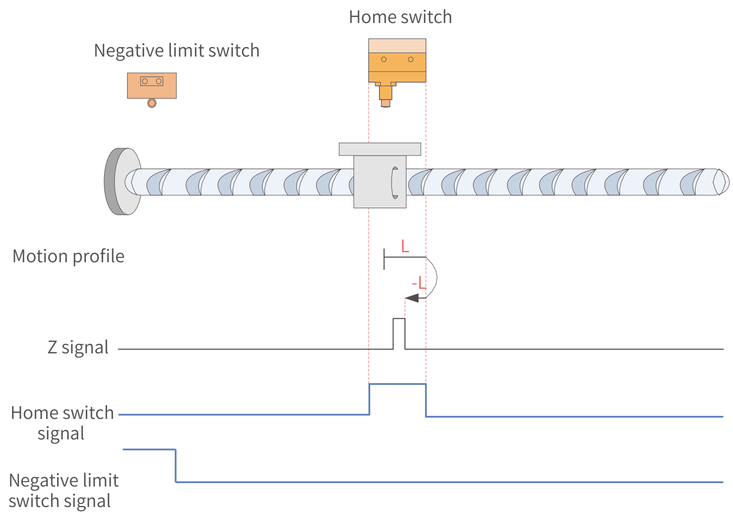


Figure 7-41 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor changes to run in the reverse direction until it stops at the first Z signal upon reaching the rising edge of the HW signal.

13) 6098 = 13

Home: Z signal

Deceleration point: home switch (HW)

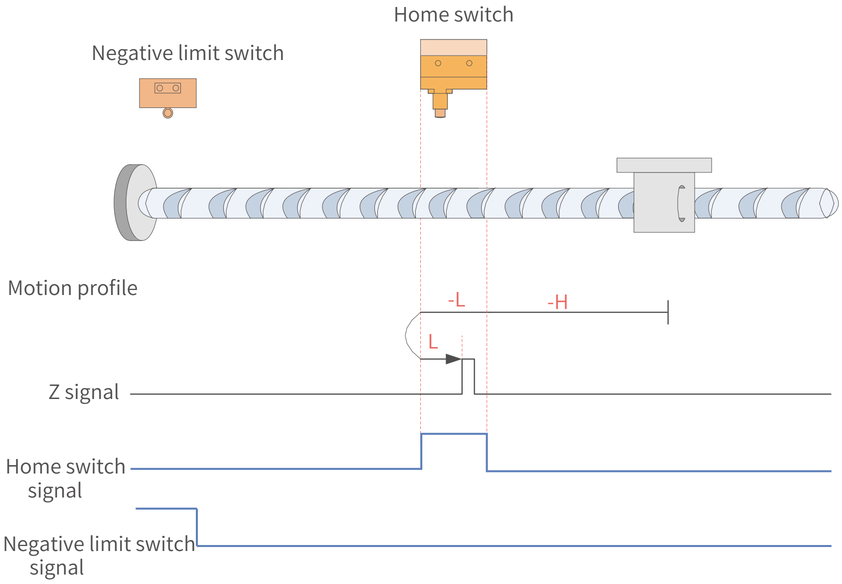


Figure 7-42 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and changes to run in the reverse direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor changes to run in the forward direction until it stops at the first Z signal upon reaching the rising edge of the HW signal again.

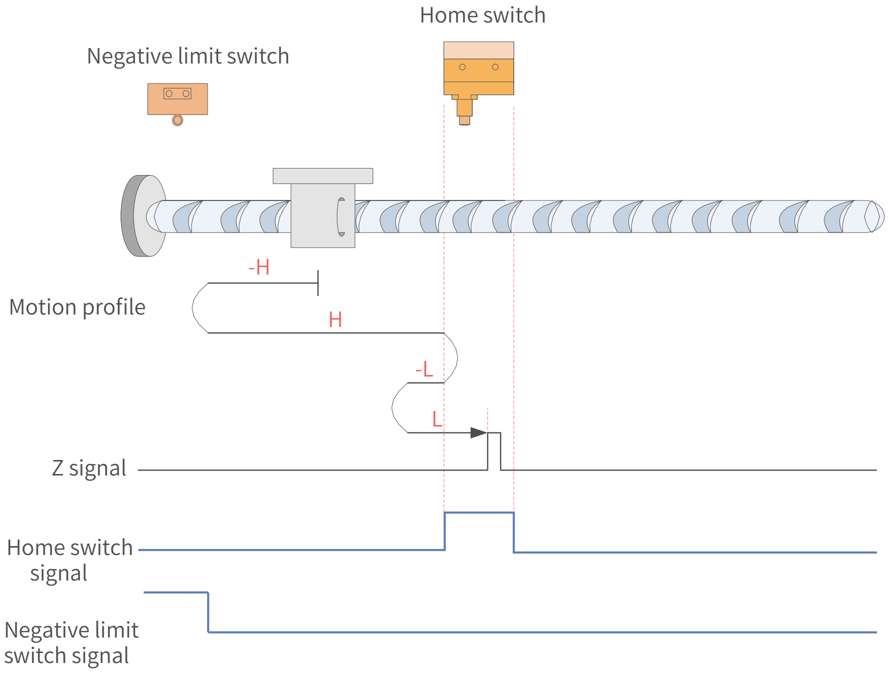


Figure 7-43 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the forward direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction. Then, after reaching the falling edge of the HW signal, the motor changes to run in the forward direction until it stops at the first Z signal upon reaching the rising edge of the HW signal again.

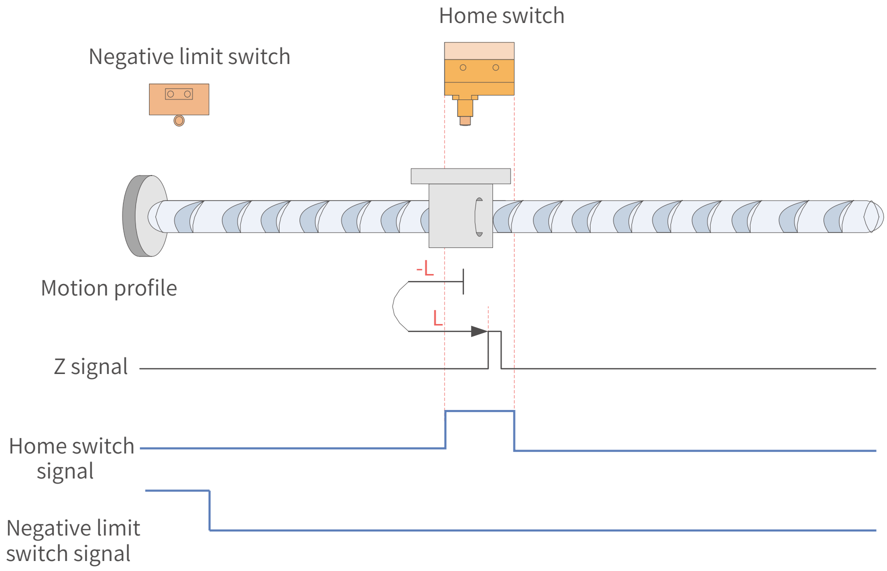


Figure 7-44 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor changes to run in the forward direction until it stops at the first Z signal upon reaching the rising edge of the HW signal.

14) 6098 = 14

Home: Z signal

Deceleration point: home switch (HW)

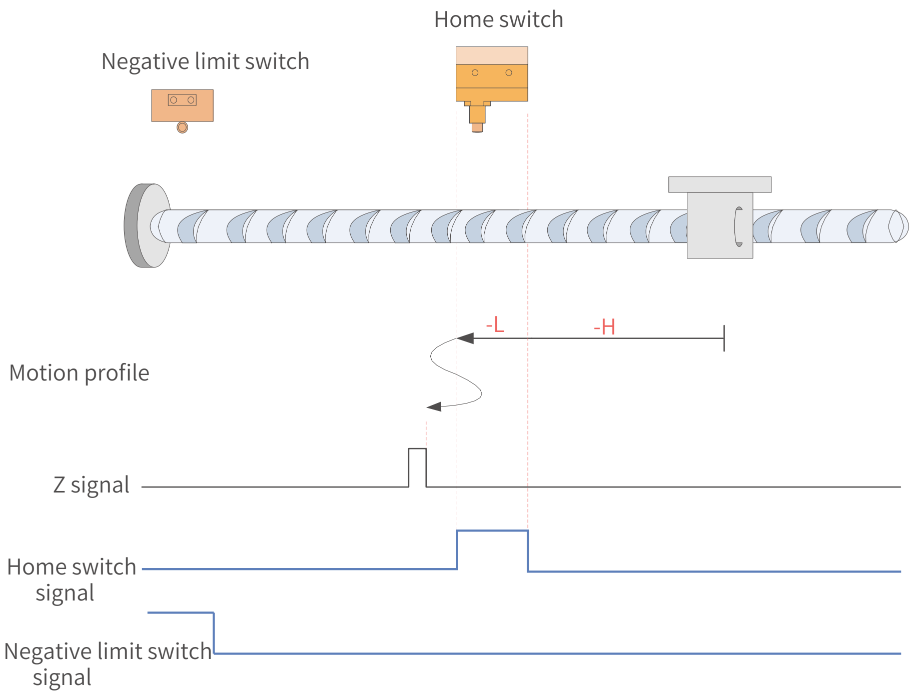


Figure 7-45 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and runs in the reverse direction after reaching the rising edge of HW signal. Then, after reaching the falling edge of HW signal, the motor decelerates and changes to run in the forward direction until reaching the rising edge of the HW signal again where it decelerates and changes to run in the reverse direction. Finally, the motor stops at the first Z signal upon reaching the falling edge of the HW signal.

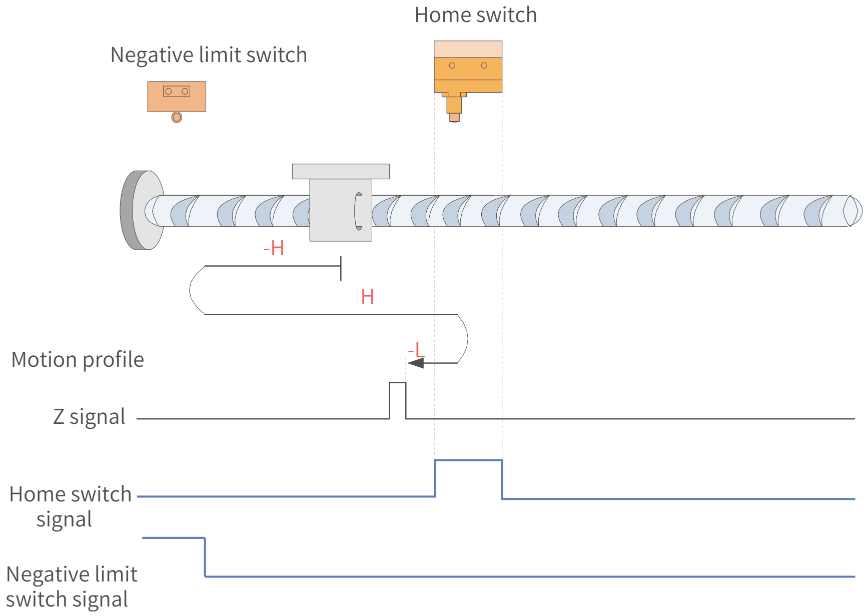


Figure 7-46 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the forward direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction until it stops at the first Z signal upon reaching the falling edge of the HW signal.

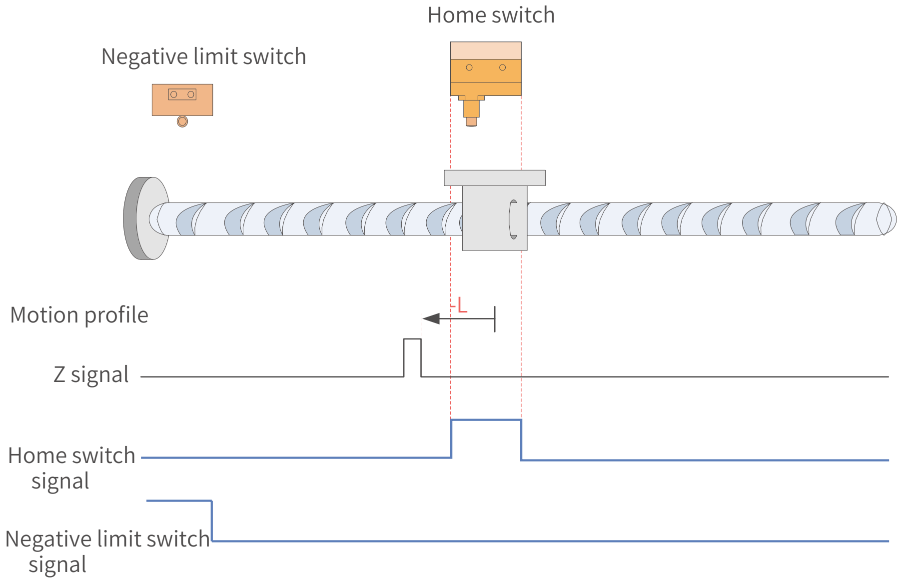


Figure 7-47 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor stops at the first Z signal.

15) 6098h = 17

Home: negative limit switch

Deceleration point: negative limit switch (N-OT)

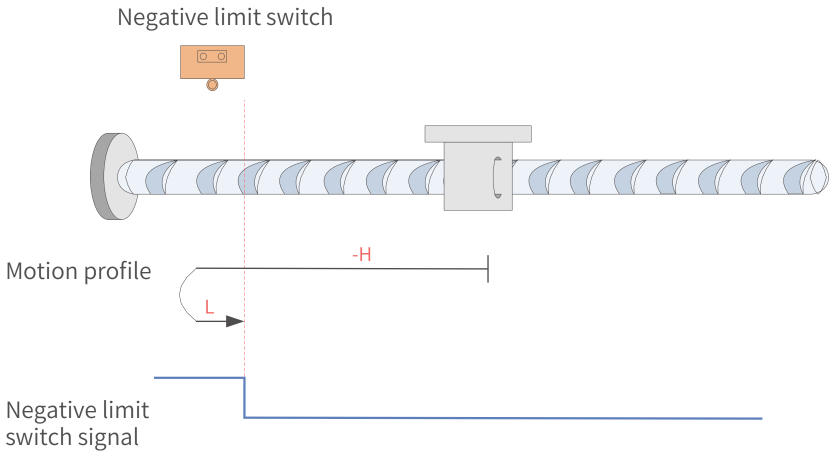


Figure 7-48 N-OT signal inactive at start

The N-OT signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. After reaching the rising edge of the N-OT signal, the motor decelerates and changes to run in the forward direction until it stops upon reaching the falling edge of the N-OT signal.

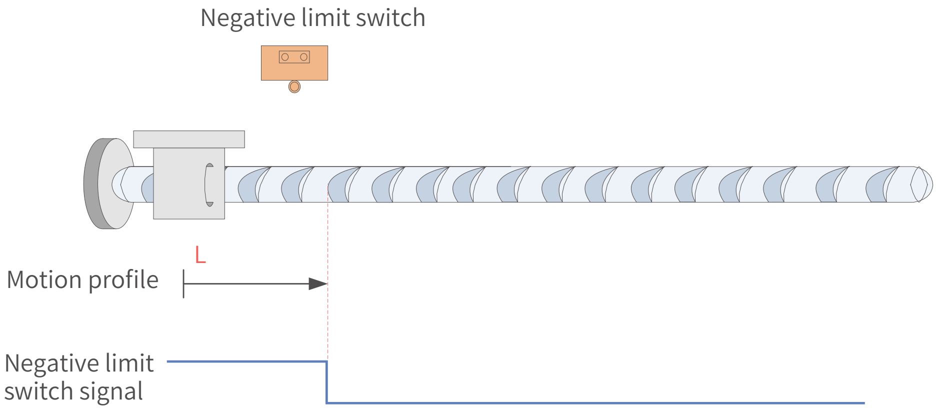


Figure 7-49 N-OT signal active at start

The N-OT signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the N-OT signal, the motor stops.

16) 6098h = 18

Home: positive limit switch

Deceleration point: positive limit switch (P-OT)

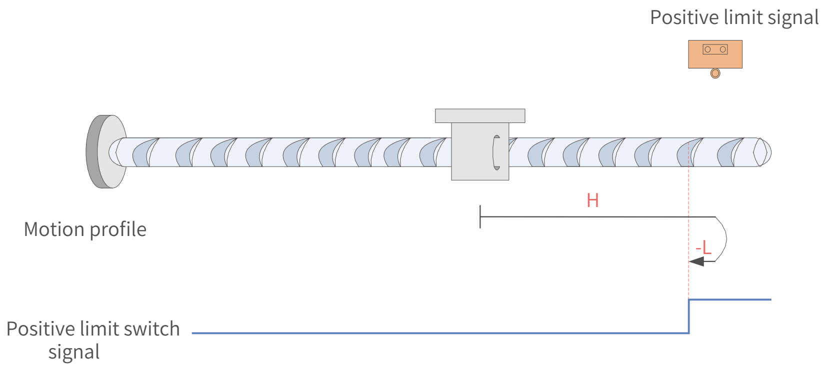


Figure 7-50 P-OT signal inactive at start

The P-OT signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. After reaching the rising edge of the P-OT signal, the motor decelerates and changes to run in the reverse direction until it stops upon reaching the falling edge of the P-OT signal.

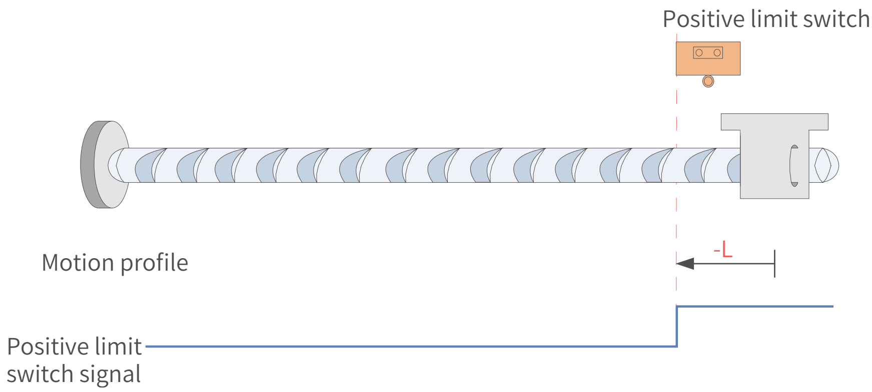


Figure 7-51 P-OT signal active at start

The P-OT signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the P-OT signal, the motor stops.

17) 6098h = 19

Home: home switch (HW)

Deceleration point: home switch (HW)

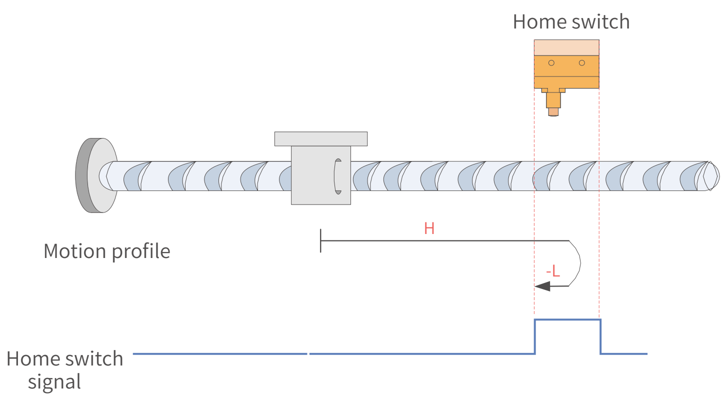


Figure 7-52 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction until it stops upon reaching the falling edge of the HW signal.

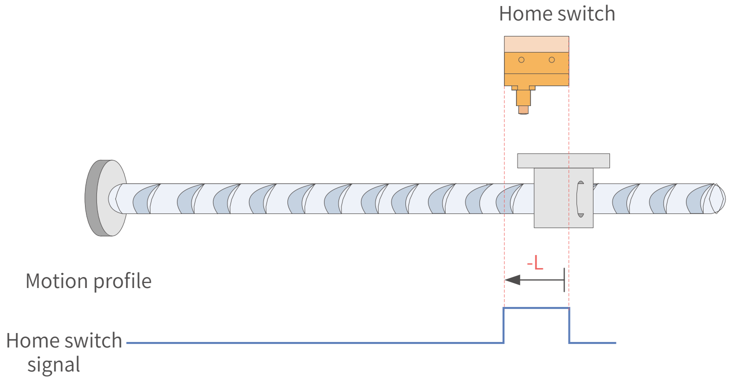


Figure 7-53 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor stops.

18) 6098 = 20

Home: home switch (HW)

Deceleration point: home switch (HW)

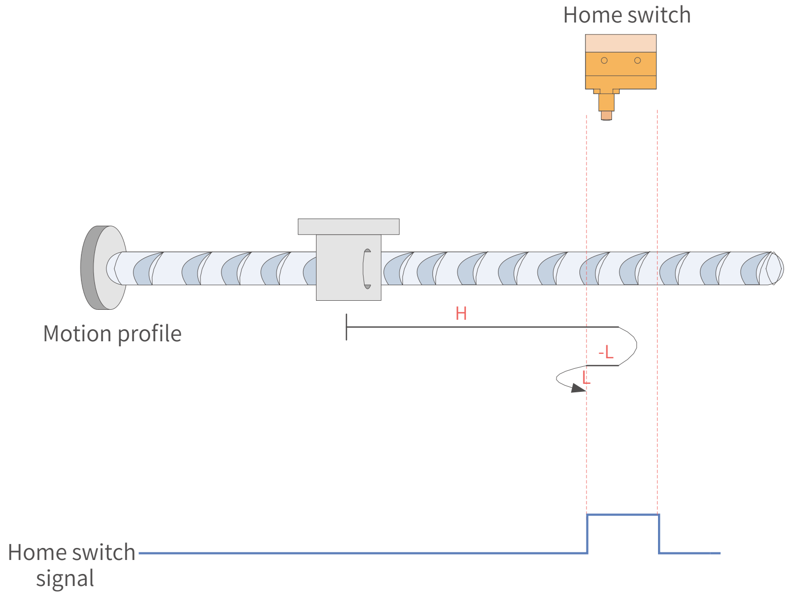


Figure 7-54 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the forward direction again until it stops upon reaching the rising edge of the HW signal.

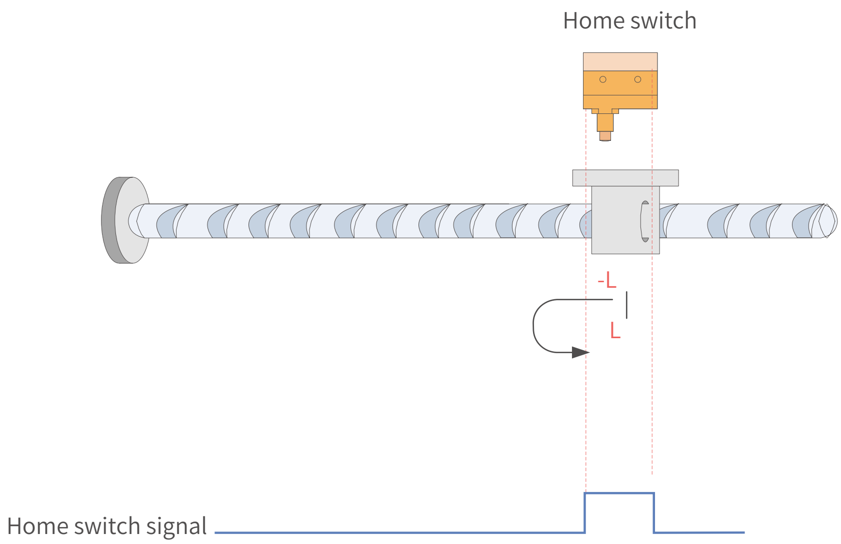


Figure 7-55 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor decelerates and changes to run in the forward direction until it stops upon reaching the rising edge of the HW signal.

19) 6098h = 21

Home: home switch (HW)

Deceleration point: home switch (HW)

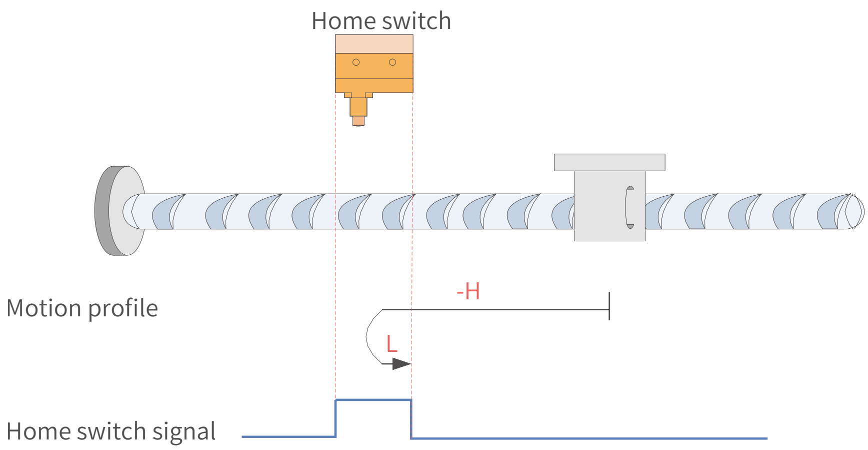


Figure 7-56 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction until it stops upon reaching the falling edge of the HW signal.

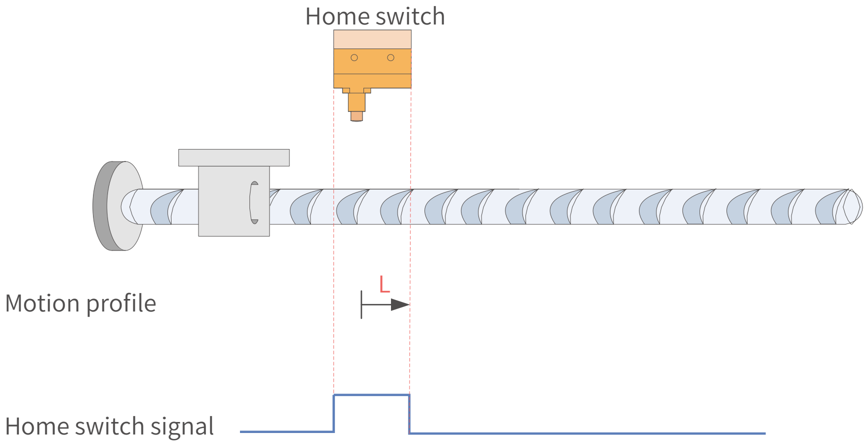


Figure 7-57 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor stops.

20) 6098 = 22

Home: home switch (HW)

Deceleration point: home switch (HW)

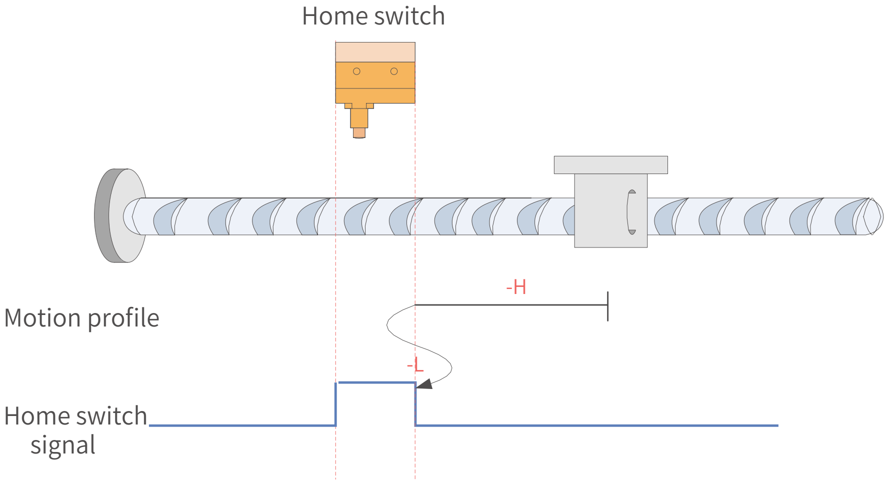


Figure 7-58 HW signal inactive at start

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction again until it stops upon reaching the rising edge of the HW signal.

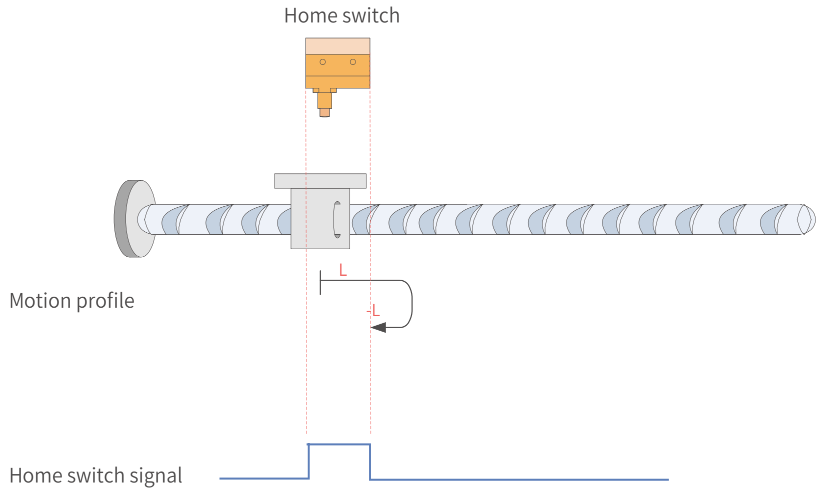


Figure 7-59 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction until it stops upon reaching the rising edge of the HW signal.

21) 6098 = 23

Home: home switch (HW)

Deceleration point: home switch (HW)

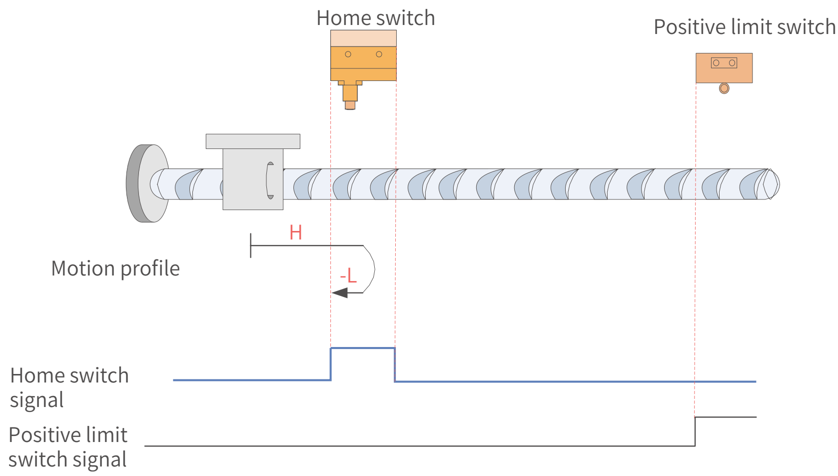


Figure 7-60 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and changes to run in the reverse direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor stops.

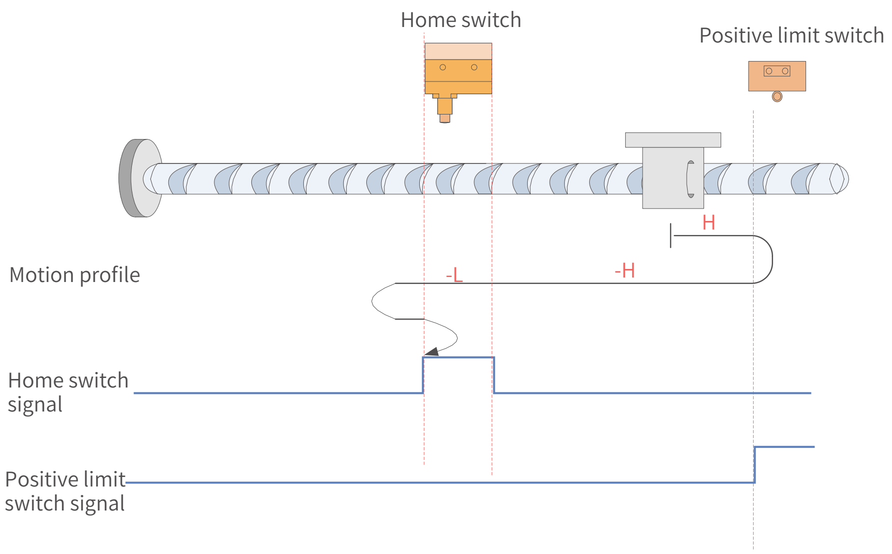


Figure 7-61 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the reverse direction at ~~a~~ high speed until it decelerates after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, it decelerates and changes to run in the forward direction until it decelerates and changes to run in the reverse direction upon reaching the rising edge of the HW signal. Finally, the motor stops upon reaching the falling edge of the HW signal again.

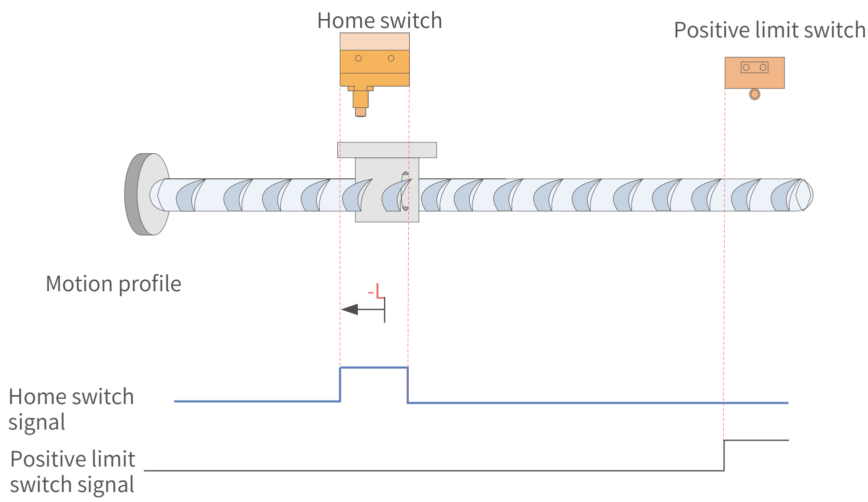


Figure 7-62 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed until it stops after reaching the falling edge of the HW signal.

22) 6098 = 24

Home: home switch (HW)

Deceleration point: home switch (HW)

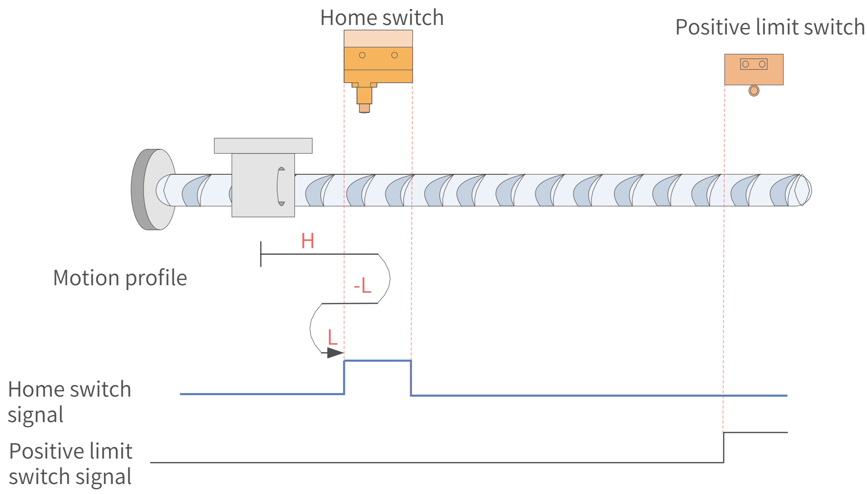


Figure 7-63 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and changes to run in the reverse direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor changes to run in the forward direction at ~~a~~ low speed until it stops upon reaching the rising edge of the HW signal again.

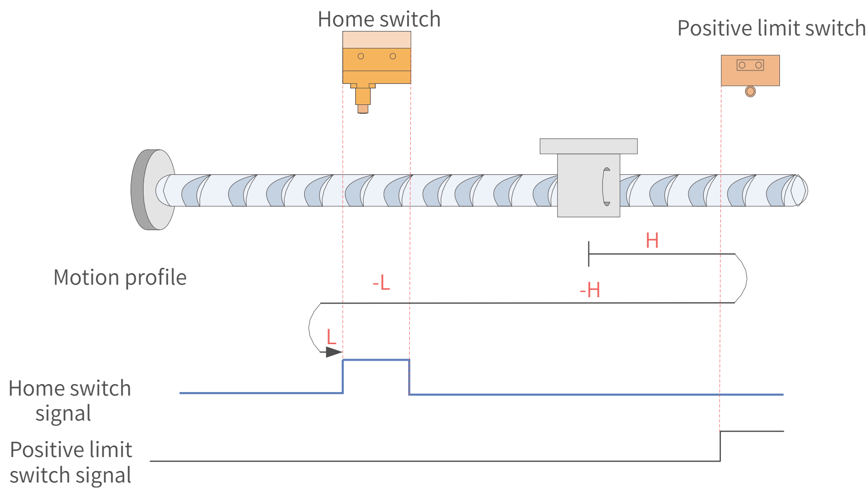


Figure 7-64 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the reverse direction until it decelerates upon reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor changes to run in the forward direction. Finally, the motor stops after reaching the rising edge of the HW signal again.

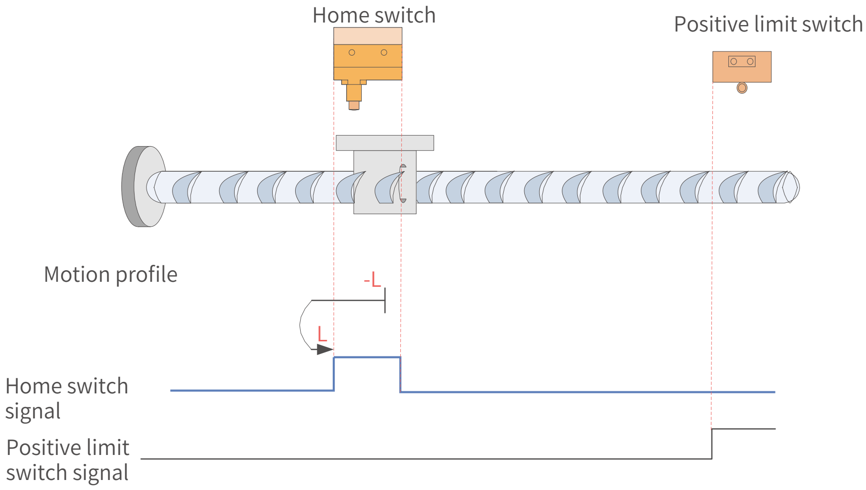


Figure 7-65 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor changes to run in the forward direction until it stops upon reaching the rising edge of the HW signal.

23) 6098 = 25

Home: home switch (HW)

Deceleration point: home switch (HW)

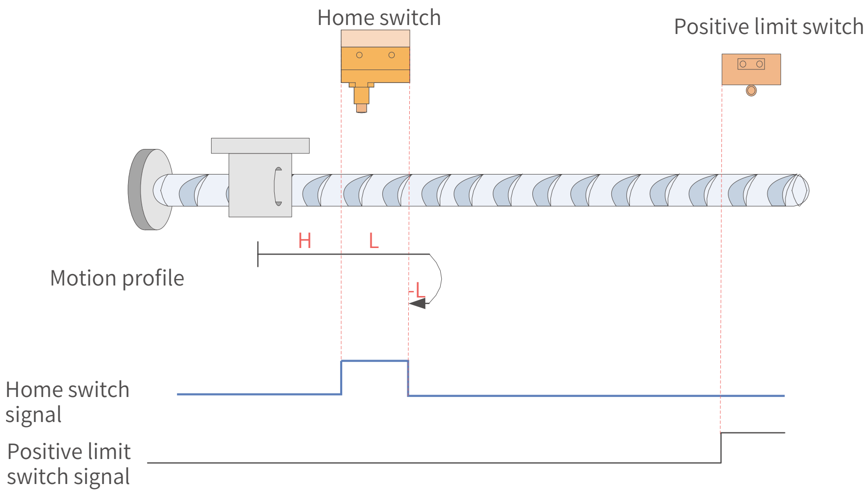


Figure 7-66 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and runs in the forward direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor changes to run in the reverse direction until it stops upon reaching the rising edge of the HW signal again.

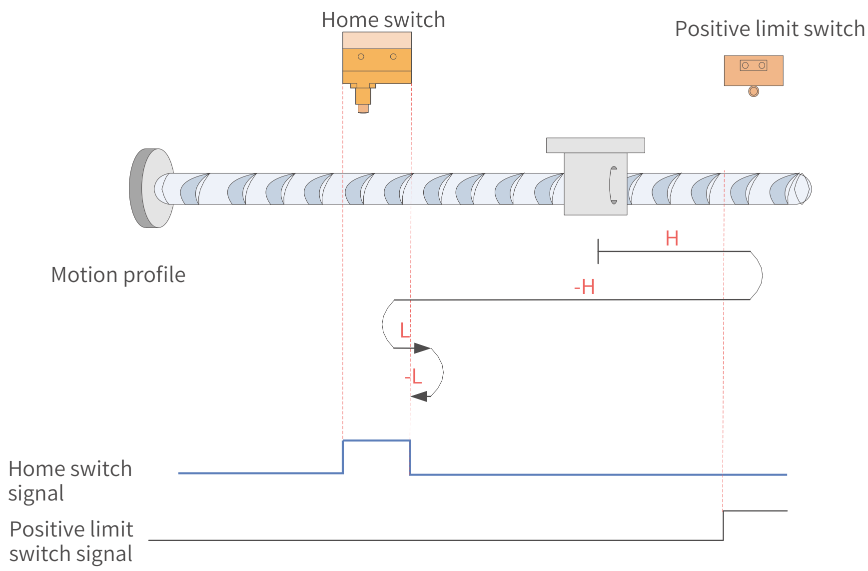


Figure 7-67 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the reverse direction. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction until reaching the falling edge of the HW signal where it changes to run in the reverse direction again. Finally, the motor stops after reaching the rising edge of the HW signal.

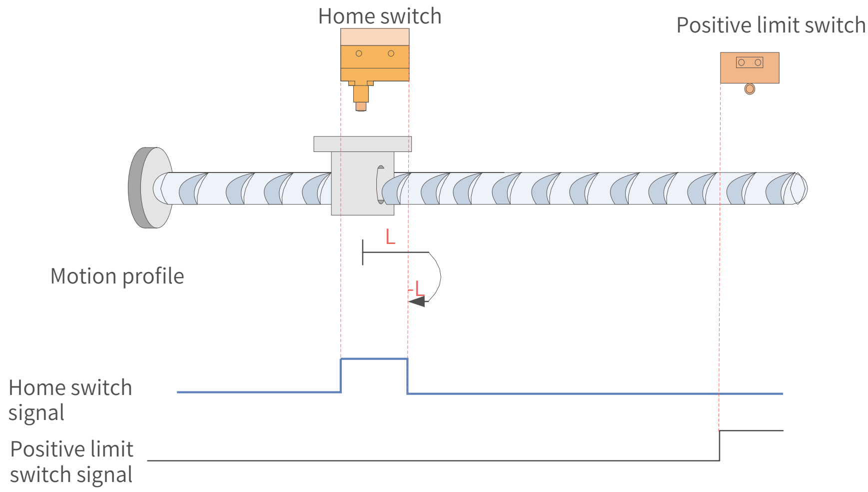


Figure 7-68 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor changes to run in the reverse direction until it stops upon reaching the rising edge of the HW signal.

24) 6098 = 26

Home: home switch (HW)

Deceleration point: home switch (HW)

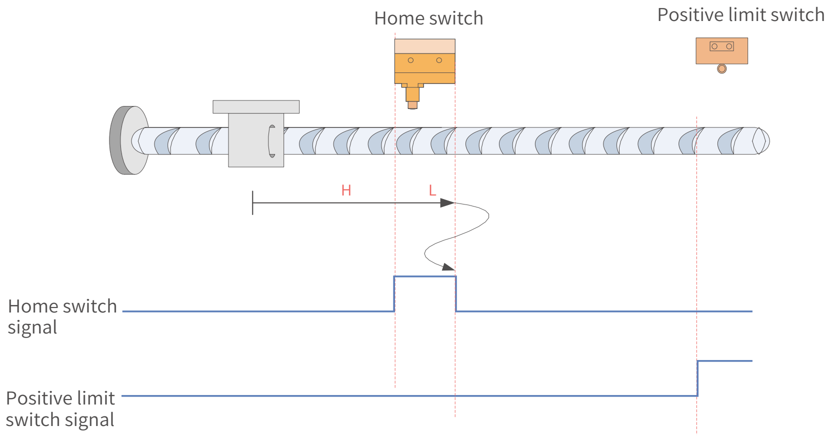


Figure 7-69 HW signal inactive at start, not hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and runs in the forward direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the reverse direction until reaching the rising edge of the HW signal again where it decelerates and changes to run in the forward direction. Finally, the motor stops after reaching the falling edge of the HW signal again.

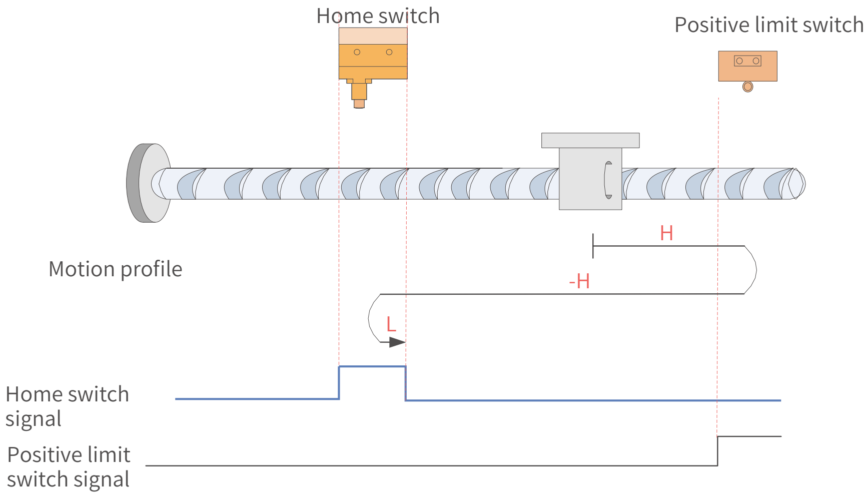


Figure 7-70 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the forward direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the reverse direction. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the forward direction until it stops upon reaching the falling edge of the HW signal.

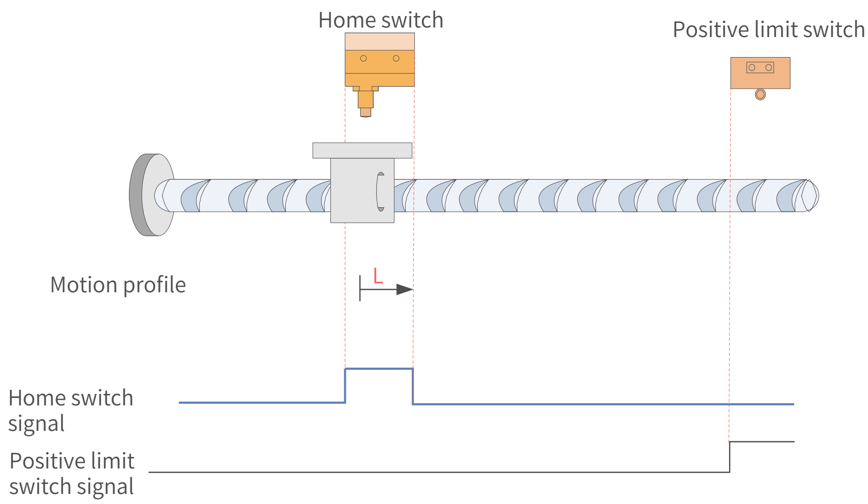


Figure 7-71 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor stops.

25) 6098 = 27

Home: home switch (HW)

Deceleration point: home switch (HW)

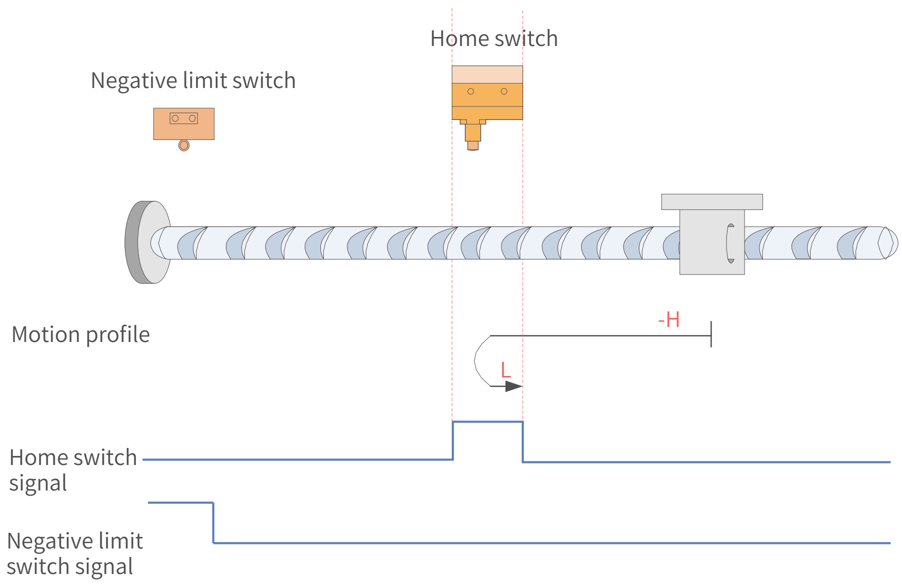


Figure 7-72 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start. The motor starts homing in the reverse direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and changes to run in the forward direction after reaching the rising edge of the HW signal. Then, the motor stops after reaching the falling edge of the HW signal.

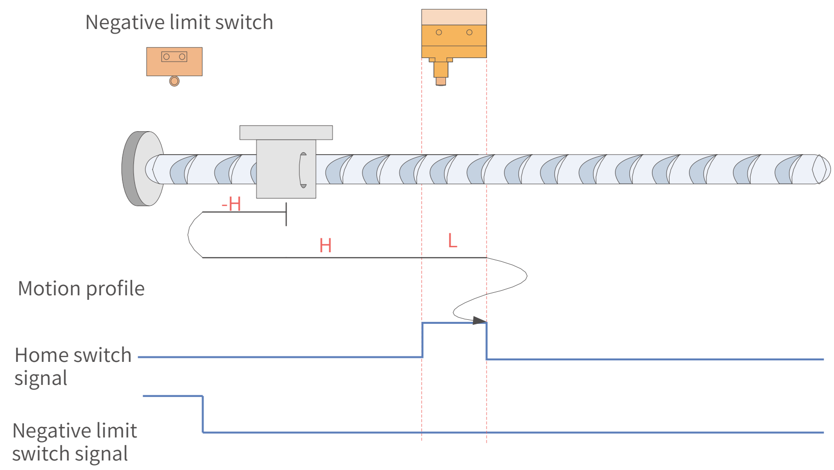


Figure 7-73 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the forward direction. After reaching the rising edge of the HW signal, the motor decelerates and keeps running in the forward direction until reaching the falling edge of the HW signal where it decelerates and changes to run in the reverse direction. Then, after reaching the rising edge of the HW signal again, the motor decelerates and changes to run in the forward direction until it stops upon reaching the falling edge of the HW signal again.

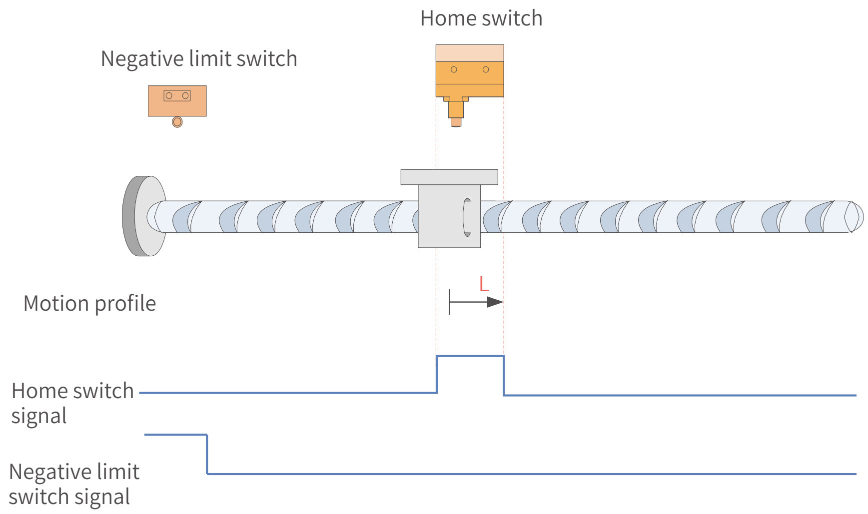


Figure 7-74 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor stops.

26) 6098 = 28

Home: home switch (HW)

Deceleration point: home switch (HW)

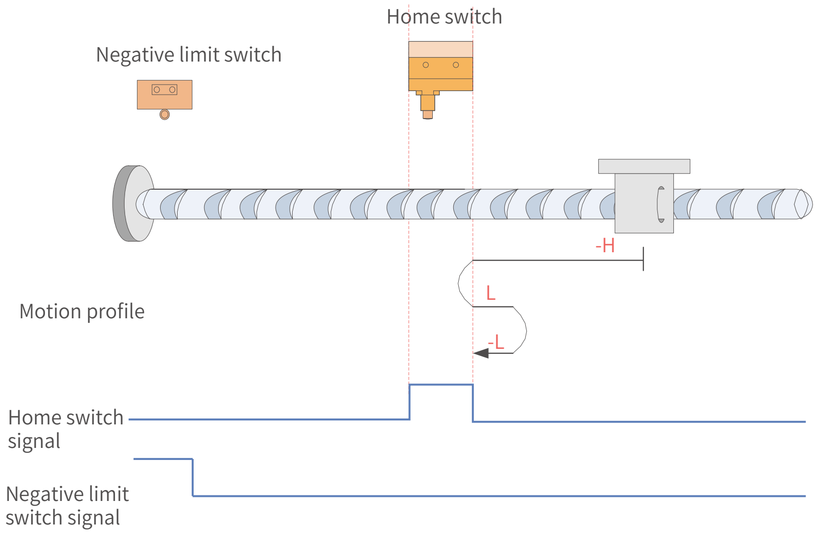


Figure 7-75 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and changes to run in the forward direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor changes to run in the reverse direction until it stops upon reaching the rising edge of the HW signal again.

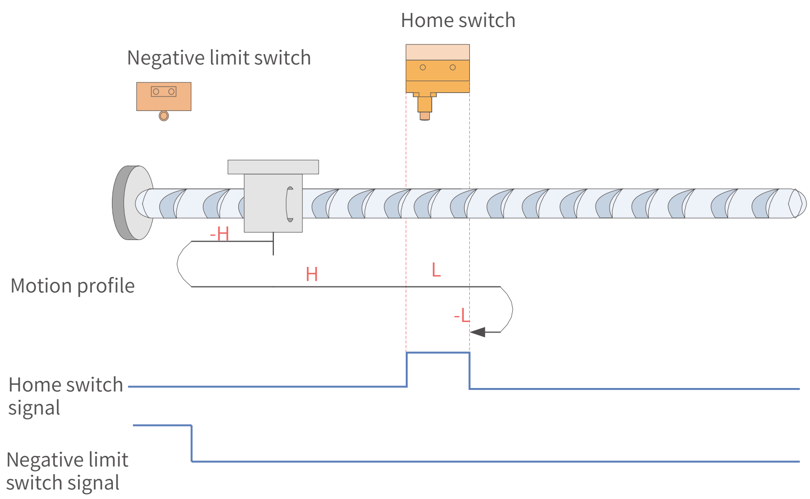


Figure 7-76 HW signal inactive at start, hitting the positive limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the forward direction until it decelerates upon reaching the rising edge of the HW signal. Then, after reaching the falling edge of HW signal, the motor decelerates and changes to run in the reverse direction. Finally, the motor stops after reaching the rising edge of the HW signal again.

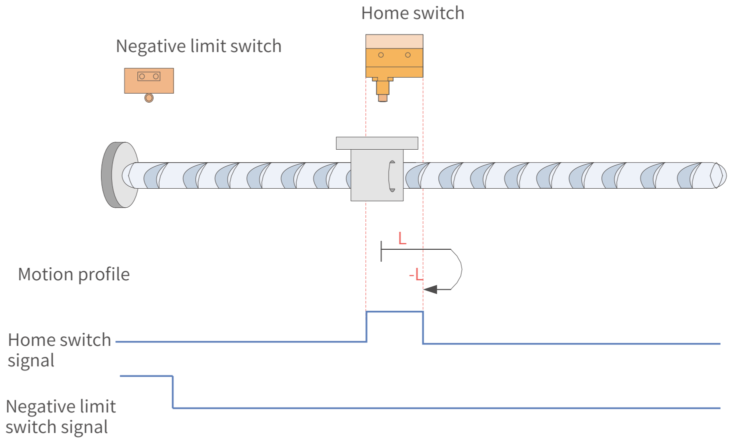


Figure 7-77 HW signal active at start

The HW signal is active at start, and the motor starts homing in the forward direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor changes to run in the reverse direction until it stops upon reaching the rising edge of the HW signal.

27) 6098 = 29

Home: home switch (HW)

Deceleration point: home switch (HW)

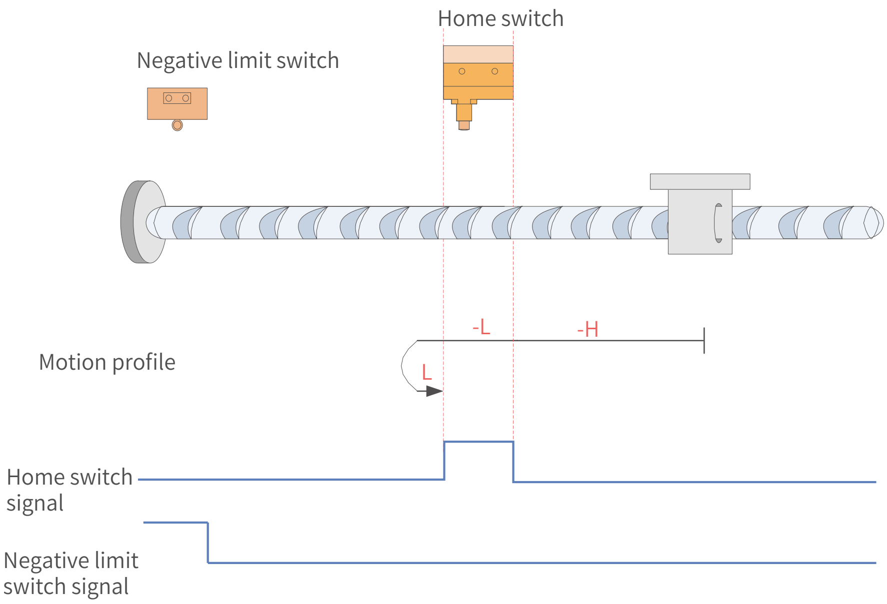


Figure 7-78 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor does not hit the limit switch, it decelerates and runs in the reverse direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor changes to run in the forward direction until it stops upon reaching the rising edge of the HW signal again.

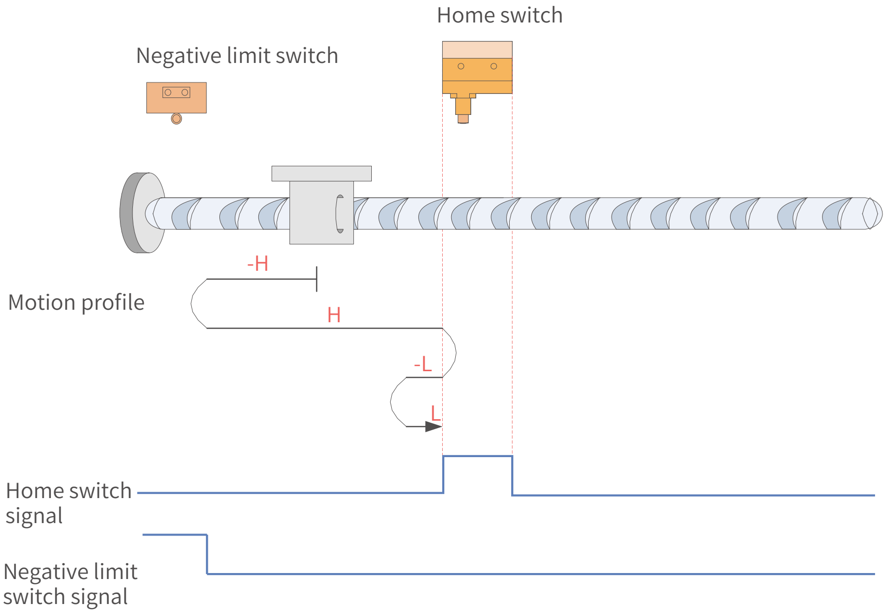


Figure 7-79 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the forward direction. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction until it changes to run in the forward direction again upon reaching the falling edge of the HW signal. Finally, the motor stops upon reaching the rising edge of the HW signal again.

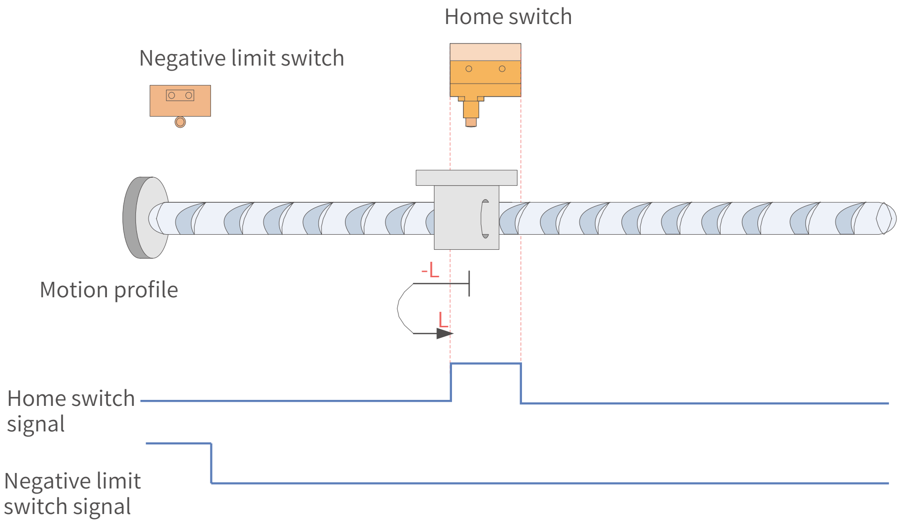


Figure 7-80 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed. After reaching the falling edge of the HW signal, the motor changes to run in the forward direction until it stops upon reaching the rising edge of the HW signal.

28) 6098 = 30

Home: home switch (HW)

Deceleration point: home switch (HW)

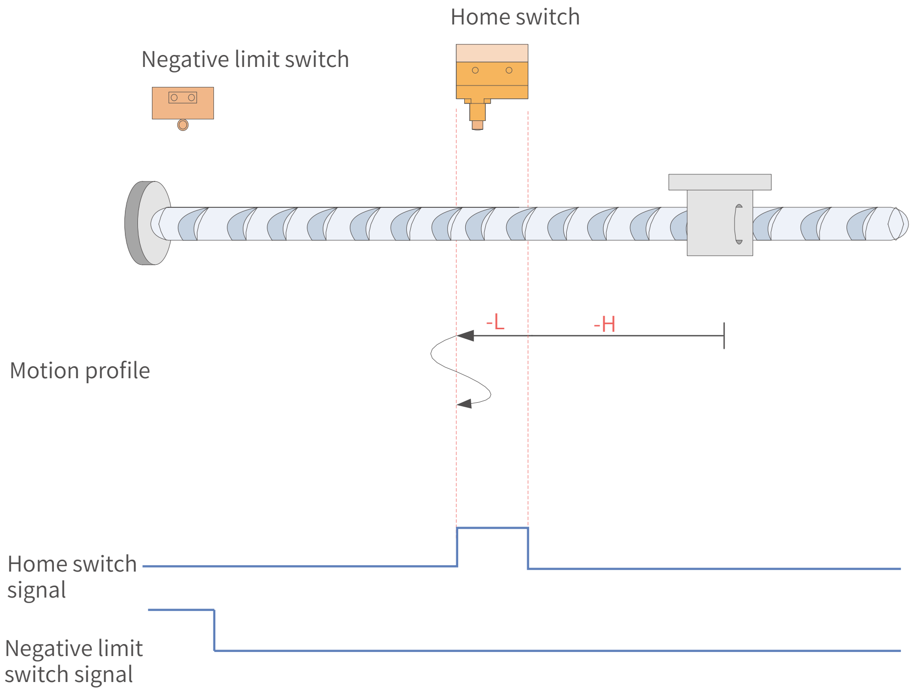


Figure 7-81 HW signal inactive at start, not hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed If the motor does not hit the limit switch, it decelerates and keeps running in the reverse direction after reaching the rising edge of the HW signal. Then, after reaching the falling edge of the HW signal, the motor decelerates and changes to run in the forward direction until reaching the rising edge of the HW signal where it changes to run in the reverse direction. Finally, the motor stops upon reaching the falling edge of the HW signal again.

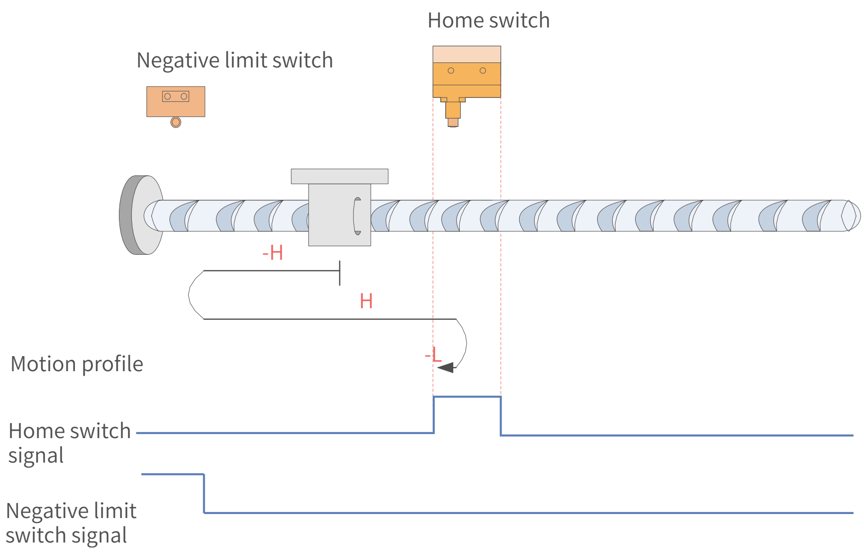


Figure 7-82 HW signal inactive at start, hitting the negative limit switch

The HW signal is inactive at start, and the motor starts homing in the reverse direction at ~~a~~ high speed. If the motor hits the limit switch, it changes to run in the forward direction at ~~a~~ high speed. After reaching the rising edge of the HW signal, the motor decelerates and changes to run in the reverse direction until it stops upon reaching the falling edge of the HW signal.

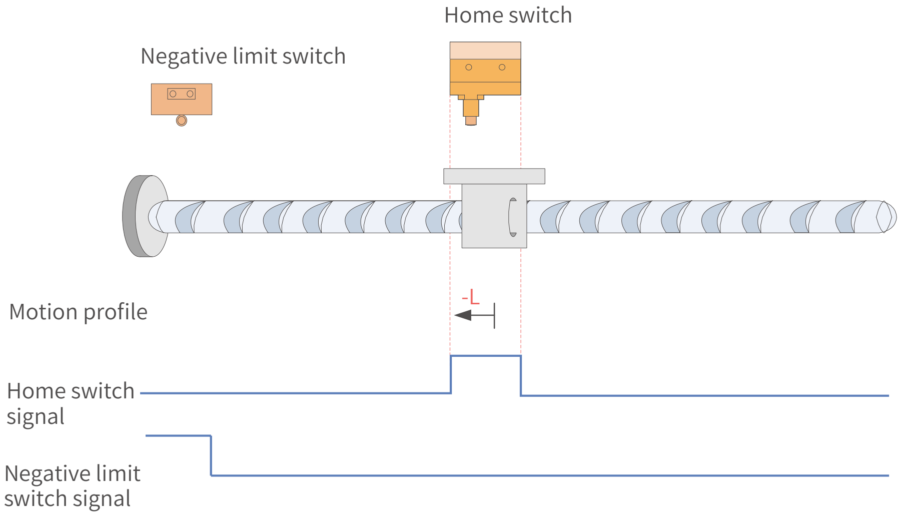


Figure 7-83 HW signal active at start

The HW signal is active at start, and the motor starts homing in the reverse direction at ~~a~~ low speed and stops after reaching the falling edge of the HW signal.

29) 6098h = 31/32

This mode is not defined in the standard 402 protocol. It can be used for extension purpose.

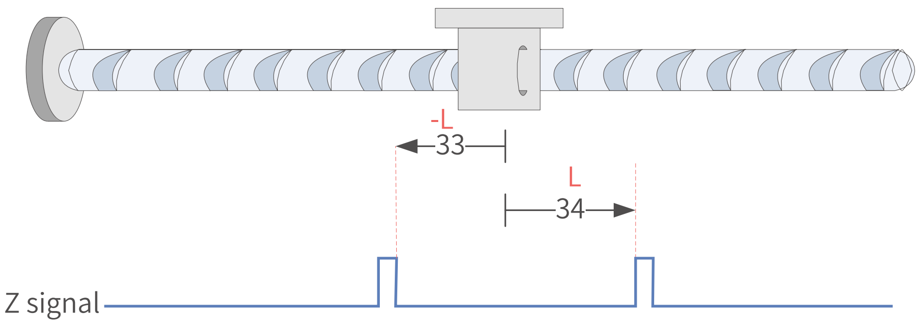
30) 6098h = 33/34

Home: Z signal

Deceleration point: None

Homing mode 33: The motor runs in the reverse direction at ~~a~~ low speed and stops at the first Z signal.

Homing mode 34: The motor runs in the forward direction at ~~a~~ low speed and stops at the first Z signal.



31) 6098h = 35

Homing mode 35: The present position is taken as the mechanical home, after homing is triggered (control word 6040: 0x0F → 0x1F):

60E6h = 0 (Absolute homing):

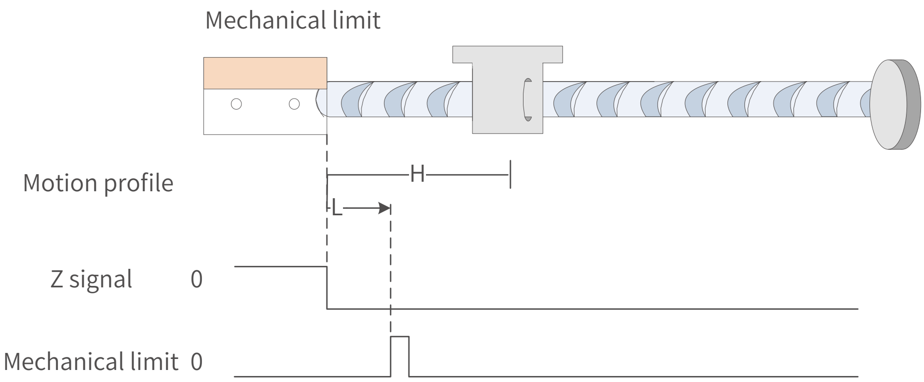
6064h (Position actual value) is equal to 607Ch (Home offset) after homing is done.

60E6h = 1 (Relative homing):

6064h is the sum of the original value plus the home offset (607Ch) after homing is done.

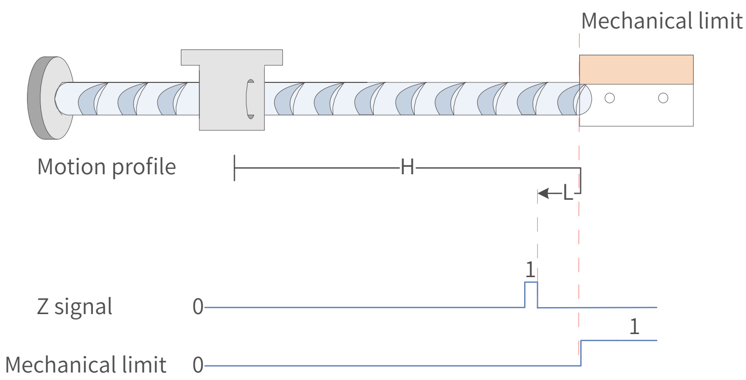
32) 6098 = –1

The servo motor runs in the reverse direction at ~~a~~ high speed first. If the torque reaches the limit and the speed is near zero after the motor hits the mechanical limit, and such status persists, it indicates the motor reaches the mechanical limit position. In this case, the motor runs in the forward direction at ~~a~~ low speed and stops upon reaching the rising edge of the Z signal for the first time.



33) 6098 = –2

The servo motor runs in the forward direction at ~~a~~ high speed first. If the torque reaches the limit and the speed is near zero after the motor hits the mechanical limit, and such status persists, it indicates the motor reaches the mechanical limit position. In this case, the motor runs in the reverse direction at ~~a~~ low speed and stops upon reaching the rising edge of the Z signal for the first time.



CAUTION

Keep sufficient clearance between the positive limit switch and negative limit switch, and set a proper acceleration rate. Failure to comply may cause collision.

7.9.5 Related Parameters

Index 6040h	Name	Control word			Setting Condition & Effective Time	During running & Immediately	Data Structure	VAR	Data Type	Uint16
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	0 to 65535	Default	0

Defines the control commands.

bit	Name	Description
0	Switch on	1: Valid, 0: Invalid
1	Enable voltage	1: Valid, 0: Invalid
2	Quick stop	0: Valid, 1: Invalid
3	Running	1: Valid, 0: Invalid
4	New set-point	0 -> 1: homing 1 -> 0: homing
8	Halt	0: Keep present running state 1: Halt

Index 6041h	Name	Status word			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	-	Default	0

Shows the servo drive status.

bit	Name	Description
0	Ready to switch on	1: Valid, 0: Invalid
1	Switch on	1: Valid, 0: Invalid
2	Operation enabled	1: Valid, 0: Invalid
3	Fault	1: Valid, 0: Invalid
4	Voltage enabled	1: Valid, 0: Invalid
5	Quick stop	0: Valid, 1: Invalid
6	Switch on disabled	1: Valid, 0: Invalid
7	Warning	1: Valid, 0: Invalid
8	Manufacturer-specific	Undefined
9	Remote	1: Valid, control word activated 0: Invalid
10	Target reached	0: Home not located 1: Home located
12	Homing attained	0: Home not found 1: Home found
13	Homing error	0: No homing error 1: Homing error occurs
15	Home find	0: Home not located 1: Home located

<table>
<tr><td rowspan="2">Index 6098h</td><td>Name</td><td colspan="3">Homing method</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>int8</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>HM</td><td>Value Range</td><td>–2 to +35</td><td>Default</td><td>0</td></tr>
</table>

Defines the homing method.

Mode	Description
–2	Forward homing: Home: Z signal Deceleration point: forward mechanical limit
–1	Reverse homing: Home: Z signal Deceleration point: reverse limit position
1	Reverse homing: Home: Z signal Deceleration point: negative limit switch (N-OT) The falling edge of the N-OT signal must be reached before reaching the Z signal.
2	Forward homing: Home: Z signal Deceleration point: positive limit switch (P-OT) The falling edge of the P-OT signal must be reached before reaching the Z signal.
3	Forward homing: Home: Z signal Deceleration point: home switch (HW) The falling edge on the same side of the HW signal must be reached before reaching the Z signal.
4	Reverse homing: Home: Z signal Deceleration point: home switch (HW) The rising edge on the same side of the HW signal must be reached before reaching the Z signal.
5	Reverse homing: Home: Z signal Deceleration point: home switch (HW) The falling edge on the same side of the HW signal must be reached before reaching the Z signal.
6	Forward homing: Home: Z signal Deceleration point: home switch (HW) The rising edge of the HW signal on the same side must be reached before reaching the Z signal.
7	Forward homing: Home: Z signal Deceleration point: home switch (HW) The falling edge on the same side of the HW signal must be reached before reaching the Z signal.
8	Forward homing: Home: Z signal Deceleration point: home switch (HW) The rising edge on the same side of the HW signal must be reached before reaching the Z signal.
9	Forward homing: Home: Z signal Deceleration point: home switch (HW) The rising edge on the other side of the HW signal must be reached before reaching the Z signal.
10	Forward homing: Home: Z signal Deceleration point: home switch (HW) The falling edge on the other side of the HW signal must be reached before reaching the Z signal.

Index 6098h	Name	Homing method			Setting Condition & Effective Time	During running & At stop	Data Structure	VAR	Data Type	int8
	Access	RW	Mapping	RPDO	Related Mode	HM	Value Range	–2 to +35	Default	0

11	Reverse homing: Home: Z signal Deceleration point: home switch (HW) The falling edge on the same side of the HW signal must be reached before reaching the Z signal.
12	Reverse homing: Home: Z signal Deceleration point: home switch (HW) The rising edge on the same side of the HW signal must be reached before reaching the Z signal.
13	Reverse homing: Home: Z signal on the other side of the home switch Deceleration point: home switch (HW) The rising edge on the other side of the HW signal must be reached before reaching the Z signal.
14	Homing in the reverse direction: Home: Z signal on the other side of the home switch Deceleration point: home switch (HW) The falling edge of the HW signal on the other side must be reached before reaching the Z signal.
15 to 16	N/A
17 to 32	Similar to 1 to 14. However, the deceleration point overlaps with the home.
33	Reverse homing. The home is the Z signal.
34	Forward homing. The home is the Z signal.
35	The present position is used as the home.

Index 6099h	Name	Homing speeds			Setting Condition & Effective Time	-	Data Structure	ARR	Data Type	Uint32
	Access	-	Mapping	Yes	Related Mode	HM	Value Range	OD data range	Default	OD default value

Defines the two speed values used in the homing mode.

◆ Speed during search for switch

◆ Speed during search for zero

Sub-index 0h	Name	Number of homing speed sub-indexes			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint8
	Access	RO	Mapping	NO	Related Mode	-	Value Range	2	Default	2

<table>
<tr><td rowspan="3">Sub-index 1h</td><td>Name</td><td colspan="3">Speed during search for switch</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint 32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>HM</td><td>Value Range</td><td>0 to (232-1) (Velocity unit/s)</td><td>Default</td><td>1747627</td></tr>
<tr><td colspan="10">Defines the speed during searching for the deceleration point signal. A large setting value helps prevent E601.0 (Homing timeout) caused by a prolonged homing process.
◆ Note: After finding the deceleration point, the slave decelerates and blocks the change of the home signal during deceleration. To prevent encountering the home signal during deceleration, set the switch position of the deceleration point signal properly to leave sufficient deceleration distance or increase the homing acceleration rate to shorten the deceleration time.</td></tr>
</table>

<table>
<tr><td rowspan="3">Sub-index 2h</td><td>Name</td><td colspan="3">Speed during search for zero</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>int32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>HM</td><td>Value Range</td><td>10 to (232-1) (velocity unit/s)</td><td>Default</td><td>100</td></tr>
<tr><td colspan="10">Defines the speed during searching for the home signal. A small setting value helps avoid overshoot during stop at a high speed, which prevents large deviation between the stop position and the preset mechanical home.</td></tr>
</table>

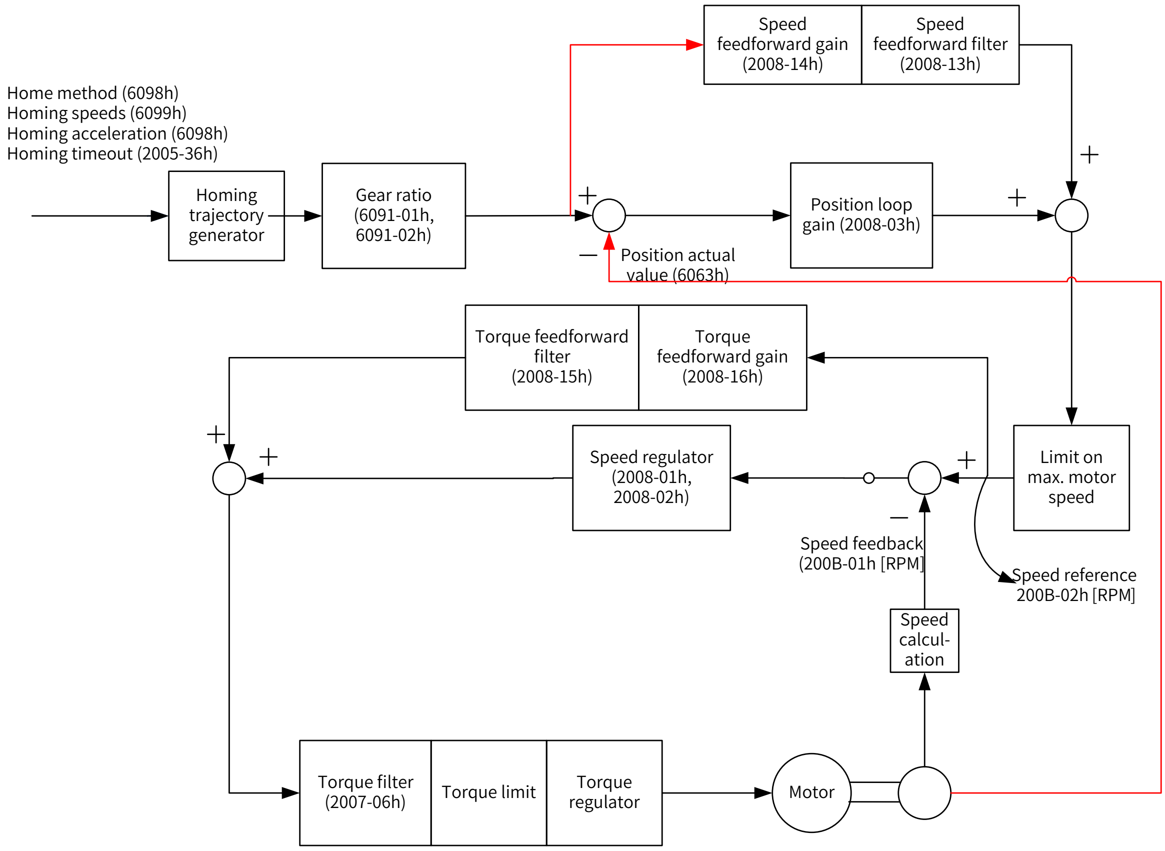
<table>
<tr><td rowspan="3">Index 609Ah</td><td>Name</td><td colspan="3">Homing acceleration</td><td>Setting Condition & Effective Time</td><td>During running & At stop</td><td>Data Structure</td><td>VAR</td><td>Data Type</td><td>DUINT32</td></tr>
<tr><td>Access</td><td>RW</td><td>Mapping</td><td>RPDO</td><td>Related Mode</td><td>HM</td><td>Value Range</td><td>0 to (2^{32}-1) (Acceleration unit/s^{2})</td><td>Default</td><td>100</td></tr>
<tr><td colspan="10">Defines the acceleration rate in the homing mode and indicates the position reference (position unit) increment per second.
The setting value takes effect after homing is started.
In the homing mode, if 605Dh (Halt option code) is set to 2, the servo drive decelerates to stop as defined by 609Ah.
For 609Ah, the setting value 0 will be forcibly changed into 1.</td></tr>
</table>

7.9.6 Recommended Configuration

The basic configuration for the homing mode is shown in the following table.

RPDO	TPDO	Description
6040: Control word	6041:Status word	Mandatory
6098: Homing method		Optional
6099-01: Speed during search for switch		Optional
6099-02: Speed during search for zero		Optional
609A: Homing acceleration		Optional
	6064: Position actual value	Optional
6060: Modes of operation	6061: Modes of operation display	Optional

7.9.7 Function Block Diagram



7.10 Auxiliary Functions

The servo drive offers the following auxiliary functions:

- Motor protection
- DI filter time setting
- Touch probe function (latch function)

7.10.1 Touch Probe Function (Latch Function)~~)~~

The latch function latches the position actual value (position unit) when an external latch input signal or the Z signal changes.

The SV660N offers two touch probes to record the positions corresponding to the rising edge or fall edge of each touch probe signal, which means four positions can be latched. Use DI5 when a DI terminal is to be used as the probe trigger signal.

CAUTION

- No specific DI logic is required when a DI terminal is used as the probe trigger signal.
- You can set the filter window for the probe signal through 200A-14h and 200A-15h when a DI terminal is used as the touch probe trigger signal.

■ Related Objects

Index (HEX)	Sub-index (HEX)	Name	Access	Data Type	Unit	Value Range	Default
2003	03	DI1 function selection	RW	Uint16	-	0 to 65535	14
…							
2003	0B	DI5 function selection	RW	Uint16	-	0 to 65535	39
60B8	00	Touch probe function (latch Function)	RW	Uint16	-	0 to 65535	0
60B9	00	Touch probe status	RO	Uint16	-	-	0
60BA	00	Touch probe 1 positive edge	RO	int32	Position unit	-	0
60BB	00	Touch probe 1 negative edge	RO	int32	Position unit	-	0
60BC	00	Touch probe 2 positive edge	RO	int32	Position unit	-	0
60BD	00	Touch probe 2 negative edge	RO	int32	Position unit	-	0
60D5	00	Touch probe 1 positive edge counter	RO	Uint16	-	-	0
60D6	00	Touch probe 1 negative edge counter	RO	Uint16	-	-	0
60D7	00	Touch probe 2 positive edge counter	RO	Uint16	-	-	0
60D8	00	Touch probe 2 negative edge counter	RO	Uint16	-	-	0

■ Operation procedures

Observe the following procedures when using DI5 as the probe trigger signal.

Requirement: continuous latching of the touch probe 1 positive value

1) Set the function of DI5 by setting 0x2003-0B to 38.
2) Set the touch probe function in 0x60B8.

The definition of each bit of the touch probe function (0x60B8) is shown in the following table.

<table>
<tr><th>Bit</th><th>Description</th><th>Remarks</th></tr>
<tr><td>0</td><td>Touch probe 1 function selection
0: Switch off touch probe 1
1: Enable touch probe 1</td><td rowspan="6">Bit0 to Bit5: settings related to touch probe 1
When the DI terminal is used as the touch probe triggering signal, the DI source is non-modifiable once the touch probe is enabled.
For an absolute encoder, the Z signal refers to the zero point of the single-turn position feedback of the motor.</td></tr>
<tr><td>1</td><td>Touch probe 1 trigger mode
0: Single trigger mode (Latches the position at the first trigger event.)
1: Continuous trigger mode</td></tr>
<tr><td>2</td><td>Touch probe 1 trigger signal selection
0: DI signal
1: Z signal</td></tr>
<tr><td>3</td><td>N/A</td></tr>
<tr><td>4</td><td>Touch probe 1 positive edge
0: Switch off sampling at positive edge
1: Enable sampling at positive edge</td></tr>
<tr><td>5</td><td>Touch probe 1 negative edge
0: Switch off sampling at negative edge
1: Enable sampling at negative edge</td></tr>
</table>

Bit	Description	Remarks
6 to 7	N/A	
8	Touch probe 2 function selection 0: Switch off touch probe 2 1: Enable touch probe 2	Bit8 to Bit13: settings related to touch probe 2
9	Touch probe 2 trigger mode 0: Single trigger mode (Latches the position at the first trigger event.) 1: Continuous trigger mode	
10	Touch probe 2 trigger signal selection 0: DI signal 1: Z signal	
11	N/A	
12	Touch probe 2 positive edge 0: Switch off sampling at positive edge 1: Enable sampling at positive edge	
13	Touch probe 2 negative edge 0: Switch off sampling at negative edge 1: Enable sampling at negative edge	
14 to 15	N/A	

Set 0x60B8 to 0x0013 in this example.

3) Read the touch probe status through 0x60B9.

The definition of each bit of the touch probe status (0x60B9) is shown in the following table.

Bit	Description	Remarks
0	Touch probe 1 function selection 0: Switch off touch probe 1 1: Enable touch probe 1	Bit0 to Bit7: status of touch probe 1
1	Touch probe 1 positive edge value 0: No positive edge value stored 1: Positive edge value stored	
2	Touch probe 1 negative edge value 0: No negative edge value stored 1: Negative edge value stored	
3 to 7	N/A	
8	Touch probe 2 function selection 0: Switch off Touch probe 2 1: Enable touch probe 2	Bit8 to Bit15: status of touch probe 2
9	Touch probe 2 positive edge value 0: No positive edge value stored 1: Positive edge value stored	
10	Touch probe 2 negative edge value 0: No negative edge value stored 1: Negative edge value stored	
11 to 15	-	

In this example, you can read bit1 of 0x60B9 to check whether the function of position latch at positive edge of touch probe 1 is enabled.

4) Read the latch position of the touch probe.

The four position values of the touch probe are saved in 0x60BA to 0x60BD.

In this example, if the function of position latch at positive edge of touch probe 1 is executed, you can read the position value through 0x60BA (Touch probe 1 positive edge, position unit). The latch times can be obtained through 0x60D5.

The following figure shows the function setting sequence and status feedback of the touch probe in the preceding example, which takes DI5 as the trigger signal and adopts positive edge latch.

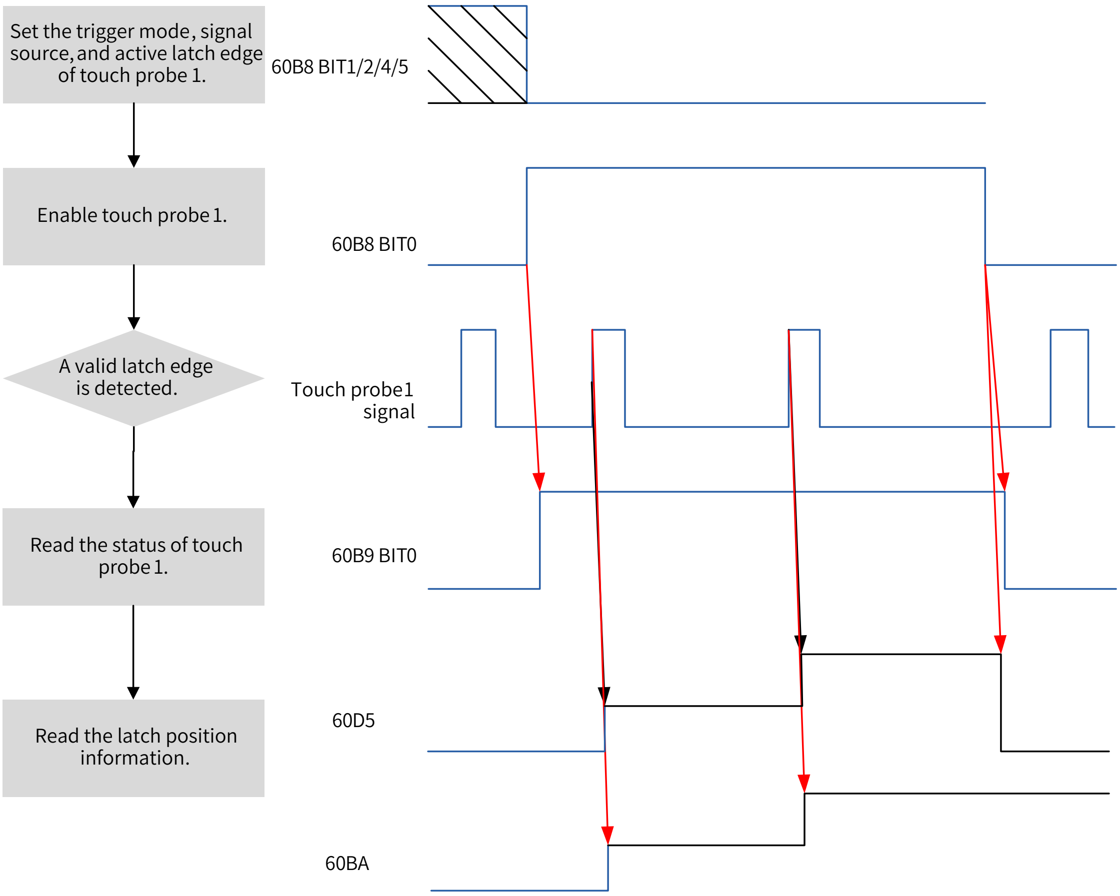


Figure 7-84 Procedures for use of the touch probe

7.10.2 Software Limit

Traditionally, the limit is defined by the external sensor signal connected to CN1, which is known as the hardware limit.

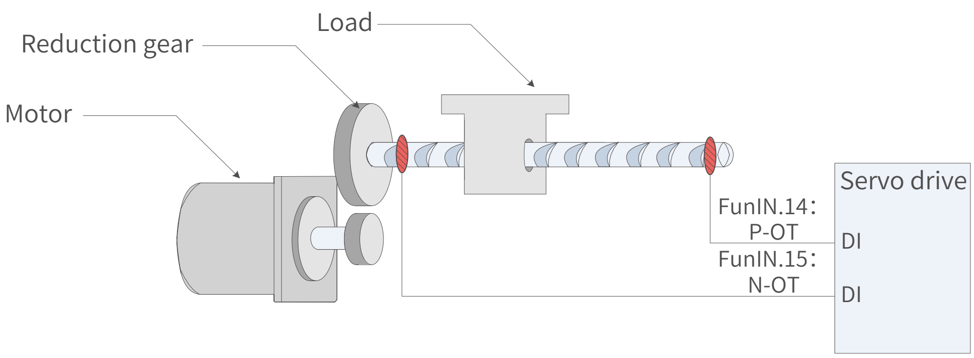


Figure 7-85 Installation of limit switches

■ Comparison between the hardware limit and software limit

Hardware limit		Software limit	
1	Restricted to linear movement and single-turn rotation movement.	1	Applicable to linear movement and rotation movement.
2	External mechanical limit switches are required.	2	Removes the need for hardware wiring, preventing malfunction due to poor contact.
3	Suffered from the risk of mechanical slip.	3	Prevents malfunction due to mechanical slip through internal position comparison.
4	Fails to judge or alarm the out-of-limit situation after power-off.		

The software limit works by comparing the set limit value with the internal feedback value. If the latter exceeds the former, a warning will be reported and the servo drive stops. This function is available in both absolute and incremental position modes. To use this function in the incremental position mode, set 200A-02h to 2 to make the servo drive perform homing upon power-on before the software limit applies.

Related objects:

200A-02h H0A-01	Name	Absolute position limit			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Value Range	0 to 2	Default	0

This object determines whether the absolute position limit is activated and the conditions for activation.

Value	Absolute Position Limit Selection
0	Disabled
1	Enabled
2	Enabled after homing

If the absolute position limit is enabled, the servo drive stops according to the setting of 2002-08h (Stop mode at overtravel) when the absolute position feedback reaches the limit value.

607D-01h	Name	Min. position limit			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	int32
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	-2^{31} to $+(2^{31}-1)$ (position unit)	Default	-2^{31}

This object defines the minimum software position limit relative to the mechanical zero point.

607D-02h	Name	Max. position limit			Setting Condition & Effective Time	During running & At stop	Data Structure	-	Data Type	int32
	Access	RW	Mapping	RPDO	Related Mode	All	Value Range	-2^{31} to $+(2^{31}-1)$ (position unit)	Default	$2^{31}-1$

This object defines the maximum software position limit relative to the mechanical zero point.

CAUTION	
⚠	◆ Ensure the value of 607D-01h is less than or equal to 607D-02h. If 607D-01h is set to a value larger than 607D-02h, the servo drive reports EE09.0 (Wrong software position limit). ◆ In the absolute rotation mode or single-turn mode, ensure 607D-01 and 607D-02 are within the mechanical position limit. Otherwise, the servo drive reports EE09.0. ◆ Ensure the value of 607Ch (Home offset) is within the software limit range. Otherwise, the servo drive reports EE09.0.

7.10.3 Position Comparison

The position comparison works by comparing the instantaneous position data with the value pre-stored in the data array and, once available, outputs a DO signal with pulse width settable for use in subsequent motion control. Such comparison is implemented through FPGA, removing the risk of software communication delay between different chips. Accurate comparison can also be performed on the motion axis rotating at a high speed.

For position comparison, you can select “active high” or “active low” for the DO terminal. When “active high” is selected, the corresponding DO is activated when it is connected to the common terminal and deactivated when it is disconnected from the common terminal. When “active low” is selected, the corresponding DO is deactivated when it is connected to the common terminal and activated when it is disconnected from the common terminal. There are three DO terminals for the SV660N servo drive.

1 Applicable conditions

Position comparison is available only when the following conditions are fulfilled.

Conditions for Position Comparison	
Control mode	All the control modes
Others	◆ After EtherCAT communication is confirmed ◆ After homing is done ◆ Motor rotating normally with critical parameters (control parameters included) set properly

2 Related Objects

The configurable DO logic functions are listed as follows:

- 0: No definition
- 1: Servo ready (SRDY)
- 2: Motor rotating
- 9: Brake
- 10: Warning (WARN)
- 11: Alarm (ALRM)
- 25: Position Comparison (CMP)
- 32: STO EDM

When position comparison is enabled, you can allocate function 25 (Position comparison) to any one of the three DOs, and the DO you select will act as the position comparison output signal.

■ Parameters for position comparison

Group H18: Position comparison output

Para. No.	Name	Description
H18: Position Comparison Output		
H18-00	Position comparison switch	1: Enabled
H18-02	Position comparison resolution	Defines the number of pulses per revolution. For example, if H18-02 is set to 2, the number of pulses per revolution is 2^{23}. 0: 24-bit 1: 23-bit 2: 22-bit 3: 21-bit 4: 20-bit 5: 19-bit 6: 18-bit 7: 17-bit
H18-03	Position comparison mode	0: Single comparison 1: Cyclic comparison
H18-04	Present position as zero	1: Enabled
H18-05	Position comparison output width	Defines the active pulse width of the DO when the comparison point is reached. The value range is 0 to 2047 (unit: 0.1 ms).
H18-07	Start point of position comparison	Activated when H18-00 is set to 1 again.
H18-08	End point of position comparison	Activated when H18-00 is set to 1 again.
H18-09	Present status of position comparison	0: No comparison n: Waiting for No. N comparison point
H18-10	Real-time position feedback	Displays the present position value during position comparison. Value range: -2^{31} to $2^{31}-1$
H18-12	Zero offset of position comparison	Defines the offset value after the present position is taken as the zero point. Value range: -2^{31} to $+2^{31}-1$
H19-00	~~Target~~ position comparison point 1	Defines the comparison value of the first target position. Value range: -2^{31} to $2^{31}-1$
H19-02	Attribute of position comparison point 1	Defines the attribute of the first comparison point. 0: Skip this point 1: Output DO active signal if current position changes from less than to more than the comparison point 2: Output DO active signal if current position changes from more than to less than the comparison point 3: Output DO active signal in both situations
H19-03	~~Target~~ position comparison point 2	Defines the second target position comparison value. Value range: -2^{31} to $2^{31}-1$
H19-05	Attribute of position comparison point 2	Defines the attribute of the second comparison point. 0: Skip this point 1: Output DO active signal if current position changes from less than to more than the comparison point 2: Output DO active signal if current position changes from more than to less than the comparison point 3: Output DO active signal in both situations

Para. No.	Name	Description
H19-06	~~Target~~ position comparison point 3	Defines the 3rd target position comparison value. Value range: -2^{31} to $2^{31}-1$
H19-08	Attribute of position comparison point 3	Defines the attribute of the third comparison point. 0: Skip this point 1: Output DO active signal if current position changes from less than to more than the comparison point 2: Output DO active signal if current position changes from more than to less than the comparison point 3: Output DO active signal in both situations
H19-09	~~Target~~ position comparison point 4	Defines the 4th target position comparison value. Value range: -2^{31} to $2^{31}-1$
H19-11	Attribute of position comparison point 4	Defines the attribute of the 4th comparison point. 0: Skip this point 1: Output DO active signal if current position changes from less than to more than the comparison point 2: Output DO active signal if current position changes from more than to less than the comparison point 3: Output DO active signal in both situations
H19-12	~~Target~~ position comparison point 5	Defines the 5th target position comparison value. Value range: -2^{31} to $2^{31}-1$
H19-14	Attribute of position comparison point 5	Defines the attribute of the 5th comparison point. 0: Skip this point 1: Output DO active signal if current position changes from less than to more than the comparison point 2: Output DO active signal if current position changes from more than to less than the comparison point 3: Output DO active signal in both situations
H19-15	~~Target~~ position comparison point 6	Defines the 6th target position comparison value. Value range: -2^{31} to $2^{31}-1$
H19-17	Attribute of position comparison point 6	Defines the attribute of the 6th comparison point: 0: Skip this point 1: Output DO active signal if current position changes from less than to more than the comparison point 2: Output DO active signal if current position changes from more than to less than the comparison point 3: Output DO active signal in both situations
H19-18	~~Target~~ position comparison point 7	Defines the 7th target position comparison value. Value range: -2^{31} to $2^{31}-1$
H19-20	Attribute of position comparison point 7	Defines the attribute of the 7th comparison point. 0: Skip this point 1: Output DO active signal if current position changes from less than to more than the comparison point 2: Output DO active signal if current position changes from more than to less than the comparison point 3: Output DO active signal in both situations
H19-21	~~Target~~ position comparison point 8	Defines the 8th target position comparison value. Value range: -2^{31} to $2^{31}-1$

Para. No.	Name	Description
H19-23	Attribute of position comparison point 8	Defines the attribute of the 8th comparison point. 0: Skip this point 1: Output DO active signal if current position changes from less than to more than the comparison point 2: Output DO active signal if current position changes from more than to less than the comparison point 3: Output DO active signal in both situations

3 Run

1) Description

■ Position comparison switch (H18-00)

When the value of H18-00 changes from 0 to 1, position comparison starts and the value of H18-09 (Present status of position comparison) is updated to the start point of position comparison. When the value of H18-00 changes to 0, position comparison stops and the present comparison status is cleared.

■ Position comparison resolution (H18-02)

The comparison resolution defines the number of pulses per revolution. Given the maximum and minimum limits on the target position (defined by group H19), you can reset the resolution when data overflow occurs on the comparison value. For example: H18-02 = 7-17bit
The maximum value of the target position is 2^{31}–1, and the motor rotates by 2^{31}–1/2^{17} circles.

The target position in group H19 is only related to the set resolution.

■ Single comparison mode (H18-03 = 0)

In the single comparison mode, when comparison of the end point is done, the comparison function is switched off automatically and the present comparison value is cleared to zero. The comparison function can be enabled again only when the position comparison ~~switch~~ is switched on again.

The real-time position feedback in the single comparison mode is an absolute value, which means it is an accumulative value based on the preceding comparison point. Such value will not be cleared automatically.

■ Cyclic comparison mode (H18-03 = 1)

In the cyclic comparison mode, the comparison function will not be switched off when the comparison of the end point is done, and the present comparison value will be set as the start point for comparison. Each time the comparison of a certain point is done, the value of H18-10 (Real-time position feedback) is cleared and re-counted for cyclic comparison.

In the cyclic comparison mode, the target position is a relative and incremental value. Each time the comparison of a certain point is done, the real-time position feedback is cleared and re-counted to be compared with the new target point.

■ Position comparison output width (H18-05)

When the position comparison conditions are fulfilled, the servo drive outputs DO active level signal. The width of the active signal can be set by H18-05 (value range: 1 to 2047 x 0.1 ms).

When the DO output is active, the comparison logic is suspended and no comparison will be performed. In this case, ensure the operating time between two ~~target~~ points is larger than the DO output width.

■ ~~Target~~ position comparison point

There are eight ~~target~~ position comparison points in total. The comparison point is a 32-bit signed number. The ~~target~~ position comparison value and the comparison attribute value must be updated to the related parameters in group H19 in advance.

■ Start point for comparison (H18-07)

The start point indicates the position of the first comparison point. For example, if the start point is set to 5, the comparison starts from the fifth ~~target~~ position point.

■ End point for comparison (H18-08)

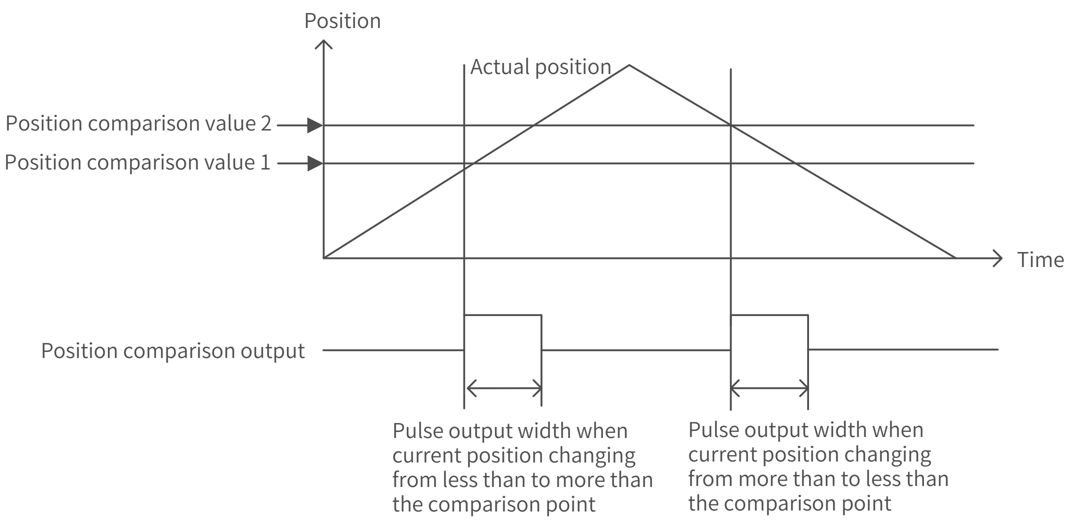
The end point indicates the position of the last comparison point. For example, if the end point is set to 7, the comparison stops or restarts from the start point after the comparison of the 7th target position point is done.

■ Zero offset of position comparison (H18-12)

The value of H18-10 (Real-time position feedback) will be changed to the offset value defined by H18-12 (Zero offset of position comparison) at the rising edge (0 → 1) of H18-04 (Present position as zero).

2) Running

■ When the position feedback of the encoder passes the target position comparison values (H19-00 to H19-21), the DO outputs the time width pulse defined by H18-05 (Position comparison output width), as shown in the following figure.

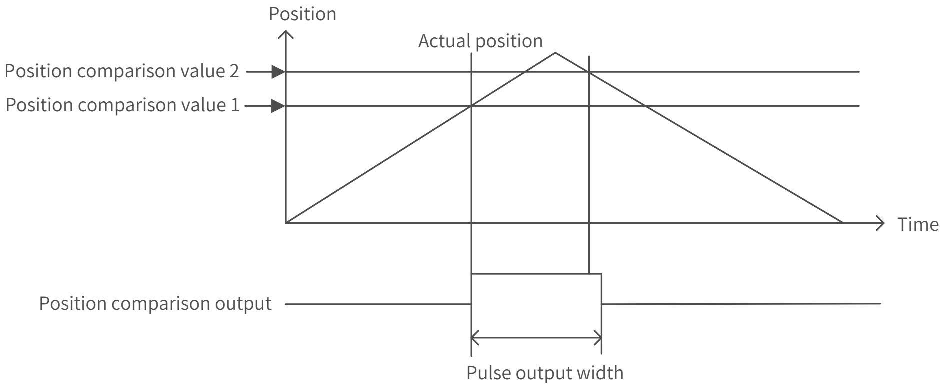


When the attribute of the target point is set to 1 (Output DO active signal if current position changes from less than to more than the comparison point), the DO outputs the position comparison signal when the encoder passes the ~~target~~ position comparison value with position changing from less than to more than the comparison point.

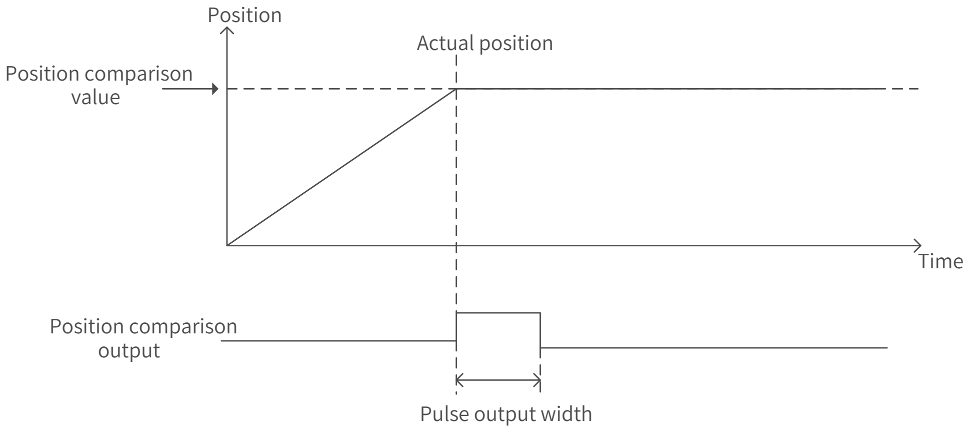
When the attribute of the target point is set to 2 (Output DO active signal if current position changing from more than to less than the comparison point), the DO outputs the position comparison signal when the encoder passes the ~~target~~ position comparison value with position changing from more than to less than the comparison point.

When the attribute of the target point is set to 3 (Output DO active signal under both situations), the DO outputs position comparison signal when the encoder passes the target position comparison value with position changing in either way.

■ When the action direction reverses and multiple position comparison values are set, no comparison will be performed once the position comparison DO output is active. Therefore, ensure the operating time between two target points is larger than the pulse output width. As shown in the following figure, no comparison is performed because the pulse output width is larger than the operating time between the two target points.



- Only one pulse will be output when the stop position is the same with the position comparison value, as shown in the following figure.

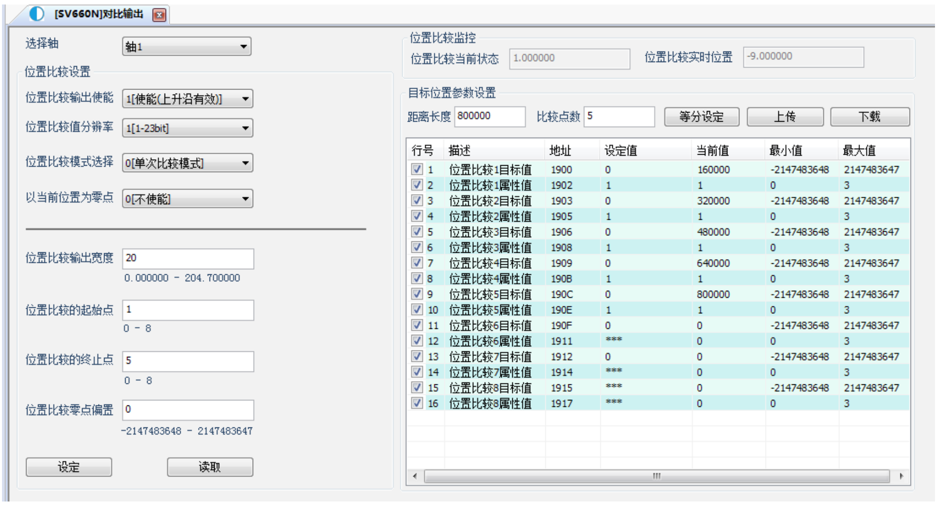


3) Interface of the software tool

For the convenience of setting the target position comparison value, the software tool provides the function of division setting. Set a proper comparison mode, start point, and end point first.

- In the single comparison mode, set the total running distance and number of comparison points. After clicking " 等分设定 " (Division setting), the target value of the first point is updated to “Distance x 1/Number of comparison points”, the target value of the second point is updated to “Distance x 2/ Number of comparison points”, and the target value of the Nth point is updated to “Distance x N/ Number of comparison points”.

- In the cyclic comparison mode, " 距离长度 " (Distance length) is used to set the operating distance between two adjacent point. " 比较点数 " (Comparison points) is used to set the numbers of points to be compared cyclically. After clicking " 等分设定 " (Division setting), the target values of the 1st to the Nth comparison points are updated to the values set in " 距离长度 " (Distance length).



7.11 Absolute System

For the wiring and battery installation of the absolute encoder, see "3.4 Connection of the Servo Drive and Servo Motor Encoder Cables".

7.11.1 Descriptions for Use of the Absolute System

■ Overview

The absolute encoder records the single-turn position and the number of revolutions. With a single-turn resolution up to 8388608 (2^{23}), the encoder can record 16-bit multi-turn data. The absolute system works in the position, speed, and torque control modes. When the servo drive is powered off, the encoder performs data backup using the power supplied by the battery. The servo drive therefore can calculate the absolute mechanical position through the encoder after power-on, removing the need for homing.

When using the absolute encoder, set 2000-01h (Motor code) to 14101 (Inovance 23-bit absolute encoder) and set 2002-02h (Absolute system selection) based on actual conditions. Er.731 will be reported when the battery is connected for the first time. Set 200D-15h (Absolute encoder reset selection) to 1 (Reset the encoder fault) to reset the encoder fault, and then perform the homing operation.

NOTE

When the value of 2002-03h (Rotation direction), 200D-15h (Absolute encoder reset selection) or the mechanical gear ratio is modified, an abrupt change will occur on the mechanical position, requiring a homing operation. After homing is done, the servo drive calculates the difference value between the absolute mechanical position and the encoder absolute position and stores the difference value in the EEPROM.

■ Related objects

■ Absolute system setting

Set 2000-01h (Motor code) to 14101 (Inovance 23-bit absolute encoder), and select the absolute position mode through 2002-02h (Absolute system mode).

2000-01h	Name	Motor code			Setting Condition & Effective Time	At stop Next power-on	Data Structure	-	Data Type	Uint16
H00-00	Access	RW	Mapping	-	Related Mode	-	Value Range	0 to 65535	Default	14101

Defines the motor code.

Value	Motor SN	Description
14000	Inovance motor with incremental encoder	Encoder resolution: 1048576 (2^{20})
14101	Inovance motor with absolute encoder	Encoder resolution: 8388608 (2^{23})

H02-01	Name	Absolute system mode			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	Uint16
2002-02h	Access	RW	Mapping	-	Related Mode	All	Value Range	0 to 4	Default	0

Defines the mode of the absolute system.

Value	Absolute system mode	Description	Remarks
0	Incremental position mode	The encoder is used as a bus-type incremental encoder without power-off memory.	Battery not needed No multi-turn fault
1	Absolute position linear mode	The encoder is used as an absolute encoder with power-off memory. This mode is applicable to applications where the load movement range is fixed and multi-turn data overflow will not occur. The multi-turn data range in the absolute position linear mode is –32768 to +32767.	Battery needed, battery fault reported upon occurrence Multi-turn counting error and overflow fault reported upon occurrence
2	Absolute position rotation mode	The encoder is used as an absolute encoder with power-off memory. This mode is mainly applicable to the applications where the load movement range is unlimited and only single-turn position feedback is needed.	Battery needed, battery fault reported upon occurrence Multi-turn overflow fault not reported upon occurrence
3	Absolute position linear mode 2	The encoder is used as an absolute encoder with power-off memory. This mode is applicable to applications where the multi-turn data overflow fault can be left unattended.	Battery needed, battery fault reported upon occurrence Multi-turn overflow fault not detected
4	Single-turn absolute mode	In this mode, only the single-turn position of the encoder is recorded.	Battery not needed No multi-turn fault

■ Encoder feedback data

The feedback data of an absolute encoder is divided into the number of revolutions and the encoder position within one turn. For the incremental position mode, there is no feedback data concerning the number of revolutions.

H0B-70 200B-47h	Name	Number of revolutions of the absolute encoder			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint16
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	-	Default	-

Represents the number of revolutions of the absolute encoder.

<table>
<tr><td>H0B-71
200B-48h</td><td>Name</td><td colspan="3">Single-turn position feedback of the absolute encoder</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint32</td></tr>
<tr><td></td><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>-
(unit: encoder unit)</td><td>Default</td><td>-</td></tr>
<tr><td colspan="11">Represents the single-turn position feedback of the encoder. If the encoder resolution is R_E (for example, $R_E = 2^{23}$), the range is 0 to (R_E−1).</td></tr>
</table>

<table>
<tr><td>H0B-77
200B-4Eh</td><td>Name</td><td colspan="3">Absolute position (low 32 bits) of absolute encoder</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>Uint32</td></tr>
<tr><td></td><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td></td><td>-
(unit: encoder unit)</td><td>Default</td><td>-</td></tr>
<tr><td>H0B-79
200B-50h</td><td>Name</td><td colspan="3">Absolute position (high 32 bits) of absolute encoder</td><td>Setting Condition & Effective Time</td><td>-</td><td>Data Structure</td><td>-</td><td>Data Type</td><td>int32</td></tr>
<tr><td></td><td>Access</td><td>RO</td><td>Mapping</td><td>TPDO</td><td>Related Mode</td><td>All</td><td>Value Range</td><td>-
(unit: encoder unit)</td><td>Default</td><td>-</td></tr>
<tr><td colspan="11">Represents the absolute position feedback of the encoder.</td></tr>
</table>

7.11.2 Absolute Position Linear Mode

This mode is applicable to applications where the load movement range is fixed and multi-turn data overflow will not occur.

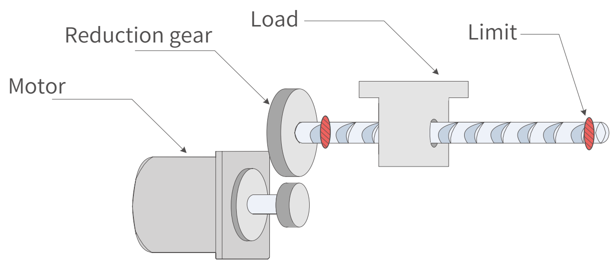


Figure 7-86 Application of the linear mode

Assume the absolute mechanical position (200B-3Bh and 200B-3Dh) is P_M, the encoder absolute position is P_E, the position offset in the absolute position linear mode (2005-2Fh and 2005-31h) is P_O, their relation will be: $P_M = P_E - P_O$

Assume the electronic gear ratio is B/A, and the mechanical absolute position (reference unit) is 200B-08h, then the following formula applies:

200B-08h = P_M/(B/A)

The multi-turn data range in the absolute position linear mode is –32768 to +32767. If the number of forward revolutions is larger than 32767 or the number of reverse revolutions is smaller than –32768, E735.0 (Encoder multi-turn counting overflow) will occur. In this case, set 200D-15h (Absolute encoder reset selection) to 2 (Reset the encoder fault and multi-turn data) to reset the multi-turn data and perform homing again. In special occasions, you can set 200A-25h (Multi-turn overflow fault of absolute encoder) to 1 (Hide) to hide E735.0 or use absolute position linear mode 2.

2005-2Fh	Name	Position offset in the absolute position linear mode (low 32 bits)			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	Uint32
H05-46	Access	RW	Mapping	-	Related Mode	All	Value Range	-2^{31} to $+(2^{31}-1)$ (encoder unit)	Default	0
2005-31h	Name	Position offset in the absolute position linear mode (high 32 bits)			Setting Condition & Effective Time	At stop & Next power-on	Data Structure	-	Data Type	int32
H05-48	Access	RW	Mapping	-	Related Mode	All	Value Range	-2^{31} to $+(2^{31}-1)$ (encoder unit)	Default	0

These parameters define the offset of the absolute mechanical position (encoder unit) relative to the absolute position (encoder unit) of the encoder in the linear mode (2002-02 = 1).

Position offset in the absolute position linear mode = Encoder absolute position - Mechanical absolute position

Note:

◆ The offset of the absolute position linear mode (2005-2Fh and 2005-31h) is 0 by default. If homing is performed, the servo drive automatically calculates the deviation between the encoder absolute position and the mechanical absolute position after homing, assigns the value to 2005-2Fh and 2005-31h, and stores the value to EEPROM.

200B-08h	Name	Absolute position counter			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	int32
H0B-07	Access	RO	Mapping	-	Related Mode	All	Value Range	-231 to +231 (encoder unit)	Default	0

Represents the current absolute position (reference unit) of the motor ~~in the position mode~~.

200B-3Bh	Name	Mechanical absolute position (low 32 bits)			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
H0B-58	Access	RO	Mapping	-	Related Mode	All	Value Range	- (unit: encoder unit)	Default	-
200B-3Dh	Name	Mechanical absolute position (high 32 bits)			Setting Condition & Effective Time	-	Data Structure	-	Data Type	int32
H0B-60	Access	RO	Mapping	-	Related Mode	All	Value Range	(unit: encoder unit)	Default	-

Represents the mechanical absolute position.

Index 6063h	Name	Position actual value*			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	int 32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (unit: encoder unit)	Default	0
Represents the absolute position of the motor (encoder unit). The value is equal to 200B-3Bh in the absolute position mode.										

Index 6064h	Name	Position actual value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	int 32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (unit: position unit)	Default	0
Represents the absolute position feedback in user defined units. Position actual value (6064h) x Gear ratio (6091h) = Position actual value* (6063h)										

200A-25h	Name	Absolute encoder multi-turn overflow fault			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	No	Related Mode	All	Value Range	0 to 1	Default	0
This object is used to hide E735.0 (Encoder multi-turn overflow fault) in the absolute position linear mode.										

Value	Description
0	0: Not hide
1	1: Hide

7.11.3 Absolute Position Rotation Mode

This mode is mainly applicable to applications where the load movement range is unlimited. The number of unidirectional revolutions of the motor is less than 32767 upon power failure, a~~s shown in the following figure~~.

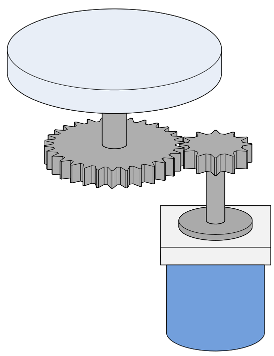
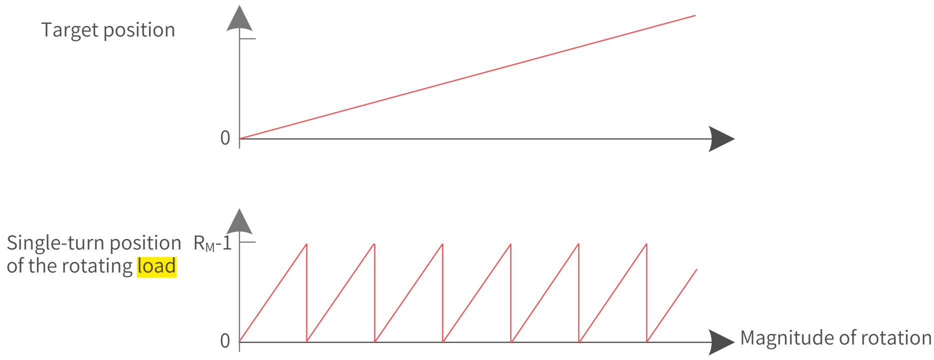
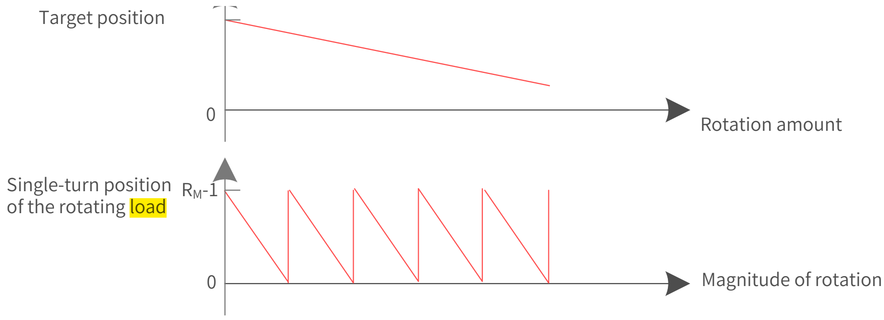


Figure 7-87 Rotating load

The single-turn position range of the rotating load is 0 to (R_M−1) (R_M: Encoder pulses per load revolution). When the gear ratio is 1:1, the variation law of the target position and the single-turn position of the rotating load during forward running is shown as follows.



The variation law of the target position and the single-turn position of the rotating load during reverse running is shown as follows.



When the motor works in the absolute rotation mode while the servo drive works in the HM mode, the setting range of the home offset is 0 to (R_M–1). If the home offset is set to a value outside this range, the servo drive reports EE09.1 (Home setting error).

The multi-turn data range is unlimited in the absolute position rotation mode. Therefore, E735.0 (Encoder multi-turn counting overflow) is hidden automatically.

Related parameters

2005-33h	Name	Mechanical gear ratio in the absolute position rotation mode (numerator)			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Value Range	1 to 65535	Default	1
2005-34h	Name	Mechanical gear ratio in the absolute position rotation mode (denominator)			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Value Range	1 to 65535	Default	1
2005-35h	Name	Pulses per load revolution in the absolute position rotation mode (low 32 bits)			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint32
	Access	RW	Mapping	-	Related Mode	All	Value Range	0 to (2^{32}-1) (encoder unit)	Default	0

2005-37h	Name	Position offset in the absolute position rotation mode (high 32 bits)			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	int32
	Access	RW	Mapping	-	Related Mode	All	Value Range	0 to 127 (unit: encoder unit)	Default	0

This parameter defines the ratio of the feedback pulses (encoder unit) per load revolution to the absolute position feedback of the encoder when the absolute system works in the rotation mode (2002-02 = 2).

Assume the encoder resolution is R_E, the encoder pulses per revolution is R_M:
when 2005-35h or 2005-37h are set to 0:
$R_M = R_E$ x 2005-33h/2005-34h
when 2005-35h or 2005-37h are set to 0:
R_M = 2005-37h x 2^{32} + 2005-35h

Note:

◆ The servo drive calculates the mechanical absolute position based on 2005-35h and 2005-37h first. If 2005-35h and 2005-37h are set to 0, the servo drive performs calculation based on 2005-33h and 2005-34h.

200B-52h	Name	Single-turn position of the rotating load (low 32 bits)			Setting Condition & Effective Time	-	Data Structure	-	Data Type	int 32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	(unit: encoder unit)	Default	-
200B-54h	Name	Single-turn position of the rotating load (high 32 bits)			Setting Condition & Effective Time	-	Data Structure	-	Data Type	Uint32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (unit: encoder unit)	Default	-

Represents the single-turn position (encoder unit) of the rotating load.
Value range: ($-R_M$+1) to (R_M–1)

200B-56h	Name	Single-turn position of the rotating load			Setting Condition & Effective Time	-	Data Structure	-	Data Type	int 32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (unit: position unit)	Default	-

Represents the single-turn position of the rotating load (position unit).

Index 6063h	Name	Position actual value*			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	int 32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (unit: encoder unit)	Default	0
Represents the absolute single-turn position of the rotating load (encoder unit). This value is equal to 200B-52h in the absolute position mode.										

Index 6064h	Name	Position actual value			Setting Condition & Effective Time	-	Data Structure	VAR	Data Type	int 32
	Access	RO	Mapping	TPDO	Related Mode	All	Value Range	- (unit: position unit)	Default	0
Represents the single-turn absolute position feedback of the rotating load in real time. This value is equal to 200B-56h in the absolute position mode. Position actual value (6064h) x Gear ratio (6091h) = Position actual value* (6063h)										

7.11.4 Single-Turn Absolute Mode

This mode is mainly applicable to applications where the load movement range is within the single-turn range of the encoder. In this case, the absolute encoder needs no battery as it records the single-turn data only.

1) Target position input range of EtherCAT communication

If a 23-bit absolute encoder is used in the single-turn absolute mode, the servo drive works in the CSP or PP mode, and the electronic gear ratio is 1:1:

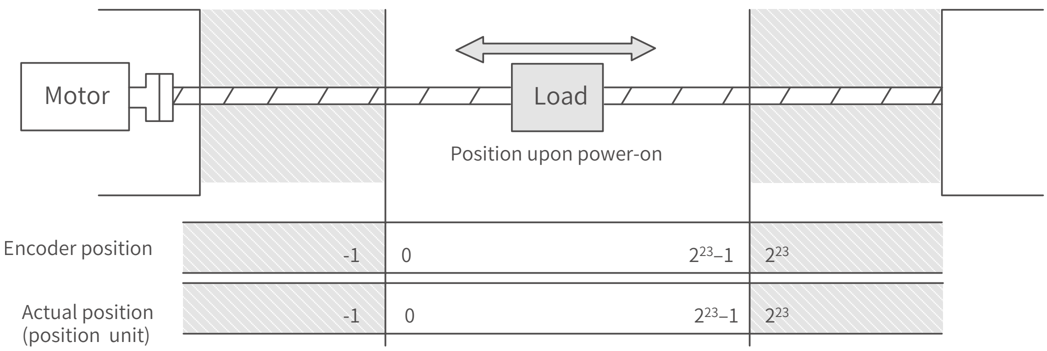
When 607Ch (Home offset) is set to 0, the target position range is 0 to (2^{23}–1).

After homing is done, the target position range is 607Ch to (2^{23}–1 + 607Ch).

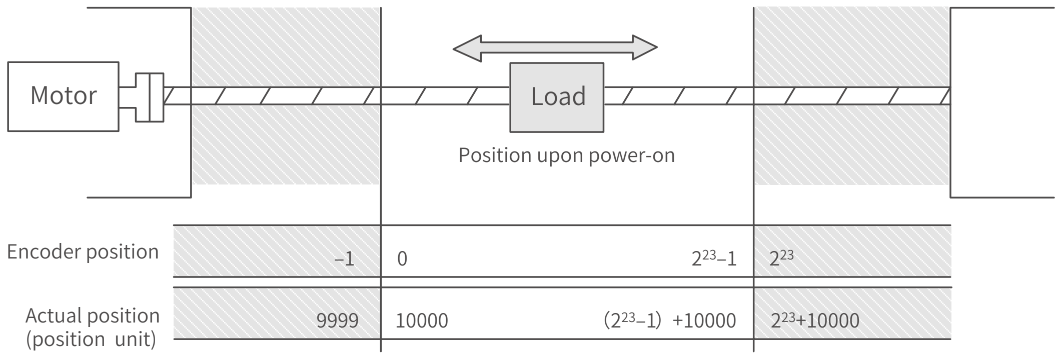
If the target position is set to a value outside the preceding range, EB01.4 (Target position beyond upper/lower limit) will be reported.

2) Example

When the gear ratio is 1:1, and 607Ch is set to 0, the diagram is shown as follows.



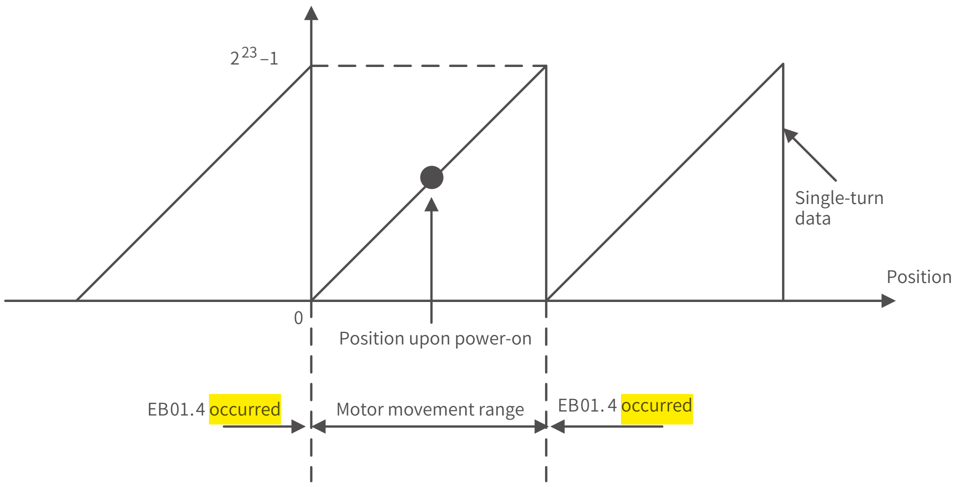
When the gear ratio is 1:1, and 607Ch is set to 10000, the diagram is shown as follows.



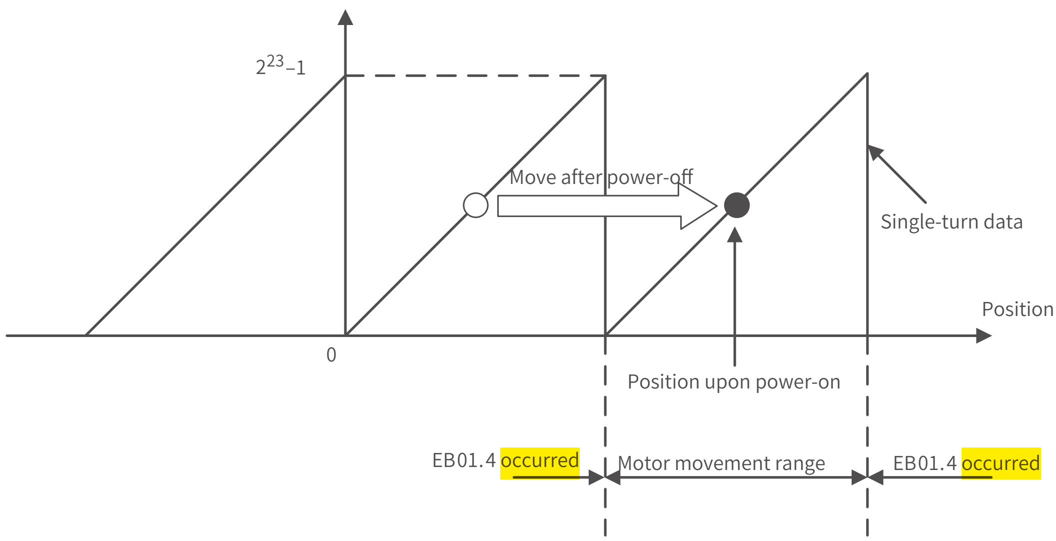
3) Precaution for the motor position upon power-on

The motor movement range is determined by the motor position upon power-on. (Take the 23-bit absolute encoder as an example)

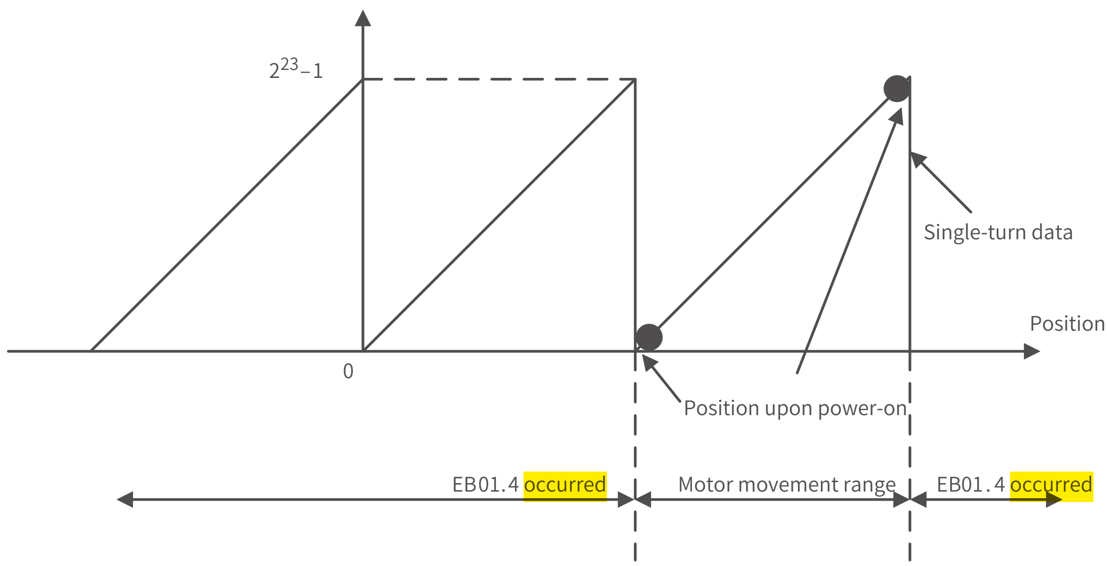
a) Position upon power-on: The motor movement range shown in the following figure is derived from the single-turn data range at the power-on position.



b) To change the motor movement range, turn off the power supply at the position shown in the preceding figure, and turn on the power supply again after the motor moves to the position shown in the following figure.



c) Note: When the power supply is switched on near the motor movement range, EB01.4 (Target position beyond the limit) may easily occur.



7.11.5 Precautions for Use of the Battery Box

E731.0 (Encoder battery fault) will be reported when the battery is connected for the first time. Set 200D-15h (Absolute encoder reset selection) to 1 (Reset the encoder fault) to reset the fault, and then perform homing.

When the battery voltage detected is smaller than 3.0 V, Er.730 (Encoder battery warning) occurs. Replace the battery according to the following procedures:

Step 1: Power on the servo drive and keep it in non-running state.
Step 2: Replace the battery.
Step 3: The servo drive automatically remove E730.0 (Encoder battery warning). If there is no other warning, make the servo drive run normally.

If you replace the battery after power-off, E731.0 (Encoder battery fault) will be reported and an abrupt change will occur on the multi-turn data. In this case, set 200D-15h to 1 to reset the fault, and then perform homing again.

When the servo drive is in the power-down state, ensure the maximum motor speed does not exceed 6000 RPM so that the encoder position can be recorded accurately.

Keep the battery box in environments within the required ambient temperature range and ensure the battery is in reliable contact and has sufficient power capacity. Otherwise, encoder data loss may occur.

Related parameter

200D-15h	Name	Absolute encoder reset selection			Setting Condition & Effective Time	At stop & Immediately	Data Structure	-	Data Type	Uint16
	Access	RW	Mapping	-	Related Mode	All	Value Range	0 to 2	Default	0

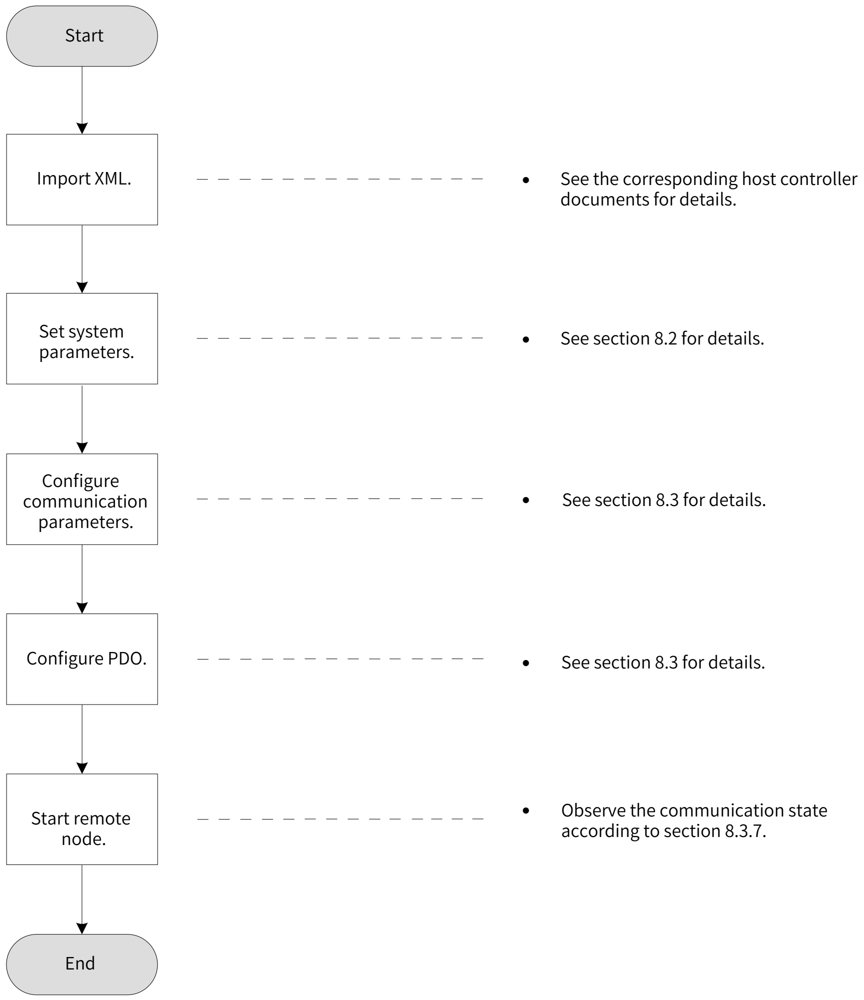
This parameter is used to reset the encoder fault or the multi-turn data.

Value	Description
0	No operation
1	Reset the encoder fault
2	Reset the encoder fault and multi-turn data

NOTE

The absolute position of the encoder changes abruptly after reset of the multi-turn data feedback. In this case, perform mechanical homing.

8 Communication Configurations



8.1 Overview of the EtherCAT Protocol

EtherCAT features high-performance, low cost, easy use and flexible topology. It is applicable to industrial applications requiring ultra-high speed I/O network. EtherCAT adopts standard Ethernet physical layer with twisted pairs or optical fibers (100Base-TX or 100Base-FX) used as the transmission media.

An EtherCAT system includes the master and the slave. The master requires a common network adapter, and the slave requires a special slave control chip, such as ET1100, ET1200, and FPGA.

EtherCAT can process data at the I/O layer, without any subbus or gateway delay：

- One system covers all devices, including input/output devices, sensors, actuators, drives, and displays.
- Transmission rate: 2 x 100 Mbit/s (high-speed Ethernet, full duplex mode).
- Synchronization: number of nodes between two devices: 300, cable length: 120 m, synchronization jitter: < 1 μs
- Refresh time:
  256 DI/DOs: 11 μs
  1000 DI/DOs distributed in 100 nodes:30 μs = 0.03 ms
  200 AI/AOs (16-bit): 50 μs, sampling rate: 20 kHz
  100 servo axes (8 byte IN+OUT for each): 100 μs = 0.1 ms
  12000 DI/DOs: 350 μs

To support more types of devices and applications, the following EtherCAT-based application protocols are established:

- CANopen over EtherCAT (CoE)
- Safety over EtherCAT (SoE, servo drive safety compliant with IEC 61800-7-204)
- Ethernet over EtherCAT (EoE)
- File over EtherCAT (FoE)

The slave only needs to support the most suitable application protocol.

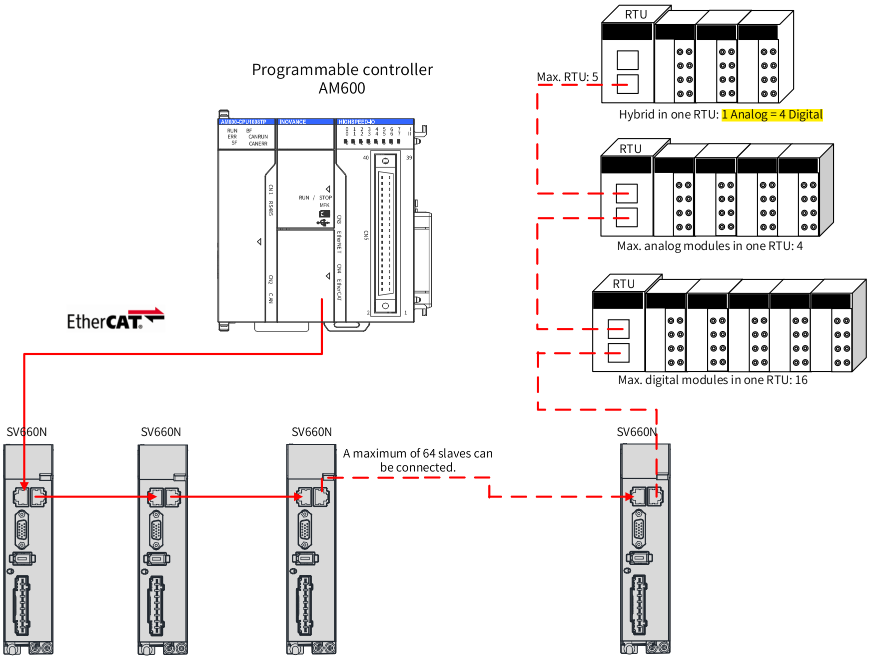


Figure 8-1 EtherCAT networking

8.2 System Parameters

8.2.1 Parameter Address Structure

Parameter access address: Index + Subindex, both are hexadecimal data.

The CiA402 protocol imposes the following limits on the parameter address.

Index (Hex)	Description
0000-0FFF	Data type description
1000-1FFF	CoE communication object
2000-5FFF	Manufacturer-specific object
6000-9FFF	Sub-protocol object
A000-FFFF	Reserved

8.2.2 System Parameter Settings

Necessary parameter settings are required for the SV660N servo drive to be connected to the EtherCAT fieldbus network.

Index	Sub-index	Name	Value Range	Default
2002	01h	Control mode	0: Speed mode 1: Position mode 2: Torque control mode 9: EtherCAT mode 255: This axis is not used.	9
200E	02h	Save parameter values modified through communication to EEPROM	0: Not save 1: Save 2XXXh series parameters 2: Save 6XXXH series parameters 3: Save all parameters	3
200E	16	EtherCAT slave alias	0 to 65535	0

CAUTION

Before saving parameters to EEPROM, set 200E-02h to a proper value. Otherwise, the parameters will be restored to the default values at next power-on.

8.3 EtherCAT Communication Basis

8.3.1 EtherCAT Communication Specifications

Item		Specifications
Communication protocol		IEC 61158 Type 12, IEC 61800-7 CiA 402 Drive Profile
Application layer	SDO	SDO request, SDO response
	Mapping	Variable PDO mapping
	CiA402	Profile position mode (PP) Profile velocity mode (PV) Profile torque mode (PT) Homing mode (HM) Cyclic synchronous position mode (CSP) Cyclic synchronous velocity mode (CSV) Cyclic synchronous torque mode (CST)
Physical layer	Transmission protocol	100BASE-TX (IEEE802.3)
	Maximum distance	100 m
	Interface	RJ45 x 2 (INT, OUT)

8.3.2 Communication Structure

Multiple protocols can be transmitted using the EtherCAT. The IEC 61800-7 (CiA 402)-CANopen motion control sub-protocol is used for the SV660N servo drive.

The following figure shows the EtherCAT communication structure at CANopen application layer.

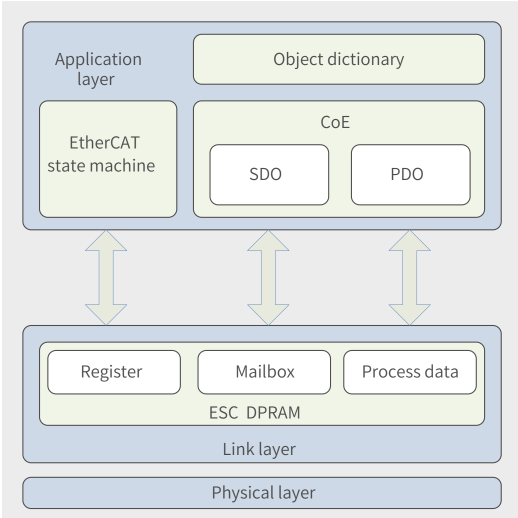


Figure 8-2 EtherCAT communication structure at CANopen application layer

The object dictionary in the application layer contains communication parameters, application process data and PDO mapping data. The process data object (PDO) contains the real-time data generated during running, which is read and written cyclically. In the SDO mailbox communication, the communication parameter objects and PDO objects are accessed and modified non-cyclically.

8.3.3 State Machine

The following figure shows the state transition diagram of the EtherCAT state machine.

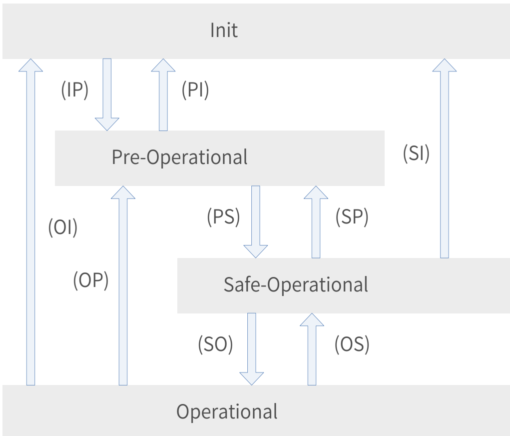


Figure 8-3 EtherCAT state machine

The EtherCAT state machine must support the following four states and coordinate the state relation between the master and slave applications during initialization and operation.

The four states are Init (I), Pre-Operational (P), Safe-Operational (S), and Operational (O).

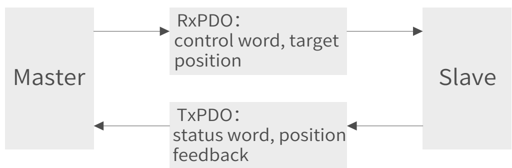
Transition from Init state to Operational state must be in the sequence of "Init → Pre-Operational → Safe-Operational → Operational". During transition from Operational state to Init state, certain steps can be skipped. The following table lists the state transition and initialization process.

Status	SDO	RPDO	TPDO	Description
Init (I)	No	No	No	Communication initialization No communication is available in the application layer, and the master can only read and write the EtherCAT slave controller (ESC) register.

Status	SDO	RPDO	TPDO	Description
IP	No	No	No	The master configures the slave addresses, mailbox, and distributed clock (DC). The master requests the Pre-Operational state.
Pre-Operational (P)	Yes	No	No	Mailbox data communication in the application layer (SDO)
PS	Yes	No	No	The master uses the process data mapping of SDO initialization. The master configures the SM channel used by the process data communication. The master configures the FMMU. The master requests the Safe-Operational state.
Safe-Operational (S)	Yes	No	Yes	SDO, TPDO, and distributed clock mode can be used.
SO	Yes	No	Yes	The master sends valid output data to request the Operational state.
Operational (O)	Yes	Yes	Yes	Normal operational state Both the input and output are valid. Mailbox communication can still be used.

8.3.4 Process Data

The real-time data transmission of EtherCAT is achieved through PDO. The PDO can be divided into RPDO (Reception PDO) and TPDO (Transmission PDO) based on the data transmission direction. The RPDO transmits the master data to the slave, and TPDO returns the slave data to the master.



The SV660N servo drive allows users to assign the PDO list and define the PDO mapping object.

1 PDO mapping

The PDO mapping is used to establish the mapping relation between the object dictionary and the PDO. 1600h to 17FFh are RPDOs, and 1A00h to 1BFFh are TPDOs. The SV660N series servo drive provides six RPDOs and five TPDOs, as listed in the following table.

RPDO (Six)	1600h	Variable mapping
	1701h to 1705h	Fixed mapping
TPDO (Five)	1A00h	Variable mapping
	1B01h to 0x1B04h	Fixed mapping

2 Fixed PDO mapping

The SV660N provides five fixed RPDOs and four fixed TPDOs.

The following table lists the typical instances of the RPDOs and TPDOs.

Control Mode	PP CSP
1701h (Outputs)	Mapping objects (four, 12 bytes)
	6040h (Control word) 607Ah (Target position) 60B8h (Touch probe function) 60FEh sub-index 1 (Physical outputs)
1B01h (Inputs)	Mapping objects (nine, 28 bytes)
	603Fh (Error code) 6041h (Status word) 6064h (Position actual value) 6077h (Torque actual value) 60F4 (Following error actual value) 60B9 (Touch probe status) 60BA (Touch probe 1 positive edge) 60BC (Touch probe 2 positive edge) 60FD (Digital inputs)

Control Mode	PP/PV/PT/CSP/CSV/CST
1702h (Outputs)	Mapping objects (7, 19 bytes)
	6040h (Control word) 607Ah (Target position) 60FFh (Target velocity) 6071h (Target torque) 6060h (Modes of operation) 60B8h (Touch probe function) 607Fh (Max profile velocity)
1B02h (Inputs)	Mapping objects (9, 25 bytes)
	603Fh (Error code) 6041h (Status word) 6064h (Position actual value) 6077h (Torque actual value) 6061h (Modes of operation display) 60B9 (Touch probe status) 60BA (Touch probe 1 positive edge) 60BC (Touch probe 2 positive edge) 60FD (Digital inputs)

Control Mode	PP/PV/CSP/CSV
1703h (Outputs)	Mapping objects (7, 17 bytes)
	6040h (Control word) 607Ah (Target position) 60FFh (Target velocity) 6060h (Modes of operation) 60B8h (Touch probe function) 60E0h (Positive torque limit value) 60E1h (Negative torque limit value)

1B03h (Inputs)	Mapping objects (10, 29 bytes)
	603Fh (Error code) 6041h (Status word) 6064h (Position actual value) 6077h (Torque actual value) 60F4 (Following error actual value) 6061h (Modes of operation display) 60B9 (Touch probe status) 60BA (Touch probe 1 positive edge) 60BC (Touch probe 2 positive edge) 60FD (Digital inputs)

Control Mode	PP/PV/PT/CSP/CSV/CST
1704h (Outputs)	Mapping objects (9, 23 bytes)
	6040h (Control word) 607Ah (Target position) 60FFh (Target velocity) 6071h (Target torque) 6060h (Modes of operation) 60B8h (Touch probe function) 607Fh (Max profile velocity) 60E0h (Positive torque limit value) 60E1h (Negative torque limit value)
1B02h (Inputs)	Mapping objects (9, 25 bytes)
	603Fh (Error code) 6041h (Status word) 6064h (Position actual value) 6077h (Torque actual value) 6061h (Modes of operation display) 60B9 (Touch probe status) 60BA (Touch probe 1 positive edge) 60BC (Touch probe 2 positive edge) 60FD (Digital inputs)

Control Mode	PP/PV/CSP/CSV
1705h (Outputs)	Mapping objects (8, 19 bytes)
	6040h (Control word) 607Ah (Target position) 60FFh (Target velocity) 6060h (Modes of operation) 60B8h (Touch probe function) 60E0h (Positive torque limit value) 60E1h (Negative torque limit value) 60B2h (Torque offset)

1B04h (Inputs)	Mapping objects (10, 29 bytes)
	603Fh (Error code) 6041h (Status word) 6064h (Position actual value) 6077h (Torque actual value) 6061h (Modes of operation display) 60F4 (Following error actual value) 60B9 (Touch probe status) 60BA (Touch probe 1 positive edge) 60BC (Touch probe 2 positive edge) 606C (Velocity actual value)

3 Variable PDO mapping

The SV660N provides one fixed RPDO and one fixed TPDO.

Variable PDO	Index	Max. Number of Mapping Objects	Max. Byte Length	Default Mapping Object
RPDO1	1600h	10	40	6040h (Control word) 607Ah (Target position) 60B8 (Touch probe function)
TPDO1	1A00h	10	40	603F (Error code) 6041h (Status word) 6064h (Position actual value) 60BC (Touch probe 2 positive edge) 60B9 (Touch probe status) 60BA (Touch probe 1 positive edge) 60FD (Digital inputs)

4 Sync Manager PDO Assignment

Several PDO mapping objects are included during EtherCAT cyclic data communication. The CoE defines the PDO mapping object list of the sync manager with 0x1C10 to 0x1C2F. The PDOs can be mapped to different sub-indexes.

The SV660N series servo drive supports assignment of one RPDO and one TPDO, as described in the following table.

Index	Sub-index	Description
0x1C12	01h	One of 0x1600 and 0x1701 to 0x1705 used as the actual RPDO
0x1C13	01h	One of 0x1A00 and 0x1B01 to 0x1B04 used as the actual TPDO

5 PDO configuration

PDO mapping parameters contain the indicators of the process data for PDOs, including the index, sub-index and mapping object length. The sub-index 0 indicates the number (N) of mapping objects in the PDO, and the maximum length of each PDO is 4 x N bytes. One or multiple objects can be mapped simultaneously. Sub-indexes 1 to N indicate the mapping content, as defined below:

Bits	31	...	16	15	...	8	7	...	0
Meaning	Index			Sub-index			Object Length		

The index and sub-index define the position of an object in the object dictionary. The object length indicates the bit length of the object in hexadecimal, as shown below:

Object Length	Bit Length
08h	8-bit
10h	16 bit
20h	32-bit

For example, the mapping parameter of the 16-bit control word 6040h-00 is 60400010h.

■ Observe the following procedures for PDO mapping:

1) Invalid PDO: Write 0 to sub-index 00h of 1C12h (or 1C13h).

Clear the original mapping content: All the original mapping content of the PDO is cleared when 0 is written to the sub-index 00h of the mapping object.

Write the PDO mapping content: Write the content in sub-indexes 1 to 10 according to the preceding mapping definition.

Write the total number of PDO mapping objects: Write the number of mapping objects written to sub-indexes 0–10 to the sub-index 0 of the mapping object.

2) Valid PDO: Write 1 to sub-index 00h of 1C12h (or 1C13h).

Configure the PDO only when the EtherCAT state machine is in Pre-Operation state ("2" displayed on the keypad). Otherwise, an error is reported.

Do not save PDO configuration parameters to EEPROM. Configure the mapping objects again every time upon power-on. Otherwise, the mapping objects are the default parameters.

An SDO fault code is returned during the following operations:

■ Modify PDO parameters in non Pre-Operational state.

■ Write a value outside 1600/1701–1705 to 1C12h, and write a value outside 1A00/1B01–1B04 to 1C13h.

8.3.5 Service Data Object (SDO)

EtherCAT SDO is used to transfer non-cyclic data, such as communication parameter configuration and servo drive running parameter configuration. The CoE service types include:

■ Emergency message

■ SDO request

■ SDO response

■ TxPDO

■ RxPDO

■ Remote TxPDO transmission request

■ Remote RxPDO transmission request

■ SDO message

The SV660N supports SDO request and SDO response.

8.3.6 Distributed Clock (DC)

The DC enables all EtherCAT devices to use the same system time and allows synchronous task execution of the slaves. A slave can generate synchronous signals according to the synchronized system time. The SV660N series servo drive supports the DC synchronization mode only. The synchronization cycle, which is controlled by SYNC0, varies with different motion modes.

8.3.7 Status Indication

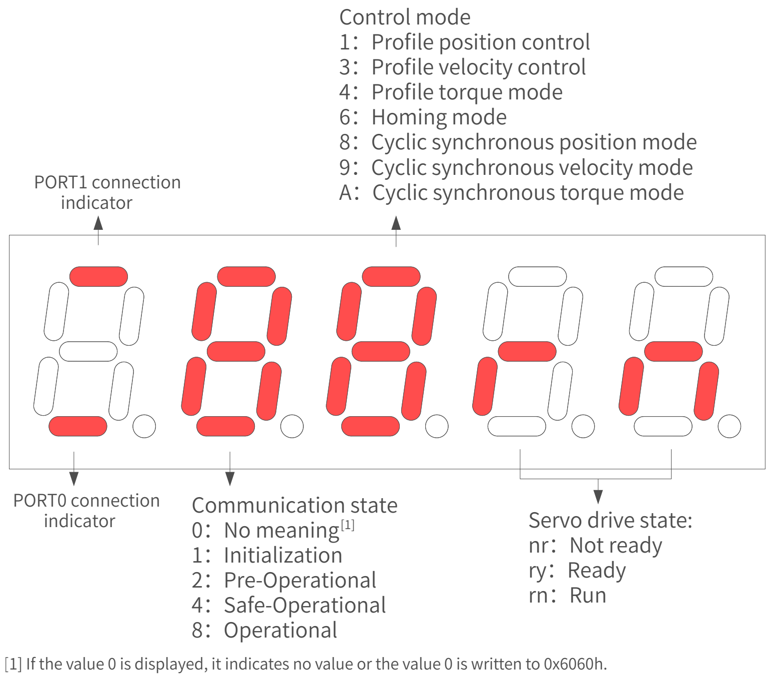


Figure 8-4 Status indication

■ Communication connection status

The connection status of the two RJ45 ports are indicated by the "-" on the upper and lower part of the first LED on the keypad. The upper "-" corresponds to PORT1, and the lower "-" corresponds to PORT0.

Solid OFF: No communication is detected in the physical layer.

Solid ON: Communication is detected in the physical layer.

■ Communication running status

The 2nd LED indicates the status of the EtherCAT state machine of the slave, as described in the following table.

Status	SDO	RPDO	TPDO	Description	Display
Init	No	No	No	Communication initialization	"1", solid ON
Pre-Operational	Yes	No	No	Network configuration initialized SDO available	"2", blinking at a interval of 400 ms
Safe-Operational	Yes	No	Yes	SDO and TPDO available, distributed clock mode available	"4", blinking at a interval of 1200 ms, ON for 200 ms and OFF for 1000 ms
Operational	Yes	Yes	Yes	Normal operational state	"8", steady on

■ Servo mode display

The 3rd LED indicates the control mode of the servo drive, as described in the following table.

Modes of operation (6060h)	Display
1: Profile position mode	1
3: Profile velocity mode	3
4: Profile torque mode	4
6: Homing mode	6
8: Cyclic synchronous position mode	8
9: Cyclic synchronous velocity mode	9
10: Cyclic synchronous torque mode	A

■ Servo status display

The 4th and 5th LEDs indicate the slave servo status, as described in the following table.

Status	Description	Display
Reset	Init	"Reset"
Not ready	Initialization is done. The control power is turned on but the main power is still off. Not ready	"nr"
Ready	The main power is turned on but the S-ON signal is deactivated. Ready	"ry" The character "y" blinks when the motor speed is not 0 RPM. When the communication layer is in Pre-Operational or Safe-Operational state, the blinking frequency is the same as that of characters "2" or "4" (communication status). When the communication layer is in Init or Operational state, the blinking frequency is 2 Hz.
Run	The S-ON signal is activated and the motor is energized. Run	"rn" The character "n" blinks when the motor speed is not 0 RPM. When the communication layer is in Pre-Operational or Safe-Operational state, the blinking frequency is the same as that of characters "2" or "4" (communication status). When the communication layer is in Init or Operational state, the blinking frequency is 2 Hz.

8.3.8 Overview of CiA402

The SV660N servo drive can run in the specified status only when it is instructed according to the flowchart defined in the standard CiA402 protocol.

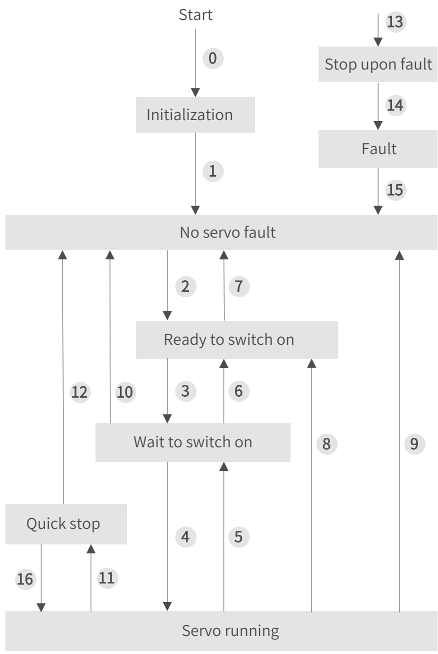


Figure 8-5 Switchover of CiA402 state machine

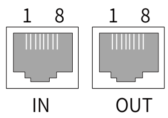
The states are described in the following table.

Init	Initialization of the servo drive and internal self-check are done. Parameters cannot be set. Functions cannot be executed.
No fault	No fault exists in the servo drive or the fault is cleared. Parameters can be set.
Ready to switch on	The servo drive is ready. Parameters can be set.
Wait to switch on	The servo drive is waiting to be switched on. Parameters can be set.
Running	The servo drive is running properly and a certain running mode is enabled. The motor is powered on and starts running when the speed reference is not 0. Parameters with the setting condition of "During running" can be set.
Quick stop	The quick stop function is activated and the servo drive is in the process of quick stop. Parameters with the setting condition of "During running" can be set.
Stop at fault	A fault occurs on the servo drive and the servo drive is in the process of stop. Parameters with the setting condition of "During running" can be set.
Fault	The stop process is done and all the functions are prohibited. Parameters can be modified for the convenience of troubleshooting.

8.3.9 Basic Characteristics

■ Interfaces

The EtherCAT cables are connected to the network ports (~~including~~ IN and OUT) equipped with metal shield. The electrical characteristics are compliant with IEEE 802.3 and ISO 8877 standards.

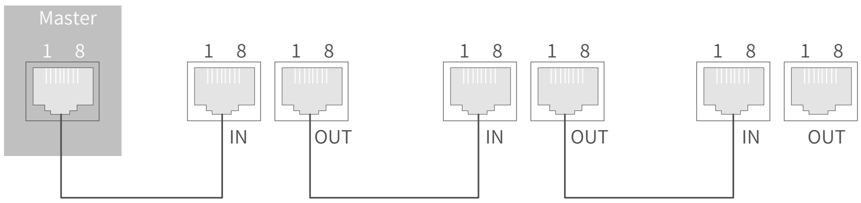


Pin	Definition	Description
1	TX+	Data transmitting (+)
2	TX-	Data transmitting (-)
3	RX+	Data receiving (+)
4	NULL	Not connected
5	NULL	Not connected
6	RX-	Data receiving (-)
7	NULL	Not connected
8	NULL	Not connected

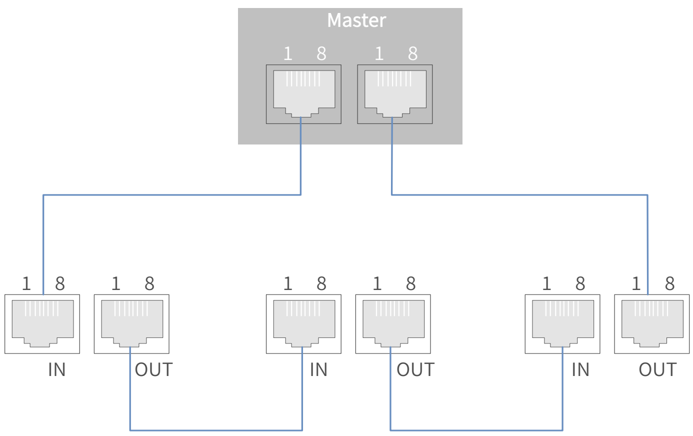
■ Topology connection

The EtherCAT features flexible topological structure, as shown in the following figures.

■ Linear connection



■ Redundancy ring connection



■ Communication cable

The Ethernet Category 5 (100BASE-TX) network cable or high-strength shielded network cable is used as the EtherCAT communication cable. The network cables used for the servo drive must also be shielded with cable length less than 100 m. The shielded network cable enhances the anti-interference capacity of the system.

■ EMC standard

The servo drive complies with the following standards:
IEC/EN61800-3:2004 (Adjustable speed electrical power drive systems---part 3:EMC requirements and specific test methods)

9 Troubleshooting

9.1 Faults and Warnings

Faults and warnings are divided into the following three levels based on severity: No.1 > No.2 > No.3.

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

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

To reset a fault/warning, use one of the following two methods:

- Set 200D-02h to 1 (Fault reset).
- Set the rising edge of bit7 of the control word 0x6040 through the host controller.

To reset a No. 1 fault and a No. 2 fault, turn off the S-ON signal and input the fault reset signal.

For the No. 3 warnings, the servo drive resets warnings automatically after the warning source is cleared.

Related parameter

Para. No.	Name	Value Range	Function	Setting Condition	Effective Time	Default Value
200Dh-02h	Fault reset	0: No operation 1: Reset the fault and warning	Stops the fault display when a resettable fault/warning occurs. Restores to "0: No operation" immediately after fault reset.	At stop	Immediately	0

9.2 Communication Faults and Warning Codes

- List of fault codes

Fault	Display	Name	Type	Resettable or Not	Fault Range
E101	E101.0	System parameter error	No.1	No	Servo drive fault
	E101.1	Parameters in group 2000h/2001h being abnormal	No.1	No	Servo drive fault
E102	E102.0	Logic configuration fault	No.1	No	Servo drive fault
	E102.8	Software version mismatch	No.1	No	Servo drive fault
E104	E104.1	MCU running timeout	No.1	No	Servo drive fault
	E104.2	Current loop running timeout	No.1	No	Servo drive fault
	E104.4	Reference update timeout	No.1	No	Servo drive fault
E105	E105.0	Internal program error	No.1	No	Servo drive fault
E108	E108.0	Parameter write timeout	No.2	Yes	Servo drive fault
	E108.1	Parameter read timeout	No.2	Yes	Servo drive fault
	E108.2	Invalid check on data written in EEPROM	No.2	Yes	Servo drive fault
	E108.3	Invalid check on data read in EEPROM	No.2	Yes	Servo drive fault

Fault	Display	Name	Type	Resettable or Not	Fault Range
E120	E120.0	Unknown encoder type	No.1	No	Axis fault
	E120.1	Unknown motor model	No.1	No	Axis fault
	E120.2	Unknown drive model	No.1	No	Axis fault
	E120.5	Mismatch of the motor current and drive current	No.1	No	Axis fault
	E120.6	Mismatch of FPGA and motor model	No.1	No	Axis fault
E122 (set by software)	E122.0	Multi-turn absolute encoder setting error	No.2	Yes	Axis fault
	E122.1	Different DIs allocated with the same function	No.2	Yes	Axis fault
	E122.3	Upper limit invalid	No.2	Yes	Axis fault
E136	E136.0	Encoder parameter error	No.1	No	Axis fault
	E136.1	Encoder communication error	No.1	No	Axis fault
E150	E150.0	STO signal input protection activated	No.1	Yes	Servo drive fault
	E150.1	STO signal input error	No.1	Yes	Servo drive fault
	E150.2	Abnormal voltage detected	No.1	Yes	Servo drive fault
	E150.3	STO upstream optocoupler detection failure	No.1	Yes	Servo drive fault
	E150.4	PWM Buffer detection failure	No.1	Yes	Servo drive fault
E201	E201.0	Phase-P overcurrent	No.1	No	Servo drive fault
	E201.1	Phase-U overcurrent	No.1	No	Axis fault
	E201.2	Phase-V overcurrent	No.1	No	Axis fault
	E201.4	Phase-N overcurrent	No.1	No	Servo drive fault
E208	E208.0	MCU position reference updated frequently	No.1	Yes	Axis fault
	E208.2	Encoder communication timeout	No.1	Yes	Axis fault
	E208.3	Current sampling fault	No.1	Yes	Axis fault
	E208.4	FPGA current loop operation timeout	No.1	Yes	Axis fault
E210	E210.0	Output shorted to ground	No.1	No	Axis fault
E234	E234.0	Runaway protection	No.1	No	Axis fault
E400	E400.0	Main circuit overvoltage	No.1	Yes	Servo drive fault
E410	E410.0	Main circuit undervoltage	No.1	Yes	Servo drive fault
E420	E420.0	Phase loss	No.2	Yes	Servo drive fault
	E420.1	PL signal error	No.2	Yes	Servo drive fault
E500	E500.0	Motor overspeed	No.1	Yes	Axis fault
	E500.1	Speed feedback overflow	No.1	Yes	Axis fault
E602	E602.0	Angle auto-tuning error	No.1	Yes	Axis fault
	E602.2	Wrong UVW phase sequence detected during angle auto-tuning	No.1	Yes	Axis fault
E620	E620.0	Motor overload	No.1	Yes	Axis fault
E630	E630.0	Locked rotor	No.1	Yes	Axis fault
E640	E640.0	IGBT over-temperature	No.1	Yes	Axis fault
E650	E650.0	Heatsink over-temperature	No.1	Yes	Axis fault
E661	E661.0	Auto-tuned gain values too low	No.2	Yes	Axis fault

Fault	Display	Name	Type	Resettable or Not	Fault Range
E731	E731.0	Encoder battery failure	No.2	Yes	Axis fault
E733	E733.0	Encoder multi-turn counting error	No.2	Yes	Axis fault
E735	E735.0	Encoder multi-turn counting overflow	No.2	Yes	Axis fault
E740	E740.2	Absolute encoder error	No.1	No	Axis fault
	E740.3	Absolute encoder single-turn calculation error	No.1	No	Axis fault
	E740.6	Encoder write error	No.1	No	Axis fault
EB00	EB00.0	Position deviation too large	No.2	Yes	Axis fault
	EB00.1	Position deviation overflow	No.2	Yes	Axis fault
EA33	EA33.0	Encoder read/write check error	No.1	No	Axis fault
EB01	EB01.1	Position reference increment too large for once	No.2	Yes	Axis fault
	EB01.2	Position reference increment too large continuously	No.2	Yes	Axis fault
	EB01.3	Reference overflow	No.2	Yes	Axis fault
	EB01.4	Reference value beyond the single-turn position limits in the absolute mode	No.2	Yes	Axis fault
EE09	EE09.0	Software limit setting error	No.2	Yes	Axis fault
	EE09.1	Home setting error	No.2	Yes	Axis fault
	EE09.2	Gear ratio over the limit	No.2	Yes	Axis fault
	EE09.3	No synchronization signal	No.2	Yes	Axis fault
	EE09.5	PDO mapping over the limit	No.2	Yes	Axis fault
EE08	EE08.0	Synchronization loss	No.2	Yes	Servo drive fault
	EE08.1	Network status switchover error	No.2	Yes	Servo drive fault
	EE08.2	IRQ loss	No.2	Yes	Servo drive fault
EE11	EE11.0	ESI check error	No.2	Yes	Servo drive fault
	EE11.1	Unsuccessful reading of EEPROM	No.2	Yes	Servo drive fault
	EE11.2	Unsuccessful update of EEPROM	No.2	Yes	Servo drive fault
EE12	EE12.0	External devices of EtherCAT being abnormal	No.1	No	Servo drive fault
EE13	EE13.0	Synchronization cycle setting error	No.2	Yes	Servo drive fault
EE15	EE15.0	Synchronization cycle error too large	No.2	Yes	Servo drive fault

■ List of warning codes

Warning	Display	Name	Type	Resettable or not	Fault Range
E121	E121.0	Invalid S-ON command	No.3	Yes	Warning
E600	E600.0	Inertia auto-tuning failure	No.3	Yes	Warning
E601	E601.0	Homing warning	No.3	Yes	Warning
	E601.1	Home switch error	No.3	Yes	Warning
E730	E730.0	Encoder battery warning	No.3	Yes	Warning
E900	E900.0	Emergency stop	No.3	Yes	Warning

Warning	Display	Name	Type	Resettable or not	Fault Range
E902	E902.0	Invalid DI setting	No.3	Yes	Warning
	E902.1	Invalid DO setting	No.3	Yes	Warning
	E902.2	Invalid torque reached setting	No.3	Yes	Warning
E908	E908.0	Invalid check byte of model identification	No.3	Yes	Warning
E909	E909.0	Motor overload	No.3	Yes	Warning
E920	E920.0	Regenerative resistor overload	No.3	Yes	Warning
E922	E922.0	Resistance of external regenerative resistor too small	No.3	Yes	Warning
E924	E924.0	Braking transistor over-temperature	No.3	Yes	Warning
E941	E941.0	Parameter modifications not activated	No.3	Yes	Warning
E942	E942.0	Parameter saved frequently	No.3	Yes	Warning
E950	E950.0	Forward overtravel	No.3	Yes	Warning
E952	E952.0	Reverse overtravel	No.3	Yes	Warning
EE09	EE09.4	Homing method setting error	No.3	Yes	Warning

9.3 Solutions to Faults

■ E101.0: System parameter error

Direct cause:

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

Values of parameters in groups 2002h and above exceed the limit, which generally occurs after software update.

Root Cause	Confirming Method	Solution
1. The control power voltage drops instantaneously.	Check whether the voltage drops during control power (L1C, L2C) cutoff or whether instantaneous power failure occurs.	Restore the default setting (2002-20h = 1), and write the parameters again.
	Measure whether the control power voltage on the non-drive side fulfills the following specifications: 220 V servo drive: Effective value: 220 V to 240 V Allowable deviation: –10% to +10% (198 V to 264 V) 380 V drive: Effective value: 380 V to 440 V Allowable deviation: –10% to +10% (342 V to 484 V)	Increase the power capacity or replace by a power supply of larger capacity. Restore the default settings (2002-20h = 1) and write the parameters again.
2. Instantaneous power failure occurs during parameter storage	Check whether instantaneous power failure occurs during parameter storage.	Power on the system again, restore the default settings (2002-20h = 1) and write the parameters again.
3. The number of parameter-write operations exceeds the limit.	Check whether parameter update is performed frequently from the host controller.	Change the parameter writing method and write parameters again. If the servo drive is faulty, replace it.

Root Cause	Confirming Method	Solution
4. The software is updated.	Check whether the software is updated.	Reset the servo drive model and the servo motor model, and restore default settings (2002-20h = 1).
5. The servo drive is faulty.	If the fault persists after several times of restart and parameter initialization, the servo drive is faulty.	Replace the servo drive.

■ E101.1: Parameters in group 2000h/2001h being abnormal

Direct cause:

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

Parameter values in group 2000h/2001h exceed the limit, which generally occurs after software update.

Root Cause	Confirming Method	Solution
1. Instantaneous power failure occurs during parameter storage.	Check whether instantaneous power failure occurs during parameter storage.	Set the servo drive model (2001-0Bh) to a wrong value first and power on again, and then set the servo drive model to a correct value and power on again.
2. Instantaneous power failure occurs during motor parameter writing.	Check whether instantaneous power failure occurs during motor parameter writing.	Write the motor parameters using the software tool.
3. The software is updated.	Check whether the software is updated.	Set the servo drive model (2001-0Bh) to a wrong value first and power on again, and then set the servo drive model to a correct value and power on again.
4. The servo drive is faulty.	If the fault persists after repeated execution of steps 1 and 2 and restart of the servo drive, it indicates the servo drive is faulty.	Replace the servo drive.

■ E102.0: Logic configuration fault

Direct cause:

The FPGA- or MCU-related hardware is damaged, resulting in communication failure between the MCU and FPGA.

Root Cause	Confirming Method	Solution
The FPGA is faulty.	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ E102.8: Software version mismatch

Cause	Confirming Method	Solution
The software version of MCU or FPGA is wrong.	Check whether the MCU firmware version (H01-00) is 9xx.x (the fourth digit displayed on the keypad is 9). Check whether the FPGA firmware version (H01-01) is 9xx.x (the fourth digit displayed on the keypad is 9).	Contact Inovance for technical support and update the software version.

■ E104.1: MCU running timeout

Direct cause:

Access to MCU times out.

Root Cause	Confirming Method	Solution
1. The FPGA is faulty. 2. The communication handshake between FPGA and host is abnormal. 3. Access timeout occurs between the host and the coprocessor.	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ E104.2: Current loop running timeout

Direct cause:

The running time of the current loop exceeds the scheduling time. This fault is reported only in the commissioning stage.

Root Cause	Confirming Method	Solution
The time interval of MCU torque interrupt scheduling is abnormal.	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ E104.4: Command update timeout

Direct cause:

Take the moment of entering the interrupt as the starting time, if the duration of command writing in MCU is longer than the FPGA starting position and speed regulator time, a warning will be reported.

Root Cause	Confirming Method	Solution
The interrupt time of the current loop is too long.	Check whether the interrupt time of the torque loop is too long by using the software tool.	Hide the unnecessary functions.

■ E105.0: Internal program error

Direct cause:

The total number of parameters is abnormal during parameter reading/writing through the EEPROM.

The parameter value range is abnormal, which generally occurs after software update.

Root Cause	Confirming Method	Solution
1. An EEPROM fault occurs.	Check the causes according to the method described in E101.0.	Restore the default settings (2002-20h = 1) and power on the servo drive again.
2. The servo drive is faulty.	The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ E108.0: Parameter write timeout

Direct cause:

Parameter values cannot be written to EEPROM.

Root Cause	Confirming Method	Solution
An error occurs when writing parameters to EEPROM.	Modify a certain parameter value, power on the servo drive again, and check whether the modified value is saved.	If the modified value is not saved and the fault persists after the servo drive is powered off and on again, replace the servo drive.

- E108.1: Parameter read timeout

Direct cause:

Parameter values cannot be read in EEPROM.

Root Cause	Confirming Method	Solution
An error occurs when reading parameter values in EEPROM.	Modify a certain parameter value, power on the servo drive again, and check whether the modified value is saved.	If the modified value is not saved and the fault persists after the servo drive is powered off and on again, replace the servo drive.

- E108.2: Invalid check on data written in EEPROM

Cause	Confirming Method	Solution
The check on the data written in EEPROM fails.	Modify a certain parameter value, power on the servo drive again, and check whether the modified value is saved.	If the modified value is not saved and the fault persists after the servo drive is powered off and on again, replace the servo drive.

- E108.3: Invalid check on data read in EEPROM

Cause	Confirming Method	Solution
The check on the data read in EEPROM fails.	Modify a certain parameter value, power on the servo drive again, and check whether the modified value is saved.	If the modified value is not saved and the fault persists after the servo drive is powered off and on several times, replace the servo drive.

- E120.0: Unknown encoder type

Direct cause:

The servo drive detects the encoder type during initialization upon power-on. If the encoder type does not comply with the requirement, the servo drive reports E120.0.

Root Cause	Confirming Method	Solution
The encoder type does not match the servo drive.	Check whether the encoder model is correct.	Replace the encoder.

- E120.1: Unknown motor model

Direct cause:

The servo drive detects the motor model (H00-00) during initialization upon power-on. If the motor model does not exist, the servo drive reports E120.1.

Root Cause	Confirming Method	Solution
The motor model is set improperly.	Check whether H00-00 (Motor code) is set properly.	Set H00-00 to a proper value that matches the motor model.

■ E120.2: Unknown drive model

Direct cause:

The servo drive detects the servo drive model (H01-10) during initialization upon power-on. If the servo drive model does not exist, the servo drive reports E120.2.

Root Cause	Confirming Method	Solution
The servo drive model is set improperly.	Check whether H01-10 (Servo drive series No.) is set properly.	Set H01-10 to a proper value that matches the servo drive model.

■ E120.5: Mismatch of the motor current and drive current

Direct cause:

The rated output current of the servo drive is higher than the rated current of the motor.

Root Cause	Confirming Method	Solution
The internal scaling value is abnormal.	Check whether the servo drive model is correct. If the set current sampling coefficient is too large, calculation overflow will occur.	Replace with a servo drive of lower rated output current or a motor with higher rated current.

■ E120.6: Mismatch of FPGA and motor model

Direct cause:

1. The motor model is set improperly, causing mismatch and malfunction of the servo drive.

2. The motor model is set properly, but the motor encoder is not supported by the servo drive.

Root Cause	Confirming Method	Solution
The FPGA does not support the motor encoder.	Check whether the FPGA firmware version (H01-01) supports the motor encoder.	Update the program or replace the motor.

■ E122.0: Multi-turn absolute encoder setting error

Root Cause	Confirming Method	Solution
The motor does not match the absolute position mode or the motor cide is set improperly.	Check the motor nameplate to see whether the motor is equipped with an absolute encoder. Check whether 200D-01h (Motor code) is set properly.	Set 200D-01h (Motor code) correctly according to the motor nameplate or replace with a matching motor.

■ E122.1: Different DIs allocated with the same function

Root Cause	Confirming Method	Solution
1. The same function is allocated to different DIs.	View 2003-03h, 2003-05h to 2003-15h, 2017-01h, and 2017-03h to 2017-1Fh to check whether they are allocated with the same DI function No..	Allocate different DI functions to the parameters that have been allocated with the same DI function. To activate the allocation, restart the control circuit or turn off the S-ON signal and send a "RESET" signal.
2. The DI function No. exceeds the number of DI functions.	Check whether the MCU firmware is updated.	Restore default settings (2002-20h = 1) and power on the servo drive again.

■ E122.3: Upper limit invalid

Cause	Confirming Method	Solution
The upper limit value of the mechanical single-turn position exceeds 2^{31} in the absolute position rotation mode.	Check the setting of the mechanical gear ratio, the upper limit of the mechanical single-turn position and the electronic gear ratio when the servo drive runs in the absolute position rotation mode (H02-01 = 2).	Reset the mechanical gear ratio, the upper limit of the mechanical single-turn position and the electronic gear ratio to ensure the upper limit of the mechanical single-turn position (reference range) does not exceed 2^{31}.

■ E136.0: Encoder parameter error

Direct cause:

When the servo drive reads parameters in the encoder ROM, no parameters are saved there or parameter values are inconsistent with the agreed values.

Root Cause	Confirming Method	Solution
1. The servo drive model does not match with the servo motor model.	View the servo drive and servo motor nameplates to check whether the devices used are Inovance SV660N series servo drive and servo motor.	Replace with the mutually-matching servo drive and servo motor.
2. A parameter check error occurs or no parameter is stored in the serial incremental encoder ROM.	Check whether the encoder cable provided by Inovance is used. For cable specifications, see "1.4 Cable Models". Ensure the cable is intact and in good contact at both ends to allow reliable connection. Measure signals PS+, PS-, +5V and GND at both ends of the encoder cable and observe whether signals at both ends are consistent. For definition of signals, see "3 Wiring"	Use the encoder cable provided by Inovance. Ensure the cable is connected to the motor securely and tighten the screws on the servo drive side. Use a new encoder cable if necessary. Do not bundle the encoder cables with the power cables (RST, UVW). Route encoder cables and power cables through different routes.
3. The servo drive is faulty.	The fault persists after servo drive is powered off and on again.	Replace the servo drive.

■ E136.1: Encoder communication error

Direct cause:

1. The encoder cable is disconnected.

2. The encoder communication is disturbed.

Root Cause	Confirming Method	Solution
The FPGA and motor encoder communication is faulty during initialization upon power-on.	Observe the value of H0B-28 to see whether it is not 0.	Check whether the encoder cables are connected properly. Check whether the motor model is set properly. Check whether H01-00 (MCU firmware version) and H01-01 (FPGA firmware version) are set properly.

■ E150.0: STO signal input protection activated

Direct cause:

The STO input protection applies (safety state).

Root Cause	Confirming Method	Solution
1. The STO is activated.	Check whether the STO function is activated.	There is no need to take any actions. Clear the fault through fault reset after the STO terminal is restored.
2. The STO power supply is abnormal.	Check whether the 24 V power supply for the STO is stable.	Tighten the cables that are loosened or disconnected.
3. The STO is deactivated.	The fault persists after preceding actions are taken.	Replace the servo drive.

■ E150.1: STO signal input error

Direct cause:

The single-channel input of STO is invalid.

Root Cause	Confirming Method	Solution
1. The STO power supply is abnormal.	Check whether the 24 V power supply for the STO is stable.	Tighten the cables that are loosened or disconnected.
2. The STO input resistor is abnormal.	The 24 V power supply is disconnected due to resistor drift after the STO function is enabled, but the single-channel STO input is normal.	Replace the servo drive.
3. The STO is deactivated.	The fault persists after preceding actions are taken.	Replace the servo drive.

■ E150.2: Abnormal voltage detected

Direct cause:

The MCU monitors the 5 V power supply provided to the PWM Buffer to detect whether overvoltage and undervoltage occurs. If the voltage is abnormal, E150.2 will be displayed.

Root Cause	Confirming Method	Solution
The 5 V power supply provided to the Buffer is abnormal.	Check the 5 V power supply.	Replace the servo drive.

■ E150.3: STO upstream optocoupler detection failure

Direct cause:

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

Root Cause	Confirming Method	Solution
Short circuit occurs on the upstream optocoupler of STO1 or STO2.	The servo drive does not display E150.0 when the 24 V power supply is powered off and on again.	Replace the servo drive.

■ E150.4: PWM Buffer detection failure

Direct cause:

An errors occurs on the PWM Buffer chip during initialization detection upon power-on (the PWM signal cannot be blocked).

Root Cause	Confirming Method	Solution
The Buffer fails to block the PWM waves.	This fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ E201.0: Phase-P overcurrent

Direct cause:

High current flows through the positive pole of the DC-AC circuit.

Root Cause	Confirming Method	Solution
High current flows through the positive pole of the DC-AC circuit.	Collect the current feedback using the software tool to check whether the current is abnormal.	◆ The motor parameters are set improperly, adjust the motor parameters. ◆ The current loop parameters are set improperly, adjust the current loop parameters. ◆ The speed loop parameters are set improperly, adjust the speed loop parameters. ◆ If the servo drive runs improperly, replace it.

■ E201.1: Phase-U overcurrent

Cause	Confirming Method	Solution
A current higher than the threshold is collected in the phase-U current.	Check the phase-U current (H0B-38) when the fault occurs.	◆ Check whether H01-38 is set properly. ◆ Check whether the motor parameters are set properly. ◆ Check whether the current loop parameters are set properly. ◆ Check whether the servo drive runs properly.

■ E201.2: Phase-V overcurrent

Root Cause	Confirming Method	Solution
A current higher than the threshold is collected in the phase-V current.	Check the phase-V current (H0B-39) when the fault occurs.	◆ Check whether H01-38 is set properly. ◆ Check whether the motor parameters are set properly. ◆ Check whether the current loop parameters are set properly. ◆ Check whether the servo drive runs properly.

■ E201.4: Phase-N overcurrent

Direct cause:

Overcurrent is detected in phase-N of the hardware.

Root Cause	Confirming Method	Solution
High current flows through the negative pole of the DC-AC circuit.	Collect the current feedback using the software tool to check whether the current is abnormal.	◆ The motor parameters are set improperly, adjust the motor parameters. ◆ The current loop parameters are set improperly, adjust the current loop parameters. ◆ The speed loop parameters are set improperly, adjust the speed loop parameters. ◆ If the servo drive runs improperly, replace it.

■ E208.0: MCU position reference updated frequently

Find the fault cause through the internal fault code (200B-2Eh).

Root Cause	Confirming Method	Solution
1. MCU communication times out.	200B-2Eh = 1208: The internal chip is damaged.	Replace the servo drive.
2. FPGA operation times out.	200B-2Eh = 0208: Find the cause according to preceding cause 1.	

■ E208.2: Encoder communication timeout

Direct cause:

The servo drive fails to receive the data fed back by the encoder in three consecutive cycles.

Root Cause	Confirming Method	Solution
The servo drive fails to receive the data returned by the encoder in three consecutive cycles.	◆ Check the bit12 of H0B-30. ◆ The encoder cables are connected improperly. ◆ The encoder cables are loosened. ◆ The encoder cables are too long. ◆ The encoder communication suffers from interference. ◆ The encoder is faulty.	◆ Check whether the motor model is correct. ◆ Check whether encoder cables are in proper condition. ◆ Check whether the encoder version (H00-04) is set properly. ◆ If servo drive runs improperly, replace it.

■ E208.3: Current sampling fault

Cause	Confirming Method	Solution
The phase-U and phase-V current sampling are abnormal.	Check whether there is large equipment generating interferences on site and whether there are multiple interference sources in the cabinet. The internal current sampling chip is damaged.	◆ Check whether the servo drive and motor are grounded and shielded properly. ◆ Install magnetic ring on the motor power cables and encoder cables. ◆ Replace the servo drive.

■ E208.4: FPGA current loop operation timeout

Cause:

The operation time of the current loop exceeds the interval threshold.

■ E210.0: Output shorted to ground

Direct cause:

The servo drive detects abnormal motor phase current or bus voltage during self-check upon power-on.

Root Cause	Confirming Method	Solution
1. Power (UVW) cables of the servo drive are short-circuited to ground.	Disconnect UVW cables from the motor and check whether the UVW cables are short circuited to ground (PE).	Re-connect or replace the servo drive power cables.
2. The motor is short circuited to ground.	After ensuring power cables of the servo drive and motor cables are connected securely, check whether the insulation resistance between UVW terminals of the servo drive and the grounding cable (PE) is at MΩ-level.	Replace the servo motor.
3. The servo drive is faulty.	Remove power cables from the servo drive. The fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ E234.0: Runaway Protection

Direct cause:

The torque reference direction is in reverse to the speed feedback direction in the torque control mode.

The speed feedback direction is in reverse to the speed reference direction in the position or speed control modes.

Root Cause	Confirming Method	Solution
1. The UVW cables are connected improperly.	Check whether UVW phase sequence on the servo drive is consistent with that on the motor side.	Connect UVW cables according to the correct phase sequence.
2. The initial phase detection on the motor rotor is incorrect due to interference signals upon power-on.	The UVW phase sequence is correct, but E234.0 occurs when the servo drive is enabled.	Power on the servo drive again.

Root Cause	Confirming Method	Solution
3. The encoder model is wrong or the wiring is improper.	View the servo drive and servo motor nameplates to check whether the devices used are Inovance SV660N series servo drive and servo motor.	Replace with the mutually-matching servo drive and servo motor. If you use Inovance SV660N series servo drive and servo motor, ensure that 2000-01h is set to 14000. Re-confirm the motor model, encoder type, and encoder cable connections.
4. The encoder cables are connected improperly, corroded or loosened.	Check whether the encoder cable provided by Inovance is used. Check whether the cable is worn out, corroded or loosened. Switch off the S-ON signal, rotate the motor shaft manually, and check whether the value of 200B-0Bh (Electrical angle) changes as the motor rotates.	Re-weld, tighten or replace the encoder cable.
5. The gravity load is too heavy in vertical axis applications.	Check whether the load of the vertical axis is too heavy. Adjust brake parameters 2002-0Ah to 2002-0Dh and then check whether the fault can be removed.	Reduce the load of the vertical axis, improve the stiffness level or hide this fault without affecting the safety performance or normal use.
6. Improper parameter settings cause excessive vibration.	The stiffness level is set too high and causes excessive vibration.	Set a proper stiffness level to avoid excessive vibration.

■ E400.0: Main circuit overvoltage

Direct cause:

The DC bus voltage between P and N exceeds the overvoltage threshold.

220 V servo drive:
Normal value: 310 V
Overvoltage threshold: 420 V

380 V servo drive:
Normal value: 540 V
Overvoltage threshold: 760 V

Root Cause	Confirming Method	Solution
1. The main circuit input voltage is too high.	Check the power input specification of the servo drive and measure whether the RST voltages on the servo drive side complies with the following specifications: ◆ 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)	Replace or adjust the power supply according to the specifications.
2. The power supply is unstable or affected by the lightning strike.	Check whether the power input to the servo drive is unstable, affected by lightning strike or complies with preceding specifications.	Connect a surge protection device and then switch on the power supply. If the fault persists, replace the servo drive.

Root Cause	Confirming Method	Solution
3. The regenerative resistor fails.	If an internal regenerative resistor is used (2002-1Ah = 0), check whether P and D are jumpered. If yes, measure the resistance between C and D. If an external regenerative resistor is used (2002-1Ah = 1, 2), measure the resistance between P and C. For the specification of the regenerative resistor, see "1.1.4 Specifications of the Regenerative Resistor".	◆ If the resistance is " ∞ " (infinite), the regenerative resistor is disconnected internally. ◆ If an internal regenerative resistor is used, replace with an external regenerative resistor (2002-1Ah = 1, 2) and remove the jumper between P and D. Select an external regenerative resistor of the same resistance and power as the internal one. ◆ If an external regenerative resistor is used, replace with a new external regenerative resistor and connect it between P and C. Set 2002-1Bh (Power of external regenerative resistor) and 2002-1Ch (Resistance of external regenerative resistor) properly according to the specifications of the external regenerative resistor used.
4. The resistance of the external regenerative resistor is too large, and energy absorption during braking is insufficient.	Measure the resistance of the external regenerative resistor between P and C, and compare the measured value with the recommended value.	Connect a new external regenerative resistor of recommended resistance between P and C. Set 2002-1Bh (Power of external regenerative resistor) and 2002-1Ch (Resistance of external regenerative resistor) properly according to the specification of the external regenerative resistor actually used.
5. The motor is in abrupt acceleration/ deceleration status and the maximum braking energy exceeds the energy absorption value.	Confirm the acceleration/deceleration time during running and measure whether the DC bus voltage between P and N exceeds the fault threshold during deceleration.	Ensure the voltage input to the main circuit is within the specified range, and then increase the acceleration/deceleration time if allowed.
6. The bus voltage sampling value deviates greatly from the measured value.	Check whether the bus voltage (200B-1Bh) complies with the following specifications: 220 V servo drive: 200B-1Bh > 420 V 380 V servo drive: 200B-1Bh > 760 V Measure whether the DC bus voltage between P and N is within the normal range and smaller than the value defined by 200B-1Bh.	Contact Inovance for technical support.
7. The servo drive is faulty.	The fault persists after main circuit is powered off and on several times.	Replace the servo drive.

■ E410.0: Main circuit undervoltage

Direct cause:

The DC bus voltage between P and N is lower than the undervoltage threshold.

220 V servo drive:
Normal value: 310 V
Undervoltage threshold: 200 V

<table>
<tr><th>Root Cause</th><th>Confirming Method</th><th>Solution</th></tr>
<tr><td>1. The main circuit power supply is unstable or fails.</td><td rowspan="2">Check the specifications of the main circuit power supply. Measure whether the input voltage of the main circuit on the non-drive side and the drive side (L1, L2) complies with the following specifications:
220 V servo drive:
Effective value: 220 V to 240 V
Allowable deviation: –10% to +10% (198 V to 264 V)
All the three phases must be measured.</td><td rowspan="3">Increase the power capacity.</td></tr>
<tr><td>2. Instantaneous power failure occurs.</td></tr>
<tr><td>3. Voltage drop occurs during running.</td><td>Observe the input voltage of the servo drive to check whether the same power supply is used to power up other devices, resulting in insufficient power capacity and voltage drop.</td></tr>
<tr><td>4. Phase loss: A single-phase power supply is used for a three-phase servo drive.</td><td>Check whether the wiring of the main circuit is proper and whether the phase loss fault detection (200A-01h) is hidden.</td><td>Replace the cables and connect the main circuit cables properly.
Three-phase: L1, L2, L3</td></tr>
<tr><td>5. The servo drive is faulty.</td><td>Check whether the bus voltage (200B-1Bh) complies with the following specifications:
220 V servo drive: 200B-1Bh < 200 V
The fault persists after the main circuit (L1, L2) is powered off and on several times.</td><td>Replace the servo drive.</td></tr>
</table>

■ E420.0: Phase loss

Direct cause:

One-phase or two-phase loss occurs on a three-phase servo drive.

<table>
<tr><th>Root Cause</th><th>Confirming Method</th><th>Solution</th></tr>
<tr><td>1. The three-phase input cables are connected improperly.</td><td>Check whether main cables (L1, L2, L3) on the drive side and non-drive side are in good condition and connected properly.</td><td>Replace the cables and connect the main circuit cables properly.</td></tr>
<tr><td>2. A single-phase power supply is applied to a three-phase servo drive.</td><td rowspan="2">Measure whether the input voltage of the main circuit complies with the following specifications.
◆ 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)
All the three phases must be measured.</td><td rowspan="2">A three-phase servo drive of 0.75 kW (2001-03h = 5) is allowed to run under a single-phase power supply.
If the input voltage complies with the specifications, set 200A-01h to 2 (Power input phase loss warning and fault inhibited).
If input voltage does not comply with the specifications, replace or adjust the power supply.</td></tr>
<tr><td>3. The three-phase power supply is unbalanced or the voltage of all the three phases are too low.</td></tr>
<tr><td>4. The servo drive is faulty.</td><td>The fault persists after the main circuit (L1, L2, L3) is powered off and on several times.</td><td>Replace the servo drive.</td></tr>
</table>

■ E420.1: PL signal error

Root Cause	Confirming Method	Solution
The power voltage signal is abnormal.	The fault persists after the servo drive is powered off and on several times.	It is recommended to use the standard voltage signal.

■ E500.0: Motor overspeed

Direct cause:

The actual speed of the servo motor exceeds the overspeed threshold.

Root Cause	Confirming Method	Solution
1. The UVW phase sequence of motor cables is incorrect.	Check whether UVW phase sequence on the servo drive side is consistent with that on the motor side.	Connect UVW cables according to the correct phase sequence.
2. 200A-09h is set improperly.	Check whether the overspeed threshold is smaller than the maximum motor speed required in actual applications. Overspeed threshold = 1.2 times the maximum motor speed (200A-09h = 0) Overspeed threshold = 200A-09h (the set value of 200A-09h is not 0 and less than 1.2 times the maximum motor speed).	Reset the overspeed threshold according to actual mechanical requirements.
3. The input reference is higher than the overspeed threshold.	Check whether the motor speed corresponding to the input reference exceeds the overspeed threshold. ◆ Position control mode In CSP mode, view the gear ratio 6091-01h/6091-02h to check the speed reference increment for a single synchronization cycle and convert it to the corresponding speed value. In PP mode, view the gear ratio 6091-01h/6091-02h and define the value of 6081h (Profile velocity). In HM mode, view the gear ratio 6091-01h/6091-02h, and define the value of 6099-01h and 6099-02h. ◆ Speed control mode: View the gear ratio (6091h), the target velocity (60FFh), the speed limit values (2006-09h and 2006-0Ah), and the maximum profile velocity (607Fh). ◆ Torque control mode: View the speed limits defined by 2007-14h and 2007-15h and check the corresponding speed limit value.	◆ Position control mode CSP: Decrease the position reference increment for a single synchronization cycle. The host controller should cover the position ramp when generating references. PP: Decrease the value of 6081h or increase the acceleration/deceleration ramp (6083h, 6084h). HM: Decrease 6099-01h and 6099-02h, or increase the acceleration/deceleration ramp (609Ah). Decrease the gear ratio according to actual conditions. ◆ Speed mode: Decrease the target velocity, speed limit, gear ratio. In PV mode, increase the speed ramp in 6083h and 6084h. In CSV mode, the host controller should cover the speed ramp. ◆ Torque control mode: Set the speed limit to a value smaller than the overspeed threshold.
4. The motor speed overshoots.	Check whether the speed feedback exceeds the overspeed threshold by using the software tool.	Adjust the gain or running conditions.
5. The servo drive is faulty.	The fault persists after servo drive is powered off and on again.	Replace the servo drive.

■ E500.1: Speed feedback overflow

Direct cause:

The FPGA speed measurement overflows.

Root Cause	Confirming Method	Solution
The FPGA speed measurement is abnormal.	Check whether the bit9 of H0B-30 is 1.	◆ The speed feedback is abnormal, check whether the encoder version (H00-04) is proper. ◆ Replace the encoder cables. ◆ The encoder cables suffer from interference. Re-connect the grounding cable and the shielded cable or install a magnetic ring.

■ E602.0: Angle auto-tuning error

Direct cause:

Abnormal jitter occurs on the encoder feedback during angle auto-tuning.

Root Cause	Confirming Method	Solution
An encoder feedback error occurs.	Check if the encoder communication suffers from interference.	Check the wiring of the encoder hardware.

■ E602.2: Wrong UVW phase sequence detected during angle auto-tuning

Direct cause:

A wrong UVW phase sequence is detected during angle auto-tuning.

Root Cause	Confirming Method	Solution
The UVW cables are connected reversely, which is detected during angle auto-tuning.	-	Exchange the cables of any two phases and perform auto-tuning again.

■ E620.0: Motor overload

Direct cause:

The accumulative heat of the servo motor reaches the fault threshold.

Root Cause	Confirming Method	Solution
1. The motor and encoder cables are connected improperly.	Check the wiring among the servo drive, servo motor and encoder according to the correct wiring diagram.	Connect cables according to the correct wiring diagram. It is recommended to use the cables provided by Inovance. If you use customized cables, ensure such cables are made and connected based on the hardware wiring instructions.
2. The load is too heavy. The motor keeps outputting the effective torque higher than the rated value.	Check the overload characteristics of the servo drive or servo motor. Check whether the average load ratio (200B-0DH) keeps exceeding 100.0%.	Replace with a high-power servo drive and a matching servo motor. Reduce the load and increase the acceleration/deceleration time.
3. The acceleration/deceleration is too frequent or the load inertia is too large.	Calculate the mechanical inertia ratio or perform inertia auto-tuning, and view the value of 2008-10h (Load inertia ratio). Confirm the single running cycle when the servo motor runs cyclically.	Increase the acceleration/ deceleration time during single running.
4. The gain is improper or the stiffness level is too high.	Observe whether the motor vibrates and generates abnormal noise during running.	Adjust the gain.

Root Cause	Confirming Method	Solution
5. The servo drive or motor models are set improperly.	View the serial encoder motor model in 2000-06h and servo drive model in 2001-0Bh.	View the servo drive nameplate and set the servo drive model in 2001-0Bh and use a matching servo motor according to *"1.1 Introduction to the Servo Drive"*.
6. Locked-rotor occurs due to mechanical factors, resulting in overload during running.	Check the RUN command and motor speed (200B-01h) through the software tool or the keypad: ◆ RUN command in the position control mode: 200B-0Eh (Position reference counter) ◆ RUN command in the speed control mode: 200B-02h (Speed reference) ◆ RUN command in the torque control mode: 200B-03h (Internal torque reference) Check whether the RUN command in the corresponding mode is not 0 but the motor speed is 0.	Eliminate mechanical factors.
7. The servo drive is faulty.	The fault persists after servo drive is powered off and on again.	Replace the servo drive.

■ E630.0: Locked rotor

Direct cause:

The actual motor speed is lower than 10 RPM but the torque reference reaches the limit, and such status persists for the duration defined by 200A-21h.

Root Cause	Confirming Method	Solution
1. Power output phase (UVW) loss or incorrect phase sequence occurs on the servo drive.	Perform motor trial run without load and check cable connections and the phase sequence.	Re-connect the cables according to the correct wiring diagram or replace the cables.
2. The motor parameters (especially the pole pairs) are set improperly and the motor angle auto-tuning is not performed.	Read parameters in group H00 to check whether the pole pairs are set properly. Perform angle auto-tuning on the motor several times and check whether the value of H00-28 is consistent during angle auto-tuning.	Modify the motor parameter values.
3. The communication commands suffer from interference.	Check whether jitter occurs on the commands sent from the host controller and whether EtherCAT communication suffers from interference.	Check whether the communication circuit between the host controller and the servo drive suffers from interference.

Root Cause	Confirming Method	Solution
4. The motor rotor is locked due to mechanical factors.	Check the RUN command and motor speed (H0B-00) through the software tool or the keypad. ◆ RUN command in the position control mode: H0B-13 (Position reference counter) ◆ RUN command in the speed control mode: H0B-01 (Speed reference) ◆ RUN command in the torque control mode: H0B-02 (Internal torque reference) Check whether the RUN command in the corresponding mode is not 0 but the motor speed is 0. Check the current feedback (torque reference) waveform.	Check whether any mechanical part gets stuck or eccentric.

■ E640.0: IGBT over-temperature

Direct cause: The IGBT temperature reaches the fault threshold defined by H0A-18 (IGBT over-temperature threshold).

■ E650.0: Heatsink over-temperature

Direct cause:

The power module temperature of the servo drive is higher than the over-temperature protection threshold.

Root Cause	Confirming Method	Solution
1. The ambient temperature is too high.	Measure the ambient temperature.	Improve cooling conditions to lower down the ambient temperature.
2. The servo drive is powered off frequently to reset the overload fault.	View the fault records: Check for overload fault (set 200B-22h and view 200B-23h) or warning (E3.610, E3.620, E3.630, E3.650).	Change the fault reset mode and perform reset 30s after overload. Increase the capacity of the servo drive and servo motor. Increase the acceleration/deceleration time and reduce the load.
3. The fan is damaged.	Check whether the fan rotates during running.	Replace the servo drive.
4. The installation direction and clearance of the servo drive are improper.	Check whether the servo drive is installed properly.	Install the servo drive according to the installation standards.
5. The servo drive is faulty.	The fault persists after power-off for five minutes and restart.	Replace the servo drive.

■ E661.0: Auto-tuned gain values too low

Direct cause:

1. The vibration cannot be suppressed. Enable vibration suppression manually to eliminate the vibration.

2. Excessive positioning overshoot occurs. Check whether the positioning threshold is too low. Increase the acceleration/deceleration time and lower the response level.

3. The command suffers from noises. Modify the electronic gear ratio to improve the command resolution, or increase the command filter time constant in the "Parameter configuration" interface.

4. The current fluctuates. Check whether the machine suffers periodic fluctuation.

5. The vibration cannot be suppressed if the load carries large inertia. In this case, increase the acceleration/deceleration time to ensure the motor current is unsaturated.

■ E731.0: Encoder battery failure

Direct cause:

The battery voltage of the absolute encoder is lower than 2.8 V.

Root Cause	Confirming Method	Solution
The battery is not connected during power-off.	Check whether the battery is connected during power-off.	Set 200D-15h to 1 to clear the fault.
The battery voltage of the encoder is too low.	Measure the battery voltage.	Replace with a new battery of the matching voltage.

■ E733.0: Encoder multi-turn counting error

Direct cause:

The encoder multi-turn counting is wrong.

Root Cause	Confirming Method	Solution
The encoder is faulty.	Set 200D-15h to 2 to clear the fault. E733.0 persists after the servo drive is powered off and on again.	Replace the servo motor.

■ E735.0: Encoder multi-turn counting overflow

Direct cause:

The multi-turn counting overflow occurs on the absolute encoder.

Root Cause	Confirming Method	Solution
The number of forward revolutions exceeds 32767 or the number of reverse revolutions exceeds 32768.	Check whether the value of H0B-70 (Number of absolute encoder revolutions) is 32767 or 32768 when the servo drive works in the absolute position linear mode (H02-01 = 1).	Set H0D-20 (Absolute encoder reset selection) to 2 (Reset the encoder fault and multi-turn data) and power on the servo drive again. Perform homing if necessary.

■ E740.2: Absolute encoder error

Direct cause:

Communication timeout occurs on the absolute encoder.

Root Cause	Confirming Method	Solution
The communication between the servo drive and the encoder is abnormal.	Check whether the value of H0B-28 (Absolute encoder fault information given by FPGA) is not 0.	◆ Check whether H00-00 (Motor code) is set properly. ◆ Check whether encoder cables are connected properly. ◆ Check whether the servo drive and servo motor are grounded properly. You can install a magnetic ring on the encoder to reduce interference.

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

Root Cause	Confirming Method	Solution
An internal fault occurs on the encoder.	Check whether bit7 of H0B-28 is 1.	◆ Check whether the encoder version (H00-04) is proper. ◆ Check whether encoder cables are in proper condition. ◆ Replace the servo motor.

■ E740.6: Encoder write error

Direct cause:

A write error occurs on the encoder.

Root Cause	Confirming Method	Solution
An error occurs during writing the position offset after angle auto-tuning.	-	Check whether the encoder cable shield and the grounding cable are connected properly.

■ EB00.0: Position deviation too large

Direct cause:

The position deviation is larger than the value defined by 6065h in the position control mode.

Root Cause	Confirming Method	Solution
1. Power output (UVW) phase loss or incorrect phase sequence occurs on the servo drive.	Perform motor trial run without load and check the cable connections.	Re-connect the cables according to the correct wiring diagram or replace the cables.
2. The servo drive UVW cables or the encoder cables are disconnected.	Check the cable connections.	Re-connect the UVW cables. The UVW phase sequence on the servo drive side must be consistent with that on the motor side. Replace with new cables if necessary and ensure the cables are connected properly.
3. The motor rotor is locked due to mechanical factors.	Check the RUN command and motor speed (200B-01h) through the software tool or the keypad: RUN command in the position control mode: 200B-0Eh (Position reference counter) RUN command in the speed control mode: 200B-02h (Speed reference) RUN command in the torque control mode: 200B-03h (Internal torque reference) Check whether the RUN command in the corresponding mode is not 0 but the motor speed is 0.	Eliminate mechanical factors.
4. The servo drive gain is low.	Check the position loop gain and speed loop gain of the servo drive. 1st gain: 2008-01h to 2008-03h 2nd gain: 2008-04h to 2008-06h	Adjust the gain manually or perform gain auto-tuning.

Root Cause	Confirming Method	Solution
5. The position reference increment is too large.	Position control mode: ◆ In CSP mode, view the gear ratio 6091-01h/6091-02h to check the speed reference increment for a single synchronization cycle and convert it to the corresponding speed value. ◆ In PP mode, view the gear ratio 6091-01h/6091-02h and define the value of 6081h (Profile velocity). ◆ In HM mode, view the gear ratio 6091-01h/6091-02h, and define the value of 6099-01h and 6099-02h.	◆ CSP: Decrease the position reference increment for a single synchronization cycle. The host controller should cover the position ramp when generating references. ◆ PP: Decrease the value of 6081h or increase the acceleration/ deceleration ramp (6083h, 6084h). ◆ HM: Decrease 6099-01h and 6099-02h, or increase the acceleration/deceleration ramp (609Ah). Decrease the gear ratio according to actual conditions.
6. The value of 6065h (Following error window) is too small in relative to the running condition.	Check whether the value of 6065h is too small.	Increase the value of 6065h.
7. The servo drive or servo motor is faulty.	Monitor the running curves through the oscilloscope function of the software tool: position reference, position feedback, speed reference, and torque reference	If the position reference is not 0, but the position feedback is always 0, replace the servo drive/motor.

■ EB00.1 (Following error actual value)

Direct cause:

The position deviation is too large.

Root Cause	Confirming Method	Solution
1. Power output (UVW) phase loss or incorrect phase sequence occurs on the servo drive.	Perform motor trial running without load and check the cable connections.	Re-connect the cables according to the correct wiring diagram or replace the cables.
2. The servo drive UVW cables or the encoder cables are disconnected.	Check the wiring.	Re-connect the UVW cables. The UVW phase sequence on the servo drive side must be consistent with that on the motor side. Replace with new cables if necessary and ensure the cables are connected properly.

Root Cause	Confirming Method	Solution
3. The motor rotor is locked due to mechanical factors.	Check the RUN command and motor speed (200B-01h) through the software tool or the keypad: ◆ RUN command in the position control mode: 200B-0Eh (Position reference counter) ◆ RUN command in the speed control mode: 200B-02h (Speed reference) ◆ RUN command in the torque control mode: 200B-03h (Internal torque reference) Check whether the RUN command in the corresponding mode is not 0 but the motor speed is 0.	Eliminate mechanical factors.
The servo drive gain is low.	Check the position loop gain and speed loop gain of the servo drive. 1st gain: 2008-01h to 2008-03h 2nd gain: 2008-04h to 2008-06h	Adjust the gain manually or perform gain auto-tuning.
5. The position reference increment is too large.	Position control mode: ◆ In CSP mode, view the gear ratio 6091-01h/6091-02h to check the speed reference increment for a single synchronization cycle and convert it to the corresponding speed value. ◆ In PP mode, view the gear ratio 6091-01h/6091-02h and define the value of 6081h (Profile velocity). ◆ In HM mode, view the gear ratio 6091-01h/6091-02h, and define the value of 6099-01h and 6099-02h.	◆ CSP: Decrease the position reference increment for a single synchronization cycle. The host controller should cover the position ramp when generating references. ◆ PP: Decrease the value of 6081h or increase the acceleration/deceleration ramp (6083h, 6084h). ◆ HM: Decrease the value of 6099-01h and 6099-02h or increase the acceleration/ deceleration ramp (609Ah). Decrease the gear ratio according to actual conditions.
6. The value of 6065h (Following error window) is too small in relative to the running condition.	Check whether the value of 6065h is too small.	Increase the value of 6065h.
7. The servo drive or the servo motor is faulty.	Monitor the running curves through the oscilloscope function of the software tool: position reference, position feedback, speed reference, and torque reference	If the position reference is not 0 but the position feedback is always 0, replace the servo drive or the servo motor.

■ EA33.0: Encoder read/write check error

Direct cause:

Internal parameters of the encoder are abnormal.

Root Cause	Confirming Method	Solution
1. The serial incremental encoder cable is disconnected or loosened.	Check the encoder cable connection.	Check for wrong connection, disconnection and poor contact of the encoder cable. Route the motor cable and encoder cable through different routes.

Root Cause	Confirming Method	Solution
2. An error occurs when reading/writing the RS485 encoder parameters.	If the fault persists after the servo drive is powered off and on several times, the encoder is faulty.	Replace the servo motor.

■ EB01.1: Position reference increment too large for once

Cause	Confirming Method	Solution
1. The target position increment is too large.	Check the variation value between two adjacent target positions by using the software tool.	1. Check whether the maximum motor speed fulfills the application requirement. If yes, reduce the target position reference increment, which is to lower the profiled reference speed. If not, replace the servo motor. 2. Before switching the modes or enabling the servo drive, check whether the target position is aligned with current position feedback. 3. The communication time sequence of the host controller is abnormal, leading to slave data receiving error. Check the communication time sequence of the host controller.

■ EB01.2: Position reference increment too large continuously

Direct cause:

The target position increment exceeds the limit value N times consecutively.

Root Cause	Confirming Method	Solution
1. The target position increment is too large.	Check the variation value between two adjacent target positions by using the software tool.	1. Check whether the maximum motor speed fulfills the application requirement. If yes, reduce the target position reference increment, which is to lower the profiled reference speed. If not, replace the servo motor. 2. Before switching the modes or enabling the servo drive, check whether the target position is aligned with current position feedback. 3. The communication time sequence of the host controller is abnormal, leading to slave data receiving error. Check the communication time sequence of the host controller.

■ EB01.3: Command overflow

Cause	Confirming Method	Solution
The target position is still in the process of transmission when the servo limit or software limit signal is activated and the 32-bit upper/low limit is reached.	Check whether the host controller keeps outputting commands when the overtravel warning occurs.	Detect the servo limit signal (bit0 and bit1 of 60FD recommended) through the host controller and stop the host controller from transmitting the limit direction command after the servo limit signal is activated.

■ EB01.4: Reference value beyond the single-turn position limits in the absolute mode

Cause	Confirming Method	Solution
The target position exceeds the upper/lower limit of the unit position in the single-turn absolute mode.	Check whether the set value of the target position is within the single-turn upper/lower limit.	Set the target position to a value within the upper/lower limit.

■ EE09.0: Software limit setting error

Root Cause	Confirming Method	Solution
The lower limit of the software is larger than or equal to the upper limit.	Check the value of 607D-01 and 607D-02.	Reset the value of 607D-01 and 607D-02 and ensure the former is smaller than the latter.

■ EE09.1: Home setting error

Direct cause:

The home offset exceeds the upper/lower limit.

Root Cause	Confirming Method	Solution
1. The home offset is beyond the software limit.	The home offset is beyond the software limit when the encoder works in the incremental mode, absolute linear mode, or single-turn absolute mode.	Set the home offset to a value within the software limit.
2. The home offset is beyond the upper/lower limit in the rotation mode.	The home offset is beyond the mechanical single-turn upper/lower limit when the encoder works in the rotation mode.	Set the home offset to a value within the limit.

■ EE09.2: Gear ratio over the limit

Direct cause:

The electronic gear ratio exceeds the limit: (0.001 x Encoder resolution/10000, 4000 x Encoder resolution/10000)

Root Cause	Confirming Method	Solution
The set electronic gear ratio exceeds the preceding limit.	Check whether the ratio of 6091-01h to 6091-02h exceeds the preceding range.	Set the gear ratio to a value within the preceding range.

■ EE09.3: No synchronization signal

Direct cause:

The MCU does not receive the synchronization signal when the servo communication is switched to OP state.

Root Cause	Confirming Method	Solution
1. The communication synchronization clock is configured improperly.	Replace with another master (such as Beckhoff, Omron PLCs) and perform tests to compare between different masters.	Solve the problem of improper configuration.
2. The IN/OUT port for EtherCAT communication is connected reversely.	Check whether the IN/OUT port is connected reversely.	Connect the IN and OUT ports according to the correct sequence.

Root Cause	Confirming Method	Solution
3. The slave controller chip is damaged.	If the problem persists after master replacement, measure the synchronization signal generated from the slave controller chip with an oscilloscope. If there is no signal, the slave controller chip is damaged.	Replace the slave controller chip.
4. The MCU pins are damaged.	Test the synchronization signal generated from the slave controller chip with an oscilloscope. If there is a signal, the pin of the MCU chip is damaged.	Replace MCU chip.

■ EE09.5: PDO mapping over the limit

Root Cause	Confirming Method	Solution
The number of the mapping objects in TPDO or RPDO exceeds 10.	Check the number of self-index configured by 1600h or 1A00h.	The number of the mapping objects in TPDO or RPDO cannot exceed 10.

9.4 Solutions to Warnings

■ E121.0: Invalid S-ON command

Direct cause:

The S-ON signal is set repeatedly.

Root Cause	Confirming Method	Solution
1. The servo drive is enabled internally the same time when the S-ON signal is activated through communication.	Check whether the S-ON signal is sent from the host controller when the auxiliary functions (200D-03h, 200D-04h, 200D-0Ch) are used.	Switch off the S-ON signal sent from the host controller.
The S-ON signal is sent from the DI and the software tool simultaneously.	Check whether the S-ON signal is sent from the DI terminal and the software tool simultaneously.	Switch off the redundant S-ON signal.

■ E600.0: Inertia auto-tuning failure

Direct cause:

1. The vibration cannot be suppressed. Enable vibration suppression manually to eliminate the vibration.

2. The auto-tuned values fluctuate dramatically. During ETune operations, the stroke of the lead screw can be shortened by increasing the maximum running speed and reducing the acceleration/deceleration time.

3. Mechanical connections of the load are loosened or eccentric. Remove the mechanical fault.

4. A warning occurs during auto-tuning and causes interruption. Clear the fault and perform inertia auto-tuning again.

5. The vibration cannot be suppressed if the load carries large inertia. In this case, increase the acceleration/deceleration time to ensure the motor current is unsaturated.

■ E601.0: Homing warning

Direct cause:

The home is not found within the time defined by 2005-24h.

Root Cause	Confirming Method	Solution
1. The home switch fails.	There is only high-speed search but no low-speed search during homing. After high-speed search for the home, the servo drive keeps low-speed search in the reverse direction.	If a hardware DI is used, check whether FunIN.31 (HomeSwitch) has been allocated to a certain DI in group 2003h and then check the wiring of the DI. Manually change the DI logic and observe whether the servo drive receives DI level change through 200B-04h. If not, the wiring of the DI is incorrect. If yes, a fault occurs during the homing. Carry out the homing operation correctly.
2. The set homing duration is too short.	Check whether the value of 2005-24h (Duration limit of homing) is too small.	Increase the value of 2005-24h.
3. The speed in high-speed search for the home switch signal is too low.	Check the distance between the initial position of homing and the home switch. Then check whether the value of 6099-01h is too small, resulting in a prolonged homing process.	Increase the value of 6099-01h.

■ E601.1: Homing switch error

Root Cause	Confirming Method	Solution
The home switch is set improperly.	Check whether the limit signals at both sides are activated simultaneously. Check whether the limit signal and the deceleration point signal/home signal are activated simultaneously.	Set the position of the hardware switch properly.

■ E730.0: Encoder battery warning

Root Cause	Confirming Method	Solution
The encoder battery voltage is lower than 3.0 V.	Measure the battery voltage.	Replace with a new battery of matching voltage.

■ E900: Emergency stop

Direct cause:

The logic of the DI (including hardware DI and VDI) allocated with FunIN.34 (EmergencyStop) is valid.

Root Cause	Confirming Method	Solution
The DI function 34 (FunIN.34: Emergency stop) is triggered.	Check whether the logic of the DI allocated with FunIN.34 is valid.	Check the running mode and clear the DI braking signal without affecting the safety performance.

■ E902.0: Invalid DI setting

Direct cause:

The DI function is set to a invalid value.

Root Cause	Confirming Method	Solution
The logics of DI1 to DI5 are set to invalid values.	Check whether the logics of 2003-03h, 2003-05h, 2003-07h to 2003-09h and 2003-0Bh are set to invalid values.	Set the DI logic to a valid value.

■ E902.1: Invalid DO setting

Direct cause:

The DO function is set to a invalid value.

Root Cause	Confirming Method	Solution
The logics of DO1 to DO3 are set to invalid values.	Check whether the logics of 2004-01h, 2004-03h, and 2004-05h are set to invalid values.	Set the DO logic to a valid value.

■ E902.2: Invalid torque reached setting

Cause	Confirming Method	Solution
The torque reached DO parameter setting is invalid in the torque control mode.	Check whether the value of 2007-17h is smaller than or equal to the value of 2007-18h (unit: 0.1%).	The value of 2007-17h must be larger than the value of 2007-18h.

■ E908.0: Invalid check bit of model identification

Direct cause:

The first two check bits of model identification are incorrect, indicating the model identification fails.

Root Cause	Confirming Method	Solution
1. The model identification parameters are not written.	The warning persists after restart.	1. Write the model identification parameters again.
2. The check bits of model identification are incorrect.		2. Set H01-72 to 1 to hide the model identification function.

■ E909.0: Motor overload warning

Direct cause:

The accumulative heat of the motor reaches the warning threshold (90% of the maximum allowable heat).

Root Cause	Confirming Method	Solution
1. The motor and encoder cables are connected improperly or in poor contact.	Check the wiring among the servo drive, servo motor and encoder according to the correct wiring diagram.	Connect cables based on the correct wiring diagram. It is recommended to use the cables provided by Inovance. If you use customized cables, ensure such cables are made and connected based on the hardware wiring instructions.
2. The load is too heavy. The motor keeps outputting the effective torque higher than the rated value.	Check the overload characteristics of the servo drive or servo motor. Check whether the average load ratio (200B-0Dh) keeps exceeding 100.0%.	Replace with a high-power servo drive and a matching servo motor. Reduce the load and increase the acceleration/deceleration time.

Root Cause	Confirming Method	Solution
3. The acceleration/ deceleration is too frequent or the load inertia is too large.	Check the mechanical inertia ratio or perform inertia auto-tuning. Then view the value of 2008-10h (Load inertia ratio). Confirm the single running cycle when the servo motor runs cyclically.	Increase the acceleration/deceleration time.
4. The gain is improper or the stiffness level is too high.	Observe whether the motor vibrates and generates abnormal noise during running.	Adjust the gain.
5. The servo drive or motor models are set improperly.	View the motor model in 2000-06h and the servo drive model in 2001-03h.	View the servo drive nameplate and set the servo drive model in 2001-03h. Update the motor model to a proper value.
6. Locked-rotor occurs due to mechanical factors, resulting in overload during running.	Check the RUN command and the motor speed (200B-01h) through the software tool or the keypad: ◆ RUN command in the position control mode: 200B-0Eh (Position reference counter) ◆ RUN command in the speed control mode: 200B-02h (Speed reference) ◆ RUN command in the torque control mode: 200B-03h (Internal torque reference) Check whether the RUN command in the corresponding mode is not 0 but the motor speed is 0.	Eliminate mechanical factors.
7. The servo drive is faulty.	Power off and on the servo drive again.	If the fault persists after restart, replace the servo drive.

■ E920.0: Regenerative resistor overload

Direct cause:

The accumulative heat of the regenerative resistor reaches the warning threshold (90% of the maximum allowable heat).

Root Cause	Confirming Method	Solution
1. The external regenerative resistor is connected improperly, disconnected or loosened.	Remove the external regenerative resistor and measure whether the resistance of the resistor is " ∞ " (infinite). Measure whether the resistance between P and C is " ∞ " (infinite).	Replace with a new external regenerative resistor and measure its resistance. If the resistance is consistent with the nominal value, connect it between P and C. Select a new cable and connect it between P and C.
2. The jumper between terminals P and D is shorted or loosened when an internal regenerative resistor is used.	Measure whether the resistance between P and D is " ∞ " (infinite).	Select a new cable and connect it between P and D.

Root Cause	Confirming Method	Solution
3. The setting of 2002-1Ah is incorrect when an external regenerative resistor is used.	View the set value of 2002-1Ah. Measure the resistance of the external regenerative resistor connected between P and C. Check whether the resistance is too large by comparing it with value listed in "Table 5-3 Specifications of the regenerative resistor for SV660N series servo drive". Check whether the value of 2002-1Ch is larger than the resistance of the external regenerative resistor connected between P and C.	Set 2002-1Ah to a proper value according to "5.4.3 Regenerative Resistor Settings": 2002-1Ah = 1 (External, naturally ventilated) 2002-1Ah = 2 (External, forcible cooling)
4. The resistance of the external regenerative resistor used is too large.		Select a proper regenerative resistor according to Table 5-3.
5. The value of 2002-1Ch (Resistance of external regenerative resistor) is larger than the resistance of the external regenerative resistor actually used.		Set 2002-1Ch according to the resistance of the external regenerative resistor actually used.
6. The input voltage of the main circuit exceeds the specification.	Check whether the input voltage of the main circuit on servo drive side complies with the following specifications: ◆ 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)	Replace the power supply or adjust the power voltage according to the specification.
7. The load inertia ratio is too large.	Perform inertia auto-tuning according to "6.2 Inertia Auto-tuning", or calculate the total mechanical inertia according to mechanical parameters. Check whether the actual load inertia ratio exceeds 30.	Select an external regenerative resistor of large capacity and set 2002-1Bh (Power of external regenerative resistor) according to the actual value. Select a servo drive of large capacity. Reduce the load if allowed. Increase the acceleration/deceleration time if allowed. Increase the motor running cycle if allowed.
8. The motor speed is too high, and deceleration is not completed within the required time. The motor is in continuous deceleration status during cyclic motion.	View the motor speed curve during cyclic motion and check whether the motor is in the deceleration status for a long time.	
9. The capacity of the servo drive or regenerative resistor is insufficient.	View the single-cycle speed curve of the motor and calculate whether the maximum braking energy can be absorbed completely.	
10. The servo drive is faulty.	-	Replace the servo drive.

■ E922.0: Resistance of the external regenerative resistor too small

Direct cause:

The value of 2002-1Ch (Resistance of external regenerative resistor) is smaller than the value of 2002-16h (Minimum permissible resistance of regenerative resistor).

Root Cause	Confirming Method	Solution
When an external regenerative resistor is used (2002-1Ah = 1, 2), ensure the resistance of the external regenerative resistor is smaller than the minimum value allowed by the servo drive.	Measure the resistance of the external regenerative resistor connected between P and C and check whether it is smaller than the value of 2002-16h.	◆ If yes, connect an external regenerative resistor that matches the servo drive between P and C and set 2002-1Ch (Resistance of external regenerative resistor) according to the actual resistance. ◆ If not, set 2002-1Ch according to the resistance of the external regenerative resistor actually used.

■ E924.0: Braking transistor over-temperature

Cause:

The estimated temperature of the braking transistor is higher than H0A-38 (Maximum protection threshold)

■ E941.0: Parameter modifications not activated

Root Cause	Confirming Method	Solution
The parameters modified are those whose "Effective time" is "Next power-on".	Check whether the modifications of these parameters are activated at next power-on.	Power on the servo drive again.

■ E942.0: Parameter saved frequently

Direct cause:

The total number of parameters modified simultaneously exceeds 200.

Root Cause	Confirming Method	Solution
A large number of parameters are modified and saved frequently to EEPROM (200E-02h = 1, 3).	Check whether parameters are modified quickly and frequently through the host controller.	Check the running mode. For parameters that need not be saved in EEPROM, set 200E-02h to 0 before the write operation of the host computer.

■ E950.0: Forward overtravel warning

Cause	Confirming Method	Solution
1. The logic of the DI allocated with FunIN.14 is valid (Forward driving inhibited).	Check whether a DI in group 2003h is allocated with FunIN.14 and check whether the DI logic of the corresponding bit of 200B-04h (Monitored DI status) is valid.	Check the running mode and on the prerequisite of ensuring safety, send a reverse run command or rotate the motor to deactivate the logic of the DI allocated with FunIN.14.
2. The servo drive position feedback reaches the positive software limit.	Check whether the position feedback (0x6064) is close to the value of 0x607D-02.	Ensure the load stroke is within the software limit range.

■ E952.0: Reverse overtravel warning

Root Cause	Confirming Method	Solution
The logic of the DI allocated with FunIN.15 (Reverse driving inhibited) is valid.	Check whether a DI in group 2003h is allocated with FunIN.15 and check whether the DI logic of the corresponding bit of 200B-04h (Monitored DI status) is valid.	Check the running mode and on the prerequisite of ensuring safety, send a reverse run command or rotate the motor to deactivate the logic of the DI allocated with FunIN.15.

■ EE09.4: Homing method setting error

Direct cause:

The homing method (0x6098h) is set improperly.

Root Cause	Confirming Method	Solution
The homing method (0x6098) is set to a value outside the range of [-2 to 14] when the absolute position single-turn mode is used (H02-01 = 4).	Check the set value of 0x6098.	Set 0x6098 to a value within the specified range.
The homing method (0x6098) is set to a value outside the range of [-2, 14], [17, 30], and [33,35] when the absolute position single-turn mode is not used.	Check the set value of 0x6098.	Set 0x6098 to a value within the specified range.

9.5 Solutions to Communication Faults

This section describes solutions to communication faults.

■ EE08.0: Synchronization loss

Direct cause:

Synchronous signal loss occurs on the master during synchronous communication.

Root Cause	Confirming Method	Solution
1. The data received by the slave is abnormal during synchronous communication.	Check whether the shielded twisted pair is used as the communication cable. Check whether the servo drive is grounded properly. Check whether the Ethernet port of the servo drive is damaged.	◆ Use the shielded twisted pairs. ◆ Connect the cables according to the wiring instructions. ◆ Check the network connection status through the first LED on the keypad.
2. The data sent by the master is abnormal during synchronous communication.	The synchronization clock of the host controller is not activated. Excessive error occurs on the synchronization clock of the host controller.	◆ Measure the synchronization cycle by using the oscilloscope function of the software tool or an actual oscilloscope. ◆ If the synchronization cycle is 0, the synchronization clock of the host controller is not activated. In this case, check whether the Ethernet cable connected to each slave comes in from the IN port and out from the OUT port. If yes, restart the network. If the network cables are connected in the correct sequence, without the need for prior check, restart the network directly. . ◆ If the synchronization cycle is within the permissible fluctuation range (2 µs) of the servo drive, increase the value of 200E-21h (Threshold of EtherCAT synchronization error) of the slave.

■ EE08.1: Network status switchover error

Cause	Confirming Method	Solution
When the servo is enabled, the network status switches from OP to non-OP.	Check whether the network status switches from OP to non-OP.	Check the network status switchover program of the host controller.

■ EE08.2: IRQ loss

Direct cause:

Synchronization signal loss occurs on the master during synchronous communication.

Root Cause	Confirming Method	Solution
1. The data received by the slave is abnormal during synchronous communication.	Check whether the shielded twisted pair is used as the communication cable. Check whether the servo drive is grounded properly. Check the Ethernet port of the servo drive is damaged.	Use the shielded twisted pairs. Connect the cables according to the wiring instructions. Check the network connection status through the first LED on the keypad.
2. The data sent by the master is abnormal during synchronous communication.	The synchronization performance of the host controller is unsatisfactory.	Check the synchronization performance of the host controller and increase the value of 200E-21h (Threshold of EtherCAT synchronization error) of the slave.

■ EE11.0: ESI check error

Direct cause:

Uploading of the XML file fails during EtherCAT communication.

Root Cause	Confirming Method	Solution
1. The XML file is not written to the EEPROM. 2. The XML file in the EEPROM is modified unexpectedly.	Check whether the XML version displayed in H0E-96 is normal.	Write the XML file to the EEPROM.

■ EE11.1: Unsuccessful reading of EEPROM

Direct cause:

The EEPROM communication of external EtherCAT devices fails.

Root Cause	Confirming Method	Solution
The EtherCAT data in the EEPROM cannot be read.	This fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ EE11.2: Unsuccessful update of EEPROM

Direct cause:

The communication is normal but the message error or loss occurs on the EEPROM.

Root Cause	Confirming Method	Solution
The EtherCAT data in the EEPROM cannot be updated.	This fault persists after the servo drive is powered off and on several times.	Replace the servo drive.

■ EE12.0: External devices of EtherCAT being abnormal

Direct cause:

The EtherCAT network cannot be initialized.

Root Cause	Confirming Method	Solution
1. The FPGA firmware is not programmed.	Check whether the value of 2001-02h is 09xx.Y.	Program the FPGA firmware.
2. The servo drive is faulty.	Connect to the master and check whether the servo drive is faulty.	Replace the faulty servo drive.

■ EE13.0: Synchronization cycle setting error

Cause	Confirming Method	Solution
The synchronization cycle is not a integral multiple of 125 μs or 250 μs.	Check the setting of the synchronization cycle in the controller.	Set the value of synchronization cycle to an integral multiple of 125 μs or 250 μs.

■ EE15.0: Synchronization cycle error too large

Direct cause:

The synchronization cycle error exceeds the threshold.

Root Cause	Confirming Method	Solution
Excessive synchronization cycle error occurs on the controller.	Measure the synchronization cycle of the controller by using a digital oscilloscope or the oscilloscope function of the software tool.	Increase the value of 200E-21h.

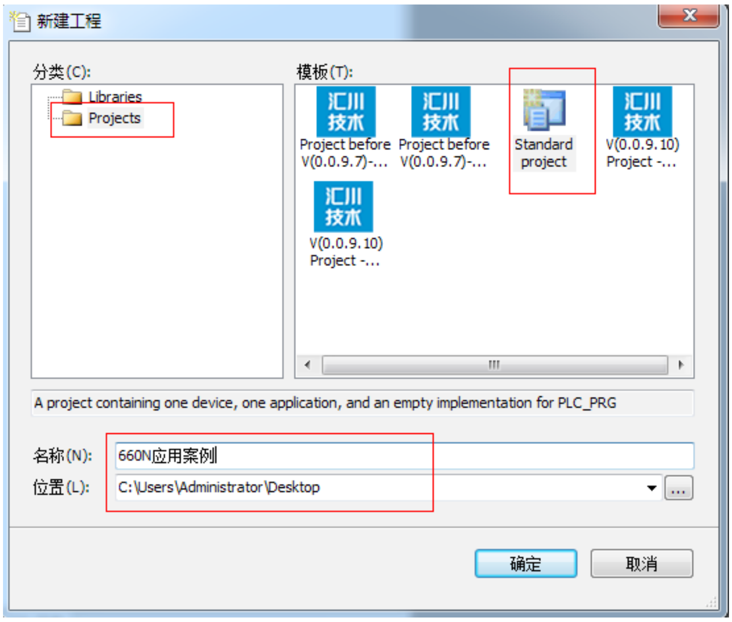
10 Application Cases

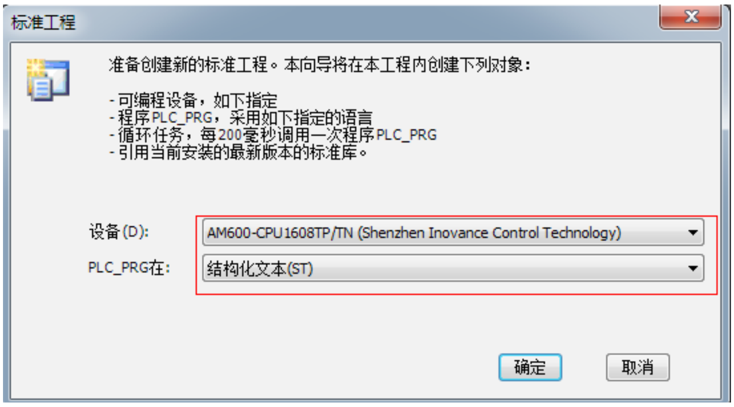
Case 1 AM600 series controller as the host controller

This section describes how to configure the SV660N series servo drive in working with the AM600 series controller.

1) Opening the software and creating an AM600 project

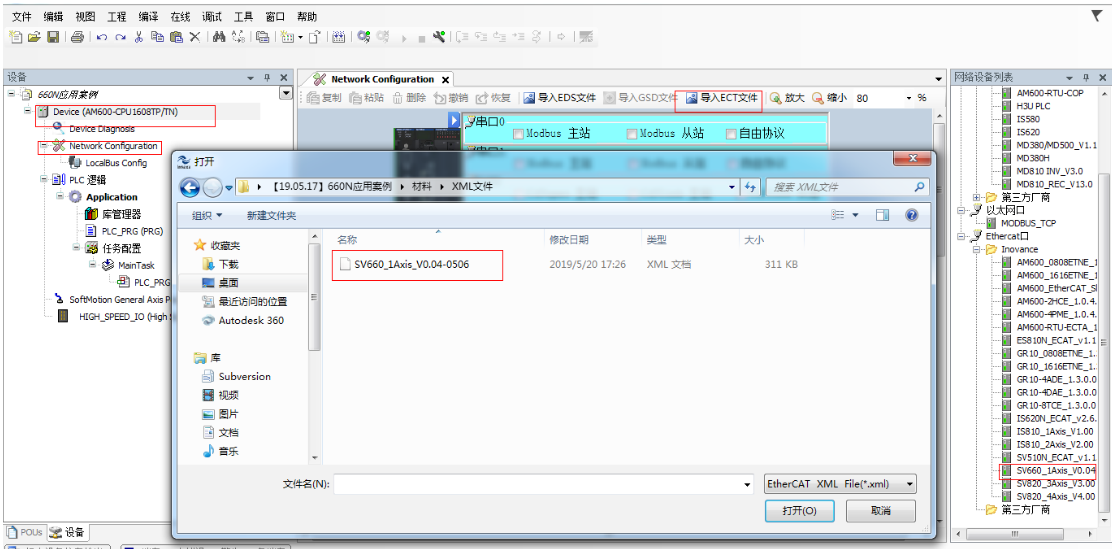
Select "AM600-CPU1608TP" as shown below.

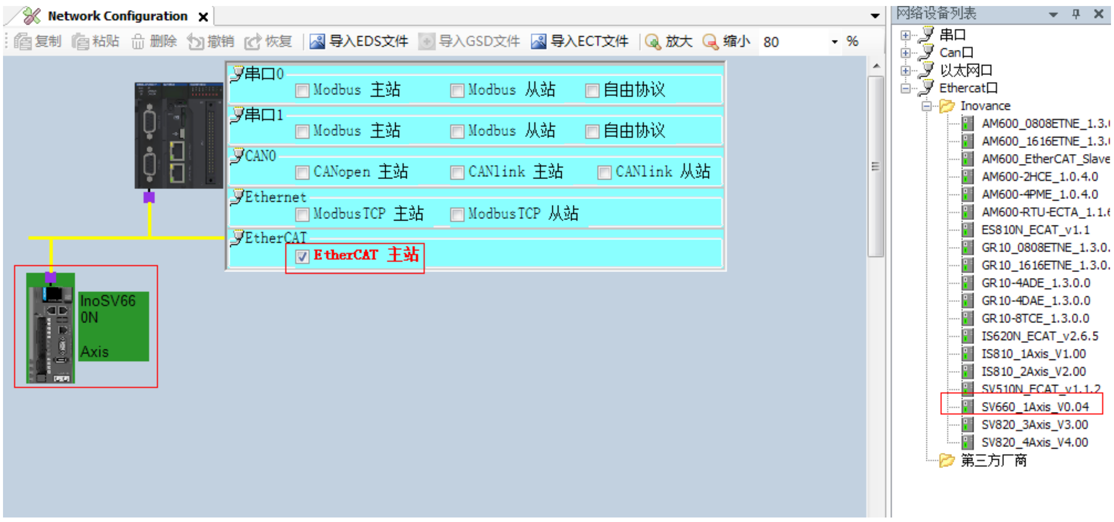




2) Adding an SV660N servo drive as a slave

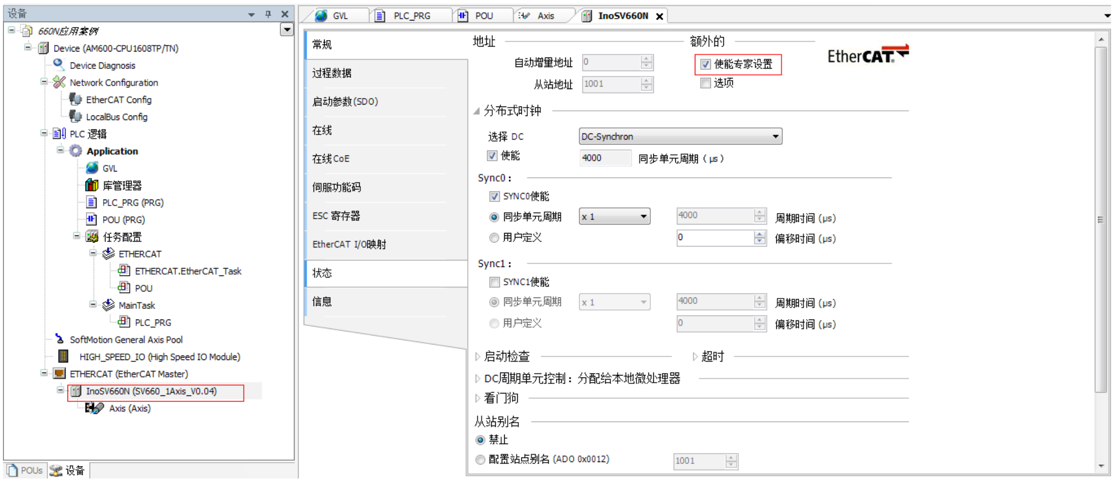
Open the network configuration and import the ECT file of SV660N. Add an SV660N servo drive as a slave, as shown below.

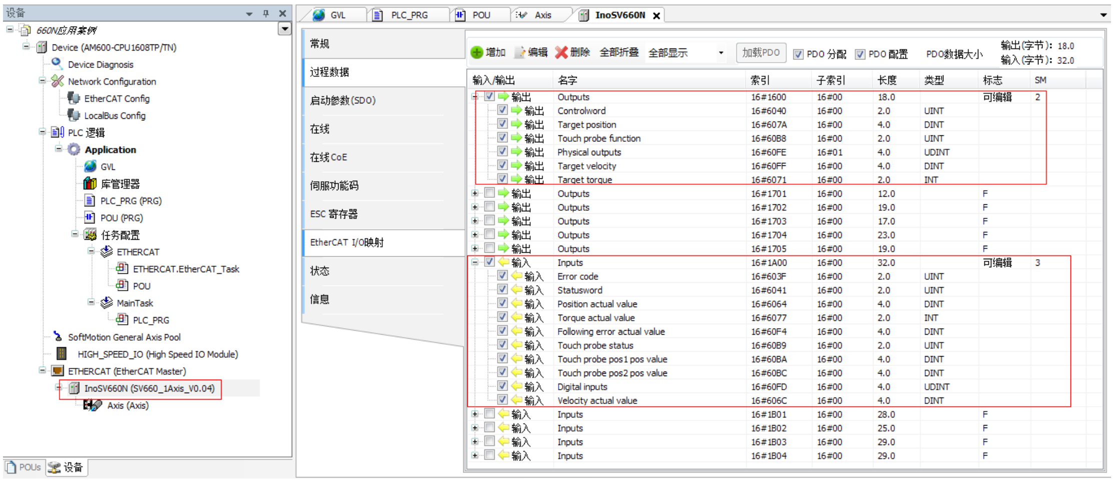




3) PDO mapping

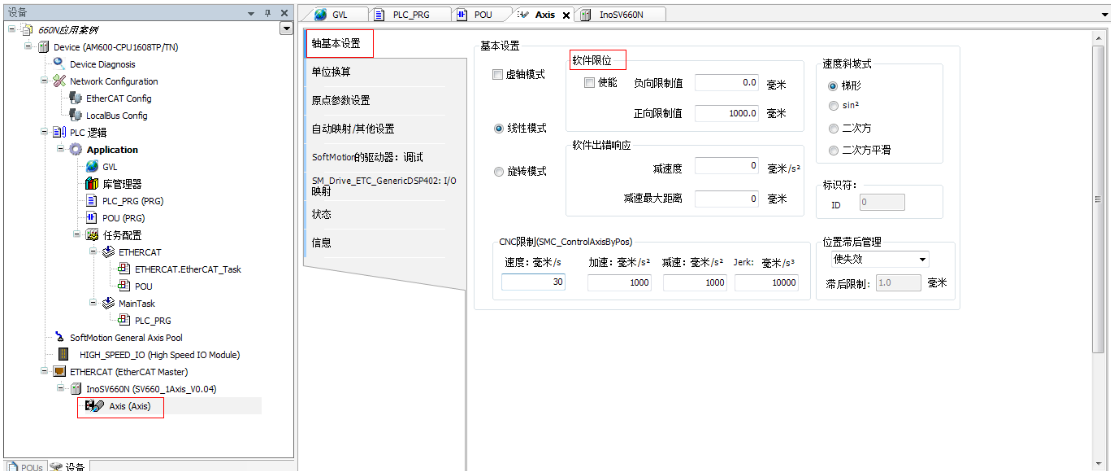
Select " 使能专家设置 " (Enable expert setting) and perform PDO mapping in the process data according to the control needs. In Case 1, CSP is used as the control mode and the default values of 1600 and 1A00 are used for PDO parameters.



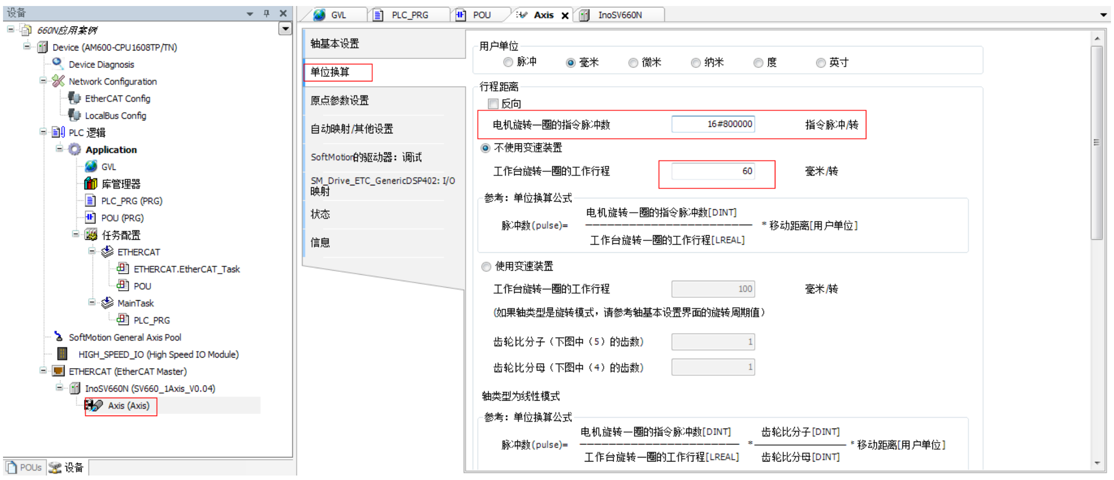


4) Configuring axis parameters

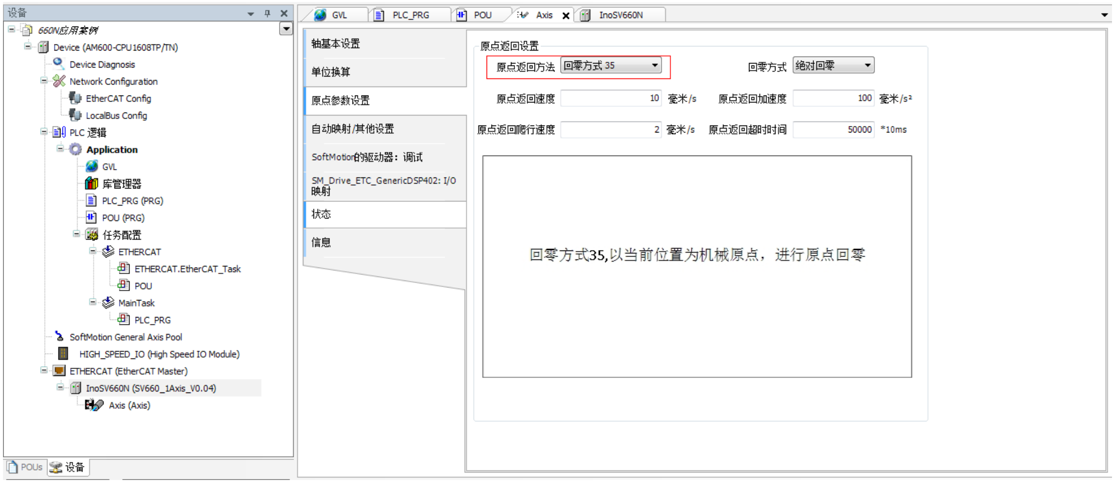
Set the software limit and the running mode in basic axis settings.



Select 16#800000 for the 23-bit encoder and 16#100000 for the 20-bit encoder during unit conversion. In Case 1, the single-circle stroke is set to 60 mm, and 1 mm/s equals to 1 RPM of the motor.

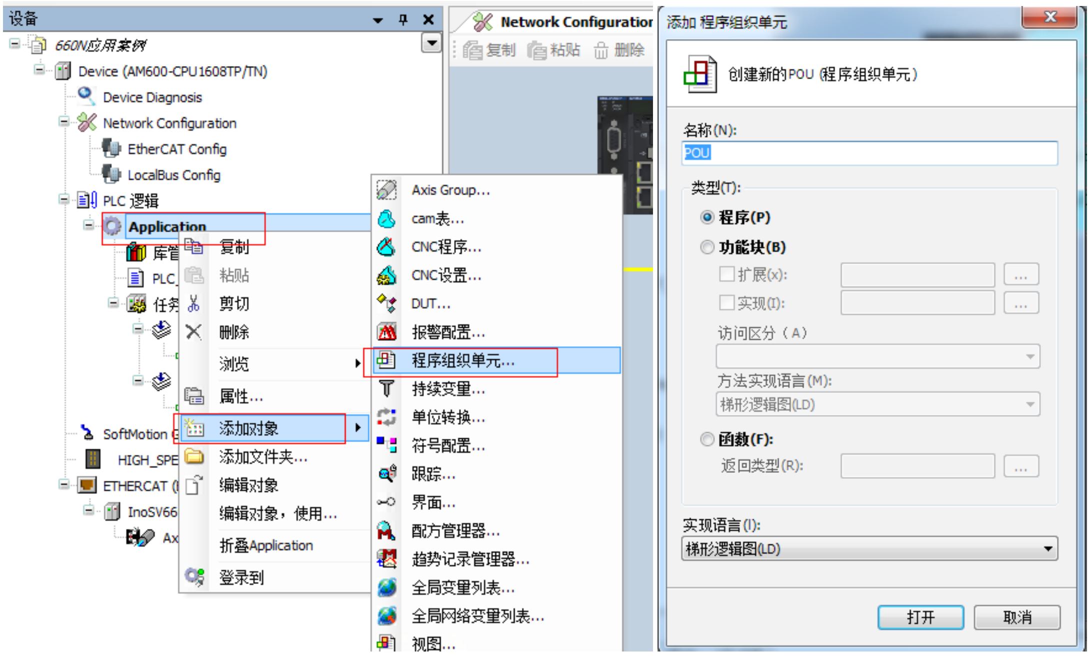


Select the homing mode according to actual needs. See "7.9.4 Homing Operation" for details on the homing mode.

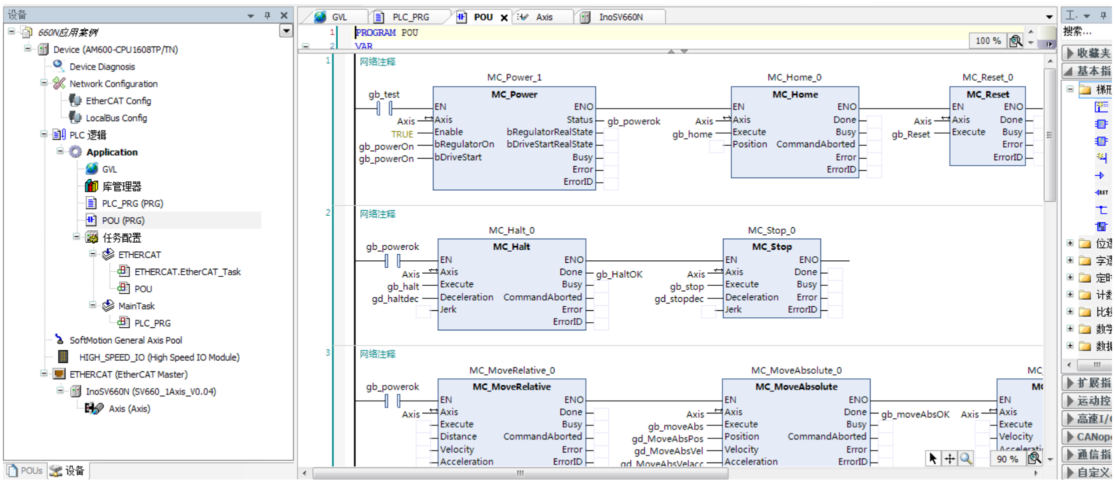


5) Adding a program

Add a program to control the servo axis position, as shown below.

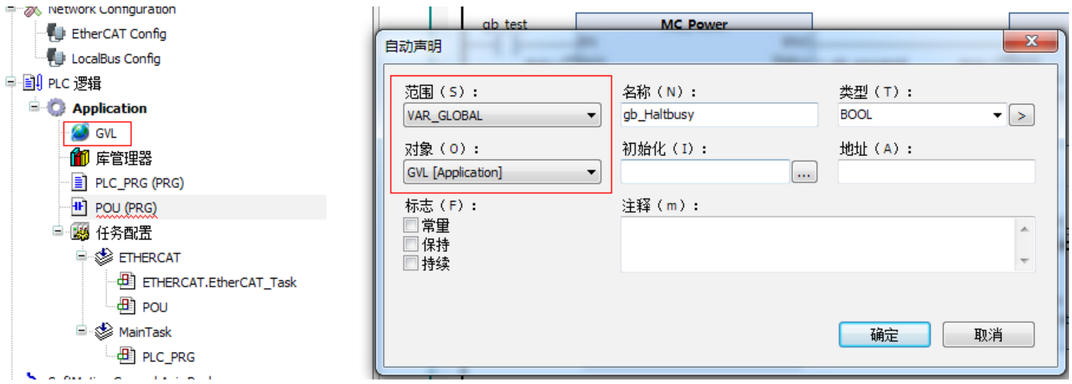


Implement the basic functions such as homing and positioning through adding the function block.



To implement directional motion through the logic program, call variables through different POUs and set the variables as global variables.

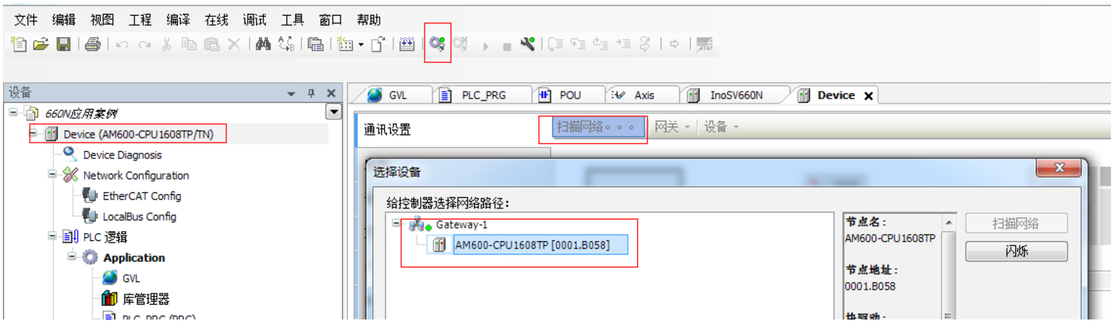
```
CASE iStatus OF
    10://轴上电使能
    gb_powerOn:=TRUE;
    IF gb_powerok THEN//轴上电成功执行下一步
    iStatus:=20;
    END_IF
    20://轴以200单位速度移动到1000单位位置
    gd_MoveAbsPos:=1000;gd_MoveAbsVel:=200;gd_MoveAbsVelacc:=200;gd_MoveAbsVeldec:=200;gb_moveAbs:=TRUE;
    IF gb_moveAbsOK THEN//移动完成复位状态，执行下一步
    gb_moveAbs:=FALSE;iStatus:=30;
    END_IF
    30://轴以线速度400单位速度移动到2000单位位置
    gd_MoveAbsPos:=2000;gd_MoveAbsVel:=400;gd_MoveAbsVelacc:=400;gd_MoveAbsVeldec:=400;gb_moveAbs:=TRUE;
    IF gb_moveAbsOK THEN//移动完成复位状态，执行下一步
    gb_moveAbs:=FALSE;iStatus:=40;
    END_IF
    40://轴以线速度1000单位速度移动到0单位位置
    gd_MoveAbsPos:=0;gd_MoveAbsVel:=1000;gd_MoveAbsVelacc:=1000;gd_MoveAbsVeldec:=1000;gb_moveAbs:=TRUE;
    IF gb_moveAbsOK THEN//移动完成复位状态，执行下一步
    gb_moveAbs:=FALSE;iStatus:=50;
    END_IF
    50://定位运动完成，伺服使能关闭
    gb_powerOn:=FALSE;
    iStatus:=0;
END_CASE
```



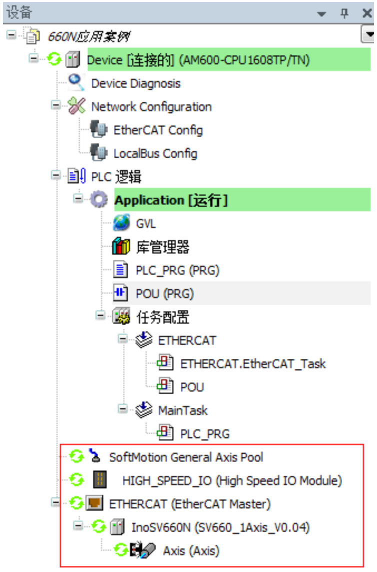
After editing the program, click " 编译 " (Compile) to detect whether the program is correct.

6) Downloading and performing commissioning on the program

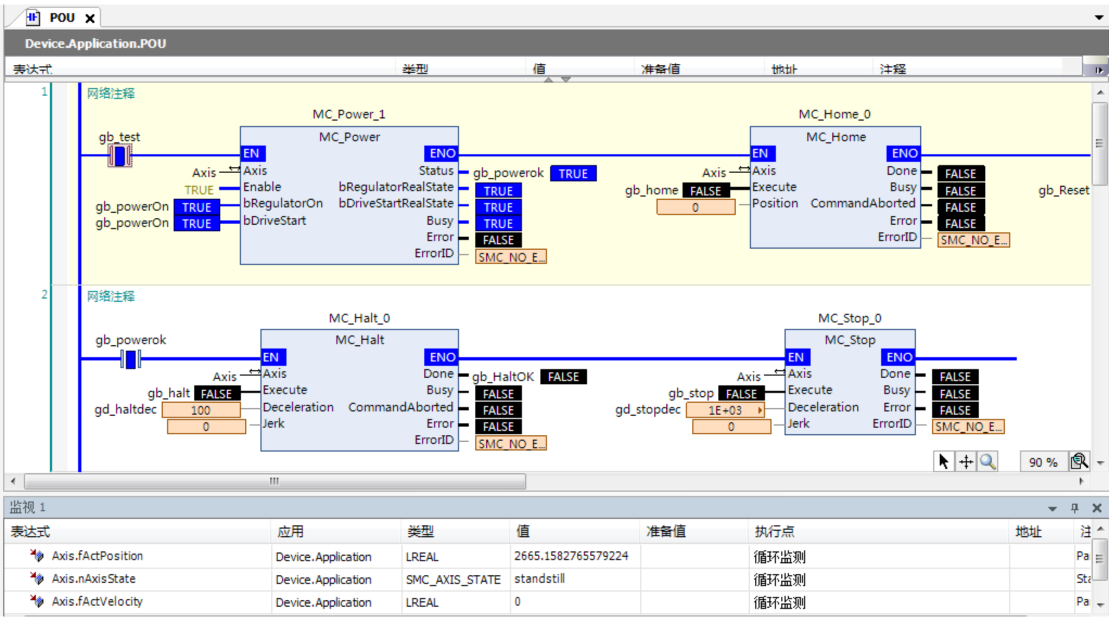
After the program detection is done, download the program to PLC. The program can be activated upon running. Before downloading, scan the PLCs first to select the target PLC, and then click the download icon, as shown below.



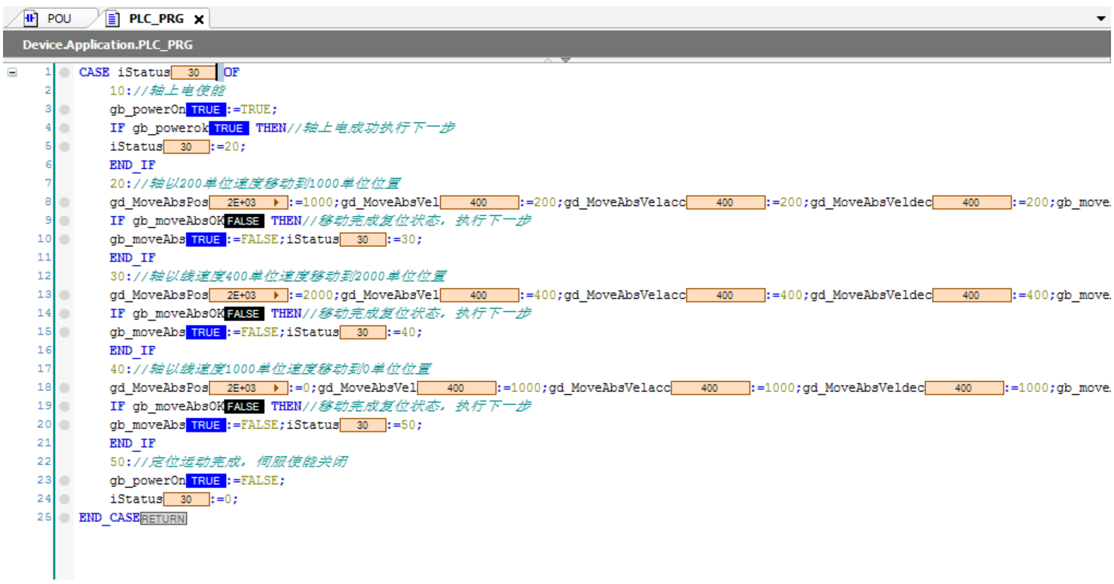
After log-in, ensure the servo drive and the axis are in normal state.



Monitor critical parameters through the monitoring function. Start the testing procedures to perform basic tests such as homing and positioning.



After the testing is done, perform directional running program.



Case 2 Omron NX1P2 controller as the host controller

This section describes how to configure the SV660N series servo drive in working with Omron NX1P2 controller.

1) Installing the Sysmac Studio software

It is recommended to install the Sysmac Studio software of V1.10 or later.

2) Importing the device description file (V2.5 or later recommended)

Use the device description file of "SV660_1Axis_V0.04-0506.xml" or later version. The file path is as follows:

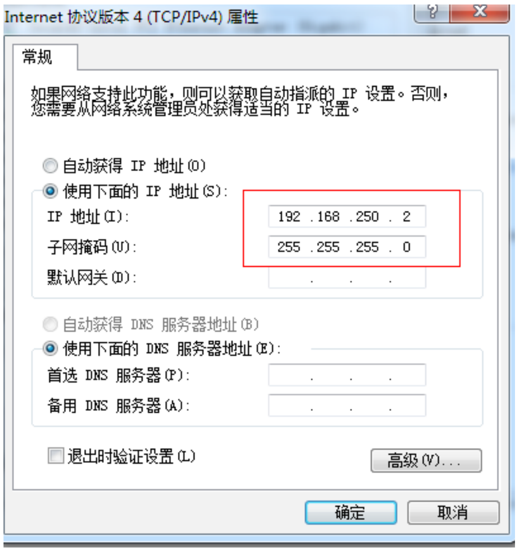
OMRON\Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles

If the file is stored in this path for the first time, the Sysmac Studio software must be restarted.

3) Setting the network connection attribute of the computer

If the computer is connected to the controller through an USB , this step can be skipped.

If the computer is connected to the controller through the Ethernet, set the TCP/IP attribute of the computer, as shown below.



4) Configuring the servo drive

Recommended version:

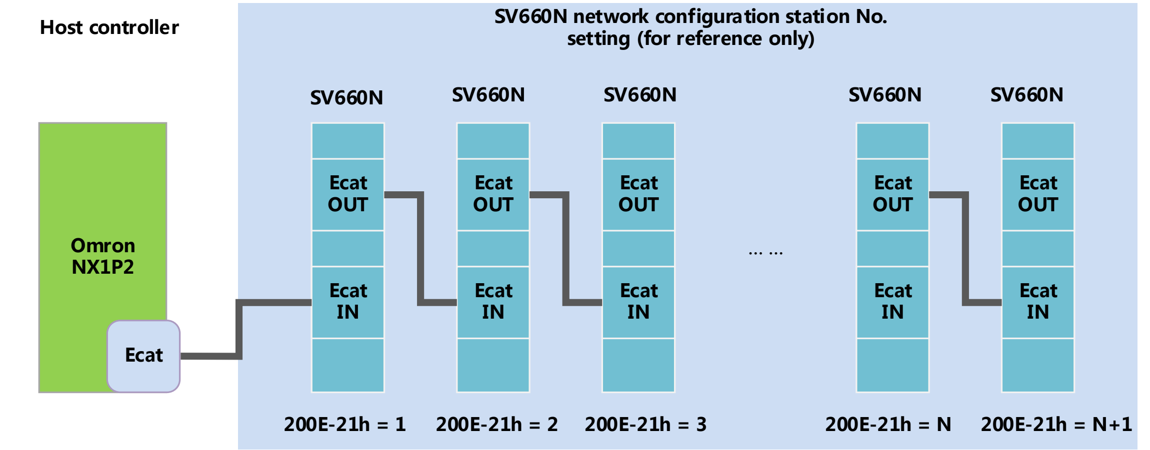
The MCU version of the PCB software is "H0100 = 0900.1" or higher.

The FPGA version of the PCB software is "H0100 = 0902.1" or higher.

Pay attention to the setting of H0E-21.

Para. No.		Name	Value Range	Unit	Default	Related Mode	Setting Condition	Effective Time	Value
H0E	21	EtherCAT slave alias	0-65535	-	0	-	At stop	Immediately	Any value but 0

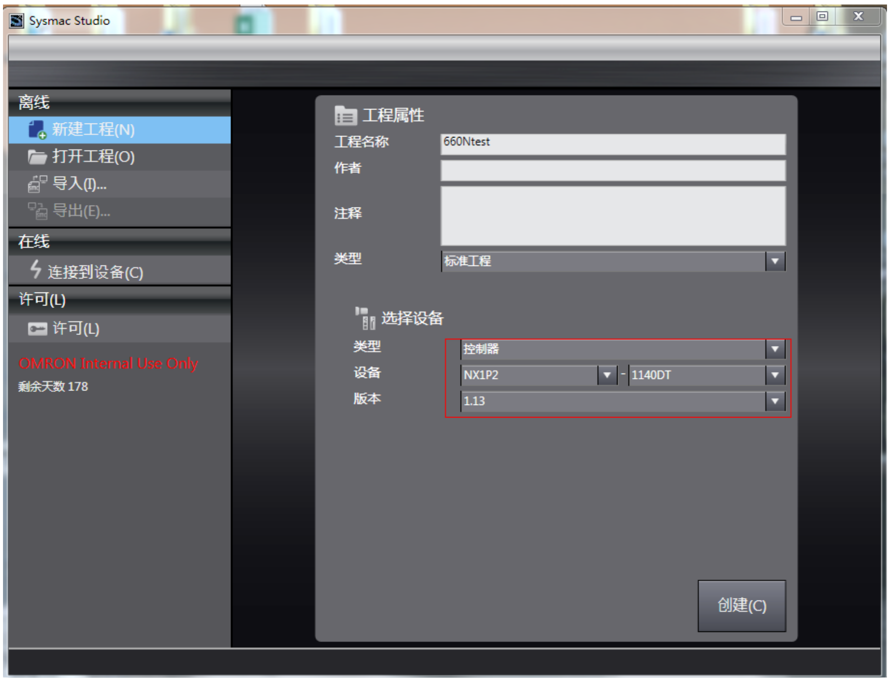
Para. No.	Name	Value Range	Unit	Default	Related Mode	Setting Condition	Effective Time	Value
When an Omron controller is used, set the EtherCAT communication station number in H0E-21. It is recommended to set the station number according to the actual physical connection sequence to facilitate management.								



5) Creating a project

Device: Select the device according to the actual controller model.

Version: Use V1.09 or later versions. NX1P2-1140DT supports V1.13 only.

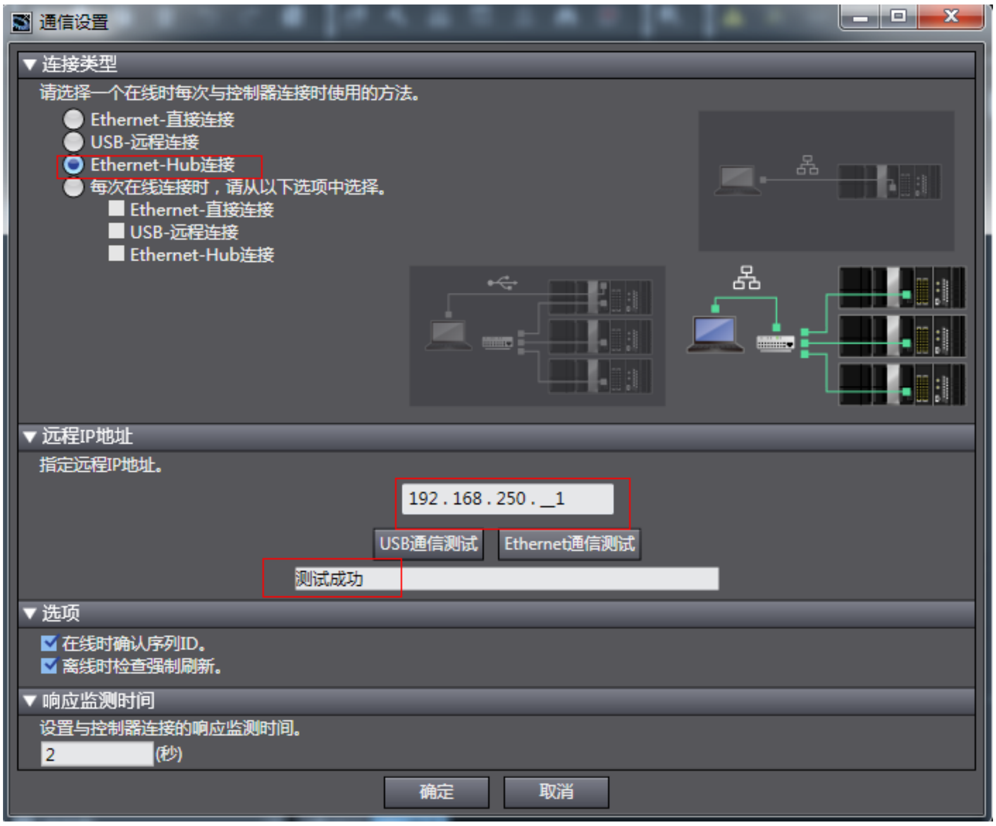


6) Communication setting

After entering the main interface, set the connection mode between the computer and the controller in " 控制器 " (Controller)→" 通讯设置 " (Communication setting).

Select "USB→ 远程连接 " (USB→Remote connection) to perform "USB 通讯测试 " (USB communication test). If the test is passed, go to the next step.

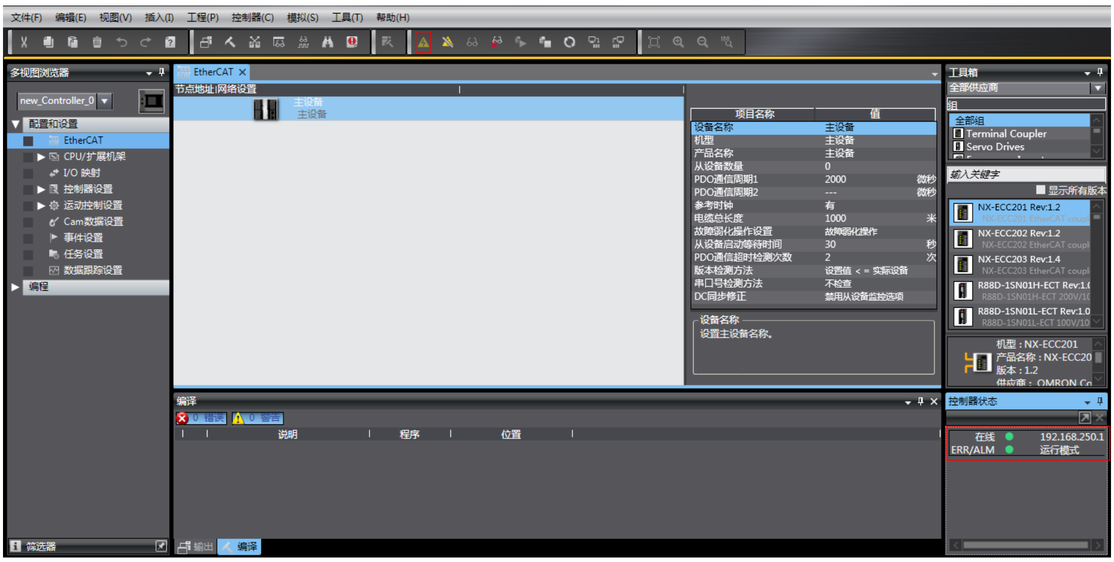
Select "Ethernet→Hub 连接 " (Ethernet→Hub connection), set the IP to 192.168.250.1 (IP controlled by NX), and then perform "Ethernet 通讯测试 " (Ethernet communication test). If the test is passed, go to the next step.



7) Scanning the device

Switch the controller to the online running mode.

Observe the controller status in the lower right corner: online, running mode.

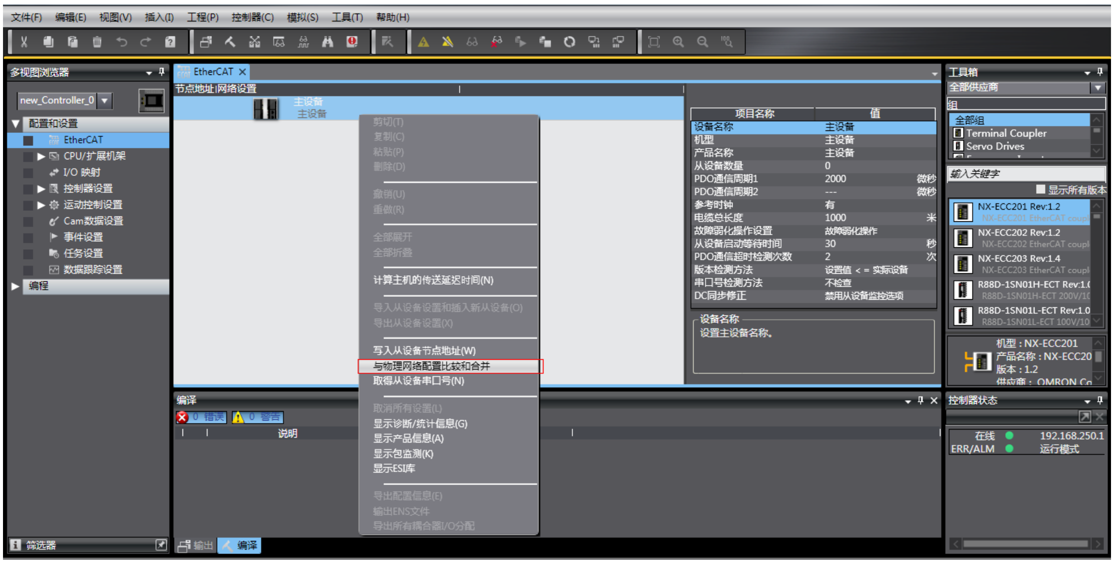


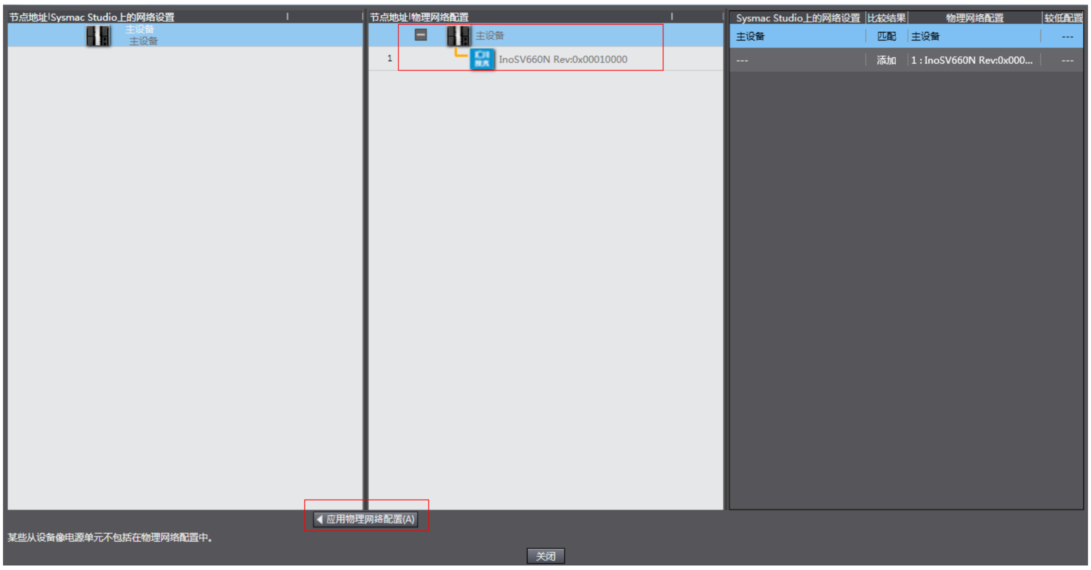
A prompt is displayed if it is a new controller.

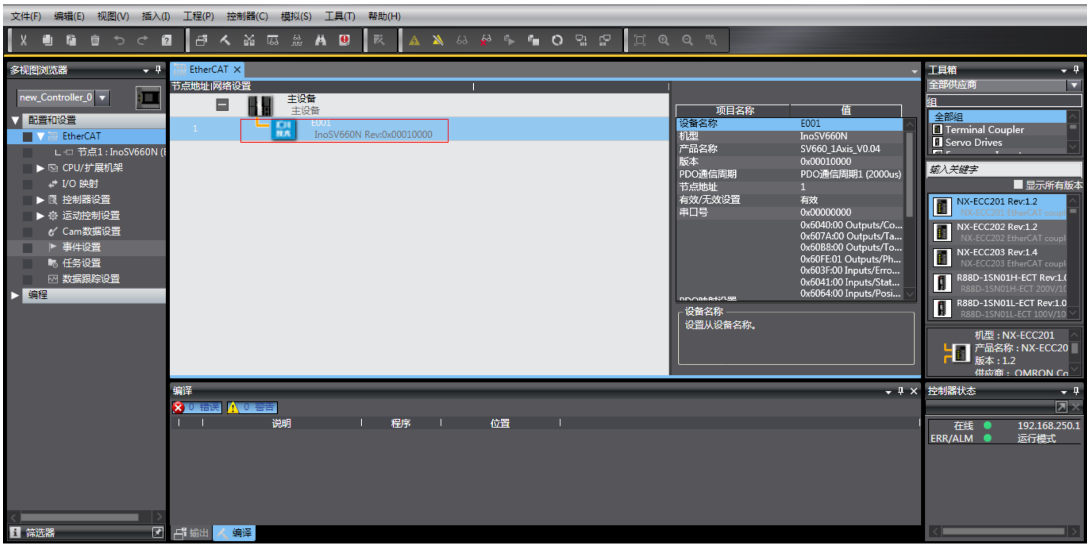
Click " 是 " (Yes). The name here is the project name.

Scan the devices and add slaves.

Right click " 配置和设置 " (Configuration and setting)→"EtherCAT"→" 主设备 " (Master device), and select " 与物理网络配置比较和合并 " (Compare and merge with physical network configurations). The controller scans all the slaves within the network (an error will be reported if the station number is 0). After scanning, click " 应用物理网络配置 " (Apply physical network configurations) in the pop-up window to add the slave. You can view in the main page for the slaves added .



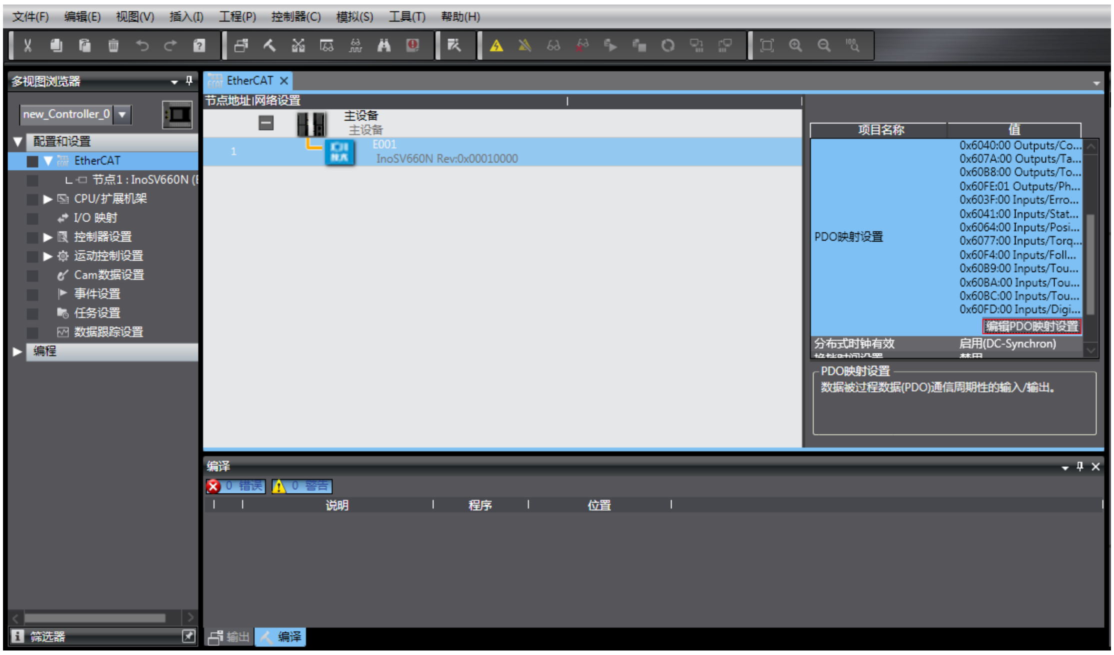




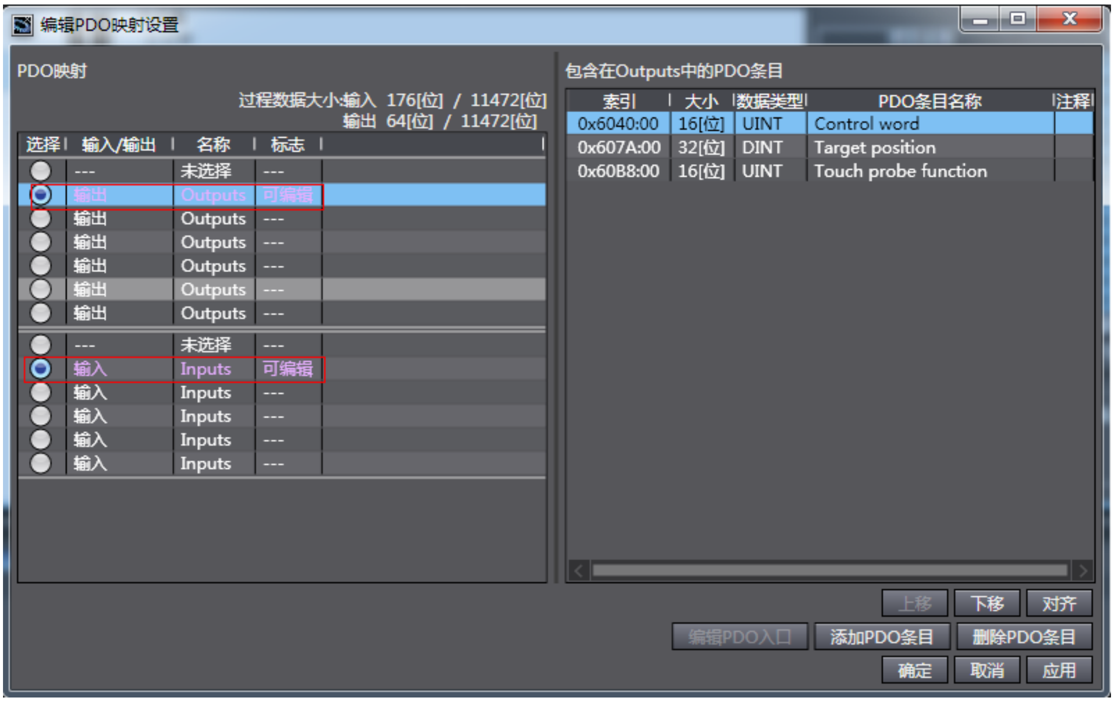
8) Setting parameters

Switch the controller to the offline mode and set PDO mapping, axis parameters, and the DC clock.

8-1) Setting PDO mapping



Select the editable RPDO and TPDO provided by SV660N for configuration.



Modify the PDO mapping object through " 添加 PDO 条目 " (Add PDO entries) and " 删除 PDO 条目 " (Delete PDO entries). The frequently used mapping parameters are shown below.

RPDO

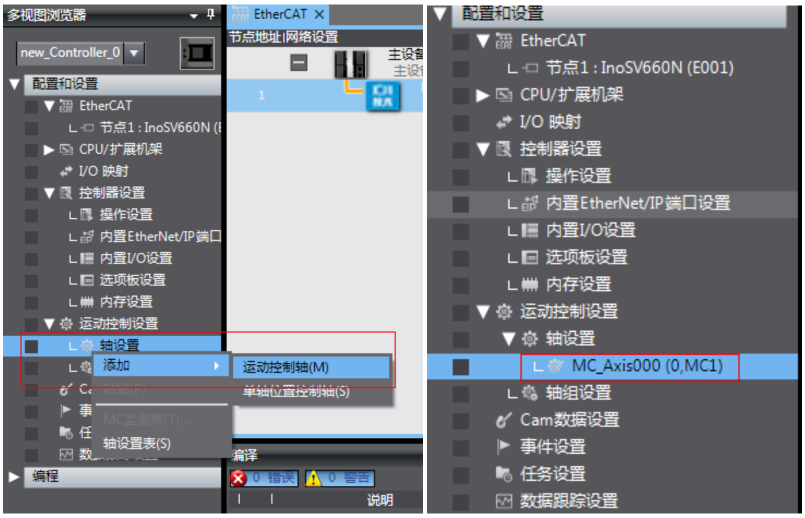
索引	大小	数据类型	PDO条目名称
0x6040:00	16[位]	UINT	Controlword
0x6060:00	8[位]	SINT	Modes of operation
0x607A:00	32[位]	DINT	Target position
0x60B8:00	16[位]	UINT	Touch probe function

TPDO

索引	大小	数据类型	PDO条目名称
0x6041:00	16[位]	UINT	Statusword
0x6061:00	8[位]	SINT	Modes of operation display
0x6064:00	32[位]	DINT	Position actual value
0x60B9:00	16[位]	UINT	Touch Probe Status
0x60BA:00	32[位]	DINT	Touch Probe pos 1 pos value
0x60FD:00	32[位]	UDINT	Digital inputs

8-2) Setting axis parameters

Right click " 运动控制设置 " (Motion control setting)→" 轴设置 " (Axis setting) and add " 轴设置 " (Axis setting) as shown below.



"MC_Axis000" can be renamed through a simple click. For example, if it is named as " 卷针轴 " (Rewind axis), the axis variable " 卷针轴 " (Rewind axis) used in the NX program represents control on this SV660N servo axis.

Double-click "MC_Axis000" and configure the SV660N device of the corresponding station in the corresponding basic axis setting interface.

1) Axis allocation

轴号 (Axis No.): Represents the Ethernet communication station No. of the servo drive, which is also the value of H0E-21.

轴使用 (Axis used): Represents the axis in use.

轴类型 (Axis type): Represents the servo axis.

输出设备 1 (Output device 1): Select the SV660N servo drive.

2) Detailed settings

Select the PDO mapping objects according to step 8-1, which is to allocate the output parameters (controller to device) and input parameters (device to controller). Note that the object name, node number, and index number must be set correctly. Each mapping object selected in step 8-1 must be allocated correctly. Otherwise, an error will be reported.

▼ 详细设置

恢复默认值

功能名称	设备	过程数据
- 输出(控制器到设备)		
★ 1. Controlword	节点:1 InoSV660N(E001)	6040h-00.0(Outputs_Control word_6040_00)
★ 3. Target position	节点:1 InoSV660N(E001)	607Ah-00.0(Outputs_Target position_607A_00)
5. Target velocity	<未分配>	<未分配>
7. Target torque	<未分配>	<未分配>
9. Max profile Velocity	<未分配>	<未分配>
11. Modes of operation	节点:1 InoSV660N(E001)	6060h-00.0(Outputs_Modes of operation_6060_00)
15. Positive torque limit value	<未分配>	<未分配>
16. Negative torque limit value	<未分配>	<未分配>
21. Touch probe function	节点:1 InoSV660N(E001)	60B8h-00.0(Outputs_Touch probe function_60B8_0(
44. Software Switch of Encoder's Input	<未分配>	<未分配>

- 输入(设备到控制器)		
★ 22. Statusword	节点:1 InoSV660N(E001)	6041h-00.0(Inputs_Sta
★ 23. Position actual value	节点:1 InoSV660N(E001)	6064h-00.0(Inputs_Pos
24. Velocity actual value	<未分配>	<未分配>
25. Torque actual value	<未分配>	<未分配>
27. Modes of operation display	<未分配>	<未分配>
40. Touch probe status	节点:1 InoSV660N(E001)	60B9h-00.0(Inputs_Tou
41. Touch probe pos1 pos value	节点:1 InoSV660N(E001)	60BAh-00.0(Inputs_Tou
42. Touch probe pos2 pos value	<未分配>	<未分配>
43. Error code	节点:1 InoSV660N(E001)	603Fh-00.0(Inputs_Errc
45. Status of Encoder's Input Slave	<未分配>	<未分配>
46. Reference Position for csp	<未分配>	<未分配>

+ 输入(设备到控制器)		
- 数字输入		
28. Positive limit switch	节点:1 InoSV660N(E001)	60FDh-00.1(Inputs_Digital inputs_60FD_00)
29. Negative limit switch	节点:1 InoSV660N(E001)	60FDh-00.0(Inputs_Digital inputs_60FD_00)
30. Immediate Stop Input	节点:1 InoSV660N(E001)	60FDh-00.25(Inputs_Digital inputs_60FD_00)
32. Encoder Phase Z Detection	节点:1 InoSV660N(E001)	60FDh-00.16(Inputs_Digital inputs_60FD_00)
33. Home switch	节点:1 InoSV660N(E001)	60FDh-00.2(Inputs_Digital inputs_60FD_00)
37. External Latch Input 1	节点:1 InoSV660N(E001)	60FDh-00.17(Inputs_Digital inputs_60FD_00)
38. External Latch Input 2	节点:1 InoSV660N(E001)	60FDh-00.18(Inputs_Digital inputs_60FD_00)

60FDh must be mapped to objects by bit. The mapping must be consistent with that in the Omron controller. SV660N only support the positive/negative limit switch and home switch.

- 数字输入		
28. Positive limit switch	节点:1 InoSV660N(E001)	60FDh-00.1(Inputs_Digital inputs_60FD_00)
29. Negative limit switch	节点:1 InoSV660N(E001)	60FDh-00.0(Inputs_Digital inputs_60FD_00)
30. Immediate Stop Input	<未分配>	<未分配>
32. Encoder Phase Z Detection	<未分配>	<未分配>
33. Home switch	节点:1 InoSV660N(E001)	60FDh-00.2(Inputs_Digital inputs_60FD_00)
37. External Latch Input 1	<未分配>	<未分配>
38. External Latch Input 2	<未分配>	<未分配>

CAUTION

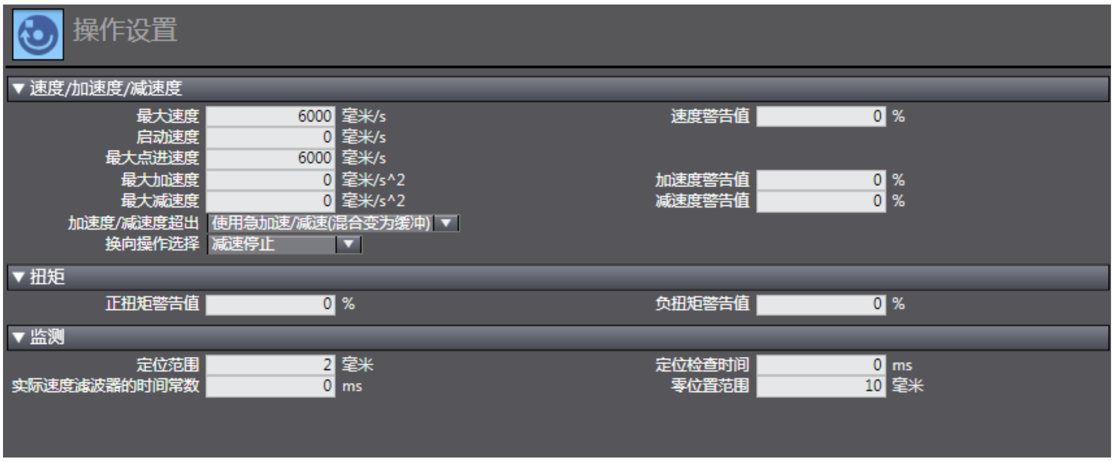
The axis configuration of SV660N needs to be performed manually.

8-3) Unit conversion setting

Set " 电机转 1 圈的指令脉冲数 " (Pulses per motor revolution) based on the resolution of the motor in use (example: 8388608 pulses for 23-bit motor). To facilitate commissioning, set to 60 mm per revolution, indicating 1 mm/s equals to 1 RPM of the motor.

Select the " 显示单位 " (Display unit) based on the actual running unit when setting the gear ratio. All the position-type parameters in the host controller will be displayed in this unit.

8-4) Operation settings

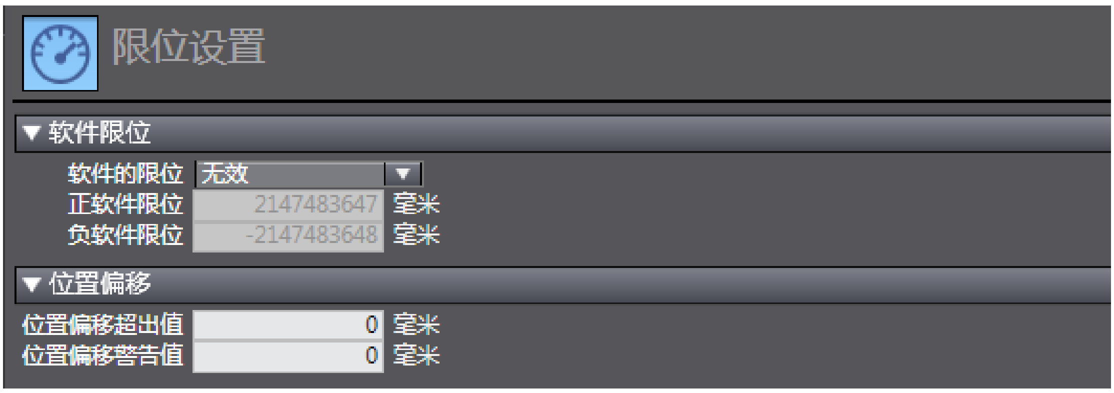


■ 速度 / 加速度 / 减速度 (Speed/Acceleration/Deceleration): Set the maximum speed of the load according to actual conditions. If the motor speed converted from the set value exceeds 6000 RPM, a prompt will be displayed in the form of a red box.
If the acceleration/deceleration rate is 0, the running curve will be generated based on the maximum acceleration/deceleration rate. If there is no special requirement, this parameter needs no setting.

■ 扭矩 (Torque): If the warning value is set to 0, no warning will be reported. If there is no special requirement, this parameter needs no setting.

■ 监测 (Monitoring): Set " 定位范围 " (Positioning range) and " 零位置范围 " (Zero position range) based on actual motor and mechanical conditions. If the set value is too small, positioning or homing may not be completed.

8-5) Software limit



The set software limit will be activated after homing.

8-6) Homing

The homing mode involves the servo drive and the host controller. Set the homing mode according to the following table.

Description of NX Software	Servo Drive Function	Terminal Configuration
Home proximity signal	Home switch (FunIN.31)	-
Positive limit input	P-OT (FunIN.14)	DI1
Negative limit input	N-OT (FunIN.15)	DI2

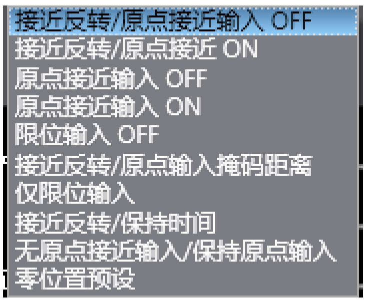
Select the homing mode of the host controller and set the homing speed, acceleration, and home offset based on actual mechanical conditions.

■ Introduction to homing

Function block: MC_Home and MC_HomeWithParameter

1) Set MC_Home in the preceding figure and MC_HomeWithParameter in the function block.

2) The two function blocks both include 10 kinds of homing modes.

MC_Home	MC_HomeWithParameter
	Designates the homing action to be modified. 0: Promixity reverse turn/home proximity input OFF 1: Proximity reverse turn/home proximity input ON 4: Home proximity input OFF 5: Home proximity input ON 8: Limit input OFF 9: Proximity reverse turn/home input mask distance 11: Limit inputs only 12: Proximity reverse turn/holding time 13: No home proximity input/holding home input 14: Zero position preset

■ Home proximity input OFF: The host controller searches for the home signal after reaching the falling edge of the home proximity switch.

■ Home proximity input ON: The host controller searches for the home signal after reaching the rising edge of the home proximity switch.

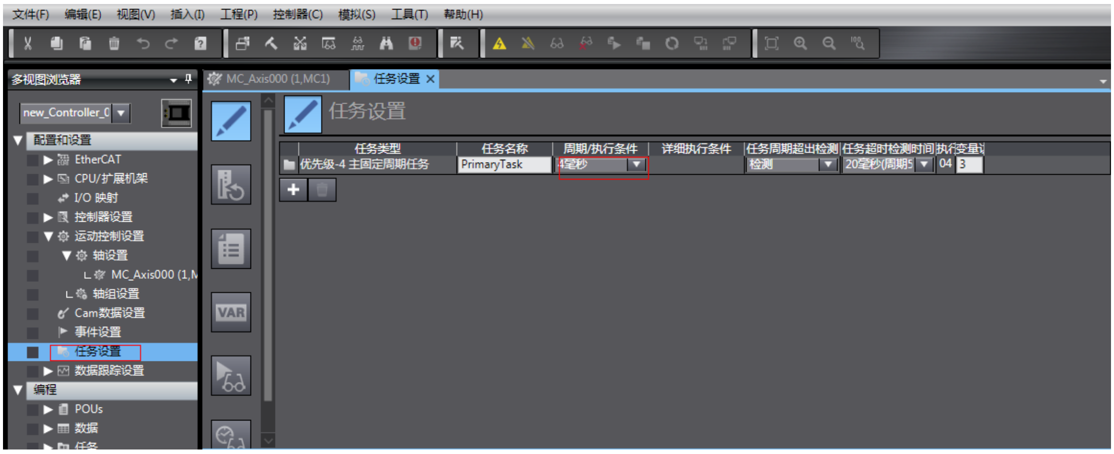
■ Proximity reverse turn: If the home proximity signal is ON when homing is enabled, the host controller reverses the running direction immediately after reaching the falling edge of the home proximity signal.

- Home input mask distance: The host controller masks the homing signal within a set distance after receiving the home proximity signal (for example, edge change of home proximity signal) and starts to receive the home signal only after the set distance is passed.
- Holding time/Contact time: The host controller masks the home signal within a set period after receiving the home signal (for example, edge change of home proximity signal) and starts to receive the home signal only after the set period elapses.
- Zero position/Home preset: The host controller uses the current position as the home and the motor does not act. The host controller writes the home offset to the position reference/position feedback.

CAUTION
The home signal is searched at a low speed in all the homing modes. If the motor runs at a high speed, the home signal is masked when it decelerates from high speed to low speed.

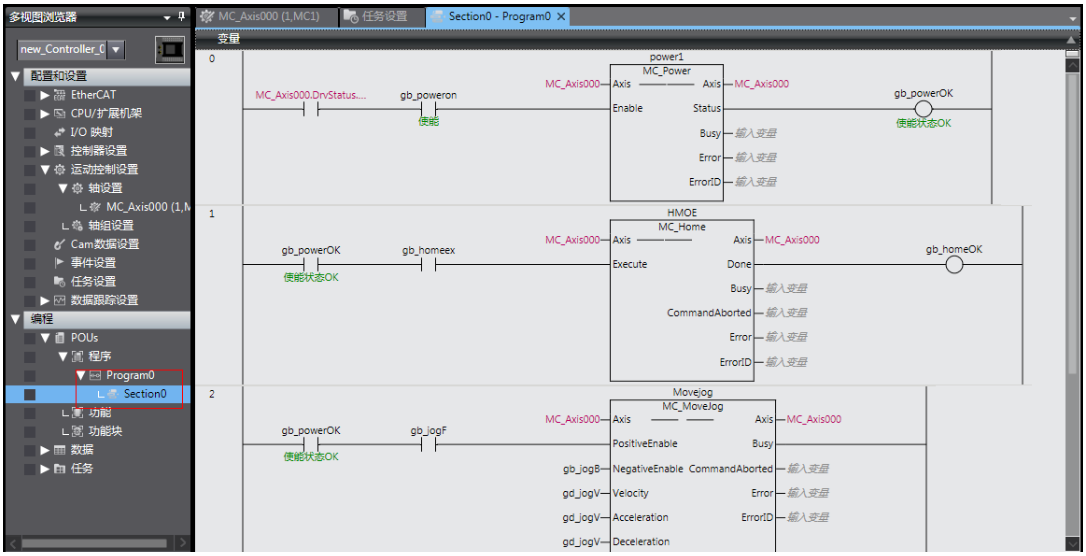
8-7) DC clock

The default clock is 1 ms. The synchronization clock (cycle of primary fixed-cycle tasks) named "PDO communication cycle" can be modified in the " 任务设置 " (Task setting) interface. The modification will be activated after switching to the online state at next power-on.



9) Program control

After configurations are done, you can control the servo drive operations through the PLC program. If the "MC_POWER" module is used, it is recommended to add the servo status bit "MC_Axis000.DrvStatus. Ready" (MC_Axis000 is the axis name). This is to prevent the situation where the PLC program is running but the communication configuration is not done.

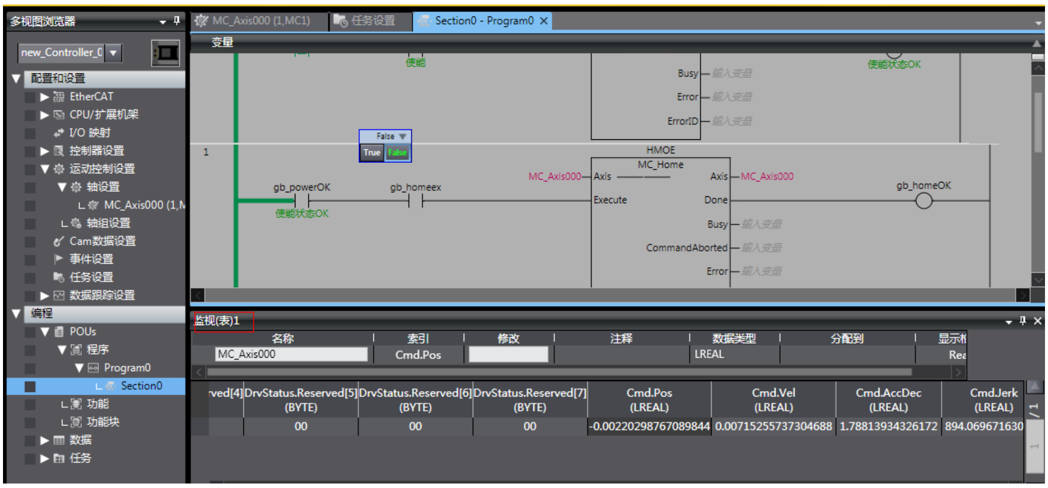


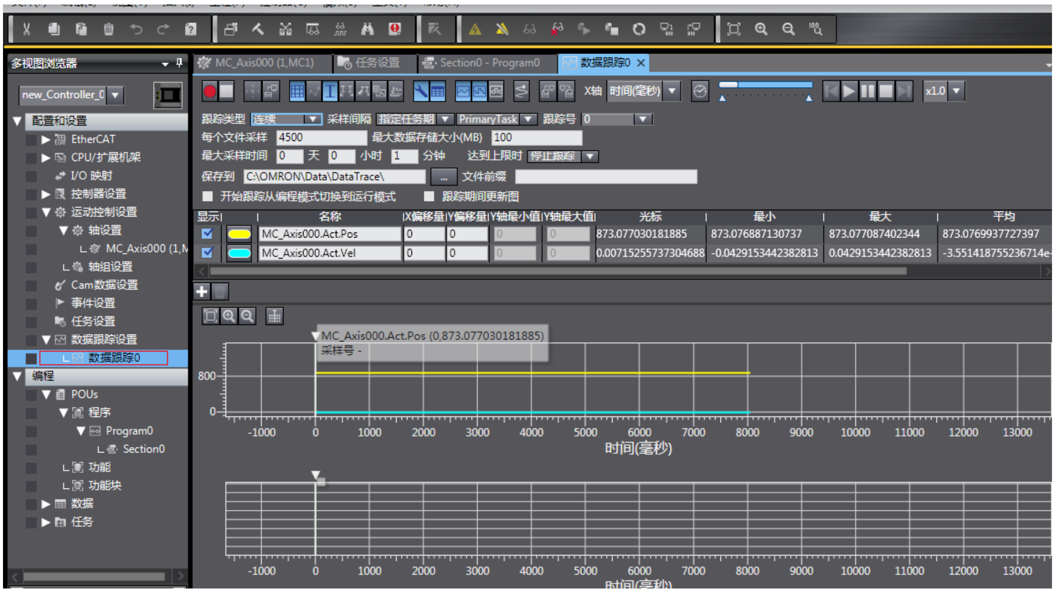
10) Online running

After all the settings and programming procedures are done, switch to the online state, and click to download the program to the controller.

Click to use the synchronization function. This function serves to compare the difference between the current program and the program in the controller, allowing users to determine whether to download the program to the controller, upload it from the controller " " or leave it unchanged based on the difference.

You can monitor the data through the monitoring list or collect the data waveform by using the data tracking function during running.





Case 3 Beckhoff TwinCAT3 as the host controller

The following section describes how to configure the SV660N servo drive in working with Beckhoff TwinCAT3.

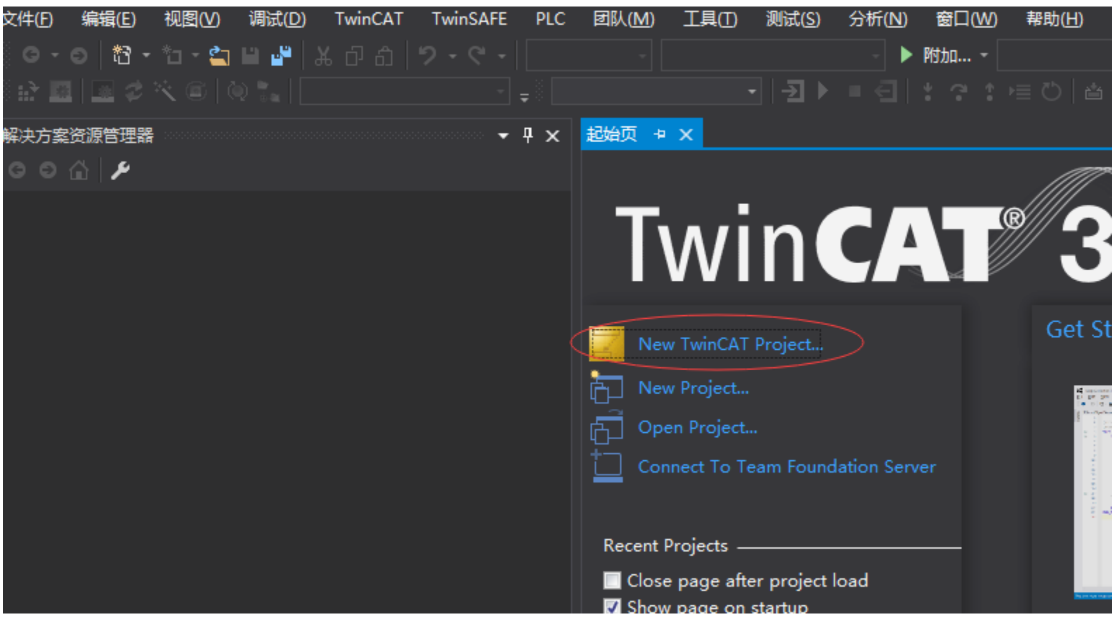
1) Installing the TwinCAT software

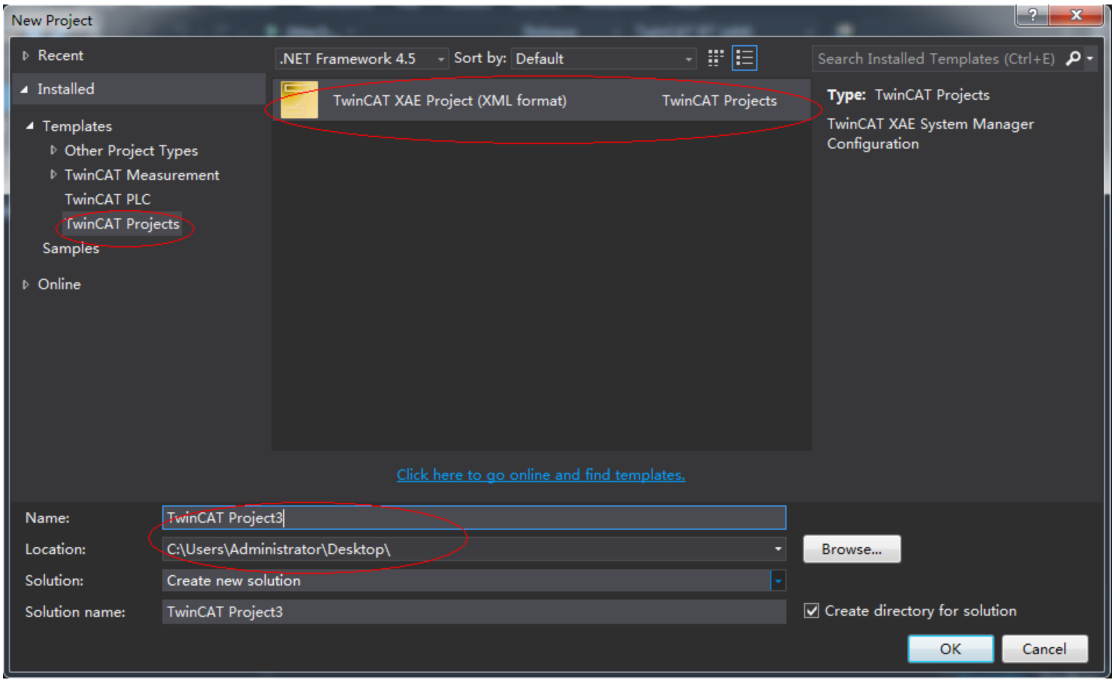
The TwinCAT3 software, which supports Win7 32-bit or 64-bit systems, can be downloaded from the official website of Beckhoff.

CAUTION	
	The Ethernet adapter must be 100M-Ethernet adapter with Intel chip. If the Ethernet adapter of other brands is used, the EtherCAT operation may fail.

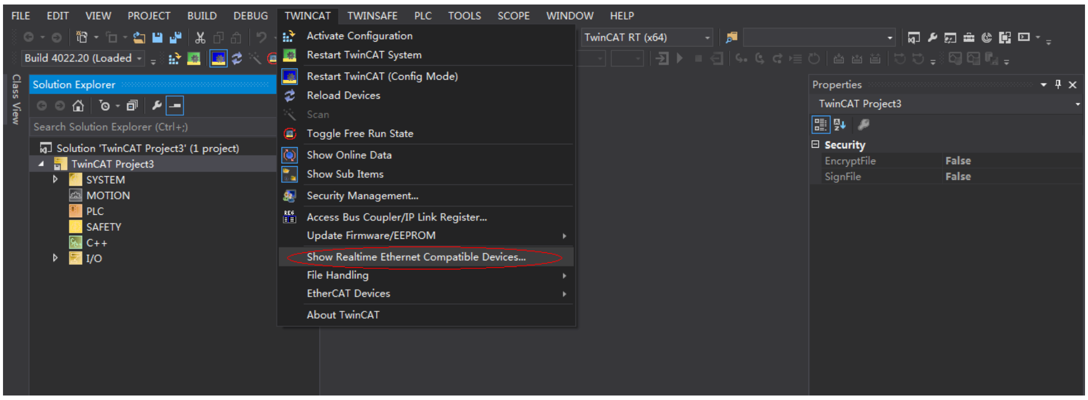
a) Copy the SV660N EtherCAT configuration file (SV660_1Axis_V0.04-0506) to the TwinCAT installation directory: TwinCAT\3.1\Config\Io\EtherCAT.

b) Open TwinCAT3 and create a New Twincat3 Project.

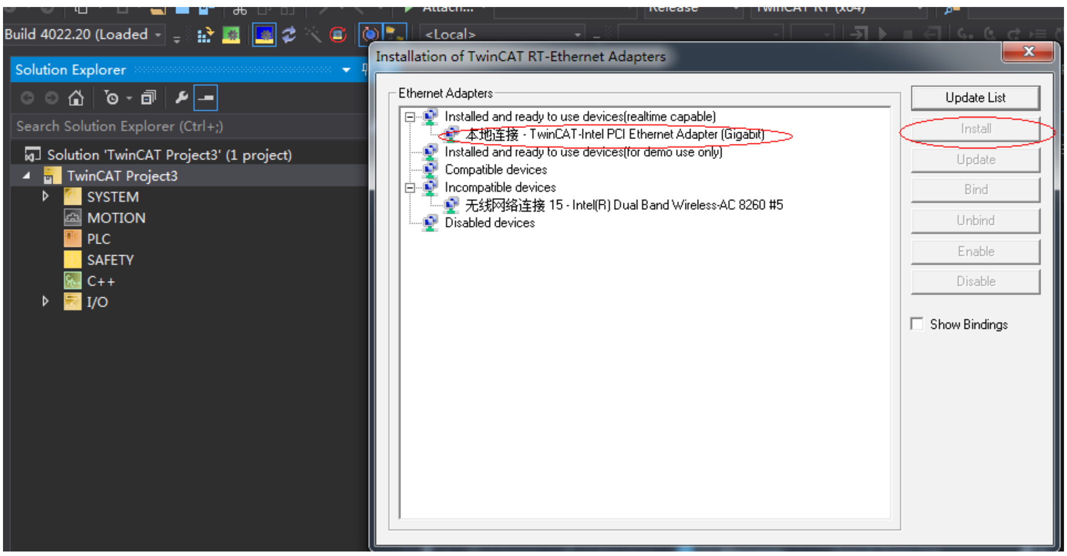




2) Installing the TwinCAT network adapter drive



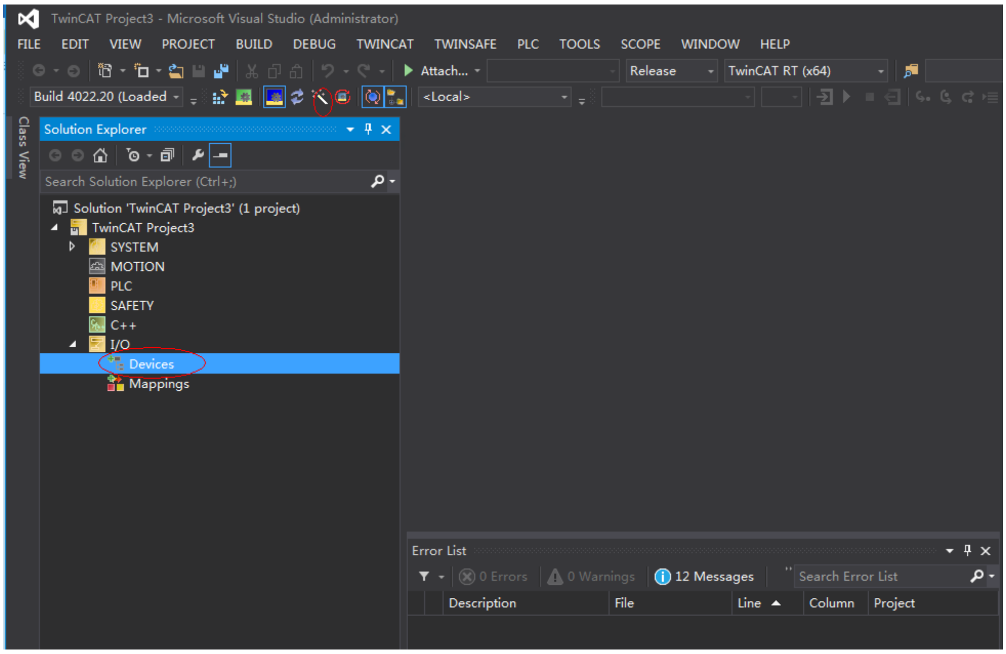
Open "Show Real Time Ethernet Compatible Devices…" in the menu shown in the preceding figure. In the displayed dialog box, select the local website in "Incompatible devices", and click "Install". After installation is done, the installed network adapter will be displayed in "Installed and ready to use devices".



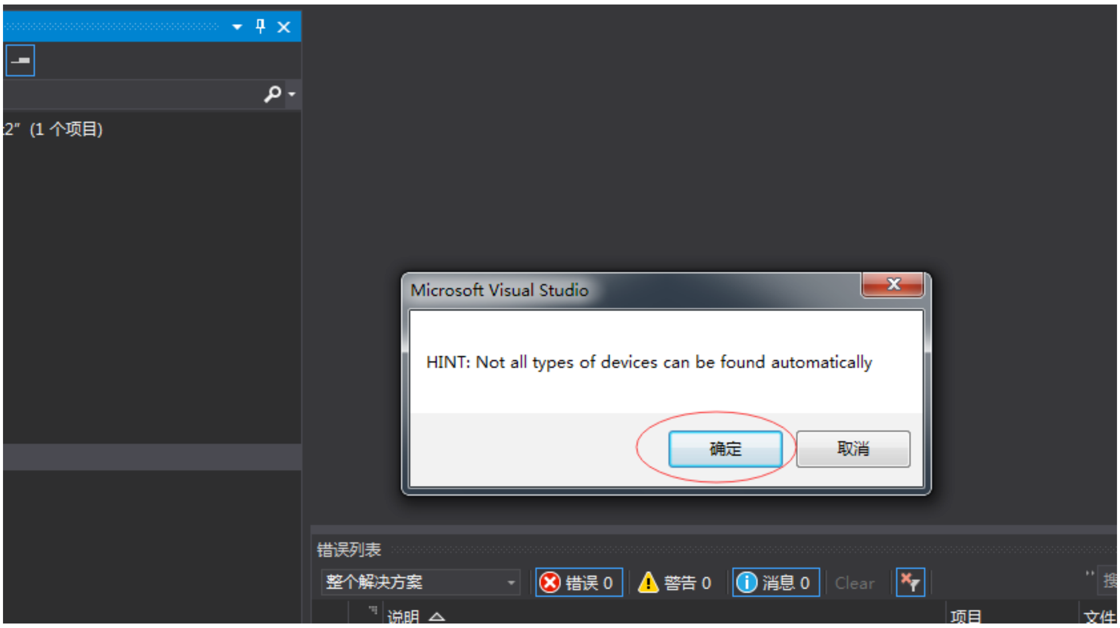
3) Searching for devices

a) Create a project and start searching for devices. Select " 

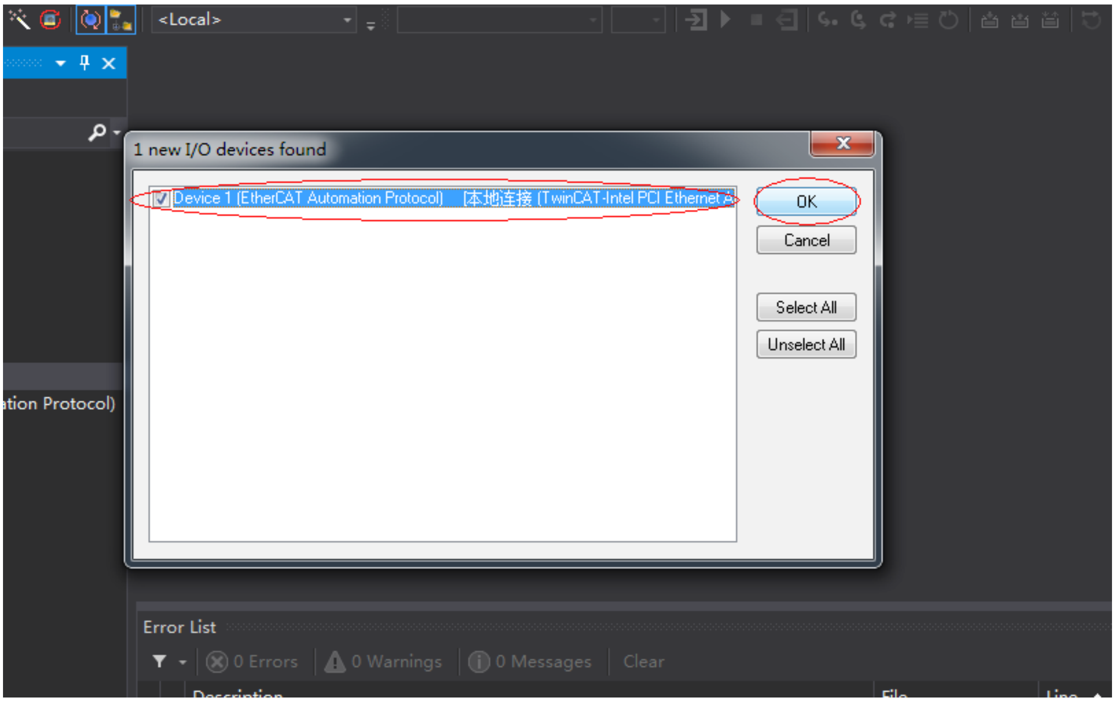
" , and click "  " as shown below.



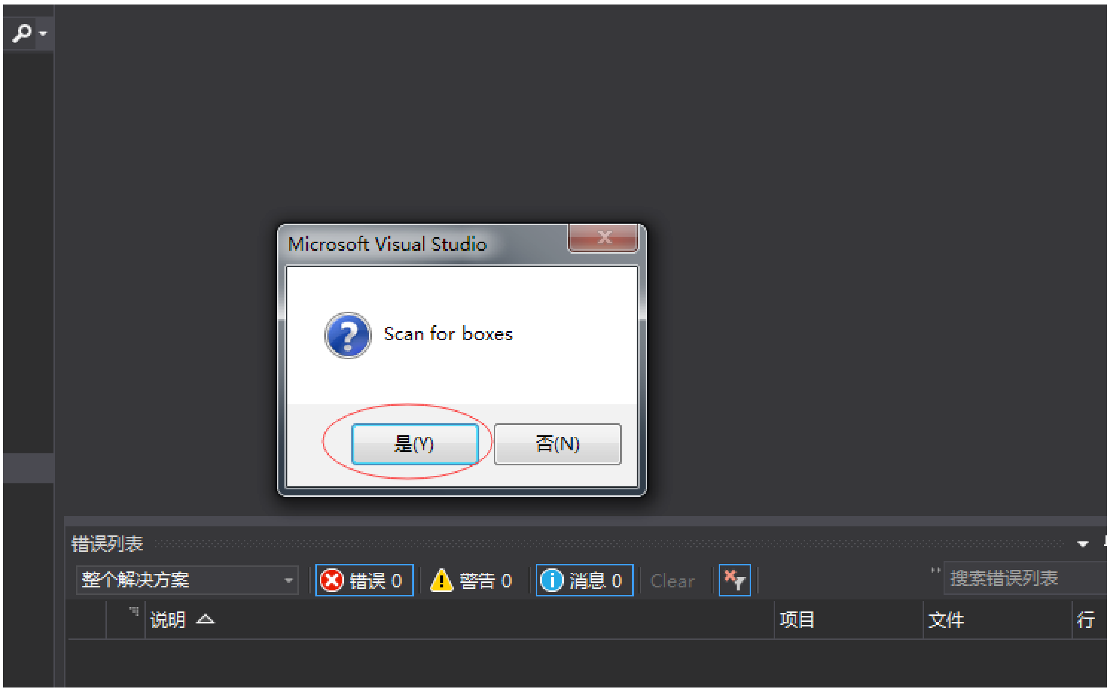
b) Click " 确定 " (OK).



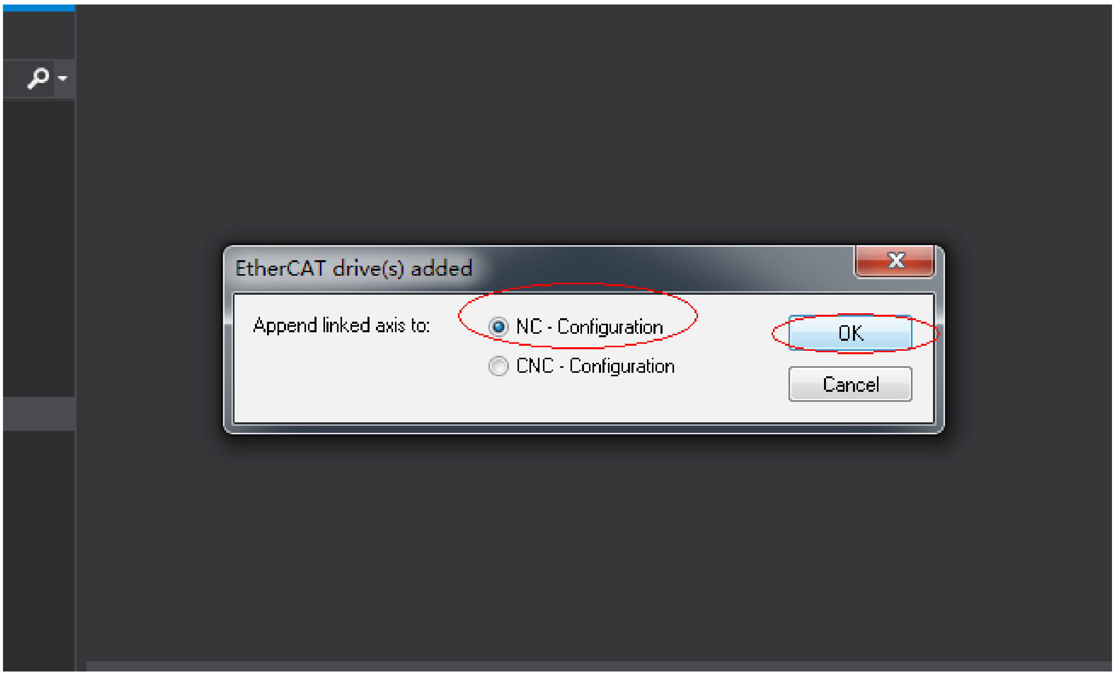
c) Click "OK".



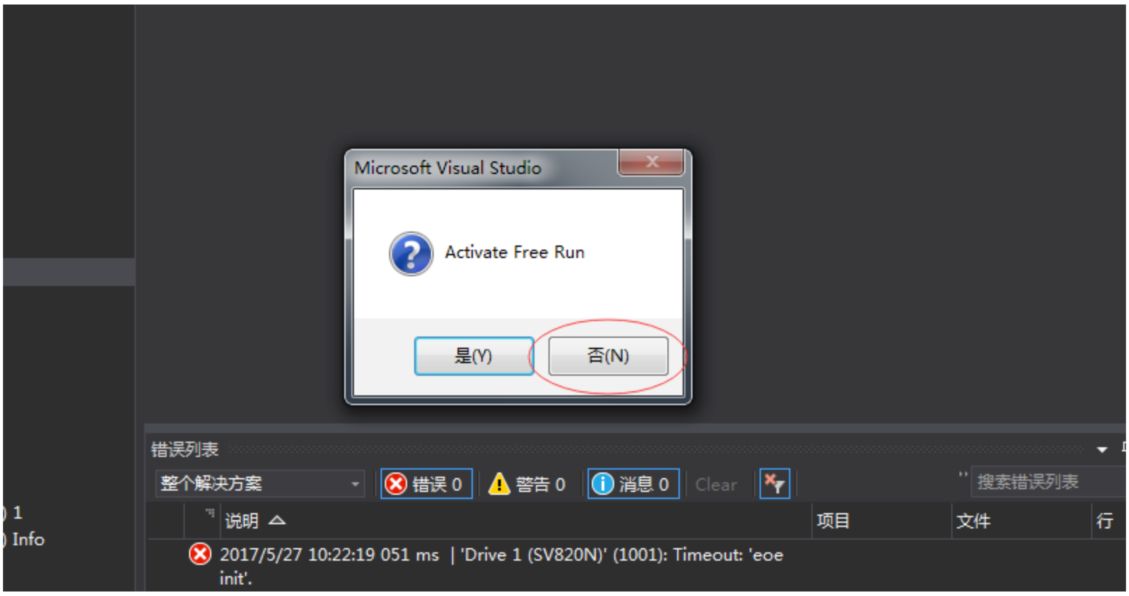
d) Click " 是 " (Yes).



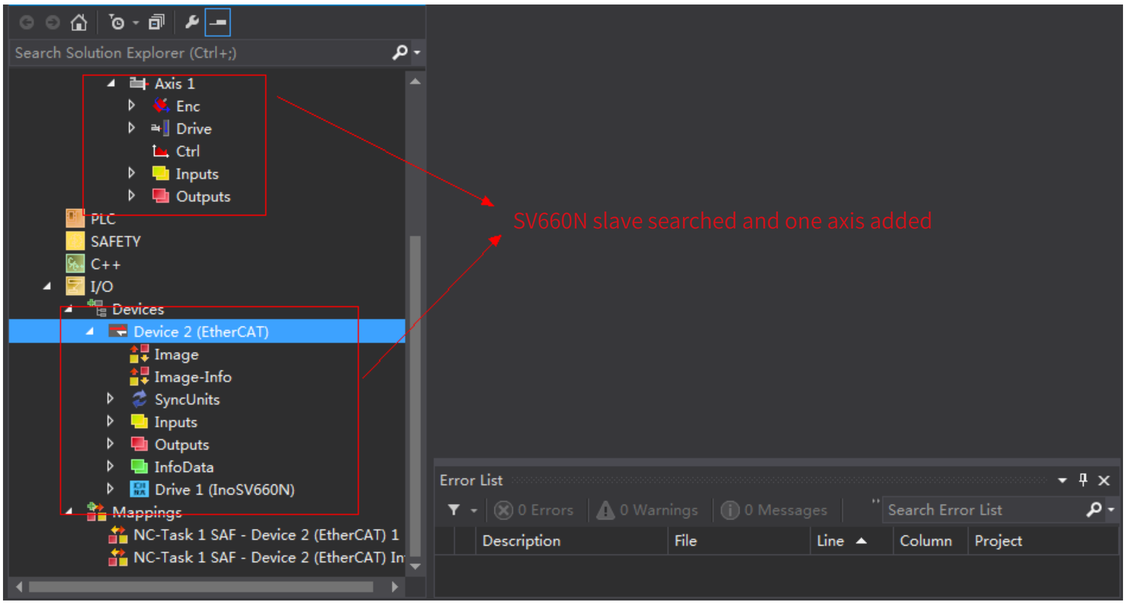
e) Click "OK".



f) Click " 否 " (No).



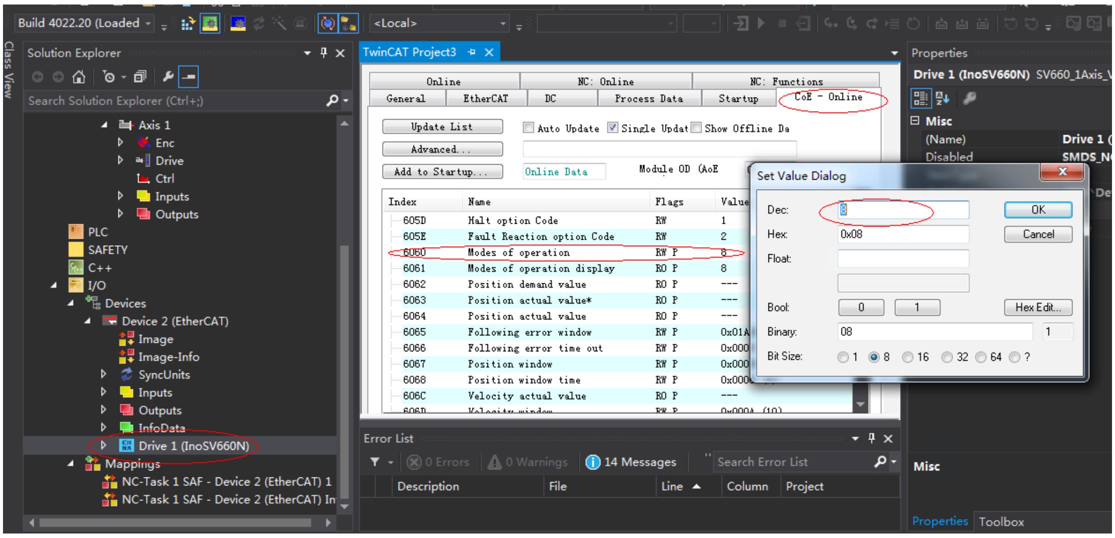
g) The device search is done, as shown below.



4) Configuring servo drive parameters

Configure the parameters through SDO communication in "CoE-Online" interface. When 200E-01h is set to 3, the parameter values modified through SDO communication will be saved upon power failure.

To modify 6060h to the CSP mode (8), follow the procedures shown in the following image.

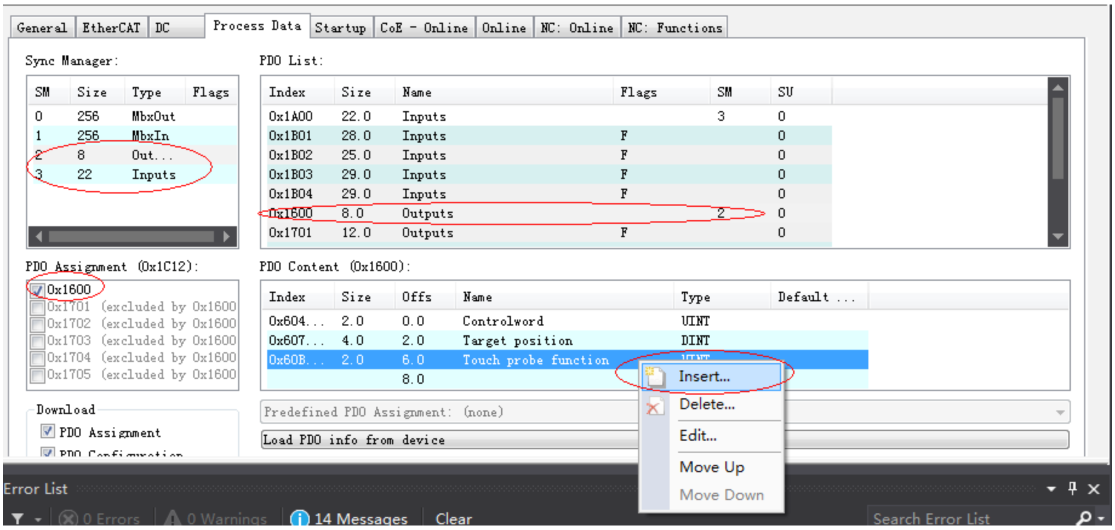


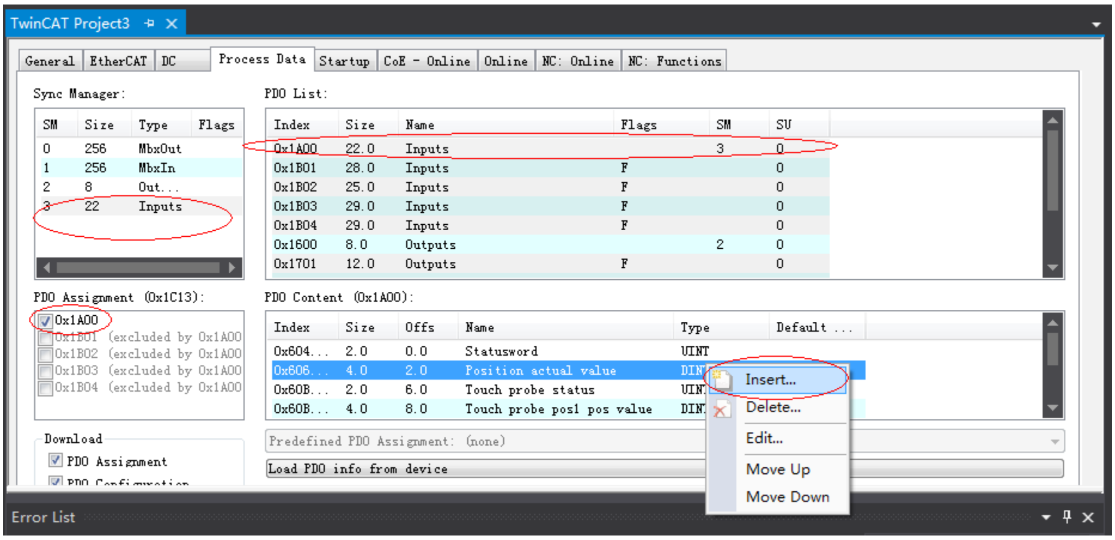
NOTE

This operation is available only when H02-00 (Control mode) is set to 9 (EtherCAT mode).

5) Configuring PDO

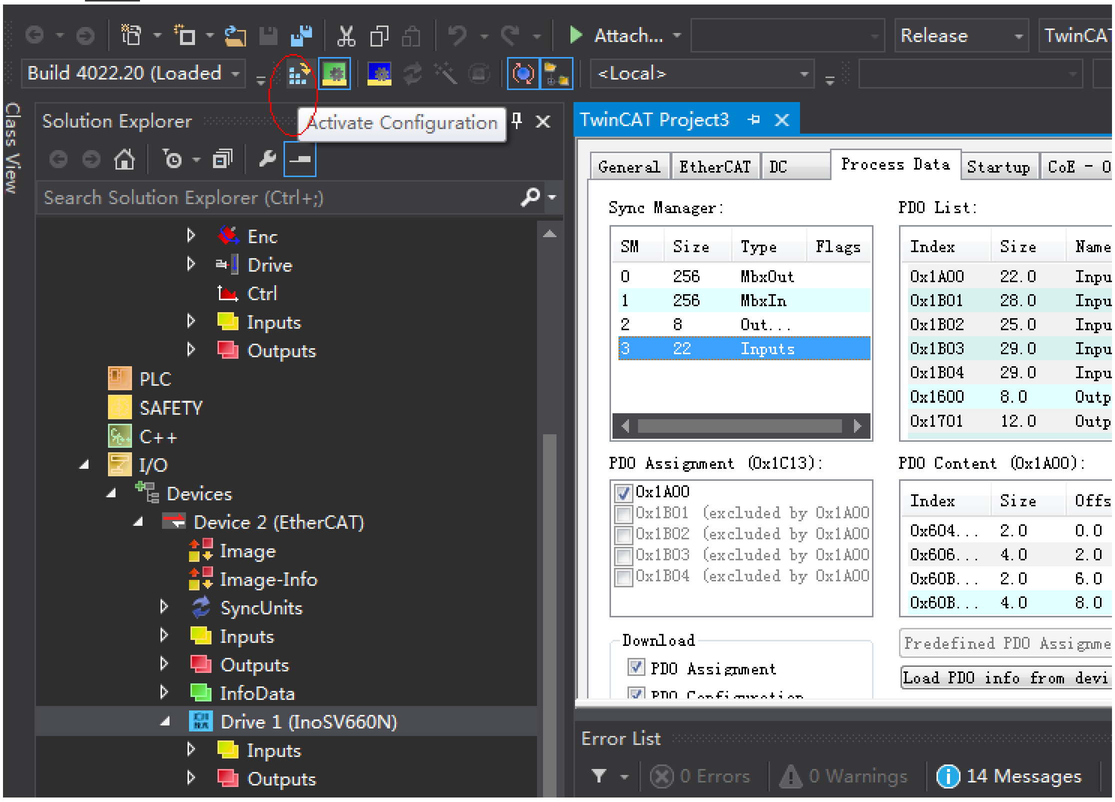
Select 0x1600 and 0x1A00 as shown in the following figure. Change the current PDO only if it does not fulfill your needs. To modify the PDO, right click the PDO Content window, click "Delete" to delete the redundant PDO or click "Insert" to add the PDO needed.


General
EtherCAT
DC
Process Data
Startup
CoE - Online
Online
NC: Online
NC: Functions
Sync Manager:
PDO List:
PDO Assignment (0x1C12):
PDO Content (0x1600):
Insert...
Delete...
Edit...
Move Up
Move Down
Predefined PDO Assignment: (none)
Load PDO info from device
Download
PDO Assignment
Error List
0 Errors
0 Warnings
14 Messages
Clear
Search Error List

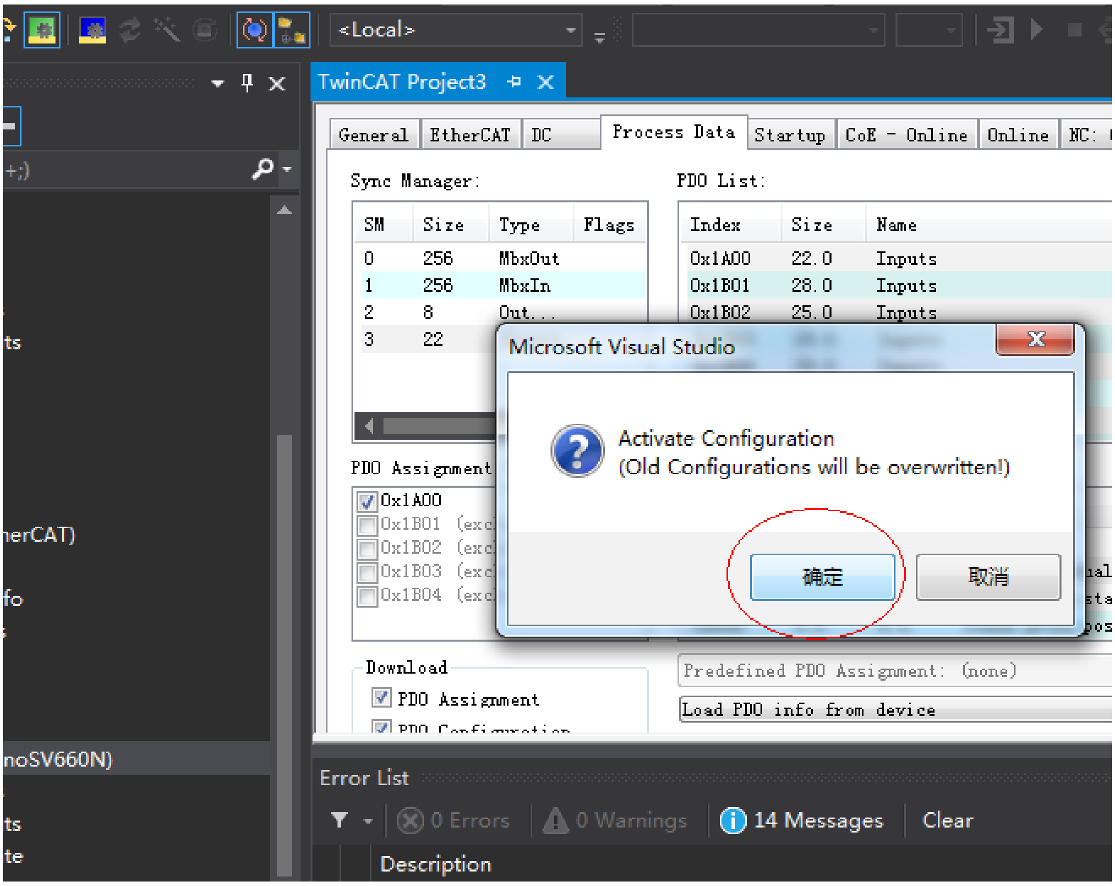

TwinCAT Project3
General
EtherCAT
DC
Process Data
Startup
CoE - Online
Online
NC: Online
NC: Functions
Sync Manager:
PDO List:
PDO Assignment (0x1C13):
PDO Content (0x1A00):
Insert...
Delete...
Edit...
Move Up
Move Down
Predefined PDO Assignment: (none)
Load PDO info from device
Download
PDO Assignment
Error List

6) Activating the configuration and switching to the running mode

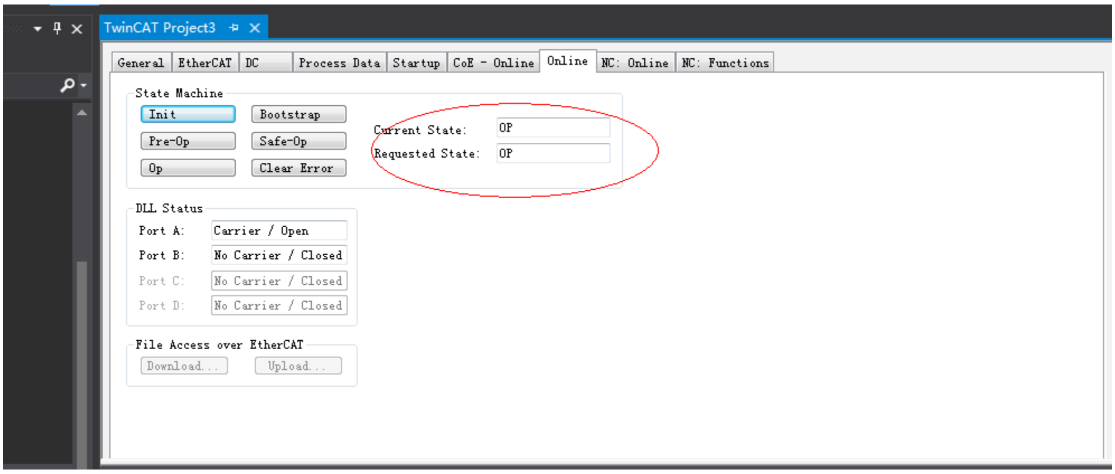
a) Click  .



b) Click " 确定 " (OK).



c) After clicking " 确定 " (OK), the device enters OP status as shown in the "Online" interface, and the 3rd LED on the keypad displays 8, the keypad display_88RY.

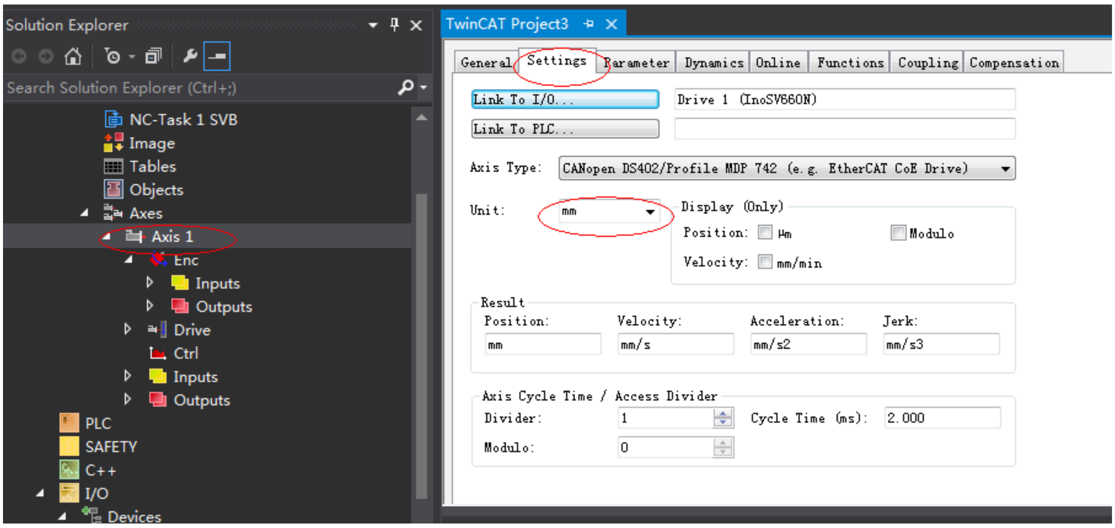


7) Controlling the servo drive through NC controller or PLC program

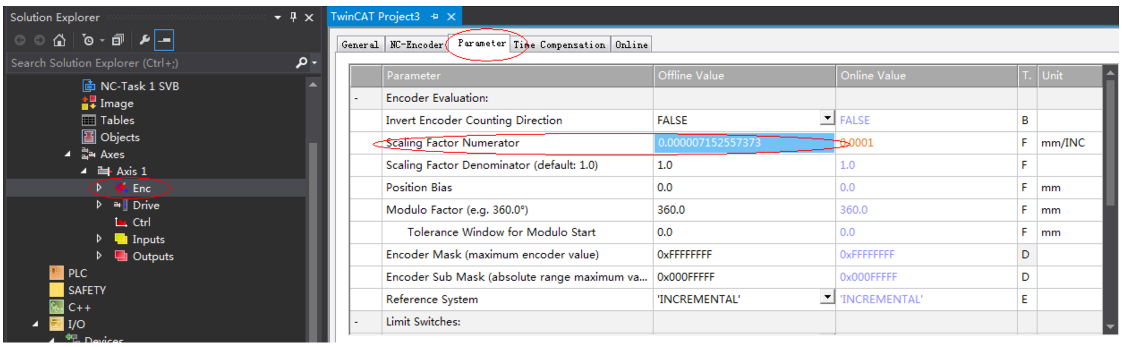
7-1) Servo drive running in the CSP mode

a) Set the unit.

The unit is "mm" during testing.



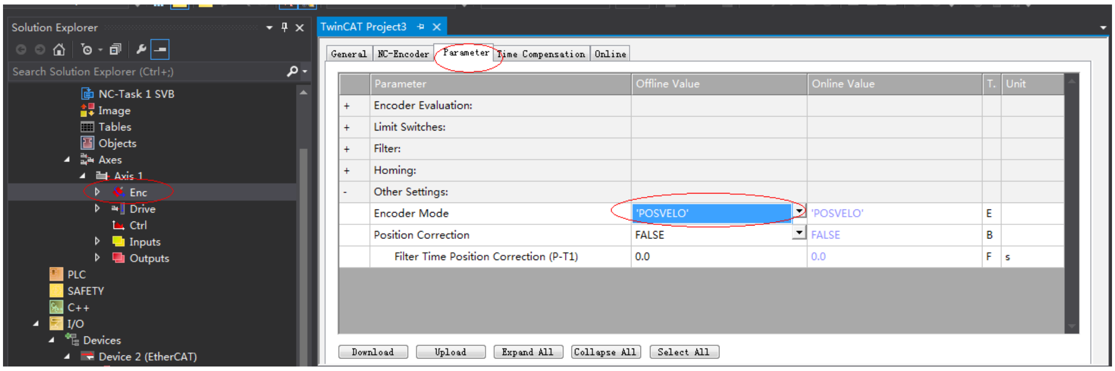
b) Set the scaling factor.



■ Scaling factor: distance corresponding to the encoder pulses per position feedback

For example, 8388608 pulses per motor revolution corresponds to the distance of 60 mm, and the scaling factor is: 60/8388608 = 0.000007152557373 mm/Inc.

c) Set the encoder feedback mode to "PosVelo".

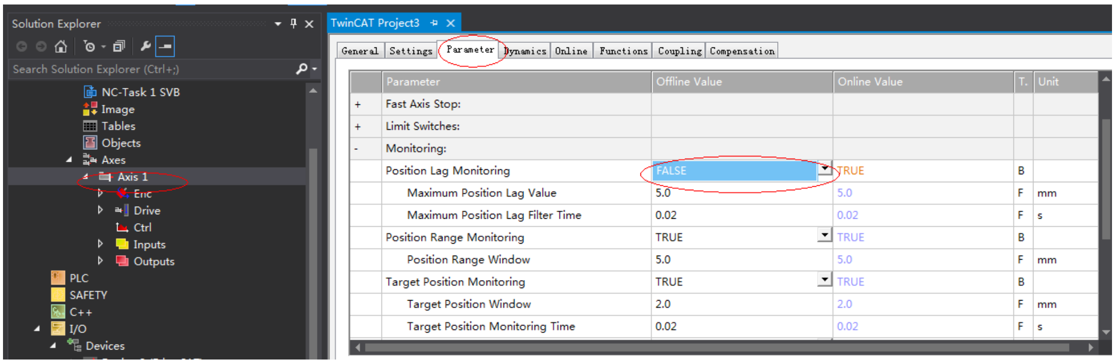


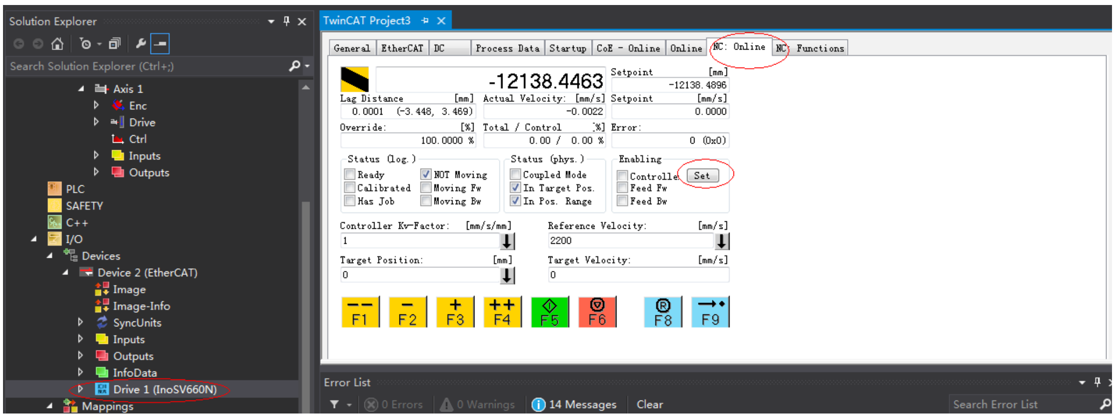
Descriptions for "Other Settings":

- Encoder mode: There are three encoder modes: Pos, PosVelo, and PosVeloAcc.
- Pos: The encoder only calculates the position and is used when the position loop is in the servo drive.
- PosVelo: The encoder only calculates the position and speed and is used when the position loop is in TWinCAT NC.
- PosVeloAcc: The TWinCAT NC uses the encoder to determine the position, speed, and acceleration.

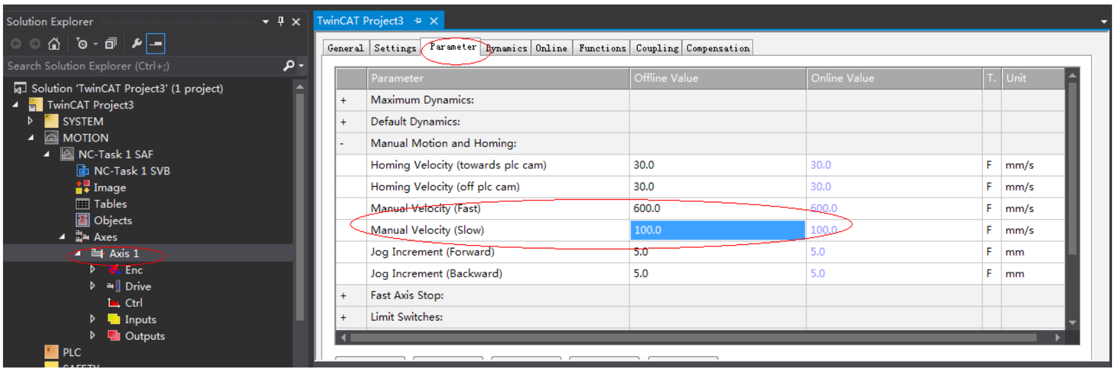
d) Jogging test

Hide the system deviation temporarily.



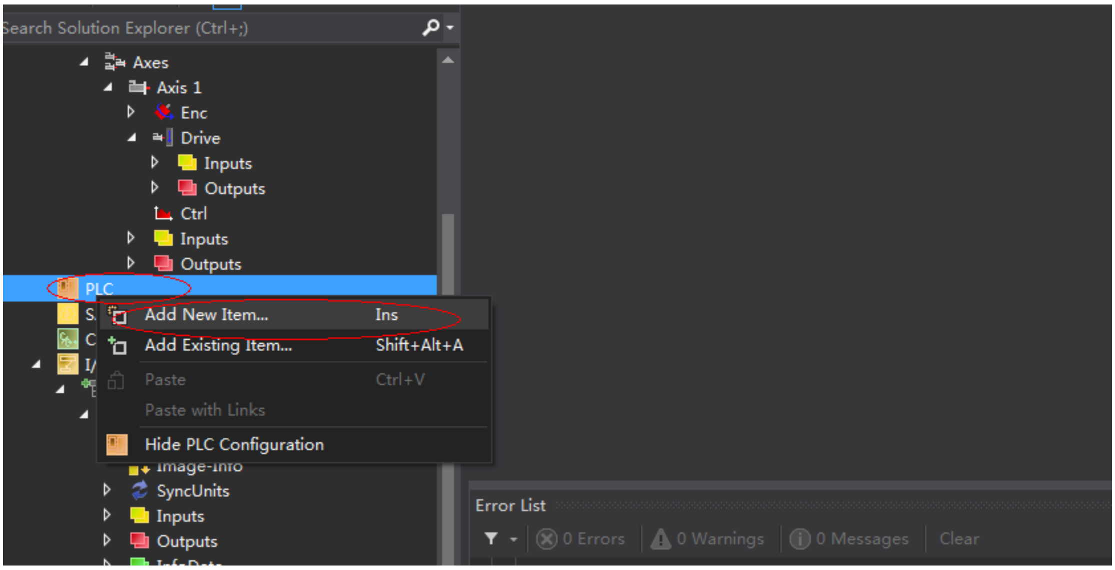


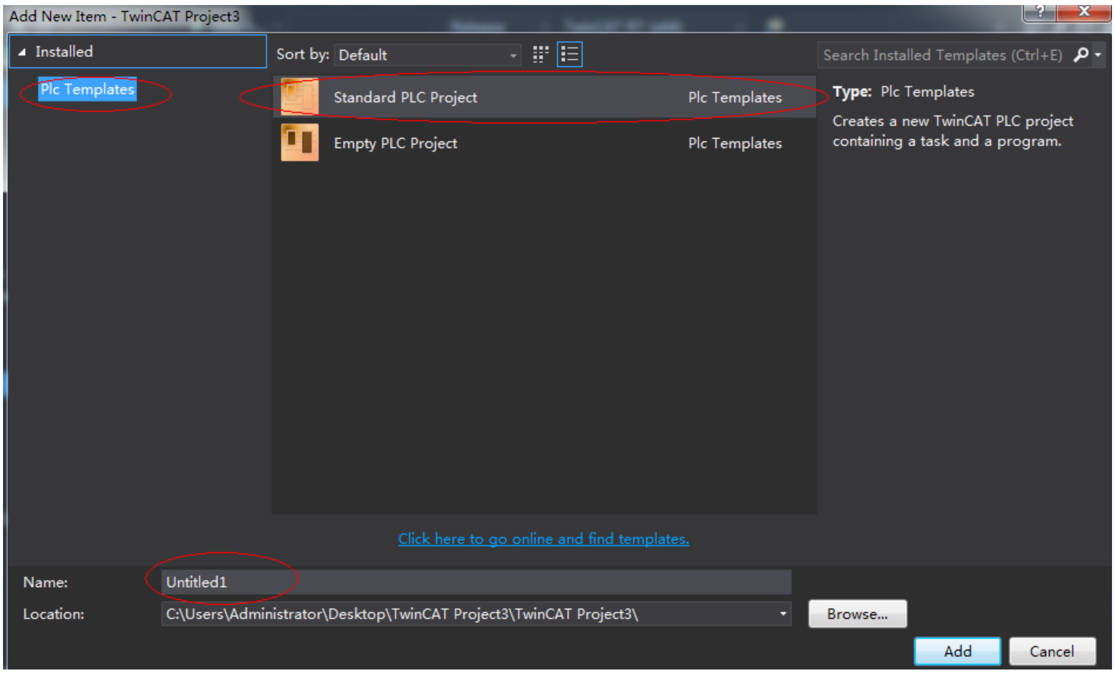
Click "Set" to display a dialog box and then click "All" to enable the servo drive. Perform jogging through F1 to F4. The jog speed is set as follows.



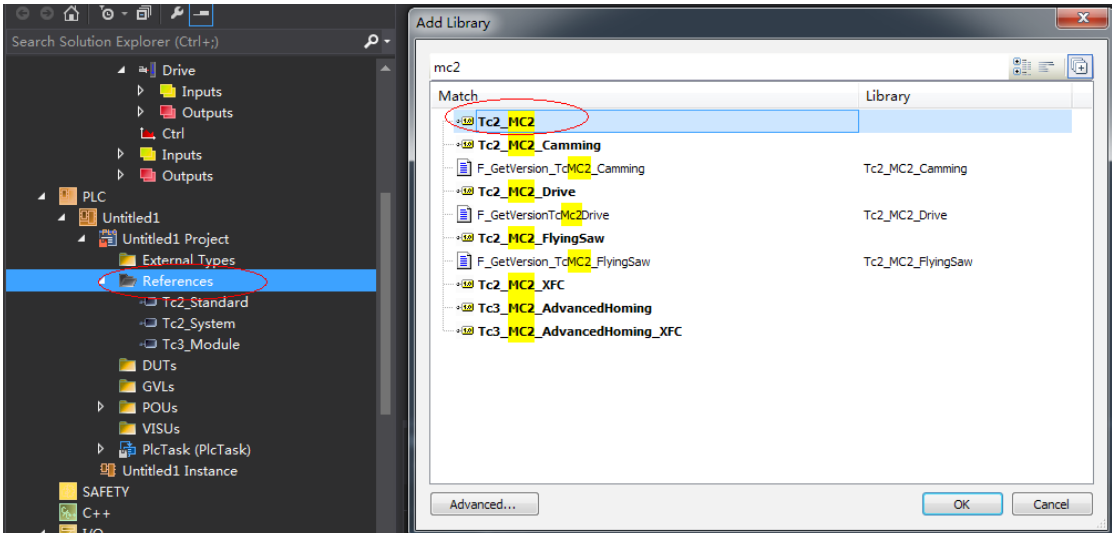
7-2) Controlling the servo operations through the PLC

a) Create a PLC program.

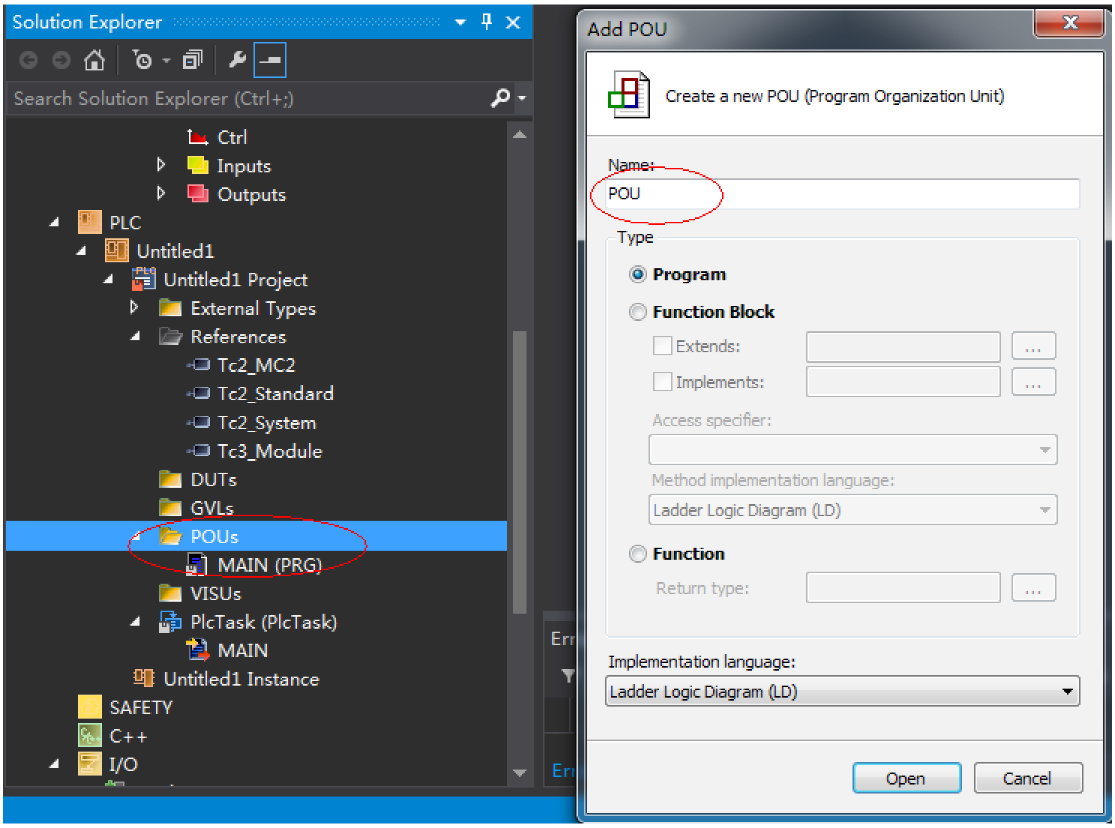




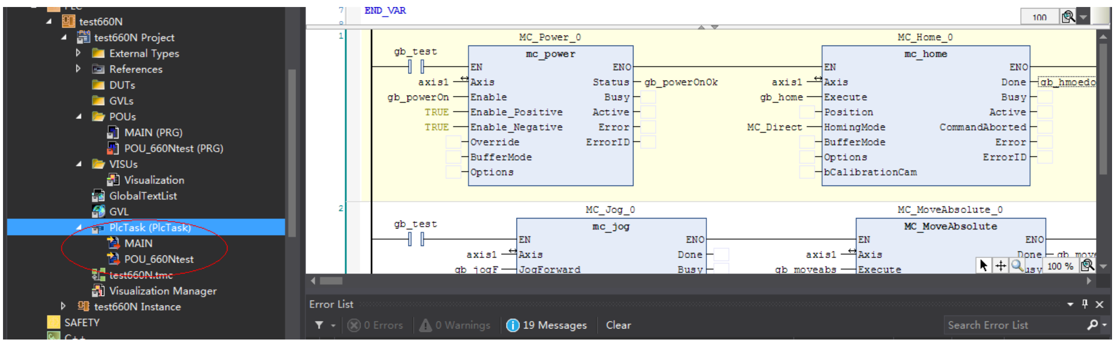
b) Add a motion control library for the convenience of calling the motion control function block.



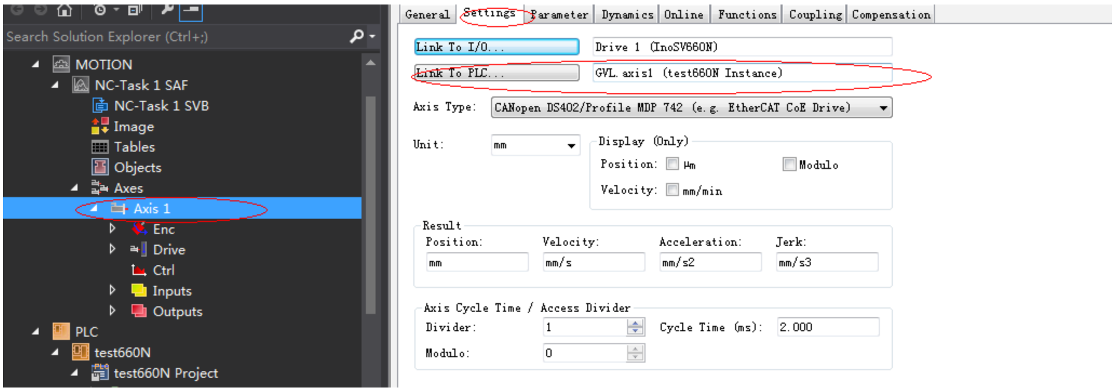
c) Create a POU program.



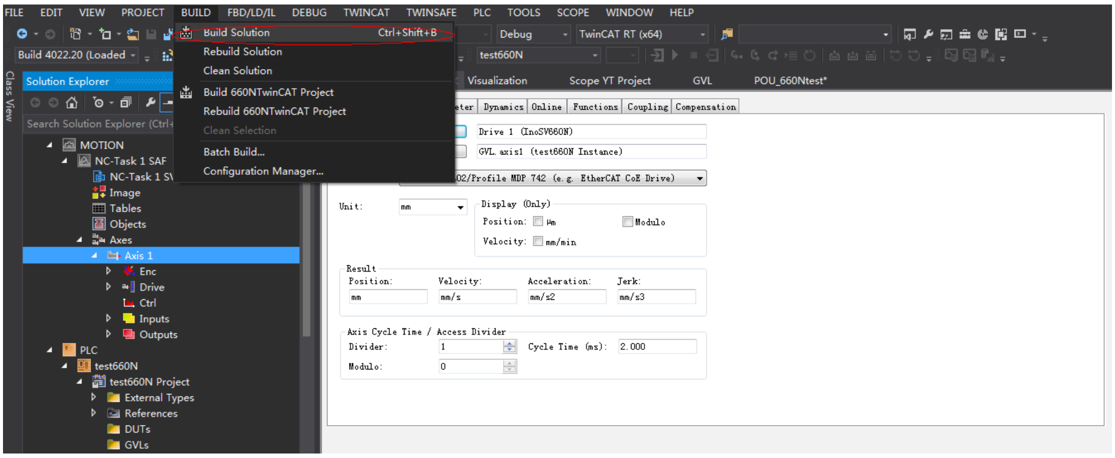
d) Call the motion module to implement some simple actions of the servo drive and input the final program to PLCtask.

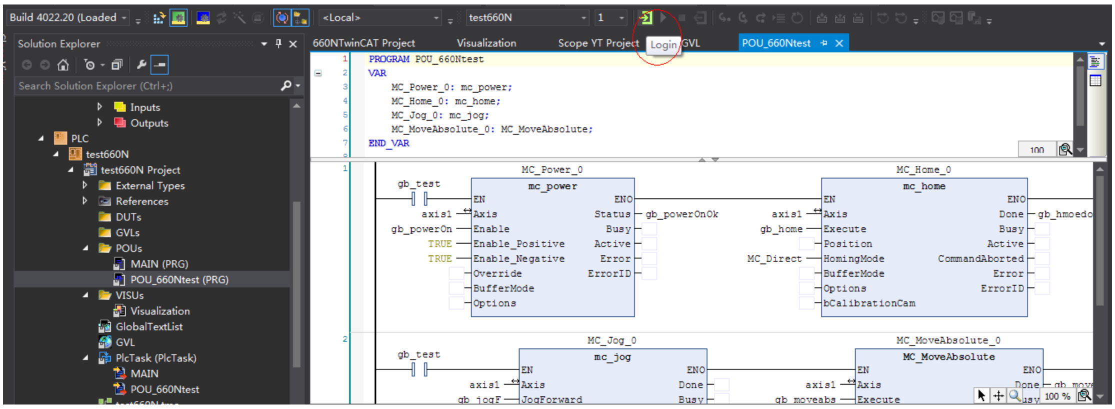


e) Link the axis to the variable defined in the PLC.

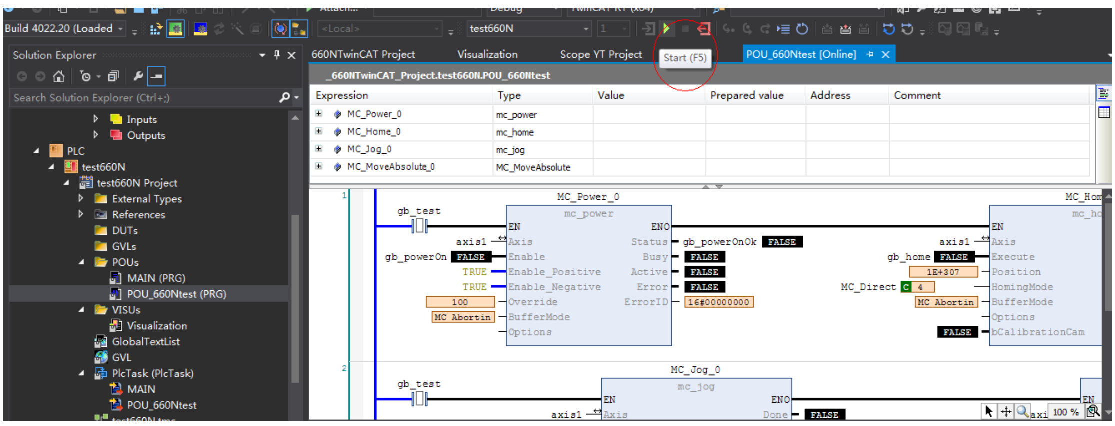


f) Compile the program. If there is not fault, activate the configuration and log onto the PLC.

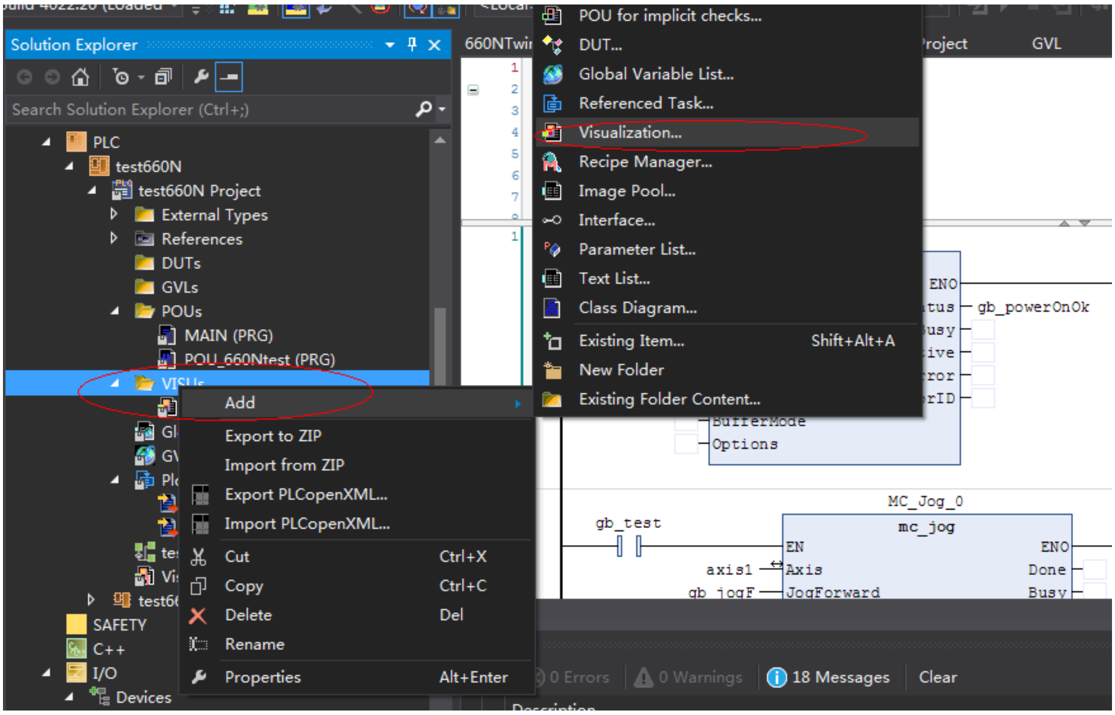




g) Click "Start" to make the servo drive run.

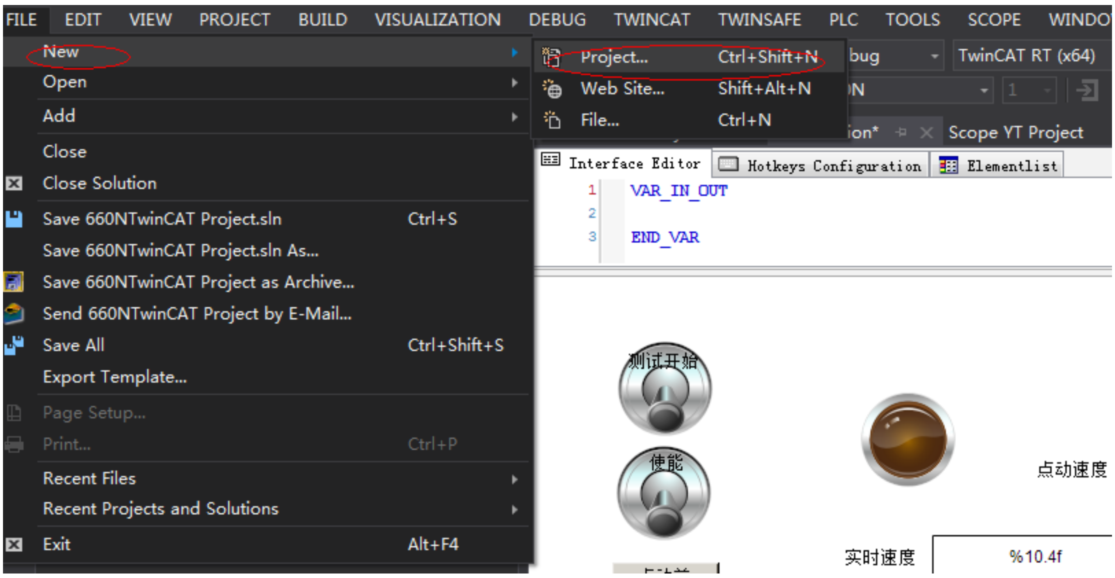


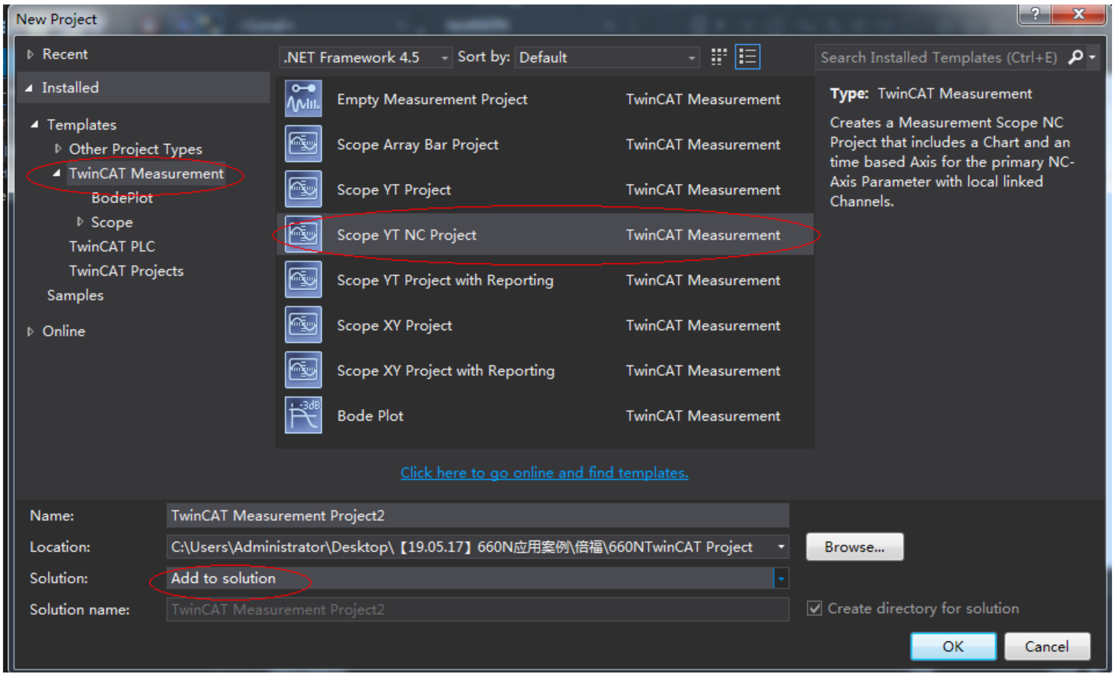
8) Adding the HMI interface to control the servo drive through the HMI interface



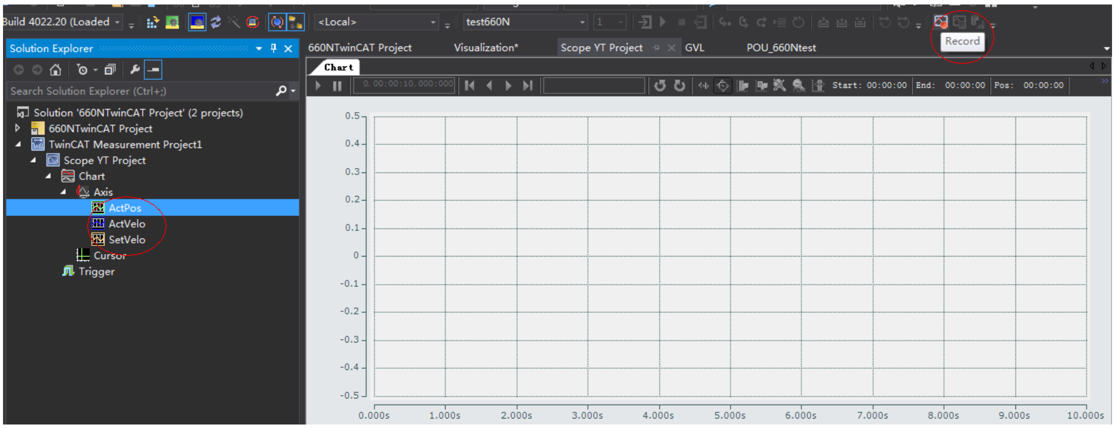
9) Using the scope view function of Beckhoff.

a) Add a scope view project as shown in the following figure.





b) Add parameters to be monitored to monitor these parameters during PLC running.



11 Appendix

11.1 Standards Compliance

11.1.1 CE Certification

■ CE Mark

Figure 11-1 CE Mark

1) The CE mark indicates compliance with European safety and environmental regulations. The European Norm includes the Machinery Directive for machinery manufacturers, the Low Voltage Directive for electronics manufacturers, and EMC directive for electromagnetic interference control.
2) The CE mark is required for engaging in commercial business (production, importation, and distribution) in Europe.
3) This servo drive carries the CE mark and complies with the following directives:

■ Low Voltage Directive: 2014/35/EU

■ EMC Directive: 2014/30/EU

4) Machines and devices integrated with this servo drive must also be CE certified.
5) The integrator who integrates this servo drive into other products and attaches CE mark to the final assembly has the responsibility of ensuring compliance with CE standards and the European Norm.

11.1.2 Low Voltage Directive Compliance

This servo drive has been tested according to IEC 61800-5-1, and it complies with the Low Voltage Directive.

Abide by the following requirements to enable machines and devices integrated with this servo drive to comply with the Low Voltage Directive.

■ Installation location

Install the servo drive in places with overvoltage and pollution respectively not higher than category 3 and severity 2 in accordance with IEC60664.

■ Fuse on the input side (primary side)

To prevent accidents caused by short circuit, connect an UL-compliant fuse on the input side. Select the fuse according to the following table.

Table 11-1 Recommended fuse model

Servo Drive Series	Servo Drive Model	Rated Input Current	Bussmann FWH Series (UL-compliant)
Single-phase 220 V			
Size A	SV660NS1R6I	2.3	FWP-15B
	SV660NS2R8I	4	FWP-20B
Size B	SV660NS5R5I	7.9	FWP-20B
Three-phase 220 V			
Size B	SV660NS6R6I	3.7	FWP-20B

NOTE

- ◆ When the fuse burns or the wiring breaker trips, do not switch on the power supply or operate the machine immediately. Check the cable connections and the models of peripherals to identify the cause. If the cause cannot be identified, contact Inovance. Do not switch on the power supply or operate the machine without permission before identifying the cause.
- ◆ Each input cable of the servo drive must be connected to a fuse. When a fuse burns, replace all the fuses.

■ In-cabinet installation to prevent entry of foreign objects

The SV660N series servo drive must be installed in a cabinet with the fire-proof housing that provides effective electrical and mechanical protection. The installation must conform to local laws and regulations and related IEC requirements.

■ Grounding

For a servo drive of class 400 V, connect the neutral point of the servo drive power supply to the ground.

11.1.3 EMC Directive Compliance

Electromagnetic compatibility (EMC) describes the ability of electrical and electronic devices to work properly in the electromagnetic environment without introducing electromagnetic interferences that disturb the operation of other local devices or systems. In other words, EMC includes two aspects:
1) The electromagnetic interference generated by a device during normal operation cannot exceed a certain limit.
2) The device must have sufficient immunity to the electromagnetic interference in the environment.

Abide by the following requirements to make SV660N series servo drives comply with the European EMC directive 2014/30/EU, EN 61800-3 C2, IEC 61800-3, and IEC 61800-5-2:

1) Install the recommended external EMC filter on the servo drive' s input end and the shielded cable on the output end. Ensure that the filter is reliably grounded and the output cable shield is grounded 360 degrees with a cable gland. See section 11.1.5 for selection of the EMC filter.
2) Install the recommended AC reactor on the input end. See section 11.1.5 for selection of the reactor.
3) Use a shielded cable between the servo drive and the motor. See *"3 Wiring"* for selection and layout of the cables.
4) Install and wire the servo drive according to the recommended wiring method. See *"3 Wiring"* for details.
5) Install a common mode filter if necessary.

NOTE

◆ When applied in the first environment, the servo drive may generate radio interference. In addition to the CE compliance requirements described in this chapter, take measures to prevent the radio interference if necessary.

◆ The manufacturer of the system integrated with this drive is responsible for compliance of the system with the European EMC directive and standard EN 61800-3:2004 +A1:2012 according to the system application environment.

11.1.4 Definition of EMC Terms

First environment: Environment that includes domestic premises, and establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes

Second environment: Environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes

Category C1 drive: Power drive system (PDS) with rated voltage less than 1000 V, intended for use in the first environment

Category C2 drive: PDS with rated voltage less than 1000 V, which is neither a plug-in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by professionals

Category C3 drive: PDS with rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment

Category C4 drive: PDS with rated voltage equal to or above 1000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment

11.1.5 Selection of EMC Filters

■ EMI filter

The following series of filters fulfill the EN 61800-3 C2 emission requirement of CE certification. Connect the filter and the servo drive to the same grounding reference surface to enable reliable grounding of the filter. The cable between the filter and the servo drive must be shielded cable with length less than 30 cm.

1) Appearance

Figure 11-2 Schaffner FN3258 series filter

Figure 11-3 Schaffner FN2080 series filter

- Recommended Model Selection

The recommended Schaffner models are listed in the following table.

Table 11-2 Recommended EMC input filters

Series	Servo Drive Model	Rated Input Current (In)	Filter Model (Manufactuer: Schaffner)
Single-phase 220 V			
Size A	SV660NS1R6I	2.3	FN2090-3-06
	SV660NS2R8I	4	FN2090-4-06
Size B	SV660NS5R5I	7.9	FN2090-8-06
Three-phase 220 V			
Size B	SV660NS6R6I	3.7	FN 3258-7-44

2) Mounting dimensions (FN2080 and FN3258)

Multiple servo drives can be connected to the same external EMI filter if the following conditions are met:

- The single-phase device is connected to a single-phase EMI filter, and the three-phase device is connected to a three-phase EMI filter.
- The total power consumption of the connected device must be equal to or less than the rated current allowed by the EMI filter.
- Dimensions of Schaffner FN2080 series filters (1-16 A)

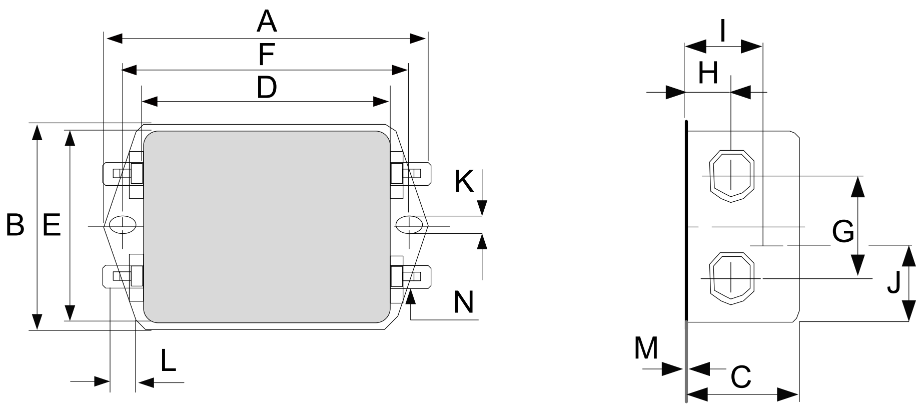


Figure 11-4 Dimensions of FN2080 series filters (1–16 A) (unit: mm)

Table 11-3 Dimensions of FN2080 series filters (1-16 A) (unit: mm)

Rated Current (A)	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	85	54	30.3	64.8	49.8	75	27	12.3	20.8	19.9	5.3	6.3	0.7	6.3 x 0.8
3	85	54	40.3	64.8	49.8	75	27	12.3	29.8	11.4	5.3	6.3	0.7	6.3 x 0.8
6	113.5±1	57.5±1	45.4±1	94±1	56	103	25	12.4	32.4	15.5	4.4	6	1	6.3 x 0.8
10	156±1	57.5±1	45.4±1	130.5±1	56	143	25	12.4	32.5	15.5	5.3	6	1	6.3 x 0.8
12	156±1	57.5±1	45.4±1	130.5±1	56	143	25	12.4	32.5	15.5	5.3	6	1	6.3 x 0.8
16	119±1	85.5±1	57.6±1	98.5±1	84.5	109	40	15.6	-	42.25	4.4	7.4	1.2	6.3 x 0.8

■ Dimensions of Schaffner FN3258 series filters (7-180 A)

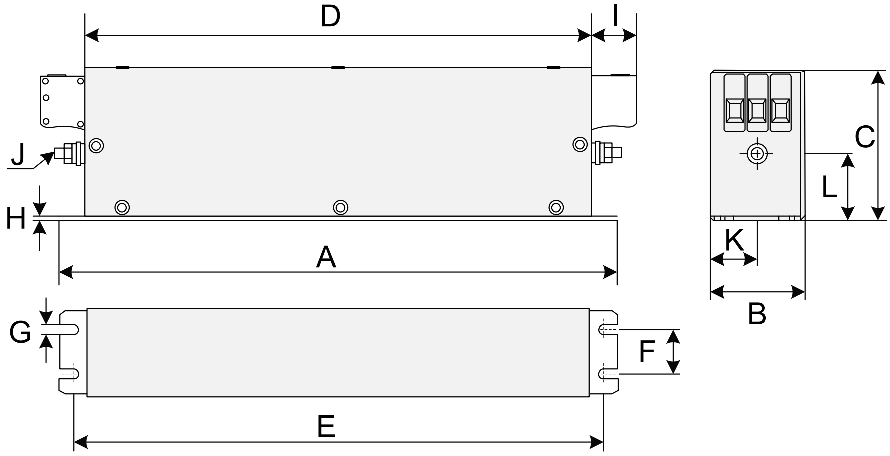


Figure 11-5 Dimensions of FN3258 series filters (7-180 A) (unit: mm)

Table 11-4 Dimensions of FN3258 series filters (7-180 A)

Rated Input Current (A)	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	H (mm)	I (mm)	J	K (mm)	L (mm)
7	190	40	70	160	180	20	4.5	1	22	M5	20	29.5
16	250	45	70	220	235	25	5.4	1	22	M5	22.5	29.5
30	270	50	85	240	255	30	5.4	1	25	M5	25	39.5
42	310	50	85	280	295	30	5.4	1	25	M6	25	37.5
55	250	85	90	220	235	60	5.4	1	39	M6	42.5	26.5
75	270	80	135	240	255	60	6.5	1.5	39	M6	40	70.5
100	270	90	150	240	255	65	6.5	1.5	45	M10	45	64
130	270	90	150	240	255	65	6.5	1.5	45	M10	45	64
180	380	120	170	350	365	102	6.5	1.5	51	M10	60	47

3) Safety capacitance box and ferrite core

To filter out part of the interference generated during running, connect a safety capacitance box and wind a ferrite core around the input/output cable in some applications.

The safety capacitance box must be grounded to the grounding terminal of the servo drive with a grounding cable as short as possible (within 15 cm).

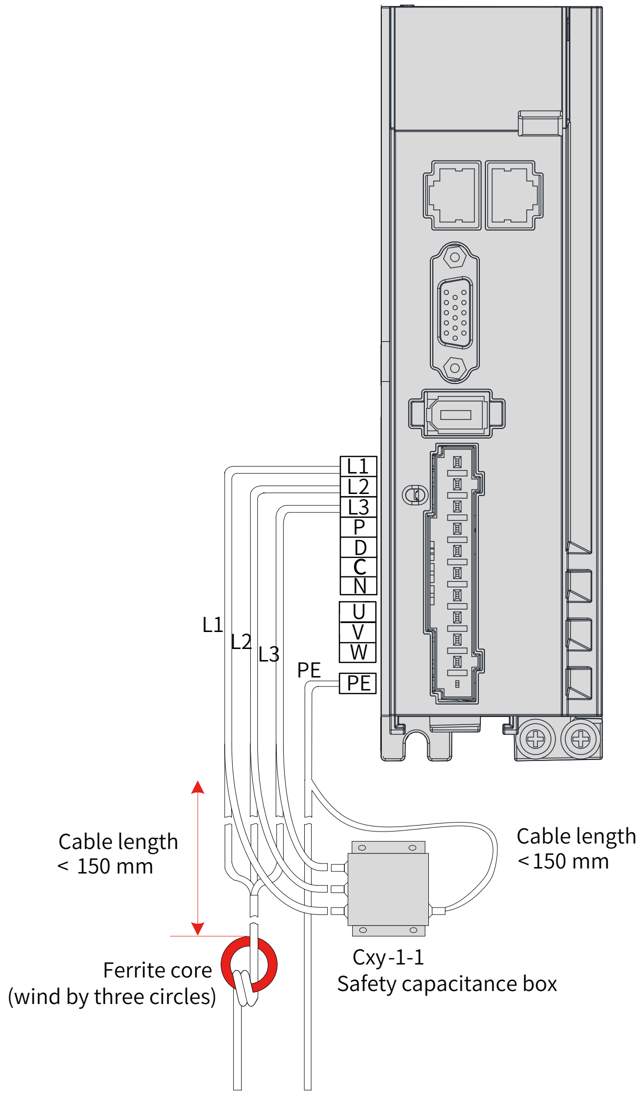


Figure 11-6 Installation of the capacitance box and the ferrite core

■ Dimension drawing of the safety capacitance box

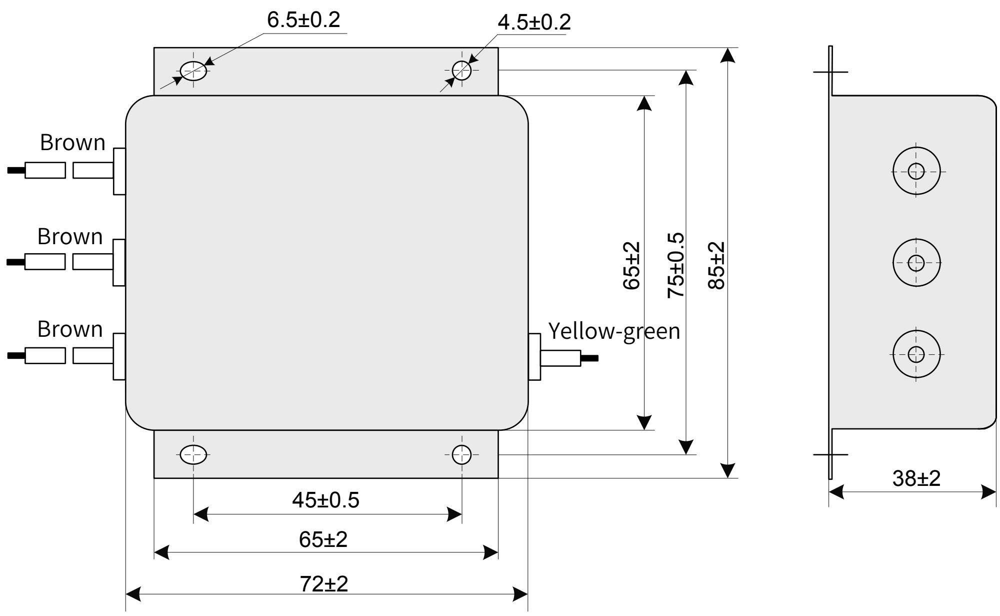


Figure 11-7 Dimensions of the safety capacitance box

Table 11-5 Dimensions of the safety capacitance box

Safety Capacitance Box Model	Code	Dimension (Width x Depth x Height) (mm)	Mounting Dimension (Width x Depth) (mm)
Cxy-1-1	11025018	85 x 72 x 38	45 x 75

■ Selection of the output ferrite core

To reduce the noise current and the interference to neighboring devices, install the output ferrite core around the U/V/W power cables (PE excluded) near the servo drive side.

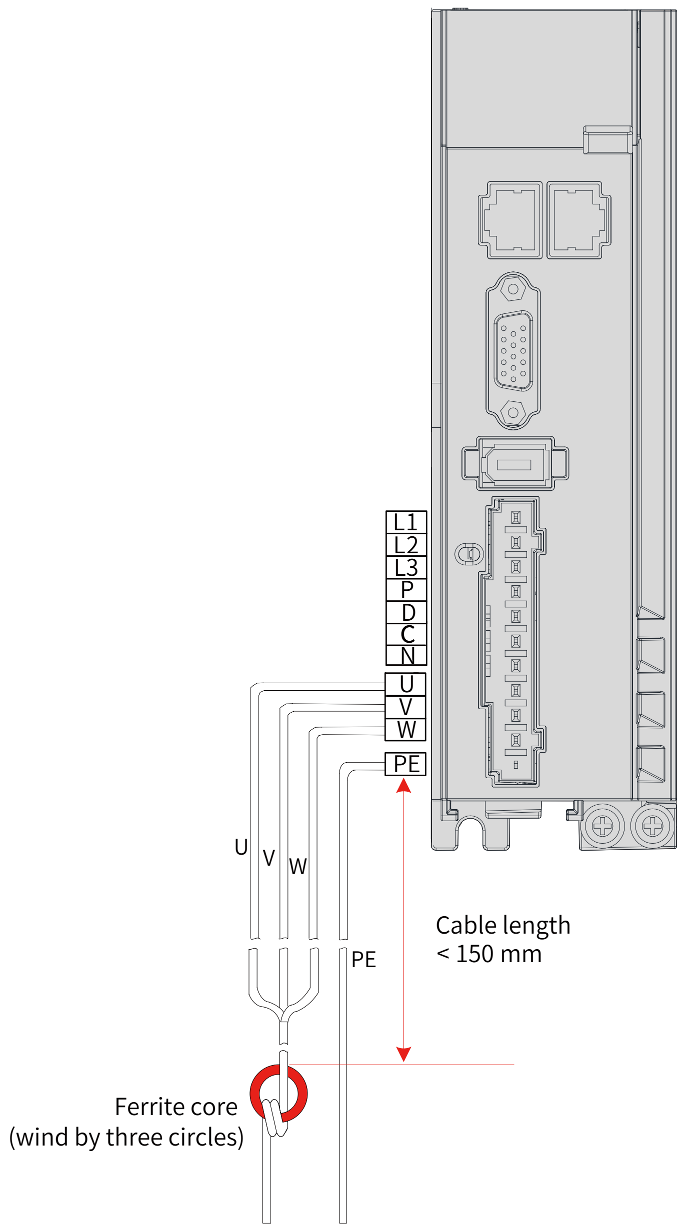


Figure 11-8 Installation of the output ferrite core (external)

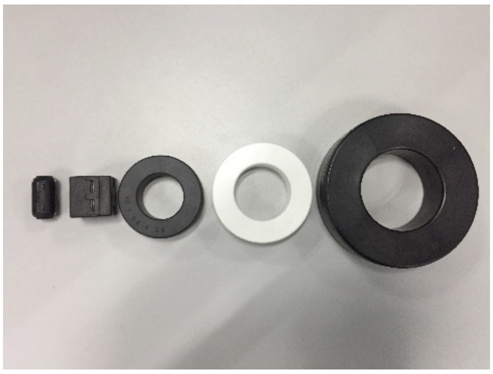


Figure 11-9 Appearance of the output ferrite core (external)

Table 11-6 Model selection of the output ferrite core (external)

Ferrite Core Model	Code	Dimension (Outer Diameter x Inner Diameter x Thickness) (mm)
CTRC 0930 -1B	11013003	19.5 x 9 x 35
7427122S	11013046	32.8 x 13.5 x 28
DY644020H	11013031	64 x 40 x 20
DY805020H	11013032	80 x 50 x 20
DY1207030H	11013033	120 x 70 x 30

■ AC input reactor

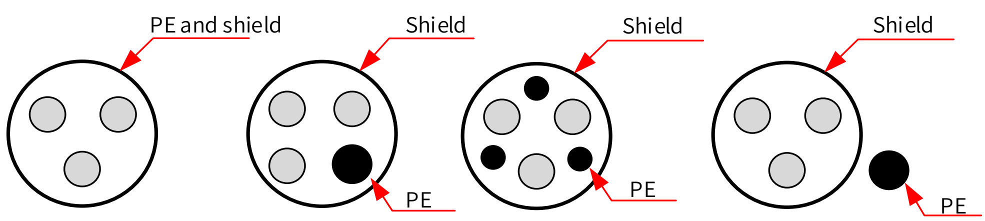
The AC input reactor is an option used to suppress the harmonics in the input current. In applications where strong suppression of harmonics is required, install an external AC input reactor.

11.1.6 Cable Requirements and Routing

■ Requirements on Power Cables

To fulfill the EMC requirements of CE marking, use shielded cables. Shielded cables are classified into three-conductor cables and four-conductor cables. If the conductivity of the cable shield cannot meet the requirement, add a separate PE cable, or use a four-conductor shielded cable, of which one phase conductor is PE cable. The cable shield, which serves to suppress the emission and conduction of the radio frequency interference, must be made of co-axial copper braids with a weaving density larger than 85% to enhance shielding and conductivity performance.

Power cables recommended are shielded cables, as shown in the following figure.



■ Requirements on wiring

1) The motor cables and PE shielded cables (twisted) must be as short as possible. For motor cables over 100 meters, install an output filter or a dv/dt reactor.

2) It is recommended to adopt shielded cables as control cables.

3) It is recommended to adopt shielded cables as motor brake cables.

4) The motor cables must be routed away from other cables. The motor cables of several servo drives can be routed in parallel.

5) It is recommended that the motor cables, power input cables and control cables be routed in different cable duct. The motor cables and other cables cannot be routed in parallel for a long distance. This is to prevent the electromagnetic interference caused by rapid change of the drive output voltage.

6) If the control cable must pass through the power cable, make sure the angle between them is close to 90 degrees. Other cables cannot pass through the servo drive.

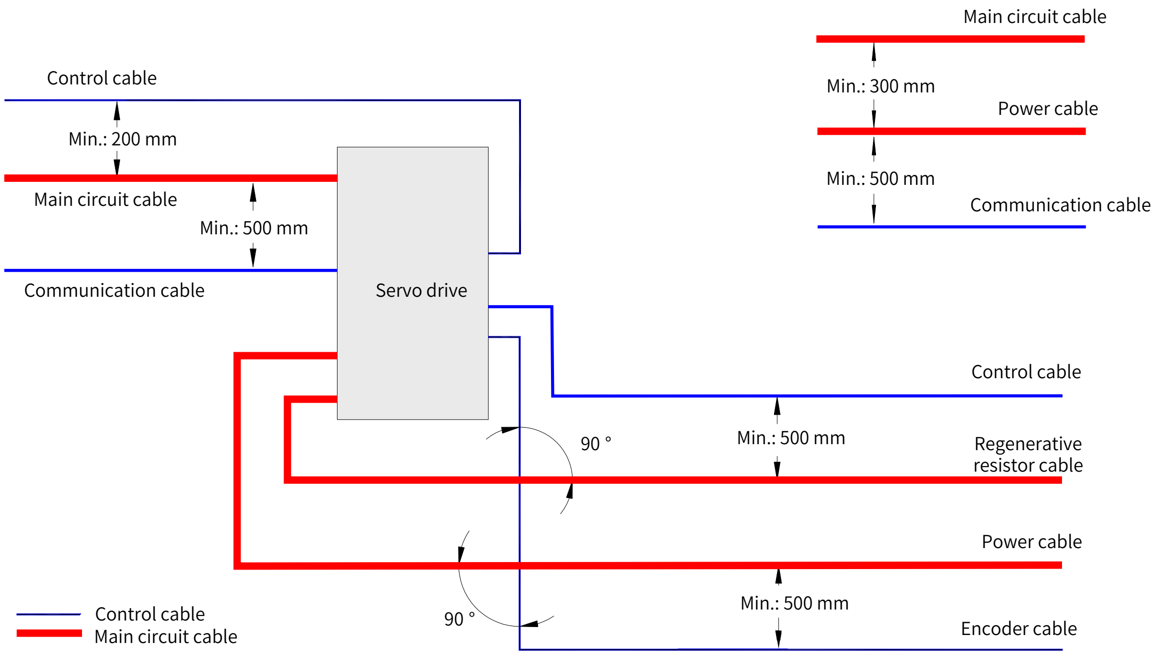
7) Power input and output cables and signal cables (such as control cables) of the servo drive should, if possible, be laid vertically rather than in parallel.

8) Cable ducts must be in good connection and well grounded. Aluminum cable ducts can be used to improve equal potential.

9) The grounding plane of different equal potential must be connected properly with cables of above 16 mm^2.

10) The filter, the servo drive and the motor must be properly connected to systems, with the conductive metal kept in full contact.

■ The recommended wiring diagram is shown below.



11.1.7 Solutions to Leakage Current

The servo drive outputs high-speed pulse voltage, which may generate high-frequency leakage current. It is recommended to use a residual current device (RCD) with action current no less than 100 mA. If multiple servo drives share the same RCD, the action current of this RCD must be no less than 300 mA.

Factors that affect the leakage current are listed as follows:

■ Distributed capacitance of the motor

■ Carrier frequency

■ Type and length of the motor cables.

■ EMI filter

When the leakage current generated by the servo drive triggers the RCD to act, take the following measures:

- Increase the rated action current of the RCD.
- Replace the original RCD with a time-delay type-B RCD.
- Reduce the carrier frequency.
- Shorten the length of the output drive cables.
- Wind the ferrite core around the power cables (PE cable excluded). Recommended RCD brands are Chint and Schneider.

11.1.8 Solutions to Common EMC Problems

The servo drive generates strong interferences. Although EMC measures are taken, interference may still exist due to improper wiring or grounding during use. When the servo drive interferes with other devices, adopt the following solutions.

Table 11-7 Solutions to common EMC interference problems

Interference Type	Solution
RCD tripping	◆ Reduce the carrier frequency without compromising the performance. ◆ Shorten the servo drive cable length. ◆ Wind the ferrite core around the power cables (PE cable excluded). ◆ For tripping at the moment of power-on, disconnected the capacitor that carries larger capacity (disconnect the grounding end of the external or internal filter and the grounding end of the grounding Y capacitor of the input terminal). ◆ For tripping during running or enabling, take leakage current suppression measures (install a leakage current filter, or install a safety capacitor and wind the ferrite core, ~~or wind the ferrite core~~).
Interference generated during running	◆ Connect the motor housing to the PE terminal of the servo drive. ◆ Connect the PE terminal of the servo drive to the PE terminal of the mains power supply. ◆ Route the power cables (main circuit cables，power cables, and regenerative resistor cables), control cables, and signal cables through different routes. ◆ Wind the ferrite core around the power cables (PE cable excluded). ◆ Install a capacitor to the interfered signal port or wind the ferrite core around this port. ◆ Install a matching resistor between the communication cable source and the load end. ◆ Add an auxiliary reference ground wire if the differential cable pair are used for communication. ◆ Adopt shielded cables as communication cables ◆ Apply additional common-ground connection between devices and cabinets.

11.1.9 UL Certification

C UL US
LISTED
E467465
IND.CONT.EQ.

Figure 11-10 UL/cUL mark

The UL/cUL mark is commonly applied to products in the United States and Canada. It indicates that UL has performed product tests and evaluations, and determined that their stringent standards for product safety have been met. For a product to receive UL certification, the main components inside that product must also be UL certificated.

This series of servo drives have been tested in accordance with UL standard UL508C and comply with UL standards. Abide by the following requirements to enable machines and devices integrated with this servo drive to comply with UL standards.

- Installation location

Install the servo drive in a place with pollution degree 1 or 2 (UL standard).

- Ambient temperature

Run the servo drive in an ambient temperature not higher than 50° C.

- Wiring example

See "3 Wiring" or the wiring diagram that complies with the Low Voltage Directive.

- Wiring of main circuit terminals

To meet UL standard, use UL-compliant crimping terminals to crimp the cables on main circuit terminals with the tools recommended by the terminal manufacturer for crimping. Use crimping terminals with insulated cladding or insulated sleeves.

Adopt UL-compliant insulated copper cables as main circuit cables, and the continuous maximum allowable temperature of such cables is 75° C.

Select the cable dimension and tightening torque according to "3 Wiring" during wiring.

(Note: “⏚“ indicates the grounding terminal defined in IEC/EN60417-5019)

- Fuse on the input side (primary side)

To prevent accidents caused by short circuit, connect a fuse that complies with UL standards on the input side. See "Table 11-1 Recommended fuse model" for fuse selection.

See the specifications and model selection of the servo drive for the input and output current of the servo drive.

See "Table 11-1 Recommended fuse model" for fuse model recommendations.

NOTE

- ◆ When the fuse burns or the wiring breaker trips, do not switch on the power supply or operate the machine immediately. Check the wiring and the models of peripherals to identify the cause. If the cause cannot be identified, contact Inovance. Do not switch on the power supply or operate the machine without permission before identifying the cause.
- ◆ Each input cable of the servo drive must be connected to a fuse. When a fuse burns, replace all the fuses.

- Short-circuit withstand capacity

This series of servo drives adopt the Bussmann FWH series fuses, which can be used in a 480 V (400 V class) and below mains circuit with short-circuit current less than 100,000 A.

11.2 List of Object Groups

Description of Object Groups

Parameter access address: Index + subindex, both are hexadecimal data.

The CiA402 protocol establishes the following constraints on the parameter address.

Index (Hex)	Description
0000-0FFF	Data type description
1000-1FFF	CoE communication object
2000-5FFF	Manufacturer-defined object
6000-9FFF	Sub-protocol object
A000-FFFF	Reserved

Object Group 1000h

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default
1000	00	Device Type	RO	NO	UINT32	-	-	0x00020192
1008	00	Manufacturer device name	RO	NO	-	-	-	SV660N-ECAT
1009	00	Manufacturer hardware version	RO	NO	-	-	-	Determined by the software version
100A	00	Manufacturer software version	RO	NO	-	-	-	Determined by the hardware version
1018	ID object							
	00	Highest sub-index No. included in the ID object	RO	NO	UINT8	-	-	0x04
	01	Vendor ID	RO	NO	UINT32	-	-	0x00100000
	02	Product code	RO	NO	UINT32	-	-	0x000C010D
	03	Revision number	RO	NO	UINT32	-	-	0x00010001
	04	Serial No.	RO	NO	UINT32	-	-	0x00000000
1C00	Manufacturer software version							
	00	Number of Sync Manager channels	RO	NO	UINT8	-	-	0x04
	01	Communication type SM0	RO	NO	UINT8	-	-	0x01
	02	Communication type SM1	RO	NO	UINT8	-	-	0x02
	03	Communication type SM2	RO	NO	UINT8	-	-	0x03
	04	Communication type SM3	RO	NO	UINT8	-	-	0x04

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default
1600	RPDO mapping object in group 1600							
	00	Number of mapped application objects in group 1600	RW	NO	UINT8	-	0–0x0A	0x03
	01	1st application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x60400010
	02	2nd application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x60600008
	03	3rd application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x60B80010
	04	4th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-
	05	5th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-
	06	6th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-
	07	7th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-
	08	8th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-
	09	9th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-
	0A	10th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-
1701	RPDO mapping objects in group 1701							
	00	Number of mapped application objects in group 1701	RO	NO	UINT8	-	-	0x04
	01	1st application object	RO	NO	UINT32	-	-	0x60400010
	02	2nd application object	RO	NO	UINT32	-	-	0x607A0020
	03	3rd application object	RO	NO	UINT32	-	-	0x60B80010
	04	4th application object	RO	NO	UINT32	-	-	0x60FE0120
1702	RPDO mapping objects in group 1702							
	00	Number of mapped application objects in group 1702	RO	NO	UINT8	-	-	0x07
	01	1st application object	RO	NO	UINT32	-	-	0x60400010
	02	2nd application object	RO	NO	UINT32	-	-	0x607A0020
	03	3rd application object	RO	NO	UINT32	-	-	0x60FF0020
	04	4th application object	RO	NO	UINT32	-	-	0x60710010
	05	5th application object	RO	NO	UINT32	-	-	0x60600008
	06	6th application object	RO	NO	UINT32	-	-	0x60B80010
	07	7th application object	RO	NO	UINT32	-	-	0x607F0020
1703	RPDO mapping objects in group 1703							
	00	Number of mapped application objects in group 1703	RO	NO	UINT8	-		0x07
	01	1st application object	RO	NO	UINT32	-		0x60400010
	02	2nd application object	RO	NO	UINT32	-		0x607A0020
	03	3rd application object	RO	NO	UINT32	-		0x60FF0020
	04	4th application object	RO	NO	UINT32	-		0x60600008
	05	5th application object	RO	NO	UINT32	-		0x60B80010
	06	6th application object	RO	NO	UINT32	-		0x60E00010
	07	7th application object	RO	NO	UINT32	-		0x60E10010

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default
1704	RPDO mapping objects in group 1704							
	00	Number of mapped application objects in group 1704	RO	NO	UINT8	-	-	0x09
	01	1st application object	RO	NO	UINT32	-	-	0x60400010
	02	2nd application object	RO	NO	UINT32	-	-	0x607A0020
	03	3rd application object	RO	NO	UINT32	-	-	0x60FF0020
	04	4th application object	RO	NO	UINT32	-	-	0x60710010
	05	5th application object	RO	NO	UINT32	-	-	0x60600008
	06	6th application object	RO	NO	UINT32	-	-	0x60B80010
	07	7th application object	RO	NO	UINT32	-	-	0x607F0020
	08	8th application object	RO	NO	UINT32	-	-	0x60E00010
	09	9th application object	RO	NO	UINT32	-	-	0x60E10010
1705	RPDO mapping objects in group 1705							
	00	Number of mapped application objects in group 1705	RW	NO	UINT8	-	-	0x08
	01	1st application object	RW	NO	UINT32	-	-	0x60400010
	02	2nd application object	RW	NO	UINT32	-	-	0x607A0020
	03	3rd application object	RW	NO	UINT32	-	-	0x60FF0020
	04	4th application object	RW	NO	UINT32	-	-	0x60600008
	05	5th application object	RW	NO	UINT32	-	-	0x60B80010
	06	6th application object	RW	NO	UINT32	-	-	0x60E00010
	07	7th application object	RW	NO	UINT32	-	-	0x60E10010
	08	8th application object	RW	NO	UINT32	-	-	0x60B20010
1A00	Mapping objects in group 1A00							
	00	Number of mapped application objects in group 1A00	RW	NO	UINT8	-	0–0x0A	0x07
	01	1st application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x60410010
	02	2nd application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x60640020
	03	3rd application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x60B90010
	04	4th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x60BA0020
	05	5th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x60BC0020
	06	6th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x603F0010
	07	7th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	0x60FD0010
	08	8th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-
	09	9th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-
	0A	10th application object	RW	NO	UINT32	-	0–0xFFFFFFFF	-

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default
1B01	Mapping objects in group 1B01							
	00	Number of mapped application objects in group 1B01	RO	NO	UINT8	-	-	0x09
	01	1st application object	RO	NO	UINT32	-	-	0x603F0010
	02	2nd application object	RO	NO	UINT32	-	-	0x60410010
	03	3rd application object	RO	NO	UINT32	-	-	0x60640020
	04	4th application object	RO	NO	UINT32	-	-	0x60770010
	05	5th application object	RO	NO	UINT32	-	-	0x60F40020
	06	6th application object	RO	NO	UINT32	-	-	0x60B90010
	07	7th application object	RO	NO	UINT32	-	-	0x60BA0020
	08	8th application object	RO	NO	UINT32	-	-	0x60BC0020
	09	9th application object	RO	NO	UINT32	-	-	0x60FD0010
1B02	Mapping objects in group 1B02							
	00	Number of mapped application objects in group 1B02	RO	NO	UINT8	-	-	0x09
	01	1st application object	RO	NO	UINT32	-	-	0x603F0010
	02	2nd application object	RO	NO	UINT32	-	-	0x60410010
	03	3rd application object	RO	NO	UINT32	-	-	0x60640020
	04	4th application object	RO	NO	UINT32	-	-	0x60770010
	05	5th application object	RO	NO	UINT32	-	-	0x60610008
	06	6th application object	RO	NO	UINT32	-	-	0x60B90010
	07	7th application object	RO	NO	UINT32	-	-	0x60BA0020
	08	8th application object	RO	NO	UINT32	-	-	0x60BC0020
	09	9th application object	RO	NO	UINT32	-	-	0x60FD0010
1B03	Mapping objects in group 1B03							
	00	Number of mapped application objects in group 1B03	RO	NO	UINT8	-	-	0x0A
	01	1st application object	RO	NO	UINT32	-	-	0x603F0010
	02	2nd application object	RO	NO	UINT32	-	-	0x60410010
	03	3rd application object	RO	NO	UINT32	-	-	0x60640020
	04	4th application object	RO	NO	UINT32	-	-	0x60770010
	05	5th application object	RO	NO	UINT32	-	-	0x60F40020
	06	6th application object	RO	NO	UINT32	-	-	0x60610008
	07	7th application object	RO	NO	UINT32	-	-	0x60B90010
	08	8th application object	RO	NO	UINT32	-	-	0x60BA0020
	09	9th application object	RO	NO	UINT32	-	-	0x60BC0020
	0A	10th application object	RO	NO	UINT32	-	-	0x60FD0010

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default
1B04	Mapping objects in group 1B04							
	00	Number of mapped application objects in group 1B04	RO	NO	UINT8	-	-	0x0A
	01	1st application object	RO	NO	UINT32	-	-	0x603F0010
	02	2nd application object	RO	NO	UINT32	-	-	0x60410010
	03	3rd application object	RO	NO	UINT32	-	-	0x60640020
	04	4th application object	RO	NO	UINT32	-	-	0x60770010
	05	5th application object	RO	NO	UINT32	-	-	0x60610008
	06	6th application object	RO	NO	UINT32	-	-	0x60F40020
	07	7th application object	RO	NO	UINT32	-	-	0x60B90010
	08	8th application object	RO	NO	UINT32	-	-	0x60BA0020
	09	9th application object	RO	NO	UINT32	-	-	0x60BC0020
	0A	10th application object	RO	NO	UINT32	-	-	0x606C0020
1C12	Sync Manager 2_RPDO assignment							
	00	Number of assigned RPDOs	RW	NO	UINT8	-	0–0x01	0x01
	01	1st PDO mapping object index of assigned RPDO	RW	YES	UINT16	-	0–0xFFFF	0x1701
1C13	Sync Manager 2_TPDO assignment							
	00	Number of assigned TPDOs	RW	NO	UINT8	-	0–0x1	0x01
	01	1st PDO mapping object index of assigned TPDO	RW	YES	UINT16	-	0–0xFFFF	0x1B01
1C32	Sync Manager 2 Synchronization output							
	00	Number of synchronization parameters	RO	NO	UINT8	-	-	0x20
	01	Synchronization type	RO	NO	UINT16	-	-	0x0002
	02	Cycle Time	RO	NO	UINT32	ns	-	0
	04	Synchronization types supported	RO	NO	UINT16	-	-	0x0004
	05	Minimum cycle time	RO	NO	UINT32	ns	-	0x0003D090
	06	Calculation and copy time	RO	NO	UINT32	ns	-	-
	09	Delay time	RO	NO	UINT32	ns	-	-
	20	Synchronization error	RO	NO	BOOL	-	-	-

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default
1C33	Sync Manager 2 Synchronization input							
	00	Number of synchronization parameters	RO	NO	UINT8	-	-	0x20
	01	Synchronization type	RO	NO	UINT16		-	0x0002
	02	Cycle Time	RO	NO	UINT32	ns	-	0
	04	Synchronization types supported	RO	NO	UINT16	-	-	0x0004
	05	Minimum cycle time	RO	NO	UINT32	ns	-	0x0003D090
	06	Calculation and copy time	RO	NO	UINT32	ns	-	-
	09	Delay time	RO	NO	UINT32	ns	-	-
	20	Synchronization error	RO	NO	BOOL	-	-	-

Object Group 2000h

Parameter Group: Hexadecimal: Group	Parameter Group: Hexadecimal: Index Code	Parameter Group: Decimal: Para. No.	Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
2000h/H00 Servo motor parameters										
2000	01h	H00-00	Motor code	-	0–65535	14101	1	16 bits	At stop	Next power-on
	03h	H00-02	Customized software version	-	0–0xFFFFFFFF	0	1	32 bits	-	-
	05h	H00-04	Encoder version	-	0–65535	0	0.1	16 bits	-	-
	06h	H00-05	Serial encoder motor code	-	0–65535	0	1	16 bits	-	-
	07h	H00-06	FPGA customized No.	-	0–65535	0	1	16 bits	-	-
	08h	H00-07	STO version		0–65535	0	1	16 bits	-	-
	09h	H00-08	Serial encoder type	-	0–65535	0	1	16 bits	At stop	Next power-on
2001h/H01: Servo drive parameters										
2001	01h	H01-00	MCU firmware version	-	0–65535	0	0.1	16 bits	-	-
	02h	H01-01	FPGA firmware version	-	0–65535	0	0.1	16 bits	-	-
	0Bh	H01-10	Servo series No.	2: 1R6 3: S2R8 5: S5R5 60005: S6R6 6: S7R6 7: S012 10001: T3R5 10002: T5R4 10003: T8R4 10004: T012 10005: T017 10006: T021 10007: T026	0–65535	3	1	16 bits	At stop	Next power-on
	0Ch	H01-11	Voltage class of the drive unit	-	0–65535	220	1 V	16 bits	-	-
	0Dh	H01-12	Rated power of the servo drive	-	0–1073741824	40	0.01 kW	32 bits	-	-
	0Fh	H01-14	Max. output power of the servo drive	-	0–1073741824	40	0.01 kW	32 bits	-	-
	11h	H01-16	Rated output current of the servo drive	-	0–1073741824	280	0.01 A	32 bits	-	-
	13h	H01-18	Max. output current of the servo drive	-	0–1073741824	1010	0.01 A	32 bits	-	-
	29h	H01-40	DC bus overvoltage protection threshold	-	0–2000	420	1 V	16 bits	-	-
2002h/H02 Basic control parameters										
2002	01h	H02-00	Control mode	0: Speed mode 1: Position mode 2: Torque mode 9: EtherCAT mode	0–9	9	1	16 bits	At stop	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2002	02h	H02-01	Absolute system selection	0: Incremental mode 1: Absolute position linear mode 2: Absolute position rotation mode 3: Absolute position linear mode, no encoder overflow alarm 4: Absolute position single-turn mode	0–4	0	1	16 bits	At stop	Next power-on
	03h	H02-02	Rotation direction	0: CCW direction as the forward direction 1: CW direction as the forward direction	0–1	0	1	16 bits	At stop	Next power-on
	08h	H02-07	Stop mode upon overtravel	0: Coast to stop, keeping de-energized state 1: Stop at zero speed, keeping position lock state 2: Stop at zero speed, keeping de-energized state 3: Ramp to stop as defined by 6085h/609Ah, keeping de-energized state 4: Ramp to stop as defined by 6085h/609Ah, keeping position lock state 5: DB stop, keeping de-energized state 6: DB stop, keeping DB state 7: Not responding to overtravel, displaying the alarm only	0–7	1	1	16 bits	At stop	Immedi-ately
	09h	H02-08	Stop mode at No. 1 fault	0: Coast to stop, keeping de-energized state 1: DB Stop, keeping de-energized state 2: DB Stop, keeping DB state	0–2	2	1	16 bits	At stop	Immedi-ately
	0Ah	H02-09	Delay from brake output ON to command received	-	0–500	250	1 ms	16 bits	During running	Immedi-ately
	0Bh	H02-10	Delay from brake output OFF to motor de-energized	-	50–1000	150	1 ms	16 bits	During running	Immedi-ately
	0Ch	H02-11	Motor speed threshold at brake output OFF in the rotation status	-	20–3000	30	1 RPM	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2002	0Dh	H02-12	Delay from S-ON OFF to brake output OFF in the rotation state	-	1–1000	500	1 ms	16 bits	During running	Immedi-ately
	10h	H02-15	Warning display on keypad	0: Output warning information immediately 1: Not output warning information	0–1	0	1	16 bits	During running	Immedi-ately
	11h	H02-16	Brake switch	0: Disable 1: Enable	0–1	1	1	16 bits	During running	Immedi-ately
	16h	H02-21	Permissible min. resistance of regenerative resistor	-	1–1000	40	1 Ω	16 bits	-	-
	17h	H02-22	Power of built-in regenerative resistor	-	0–65535	0	1 W	16 bits	-	-
	18h	H02-23	Resistance of built-in regenerative resistor	-	0–65535	0	1 Ω	16 bits	-	-
	19h	H02-24	Resistor heat dissipation coefficient	-	10–100	30	1%	16 bits	During running	Immedi-ately
	1Ah	H02-25	Regenerative resistor type	0: Built-in 1: External, naturally ventilated 2: External, forced air cooling 3: No regenerative resistor needed	0–3	3	1	16 bits	During running	Immedi-ately
	1Bh	H02-26	Power of external regenerative resistor	-	1–65535	40	1 kW	16 bits	During running	Immedi-ately
	1Ch	H02-27	Resistance of external regenerative resistor	-	1–1000	50	1 Ω	16 bits	During running	Immedi-ately
	1Fh	H02-30	User password	-	0–65535	0	1	16 bits	During running	Immedi-ately
	20h	H02-31	System parameter initialization	0: No operation 1: Restore default settings 2: Clear fault records	0–2	0	1	16 bits	At stop	Immedi-ately
	21h	H02-32	Group H0B parameter selection	-	0–99	50	1	16 bits	During running	Immedi-ately
	24h	H02-35	Keypad data refresh rate	-	0–20	0	1 Hz	16 bits	During running	Immedi-ately
	2Ah	H02-41	Factory password	-	0–65535	0	1	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2003h/H03 Terminal input parameters										
2003	03h	H03-02	DI1 function selection	0: No definition 1: S-ON 2: Fault reset 14: Positive limit switch 15: Negative limit switch 31: Home switch 34: Emergency stop 38: Touch probe 1 39: Touch probe 2	0–65535	14	1	16 bits	During running	Immedi-ately
	04h	H03-03	DI1 logic selection	0: Normally open 1: Normally closed	0–1	0	1	16 bits	During running	Immedi-ately
	05h	H03-04	DI2 function selection	0–39 See the description of H03-02 for details.	0–65535	15	1	16 bits	During running	Immedi-ately
	06h	H03-05	DI2 logic selection	0–1 See the description of H03-03 for details.	0–1	0	1	16 bits	During running	Immedi-ately
	07h	H03-06	DI3 function selection	0–39 See the description of H03-02 for details.	0–65535	31	1	16 bits	During running	Immedi-ately
	08h	H03-07	DI3 logic selection	0–1 See the description of H03-03 for details.	0–1	0	1	16 bits	During running	Immedi-ately
	09h	H03-08	DI4 function selection	0–39 See the description of H03-02 for details.	0–65535	39	1	16 bits	During running	Immedi-ately
	0Ah	H03-09	DI4 logic selection	0–1 See the description of H03-03 for details.	0–1	0	1	16 bits	During running	Immedi-ately
	0Bh	H03-10	DI5 function selection	0–39 See the description of H03-02 for details.	0–65535	38	1	16 bits	During running	Immedi-ately
	0Ch	H03-11	DI5 logic selection	0–1 See the description of H03-03 for details.	0–1	0	1	16 bits	During running	Immedi-ately
	3Dh	H03-60	DI1 filter time	-	0–50000	50	0.01 ms	16 bits	During running	Immedi-ately
	3Eh	H03-61	DI2 filter time	-	0–50000	50	0.01 ms	16 bits	During running	Immedi-ately
	3Fh	H03-62	DI3 filter time	-	0–50000	50	0.01 ms	16 bits	During running	Immedi-ately
	40h	H03-63	DI4 filter time	-	0–50000	50	0.01 ms	16 bits	During running	Immedi-ately
	41h	H03-64	DI5 filter time	-	0–50000	50	0.01 ms	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2004h/H04 Terminal Output Parameters										
2004	01h	H04-00	DO1 function selection	0: No definition 1: Servo ready 2: Motor rotating 9: Brake output 10: Warning 11: Fault 25: Comparison output 32: STO EDM	0–32	1	1	16 bits	During running	Immedi-ately
	02h	H04-01	DO1 logic selec-tion	0: Normally open 1: Normally closed	0–1	0	1	16 bits	During running	Immedi-ately
	03h	H04-02	DO2 function selection	0–32 See the description of H04-00 for details.	0–32	11	1	16 bits	During running	Immedi-ately
	04h	H04-03	DO2 logic selec-tion	0–1 See the description of H04-01 for details.	0–1	0	1	16 bits	During running	Immedi-ately
	05h	H04-04	DO3 function selection	0–32 See the description of H04-00 for details.	0–32	9	1	16 bits	During running	Immedi-ately
	06h	H04-05	DO3 logic selec-tion	0–1 See the description of H04-01 for details.	0–1	0	1	16 bits	During running	Immedi-ately
2005h/H05 Position control parameters										
2005	05h	H05-04	First-order low-pass filter time constant	-	0–65535	0	0.1 ms	16 bits	At stop	Immedi-ately
	06h	H05-05	Average filter time constant 1	-	0–1280	0	0.1 ms	16 bits	At stop	Immedi-ately
	07h	H05-06	Average filter time constant 2	-	0–1280	0	0.1 ms	16 bits	At stop	Immedi-ately
	14h	H05-19	Speed feedforward control selection	0: No speed feedforward 1: Internal speed feedforward 2: 60B1 as speed feedforward 3: Zero phase control	0–3	1	1	16 bits	At stop	Immedi-ately
	24h	H05-35	Duration limit of homing	-	0–65535	50000	0.1s	16 bits	During running	Immedi-ately
	33h	H05-50	Numerator of the mechanical gear ratio in absolute position rotation mode	-	1–65535	1	1	16 bits	At stop	Immedi-ately
	34h	H05-51	Denominator of mechanical gear ratio in absolute position rotation mode	-	1–65535	1	1	16 bits	At stop	Immedi-ately
	35h	H05-52	Pulses per revolution of the load in absolute position rotation mode (low 32 bits)	-	0–4294967295	0	1p	32 bits	At stop	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2005	37h	H05-54	Pulses per revolution of the load in absolute position rotation mode (high 32 bits)	-	0–4294967295	0	1p	32 bits	At stop	Immedi-ately
2006h/H06 Speed control parameters										
2006	04h	H06-03	Speed reference	-	-6000 to +6000	200	1 RPM	16 bits	During running	Immedi-ately
	06h	H06-05	Acceleration ramp time of speed reference	-	0–65535	0	1 RPM	16 bits	During running	Immedi-ately
	07h	H06-06	Deceleration ramp time of speed reference	-	0–65535	0	1 RPM	16 bits	During running	Immedi-ately
	09h	H06-08	Forward speed limit	-	0–6000	6000	1 RPM	16 bits	During running	Immedi-ately
	0Ah	H06-09	Reverse speed limit	-	0–6000	6000	1 RPM	16 bits	During running	Immedi-ately
	0Bh	H06-10	Deceleration unit under emergency stop	0: x 1 1: x 10 2: x 100	0–2	0	1	16 bits	At stop	Immedi-ately
	0Ch	H06-11	Torque feedforward control selection	0: No torque feedforward 1: Internal torque feedforward 2: 60B2 as external torque feedforward	0–2	1	1	16 bits	During running	Immedi-ately
	0Dh	H06-12	Jog speed acceleration ramp time	-	0–65535	10	1 ms	16 bits	During running	Immedi-ately
	0Eh	H06-13	Speed feedforward smoothing filter	-	0–2000	0	1	16 bits	During running	Immedi-ately
	11h	H06-16	Motor speed threshold	-	0–1000	20	1 RPM	16 bits	During running	Immedi-ately
	1Dh	H06-28	Spline torque compensation selection	0: Disable 1: Enable	0–1	1	1	16 bits	During running	Immedi-ately
2007h/H07 Torque control parameters										
2007	04h	H07-03	Torque reference value set through keypad	-	-3000 to +3000	0	0.1%	16 bits	During running	Immedi-ately
	06h	H07-05	Torque reference filter time constant 1	-	0–3000	79	0.01 ms	16 bits	During running	Immedi-ately
	07h	H07-06	Torque reference filter time constant 2	-	0–3000	79	0.01 ms	16 bits	During running	Immedi-ately
	0Ah	H07-09	Forward internal torque limit	-	0–3000	3000	0.1%	16 bits	During running	Immedi-ately
	0Bh	H07-10	Reverse internal torque limit	-	0–3000	3000	0.1%	16 bits	During running	Immedi-ately
	10h	H07-15	Emergency stop torque	-	0–3000	1000	0.1%	16 bits	During running	Immedi-ately
	12h	H08-17	Zero phase delay	-	0–40	0	1 ms	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2007	14h	H07-19	Forward internal speed limit in torque control	-	0–6000	3000	1 RPM	16 bits	During running	Immedi- ately
	15h	H07-20	Reverse internal speed limit in torque control	-	0–6000	3000	1 RPM	16 bits	During running	Immedi- ately
	16h	H07-21	Base value for torque arrival	-	0–3000	0	0.1%	16 bits	During running	Immedi- ately
	17h	H07-22	Torque output value when torque arrival DO signal turned on	-	0–3000	200	0.1%	16 bits	During running	Immedi- ately
	18h	H07-23	Torque output value when torque arrival DO signal turned off	-	0–3000	100	0.1%	16 bits	During running	Immedi- ately
	25h	H07-36	Time constant of low-pass filter 2	-	0–10000	0	0.01 ms	16 bits	During running	Immedi- ately
	26h	H07-37	Torque reference filter selection	0: First-order filter 1: Biquad filter	0–1	0	1	16 bits	During running	Immedi- ately
	27h	H07-38	Attenuation ratio of biquad filter	-	0–50	16	1	16 bits	At stop	Immedi- ately
2008h/H08 Gain parameters										
2008	01h	H08-00	Speed loop gain	-	1–20000	400	0.1	16 bits	During running	Immedi- ately
	02h	H08-01	Speed loop integral time constant	-	15–51200	1989	0.01 ms	16 bits	During running	Immedi- ately
	03h	H08-02	Position loop gain	-	1–20000	640	0.1 Hz	16 bits	During running	Immedi- ately
	04h	H08-03	2nd speed loop gain	-	1–20000	750	0.1 Hz	16 bits	During running	Immedi- ately
	05h	H08-04	2nd speed loop integral time constant	-	15–51200	1061	0.01 ms	16 bits	During running	Immedi- ately
	06h	H08-05	2nd position loop gain	-	1–20000	1200	0.1 Hz	16 bits	During running	Immedi- ately
	09h	H08-08	2nd gain mode setting	0: Fixed at the 1st gain, P/PI switchover through bit26 of 60FE 1: 1st/2nd gain switchover valid, with H08-09 as the switchover condition	0–1	1	1	16 bits	During running	Immedi- ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2008	0Ah	H08-09	Gain switchover condition	0: Fixed at 1st gain (PS) 1: Switchover through bit26 of 60FE 2: Torque reference too large (PS) 3: Speed reference too large (PS) 4: Speed reference change ratio too large (PS) 5: Speed reference high/low-speed threshold (PS) 6: Position deviation too large (P) 7: Position reference available (P) 8: Positioning unfinished (P) 9: Actual speed (P) 10: Position reference existed + Actual speed (P)	0–10	0	1	16 bits	During running	Immedi-ately
	0Bh	H08-10	Gain switchover delay	-	0–10000	50	0.1 ms	16 bits	During running	Immedi-ately
	0Ch	H08-11	Gain switchover level	-	0–20000	50	1	16 bits	During running	Immedi-ately
	0Dh	H08-12	Gain switchover hysteresis	-	0–20000	30	1	16 bits	During running	Immedi-ately
	0Eh	H08-13	Position gain switchover time	-	0–10000	30	0.1 ms	16 bits	During running	Immedi-ately
	10h	H08-15	Load inertia ratio	-	0–12000	100	0.01	16 bits	During running	Immedi-ately
	12h	H08-17	Zero phase delay	-	0–40	0	1 ms	16 bits	During running	Immedi-ately
	13h	H08-18	Speed feedforward filter time constant	-	0–6400	50	0.01 ms	16 bits	During running	Immedi-ately
	14h	H08-19	Speed feedforward gain	-	0–1000	0	0.1%	16 bits	During running	Immedi-ately
	15h	H08-20	Torque feedforward filter time constant	-	0–6400	50	0.01 ms	16 bits	During running	Immedi-ately
	16h	H08-21	Torque feedforward gain	-	0–3000	0	0.1%	16 bits	During running	Immedi-ately
	17h	H08-22	Speed feedback filter option	0: Average filter on speed feedback inhibited 1: 2 times of average filter on speed feedback 2: 4 times of average filter on speed feedback 3: 8 times of average filter on speed feedback 4: 16 times of average filter on speed feedback	0–4	0	1	16 bits	At stop	Immedi-ately
	18h	H08-23	Cutoff frequency of low-pass filter of speed feedback		100–4000	4000	1 Hz	16 bits	During running	Immedi-ately
	19h	H08-24	PDFF control coefficient		0–1000	1000	0.1%	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2008	1Ch	H08-27	Speed observer cutoff frequency	-	10–2000	170	1 Hz	16 bits	During running	Immedi-ately
	1Dh	H08-28	Speed observer inertia correction coefficient	-	10–10000	100	0.01%	16 bits	During running	Immedi-ately
	1Eh	H08-29	Speed observer filter time	-	2–2000	80	0.01 ms	16 bits	During running	Immedi-ately
	1Fh	H08-30	Disturbance compensation time	-	2–10000	20	0.01 ms	16 bits	During running	Immedi-ately
	20h	H08-31	Disturbance observation cutoff frequency	-	10–1700	600	1 Hz	16 bits	During running	Immedi-ately
	21h	H08-32	Disturbance compensation gain	-	0–100	0	1%	16 bits	During running	Immedi-ately
	22h	H08-33	Disturbance observer inertia correction coefficient	-	1–10000	100	0.01%	16 bits	During running	Immedi-ately
	29h	H08-40	Speed observer selection	0: Disabled 1: Enabled	0–1	0	1	16 bits	During running	Immedi-ately
	2Bh	H08-42	Model control selection	0: Disabled 1: Enabled	0–1	0	1	16 bits	During running	Immedi-ately
	2Ch	H08-43	Model gain	-	0–20000	400	0.1	16 bits	During running	Immedi-ately
	2Fh	H08-46	Feedforward value	-	0–1024	950	0.1	16 bits	During running	Immedi-ately
	36h	H08-53	Medium and low frequency jitter suppression frequency 3	-	0–300	0	0.1 Hz	16 bits	During running	Immedi-ately
	37h	H08-54	Medium- and low-frequency jitter suppression compensation 3	-	0–200	0	1%	16 bits	During running	Immedi-ately
	39h	H08-56	Medium- and low- frequency jitter suppression phase modulation 3	-	0–600	100	1%	16 bits	During running	Immedi-ately
	3Ch	H08-59	Medium- and low-frequency jitter suppression frequency 4	-	0–300	0	0.1 Hz	16 bits	During running	Immedi-ately
	3Dh	H08-60	Medium- and low-frequency jitter suppression compensate 4	-	0–200	0	1%	16 bits	During running	Immedi-ately
	3Eh	H08-61	Medium- and low- frequency jitter suppression phase modulation 4	-	0–600	100	1%	16 bits	During running	Immedi-ately
	3Fh	H08-62	Position loop integral time constant	-	15–51200	51200	0.01	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2008	40h	H08-63	2nd position loop integral time constant	-	15–51200	51200	0.01	16 bits	During running	Immedi-ately
	41h	H08-64	Speed observation feedback source	0: Disable 1: Enable	0–1	0	1	16 bits	During running	Immedi-ately
2009h/H09 Gain auto-tuning parameters										
2009	01h	H09-00	Gain auto-tuning mode	0: Invalid, gain parameters adjusted manually 1: Standard gain auto-tuning mode 2: Positioning mode 3: Interpolation mode + Inertia auto-tuning 4: Normal mode + Inertia auto-tuning 6: Quick positioning mode + Inertia auto-tuning	0–7	0	1	16 bits	During running	Immedi-ately
	02h	H09-01	Stiffness level selection	-	0–41	15	1	16 bits	During running	Immedi-ately
	03h	H09-02	Adaptive notch mode selection	0: Adaptive notch no longer updated 1: One adaptive notch activated (3rd notch) 2: Two adaptive notches activated (3rd and 4th notches) 3: Resonance point tested only, displayed in H09-24 4: Adaptive notch cleared, values of the 3rd and 4th notches restored to default settings	0–4	0	1	16 bits	During running	Immedi-ately
	04h	H09-03	Online inertia auto-tuning mode	0: Online auto-tuning turned off 1: Online auto-tuning turned on, changing slowly 2: Online auto-tuning turned on, changing normally 3: Online auto-tuning turned on, changing quickly	0–3	0	1	16 bits	During running	Immedi-ately
	06h	H09-05	Offline inertia auto-tuning mode	0: Bidirectional 1: Unidirectional	0–1	0	1	16 bits	At stop	Immedi-ately
	07h	H09-06	Maximum speed of inertia auto-tuning	-	100–1000	500	1 RPM	16 bits	At stop	Immedi-ately
	08h	H09-07	Time constant for accelerating to the maximum speed during inertia auto-tuning	-	20–800	125	1 ms	16 bits	At stop	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2009	09h	H09-08	Inertia auto-tuning interval	-	50–10000	800	1 ms	16 bits	At stop	Immedi-ately
	0Ah	H09-09	Number of motor revolutions per inertia auto-tuning	-	0–65535	0	0.01	16 bits	-	-
	0Ch	H09-11	Vibration threshold		0–1000	0	0.1%	16 bits	During running	Immedi-ately
	0Dh	H09-12	1st notch frequency	-	50–4000	4000	1 Hz	16 bits	During running	Immedi-ately
	0Eh	H09-13	Width level of the 1st notch	-	0–20	2	1	16 bits	During running	Immedi-ately
	0Fh	H09-14	Depth level of the 1st notch	-	0–99	0	1	16 bits	During running	Immedi-ately
	10h	H09-15	2nd notch frequency	-	50–4000	4000	1 Hz	16 bits	During running	Immedi-ately
	11h	H09-16	Width level of the 2nd notch	-	0–20	2	1	16 bits	During running	Immedi-ately
	12h	H09-17	Depth level of the 2nd notch	-	0–99	0	1	16 bits	During running	Immedi-ately
	13h	H09-18	3rd notch frequency	-	50–4000	4000	1 Hz	16 bits	During running	Immedi-ately
	14h	H09-19	Width level of the 3rd notch	-	0–20	2	1	16 bits	During running	Immedi-ately
	15h	H09-20	Depth level of the 3rd notch	-	0–99	0	1	16 bits	During running	Immedi-ately
	16h	H09-21	4th notch frequency	-	50–4000	4000	1 Hz	16 bits	During running	Immedi-ately
	17h	H09-22	Width level of the 4th notch	-	0–20	2	1	16 bits	During running	Immedi-ately
	18h	H09-23	Depth level of the 4th notch	-	0–99	0	1	16 bits	During running	Immedi-ately
	19h	H09-24	Auto-tuned resonance frequency	-	0–2000	0	1 Hz	16 bits	-	-
	21h	H09-32	Gravity compensation	-	-1000 to +1000	0	0.1%	16 bits	During running	Immedi-ately
	22h	H09-33	Forward friction compensation	-	-1000 to +1000	0	0.1%	16 bits	During running	Immedi-ately
	23h	H09-34	Reverse friction compensation	-	-1000 to +1000	0	0.1%	16 bits	During running	Immedi-ately
	24h	H09-35	Friction compensation speed	-	10–300	20	0.1	16 bits	During running	Immedi-ately
	25h	H09-36	Friction compensation speed selection	0x00: Slow mode + Speed reference 0x01: Slow mode + Model speed 0x02: Slow mode + Speed feedback 0x10: Quick mode + Speed reference 0x11: Quick mode + Model speed 0x12: Quick mode + Speed feedback	0–0x12	0	1	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
2009	26h	H09-37	Vibration monitoring time	-	0–65535	1200	1	16	During running	Immedi-ately
	27h	H09-38	Low-frequency resonance suppression frequency 1 at the mechanical end	-	1–1000	1000	0.1 Hz	16 bits	During running	Immedi-ately
	28h	H09-39	Low-frequency resonance suppression 1 at the mechanical end	-	0–3	2	1	16 bits	At stop	Immedi-ately
	2Ah	H09-41	5th notch frequency	-	50–8000	5000	1 Hz	16 bits	During running	Immedi-ately
	2Bh	H09-42	Width level of the 5th notch	-	0–20	2	1	16 bits	At stop	Immedi-ately
	2Ch	H09-43	Depth level of the 5th notch	-	0–99	0	1	16 bits	At stop	Immedi-ately
	2Dh	H09-44	Low-frequency resonance suppression frequency 2 at the mechanical end	-	0–2000	0	0.01	16 bits	During running	Immedi-ately
	2Eh	H09-45	Low-frequency resonance suppression response 2 at the mechanical end	-	1–1000	100	0.01	16 bits	During running	Immedi-ately
	30h	H09-47	Low-frequency resonance suppression width 2 at the mechanical end	-	0–200	100	0.01	16 bits	During running	Immedi-ately
	32h	H09-49	Low-frequency resonance suppression frequency 3 at the mechanical end	-	0–2000	0	0.01	16 bits	During running	Immedi-ately
	33h	H09-50	Low-frequency resonance suppression response 3 at the mechanical end	-	1–1000	100	0.01	16 bits	During running	Immedi-ately
	35h	H09-52	Low-frequency resonance suppression width 3 at the mechanical end	-	0–200	100	0.01	16 bits	During running	Immedi-ately
200Ah/H0A Fault and Protection Parameters										
200A	01h	H0A-00	Power input phase loss protection	0: Enable 1: Hide Note: In common-bus connection mode, set 200A-01h to 1. Otherwise, the servo drive cannot enter "rdy" state after power-on.	0–1	0	1	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200A	02h	H0A-01	Absolute position limit selection	0: Disable 1: Enable 2: Enabled after homing	0–2	0	1	16 bits	At stop	Immedi-ately
	05h	H0A-04	Motor overload protection gain	-	50–300	100	1	16 bits	At stop	Immedi-ately
	09h	H0A-08	Overspeed threshold	-	0–10000	0	1 RPM	16 bits	During running	Immedi-ately
	0Dh	H0A-12	Runaway protection	0: Disable 1: Enable	0–1	1	1	16 bits	During running	Immedi-ately
	13h	H0A-18	IGBT over-temperature threshold	-	100–175	120	1°C	16 bits	During running	Immedi-ately
	14h	H0A-19	Probe 1 filter time constant	-	0–630	200	0.01 μs	16 bits	During running	Immedi-ately
	15h	H0A-20	Probe 2 filter time constant	-	0–630	200	0.01 μs	16 bits	During running	Immedi-ately
	18h	H0A-23	TZ signal filter time	-	0–31	15	125 ns	16 bits	At stop	Next pow-er-on
	1Ah	H0A-25	Filter time constant of speed feedback display value	-	0–5000	50	1 ms	16 bits	At stop	Immedi-ately
	1Bh	H0A-26	Motor overload selection	0: Not hide motor overload warning 1: Hide motor overload warning (E909.0) and fault (E620.0)	0–1	0	1	16 bits	At stop	Immedi-ately
	1Ch	H0A-27	Speed DO filter time constant	-	0–5000	50	1 ms	16 bits	During running	Immedi-ately
	21h	H0A-32	Time threshold for locked rotor over-temperature protection	-	10–65535	200	1 ms	16 bits	During running	Immedi-ately
	22h	H0A-33	Locked rotor over-temperature protection	0: Hide 1: Enable	0–1	1	1	16 bits	During running	Immedi-ately
	25h	H0A-36	Encoder multi-turn overflow fault	0: Not hide 1: Hide	0–1	0	1	16 bits	During running	Immedi-ately
	29h	H0A-40	Overtravel compensation switch	0: Compensation activated 1: Compensation inhibited	0–1	0	1	16 bits	At stop	Immedi-ately
	32h	H0A-49	Regenerative resistor over-temperature threshold	-	100–175	115	1°C	16 bits	During running	Immedi-ately
	33h	H0A-50	Encoder communication fault tolerance threshold	-	0–31	3	1	16 bits	During running	Immedi-ately
	34h	H0A-51	Phase loss detection filter times	-	3–36	20	55 ms	16 bits	During running	Immedi-ately
	35h	H0A-52	Encoder over-temperature threshold	-	0–150	0	1°C	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200A	38h	H0A-55	Runaway current threshold	-	1000–4000	2000	0.1%	16 bits	During running	Immedi-ately
	3Ah	H0A-57	Runaway speed threshold	-	1–1000	50	1 RPM	16 bits	During running	Immedi-ately
	3Bh	H0A-58	Runaway speed filter time	-	1–1000	20	0.1 ms	16 bits	During running	Next pow-er-on
	3Ch	H0A-59	Runaway protection detection time	-	10–1000	30	1 ms	16 bits	During running	Immedi-ately
200Bh/H0B Monitoring parameters										
200B	01h	H0B-00	Speed feedback	-	-32767 to +32767	0	1 RPM	16 bits	-	-
	02h	H0B-01	Speed reference	-	-32767 to +32767	0	1 RPM	16 bits	-	-
	03h	H0B-02	Internal torque reference	-	-3000 to +3000	0	0.1%	16 bits	-	-
	04h	H0B-03	Monitored DI status	-	0–0x00FFFFFF	0	1	32 bits	-	-
	06h	H0B-05	Monitored DO status	-	0–0xFFFF	0	1	16 bits	-	-
	08h	H0B-07	Absolute position counter	-	-2147483648 to +2147483647	0	1p	32 bits	-	-
	0Ah	H0B-09	Mechanical angle	-	0–3600	0	0.1°	16 bits	-	-
	0Bh	H0B-10	Electrical angle	-	0–3600	0	0.1°	16 bits	-	-
	0Dh	H0B-12	Average load ratio	-	0–65535	0	0.1%	16 bits	-	-
	10h	H0B-15	Position following deviation (encoder unit)	-	-2147483648 to +2147483647	0	1p	32 bits	-	-
	12h	H0B-17	Feedback pulse counter	-	-2147483648 to +2147483647	0	1p	32 bits	-	-
	14h	H0B-19	Accumulative power-on time	-	0–4294967295	0	0.1s	32 bits	-	-
	19h	H0B-24	RMS value of phase current	-	0–65535	0	0.01 A	32 bits	-	-
	1Bh	H0B-26	Bus voltage	-	0–65535	0	0.1 V	16 bits	-	-
	1Ch	H0B-27	Power module temperature	-	0–65535	0	1°C	16 bits	-	-
	1Dh	H0B-28	Absolute encoder fault information given by FPGA	-	0–0xFFFF	0	1	16 bits	-	-
	1Eh	H0B-29	Axis status information given by FPGA	-	0–0xFFFF	0	1	16 bits	-	-
	1Fh	H0B-30	Axis fault information given by FPGA	-	0–0xFFFF	0	1	16 bits	-	-
	20h	H0B-31	Encoder fault information	-	0–0xFFFF	0	1	16 bits	-	-
	22h	H0B-33	Fault log	-	0–9	0	1	16 bits	During running	Immedi-ately
	23h	H0B-34	Fault code of the selected fault record	-	0–0xFFFF	0	1	16 bits	-	-

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200B	24h	H0B-35	Time stamp upon occurrence of the selected fault	-	0–4294967295	0	0.1s	32 bits	-	-
	26h	H0B-37	Motor speed upon occurrence of the selected fault	-	-9999 to +9999	0	1 RPM	16 bits	-	-
	27h	H0B-38	Motor phase U current upon occurrence of the selected fault	-	-32768 to +32767	0	0.01 A	16 bits	-	-
	28h	H0B-39	Motor phase V current upon occurrence of the selected fault	-	-32768 to +32767	0	0.01 A	16 bits	-	-
	29h	H0B-40	Bus voltage upon occurrence of the selected fault	-	0–65535	0	0.1 V	16 bits	-	-
	2Ah	H0B-41	Input terminal state upon occurrence of the selected fault	-	0–0x00FFFFFF	0	1	32 bits	-	-
	2Ch	H0B-43	Output terminal state upon occurrence of the selected fault	-	0–0xFFFF	0	1	16 bits	-	-
	2Eh	H0B-45	Internal fault code	-	0–0xFFFF	0	1	16 bits	-	-
	2Fh	H0B-46	Absolute encoder fault information given by FPGA upon occurrence of the selected fault	-	0–0xFFFF	0	1	16 bits	-	-
	30h	H0B-47	System state information given by FPGA upon occurrence of the selected fault	-	0–0xFFFF	0	1	16 bits	-	-
	31h	H0B-48	System fault information given by FPGA upon occurrence of the selected fault	-	0–0xFFFF	0	1	16 bits	-	-
	32h	H0B-49	Encoder fault information upon occurrence of the selected fault	-	0–0xFFFF	0	1	16 bits	-	-
	34h	H0B-51	Internal fault code upon occurrence of the selected fault	-	0–0xFFFF	0	1	16 bits	-	-
	36h	H0B-53	Position following deviation (reference unit)	-	-2147483648 to +2147483647	0	1p	32 bits	-	-
	38h	H0B-55	Actual motor speed	-	-60000 to +60000	0	0.1 RPM	32 bits	-	-
	3Ah	H0B-57	Bus voltage of control circuit	-	0–65535	0	0.1 V	16 bits	-	-
	3Bh	H0B-58	Mechanical absolute position (low 32 bits)	-	0–4294967295	0	1p	32 bits	-	-

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200B	3Dh	H0B-60	Mechanical absolute position (high 32 bits)	-	-2147483648 to +2147483647	0	1p	32 bits	-	-
	40h	H0B-63	NotRdy status	0: None 1: Abnormal control power 2: Abnormal phase loss detection 3: Abnormal main circuit power detection	0–4	0	1	16 bits	-	-
	43h	H0B-66	Encoder temperature	-	-100 to +200	0	1°C	16 bits	-	-
	44h	H0B-67	Regenerative resistor load ratio	-	0–2000	0	0.1%	16 bits	-	-
	47h	H0B-70	Number of absolute encoder revolutions	-	0–65535	0	1	16 bits	-	-
	48h	H0B-71	Position of the absolute encoder within one turn	-	0–2147483647	0	1p	32 bits	-	-
	4Eh	H0B-77	Encoder position (low 32 bits)	-	0–4294967295	0	1p	32 bits	-	-
	50h	H0B-79	Encoder position (high 32 bits)	-	-2147483648 to +2147483647	0	1p	32 bits	-	-
	52h	H0B-81	Single-turn position of the rotating load (low 32 bits)	-	0–4294967295	0	1p	32 bits	-	-
	54h	H0B-83	Single-turn position of the rotating load (high 32 bits)	-	-2147483648 to +2147483647	0	1p	32 bits	-	-
	56h	H0B-85	Single-turn position of the rotating load (reference unit)	-	-2147483648 to +2147483647	0	1p	32 bits	-	-
	5Bh	H0B-90	Group No. of the abnormal parameter	-	0–0xFFFF	0	1	16 bits	-	-
	5Ch	H0B-91	Offset within the group of the abnormal parameter	-	0–65535	0	1	16 bits	-	-
200Dh/H0D Auxiliary function parameters										
200D	01h	H0D-00	Software reset	0: No operation 1: Enable	0–1	0	1	16 bits	At stop	Immediately
	02h	H0D-01	Fault reset	0: No operation 1: Enable	0–1	0	1	16 bits	At stop	Immediately
	04h	H0D-03	Encoder initial angle auto-tuning	0: No operation 1: Enable	0–1	0	1	16 bits	At stop	Immediately
	05h	H0D-04	Encoder ROM read/write	0: No operation 1: Write ROM 2: Read ROM	0–2	0	1	16 bits	At stop	Immediately
	06h	H0D-05	Emergency stop	0: No operation 1: Emergency stop	0–1	0	1	16 bits	During running	Immediately
	0Ch	H0D-12	UV phase current balance correction	0: Disable 1: Enable	0–1	0	1	16 bits	During running	Immediately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200D	12h	H0D-17	Forced DI/DO selection switch	0: No operation 1: Forced DI enabled, forced DO disabled 2: Forced DI disabled, forced DO enabled 3: Forced DI and DO enabled 4: EtherCAT forced DO enabled	0–4	0	1	16 bits	During running	Immedi-ately
	13h	H0D-18	Forced DI setting value	-	0x00–0x1F	0	1	16 bits	During running	Immedi-ately
	14h	H0D-19	Forced DO setting value	-	0x00–0x07	0	1	16 bits	During running	Immedi-ately
	15h	H0D-20	Absolute encoder reset selection	0: No operation 1: Reset the encoder fault 2: Reset the encoder fault and multi-turn data	0–2	0	1	16 bits	At stop	Immedi-ately
200Eh/H0E Auxiliary function parameters										
200E	01h	H0E-00	Node address	-	0–127	1	1	16 bits	During running	Immedi-ately
	02h	H0E-01	Save objects written through communication to EEPROM	0: Not save parameters and object dictionaries written through communication to EEPROM 1: Save parameters written through communication to EEPROM 2: Save object dictio-naries written through communication to EEPROM 3: Save parameters and object dictionaries written through communication to EEPROM	0–3	3	1	16 bits	During running	Immedi-ately
	15h	H0E-20	EtherCAT slave name	-	0–65535	0	1	16 bits	-	-
	16h	H0E-21	EtherCAT slave alias	-	0–65535	0	1	16 bits	At stop	Immedi-ately
	17h	H0E-22	Number of synchronization interrupts allowed by EtherCAT	-	1–20	9	1	16 bits	During running	Immedi-ately
	19h	H0E-24	Synchronization loss count	-	0–65535	0	1	16 bits	-	-
	1Ah	H0E-25	Maximum value of invalid frames and errors of EtherCAT port 0 per unit time	-	0–0xFFFF	0	1	16 bits	-	-

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200E	1Bh	H0E-26	Maximum value of invalid frames and errors of EtherCAT port 1 per unit time	-	0–0xFFFF	0	1	16 bits	-	-
	1Ch	H0E-27	Maximum value of transfer errors of EtherCAT port per unit time	-	0–0xFFFF	0	1	16 bits	-	-
	1Dh	H0E-28	Maximum value of EtherCAT data frame processing unit errors per unit time	-	0–0x0255	0	1	16 bits	-	-
	1Eh	H0E-29	Maximum value of link loss of EtherCAT port 0 per unit time	-	0–0xFFFF	0	1	16 bits	-	-
	20h	H0E-31	EtherCAT synchronization mode setting	-	0–2	1	1	16 bits	At stop	Next power-on
	21h	H0E-32	EtherCAT synchronization error threshold	-	100–4000	3000	1 μs	16 bits	At stop	Immedi-ately
	22h	H0E-33	Connection state between EtherCAT state machine and the port	-	0–65535	0	1	16 bits	-	-
	23h	H0E-34	Excessive CSP position reference increment count	-	0–7	1	1	16 bits	During running	Immedi-ately
	25h	H0E-36	EtherCAT AL enhanced link selection	0: Disable 1: Enable	0–1	0	1	16 bits	During running	Next power-on
	26h	H0E-37	EtherCAT reset XML selection	0: Disable 1: Enable	0–1	0	1	16 bits	During running	Next power-on
	51h	H0E-80	Modbus baud rate	0: 300 bps 1: 600 bps 2: 1200 bps 3: 2400 bps 4: 4800 bps 5: 9600 bps 6: 19200 bps 7: 38400 bps 8: 57600 bps 9: 115200 bps	0–9	9	1	16 bits	During running	Immedi-ately
	52h	H0E-81	Modbus data format	0: No parity, 2 stop bits (8-N-2) 1: Even parity, 1 stop bit (8-E-1) 2: Odd parity, 1 stop bit (8-O-1) 3: No parity, 1 stop bit (8-N-1)	0–3	3	1	16 bits	During running	Immedi-ately
	53h	H0E-82	Modbus response delay	-	0–20	0	1 ms	16 bits	During running	Immedi-ately

Parameter Group			Name	Option Description	Value Range	Default	Min. unit	Width	Setting Condition	Effective Time
Hexadecimal		Decimal								
Group	Index Code	Para. No.								
200E	54h	H0E-83	Modbus communication timeout	-	0–600	0	1 ms	16 bits	During running	Immediately
	5Bh	H0E-90	Modbus version No.	-	0–65535	0	0.01	16 bits	-	-
	5Eh	H0E-93	EtherCAT CoE version No.	-	0–65535	0	0.01	16 bits	-	-
	61h	H0E-96	XML version No.	-	0–65535	0	0.01	16 bits	-	-

Object Group 6000h

The object group 6000h contains objects supported and related to sub-protocol DSP 402.

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default	Setting Condition	Effective Time
603F	00	Error code	RO	TPDO	UINT16	-	-	-	-	-
6040	00	Control word	RW	RPDO	UINT16	-	0–0xFFFF	0	During running	Immediately
6041	00	Status word	RO	TPDO	UINT16	-	-	-	-	-
605A	00	Quick stop option code	RW	NO	INT16	-	0–0x07	0x02	During running	At stop
605C	00	Disable operation option code	RW	NO	INT16	-	0xFFFD–0x01	0	During running	At stop
605D	00	Stop option code	RW	NO	INT16	-	0x01–0x03	0x01	During running	At stop
605E	00	Fault reaction option code	RW	NO	INT16	-	0xFFFB–0x03	0x02	During running	At stop
6060	00	Modes of operation	RW	RPDO	INT8	-	0–0x0A	0	During running	Immediately
6061	00	Modes of operation display	RO	TPDO	INT8	-	-	-	-	-
6062	00	Position demand value	RO	TPDO	INT32	Reference unit	-	-	-	-
6063	00	Position actual value	RO	TPDO	INT32	Encoder unit	-	-	-	-
6064	00	Position actual value	RO	TPDO	INT32	Reference unit	-	-	-	-
6065	00	Following error window	RW	RPDO	UINT32	Reference unit	0–0xFFFFFFFF	0x00300000	During running	Immediately
6066	00	Following error time out	RW	RPDO	UINT32	ms	0–0xFFFF	0	During running	Immediately
6067	00	Position window	RW	RPDO	UINT32	Reference unit	0–0xFFFFFFFF	0x000002DE	During running	Immediately
6068	00	Position window time	RW	RPDO	UINT16	ms	0–0xFFFF	0	During running	Immediately
606C	00	Velocity actual value	RO	TPDO	INT32	Reference unit/s	-	-	-	-
606D	00	Velocity window	RW	RPDO	UINT16	RPM	0–0xFFFF	0x0A	During running	Immediately

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default	Setting Condition	Effective Time
606E	00	Velocity window time	RW	RPDO	UINT16	ms	0–0xFFFF	0	During running	Immediately
606F	00	Velocity threshold	RW	RPDO	UINT16	RPM	0–0xFFFF	0x0A	During running	Immediately
6070	00	Velocity threshold time	RW	RPDO	UINT16	ms	0–0xFFFF	0	During running	Immediately
6071	00	Target torque	RW	RPDO	INT16	0.1%	0xF448–0x0BB8	0	During running	Immediately
6072	00	Max torque	RW	RPDO	UINT16	0.1%	0–0x0BB8	0x0BB8	During running	Immediately
6074	00	Torque demand value	RO	TPDO	INT16	0.1%	-	0	-	-
6077	00	Torque actual value	RO	TPDO	INT16	0.1%	-	0	-	-
607A	00	Target position	RW	RPDO	INT32	Reference unit	0x80000000–0x7FFFFFFF	0	During running	Immediately
607C	00	Home offset	RW	RPDO	INT32	Reference unit	0x80000000–0x7FFFFFFF	0	During running	Immediately
607D	Software absolute position limit									
	00	Highest sub-index supported	RO	NO	UINT8	-	-	0x02	-	-
	01	Min position limit	RW	RPDO	INT32	Reference unit	0x80000000–0x7FFFFFFF	0x80000000	During running	Immediately
	02	Max position limit	RW	RPDO	INT32	Reference unit	0x80000000–0x7FFFFFFF	0x7FFFFFFF	During running	Immediately
607E	00	Polarity	RW	RPDO	UINT8	-	0–0xFF	0	During running	Immediately
607F	00	Max profile velocity	RW	RPDO	UINT32	Reference unit/s	0–0xFFFFFFFF	0x06400000	During running	Immediately
6081	00	Profile velocity	RW	RPDO	UINT32	User speed unit	0–0xFFFFFFFF	0x001AAAAB	During running	Immediately
6083	00	Profile acceleration	RW	RPDO	UINT32	Reference unit/s^2	0–0xFFFFFFFF	0x0A6AAAAA	During running	Immediately
6084	00	Profile deceleration	RW	RPDO	UINT32	Reference unit/s^2	0–0xFFFFFFFF	0x0A6AAAAA	During running	Immediately
6085	00	Quick stop deceleration	RW	RPDO	UINT32	User acceleration unit	0–0xFFFFFFFF	0x7FFFFFFF	During running	Immediately
6086	00	Motion profile type	RW	RPDO	INT16	-	0x8000–0x7FFF	0	During running	Immediately
6087	00	Torque slope	RW	RPDO	UINT32	0.1%/s	0–0xFFFFFFFF	0xFFFFFFFF	During running	Immediately
6091	Gear ratio									
	00	Highest sub-index supported	RO	NO	UINT8	Uint8	-	0x02	-	-
	01	Motor revolutions	RW	RPDO	UINT32	-	0–0xFFFFFFFF	1	During running	Immediately
	02	Shaft revolutions	RW	RPDO	UINT32	-	1–0xFFFFFFFF	1	During running	Immediately
6098	00	Homing method	RW	RPDO	INT8	-	-2 to 35	0x01	During running	Immediately

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default	Setting Condition	Effective Time
6099	Homing speed									
	00	Highest sub-index supported	RO	NO	UINT8	-	-	0x02	-	-
	01	Speed during search for switch	RW	RPDO	UINT32	Reference unit/s	0–0xFFFFFFFF	0x001AAAAB	During running	Immediately
	02	Speed during search for zero	RW	RPDO	UINT32	Reference unit/s	0–0xFFFFFFFF	0x0002AAAB	During running	Immediately
609A	00	Homing acceleration	RW	RPDO	UINT32	Reference unit/s^2	0–0xFFFFFFFF	0x0A6AAAAA	During running	Immediately
60B0h	00	Position offset	RW	RPDO	INT32	Reference unit	0x80000000–0x7FFFFFFF	0	During running	Immediately
60B1h	00	Velocity offset	RW	RPDO	INT32	Reference unit/s	0x80000000–0x7FFFFFFF	0	During running	Immediately
60B2h	00	Torque offset	RW	RPDO	INT16	0.1%	0xF448–0x0BB8	0	During running	Immediately
60B8h	00	Touch probe function	RW	RPDO	UINT16	-	0–0xFFFF	0	During running	Immediately
60B9h	00	Touch probe status	RW	TPDO	UINT16	-	-	0	-	-
60BAh	00	Touch probe 1 positive edge	RW	TPDO	INT32	Reference unit	-	0	-	-
60BBh	00	Touch probe 1 negative edge	RW	TPDO	INT32	Reference unit	-	0	-	-
60BCh	00	Touch probe 2 positive edge	RW	TPDO	INT32	Reference unit	-	0	-	-
60BDh	00	Touch probe 1 negative edge	RW	TPDO	INT32	Reference unit	-	0	-	-
60C5h	0	Max acceleration	RW	RPDO	UINT32	User acceleration unit	0–0xFFFFFFFF	0xFFFFFFFF	During running	Immediately
60C6h	0	Max deceleration	RW	RPDO	UINT32	User acceleration unit	0–0xFFFFFFFF	0xFFFFFFFF	During running	Immediately
60D5h	0x00	Touch probe 1 positive edge counter	RO	TPDO	UINT16	-	-	0	-	-
60D6h	0x00	Touch probe 1 negative edge counter	RO	TPDO	UINT16	-	-	0	-	-
60D7h	0x00	Touch probe 2 positive edge counter	RO	TPDO	UINT16	-	-	0	-	-
60D8h	0x00	Touch probe 2 negative edge counter	RO	TPDO	UINT16	-	-	0	-	-
60E0h	00	Positive torque limit value	RW	RPDO	UINT16	0.1%	0–0x0BB8	0x0BB8	-	Immediately
60E1h	00	Negative torque limit value	RW	RPDO	UINT16	0.1%	0–0x0BB8	0x0BB8	-	Immediately

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default	Setting Condition	Effective Time
60E3h		Supported Homing Methods								
	00	Highest sub-index supported	RO	NO	UINT8	-	-	0x1F	-	-
	01	1st supported homing method	RO	NO	UINT16	-	-	0x0301	-	-
	02	2nd supported homing method	RO	NO	UINT16	-	-	0x0302	-	-
	03	3rd supported homing method	RO	NO	UINT16	-	-	0x0303	-	-
	04	4th supported homing method	RO	NO	UINT16	-	-	0x0304	-	-
	05	5th supported homing method	RO	NO	UINT16	-	-	0x0305	-	-
	06	6th supported homing method	RO	NO	UINT16	-	-	0x0306	-	-
	07	7th supported homing method	RO	NO	UINT16	-	-	0x0307	-	-
	08	8th supported homing method	RO	NO	UINT16	-	-	0x0308	-	-
	09	9th supported homing method	RO	NO	UINT16	-	-	0x0309	-	-
	0A	10th supported homing method	RO	NO	UINT16	-	-	0x030A	-	-
	0B	11th supported homing method	RO	NO	UINT16	-	-	0x030B	-	-
	0C	12th supported homing method	RO	NO	UINT16	-	-	0x030C	-	-
	0D	13th supported homing method	RO	NO	UINT16	-	-	0x030D	-	-
	0E	14th supported homing method	RO	NO	UINT16	-	-	0x030E	-	-
	0F	15th supported homing method	RO	NO	UINT16	-	-	0x030Fh	-	-
	10	16th supported homing method	RO	NO	UINT16	-	-	0x0310	-	-
	11	17th supported homing method	RO	NO	UINT16	-	-	0x0311	-	-
	12	18th supported homing method	RO	NO	UINT16	-	-	0x0312	-	-
	13	19th supported homing method	RO	NO	UINT16	-	-	0x0313	-	-
	14	20th supported homing method	RO	NO	UINT16	-	-	0x0314	-	-
	15	21th supported homing method	RO	NO	UINT16	-	-	0x0315	-	-
	16	22th supported homing method	RO	NO	UINT16	-	-	0x0316	-	-
	17	23th supported homing method	RO	NO	UINT16	-	-	0x0317	-	-
	18	24th supported homing method	RO	NO	UINT16	-	-	0x0318	-	-

Index (hex)	Sub-index (hex)	Name	Accessibility	PDO Mapping	Data Type	Unit	Data Range	Default	Setting Condition	Effective Time
60E3h	19	25th supported homing method	RO	NO	UINT16	-	-	0x0319	-	-
	1A	26th supported homing method	RO	NO	UINT16	-	-	0x031A	-	-
	1B	27th supported homing method	RO	NO	UINT16	-	-	0x031B	-	-
	1C	28th supported homing method	RO	NO	UINT16	-	-	0x031C	-	-
	1D	29th supported homing method	RO	NO	UINT16	-	-	0x031D	-	-
	1E	30th supported homing method	RO	NO	UINT16	-	-	0x031E	-	-
	1F	31th supported homing method	RO	NO	UINT16	-	-	0x031F	-	-
60E6h	00	Additional position encoder resolution – encoder increments	RW	NO	UINT16	-	0–1	0	During running	Immedi-ately
60F4h	00	Following error actual value	RO	TPDO	INT32	Reference unit	-	-	-	-
60FCh	00	Position demand internal value	RO	TPDO	INT32	Encoder unit	-	-	-	-
60FDh	00	Digital inputs	RO	TPDO	UINT32	-	-	-	-	-
60FEh	Digital output									
	00	Highest sub-index supported	RO	NO	UINT8	-	-	0x02	-	-
	01	Physical outputs	RW	RPDO	UINT32	-	0–0xFFFFFFFF	0	During running	Immedi-ately
	02	Bit mask	RW	NO	UINT32	-	0–0xFFFFFFFF	0	During running	Immedi-ately
60FFh	00	Target velocity	RW	RPDO	INT32	Reference unit/s	0x80000000–0x7FFFFFFF	0	During running	Immedi-ately
6502h	00	Supported drive modes	RO	NO	UINT32	-	-	0x000003AD	-	-

SDO Abort Transfer Code

Abort Code	Function Description
0503 0000	Trigger bits are not alternated.
0504 0000	Timeout occurs in the SDO protocol.
0504 0001	The client/server command word is invalid or unknown.
0504 0005	Memory overflow occurs.
0601 0000	Access to objects is not supported.
0601 0001	Attempt to read a write-only object
0601 0002	Attempt to write a read-only object
0602 0000	The object does not exist in the object dictionary.
0604 0041	The object cannot be mapped to the PDO.
0604 0042	The number and length of mapped objects exceed the PDO length.

Abort Code	Function Description
0604 0043	General parameters are incompatible.
0604 0047	General device content is incompatible.
0606 0000	Accessing objects fails due to an hardware error.
0607 0010	The data type does not match and the service parameter length does not match.
0607 0012	The data type does not match and the service parameter is too long.
0607 0013	The data type does not match and the service parameter is too short.
0609 0011	The sub-index does not exist.
0609 0030	The value exceeds the parameter value range.
0609 0031	The parameter value entered is too large.
0609 0032	The parameter value entered is too small.
0609 0036	The maximum value is smaller than the minimum value.
0800 0000	General error
0800 0020	Data cannot be transmitted or stored to the application.
0800 0021	Data cannot be transmitted or stored to the application due to local control.
0800 0022	Data cannot be transmitted or stored to the application due to current device status.
0800 0023	An error occurs in the object dictionary or the object dictionary does not exist.
0800 0024	The value does not exist.

11.3 Safety Protection Function: STO

11.3.1 Description of Technical Terms

■ Terms and abbreviations:

Terms/Abbreviations	Description
Cat.	Classification of the safety-related parts of a control system. The categories are: B,1,2,3,4 (EN 13849-1).
CCF	Common cause failure
DC	Diagnostic coverage (%)
DTI	Diagnostic test interval time
SFF	Safe failure fraction
HFT	Hardware fault tolerance
PFH	Average frequency of dangerous failures per hour
PL	Performance level
SC	Systematic capability
SIL	Safety integrity level
T1	Proof test interval
T2	Diagnostic test interval
DI	Digital input
DO	Digital output
PCB	Printed circuit board
MCU	Micro computer unit
FPGA	Center processor unit

■ Description of technical terms:

Terms	Description
Safe Torque Off (STO)	The STO function brings the machine safely into a no-torque state and prevents it from unexpected starting. If the motor is running when STO function is activated, it coasts to a stop.
Safe state	Used to disable the PWM gating signal of the drive.
System reset	Reset the servo system by shutting off the power or executing software reset.
Proof test	Used to detect the failure of the safety-related system, not applied to STO circuits.
Mission time	Refers to the specified cumulative operating time of the safety-related parts of the servo drive during its overall lifetime.

Overview of the safety drive with safety function is shown in Fig 11-1. The parts marked in the orange dashed line is the safety-related. They are integrated in the control board of the drive.

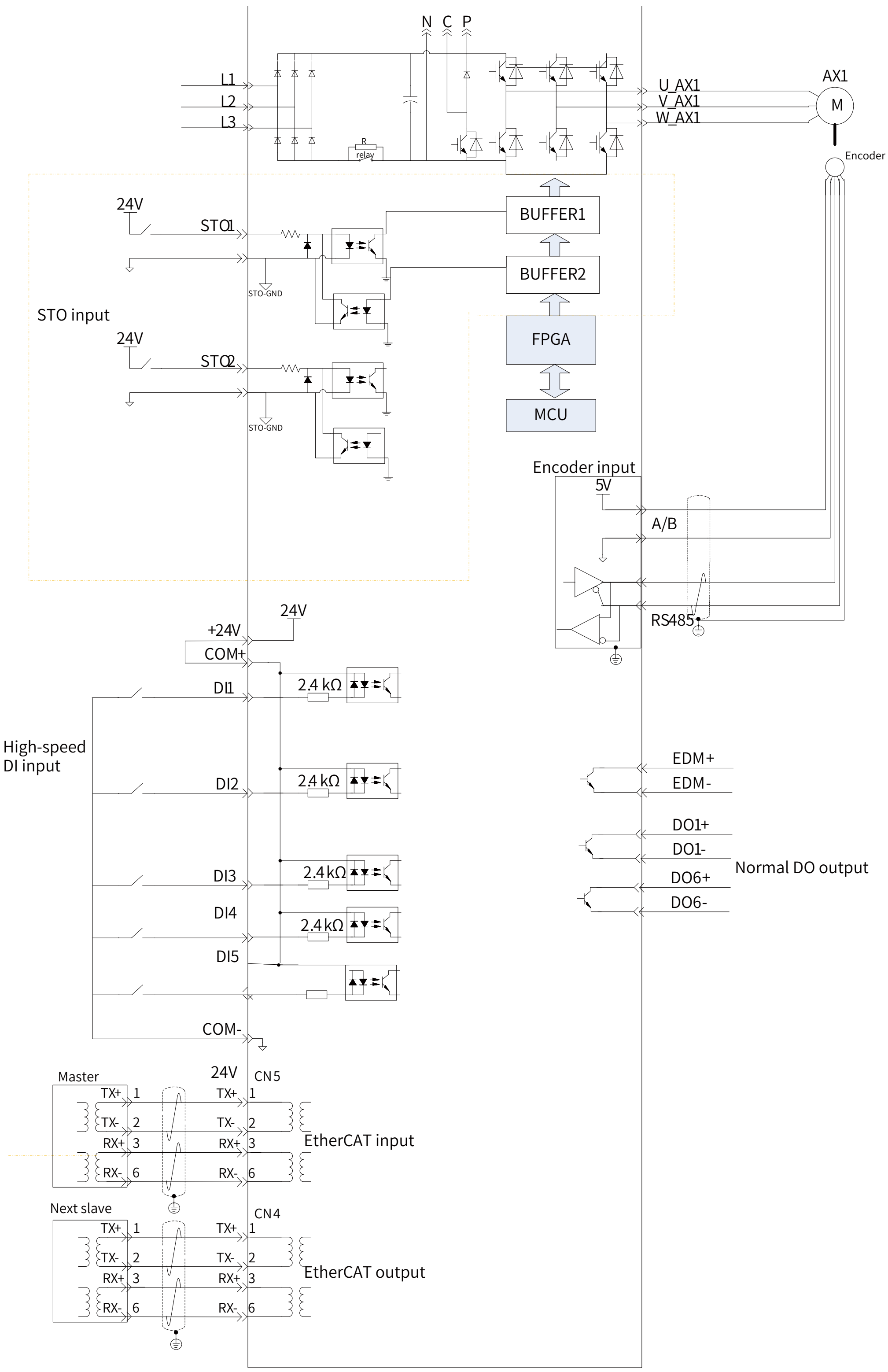


Figure 11-11 Overview of the safety drive

11.3.2 Standards Compliance

■ North American Standards (UL)

UL 61800-5-1

CSA C22.2 No. 274

■ European Directives

Low Voltage Directive 2014/35/EU EN 61800-5-1 and IEC 61800-5-1

Electromagnetic Compatibility Directive 2014/30/EU EN 61800-3, IEC 61800-3, and IEC 61800-5-2

Machinery Directive 2006/42/EC (functional safety)

■ Safety Standards

Model	Safety Standards	Standards
SV660NXXX	Safety of machinery	ISO 13849-1: 2015 IEC 60204-1: 2016
	Functional Safety	IEC 61508: 2010, parts 1-7 IEC 62061: 2015 IEC 61800-5-2: 2016
	Electromagnetic Compatibility (EMC)	IEC 61326-3-1 IEC 61800-3 IEC 61800-5-2

■ Safety Performance

Items	Standards	Performance level
Safety integrity level	IEC 61508	SIL3
	IEC 62061	SILCL3
Probability of Dangerous Failure per Hour (PFH)	IEC 61508 IEC 62061	PFH ≤ 0.1 x 10^{-7} [1/h] (10% of SIL3)
Performance level (PL)	ISO 13849-1	PL e (category 3)
Mean time to dangerous failure of each channel	ISO 13849-1	MTTFd: High
Ave. diagnostic coverage	ISO 13849-1	DCave: Medium
Stop category	IEC 60204-1	Stop category 0
Safety function	IEC 61800-5-2	STO
Mission time	IEC 61508	5 years
Hardware fault tolerance (HFT)	IEC 61508	1
Systematic capability (SC)	IEC 61508	3
Application mode	IEC 61508	High demand or continuous mode

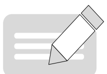
11.3.3 General Safety Information

This section contains the warning symbols used in this user guide and the safety instructions which you must obey when you install, use or maintenance a safety option module of a servo drive. If you ignore the safety instructions, injury, death or damage may occur. Read this section 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 user guide is applicable.

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

■ Warnings, Cautions and Notes

Pictogram	Signal word	Meaning	Consequences In Case of Disregard
Example:  General danger  Specific danger (such as 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
 NOTE	NOTE	A Note containing information or tip which helps ensure correct operation of the product	-

 WARNING	
	◆ 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.

11.3.4 Specifications

- Electrical safety complies with IEC 618:00-5-1:2016, over voltage category II.
- The environment test requirement complies with IEC 618:00 -5-1:2016.
- The operating conditions are as follows.

<table>
<tr><th>Items</th><th>Description</th></tr>
<tr><td>Surrounding air/Storage temperature</td><td>0°C to 55°C /-20°C to +70°C</td></tr>
<tr><td>Ambient/Storage humidity</td><td>20%–95% RH (without condensation)</td></tr>
<tr><td>Vibration</td><td>
<table>
<tr><th>Subject</th><th>Test conditions</th></tr>
<tr><td>Test reference</td><td>Test Fc of IEC 60068-2-6 4.6</td></tr>
<tr><td>Conditions</td><td>The EUT is powered up and operating normally.</td></tr>
<tr><td>Motion</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>Vibration duration</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>Subject</th><th>Test conditions</th></tr>
<tr><td>Test reference</td><td>Test Ea of IEC 60068-2-27: 2008 Table 17</td></tr>
<tr><td>Conditions</td><td>The EUT is powered up and operating normally.</td></tr>
<tr><td>Motion</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>
<tr><td>IP rating/Pollution degree (PD)</td><td>IP 20
PD 2: free of corrosive or explosive gases; free of exposure to water, oil or chemicals; free of dust, salts or iron dust</td></tr>
<tr><td>Altitude</td><td>2000 m or below</td></tr>
<tr><td>Cooling method</td><td>Dry clean air (natural convection)</td></tr>
<tr><td>Others</td><td>Free of static electricity, strong electromagnetic fields, magnetic fields or exposure to radioactivity</td></tr>
</table>

- The servo drive follows the EMC standards IEC 61800-3:2017, IEC 61326-3-1, and IEC 61800-5-2.

■ Others

Items	Description
Applicable Servo Drive	SV660NS1R6I-FS SV660NS2R8I-FS SV660NS5R5I-FS SV660NS6R6I-FS SV660NS7R6I-FS SV660NS012I-FS SV660NT3R5I-FS SV660NT5R4I-FS SV660NT8R4I-FS SV660NT012I-FS SV660NT017I-FS SV660NT021I-FS SV660NT026I-FS
Placement	Integrated in the control board of the servo drive
Safety function - Inputs	2 channels: STO1/STO2

The STO subsystem elements must always ~~be likely to~~ operate within the range of temperature, humidity, corrosion, dust, vibration, and other items specified above.

11.3.5 Installation

Since the STO function is integrated in the control board of the servo drive, its installation requirements are consistent with the servo drive. Observe the installation requirements of the servo drive.

Designers and installers must be trained to understand the requirements and principles of designing and installing safety-related systems.

11.3.6 Terminal and Wiring

This section describes the definition and function of the I/O connecting terminal (CN6) for STO.

See details in *"3.7 Definition and Connection of STO terminal"*

11.3.7 Requirement for Commission, Operation and Maintenance

1 General

- Technicians must be trained to understand the requirements and principles of designing and commissioning safety-related systems.
- Those performing the maintenance must be trained to understand the requirements and principles of designing and operating safety-related systems.
- Operators must be trained to understand the requirements and principles of designing and operating safety-related systems.
- If the safety-related circuits on the control board fails to operate, replace it with a new one because it is not repairable.

2 Commissioning checklists

■ Start-up test and validation

IEC 61508, EN IEC 62061 and EN ISO 13849 require that the final assembler of the machine validates the operation of the safety function with an acceptance test. The acceptance tests for the standard safety functions of the drive are described in the drive manuals. The tests for the optional safety functions are described in the appropriate option manuals.

The acceptance test must be performed:

1) at initial start-up of the safety function

2) after any changes related to the safety function (including wiring, components, and settings)

3) after any maintenance work related to the safety function.

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

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

■ Start-up checklist

Step	Action	Result
1	Ensure that the servo drive can run and stop freely during the commissioning.	
2	Stop the servo drive (if running), switch the input power off and isolate the drive from the power line by a disconnector.	
3	Check the STO circuit connections against the circuit diagram.	
4	Check that the shield of the STO input cable is grounded to the drive frame.	
5	Close the disconnector and switch the power on.	
5.1	Test the STO signal #1 when the motor is stopped. Set STO1 and STO2 to "H". Give a stop command for the drive (if running) and wait until the motor shaft is at standstill. Awake the STO function by disconnecting (low state or open-circuit) the STO input signal #1 and give a start command for the drive. Ensure that the motor stays at standstill and the LED display of the servo drive displays "E150.1".	
5.2	Set STO1 to "H", disable the ON/RUN command of the drive, then automatically reset the drive, enable ON/RUN command of the drive and check that the motor runs normally.	
5.3	Test the STO signal #2 when the motor is stopped. Set STO1 and STO2 to "H". Give a stop command for the drive (if running) and wait until the motor shaft is at standstill. Awake the STO function by disconnecting (low state or open-circuit) the STO input signal #2 and give a start command for the drive. Ensure that the motor stays at standstill and the LED display of the servo drive displays "E150.1".	
5.4	Set STO2 to "H", disable the ON/RUN command of the drive, then automatically reset the drive, enable ON/RUN command of the drive and check that the motor runs normally.	

Step	Action	Result
6.1	Test the STO channel #1 when the motor is running. Set STO1 and STO2 to "H". Start the drive and ensure the motor is running. Awake the STO function by disconnecting (low state or open-circuit) the STO input signal #1. Ensure that the motor stops and the drive trips. Reset the fault and try to start the drive. Ensure that the motor stays at standstill and the LED display of the servo drive displays "E150.1".	
6.2	Set STO1 to "H", disable the ON/RUN command of the drive, then automatically reset the drive, enable ON/RUN command of the drive and check that the motor runs normally.	
6.3	Test the STO channel #2 when the motor is running. Set STO1 and STO2 to "H". Start the drive and ensure the motor is running. Awake the STO function by disconnecting (low state or open-circuit) the STO input signal #2. Ensure that the motor stops and the drive trips. Reset the fault and try to start the drive. Ensure that the motor stays at standstill and the LED display of the servo drive displays "E150.1".	
6.4	Set STO2 to "H", disable the ON/RUN command of the drive, then automatically reset the drive, enable ON/RUN command of the drive and check that the motor runs normally.	
7	Document and sign the acceptance test report which verifies that the safety function is safe and accepted to operation.	

3 Special requirements

To fulfill SIL 3 PL e (cat3), power off the servo drive once per 3 months to perform the power-on diagnostic.

11.3.8 Safety Function: STO

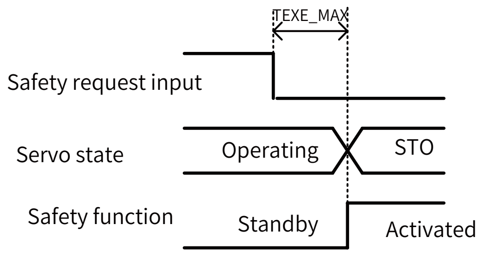
1 Description of safety function

Safe Torque Off (STO) is a safety function that complies with IEC 61800-5-2:2016. It is built into Inovance SV660N series servo drives.

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

The STO function prevents the movement of the motor by two redundant external hardware signals: STO1 and STO2 that block the PWM signals to be transmitted to the power layer of the drive. These two +24VDC signals must be active to enable the drive’s normal operations.

If either one or both signals are set low, the PWM signals are blocked within a time of 20 ms.



■ The STO function table is as follows.

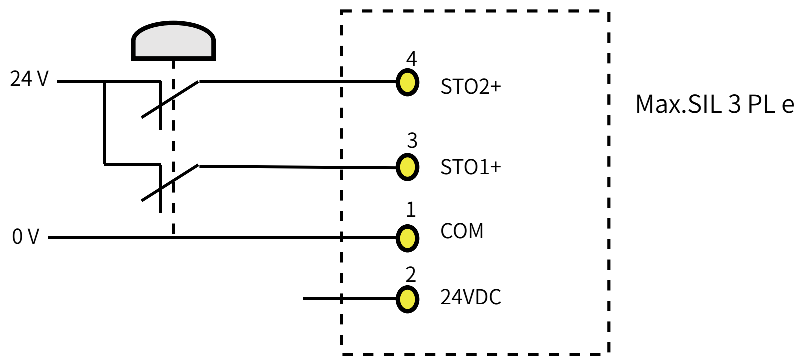
STO1 Input	STO2 Input	PWM Signal
H	H	Normal
L	H	Inhibited
H	L	Inhibited
L	L	Inhibited

STO (Safe Torque Off)	
Definition	Cuts off the force-producing power to the motor.
Description	The STO function brings the machine safely into a no-torque state and prevents it from unexpected starting. If the motor is running when STO function is activated, it coasts to a stop.
Safe state	Used to disable the PWM gating signal of the drive.
Operating mode	High demand mode or continuous mode

2 Application example of safety function

■ Example 1: Direct Stop, stop category 0, safety stop: STO

Emergency pushbutton (double contacts) Category 3 IEC13849



3 Monitoring of safety function

The LED display of the servo drive displays the selected mode, the status, and the error information of the servo drive.

Error: Displays drive fault code.

You can select and modify the configuration through the keypad. See *"4 Keypad Display and Operations"* for the definition of the keypad.

■ Fault codes related to the STO function are shown below.

Fault code	Status	Description
E150.0	STO activated by external request	Both of STO1/STO2 in "Low" state
E150.1	Status of STO1/STO2 not consistent	Only one of STO1/STO2 in "Low" state, status of STO1/STO2 inconsistent
E150.2	STO activated by diagnosis	OV/UV of 5 V power supply detected
E150.3	STO activated by diagnosis	Input circuits of STO working abnormally
E150.4	STO activated by diagnosis	Buffer circuits of STO working abnormally

4 STO status during exceptional operations

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

1) The PWM buffer is disabled through pulling-up of the enable terminal during power-on, so the PWM signal is prohibited.

2) The PWM buffer is disabled through pulling-up of the enable terminal during initialization of MCU, so the PWM signal is prohibited. This condition is relieved once the initialization phase is finished and servo drive works normally.

3) When servo system enters safe state through the STO function, the safe state can be cleared to return to normal operation after auto-reset of the drive when all of the following conditions are met:

■ The input state of the STO request must be "high".

■ The S-ON or RUN command must be inactive.

■ No dangerous faults exist.

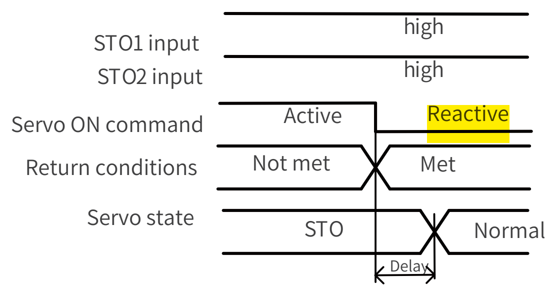


Figure 11-12 Return condition of S-ON/RUN command

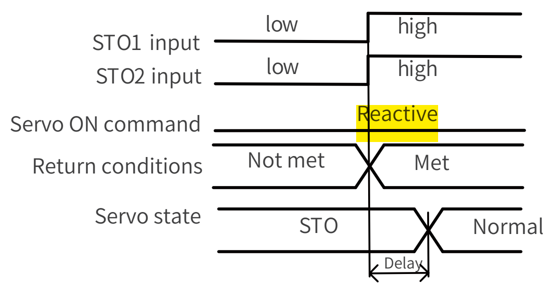


Figure 11-13 Return condition of external STO request state

11.3.9 Trouble Shooting

See the following table to identify the fault cause and the action to be taken. Contact your Inovance representative if the problem cannot be solved by the described corrective actions. Fault codes related to the STO function are shown below.

Fault Code	Cause	Action
E150.0	STO1/STO2 not connected to the 24 V input voltage	Connect the STO1 and STO2 to the 24 V input voltage signal.
E150.1	Input states of STO1/STO2 being inconsistent	1) Ensure the requests for disconnecting the voltage of STO1 and STO2 are triggered simultaneously. 2) The input circuit is abnormal and a certain STO input signal is still in "High" status after the 24 V signal is disconnected.
E150.2	OV/UV of 5 V power supply detected	Restore the 5 V power supply to normal state.
E150.3	Input circuit of STO working abnormally	Fix the input circuit fault.
E150.4	Buffer circuit of STO working abnormally	Fix the buffer circuit fault.

11.3.10 Product Information

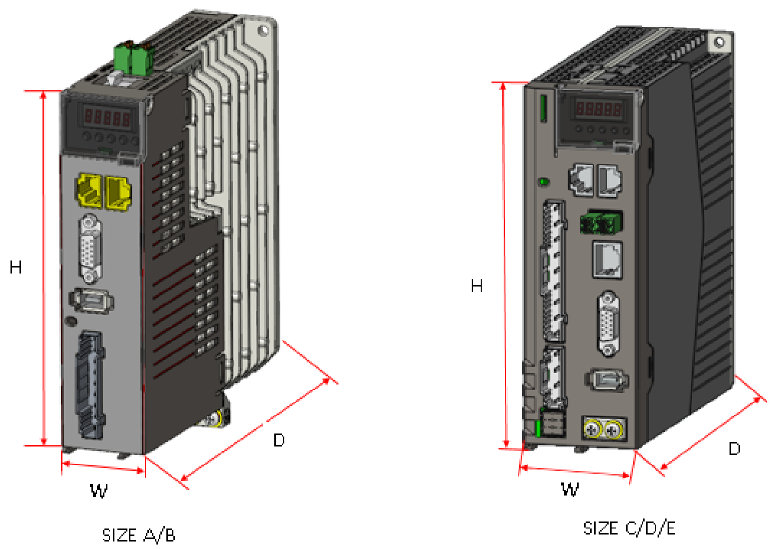
1 Nameplate and model number

See "1.1.1 Nameplate and Model Number" for details.

2 Applicable servo drive

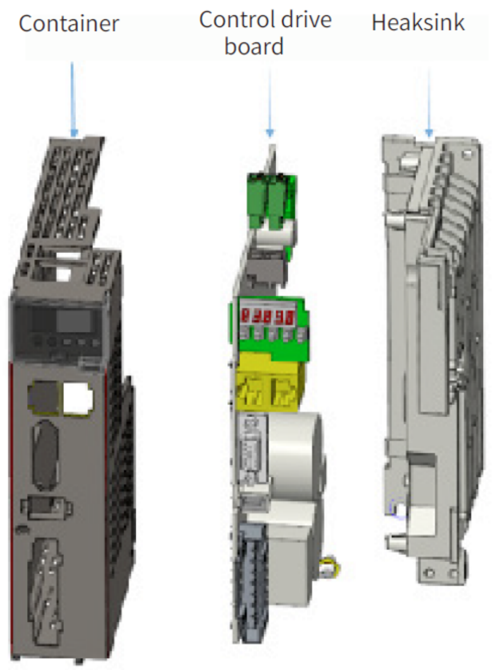
STO applies to the servo drives in the following two kinds of physical structures.

Size	Power Range	Physical Structure	W x H x D (mm^3)
A	200 W to 400 W	Integrated structure	40 x 160 x 150
B	750 W to 850 W	Integrated structure	50 x 160 x 173
C	1 kW to 1.5 kW	Separated structure	55 x 170 x 173
D	1.8 kW to 3 kW	Separated structure	75 x 170 x 183
E	5 kW to 7.5 kW	Separated structure	90 x 250 x 230



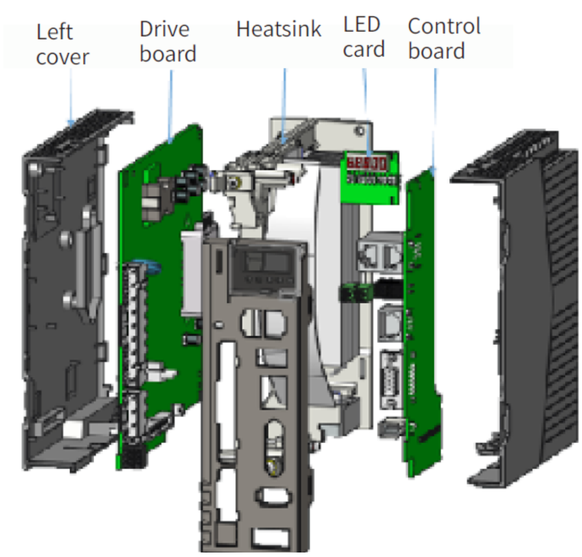
NOTE

Integrated structure means that the control parts and power parts are on the same PCB.



NOTE

Separated structure means that the control parts and power parts are on different PCBs.



11.3.11 Precautions

This section describes the information needed before starting operation. Be sure to read the following safety instructions, risk assessment information, and limitations before starting operation. Safety function: use the STO function after properly understanding all ~~of~~ these information.

1 Safety protective measures

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

- The STO function is not intended as a replacement for an Emergency Stop function (E-stop). In an emergency situation, the power supply cannot be cut off if no other measure is taken, and the electrical parts of the motor and drive are still energized, incurring the risk of electric shock or other risks. Therefore, maintenance work on electrical parts of the drive or motor can only be carried out after isolating the drive system from the main power 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, not for 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 quick stop through other means such as dynamic or regenerative braking.

NOTE

In the use of permanent-magnet motors, reluctance motors, and salient-pole induction motors, in spite of the activation of the STO function, a possible (although highly unlikely) failure mode may cause two power devices in the drive to conduct incorrectly. The drive system can produce an alignment torque which maximally rotates the motor shaft by 180° electrical angle for a permanent-magnet motor, or by 90° electrical angle for a salient pole induction motor or reluctance motor. This possible failure mode must be allowed for in the machine system design.

WARNING

$$\text{Max. rotating angle of the motor shaft} = \frac{360^{\circ}\ \text{electrical angle}}{\text{Motor poles number}}$$

WARNING

- The design of safety-related systems requires specialist knowledge. To ensure that a complete control system is safe, the whole system needs 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 the safety of the complete system.
- The STO function can be used for stopping the servo drive in emergency stop situations.
- In normal operating mode, it is recommended not to stop the servo drive by using the STO function. If a drive running is stopped by using STO, the drive perform a coast to stop. If this is not acceptable, the system must be stopped using the correct mode instead of the STO function.
- This publication is a guide to the application of Inovance STO function, 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.

2 Risk assessment

- When using the safety function STO, be sure to perform risk assessment of 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. Use a separate mechanical brake to secure the motor.
- If the servo drive fails, the motor may operate within a range of 180 electrical degrees. Make sure that safety is ensured even in hazardous situations.
- The number of rotations and movement distance for each type of motor are listed below.

Rotational motor: 1/6 rotation max. (rotation angle at motor shaft conversion)

Direct drive motor: 1/20 rotation max. (rotation angle at motor shaft conversion)

Linear servo motor: 30 mm max.

Shenzhen Inovance Technology Co., Ltd.
Add.: Building E, Hongwei Industry Park, Liuxian Road, Baocheng No. 70 Zone, Bao' an District, Shenzhen
Tel: +86-755-2979 9595
Fax: +86-755-2961 9897
Service Hotline: 400-777-1260
http: //www.inovance.com

Suzhou Inovance Technology Co., Ltd.
Add.: No. 16 Youxiang Road, Yuexi Town, Wuzhong District, Suzhou 215104, P.R. China
Tel: +86-512-6637 6666
Fax: +86-512-6285 6720
Service Hotline: 400-777-1260
http: //www.inovance.com

19011236A00